

Gully erosion

Gully erosion is a more advanced stage of rill erosion in which the incisions are 1 ft deep or more (Figure 2.54). It occurs most often in areas with long, steep slopes. Gullies that have not been armored or stabilized pose a threat to the Trail as they may eventually intercept and damage it.

Streambank and lakeshore erosion

Streambank erosion is found along all major creeks that enter the Lake. This is a result of the creeks' urban setting and the powerful force of Central Tex-

as downpours. Waller Creek exhibits the greatest amount of streambank erosion. Plans are currently underway to address Waller's erosion issues. Recent restoration work at Shoal Creek has mitigated some of the bank erosion. Minor lakeshore erosion is taking place in many places along Lady Bird Lake, particularly in areas where giant reed has been treated, as shown in Figure 2.55.

Decomposed Granite Deposition

A tremendous volume of decomposed granite is leaving the Trail and entering the natural areas or the Lake itself (Figure 2.56). This material can bury

the native herbaceous plants and soil, making the soil more susceptible to future erosion and lowering the quality of the natural area. Examples of deposition occur throughout the study area, but are most evident where the Trail is close to the Lake on the north shore near Austin High, at Festival Beach, just east of Congress Avenue on the south shore, and at the water access points between Barton Creek and the Lamar Bridge. Some of the steep slopes on the northern edge of Zilker Park are also being impacted by this process.

Figure 2.54: Gully erosion is a more advanced stage of rill erosion.



Figure 2.55: Bank erosion often occurs where giant reed has been removed, such as this area near Longhorn Dam.



Figure 2.56: Decomposed granite is sloughing off the Trail directly into the Lake.





Natural Area Management Guidelines

The natural area management guidelines recommended in this chapter stem from the great value placed by the community on vibrant, aesthetically pleasing, ecologically functional natural areas around the Butler Trail and Lady Bird Lake. The guidelines build on work started many decades ago to enhance the tree canopy and riparian areas around the Lake. Because of the study area's urban location and history of human impact, carefully planned, ongoing actions such as the ones outlined here will be necessary to maintain this community resource for future generations. In addition to ecological health, the immense draw of recreation within the study area was a core consideration in the creation of the guidelines. The guidelines look to enhance the user experience in all aspects of the project through aesthetic appeal and a more functional trail system.

The guidelines are organized within a process-oriented framework that seeks to initiate natural recovery and self-repair of damaged or diminished areas with realistic management objectives. When these techniques are applied in a steady, incremental, and adaptive manner, the outcomes will include:

- **Restored and enhanced plant communities:** native trees, understory, and groundcover create diverse and aesthetically appealing plant communities that provide rich wildlife habitat.
- **Repaired and improved ecological function:** landscape can better absorb and clean water, regenerate native flora, filter air, create and stabilize soil, reduce urban temperatures, and provide shade.
- **Enhanced resiliency:** landscape is better able to adapt to and withstand drought, heavy use, climate change, and other major disturbances.
- **Enhanced user experience:** the site provides aesthetically pleasing, compelling, comfortable, and intricate natural surroundings.
- **Improved stewardship:** catalyze opportunities to appreciate, observe, and care for the natural environment as an ongoing part of people's lives.

ADAPTIVE MANAGEMENT AND PROCESS APPROACH

The recommendations here are based on best practices established by the City, The Trail Foundation, Siglo Group, and other entities. They are the most appropriate, efficient, and effective treatments known for current and expected conditions. It is imperative to remember that the urban forest and

natural areas of Lady Bird Lake are dynamic, ever-changing landscapes that will respond differently at different times to the same treatment. In addition, land management practices often take multiple steps over many years, and conditions may change midcourse. All information here should therefore be viewed through an adaptive management lens. Adaptive management is a process that allows land management practitioners to adjust methods according to existing conditions, previous successes, and unforeseen challenges. This approach is imperative in the face of potential climate change and prolonged drought.

To facilitate the implementation of the project, the study area has been divided into 16 management units based on current use, topography, needed management tasks, and plant communities as seen in figure 3.2. In the following chapter, the guidelines described below are applied to each management unit to create specific, implementable tasks that work towards the overall goals of these guidelines over a four year period.

INTEGRATING MANAGEMENT WITH THE USER EXPERIENCE

As described earlier, the urban forest and natural areas around Lady Bird Lake house the highest-use trail in Central Texas, with over 1.5 million visits

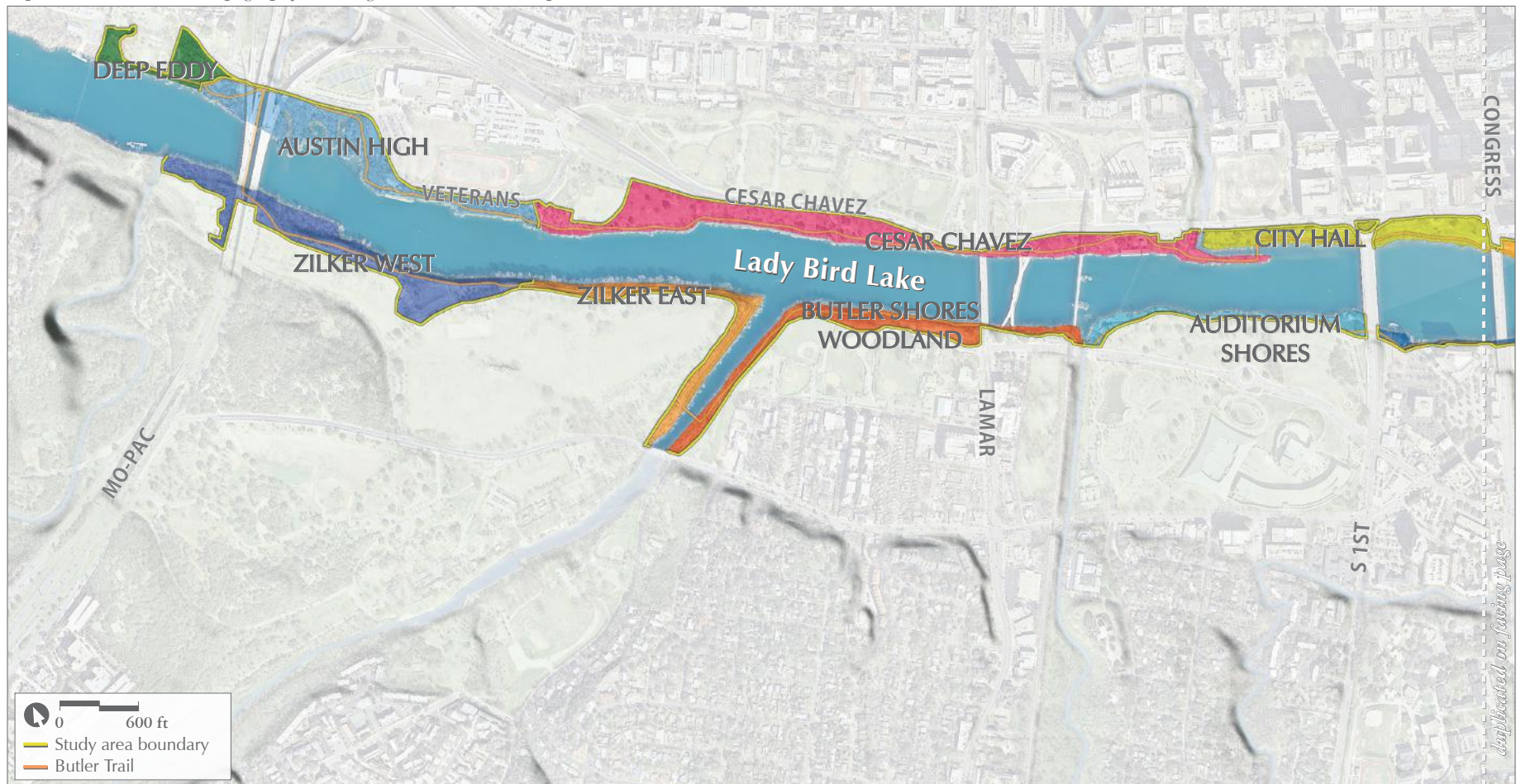
Figure 3.1: Trail bridge over Shoal Creek, the site of recent restoration work.

per year (COA 2003). The natural areas management guidelines recognize the importance of the user experience and recommend ways to enhance that experience by increasing shade, reducing erosion hazards, creating more stable trails, increasing forest and tree health, enabling interaction with the flora and fauna of Central Texas, framing views, and enhancing aesthetic appeal.

Heavy use in recent decades, coupled with increased knowledge of erosion and compaction impacts, has created the need for some of the infrastructure to be altered or relocated. The proposed changes would reduce trampling, erosion, and compaction, allow for greater woodland areas at the shoreline, create more interesting and sustainable trail alignments, and formalize water access points to make it easier

for users to enjoy the water's edge without causing damage. The integration of the user experience with natural area management is emphasized throughout this document.

Figure 3.2: The study area of the Urban Forest and Natural Area Management Guidelines for Lady Bird Lake & the Butler Trail is split up into Management Units to facilitate implementation based on topography, existing use, and restoration potential.



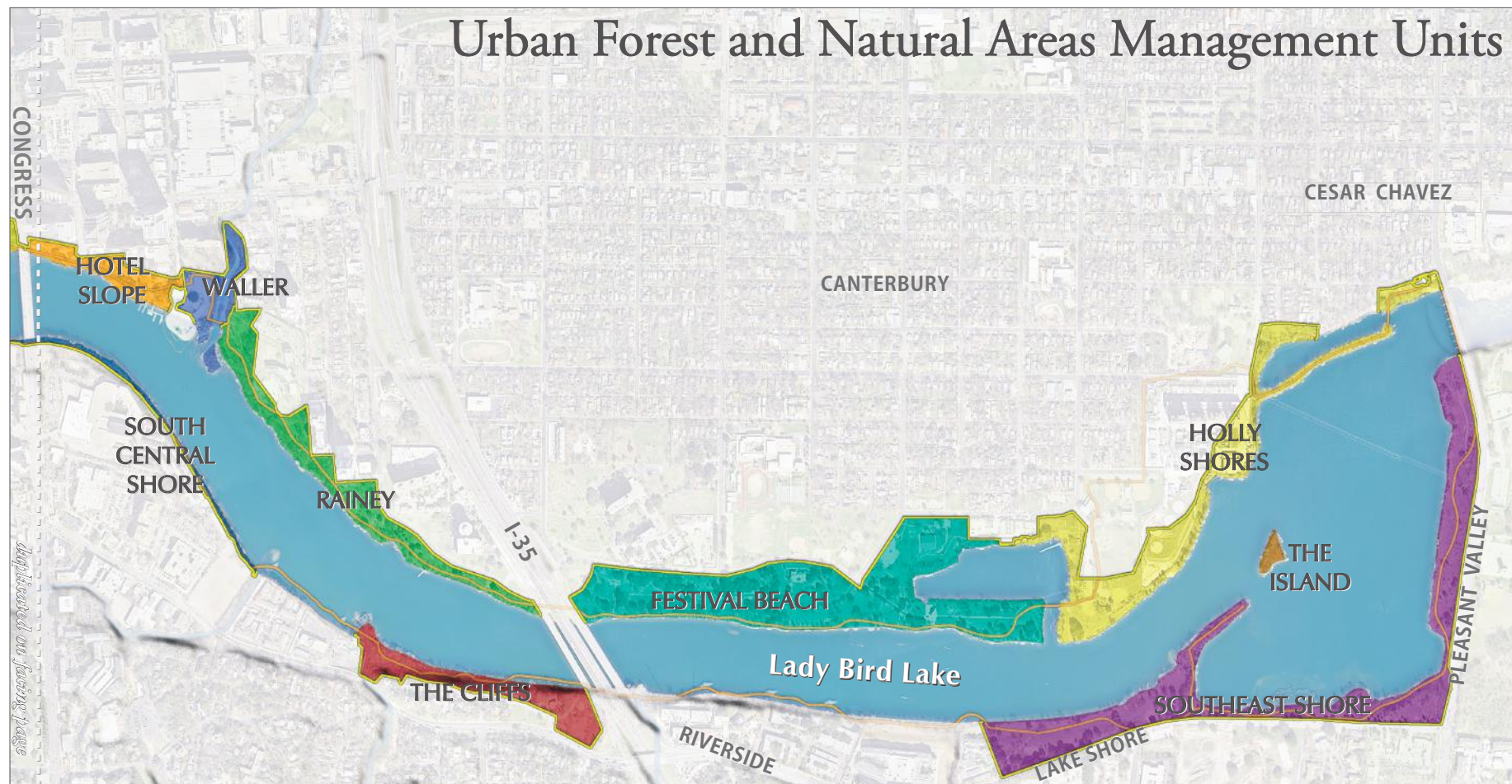
NATURAL AREA MANAGEMENT AND ECOLOGICAL RESTORATION

Natural area management recognizes that people have a role to play in our natural areas. This is particularly true in urban areas that experience ongoing impacts and influences from surrounding areas, including stormwater flows, high recreational use, soil compaction, introduction of invasive species, and

limited connection with other natural areas. The methods here work towards the ecological restoration of the site. Ecological restoration is the act of enhancing natural processes in a landscape where they may not exist, are impaired, or simply can be improved. We look at repairing environmental degradation as well as enhancing plant communities and habitat to create resilient, aesthetically pleasing, and ecologically functional natural areas. Resiliency

of the site is heightened through:

- Reintroduction and restoration of plants and plant communities that evolved in and are adapted to this area.
- Increased plant diversity to endure substantial changes in weather conditions such as ongoing drought or climate change as some species and even some genotypes may do better than others as circumstances change.



REPAIRING ENVIRONMENTAL DEGRADATION

Environmental degradation can come from many factors, both natural and manmade. The major issues impacting an area must be addressed before or during restoration, or restoration efforts will be ineffective. Here we will discuss management of the main factors degrading the natural areas: invasive species and soil disturbances.

Invasive Species

Invasive species are components of our modern environment that require persistent management. The goal of the management practices outlined below is to remove and discourage the establishment of harmful non-natives while encouraging the establishment and health of native plants. The end goal is to have plant communities dominated primarily by native plants in one decade. We outline here the best management practices to control the major invasive species found throughout the site, and recommend additional practices that align with desired management outcomes of increased woodlands and increased native plant diversity.

The ideal defense against invasive species is a more robust native flora that weakens or prevents the establishment of invasives. Expanding the woodlands over the next four years can have a substantial impact on areas currently dominated by invasive species that have an affinity for full sun. This will not work in all areas, but in many areas expanding woodlands may weaken problematic species such as giant reed and Johnsongrass. In all cases, treatment of invasive species should also work toward the overall ecological goals of a particular area.

There are 31 invasive plant species found in the study area that are negatively impacting the property, as seen in Table 2.5 of the Ecology chapter. The invasive plants causing the largest impact in the study area or having the potential for a substantial impact in the near future are: tree of heaven, giant reed, paper mulberry, sweet autumn clematis, elephant ear, golden rain tree, catclaw vine, China-berry, Chinese tallow, Chinese lacebark elm, Ligustrum, Johnsongrass, and common chaste tree. Best management practices for each of these species are presented in the following pages as recommended

by the City of Austin, Siglo Group, the National Parks Service, and TexasInvasives.org. As these practices are implemented, it is critical to remember that invasive species control is a multi-step process. After an initial treatment, follow up treatments are the only thing that will keep the situation from regressing (Texas Invasives 2015). For example, many of the giant reed patches throughout the study area have been previously treated by the City's Watershed Protection Department, but are growing back and are currently in need of follow up treatment and restoration planting (Figure 3.3).

Figure 3.3: Giant reed resprouting after treatment.



Invasive Species Control Guide

Paper Mulberry, Golden Rain Tree, Chinaberry, Chinese Tallow, Chinese Lacebark Elm, Ligustrum, and Common Chaste Tree (All invasive trees except Tree of Heaven)

Mechanical removal	Remove plants 2" or less in basal diameter using a Weed Wrench™ or other mechanical device. Hand pulling of new seedlings is required for multiple years until the seed bed is diminished and other plants can fill the niches. Provide for erosion control as needed. Leave as much of the pulled material as possible on site in low-use woodlands, taking care to remove any seed material, and leaving roots without soil contact. Slash from higher-use areas can be moved for use elsewhere on the site or removed altogether.	Where Appropriate: Areas with slopes <3:1 Optimal Time of Year: Any time Plant size: ≤2" diameter Effectiveness: High Applicator Required: No Labor Intensity: High
Cut stump	Cut tree down, providing for safety first. Paint the top of the stump with a triclopyr-based solution immediately, taking care to cover edges. Leave as much of the downed material as possible on site in low-use woodlands, taking care to remove any seed material. Slash or mulch from higher-use areas can be moved for use elsewhere on the site or removed altogether.	Where Appropriate: All areas Optimal Time of Year: Fall Plant size: >2" diameter Effectiveness: Moderate Applicator Required: Yes Labor Intensity: Moderate
Basal spray	Spray the bottom 12–15" of the tree with a triclopyr and oil solution. The standing dead snag will be excellent habitat for many insects and birds. Only use when tree height is shorter than the distance to the nearest trail or recreational use area. Will not be as effective if bark is thick, a species dependent condition.	Where Appropriate: Away from trail Optimal Time of Year: Slight fall preference Plant size: >2" diameter Effectiveness: Moderate Applicator Required: Yes Labor Intensity: Low

Tree of Heaven, *Ailanthus altissima*

Mechanical removal	Remove plants 2" or less in basal diameter using a Weed Wrench™ or other mechanical device. Hand pulling of new seedlings is required for multiple years until the seed bed is diminished and other plants can fill the niches. Provide for erosion control as needed. Leave as much of the pulled material as possible on site in low-use woodlands, taking care to remove any seed material, and leaving roots without soil contact. Slash from higher-use areas can be moved for use elsewhere on the site or removed altogether.	Where Appropriate: Areas with slopes <3:1 Optimal Time of Year: Any time Plant size: ≤2" diameter Effectiveness: High Applicator Required: No Labor Intensity: High
Hack and squirt	Tree of heaven will aggressively root sprout if cut completely. Instead, use a hatchet or girdling tool to create several wounds around the base of the tree. Do not completely girdle stem. Wound approximately 50% of diameter, with each wound 1 to 2" in height. Spray triclopyr-based solution onto wounds. This treatment is most suitable when tree height is shorter than the distance to the nearest trail or recreation areas. For trees closer to trails or recreational areas, a follow up removal of the tree should occur 6 months after the initial hack and squirt treatment.	Where Appropriate: Away from trail Optimal Time of Year: Slight fall preference Effectiveness: Moderate Applicator Required: Yes Labor Intensity: Moderate

Invasive Species Control Guide (*continued*)

Giant Reed, *Arundo donax*

Foliar spray	Apply foliar spray with imazamox solution. If not mixed with desirable vegetation, a combination of glyphosate and imazamox can be used. When stems die, cut and remove vegetation. Repeat as necessary. Erosion control efforts such as silt fences or erosion control fabric should be used and restoration plantings should be installed as soon as possible. Do not cut giant reed for at least a year before treatment, or effectiveness will be greatly reduced.	Where Appropriate: All areas Optimal Time of Year: Mid- to late summer Effectiveness: Moderate Applicator Required: Yes Labor Intensity: Moderate
Digging and root removal	Cut and remove tops of plants. Dig and remove as much of the roots as possible to minimize resprouting and dispose of all plant material off site. Wait for new sprouts to show and dig a second time. Digging will cause massive soil disturbance and open the area to erosion. Erosion control efforts such as silt fences or erosion control fabric should be used and restoration plantings should be installed as soon as possible.	Where Appropriate: For immediate removal Optimal Time of Year: Any time Effectiveness: Low Applicator Required: No Labor Intensity: High
Wick chemical application or cut and squirt	Use wick applicator to wipe the leaves with glyphosate/surfactant mix, allowing for application without harming nearby restoration plantings. Or cut individual stems and squirt a glyphosate solution into the stem cavity. Erosion control efforts such as silt fences or erosion control fabric should be used and restoration plantings should be installed as soon as possible.	Where Appropriate: Mowed/dug areas Optimal Time of Year: Summer Effectiveness: Uncertain Applicator Required: Yes Labor Intensity: High
Changing site conditions	Increase the tree canopy to shade out and weaken the establishment of giant reed. This can be done by planting riparian trees recommended in Table 3.1 directly around a treated area of giant reed, with particular focus on fast-growing trees such as box elder, hackberry, and black willow.	Where Appropriate: Treated areas Optimal Time of Year: Fall Effectiveness: Uncertain Applicator Required: No Labor Intensity: High

Sweet Autumn Clematis, *Clematis terniflora*

Mechanical removal	Seedlings can be pulled by hand or mowed. Mature plants can be cut or mowed, but the roots must also be dug up for effective removal. In areas with slopes greater than 3:1, erosion control fabric should be used and replacement planting should occur as soon as possible.	Where Appropriate: All areas Optimal Time of Year: Any time Effectiveness: Uncertain Applicator Required: No Labor Intensity: High
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Elephant Ear, *Colocasia esculenta*

Mechanical removal	Carefully dig and dispose of tubers; even small fragments may re-root. This can cause severe soil disturbance, and coir logs can be installed to prevent erosion. Plant replacement species immediately.	Where Appropriate: Along shoreline Optimal Time of Year: Low lake level Effectiveness: Low Applicator Required: No Labor Intensity: High
Foliar spray	Spray foliage with an aquatic approved glyphosate or imazamox solution. Repeat treatment as recommended by herbicide manufacturer when needed. Plant replacement species in late fall.	Where Appropriate: Along shoreline Optimal time of year: April–October Effectiveness: Low Applicator Required: Yes Labor Intensity: High

Catclaw Vine, *Macfadyena unguis-cati*

Mechanical removal Cut vines close to ground and dig up all root material.

Where Appropriate: All areas
Optimal Time of Year: Any time
Effectiveness: Moderate
Applicator Required: No
Labor Intensity: High

Combined cutting and foliar spray Where catclaw is tangled in overstory trees and cannot be pulled down without damaging native tree branches, cut it at head height and allow vines in the upper branches to desiccate and fall on their own. On remaining vegetation, use a foliar spray with an herbicide solution that contains glyphosate and triclopyr.

Where Appropriate: Monocultures
Optimal Time of Year: Non-drought
Effectiveness: Uncertain
Applicator Required: Yes
Labor Intensity: Moderate

Cutting followed by foliar spray Cut catclaw at ground level, and remove the aboveground biomass from the site. Where catclaw is tangled in overstory trees and cannot be pulled down without damaging tree branches, cut it at head height and allow the vine in the upper branches to desiccate and fall on its own. Allow catclaw to re-sprout from underground tubers. When it reaches 2 ft in height/spread, use foliar spray with an herbicide solution that contains glyphosate and triclopyr.

Where Appropriate: Non-monoculture
Optimal Time of Year: Non-drought
Effectiveness: Uncertain
Applicator Required: Yes
Labor Intensity: High

Johnsongrass, *Sorghum halepense*

Foliar spray Foliar spray with glyphosate-based herbicide. Replant affected area with native vegetation.

Where Appropriate: Away from desirable plants
Optimal Time of Year: September, October
Effectiveness: High
Applicator Required: Yes
Labor Intensity: Moderate

Wick application In areas with desirable groundcover underneath Johnsongrass, apply glyphosate-based herbicide with a wick applicator. This method tends to actually use more herbicide product, but avoids non-target kill.

Where Appropriate: Near desirable plants
Optimal Time of Year: Spring or fall
Effectiveness: High
Applicator Required: Yes
Labor Intensity: Moderate

Changing site conditions Improve canopy cover of urban forest to reduce direct sunlight on herbaceous layer to decrease vitality of Johnsongrass and increase viability of competition by native species.

Where Appropriate: Where woodland is desired
Optimal Time of Year: Fall
Effectiveness: Uncertain
Applicator Required: No
Labor Intensity: High

Mitigating Soil Disturbance And Erosion

Healthy soils are the foundation of a healthy natural area. As discussed in the ecology chapter, human actions, infrastructure, and stream inflows have a great impact on the site's ability to support stable soils and healthy plant communities. The recommendations here focus on techniques to alleviate soil disturbance and erosion within the bounds of the study area. In some areas, due to the narrowness of the site or the size of the problem, additional actions may need to take place outside of the study area. The major issues addressed here include: informal trails, formal trail alignments, trail erosion, water access, soil compaction, and sheet, rill, and gully erosion. The solutions include green infrastructure, formalization of user access, redirection of storm water, regrading, soil amendments, soil decompaction, and infrastructure modification. Soil chemistry is another important component of healthy soil, but is not addressed here as a complete soil analysis was beyond the scope of this project.

User Impacts

Austinites love the Trail and the natural areas around Lady Bird Lake. Unfortunately, the site's heavy use is sometimes to the detriment of the very thing being enjoyed. Off-trail recreation, access to the water, and the general condition of our trails are impacting the natural areas. Numerous problems associated with user impacts can be alleviated by decommissioning informal trails, making sure there are adequate trails where needed, making sure there are sufficient formal water access points, realigning the trails away from the water's edge or steep slopes where possible, and stabilizing the trail surface to reduce the amount of trail material sloughing off into

the natural areas and the Lake.

Formalizing access to the water

As discussed in the ecology chapter, there are numerous areas around the Lake where people access the water. Twenty-two established water access points with varying levels of supporting infrastructure can be seen in figure 2.50. There are, however, many more access points that are informal, with little to no supporting infrastructure. To protect the fragile ribbon of habitat at the water's edge, we propose the installation of formal water access points and upgrading of established access points where there is need and the topography allows. These areas will be clearly linked to the main trail, have appropriate amounts of space to accommodate users, and will have ample infrastructure to support appropriate activities such as sitting, fishing, putting in a boat, or viewing birds. In addition to accommodating the users' needs, these sites must be stabilized to withstand both floodwaters and foot traffic and must be designed in such a manner that discourages adjacent off-trail activities. An example formal water access location can be seen in Figure 3.4. As plans are further developed for these formal water access locations, they could become iconic pieces of architecture that complement the natural areas, much like the bathroom facilities that have been installed along the Trail by The Trail Foundation.

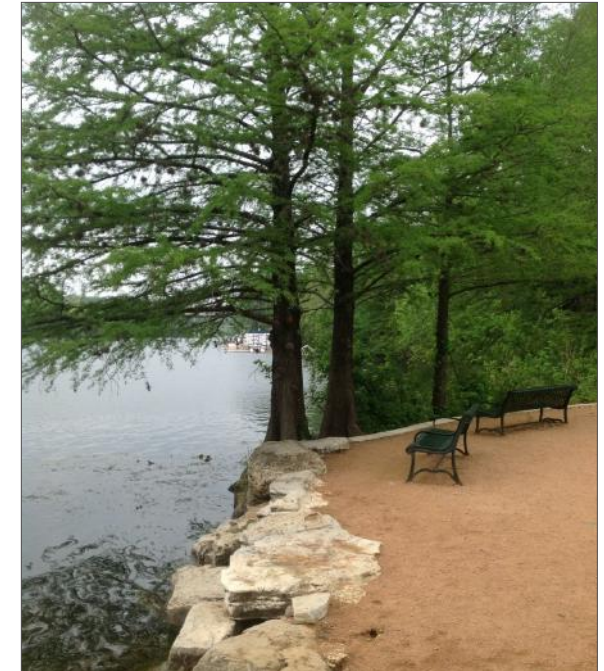
Formalizing Trails and Improving Infrastructure

There are numerous areas where paths created by recurring use make sense for the current configuration of the natural areas but are not maintained as a part of the trail system. In these areas, trails should be formalized and maintained per the criteria below.

This directs the flow of users to these formalized areas, decreases informal use, and allows for reclamation of other areas previously being used informally. For example, this approach is recommended for the numerous trails running from Veteran's Drive behind Austin High and the Butler Trail. Formalizing two trails would allow other trails to be decommissioned and restored.

In many areas, structures such as docks, retaining walls, and gazebos have not been maintained over time. Repair and restoration of these structures offer the opportunity for design that fits into the sur-

Figure 3.4: Formal water access areas, like the "Northshore Overlook" installed by The Trail Foundation in 2006, allow visitors to engage with the water without causing damage to the sensitive lakeshore.



rounding area and functionally facilitates the user experience while moving people away from informal use of the natural areas that leads to degradation.

Trail Alignments and Surfacing

Two major trail issues throughout the study area are the placement of the Trail in sensitive areas and erosion of trail material. The narrowness of the site and steepness of the terrain often dictate the Trail's location. In these cases, stabilizing the trail surface (discussed below) and insuring proper drainage are critical to reducing the impacts of the Trail on the

Figure 3.5: In areas where the Trail cannot be moved away from the shore, such as the Shoal Creek peninsula, the surface should be stabilized by paving or other means.



natural areas. In many places, however, there is room to adjust the trail position, which will reduce overall impacts on the natural area and thereby create a better user experience. Areas of note include the section along Cesar Chavez from Austin High to Lamar and Festival Beach. While this will initially seem like a large change, the inclusion of formal water access points, the aesthetic appeal of a more sinuous trail, and the realization that trail material has to be replaced (due to erosion) multiple times per year in some areas, makes these changes necessary, appealing, and cost effective. There are also areas where finer-scale changes in trail alignment are recommended. For instance, on the section paralleling Veteran's Drive, reducing the width of the Trail by a few feet and bringing it inland several feet will allow space for riparian vegetation. Another example of finer scale trail realignment that may involve cooperation with adjacent landowners is reducing the hardscape next to the Hyatt that creates one of the major bottlenecks in the trail system.

On portions of the Trail that either cannot be moved away from the water's edge or are bordered by a steep downhill slope, the crushed granite needs be stabilized or another material should be used. Using crushed granite as the surface of the Trail makes sense in terms of availability and softness. Unfortunately the Trail is washed out repeatedly throughout the study area, leading to ongoing maintenance challenges, a sprawling trail up to 25 ft wide in some areas, and deposition of granite material in the natural areas, which impacts both aquatic and terrestrial habitat. Potential guidelines for all trails moving forward are:

- 14 ft maximum Trail width in most areas—This recommendation is based on the recent improvements at Shoal Creek and other loca-

tions, as well as the AASHTO (1999) trail standards for multi-modal trails. This standard may not be valid in the most highly used Trail segments and should be evaluated in each segment based on user groups including: commuters, recreational bicyclists, runners, and pedestrians.

- Stabilize trails within 50 ft of the water's edge.
- Stabilize trails with a downslope side of 15% or greater within 2 ft of the trail.
- Stabilize trails in low-lying or frequently flooded areas.

These criteria are aligned with the City of Austin Environmental Criteria Manual, would considerably improve the Trail's function, and would substantially reduce the Trail's impacts on the natural areas.

Stabilization of trail material can come in numerous forms, including paving (as seen in Figure 3.5), geocell systems, spraying a polymer on the crushed granite, or a ribbon curb on the downslope side of the trail. In all cases, the reduction of trail material entering the natural areas should be the measurement of success. These Trail criteria and stabilization options will result in a better user experience and healthier natural areas.

Repairing Informal Trails, Retired Trails, Water Access, and Trampled Areas

Decommissioning informal water access points and trails and revegetating impacted areas are essential complements of creating formal access points and trails. Numerous informal trails are pointed out in the Management Units chapter, but monitoring and mitigating informal trails as they arise should be a

part of ongoing monitoring and management plans.

Brushing is a simple, effective way to reclaim informal trails. Brushing uses cut vegetation from pruning or invasive species removal to block the trail. Cut vegetation should be placed over impacted areas for at least 30 ft from intersections with formal trails. The cut pieces do not need to be large or tall, only difficult to walk through. Densely branched invasive species such as *Ligustrum* are especially good for brushing informal trails, though care must be taken to remove all seed material. Where the informal trail is in a relatively open area, the pieces should extend 3 to 5 ft beyond the edge to discourage visitors from widening the trail by walking beside the cut brush.

Brushing can be effective for small trampled areas as well. Larger downed material from invasive management or other maintenance in the area can be used to create additional obstacles to use.

Some of the larger trampled areas may be in need of additional soil amendments, decompaction, and planting. In high-use areas, temporary fencing, along with appropriate interpretation, may be necessary to allow areas to recover.

Stormwater

Stormwater runs downhill into the study area on its way to the Lake, causing numerous issues outlined in the Ecology chapter and shown in figure 2.47. Green infrastructure methods associated with slowing down flow are preferred for addressing stormwater issues within the study area. This can include swales, depressed areas within the landscape that retain stormwater, appropriate native plantings,

and/ or simple grading changes. Where these solutions will not work, engineered solutions or solutions outside the study area are needed. In all cases, aesthetics should be taken into consideration when choosing solutions within and adjacent to the natural areas.

Trail Runoff

In numerous areas along the Trail, grade dips and small culverts are used to shunt water off of the Trail. In some areas, additional dips and small culverts should be installed to increase the number of locations where water moves across the Trail and reduce the volume for existing culverts. This may be especially necessary in areas where infrastructure di-

verts large amounts of fast-moving runoff onto the Trail, like the area shown in Figure 3.7.

Sheet erosion

Where sheet erosion is occurring, upslope solutions to reduce or slow flow should be considered. Possibilities include grading changes, swale installation, and rain capture areas. For minor sheet erosion issues, such as in the upper portions of Festival Beach, organic material can be added to cover exposed tree roots, along with the appropriate planting and seeding of understory plants to stabilize the soil and increase water uptake.

Figure 3.6: Brushing, as seen here on the Barton Creek Greenbelt, is an effective way to deter informal trail use.



Rill Erosion

As with sheet erosion, upslope solutions should be considered first. Where those can be installed, minor cases of rill erosion can be treated like sheet erosion with the addition of organic material to cover tree roots and create appropriate conditions for revegetation. Where upslope solutions are not feasible, erosion mats and additional plants to hold the soil may be adequate. Installing erosion mats will temporarily hold the soil until the new plants are firmly established.

Gully Erosion

Upslope solutions are preferred. Many of the gullies

Figure 3.7: Runoff from infrastructure is causing rill erosion and erosion of trail material at Auditorium Shores.



are caused by culvert discharges onto steep slopes. In these areas, water-dispersing armoring should be installed where feasible. A variety of materials may be used to disperse the water, including rip-rap, concrete, loose stones, and limestone block gabions. Native rock is the preferred material.

Where large culverts are causing erosion and it is not feasible to disperse the water due to the slope below or the volume of water, the most effective solution in some cases will be to extend the culvert to the Lake, thereby eliminating further erosion. Where this solution is employed, aesthetic considerations and restoration are critical to ensure that the new infrastructure does not negatively impact the user experience and that the previously impacted

Figure 3.8: One of the locations where creation of streamlets is recommended in the Rainey management unit.



area can sustain native plantings.

Creating Streamlets

Stormwater moving across the study area at regular intervals, when accommodated, is a useful resource. The recommendations above address areas where it is not currently being accommodated. In a few instances, it is possible to utilize the existing erosion channel to create a streamlet within the study area. A streamlet is simply a small drainage channel. Where they occur naturally in central Texas, they are filled with plants that do not require consistently wet soils but thrive in seasonally wetter soils, such as Lindheimer's muhly and seep muhly. Formalizing the existing channels by reinforcing the erosion bed with rock and gravel, planting appropriate plants, and reducing mowing frequencies to once a year or less will prevent erosion issues, accommodate the water flow, and create a more dynamic environment in the natural areas. There are two sites near Rainey Street (one is shown in Figure 3.8) and two sites in Festival Beach where this technique is recommended, as discussed in the Management Units chapter.

Streambank erosion

Mitigating the streambank erosion occurring along the major creeks such as Waller, Shoal, Johnson, and Blunn is outside the scope of this project. The City of Austin's Watershed Protection Department (WPD) has a process for evaluating and mitigating these issues. The recommendations in this document can complement the major infrastructure work associated with streambank restoration.

Soil restoration

As mentioned above, soils in impacted areas will need to be restored through decompaction and amendment. Unless issues of soil porosity/water infiltration and decreased organic matter content are addressed, these soils will not be able to support healthy plant communities. In heavily impacted areas—such as those where vehicles have driven, former trails, or infrastructure staging areas—decompaction will be necessary. This can be accomplished through tilling and/or aeration, though care must be taken to protect tree roots. In areas with bare soil or in existing lawns being converted to woodland or savanna, organic amendments are recommended. Native mulch or mulch from the site is recommended for areas under trees and areas being converted to woodlands to a depth of 4” the spring or summer before fall planting and as needed thereafter. In areas where seeding will take place in the next year, a mature stable compost approved by the City of Austin is recommended to be lightly mixed with the top 2” of weed-free soil.

In all cases, amendment material is only recommended in areas where it does not pose a risk of washing away during regular rain events and entering Lady Bird Lake. If amendments are needed in unstable areas, erosion blankets or equivalent structures should be used. While it is likely that the appropriate soil fauna will enter into treated soils from the surrounding landscape and from compost amendments, it may be necessary to move a small amount of healthy soil from a nearby natural area into areas that will be planted or seeded to ensure that the appropriate soil biota is present.

Use of downed material

Woody material from invasive plant removal, pruning, and other management activities can be used throughout the study area. Some of the woody material can be mulched to use in soil restoration efforts mentioned above, but the majority can be left in larger pieces and either left in place or moved to other woodland enhancement or woodland expansion areas. The large woody debris will eventually decompose, returning nutrients to the soil, but in the meantime it will provide cover for wildlife, discourage creation of new informal trails, and help slow down falling rain to reduce erosion. Leaving the debris intact will also save on time and equipment usage. In some cases, the Lake should be considered as a means for transporting woody debris from one area to another as some locations

are most easily accessed via the water.

RESTORING AND ENHANCING PLANT COMMUNITIES AND HABITAT

Vegetation creates the ecological structure of the natural areas. Once degradation in an area has been controlled, native vegetation can be restored or enhanced to create habitat for wildlife as well as a beautiful setting for human enjoyment. Here we describe the basics of establishing and caring for native flora, restoring plant communities, and enhancing wildlife habitat. The implementation of these steps along with those listed above will result in restored aquatic, woodland, and savanna plant communities throughout the study area.

Restoration areas were defined by topography, existing and likely use, soils, infrastructure constraints, proximity to water, likely response to different management, and the likelihood of restoration success. The recommendations are shown in Figure 3.9 and include: woodland enhancement, woodland expansion, savanna restoration, and aquatic planting. Some areas have no recommendations as they are considered formal recreation areas or areas with infrastructure.

The 60 acres of the site currently defined as woodland are recommended for woodland enhancement. Enhancement recommendations include invasive species management or erosion control where there is degradation, and for areas in relatively good condition, increases in diversity.

Woodland expansion is recommended for areas that are currently—or were until very recently—managed as Lawn, but are not active recreation areas. These areas make up 80 acres of the study area and an additional 5 acres directly adjacent to the study area. Historically, these areas would be part of a floodplain terrace woodland with a nearly continuous, cathedral-like canopy along with thriving understory and herbaceous layers. In some areas, woodland expansion may be passive, simply changing management from mowed to Grow Zone and controlling for invasive species and erosion problems if they arise. In other areas, recommendations include native tree plantings to speed canopy establishment, followed by understory and groundcover establishment, while always controlling invasives and erosion.

Several smaller areas are dedicated to savanna restoration. The areas chosen have

Gaddy soils that can support a savanna plant community not found in any protected area in Travis County. While savanna restoration is an appropriate goal, the high level of preparation and ongoing maintenance makes it a lower priority than woodland expansion at this time.

Finally, the guidelines point to areas where emergent aquatic plantings would be appropriate based on bathymetry and existing aquatic plant colonization.

In all areas, whether woodland enhancement, woodland expansion, savanna restoration, or aquatic restoration, natural regeneration of plant material will be a crucial part of restoration activities. Natural regeneration will be most effective in areas with a sufficient native plant seedbank, proper soil conditions, time for recovery, ample water availability, and protection from degradation. Because it is rare for those conditions to coincide in this study area currently, and because of the high value placed on the study area, active restoration is recommended throughout much of the study area.

Plant Material, Planting, and Seeding

In all cases, seeds and plants sourced from Texas (preferably Central Texas) are recommended to ensure that plants are well adapted for the study area. In addition, planting, care, and seeding should be overseen by experienced professionals or volunteers to increase survivorship from initial planting and seeding to full establishment in 3 to 5 years.

A full list of recommended plants can be found in table 3.1. This list creates a substantial baseline for healthy plant communities in the study area. The plants are chosen based on the following criteria:

- Native to the Central Texas area;
- Available through the local nursery trade or native plant society groups;
- Successfully used in restoration projects within Central Texas;
- Add diversity to the plant palette around Lady Bird Lake;
- Included in the Texas Parks and Wildlife Department's Wildscapes list of plants that are beneficial for wildlife;
- Listed in the Texas Parks and Wildlife Department's descriptions of the vegetation types found in the study area; and/or
- Recommended for this or similar projects by arborists, ecologists, or land management professionals.

Live plantings work to quickly stabilize soils, increase diversity, shade out invasives, and better define the user experience. The next chapter highlights specific management units where canopy, understory, and groundcover plantings are recommended. Variables that help decide whether live planting is cost effective include: availability of irrigation, visibility of the site, whether invasive species may inhibit seeding, cost of labor and resources for planting and management during establishment, and whether natural recovery is an option.

Live plantings can consist of trees, understory, groundcover, or any combination of the three. In all cases, the following guidelines are critical:

- **Prepare for success:** Ensure that trained individuals are part of all planting activities, make sure the area is prepared for planting and any degradation issues have been managed (such as invasive species, erosion, or soil compaction).
- **Plant at the right time of year:** To allow for initial establishment before the heat of the summer, most planting should occur October to February.
- **Plant the right plant in the right place:** The recommended plant list found in Table 3.1 includes appropriate locations for each species. Ensure shoreline trees are planted along the shoreline and upland trees are planted away from the shoreline, keeping in mind that some species may be appropriate for a variety of settings. Beyond the distinctions in the recommended plant list, an experienced professional and/or volunteer should facilitate decisions about where particular plants are placed.
- **Size matters:** Plants should be the smallest size suitable for the circumstances. For example, planting small caliper and bareroot trees allows resources to go much farther because the plant material and installation costs are substantially reduced (Duncan and Richter 2012). That said, in areas where trampling or aesthetics are of immediate concern, larger plants may be appropriate.
- **Irrigation:** Temporary irrigation during the summer months is critical in the first three to five years of establishment after planting. Irrigation is available through much of the study area and creative, cost-effective means of utilizing it in all restoration activities will substantially increase plant survivability.
- **Continued care:** Whether trees, understory, or groundcover, planting is only the first step. Ensuring that the new plants have sufficient water, are not being outcompeted by invasives, and are not being negatively impacted by erosion issues are all critical to a project's success.

When planting trees, it is also important to use a naturalistic planting design. Planting trees in clumps rather than spacing them evenly will create a more natural aesthetic. These trees will grow up to form groves, which is often how trees are encountered in central Texas.

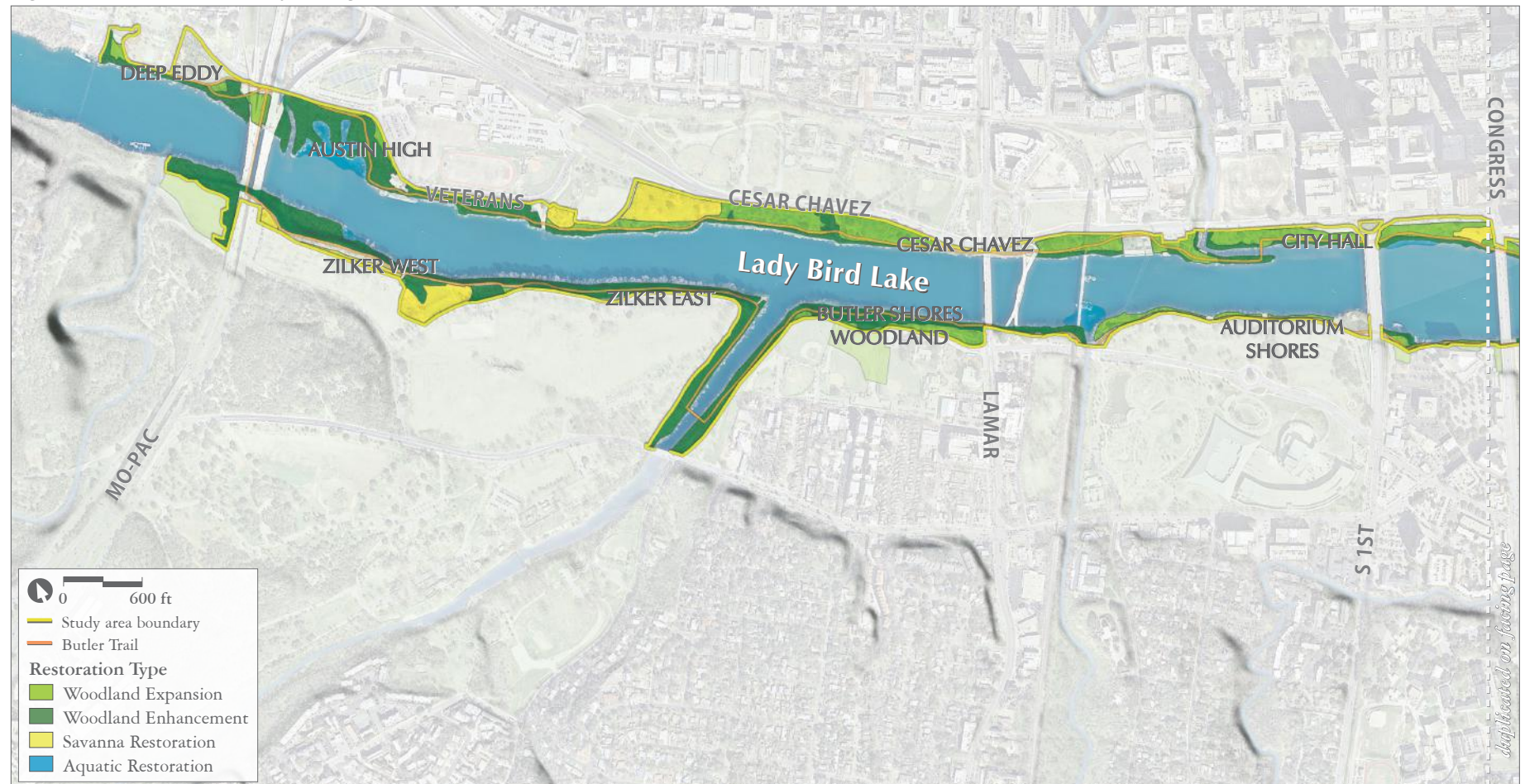
Seeding can be used independently or as a complement to live plantings in areas where trampling is

unlikely, for particular species that grow best from seed, where immediate results are not as critical, or where live planting is not practical. As with all practices, seeding should be overseen by a trained professional or volunteer with a focus on seed bed preparation and insuring that no invasive species in the area will undermine the seeding efforts. While restoring or augmenting plant species is recommended in each of the management units discussed

in the following chapter, it may not be realistic to plant or seed entire areas due to costs, labor, access, or time.

Restoration is an ongoing process, so planting or seeding some areas as “seed islands” is appropriate. A seed island is an area that has been planted or seeded with the intent of the plant material spreading to surrounding areas. The area can be quite

Figure 3.9: Areas recommended for ecological restoration. Sources: COA, NAIP.



small (as small as 8 ft by 8 ft). The area should have invasive species removed, soil supplemented (with mulch or compost per recommendations in soil restoration section above), and erosion controlled as needed. After preparation, the area should be seeded and/or planted. The Grow Zone program uses this approach in some areas. The seed island concept can be used in any of the management units and all planting and seeding efforts should be thought of as

seed islands for the surrounding areas.

The practices outlined above for live plantings also apply to seeding (with the exception of “Size matters”). An additional consideration is proper seeding rates, which will vary based on whether the seeding is adding diversity to an area with existing vegetation, complementing live plantings, or establishing vegetation in an area prepped specifically for seed-

ing. It is important to remember that good timing for seeding may be different than for live plantings. Cool season grasses and spring wildflowers will do better if sown in the fall, while warm season grasses and fall wildflowers may be planted in late winter.

As discussed previously in the trampling section, it is recommended that newly planted or seeded areas be fenced off where additional trampling is a risk.



Table 3.1: Recommended plants by growth form. *Included in TPWD's Wildscapes plant list. Ecological zone codes: SW=shoreline woodland, SH=shoreline non-woodland, FT=floodplain terrace, away from edge, GS=Gaddy savanna, SV=savanna, RO=rocky outcrops/slopes, FP=floodplain terrace, away from edge, showy/formal planting.

Recommended Plants

Herbaceous Species

		Ecological Zones									Ecological Zones						
Common Name	Scientific Name	SW	SH	FT	GS	SV	RO	FP	Common Name	Scientific Name	SW	SH	FT	GS	SV	RO	FP
American basketflower	<i>Centaurea americana</i>				x	x			Narrowleaf sunflower	<i>Helianthus angustifolius</i>					x		
Antelope horns	<i>Asclepias asperula</i>					x			Netted milkvine	<i>Matelea reticulata</i>	x		x				
Beardtounge	<i>Penstemon laxiflorus</i>					x			Old-man's-beard	<i>Clematis drummondii</i>			x				x
Black-eyed susan	<i>Rudbeckia hirta</i> *				x	x			Partridge pea	<i>Chamaecrista fasciculata</i>				x			
Blue curls	<i>Phacelia congesta</i>	x		x					Pigeonberry	<i>Ravina humilis</i>	x	x	x				
Blue-eyed grass	<i>Sisyrinchium scabrum</i>				x	x			Pink evening primrose	<i>Oenothera speciosa</i>				x	x		
Cardinalflower	<i>Lobelia cardinalis</i>		x						Plains coreopsis	<i>Coreopsis tinctoria</i> var. <i>tinctoria</i>				x	x		
Carolina larkspur	<i>Delphinium carolinianum</i> subsp. <i>virescens</i>					x			Prairie agalinis	<i>Agalinis heterophylla</i>					x		
Cedar sage	<i>Salvia roemeriana</i> *	x		x					Prairie fleabane	<i>Erigeron modestus</i>				x	x		
Clammyweed	<i>Polanisia dodecandra</i> subsp. <i>trachysperma</i>				x				Prairie gaillardia	<i>Gaillardia aestivalis</i>				x			
Clasping coneflower	<i>Dracopis amplexicaulis</i>					x			Prairie nymph	<i>Herbertia labue</i>					x		
Cowpen daisy	<i>Verbesina encelioides</i>	x		x		x			Prairie parsley	<i>Polytaenia nuttallii</i>					x		
Cutleaf evening primrose	<i>Oenothera laciniata</i>				x				Prairie verbena	<i>Glandularia bipinnatifida</i> var. <i>bipinnatifida</i>				x	x		
Engelmann's daisy	<i>Engelmannia peristenia</i> *				x	x			Purple coneflower	<i>Echinacea purpurea</i>				x	x		
Four o'clock	<i>Mirabilis albida</i>	x		x					Purple leatherflower	<i>Clematis pitcheri</i>	x		x				x
Frostweed, iceplant	<i>Verbesina virginica</i>	x		x					River fern	<i>Thepteris ovata</i>	x		x				
Gayfeather	<i>Liatris pycnostachya</i>					x			Scarlet clematis	<i>Clematis texensis</i>	x		x				
Golden groundsel	<i>Puckera obvata</i>	x		x					Scrambled eggs	<i>Corydalis curvisiliqua</i>					x		
Golden groundsel	<i>Senecio obovatus</i>	x		x					Shrubby boneset	<i>Ageratina havanensis</i> *	x		x			x	
Golden wave coreopsis	<i>Coreopsis basalis</i>				x				Slender greenthread	<i>Tbelesperma filifolium</i> *				x	x		
Hairy zexmenia	<i>Wedelia hispida</i>					x			Slenderleaf four-nerve daisy	<i>Tetrameuris linearifolia</i>					x		
Horsemint	<i>Monarda citriodora</i>				x	x			Slenderlobe passionflower	<i>Passiflora tenuiloba</i>	x		x				
Indian blanket	<i>Gaillardia pulchello</i>				x	x			Snapdragon vine	<i>Maurandya antirrhiniflora</i>	x		x				
Indian paintbrush	<i>Castilleja indivisa</i>				x	x			Standing cypress	<i>Ipomopsis rubra</i> *				x	x		
Lanceleaf coreopsis	<i>Coreopsis lanceolata</i>				x	x			Texas bluebonnet	<i>Lupinus texensis</i>				x	x		
Late boneset	<i>Eupatorium serotinum</i>	x		x					Texas vervain	<i>Verbena halei</i>				x	x		
Limestone gaura	<i>Gaura calcicola</i>				x	x			Texas yellow star	<i>Lindheimeria texana</i>				x	x		
Lindheimer's senna	<i>Senna lindheimeri</i>					x			Turk's cap	<i>Malvaviscus drummondii</i> *	x		x				
Maxillilian sunflower	<i>Helianthus maximiliani</i>				x	x			Winecup	<i>Callirhoe involucrata</i>				x	x		
Mealy sage	<i>Salvia farinacea</i>		x			x			Yellow passionflower	<i>Passiflora lutea</i>	x		x				
Missouri primrose	<i>Oenothera missouriensis</i>					x											

Tree and Shrub Species

		Ecological Zones									Ecological Zones						
Common Name	Scientific Name	SW	SH	FT	GS	SV	RO	FP	Common Name	Scientific Name	SW	SH	FT	GS	SV	RO	FP
American beautyberry	<i>Callicarpa americana*</i>	x		x				x	Lacey oak	<i>Quercus glaucooides</i>							x
American elm	<i>Ulmus americana*</i>	x		x					Live oak	<i>Quercus fusiformis</i>			x		x	x	x
Anachacha orchid tree	<i>Baubinia lunarioides</i>						x		Mesquite	<i>Prosopis glandulosa</i>					x		
Bald cypress	<i>Taxodium distichum*</i>	x							Mexican buckeye	<i>Ungnadia speciosa</i>			x		x		x
Black walnut	<i>Juglans nigra*</i>	x		x					Mexican plum	<i>Prunus mexicana*</i>			x				x
Black willow	<i>Salix nigra</i>	x							Monterrey oak	<i>Quercus polymorpha</i>							x
Bois d'arc	<i>Maclura pomifera</i>	x		x					Pecan	<i>Carya illinoensis*</i>	x		x			x	
Box elder	<i>Acer negundo</i>	x		x					Possumhaw holly	<i>Ilex decidua*</i>			x				
Burr oak	<i>Quercus macrocarpa*</i>			x		x			Red mulberry	<i>Morus rubrum*</i>			x				
Buttonbush	<i>Cephalanthus occidentalis*</i>		x						Retama	<i>Parkinsonia aculeata</i>					x		x
Cedar elm	<i>Ulmus crassifolia*</i>			x		x	x		Roughleaf dogwood	<i>Cornus drummondii</i>	x	x	x				
Chinquapin oak	<i>Quercus muhlenbergii*</i>			x				x	Scarlet buckeye	<i>Aesculus pavia*</i>			x			x	x
Common elderberry	<i>Sambucus nigra</i> subsp. <i>canadensis*</i>	x	x						Spanish oak	<i>Quercus buckleyi*</i>			x			x	x
Cottonwood	<i>Populus deltoides*</i>	x							Sugar hackberry	<i>Celtis laevigata</i>	x		x				
Desert willow	<i>Chilopsis linearis</i>						x		Sycamore	<i>Platanus occidentalis*</i>	x						
Eastern redbud	<i>Cercis canadensis*</i>			x			x		Texas ash	<i>Fraxinus albicans</i>							
Eve's necklace	<i>Styphnolobium affine</i>			x		x	x		Texas persimmon	<i>Diospyros texana*</i>			x		x		
False indigo	<i>Amorpha fruticosa</i>	x	x						Wafer ash	<i>Ptelea trifoliata</i>			x				
Green ash	<i>Fraxinus pennsylvanica</i>	x		x					Western soapberry	<i>Sapindus drummondii</i>			x				
Gum bumelia	<i>Sideroxylon lanuginosum</i>			x					Yaupon holly	<i>Ilex vomitoria*</i>			x			x	

Grasses and Grass-like Species

		Ecological Zones									Ecological Zones						
Common Name	Scientific Name	SW	SH	FT	GS	SV	RO	FP	Common Name	Scientific Name	SW	SH	FT	GS	SV	RO	FP
Big bluestem	<i>Andropogon gerardii</i>		x			x			Meadow dropseed	<i>Sporobolus compositus</i>					x		
Buffalograss	<i>Bouteloua dactyloides</i>				x	x			Purple threeawn	<i>Aristida purpurea</i>				x	x		
Bushy bluestem	<i>Andropogon glomeratus</i>		x						Purpletop	<i>Tridens flavus</i>				x	x		
Canada wildrye	<i>Elymus canadensis*</i>	x		x					Sand dropseed	<i>Sporobolus cryptandrus</i>				x			
Carolina joint-tail	<i>Coelorachis cylindrica</i>				x	x			Sideoats grama	<i>Bouteloua curtipendula</i>				x	x		
Curly mesquite	<i>Hilaria belangeri</i>				x	x			Silver bluestem	<i>Bothriochloa laguroides</i>				x	x		
Eastern gamagrass	<i>Tripsacum dactyloides</i>		x						Spikesedge	<i>Eleocharis sp.</i>		x					
Feather windmillgrass	<i>Chloris virgata</i>				x	x			Switchgrass	<i>Panicum virgatum</i>		x					
Green sprangletop	<i>Leptochloa dubia</i>				x	x			Texas cupgrass	<i>Eriochloa sericea</i>					x		
Hall's panicum	<i>Panicum hallii</i>					x			Texas wintergrass, speargrass	<i>Nassella leucotricha</i>				x	x		
Indiangrass	<i>Sorghastrum nutans*</i>				x	x			Virginia wildrye	<i>Elymus virginicus</i>	x		x				
Inland sea oats	<i>Chasmanthium latifolium</i>	x		x					Wild barley	<i>Hordeum pusillum</i>					x		
Little bluestem	<i>Schizachyrium scoparium*</i>				x	x			Windmillgrass	<i>Chloris verticillata</i>				x	x		
Lovegrass	<i>Eragrostis intermedia</i>				x	x			Witchgrass	<i>Panicum capillare</i>				x			

Recommended Plants (*continued*)

Aquatic Species

Common Name	Scientific Name	Common Name	Scientific Name
American pondweed	<i>Potamogeton nodosus</i>	Slender spikerush	<i>Eleocharis acicularis</i>
Arrowhead	<i>Sagittaria latifolia</i>	Smooth beggartick	<i>Bidens laevis</i>
Bulltounge	<i>Sagittaria platyphylla</i>	Softstem bulrush	<i>Schoenoplectus tabernaemontani</i>
Creeping burrhead	<i>Echinodorus cordifolius</i>	Spatterdock	<i>Nuphar advena</i>
Emory sedge	<i>Carex emoryi</i>	Squarestem spikerush	<i>Eleocharis quadrangulata</i>
False dragonhead	<i>Physostegia virginiana</i>	Swamp milkweed	<i>Asclepias incarnata</i>
Flatstem spikerush	<i>Eleocharis palustris</i>	Water hyssop	<i>Bacopa monnieri</i>
Giant bulrush	<i>Schoenoplectus californicus</i>	Water stargrass	<i>Heteranthera dubia</i>
Illinois pondweed	<i>Potamogeton illinoensis</i>	Water willow	<i>Justicia americana</i>
Pale spikerush	<i>Eleocharis macrostachya</i>	White water lily	<i>Nymphaea odorata</i>
Pickerelweed	<i>Pontederia cordata</i>	Wild celery	<i>Vallisneria americana</i>

Figure 3.10: Planting shoreline species like bald cypress and eastern gamagrass close to the water will greatly increase the likelihood of restoration success.



Fencing should be accompanied by explanatory interpretation.

Expanding and Enhancing the Urban Forest

As mentioned in the Ecology chapter, the study area is part of the floodplain terrace that would naturally be wooded. Many parts of the study area are recommended for woodland expansion in order to return more of the site to a natural state and to increase ecological function, shade, and visual interest (Figure 3.9). These areas were carefully chosen to minimize impacts on recreation or infrastructure. The establishment of woodlands in underutilized areas is one of the most effective ways to enhance the user experience and increase the ecological functionality of the natural areas.

This expansion will begin to naturally happen through regeneration (as seen in Figure 3.11) in areas designated as Grow Zone—which we suggest should include all areas recommended for woodland enhancement, woodland expansion, or savanna restoration in Figure 3.9. The simple act of changing visitor use patterns and mowing regimes will create new woodlands, though some maintenance will be needed to ensure that the regenerating species are desirable.

Tree planting is necessary to expedite the establishment of an ecologically functional, diverse, and aesthetically pleasing canopy. A diverse canopy will be more resilient when facing blight, drought, and climate change in the future. The recommendations in the Management Units chapter include 80 acres of woodland expansion throughout the study area. Planting densities in these areas will be variable according to the availability of resources and desired

effect in each area.

There are two primary methods used to plant trees in City of Austin parkland. The first method, primarily used by PARD, uses container plants (5 gallon or similar) with accompanying temporary irrigation, support, and ongoing maintenance. The second method, primarily used by the Watershed Protection Department in Grow Zones, is the high density planting of seedlings along waterways with little to no supporting infrastructure. These two methods vary in survival rate, installation labor, ongoing maintenance needs, overall costs, initial impact, and control of final aesthetics. The restoration and expansion of woodlands around Lady Bird Lake will rely on both of these methods.

Recommended tree planting densities should consider the benefits of these tree planting methods as well as standards for riparian and bottomland forest restoration (Allen et al. 2001). For our purposes we can look at the 80 acres of woodland expansion with a desired density of at least 85 container trees per acre to be planted over the next 4 years and an additional 200 seedlings per acre. To maximize the benefits of both practices, container trees should be initially planted in groves with accompanying infrastructure and should be concentrated in, but not limited to, areas that shade the trail. Spacing can range from 10 to 30 ft. These areas can then be expanded with additional seedlings planted within and around the groves. This combination of planting, along with proper site preparation as described above, will substantially increase seedling survivorship, especially if there is temporary irrigation or a water source available during drought periods. In addition to this method, seedlings can be planted along the water's edge and near existing woodlands.

In woodland enhancement areas, the density and type of planting will be contingent on what is currently there. The overall goal will be to increase age class, size, and species diversity to create a more resilient canopy. Planting in these areas is currently not as high a priority as establishing new woodlands in other areas. The highest priorities in existing woodlands are controlling invasives and erosion. When the degradation is significant enough, however, planting may be necessary to repair an erosion issue or to fill an ecological niche formerly filled by an invasive species.

In woodland expansion areas, understory and

groundcover establishment will be a critical part of creating healthy woodland plant communities. As canopy trees are being established, the understory can also be enhanced by planting species such as: yaupon holly, possumhaw holly, gum bumelia, red mulberry, roughleaf dogwood, common buttonbush, wafer ash, Eve's necklace, American beautyberry, Texas persimmon, and false indigo. In addition, early successional species and fast growing plants that can begin to reduce the dominance of Bermuda grass can be used as transitional species as trees are establishing. These areas can also be seeded with native wildflowers to make them more visually appealing as they transition to woodlands.

Figure 3.11: Abundant cottonwood seedlings in a recently converted Grow Zone in the Southeast Shore.



As trees become established in a three to five year timeframe, more attention should be given to more shade-tolerant understory and groundcover species.

In woodland enhancement areas, increasing the diversity of understory and groundcover is an effective means of filling ecological niches after invasive species control and/or erosion mitigation. As other management priorities are addressed, increasing diversity within existing woodlands will become a higher priority. It is also a way to supplement wildlife food plants and create aesthetic appeal throughout the study area.

Tree Care

As a part of this assessment, consulting arborist Don Gardner compiled a list of trees in need of care or removal. A list of trees needing attention, along with location information, was provided to PARD. Gardner also pointed out 7 live oak groves in need of crown cleaning and structural pruning in the following locations:

- In Festival Beach south of Nash Hernandez Street between I-35 and nearest parking lot.
- In Festival Beach north of the parking lot mentioned above to the old Aquatic Center.
- In Festival Beach north of the eastern end of Nash Hernandez, just west of Fiesta Gardens.
- In the “Love of Christi” grove in Festival Beach.
- On the south shore, near the Austin American Statesmen building and going east.
- Near the Hostel in the Southeast Shore.
- Near Lakeshore Drive, from the new restroom at the east end of the boardwalk, going east.

In his assessment he noticed a positive change in the maintenance of trees and encouraged the Urban

Forestry Department to maintain their efforts along the Butler Trail. We also recommend institutionalizing an annual tree risk assessment for the Trail.

Savanna Restoration

Many of the large mowed areas in the study area present opportunities for more sun-loving plants characteristic of the Blackland Prairie found in the eastern portions of Austin and the unique Gaddy soils found in several parts of the study area. Grasses such as little bluestem, big bluestem, Indiangrass, switchgrass, and eastern gamagrass can be planted to shade out Bermuda grass in select areas and, where appropriate, plants appropriate for Gaddy Soils such as witchgrass, sand dropseed, evening primrose, and partridge pea should be included in the seed mix. A list of recommended savanna species is in Table 3.1.

Restoring native savanna is challenging in general and will be particularly challenging in the study area due to an entrenched carpet of Bermuda grass and other urban influences. While increasing diversity in the study area is a goal, savanna restoration is not seen as an immediate high priority due to the resource intensity of dealing with invasive species, the high level of ongoing management needed, and the long list of other priorities in the study area. As other priorities are addressed in the study area and better options for savanna restoration become available with examples from comparable sites, the restoration of savanna plant communities on the Gaddy soils will become a higher priority for implementation.

In the shorter-term, it is recommended that areas recommended for savanna restoration move towards the wildflower meadow practices already in place

for parts of the study area that reduce overall mowing. A mix of Texas wildflowers can transform the current lawns into beautiful spring wildflower displays—pleasing to trail users and beneficial for native bees, butterflies, and other pollinators—like the ones currently found in several areas along the north shore near Cesar Chavez Street. The long-term restoration of savanna plant communities and the near-term increase in wildflower and savanna species will increase the diversity of plants and animals found within the study area and protect a plant community currently unprotected in Travis County.

Aquatic Restoration

The City of Austin’s Watershed Protection Department is working to increase the diversity and volume of aquatic plantings in Lady Bird Lake. Since 2004 the City of Austin has partnered with the University of North Texas on aquatic vegetation restoration efforts in Lady Bird Lake and Lake Austin (Dodd, Dick, and Schad 2013). To facilitate expanding upon those efforts, we have identified areas that may be appropriate for aquatic plantings based on existing vegetation, protection from flood flows, and the existing water levels. The goal of the aquatic plantings is to increase the diversity of the site overall, increase wildlife habitat, and improve water quality. Plantings should follow City of Austin best management practices and practices laid out in TPWD’s Propagation and Establishment of Native Aquatic Plants in Reservoirs document (Clamman 2015, Webb et al. 2012). Best management practices will need to include sediment stabilization, species selection, caging to protect against herbivory (as shown in Figure 3.12), and protection from high winds and wave action.

Wildlife Habitat Enhancement

The urban forest and natural areas of Lady Bird Lake serve as a refuge and a corridor for wildlife in the highly urbanized Austin area. Over 190 bird species have been documented in the study area and the immediate surroundings, with over 80 additional species of reptiles, amphibians, and mammals known to inhabit surrounding areas. By addressing degradation issues, changing land management practices, and restoring natural areas per the recommendations here, the wildlife habitat within the study area will more than double in size and food and shelter options will increase substantially. Continued enhancement of the natural areas and creation of more resilient native plant communities, with an emphasis on plants that provide wildlife food or habitat as shown in Table 3.1, will encourage a greater amount and diversity of wildlife to inhabit the study area.

Aquatic plantings will provide valuable food and cover for invertebrates, fish, and other wildlife. Additional riparian trees will increase shade to help regulate temperature on hot summer days and provide important refugia for fish such as perch. Woodland expansions will increase patch sizes substantially, from a narrow strip throughout most of the site to contiguous woodland as large as 20 acres. Large woodland patches will provide more cover and food, improving habitat for numerous animals not currently common around Lady Bird Lake but seen in other natural areas nearby. Savannas and expanded wildflower meadows can provide habitat for wintering sparrows and numerous migratory species passing through every year. They can also provide habitat and food needed by lizards, small mammals, and numerous beneficial insects including native species of bees and butterflies.

Expanding the amount of land under natural area management and improving the quality of the existing plant communities will lead to better wildlife habitat. Wildlife habitat can be augmented with nesting boxes for both birds and native pollinators as desired. In addition, formal garden areas along the Trail can continue to be planted in “wildlife

themes” that also work as seed sources, such as:

- Native milkweed-dominated beds for monarch butterflies.
- Urban bird food plants.
- Plants beneficial for native bees.
- Plants beneficial for native butterflies.

Figure 3.12: Exclosures are recommended for some aquatic plantings to protect against herbivory.





Management Units

The project area has been divided into management units to facilitate implementation and discussion of current conditions, needed management, priorities, and work tasks. The management units can be seen in Figure 4.2. They are primarily distinguished by slope, the ratio of heavily managed lawn to lightly managed woodland, and the quality of natural areas present.

This chapter contains a description of the current ecological state of each management unit, a narrative description of management needs, and a list of prioritized management tasks. While there are discrete tasks recommended, this document should remain dynamic and adapt to successes and challenges within the study area, new information from related projects, changes in weather patterns, the availability of resources, and/or changes in user preferences.

To generally categorize management needed in each area, the tasks have been put into the following categories:

[R] Restoration: This category includes activities such as converting an area from lawn to woodland and planting to increase diversity.

[I] Invasive species management: These actions actively or passively reduce a particular invasive species, and include: physical removal, the use of herbicides, out competing, and shading out.

[E] Erosion control and soil restoration: This category includes all activities designed to mitigate erosion impacts or repair damaged soil. Activities address the need for green infrastructure, hard infrastructure, and/or soil restoration and include: bioswale instillation, regrading, culvert instillation, soil decompaction, and mulching.

[U] User experience: This category encompasses a wide range of activities designed to enhance the experience of using the Trail, including: increased aesthetic appeal, improved access to the water, trail improvements, and increased safety.

About the Tree Data

The ecological descriptions for each unit include tree inventory information for both woodland areas and mowed areas. All data about number and density of trees refers only to individuals with a diameter at breast height (4.5 ft) of 8" or more.

There are also two designations from the City of Austin Code of Ordinances used in the descriptions:

Protected Trees: trees 19" or greater in diameter at breast height.

Heritage Trees: certain desirable native trees 24" or greater in diameter at breast height. Species that qualify as heritage trees are: Texas ash, bald cypress, American elm, cedar elm, bigtooth maple, all oak species, pecan, Arizona walnut, and eastern black walnut.

Tables 4.1 and 4.2 provide summaries of the tree data and overall vegetation information by management unit for quick comparison across the entire study area.

Figure 4.1: Area in Festival Beach where woodland expansion and re-establishment of groundcover will improve the aesthetics, reduce erosion, and increase ecological function.

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Table 4.1: Summary of tree data by management unit based on information collected during the 2014 tree inventory conducted by Siglo Group.

Management Unit	Total acres	Tree count	Trees/acre	Basal area (ft ² /acre)	Average DBH	Protected tree count	Heritage Tree count	Trees/100' of shoreline	% shade on trail	% canopy cover	Acres woodland	Trees/acre woodland	Acres non-woodland	Trees/acre non-woodland
Deep Eddy	1.7 [†]	90	53	66	13	7	3	4.8	36%	57%	1.0	86	0.8	11
Austin High	12.2	917	75	87	13	154	61	7.5	71%	71%	8.7	104	3.5	3
Cesar Chavez	19.4	745	38	72	17	232	110	6.7	40%	46%	3.0	141	16.4	20
City Hall Strip	7.7	247	32	49	15	54	22	5.2	63%	46%	1.3	131	6.4	13
Hotel Slope	4.8	135	28	66	19	36	17	2.9	72%	69%	0.9	40	4.0	25
Waller Creek	5.1	n/a	n/a	n/a	13*	n/a	n/a	n/a	45%	67%	3.1	n/a	2.1	n/a
Rainey	12.9	406	31	54	16	114	51	4.3	47%	57%	3.0	81	9.9	16
Festival Beach	35.3	722	20	44	18	293	148	1.8	44%	41%	1.6	96	33.8	17
Holly Shores	20.9	535	26	41	15	108	50	4.5	22%	29%	5.2	85	15.7	6
Southeast Shore	30.7	373	14**	28**	18	194	76	3.5	21%	35%	5.3	70**	25.4	11
The Cliffs	5.6 [†]	349	63	70	13	49	n/a	7.6	94%	89%	5.6	63	0.0	n/a
Southcentral Shore	3.3	276	83	190	19	118	62	6.8	69%	66%	2.0	120	1.4	29
Auditorium Shores	3.7	99	26	46	16	27	9	3.1	25%	40%	0.0	n/a	3.7	26
PARD Woodland	8.2	403	49	99	17	108	59	6.1	82%	77%	6.0	59	2.2	23
Zilker East	6.1	316	52	156	19	116	73	5.3	55%	76%	5.9	53	0.3	12
Zilker West	13.2	660	50	59	13	86	31	7.8	22%	54%	7.6	83	5.6	6
All	190.9 [†]	6273	34	56	16	1696	772	5.4	48%	49%	59.8	80	131.1	14

*The average DBH reported for Waller Creek was based on the 70 trees for which information was available from PARD as that unit was not included in Siglo Group's tree inventory. **Data reported excludes 3.8 acres of woodland that were outside of Siglo Group's inventory and for which consistent data were not available from PARD. [†]Excludes dog park, community garden, and fenced off areas.

Table 4.2: Summary of species counts by management unit based on botanical survey by Bill Carr in Fall 2014.

Management Unit	Species count	Native species	Exotic Species	Invasive Species	Aquatic Species	Annual Forbs	Annual Forb Vines	Perennial Forbs	Perennial Forb Vines	Annual Grasses*	Perennial Grasses*	Perennial Ferns or Fern Allies	Shrubs	Trees	Woody Vines
Deep Eddy	53	30	12	4	0	8	0	7	2	3	4	0	10	12	7
Austin High	124	89	28	3	4	21	1	31	8	4	12	0	13	20	10
Cesar Chavez	148	91	24	13	2	11	0	28	5	4	20	0	32	35	11
City Hall Strip	89	53	19	2	2	9	0	16	4	2	8	0	21	21	6
Hotel Slope	56	36	12	3	3	4	0	10	3	0	8	0	7	13	8
Rainey	60	46	8	1	1	7	0	10	5	1	7	0	7	15	7
Festival Beach	122	86	21	5	5	18	0	25	5	3	17	0	15	27	7
Holly Shores	115	79	24	6	1	18	0	30	5	3	14	1	12	25	6
Southeast Shore	168	114	30	4	6	25	0	36	7	7	23	1	26	30	7
The Cliffs	118	75	23	4	1	14	0	23	5	6	10	1	24	27	7
Southcentral Shore	73	49	16	3	1	5	0	9	3	2	8	0	14	23	8
Auditorium Shores	93	69	16	4	3	12	1	20	4	5	9	1	11	21	6
PARD Woodland	67	48	12	1	2	6	0	12	5	1	6	0	8	21	6
Zilker East	92	69	13	3	2	9	0	22	4	1	8	0	14	22	10
Zilker West	87	65	14	2	1	18	0	16	4	3	8	1	10	19	7

*Or grass-like species.

SUMMARY OF HIGH PRIORITY LAND MANAGEMENT TASKS FOR ALL UNITS

[E & R] Use downed material as mulch to increase organic matter in the soil where it has been eroded or depleted.

[R & I] Passively reduce patch size and health of Johnsongrass and giant reed through increased density of the native canopy.

[R] Annual mulching under trees that are currently without an herbaceous layer.

[E] Stabilize trail and eliminate crushed granite deposition off-trail.

[U] Ensure there is formal access along the water's edge in every unit where feasible to enhance the user experience and reduce degradation from informal access to the sensitive shoreline area.

[U, E, & R] Where the trail is impacting the water's edge or is next to a steep slope, move the trail farther inland by reducing trail width (where practical) and/or moving the trail inland as space allows to increase riparian area and reduce degradation of the shoreline.

[R] Consider the majority of the study area as part of the Grow Zone and work towards a fully functional riparian area.

[R] Demarcate existing Grow Zones (defined on page 27) as well as those being added and ensure coordination of land management activities between PARD and Watershed Protection.

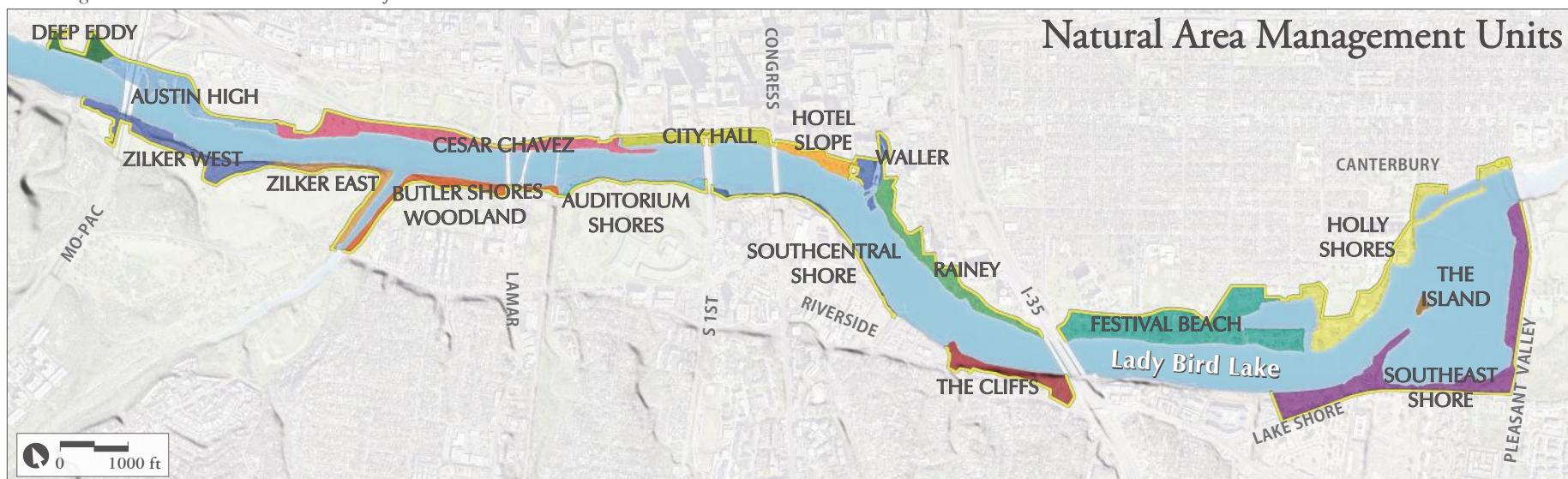
[R] Reduce the amount of underutilized mowed areas wherever feasible and restore areas to Floodplain Terrace Woodland or Shoreline Woodland, depending on location.

[R] Increase diversity of plants beneficial to wildlife through seeding and live planting with special attention to areas around the Trail, park infrastructure, the Lake, and creeks.

[I] Monitor for invasives biannually and address new issues as they arise. This will require ensuring that resources are available on an ongoing basis for these activities.

[R & I] Where tree establishment is occurring, control for invasives and thin more common trees to allow for the establishment of a more diverse canopy.

Figure 4.2: Natural Area Management Units. Sources: COA, NAIP. Note: While The Island is considered part of the study area, because of its remoteness and other high priorities, no management recommendations were made for The Island at this time.



DEEP EDDY UNIT

The Deep Eddy Unit consists of the western portion of Eilers Park (the eastern portion of which contains Deep Eddy pool) and woodland areas on the western edge of the park and south of Butler Creek Trail (Figure 4.3). The unit also includes a woodland area east of Eilers Park that is fenced off and a community garden, neither of which were included in the description and recommendations below. Recommendations are made for 1.3 acres of the 4-acre unit (Figure 4.5).

Ecology

Eilers Park is a mowed area, but contains a 60" diameter cottonwood and several smaller trees. The woodland section is just under 1 acre of the 1.7 acres inventoried (which excludes the fenced-off area and community garden) and is on a short, steep slope to the Lake. Current overstory trees of the wood-

land include sugar hackberry, pecan, American elm, and Chinaberry. Chinese tallow, black willow, and bald cypress are common along the shore. It is not a very dense shoreline woodland, with fewer than 5 trees per 100 ft of shoreline. The woodland is dominated by small trees, with only 6 protected trees in the woodland. The understory consists primarily of cherry laurel, along with white mulberry and Texas redbud along the Trail. There are also substantial patches of American elm regeneration. The slope from the Trail to the Lake is relatively steep. The most distinguishing feature of this management unit is the proliferation of vines that cover much of the natural area. English ivy is an abundant groundcover and many trees and shrubs are shrouded in peppervine, poison ivy, mustang grape, Virginia creeper, and sweet autumn clematis (Figure 4.4). Large metal scraps and the remains of a short

limestone wall within the woodland suggest that this area was once heavily managed or manicured.

Invasive Species

Invasive species pose a significant threat in this management unit. A large catchlaw vine infestation at the entrance of Eilers Park is one of only 5 documented locations for the species within the study area. Sweet autumn clematis is another invasive vine found in the unit. It, along with several native vine species, is smothering many of the trees along the Trail. Chinese tallow is found along much of the shoreline, with an especially large infestation in the southwest corner of the unit. Chinaberry is also common in the overstory farther inland. Loquat is

Figure 4.3: Deep Eddy Management Unit boundaries. Sources: COA, NAIP



Table 4.3: Tree summary for all trees $\geq 8"$ diameter in the Deep Eddy Unit. *Excludes the 2.3 acres of community garden and fenced-off woodland.

Tree Summary

Unit area	1.7 acres*
Total trees	90
Trees/acre	53
Basal area	66 ft ² /acre
Average diameter	13"
Protected tree count	7
Heritage Tree count	3
Trees/100' of shoreline	4.8
Canopy cover	57%
Shaded trail	36%
Woodland area	0.95 acres
Trees/acre in woodland	86
Non-woodland area	0.75 acres
Trees/acre non-woodland	11

quite common in this unit. There are also several large, very dense patches of giant reed along the shoreline and north and west of Eilers Park.

Disturbance

Though there are relatively steep slopes within this unit, they are currently stable and do not show signs of excessive erosion.

Management Recommendations

The primary management goals in this area are to increase both the size and ecological health of the woodlands. Underutilized portions of Eilers Park can be converted to woodland, and the health of the woodlands can be improved through a combination of addressing invasive species issues, managing the abundant vines, and, eventually, increasing biodiversity by seeding and planting.

Land Management Tasks

[R] Increase area and canopy cover of the woodlands in lower section of Eilers Park. **High priority**

[I] Remove catclaw vine at the entrance to Eilers Park. **High priority**

[U & R] Cut grape vines off some of the trees south of trail, use this as an opportunity to cut “windows” through the vegetation so that the Lake can be seen from Deep Eddy Pool area. **High priority**

[I & R] Remove giant reed along shoreline. This action will necessitate bank stabilization, planting, and seeding in the following years. **Medium priority**

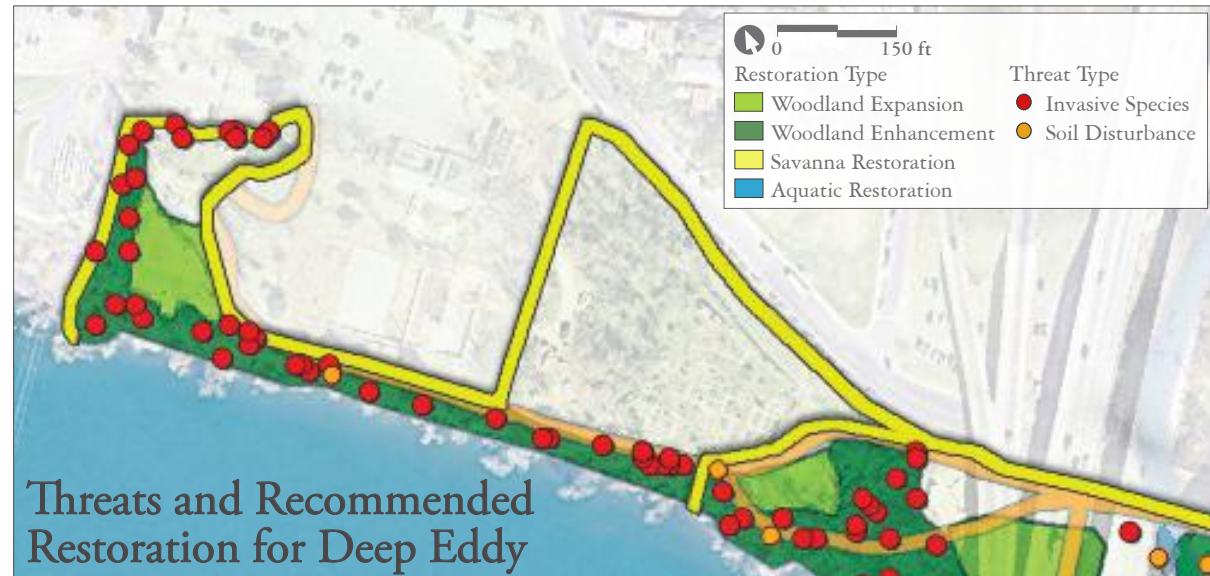
[I] Remove Chinese Tallow and Chinaberry in woodland. **Low priority**

[R] Increase diversity of existing woodland—will become higher priority after the above issues are addressed. **Low priority**

[I] Remove English ivy. Not worth the soil disturbance at this time. **Not recommended**



Figure 4.4 (Left): Abundant vines cover much of the Deep Eddy Unit. Figure 4.5 (Below): Invasive species, erosion issues, and recommended restoration work in the Deep Eddy Unit. Sources: COA, NAIP.



AUSTIN HIGH UNIT

The Austin High Unit lies between Veteran's Trail to the north, the community gardens to the west, the Lake to the south, and the boat ramp to the east (Figure 4.6). The far western extent of the unit is part of Eilers Park, but the remainder is part of Lamar Beach at Lady Bird Lake Metro Park. MoPac and Johnson Creek cross the unit, Austin High is just to the north, and there is a rowing facility within the unit. The unit includes 12.2 acres with recommendations here for 10.2 acres and aquatic restoration recommended in an additional 2.8 acres (Figure 4.9).

Ecology

This management unit primarily consists of woodland, 8.7 acres, except for the area under the MoPac bridges. To the west of MoPac, the woodland is primarily young sugar hackberry with some older pecans and a dense understory of roughleaf dogwood, cherry laurel, and poison ivy. The woodland is on

a steep slope down to the shoreline, where bald cypress is dominant. The central section of the unit slopes steeply from the Trail down to a relatively wide and flat woodland that fingers out into the Lake. These low peninsulas have some of the wettest soils in the study area and some of the most intact, diverse woodlands with a mixture of box elder, sugar hackberry, American elm, black willow, and invasive Chinese tallow. The wettest portion, near the mouth of Johnson Creek, is primarily young box elder and black willow, with a thick groundcover of poison ivy, inland sea oats, false-nettle, and giant ragweed along with invasives including elephant ear, Mexican petunia, and sweet autumn clematis. Several seasonal pools on the peninsula are among the only such features found in the study area. Farther upland, the woodland is heavily dominated by sugar hackberry, with abundant cherry laurel in the shrub layer.

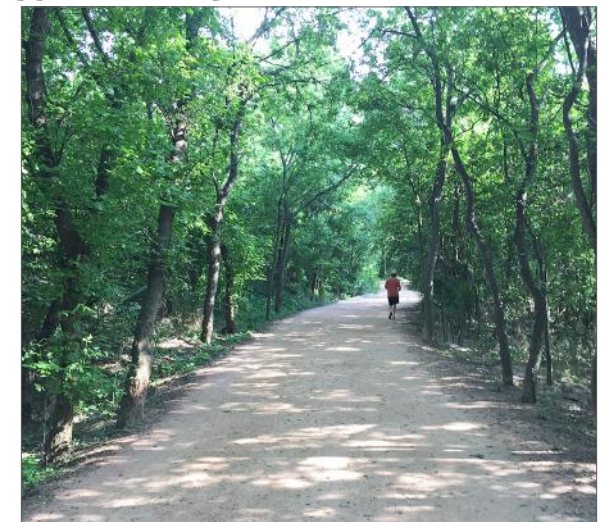
Figure 4.6: Austin High Management Unit boundaries. Sources: COA, NAIP.



Table 4.4: Tree summary for all trees $\geq 8''$ diameter in the Austin High Unit.

Tree Summary	
Unit area	12.2 acres
Total trees	917
Trees/acre	75
Basal area	87 ft ² /acre
Average diameter	13"
Protected tree count	154
Heritage Tree count	61
Trees/100' of shoreline	7.5
Canopy cover	71%
Shaded trail	71%
Woodland area	8.7 acres
Trees/acre in woodland	104
Non-woodland area	3.5 acres
Trees/acre non-woodland	3

Figure 4.7: The dense woodlands in much of the Austin High unit shade the Trail, making it one of the most pleasant and popular stretches along the Trail.

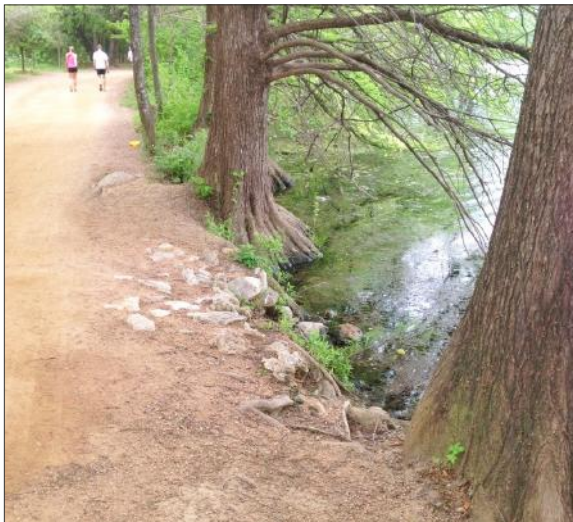


The numerous inlets and peninsulas in this management unit result in nearly 4,000 ft of shoreline. With 7.5 trees per 100 ft of shoreline, it is one of the most densely treed sections of shoreline in the study area. Bald cypress is abundant in the unit, including numerous Heritage Trees. The Trail is extremely close to the shoreline in the eastern portion of this unit, providing little room for riparian vegetation and in some cases spilling decomposed granite directly into the Lake (Figure 4.8). Though there is little terrestrial riparian vegetation, there are several aquatic plant species present. Native species include American water-willow, Emory sedge, and pickerel weed (which is native to Texas, but not to Travis County).

Invasive Species

Invasive species in this unit include: elephant ear, Mexican petunia, and Chinese tallow. Sweet autumn clematis is also abundant on the peninsulas.

Figure 4.8: Decomposed granite covering riparian vegetation and falling directly into the Lake.



Several aquatic invasives are found along the eastern section of the unit, including yellow iris, and alligator-weed. Chinaberry is present primarily on the edges of the woodland, and heavenly bamboo is present throughout much of the upland forest.

Disturbance

Several heavily used informal trails connect Veterans Drive to the Trail (Figure 4.10). These trails are quite wide in some areas and have compacted soils. Additional informal trails are found on the peninsulas. One heavily used trail goes to a wooden landing at the water's edge, suggesting that it was at one time a formal trail. Several other more lightly used trails lead farther onto the peninsulas, some leading to trash and debris from former encampments. High water events have also deposited large amounts of trash on the peninsulas and led to bank erosion along Johnson Creek.

Management Recommendations

Management in this area should focus on enhancing the relatively intact woodland in this unit while addressing acute issues. In the woodlands and associated aquatic areas, efforts should focus on invasive species removal, general cleanup, and increasing plant diversity through planting and seeding. In the eastern portions of the unit, the Trail should be shifted several feet inland and the trail surface should be stabilized. This change will necessitate restoration plantings. Two informal trails between Veterans Drive and the Trail and one in the wooded peninsulas should be formalized and the rest should be decommissioned. As resources become available, the area under MoPac can be restored. Work under the highway has great potential to expand the natural areas but will need to address stormwater issues, soil decompaction, and a lack of direct sun for most of the area.

Figure 4.9: Invasive species, erosion issues, and recommended restoration areas in the Austin High Unit. Sources: COA, NAIP.





Figure 4.10: One of several of the heavily used informal trails between Veteran's Drive and the Trail.

Land Management Tasks

{U, E, & R} Move edge of Trail inland several feet where feasible to create more habitat for riparian plants. This can be accomplished through a combination of reducing the width of the Trail and moving it inland.

High priority

{E} Stabilize Trail and eliminate crushed granite deposition off-trail.

High priority

{R} Plant riparian areas between moved trail and water's edge. Temporary signage and/or fencing may be needed to discourage trampling until plants become established. **High priority**

{U, E, & R} Formalize the two major informal trails leading from Veterans Drive to the Trail and restore others with a combination of brushing, soil decompaction, and planting tree seedlings. **High priority**

{I} Remove catchclaw vine patches before they become a major issue in the area. **High priority**

{R} Increase woodland diversity with special attention to the more intact areas in western portions of the management unit. **Medium priority**

{R} Plant aquatic species to promote greater aquatic plant diversity. **Medium priority**

{U, E, & R} Formalize a portion of the trails on the peninsula and decommission other trails with a combination of brushing, soil decompaction, and planting of tree seedlings. **Medium priority**

{R} Add sediment capture structures near existing wetland to encourage its spread. **Medium priority**

{R} Remove homeless encampment debris on peninsulas. **Medium priority**

{I} Remove Chinaberry and Chinese Tallow throughout area with special attention to those impacting native trees. **Medium priority**

CESAR CHAVEZ UNIT

The Cesar Chavez Unit is bordered by Cesar Chavez Street to the north, the boat launch to the west, the Lake to the south, and Shoal Creek to the east (Figure 4.12). It is crossed by Lamar and the Pfluger Pedestrian Bridge, and it contains the now-retired Green Water Treatment Plant intake buildings that are currently being considered for restoration. The majority of the unit is within Lamar Beach at Lady Bird Lake Metro Park, but the area east of Lamar is in Shoal Beach at Lady Bird Lake Metro Park. The unit is 19.4 acres, with recommendations for 16.5 acres (Figure 4.13).

Ecology

The unit is relatively flat, with large expanses of lawn edged by steep, narrow woodlands sloping down to the Lake. Just under 3 acres of this unit are considered woodland, primarily in a thin 10 to 30-ft strip between the Lake and the Trail. Bald cypress makes up over 40% of the surveyed trees. Of the 187 bald cypress surveyed in the woodland,

Tree Summary

Unit area	19.4 acres
Total trees	745
Trees/acre	38
Basal area	72 ft ² /acre
Average diameter	17"
Protected tree count	232
Heritage Tree count	110
Trees/100' of shoreline	6.7
Canopy cover	46%
Shaded trail	40%
Woodland area	3.0 acres
Trees/acre in woodland	141
Non-woodland area	16.4 acres
Trees/acre non-woodland	20

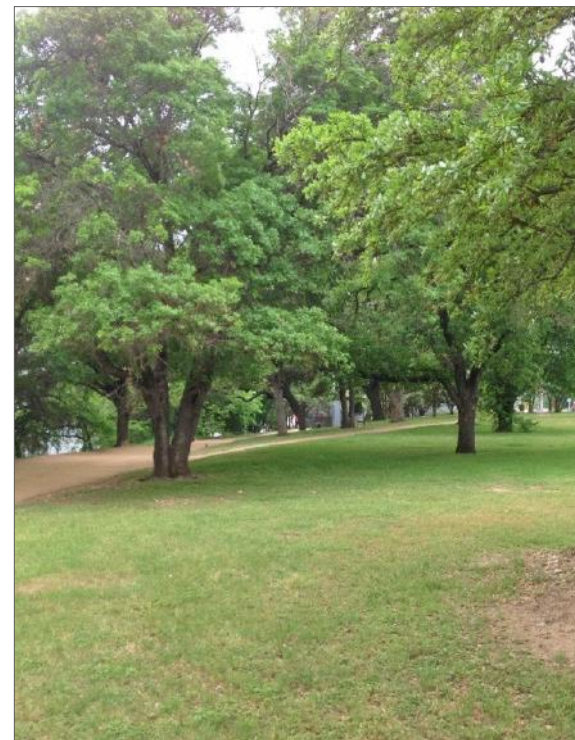


Table 4.5 (Above, left): Tree summary for all trees $\geq 8"$ diameter in the Cesar Chavez Unit. Figure 4.11 (Above, right): The majority of the Cesar Chavez Unit is mowed lawn accented with shade trees. Figure 4.12 (Below): Cesar Chavez Management Unit boundaries. Sources: COA, NAIP.



Land Management Tasks

- [R] Expand woodland throughout the area. **High priority**
- [E & U] Stabilize crushed granite trail to minimize granite deposition off-trail. **High priority**
- [U & R] Move sections of the Trail away from the shore to create more interesting trail, reduce granite deposition onto the sensitive shoreline area, and allow for a wider riparian zone. **High priority**
- [I & R] Remove Chinaberry near Shoal Creek restoration project to reduce potential infestation in newly restored areas. May require tree planting and erosion control blankets. **High priority**
- [R] Amend and decompact soil, plant, and seed areas formerly part of the Trail. **High priority**
- [R] Convert areas recommended for savanna restoration to wildflower meadow management to begin transition towards savanna. **High priority**
- [I & R] Remove Chinese Lacebark elm. Will require extensive lakeshore tree plantings and erosion control blankets. **Medium priority**
- [U & E] Coordinate with Watershed Protection Department to determine need for and proper location of water access. **Medium priority**
- [R] Increase diversity of existing woodland—will become higher priority after the above issues are addressed. **Medium priority**
- [R] Restore savanna on Gaddy soils just east of baseball field. **Low priority**
- [R] Restore savanna area under Mesquite grove southwest of the Austin High baseball field. **Low priority**
- [U & E] Decommission informal trails near Seaholm with a combination of brushing, soil decompaction, and planting tree seedlings. **Low priority**

66 are Heritage Trees. Although it is narrow, the woodland is quite dense, with 141 trees per acre, and contains larger trees than many comparable sections of the study area. Despite their dominance in the canopy, there is very little regeneration of bald cypresses. The understory in the western portion of the unit is dominated by invasive Chinese lacebark elm. Farther east, cherry laurel and roughleaf dogwood are abundant in the understory.

The remainder of the area is managed lawn with scattered shade trees and ornamental plantings (as seen in Figure 4.11), much of which is on Gaddy sandy soils. Pecan and live oak are the most abundant shade trees in the lawn, though Chinese tallow, sugar hackberry, and red oak, are also common. In addition to the more common shade tree species, the area west of the baseball field contains one of the few mesquite groves found in the study area. Tree plantings by The Trail Foundation, the most recent taking place in 2012, contain a mixture of native (bur oak) and native but out of natural range (Mexican white oak) trees.

Figure 4.13: Invasive species, erosion issues, and recommended restoration areas in the Cesar Chavez Unit. Sources: COA, NAIP.



The peninsula at the mouth of Shoal Creek is the site of a restoration project, including native tree plantings as well as restoration of the herbaceous layer. Because the peninsula has already been the focus of extensive planning and restoration work, this report does not make detailed recommendations for that area.

Invasive Species

Invasive trees form a significant component of the woodlands in this unit. Chinese lacebark elm is the most abundant throughout, forming a near monoculture of both saplings and mature individuals in the western portion. There is a large, dense infestation of sweet autumn clematis at the western extent of the unit and smaller patches scattered east of Lamar Boulevard. Elephant ear is common along the shoreline, but less pervasive than in much of the study area. Chinese tallow is common along the shoreline, both as dense stands and as scattered individuals. Invasive species are also posing a threat to the restoration project at Shoal Creek. Johnsongrass and elephant ear are already common, and nearby infestations of Chinaberry and Chinese tallow are likely serving as undesirable seed sources to the restored area.

Disturbance

There are several informal trails near the Seaholm intake area and occasional informal trails elsewhere. There is some waterside trampling and a culvert resulting in gully erosion just south of the baseball diamond in the western portion of the unit.

Management Recommendations

The area will benefit greatly from expansion of the woodlands into underutilized lawn areas as well as trail alignment alterations that move the Trail away

from commonly wet areas and allow for a larger riparian edge (Figure 4.14). As resources become available, restoring savanna plant communities in the Gaddy soils can make this a unique site among protected lands in Travis County.

Figure 4.14: The Trail is extremely close to the Lake in parts of the Cesar Chavez unit. Trail realignment would allow for a wider riparian edge.



CITY HALL UNIT

The City Hall Unit is bordered by Cesar Chavez Street to the north, Shoal Creek to the west, the Lake to the south, and Congress Avenue to the east (Figure 4.15). The unit makes up the majority of the Shoal Beach at Lady Bird Lake Metro Park. It is crossed by South 1st Street, has overhead powerlines running through its length, and is heavily influenced by downtown. The unit consists of 7.7 acres, with 6 acres recommended for specific natural area management tasks along with 0.3 additional acres of aquatic restoration (Figure 4.17).

Ecology

The City Hall Unit's woodland is a thin strip between the Trail and the Lake ranging from approximately 8 to 35 ft wide. Only 1.3 acres of this unit are currently woodland. The woodland area is heavily impacted by invasive species. East of 1st Street the understory is dense and almost entirely golden rain tree. West of 1st Street the understory is less dense but also more diverse, with sugar hackberry, American elm, cedar elm, huisache, box elder, green

ash, and Spanish oak. Bald cypress is present but is less abundant here than comparable areas. Only 11 bald cypress were recorded out of 168 inventoried trees (6%), whereas bald cypress made up 42% of inventoried woodland trees in the Cesar Chavez Unit and 19% in the Austin High Unit. The woodland is composed primarily of small trees, with 64% of trees surveyed falling between 8 and 14" diameter. This unit has fewer trees along the shoreline than other similar units.

North of the Trail is steeply sloping lawn with both older and newly planted trees and shrubs. The older plantings include exotic species such as crepe myrtle, Bradford pear, and golden rain tree. The recent plantings by The Trail Foundation include live oak, cedar elm, desert willow, flameleaf sumac, evergreen sumac, Texas kidneywood, Mexican-olive, and anacacho orchid tree. Portions of the lawn are managed as wildflower meadows, with spring mowing delayed until after wildflowers have gone to seed (Figure 4.16).

Invasive Species

In the woodland area, invasive species infestation is extensive, with 26 inventoried invasive trees per acre. This is by far the highest density of inventoried (≥ 8 " diameter) invasive trees in the study area. Golden rain tree is rampant between 1st Street and Congress Avenue (Figure 4.18). Chinese lacebark elm, Chinese tallow, sweet autumn clematis, and giant reed are present, along with substantial stands of elephant ear at the Lake's edge. Chinaberry is another common woodland invader and is also present in the mowed areas.

Disturbance

There is gully erosion just west of Congress Avenue Bridge (Figure 4.19). The lawn area just east of Shoal Creek has been used as a staging area during restoration work at Shoal Creek and has compacted soils.

Figure 4.15: City Hall Management Unit boundaries. Sources: COA, NAIP.



Management Recommendations

Planting of native trees, invasive species treatment and erosion control are urgently needed in this unit. The area provides an opportunity to add many trees to a highly urban census tract that was deemed a high priority area for tree planting by Austin's Urban Forestry Program (Halter 2014). Due to the

extent of infestations, removal of giant reed and invasive trees will need to be accompanied by substantial erosion control efforts and plantings. In addition, the underutilized, steep lawns can be converted to woodland. Plant selections should complement the recently planted native shrubs and, where necessary, should be appropriate for planting under powerlines. Trail alignment and stability also need to

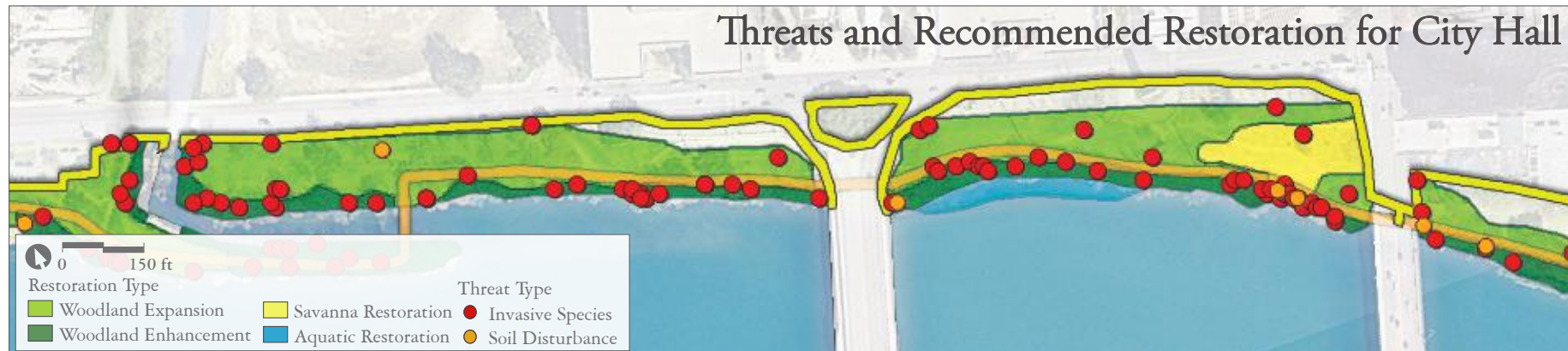
be addressed in this area. Finally, the western-most portion of this area, adjacent to Shoal Creek, is in need of soil remediation and decompaction from use as a staging area. This western portion offers great potential for restoration and further aesthetic improvements to the natural areas.

Tree Summary

Unit area	7.7 acres
Total trees	247
Trees/acre	32
Basal area	49 ft ² /acre
Average diameter	15"
Protected tree count	54
Heritage Tree count	22
Trees/100' of shoreline	5.2
Canopy cover	46%
Shaded trail	63%
Woodland area	1.3 acres
Trees/acre in woodland	131
Non-woodland area	6.4 acres
Trees/acre non-woodland	13



Table 4.6 (Above, left): Tree summary for all trees $\geq 8"$ diameter in the City Hall Unit. Figure 4.16 (Above, right): Some sections have a delayed mowing schedule to allow for spring wildflowers. Figure 4.17 (Below): Invasive species, erosion issues, and recommended restoration areas in the City Hall Unit. Sources: COA, NAIP.



Land Management Tasks

[I & R] Manage and remove golden rain tree, Chinese tallow, and Chinaberry. Initial treatment should focus on removal from around native trees. Secondary treatment should include the entire area. Treatment must be coupled with erosion control and restoration plantings due to the extent of the issue. **High priority**

[E & U] Stabilize Trail to eliminate crushed granite deposition off-trail. **High priority**

[R] Expand woodland throughout area, with species selection meeting height limits set by Austin Energy due to overhead powerlines. Aesthetics and seasonal color should also be considered due to the high visibility of the area. **High priority**

[E & R] Decomact soils used as a staging area in the western extent of the unit and plant and seed for woodland expansion. **High priority**

[E] Stabilize gully west of Congress Avenue Bridge. **High priority**

[R] Convert areas recommended for savanna restoration to wildflower meadow management to begin transition towards savanna. **High priority**

[E & U] Move the Trail inland where topography allows to expand the riparian area. **Medium priority**

[I & R] Remove giant reed. This action will necessitate bank stabilization, planting, and seeding in the following years. **Medium priority**

[U & E] Coordinate with Watershed Protection Department to determine need for and proper location of water access. **Medium priority**

[R] Increase diversity of existing woodland—will become higher priority after the above issues are addressed. **Low priority**

[R] Add sediment capture structures near existing wetland to encourage its spread. **Low priority**

[R] Plant aquatic species to promote greater aquatic plant diversity. **Low priority**



Figure 4.18 (Above): Golden rain tree dominates much of the woodland in the City Hall Unit.

Figure 4.19 (Below): Gully erosion west of Congress Avenue Bridge.



HOTEL SLOPE UNIT

The Hotel Slope Unit is bordered by the Radisson and Four Seasons to the north, Congress to the west, the Lake to the south, and the Austin Rowing Club Boat House to the east (Figure 4.20). It includes numerous trails to the hotels, as well as the boat dock for the Austin Rowing Club, and is entirely within the Waller Beach at Lady Bird Lake Metro Park. The unit consists of 4.8 acres with land management recommendations over 3.1 acres described here (Figure 4.22).

Ecology

The wooded riparian strip between the Trail and the Lake makes up only 0.9 acres of this unit. The majority of the woodland is between 20 and 30 ft wide, but the eastern extent widens to nearly 70 ft.

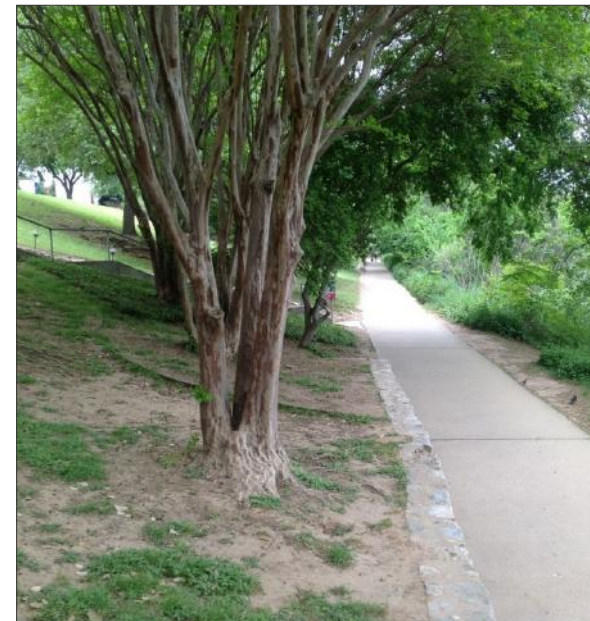
The size distribution within the woodland is distinct from many other sections of the study area. There are comparatively few trees per acre, but they have an average diameter of 19". There are relatively few medium-size trees, but numerous shrubs, small trees, and vines give the impression of a dense woodland. Grape vine is particularly dense and weighing down trees in some cases.

The unit has comparatively few shoreline trees, with 2.9 trees per 100 ft. The quality of woodland improves from west to east as invasive species density decreases and the amount of bald cypress and green ash increases, both in the understory and the canopy. The banks of the western portion of woodland are steep and narrow. At the eastern end, the shore-

Tree Summary

Unit area	4.8 acres
Total trees	135
Trees/acre	28
Basal area	66 ft ² /acre
Average diameter	19"
Protected tree count	36
Heritage Tree count	17
Trees/100' of shoreline	2.9
Canopy cover	69%
Shaded trail	72%
Woodland area	0.9 acres
Trees/acre in woodland	40
Non-woodland area	4.0 acres
Trees/acre non-woodland	25

Figure 4.20 (Below, left): Hotel Slope Management Unit boundaries. Sources: COA, NAIP. Table 4.7 (Above, right): Tree summary for all trees $\geq 8"$ diameter in the Hotel Slope Unit. Figure 4.21 (Below, right): The Hotel Slope Unit is characterized by sloping lawns, with a narrow woodland between the Trail and Lake.



line is very low, and many small green ash grow in shallow water. Tule has formed large colonies near the boat docks. Other naturally occurring species include: American water-willow, false nettle, Emory sedge, tall aster, climbing hempweed, American germander, major plantain, and tall water-primrose. Planted species include: bushy bluestem, Lindheimer's muhly, and eastern gamagrass. The majority of the area that is not currently woodland contains moderately sloping St. Augustine and Bermuda grass lawns maintained by the neighboring hotels, with shade from live oak, cedar elm, crepe myrtle, and other planted trees. Although they are currently maintained by the hotels, these lawns are public parkland.

Land Management Tasks

[R] Expand riparian woodland upslope.

High priority

[I] Remove golden rain tree. **High priority**

[I] Cut grape vines. **High priority**

[I] Remove common chaste tree. **Medium priority**

[E] Decommission informal trails with a combination of brushing, soil decompaction, and restoration plantings. **Medium priority**

[R] Add sediment capture structures near existing wetland to encourage its spread.

Medium priority

[R] Increase diversity of existing woodland—will become higher priority after the above issues are addressed. **Low priority**

[R] Plant aquatic species to promote greater aquatic diversity. **Low priority**

Invasive Species

Common chaste tree is pervasive in the unit, with several individuals in the maintained hotel lawns as well as a large infestation at the western end of the herbaceous wetland. Within the wetland, elephant ear and giant reed are plentiful. Alligator weed was also observed. Sweet autumn clematis was found both near the wetland and in the central portion of the unit. The western end of this unit is dominated by golden rain tree in the understory and canopy.

Disturbance

The main form of disturbance in this unit is informal trails between the Trail and the shore. There is also sheet erosion that has exposed tree roots in several parts of the parkland mowed by the hotels.

Management Recommendations

The unit's ecological function and user experience can be improved by converting portions of the Bermuda grass and St. Augustine lawn area to woodland. Increasing the amount of woodland would also support the work of the City's Urban Forestry Program, which has deemed the census tract containing the Hotel Slope Unit a high priority for tree planting (Halter 2014). In addition, repair and improvement of dilapidated water access points would improve the user experience and reduce trampling issues. The wetland area near the boat docks can be protected and enhanced through the addition of sediment capture structures and aquatic plantings.

Figure 4.22: Invasive species, erosion issues, and recommended restoration areas in the Hotel Slope Unit. Sources: COA, NAIP.



WALLER CREEK UNIT

The Waller Creek Unit is bound by residential and commercial buildings to the north, the Austin Rowing Club to the west, the Lake to the south, and the Trail to the east (Figure 4.25). The area consists of 5.1 acres and contains sections of Waller Beach at Lady Bird Lake Metro Park and the Waller Creek Greenbelt. While some general recommendations are made here, the area is being substantially planned for by the Waller Creek Conservancy, and therefore the major recommendations look at protecting vital resources and supporting the forthcoming plan (4.26).

Ecology

This management unit is in the process of being radically transformed. Almost the entire site is either construction zone or woodland. It is unique among the management units because it contains almost no lakeshore other than right at the mouth of Waller Creek. The banks of Waller Creek are extremely steep, with abundant erosion problems. The island at the mouth of the creek has high conservation value as a wildlife and bird refuge. Woodland areas contain high levels of invasive species. A thorough tree inventory of this management unit was not included in this project because several tree inventories have recently been conducted on portions of the site. Data for 70 woodland trees are available for the southern portion of the unit, where sugar hackberry and black willow are the most abundant species, fol-

Table 4.8 (Right, above): Canopy cover summary for the Waller Creek Unit. Figure 4.23 (Right, middle): The wooded banks of Waller Creek, looking upstream from the footbridge. Figure 4.24 (Right, below): The ecologically significant wooded island at the mouth of Waller Creek, viewed from the footbridge over the creek. Figure 4.25 (Far right): Waller Creek Management Unit Boundaries. Sources: COA, NAIP.

Tree Summary

Unit area	5.1 acres
Canopy cover	67%
Woodland area	3.1 acres
Non-woodland area	2.1 acres

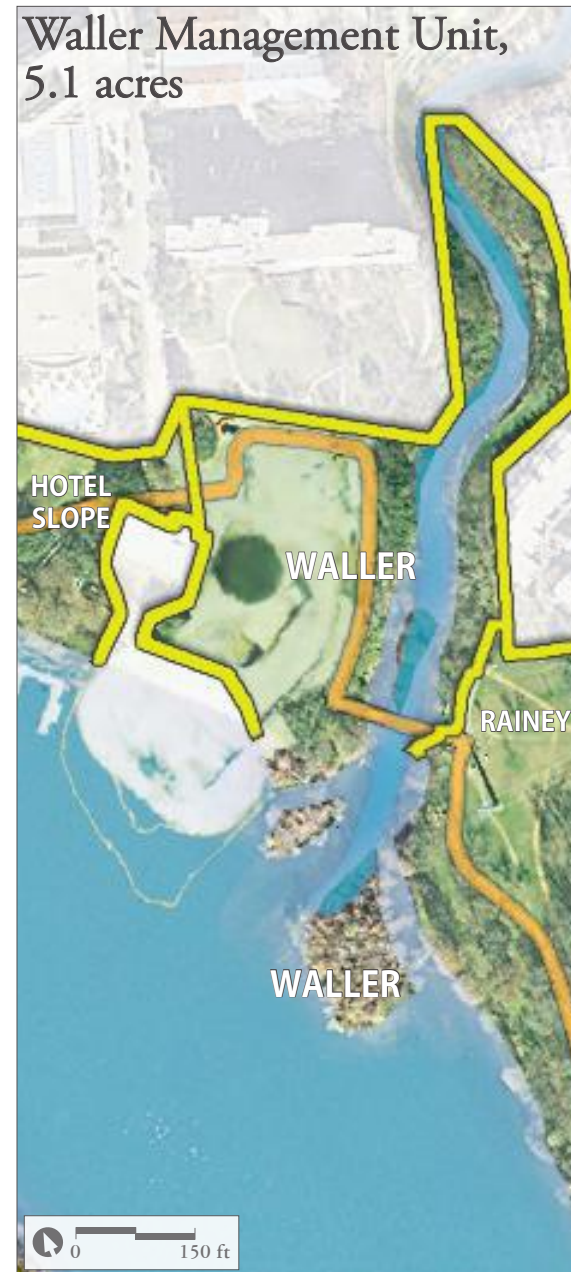




Figure 4.26: Invasive species, erosion issues, and recommended restoration areas in the Waller Creek Unit. Sources: COA, NAIP.

lowed by cottonwood, cedar elm, bald cypress, mulberry, and Chinaberry. The majority of these trees are small, with an average diameter of 13”.

Invasive Species

Several invasive species are abundant in this unit. Perhaps the most concerning is the large infestation of giant reed along the western banks of Waller Creek. The mouth of Waller Creek is also laden with elephant ear and Mexican petunia. On the banks, Chinaberry is common and golden rain tree is present in the northern portion of the unit. Ligustrum, common chaste tree, and heavenly bamboo are present, particularly on the western banks.

Disturbance

The steep banks of Waller Creek, coupled with flashy flows, have led to high amounts of sheet erosion on the eastern upper banks despite armoring on the lower banks. The western banks also suffer from erosion, exacerbated by an extensive network of informal trails.

Management Recommendations

Management in the Waller Creek Unit should support the implementation of plans by the Waller Creek Conservancy and the City of Austin. Goals for management should include protecting the island at the mouth of Waller Creek, enhancing existing wetland communities, stabilizing banks, and addressing rampant invasive species such as giant reed.

Land Management Tasks

[R & I] Ensure island at mouth of creek is protected as plant and wildlife refuge and enhance by increasing plant diversity and managing invasives. **High priority**

[U, E, I, & R] Complement restoration and bank stabilization efforts being planned by Waller Creek Conservancy, the City of Austin Watershed Protection Department, and their partners. **High priority**

[I] Remove Mexican petunia and elephant ear where feasible. **High priority**

[R] Restore herbaceous and shrub layer throughout. **High priority**

[I & R] Remove giant reed on western banks of Waller Creek. This action will necessitate bank stabilization, planting, and seeding in the following years. **High priority**

[I] Remove woody invasive species including Ligustrum, Chinaberry, heavenly bamboo, and common chaste tree on western side of Waller Creek. **Medium priority**

[U & E] Decommission informal trails with a combination of brushing, soil decompaction, and planting tree seedlings west of Waller Creek. **Medium priority**

[R] Add sediment capture structures near existing cattail patch to encourage its spread. **Low priority**

[R] Plant aquatic species to promote greater aquatic plant diversity. **Low priority**

RAINEY UNIT

The Rainey Unit is bound by the banks of Waller Creek to the west, the Lake to the south, I-35 to the east, and various roads and buildings to the north, including East Avenue, Cummings Street, and the Mexican American Cultural Center (Figure 4.27). The unit is entirely within Waller Beach at Lady Bird Lake Metro Park. The site is 12.9 acres, with recommendations here for 11.7 acres and an additional 0.1 acres of aquatic restoration (Figure 4.30). There is no current master plan known for this area although the Waller Creek Plan will likely have impacts on the western portion of the unit. As these plans become known, the recommendations here can be adapted to support that plan as appropriate.

Ecology

This unit contains 3 acres of woodland. Woodland slopes south of the Trail in the central part of the unit are very steep, and many have erosion problems. The steepness does, however, ensure that there is a wider buffer between the Trail and the Lake than occurs along most of the northern shoreline. The woodland in the western portion generally ranges between 50 and 100 ft. The canopy of sugar hackberry, pecan, American elm, and the invasive Chinaberry is generally continuous, with green ash, mulberry, box elder, and American elm near Waller Creek. Slope and soil erosion issues limit groundcover growth. There are 4.3 trees per 100 ft of shoreline, primarily bald cypress and eastern sycamore. Invasive trees form a smaller percentage of the canopy than in many other units. In the western and eastern portions of the unit, there are large expanses of underutilized lawn areas, 1.8 acres and 6.9 acres respectively (Figure 4.28). In the eastern portion, the Trail is within 25 ft of the shoreline and sometimes as close as 10 ft. The trees are sparse between the Trail and Lake in this portion, with no continuous woodland and only 2.3 trees per 100 ft of shoreline.

Invasive Species

While invasive trees only make up a small portion of the surveyed trees, there is an abundance of smaller Chinaberry in the woodland and Chinese tallow is found in the drainage area near East Avenue and as scattered individuals. Multiple giant reed patches on the woodland slopes are likely preventing tree regeneration, and yellow bamboo is present. A large patch of sweet autumn clematis is affecting much of the lakeshore near the mouth of Waller Creek.



Figure 4.27: Rainey Management Unit boundaries. Sources: COA, NAIP.

Disturbance

Several instances of incomplete or failing infrastructure are causing problems within this unit, including dumped culvert material southwest of the Mexican American Cultural Center (MACC) and two crumbling docks. Southeast of the MACC, a long concrete staircase descends to the Shoreline Woodland with no additional infrastructure near the water's edge and has led to a large trampled area (Figure 4.29). In addition to the infrastructure-related issues, there is a



Figure 4.28 (Above): Much of the Rainey Unit is underutilized lawn. Figure 4.29 (Below): Staircase ends without infrastructure to access water, causing extensive trampling.



Tree Summary

Unit area	12.9 acres
Total trees	406
Trees/acre	31
Basal area	54 ft ² /acre
Average diameter	16"
Protected tree count	114
Heritage Tree count	51
Trees/100' of shoreline	4.3
Canopy cover	57%
Shaded trail	47%
Woodland area	3.0 acres
Trees/acre in woodland	81
Non-woodland area	9.9 acres
Trees/acre non-woodland	16

Table 4.9: Tree summary for all trees $\geq 8"$ diameter in the Rainey Unit.

large gully erosion issue in the woodlands. In both the western and eastern flatter portions of the unit, gullies are being created from stormwater runoff. Waterside trampling is an issue throughout the eastern portions of this unit.

Management Recommendations

Converting areas of underutilized lawn to woodland and enhancing the diversity of the existing woodlands are priorities for this unit. This aligns with the work of the Urban Forestry Program, which has deemed the census tract containing the Rainey Unit a high priority for tree planting (Halter 2014). There are multiple erosion issues that need to be addressed before restoration plantings occur. Grading and green infrastructure should be used in western and eastern portions to slow down stormwater entering the areas and address gully erosion. Rill erosion caused by culverts under the Trail can be miti-



Figure 4.30: Invasive species, erosion issues, and recommended restoration work in the Rainey Unit. Sources: COA, NAIP.

gated with armoring and dispersal. The extensive trampling at the bottom of the concrete stairs requires a hardscape or other infrastructure solution, and the network of informal trails needs to be decommissioned and restored. Erosion control efforts will be needed in areas where giant reed removal is recommended. If appropriate, small streamlets in the lawn areas in the western and eastern portions of the unit can be enhanced. On the steep woodland slopes, increasing the herbaceous and understory layers will help control erosion as well as increase woodland diversity.

Land Management Tasks

- [R] Convert underutilized lawn to woodland through planting and seeding west and southeast of the Mexican American Cultural Center and south of East Avenue. This will require added irrigation. **High priority**
- [E] Install green infrastructure in the western and eastern portions of the study area to retain and slow down stormwater as it moves through the unit. **High priority**
- [R] Replace and enhance shade tree cover at terminus of Rainey Street. **High priority**
- [U & E] Add formal water access from base of concrete stairs and restore areas affected by trampling and compaction. **High priority**
- [I] Remove Chinaberry. **High priority**
- [E & R] Enhance the growing streamlets in the western and eastern portions of the management unit through rock placement and plantings appropriate for small ephemeral streams. **High priority**
- [U, E, & R] Decommission informal trails with a combination of brushing, soil decompaction, and planting tree seedlings. **High priority**
- [I] Remove giant reed. This action will necessitate bank stabilization, planting, and seeding in the following years. **High priority**
- [E & R] Stabilize the two principal gullies with green infrastructure that includes a combination of armoring, diversion, swales and retention upslope, and planting. **High priority**
- [R] Increase diversity of existing woodland. **Medium priority**
- [E] Use armoring, diversion and/or dispersal to address erosion caused by numerous small culverts that shunt water under trail. **Medium priority**
- [U & R] Remove old wooden docks. **Low priority**
- [R] Add sediment capture structures near existing cattail patch to encourage its spread. **Low priority**
- [R] Plant aquatic species to promote greater aquatic plant diversity. **Low priority**

FESTIVAL BEACH UNIT

The Festival Beach Unit is bordered by Nash Hernandez Senior Road and Jesse E. Segovia Street to the north, I-35 to the west, the Lake to the south, and the lagoon to the east (Figure 4.31). The unit is part of the Edward Rendon Sr. Metro Park at Festival Beach. It includes three picnic areas, a boat ramp, an old fire station, and the western portions of Fiesta Gardens. The unit is 35.3 acres, with land management recommendation for 21.4 acres and an additional 0.9 acres of aquatic restoration. There is an approved master plan for this area and the adjacent Holly Shores Unit that will eventually include substantial changes to amenities including opening new waterways to the lagoon and adding new trails. The recommendations made here are compatible with these overall goals and revisions can be made as the master plan moves towards implementation (Figure 4.32).

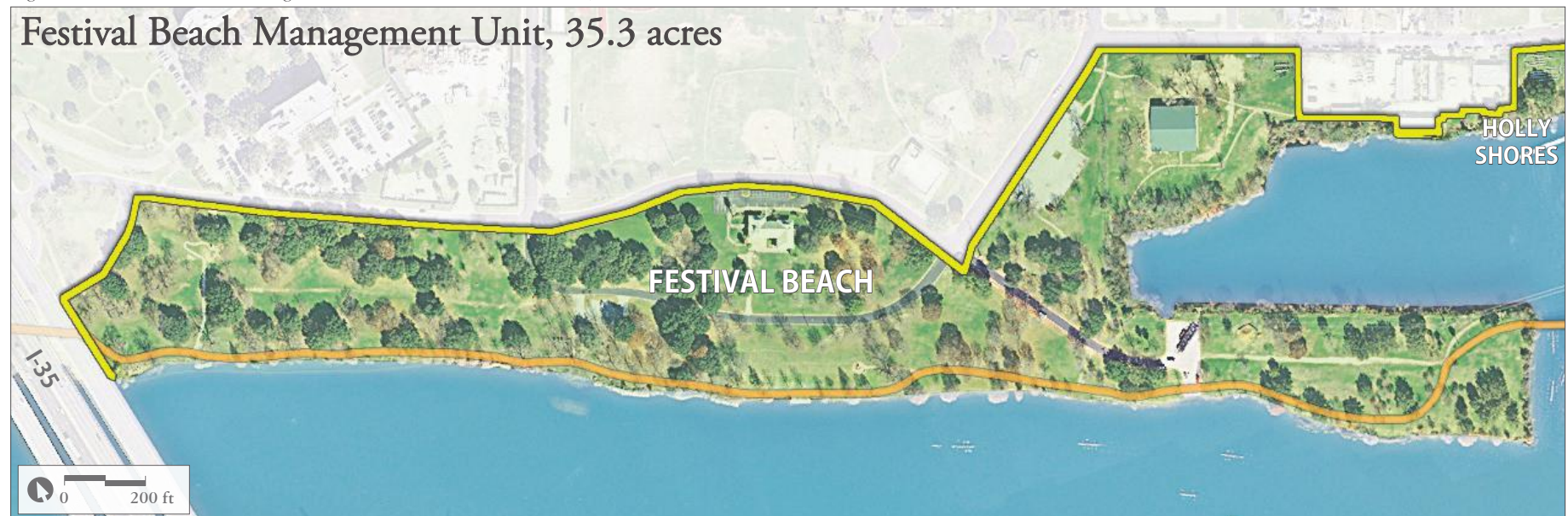
Ecology

This is a relatively flat, wide management unit where the Trail stays very close to the shoreline, with an expansive mowed area to the north. The majority of the Trail is within 15 ft of the Lake and some areas are less than 5 ft from the Lake, like the area shown in Figure 4.33. While there are numerous trees in Festival Beach, including many Heritage Trees, there is almost no continuous canopy and the riparian area is heavily impacted. The proximity of the Trail to the water is degrading existing vegetation, causing trail erosion, and inhibiting regeneration of the woodland canopy and understory plants. There are only 1.8 trees per 100 ft of shoreline, the fewest of any management unit. There are, however, a number of good specimens of bald cypress, pecan,

and other canopy trees scattered along the shoreline. The mowing regime has been recently altered within this area, resulting in dense stands of giant ragweed. As of yet, natural regeneration of native trees has been limited. The Trail Foundation has planted approximately 20 bald cypress trees along the shoreline in recent years, which will help to fill out the riparian canopy as they mature.

There is woodland surrounding the lagoon that is laden with invasive species. In this 1.6 acres of woodland, sugar hackberry is the most abundant tree, followed by bald cypress along the shoreline. Sabal is abundant in this area, likely escaped from the landscaping at Fiesta Gardens. Other trees in the woodland include American elm, live oak, green ash, sycamore, pecan, Chinaberry, and Chinese tal-

Figure 4.31: Festival Beach Management Unit Boundaries. Sources: CAO, NAIP.



low. It is notable that there is substantial regeneration of bald cypress in the woodland along the southern shore of the lagoon. While these are currently small trees, they are protected from mowing and will likely create a substantial change in the canopy in the years to come.

The vast majority of the management unit is mowed lawn, with shade trees and ornamental shrubs throughout (Figure 4.34). Live oak is the most abundant species, though crepe myrtle, pecan, Spanish oak, chinquapin oak, cedar elm, and Chinese tallow are also common. There are 125 Heritage Trees in the Festival Beach lawn, the majority of which are live oaks. Most of the remaining Heritage Trees are pecan or Spanish oak. The overall density of trees and shrubs large enough to be inventoried is 17 per acre, but the distribution of those trees is highly variable. There are several dense groves of live oaks

with almost 30 trees per acre as well as large expanses of open lawn. Under several oak groves there is no groundcover due to leaf litter accumulation, trampling, sheet erosion, and/or lack of sun. This lack of groundcover is causing erosion issues. The mowed area is heavily used in some areas, but many areas are underutilized.

Invasive Species

The shoreline of Festival Beach has lower amounts of invasive species than comparable areas, though Chinaberry, sweet autumn clematis, and elephant ear are common. Ubiquitous Bermudagrass in the area has likely limited the amount of other invasives. There are numerous large Chinese tallow within the mowed area, and recently planted Chinese lacebark elm is a potential issue. Johnsongrass is becoming abundant in areas that have recently changed mow-

Tree Summary

Unit area	35.3 acres
Total trees	722
Trees/acre	20
Basal area	44 ft ² /acre
Average diameter	18"
Protected tree count	293
Heritage Tree count	148
Trees/100' of shoreline	1.8
Canopy cover	41%
Shaded trail	44%
Woodland area	1.6 acres
Trees/acre in woodland	96
Non-woodland area	33.8 acres
Trees/acre non-woodland	17

Table 4.10: Tree summary for all trees ≥8" diameter in the Festival Beach Unit.

Figure 4.32: Invasive species, erosion issues, and recommended restoration work in the Festival Beach Unit. Sources: COA, NAIP.



ing regimes, especially on the southern edge of the lagoon. King Ranch blue-stem is abundant in one such area in the eastern part of the unit.

The woodland around the lagoon has much higher densities of invasive species. Chinese tallow is abundant throughout the woodland and Chinaberry is present, though less pervasive. On the northern shore of the lagoon, these common invaders are joined by tree of heaven at the western edge of the woodland and extremely dense infestations of both confederate jasmine and primrose jasmine near Fiesta Gardens.

Disturbance

The unit contains numerous erosion and soil issues due to stormwater flows and user impacts. The thin area between the Trail and the Lake is severely impacted by informal trails and trampling. There is also substantial trampling around benches that lack appropriate infrastructure. Several areas under dense tree groves are lacking vegetation due to stormwater flows, trampling, and limited light availability. These issues have resulted in many areas with sheet erosion and some progressing to rill and/or gully erosion. Informal trails are abundant on the steep southern shore of the lagoon, creating significant erosion. There is an informal trail as wide as the main Trail extending nearly 600 ft to the east of the boat ramp parking area.

Management Recommendations

Major recommendations for this unit include woodland expansion into some of the large areas of underutilized lawn and relocation of portions of the Trail away from the water's edge to allow for a more stable trail and a healthy riparian edge. Expanding the woodland here is in line with the work of the Urban Forestry Program, which has deemed the census tract containing Festival Beach a high priority for tree planting (Halter 2014). The live oak groves pointed out in Don Gardner's report should be pruned. They are located south of Nash Hernandez Street between I-35 and nearest parking lot, north of the same parking lot to the old Aquatic Center, the Love of Christi Grove, and north of the eastern end of Nash Hernandez, just west of Fiesta Gardens.

Waterside trampling is currently an issue along much of the shoreline, but could be mitigated by simultaneously formalizing several access points to the water,



Figure 4.33: The majority of the Festival Beach unit has only a thin strip of vegetation between the Trail and the shoreline and has scattered trees rather than a continuous canopy.

increasing the density of vegetation in riparian areas, relocating the Trail farther away from the shoreline in selected areas, and restoring damaged areas. Because of the openness of much of this unit, there is the opportunity for small scale grading changes that will reduce the overall impacts of stormwater on the natural areas. There are several long erosion channels in the mowed areas where streamlet enhancement may be appropriate. Overall, invasive species are not currently as problematic in this management unit as in others, but several species should



Figure 4.34: Festival Beach consists primarily of large underutilized lawns.

be addressed quickly before they become worse. Johnsongrass is beginning to take over some of the Grow Zone areas and should be managed so that it does not become rampant as more area is converted to a more natural state. Tree of heaven is uncommon in the study area, but several individuals were found in the natural area around the lagoon at Fiesta Gardens. Swift removal of these trees will help prevent a more substantial infestation.

Land Management Tasks

[R] Convert underutilized lawns to woodland; leave more utilized lawns in current use. **High priority**

[I] Remove Johnsongrass. **High priority**

[R] Mulch and prune pecan trees near covered pavilion and prune live oak groves designated by Don Gardner. **High priority**

[U, E & R] Realign the Trail to create more dynamic experience and allow for greater riparian habitat near the shoreline. **High priority**

[R] Amend and decompact soil, plant, and seed in areas that were formerly part of the Trail. **High priority**

[U, E, & R] Decommission informal trails and informal water access points with a combination of brushing, soil decompaction, planting, and seeding. **High priority**

[I] Remove tree of heaven before it becomes a larger issue. **High priority**

[R] Increase diversity of existing woodland. **Medium priority**

[I] Remove Chinese tallow and Chinaberry. **Medium priority**

[U & E] Coordinate with Watershed Protection Department to determine need for and proper location of water access. **Medium priority**

[E & R] Install bioswales to increase water retention and eliminate numerous erosion issues throughout area while creating small-scale grading changes that increase the diversity of habitat. **Medium priority**

[I] Remove and replace Chinese lacebark elm planted in the mowed areas. **Medium priority**

[R] Add sediment capture structures near cattail patch to encourage its spread. **Medium priority**

[R] Plant aquatic species to promote greater aquatic diversity. **Medium priority**

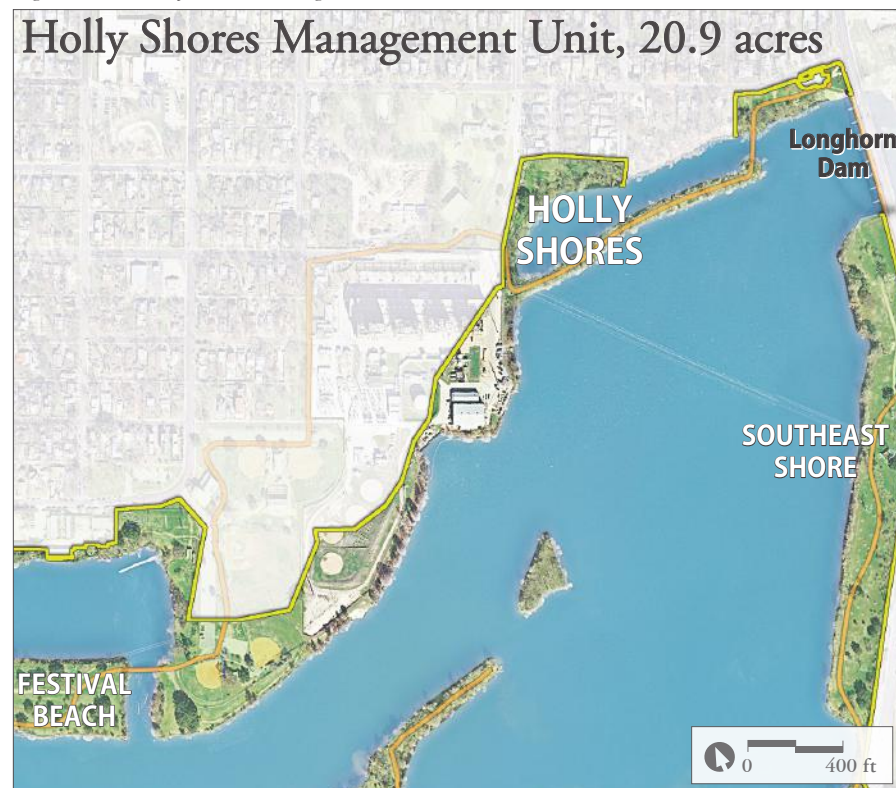
[E & R] Enhance streamlets in existing erosion channels. **Medium Priority**

[U & E] Add hardscape around existing bench just east of I-35 to prevent continued erosion and provide a better view of the Lake. **Low priority**

HOLLY SHORES UNIT

The Holly Shores Unit is bordered on the west by the lagoon, the south by the Lake, the east by Pleasant Valley Drive, and the north by Canterbury Street, private homes, the electric transmission station that is remaining at the former Holly Power Plant, and the Rendon Baseball fields (Figure 4.35). The western portion of the unit is part of Edward Rendon Sr. Metro Park at Festival Beach, and the eastern portion is Holly Shores at Lady Bird Lake Metro Park. The central portion is not currently managed as part of a park. The unit is 20.9 acres, with land management recommendations made for 15.2 acres and an additional 2.7 acres of aquatic restoration (Figure 4.36). The recent Holly Shores Master Plan calls for various amenities and changes to the site including reconfigurations of the baseball fields and reclamation of the former Holly Power Plant area for passive and active recreation. The recommendations made here are compatible with these overall goals and revisions can be made as the master plan moves towards implementation.

Figure 4.35: Holly Shores Management Unit boundaries. Sources: COA, NAIP.



Ecology

The central portion of this unit is dominated by the former Holly Power Plant and recreational fields, while the western section contains a combination of mowed lawn and woodland, and the eastern end is primarily natural area. Only 5.2 acres are currently considered woodland, spread out along the shorelines of the lagoon, the Lake, and the inlet near Longhorn Dam. The woodland in this management unit is comparable in density to much of the study area. American elm is the most abundant species in the eastern section of the unit. Bald cypress is also common throughout, as are sugar hackberry, black willow, box elder, sycamore, live oak, and Chinaberry. The stretch of shoreline directly south of the baseball fields, shown in Figure 4.38, has only 2.5 trees per 100 ft of shoreline. The herbaceous layer in this section is comparatively well-developed, with native sawgrass, water hemlock, false-nettle, tall goldenrod, and Emory sedge.

In the eastern part of this management unit, the Trail crosses a long, narrow peninsula. On the peninsula, 10 to 15 ft on each side of the Trail is mowed, and decomposed granite from the Trail has migrated into the surrounding vegetation in many places (Figure 4.39). The woodland of the peninsula differs slightly from the woodland of the mainland, containing more sycamore trees and invasive common chaste tree. Some of the natural area along the peninsula is in comparatively good condition, with eastern gamagrass, sawgrass, and natural regeneration of bald cypress.

As the power plant lands are opened for restoration and new ball fields, the Trail can be realigned and the two ball fields closest to the Lake can be relocated to Riverview Street.

Invasive Species

Chinaberry is common throughout the woodlands in this unit. Chinese tallow is present on the eastern peninsula but most abundant on the shore of the Fiesta Gardens lagoon. Sweet autumn clematis is also abundant on the peninsula and present in several patches on the shoreline south of the baseball fields. Common chaste tree is more abundant here than in other management units. One of the few occurrences of tree of heaven along the Trail is found at the western end of

Tree Summary

Unit area	20.9 acres	Trees/100' of shoreline	4.5
Total trees	535	Canopy cover	29%
Trees/acre	26	Shaded trail	22%
Basal area	41 ft ² /acre	Woodland area	5.2 acres
Average diameter	15"	Trees/acre in woodland	85
Protected tree count	108	Non-woodland area	15.7 acres
Heritage Tree count	50	Trees/acre non-woodland	6

Table 4.11: Tree summary for all trees $\geq 8"$ diameter in the Holly Shores Unit.

the peninsula. Dense patches of giant reed have been treated in this unit but show signs of regrowth. Elephant ear is abundant in the inlet near Longhorn Dam and present in patches along the majority of the shoreline. The unmanaged areas in the Holly Street Power Plant grounds contain large amounts of Johnsongrass.

Disturbance

The southwest corner of this unit is a heavily trampled informal water access. There are also many informal trails and substantial trampling along the peninsula and on the slopes south of the Canterbury parking area. The peninsula has some bank erosion where giant reed has been treated and is littered with large chunks of concrete that were previously placed for erosion control. The central section of the unit is largely fenced off and therefore has comparatively few informal trails and trampling issues. There is a large gully caused by power plant infrastructure on the eastern edge of the power plant facility.

Management Recommendations

As the site of the former Holly Street Power Plant is converted to parkland, those areas not designated for active recreation will be restored to woodland through planting and seeding. The new trail alignment should meet the criteria recommended here to reduce impact to the natural areas and allow for a substantial riparian edge. In addition, several formal water access points will help protect the newly-restored vegetation by guiding users to appropriate access points.



Figure 4.36 (Above): The woodland along the western edge of the Holly Shores unit contains several large bald cypress. Figure 4.37 (Below): Invasive species, erosion issues, and recommended restoration work in the Holly Shores Unit. Sources: COA, NAIP.





Figure 4.38 (Above): The strip of vegetation between lawn and Lake is extremely narrow south of the baseball fields. Figure 4.39 (Below): Trail material extends well beyond the width of the Trail on portions of the peninsula.



Land Management Tasks

[R] Expand woodlands through planting and seeding of canopy, understory, and herbaceous layers with special attention to those areas retired from the Holly Power Plant and lawn that are now planned for passive recreation and natural areas. **High priority**

[U, E, & R] Reduce the existing trail width to 14 ft, stabilize surface, install connecting trail through former Holly Power Plant area and on to Festival Beach Unit using standards described in management section.

High priority

[E & R] Remove concrete embankments as feasible. **High priority**

[I & R] Continue giant reed removal along with bank stabilization, planting, and seeding. **High Priority**

[R & I] Plant canopy trees around giant reed invasion to shade out reed and enhance woodland canopy. **High priority**

[I] Remove tree of heaven. **High priority**

[E] Utilize open areas to install green infrastructure such as swales and rain gardens where feasible to increase absorption and reduce erosion issues. **High priority**

[R] Increase diversity of existing woodland. **Medium priority**

[R] Plant aquatic species to promote greater aquatic plant diversity, especially in the lagoons. **Medium priority**

[E] Decommission informal trails with a combination of brushing, soil decompaction, and plantings with special attention to the steep areas near the Canterbury parking area. **Medium priority**

[U & E] Coordinate with Watershed Protection Department to determine need for and proper location of water access. **Medium priority**

[R] Add sediment capture structures near cattail patch to encourage its spread. **Medium priority**

[I] Remove common chaste tree, Johnsongrass, Chinaberry, and Chinese tallow. **Low priority**

SOUTHEAST SHORE UNIT

The Southeast Shore is bound by the Lake to the north and west, by Pleasant Valley Drive to the east, and by South Lakeshore Boulevard to the south (Figure 4.40). The unit includes Longhorn Shores, Lakeshore, Peace Point, and International Shores at Lady Bird Lake Metro Park. The Trail Foundation's Southeast Shore Master Plan (adopted in 2014) covers the entire unit, which forms the eastern shoreline of the Lake and wraps around to form the eastern most portions of the southern shore. It includes a peninsula jutting out substantially into the Lake. There are high overhead powerlines running through the site parallel with Pleasant Valley, and local overhead powerlines running parallel with S. Lakeshore Blvd. The Hostelling International Austin building is located within this unit and the Boardwalk starts at the western end of this unit. The unit consists of 30.7 acres and recommendations have been made for 25.4 acres (Figure 4.41).

Tree Summary

Unit area	30.7 acres
Total trees	373
Trees/acre	14
Basal area	28 ft ² /acre
Average diameter	18"
Protected tree count	194
Heritage Tree count	76
Trees/100' of shoreline	3.5
Canopy cover	35%
Shaded trail	21%
Woodland area	5.3 acres
Trees/acre in woodland	70*
Non-woodland area	25.4 acres
Trees/acre non-woodland	11

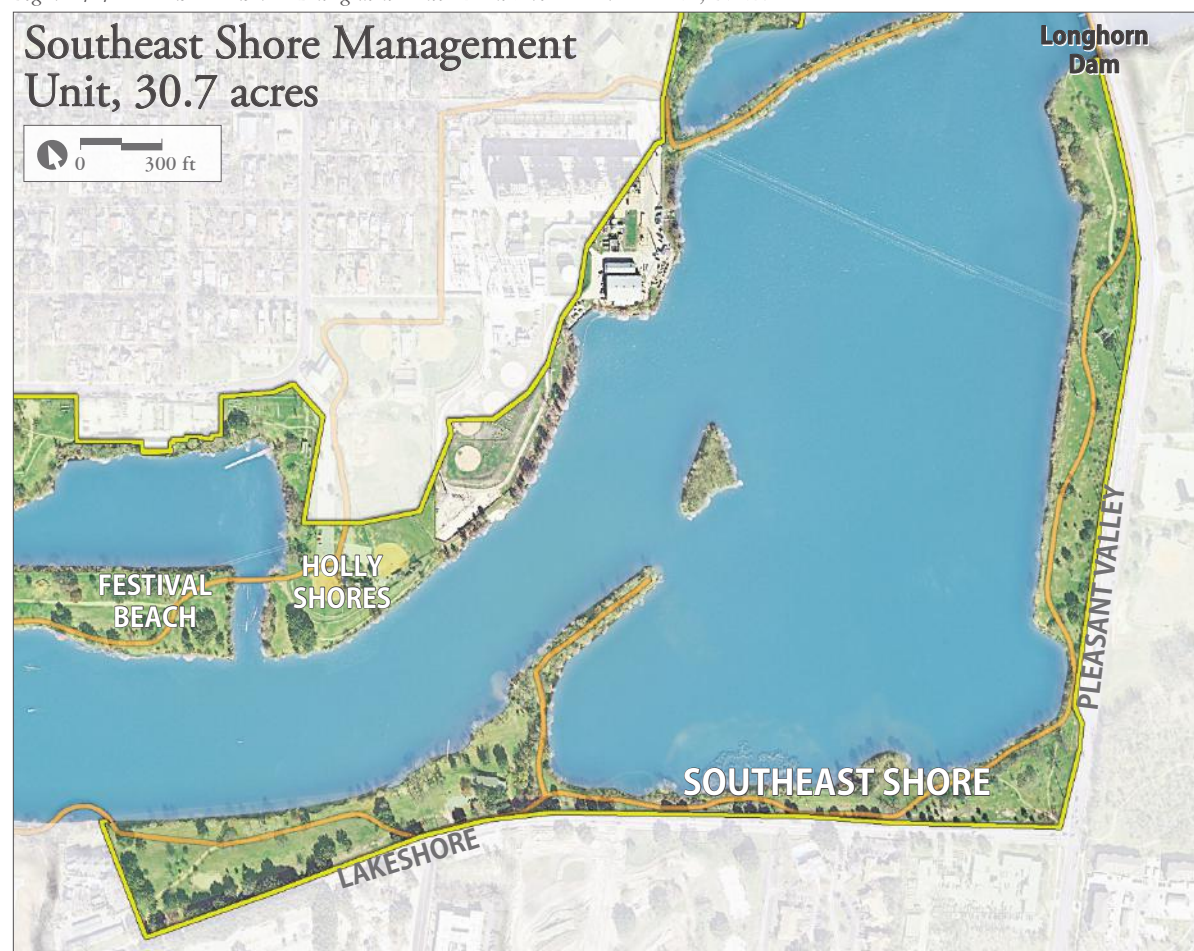
*Table 4.12: Tree summary for all trees ≥8" diameter in the Southeast Shore Unit. *Calculated only for the 1.5 acres inventoried by Siglo Group.*

Ecology

The majority of the area is managed lawn with a variety of planted trees and shrubs with 5.3 acres of woodland. Older plantings throughout the area are primarily crepe myrtle, live oak, and pecan. More recent plantings are a variety of native trees and shrubs, including sycamore, cedar elm, chinqua-

pin oak, Mexican buckeye, Texas kidneywood, and Texas mountain laurel. Aquatic plantings have also been added recently at several locations along the shoreline. The vegetation survey revealed that burrobush, a shrub that has not been documented in Travis County since 1937, is thriving on the uncommon Gaddy soils found in this unit.

Figure 4.40: Southeast Shore Management Unit Boundaries. Sources: CAO, NAIP.



The woodland is primarily a thin strip along the shoreline, often between 5 and 25 ft wide, with the exception of a small area just south of the Trail near the corner of Lakeshore Boulevard and Pleasant Valley. The Shoreline Woodland is dominated by bald cypress, along with American elm, cottonwood, and sycamore. Sugar hackberry is also common farther inland. The western section of the management unit was not included in the tree inventory due to limitations in project scope and because there was

relatively recent tree inventory data available from the City of Austin Parks and Recreation Department (PARD). The 1.7 acres of woodland in the eastern section (running parallel to Pleasant Valley) has only 70 trees per acre, but has a dense understory of box elder, false indigo-bush, buttonbush, roughleaf dogwood, common chaste tree, and false willow along with dense poison ivy, mustang grape, and sweet autumn clematis. PARD data were not available for some of the woodland, but did cover an

additional 2.7 acres, including the peninsula.

The western section of shoreline is not considered woodland as it has only 2.2 trees per 100 ft of shoreline and lacks a well-developed understory. This section gently slopes into the water, and therefore has a comparatively rich aquatic plant community. The City of Austin is currently constructing an ADA accessible fishing pier in this area.

Invasive Species

Giant reed is the most conspicuous invasive species in this management unit, with large, dense stands along much of the unshaded shoreline. Many of the stands have been treated, but are growing back. Sweet autumn clematis is abundant, especially in the eastern woodland. Elephant ear is common along the shoreline. Chinese tallow, chinaberry, and common chaste tree are present throughout the woodlands. Johnsongrass is abundant in grassy areas with recent changes in mowing regime.

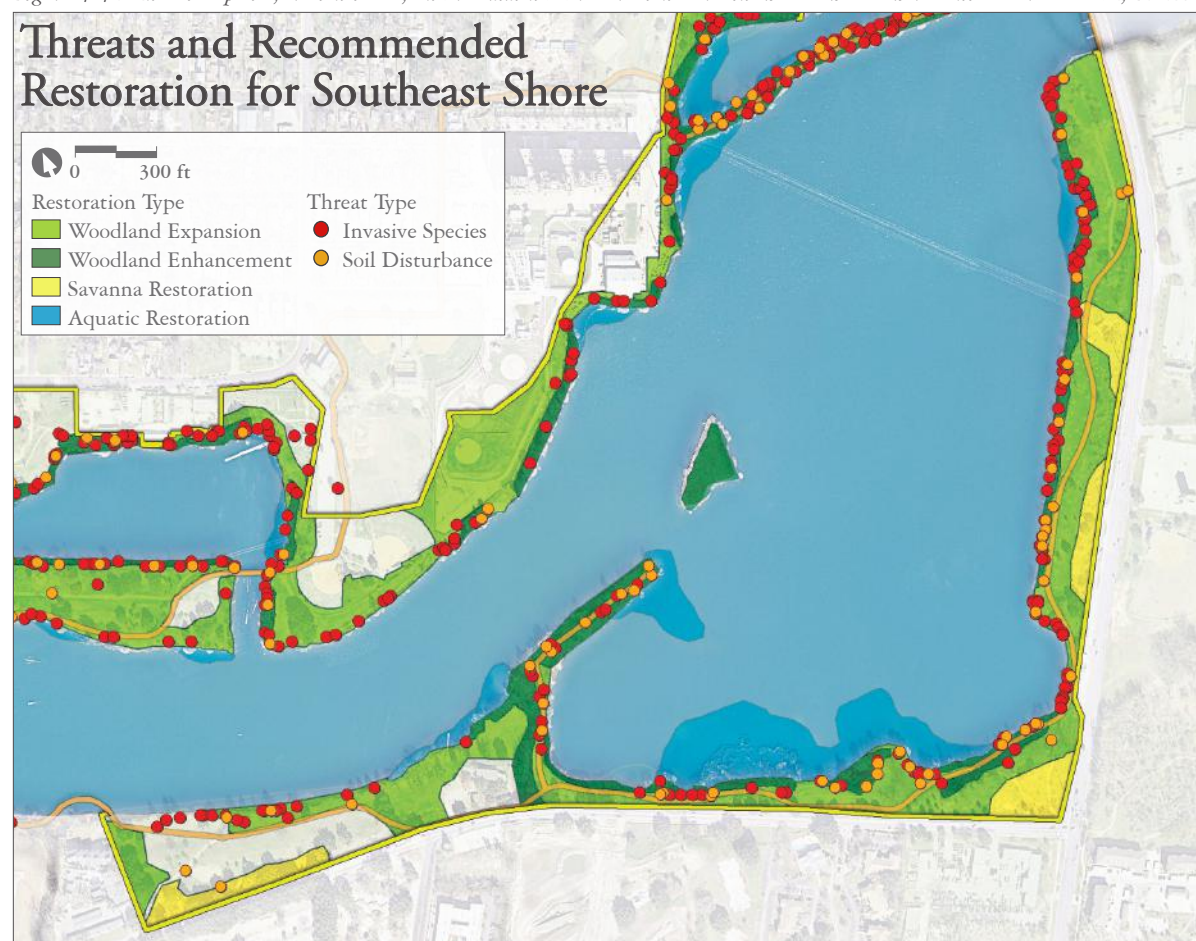
Disturbance

Lack of sufficient formal water access has resulted in numerous informal trails and trampling near the water's edge. The end of the peninsula and the two areas with picnic tables are badly trampled. There is also a large gully on the southern shore and significant erosion underneath a nearby concrete embankment. Bank erosion is common in the southeast portion of the shoreline and along Longhorn Shores, mainly associated with giant reed treatment.

Management Recommendations

Much of the area is recommended for woodland

Figure 4.41: Invasive species, erosion issues, and recommended restoration work in the Southeast Shore Unit. Sources: COA, NAIP.



expansion to increase overall canopy, shading, ecological function, and to passively control giant reed along the shore. Before planting occurs, grading changes should be made at erosion points to slow down and retain water and reduce erosive effects of stormwater. Gaddy soils also occur in this unit, making savanna restoration a long-term goal for

limited areas. Additional recommendations include the continued treatment of giant reed, wetland expansion at multiple sites along the substantial shoreline found in this unit, and pruning of live oak groves near the hostel and between the restroom and the eastern end of the Boardwalk, as identified in Don Gardner's report.

Land Management Tasks

{E & R} Stabilize eroding banks with erosion control fabric and plant additional trees and herbaceous material. **High priority**

{I} Treat Johnsongrass. **High priority**

{R} Expand woodland throughout much of the area, with special attention to the areas behind the hostel, the peninsula, the eastern shore, and the area parallel with Lakeshore Drive east of the hostel. Shorter species will be needed in some areas to accommodate the overhead powerlines. **High priority**

{I & R} Continue removal of giant reed along shoreline. This action will necessitate bank stabilization, planting, and seeding in the following years. **High priority**

{R & I} Plant canopy trees around giant reed invasion to shade out reed and enhance woodland canopy. **High priority**

{E & R} Utilize grading in the upper portions of the unit to retain and slow down stormwater. Plant as appropriate. **High priority**

{E} Stabilize gully erosion using green infrastructure where feasible. Armoring may be necessary in some places. **High priority**

{R} Convert areas recommended for savanna restoration to wildflower meadow management to begin transition towards savanna. **High priority**

{R} Prune live oak groves designated by Don Gardner. **High priority**

{I} Remove sweet autumn clematis, with focus on the eastern woodland. **Medium priority**

{U & E} Coordinate with Watershed Protection Department to determine need for and proper location of water access. **Medium priority**

{R} Install sediment capture structures at edges of existing wetlands and install emergent aquatic plants, using exclosures as needed, as part of wetland expansion pilot project. **Medium priority**

{R} Create a pilot area of Gaddy soil savanna under powerlines in eastern part of unit. **Low priority**

{I} Remove Chinese tallow, Ligustrum, and common chaste tree. **Low priority**

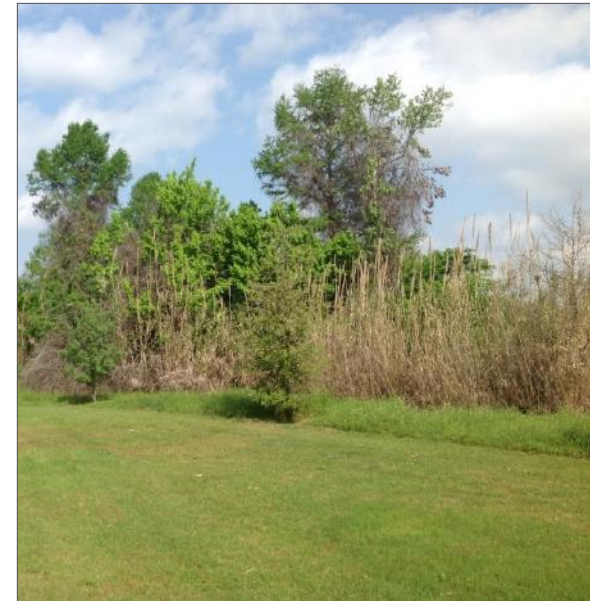


Figure 4.42 (Above): The unit contains many large patches of invasive giant reed. Figure 4.43 (Below): A combination of savanna restoration and woodland expansion is recommended for the mowed area between the Lake and Pleasant Valley.



THE CLIFFS UNIT

The Cliffs Unit is bound by I-35 on the east, the Lake on the north, Blunn Creek on the west, and Riverside Drive, residential lots, and Edgecliff Terrace on the south (Figure 4.44). The unit is within the Norwood Tract at Town Lake Metro Park. The Boardwalk cuts through the unit near Blunn Creek and runs parallel to it over the water to I-35. The area is 8.7 acres, with land management recommendations for 5.6 acres and 0.9 acres of aquatic restoration (Figure 4.47). Recommendations were not made for the dog park or Norwood House lot as their specific uses are incompatible with natural area management and therefore beyond the scope of this project.

Ecology

This is the only unit that contains exposed limestone bluffs (Figure 4.45), defined by the City as Critical Environmental Features. The bluffs have populations of Mexican Buckeye, wafer ash, Eve's necklace, and shrubby boneset, which are either absent or rare along the rest of Trail. The wetland at the mouth of Blunn Creek is undergoing a substantial restoration project by The Trail Foundation (Figure 4.46).

Table 4.13: Tree summary for all trees ≥ 8 " diameter in The Cliffs Unit. *Excludes dog park and Norwood House lot.

Tree Summary	
Unit area	5.6 acres*
Total trees	349
Trees/acre	63
Basal area	70 ft ² /acre
Average diameter	13"
Protected tree count	49
Trees/100' of shoreline	7.6
Canopy cover	89%
Shaded trail	94%
Woodland area	5.6 acres

The wetland contains the globally rare Correll's false-dragonhead. The trees in this area were not inventoried as a part of this project, so the ability to quantify tree density and type is limited. The riparian woodland along the Boardwalk contains bald cypress, black willow, green ash, and American elm and has 7.6 trees per 100 ft of shoreline.

Invasive Species

Invasive species are rampant in this unit. An impressive catclaw vine infestation is blanketing a large area (over $\frac{1}{4}$ acre) about 400 ft east of the mouth of Blunn Creek and there are several smaller patches of it along the Boardwalk spur leading to Riverside Drive (Figure 4.48). Both sweet autumn clematis and Japanese honeysuckle are also mixed in with the catclaw, adding to the thick mat of vines

covering much of the native vegetation. *Ligustrum* is dense and abundant on the cliffs and *Chinaberry* is present throughout. There are also small patches of giant reed along the shoreline. The dog park has a very large stand of golden bamboo that is spreading downslope into the woodland. A non-native morning glory is behaving invasively throughout the area and is the dominant vine in some eastern sections of the unit. Elephant ear is abundant in the western end.

Management Recommendations

The primary management goals for this unit are to lessen the impact of invasive species, support existing restoration efforts, increase woodland diversity, and expand and enhance the wetland through sediment capture, plantings, and maintenance.

Figure 4.44 (Above): The Cliffs Management Unit Boundaries. Sources: CAO, NAIP.

