Vegetation Management Plan
Pond Embankments

Hornsby Bend Biosolids Management Plant

Prepared for:

Austin Water Utility
2210 South FM 973
Austin, Texas 78725

Baer Engineering Project No. 142069-8i.013
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1.0 SUMMARY

Baer Engineering prepared this Vegetation Management Plan for Hornsby Bend Biosolids Management Plant (HBBMP) to address Texas Commission on Environmental Quality's (TCEQ) recommendation to prevent the proliferation of additional trees on or within 10 feet of the toe of the berms surrounding the ponds 1E, 1W, and 2. This plan will be implemented after the Tree Removal Plan is completed. The Tree Removal Plan will implement the removal of dead and diseased trees located on the berms.

This Vegetation Management Plan includes a general list of maintenance procedures and activities, a schedule to remove existing trees, and a plan to prevent new trees from becoming established on the embankments. The scope of work described herein should be conducted between September 16 and March 14 (of any consecutive years), in order to avoid violating the Migratory Bird Treaty Act (MBTA). If work must occur between March 15 and September 15 (of any year), then the contractor will need to follow the MBTA Compliance Plan provided under a separate cover.

We divided the area surrounding the pond berms into eight management areas. At this time, five of these management areas require the removal of existing living trees and their root systems. The three remaining management areas do not have existing living trees on them. Removal techniques will depend on the size of the tree. To maintain its integrity, the berm must be repaired immediately following root extraction. Berm repairs should be accomplished in accordance with the appropriate berm specifications for soil placement, compaction, and materials testing. Baer Engineering recommends accomplishing tree removal in the five management areas over a period of eight years.

To quantify the maintenance activities, HBBMP will record progress on the enclosed data sheets. Once the woody plants are removed, HBBMP will visually inspect the berm quarterly to check berm integrity. The individuals should be qualified Engineers with experience or training on how to conduct an integrity inspection, using TCEQ guidance documents. Example data sheets for keeping track of maintenance and inspection activities are provided in **Appendix A**, these are examples and other means of documentation are acceptable.

Removing trees with DBH's greater than or equal to eight inches will require mitigation following City of Austin (COA) mitigation calculations. Coordination with the COA Arborist and a Texas-licensed geotechnical engineer is recommended prior to conducting tree removal.

2.0 INTRODUCTION AND PURPOSE

Baer Engineering prepared this document to provide guidance to the HBBMP staff. This document describes the goals of the Vegetation Management Plan, the steps necessary to achieve the goals, and methods to record progress. In addition to this document, the maintenance staff will need to complete the Tree Removal Plan and follow the MBTA Compliance Plan, both provided under separate cover.

It is our understanding that the HBBMP received a Notice of Violation (NOV) after a Compliance Evaluation investigation by the TCEQ on March 16, 2015. The NOV letter stated HBBMP failed to adequately prevent the proliferation of trees on the berms of ponds 1E, 1W, and 2. The TCEQ recommended the following corrective action for the ponds:

1. Begin removing small trees on or near the embankment of the ponds as long as tree removal does not impact the integrity of the embankment and cause an unauthorized discharge.
2. Prepare and implement, with timelines, a Tree Management Plan geared toward removing dead or diseased trees and preventing the proliferation of additional trees on or near the embankment.
3. All tree removal should be conducted above the water table of the ponds to minimize the potential of unauthorized discharges and to prevent decaying roots from compromising the hydraulic integrity of the embankments.
4. Maintenance records should be kept that document actions recommended by the Tree Management Plan.
5. Provide a copy of the Tree Management Plan to the TCEQ Austin Regional Office for review by the compliance due date of October 16, 2015.

Baer Engineering prepared a Tree Removal Plan to address TCEQ's recommendation to remove dead and diseased trees. This Vegetation Management Plan, in conjunction with the Tree Removal Plan, will be provided to TCEQ to demonstrate that HBBMP has addressed TCEQ's corrective action recommendations.

3.0 VEGETATION MANAGEMENT GOALS

The goals of this Vegetation Management Plan are to outline a plan to:

1. Remove existing small diameter (≤6 inch DBH) trees on or within 10 feet of the toe of the berms surrounding 1E, 1W, and 2 Ponds;

2. Use tree removal methods that do not impact the integrity of the embankment and cause an unauthorized discharge;

3. Prevent proliferation of new trees on or near the embankments; and

4. Provide a schedule and method to measure maintenance progress.

In order to keep the majority of the berm intact during tree removal, we have separated the berms surrounding the ponds into eight management areas. For reference, **Figure 1** depicts these areas. Within management areas 1 through 5, trees and their root systems will be removed. To maintain its integrity, the berm must be repaired immediately following root extraction. Berm repairs should be accomplished in accordance with the appropriate berm specifications for soil placement, compaction, and materials testing. Removing trees with DBH's greater than or equal to eight inches will require mitigation following COA mitigation calculations. Management areas 6, 7, and 8 do not have any existing trees.

Figure 1. Hornsby Bend Biosolids Management Plan overview of the eight management areas

4.0 TREE REMOVAL ON BERMS

Tree removal is planned on or within 10 feet of the toe of the berms, to illustrate the approximate limits refer to the 1957 Recorded Plans note in **Appendix B**. The berm varies in height from 7.0 feet to 13.5 feet with a side slope of 3:1 (3 feet horizontal to 1 foot vertical) and a 10 foot top width. Therefore the limits would correlate to approximately 36 feet minimum to 55.5 feet maximum from the centerline of the berm.

Tree removal will be conducted in one management area at a time to 1) allow for a solid continuous repair along the berm, 2) ensure berm integrity by determining success of previous repairs, and 3) allow the COA to allocate the necessary funds to achieve the vegetation management goals.

Removal techniques will depend on the size of tree. Removal techniques for trees above and near the waterline are presented in the following subsections and are specified in the attached detail sheet in **Appendix C**.

Trees on the berms may need to be surveyed for size and species before removal begins. Removing trees that are greater than or equal to eight inches in diameter at breast height (DBH) will require mitigation following COA mitigation guidelines. Coordination with the COA Arborist and a Texas-licensed geotechnical engineer is recommended prior to conducting tree removal.

4.1 Tree removal

4.1.1 Small diameter trees (≤6 inches DBH)

Live small diameter trees exist on and within 10 feet of the toe of the berms surrounding the ponds. Small diameter trees are defined in this plan as those with stems less than or equal to six inches in DBH. These trees will be cut flush with the ground. The trees need to fall on the berm of the ponds and not in the water. Felling trees into the water could damage the liner of the ponds and result in water quality violations. Immature trees of this size typically do not have a substantial root system and are not expected to impact the berm. Leaving a stump from a live tree is not ideal because the stump will likely re-sprout. Within five minutes of the final flush cut, glyphosate or a similarly approved herbicide will be brushed, with a disposable paint brush, onto the top of the stump. The herbicide will be applied by a licensed applicator. The manufacturer's instructions for applying the proper concentration of the herbicide must be followed. The minimum amount of glyphosate should be used to completely cover the top of the stump. Care should be taken to treat only the target stump. The herbicide should not affect the surrounding vegetation or water. The woody debris resulting from this work will be properly removed.

4.1.2 Dead large diameter trees (>6 inches DBH)

Large diameter trees are defined in this plan as trees with stems that are greater than six inches DBH. COA has opted to leave the existing living large diameter trees and allow these trees to die naturally. As these trees die naturally, they should be felled, and their root systems should be removed within one to two years, following the methods described below.

Directional Notch

The directional notch comprises a top cut and bottom cut. The first cut is the top cut; it determines the direction of the fall. The top cut should be at a 45° angle from the horizontal. The second cut is referred to as the bottom cut. The bottom cut is a horizontal cut that meets the top cut. The directional notch depth should be equal to one-fourth of the tree's diameter.

Felling Cut
The third cut, or felling cut, will occur on the opposite side of the tree from the directional cut. This cut may be either a straight cut from behind the notch cut (typically used for smaller trees), or the person operating the chainsaw may use a bumper spike. Both techniques should use a felling wedge for larger trees to prevent pinching of the guide bar. Both types of cuts will be two inches above the corner of the notch cut.

Once the tree is down, cut it into pieces that can be loaded into a hauler and mulch for reuse or dispose of properly.

Stump and Root Removal
The decaying roots of woody species can create channels into the pond berms comprising the berm's integrity. Only hand tools will be used to dig around the base of the stump exposing the root ball. The stump and root ball should be pulled using a winch to loosen the root ball. Continue to use hand tools to grub around the base of the stump and pull with a winch until the stump and root ball are removed. Once the stump is removed, grub out any remaining roots greater than two inches in diameter. If water or saturated soil is encountered during excavations, cut exposed roots and begin berm repair under the direction of a Texas-licensed geotechnical engineer.

The critical root zone (CRZ) area should be assigned to each tree, based on the trunk diameter size. For example a 10-inch diameter tree has a 20-feet diameter CRZ. The goal for the stump and root removal is to extract a significant portion of the roots. Therefore we expect one-half of the CRZ will need to be extracted. Stumps that are within a distance of the water's edge that is one-half the CRZ diameter will require a temporary dewatering plan.

4.2 Dewatering for dead large diameter trees near water's edge
A temporary dewatering plan will be required for trees within a distance of the water's edge that is one-half the CRZ diameter. Sufficient size and capacity of the dewatering system is necessary to lower and maintain the water table and to allow material to be excavated in a reasonably dry condition. Dewatering will be accomplished through the use of cofferdams, or equivalent. The dewatering system will be operated continuously until repair of the berm is completed. The water removed from the excavation should be disposed of in such a manner as will not interfere with work under construction. We suggest pumping the water back into the pond. Once the stump and roots have been excavated and the berm has been repaired, the cofferdam should be removed.

Dewatering may or may not be required for trees located farther than one-half the CRZ diameter from the water's edge. This will depend upon the elevation of the water in the ponds and the depth of the rootball. The need for dewatering must be evaluated on a case-by-case basis.

4.3 Berm repair (typical)
The Federal Emergency Management Agency (FEMA) has investigated numerous dam failures caused by vegetation. In its *Technical Manual for Dam Owners – Impacts of Plants on Earthen Dams*, (published as FEMA 534 in September 2005), FEMA describes typical methods of dam repair after tree removal. FEMA states, "Design and construction practices of using optimum compaction of embankment soils reduce potential settlement of embankments, increases shear strength of the embankment soils, decreases the permeability of the embankment soils, and minimizes long-term changes in the physical and engineering properties of soils. When embankment soil compaction results in the attainment of desirable objectives from a geotechnical engineering behavior perspective of earthen slopes, compaction of embankment

soils also precludes tree root growth and elongation as a result of exclusion of most of the requirements for healthy root elongation and tree growth.

Traditional embankment soil compaction specifications require that the soil be compacted to about 95 to 98 percent of the standard Proctor maximum dry density as determined by ASTM D-698. Furthermore, most properly written soil compaction specifications generally require that compaction moisture contents be maintained about two percent below to three percent above optimum moisture content. At these degrees of compaction and at these moisture contents, soil oxygen content, water content, and soil pore size are not available for healthy root elongation and tree growth. Even if there is sufficient moisture content in the soil to otherwise sustain healthy root elongation, the soil pore sizes are so small that available pore water cannot be effectively moved to the root system. Consequently, the compacted dam embankment fill soil produces an exclusion system that mechanically impedes healthy root elongation and tree growth." In Chapter 6 – Dam Remediation Design Considerations, there are a number of remediation design considerations associated with the removal of trees and woody vegetation from the embankments of earthen dams. Chapter 6 is provided in **Appendix D** to this Vegetation Management Plan as a guidance document. Consultation with a Texas-licensed geotechnical engineer is strongly encouraged when removing large diameter trees that require substantive repairs to the berm after removal.

In order to comply with the COA Land Development Code, soil used for backfill must comply with COA Specification 601S. The backfill should then be graded to blend with the surrounding contours and seeded following the COA Standard Specification 604S Seeding for Erosion Control on all disturbed areas above the water table. Please check with the COA website for the current Specifications.

5.0 EXISTING LARGE DIAMETER LIVE TREES (>6 INCHES DBH)

Large diameter trees are defined in this plan as trees with stems that are greater than six inches DBH. COA has opted to leave living large diameter trees and allow these trees to die naturally. The COA is evaluating potential options for management of hydraulic loading and how this may affect whether or not the ponds remain in service over the long term. If the ponds do remain in service at their current capacity, allowing trees to continue to grow on the berms increases the likelihood of future berm instability. The larger the tree is allowed to grow, the larger the "scar" on the berm after extraction.

The following live trees were observed on and near the berms of the ponds:

Hackberry species (*Celtis* spp.) The majority of the live trees surrounding the ponds are a species of hackberry. There are three species which commonly occur in the Austin area: *Celtis laevigata*, *C. occidentalis*, and *C. reticulata*. Hybridization is common with the genus *Celtis* and most species are poorly defined (Elias 1970); therefore we have presented general botanical characteristics for the three species in **Table 1**.

Table 1. Botanical characteristics for the three *Celtis* species that commonly occur in the Austin area.

	Celtis Species:		
Botanical Characteristics	*C. laevigata*	*C. occidentalis*	*C. reticulata*
Height Range	60 to 100 feet [1,2]	50 to110 feet [4,5]	7 to 53 feet [9,10]
Diameter Mature Tree	18 inches [2]	20 inches [4]	
Diameter Maximum		6 feet [5]	24 inches [9,10]
Life Span	<150 years [3]	150 to 200 years [4]	100 to 200 years [11]
Root depths	Shallow [3]	Deep up to 9 feet [6]	Deep up to 15 feet [12, 13]
Growth Pattern	Slow [2]	Varies depending on site conditions [7,8]	Slow [12]

Citations: [1]*(Bonner 1974);* [2]*(McKnight 1965);* [3]*(Burns et al. 1990);* [4]*(Farrar 1995);* [5]*(Duncan and Duncan 1988);* [6]*(Sprackling and Read 1979);* [7]*(Braun 1989);* [8]*(Gleason and Cronquist 1991);* [9]*(GPFA 1986);* [10](*Munz 1974);* [11]*(Simpson 1988);* [12]*(Sutton 1974);* [13]*(Zimmerman 1969)*

Jerusalem Thorn (*Parkinsonia aculeata*) typically grows up to 15 feet tall with a diameter of 6 to 12 inches (Lady Bird Johnson Wildflower Center 2015). This is a fast growing tree that lives about 30 years (Pima Community College 2015).

The following remaining tree species were observed in lower numbers:

Honey Mesquite (*Prosopis glandulosa*) typically grows up to 20 to 40 feet (Meyer et al. 1971) with tap roots extending to the local water table (3 to 40 feet; Ansley et al. 1989). Mesquite life span ranges between 70 and 110 years (Fisher et al. 1959).

Red Mulberry (*Morus rubra*) is a rapid growing tree which typically averages 15 to 70 feet in height with diameters of 30 inches (Lamson 1990). The root system of red mulberry is shallow and this tree usually lives 125 years or less (Van Dersal 1938).

Box Elder (*Acer negundo*) has a fast growth rate and short life span, typically living for 75 years

or less (Loehle 1988). The root system is typically shallow and spreading (Sutton and Johnson 1974).

Black Willow (*Salix nigra*) is a short lived tree with a shallow root system and an average life span of 55 years (McKnight 1965). Trees can reach 140 feet in height with diameters of 48 inches under ideal conditions.

6.0 ONGOING MAINTENANCE ACTIVITIES

After the initial small diameter tree removal is completed, ongoing maintenance is necessary to prevent woody plants from becoming established on the pond embankment. When the ponds' embankments are free of trees, maintenance staff or assigned contractor should:

1. Remove shrubs and vines growing on the berms in early spring (before March 15) and early fall (after September 15);

2. Use hand tools, saws, or weed wrenches to remove small diameter (≤6 inches) woody plants that are growing on the berms in early spring (before March 15) and early fall (after September 15);

3. Remove dead trees using hand tools, saws, winches on the berms in early spring (before March 15) and early fall (after September 15);

4. Attempt to re-establish grass as a ground cover where soil is exposed following COA Standard Specification 604S; and

5. Mow the berms at least twice a year, between September 15 and March 15. Height of grass should be a minimum height of 4 inches high to promote healthy ground cover.

Vegetation, including trees, shrubs, and grasses in the project area may provide habitat for migratory birds. Vegetation maintenance, including removing trees (dead or living), removing shrubs, and mowing grass around the ponds, should occur between September 16 and March 14, to avoid disturbance of migratory birds and their nests.

7.0 SCHEDULE OF ACTIVITIES AND RECORDKEEPING

7.1 Quarterly Inspections Schedule

Once the small diameter woody plants are removed, visually inspect the berm quarterly to check berm integrity. These inspections will need to be made for several years after root system removal to ensure berm repairs are intact as the roots decay. HBBMP will keep records of the inspection and maintenance activities that are conducted. Example data sheets for keeping track of inspection and maintenance activities are provided in **Appendix A**, these are examples and other means of documentation are acceptable.

The following is a list of inspection activities that should occur along the pond berms at HBBMP.

- Inspect berms for evidence of safety issues (e.g., tension cracks, slope failure scarps, internal and external erosion features, etc.)
- Note if mowing is required, and schedule mowing between September 15 and March 15.
- Inspect berms for exposed soil.
- Inspect berms for sprouting trees, shrubs, and vines.
- Identify dead or diseased trees on the berms or within 10 feet of the berm's toe.

If concerns on the berms (safety issues, exposed soil, or sprouting trees, shrubs, and vines) are documented, schedule a date to make necessary repairs.

7.2 Maintenance Schedule

The following is a schedule of vegetation maintenance activities along the pond berms at HBBMP for the next eight years.

Year One (September 15, 2015 to March 15, 2016):

- Follow Tree Removal Plan, prepared under a separate cover, and remove as many of the dead and diseased trees from berms as feasible. Document which trees were removed. Repair berm where trees were excavated.

- Mow tall grass on the berms, where trees are not present, to a height of four to six inches.

Year Two (September 15, 2016 to March 15, 2017):

- Follow Tree Removal Plan, prepared under a separate cover, and remove as many of the dead and diseased trees from berms as feasible. Document which trees were removed. Repair berm where trees were excavated.

- Mow tall grass on the berms, where trees are not present, to a height of four to six inches.

- Remove dead, diseased and damaged trees and remove small diameter woody plants that are growing on the berm in management area 1.

- Establish grass in areas where soil is exposed, following COA Standard Specification 604S.

- Complete Maintenance Data sheets every day that maintenance activities occur.

Year Three (September 15, 2017 to March 15, 2018):

- If all activities outlined in the Tree Removal Plan were not completed during the previous year, continue to implement the Tree Removal Plan.
- Cut all trees' stems with DBH's less than or equal to six inches flush with the ground and treat all cut stumps with an herbicide to prevent sprouting.
- Mow tall grass on the berms, where trees are not present, to a height of four to six inches.
- Remove dead, diseased and damaged trees and remove small diameter woody plants that are growing on the berm in management area 2.
- Establish grass in areas where soil is exposed; following COA Standard Specification 604S.
- Complete Maintenance Data sheets every day that maintenance activities occur.

Years Four (September 15, 2018 to March 15, 2019):

- Mow tall grass on the berms, where trees are not present, to a height of four to six inches.
- Remove dead, diseased and damaged trees and remove small diameter woody plants that are growing on the berm in management area 3 and others that have been cleared of trees.
- Establish grass in areas where soil is exposed, following COA Standard Specification 604S.
- Complete Maintenance Data sheets every day that maintenance activities occur.

Years Five (September 15, 2019 to March 15, 2020):

- Mow tall grass on the berms, where trees are not present, to a height of four to six inches.
- Remove dead, diseased and damaged trees and remove small diameter woody plants that are growing on the berm in management area 4 and others that have been cleared of trees.
- Establish grass in areas where soil is exposed, following COA Standard Specification 604S.
- Complete Maintenance Data sheets every day that maintenance activities occur.

Years Six (September 15, 2020 to March 15, 2021):

- Mow tall grass on the berms, where trees are not present, to a height of four to six inches.
- Remove dead, diseased and damaged trees and remove small diameter woody plants that are growing on the berm in management area 5 and others that have been cleared of trees.
- Establish grass in areas where soil is exposed, following COA Standard Specification 604S.
- Complete Maintenance Data sheets every day that maintenance activities occur.

Years Seven (September 15, 2021 to March 15, 2022):

- Mow tall grass on the berms, where trees are not present, to a height of four to six inches.
- Remove dead, diseased and damaged trees and remove small diameter woody plants that are growing on the berm in management areas 6 through 8 and others that have been cleared of trees.
- Establish grass in areas where soil is exposed, following COA Standard Specification 604S.
- Complete Maintenance Data sheets every day that maintenance activities occur.

To Be Conducted Yearly After Year Seven (Between September 15 and March 15):

- Mow tall grass on the berms, to a height of four to six inches.
- Remove shrubs and vines growing on the berms.
- Use hand tools to remove small diameter (≤6 inches) woody plants growing on the berms
- Remove dead or diseased trees located on the berms or within 10 feet of the berm's toe.
- Establish grass in areas where soil is exposed, following COA Standard Specification 604S.
- Complete Maintenance Data sheets every day that maintenance activities occur.

7.3 Inspector Training

The individual who conduct berm inspections should be trained in how to identify berm safety issues and the methods of evaluation. We recommend the designated individuals be Engineers who have equivalent experience or who have participated in training workshops that educate participants on at least the following items:

- Earthen berm configuration and vernacular
- Evaluation methodology
- Signs of wetting, saturation and seepage

- Safety inspections of the various evaluation zones (i.e., upstream or water side slope, crest, upper and lower downstream or land side slopes, and toe)
- Signs of internal erosion
- Signs of external erosion

In addition, the inspection and Hornsby Bend staff should attend a TCEQ Dam Safety Workshop and/or review the materials available at the following websites.

https://www.tceq.texas.gov/field/damsafetyprog.html
https://www.tceq.texas.gov/assets/public/compliance/field_ops/damsafety/Workshop.2015.Session3.pdf

8.0 PUBLIC NOTIFICATION

The Hornsby Bend Bird Observatory (HBBO) is located at the HBBMP. The HBBO is a program of the Austin Water Utility's Center for Environmental Research. The HBBMP is known for its biodiversity, ecotourism, and is likely one of the best birding sites in Central Texas. One individual observed 249 species in a single year (Carpenter 2005). Bird watchers are present year-round and monthly bird surveys are conducted on the 2nd Saturday of each month.

Baer Engineering recommends all vegetation maintenance is scheduled in advance and public notifications of those schedules are posted at Hornsby Bend in the Center for Environmental Research. Scheduling and appropriate public outreach should be coordinated the Center for Environmental Research at Hornsby Bend.

We suggest including the following information in the public announcements:

1. Justification for maintenance (e.g. berm safety, protection of water quality);
2. Methods for complying with the MBTA;
3. Maintenance techniques that will be implemented (e.g., mowing, chainsaw, etc.);
4. Schedule and location(s) for maintenance activities; and
5. Contact information for HBBMP staff responsible for contractor.

9.0 QUALIFICATIONS

Field work was performed on June 3, 16, and 19, 2015. Conditions observed, during field work, may not reflect site conditions during other parts of the year. Baer Engineering assessed the potential impacts based on information provided to us by the COA and HBBMP. Subsequent changes in maintenance plans and specific maintenance methods are not covered in this plan.

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Appendix A:

Example

Inspection and Maintenance Data Sheets

QUARTERLY BERM INSPECTION DATA SHEET			
Date:	Inspected By:		
Existing Conditions			
Provide a general assessment for each segment.			
Maintenance Area 1.			
Evidence of erosion along embankments?		YES	NO
If yes, provide description:			
Do vegetated areas need mowing?		YES	NO
Only applicable between September 15 and March 15.			
Do areas need to be re-vegetated?		YES	NO
Approximate size of area to be re-vegetated?			
Evidence of trees, shrubs, or vines growing?		YES	NO
If yes, provide approximate height:			
Evidence of dead trees?		YES	NO
Maintenance Area 2.			
Evidence of erosion along embankments?		YES	NO
If yes, provide description:			
Do vegetated areas need mowing?		YES	NO
Only applicable between September 15 and March 15.			
Do areas need to be re-vegetated?		YES	NO
Approximate size of area to be re-vegetated?			
Evidence of trees, shrubs, or vines growing?		YES	NO
If yes, provide approximate height:			
Evidence of dead trees?		YES	NO
Maintenance Area 3.			
Evidence of erosion along embankments?		YES	NO
If yes, provide description:			
Do vegetated areas need mowing?		YES	NO
Only applicable between September 15 and March 15.			
Do areas need to be re-vegetated?		YES	NO
Approximate size of area to be re-vegetated?			
Evidence of trees, shrubs, or vines growing?		YES	NO
If yes, provide approximate height:			
Evidence of dead trees?		YES	NO
Maintenance Area 4.			
Evidence of erosion along embankments?		YES	NO
If yes, provide description:			
Do vegetated areas need mowing?		YES	NO
Only applicable between September 15 and March 15.			
Do areas need to be re-vegetated?		YES	NO
Approximate size of area to be re-vegetated?			
Evidence of trees, shrubs, or vines growing?		YES	NO
If yes, provide approximate height:			
Evidence of dead trees?		YES	NO

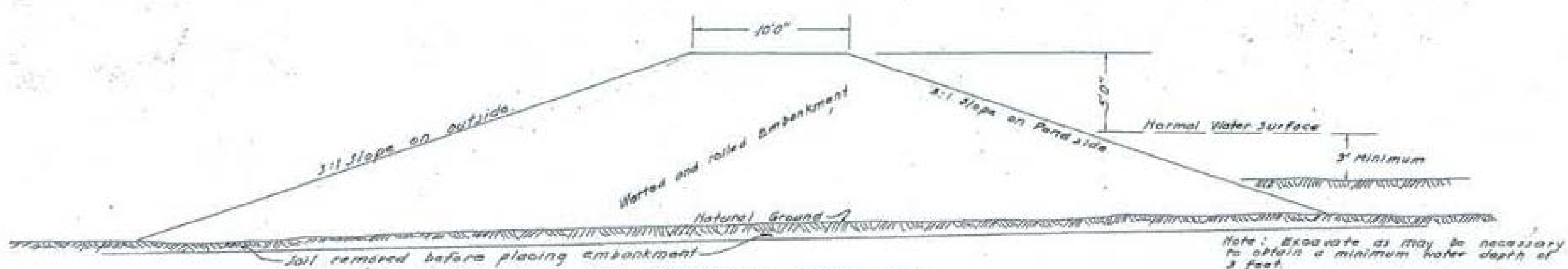
Maintenance Area 5.		
Evidence of erosion along embankments?	YES	NO
If yes, provide description:		
Do vegetated areas need mowing?	YES	NO
Only applicable between September 15 and March 15.		
Do areas need to be re-vegetated?	YES	NO
Approximate size of area to be re-vegetated?		
Evidence of trees, shrubs, or vines growing?	YES	NO
If yes, provide approximate height:		
Evidence of dead trees?	YES	NO
Maintenance Area 6.		
Evidence of erosion along embankments?	YES	NO
If yes, provide description:		
Do vegetated areas need mowing?	YES	NO
Only applicable between September 15 and March 15.		
Do areas need to be re-vegetated?	YES	NO
Approximate size of area to be re-vegetated?		
Evidence of trees, shrubs, or vines growing?	YES	NO
If yes, provide approximate height:		
Evidence of dead trees?	YES	NO
Maintenance Area 7.		
Evidence of erosion along embankments?	YES	NO
If yes, provide description:		
Do vegetated areas need mowing?	YES	NO
Only applicable between September 15 and March 15.		
Do areas need to be re-vegetated?	YES	NO
Approximate size of area to be re-vegetated?		
Evidence of trees, shrubs, or vines growing?	YES	NO
If yes, provide approximate height:		
Evidence of dead trees?	YES	NO
Maintenance Area 8.		
Evidence of erosion along embankments?	YES	NO
If yes, provide description:		
Do vegetated areas need mowing?	YES	NO
Only applicable between September 15 and March 15.		
Do areas need to be re-vegetated?	YES	NO
Approximate size of area to be re-vegetated?		
Evidence of trees, shrubs, or vines growing?	YES	NO
If yes, provide approximate height:		
Evidence of dead trees?	YES	NO
Other observations:		

DAILY VEGETATION MAINTENANCE DATA SHEET										
Maintenance Date:	Data sheet Completed By:									
Maintenance Work Completed By (names):										
Fill out this data sheet daily to record vegetation maintenance activities performed at HBBMP.										
MANAGEMENT AREA NUMBER(S):										
Number of small diameter (≤6 inches) trees cut and treated:										
Number of root systems excavated:										
If dewatering was necessary, what method(s) was used?										
Approximate size of dewatered area:										
Number of excavations repaired and approximate volume of each (ft^3):	1	2	3	4	5	6	7	8	9	10
Areas revegetated following COA Standard Specification 604S? YES NO										
Approximate area (ft^2) revegetated?										
Only applicable between September 15 and March 15:										
Mowing conducted? YES NO										
Other observations:										

Appendix B:
1957 Recorded Plans

1957 Record Plans

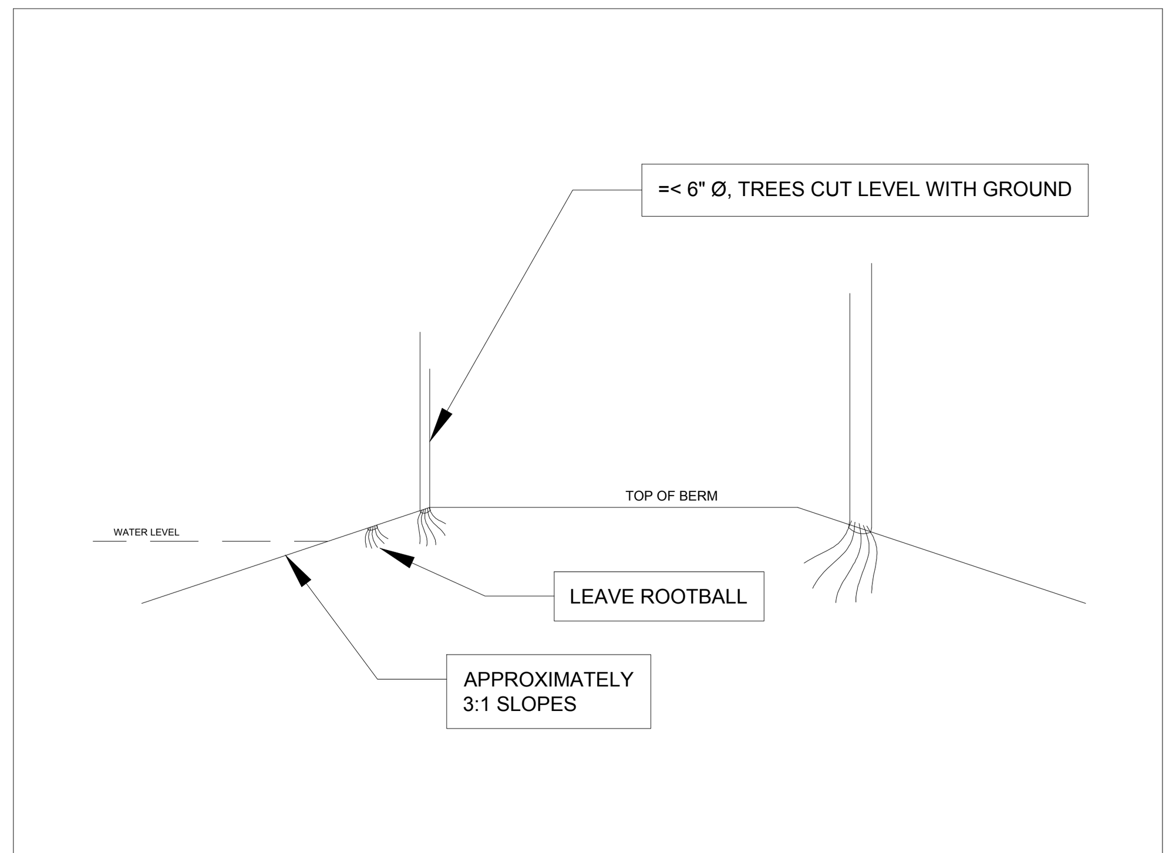
Top of Berm 440'(south/spillway) - 443'(north)MSL
Bottom of Berm varies ~426.5' – 436' MSL
Height of Berms varies ~7' – 13.5'
with designed 5' free board



TYPICAL SECTION
No Scale

Appendix C:

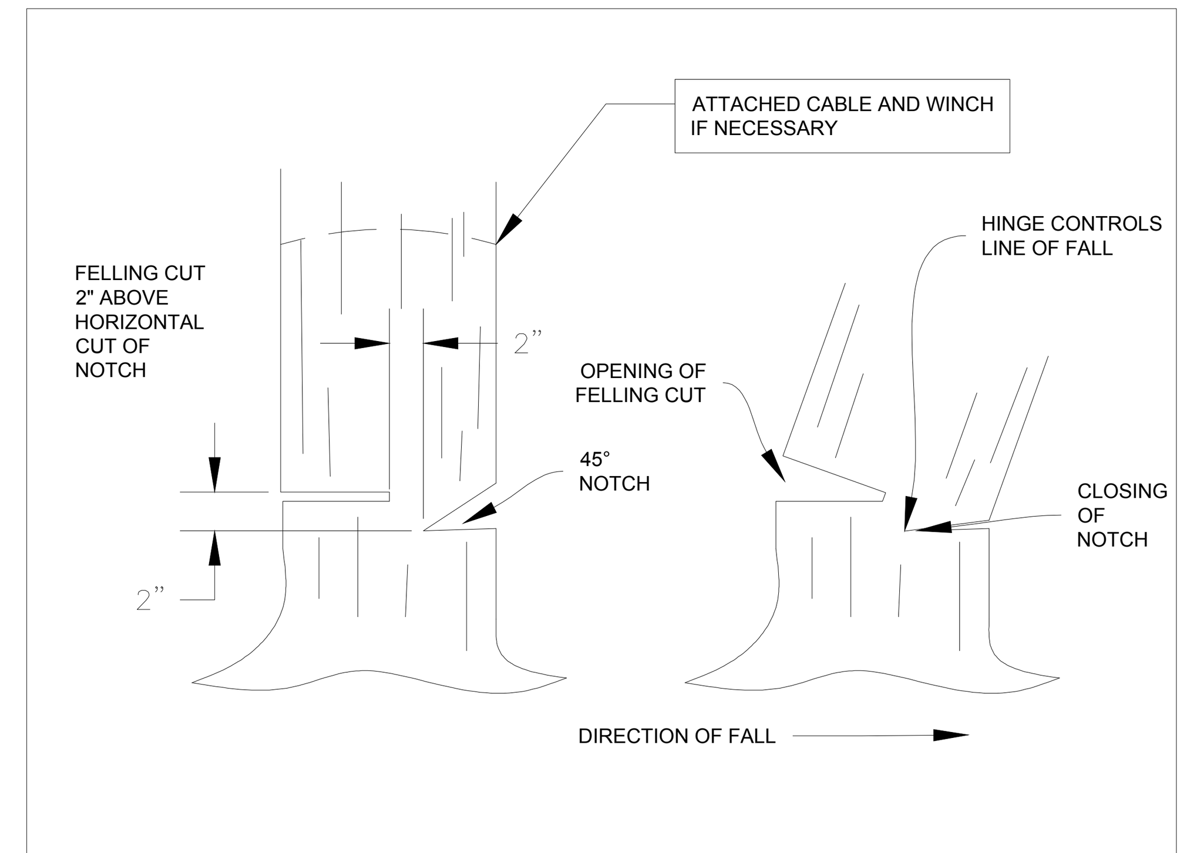
Tree Removal Instruction and Example Detail



NOTES:
1. THE STEMS OF TAGGED TREES THAT ARE EQUAL TO OR LESS THAN SIX (6) INCHES IN DBH WILL BE CUT FLUSH WITH THE GROUND.
2. AS THE TREES ARE CUT DOWN, THEY MUST FALL ON THE BERM AND NOT INTO THE WATER.
3. EACH STUMP WILL BE TREATED WITH GLYPHOSATE WITHIN 5 MINUTES OF CUTTING.
4. GLYPHOSATE WILL BE BRUSHED, WITH A DISPOSAL PAINT BRUSH, ONTO CUT SIDE OF STUMP.
5. GLYPHOSATE WILL BE APPLIED BY A LICENSED APPLICATOR.

INSTRUCTIONS ON SMALL TREE REMOVAL

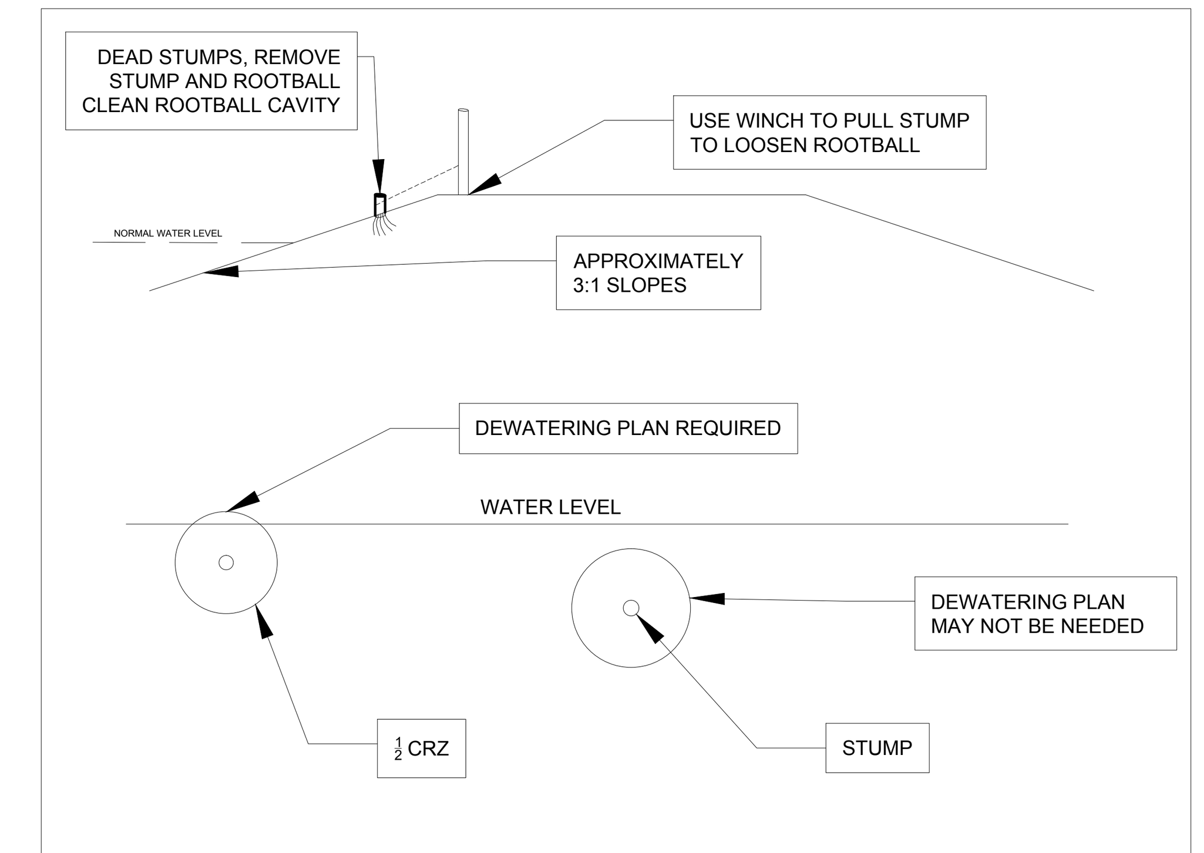
ADDITIONAL INFORMATION PROVIDED IN SECTION 4.0 OF TREE REMOVAL PLAN



NOTES:
1. ENTIRE TREE SHALL FALL ON THE EARTHEN BERMS.
2. USE DIRECTIONAL FELLING TO CONTROL LANDING OF FALLING TREE, USE WINCH IF NECESSARY.

INSTRUCTIONS ON FELLING TREES

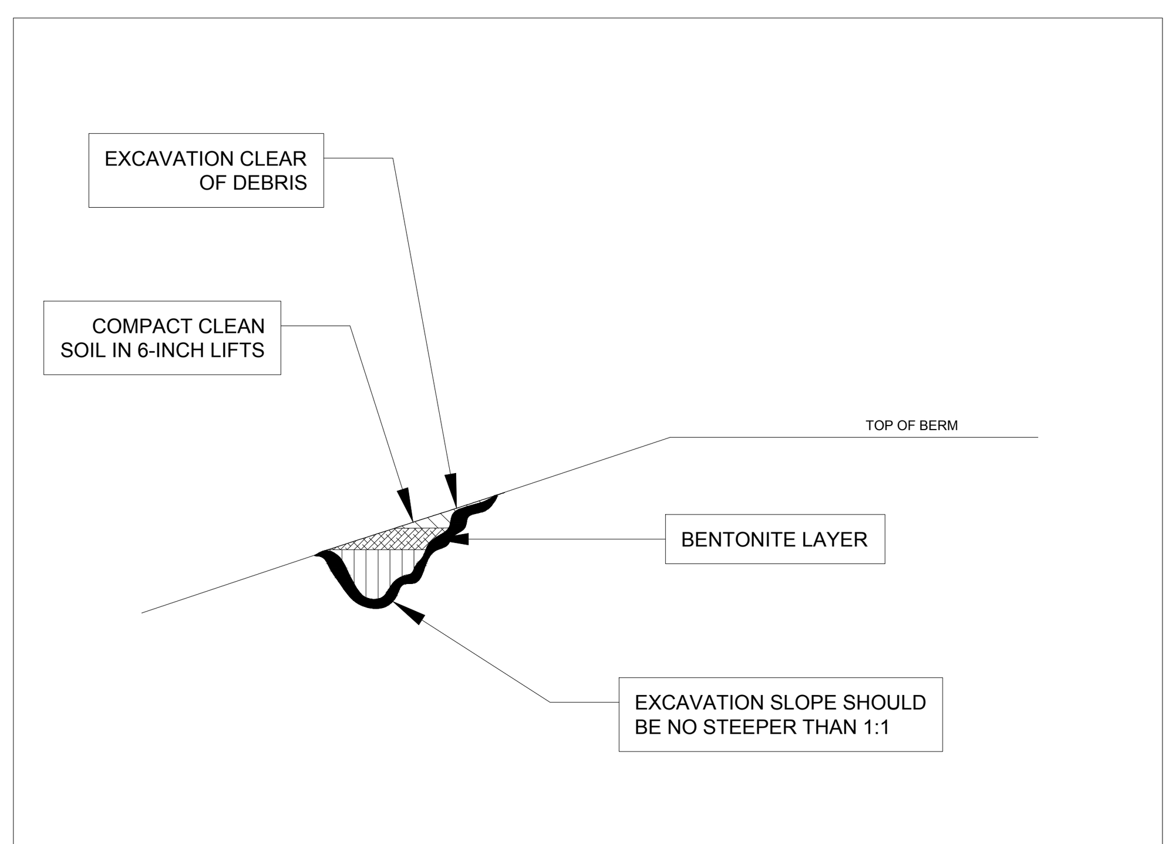
ADDITIONAL INFORMATION PROVIDED IN SECTION 6.1 OF TREE REMOVAL PLAN



NOTES:
1. DEWATER STUMPS THAT ARE LESS THAN ½ THEIR CRITICAL ROOT ZONE (CRZ) FROM WATER'S EDGE
2. USE HAND TOOLS TO DIG AROUND BASE OF THE STUMP TO EXPOSE ROOTBALL
3. USE WINCH TO PULL STUMP TO LOOSEN ROOTBALL
4. CONTINUE TO DIG AROUND ROOTBALL, REPEAT UNTIL STUMP IS REMOVED
5. GRUB OUT ANY REMAINING ROOTS LARGER THAN 2-INCH IN DIAMETER.

INSTRUCTIONS ON STUMP REMOVAL

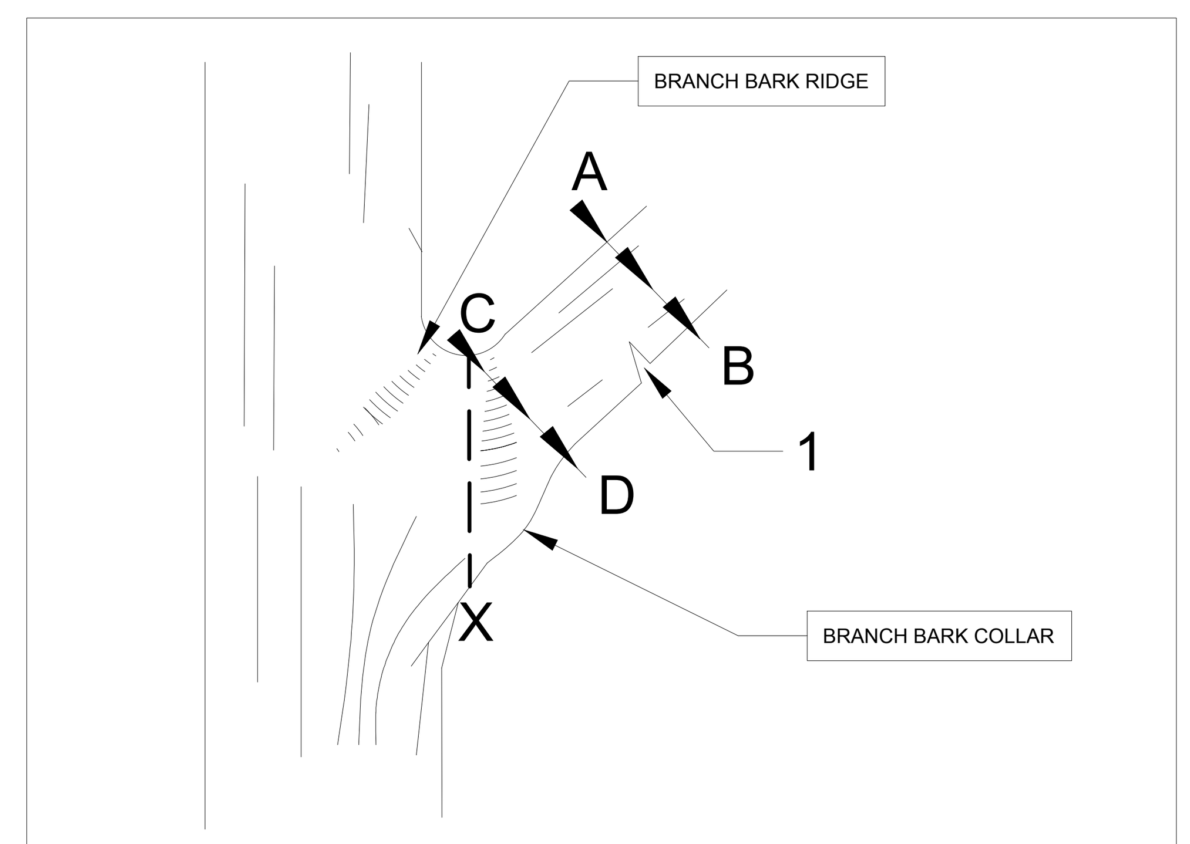
ADDITIONAL INFORMATION PROVIDED IN SECTION 6.2.3 OF TREE REMOVAL PLAN



NOTES:
1. CLEAR EXCAVATION OF LOOSE SOIL
2. LAYER BENTONITE CLAY ALONG BOTTOM AND SIDES OF EXCAVATION
3. BACKFILL EXCAVATION IN 6-INCH LIFTS OF NATIVE SOIL, COMPLY WITH SPECIFICATION 601S
4. COMPACT EACH 6-INCH LIFT USING COMPACTION EQUIPMENT
5. GRADE TO BLEND WITH SURROUNDING CONTOURS
6. SEED FOLLOWING SPECIFICATION 604S

INSTRUCTIONS ON BERM REPAIR

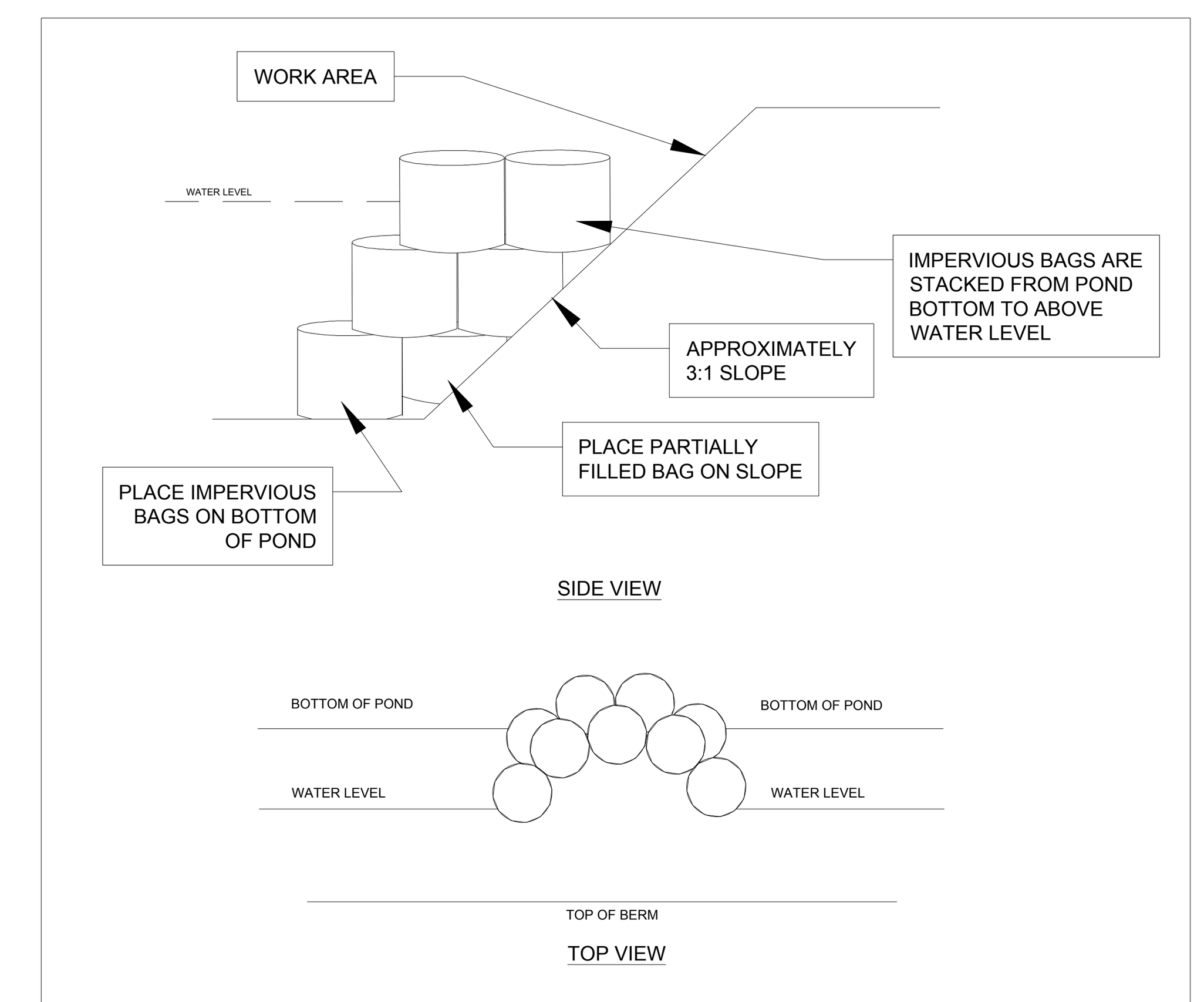
ADDITIONAL INFORMATION PROVIDED IN SECTION 6.3 OF TREE REMOVAL PLAN



NOTES:
1. FIRST CUT NOTCH AT 1
2. SECOND CUT, FROM A TO B
3. THIRD CUT, FROM C TO D
4. DO NOT CUT ALONG C-X

INSTRUCTIONS ON PRUNING DAMAGED TREES

ADDITIONAL INFORMATION PROVIDED IN SECTION 8.0 OF TREE REMOVAL PLAN



NOTES:
1. FILL IMPERVIOUS BAGS WITH GRAVEL OR SAND.
2. PLACE BAG ON BOTTOM OF POND (FLAT SURFACE)
3. STACK BAGS FROM BOTTOM OF POND TO ABOVE WATER LEVEL
4. USE PARTIALLY FILLED BAGS ON SLOPE
5. USE PUMP TO PUMP WATER OUT OF WORK AREA
6. DO NOT USE ANCHORS OR OTHER OBJECTS THAT WOULD PIERCE THE POND OR LINER OR BERM.

EXAMPLE DEWATERING PLAN

ADDITIONAL INFORMATION PROVIDED IN SECTION 6.2.2 OF TREE REMOVAL PLAN

REV	DESCRIPTION	DATE	APR
△			
△			
△			
△			
△			

REV	DESCRIPTION	DATE	APR
△			
△			
△			
△			
△			

DESIGNED BY J. LUECKEMEYER
DRAWN BY: L. HAXTON
REVIEWED BY: T. BAER
CHECKED BY: J. LUECKEMEYER
FILE NAME: COA TREE RMV DTL.DWG
PLOT DATE: June 2015
DRAWING SCALE: AS NOTED

PRELIMINARY DESIGN DOCUMENT
THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF INTERIM REVIEW UNDER THE AUTHORITY OF THERESE M. BAER, P.E. 64040 ON 9/27/2013. IT IS NOT TO BE USED FOR BIDDING, OR PERMIT PURPOSES. CONSTRUCTION,
ENGINEER OF RECORD: XXXXXXXXX
NO.: XXXXXXXX
DATE:

CITY OF AUSTIN
PUBLIC WORKS
DEPARTMENT

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T.B.P.E. Firm Registration No. F-3181

HORNSBY BEND BIOSOLIDS
MANAGMENT PLANT
TREE REMOVAL PLAN

TREE REMOVAL INSTRUCTIONS AND DETAIL EXAMPLES

SHEET REFERENCE NUMBER
CE-001
SHEET XX OF XX

90% SUBMITTAL

Appendix D:

Chapter 6

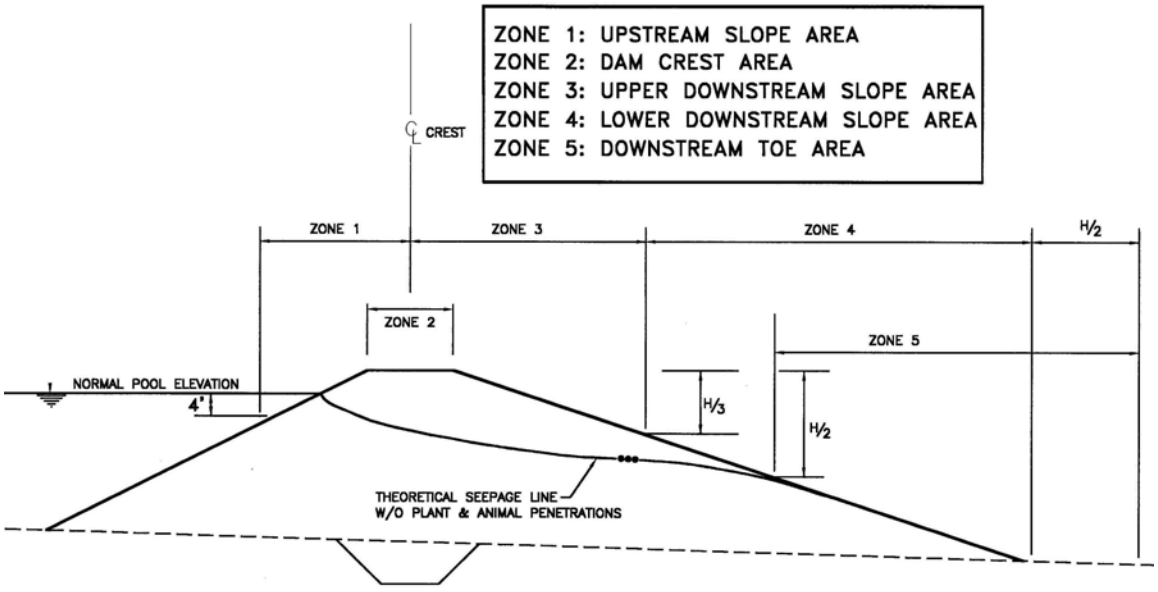
Dam Remediation Design Considerations

(FEMA 534, September 2005)

Note: This FEMA document is public domain; however, the steering committee responsible for its publishing intends to continue technological development in the area of controlling tree and woody vegetation growth on earthen dams. As such, the committee would appreciate documentation of unusual cases of tree and woody vegetation growth related to safety issues associated with earthen dams. Documentation of these issues may be communicated through ASDSO (Association of State Dam Safety Officials) at http://www.damsafety.org/.

Chapter 6
Dam Remediation Design Considerations

Specific dam remediation design considerations, procedures, and techniques will be considered for each of the previously identified dam safety inspection and evaluation zones. Figure 1 presents these zones as a review prior to discussion of potential dam remediation design considerations for each zone. Dam remediation design alternatives presented herein should be considered examples. These remediation design examples should not be considered the only alternatives for use in dam remediation design to correct deficiencies associated with tree and woody vegetation growth on earthen dams. Some additional dam remediation design alternatives presented for correction of tree and woody vegetation growth related deficiencies also provide positive correction of other deficiencies and protection against other types of earthen dam deterioration.



REMEDIAL DAM REPAIR ZONES

Figure 1

Inspection and Evaluation Zone 1

Figure 2 illustrates potential problems that can occur in Zone 1 with respect to tree and woody vegetation growth on earthen dams. This illustration also depicts the occurrence of wave erosion, vehicle access, and surface runoff erosion. Potential problems illustrated include instability of relatively large trees on the upstream slope and dam crest, and alteration of the seepage line as a result of wave erosion.

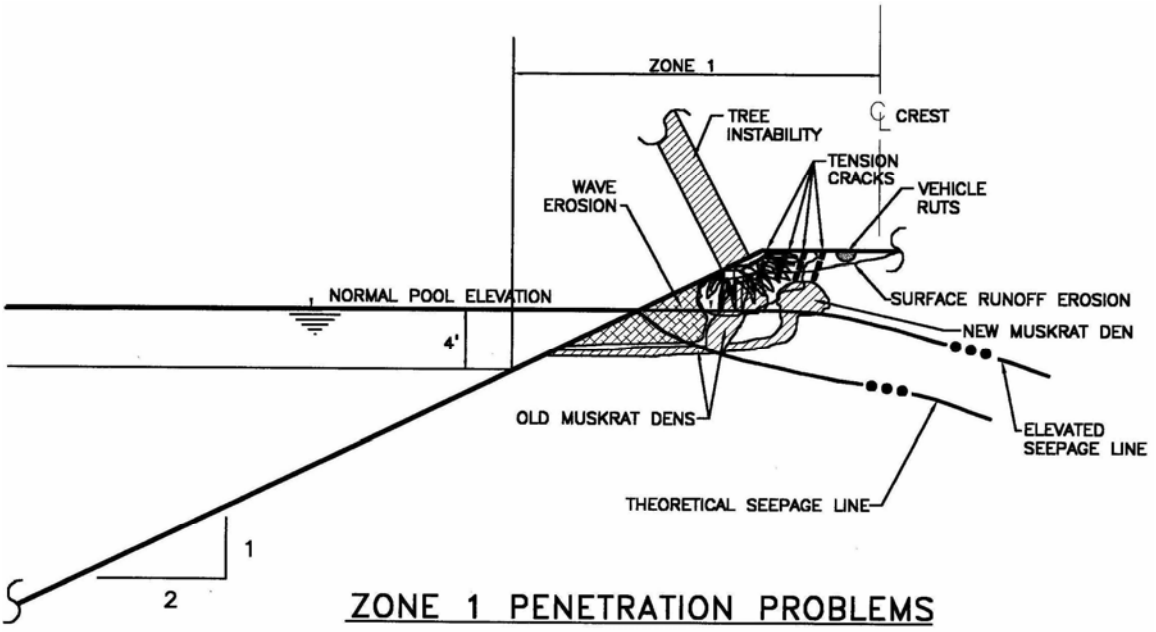


Figure 2

Dam remediation design techniques necessary to address potential problems illustrated in Figure 2 are illustrated in Figures 3 and 4. Dam remediation construction typically requires lowering of the normal pool elevation and/or complete drawdown of the retained reservoir. This is particularly true for dam remediation construction in Zone 1. The normal pool elevation should be lowered as far ahead of the scheduled dam remediation construction as practicable.

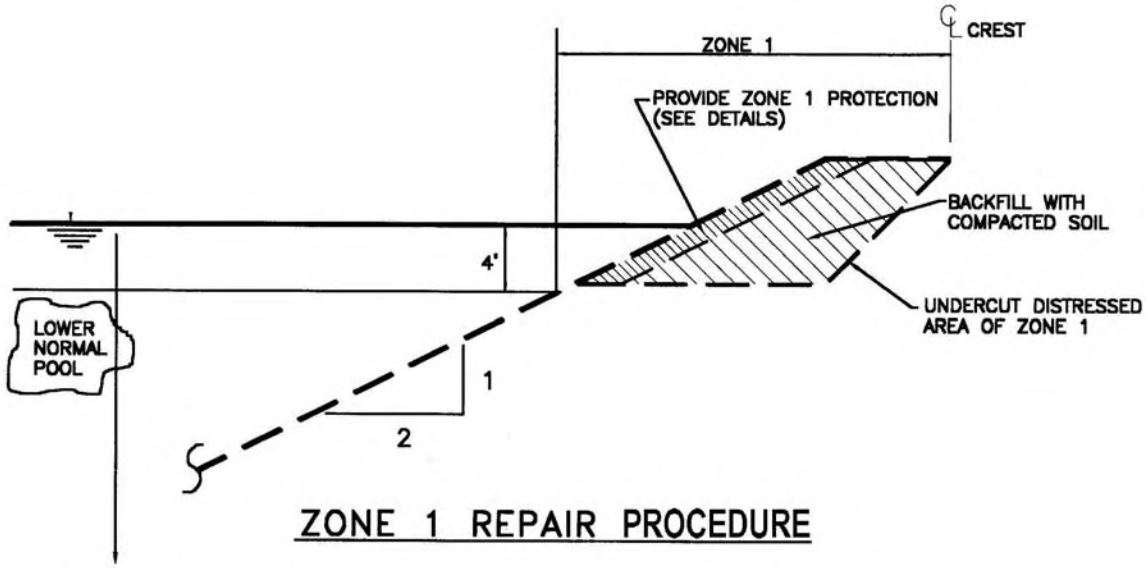
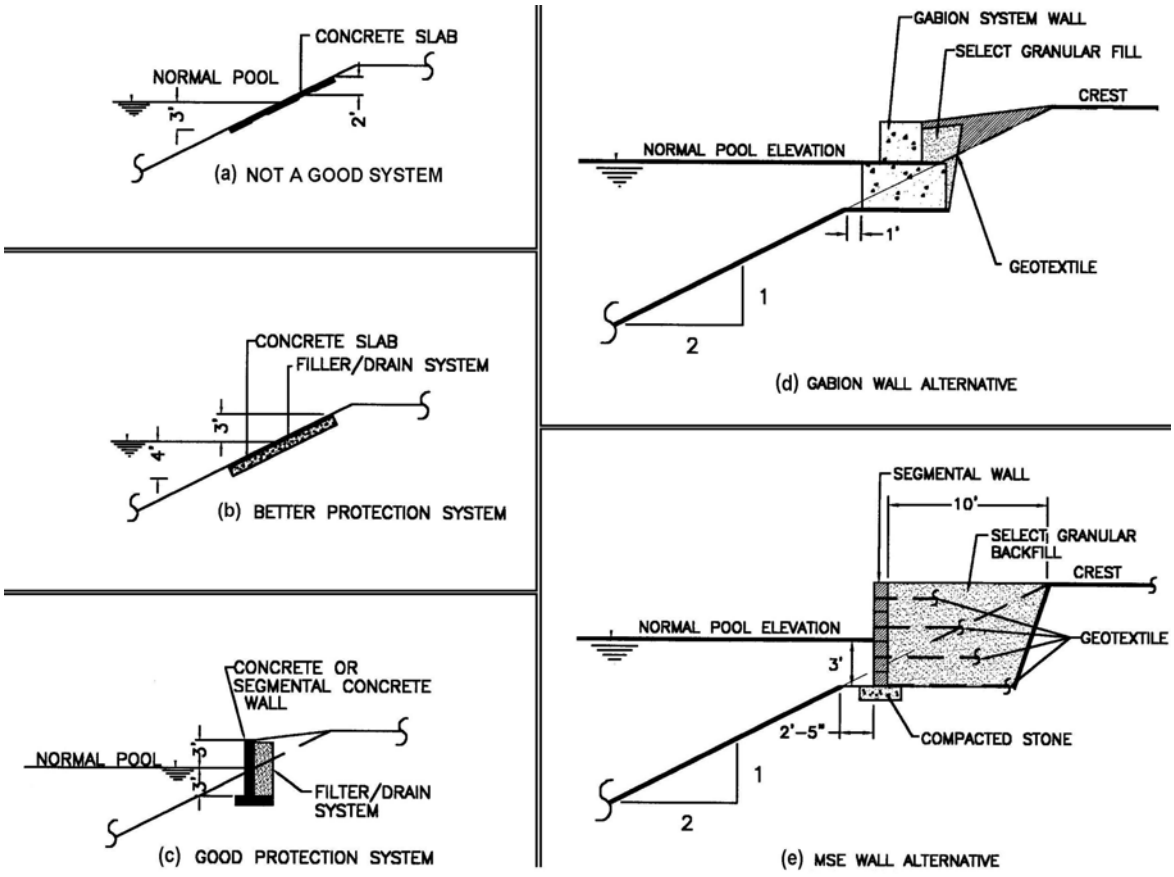


Figure 3



REMEDIAL REPAIR DESIGN
ALTERNATIVES FOR ZONE 1

Figure 4

Tree and woody vegetation growth in Zone 1 must be undercut to remove all stumps, rootballs, and root systems developed by tree penetrations as illustrated in Figure 3. The required depth of undercutting typically extends to near the limits of Zone 1, which is about four feet below normal pool elevation. In the case of earthen dams with narrow crest widths, the backslope of the undercut area will typically extend to near the centerline of the dam crest or the downstream limits of Zone 1. Subsequent to undercutting affected areas of Zone 1, the undercut area must be thoroughly inspected to confirm that all major root systems (greater than about one-half inch in diameter) have been removed during the undercutting operation. Following inspection and approval of the undercut area by the engineer, suitable backfill should be placed in the excavation and properly compacted to the dam remediation design limits. Backfill should consist of approved embankment fill material and should be compacted to a minimum of 95 percent of the maximum dry density of the fill soil as determined by the standard Proctor compaction test (ASTM D-698). In conjunction with the undercutting and backfilling, the dam remediation design should include a slope protection system to deter future tree and woody vegetation growth and reduce the potential for wave and surface runoff erosion.

Figures 4(a) through 4(c) illustrate various configurations of rigid (concrete) upstream embankment slope protection systems. Figure 4(a) illustrates a concrete slab being placed directly on the upstream slope from about three feet below to about two feet above normal pool elevation. While this system is somewhat limited relative to the area of protection, the most critical aspect of this system is that it provides no filtration and/or drainage system beneath the concrete slab. Continual wave action and the buildup of hydrostatic pressures beneath the concrete slab will eventually result in downward movement of the slab. Figure 4(b) illustrates a better dam remediation design utilizing a concrete slab slope protection system. This slope protection system has been improved over the original system by covering a larger area of the upstream slope and by providing a filter system beneath the concrete slab protection system. The author is of the opinion

that the dam remediation protection system shown in Figure 4(c) is the most desirable and cost effective design for use of reinforced concrete for a protection system. The reinforced concrete wall provides a gentle slope to flat backfill area that can easily be maintained by mowing to preclude tree and woody vegetation growth. In addition, this dam remediation design alternative can be used to provide a wider effective dam crest and provides excellent protection against wave erosion.

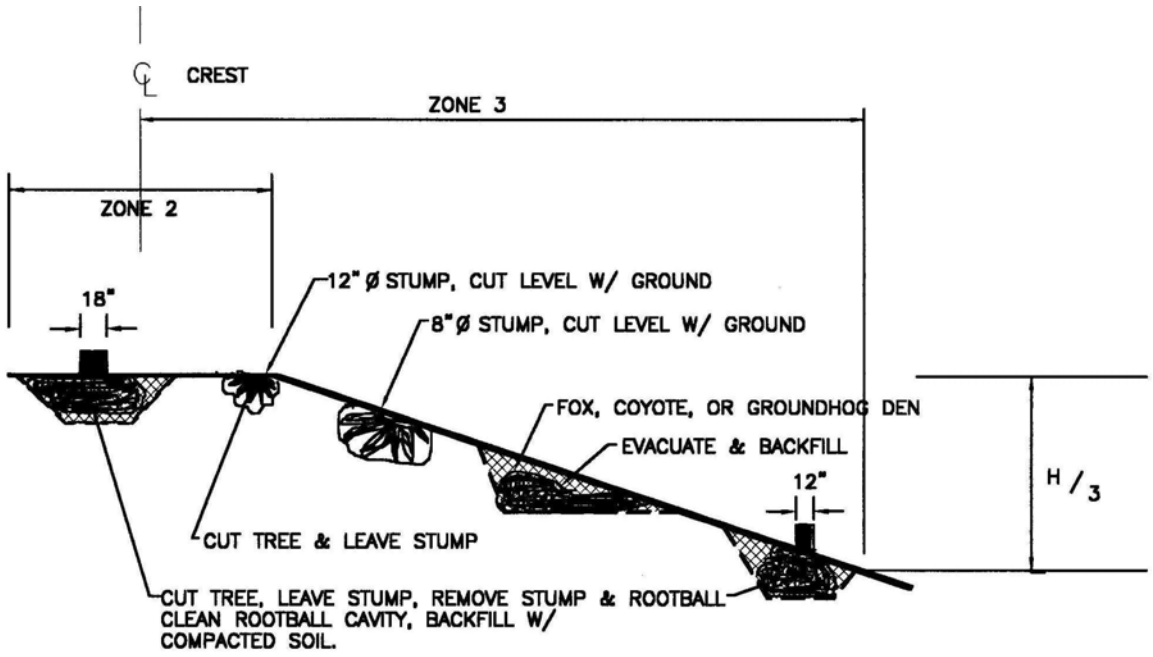
NOTE: Reinforced concrete wall and slab systems constructed on the upstream slope must always be provided with filtration/drainage systems to reduce the potential for development of excessive hydrostatic pressures and internal erosion and scour of soil from beneath the structures. The referenced figures are presented for illustrative purposes and should not be used for actual dam remediation design without proper design analyses to confirm any indicated dimensions of the drawings.

Alternative flexible upstream slope protection system designs for use in Zone 1 are shown in Figures 4(d) and 4(e). The author has utilized both of these flexible slope protection systems effectively to reduce potential tree and woody vegetation growth on upstream slopes and to provide resistance to wave and surface erosion. Figure 4(d) illustrates a typical gabion wall system while Figure 4(e) illustrates the use of a Mechanically Stabilized Earth (MSE) wall system for protection of the upstream slope of an earthen dam.

NOTE: Granular backfill material used in design and construction of these flexible wall systems must be protected against soil contamination and internal erosion of retained soil by an effective geotextile filter/drainage material and/or a graded aggregate filter. These figures are presented herein for illustrative purposes and should not be used for actual design without proper design analyses to confirm any indicated dimensions of the drawings.

Inspection and Evaluation Zones 2 and 3

Potential problems associated with tree and woody vegetation growth on earthen dams in identified Zones 2 and 3 are illustrated with dam remediation design procedures in Figure 5. Potential problems illustrated for Zone 2 include the growth of mature trees having stump diameters greater than twelve inches. Mature trees having stump diameters greater than eight inches are illustrated at various locations throughout Zone 3 and in the overlap area of Zones 2 and 3.



ZONE 2 & 3 REPAIR PROCEDURES

Figure 5

Two dam remediation design procedures are illustrated in Figure 5 for removal of trees of various sizes. This illustration implies that trees located in the overlap area of Zones 2 and 3 having stump diameters less than about twelve inches could be cut flush with the ground and left in place for future treatment of the decayed stump and rootball system. However, removal of all stumps, rootballs and root systems is always the better and more conservative approach to removal of mature trees. Subsequent to cutting of trees having stump diameter less than about twelve inches in the overlap area of Zones 2 and 3, the surface of the stump can be treated with a protective coating similar to polyurethane that will prolong the decaying process. Conversely, the referenced illustration indicates that any trees in Zone 2 upstream of the overlap area of Zones 2 and 3 having stump diameters of twelve inches or greater should be treated by total removal of the tree, stump, rootball, and root system. The suggested dam remediation design and construction procedure suggested for complete removal of trees, stumps, rootballs, and root systems in Zones 2 and 3 consists of the following activities:

1. **Cut** the tree approximately two feet above ground leaving a well-defined stump that can be used in the rootball removal process;

2. **Remove** the stump and rootball by pulling the stump, or by using a track-mounted backhoe to first loosen the rootball by pulling on the stump and then extracting the stump and rootball all together (this is much the same procedure a dentist would use in extracting a tooth);

3. **Remove** the remaining root system and loose soil from the rootball cavity by excavating the sides of the cavity to slopes no steeper than 1:1 (horizontal to vertical) and the bottom of the cavity approximately horizontal; and

4. **Backfill** the excavation with well-compacted soil placed in relatively thin lifts not greater than about eight inches in loose lift thickness. Compaction of backfilled soils in these tree stump and rootball excavations typically requires the use of manually operated compaction equipment or compaction equipment attached to a backhoe.

NOTE: All disturbed areas must be protected by seeding and mulching.

Figure 5 further illustrates that trees located in Zone 3 that have stump diameters greater than about eight inches should be treated by total removal. The removal procedure should be the same as previously described for larger trees in Zone 2. Trees having stump diameter of less than about eight inches could be cut flush with the ground and treated with a waterproofing sealant similar to polyurethane to prolong the stump and rootball decaying process. Again, complete removal of the stumps, rootballs, and root systems of all mature trees is a better and more conservative method of remediation.

Inspection and Evaluation Zone 4

Figure 6 illustrates potential problems associated with tree and woody vegetation growth in Zone 4 of an earthen dam with suggested dam remediation design and construction procedures.

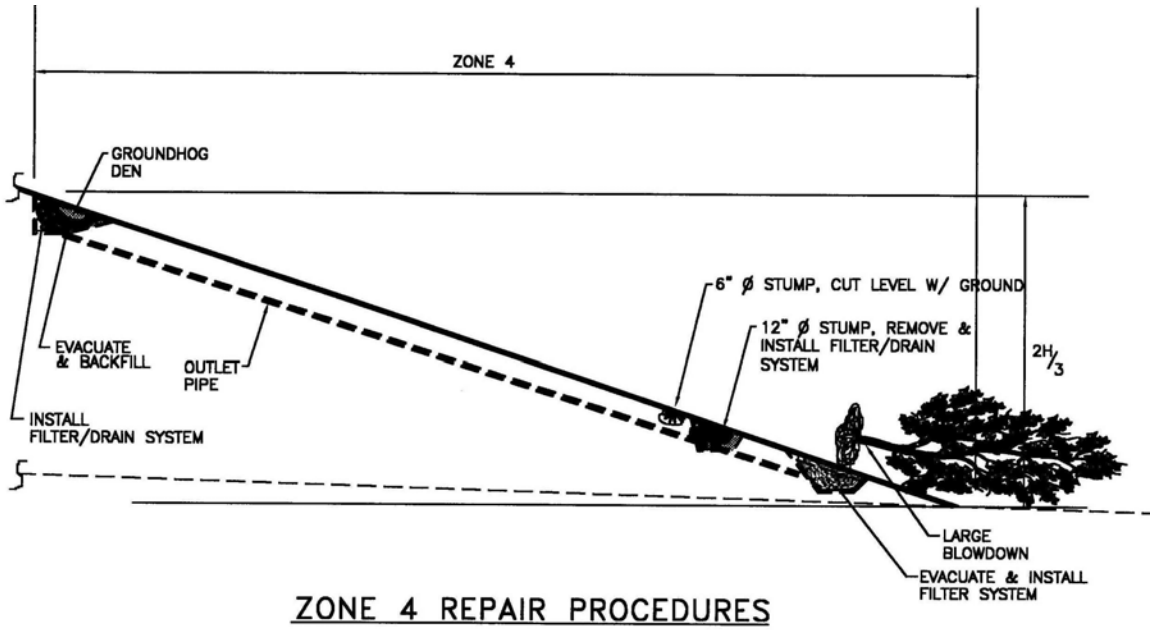


Figure 6

Young immature trees having stump diameters less than about six inches can be removed by cutting flush with the ground and treating the stump with a wood preservative and/or sealant to prolong the decaying process. This procedure is based upon the fact that immature trees of this size typically have not developed a rootball and/or root system that will significantly impact the zone of saturation or the seepage line in Zone 4.

Trees having stump diameters greater than about six inches must be treated by complete removal; however, the dam remediation design and construction procedure for total removal of trees in Zone 4 is somewhat more complicated than total removal of trees in previously discussed zones. Treatment of mature tree penetrations in Zone 4 involves the following activities:

1. **Cut** the tree approximately two feet above ground level leaving a prominent stump for use in the rootball extraction process;

2. **Remove** the stump and rootball by pulling the stump or extracting with a track-mounted backhoe after loosening the rootball by pulling on the stump from different directions;

3. **Clean** the rootball cavity to remove loose soil and the remaining root system by excavating the rootball cavity with maximum 1:1 (horizontal to vertical) side slopes and a horizontal bottom; and

4. **Install** a subdrain and/or filter system in the tree penetration excavation and backfill with compacted soil placed in maximum loose lifts of eight inches.

Note: Backfill placed in all tree removal excavations must be compacted to a minimum of 95 percent of the maximum dry density as determined by ASTM D-698.

Note: Subdrain and/or filter systems installed in tree removal excavations in Zone 4 may be incorporated into major subdrain systems to be installed in the overlap area of Zones 4 and 5.

Inspection and Evaluation Zone 5

The author identified Zone 5 as one of the two most critical zones for tree and woody vegetation growth on an earthen dam. Figure 7 illustrates some of the problems that can occur with tree and woody vegetation growth in Zone 5. The major adverse feature in Zone 5 is typically the interception of the downstream embankment slope by the seepage line. The author is a strong advocate of the installation of embankment subdrain systems during dam remediation design and construction even though the earthen dam may have been provided with an embankment subdrain system during original design and construction.

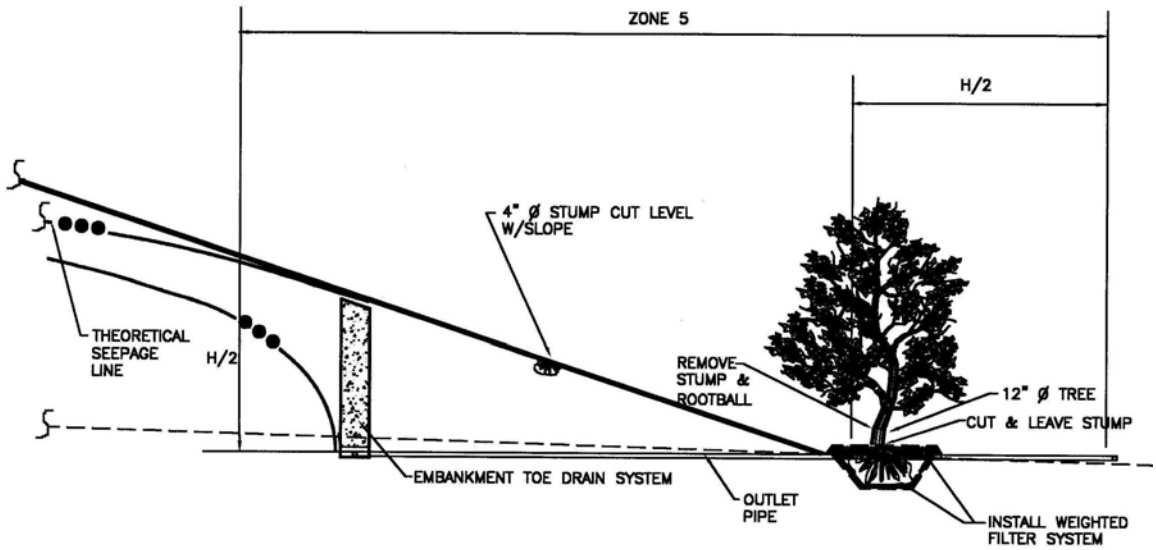


Figure 7

One must understand the impact of tree removal in Zone 5 on the seepage line and the quantity of seepage that will occur subsequent to dam remediation in this zone. As indicated by Figure 7, trees in Zone 5 having stump diameters less than about four inches can be cut flush with the ground and the stump treated with a waterproof sealant to

prolong stump and rootball decay. Trees having stump diameters greater than about four inches must be removed completely. If the embankment toe drain or subdrain system is installed in advance of tree removal in Zone 5, the rootball cavity can be backfilled with compacted soil, provided seepage does not emerge from the excavation and/or the tree is located beyond the toe of the embankment slope. Tree rootball cavities existing beyond the toe of the downstream embankment slope generally require the installation of a filter system and in some cases a weighted filter system as indicated in Figure 7. The weighted filter system may be converted to a weighted drain system by installing a drain and outlet pipes connected to the outlet pipe of the embankment subdrain system.

Summary of Dam Remediation Design Considerations

A summary of dam remediation design considerations for treatment of tree and woody vegetation on earthen dams is presented below. Dam remediation design procedures and techniques are presented for treatment of various size trees in the identified dam safety inspection and evaluation zones.

Remedial Repair Zone	**Procedures and Techniques**
Zone 1	Remove all trees, stumps, rootballs, and root system; clean rootball cavity; and backfill with properly placed and compacted soil backfill. Install tree and woody vegetation and wave erosion protection system on the upstream slope from about four feet below normal pool elevation to about three feet above normal pool elevation.
Zone 2	Cut trees in overlap area of Zone 2 and Zone 3 having stump diameters of twelve inches or less flush with the ground and treat the stump with a waterproof sealant to prolong stump decay.

Completely remove trees having stump diameters of about twelve inches and greater, and backfill rootball cavity with properly compacted backfill soil.

Zone 3

Cut trees having stump diameters of about eight inches and less level with the ground and treat the stump with a waterproof sealant to prolong stump and rootball decay.

Completely remove all trees having stump diameters greater than about eight inches and backfill the cleaned rootball cavity with compacted backfill soil.

Zone 4

Cut all trees having stump diameters of six inches or less flush with the ground and treat the stump with a waterproof sealant to prolong stump and rootball decay.

Remove all trees having stump diameters greater than about six inches, install subdrain and/or filter systems, and backfill with properly compacted soil around the filter/drain system.

Zone 5

Cut all trees having stump diameters of about four inches and smaller flush with the ground and treat the stump to prolong stump and rootball decay.

Install a major embankment toe drain or subdrain system to lower the phreatic surface, filter, collect, and discharge embankment seepage. Incorporate major subdrain with tree rootball and stump removal where possible.

Remove all trees located beyond the toe of the downstream slope having stump diameters greater than about four inches. Install weighted filters and/drain systems in rootball cavities where seepage boiling and soil piping is likely to occur.

Tree and Woody Vegetation Growth Control Program

Many individual dam owners and small dam owner organizations are not financially capable of undertaking comprehensive dam remediation projects in one major construction contract. Therefore, they must undertake dam remediation programs in a sequential manner. The following sequential dam remediation program for controlling tree and woody vegetation growth provides the owner, regulator, and engineer with a reasonable opportunity to effectively evaluate the condition of an earthen dam and to prioritize dam remediation relative to observed dam safety issues.

1. **First Year**: Cut all tall grasses, weeds, underbrush, and trees and woody vegetation having stump diameters of four inches or less flush with the ground and treat all cut stumps with a waterproof preservative to prolong rootball and stump decay.

2. **Second Year**: Cut all trees in Zones 1 through 4 having stump diameters of six inches or less flush with the ground and treat the stumps to prolong stump and rootball decay. Keep all zones mowed and/or maintained to preclude renewed growth of previously cut woody vegetation. Repair most severe animal penetrations that exhibit seepage flows and/or cause unstable slope conditions on Zones 1, 4, and 5.

3. **Third Year**: Initiate comprehensive remedial dam repair investigations, analyses, and preliminary design. Remove all trees from Zones 1 through 3 having stump diameters less than about eight inches by cutting flush with the ground and treating the stump with a preservative to prolong stump and rootball decay.

4. **Fourth Year**: Finalize remedial dam repair design and begin construction of remedial repairs for all plant and animal penetrations that require special remedial dam repair design considerations.

5. **<u>Fifth Year</u>**: Finalize remedial dam repair construction and begin an operation and maintenance program that will preclude the need for future remedial dam repair associated with plant and animal penetrations of earthen dams.

<u>NOTE:</u> **Earthen dams that exhibit severe dam safety deficiencies and dam safety issues that cannot be prolonged as a result of potential imminent dam failure <u>are not</u> subject to the use of this type of sequential dam remediation program!!!**