Lower Colorado River Authority
Highland Lakes Dredge and Fill Ordinance
Technical Manual

Effective Date: Jan. 1, 2022

Section 1. INTRODUCTION

The Lower Colorado River Authority (LCRA) has established standards for dredge and fill activities performed in and along the Highland Lakes to protect water quality and to address operational and safety issues related to these activities.

This manual is intended to provide minimum criteria and guidance for complying with LCRA's Highland Lakes Dredge and Fill Ordinance ("the Ordinance" or "HLDO"). The manual is not a comprehensive guide to all acceptable methods and is intended to address commonly encountered conditions. Applicants should contact LCRA staff to discuss unusual site conditions or proposals involving alternative guidance or criteria prior to submitting plans for approval.

Persons conducting these activities must also comply with other regulatory requirements, including Section 404 of the Clean Water Act, Texas Commission on Environmental Quality rules, and city and county codes and ordinances.

Section 2. DEFINITIONS

Certain terms used in this manual are defined in Section 3 of the HLDO. Additional definitions not found in the Ordinance are as follows:

Fetch Length: The horizontal distance over which wave-generating winds blow. In an enclosed body of water, fetch is also defined as the distance between the points of minimum and maximum water-surface elevation. This line generally coincides with the longest axis in the general wind direction.

Filter Fabric: A filter consisting of one or more layers of permeable textile. Also referred to as geotextiles and engineering fabrics.

Flanking: Erosion of shoreline on either side of a Shoreline Stabilization system.

Freeboard: Vertical distance from the top of the Shoreline Stabilization system to the water surface at design condition.

Gabion: Rectangular wire baskets filled with rocks used in the construction of a variety of erosion control structures. Also, the name used for a number of these structures.

Median Diameter (D50): The midpoint of the size distribution of riprap or gravel filter particles such that half the weight of the material is composed of particles that are larger than the median diameter and half is composed of particles smaller than the median diameter.

Riprap: A well-graded mass of durable stone or other material that is specifically designed to provide protection from flow induced erosion.

Toe: The lower terminus, base or foundation of a shoreline stabilization system.

Wave Height: The height of a wave calculated in accordance with engineering practice.

Wave Run-up: The movement of water up a channel bank or shoreline as a result of the breaking of a wave at the bank line; The extent and magnitude of the wave run-up is a function of the energy in the wave.

Section 3. APPLICATION PROCESSING

Tier I projects conducted under LCRA's Lakewide permit do not require an individual notification. A Lakewide permit is a specific authorization issued pursuant to a Programmatic General Permit ("PGP") issued by the Army Corps of Engineers. A Lakewide permit allows for repair work and maintenance dredging up to a specific volume (the current PGP allows 2,000 cubic yards) during a planned drawdown of a specific lake or lakes. The Lakewide permit contains requirements tailored to the specific conditions of each planned drawdown. Individuals must sign up on lcra.org or by contacting LCRA, and must meet the permit requirements.

Other non-emergency Tier I projects must be authorized by a written notification to LCRA. The written notification should include all information on the checklist on www.lcra.org. The notification should be sent to LCRA per the instructions on www.lcra.org.

Emergency repairs of utility infrastructure may begin without a written notification to LCRA; however, the utility must provide written notification within 24 hours per the checklist found on LCRA's website. The utility is encouraged to contact LCRA in advance to review the checklist prior to submitting the notification.

Tier II and III permit applications are processed in accordance with Section 6 of the Ordinance. A checklist of required application materials is available on www.lcra.org.

Financial Security: For Tier II and III permit applications, the applicant must provide a cost estimate for the installation and maintenance of turbidity control, Shoreline Stabilization and remediation, in accordance with the Permit and any other provision of the Ordinance. The amount shall not be less than 100% of the cost as estimated by the professional engineer who seals the application materials as approved by LCRA.

Upon review and approval of the cost estimate by LCRA staff, the applicant must provide a letter of credit in a form acceptable to LCRA or cash deposit. A template for a letter of credit can be found on www.lcra.org.

Section 4. STANDARDS FOR DREDGE AND FILL ACTIVITIES

4.1 Property Ownership or Control

See HLDO Section 5.1(a). Applications must provide evidence of property ownership or control of the area where dredge and fill activities will occur. Refer to the application checklists for acceptable documentation. In most cases, ownership can be verified through the county courthouse or tax appraisal offices. When researching ownership, the most recent survey or plat should be used.

For Tier III applications, and as necessary in other circumstances, LCRA may require applicants to provide an attorney title opinion, or a title commitment and any other documentation deemed necessary by LCRA to verify compliance with HLDO Section 5.1(a).

4.2 Publicly Owned Land

Some land under the Highland Lakes is owned by a city or county, the state or another public entity such as LCRA. Each of these entities may have additional requirements applicable to dredge and fill activities over land they own.

Applicants must determine which public entity owns the land and what type of permission is needed before conducting work. Applicants are responsible for complying with any requirements imposed by an entity that has jurisdiction over the property.

LCRA does not allow encroachment on LCRA land; all activities must be conducted on the land where the applicant has demonstrated ownership or control. Dredging on LCRA property requires approval from LCRA before work begins. Any unauthorized fill placed on LCRA land will be subject to removal at the applicant or encroaching party's expense. For help determining LCRA ownership of shoreline and submerged land, please contact LCRA's Real Estate Services at 800-776-5272, ext. 4406.

4.3 Dredge and Fill Project Planning

Dredge and Fill projects require careful consideration of the benefits and consequences of the activity.

(a) Dredging

(i) Dredging below the original channel depth can cause bank sloughing and collapse that could quickly refill the dredged area, impact neighbors and cause water pollution.

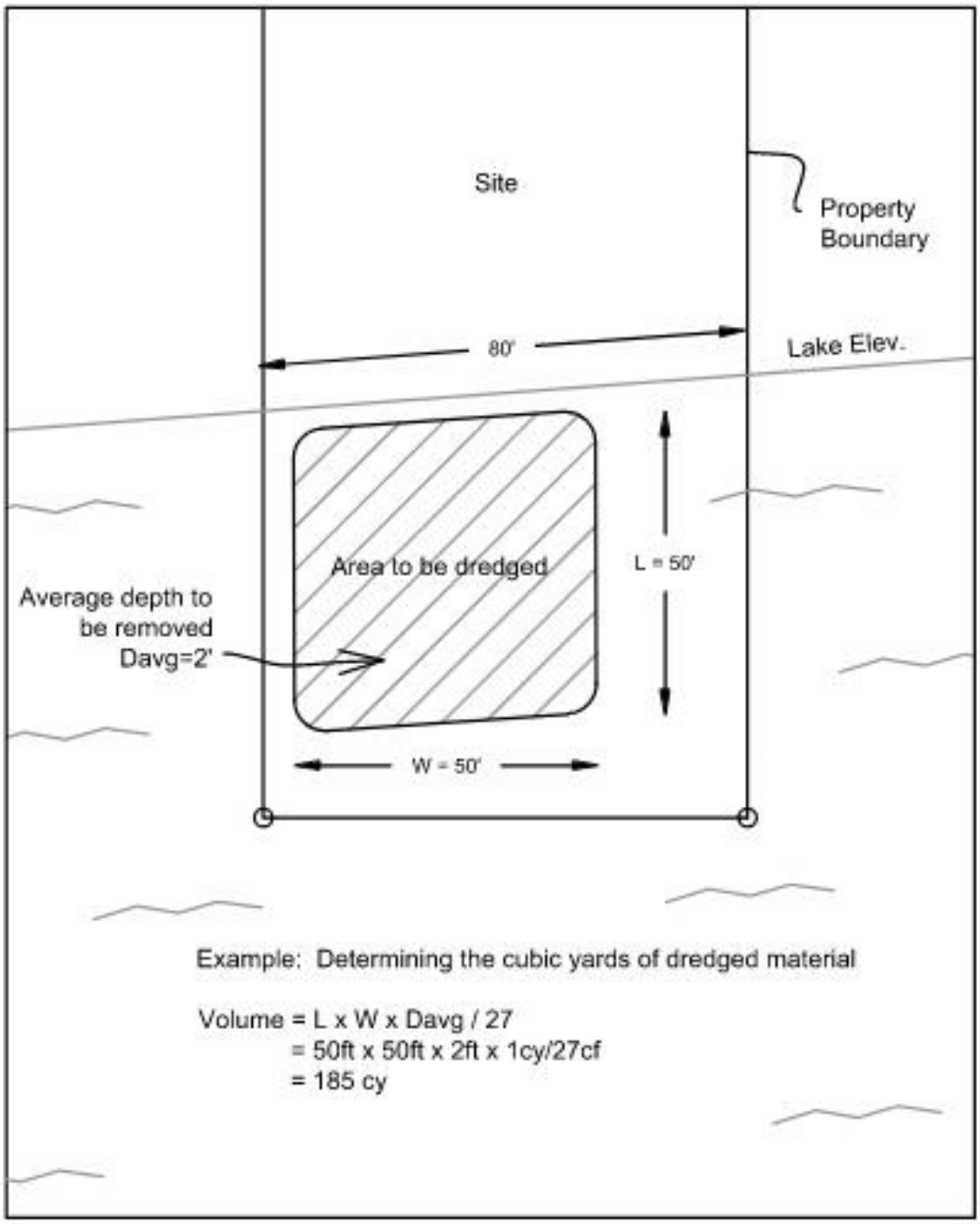
(ii) Plan carefully to ensure safe access for removal of the dredged material. Ensure that dredged material is placed in a secure area protected from erosion and re-entry into the waterway.

(iii) Dredging in dry conditions during planned lake lowering events or when the lake has receded is recommended. Turbidity controls such as turbidity curtains or coffer dams are required for dredging under submerged conditions.

(iv) Avoid dredging where upland waterways or storm drainage conveyances could erode the dredged area. Ensure proper stabilization or armoring if these areas cannot be avoided.

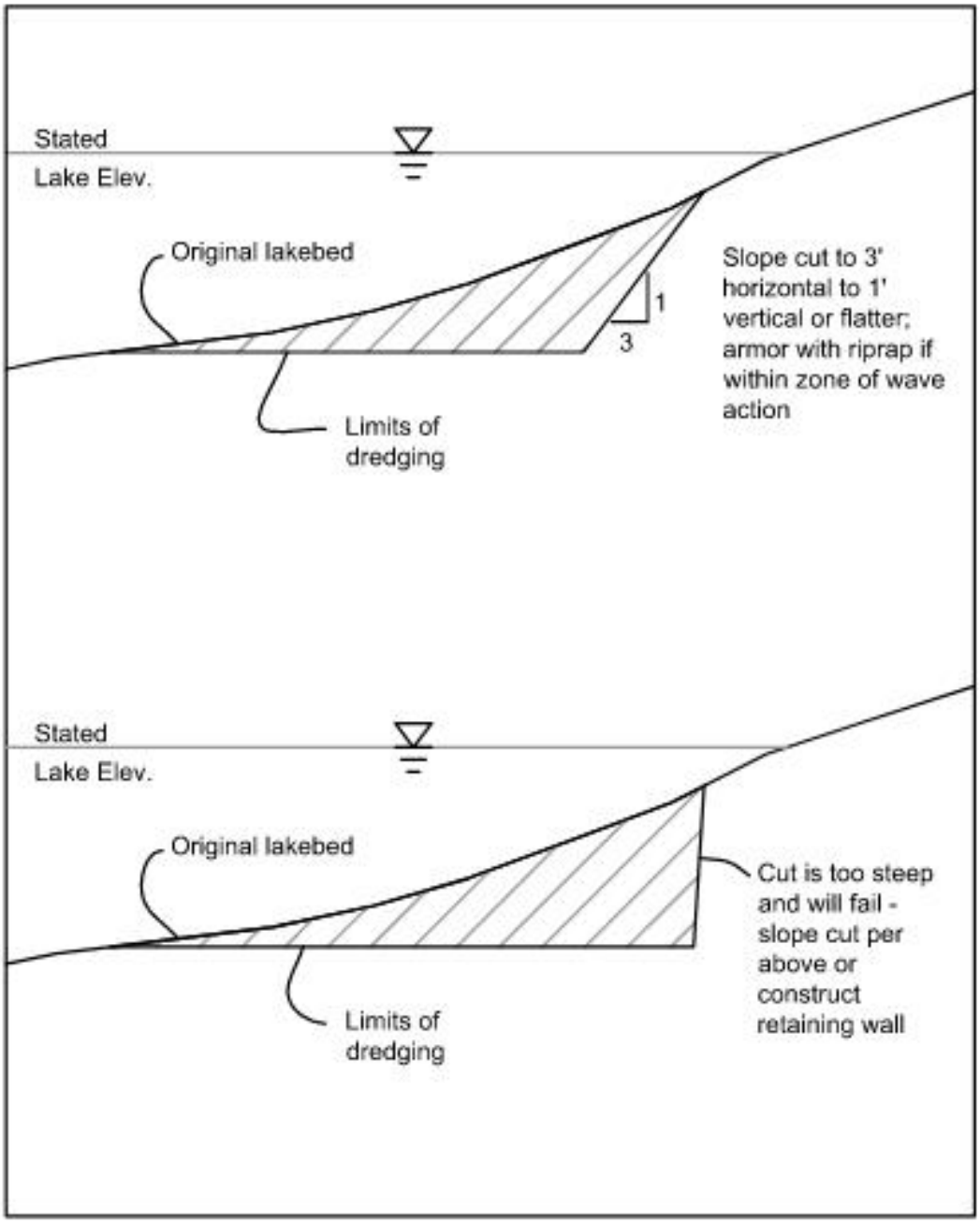
(v) Calculate the volume of material to be removed in advance to ensure the project does not exceed the authorized volume and/or length. See Figure 1 for guidance.

FIGURE 1: Determining the Cubic Yards of Dredged Material



(vi) Ensure that Dredged or Filled areas are gradually sloped downward from the shoreline to blend the newly Dredged or Filled area into the existing lake bottom contour. Dredged or Filled areas must be contoured and reinforced as necessary to prevent any irregular surfaces or cuts that might collapse or erode. See Figure 2 for guidance.

FIGURE 2: Cut Slope for Dredged Area



(b) Shoreline Stabilization Systems

See HLDO Section 5.1(e). Shoreline Stabilization systems include the construction of structures such as revetment, riprap, retaining walls, gabions or bulkheads to stabilize the shoreline of a body of water. Shoreline Stabilization systems require careful planning to ensure the structures meet standards for siting, stability and water quality protection.

(i) Ensure that potential failure mechanisms such as erosion, slump, sliding, structural failure, wave overtopping and flanking erosion are addressed in accordance with accepted engineering practices. Figures 3 and 4 below illustrate wave-related design parameters to be addressed in the design. Figure 5 shows additional potential failure mechanisms.

Figure 3: Shoreline Stabilization Using Rock Riprap

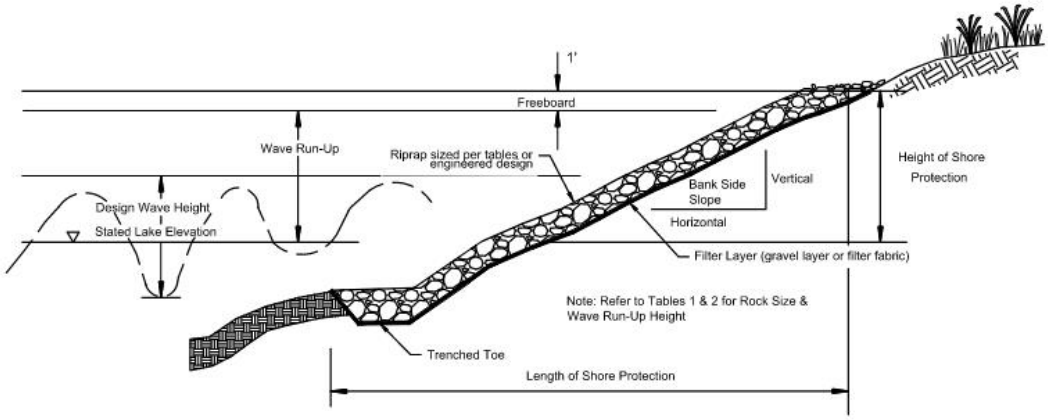
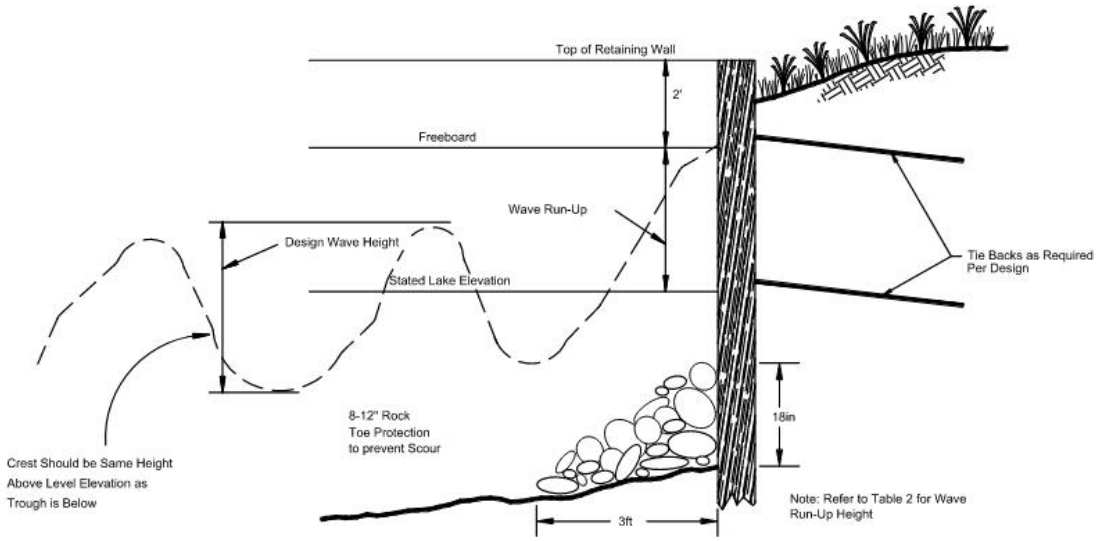


Figure 4: Shoreline Stabilization Using a Retaining Wall



Tables 1 and 2 provide riprap sizing and wave run-up height based on HEC-11. Designers should use a minimum 3-foot wave height in areas with no wake control. Designers should calculate wave height based on USDOT/FHWA Hydraulic Engineering Circular No. 11 (HEC-11) Chart 6, where shorelines are exposed to a fetch length more than 5 miles.

Table 1: Riprap Size for Wave Protection

(Source: HEC-11 Chart 7. Hudson relationship for riprap size required to resist wave erosion)

$D50 = 0.57H / \cot^{1/3} \theta$
D50 = Median riprap size (inches)
H = Wave height (feet)
θ = Bank angle with horizontal

	Bank side slope (horizontal: vertical)					
D50, in	2:1	2.5:1	3:1	4:1	5:1	6:1
H, ft						
1	5	5	5	4	4	4
2	11	10	9	9	8	8
3	16	15	14	13	12	11
4	22	20	19	17	16	15
5	27	25	24	22	20	19
6	33	30	28	26	24	23

example: *H = 3 feet, side slope = 2 horizontal to 1 vertical*
result -use rock with D50 of 16 inches

Table 2: Wave Run-Up Height for Angular Rock Riprap

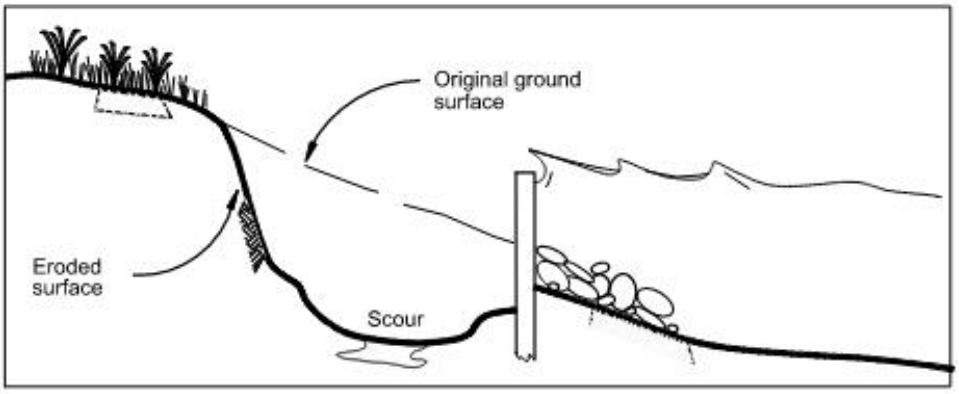
(Source: HEC-11 Chart 8. Wave run-up on smooth, impermeable slopes & Table 9. Correction for wave run-up)

R = Wave run-up height (feet)
H = Wave height (feet)
θ = Bank angle with horizontal
Cf = Correction factor (0.6 for angular rock riprap)

	Bank side slope (horizontal: vertical)					
R, ft	2:1	2.5:1	3:1	4:1	5:1	6:1
H, ft						
1	2	2	2	2	2	2
2	3.4	3.7	4.0	4.3	4.3	4.3
3	5	6	6	6	6	6
4	6.7	7.4	7.9	8.6	8.6	8.6
5	8	9	10	11	11	11
6	10.1	11.2	11.9	13.0	13.0	13.0

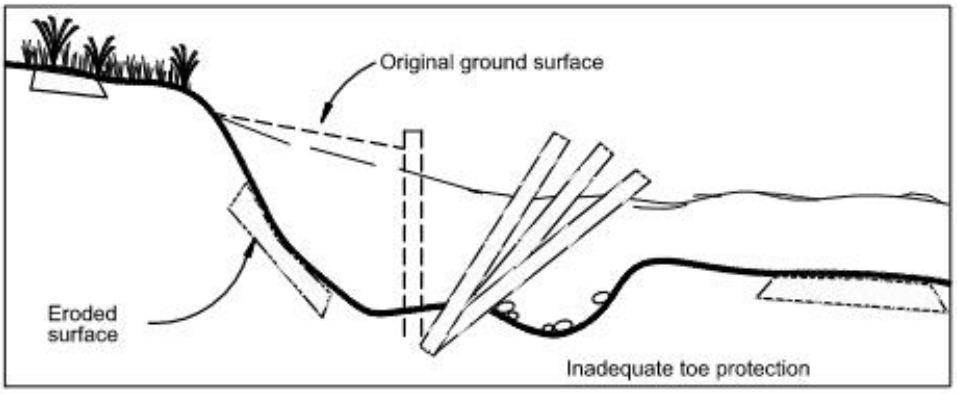
example: *H = 3 feet, side slope = 2 horizontal to 1 vertical*
result - wave run-up extends 5 feet above water level

Figure 5: Failed Shoreline Protection Systems



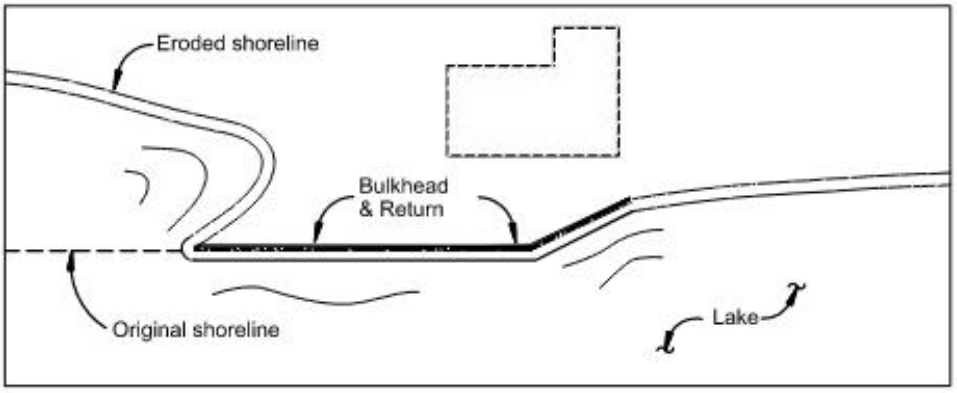
Erosion Behind Structure - Waves Lap Over Top

Side View



Slumping Due to Toe Scour

Side View



Plan View -- Flank Erosion

(ii) Ensure that potential erosion from upland waterways and storm drainage conveyances is addressed in the design. See HLDO Section 5.1(b).

(iii) Ensure that Shoreline Stabilization design construction follows the existing shoreline and the amount of material is within the approved limits. See HLDO Section 5.1(d).

(iv) Consider using designs that reduce wave refraction. Sloping and naturally vegetated shorelines are encouraged where suitable conditions exist. The City of Austin Environmental Criterial Manual, Section 1.13, includes several examples of vegetated, structural and hybrid stabilization methods.

(v) Do not use unsuitable materials such as trash, debris, car bodies, asphalt or any other materials that may cause pollution of the lake or unsafe conditions.

(vi) Riprap shall be hard durable stone or other materials that meet Texas Department of Transportation or City of Austin Specifications.

(vii) All Shoreline Stabilization systems must be designed and constructed in accordance with accepted engineering and construction practices.

4.4 Water Quality Protection Best Management Practices

See HLDO Section 5.1(b).

(a) Erosion/Sediment Controls

Erosion and sedimentation resulting from shoreline disturbances and adjacent upland areas must be controlled as per LCRA's Highland Lakes Watershed Ordinance; for criteria and guidance see the HLWO Technical Manual.

(b) Turbidity Controls

Dredge and Fill Activities must control turbidity when work is conducted under submerged conditions using the management practices found in this section. Tier II and Tier III activities must also develop a monitoring plan as described in Section 5.2(b) of the HLDO.

If the turbidity controls fail to manage turbidity impacts to adjacent waters outside the control area, the operator must stop the work and modify the turbidity controls and/or work practices such that the turbidity impacts are eliminated. Sediment deposits within the control area that are subject to mobilization by currents or wave action shall be removed before the controls are dismantled.

(i) Turbidity (Silt) Curtains

1) Description: A turbidity curtain is a temporary fabric curtain with very low permeability, installed in a waterway or waterbody to minimize sediment transport.

2) Conditions where practice applies: This practice applies where construction activities occur in submerged conditions within or adjacent to a waterway or waterbody. This includes but is not limited to bridge construction, utility work, streambank restoration, recessed boat slips, retaining walls, boat docks, boat launches and dredging.

Type I curtains are limited to projects with a duration of less than one month, shoreline disturbance of less than 200 feet and no significant exposure to wind, wave or current action.

Type II curtains are required for use on lakes where the work area is subject to current, wind or wave action. Most locations on the main body of the Highland Lakes are subject to currents due to river and creek inflows and dam releases, as well as wave and wind action.

3) Purpose: The purpose of this practice is to provide sediment containment while construction activities are occurring in or directly adjacent to a waterway or waterbody. Higher turbidity increases water temperatures because suspended particles absorb more heat. This, in turn, reduces the concentration of dissolved oxygen (DO) because warm water holds less DO than cold. Higher turbidity also reduces the amount of light penetrating the water, which reduces photosynthesis and the production of DO. Suspended materials can clog fish gills, reducing resistance to disease in fish, lowering growth rates, and affecting egg and larval development. As the particles settle, they can blanket the stream bottom, especially in slower waters, and smother fish eggs and benthic macroinvertebrates.
[reference http://water.epa.gov/type/rsl/monitoring/vms55.cfm]

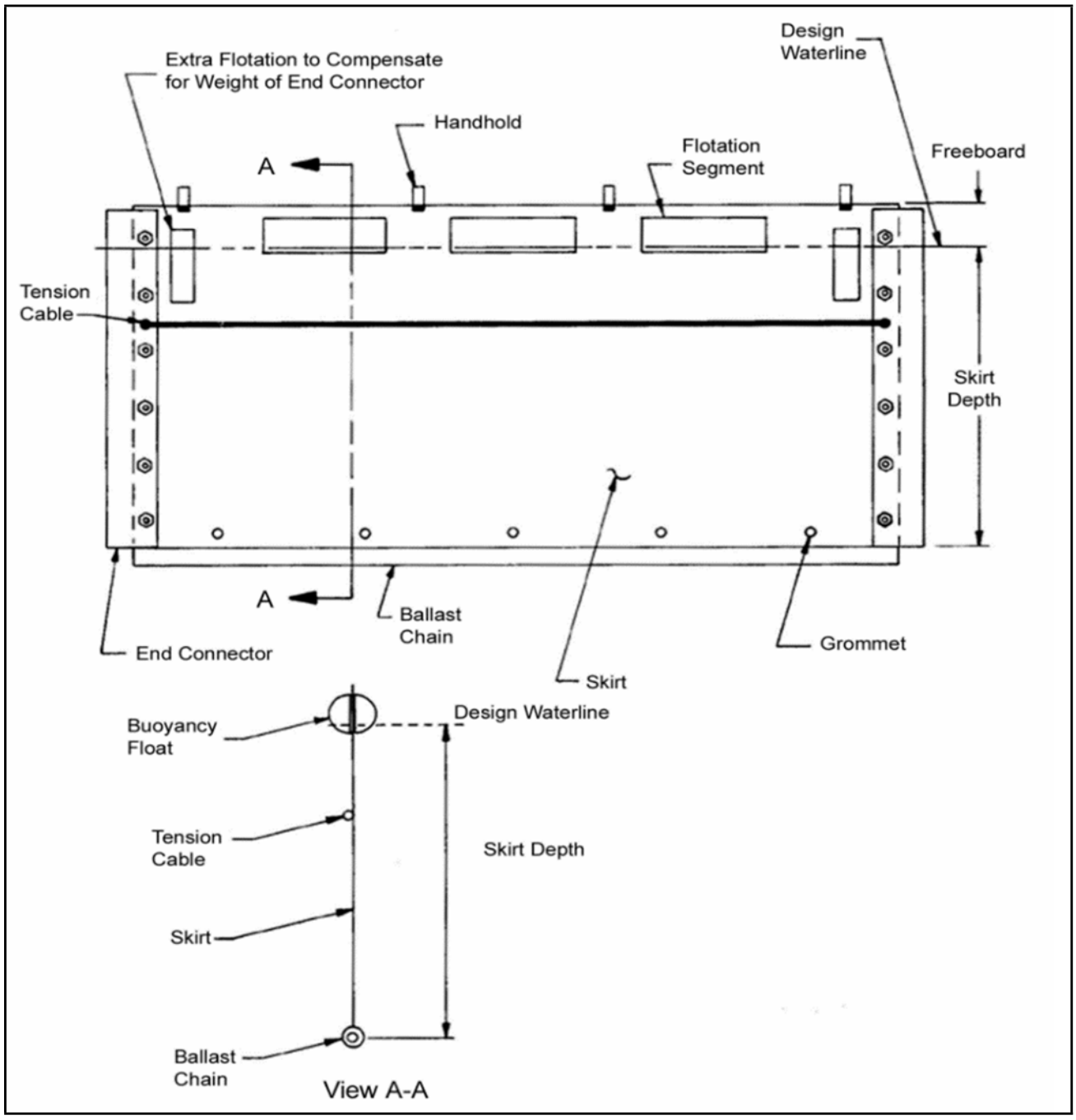


Figure 1. Construction of a typical silt curtain section (JBF Scientific Corporation,1978)

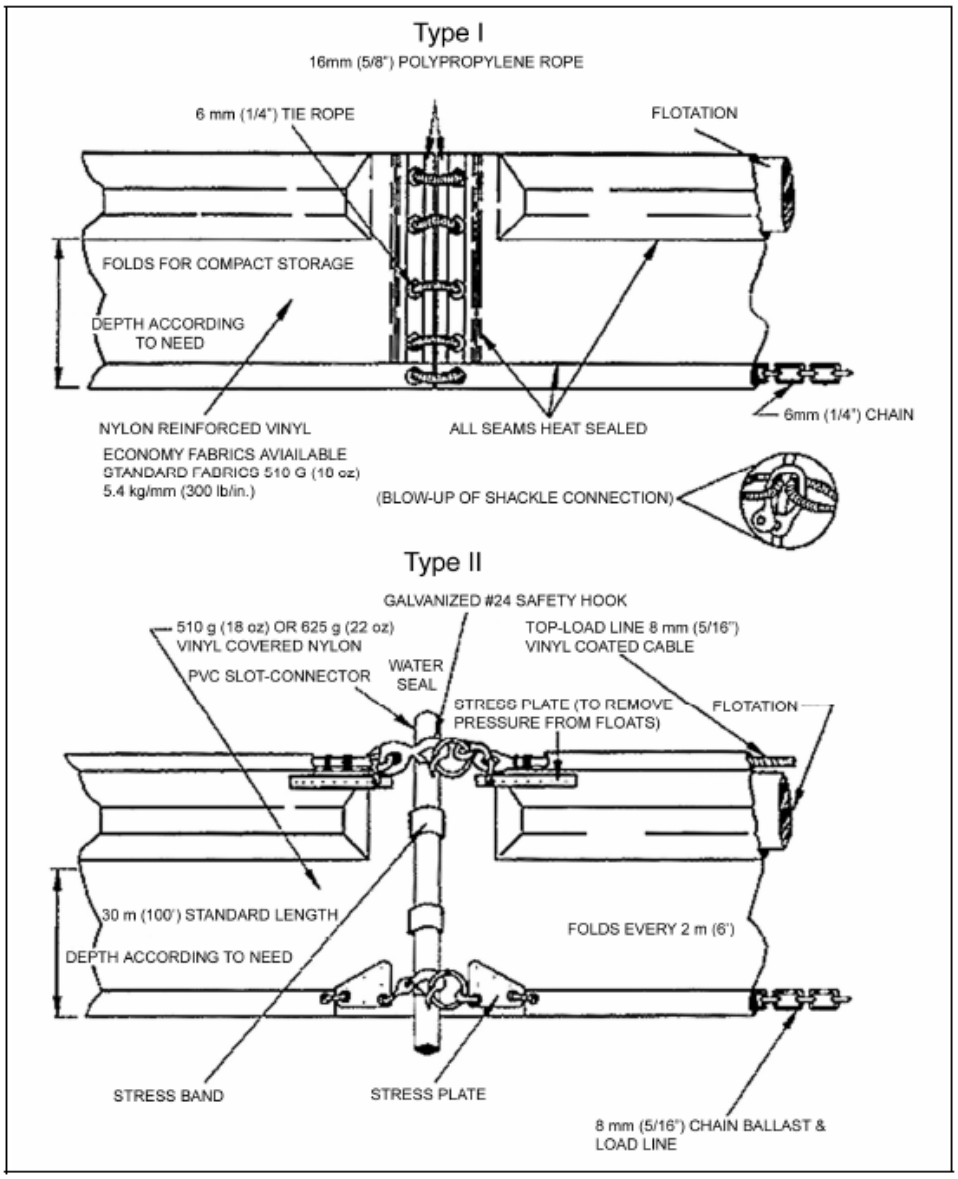


Figure 2. Type I and II Turbidity Curtains

4) Installation: Also refer to Figure 3 as a guide for installation.

a) The curtain should be installed before construction activities are initiated.

b) The curtain should remain in place and be maintained until the construction activity is completed and the disturbed area has stabilized.

c) The ends of the curtain should be securely anchored and keyed into the shoreline to fully enclose the area where sediment may enter the water.

d) A turbidity curtain should not be installed perpendicular to the direction of flow in a waterway or waterbody. Turbidity curtains should be installed at an angle not greater than 45 degrees parallel to the direction to flow.

e) Driven posts can be used to hold the curtain in position. The maximum spacing between posts should be 10 feet. When curtain height exceeds 8 feet, post spacing may need to be decreased.

f) When bedrock prevents the installation of posts, float devices may be used. Flotation devices shall be flexible, buoyant units contained in an individual flotation sleeve or collar attached to the turbidity curtain. Buoyancy provided by the flotation devices shall be sufficient to support the weight of the turbidity curtain and maintain a freeboard of at least one-third of the flotation device cross section above the water surface.

g) Type II curtains should extend to the bottom of the water body within 20 feet of the shoreline. Type I curtains and Type II curtains located more than 20 feet from the shoreline should have a gap between the bottom of the curtain and the bottom of the water body no less than one foot from the lake substrate to allow hydraulic connectivity at normal pool elevation. The curtain should be weighted at the bottom (as shown in Figure 1) to maintain the desired depth. A curtain should not be required to exceed 8 feet below the water surface unless special conditions require a greater depth.

h) Ballast or anchors should be used to hold the curtain in a vertical position. Bottom load lines may consist of a chain incorporated into the bottom hem of the screen, of sufficient weight to serve as ballast to hold the screen in a vertical position. Additional anchorage should be provided if necessary.

i) Hazard buoys may be required around turbidity curtains to alert and protect boat traffic.

5) Materials

a) Components of the turbidity curtain system should be clean and free of exotic species.

b) Top load lines should consist of steel cable sufficient to support the load of the turbidity curtain system.

c) Fabric should be selected according to the specifications in Table 1.

Table 1. Fabric Specifications for Turbidity Curtain

Requirement	Method	Value
Min. grab tensile strength	ASTM D4632	200 lb (890 N)
Min. puncture strength	ASTM D4833	90 lb (400 N)
Maximum permeability	ASTM D4491	≤ $1X10^{-7}$ cm/s
Min. ultraviolet stability	ASTM D4355	70%

Source: WisDOT Spec 628.2.10.

6) Operation and Maintenance

a) Turbidity curtains shall be inspected daily and repaired/adjusted as necessary to maintain proper installation practice and compliance with site plan, and as directed by LCRA inspector.

b) Turbidity curtains should not be removed until the water contained within the curtain has equal or lower turbidity than the waterway or waterbody, or if a flood event is imminent.

c) Care should be taken when removing the curtain to minimize the release or re-suspension of sediment.

d) Turbidity curtains that have been previously used in other water bodies must be properly cleaned to prevent the spread of invasive exotic species from other sites. If any materials (including turbidity curtains, buoys and chains) have been previously used, they shall be disinfected with vinegar or cleaned with hot water greater than 104 degrees Fahrenheit, then allowed to completely dry for a minimum of five days. For questions about the occurrence of zebra mussels (Dreissena polymorpha), Giant salvinia (Salvinia molesta) or other aquatic invasive species in a waterbody, contact the Texas Parks and Wildlife Department.

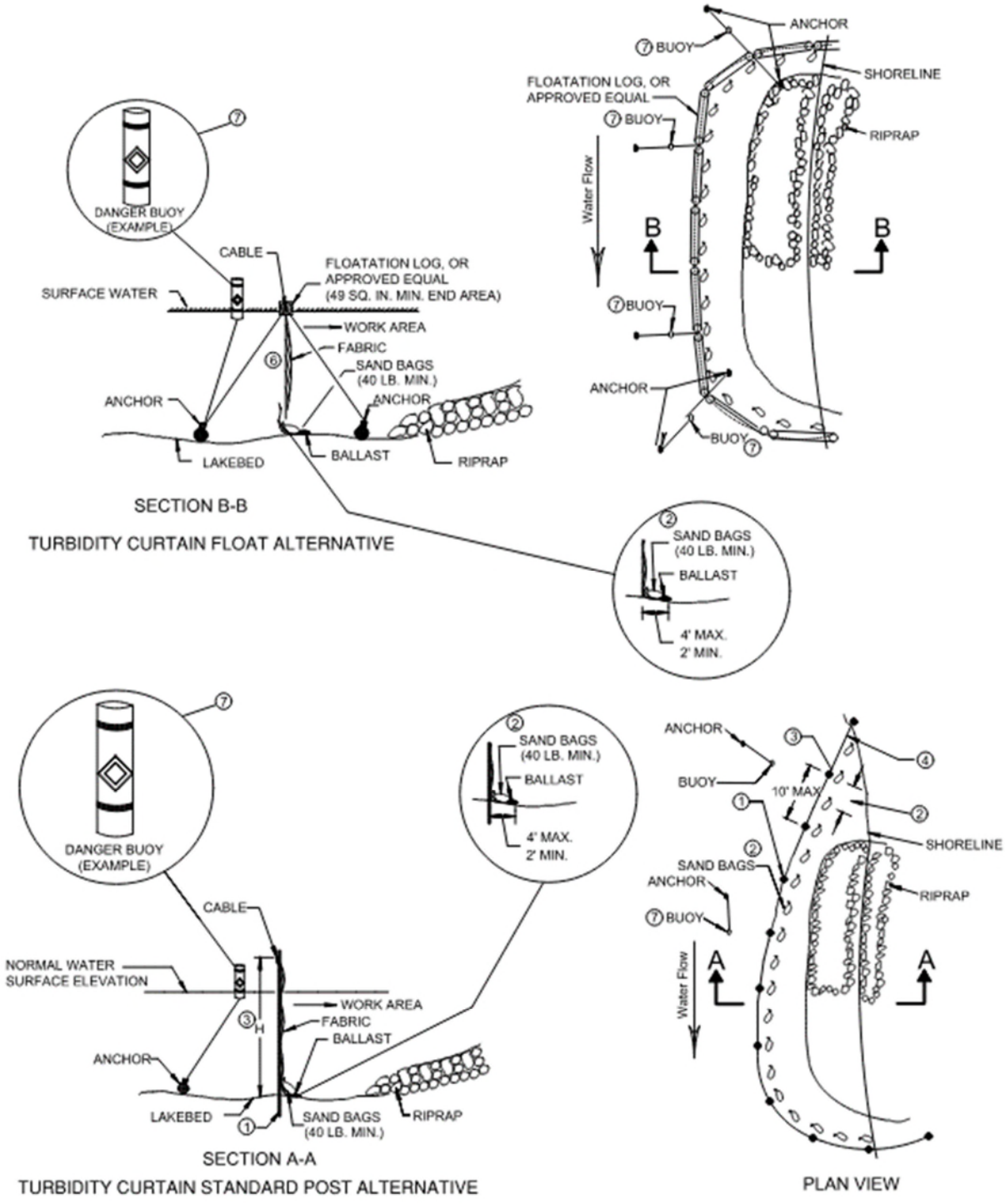


Figure 3. Turbidity Curtain Placement Details
(Modified from Wisconsin DNR TS1069)

(c) Coffer Dams

Coffer dams may be employed provided they are designed, constructed and maintained in accordance with accepted engineering practices.

(d) Shoreline Excavation

Excavation of recessed slips or new channels should be performed by excavating the land side first, leaving a sufficient earthen dam or “plug” to isolate the excavation from the lake until the excavation is stabilized. Following stabilization, the dam or plug can then be removed and the excavation completed, including stabilization of the dam/plug area.

4.5 Additional Considerations

(a) Invasive Species

See HLDO Section 5.1(f) for requirements for ensuring equipment does not facilitate the spread of invasive species to and from the Highland Lakes. Refer to the regulations on Potentially Harmful Fish, Shellfish and Aquatic Plants in the Texas Administrative Code, Title 31, Part 2, Chapter 57, Subchapter A. Additional guidance can be found at www.texasinvasives.org.

(b) Public Water Supply Intakes

See HLDO Section 5.1(g)(i) for restrictions.

(c) Other Permits

See HLDO Section 5.1(g)(iii) and (iv) for requirements.

4.6 Additional Standards for Tier II Dredge and Fill Activities

See HLDO Section 5.2.

(a) Turbidity Management and Monitoring

See HLDO Section 5.2(b) for requirements. The plan must address locations, number of samples based on site specific factors, including water depth, current, proximity to dams, intakes, etc. Additional guidance will be provided by LCRA during the required pre-application meeting.

(b) Emergency Operations Plan

See HLDO Section 5.2(c) for requirements. Additional guidance will be provided by LCRA during the required pre-application meeting.

4.7 Additional Standards for Tier III Commercial Dredge and Fill Activities

See HLDO Section 5.3.

Section 5. REFERENCES

City of Austin Environmental Criterial Manual, 2021

Texas Administrative Code, Title 31, Part 2, Chapter 57, Subchapter A

USACE ERDC TN-DOER-E21 September 2005

USDOT/FHWA Hydraulic Engineering Circular No. 11 (HEC-11)

Wisconsin Department of Transportation Standards and Specifications