Erosion Control for Wisconsin’s Inland Lakes and Flowages
Wind Generated Waves

\[ H_s = \text{function} \ (1) \ \text{wind speed} \ U_{10} \\
(2) \ \text{fetch [size of lake]}, \ X \\
(3) \ \text{water depth}, \ d \]
Wave Processes
Deep Water – Off Shore Generation
Wave Processes
Shallow Water – Near Shore

- Shoaling
- Breaking
Young’s Relationship

\[
\frac{gH_s}{U_{10}^2} = 0.241 \left\{ \tanh A_1 \tanh \left[ \frac{B_1}{A_1} \right] \right\}^{0.87} \\
\frac{U_{10}^2}{T_s g} = 0.133 \left\{ \tanh A_2 \tanh \left[ \frac{B_2}{A_2} \right] \right\}^{-0.37}
\]

\[
A_1 = 0.493 \left( \frac{gd}{U_{10}^2} \right)^{0.75}, \quad B_1 = 0.00313 \left( \frac{g}{U_{10}^2} \right)^{0.57}
\]

Where

\[
A_2 = 0.331 \left( \frac{gd}{U_{10}^2} \right)^{1.01}, \quad B_1 = 0.0005215 \left( \frac{g}{U_{10}^2} \right)^{0.73}
\]
SHAID_TYP – A two-character code for each region. The code represents areal water features. This item is indexed.

BA Backwater
CB Cranberry Bog
DP Duck Pond
DC Ditch or Canal
FH Fish Hatchery or farm
FE Flooded Excavation (e.g. pits, quarries, old mines)
IA Inundation Area
IW Industrial Waste Pond
LP Lake or Pond
RF Reservoir or Flowage
ST Double-line Stream
SD Sewage disposal pond or filtration beds
TP Tailings Pond
UN Unknown hydrography polygon
ZZ Convoluted Stream
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ZZ Convoluted Stream
Fetch length is the longest continuous distance originating from the shore across the water surface to the opposite intersect with the shore or land.

What’s the wave height at my site?

Mean depth can be measured along the fetch by averaging depths recorded at 5 equally placed intervals.

1” = 800 feet

4.5 inches x 800 ft./inch = 3600 ft.

\[
\frac{(45’+105’+75’+55’+25’)}{5} = 61 \text{ ft.}
\]
6. To convert the ruler measurement of fetch to actual distance, multiply feet per inch (found in step 2) by the measured fetch line (found in step 5):

\[
\text{Lake Fetch} = \underline{\text{feet}} \times \underline{\text{inch}} = \underline{\text{feet}}
\]

7. Measure the mean depth along your fetch line:
   1. Locate and mark at least 5 equally-spaced points along your fetch line.
   2. Estimate and record the depths at these equally spaced points (for example: 45', 105', 75', 55' and 25').
   3. Add these depth values together and then divide by the number of sample points taken, and record the result. For example, \((45' + 105' + 75' + 55' + 25')/5 = 61\) feet. Use this example (PDF, 273KB) for reference.

8. Using the two values obtained in steps six and seven, fetch from your site and mean depth on your fetch line, use the wind wave model below to calculate the storm wave height at your site. The storm wave height is used to determine the energy category at your site.

<table>
<thead>
<tr>
<th>Lake Mean Water Depth</th>
<th>22 feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lake Fetch From My Site</td>
<td>3.3 miles</td>
</tr>
<tr>
<td>Storm Wind Speed</td>
<td>51.33 ft/sec</td>
</tr>
</tbody>
</table>

Calculate

<table>
<thead>
<tr>
<th>Storm Wave Height</th>
<th>1.80 feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Category</td>
<td>Moderate Energy</td>
</tr>
</tbody>
</table>

9. Print out this page and submit it with your application.

Note: This page contains one or more Adobe Portable Document Format (PDF) files, which can be viewed and printed with the freely available Adobe® Reader® software.
NR 328-Using DNR WebView
(http://maps.dnr.state.wi.us/webview/) to Calculate Maximum Fetch, Average Fetch, and Shore Orientation
Toggle on the Advance Tools button
Use the “find location” to search by TRN, or city, etc.

Bring in the map layers that you desire
Activate the local road layer, in this example the applicant’s residence is 1963 Hershey Lane.
Use the markup tool to identify the site of interest, this is useful when you later zoom out for a whole-lake view.
Use the measure tool to locate and measure the maximum fetch at the site.
Energy Category
• Classifies Shoreline Sites Based on Erosion Severity

<table>
<thead>
<tr>
<th>Low Energy</th>
<th>Moderate Energy</th>
<th>High Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1 foot</td>
<td>1- 2.3 feet</td>
<td>&gt;2.3 feet</td>
</tr>
</tbody>
</table>
What Causes Erosion?

- Boating Waves
- Ice action
- Long-shore currents
- Removal/loss of bank vegetation
- Removal/loss of shallow water aquatic plants
- Tributary areas and flowing water
- Wind-driven waves
What Causes Erosion?

• Wind-driven waves
• Boating Waves
• Ice action
• Long-shore currents
• Removal/loss of bank vegetation
• Removal/loss of shallow water aquatic plants
• Tributary areas and flowing water
Erosion Intensity
Alternative Site Assessment Method

- Fetch
- Shoreline Geometry
- Shoreline Orientation
- Boat Wakes
- Bank Height
- Bank Composition
- Influence of Adjacent Structures
- Depth at 20 Feet
- Depth at 100 Feet
- Aquatic Vegetation
- Bank Stability
- Bank Vegetation
Locating and Measuring Average Fetch
Note: Average fetch; The following diagram describes the calculation of average fetch.

\[
\text{ave. fetch} = \frac{B + C}{2}
\]
Erosion Intensity Metrics, Average Fetch

Using the measure tool draw a 45 degree offset to the opposite shore this is the measure of distance B.

\[
\text{Ave. Fetch} = \frac{(B + C)}{2}
\]
Using the measure tool draw the other 45 degree offset to the opposite shore this is the measure of distance C.

\[ \text{Ave. Fetch} = \frac{(B + C)}{2} \]
Erosion Intensity
Lake Map

- **Fetch** (you just measured from the storm wave height exercise)
- **Shoreline Geometry (3 choices)**
  - cove/bay (1)
  - irregular shoreline (4)
  - headland, point, or straight shoreline (8)
Cove/bay

Point/Straight

Irregular

Shoreline Geometry
Shoreline Geometry

Maple Bluff, Lake Mendota
Maple Bluff, Lake Mendota
Maple Bluff, STWAVE Model

$H_o = 1.14 \text{ m}$

$T = 4.38 \text{ sec}$
Shoreline Geometry

Yahara Inlet, Lake Mendota
Shoreline Geometry

Yahara Inlet, Lake Mendota
Yahara Inlet, STWAVE Model

\[ H_o = 0.72 \text{ m} \]
\[ T = 3.41 \text{ sec} \]
Determining Shore Orientation

The following lakemap shows an example of classifying shore orientation exposed to prevailing winds. Shorelines are exposed to one of the following:

- Light Winds
- Moderate Winds
- Heavy Winds
Determining wind exposure from the direction the shoreline faces
Erosion Intensity Metrics, Shore Orientation

Draw a line perpendicular to the shoreline of interest, examine the true course, in this case it’s 262.1°, and therefore is exposed to heavy winds.
Erosion Intensity
Lake Map

- Fetch
- Shoreline Geometry
- Shoreline Orientation

- **Boat Wakes (proximity to and use of boat channels)**
  - 3 choices are: (1) no channels within 100 yards, broad open water body, or constricted shallow water body; (6) minor thoroughfare within 100 yards of shore carrying limited traffic, or major channel 100 yards to ½ mile offshore; (12) major thoroughfare within 100 yards carrying intensive traffic.
Erosion Intensity

Lake Map

• Boat Wakes (proximity to and use of boat channels)

Note: Boating; A thoroughfare is identified as physical narrowing of the waterbody that by its nature intensifies boating activity near the shore. Thoroughfares which are 250 yards or wider are not scored 12 points, unless the depth contours of the thoroughfare constricts boating activity in close proximity to one shore, and the traffic is intensive.

Note: Boating; Intensive traffic is defined by a location where at least 50% of the public boating access available must pass through the thoroughfare to reach the open water of the lake, provided the waterway has a total of more than 60 car-trailer units.

Note: Boating; Limited traffic is defined by a location where at least 30% of the public boating access available must pass through the thoroughfare to reach the open water of the lake, provided the waterway has a total of more than 40 car trailer units.
Erosion Intensity

- Fetch
- Shoreline Geometry
- Shoreline Orientation
- Boat Wakes

- **Bank Height** (anchor the measure stick at the bank toe, walk back waterward on the pier, and estimate the bank height (ft)).
  - 5 Choices are: <1, 1-5, 5-10, 10-20, or >20
Erosion Intensity

Bank height is the vertical measure (feet) from the bank-toe to the top of the bank-lip, irrespective of changes in the water level.
Erosion Intensity

- Fetch
- Shoreline Geometry
- Shoreline Orientation
- Boat Wakes
- Bank Height

- Bank Composition (examine the composition and degree of cementation of the bank sediments)
  - 3 choices are: (0) rock, marl, tight clays and cemented sands that must be dug with a pick; (7) soft clay, clayey sand, moderately cemented easily dug with a knife; (15) uncemented sands or peat easily dug with your hand.
Erosion Intensity

- Fetch
- Shoreline Geometry
- Shoreline Orientation
- Boat Wakes
- Bank Height
- Bank Composition

**Influence of Adjacent Structures**
- 5 choices are: (0) no armoring on either side; (1) hard armoring on one side; (2) hard armoring on both sides; (3) hard armoring on one side with noticeable recession; (4) hard armoring on both sides with noticeable recession.
Erosion Intensity

- Fetch
- Shoreline Geometry
- Shoreline Orientation
- Boat Wakes
- Bank Height
- Bank Composition
- Influence of Adjacent Structures
- **Depth at 20 Feet (depth of the water 20 feet from the shore)**
  - 5 choices are: <1; 1-3; 3-6; 6-12; >12.
Erosion Intensity

- Fetch
- Shoreline Geometry
- Shoreline Orientation
- Boat Wakes
- Bank Height
- Bank Composition
- Influence of Adjacent Structures
- Depth at 20 Feet

**Depth at 100 Feet** (depth of the water 100 feet from the shore)
- 5 choices are: <1; 1-3; 3-6; 6-12; >12.
Erosion Intensity

- Fetch
- Shoreline Geometry
- Shoreline Orientation
- Boat Wakes
- Bank Height
- Bank Composition
- Influence of Adjacent Structures
- Depth at 20 Feet
- Depth at 100 Feet

- **Aquatic Vegetation** (type and abundance of vegetation occurring in the water off the shoreline)
  - 3 choices are: (1) dense or abundant emergent, floating or submerged vegetation; (4) scattered or patchy emergent, floating or submergent vegetation; or (7) lack of emergent, floating or submergent vegetation.
(1) dense or abundant emergent, floating or submerged vegetation

On average, 50-100% of the bottom is visually obstructed by plants
(4) scattered or patchy emergent, floating or submergent vegetation

On average, 1-49% of the bottom is visually obstructed by plants
Erosion Intensity

- Fetch
- Shoreline Geometry
- Shoreline Orientation
- Boat Wakes
- Bank Height
- Bank Composition
- Influence of Adjacent Structures
- Depth at 20 Feet
- Depth at 100 Feet
- Aquatic Vegetation
- **Bank Stability**
Erosion Intensity

- Fetch
- Shoreline Geometry
- Shoreline Orientation
- Boat Wakes
- Bank Height
- Bank Composition
- Influence of Adjacent Structures
- Depth at 20 Feet
- Depth at 100 Feet
- Aquatic Vegetation
- Bank Stability
- Bank Vegetation (type and abundance of vegetation occurring on the bank face and immediately on top of the bank lip)
  - 3 choices are: (1) dense vegetation, upland trees and shrubs; (4) clumps of vegetation alternating with areas lacking vegetation; (8) lack of vegetation (cleared), crop or agricultural land.
<table>
<thead>
<tr>
<th>SHORELINE VARIABLES</th>
<th>DESCRIPTIVE CATEGORIES</th>
<th>ASSIGNED EI</th>
</tr>
</thead>
<tbody>
<tr>
<td>FETCH-AVERAGE, longest continuous</td>
<td>(0) &lt;1/10</td>
<td>(2) 1/10 –1/3</td>
</tr>
<tr>
<td>linear distance the site across the</td>
<td>water surface to the opposite intersect with the shore or land.</td>
<td></td>
</tr>
<tr>
<td>DEPTH AT 20 FEET, depth of water</td>
<td>(1) &lt;1</td>
<td>(2) 1-3</td>
</tr>
<tr>
<td>(feet) 20 feet from shoreline</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEPTH AT 100 FEET, depth of water</td>
<td>(1) &lt;1</td>
<td>(2) 1-3</td>
</tr>
<tr>
<td>(feet) 100 feet from shoreline</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BANK HEIGHT, height of bank (feet)</td>
<td>(1)&lt;1</td>
<td>(2) 1-5</td>
</tr>
<tr>
<td>at the shoreline or just behind the</td>
<td></td>
<td></td>
</tr>
<tr>
<td>sediment beach</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BANK COMPOSITION</td>
<td>(0) Rock, marl, tight clay, well cemented sand (dig with a pick or swamp forest)</td>
<td>(7) soft clay, clayey sand, moderately cemented (easily dug with a knife)</td>
</tr>
<tr>
<td>composition and degree of cementation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>of the sediments</td>
<td></td>
<td></td>
</tr>
<tr>
<td>INFLUENCE OF ADJACENT STRUCTURES,</td>
<td>(0) no hard</td>
<td>(1) hard armoring on one adjacent</td>
</tr>
<tr>
<td>likelihood that adjacent structures</td>
<td>armoring on</td>
<td>property</td>
</tr>
<tr>
<td>are causing flank erosion at the site</td>
<td>either adjacent property</td>
<td></td>
</tr>
<tr>
<td>AQUATIC VEGETATION</td>
<td>(1) dense or abundant emergent, floating or submerged vegetation</td>
<td>(4) scattered or patchy emergent, floating or submerged vegetation</td>
</tr>
<tr>
<td>type and abundance of vegetation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>occurring in the water off the</td>
<td></td>
<td></td>
</tr>
<tr>
<td>shoreline</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SHORE VEGETATION</td>
<td>(0) rocky substrates unable to support vegetation.</td>
<td>(1) dense continuous vegetation, marsh fringe and shrubs</td>
</tr>
<tr>
<td>type and abundance of the vegetation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>occurring between the bank and</td>
<td></td>
<td></td>
</tr>
<tr>
<td>shoreline</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BANK VEGETATION, type and abundance</td>
<td>(1) dense vegetation, upland trees, shrubs and grasses</td>
<td>(4) clumps of vegetation alternating with areas lacking vegetation</td>
</tr>
<tr>
<td>of the vegetation occurring on the</td>
<td></td>
<td></td>
</tr>
<tr>
<td>bank and immediately on top of the</td>
<td></td>
<td></td>
</tr>
<tr>
<td>bank lip</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SHORELINE GEOMETRY</td>
<td>(1) coves</td>
<td>(4) irregular shoreline</td>
</tr>
<tr>
<td>general shape of the shoreline at the</td>
<td></td>
<td></td>
</tr>
<tr>
<td>point of interest plus 200 yards on</td>
<td></td>
<td></td>
</tr>
<tr>
<td>either side</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SHORELINE ORIENTATION</td>
<td>(0) &lt; 1/3 mile fetch</td>
<td>(1) south to east</td>
</tr>
<tr>
<td>general geographic direction the</td>
<td></td>
<td></td>
</tr>
<tr>
<td>shoreline faces</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BOAT WAKES</td>
<td>(1) no channels within 100 yards, broad open water body, or constricted shallow water body</td>
<td>(6) minor thoroughfare with 100 yards carrying limited traffic, or major channel 100 yards to ½ mile offshore</td>
</tr>
</tbody>
</table>
## Energy Category

<table>
<thead>
<tr>
<th>Method</th>
<th>Low Energy</th>
<th>Moderate Energy</th>
<th>High Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind-wave</td>
<td>&lt; 1 foot</td>
<td>1- 2.3 feet</td>
<td>&gt;2.3 feet</td>
</tr>
<tr>
<td>Erosion Intensity</td>
<td>≤47</td>
<td>48-67</td>
<td>&gt;67</td>
</tr>
</tbody>
</table>
Monitoring - Erosion Pin Method

Bank-lip

Bank-face

Lake-bed

Erosion Pins

Place pins 10 feet apart at the vertical midpoint of the bank face

Rebar

Bank toe is the inflection point between the bank face and lakebed
Monitoring- Erosion Pin Method
**Waterway Bank Pin Erosion Monitoring Datasheet**

Attention: Within a week after installation you must submit your photos, the erosion pin monitoring form, and a copy of your initial pin exposure distance data to your water management specialist.

Landowner Name
Phone Number
Mailing Address

Date of Erosion Pin Installation:
Total Number of Pins Installed:
Recorder Name:

<table>
<thead>
<tr>
<th>Pin #</th>
<th>Date of Initial Measure</th>
<th>Initial Pin Exposure Distance (Nearest 1/16” or mm)</th>
<th>Date of 2nd Measure</th>
<th>Pin Exposure Distance @ 2nd measurement (Nearest 1/16” or mm)</th>
<th>Date of 3rd Measure</th>
<th>Pin Exposure Distance @ 3rd measurement (Nearest 1/16” or mm)</th>
<th>Net Change over the period (Nearest 1/16”)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (left most pin when facing the bank)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Shoreline Type
• Low Energy
• Moderate Energy
• High Energy

Treatment Type
• Biological
• Biotechnical
• Technical
Shore Protection Techniques

Biological
- Live stakes
- Brush mattresses with jute roping
- Coir fiber rolls with jute netting

Biotechnical - “Vegetated Armoring”
- Integrated Toe Protection
- Joint plantings among riprap

Technical - “Hard Armoring”
- Rock riprap
- Wooden vertical seawalls
- Concrete retaining walls
Vegetation - The Roots of the Solution

The riparian areas of shorelines are glued together by a diversity of plants with strong, deep root systems, especially those of woody plants.
Vegetation - The Roots of the Solution
Improve Water Clarity
Fish and Wildlife Habitat
Hold Sediments
Nutrient Cycling
Invertebrates
Aesthetics
PLACE COIR ROLLS PARALLEL TO THE STREAMBANK ALONG A HORIZONTAL CONTOUR

DOUBLE STAKES OPTIONAL REQUIRED FOR OFFSHORE INSTALLATION

LENGTH OF STAKE DETERMINED BY THE SUBSTRATE

PLACE COIR ROLL SUCH THAT THE ROLL EXTENDS 2" (50 mm) ABOVE MEAN WATER ELEVATION

MEAN WATER ELEVATION

DRIVE STAKE THROUGH NETTING

NOT TO SCALE

COIR ROLL/COIR MATS
Biological
Figure 16-56  Coconut fiber roll details

Cross section
Not to scale

Vegetative plantings

Mean high water elevation

Coconut fiber roll

Lakebed

Eroded shoreline

2 in. x 2 in. x 36 in. oak stakes
Biological
Typical use of willow stakes to anchor willow wattles, straw rolls, bio mats, or turf reinforcement mats.

Typical area staking 1-3 ft. (0.3-1 m) apart.

Cut top of stake square.

2 to 5 buds scars shall be above the ground.

Plant 80% of stake length into the ground.

18 in. (0.5 m) min.

Trim branches close.

3/4-3 in. (20-75 mm) diameter.

Make angled cut at butt-end, plant butt-end down.

NOTES:
1. Harvest and plant stakes during the dormant season.
2. Use healthy, straight and live wood at least 1 year old.
3. Make clean cuts and do not damage stakes or split ends during installation, use a pilot bar in firm soils.
4. Soak cuttings for 24 hours (min.) prior to installation.
5. Tamp the soil around the stake.

LIVE STAKING AND JOINT PLANTING
Biological

Step 1: Excavate trench and grade bank.

Step 2: Place willow branches making sure that the butt ends reach the bottom.

Step 3: Place stake (notched) on 1.0m (3ft.) centers and secure the mattress with twine, rope or wire.

Step 4: Drive the stakes deeply into the bank to tightly compress the branches against the soil. Cover and partially bury the mattress to encourage rooting.

BRUSH MATTRESS
Wattles shall be 6–30 ft. (2–10 m) long.

Tie 12–15 in. (300–400 mm) O.C.

6–12 in. (150–300 mm) diameter.

Prepare wattles with 1/4–1/2 in. (9–40 mm) cuttings with alternating butt-ends and tied securely with twine or rope.

TYPICAL LIVE STAKE

Trench ready for wattle installation.

NOTES:
1. Harvest and install wattles during dormant season or favorable conditions.
2. Install wattles on slope contours.
3. All work proceeds from the bottom of the slope to the top.
4. Fill or partially cover wattle with soil from slope or trench above.
5. Compact and work soil into completed wattles.
Shore Protection Techniques

**Biological**
- Live stakes
- Brush mattresses with jute roping
- Coir fiber rolls with jute netting

**Biotechnical - “Vegetated Armoring”**
- Integrated Toe Protection
- Joint plantings among riprap

**Technical - “Hard Armoring”**
- Rock riprap
- Wooden vertical seawalls
- Concrete retaining walls
Biotechnical

**BRUSHLAYERING WITH ROCK TOE PROTECTION**

- Crisscross branches 5-8 branches/ft. min. (20/linear meter) placed at random with regard to size and age.

**NOTES:**
1. tilt branches down into the slope 10°-20° min.
2. Brushlayering may be constructed with non-compacted or compacted backfill without damage to the brush layer.
3. Branches irrespective of length, should protrude 8-18in. (0.20-0.50 meters) beyond the face of the slope.
NOTES:
1. Willow pole planting and brush layering shall be installed during bank grading and riprap placement to ensure good contact with ‘native ground’ and soil fill.
2. Willow poles and brush layers shall extend down into expected soil moisture zones (vadose).
3. Cut small holes or slits in filter fabric as necessary.
4. Place soil fill (cobbles, gravel, soil) around cuttings.
5. Place riprap carefully, do not end dump. Some damage to brush layers and willow poles is unavoidable and acceptable. Deeply planted willow material will regenerate.

Grade bank to 1-1/2:1 or flatter.

Excavate below anticipated scour line.

Filter layer graded aggregate and/or filter fabric.

VEGETATED RIPRAP DURING CONSTRUCTION
Biotechnical

BRUSHLAYERING WITH
GEOTEXTILE SOIL WRAP

NOTES:
1. Brush layers, geofabrics and geogrids are tensile inclusions, which modify shear stress.
2. Additionally, once established the root systems bind the entire system together as a coherent mass.
3. Live brush layers act as horizontal drains and improve slope stability by redirecting the flow direction.
4. Cut branches 3' to 12' long from appropriate salix, cornus or populus species.
5. Branches up to 12' long can be used on fillslope installations. Branches for cutslope installation can be 2' to 10' long depending on the bench excavation.
6. Natural geofabrics (coir netting) or geogrids can be wrapped around soil layers to provide additional soil reinforcement.

Alternative design treatments for toe of slope include, geobags, riprap, rootwads, logs, etc...

GRAVEL-SOIL MIX

TOPSOIL LAYER

GEOTEXTILE WRAP

GEGRID (OPTIONAL)

BRUSH LAYER

NATIVE PLANTS
General Permit Application Review

• Application Completeness
• Verify data submitted reflects site conditions (desktop approach for both Windwave and EI)
• Assess whether treatment type is GP eligible
• Review adequacy of erosion control plan
• Review if GP conditions are met in the plan.
Windwave Modeling

• For All Apps-Quickly Review all data submitted for Windwave Model.

  – Check Max Fetch on Webview. For that fetch, eyeball a mean depth estimate from a lake map to discern if the applicant’s mean depth estimate is reasonable.

  – Run the Windwave Model. Verify agreement with the applicant’s energy classification.

  – If disagreement in energy class exists with the applicant, verify that your shoreline location is correct, calculate the mean depth and rerun the model.

  – Note for lakes<400 acres, windwave model output will always be low, nonetheless applicant should calculate a storm wave height estimate.
Desktop Review All Submitted EI’s

- Fetch
- Shoreline Geometry
- Shoreline Orientation
- Boat Wakes
- Bank Height
- Bank Composition
- Influence of Adjacent Structures
- Depth at 20 Feet
- **Depth at 100 Feet**
- Aquatic Vegetation
- Bank Stability
- Bank Vegetation

Red Bold Metrics Can be calculated from Desktop

“Estimates” of the other metrics can be made from Photo Interpretation

If your red bolded metrics along with the applicant’s other metrics results in a different energy class, then inform the applicant of the energy reclassification and their options.
When to Conduct a Site Review of Applicant’s EI?

If your Desktop metrics along with your “photo-interpreted” metrics results in a different energy class and the difference between the applicants EI and your EI is due to differences in the “photo-interpreted” metrics.
Where should a WMS initiate an EI along moderate/high energy shorelines?

• IP’s
• Designated sensitive areas
• Tributary areas and embayments
• Areas containing no-wake boating
• Photographic evidence of very low banks, zero slope profiles.
• Adjacent stands of emergent/floating vegetation, dense woody cover.
• An expansive distance of shallow water offshore.
• Other local knowledge
What Constitutes a Revegetation Plan that meets NR328 Standards?

(b) Willow wattles, willow posts, brush mattresses, brush layering, fiber roll breakwaters, plant carpets, root wads, and other natural materials shall be installed by hand.

(c) Vegetation shall be plant species which are native to the area of Wisconsin where the project is located. Vegetative treatments shall be installed according to Natural Resources Conservation Service Conservation Practice Standard Code 580 (Streambank and Shoreline Protection) or the Natural Resources Conservation Service Engineering Field Handbook (chapter 16).

(j) Riprap or other vegetated armoring along moderate energy sites shall be re-vegetated above the ordinary high water mark by using native shrub plantings, native live stakes or native jointed plantings.
What Constitutes a Revegetation Plan that meets the Rule Standards?

• Plant Species List Including Only Native Plants: Species/type/number

• Diagrams showing planting above the OHWM along the bank face and immediately landward of the bank lip (at least one shrub layer, 5-15’ depending on bank height (low Banks-5 feet, high banks 15’ feet).

• Diagrams showing the upper limit of rock in relation to OHWM and Storm-Wave Height.

• A plan to incorporate plants into the rock design from the OHWM up to the top of the rock (PSWH). Or a plan to limit the rock to below the OHWM and revegetate above.

• Wisconsin Biology Tech Note #1 for Density Standards

• Give Good Advice Based on EI’s--Dormant Cuttings/Woody Shrubs should be encouraged on EI’s above 42. Bushlayering/Brush Mattresses/etc.
### Table 1. Shoreland Habitat Planting Densities

<table>
<thead>
<tr>
<th>Layer</th>
<th>Minimum Number of Species(^1)</th>
<th>Density</th>
<th>Minimum Number of Species(^1)</th>
<th>Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trees(^2)</td>
<td>2</td>
<td>0.5 – 5 per 100 sq. ft.</td>
<td>0</td>
<td>0 - 0.2 per 100 sq. ft.</td>
</tr>
<tr>
<td>Shrubs</td>
<td>3</td>
<td>1 - 4 per 100 sq. ft.</td>
<td>2</td>
<td>0.2 - 0.5 per 100 sq. ft.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>If clumped, maintain min. 2 foot spacing</em></td>
<td></td>
<td><em>If clumped, maintain min. 2 foot spacing</em></td>
</tr>
<tr>
<td>Herbaceous Cover(^3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Plant plugs</td>
<td>3</td>
<td>25 – 75 plants per 100 sq. ft.</td>
<td>5</td>
<td>50 – 100 plants per 100 sq. ft.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Soil must be mulched</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Seeding</td>
<td>3</td>
<td>Grass/Sedges: 4-8 oz. per 1000 sq. ft.</td>
<td>5(^4)</td>
<td>Grass/Sedges: 4-8 oz per 1000 sq. ft.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Forbs: 2-4 oz per 1000 sq. ft.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Additional Informational Resources

- **Lakescaping for Wildlife and Water Quality** (180 pages, $19.95, available from the Minnesota Bookstore at 1-800-657-3757). Wisconsin DNR staff recommend this book as a detailed planning guide for shoreland restoration in Wisconsin.

- **NRCS Engineering Field Handbook**

- **The Living Shore**, a 17-minute video produced by UW-Extension and University of Minnesota Extension showing the importance of leaving a natural ‘buffer zone’ between the lake and lake owners’ dwellings, and providing information about selecting and planting shoreline plants. Call the Wisconsin Association of Lakes (1-800-542-LAKE) to order a copy for $15 plus $2 in shipping, or check your local library for a copy.

- **A Fresh Look at Shoreland Restoration**, A 4-page pamphlet describing options for restoring shoreland habitat. Available from UW-Extension # GWQ027, or the DNR, publication # DNR-FH-055

- **What is a shoreland buffer?**, A brief ecological and legal overview of shoreland buffers. Available from the UW-Extension, publication #GWQ028 or the DNR, publication # DNR FH-233.

- **The Water’s Edge.** A 12-page brochure about what you can do on your lakeshore property to improve habitat for fish and wildlife. Available from your local DNR Service Center.

- **Life on the Edge... Owning Waterfront Property**, UW-Extension. Send $3 per copy plus $1.50 for shipping and handling for a total of $4.50 (make checks payable to UW-Extension) to: UWEX-Lakes Program, College of Natural Resources, University of Wisconsin, 1900 Franklin St. Stevens Point, WI 54481
Landowner's Guide to Controlling Shoreline Erosion Book ©

- 1 Book $22.95 + $2.50
- Shipping and Handling = $25.25
- Purchase 1 Book

- 9 Books $45.90 + $3.50
- Shipping and Handling = $49.40
- Purchase 2 Books

- 5 Books $114.75 + $4.95
- Shipping and Handling = $119.70
- Purchase 5 Books

- 10 Books $229.50 + $6.63
- Shipping and Handling = $236.13
- Purchase 10 Books

Please call with any Questions 920 294-3116

This exciting new book, written by Lisa J. Reas and David Knapp, is now available online. Written in 2004, The Landowner’s Guide to Controlling Shoreline Erosion© is a full color book showing actual Wisconsin shoreline photos of before and after stabilization projects. The book’s eight chapters and appendix material are designed to guide landowners through the stabilization process. Also included are cross sectional diagrams of eroded and stabilized shorelines. The book is designed to answer basic questions of shoreline landowners including:
NR 328 - Subchapter III

Shore Erosion Control - Rivers and Streams

Why an Emergency?

• No statutory exemptions provided for stream/river shoreline protection

• Since Act 118, all projects require IP, including public notice

• General permits will avoid delay for 25-30% of stream/river shoreline projects for 2005
NR 328 Subch. III - Applicability

• Shore erosion control measures placed below the ordinary high water mark require authorization

• Practices involving grading more than 10,000 square feet on the bank require a permit, except on lands used entirely for agriculture.
Integrated Treatment example
NR 328 Subchapter III - General Permits

Conditions:
1. Construction timing to protect spawning
2. Protection of coarse woody cover
3. No impact to Endangered/Threatened species
4. Designated waters - GP not available for:
   - wetlands
   - streams greater than 35 feet wide
   - federal or state wild rivers (Integrated treatment)
NR 328 - General Permits

Conditions, cont’d:

5. Erosion Control and Stormwater Management

6. Maximum length for individual site (one meander) 150 feet; maximum length for project (multiple sites) 500 feet.

Alternate process for large habitat projects not meeting GP standards.
Determining project length

Trout Habitat Project--Total Project 350’

150’

125’

75’

(b)

Pool

Riffle

Bank Sloping/Stabilization

Rock Toe Protection