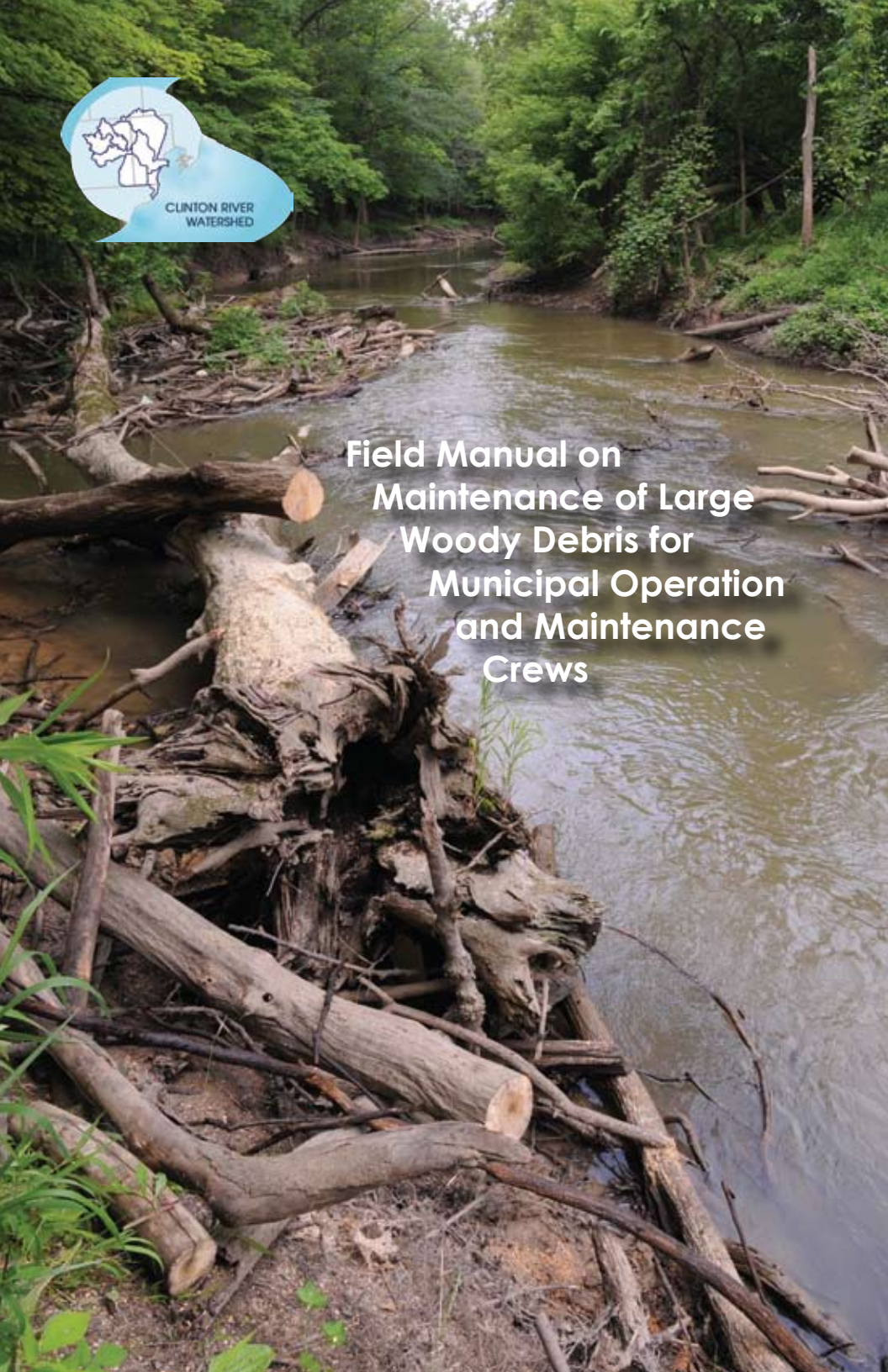

Field Manual on Maintenance of Large Woody Debris for Municipal Operation and Maintenance Crews

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INTRODUCTION

Large Woody Debris (LWD) is an important component of a stream's anatomy. Consisting primarily of woody material at least four inches in diameter and six feet long that protrudes into a stream's bank-full channel, LWD is also known as logjams, snags, or debris dams. Historically, LWD was removed from a stream to enhance recreational access or to prevent flooding. LWD is now managed as an important resource for stream health and erosion control.

LWD has been around for as long as trees have grown next to streams. Natural processes like wind, aging of trees, and erosion deposit logs and large branches into a stream's flow. These starter components, in turn, trap other woody and organic debris. The resulting tangle of debris can alter the stream's morphology, creating pools, bars, channels, and other desirable habitats around the jam.

Figure 1 - Large woody debris

The wood and other organic debris within a LWD structure provides food and cover for a variety of aquatic creatures that, in turn, feed fish and other animals further up the food chain. LWD structures also moderate stream flow, creating backwaters where sediment can settle out, and cutting deep pools that provide shelter for a variety of fish. Stream restabilization occurs more quickly after a major flooding event when LWD is present.

This guide will demonstrate how to manage an existing LWD structure in an environmentally friendly manner, as well as how to install a LWD structure for erosion control, bank stabilization, and habitat improvement.

PHYSICAL PROPERTIES OF LWD STRUCTURES

LWD accumulates in a stream in an unlimited number of configurations. However, most LWD structures consist of several logs oriented in one of three positions relative to the stream current (facing upstream, perpendicular, facing downstream) and protruding into the stream's bank-full channel.

Recognizing how LWD is organized in a stream, and how each component functions, is necessary before deciding how and when to remove or modify the structure. This section demonstrates the key components of a LWD structure, how stream flow is affected by LWD, and how sediment is trapped and distributed.

Components

Many different types of woody debris can be found in a stream. Small floating debris such as sticks and small limbs may form minor, temporary jams that are easily swept downstream. There are usually no significant maintenance problems associated with this type of debris. Medium floating debris consists of larger tree limbs and sticks introduced into the stream by bank erosion, windthrow, or the natural shedding of riparian trees and other vegetation. This type of debris could present a maintenance problem if it accumulates at culvert or bridge structures.

LWD consists of one to several "key" logs, four inches or more in diameter and at least six feet long, which act as a base on which other stream-borne debris accumulates. The key logs may include intact branches and may be above or below the water surface or partially submerged. The logs may also contain portions of the tree's root structure, called the "root wad," which acts to stabilize the LWD structure and anchor it in place.

Figure 2 - Typical components of a LWD structure including the key log, root wad, and secondary debris accumulation

Flow Characteristics

While each LWD structure is unique, generalizations can be made about the changes it can bring to the adjacent flow patterns in a stream. Differences in flow velocity caused by LWD can trigger either deposition or scour. Upstream of LWD, especially a channel-spanning structure, velocity decreases causing sediment deposition. Increased velocity due to flow constriction caused by LWD produces downstream streambed scour and erosion. A LWD structure that occurs near the stream bank may cause a new channel to form resulting in erosion along the bank. When working around LWD, be aware of the possibility of deep pools, increased flow velocity, deep-cut channels, and soft sediment accumulation. The table below shows some of the possible changes in channel morphology created by flow alterations around LWD.

Changes in Stream Morphology Created by Flow Alterations

Orientation of LWD to Flow	Stream Morphology Changes	
	Upstream	Downstream
Parallel	Scour Pool	Bar or Island
Angled	Pool and Bar	Pool and Bar
Perpendicular: on streambed	Depositional Zone	Scour Pool
Perpendicular: above streambed	Scour Pool	Scour Pool

From JF NEW, A Primer on LWD Management

Figure 3 - Measuring stream morphology changes around a LWD structure

Sedimentation

Significant sedimentation can occur behind a LWD structure, sometimes extending several hundred feet upstream. The upstream reduction in flow velocity and the increased channel roughness caused by a LWD structure can store substantial amounts of sediment. To the detriment of downstream habitats, this sediment may be quickly released if the LWD structure is suddenly removed. Equally, LWD can essentially block the downstream transport of sediment. LWD in a stream's floodplain can also cause increased sedimentation during high flow conditions.

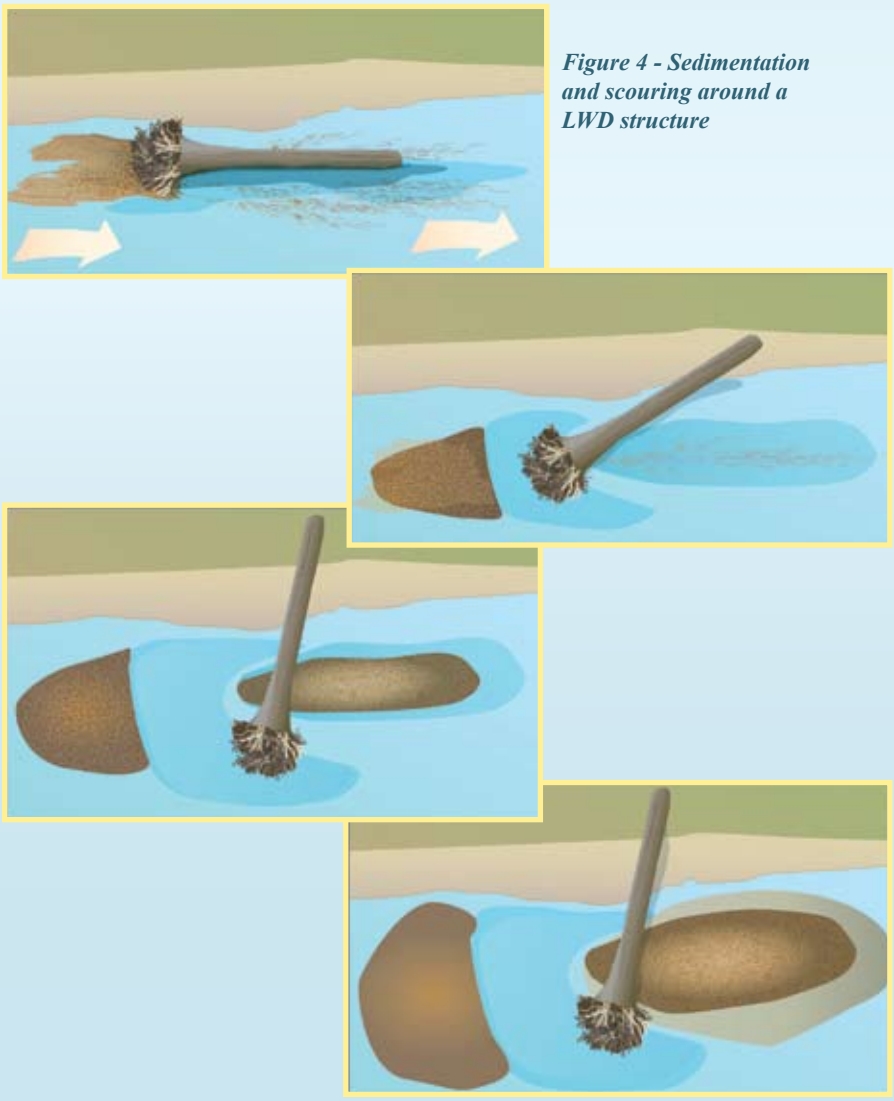

Figure 4 - Sedimentation and scouring around a LWD structure

Erosion

The orientation and proximity of LWD relative to the stream bank can have a profound effect on erosion. Depending on its size and orientation, LWD can either cause or deter erosion. LWD that lies within the channel and perpendicular to the flow may force water toward the bank, causing channel widening or bank erosion. Likewise, a log oriented upstream of the flow may also channel water toward the bank with the same effect.

Figure 5 - Bank erosion can damage property and introduce excess sediment into a stream.

Downstream facing LWD that is somehow anchored to the bank, either naturally or artificially, can prevent bank erosion by directing flow away from the bank and toward the midstream. LWD that is adjacent and parallel to the bank can effectively armor the bank and prevent erosion.

Figure 6 - LWD armoring stream bank

ASSESSING LWD STRUCTURES

The assessment of LWD structures is based on several factors including the stream's usage (recreational, agricultural runoff, urban runoff, habitat, etc.) the size and location of the LWD within the stream, as well as its proximity to infrastructure, and the LWD's physical characteristics. Results from the assessment of a LWD structure will determine what remedial actions (if any) need be taken.

Recreational Use: A recreational stream is used by the public for boating or fishing. In these streams, LWD maintenance should be limited to removing those portions of a structure which inhibit free movement of watercraft along the river while maintaining a natural feel to the stream and ensuring that sufficient habitat cover remains for fish and other wildlife. A LWD removal project will look more natural and less engineered if an irregular, random array of LWD structures is preserved on the stream.

Runoff: LWD plays an important role in streams which receive a large volume of rainwater runoff either from agricultural fields or from urban areas. By slowing flow and trapping sediment, LWD helps define a stream's response to higher than normal flows. It is important to recognize how LWD is affecting flow and sedimentation, as well as preventing (or causing) stream bank erosion in these types of streams. LWD structures which decrease flow and enhance sedimentation should be left in place, while structures that are causing erosion during high flow events should be modified to lessen these tendencies.

Figure 7 - Stormwater runoff entering a stream

Flooding: In certain circumstances, LWD may cause upstream flooding. As a rule, flow upstream of a LWD structure is not significantly affected unless the structure covers a significant portion of the channel's cross section (a good example of this is a beaver dam that spans the entire channel) or if it occurs at a point of stream constriction. Removing minor LWD does not typically reduce upstream flooding.

Figure 8 - LWD structure occupying most of the stream channel cross section

Habitat: By forming deep scour pools and providing cover and shade, LWD structures can create important habitat within a stream. LWD provides a platform for the growth of biofilm, a food source for the macro invertebrates that form the basis of a stream's food chain. Debris in a stream also creates near-zero water velocity zones that are utilized as resting areas by fish. Scour pools created by LWD structures provide deep-water shelter for fish and other aquatic animals during times of low water, and above-water portions of LWD provide roosting and feeding stations for a variety of animals and birds.

Field Inventory of LWD Structures: Field inventories may be used to select and prioritize LWD structures for maintenance. An inventory of LWD structures within a stream reach should be conducted prior to maintenance work and a record of the inventory should be kept to track changes in LWD over time. The inventory typically includes photographs and a sketch of the structure showing its major components, how the structure is anchored, nearby infrastructure, landmarks and road crossings, and the bank-full width of the stream at the structure. Note where the structure is located (a GPS unit is helpful for this). Field measurements include water depth, bottom condition, and the size and coverage of the LWD in the stream.

Field Maintenance Assessment of LWD Structures: To assure that work crews have the proper equipment and resources to perform maintenance on a LWD structure, a maintenance assessment of the structure should be conducted in the field prior to the arrival of the crew. The maintenance assessment includes a characterization of the LWD structure and an evaluation of what work needs to be performed. A maintenance priority should be assigned to the structure to ensure quick action on problem sites and to help work crews better manage time spent in the field.

Figure 9 - Crew assessing LWD in the field

Working in the water with heavy logs is inherently dangerous. The Woody Debris Evaluation Form also lists safety and access issues that may impact the ability of work crews to complete their job in a safe manner. Caution should also be exercised during the initial assessment of the LWD structure.

The initial assessment includes estimates of the tools and supplies a work crew will need to perform their job. Completing an inventory of the size and number of logs in a structure will help work crews estimate how much time and what equipment they will need.

A copy of a Woody Debris Evaluation Form is on pages 11 and 12.

Woody Debris Evaluation Form

Date__________ Time__________ Weather____________________________________

Crew____

Stream Name_______________________ Map Coordinates_______________________

Latitude_______________ Longitude_______________

Land Ownership: ❑ Public ❑ Private ❑ Unknown ❑ Other___________________

Riparian Corridor Available: ❑ none ❑ ≤25 ft ❑ 26-50 ft ❑ 51-100 ft ❑ >100 ft

Photo	Photo Number	Photo	Photo Number
Main Structure		Left Bank (facing upstream)	
Anchor Point		Right Bank (facing upstream)	
Area of Concern		(describe)	

SITE ASSESSMENT

Site Sketch (include major components, north arrow, bank-full width, nearby landmarks, road crossing, infrastructure, and access points)

⇦ ❑ flow ❑ ⇨

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Water Depth

(at deepest point)

- ❑ knee (0-1 ½ ft)
- ❑ waist (1 ½-3 ft)
- ❑ chest (3-4 ft)
- ❑ deep (>4 ft)

Bottom

- ❑ firm
- ❑ slight muck
- ❑ knee deep muck
- ❑ muck over knees
- ❑ deep holes or channel

Is site accessible to heavy equipment?

❑ yes ❑ no

Is there area available to leave woody debris on-site?

❑ yes ❑ no

LWD Stream Coverage

❑ ≤25% ❑ 50% ❑ 75% ❑ 75-100%

SITE MAINTENANCE

Repair Needed: ❑ Clean and Open ❑ Habitat Improvement ❑ None

LWD Characteristics (check all that apply)

❑ Fallen tree attached to bank ❑ Floating debris ❑ Beaver dam

❑ Jam at culvert or outfall ❑ Jam at bridge face ❑ Stream bank failure

❑ Blocking boat passage ❑ Causing bank erosion ❑ Causing flooding

❑ Log imbedded in the river bottom/bed

Maintenance to be Completed (check all that apply)

❑ Clean and remove trash ❑ Trim small branches ❑ Open channel

❑ Remove structure ❑ Reorient key logs ❑ Anchor structure

❑ Armor bank ❑ Dispose of large removed debris

Maintenance Priority

❑ Low ❑ Average ❑ High ❑ Urgent

Safety

❑ Yes ❑ No Is site accessible to maintenance or emergency vehicles?

❑ Yes ❑ No Can the site be accessed from the bank?

❑ Yes ❑ No Are there deep water, holes, submerged debris, or strong currents near the structure?

❑ Yes ❑ No Are power tools needed for the job?

❑ Yes ❑ No Could the site be a potential volunteer clean-up location?

❑ Yes ❑ No Is poison ivy present?

Log Tally

(Estimate for Equipment/Time Needs)

	Large Logs >12" Diameter	Medium Logs 6-12" Diameter	Small Logs <6" Diameter
Approximate Number Present and Lengths			

Equipment Needed

❑ 30 gallon trash bags _____(number)

❑ Hand tools (hand saw, pry bar, come-along, branch lopper, rope/chain)

❑ Power tools (chain saw, power winch)

❑ Small motorized equipment (skid steer, small tractor)

❑ Heavy equipment (front end loader, dump truck, trash dumpster)

❑ Personal Safety Equipment (safety glasses, ear plugs, gloves, life vest, first aid kit)

❑ Other (list)_____

LWD MAINTENANCE

After an assessment phase is completed, work to manage LWD structures may begin. Based on the information gathered during the assessment, decisions can be made on how best to manage and maintain the existing LWD structures in the stream. Options for maintenance may include removal of some portions of a structure, cutting portions of a structure to open the stream's channel, repositioning or anchoring key components, complete removal of the LWD, or no action. Since LWD has been found to have a significant positive influence on a stream's health, the best policy is to do a minimal amount of maintenance.

Develop a work plan that includes disposal options for wood removed from a structure, trash disposal, and if heavy equipment is being used, a plan to avoid disturbing the surrounding stream bank and riparian border. Since the use of heavy equipment has a greater potential to disturb surrounding habitat, hand tools and manual labor should be used whenever possible. This is also the time to obtain any applicable permits (refer to the Permits section on page 45).

Figure 10 - Using hand tools for LWD maintenance

Any type of maintenance work carries the inherent risk of injury. This is especially true of LWD maintenance where work is done in and around water, on uneven terrain, and involves using power tools and moving heavy, wet wood. A safety training program should be an integral part of any LWD maintenance work. Due to the demanding nature of LWD maintenance, both workers and volunteers must demonstrate an adequate level of physical fitness.

Figure 11 - If conditions allow, a small skid steer or tractor may be used to remove LWD

Removed Wood: Place LWD that has been removed during maintenance operations in a secure spot in the local floodplain out of the river's bank-full channel. Cut wood should be removed to the riparian zone only if the zone is publicly owned or if permission has been granted by the landowner. To minimize disturbance of the surrounding riparian zone, cut wood should be floated to a pre-selected take-out or removal point. Removed wood may also be used to create habitat structure (see page 36) or it may be moved to an off-site location. Water-soaked wood is heavy and often slippery, therefore caution should be used when it is handled or moved (see figure 13).

Habitat Protection: Be cautious of disrupting both aquatic and riparian (shoreline) habitat while working on LWD structures. Do not damage live trees or other plants and be aware that foot traffic and heavy equipment can cause erosion or soil compaction.

Figure 12 - Be careful not to damage live trees or vegetation with heavy equipment

Trash: Trash that has accumulated on or near a LWD structure should be collected for disposal. Recycle materials such as plastic. The remaining trash should be placed in a trash bag and disposed of properly.

Safety: Work crews should be briefed on safety before setting out to assess or maintain LWD structures. All team members should have personal protection equipment including eye and hearing protection, gloves, and a safety vest as well as a first aid kit. A plan to contact professional help in the event of an emergency should also be in place. Power tools should be used with care and only by those trained to use them.

Tools: Depending on the size and accessibility of the LWD, the following tools may be needed.

For smaller LWD structures (volunteer help).

- ❑ Hand saw or chain saw
- ❑ Branch lopper
- ❑ Come-along, rope or heavy chain
- ❑ Wheel barrow
- ❑ Skid steer or small tractor

For large LWD structures (professional workers).

- ❑ Front-end loader
- ❑ Power winch
- ❑ Dump truck

Supplies: The following supplies should always be utilized while assessing or maintaining LWD structures.

- ❑ Hard hats
- ❑ Safety glasses
- ❑ Ear plugs
- ❑ Safety vests
- ❑ Ladder (for steep banks)
- ❑ Whistle
- ❑ Heavy-duty rubber gloves
- ❑ Garbage bags
- ❑ Waders
- ❑ Bug spray
- ❑ Poison ivy block
- ❑ First aid kit
- ❑ Hand wipes

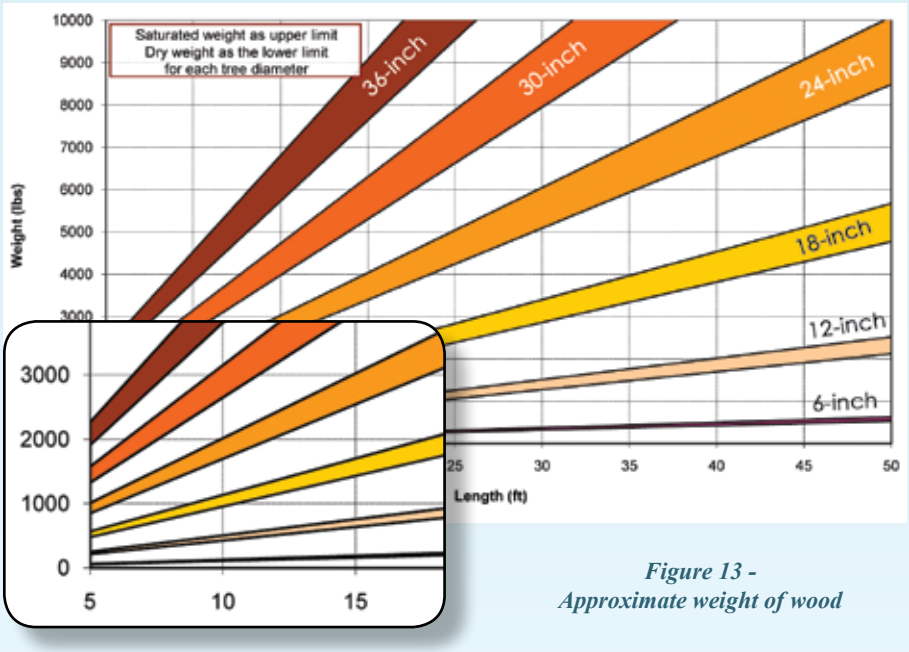


Figure 13 - Approximate weight of wood

Weight of Wood: When planning and performing maintenance activities, the weight of the wood that will be moved should be taken into account. Figure 13 may be used to estimate the weight of the wood.

Figure 14 - Handling water-logged wood requires teamwork and caution

ICONS

The following pages contain maintenance scenarios that may be encountered when managing LWD. While each LWD structure is unique, the management techniques can be applied to the maintenance of all LWD structures.

These icons have been included to assist the maintenance crew in choosing the best method to follow when working on LWD structures.

Habitat: Maintenance method that creates or improves wildlife habitat in the stream.

Flood: This type of work is undertaken to prevent or lessen upstream flooding.

Erosion: Maintenance that can lessen, prevent, or eliminate stream bank erosion caused by LWD.

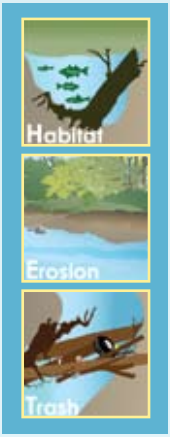
Trash: Structures that tend to accumulate or trap floating trash.

Sediment: Maintenance that enhances sedimentation or structures that tend to cause excessive or detrimental sedimentation.

Property Damage: LWD structures that may be causing flooding, erosion, or some other form of damage to private property within the stream's riparian zone.

Recreational: Maintenance method that enhances the value of a stream to boaters, paddlers, or fishermen or a structure that may enhance recreational activity in the stream.

MINOR SNAGS



Description: A collection of small or medium woody debris or other minor snag. A minor snag has no impact on a stream's recreational use and does not impair travel on the water. It may trap a small amount of additional debris, but it is positioned such that it is not causing bank erosion, excessive sedimentation, nor does it compromise or threaten infrastructure such as a culvert or bridge abutment. Minor snags should not be removed under these conditions.

Permit Required: No.

Approach:

- ❑ Note the location of the structure.
- ❑ Assess the impact the structure is having on the stream and bank. If the snag is not impacting the stream or bank in a negative way, no modification is required.
- ❑ While assessing the snag, do not disturb any live vegetation or damage the adjacent bank or habitat.
- ❑ Remove and properly dispose of trash.

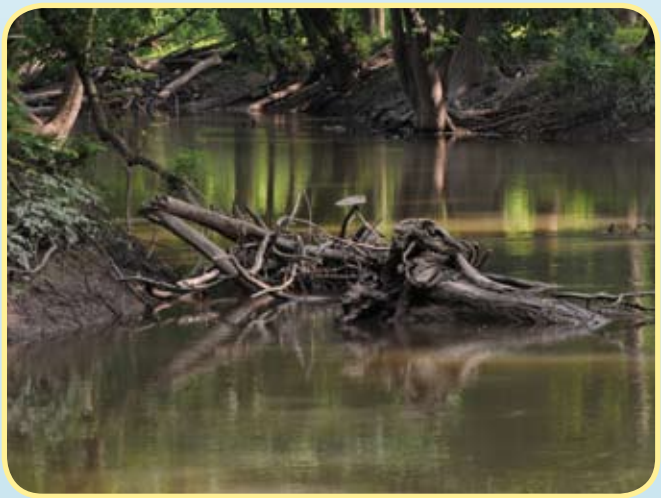


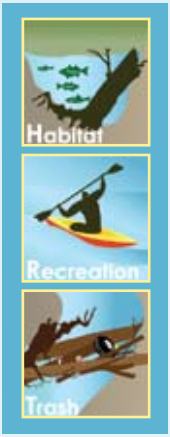
Figure 15 - Minor snag

Figure 16 - Team assessing a minor snag

Figure 17 - Minor trash accumulation

Figure 18 - Intact riparian buffer near minor snag

TRIMMING LWD TO ALLOW FOR BOAT PASSAGE



Description: This situation is characterized by woody debris that lies in or across a stream and creates an obstacle or hazard for boat or paddling passage. This type of LWD may be either above or just below the water's surface, or it may emerge during periods of low flow.

Permit Required: If the debris is floating and not anchored to the shore or to the riverbed, then no permit is required. If it is anchored, a permit may be required.

Approach:

- ❑ Protect surrounding habitat and bank.
- ❑ Determine how much of the LWD should be removed to create a safe passage for watercraft.
- ❑ Evaluate the need to reorient and anchor the LWD.
- ❑ Remove and properly dispose of smaller woody debris and trash.
- ❑ Reorient (page 24) and anchor (page 26) the LWD as needed.
- ❑ Cut and remove the obstructing log(s) to allow for safe boat or paddling passage.
- ❑ Trim branches above the water on remaining logs to prevent debris accumulation (page 22) as needed.
- ❑ Properly dispose of trimmings and trash.

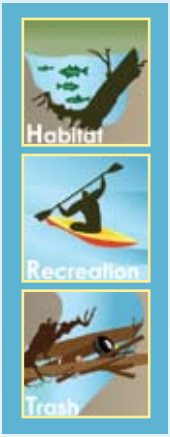
Figure 19 - Paddlers blocked by LWD

Figure 20 - Trimming for boat passage

Figure 21 - Trimming above-water branches

Figure 22 - Placing cut debris above bankfull channel

TRIMMING TO PREVENT FURTHER DEBRIS ACCUMULATION



Description: This scenario is characterized by a small to medium-sized tree falling, or becoming lodged, across part of the stream. Boat or paddling passage is possible around the LWD, however there is concern that additional debris will accumulate. The LWD may be anchored at one point but is otherwise floating.

Permit Required: If the debris is floating and not anchored to the shore or to the riverbed, then no permit is required. If it is anchored, a permit may be required.

Approach:

- ❑ Protect surrounding habitat and bank.
- ❑ Remove and properly dispose of smaller woody debris and trash.
- ❑ Evaluate the need to reorient and anchor the LWD.
- ❑ Trim branches extending above the water.
- ❑ Leave branches near the stream bank intact.
- ❑ Do not disturb the anchoring point.
- ❑ Properly dispose of trimmings and trash.

Figure 23 - Small snag needing only trimming and cleaning

Figure 24 - Trim above-water branches

Figure 25 - Pile cut branches and debris above stream bankfull channel

Figure 26 - Collect and dispose of trash

REORIENTING LWD TO POINT DOWNSTREAM

Description: In this scenario, a log is projecting perpendicular to the stream flow or is pointing upstream. In this position, the log will tend to catch and trap debris and cause increased bank erosion, more than if it were pointing downstream. Reorienting the log to point downstream is a proactive way of preventing further problems. It is not necessary to reorient every log in the stream. This technique should be reserved for logs that may cause significant future problems.

Permit Required: If the log is anchored to one stream bank and otherwise floating, then no permit is required. If the log is anchored to the stream bottom or if the stream bottom will be disturbed while repositioning the log, then a permit may be required.

Approach:

- ❑ Protect surrounding habitat and bank.
- ❑ Remove and properly dispose of smaller woody debris and trash.
- ❑ Remove branches above the water that will be in the way while reorienting the log.
- ❑ Evaluate the major anchoring point of the log. Reinforce the anchoring point as needed (page 26).
- ❑ Evaluate other branches below the water's surface. Branches below the surface that are anchored or that will otherwise prevent the reorientation of the log may be removed. Use extreme caution while doing this as the structure may shift suddenly.
- ❑ Use a come-along or other device, as needed, to pull and re-orient the log to point downstream.
- ❑ Recheck the anchoring point after reorienting the log.
- ❑ Trim branches above the water on remaining logs to prevent debris accumulation (page 22) as needed.
- ❑ Properly dispose of trimmings and trash.

Figure 27 - Log perpendicular to flow

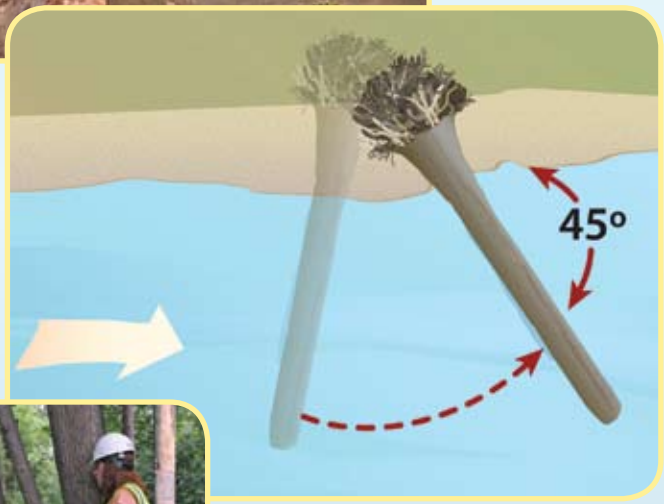


Figure 28 - Reposition large logs to face downstream at about 45° from the bank

Figure 29 - Using a come-along to reposition log

ANCHORING LWD

Description: Often, LWD that is serving an important function in a stream (e.g., reducing bank erosion or acting to control grade) may not be sufficiently anchored in place. In shallow streams with minimal flashiness, this does not present a problem. However, if the stream's flow is strong enough or the stream is prone to periods of significantly higher flow such as after a rainfall or during spring melt off, then the LWD may need to be securely anchored.

Permit Required: A permit may be required for this work.

Approach:

- ❑ Protect surrounding habitat and bank.
- ❑ Remove and properly dispose of smaller woody debris and trash.
- ❑ If the primary logs are perpendicular to the flow or pointing upstream, consider orienting the log downstream.
- ❑ Securely anchor the existing LWD to the stream bed or bank (refer to the Habitat Structure Method, page 36).

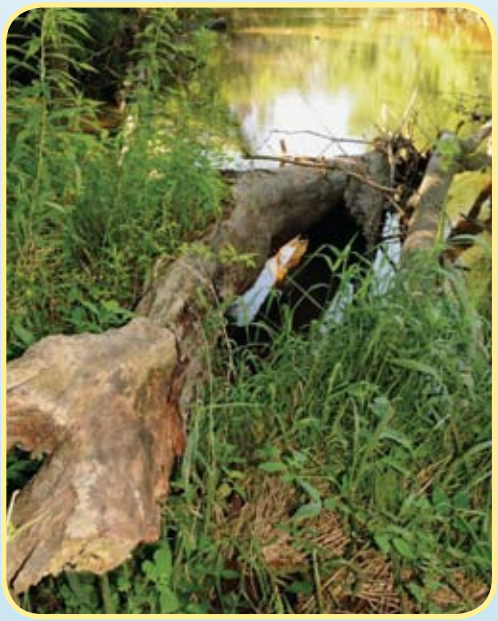


Figure 30 - Poorly anchored LWD

Figure 31 - Naturally anchored log

Figure 32 - Anchoring log to bank with rebar

Figure 33 - Bend rebar to secure log in place. The easiest way to bend rebar is to apply leverage to the top of the bar after it has been pounded into the woody debris and substrate.

FLOATING DEBRIS DAM

Description: A floating debris dam is a collection of large, medium, and small woody debris that has become entangled on a tree or log that is not anchored to the stream bed or bank. The collection of floating debris may be interfering with boating or paddling and it may also be preventing downstream passage of natural debris. If the floating debris dam is large enough, it may cause upstream flooding.

Permit Required: No. Removal of woody debris that is floating freely does not require a permit. If the bank or river channel is disturbed during maintenance activities, a permit may be required.

Approach:

- ❑ Protect surrounding habitat and bank.
- ❑ Remove accumulated trash.
- ❑ Remove accumulated woody debris.
  - ❑ Removal process should proceed from the upstream side.
  - ❑ Remove large branches from logs prior to removing the entire log.
  - ❑ Cut the logs into manageable pieces.
  - ❑ Float cut logs to the predetermined removal location and remove them from the stream.
- ❑ Trim branches above the water on remaining logs to prevent debris accumulation (page 22) as needed.
- ❑ Properly dispose of trimmings and trash.

Figure 34 - A floating debris dam

Figure 35 - Trash and debris accumulation on floating debris dam

Figure 36 - Removing accumulated smaller debris

DEBRIS DAM FIRMLY ANCHORED

Description: An anchored debris dam is a collection of large, medium, and small woody debris entangled on a tree or log that is anchored to the stream bed or bank on one or both ends. The debris dam may be interfering with boating or paddling and it may also be preventing downstream passage of natural debris. If the anchored debris dam is large enough, it may cause upstream flooding. An example is a fallen tree in which the root ball is still intact and anchored to the stream bank. The tree's limbs may also be embedded in the streambed. Floating debris may be caught on the upstream side.

Permit Required: Yes. Removal of woody debris firmly anchored into the stream bank or bottom, requires a permit.

Approach:

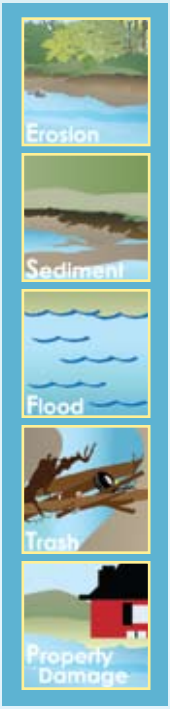
- ❑ Protect surrounding habitat and bank.
- ❑ Evaluate which LWD needs to be removed.
- ❑ Remove accumulated trash.
- ❑ Remove accumulated woody debris.
  - ❑ Removal process should proceed from the upstream side.
  - ❑ Remove large branches from logs prior to removing the entire log.
  - ❑ Branches extending under water may need to be cut prior to removing the logs. Use extreme caution as the structure may shift suddenly.
  - ❑ Cut the logs into manageable pieces.
  - ❑ Float cut logs to the predetermined removal location and remove them from the stream.
- ❑ Evaluate the anchoring points and orientation of the remaining woody debris and modify as needed.
- ❑ Trim branches above the water on remaining logs to prevent debris accumulation (page 22) as needed.
- ❑ Properly dispose of trimmings and trash.

Figure 37 - An anchored debris dam

Figure 38 - Float cut logs to predetermined removal location

Figure 39 - Remove cut logs at designated place, above bankfull channel

DEBRIS CAUGHT ON A CULVERT OR A BRIDGE



Description: Significant LWD can collect around bridge piers and road culverts. The debris jam may consist of one or more large logs lodged against the structure, which is collecting additional debris, or it may be a collection of smaller debris that has become tangled together. Debris accumulation around bridge piers or culverts may impact water conveyance or it may cause scour that could lead to failure of the structure.

Permit Required: No. The debris caught at culverts and bridges generally floated down the stream and was caught on the structure based on its size and orientation. The woody debris is generally not embedded in the stream bank or streambed.

Approach:

- ❑ Protect surrounding habitat and bank.
- ❑ Remove trash.
- ❑ Remove accumulated woody debris.
  - ❑ Removal process should proceed from the upstream side.
  - ❑ Remove large branches on logs prior to removing the entire log.
  - ❑ Cut the logs into manageable pieces.
  - ❑ Remove all woody debris from the face of the bridge or culvert.
- ❑ Properly dispose of trimmings and trash.
- ❑ Keep track of the amount and frequency of debris accumulation at the culvert/bridge face. If it is a frequent reoccurring problem, consider retrofitting the bridge/culvert with debris countermeasures. Refer to *Debris Control Structures - Evaluation and Countermeasures Third Edition,* Report No. FHWA-IF-04-016 HEC-9.

Figure 40 - Minor LWD accumulation on bridge pier

Figure 41 - Major LWD accumulation on bridge pier

Figure 42 - LWD blocking culvert

BEAVER DAMS

Description: Beaver dams consist of medium and small woody debris collected by the animal and placed across the stream. The dam foundation may include one or several large trees that have been cut and have fallen across the stream. Evidence of beaver activity includes logs that have been gnawed to a rounded point, drag trails on the bank leading to the structure, and leafed branches that have been anchored underwater on the upstream side of the dam. There may also be extensive flooding upstream of the dam.

Permit Required: Yes. A Wildlife Damage and Nuisance Control Permit is required from the Michigan Department of Natural Resources and Environment, Wildlife Management Division before removing/relocating animals.

Approach:

- ❑ Remove/Relocate animals.
- ❑ Protect surrounding habitat and bank.
- ❑ Remove trash and dispose of properly.
- ❑ Disassemble dam with caution and watch for deep water, soft silt buildup, and sudden release of woody material or backed-up water.
- ❑ Dispose of removed debris properly.

Figure 43 - Beaver at lodge

Figure 44 - Beaver dams can drastically restrict flow and cause upstream flooding

Figure 45 - A beaver lodge can be found either in the water or along the bank upstream of the dam

HABITAT STRUCTURE METHOD

Woody debris structures can be assembled in a stream for bank protection or habitat improvement. Unlike some LWD removal work, the Habitat Structure Method work always requires a permit from MDNRE before it is started. Please review the section on permits in this guide (page 45) before implementing the Habitat Structure Method.

The Habitat Structure Method is designed to give guidance on how to make use of woody materials in a stream in order to realize the benefits of LWD structures while minimizing the problems they can create. Some of the benefits of adding LWD to a stream include:

- ❑ Enhancement of fish, aquatic invertebrate, and wildlife habitat
- ❑ Reduction in localized flooding and erosion
- ❑ Flow moderation
- ❑ Increased sedimentation
- ❑ Enhance a stream's aesthetic quality

Care should be taken before adding woody debris to a stream or stream bank. Placing LWD in a stream without consideration for how it will affect the stream's hydrology and ecology will often do more harm than good. A work plan that includes specific goals of the project, benefits of adding LWD to a stream, estimations on materials and manpower, and a safety plan should be compiled before the Habitat Structure work begins.

Figure 46 - Creating a habitat structure

Placement: The Habitat Structure Method can be used for a variety of purposes including erosion control, flow control, habitat creation, or to increase sedimentation. For erosion control, logs may be anchored along an eroding stream bank or placed in the stream to direct flow away from an eroding bank. Logs or large pieces of debris placed in the stream's flow can also help reduce water velocities during periods of high flow, decrease downstream erosion, and help to settle out suspended sediment. For hydrologic efficiency and stability, debris should be placed in zones of low flow velocities along channel margins or on the inside bank of meanders. Orient logs added to the stream so they are pointing downstream at a 45° angle to the stream bank. Securely anchor woody debris to a stream bank to prevent movement during high flow. Trim logs to facilitate boat or paddling passage and minimize trash accumulation.

Figure 47 - Debris anchored on bank for erosion control

Figure 48 - Log matrix used to armor bank

Logs with root wads are especially stable and, if correctly placed, can create pool or riffle habitat, prevent bank erosion, and increase sedimentation in the stream.

Figure 49 - Tree with root wad in stream

Do not cut live trees!

Materials: Raw materials for constructing a habitat structure can come from the stream or surrounding floodplain, or may be brought in from the outside. Nearby LWD structures that are slated for removal or modification are excellent sources for large logs, as are overhanging dead trees that will eventually fall into the stream. Be sure that your permit allows for cutting standing trees and never remove or cut any wood without the landowner's permission.

Move large wood with caution to avoid damaging the surrounding riparian habitat. Logs with the branches left intact provide more surface area and offer better interstitial spaces for habitat than those cut down to the bole. LWD with intact branches also traps sediment better and lessens stream bed degradation.

In every case, the negative impacts of adding LWD should be carefully assessed. Heavy equipment and foot traffic can damage riparian habitat and uprooting or removing stream side wood can destabilize the bank and destroy existing habitat. Adding LWD can also increase flow resistance and the potential for upstream flooding.

Anchor the LWD to the stream bank rather than the stream bed. LWD may also be anchored to dead wood on the bank (never to live trees). When anchoring LWD in the stream flow, it should be anchored, if possible, so that it is constantly submerged under normal flow conditions as continual wetting and drying hastens wood deterioration.

Tools: The following tools and hardware may be useful when constructing and securing a new habitat structure:

- ❑ Hand saw
- ❑ Chain saw
- ❑ Come-along, block and tackle
- ❑ Steel post
- ❑ Steel cable or link chain
- ❑ Steel spikes
- ❑ Thimble kits
- ❑ Sledge hammer
- ❑ Bobcat or tractor (for larger wood pieces)

Anchoring Methods: Unless woody debris is firmly embedded in the bank or somehow naturally secured in place, some form of anchoring must be employed. Stream flow, especially at times of high water, can put a tremendous strain on anchoring, so any LWD added to a stream must be secured so that it does not move around in the current. As the LWD collects additional debris, the drag force on the structure is increased dramatically so proper anchoring is essential.

Cabling (Palmiter Method): LWD may be anchored to an existing or introduced anchoring point on the stream bank by a steel cable or link chain. Good anchoring points that may already be stream side include: stumps with buried roots; large, downed tree trunks that are out of the bank-full channel; boulders; or well-rooted standing dead timber. Cable wire or link should be heavy enough to hold the log in place during high flow events. The point of attachment to the bank should also be strong enough to hold up under high-flow stress. Keep the cable as short as possible and attach it to at least two points on the log.

Figure 50 - Anchoring a log using the Palmiter Method

Figure 51 - Logs removed from a jam may be re-used to create habitat structures

Treated wood or metal T-posts that have been dug or pounded into the bank can also serve as anchor points. If necessary, the posts can be cemented into place. Anchor posts should be dug or driven below grade for safety and aesthetics.

Debris Clusters: Fasten several large pieces of LWD together and anchor them into place to either create habitat or to armor a stream bank. The increase in mass gained by clustering several large logs will help stabilize the structure. Logs can be attached to one another using cable or steel link. Pound or drill reinforced bar (rebar) through two or more logs and then bend it to 90° on the end to prevent the logs from coming apart. A large washer can also be welded on each end of the rebar for the same purpose. The debris cluster can then be anchored into place if need be.

Mechanical and Weighted Anchors: There are several types of mechanical or weighted anchors that can be used to secure LWD structures in place. Simple anchors made from concrete-filled buckets or drums can be used to anchor smaller pieces of LWD, or they can be used in conjunction with other anchoring devices for larger logs. A ”dead man” anchor (a post or other large object that is buried horizontally in the substrate) can also be used to secure LWD. Heavy equipment is usually required to install this type of anchor.

Screw type and “duckbill” anchors are available commercially and can be installed in many types of substrate using only hand tools. These anchors are particularly useful because they are designed to have cables directly attached to them.

Figure 52 - LWD may be cabled to secured objects on the bank (Palmiter Method). Secure cables to downed or dead wood only

Figure 53 - "Deadman" anchor

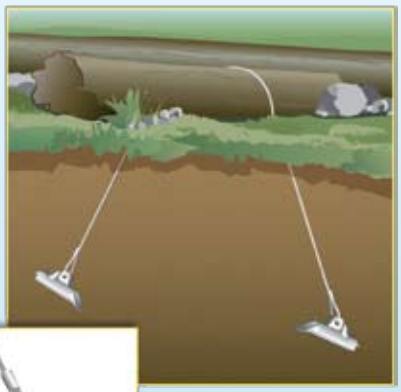


Figure 54 - "Duckbill" anchor

Pinning: Rebar can be pounded or drilled through LWD to anchor it to the substrate although it has very little holding power in soil. It is best suited for use in smaller streams that do not flood. The rebar rod should be bent or capped with a welded washer to prevent movement of the LWD.

Ballast: Heavy objects such as boulders, large rip rap, or large secured logs can be used to hold LWD in place.

Scenario 1: Armoring a Stream Bank

Armoring a bank with woody debris:

- ❑ Obtain the appropriate permits from the MDNRE
- ❑ Obtain permission to work on private property
- ❑ Have a detailed plan for the structure in place
- ❑ Determine where you will get your woody debris
- ❑ Move logs with caution and use tools safely
- ❑ Minimize impact on surrounding habitat
- ❑ Fasten logs securely to bank

Figure 55 - Woody debris and rip rap combined to armor a streambank

Figure 56 - Logs cabled together to armor eroding bank

Scenario 2: Habitat Creation

Creating habitat with woody debris:

- ❑ Obtain the appropriate permits from MDNRE
- ❑ Obtain written authorization from riparian landowner and MDNRE wildlife or fisheries biologist
- ❑ Consult a habitat professional to help plan the structure
- ❑ Obtain permission to work on private property
- ❑ Have a detailed plan for the structure in place
- ❑ Determine where you will get your woody debris
- ❑ Move logs with caution and use tools safely
- ❑ Minimize impact on surrounding habitat

Figure 57 - Habitat structure

Figure 58 - LWD structures provide excellent habitat for a variety of game fish

Scenario 3: In-Stream LWD Placement for Erosion Control

LWD placement for bank erosion control:

- ❑ Obtain the appropriate permits from MDNRE
- ❑ Obtain permission to work on private property
- ❑ Have a detailed plan for the structure in place
- ❑ Determine where you will get your woody debris
- ❑ Move logs with caution and use tools safely
- ❑ Minimize impact on surrounding habitat

Figure 59 - LWD structure causing bank erosion

Figure 60 - LWD lying parallel to the bank provides erosion control

State and Federal

Any work that involves excavating or moving woody debris, fulfills an identifiable need for erosion protection, bank stabilization, protection of uplands, or involves bioengineering shoreline protection, requires permit application on an MDNRE/USACE Joint Permit Application form. Placement of structures designed as fish or wildlife habitat will require the written authorization of the riparian landowner and the appropriate department district fisheries or wildlife biologist, or both.

Joint permit application (MDNRE-USACE) information is available at: www.michigan.gov/jointpermit.

Wildlife Damage and Nuisance Control Permit: Before measures are taken to control nuisance beaver on private land in the Clinton River Watershed, a Wildlife Damage and Nuisance Control permit is required. The permit allows control measures to be taken during closed hunting season. At no time shall beaver be live trapped and relocated without authorization from the MDNRE Wildlife Management Unit Supervisor.

County

A Soil Erosion and Sedimentation Control (SESC) permit may be required when performing work along a waterway. Contact the county in which the work is being done to find out who the Authorized Public Agency is for your community. Also, it is important to contact your local county drain commissioner's office when performing work in a legally established county drain. Depending on the work being proposed, a permit may be required.

Cities, Villages, and Townships

It is important to provide details of the work to be performed in and along a waterway to the appropriate community engineering department for review and approval. Changes in water flow, if done improperly, can cause further damage downstream.

FURTHER READING AND REFERENCES

A Primer on Large Woody Debris, Prepared for the City of Rochester Hills by JFNew, September, 2006

Yahara River Large Woody Debris Management Primer, Prepared for the Village of Deforest by JFNew, May, 2008

Fact Sheet 7: Managing Woody Debris in Rivers, Prepared by Land & Water Australia, July 2002

Large Woody Debris Fact Sheet, Connecticut Department of Environmental Protection

Field Guide for Riparian Management, Willamette National Forest, Dr. Stan Gregory, Linda Ashkenas, Department of Fisheries and Wildlife, Oregon State University

Technical Report EL-92-35, Incremental Effects of Large Woody Debris Removal on Physical Aquatic Habitat, Roger H. Smith, Center for River Studies, Memphis State University, November 1992

Woody Debris Management 101 and 201, Riparian Corridor Management Technical Advisory Committee, Friends of the Rouge

Design Considerations for Large Woody Debris Placement in Stream Enhancement Projects, Robert H. Hilderbrand, North American Journal of Fisheries Management 18: 161-167, 1998

Streambank Habitat Enhancement with Large Woody Debris, J. Craig Fischenich and James Morrow Jr., Ecosystem Management and Restoration Research Program, May 2000

Debris Control Structures- Evaluation and Countermeasures Third Edition, Report No. FHWA-IF-04-016 HEC-9

Course Woody Debris in Stream Channels in Relation to River Channel Management in Woodland Areas, K. J. Gregory and R. J. Davis, John Wiley & Sons, Ltd., 1992

Debris Control Measures for Bridges and Abutments, National Technical Information Service, www.fedworld.gov/ntis

ACRONYMS

GPS – Global Position System

LWD – Large Woody Debris

MDNRE – Michigan Department of Natural Resources and Environment

SESC – Soil Erosion and Sedimentation Control

USACE – United States Army Corps of Engineers

CONTACTS

Clinton River Watershed Council
101 Main St., Rochester, MI 48307
248.601.0606
www.CRWC.org

Lapeer County Drain Commissioner
255 Clay St., Lapeer, MI 48446-2205
810.667.0371
www.lapeercountyweb.org

Macomb County Public Works Office
21777 Dunham Rd., Clinton Twp., MI 48036
586.469.5325
www.macombcountymi.gov/publicworks

Michigan Department of Natural Resources and Environment
www.michigan.gov/dnr

Oakland Co. Water Resources Commissioner
One Public Works Dr., Bldg. 95 West
Waterford, MI 48328-1907
www.oakgov.com/water

St. Clair County Drain Commissioner
21 Airport Dr., St. Clair, MI 48079
810.364.5369
www.stclaircounty.org/offices/drain_commission

LWD DEFINITIONS

Anchored – Firmly held in place by natural or engineered means. A log that is securely fixed to the bank with heavy steel cable is said to be anchored.

Bank Stability – The ability of a streambank to counteract erosion or gravity forces.

Bankfull Channel Width – The top surface width of a stream channel when flowing at a bankfull discharge.

Bankfull Discharge – The stream discharge corresponding to the water stage that first overtops the natural banks, occurring, on average, about once every one to two years.

Bankfull Depth – Depth of water measured from the surface to the channel bottom when the water surface is even with the top of the streambank.

Biofilm – A complex aggregation of microorganisms attached to a solid body such as a log or rock in a stream.

Downstream – Opposite of upstream; facing away from the source of flow.

Embedded – An object or piece of woody debris implanted or rooted in a stream's bank or substrate.

Embeddedness – The extent that boulders, larger cobbles, or gravel are surrounded or covered by fine sediment (sand, silt, clay).

Flashiness - Measure of a stream's tendency to exhibit a wide range of flow conditions.

Floodplain – Area adjacent to a stream or river where water from the stream or river overflows its banks at some frequency during extreme storm events.

Habitat – The local environment in which organisms normally live and grow.

Large Woody Debris – Logs, stumps, or root wads in the stream channel, or nearby. Commonly consisting of wood larger than 10-feet long and 4-inches in diameter.

Minor Snag – A collection of woody debris that does not adversely affect the morphology of a stream.

Riparian Area – An area of land and vegetation adjacent to a stream that has a direct effect on the stream.

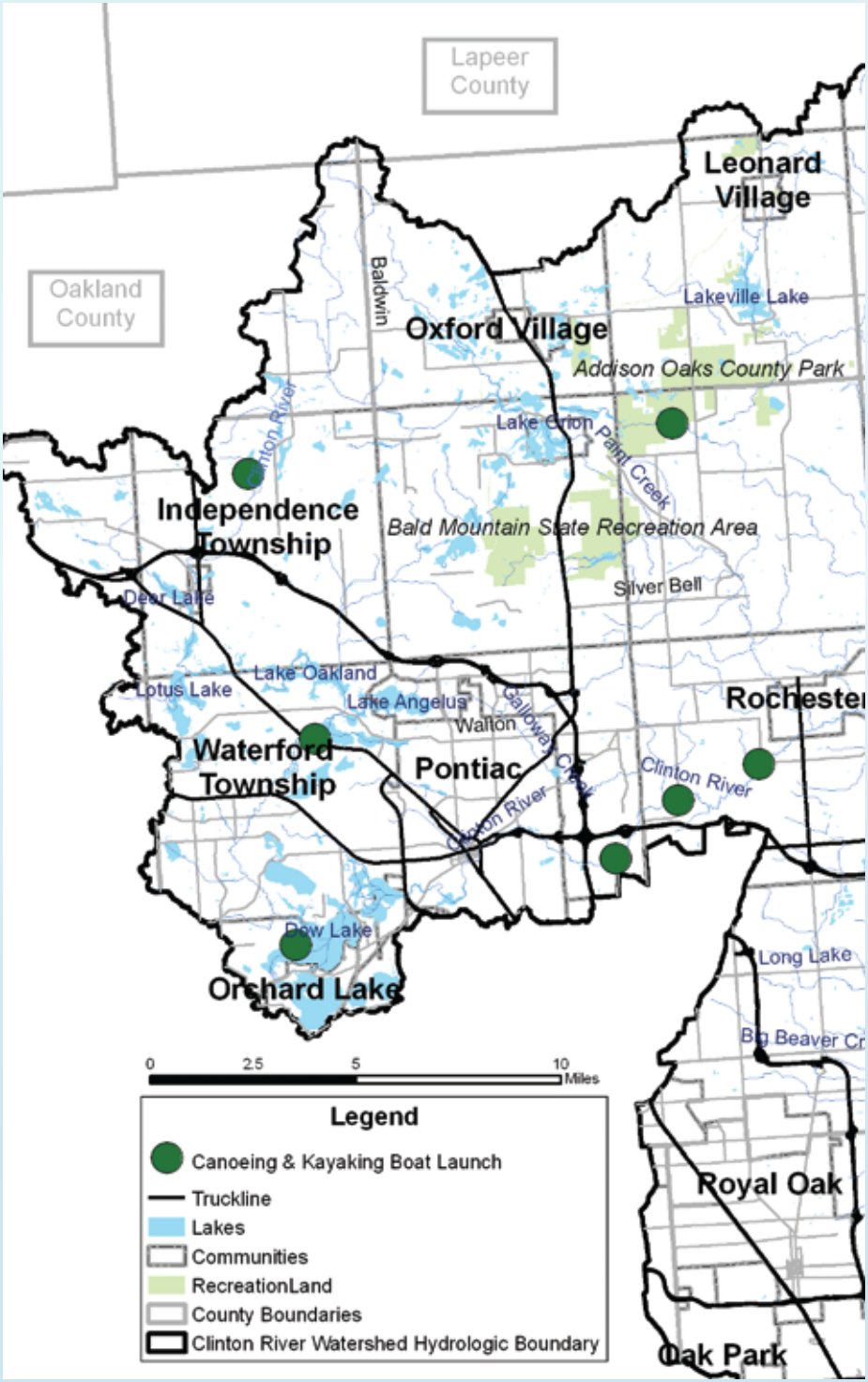
Rootwad – Lower trunk and root fan of a large tree.

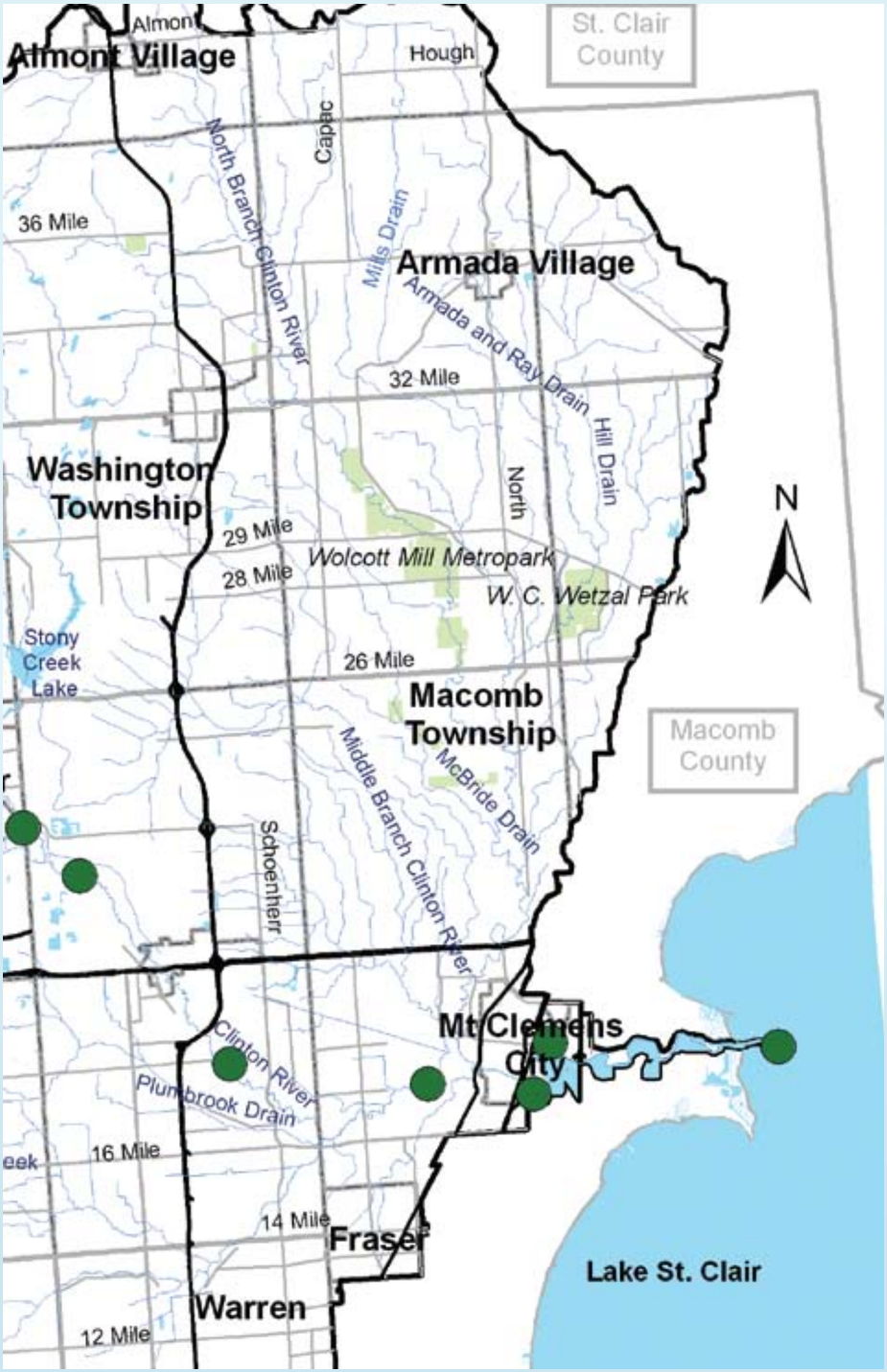
Scour – Erosive action of running water in streams, which excavates and carries away material from the bed and banks.

Snag – Trees, branches, and other pieces of naturally occurring wood found sunken in rivers and streams.

Upstream – Position of facing the current or the source of flow.

Woody Debris – Referring to wood in streams.


Lapeer County
Oakland County
Leonard Village
Baldwin
Oxford Village
Lakeville Lake
Addison Oaks County Park
Lake Orion
Paint Creek
Clinton River
Independence Township
Bald Mountain State Recreation Area
Silver Bell
Deer Lake
Lotus Lake
Lake Oakland
Lake Angelus
Walton
Galloway Creek
Rochester
Waterford Township
Pontiac
Clinton River
Clinton River
Dow Lake
Orchard Lake
Long Lake
Big Beaver Cr
Royal Oak
Oak Park
0
2.5
5
10
Miles
Legend
Canoeing & Kayaking Boat Launch
Truckline
Lakes
Communities
RecreationLand
County Boundaries
Clinton River Watershed Hydrologic Boundary


Almont
Almont Village
Hough
St. Clair County
Capac
North Branch Clinton River
Mills Drain
36 Mile
Armada Village
Armada and Ray Drain
Hill Drain
32 Mile
Washington Township
North
29 Mile
28 Mile
Wolcott Mill Metropark
W. C. Wetzal Park
N
Stony Creek Lake
26 Mile
Macomb Township
Macomb County
McBride Drain
Middle Branch Clinton River
Schoenherr
Clinton River
Mt Clemens City
Plumbrook Drain
16 Mile
14 Mile
Fraser
Lake St. Clair
Warren
12 Mile


MACOMB COUNTY
MICHIGAN
CLINTON RIVER
WATERSHED COUNCIL
TETRA TECH
US Army Corps
of Engineers