Unit	1138
Title	Describe Winch Assist
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Canada

BRITISH COLUMBIA

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BC **Forest Safety**

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Table of Contents

Unit Introduction

What you will learn in this unit

By the end of this unit, you will be able to demonstrate knowledge of:

- Planning and layout considerations
- Best practices when using winch assist
- Features of winch assist
- Wire rope and anchors

Section 1138-01: Best Practices when using Winch Assist

What you will learn in this section

1.1 Capabilities, advantages, and limitations of winch-assist systems

1.2 Manufacturer’s instructions or safe work procedures

1.3 Safe operations

1.4 When additional best practices or safe work procedures may be required

Key Point 1.1: Capabilities, Advantages, and Limitations of Winch-Assist Systems

Winch assist refers to the practice of attaching a cable or cables to a forestry machine to increase its operability on slopes.

The cable's tension increases the machine's traction in order to prevent slippage and, to a lesser extent, increases the machine's stability on slopes. The increase in traction allows the machine to work on steeper slopes while reducing ground and soil disturbance.

Double line winch assist machine

Winch-assist systems are relatively new to North America and are used to increase the operating range of ground-based equipment. They reduce the need for hand fallers and cable yarding crews, some of the most dangerous jobs in forestry.

Benefits to using winch assist include:

- Safety: reduced risk of incidents associated with hand fallers and yarding crews
- Increased harvesting productivity
- Reduced costs
- Reduced site disturbance

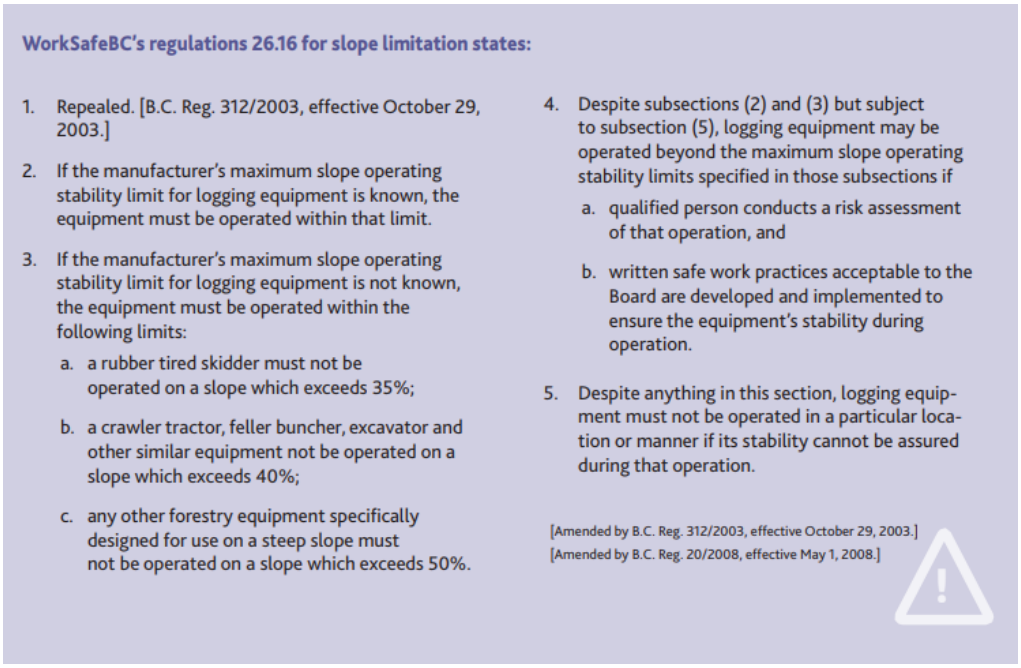
A fundamental principle when using winch assist is that the machine must remain stable and have traction without the cable.

Learning Point

The cable only assists with traction. The machine must remain stable and have traction without the cable.

WorkSafeBC Slope Limitations

If the manufacturer's maximum slope-operating stability limit is not known, then WorkSafeBC's slope limits in Part 26 of the OHSR applies. Exceeding these limits requires a steep slope logging risk assessment and the development of site specific safe work procedures.



WorkSafeBC's regulations 26.16 for slope limitation states:

1. Repealed. [B.C. Reg. 312/2003, effective October 29, 2003.]
2. If the manufacturer's maximum slope operating stability limit for logging equipment is known, the equipment must be operated within that limit.
3. If the manufacturer's maximum slope operating stability limit for logging equipment is not known, the equipment must be operated within the following limits:
   a. a rubber tired skidder must not be operated on a slope which exceeds 35%;
   b. a crawler tractor, feller buncher, excavator and other similar equipment not be operated on a slope which exceeds 40%;
   c. any other forestry equipment specifically designed for use on a steep slope must not be operated on a slope which exceeds 50%.
4. Despite subsections (2) and (3) but subject to subsection (5), logging equipment may be operated beyond the maximum slope operating stability limits specified in those subsections if
   a. qualified person conducts a risk assessment of that operation, and
   b. written safe work practices acceptable to the Board are developed and implemented to ensure the equipment's stability during operation.
5. Despite anything in this section, logging equipment must not be operated in a particular location or manner if its stability cannot be assured during that operation.

[Amended by B.C. Reg. 312/2003, effective October 29, 2003.]
[Amended by B.C. Reg. 20/2008, effective May 1, 2008.]

WorkSafeBC slope limitations (image from FPInnovations)

Capabilities, Advantages, and Limitations of Winch-Assist Systems—Self-Quiz

1. Winch assist allows harvesting machines to work on any slope because the machine is supported by a cable for safety.

   ☐ True

   ☐ False

2. A fundamental principle when using winch assist is:

   ☐ WorkSafeBC slope limits apply and cannot be exceeded

   ☐ Two or more cables must be used

   ☐ The machine must remain stable without the cable

   ☐ None of these answers

3. Logging equipment must not be operated in a particular location if:

   ☐ The slope exceeds 40%

   ☐ Its stability cannot be assured during operation

   ☐ The slope exceeds 35%

   ☐ Operating conditions are not favourable that day

Now check your answers on the next page.

Capabilities, Advantages, and Limitations of Winch-Assist Systems—Self-Quiz Answers

1. Winch assist allows harvesting machines to work on any slope because the machine is supported by a cable for safety.

   Answer: **False**

2. A fundamental principle when using winch assist is:

   Answer: **The machine must remain stable without the cable**

3. Logging equipment must not be operated in a particular location if:

   Answer: **Its stability cannot be assured during operation**

Key Point 1.2: Manufacturer’s Instructions or Safe Work Procedures

When winch-assist logging is used, WorkSafeBC has identified these areas to be addressed by manufacturer’s instructions or written safe work procedures:

- Stump selection, method of securement, and frequency of inspection
- Winch and cable inspection frequency and standards
- Potential to damage or sever cable with head, boom, or logs
- Abrasion of cable on rock outcrops or other obstacles
- Safe working area around the machine and cable (area of no entry)
- Rescue procedure for breakdown or misadventure
- Worker training
- Lockout and de-energization procedures
- Winch capacity/load rating, safety systems, and failsafes
- Cable size and strength
- Snubbing loads on steep grades

Key Point 1.3: Safe Operations

Generally, the winch system should only be used to assist with traction and should not be used to support any weight of the assisted machine.

Learning Point

Machine stability must be tested by releasing the cable tension regularly when working, including whenever the machine is repositioned.

Test to ensure the machine is stable without assistance. If it is not stable during the test, work must not start or continue in the test position until conditions are resolved and the machine is stable.

In some cases, with various winch-assist systems and under certain terrain and weather conditions, the winch can safely provide more support than just tractive assistance. In these cases:

- The minimum pulling and braking force of the winch and cable must be suitably rated (this is a function of the weight of the supported machine with the load, the traction coefficient of the surface (soil, debris, ice, snow, etc.), and the maximum gradient the supported machine is expected to work on)
- Properly functioning fail-safe mechanisms, warning systems, and sensors must be present and monitored
- Working procedures should minimize the risks for loss of traction and provide the operator with steps to rapidly mitigate any loss of traction

Operational Best Practices

- The traction winch cable should only be used for traction assistance and never for other purposes, such as pulling logs or winching the machine into place
- Operate the machine only in places where the operator feels comfortable. The operator cannot be compelled to work in areas or conditions where they feel there is a safety risk (right to refuse unsafe work)
- The winch on a winch-assist system should be used whenever working on slopes over 40% unless the steep slope assessment has determined that winch-assist is unnecessary
- Always assume a wire rope could break at any time and operate accordingly
- An alternative plan must be in place for unsuitable working conditions (i.e., unsuitable weather or soil)

- Do not work near or pass under or over the cable while the machine is operating. Stay clear of the wire rope during operation
- Do not work near or below a machine that is operating
- Do not ride on or in remote-controlled machines when they are moving or operating
- Inspect and maintain all mechanical components as per the manufacturer's specifications (winch, gearbox, pumps, control systems)
- Always wear a secured four-point or greater seat belt during operation
- Remove or secure all loose objects in the cab before operation

Cab Entry and Exit

- Position the machine on flat or less steep ground, if possible
- Ensure the machine is secure before attempting to enter or exit the cab
- Position the machine to use the tracks, stumps, or logs to reduce the distance to ground on steep slopes
- Use a 3-point contact at all times and use any provided hand or foot holds

- Use caution if the cab is not level, as gravity will cause the door to swing if not controlled

Best Practices to Maximize Safe Operations—Self-Quiz

1. The traction winch cable can be used for:

   - ☐ Pulling logs
   - ☐ Winching the machine into place
   - ☐ Traction assistance only

Now check your answers on the next page.

Best Practices to Maximize Safe Operations—Self-Quiz Answers

1. The traction winch cable can be used for:

   Answer: **Traction assistance only**

Key Point 1.4: When Additional Best Practices or Safe Work Procedures may be Required

Not all systems or circumstances are the same. Different or additional best practices may be required depending on the system and the application. Safe work procedures and WorkSafeBC regulations for winch assist are currently being updated in BC.

Application

Traction Assist Only vs. Machine Support

In Europe, the winch is used only as a traction aid and is not a safety system. The winch is used mainly when driving uphill and in conditions where the machine can stop on its own, without the aid of the winch, should the cable or winch fail.

In New Zealand, tethering occurs on slopes >100% and the line may support part of the weight of the machine. In these cases, a backup system is required.

Winch-assist is a developing technology and only a handful are in use in British Columbia. Over time, and in certain applications, it may be suitable to use winch-assist to support part of the weight of the machine. In these cases, best practices and safe work procedures would be adapted, and operators and crew appropriately trained.

Video 3:58

The video link below shows a 2 line traction assist system that is being used on Vancouver Island:

https://www.youtube.com/watch?v=U0pjNRqouII&feature=emb_logo

When you are finished, continue in this section.

Above the Road vs. Below the Road Operations

Planning should allow for an exit route when cutting below the road if there is no road access below.

Careful planning is needed when there is no road or built trail above the block. A route for cutting up to the top of the block, or a means of

dragging the cable up the hill is required. Due diligence is required when selecting and using anchors (see Key Point 4.3: Anchoring).

Backup Systems

In machine support applications (i.e., New Zealand), all winch-assist systems are required to have a backup system in the event of failure. Current accepted backup systems include a blade brake, a double line system, and a warning system.

Each backup system has advantages and disadvantages and none can be guaranteed to work in all circumstances. Below are some points to consider if a backup system is used, along with some suggested best practices.

Blade

A blade is designed to stop the machine if there is a failure with the cable, attachment point, or anchor.

Fast actuating blade mounted on a ClimbMAX winch-assist machine (image from FPInnovations)

Disadvantages

- The momentum of a sliding machine might lead to a “tripped upset,” where the downed blade actually serves as a pivot point
- The blade may not be applied in time to stop the machine

Best Practices

- Do not use with a non-constant tension system
- Never allow slack to develop in the line
- The tethered machine should have a low center of gravity

Double Line or Second Line

Double line refers to the practice of attaching a second cable to the machine in case the main cable fails. There is a main working line and a safety line.

Advantages

- If the main working line fails, the second cable is designed to hold the assisted machine in place. However, it has been argued that failure of one cable may shock load the second cable when the first cable fails (instances of both cables breaking almost simultaneously are known)
- If one cable is accidently cut by the felling head, the operator may be able to correct the situation before the second cable is cut
- Some operators are more comfortable when working with a second cable

Disadvantages

- The mechanisms for control and maintenance are more complex
- It is more difficult to manipulate two cables around obstacles

Best Practices

- Do not exceed the anchoring capacity of the machine anchor's site-specific condition
- Monitor the weather and soil moisture conditions that may affect the load capacity of the machine or stump anchor. Reduce the max allowable slope or cease operations until conditions improve.

Warning System

The third type of emergency backup system accepted in New Zealand is "an operating system which includes warning instruments, operating procedures, and training."

Advantages

Operator is aware that only their skill and speed of implementing the emergency operating procedures can prevent an incident. This may prevent them from taking unsafe risks.

Disadvantages

Relies on the operator receiving the warning and following the operating procedures in time to prevent an incident.

Best Practices

- Maintain and test the warning system daily and after any suspect event

- Operators should practice the emergency operating procedures monthly in a low-risk environment

Cutting Head Type

The four types of felling heads (continuous rotation disc, intermittent disc, feller-director, and harvester) all have the potential to sever the wire rope cable. A continuous rotation disc saw poses the greatest risk because of its high disc rotation speed, heavy-duty disc and saw teeth, and instant damage potential from even minor contacts.

It may be that the saw type makes little or no difference to the risk because a line under tension is already at a greater risk of breaking if it comes into contact with a sharp edge. Testing or engineering analysis may be required to rank the relative risk of various head types. **It is recommended to use the lowest possible line tension when cutting near cable regardless of the cutting attachment.**

Tasks

The main task performed by forestry winch-assist systems in North America is tree falling. However, other tasks such as hoe-chucking, bunching, forwarding, and skidding are performed, and these will require adapted best practices.

When Additional Best Practices or Safe Work Procedures may be Required —Self-Quiz

1. The function of the blade on a winch-assist machine is to:

   - ☐ Push logs down the slope
   - ☐ Stop the machine if there is a failure with the cable, attachment point, or anchor
   - ☐ Build road
   - ☐ All of these answers

2. How can you lower the risk of cutting the cable with the cutting head?

   - ☐ Have a spare cable on hand
   - ☐ Use only a continuous rotation disc cutting head
   - ☐ Never cut near the cable
   - ☐ Use the lowest line tension necessary

Now check your answers on the next page.

When Additional Best Practices or Safe Work Procedures may be Required —Self-Quiz Answers

1. The function of the blade on a winch-assist machine is to:

   Answer: **Stop the machine if there is a failure with the cable, attachment point, or anchor**

2. How can you lower the risk of cutting the cable with the cutting head?

   Answer: **Use the lowest line tension necessary**

Section 1138-02: Machine Components and Design

What you will learn in this section

2.1 Basic mechanical and non-mechanical elements

2.2 Machine design for winch-assist systems

Key Point 2.1: Basic Mechanical and Non-mechanical Elements

The basic mechanical elements of a winch-assist system are:

- Base machine (the logging machine working the slope)
- Anchor (usually a machine or a stump)
- Winch (can be mounted to the anchor machine, the base machine, or stand alone, though rare)
- Wire rope
- Rigging components

The first photo below is an example of the winch mounted to the anchor machine. The second photo shows the winch mounted to the base machine and a stump being used as an anchor.

The yellow machine (left) is the base machine, and the blue machine (right) is the anchor and the winch (image from Gerard Messier)

The winch is mounted to the base machine and a stump is used as an anchor (image from Dorian Uzzell, Wahkash Contracting)

The mechanical elements will be covered in more detail later in this module.

Non-mechanical elements that greatly affect the system's safety include the following:

- Operator
- Environmental conditions
- Operating Procedures
- Regulations

Operator

The operator's competency (knowledge, skills and attributes) and shift length can affect productivity and safety.

Environmental conditions

Environmental conditions include soil type, terrain characteristics (gullies, benches, exposed rock, etc.), hazards, slope steepness, and weather conditions.

Reference

Hazard alert about dangers of rock outcroppings on steep slope operations:

http://nzfoa-iris.com/SafetyAlerts/ShowSafetyPDF.aspx?id=146.

When you are finished, continue in this section.

Operating Procedures

Site-specific procedures will be developed for safe operation on that slope. Hazards, procedures, and emergency response plans should be reviewed in pre-work meetings.

Regulations

WorkSafeBC regulations for operating limits and health and safety must be followed at all times. A company's procedures must take these regulations into account.

Basic Mechanical and Non-mechanical Elements—Self-Quiz

1. Which of the following elements affect safety?

   - ☐ Rope condition
   - ☐ Machine condition
   - ☐ Operator condition
   - ☐ Soil condition
   - ☐ All of these answers

Now check your answers on the next page.

Basic Mechanical and Non-mechanical Elements—Self-Quiz Answers

1. Which of the following elements affect safety?

   Answer: **All of these answers**

Key Point 2.2: Machine Design for Winch-Assist Systems

Typical base machines for winch-assist tree cutting and log processing include:

- Levelling or non-leveling wheeled harvester
- Levelling or non-leveling tracked harvester/feller-director/feller-buncher

Levelling winch-assist wheeled harvester (image from FPInnovations)

Levelling winch-assist tracked feller-director (image from FPInnovations)

Typical base machines for winch-assist log or tree extraction include:

- Levelling or non-leveling tracked excavator forwarder
- Wheeled forwarder or clambunk skidder
- 4- or 6-wheeled rubber-tired skidder

Flat-bottom excavator-loader downhill (image from FPInnovations)

Tilting feller-director uphill stem forwarding (image from FPInnovations)

Winch-assisted wheeled clambunk skidder (image from FPInnovations)

Winch-assisted wheeled skidder uphill stem forwarding (image from FPInnovations)

Section 1138-03: Features

What you will learn in this section

3.1 Features of base machines used in winch-assist operations

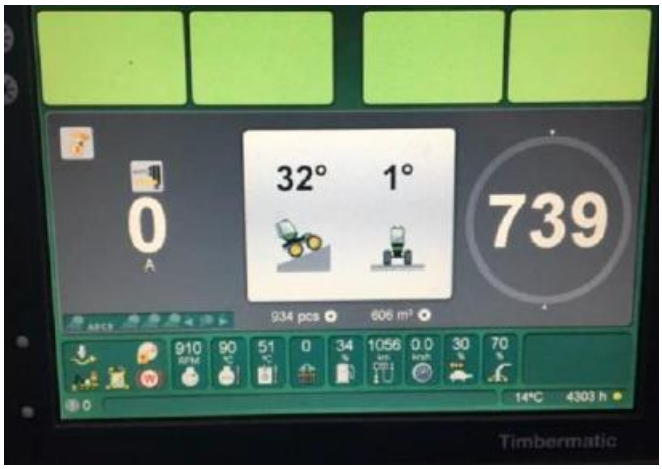
3.2 Features of the winch mounted on logging machine working the slope

3.3 Features of stationary winch/anchor machine

Key Point 3.1: Features of Base Machines used in Winch-Assist Operations

The following features must be included in the base machine, either by the original equipment manufacturer or as after-market additions:

- Inclinometer that measures and displays machine frame angle



Example of an in-cab longitudinal and lateral machine slope display (image from FPInnovations)

- Fluid systems (hydraulics, engine oil, coolant, fuel) that are designed to operate on steep slopes
- Secure operator restraints (minimum four- or five-point harness system, ideally with an adjustable locking mechanism)
- Cable attachment points engineered for the expected loads
- Live display of cable tension and display of remaining available rope length and rope length in use.

Live display of cable tension (image from FPInnovations)

These features may also be included in the base machine:

- Audible and visual warnings for cable overloads, winch failure, spooling errors, cable damage, anchor movement, and reaching the minimum number of cable wraps
- Adequate tractive and swing power for steep slopes
- Traction devices suitable for the conditions (e.g., tire chains or tracks for wheels, ice lugs or double grousers for tracks). A grouser is a bar on a track shoe which improves traction.
- GPS navigation system with potential hazards identified on a map display
- Camera display of winch drum(s) if not visible from the operator's cab
- Camera display of obstructed view areas
- Hour meter that tallies the number of hours the winch and cable have operated
- Display of winch hydraulic temperature with indication of operating limits, visible to the operator of the assisted machine
- A mechanism or system to prevent accidental operation of the assisted machine when the winch is in manual mode

Welded ice lugs on every other track plate (image from FPInnovations)

Welded double grousers on every track plate (image from FPInnovations)

Features of Base Machines Used in Winch-Assist Operations—Self-Quiz

1. Live display of cable tension is required on the base machine.

   ☐ True

   ☐ False

2. Camera display of the winch drum is required on the base machine.

   ☐ True

   ☐ False

Now check your answers on the next page.

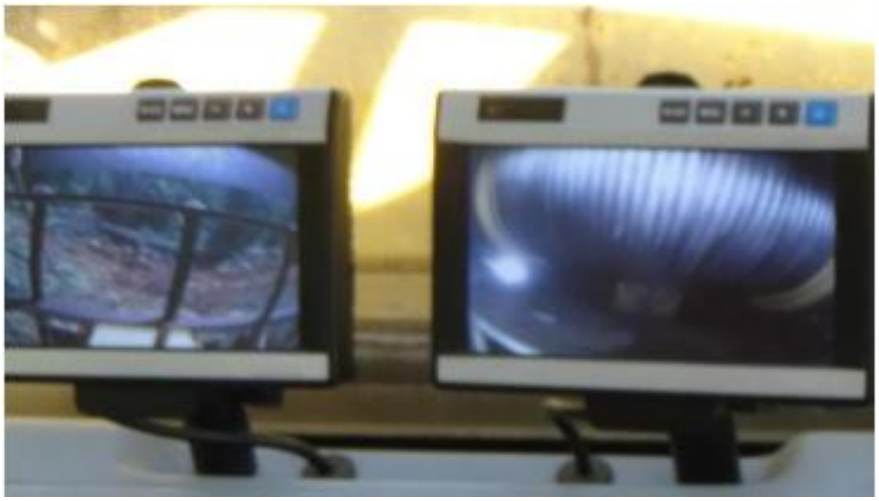
Features of Base Machines Used in Winch-Assist Operations—Self-Quiz Answers

1. Live display of cable tension is required on the base machine.
   Answer: **True**
2. Camera display of the winch drum is required on the base machine.
   Answer: **False**

Key Point 3.2: Features of Winch Mounted to Logging Machine

The following features are part of an integrated winch machine (a winch that is mounted to the logging machine working the slope):

- Display of the remaining available rope length and rope length in use
- Live display of cable tension
- Audible and visual warnings for cable overloads, winch failure, spooling errors, cable damage, anchor movement, and reaching the minimum number of cable wraps
- Camera display of winch drum(s) if not visible from the operator's cab
- Camera display of obstructed view areas



Display of winch drum and obstructed view area (image from FPInnovations)

- Hour meter that tallies the number of hours the winch and cable have operated
- Display of winch hydraulic temperature with indication of operating limits, visible to the operator of the assisted machine
- A mechanism or system to prevent accidental operation of the assisted machine when the winch is in manual mode

Winch mounted to logging machine

Key Point 3.3: Features of Stationary Winch/Anchor Machine

The following features are part of a separate (autonomous) stationary winch/anchor machine:

- Winch auto-stop or gradual brake system in case of power failure
- Hour meter that tallies the number of hours the winch and cable have operated to monitor cable use and life
- Anchor movement monitor

These features may also be included:

- Guy line drum(s) to secure the anchor machine
- Anti-lock style braking system that applies winch brake gradually in an emergency to prevent shock loading to the wire rope and other system components
- Data-logger of the cable tensions
- Alarm when cab door opens

Guy line drum (image from FPInnovations)

Section 1138-04: Wire Rope and Anchors

What you will learn in this section

4.1 Wire rope integrity in forestry equipment

4.2 Wire rope failure

4.3 Anchoring

4.4 Maximizing machine stability

4.5 Maximizing traction

4.6 Connecting hardware

4.7 Machine attachment points

4.8 Felling with winch assist

4.9 Rope management and catching

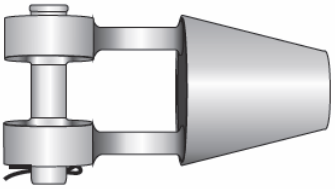
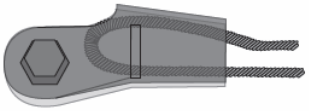
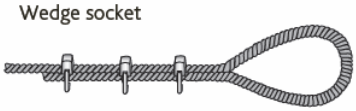
Key Point 4.1: Wire Rope Integrity in Forestry Equipment

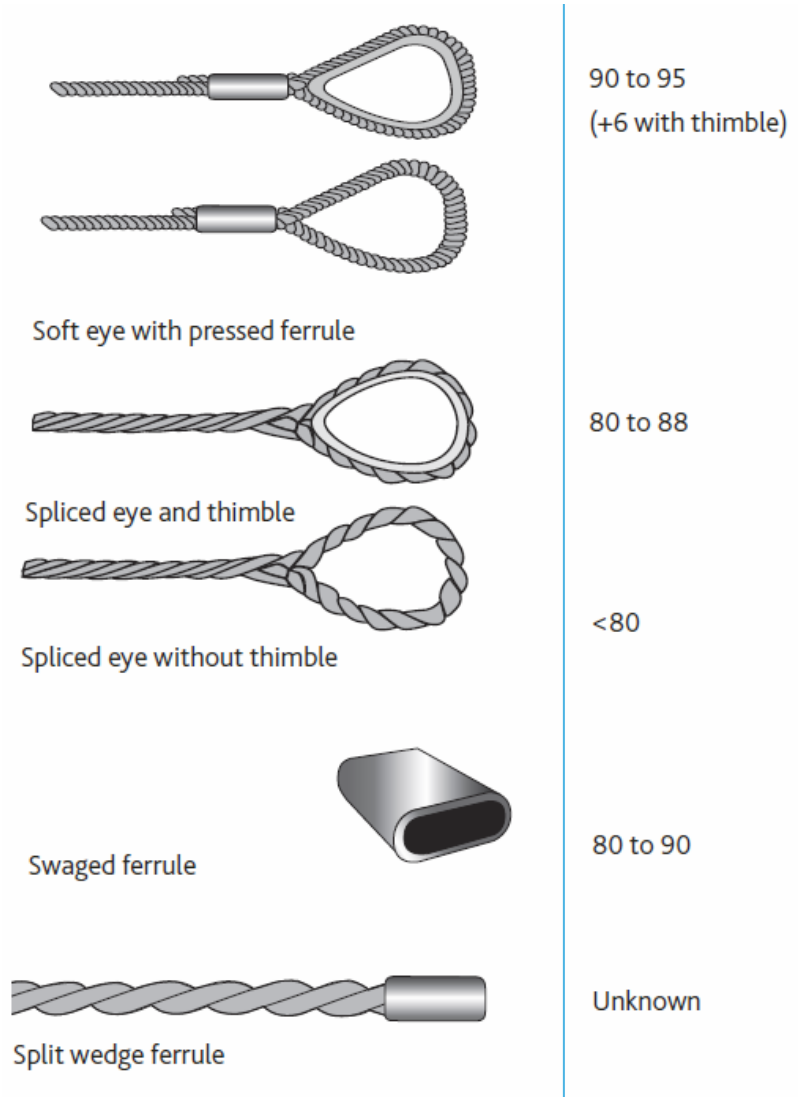
Every rope has its own characteristics that affect its strength, abrasion resistance, crushing resistance, and fatigue resistance.

Follow these best practices to maximize the service life of the rope and prevent accidents.

- Know the safe working load (SWL) strength of the rope, and operate the system so as not to exceed it
- The SWL should be reduced according to the efficiency rating of the weakest connector in the system (see table below)

STRENGTH EFFICIENCY OF END CONNECTORS

ATTACHMENT OR SPLICE	Efficiency (% of rope strength)
 Spelter and swaged socket	100
 Wedge socket	70 to 90
 Cable clips	80
  Flemish eye with pressed ferrule	92 to 95 (+6 with thimble)



Strength efficiency of end connectors (image from FPInnovations)

PPE Reminder
Always wear gloves when handling steel cable. Steel wire fragments will protrude from the cable as it wears.

- Wire rope attachment points should be visually checked daily
- Damaged wire ropes should be replaced

Attachment points require daily inspection (image from FPInnovations)

- The entire wire rope should be thoroughly inspected following the manufacturer's or regulator's recommended procedures. This is typically every two weeks or every 100 hours of operation. A less thorough visual inspection of the rope and attachment points should be done before each use.
- Do a thorough inspection if an incident occurs including significant shock loading or a failure in part of the system.
- Keep a log noting dates and details of cable use hours, cable inspections, any cable damage, any shock loading incidents, and any connector replacements
- If significant changes in the rope condition are observed, conduct a thorough hands-on and internal inspection. Replace damaged wire rope.
- Knots should not be tied in wire ropes
- Avoid running the cable over sharp bends of rock and other material that could sever the cable. Use suitably sized catching stumps or trees to direct the rope around (see Key Point 4.9: Rope Management and Catching)

High stumps left on both sides of a sharp rock outcrop used for catching (image from FPInnovations)

- Avoid contacting the cable with abrasive surfaces
- Avoid dragging the cable through the soil or on the ground. Place stems or logs on rough ground or surfaces for the wire ropes to run across and be protected from damage. Reposition the anchor machine, assisted machine, or rigging, or use catching stumps/trees as necessary to avoid dragging the cable deep through soil or on rough ground

Sill log placed on the road to protect the moving wire rope (image from FPInnovations)

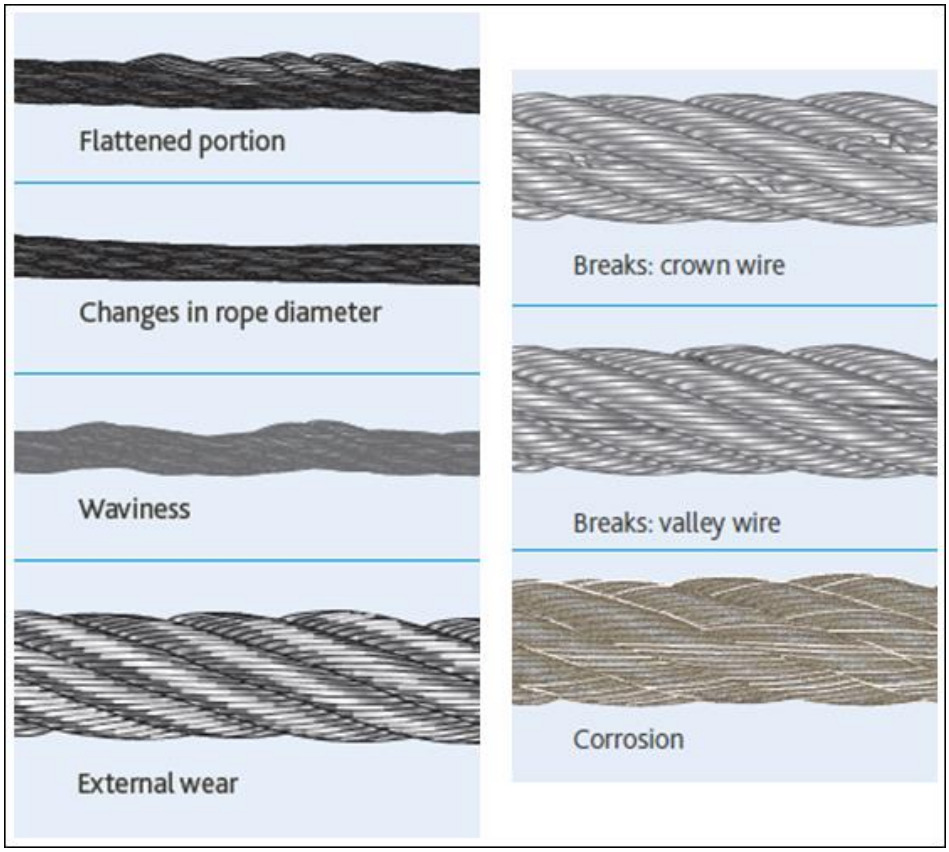
Several whole stems used to protect the moving wire rope (image from FPInnovations)

Inspecting Wire Rope

Visually inspect the rope's entire length and all attachment points before each use. If you observe significant changes to the rope's condition, replace it.

Look for the following defects:

- Broken, worn, or abraded wires
- Reduction in rope diameter
- Rope stretch
- Corrosion
- Crushed, flattened, or jammed strands



Examples of defects (image from FPInnovations)

Schedule periodic, more extensive inspections according to manufacturer or regulator recommendations, or at least at every 100 hours of operation. This inspection should be completed by a trained operator or a service mechanic.

Best Practices for Wire Rope Integrity—Self-Quiz

1. When should the rope be inspected?
   - ☐ After an incident
   - ☐ Before each use
   - ☐ After 100 hours of use
   - ☐ All of these answers
2. The SWL of the rope should be reduced to accommodate:
   - ☐ The weakest link
   - ☐ Operator experience
   - ☐ The grade of the slope
   - ☐ None of these answers

Now check your answers on the next page.

Best Practices for Wire Rope Integrity—Self-Quiz Answers

1. When should the rope be inspected?

   Answer: **All of these answers**

2. The SWL of the rope should be reduced to accommodate:

   Answer: **The weakest link**

Key Point 4.2: Wire Rope Failure

Certain conditions can lead to wire rope failure. Be aware of the following risks and the best practices to mitigate them.

Shock Loading

Shock loading refers to abrupt spikes in cable tension. Avoid shock loading and mitigate its effects as follows:

- Install and use a tension monitoring and a tension recording system
- Review tension log data daily and whenever shock loading is known or suspected to have occurred
- If shock loading has occurred or is suspected, inspect the wire rope for damage. Cease operations and replace the rope if tension ever exceeds the elastic limit (usually 2/3 of the cable-breaking strength)
- If the rope's tension exceeds its endurance limit (usually 50% of breaking strength), the rope's lifespan is also reduced and more frequent inspections are required

Abrasion

- Use a heavy-duty chain segment to prevent or reduce wire rope wear close to the machine and in other areas of high wear

Heavy-duty chains are used in areas of high wear (image from FPInnovations)

- Position the anchor machine to prevent bends in the line at ground breaks, especially over rock. Move the anchor or anchor machine as needed to prevent cable contact at ground breaks
- Avoid running the cable over rock or on the ground

- Inspect the wire rope for surface wear, nicks, cuts, and broken wires. Note that some types of cable (e.g., swaged) appear fine when they are worn out, so know the characteristics of the cable type. Replace the cable according to the manufacturer's requirements for wear

Fatigue

- Monitor and record the operating hours on the cable and replace it as per the manufacturer's requirements

---

Reference

BC Forest Safety
This link presents hazards that can be associated with wire rope failure:
http://www2.bcforestsafe.org/files/Alert_Steep_Slope_Tether_Cable_Breaks-May-1-2018.pdf

When you are finished, continue in this section.

Wire Rope Failure—Self-Quiz

1. What can lead to wire rope failure?

   - ☐ Spikes in tension
   - ☐ Running the cable over rock
   - ☐ Using the cable more than the recommended number of hours
   - ☐ All of these answers

Now check your answers on the next page.

Wire Rope Failure—Self-Quiz Answers

1. What can lead to wire rope failure?

   Answer: **All of these answers**

Key Point 4.3: Anchoring

Stumps, trees, and machines are most commonly used to anchor winch-assist machines. Deadman (buried) anchors and rock anchors can also be used.

Anchor straps and rigging must match or exceed the safe working load of the wire rope.

Machine Anchors

- Use an anchor machine with a low centre of gravity and low cable exit point(s) to prevent overturning. Typically an excavator or bulldozer is modified to act as an anchor for the base machine
- Position the anchor machine on level or upsloping ground whenever possible. For down sloping ground, place the anchor machine in the least down sloping position possible
- Position and secure the anchor machine to prevent any sideways rotation or downslope movement
- Always position the anchor machine and its drum in line with the assisted machine to prevent overturning
- Apply the anchor machine's track brakes during winching operations
- Use the anchor machine's blade or bucket to secure the machine by placing the blade or bucket against a stump or tree, or by digging it into the ground. For bulldozer-style blades, force the anchor machine's blade at least halfway into the soil. Reversing the bucket on an excavator-style anchor machine may improve its stability in the soil

Machine anchor with blade half buried in the soil (image from FPInnovations)

- Guy the anchor machine to one or more stumps, trees, or other suitable anchors on the machine's uphill side, with one or more guy lines as necessary to prevent anchor movement. Ensure guy line(s) are tight and the forces are equal (if using more than one guy line) before operating the system
- Install and use a tension monitor that relays information to the base machine operator
- Install and use video camera(s) to provide a live feed of cable spooling on the winch drum to base machine operator
- Install and use an anchor movement alarm (break away switch) that signals the operator and applies the winch brake should the anchor machine move
- Take extra care to secure the anchor machine adequately on frozen ground, as friction will be low

Stump and Tree Anchors

Predicting the holding power of a stump is difficult. A stump's holding power is proportional to the square of the diameter, so an 80 cm (32 in.) stump is four times stronger than a stump half its diameter (40 cm or 16 in.).

The holding power of a stump:

- Increases with soil depth
- Increases with soil density
- Is greater on an uphill pull
- Decreases as soil moisture increases

Choose sound trees or stumps that are well rooted and in good health, with no exposed roots or rocks. Choose trees with a healthy treetop.

Learning Point

All stumps used as anchors must be inspected daily.

Ensure anchor stumps are tall enough to prevent the strap from slipping off. Notch the stump to make sure the strap is secure. Notching isn't necessary if the stump is uphill and the cable is pulling downward.

Douglas-fir is preferred. Pine, cedar, and spruce are acceptable. Hemlock should be avoided. Don't use balsam fir.

Example of a good anchor stump (image from FPInnovations)

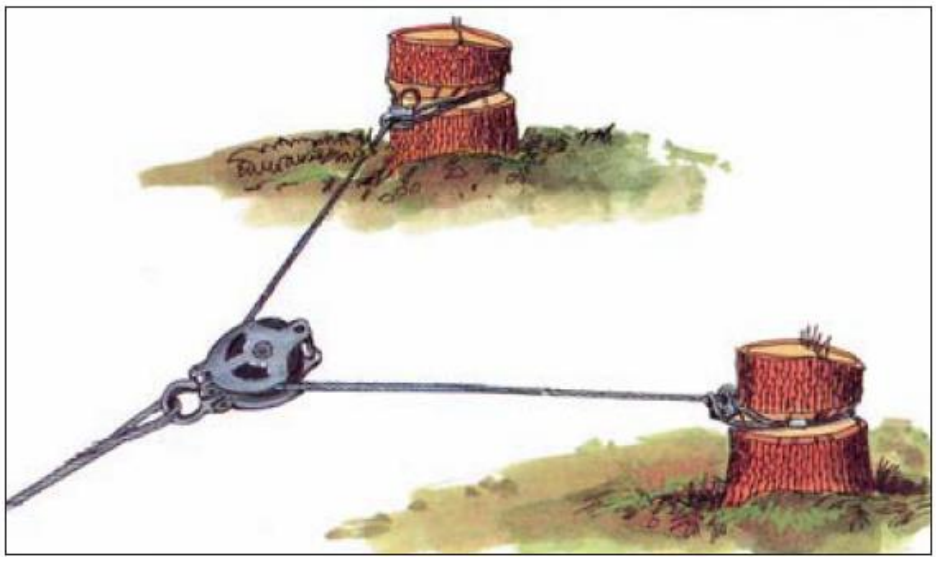
Example of an anchor stump that is too short (image from FPInnovations)

Avoid anchor stumps perched on rock outcrops (image from FPInnovations)

If a single stump is not adequate, multiple stumps can be tied together and used. This could be a two-stump configuration where a bridle block is used, or it could be several stumps tied together.

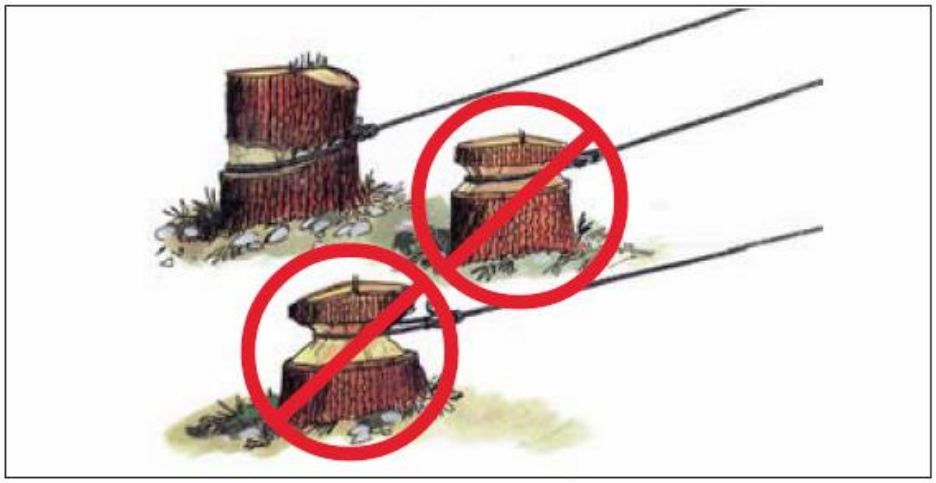
Stump/Tree Sizes

- Larger than 45 cm (>18 in.) diameter— single tree or stump is sufficient
- 30 to 45 cm (12 to 18 in.) diameter—use two trees or stumps
- 20 to 30 cm (8 to 12 in.) diameter—use three trees or stumps
- Less than 20 cm (8 in.) diameter—install multi-tree anchor with supervisor or use alternative anchor system



Bridle block (image from WorkSafeBC)

Notches should be as close to the bottom of the stump as possible, without cutting the roots, and on the same angle as the guy line.



The top stump is properly notched. The notch in the middle stump is placed too high. The notch in the bottom stump is too deep. (image from WorkSafeBC)

Testing Tree and Stump Anchor(s)

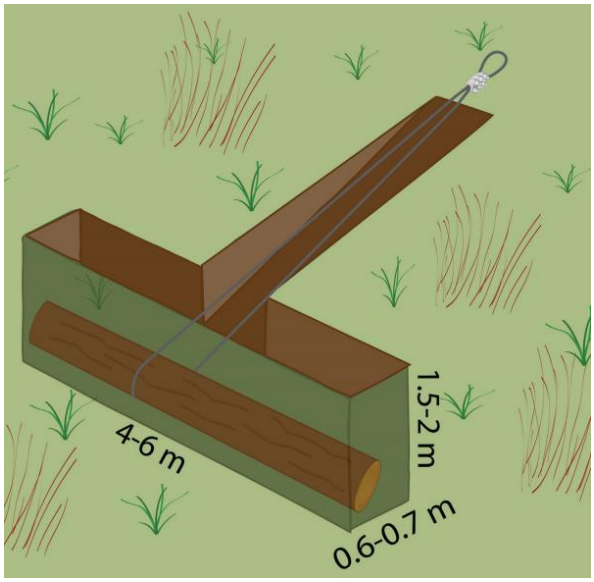
Once the anchor is connected, perform the following test:

1. Stand outside the machine, 5 metres away from anchor tree, and at a 45 degree angle above and behind the uppermost stump or tree in the anchor system.
2. Use the remote control to engage the winch on the harvester and pull on the anchor with a maximum force of 3 tonnes.
3. Watch the upper part of the root for movement during the test.
4. If there is movement in the ground, stop and find another anchor tree or stump.
5. If there is no movement, increase the winch force to 6 tonnes.
6. If there is no movement, then the harvester can be operated using a maximum winch force of 5 tonnes.
7. If there is no movement, increase the winch force to 9 tonnes.
8. If there is no movement, then the harvester can be operated using a maximum winch force of 7 tonnes.

CAUTION!
Always maintain a 5-metre safety zone around the anchor when it is under tension. Do not stand below the anchor.

Deadman Anchors

Deadman anchors may be used if adequate stumps, trees, or equipment anchors aren't available. A deadman anchor is made by burying a log lengthways in a trench, with an attached cable extending above ground.



Deadman anchor (image from FPInnovations)

The trench should be about 6 metres long and 1.5 to 2 metres deep. Bury a large, sound, 5 metre-long log lengthways in the trench, with a cable wrapped around the log's mid-point and extending above ground to attach to the winch's wire rope.

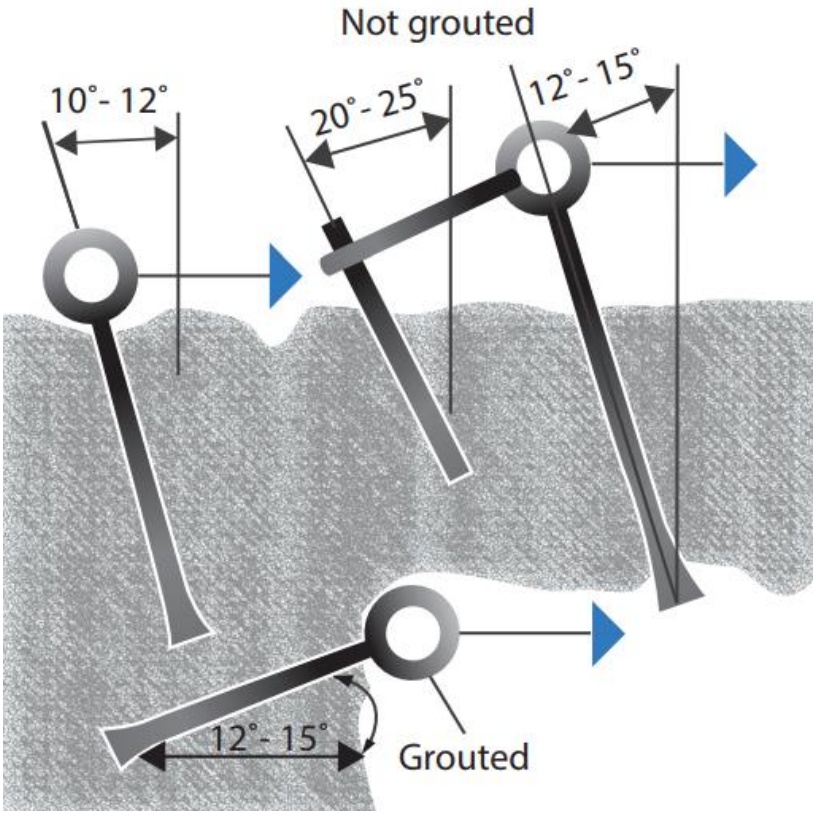
Deadman anchor with bright paint on hook-up for visibility (image from FPInnovations)

Rock Anchors

A rock anchor is made by drilling a hole into solid and competent rock and inserting a bolt as an anchor.

Considerations:

- Rock anchors have strong tensile strength but weak shear strength
- Drill access to the site or a portable drill is required
- Untrue drill holes or non-cylindrical holes will reduce holding power
- Avoid fractured rock, or drill beyond the fractures, or grout the fractures
- A safety factor of 3 is recommended (the bolt should be rated to hold three times the expected load)
- Different types (expansion bolts, grouted steel pins, unwedged, or ungrouted steel pins) have different advantages and disadvantages that should be considered
- The number of bolts required depends on the load
- Use equalizer blocks or turnbuckles for multiple bolts
- Point the bolt in the direction of pull
- Torque and test before use



Rock anchor (image from FPInnovations)

Testing the Anchor and Starting Work

Once the cable loop strap or synthetic strap is placed around the anchor point, stand in the safe zone (check winch manufacturer's operators manual) and tighten the cable to the recommended test pressure using the remote control. If the anchor is safe and fully secured, you can go to the machine and start working.

When walking to the machine along the route the cable lies, check that the cable will have a clear path back to the machine.

You can use the cable for support when walking back to the machine. Always wear gloves.

Once in the machine, set the winch using the manufacturer's recommendations, then begin work.

Anchoring—Self-Quiz

1. Which species should not be used as an anchor tree or stump?

   - ☐ Pine
   - ☐ Cedar
   - ☐ Douglas-fir
   - ☐ Balsam fir

2. Notching isn't necessary if the stump is up slope and the cable is pulling downhill.

   - ☐ True
   - ☐ False

3. What conditions might lead you to consider a deadman anchor?

   - ☐ A good tree or stump anchor isn't available
   - ☐ A machine anchor isn't feasible
   - ☐ You're able to dig a trench at least a metre and a half deep
   - ☐ All of these answers

Now check your answers on the next page.

Anchoring—Self-Quiz Answers

1. Which species should not be used as an anchor tree or stump?

   Answer: **Balsam fir**

2. Notching isn't necessary if the stump is up slope and the cable is pulling downhill.

   Answer: **True**

3. What conditions might lead you to consider a deadman anchor?

   Answer: **All of these answers**

Key Point 4.4: Maximizing Machine Stability

Unless operating with machine support (see Traction Assist Only vs. Machine Support in Key Point 1.4), operate only on terrain where you can maintain traction and stability to move up and down the slope.

Avoid crossing hazardous areas by:

- Maneuvering around obstacles and small steep-slope areas
- Using booms and extendable grapples to reach trees that are across a hazardous area
- Removing wind throw, stumps, decadent timber, woody debris, dense understory, and ground cover that obscures the operator's view of the ground

Best Practices: All Machines

The following best practices for maximizing stability apply to all machines operating with winch assist:

- Conduct work straight up or down the slope. Never travel across the slope. Use a circle route to access timber, if necessary
- Do not attempt to turn around on a steep slope. Use a bench that is adequately flat and wide
- Cut narrower falling swaths as slope increases
- Avoid travel over obstacles. Cut and move aside woody debris, minimize slash creation, and shave stumps
- Understand and work within the machine's cutting diameter and lifting limits. Consider boom reach and position relative to the ground slope. Avoid "collecting" trees in the head and packing multiple stems
- Avoid multiple saw entries into the tree. Cut once completely through the tree whenever possible
- Keep the saw head or grapple close to the ground for stability and to provide quick support if required
- Extend the boom uphill for travel when facing uphill. Never travel uphill with the boom folded in or the attachment held high
- Keep the boom close to the machine for travel when facing downhill
- Do not attempt to fell or lift trees that are greater than the machine's safe lifting capacity
- Do not attempt to fell or lift trees that are beyond the machine's safe reach
- Avoid swinging trees to the downhill side of the machine
- Avoid lifting the boom straight up and tilting trees back over the machine (to the downhill side)
- Position cut timber at 10 o'clock to 2 o'clock when working uphill

- Use a felling head that rotates at the wrist for better grappling of the tree
- Reduce bunch size taken in one swath, if necessary
- Ensure the machine is in a stable position before swinging wood

Wheeled Machines

- Cut while facing downhill with a wheeled harvester. Keeping the weight of the engine uphill will increase stability
- Ensure proper tire inflation
- For line skidders, avoid winching a turn of logs at an angle to the machine
- For forwarders, ensure loads are close to the machine before initiating lift (avoid long reaches)
- Use wheel spacers or wide floatation tires if conditions warrant
- Make smaller turns to avoid over-loading or over-balancing the machine
- For skidders, carry turns as low to the ground as possible without hanging up on stumps or rocks

Tracked Machines

- When working facing uphill, keep the idlers forward (upslope)
- When working facing downhill, keep the idlers downslope and the drive motors upslope. The drive motors are heavier and having more weight upslope will increase stability. Tracked machines are designed to have the load over the idlers when working
- If it is necessary to swing downhill, swing gently and slowly and keep the boom and attachment close to the machine to avoid overwhelming the swing brake
- Extending the track frame will increase machine stability

Maximizing Machine Stability—Self-Quiz

1. Having more weight upslope generally increases stability.

   ☐ True

   ☐ False

2. Tracked machines are designed to have the load over the idlers when working.

   ☐ True

   ☐ False

Now check your answers on the next page.

Maximizing Machine Stability—Self-Quiz Answers

1. Having more weight upslope generally increases stability.

   Answer: **True**

2. Tracked machines are designed to have the load over the idlers when working.

   Answer: **True**

Key Point 4.5: Maximizing Traction

Unless operating with machine support (see Traction Assist Only vs. Machine Support in Key Point 1.4), operate only on terrain where you can maintain traction and stability to move up and down the slope.

Avoid crossing hazardous areas by:

- Maneuvering around obstacles and small steep-slope areas
- Using booms and extendable grapples to reach trees that are across a hazardous area
- Removing wind throw, stumps, decadent timber, woody debris, dense understory, and ground cover that obscures the operator's view of the ground

Best Practices: All Machines

The following best practices for maximizing traction apply to all machines operating with winch assist:

- Avoid exposed rock and thin soil over rock
- Avoid clay soil or soil with high organic content
- Avoid wet soil, including subsurface flows, springs, and poorly drained soils
- Avoid ice
- Never back down a slope if you may need the attachment in front to stop a slide
- When negotiating a drop (for example, if the slope begins with a sharp edge), lower the boom and attachment ahead of the machine and use them to control the machine and prevent a slide
- For uphill travel, use the attachment to stop the machine from sliding. It can be used to pull the machine uphill, if necessary
- Do not swing the machine or boom when traveling on a slope, as the machine may lose traction on one side

Wheeled Machines

- Use wheel tracks to increase traction
- Use chains with lugs on front wheels, or all wheels. Frequently inspect chains for integrity, condition, and tightness
- Engage differential lock (if equipped) for added traction travelling uphill but disengage when descending or turning, as steering will not respond properly when differential is locked

Wheeled harvester with chains for extra traction (image from FPInnovations)

Tracked Machines

- Keep tracks and lugs in good condition
- Use narrow track configurations to increase ground pressure on very firm soils or rocky sites
- Use wide tracks to decrease ground pressure on soft surfaces. Wider track shoes may reduce undercarriage life due to flexing when the machine travels over obstacles
- Use single bar grouser track shoes for the best traction on a slope. Single bar grousers allow deeper penetration and better traction and help prevent machine sliding. Triple bar grousers are for flat ground and should not be used for harvesting on slopes
- Double grouser track shoes are a compromise between single and triple grouser shoes for both soft and hard ground, offering traction and flotation. They are suitable for medium to firm ground
- Add ice lugs (tips or picks) to grousers to increase traction
- Keep the tracks parallel to the slope so the grousers provide resistance to sliding
- If a machine is equipped with a dozer blade, use it pointed downhill and pushed into the ground for grip against sliding. Do not raise and operate the machine up on the dozer blade structure. This reduces the traction of the track shoes and is hard on the dozer linkage

Maximizing Traction—Self-Quiz

1. How can the attachment be used to help with traction?
   - ☐ It can be used to stop the machine from sliding
   - ☐ It can be used to pull the machine uphill
   - ☐ It can be used to control the machine when negotiating a drop
   - ☐ All of these answers
2. Which conditions provide the best traction?
   - ☐ Clay soil
   - ☐ Firm, dry soil
   - ☐ Wet, organic soil
   - ☐ A thin soil cover over rock

Now check your answers on the next page.

Maximizing Traction—Self-Quiz Answers

1. How can the attachment be used to help with traction?

   Answer: **All of these answers**

2. Which conditions provide the best traction?

   Answer: **Firm, dry soil**

Key Point 4.6: Connecting Hardware

Connecting hardware includes shackles, chains, and wire rope terminations.

Every connector's rating must match or exceed the wire rope safe working load, unless the connector is designed to be a "fuse" in the system. A fuse is a connector that will fail at a predetermined tension to prevent overloading the system.

Every connector must be inspected daily for wear or damage. Replace hardware according to the manufacturer's recommendations.

Measure the chain's length and the links' hole diameters (a simple gauge can be fabricated) to check for stretch. Replace the chain if it appears worn, damaged, or stretched beyond the manufacturer's recommended limits.

Daily inspection of connectors is required (image from FPInnovations)

Key Point 4.7: Machine Attachment Points

Machine attachment points are the connection points on the supported machine that are designed for attaching the rope of the winch.

A low frame-mounted attachment point is usually best.

Machine attachment points (image from FPInnovations)

CAUTION!
Use only engineered attachment point(s) designed to support at least the weight of the machine.

Use only attachment points that have been inspected and certified by a professional engineer.

Inspect the attachment points regularly for wear or damage. Repair or replace as necessary. Points must be recertified after any repairs or modifications.

Always use an attachment point. Do not sling rope around the lower structure of the machine itself. Sharp edges can damage the rope or chain. The machine structure could also be damaged.

Key Point 4.8: Felling with Winch Assist

Follow these felling best practices to maximize efficiency and safety, and to meet forestry standards:

- Reduce the risk of severing the cable
- Plan the felling location (the hole)
- Position the cutting head
- Make clean cuts

Reduce the Risk of Severing the Cable

Keep the line tension to the minimum necessary so it is less likely to sever if the saw blade makes contact.

Wherever practical, only fell or harvest trees when the machine is facing downhill.

Facing downhill while cutting (image from FPInnovations)

Never swing the energized felling head more than 90 degrees uphill when relying on the cable for support and when facing downhill. This will prevent the cutting head from contacting and accidentally severing the cable or chain.

If trees are felled when the machine is facing uphill:

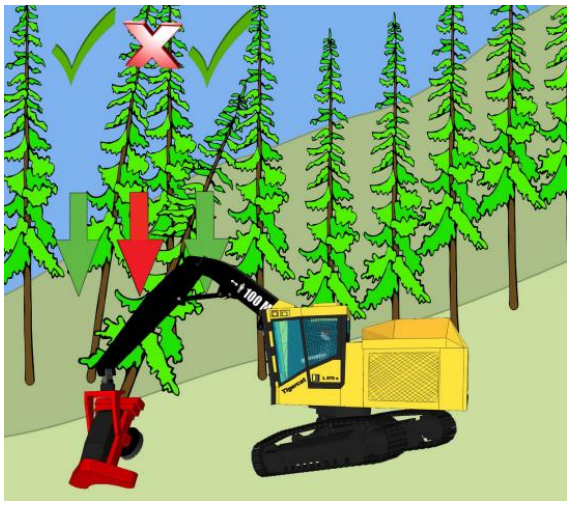
- Add a segment of heavy-duty chain (about 10 metres long) between the assisting cable and the assisted machine. The chain should be robust enough to resist cutting by the type of cutting head in use and long enough to prevent the head from contacting the cable when the system is under tension and the boom is fully extended.

Heavy duty chain between the cable and assisted machine (image from FPInnovations)

- De-energize a hot saw whenever the head is used to lift, reposition, or move the cable or chain
- Do not swing an energized saw over or near the cable/chain
- Activate grapple, feller director, and intermittent disc type saws only when cutting a tree. Deactivate when performing other functions, such as moving the head to or from a tree, travelling with machine, maneuvering, or positioning the machine or head (i.e., for a multi-cut operation)

Plan the Felling Location (the Hole)

A hole is a gap in the trees that provides space for you to maneuver and pile felled trees. It is important to select the hole before cutting and felling the tree. As seen in the image below, the green arrow indicates a good hole, while the red arrow indicates a poor location to fell the tree.



Planning and finding the felling location (hole) (image from FPInnovations)

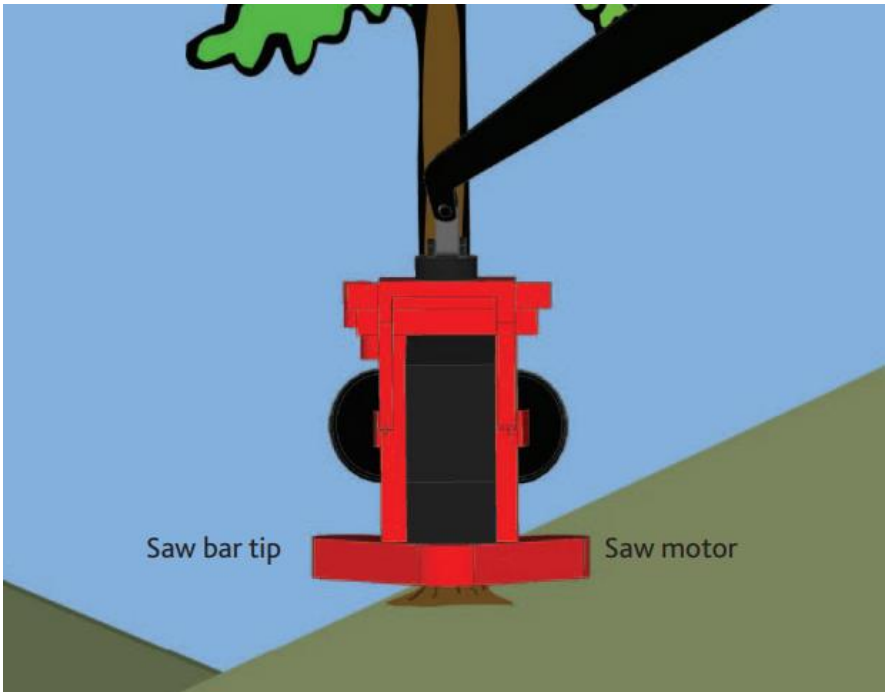
With practice, you'll learn to read the hole without seeing the top of the trees, as you can normally only see part way up. A felling hole enables the tree to fall easily to the ground and promotes good pile alignment if each tree in the set is felled into the same hole.

When working the harvester on steep ground, it is best practice to keep the tree as low as possible to the ground after making the felling cut. Keeping the head low helps you control the tree and get it safely to the pile.

Position the Cutting Head

When you position the head, consider the best location to avoid running the saw into the hillside. By placing the head at 90 degrees to the hill (or the high point on the stump) and rotating the head to the desired position to make the cut, you'll avoid running the saw into the ground.

In the image below, the cutting head is placed so the saw motor is next to the hill and the saw bar tip is away from the hill.



Keeping the saw bar tip away from the hill and out of the dirt (image from FPInnovations)

Minimize Stump Height

High stumps are not permitted. Cut as low as possible without running the saw into the ground. The standard regulation for stump height is no more than 15 cm (6 in.) above the root collar.

Make Clean Cuts

Making clean cuts on steep ground is challenging. It's important to ensure that no damage is done to the harvester, saw bar, chain, or tree.

These best practices will help you make clean cuts:

- Maintain the condition of the saw, bar, and chain
- Ensure the machine and head are set up to specifications
- Manage debris around the butt of the tree
- Apply the correct pressure to the bar to finish the cut. The angle at which the saw bar exits the saw box can determine what type of pressure should be applied to the bar to finish the cut. Being aware of this angle can help avoid issues such as over-pressuring
- Make sure the head has a firm and proper grip on the tree before cutting
- Know when multiple cuts are needed to reduce the overall size of the final cut

Making Multiple Cuts on Larger Trees

Multiple cuts, or double and triple cutting, are techniques used mostly when harvesting oversized trees. On steep terrain, a smaller tree may also require this technique, though machine stability must be considered when repositioning the saw head.

Depending on an operator's skill level, it may be necessary to double cut trees in the range of 38 cm (15 in.) to 50 cm (20 in.), and triple cut trees 53 cm (21 in.) to 76 cm (30 in.). This ensures that:

- No damage will be done to the bar, chain, or tree during felling because there will be no chain exposure to the ground
- The operator will have more control of the tree during the cutting and felling cycle

The proper procedure for performing the double cut is to make the first cut on the side that the bar tip will pass by when you make the second (final) cut.

For the triple cut, make a triangular formation: Make the first cut on the tip side, and the final cut in the direction you want the tree to fall.

Trees too large to be cut with the felling head should be cut by a hand faller.

Stump cut with the triple-cut method (image from FPInnovations)

Felling Best Practices—Self-Quiz

1. What is the regulation stump height?

   - ☐ 15 cm above ground
   - ☐ 15 cm above root collar
   - ☐ 20 cm above ground
   - ☐ 20 cm above root collar

2. The saw should only be energized when cutting.

   - ☐ True
   - ☐ False

3. A felling hole is:

   - ☐ A trench for piling felled trees
   - ☐ A gap in the trees that provides space for you to maneuver and pile felled trees
   - ☐ The hole left when a tree is removed
   - ☐ None of these answers

Now check your answers on the next page.

Felling Best Practices—Self-Quiz Answers

1. What is the regulation stump height?

   Answer: **15 cm above root collar**

2. The saw should only be energized when cutting.

   Answer: **True**

3. A felling hole is:

   Answer: **A gap in the trees that provides space for you to maneuver and pile felled trees**

Key Point 4.9: Rope Management and Catching

The practice of using a stump or a tree to change the direction of the tethered machine is known as catching.

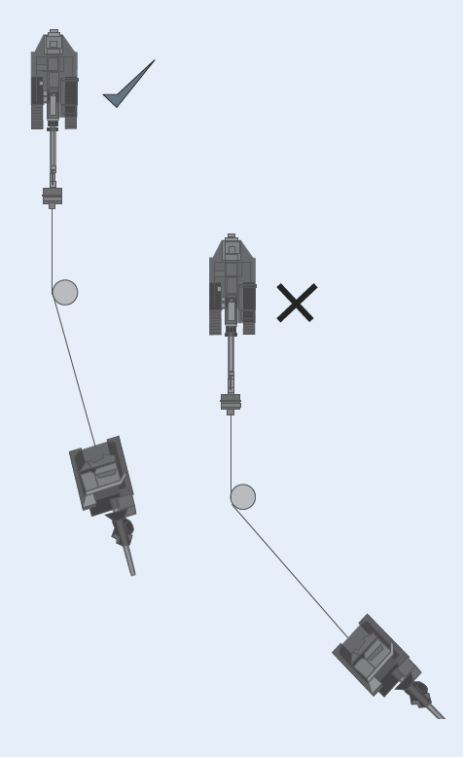
Catching the wire rope around an object helps maintain a proper lead angle. And, catching can help the base machine cover more ground and therefore avoid changing the location of the anchor machine.

But catching presents a number of hazards. The stump or tree used for catching may move, potentially causing uncontrolled movement of the machine, shock loading of the cable, and machine upset.

Catching can also lead to rope tension being different above and below the stump, which can result in inaccurate tension readings. The abrasion and high temperatures resulting from friction around a stump will result in increased wear of the wire rope. In some cases, the rope may even cut into the stump and become wedged.

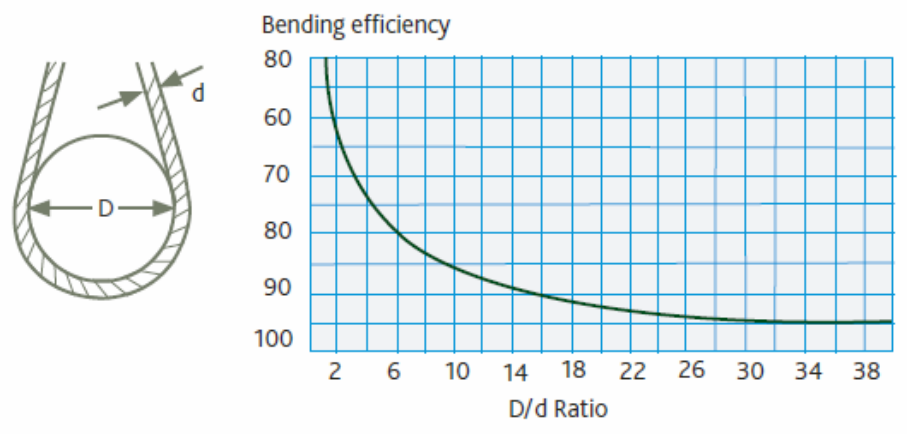
Some manufacturers' guidelines allow catching, but with restrictions. To mitigate hazards associated with catching, follow these best practices:

- Keep deflection angles as wide as possible (see picture below)



Proper deflection angle (image from FPInnovations)

- Do not catch around objects that may move
- Use stumps rather than trees, where possible, as stumps are more stable. Leave a stump about one metre high to use it as a catch stump
- Keep two tree lengths away from any caught standing tree when the rope is under tension
- Check a caught object frequently to confirm its stability. Check after any change that may reduce its stability, like saturated soils after heavy rain
- Ensure the diameter of the stump or tree used for catching is large enough, relative to the diameter of the wire rope (see D/d ratio below), to avoid excessive bending fatigue in the rope. Follow the manufacturer's specified minimum D/d ratio. If the manufacturer's instructions are not available, maintain a minimum ratio of 16:1



Sheave/rope diameter ratio	Efficiency of rope (%)
(D/d)	79
12:1	83
14:1	86
16:1	88
18:1	90
20:1	91
24:1	93
30:1	95
[a] Ratios of 10:1 and less will lead to permanent distortions within the rope.	

D/d ratio and bending efficiency (images from FPInnovations)

- Position the rope to avoid unintentional catching on other objects
- Note that catching may result in inaccurate tension readings, which means shock-loading events could go undetected
- Avoid catching during periods of high fire hazard

Catch stumps must be large enough to support the machine while it works on the changed angle. The higher the cable sits on the stump and the greater the angle of redirection, the larger the stump must be to support the machine. The location of the catch stump is critical to getting the cable as low as possible on the stump.

Rope Management and Catching—Self-Quiz

1. Trees are preferable to stumps for catching because they're more stable.

   ☐ True

   ☐ False

2. When catching on a stump, it's best to position the cable as low as possible.

   ☐ True

   ☐ False

3. What is the D/d ratio?

   ☐ The diameter of the catch stump relative to the diameter of the wire rope

   ☐ The deflection angle relative to the diameter of the catch stump

   ☐ The deflection angle relative to the diameter of the wire rope

   ☐ None of these answers

Now check your answers on the next page.

Rope Management and Catching—Self-Quiz Answers

1. Trees are preferable to stumps for catching because they're more stable.

   Answer: **False**

2. When catching on a stump, it's best to position the cable as low as possible.

   Answer: **True**

3. What is the D/d ratio?

   Answer: **The diameter of the catch stump relative to the diameter of the wire rope**

Section 1138-05: Planning and Records

What you will learn in this section

5.1 Planning and layout considerations

5.2 Recognize, evaluate, and control hazards

5.3 Emergency response procedures

5.4 Environmental considerations

5.5 Record keeping

Key Point 5.1: Planning and Layout Considerations

Operational planning is important in any operation, but much more so in a winch-assist situation.

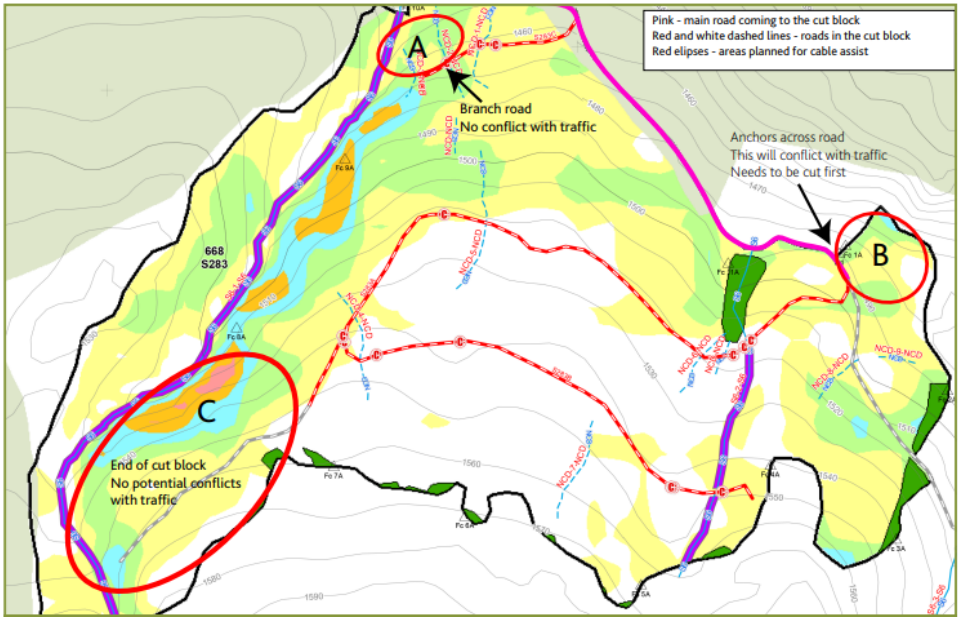
A new cut block or area should be planned well in advance for winch-assist logging. Many factors must be considered, including where and when to plan anchors, hill access ramps, and forwarder piling areas. Weather and seasons will affect all of these.

Layout must be detailed and the plan should establish which machines are cutting where, and whether there are conflicts with any other phases of the operation.

Learning Point

Winch-assisted machines must be able to work on tethered cables without disruption from other activities in the operation, such as trucks, pickups, and other machines that may need to pass on a road the harvester is tethered across.

Areas that are designated for winch-assist machines should be earmarked to be cut as early as possible in the cut block or area plan.



Planning sections of the block on the map (image from FPInnovations)

These areas should get cut and forwarded before trucking occurs beyond that point on the road. Normally, this would mean that designated areas near the front of the block would be cut first and areas near the back of the cut block or on branch roads would be cut last.

It is important to ensure good communication between everyone involved in the operation. Everyone must know and understand the plan so it can be executed as designed.

Road Planning Within the Cut Block

Roads are a significant part of harvesting every cut block and even more so when harvesting steep ground.

Many mountain or hillside sites will have rock formations that can add complexity to harvesting slopes. The ability to access and harvest depends on where the roads are placed.

Well-planned roads can make a considerable difference to the ability of trucks and loaders to maneuver without becoming stuck or being unable to access wood on the cut block. Road planning and harvest cut block planning should be done jointly to help ensure the safest and most efficient plan possible. This includes proper truck turn arounds and wide out areas placed at strategic locations to facilitate traffic flow.

Decking space is critical when grapple yarding bunched wood from winch-assist systems. Change the road location if necessary to ensure adequate decking space for high-productivity grapple yarding and to avoid phase congestion.

Road locations can sometimes be moved to cheaper locations or eliminated compared to normal grapple yarding because wood can be moved into areas with adequate deflection by the winch-assist machine.

On-site Shop or Service Facility

Along with the typical service tooling, make sure the on-site service truck or trailer stocks extra cable, wedge sockets, cable clamps, shackles, and hooks. All of these are essential for winch-assist logging, and if one piece is damaged or broken, the whole operation may be forced to halt.

Preparation for Other Seasons

Planning of future cut areas is critical for winch-assist logging.

If the cut block will be harvested during late fall or winter, snow is a consideration. Winch-assist logging works best up to 1 metre of snow. If a future cut block is located in higher elevation, it may need to be harvested in the summer season.

If the future cut block is suitable to be cut during cold weather months, advance preparation is required, including digging and

preparing deadman anchors, access ramps on the downhill side of the road, and any landings for the forwarder to place piles of wood.

Planning a New Cut Block/Area

When planning a new cut block/area, trails need to be planned with anchors, ramps, and piling areas. Access ramps and piling areas are covered below. See Key Point 4.3 for details on anchors.

Access Ramps

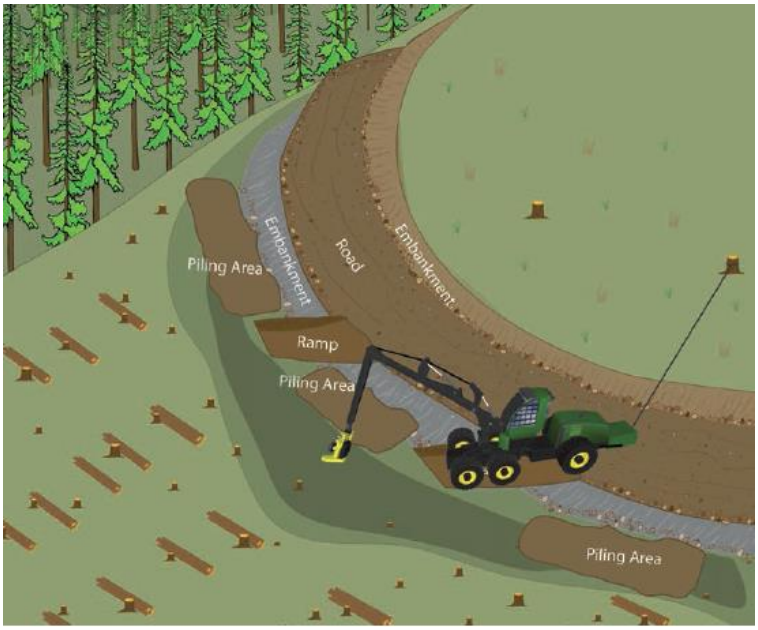
Ramps are small 45-degree trails that are opened up on the downhill edge of the cut block road to allow both the harvester and forwarder to access the trails below the road. These access points are designed to be small and not cause any loss of integrity of the cut block haul road.

Because of their 45-degree design, the width can be kept to a minimum yet accessible for the machines using them. They must also be designed as short as possible to minimize erosion. By building these ramps short and facing back into the forest floor, any erosion will end here.

Piling Areas

Piling areas require planning and their locations may vary based on the terrain and road systems of the site.

A piling area near the bottom of a ramp where it meets the harvest trail is ideal. This setup allows the forwarder to place wood near the road for loading and reduces the need to go onto the ramp and road, which may lead to damage that could increase road maintenance costs.



Piling areas near ramps (image from FPInnovations)

Piling space is normally limited. If there is either not enough piling space or no piling space due to terrain issues, piling locations may be required either at the edge of the road surface or across the road.

Harvest Slope Considerations

- Uniform slopes work the best for most cable systems, though winch-assist systems allow for operating on rolling terrain or terrain with benches
- “Road to road” situations (harvesting between upper and lower roads) are most desirable but not necessary for winch assist
- Avoid rocky ground and terrain with rocky outcrops
- Winch-assist can be used in conjunction with grapple yarding to move wood into areas with adequate deflection for yarding
- Provide the falling machine operators with pre-established yarding direction and decking locations on maps so they can position the wood for yarding
- When using an anchor machine, ensure adequate space and suitable terrain is available for that machine

CAUTION!
Walk the harvest site and identify any machine no-go areas before starting work. Ensure these are clearly communicated and highlighted on the map.

Planning and Layout Considerations—Self-Quiz

1. Harvest planning should begin as soon as road planning is complete.

   ☐ True

   ☐ False

2. Road planning is critical because:

   ☐ The ability to access and harvest depends on where roads are placed

   ☐ Decking space is critical to avoid congestion

   ☐ Truck turns around in the right locations facilitate traffic flow

   ☐ All of these answers

Now check your answers on the next page.

Planning and Layout Considerations—Self-Quiz Answers

1. Harvest planning should begin as soon as road planning is complete.

   Answer: **False**

2. Road planning is critical because:

   Answer: **All of these answers**

Key Point 5.2: Recognize, Evaluate and Control Hazards

Prior to logging on steep slopes that exceed the limits outlined in the OHSR, a risk assessment must be completed and site-specific procedures must be developed and communicated to everyone working on the steep slope.

These tasks are explained below using the following risk assessment form from the BC Forest Safety Council. Your employer might use a different form.

Steep Slope Logging – Risk Assessment and Site Pre-Work											
Date						**Licensee/Owner**					
Cutting Permit						**Contractor**					
Block		**Steep Slope % (range)**				**Location within Block**					
Machine		**Max Slope % allowed**		**Operator**		**Estimate of hours to do work**					
Machine		**Max Slope % allowed**		**Operator**		**Estimate of hours to do work**					
Appropriate Information Supplied by Owner (map, slope %, hazards)					Yes ☐						
Assessor Qualified to Conduct Steep Slope Assessment					Yes ☐						
Risk Assessment of Steep Slope						**Site Specific Procedures (Refer to Part 2 – Safe Work Practices for Steep Slope Operations)**					
Note: Site specific procedures must be developed for each type of machine that is operating on the steep slope.											
Slopes greater than 35% for wheeled machines					Yes ☐	N/A ☐					
Slopes greater than 40% for tracked machines					Yes ☐	N/A ☐					
Unstable Ground (slumps, Terrain Stability Field Assessment, talus)					Yes ☐	N/A ☐					
Ground Roughness (boulders, rock outcrops, hummocks, gulleys)					Yes ☐	N/A ☐					
Unsafe slopes below operating area					Yes ☐	N/A ☐					
Shallow Soil Depth over Bedrock					Yes ☐	N/A ☐					
Soil conditions (sandy or saturated organic soils, consider how logging may affect water flow and soils on site)					Yes ☐	N/A ☐					
Poor winter ground conditions (poor snow, minimal frost depth on site)					Yes ☐	N/A ☐					
Slash (amount, elevated, size)					Yes ☐	N/A ☐					
Poor visibility (snow, fog, night shift)					Yes ☐	N/A ☐					
Harvest Plan Requirements (reserve areas, leave trees, planned skid trails)					Yes ☐	N/A ☐					
Oversized Trees (size, weight and species)					Yes ☐	N/A ☐					
High Stumps (what is the allowable stump height)					Yes ☐	N/A ☐					

Isolated Work (how close is machine assistance to overcome a difficulty)	Yes ☐	N/A ☐	
Other:	Yes ☐	N/A ☐	
Steep Slope Pre-Work			**Check that the following requirements are in place and communicated with all workers on site.**
Steep slopes and No Go areas are easily identified, mapped and map provided to workers.	Yes ☐	N/A ☐	
Manual Tree Falling Required	Yes ☐	N/A ☐	
Duration of Exposure minimized (consider shift length, # of breaks, # of consecutive days on shift)	Yes ☐	N/A ☐	
Machine capabilities appropriate for timber type (tree size and weight)	Yes ☐	N/A ☐	
Confirm good working condition of machine(s) (hydraulics, tires/tracks, ROPS, guarding, seatbelts, escape hatches)	Yes ☐	N/A ☐	
Operator Competency (check experience and training)	Yes ☐	N/A ☐	
Operator State of Mind – alertness, understanding of plan – Avoid fatigue, rushing, complacency	Yes ☐	N/A ☐	
Operator – can measure slope %, stop operations if unsure/uncomfortable and contact supervisor	Yes ☐	N/A ☐	
Skid trail construction (locations and specs discussed)	Yes ☐	N/A ☐	
Supervision and Man-check frequency	Yes ☐	N/A ☐	Who: How Often:
Emergency Response Plan in place	Yes ☐		

Reassessment Date and Update to Site Specific Procedures:	
Date:	Updates:
Date:	Updates:

Signatures:	
Operators	
Qualified Assessor	
Supervisor	

Risk Assessment and Site Pre-Work form

When completing a hazard assessment, follow these guidelines:

- Use a map that shows block boundaries, roads, steep slope sites, riparian areas, sensitive soils, etc. Consult other key information, such as preliminary steep slope assessment map, Terrain Stability Field Assessment map, etc.
- Walk the area planned for harvesting. Identify areas with slopes or characteristics that pose machine stability risks. If site conditions change during the operation, it may be necessary to re-evaluate and complete another assessment
- On the form, check off the conditions that pose a risk for machine stability. For each condition with a “Yes” checked, write the site-specific procedures that will be followed to allow safe operations on that slope

- Consider state of mind, operator competency, and duration of exposure for operators that will do the work
- Consider other site features (e.g., convex slopes, bluffs, gullies, benches, and escape routes) plus operational constraints (e.g., soil disturbance limits, retention strategy, danger trees, upslope terrain stability, or avalanche risk). Identify each one and consider how they will affect operations
- If stability risks cannot be adequately controlled, designate and map the area as “no go”. Develop an alternate harvest plan or amend boundaries to exclude the area
- Conduct a pre-work meeting to communicate the hazards and site-specific procedures to all the workers and supervisors who will be involved in the steep slope operation

Reference

BC Forest Safety

The following link refers to the BC Forest Safety Council Steep Slope Logging Resource Package which provides information and tools for assessing risks and planning mechanical harvesting on steep slopes: http://www2.bcforestsafe.org/files/res_xSteepSlopeLogging.pdf

When you are finished, continue in this section.

Evaluate and Control Hazards—Self-Quiz

1. What are the three main activities conducted to evaluate and control hazards?

   - ☐ Develop site-specific procedures, assess operator readiness, designate no-go areas
   - ☐ Complete the hazard assessment form, designate no-go areas on the map, conduct a pre-work meeting to communicate hazards to workers and supervisors
   - ☐ Conduct a steep slope hazard assessment, develop site-specific procedures, conduct a pre-work meeting to communicate hazards and procedures to workers and supervisors

Now check your answers on the next page.

Evaluate and Control Hazards—Self-Quiz Answers

1. What are the three main activities conducted to evaluate and control hazards?

   Answer: **Conduct a steep slope hazard assessment, develop site-specific procedures, conduct a pre-work meeting to communicate hazards and procedures to workers and supervisors**

Key Point 5.3: Emergency Response Procedures

Follow any emergency procedures provided by the manufacturer of the winch assist equipment in the event of an incident. Additionally, the following procedures are recommended. Emergency response procedures should be developed and clearly communicated to all workers at every worksite.

Cable System Failure

In the case of a cable system failure (includes machine attachment point, connectors, chains, wire rope, or anchors):

- Activate the blade braking device on the assisted machine, if available
- Activate the track or wheel brakes on the assisted machine
- Use the head's grapple to hold on a tree or stump, or set the head or heel rack (if available) into the ground to provide further braking resistance
- Exit the cab only if it is safe to do so and the assisted machine is fully immobilized

Damaged wire rope

Communication Failure

In the case of communication failure between the operator and winch assist machine:

- Follow the manufacturer's operating procedures. With a constant tension system, the winch will continue to maintain the tension that was pre-set prior to the communication failure

Retrieving Emergency Equipment

In the event of an emergency, the crew must know where to locate and how to use emergency equipment, including:

- Spill kit for fuel and hydraulic oil spills and leaks
- First aid kits and equipment for treating and packaging a patient for transport to ambulance, fire rescue, or search and rescue emergency response personnel
- Cab extrication equipment for freeing a worker trapped inside a cab after a roll over
- Emergency communication equipment to ensure 911 can be reached and resources can be dispatched
- Equipment stabilizing struts to brace and stabilize equipment in the event of a roll over

Steps for Dealing with Breakdowns & Emergencies

In the event of equipment breakdown, precarious situations and upset conditions, always:

Stay calm – To respond effectively you need to proceed rationally. Don't jeopardize your own safety. Your example can influence others and thereby aid the emergency response.

Assess the situation – What is the problem or emergency? What has happened, and what will continue to happen if no action is taken? Identify the cause that must be controlled to eliminate immediate, ongoing, or further danger. What are the possible courses of action? Which ones have the greatest likelihood of success? What are the risks and dangers associated with those actions?

Next

- Establish radio contact with your supervisor or on-site contact.
- Identify your location; explain the situation, request assistance.
- Await their recommendations / direction. Do as they say.

Equipment Breakdown on Steep Slopes

Completing repairs while a machine is on a steep slope poses significant hazards and risks. If it is not possible to move the machine to stable location, take the following steps.

- Before exiting, ensure the machine is stable. If the machine feels unstable, and it is safe to do so, lower boom / blade / attachments and release loads to increase stability.
- Survey the area for hazards – danger trees, debris, partially cut trees, unstable logs, etc.
- Engage and confirm lockout procedures before undertaking any checks or repairs.
- Conduct only those repairs necessary to allow moving the machine to a flat site.

Precarious Positions – Nearly Upset Condition

- Evaluate the situation. Will releasing the load improve or reduce machine stability? Will raising or lowering the blade / boom / attachments increase or decrease the likelihood of incurring a rollover?
- Conduct any / all movements and operate controls smoothly and precisely.
- Stay in the cab – exiting the cab may upset the balance, or you may injure yourself as you jump, or inadvertently to a location onto which the unbalanced machine then rolls.
- If your assessment determines the least risk option is to exit the cab, first survey the area for hazards – uneven ground, debris, unstable logs, etc. Communicate your plan before exiting.

Machine in Upset Condition

- Stay in the cab. Heavy equipment sometimes comes to rest in delicately balanced conditions. Getting out may upset that balance and expose you to further harm.
- Secure yourself against further injury, should further machine movement occur.
- Wait for assistance to arrive.
- If your assessment rationally determines that further machine movement is likely and will result in greater injury to you, survey the area for hazards before exiting.

General Best Practices

Everyone needs a basic level of understanding of emergency procedures. Relying on your supervisor won't work if they get hurt and need your help.

All crew members should carry block locations and a list of who is working where in case they need to direct someone to a location.

Train helpers on how to support the first aider. The first aider should be with the radio at all times.

Ideally, seven people are needed to carry a crew member on a stretcher: six people carrying and one rotating out for a break and scouting the best route to get down. Use a sled-style stretcher that can be dragged down the hill.

Determine in advance who drives which vehicles and who moves unattended vehicles to another location.

Maintain a tidy vehicle to make it easier to find the emergency response plan information when it's needed.

Establish ground support directions (i.e., how to direct an ambulance to your site).

Practice using a satellite phone, and remember that 911 usually won't work in the bush. Know in advance who to call and what to say.

Have pre-determined muster or rendezvous points and consider helicopter and road transfer points.

To the best of your ability, stay calm and focused. In the chaos of an emergency, a secondary incident can happen that makes the first incident even more traumatic.

In tragic situations, crew members are often left at the worksite wondering how the person is doing, feeling stressed, and even guilty. Have a plan to place someone in charge, deal with critical equipment and vehicles, and, if appropriate, get people back to a safe place, such as town or camp.

Emergency Response Procedures—Self-Quiz

1. What should you do if the cable system fails?

   - ☐ Exit the cab immediately
   - ☐ Radio for assistance
   - ☐ Activate the brakes on the assisted machine
   - ☐ None of these answers

Now check your answers on the next page.

Emergency Response Procedures—Self-Quiz Answers

1. What should you do if the cable system fails?

   Answer: **Activate the brakes on the assisted machine**

Key Point 5.4: Environmental Considerations

Ground-based equipment can damage soils through excessive disturbance, mostly by causing rutting or compaction. This can reduce future tree growth and cause water redirection or concentration and soil erosion.

Following these best practices will limit environmental impacts:

- Use tire tracks on wheeled machines to help prevent wheel spin
- Use wider track pads to reduce ground pressure on tracked machines
- In soft ground conditions, distribute slash to drive the equipment over
- Before cutting, locate and clearly mark wetlands so operators can avoid disturbing the soil
- Align logs and slash so water flow is not concentrated
- Minimize the turning of wheels and especially tracks
- Closely monitor operations where track or wheel spin is damaging soils and cease or move operations if necessary
- Minimize repeated machine passes over the same trail
- Avoid spinning the tracks when working on sensitive soil types as this may create ruts which could direct and concentrate water flow onto slopes
- Use the winch system wherever an un-tethered operation would cause soil damage
- Maintain a constant tension so the machine does not slip or slide
- Be aware of any track or tire spin due to malfunction, unsuitable conditions, or exceeding the limits of the system and stop before damage is done to the soils
- Follow wet weather shutdown guides or any specific prescriptions by a qualified professional
- Recognize that winch-assist operation may not be suitable everywhere and an alternative harvest system such as hand falling, or cable yarding may still be necessary in some areas under certain environmental constraints

Environmental Considerations—Self-Quiz

1. What can be done to limit soil damage?

   - ☐ Avoid spinning the tracks in sensitive soil conditions
   - ☐ Maintain a constant tension on the cable
   - ☐ Recognize when winch assist is not suitable
   - ☐ Recognize when winch assist would reduce soil damage
   - ☐ All of these answers

Now check your answers on the next page.

Environmental Considerations—Self-Quiz Answers

1. What can be done to limit soil damage?

   Answer: **All of these answers**

Key Point 5.5: Record Keeping

Develop and keep written records of incidents and all inspections and maintenance.

Keep logs of the following:

- Number of hours the machine is in use
- All line replacements and replacement of rigging, connection, or winch components
- Dates and details of cable use hours, cable inspections, cable damage, and any shock loading incidents
- Formal and periodic inspections and maintenance
- Events of traction loss or tensions that exceed safe working load. If the machine does not have a system that automatically records the line loading, record these events manually from the load cell read out

A qualified person with wire rope expertise should review the line loading records regularly to ensure the wire rope is replaced in a timely manner. Reviews must also be done immediately after any overload conditions.