TECHNICAL MEMORANDUM

To: BC Timber Sales, TST Business Area
From: Drew Brayshaw, Ph. D., P. Geo.

Date: September 22, 2021

RE: Wet Weather Shutdown Criteria for Worker Safety – Operational Guidelines

This document outlines the recommended procedure to determine whether or not forestry operations should be shut down due to adverse weather conditions which present a risk to workers and equipment. It is intended to be used by BC Timber Sales' staff, licensees, and contractors to help determine safety shutdown procedures for field workers. It is only intended to protect worker safety with respect to landslides, debris flows, and other hazardous geotechnical phenomena and was not designed to address, for example, environmental shutdown criteria to protect water quality or fish habitat.

When to Use the Shutdown Criteria

Shutdown criteria apply when work sites or access routes are located on, downslope of, or are exposed to landslide-prone terrain, as defined in the guidance document. Workers are exposed to terrain stability hazards not only at the work site but also along access routes that reach the work site. Accordingly, shutdown criteria apply not only to work sites such as cutblocks and roads under construction, but also roads used for access to and from these work sites, except for public highways. Shutdown criteria apply to all BCTS staff and contractors and provide guidance to licensees.

Workers should check forecasts and predicted/reported rainfall totals before travelling to the work site. Environment Canada provides forecasts and measurements of rainfall of varying accuracy for all of the TCH, TST, and TSG business areas. These forecasts are available online, are broadcast, and are updated several times per day. Where forecasts and measurements do not accurately reflect conditions at the work site, they typically underestimate, rather than overestimate, actual rainfall experienced on site. If predicted or recorded rainfall for the day from the Environment Canada weather forecast exceeds the listed shutdown thresholds, it is likely unsafe to travel to the work site,

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and there is no need to expose workers to additional hazards by requiring them to check the rain gauge at the work site. If predicted rainfall for the day, for example, is 80 mm, and the shutdown criteria for the job site is 50 mm/24 hr, it is unnecessary to check an on-site rain gauge: assume that it is not safe to work that day.

How to Use These Shutdown Criteria

The wet weather shutdown criteria are based on a zone model, with five zones identified based on climate criteria, and a sixth zone based on *identified unstable conditions*. The five climatic zones are based on mean annual precipitation (Table 1). The sixth zone recognizes the presence of unstable conditions warranting special measures and extra caution to protect worker safety which may be present in any climatic zone. It can and will be identified by BCTS staff before work takes place. Determination of the applicable climatic zone will also be made by BCTS staff or planning and development contractors before work begins. The applicable zone and associated shutdown thresholds can be included within the project particulars (e.g., Contract, License etc.).

Refer to Table 1 to determine shutdown criteria for 12-, 24-, 48- and 72-hour time periods for the appropriate zone. Temperature and precipitation will be measured at the job site using a rain gauge and thermometer. Total rainfall measured by the gauge and air temperature are to be recorded at the start and end of every work shift (at minimum, twice a day).

Table 1: Shutdown Criteria by Zone within the TSG, TST and TCH Business Areas

Zone	Zone (annual precipitation)	Time Period			
		At start of or before end of shift (12-hr)	24-hr	48-hr	72-hr
1	Very wet (3000 mm to 4000 mm or more)	60 mm	100 mm	150 mm	200 mm
2	Wet (2500 mm to 3000 mm)	50 mm	80 mm	120 mm	160 mm
3	Average (1500 mm to 2500 mm)	40 mm	70 mm	100 mm	130 mm
4	Dry (750 mm to 1500 mm)	30 mm	50 mm	80 mm	110 mm
5	Very dry (less than 750 mm)	20 mm	30 mm	50 mm	80 mm
6	Identified Unstable Conditions	10 mm	20 mm	30 mm	40 mm

Table 1 assumes that rainfall will be measured in the gauge located at the work site. Rain gauges are usually located near where workers enter the job site. It is expected that in some forestry settings, there may be a considerable elevation range between the elevation of the rainfall gauge and the highest elevation at which work is taking place, and that more rainfall may occur at higher elevations than is measured at the gauge. The shutdown criteria incorporate this assumption.

Modifiers to Shutdown Criteria

Numerous factors other than direct rainfall can contribute to slope instability, including snow melt (either from rain-on-snow precipitation, high temperatures, or both), high winds, blocked drainage structures or diverted drainage upslope, long-term antecedent precipitation, earthquakes, and other less probable events. To account for these factors without requiring multiple difficult and potentially inaccurate calculations, a simpler system is used. Potential additional risk factors beyond simple rainfall totals are listed below. The presence of one or more of these additional risk factors cause the zone number used to determine the shutdown criteria to change. Each additional risk factor present increases the zone number by one. For instance, a project is located in Zone 2 which has a 24-hr threshold of 80 mm. A storm brings 60 mm of rainfall in 24 hours, accompanied by both warm temperatures with snow present (one factor) and rain falling on snow (one factor). Zone 2 is therefore shifted to Zone 4 (base of 2, plus two for additional risk factors). The measured 60 mm of rainfall is greater than the 24-hr shutdown value of 50 mm in Zone 4, so work shuts down.

The presence of, and number of, additional risk factors should be noted and recorded at the same time that precipitation and temperature are recorded at the gauge. In cases where weather conditions change quickly, such as if intense precipitation falls, or if recorded values are close to a shutdown threshold, it may be necessary to check the rainfall gauge more than twice a day to determine if unsafe conditions are occurring.

The additional risk factors beyond rainfall totals are:

- Rain falling on snow at the job site;
- Warm temperatures (greater than 5 °C at the gauge) with snow present on the ground at the job site;

For these two conditions, any snow, even small amounts of patchy snow, at the job site is counted as snow. Small amounts of snow at a job site indicate larger amounts of snow upslope.

- High winds (windspeed reported or predicted >60 km/h, or visibly breaking branches or causing windthrow) at job site;
- Very wet conditions (defined as any period of 21 days or longer with precipitation recorded on every day). Periods longer than 21 days do not increase the very wet conditions hazard further;
- Visibly high stream flow (ditches full and overflowing onto roads, culverts discharging at capacity, culverts blocked by debris flow and diverting water to adjacent streams, floodwater present on adjacent highways, etc.)
- Earthquakes of magnitude 5.0 or greater within last week, reported with epicenter within 50 km of job site.

If the presence of additional risk factors increases the zone beyond Zone 6, i.e., beyond the *identified unstable conditions* zone, work should shut down regardless of whether or not the rainfall shutdown value has been exceeded, and should remain shut down until the additional risk factors are no longer present or until a qualified professional approves a return to work.

Other Shutdown Criteria

In addition to shutdowns resulting from the exceedance of rainfall criteria, workers and supervisors should remain aware of other indicators of geotechnical instability. These can include, but are not limited to:

- Pulses of sediment-laden water in streams, especially in gullies,
- Streams suddenly drying up when conditions are otherwise wet,
- Constant small rock falls,
- Cutslope slumps that block ditches and/or roads,
- Tension cracks appearing in road fills or slopes,
- Fresh avalanches, landslides or debris flows or their deposits observed that were not present during the last shift,
- Anchor stumps pulling out of wet ground during cable yarding,
- Diverted streams with flow appearing in new stream courses that were previously dry.

If any of these indicators of instability are observed, work should shut down until a qualified professional can be brought in to determine if it is safe for work to proceed.

Resumption of Work Following Shut Down

Once shutdown criteria have been exceeded, work should remain shut down for at least 24 hours after the hazardous conditions end. In the case of 48-hour or 72-hour rainfall criteria being exceeded, work should remain shut down for at least two days (48 hours) after shutdown criteria have been exceeded. If workers and supervisors believe it is safe for work to resume before the recommended 24- or 48-hour period is over, they should consult a qualified professional to confirm and document this before resuming work.

Yours truly

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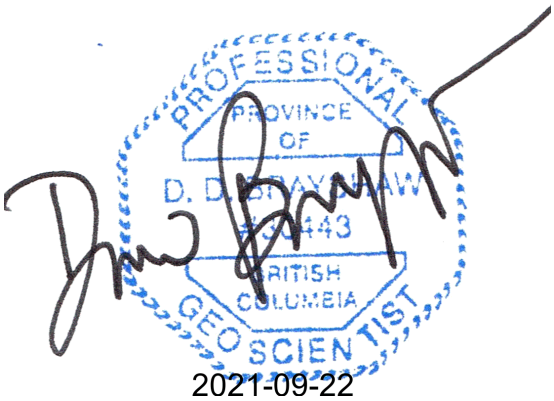

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