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May 13, 2024

To: Board of Natural Resources
MS 47000
Olympia, WA 98504-7000
Submitted via email: bnr@dnr.wa.gov

Re: Geomorphic Analysis – Pilchuck River near Bologna Timber Sale Units 1 and 2

The Pilchuck River between Kelly Creek and Ahtanum Creek is a dynamic, rapidly evolving river system. Historically, avulsions and other sudden changes in the orientation of the main channel were common within this reach of the river. Since the last ice age, this reach of the river has migrated back and forth across the river valley bottom, cutting its way through most of the glacial till that was deposited in the valley. This is clearly evident in the LiDAR, which exhibits multiple, divergent channel scars indicative of dynamic, unconstrained river system.

Units 1 and 2 of the proposed "Bologna" timber sale are located directly on top of one of the few remaining glacial outwash terraces in the Pilchuck River valley (Figure 6). The northwest edge of Unit 1 of the Bologna timber sale runs right along the outer boundary of the active channel migration zone, while the river is actively eating into this terrace near the north end of Unit 2 of the timber sale. There is no doubt that the river will continue to erode this terrace. Logging the terrace will further destabilize the already erodible glacial deposits, and increase the rate of bank erosion and future channel migration, by eliminating a future source of large wood recruitment.

Logging within the channel migration zone (CMZ) is prohibited under state law (WAC 222-30-022). Forest practices rules define a CMZ as "the area where the active channel of a stream is prone to move and this results in a potential near-term loss of riparian function and associated habitat adjacent to the stream, except as modified by a permanent levee or dike. For this purpose, near-term means the time scale required to grow a mature forest" (WAC 222-16-010). In this case, there are no levees or dikes separating the river from the glacial outwash terrace on which the two timber sale units are located. Although the glacial outwash terrace has not been previously occupied by the river, it is *certainly within the channel migration zone.*

The Forest Practices Board Manual defines four components of the CMZ: (1) the historic channel migration zone (HMZ), (2) the avulsion hazard zone (EHA), (3) the erosion hazard area (HA), and (4) the disconnected migration area (DMA). Unit 1 of the Bologna timber sale is adjacent to an alluvial terrace that is within both the EHA and the HMZ (Figure 5). We found river gravel right along the northwestern boundary of Unit 1, which is clear indicator that water has been flowing through this area in the recent past (Figure 1).

Figure 1. River Gravel Found Along Northwest Edge of Unit 1

At least a portion Unit 2 of the Bologna timber sale is within the EHA. The EHA includes those areas outside of the HMZ and AHZ which are susceptible to bank erosion. According to the Forest Practices Board Manual, the EHA is typically comprised of portions of floodplain and terrace surfaces outside of the HMZ and AHZ.

Noah Dudley and Zach Click prepared a Geologic Memorandum for the Bologna timber sale in December, 2023. The memorandum includes a cursory analysis of historic channel migration, and a map of the purported channel migration zone.

Dudley and Click conclude that because "the Pilchuck River channel appears to have remained relatively stable… proposed buffers provide adequate protection for Pilchuck River's desired future condition in the 140-year near term." This conclusion is based on a number of false or dubious assumptions:

- The rate of channel migration over the next 140 years will be similar to that the rate of channel migration over the past 67 years.

- There is no risk of an avulsion within 250 feet of the northwest edge of Unit 1 of the Bologna timber sale.
- There has been no measurable retreat of the river bank north of Unit 2 within the past 67 years.
- The glacial outwash terraces are resistant to erosion.

All of these assumptions either unsupported by existing data, or contradicted by field observations and historical trends. There is no reason to believe that the rate of channel migration over the past 67 years is typical or indicative of the future rate of channel migration. Intensive logging within the floodplain, and removal of large woody debris from the river, have increased the rate of relative sediment transport and led to river bed degradation (lowering of the river bed elevation), and a dearth of large, habitat forming wood. While the risk of an avulsion across the floodplain just north of Unit 1 may currently be low, the risk is likely to increase as wood is reintroduced, and the riverbed once again begins to aggrade.

Dudley and Click provide no basis for locating the edge of the channel migration zone to the north of Unit 1 in the middle of the active floodplain. The alluvial terrace clearly extends right up to the northwest boundary of Unit 1 (Figure 5). This puts the glacial outwash terrace that Unit 1 occupies at significant risk of future erosion.

Figure 2. Bank Failure on Outside of Meander Bend
(River is cutting a new channel behind the small tree in the foreground.)

Dudley and Click's statement that there has been no measurable retreat of the river bank north of Unit 2 within the past 67 years is contracted by their own analysis. Figure 5 of their memorandum, which is based on historic aerial photos, reveals that the river bank has retreated by about 200 feet, and river is still actively eroding the glacial outwash terrace at this location. A large portion of the terrace has recently collapsed, as is obvious in Figure 2 (above). The river has cut its way around the boulder in the foreground and formed a new channel that runs along the toe of the terrace. This is a pattern that repeats itself: the river undermines the terrace until the slope can no longer support its own weight. The bank collapses, and the river moves further inland.

Dudley and Click also provide no data or evidence to support their assertion that the glacial outwash terraces are resistant to erosion. In fact, historical trends and field observations suggest just the opposite. Units 1 and 2 of the Bologna timber sale are located directly on top of one of the last remaining glacial outwash terraces in the Pilchuck River valley. There is no reason to believe that this terrace is any less erodible than any of the those terraces that that were historically present and have almost all been washed away by the river.

Effect of Log Jams on Channel Migration

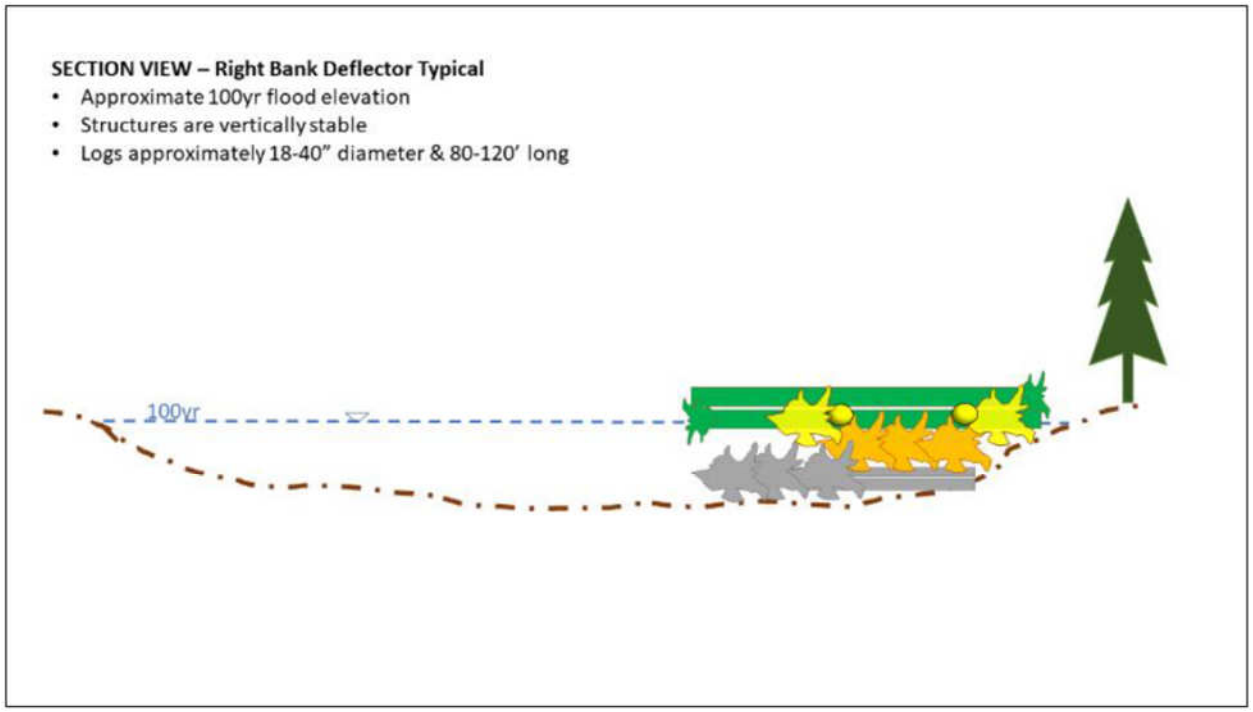
Dudley and Click completely ignore the effect that log jams and large woody debris have had on channel migration over time. Natural log jams can have a dramatic effect on river channel evolution and the rate of channel migration. Log jams initiate aggradation of the river bed, much like a small dam, increasing water velocities and causing the river to widen, migrate, form new side channels, and/or avulse (carve entirely new channels through alluvial or glacial deposits). Historically, huge, old growth trees would have been abundant along the banks of the Pilchuck River, and large log jams would have been much more common. In the 1900's, much of this wood was removed from the river to facilitate the transport of timber to mills, and the construction of the Pilchuck River dam, which was located about two miles downstream of Unit 1 of the Bologna timber sale. (The dam was removed in 2020.) Today, large, habitat forming trees and logs are mostly absent along the Pilchuck river and its floodplain.

Dudley and Click assume that, because the rate of channel migration has decreased since 1954, the risk of further channel migration over the next 140 years is low. This assumption is fundamentally flawed. The period over which Dudley and Click analyzed the rate of channel migration is precisely the period over which there was an historical dearth of large woody debris within the river. Dudley and Click neglect to consider the effect of future large woody recruitment and log jams, which are likely to increase over the next 100 years, as trees along the river mature.

Dudley and Click also fail to consider the impacts of the project that the Tulalip Tribe is currently planning, to install up to 300 full-size trees measuring up to 120 feet in length between River Mile (RM) 27 to 35. Units 1, 2, 3, and 4 of the Bologna timber sale are located near RM 29, right in the middle of the reach where these log jams are planned (Figure 4). The stated objectives of the project include: (a) reinitiation of dynamic channel-forming processes driven by large, complex woody debris jams, indicative of historic conditions; (b) improved frequency of mainstem-floodplain interaction; (c) improved connectivity and access from mainstem to side channels; (d) scour and deposition of sediment associated with wood structures; and (e) creation of in-channel habitat

elements including pools, bank edge habitat, and natural cover (Fisher, et. al., 2002). In other words, the project is intended to restore natural floodplain processes by increasing water surface elevations, and accelerating the rate of river bed aggradation and channel migration. These objectives stand in direct contrast to the assumption by Dudley and Click that the river will remain confined within its existing channel.

Figure 3. Typical Log Jam Design
Source: Pilchuck LWD Preliminary Design Report, Tulalip Tribe



Risk of Avulsion Near Unit 2

Dudley and Click mischaracterize the HMZ as limited only to those channel boundaries that can be seen in available aerial photos. In reality, the HMZ extends all the way to the northwest edge of Unit 1 of the Bologna timber sale (Figure 6).

There is a significant risk that the river will avulse across the low-lying, alluvial floodplain terrace to the north of Unit 1. Dudley and Click claim that only a portion of this alluvial floodplain terrace is within the AHZ, but provide no evidence to support this assertion. In fact, there is nothing preventing the river from cutting a new channel across this terrace and migrating toward the northwest edge of Unit 1 of the Bologna timber sale (Figure 5). The risk of an avulsion will almost certainly increase over time, as large wood is reintroduced to the system, and this reach of the river begins to aggrade and transition from a relatively static, transport dominated plane bed morphology and return to its former dynamic state.

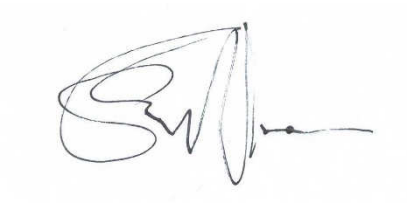
Conclusion

The northwest edge of Unit 1 of the Bologna timber sale runs right along the historic channel migration zone, and therefore violates forest practices rules. Required stream buffers are measured horizontally from the outer edge of the bankfull width or channel migration zone, whichever is greater, and extend outward 90 to 200 feet, depending on the site class. The CMZ does not stop at the edge of the HMZ, but extends some distance outward, depending on the anticipated rate of channel migration.

Similarly, the sharp meander bend in the river just north of Unit 2 is actively migrating outward and eroding way the terrace on which Unit 2 is located. The 100-foot buffer that DNR has established is clearly inadequate, and almost certainly violates state law, which again requires a minimum 90 to 200 foot buffer, extending outward from the edge of the EHA.

It is impossible to estimate the rate at which the Pilchuck River might migrate to into the glacial outwash terrace over the next 140 years. Caution would dictate that DNR avoid any logging on top of the glacial outwash terrace.

Stephen Kropp



\References

Dudley, N. and Click, Z. 2023. Geologic Memorandum for the Bologna Timber Harvest, Snohomish County, Washington Forest Resources Division, DNR Forest Resources Division.

Fisher, L., Bailey, D., and Marks, D. 2002. Pilchuck LWD Preliminary Design Report, Tulalip Tribes Timber Fish and Wildlife Program.

Washington Forest Practices Board (WFPB), 2001, Forest Practices Board Manual: Olympia, WA, Department of Natural Resources.

Figure 4. Planned Log Jam Locations
Source: Pilchuck LWD Preliminary Design Report, Tulalip Tribe
(modified to show locations of timber sale units)

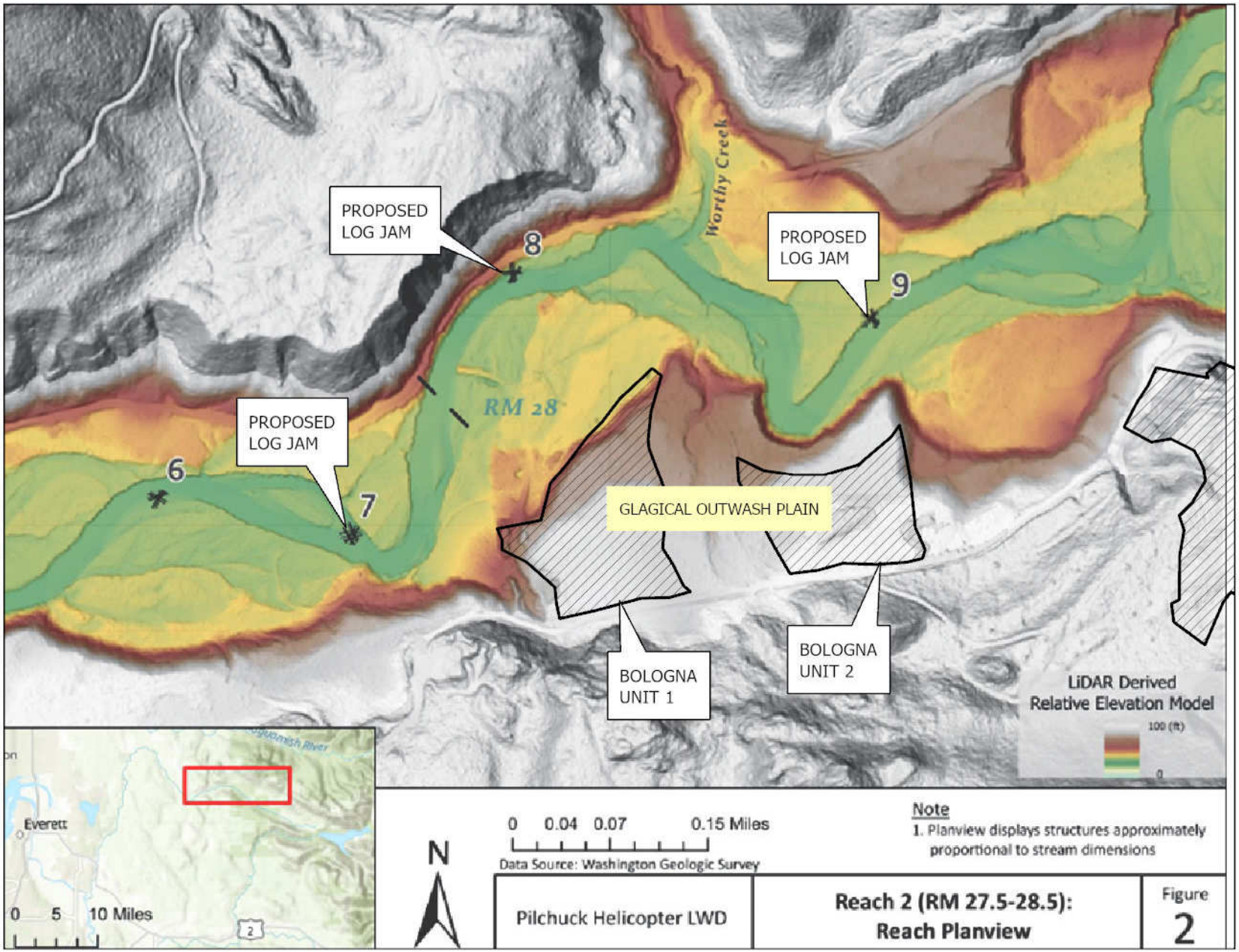


Figure 5. Topographic Map – Vicinity of Bologna Units 1 and 2

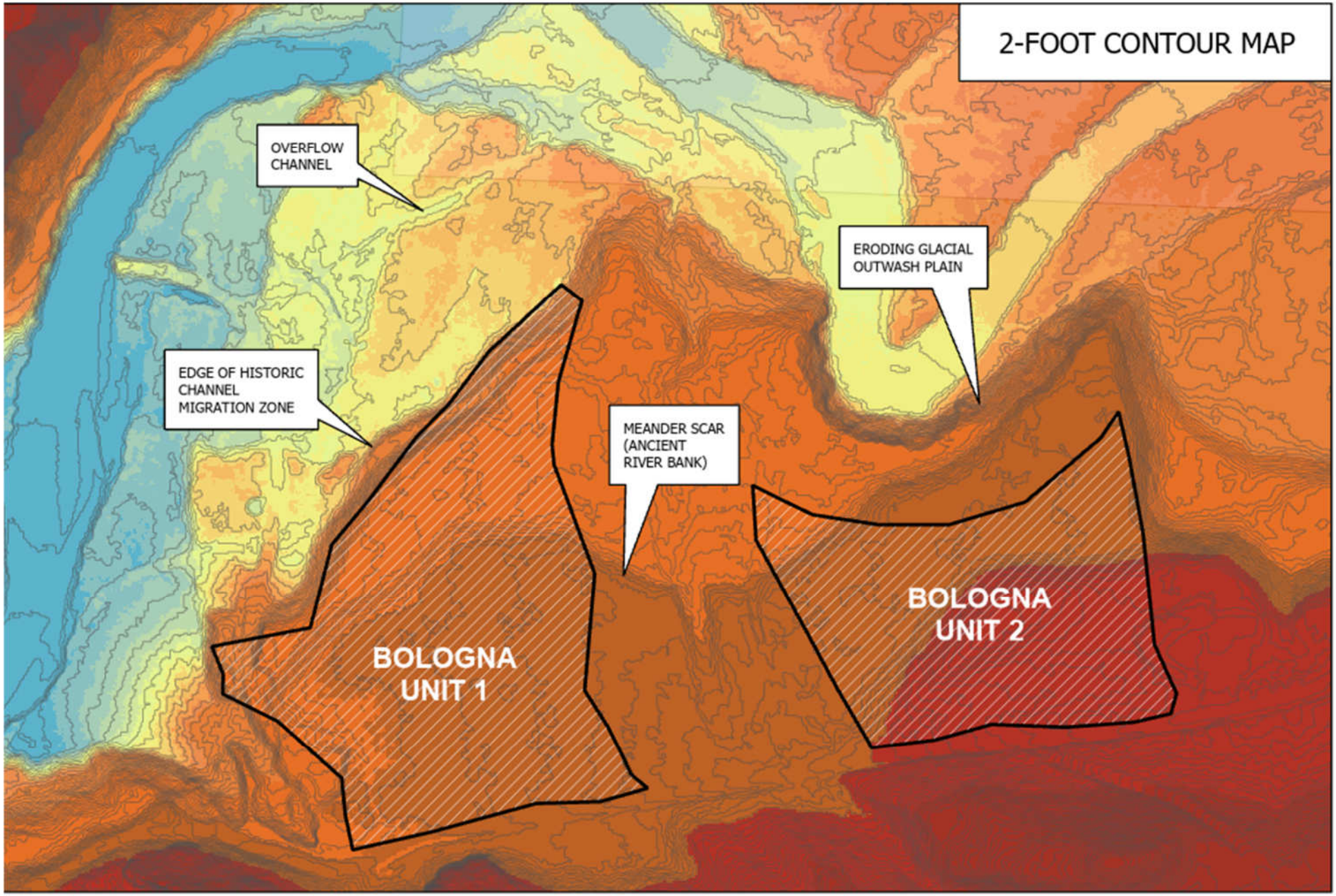


Figure 6. Historic Channel Migration Zone