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GEOLOGIC REPORT FOR THE TROJAN WAR FILL REMOVAL PROJECT #1

August 28, 2020

Prepared for: Matt Kennedy, Forest Engineering Specialist
Longview Forest Area
Castle Rock, Washington

Project Name:	Trojan War Digout
HPU:	22852
Watershed:	Lower Coweeman
Location:	Cowlitz County, Washington Section 22 T8N R1W, W.M.

OBJECTIVE

The objective of this report is to document the geologic review that was conducted on the Trojan War Fill Removal Project #1 in accordance with Weyerhaeuser policies and State of Washington regulations addressing slope stability, erosion, and forest practices. The review was specifically conducted in accordance with Section 16 of the Forest Practices Board Manual, Guidelines for Evaluating Potentially Unstable Slopes and Landforms (Division of Forest Practices, 2016).

INTRODUCTION

The Trojan War Digout #1 is a fill removal project involving the decommission of a seasonal non-fish stream crossing adjacent to a historically active deep-seated landslide (Figures 1, 2, and 3). The section of road affected by the slide on the south side of the crossing was effectively buried and obliterated by the slide, probably not long after its construction to provide logging access in the 1970's. A bypass around the slide was constructed to provide access for the recent timber harvest. With no needs or plans to reconstruct the road across the slide, the stream crossing at the project site is no longer needed and will be decommissioned accordingly.

The site was identified during layout of the Trojan War Harvest Unit. The harvest unit has already been permitted and harvested. Refer to my report titled "Geologic Report for the Trojan War Harvest Unit" and dated "December 12, 2019". Of note in that report, we evaluated the potential for shallow, rapidly moving landslides to initiate on steep slopes within the harvest unit

and to travel downstream to structures below. Although the risk was generally determined to be low, we laid out the unit conservatively to avoid increasing any risk to public safety. Also of note in that report, I made the following recommendation addressing this project site: "Avoid adverse impacts to the stability of the adjacent deep-seated slide when removing the culvert and fill during road decommission."

The project site is located in the middle of the Trojan War Harvest Unit at the end of the Mount Brynion Road about five miles east of the town of Kelso. We looked at LiDAR-generated topographic data, geologic maps, soil maps, existing landslide inventories, and available photos to conduct a thorough office review of the site. We visited the site several times during the spring and summer of 2019 as we laid out the associated harvest unit. The site was protected in a UNS buffer during the timber harvest. We returned recently after the harvest on August 11, 2020 to conduct a field review of specific decommission plans for the site.

BACKGROUND INFORMATION – OFFICE REVIEW

Stand Description

The surrounding unit was just harvested, but the project site was protected in a UNS buffer dominated by 42 year old second-growth Douglas fir, western hemlock, and other species.

Geomorphology

The site is located high on the eastern flank of Mount Brynion, the dividing ridge along the north side of the Coweeman River where it flows through Rose Valley (Figure 4). The site drains to the southeast into an unnamed tributary to the river. The stream crossing at the site is located where the NS stream flows over a slope break with gentle to moderate slopes in relict to dormant-indistinct deep-seated landslide terrain above and steep (>60%) slopes down to the stream below (Figure 5). The adjacent slide on the south approach to the crossing toes out above the road on the Elevation at the site is approximately 1100 feet above mean sea level.

Geology

I reviewed the harvest unit using the WDNR interactive geologic map (Division of Geology and Earth Resources, 2020). Rocks at the site are mapped as OEva(g), Oligocene-Eocene andesite flows of the Goble Volcanics. There are numerous northeast and northwest trending faults mapped in the region, but none near the site. Rocks a mile and a half north of the site are dipping 34 degrees to the southeast.

Soils

I reviewed the harvest unit using the NRCS interactive soil map (Soil Survey Staff, 2020). Soils at the site are mapped as very gravelly loams of the Schneider Series. The soils are classified as GM soils using the Unified Soil Classification System. The soils are well-drained.

Landslide History

I reviewed the harvest unit using the landslide maps available on the WDNR interactive geologic map (Division of Geology and Earth Resources, 2020). The WDNR landslide inventory does not identify any slides at the site.

OBSERVATIONS – FIELD REVIEW

We made the following observations at the site:

- Seasonal non-fish stream crossing on old haul road
- Fill embankment appears relatively intact and in good condition with no signs of past or current instability
- Culvert consists of 18 inch diameter x 50 feet long metal pipe
- Embankment 7 feet high at inside shoulder and 22 feet high at outside shoulder
- Embankment has 65-68% fill slopes
- Road becomes impassable immediately south of the crossing due to historically active deep-seated slide
- Toe of slide does not appear to be encroaching on embankment and crosses the road 20 feet or more to the south of the embankment

INTERPRETATION and RECOMMENDATIONS

The stream crossing appears relatively intact and in good condition. However, due to the slide just beyond the crossing, the section of road is no longer needed and will be decommissioned. I recommended avoiding adverse impacts to the slide during removal of the embankment. After further discussion with several other forest engineers, it was decided that the best approach would be to significantly lower the embankment while leaving the base of the embankment with the currently functioning pipe in place to avoid potential adverse impacts to the adjacent slide.

We decided on the following design (Figures 6, 7, and 8):

- Lower the embankment height by 5 feet at the inside shoulder, 6.5 feet at centerline, and 8.5 feet at the outside shoulder as measured above the culvert.
- Leave the base of the embankment and the culvert in place with a thin lift of fill over it.
- Layback the cut on both sides of the culvert at 2:1 slopes.
- Armor the cut and the downslope face of the embankment.

We decided to leave the base of the embankment with the culvert in place to avoid potentially undermining the toe of the adjacent slide. The excavation limits were clearly marked in the field with the goal of keeping equipment away from the slide. The cut will be laid back at 2:1 slopes that should maintain the stability of the cut through the embankment. This approach will also significantly lower the embankment, reducing the potential for ponding water if the culvert plugs as well as reducing the overall volume of fill that could fail if the culvert plugs. Armoring the cut through the embankment and the downstream face of the embankment will prevent erosion if the culvert plugs and the stream flows through the new notch in the embankment. The clearing limits were also marked with the goal of minimizing the amount of leave trees in the UNS buffer that will need to be cut. Only one significant merch tree growing on the embankment will need to be cut. Several other trees of lesser significance on/next to the embankment will also need to be cut and/or removed as part of the excavation and/or to provide safe access.

CONCLUSIONS

We identified this site for decommission during layout of the Trojan War Harvest Unit. We conducted a thorough office review of existing information and followed up with several field reviews of the site.

I recommended avoiding adverse impacts to the adjacent slide during removal of the embankment. We decided that the best approach would be to significantly lower the embankment while leaving the base of the embankment with the currently functioning pipe in place to avoid potential adverse impacts to the adjacent slide. This approach will still significantly lower the embankment and we have incorporated measures to protect against potential erosion at the site if the culvert plugs.

I have attached an evaluation of the proposed harvest unit directly addressing Washington Department of Natural Resources requirements outlined in WAC 222-10-030 (1). This evaluation can be found in Appendix B.

LIMITATIONS

We have conducted our geologic review to the standard of care for such reviews of forest practices in Washington, consistent with work conducted by other qualified experts, and in accordance with the requirements of the Washington Department of Natural Resources and the Geologist Licensing Board. Our review was specifically conducted in accordance with Section 16 of the Forest Practices Board Manual, Guidelines for Evaluating Potentially Unstable Slopes and Landforms (Division of Forest Practices, 2016).

We utilized available information for our office review and conducted a reconnaissance-level field review. Our investigation was limited to observations of surface conditions and we did not conduct a sub-surface investigation.

Landslides are a natural hazard inherent to the slopes of the Pacific Northwest and are part of the geologic process. Forest practices may exacerbate that hazard. We have conducted our review with the intent of reducing potential adverse impacts that the planned forest practices may have on slope stability.

CLOSING

Thank you for the opportunity to review this project. Please let me know if you have any questions or concerns.

Sincerely,

Jason Hinkle, LEG, QE

APPENDIX A

REFERENCES

Division of Forest Practices, Washington State Department of Natural Resources, Forest Practices Board Manual Section 16 Guidelines for Evaluating Potentially Unstable Slopes and Landforms. Available online at http://www.dnr.wa.gov/Publications/fp_board_manual_section16.pdf . 2016.

Division of Geology and Earth Resources, Washington State Department of Natural Resources, Washington Interactive Geologic Map. Available online at https://fortress.wa.gov/dnr/geology/?Site=wigm . Accessed 2020.

Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Soil Survey Geographic (SSURGO) Database for Lewis County, Washington. Available online at http://soildatamart.nrcs.usda.gov . Accessed 2020.

APPENDIX B

WASHINGTON DEPARTMENT OF NATURAL RESOURCES WAC 222 10-030 REQUIREMENTS

The following are responses addressing WAC 222-10-030 (1) (a, b, c).

(1) In order to determine whether such forest practices are likely to have a probable significant adverse impact, and therefore require an environmental impact statement, the applicant must submit the following additional information, prepared by a qualified expert. The expert must describe the potentially unstable landforms in and around the application site and analyze:

(a) The likelihood that the proposed forest practices will cause movement of the potentially unstable slopes or landforms, or contribute to further movement of a potentially unstable slope or landforms;

The likelihood that the project will cause movement of potentially unstable slopes is low because we are significantly reducing the potential for impacts at the site if the culvert plugs and/or the crossing fails and we are avoiding adverse impacts to the adjacent slide.

(b) The likelihood of delivery of sediment or debris to any public resources or in a manner that would threaten public safety; and

The likelihood of sediment delivery to streams resulting from the project is low. We have designed the project to avoid and minimize the risk of sediment delivery.

The risk to public safety from shallow, rapidly moving landslides associated with the project is low because:

- *The RIL's and other steep slopes adjacent to the site with the most potential to deliver a shallow, rapidly moving landslide to the stream above the structures will be protected in a combination of UNS and RMZ buffers.*
- *The stream channels do not maintain confinement and gradient sufficient to deliver a shallow, rapidly moving landslide down to the structures.*
- *We are significantly reducing the potential for a fill failure at the site.*

(c) Any possible mitigation for the identified hazards and risks.

I recommended avoiding adverse impacts to the adjacent slide during removal of the embankment. We decided that the best approach would be to significantly lower the embankment while leaving the base of the embankment with the currently functioning pipe in place to avoid potential adverse impacts to the adjacent slide. This approach will still significantly lower the embankment and we have incorporated measures to protect against potential erosion at the site if the culvert plugs.

APPENDIX C

Figure 1: View south across embankment. Toe of adjacent slide in snow beyond engineer.

Figure 2: View down at embankment.

Figure 3. View up at embankment.

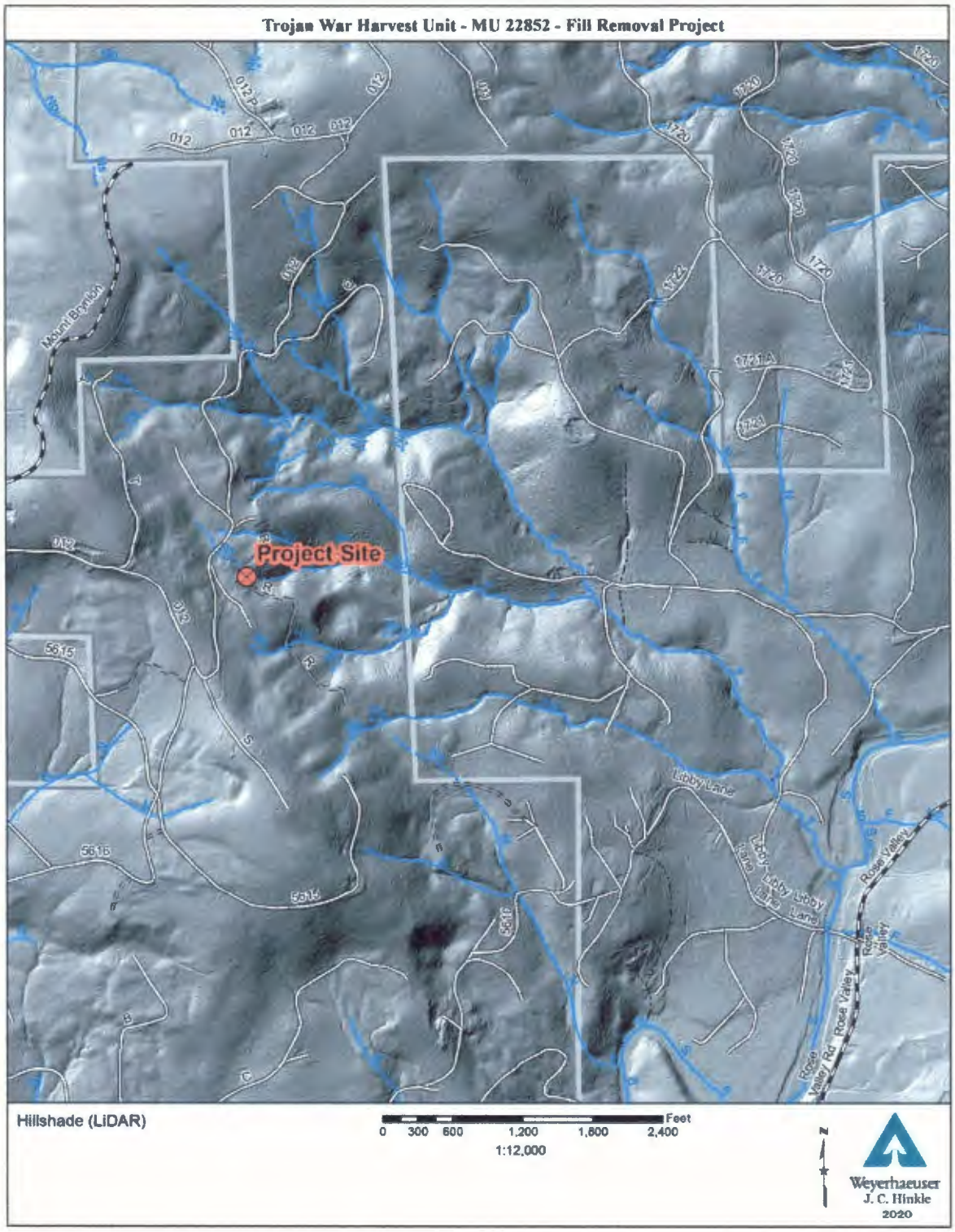

Figure 4: Location map.

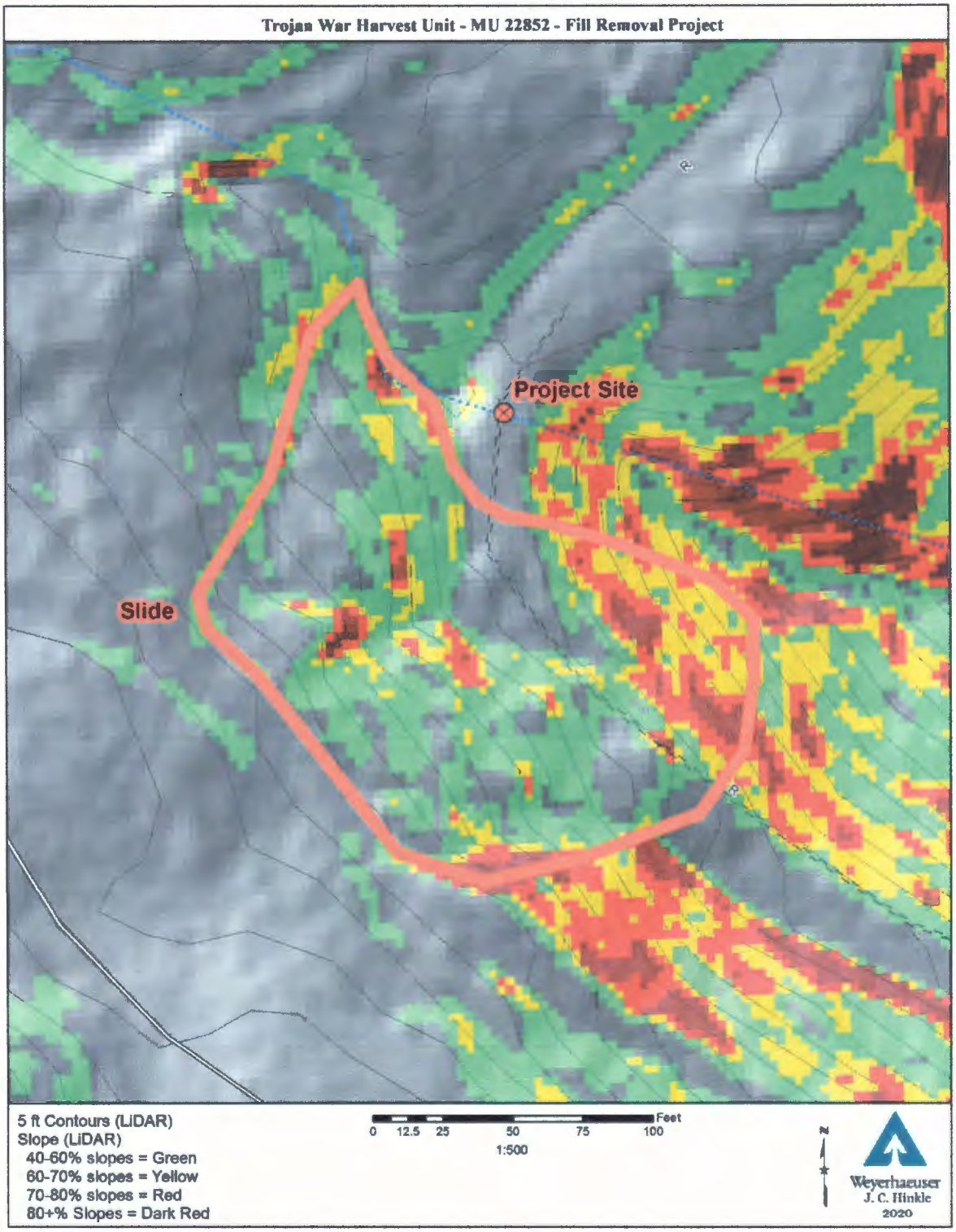

Figure 5: Site map.

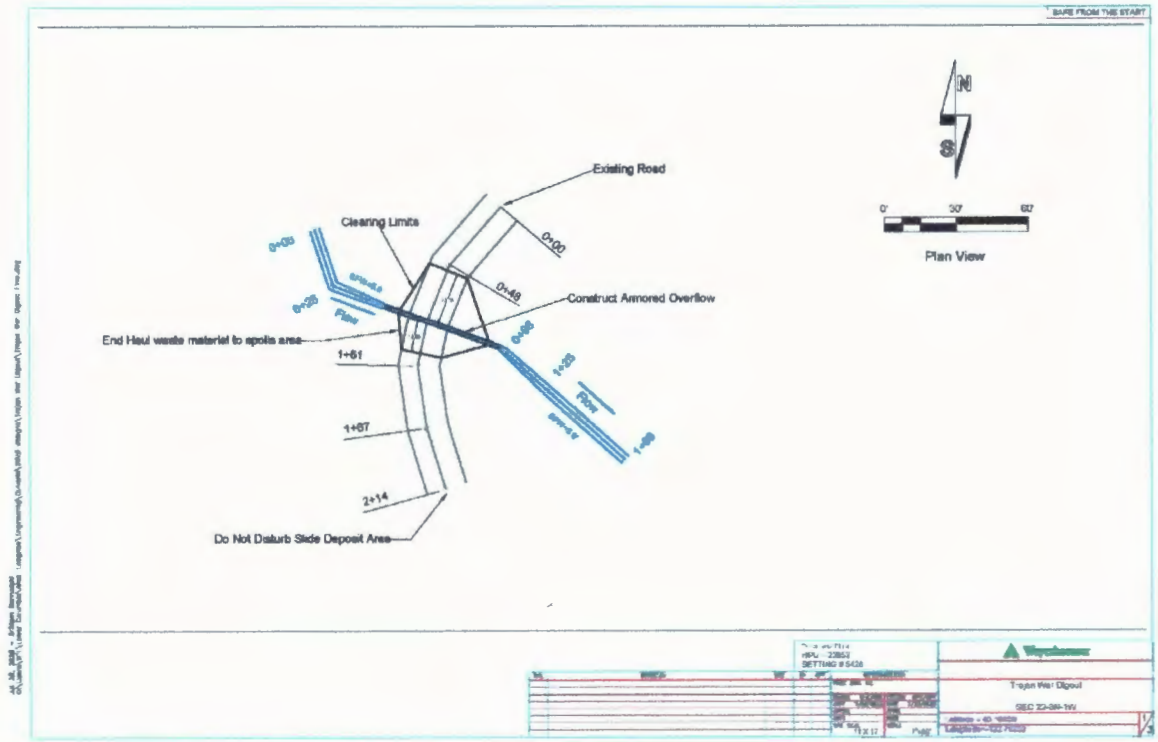

Figure 6: Plan view of proposed work from engineering notes.

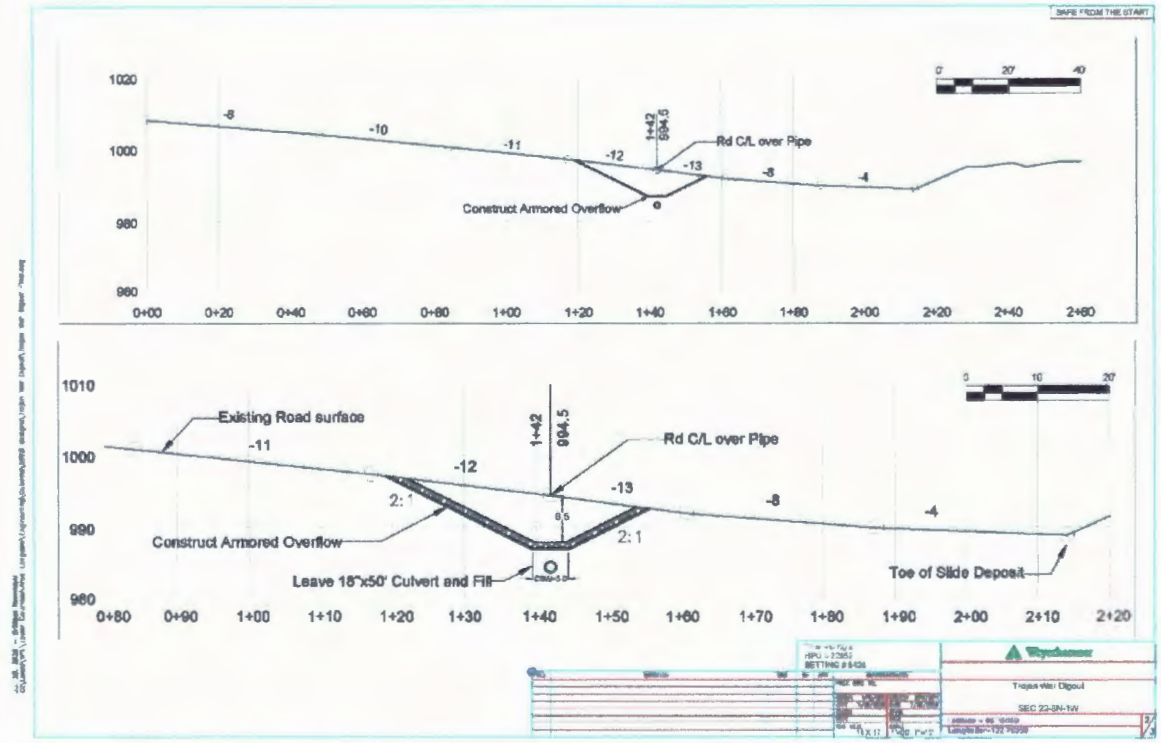

Figure 7: Road profile of proposed work from engineering notes.

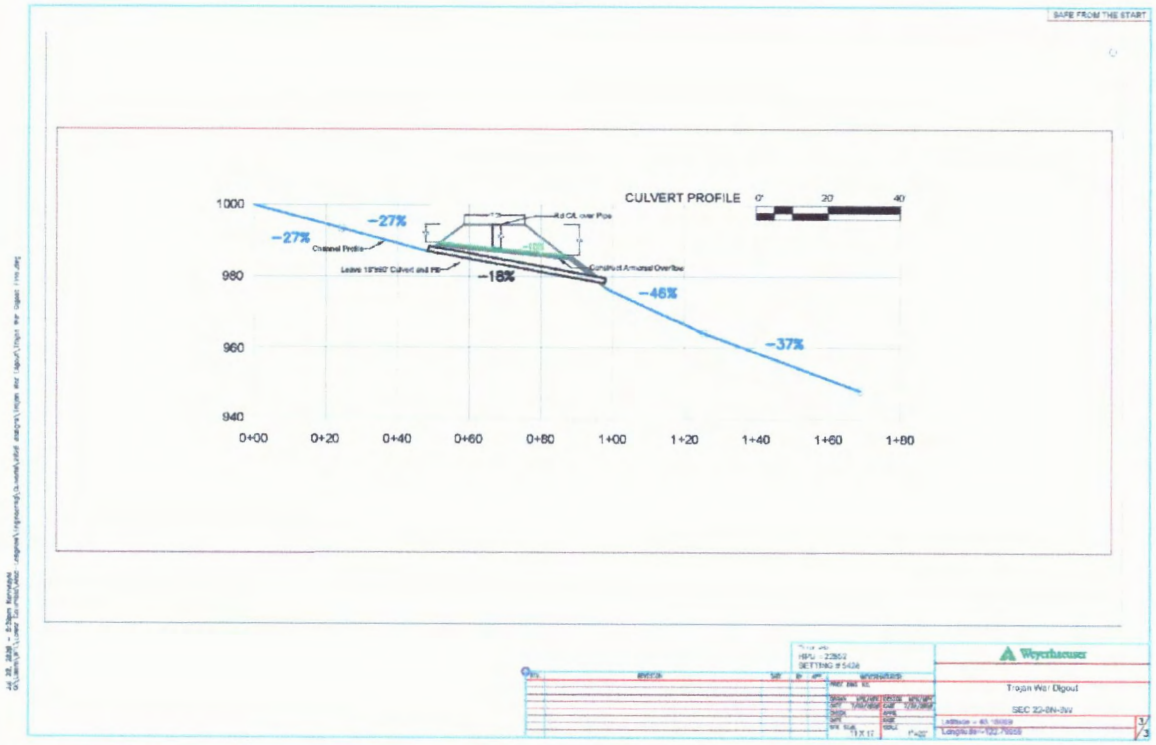

Figure 8: Stream profile of proposed work from engineering notes.