
RDKB SADDLE LAKE DAM 2018 ANNUAL INSPECTION REPORT



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Introduction

On October 30th, 2018, Austin Engineering Ltd. (Austin Engineering), completed the 2018 Annual Dam Inspection of the Regional District of Kootenay Boundary's (RDKB) Saddle Lake Dam, located on Reservoir Road in Grand Forks, BC. This inspection satisfies the dam safety requirements for the Ministry of Forests, Lands and Natural Resource Operations and was performed in accordance with the Canadian Dam Association *Dam Safety Guidelines 2007 (2013 Edition)*.

Saddle Lake Dam is a concrete faced earth-fill dam and impounds a small reservoir with an unknown water source, which is likely groundwater with some overland flow from the small catchment area. The earth portion of the dam serves as the weighted mass to counteract the upstream pressure from the water, while the concrete serves as the impervious barrier to prevent water from seeping through the dam.

The dam structure is six (6) meters tall and approximately 44 meters wide and impounds the area of water known as Saddle Lake. Saddle Lake is a man-made lake located in the saddle-like depression between Eagle Mountain and a smaller unnamed mountain 6 km west of Grand Forks. It was built by Doukhobors in 1912 as a reservoir dam to meet irrigation needs for the extensive communal orchards and grain fields below.

Observations

During the 2018 Dam Safety Annual Inspection, Austin Engineering made the following observations:

1. The sign that was previously located on the east abutment, indicating that Saddle Lake Dam is a dam as required by with the BC Dam Safety regulations, was no longer in place and has been removed.
2. Small barriers that were noted during previous inspections have been reinstalled at the access point for crossing the dam. These barriers are easily removable and likely act primarily as a deterrent rather than physically preventing vehicles from crossing. Austin Engineering recommends installing effective barriers to stop traffic from crossing over the crest of the dam.
3. Wheel ruts were visible along the crest of the dam in the form of continuous depressions, which create zones where water can collect and penetrate the top of the dam. The ingress of water through these zones acts to decrease the effective stress of the soil and therefore decreases the stability of the downstream earth portion of the dam. While barriers are set up to prevent vehicles from crossing, the ruts can also be attributed to smaller vehicles, as the dam provides access to local trails.
4. On the downstream side of the dam, the trees and vegetation along the downstream toe on the right abutment were removed in 2016. Vegetation in this area continues to be well-managed by the dam owner and operator.

5. Some the downstream riprap is raveling due to the rock being oversteepened. Austin Engineering has made a recommendation below to install additional riprap as part of the spillway upgrade project.
6. A hose was noted on the crest/downstream face at approximately the centerline of the dam. This hose may have contributed to material movement on the downstream face of the dam. The discharge end of the line was resting midway down the downstream face of the dam near the centerline. Water should not be discharged at this location. While this hose was not currently discharging, the discharge end should be extended from this location to the streambed below the dam to avoid future discharge onto the downstream face of the dam.
7. The seepage location previously noted on the downstream side of the west abutment was dry at the time of inspection, however, moss and signs of seepage were still evident at this location. The lack of visible seepage at this location is likely due to the lower reservoir level at the time of the 2018 inspection. Austin Engineering has made a recommendation below to install a weir to enable monitoring of the seepage flows and better assess the risk of this seepage to the structure.
8. Austin Engineering noted the small overflow pipe located on the left abutment. This pipe is insufficient from a dam safety perspective to ensure that an overtopping event does not occur. The downstream end of this pipe was attached to plastic piping likely in place to divert water away from the downstream face of the dam. This plastic piping was noted to be disconnected and would require reconnection to effectively convey water away from the dam structure.
9. Some dewatering piping was noted to be left in place over the top of the dam, likely intended for pumping and draining when the reservoir requires lowering to maintain adequate freeboard. This method currently relies heavily on the dam operator's response to a rainfall event. As noted in the previous annual inspection reports, a spillway should be installed and sized for an appropriate rainfall event. This spillway has been designed and has been submitted and approved for construction by the Dam Safety Officer and will be constructed following acquisition of the required downstream lands.
10. The gate and signage on the downstream tunnel and valve access appeared to be in good condition; however, they are partially hidden by vegetation, somewhat limiting their effectiveness at preventing people from entering this confined space. The inside of the valve chamber was not inspected during this site visit due to confined space hazards.
11. The precast riser structure located directly downstream of the dam is still surrounded by saturated soil and an active seepage location was noted in the vicinity. It is Austin Engineering's understanding that the riser structure has not yet been pumped dry or inspected. The seepage in this location should be closely monitored during inspections as pipes may extend from the upstream side of the dam to this precast structure, seepage may indicate a failure in these pipes

leading to potential piping and seepage may indicate a failure in these pipes leading to the potential for progressive internal soil erosion at this location. Austin Engineering highly recommends pumping this area and conducting a closer inspection of the precast rings.

12. On the downstream side of the dam, standing water was found that is likely attributed to seepage flows from the dam. As noted in previous inspections, standing water lowers the safety factor of the dam and reduces its overall stability. Removal of debris downstream could dissipate this standing water and improve overall dam stability.
13. The water level of Saddle Lake was noted to be 681.15 m (measured off of the 683.00 m marker on the dam) at the time of inspection. This is a lower water level than previous years of inspection due to a planned gradual draw down in preparation for spillway construction. The condition of the upstream concrete face appears to be in good condition and no cracking, settling or overturning was noted during the inspection. While the upstream concrete face of the dam is visibly in good condition, it should be noted that only the portion above the water can be visually inspected.
14. An 8-inch-wide by 2.5-inch-deep hole with a rough surface was noted in the east side of the upstream concrete face of the dam. This hole is suspected to be the result of an aggregate having dislodged out of the face at this location. Repair and patch concrete in this void to ensure continuity of the water barrier.

Recommendations

After assessment of the inspection findings, Austin Engineering provides the following recommendations and corresponding rating of low (L), medium (M), High (H), or very high (VH) criticality, to ensure the continued safe operation and maintenance of the Saddle Lake Dam:

1. Install spillway. **(VH)**
2. Replace the sign which provided Dam Safety information that was previously located near the east abutment of the dam. **(M)**
3. Install more effective barriers to physically limit traffic across the crest of the dam. **(M)**
4. Repair the ruts and depressions along the top of the dam. Repairs should include leveling, backfilling and reseeding to prevent any water from ponding on the top of the dam and reducing the stability of the earthen embankment. **(M-H)**
5. Remove vegetation growth on the east side of the downstream slope of the dam and implement a maintenance schedule to ensure vegetation growth is monitored and removed as required. **(M)**

6. Install additional riprap to change the downstream slope angle and enhance the stability of the toe. Austin Engineering recommends completing this installation as part of the upgrades to the spillway. *(H)*
7. Relocate the hose laying across the midsection of the dam crest and reconnect corrugated plastic diversion piping to the overflow pipe. These measures will keep water from discharging onto the downstream slope of the dam if either the hose or discharge pipe are in use. *(H)*
8. Install a weir to monitor any changes in seepage and to allow the operator to identify any changes in the steady-state condition of the dam. *(M-H)*
9. Conduct further investigation of the original discharge valve behind the gated 'confined' space area, as it is a weak point in the dam's ability to retain control of the water. This piping should be inspected to confirm its condition and the concrete chamber should be pumped to better establish seepage/leakage rates. *(H)*
10. Monitor closely and conduct further investigation of the precast riser structure located directly downstream of the dam. As this structure is surrounded by saturated soil, Austin Engineering recommends removing the cap and pumping out any water to facilitate further inspection and confirm whether this structure is still in active use. *(VH)*
11. Widen the trench downstream of the dam from 1 ft wide to 2 ft wide to facilitate draining of the standing water below the dam. Removal of this standing water will increase the stability of the earthen portion of the dam. *(H-VH)*
12. Continue to monitor the earthen section of the dam for increases in rodent activity (as was noted in previous inspections). If rodent activity is found to be increasing, remove rodents as required. *(M)*
13. Consider budgeting to patch the concrete surface on the upstream face of the dam to extend the life of the concrete and protect against freeze-thaw action. However, at this time only minor levels of deterioration are present, and the concrete is in generally good condition where visible. *(M)*

Conclusion

Overall, the Saddle Lake Dam is in fair condition. The most important items to be addressed are moving ahead with the spillway upgrade, investigating the seepage in the vicinity of the precast riser and pumping the riser for inspection, resloping the downstream riprap and inspecting the outlet piping.

These measures, along with the other recommendations listed above, will ensure the continued safe operation of the facility and improve the overall stability of the structure. I trust that this report and the

attached reference photos are to your satisfaction and if you have any questions or concerns, please do not hesitate to contact me.

Regards,



Roger Austin, P.Eng.
Dam Safety Engineer
Austin Engineering Ltd.



Enclosed:

- Reference Photos

Reference Photos



Photo 1: Dam safety signage missing from east abutment – requires replacement.



Photo 2: Small barriers on dam crest to deter vehicle traffic, and intact dam safety signage on west abutment.



Photo 3: Over-steepened downstream toe to be addressed during the spillway upgrade.



Photo 4: View of the concrete face of the dam.



Photo 5: Hole in upstream east side of concrete face of the dam.



Photo 6: Upstream concrete face in generally good condition; consider patching concrete to extend the life of the dam.



Photo 7: Visible wheel ruts on dam crest.

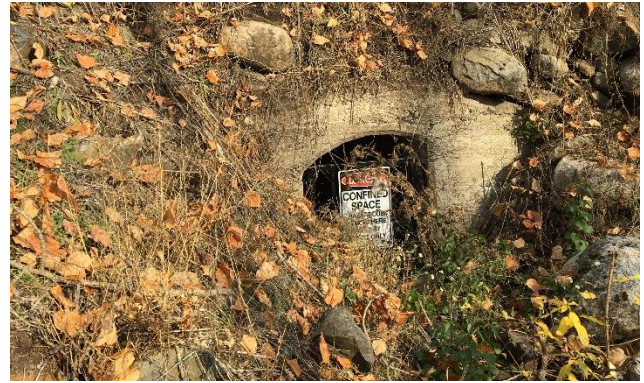


Photo 8: Valve chamber appropriately signed and gated (inside of valve chamber not inspected due to confined space access requirements).



Photo 9: Some vegetation growth noted on downstream east slope which should be cleared.



Photo 10: Seepage flow throughout the dam resulting in standing water near toe. Widen the trench width and maintain trench to avoid pooling at downstream toe.



Photo 11: Piping used by the dam operator to diver pipe discharge water from eroding dam. Reconnect piping..



Photo 12: Active seepage noted on downstream east side of dam near precast riser.



Photo 13: Precast riser structure located downstream of the dam is surrounded by saturated soil.



Photo 14: Some raveling of riprap noted on the over-steepened downstream slope.



Photo 15: Moss, which noted a previous seepage location on downstream west slope, was dry, likely due to low water level at time of inspection.



Photo 16: Hose laying across downstream face at approximately the centre of the dam appears to have eroded material off of the downstream face.



Photo 17: Discharge end of hose (not currently discharging) is located on downstream dam face and should be extended prior to use.



Photo 18: View of Saddle Lake.