Peace Project Water Use Plan

Williston Trial Wetlands

Construction Completion Report

Reference: GMSWORKS-17

BC Hydro – Williston Reservoir Wetland Demonstration Site 34 Beaver Pond Completion Report

Study Period: May 2014

Golder Associates

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REPORT

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BC HYDRO - WILLISTON RESERVOIR WETLAND DEMONSTRATION SITE 34 BEAVER POND

Completion Report
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1.0 INTRODUCTION

In 2009 Golder Associates Ltd. (Golder) inventoried and identified a number of opportunities to create wetlands in the Williston Reservoir area (Golder, 2010), the broad objectives of which are identified in the Peace Williston Water Use Plan (PWUP 2003). These objectives included anticipated improvements to fisheries and wildlife habitat, riparian habitat along the reservoir's foreshore and potentially dust control by creating "perched" wetlands.

BC Hydro selected two Wetland Demonstration Sites (WDS) from five candidates identified by Golder in 2009 for development (Golder 2010), including WDS 6-2 (Airport Lagoon) and WDS 34 (Beaver Pond). In August of 2010, Golder was retained by BC Hydro to develop preliminary engineering designs and associated construction cost estimates for the two selected demonstration wetland sites (Golder, 2011). In February, 2013, BC Hydro requested that Golder update the designs for WDS 6-2 and WDS 34 in preparation for tendering and construction in May, 2013. WDS 6-2 is described in a previous report (Golder, 2013a) and consisted of installation of two culverts to allow back flooding to create a wetland area connected to Williston reservoir. Construction of WDS 6-2 was completed in 2013, for which Golder provided construction monitoring services, including a summary of construction activities and associated record drawings of the completed works (Golder, 2013b). Reservoir conditions in 2013 did not permit construction of WDS 34, and construction of this site was delayed until May of 2014. Prior to construction, revisions to WDS 34 Issued for Construction (IFC) drawings were completed in February of 2014 (Golder, 2014).

This report provides a summary of the construction monitoring that occurred during the construction of WDS 34 (the Site) which involved installation of two Macaferri Mactubes® (Mactube – the Structure) between May 21 and May 31, 2014. This report includes Daily Activity Reports (DAR) from the Contractor for the period from May 14 to June 10 (Appendix A), representative site photos taken during construction (Appendix B), Daily Field Inspection Reports (DFIR) from Golder between May 21 and May 31 (Appendix C), and the Record Drawings of the completed works (Appendix D)

This report should be read in conjunction with the limitations section at the end of this document.

2.0 CONSTRUCTION MONITORING

The construction of WDS 34 commenced on May 14, with mobilization and construction access to the Site, and was completed by June 10, 2014, when demobilization occurred. The contractor that completed the work was Duz Cho Construction LP (Duz Cho), who subcontracted environmental and survey activities to DWB Consulting Services Ltd., and dredging activities to Canadian Dewatering LP. Golder provided a Field Engineer and sub-contracted a Mactube Filling Representative from Hydra Marine to monitor construction activities.

Golder's construction monitoring and provision of associated DFIRs occurred from May 21 to May 31, 2014. Duz Cho provided DARs from May 14 to June 10, 2013.

The sequence of construction can be described as six separate phases of work including:

1) mobilization of equipment and preparation of site access;

2) setup of equipment and preparation of the Site for placement of Mactubes;

3) filling of Mactubes and creating a spillway across the Mactubes;

4) placement of the downstream log boom and associated anchors;

5) rip rap placement for a spillway apron; and,

6) demobilization of equipment and site cleanup.

More detailed descriptions of these phases of work are provided in the sections below.

2.1 Mobilization of equipment and preparation of Site Access

Mobilization of equipment occurred on May 14, 2014; however, access to the construction site was hampered by saturated ground at the reservoir foreshore, which could not be mitigated by the use of rig mats. Consequently, access required clearing vegetation and an associated bird nest survey, prior to completion of an overland route to reach the construction site (DAR - May 14, Appendix A). Access to the construction site was completed by May 21, 2014 (Photograph 1, Appendix B).

A Golder Construction representative familiar with the transport and handling of Mactubes arrived in Mackenzie on May 12 to inspect the Mactubes and advise the Contractor on proper handling and transport of the Mactubes prior to mobilization of these items to the Site.

2.2 Setup of Equipment, Ground Preparation and Mactube Placement

Setup of equipment, including a contained fuel storage, site office trailer, generator and dredge equipment (mud tank, dredge pump and associated hoses) occurred concurrent with the construction of site access, and was completed by May 24 (DAR - May 22 to 24). Additional equipment setup included the placement of three silt curtains within the embayment leading towards the main area of the Williston Lake Reservoir. A fish salvage was completed within the area contained within the silt curtains, including the small drainage originating from the upstream beaver ponds.

Golder's Field Engineer and Mactube Filling Representative arrived in Mackenzie on May 21 and were on Site May 22.

Test pits dug along the foreshore of the reservoir near the landing area identified the presence of soil material considered suitable fill to pump into the Mactubes, which was confirmed by the Mactube Filling Representative (Photograph 2). The process of stockpiling fill material commenced, which was then trucked to the mud-tank where it was mixed and pumped as a slurry into the Mactubes.

Ground preparation for the Mactube bedding plane commenced on May 23 (Photograph 3). Ground preparation included the placement of a clay plug in the existing channel of the small drainage originating from the upstream beaver dams. This plug was placed to level the ground rather than rely on the Mactube to conform to this small channel, thereby reducing potential for leakage at this location. Ground preparation also stripped surface material to remove debris that could potentially puncture the Mactubes (i.e., protruding logs, embedded branches and/or sharp rocks).

IFC drawings specified the excavation of a bedding plane with a 3% grade along the alignment of the Mactubes. However, the 3% grade was not constructed due to concerns raised by the Contractor regarding the workability of the soil given saturated conditions. Also, because of saturated soils, slope stability was also concern where the temporary excavation would have been deepest near the ends of the Mactubes. The Mactube Filling Representative advised that the existing grade along the proposed alignment of the Mactubes was not excessive and was workable, without excavation of the specified 3% grade bedding plane.

A manufacturer's supplied liner was placed along the alignment of the Mactubes, and then two Mactubes were placed on top of the liner and rolled out (Photograph 4). Prior to filling, the Mactubes were tied off at identified anchor points on the bags, and connected to secure upstream objects, to prevent potential rolling and/or movement of the Mactubes during filling. The seam between the two Mactubes consisted of overlapping Mactube 1 (the south Mactube) with Mactube 2 (the north Mactube).

2.3 Filling of Mactubes and Construction of the Spillway

Mactube filling began on May 24, and was completed in the early afternoon of May 31. A "box and pump" method using a Toyo electric dredge pump, instead of a drag flow hydraulically operated dredge method, was used to fill the Mactubes. The box and pump system relies upon delivery of material into a mud tank where it is mixed with water to create a slurry which is then pumped via a dredge pump into the Mactubes (Photograph 5). The drag flow dredge relies upon dredging sediment directly from a water source such as Williston Lake Reservoir. Hydraulically operated dredge pumps allow for better control of pump pressure, whereas electric dredges are typically on or off, and therefore have less control over pump pressure.

A one inch diameter grizzly was used to separate debris and larger sized particles (gravel, cobble, rock etc.) from the entering the mud tank prior to being pumped into the Mactubes (Photograph 6). The one inch grizzly proved to be too small, and consequently, Mactube filling (production) was slowed by a constant need to tend the grizzly screen which frequently plugged. Reportedly, Toyo electric dredge pumps have the capacity to pump material with a particle size of up to 2.4 inches (Pers. Comm. John Smith Golder Construction, May, 2014), and consequently, the decision was made on May 27 to cut alternating metal grates from the grizzly to create a two inch diameter grate size. This adaptation to the grizzly greatly improved production by allowing larger gravel to be pumped into the Mactubes. The addition of larger particles was also considered beneficial in that it added complexity to the aggregate particle size within the Mactubes, which in part reduced the amount of fines leaving the Mactubes during decanting.

During filling of Mactube 1 (south side) on May 28, two small holes (approximately 10 cm in diameter) were observed in the Mactube approximately 5.3 m south of the proposed centre line of the spillway, and adjacent to a filling port (Photograph 7). Mactubes are at risk of bursting if over pressurized as they become filled to capacity; however, the holes observed were atypical of those witnessed by the Mactube Filling Representative in past work for the following reasons:

- Mactube 1 was well below the manufacturer's identified filling capacity height when the holes developed. The height of the Mactube was less than 2.0 m when the holes were observed, opposed to 3.0 m in height which is the theoretical capacity. The two holes developed side by side along the top of the Mactube, rather than a tear along the seam of a Mactube, as has been observed in the past (Photograph 8).
- An attempt to sew the holes together caused the rip-stop nylon used to construct the Mactube to rip (Photograph 9) even though sewing material was being tightened by hand.
- The Mactube material at the location of the hole was described as "looking and acting like rotten, worn out clothes".

Development of these holes occurred when the Mactube crest height was at approximately 667.5 metres above sea level (masl), approximately 0.8 m lower than the designed invert elevation for the spillway. Work was stopped and the construction crew went on standby for May 29 and part of May 30, while Golder consulted with BC Hydro to consider options for continuing work. The main concern was further filling could worsen the hole in the Mactube.

During the work stoppage, Golder contacted the Macaferri sales representative and arranged delivery of a patch kit to repair the holes. Macaferri informed Golder that patches are normally applied to the inside of Mactubes which was not possible; therefore a single large patch was placed on the outside of the Mactube over the affected area (DAR - June 9). This repair did not occur until June 9, when the patch materials from Macaferri arrived on site. A rock bag weighted with soil was placed over the patch on the hole in Mactube 1 to reduce the potential for further damage from ice scour or potentially from water flowing into or out of the impoundment area at this location.

Due to the rising water levels in the reservoir and the cost associated with keeping equipment and crews on standby, Golder, in consultation with BC Hydro, decided to continue filling Mactube 1, and recommended that the invert elevation of the proposed spillway on Mactube 1 be lowered to an elevation of approximately 667.5 masl. This allowed construction to continue, recognizing the lower spillway elevation would reduce the area elevation of the impoundment. This change reduced the estimated area of impoundment by approximately half of the proposed design, from approximately 0.623 Ha to approximately 0.324 Ha. Mactube filling resumed the afternoon of May 30.

The new spillway was intended to be in the approximate location of the two holes. The intent was to fill remaining sections of Mactube 1 to a minimum of 0.2 m higher than the new spillway invert elevation. This approach reduced the risk of enlarging the holes.

The proposed methodology for constructing the spillway was to place a weighted object across the width of Mactube 1 at each end of the proposed spillway, and continue filling Mactube 1 on either side of the weighted area. Rock bags filled with available spoil material were placed as weights across the width of Mactube 1 and filling proceeded (Photograph 10). This method failed as the weighted rock bag did not prevent slurry pumped into the Mactube upslope of the placed weights from flowing into the proposed spillway location. As a result, only a slight depression was achieved for the spillway in Mactube 1, approximately 15 m south from the designed center line for this feature (Drawings 1006-C09-00172 and 173 – Appendix D).

2.4 Placement of the Downstream Log Boom and Associated Anchors

Four in-field changes occurred in the construction of log booms from that specified in the IFC drawings. The upstream log boom, identified as an option was not placed, and anchor blocks for the downstream log boom were sourced from BC Hydro, originally designed for use at the Taylor Boat launch. The anchor block configuration supplied by BC Hydro had a 32 mm hot dip galvanized chain embedded within the cement block, opposed to the recommended 37.5 mm non-galvanized steel road (Drawing 1006-C09-00174). These new anchor blocks chains were flexible as opposed to rigid. Golder reviewed and approved the changes to the anchor blocks. The gap between anchor individual logs was reduced from 1000 mm to 500 mm and traffic cones were affixed to the tops of logs as markers to identify the presence of the boom for boat navigation (Photograph 11).

2.5 Rip Rap Placement of Spillway Apron

There was a two day delay between delivery of the first load of rip rap (June 2) for the spillway apron, and completion of filling the Mactubes (May 31) due to availability of the barge transporting equipment. Rip Rap placement occurred between June 3 and June 5. Golder's field engineer was instructed to leave the site the afternoon of May 31 as it was not clear exactly when delivery and placement of rip rap would occur. There was also concern regarding construction cost overruns due to difficulty in accessing the site at the start of the project, and standby costs due to delays in production when the two holes were identified in Mactube 1. Consequently, Golder's Field Engineer/Construction monitor was not present during the placement of rip rap, but the May 31 DFIR provided instructions to the contractor regarding the placement of rip rap, which including two field modifications described below.

Two deliveries of rip rap were barged to the Site, concurrent with the demobilization of unnecessary equipment. The first load was class 10 kg rip rap (14 m^3 approx.) delivered on June 2, followed by a second load (14 m^3 approx.) of class 50 kg rip rap which arrived on July 3.

Field modifications to recommendations specified in the IFC drawings during the placement of rip rap included the following changes:

- Duz Cho indicated that placement of rip rap on the upstream side of the spillway would not be possible given that water was impounded in the treatment area and the excavator would not have sufficient reach to place the riprap. Even if the pond was emptied of water, saturated ground could not be negotiated by an excavator to place rip rap on the upstream side of Mactube 1.

Golder reviewed this request and agreed to the modification. It is anticipated that the ponded water upstream of the Mactubes will buffer the impact of plunging water on the bottom of the impoundment, when water begins flowing from the reservoir through the spillway in the spring.

- Golder requested that excess RPE liner under the Mactube 1 protruding downstream of the structure be rolled up over the Mactubes before placement of rip rap against Mactube 1, to provide added protection for the Mactube from potential punctures by rip rap as the spillway apron was being placed.

Duz Cho applied this change during construction of the rip rap spillway apron.

- Golder requested that non-woven geo-textile fabric be placed on original ground as a substitute for the RPE liner which was rolled up against the Mactube 1 as describe above.

Duz Cho applied this change during construction of the rip rap spillway apron. However, it is noted that Class 10 kg rip rap was placed directly upon the non-woven geotextile without placement of the prescribed 200 mm layer of 75 minus well graded sand and gravel. Golder was neither advised of, nor requested to approve this change.

- Golder requested that additional class 50 kg rip rap be brought on site and placed over top of the class 10 kg rip rap for additional protection against the potential displacement of class 10 kg rip rap.

Duz Cho applied this change during completion of the rip rap spillway apron.

Finally, based on survey data completed on June 9, and provided by Duz Cho to Golder on June 18, it appears that the rip rap spillway apron was not placed at the lowest point of Mactube 1. It cannot be confirmed from provided survey data if the apron matches the location of the spillway, and provided data for the rip rap apron is sparse in terms of the depth of placed rip rap, as well as the length and width of the rip rap apron. It is possible that rip rap was placed prior to identifying the lowest point along Mactube 1, or else rip rap placement followed tender document recommendations without confirming the lowest point with survey data. It is also possible the south end of Mactube 1 was still decanting water and had not settled completely, providing a false impression of where the spill way on Mactube 1 should be located if the record survey was completed prior to placement of rip rap which identified the low point in Mactube 1. Regardless, the actual location of the spillway was apparently shifted approximately 15 m south of the specified spillway centre line, and as a result it appears that the spillway on Mactube 1 is located approximately 10 m south of the southern edge of the placed rip rap spillway apron (Drawing 1006-C009-00172).

2.6 Demobilization of Equipment and Site Clean Up

Demobilization of the site occurred in conjunction with delivery of final construction materials (specifically rip rap for the spillway and log booms). Clean up included removal of rig mats, grading of the foreshore area, and spreading of larger gravel and cobble sorted by the grizzly. Final demobilization of equipment was completed on June 9.

3.0 RECORD DRAWINGS

Golder has prepared record drawings of the constructed works which are attached in Appendix D, including Drawings 1006-C09-00172 to 1006-C09-00175. Record drawings are based on the Completion Survey conducted by DWB Consulting Services Ltd. on behalf of Duz Cho, finished after Golder left the site.

A summary of the changes to specifications in the IFC drawings, as shown in the attached record drawings, are provided in Table 1 below.

Table 1: Summary of Changes Between IFC Design and the Completed Structure and Anticipated Impacts

Design Item	Requested Change	Request by Whom	Rationale	Anticipated Impact	Comment
3% grade on bedding plane for Mactubes	Use existing ground, no excavation	Duz Cho	Ground too saturated to excavate	Mactube alignment	Upon completion of the project, the Hydra Marine Mactube Filling Representative suggested the alignment of the Mactubes would have remained straighter if a bedding plane 25 to 50 cm deep was constructed along the length of each Mactube.
668.2 masl spillway invert elevation.	667.25 masl spillway invert elevation.	Golder	Concern regarding expanding holes in Mactube 1 if infilling continued.	Impoundment area reduced by approximately 0.3 Ha. Establishment of riparian vegetation may be hindered. More frequent full pool inundation of impoundment area due to lesser volume. Potentially more prone to drying out during low water years	The decision to continue was made by Golder in consultation with BC Hydro.
Log-boom	Concrete anchors utilizing 32 mm galvanized chain within the lock block opposed to 37.5 mm non galvanized steel rod. Gap between each log reduced to 500 mm from 1000 mm, traffic cones affixed to logs as markers.	BCH/Transport Canada	Available concrete anchors and cost savings.	None	Lock blocks available through BCH previously designed for use at Taylor Boat Launch.
In-field change	Additional Class 50 Kg rip rap.	Golder	Additional protection from ice scour/wave wash.	Additional protection for smaller rip rap from potential wave wash and ice scour.	50 Kg rip rap appeared to have (from pictures) substantial fines content.

Design Item	Requested Change	Request by Whom	Rationale	Anticipated Impact	Comment
Upstream rip rap spillway apron for inflowing reservoir water	Do not install.	Duz Cho	Excavator has insufficient reach to place material in flooded pond.	Minimal	Inflowing water from the rising reservoir is expected to be buffered by impounded water on the upstream side of the Mactubes.
RPE liner under Mactubes	Excess RPE liner rolled up over Mactube 1 between the rip rap spillway apron and the Mactube. Non-woven geotextile used as replacement for RPE liner between sand/gravel layer and original ground.	Golder	Added protection to Mactube during placement of rip rap.	None	Concern that placement of rip rap against Mactube could puncture the Mactube.
Sand-gravel layer between rip rap and ground liner	Not requested	Not requested	Unknown	Minimal	Golder field engineer not on site during placement of rip rap. Placement of filter cloth below rip rap is considered an equivalent to placing a sand and gravel layer.
Spillway location and width	Not requested	Not requested	Inability to create depression in Mactube 1 using weighted material.	Relocation of the spillway is not in itself anticipated to impact the project goals; however, placement of the downstream rip rap apron away from the actual spillway location may result in erosion at the downstream toe of the Mactube.	The actual spillway location with respect to the rip rap spillway apron should be confirmed as soon as the spillway can be observed in operation. If it is found that the rip rap spillway apron is not below the spillway, and signs of erosion and/or undermining of the geo-tube is confirmed with potential impact to the structure, rip rap apron placement may have to be adapted.

4.0 EXPECTED PERFORMANCE, INSPECTION AND MAINTENANCE

As WDS 34 is a demonstration site, the Site should be inspected periodically to confirm that the Mactubes are performing as intended and that there are no issues that may impact the performance of the structure. Performance of the structure can be monitored through an inspection program, which in turn may identify issues that should be pro-actively addressed to identify maintenance requirements, potentially extending the longevity of the structure. Such monitoring inspections can also provide input towards “lessons learned” for future consideration should the same method be applied elsewhere.

4.1 Structure Performance

Due to considerations of the British Columbia Dam Safety Regulation (as part of the *B.C. Water Act*), the invert elevation for the structure was changed from 669 masl to 668.2 masl in the IFC documents. This change reduced the estimated impoundment area of WDS 34 from approximately 0.9 Ha identified in the preliminary design documents (Golder 2011) to 0.62 Ha. As a result of the holes that developed in Mactube 1 as discussed in Section 2, a final invert elevation of 667.25 masl was established, further reducing the area of impoundment to about 0.32 Ha.

Structure performance is separated into biological and physical performances, and compares the differences in performance expected due to the change in spillway elevation from 669 masl originally proposed, to 667.25 masl as eventually constructed, described in the sections below.

4.1.1 Biological Performance

Anticipated changes in biological performance of WDS 34 are speculative, when compared to the original objectives identified for this project (Golder 2010 and 2011). The rationale for the project was to create a permanent wetland through the impoundment of water via the use of Mactubes. The conceptual design originally identified an impoundment target elevation of 669 masl, to create approximately 0.9 Ha of wetted habitat. This elevation was selected for the following reasons and objectives:

- the 669 masl elevation maximized shallow water (<1 m) habitat around the perimeter of the Site;
- the 669 masl elevation represents the average impoundment elevation of Williston Reservoir for the period of record. Maintaining a wetland at this elevation would reduce the frequency of inundation from the reservoir during average annual reservoir operating conditions;
- the 669 masl impoundment level of WDS 34 reduces maximum drawdown at WDS 34 to between 0 and 3 m since full pool for the reservoir is (672.08 masl); and,
- full pool is an infrequent occurrence, therefore, the duration of flooding over the impounded level of WDS 34 would be less during the annual average reservoir operating conditions than if the impoundment level of WDS 34 was at a lower elevation.

The above three points were all anticipated to positively influence establishment of riparian and emergent vegetation at WDS 34. This assumption is especially relevant during years of low reservoir levels when such vegetation has the greatest chance of becoming established in the drawdown zone of the reservoir, since a nearby water source for root systems is provided by impounded water at WDS 34. Once established, such vegetation is anticipated to better withstand flooding from the reservoir since it would not be flooded as frequently and for a lesser duration if it had established at lower elevations.

Additionally, a permanent impoundment of water at WDS 34 is anticipated to encourage the establishment of submergent vegetation which requires water coverage for growth and reproduction.

Provision of a permanent water body, combined with the establishment of vegetation is anticipated to be beneficial for wildlife, such as water fowl, wading birds, herptiles, and potentially fish.

GMSMON 15, Williston Reservoir Wetland Habitat Monitoring is a monitoring program presently being completed by Cooper Beauchesne. The focus of GMSMON 15 is to identify pre and post biological conditions at the Site, including wildlife use and the extent that vegetation is established within and around the perimeter of the impounded area (Cooper Beauchesne, 2013). Ultimately, this study will determine if the objectives of WDS 34 are achieved.

Prior to submission of results of the long term monitoring by Cooper Beauchesne, the impact of lower impoundment levels for WDS 34 due to the lowering of the originally proposed invert of 669 masl to that of the established invert elevation of 667.25 are speculated as follows:

- full impoundment of the area should be more easily achieved during spring conditions due to the lesser volume of water required to flood to the invert elevation of 667.25 masl;
- normal reservoir operations, on average, can be expected to flood the area more frequently and to a greater depth, and,
- during low water year's when the reservoir does not exceed 667.25 masl, the wetland will be more prone to drying over the summer as the ephemeral water source dries up.

Given the objectives identified for this project, the biological performance may include the following:

- lowered elevation of impoundment at WDS 34 will adversely affect the establishment of riparian and emergent vegetation at WDS 34;
- a sustained stable impoundment of water at WDS 34 is still anticipated to facilitate the establishment of submergent (true aquatic) vegetation. However, a higher potential for full drying of the pond may adversely impact sustaining submergent vegetation; and,
- use of WDS 34 by wildlife may be reduced if the vegetation is not established as extensively or grows as vigorously as anticipated than if water impoundment was at a higher elevation.

4.1.2 Physical Performance

A primary objective of utilizing Mactubes in the construction of WDS 34 was to determine the effectiveness of this method in utilizing locally available silt and sand as building material to impound water. Impoundment of water was achieved during filling of the two Mactubes, although much of the source water that filled the impoundment area was from the decanting process during the filling of the Mactubes. Since impounded water upstream of the Mactubes was pumped out of the area after the holes were discovered in Mactube 1 so that both Mactubes could be thoroughly inspected for other potential defects or issues, the impoundment area was not at full pool by the time of demobilization. Consequently, how the water behaves while the spillway is flowing over the Mactubes, and whether the spillway apron was placed at the correct location, could not be verified by the time Duz Cho had demobilized from the work site.

Compromises in the structure's ability to retain water may be expected over time due to the loss of structural integrity of the Mactubes if damaged from reservoir processes. These processes could include wave action, inflowing and outflowing water as the reservoir rises and falls, and physical damage to Mactubes from rafted debris and/or ice formation and movement.

Aging of the Mactubes may also eventually cause degradation of Mactube fabric which may cause leakage through the Mactubes. The manufacturer suggests a 10 year life span for Mactube material, but it is unknown if the anticipated performance of Mactube 1 will be affected by the presence of the patched holes, or if the patch will have a similar life span.

The low invert level of the established spillway (667.25) relative to the elevation at the south end of Mactube 1 (667.82) may provide a route for water to circumvent the spillway and cause erosion at the end of Mactube 1. Such circumvention of water may impact the structures ability to impound water.

To better understand the physical performance of the Mactubes, an inspection and monitoring program is proposed, as discussed below.

4.2 Inspection and Monitoring

The selection of WDS 34 was proposed, in part, because the site is at the end of a small bay and is somewhat protected from the large reservoir. It is anticipated that the protected nature of the site will likely minimize maintenance requirements. The narrow opening of the channel leading to the site, as well as the orientation of this channel, reduces exposure of the site to waves and debris (individual or rafted logs). The addition of the downstream (reservoir side) log-boom is anticipated to further minimize the potential impact from waves and debris on the Mactubes, however, failure of the log boom could detrimentally impact the Mactubes. Similarly, displacement of rip rap could result in scour at the toe of the Mactubes and affect the integrity of the structure. Consequently, monitoring the integrity of the log boom, and monitoring for signs of erosion, scour and damage to the Mactubes from reservoir processes and/or the flow of water in, or out of the impoundment created by WDS 34 should be implemented. Table 2 identifies monitoring and inspection recommendations and the rationale for each recommendation. Based upon the findings of the monitoring and inspection program, periodic maintenance of WDS 34 may be required.

Table 2: Summary of anticipated inspection items at WDS 34 - Beaver Pond

Item No.	Item Name	Inspection Items	Rationale	Potential Impact	Comments
1	Erosion and Scour	Along base of Mactubes on upstream and downstream sides of the structure.	Outflowing and inflowing water and/or wave wash may erode silty/sandy soils not protected by rip rap.	Loss of structural integrity if shifting and/or rolling of Mactubes occurs if undermined.	Downstream side can be inspected in spring prior to rising reservoir levels. Viewing tube/goggles/snorkeling may be required to view into impounded water on the upstream side of the structure. Undercutting from spilling water may occur at the defined spillway at the downstream or possibly upstream base of Mactubes 1 if the spillway apron is at the wrong location, or at other areas water is spilling over the structure.
2	Erosion and Scour	South end of Mactube 1	Erosion may result if water flowing in or out of the structure circumvents the designed spillway and flows around the south end of Mactube 1.	Loss of designed invert, inability to impound water.	There is some concern regarding impounded water circumventing around the low elevation of the south end of Mactube 1 (667.82 masl) relative to the spillway elevation, particularly if settlement occurs at the end Mactube 1.
3	Log Boom	Disconnected boom, chain condition (excessive corrosion), anchor shifting, presence and condition of five traffic cones marking the log boom. Gaps between individual logs.	Wear and tear from reservoir action upon corroded chain may cause chain breakage, and opening of the log boom, allowing waves and debris to come in direct contact with Mactubes. Loss of markers identifying presence of log boom during high water. Large gaps between logs may allow passage of debris.	Scour at downstream base of Mactubes; puncture/fraying of Mactube material. Navigation hazard to boaters.	The Log Boom should be aligned perpendicular to shores. Misalignment of anchors may indicate anchors have shifted or have been displaced. Aside from gaps between boom logs, checking for gaps between individual logs and the shoreline (particularly near shore edge where long logs may not lie flat) may allow passage of woody debris under/over the log at these gaps. Shortening near-shore logs may mitigate potential for debris to move under logs.
4	Mactube General Condition	Fabric tears/fraying/wear.	Wear and tear upon the fabric of the Mactube from reservoir processes and/or aging	Deterioration of the Mactube fabric, if observed, may impact the integrity of the Mactube and the structure's ability to impound water.	View all exposed areas of the Mactube. A viewing tube, or snorkel gear and mask may aid viewing areas of the Mactubes within the impoundment area upstream of the structure.

Item No.	Item Name	Inspection Items	Rationale	Potential Impact	Comments
5	Debris Accumulation	Identify if debris is accumulating against either upstream or downstream sides of Mactubes.	Log and other large debris against the Mactubes, worked by wave and wind action may puncture or otherwise damage Mactube fabric.	Loss of structural integrity of Mactube could reduce life span of the Mactube and/or impact ability of the structure to retain water if soil material leaks out of the Mactube.	Experience from WDS 6-2 (Airport Lagoon) indicated debris was able to get under/over a log boom, requiring near shore logs to be shorter in length to better hug the shoreline during rising and falling reservoir water levels. The decision to not place a log boom on the upstream side of the structure was based upon the short fetch for wind to work existing upstream debris against the Mactubes, which should be confirmed by inspections.
6	Settlement of Mactubes	Determine the location and path of outflowing water by visually observing the location outflowing water relative to the rip rap apron.	The weight of the Mactubes is heaviest towards the centre of the structure. Differential settlement along the length of the Mactubes may occur depending upon underlying ground conditions.	Settlement of the central portion of the Mactubes in and around the placed rip rap for the spillway apron would be a positive development, but differential settlement along any other portion of the Mactubes would be undesirable.	Completion drawings suggest the present location of the rip rap spillway apron may not be aligned with the lowest point of the Mactubes, and consequently, outflowing water may result in scour at an unprotected area along the base of a Mactube. Identify if unanticipated erosion at the base of the Mactubes exists, which may indicate settling of the Mactube, and/or miss-positioned spill apron.
7	Displacement of Placed Rip Rap	Look for signs of riprap loss and displacement.	Displacement of rip rap may represent settling of material, or inappropriate sizing relative to actions from wave wash, ice scour, or outflowing water.	Loss of rip rap may increase potential for scour as described in Items 1 and 6.	Spillway apron is not likely aligned with the spillway.

Item No.	Item Name	Inspection Items	Rationale	Potential Impact	Comments
8	Expansion of Existing Holes in Mactubes.	Check top of Mactube 1 at location of holes, marked by placed rock bag covering the holes and patch. Determine if tears have expanded beyond the patch, or if the rock bag is still covering the patch, check for tears extending beyond the rock bag.	Expansion of tears beyond the patch will indicate an enlargement of the hole.	Loss of material out of holes from outflowing/inflowing water may impact the invert elevation of Mactube 1 and also advance the deterioration of the Mactube. If observed, this may impact the integrity of the Mactube and the structure's ability to impound water.	Patch placed on outside of the Mactube after the Mactube was near full. Normally, the manufacturer recommends patches are placed inside the Mactube.
9	Water Leakage	Inspect Mactubes for leakage under MacTubes at the seam between the Mactubes, and under the Mactube at the old creek channel	Loss of water, and potential erosion of foundation.	Impaired ability to retain water sourced from the ephemeral stream, and potential worsening of water loss due to erosion. Significant erosion of the foundation could circumvent the spillway and eliminate the structures ability to retain water.	This item is particularly relevant when reservoir elevation does not exceed the invert elevation of the structure during low water years. This may increase the potential for the impoundment to dry out towards the end of the summer or into the fall.
10	Vandalism	Slashes or cuts to Mactube material, disconnection of log boom chain.	The area is not readily observed from the main body of the reservoir, so the area is remote and not attended and may be subject to vandalism.	As identified in Items 3, 4 and 7.	File police report as required. Consider site surveillance (bush cameras) if vandalism occurs.

In regards to the timing, frequency of inspections, and the qualifications of personnel completing inspections, Golder recommends the following:

1) Inspections should occur in the spring, after ice-off, but prior to rising reservoir levels reaching the structure. Ideally, inspections should occur at a reservoir elevation of 665 masl or less based upon weather conditions and/or reservoir levels as discussed in further detail below, to facilitate full viewing of the Mactubes. The base of the structure is located at 665.8 masl (approx.).

The date at which ice off occurs in Williston Reservoir can be highly variable but should be expected to occur between April and the end of May in most years. The date of ice off is important since this will determine when the site can be accessed by boat. As shown in Figure 1, on average, reservoir water levels can be expected to reach the base of the Mactubes as early as May 23 during years of high water level operating regimes, or as late as June 17 for mean water level regimes, or potentially not at all during minimum reservoir operating regimes. For this reason, it is important the individuals retained to complete monitoring inspections coordinate the scheduling of their visit to WDS 34 with their BCH representative who should be able to provide up to date reservoir levels and forecasted reservoir levels into the near future.

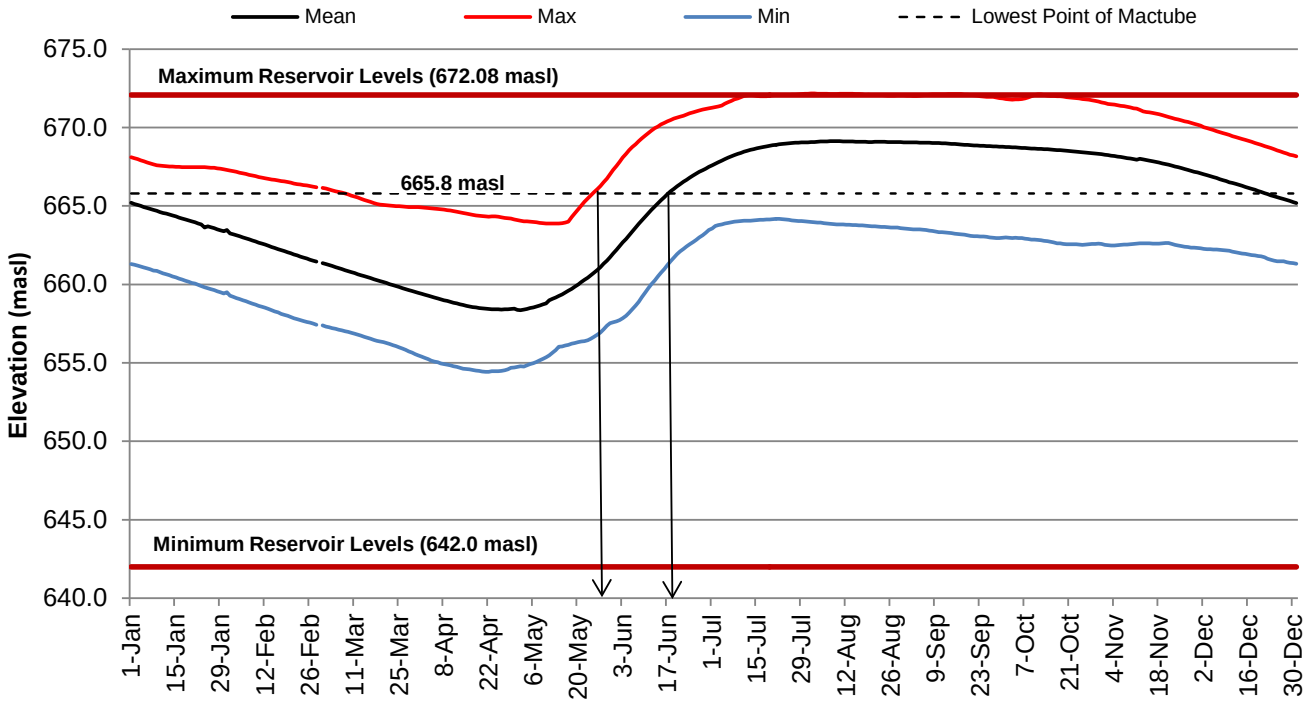


Figure 1: Average of maximum, minimum and mean annual water levels in Williston Reservoir for the period 1984 to 2010 showing minimum and maximum supply elevations relevant to the approximate elevation (metres above sea level) of the lowest point of the Mactubes. Arrows show a possible range of dates the base of the Mactubes may be reached in any given year of operation of the Williston Reservoir.

One field day, not including travel to and from Mackenzie, should be allocated for inspections, including boat travel to and from the site.

2) The minimum frequency of inspections should be once annually.

   - During years that the reservoir does not exceed the invert elevation of the structure's spillway, an inspection may be considered during the late summer or fall to determine if water is still present upstream of the structure. However, variations in impoundment level over time may be more accurately determined on an annual basis by installation of a water level data recorder (Solinst Level logger or equivalent).

3) Qualifications of inspectors could be an engineer and/or a qualified environmental professional (QEP), however, the individual should have general understanding of the following items:

   - reservoir operations;
   - recognizing and differentiation between types of erosion and potential causes of such erosion (i.e., distinguishing erosion/scour resulting from wave wash as opposed to flowing water); and,
   - the inspector should be aware of construction techniques that may be required to mitigate issues that are observed.

4) Resources suggested for monitoring surveys are not extensive or specialized, however, safety should be a key consideration, including the following suggestions:

   - carry a copy of this completion report document including completion report pictures, and completion drawings;
   - standard gear including camera, 50 m tape, metre stick, GPS and survey level (this last piece of equipment is optional and will require two individuals);
   - needle and thread and patch material for possible minor repair if damage to the fabric of Mactube is observed;
   - a viewing tube or snorkel gear (optional – the latter likely requiring a dry suit);
   - boat with appropriate safety gear as identified by transport Canada to travel to and from the site (i.e., flares, throw bags, oars, life vests etc.) in addition to spare fuel, spare ('kicker") motor and other gear as follows:
     - two way radio programmed with appropriate local channels;
     - satellite phone;
     - cell phone (cell phone coverage exists at site, but not necessarily along travel routes to site);
     - survival gear (should the monitor not be able to return the same day due to unforeseen conditions); and,
     - rain and cold weather gear and waders.

- For reasons of safety related to boating to a remote location on Williston Reservoir, two individuals should be used to inspect WDS 34. To this end, the initial monitoring inspection should consider incorporation of both a QEP and engineer to inspect the structure, which would facilitate cross training between individuals and the interchange of monitors for future inspections if required.

4.3 Maintenance

Maintenance requirements, if any, will be determined by inspections. The types of maintenance anticipated may include:

1) Removing logs from within the log boom barrier and/or shortening the near shore log boom lengths. At Site 6-2, it was speculated that when the water levels are low, one end of the log sits up on the embankment slope while the other end is submerged, creating a gap to allow logs and debris to bypass the log boom.

2) Reapplication of a patch or other suitable cover to prevent further enlargement of the existing holes in Mactube 1, or patching holes that develop elsewhere.

3) Addition of rip rap at the outflow (downstream) or moving existing rip rap to the outflow. If scour is observed at the upstream side of the spillway, the construction of an upstream spillway apron may be required.

4) Addition of more Mactubes if BCH decides to achieve the design impoundment level for the structure.

5) Replacement of damaged or broken log-boom chains, and/or repositioning of log-boom anchors if the anchors are substantially displaced.

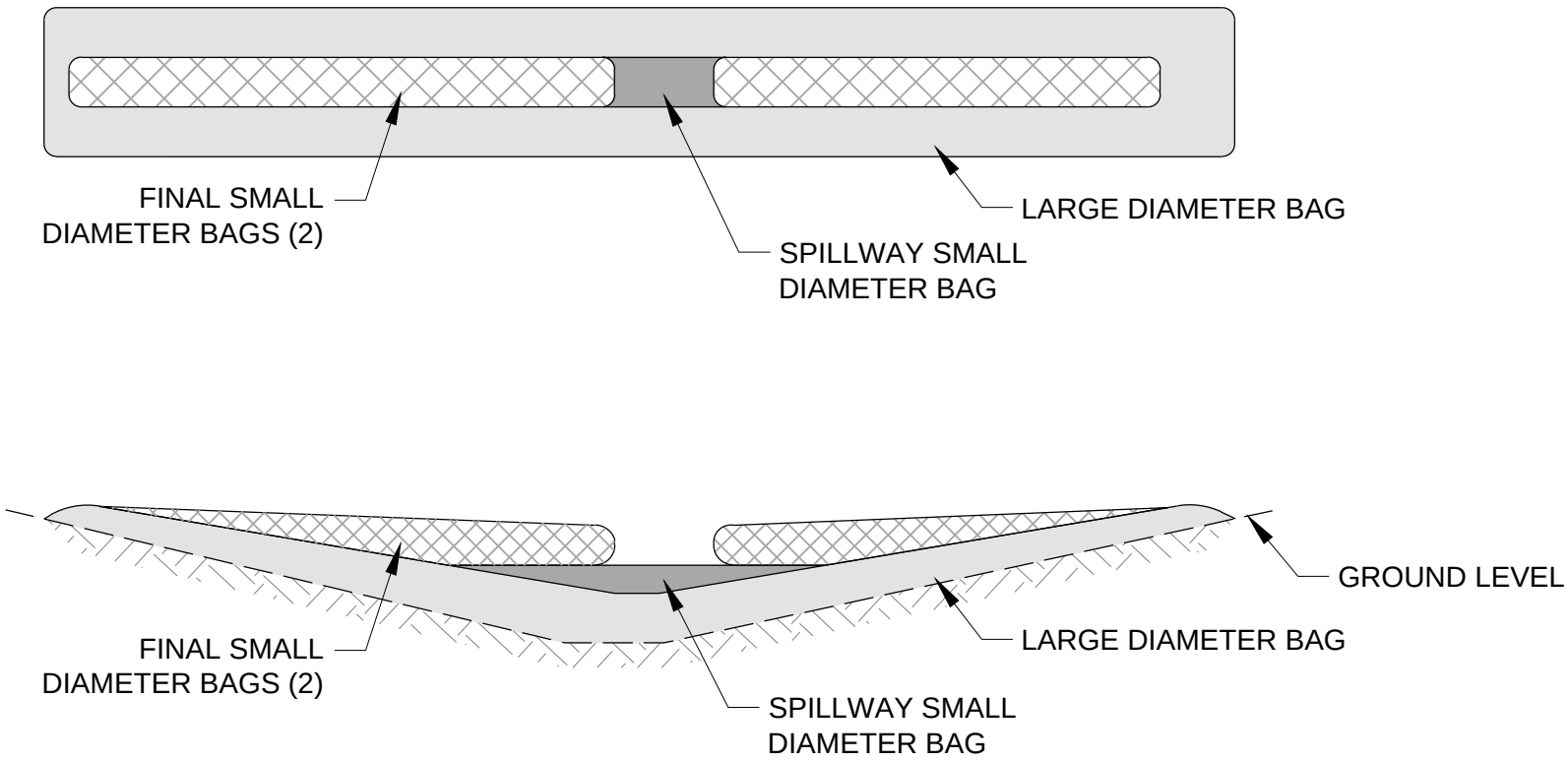
5.0 CONCLUSIONS AND LEARNINGS

Golder provided on-site construction monitoring from May 21 to May 31, 2014. During this construction period, a number of notable construction issues were encountered, altering how the works were completed relative to the IFC drawings (described in detail in Section 3.0). The following items are considered most significant and warrant specific attention during proposed annual inspections:

1) The specified impoundment water level determined by a designed spillway elevation of 668.2 masl was not achieved due the appearance of two holes in Mactube 1. Rather, filling of the Mactubes was curtailed to a spillway elevation of 667.25 to avoid potential further enlargement of the holes.

2) The proposed method for constructing the spillway (weighting the area of the spill way and filling the Mactube on either side of the spillway) was unsuccessful. For future projects, multiple Mactubes may be considered to create a defined spillway, as opposed to weighting the Mactubes as attempted on this project (Figure 1).

3) The rip rap spillway apron location may not coincide with the location of the spillway based upon completion survey data. Identification that the spillway matches the location of the apron, as opposed to what is shown on completion drawings to confirm potential for scour due to plunging water onto unarmoured soil.



RECOMMENDED BAG USE TO CREATE SPILLWAY

Golder Associates

FIGURE: 2

In addition to the above substantive alterations from the IFC drawings, the following learnings have been identified for future consideration:

1) The available material was suitable for filling the Mactubes, however, completing test pits prior to construction to confirm the material source is recommended for future projects. A high sand content and low silt content increases production and decreases turbidity associated with decanted water.

2) Box and pump method is an effective means for filling Mactubes, however, a hydraulically operated dredge method is recommended for future projects instead of an electric dredge pump as hydraulic dredge pumps allow for varying the fill rate as Mactube become full, thereby reducing the risk of over-pressurization of Mactubes.

3) A more formal ground anchoring system (e.g., buried deadmen) at every anchor point on the Mactube to better control the alignment of Mactubes during filling. Anchor lines were used, but the anchors were insufficient in weight to properly secure the Mactubes.

4) Excavating a shallow trench (25 to 50 cm in depth and 3 to 4 m wide) along the centre line of the Mactube to aid locking the Mactube into proper alignment.

5) If the “box and pump” system is used, an appropriately sized grate on the grizzly that matches the dredge pumps particle size capability increases production.

    a. Note that screening of fill prior to pumping, if the box and pump system is used, is also recommended to keep small woody debris from plugging the dredge pump.

6) A resurvey of WDS 34 would be useful to determine if settlement at WDS 34 is occurring, but also to verify topographic survey data collected at the end of construction in 2014 which provided limited data. A resurvey for this project, or surveying for future Mactube projects should include, at minimum, the following:

    - more cross-sections along the length of the Mactubes, including elevations across the entire Mactube to the each edge;
    - more detail for the rip rap spillway apron, including the width and length of the apron and the thickness;
    - survey points of the original ground along the length of the Mactubes on both sides and the ends of the structure;
    - co-ordinates of the road alignment and width through the forested area that was cleared to gain access;
    - survey of the perimeter of impounded water to confirm the impoundment area; and,
    - co-ordinates for the hole in Mactube 1.

6.0 CLOSURE

We trust this Completion Report for the construction of the WDS 34 Beaver Pond meets your current requirements. Please contact the undersigned if you require any further information regarding this Completion Report.

Yours truly,

GOLDER ASSOCIATES LTD.

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Senior Fisheries Biologist

Bruce Bosdet, M.A.Sc., P.Eng.
Consultant, Senior Geotechnical Engineer

MG/MT/BB/tc

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7.0 REFERENCES

Cooper Beauchesne. 2013. Peace Project Water Use Plan, Reservoir Wetland Habitat Monitoring - Implementation Year 2 Reference: GMSMON-15. Prod. For BC Hydro Water Licensing Requirements, Burnaby, B.C. Prod. by Cooper Beauchesne and Associates Ltd., Northern Interior Office, Prince George, B.C.

Golder, 2010. GMSWORKS 16 – Williston Reservoir Wetlands Inventory. Prod. For BCH, Water Licencing Requirements, Burnaby, B.C. Prod. by Golder Associates, Kamloops, B.C.

Golder, 2011. GMSWORKS 17, Williston Reservoir Wetland Demonstration Sites, Stage II – Detailed Design and Cost Estimate. Prod. For BCH, Water Licencing Requirements, Burnaby, B.C. Prod. by Golder Associates, Kamloops, B.C.

Golder, 2013a. BCH Williston Reservoir – WDS 6-2 Airport Lagoon, Detailed Design Basis Memorandum (Technical Memorandum). Prod. for BCH, Generation Project Delivery, Burnaby, B.C. Prod. by Golder Associates, Kamloops, B.C.

Golder, 2013b. Completion Report- BC Hydro Report # N3589. BC Hydro Williston Reservoir Wetland Demonstration Site 6-2, Airport Lagoon. Prod. for BCH, Generation Project Delivery, Burnaby, B.C. Prod. by Golder Associates, Kamloops, B.C.

Golder, 2014. BCH Williston Reservoir – WDS 34 Beaver Pond, Detailed Design Basis Memorandum (Technical Memorandum). Prod. for BCH, Generation Project Delivery, Burnaby, B.C. Prod. by Golder Associates, Kamloops, B.C.

Peace Water Use Plan Committee (PWUP) 2003. Peace Water Use Plan – Committee Report Vol. I. Prep. by BC Hydro. Prep. for the PWUP. ISBN 0-7726-5103-5.

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APPENDIX A

Duz Cho - Daily Activity Reports (May 14 – June 10, 2014)

BC Hydro Beaver Pond Trial Wetlands	

May 14, 2014	Day 40	7^0- 18^0	Light rain in morning and overcast with sunny breaks.

Daily Comment: Held daily tailboard safety meeting. Continued off-loading barge. Saturated lower sub-soils are quite soft and makes work conditions difficult. Started stockpiling material for Mac Tubes.

Placing mats on foreshore sub-soil

Excavator stockpiling material for Mac Tubes.

BC Hydro Beaver Pond Trial Wetlands

May 15, 2014	Day 41	7^0- 18^0	Sunny

Daily Comment: Held daily tailboard safety meeting. Continued placing swamp mats to create a road from the barge to site. Completed off-loading. Completed weekly safety inspections. Proposed road alignment cannot be used due to fine textured saturated sub-soils. Discussed issue with BC Hydro representative and notified BC Parks.

View of barge landing from water.

Sloughing side slope along proposed road alignment.

BC Hydro Beaver Pond Trial Wetlands

May 16, 2014	Day 42	7^0-18^0	Sunny

Daily Comment: Held daily tailboard safety meeting. Held weekly safety meeting and site inspection. Worked on access up to Park boundary. Cleared area for fuel tank liner and secured fuel tank into place. Cleaned up site, locked everything and placed drip trays under all equipment.

Fuel tank liner installation.

Drip trays in place.

BC Hydro Beaver Pond Trial Wetlands

May 20, 2014	Day 46	12^0	Overcast with Sun

Daily Comment: Held daily tailboard safety meeting. Loaded matting on barge and sent it to site. DWB slashed trail through Park into the work area. Started clearing road into work area.

Slashing

Trail to work area. Note safety berm along steep left side of access.

BC Hydro Beaver Pond Trial Wetlands

May 21, 2014	Day 47	12^0	Overcast with Sun

Daily Comment: Held daily tailboard safety meeting. Reviewed working around water safety. Unloaded barge and filled up fuel tank. Continued placing mats on the road that was slashed the previous day. Canadian Dewatering set up pump float in the bay and are laying hoses and power cables. Minor spill was reported when dewatering generator leaked due to the angle it was sitting. The spill was cleaned up and reported.

Filling fuel tank.

Unloading of matting

Placing of matting.

BC Hydro Beaver Pond Trial Wetlands

May 22, 2014	Day 48	8^0	Overcast and Rain

Daily Comment: Held daily tailboard safety meeting. Placed mud tank on matting. DWB set up fish traps. A test hole was dug and usable material was discovered. Leveled out work area where begs will be laid.

Mud tank.

Testing material.

BC Hydro Beaver Pond Trial Wetlands

May 23, 2014	Day 49	4-18^0	Overcast and Rain

Daily Comment: Held daily tailboard safety meeting. SSSMP and detailed constructions plan has now been approved around mid-day. Bags can now begin to be filled. DWB set up silt curtains and continued with fish traps for fish salvage. The setup of dewatering equipment was completed and tested. The stockpiling of material for bags has now begun at slurry tank.

Clean water pump and float set up in bay.

Hooking up water and power lins from pump to mud tank

Silt curtains set up at mouth of creek

Bentonite clay mixed with soil at former stream channel under Mac Tubes

BC Hydro Beaver Pond Trial Wetlands

May 24, 2014	Day 50	6-17^0	Sunny with clouds and rainy periods.

Daily Comment: Held daily tailboard safety meeting. Placed liner and Mac Tubes. Started filling bags but started having problems with grizzly screen not allowing enough material into the mud tank. Mac Tubes were anchored with deadmen to the upslope side to prevent rolling. DWB relocated the fish that they had gathered in the traps. Relocated slump to gather ground water more efficiently, as well as ongoing stream flow.

Laying liner prior to placing Mac Tubes

Mac Tubes laid out ready for filling

Rock truck delivering material

Silt curtains keeping sediment out of reservoir

BC Hydro Beaver Pond Trial Wetlands

May 25, 2014	Construction Day 14	6-16^0	Overcast with sunny periods.

Daily Comment: Held daily tailboard safety meeting. Continued hauling material for the filling of bag. Removed grizzly screen on mud tank as it as preventing most of the material from being put into slurry DWB was on site monitoring the daily environmental activities.

Feeding the mud tank.

Hauling of material.

Filling of bag.

BC Hydro Beaver Pond Trial Wetlands

May 26, 2014	Construction Day 15	3-18^0	Overcast with sunny periods.

Daily Comment: Held daily tailboard safety meeting. Continued hauling material to mud tank. Continued filling mud tank with sand and Mac Tubes with slurry. DWB surveyed material in bag as well as continued on-site monitoring.

Filling mud tank and pumping slurry

Filling Mac Tube.

BC Hydro Beaver Pond Trial Wetlands

May 27, 2014	Construction Day 16	3-14^0	Overcast with sunny periods

Daily Comment: Held daily tailboard safety meeting. Continued hauling sand to mud tank filling mud tank and filling Mac Tubes. Began cutting grizzly to allow bigger pieces of material to fall through. DWB continued monitoring activates on site. Cut out every second grate on Grizzly Screen to allow more material to pass into mud tank.

Filling mud tank.

Filling the bag

Cutting every second grate out of grizzly screen

BC Hydro Beaver Pond Trial Wetlands

May 28, 2014	Construction Day 17	3-17^0	Sunny with overcast periods

Daily Comment: Held daily tailboard safety meeting. Continued filling mud tank and filling bags with slurry. DWB continued monitoring activates on site. Failure in the material of the bag has caused it to burst in 2 small holes (10 cm diam.) while being filled. Manufacture has been contacted to see if bag can be repaired. Work has been put on hold until a go-forward decision has been made by the engineer and agreed to by BC Hydro.

Filling Bag

Bag Failure.

Unsuccessful patch

BC Hydro Beaver Pond Trial Wetlands

May 29, 2014	Construction Day 18	3-17^{0}	Sunny with overcast periods

Daily Comment: Crew is on standby waiting on notification if the project is still going to go forward.

Sorry, no pictures today.

BC Hydro Beaver Pond Trial Wetlands

May 30, 2014	Construction Day 19	9-19^0	Sunny with Overcast.

Daily Comment: Held daily tailboard safety meeting. Got approval from Golder to continue filling bag but at a lower elevation. Continued hauling material and filling bag.

Filling of bag.

BC Hydro Beaver Pond Trial Wetlands

May 31, 2014	Construction Day 20	9-19^0	Overcast with rainy periods.

Daily Comment: Held daily tailboard safety meeting. Finished filling bag. Began demobilization of the dewatering equipment.

Silt curtains keeping water clear (reservoir is to left)

BC Hydro Beaver Pond Trial Wetlands

June 1, 2014	Construction Day 21	9-23^0	Sunny.

Daily Comment: Held daily tailboard safety meeting. Began demobilization and moving swamp mats.

Sorry, no pix today

BC Hydro Beaver Pond Trial Wetlands

June 2, 2014	Construction Day 23	9-23^0	Sunny.

Daily Comment: Held daily tailboard safety meeting. Barge delivered fuel truck to off-load fuel tanks, rip rap and boom logs.

Barge coming in

Loading the barge

Rip rap delivered

Boom logs delivered

BC Hydro Beaver Pond Trial Wetlands

June 3, 2014	Construction Day 24	9-23^0	Sunny.

Daily Comment: Held daily tailboard safety meeting. Placed rip rap in spill way. Continued demobilization and finished first barge load.

Loading the swamp mats

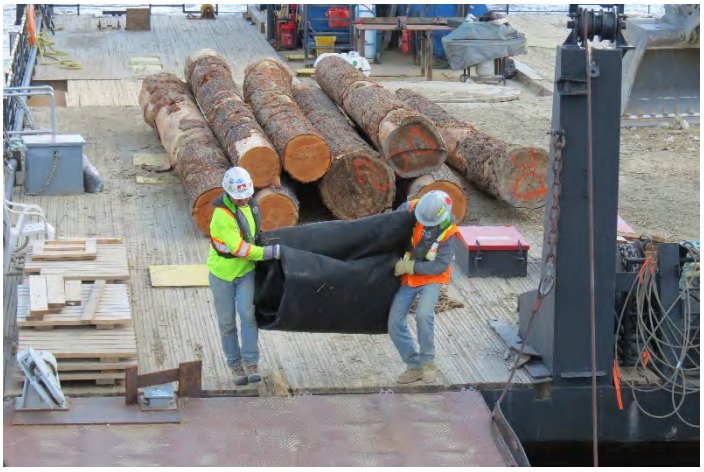
Drilling the boom logs

Placing the filter stone

Placing the boom logs

BC Hydro Beaver Pond Trial Wetlands

June 3-5, 2014	Non-woven geotextile placement	Sunny



Delivering the geotextile

Prepping for placement

Site prepped for geotextile placement

Placing the geotextile

Placing the filter stone on the geotextile

Finished product with plastic liner on Mac Tube

BC Hydro Beaver Pond Trial Wetlands

June 4, 2014	Construction Day 25	3-7^0	Snow and Rain.

Daily Comment: Held daily tailboard safety meeting. Unloaded first barge load in Mackenzie and delivered load of 50 kg rip rap to barge. Crew continued demobilizing at Beaver Pond.

Sorry, no pix today.

BC Hydro Beaver Pond Trial Wetlands

June 5, 2014	Construction Day 26	7-23^0	Sunny

Daily Comment: Held daily tailboard safety meeting. Loaded all remaining supplies and equipment on second barge load and sent it to Mackenzie. Completed weekly safety inspection

50 kg rip rap placed over filter stone

Larger piece of rip rap (80 cm)

Trail through park with mats removed

Contouring laydown area

BC Hydro Beaver Pond Trial Wetlands

June 6, 2014	Construction Day 27	7-23^0	Sunny

Daily Comment: Held daily tailboard safety meeting. Finished demobilization and unloading barge. Only site work left is to patch Mac Tube, survey site and remove silt curtains.

Canadian Dewatering gear ready for shipping

New mats and bridge module to be returned

Used mats

BC Hydro Beaver Pond Trial Wetlands

June 9, 2014	Construction Day 28	3-7^0	Overcast with rainy periods.

Daily Comment: Held daily tailboard safety meeting. Finished patching hole in bag. Final inspection was completed. Demobilization and separating out BCH and 3rd party supplies and equipment continued at the barge landing in Mackenzie.

Finished berm

Wildlife on site

Completing the As-built survey

Patched bag

BC Hydro Beaver Pond Trial Wetlands

June 10, 2014	Construction Day 29	3-7^0	Overcast with rainy periods.

Daily Comment: Held daily tailboard safety meeting. Used a crane to load up all dewatering equipment and shipped it out. As per BCH, began transferring used swamp mats to Duz Cho's Mackenzie Sawmill yard and arranged to have new/unused mats sent back to manufacturer for credit.

APPENDIX B

Construction Photos

APPENDIX B
CONSTRUCTION PHOTOS

Photo 1: Access to the site required an overland route through the forest, opposed to following the shoreline into the small embayment where WDS 34 is located.

Photo 2: Test pit to determine depth of suitable material for filling Mactubes prior to reaching clay.

Photo 3: Ground preparation of the bedding plane for the Mactubes was limited to removal of woody debris and other sharp objects that could puncture the bags.

Photo 4: Placement of the RPE liner for Mactube 1. Mactube 2 at the north end of WDS 34 has already been laid out over the liner.

Photo 5: Box and pump system, showing the mud tank in the back ground and Toyo electric dredge pumps (one in the tank and the spare in the foreground).

Photo 6: Material being fed through the 1 inch grizzly and washed into the mud tank. Note the gravel/cobble (arrow) at the base of the grizzly. The grate size of the grizzly was eventually cut to 2 inch size to facilitate passage of larger particle sized material into the tank, increasing Mactube filling production.

Photo 7: The two holes discovered in Mactube 1 were atypical of those observed by Golder Construction and the Mactube filling monitor in the past from over pressurization of the Mactube.

Photo 8: Over pressurization during filling of Mactubes typically results in longtitudinal tears along the seams of the bag (Courtesy of John Smith-Golder Construction).

Photo 9: An attempt to sew the holes together was unsuccessful, as the material ripped and the two holes became one.

Photo 10: Weighted rock bags filled with silt were not sufficient to form a barrier to prevent slurry from flowing into the area designated as a spillway.

Photo 11: Log boom markers identifying location of the log boom for boaters that may enter the area. (Photo Courtesy of N. Vanderkwaak).

APPENDIX C

Golder - Field Inspection Forms (May 21 – May 31, 2014)

ENGINEER / INSPECTOR'S DAILY REPORT

PROJECT

Project No:	14-1434-0003	**Project Name:**	BCH Beaver Pond Const. Services

WORK SHIFT

Date:	May 21, 2014	**Work Shift:**	Day
Time Arrived on Site:	To Mackenzie 12:30 pm	**Time Left Site:**	3:15 pm
Travel Time to Site:	From PG 2.15 hrs	**Travel Time from Site:**	0.25 hrs
Other Time:	(Report + Photos) 0.5 hrs	**Total Time :**	
Weather:	Overcast	**Temperature Range:**	10-14 degrees
Golder Inspector:	Nader Gendy	**Other Personnel:**	Ian Clark (Hydra Marine)

WORK SITE

SITE:	Duz Cho office in Mackenzie	**LOCATION:**	Mackenzie BC
Contractor(s):	Duz Cho	**Contractor's Working Hrs:**	7:30am – 6:30 pm

DAILY SITE ACTIVITIES REPORT

Golder and Hydra Marine attended a health and safety orientation that was presented by Duz Cho in their office in Mackenzie.

Golder (Nader Gendy) and Duz Cho (Grant Webber) discussed the excavation procedure and requirements; BCHydro (Wolly) and Hydra Marine (Ian Clarke) were present and participated in the conversation. It is our understanding that BCHydro (client) and Duz Cho (contractor) are willing to place the Mac Tubes without excavating to bearing soil – only minimal excavation (horizontal) is planned to have a fair contact area between soil and the bottom of tubes. Golder made it clear to both parties that settlement would be expected, in both short terms and long terms; to keep top of tubes elevation as designed, further tube filling will be required to accommodate settled soil.

Golder inspected Rip Rap and photos were taken; Golder recommended not using any particles less than 90 mm in size. The inspected site is a boat ramp that the same rip rap will be used for Beaver Pond site. Golder communitated with Duz Cho through a text message, sent to Grant Webber, and a copy of this daily report forwarded through e-mail as well.

Distribution:		
Golder Files	**Engineer/Inspector**	Nader Gendy

ENGINEER / INSPECTOR'S DAILY REPORT

PROJECT

Project No: 14-1434-0003 **Project Name:** BCH Beaver Pond Const. Services

WORK SHIFT

Date:	May 22, 2014	**Work Shift:**	Day
Time Arrived on Site:	8:00 am (to the boat ramp)	**Time Left Site:**	10:00 am (from the boat ramp)
Travel Time to Site:	1 hrs	**Travel Time from Site:**	1 hrs
Other Time:	0.5 hrs (Report + Duz cho)	**Total Time :**	4.5 hrs (min 8 hrs)
Weather:	Overcast and rainig	**Temperature Range:**	8-10 dgrees
Golder Inspector:	Nader Gendy	**Other Personnel:**	Ian Clarke (Hydra Marine)

WORK SITE

SITE:	Beaver Pond BCH	**LOCATION:**	Mackenzie BC
Contractor(s):	Duz Cho	**Contractor's Working Hrs:**	7:30am – 6:30 pm

DAILY SITE ACTIVITIES REPORT

Golder, Hydra Marine and BCHydro personnels started with site safety meeting in Duz Cho trailer onsite.

A quick testpit was excavated by Duz Cho, and logged by Golder, to know the encountered soil material and availability for using the same material to fill Mac Tubes. Testpit location is 55° 28' 48"N 123° 19' 44"W; it was excavated to 1.00m below ground level and material description is 'ML CLAYEY SILT, trace fine sand and coarse gravel; brown-grey, cohesive, loose to compact, wet, varved, contains organics (rotten logs and old roots) '. Hydra Marine (Ian Clarke) approved encountered material for Mac Tubes filling.

Golder asked Duz Cho (Rob Wallace, not sure of the last name.) to survey the existing slope, along Mac Tubes and report to either Golder or BCHydro. Slopes look flatter than 1:3 as specified by Golder; surveying is for records.

Wood pads are laid down from the boat ramp, almost, to the location of Mac Tubes.

Filling the tubes will start tomorrow.

From the preliminary investigation and quick discussion with Duz Cho, having soil piled along tubes sides (Section C-C of Golder drawing # 1006-C09-00173) is not feasible due to lack of material – barely enough to fill the tubes. Bruce, Matt or Sullivan please approve/disapprove.

ENGINEER / INSPECTOR'S DAILY REPORT

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ENGINEER / INSPECTOR'S DAILY REPORT

PROJECT

Project No:	14-1434-0003	**Project Name:**	BCH Beaver Pond Const. Services

WORK SHIFT

Date:	May 23, 2014	**Work Shift:**	Day
Time Arrived on Site:	8:00 am	**Time Left Site:**	3:00 pm
Travel Time to Site:	1 hrs	**Travel Time from Site:**	1 hrs
Other Time:	0.5 hrs (report+photos)	**Total Time :**	9.5 hrs
Weather:	Rainy, cloudy	**Temperature Range:**	10 – 14 degrees
Golder Inspector:	Nader Gendy	**Other Personnel:**	Ian Clarke (Hydra Marine)

WORK SITE

SITE:	Beaver Pond BCH	**LOCATION:**	Mackenzie BC
Contractor(s):	Duz Cho	**Contractor's Working Hrs:**	7:00 am – 5:00 pm

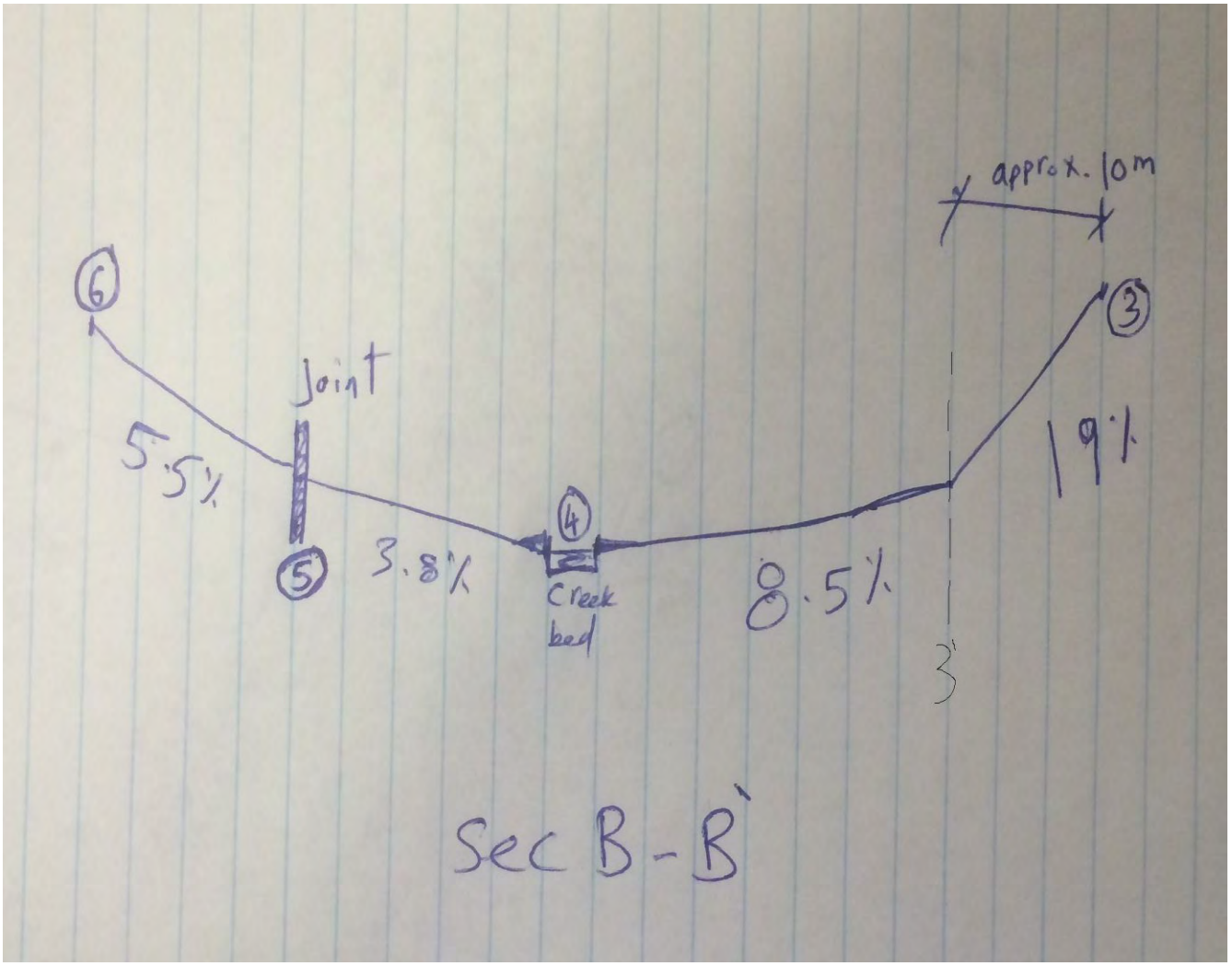
DAILY SITE ACTIVITIES REPORT

Golder arrived onsite and discussed the working plan with Duz Cho (Dustin Leegh).

Silt curtains installed in the downstream side just before Williston Lake.

Surveyor (Saen from DWB) took shoots of natural slope and after stripping soil; results were per table below:

See attached photos to identify sections	Natural Slope	After stripping soil
Sec 3 – 3' (approx. 10 m long)	19 %	7.5 %
Sec 3' – 4	8.5 %	7.5 %
Sec 4 – 5 (point 5 is the joint)	3.8 %	3.7 %
Sec 5 - 6	5.5 %	5.2 %



Stripping under BAG 1

Under BAG 2 after stripped

(Slurry + pump) tank was placed in position at the time Golder arrived onsite.

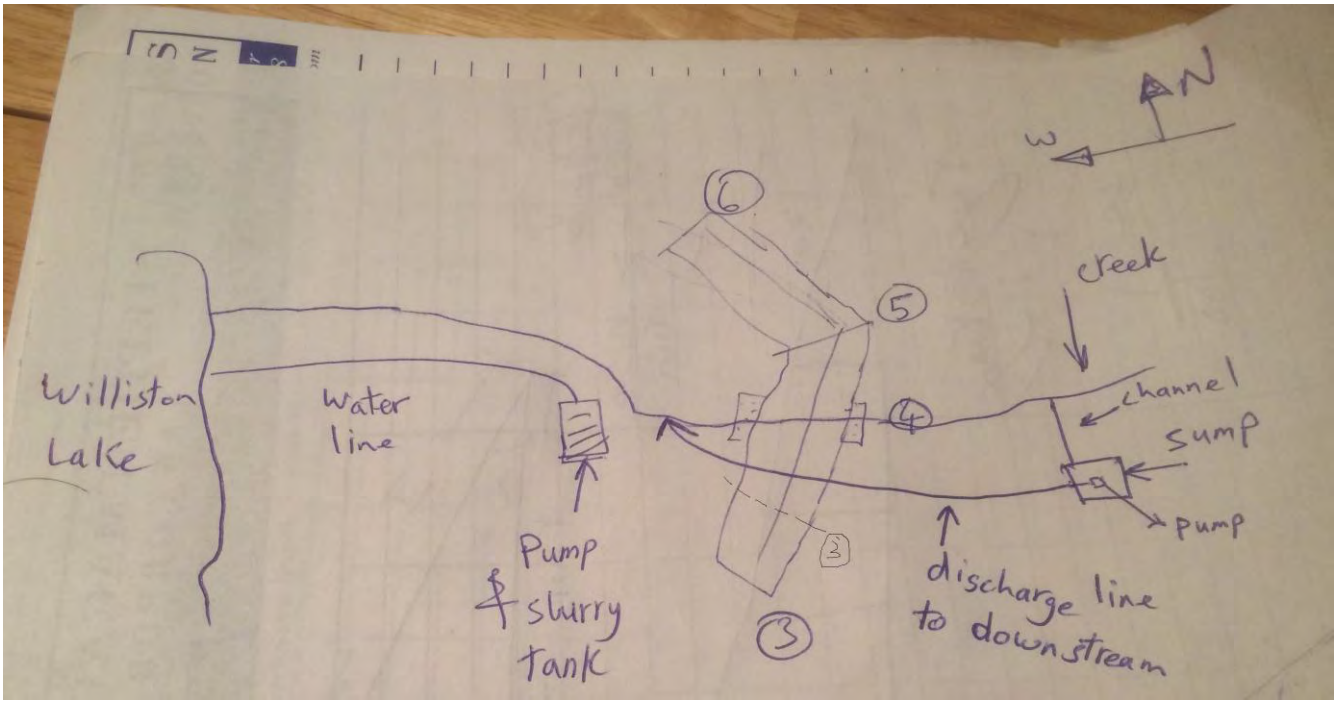
The water source is placed in Williston Lake and connected through water lines to the (pump + slurry) tank

Water Source

Water Line from the source to the (pump + slurry) tank

A sump excavated upstream and discharged creek water to Williston Lake to the west (downstream).

A channel from the creek to a sump



The creek section under Mac Tubes was filled with soil mixed with grout powder.

Soil from both sides to act like forms for the grout

Grout mixed with soil filled the creek

A Conservation officer (Officer Chretien) and a Fish and Wild Life BC Parks officer (Officer Hess) showed up for inspection. Officer Chretien recommended a signage on the log booms by Williston Lake for boaters.

After lunch, Duz Cho discovered they don not have enough linear onsite; not much progress has been achieved till Golder left site.

Water rises about 0.3 m a day; the window of dry working area is getting shorter.

Should you have further inquiries, please contact Nader Gendy from Golder Associates or Ian Clarke from Hydra Marine.

Distribution:

Golder Files

Engineer/Inspector Nader Gendy

ENGINEER / INSPECTOR'S DAILY REPORT

PROJECT

Project No: 14-1434-0003 **Project Name:** BCH Beaver Pond Const. Services

WORK SHIFT

Date:	May 24, 2014	**Work Shift:**	Day
Time Arrived on Site:	8:00 am	**Time Left Site:**	5:00 pm
Travel Time to Site:	1 hrs	**Travel Time from Site:**	1 hrs
Other Time:	0.5 (Report + Photos)	**Total Time :**	11.5
Weather:	Rainy, overcast	**Temperature Range:**	10-13 degrees
Golder Inspector:	Nader Gendy	**Other Personnel:**	Ian Clarke (Hydra Marine)

WORK SITE

SITE:	Beaver Pond BCH	**LOCATION:**	Mackenzie BC
Contractor(s):	Duz Cho	**Contractor's Working Hrs:**	

DAILY SITE ACTIVITIES REPORT

Material was piled by excavating 40m far from the Mac Tubes. (See photo 1)

Liner was placed for Bag #1 and Bag #2. (See photos 2 – 3)

Bags #1 and Bag #2 were placed. (See photos 4 – 7)

Bag #1 was tied from edges to prevent shifting during filling. (See photo 8)

A bridge was placed over the creek for foot trafficking. (H&S) (See photo 9)

At the joint between bags, Bag#1 was placed over Bag #2. (See photo 10)

Started pumping and filling from the creek section. (See photos 11 – 12)

Once the bag started to be filled, slurry went with the slope and the bag shifter 0.3 m. Contractor placed ground anchors, by tying a rope to logs and burying them in ground. (See Photos 13 – 14)

Contractor had a challenge when trying feeding material through the grizzly screen, doesn't pass more than 1". It took longer than what was anticipated for each load (excavator bucket). (See photo 15)

Contractor has to mix, or feed to the pump, sand with no more than 1" gravel in order to get the bags filled.

Photo 1

Photo 2

Photo 3

Photo 4

Photo 5

Photo 6

Photo 7

Photo 8

Photo 9

Photo 10

Photo 11

Photo 12

Photo 13

Photo 14

Photo 15

Distribution:

BC Hydro

Duz Cho

Hydra Marine

Golder Files

Engineer/Inspector Nader Gendy

ENGINEER / INSPECTOR'S DAILY REPORT

PROJECT

Project No: 14-1434-0003 **Project Name:** BCH Beaver Pond Const. Services

WORK SHIFT

Date:	May 25, 2014	**Work Shift:**	Day
Time Arrived on Site:	8:00 am	**Time Left Site:**	4:00 pm
Travel Time to Site:	1 hrs	**Travel Time from Site:**	1 hrs
Other Time:		**Total Time :**	10
Weather:	Rainy, overcast	**Temperature Range:**	10-13 degrees
Golder Inspector:	Nader Gendy	**Other Personnel:**	Ian Clarke (Hydra Marine)

WORK SITE

SITE:	Beaver Pond BCH	**LOCATION:**	Mackenzie BC
Contractor(s):	Duz Cho	**Contractor's Working Hrs:**	

DAILY SITE ACTIVITIES REPORT

Golder arrived on-site at 8:00 am.

Contractor (Duz Cho) supervisor on-site is Rob Wallin.

Duz Cho borrowed material from the shore (Silty SAND, some gravel, contains organics) and piled it by the office trailer. (Photo 1)

The program that Duz Cho followed is per the following;

1) An excavator loaded a dump truck by the shore (Photo 1);
2) The dump truck drove to the (pump + slurry) tank and dumped the load (Photo 2);
3) A dozer pushed the load to another pile by the (pump + slurry) tank (Photo 2);
4) Another excavator dumps material, pushed by the dozer, into the (pump + slurry) tank. (Photo 3).

Having the grizzly with 1" opening slowed the process so contractor made phone calls to arrange for dumping material into (pump and slurry) tank directly – without the grizzly. (Photo 3 and 4))

Grizzly was removed (Photo 5)

Production went way faster for a while then pumping stopped completely from 2:45 pm till Golder left at 4:00 pm due to pump problems. (Too much wood debris) (Photos 6 and 7)

Photo 1

Photo 2

Photo 3

Photo 4

Photo 5

Photo 6

Photo 7

Distribution:

BC Hydro

Duz Cho

Hydra Marine

Golder Files

Engineer/Inspector Nader Gendy

ENGINEER / INSPECTOR'S DAILY REPORT

PROJECT

Project No:	14-1434-0003	**Project Name:**	BCH Beaver Pond Const. Services

WORK SHIFT

Date:	May 26, 2014	**Work Shift:**	Day
Time Arrived on Site:	7:00 am	**Time Left Site:**	3:00 pm
Travel Time to Site:	1 hrs	**Travel Time from Site:**	1 hrs
Other Time:		**Total Time :**	10
Weather:	Sunny, cloudy	**Temperature Range:**	10-13 degrees
Golder Inspector:	Nader Gendy	**Other Personnel:**	Ian Clarke (Hydra Marine)

WORK SITE

SITE:	Beaver Pond BCH	**LOCATION:**	Mackenzie BC
Contractor(s):	Duz Cho	**Contractor's Working Hrs:**	

DAILY SITE ACTIVITIES REPORT

Golder arrived on-site at 7:00 am.

Contractor is following the same program of excavating and loading slurry tank as the previous day.

Contractor started excavating/borrowing sand closer to the shore. (Photo 1)

Water drained from the bag (dewatering), and existed creek, formed a pond approx. 1m deep (at the old creek bed) and for about 4 m wide (goes shallower by the edges) (Photos 2 – 3)

Grizzly was moved from working area to minimize hazards. (It was setting beside the slurry tank if needed) (Photo 4)

Occasionally pump was plugged and needed service/cleaning. (Photo 5)

Occasionally hose was stuck in the bag after dewatering. (Photos 6 – 7)

Surveyor took elevation shots; see findings below: (Photos 8 – 9)

1) The end of South Bag (#1) is at elevation 668.25 m (it was originally stripped for a gentler slope)
2) The end of North Bag (# 2) is at elevation 668.6 m
3) The section by the creek is already filled to elevation 666.9 m (for about 8 m long)

Photo 1

Photo 2

Photo 3

Photo 4

Photo 5

Photo 6

Photo 7

Photo 8

Photo 9 – North Bag (# 2) is longer than what needed.

Photo 10 – South Bag (# 1) is shorter than what needed (soil was trimmed for getting better slope).

Distribution:

BC Hydro

Duz Cho

Hydra Marine

Golder Files

Engineer/Inspector Nader Gendy

ENGINEER / INSPECTOR'S DAILY REPORT

PROJECT

Project No: 14-1434-0003 **Project Name:** BCH Beaver Pond Const. Services

WORK SHIFT

Date:	May 27, 2014	**Work Shift:**	Day
Time Arrived on Site:	7:00 am	**Time Left Site:**	4:00 pm
Travel Time to Site:	1 hrs	**Travel Time from Site:**	1 hrs
Other Time:	1 hr waiting for the boat	**Total Time :**	11 hrs
Weather:	Overcast, rainy	**Temperature Range:**	10-13 degrees
Golder Inspector:	Nader Gendy	**Other Personnel:**	Ian Clarke (Hydra Marine)

WORK SITE

SITE:	Beaver Pond BCH	**LOCATION:**	Mackenzie BC
Contractor(s):	Duz Cho	**Contractor's Working Hrs:**	

DAILY SITE ACTIVITIES REPORT

Golder arrived on-site at 7:00 am.

Duz Cho piled more material closer to the slurry tank (Photo 1)

Duz Cho is following the same program of excavating and loading slurry tank as the previous day.

Canadian dewatering started the day with the jetted pump, back up pump and no grizzly, which didn't work any better - jets were ineffective. Pumping stopped many time due to pump plugged or hose twisted. (Photos 2 – 3)

Golder estimated losing 20 mins to pump cleaning up for every 1 hour of working, 2/3 efficiency.

Ian Clarke stayed on-site to cut the openings in the grizzly to 2" (his total working hours for the day are 13.5 hrs)

The South Bag (#1) started to curve towards the downstream as getting filled up. (Photos 4 – 5)

See photos below:

Photo 1

Photo 2

Photo 3

Photo 4

Photo 5

Distribution:

BC Hydro

Duz Cho

Hydra Marine

Golder Files

Engineer/Inspector Nader Gendy

ENGINEER / INSPECTOR'S DAILY REPORT

PROJECT

Project No: 14-1434-0003 **Project Name:** BCH Beaver Pond Const. Services

WORK SHIFT

Date:	May 28, 2014	**Work Shift:**	Day
Time Arrived on Site:	7:00 am	**Time Left Site:**	4:00 pm
Travel Time to Site:	1 hrs	**Travel Time from Site:**	1 hrs
Other Time:	2 hrs back to look at the ripped bag, with Grant and Wally	**Total Time :**	13 hrs
Weather:	Overcast, rainy	**Temperature Range:**	10-13 degrees
Golder Inspector:	Nader Gendy	**Other Personnel:**	Ian Clarke (Hydra Marine)

WORK SITE

SITE: Beaver Pond BCH **LOCATION:** Mackenzie BC

Contractor(s): Duz Cho **Contractor's Working Hrs:**

DAILY SITE ACTIVITIES REPORT

Golder arrived on-site at 7:00 am.

Duz Cho followed the same program of excavating and loading slurry tank as the previous day.

The South Bag (#1) is filled to approx. 55 – 60 % of soil to reach designed elevation.

At 2:45 pm, two holes rip were noticed on the top of the South Bag (#1), close to a port that was not used; the port distances 4.6 m south of the centre line of the spill way. (Photo 1 – 2)

Ian Clarke tried pulling the pieces together and left site at 4:00 pm; later contractor called for more assessment on the situation since the ripped part was getting bigger as the bag was pressured. The ripped part started with 2 holes approx. 200 mm diameter each. During Ian's attempt to repair, the two holes took a square shape 400 mm X 200 mm. (Photos 3 – 9)

At the ripped part the bag is approx. at elevation 667.0 m

Duz Cho is on a stand-by and is waiting for Golder/BCH to give further instructions.

See photos below:

Photo 1 – when the ripped parts were noticed. Look and act like rotten/worn-out clothes

Photo 2 – Standing upstream and showing the ripped part in relation to downstream. (Spillway)

Photo 3 – Ian trying to fix the rip

Photo 4

Photo 5 – Ian trying to pull ripped pieces together.

Photo 6 – trying pulling ripped pieces together.

Photo 7

Photo 8 – Distance to centre line of the spillway. (See Photo 9)

Photo 9 – Distance from the ripped part to centre line of the spillway

Distribution:

BC Hydro

Duz Cho

Hydra Marine

Golder Files

Engineer/Inspector Nader Gendy

ENGINEER / INSPECTOR'S DAILY REPORT

PROJECT

Project No: 14-1434-0003 **Project Name:** BCH Beaver Pond Const. Services

WORK SHIFT

Date:	May 30, 2014	**Work Shift:**	Day
Time Arrived on Site:	11:00 am	**Time Left Site:**	6:00 pm
Travel Time to Site:	1 hrs	**Travel Time from Site:**	1 hrs
Other Time:	(started @ 8:00 am)	**Total Time :**	10
Weather:	Rainy, overcast	**Temperature Range:**	10-13 degrees
Golder Inspector:	Nader Gendy	**Other Personnel:**	Ian Clarke (Hydra Marine)

WORK SITE

SITE:	Beaver Pond BCH	**LOCATION:**	Mackenzie BC
Contractor(s):	Duz Cho	**Contractor's Working Hrs:**	

DAILY SITE ACTIVITIES REPORT

Golder arrived on-site to assist the situation with the ripped part of the South Bag (#1); Mike Galesloot (Golder) and Nick Vanderkwaak (BCH) decided to proceed filling the bags to 0.2 m above current spillway elevation.

Surveyor showed up on-site and findings are as follows: Current Spillway elevation is 667.5 m. Elevation under the Bag base from the downstream side is 665.8 m. Current width of the spillway is 8.4 m. Current elevation at the joint is 668.1 m. Rough estimate of total volume that pumped in the bag is 475 cubic meters. Current lowest elevation of filled bag is 667.3 m.

By the end of today, approx. 92-95% of both bags were filled already. (Photos 1, 2)

Smaller Bags were filled with soil and placed, on top of the South Bag (#1), to create a lower elevation for the spillway. (Photos 2, 3)

We tried to get the joint seam in both bags to the same elevation of 668.1 m. (Photo 4, 5)

Contractor expects to finish pumping the following day late afternoon.

See photos below:

Photo 1 – Approx. 92-95% of North Bag (#2) is filled already

Photo 2 – South Bag (#1) is filled to desired elevation. Also showing small bags filled with soil placed on top.

Photo 3 – Closer view of smaller bags filled with soil and placed on top of South Bag (#1) to creat spill way Elev.

Photo 4 – Showing the seam between the two bags – Standing on South Bag (#1) looking North.

Photo 5 – Showing the joint between the two bags; standing by the upstream corner looking southwest.

Distribution:

BC Hydro

Duz Cho

Hydra Marine

Golder Files

Engineer/Inspector Nader Gendy

ENGINEER / INSPECTOR'S DAILY REPORT

PROJECT

Project No: 14-1434-0003 **Project Name:** BCH Beaver Pond Const. Services

WORK SHIFT

Date:	May 31, 2014	**Work Shift:**	Day
Time Arrived on Site:	7:00 am	**Time Left Site:**	3:00 pm
Travel Time to Site:	1 hrs	**Travel Time from Site:**	1 hrs
Other Time:	2.5 hrs Driving to PG (Ian's flight)	**Total Time :**	12.5
Weather:	Rainy, overcast	**Temperature Range:**	10-13 degrees
Golder Inspector:	Nader Gendy	**Other Personnel:**	Ian Clarke (Hydra Marine)

WORK SITE

SITE:	Beaver Pond BCH	**LOCATION:**	Mackenzie BC
Contractor(s):	Duz Cho	**Contractor's Working Hrs:**	

DAILY SITE ACTIVITIES REPORT

Golder arrived on-site at 7:00 am.

Contractor followed the same program as previous days for pumping soil into the bags.

Surveyor didn't show up; Ian estimated top of bags elevations to designed elevations, based on pre-surveyed sticks; exact elevations will be surveyed on Monday.

The small bags on top of the South Bag (#1) did not keep the slurry from filling along the bag. Spillway would be identified according to surveyed elevations on Monday. Golder and Duz Cho (Rob Wallin) agreed to locate the spill way by finding the lowest elevation along South Bag (#1) – The lowest elevation is to be the centre line of the spill way; Duz Cho will measure 5m on each side of the identified centre line to mark the boundaries of where riprap will be placed. The total length of riprap layer is 10m along the bag, will extend 2m far from the bag and it is 0.5m thick. Duz Cho will fold the existing linear, that is under the bag, to the top of the bag; a non-woven geotextile will lay on the ground (minimum 10m X 2m along the bag) then riprap will be placed on top of the geotextile. (Photo 8)

Duz Cho agreed to take photos of each procedure as described above and send it to either BCH or to Golder (or both).

Log boom anchor blocks were placed as designated, only upstream. (Photos 3, 4 and 5)

Contractor started demobbing and spreading extra material on the bank of existing stream. (Photos 6 and 7)

Photo 1 – These small bags on top could not keep slurry from filling along the bag

Photo 2 – North Bag (#2) was pumped few centimetres above designed elevation and dewatering (will settle to designed eleation after dewatering)

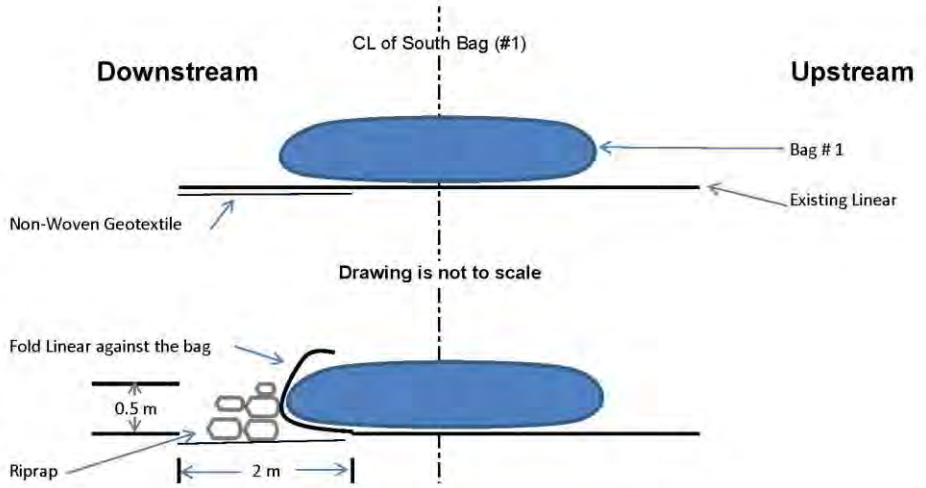
Photo 3 – Anchors for the Log Booms are in place (downstream)

Photo 4 - Anchors for the Log Booms are in place (downstream)

Photo 5 – This Anchor Block will be placed where the surveyed stick shows in the photo (2 m from where the block is placed in this photo)

Photo 6 – Contractor is demobbing

Photo 7 – spreading extra material that was not used to fill the bags



Locating spillway and placing riprap

1) Based on surveyor's data, locate the lowest elevation along South Bag (#1) and take it as a Centre Line of the Spillway
2) Measure 5 m from the Centre Line, on both sides, and mark as boundaries for the Spillway (total of 10 m)
3) fold existing linear against the bag
4) Place non-woven geotextile on the ground (from under the bag to 2m far from the bag along the 10m width of the spillway.
5) Place the riprap against on the non-woven geotextile against folded linear as shown above.

Final layer of riprap will be 10m long X 2m wide X 0.5m thick

Photo 8 (Drawings – How to locate spillway and place riprap)

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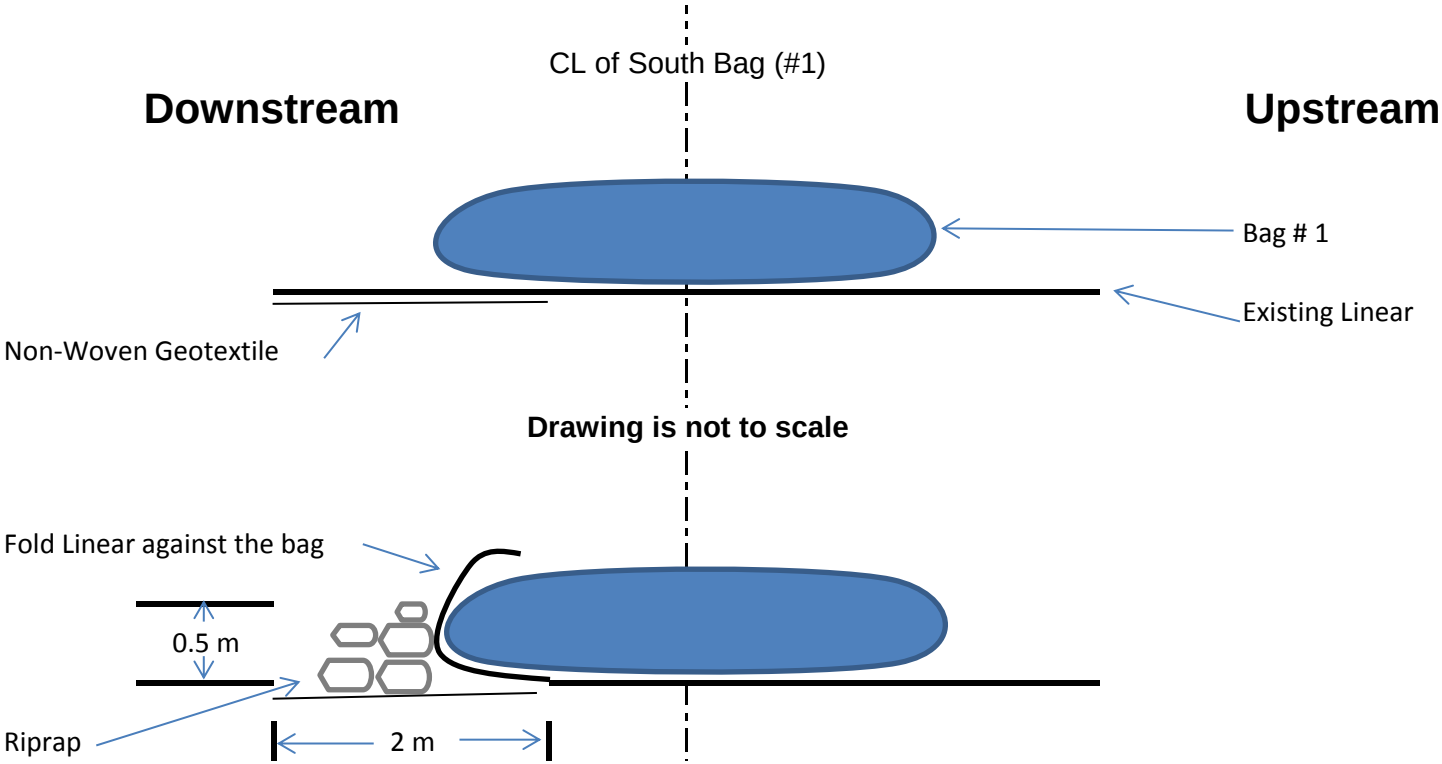
Engineer/Inspector Nader Gendy



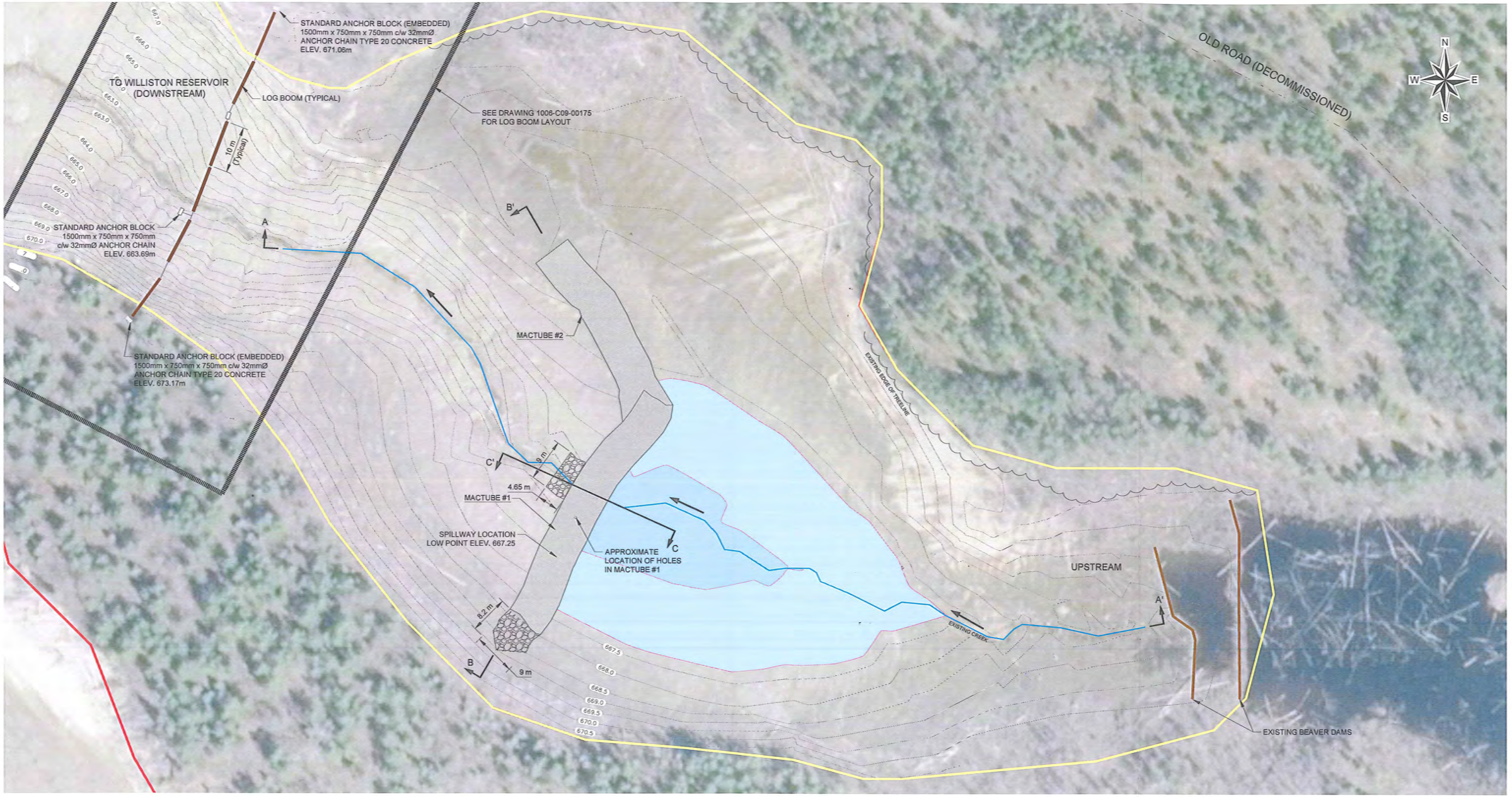
Locating spillway and placing riprap

1) Based on surveyor's data, locate the lowest elevation along South Bag (#1) and take it as a Centre Line of the Spillway
2) Measure 5 m from the Centre Line, on both sides, and mark as boundaries for the Spillway (total of 10 m)
3) fold existing linear against the bag
4) Place non-woven geotextile on the ground (from under the bag to 2m far from the bag along the 10m width of the spillway.
5) Place the riprap against on the non-woven geotextile against folded linear as shown above.

Final layer of riprap will be 10m long X 2m wide X 0.5m thick

APPENDIX D

Record Drawings



LEGEND

- BERM LOCATION
- LOW ARCHAEOLOGICAL POTENTIAL
- HIGH ARCHAEOLOGICAL POTENTIAL
- FLOOD AREA BASIN WITH DEPTH LESS THAN 1.0m
- FLOOD AREA BASIN WITH DEPTH GREATER THAN 1.0m
- APPROXIMATE CREEK CENTERLINE
- PROPOSED LOG BOOM LOCATION (SEE DRAWING 1006-C09-00175)

NOTES

MAJOR CONTOURS AT 1m INTERVALS
MINOR CONTOURS AT 0.5m INTERVALS

REFERENCE

COORDINATES: UTM ZONE 11n, NAD83.
1. IMAGERY: BASE IMAGERY PROVIDED BY B.C. HYDRO.

2. RECORD LINEWORK FROM DWB CONSULTING SERVICES LTD. DWG NO. 14117-072 VIA DUZ CHO CONSTRUCTION LTD. REFER TO COMPLETION REPORT TEXT FOR FURTHER DETAIL REGARDING SURVEY DATA.

0 20 40
1:400 METRES

REF#	DRAWING NUMBER	TITLE

REFERENCE DRAWINGS

NO	REMARKS	DATE	DESIGNED	INDEP CHK	DFTG	DFTG CHK	INSP	REV	ACPT
0	RECORD	16-01-15	MS	MG	BKL	MT			
0	ISSUED FOR CONSTRUCTION	26-07-13	MS	MT	RP	KBD			
	ISSUED FOR TENDER	30-04-13	MS	MS	RP	KBD			

REVISIONS

DSGN	MS
INDEP CHK	MS
DFTG	RP
DFTG CHK	BD
INSP	
REV	
ACPT	

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA B. W. BOSDET Jan 19/2015

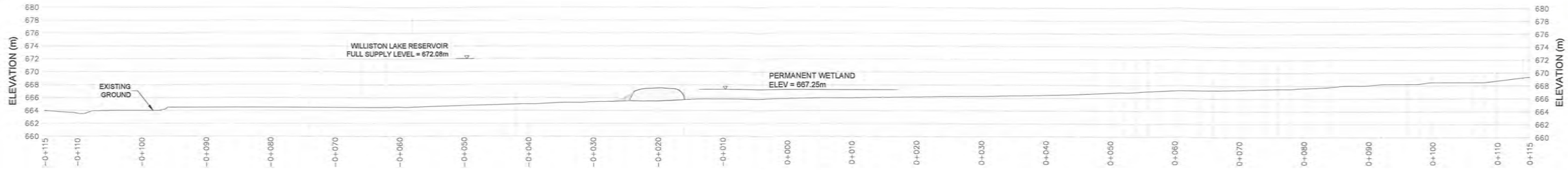
Golder Associates
BC hydro

GMSWORKS 17
WILLISTON RESERVOIR WETLAND DEMONSTRATION SITES
STAGE II - RECORD DRAWINGS

WDS 3D BEAVER POND
SITE PLAN

DATE 16-01-15 | DIST - | DWG NO 1006-C09-00172 | SIZE D | R 0

N:\Graphics\2014\1434\14-1434-0003\DRAFTING\PRODUCTION\1006-C09-00172 Drawing 1 - Site Plan.dwg



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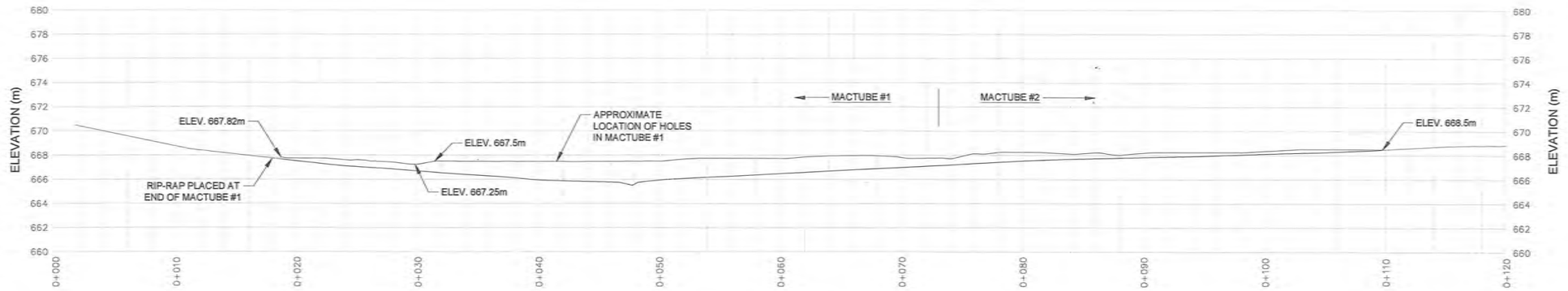
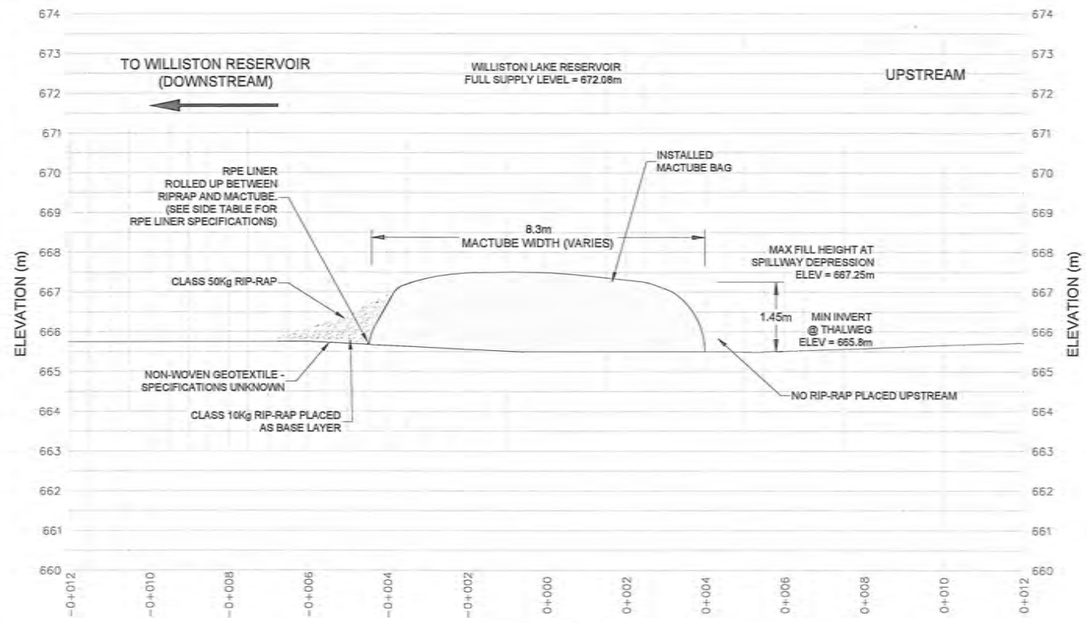


CROSS-SECTION B-B'
SCALE 1:200



CROSS-SECTION C-C'
SCALE 1:750

7 SEPT 2012	RPE® 15 TYPICAL MATERIAL PROPERTIES
STYLE	RPE® 15
THICKNESS (NOMINAL)	12 mil (0.30 mm)
COATING THICKNESS BOTH SIDES (NOMINAL)	1.75 mil (0.044 mm)
WEIGHT (NOMINAL)	6.0 oz/yd² (203 g/m²)
TENSILE STRENGTH MD	215 lbs (955 N)
TENSILE STRENGTH CD	180 lbs (801 N)
ELONGATION	15%
LOW TEMPERATURE BEND	-67°F (-55°C)
BURST STRENGTH	370 psi (2553 kPa)
UV RESISTANCE (STRENGTH RETAINED)	>80%[1]

NOTE 1: UV RESULTS ARE FOR BLACK PRODUCT ONLY. COLOURS OTHER THAN BLACK MAY HAVE A LOWER UV RESISTANCE.

7 SEPT 2012	RPE® 15 MINIMUM SHOP SEAM STRENGTHS
STYLE	RPE® 15
HEAT BONDED SEAM STRENGTH	90 ppi (15.8 N/mm)
HEAT BONDED PEEL ADHESION STRENGTH	FTB AD-DEL

REINFORCED POLYETHYLENE (RPE) LINER
SCALE N/A

PERCENT LIGHTER (FINER) THAN	CLASS 10-kg LAYER THICKNESS = 380mm		CLASS 50-kg LAYER THICKNESS = 600mm	
	MASS (kg)	EQUIVALENT SIZE* (mm)	MASS (kg)	EQUIVALENT SIZE* (mm)
15	1	90	5	154
30	4	- 140	19	240
50	10	190	50	331
85	30	280	150	477
100	50	330	250	566

*EQUIVALENT SIZE IS AN APPROXIMATE DIMENSION FOR A SPHERICAL STONE FOR EACH GIVEN MASS. STONE MASS GOVERNS EACH CLASS AND ITS GRADATIONS. ABOVE GRADATION TABLE IS BASED ON AN ASSUMED SPECIFIC GRAVITY OF 2.64 FOR RIPRAP (S=2.64).

NOTE: RIPRAP SHALL BE HARD, DURABLE, ANGULAR, AND GENERALLY GOOD QUALITY QUARRY ROCK THAT DOES NOT GENERATE ACIDS OR METAL LEACHATES. RIPRAP SHALL BE FREE OF STRUCTURAL DEFECTS, CLEAN, AND GENERALLY WELL-GRADED ACCORDING TO THE ABOVE GRADATION TABLE.

RIP-RAP TABLE - CLASS 10 & 50 kg
SCALE N/A

MECHANICAL PROPERTIES	TEST METHOD	UNIT	MINIMUM AVERAGE ROLL VALUES (MARV)
TENSILE STRENGTH (@ ULTIMATE) MD*	ASTM D4595	kN/m	70 @ 20%
TENSILE STRENGTH (@ ULTIMATE) CMD*	ASTM D4595	kN/m	100 @ 10%
APPARENT OPENING SIZE (AOS)	ASTM D4751	mm (US SIEVE #)	0.425 (40)
FLOW RATE	ASTM D4491	l/m/m²	813
UV RESISTANCE (@ 500 hrs)	ASTM D4355	% STRENGTH RETAINED	80
FACTORY SEAM STRENGTH	ASTM D4884	kN/m	70
MASS	ASTM D5261	g/m²	515
FABRIC WEAVE STYLE	-	-	RIP-RESISTANT
SELVEDGE	-	-	100mm REINFORCED
PORT CONNECTION	-	-	REINFORCED RADIAL
COLOUR	-	-	SAND

NOTE: MINIMUM AVERAGE ROLL VALUES REPRESENT A 97.5% CONFIDENCE LEVEL, CALCULATED AS THE MEAN MINUS TWO STANDARD DEVIATIONS. FIFTY PERCENT OF TEST VALUES WILL EXCEED THE TYPICAL VALUE LISTED ABOVE.

MACTUBE OS400 SPECIFICATIONS
SCALE N/A

REFERENCE

1. RECORD LINEWORK FROM DWB CONSULTING SERVICES LTD. DWG NO. 14117-072 VIA DUZ CHO CONSTRUCTION LTD. REFER TO COMPLETION REPORT TEXT FOR FURTHER DETAIL REGARDING SURVEY DATA.

REF #	DRAWING NUMBER	TITLE

REFERENCE DRAWINGS

NO	REMARKS	DATE	DESIGNED	INDEP CHK	DFTG	DFTG CHK	INSP	REV	ACPT
0	RECORD	16-01-15	MS	MG	BKL	MT			
0	ISSUED FOR CONSTRUCTION	26-07-13	MS	MT	RP	KBD			
	ISSUED FOR TENDER	30-04-13	MS	MS	RP	KBD			

REVISIONS

DSGN	MS
INDEP CHK	MS
DFTG	RP
DFTG CHK	BD
INSP	
REV	
ACPT	

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GMSWORKS 17
WILLISTON RESERVOIR WETLAND DEMONSTRATION SITES
STAGE II - RECORD DRAWINGS

WDS 3D BEAVER POND
CROSS SECTION A-A', B-B' & C-C'

DATE	DIST	DWG NO	SIZE	R
16-01-15	-	1006-C09-00173	D	0

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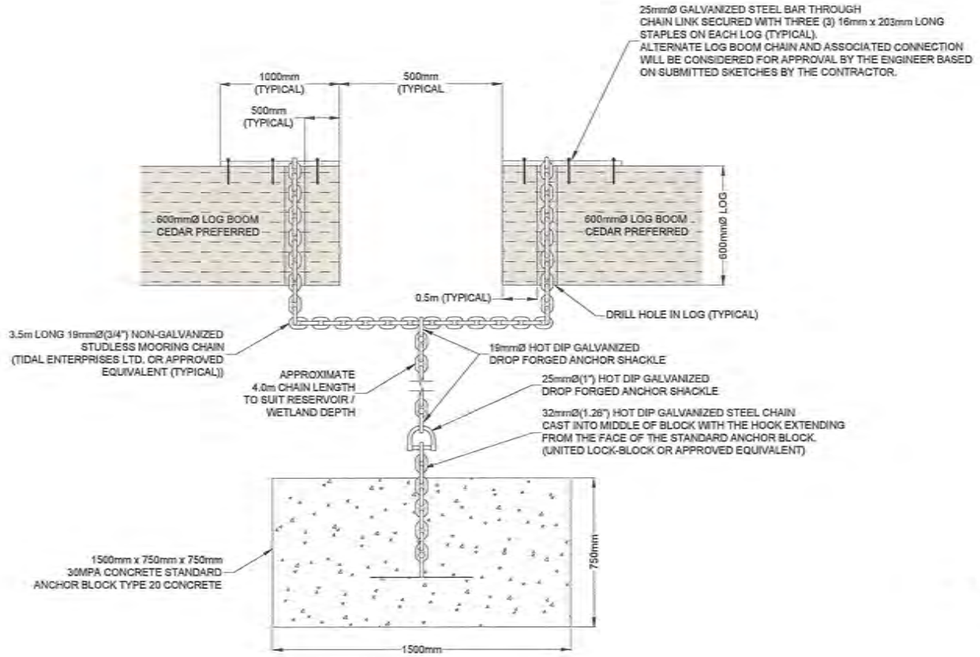
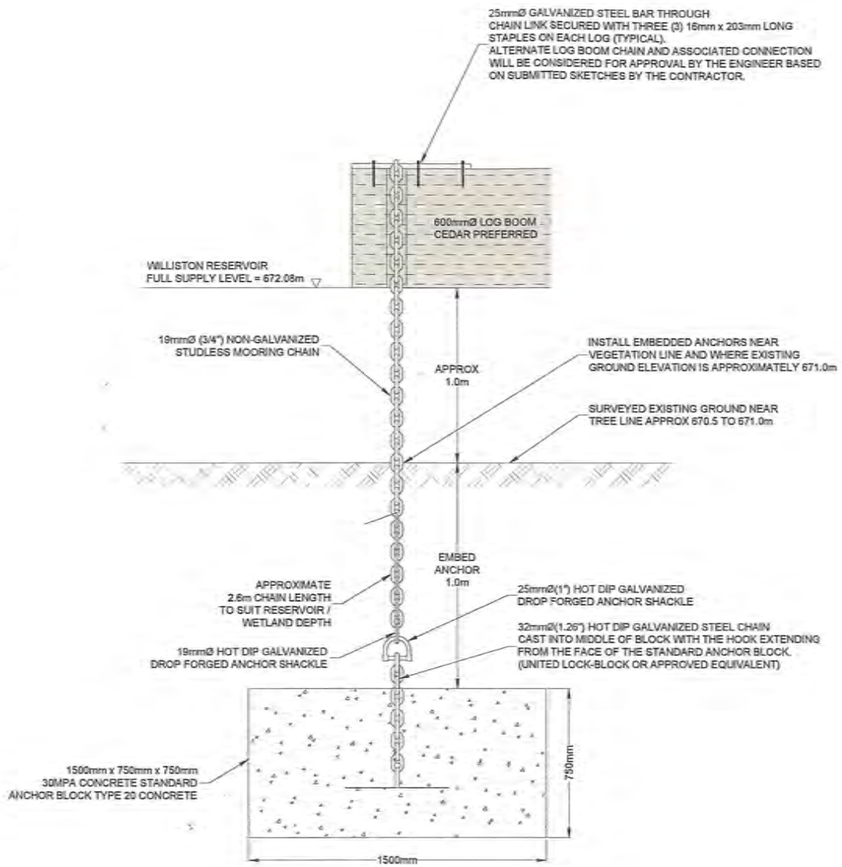


TYPICAL STANDARD ANCHOR BLOCK DETAIL
NTS



TYPICAL STANDARD ANCHOR BLOCK (EMBEDDED) DETAIL
NTS

NOTES

1. ADHERE TO ALL ENVIRONMENTAL REQUIREMENTS AS DIRECTED BY THE ENVIRONMENTAL CONSULTANT.
2. REMOVE DEBRIS AND ROCKS ALONG BEDDING PLANE FOR MACTUBES.
3. INSTALL REINFORCED POLYETHYLENE (RPE) LINER ALONG ENTIRE LENGTH AND WIDTH OF THE EXCAVATED BASE, 8.0m X 106m. NON-WOVEN GEOTEXTILE SHALL EXTEND A MINIMUM OF 2.0m OUT FROM THE BASE OF THE EXCAVATION AT THE SPILLWAY ON EITHER SIDE OF THE PROPOSED MACTUBE FOR A LENGTH OF APPROXIMATELY 10.0m AS AN UNDER LAYER FOR THE PROPOSED 75mm MINUS SAND AND GRAVEL FILTER LAYER AND RIP-RAP. THE RPE LINER SHALL EXTEND APPROXIMATELY 600mm UP THE SIDES OF THE MACTUBE IN THE LOCATION OF THE PROPOSED RIPRAP APRON ENOUGH TO PROTECT THE MACTUBE FROM POTENTIAL PUNCTURES FROM THE RIPRAP.
4. INSTALL MACTUBES. ONE MACTUBE IS APPROXIMATELY 61.0m IN LENGTH AND THE OTHER IS APPROXIMATELY 45.0m IN LENGTH. THE MACTUBES SHALL FORM A "BUTT" CONNECTION AT THE CHANGE IN HORIZONTAL ALIGNMENT. CARE SHALL BE TAKEN TO ENSURE A WATER TIGHT SEAL AT THE CONNECTION. THE MAXIMUM FILL HEIGHT OF THE MACTUBE AT THE PROPOSED SPILLWAY LOCATION AND EXISTING CHANNEL THALWEG SHALL BE 2.4m(668.20m). A 6.0m LONG SPILLWAY SHALL BE INCORPORATED INTO THE TOP PORTION OF THE MACTUBE IN THE LOCATION OF THE EXISTING CHANNEL THALWEG. INGENUITY BY THE CONTRACTOR WILL BE REQUIRED DURING THE FILLING OF THE MACTUBES TO INCORPORATE THE SPILLWAY. THIS COULD INCLUDE OPTIONS SUCH AS PLACING OBJECTS (WEIGHT) ON THE MACTUBE IN THE LOCATION OF THE PROPOSED SPILLWAY DURING THE FILLING PROCESS.
5. INSTALL GRANULAR FILTER LAYER, 75mm MINUS, WELL GRADED SAND AND GRAVEL UNDERNEATH PROPOSED RIP-RAP, LAYER THICKNESS = 200mm.
6. INSTALL CLASS 10 KG RIPRAP (OR APPROVED EQUIVALENT), (AVERAGE STONE SIZE D50 = 190mm) FOR THE 10.0 M LONG APRON IN THE LOCATION OF THE SPILLWAY. RIPRAP TOTAL THICKNESS LAYER SHALL BE MINIMUM 390mm THICK.
7. INSTALL CLASS 50kg RIP-RAP (AVERAGE STONE SIZE 331mm) OVER 10kg RIP-RAP IN THE LOCATION OF THE SPILLWAY. A RIP-RAP SPECIFICATION TABLE IS PROVIDED ON DRAWING 1006-C09-00173. TOTAL RIP-RAP THICKNESS LAYER FOR 10kg & 50kg RIP-RAP SHALL BE A MINIMUM OF 390mm.
8. LOG BOOMS SHALL BE INSTALLED UPSTREAM (OPTIONAL) AND DOWNSTREAM (REQUIRED) OF THE PROPOSED MACTUBES AS SHOWN ON DRAWING 1006-C09-00172 AND DRAWING 1006-C09-00175. STANDARD ANCHOR BLOCKS SHALL BE USED TO ANCHOR THE LOG BOOM AT THE SHORE ENDS (EMBEDDED) AS WELL AS STANDARD ANCHOR BLOCKS ALONG THE LENGTH OF EACH LOG BOOM. THE STANDARD ANCHOR BLOCKS SHALL BE 1.5m X 0.75m X 0.75m, 30 MPa, TYPE 20 CEMENT LOCK-BLOCKS (UNITED LOCK-BLOCK OR APPROVED EQUIVALENT) C/W A 32mmØ(1.26") HOT DIP GALVANIZED STEEL CHAIN. 25.0mm DIAMETER (1") HOT DIP GALVANIZED DROP FORGED STEEL ANCHOR SHACKLES ARE PROPOSED TO CONNECT TO THE ANCHOR HOOK. 19.0mm DIAMETER HOT DIP GALVANIZED DROP FORGED STEEL ANCHOR SHACKLES ARE PROPOSED TO CONNECT TO THE 25mm DIAMETER SHACKLE AND THE 19mm DIAMETER SHACKLE WILL CONNECT TO THE PROPOSED 19mm DIAMETER (3/4") GALVANIZED STUDLESS MOORING CHAIN, (TIDAL ENTERPRISES LTD. OR APPROVED EQUIVALENT). THE STANDARD ANCHOR BLOCKS (EMBEDDED) AT THE SHORE SHALL BE BURIED A MINIMUM OF 1.0m VERTICALLY INTO THE GROUND NEAR THE TREE LINE ON EITHER BANK. THE CHAIN SHALL CONNECT TO THE LOGS AS SHOWN ON DRAWING 1006-C09-00175.

REFERENCE

1. RECORD LINEWORK FROM DWB CONSULTING SERVICES LTD.
DWG NO. 14117-072 VIA DUZ CHO CONSTRUCTION LTD. REFER TO COMPLETION REPORT TEXT FOR FURTHER DETAIL REGARDING SURVEY DATA.

REF #	DRAWING NUMBER	TITLE
	REFERENCE DRAWINGS	

NO	REMARKS	DATE	DESIGNED	INDEP CHK	DFTG	DFTG CHK	INSP	REV	ACPT
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0	ISSUED FOR CONSTRUCTION	26-07-13	MS	MT	RP	KBD			
	ISSUED FOR TENDER	30-04-13	MS	MS	RP	KBD			
	REVISIONS								

DSGN	MS
INDEP CHK	MS
DFTG	RP
DFTG CHK	BD
INSP	
REV	
ACPT	

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WILLISTON RESERVOIR WETLAND DEMONSTRATION SITES
STAGE II - RECORD DRAWINGS

WDS 3D BEAVER POND
DETAILS

DATE	DIST	DWG NO	SIZE	R
16-01-15	-	1006-C09-00174	D	0

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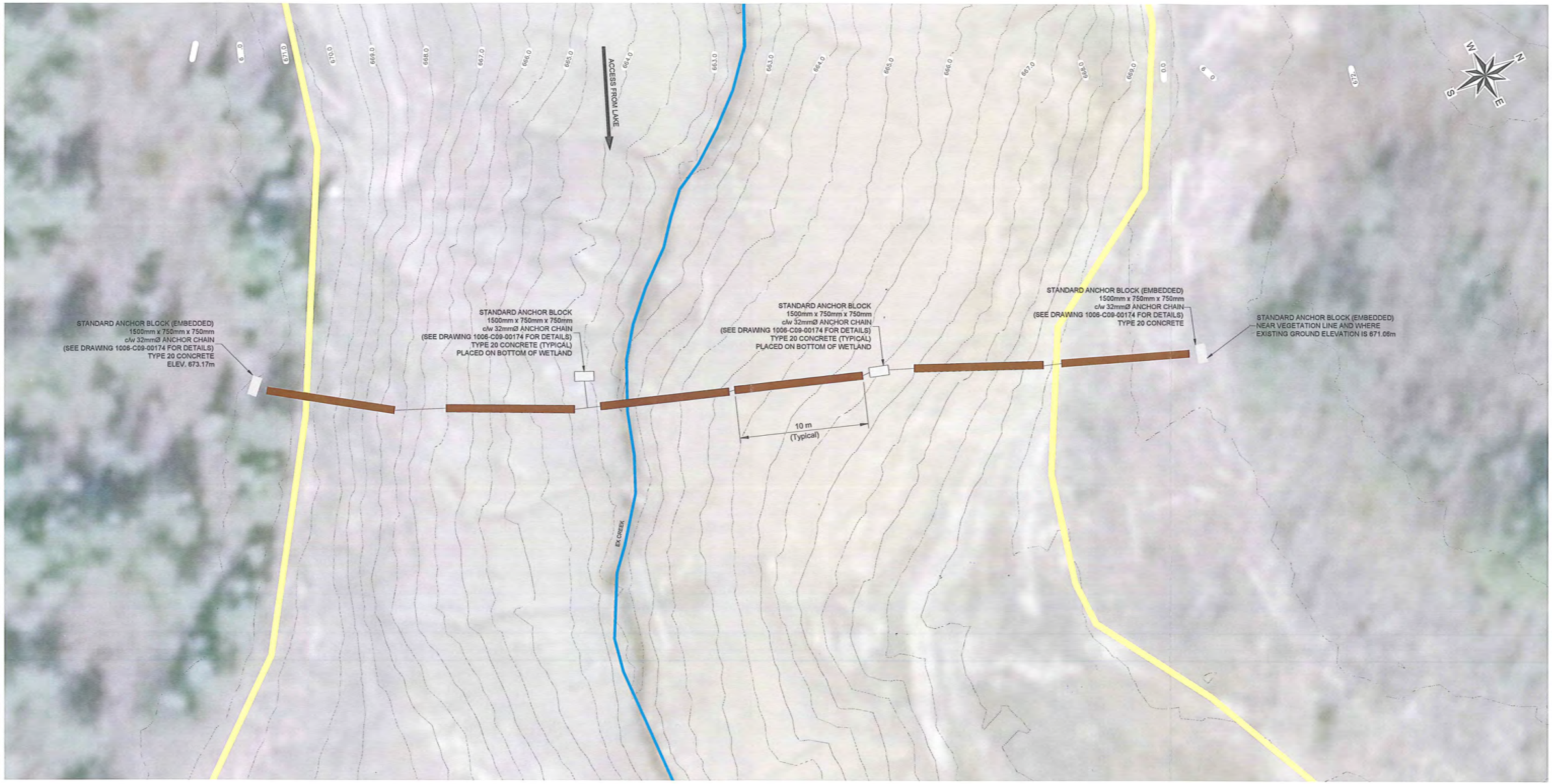

LEGEND

- APPROXIMATE CREEK CENTERLINE
- LOW ARCHAEOLOGICAL POTENTIAL
- HIGH ARCHAEOLOGICAL POTENTIAL

NOTES

MAJOR CONTOURS AT 1.0m INTERVALS
MINOR CONTOURS AT 0.5m INTERVALS

REFERENCE

COORDINATES: UTM ZONE 11n, NAD83.
1. IMAGERY: BASE IMAGERY PROVIDED BY B.C. HYDRO.

2. RECORD LINEWORK FROM DWB CONSULTING SERVICES LTD. DWG NO. 14117-072 VIA DUZ CHO CONSTRUCTION LTD. REFER TO COMPLETION REPORT TEXT FOR FURTHER DETAIL REGARDING SURVEY DATA.

REF #	DRAWING NUMBER	TITLE

REFERENCE DRAWINGS

NO	REMARKS	DATE	DESIGNED	INDEP CHK	DFTG	DFTG CHK	INSP	REV	ACPT
0	RECORD	16-01-15	MS	MG	BKL	MT			
0	ISSUED FOR CONSTRUCTION	26-07-13	MS	MT	RP	KBD			
	ISSUED FOR TENDER	30-04-13	MS	MS	RP	KBD			

REVISIONS

DSGN	MS
INDEP CHK	MS
DFTG	RP
DFTG CHK	BD
INSP	
REV	
ACPT	

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WILLISTON RESERVOIR WETLAND DEMONSTRATION SITES
STAGE II - RECORD DRAWINGS

WDS 3D BEAVER POND
WEST LOG BOOM LAYOUT

DATE 16-01-15 | DIST -

DWG NO 1006-C09-00175 | SIZE D | R 0

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At Golder Associates we strive to be the most respected global company providing consulting, design, and construction services in earth, environment, and related areas of energy. Employee owned since our formation in 1960, our focus, unique culture and operating environment offer opportunities and the freedom to excel, which attracts the leading specialists in our fields. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees who operate from offices located throughout Africa, Asia, Australasia, Europe, North America, and South America.

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