REPORT N^{O} 161-16816-00

ADDENDUM
REVIEW OF CONTACT AND NON-CONTACT WATER MANAGEMENT SYSTEMS

COBBLE HILL HOLDINGS

DRAFT FOR MOE REVIEW

CONFIDENTIAL

20 FEBRUARY 2017

WSP

ADDENDUM TO THE REVIEW OF CONTACT AND NON-CONTACT WATER MANAGEMENT SYSTEMS

Cobble Hill Holdings

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Project no: 161-16816-00
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February 20, 2017

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Dear Mr. Block,

Subject: Addendum to the Review of the Contact and Non-Contact Water Management Systems –DRAFT FOR MOE REVIEW

Please find attached an Addendum to the Review of the Contact and Non-Contact Water Management System that was submitted to the BC Ministry of Environment December 19, 2016 by WSP on behalf of Cobble Hill Holdings Ltd. This addendum adds a detailed review of the contact water treatment system including the contact water sources, answers specific questions about the analyses in the December 19, 2016 report, and includes a Work Plan Schedule. We believe that this addresses the issues raised by the minister of environment in her January 27, 2017 letter.

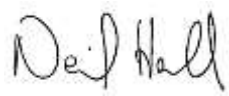
Yours sincerely,

Anthony Dickinson, M.A.Sc., P.Eng.
Senior Environmental Engineer, EHS Group

XX/xx
cc:
Encl.

SIGNATURES

PREPARED BY



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EXECUTIVE SUMMARY

WSP has been retained by Cobble Hill Holdings (Client) to provide an addendum to the December 19, 2016 report prepared by WSP (WSP 2016 Report). The addendum contains additional analysis of the contact and non-contact water management systems of the mine, in response to the British Columbia Ministry of Environment letter dated January 27, 2017. Specifically, the addendum includes the following scope:

- Review of the Contact Water System as-built drawings, operational records, and test data for the whole system including:
  - Contact Water Pond,
  - Permanent Encapsulation Area (PEA),
  - Soil Management Area (SMA),
  - Wheel Wash Area,
  - Lead Detection system, and
  - Leachate collection system
- Hydrotechnical Comment Review
  - Hydrogeological Investigation
  - Seepage Blanket Review
  - Settling Pond
  - Contact Water Pond
  - Lake Cowichan IDF Data/ 200 Year Event
- Draft Work Plan and Schedule

This addendum contains four sections and the executive summary.

Executive Summary – provides an overview of the scope for the addendum and a summary of the conclusions and recommendations contained in the addendum
Section 1: Review of the Contact Water System
Section 2: Hydrotechnical Comment Review
Section 3: Work plan and schedule
Section 4: Summary of criteria for the Contact and Non-Contact Water Management System drawn from the letters and reports referenced by MOE.

Summary of Conclusions and Recommendations

A number of conclusions and recommendations expressed in this addendum and the original report are incorporated into the Draft Work Plan and Schedule. One of the most significant conclusions from the WSP 2016 Report was that the rainfall intensity curves used in the original Technical Assessment Report (TAR) for the site underestimated the volume and intensity of precipitation events. A new set of rainfall intensity curves (IDF) were provided in the WSP 2016 Report. These curves were used when assessing the adequacy of the storm water control systems at the site in both the WSP 2016 Report and this Addendum to the report.

- The new IDF curves developed in the WSP 2016 Report based on the Lake Cowichan weather station should be used for future design of runoff control systems at the site, in particular the ditches, contact water pond and the settling pond systems.

Conclusions and recommendations from this addendum are a result of the Contact Water System Review and additional Hydrotechnical calculations.

Contact Water System

- Contact water pond:
  - The size of the Contact Water Pond surveyed in June 2016 is smaller than the as-built size in the Active Earth documents.
  - The contact water pond is not large enough to handle the contact water that would be generated by a 200 year storm with snow melt. We recommend that the pond be enlarged to be able to handle the 200 year storm with snow melt that would be associated with the maximum PEA collection area.
  - Contact water pond should be drawn down prior to forecast storm events to maximize retention capacity.
- Contact water treatment system (CWTS):
  - The treatment system is effective at removing particulates, metals, VOC's, hydrocarbons, Glycols, polycyclic aromatic hydrocarbons, and some nutrients. Chlorides and Sulphates are not effectively removed.
  - If necessary the CWTS can be run as a batch operation and held in storage until tests show the batch meets discharge quality
  - Ideally the detection limits for analysis should be no more than half the criteria limits. Better detection limits should be sought for Toluene and Acridine,
  - We recommend adding a module to the CWTS to remove chlorides and sulphates to avoid reliance on dilution by mine water (non-contact) to meet discharge limits
- PEA:
  - PEA has not been covered with 0.66 m of soil as required in the current EMP/OMC. This procedure is designed to protect the HDPE from puncture by fly rock or ungulates as well as to increase the life of the HDPE.
  - If the PEA is to be covered with a layer of soil as required in the current EMP/OMC the surface slopes of the PEA will have to be graded and perhaps hydroseeded to avoid erosion.
  - As built drawings for the PEA do not clearly indicate if a seepage blanket was installed. However, the as-built drawings indicate a compacted layer of clay soils topped with 0.3 m of sand (for the leak detection system) at a 2% grade under a 40 mm HDPE liner with 0.3 m of sand on top of the liner (for the leachate collection system). Both the leak detection system and leachate collection systems drain to a gravel drain, with a perforated pipe for each system, at the toe of the PEA Cells. Installation of the seepage blanket cannot be confirmed without removing the PEA. In the future, photographs of the seepage blanket installation should be included with the as built reports.
- SMA
  - The installation of a roof over the SMA minimizes the generation of contact water from the SMA. The gutter installation should be completed to allow water collected from the roof area to be directed away from the contact water pond.
  - The asphalt surface should be inspected annually for degradation due to chemical attack by hydrocarbon containing soils. Repair any damaged areas as necessary
- Leachate and Leak Detection Piping, Inspection Ports, Sumps
  - Leachates generated from within the PEA, wheel wash area, and SMA are being successfully collected. Monday to Friday inspections of the contact water system include the leachate pipe inspection ports, sumps and reservoirs. This has ensured that any blockages are cleared relatively

quickly and allows the operators to monitor the volume of leachate that is collected in the PEA and SMA reservoirs before pumping to the contact water pond.

- EPM/OMC is a comprehensive document containing procedures for the management of soils including a pre-approval process to prevent hazardous wastes arriving at the site.

Non-contact Water

- Settling pond
  - The settling pond is not large enough to achieve 10 µm particle removal.
  - Runoff from the mine area contains naturally occurring levels of metals in particular iron. Analysis indicates that less than 10% of the total iron in the discharge is dissolved. Thus a properly sized settling pond should reduce iron concentrations in the discharge to below the 1 mg/L limit.
  - Recommend construction of a properly sized settling pond in the mine pit to remove particulates down to 10 µm from the mine water.
  - Recommend the discharge pipe be designed so the inlet is below the surface of the pond. Oils lost in the mine area will thus be trapped at the surface of the pond and not discharged to SW-1.
  - A particle size analysis of discharge water indicated that 80% of the particulate volume is over 10 µm.

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FIGURES

1 REVIEW OF CONTACT WATER MANAGEMENT SYSTEM

Any water on the site that has the potential to come into contact with the contaminated soils handled is identified as “Contact water”. A collection and treatment system was designed to capture and treat contact water to meet the most stringent of the BC Approved Water Quality Guidelines Aquatic Life or Drinking Water criteria (BCAWQG) and the BC Working Water Quality Guidelines (BCWWQG). The sections that follow describe the components of the system, their design, and their effectiveness.

1.1 CONTACT WATER SOURCES

Contact water at the site includes leachate from the “Permanent Encapsulation Areas” (PEA), runoff from the PEA, drainage off the Soil Management Area (SMA), the vehicle wheel wash area, and backwash from the contact water treatment system. Minor volumes from SMA wash down water, truck wash water, or storm water collected using vacuum trucks or sump pumps are also directed to the contact water pond.

1.1.1 PEA LEACHATE COLLECTION

Each Permanent Encapsulation Area (PEA) is designed to have a layer of compacted clay/till above the bedrock surface. The existing PEA consists of three cells 1A, 1B and 1C completed July 2015, November 2015 and July 2016 respectively. Based on the as-built reports for the construction of each cell, the cells were constructed as follows:

- Place a layer of compacted clay, a minimum of 1 m thick, with a 2% slope to the toe
- Place 0.3 m of sand on top of the clay for the Leak Detection System
- Place a 40 mil LLDPE “Blue” Solmax 140-7000 base liner, extrusion welded joints
- Place 0.3 m of sand on top of the base liner for the Leachate Collection System
- Construct a 1 m wide gravel toe with a 4” diameter perforated pipe hydraulically connected to the sand under the base liner to collect drainage for the Leak Detection System and a 4” diameter perforated pipe above the base liner hydraulically connected to the sand above the liner to collect drainage from the Leachate Collection System (see Figure 1)
- Connect the perforated pipes to the Leak Detection Reservoir (2,500 Imperial gallon tank) and Leachate Collection Reservoir (2,500 Imperial gallon tank)
- After placing soils into the cells, they were covered with a “Green” geotextile (30 mil Solmax 130-2000 LLDPE geomembrane) sealed onto the base liner using an anchor trench around the side of each cell (see Figure 2).
- The final layer in the design is a minimum 0.6 m layer of soil to protect the geomembrane from sunlight damage, blasting fly rock, and ungulates (deer or elk hooves can puncture the geomembrane material)

Before construction the bedrock was inspected for fractures containing water and none were identified. During construction of the cells the underlying clay was tested for particle size distribution

and compaction tested to confirm greater than 90% standard proctor had been achieved before covering with sand. The LLDPE base liner was joined at the factory. Joint test documentation was included with the as-built documentation indicating the ends and midpoints of the joints had been tested for separation to ensure bonding was successful.

The base liner of Cell 1B was hot welded in the field to the Cell 1A liner to form a continuous base. Similarly Cell 1C base liner was hot welded to Cell 1B liner.

Original designs included a layer of crushed rock over the bed rock to form a “seepage blanket” to level the underlying bedrock. However, the as-built reports did not indicate that crushed was placed over the bedrock but that between 1-3 m of clay was placed over the bedrock.

Figure 1: Detail of PEA Cell Toe Construction

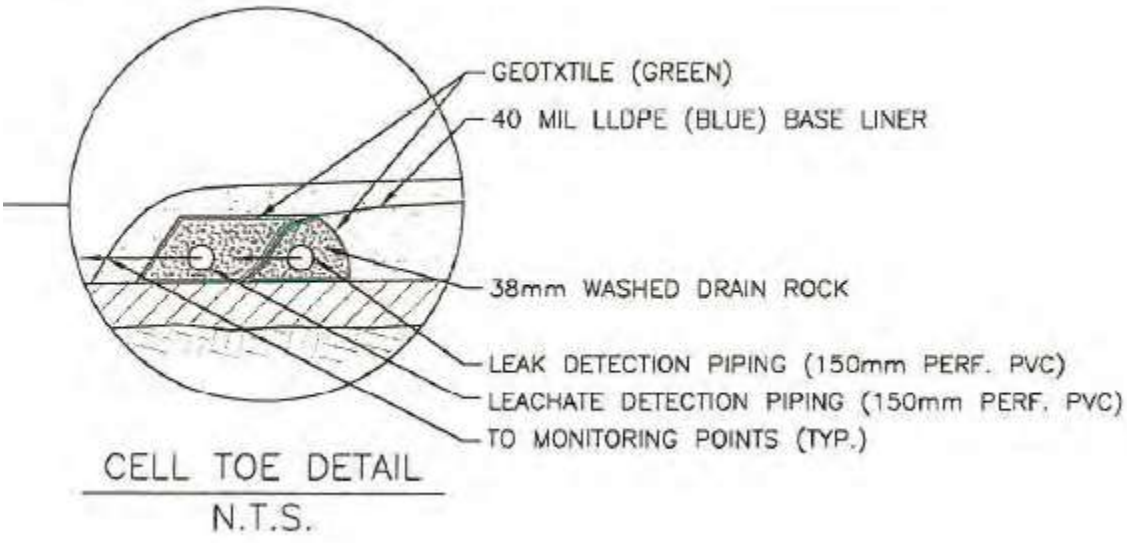
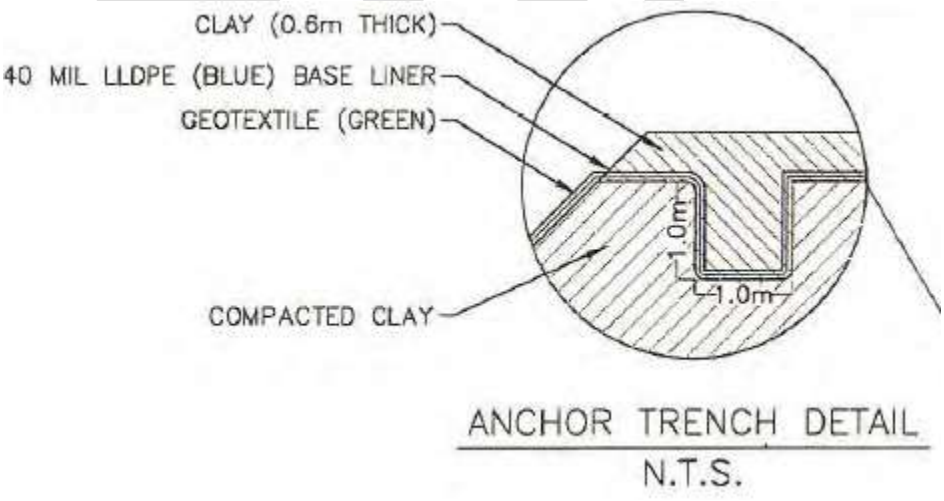


Figure 2: Anchor Trench Detail



As the cells in the PEA are filled, the drainage layer at the bottom of the landfill serves to collect and direct precipitation to the toe of the PEA for collection in the perforated leachate pipe. Precipitation that falls upon an active cell before the installation of a permanent cover may generate contact water.

This contact water is collected in the drainage layer. Very little water is expected from soil dewatering and once covered with a permanently fused cap-liner, this leachate drainage from the soils is expected to dry up.

Accumulated water from encapsulated soil leachate is pumped from the PEA Leachate Collection Reservoir to the contact pond and subsequently to the Water Treatment System. An inspection port, at the top of the contact water reservoir, allows monitoring of flow/volume and for sample collection. Similarly for the PEA Leak Detection Reservoir, the flow/volume and sample collection is facilitated by an inspection port at the top of the reservoir.

When completed the PEA design uses standard encapsulation technology to seal contaminated soils and prevent precipitation from leaching contaminants from the soils. The liquids that do drain from the encapsulated soils are captured using a gravity drainage system. Both the Leak Detection Reservoir and the Leachate Collection Reservoir are included in the daily inspection checklist.

Conclusion:

- PEA design is effective and appropriate for storing contaminated soils that do not contain incompatible chemicals for the lifespan of the LLDPE liner.
- Leachates generated from within the PEA are captured by the leachate collection system
- The leak detection system design should be effective for detecting leaks
- Monday to Friday inspections of the leachate and leak detection pipe inspection ports and reservoirs ensure that any blockages are cleared relatively quickly
- Daily inspection reports on the leak detection and leachate reservoirs allow the operators to monitor the volume of leachate that is collected in the PEA before pumping to the contact water pond.

Recommendation:

- Complete the cells that are finished by placing the 0.6 m of protective soil over the cap liner. Surface slope of the PEA should be minimized to avoid erosion of the protective soil cover. Hydroseed steeper areas of the PEA surface if necessary.

1.1.2 SMA LEACHATE COLLECTION

Although there is a roof over the Soil Management Area (SMA) water may drain from the soils stored on the surface and precipitation landing on the apron outside the roof area. Surface water on the asphalt drains across the asphalt surface via gravity to a catch basin. The catch basin water is piped to the contact water pond. Runoff from the roof, is captured by a gutter system. Roof water is considered clean water and is currently directed to the settling pond.

Soils containing hydrocarbons such as gasoline may cause some degradation of the asphalt surface over time. If damaged areas are identified the damaged areas could be resurfaced with additional asphalt..

The SMA was constructed with a road base material with 4” (100 mm) diameter perforated pipe laid underneath the geomembrane – 30 mil LLDPE – geomembrane layer which was covered with road crush and asphalt. A 10” (300 mm) inspection port was installed at the downslope end of the array of leak detection pipes just before the manhole to collect surface runoff from the SMA. The leak detection system empties into the SMA manhole which then drains by gravity to the contact water

pond. Figure 2 of the October 29, 2013 As-Built Summary report includes elevation and plan views of the SMA leachate collection system.

Daily inspections of the SMA Inspection Port are included as part of the daily checklist for the site. Normally the port would be dry, but it was installed to identify and collect any water that may pass through both the asphalt surface and the underlying synthetic liner.

With the installation of the roof structure the volume of contact water from the SMA has been reduced. Once the gutter installation is completed for the roof the water management at the SMA will be complete. Regular inspection of the inspection port and catch basin should continue to help to ensure that this system operates as intended.

Conclusion:

- SMA is built to capture water that drains out of the soils that are handled. The asphalt surface is resistant to many liquids although some solvents will cause asphalt to crumble. Annual inspections of the pad should be able to identify this sort of damage if it occurs and additional asphalt can easily be applied to repair the surface if necessary.
- The under pad leachate collection system design should be effective for capture of any liquids that penetrate the pad. As a last line of defense the LLDPE liner should provide decades of protection to the soils underneath the SMA.
- The SMA inspection port allows a visual inspection for leaks
- Monday to Friday inspections of the SMA catch basin, SMA area and the SMA inspection port allow for early detection of potential issues associated with the SMA pad.

Recommendation:

- The asphalt surface should be inspected annually for degradation due to chemical attack by hydrocarbon containing soils. Repair any damaged areas as necessary

1.1.3 WHEEL WASH

The wheel wash area is sloped towards the wheel wash catch basin. Trucks leaving the site must drive through the automated wheel and undercarriage wash. Soils and wash water are captured in the wheel wash catch basin. Sludge from the catch basin is returned to the SMA for stabilization/ solidification/ drying. The wash water in the sump drains via pipe directly to the contact water pond.

Conclusion:

- The wheel wash is built to capture water and potentially contaminated soils from the undercarriage and tires of vehicles leaving the SMA. Wash water and sludge are effectively managed.

Recommendation:

- Continue with the program of regular cleaning and inspection of the catch basin

1.1.4 CONTACT WATER POND

A containment pond was designed to hold contact water (Contact Water Pond) emanating from the operations at the site. The purpose of the contact water pond is to provide sufficient capacity to store a 200 year 24 hour storm with snow melt beyond the two 2,500 imperial gallon reservoirs (roughly 11 m^3 storage capacity) for the PEA Leak Detection and PEA Leachate Collection systems. The December 6, 2013 Water Treatment System as built report describes the contact pond as a 25 m x 25 m containment reservoir 4 m deep, lined with 30 mil LLDPE synthetic liner. In June of 2016, the contact pond dimensions were surveyed. Subsequent calculations for the December 2016 report found the actual contact pond capacity to be smaller than the original design (see section 2.4.2). The reason for the discrepancy is not clear at this time.

The contact water pond is undersized to store a 200 year storm with snow melt based on an extrapolation of the rainfall intensity curves (see section 2.4). However, if a storm of this size were to occur before the contact water pond can be enlarged, the contact water treatment system has sufficient capacity to process an event of this size without exceeding the current discharge permit volume conditions.

As described in the EPM/OMS the contact water is treated as required to maintain the 0.5 m freeboard. Operators run the CWTS to draw down the contact water pond in anticipation of forecast storm events. The Daily Inspection and Maintenance Log is an essential tool for monitoring the contact water pond.

Conclusion:

- The contact water pond has been effectively managed to minimize sludge build up and maintain a 0.5 m freeboard.
- Based on the Lake Cowichan weather station the pond is undersized to handle a 200 year 24 hour storm with snow melt.

Recommendation:

- Contact Water Pond should be enlarged to hold the design 200 year 24 hour storm with snow melt.
- Additional drawdown of the pond prior to forecast storm events is a critical operational procedure to maximize capacity of the pond for extreme events.

1.1.5 SETTLING POND

The Settling Pond is fed by non-contact water from disturbed areas, active mine areas and treated effluent from the contact water treatment system. The size of this pond is discussed in the hydrotechnical section of the main report and this addendum.

The pond is operated to maintain at least 0.5 m of water. Maintenance entails periodic removal of the sludge from the bottom of the pond. Settled solids, which have accumulated in the pond are removed as required to maintain a minimum water depth below the pond decant of 0.5 m. Sludge material is treated as suspect waste soil, transferred to the SMA and characterized.

Conclusion:

- The settling pond is undersized to achieve settling of 10 µm particles

Recommendation:

→ The settling pond should be increased to achieve the retention time and settling of particles recommended by the DFO guidelines

1.2 CONTACT WATER TREATMENT SYSTEMT

The contact water treatment system (CWTS) was designed by Stormtec Filtrations to handle 75 gpm but can operate between 200 – 1,250 L/min. The system is described in detail in the December 6, 2013 As-Built Summary sent to attention of Mr. Luc Lachance at the BC MOE. The flow chart included in Figure 3 below is from the As-Built Summary document.

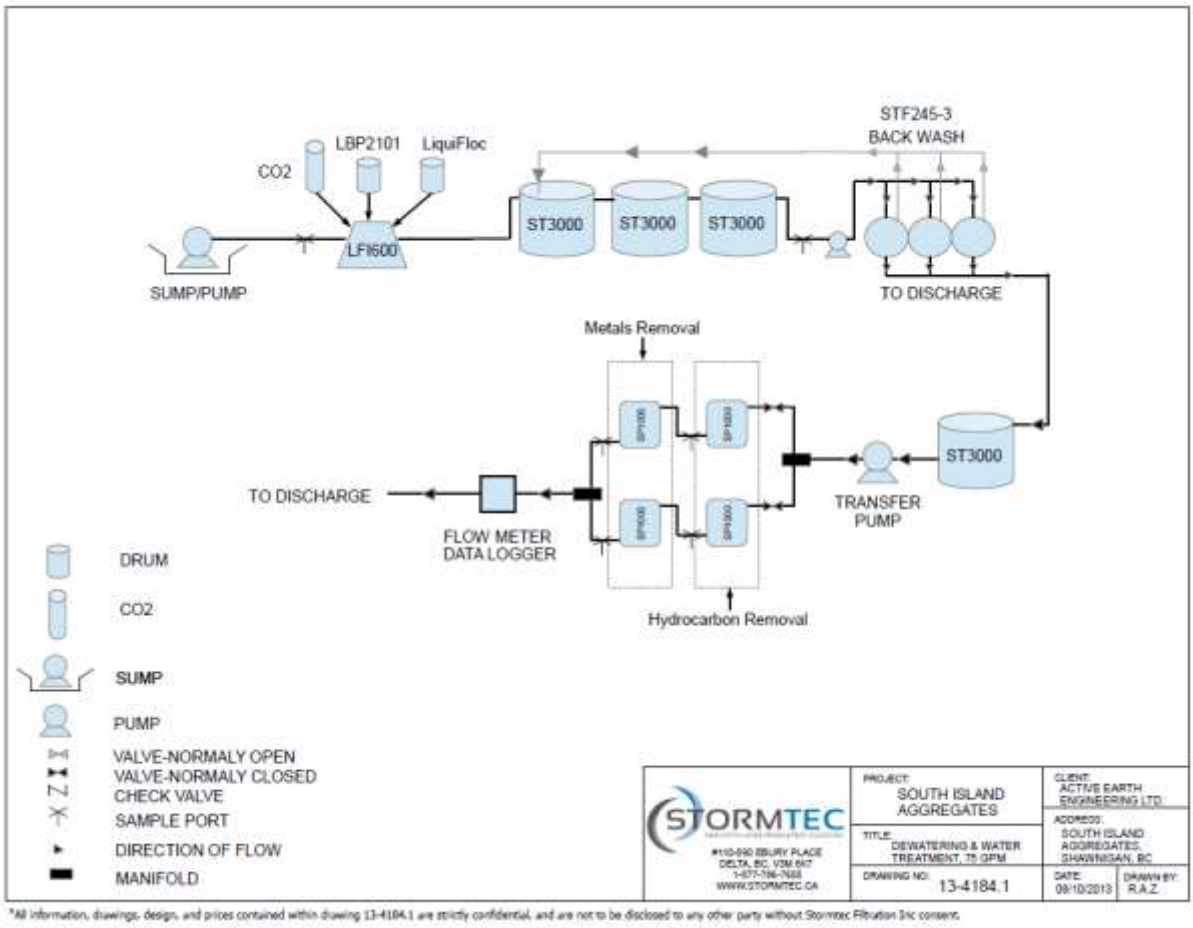
Treatment starts at the pH Remediation System module CS250e which adjusts high pH contact water by adding carbon dioxide CO_2. There is an auto shutoff when there is no flow pressure and CO_2 flow is controlled by a calibrated pH sensor. The pH adjusted water then passes through the flocculent injection system (LFI600).

After the pH and flocculent addition, flow is directed to holding tanks to allow settling of the solids. Solids are periodically removed to the SMA for stabilization. The liquid is then filtered through a sand filter before pumping through two granular activated carbon filters to remove hydrocarbons and two activated alumina filters to remove metals before discharge to a holding tank or the settling pond.

Performance of the filters is monitored by measuring the pressure drop across the filters. When the pressure rises, to indicate plugging of the filters, they are automatically backwashed with the backwash emptying to the contact pond. Automatic float switches will shut down flow to provide extra safeguards against overflow of the filters.

Sludge depth in the contact water pond is checked after every major event. Sludge is removed to the SMA for drying and placement into the PEA. As part of the daily operations inspection the contact water pond freeboard is measured (see EPM/OMS Daily Inspection and Maintenance Log). Operators maintain a 0.5 m freeboard.

Figure 3: Flow Diagram of the Stormtec Water Treatment Plant



Conclusion:

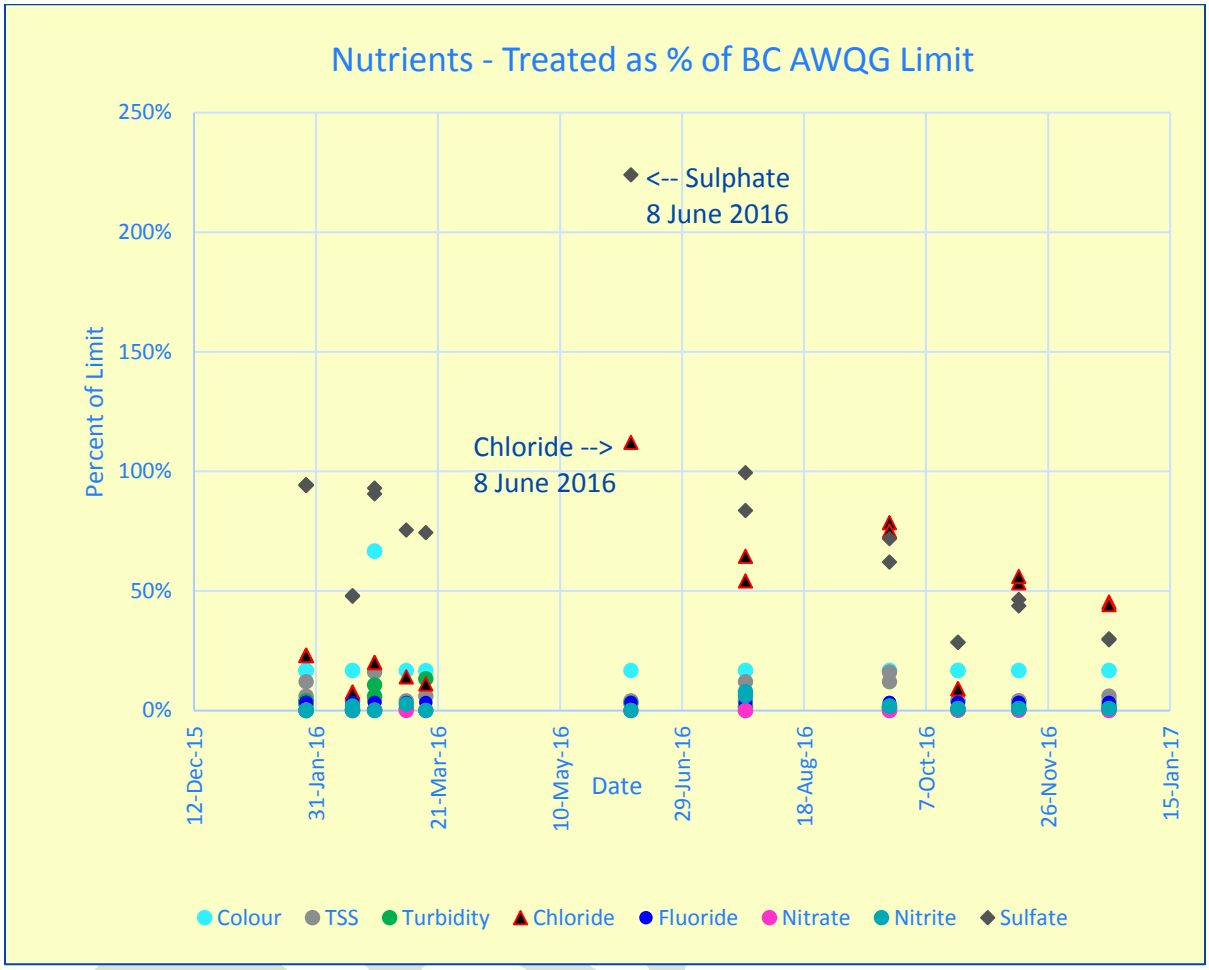
- → The contact water treatment system uses standard treatment technology
- → The capacity is adequate to handle a 200 year 24 h event with snow melt (see section 2.4)

1.2.1 EVALUATION OF THE CWTS EFFECTIVENESS

The CWTS is operated on an as needed basis. It can be operated in a batch or continuous mode. Under the terms of the permit PR105809 the treated water discharge effluent and the settling pond discharge point (SW-1) must be sampled monthly or every 2,000 m^3 of discharge whichever is more frequent. The CWTS was updated between 21-27 January, consequently a review of the treated water discharge effluent data for 2016 should be indicative of the performance of the system.

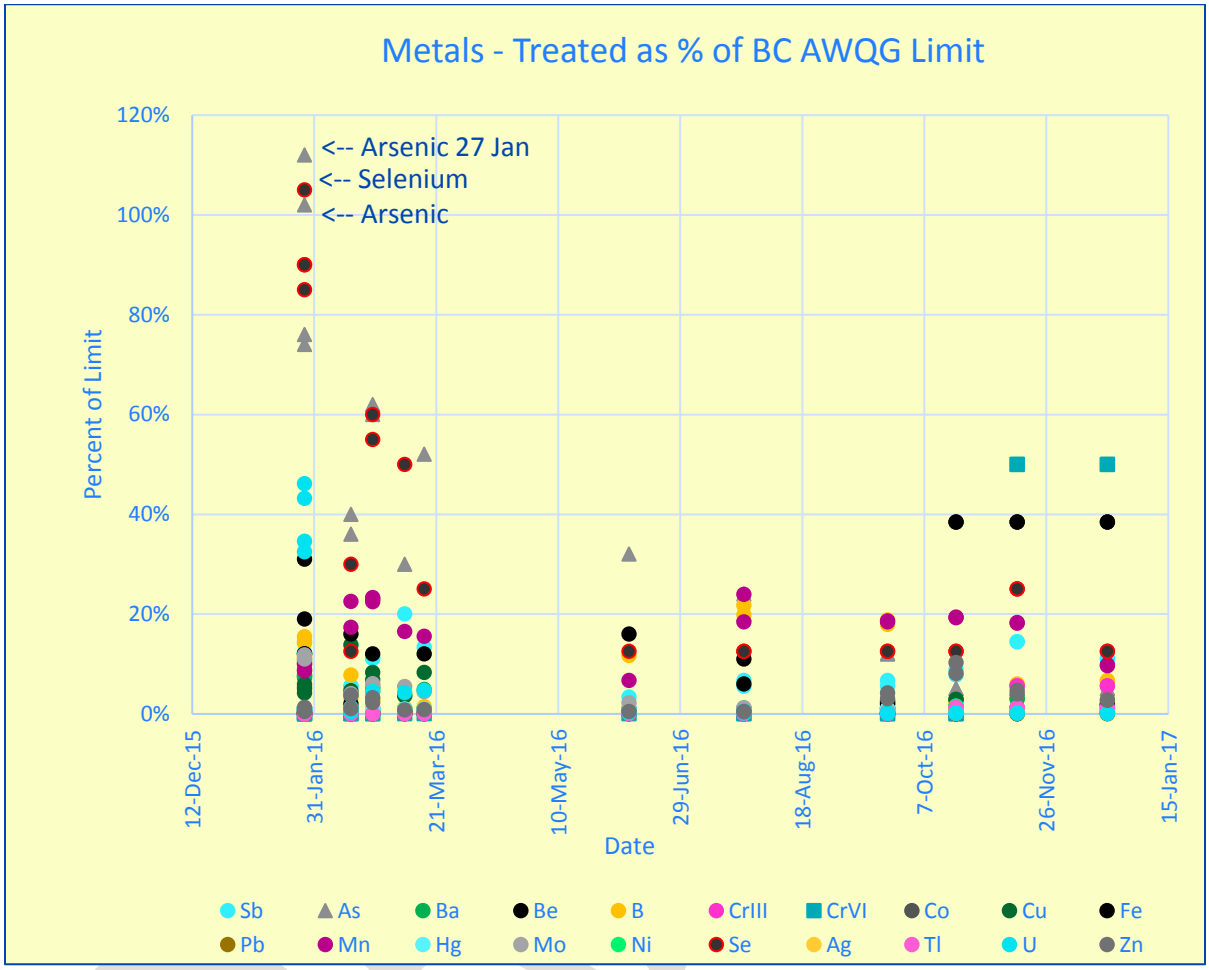
Data has been normalized to allow grouping of multiple parameters into one graph. Analysis results for each parameter were divided by the applicable most stringent criteria to normalize the data in the following figures (see Figure 4 through Figure 8).

Figure 4: CWTS Discharge - Nutrients



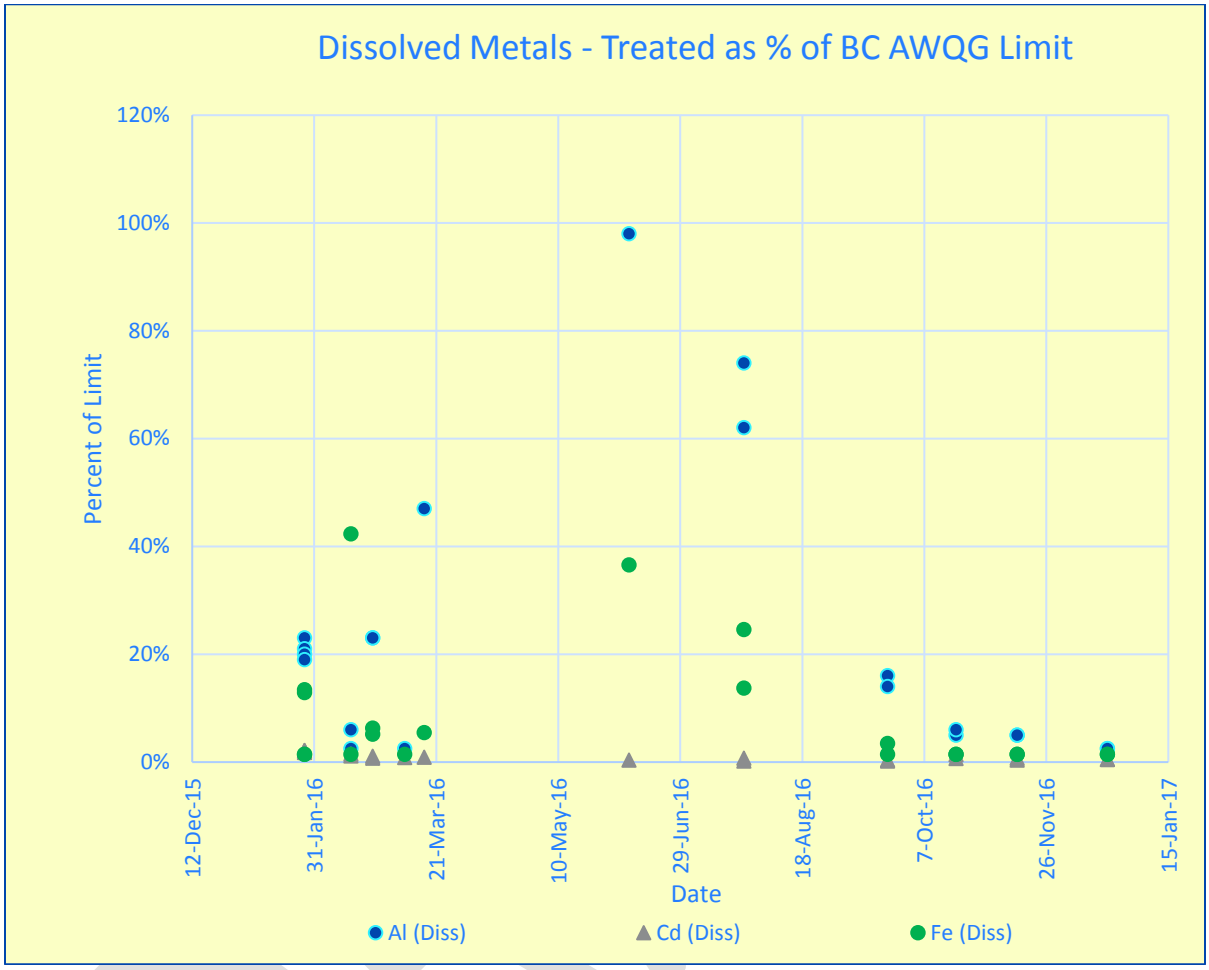
The elevated levels of Sulphate and Chloride in the treated water were not detected at SW-1 after mixing the comparatively small volume of treated water to the much larger volume of non-contact water in the settling pond (see Figure 9).

Figure 5: CWTS Discharge - Metals



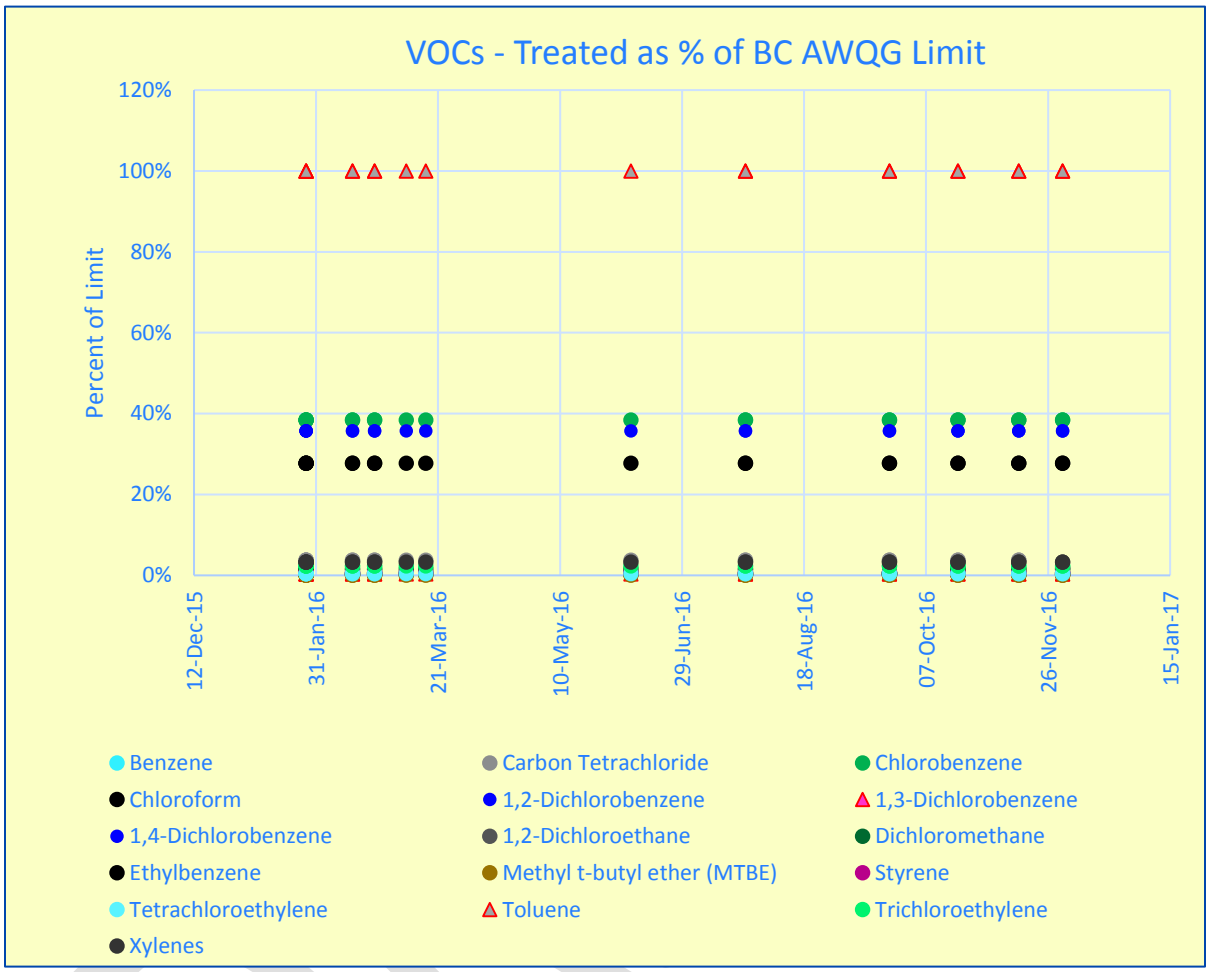
In the SIRM first quarter report for 2016 (page 23/510) it was noted that the CWTS underwent system maintenance after January 21, 2016. Elevated levels of Aluminum, Arsenic and Selenium were detected so the first batch of treated water was sent to an accredited facility and some was recycled back to the contact water pond. Additional equipment was commissioned in the CWTS and the January 27, 2016 samples were the first batch through the updated CWTS. Data indicated slightly elevated levels of Arsenic and Selenium. This was deemed acceptable for mixing with the much larger volume of non-contact water in settling pond. No exceedance of Arsenic or Selenium was detected at SW-1.

Figure 6: CWTS Discharge - Dissolved Metals



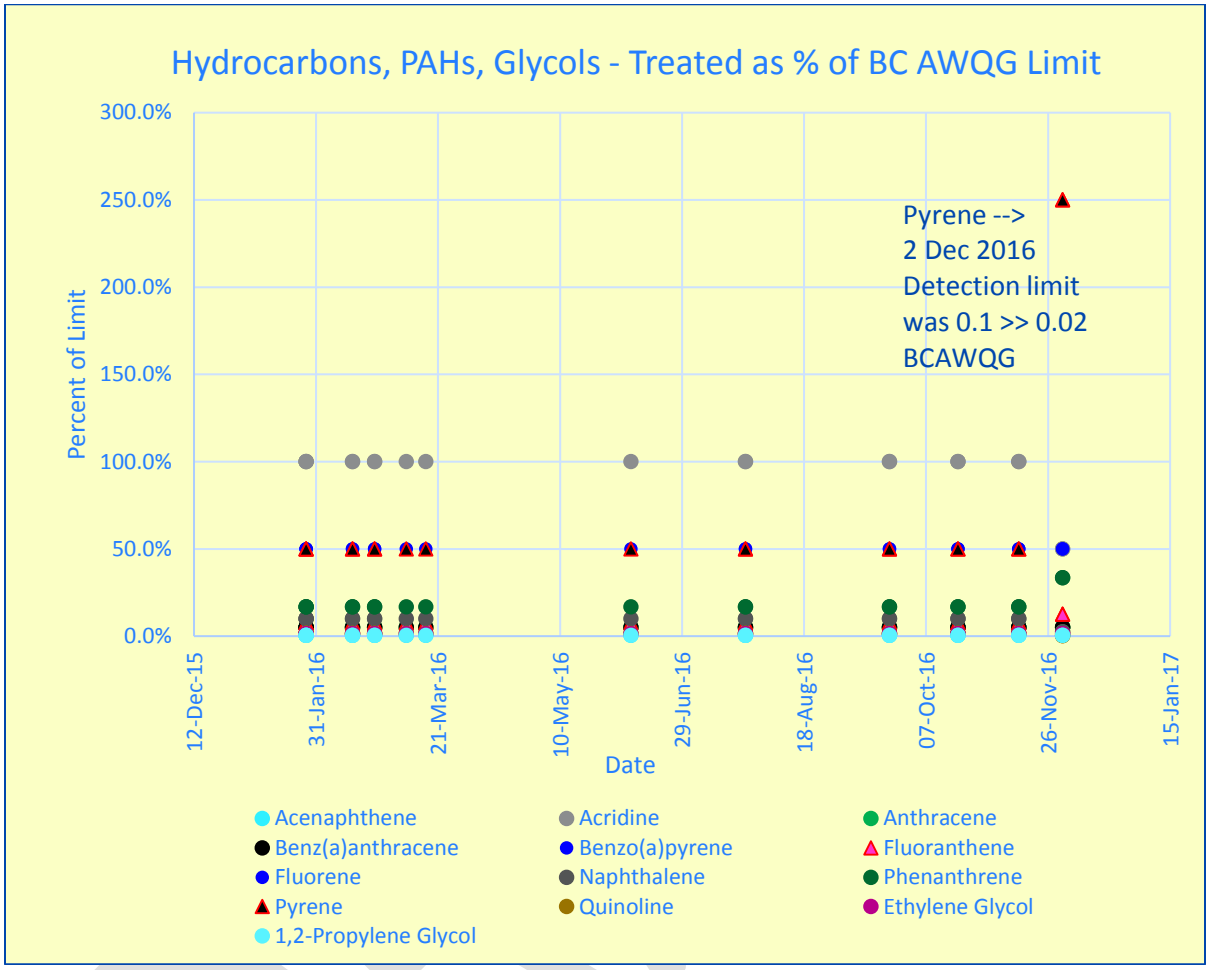
All three dissolved metals that have associated BC AWQG were below guideline limits in 2016.

Figure 7: CWTS Discharge - VOC's



All results were at detection limits.

Figure 8: CWTS Discharge - Hydrocarbons, PAHs, Glycols



Due to interference in the sample the detection limit for the December 2, 2016 pyrene sample was not low enough. All the other samples in 2016 were at the detection limits.

Conclusions:

- Review of the 2016 data since January 27 indicates that the system is effectively removing particulates and metals. VOC's, Hydrocarbons, PAH's and Glycols were consistently removed in 2016 to detection limits of all parameters with a BC AWQG limit. The only exceedances were for Chloride and Sulphate.

Recommendations:

- Ideally the detection limits for analysis should be no more than half the criteria limits. Better detection limits should be sought for Toluene and Acridine,
- An additional treatment module should be added to remove chloride and sulphate. Many different methods could be used to remove these two ions including ion exchange resin, precipitation with pH adjustment, flocculating agents, RO, nano-filtration, and bio absorption. A quick review with water treatment system suppliers should be conducted to select a cost effective and robust system to handle the range in water quality that will need to be treated. Ideally this could be added in line with the existing water treatment system.

1.3 CWTS QUALITY CONTROLS

The CWTS is equipped with automatic controls to prevent overflow of the system or excessive acidification. Float switches are installed on the filter to prevent overflow of the filters. Each filter has pressure sensors to monitor the pressure drop across the filters. This is connected to the automatic backwash system which backwashes the filters when the pressure drop is too high (backwash water is directed to the contact water pond).

The pH adjustment system uses CO_2 to acidify the contact water. A flow sensor and pH probe are used to control the flow of CO_2. Flow of CO_2 is automatically shut off if the pH is low enough or if there is no flow. The pH probe is calibrated monthly.

Standard sampling protocol is employed requiring duplicate sampling. Permit 105809 requires samples of the treated water to be collected at least once every 2,000 m^3 of treated water.

As part of the Daily Inspection and Maintenance Log (detailed in section 11-3 of the EPM/OMS) the water treatment plant is checked for the following:

- Pipes and connections not leaking
- Mechanical & sensor components functioning
- Holding Tanks are not overfilled
- Chemical/Flocculent stores are adequate

In addition the Daily Inspection and Maintenance Log includes sections for inspection of the contact water sources such as:

- PEA liner, surrounding berms, flow to the CWTS, leachate collection system and the leak detection system
- Sediment control and diversion works which includes the splash guards on the bridge over Shawnigan creek
- Settling Pond – check that there is 0.5 of water below the decant line, no erosion of the berm, no short circuiting of the flow,

In addition to the Daily Inspection and Maintenance Log, the Settling Pond, PEA and SMA contact water collection systems are inspected as part of the daily Effluent Monitoring and Sampling Record. This record includes observations and measurement of:

- SMA inspection port - observation to see if there is a flow
- SMA manhole - observation to check for plugging, and amount of sludge
- PEA Leak Detection port - check for plugging and flow
- PEA Leachate Collection System port - check for plugging and flow
- PEA Leak Detection Reservoir - volume of water
- PEA Leachate Collection System Reservoir - volume of water

Conclusion:

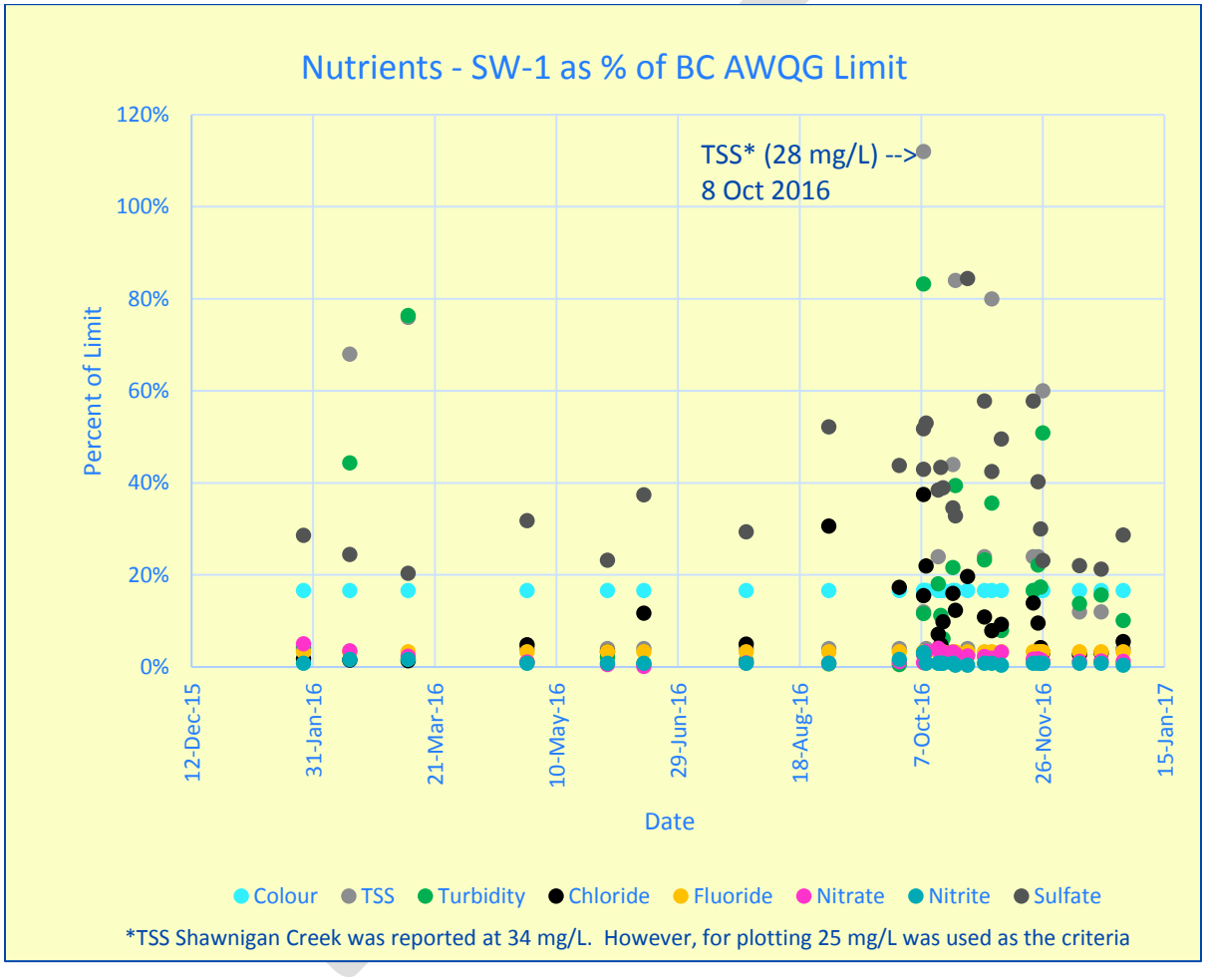
→ Daily inspections are undertaken of the SMA, PEA, CWTS, contact water pond and settling pond. These inspections are the foundation of a proactive preventative maintenance program.

1.4 DISCHARGE QUALITY

Discharge quality is measured at the SW-1 sampling point.

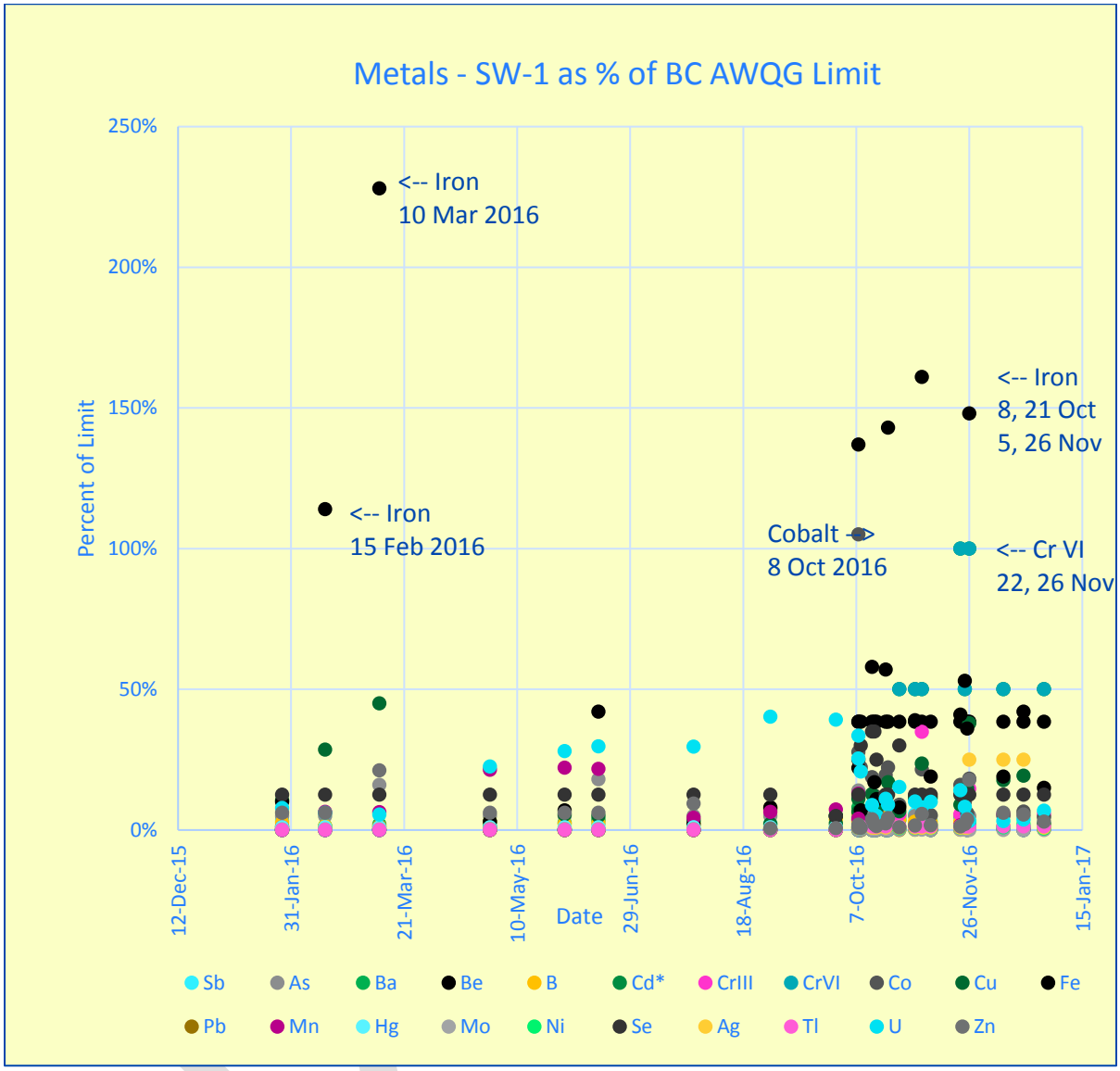
1.4.1 DISCHARGE DATA FOR 2016

Figure 9: Discharge Point (SW-1) - Nutrients



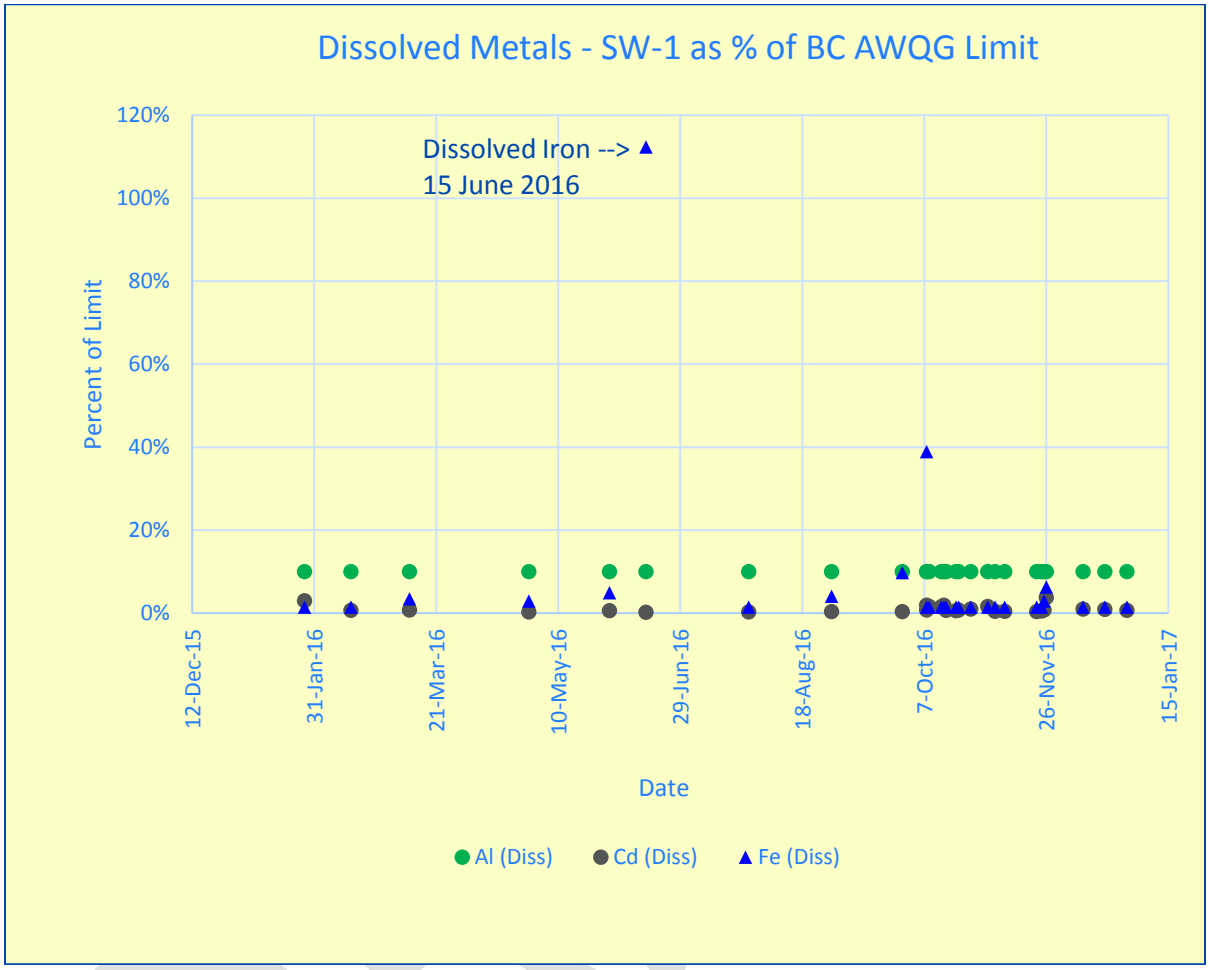
A major storm event occurred on 8 October 8, 2016 wish flushed soils from an unclosed PEA cell into one of the drainage ditches. This resulted in excessive TSS loading to the settling pond. Background levels for Turbidity and TSS in Shawnigan Creek were noted in the fourth quarter SIRM report at 50 NTU and 34 mg/L respectively (page 3/1073). Thus the 28 mg/L TSS reading was below the background levels in Shawnigan Creek.

Figure 10: Discharge Point (SW-1) - Metals



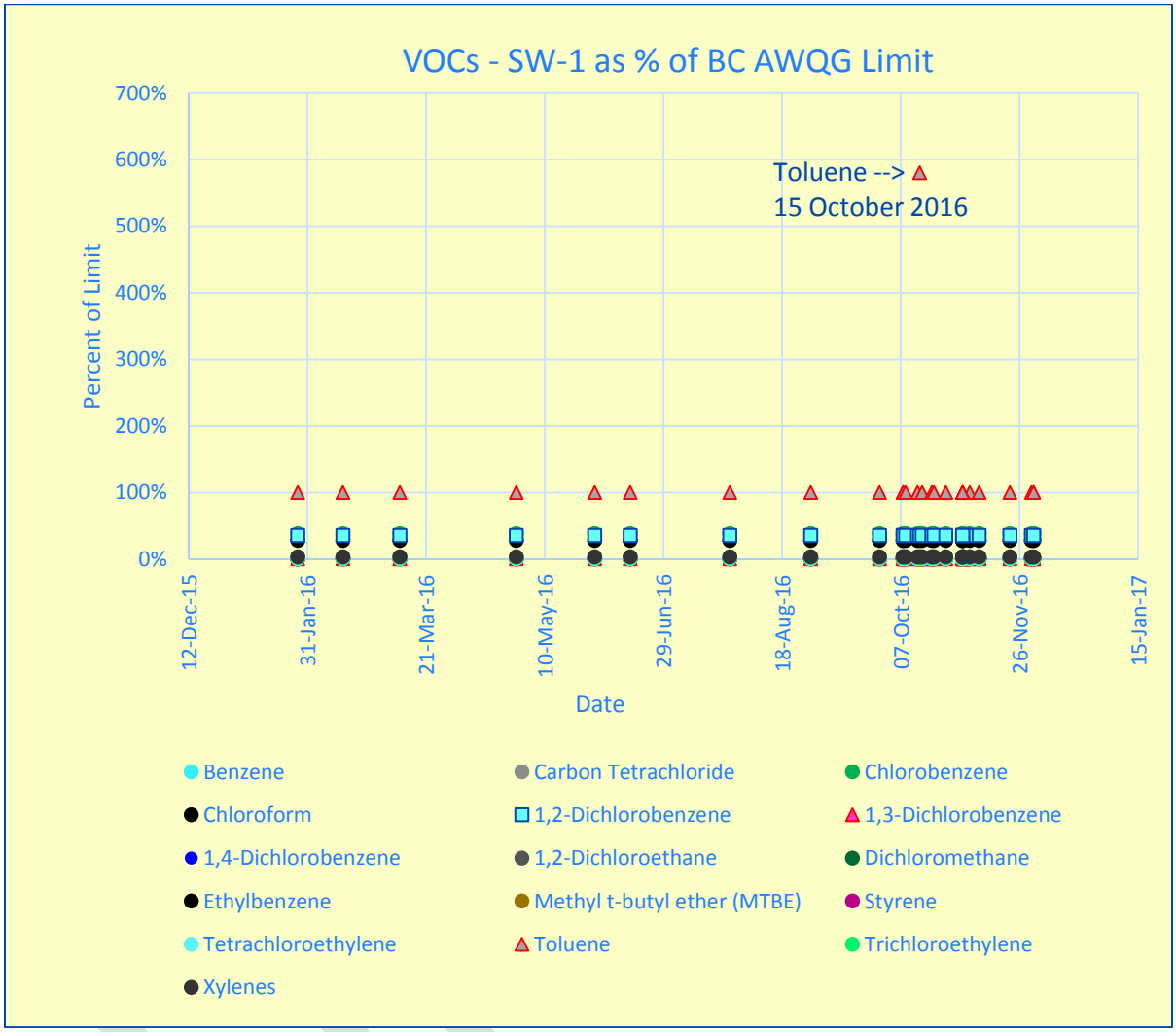
The elevated levels of total Iron (Fe), Cobalt (Co), Chromium VI(CrVI) shown in Figure 10 above were not associated with a spike in total iron or the treated water discharge. Thus the source of these metals is likely from suspended mine solids.

Figure 11: Discharge Point (SW-1) - Dissolved Metals



The elevated level of dissolved iron shown in Figure 11 above was not associated with a spike in total iron or the treated water discharge. Thus the source of the iron is likely from background levels in the mine.

Figure 12: Discharge Point (SW-1) - VOC's



The single pyrene value above the BC AWQG shown in Figure 13 is associated with an HEPH of 1660 mg/L. None of the treated water samples in 2016 exceeded 1000 mg/L. Thus this result was likely from non-contact water.

Figure 13: Discharge Point (SW-1) - Hydrocarbons, PAHs, Glycols

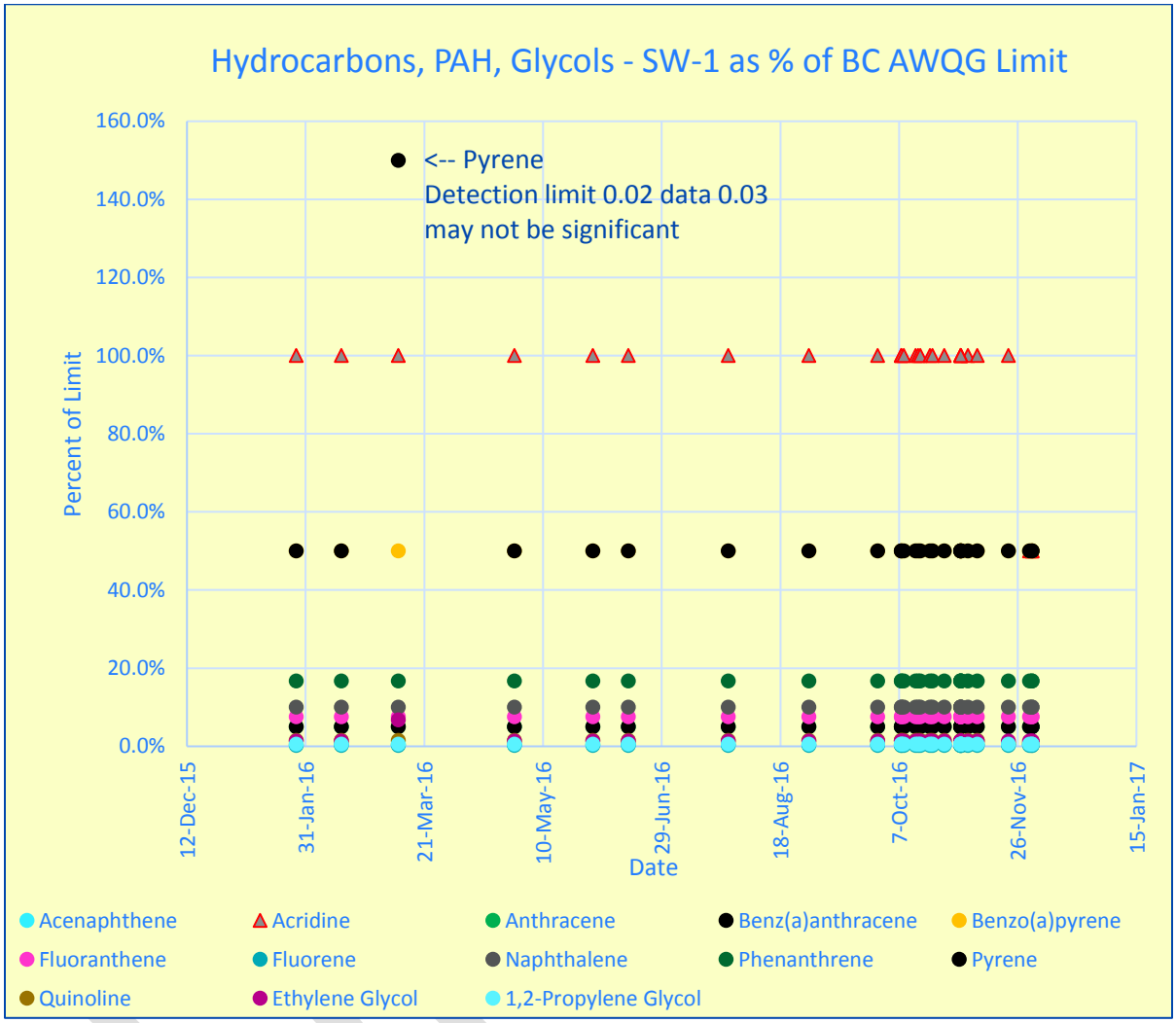
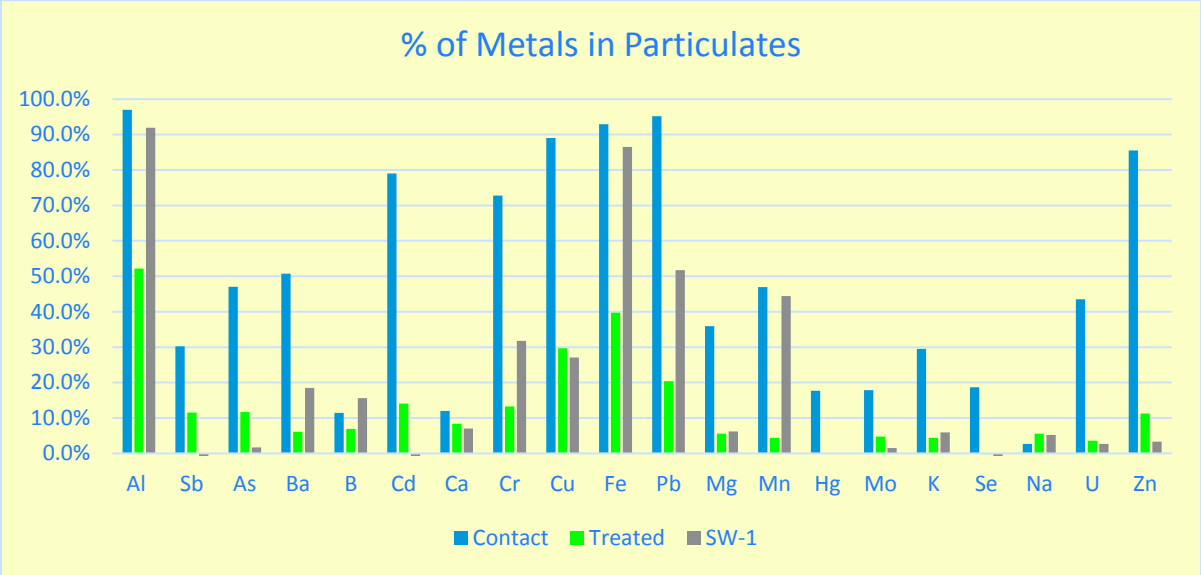


Figure 14 shows that the treatment system is effectively reducing the non-soluble metals (particulates). For example over 85% of the Aluminum (Al), Copper (Cu), Iron (Fe), Lead (Pb), Zinc (Zn) in the contact water is associated with non-soluble metals. After the treatment system: 50% of the Al is non-soluble, 30% of the Cu, 40% of the Fe, 20% of the Pb, and 10% of the Zn. The fact that the non-soluble components of these metals rose up over 85% for the Al and Fe in the SW-1 indicates that they are either coming out of solution to form precipitates or there is Al and Fe particulate loading from the mine water.

Figure 14: Percent of Metals in Particulates



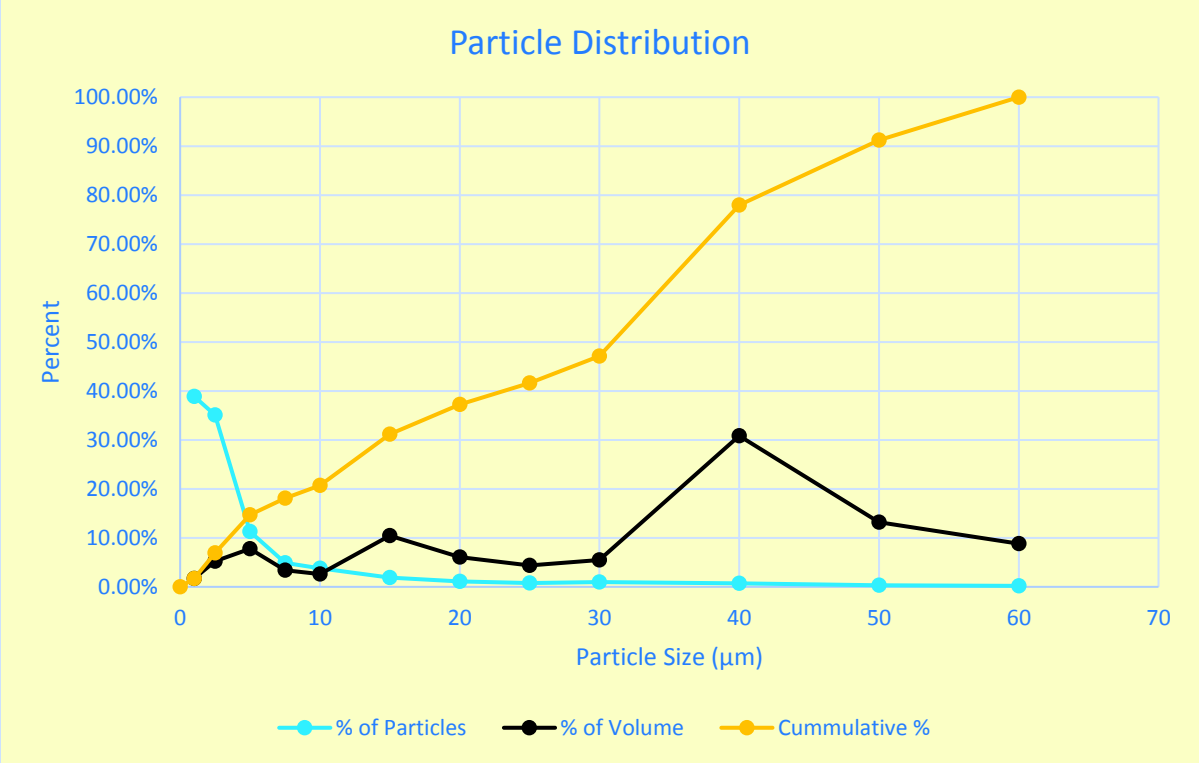
There is a rise in the proportion of metal particulates (Al, Ba, B, Cr, Fe, Pb, Mn) in SW-1, is likely due to the natural metal levels in the mine. Thus if the settling pond is of sufficient size most of the particulate mass should be removed (assuming that metals are uniformly distributed in particles) and thus the site should be able to meet the discharge standards for metals (based on the 2016 data). The elevated metals readings appear to be associated with TSS values of 15 mg/L or more in non-contact water (see analysis for iron exceedances in 2016 in Table 1 below).

Table 1: Potential Reduction of Iron by Settling 10 µm Particles

DATE	IRON % OF LIMIT (1 MG/L)	TSS (MG/L)	% IRON IN SOLIDS	IRON % OF LIMIT IF 70% OF SOLIDS REMOVED
15 Feb	114	17	99.1%	35
10 Mar	228	19	99.5%	69
8 Oct (11 am)	137	28	90.7%	50
21 Oct	143	21	99.3%	44
5 Nov	161	20	99.7%	49
26 Nov	148	15	98.5%	46

Note: Based on the particle distribution graph, 80% of the particle volume is over 10 µm (the target size for settling pond design).

Figure 15: Particle Size Distribution



Conclusions:

- The non-contact water from the mine contains particulate that can have elevated levels of some metals in particular iron.
- Metals in the non-contact water are predominantly non-soluble and thus removal of 10 µm particulates should prevent exceedances of metals at SW-1
- If oils are lost in the mine area they will be flushed to the settling pond. There is currently no protection in the discharge design piping to prevent discharge of oils which float on the pond surface.

Recommendations:

- The settling pond should be increased in size to achieve settling of 10 µm particles (see section 2.3)
- Modify the discharge piping arrangement so the inlet for the discharge is below the pond surface. This will avoid discharge of any oil products that float on the pond surface.

2 HYDROTECHNICAL COMMENT REVIEW

The following sections address critical hydrotechnical and hydrogeological comments indicated by the Ministry of Environment (MOE) in their report review letter dated January 27, 2017. In general,

comments relate to: shallow subsurface flow, seepage blanket review, settling pond design, and the containment pond design. Additionally, it was indicated that, "The WSP report did not include a required work plan and schedule for carrying out the report's recommendations", which has now been created and is referenced and provided with this document.

2.1 HYDROGEOLOGICAL INVESTIGATION

MOE comments:

1. *The WSP non-contact water management review report did not fully satisfy the MOE Director's letter dated June 29, 2016. The scope and content of the WSP non-contact water management review report was not fully consistent with the Stantec Terms of Reference Water Management Assessment, dated January 15, 2016, and did not fully address the previous Stantec reports and relevant information in the MOE letter of January 22, 2016.*
    I. *The WSP report did not address hydrogeological investigation of shallow sub-surface flow (inter-flow), infiltration into the settling pond, and the installation and sampling of 2-3 shallow monitoring wells within the layer of blast rock (on the western property line). The WSP report (section 3.1.3) did indicate that permeability tests could estimate the location and rate of infiltration but did not recommend or carry out these tests.*

From the MOE's comments it has been indicated that the hydrogeological investigation aspects of the Stantec Terms of Reference Water Management Assessment were not addressed. The primary objective of the hydrogeological investigation, as identified by Stantec, is to better define the nature of the subsurface drainage path of the site, settling pond and discharge point along the western property. The Terms of Reference Water Management Assessment proposed:

"*A phased approach to the practical investigation will be taken, the first phase focusing on the hydrogeology of the immediate area around the settling pond on the western perimeter. This investigation will include a percolation test for the settling pond, and the installation of 2-3 shallow monitoring wells within the layer of blast rock to better characterize inter-flows. This first phase of on-site well construction and percolation testing will provide the following clarifications:*

1. *Rate of infiltration to ground from the settling pond, which will allow for the pond design to be refined,*
2. *Access to inter-flow water via the wells for water quality testing. Currently, there is no method by which the inter-flow water can be accessed.*

Depending on the result of this first phase of on-site testing, additional shallow wells may be required."

This proposal for flow monitoring would provide information regarding the rate of infiltration from the settling pond, and information to characterize site inter-flows. The WSP report indicated that by neglecting infiltration rates within the settling pond, a more conservative estimate was calculated. This methodology makes the installation of monitoring wells redundant, as infiltration data collected from the system would not be applied to calculations. However, the implementation of the monitoring wells would provide practical settling pond infiltration values. To confirm its impact settling pond infiltration will be measured as a part of the site hydrogeological investigation as indicated in the work plan Task 3.

The installation of monitoring wells for the non-contact mine water management system would provide access to inter-flow information, which could be used for the primary objective of characterizing on-site shallow sub-surface flows. This has been recommended to be completed as per Task 2 in the work plan schedule.

2.2 SEEPAGE BLANKET REVIEW

MOE comments:

1. *The WSP non-contact water management review report did not fully satisfy the MOE Director's letter dated June 29, 2016. The scope and content of the WSP non-contact water management review report was not fully consistent with the Stantec Terms of Reference Water Management Assessment, dated January 15, 2016, and did not fully address the previous Stantec reports and relevant information in the MOE letter of January 22, 2016.*
    I. *A primary objective of this investigation is to better define the nature of this subsurface drainage path and this will be achieved by conducting a hydrogeological site investigation and a review of the "seepage blanket" design. Deep groundwater flow will not be included in this review. This review will focus on the shallow sub-surface flow (referred to as "inter-flow"). (Stantec Terms of Reference Water Management Assessment, January 15, 2016, Section 2.1).*

A review of the Seepage Blanket Details letter, December 10, 2013, was completed. The seepage blanket design proposes the placement of crushed rock to fill depressions at the mined surface, with the installation of a geotextile fabric to prevent migration of fines. Upon reviewing the as-built details for Cell 1A dated August 28, 2015 the drawings do not clearly show a seepage blanket layer. The uncertainty in this construction is anticipated to be addressed through the shallow subsurface flow investigation, as outlined in the previous section, which should indicate whether subsurface flow is a concern around the cells.

2.3 SETTLING POND

MOE comments:

1. *The WSP report (Figure 1 & section 3.1.1) shows a settling pond catchment area of 4.5 ha. This is less than the area used in prior technical information (10.4 ha), and less than the landfill area on the permit site plan. The WSP report indicates that settling pond capacity should be reviewed prior to future increases in catchment area. The catchment area affects the design of the required non-contact water management works including the settling pond.*
2. *The WSP report indicates that (with recommended improvement to increase storage volume) the settling pond is estimated to have the capacity to settle a 19 µm sized particle and should be capable of providing approximately 16 hours of residence time. This appears inconsistent with MOE Technical Guidance 7 Assessing the Design, Size, and Operation of Sediment Ponds Used in Mining, December 2015, initial recommended maximum 10 µm design particle size, and minimum 20 hour retention time (Method a Simplistic Design Approach).*
3. *The WSP report identified deficiencies with the settling pond spillway chute slope, rock size, and riprap thickness, recommended improvements to increase effective pond volume, indicated additional review will be required to confirm the settling pond design meets permit requirements, and that following review, the settling pond capacity may need to be increased.*
4. *Additional review and improvements to the settling pond will be necessary to satisfy permit requirements*

The reduced settling pond catchment area of 4.5 ha from 10.4 ha is due to the investigation of on-site grades. Areas of the site do not drain to the settling pond, which results in the reduced area. As noted by MOE, the WSP report indicates that settling pond capacity should be reviewed prior to future increases in catchment area. The catchment area affects the design of the required non-contact water management works including the settling pond.

As indicated in the WSP report the settling pond is estimated to have the capacity to settle a 19 µm sized particle and should be capable of providing approximately 16 hours of residence time. According to the MOE Technical Guidance 7 Assessing the Design, Size, and Operation of Sediment Ponds Used in Mining, December 2015, the settling pond should have the capacity of a 10 µm design particle size, and minimum 20 hour retention time (Method a Simplistic Design Approach). A design for the mine water management system is to be completed as per the work plan schedule Task 2.

As indicated in the MOE comments; the WSP report identified deficiencies with the settling pond spillway chute slope, rock size, and riprap thickness, recommended improvements to increase effective pond volume, indicated additional review will be required to confirm the settling pond design meets permit requirements, and that following review, the settling pond capacity may need to be increased. The settling pond, as indicated by the MOE, will require additional review and improvements to the settling pond will be necessary to satisfy permit requirements. Redesign of the settling pond is to be completed as per the work plan schedule Task 6.

2.4 CONTACT WATER POND

MOE comments:

1. *The WSP report proposes contact water design criteria of a 25 and/or 50 year return period rainfall event. This is inconsistent with prior technical information, including plans and specifications that indicated the contact water management system was designed for a 200 year 24 h storm event plus snowmelt.*
2. *The WSP report indicates the contact water holding pond has a total volume of 320 m^3 and a volume below the high water level of approximately 206 m^3. This is inconsistent with prior technical information, including plans and specifications that indicated the volume of the contact water holding pond is approximately 1100 m^3.*
3. *The WSP report indicates that additional contact water storage will be required for future landfill encapsulation cell construction.*
4. *The WSP report indicated the permitted annual average rate of discharge (12.1 m^3/day) is not sufficient, and the permitted maximum rate of discharge (274 m^3/day) may have to be increased if future landfill encapsulation cell areas will exceed an additional 0.20 ha.*
5. *Additional review and improvements to the contact water management works will be necessary to satisfy permit requirements.*

2.4.1 DESIGN EVENT AND RUNOFF VOLUME ESTIMATE

The Active Earth Engineering Ltd. Technical Assessment report, August 2012, (pg. 62) indicated the design criteria for the contact water as having a maximum effluent discharge rate at 3.2L/s, and an average effluent discharge rate at 0.14 L/s for a 200-year, 24-hour event.

The Active Earth As-Built Summary – Soil Management Area, October 29, 2013, indicated:

> *"In addition to the SMA surface, a water holding pond was constructed as part of the water management infrastructure. This holding pond is sized to handle a 200 year storm plus snowmelt assuming the entire SMA is uncovered."*

The August 2012 design criteria does not specify a contact holding pond volume requirement, only a maximum effluent discharge rate from the soil management and treatment area. The report also only specifies the 200 year 24 hour storm event and does not indicate a requirement for snowmelt. However, the as-built letter from October, 2013 does specify a 200 year 24 hour design event capacity with snowmelt, but does not estimate the required volume.

WSP has estimated the runoff volumes, in the table below, for both the 200-year 24 hour event with and without snow, based on rational method calculations as outlined in the BC Supplement to TAC Geometric Design Guide (2007).

Table 2: 200 Year Storm With Snow Melt

CATCHMENT	TOTAL AREA (ha)	200-YEAR EVENT (m^3)	200-YEAR EVENT + SNOW (m^3)
Wheel Wash and Containment Pond	0.2	337.4	371.14

2.4.2 EXISTING CONTACT POND CAPACITY

Upon the review of previous technical documents it has been found that there is a discrepancy between the initially indicated design capacity for the contact water pond, and the as-built design capacity. The volume estimated from the containment pond survey provided to WSP is inconsistent with the Active Earth letters data October 29, 2013, and December 6, 2013.

The estimated design event runoff volume exceeds the current estimated capacity of the contact water containment pond. From the December 2016 WSP report the containment pond is estimated to have a total volume of 320 m^3, based on survey data from June 2016 provided by the client. The pond high water level (HWL) is defined by the inlet pipe from the SMA piped drainage system, which is approximately 0.5 m below the top of bank. Approximately 206 m3 of storage is available below the HWL. Additional contact water storage will be required under the design criteria of a 200-year 24 hour event. Any future added area to the contact water containment pond will also require additional storage.

2.4.3 PERMITTED AVERAGE ANNUAL AND MAXIMUM DISCHARGE RATES

The current permitted maximum rate of discharge is sufficient to draw down contact water accumulated from a 200-year 24-hour event with snowmelt. An increase to the permitted discharge rate will be required if future encapsulation areas exceed 0.10 ha.

The current permitted annual average rate of discharge should be increased, as outlined in the in the December 2016 WSP report. The required annual average discharge rate for the current 0.20 ha site is approximately 14.9 m^3/day; consideration should be taken for future encapsulation cells, which would increase the discharge rate.

As indicated by the MOE comments, additional review and improvements to the contact water management works will be necessary to satisfy permit requirements. The containment pond and contact water treatment system are identified to be assessed and redesigned as per the work plan schedule Task 4.

2.5 LAKE COWICHAN IDF DATA/ 200-YEAR EVENT

MOE comments:

1. *The WSP report used the Lake Cowichan climate station (annual precipitation 2047.5 mm), calibrated and validated using the available local hydrometric and meteorological data, for design. The WSP report indicated that annual rainfall volumes at other local meteorological stations with IDF curves (North Cowichan and Victoria International Airport) are significantly less than that observed at the Site. Prior technical information used the North Cowichan*

climate station (annual precipitation 1170 mm) IDF curve for design. This affects the design of the required non-contact water management works including the settling pond. This affects the design of the required contact water management works including the contact water holding pond and water treatment system.

WSP acknowledges that the change in applied climate station will affect the design of the non-contact and contact water management systems. As indicated within the initial report, "The Lake Cowichan Station was selected since the recorded annual rainfall volumes were a conservative representation of those recorded at the site. Annual rainfall volumes at other local meteorological stations with IDF curves (North Cowichan and Victoria International Airport) are significantly less than that observed at the Site. Results generated from this rainfall data, including peak discharge and runoff volumes, are anticipated to be conservative."

It is important to note that the available data from the IDF data table does not extend to the 200-year return period. A trend was calculated between the return period and rainfall, so as to extrapolate the data for the 200-year return period. Data below with the grey highlighted cells were extrapolated data points.

Table 3: Lake Cowichan Rainfall Projections

LAKE COWICHAN IDF (mm/hr)					
Return Period	**10 Year**	**25 year**	**50 Year**	**100 Year**	**200 Year**
2 hour	12.2	13.7	14.8	15.9	17.0
6 Hour	8.6	9.4	10	10.6	11.2
24 Hour	5.1	5.7	6.1	6.6	7.0

LAKE COWICHAN RAINFALL AMOUNT (mm)					
Return Period	**10 Year**	**25 year**	**50 Year**	**100 Year**	**200 Year**
2 hour	24.4	27.4	29.6	31.8	34.0
6 Hour	51.6	56.4	60	63.6	67.2
24 Hour	122.4	136.8	146.4	158.4	168.7

3 WORK PLAN & SCHEDULE

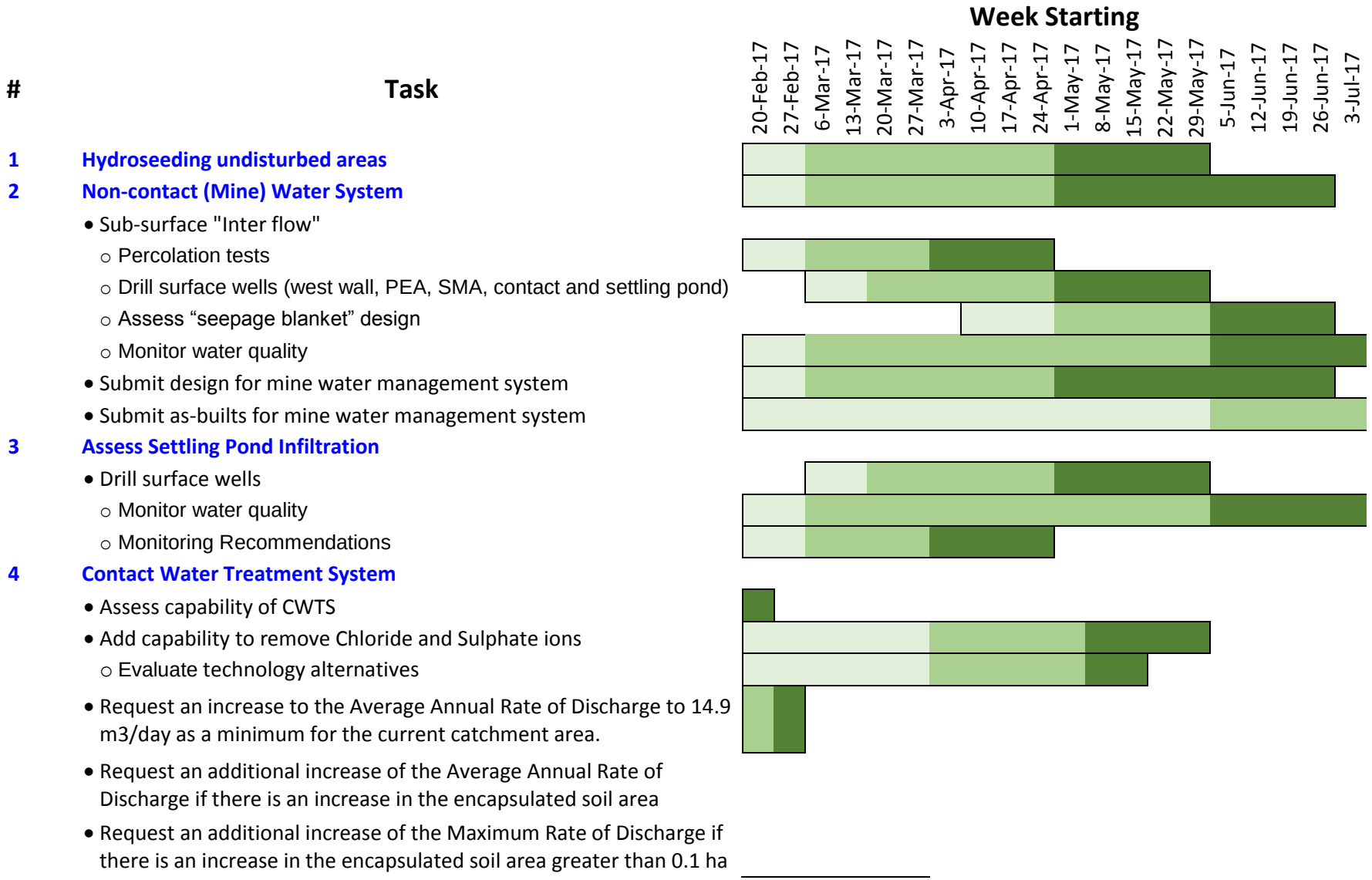
A work plan was developed based on tasks that need to be undertaken to provide further improvements to the contact and non-contact water management systems. In addition tasks are included to address the outstanding items from 2016 including hydro-seeding and development of shallow wells to better understand the sub-surface flows. Target dates for completion of the planning, design and construction/monitoring of each task are included in the table below. This is visually presented in a GANTT chart.

Table 4: Draft Work Plan

#	Task	Planning	Design	Completion
1	**Hydroseeding undisturbed areas**	28-Feb-17	30-Apr-17	31-May-17
2	**Non-contact (Mine) Water System**	28-Feb-17	30-Apr-17	30-Jun-17
	• Sub-surface "Inter flow"			
	○ Percolation tests	28-Feb-17	31-Mar-17	30-Apr-17
	○ Drill surface wells	15-Mar-17	30-Apr-17	31-May-17
	○ Assess "seepage blanket" design	30-Apr-17	30-May-17	30-Jun-17
	○ Monitor water quality	28-Feb-17	31-May-17	Jun 2017- Jun 2018
	• Submit design for mine water management system	28-Feb-17	30-Apr-17	30-Jun-17
	• Submit as-builts for mine water management system	1-Jun-17	31-Jul-17	30-Sep-17
3	**Assess Settling Pond Infiltration**			
	• Drill surface wells	15-Mar-17	30-Apr-17	31-May-17
	○ Monitor water quality	28-Feb-17	31-May-17	Jun 2017- Jun 2018
	○ Monitoring Recommendations	28-Feb-17	31-Mar-17	30-Apr-17
4	**Contact Water Treatment System**			
	• Assess capability of CWTS			20-Feb-17
	• Add capability to remove Chloride and Sulphate ions	31-Mar-17	30-Apr-17	31-May-17
	○ Evaluate technology alternatives	31-Mar-17	30-Apr-17	15-May-17
	• Request an increase to the Average Annual Rate of Discharge to 14.9 m3/day as a minimum for the current catchment area.	28-Feb-17		
	• Request an additional increase of the Average Annual Rate of Discharge if there is an increase in the encapsulated soil area	6 mo prior to addition		
	• Request an additional increase of the Maximum Rate of Discharge if there is an increase in the encapsulated soil area greater than 0.1 ha	6 mo prior to addition		

#	Task	Planning	Design	Completion
5	**East-West Ditch - supplement riprap armouring**	28-Feb-17	15-Mar-17	31-Mar-17
	Updated As-Built drawing	15-Mar-17	30-Mar-17	30-Apr-17
6	**Existing Settling Pond**			
	• Upgrade Discharge piping	28-Feb-17	31-Mar-17	30-Apr-17
	• Upgrade pond and discharge channel armouring	28-Feb-17	30-Apr-17	30-Jun-17
	• Updated As-Built drawing	30-May-17	30-Jun-17	31-Jul-17
	• Size - this pond is large enough to handle current contact water volume			20-Feb-17
7	**Updated 18 Feb 2016 Topographical Survey after revegetation and re-activation of the east-west ditch**	28-Feb-17	31-May-17	31-Jul-17
8	**Physical Model for the site**			20-Dec-16
	• HEC-HMS evaluation of non-contact disturbed areas			20-Dec-16
	• Rational method evaluation of non-contact undisturbed areas			20-Dec-16
9	**Installation of gutters on SMA roof to divert this clean runoff to the mine settling pond**	30-Nov-16		28-Feb-17
10	**Monitoring Recommendations**			
	• Shallow Wells (west wall, PEA, SMA, contact pond and settling pond)	28-Feb-17	31-Mar-17	30-Apr-17
	• Mine Water system	15-Mar-17	30-Apr-17	31-May-17
	• Improvements to Existing Monitoring			28-Feb-17
11	**Annual Update of the EPM/OMS**			31-Mar-17

Figure 16: Gantt Chart for Work Plan (Week 20 February – 3 July 2017)



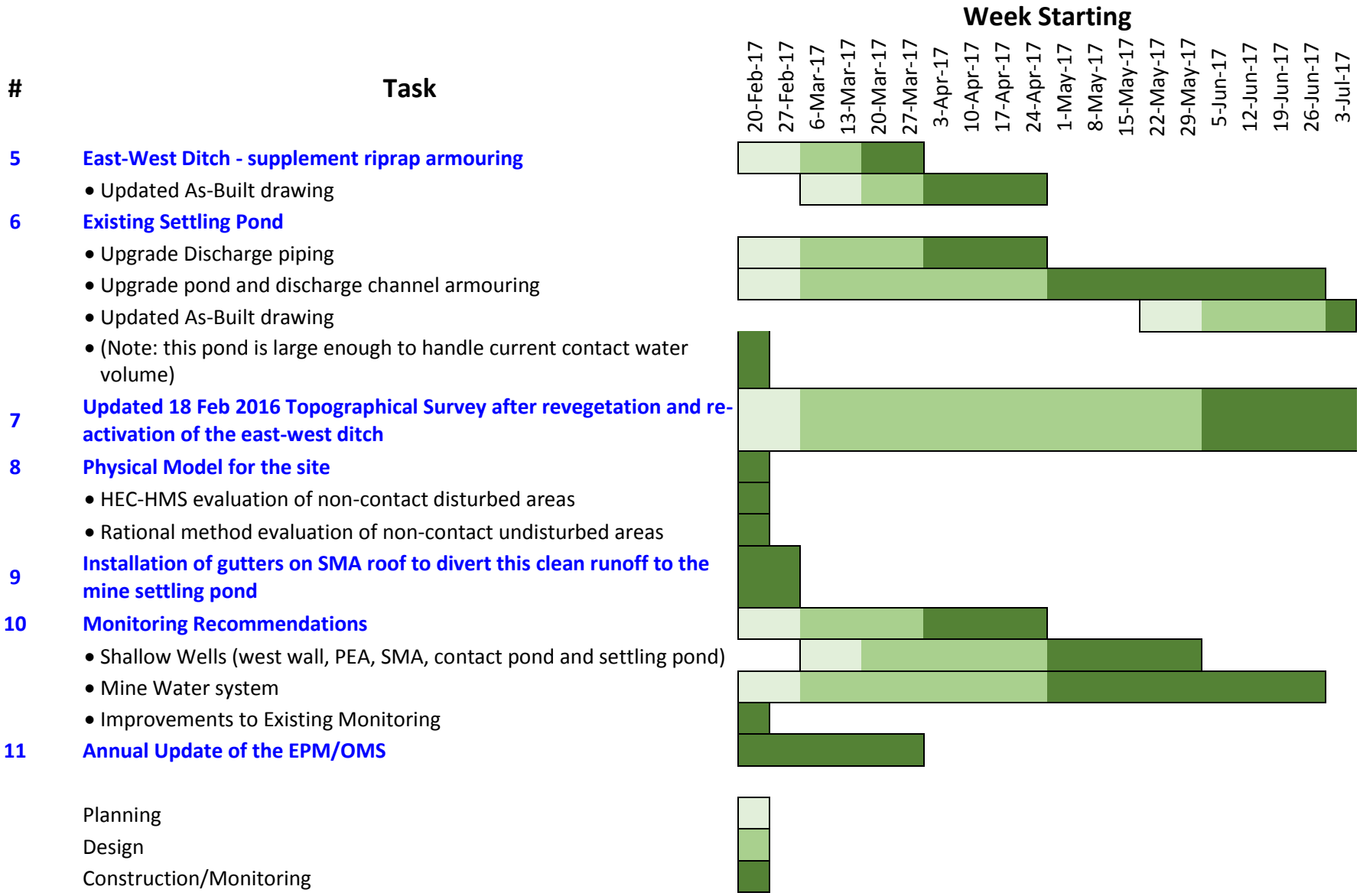
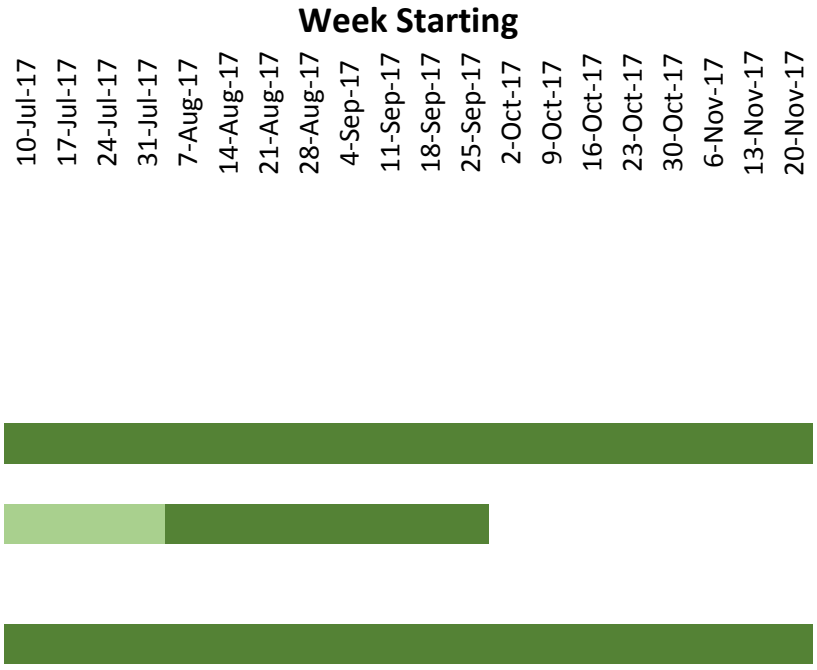

Week Starting
20-Feb-17
27-Feb-17
6-Mar-17
13-Mar-17
20-Mar-17
27-Mar-17
3-Apr-17
10-Apr-17
17-Apr-17
24-Apr-17
1-May-17
8-May-17
15-May-17
22-May-17
29-May-17
5-Jun-17
12-Jun-17
19-Jun-17
26-Jun-17
3-Jul-17
Task
5 East-West Ditch - supplement riprap armouring
• Updated As-Built drawing
6 Existing Settling Pond
• Upgrade Discharge piping
• Upgrade pond and discharge channel armouring
• Updated As-Built drawing
• (Note: this pond is large enough to handle current contact water volume)
7 Updated 18 Feb 2016 Topographical Survey after revegetation and re-activation of the east-west ditch
8 Physical Model for the site
• HEC-HMS evaluation of non-contact disturbed areas
• Rational method evaluation of non-contact undisturbed areas
9 Installation of gutters on SMA roof to divert this clean runoff to the mine settling pond
10 Monitoring Recommendations
• Shallow Wells (west wall, PEA, SMA, contact pond and settling pond)
• Mine Water system
• Improvements to Existing Monitoring
11 Annual Update of the EPM/OMS
Planning
Design
Construction/Monitoring

Figure 17: Gantt Chart continued (weeks 10 July to 20 September 2017

#	Task
1	**Hydroseeding undisturbed areas**
2	**Non-contact (Mine) Water System**
	• Sub-surface "Inter flow"
	○ Percolation tests
	○ Drill surface wells (west wall, PEA, SMA, contact and settling pond)
	○ Assess “seepage blanket” design
	○ Monitor water quality
	• Submit design for mine water management system
	• Submit as-builts for mine water management system
3	**Assess Settling Pond Infiltration**
	• Drill surface wells
	○ Monitor water quality
	○ Monitoring Recommendations
4	**Contact Water Treatment System**
	• Assess capability of CWTS
	• Add capability to remove Chloride and Sulphate ions
	○ Evaluate technology alternatives
	• Request an increase to the Average Annual Rate of Discharge to 14.9 m3/day as a minimum for the current catchment area.
	• Request an additional increase of the Average Annual Rate of Discharge if there is an increase in the encapsulated soil area
	• Request an additional increase of the Maximum Rate of Discharge if there is an increase in the encapsulated soil area greater than 0.1 ha



#	Task
5	**East-West Ditch - supplement riprap armouring**
	Updated As-Built drawing
6	**Existing Settling Pond**
	• Upgrade Discharge piping
	• Upgrade pond and discharge channel armouring
	• Updated As-Built drawing
	• (Note: this pond is large enough to handle current contact water volume)
7	**Updated 18 Feb 2016 Topographical Survey after revegetation and re-activation of the east-west ditch**
8	**Physical Model for the site**
	• HEC-HMS evaluation of non-contact disturbed areas
	• Rational method evaluation of non-contact undisturbed areas
9	**Installation of gutters on SMA roof to divert this clean runoff to the mine settling pond**
10	**Monitoring Recommendations**
	• Shallow Wells (west wall, PEA, SMA, contact pond and settling pond)
	• Mine Water system
	• Improvements to Existing Monitoring
11	**Annual Update of the EPM/OMS**

4 MOE ELEMENTS ADDRESSED FROM PRIOR CORRESPONDENCE WITH CHH

The Minister of Environment's letter of January 27, 2017 refers to criteria to be met in the January 19, 2017 review of the WSP 2016 report. The review refers to criteria for the review of the Contact Water and Non-Contact Water Management System that have evolved through a series of documents since January 15, 2016. To assist in tracking the review criteria Table 5 below lists the reference document and the criteria. The column on the right indicates if the item has already been addressed in the WSP 2016 Report or the 2017 Addendum. If the item has yet to be completed the Task number in the work plan is referenced. Documents referenced in the following Table 5 include:

- MOE letters of:
  - February 16, 2017;
  - January 27, 2017;
  - January 19, 2017;
  - November 4, 2016;
  - October 12, 2016 (PPO);
  - October 11, 2016;
  - June 29, 2016;
  - May 26 2016;
  - January 22, 2016
- Stantec
  - Terms of Reference, Water Management Assessment - January 15, 2016.
  - Memo Assessment of Stormwater Management Outside of Active Site Area – Jan. 15, 2106

Table 5: Criteria Cross Reference for the Contact and Non-Contact Water Management Systems Review

STANTEC MEMO ASSESSMENT OF STORMWATER MANAGEMENT OUTSIDE OF ACTIVE SITE AREA -JAN. 15, 2016	ADDRESSED
Naturally occurring vegetated storm water flows should be intercepted and diverted away from the pit floor, as stated in the DFO Land Development Guidelines. It is therefore recommended to reinstate the east-west cut off ditch to the south of the active mine areas to divert flows from the southern vegetated areas away from the active mine area. This will minimize the flow over disturbed areas and limit sediment loading on the settling pond	The East-West ditch was reinstated during the summer of 2016. **Task 5** - Upgrades to the East West Ditch Improvements to the armouring of the ditch are to be undertaken as
Hydro-seeding should take place on any disturbed areas currently not being utilized in site activities	**Task 1** – Hydroseed non-vegetated areas

STANTEC TERMS OF REFERENCE, WATER MANAGEMENT ASSESSMENT JAN. 15, 2016	ADDRESSED
Review of all storm water management practices on site, with the objective to update the water management plan to reflect the recommendations that arise from this investigation	**WSP Dec. 19, 2016 Report and WSP Feb. 19, 2017 Addendum**
Geotechnical/Hydrogeological Considerations: Investigation of subsurface drainage path. Characterize inter-flows in the blast rock to clarify rate of infiltration to ground from the settling pond and assess the water quality of the inter-flow	**Task 2** – Sub-surface "inter flow" percolation tests and surface wells **Task 10** – shallow well monitoring around the PEA, SMA, Contact water pond, settling pond and west wall.
Storm Water/Hydraulic Modeling • Updated topographic survey • Physical model for storm water modelling • Use model to assess performance of the on-site storm water system – including assessing the size of the settling ponds to meet MOE and DFO guidelines. Also assess the size of the ditch systems	Topographic survey updated February 2016 **WSP Dec. 19, 2016 Report and WSP Feb. 19, 2017 Addendum**
Water Quality and Treatment Non-contact Water • Assess the settling pond, conduct a particle distribution analysis, sampling regime of inflow and outflow to refine the pond design. • Use shallow monitoring wells to assess quality of non-contact water and make recommendations to improve subsurface water quality if required. • Shallow well monitoring along western property line	Particle size distribution analysis conducted February 7, 2017 and is included in the **WSP Feb. 19, 2017 Addendum** Pond size was assessed in the **WSP Dec. 19, 2016 Report and WSP Feb. 19, 2017 Addendum** **Task 2** and **Task 10** – Shallow well installation and monitoring
Water Quality and Treatment Contact Water • Peer review of available design criteria, as-built drawings, operational records and test data • Assess suitability of treatment system to meet permit requirements • Detailed review of all available information pertaining to other aspects of the contact water management system including the contact water pond, SMA, PEA, and piping • Assess the ability of the CWTS to ensure ongoing compliance with the MOE permit	Section 1 of the **WSP Feb. 19, 2017 Addendum**
Update the Environmental Management Plan (to reflect the findings of the assessments)	**Task 11** – update the EPM/OMS
MOE LETTER JAN. 22, 2016	**ADDRESSED**
Comprehensive review of all non-contact water management on-site including surface storm water management and shallow sub-surface flow of water which infiltrates into the ground	Non-contact water and storm water volumes were assessed in **WSP Dec. 19, 2016 Report and WSP Feb. 19, 2017 Addendum** **Task 2** and **Task 10** – Shallow well installation and monitoring
Hydrogeological site investigation and a review of the "seepage blanket" design	**WSP Dec. 19, 2016 Report and WSP Feb. 19, 2017 Addendum** "Seepage blanket" design to be addressed after the shallow well study to establish sub-surface flow. **Tasks 2 & 10**

First phase of shallow sub-surface flow investigation	**Tasks 2 & 10** – Shallow well installation and monitoring around the settling pond and western property line
Storm water hydraulic modeling of the site	**WSP Dec. 19, 2016 Report and WSP Feb. 19, 2017 Addendum**
Assessment of the west side settling pond and ditches	**WSP Dec. 19, 2016 Report and WSP Feb. 19, 2017 Addendum** - assessed the size of the settling pond, the size, and erosion protection of the drainage ditches on site.
Expansion of the monitoring program to include monitoring of the shallow wells	**Task 10 - monitoring**
Preparation of Report and update EPM	Water Management Assessment included in **WSP Dec. 19, 2016 Report and WSP Feb. 19, 2017 Addendum** EPM was updated in 2016 and will be updated again for March 2017 – **Task 11**
Review of Contact Water Management to include a review of all available information pertaining to the water treatment system, assessment of the suitability of the water treatment system to meet permit requirements and recommendations for upgrades if required. Review of all available information pertaining to other aspects of the contact water management system including the contact pond, SMA, PEA and piping Contact water review should include facilities, works, design, construction, operation, functioning and performance, systems and procedures and report conclusions and recommendations.	**WSP Dec. 19, 2016 Report and WSP Feb. 19, 2017 Addendum**
Move forward with the Stantec reports' recommendations including with regard to the west settling pond, west pit floor cut-of ditch, east-west cut-off ditch restoration of diversion away from the active mine area and the non-contact water management review. Non-contact water management review should consider storm water infiltration into the shallow sub-surface and west settling pond infiltration, flow directions, quantities and qualities on-property, at property lines and off-property.	MOE acknowledged June 29, 2016 the east-west cut-off ditch was re-instated, the west ditch re-shaping and flow diversion into the southeast corner of the west settling pond and increased height of internal berms in the settling pond. **Task 5** - Improvements to the armouring of the ditch Non-contact water volumes were reassessed in **the WSP Dec. 19, 2016 Report and WSP Feb. 19, 2017 Addendum** Sub-surface flows will be investigated **Tasks 2 & 10**
Updated EPM/OMS	**Task 5** – annual review and update of the EMP/OMS

MOE LETTER MAY 26, 2016	ADDRESSED
Proposed Stantec Study of the shallow subsurface storm flow and settling pond influent sampling program as well as Settling Pond percolation infiltration test, geotechnical and hydrogeological assessment and storm water modeling.	**Tasks 2, 3 & 10** – install shallow wells, conduct percolation test, monitor and report Hydrogeological assessment and storm water modeling were included in **WSP Dec. 19, 2016 Report and WSP Feb. 19, 2017 Addendum**
As-builts for final west ditch, settling pond and east-west pit crest ditch	**Task 7** – updated survey after completion of hydroseeding in **Task 1** Updated as-builts for east-west ditch after supplemental riprap armouring **Task 5** Updated as-builts for the settling pond after expansion **Task 6**
SIRM 2015 annual and 2016 Q1 report show that precipitation at the on-site weather station was much higher than at the Shawnigan Lake weather station	**WSP Dec. 19, 2016 Report and WSP Feb. 19, 2017 Addendum** recommended updated IDF curves
2012 Technical Assessment Report assumed an operational/exposed area within the landfill of 1,800 m2 to determine the contact water discharge rate.	Contact water catchment area was reassessed in the **WSP Dec. 19, 2016 Report and WSP Feb. 19, 2017 Addendum**
SIRM 2015 annual report and 2016 Q1 report show permit exceedance for TSS, Turbidity and total iron in the settling pond discharge, partly due to non-soluble particulate matter in non-contact water from heavy rains.	**WSP Dec. 19, 2016 Report and WSP Feb. 19, 2017 Addendum** - assessment of the settling pond found that the pond was not large enough to achieve settling of 10 µm particles. Recommendations in the WSP report include enlarging the settling pond. Analysis of the particulate distribution indicates that removal of the non-soluble iron particulates over 10 µm should eliminate iron exceedances.
SIRM 2015 annual report and 2016 Q1 report indicated that the discharge rate for the CWTS was exceeded on three occasions partially due to heavy rains.	**WSP Dec. 19, 2016 Report and WSP Feb. 19, 2017 Addendum** – Recommends resizing of the contact water pond. The contact water pond was found to be smaller than in the as-built drawings and the volume from the roof of the SMA will be directed away from the contact water pond.
Requested an updated workplan and schedule	**WSP Feb. 19, 2017 Addendum**
MOE LETTER JUNE 29, 2016	**ADDRESSED**
Non-contact water management review to be generally consistent with the Stantec Terms of Reference Waste Management Assessment dated Jan. 15, 2016 and address the previous Stantec reports and relevant information in the MOE letters of Jan. 22 and May 26, 2016. Address the much higher precipitation at the on-site weather station.	**WSP Dec. 19, 2016 Report** recommended a new set of IDF curves for estimating precipitation at the site **WSP Dec. 19, 2016 Report and WSP Feb. 19, 2017 Addendum** – address terms of reference other than hydroseeding (**Task 1**), drilling and monitoring shallow wells **Task 2 & 10**
Submit a non-contact water management review including a work plan and schedule for carrying out the report's recommendations	**WSP Dec. 19, 2016 Report and WSP Feb. 19, 2017 Addendum**

Submit a contact water management review including a work plan and schedule for carrying out the report's recommendations	**WSP Dec. 19, 2016 Report and WSP Feb. 19, 2017 Addendum**
MOE LETTER OCTOBER 11, 2016	**ADDRESSED**
Requested Contact and Non-Contact Water Management System reviews.	**WSP Dec. 19, 2016 Report and WSP Feb. 19, 2017 Addendum –** and **Tasks 1 through 11**
MOE POLLUTION PREVENTION ORDER OCTOBER 12, 2016	**ADDRESSED**
Cover the landfill areas completely with a weighted and secured impermeable cover, and provide sufficient weather protection for the cover in order to ensure its effectiveness	PEA are covered with a layer of 30 mil LLDPE and geomembrane with rock spaced at intervals to hold down the material
Maintain and if necessary construct, appropriate lined ditching and/or other collection and conveyance systems to capture all contact water so it can be managed in accordance with Permit 105809	SMA has had a roof installed to divert non-contact water away from the CWTS. Daily inspections of the CWTS; PEA and SMA leak detection systems; PEA leachate detection system; Levels in the Leak detection and Leachate collection reservoirs; levels in the CWTS; levels in the settling pond and ditches for erosion
Ensure appropriate contingency measures are in place to manage contact water, including but not limited to, provision of additional onsite storage capacity and arrangement of backup transport for contact water to other authorized facilities, in the event that this is needed.	Additional storage capacity was brought on site.
Conduct ongoing inspection of the landfill cover and contact water collection system as needed to ensure the remain in place and functional, and maintain documentation of inspection activities	Included in the Daily Inspection and Maintenance Log
Monitor and sample the quantity and quality of effluent discharged from the settling pond outlet on a daily basis when there is a discharge from the settling pond.	Results are posted in the SIRM Quarterly reports
Estimate the flow of the ephemeral creek immediately downstream of the settling pond outlet daily and collect a daily water quality sample when there is a discharge from the settling pond.	Results are posted in the SIRM Quarterly reports
MOE LETTER NOVEMBER 4, 2016	**ADDRESSED**
Requested Contact and Non-Contact Water Management System reviews.	**WSP Dec. 19, 2016 Report and WSP Feb. 19, 2017 Addendum –** and **Tasks 1 through 11**
MOE LETTER JANUARY 19, 2017	**ADDRESSED**
WSP Dec. 19, 2016 Report did not include a work plan and schedule for completion of recommendations	**WSP Feb. 19, 2017 Addendum**
WSP Dec. 19, 2016 Report did not fully address the previous Stantec reports and relevant information in the MOE Letter of Jan. 22, 2016	**WSP Dec. 19, 2016 Report and WSP Feb. 19, 2017 Addendum –** and **Tasks 1 through 11** – see specific items from the January 22, 2016 MOE letter above
Recent settling pond discharge effluent sampling data as a result of Pollution Prevention Order 108608 (Oct. 12, 2016) shows effluent quality limits were not fully satisfied.	**WSP Feb. 19, 2017 Addendum** includes detailed analysis of discharge effluent quality and recommends enlarging the settling pond to achieve 10 µm particle settling.

The WSP 2016 report (Figure 1) shows a settling pond catchment area of 4.5 ha. This is less than the area used in prior technical information (10.4 ha), and less than the landfill area on the permit site plan. The WSP report indicates that settling pond capacity should be reviewed prior to future increases in catchment area. The catchment area affects the design of the required noncontact water management works including the settling pond.	**WSP Feb. 19, 2017 Addendum** includes a work plan and schedule for increasing the size of both the settling pond and the contact water pond. The report also identifies that the pond should be sized to handle future PEA.
The WSP report indicates that (with recommended improvement to increase storage volume) the settling pond is estimated to have the capacity to settle a 19 µm sized particle and should be capable of providing approximately 16 hours of residence time. This appears inconsistent with MOE Technical Guidance 7 Assessing the Design, Size, and Operation of Sediment Ponds Used in Mining, December 2015, initial recommended maximum 10 µm design particle size, and minimum 20 hour retention time (Method A Simplistic Design Approach).	**WSP Dec. 19, 2016 Report and WSP Feb. 19, 2017 Addendum –** calculations were to show that the settling pond was undersized to achieve settling of a 10 µm particle. Resizing of the pond to achieve appropriate particle removal and residence time is recommended in the WSP reports. Task 6 includes resizing the settling pond.
The WSP report identified deficiencies with the settling pond spillway chute slope, rock size, and riprap thickness, recommended improvements to increase effective pond volume, indicated additional review will be required to confirm the settling pond design meets permit requirements, and that following review, the settling pond capacity may need to be increased.	**WSP Feb. 19, 2017 Addendum** includes a work plan and schedule for increasing the size of both the settling pond and the contact water pond. Also, includes a recommendation to improve the armouring of the East-West ditch and settling pond discharge channel **Tasks 5 and 6.**
Additional review and improvements to the settling pond will be necessary to satisfy permit requirements.	**WSP Feb. 19, 2017 Addendum** includes a work plan and schedule for increasing the size of both the settling pond and the contact water pond
The WSP contact water management review report did not fully satisfy the MOE Director's letter dated June 29, 2016. The WSP report did not fully review all aspects of the contact water management system including all facilities, works, design, construction, operation, functioning and performance, systems and procedures, and its ability to treat the contact water to permit effluent quality requirements.	**WSP Feb. 19, 2017 Addendum and Task 4 –** specific responses to the June 29, 2016 letter are included above.
Contact water effluent quality has been in non-compliance with permit requirements. The MOE Inspection record 29727, issued November 16, 2016, for 2016 2nd Quarter report, determined the permittee was in noncompliance with the contact water quality requirements (section 1.4.4): Chloride and Sulfate levels within the WTS effluent were above applicable guidelines between June 11, 2016 and June 16, 2016.	**WSP Feb. 19, 2017 Addendum –** recommendation for the addition of chloride and sulphate removal capability in the CWTS **Task 4**
The WSP report used the Lake Cowichan climate station (annual precipitation 2047.5 mm), calibrated and validated using the available local hydrometric and meteorological data, for design. The WSP report indicated that annual rainfall volumes at other local meteorological stations with IDF curves (North Cowichan and Victoria International Airport) are significantly less than that observed at the Site. Prior technical information used the North Cowichan climate station (annual precipitation 1170 mm) IDF curve for design. This affects the design of the required contact water management works including the contact water holding pond and water treatment system.	**WSP Dec. 19, 2016 Report and WSP Feb. 19, 2017 Addendum – Tasks 1 through 11.** – recommendations to resize the contact water pond, the settling pond, and improved armouring are all repercussions of recognizing the higher precipitation levels associated with the IDF curves WSP has recommended.
The WSP report proposes contact water design criteria of a 25	**WSP Feb. 19, 2017 Addendum**

and/or 50 year return period rainfall event. This is inconsistent with prior technical information, including plans and specifications, that indicated the contact water management system was designed for a 200 year 24 h storm event plus snowmelt.	Estimates for a 200 year 24 storm event plus snow melt were included
The WSP report indicates the contact water holding pond has a total volume of 320 m3 and a volume below the high water level of approximately 206 m3. This is inconsistent with prior technical information, including plans and specifications, that indicated the volume of the contact water holding pond is approximately 1100 m3.	**WSP Dec. 19, 2016 Report -** the contact water pond was surveyed in June 2016 and found to be smaller than shown in the as built document. **Task 4** includes resizing the Contact water pond
The WSP report (section 4.2) assumes a catchment area of 0.2 ha from the wheelwash and contact water containment pond (i.e. no catchment area from landfill or soil management area (gutters being installed)) and indicates that the contact water holding pond storage volume, with freeboard included, is adequate to contain runoff from the existing contact water catchment for a design event.	**WSP Feb. 19, 2017 Addendum** – with the 200 year + snow melt estimate the contact water pond is too small. **Task 4** includes resizing the Contact Water Pond using precipitation estimates based on the more conservative Lake Cowichan weather station.
The WSP report indicates that additional contact water storage will be required for future landfill encapsulation cell construction.	**WSP Dec. 19, 2016 Report** – Precipitation forecasts based on the Lake Cowichan weather station data indicate that the contact water pond needs to be enlarged **Task 4**
The WSP report indicated the permitted annual average rate of discharge (12.1 m3/day) is not sufficient, and the permitted maximum rate of discharge (274 m3/day) may have to be increased if future landfill encapsulation cell areas will exceed an additional 0.20 ha.	**WSP Dec. 19, 2016 Report and WSP Feb. 19, 2017 Addendum –** original permit discharge numbers were based on the precipitation predictions that were shown to underestimate actual flows. Discharge numbers should be based on the more conservative IDF curves that WSP has identified. **Task 4**
Additional review and improvements to the contact water management works will be necessary to satisfy permit requirements.	**WSP Dec. 19, 2016 Report and WSP Feb. 19, 2017 Addendum** and **Tasks 1 through 11**
The WSP report did not include a required workplan and schedule for carrying out the report's recommendations	**WSP Feb. 19, 2017 Addendum** – includes a work plan and schedule
The permittee did not submit a commitment to carry out the recommendations of the WSP report.	Addressed in a separate letter from permittee
The scope and content of the WSP non-contact water management review report did not fully satisfy the MOE Director's letter dated June 29, 2016 (e.g. did not address the hydrogeological investigation of shallow sub-surface flow (inter-flow), infiltration into the settling pond, and the installation and sampling of 2-3 shallow monitoring wells within the layer of blast rock (on the western property line)).	**WSP Dec. 19, 2016 Report and WSP Feb. 19, 2017 Addendum** and **Tasks 2, 3, 10 –** installation and sampling of shallow monitoring wells**.** Specific comments to the June 29, 2016 letter are included above
The WSP report identified deficiencies with the settling pond overflow spillway, recommended improvements to increase effective pond volume, indicated additional review will be required to confirm the settling pond design meets permit requirements, and that following review, the settling pond capacity may need to be increased.	**WSP Feb. 19, 2017 Addendum** – Settling pond should be resized to provide adequate retention and removal of 10 µm particles - **Task 6**

MOE LETTER JANUARY 27, 2017	ADDRESSED
Requested a Draft non-contact and contact water management review report (or reports) that corrects all the deficiencies identified in the Ministry Review dated Jan. 19, 2017 and includes a work plan and schedule for completion of all recommendations in the report within 90 days of the approval of the report. The report must be prepared and certified by a qualified, independent professional. The report must be provided by February 20, 2017	**WSP Dec. 19, 2016 Report and WSP Feb. 19, 2017 Addendum –** and **Tasks 1 through 11**
MOE LETTER FEBRUARY 16, 2017	**ADDRESSED**
A detailed work plan and schedule must be submitted taking into account all of the specific items needing to be addressed as per the results and recommendations of properly- scoped contact and non-contact water management reviews	**WSP Dec. 19, 2016 Report and WSP Feb. 19, 2017 Addendum –** and **Tasks 1 through 11**
Regarding the list of six numbered deficiencies in the scope of the contact and non-contact water management review report, the listed deficiencies do not fully address all the scope and content deficiencies and items that must be addressed to satisfy the permit requirements and MOE guidance. Given the complexities and interrelationships between contact and non-contact water management design, facilities, operations, and performance, it is highly recommended that CHH and their Qualified Professionals thoroughly review and address the many points listed in the ministry review dated January 19, 2017. This includes items in the Table, and excerpts from the MOE Director's letter dated June 29, 2016 including referenced documents (e.g. Stantec Terms of Reference Water Management Assessment, dated January 15, 2016, including Contact Water- high level scope for contact water management review, previous Stantec reports, and relevant information in the MOE letters of January 22, 2016 and May 26, 20916. It is highly recommended that CHH address all of the deficiencies and items (identified in the ministry review) in a comprehensive draft non-contact and contact water management review report.	**WSP Dec. 19, 2016 Report and WSP Feb. 19, 2017 Addendum –** and **Tasks 1 through 11.** Items from the various letters and reports are included in this table as a checklist to show that all the items identified have been addressed.