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|  | **To:** | Brian Geddes | | |
|  | **From:** | Nicole Jacques | | |
|  | **Project:** | Mount Nansen Reclamation Task | | |
|  | **Subject:** | Reclamation Site Investigation Results | | |
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**1. Site Characterization Purpose**

Based on our review of historical reports made available by YG-AAM, and anecdotal accounts offered by YG-AAM and Denison Environmental Services we identified areas of potential environmental concern. These areas included the Ketza Shop Area, Mill Area, roadways and the historical explosives storage area (Figure 1). The Site Characterization component of the Mount Nansen Remediation Plan focused on identifying potential contamination including metals, hydrocarbons, anti-freeze, land-fill parameters, cyanide, and hydrocarbons.

**2. Summary of Investigations Completed**

The Site Characterization component consisted of soil sampling from test-pits and boreholes at the Ketza Shop Area, the Mill Area, and the roadways. Soil samples were collected at 0.5 m intervals, and samples were sent for analysis to ALS Laboratory in Whitehorse. At each borehole and test-pit location, laboratory packaging methods were followed and packaged site-specific for the relevant potential contaminations of concern (PCoCs). The locations and summary of the soil sampling included:

* **Ketza Shop Area**: Due to historic spills at this location, the PCoCs include hydrocarbons and metals. Two boreholes were advanced using a sonic drill rig to 3.5 – 4.0 metres below ground surface (mbgs) and three test-pits were advanced with a backhoe to 2.0 mbgs.
* **Mill Area**: Due to the variety of hazardous chemicals that were stored and used in this location, the PCoCs include metals, antifreeze parameters, cyanide, landfill parameters and hydrocarbons. Nine boreholes were advanced to 3.0 - 5.5 mbgs, and five test-pits were advanced to 2.0 - 5.0 mbgs.
* **Roadways:** Due to uncertainty about contaminated materials (i.e., hydrocarbons and waste rock) used during road construction and maintenance, the PCoCs include hydrocarbons, and metals. Five test-pits were advanced to depths of 1.9 - 2.0 mbgs.
* **Former Explosive Storage Area:** Due to storage of explosives in this location, the PCoCs include nutrients. Four surface samples (0.1-0.2 mbgs) were collected. Three of them were within the former explosives area clearing, and one was collected approximately 200 m up gradient of the site for background concentrations.

A hazardous materials inventory and investigation was conducted in order to identify and characterize the hazardous materials that remain at the Project Area.

**3. Sonic Drilling**

Boreholes were advanced by Kryotek Arctic Innovations Inc. using a sonic drill rig. Stuart Van Bibber of Associated Engineering conducted the field work onsite from September 9 – 13, 2013. Soil samples were collected in 0.5 m intervals, and observations noting the presence or absence of pyrite, limestone, and rust staining, grain size composition, moisture content, and odours were recorded. Additionally, readings were measured for each sample using an RKI Eagle 2 Photo-ionization detector (PID). Depending on the nature and extent of contamination that was expected for each borehole, target depths varied. Samples were submitted to the laboratory for the PCoCs identified by the sample depth and location, as well as the field screening indicators noted. Site Characterization boreholes were advanced at the Ketza Shop and the Mill Areas.

**4. Test Pitting**

Test-pits were advanced with a track mounted backhoe by Boreal Engineering Ltd. Stuart Van Bibber of Associated Engineering conducted the field work onsite from September 9 – 13. Soil samples were collected in 0.5 m intervals from the test-pit faces, and observations involving the presence or absence of pyrite, limestone, rust staining, grain size composition, moisture content, and odours were recorded. Additionally, PID readings were measured from each sample. Depending on the nature and extent of contamination that was expected at each location, target test-pit depths varied. Samples were submitted to the laboratory for the PCoCs identified by the sample depth and location, as well as the field screening indicators noted. Site Characterization test-pits were dug at the Ketza Shop Area, the Mill Area, and along the roadways.

**5. Grab Sampling**

Grab samples were collected by Associated Engineering onsite between September 9 – 13. These were collected by manually scrapping the topsoil (up to 10 cm) off at each sample location, then by collecting a grab sample using a trowel. Samples were submitted to the laboratory for the PCoCs identified by the sample depth and location. Grab samples were collected in the Former Explosives Storage Area.

**5.1 Sampling Protocols**

Sample collection procedures followed laboratory sampling protocols. The soil samples that were collected were put in chemically inert 125 mL glass jars or sealed plastic bags. As directed by ALS Laboratory, certain samples were packaged with no headspace. Samples were placed in a cooler, and submitted to the ALS Laboratory in Whitehorse, Yukon. The samples were collected in accordance with the *Yukon Environment Act 2002/171* Contaminated Sites Regulation (CSR) Protocol No. 3 (YG 2012b).

In order to collect quality data, duplicate soil samples were collected at a rate of 10%, and comprehensive quality assurance/quality control (QA/QC) measures proposed by BCMOE (2003) were used as guidelines, and included:

* wearing a new pair of disposable nitrile gloves for collecting and handling each soil sample;
* using laboratory supplied jars according to the laboratory’s recommendations;
* keeping the sealed samples in a cooler filled with ice;
* shipping the samples on time, respecting the samples’ holding time requirements proposed through the laboratory QA/QC measures;
* collecting field duplicates for laboratory QA/QC. Field duplicates of soil samples were collected by splitting the soil sample into two separate containers; and
* decontaminating all reusable sampling equipment that was used between locations to prevent cross contamination.

**5.2 Laboratory Methods**

Soil samples were delivered to the ALS Laboratory in Whitehorse, then repackaged and shipped to their ALS Laboratory in Burnaby, which is a Canadian Association for Laboratory Accreditation accredited facility. The samples were analyzed for PCoCs, and the methods used were compliant with the CSR Protocol No. 2 (YG 2012a) and with Protocol No. 5 (YG 2011). Laboratory methods are explained in detail in the analytical reports (Appendix D5), and are summarized below:

* total organic carbon by the organic carbon combustion method;
* chlorinated hydrocarbons in soil by gas chromatography–mass spectrometry;
* chlorinated phenols by tumbler/ gas chromatography–mass spectrometry;
* chromium trivalent and hexavalent;
* cyanide;
* dioxins and furans HR 1613B;
* extractable petroleum hydrocarbons (EPH) in solids by tumbler/ gas chromatography–mass spectrometry;
* glycols (waste anti-freeze) in soil by wrist shaker gas chromatogram by flame ionization detector;
* mercury in soil by cold vapour atomic fluorescence spectroscopy;
* moisture for CSR Metals Calculations;
* light and heavy extractable petroleum hydrocarbons (LEPH/HEPH) subtraction method;
* metals in soil by collision reaction cell Inductively coupled plasma mass spectrometry;
* metals by [inductively coupled plasma atomic emission spectroscopy](http://en.wikipedia.org/wiki/Inductively_coupled_plasma_atomic_emission_spectroscopy) (toxicity characteristic leaching procedure);
* mercury by cold vapour atomic fluorescence spectroscopy (toxicity characteristic leaching procedure);
* phenolics by tumbler gas chromatography–mass spectrometry;
* polycyclic aromatic hydrocarbons (PAH) by rotary extraction;
* polychlorinated biphenyls (PCBs)by extraction with gas chromatogram with electron capture detector;
* total PCBs in soil;
* pH in soil 1:2 soil: water extraction;
* volatile hydrocarbons (VH) in soil by headspace gas chromatography–mass spectrometry;
* volatile petroleum hydrocarbons (VPH) VH minus select aromatics;
* volatile organic compounds (VOC) 7 and/or VOC surrogates for soils;
* volatile petroleum hydrocarbons (VPH) VH minus BTEX/nC6/nC10;
* benzene, ethylbenzene, toluene, xylene (BTEX);
* VPH subtraction methods; and
* sum of xylenes isomer concentrations.

**6. Mill Area**

**6.1 Objectives and Scope**

Around the Mill Area there was a variety of historic potential contaminant sources each with their PCoCs. The purpose of the Site Characterization field work in the Mill Area was to identify and delineate this potential historical contamination, and to conduct a hazardous materials inventory. The field work around the mill consisted of eight boreholes, five test-pits, and a hazardous materials investigation (Figure 5).

**6.1.1 Borehole Purpose and Objectives**

The purpose and objective for each borehole in the Mill Area was unique, illustrated on Figure 5, and summarized as follows:

* **BH-M-13-01** was drilled in order to delineate potential contamination that may have resulted from landfill seepage, as well as the potential use of waste-rock. The PCoCs included hydrocarbons, and metals, as well as PCBs, glycols, chlorinated hydrocarbons, phenolics, dioxins and furans, (commonly referred to as landfill parameters).
* **BH-M-13-02** was drilled in order to delineate potential contamination that may have resulted from landfill seepage, the potential use of waste-rock. The PCoCs included hydrocarbons, and leachable metals.
* **BH-M-13-03, BH-M-13-04**, and **BH-M-13-05** were drilled in order to characterize materials, which may have been contaminated by two historic fuel spills, and to characterize materials to determine if waste-rock were used in the construction of the area. Additionally, BH-M-13-03 was drilled to determine if contamination may have resulted from the waste oil barrel storage at this location, and BH-M-13-04 and BH-M-13-05 were drilled to characterize spills near a transformer storage area. PCoCs included hydrocarbons, PCBs metals and cyanide for BH-M-13-05.
* **BH-M-13-06** was drilled in order to characterize materials that may have been contaminated from reportedly two historic spills, to determine if waste-rock were used in the construction of the area, to determine if potential contamination from waste oil storage has reached this location, and to determine if there is contamination from the above ground storage oil tank (AST) at this location. PCoCs include hydrocarbons and metals.
* **BH-M-13-07** was drilled in order to characterize materials from two reported historic fuel spills, to characterize materials in order to determine if waste-rock were used in the construction of the area, to characterize potential contamination in front of the generator building, and to determine if contamination from fuel storage and spills in the generator building have extended to this location. PCoCs include metals, cyanide and hydrocarbons. PCoCs for BH-M-13-07 also included antifreeze parameters.
* **BH-M-13-08** was drilled in order to characterize materials from reportedly two historic fuel spills, to characterize materials in order to determine if waste-rock was used in the construction of the area, and to determine if possible spills from in front of the mill building have extended to this location. PCoCs include metals, cyanide and hydrocarbons. PCoCs for BH-M-13-07 also include antifreeze parameters.

**6.1.2 Test-Pit Purpose and Objectives**

The purpose and objective for each test-pit in the Mill Area (Figure 5) was unique and are summarized as follows:

* **TP-M-13-01** was excavated in order to characterize materials which may have been contaminated by two reported historic fuel spills, and to determine if waste rock was used in the construction of the area. The PCoCs for this location were metals, cyanide and hydrocarbons.
* **TP-M-13-02, TP-M-13-03**, and **TP-M-13-04** were excavated in order to characterize materials which may have been contaminated reportedly by two historic fuel spills, to characterize spills near the transformer storage area, and to characterize materials to determine if waste rock was used in the construction of the area. The PCoCs were metals, cyanide, and hydrocarbons.
* **TP-M-13-05** was excavated in order to delineate vertical hydrocarbon contamination from a reportedly previous spill. The PCoCs for this location were metals, cyanide and hydrocarbons.

**6.1.3 Hazardous Materials Inventory Purpose and Objectives**

A hazardous materials inventory was conducted at the Mill Area in order to classify and quantify the existing hazardous materials. The scope of the hazardous materials inventory included an investigation of the old rail car tank, a site reconnaissance, collecting samples, and materials analyses.

**6.2 Summary of Results**

A summary of the results from the field screening and observations, along with a description of the samples that were submitted to the laboratory for analyses are outlined below for each borehole or test-pit, also illustrated on Figure 5. Analytical results from the Mill Area are summarized in Appendix D5 and borehole logs are available in Appendix A. Analytical results from duplicate samples and from some samples collected from Mill Area test-pits are not yet available.

**6.2.1 Borehole Results**

**BH-M-13-01**

* BH-M-13-01 extended to 3.0 mbgs. The field screening results from this borehole included PID readings of 0 ppm with no observed odours for the entire length of the borehole. From 0 – 1.0 mbgs, assorted garbage was found but there was not sufficient soil to sample. Soil samples were collected from 1.1 – 3.0 mbgs. Some garbage was still observed between 1.1 – 1.5 mbgs, and garbage and woody debris were noted from 2.5 – 3.0 mbgs. Rust staining was present in samples from 1.1 – 3.0 mbgs, and there was no indication of pyrite observed at any depths throughout the borehole. Possible signs of limestone were noted at 2.1 – 2.5 mbgs and indications of galena were noted from 1.6 – 2.5 mbgs. The soil in this borehole is consistent and best described as damp gravel and sand with trace amounts of silt. Drilling refusal (i.e., drilling termination due to underlying boulder or bedrock stratigraphy) was encountered at 3.0 mbgs due to a boulder.
* PCoCs analyzed included: Metals and EPH analyses on the samples from 1.1 – 2.5 mbgs. Additionally, the sample from 1.1 – 1.5 was analyzed for LEPH/HEPH, total organic carbon, BTEX, VPH, PAH, landfill parameters and leachable metals.

**BH-M-13-02**

* BH-M-13-02 extended to 3.5 mbgs. The field screening from this borehole included PID readings of 0 ppm and no observed odours for the boreholes’ entire depth of 3.5 mbgs. Rust staining was observed in samples from 2.1 – 3.5 mbgs, and there was no indication of pyrite or limestone observed at any depths throughout the borehole. The soil at this location is relatively consistent and best described as damp sand with some gravel. Moisture content in the sample collected from 3.1-3.5 mbgs was saturated. Additionally, organics were observed in the top 1.0 mbgs, and trace cobbles were observed at depths greater than 2.1 mbgs.
* PCoCs analyzed from the 3.1 – 3.5 mbgs sample included: total organic carbon, metals, BTEX, VPH, PAH, LEPH/HEPH, EPH, PCBs, glycols, chlorinated hydrocarbons, phenolics, and dioxins and furans. Arsenic was analyzed for the sample from 1.6-2.0 mbgs.

**BH-M-13-03**

* BH-M-13-03 extended to 4.1 mbgs. The field screening results from this borehole included PID readings of 0 ppm and no observed odours for the borehole’s entire depth of 4.0 mbgs. Rust staining was observed in samples from 0.6 – 2.5 mbgs, and there was no indication of pyrite or limestone throughout the borehole. The soil at this location is best described as damp gravelly sand. Additionally, some clay was observed from 0.6 – 1.0 mbgs, an aluminum can was found at 0.75 mbgs, some silt was observed from 2.1 – 3.0 mbgs, and trace organics were found from 3.0 – 3.3 mbgs. Refusal was encountered at 4.1 mbgs where cobble was encountered.
* PCoCs analyzed included: cyanide, metals, BTEX, LEPH/HEPH, EPH, PAH, VPH and leachable metals for samples from 0.0 – 0.5 mbgs. Metals were analyzed on samples from 0.0 – 0.5 mbgs, 1.1 – 1.5 mbgs.

**BH-M-13-04**

* Due to refusal at 2.0 mbgs, the first attempt at drilling this borehole was abandoned and it was relocated to an adjacent location. BH-M-13-04 was advanced to 4.5 mbgs. The field screening for this borehole indicated methane concentrations of 270 ppm at 1.1 – 1.5 mbgs, and that there are no observed odours for the entire 4.5 mbgs depth of this borehole. No samples were recovered from 1.6 – 3.0 mbgs due to an air pocket. Soils from this borehole are relatively consistent and described as sand and gravel with trace amounts of silt. There was also trace amounts of clay noted from 3.1 – 4.5 mbgs.
* PCoCs for samples from 0.0 – 0.5 mbgs and 1.1 – 1.5 mbgs were analyzed for cyanide, metals, BTEX, LEPH/HEPH, EPH, PAH and VPH. Additionally, the sample from 0.0 – 0.5 mbgs was analyzed for leachable metals and the sample from 31.-3.5 mbgs for metals.

**BH-M-13-05**

* Due to refusal at 2.0 mbgs, the first attempt at drilling this borehole was abandoned and it was relocated to an adjacent location. BH-M-13-05 was advanced to 5.5 mbgs. Other than a faint, indistinguishable odour at 0.6 – 1.0 mbgs, field screening results from this borehole’s second location included no observed odours for its entire depth. Except for the sample from 1.1 – 1.5 mbgs which had a hydrocarbon vapour reading of 3 ppm, PID readings showed PID readings of 0 ppm. Methane concentrations of 10 – 55 ppm were observed between 0.6 – 2.0 mbgs. Rust staining was observed in all of the samples except those from 3.6 – 4.5 mbgs, and no indicates of pyrite or limestone were observed throughout the entirety of the borehole. The soil at this location is best described as gravel and sand with trace amounts of silt. Some cobbles were observed sporadically throughout the borehole, and some organics were observed between 3.6 – 4.2 mbgs. The soil was generally observed to be dry until approximately 2.6 mbgs where it was damp, and groundwater was encountered at 5.2 mbgs.
* PCoCs analyzed included: Metals on samples from 0.0 – 2.5 mbgs. Additionally, BTEX, LEPH/HEPH, EPH, PAH and VPH were analyzed on samples from 0.0 – 0.5 mbgs, and from 1.1 – 1.5 mbgs. Leachable metals and PCBs were analyzed on the sample from 1.1 – 1.5 mbgs.

**BH-M-13-06**

* BH-M-13-06 was extended to 4.5 mbgs. The field screening results include no observed odours, and PID readings of 0 ppm for the entire borehole depth. Rust staining was observed in the first 2.0 mbgs only, and no indications of limestone or pyrite were observed in this borehole. The soil at this location is best described as gravelly sand from 0.0 – 2.5 mbgs, with some clay also observed from 1.1 – 2.5 mbgs. From 2.6 – 4.5 mbgs, the soil is best described as silt with some sand, and trace gravels. The moisture content of the soil was wet at the surface and otherwise damp until 3.3 – 3.6 mbgs, where a permafrost layer was encountered. A second permafrost layer was encountered from 4.0 – 4.3 mbgs.
* No soil samples were sent to the laboratory for analysis from this location due to the lack of contamination indication through field screening.

**BH-M-13-07**

* The first attempt at drilling this borehole was abandoned at 4.5 mbgs due to groundwater at 2.0 mbgs that compromised sample collection. The second attempt at this borehole extended to a depth of 3.0 mbgs. No samples were collected from 1.6 – 2.5 mbgs due to groundwater at this depth. Field screening results indicated that odours were present from 0.4 – 1.5 mbgs and from 2.6 – 3.0 mbgs. PID readings between 43 – 168 ppm were observed. Rust staining was observed from 0.0 – 0.5 mbgs, and from 2.6 – 3.0 mbgs only, and no indications of pyrite or limestone were observed. The soil from this borehole is relatively consistent and is best described as moist sand and gravel with trace silts. Groundwater was encountered from 1.6 – 2.5 mbgs with unsaturated soil beneath this depth.
* PCoCs analyzed included metals from 0.0 – 1.5 mbgs and 2.6 – 3.0 mbgs for metals (with leachable metals analyzed for samples from 0.0 – 1.0 mbgs). Furthermore, samples from 0.0-1.5 mbgs were analyzed for BTEX, LEPH/HEPH, EPH, PAH and VPH.

**BH-M-13-08**

* The first attempt at drilling this borehole was abandoned due to refusal from a clay layer at 2.0 mbgs. The second attempt at this borehole extended to 4.0 mbgs. The field screening results from this borehole included PID readings of 0 ppm from 0.0 – 3.0 mbgs, and 21 - 35 between 3.1 – 4.0 mbgs. No odours were observed in any samples from the entire 4.0 m depth of this borehole. Rust staining was observed at depths greater than 0.6 mbgs, and no indications of pyrite or limestone were observed. Soil at this location is described as saturated sand with some gravel and trace silt for the first 0.5 mbgs. From 0.6 – 1.5 mbgs, the soil is comprised of damp gravel and sand with trace silt, and from 1.6 – 2.0, it consists of clay with some silt and traces of sand and gravel. From 2.1 – 4.0 mbgs, the soil generally consists of relatively equal amounts of damp gravel, sand, silt, and clay.
* PCoCs analyzed in soils from 0.0 – 0.5 mbgs, and from 2.6 – 4.0 mbgs included metals BTEX, LEPH/HEPH, EPH, PAH and VPH. Additionally, samples from 2.6 – 3.5 mbgs were analyzed for leachable metals and the sample from 3.1 – 3.5 mbgs was analyzed for cyanide.

**6.2.2 Test-Pit Results**

**TP-M-13-01**

* TP-M-13-01 was extended to a depth of 3.5 mbgs. The field screening results from this test-pit included PID readings of 0 ppm, and no observed odours for the entire depth of the test-pit. Rust staining was observed in samples from 0 – 2.5 mbgs, and pyrite was observed in samples from 0.0 – 1.0 mbgs, and 1.6 – 2.0 mbgs. There were no indications of limestone throughout the borehole. The soil at this borehole is relatively consistent and is best described as damp sand with some gravel, cobbles, and organics, and trace silts. No observations of geochemical indicators or soil compositions were made beyond 2.5 mbgs.
* PCoC included metals, analyzed on three soil samples at this location.

**TP-M-13-02**

* The first attempt at this test pit was abandoned due to a pipe which was encountered at 1.4 mbgs that compromised sample collection. A test pit was excavated adjacent to the location to a depth of 2.0 mbgs. The field screening results from this test-pit included PID readings of 0 ppm, and no observed odours for the entire depth of the test-pit. Indications of rust staining were observed in the soil, and there were no signs of limestone or pyrite for the entire test-pit. The soil is best described as damp sand with some gravel and cobbles, and trace of silts.
* PCoC included metals at two soil samples from this location.

**TP-M-13-03**

* TP-M-13-03 was extended to 5.0 mbgs. The field screening results from this test-pit included PID readings of 0 ppm, and no observed odours from 0.0 – 2.0 mbgs. From 2.1- 4.0 mbgs, odours were observed and PID readings between 2 – 25 ppm were recorded. From 4.1 – 5.0 mbgs, PID readings of 0 ppm were observed, and possible faint odours were noted in the soil. Indications of rust staining and pyrite, and no indications of limestone were observed in the soil to a depth of 2.5 mbgs. No geochemical observations were made between 2.6 – 3.5 mbgs; however, from 3.6 – 5.0 mbgs, there were no signs of rust staining, pyrite, or limestone in the soil. From 0 – 3.5 mbgs, the soil can be described as sand with some gravel, and trace silts, cobbles, and organics. From 3.6 – 5.0 mbgs, the soil is comprised of sand with some silts and trace organics. The moisture content of the soil was damp until 4.8 mbgs, where groundwater was encountered.
* Four soil samples are being analyzed for metals from this location.

**TP-M-13-04**

* This test-pit was extended to 2.0 mbgs. The field screening results from this test-pit included PID readings of 0 ppm, and no observed odours for the entire 2.0 mbgs depth of the test-pit. Pyrite and rust staining was observed to a depth of 1.0 mbgs and 1.5 mbgs, respectively. No signs of limestone were noted in the soil from 0.0 – 1.5 mbgs.
* No soil samples were sent to the laboratory for analysis from this location.

**TP-M-13-05**

* TP-M-13-05 was extended to a depth of 2.0 mbgs. The field screening results from this test-pit included PID readings of 0 ppm, and no observed odours for the entire depth of the test-pit. Rust staining was observed throughout the samples collected, and pyrite was observed from 0.6 – 1.5 mbgs only. There was no evidence of limestone throughout the test-pit. The soil at this location is best described as damp sand with some gravel and cobbles, with the addition of trace silts from 1.6 – 2.0 mbgs.
* No soil samples were sent to the laboratory for analysis from this location.

**6.2.3 Hazardous Materials Inventory Results**

The following is a summary of the hazardous materials inventory that was completed at the Mill Area (Figure 5):

**Rail Car Tank**

Sumas Environmental Services Inc. was tasked to identify the contents of the rail car tank located at the northwest end of the Mill Area. A process sheet was found in the Mill building lab included a diagram that indicated the rail car tank contained sulphur dioxide. After opening a valve at the manifold on top of the rail car tanker, and a valve at the pressure gauge box, a small “puff” of gas exited the tank. From this off-gassing, the field monitor measured 70 ppm of sulphur dioxide. More valves were opened, but no measurable sulphur dioxide was released. A manifold valve on top of the tank was removed, and three holes were drilled in the side of the tank. A tube with a small hand pump was inserted into the tank to collect a liquid sample from the bottom of the tank. No sample was retrieved as it was dry. From our reconnaissance, we found the rail car to be empty and we believe that it historically contained sulphur dioxide.

**Thickener and Clarifier Tanks**

Located west of the rail car tank are the thickener and clarifier tanks. The area under the tanks contains a significant pile of mill sludge. This area was flooded by surface run-off as it travels through the building and floods the berms around Tanks 1 – 6. The mill sludge pile was sampled for hazardous materials characterization. The contents of the tanks were not sampled.

**South of the Mill**

At the south end of the mill, past the generators and fuel storage area, there was a landfill which contained three above ground storage tanks (two approximately 1,000 L and one 3,000 L tanks). Each of these tanks was found to contain approximately 100 L of diesel fuel.

**West of the Mill**

West of the mill, there was a collection of battered drums, mostly in poor condition, which contained oil, grease, dirt, rags, and rain water. Adjacent to this was a field containing mostly electrical debris. During the hazardous material survey of this field, the visual observations found no PCB ballasts, capacitors, or transformers.

**East of the Mill**

On the east side of the mill there were two ASTs containing diesel. Between the generator room and Dennison Environmental Services workshop was a full propane bottle storage rack shop. The bottles appeared to be well maintained, and in use by Dennison Environmental Services.

**Inside the Mill Building**

During the hazardous materials survey, samples were collected and inventoried within the mill building.

* Tanks 1-6 were found to contain sludge and solids. The tanks had holes cut in them, and the bermed area around them was flooded with water run-off and process sludge, which was sampled. The ground water flowed through the bermed area and migrated to the east wall of the building. The refined process sludge will be analyzed in order to categorize this material.
* Twelve tote sacks of lime and 5.5 skids of flocculants, sodium metabisulphite, and ferric chloride were found in the ball mill. These appeared to be unused and still in their original packaging. Approximately 5 m3 of lime appeared to have been spilled on the floor surrounding the tote sacks.
* The other mill tanks appeared empty, except for some dried residue on the bottom of the tanks. This material was sampled, analyzed, and documented in historic reports.
* The coarse ore bin and the two fine ore bins in the Mill Building were found to be mostly empty, except for some residue material that remains in each of them. A sample of fine ore residue was collected but it has not been analyzed as there is material can be classified from the historical use of these bins.

**7. Ketza Shop Area**

**7.1 Objectives and Scope**

The objectives of the site characterization at the Ketza Shop were to identify and delineate previous hydrocarbon spills, and to determine if geochemical contamination resulting from waste rock is present at this location. The scope of the site characterization investigations at the Ketza Shop comprised of two boreholes and three test-pits, as well as a hazardous materials inventory, as described below (Figure 5).

**7.1.1 Borehole Purpose and Objectives**

Two boreholes were advanced at the Ketza Shop Area to delineate hydrocarbon contamination from previous spills.   
BH-KZ-13-01 was drilled near the area where a spill occurred from a former AST, and BH-KZ-13-02 was drilled near the location of a previous spill beneath the former Ketza shop. The PCoCs for these boreholes included metals, cyanide and hydrocarbons.

**7.1.2 Test-Pit Purpose and Objectives**

Three test-pits were dug at the Ketza Shop location to delineate hydrocarbon contamination that occurred from spills within the shop, to the west of the shop, and to the south of the shop. TP-KZ-13-01 was dug north of the expected contamination, TP-KZ-13-02 was west of the expected contamination, and TP-KZ-13-03 was dug southwest of the expected contamination. The PCoCs for these locations were metals, cyanide and hydrocarbons.

**7.1.3 Hazardous Materials Inventory Purpose and Objectives**

A hazardous materials inventory was conducted at the Ketza Shop Area to classify and quantify the hazardous materials that remain at this location. The scope of the hazardous materials inventory included a site reconnaissance, collecting samples, and analyses of samples for categorizing hazardous materials.

**7.2 Summary of Results**

Analytical results from the Ketza Shop are available in Appendix D5 and borehole logs are available in Appendix A. A summary of the results from the field screening and observations, along with a description of the samples that were submitted to the laboratory for analyses are outlined for each borehole or test-pit below:

**7.2.1 Borehole Results**

**BH-KZ-13-01**

* BH-KZ-13-01 was extended to 4.0 mbgs. The field screening results from BH-KZ-13-01 indicated PID readings < 50 ppm for the first 1.0 mbgs, and below 10 ppm for the other samples. Hydrocarbon odours were observed from 3.1 – 3.5 mbgs. Some methane (1720 ppm) was observed in the first 0.5 mbgs, but was not at depths greater than this. Rust staining was observed in samples from 1.1 – 3.5 mbgs only, and there was no indication of pyrite or limestone observed at any depths throughout the borehole. The soil at this location is best described as damp sandy gravel or gravelly sand with trace cobbles, with the addition of some clay between 0.6 – 2.0 mbgs. Refusal was encountered at 4.0 mbgs.
* PCoCs included: cyanide, BTEX, EPH, and PAHs which were analyzed in soil collected from the first 1.0 mbgs. Leachable metals were analyzed on the sample from the first 0.5 mbgs, and total metals were analyzed on all of the samples from the first 1.5 mbgs. Arsenic was also analyzed from samples collected from 2.1 – 2.5 mbgs, and 3.1 – 3.5 mbgs.

**BH-KZ-13-02**

* BH-KZ-13-02 was extended to 3.5 mbgs. The field screening from this borehole included PID readings of 0 ppm, no observed odours, and no observations of pyrite or limestone for the entire borehole depth of 3.5 mbgs. Some rust staining was observed in soil samples from 2.1 – 2.5 mbgs only. The soil at this location is best described as damp sand, with trace to some gravels, and the addition of trace cobbles at 2.1 - 3.0 mbgs.
* PCoCs included: cyanide, and leachable metals analyzed in samples from 0 – 0.5 mbgs. BTEX, LEPH/HEPH, and PAH were also analyzed in samples from 1.0 – 1.5 mbgs, and total metals were analyzed in samples from 0.0 – 0.5, 1.0 – 1.5, and 2.0 – 2.5 mbgs.

**7.2.2 Test-Pit Results**

**TP-KZ-13-01**

* TP-KZ-13-01 was extended to 2.0 mbgs. The field screening from this test-pit included PID readings of 0 ppm, and no observed odours for the borehole’s entire depth. Rust staining was observed throughout the test-pit, and there were no indications of pyrite or limestone. The soil at this location is best described as dry to damp gravel and sand with some boulders and cobbles from 0.0 – 1.0 mbgs, and as damp sand with some gravel, and traces of silt and cobbles from 1.0 – 2.0 mbgs.
* No soil samples were analyzed at the laboratory from this test-pit.

**TP-KZ-13-02**

* TP-KZ-1302 was extended to 2.0 mbgs. The field screening from this test-pit included PID readings of 0 ppm, and no observed odours for the borehole’s entre depth. Pyrite and indications of limestone were observed from 0.0 – 1.0 mbgs and rust staining was observed through in of the samples in this test-pit. The soil at this location is best described as dry gravel and sand from 0.0 – 1.0 mbgs, and as damp sand with some cobbles, gravel, and silt from 1.0 – 2.0 mbgs.
* No soil samples were analyzed at the laboratory from this test-pit.

**TP-KZ-13-03**

* TP-KZ-13-03 was advanced to 2.0 mbgs. The field screening results from this test-pit does not include PID results, and the presence or absence of odours is not noted for its entire depth of 2.0 mbgs. Rust staining and no indications of pyrite or limestone were observed in soil throughout the entire depth of this test-pit. The soil at this location is described as damp, and a relatively equal mixture of gravel, sand and cobble for the first 0.0 – 1.0 mbgs. From 1.0 – 2.0 mbgs, the soil is described as moist sand and cobbles with some gravel.
* No soil samples were analyzed at the laboratory from this test-pit.

**7.2.3 Hazardous Materials Inventory Results**

Although the shop has been removed, hazardous materials remain in this area. The materials observed include:

* five yellow sealed containers labelled as copper sulphate also contain dirt. This may be from a spill clean-up;
* two drums and nine pails contain solvents, oils and antifreeze; and
* approximately 30 wooden poles or piles are piled beside the drums under a tarp. These appear to be treated with a “creosote-like” wood preservative.

**8. Roadways**

**8.1 Objectives and Scope**

The objectives of the Site Characterization field work along the roadways were to determine if these were constructed with waste rock or if this material may have been contaminated from the use of oil as a dust suppressant. The PCoCs for these samples included: metals, cyanide and hydrocarbons. The scope of the work along the roadways included five test-pits (Figure 5).

**8.2 Summary of Results**

Analytical results from the Roadways are available in Appendix D5 and borehole logs are available in Appendix A. Soil sample and duplicate sample analytical results collected from the roadways are not yet available. A summary of the results from the field screening and observations, along with a description of the samples that were submitted to the laboratory for analyses is outlined for each test-pit, illustrated on Figure 5 and described below:

**TP-R-13-01**

* TP-R-13-01 was advanced to 1.9 mbgs. The field screening results from this test-pit included PID readings of 0 ppm, and no observed odours for its entire depth, where cobble was encountered at 1.9 mbgs. Rust staining was observed in samples throughout the test-pit, and indications of pyrite were observed from 0.6 – 1.9 mbgs. No limestone was observed at this location. The soil at this test-pit can generally be described as damp sand with some gravel, cobbles, and boulders, and trace amounts of silt.
* Four soil samples are being analyzed for metals, and one additional sample is being analyzed for leachable metals from this test-pit.

**TP-R-13-02**

* TP-R-13-02 was extended to 2.0 mbgs. The field screening results from this test-pit included PID readings of 0 ppm, and no observed odours for its entire depth of 1.5 mbgs. Rust staining was observed in samples throughout the test-pit, pyrite was observed from 0.6 – 1.0 mbgs and no indications of limestone were observed. The soil at this test-pit is best described as damp gravelly-sand, with some cobbles and trace boulders.
* Four soil samples are being analyzed for metals, and one soil sample is being analyzed for leachable metals.

**TP-R-13-03**

* TP-R-13-03 extended to 2.0 mbgs. The field screening results from this test-pit included PID readings of 0 ppm, and no observed odours for its entire depth. Rust staining and pyrite were observed were observed throughout the entire test-pit, and no indications of limestone were observed. The soil at this test-pit is best described as damp gravelly-sand, with some cobbles and trace boulders.
* Two soil samples are being analyzed for metals, and one for leachable metals.

**TP-R-13-04**

* TP-R-13-04 was extended to 2.0 mbgs. The field screening results from this test-pit included no observed odours for its entire depth of 2.0 mbgs. There are no PID results recorded for this test-pit. Rust staining was observed throughout the test-pit, and there are no indications of pyrite or limestone for this location. The soil at this location is best described as damp gravel with some sand and cobbles, and trace silts in the first 0.5 m, and as gravelly sand with some cobbles from 0.6 – 2.0 mbgs. Additionally, trace silts were observed between 1.1 – 1.5 mbgs.
* No soil samples were analyzed at the laboratory from this location.

**TP-R-13-05**

* TP-R-13-05 was extended to 2.0 mbgs. The field screening results from this test-pit included PID readings of 0 ppm, and no observed odours for its entire depth. Rust staining and pyrite were observed throughout the test-pit, and there were no indications of limestone were noted. The soil at this location is best described as damp gravel and sand with trace silts in the top 1.0 mbgs. From 1.1 – 2.0 mbgs, the soil is described as damp sand with some gravel and trace silts.
* No soil samples were analyzed at this location.

**9. Bunkhouse Area**

**9.1 Objectives and Scope**

A hazardous materials inventory was conducted at the bunkhouse area (Figure 5) in order to classify and quantify the hazardous materials that remain at this location. The scope of the hazardous materials inventory included a site reconnaissance, collecting samples and hazardous materials categorizing.

**9.2 Summary of Results**

The hazardous materials survey identified the following concerns near the bunkhouse:

* three propane tanks located behind the cookhouse are still in use;
* one gas tank by the bunkhouse is still in use;
* one drum containing grease, debris, and water; and
* a large pile of garbage bags containing insulation.

**10. Former Explosives Storage Area**

**10.1 Objectives and Scope**

Sample and analyses of soil from the former explosives storage area was conducted (Figure 1) in order to classify and quantify the hazardous materials that remain at this location.

The objective of the Site Characterization field work around the Former Explosives Storage Area was to determine if contamination from the explosives may be present. The PCoCs for these samples included: total Kjeldahl Nitrogen, available ammonium (as N), nitrate + nitrite (as N), nitrate (as N) and nitrite (as N). The scope of the work for this area included four grab samples.

**10.2 Summary of Results**

Analytical results from the Former Explosives Storage Area are available in Appendix D5. The three samples from the area and the one background samples were analyzed for the PCoCs associated with explosives. They were also analyzed for metals concentrations to further understand the distribution of metals concentration with the Mount Nansen area.

**References**

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