3.0 TECHNICAL DOCUMENTATION REPORT

Appendix A

North 40 Quarry Water Management

TECHNICAL MEMORANDUM

DATE June 21, 2023 **Project No.** 21482890

TO Amarjit Sandhu
MHBC Planning Urban Design & Landscape Architecture

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IQALUIT NORTH 40 QUARRY WATER MANAGEMENT

1.0 BACKGROUND AND SITE DESCRIPTION

WSP Canada Inc. (WSP) was retained by MHBC Planning Urban Design & Landscape Architecture (MHBC), to identify water management practices for protection of the surrounding natural environment while operating the Iqaluit North 40 Quarry located at 63°47'07" N, 68°33'33" W approximately 1 km north of Iqaluit International Airport, Iqaluit, NU (see Figure 1). It is our understanding that the quarry expansion is to be developed in two initial extraction areas: Extraction Area 1 and Extraction Area 2, located west and east of the Federal Road, respectively. Area 1 is located on the east side of an upward trending bedrock ridge and Area 2 is located on a bedrock hill (knob) with the high-point at its north-central part. The Federal Road is the main access road to the quarry expansion. A second access to Extraction Area 2 is provided through Kakivak Road.

Based on the contours provided by MHBC for the quarry expansion and Google Earth imagery, the area between the Federal Road and Kakivak Road has a lower relief compared to Extraction Areas 1 and 2. Ground elevations, in the intervening area, range between approximately 25 m above sea level (masl) at its north end and 15 masl at its south end, where the two roads intersect. A local stream between the two extraction areas flows from northwest to southeast, then continues south through Iqaluit and eventually discharges at Koojesse Inet in Frobisher Bay. A Federal landfill exists within the lower-relief area south of the quarry and is surrounded by a few ponds that outlet to a channelized stream, which flows south along the east border of the airport. This channelized stream discharges into the previously mentioned local stream at a location approximately 560 m north from the southeast corner of the airport. Appendix A includes sample photos provided by MHBC from a site visit in June 2022 that show some of the features on site.

Extraction Area 1 has ground elevations along its ridge ranging from approximately 95 masl at its peak to 20 masl at the base, while Extraction Area 2 has ground elevations ranging from approximately 110 masl to 20 masl, correspondingly. The eastern face of Extraction Area 1 has maximum slopes ranging from approximately 24% at its north end to 14% at its south end, whereas the western face of Extraction Area 2 has slopes ranging from approximately 37% to 13%, correspondingly. The eastern face of Extraction Area 2 has milder slopes of 14% and less. Figure 1 shows the general surface water runoff flow paths in the area.

Both Extraction Areas 1 and 2 have existing and proposed quarrying activities, and there are six contractors operating at the quarry expansion with designated occupancy areas as shown in Figure 2. Table 1 below lists the

quarrying area estimates at both the existing and proposed operational phases of the quarry expansion. Table 2 lists the contractors on site and their occupancy areas. It is our understanding that the quarry expansion is intended to be further extracted in future to the full area boundaries of both Extraction Area 1 and Extraction Area 2.

Table 1: Quarrying Phases and their Area Estimates

Phase and Location	Existing							Proposed				
	A01	Q01	Q02	Q03	Q04	Q05	Total	P1	P2	P3	P4	Total
Area (ha)	2.35	6.19	4.94	0.82	0.21	2.91	17.42	5.96	5.85	4.04	5.77	21.62

Table 2: Contractor Occupancy Areas

Contractor	Baffin Building Systems	Baffin Central Construction	Kudlik	Nunavut Excavating	Qikiqtani Industry Ltd.	Tower Arctic	Total
Area (ha)	2.78	0.73	11.21	3.96	0.79	4,69	24.16

The quarrying areas at the existing and proposed phases total up to approximately 39.04 ha. The full areas of Extraction Areas 1 and 2 are approximately 51.5 ha and 24.8 ha, respectively.

As seen in Figure 2, the contractor occupancy area K5 is designated for sheltering explosives that will be used for blasting the extraction areas to operate the quarry. It is our understanding that the existing area A01 will not be extracted any further south.

Contractor occupancy areas K5, N2, N6 and T2 are within the extraction area boundaries, and are proposed for extraction. These areas have been considered in the enclosed water management plan and water balance calculations as part of the extraction areas. It is the responsibility of the contractors in these areas to verify and apply for any required operation-related approvals for environmental compliance, prior to quarry operations in these areas.

2.0 SCOPE OF WORK

The scope of work of this study at this stage includes the following tasks:

1) Background data review;

2) Developing a conceptual water handling strategy or water management plan for the operation of the quarry; this pertains to surface runoff given the aggregate extraction is planned to remain above the groundwater table;

3) Completing a water balance analysis for the quarry, including pre-development, i.e., existing as a baseline assessment to compare against, fully operational (accounting for the full extents of the extraction areas), and rehabilitated scenarios;

4) Completing an effects or impacts assessment by comparing surplus water generated under fully operational and rehabilitated scenarios to the baseline, i.e., the existing scenario; and

5) Preparing Best Management Practices (BMP) for quarry water management, including erosion and sediment control (ESC) measures and water quality monitoring plan, and active dewatering of the quarry expansion.

It is our understanding that no aggregate washing is required on site, given the materials are mostly bedrock, which is not anticipated to result in significant amounts of fine-grained particulates, and the local climate conditions, which will result in constrained operations. Water trucks may be used for dust suppression purposes, if necessary; this is currently facilitated under existing conditions through a local sump-pump configuration (see Photo 8 in Appendix A).

3.0 BACKGROUND DATA REVIEW

WSP did a background review of the available online data sources that are relevant to the site, as well as other data provided by MHBC, and guidelines and standards for BMP; these data are listed below along with their use:

- Meteorological Service Data Analysis and Archive Division of Environment Canada (EC); the database was used to extract meteorological data, i.e., monthly averages of water budget components including precipitation, rainfall, snowmelt, potential evaporation, etc. for EC Iqaluit A/Climate/UA station [ID 2402590] for each of the available years in the historic record (1951 – 2021), as well as average monthly values over the entire record for water balance analysis;
- Surficial geological mapping from the Canadian Geoscience Map 64 for the City of Iqaluit, Nunavut (Allard et al., 2012); the map was used to identify the soil types on site for water holding capacity and water balance calculations;
- Site visit photos from June 2022, contour and topographical mapping of the quarry expansion area (October 2022), and a contactor activities and occupancy map; these were provided by MHBC and were used for site acquaintance, developing the water management plan and water balance calculations;
- Relevant Guidelines and Standards are included under References at the end of this document.

4.0 WATER MANAGEMENT PLAN

4.1 Surface Water Drainage System

4.1.1 Existing and Operational Scenarios

The aggregate extraction in the quarries is assumed to remain above the groundwater table. It is our understanding at this stage, based on the site visit photos and the provided topographical contours, that the existing quarry excavations are at floor elevations of approximately 21 masl within Extraction Areas 1 and 2 and have shown no signs of groundwater seepage during operations (Photos 1, 2 in Appendix A). It is anticipated that

quarry expansions in the proposed extraction areas will likely not encounter groundwater during future operations. Should groundwater be encountered during future operations, it is recommended to install local groundwater monitoring wells, to verify the groundwater table elevations. The water management plan may, therefore, be a combination of diverting clear surface runoff around the excavation areas and capturing potentially silt-laden runoff from within the quarry areas for treatment in proposed sedimentation facilities, for example, settling ponds or sumps and infiltration basins.

The surficial geological Map 64 for the City of Iqaluit indicates that approximately three-quarters of Extraction Area 1 from south to north is predominantly composed of Precambrian bedrock. Map 64 also shows that the northern approximately one quarter of Extraction area 1 and Extraction Area 2 exhibit overburden of till veneer (sand, gravel and boulders in silty sand mix) with a depth varying from 0.5 m to 2.0 m overlying bedrock. Due to these geological and soil conditions at the quarry location, infiltration losses are expected to be minimal. Hence, settling ponds or sumps are a suitable alternative for treating silt-laden runoff on site.

Figure 3 shows the proposed quarry surface water management plan and features for the existing and operational scenarios. Surface runoff within the extraction areas is anticipated to flow downslope then contribute to the existing streams from north to south. The drainage system consists of a series of proposed perimeter ditches within and bordering the extraction area boundaries, to collect the surface runoff and discharge it into sedimentation ponds. It is recommended that the ponds have an overflow spillway, for collected surface runoff in excess of the pond capacity during extreme rainfall events to outflow downstream into the receiving water bodies. Appendix A includes typical cross-section details for both the ditches with side slopes of 1.5:1 (H:V) and the pond outfall structure.

Four sedimentation ponds are proposed for the quarry; three ponds for Extraction Area 1, and one pond for Extraction Area 2 (see Figure 3). The locations of the proposed ponds were chosen to serve the phasing of the existing and future quarrying activities, while also considering comparable runoff contributing areas. The proposed number of ponds is preliminary and should be reviewed prior to detailed design.

In Extraction Area 1, the first pond on the north will initially collect runoff from Q03 and Q04 during the existing scenario; the pond will expand in volume to account for future larger sediment-laden runoff collected during quarrying the additional areas above Q03, Q04 and P3. Outflow from this northern pond will discharge into the water bodies around the Federal Landfill and eventually reach the channelized stream beside Iqaluit Airport. The intermediate and south ponds will collect sediment-laden runoff from Q02 and Q01, respectively during the existing scenario, and additional runoff from P1 and P2 in future and the outflow will be discharged into the same channelized stream by the airport. Culverts crossing the Federal Road are proposed to convey the outflows from the ponds to the receiving channel.

In Extraction Area 2, one pond is proposed at the confluence of the perimeter ditches and will outflow through a proposed spillway/broad-crested weir or rock chute into the existing natural stream. It is recommended that the confluence area below the proposed pond is rock armoured to protect the streambed against erosion.

The sedimentation ponds are assumed to be excavated approximately 1.0 m below the lowest point in the surrounding topography with their outlet structure located at the lowest location; this is to allow for dewatering of the quarried areas by gravity. Section 4.4 includes more details on the design criteria of the ponds and other features.

It is our understanding that dust suppression is currently undertaken for the existing quarry areas and that water is used as a suppressant through an existing sump-pump configuration (see Photo 8 in Appendix A).

4.1.2 Rehabilitation Scenario

It is recommended that rehabilitation of the quarry takes place progressively after each quarry area is excavated. Rehabilitation of quarry areas will be achieved by leaving the final extracted rock surfaces (quarry face and floor) in a safe condition. Safety fences should be installed along the perimeter of the quarried areas, to prevent access to the top of the quarry face; similar safety measures should be installed at the ground level. It is our understanding that this type of fencing is currently being undertaken at the existing quarries (see Photo 9 in Appendix A).

During rehabilitation conditions, it is assumed that the quarried areas will continue to drain by gravity into the proposed ponds; this should result in little to no ponded water in the quarry. Any non-aggregate materials and unmarketable aggregate or overburden collected during operations could be stockpiled and utilized for constructing access roads or protection berms during rehabilitation, to prevent overland surface flow from entering the receiving streams directly.

At the end of rehabilitation, it is recommended to maintain the extraction area collection ditches for drainage of the quarried areas, but to flatten their side slopes from 1.5:1 to 4:1 (H:V). This is to facilitate egress and to reduce the risk of accidents or injuries if people practise snowmobiling or quad biking in the area after quarry closure. Assuming the quarry will continue to drain by gravity after rehabilitation, it is recommended to reduce the proposed sedimentation ponds during operations into shallow surface water management ponds near the outlets that may be sized to 5% to 10% of their upstream catchment areas.

4.2 Erosion and Sediment Control Plan, and Construction Sequence

Different erosion and sediment control (ESC) measures may be applied on site, to help reduce the impacts of soil erosion and sediment transport to the receiving water bodies. These measures include silt fences, check dams, settling ponds, slope hydro mulching, perimeter berms and ditches, and sedimentation basins among others. For the proposed surface water drainage system in Figure 3, it is recommended to apply the following ESC measures while adopting the below construction sequence:

- establish control of the site and remove any large debris from the areas to be extracted;
- install Regular Silt Fence (see Ontario Provincial Standard Drawing (OPSD 219.110) in Appendix A) around the downslope side of each extraction area. Silt fencing should be maintained and remain in place, at least until all drainage system components are constructed and disturbed ground has been stabilized;
- excavate the settling ponds at the proposed locations and construct the outflow structure (weir, spillway, rock chute) as illustrated in the example outfall detail in Appendix A and per the guidelines under Section 4.4 below;
- construct the required culverts at road crossings following Ontario Provincial Standard OPSS.PROV 421 as applicable to the site conditions; this includes installing a metal grate at the inlets to prevent debris from entering the culverts. Culvert inlet and outlet protection to be provided by placing suitable riprap sizes, gradation and thickness according to standard guidelines (see OPSD 221.040 in Appendix A);

- construct the extraction area collector ditches and ensure proper connection to the settling ponds for discharging the collected contact water into the ponds. Rock-armor the ditch beds and bank areas subject to increased erosive forces, using suitable riprap sizes based on the estimated flow velocities of the design discharge from a 100-year storm event;
- install silt fence check dams, rock check dams, straw bales or straw wattles across the ditches at suitable intervals along the ditch, typically every 50 m and more frequently for steeper-slope ditch reaches; the choice of the suitable ESC measure depends on the longitudinal slope and estimated sediment load (see Appendix A for sample typical details).

It is assumed that after the construction of the proposed surface drainage system and associated ESC measures, quarry operations will progress from east to west in Extraction Area 1 during all phases as this is the topographically upward direction. In Extraction Area 2, operations are assumed to start in the existing extraction area N6 and progress from west to east with a transition to northwest as shown in Figure 3. This general direction of excavation will allow for the quarry face to progress across a broader front through the spine of the deposit, while maintaining a topographic 'low to high' approach for most of Extraction Area 2. The approach also facilitates locating portable processing plants near the extraction faces by the operators, hence reducing costs and operational challenges.

The proposed surface water drainage system and associated ESC measures may be fully constructed from the start of operations, or phased as follows:

- Phase 1 serving extractions in the existing and proposed quarry areas, i.e., Q1 through Q5 (existing scenario) and P1 through P5 (proposed or interim scenario); and
- Phase 2 serving the full operational scenario of the whole quarry.

At the end of quarry operations, rehabilitation is assumed to follow per the recommendations previously described in Section 4.1.2.

4.3 Water Quality Monitoring Plan

As shown in Figure 3, five water quality monitoring locations are selected near the outlets of the proposed sedimentation ponds. In Extraction Area 1, one monitoring location is proposed below the north pond outlet and one other location below the south pond outlet; the intermediate pond outflow will eventually reach the south pond. In Extraction Area 2, three monitoring locations are proposed; two locations upstream from the confluence of the receiving streams, to provide baseline stream water quality above the proposed pond, and one downstream from the confluence to assess the effect of the pond effluent discharge.

Grab samples of the effluent should be taken at the proposed water quality monitoring locations monthly, or more frequently as triggered by stormwater events, and in any month that blasting and quarrying are conducted, when the ponds have outflows during ice free periods. Environment Canada's Climate Normals for Station Iqaluit A (Climate ID: 2402590) show snow-free period to be during June through September. The samples should be analysed at an accredited third-party lab for turbidity and total suspended solids (TSS) due to potentially released sediments from the ponds. Water temperature and pH should be measured in the field at the time of sampling using in-situ methods.

Also, if complete combustion is not attained during blasting of explosives, there is some potential for pollutants to be released into the receiving environment, which may negatively affect the water quality in the water bodies. Based on the results of a recent survey that MHBC completed with three quarry operators, WSP understands that Ammonium Nitrate and Fuel Oil (ANFO) will be used for blasting as it is a common explosive in quarry operations in the area. As such, it is also recommended to analyse for total ammonia, oil and grease, nitrates and nitrites and the results compared to the Canadian Council of Ministries of the Environment (CCME) Water Quality Guidelines for the protection of aquatic life.

4.4 Design Criteria

Different local and provincial stormwater management design guidelines and standards were reviewed to select suitable design criteria for the drainage system. While some guidelines adopt storm-based approach for designing the drainage features, others call for long-term and continuous flow criteria. The proposed features should be designed to the relevant standard (or equivalent) as follows:

- the extraction area collection ditches are to be designed for conveyance of peak flows during the 100-year storm event (see Appendix A for a typical cross-section detail). A minimum freeboard of 0.30 m to be provided;
- the sedimentation ponds are to be designed based on guidelines provided in Table 3.2 of the Ontario Ministry of Environment, Conservation and Parks (MECP) Stormwater Management Planning and Design Manual (MECP, 2003) for enhanced 80% long-term suspended solids removal using wet ponds with 85% impervious level. The surface area of each settling pond at the elevation of the outfall weir invert, will be at least 250 m^2 per hectare of upstream catchment area;
- Supplemental to the previous sedimentation ponds design criteria, a minimum pond depth of 1.0 m below the outlet invert elevation should be considered in the design;
- the pond outflow structure (weir, spillway or rock chute) to be designed for conveyance of the 100-year peak flow discharge with a minimum free-board of 0.30 m. The outfall structure will be constructed by grading the existing overburden and armouring the crest and tailwater area with nominal 300 mm rock riprap underlain by a non-woven geosynthetic filter fabric as illustrated on the settling pond outfall detail in Appendix A. Half metre (0.5 m) high berms will be constructed around the downslope side of the settling pond to provide additional freeboard for large runoff events;
- the culverts should be installed in firm and compacted soil with headwalls at their inlets and erosion protection rock outlets, with a minimum depth of cover of 12 inches. Culvert sizing may be determined considering a maximum flow velocity of 2 m/s through the culvert for the design discharge, and a minimum freeboard of 0.15 m. The 10-year design discharge may be considered for sizing the culverts assuming their anticipated service life is longer than 2 years; and
- accounting for climate change impacts when estimating the design discharge for the above drainage and settling components; an increase of 8% is recommended based on recent research findings of Arctic precipitation.

While the above design criteria are recommended to be adopted; the final design configurations of the proposed features remain the responsibility of the design engineer to be verified during the detailed design.

5.0 SITE WATER BALANCE

A water balance assessment related to the two proposed extraction areas of the quarry development was carried out to assess the potential hydrogeological impacts of the proposed quarry development with respect to loss in surplus, including potential impacts to downstream surface water features. The assessment included the existing, operational (full extraction), and rehabilitated conditions within the proposed extraction limits.

5.1 Methodology

The Meteorological Service Data Analysis and Archive Division of Environment Canada (EC) provides monthly water budget summaries for meteorological stations with greater than 20 years of meteorological data. These water budgets include monthly values for all components of the water budget (rainfall, snowmelt, potential evaporation, etc.) for each of the years in the historic record, as well as average monthly values over the entire record.

The water balance assessment presented herein is based on composite meteorological data from the EC Thornthwaite water budgets (Environment Canada Iqaluit A/Climate/UA station [ID 2402590] between 1951 and 2021), watershed boundaries, land use data, and the existing soil types. The meteorological data set used in this assessment was derived by combining daily observations of Iqaluit A (2402590, 1951-2008), Iqaluit UA (2402594, 1997 - 2016), and Iqaluit Climate (2402592, 2004 – 2021), noting that the data in 1947-1950 from the Iqaluit A Station are utilized to replace the missing records for the same date (MMDD) of any given year within its record.

The Thornthwaite method describes water flux in a unit area of soil on a monthly basis based on a balance of precipitation (rainfall and snowmelt), evapotranspiration (ET), soil storage, and surplus.

The water budget can be summarized as follows:

$$P = S + ET + R + I$$

Where: P = precipitation;

S = change in soil water storage;

ET = evapotranspiration;

R = surface runoff; and,

I = infiltration (infiltration below the root zone and available for groundwater recharge).

The various water budget components associated with catchment areas are typically presented in millimetres (mm) per time step over their respective sub-catchments and represent the amount of water per unit of watershed area.

The water budget model combines accumulated rainfall and snowmelt to estimate total precipitation. Rainfall represents precipitation when monthly mean temperatures are greater than 0 °C. Snowmelt is initiated when snow is on the ground and monthly mean temperatures are greater than 0 °C. Hence, snowmelt is based on the depletion of snow storage (accumulated precipitation during periods of sub-zero temperatures). Composite precipitation data collected at the Iqaluit A/Climate/UA monitoring station (1951 to 2021) indicated a mean annual precipitation (P) of 401 mm/y.

The potential or maximum ET is estimated, in this case, by the empirical Thornthwaite equation (using average monthly temperature and hours of daylight) and represents the amount of water that would be evaporated or transpired under saturated soil-water scenarios. The actual ET is the total evapotranspiration for the period of study based on evapotranspiration demand, available soil-water storage, and the rate at which soil water is drawn from the ground (as defined by an established drying curve specific to the soil type). Wintertime sublimation was assumed to approach zero in all evaluated scenarios. As this assumption was applied to all scenarios, it is not expected to significantly affect the presented effects assessment, which is based on comparison of the scenarios. The mean annual potential ET for the Site is approximately 376 mm/y based on data provided by EC.

Annual water surplus is the difference between P and the actual ET assuming year to year changes in soil moisture storage are negligible. The water surplus represents the total amount of water available for either surface runoff (R) or groundwater infiltration (I) on an annual basis. On a monthly basis, surplus water remains after actual evapotranspiration has been removed from the sum of rainfall and snowmelt, and maximum soil or snowpack storage is exceeded. Maximum soil storage is quantified using a Water Holding Capacity (WHC) specific to the soil type and land use. WHC is defined as the difference is soil moisture content between the field capacity and wilting point and is assigned across the site based on soil type and vegetation cover.

5.1.1 Catchment Delineation

The water balance evaluation was performed for the Iqaluit quarry property with specific interest in the two proposed extraction areas. For the purposes of this assessment, no adjacent lands outside of the proposed extraction areas were evaluated, noting that the available topographic mapping details high points centered within the two extraction areas that drain outward, so no adjacent land flow would be entering the proposed extraction areas. Land uses under existing, operational (full extraction), and rehabilitated conditions were taken from desktop delineations using available aerial imagery and additional site information/photography.

5.1.2 Water Balance Scenarios

Under existing conditions, the existing/proposed extraction and contractor occupancy areas are composed of sections of stripped area, operational buildings, existing quarry extraction activity, and arctic tundra.

Under operational (full extraction) conditions, all available arctic tundra area within the two proposed extraction areas will be blasted to form the proposed quarry. Under full extraction, several of the existing contractor occupancy zones will either be fully or partially removed for extraction purposes. All contractor occupancy areas will otherwise remain the same. The operational condition considers the quarry area to drain by gravity towards the proposed drainage ditches.

Rehabilitated conditions were also considered in this study to determine the water surplus after quarry operations have ceased and the quarry is decommissioned. The rehabilitated condition considers the quarry area will remain similar to operational conditions with the exception of regrading to a flatter slope as well as the addition of small stormwater management (SWM) ponds near the outlets of both extraction areas to act as a storage element for drainage to mitigate the rate of runoff to the downstream receivers.

5.1.3 Water Balance Parameters

Soils within the proposed extraction areas consist primarily of bedrock and fine sandy loam, based on surficial geology mapping from the Canadian Geoscience Map 64 for the City of Iqaluit, Nunavut (Allard et al., 2012), with sections of compacted sand / gravel present within the contractor occupancy areas that overlap. Bedrock was

assumed to be the operational conditions soil type for the proposed extraction quarry areas. The maximum soil storage is quantified using a Water Holding Capacity (WHC) that is based on guidelines provided in Table 3.1 of the MECP Stormwater Management Planning and Design Manual (MECP, 2003), (MECP manual).

WHCs are specific to the soil type and land use, whereby values typically range from approximately 10 mm for bedrock to 400 mm for mature forest over silt loam. For temperate region watersheds, soil storage is typically relatively stable year-round, remaining at or near field capacity with the exception of the typical mid- to late-summer dry period. As such, the change in soil storage is a minor component in the water budget, particularly at an annual scale. Surplus water remains in the system after actual ET has been removed (ET demand is met) and the maximum WHC is exceeded (soil-water storage demand is met).

The surplus data obtained from ECCC for the respective water holding capacities were split into infiltration and runoff components by applying an infiltration factor based on Table 3.1 from the MECP *SWM Manual* (MECP, 2003). The infiltration factors were based on a sum of site-specific topography, surficial soil type and vegetative cover factors as presented in Table A-1 of Appendix A.

The water balance analyses were developed under the following assumptions:

- WHCs were chosen based on Table 3.1 in the MECP *SWM Manual* (2003) corresponding to the bedrock soil type, existing land uses and operational/rehabilitation conditions for the water balance.
    - Undeveloped Extraction Area (Arctic Tundra over Bedrock): 75 mm WHC and a 0.25 infiltration factor for ¾ of Extraction Area 1 (existing conditions), noting that the infiltration factor was not considered where the extraction area is mostly bedrock.
    - Undeveloped Extraction Area (Arctic Tundra over Fine Sandy Loam): 125 mm WHC and a 0.25 infiltration factor for ¼ of Extraction Area 1 and a 0.20 infiltration factor for Extraction Area 2 (existing conditions), noting that the infiltration factor was not considered given the extraction area is bedrock underneath.
    - Compacted Operational Zones / Roadways (Stripped Area): 10 mm WHC and a 0.25 infiltration factor for Extraction Area 1 and a 0.20 infiltration factor for Extraction Area 2 (existing conditions).
    - Operational Quarry Extraction Area (Quarry – Gravity Draining): 10 mm WHC and a 0.15 infiltration factor for (existing and operational conditions).
    - Decommissioned Quarry (Quarry – Gravity Draining): 10 mm WHC and a 0.2 infiltration factor for (rehabilitated conditions).
    - Impervious Built-Up Areas (i.e., rooftops): 3 mm WHC and a null (i.e., 0%) infiltration factor (existing conditions).
- For the open water areas (i.e., the SWM ponds), it was assumed surplus equals the difference of the precipitation and potential ET. This assumption is generally supported by comparing local pan evaporation estimates provided by Environment Canada with the use of a correction factor (0.7) for the energy transfer through the side and bottom of the pan, as described by the Hydrological Atlas of Canada, Mean Lake Evaporation, 1978.

- Net surplus was estimated by multiplying the estimated monthly surplus (mm/month) for the assumed WHC by the associated drainage area. Annual evapotranspiration and surplus values were obtained from the meteorological data from the composite Iqaluit A/Climate/UA ECCC Meteorological Station based on the WHC assigned to each land use area.
- Runoff was calculated as the difference between surplus and infiltration.

5.2 Water Balance Results

An average annual water balance assessment was carried out based on a proposed extraction area basis. The results for the existing, operational (full extraction), and rehabilitated scenarios are presented in this section.

5.2.1 Existing Condition

Based on the results of the assessment, the average annual existing water balance was estimated on a proposed extraction area basis as summarized in Table 3, and as detailed in Table A-2, Appendix A.

Table 3: Existing Average Annual Water Balance Results – Proposed Extraction Areas

Average Annual Volume (m^3/y)	Proposed Extraction Areas	
	Extraction Area 1 [(1)]	Extraction Area 2 [(2)]
Precipitation (P)	206,950	99,750
Evapotranspiration (ET)	153,050	78,050
Surplus (S)	53,175	21,500
Infiltration (I)	13,055	5,595
Runoff (R)	40,120	15,905

Note:

[(1)] The total area of the proposed "Extraction Area 1" is 51.5 ha, as shown on Figure 1.

[(2)] The total area of the proposed "Extraction Area 2" is 24.8 ha, as shown on Figure 1.

The total average annual surplus for the proposed Extraction Area 1 under existing conditions was estimated to be 103 mm or 53,175 m^3/y and the estimated infiltration is approximately 25 mm or 13,055 m^3/y. Runoff was calculated as the difference between surplus and infiltration and was estimated to be 78 mm or 40,120 m^3/y. Based on the assessment, approximately 24% of the annual surplus infiltrates while the remaining 76% is surface runoff under existing conditions.

The total average annual surplus for the proposed Extraction Area 2 under existing conditions was estimated to be 87 mm or 21,500 m^3/y and the estimated infiltration is approximately 23 mm or 5,595 m^3/y. Runoff was calculated as the difference between surplus and infiltration and was estimated to be 64 mm or 15,905 m^3/y. Based on the assessment, approximately 26% of the annual surplus infiltrates while the remaining 74% is surface runoff under existing conditions.

5.2.2 Operational Condition (Full Extraction)

Based on the results of the assessment, the average annual operational water balance was estimated on a proposed extraction area basis as summarized in Table 4, and as detailed in Table A-2, Appendix A.

Table 4: Operational (Full Extraction) Average Annual Water Balance Results – Proposed Extraction Areas

Average Annual Volume (m^3/y)	Proposed Extraction Areas	
	Extraction Area 1 (1)	Extraction Area 2 (2)
Precipitation (P)	206,940	99,750
Evapotranspiration (ET)	127,660	61,530
Surplus (S)	77,730	37,470
Infiltration (I)	11,660	5,620
Runoff (R)	66,070	31,850

Note:
(1) The total area of the proposed "Extraction Area 1" is 51.5 ha, as shown on Figure 1.
(2) The total area of the proposed "Extraction Area 2" is 24.8 ha, as shown on Figure 1.

The total average annual surplus for the proposed Extraction Areas 1 and 2 under operational (full extraction) conditions was estimated to be 151 mm (77,730 m^3/y and 37,470 m^3/y, respectively) and the estimated infiltration is assumed to be approximately 23 mm (11,660 m^3/y and 5,620 m^3/y, respectively). Runoff was calculated as the difference between surplus and infiltration and was estimated to be 128 mm (66,070 m^3/y and 31,850 m^3/y, respectively). Based on the assessment, approximately 15% of the annual surplus is expected to infiltrate so that 85% of the surplus is expected to run off under operational (full extraction) conditions by gravity drainage.

5.2.3 Rehabilitated Condition

Based on the results of the assessment, the average annual rehabilitated water balance was estimated on a proposed extraction area basis as summarized in Table 5, and as detailed in Table A-2, Appendix A.

Table 5: Rehabilitated Average Annual Water Balance Results – Proposed Extraction Areas

Average Annual Volume (m^3/y)	Proposed Extraction Areas	
	Extraction Area 1 (1)	Extraction Area 2 (2)
Precipitation (P)	206,940	99,750
Evapotranspiration (ET)	130,960	63,120
Surplus (S)	74,515	35,920
Infiltration (I)	14,770	7,120
Runoff (R)	59,745	28,800

Note:
(1) The total area of the proposed "Extraction Area 1" is 51.5 ha, as shown on Figure 1.
(2) The total area of the proposed "Extraction Area 2" is 24.8 ha, as shown on Figure 1.

The total average annual surplus for the proposed Extraction Areas 1 and 2 under rehabilitated conditions was estimated to be 145 mm (74,515 m^3/y and 35,920 m^3/y, respectively) and the estimated infiltration is approximately 29 mm (14,770 m^3/y and 7,120 m^3/y, respectively). Runoff was calculated as the difference between surplus and infiltration and was estimated to be 116 mm (59,745 m^3/y and 28,800 m^3/y, respectively). Based on the assessment, approximately 20% of the annual surplus infiltrates while the remaining 80% is surface runoff under rehabilitated conditions.

5.2.4 Summary of Water Balance Results

A summary of the annual water balance assessment considering surplus, infiltration, and runoff for the existing, operational (full extraction), and rehabilitated conditions is provided in Table 6 and Table 7.

Table 6: Water Balance Summary - Surplus

Proposed Extraction Areas	Scenarios Considered		
	Surplus (m^3/y)		
	Existing Conditions	Operational (Full Extraction) Conditions	Rehabilitated Conditions
Extraction Area 1 (1)	53,175	77,730	74,510
Extraction Area 2 (2)	21,500	37,470	35,920

Note:
(1) The total area of the proposed "Extraction Area 1" is 51.5 ha, as shown on Figure 1.
(2) The total area of the proposed "Extraction Area 2" is 24.8 ha, as shown on Figure 1.

Table 7: Water Balance Summary – Infiltration and Runoff

Proposed Extraction Areas	Scenarios Considered					
	Existing Conditions		Operational Conditions		Rehab Conditions	
	Infiltration (m^3/y)	Runoff (m^3/y)	Infiltration (m^3/y)	Runoff (m^3/y)	Infiltration (m^3/y)	Runoff (m^3/y)
Extraction Area 1	13,055	40,120	11,660	66,070	14,770	59,745
Extraction Area 2	5,595	15,905	5,620	31,850	7,120	28,800

Note:
(1) The total area of the proposed "Extraction Area 1" is 51.5 ha, as shown on Figure 1.
(2) The total area of the proposed "Extraction Area 2" is 24.8 ha, as shown on Figure 1.

Under operational conditions, surplus within the proposed Extraction Areas 1 and 2 is anticipated to increase by 46% and 74%, respectively – representing a decrease in evapotranspiration due to changed land use in the quarry extraction area. Infiltration is expected to decrease to 11,660 m^3/y for Extraction Area 1, compared to existing conditions, as the surplus from the quarry will drain by gravity to the proposed sedimentation ponds via the proposed drainage ditches and only the quarry floor will be available for infiltration. However, infiltration is

expected to increase to 5,620 m^3/y for Extraction Area 2, as the infiltration capacity of the Extraction Area 2 quarry floor will be similar to existing conditions and the surplus will increase significantly. This will effectively increase the total runoff from the proposed Extraction Areas 1 and 2 to 66,070 m^3/y and 31,850 m^3/y, respectively.

Under rehabilitated conditions, the components of the water balance will continue to function very similarly to operational conditions, however, two SWM ponds will be added near the outlets of both extraction areas. Surplus within the proposed Extraction Areas 1 and 2 are projected to increase by 40% and 67%, respectively (compared to existing). Runoff is expected to be conveyed to the downstream surface water features by gravity. Infiltration is expected to increase to 14,770 m^3/y for Extraction Area 1 and 7,120 m^3/y for Extraction Area 2. Overall, runoff will increase to 59,745 m^3/y for Extraction Area 1 and 28,800 m^3/y for Extraction Area 2.

6.0 EFFECTS ASSESSMENT

Several surface water drainage features, as seen on Figure 3, sit within the vicinity of the proposed Extraction Areas 1 and 2 and receive runoff from the existing arctic tundra, extraction, and stripped areas. There are two drainage features nearest to the extraction areas; one situated between Extraction Areas 1 and 2 and one situated east of Extraction Area 2. These two features converge at the southeast tip of Extraction Area 2 and flow southeast towards the City of Iqaluit. An additional drainage feature is situated near the southeast tip of Extraction Area 1 downstream of a series of ponded water features adjacent to the contractor occupancy areas and a federal landfill footprint. These features also receive drainage from the two surface water features adjacent to Extraction Area 2. Based on observations noted during field investigations, the surface water features can be characterized as shallow streams with an inconsistent flow behaviour due to the presence of sediment build-up triggered by sediment heavy runoff from precipitation events.

Due to the shallow nature of the surface water features within the vicinity of the proposed Extraction Areas 1 and 2, concerns with regards to the potential water quality of the water features as the quarry progresses are expected. Additionally, concerns with regards to potential flooding of the features is also expected due to sediment build-up.

The proximity of the water features to the contractor occupancy and proposed extraction areas poses a risk for potential damages to site equipment and buildings. As detailed in the water management plan above and as seen in Figure 3, runoff from the footprint of Extraction Areas 1 and 2 will be captured by drainage ditches along the perimeter that will redirect flow into the proposed sedimentation ponds. As the proposed extraction areas are stripped for future use, sediment within those areas will be more easily carried by runoff from precipitation events downstream. These drainage ditches will act as a barrier between the extraction areas and the surface water features. Adequate sedimentation within the sedimentation ponds will then allow for clear effluent discharge back to the adjacent surface water features reducing the risk of sediment build-up.

Proper maintenance of these drainage ditches and sedimentation ponds will also ensure a lower risk of sediment build-up and potential flooding within the extraction area footprints. This will also help mitigate any potential risks to aquatic life further downstream as well as flooding concerns. Additionally, during periods of high precipitation, the quarry can act as a storage basin to help mitigate peak flows to the adjacent surface water features. It is also to be noted that the proposed extraction areas likely form a small fraction of the total drainage area contributing to the receiving watercourses; this is to be verified during the detailed design.

The water balance assessment in Section 4.0 suggests that overall, there will be increase in water surplus of 46% for Extraction Area 1 and 74% for Extraction Area 2 under operational conditions compared to existing conditions. Post-rehabilitation, the water balance assessment predicts an increase in water surplus of 40% for Extraction Area 1 and 67% for Extraction Area 2 relative to existing conditions. As observed above, runoff volumes to adjacent surface water features are expected to decline, however, effluent discharge to these features is expected to balance the loss in catchment during operational conditions. Notably, the grading of the quarried areas and establishing perimeter berms around them under the rehabilitated condition will result in a flatter slope and ensure internalized surface drainage within the quarried areas and increased infiltration of 13% and 27% for Extraction Areas 1 and 2, respectively, compared to existing conditions. This increase in infiltration will likely have minimal impacts on the groundwater table as the quarry is assumed to be above the groundwater table.

Overall, the quarrying of aggregates within Extraction Areas 1 and 2 is predicted to have a few adverse impacts on the surface water hydrology of local surface water features, due to the increase in sediment transport which could negatively impact the surface water quality and flooding potential of the adjacent features. The implementation of the proposed water management plan, however, will help mitigate these impacts and ensure sediment transport from the site runoff is controlled prior to its return to the adjacent receiving water courses and features.

7.0 RECOMMENDED BEST MANAGEMENT AND PRACTICES

WSP has reviewed multiple relevant guidelines and standards that are local, provincial and international pertaining to the BMP for aggregate and quarry mining water management. These guidelines and standards are included under References at the end of this document and some of them in Appendix A.

WSP understands that the quarry is to be developed above the local groundwater table. In this configuration, it is expected that the majority of surface runoff from small rainfall and snowmelt events will infiltrate during ice-free periods but may accumulate in the overburden areas of Extraction Area 2 and approximately the north quarter of Extraction Area 1. As such, any runoff from the active extraction areas (contact water) will be collected and directed through perimeter ditches to sedimentation ponds as shown in Figure 3, where it will be allowed to infiltrate, or be retained to settle the majority of suspended solids before the clear water decants through an outlet structure and flows to the receiving watercourse.

The following BMP are supplemental to others described earlier in Sections 4.2 through 4.4:

- sequencing of construction, site access and disturbance of existing vegetation should be minimized to the extent feasible. Initial mobilization of equipment must avoid low lying area adjacent to surface water features whenever possible and should be limited to high, flat sloped ground whenever feasible;
- the contractor should use ESC Best Management Practices (BMPs) as appropriate. BMPs should be used in any areas where ground disturbance is necessary outside of the active quarry area, where water is managed in the water management features;
- If, during construction of the quarry and before the sedimentation ponds are fully implemented, any accumulations of water need to be removed from the excavation area, BMPs for temporary construction dewatering include:

  - identifying a flat and stable upland receiving area, at least 30 m or as approved by Nunavut Impact Review Board (NIRB) whichever is larger, from any permanent waterbody, to receive pumped water;
  - isolating the receiving area with a complete perimeter of straw bales or a coarse gravel berm to slow discharge to the receiving environment;
  - pumping at the lowest feasible flow rate to maintain dry working conditions; and
  - discharging the pumped water into an appropriately sized geosynthetic filter bag located in the isolated upland receiving area. The opening of the filter bag should be secured around the end of the outlet pipe and oriented with the opening located at the upslope side of the receiving area.
- It is recommended to use water for dust suppression; other chemical dust suppressants may only be used after approval by the Nunavut Department of Environment;
- Contingency plans should be developed by the quarry operation contractors for accidental spills of hazardous materials including explosives used for blasting, fuel gas, or other chemicals that may harm the surrounding environment. All spills of hazardous materials must immediately be reported to Nunavut 24-hour Spill Report Line in accordance with the Spill Contingency planning and Reporting Regulations;
- Care of the surrounding environment and water management are the responsibility of the quarry construction and operation contractors. The water management features and BMPs described herein are based on our understanding of site conditions at the time of issue of this memorandum. The quarry construction and operation contractors should have additional supplies of ESC materials readily available and must constantly react to changing or unexpected site conditions in order to minimize effects on the surrounding environment; and
- All contractors should adhere to health and safety standards and measures while working around water. Examples including wearing suitable personal protective equipment (PPE), life jackets, safety boots and hard hats. It is also recommended to install throw rings near the ponds and surround the pond perimeters with posts connected by suitable reflective caution tape for safety.

8.0 CLOSURE

We trust that this information addresses your current need. Please do not hesitate to contact the undersigned if you have any questions or additional information requests.

WSP Canada Inc.

Hesham Fouli, PhD, PEng
Senior Water Resources Engineer

Kevin MacKenzie, MSc, PEng (ON, NS)
Senior Principal / Water Resources Engineer

MR/HF/KMM/mp

Distribution: MHBC Planning – Electronic Submission (PDF)

Attachments: Figure 1: General Site Plan
Figure 2: Existing and Proposed Quarries and Contractor Occupancies
Figure 3: Proposed Water Management Plan

Appendix A including:
- Typical Ditch Cross Section Detail
- Sedimentation Pond Outfall Detail
- OPSD 219.211 Rock Check Dam – Trapezoidal
- OPSD 219.110 Regular Silt Fence
- OPSD 221.040 Temporary Culvert Crossing
- Sample Site Photos
- Water Balance Calculation Sheets

https://golderassociates.sharepoint.com/sites/151108/project files/6 deliverables/reports/final/21482890-tm-final-iqaluit_north-40-quarry-watermanagementplan-21jun2023.docx

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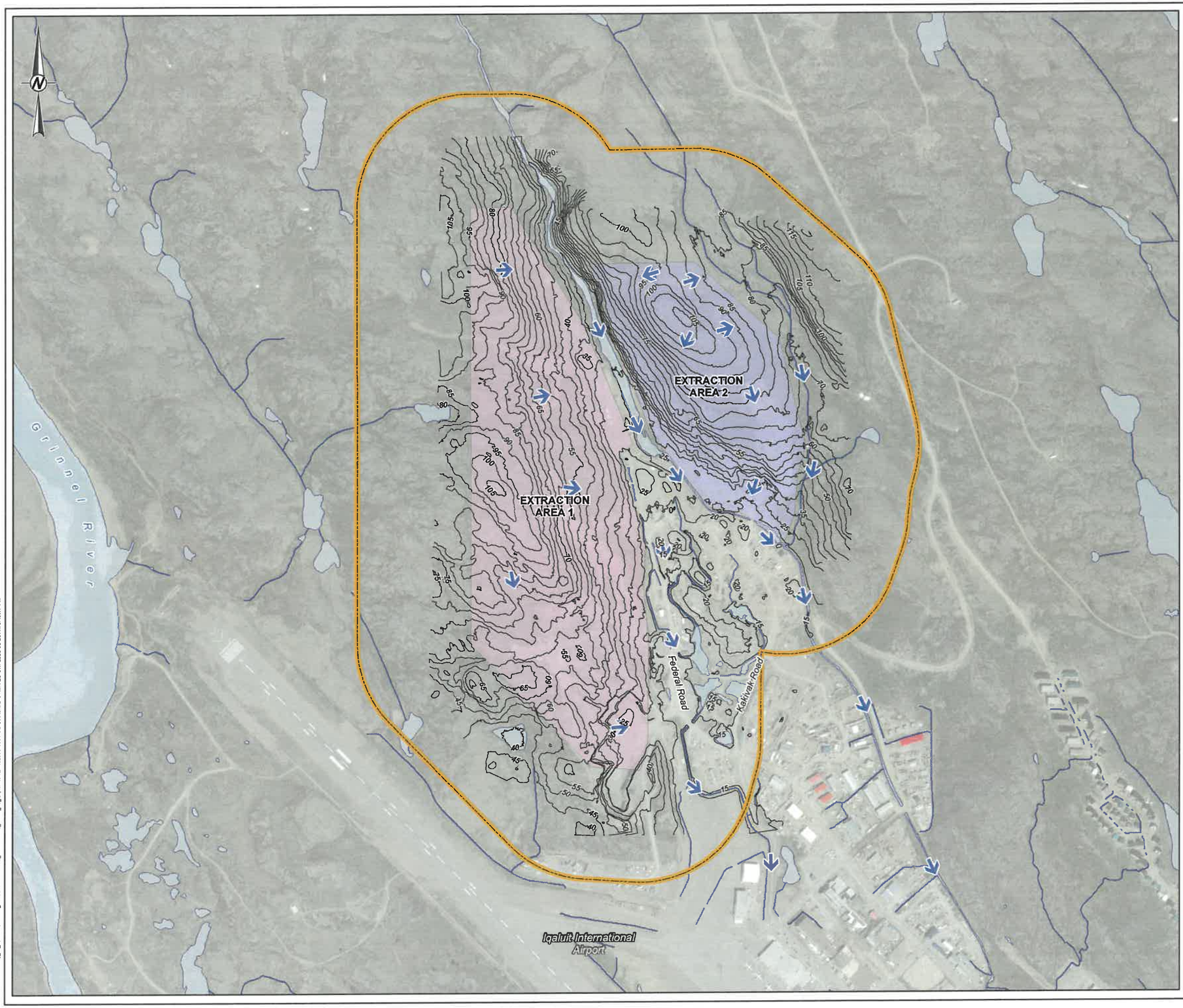
FIGURES



KEY MAP

SCALE 1:80,000,000

LEGEND

- SURFACE WATER FLOW DIRECTION
- 300m OFFSET FROM EXTRACTION AREAS
- EXTRACTION AREA 1
- EXTRACTION AREA 2
- MAJOR - CONTOURS (5m)
- MINOR - CONTOURS (1m)
- WATERBODY

0 90 180 360

1:10,000 METRES

NOTE(S)
1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE(S)
1. CONTAINS INFORMATION LICENSED FROM GOVERNMENT OF NUNAVUT (COMMUNITY AND GOVERNMENT SERVICES)
2. COORDINATE SYSTEM: NAD 1983 UTM ZONE 19N

CLIENT
MHBC - PLANNING URBAN DESIGN AND LANDSCAPE ARCHITECTURE

NORTH 40 QUARRY EXPANSION
IQALUIT, NUNAVUT

TITLE
GENERAL SITE PLAN

CONSULTANT

wsp

YYYY-MM-DD	2023-06-20
DESIGNED	---
PREPARED	RRD
REVIEWED	HF
APPROVED	---

PROJECT NO.	CONTROL	REV.	FIGURE
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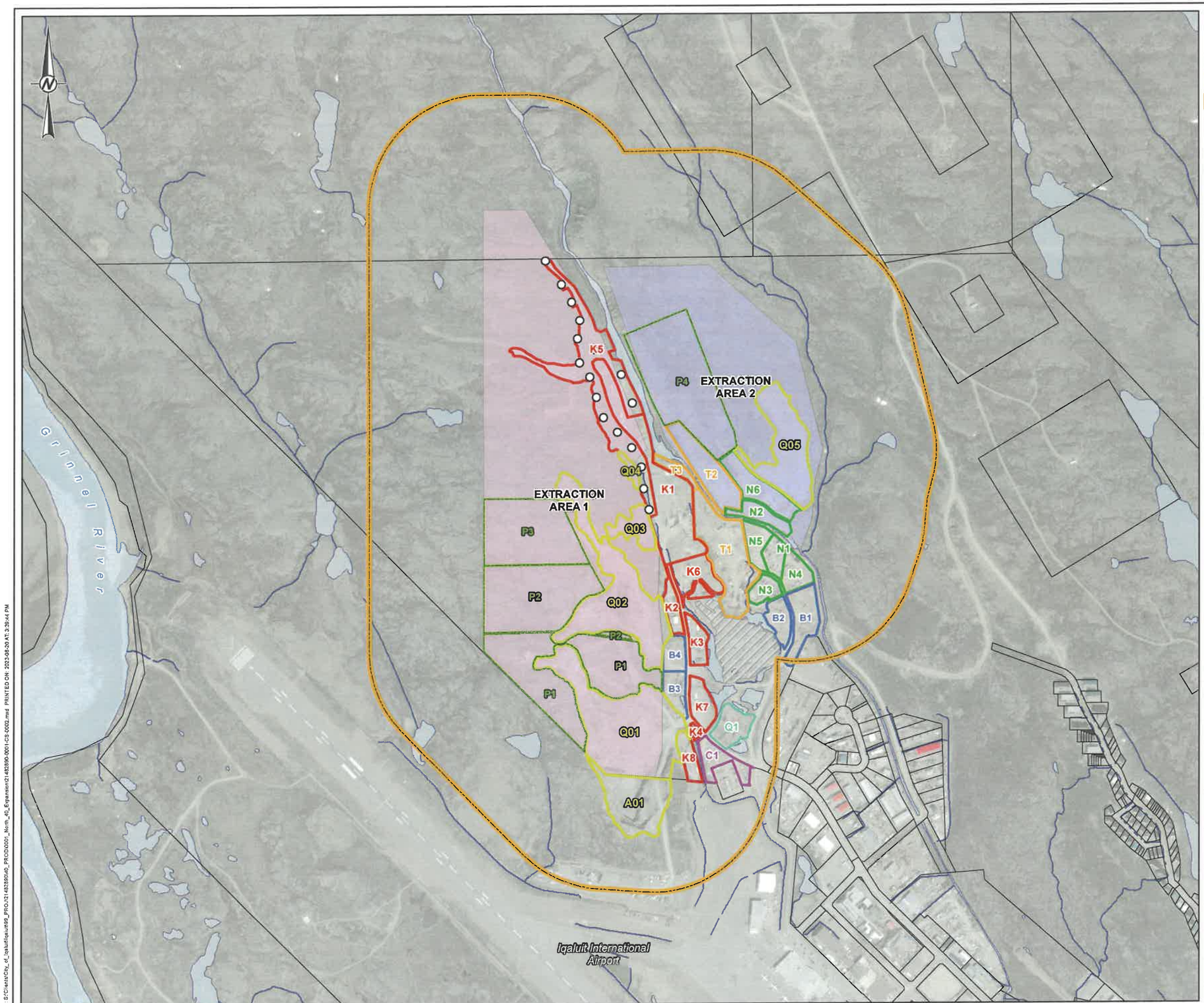

LEGEND

- EXPLOSIVE SHELTER LOCATION
- APPROXIMATE FEDERAL LANDFILL FOOTPRINT
- EXISTING EXTRACTION AREAS
- 300m OFFSET FROM EXTRACTION AREAS
- EXTRACTION AREA 1
- EXTRACTION AREA 2
- PROPOSED EXTRACTION AREAS
- WATERBODY

CONTRACTOR OCCUPANCY AREAS

- BAFFIN BUILDING SYSTEMS
- BAFFIN CENTRAL CONSTRUCTION
- KUDLIK
- NUNAVUT EXCAVATING
- QIKIQTANI INDUSTRY LIMITED
- TOWER ARCTIC

0 90 180 360

1:10,000 METRES

NOTE(S)
1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE(S)
1. CONTAINS INFORMATION FROM GOVERNMENT OF NUNAVUT (COMMUNITY AND GOVERNMENT SERVICES)
2. COORDINATE SYSTEM: NAD 1983 UTM ZONE 19N

CLIENT
MHBC - PLANNING URBAN DESIGN AND LANDSCAPE ARCHITECTURE

PROJECT
NORTH 40 QUARRY EXPANSION
IQALUIT, NUNAVUT

TITLE
EXISTING AND PROPOSED QUARRIES AND CONTRACTOR OCCUPANCIES

CONSULTANT

wsp

YYYY-MM-DD	2023-06-20
DESIGNED	---
PREPARED	RRD
REVIEWED	HF
APPROVED	---

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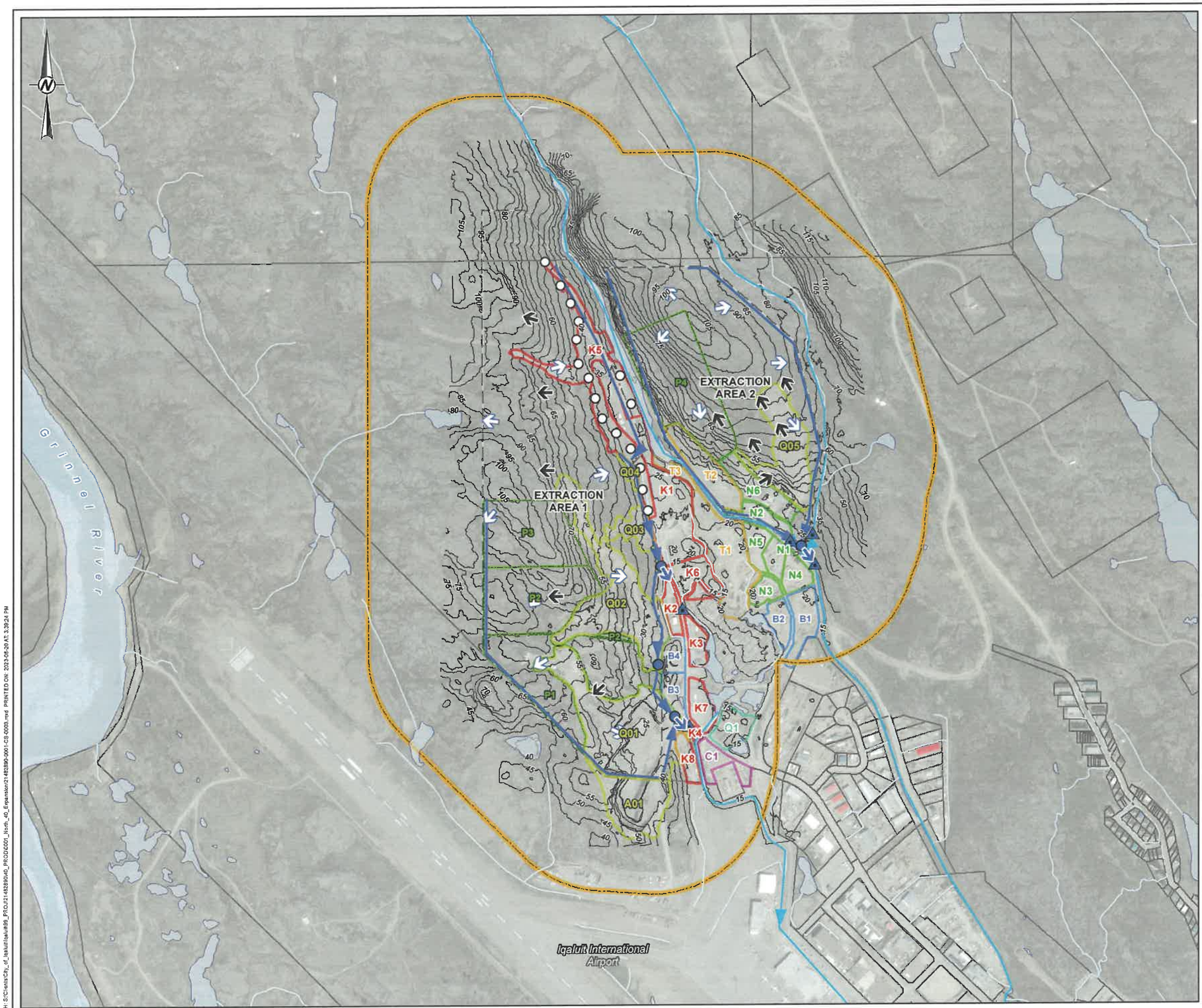

LEGEND

- GENERAL DIRECTION OF EXCAVATION
- SURFACE WATER FLOW DIRECTION
- EXPLOSIVE SHELTER LOCATION
- CLEAR WATER OUTFLOW
- PROPOSED FLOW MONITORING STATION
- PONDS/SUMPS
- PROPOSED EXTRACTION AREA COLLECTION DITCH
- EXISTING STREAM
- LOT LINES
- APPROXIMATE FEDERAL LANDFILL FOOTPRINT
- EXISTING EXTRACTION AREAS
- 300m OFFSET FROM EXTRACTION
- EXTRACTION AREA BOUNDARY
- PROPOSED EXTRACTION

CONTRACTOR OCCUPANCY AREAS

- BAFFIN BUILDING SYSTEMS
- BAFFIN CENTRAL CONSTRUCTION
- KUDLIK
- NUNAVUT EXCAVATING
- QIKIQTANI INDUSTRY LIMITED
- TOWER ARCTIC

0 90 180 360

1:10,000 METRES

NOTE(S)

1. ALL LOCATIONS ARE APPROXIMATE
2. THE PROPOSED EXTRACTION AREA COLLECTION DITCHES MAY BE CONSTRUCTED IN PHASES (EXISTING, PROPOSED AND FULL OPERATIONAL) AS QUARRYING ACTIVITIES DEVELOP.
3. THE NORTH END OF THE PROPOSED WEST COLLECTION DITCH OF EXTRACTION AREA 1 TO BE REVISED BASED ON POTENTIAL FUTURE QUARRYING ACTIVITIES.

REFERENCE(S)

1. CONTAINS INFORMATION LICENSEDFROM GOVERNMENT OF NUNAVUT (COMMUNITY AND GOVERNMENT SERVICES)
2. COORDINATE SYSTEM: NAD 1983 UTM ZONE 19N

CLIENT
MHBC - PLANNING URBAN DESIGN AND LANDSCAPE ARCHITECTURE

PROJECT
NORTH 40 QUARRY EXPANSION
IQALUIT, NUNAVUT

TITLE
PROPOSED WATER MANAGEMENT PLAN

CONSULTANT

wsp

YYYY-MM-DD	2023-06-20
DESIGNED	---
PREPARED	RRD
REVIEWED	HF
APPROVED	---

PROJECT NO.	CONTROL	REV.	FIGURE
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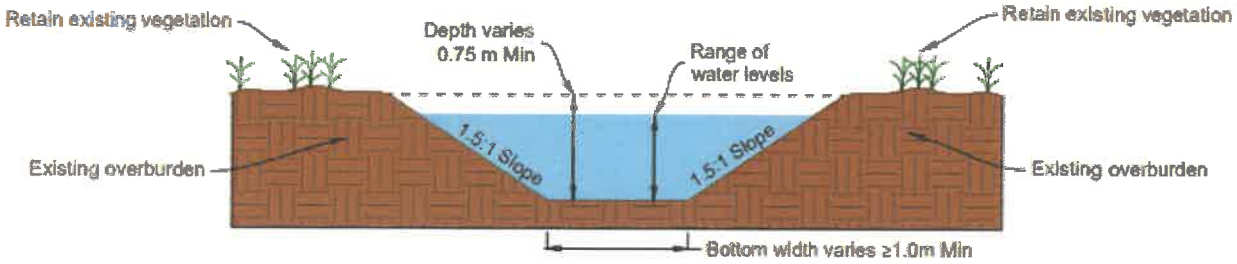
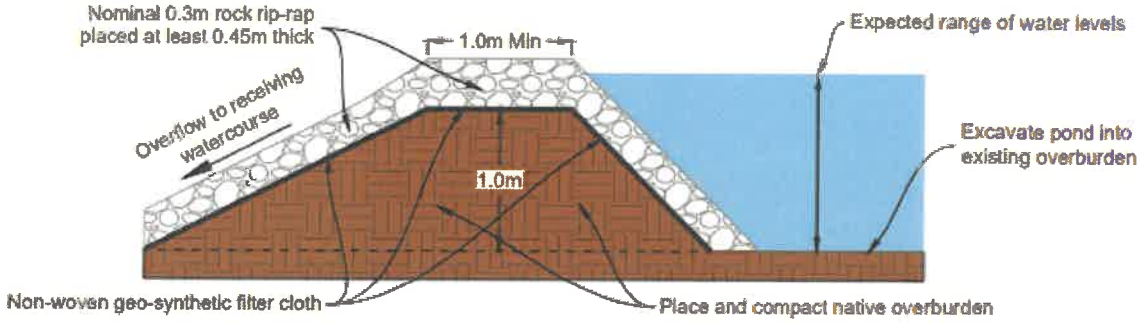
APPENDIX A

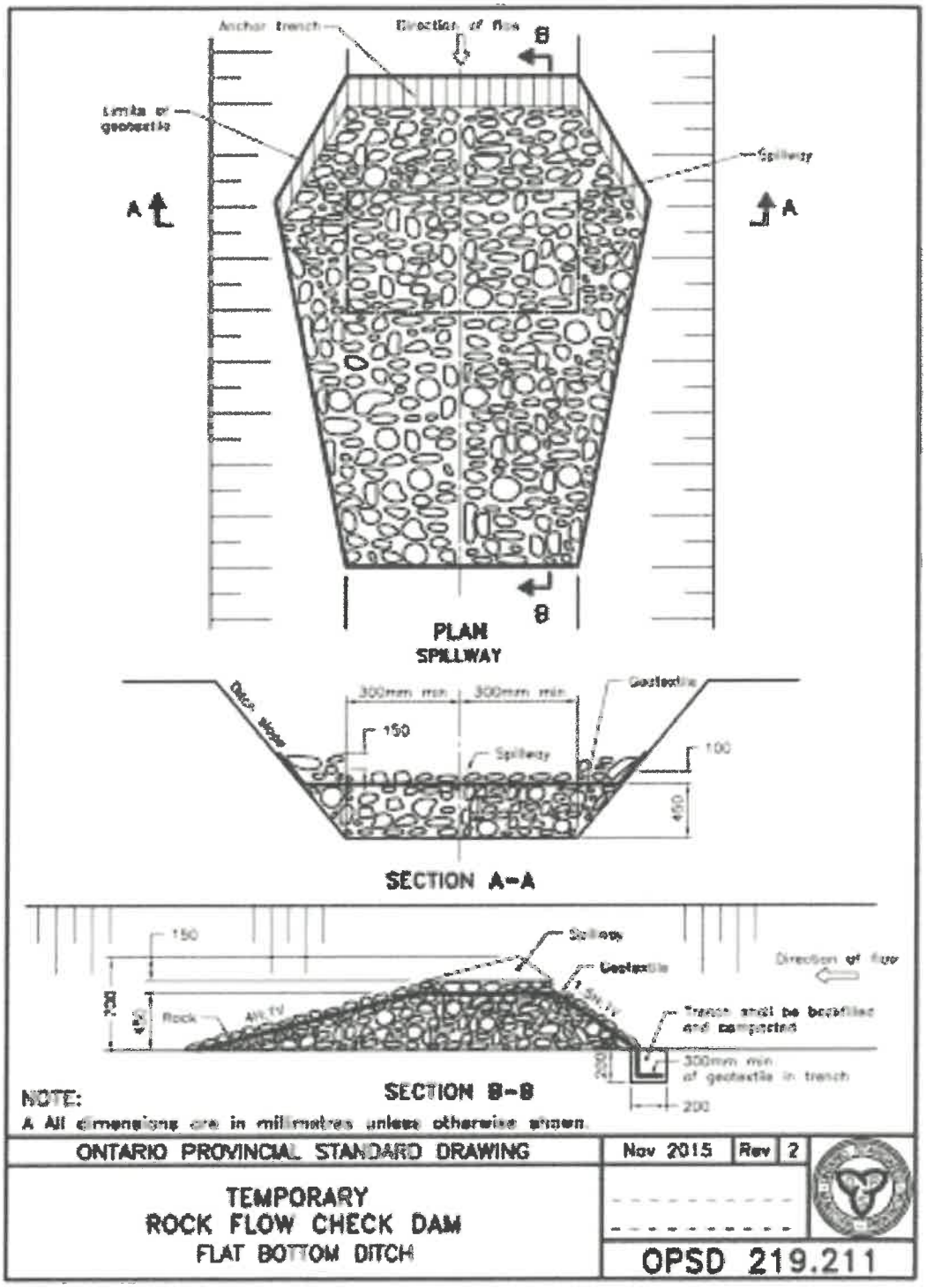
Schematic Details, Site Photos and Water Balance Calculations

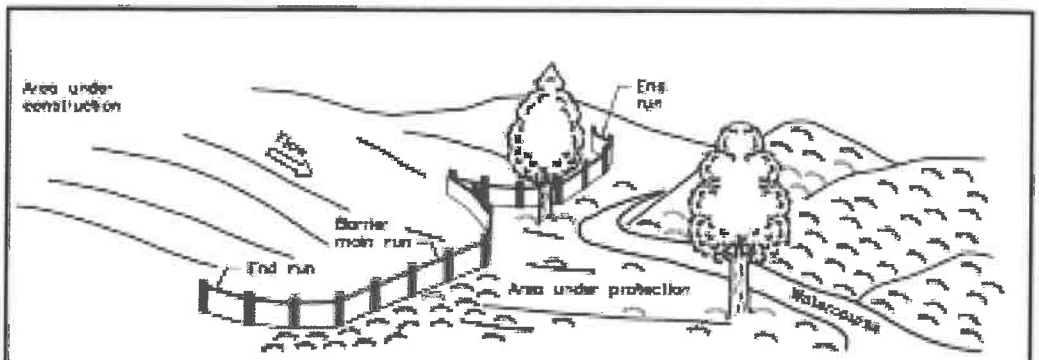


Typical Ditch Cross Section Detail - NTS

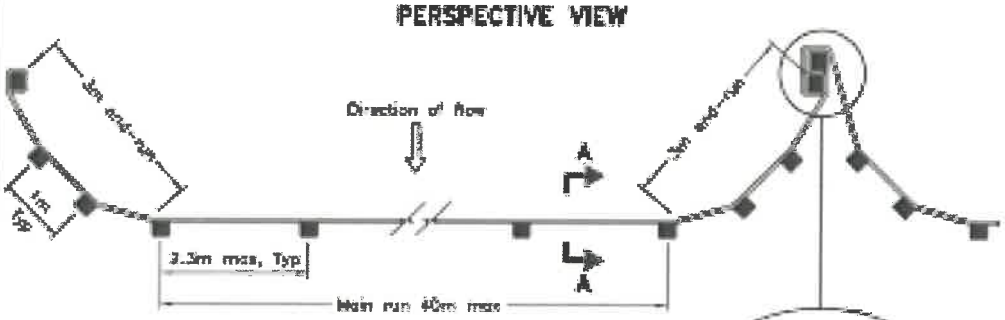


Stormwater Management Outfall Detail - NTS

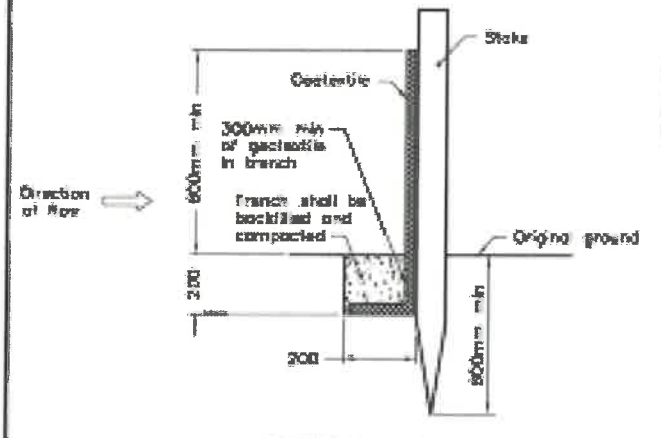

Anchor trench
Direction of flow
B
Limits of geotextile
Spillway
A
A
B
PLAN
SPILLWAY
300mm min
300mm min
Geotextile
150
Spillway
100
450
SECTION A-A
150
Spillway
Geotextile
Direction of flow
Rock
Trench shall be backfilled and compacted
300mm min of geotextile in trench
200
SECTION B-B
NOTE:
A All dimensions are in millimetres unless otherwise shown.
ONTARIO PROVINCIAL STANDARD DRAWING
Nov 2015
Rev 2
TEMPORARY
ROCK FLOW CHECK DAM
FLAT BOTTOM DITCH
OPSD 219.211



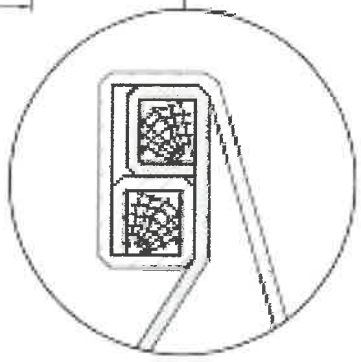
PERSPECTIVE VIEW



PLAN



SECTION A–A



JOINT DETAIL

NOTE:
A All dimensions are in millimetres unless otherwise shown.

ONTARIO PROVINCIAL STANDARD DRAWING	Nov 2015	Rev 2	
LIGHT–DUTY SILT FENCE BARRIER			OPSD 219.110

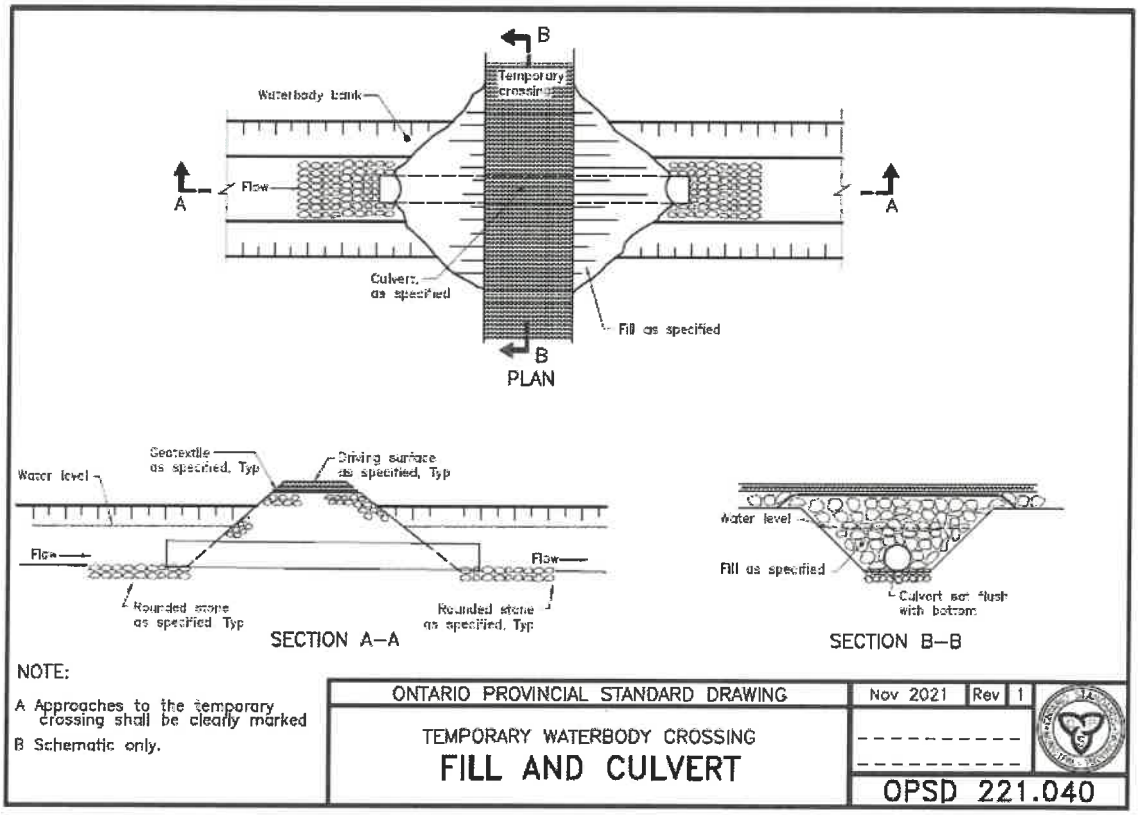

B
Temporary crossing
Waterbody bank
A
Flow
A
Culvert as specified
Fill as specified
B
PLAN
Geotextile as specified, Typ
Driving surface as specified, Typ
Water level
Flow
Flow
Rounded stone as specified Typ
Rounded stone as specified, Typ
SECTION A–A
Water level
Fill as specified
Culvert set flush with bottom
SECTION B–B
NOTE:
A Approaches to the temporary crossing shall be clearly marked
B Schematic only.
ONTARIO PROVINCIAL STANDARD DRAWING
Nov 2021
Rev 1
TEMPORARY WATERBODY CROSSING
FILL AND CULVERT
OPSD 221.040

Photo 1: Looking west at Extraction Area 1 from Extraction Area 2; the federal landfill is seen in the middle surrounded by the small water bodies.

Photo 2: A zoomed-in view of the existing southmost quarry area of Extraction Area 1 shown in Photo 1; its lowest floor elevation of 21.0 masl is indicated.

Photo 3: Looking southeast at Extraction Area 2 from Extraction Area 1; the federal landfill and the contractor occupancy areas are seen in the middle.

Photo 4: Looking upstream along the natural existing watercourse flowing west of Extraction Area 2.

Photo 5: Looking downstream along the natural existing watercourse in Photo 4.

Photo 6: Quarrying in existing extraction area and view of Extraction Area 2.

Photo 7: Culvert outflow into the channelized stream flowing by the airport; vehicle parked at the edge of right bank and aggregate stockpiled on the left.

Photo 8: Existing sump-pump configuration for water used in dust suppression as needed.

Photo 9: Safety fencing around existing quarry areas.

Photo 10: Stockpiled aggregate from existing quarry areas and view of Extraction Area 2.

Photo 11: Sample ingress/egress gate across the road to one of the existing quarry areas.

Photo 12: Sample signage in three languages warning against unauthorized entry to explosives area.

Table A-1
Summary of Results - Land Uses, Surficial Geology, and WHC's

Existing Conditions

Proposed Extraction Areas	Occupancy / Location Areas	Type	WHC	Type of Land Use	Soil Type	Infiltration Factor (%)				Catchment Areas
						Topo	Soils	Cover	Total	(m^2)
Extraction Area 1	K1	Impervious Built-Up Areas	3 mm	Buildings	n/a	0	0	0	0.00	570
		Compacted Operational Zones / Roadways	10 mm	Stripped Area	Sand / Gravel	0.1	0.4	0	0.50	8,355
	K5	Impervious Built-Up Areas	3 mm	Buildings	n/a	0	0	0	0.00	142
		Compacted Operational Zones / Roadways	10 mm	Stripped Area	Sand / Gravel	0.1	0.4	0	0.50	29,916
	Q01	Quarry Extraction Area	10 mm	Quarry (Gravity Draining)	Bedrock	0.15	0	0	0.15	52,233
	Q02									47,152
	Q03									8,190
	Q04									1,969
	P1	Undeveloped Extraction Area (Bedrock)	75 mm	Arctic Tundra over Bedrock	Bedrock	0.15	0	0.1	0.25	61,885
	P2									48,654
	P3									41,269
	Remaining Extraction Area 1									114,930
	Remaining Extraction Area 1	Undeveloped Extraction Area	125 mm	Arctic Tundra over Fine Sandy Loam	Fine Sandy Loam	0.15	0	0.1	0.25	99,503
Extraction Area 2	N2	Compacted Operational Zones / Roadways	10 mm	Stripped Area	Sand / Gravel	0.1	0.4	0	0.50	5,408
	N6	Compacted Operational Zones / Roadways	10 mm	Stripped Area	Sand / Gravel	0.1	0.4	0	0.50	12,184
	T2	Compacted Operational Zones / Roadways	10 mm	Stripped Area	Sand / Gravel	0.1	0.4	0	0.50	15,880
	Q05	Quarry Extraction Area	10 mm	Quarry (Gravity Draining)	Bedrock	0.15	0	0	0.15	29,078
	P4	Undeveloped Extraction Area	125 mm	Arctic Tundra over Fine Sandy Loam	Fine Sandy Loam	0.1	0	0.1	0.20	56,829
	Remaining Extraction Area 2									128,745
									Total	762,881

Operational (Full Extraction) Conditions

Proposed Extraction Areas	Occupancy / Location Areas	Type	WHC	Type of Land Use	Soil Type	Infiltration Factor (%)				Catchment Areas
						Topo	Soils	Cover	Total	(m^2)
Extraction Area 1	K1	Quarry Extraction Area	10 mm	Quarry (Gravity Draining)	Bedrock	0.15	0	0	0.15	8,925
	K5									30,058
	Q01									52,233
	Q02									47,152
	Q03									8,190
	Q04									1,969
	P1									61,885
	P2									48,654
	P3									41,269
	Remaining Extraction Area 1									214,433
Extraction Area 2	N2									5,408
	N6									12,184
	T2									15,880
	Q05									29,078
	P4									56,829
	Remaining Extraction Area 2									128,745
									Total	762,881

Entered by: MR
Checked by: KMM

Table A-1
Summary of Results - Land Uses, Surficial Geology, and WHC's

Rehabilitated Conditions

Proposed Extraction Areas	Occupancy / Location Areas	Type	WHC	Type of Land Use	Soil Type	Infiltration Factor (%)				Catchment Areas
						Topo	Soils	Cover	Total	(m^2)
Extraction Area 1	K1	Decommissioned Quarry	10 mm	Quarry (Gravity Draining)	Bedrock	0.2	0	0	0.20	8,935
	K5									30,058
	Q01									52,233
	Q02									47,152
	Q03									8,190
	Q04									1,969
	P1									61,885
	P2									48,654
	P3									41,369
	Remaining Extraction Area 1									188,695
	Remaining Extraction Area 1	SWM Pond	Precip. - PET	Pond	n/a	0	0	0	0.00	25,738
Extraction Area 2	N2	Decommissioned Quarry	10 mm	Quarry (Gravity Draining)	Bedrock	0.2	0	0	0.20	5,408
	N6									12,184
	T2									15,880
	Q05									29,078
	P4									56,829
	Remaining Extraction Area 2									116,339
	Remaining Extraction Area 2	SWM Pond	Precip. - PET	Pond	n/a	0	0	0	0.00	12,406
									Total	762,891

Note:
WHC - Water Holding Capacity
The infiltration factor is estimated by summing a factor for topography, soils and cover (MOE Stormwater Management Planning and Design Manual, 2003-Table 3.1)

Entered by: MR
Checked by: KMM

Table A-2
Summary of Results - Proposed Extraction Area Water Balance

Existing Condition - Estimated Annual Average Water Balance												
Proposed Extraction Area	Land Use	Area	Precipitation		ET		Surplus		Infiltration		Runoff	
		(m^2)	(mm/a)	(m^3/a)	(mm/a)	(m^3/a)	(mm/a)	(m^3/a)	(mm/a)	(m^3/a)	(mm/a)	(m^3/a)
Extraction Area 1	Impervious Built-Up Areas	712	402	290	242	170	158	115	0	0.0	158	115
	Compacted Operational Zones / Roadways	38,271	402	15,390	248	9,490	151	5,780	76	2,890	76	2,890
	Quarry Extraction Area	109,544	402	44,040	248	27,170	151	16,540	23	2,480	128	14,060
	Undeveloped Extraction Area (Bedrock)	266,738	402	107,230	310	82,690	91	24,275	23	6,070	68	18,205
	Undeveloped Extraction Area	99,503	402	40,000	337	33,530	65	6,470	16	1,620	49	4,850
Extraction Area 2	Compacted Operational Zones / Roadways	33,471	402	13,460	248	8,300	151	5,050	76	2,525	76	2,525
	Quarry Extraction Area	29,078	402	11,690	248	7,210	151	4,390	23	660	128	3,730
	Undeveloped Extraction Area	185,574	402	74,600	337	62,540	65	12,060	13	2,410	52	9,650
TOTAL - Extraction Area 1		**514,768**	**402**	**206,950**	**297**	**153,050**	**103**	**53,180**	**25**	**13,060**	**78**	**40,120**
TOTAL - Extraction Area 2		**248,123**	**402**	**99,750**	**315**	**78,050**	**87**	**21,500**	**23**	**5,595**	**64**	**15,905**
TOTAL		**762,891**	**402**	**306,700**	**303**	**231,100**	**98**	**74,680**	**24**	**18,655**	**73**	**56,025**

Operational (Full Extraction) Condition - Estimated Average Annual Water Balance												
Proposed Extraction Area	Land use	Area	Precipitation		Evapotranspiration		Surplus		Infiltration		Runoff	
		(m^2)	(mm/a)	(m^3/a)	(mm/a)	(m^3/a)	(mm/a)	(m^3/a)	(mm/a)	(m^3/a)	(mm/a)	(m^3/a)
Extraction Area 1	Quarry Extraction Area	514,768	402	206940	248	127660	151	77730	23	11660	128.35	66070
Extraction Area 2	Quarry Extraction Area	248,123	402	99,750	248	61,530	151	37,470	23	5,620	128	31,850
TOTAL		**762,891**	**402**	**306,690**	**248**	**189,190**	**151**	**115,200**	**23**	**17,280**	**128**	**97,920**

Rehabilitated Condition - Estimated Average Annual Water Balance												
Proposed Extraction Area	Land use	Area	Precipitation		Evapotranspiration		Surplus		Infiltration		Runoff	
		(m^2)	(mm/a)	(m^3/a)	(mm/a)	(m^3/a)	(mm/a)	(m^3/a)	(mm/a)	(m^3/a)	(mm/a)	(m^3/a)
Extraction Area 1	Decommissioned Quarry	489,030	402	196590	248	121280	151	73845	30	14770	121	59075
	SWM Pond	25,738	402	10350	376	9680	26	670	0	0	26	670
Extraction Area 2	Decommissioned Quarry	235,717	402	94,760	248	58460	151	35595	30	7120	121	28475
	SWM Pond	12,406	402	4,990	376	4660	26	325	0	0	26	325
TOTAL - Extraction Area 1		**514,768**	**402**	**206,940**	**254**	**130,960**	**145**	**74,515**	**29**	**14,770**	**116**	**59,745**
TOTAL - Extraction Area 2		**248,123**	**402**	**99,750**	**254**	**63,120**	**145**	**35,920**	**29**	**7,120**	**116**	**28,800**
TOTAL		**762,891**	**402**	**306,690**	**254**	**194,080**	**145**	**110,435**	**29**	**21,890**	**116**	**88,545**

Appendix B

North 40 Quarry Blasting Guidelines

TECHNICAL MEMORANDUM

DATE June 23, 2023 **Project No.** 21482890

TO Amarjit Sandhu
MHBC Planning, Urban Design & Landscape Architecture

FROM Daniel Corkery **EMAIL daniel.corkery@wsp.com**

IQALUIT NORTH 40 QUARRY - BLASTING GUIDELINES

MHBC is developing an operational plan for the proposed North 40 quarry near Iqaluit (the Quarry), Nunavut. MHBC has retained WSP Canada Inc. (formerly Golder Associates Ltd), to provide blasting guidelines that are required for the operational plan from the perspective of effective extraction, as well as worker and public health and safety and environmental considerations. This technical memorandum provides the blasting guidelines for the operational plan.

1.0 WORKER AND PUBLIC HEALTH AND SAFETY

1.1 Explosives Regulations

The Quarry operators will require an Explosives Authorization from Natural Resources Canada Worker's Safety and Compensation Commission to possess, transport and use explosives. In addition to the Explosives Authorization, the following regulations and guidelines will need to be followed to reduce risk associated with transporting, handling, and storing explosives and reduce adverse impacts due to blasting:

- Transportation of Dangerous Goods Act;
- Canada Explosives Act;
- National Standards of Canada CAN/BNQ 2910-510/2015 Explosive Quantity Distances;
- National Standards of Canada CAN/BNQ 2910-500/2015 (R 2022) Explosive – Magazines for Industrial Explosives;
- Nunavut - Consolidation of Explosives Use Act (2012);
- NT *Mine Health and Safety Act (2015)*;
- Natural Resources Canada – Explosives Regulations (SOR 2013-211);
- Guidelines for Bulk Explosives Facilities – Minimum Requirements (NRCan February 2014);
- Guidelines for the Use of Explosives in or Near Canadian Fisheries Waters (Wright and Hopky 1998); and

- Canadian Environment Protection Act – Environmental Emergency Regulations (E2) Regulations.

The Nunavut Explosives Use Act has extensive guidelines for the protection of site workers. However, there are no specific regulations for the protection of the public (or site workers) against flyrock, vibration, or overpressure.

According to the Nunavut Explosives Use Act, no person shall explode or cause to be exploded any explosives in unless he or she is the holder of a permit issued under the Act. Additionally, it is recommended that the blaster in charge shall provide proof of experience and competency for quarry blasting.

1.2 Flyrock

Flyrock causes the most injuries and damage in reported blasting incidents at surface mines and quarries. It can be considered as the unplanned ejection of rock fragments through the air or along the ground beyond the blast zone. Flyrock occurs when excessive explosives are used or where the blasthole is poorly confined and high-pressure gas propels broken rock fragments. Flyrock generally results from a mismatch between the available energy and the work required to break the rock.

The Blaster who is responsible for the blast will assess the potential for flyrock in every blast and estimate the required blast radius where equipment needs to be removed and where guards must not be within. The following requirements relate to the ejection of flyrock from blasts on site:

- Flyrock is not to leave the site. Blasts and tie-in sequences will need to be designed to prevent flyrock from leaving the site.
- Prior to each blast, the area between the blast and the site boundary must be cleared of site personnel and the public.

1.3 Blast Pattern Access, Clearance, and Communication

The perimeter of the loaded pattern will be clearly marked so that unauthorized equipment and personnel are prohibited from entering the blasting area. Only authorized blasting equipment (i.e., blaster vehicles, explosive trucks or the stemming loader) may come within 8 m of a loaded blast hole. Should any other equipment require access, a risk assessment and a signed authorization from the Quarry Contractor will be required. Once blast hole tie-in has commenced, no vehicles will be allowed on the blast pattern.

When drill servicing is required, the drills will be moved off the blast pattern. Similarly, welding, cutting, burning, and smoking will not be permitted within 20 m of a loaded blast hole, unless a risk assessment is completed, and a signed authorization is obtained from the Quarry. No drilling shall be allowed within 5 m of a misfired hole, a cut-off hole, or a hole containing explosives. Any re-drilling associated with misfired holes will be conducted according to the NT *Mine Health and Safety Act* and Regulations Clauses 14.56 4,5.

A standard operating procedure for blast clearance will be developed and all relevant Quarry personnel will be trained in blast clearance requirements. A minimum 500 m blast radius exclusion zone will be used for personnel clearance. A surveyor will mark blast guard locations in the field and blast guards will be put in place to prevent access. The blast area will then be checked to determine that no personnel or equipment is within the blast area prior to initiating the blast. Blast guards will be trained in using radio communication during blast times and in preventing access into the blast radius exclusion zone. Radio silence will be announced prior to the blast countdown and the radio channel will be reserved for the blaster in charge and to signal an emergency.

At five minutes prior to the planned initiation time, a blast warning siren will be sounded for a duration of one minute. One minute before planned initiation time, a warning siren will be sounded. The blaster will only fire the blast when given a direct verbal order to do so by the drill and blast sub-contractor's supervisor. Before firing a shot, the blaster must verify the immediate area is clear of personnel, public, and aircrafts. Radio silence will be maintained except to signal an emergency or to alert the blaster to halt the blasting process.

Following the blast, the blast supervisor and blaster will inspect the fired shot for indications of any problems such as misfires or cut-offs. Once the area is cleared of hazards such as blast fumes, misfires or explosives, the blaster will announce on the quarry radio channel that the blast guards can be released from their position and workers may return to the area. At that time, the "all-clear" warning siren will be sounded.

In the event of poor visibility (e.g., ice fog or semi white outs), the drill pattern will be well-lit and clearly demarcated. Explosive vehicles will be parked in a safe position or used in well-lit areas. Where there is a potential of lightning storms, the blast supervisor shall have a lightning detector to provide an early warning of an approaching storm. In the event of lightning storms, loaded blast patterns will be evacuated to a minimum 500 m distance from loaded holes and all personnel will be required to relocate outside of the 500 m blast radius exclusion zone. Prior to blasting, wind direction will be monitored, and the blast supervisor will determine if the blast radius exclusion zone needs to be extended to cover a greater area downwind of the blast.

1.4 Storage, Handling, Transportation and Disposal Controls

Careful handling, storage, and loading of material will be undertaken to prevent spillage of explosives, and proper clean-up of any material will be undertaken prior to blast. All blasting agents, packaged explosives and accessories will be supplied by a licensed explosive contractor and transported to the Quarry. The drill and blast Contractor will arrange to have the explosives transported to the Quarry from a licensed on-site explosive magazine. The transportation of explosives and explosive accessories to and around Quarry will follow the regulations and guidelines outlined in the following documents:

- *Transportation of Dangerous Goods Act*
- Canada *Explosives Act*NT *Mine Health and Safety Act* and Regulations
- *Natural Resources Canada – Explosives Regulations (SOR 2013-211)*

The explosive Contractor will be licensed and responsible for the transportation of explosive materials. The vehicles will be in sound mechanical condition and with appropriate equipment (e.g., flashers, buggy whips, signage, and fire extinguishers), as required. Loaded vehicles will not be left unattended. Authorized personnel will be responsible for the security of the explosives under their control. The driver will be certified with Transportation of Dangerous Goods (TDG). Proper TDG documentation will always be prepared and with the vehicle. Loading, unloading and on-site transportation will follow the Drill and Blast Contractor operating procedure.

Currently, there are a number of explosive magazines on the site. Explosives intended for storage at site must be stored in an approved location and in licensed magazines in accordance with the regulations and guidelines outlined in the following documents and any other applicable regulations:

- Canada *Explosives Act*

- Natural Resources Canada – Explosives Regulations (SOR 2013-211)
- National Standards of Canada CAN/BNQ 2910-510/2015 Explosive Quantity Distances
- *National Standards of Canada CAN/BNQ 2910-500/2015 (R 2022) Explosive – Magazines for Industrial Explosives*

Any unused explosives will be returned to the supplier/blast contractor's appropriate site magazine. The amount of explosives brought to and returned from the blast site will be accounted for by the drill blast contractor.

When handling and transporting explosives, care will be taken to avoid spillage. Protecting water-soluble products from the elements is particularly important. This is primarily an environmental concern to avoid runoff of the soluble product, which could adversely affect water quality and aquatic life.

Should there be deteriorated or damaged explosives which require disposal, the drill and blast contractor will consult with the explosive supplier to determine if the explosives can be returned or if they must be destroyed on the Quarry site. Preference will be to send the deteriorated or damaged explosives back to the supplier, however if this is not possible, safe, or practical, they will be disposed of in a production blast.

1.5 Blast Schedule and Notifications

1.5.1 Blast Schedule

To limit the disturbance to the local communities, blasting will take place during daytime hours and noise will be managed in accordance with the Iqaluit by-laws. Further to this, blasting times will be evaluated on an ongoing basis as needed to consider culturally significant activities that could be impacted by blasting air overpressure and ground vibrations.

Blasting should be scheduled so that it occurs routinely during a specific period of time each day where possible. Drilling and blasting should be prohibited on Sundays and all Statutory holidays.

1.5.2 Notifications

The proposed Expansion Area 1 is located within 370 m of the runway for the Iqaluit Airport (YFB) but is not directly under the runway landing approach or take-off departure paths. The Quarry Contractor will contact NAV Canada / NOTAM / air traffic authority, as instructed by them, to obtain authorization to blast. Discussions with NAV Canada would provide guidance regarding when they should contact them and the appropriate contact for the notification.

1.5.3 Public Service Announcements

The current protocol is to provide Public Service Announcement (PSA) regarding an upcoming blast. A part of the protocol entails Contractors provide the City details of the dates and times of the planned blast, and the City issues a PSA with the blast details on their web site. In line with the existing protocol, the Quarry Contractor will provide the City details of all upcoming blast details sufficiently ahead of time for the issuance of the PSA.

2.0 ENVIRONMENTAL CONSIDERATIONS

2.1 Vibration Guidelines and Impact on Sensitive Infrastructure

As indicated in Section 1.1, there are no specific regulations for the protection of the public (or Quarry workers) against vibration, or air overpressure. Based on a review of regulatory limits for jurisdictions across Canada, the following guideline limits for ground vibration and air overpressure (noise) levels at the nearest sensitive receptor to the Quarry property are proposed:

- Ground vibrations - 12.5 mm/s; and
- Air overpressure - 128 dBL.

It is understood the no residential structures occur within 500 m of the proposed quarry blasting areas. Although there are no Nunavut regulations regarding quarry blast monitoring, other Canadian jurisdictions (e.g., Ontario) consider any residence within 500 m as a sensitive receptor and monitoring would be necessary. While there are no residential structures within 500 m of the proposed quarry, ground vibrations and air overpressure levels shall be monitored between the blast and the closest residence to the blasts to ensure compliance with the above limits. For example, the ground vibrations / air overpressure instrument may be installed on public land between the blast and the nearest residence.

2.2 Fisheries Habitat

The detonation of explosives in or near water can produce compressive shock waves which initiate damage to the internal organs of fish in close proximity and may result in the death of the fish. Ground vibrations induced at active spawning beds may adversely impact incubating eggs. In an effort to mitigate potential impacts on fish populations, Fisheries and Oceans Canada (DFO) developed the Guidelines for the Use of Explosives in or Near Canadian Fisheries Waters (Wright and Hopky 1998). Subsequent work by Cott and Hanna (2005), also of the DFO, suggested that a more appropriate limit for fisheries habitat in northern waters (such as in the area near the Quarry) is 50 kPa. As such, the DFO requires a 50 kPa limit for the fisheries habitat in northern waters. Thus, the limits are as follows:

- Maximum water overpressure – 50 kPa; and
- Maximum PPV at active spawning beds – 13 mm/s.

The only aquatic features in the area appear to be the central creek and some isolated ponds. Currently, it is not clear whether these waterways are inhabited by fish and/or contain spawning beds for any fish species in the area. Until it becomes clear that the local waterways are not fisheries habitat, the quarry blasts shall be designed to mitigate the potential of exceeding either of the above limits.

2.3 Nitrates from Explosives

Quarries are subject to regulations limiting ammonia, nitrate and nitrite levels in mine effluents released into the environment. Discharge limits are typically defined in consultation with the regulators based on legislated water quality guidelines where they exist.

Three of the most common forms of explosives used today for quarry blasts are Ammonium Nitrate and Fuel Oil (ANFO) and pumped bulk emulsion. The DFO suggests the use of free-flowing ANFO in or near watercourses should be avoided (Wright and Hopky 1998). ANFO has poor water resistance, while most emulsions have

excellent water resistance. The blasting industry prefers emulsion or emulsion blend explosives in wet (or partially wet) environments mostly because of its water resistance. Currently, quarries in the Iqaluit area use ANFO and this has not been problematic as the volume of flowing water in blastholes is typically low. ANFO is also preferred as it is easily movable by plane into other Nunavut hamlets, which is important to local quarries.

If ANFO is to be used, holes should have water pumped before the loading of ANFO commences. If keeping the blastholes dry proves to be difficult, wet holes should be loaded with packaged emulsion explosive or water resistant ANFO to the water level with the remaining column loaded with ANFO. Alternatively, holes can implement polyethylene liners in wet holes. However, the use of polyethylene liners is typically challenging in very cold temperatures as the liners become stiff and brittle.

3.0 EFFECTIVE EXTRACTION

In addition to designing blasts that minimize potential damage to the fisheries habitat and nearby sensitive infrastructure, the design must also ensure that the resulting blasted rock has a size distribution that complies with the Quarry's requirements and downstream processes such as crushing. It is assumed the target fragmentation size distribution required by the Quarry includes a preliminary fragmentation size requirement, which will inform the initial blast design. It is understood that the blast designs will need to be adjusted based on the results of the initial blasts.

4.0 CLOSURE

We trust that the information and discussion contained within this technical memorandum is sufficient for your current requirements. If you require addition, please contact the undersigned.

WSP Canada Inc.

Daniel Corkery
Principal Blasting Consultant

Sean McFarland
Principal, Senior Hydrogeologist

DC/SM/jl

Appendix C

Government of Nunavut- Dust and Spills BMP

NT-NU SPILL REPORT

OIL, GASOLINE, CHEMICALS AND OTHER HAZARDOUS MATERIALS

NT-NU 24-HOUR SPILL REPORT LINE
TEL: (867) 920-8130
FAX: (867) 873-6924
EMAIL: spills@gov.nt.ca

REPORT LINE USE ONLY

A	REPORT DATE: MONTH – DAY – YEAR	REPORT TIME	☐ ORIGINAL SPILL REPORT, OR ☐ UPDATE # _____ TO THE ORIGINAL SPILL REPORT	REPORT NUMBER ____-_____
B	OCCURRENCE DATE: MONTH – DAY – YEAR	OCCURRENCE TIME		

C	LAND USE PERMIT NUMBER (IF APPLICABLE)	WATER LICENCE NUMBER (IF APPLICABLE)
D	GEOGRAPHIC PLACE NAME OR DISTANCE AND DIRECTION FROM NAMED LOCATION	REGION ☐ NWT ☐ NUNAVUT ☐ ADJACENT JURISDICTION OR OCEAN
E	LATITUDE DEGREES MINUTES SECONDS	LONGITUDE DEGREES MINUTES SECONDS

F	RESPONSIBLE PARTY OR VESSEL NAME	RESPONSIBLE PARTY ADDRESS OR OFFICE LOCATION	
G	ANY CONTRACTOR INVOLVED	CONTRACTOR ADDRESS OR OFFICE LOCATION	
H	PRODUCT SPILLED	QUANTITY IN LITRES, KILOGRAMS OR CUBIC METRES	U.N. NUMBER
	SECOND PRODUCT SPILLED (IF APPLICABLE)	QUANTITY IN LITRES, KILOGRAMS OR CUBIC METRES	U.N. NUMBER
I	SPILL SOURCE	SPILL CAUSE	AREA OF CONTAMINATION IN SQUARE METRES
J	FACTORS AFFECTING SPILL OR RECOVERY	DESCRIBE ANY ASSISTANCE REQUIRED	HAZARDS TO PERSONS, PROPERTY OR ENVIRONMENT
K	ADDITIONAL INFORMATION, COMMENTS, ACTIONS PROPOSED OR TAKEN TO CONTAIN, RECOVER OR DISPOSE OF SPILLED PRODUCT AND CONTAMINATED MATERIALS		

L	REPORTED TO SPILL LINE BY	POSITION	EMPLOYER	LOCATION CALLING FROM	TELEPHONE
M	ANY ALTERNATE CONTACT	POSITION	EMPLOYER	ALTERNATE CONTACT LOCATION	ALTERNATE TELEPHONE

REPORT LINE USE ONLY

N	RECEIVED AT SPILL LINE BY	POSITION STATION OPERATOR	EMPLOYER	LOCATION CALLED YELLOWKNIFE, NT	REPORT LINE NUMBER (867) 920-8130

LEAD AGENCY ☐ EC ☐ CCG ☐ GNWT ☐ GN ☐ ILA ☐ INAC ☐ NEB ☐ TC | SIGNIFICANCE ☐ MINOR ☐ MAJOR ☐ UNKNOWN | FILE STATUS ☐ OPEN ☐ CLOSED

AGENCY	CONTACT NAME	CONTACT TIME	REMARKS
LEAD AGENCY			
FIRST SUPPORT AGENCY			
SECOND SUPPORT AGENCY			
THIRD SUPPORT AGENCY			

CONTINGENCY PLANNING AND SPILL REPORTING IN NUNAVUT

A Guide to the New Regulations

CONTINGENCY PLANNING

The *Spill Contingency Planning and Reporting Regulations* for Nunavut include the requirement for a contingency plan to be prepared and filed for facilities where petroleum, chemicals and other contaminants are stored. This guide has been developed to assist individuals or companies in preparing a contingency plan. They explain the requirements under the regulations, as well as suggesting supplementary information which may enhance any plan.

To assist you in using this guide it is important to note two things. First, as with any legislation, it is important to read the regulations in respect of the *Environmental Protection Act* (EPA). If a definition is not in the regulations, refer to the act. Second, the act and regulations will, by policy, be enforced on Commissioner's Land by Government of Nunavut employees familiar with the legislation. There is no intention to duplicate the requirements of other regulatory agencies.

What is a contingency plan?

A contingency plan, also called an emergency response plan or a spill response plan, is a set of procedures to be followed to minimize the effects of an abnormal event, such as a spill. It is important to note that the plan is not something you read after the fact. It serves as a guide or reminder of the steps to take during your response and identifies personnel and their responsibilities. To be effective, the information in the plan must be material with which you are already familiar. You do not want to be reading your plan for the first time during an emergency.

Why have one?

An emergency, such as a spill, is often a stressful situation. Under such conditions, important steps of response can be overlooked or forgotten. Following a plan helps to ensure all necessary concerns are addressed, i.e. life is protected, injuries are minimized, resources are used effectively, environmental impact is kept to a minimum and essential reporting is completed.

Who is required to file a plan?

Under the *Spill Contingency Planning and Reporting Regulations,* any person storing contaminants in an underground facility with a capacity equal to or greater than 4000 litres or kilograms, or any person storing contaminants in an aboveground storage facility with a capacity equal to or greater than 20,000 litres or kilograms, is required to file a plan. Although these quantities represent the minimum requirements for filing a plan, we recommend anyone who stores any quantity of contaminants prepare a plan.

The Chief Environmental Protection Officer may require a plan be submitted for a facility which does not meet the above requirements or may exempt a person from the requirements. These regulations are not intended to require a person who is already required to submit a contingency plan to another regulatory authority to also submit their plan to the Chief Environmental Protection Officer.

When must a plan be filed?

Owners of existing facilities have one year after the regulations are proclaimed within which to file a plan. Owners of new facilities must file a plan before the facility is used. It is a requirement to review and update the plan annually and to file the changes. The most common types of amendments include telephone numbers, named response personnel, equipment available, contaminants stored and handles, and emergency services available. The Chief Environmental Protection Officer will review all filed plans and amendments and may require changes. This review does not constitute a guarantee that the plan is adequate not provide a defence to liability imposed under the EPA.

Who should prepare the plan?

The best person to prepare the plan is you, the person who will use the plan. Who knows your facility and the surrounding area better than you or your employees? The references at the end of the guidelines include several sources of information which can assist you in developing a simple and effective plan.

What is in the plan?

The regulations require the following information be included in a contingency plan:

"(a) the name and address of the person in charge, management or control;"

> This is the on-site person responsible for managing the facility. When a spill occurs or is likely to occur, Section 5.1 of the *Environmental Protection Act* describes who is responsible for doing what. Included is the person in charge, management or control of the contaminant. It is likely that the person will be initially responsible for clean up activities. This section could also define the scope of the authority and responsibility designated to this person. Should this person have limited authority, the procedure to activate the higher levels of response should be indicated.

"(b) the name and address of the employer if the person described in paragraph (a) where applicable;"

> this is the person or company ultimately responsible for the facility, usually the owner.

"(c) a description of the facility including the location, size and storage capacity;"

> All responders must be familiar with the facility and its' contents. This is particularly important if persons unfamiliar with the facility are to assist in the planning or undertaking of the clean-up. The description could include a map and / or diagrams.

"(d) a description of the type and amount of contaminants normally stored on the site;"

This section would include the chemical name(s) and the volumes or weights of the contaminants. Volumes or weights would be the maximum amount of contaminant that may be on-site at anytime. This information is vital, ensuring safety of on-scene response personnel.

"(e) the steps to be taken to report, contain, clean up and dispose of a contaminant in the case of a spill;"

Reporting is the notification of all parties involved. This can include internal as well as external reporting procedures. A copy of the spill report form can be included. As well, a description of a public reporting procedure used to alert anyone who may be affected by the spill is required.

Clean up is the removal of the contaminant from the environment. You should consider the possible scenarios or spill incidents that occur at your facility including a worst case scenario, and describe how you would address those situations. A detailed description of actual containment and cleanup techniques or methods may or may not be included. Remember this is not a training manual. Your methods should already be familiar to your employees.

Disposal is treatment if the contaminant such that it is no longer a threat to the environment. Contingency plans must contain appropriate disposal procedures for the materials stored at the facility. Plans may include locations of disposal sites approved to accept wastes, means of storage prior to disposal and other approvals required. As the disposal techniques can be complex, the disposal of any contaminated soil or water must be authorized by the regulatory agency investigating the incident. However, the regulator is there to ensure clean up and disposal occurs, not to tell you what to do. Your disposal techniques should already be identified in your plan.

"(f) a site map;"

This map is intended to illustrate the facilities relationship to other areas which may be affected by a spill. The map should be to scale and be large enough to include the location of your facility, nearby buildings or facilities, roads, culverts, catch basins, drainage patterns and any nearby bodies of water which could be impacted by a spill or topographic features which would affect access and response.

"(g) the name, job title and 24 hour telephone number for the persons responsible for activating the contingency plan;"

This ensures the employee discovering the spill can activate a response and provides a 24 hour point of contact for the authority investigating the spill.

"(h) a description of the training provided to employees to respond to a spill;"

A sound training program is necessary when dealing with an emergency situation. The description can include a syllabus or brief outline of any training, whether it be on-the-job or formal courses. Fundamentals should include knowledge and use of any response equipment that may be used as well as knowledge of the hazards from the products that may be encountered. The training should provide for rapid and competent response consistent with company policies and procedures.

"(i) the means by which the contingency plan is activated;"

This section should outline internal company procedures to activate appropriate response equipment and personnel.

"(j) an inventory and the location of response and clean-up equipment available to implement the plan;"

This includes your equipment as well as any to be used by another person responding to the spill on your behalf. It is imperative, for your protection, that written agreements be made with others who will respond to your spills. This is a commitment made by then to act on your behalf. Another company with a response capability will not necessarily respond on anyone's behalf at anytime of the day or night.

"(k) the date the contingency plan was prepared;"

The following types of information, although not required, will enhance the effectiveness of the plan.

A listing of local contractors or clean-up specialists who may be called upon to assist in responding to spills.

A listing if emergency numbers such as fire, ambulance and police. Also include local health emergency numbers.

Material Safety Data Sheets for each product or contaminant stored at your facility.

We also suggest sending a copy of your plan to your local emergency response agency such as the fire department.

Holders of contingency plans should conduct simulation exercises to test the plan's effectiveness. This kind of assessment can be conducted in stages on various parts of the plan or on full-scale. Realism is critical to good assessment. Practice gives people confidence and can go a long way toward ensuring a more successful response in an actual emergency. Exercises should be noted in the plan.

For questions or clarification of the regulations or the guide contact:

Environmental Protection Service
Department of Sustainable Development
P.O. Box 1000, Station 1195
Iqaluit, Nunavut, X0A 0H0
Phone: (867) 975-5900
Fax: (867) 979-5981

Contingency plans are to be submitted to the above address.

SPILL REPORTING

The *Spill Contingency Planning and Reporting Regulations* for Nunavut include the requirement to report spills of contaminants in excess of specifies quantities. The minimum reportable quantities in Schedule B are listed by type of contaminant. For consistency, descriptions of the different types of contaminants comes from the *Transportation of Dangerous Goods Act* (TDG). Contaminants not described in the TDG Act are usually in "Other contaminants". An example is lube oil.

There may be times when the volume of spilled material is close to the reportable quantity or you are not sure if the spilled material is classified as a contaminant. If in doubt as to whether or not a spill should be reported, it is recommended to report the incident.

As noted in clause 11(2) if the regulations, you cannot delay the reporting of a spill because you so not have all of the required information.

Remember, the Act required you to clean up **any** spill and to notify any member of the public who may be affected by the incident, regardless if the spill is reportable or not.

REFERENCES

1. Canadian Standards Association, *Emergency Planning for Industry*. CAN/CSA-Z731-M91, CSA, Rexdale, Ontario, 1991

2. Northwest Territories Water Board, *Guidelines for Contingency Planning.* Yellowknife, NWT, 1987

3. Environmental Protection Service, Department of Resources, Wildlife and Economic Development, Government of Nunavut, *Spill Contaminant and Clean-up Course*. Yellowknife, NWT, 1991

4. Tilden, D.C., and H.E. Westermann, *Guidelines for the Preparation of Hazardous Material Spill Contingency Plans*. Environment Canada, Yellowknife, NWT, 1990

If you would like to be placed on a mailing list to receive guideline amendments or for public consultation on Environmental Protection Service legislation please fill this out and mail or fax to:

Environmental Protection Service
Department of Sustainable Development
P.O. Box 1000, Station 1195
Iqaluit, Nunavut, X0A 0H0
Fax: (867) 979-5981

Users of this guide are encouraged to report any errors, misspellings, etc. contained within, to EPS at the above address

Mailing List for Environmental Protection Service Information

Name: _____

Title: _____

Address: _____

_____

Phone / Fax Number: _____

Environmental Guideline for

Dust Suppression on Unpaved Roads

Department of Environment
Government of Nunavut

GUIDELINE: DUST SUPPRESSION ON UNPAVED ROADS

Original: January 2002
Revised: April 2014

This Guideline has been prepared by the Department of Environment's Environmental Protection Division and approved by the Minister of Environment under the authority of Section 2.2 of the *Environmental Protection Act.*

This Guideline is not an official statement of the law and is provided for guidance only. Its intent is to increase the awareness and understanding of the risks, hazards and best management practices associated with dust suppression on unpaved roads. This Guideline does not replace the need for the owner or person in charge, management or control of dust suppressants to comply with all applicable legislation and to consult with Nunavut's Department of Environment, other regulatory authorities and qualified persons with expertise in the control of dust from unpaved roads.

Copies of this Guideline are available upon request from:

Department of Environment
Government of Nunavut
P.O. Box 1000, Station 1360, Iqaluit, NU, X0A 0H0
Electronic version of the Guideline is available at http://env.gov.nu.ca/programareas/environmentprotection

Cover Photos: Top – Cypher Environmental Ltd.
Bottom – Midwest Industrial Supply Inc.

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Introduction

All unpaved roads and other surfaces will give off dust when driven on. This dust can be a significant source of particulate matter in the atmosphere and have environmental, health and safety impacts. These may include reducing visibility along the road, increasing the risk of vehicle accidents, aggravating symptoms in individuals who suffer from respiratory diseases and impacts to aesthetics. Dust from unpaved roads can also slow the growth of plants up to 150 meters from the road edge by settling on leaves (the shading effect) and reducing photosynthesis.

Loss of fine particles can also lead to road surface damage and exposure the of larger gravel. This gravel can then be scattered by vehicles or washed away, making the road surface rough and unstable. Potholes and areas of washboard may develop which contribute to further road deterioration and travel safety issues, increased road maintenance needs and increased vehicle repair costs.

When used in accordance with manufacturers' instructions, dust suppressants can lower the environmental, health and safety impacts associated with road dust. Numerous products and techniques are available to reduce dust conditions and preserve road surfaces. In a report prepared for the federal Road Salts Working Group[1], Environment Canada describes seven broad categories of chemical dust suppression products: chloride salts and brines (i.e. calcium chloride and magnesium chloride); organic non-bituminous chemicals (i.e. lignosulfonates, sulphite pulp mill liquors, tall oil pitch, pine tar, vegetable oils, and molasses); petroleum-based binders and waste oils; electro-chemical stabilizers; various polymers; enzyme slurries; and cementitious binders. Each category of suppressant is unique with its own characteristics, benefits and limitations (i.e. toxicity, visual appearance, application rate and methods, costs).

This *Environmental Guideline for Dust Suppression on Unpaved Roads* (the Guideline) examines the most commonly used dust suppressants and the conditions under which they are most effective. It is intended to increase awareness and understanding of characteristics, benefits and hazards associated with commonly used dust suppressants and introduce best management practices to reduce dust levels from unpaved roads. It is not an official statement of the law. For further information and guidance, the owner or person in charge, management or control of dust suppressants is encouraged to review all applicable legislation and consult the Department of Environment, other regulatory agencies or qualified persons with expertise in the control of dust from unpaved roads.

The *Environmental Protection Act* enables the Government of Nunavut to implement measures to preserve, protect and enhance the quality of the natural environment. Section 2.2 of the *Act* provides the Minister of Environment with authority to develop, coordinate, and administer the Guideline.

1.1 Definitions

Approved Product	A product listed in section 3.2 *Approved Dust Suppressants* or approved by the Environmental Protection Division under section 3.5 *Approval of New Dust Suppressants*.

[1] Profile of Chloride-Based Dust Suppressants Used in Canada.

Commissioner's Land	Lands that have been transferred by Order-in-Council to the Government of Nunavut. This includes roadways and land subject to block land transfers. Most Commissioner's Land is located within communities.
Contaminant	Any noise, heat, vibration or substance and includes such other substance as the Minister may prescribe that, where discharged into the environment, (a) endangers the health, safety or welfare of persons, (b) interferes or is likely to interfere with normal enjoyment of life or property, (c) endangers the health of animal life, or (d) causes or is likely to cause damage to plant life or to property.
Dust Suppressant	Any treatment material for reducing dust emissions.
Environment	The components of the Earth and includes (a) air, land and water, (b) all layers of the atmosphere, (c) all organic and inorganic matter and living organisms, and (d) the interacting natural systems that include components referred to in paragraphs (a) to (c) above.
Inspector	A person appointed under subsection 3(2) of the *Environmental Protection Act* and includes the Chief Environmental Protection Officer.
Roadway	The travelled surface of a road from shoulder to shoulder, but does not include the side slopes or ditches of the road.
Used Oil	Engine, turbine and gear lubricating oil, hydraulic and transmission fluid and insulating coolant (i.e. transformer fluid) that is unsuitable for its intended purpose due to the presence of impurities or the loss of original properties, but does not include waste derived from animal or vegetable fat or a petroleum product spilled on land or water.
Waste Fuel	A flammable or combustible petroleum hydrocarbon that is unsuitable for its intended purpose due to the presence of impurities or the loss of original properties, and includes gasoline, diesel and fuel oil, aviation fuel, kerosene and naphtha, but does not include paint, solvent or propane.

1.2 Roles and Responsibilities

1.2.1 Owners and Applicators of Dust Suppressants

Owners or persons in charge, management or control of a chemical dust suppressant, also referred to as the Responsible Party, and applicators must ensure the chemical is properly and safely managed from the time it is purchased to its final use or disposal. This includes community, territorial and federal government, commercial, industrial and institutional operators and any person who may own or possess chemical dust suppressants.

Contractors may manage and apply dust suppressants on behalf of the Responsible Party. However, the Responsible Party remains liable for ensuring the contractor complies with all applicable statutes, regulations, standards, guidelines and community by-laws. If the contractor does not comply with the requirements of the *Environmental Protection Act* and is charged with a violation while managing or applying the dust suppressant, the Responsible Party may also be charged.

If a dust suppressant becomes contaminated, expires or otherwise becomes unsuitable for its intended purpose, it may be categorized and managed as a hazardous waste. Information on the management of hazardous waste and the registration of generators, carriers, receivers and hazardous waste management facilities can be obtained by referring to the *Environmental Guideline for the General Management of Hazardous Waste*.

1.2.2 Government of Nunavut

Department of Environment

The Department of Environment's Environmental Protection Division is the key territorial agency with responsibility for ensuring Nunavut's natural environment is protected. Authority is derived from the *Environmental Protection Act*, which prohibits the discharge of contaminants to the environment and enables the Minister to undertake actions to ensure appropriate management measures are in place. Although programs and services are applied primarily to activities taking place on Commissioner's and community lands and to Government of Nunavut undertakings, the *Environmental Protection Act* may be applied to the whole of the territory where other controlling legislation, standards and guidelines do not exist. A complete listing of relevant legislation and guidelines can be obtained by contacting the Department or by visiting the web site at http://env.gov.nu.ca/programareas/environmentprotection.

The *Environmental Guideline for Ambient Air Quality* sets standards for maximum levels of dust in ambient air. The standard for fine particulate matter[2] measured over a 24 hour period is 30 micrograms per cubic meter (µg/m^3) while the standard for total suspended particulate[3] measured over a 24 hour period is 120 µg/m^3. These standards apply to the whole of Nunavut. They are used to assess the impact dust levels may have on the environment, facilitate regional air quality management planning and establish benchmarks for reporting on the state of air quality. A copy of the *Environmental Guideline for Ambient Air Quality* can be downloaded from the Department's web site at http://env.gov.nu.ca/node/82#Guideline Documents.

Workers' Safety and Compensation Commission

The Workers' Safety and Compensation Commission is responsible for promoting and regulating worker and workplace health and safety in Nunavut. The Commission obtains its authority from the *Workers' Compensation Act* and *Safety Act* which require an employer to maintain a safe workplace and ensure the safety and well being of workers. The Workplace Hazardous Materials Information System, or WHMIS, requires information be provided to workers on the safe use of any hazardous material used in the workplace.

[2] Fine particulate matter consists of extremely fine particles and droplets with a diameter of less than 2.5 microns (one micron equals one millionth of a meter).
[3] Commonly referred to as airborne dust or dirt, total suspended particulate consists of airborne particles or droplets that have a diameter of up to 100 microns.

Department of Health and Social Services

Activities related to the handling, storage, transportation, application and disposal of dust suppressants may have an impact on public health. The Office of the Chief Medical Officer of Health and Regional Environmental Health Officers should be consulted regarding legislated requirements under the *Public Health Act.*

Department of Community and Government Services

The Department of Community and Government Services is responsible under the *Commissioner's Lands Act* for issuing land leases, reserves, licenses and permits on Commissioner's Lands. The Department, in cooperation with community governments, is also responsible for planning and funding solid waste and sewage disposal facilities in most Nunavut communities. The Department's emergency planning responsibilities under the *Emergency Measures Act* include developing territorial emergency response plans, coordinating emergency operations at the territorial and regional levels and supporting community emergency response operations.

The Office of the Fire Marshal is responsible for ensuring the safe storage, handling and use of flammable and combustible liquids and materials and obtains its authority from the *Fire Prevention Act*, *National Fire Code* and *National Building Code*.

Department of Economic Development and Transportation

The Airports Division of the Department of Economic Development and Transportation is responsible for the safe, efficient and effective management and operation of airports in Nunavut including the maintenance of runways and airport terminal aprons. The Motor Vehicles Division is responsible for the safe transport of dangerous goods and hazardous waste by road through administration of the *Transportation of Dangerous Goods Act*.

1.2.3 Government of Canada

Environment Canada

Environment Canada is responsible for administering the *Canadian Environmental Protection Act* (CEPA). In 1995, chloride-based dust suppressants were placed on the Government of Canada's Priority Substances List 2 for assessment to determine their toxicity under the CEPA. The resulting scientific assessment concluded road salts pose a serious threat to the aquatic environment, plants and animals due to high releases around storage and snow disposal sites and run-off from roadways into soils, streams and rivers.

Environment Canada also regulates the interprovincial and international movement of hazardous waste under the *Interprovincial Movement of Hazardous Waste Regulations* and *Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations.* It is also responsible for administering the pollution prevention provisions of the federal *Fisheries Act*.

Aboriginal Affairs and Northern Development Canada

Aboriginal Affairs and Northern Development Canada is responsible under the *Territorial Lands Act* and *Nunavut Waters and Nunavut Surface Rights Tribunal Act* for the management of federal lands and waters, including the impact dust suppressants may have on the quality of these lands and waters.

1.2.4 Community Governments and Co-management Boards

Local Community Governments

Community governments perform an important role in the proper management of dust suppressants. In addition to being major users of dust suppressants, community governments are entitled under the Nunavut Land Claims Agreement to control their own community landfill site and sewage lagoon. Unwanted dust suppressants may be deposited into landfills and sewage lagoons only with the consent of the local community government. The local fire department may also be called upon if a fire or other public safety issue involving chemical dust suppressants is identified.

Co-management Boards and Agencies

Co-management boards and agencies established under the Nunavut Land Claims Agreement have broad authority for land use planning, impact assessment and the administration of land and water. Activities involving the management and use of dust suppressants may be controlled through setting terms and conditions in plans, permits and licenses issued by the Nunavut Water Board, Designated Inuit Organizations responsible for land administration and other co-management boards and agencies.

Overview of Dust Suppressants

2.1 Dust Suppression Products and Alternatives

There are many different methods which can be used to control dust from unpaved roads. It is best to choose a method that will be most effective and economical. When planning a dust suppression program, the dust suppressant material or technique should be:

- Environmentally safe
- Easily applied using locally available road maintenance equipment
- Workable and responsive to maintenance activities
- Reasonably effective at controlling dust
- Not degrading to ride quality or use of the road
- Relatively harmless to vehicles using the road
- Posing little hazard or inconvenience to users of the road and adjacent residents
- Cost effective

The most commonly used dust suppressants are water, chloride salts, asphalt products and lignins. The general characteristics of these and other treatments used to control dust on unpaved roads are described in this section.

Water

Water is the most commonly used dust control agent. Water wets the road surface and binds fine particles together by the surface tension of the water. While water is readily available, low cost and easy to apply, it evaporates quickly and generally controls dust for less than 12 hours. Seawater is more effective for controlling dust than freshwater but repeated applications and long-term use may harm nearby vegetation and freshwater aquatic life.

Chloride Salts

Calcium chloride and *magnesium chloride* are the two most commonly used chemical dust suppressants. They are hygroscopic, or water attracting, agents that increase the moisture content of the road surface by attracting moisture from the air. This helps form a crusty layer which holds the fine particles on the road surface. Usually one to two treatments is required each year to maintain effective dust control.

Lignins and Petroleum Products

Lignosulfonate, a residue of paper production, and *petroleum products* is the other major group of chemical dust suppressants. Unlike chloride salts, these materials are adhesives and binders that physically glue soil particles together. These form a hard crust and are waterproof which helps to protect and stabilize the road surface. Lignin derivatives usually require one or two treatments each year and can create low dissolved oxygen conditions that are harmful to aquatic life if a spill or runoff from the road surface is allowed to enter adjacent rivers or lakes. A wide range of petroleum products (i.e. bitumens, tar and resins) are commercially available in Canada for dust suppression. Their effectiveness, safe use and environmental risks vary widely.

Other Dust Suppressants

Electro-chemical stabilizers attract positively charged dust particles and bind ionically to them. They also expel absorbed water and aid in compaction of the road surface. While a large variety of these materials are commercially available, their performance can be variable and pilot tests should be performed

before large-scale applications take place. *Polymers* are composed of long-chained molecular structures and bind road particles together to form a semi-rigid film on the road surface. These suppressants are usually more expensive than competitive road surface treatments and are most effective on lightly trafficked surfaces. *Enzyme slurries* promote compaction and have been effective in reducing dust under highly specific trafficked surfaces and gravel conditions. *Cementitious binders* work to chemically and permanently bind soil particles together.

Refer to Appendix 2 *Comparison of Dust Suppressant Characteristics* for more details on these and other dust suppressants.

2.2 Potential Effects of Chemical Dust Suppressants on the Environment and Human Health

There are no environmental hazards associated with the use of freshwater as a dust suppressant if it is not applied excessively. Repeated applications and long-term use of seawater may however, impact nearby vegetation and aquatic life as it contains small quantities of chloride salts.

Chloride salts are not toxic to humans at low concentrations. Domestic pets (i.e. dogs) can however, develop drooling, vomiting and diarrhea from ingesting road salts either by eating them directly or licking salty paws. Exposure of a dog's paws to road salt can also produce painful irritations, inflammation and cracking of the feet pads. The most visible impact of road salt on the environment is on plants along treated roadways. Stress and dehydration caused by salt can result in foliage damage and reductions in seed germination and flowering. Elevated levels of chloride salt in soil can also cause a colonization of salt tolerant plant species such as cattails, thereby reducing plant diversity. In addition, elevated chloride levels can be toxic to many forms of freshwater fish and aquatic insects.

Lignosulfonates are low in toxicity based on results of tests in laboratory animals including rats, rabbits and guinea pigs. The primary environmental concern from lignosulfonate use comes from its high solubility in water and high biological oxygen demand. Dissolved oxygen will be removed from waterways during lignosulfonate decomposition to levels that may be harmful to fish and other aquatic organisms. Allowing these products to enter waterways can also result in foaming and discoloration.

The potential effects of petroleum products and petroleum-derived dust suppressants on the environment and human health is directly related to their physical properties and the types and levels of contaminants present. While petroleum-derived dust suppressants generally have a low volatility, inhaling the more volatile components can cause irritation and inflammation of the throat and lungs. Prolonged or repeated skin contact may cause irritation and dermatitis, and should be avoided.

Used oil was once commonly used as a dust suppressant in Nunavut but now its use is strictly prohibited. During its use in engines, lubricating oil can become contaminated with by-products of combustion from engine wear. These contaminants include cancer-causing polycyclic aromatic hydrocarbons (PAHs) and metals (i.e. aluminum, cadmium, chromium, lead and copper). When used oil is applied to a road surface, these contaminants can bind to dust particles and then be washed off the road by rainfall or get blown into the air by traffic and wind. People and animals may swallow these harmful chemicals and metals through drinking water, breathing in contaminated air or dust, or eating contaminated berries or vegetation.

Best Management Practices

3.1 Pollution Prevention

Pollution prevention involves methods and practices that minimize or eliminate the generation of waste. Employing these methods only makes good sense as they help to reduce the hazards and costs associated with handling, storing, transporting, recycling, treating and disposing of any resulting waste. Implementing pollution prevention methods and practices also helps to reduce impacts on the environment, human and worker health and safety and minimize the use of raw materials.

Owners of dust suppressants can help prevent pollution and reduce costs by implementing a range of waste reduction, reuse and recycling initiatives. These include changes to operational procedures, maintenance practices and raw material use. Several of these initiatives are identified below.

Reduce

- Purchase the right type of dust suppressant and only the amount needed
- Use what you purchase
- Develop effective inventory controls and ensure the stored dust suppressants are completely used before purchasing additional supplies
- Establish and maintain storage methods and schedules that are consistent with those suggested by the manufacturer or supplier

Reuse and Recycling

- Donate unused dust suppressant to reputable local companies or individuals
- Make an agreement with your supplier to return un-opened and undamaged containers or packages of dust suppressants

There are also several practical alternatives to dust suppressants that will help reduce the level of dust from unpaved roads. Table 1 describes several of these alternatives.

Table 1.

	Description
Reducing Traffic	Reducing the number of vehicles on the road can reduce dust. Traffic can be reduced voluntarily by encouraging people to walk. Alternatively, limiting vehicle access to certain unpaved roads and paths will reduce dust levels.
Reducing Speed	Fast moving vehicles result in more dust than slow moving vehicles. Reducing speed from 60 kilometers per hour to 30 kilometers per hour can reduce dust by as much as 65%. Speed limit signs, enforcement and awareness can reduce vehicle speeds.
Improving Road Design	Good road design and drainage can reduce dust. When a road has poor drainage, water in puddles floats the fine particles up from the soil beneath the road. Traffic and wind can then spread the dry fine particles as dust.
Reducing Exposed Ground	Covered ground does not blow away and create dust. Covering the road surface with gravel can reduce the levels of dust from unpaved roads.
Slowing the Wind	Windbreaks are barriers designed to slow the speed and direction of wind. Methods may include leaving snow fences stand in place during the summer and maintaining vegetation along ATV paths.

3.2 Approved Dust Suppressants

Industrial suppliers offer many different products for controlling dust on unpaved roads. Each product has its own environmental, safety and operational benefits and limitations. The following dust suppressants are currently approved for use in Nunavut:

Freshwater and sea water
Calcium chloride
DL 10
EK-35
DUST-STOP

Refer to appendix #3 *Approved Dust Suppressants* for information on these approved products.

Dust suppressants may only be used on unpaved roads in Nunavut if they are listed as an 'approved dust suppressant' or have been approved for use by the Nunavut Department of Environment or through the setting of terms and conditions in plans, permits and licenses issued by the Nunavut Water Board or a Designated Inuit Organization responsible for land administration. Refer to section 3.5 *Approval of New Dust Suppressant Products* for information on the assessment and approvals process.

Used oil and waste fuel are strictly prohibited from use as dust suppressants on unpaved roads.

3.3 General Application Procedures for Approved Dust Suppressants

Regardless of the dust suppressant used, there are general application procedures which should be followed when planning or undertaking any dust suppression program in Nunavut. Table 2 describes these general procedures.

Table 2.

	General Application Procedures
Manufacturer's Directions	The manufacturer's specifications, directions and other procedures must be followed at all times. Where the dust suppressant is a manufactured product, these specifications and directions are available through the supplier.
Notification	The general public or other users of the road should be notified at least 24 hours before any application is scheduled to begin. This notification can be through the use of temporary road signs, public notices and local media announcements. The local office of the territorial Department of Environment should be provided with information on the dust suppressants to be used, location and schedule of work. If a dust suppressant is to be applied on private property, a written agreement should be entered into between the property owner and the applicator.

When to Apply	Dust suppressants generally work best when applied to damp road surfaces. If the road surface is dry, a water truck can be used to dampen the road before applying the suppressant. Caution should be undertaken when applying chloride salts and lignosulphonates because they are soluble and can be leached out of a road by excess water. Soluble suppressants should not be applied when it is raining or if rain is forecast in the next few days.
How to Apply	The road surface should be tested to ensure proper gradation. The dust suppressant should not pool on the surface due to depressions in the road surface or run off the traveled area because of excessive surface slope. If the road surface is tight and penetration of the liquid suppressant is poor, the top one to two inches of road surface should be loosened or scarified before applying the dust suppressant. Application equipment should be accurately calibrated and the suppressant applied evenly across the road surface. The amount of dust suppressant should not exceed the minimum amount required to effectively suppress dust. The dust suppressant should be bladed or incorporated into the road surface immediately following its application. This helps to ensure the product is incorporated into the surface materials and does not migrate off the roadway. It is ideal to keep traffic off the road for up to two hours after application has been completed. Avoid applying dust suppressant when heavy vehicle traffic is expected (i.e. immediately before or after regular office hours). If this is not possible, then only one side of the road should be treated at a time and traffic diverted. This will help to minimize the spreading of dust suppressant by vehicles and protect vehicles from metal corrosion.
Where to Apply	The application must be limited to the roadway or parking lot surface. Carefully monitor the application rate to ensure adequate coverage is achieved without any runoff of the product. Limit the application of dust suppressants near open bodies of water (i.e. lakes and streams) to prevent runoff or leachate from entering the water. Never apply a dust suppressant to areas of roads that are subject to flooding.
Cleaning of Equipment	The application equipment should be cleaned immediately following use when using chloride salts due to their corrosive nature.
Reworking the Road Surface	Many dust suppressants allow the road surface to be periodically reworked to remove potholes and ruts. Grading should never exceed the depth of the suppressant to avoid its dilution with untreated gravel and sand.
Test Sections	It is sometimes difficult to predict what level of performance will be achieved through the use of a dust suppressant. It is advisable to test the suppressant on a small portion of the road when the product is being applied for the first time.

3.4 Spill Response and Cleanup

Spills of chemical dust suppressants can affect soil, groundwater and surface water quality if they are not cleaned up quickly and properly. Be prepared to respond to accidental spills. Spill contingency plans

should be developed by the person in charge, management or control of any chemical dust suppressant. All spills of hazardous materials must immediately be reported to the NWT/Nunavut 24-Hour Spill Report Line at (867) 920-8130 in accordance with the *Spill Contingency Planning and Reporting Regulations*.

3.5 Approval of New Dust Suppressants

Dust suppressants may only be used if they have either been listed as an 'approved dust suppressant' (refer to section 3.2 *Approved Dust Suppressants*) or been approved for use by the Nunavut Department of Environment or through the setting of terms and conditions in plans, permits and licenses issued by the Nunavut Water Board or a Designated Inuit Organization responsible for land administration.

To enable new dust suppressants to be assessed, specific information should be provided to the Environmental Protection Division of the Department of Environment no later than 30 calendar days before the dust suppression program is scheduled to begin. Table 3 describes the type of information needed to assess new dust suppressants. The submission of incomplete information may result in delays in obtaining the necessary approval.

Table 3.

	Information Requirements
Product Information	Manufacturer's product information (including toxicity and solubility) and Material Safety Data Sheet
Procedures	Manufacturer's Standard Operating Procedures (SOP) for the handling, storage and application of the dust suppressant
Laboratory Testing	Results of the Toxicity Characteristic Leaching Procedure[4] if the dust suppressant and road material forms a solid substance following application
Schedule and Location	Schedule for applying dust suppressant to road test sections and its full application. Include a map of the area to be treated including location of any sensitive environments (i.e. lakes, streams, rivers), homes and businesses
Other Information	Copies of regulatory approvals from other Canadian jurisdictions, Boards and agencies; and accounts of product effectiveness and subsequent durability of the treated road surface

[4] The recommended leachate testing procedure is the United States Environmental Protection Agency Toxicity Characteristic Leaching Procedure (TCLP) Test Method 1311. The procedure is designed to assess the mobility of organic and inorganic analytes by simulating material residing inside a landfill containing unsegregated waste. Any leachate collected from the test must then be analyzed using methods contained in the most recent edition of *Standard Methods for the Examination of Water and Wastewater.* Analysis must be conducted by a laboratory that has been formally recognized by the Canadian Association of Environmental Analytical Laboratories (CAEAL) as being competent to perform the specified tests.

Conclusion

Dust from unpaved roads can have environmental and public heath and safety impacts. Use of chemical and non-chemical dust suppressants can be effective in reducing the impacts of fugitive dust by minimizing the loss of fine particles to the air and stabilizing the road surface. Numerous products and techniques are available, each with its own characteristics (i.e. toxicity and solubility), benefits and limitations. This Guideline examines the most commonly used dust suppressants and the conditions under which they are most effective. It is intended to increase the awareness and understanding of the characteristics, benefits and hazards associated with dust suppressants and introduce the reader to best management practices which, when safely and properly applied, can reduce the impacts of dust suppressants and minimize fugitive dust levels from unpaved roads.

Familiarity with the Guideline does not replace the need for the owner or person in charge, management or control of dust suppressants to comply with all applicable federal and territorial legislation and community by-laws. The management of these products may also be controlled through permits and licenses issued by Nunavut's co-management boards, Aboriginal Affairs and Northern Development Canada and other regulatory agencies. These permits and licenses must be complied with at all times.

For additional information on the management of dust suppressants in Nunavut, or to obtain a list of available guidelines, go to the Department of Environment web site or contact the Department at:

Environmental Protection Division
Department of Environment
Government of Nunavut
Inuksugait Plaza, P.O. Box 1000, Station 1360
Iqaluit, Nunavut X0A 0H0

Telephone: (867) 975-7729
Fax: (867) 975-7739
Email: EnvironmentalProtection@gov.nu.ca
Website: http://env.gov.nu.ca/programareas/environmentprotection

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APPENDICES

APPENDIX 1 - *ENVIRONMENTAL PROTECTION ACT*

The following are excerpts from the *Environmental Protection Act*

1. "Contaminant" means any noise, heat, vibration or substance and includes such other substance as the Minister may prescribe that, where discharged into the environment,
   (a) endangers the health, safety or welfare of persons,
   (b) interferes or is likely to interfere with normal enjoyment of life or property,
   (c) endangers the health of animal life, or
   (d) causes or is likely to cause damage to plant life or to property;

   "Discharge" includes, but not so as to limit the meaning, any pumping, pouring, throwing, dumping, emitting, burning, spraying, spreading, leaking, spilling, or escaping;

   "Environment" means the components of the Earth and includes
   (a) air, land and water,
   (b) all layers of the atmosphere,
   (c) all organic and inorganic matter and living organisms, and
   (d) the interacting natural systems that include components referred to in paragraphs (a) to (c).

   "Inspector" means a person appointed under subsection 3(2) and includes the Chief Environmental Protection Officer.

2.2 The Minister may
   (a) establish, operate and maintain stations to monitor the quality of the environment in the Territories;
   (b) conduct research studies, conferences and training programs relating to contaminants and to the preservation, protection or enhancement of the environment;
   (c) develop, co-ordinate and administer policies, standards, guidelines and codes of practice relating to the preservation, protection or enhancement of the environment;
   (d) collect, publish and distribute information relating to contaminants and to the preservation, protection or enhancement of the environment:

3. (1) The Minister shall appoint a Chief Environmental Protection Officer who shall administer and enforce this Act and the regulations.

   (2) The Chief Environmental Protection Officer may appoint inspectors and shall specify in the appointment the powers that may be exercised and the duties that may be performed by the inspector under this Act and regulations.

5. (1) Subject to subsection (3), no person shall discharge or permit the discharge of a contaminant into the environment.

   (3) Subsection (1) does not apply where the person who discharged the contaminant or permitted the discharge of the contaminant establishes that
   (a) the discharge is authorized by this Act or the regulations or by an order issued under this Act or the regulations;
   (b) the contaminant has been used solely for domestic purposes and was discharged from within a dwelling house;
   (c) the contaminant was discharged from the exhaust system of a vehicle;

(d) the discharge of the contaminant resulted from the burning of leaves, foliage, wood, crops or stubble for domestic or agricultural purposes;
(e) the discharge of the contaminant resulted from burning for land clearing or land grading;
(f) the discharge of the contaminant resulted from a fire set by a public official for habitat management of silviculture purposes;
(g) the contaminant was discharged for the purposes of combating a forest fire;
(h) the contaminant is a soil particle or grit discharged in the course of agriculture or horticulture; or
(i) the contaminant is a pesticide classified and labelled as "domestic" under the *Pest Control Products Regulations* (Canada).

(4) The exceptions set out in subsection (3) do not apply where a person discharges a contaminant that the inspector has reasonable grounds to believe is not usually associated with a discharge from the excepted activity.

5.1. Where a discharge of a contaminant into the environment in contravention of this Act or the regulations or the provisions of a permit or license issued under this Act or the regulations occurs or a reasonable likelihood of such a discharge exists, every person causing or contributing to the discharge or increasing the likelihood of such a discharge, and the owner or the person in charge, management or control of the contaminant before its discharge or likely discharge, shall immediately:
(a) subject to any regulations, report the discharge or likely discharge to the person or office designated by the regulations;
(b) take all reasonable measures consistent with public safety to stop the discharge, repair any damage caused by the discharge and prevent or eliminate any danger to life, health, property or the environment that results or may be reasonably expected to result from the discharge or likely discharge; and
(c) make a reasonable effort to notify every member of the public who may be adversely affected by the discharge or likely discharge.

6. **(**1) Where an inspector believes on reasonable grounds that a discharge of a contaminant in contravention of this Act or the regulations or a provision of a permit or license issued under this Act or the regulations has occurred or is occurring, the inspector may issue an order requiring any person causing or contributing to the discharge or the owner or the person in charge, management or control of the contaminant to stop the discharge by the date named in the order.

7. (1) Notwithstanding section 6, where a person discharges or permits the discharge of a contaminant into the environment, an inspector may order that person to repair or remedy any injury or damage to the environment that results from the discharge.

(2) Where a person fails or neglects to repair or remedy any injury or damage to the environment in accordance with an order made under subsection (1) or where immediate remedial measures are required to protect the environment, the Chief Environmental Protection Officer may cause to be carried out the measures that he or she considers necessary to repair or remedy an injury or damage to the environment that results from any discharge.

APPENDIX 2 – COMPARISON OF DUST SUPPRESSANT CHARACTERISTICS

Dust Suppressant	Properties	Limitations	Applications	Sources
Freshwater	Moisture wets surface particles binding them together by the surface tension of the water. * Usually readily available. * Low cost. * Easy to apply.	Evaporates easily. Usually controls dust for less than 12 hours.	Usually effective for less than 12 hours.	Freshwater lakes, rivers and streams.
Salt Water	Moisture stabilizes fines. * Contains small quantities of salt (mostly magnesium chloride) which retain moisture in road. * Usually readily available. * Low cost. * Easy to apply.	Evaporates easily. Usually controls dust for one day.	Usually effective for one day.	Sea.
Calcium Chloride	Starts to absorb water from air at 29% relative humidity (25^{o}C). * Reduces rate of evaporation 3.4 times. * Significantly increases surface tension of water film between particles. * Lowers freezing point of water solution to -50^{o}C, minimizing frost heave. * Treated road can be regraded and recompacted with less concern for losing moisture and density.	Corrosive to steel and aluminum. * Rainwater tends to infiltrate road surface and leach out highly soluble chlorides. * During dry periods upward capillary action may cause chlorides to crystallize near surface where they can be leached away by rain. * Low cementing action. Effective only with well graded, stable road surfaces. * Spills may kill or burn vegetation.	Typically 2 treatments per year. * Must be stored airtight or in buildings with solid floors and protected from wet, humid conditions. * Significant heat released when mixed with water. * Spread by tank trucks with pressure distributors and spinner disk.	Byproduct brine from manufacture of sodium carbonate and bromines from natural brines. * Three forms: flake, pellet and clear liquid.
Magnesium Chloride	Starts to absorb water from air at 32% relative humidity (25^{o}C). * Reduces rate of evaporation 3.1 times. * Increases surface tension more effectively than calcium chloride solutions. * Results in very hard road surface. * Lowers freezing point of water solution to -27^{o}C (22% solution). * Treated road can be regraded and recompacted with less concern for losing moisture and density.	Very corrosive to steel in concentrated solutions. Some products may contain corrosion-inhibiting additive. * Rainwater tends to infiltrate road surface and leach out highly soluble chlorides. On roads with proper crown, most water is deflected into ditches. * During dry periods upward capillary action may cause chlorides to crystallize near surface where they can be leached away by rain.	Typically 2 treatments per year. * Storage and handling same as for calcium chloride. * Applied preferably with pressure bars as splash bars apply unevenly.	Occurs naturally as brine (evaporated). Also byproduct of potash production. * Usually liquid form, 25%-35% solution.

Dust Suppressant	Properties	Limitations	Applications	Sources
Bitumens, Tars and Resins	Binds soil because of asphalt's adhesive properties. * Waterproofs road. * May be adapted to suit wide range of soils, gravels and traffic conditions.	***Use of waste oil is prohibited in Nunavut***. * May not maintain resilience under dry conditions. Can form a crust and fragment under heavy traffic loads.	Generally 1-2 treatments per year. * 0.1 to 1.0 gallons/sq yard depending on road surface condition and dilution. * Sprayed using many different types of equipment: hand-held hoses to asphalt distributors.	Tars (coal residues) and bitumens (crude oil residues) combined with water and emulsifier or lighter distillate.
Lignosulphonate and Processed Lignin Products	Greatly increases dry strength of soil similar to 3 inches of asphalt. Outperforms bituminous binders under dry conditions. * During rain, disperses clay which in turn swells and plugs pores, reducing water penetration. * Tends to stay slightly plastic, permitting reshaping and additional traffic compaction.	Control depends on well graded soil-aggregate mix, loosened to a depth of 1-2 inches just before initial application. Silt and clay content of road surface needs to be 4-8%. * High acidity of unprocessed liquor may cause corrosion of aluminum and has potential to discolour paint or other surfaces. * Surface binding action may be destroyed by heavy rain because of solubility of solids. * Slippery when wet. Brittle when dry. * Temporary strong odour.	Generally 1-2 treatments per year. * 0.5 to 1.0 gallons/sq yard at 10-25% solution. 0.5 kg to 1.0 kg/sq yard when in powder form.	Water liquor of papermaking industry. Contains lignin (the natural cement that binds wood fibers) and carbohydrates in solution. Composition depends on raw materials and chemicals used to extract wood cellulose.

Source: Adopted from Wisconsin Transportation Bulletin #13: Dust Control on Unpaved Roads.

APPENDIX 3 – APPROVED DUST SUPPRESSANTS

Calcium Chloride

Calcium chloride is the most commonly used chemical dust suppressant in Canada. Environment Canada estimates that 98,000 tonnes of calcium chloride was used for dust suppression in 2000. Calcium chloride is hygroscopic, or water attracting, and increases the moisture content of the road surface by attracting moisture from the air. As the humidity increases, more moisture is absorbed by the solution. This helps form a crusty layer which holds the fine particles into the road surface. Calcium chloride also lowers the freezing point of moisture in the road thereby delaying freezing of the road surface in winter.

Calcium chloride is corrosive to steel and aluminum and may be toxic to aquatic organisms if allowed to enter freshwater lakes, rivers and streams. It is a skin and eye irritant in concentrated form. Skin should immediately be flushed with plenty of water after contact.

This type of dust control is normally used for lower traffic areas. Usually one to two treatments is required each year to maintain effective dust control. Calcium chloride is available in three forms: flake, pellet and clear liquid.

DL 10

DL 10 is an asphalt product that is mixed with water and a soap solution prior to its application on a road surface. Treated areas may be visually unappealing, odourous and very sticky immediately following its application. DL 10 should be applied to one side of the road at a time, and allowed to set for approximately three hours before vehicles travel on the treated surface. A pilot car or road attendants may be required to direct traffic during its application and until it has set.

Fresh DL 10 can be washed off using soap and water. A petroleum-based solvent may be required if it is allowed to dry.

EK-35[5]

EK-35 is a synthetic organic dust control product that binds surface aggregate and fine particles together. It is applied to the road surface without mixing with any other substance. Weather is not a significant consideration in its application as EK-35 will not wash away with precipitation. Application to the road surface by sprayer should be in one continuous operation to ensure a consistent finish. Multiple passes may be required to achieve a desired finish. EK-35 can be re-worked (i.e. graded) without re-application.

EK-35 is non-flammable but will burn on prolonged exposure to flame or high temperature. It can be stored indefinitely and will not freeze. Although toxicity levels are low, eye protection and protective clothing should be provided to workers to minimize skin contact.

[5] Registered trade name is “EK-35 Synthetic Organic Dust Control”

DUST-STOP

DUST-STOP is a proprietary modified cellulose blend made up of two primary constituents: a mineral based component and a starch based polymer derivative. The dust control efficacy of the product comes from the polymer which forms a cross linking molecular chain when mixed with water that binds to road particles. The mineral component is added to act as filler between the polymer particles, otherwise the product would gel before it could be applied to the road surface.

DUST-STOP is an odourless white to off-white free-flowing powder. While it is nonirritating to eyes and skin, safety glasses and clean body-covering clothing should be worn by workers. DUST-STOP is non-toxic except when ingested in relatively large amounts. It should be stored in a dry place at temperatures below 32 ^{o}C.

APPENDIX 4 – GOVERNMENT CONTACTS

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Motor Vehicles Division
Department of Economic Development and Transportation
P.O. Box 10, NCC Building
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Fax: (867) 360-4619

Workers' Safety and Compensation Commission
Qamutiq building, 2nd Floor
611 Queen Elizabeth Way
P.O. Box 669
Iqaluit, Nunavut X0A 0H0
Telephone: 1-877-404-4407 (toll free)
Fax: 1-866-979-8501

Department of Community and Government Services (all Divisions)
P.O. Box 1000, Station 700
4th Floor, W.G. Brown Building
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Office of Chief Medical Health Officer of Health
Department of Health and Social Services
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Government of Canada

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