Volume 1 Annex V1-7 Type A Water Licence Applications

Package P5-28

Hope Bay Project: Boston Surface Infrastructure Preliminary Design

TMAC RESOURCES

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Memo

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From:	Cameron Hore, CPEng, PEng Megan Miller, PEng	**Project No:**	1CT022.013
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Subject:	Hope Bay Project: Boston Surface Infrastructure Preliminary Design		

Change Log

The following table provides an overview of material changes to this report from the previous version issued as Appendix V3-3J as part of the DEIS for Phase 2 of the Hope Bay Project dated December 2016.

Changes by Section

Information Request, Technical Comment, or Other Change	Section	Comments
Other	4.2	Contact water ponds now addressed in separate report (SRK 2017c)
Other	2.2, 4.1.1, Attachment 2	Increase in select infrastructure footprints to accommodate doré production.
Other	4.8	Inclusion of explosives facility in Quarry V
Other	4.7	Additional fuel storage capacity
INAC-IR2 (a)	2.2	Inclusion of incinerator in Table 2.1
INAC-IR4	4.5.2	Additional details on landfill design included
KIA-IR176 (1)	4.1.1	Clarification of overall slope angle
KIA-IR176 (2)	4.5.2	Additional details on landfill cover included
Other	4.9	New section, providing details on reagent facility required to store reagents for doré production

1 Introduction

1.1 General

The Hope Bay Project (the Project) is a gold mining and milling undertaking of TMAC Resources Inc. The Project is located 705 km northeast of Yellowknife and 153 km southwest of Cambridge Bay in Nunavut Territory, and is situated east of Bathurst Inlet. The Project comprises of three distinct areas of known mineralization plus extensive exploration potential and targets. The three areas that host mineral resources are Doris, Madrid, and Boston.

The Project consists of two phases: Phase 1 (Doris project), which is currently being carried out under an existing Water Licence, and Phase 2 (Madrid-Boston project) which is in the environmental assessment and regulatory stage. Phase 1 includes mining and infrastructure at Doris, while Phase 2 includes mining and infrastructure at Madrid and Boston located approximately 10 and 60 km due south from Doris, respectively. Boston will be a standalone self-contained mining complex complete with all surface infrastructure to support mining and ore processing required to produce doré.

1.2 Objectives

This memo provides preliminary engineering design details of the Boston surface infrastructure, excluding the tailings management area (SRK 2017a), the airstrip (SRK 2017b), the contact water ponds (SRK 2017c) and the Madrid-Boston all-weather road (SRK 2017d).

2 Design Concept

2.1 Approach

Boston is a self-contained mining complex, and thus contains all surface infrastructure required to support the mining operations, including a camp and ore processing facility.

The overall design concepts for the Boston surface infrastructure (i.e. pads, roads and water management facilities) are based on the same principles as used for Doris. As far as practical, all facilities will be constructed either on bedrock, or geochemically suitable rock fill pads designed to protect the permafrost. Site layouts are designed to minimize the overall footprint, and minimize the volume of contact water that has to be captured and managed via ponds for appropriate disposal.

Access roads are considered private roads, administered and controlled entirely by TMAC. TMAC has opted to design all site roads to mine haul road standards as set out in the Nunavut Mine Health and Safety Act (WSCC 2015).

2.2 Infrastructure Components

The surface infrastructure associated with the mining activities at Boston include necessary access roads, water management facilities and pads to support buildings associated with accommodations, processing and other mining support services. These components along with limitations on their location are summarized in Table 2.1. Infrastructure components have been grouped into zones with the understanding that these components should be grouped together for functionality.

Table 2.1: Summary of Infrastructure Associated with Boston

Zone	Infrastructure Component	Surface Area	Limitations and Comments
Camp	Camp	10,224 m² (71 x 144 m)	Minimum 10 m offset from other buildings; Connected to processing and mine zone buildings via arctic corridors
	Sewage Treatment Plant	30 m² (6.1 x 4.9 m)	Minimum 10 m offset from other buildings; Downwind of the camp
	Potable Water Treatment Plant	45 m² (6.1 x 7.3 m)	Minimum 10 m offset from other buildings
	Fire Water Tank	79 m² (10 m diameter)	Minimum 10 m offset from buildings
Geology	Heliport	729 m² (27 x 27 m)	Requires 27 m clearance distance from all buildings
	Heliport Shack	15 m² (6.1 x 2.4 m)	Shack at edge of 27 m heliport clearance
	Exploration Office	250 m² (15 x 10 m)	Minimum 10 m offset from other buildings
	Core Shack	325 m^3 (25 x 13 m)	Minimum 10 m offset from other buildings
	Core Storage	10,000 m²	General outside storage
Processing	Power Station	1,250 m² (50 x 25 m)	Minimum 10 m offset from other buildings; Requires bedrock, or piled foundation
	Process Plant Office	144 m² (12 x 12 m)	Minimum 10 m offset from other buildings; Connected to camp and mine zone buildings via arctic corridors; Near power station to maximize heat recovery opportunity
	Water Treatment Plant	30 m² (6.1 x 4.9 m)	For treatment of process and contact water; Minimum 10 m offset from other buildings, or inside processing plant
	Ore Pad (and Associated Ore Stockpile)	2,400 m²	Haul distance of less than 500 m from portal preferred; Haul road grade cannot exceed 7%; Two ore stockpiles, each with a minimum ore storage capacity of 20,000 tonnes (11,100 m^3) Expected operational Ore Stockpile tonnage is 8,000 tonnes (4,400 m^3). Must drain towards a contact water pond
	Warehouse	1000 m² (50 x 20 m)	Minimum 10 m offset from other buildings
	Processing Plant	14,000 m²	Minimum 10 m offset from other buildings; Requires bedrock, or piled foundation; Connected to camp and mine zone buildings via arctic corridors; Near power station to maximize heat recovery opportunity

Zone	Infrastructure Component	Surface Area	Limitations and Comments
	Reagent Storage	15 m² (6.1 x 2.4 m)	Can be immediately adjacent to or inside the processing plant building
	Emergency Response Center	144 m² (12 x 12 m)	Minimum 10 m offset from other buildings. Near process plant.
Mine	Portal Access Clearance	36 m² (6 x 6 m)	-
	Vent Raise	625 m² (25 x 25 m)	-
	Mine Office	300 m² (12 x 25 m)	Minimum 10 m offset from other buildings; Connected to camp and mine zone buildings via arctic corridors; Near power station to maximize heat recovery opportunity
	Mine Dry	600 m² (30 x 20 m)	
	Mobile Equipment Workshop	600 m² (30 x 20 m)	
	Waste Rock Pad (and associated waste rock pile)	As required for 349,000 m³	Haul distance of less than 500 m from portal; Haul road grade cannot exceed 7%; Minimum storage of 628,000 tonnes (349,000 m^3); Should drain to a contact water pond
Other	Water Supply Pump House	15 m² (6.1 x 2.4 m)	Minimum 10 m offset from other buildings
	Landfarm	4,725 m² (105 x 45 m)	Minimum 10 m offset from buildings
	Reagent Facility	4,125 m^2 (75 x 55 m)	Minimum 10 m offset from buildings
	Incinerator	15 m² (6x2.5 m)	Minimum 10 m offset from buildings
	Non-Hazardous Landfill	50,000 m^2	Located within a quarry, more than 450 m from camp, but less than 10 km from the mine
	Fuel Storage Facility	9,900 m² (165 x 60 m)	Minimum 10 m offset from buildings; Requires bedrock, or piled foundation
	Laydown Areas	36,000 m²	General outside storage area for equipment and supplies
	Overburden Pile	As required for 54,100 m³	Minimum storage of 54,100 m^3; Should drain to a sedimentation pond
	Contact Water Pond(s)	As required	Needed downstream of ore, waste rock and processing pads
	Explosives facility	35,000 m^2 (700 x 50 m)	Based on separation distances between individual facilities as defined by NRCan 2007.

2.3 Foundation Conditions

Numerous geotechnical investigations have been performed at the Project site. A surficial geology and permafrost investigation was carried out at Boston in 1996 (EBA 1996).
The investigation included air photo interpretation followed by ground truthing and completion of six onshore drill holes, followed up by laboratory testing of select geotechnical samples.
The investigation found the proposed Boston area is characterized mostly by marine deposits of silty-clay with trace sand. With small pockets of glaciofluvial deposits of coarse sand and some gravel.

Project-wide overburden consists of permafrost soils which are mainly marine clays, silty clay, and clayey silt, with pockets of moraine till underlying these deposits. The marine silts and clays contain ground ice ranging from 10 to 30% by volume on average, but occasionally as high as 50%. The till typically contains low to moderate ice contents ranging from 5 to 25%. Overburden soil pore water is typically saline due to past inundation of the land by seawater following deglaciation of the Project area. Salinity measurements in the EBA (1996) investigation ranged from 3 to 48 parts per thousand, which depresses the freezing point and contributes to higher unfrozen water content at below freezing temperatures.

Permafrost at the Project area extends to depths of about 565 m, with an average geothermal gradient of 0.021°C/m. Active layer depth in overburden soil averages 0.9 m, with a range from 0.5 to 1.4 m (SRK 2017e).

Isopach maps developed from seismic surveys and exploration and geotechnical drill holes indicate that depth of overburden under the infrastructure is expected to range from 0 to 10 m, with most areas having less than 6 m of overburden. The closest geotechnical drill holes (EBA-12259-02 and EBA-12259-03) indicate that the overburden under the infrastructure pads is likely silts, clays, and sands. Ice content of the foundation soils could also be in the higher end of those typically found on the Project, as those drill holes note ice contents up to 70% (EBA 1996).

General foundation conditions, material properties for geotechnical analysis, and development of the overburden isopach surface are described in more detail in SRK's Geotechnical Report (2017e).

2.4 Environmental Setbacks

The following environmental setbacks have been applied when selecting the location of the infrastructure:

- Minimum 31 m setback from waterbodies, 50 m setback where possible;
- Minimum 30 m buffer zone from known rare plants; and
- Minimum 30 m buffer zone from known archeological sites.

While priority was given to avoid these areas, in some cases the minimum buffer around archeological sites and rare plants could not be maintained. In these instances, the archeological site will be mitigated in accordance with the Heritage Resources Protection Plan (TMAC 2016).

3 Alternatives

3.1 Overall Site Layout

Alternative layouts were prepared primarily based on watershed areas, overburden thickness, and a 50 m crown pillar based on the current and future mine development. Components that take priority in developing alternate site layouts are the processing plant, the power plant, and the fuel storage facility, as these facilities should be constructed on a competent foundation, ideally bedrock, and outside of the 50 m crown pillar offset. Since the Boston area has limited exposed bedrock, areas where bedrock is less than 3 m deep was deemed suitable as excavation of this amount of overburden would be practical.

A second priority in evaluating site layout alternatives was to minimize the amount of affected watersheds. To that end the areas where contact water may be impacted by operations, such as the mine and processing zones, was grouped to minimize the footprint and affect the minimum amount of watersheds such that contact water ponds can be minimized and reduced in size.

Components in the camp zone should be relatively close to the mine and processing zone infrastructure, while the geology zone, landfarm, landfill, overburden storage area, and laydown areas were assumed to be the least critical infrastructure in terms of limitations on placement. Table 3.1 lists the three general site layouts that were considered (Figures 1 to 3). Alternative 3 is preferred as it is the most functional of the options, has the required space for all infrastructure, and has the most favourable foundation conditions.

Table 3.1: Alternative Infrastructure Locations

Alternative	Details
1	The camp and geology zone buildings would be located ~200 m north of the current portal. The mine and processing infrastructure would be placed ~50 m east of the portal, close to the planned waste rock pile. Laydown areas, fuel facility, and the landfarm would be placed ~700 m south of the portal. The advantages of this layout are the short haul distances between the portal and the processing, the nearness of the camp to the mine and processing infrastructure, and that contact water from the mine and process plant are contained within the same contact water pond as the waste rock pile. The disadvantage of this layout is that there are three distinct separated areas.
2	The camp and geology zone buildings would be located ~200 m north of the current portal. The mine and processing infrastructure as well as the infrastructure within the other zone would be placed ~700 m south of the portal. The advantage of this layout is that the camp is located close to the portal. The disadvantage of this layout is that the mine and processing infrastructure are far from the camp and portal.
3	All infrastructure excluding the waste rock pile and overburden pile would be located ~700 m south of the portal. The majority of the infrastructure is contained within one location. There is greater access to areas with shallow bedrock and increased space for access roads and pads. There is a relatively long distance from the process plant and the addition of a second ore storage pile is required.

4 System Design

4.1 Waste Rock, Ore Stockpiles and Overburden Pile

4.1.1 Design Criteria

The waste rock pile is expected to be a temporary stockpile and, prior to closure, all waste rock will be hauled for underground stabilization. However, the waste rock pile will be designed for the maximum volume of waste rock expected to be brought to surface from the Boston Mine. During construction of the infrastructure pads for the processing and mine zone components, some overburden may have to be removed to expose bedrock. Since this material may not be suitable for use as mine backfill, a permanent storage area for this material is required. The design criteria for the waste rock storage area, ore stockpile and overburden pile are as follows:

- Minimum waste rock storage capacity of 628,000 tonnes (349,000 m^3);
- Two ore stockpiles, each with a minimum ore storage capacity of 20,000 tonnes (11,100 m^3);
- Minimum overburden storage capacity of 37,000 m^3;
- Maximum overall slope angle for waste rock and ore of 2.5H:1V (21.8°) as measured from the toe of the lowest bench to the set-back of the highest bench, assuming inter-bench angle of repose slopes of 1.3H:1V (37°), bench heights of 5 m and bench widths of 6 m. Minimum slope angle of 5H:1V (11°) for overburden;
- Maximum height of 100 m for waste rock and ore, and 5 m for overburden;
- Factors of safety (FOS) as defined in the Mined Rock and Overburden Piles Interim Guidelines (Piteau 1991) of:
  - 1.0 for pile surface during construction;
  - 1.3 for short and long term deep seated stability; and
  - 1.1 for pseudo-static deep-seated stability.
- Seismic parameters, as defined in the Mined Rock and Overburden Piles Interim Guidelines (Piteau 1991) for an event with a 10% probability of exceedance in 50 years (1:500 year return period); and
- Design vehicle for the ore and waste rock piles is a loaded Sandvik TH540 (40 tonne) haul truck.

4.1.2 Design

The Boston waste rock pile has a maximum available capacity of 349,000 m^3 (628,000 tonnes), and a maximum height of approximately 23 m. The waste rock pile is located on a 1 m thick geochemically suitable run-of-quarry (ROQ) or run-of-mine (ROM) material pad.

The Boston waste rock pile has a pile stability rating of LOW according to the classification standards outlined by the Mined Rock and Overburden Piles Interim Guidelines (Piteau 1991). This rating is due to the shallow foundation slopes, low seismicity, side hill design, thin lifts, and slow dumping rate (Attachment 1).

The Boston overburden pile has a maximum available capacity of 37,000 m^3 and a maximum height of approximately 5 m. The overburden pile is located on a 1 m thick ROQ or geochemically suitable ROM material pad. The pile is located within the Stickleback Lake watershed and the Madrid-Boston all-weather road will act as a sedimentation berm for the overburden pile, by allowing water to slowly filter through the road and depositing entrained sediments.

Stability analysis performed on a general waste rock pile on site indicates that a waste rock pile designed to the design criteria listed above should be stable under static and pseudo-static conditions. Details of the stability analysis including material properties and seismic parameters used in this assessment are described in SRK (2017e).

4.2 Contact Water Ponds

There will be two unlined contact water ponds and one lined surge pond at Boston. These ponds will be located downstream of the waste rock pile, ore stockpiles, camp, mine and processing infrastructure.

The design criteria and design of the contact water ponds and surge pond are provided in the Boston Water Management Engineering Report (SRK 2017c).

4.3 Infrastructure Pads

4.3.1 Design Criteria

The design criteria for the pads are as follows:

- Minimum fill thickness is 1 m;
- Side slopes will be 1.5H:1V (34°) when fill thickness are less than 2 m;
- Side slopes will be 2H:1V (26.5°) when fill thicknesses are great than 2 m;
- No cut is allowed in overburden; and
- The floor of bedrock cuts should slope at 1% to shed water.

4.3.2 Design

The pads are designed with a minimum 1 m fill thickness that consists of a minimum of 0.85 m of geochemically suitable ROQ or ROM material overlain by 0.15 m of surfacing material consisting of crushed rock. The exceptions are waste rock and ore storage pads which do not have the layer of surfacing material. Design analysis to demonstrate the suitability of a 1 m thick rock fill pad for permafrost protection is presented in SRK (2017f).

The process plant pad is to be excavated to bedrock, with the blasted material expected to be suitable for construction of the camp pads. The process plant pad will have a 0.15 m layer of geochemically suitable surfacing material. The terraced camp pads and process plant pad are sloped at 1% towards the contact water pond so that contact water and sediments are collected. A rare plant and archeological site have been identified within the footprint of the process plant pad; these items will be mitigated prior to construction.

While the process plant pad has been identified as a quarry (Quarry AD), the rock produced from this quarry is not expected to suitable for use in construction. Therefore, this material will be stockpiled in the waste rock pile until it can be placed underground for structural backfill. Detailed design will consider minimizing the cut within this area.

There is no sediment or contact water pond associated with the vent raise pad; therefore, a silt fence may be required the first spring after construction.

4.4 Access and Haul Roads

4.4.1 Design Criteria

Several access roads are needed in the Boston mining area, excluding the Madrid-Boston Road, these include an access road to the contact water pond #1 berm, an access road to the vent raise, an access road to the heliport, the process plant haul road, the water intake and water discharge access roads, and the camp ring road.

The design criteria for the access and haul roads is similar to that used on other roads on-site:

- The design vehicles will be crew cab trucks, personnel transfer busses, Super B fuel trucks and Super B trucks, mine trucks, and lowbed trucks. In addition, construction equipment will periodically travel the road, which is expected to include CAT 988 loaders, and CAT 330 excavators;
- Haul roads shall have a maximum grade of 7%, while access roads shall have a maximum grade of 10%;
- The roadway will be crowned at 0.5% to promote drainage;
- Side slopes shall be 2H:1V (26.5°) when fill thickness is greater than 2 m, and 1.5H:1V (34°) when fill thicknesses are less than 2 m;
- Unless otherwise noted roads shall be single lane with turnouts to allow for passing;
- Single lane access road should be a minimum of 8 m wide and dual lane haul roads should be a minimum of 11 m wide;
- Where road thickness is greater than or equal to 3 m safety berms or barriers will be placed along the road edge, and the road crest will be widened to accommodate the berms; and
- No cut is allowed into overburden.

4.4.2 Design

The process plant haul road will be a 694 m long dual lane, 11 m wide, haul road running from the mill pad to the Madrid-Boston all-weather road. This road can be seen on Drawings BC-02 and BC-04 (Attachment 2). The camp ring road is a single lane, 8 m wide, access road that runs south from where the process plant haul road enters the camp area along the top of the contact water pond #2 berm to the process plant pad (Drawing BC-03, Attachment 2).

The contact water pond #1 berm and access road, is a 8 m wide, 170 m long road that starts from the existing camp pads and ends in a turn out on the east side of the waste rock pile. Two short, single lane, 8 m wide access roads are required to access the heliport and vent raise pads (Drawing BC-02, Attachment 2). The water intake and water discharge access roads will be 8 m wide access roads with 15 m radius turnarounds near the edge of the lake (Drawings BC-15 and BC-16, Attachment 2).

All roads will be constructed of geochemically suitable ROQ or (ROM) material, with a 0.15 m thick surfacing layer.

4.5 Landfill

4.5.1 Design Criteria

The non-hazardous landfill at Boston will be similar to that at Doris. The design criteria for the landfill are listed below:

- The landfill shall be a non-hazardous waste landfill;
- Minimum non-hazardous waste storage volume of 50,000 m^3;
- The landfill shall be located:
  - Within a quarry;
  - A minimum of 450 m from Boston Camp (R.R.N.W.T. 1990);
  - Where practical, a minimum of 90 m from the Madrid-Boston all-weather road (R.R.N.W.T. 1990); and
  - A maximum of 10 km from Boston Mine.
- The landfill shall be located in an area with low surface runoff, or water diversion should be used to minimize water run-on;
- Ramp grades shall not exceed 5H:1V (11°);
- Ramps shall have a minimum width of 5 m;
- Minimum slope of 0.5% towards a sump to allow for drainage;
- Minimum 1.0 m thick rockfill cover placed at closure; and
- Closure cover shall be sloped at 1% to shed water.

4.5.2 Design

The non-hazardous waste landfill will be located in Quarry V and accessed by a 1,260 m long road (Drawings BC-10 to BC-12, Attachment 2). The landfill will have a surface area of 11,000 m^2. The quarry floor will drain to a sump at a slope of 1%.

The capacity of the landfill is to be defined by the waste storage volume required. The maximum capacity is constrained by the size of Quarry V. The minimum design volume is expected to be 50,000 m^3. This is the same approach undertaken for the Doris landfill to be located within Quarry 3.

Two sides of the landfill will abut the quarry highwalls, the other two sides of the landfill will consist of berms constructed of geochemically suitable transition (0.15 m minus) material. The berms shall have a minimum crest width of 3.0 m and minimum side slopes of 2H:1V (26.5°).

Geotechnical information on the bedrock quality at the proposed landfill location (Quarry V) is not currently available. The geotechnical quality of the bedrock will be assessed following completion of quarrying operations in Quarry V and prior to IFC design of the landfill.

Waste should be placed and compacted within the landfill in 0.85 m thick lifts. A series of 0.15 m thick interim covers of geochemically suitable surfacing material shall be placed as needed to prevent the production of dust. Alternatively, non-hazardous waste could be placed in seacans which would be placed within the landfill.

At closure, the facility will be covered with an isolation cover which shall have a minimum thickness of 0.3 m of geochemically suitable ROQ or ROM material. The closure cover will be sloped at 1% to allow drainage. The landfill will contain only non-hazardous waste and therefore leachate is not a concern. As the leachate is not a concern, the cover is only an isolation cover and does not require freeze-thaw protection. The cover thickness will be the minimum thickness that can reasonably be constructed with the available run-of-quarry rock and that estimated to be about 0.3 m. This is consistent with the currently approved non-hazardous landfill at the Doris Mine.

4.6 Landfarm

4.6.1 Design Criteria

The landfarm will be similar to the existing landfarm at Doris. It will consist of three cells, one for contaminated snow and water, one for clean water (pending discharge) and one for contaminated soil. The landfarm will not be used for treatment as this is inefficient in the arctic, rather it is an area to store hydrocarbon contaminated soils, water and snow. Soil will be stored temporarily within the facility until it can be disposed of underground in permafrost areas. Snow and water will be placed in the contaminated snow and water pond, and hydrocarbons will be separated from the water using an oil water separator. Decontaminated water will be moved into the clean water pond until testing can confirm it meets discharge criteria.

The design criteria for the landfarm are:

- Minimum clean water and soil pond containment volumes of 360 m^3;
- Minimum contaminated snow and water containment volume of 550 m^3;
- The floor of each cell will sloped at 1% towards a sump;
- Each cell will be accessed via access ramps sloped at 5H:1V (11°);
- Each cell shall be lined with a geomembrane liner; and
- Landfarm berms will have:
  - A minimum of 3.4 m crest width;
  - Inner slopes of 2H:1V (26.5°), and
  - Outer slopes of 1.5H:1V (34°).

4.6.2 Design

The landfarm berms will be constructed of geochemically suitable transition material, and bedding material. The landfarm cells will be lined with a textured HDPE liner sandwiched between two layers of non-woven geotextile. A 0.15 m thick layer of bedding material will be placed below the liner system and a 0.6 m thick layer of bedding material will be placed above the liner system (Drawing BC-07, Attachment 2). All materials should be placed and compacted in accordance with the Technical Specification (SRK 2011).

4.7 Fuel Storage Facility

4.7.1 Design Criteria

The fuel facility will include six 1.5 million litre fuel storage tanks (five diesel tanks and one aviation fuel tank) and a fuel transfer station for refueling of vehicles. Design criteria for the fuel facility is as follows:

- Fuel storage tanks and transfer station will be within a lined facility to provide secondary containment;
- The design vehicles for the facility are crew cab trucks and Super B train fuel trucks (60,000 L capacity);
- The secondary containment facility will be designed to contain 110% of the fuel tank volume of the single largest tank, and all the rainfall from the 1:100 year, 24-hour storm runoff (55 mm), and the average maximum daily snowmelt (18 mm); and
- The containment area should have a minimum slope of 1% towards a sump.

In addition, the fuel facility should be designed to the following codes and guidelines:

- NFPA 30, Flammable and Combustible Liquids Code, 2015 Edition (NFPA 2014);
- SOR/2008-197, Storage Tank Systems for Petroleum Products and Allied Petroleum Products Regulations (Government of Canada 2012); and,
- Environmental Code of Practice for Aboveground and Underground Storage Tank Systems Containing Petroleum and Allied Petroleum Products (CCME 2015).

4.7.2 Design

The entire footprint of the fuel facility will be lined with an HDPE geomembrane sandwiched between two layers of 12 oz non-woven geotextile. A 0.15 m thick layer of bedding material will underlie the geomembrane, and a 0.3 m thick bedding layer will overlie the geomembrane. The interior of the facility will also have a 0.3 m thick layer of surfacing material.

The fuel tanks will be located in a row in the center of the facility, a minimum of 3.0 m from the base of the containment area berms, and 9.8 m between tanks to allow access. The containment berms will be constructed of transition material overlain by the geomembrane and bedding layers described above. To reduce the amount of construction material required and the height of the containment berms, the base of the fuel facility will be cut into bedrock. The berms will have interior slopes of 2H:1V (26.5°) to allow for geomembrane placement and will have exterior slopes of 1.5H:1V (34°). The secondary containment facility will have a surface area of 8,400 m^2 and a minimum containment capacity of 2,750 m^3.

There will be a 6 m wide ramp allowing vehicles to drive through the fuel facility. Ramps sloping at 5 to 6% enter and exit the facility. A flat area within the facility is where the fuel transfer module will be set up and where refueling will occur.

Details of the fuel facility design are presented in Drawing BC-06 (Attachment 2).

4.8 Explosives facility

4.8.1 Design Criteria

An explosives facility for the Boston mining area will be located in one of the quarries along the Madrid-Boston all-weather road, as determined by negotiation with the regulators. This facility will be sited to meet the setback requirements outlined in regulations and guidelines. A preliminary design as per NRCan 2007 and NRCan 1993 has been developed and shows the explosives facility within Quarry V as presented on Drawings BC-13 (Attachment 2). This is the same design as the permitted explosives facility at Doris. The Boston explosives facility will only be developed within Quarry V once quarrying of the final selected Quarry is determined complete. The design is shown on existing surface contours; however the final layout of the Boston explosives facility will be determined based on final quarry surface.

4.9 Reagent Facility

4.9.1 Design Criteria

The reagent facility will be separated into two lined containment areas, one area for acid and one area for bases. Design criteria for the reagent facility are as follows:

- Shipping containers (seacans) filled with reagent will be stored within a lined facility to provide secondary containment;
- The reagent facilities will be designed to contain 100% of the volume of one shipping container (67 m^3) and all the rainfall from the 1:100 year, 24-hour storm runoff (55 mm), and the average maximum daily snowmelt (18 mm);
- The design vehicle for the facility is the Hyster HR45-40LS reach stacker;
- The base side of the reagent facility should be large enough to contain 24 shipping containers without stacking, and the acid side should be large enough to contain six shipping containers without stacking;
- Containers should be located a minimum of 2.5 m from the toe of the containment berms to allow for snow clearing;
- Containers can be stacked a maximum of two high; and
- The base of each cell should be graded towards a sump with a minimum slope of 1%.

4.9.2 Design

The reagent facility berms will be constructed of geochemically suitable transition material, and bedding material. The reagent facility cells will be lined with a textured HDPE liner sandwiched between two layers of non-woven geotextile. A 0.15 m thick layer of bedding material will be placed below the liner system and a minimum 0.9 m thick layer of bedding material will be placed above the liner system in the floor of the facility. An additional layer of textured HDPE liner and non-woven geotextile will be placed at the access ramp location to prevent puncture of the liner. All materials should be placed and compacted in accordance with the Technical Specification (SRK 2011).

Details of the reagent facility design are presented in Drawing BC-08 (Attachment 2).

5 Construction Methodology

All construction fill materials will be obtained from geochemically suitable permitted quarries, or geochemically suitable waste rock. Management and monitoring of these quarries will be according to the quarry monitoring plan (TMAC 2017). Surfacing (32 mm minus), bedding (19 mm minus), and transition (150 mm minus) materials will be produced at an on-site crusher located within one of the permitted quarries. The estimated construction quantities are provided in Drawing BC-17 (Attachment 2).

All material excavated from Quarry AD is not expected to be geochemically suitable (SRK 2017g) for construction usage, so all material excavated from this quarry will be stored for use as underground backfill material.

Based on previous surface infrastructure construction on the Project, it is assumed that the construction fleet will consist of CAT 730 haul trucks, CAT 773 haul trucks, CAT D8 dozers, CAT C330 excavator(s), CAT CS563 compactor and a crusher.

Prior to construction the road alignments and pad areas should be cleared of snow and ice. At no time will disturbance of the tundra vegetation or soils be allowed outside of the road footprint, and no permafrost disturbance will be allowed. Construction fill will be placed by end-dumping on the existing road or pad surface and pushing the dumped material with a bulldozer. Surfacing material will not be placed until the ROQ material layer is at design grade and level. All construction should be performed in accordance with the Technical Specifications (SRK 2011). Where necessary, rock drains will be installed at topographic lows to ensure no standing water is created along the edges of roads or pads. Prior to quarry excavation all overburden material should be stripped and placed in the overburden dump.

Wherever possible, pads and roads will be constructed in the winter to ensure the foundation materials remain frozen. Summer construction may be required to meet development schedules. Winter and summer construction techniques will be identical; however, summer construction will result in the use of more construction material as greater imbedding of material into the active layer will occur. Summer construction will also require careful screening of the site for nesting birds, and modifications to the construction schedule may be required to avoid disturbing nesting birds.

6 References

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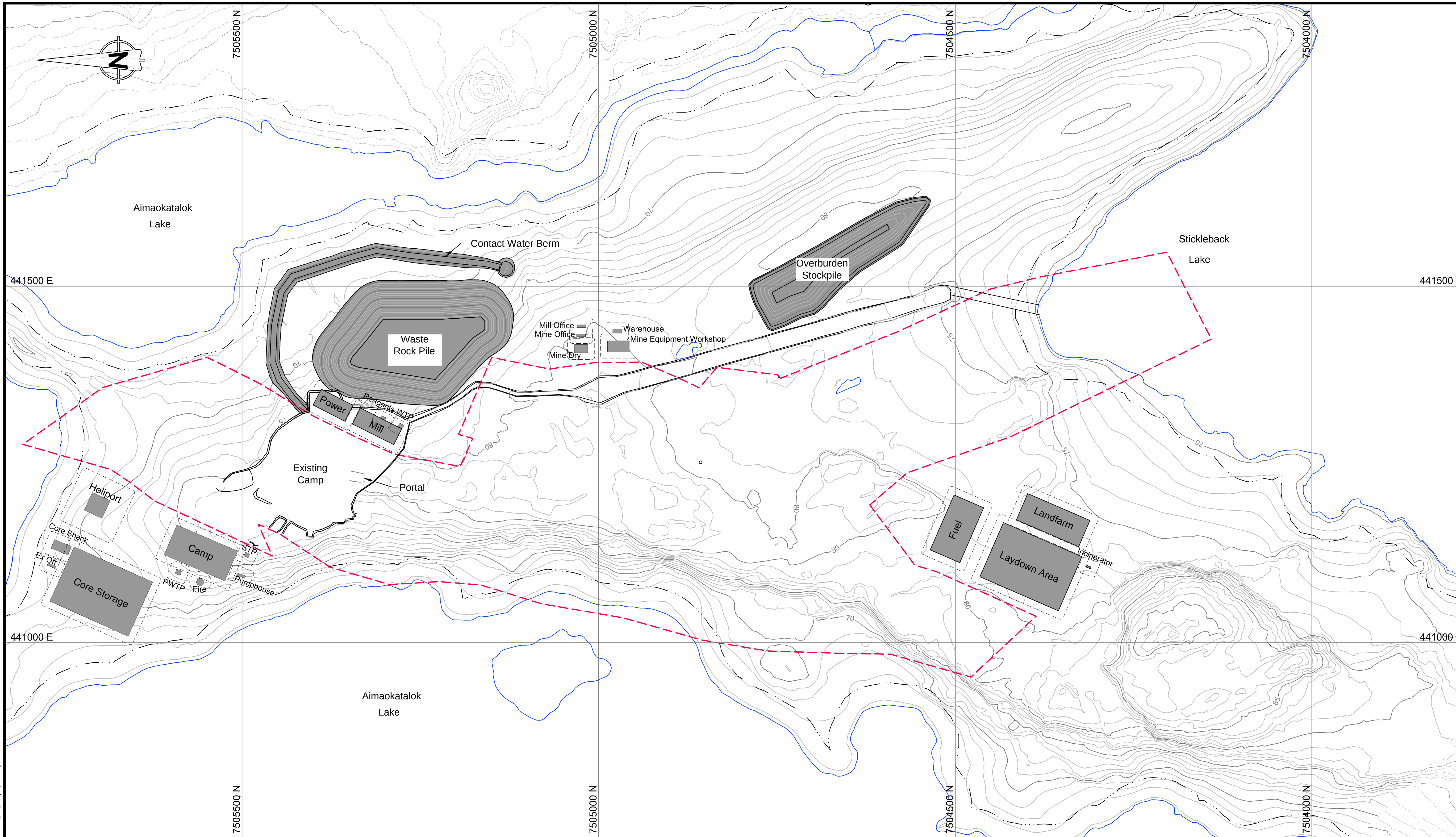
Figures



LEGEND

- 31m Stream / Lake Setback
- 50m Underground Workings Buffer

NOTES

1. The coordinate system is UTM Zone 13, NAD83.
2. Dimensions in metres unless noted otherwise.
3. Contour labels are oriented facing upslope.

0 20 40 60 80 100
Scale in Metres

srk consulting

SRK JOB NO.: 1CT022.013-110

FILE NAME: 1CT022.013_110_Camp Options.dwg

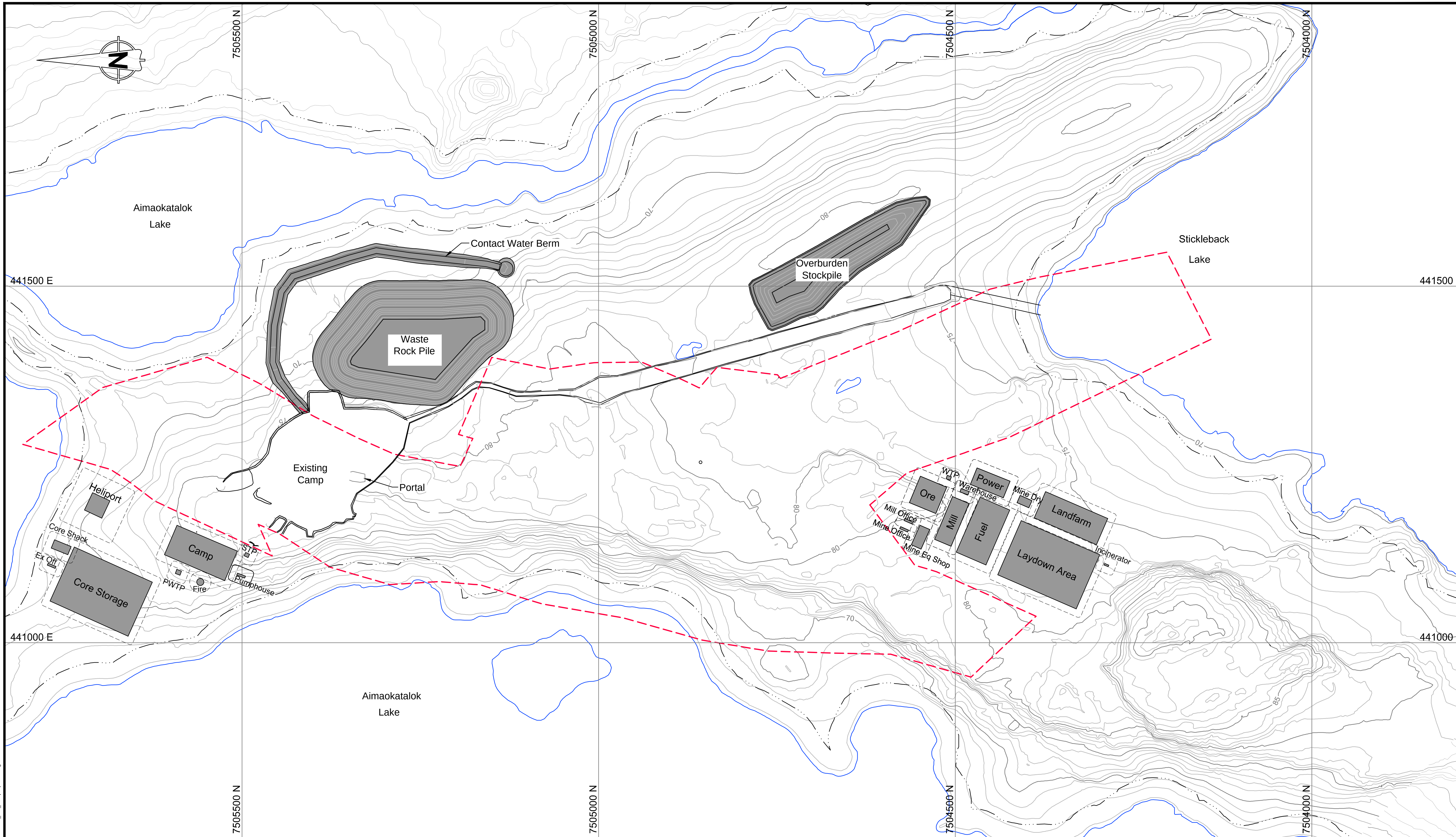
TMAC RESOURCES

HOPE BAY PROJECT

Boston Surface Infrastructure

Camp Layout
Option 1

DATE:	APPROVED:	FIGURE:
Nov. 2017	MMM	1



LEGEND

- 31m Stream / Lake Setback
- 50m Underground Workings Buffer

NOTES

1. The coordinate system is UTM Zone 13, NAD83.
2. Dimensions in metres unless noted otherwise.
3. Contour labels are oriented facing upslope.

0 20 40 60 80 100
Scale in Metres

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SRK JOB NO.: 1CT022.013–110

FILE NAME: 1CT022.013_110_Camp Options.dwg

MAC RESOURCES

HOPE BAY PROJECT

Boston Surface Infrastructure

Camp Layout
Option 2

DATE:	APPROVED:	FIGURE:
Nov. 2017	MMM	2

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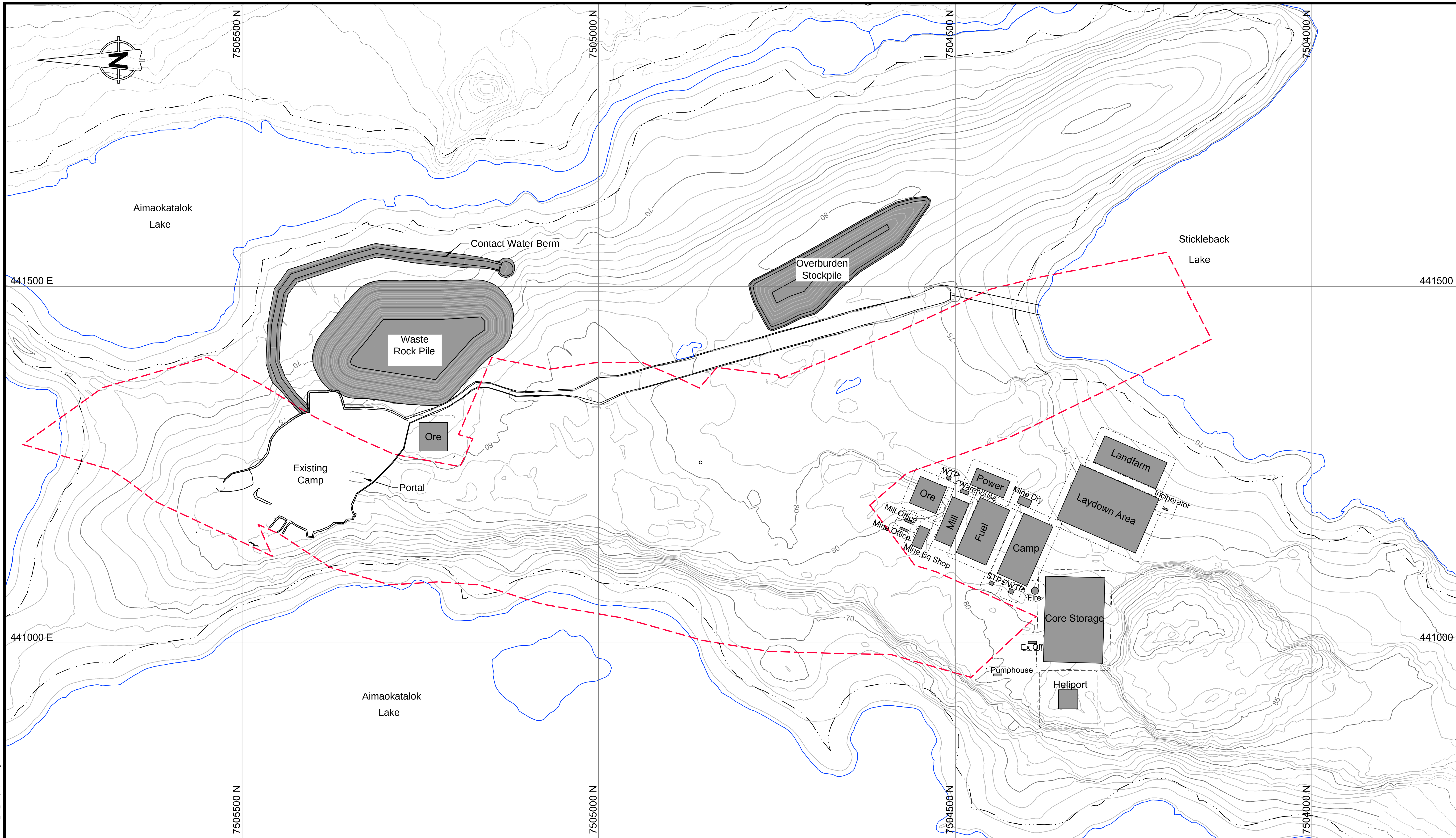

LEGEND

31m Stream / Lake Setback

50m Underground Workings Buffer

NOTES

1. The coordinate system is UTM Zone 13, NAD83.
2. Dimensions in metres unless noted otherwise.
3. Contour labels are oriented facing upslope.

0 20 40 60 80 100
Scale in Metres

srk consulting

SRK JOB NO.: 1CT022.013–110

FILE NAME: 1CT022.013_110_Camp Options.dwg

TMAC RESOURCES

HOPE BAY PROJECT

Boston Surface Infrastructure

Camp Layout
Option 3

DATE: Nov. 2017

APPROVED: MMM

FIGURE: 3

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Attachment 1
Dump Stability Rating

Structure Name:Boston Waste Rock Pile

Key Factor Affecting Stability	Conditions	Description	Rating Points
Pile height (m)	<50m		0
Pile volume (m³)	Small	< 1 million BCM's	0
Pile slope	Moderate	26 - 35 deg	50
Foundation Slope	Flat	<10%	0
Degree of confinement	Moderately Confined	-Natural benches or terraces on slope -Even slopes, limited natural topographical diversity -Heaped, sidehill or broad valley or cross-valley fills	50
Foundation Type	Weak	- Limited bearing capacity, soft soils - Subject to adverse pore pressure generation upon loading -Adverse groundwater conditions, springs or seeps - Strength sensitive to shear strain, potentially liquifiable	200
Pile Material Quality	Moderate	- Moderately strong, variable durability -10 to 25% fines	100
Method of Construction	Favorable	- Thin lifts (<25m thick), wide platforms -Dumping along contours -Ascending construction -Wrap-arounds or terraces	0
Piezometric and Climatic Conditions	Favorable	- Low piezometric pressures, no seepage in foundation - Development of phreatic surface within dump unlikely -Limited precipitation -Minimal infiltration into dump - No snow or ice layers in dump or foundation	0
Dumping rate	Slow	- <25 BCM's per lineal metre of crest per day - Crest advancementrate < 0.1m per day	0
Seismicity	Low	Seismic Risk Zone 0 and 1	0
		Dump Stability Rating (DSR)	

Pile Stability Class	Failure Hazard	Recommended Level of Effort for Investigation, Design and Construction	Dump Stability Rating (DSR)
2	**Low**	- Thorough site investigation - Test pits, sampling may be required - Limited lab index testing - Stability may or may not influence design - Basic stability analysis required - Limited restrictions on construction - Routine visual and instrument monitoring	**400**
Comments: The foundation type listed is for thawed conditions, under frozen conditions the foundation type would be concidered intermediate or competent			

Based on the BC Mine Waste Rock Pile Research Committee; Mined Rock and Overburden Piles Investigation and Design Manual, Interm Guidelines, May 1991.

Attachment 2
Engineering Drawings for the Boston Surface Infrastructure

Engineering Drawings for the Boston Surface Infrastructure, Hope Bay Project, Nunavut, Canada

ACTIVE DRAWING STATUS

DWG NUMBER	DRAWING TITLE	REVISION	DATE	STATUS
BC-00	Engineering Drawings for the Boston Surface Infrastructure, Hope Bay Project, Nunavut, Canada	C	Dec. 7, 2017	Issued for Discussion
BC-01	Boston General Arrangement	C	Dec. 7, 2017	Issued for Discussion
BC-02	Boston Waste Rock and Overburden Piles	C	Dec. 7, 2017	Issued for Discussion
BC-03	Boston Camp Infrastructure Layout	C	Dec. 7, 2017	Issued for Discussion
BC-04	Boston Process Plant Haul Road Profile	B	Dec. 7, 2017	Issued for Discussion
BC-05	Sections A - D	B	Dec. 7, 2017	Issued for Discussion
BC-06	Fuel Facility Plan and Sections	B	Dec. 7, 2017	Issued for Discussion
BC-07	Landfarm Plan and Section	B	Dec. 7, 2017	Issued for Discussion
BC-08	Reagent Facility Plan and Section	B	Dec. 7, 2017	Issued for Discussion
BC-09	Berm, Barrier and Fuel Facility Details	B	Dec. 7, 2017	Issued for Discussion
BC-10	Quarry V Conceptual Excavation and Access Road	B	Dec. 7, 2017	Issued for Discussion
BC-11	Non-Hazardous Waste Landfill Design	B	Dec. 7, 2017	Issued for Discussion
BC-12	Non-Hazardous Waste Landfill Sections	C	Dec. 7, 2017	Issued for Discussion
BC-13	Explosive Facility Design	B	Dec. 7, 2017	Issued for Discussion
BC-14	Typical Road Plan and Sections	B	Dec. 7, 2017	Issued for Discussion
BC-15	Southern Vent Raise and Water Intake Access Roads Layout	B	Dec. 7, 2017	Issued for Discussion
BC-16	Water Discharge Pipeline and Access Road	B	Dec. 7, 2017	Issued for Discussion
BC-17	Material List and Quantity Estimates	C	Dec. 7, 2017	Issued for Discussion

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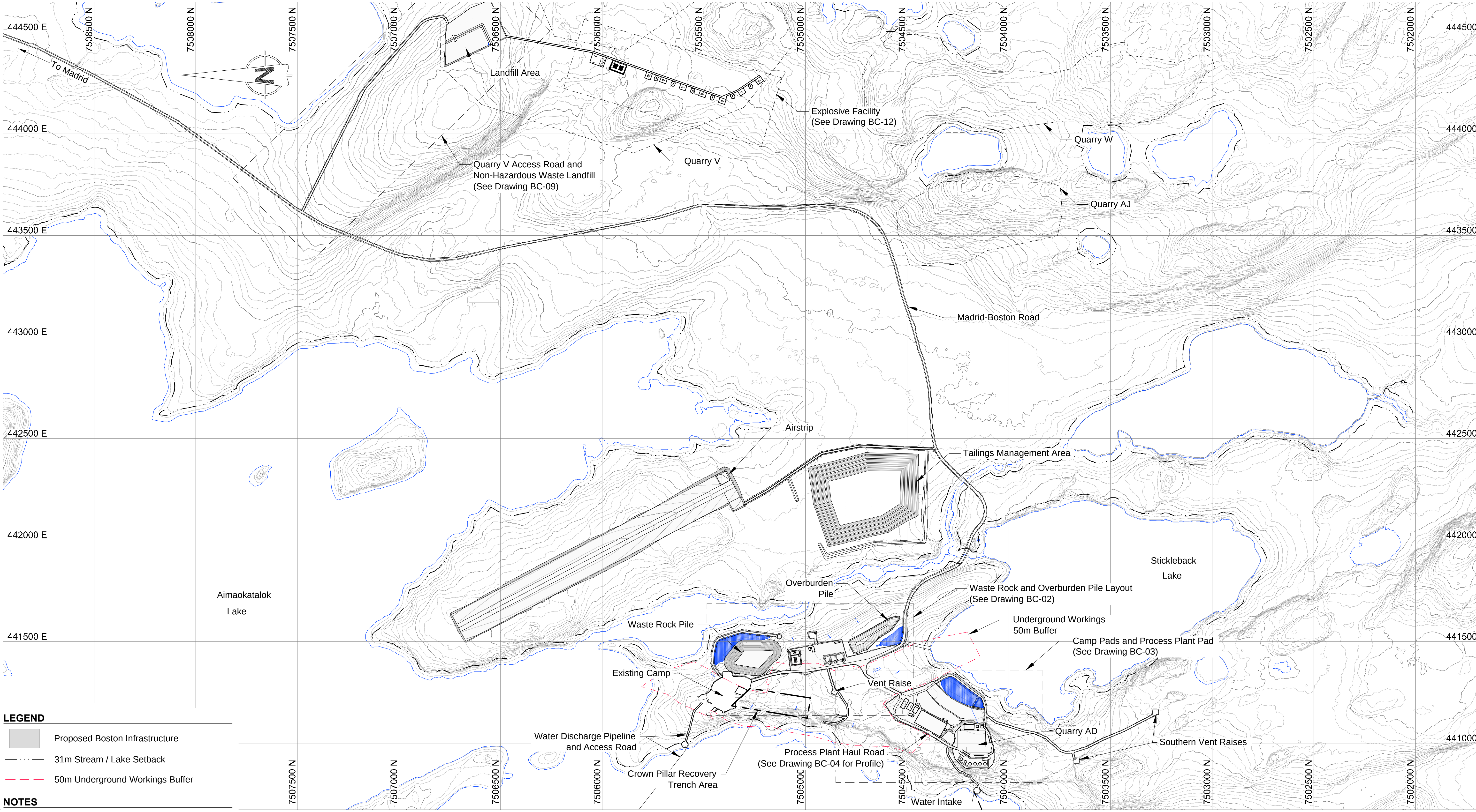
PROJECT NO: 1CT022.013
Revision C
December 7, 2017
Drawing BC-00



LEGEND

- Proposed Boston Infrastructure
- 31m Stream / Lake Setback
- 50m Underground Workings Buffer

NOTES

1. The coordinate system is UTM Zone 13, NAD83.
2. Dimensions in metres unless noted otherwise.
3. Contour labels are oriented facing upslope.

0 100 200 300 400 500
Scale in Metres

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE	NO.	DESCRIPTION	CHK'D	APP'D	DATE
				C	Issued for Discussion	KK	EMR	7Dec17
				B	Issued for Discussion	MMM	EMR	16Nov16
				A	Issued for Discussion	MMM	EMR	8Jul16

REFERENCE DRAWINGS | REVISIONS | PROFESSIONAL ENGINEERS STAMP

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DESIGN: TSF | DRAWN: NV | REVIEWED: TSF
CHECKED: MMM | APPROVED: EMR | DATE: Dec. 2017
FILE NAME: 1CT022.013_670_Boston_BC-1.dwg

TMAC RESOURCES

HOPE BAY PROJECT

SRK JOB NO.: 1CT022.013

Boston Surface Infrastructure

DRAWING TITLE:

Boston General Arrangement

DRAWING NO.: BC-01 | SHEET 2 of 18 | REVISION NO. C

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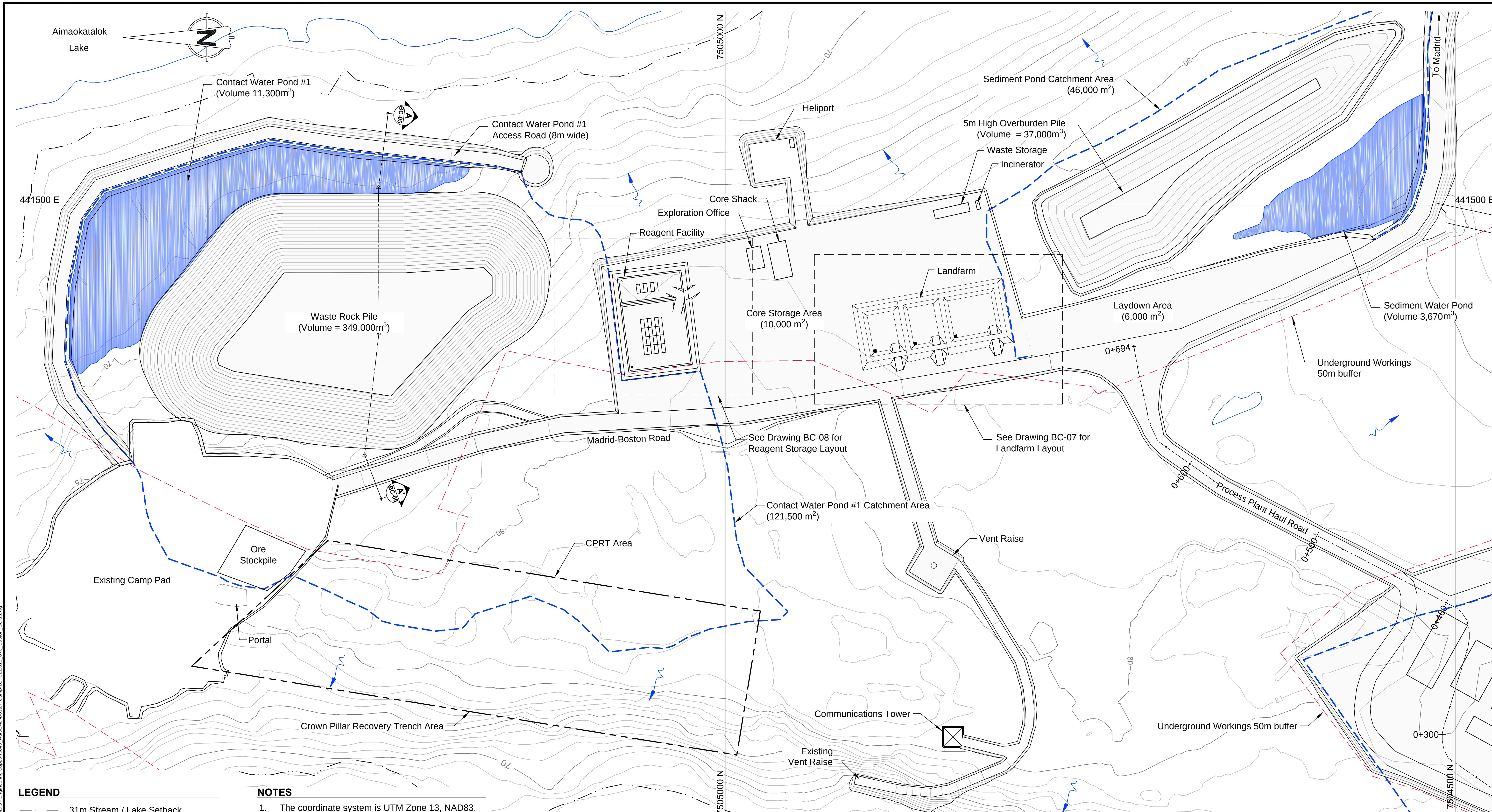

LEGEND

- 31m Stream / Lake Setback
- 50m Underground Workings Buffer
- Non-Contact Water Flow

NOTES

1. The coordinate system is UTM Zone 13, NAD83.
2. Dimensions in metres unless noted otherwise.
3. Contour labels are oriented facing upslope.

0 10 20 30 40 50
Scale in Metres

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				A	Issued for Discussion	MMM	EMR	8Jul16
REFERENCE DRAWINGS				REVISIONS				

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TMAC RESOURCES

HOPE BAY PROJECT

SRK JOB NO.: 1CT022.013

Boston Surface Infrastructure

DRAWING TITLE:

Boston Waste Rock and Overburden Piles

DRAWING NO.	SHEET	REVISION NO.
BC-02	3 of 18	C

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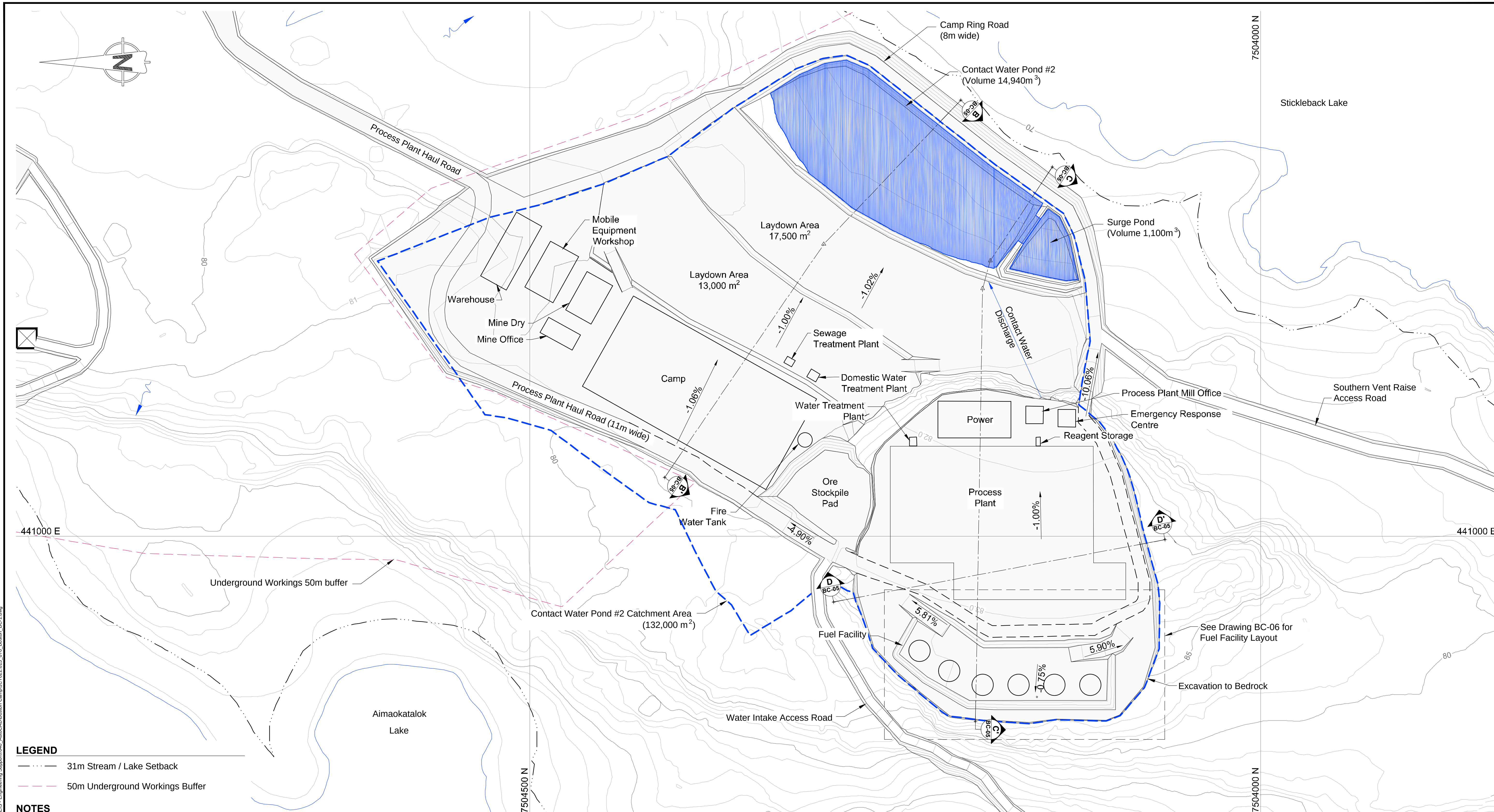

LEGEND

31m Stream / Lake Setback

50m Underground Workings Buffer

NOTES

1. The coordinate system is UTM Zone 13, NAD83.
2. Dimensions in metres unless noted otherwise.
3. Contour labels are oriented facing upslope.

0 10 20 30 40 50
Scale in Metres

NO.	DESCRIPTION	CHK'D	APP'D	DATE
C	Issued for Discussion	KK	EMR	7Dec17
B	Issued for Discussion	MMM	EMR	16Nov16
A	Issued for Discussion	MMM	EMR	8Jul16

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TMAC RESOURCES

HOPE BAY PROJECT

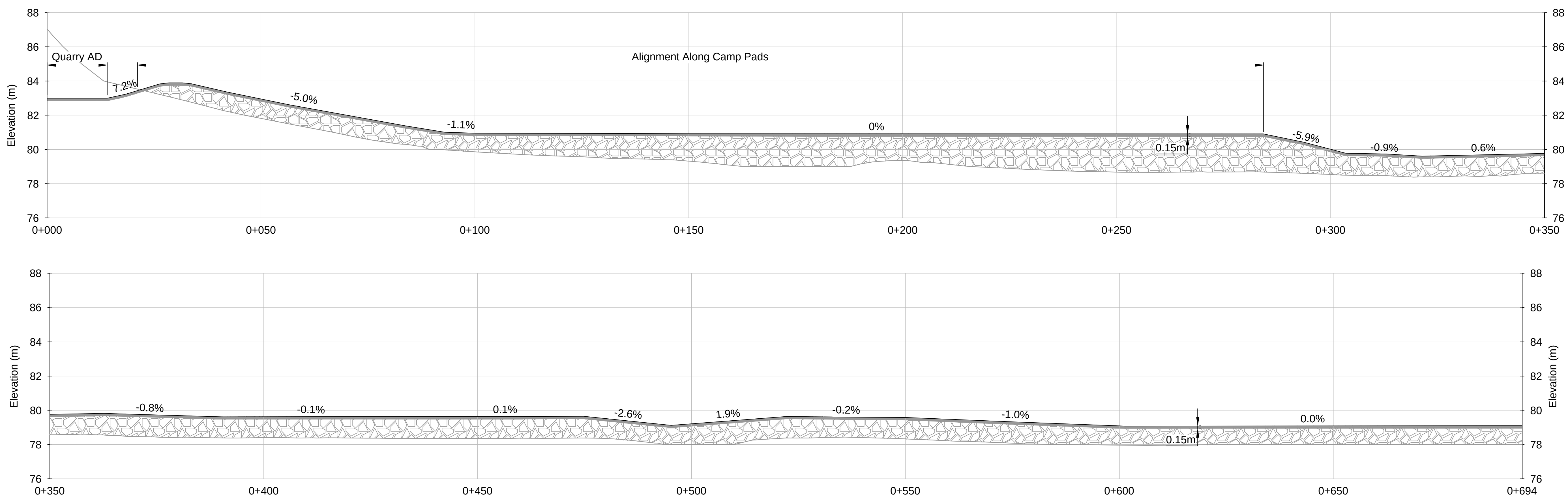
SRK JOB NO.: 1CT022.013

Boston Surface Infrastructure

DRAWING TITLE:

Boston Camp Infrastructure Layout

DRAWING NO.: BC-03 | SHEET: 4 of 18 | REVISION NO.: C



PROCESS PLANT HAUL ROAD PROFILE

0 5 10 15 20 25

Horizontal Scale in Metres
Vertical Exaggeration 4X

LEGEND

- Surfacing Material
- Run of Quarry Material

NOTES

1. Dimensions in metres unless noted otherwise.

Tolerances Road Material Placement:

Location	Fill (mm)	Excavation (mm)
Vertical Tolerance on Roads	0 to +75	n/a
Horizontal Tolerance on Roads	-150 to +150	

Note: Grade shall not be uniformly high or low.

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE

REFERENCE DRAWINGS

NO.	DESCRIPTION	CHK'D	APP'D	DATE
B	Issued for Discussion	KK	EMR	7Dec17
A	Issued for Discussion	MMM	EMR	8Jul16

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HOPE BAY PROJECT

SRK JOB NO.: 1CT022.013

Boston Surface Infrastructure

DRAWING TITLE:

Boston Process Plant
Haul Road Profile

DRAWING NO.	SHEET	REVISION NO.
BC-04	5 of 18	B

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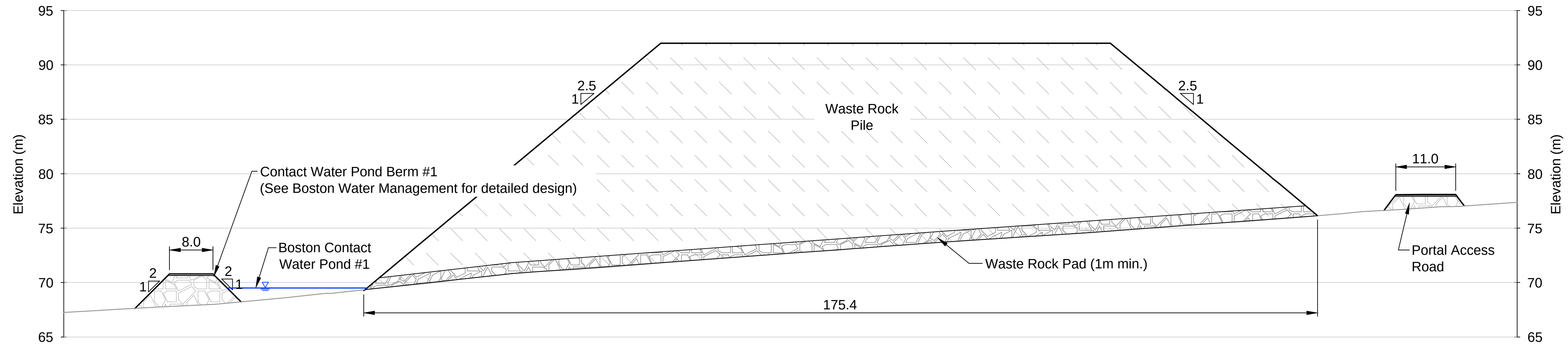
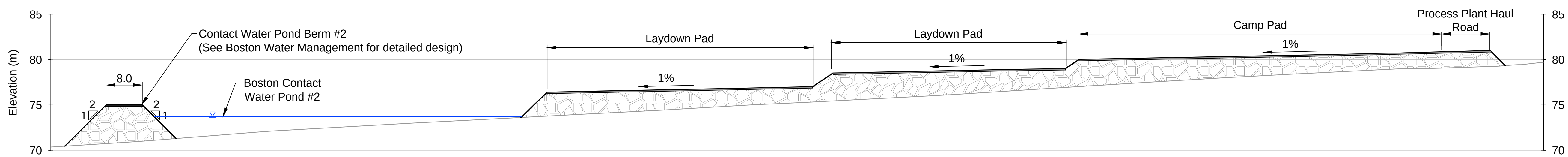


A BC-02 **SECTION A - A'**



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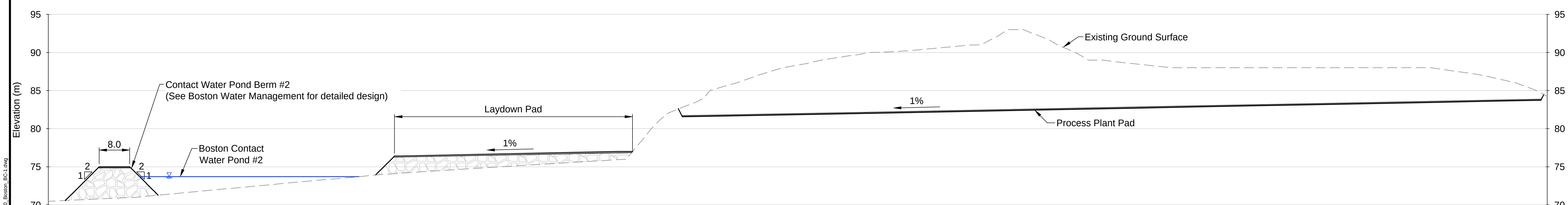


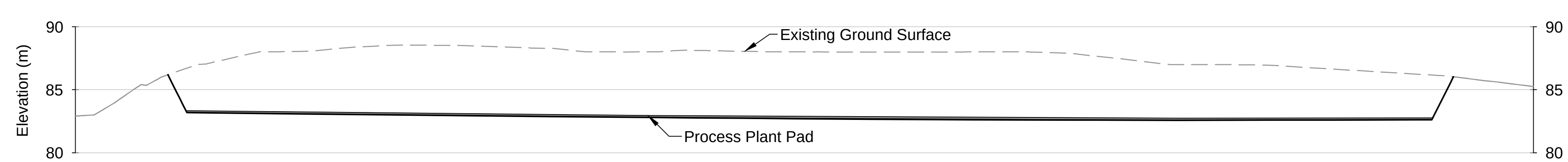
C BC-03 **SECTION C - C'**

LEGEND

- Surfacing Material
- Run of Quarry Material
- Waste Rock

NOTES

1. Maximum overall slope angle for waste rock of 2.5H:1V (21.8°) as measured from the toe of the lowest bench to the set-back of the highest bench, assuming inter-bench angle of repose slopes of 1.3H:1V (37°), bench heights of 5 m and bench widths of 6 m.
2. Dimensions in metres unless noted otherwise.



D BC-03 **SECTION D - D'**

Horizontal Scale in Metres
Vertical Exaggeration 2X

NO.	DESCRIPTION	CHK'D	APP'D	DATE
B	Issued for Discussion	KK	EMR	7Dec17
A	Issued for Discussion	MMM	EMR	8Jul16

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TMAC RESOURCES

HOPE BAY PROJECT

SRK JOB NO.: 1CT022.013

Boston Surface Infrastructure

DRAWING TITLE:

Sections A - D

DRAWING NO.	SHEET	REVISION NO.
BC-05	6 of 18	B

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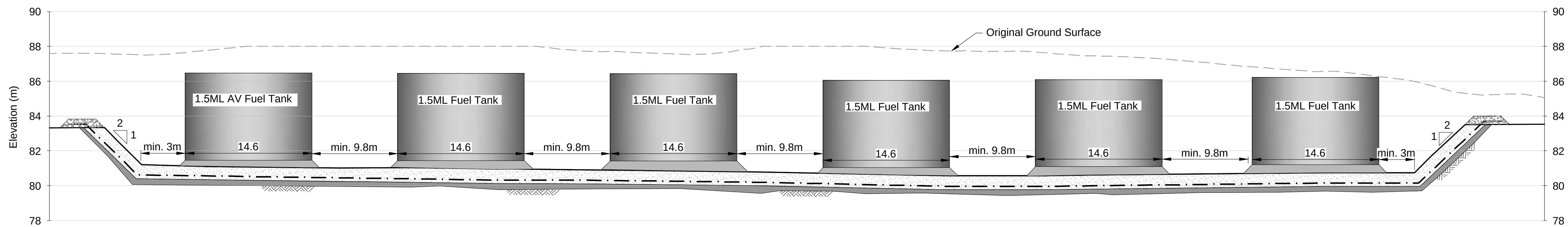
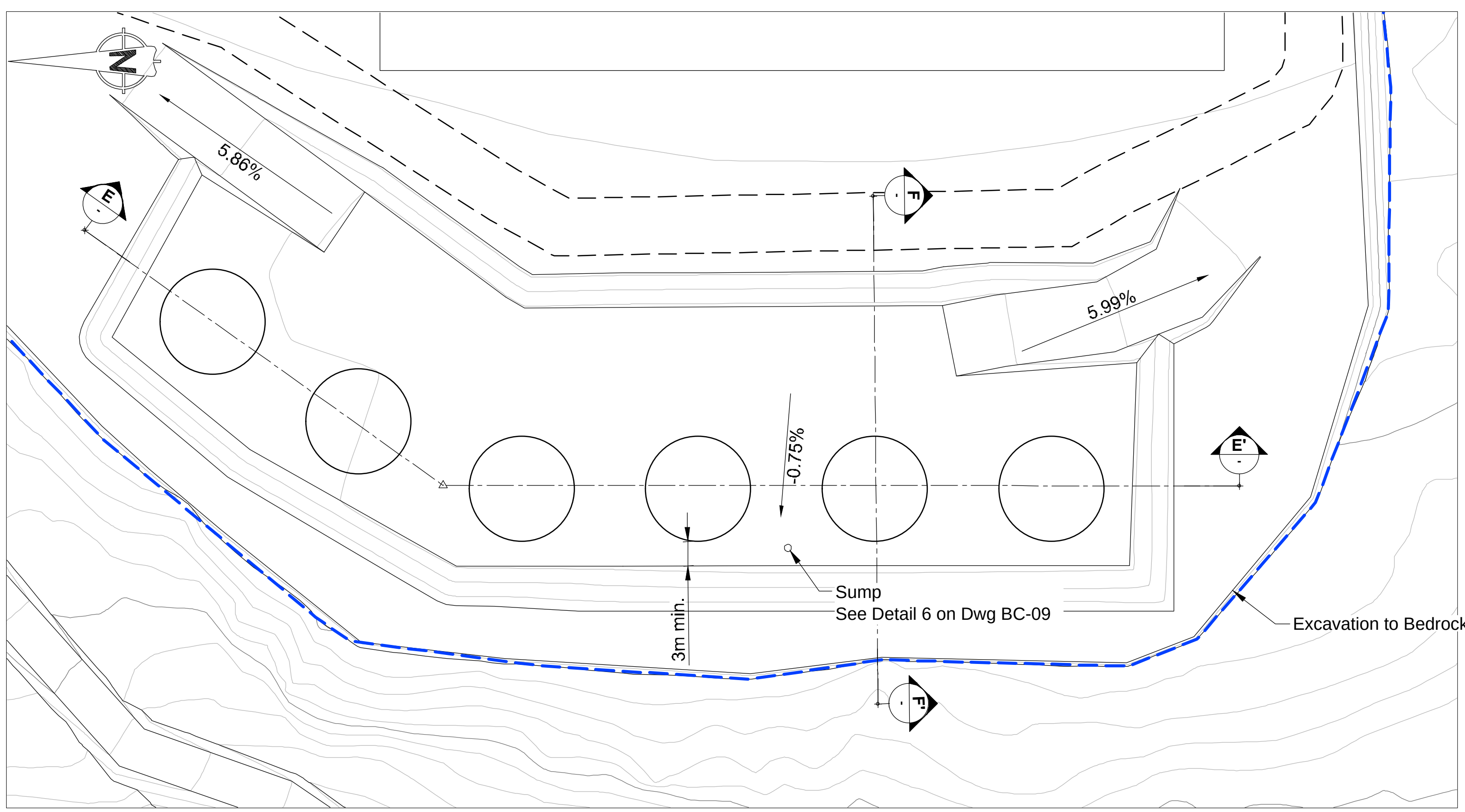


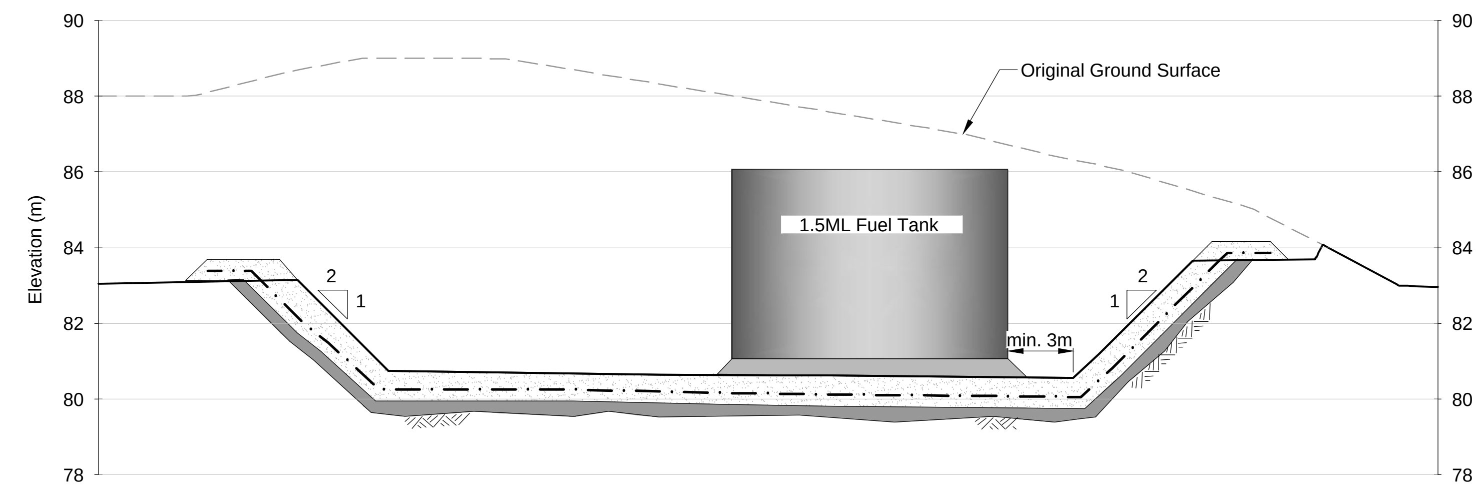
E -

SECTION E - E'

0 2 4 6 8 10

Horizontal Scale in Metres
Vertical Exaggeration 2X





F -

SECTION F - F'

0 2 4 6 8 10

Horizontal Scale in Metres
Vertical Exaggeration 2X

FUEL FACILITY PLAN VIEW

0 5 10 15 20 25

Scale in Metres

LEGEND

- Surfacing Material
- Bedding Material
- Run of Quarry Material
- Liner System

NOTES

1. The coordinate system is UTM Zone 13, NAD83.
2. Dimensions in metres unless noted otherwise.
3. Contour labels are oriented facing upslope.

NO.	DESCRIPTION	CHK'D	APP'D	DATE
B	Issued for Discussion	KK	EMR	7Dec17
A	Issued for Discussion	MMM	EMR	8Jul16

REVISIONS

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE

REFERENCE DRAWINGS

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CHECKED: MMM
APPROVED: EMR
DATE: Dec. 2017
FILE NAME: 1CT022.013_670_Boston_BC-1.dwg

TMAC RESOURCES

HOPE BAY PROJECT

SRK JOB NO.: 1CT022.013

Boston Surface Infrastructure

DRAWING TITLE:

Fuel Facility Plan and Sections

DRAWING NO.: BC-06
SHEET 7 of 18
REVISION NO.: B

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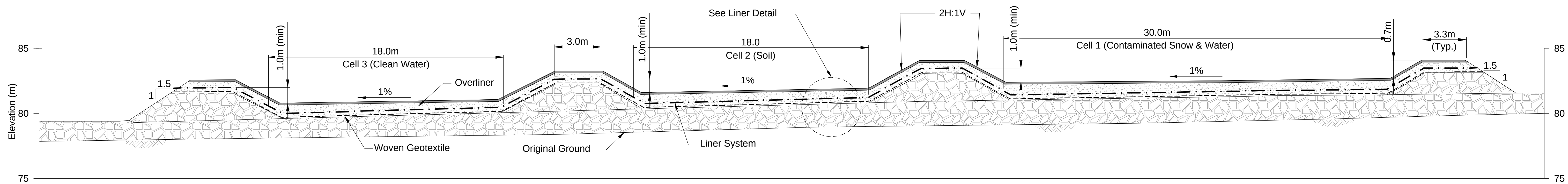
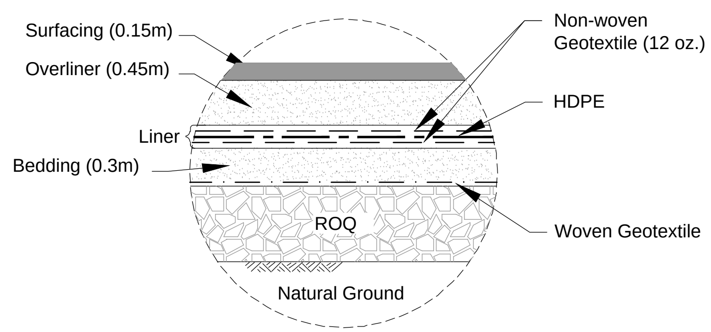


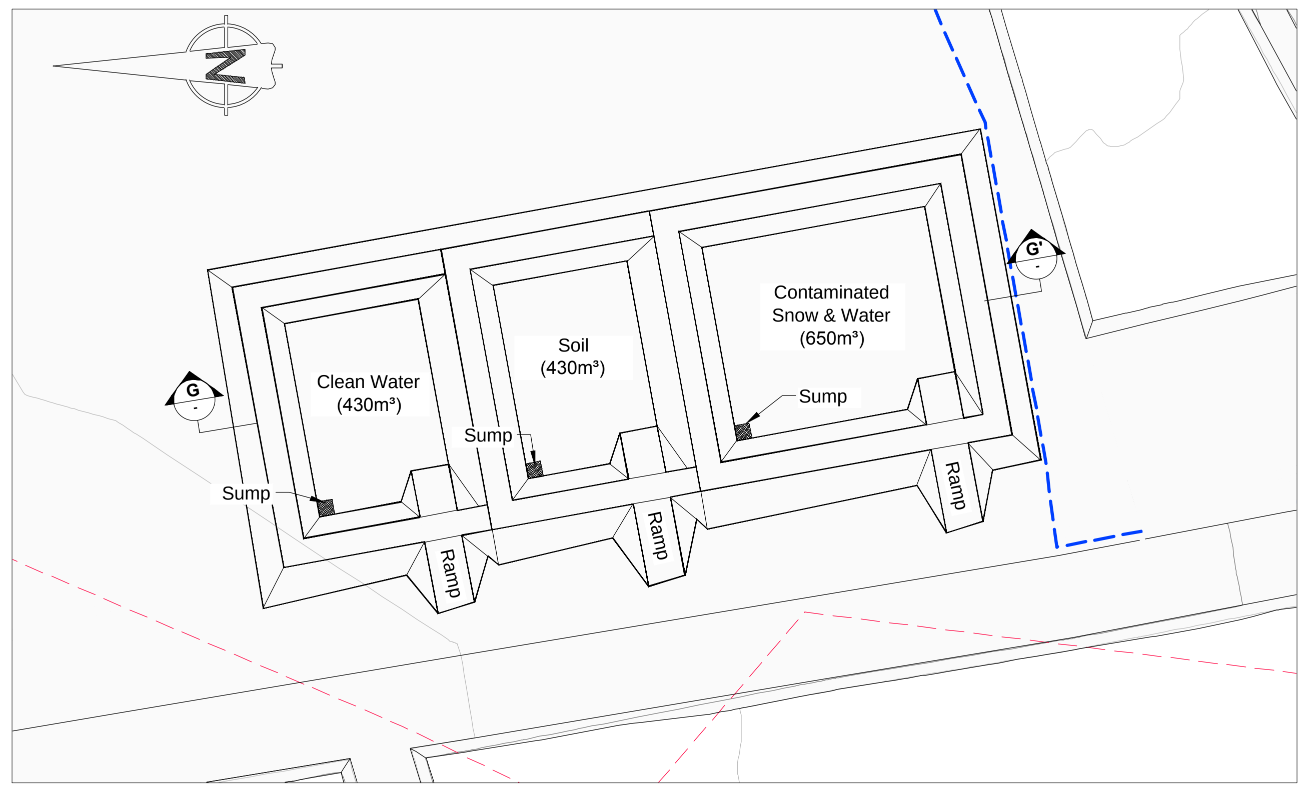
CROSS SECTION G - G'

G
-
0 2 4 6 8 10
Scale in Metres



LANDFARM LINER TYPICAL DETAIL

(NTS)



LANDFARM PLAN VIEW

0 5 10 15 20 25
Scale in Metres

LEGEND

- Surfacing Material
- Bedding Material
- Run of Quarry Material
- Liner System

NO.	DESCRIPTION	CHK'D	APP'D	DATE
B	Issued for Discussion	KK	EMR	7Dec17

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE

REFERENCE DRAWINGS

REVISIONS

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FILE NAME: 1CT022.013_670_Boston_BC-1.dwg

TMAC RESOURCES

HOPE BAY PROJECT

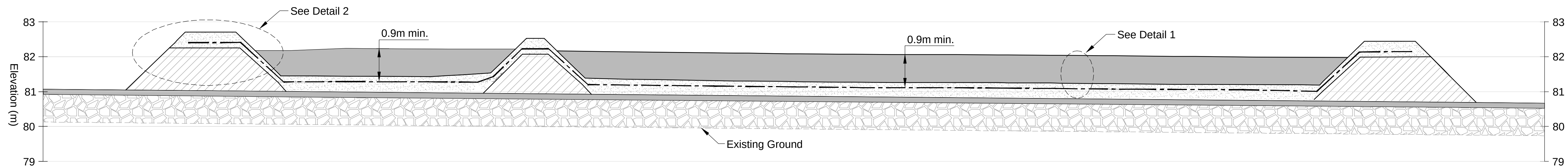
SRK JOB NO.: 1CT022.013

Boston Surface Infrastructure

DRAWING TITLE:

Landfarm Plan and Section

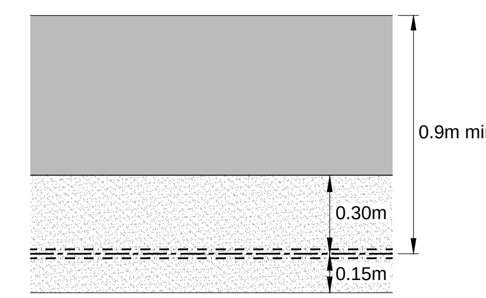
DRAWING NO.: BC-07 | SHEET: 8 of 18 | REVISION NO.: B



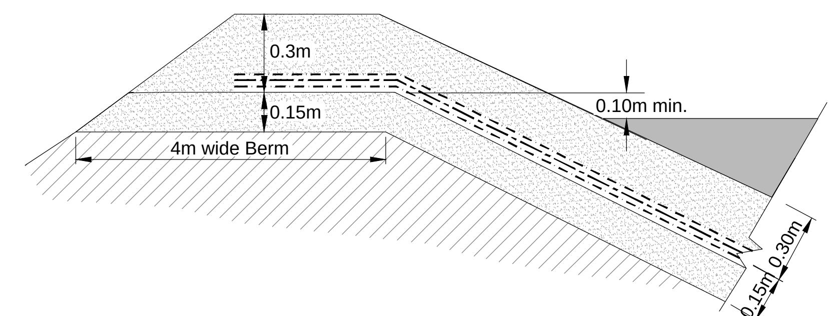
H
-
CROSS SECTION H - H'
0 1 2 3 4 5
Horizontal Scale in Metres
Vertical Scale 2X

LEGEND

- Surfacing Material
- Bedding Material
- Transition Material
- Run of Quarry Material
- Non-woven Geotextile (385g/m²)
- 60 mil HDPE Liner

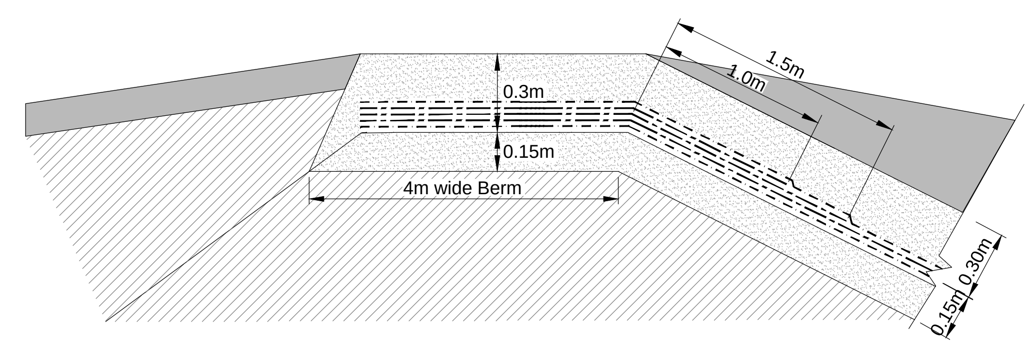


DETAIL 1
TYPICAL LINER SYSTEM
NTS



DETAIL 2
TYPICAL LINER SYSTEM AT CONTAINMENT BERM
NTS

REAGENT FACILITY PLAN VIEW
0 4 8 12 16 20
Scale in Metres



DETAIL 3
TYPICAL LINER SYSTEM AT ACCESS RAMP
NTS

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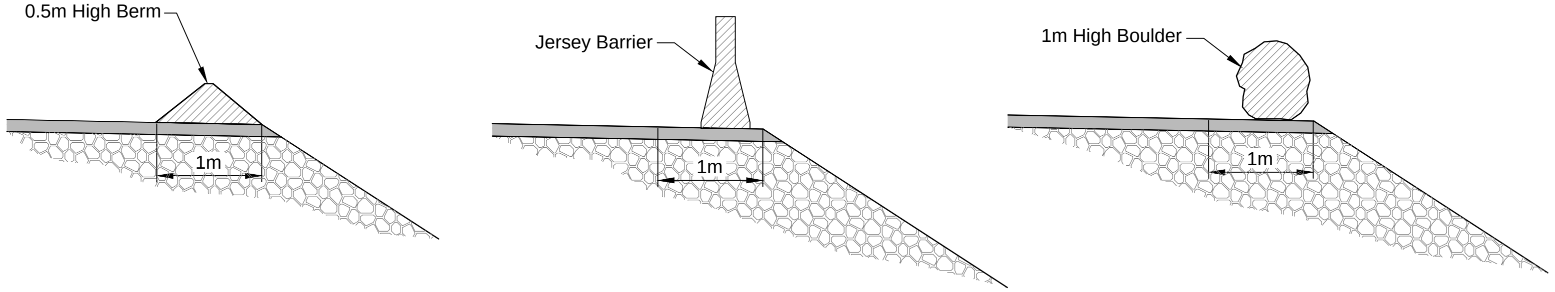
FILE NAME: 1CT022.013_670_Boston_BC-1.dwg

TMAC RESOURCES

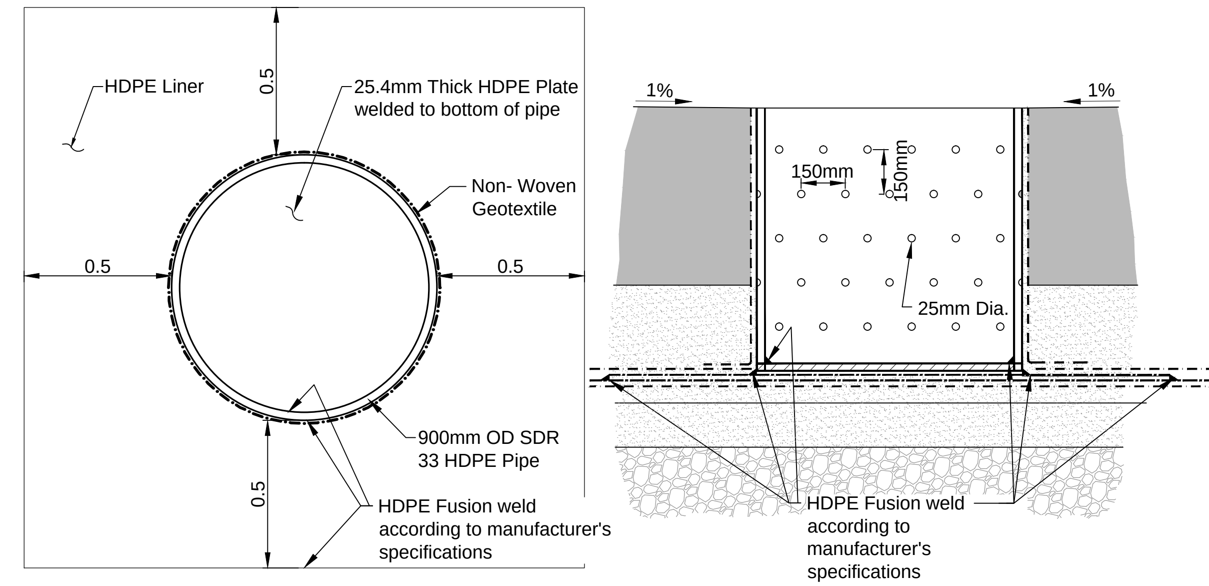
HOPE BAY PROJECT
SRK JOB NO.: 1CT022.013

Boston Surface Infrastructure
DRAWING TITLE:
Reagent Facility Plan and Section

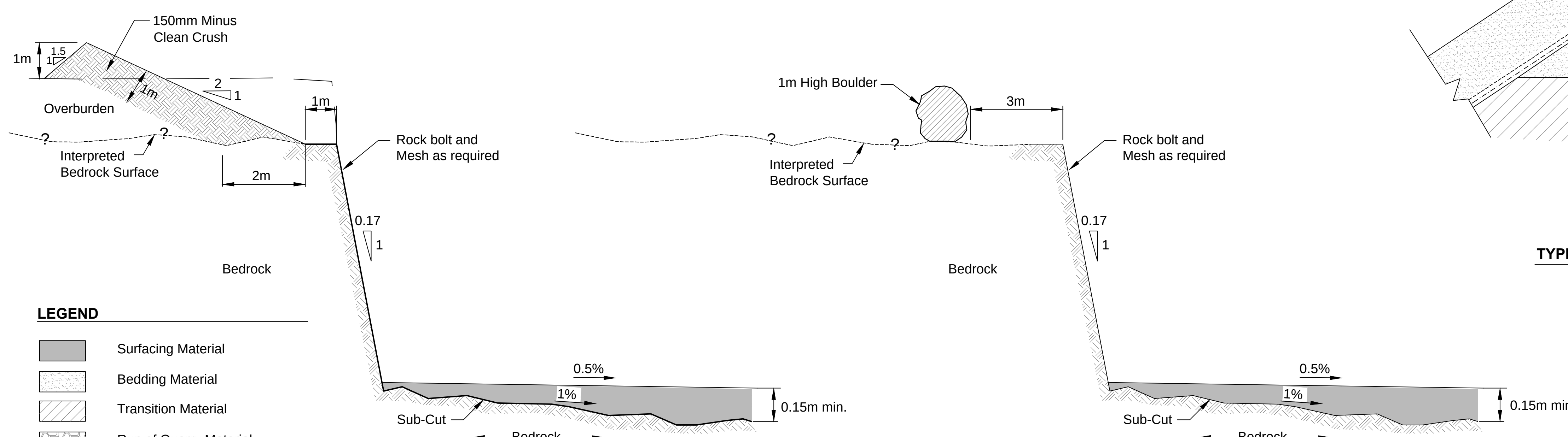
DRAWING NO.: BC-08 | SHEET: 9 of 18 | REVISION NO.: B

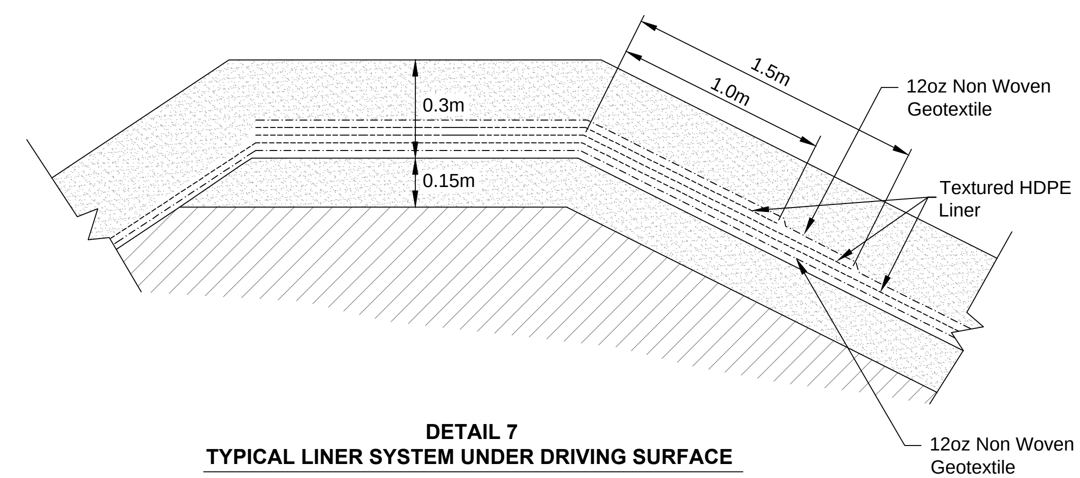


DETAIL 4
TYPICAL BERM BARRIER OPTIONS
NTS



DETAIL 6 - SUMP
NTS





DETAIL 7
TYPICAL LINER SYSTEM UNDER DRIVING SURFACE
NTS

LEGEND

- Surfacing Material
- Bedding Material
- Transition Material
- Run of Quarry Material
- Rip Rap
- Non-woven Geotextile
- HDPE Liner

NOTE

1. Dimensions in metres unless noted otherwise.

DETAIL 5
TYPICAL SECTIONS OF HIGHWALL AND SAFETY BARRIER
NTS

NO.	DESCRIPTION	CHK'D	APP'D	DATE
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A	Issued for Discussion	MMM	EMR	8Jul16

REVISIONS

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HOPE BAY PROJECT

SRK JOB NO.: 1CT022.013

Boston Surface Infrastructure

DRAWING TITLE:
Berm, Barrier, and Fuel Facility Details

DRAWING NO.: BC-09 | SHEET 10 OF 18 | REVISION NO. B

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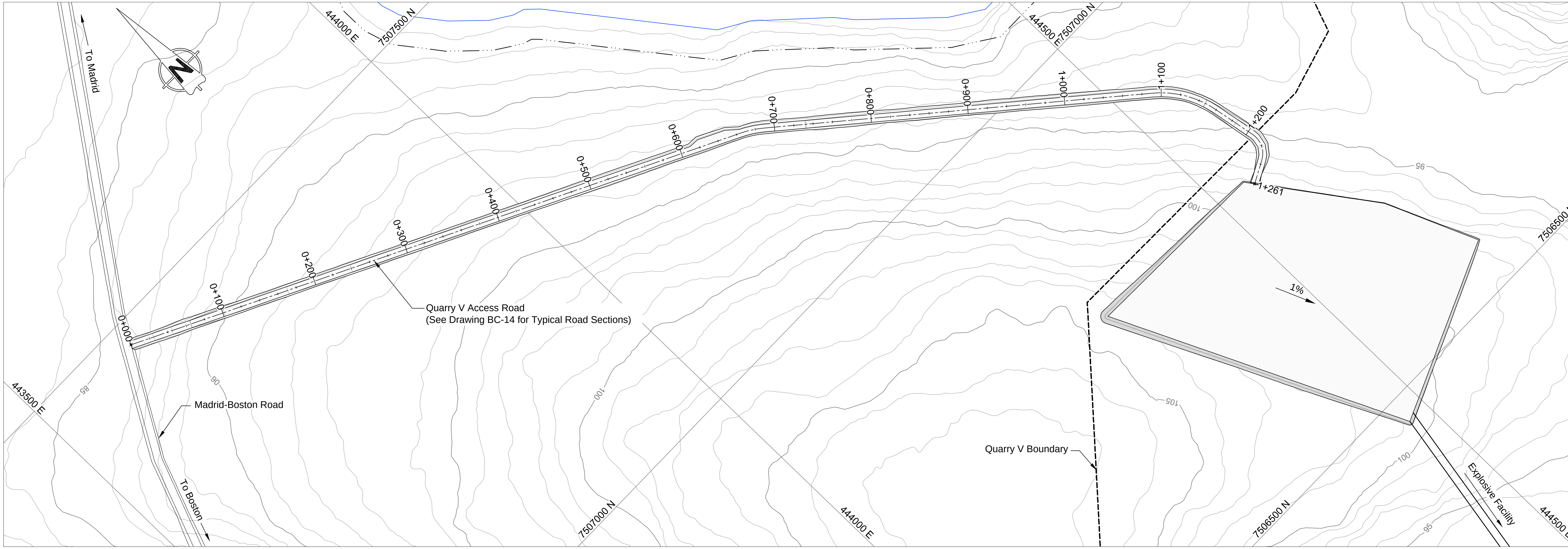


NOTES

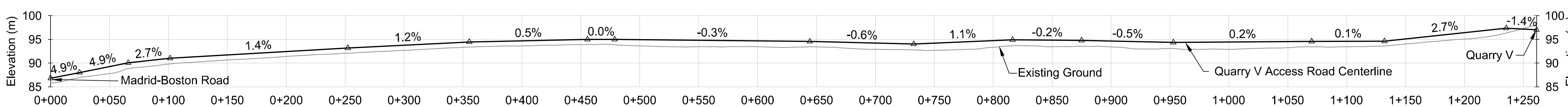
1. The coordinate system is UTM Zone 13, NAD83.
2. Dimensions in metres unless noted otherwise.
3. Contour labels are oriented facing upslope.

LEGEND

— · · · — 31m Stream / Lake Setback

QUARRY V PLAN VIEW

0 20 40 60 80 100
Scale in Metres



QUARRY V ACCESS ROAD PROFILE

0 20 40 60 80 100
Horizontal Scale in Metres
Vertical Exaggeration 4X

PROFILE LEGEND

△ Point of Vertical Intersection

6.1% Grade

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SRK JOB NO.: 1CT022.013

Boston Surface Infrastructure

DRAWING TITLE:
Quarry V Conceptual Excavation and Access Road

DRAWING NO.: BC-10
SHEET 11 of 18
REVISION NO.: B

NOTES

1. The coordinate system is UTM Zone 13, NAD83.
2. Dimensions in metres unless noted otherwise.
3. Contour labels are oriented facing upslope.

NO.	DESCRIPTION	CHK'D	APP'D	DATE
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A	Issued for Discussion	MMM	EMR	8Jul16

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HOPE BAY PROJECT

SRK JOB NO.: 1CT022.013

Boston Surface Infrastructure

DRAWING TITLE:

Non-Hazardous Waste Landfill Design

DRAWING NO. BC-11 | SHEET 12 of 18 | REVISION NO. B

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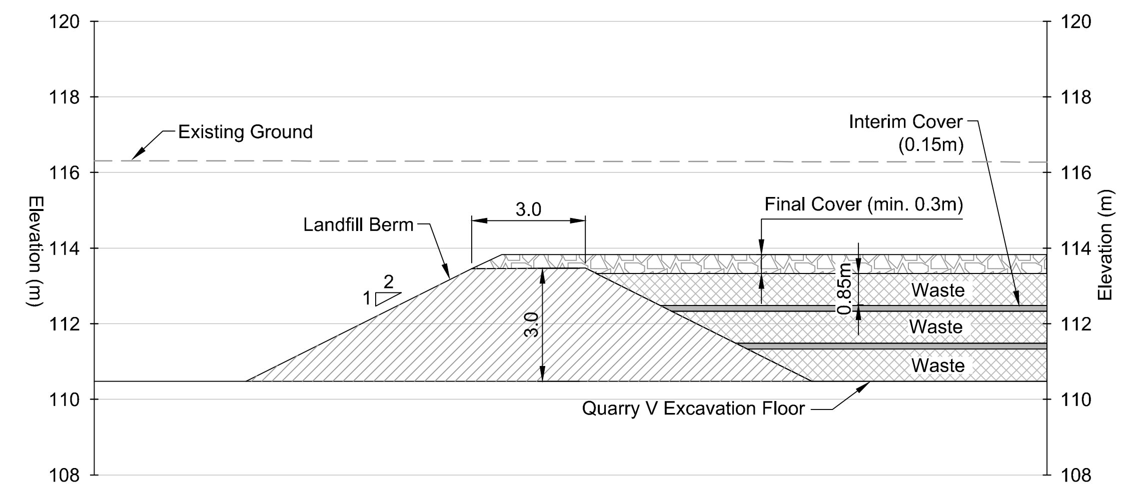
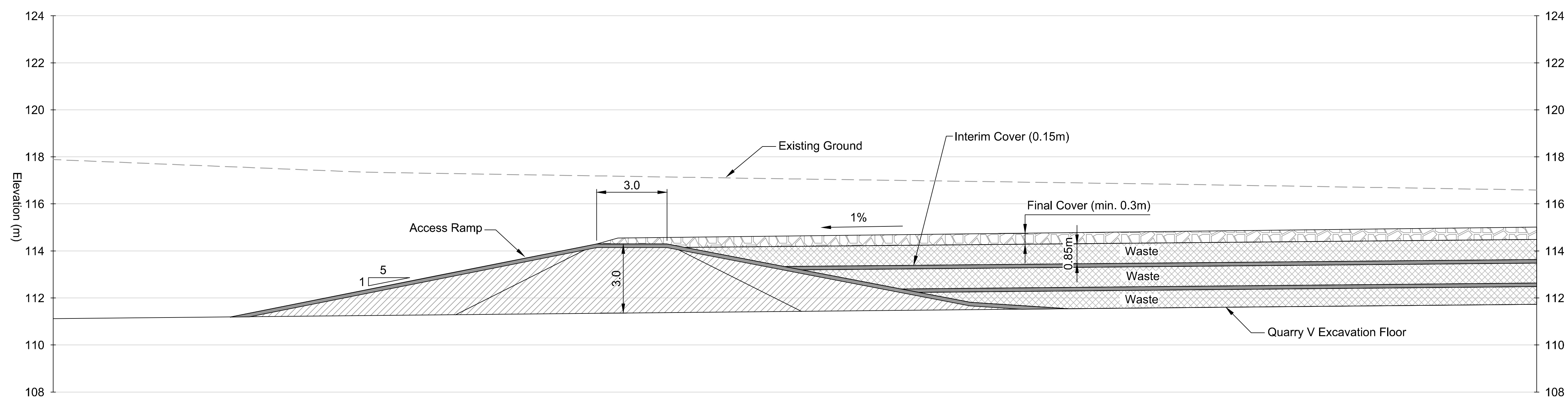


I BC-11 **SECTION I**

0 1 2 3 4 5
Scale in Metres



J BC-11 **SECTION J**

0 1 2 3 4 5
Scale in Metres

LEGEND

- Surfacing Material
- Run of Quarry Material
- Transition Material
- Non-Hazardous Waste

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NO.	DESCRIPTION	CHK'D	APP'D	DATE
C	Issued for Discussion	KK	EMR	7Dec17
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A	Issued for Discussion	MMM	EMR	8Jul16

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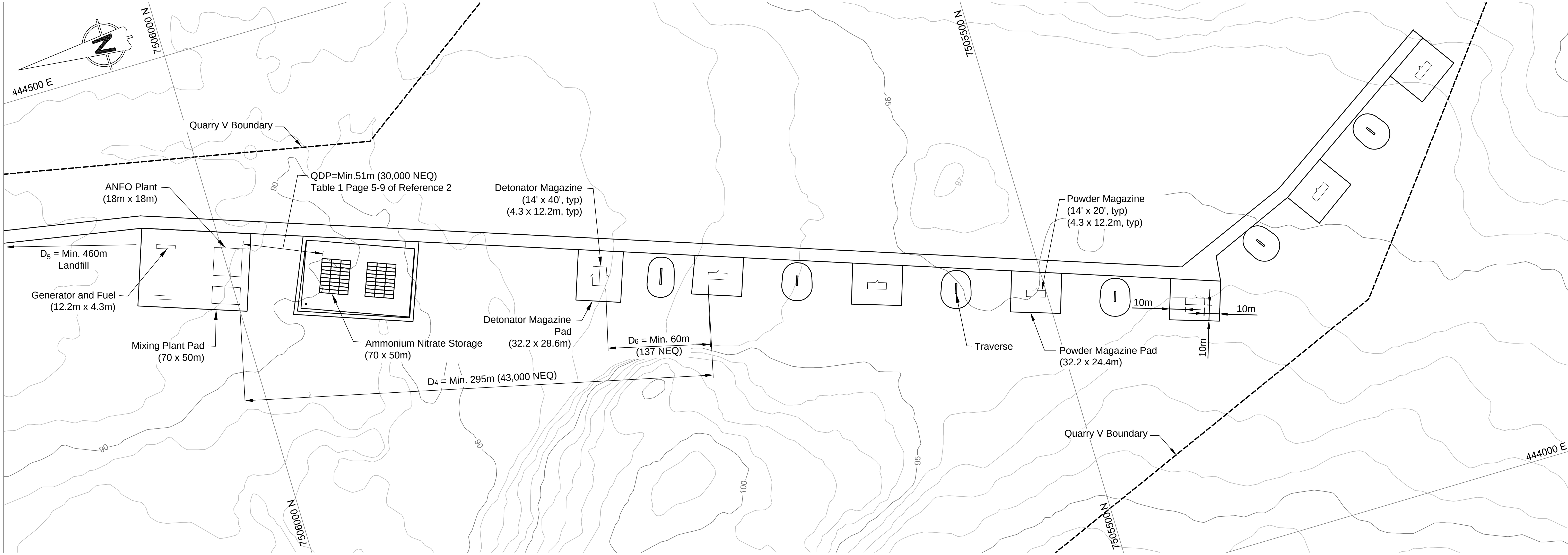
SRK JOB NO.: 1CT022.013

Boston Surface Infrastructure

DRAWING TITLE:

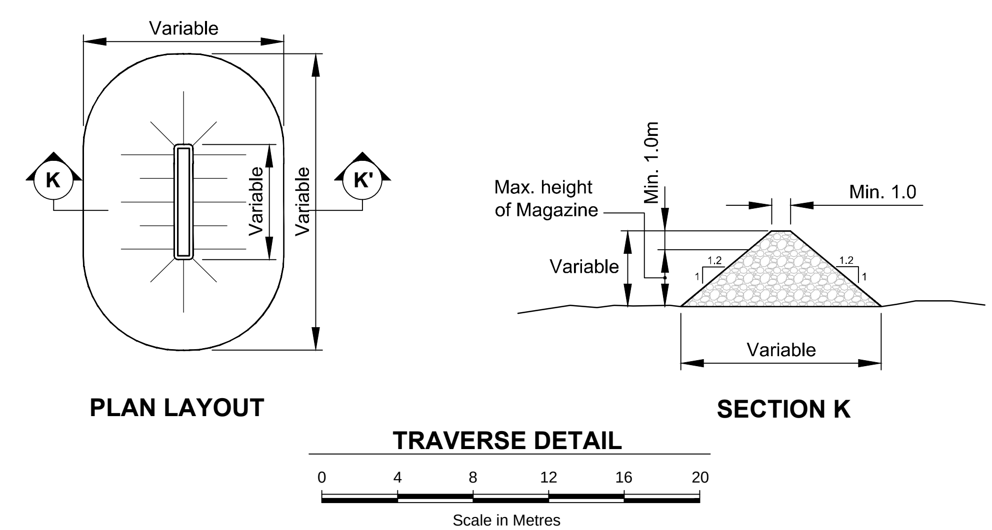
Non-Hazardous Waste Landfill Sections

DRAWING NO. BC-12 | SHEET 13 of 18 | REVISION NO. C



EXPLOSIVES FACILITY PLAN LAYOUT

0 10 20 30 40 50
Scale in Metres



TRAVERSE DETAIL

NOTES

1. Explosives facility to only be developed within Quarry V once quarrying of Quarry V is determined complete.
2. Design is shown on existing surface contours. Final layout of explosives facility to be determined based on final surface of Quarry V.
3. The Construction Manager is responsible for moving and stocking of the Type 4 magazine in accordance to regulations and permits.
4. TMAC is responsible for obtaining the required permits for the facility.
5. All facility pads must be level with minimum 0.15m surfacing material on quarry floor.
6. Design of the Explosives facility followed Quantity distance Tables listed Table 5-1, Blasting Explosives and Detonators.
7. Design of the Explosives facility followed the Table on Page 5-9 Quantity Distance Principles (QDP)
8. Quantity/Distance table values on this drawing are shown in Italics and are Line of Sight distances.
9. All Engineering units on the drawing is measured along centerline of the Access Road.
10. Barricades are required where fills exceed 3m.

REFERENCES

1. Blasting Explosives and Detonators: Storage, Possession, Transportation, Destruction and Sale. Natural Resources Canada, Explosives Branch, 1993.
2. Quantity Distance Principles: Users Manual. Natural Resources Canada, Explosives Branch July 2007.

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE

REFERENCE DRAWINGS

NO.	DESCRIPTION	CHK'D	APP'D	DATE
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TMAC RESOURCES

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Boston Surface Infrastructure

DRAWING TITLE: Explosive Facility Design

DRAWING NO.: BC-13
SHEET 14 of 18
REVISION NO.: B

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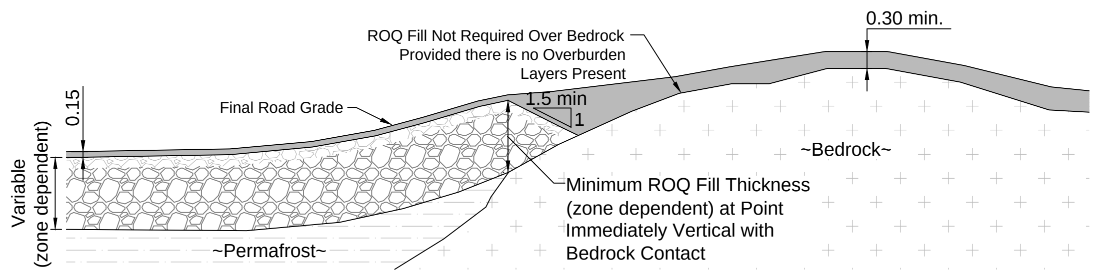
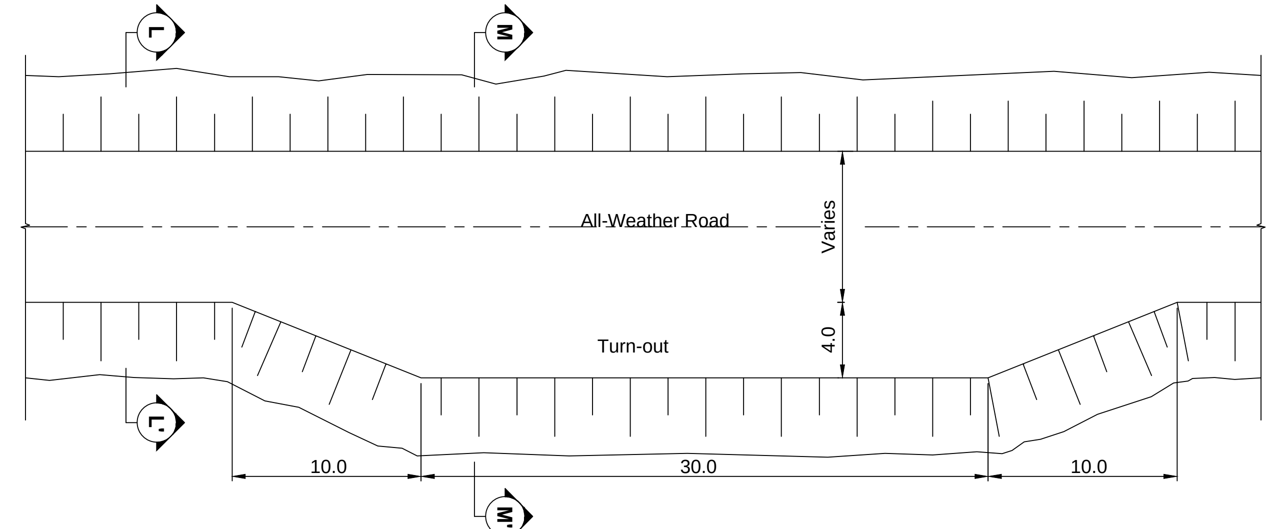


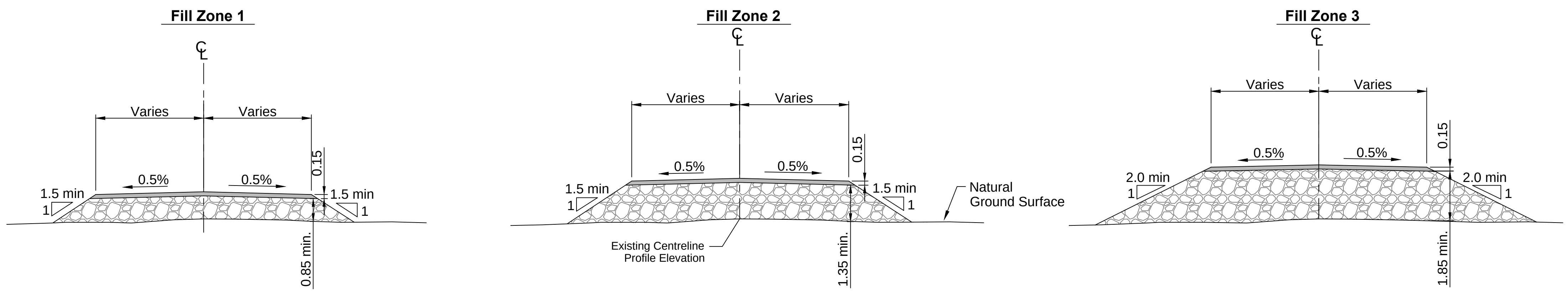
ALL-WEATHER ROAD PROFILE
TRANSITION FROM PERMAFROST TO BEDROCK

0 1 2 3 4 5
Scale in Metres



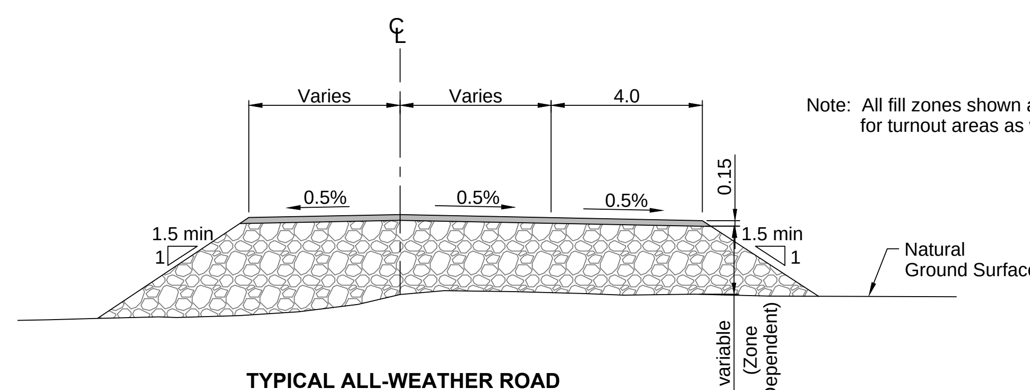
PLAN
TYPICAL ALL-WEATHER ROAD & TURNOUT

0 2 4 6 8 10
Scale in Metres



TYPICAL
ALL-WEATHER ROAD SECTIONS
(L)

0 1 2 3 4 5
Scale in Metres



Note: All fill zones shown above apply for turnout areas as well.

TYPICAL ALL-WEATHER ROAD
WITH TURN-OUT SECTION
(M)

0 1 2 3 4 5
Scale in Metres

LEGEND

- Surfacing Material
- Run of Quarry Material

NOTES

1. All dimensions in metres unless noted otherwise.
2. Minimum design thickness must be maintained for all sections of the all-weather road including turnouts.
3. Notes in this drawing apply to all other active drawings.

NO.	DESCRIPTION	CHK'D	APP'D	DATE
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TMAC RESOURCES

HOPE BAY PROJECT

SRK JOB NO.: 1CT022.013

Boston Surface Infrastructure

DRAWING TITLE: Typical Road Plan and Sections

DRAWING NO.	SHEET	REVISION NO.
BC-14	15 of 18	B

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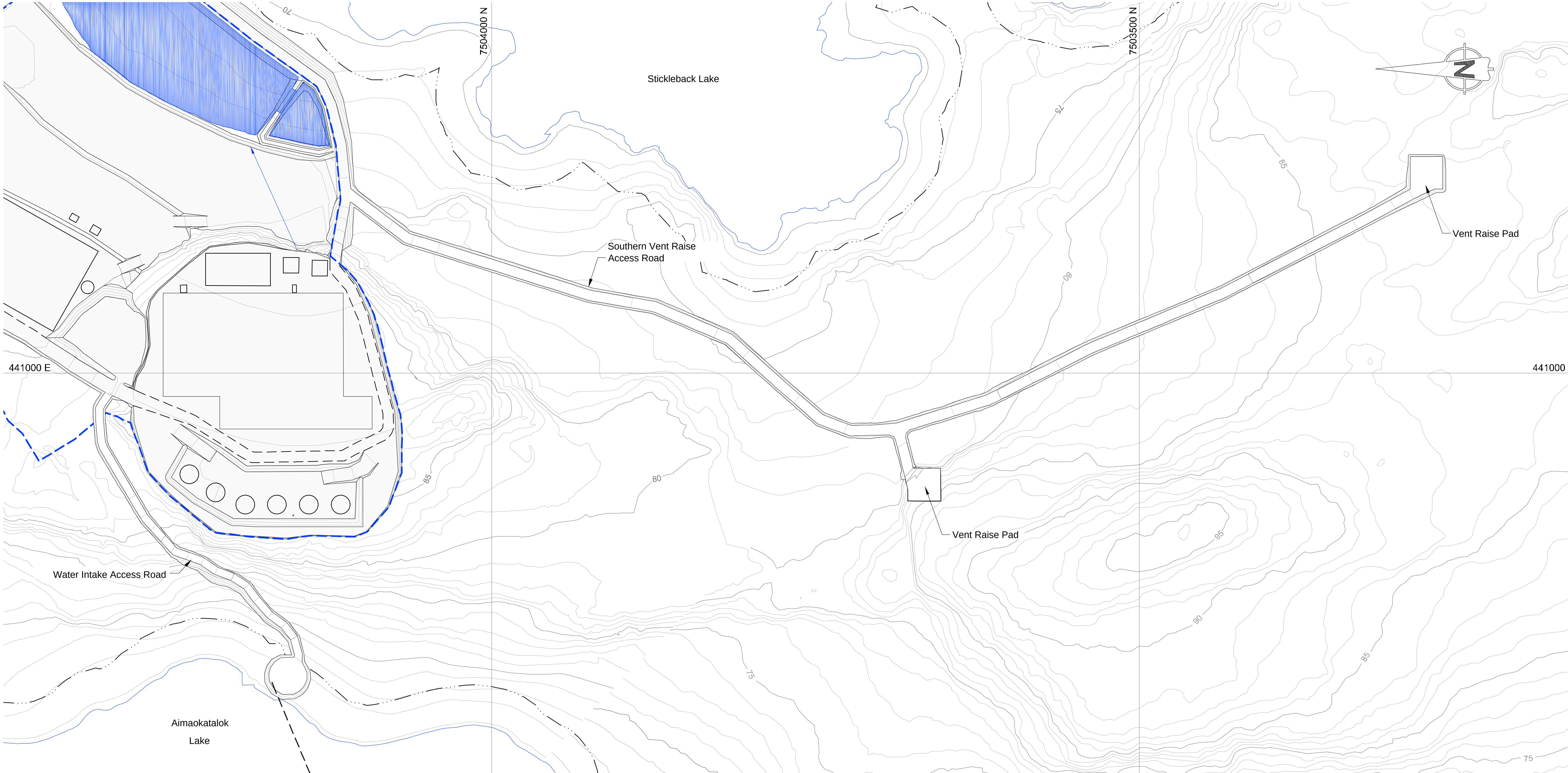

LEGEND

- 31m Stream / Lake Setback
- 50m Underground Workings Buffer

NOTES

1. The coordinate system is UTM Zone 13, NAD83.
2. Dimensions in metres unless noted otherwise.
3. Contour labels are oriented facing upslope.

0 10 20 30 40 50
Scale in Metres

NO.	DESCRIPTION	CHK'D	APP'D	DATE
B	Issued for Discussion	KK	EMR	7Dec17
A	Issued for Discussion	MMM	EMR	16Nov16

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TMAC RESOURCES

HOPE BAY PROJECT

SRK JOB NO.: 1CT022.013

Boston Surface Infrastructure

DRAWING TITLE:
Southern Vent Raise and Water Intake Access Roads Layout

DRAWING NO.: BC-15 | SHEET 16 of 18 | REVISION NO. B

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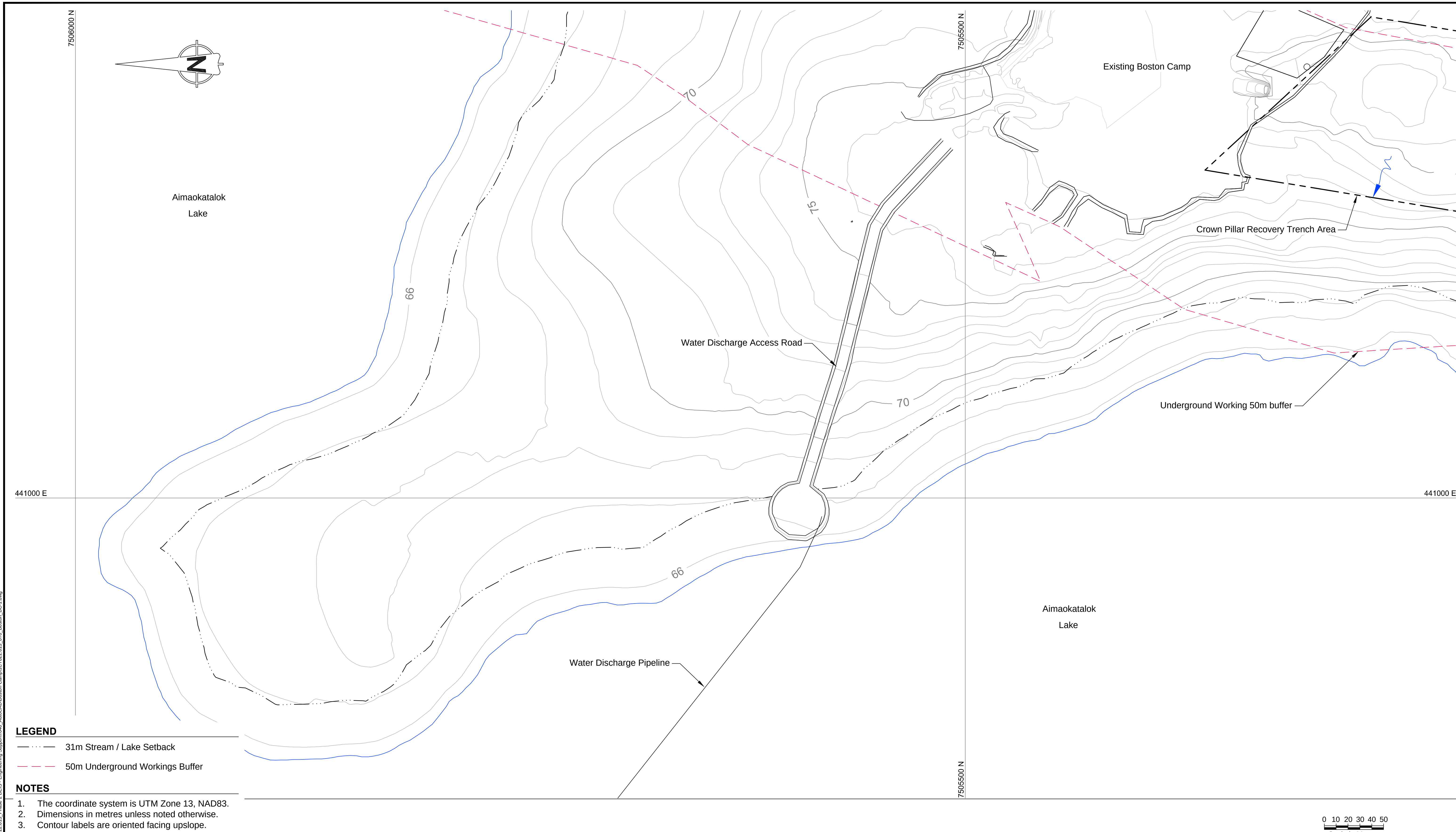

LEGEND

- 31m Stream / Lake Setback
- 50m Underground Workings Buffer

NOTES

1. The coordinate system is UTM Zone 13, NAD83.
2. Dimensions in metres unless noted otherwise.
3. Contour labels are oriented facing upslope.

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A	Issued for Discussion	MMM	EMR	16Nov16

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TMAC RESOURCES

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SRK JOB NO.: 1CT022.013

Boston Surface Infrastructure

DRAWING TITLE:

Water Discharge Pipeline and Access Road

DRAWING NO. BC-16 | SHEET 17 of 18 | REVISION NO. B

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Materials List and Quantity Estimates

Item	Quantity / Area / Volume	ROQ (cu.m.)	Cut (cu.m.)	Description
1. Run of Quarry Material	Sediment Pond Berm	12,600		Approximate In-Place Neat-line Volume (3D volume based on Civil 3D surfaces - no allowance has been made for losses and/or tundra embedment)
	Camp Pads	118,130		
	Waste Rock Pad	38,500		
	Overburden Pad	18,800		
	Vent Raise Road and Pad	2,430		
	Heliport Road and Pad	5,010		
	Process Plant Haul Road	6,960		
	Camp Ring Road	4,560	100	
	Southern Vent Raise Access Road & Pads	11,340	1,870	
	Water Intake Access Road	4,410		
	Water Discharge Access Road	2,435		
	Communications Tower Access Road	3,420		
	Exploration Pad	48,950		
	Process Plant Pad		196,200	
	Fuel Facility Excavation		8,600	
	Totals	277,545	206,670	
2. Surfacing Material	Sediment Pond Berm	410		Approximate In-Place Neat-line Volume
	Camp Pads	11,010		
	Vent Raise Road and Pad	220		
	Heliport Road and Pad	180		
	Process Plant Haul Road	840		
	Camp Ring Road	390		
	Southern Vent Raise Access Road & Pads	1,310		
	Water Intake Access Road	355		
	Water Discharge Access Road	295		
	Communications Tower Access Road	240		
	Exploration Pad	6,010		
	Process Plant Pad	5,200		
	Total	26,070		
3. Overburden			Cut (cu.m.) 35,000	Estimated

Materials List and Quantities for Landfill and Landfill Access Road

Item	Volume		Description
1. Run-of-Quarry Material	Final Cover within Berm	26,000 m^3	Approximate In-Place Neat-line Volume
	Quarry V Access Road	3,200 m^3	
2. Transition Material	Berm (includes access ramp)	9,900 m^3	Approximate In-Place Neat-line Volume
3. Surfacing Material	Quarry V Access Road	1,500 m^3	Approximate In-Place Neat-line Volume
	0.15m Interim Covers	7,200 m^3	
	Access Ramp	30 m^3	
4. Non-Hazardous Waste	Storage Capacity	61,000 m^3	Approximate In-Place Neat-line Volume

Materials List and Quantities for Explosive Facility

Item	Volume		Description
1. Run-of-Quarry Material	6 Traverses	4,800 m^3	Approximate In-Place Neat-line Volume
2. Surfacing Material	Access Road	1,600 m^3	Approximate Volume by footprint areas
	Pads	2,100 m^3	

Materials List and Quantities (Fuel Storage Facility)

Item	Quantity / Area / Volume		Description
Excavation Cut		8,600 m^3	Volumes derived by Civil 3D - Side slopes 2H:1V Unless otherwise noted
Bedding Material	OverLiner	2940 m^3	
	UnderLiner	980 m^3	
Surfacing Material	Floor Leveling beneath underliner	600 m^3	
Geotextile (2 Layers)	Geotextile OverLiner	6550 m^2	12 oz. Non Woven
	Geotextile UnderLiner	6550 m^2	
	Sump	5 m^2	
Liner	Geomembrane Liner	6550 m^2	Textured HDPE 60 mil or Equivalent
	Sump	5 m^2	

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A	Issued for Discussion	MMM	EMR	8Jul16

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FILE NAME: 1CT022.013_670_Boston_BC-3.dwg

TMAC RESOURCES

HOPE BAY PROJECT

SRK JOB NO.: 1CT022.013

Boston Surface Infrastructure

DRAWING TITLE: Material List and Quantity Estimates

DRAWING NO. BC-17 | SHEET 18 OF 18 | REVISION NO. C