

Volume 1 Annex V1-7 Type A Water Licence Applications

Package P5-17

Hope Bay Project: Madrid North Surface Infrastructure
Preliminary Design



Memo

To:	John Roberts, PEng, Vice President Environment Oliver Curran, MSc, Director Environmental Affairs	Client:	TMAC Resources Inc.
From:	Cameron Hore, CPEng, PEng	Project No:	1CT022.013
Reviewed By:	Maritz Rykaart, PhD, PEng	Date:	November 30, 2017
Subject:	Hope Bay Project: Madrid North 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 V3-3G 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	1,2,3,4	Reference to infrastructure approved under 2BB-MAE1727
KIA-DEIS-57	2.4	Clarification that additional geotechnical investigations will be completed prior to detailed engineering.

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

Mining and infrastructure at Madrid will comprise of two separate areas: Madrid North and Madrid South, located approximately 5 km apart via an all-weather road. These areas are not self-contained mining complexes like Doris, but rather satellite facilities focused on supporting mining activities with final processing (including tailings) and camp services relied upon at Doris.

A Type “B” Water Licence (No. 2BB-MAE1727; TMAC – Madrid Advanced Exploration Program) for the Madrid area was approved in May 2017. The preliminary designs and drawings for development of the Madrid North surface infrastructure for Phase 2 as presented in this memo builds on the infrastructure approved under this license (2BB-MAE1727).

1.2 Objectives

This memo provides preliminary engineering design details of the Madrid North surface infrastructure for Phase 2.

2 Design Concept

2.1 Approach

As mentioned, Madrid North is not a self-contained mining complex, but is a satellite mine that shares the processing and camp facilities of Doris. To this end, the Madrid North surface infrastructure is limited to the minimum necessary to support underground mining activities at source, but does include a 1,200 tonnes per day (tpd) processing plant where gold concentrate will be produced. About 10% of the reprocessed ore at this facility will be trucked as concentrate to the Doris processing plant for further refinement. The floatation tailings produced at Madrid North will be pumped to the Doris tailings impoundment area (TIA).

The overall design concepts for the Madrid North surface infrastructure (i.e., pads, roads and water management facilities) are based on the same principles as used for Doris. 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 decided that all-site roads should be designed to the minimum haul road requirements set out in the Nunavut Mine Health and Safety Regulations (WSCC 2015).

2.2 Infrastructure Components

The infrastructure associated with the mining activities at Madrid North consist of infrastructure at the portal and infrastructure at the vent raises. These components, along with limitations on their location are summarized in Table 2.1.

Table 2.1: Summary of Infrastructure Associated with Madrid North

Infrastructure Component	Surface Area	Limitations and Comments	Change from approved infrastructure under 2BB-MAE1727
Waste rock pad (and associated waste rock pile)	Location dependant	Haul distance of less than 500 m from portal Haul road grade cannot exceed 7% Minimum storage of 646,000 tonnes (359,000 m ³) of waste rock	Increase in storage from 285,000 tonnes to 646,000 tonnes (127% increase in storage tonnage).
Ore pad (and associated ore stockpile)	Location dependant	Haul distance of less than 500 m from portal Haul road grade cannot exceed 7% Maximum storage of 50,000 tonnes (27,800 m ³)	No change Expected Phase 2 operational Ore Stockpile tonnage is 16,000 tonnes (9,000 m ³).
Contact water pond	Location dependant	Downstream of ore and waste rock pads Considered an event pond, (i.e. not designed to retain water for prolonged time periods)	No change in criteria, minor change in layout.
Mine equipment shop	450 m ² (15 x 30 m)	Routine servicing of underground mine fleet Major repairs/rebuilds conducted at Doris	No change
Compressor building	25 m ² (5 x 5 m)	Attached to the mine equipment shop	New for Phase 2
Laydown area	10,000 m ²	General outside storage area for equipment and supplies	Increase from 1,000 m ²
Diesel generator	19 m ² (2.5 x 7.5 m)	Directly adjacent to portal Self-contained unit	No change
Office trailer	169 m ² (13 x 13 m)	Building	Change from trailer to building, minor increase in expected size.
Emergency shelter	37.5 m ² (3 x 12.5 m)	Trailer	No change

Infrastructure Component	Surface Area	Limitations and Comments	Change from approved infrastructure under 2BB-MAE1727
Brine mixing facility	19 m ² (2.5 x 7.5 m)	Will likely be placed underground Alternatively, directly adjacent to portal Modified seacan container Also includes area for calcium chloride storage	No change
Water tank (saline underground mine water)	144 m ² (12 x 12 m)	Directly adjacent to portal Assumed to be a 50,000 L steel tank with 4.4 m radius, in a lined containment area	No change
Power plant	575 m ² (25 x 38 m)	Requires bedrock, or piled foundation	New for Phase 2
Processing plant (concentrate only)	4,500 m ² (60 x 75 m)	Requires bedrock, or piled foundation Near power station to maximize heat recovery opportunity	New for Phase 2
Fuel storage facility	5,400 m ² (60 x 90 m)	Includes fuel transfer station Lined secondary containment area Contains three 1.5 ML fuel tanks Should be founded on bedrock or shallow (< 3 m) overburden	Increase in storage from 0.075 ML to 4.5 ML.
Air heating facility	19 m ² (2.5 x 7.5 m)	Immediately adjacent to vent raise Updraft vent with electrical power supplied from underground substation	No change
Vent raise pads (3)	625 m ² (25 x 25 m)	Vent raise pads with nominal area, infrastructure on these pads to be determined	Two (2) additional vent raises

2.3 Topographic Data

Design of the Madrid North infrastructure pads, access roads and water management structures are based on topographic contour maps with 0.5 m vertical resolution produced from 2008 aerial photography supplied by Hope Bay Mining Limited. Detailed ground surveys have not been completed.

2.4 Foundation Conditions

Numerous geotechnical investigations have been performed at the Project site, though no geotechnical investigation, or laboratory testing have been performed within the footprint of the Madrid North site. The closest geotechnical drill hole to the site is approximately 500 m to the North of the Madrid North Portal (SRK 2009). Additional geotechnical investigations will be completed prior to detailed engineering.

Project wide overburden consists of permafrost soils which are mainly of 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% (SRK 2017a). 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. The salinity of the marine silts and clays typically ranges from 37 to 47 parts per thousand which depresses the freezing point and contributes to higher unfrozen water content at below freezing temperatures.

Permafrost at the Project site extends to depths of about 570 m, with an average geothermal gradient of 0.021°C/m. Active layer depths in overburden soil averages 1.0 m, with a range from 0.5 to 1.7 m (SRK 2017b).

Isopach maps developed from exploration and geotechnical drill holes indicate that depths of overburden under the mining infrastructure is expected to range from 0 to 10 m, with most areas having less than 3 m of overburden. The closest drill holes (SRK-07-34, SRK-07-35 and SRK-07-37) indicate that the overburden under the infrastructure pads is likely silty clay or silty sand, and that there could be thin layers of black organic material at a depth of ~11 m. Ice content of the foundation soils could also be in the higher end of those typically found on the Project, as drill hole SRK-07-35 (~700 m northeast of the portal) notes ice contents up to 50% (SRK 2009).

General foundation conditions, material properties for geotechnical analysis, and development of the overburden isopach surface area are described in more detail in SRK (2017a).

2.5 Environmental Setbacks

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

- Minimum 31 m setback from waterbodies, 51 m setback where ever 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 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 Level of Surface Infrastructure Development

Three alternative levels of development were considered for Madrid North as described in Table 2.1.

Table 3.1: Alternative Level of Surface Infrastructure Development

Alternative	Details
No surface Infrastructure, Access via Doris Portal	Access to Madrid North deposits would be underground via the Doris, Connector and Central underground workings, with no surface infrastructure, and no portal. This alternative would result in substantial additional underground development and associated waste rock, a need for additional vent raises, and substantial underground haul distances which are less effective than surface haul.
Full Satellite Mine Development	Vent raise, portal, and infrastructure pads with all-weather road access to Doris. All waste rock would be stored on-site until final deposition underground. Infrastructure pad footprint is not much larger than the minimal development option.
Complete Standalone Mine Development	Construction and operation of a camp and processing facility at Madrid North. This would require extensive additional infrastructure footprint similar to that currently at Doris.
Hybrid Satellite Mine Development	Construction of a nominal concentrator processing facility at Madrid North in addition to all of the remaining facilities planned for the full satellite mine development alternative. No camp facilities. This would require less footprint than a complete standalone mine, but offer the flexibility of local processing of higher grade ore.

The hybrid satellite mine development alternative is the preferred alternative because it has the smallest surface footprint while maximizing flexibility, produces less waste rock, and surface haul is more effective than underground haul.

3.2 Waste Rock Pile

Waste rock needs to be temporarily stored on surface until it can be returned underground for use as backfill. Table 3.2 describes four waste rock piles that were considered. The west waste rock pile, configured as hilltop facility was selected as the preferred location based on the portal location, water management requirements and overall footprint size. This is the same location as the Waste Rock Pile approved under 2BB-MAE1727.

Table 3.2: Alternative Waste Rock Pile Locations

Alternative	Details
South Waste Rock Pile – Gulley Fill	For this alternative, the waste rock pile would span a gulley to the south of the rock outcrop where the portal will be located. The ore stockpile and portal infrastructure would be located uphill from the waste rock pile. Two contact water ponds would be required to contain contact water, one of which would be expected to have high berms. Extensive no-contact water diversions would be required to prevent freshwater from running onto infrastructure pads. This alternative would have a compact footprint.
South Waste Rock Pile – Sidehill	For this alternative, the waste rock pile would be constructed on the side of the hill south of the rock outcrop where the portal will be located. The ore stockpile and portal infrastructure would be located uphill from the waste rock pile. Two contact water ponds would be required, one of which would be expected to have high berms. This alternative would have a larger footprint, and only minor freshwater diversions would be required.
West Waste Rock Pile - Hilltop	For this alternative the waste rock pile would be constructed on top of the rock outcrop west of the portal location. The ore stockpile would be downhill of the waste rock pile, draining into the same contact water pond. It is expected that one contact water pond with relatively low berms would be required. Development of the portal and infrastructure pad would require cutting into the rock. This alternative would have a relatively compact layout.
East Waste Rock Pile - Hilltop	For this alternative, the waste rock pile would be constructed on top of the rock outcrop to the west of the portal location. The waste rock stockpile would be constructed in part on rock outcrop. Two contact water ponds would be required, both ponds would require low berms. Diversion berms would be required to direct the contact water towards the contact water ponds and reduce run-on from freshwater. This alternative would have a larger footprint.

4 System Design

4.1 Waste Rock Pile and Ore Stockpile

4.1.1 Design Criteria

The waste rock pile and ore stockpile are expected to be temporary facilities, with all waste rock being returned underground as mine backfill, and all ore processed. The design criteria for these two facilities are listed below:

- Minimum waste rock storage capacity of 646,000 tonnes (359,000 m³, based on an in place density of 1.8 t/m³);
- Minimum ore storage capacity of 16,000 tonnes (9,000 m³), based on an in place density of 1.8 t/m³), which is equivalent to five days storage at maximum production;
- Maximum overall slope angle 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 (37.5°), bench heights of 5 m, and bench widths of 6 m;
- Maximum height of 100 m;
- Factors of safety (FOS) as defined in the Mined Rock and Overburden Piles Interim guidelines (Piteau 1991) of:
 - 1.1 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 is a loaded Sandvik TH540 (40 tonne) haul truck.

4.1.2 Design

The Madrid North waste rock pile has a maximum available capacity of 652,000 tonnes (359,000 m³), and a maximum height of approximately 20 m. The waste rock pile is located on a 1 m thick run-of-quarry (ROQ) or geochemically suitable run-of-mine (ROM) waste rock material pad. The waste rock pile pad will cover an area of 42,000 m² and the expected ore stockpile will cover an area of 2,500 m² within the upper portal pad. The waste rock pile is to be located in the same location as the waste rock pile approved under 2BB-MAE1727 with a 127% increase in storage tonnage and a 50% increase in pad footprint.

The Madrid North waste rock pile has a dump 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).

To evaluate the stability of all site waste rock piles, a stability analysis was performed on the Madrid South waste rock pile, and a conceptual maximum waste rock pile with a height of 100 m. This analysis indicates that waste rock piles on-site are expected to be stable, provided that the design vehicle remains 5.5 m from the crest of the pile during operations. Details of the stability analysis including material properties, and seismic parameters used in this assessment are described in SRK (2017a).

4.2 Contact Water Pond

There will be a single unlined contact water pond at Madrid North, this pond will be located downstream of the waste rock pile and ore stockpile. This is the same location as the contact water pond approved under 2BB-MAE1727.

The design criteria and design of the contact water pond is provided in SRK– Madrid Water Management Engineering Report (2017c).

4.3 Infrastructure Pads

4.3.1 Design Criteria

The design criteria for the infrastructure pads are listed below.

- Minimum fill thickness of 1 m;
- 1.5H:1V (34°) side slopes when fill thickness are less than 2 m;
- 2H:1V (26.5°) side slopes 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 which consists of a minimum of 0.85 m of ROQ of geochemically suitable waste rock material overlain by 0.15 m of surfacing material consisting of crushed quarry or waste rock material. The exception being the waste rock pile and ore stockpile pads which do not have the layer of surfacing material. The mining area pads are sloped at 0.5% towards the contact water pond. Design analysis to demonstrate the suitability of a 1 m thick ROQ pad to protect the permafrost is presented in SRK (2017d).

4.4 Access and Haul Roads

4.4.1 Design Criteria

Six access roads are needed in the Madrid North mining area:

1. An access/haul road that links the mining infrastructure with the Madrid-South all-weather road (upper portal access road, approved under 2BB-MAE1727),
2. An access road around the contact water pond berm (pond access road, approved under 2BB-MAE1727),

3. An access/haul road that links the fuel storage facility with the mining infrastructure and with the Madrid-South all-weather road (fuel storage facility access road),
4. An access road to the Madrid North air heating facility and vent raise (Madrid-North air heating facility access road, approved under 2BB-MAE1727),
5. An access road to the two other vent raise pads (vent raise pad access road), and
6. An access/haul road to the eastern Madrid crown pillar recovery trench (Madrid CPRT access road).

The design criteria for the access and haul roads is similar to that used on other roads at the Project site. Specific criteria are:

- 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 9.5 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.
- No cut is allowed into overburden.

4.4.2 Design

The upper portal access road is 300 m long and 10.0 m wide and extends from the Madrid-South all-weather road to the portal upper pad. The pond access road will come off the side of this road. This road can be seen on Drawing DEIS-MN-03 (Attachment 2).

The pond access road will run from the portal pad around the contact water pond berms (Drawing DEIS-MN-03, Attachment 2) to the upper portal access road adjacent to the laydown area. This road is 440 m long and 8.0 m wide.

The fuel storage facility access road runs from the Madrid-South all-weather road to the upper portal pad via the fuel storage facility and the waste rock pile pad (Drawing DEIS-MN-03, Attachment 2). This road is 450 m long and 10.0 m wide. A fuel storage facility bypass road links the fuel storage facility access road and the waste rock pile, bypassing the fuel storage facility. The fuel storage facility bypass road is 115 m long and 8.0 m wide.

The Madrid North air heating facility access road is 130 m long and 8.0 m wide, and extends from the Madrid-South all-weather road to the Madrid North air heating facility and vent raise (Drawing DEIS-MN-07, Attachment 2).

The vent raise pad access road is 1,130 m long and 8.0 m wide, and extends from the Madrid-South all-weather road to the south-east (Drawing DEIS-MN-09, Attachment 2).

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

4.5 Fuel Storage Facility

4.5.1 Design Criteria

The fuel storage facility will include a fuel transfer station for refueling of vehicles. Design criteria for the fuel storage facility and fuel transfer station are listed below.

- Fuel storage tank and transfer station will be within a lined facility to provide secondary containment.
- The total fuel tank capacity will be 4.5 ML (three 1.5 ML tanks).
- The design vehicles for the facility are crew cab trucks, and Super B fuel trucks (60,000 L capacity).
- The secondary containment facility will be designed to contain 110% of the largest fuel tank volume, 10% of the fuel transport truck volume, all the rainfall from the 1:100 year, 24-hour storm (55 mm) and the average maximum daily snowmelt (18 mm).
- The containment area should have a minimum slope of 1% towards a sump.

In addition, the fuel storage facilities 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).

4.5.2 Design

The entire footprint of the fuel storage area 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 the center of the facility, a minimum of 3.0 m from the base of the containment area berms to allow access. The containment berms will be constructed of transition material overlain by the geomembrane and bedding layers described above. The berms will have interior slopes of 2H:1V (26.5°) to allow for geomembrane placement, and exterior slopes of 1.5H:1V (34°). The secondary containment facility will have a surface area of approximately 5,400 m², and a minimum containment capacity of 2,100 m³.

The fuel transfer station, will be a 6 m wide ramp allowing vehicles to drive through the facility. It will consist of ramps sloping at 7% entering and exiting the facility and internal ramps sloping at 10% to a 6.7 m long flat area at the center of the facility. The flat area is where the fuel transfer module will be set up and where refueling will occur.

Details of the fuel storage facility design are presented in Drawing DEIS-MN-06 (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 MNP-12 (Attachment 2).

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 its 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 screening of the site for nesting birds, and modifications to the construction schedule may be required to avoid disturbing nesting birds.

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The opinions expressed in this report have been based on the information available to SRK at the time of preparation. SRK has exercised all due care in reviewing information supplied by others for use on this project. Whilst SRK has compared key supplied data with expected values, the accuracy of the results and conclusions from the review are entirely reliant on the accuracy and completeness of the supplied data. SRK does not accept responsibility for any errors or omissions in the supplied information, except to the extent that SRK was hired to verify the data.

6 References

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Attachment 1:
Waste Rock Pile Stability Rating

Structure Name: Madrid North 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	Moderate	10%-25%	50
Degree of confinement	Unconfined	-Convex slope in plan or section -Sidehill or ridge crest fill with no toe confinements -No gullies or benches to assist development	100
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	High	- Strong, durable - Less than about 10% fines	0
Method of Construction	Favorable	- Thin lifts (<25m thick), wide platforms -Dumping along contours -Ascending construction -Wrap-arounds or terraces	0
Piezometric and Climatic Conditions	Intermediate	- Moderate piezometric pressures, some seeps in foundation - Limited development of phreatic surface in dump possible - Moderate precipitation - High infiltration into dump - Discontinuous snow or ice lenses or layers in dump	100
Dumping rate	Slow	- <25 BCM's per lineal metre of crest per day - Crest advancement rate < 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	500
Comments: The foundation type listed is for thawed conditions, under frozen conditions the foundation type would be considered 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 Madrid North Surface Infrastructure

Engineering Drawings for the Madrid North DEIS Surface Infrastructure, Hope Bay Project, Nunavut, Canada

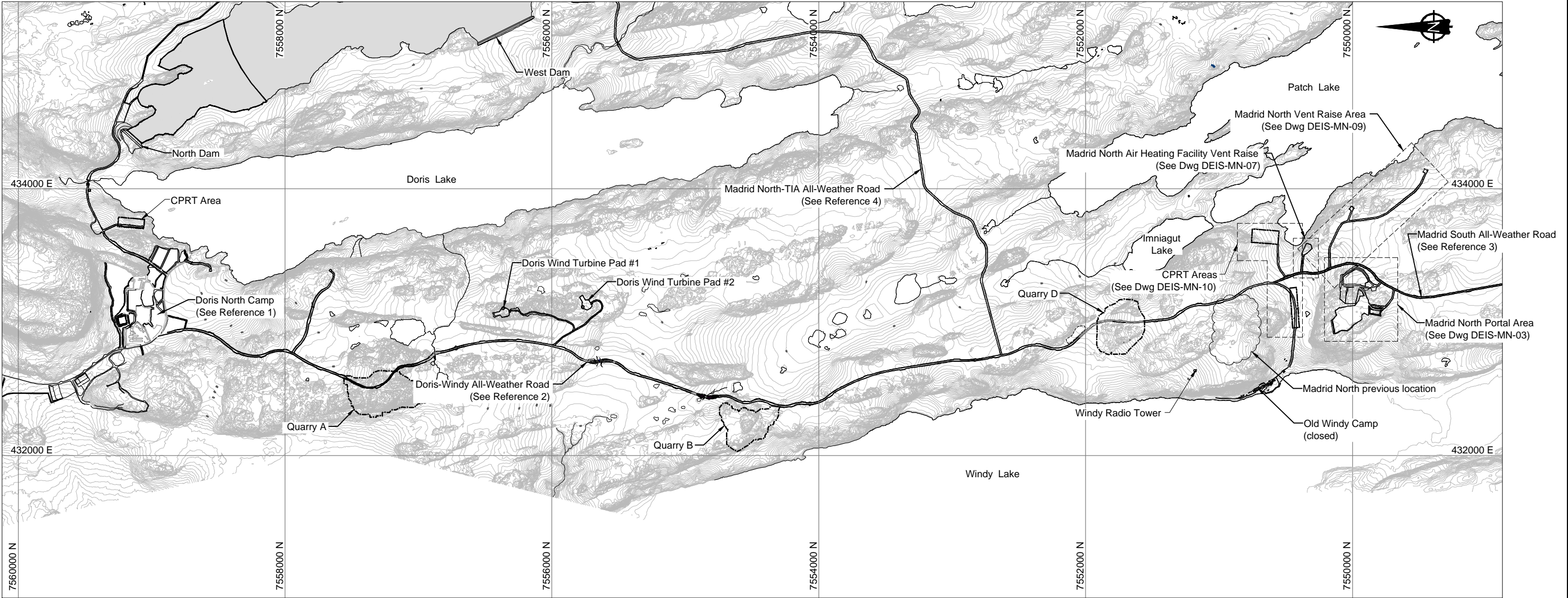
ACTIVE DRAWING STATUS

DWG NUMBER	DRAWING TITLE	REVISION	DATE	STATUS
DEIS-MN-01	Engineering Drawings for the Madrid North DEIS Surface Infrastructure, Hope Bay Project, Nunavut, Canada	B	Nov. 16, 2017	Issued for Discussion
DEIS-MN-02	General Arrangement Doris North Camp to Madrid North Portal	B	Nov. 16, 2017	Issued for Discussion
DEIS-MN-03	Site Layout Portal	B	Nov. 16, 2017	Issued for Discussion
DEIS-MN-04	Portal Pads Access Road Profiles	B	Nov. 16, 2017	Issued for Discussion
DEIS-MN-05	Sections A, B, C and D	B	Nov. 16, 2017	Issued for Discussion
DEIS-MN-06	Fuel Storage Facility Plan and Sections	B	Nov. 16, 2017	Issued for Discussion
DEIS-MN-07	Air Heating Facility Vent Raise Layout	B	Nov. 16, 2017	Issued for Discussion
DEIS-MN-08	Vent Raise Sections G and H	B	Nov. 16, 2017	Issued for Discussion
DEIS-MN-09	Vent Raise Access Road Plan and Profile	B	Nov. 16, 2017	Issued for Discussion
DEIS-MN-10	CPRT Access Road Plan and Profile	B	Nov. 16, 2017	Issued for Discussion
DEIS-MN-11	Details (1 of 2)	B	Nov. 16, 2017	Issued for Discussion
DEIS-MN-12	Details (2 of 2)	B	Nov. 16, 2017	Issued for Discussion
DEIS-MN-13	Typical Road Plan and Sections	B	Nov. 16, 2017	Issued for Discussion
DEIS-MN-14	Material List and Quantity Estimates	B	Nov. 16, 2017	Issued for Discussion



PROJECT NO: 1CT022.013
Revision B
November 16, 2017
Drawing DEIS-MN-01

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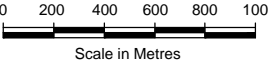


NOTES

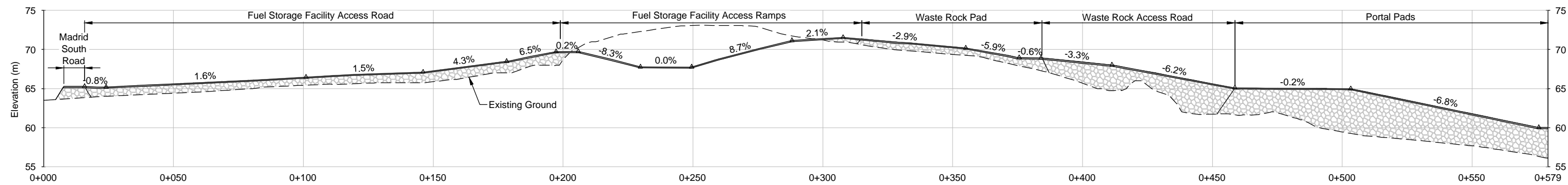
- 1. Topographic contour data for the terrain model were provided by Hope Bay Mining, and is based on 2007 Aerial Photography. Contour intervals are 1m.
- 2. The co-ordinate system is UTM NAD 83, Zone 13.
- 3. All dimensions are in metric units, unless specifically mentioned.
- 4. Notes in this drawing apply to all other active drawings.

REFERENCES

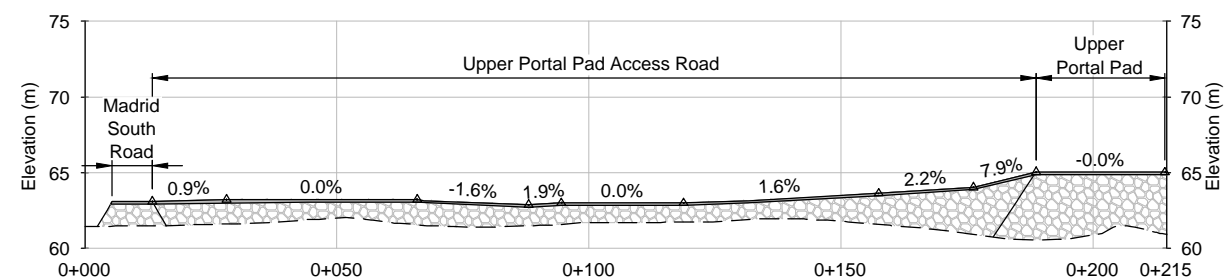
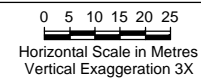
- 1) Engineering Drawings for the Doris North Camp Area, Doris North Project, Nunavut, Canada. Revision AB1. As-Built Drawings Prepared for Hope Bay Mining Limited. Project Number 1CH008.033. May 18, 2012
- 2) Engineering Drawings for the Doris-Windy All-Weather Road, Doris Infrastructure Project, Nunavut, Canada. Revision AB1. As-Built Drawings Prepared for Hope Bay Mining Ltd. Project Number: 1CH008.033/.058. May 11, 2012
- 3) Engineering Drawings for the Madrid South All-Weather Road, Hope Bay Project, Nunavut, Canada. Revision D. Issued for Discussion Drawings Prepared for TMAC Resources Inc. Project Number 1CT022.001.410. October 31, 2014
- 4) Engineering Drawings for the Madrid North to TIA All-Weather Road, Hope Bay Project, Nunavut, Canada. Revision A. Issued for Discussion Drawings Prepared for TMAC Resources Inc. Project Number 1CT022.013. November, 2016



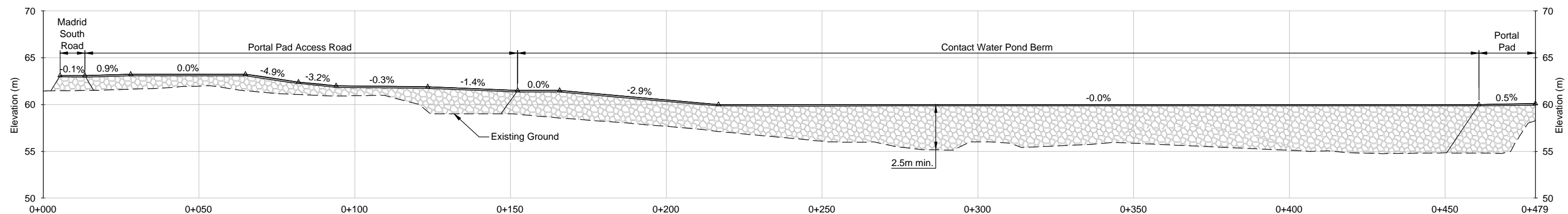
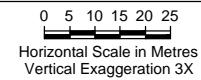
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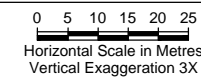
PORTAL PAD VIA FUEL STORAGE FACILITY ROAD PROFILE






UPPER PORTAL PAD ACCESS ROAD PROFILE



PORTAL PAD ACCESS ROAD / CONTACT WATER POND BERM PROFILE



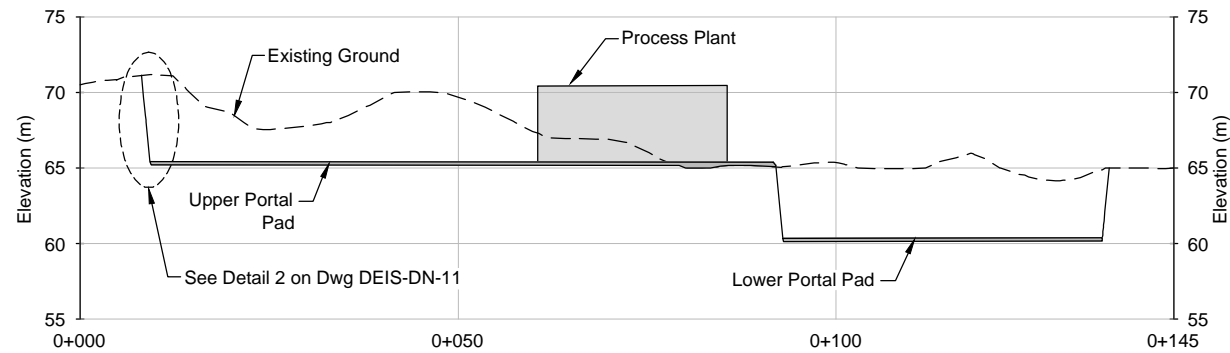
LEGEND

- | | |
|---|-------------------------|
| --- | Existing ground surface |
|  | Surfacing Material |
|  | Run of Quarry Material |
|  | Point of Intersection |
| 6.1% | Grade |

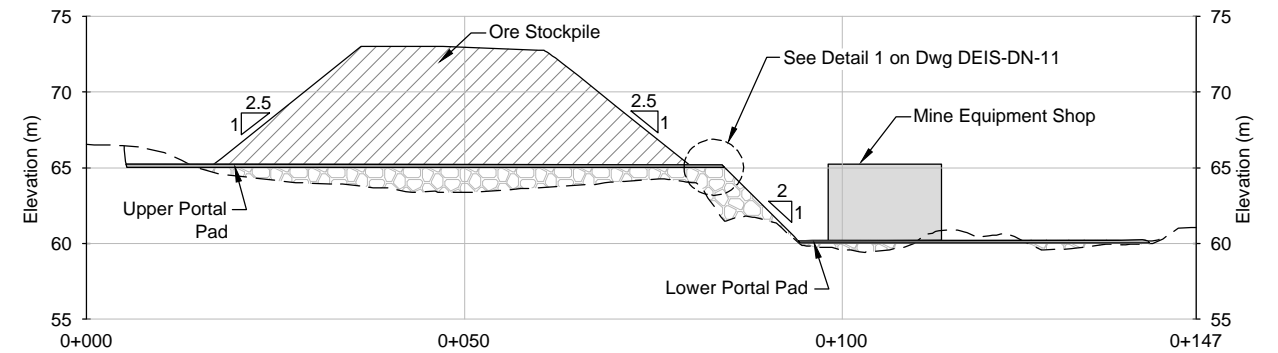
NOTES

1. All dimensions in metres unless noted otherwise.
2. Notes in this drawing apply to all other active drawings.

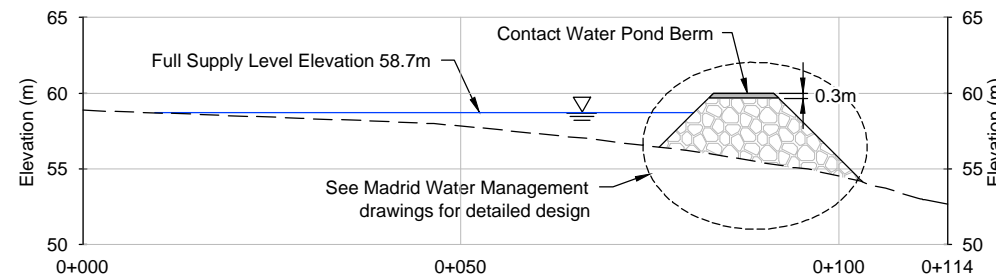
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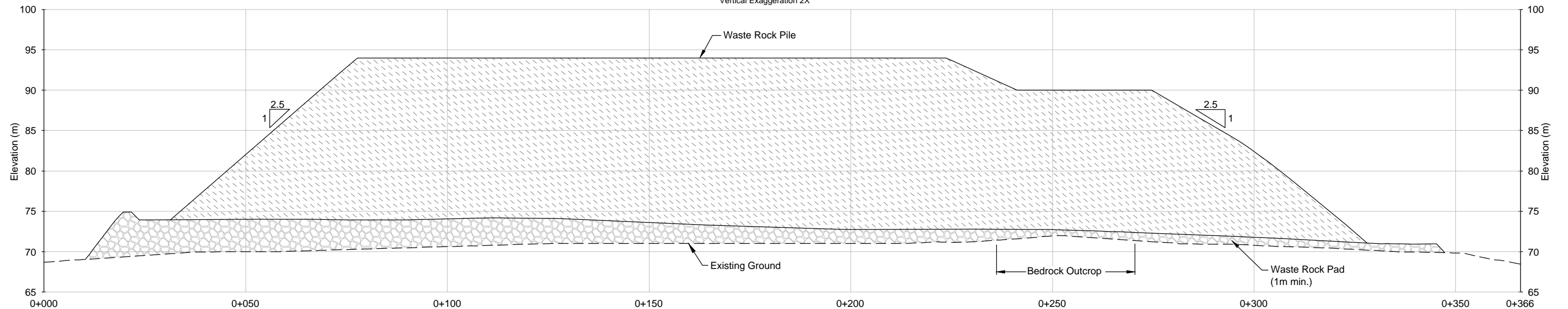
A
03
SECTION A
Horizontal Scale in Metres
Vertical Exaggeration 2X



B
03
SECTION B
Horizontal Scale in Metres
Vertical Exaggeration 2X



C
03
SECTION C
Horizontal Scale in Metres
Vertical Exaggeration 2X



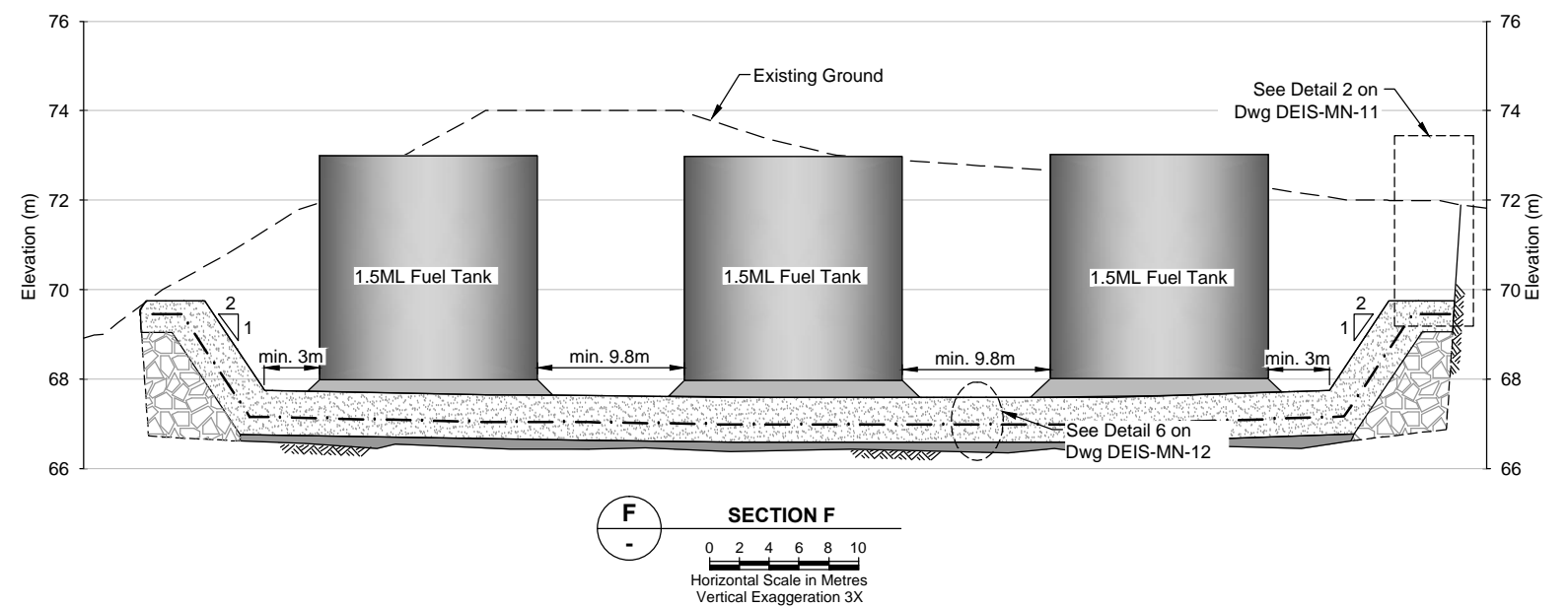
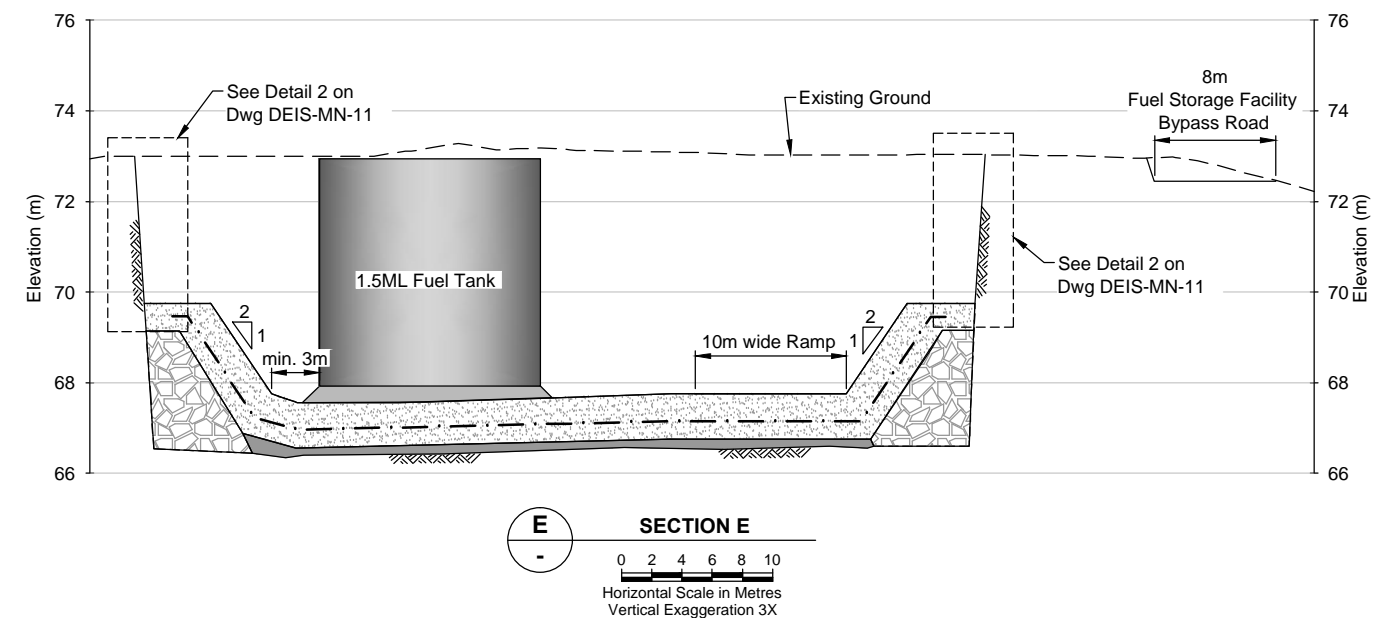
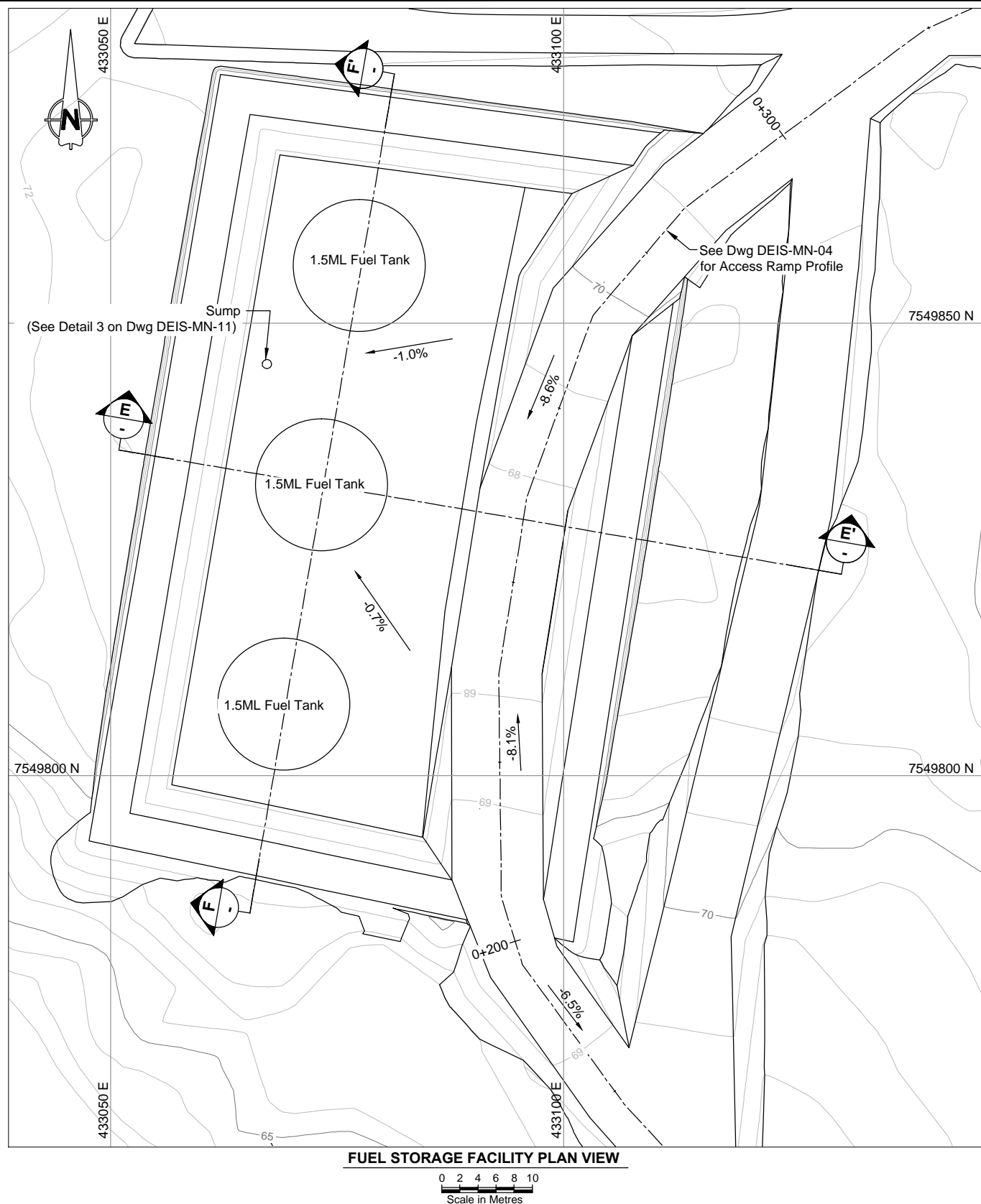
D
03
SECTION D
Horizontal Scale in Metres
Vertical Exaggeration 2X



LEGEND	
---	Existing ground surface
■	Surfacing Material
■	Run of Quarry Material
■	Waste Rock
■	Ore Stockpile

- NOTES**
- All dimensions in metres unless noted otherwise.
 - Where the thickness of the pads is greater than 3.0m allow for the placement of barriers.
 - The barriers are to consist of boulders larger than 1m in diameter, jersey-barriers (1.82 long X 1.37m high X 0.61m wide) or a rock fill berm 0.5m high. Maximum spacing between barriers is 3.3m.
 - 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.
 - Notes in this drawing apply to all other active drawings.

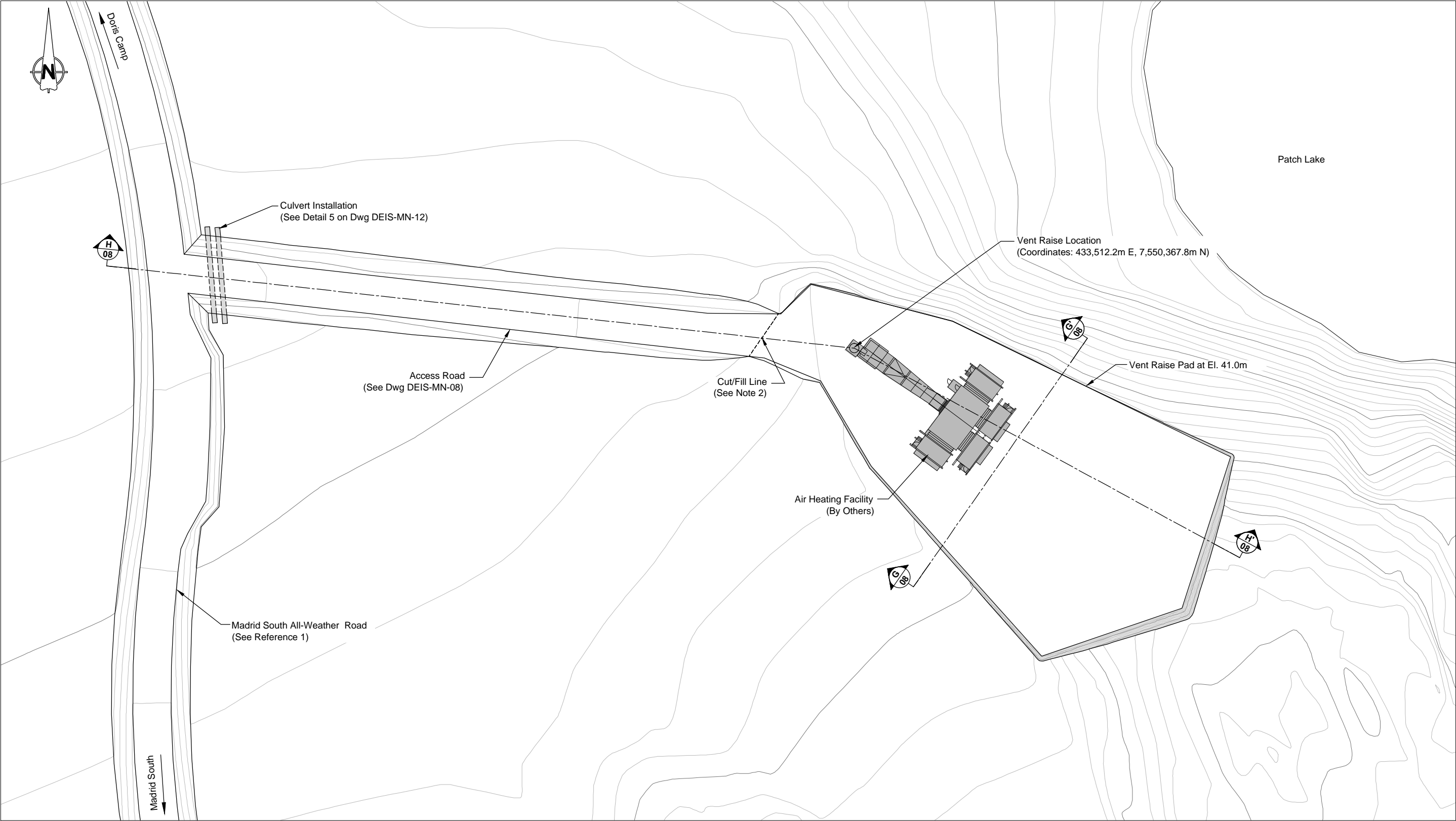
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												Madrid North DEIS Surface Infrastructure			
								srk consulting				TMAC RESOURCES			
								DESIGN: CH DRAWN: NV REVIEWED: CH				DRAWING TITLE: Sections A, B, C and D			
								CHECKED: CH APPROVED: EMR DATE: Nov. 2017				DRAWING NO. DEIS-MN-05			
								FILE NAME: 1CT022.013_DEIS_MN-2.dwg				SHEET 5 of 14			
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								CHECKED: CH APPROVED: EMR DATE: Nov. 2017				DRAWING NO. DEIS-MN-05			
								FILE NAME: 1CT022.013_DEIS_MN-2.dwg				SHEET 5 of 14			
								PROFESSIONAL ENGINEERS STAMP				REVISION NO. B			



						Madrid North DEIS Surface Infrastructure				
	DESIGN: CH			DRAWN: NV		REVIEWED: CH		DRAWING TITLE: Fuel Storage Facility Plan and Sections		
	CHECKED: CH			APPROVED: EMR		DATE: Nov. 2017				
	PROFESSIONAL ENGINEERS STAMP			FILE NAME: 1CT022.013_DEIS_MN-2.dwg		SRK JOB NO.: 1CT022.013		DRAWING NO. DEIS-MN-06	SHEET 6 OF 14	REVISION NO. B

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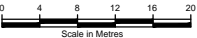


NOTES

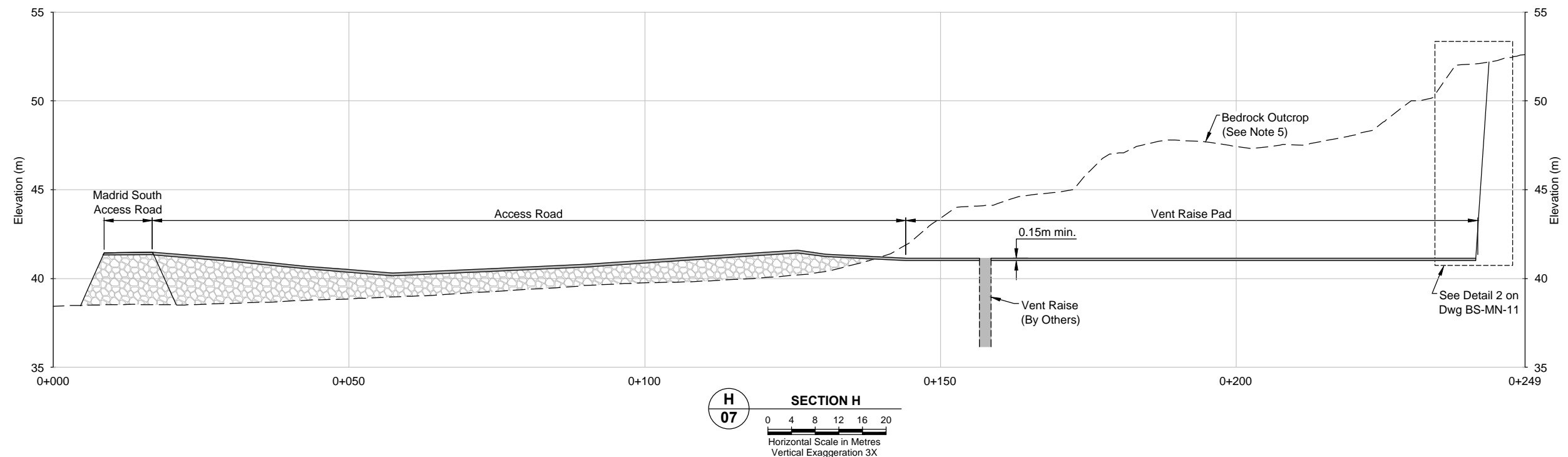
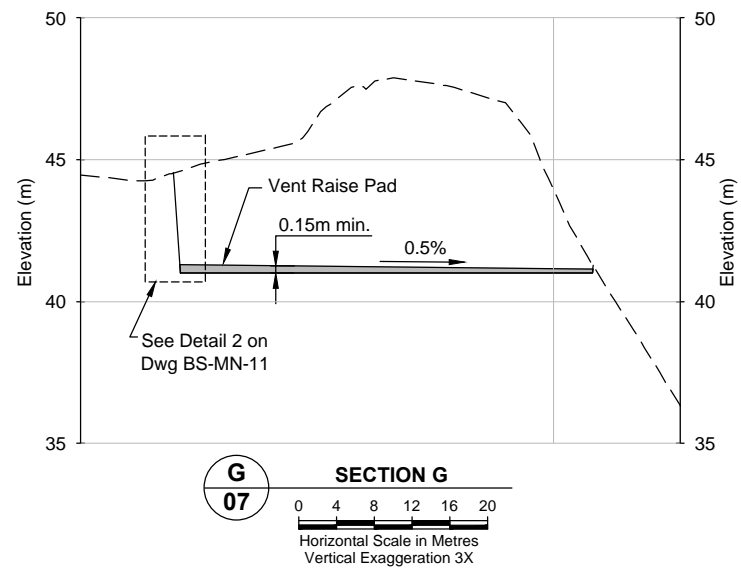
- 1. All dimensions in metres unless noted otherwise.
- 2. Cut into bedrock outcrop required for construction of vent raise collar.
- 3. Notes in this drawing apply to all other active drawings.

REFERENCES



- 1) Engineering Drawings for the Madrid South All-Weather Road, Hope Bay Project, Nunavut, Canada.
Revision D. Issued for Discussion Drawings Prepared for TMAC Resources Inc. Project Number 1CT022.001.410. October 31, 2014



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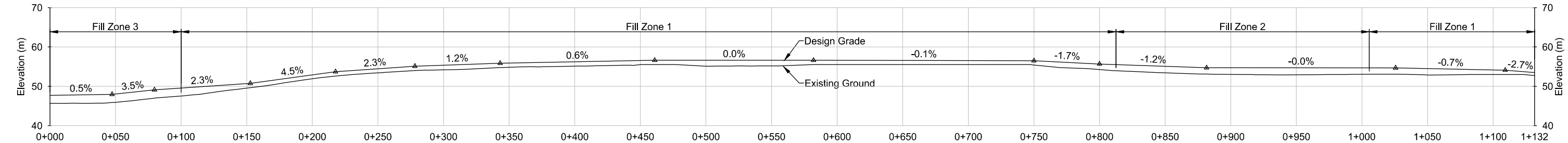
- Existing ground surface
 Surfacing Material
 Run of Quarry Material

NOTES

1. All dimensions in metres unless noted otherwise.
2. Where the thickness of the pads is greater than 3.0m allow for the placement of barriers.
3. The barriers are to consist of boulders larger than 1m in diameter, jersey-barriers (1.82 long X 1.37m high X 0.61m wide) or a rock fill berm 0.5m high. Maximum spacing between barriers is 3.3m.
4. Extents of bedrock outcrop are based on 2007 aerial orthophoto and ground inspection. To ensure layouts match site conditions exact extents of bedrock outcrops are to be surveyed prior to any construction activities.
5. Cut into bedrock outcrop required for construction of vent raise collar and pad.
6. Notes in this drawing apply to all other active drawings.

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PROFILE LEGEND

△ Point of Intersection

6.1% Grade

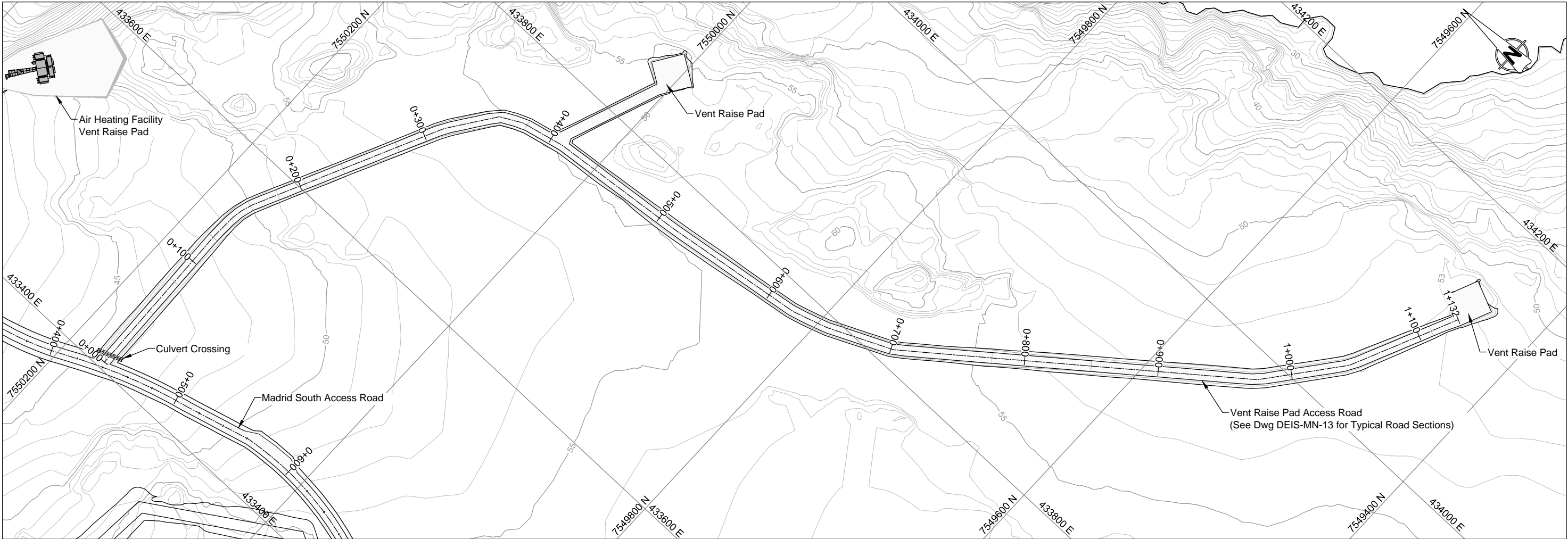
PROFILE

VENT RAISE ACCESS ROAD

0 10 20 30 40 50

Horizontal Scale in Metres

Vertical Exaggeration 3X



PLAN VIEW

MADRID NORTH VENT RAISE PADS

0 10 20 30 40 50

Scale in Metres

LEGEND

△ Point of Intersection

Route Centerline

1+000

000

== Road Alignment

==== Crossing Location

NOTES

1. All dimensions in metres unless noted otherwise.

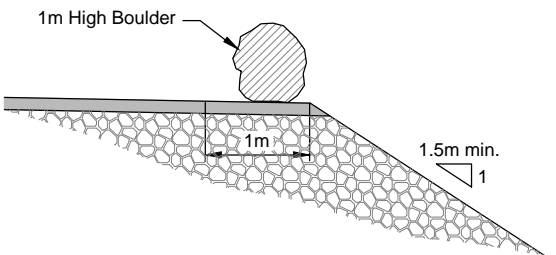
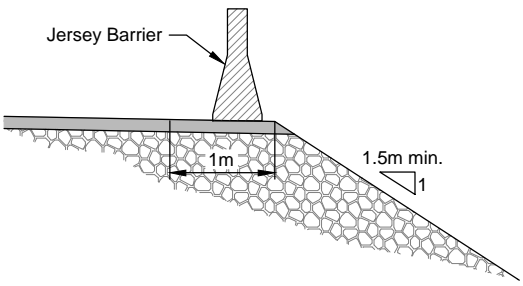
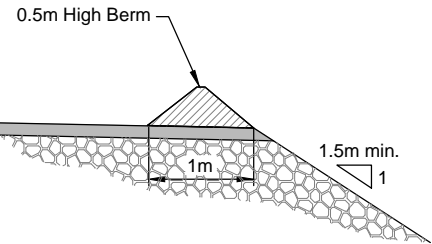
2. Notes in this drawing apply to all other active drawings.

ROAD CONSTRUCTION ZONES TABLE:					
Fill Zone 1	1.0m min. Overall Road Thickness with 1.5H:1V Side Slopes				
Fill Zone 2	1.5m min. Overall Road Thickness with 1.5H:1V Side Slopes				
Fill Zone 3	2.0m min. Overall Road Thickness with 2.0H:1V Side Slopes				
Bedrock Zone	0.3m min Road Thickness (ROQ not required) with Side Slopes to be determined in the field				

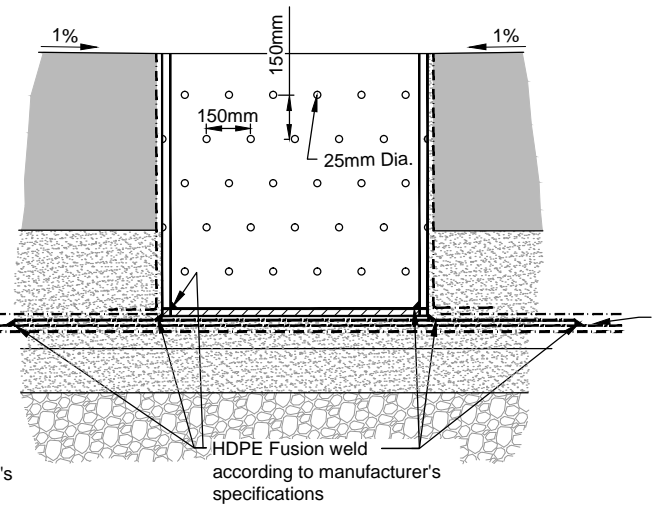
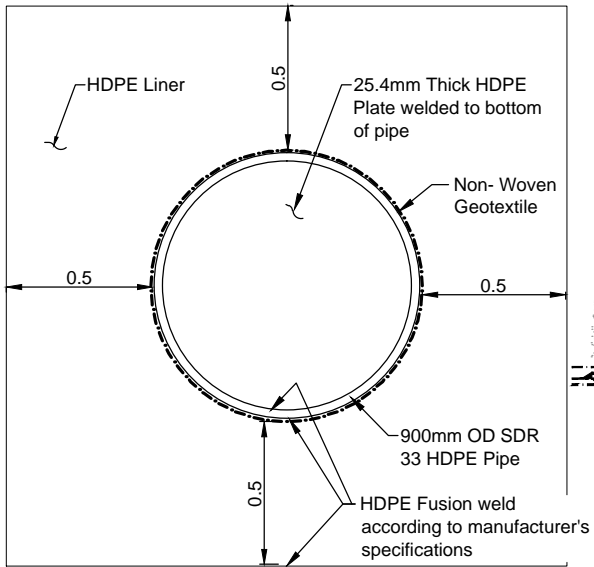
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<p>Madrid North DEIS Surface Infrastructure</p>		
<p>DRAWING TITLE:</p> <p>CPRT Access Road Plan and Profile</p>		
<p>DRAWING NO.</p> <p>DEIS-MN-10</p>	<p>SHEET</p> <p>9 OF 14</p>	<p>REVISION NO.</p> <p>B</p>

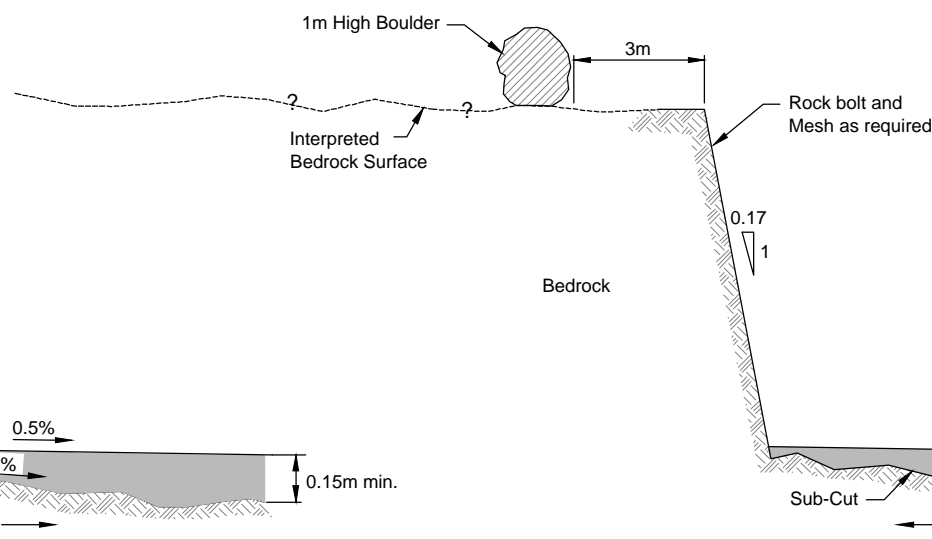
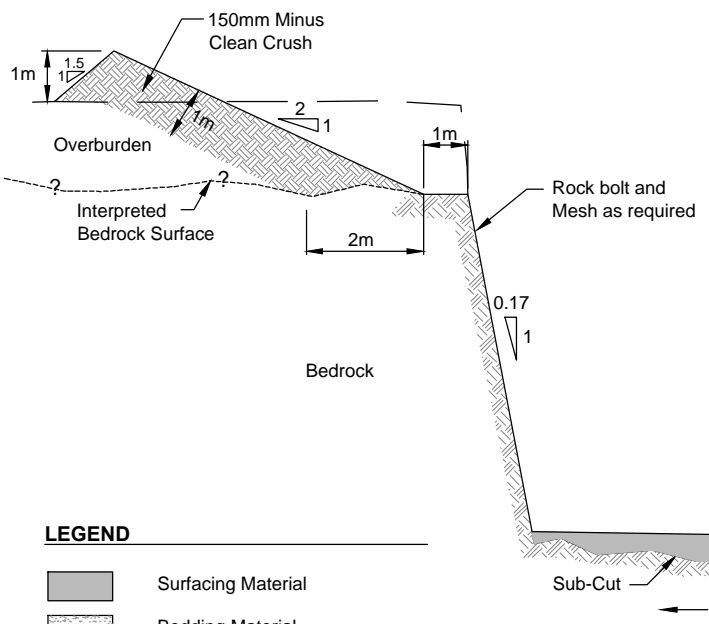
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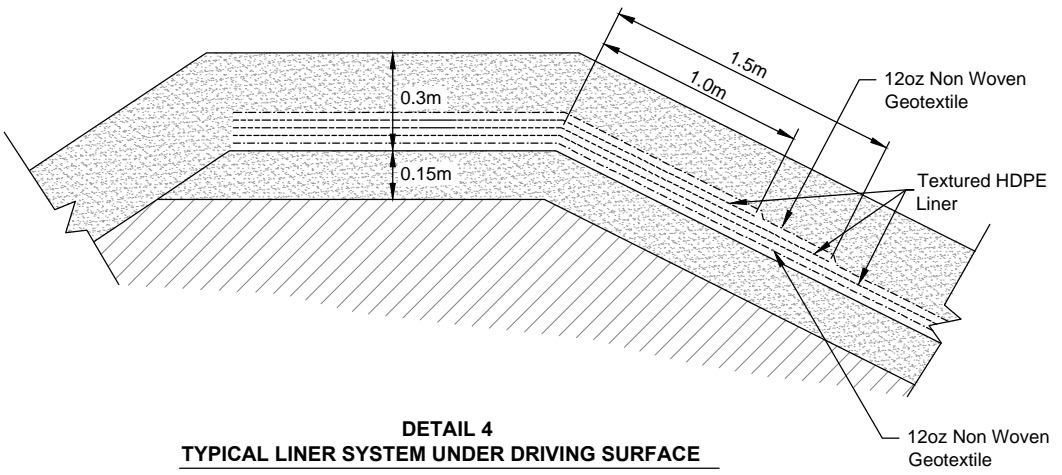
DETAIL 1
TYPICAL BERM BARRIER OPTIONS
NTS



DETAIL 3 - SUMP
NTS



DETAIL 2
TYPICAL SECTIONS OF HIGHWALL SAFETY BERM/BARRIER
NTS








DETAIL 4
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

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A cross-section diagram of a road structure. It shows three distinct layers. The top layer is 0.6m thick and has a stippled texture. The middle layer is 0.2m thick and contains horizontal dashed lines. The bottom layer is 0.15m thick and has a pattern of irregular polygons, with the label "Bedrock" written below it. Vertical arrows on the left indicate the thickness of each layer.

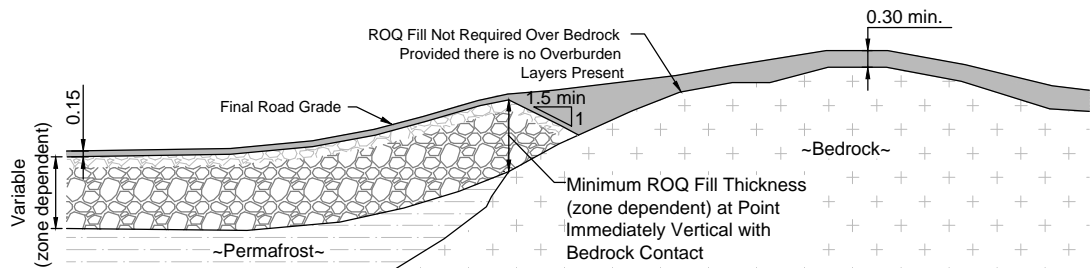
LEGEND

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

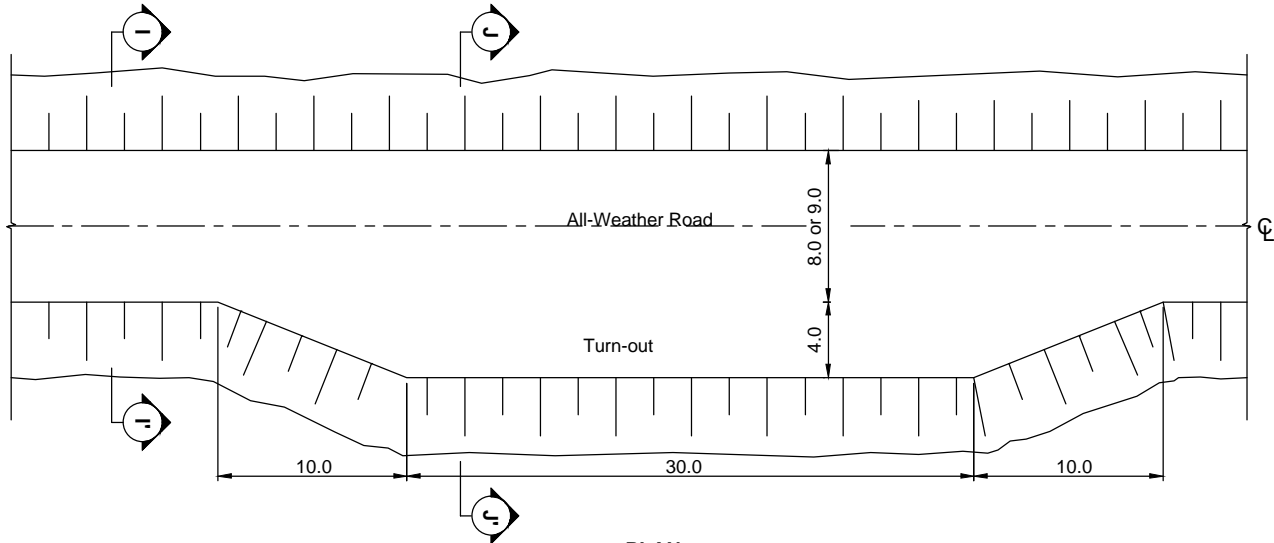
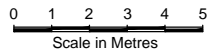
1. All dimensions in metres unless noted otherwise.
2. Locations for animal crossings will be identified by Land Owner and Elders once road construction is completed.

[illegible]

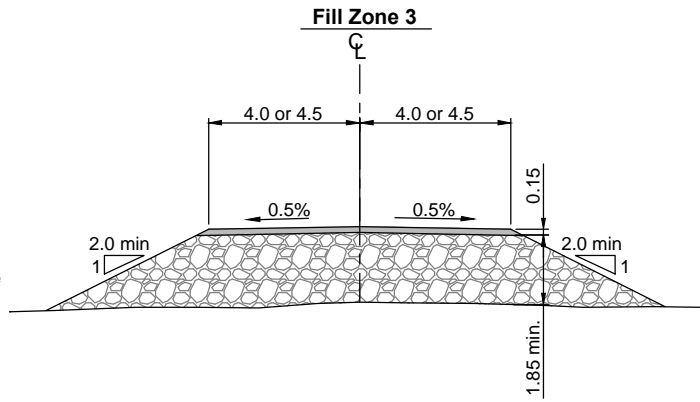
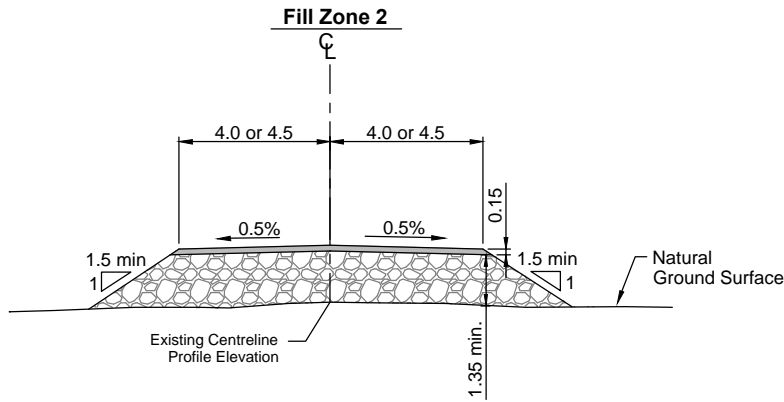
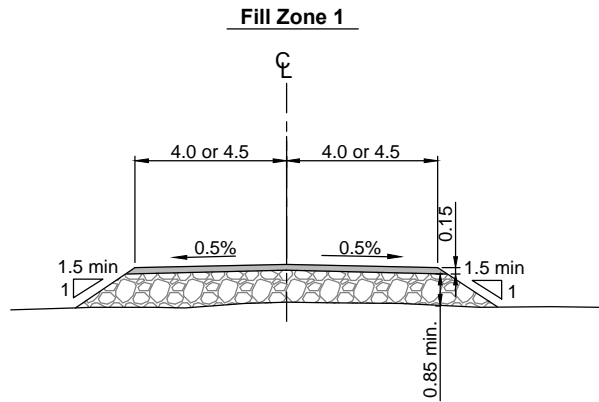
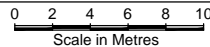
\\erlead\dfs\env\env\Projects\01_SITES\Hope Bay\1CT022.013_Phase 2 DEIS - Engineering_Support\040_AutoCAD\MadridNorthInfrastructure\1CT022_DEIS_MN-3_Road_Secs.dwg



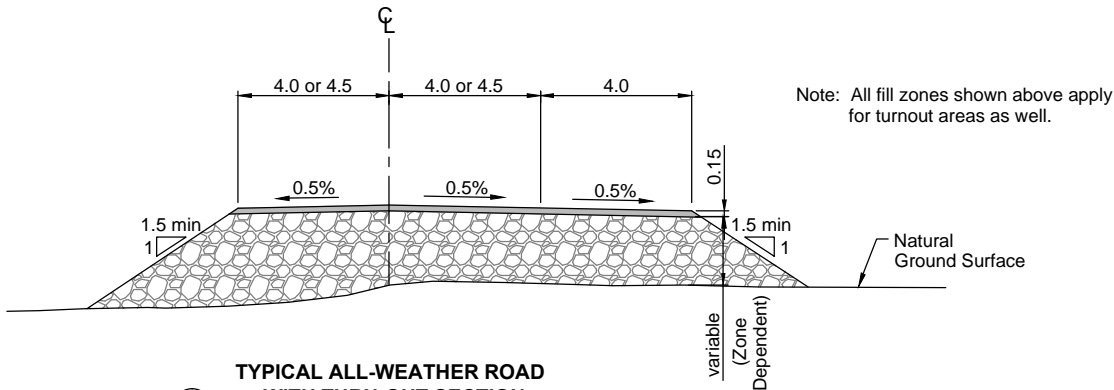
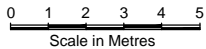
ALL-WEATHER ROAD PROFILE
TRANSITION FROM PERMAFROST TO BEDROCK



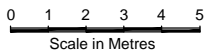
PLAN
TYPICAL ALL-WEATHER ROAD & TURNOUT



TYPICAL
ALL-WEATHER ROAD SECTIONS



TYPICAL ALL-WEATHER ROAD
WITH TURN-OUT SECTION



- LEGEND**
- Surfacing Material
 - Run of Quarry Material

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

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Materials List and Quantities (Fuel Storage Facility)

Tolerances Road Material Placement:

Note: Grade shall not be uniformly high or low.

PROFESSIONAL ENGINEERS STAMP