Doris North Portal Investigation

Final

Prepared for:

Hope Bay Mining Limited
Suite 300, 869 Harbourside Drive
North Vancouver, BC V7P 3S1

Prepared by:

SRK Consulting
Ingénieurs et scientifiques

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September 2010

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Suite 300, 869 Harbourside Drive
North Vancouver, BC
Canada, V7P 3S1

SRK Consulting (Canada) Inc.
Suite 2200, 1066 West Hastings Street
Vancouver, B.C. V6E 3X2

Tel: 604.681.4196 Fax: 604.687.5532
E-mail: vancouver@srk.com Web site: www.srk.com

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Authors: Anton Bloem and Bruce Murphy

Internal Review: Maritz Rykaart, P.Eng.

Executive Summary

The Doris North portal's rock mass (that is; the brow, adjacent slopes, and first 20 m of the decline) has been characterised and support designs prepared in anticipation of excavation and construction of the Mine's decline.

A geotechnical diamond drill-program was implemented to investigate the immediate portal rock mass, and a concurrent field-mapping exercise was completed. The oriented drill-core was logged for discontinuities and intact rock properties, and this information was then used in combination with the outcrop and longwall mapped joint-sets for the kinematic evaluation. The field investigation of the portal and its adjacent slopes included a rock-fall analysis of the sub-vertical faces within the area of worker activity (during construction and mining operations).

The rock mass was classified using industry-standard measures of rock mass condition (RMR and Q) and in conjunction with the discontinuity parameters, was used as a basis for evaluation of potential failure modes on the portal brow's slope, and the first part of the decline. The risks associated with rock-falls, overall slope-stability, and potential failure modes in the tunnel have been identified. Measures to mitigate these risks have been proposed; in the form of slope clearing, sequencing, and mechanical support designs. A hardware materials list has been prepared, and a rough work-plan to implement these measures has been compiled.

Recommendations

- Stabilize the portal brow and its adjacent slopes.
- Establish a buffer between the slopes' loose material and workers.
- Implement recommended support designs to increase stand-up time of portal and tunnel.
- Fully support the brow area before excavating the decline.
- Map decline in detail, reconcile this with the design assumptions, and increase support for wider spans and blocky ground.
- Monitor the rock mass for movement.

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1 Introduction, Objectives, and Scope

SRK Consulting (Canada) Inc. (“SRK”) was approached by Hope Bay Mining Limited (HBML), a wholly owned subsidiary of Newmont Mining Company, to implement a geotechnical program to investigate a portal for their Doris North Project (“Doris”). Doris is a greenstone-hosted quartz-carbonate vein deposit, contained within the north-south oriented 20 by 70 km Hope Bay Belt, on the shores of the Arctic Ocean in Nunavut – approximately 120 km south-west of Cambridge Bay. The Mine’s underground operations will be serviced by a decline from surface with the entry-point 300 m east of the Doris Camp (which is located at 68° 08’ 17’’ N, 106° 36’ 27’’ W), opening initially to the east, and then plunging north-east for the first reach of the tunnel.

Figure 1.1: Oblique aerial photograph looking ENE, across Camp (under construction) towards the intended portal location.

The program objectives can be divided into two main parts:

- Investigate the structural and geotechnical conditions of the portal rock mass, and comment on their impacts on the proposed portal, its design, and support requirements.
- Design the support requirements, recommend equipment and hardware, and propose a work-plan for implementation.

The area of interest is the immediate vicinity of the portal, including the adjacent slopes (for 20 m in either direction), and the first 20 m of the decline. For engineering, physiographic, logistical, and other reasons, the mine design puts the 5.5^2 m portal sill at 46 m amsl along the centre-line of 7 559 125 N, at 433 355 E (modified UTM 13, NAD 83). The portal face is oriented at approximately 75/280°.

2 Work Program and Team

2.1 Work program

The principal stages of the Project have been completed over a six week period, during March and April, with reporting during May of 2010:

1. Project briefing and scope of work.
2. Desktop review of available data, field-work and drill-program planning.
3. On-site rock-core logging (from drill-program), and outcrop mapping of portal area.
4. Data entry and validation (QA) using overlapping data-sources.
5. Data interrogation and processing to characterise rock mass and define structural features.
6. Rockfall hazard identification (from adjacent slopes).
7. Stability evaluation and analysis, including kinematic evaluation.
8. Support design for adjacent slopes, portal face, and initial part of decline.
9. Preparation of the technical report and design drawings.
10. Materials List, that is, hardware requirements and recommendations for implementation.
11. Project review, conclusion, and delivery of report.

2.2 Project team

Bruce Murphy (BM) and Maritz Rykaart (MR) prepared the proposal, from which the scope of work was derived, and Lowell Wade (LW) facilitated much of the early data-handover and client introductions. Anton Bloem (AB) completed the field-work's planning, implementation, and reporting – under the guidance of BM. The data analysis, reporting, and design were a collaborative effort of AB, BM, Ross Greenwood, and others in the SRK Mining and Geology Department. Much assistance was provided on-the-ground by managers, engineers, geologists, and other HBML personnel and contractors.

3 Raw Data, Acquisition and Synthesis

3.1 Desktop Study

A desktop study was initiated to gain an understanding of the regional geology and the available data (including previous studies) in preparation for the field-work. Sources checked for information included:

- Scientific and technical reports from industry and academia.
- Previous geological and geotechnical studies, core-logs, and models.
- Existing surface maps and primary spectro-spatial data sources.

The portal dyke extends for tens of kilometres both north and south within the property, and has an associated sill (which now forms a mesa) which budded off during emplacement. The dyke's outcrop trends NNE (030°) and is between 80 and 100 m in true thickness, extending down-dip (on approximately 35/120°) to mining depths and below. The dyke has a tabular morphology, and appears as an outcrop rising between 20 and 30 m above the surrounding tundra – on the south-eastern corner of the nearly 1^2 km, 100 m high Doris Mesa, the southern rock-face of which is approximately 300 m north of camp. The regolith in the camp vicinity is composed mostly of recent glacio-marine deposits (colluvium, beach deposits and marine salts and clay) on glacially-scoured basalt bedrock.

3.2 Geotechnical Field-Mapping

The field-mapping part of the program was designed to:

- Field-verify the interpreted structural features.
- Look for evidence of damage-zones around faults (if present).
- Check to see if the postulated joint-sets were real, and-or of consequence.
- Find examples of all joint-sets and measure their frequency and persistence.
- Map the major litho-types of the outcropping dyke.
- Map the lateral extent of the waning slopes, and assess the rock-fall hazards.
- Determine the composition of the lower-slopes if possible.

Two traverses of the ridge and one of the west-facing rock-slope were completed, during which litho-types, joints, and other brittle-deformation features were investigated. A traverse was also run along the base of the portal ridge to assess the waning slopes. The sketch-map compiled as a result of this mapping exercise is illustrated in Figure 3.1.

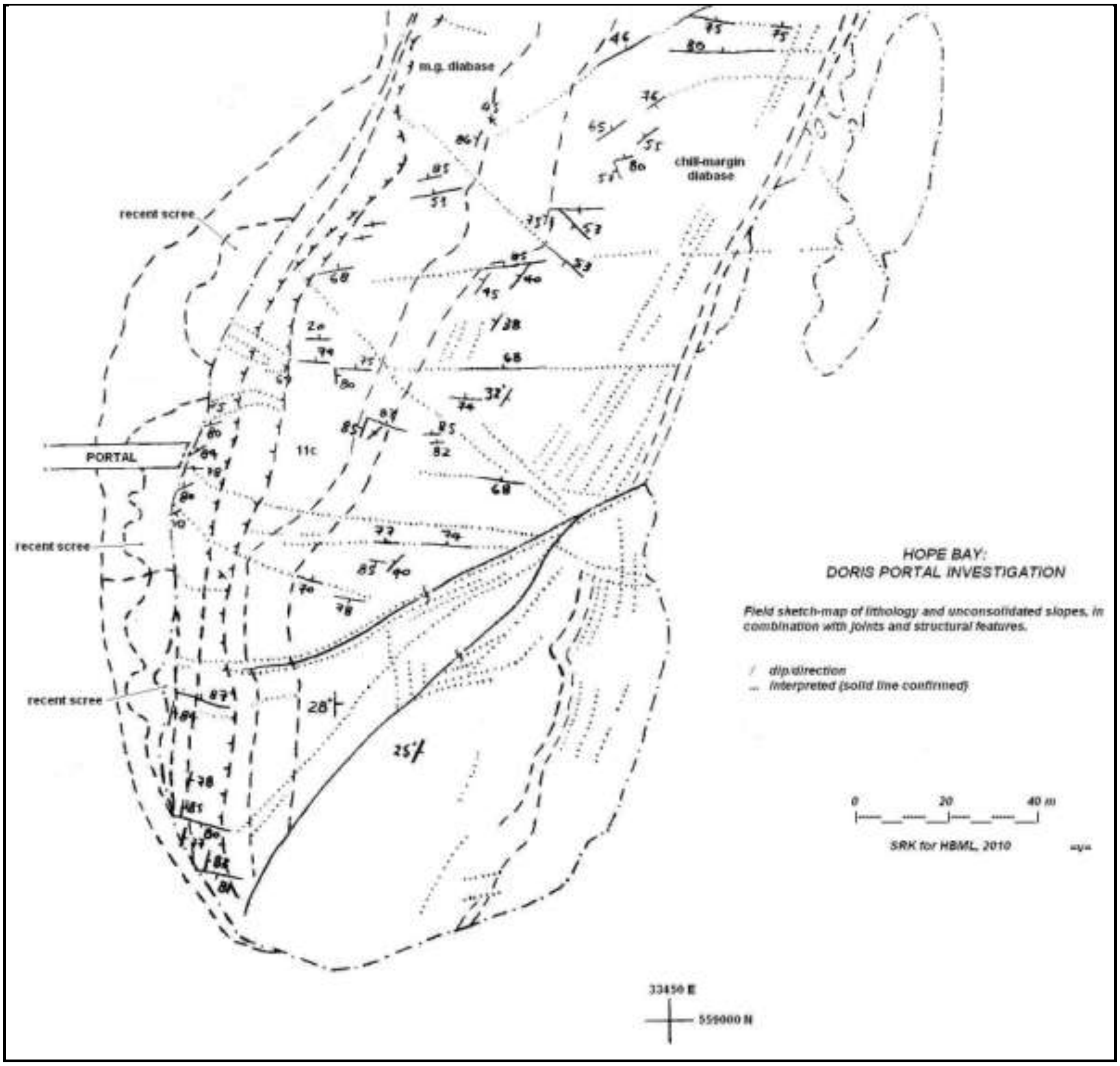


Figure 3.1: Extract of field sketch-map of outcropping lithology, scree slopes, and brittle deformation features – as well as interpreted lineaments for the diabase dyke and associated landforms.

3.2.1 Diabase Dyke and Other Rocks in Outcrop

The central-ridge exposure is composed of competent, strong and tough, coarse-grained phaneritic diabase (diabase$_{cg}$), which weathers deeply to a rough iron-stained rock. There is also a field-discernable medium-grained (1 to 5 mm, diabase$_{mg}$) phase within the dyke, which forms the bulk of the rock along the west-facing slope's ridge (the rocks exposed on the portal brow). Both of these rock-types belong to the 11c Litho Class. Most of the leeward exposure is composed of an aphanitic diabase (0.1 to 1 mm grain-size, diabase$_{fg}$) which has been glacially-scoured from the E and SSE – the scars of which are evident on outcrop – which has a thin, black to dark-brown, iron-oxide patena. This rock-type probably belongs in an independent Litho Class, 11c'. At the base of the south-western slope is a small exposure of basalt (Litho Class 1a). It has a well developed non-consistent ‘fabric’ near the contact, and is amygdaloidal and vuggy within the contact-metamorphic aureole (which is well developed between 5 and 50 m below the dyke). The diffuse contact with the overlying diabase is competent over a short distance of between 10 and 30 mm. The diabase-mg in the portal brow appears rough on a mm-scale, have a thin stained oxide patena, and are strong and brittle. From the traverse, it appeared as if diabase-mg will be the bulk of the rock to be encountered during portal excavation, with some diabase at the toe of the rock-face.

3.2.2 Diabase Dyke Ridge’s Waning Slopes

Along the eastern flank of the ridge, the narrow ‘apron’ is composed of diabase$_{fg}$ outcrop; with a couple of large boulders of leucocratic float material. On the western side of the ridge there is a linearly extensive scree-slope at the base of the rock-face extending from the southern-tip northward for approximately 300 m. The upper layers of these scree (or rubble) slopes are unconsolidated fall-rocks generated from ice-jacking of the free-face. There is a wide apron of underlying older rock-rubble with sand and fines, which has a shallow sandy rooting layer that supports tundra heath. Upon this base, is a more recent unconsolidated large-block rubble pile (labelled 11c+), which has little or no fines, no soil or vegetation cover, and is composed of recent arrivals of large blocks. South of the portal is an older small-block scree slope (labelled 1a+), both of which have a low angle of repose of less than 25°. The more recent of these slopes is best developed near the basalt-diabase$_{fg}$ contact.

3.2.3 Structural Features and Jointing

95 Joint measurements were taken from across the full length of accessible outcrop. The un-weighted (poles to the plane) stereonet plot for these field data are represented in Appendix A’s Figure A1. In these data the dominant EW joint set J_1 (75/005°) is orthogonal to the cluster of J_{2W} (70/285°) and J_{2E} (80/095°) – while an isostatic unloading set is represented by J_3 (10/160°). The position of the NE-SW interpreted fault was visited, but no ground-evidence could be found for its existence – apart from a relatively shallow dipping (45/335° 21 m long, and 46/330° 13 m long) joint face – across which no off-set could be determined. – it would need further examination under better field conditions, or from longwall mapping of the decline. This, and other sub-parallel features are represented as J_4 (50/340°), while another very widely spaced set is represented by J_5 (45/230°). From the interpretation and mapping, a minor NE-SW fault (along the J_4 trend) has been inferred to the south-east of the portal. The intra-Belt NW-SE left-lateral fault trend does not appear to be represented in the joint sets within the portal area, other than possibly the few joints in J_5 (52/227°). There are contiguous joint-planes (53/225°, 9 m long, and 53/230°, 10 m long) on the J_5 trend, but no evidence of offsets or fault-induced damage-zones were found.

The mapped joint sets’ orientation, estimates of joint-condition, and persistence in outcrop are summarized in Table 3.1. The horizontal unloading set is probably under-represented because of snow-cover and the scouring of those planes by glacial-action on the ridge, but, is well represented on the portal rock face, as illustrated in Figure 3.2. J_1 is dominant and vertically persistent, dipping slightly off to the north, and the portal brow has a relatively clean-parted face along a combination of the J_{2W} and J_{2E} sets (which are vertical to sub-vertical in the plane of the sketch, dipping westward and eastwards, to and from the viewer). The J_{2E} set is the prime cause of the unstable and toppling north and south slopes (20 to 30 m wide) adjacent to the relatively stable (20 to 25 m wide) portal face. The horizontal unloading set J_3, in combination with J_{2E} and J_1, create the blocks which (when exacerbated by ice-jacking from the back-face) topple onto the scree pile. The north and south slopes are partially-concave and over-hanging in profile, and are composed of large loose perched blocks of rock.

Table 3.1: Summary of joint-sets and their properties, as mapped in-outcrop along the ridge and western portal face.

Summary of mapped field-data						roughness			
Joint Set	Dip	Direction	Number	Length (m)	StDev	Small-scale	Large-scale	Alteration	Comment
1	75	005	41	7.6	4.5	rough	undulating	staining	very persistent
2W	70	285	19	4.4	2.2	rough	planar	slight	persistent, sheet-like
2E	80	095	17	4.3	2.1	rough	planar	slight	persistent, sheet-like
3	10	160	6	8.3	6.3	smooth	discontinuous	slight	truncates on J1, J4, & J5
4	50	340	7	9.3	6.0	rough	discontinuous	staining	rare, truncates J1
5	45	230	5	8.0	3.5	rough	discontinuous	staining	rare, small clusters

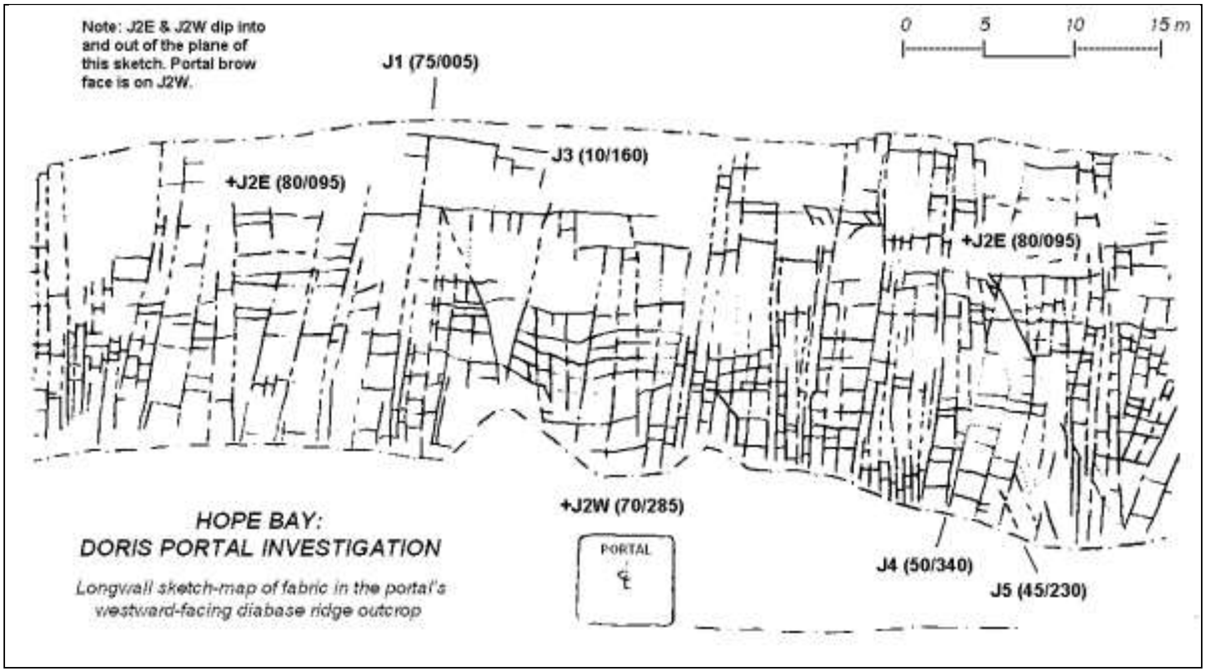


Figure 3.2: Extract of a longwall sketch-map (looking eastward) of the rock mass fabric across the portal brow. The left-hand third of the sketch is the "north-slope" while the right-hand third is the "south-slope".

3.3 Drilling and Oriented Core-Logging

A drill-hole proposal was prepared and implemented for the immediate portal brow area – it comprised four diamond drill-holes, totalling 180 m of oriented core, the locality of which are illustrated in Appendix A's Figure A6. The two northern-most collars (SRK-PTL-10-01 & -02) were drilled from the same pad and were positioned to intersect the rock mass within the back-brow volume. SRK-PTL-10-04 was positioned along the portal's centre-line, drilling westward from the ridge to intersect the brow rocks (as well as intersecting part of the decline path). The fourth hole, SRK-PTL-10-03, was drilled eastward through the waning slope at the portal to ascertain its composition, and into the portal's entry-face and floor-rocks to check for rock mass properties.

3.3.1 Logging Results: SRK-PTL-10-01, -02, -03, and -04

For the 180 m drilled (50, 50, 30, and 50 m respectively), there are 404 oriented discontinuities from which to assess the joint suite. Most of the discontinuities logged were joints (79%), with a smaller group of cemented-joints (18%), and the remaining features being fabric-parallel (3%). The individual logged discontinuities were transformed from down-hole coordinates to their dips and dip-directions – the joints from which are represented in Appendix A's Figure A2. The primary EW joint set J_1 (75/020°) is overshadowed (by the number of intersections) of the portal face-parallel J_{2W} (70/290°) and J_{2E} (70/090°) joints. The isostatic rebound and unloading classes have coalesced into the broad J_3 (20/140°) set, while J_4 (30/300°) and J_5 (35/220°) are sub-regional structural trends. The joint properties are summarised in Table 3.2.

Table 3.2: Summary of joint-sets and their properties, as logged in oriented-core from SRK-PTL-10-01, -02, -03, and -04.

Summary of core logging						roughness			
Joint Set	Dip	Direction	Number	Spacing (m)	StDev	Small-scale	Large-scale	Alteration	Comment
1	75	020	95	1.5	0.6	rough	undulating	staining	all truncate on J1
2W	70	290	21	2.0	5.0	rough	undulating	slight	some Hematite fill, smooth
2E	70	090	19	8.0	5.0	rough	undulating	slight	some Hematite fill, smooth
3	20	140	25	6.7	2.6	smooth	discontinuous	slight	narrow aperture
4	30	300	9	18.6	12.0	rough	undulating	staining	difficult to differentiate
5	35	220	6	28.0	17.8	rough	undulating	staining	rare

The basalt has abundant micro-defects which are relatively soft (calcite), and a strength estimate of between 150 and 200 MPa. These rocks have an alteration overprint (associated with the intruding dyke), and some fabric within the contact metamorphic aureole. The diabase$_{fg}$, has no micro-defects, and becomes progressively less brittle with distance from the contact (as a result of the increasing amphibole phenocryst size), and has a strength range from 180 to 220 MPa. The bulk of the rocks within the dyke are the phaneritic diabase$_{mg}$, which are very strong and homogeneous, mostly between 200 and 250 MPa. The diabase$_{m}$ grades into diabase$_{cg}$ in the upper one-third of the dyke (as the olivine content increases), and has a strength of between 100 and 150 MPa. Above that is the dyke's upper chill-margin, which is thinner than its footwall counterpart at around 5 m, has no micro-defects, and is very strong (between 200 and 250 MPa).

3.4 Summary of Findings – Combination of Mapping and Logging

An idealized west-to-east vertical and a horizontal section summarise the main features, which are illustrated in Figures 3.3 and 3.4.

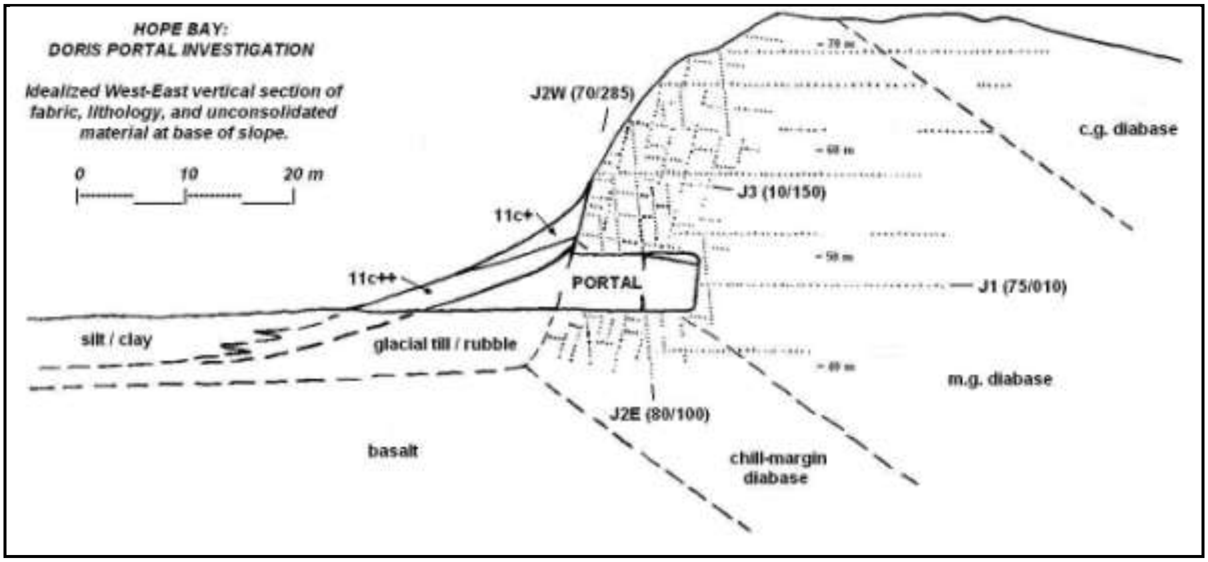


Figure 3.3: Idealized W-E vertical section through the portal slope, illustrating features to be encountered during portal excavation – fabric, intact rock, and unconsolidated material.

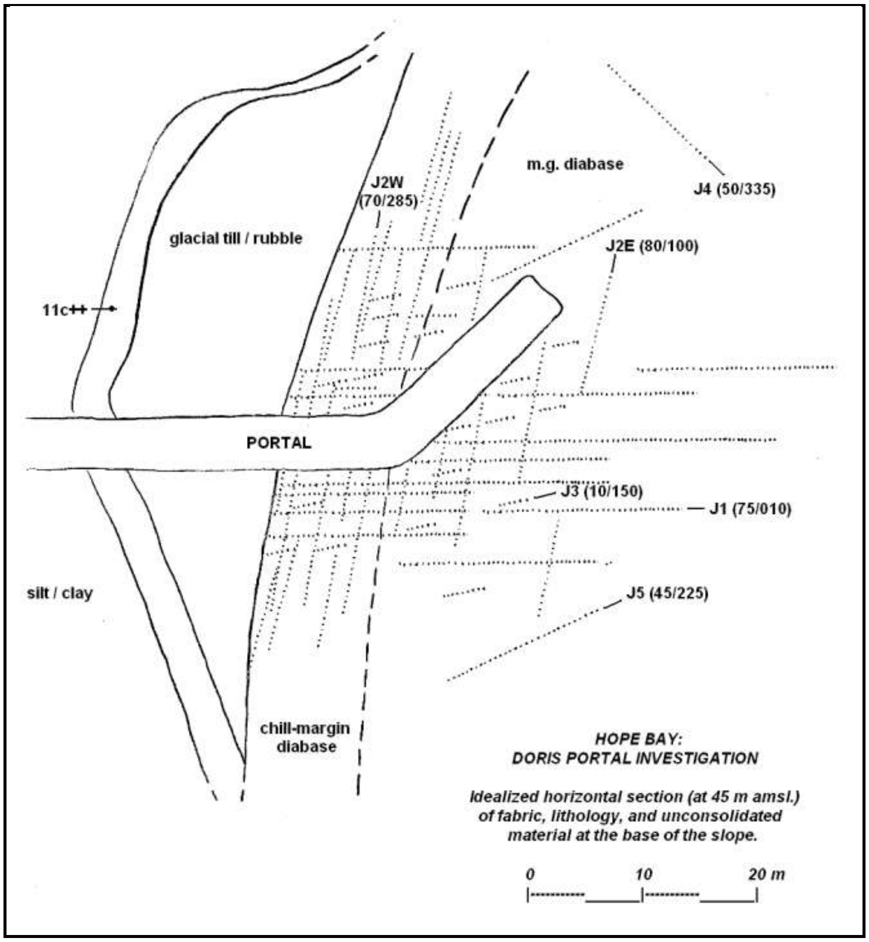


Figure 3.4: Idealized horizontal section through the base of the portal slope (on the 45 m amsl. contour), illustrating features to be encountered during portal excavation – fabric, intact rock, and unconsolidated material.

3.4.1 The Scree Slopes’ Material

The portal excavation will encounter the scree on the westward-waning slope at the base of the portal’s rock face. These unconsolidated rubble piles have a sub-angular to rounded glacial till and rubble basal layer, 8 m thick at their maximum, with an internal 20° angle of repose, extending 20 to 30 m westward from the bedrock high-wall. Deposited above this is a 3 to 5 m thick layer of post-glacial scree containing relatively small angular to sub-angular boulders (less than ~0.5 m^3) with sand and fines. There is recent rock rubble resting at a higher angle of repose (of 30° plus) on this, which is composed of large boulders and rock-blocks from the toppling free-face above – these blocks are very angular an are generally of a volume of less than 0.8 m^3, but there are some blocks with volumes up to 3 m^3

3.4.2 Major Structural Features

No major structural features have previously been mapped along the ridge, and there is no field evidence of major structural features within 100 m of the portal. The areas inspected for interpreted faults (from the formative geotechnical model), found joint orientations matching a persistent NE-

SW lineament, but no damage-zones, slickensides or gouge were found. These will need to be mapped from within the decline.

3.4.3 Intact Rock Properties, Rock Mass Discontinuities, and Fabric

The excavation for the portal will be wholly contained within the dyke. The rock-blocks within this area are columnar to square (with a small irregular component), with the primary joint-set J_1 (75/010°) defining the near-vertical EW sides of the macro-slabs. The slabs are discontinuous, inasmuch as they are cut by the second joint-set J_{2W} (70/285°) and J_{2E} (80/100°) which have wide spread across the vertical. These two NS-trending and the EW sets form the basic fabric of the dyke. In the near-surface environment there is an isostatic rebound joint-set J_3 (around 10/150°) and two other joint-sets, probably associated with structural trends and features within the sub-region, J_4 (50/335°) and J_5 (45/225°). These are illustrated in Appendix A's Figure A3.

The joints mapped and logged are mostly rough on a millimetre-scale, and undulating to planar and discontinuous on a metre-scale, as presented in Table 3.3. (The most reliable measure of joint-spacing, is that taken from outcrop – and this is what is included in the summary Table 3.3, and is what is used for all analysis.) The primary vertical to sub-vertical sets (J_1 and J_{2W} plus J_{2E}) are undulating to planar with little or no staining, with sub-millimetre apertures. The horizontal set (J_3) is smooth and planar, but is non-continuous (in that it is truncated by all other sets) and has a field-estimated friction angle (φ) of around 30°. Joint-sets J_4 and J_5 are discontinuous within the rock mass, but may be concentrated around brittle faulting in neighbouring areas – they are rough, with staining, and are discontinuous. These two sets were not seen during the long-wall mapping of the portal brow, and are therefore not considered significant factors for modelling of the portal's rock mass. The joint spacing has been adjusted to reflect the outcrop mapping and other field observations.

Table 3.3: Summary of joint-sets and their properties, as used in the stability evaluation.

Summary of all J-sets						roughness			
Joint Set	Dip	Direction	Number	Spacing (m)	StDev	Small-scale	Large-scale	Alteration	Comment
1	75	010	136	1.1	0.4	rough	undulating	staining	dominant, persistent
2W	70	285	40	0.8	0.3	rough	planar	slight	sheet-like, dips westward
2E	80	100	36	1.5	0.8	rough	planar	slight	sheet-like, dips eastward
3	10	150	31	1.3	0.5	smooth	discontinuous	slight	truncates on J1, J4, & J5
4	50	335	16	7.0	4.4	rough	discontinuous	staining	rare, truncates J1
5	45	225	11	9.0	5.7	rough	discontinuous	staining	sporadic occurrence

3.4.4 Rock Mass Domains and Classification

There are three rock mass domains in the portal area, and they follow the basic pre-established lithoclasses within the Doris area, with the exception of the diabase dyke's chill margin. The basalt is quite distinct from the overlying diabase and forms the BA (basalt) domain, while the diabase$_{fg}$ forms DIAM (diabase chill-margin) and diabase$_{mg}$ and diabase$_{cg}$ correspond spatially with DIAM (diabase, main body). The results of the rock mass classification are summarised in Table 3.4, in which the fair to good ground conditions to be encountered in the portal excavation are documented. The classification was done for each of the three main systems, namely; the Rock Quality Designation (RQD), Rock Mass Rating (RMR), and the Rock Tunnelling Quality Index (Q) – added to which are the Q-values adjusted portals Q_w (using the portal adjustment of 2Jn as well). A Geological Strength Estimate (GSI) has been included in this summary as upper and lower bounds. In terms of RQD, the rock mass becomes progressively more competent moving upward from the basalts (83%) through the chill-margin (92%) and into the main diabase dyke (96%). This progression from weak to stronger and more competent rock is repeated in the RMR, and Q results.

Table 3.4: Domain-based rock mass classification results; RQD, RMS, Q, and GSI.

Lithology	Domain	RQD	StDev	RMR	StDev	Q (est.)	Q	StDev	Qwall (p)	GSI upper	GSI lower	Comment
Diabase$_{mg}$.	DIAC	96	7	62	7	6.9	8.3	3.2	10.4	60	75	fair to good, homogenous
Diabase$_{fg}$	DIAM	92	11	57	7	4.3	5.0	1.6	6.2	50	65	fair ground conditions
Basalt	BA	83	15	41	5	0.7	4.2	1.8	6.2	40	50	poor to fair ground

4 Data Evaluation for Portal and Decline

The excavation will have its opening cut and then driven eastward for the first 5 to 15 m in DIAM – which would become progressively more competent as it approaches DIAC. Once in DIAC, the strongest and most competent domain, the excavation will advance within the DIAC-envelope for the remaining portion of the first leg of the decline.

4.1 Loose Hazard Identification

An on-site fall, bounce, and roll evaluation was conducted. The hazards are considered to be significant in both the northern and southern slopes adjacent to the portal face. There are overhangs on the southern slope, and both slopes have loose blocks in toppling mode. The overall slope angle is around 70° (0.3:1 gradient), and the effective height is 20 m, which has loose material in the *free-fall* to *bounce* categories. The risks of toppling, fall and roll, range from low to high for these slopes – all of which can be mitigated. These are illustrated in Figures A4 – A7 (Appendix A).

4.2 Stereonet Kinematic Evaluation

Rock failures from a slope (in our case the portal brow) can be considered as being either *toppling*, *planar*, or *wedging* events. The assessed risks associated with these types of failures are summarised in Table 4.1.

Table 4.1: Risks associated with failure modes in portal brow slope.

Portal Brow: 75/285° ±05/010			
Failure	**Risk**	**Criteria**	**Comment**
Toppling	**MODERATE**	Slip limit = 40°, friction angle = 30°	J_{2E} if present, J_3 base
Planar	**MODERATE**	Friction cone = 30°	J_1 and J_{2E}, may reverse-topple
Wedge	**LOW**	Friction cone = 30°	Unlikely, on J_1 and J_4

The toppling analysis was performed for the portal's brow which is oriented at around 70/285°, using a slip limit of 40° (which is the brow face's dip-angle minus the friction angle, φ, of 30° for J_3). The probability of toppling was found to be high for any J_{2E} dominated rock slope. In the immediate brow only the J_{2W}(70/285°) were mapped, which are not within the risk-envelope. The portal face is currently stable, and toppling is not a significant risk. The probability of sliding was found to be moderate to high on any unconfined J_1, J_{2W}, J_4 and J_5 features. In the portal brow, however, only the J_1 and J_{2E} sets are present – which if unconfined will tend to slide. Overall; the plane failure risk is moderate to high for portal brow slabs (defined by J_1 and J_{2E}) if the toe of the slope is opened – as will be the case for the portal's initial cut. From this analysis, it is apparent that three joint-set combinations could potentially form wedges on this face, however, seeing as two of these three joint sets (J_4 and J_5) are not seen in the immediate brow, the risk of wedge failure from the undisturbed rock face is low.

4.3 Wedge Evaluation of the Entry Tunnel

The four main joint-sets seen in the portal brow were used as the wedge-forming sides. The tunnel geometry was pre-set according to the design parameters of 5.5 x 5.5 x 15.0 m (width, height, and length), with a rock weight of 3.02 t/m^3 (which is based on the specific gravity average for the drilled diabase of 3.08), and the design factor of safety (FS) was set at 1.5. The joint sets used were J_1 (75/010, φ = 30°, waviness = 10°), J_{2W} (70/285, φ = 30°, waviness = 5°), J_{2E} (80/100, φ = 30°, waviness = 5°), and J_3 (10/150, φ = 30°, waviness = 5°) – from which four three-plane combinations were run. The largest wedges produced in the roof and side-wall are created using the joint combination of $J_1 + J_{2W} + J_{2E}$ which would result in a maximum of 9.8 tonne wedges with an apex-height of 1.7 m being formed. Hence, the risk of significant wedges forming is low.

4.4 Planar Wedge Failure of the Portal Face

The wedge and planar sliding failure risks were evaluated using a J_{2W} at 60° and a J_3 combination, assuming a back-volume tension crack failure. (These are illustrated in Appendix A's Figure A9a and A9b.) The risk of the J_{2W} failure occurring is low to moderate (237 t/m wedge weight), while the tension-crack resting on a J_3 base scenario risk is high (629 t/m wedge weight). The J_{2W} sliding risk can be mitigated using appropriate pattern-bolting, while the J_3 tension crack scenario is relatively stable even with a 14 m deep full-face detachment.

5 Support Design Recommendations

5.1 Rock-Fall Protection

The risks associated with the adjacent slopes' morphology and loose can be mitigated using draped mesh from an anchor-line above the portal face. A good position, in terms of a natural break in slope and rock mass condition, is the 68 m amsl level. An anchor-line, with a 20 m wide portal-brow protection fence, can support draped gabion mesh which would channel loose material to a 3 m wide catchment bounded by a 1.5 m high windrow. The design is illustrated in Appendix B's DN-P-01, DN-P-04 and DN-P-05 and the hardware requirements are included the table in Appendix B's Figure DN-P-06.

5.2 Portal Brow Pattern Support

The risks of failure of the portal face (from wedge and-or planar sliding) can be mitigated by pattern support in the form of rebar, cable-bolts, and mesh. To support the 237 t/m wedge weight with a factor of safety of around 1.8, the following is recommended: 15 t/m capacity (2.4 m long) fully grouted rebar at a 1.5 m spacing, 25 t/m capacity (6 m long) fully grouted cablebolts at a 3.0 m spacing, and 40 t/m capacity (10 m long) fully-grouted cablebolts at a 6.0 m spacing, with welded wire mesh. The design is illustrated in Appendix B's Figure DN-P-02 and the hardware requirements are included in the table in Appendix B's Figure DN-P-06.

5.3 Decline Support, First 20 m

The main concern in the tunnel is gravity driven falling and sliding of blocks defined by the orthogonally intersecting discontinuity suite present in the rock mass, and potentially the unravelling of more fractured and inadequately supported material. As part of the initial (beyond the Pioneer Support Structure) tunnel's support for the decline's first 10 metres of tunnel, steel sets with a 330 kPa load capacity should be used at a 1 m spacing for the first 5 m (3 units), and then at 1.5 m spacing for the next 6.0 m (4 units). Within this part of the tunnel, 15 t/m capacity (2.4m long) fully grouted rebar at 1.5 m spacing (5 per ring, oriented 20° towards the advancing face) should be used on a 1.5 m ring-spacing with welded-wire mesh between all bolts for the roof. For the next 10 m of the decline the following is recommended: 15 t/m capacity (2.4m long) fully grouted rebar at 1.5 m spacing (with one at 2.5 m above grade in each sidewall, 7 per ring in total, oriented 20° towards the advance) should be used on a 1.5 m ring-spacing with welded-wire mesh between all bolts for the roof and sidewall – added to which are 15 t/m capacity (6.0 m long) fully grouted cablebolts at a 3.0 m spacing (2 per ring, 0.75 m off-section, oriented 30° towards the advance). The design is illustrated in Appendix B's Figures DN-P-02 and DN-P-03, and the hardware requirements are included in the table in Appendix B's Figure DN-P-06.

6 Conclusion, Site Preparation and Work Sequence

The portal support design has been based largely on drill-core information, and rock mass and joint information extracted from the outcrop with snow and ice conditions.

Depending on the work crew availability and time-of-year, there may be some flexibility on the sequence of events during start-up of construction. The portal brow, however, needs to be fully supported before the decline begins. Below is a rough guideline, and on-site inspection of rock mass conditions and design implementation is required throughout the program:

1. Establish anchor-line on the 68 m level using fully grouted eyebolts and cable.
2. Remove loose material from the slopes, 30 m either side of the portal.
3. Clear scree material from the toe of the slope, to the 46 m amsl level.
4. Create 3 m wide catchment area, bounded by the rock-face and a 1.5 m high windrow.
5. Drape and weight mesh over slopes adjacent to portal brow.
6. Bolt and mesh portal brow.
7. Opening cut on advance.
8. Individual large wedges and blocks should be identified through ongoing mapping and supported before they are fully exposed by the advancing portal/decline excavation.
9. Install Pioneer Structure, steel sets, and on-going tunnel support.
10. Assess ground conditions; adjust support design if required, and monitor.

It is essential that these recommendations be further verified once the full rock face is exposed following the spring/summer thaw. As part of the portal mining plan it will be required to undertake additional mapping as the various surfaces are exposed and these findings correlated to these design parameters and findings.

This report, "**Doris North Portal Investigation**", was prepared by SRK Consulting (Canada) Inc.

Prepared by

A. Bloem

Anton Bloem

Bruce Murphy

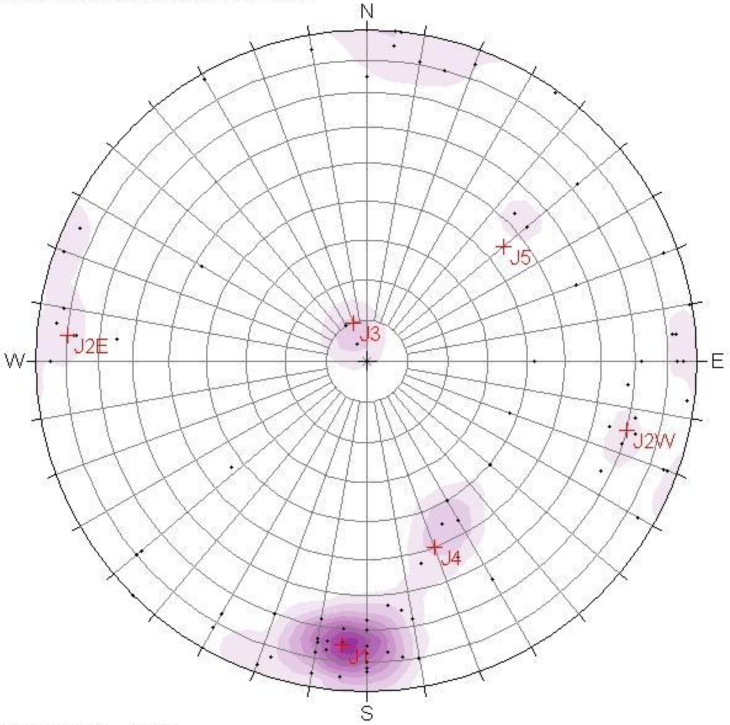
Reviewed by

Maritz Rykaart, P.Eng.

Appendix A

Raw Data and Evaluation

Doris Portal: All Field-Mapped Joints



SRK for HBML, 2010

Orientations

ID	Dip / Direction
1	75 / 005
2W	70 / 285
2E	80 / 095
3	10 / 160
4	50 / 340
5	45 / 230

Equal Area
Lower Hemisphere
623 Poles
95 Entries

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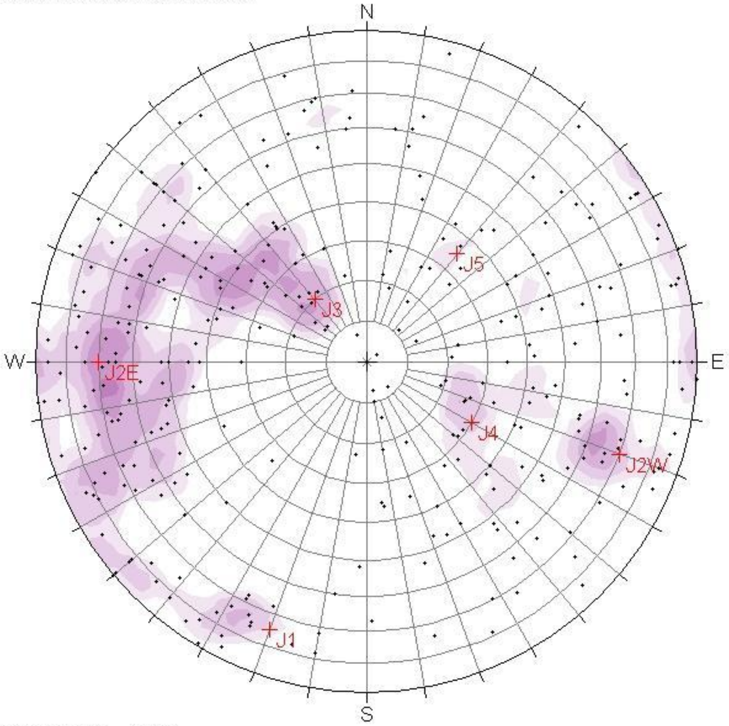
Hope Bay: Doris Portal Investigation

Stereonet plot of all field-mapped joints along the diabase dyke ridge.

PROJECT:	DATE:	APPROVED:	FIGURE:
2CH009.000	June 2010	BM	A1

Doris Portal: All Logged Joints



SRK for HBML, 2010

Orientations

ID	Dip / Direction
1	75 / 020
2W	70 / 290
2E	70 / 090
3	20 / 140
4	30 / 300
5	35 / 220

Equal Area
Lower Hemisphere
318 Poles
318 Entries

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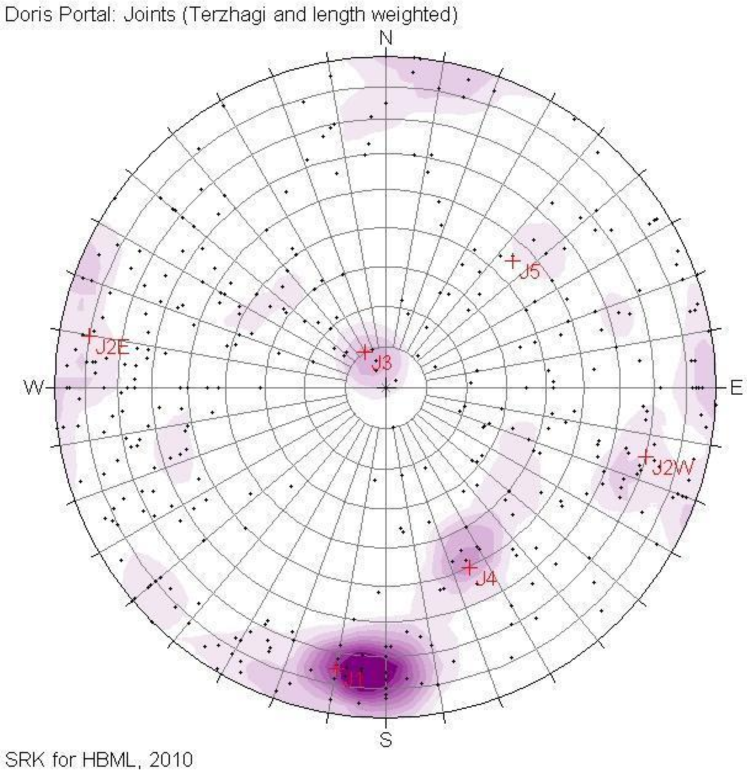
Stereonet plot of all joints and main joint-sets, logged from core in the portal area.

PROJECT:	DATE:	APPROVED:	FIGURE:
2CH009.000	June 2010	BM	A2



Orientations

ID	Dip / Direction
1	75 / 010
2W	70 / 285
2E	80 / 100
3	10 / 150
4	50 / 335
5	45 / 225

Equal Area
Lower Hemisphere
1104 Poles
386 Entries

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Hope Bay: Doris Portal Investigation

Stereonet plot of joints and their sets (Terzaghi and length weighted) for the diabase dyke.*

PROJECT:	DATE:	APPROVED:	FIGURE:
2CH009.000	June 2010	BM	A3

** From both the field-mapping and core logging.*

🟨 Approximate Portal Location

Structure to be Avoided

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Hope Bay, Doris Portal Investigation

Overview of Proposed Doris Portal Site – East View

PROJECT:	DATE:	APPROVED:	FIGURE::
2CH009.001	September 2010	BM	A4

Toppling Risk (Current Status):	MODERATE	LOW	HIGH	LOW
Slope Stability Risk (On Excavation):	LOW	HIGH	LOW	NONE
Consequences:	moderate	severe	high	none

1

2

3

Portal to be sited left of the open structures indicated in red.

4

5

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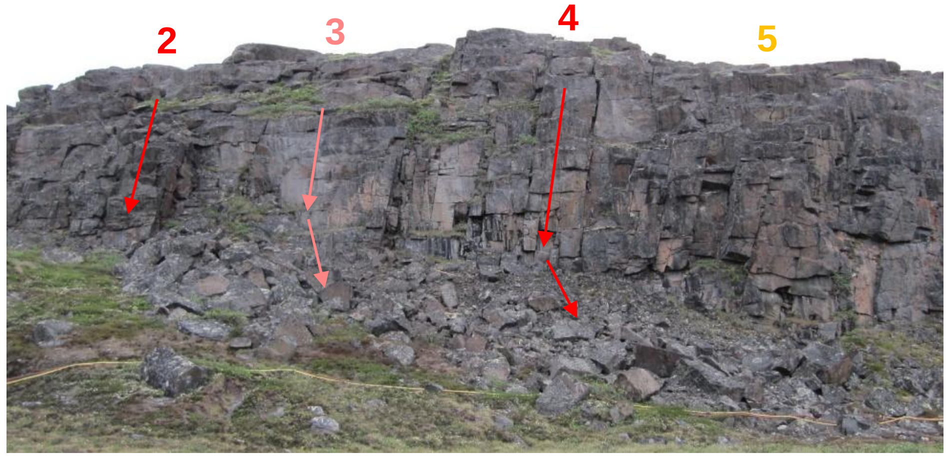
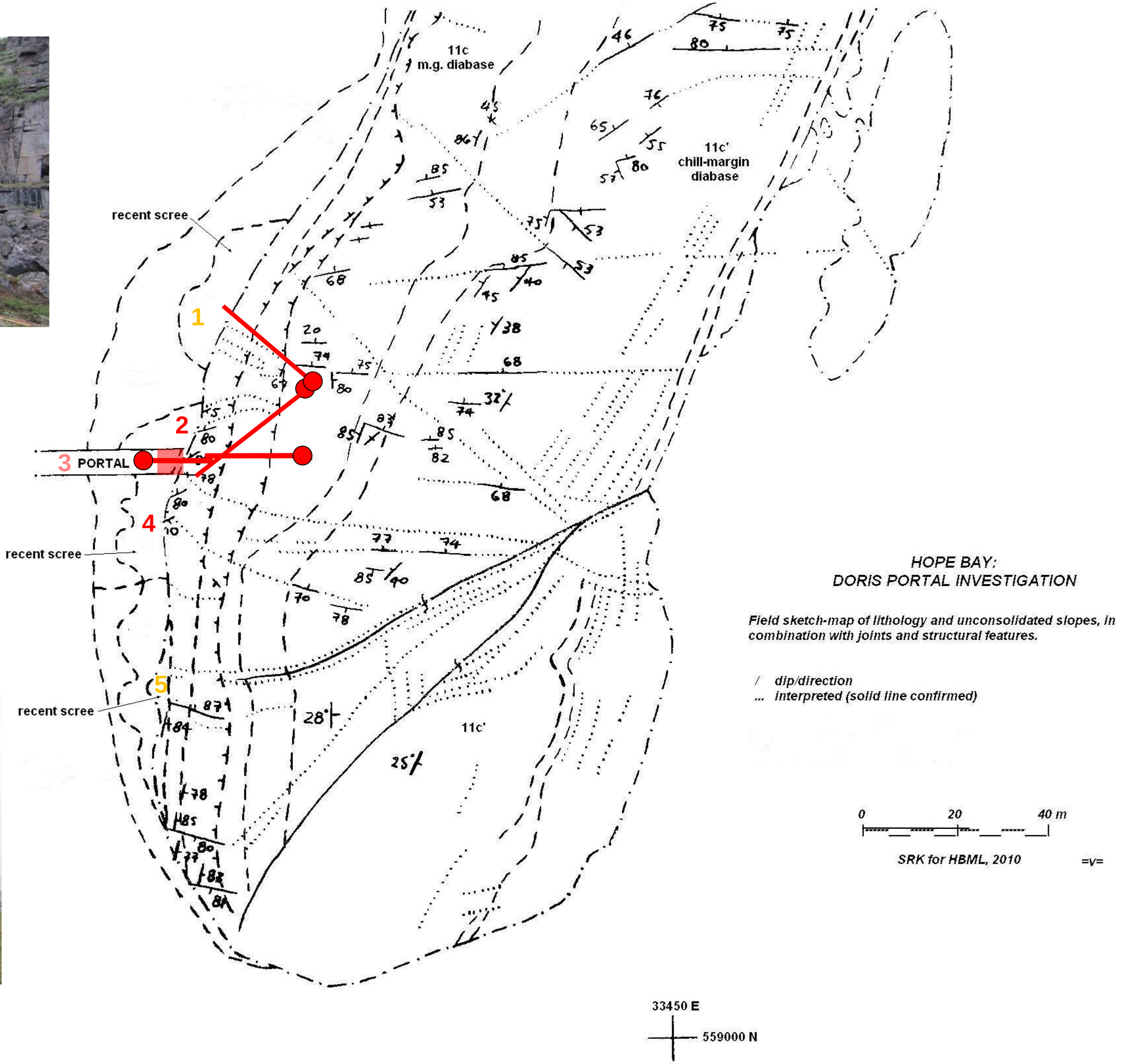
Hope Bay: Doris Portal Investigation

Slope Risk Areas Along Portal Face,
Front View

PROJECT:	DATE:	APPROVED:	FIGURE::
2CH009.001	September 2010	BM	A5





Risks:

Slope	**Height (m)**	**Fall-Risk**	**Roll-Risk**
Far North 1	15	MODERATE	LOW
North 2	20	HIGH	MODERATE
Portal 3	25	LOW	HIGH
South 4	30	HIGH	MODERATE
Far South	10	LOW	LOW

● Schematic of drillhole locations

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Hope Bay: Doris Portal Investigation

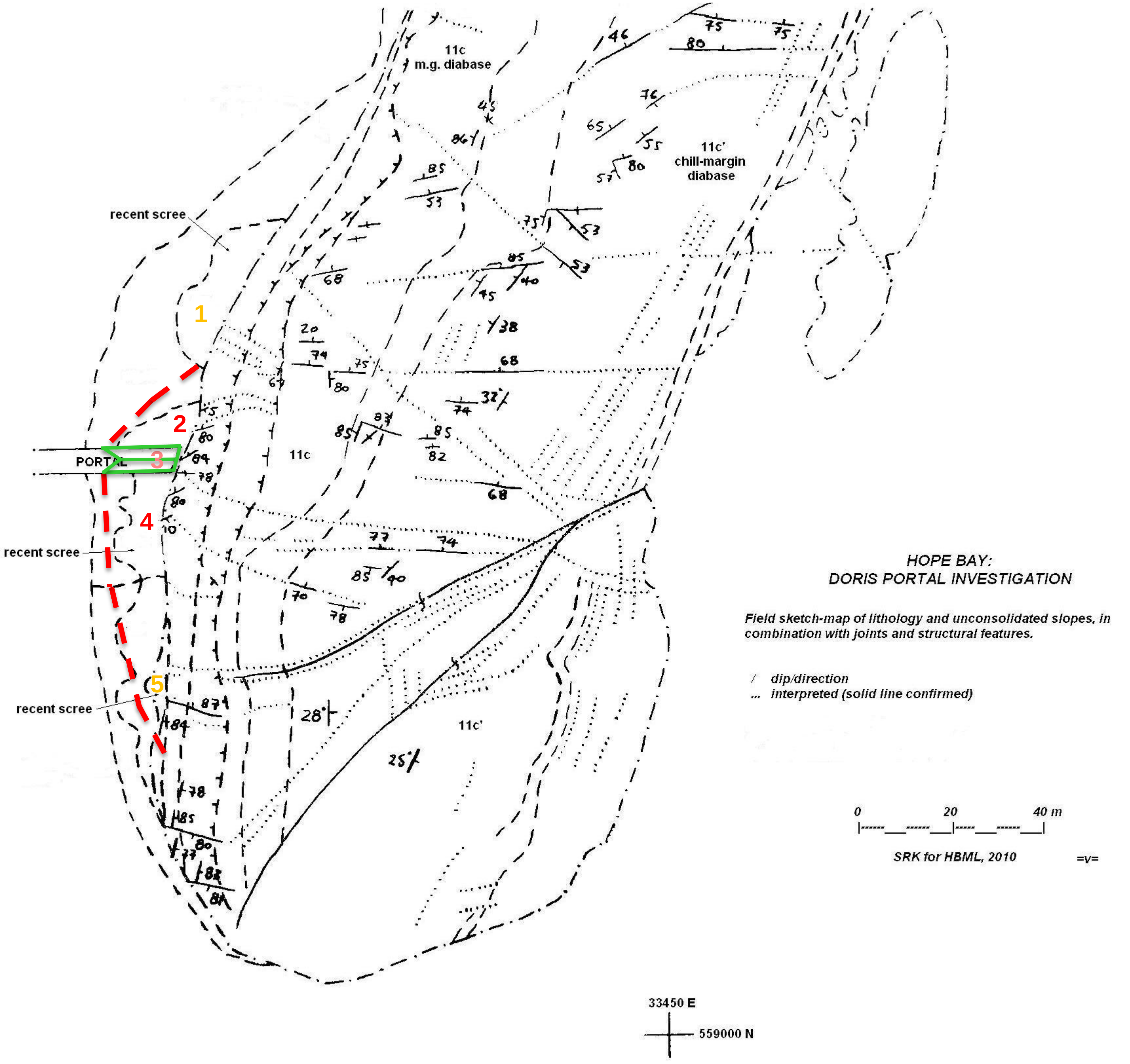
Rock-Fall, bounce, and Roll Risk
Along Portal Face, Plan View

PROJECT:	DATE:	APPROVED:	FIGURE::
2CH009.001	September 2010	BM	A6

Mitigation Measures:

Far North 1	None required, out of activity zone
North 2	Draped mesh, fall-ditch
Portal 3	Pattern-bolts, straps, mesh
South 4	Spot-bolts, draped-mesh, fall-ditch
Far South 5	5 m Perimeter fence

🟩	Steel-reinforced concrete entry-way
🟥	Protection berm



HOPE BAY:
DORIS PORTAL INVESTIGATION

Field sketch-map of lithology and unconsolidated slopes, in combination with joints and structural features.

/ dip/direction
... interpreted (solid line confirmed)

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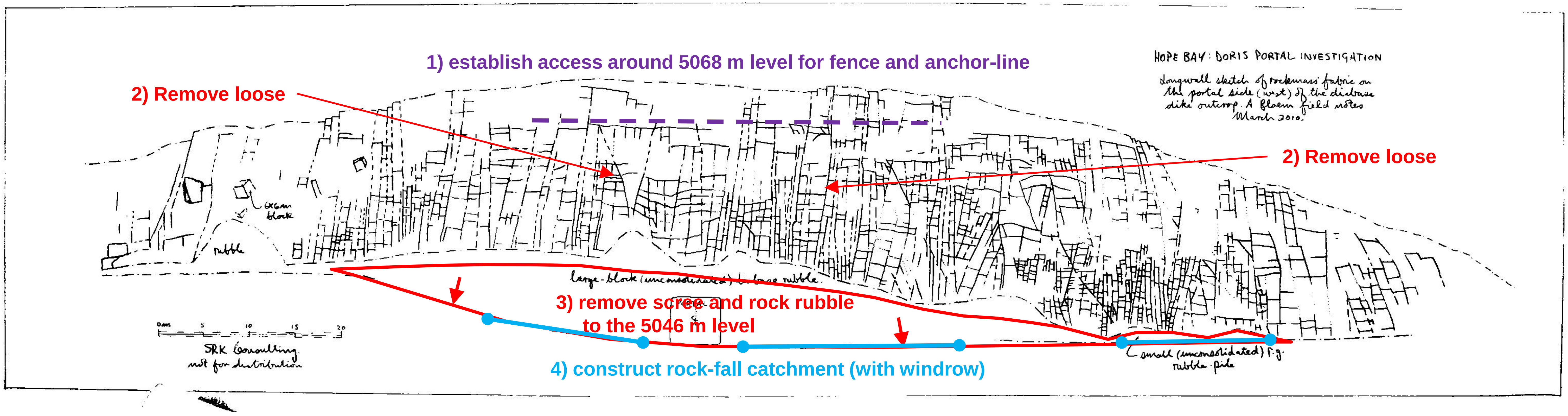
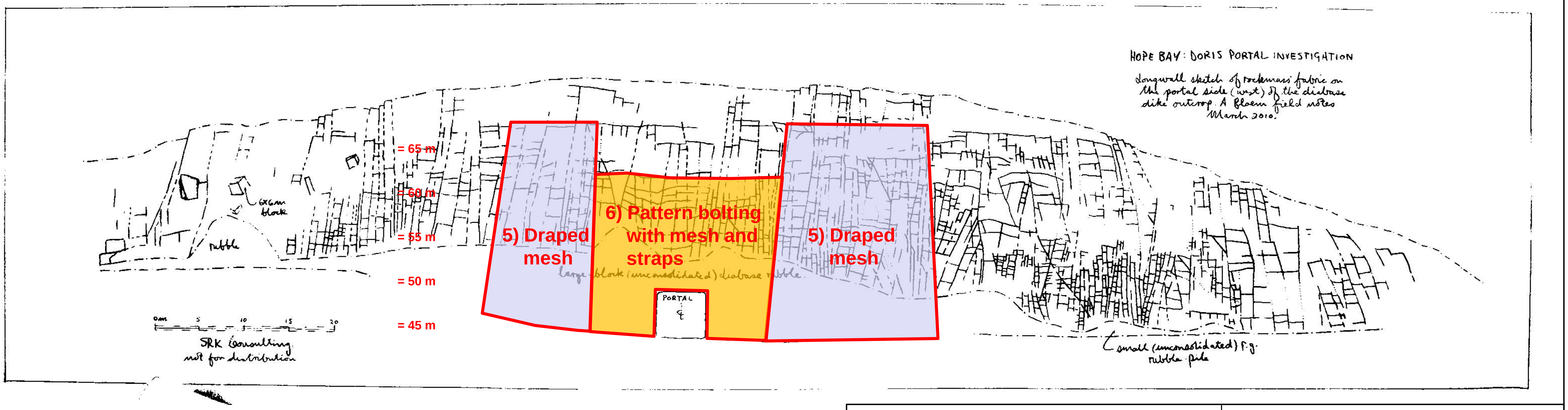
Hope Bay: Doris Portal Investigation

Slope Mitigation Measures along
Portal Face, Plan View

PROJECT:	DATE:	APPROVED:	FIGURE::
2CH009.001	September 2010	BM	A7





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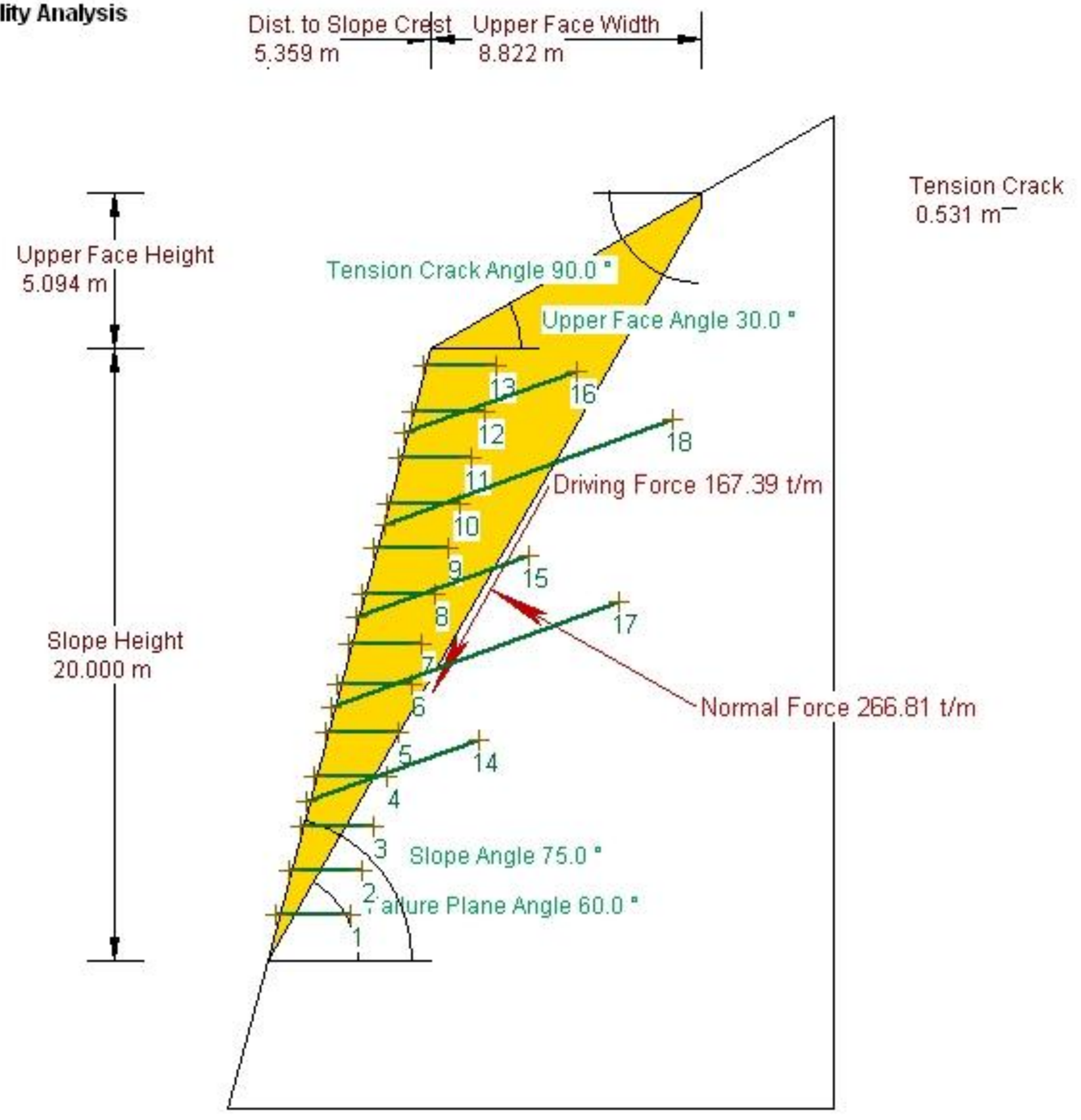
Hope Bay: Doris Portal Investigation

Portal Face Support Requirements, Front View

PROJECT:	DATE:	APPROVED:	FIGURE::
2CH009.001	June 2010	BM	A8

Filename: DP_J2W60TC90_BCC2.pln
Project Title: Doris Portal (J2w at 60 deg) Planar Wedge Stability Analysis



Bolt Properties:

#	*Angle*	*Capacity*	*Length*	*AnchLength*
1	0.0 °	15.00t/m	2.400 m	1.907 m
2	0.0 °	15.00t/m	2.400 m	1.458 m
3	0.0 °	15.00t/m	2.400 m	1.003 m
4	0.0 °	15.00t/m	2.400 m	0.502 m
5	0.0 °	15.00t/m	2.400 m	0.046 m
6	0.0 °	15.00t/m	2.400 m	0.000 m
7	0.0 °	15.00t/m	2.400 m	0.000 m
8	0.0 °	15.00t/m	2.400 m	0.000 m
9	0.0 °	15.00t/m	2.400 m	0.000 m
10	0.0 °	15.00t/m	2.400 m	0.000 m
11	0.0 °	15.00t/m	2.400 m	0.000 m
12	0.0 °	15.00t/m	2.400 m	0.000 m
13	0.0 °	13.00t/m	2.400 m	0.000 m
14	20.0 °	25.00t/m	6.000 m	3.670 m
15	20.0 °	25.00t/m	6.000 m	1.180 m
16	20.0 °	25.00t/m	6.000 m	0.000 m
17	20.0 °	40.00t/m	10.000 m	6.393 m
18	20.0 °	40.00t/m	10.000 m	4.121 m

Factor of Safety	1.82
Driving Force	167.39t/m
Resisting Force	305.33t/m
Wedge Weight	236.58t/m
Wedge Volume	78.34m^3/m
Shear Strength	182.40t/m^2
Normal Force	266.81t/m
Plane Waviness	5.0°
Active Bolt Force	75.00t
Active Bolt Angle	0.0°
Passive Bolt Force	130.00t
Passive Bolt Angle	-20.0°

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Hope Bay: Doris Portal Investigation

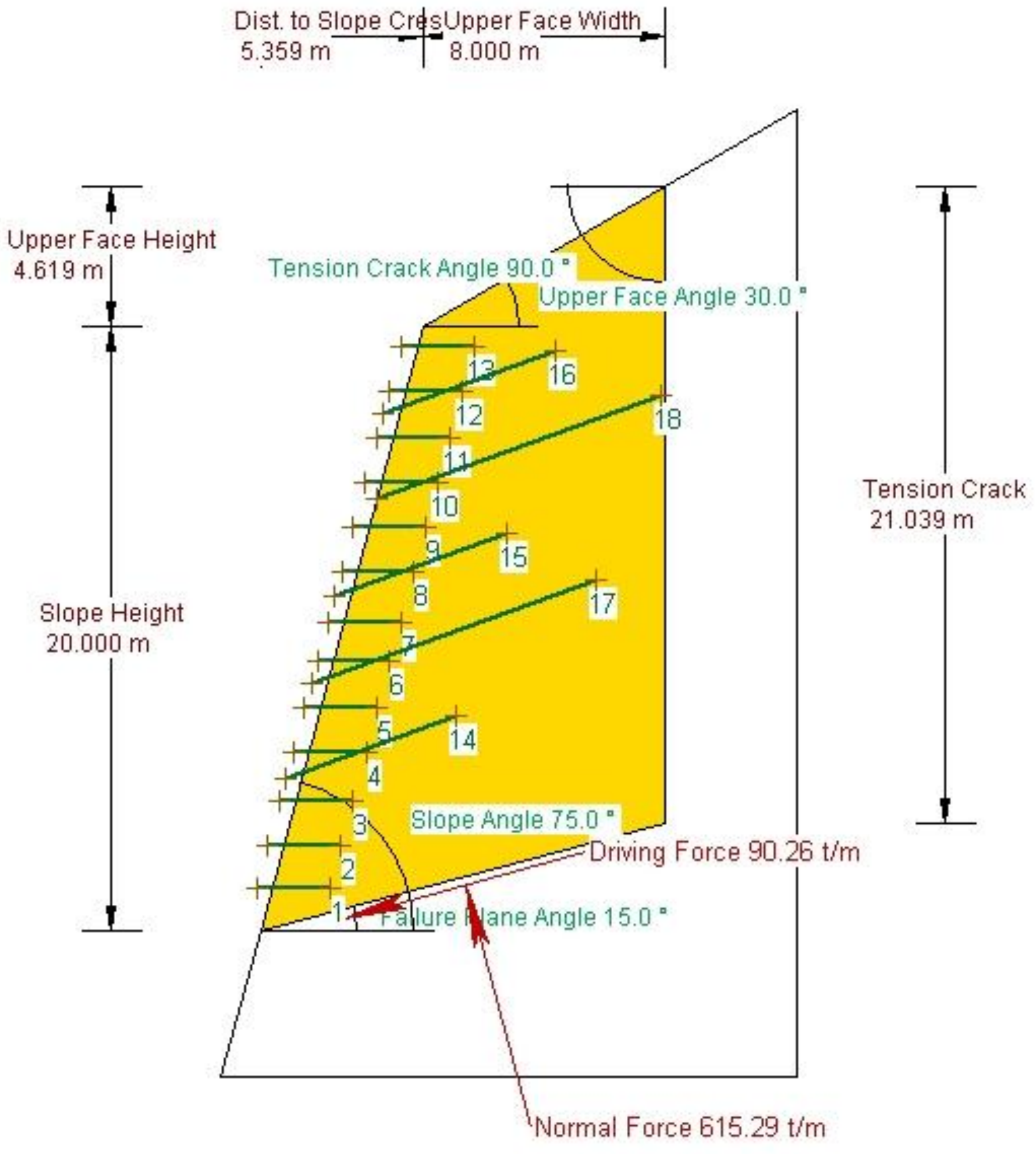
Planar Wedge Stability Analysis
J2w at 60 Degrees

PROJECT:	DATE:	APPROVED:	FIGURE:
2CH009.001	June 2010	BM	A9a

Filename: DP_J3TC90_BCC2.pln
Project Title: Doris Portal (J3 and Tension Crack) Planar Wedge Stability Analysis

Bolt Properties:

#	*Angle*	*Capacity*	*Length*	*AnchLength*
1	0.0 °	15.00t/m	2.400 m	1.907 m
2	0.0 °	15.00t/m	2.400 m	1.458 m
3	0.0 °	15.00t/m	2.400 m	1.003 m
4	0.0 °	15.00t/m	2.400 m	0.502 m
5	0.0 °	15.00t/m	2.400 m	0.046 m
6	0.0 °	15.00t/m	2.400 m	0.000 m
7	0.0 °	15.00t/m	2.400 m	0.000 m
8	0.0 °	15.00t/m	2.400 m	0.000 m
9	0.0 °	15.00t/m	2.400 m	0.000 m
10	0.0 °	15.00t/m	2.400 m	0.000 m
11	0.0 °	15.00t/m	2.400 m	0.000 m
12	0.0 °	15.00t/m	2.400 m	0.000 m
13	0.0 °	13.00t/m	2.400 m	0.000 m
14	20.0 °	25.00t/m	6.000 m	3.670 m
15	20.0 °	25.00t/m	6.000 m	1.180 m
16	20.0 °	25.00t/m	6.000 m	0.000 m
17	20.0 °	40.00t/m	10.000 m	6.393 m
18	20.0 °	40.00t/m	10.000 m	4.121 m



Factor of Safety	6.12
Driving Force	90.26t/m
Resisting Force	552.41t/m
Wedge Weight	628.63t/m
Wedge Volume	208.16m^3/m
Shear Strength	369.07t/m^2
Normal Force	615.29t/m
Plane Waviness	5.0°
Active Bolt Force	75.00t
Active Bolt Angle	0.0°
Passive Bolt Force	130.00t
Passive Bolt Angle	-20.0°

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Hope Bay: Doris Portal Investigation

Planar Wedge Stability Analysis
J3and Tension Crack

PROJECT:	DATE:	APPROVED:	FIGURE::
2CH009.001	June 2010	BM	A9b

Appendix B

Locality Map and Design Drawings

Engineering Drawings for the
Doris North Portal,
Doris North Project, Nunavut, Canada

ACTIVE DRAWING STATUS

SRK DWG NUMBER	NEWMONT DWG NUMBER	DRAWING TITLE	REVISION	DATE	STATUS
DN-P-00	HB+R-CIV-CIV-OND-0019	Engineering Drawings for Doris North Portal	0	September 9, 2010	Issued for Construction
DN-P-01	HB+R-CIV-CIV-OND-0020	Doris Portal General Arrangement	0	September 9, 2010	Issued for Construction
DN-P-02	HB+R-CIV-CIV-OND-0021	Doris Portal Pattern Support Design	0	September 9, 2010	Issued for Construction
DN-P-03	HB+R-CIV-CIV-OND-0022	Doris Portal Pattern Support Design Sections and Details	0	September 9, 2010	Issued for Construction
DN-P-04	HB+R-CIV-CIV-OND-0023	Details and Sections of Draped Mesh on Slopes	0	September 9, 2010	Issued for Construction
DN-P-05	HB+R-CIV-CIV-OND-0024	Loose Rock Catchment Windrow Plan and Sections	0	September 9, 2010	Issued for Construction
DN-P-06	HB+R-CIV-CIV-OND-0025	Material Specifications	0	September 9, 2010	Issued for Construction

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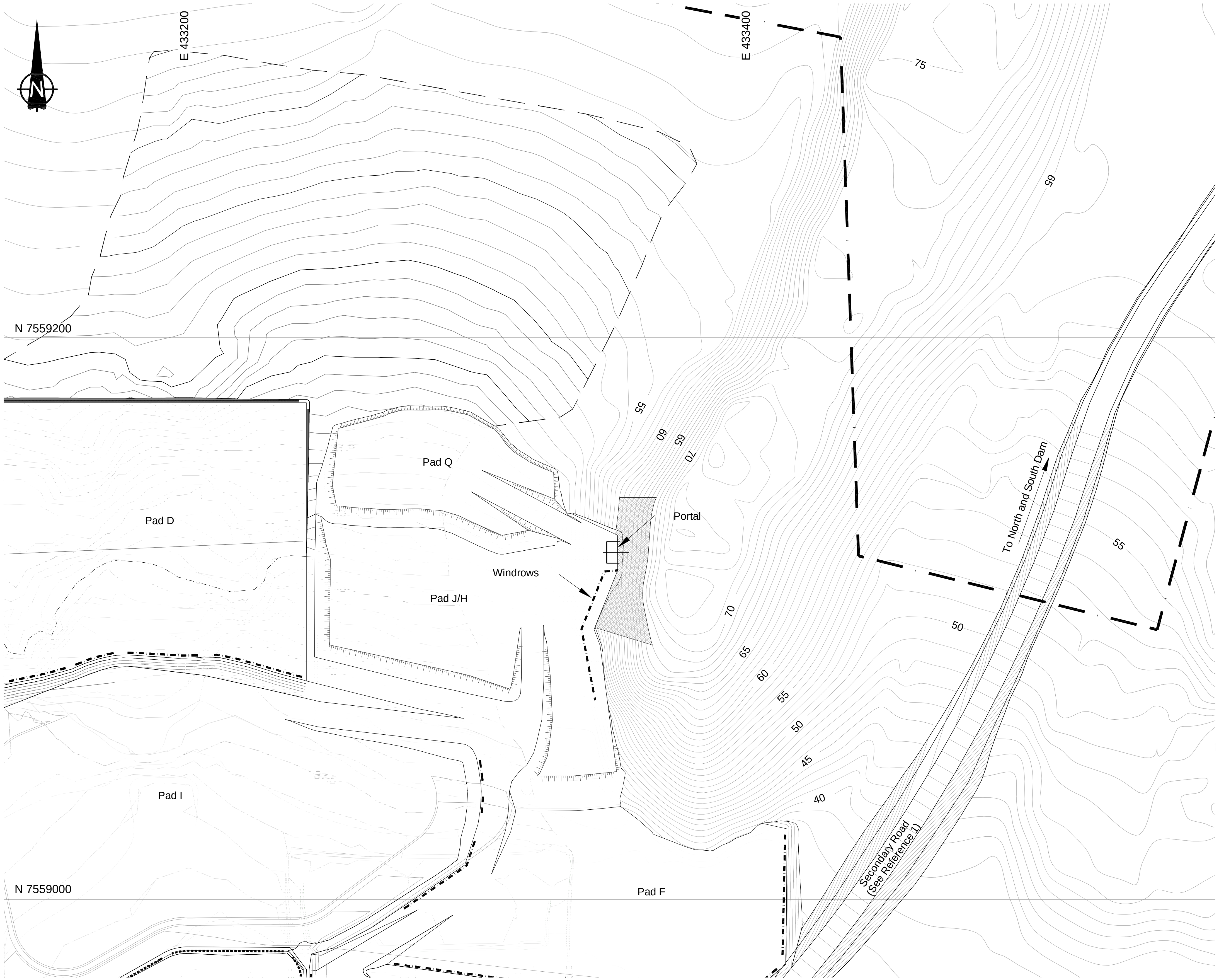
Vancouver

PROJECT NO: 2CH009.001
ISSUED FOR CONSTRUCTION
Revision 0
SEPTEMBER 9, 2010
DN-P-00 / HB+R-CIV-CIV-OND-0019



NOTES:

1. The portal support design has been based largely on drill-core information and rock mass and joint information extracted from the outcrop with snow and ice conditions. It is essential that these recommendations be further verifiedand evaluated once the full rock face is exposed. As part of the portal mining plan it will be required to undertake additional mapping as the various surfaces are exposed and these findings correlated to these design parameters and findings.

2. The portal brow area needs to be fully supported before the decline begins.

3. Below is the rough guideline of events during construction startup:

   a. Establish anchor-line on the 68m level using fully grouted eyebolts and cable.
   b. Remove loose material from the slopes, 30m either side of the portal.
   c. Clear scree material from the toe of the slope, to the 46m level.
   d. Create 3m wide catchment area, bounded by the rock-face and a 1.5m high windrow.
   e. Drape and weight mesh over slopes adjacent to portal brow.
   f. Bolt and mesh portal brow.
   g. Opening cut on advance.
   h. Individual large wedges and blocks should be identified through ongoing mapping and supported before they are fully exposed by the advancing portal excavation.
   i. Install Pioneer Structure, steel sets and on-going tunnel support.
   j. Assess ground conditions; adjust support design if required and monitor.

4. On site inspection of rock mass conditions and design implementation is required throughout the program.

LEGEND:

-·-·-	Berms
▨	Support and Mesh

0 5 10 15 20 25
Scale in Metres

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE

REFERENCE DRAWINGS

NO.	DESCRIPTION	CHK'D	APP'D	CLIENT	DATE
A	ISSUED FOR CONSTRUCTION	BM	LW	–	09SEP10

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Vancouver

DESIGN: MK
DRAWN: VY
REVIEWED: EMR
CHECKED: BM
APPROVED: LW
DATE: Sep. 9, 2010
FILE NAME: DN Portal–GA.dwg

NEWMONT
NORTH AMERICA

HOPE BAY MINING LTD.

SRK JOB NO.: 2CH009.001
SRK DWG NO.: DN-P-01

Doris North Project

DRAWING TITLE:
Doris Portal
General Arrangement

NEWMONT DRAWING NO.: HB+R-CIV-CIV-OND-0020
SHEET: 2 of 7
REVISION NO.: 0

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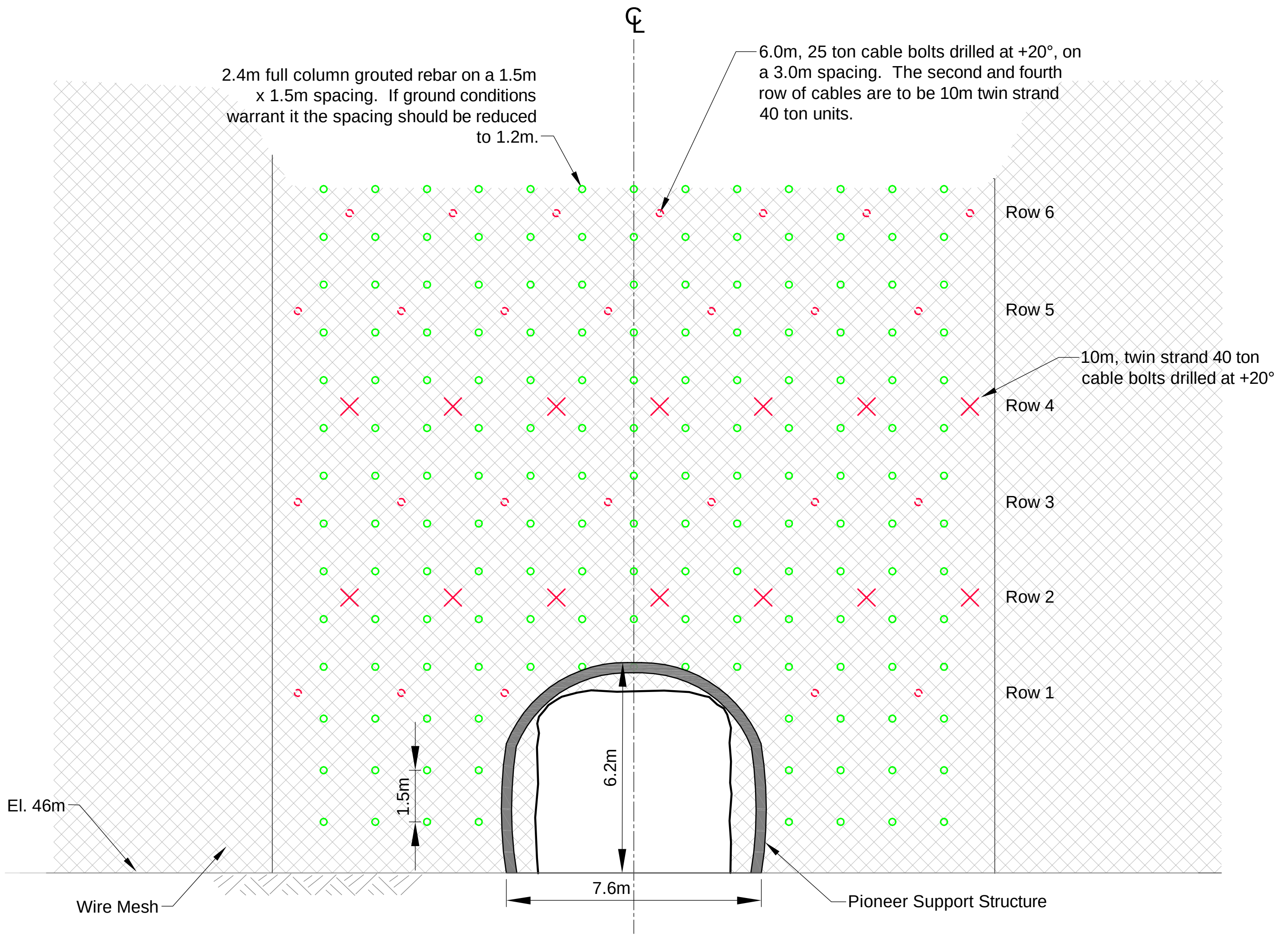
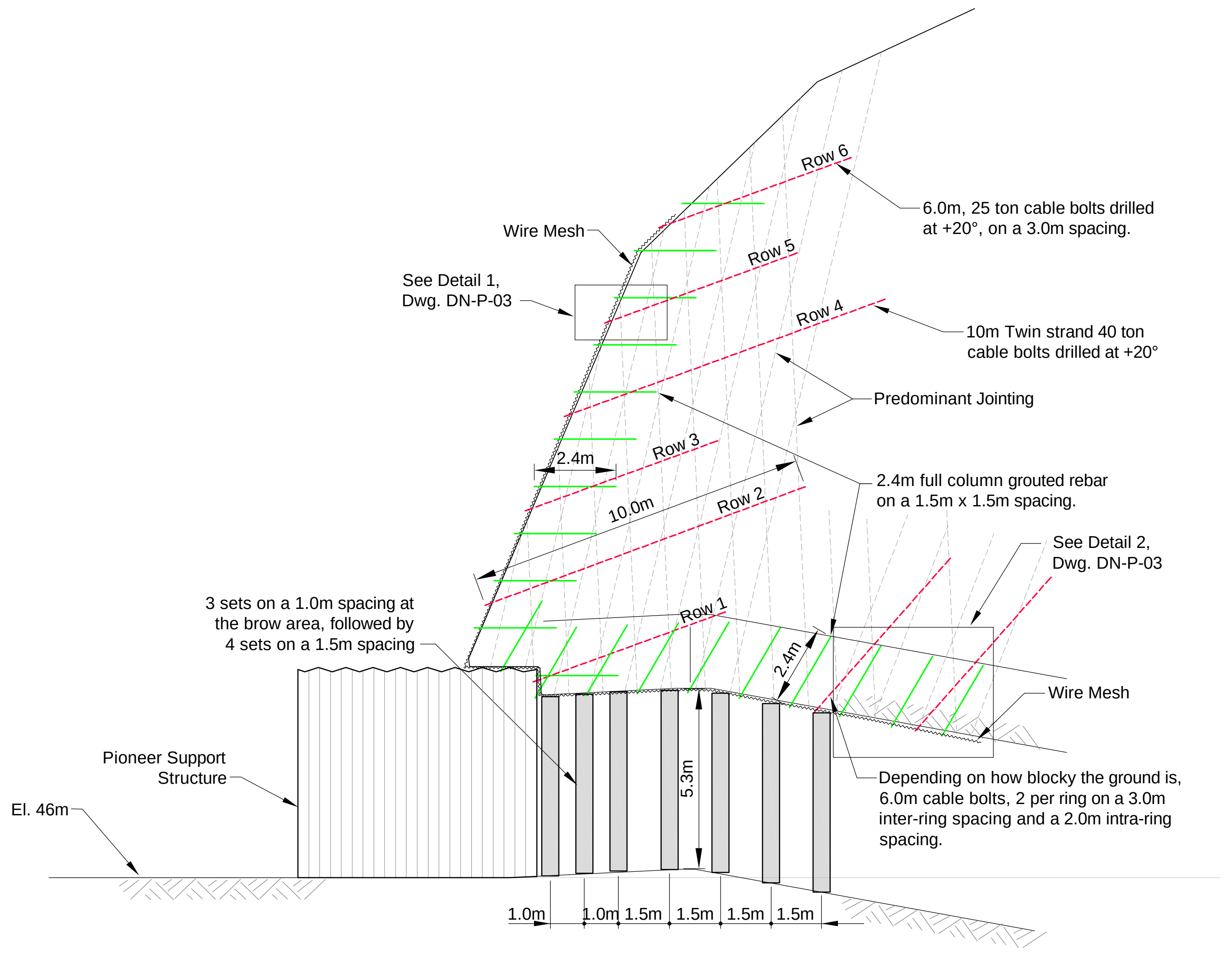


Portal Support Face View



Portal Support Section

NOTES:

1. If ground conditions warrant it, the spacing of the full column grouted rebar along the rock face should be reduced to 1.2m.
2. Steel set supports are to be horseshoe or modified horseshoe shape and designed to support a load of 0.3MPa at a depth of 15m.
3. Tie bars are required between steel set supports.
4. 2.4m fully grouted rebar supporting the tunnel are to be oriented at 20° towards the advancing face.
5. Steel sets and Pioneer Support Structure are to be installed per the manufacturers instructions.
6. 6.0m 25 ton Cable bolts are to be installed following the final steel set until ground conditions improve.

0 1 2 3 4 5
Scale in Metres

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE
–	–		

REFERENCE DRAWINGS

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DESIGN: AB
DRAWN: NV/VY
REVIEWED: EMR
CHECKED: MK
APPROVED: LW
DATE: Sep. 9, 2010
FILE NAME: DN Portal Support.dwg

NEWMONT NORTH AMERICA

HOPE BAY MINING LTD.

SRK JOB NO.: 2CH009.001
SRK DWG NO.: DN-P-02

Doris North Project

DRAWING TITLE:
Doris Portal
Pattern Support Design

NEWMONT DRAWING NO.: HB+R-CIV-CIV-OND-0021
SHEET: 3 of 7
REVISION NO.: 0

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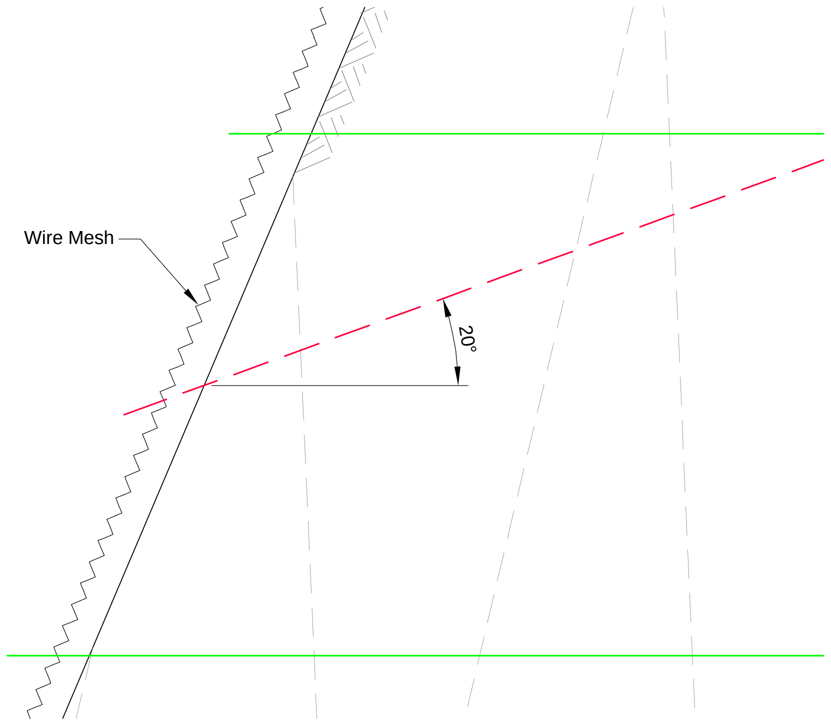
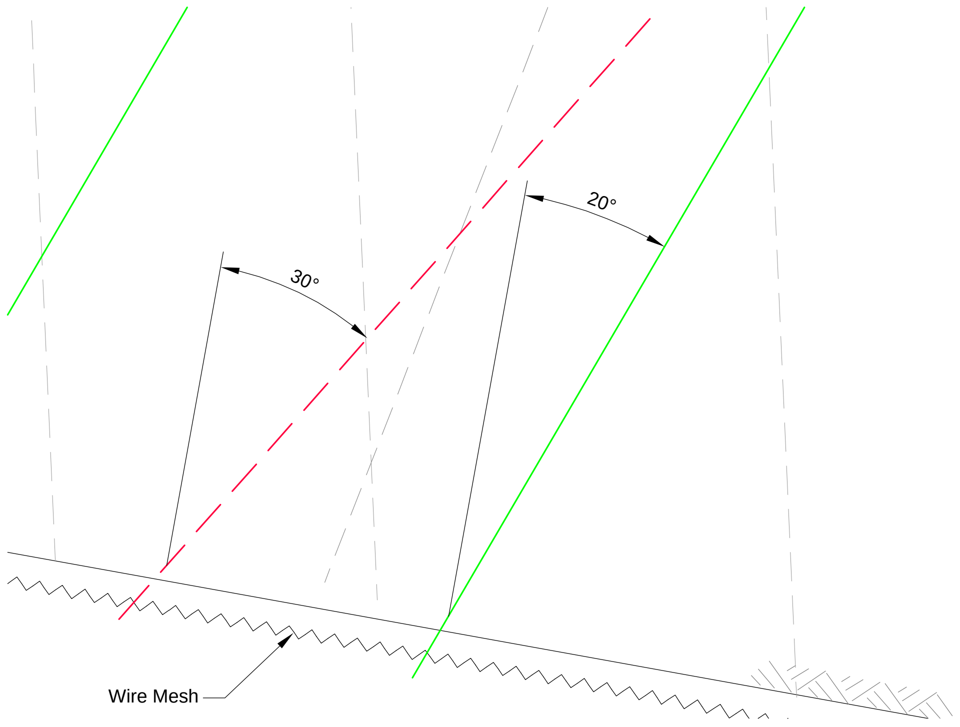


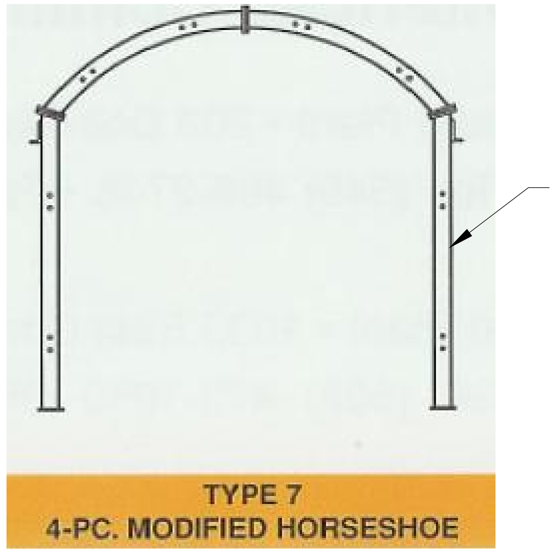
1 DN-P-02 **DETAIL 1**

0 0.1 0.2 0.3 0.4 0.5
Scale in Metres

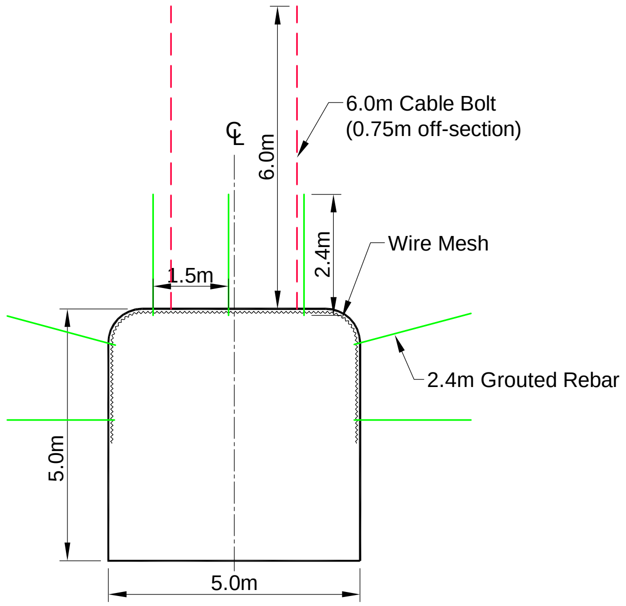


2 DN-P-02 **DETAIL 2**

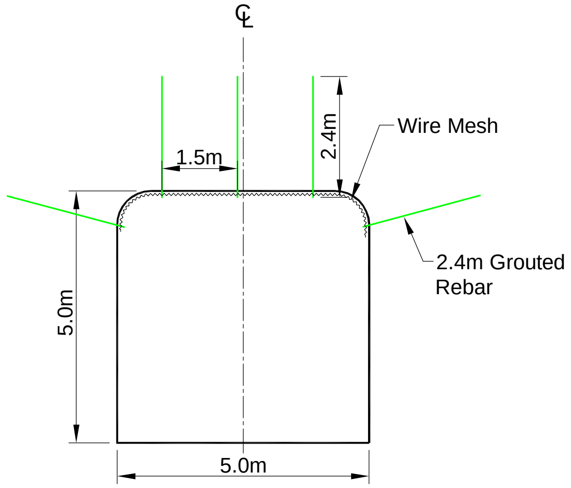
0 0.1 0.2 0.3 0.4 0.5
Scale in Metres



- Steel set to support a conservative load of 0.3 MPa at a depth of 15m
- Estimated spacing of 1.0m and 1.5m
- Horseshoe or modified horseshoe shape
- No horizontal loads expected
- Bearing plates at base of leg
- No invert strut required
- Tie bars between sets

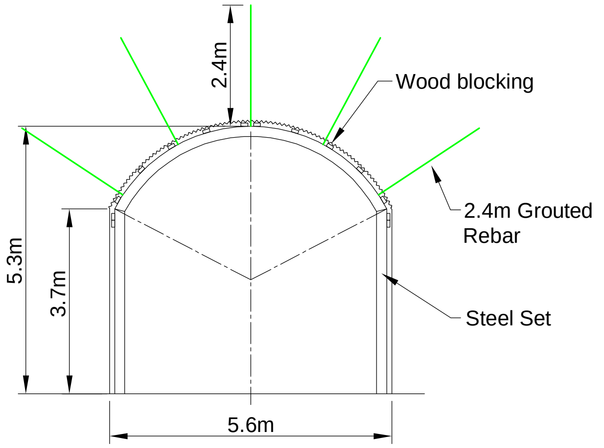


Tunnel Support Section in Blocky Ground



Typical Tunnel Support Section

0 10 20 30 40 50
Scale in Metres



Tunnel Support Section in Steel Set Area

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE
–	–		

REFERENCE DRAWINGS

NO.	DESCRIPTION	CHK'D	APP'D	CLIENT	DATE
A	ISSUED FOR CONSTRUCTION	BM	LW	–	09SEP10

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Vancouver

DESIGN: AB
DRAWN: VY
REVIEWED: EMR
CHECKED: AB
APPROVED: LW
DATE: Sep. 9, 2010
FILE NAME: DN Portal Support.dwg

NEWMONT NORTH AMERICA

HOPE BAY MINING LTD.

SRK JOB NO.: 2CH009.001
SRK DWG NO.: DN-P-03

Doris North Project

DRAWING TITLE:
Doris Portal
Pattern Support Design
Sections and Details

NEWMONT DRAWING NO.: HB+R-CIV-CIV-OND-0022
SHEET: 4 of 7
REVISION NO.: 0

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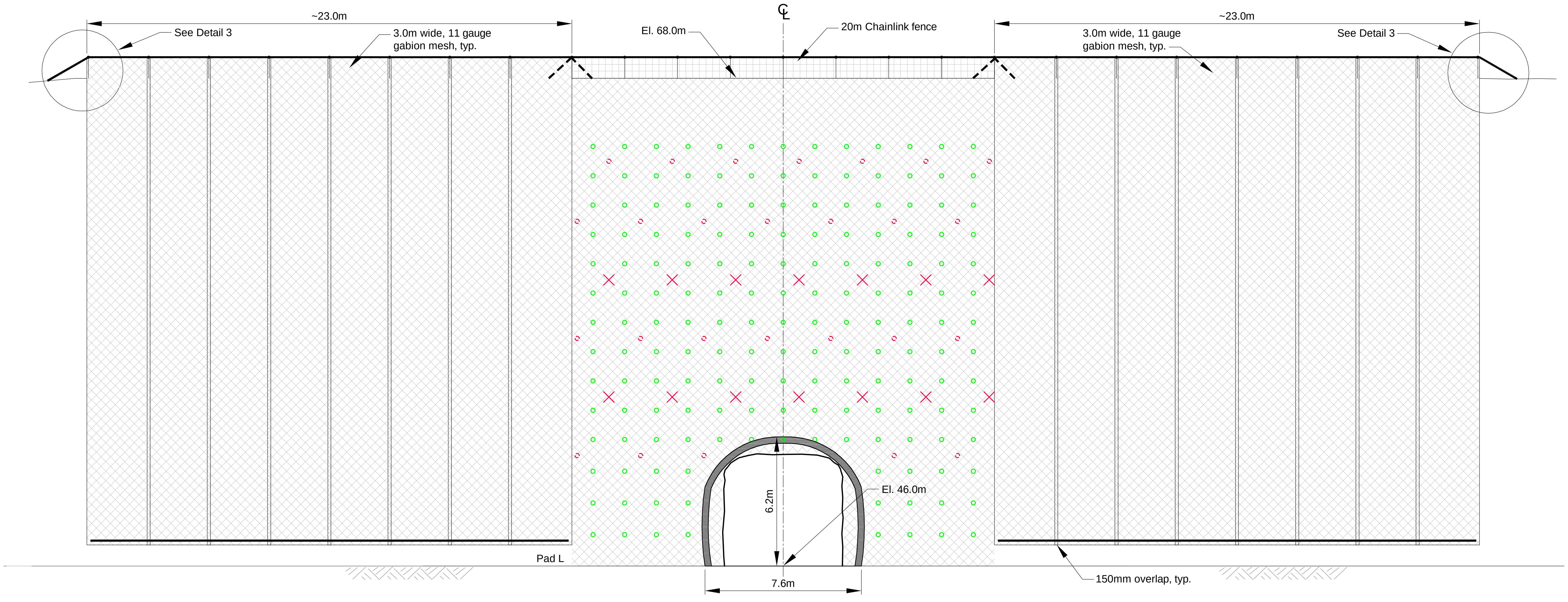
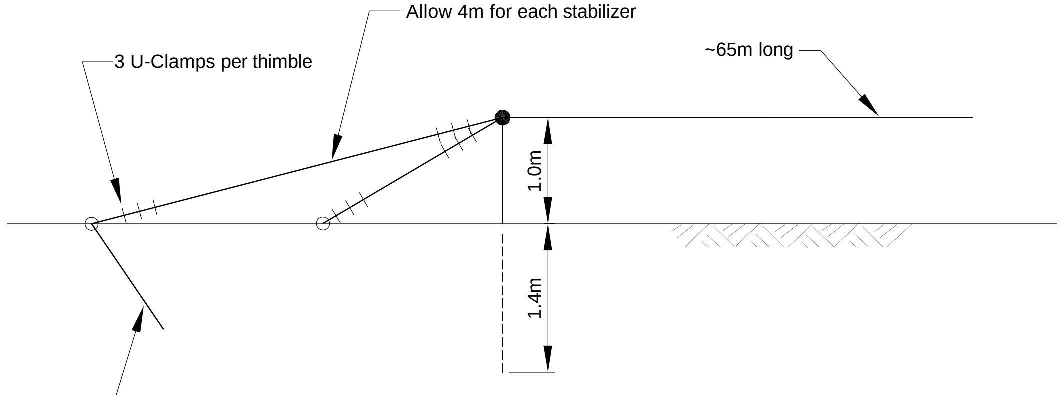
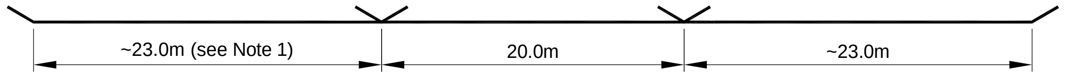


Draped Mesh on Slopes

0 1 2 3 4 5
Scale in Metres



3 DN-P-02 **Detail 3**
NTS



Main Cable Anchor-Line - Plan Detail

0 2 4 6 8 10
Scale in Metres

NOTE:

1. Number of mesh pannels to be determined on-site, depending on conditions.

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE
–	–		

REFERENCE DRAWINGS

NO.	DESCRIPTION	CHK'D	APP'D	CLIENT	DATE
A	ISSUED FOR CONSTRUCTION	BM	LW	–	09SEP10

REVISIONS

PROFESSIONAL ENGINEER'S STAMP

SRK Consulting
Engineers and Scientists
Vancouver

DESIGN: AB
DRAWN: VY
REVIEWED: EMR
CHECKED: AB
APPROVED: LW
DATE: Sep. 9, 2010
FILE NAME: DN Portal Support.dwg

NEWMONT
NORTH AMERICA

HOPE BAY MINING LTD.

SRK JOB NO.: 2CH009.001
SRK DWG NO.: DN-P-04

Doris North Project

DRAWING TITLE:
Details and Sections of
Draped Mesh on Slopes

NEWMONT DRAWING NO.: HB+R-CIV-CIV-OND-0023
SHEET: 5 of 7
REVISION NO.: 0

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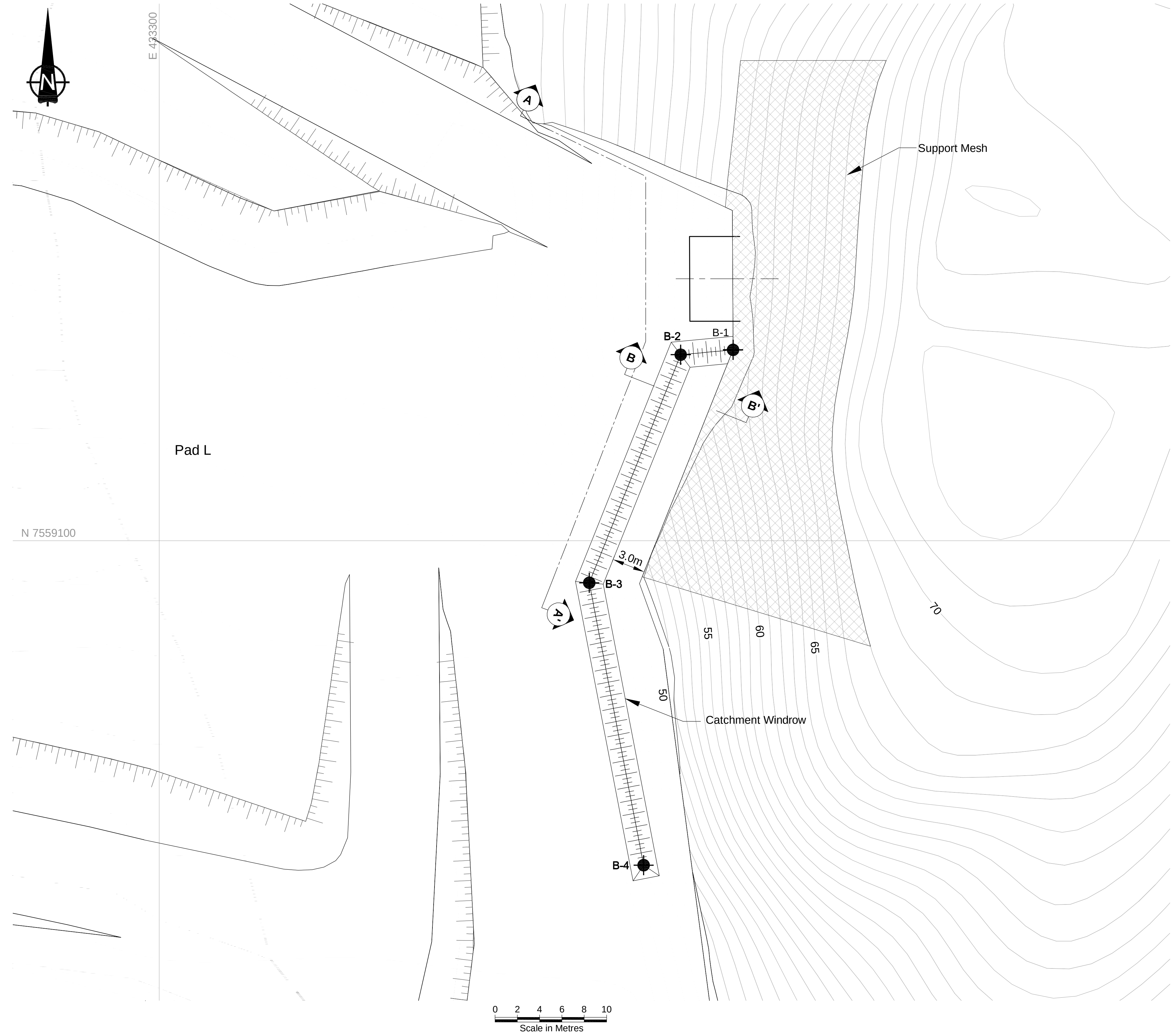
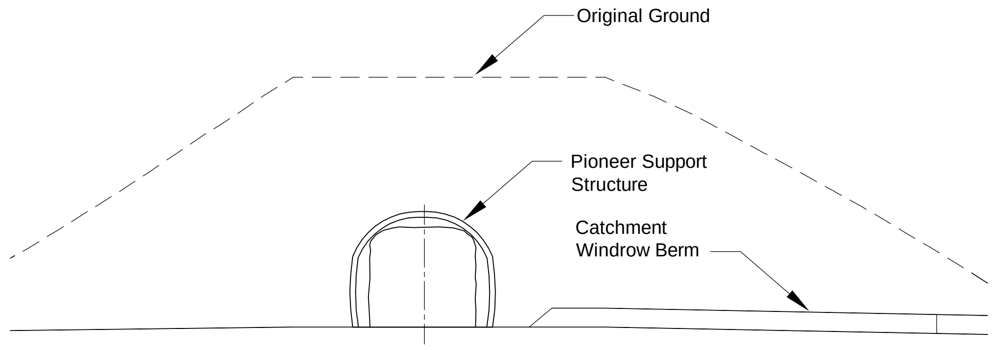
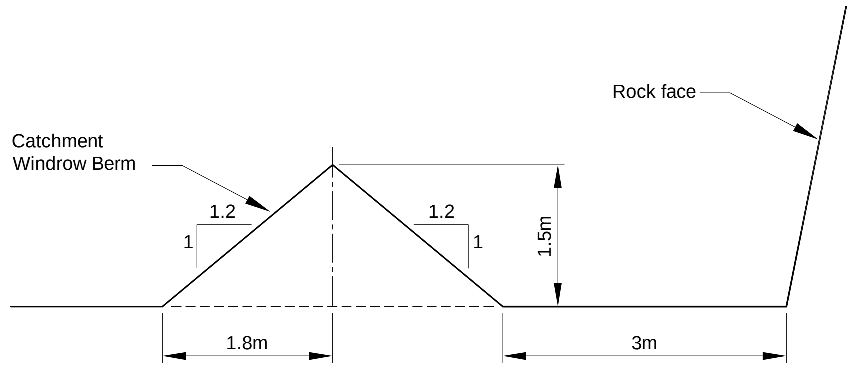




SECTION A-A'

0 2 4 6 8 10
Scale in Metres



SECTION B-B'

0 0.4 0.8 1.2 1.6 2
Scale in Metres

NOTE:

1. See Dwg. DN-P-06 for Stake Out Table of Catchment Windrow.

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE
REFERENCE DRAWINGS			

NO.	DESCRIPTION	CHK'D	APP'D	CLIENT	DATE
A	ISSUED FOR CONSTRUCTION	BM	LW	–	09SEP10
REVISIONS					

PROFESSIONAL ENGINEER'S STAMP

SRK Consulting
Engineers and Scientists
Vancouver

DESIGN: MK	DRAWN: VY	REVIEWED: EMR
CHECKED: BM	APPROVED: LW	DATE: Sep. 9, 2010
FILE NAME: DN Portal–GA.dwg		

NEWMONT
NORTH AMERICA

HOPE BAY MINING LTD.

SRK JOB NO.: 2CH009.001
SRK DWG NO.: DN-P-05

Doris North Project

DRAWING TITLE:
Loose Rock Catchment Windrow
Plan and Sections

NEWMONT DRAWING NO.: HB+R-CIV-CIV-OND-0024
SHEET: 6 of 7
REVISION NO.: 0

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MATERIALS LIST AND QUANTITIES

Area	Item	Length (m)	Width (m)	Diameter (mm)	Quantity	Comment
Portal Brow and Adjacent Slopes	#7 Anchornut				201	
	#7 Domed Plate Washer (0.2 m square)	0.2	0.2		201	
	#7 DYWIDAG Threadbar (slashed end)	2.4		22	201	Full column grouted, in 33 mm hole (1 1/4 ")
	#7 Rebar Eyebolt (slashed end, square spinner head, butt weld, 3" eye)	1.2		22	60	Fully grouted installation for posts (1 m proud)
	#7 Rebar Eyebolt (slashed end, square spinner head, butt weld, 4" eye)	2.4		22	30	Fully grouted installation for anchor-line
	00 gauge (8.6 mm), Welded Wire Mesh Strap, ASTM A185 specifications	2.7	0.3		36	
	0-30 sec. resin, 18" cartridge, oil based resin (Ground Lok or similar)	0.5		30	291	For fully grouting 2.4 m long holes
	5-7 min. resin, 24" cartridge, oil based resin (Ground Lok or similar)	0.6		30	1052	
	10 mm 7-strand cable	120		10	120 m	To be cut to approx 2 m lengths on-site
	10 mm Wire Rope Clamps (Crosby Clips)				360	
	10 mm Wire Rope Thimbles (ID 30 mm)				120	
	11 gauge (3 mm) Hogrings, in thousands:				15	Fifteen thousand units for 322 m of gabion-mesh seam (40/m)
	11 gauge (3 mm) wire	240		3	240 m	On-site sizing, supply in 50 m (and shorter) lengths
	11 gauge (3 mm), Gabion Mesh, ASTM A975 specifications	25	3		16	16 units of 25 x 3 m panels
	13 mm 7-strand cable	78		13	78 m	To be cut into three 20 m (approx) lengths on-site
	13 mm Wire Rope Clamps (Crosby Clips)				22	
	13 mm Wire Rope Thimbles				8	
	15 mm 7-strand cable	48		15	48 m	To be cut into two 20 m (approx) lengths on-site
	15 mm Bulbed (@ 1.0 m intervals) Cable Bolt, 25 Ton	6.5		15	32	In 51 mm hole (2")
	End Holding Device -- fish hook style				32	
	Domed Plate Washer (0.2 m square)	0.2	0.2		32	
	Cast Domed Cable Grip (wedges with retaining clip)				32	
	15 mm Twin-strand Bulbed (@ 1.0 m intervals) Cable Bolt, 50 Ton	10.5	0	15	17	In 51 mm hole (2")
	Twin-strand End Holding Device -- fish hook style				17	
	Domed Twin-strand Plate Washer (0.2 m square)	0.2	0.2		17	
	Cast Domed Twin-strand Cable Grip (wedges with retaining clip)				17	
	15 mm Wire Rope Clamps (Crosby Clips)				96	For attaching 15 mm cable-weight to draped mesh
	19 mm Wire Rope Clamps (Crosby Clips)				22	For attaching fence-line to eye-bolts
	9 Gauge (3.8 mm) wire	120			120 m	For repairs and temporary joins
	9 gauge (3.8 mm), Chainlink Mesh, ASTM A392 specifications	22	1		2	For upper anchor-line along 68 m level
	9 gauge (3.8 mm), Chainlink Mesh, ASTM A392 specifications	20	3		9	7 Panels, 3 m wide each
	Breather-tube (3/8")	324		12	324 m	Can be spooled in 50 m lengths
	Fill-tube (3/4")	97		19	97 m	Wall-thickness to cope with 0.35 to 0.40 CW mix
	Plastic 'birdie'				201	To hold cartridges in place
Decline (First 20 m)	#7 Anchornut				118	
	#7 Domed Plate Washer (0.2 m square)	0.2	0.2		118	
	#7 DYWIDAG Threadbar (slashed end)	2.4		22	118	Full column grouted, in 33 mm hole (1 1/4 ")
	00 gauge (8.6 mm), Welded Wire Mesh Strap, ASTM A185 specifications	2.7	0.3		20	Use for bagging support if unravelling possible
	0-30 sec. resin, 18" cartridge, oil based resin (Ground Lok or similar)	0.5		30	128	For fully grouting 2.4 m long holes
	5-7 min. resin, 24" cartridge, oil based resin (Ground Lok or similar)	0.6		30	384	
	15 mm Bulbed (@ 1.0 m intervals) Cable Bolt, 25 Ton	6.5		15	11	
	End Holding Device -- fish hook style				11	
	Domed Plate Washer (0.2 m square)	0.2	0.2		11	
	Cast Domed Cable Grip (wedges with retaining clip)				11	
	9 gauge (3.8 mm), Welded Wire Mesh, ASTM A185 specifications	3.2	1.7		30	Walls and roof, as tight as possible
	Breather-tube (3/8")	7		12	77 m	Can be spooled in 50 m lengths
	Fill-tube (3/4")	2		19	22 m	Wall-thickness to cope with 0.35 to 0.40 CW mix
	Plastic 'birdie'				118	To hold cartridges in place
	#7 Push-on-Plate (5", 0.13 m square)	0.13	0.13		24	For installing screen/mesh (backup)
	Type 7 (4-pc) Modified Horseshoe Steel Set (5.5 m H, 5.5 m W)				9	As per design specifications
Miscellaneous	#7 Hex Socket Nutrunner				6	
	#7 Hex Socket Oval Spinner				6	
	#7 Hex Socket Square (1 1/8") Nutrunner				2	
	#7 Hex Socket Square (1 1/8") Spinner				2	
	30 Ton, Tension Jack / Pull Test Kit				1	Complete assembly including 10,000 psi Hand Pump
	CBJ-1 Cable Bolt Tensioning Jack				2	
	Combination wrench set to fit the 10, 13, and 15 mm U-bolts				5	
	Hand-crimping tool, pliers (for hog-ties)				5	
	Pull collar for #7 DYWIDAG				6	For testing down decline
	Pull collar for FS-33				60	For testing down decline
	Pull collar for FS-39				60	For testing down decline
	Pump for bolt-tensioning jack				2	follow DSI recommendation
	Side-cutters (for 3.8 mm wire), lineman style plyers				5	
	Socket wrench set to fit the 10, 13, and 15 mm U-bolts				5	
Contractors' Responsibility	Electrical tape, rolls					For taping fill-tube to cable-bolts
	Grouting pump system					
	Portland cement (for 0.35 cement/water mix) with cold-weather additives					As required for cablebolt grouting (approx 1:8 mix)
	Steel wool (in 'un-compressed' cubic-inches)					Temporary plug of cable-bolt grout to allow cure
	Wooden wedges (pine), 1 x 1.5 x 6"					Keep cable-tube arrangement steady in hole while grouting
	Cable ties					For temporary holding of rope etcetera

CATCHMENT WINDROW STAKE OUT TABLE

Point ID	Eastings	Northings
B1	433351.48	7559117.13
B2	433346.78	7559116.69
B3	433338.58	7559096.23
B4	433343.46	7559070.90

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE

REFERENCE DRAWINGS

NO.	DESCRIPTION	CHK'D	APP'D	CLIENT	DATE
A	ISSUED FOR CONSTRUCTION	BM	LW	–	09SEP10

REVISIONS

PROFESSIONAL ENGINEER'S STAMP

SRK Consulting
Engineers and Scientists
Vancouver

DESIGN: MK
DRAWN: VY
REVIEWED: EMR
CHECKED: BM
APPROVED: LW
DATE: Sep. 9, 2010
FILE NAME: DN Portal–Material Specs.dwg

NEWMONT.
NORTH AMERICA

HOPE BAY MINING LTD.

SRK JOB NO.: 2CH009.001
SRK DWG NO.: DN-P-06

Doris North Project
DRAWING TITLE:
Doris Portal
Material Specifications

NEWMONT DRAWING NO.: HB+R-CIV-CIV-OND-0025
SHEET: 7 of 7
REVISION NO.: 0

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Appendix C

Geotechnical Logs

SRK Consulting
Engineers and Scientists

BOREHOLE LOG

PROJECT: 2010 Doris North Portal Investigation
LOCATION: Hope Bay, Nunavut, Canada
SITE & PROJECT No: HOPE BAY (2CH009.001)
BORING DATE: 2010-03-18 **TO** 2010-03-18
DIP: -53.00 **AZIMUTH:** 230.00
COORDINATES: 559138.90N 33379.24E **DATUM:** Nad83

BOREHOLE: SRK-PTL-10-01
PAGE: 1 **OF** 2
DRILL TYPE:
DRILL:
SRK HOLE ID:
PLAN No:

DEFINITIONS

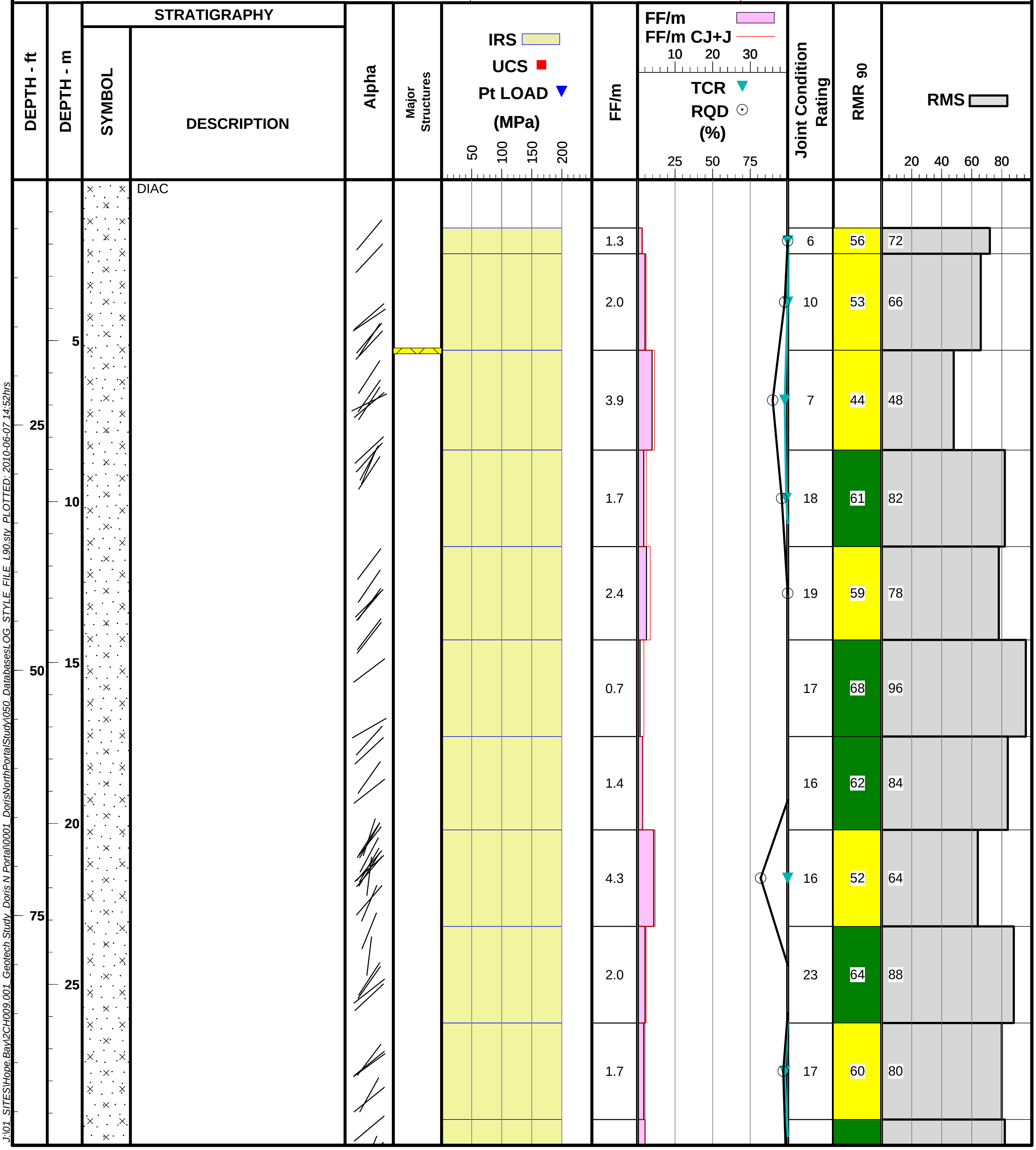
IRS: Intact Rock Strength (subjective)
UCS: Uniaxial Compressive Strength (MPa)
Pt LOAD: Point Load Test (MPa)
FF/m: Fracture Frequency per m
TCR: Total Core Recovery
RQD: Rock Quality Designation
RMR: Rock Mass Rating
RMS: Rock Mass Strength

LEGEND OF MAJOR STRUCTURES

- ■ Gouge
- ▨ Sheared
- ▨ Broken
- ▨ Jointed

LEGEND OF RMR

🟥 0 - 20 🟫 21 - 40 🟨 41 - 60 🟩 61 - 80 🟦 81 - 100



1.3	6	56	72
2.0	10	53	66
3.9	7	44	48
1.7	18	61	82
2.4	19	59	78
0.7	17	68	96
1.4	16	62	84
4.3	16	52	64
2.0	23	64	88
1.7	17	60	80

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SRK Consulting
Engineers and Scientists

BOREHOLE LOG

PROJECT: 2010 Doris North Portal Investigation
LOCATION: Hope Bay, Nunavut, Canada
SITE & PROJECT No: HOPE BAY (2CH009.001)
BORING DATE: 2010-03-18 **TO** 2010-03-18
DIP: -53.00 **AZIMUTH:** 230.00
COORDINATES: 559138.90N 33379.24E **DATUM:** Nad83

BOREHOLE: SRK-PTL-10-01
PAGE: 2 **OF** 2
DRILL TYPE:
DRILL:
SRK HOLE ID:
PLAN No:

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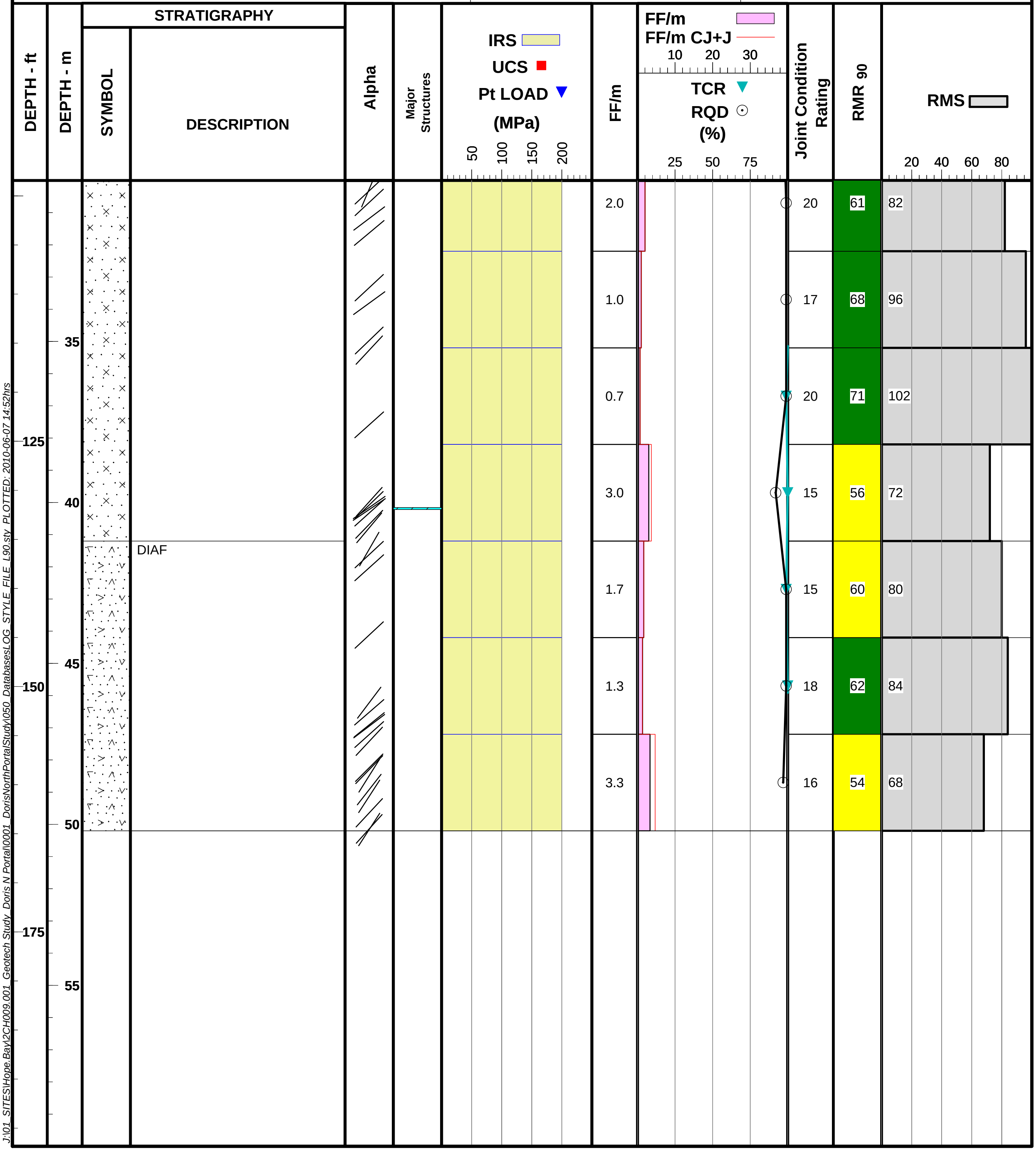
LEGEND OF MAJOR STRUCTURES

■ Gouge
▨ Sheared
▨ Broken
▨ Jointed

LEGEND OF RMR

0 - 20	21 - 40	41 - 60	61 - 80	81 - 100
🟥	🟫	🟨	🟩	🟦



2.0	20	61	82
1.0	17	68	96
0.7	20	71	102
3.0	15	56	72
1.7	15	60	80
1.3	18	62	84
3.3	16	54	68

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SRK Consulting
Engineers and Scientists

BOREHOLE LOG

PROJECT: 2010 Doris North Portal Investigation
LOCATION: Hope Bay, Nunavut, Canada
SITE & PROJECT No: HOPE BAY (2CH009.001)
BORING DATE: 2010-03-17 **TO** 2010-03-18
DIP: -60.00 **AZIMUTH:** 310.00
COORDINATES: 559139.74N 33380.67E **DATUM:** Nad83

BOREHOLE: SRK-PTL-10-02
PAGE: 1 **OF** 2
DRILL TYPE:
DRILL:
SRK HOLE ID:
PLAN No:

DEFINITIONS

IRS: Intact Rock Strength (subjective)
UCS: Uniaxial Compressive Strength (MPa)
Pt LOAD: Point Load Test (MPa)
FF/m: Fracture Frequency per m
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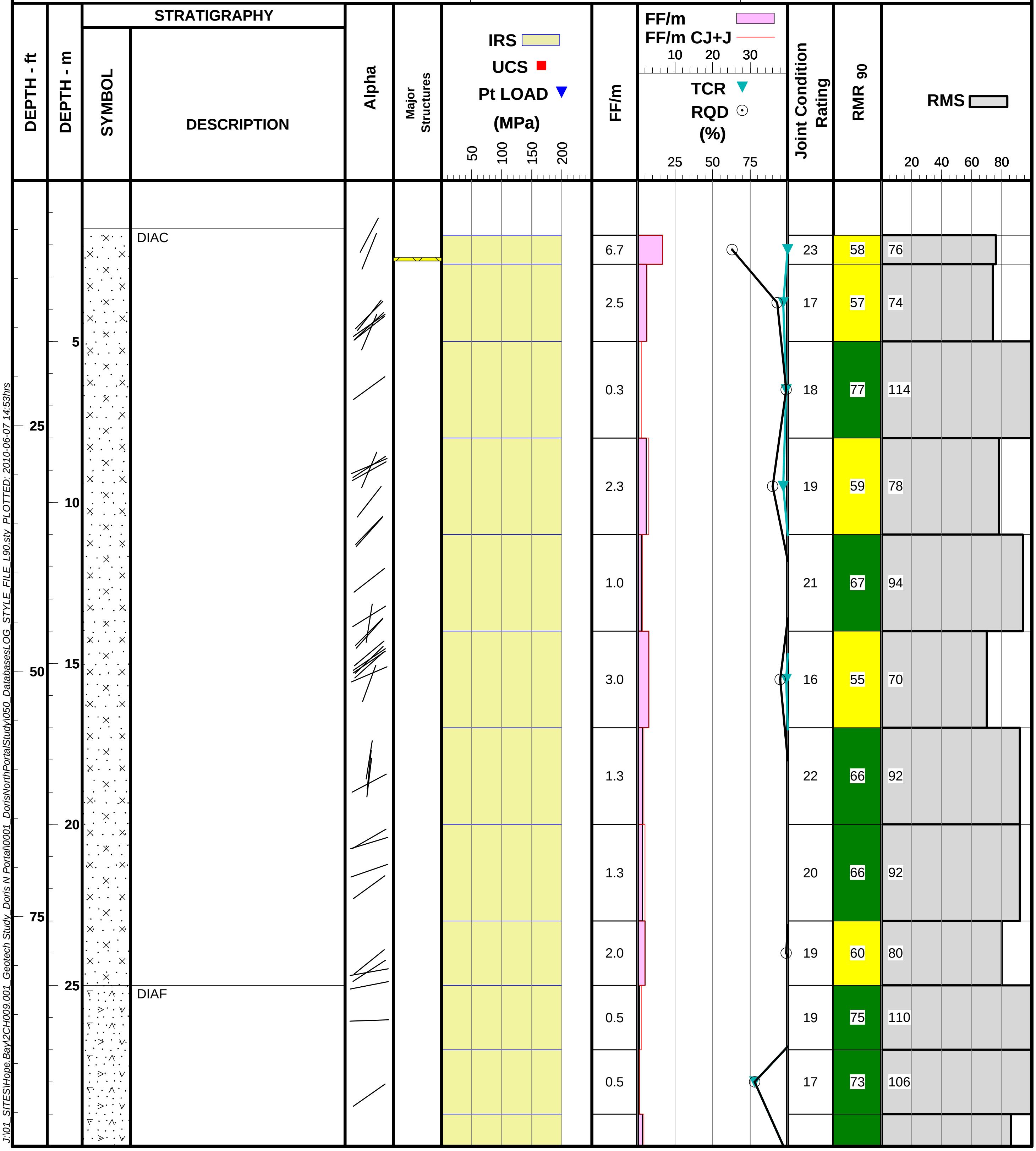
LEGEND OF MAJOR STRUCTURES

- ■ Gouge
- ▢ Sheared
- ▨ Broken
- ▨ Jointed

LEGEND OF RMR

- 🟥 0 - 20
- 🟫 21 - 40
- 🟨 41 - 60
- 🟩 61 - 80
- 🟦 81 - 100



FF/m	Joint Condition Rating	RMR 90	RMS
6.7	23	58	76
2.5	17	57	74
0.3	18	77	114
2.3	19	59	78
1.0	21	67	94
3.0	16	55	70
1.3	22	66	92
1.3	20	66	92
2.0	19	60	80
0.5	19	75	110
0.5	17	73	106

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SRK Consulting
Engineers and Scientists

BOREHOLE LOG

PROJECT: 2010 Doris North Portal Investigation
LOCATION: Hope Bay, Nunavut, Canada
SITE & PROJECT No: HOPE BAY (2CH009.001)
BORING DATE: 2010-03-17 **TO** 2010-03-18
DIP: -60.00 **AZIMUTH:** 310.00
COORDINATES: 559139.74N 33380.67E **DATUM:** Nad83

BOREHOLE: SRK-PTL-10-02
PAGE: 2 **OF** 2
DRILL TYPE:
DRILL:
SRK HOLE ID:
PLAN No:

DEFINITIONS

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LEGEND OF MAJOR STRUCTURES

■ Gouge
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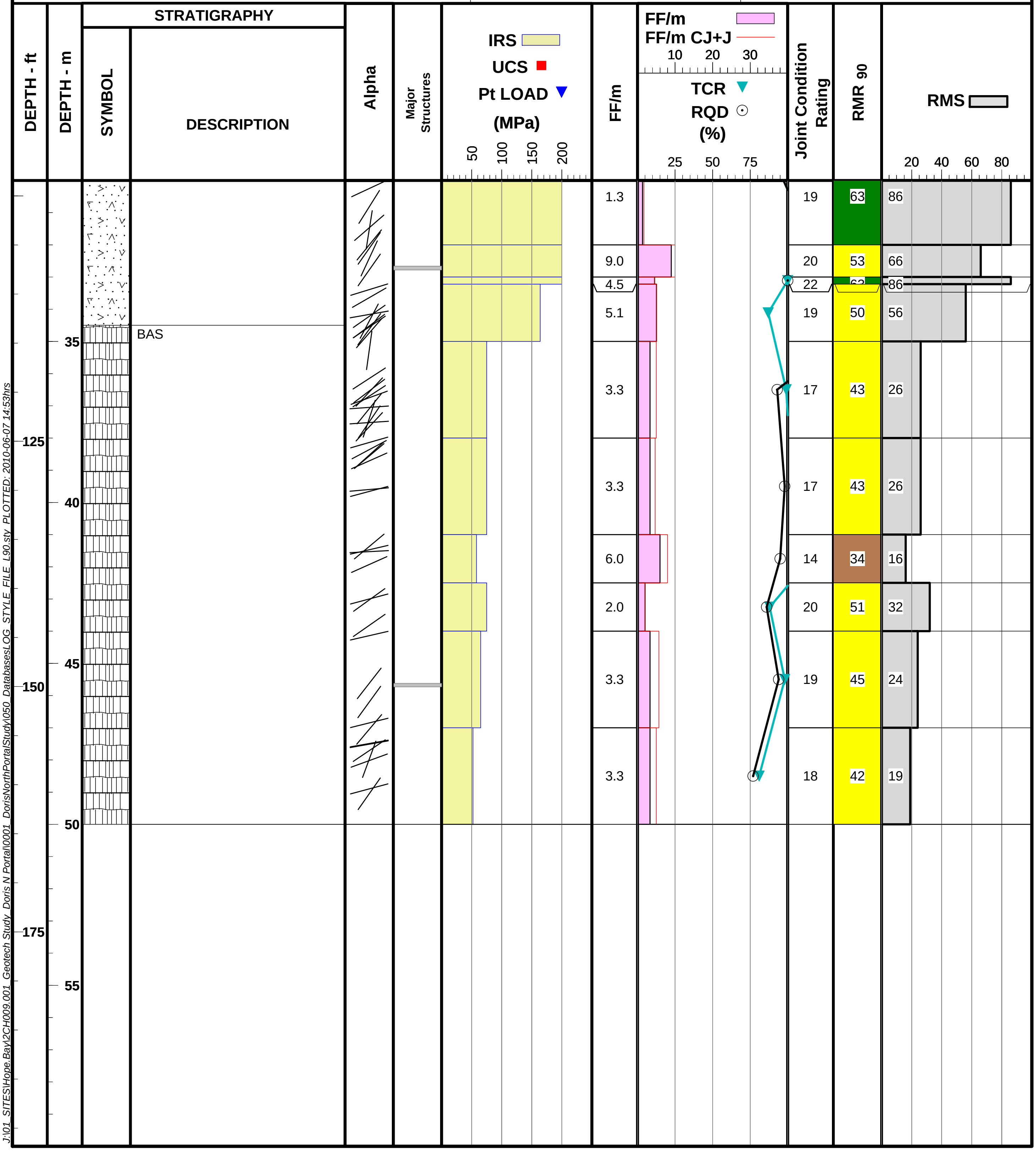
▨ Jointed

LEGEND OF RMR

🟥 0 - 20
🟫 21 - 40
🟨 41 - 60
🟩 61 - 80
🟦 81 - 100



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SRK Consulting
Engineers and Scientists

BOREHOLE LOG

PROJECT: 2010 Doris North Portal Investigation
LOCATION: Hope Bay, Nunavut, Canada
SITE & PROJECT No: HOPE BAY (2CH009.001)
BORING DATE: 2010-03-22 **TO** 2010-03-23
DIP: -45.00 **AZIMUTH:** 90.00
COORDINATES: 559123.50N 33344.15E **DATUM:** Nad83

BOREHOLE: SRK-PTL-10-03
PAGE: 1 **OF** 1
DRILL TYPE:
DRILL:
SRK HOLE ID:
PLAN No:

DEFINITIONS

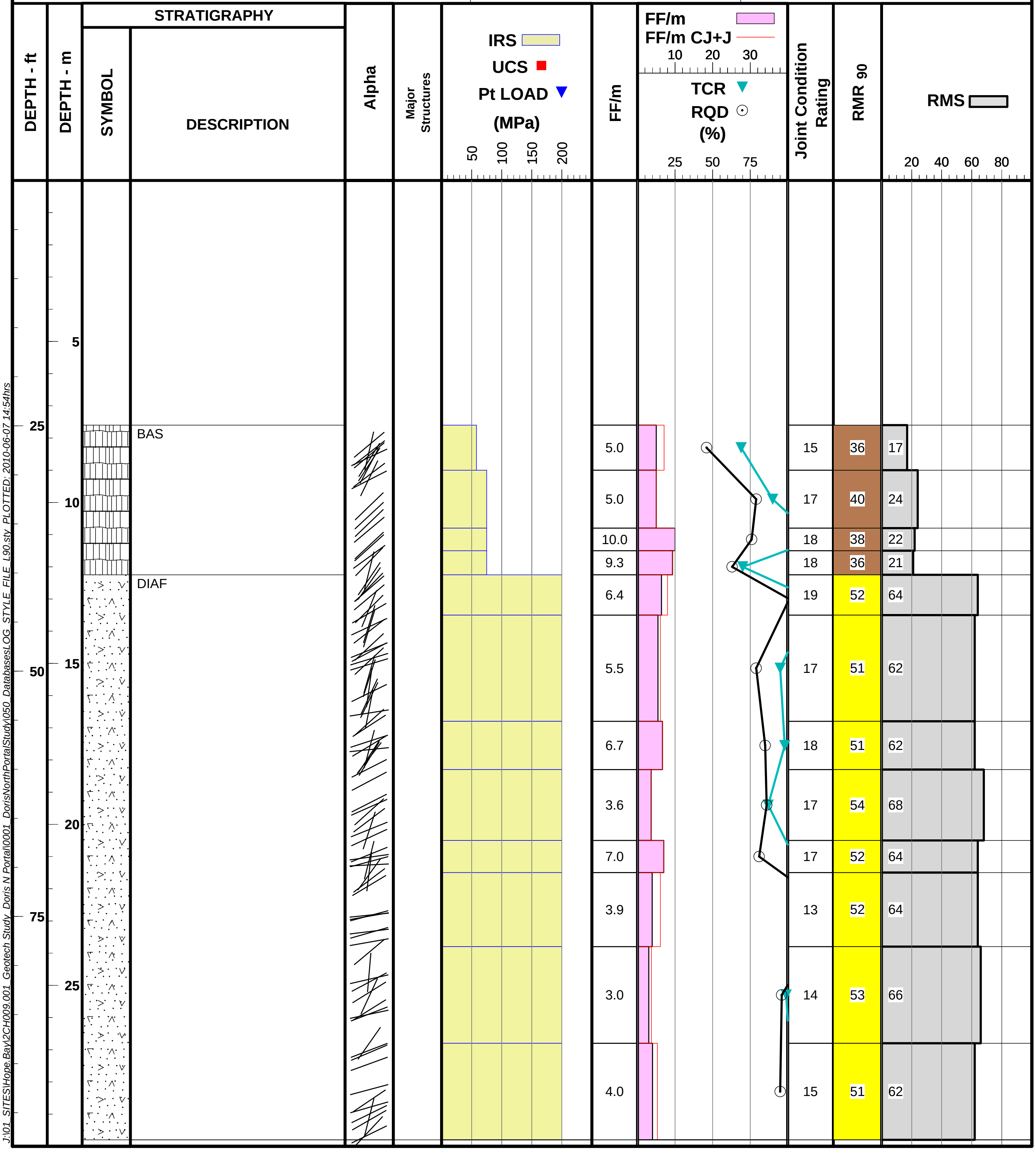
IRS: Intact Rock Strength (subjective)
UCS: Uniaxial Compressive Strength (MPa)
Pt LOAD: Point Load Test (MPa)
FF/m: Fracture Frequency per m
TCR: Total Core Recovery
RQD: Rock Quality Designation
RMR: Rock Mass Rating
RMS: Rock Mass Strength

LEGEND OF MAJOR STRUCTURES

■ Gouge
▨ Sheared
▩ Broken
▧ Jointed

LEGEND OF RMR

🟥 0 - 20
🟫 21 - 40
🟨 41 - 60
🟩 61 - 80
🟦 81 - 100



DESCRIPTION	FF/m	Joint Condition Rating	RMR 90	RMS
BAS	5.0	15	36	17
	5.0	17	40	24
	10.0	18	38	22
	9.3	18	36	21
DIAF	6.4	19	52	64
	5.5	17	51	62
	6.7	18	51	62
	3.6	17	54	68
	7.0	17	52	64
	3.9	13	52	64
	3.0	14	53	66
	4.0	15	51	62

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SRK Consulting
Engineers and Scientists

BOREHOLE LOG

PROJECT: 2010 Doris North Portal Investigation
LOCATION: Hope Bay, Nunavut, Canada
SITE & PROJECT No: HOPE BAY (2CH009.001)
BORING DATE: 2010-03-18 **TO** 2010-03-19
DIP: -60.00 **AZIMUTH:** 270.00
COORDINATES: 559124.32N 33378.78E **DATUM:** Nad83

BOREHOLE: SRK-PTL-10-04
PAGE: 1 **OF** 2
DRILL TYPE:
DRILL:
SRK HOLE ID:
PLAN No:

DEFINITIONS

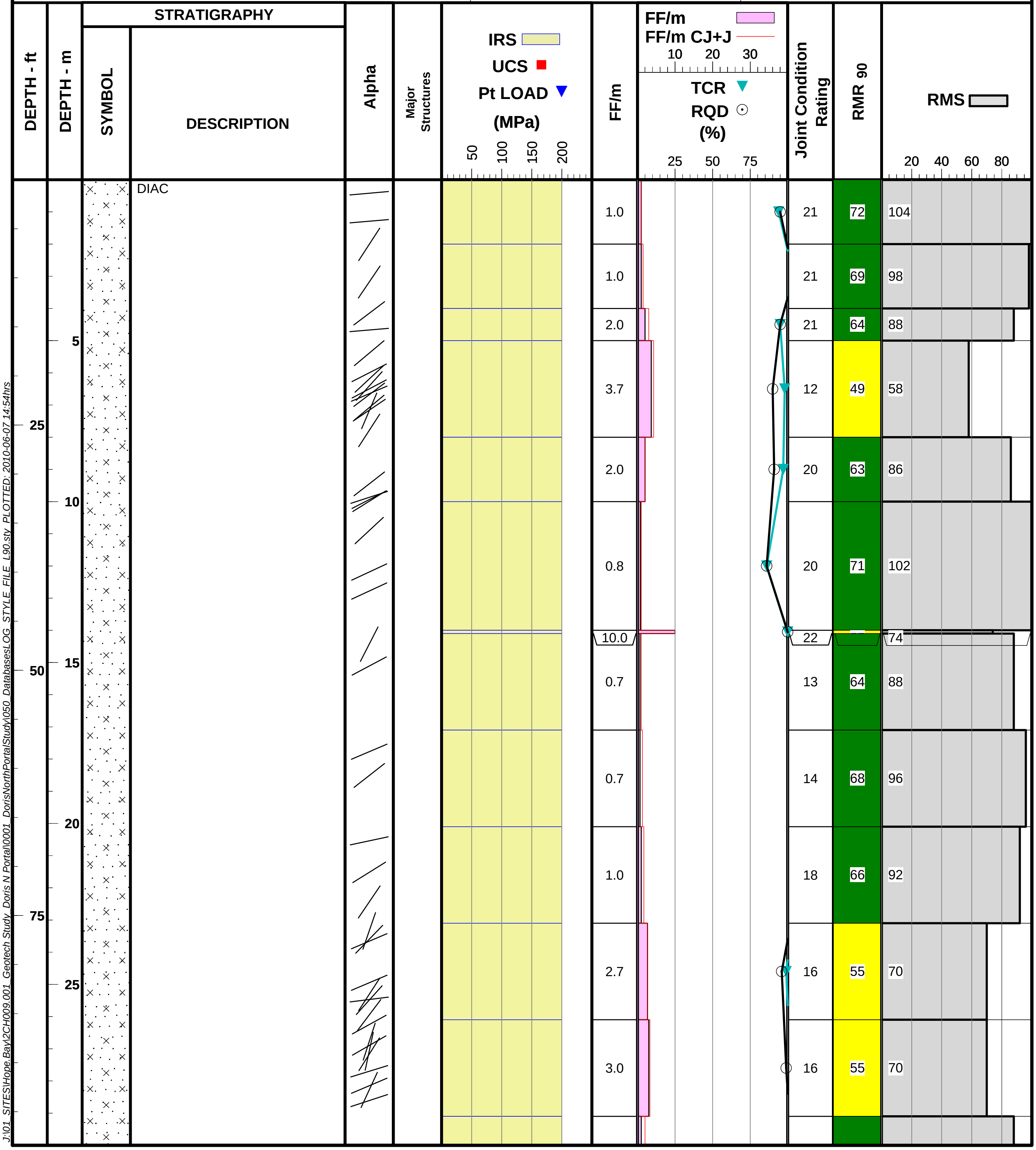
IRS: Intact Rock Strength (subjective)	TCR: Total Core Recovery
UCS: Uniaxial Compressive Strength (MPa)	RQD: Rock Quality Designation
Pt LOAD: Point Load Test (MPa)	RMR: Rock Mass Rating
FF/m: Fracture Frequency per m	RMS: Rock Mass Strength

LEGEND OF MAJOR STRUCTURES

- ■ Gouge
- ▢ Sheared
- ▨ Broken
- ▨ Jointed

LEGEND OF RMR

0 - 20	21 - 40	41 - 60	61 - 80	81 - 100
🟥	🟫	🟨	🟩	🟦



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BOREHOLE LOG

PROJECT: 2010 Doris North Portal Investigation
LOCATION: Hope Bay, Nunavut, Canada
SITE & PROJECT No: HOPE BAY (2CH009.001)
BORING DATE: 2010-03-18 **TO** 2010-03-19
DIP: -60.00 **AZIMUTH:** 270.00
COORDINATES: 559124.32N 33378.78E **DATUM:** Nad83

BOREHOLE: SRK-PTL-10-04
PAGE: 2 **OF** 2
DRILL TYPE:
DRILL:
SRK HOLE ID:
PLAN No:

DEFINITIONS

IRS: Intact Rock Strength (subjective)
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RMR: Rock Mass Rating
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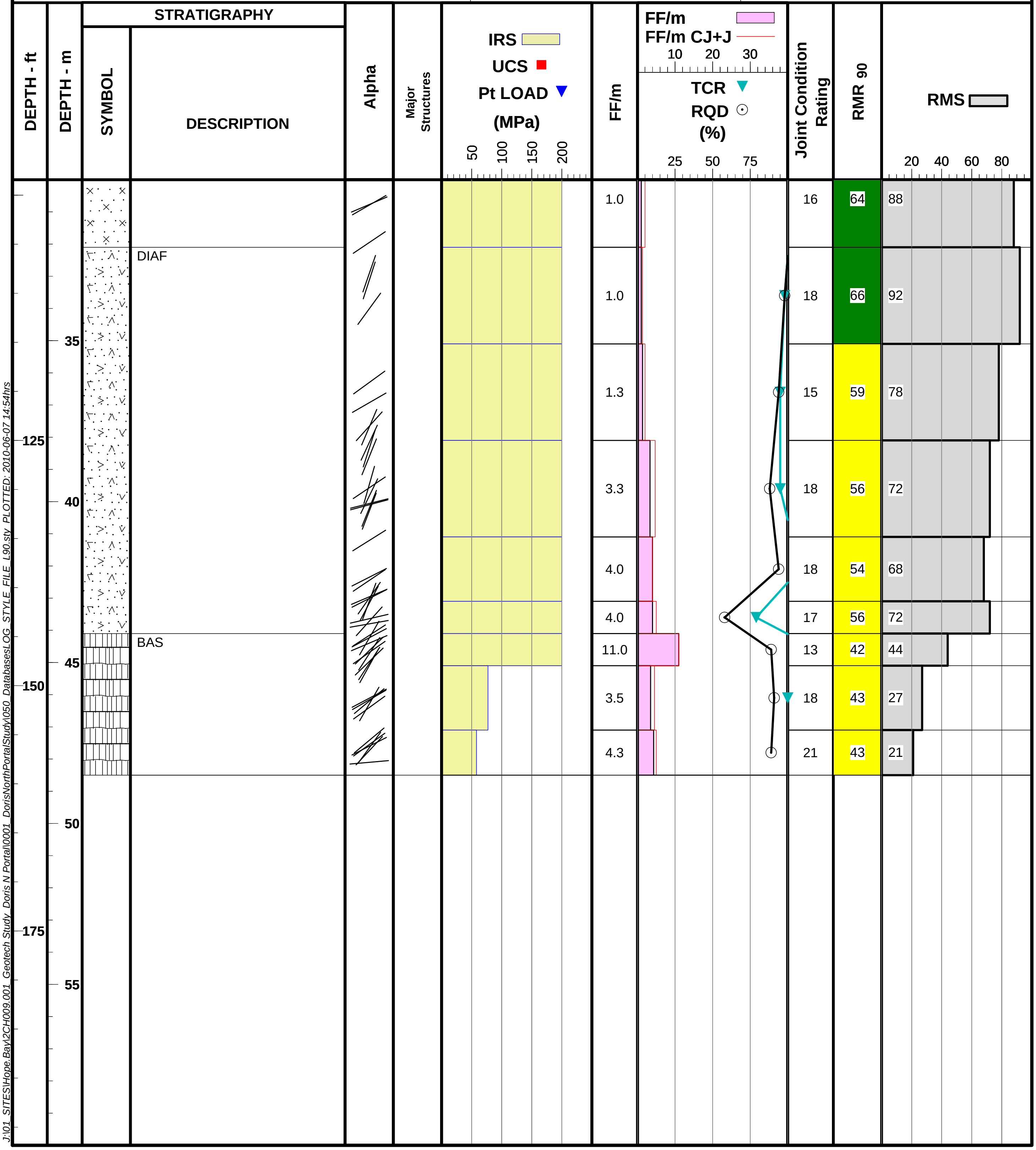
LEGEND OF MAJOR STRUCTURES

- ■ Gouge
- ▨ Sheared
- ▩ Broken
- ▧ Jointed

LEGEND OF RMR

0 - 20	21 - 40	41 - 60	61 - 80	81 - 100
🟥	🟫	🟨	🟩	🟦



FF/m	Joint Condition Rating	RMR 90	RMS
1.0	16	64	88
1.0	18	66	92
1.3	15	59	78
3.3	18	56	72
4.0	18	54	68
4.0	17	56	72
11.0	13	42	44
3.5	18	43	27
4.3	21	43	21

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