**Appendix C.7**

**Thor Lake Project: Hydrometallurgical Site – 2010 Geotechnical Field Program Summary. Report NB10-00673**

Knight Piésold
CONSULTING

# MEMORANDUM

| | | | |
|---|---|---|---|
| To: | Mr. David Swisher | Date: | December 23, 2010 |
| Copy To: | Bill Mercer | File No.: | NB101-390/2-A.01 |
| From: | Ryan Weir | Cont. No.: | NB10-00673 |
| Re: | Thor Lake Project – Hydrometallurgical Site – 2010 Geotechnical Field Program Summary | | |

## INTRODUCTION

Avalon Rare Metals Inc. (Avalon) is planning to develop a hydrometallurgical processing facility at Pine Point located 80 km east of the community of Hay River, NWT. The processing facility will support Avalon's Thor Lake Project (the Project); the mining of the Nechalacho Rare Earth Element Deposit located 100 km east southeast of Yellowknife, NWT. Figure 1 shows the locations of the Project and Pine Point.

Knight Piésold Ltd. (Knight Piésold) was retained to coordinate and supervise an initial geotechnical field program at the hydrometallurgical site, including excavating test pits, surface sampling, logging of soil, and material index testing. The objective of the 2010 geotechnical field program was to characterize foundation conditions at the proposed plant site area and also characterize potential borrow materials from the site that can be used for construction purposes.

A total of nine test pits were successfully excavated at the proposed plant site area and eight surface samples taken from various locations around the hydrometallurgical site. Test pit and surface sample locations are shown on Figure 2. All work was completed under the direction and supervision of Knight Piésold field personnel between November 14 and 15, 2010.

## GENERAL SITE OVERBURDEN CONDITIONS

Based on review of background data and site observations, overburden within the Pine Point area generally consists of the following:

- Within the upland areas in the vicinity of the proposed Hydrometallurgical Process Plant, the depth of organics is minimal, typically less than 50 cm.

- Beach ridges (coarse-textured alluvial or wave-washed till) form prominent linear features running parallel to contour or in an east–west trend within the area. The ridges mark the former extent of glacial Lake McConnell and provide a local abundant source of sand and gravel. Exposures of the sand and gravel on open pit slopes and within historic borrow pits suggest that the stratum is up to 3 to 4 m thick.

- Flat lacustrine plains overlain by peatlands (poorly drained muskeg up to 3 m deep) cover much of the area north of the proposed Hydrometallurgical Process Plant area and south of Great Slave Lake. Wetlands occur throughout this area.

- A basal glacial till deposit typically underlies the beach and organic deposits. The till stratum is exposed in historic open pit walls around the site and ranges from a few meters in depth to upwards of 30 to 40 m. Based on site visit observations, the till stratum appears to be relatively homogeneous consisting of a compact to dense clayey sand and silt with some gravel and small boulders.

## FIELD PROGRAM DETAILS

The following is a detailed summary of the 2010 geotechnical field program.

### Test Pit Program

The excavation of test pits was carried out with the intent of characterizing and sampling the surficial soils in the plant site area. Representative soil samples were submitted to the laboratory for material index testing.

The excavation work was subcontracted by Procore Drilling Ltd. (Procore) to Carter Industries Ltd. (Carter). The test pits were excavated by Carter using a CAT 416C backhoe. All test pits were located in previously disturbed areas. Test pits were excavated to the limits of the equipment or to a depth limited by groundwater conditions. Test pits were backfilled with the excavated material upon completion of logging and sampling activities.

A total of nine test pits were dug during the field program on November 15, 2010. One bucket sample was taken from each test pit (nine bucket samples in total) and submitted to the laboratory for material index testing. Test pit depths ranged from 1.61 to 2.12 m and averaged 1.92 m. Table 1 provides a summary of the test pit details, including handheld GPS UTM coordinates, total depth and start and end dates. Table 2 lists all samples taken from the test pits and submitted to the laboratory for index testing. Figure 2 shows the locations of the test pits completed on the Pine Point property. Appendix A2 provides the geotechnical logs for the test pits. Appendix B2 provides photo summaries of each test pit including general site conditions, test pit profile and excavated material.

### Surface/Grab Sampling

The surface/grab sampling was carried out with the intent of characterizing and sampling the potential borrow materials from select locations around the hydrometallurgical site. Representative soil samples were submitted to the laboratory for material index testing.

Surface sampling was conducted using a pick and shovel from waste piles or surface exposures of sand and gravel, till and waste rock. All surface samples were taken from previously disturbed areas. A total of eight surface samples were taken: two sand and gravel samples, three till samples and three waste rock samples.

### Logging and Sampling

Logging of soil in test pits consisted of general description of site conditions; depths; and general soil description, including observed particle size, particle shape, plasticity, colour, odour, compactness or consistency, structure, inclusions, moisture condition and an interpretation of the origin of the soil where applicable.

### In Situ Testing

In situ testing during the field program consisted of taking temperature readings at various depths in select test pits using an infrared thermometer gun. Temperature readings are listed in Table 3 and graphically represented on Figure 3.

### Laboratory Testing

Maskwa Engineering Ltd. (Maskwa) was contracted to perform material index testing on representative soil samples from test pits and surface/grab sampling. All laboratory material index testing reports are provided in Appendix C.

## FIELD PROGRAM RESULTS

The following is a discussion of the field program results compiled by area or source.

### Plant Site Results

The proposed plant site area will be located on a previously disturbed area as shown on Figure 2. The proposed area consists of a historic gravel borrow area stripped of vegetation and organics. Inspection of the site during previous site reconnaissance visits indicates that it consisted of east-west trending beach ridges which have been excavated for borrow in the past. The surficial materials exposed at the site primarily consist of exposed sand and gravel. Completion of one hydrogeological drillhole in the area (DH-2010-05) indicates that the overburden thickness is about 11 m with the top portion consisting of sand and gravel and the lower portion consisting of dense till. Details of the hydrogeological drillholes have been presented in Knight Piesold Memo Cont. No. NB10-00656 dated December 8, 2010.

A total of nine test pits were completed in the plant site area to characterize the near surface conditions. Logs for the plant site area test pits are included in Appendix A. Results of particle size analyses for the plant site area samples are provided in Appendix C.

*Glaciolascustrine (Sand and Gravel)*

Glaciolacustrine (beach) deposits of sand and gravel are present over most of the plant site area, mainly in the south and west, and extend vertically from surface to greater than 2.10 m (at TP-2010-03). The deposits are typically brown in colour. The gradation of the material is gravelly sand, trace silt based on the two samples that were tested (samples from TP-2010-06 and 08 shown on Figure 4). Observations on material in the bank of the test pits, indicates that there is some oversize up to 300 mm in size. An approximate grainsize curve accounting for oversize not sampled is shown on Figure 3. The moisture content of the material ranged from 3.5 to 12.9%. Based on observations during the test pit program the sand and gravel is judged to range from a compact to dense relative density.

*Till Deposit*

Till was found in the northeast portion of the plant site area and extend vertically from surface to greater than 2.12 m (at TP-2010-02). The deposits are brown in colour and consist of silty sand with some gravel and trace clay based on the two representative samples that were tested (samples from test pits TP-2010-06 and 08 as shown on Figure 4). The moisture content of the till material ranged from 8.4 to 16.0%. Based on observations during the test pitting, the till stratum is judged to have a compact to dense relative density.

*Shallow Groundwater Conditions*

Seepage was observed in four of the nine test pits, specifically those on the south side of the site. The seepage was recorded at depths ranging from 0.72 m in the west part of the plant site area to 1.75 m in the east part suggesting a gradient from west to east. This seepage may indicate a localized perched ground water table within the sand and gravel in the area, likely due to the till stratigraphic unit acting as an aquitard.

*Potential Borrow Materials*

*Sand and Gravel Sample Results*

A total of two surface samples were taken from sources of sand and gravel at the hydrometallurgical site. The samples were taken from a excavated face north of the N-38 pit and adjacent to the main east west road through the site. Results of test work for the sand and gravel sources are provided in Appendix C. As shown on Figure 5, the gradation of the material is sand and gravel with some silt based on the two samples that were tested. Based on observations during surface sampling, the oversize in the sand and gravel ranges in size up to 400 mm. An approximate grainsize curve inclusive of oversize is shown on Figure 5 and indicates that the material in the bank consists of a sandy gravel with some silt and cobbles and trace boulders. The moisture content of the material ranged from 5.2 to 5.8%. Modified Proctor testing on a composite of the two samples of sand and gravel yielded a maximum dry density of 2,322 $kg/m^3$ and an optimum moisture content of 3.0%.

*Till Sample Results*

A total of three surface samples were taken of potential sources of till from waste stockpiles located around the N-38 Pit. Results of test work for the till samples are provided in Appendix C. The gradation of the till is a silty sand with some gravel and trace clay as shown on Figure 6 for the three samples that were tested. Based on observations in the field, the oversize in the till generally ranges in size up to 200 mm. An approximate grainsize curve inclusive of oversize is shown on Figure 6 and indicates the till in-situ is a gravelly silty sand with trace clay and cobbles. The moisture content of the material ranged from 9.1 to 13.5%. Standard Proctor testing on a composite of all samples of till yielded maximum a dry density of 2,266 $kg/m^3$ and an optimum moisture content of 6.1%.

***Waste Rock Sample Results***

A total of three surface samples were taken of waste rock from waste piles within the L-37 pit. Results of test results for the waste rock samples are provided in Appendix C.

The gradation of the material as shown on Figure 6 is mainly gravel based on the three samples that were tested. The data presented does not include oversized fractions observed in the field. Based on field observations, the oversize is estimated to be range in size up 600 mm to 900 mm. An approximate grainsize curve inclusive of oversize shown on Figure 7 indicates that the material is a coarse gravel with cobbles and boulders in the bank.

## CONCLUSIONS

The following are conclusions from the geotechnical field program:

*Plant Site Area Foundation Conditions*

1. The primary overburden stratigraphic layer encountered at the plant site area is a glaciolacustrine (beach deposit) sand and gravel. This layer extends from surface to greater than 2.12 m below surface. Based on observations during the test pit program the sand and gravel is judged to range from a compact to dense relative density.
2. It is judged that a basal till unit underlies the sand and gravel layer under the entire area. The till unit was found at surface to the northeast side of the site. Based on one hydrogeological hole completed at the plant site area the till unit is believed to overlie bedrock at about 11 m depth. The till stratum is judged to have a compact to dense relative density based on observations from the test pit program.
3. Based on observations during the test pit program it is apparent that there is a localized perched ground water table above the basal till within the surface sand and gravel deposit to the south side of the plant site area.
4. Measurement of near surface ground temperatures in some test pits indicates that there is no permafrost within the top 2 m. There was no surficial evidence that there is permafrost at deeper depths under the area proposed for the plant site, however installation of thermistors would be required to confirm this.

*Site Borrow Materials*

1. It is evident from site reconnaissance that the naturally occurring sand and gravel deposits have been used as fills for roads and general fill materials. Samples tested from one deposit indicate that it consists of sandy gravel with some silt and cobbles and trace boulders. This material is suitable for general fills and processing to generate finer grained granular materials for road surfacing, drainage zones and foundation backfilling.
2. Testing results for samples of till from waste stockpiles adjacent to the N-38 Pit indicate that it is a well graded material consisting of gravelly silty sand with trace clay and cobbles. Due to the fines content (silt and clay), this material will likely have a relatively low permeability and will be suitable for low permeability zones if required for any water management structures. The till can also be considered as a secondary general fill material.
3. Samples of wasterock from the N-38 Pit were tested to determine grainsize characteristics. Results of the testing program and filed observations indicate that the waste rock consists of coarse gravel with cobbles and boulders in the bank. This material is suitable for general structural type fills and with processing can be used for rip-rap or finer grained granular fills for structural fills or drainage zones.

**RECOMMENDATIONS**

Based on the 2010 site investigation results, the following recommendations are provided:

1. The foundation conditions at the proposed plant site area are judged to be relatively consistent across the site. Additional work that should be considered to support detailed design includes:
   a. Additional drillholes using sonic drilling or other geotechnical investigation methods to allow relatively undisturbed samples to be retrieved from deeper within the overburden. Sonic drilling methods would be preferable to be able to penetrate through cobbles and boulders while limiting disturbance of in-situ materials. Retrieval of relatively undisturbed core and samples will also confirm permafrost conditions.
   b. Installation of thermistors to confirm ground temperature profile.

2. Initial index testing has been completed to characterize three types of borrow materials available at site. Additional testing including concrete aggregate suitability, permeability etc. may be warranted for detailed design requirements.

We trust this provides you with the information you require at this time. We would be pleased to provide preliminary geotechnical recommendations for foundation design related to the feasibility study at your request.

LICENSED PROFESSIONAL ENGINEER
M. R. PARFITT
DEC 2 3 2010
PROVINCE OF ONTARIO

Signed: ______________________ Approved: ______________________

Ryan Weir, EIT
Geological Engineering

Matthew Parfitt, P.Eng.
Specialist Engineer / Project Manager

Attachments:

| | |
|---|---|
| Table 1 Rev 0 | Summary of Test Pit and Surface Sampling Details |
| Table 2 Rev 0 | Summary of Test Pit and Surface Samples |
| Table 3 Rev 0 | List of Test Pit Temperature Readings |
| Table 4 Rev 0 | General Soil Properties |
| Figure 1 Rev 0 | Project Location Map |
| Figure 2 Rev 0 | Site Plan |
| Figure 3 Rev 0 | Test Pit Temperature Profiles |
| Figure 4 Rev 0 | Particle Size Analysis – Plant Site |
| Figure 5 Rev 0 | Particle Size Analysis – Sand and Gravel |
| Figure 6 Rev 0 | Particle Size Analysis – Till |
| Figure 7 Rev 0 | Particle Size Analysis – Waste Rock |
| Appendix A | Test Pit Logs |
| Appendix B | Photo Summaries |
| Appendix C | Laboratory Material Index Testing Reports |

/rdw

**Appendix C.8**

**Thor Lake Site - Nechalacho Deposit 2010 Hydrogeological Site Investigation Results.**
**Report NB10-00587**

Knight Piésold
CONSULTING

# MEMORANDUM

| | | | |
|---|---|---|---|
| To: | Mr. David Swisher | Date: | November 12, 2010 |
| Copy To: | Bill Mercer | File No.: | NB101-390/2-A.01 |
| From: | Jordin Barclay | Cont. No.: | NB10-00587 |
| Re: | Thor Lake Site - Nechalacho Deposit 2010 Hydrogeological Site Investigation Results | | |

## 1.0 Introduction

A hydrogeological site investigation program was completed at Avalon's Thor Lake site as part of the geomechanical site program to determine hydraulic characteristics of the Nechalacho Deposit rock mass. Results of the hydrogeological testing program will be used to estimate mine water inflows associated with the proposed underground mine. The hydrogeological program consisted of packer testing in seven drillholes, installation of thermistor strings in two drillholes and collecting information regarding geological descriptions from eight (8) diamond drillholes. The hydrogeological program was conducted on site from August 21, 2010 to September 30, 2010. This memorandum presents the observations and results of the packer tests completed during the hydrogeological program. A site plan with the locations of the drillholes is included in Figure 1.

## 2.0 Rock Quality

The dominant groundwater flow pathways within bedrock typically occur within fractures or faults. As part of the geomechanical site investigation, RQD and RMR were logged for each drillhole. The RQD and RMR range that was recorded along each of the tested intervals is included in Table 1. The RQD and RMR values are characteristic of good to very good quality rock indicating there are limited pathways for groundwater flow.

## 3.0 Packer Testing

Packer testing was conducted from August 22 to September 10, 2010. A total of 14 packer tests were conducted in seven drillholes. All tests were conducted using a single HQ nitrogen packer system. In general, drillholes were advanced using a synthetic polymer and packer tests were conducted after the drillholes were flushed. The packer tests included measurements of flow during five pressure stages. The packer system was checked for leaks and inadequate seals during each test.

The majority of the packer tests were conducted within the lower portion of the drillholes to target the rock mass where underground openings will be developed. The tests were conducted within drillholes that were inclined at a dip of either 65 degrees or 55 degrees. Test interval lengths ranged from 16.5 m to 73.5 m. The depth of the test intervals ranged from 86 m below ground surface (bgs) to 119 m bgs and from 256 m bgs to 271 m bgs.

A summary of the packer tests conducted including results (hydraulic conductivity) are included in Table 1. The hydraulic conductivity ranges from $3 \times 10^{-9}$ m/s to $2 \times 10^{-7}$ m/s. The hydraulic conductivity for each of the packer tests is plotted on Figure 2. A slight trend of decreasing hydraulic conductivity with depth is observed on Figure 2.

### 4.0 Thermistor Installation

Thermistor strings were installed in boreholes L10-280 and L10-285 between September 28, 2010 and September 30, 2010. The thermistors were installed to determine if permafrost is present and if so, the extents and depth of permafrost. Of particular interest is to determine if permafrost is present under the local lakes (i.e. Long Lake). The thermistor string that was installed in L10-280 consisted of 17 thermistors spaced approximately 5 m apart. The thermistor string that was installed in L10-285 consisted of 22 thermistors spaced approximately 5 m apart. Readings were collected prior to installation and shortly after installation. It is not expected that these initial readings are characteristic of the natural temperature conditions since the readings were collected shortly after installation. Dataloggers have been sent to site and will be installed shortly.

### 5.0 Conclusion

The hydraulic conductivity estimated from packer testing during the 2010 hydrogeological site investigation was consistently very low. The permeability is consistent with groundwater flow regime that is dominated by competent bedrock with good to very good rock quality.

The thermistor dataloggers have not been installed to date and the presence or absence of permafrost in the area of the proposed underground has not been confirmed. Once some data is available this information will be factored into the hydrogeological model for the area.

PROFESSIONAL ENGINEER
LICENSED
M. R. PARFITT
NOV 12 2010
PROVINCE OF ONTARIO

Signed: Jordin Barclay
For
Project Hydrogeologist

Approved: Matthew R. Parfitt, P.Eng.
Specialist Engineer/Project Manager

Attachments:

Table 1 Rev 0 2010 Hydrogeological Site Investigation - Summary of Results
Figure 1 Rev 0 2010 Hydrogeological Site Investigation - Drillhole Plan
Figure 2 Rev 0 2010 Hydrogeological Site Investigation - Packer Test Results

jb/mrp

Knight Piésold CONSULTING

TABLE 1

AVALON RARE METALS INC.
THOR LAKE PROJECT

2010 HYDROGEOLOGICAL SITE INVESTIGATION
SUMMARY OF RESULTS

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| Drillhole | Drillhole Dip | Test # | Downhole Depth Interval | | | Interval Elevation | | | Hydraulic Conductivity (m/s) | RQD Range (%) | RMR Range |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | From (m) | To (m) | Length (m) | From (m) | To (m) | Length (m) | | | |
| L10-273 | 65 | 1 | 204.5 | 278.0 | 73.5 | 64.2 | -2.4 | 66.6 | **3E-09** | 91 - 100 | 70 - 98 |
| L10-275 | 65 | 1 | 282.5 | 299.0 | 16.5 | -12.0 | -27.0 | 15.0 | **4E-09** | 92 - 100 | 71 - 72 |
| L10-277 | 55 | 1 | 111.5 | 176.0 | 64.5 | 150.7 | 97.8 | 52.8 | **1E-07** | 81 - 100 | 72 - 81 |
| | | 2 | 186.5 | 233.0 | 46.5 | 89.2 | 51.1 | 38.1 | **4E-09** | 80 - 100 | 62 - 85 |
| L10-279 | 65 | 1 | 108.5 | 155.0 | 46.5 | 145.6 | 103.5 | 42.1 | **2E-08** | 88 - 100 | 67 - 84 |
| | | 2 | 156.5 | 194.0 | 37.5 | 102.1 | 68.1 | 34.0 | **6E-08** | 92 - 100 | 68 - 81 |
| | | 3 | 201.5 | 249.5 | 48.0 | 61.3 | 17.8 | 43.5 | **7E-08** | 92 - 100 | 70 - 82 |
| L10-281 | 65 | 1 | 153.5 | 194.0 | 40.5 | 103.8 | 67.1 | 36.7 | **2E-08** | 89 - 100 | 71 - 84 |
| | | 2 | 219.5 | 269.0 | 49.5 | 44.0 | -0.9 | 44.9 | **3E-08** | 82 - 100 | 63 - 83 |
| L10-283 | 65 | 1 | 111.5 | 152.0 | 40.5 | 141.5 | 104.8 | 36.7 | **7E-09** | 95 - 100 | 68 - 87 |
| | | 2 | 159.5 | 200.0 | 40.5 | 98.0 | 61.3 | 36.7 | **1E-08** | 90 - 100 | 73 - 80 |
| L10-285 | 55 | 1 | 105.1 | 145.6 | 40.5 | 155.1 | 121.9 | 33.2 | **2E-07** | 92 - 100 | 70 - 85 |
| | | 2 | 165.1 | 199.6 | 34.5 | 105.9 | 77.7 | 28.3 | **6E-09** | 94 - 100 | 66 - 81 |
| | | 3 | 231.1 | 277.6 | 46.5 | 51.9 | 13.8 | 38.1 | **1E-08** | 95 - 100 | 70 - 81 |

I:\1\01\00390\02\A\Correspondence\NB10-00587 - TLS hydrogeo Summary\[Packer Testing Summary (and Geology).xls]Table 1

**NOTES:**

1. UNLESS OTHERWISE NOTED, DRILLHOLES ADVANCED USING SYNTHETIC POLYMER ADDITIVE.
2. UNLESS OTHERWISE NOTED, DRILLHOLES FLUSHED UNTIL RETURN WAS CLEAN PRIOR TO PACKER TESTING.
3. ALL TESTS WERE PERFORMED USING A SINGLE HQ PACKER NITROGEN SYSTEM.
4. THE ACCURACY OF THE FLOW METER USED IS UNKNOWN.
5. WITH THE EXCEPTION OF L10-285 TEST #2, NO OR NEGLIGIBLE LEAKING WAS OBSERVED FROM THE SYSTEM DURING TESTING.
6. RQD AND RMR RANGES ARE WITHIN THE TESTED INTERVAL.

| REV | DATE | DESCRIPTION | PREP'D | CHK'D | APP'D |
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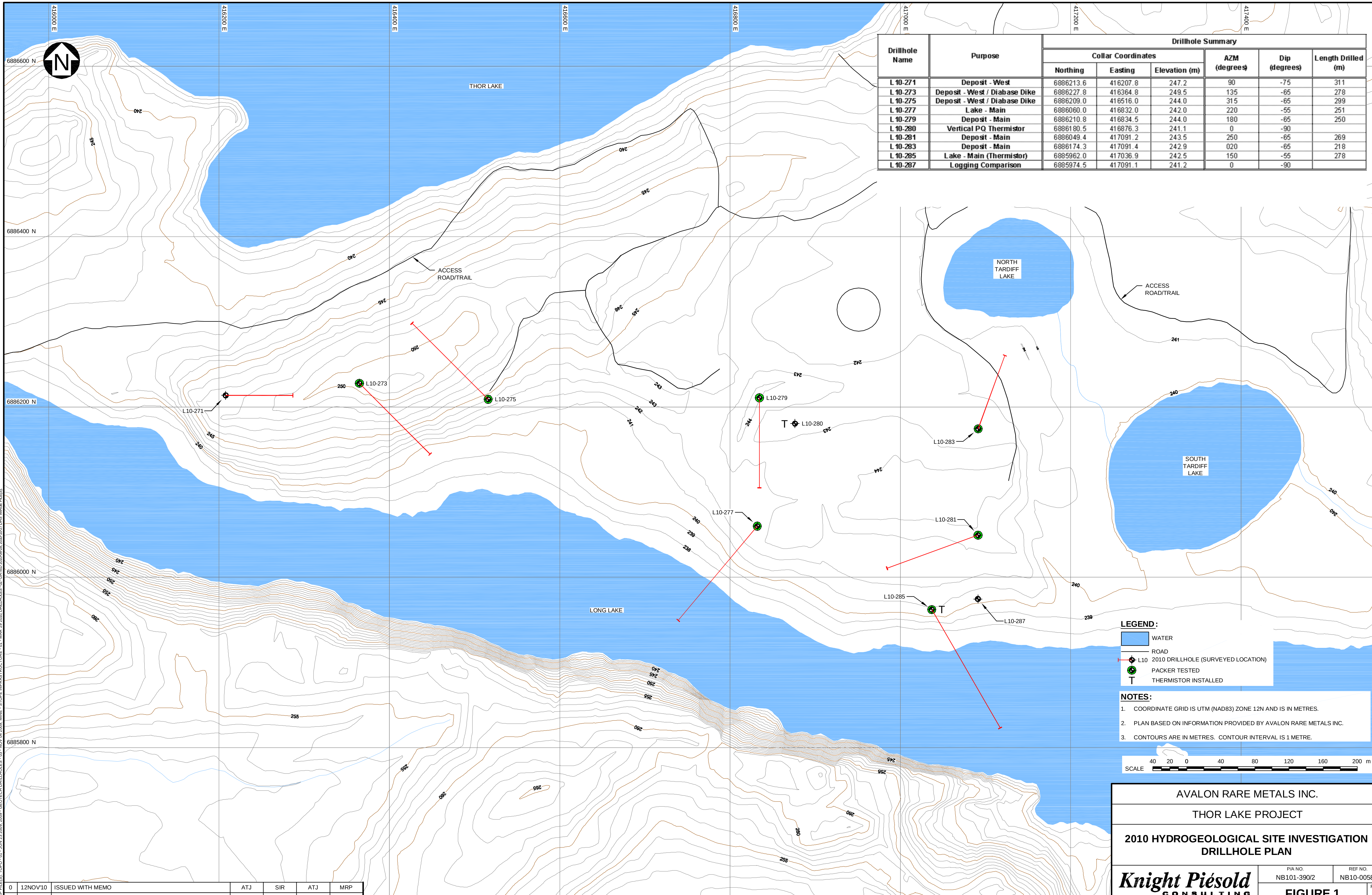


| Drillhole Name | Purpose | Drillhole Summary | | | | | |
|---|---|---|---|---|---|---|---|
| | | Collar Coordinates | | | AZM (degrees) | Dip (degrees) | Length Drilled (m) |
| | | Northing | Easting | Elevation (m) | | | |
| L10-271 | Deposit - West | 6886213.6 | 416207.8 | 247.2 | 90 | -75 | 311 |
| L10-273 | Deposit - West / Diabase Dike | 6886227.8 | 416364.8 | 249.5 | 135 | -65 | 278 |
| L10-275 | Deposit - West / Diabase Dike | 6886209.0 | 416516.0 | 244.0 | 315 | -65 | 299 |
| L10-277 | Lake - Main | 6886060.0 | 416832.0 | 242.0 | 220 | -55 | 251 |
| L10-279 | Deposit - Main | 6886210.8 | 416834.5 | 244.0 | 180 | -65 | 250 |
| L10-280 | Vertical PQ Thermistor | 6886180.5 | 416876.3 | 241.1 | 0 | -90 | |
| L10-281 | Deposit - Main | 6886049.4 | 417091.2 | 243.5 | 250 | -65 | 269 |
| L10-283 | Deposit - Main | 6886174.3 | 417091.4 | 242.9 | 020 | -65 | 218 |
| L10-285 | Lake - Main (Thermistor) | 6885962.0 | 417036.9 | 242.5 | 150 | -55 | 278 |
| L10-287 | Logging Comparison | 6885974.5 | 417091.1 | 241.2 | 0 | -90 | |

| REV | DATE | DESCRIPTION | PREPARED | DRAWN | CHK'D | APP'D |
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AVALON RARE METALS INC.

THOR LAKE PROJECT

**2010 HYDROGEOLOGICAL SITE INVESTIGATION DRILLHOLE PLAN**

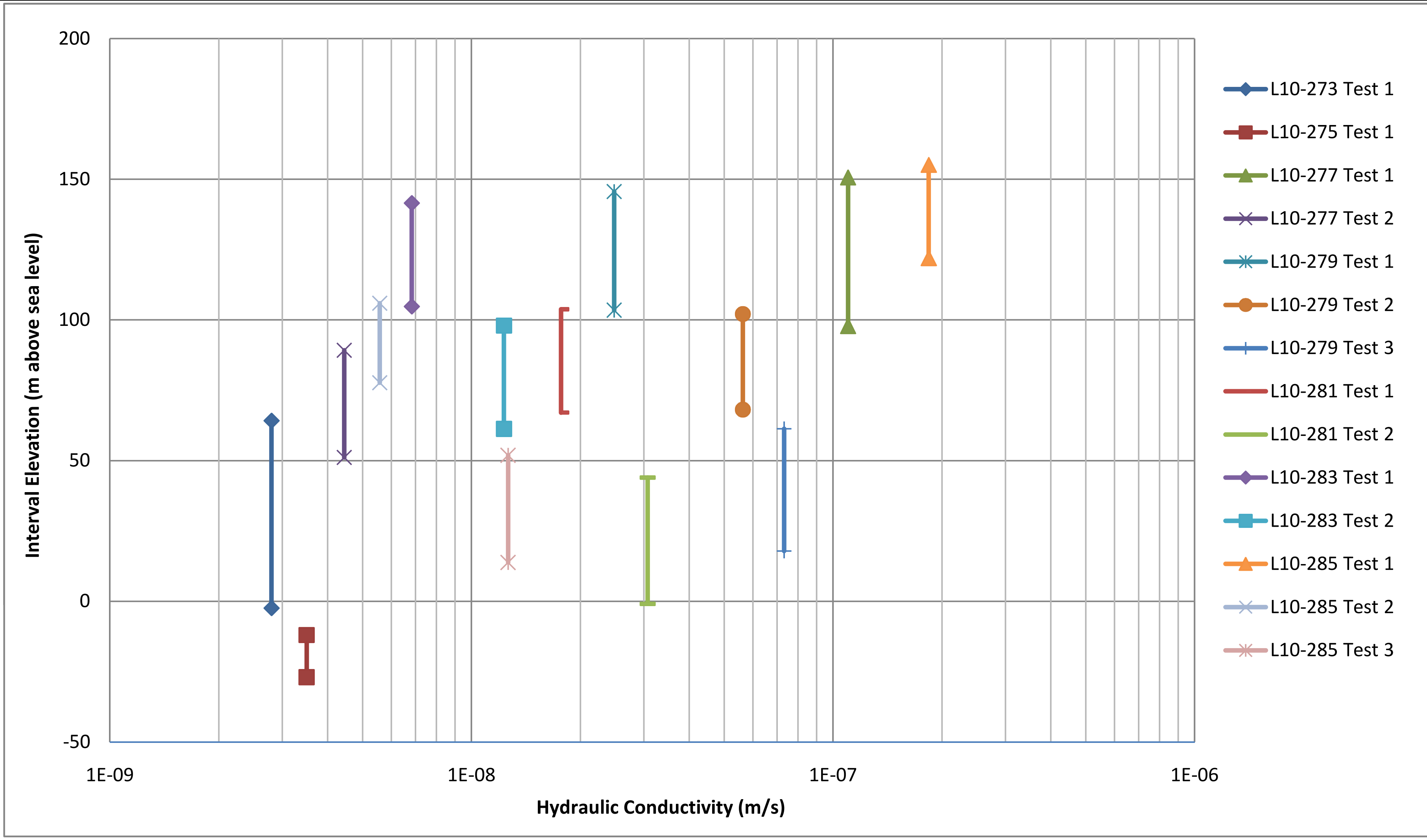
Knight Piésold CONSULTING

P/A NO. NB101-390/2

REF NO. NB10-00587

**FIGURE 1**

REV 0

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AVALON RARE METALS INC.

THOR LAKE PROJECT

**2010 HYDROGEOLOGICAL SITE INVESTIGATION**
**PACKER TEST RESULTS**

Knight Piésold CONSULTING

P/A NO. NB101-390/2

REF. NO. NB10-00587

**FIGURE 2**

REV 0

**Appendix C.9**

**Thor Lake Project – 2010 Geomechanical Site Investigations Summary. Report NB10-00570**

Knight Piésold
CONSULTING

# MEMORANDUM

| | | | |
|---|---|---|---|
| To: | David Swisher | Date: | November 26, 2010 |
| Copy To: | Bill Mercer | File No.: | NB101-390/2-A.01 |
| From: | Ben Peacock | Cont. No.: | NB10-00570 |
| Re: | Thor Lake Project – 2010 Geomechanical Site Investigations Summary | | |

## 1.0 Introduction

A geomechanical site investigation program was completed in August and September of 2010 at Avalon Rare Metals Inc.'s Thor Lake Project in the Northwest Territories. The purpose of the program was to collect the data needed to support feasibility level engineering for the underground mine.

The geomechanical program consisted of eight (8) oriented diamond drillholes, detailed geomechanical core logging, packer testing and the installation of two thermistors. The packer testing procedures and results are discussed in Memo NB10-00587 and the thermistor installations will be the subject of a future memo. An additional drillhole was used to compare 2009 and 2010 logging practices. A summary of the program and the data collected is set out below.

## 2.0 Geomechanical Drilling and Logging

The geomechanical drillholes targeted the Nechalacho deposit, including the recently identified Lake Zone, with the objective of better characterizing the rock mass in the region of the deposit. Specifically, the program focused on the rock masses in and around the Basal Zone, although data was also collected for the upper mineralized zones. Drillhole locations are presented on Figure 1.

All of the drillholes, with the exception of the drillhole used for the logging comparison, were HQ3 diameter and were drilled using triple-tube techniques in order to improve core recovery and minimise drilling-induced fractures. Drill core was oriented using the Reflex ACT core orientation system. Knight Piésold Ltd. (KPL) staff trained Avalon Rare Metals Inc. (Avalon) staff to supervise the drilling, orient the core and collect basic core orientation and rock mass parameters.

Project coordination and detailed logging was performed by KPL staff. Logging procedures allowed the rock mass quality to be assessed with both the Rock Mass Rating ($RMR_{89}$) and NGI-Q (Q') systems and included the collection of joint orientation data**.** Field estimates of Unconfined Compressive Strength (UCS) were obtained through the use of a low impact Schmidt Hammer and will be correlated with values obtained through laboratory UCS testing. A discussion of the UCS sampling program and the results of the laboratory testing was issued as separate Memo (KPL Ref No. NB10-00597).

Downhole plots have been compiled for each drillhole summarizing Recovery, Rock Quality Designation (RQD), $RMR_{89}$, lithology and the location of laboratory UCS samples. The lithology was based on geological logs provided by Avalon (Pedersen, *pers. comm*. Oct, 2010) and represents a preliminary assessment of the location of the Hangingwall, Ore and Footwall domains.

Figure 2 through Figure 33 summarize the collected information for each drill hole and include: downhole plots, orientation statistics and $RMR_{89}$ and Q' parameter histograms. It should be noted that the presented rock mass information and domain definitions are preliminary and may be revised during future analyses.

Discontinuity orientation data was collected to assist in the identification of major joint sets. Preliminary stereonets of the joint orientation data are included as Figure 34 and Figure 35. The stereonet data has been filtered to remove any discontinuities that were likely induced by drilling.

### 3.0 Drillhole Logging Comparison

For the 2009 pre-feasibility level investigations, Avalon site geology staff collected rock mass quality data based on a modified version of KPL's logging spreadsheet. This data was then evaluated by KPL staff and augmented and adjusted on the basis of engineering judgement to produce a preliminary assessment of rock mass quality.

In order to make the best possible use of the data collected during the 2009 investigations, it was decided to compare the 2009 and 2010 logging practices on drillhole L10-287. This drillhole was neither orientated nor triple-tubed. The drillhole was initially logged by the Avalon geologist who had completed the 2009 work and was then logged by KPL staff. The downhole plots, $RMR_{89}$ histogram summaries and Q' histogram summaries for both logs are included as Figure 36 through Figure 40. The results suggest that, while there are some differences, there is a reasonable agreement between the two sets of practices. The results of this comparison will be utilized to update the 2009 logs for incorporation into the 2010 database.

We trust this meets your needs at this time. Please let us know if you have any questions or require further information.

R. A. MERCER
NOV 26 2010

Signed: Ben D. Peacock, EIT
Civil Engineering

Reviewed: Robert A. Mercer, Ph.D., P.Eng.
Specialist Engineer – Rock Mechanics

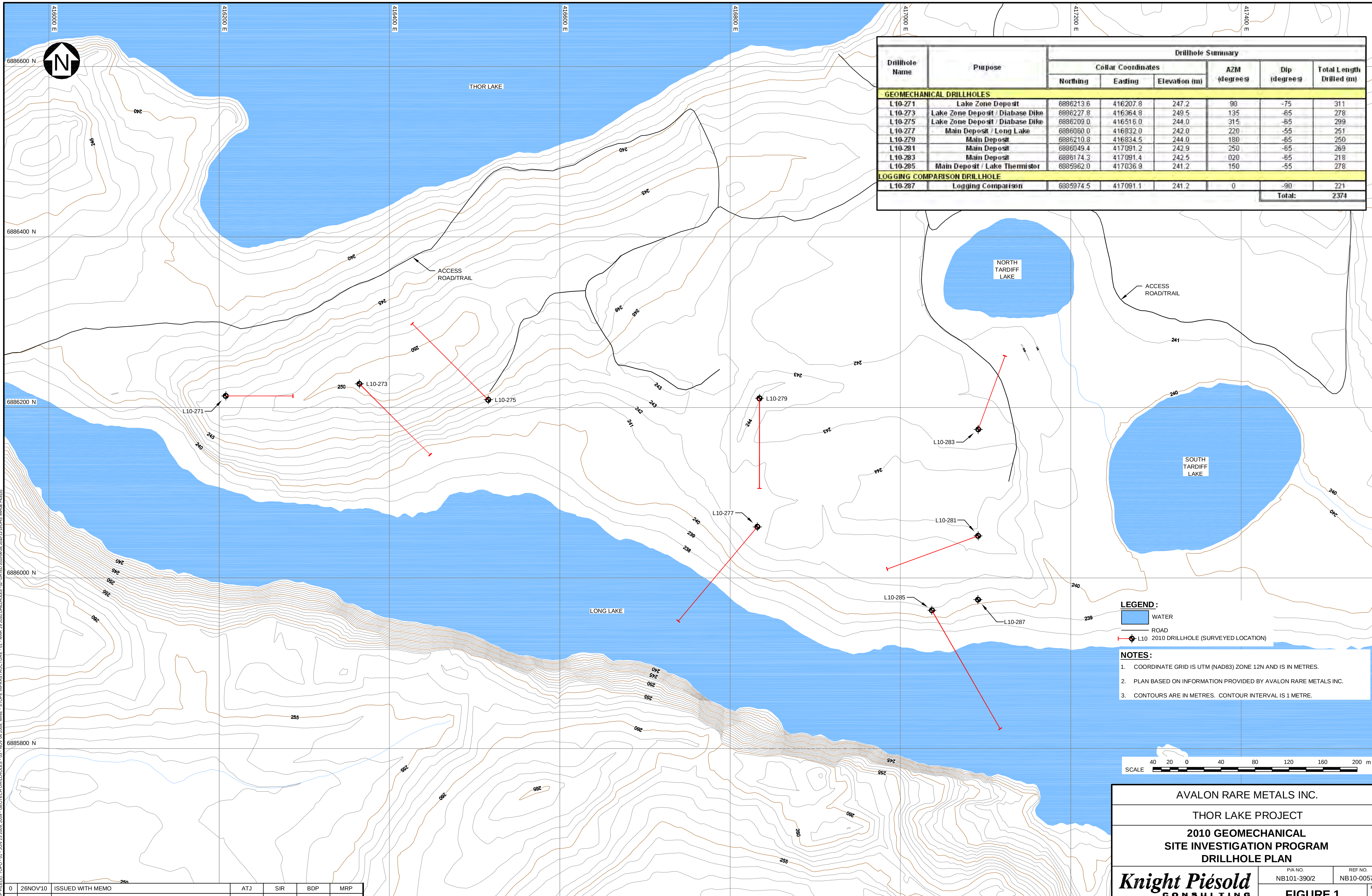
Approved: Matthew R. Parfitt, P.Eng.
Senior Engineer / Project Manager

Attachments:

Figure 1 Rev 0 2010 Geomechanical Site Investigation Program Drillhole Plan

Figure 2 Rev 0 Drillhole Orientation Results L10-271
Figure 3 Rev 0 Downhole Plots for L10-271
Figure 4 Rev 0 $RMR_{89}$ Parameter Histograms for L10-271
Figure 5 Rev 0 Q' Parameter Histograms for L10-271

/bdp




| Drillhole Name | Purpose | Drillhole Summary | | | | | |
|---|---|---|---|---|---|---|---|
| | | Collar Coordinates | | | AZM (degrees) | Dip (degrees) | Total Length Drilled (m) |
| | | Northing | Easting | Elevation (m) | | | |
| GEOMECHANICAL DRILLHOLES | | | | | | | |
| L10-271 | Lake Zone Deposit | 6886213.6 | 416207.8 | 247.2 | 90 | -75 | 311 |
| L10-273 | Lake Zone Deposit / Diabase Dike | 6886227.8 | 416364.8 | 249.5 | 135 | -65 | 278 |
| L10-275 | Lake Zone Deposit / Diabase Dike | 6886209.0 | 416516.0 | 244.0 | 315 | -65 | 299 |
| L10-277 | Main Deposit / Long Lake | 6886060.0 | 416832.0 | 242.0 | 220 | -55 | 251 |
| L10-279 | Main Deposit | 6886210.8 | 416834.5 | 244.0 | 180 | -65 | 250 |
| L10-281 | Main Deposit | 6886049.4 | 417091.2 | 242.9 | 250 | -65 | 269 |
| L10-283 | Main Deposit | 6886174.3 | 417091.4 | 242.5 | 020 | -65 | 218 |
| L10-285 | Main Deposit / Lake Thermistor | 6885962.0 | 417036.9 | 241.2 | 150 | -55 | 278 |
| LOGGING COMPARISON DRILLHOLE | | | | | | | |
| L10-287 | Logging Comparison | 6885974.5 | 417091.1 | 241.2 | 0 | -90 | 221 |
| | | | | | | Total: | 2374 |

**NOTES:**

1. COORDINATE GRID IS UTM (NAD83) ZONE 12N AND IS IN METRES.
2. PLAN BASED ON INFORMATION PROVIDED BY AVALON RARE METALS INC.
3. CONTOURS ARE IN METRES. CONTOUR INTERVAL IS 1 METRE.

| REV | DATE | DESCRIPTION | PREPARED | DRAWN | CHK'D | APP'D |
|---|---|---|---|---|---|---|
| 0 | 26NOV'10 | ISSUED WITH MEMO | ATJ | SIR | BDP | MRP |

AVALON RARE METALS INC.

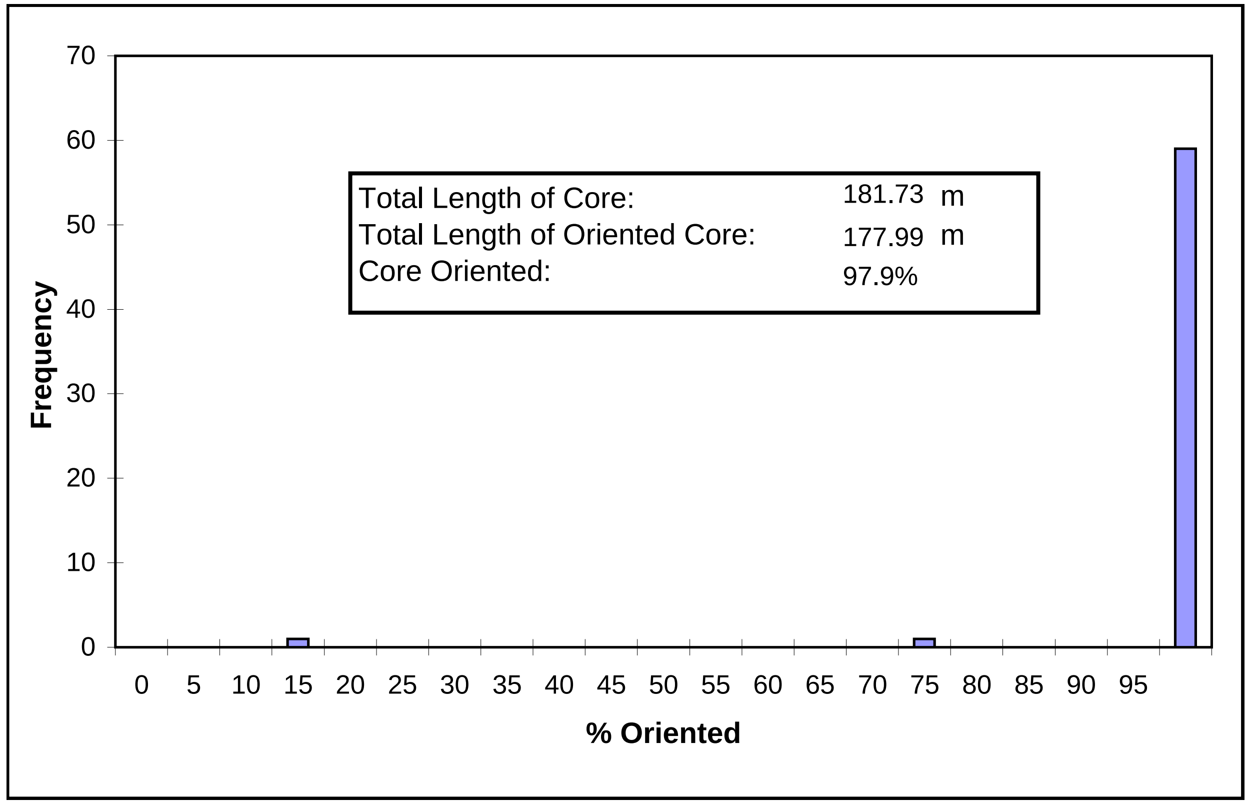
THOR LAKE PROJECT

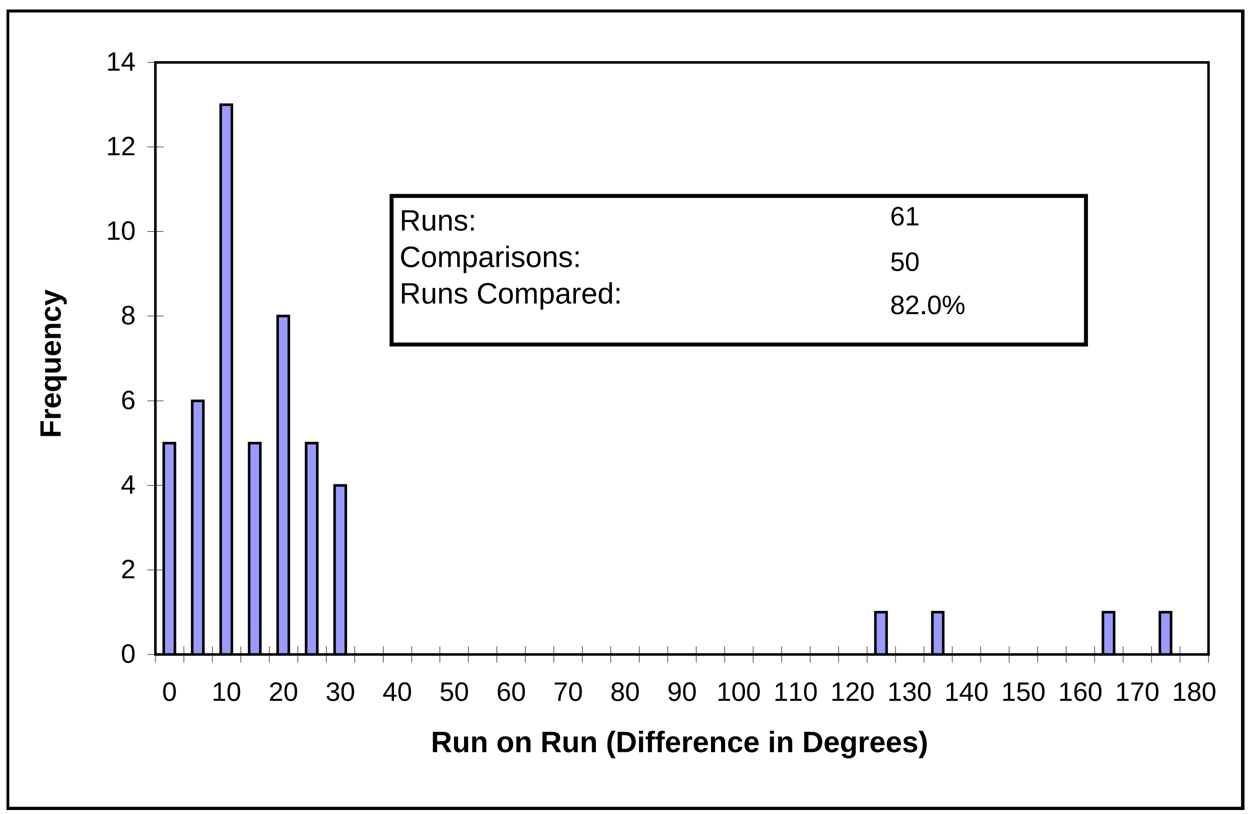
**2010 GEOMECHANICAL SITE INVESTIGATION PROGRAM DRILLHOLE PLAN**

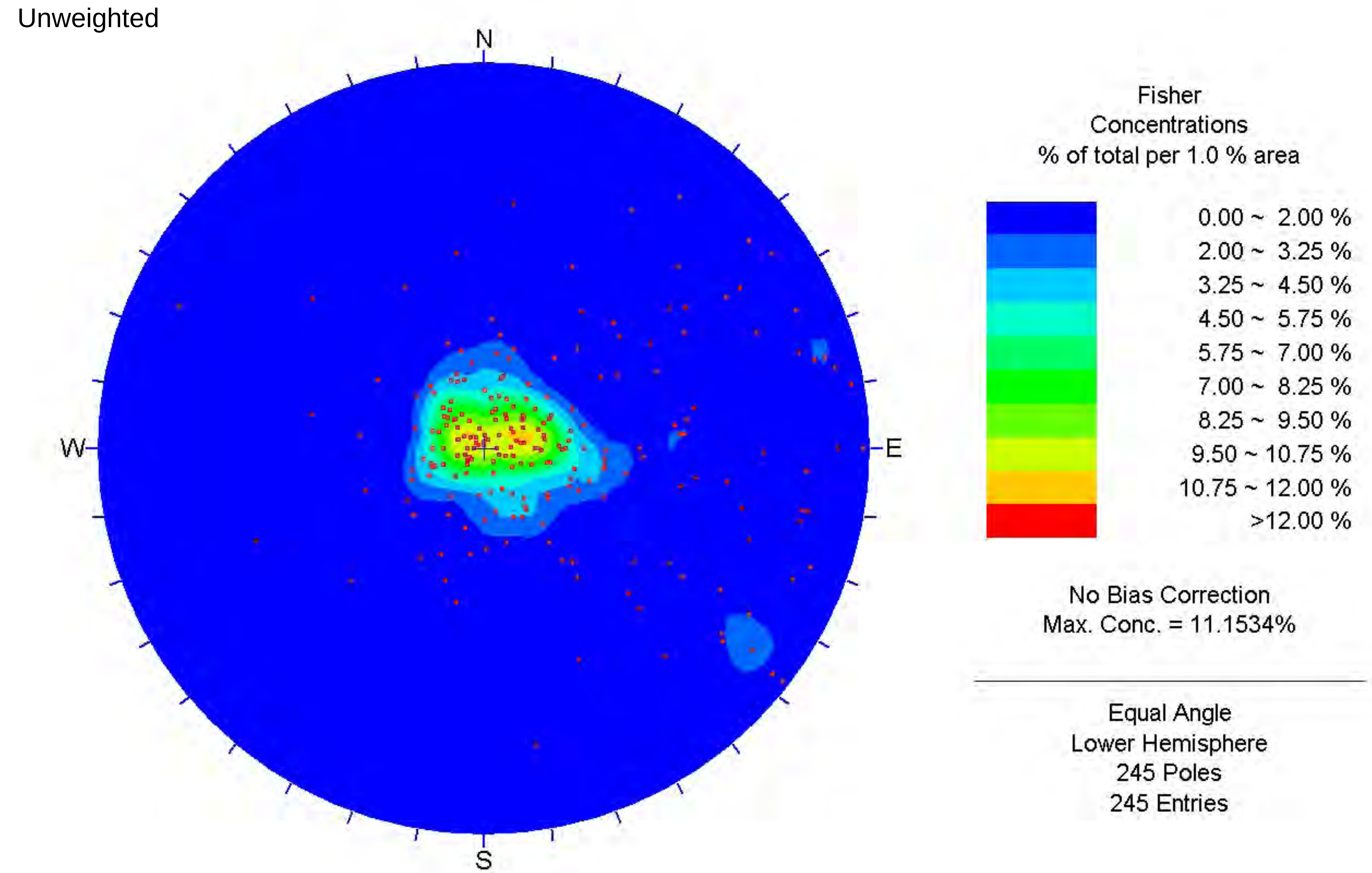
Knight Piésold CONSULTING

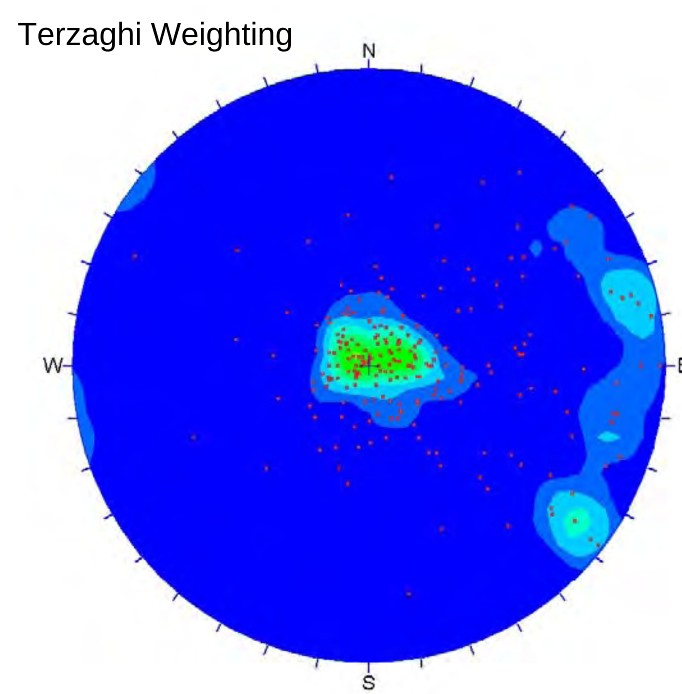
P/A NO. NB101-390/2 | REF NO. NB10-00570

FIGURE 1 | REV 0



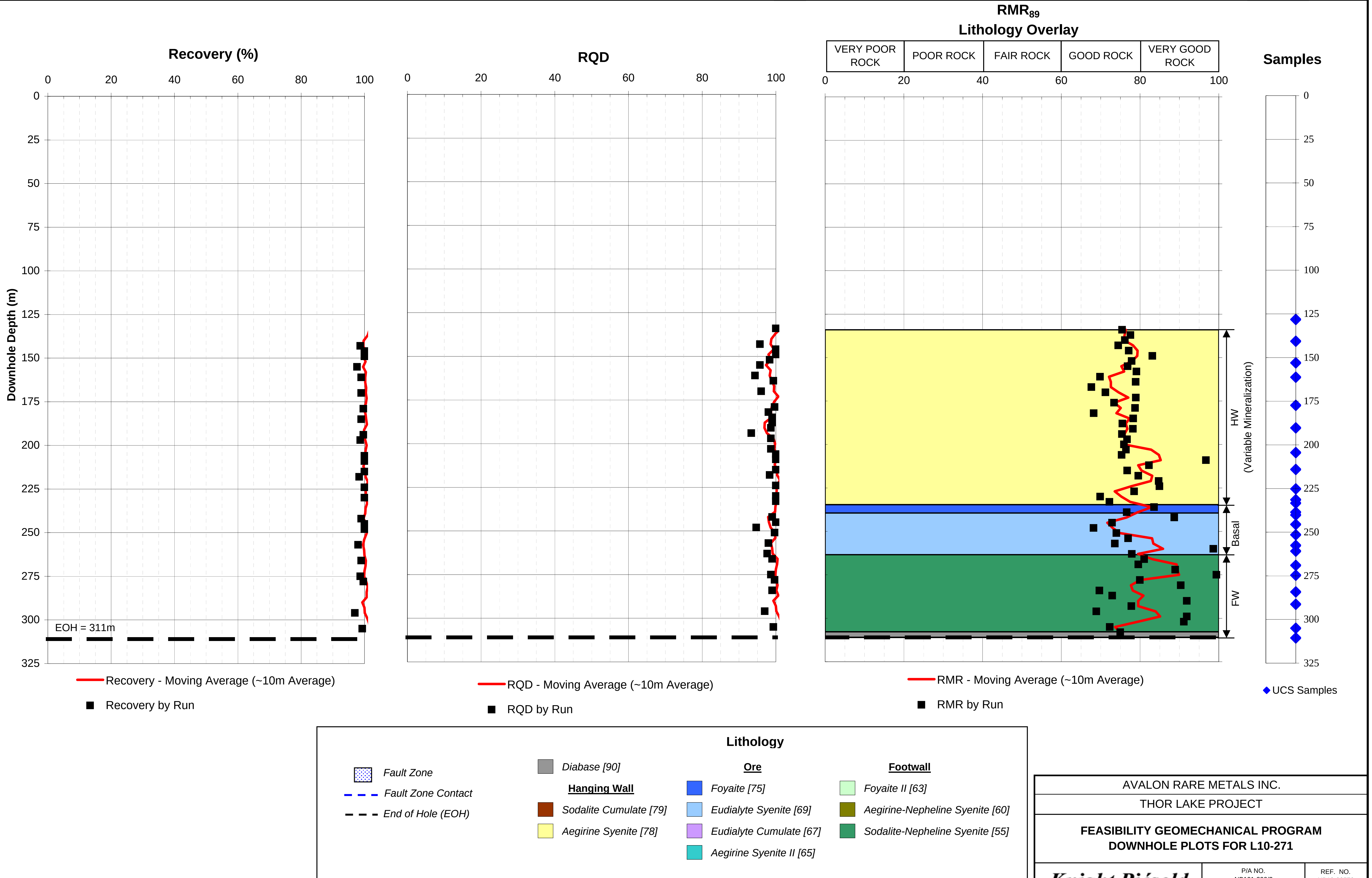




## Drillhole Details

Azimuth: 90°
Dip: -75°
Length: 311 m

| | | |
|---|---|---|
| AVALON RARE METALS INC. | | |
| THOR LAKE PROJECT | | |
| **FEASIBILITY GEOMECHANICAL PROGRAM DRILLHOLE ORIENTATION RESULTS L10-271** | | |
| Knight Piésold CONSULTING | P/A NO. NB101-390/2 | REF. NO. NB10-00570 |
| | **FIGURE 2** | REV 0 |

| 0 | 19NOV'10 | ISSUED WITH MEMO | AJ | BDP | RAM |
|---|---|---|---|---|---|
| REV | DATE | DESCRIPTION | PREP'D | CHK'D | APP'D |




| | | | | | |
|---|---|---|---|---|---|
| 0 | 19NOV'10 | ISSUED WITH MEMO | AJ | BDP | RAM |
| REV | DATE | DESCRIPTION | PREP'D | CHK'D | APP'D |

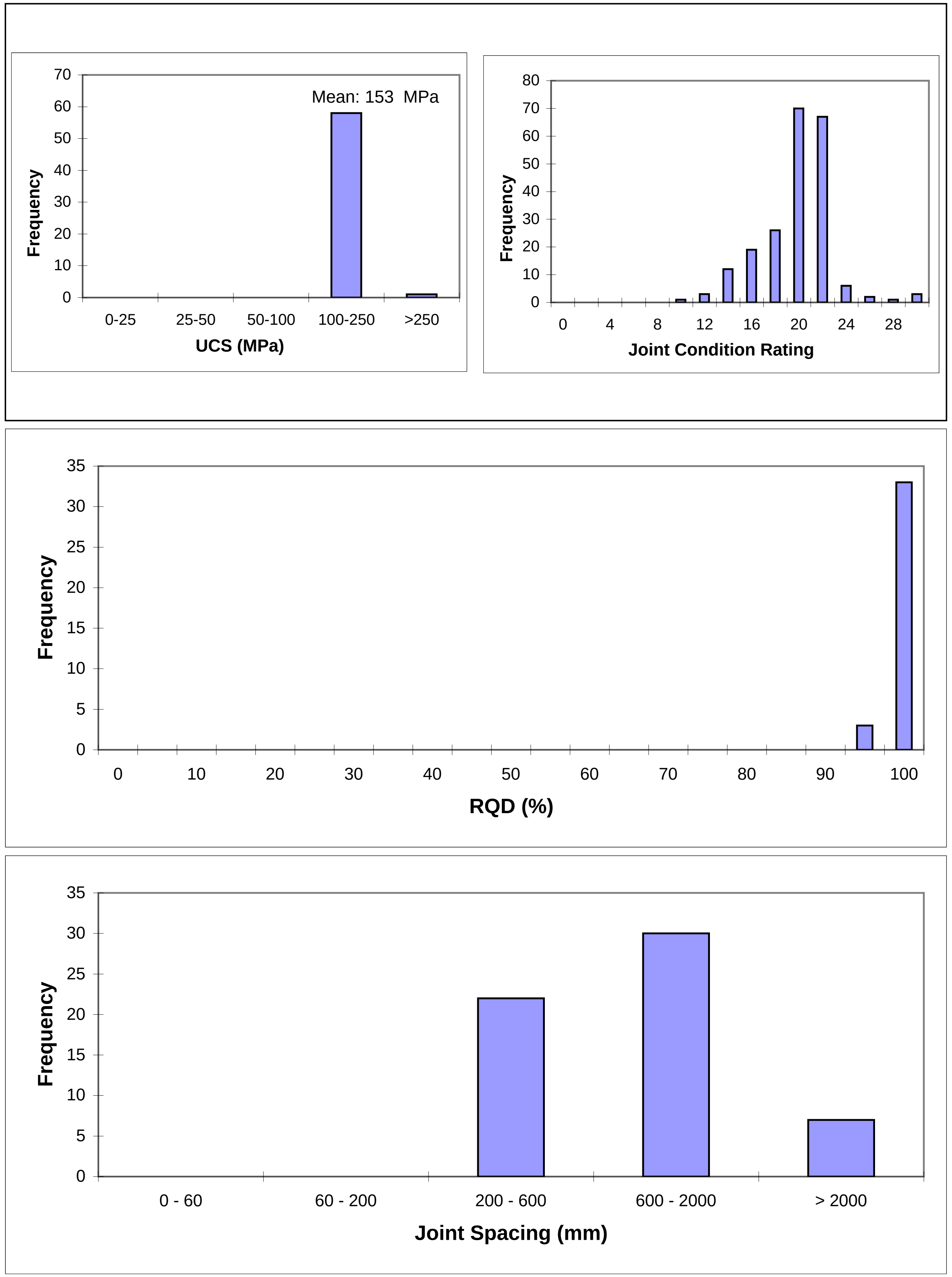
AVALON RARE METALS INC.
THOR LAKE PROJECT

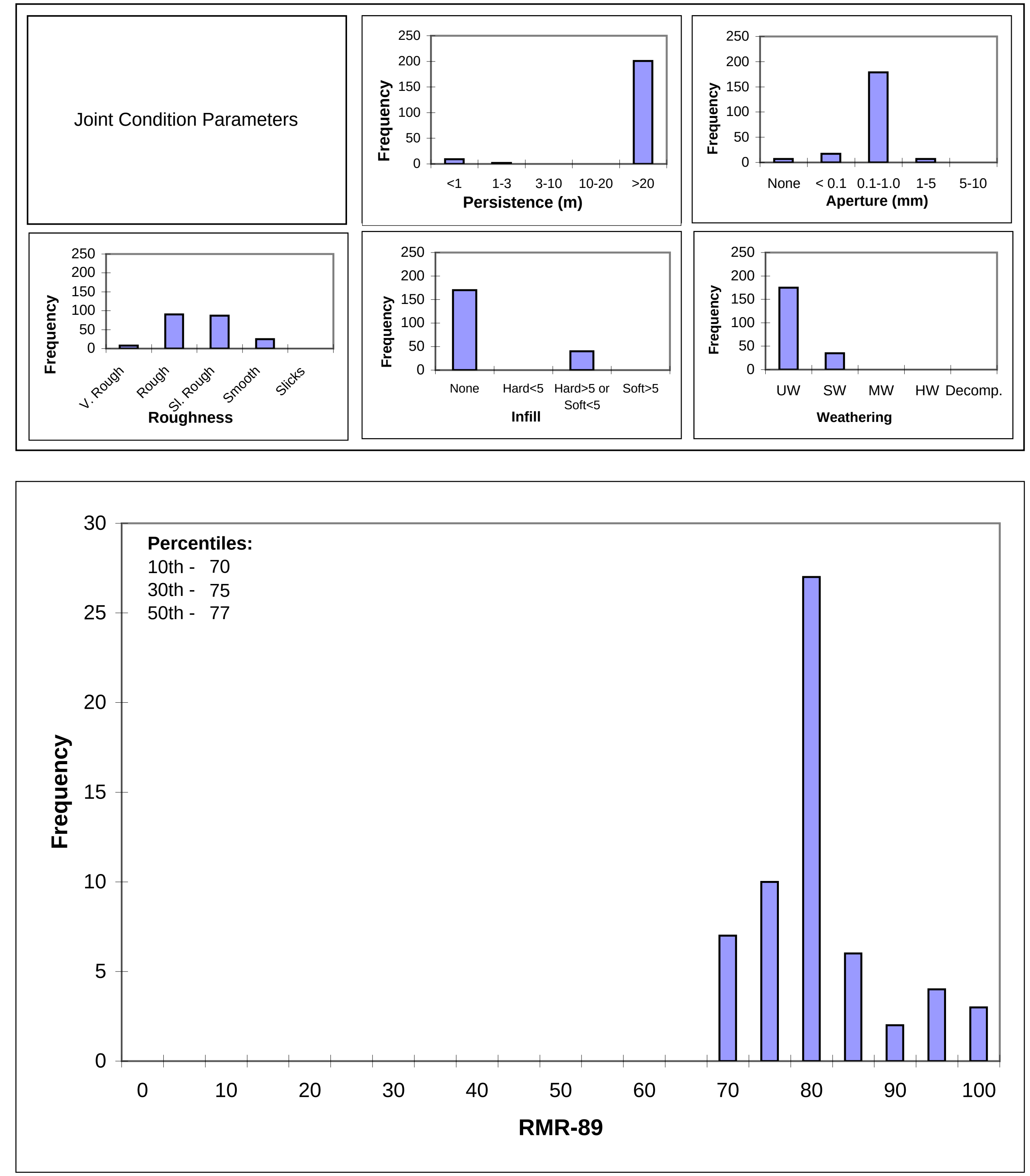
**FEASIBILITY GEOMECHANICAL PROGRAM**
**DOWNHOLE PLOTS FOR L10-271**

Knight Piésold CONSULTING

P/A NO. NB101-390/2 | REF. NO. NB10-00570

**FIGURE 3** REV 0




**NOTES:**

1. BINS INCLUDE PREVIOUS RANGE (I.E., BIN 60 INCLUDES VALUES FROM 55-60).
2. RQD, RMR89, JOINT SPACING, AND UCS ARE RUN BASED PARAMETERS WHILE JOINT CONDITION RATING AND PARAMETERS ARE BASED ON INDIVIDUAL DISCONTINUITIES WITHIN A LOGGING RUN.

| | | | | | |
|---|---|---|---|---|---|
| 0 | 19NOV'10 | ISSUED WITH MEMO | AJ | BDP | RAM |
| REV | DATE | DESCRIPTION | PREP'D | CHK'D | APP'D |

AVALON RARE METALS INC.

THOR LAKE PROJECT

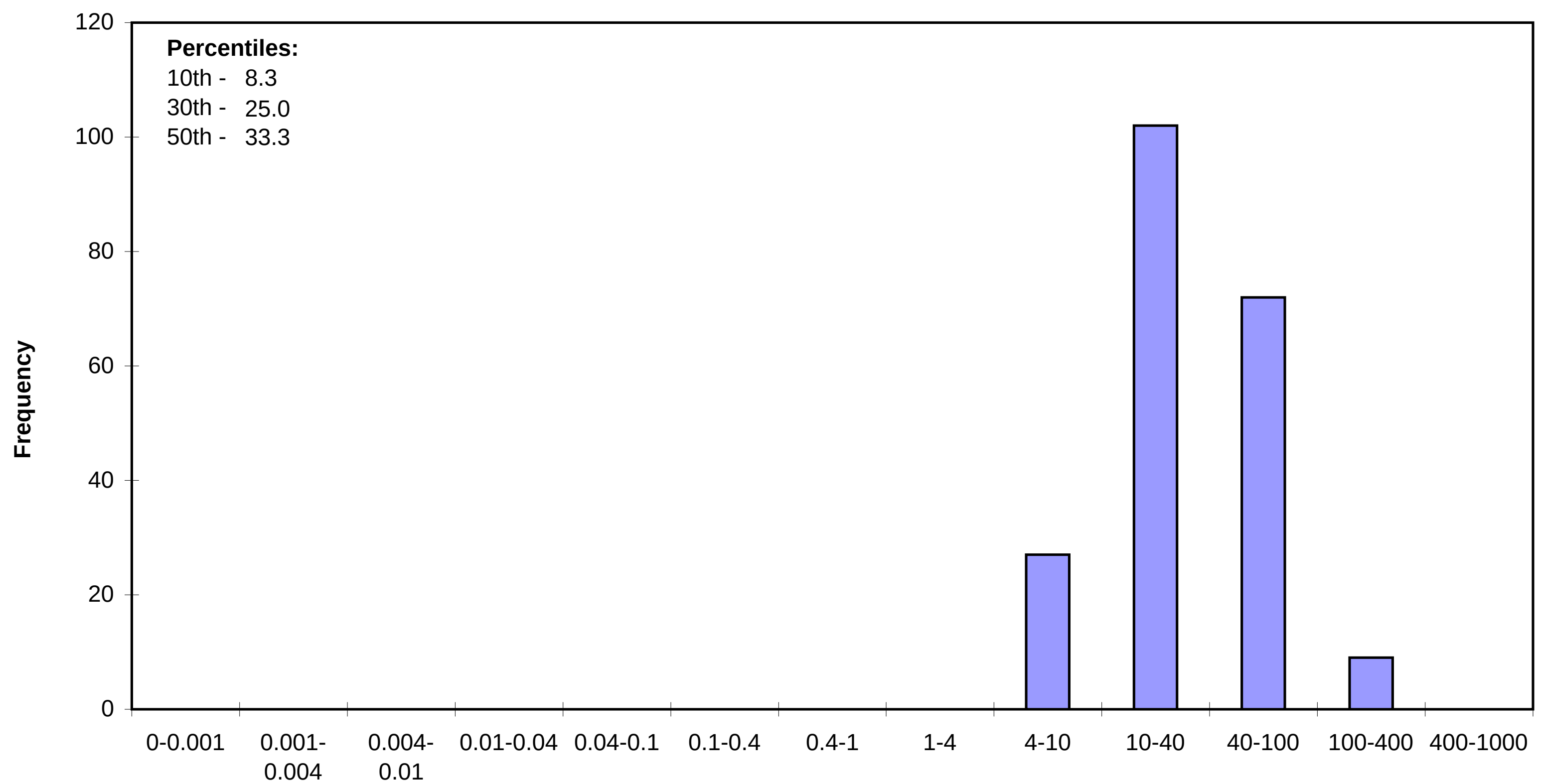
**FEASIBILITY GEOMECHANICAL PROGRAM**

**$RMR_{89}$ PARAMETER HISTOGRAMS FOR L10-271**

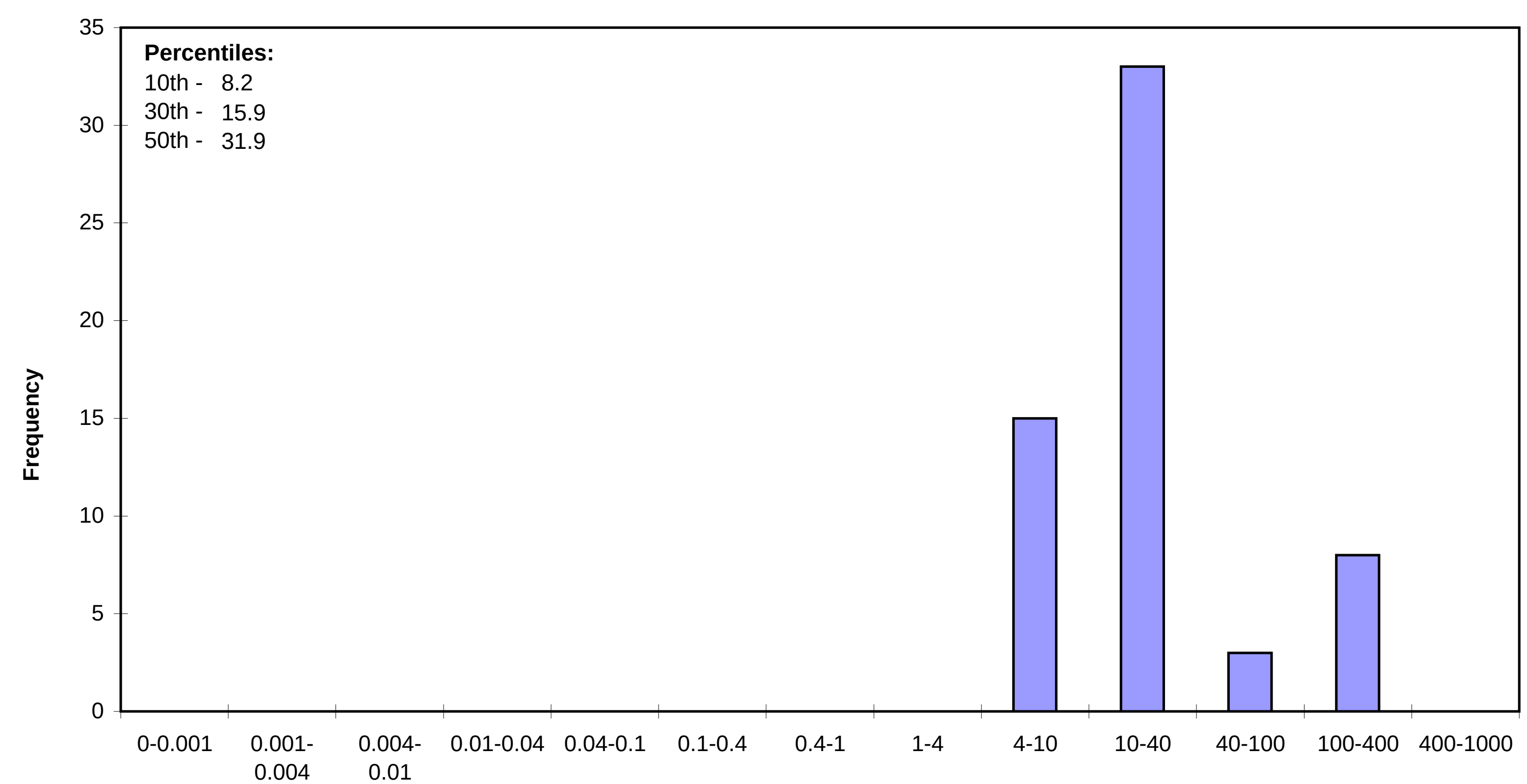
Knight Piésold CONSULTING

| P/A NO. | REF. NO. |
|---|---|
| NB101-390/2 | NB10-00570 |

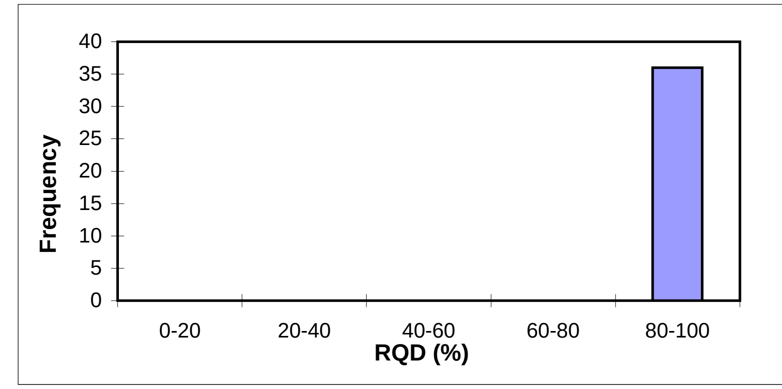
**FIGURE 4** REV 0

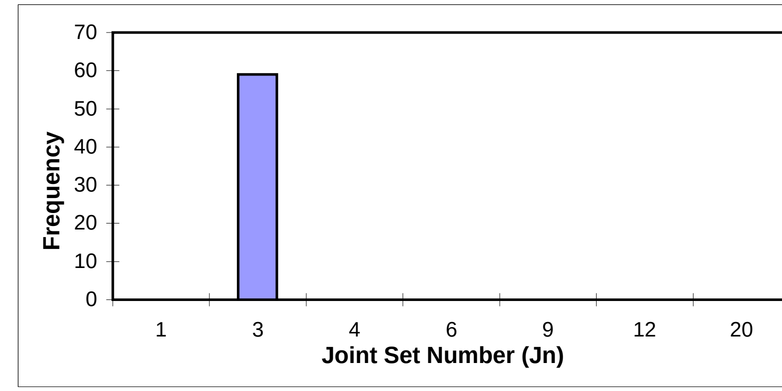


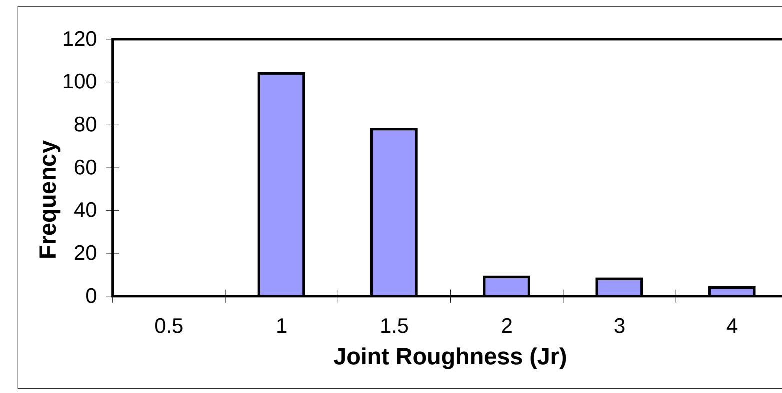

Q' by Discontinuity

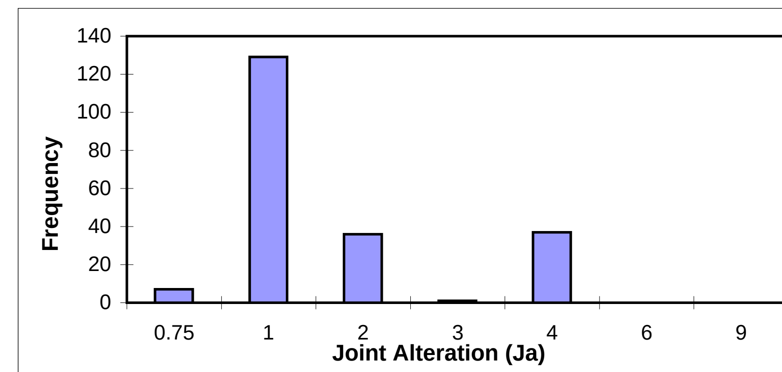



Q' by Logging Run (using minimum)




**NOTES:**
1. RQD AND Jn ARE RUN BASED PARAMETERS WHILE Jr AND Ja ARE BASED ON INDIVIDUAL DISCONTINUITIES WITHIN A LOGGING RUN.

AVALON RARE METALS INC.

THOR LAKE PROJECT

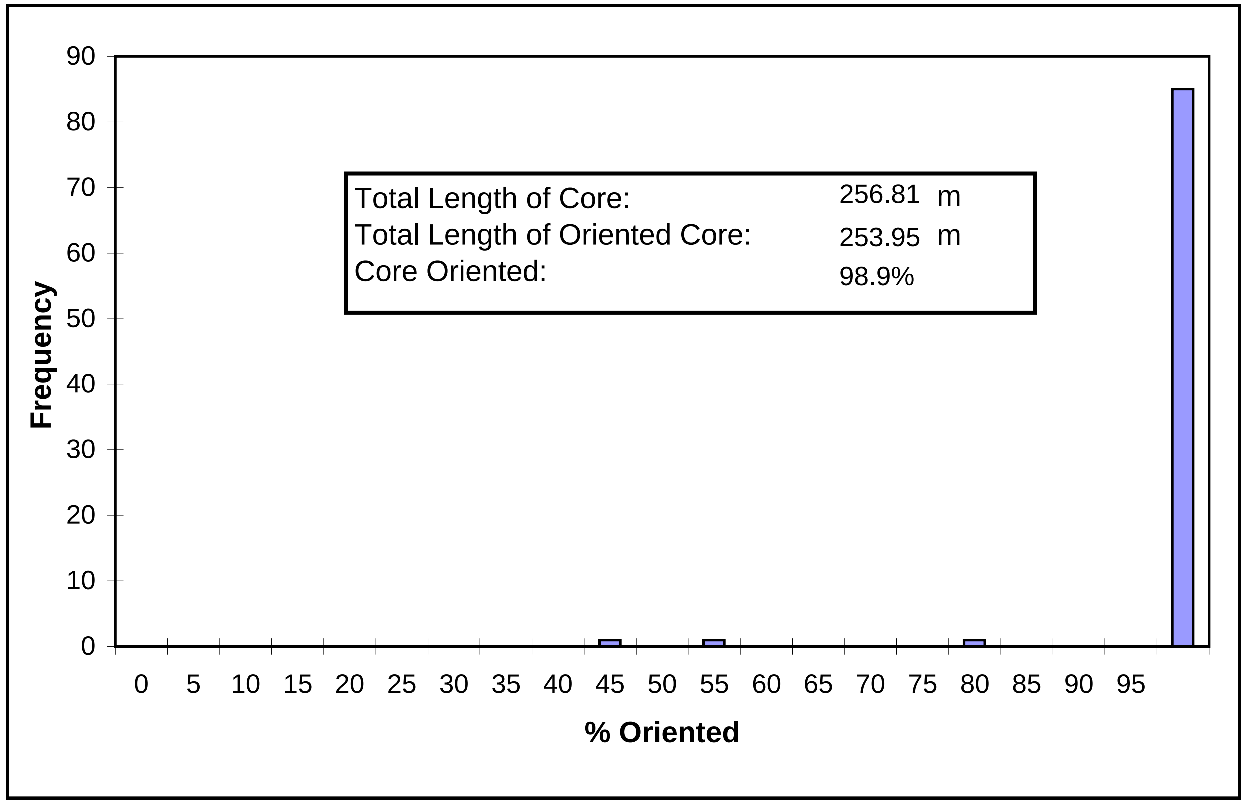
**FEASIBILITY GEOMECHANICAL PROGRAM**
**Q' PARAMETER HISTOGRAMS FOR L10-271**

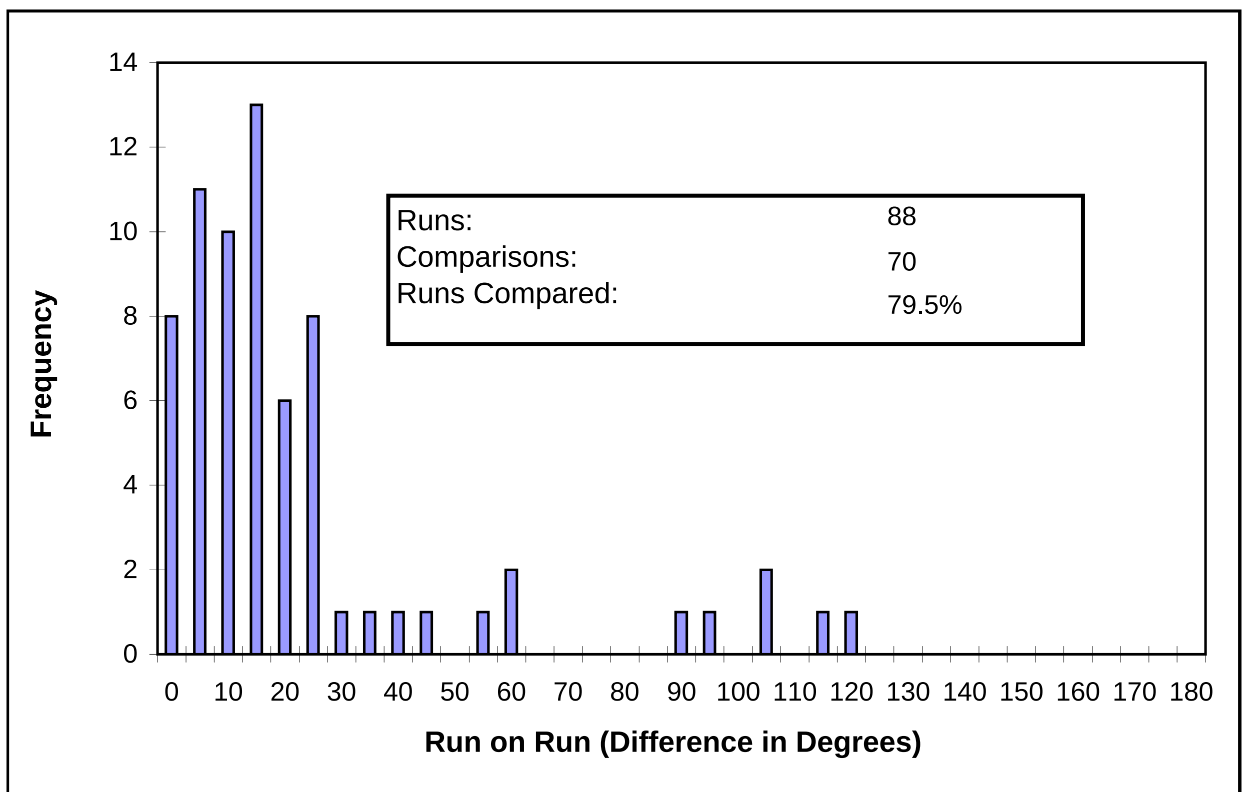
Knight Piésold CONSULTING

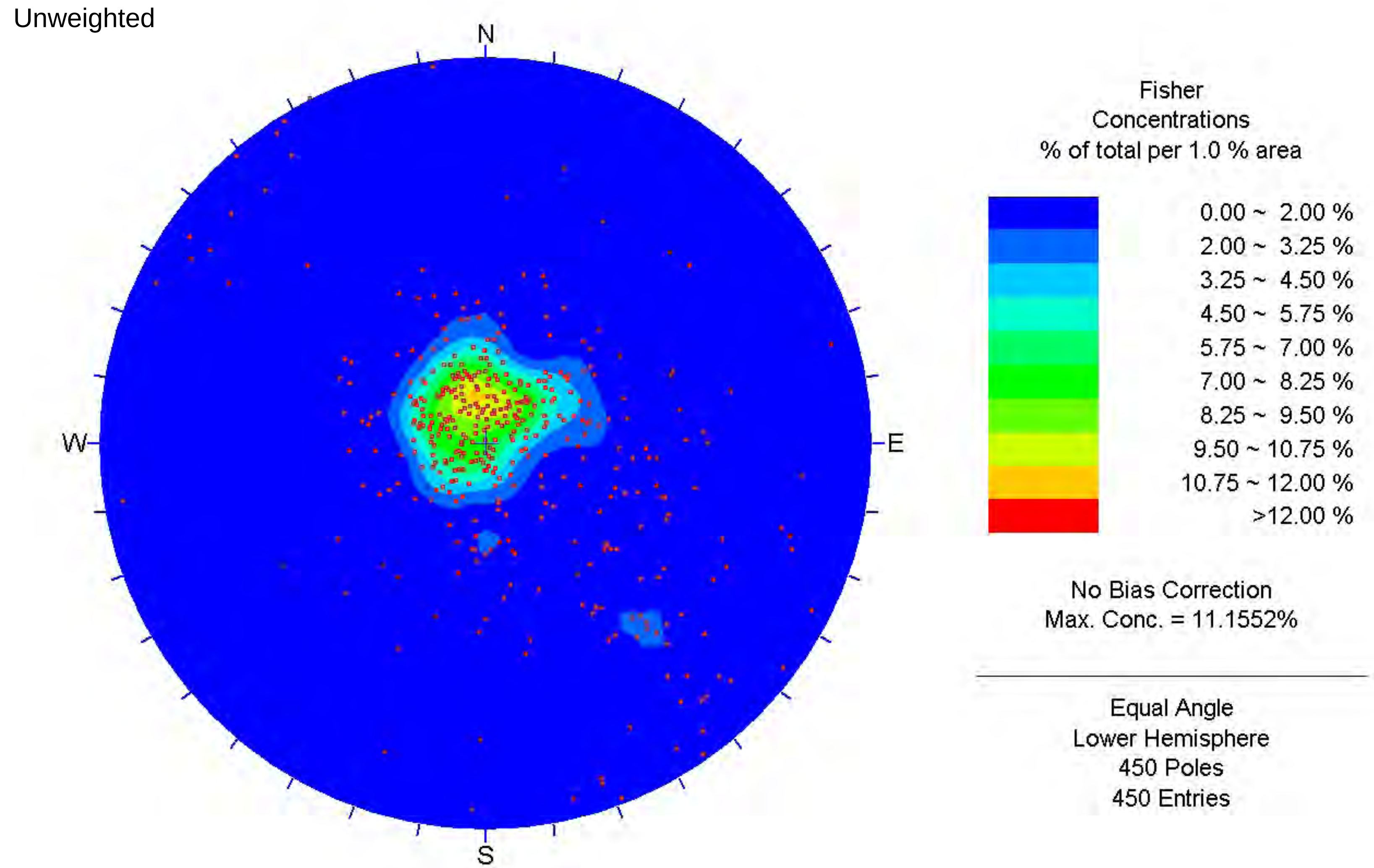
| P/A NO. | REF. NO. |
|---|---|
| NB101-390/2 | NB10-00570 |

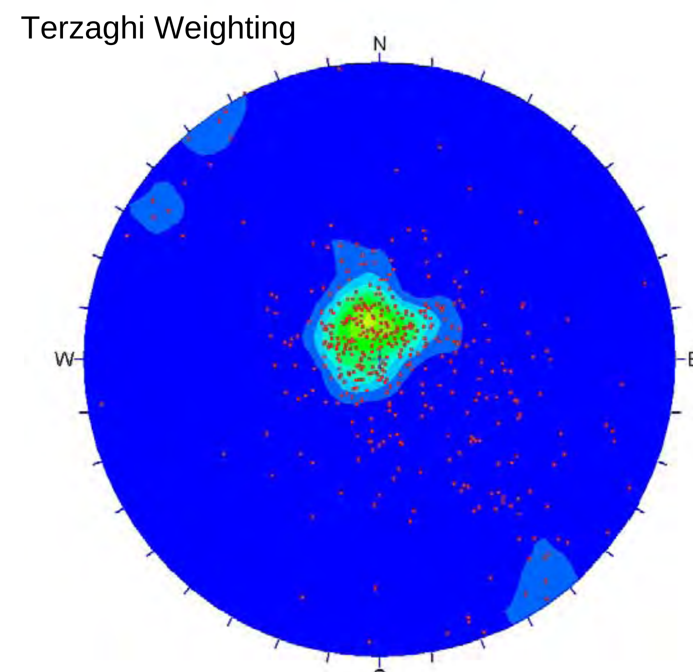
**FIGURE 5** REV 0

| REV | DATE | DESCRIPTION | PREP'D | CHK'D | APP'D |
|---|---|---|---|---|---|
| 0 | 19NOV'10 | ISSUED WITH MEMO | AJ | BDP | RAM |




**Drillhole Details**

Azimuth: 135°

Dip: -65°

Length: 278 m

AVALON RARE METALS INC.

THOR LAKE PROJECT

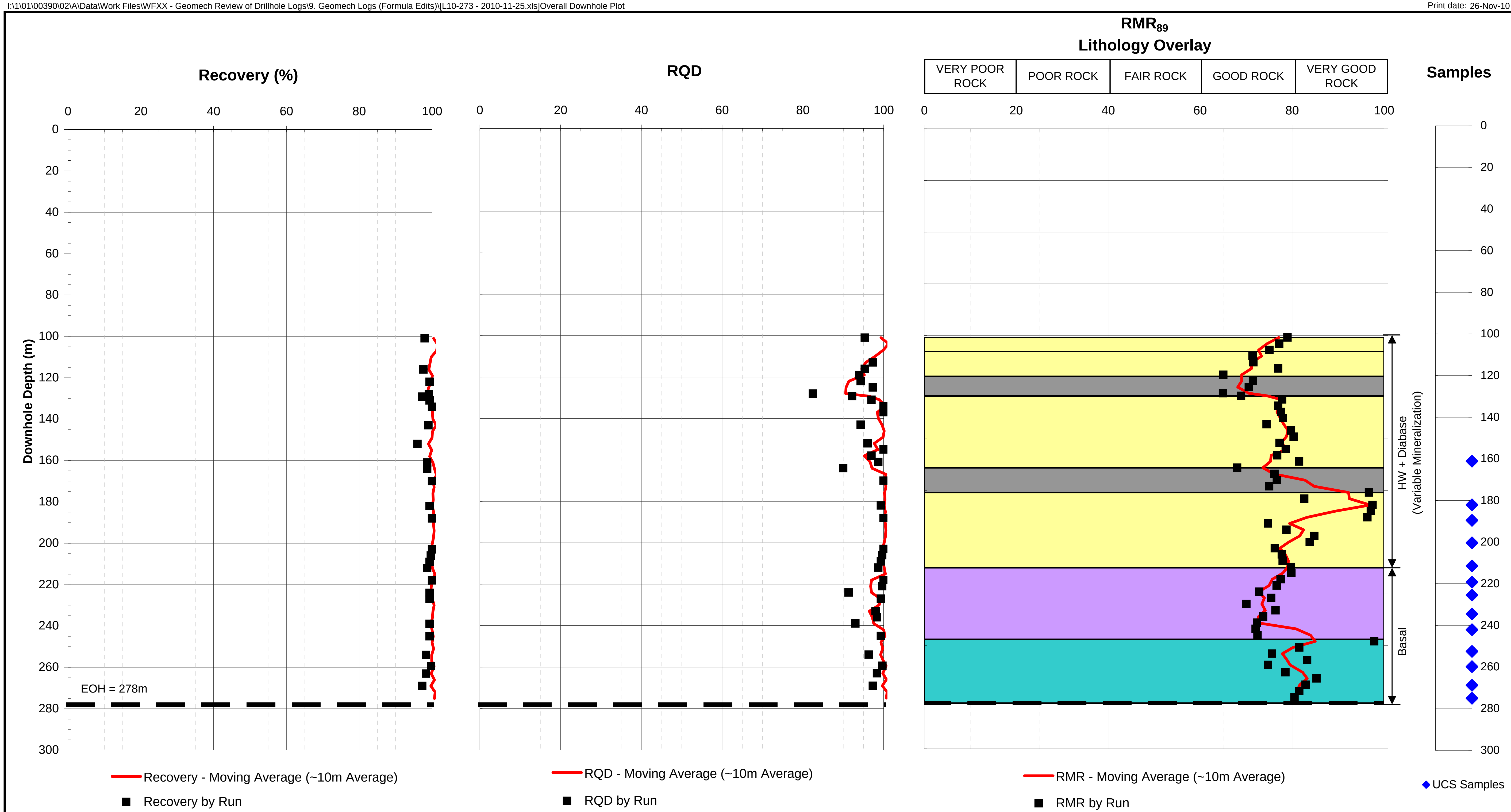
**FEASIBILITY GEOMECHANICAL PROGRAM**
**DRILLHOLE ORIENTATION RESULTS**
**L10-273**

Knight Piésold CONSULTING

| P/A NO. | REF. NO. |
|---|---|
| NB101-390/2 | NB10-00570 |

**FIGURE 6** REV 0

| REV | DATE | DESCRIPTION | PREP'D | CHK'D | APP'D |
|---|---|---|---|---|---|
| 0 | 19NOV'10 | ISSUED WITH MEMO | AJ | BDP | RAM |




## Lithology

| | | | |
|---|---|---|---|
| Fault Zone | Diabase [90] | **Ore** | **Footwall** |
| Fault Zone Contact | **Hanging Wall** | Foyaite [75] | Foyaite II [63] |
| End of Hole (EOH) | Sodalite Cumulate [79] | Eudialyte Syenite [69] | Aegirine-Nepheline Syenite [60] |
| | Aegirine Syenite [78] | Eudialyte Cumulate [67] | Sodalite-Nepheline Syenite [55] |
| | | Aegirine Syenite II [65] | |

AVALON RARE METALS INC.

THOR LAKE PROJECT

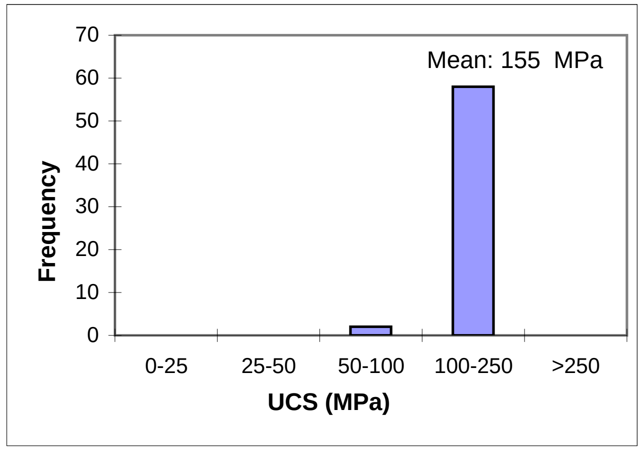
**FEASIBILITY GEOMECHANICAL PROGRAM**
**DOWNHOLE PLOTS FOR L10-273**

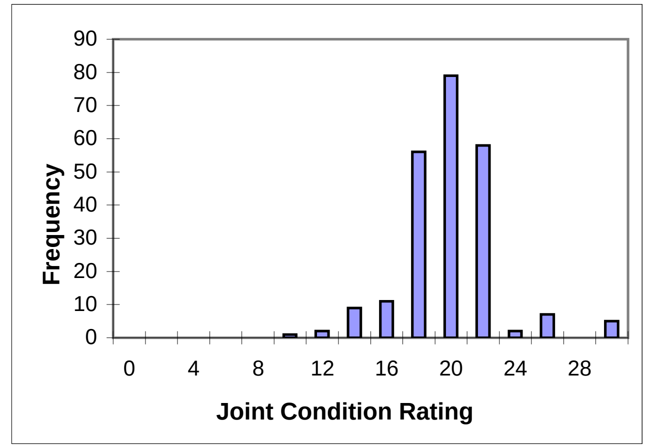
Knight Piésold CONSULTING

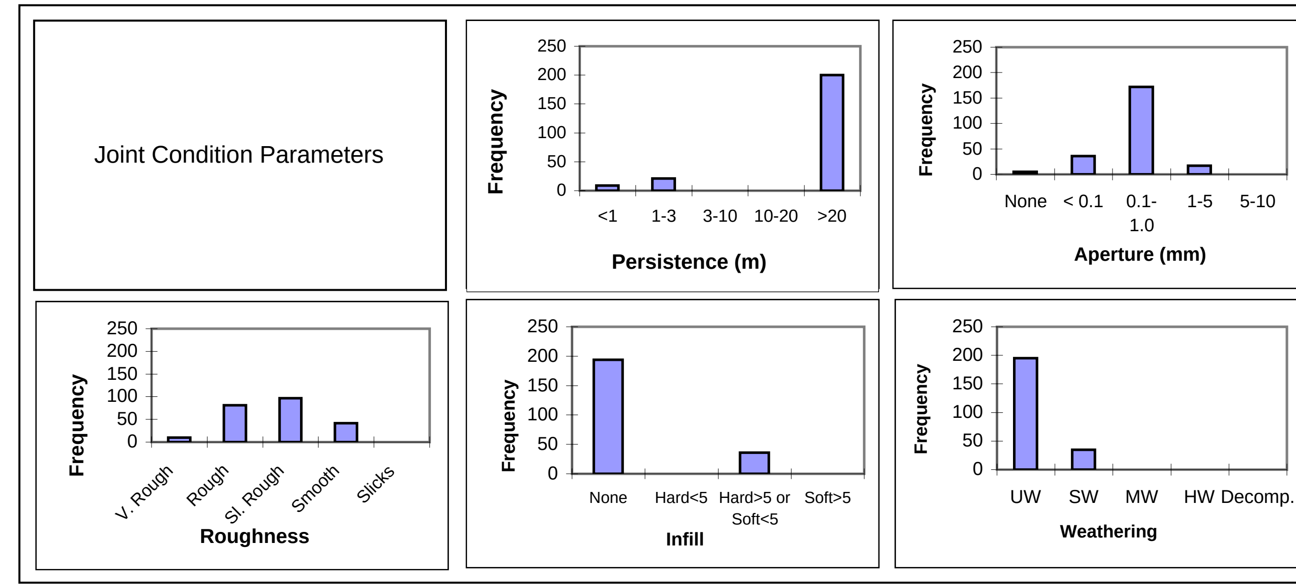
| P/A NO. | REF. NO. |
|---|---|
| NB101-390/2 | NB10-00570 |

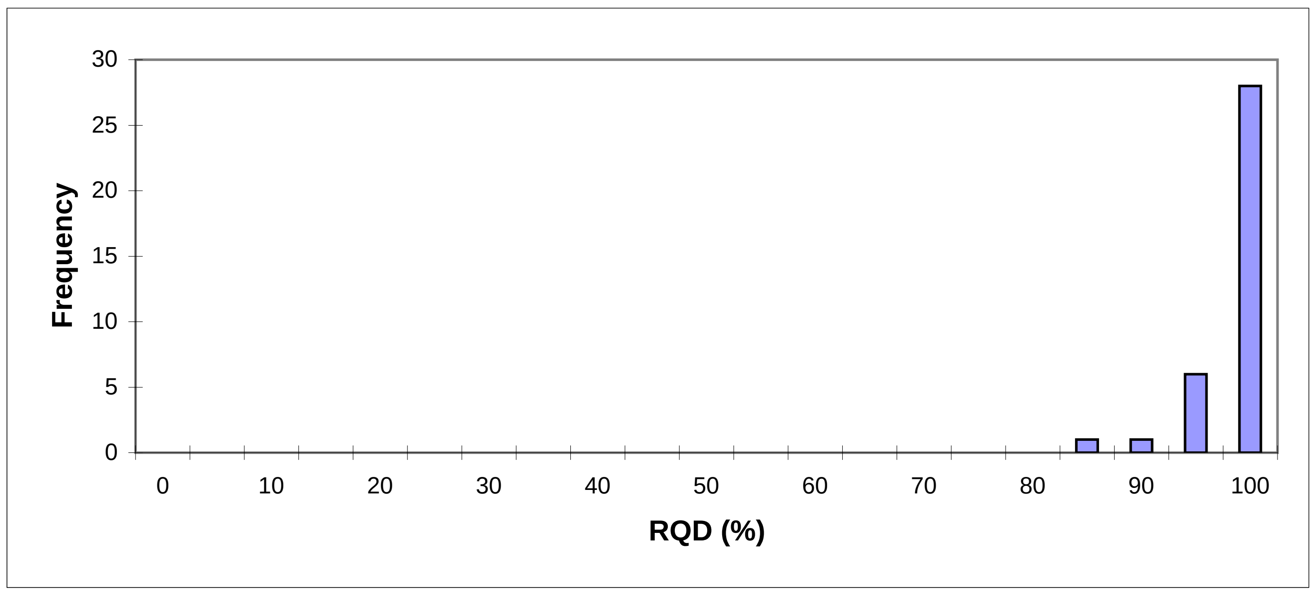
**FIGURE 7** REV 0

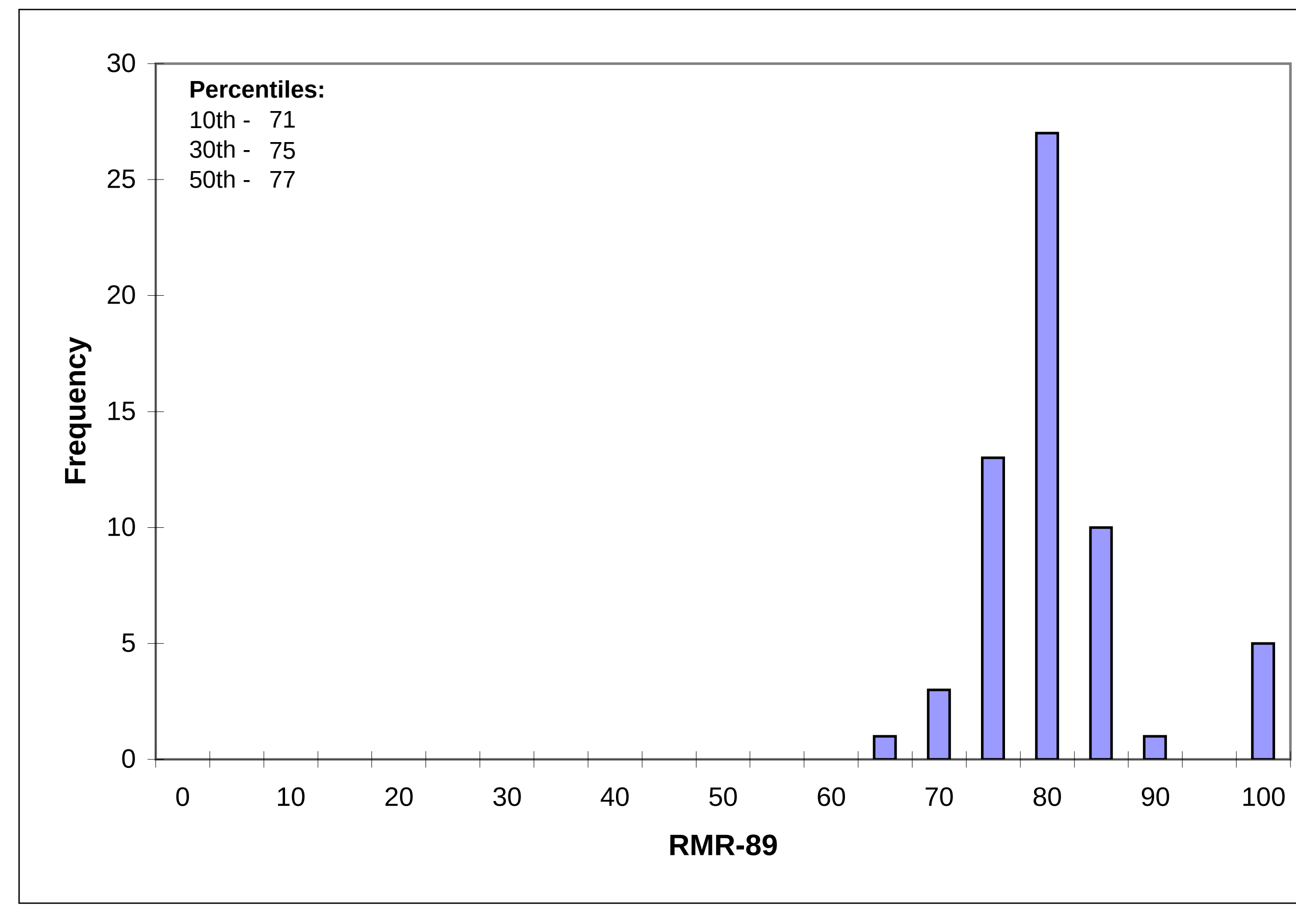
| 0 | 19NOV'10 | ISSUED WITH MEMO | AJ | BDP | RAM |
|---|---|---|---|---|---|
| REV | DATE | DESCRIPTION | PREP'D | CHK'D | APP'D |

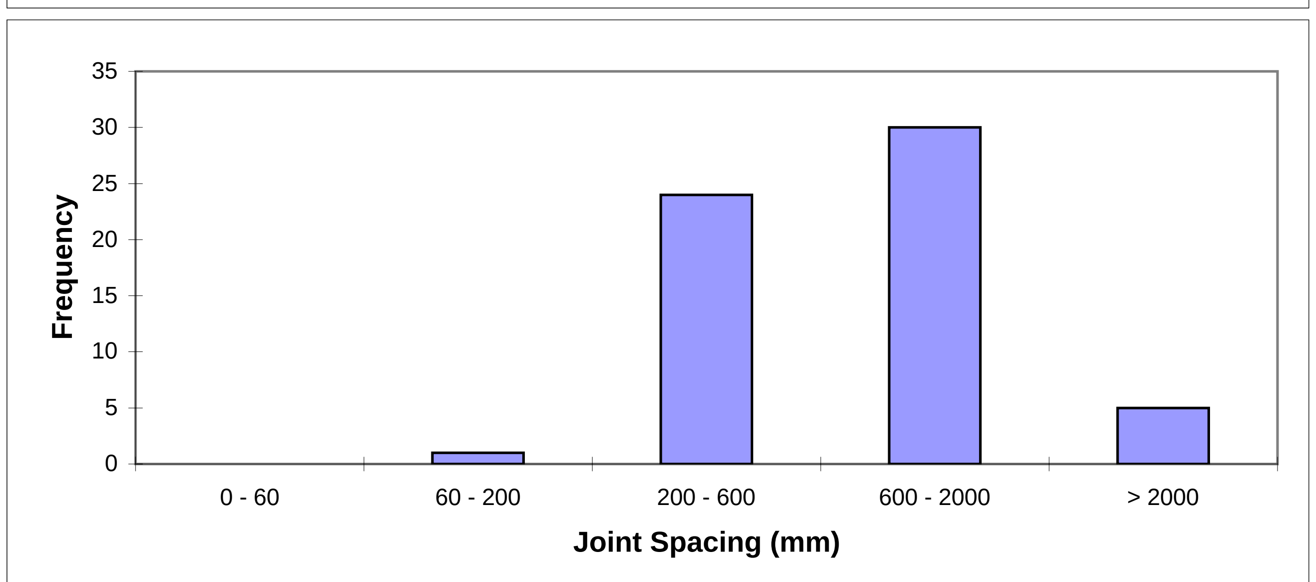



**NOTES:**

1. BINS INCLUDE PREVIOUS RANGE (I.E., BIN 60 INCLUDES VALUES FROM 55-60).
2. RQD, RMR89, JOINT SPACING, AND UCS ARE RUN BASED PARAMETERS WHILE JOINT CONDITION RATING AND PARAMETERS ARE BASED ON INDIVIDUAL DISCONTINUITIES WITHIN A LOGGING RUN.

| | | | | | |
|---|---|---|---|---|---|
| 0 | 19NOV'10 | ISSUED WITH MEMO | AJ | BDP | RAM |
| REV | DATE | DESCRIPTION | PREP'D | CHK'D | APP'D |

AVALON RARE METALS INC.

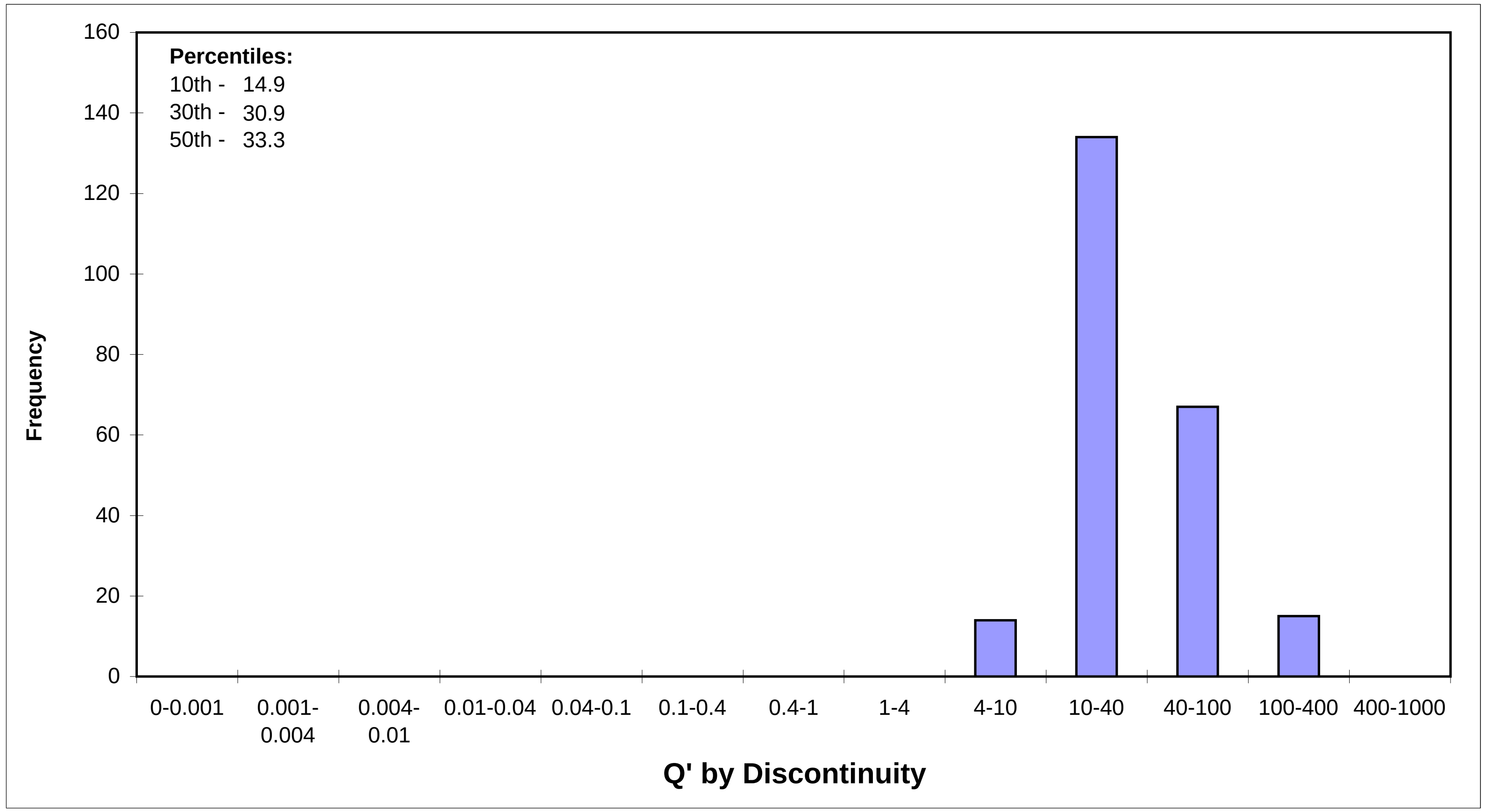
THOR LAKE PROJECT

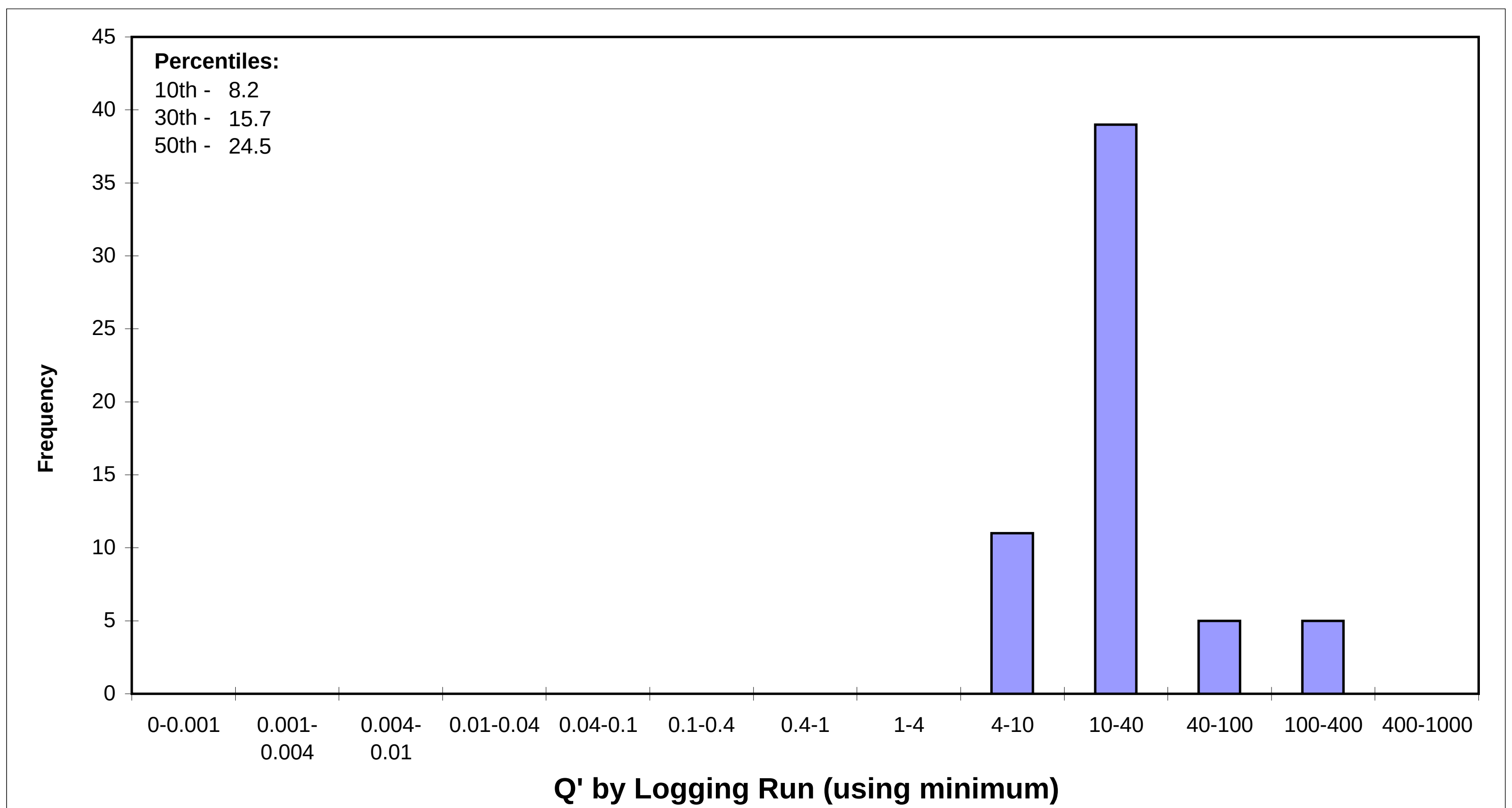
**FEASIBILITY GEOMECHANICAL PROGRAM**
**$RMR_{89}$ PARAMETER HISTOGRAMS FOR L10-273**

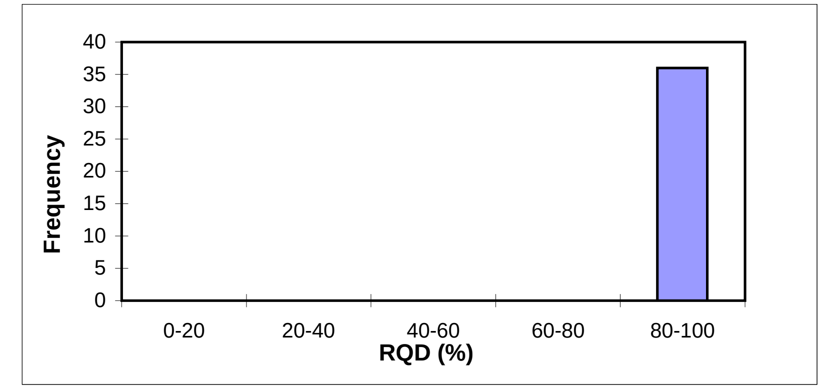
Knight Piésold CONSULTING

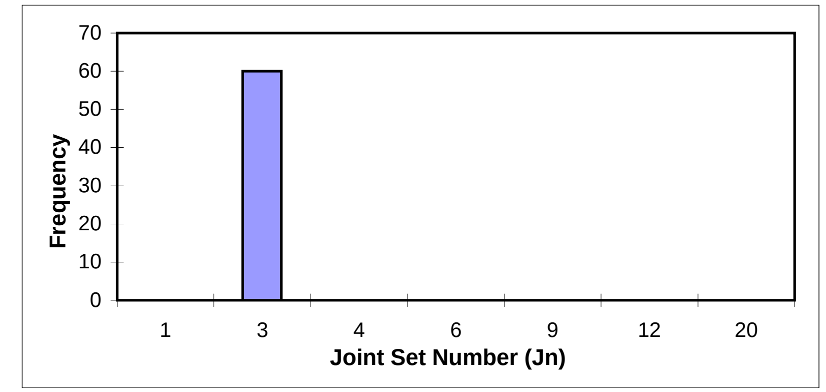
| P/A NO. | REF. NO. |
|---|---|
| NB101-390/2 | NB10-00570 |

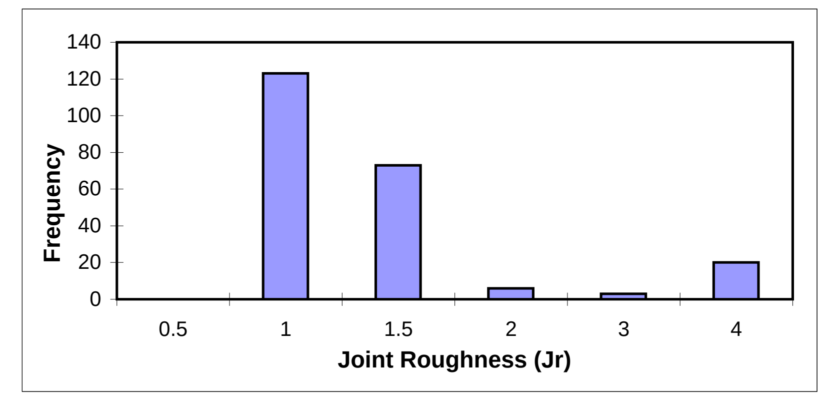
**FIGURE 8** REV 0

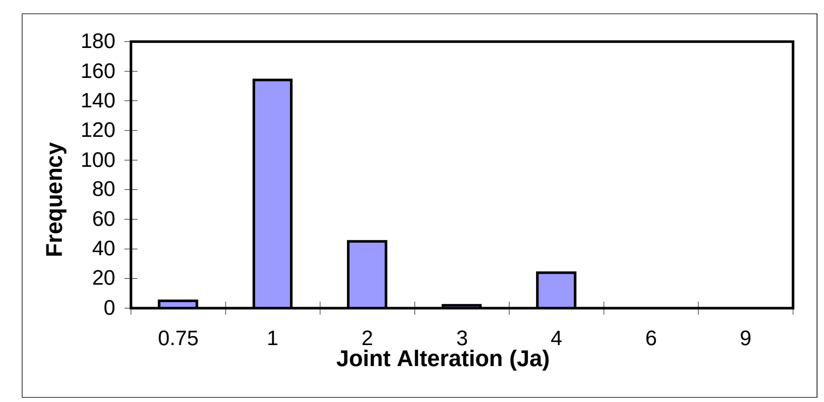



**NOTES:**

1. RQD AND Jn ARE RUN BASED PARAMETERS WHILE Jr AND Ja ARE BASED ON INDIVIDUAL DISCONTINUITIES WITHIN A LOGGING RUN.

AVALON RARE METALS INC.

THOR LAKE PROJECT

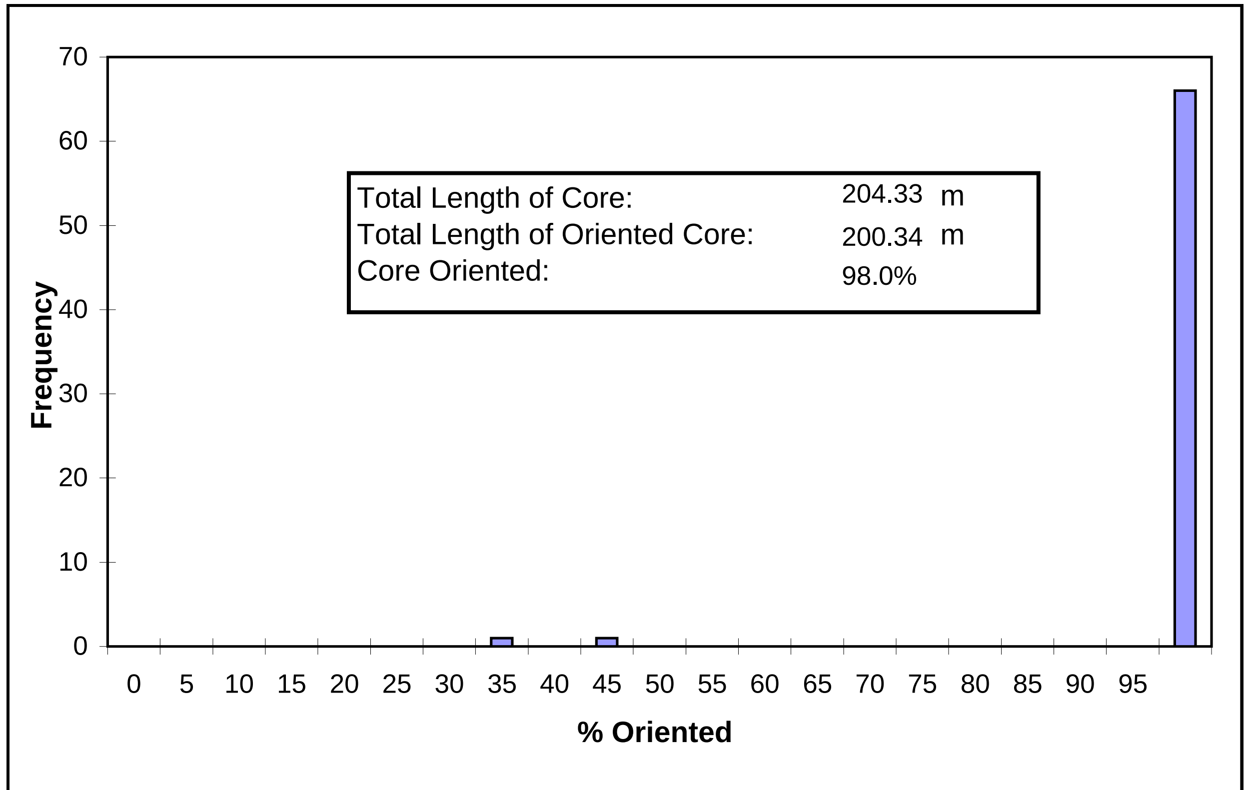
**FEASIBILITY GEOMECHANICAL PROGRAM**
**Q' PARAMETER HISTOGRAMS FOR L10-273**

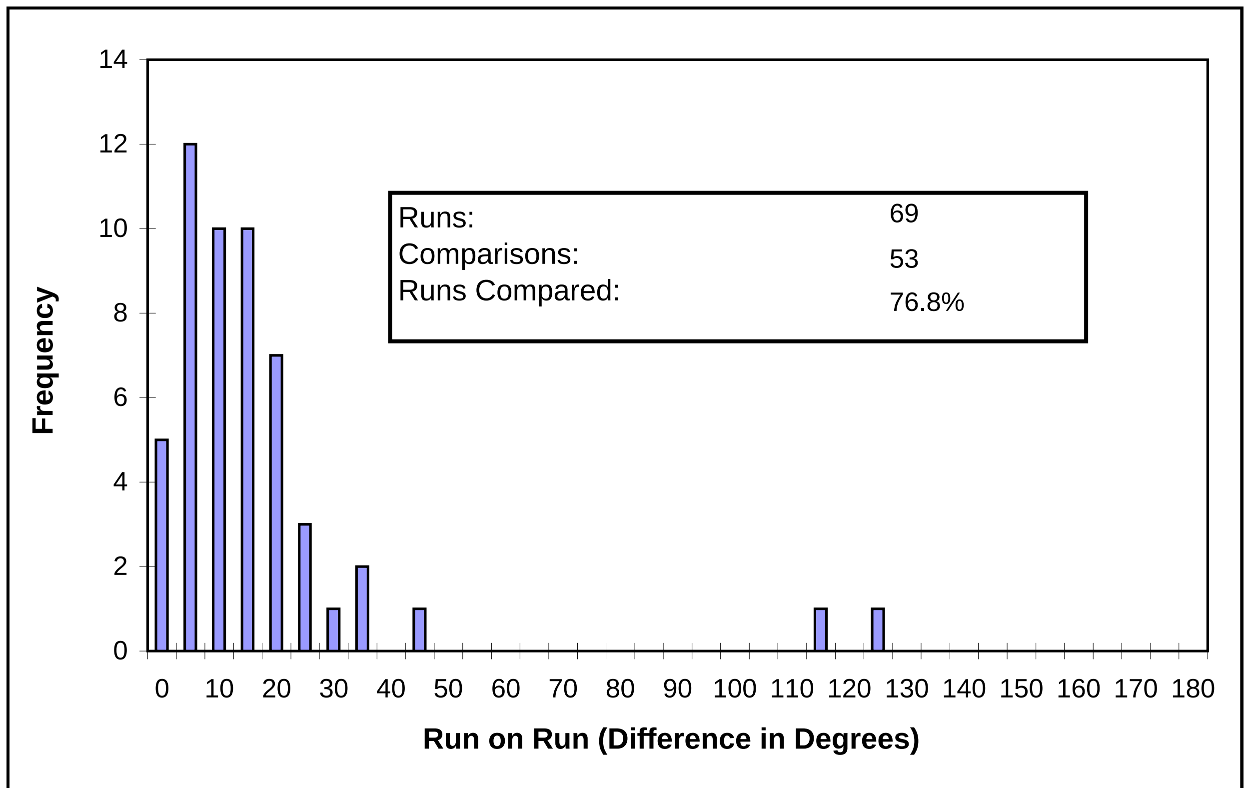
Knight Piésold CONSULTING

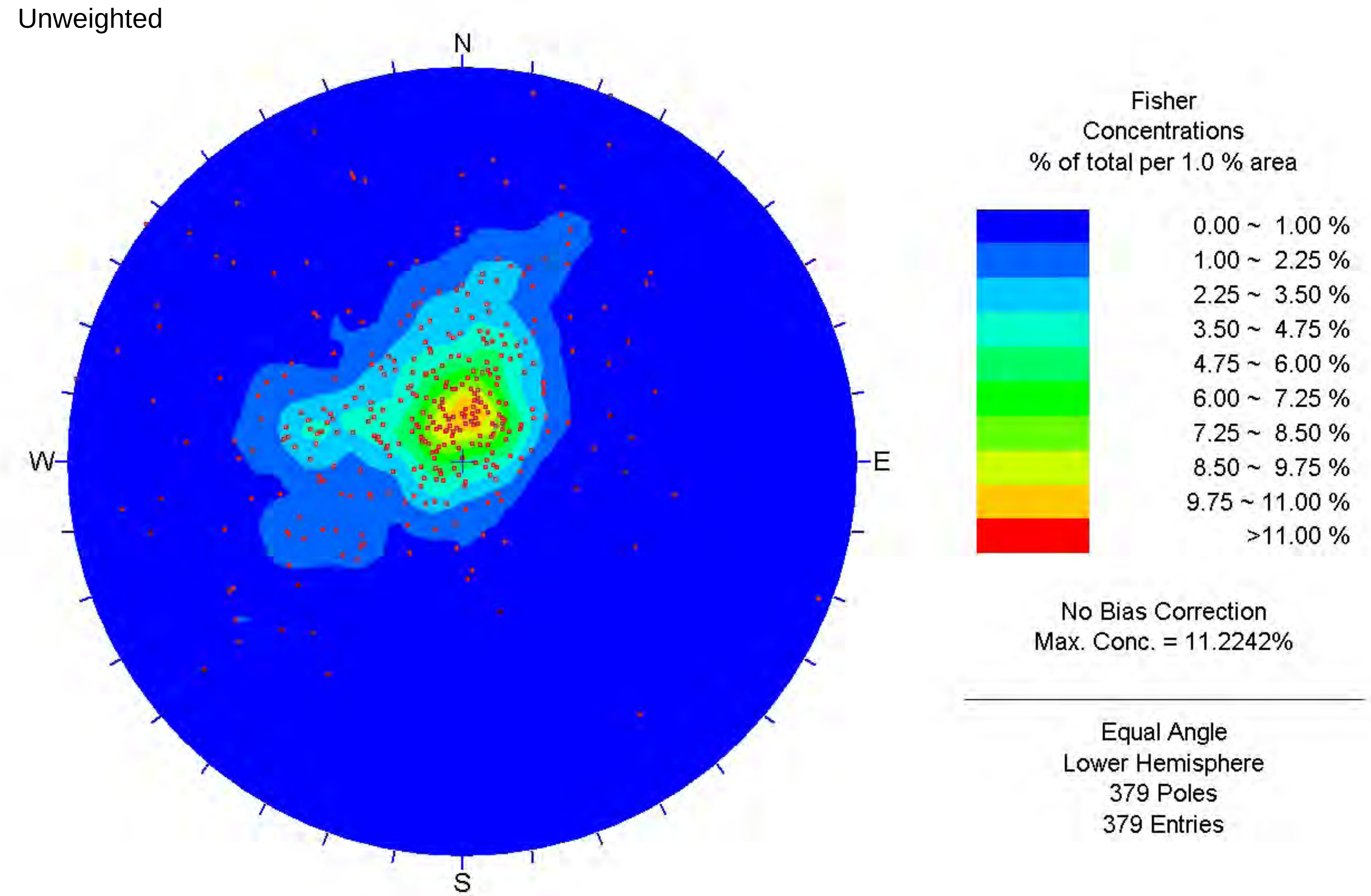
| P/A NO. | REF. NO. |
|---|---|
| NB101-390/2 | NB10-00570 |

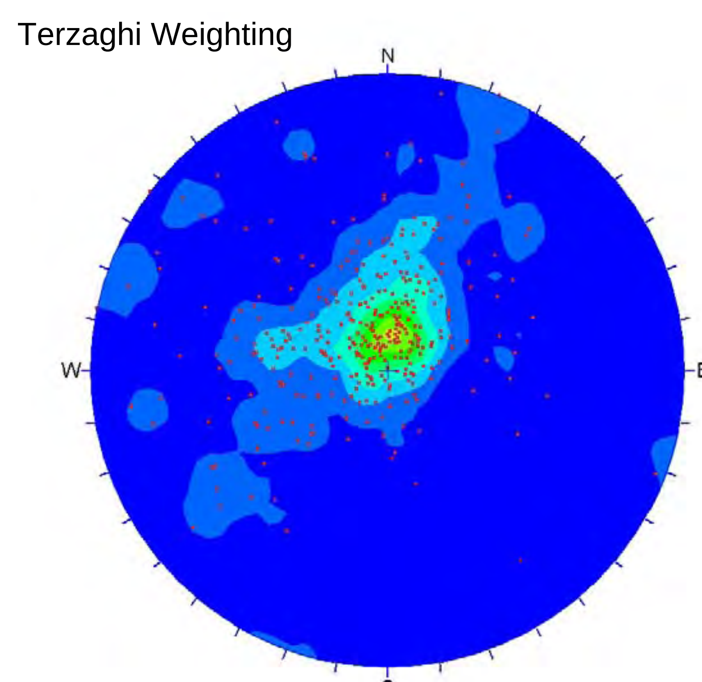
FIGURE 9 — REV 0

| REV | DATE | DESCRIPTION | PREP'D | CHK'D | APP'D |
|---|---|---|---|---|---|
| 0 | 19NOV'10 | ISSUED WITH MEMO | AJ | BDP | RAM |




**Drillhole Details**

Azimuth: 315°

Dip: -65°

Length: 299 m

AVALON RARE METALS INC.

THOR LAKE PROJECT

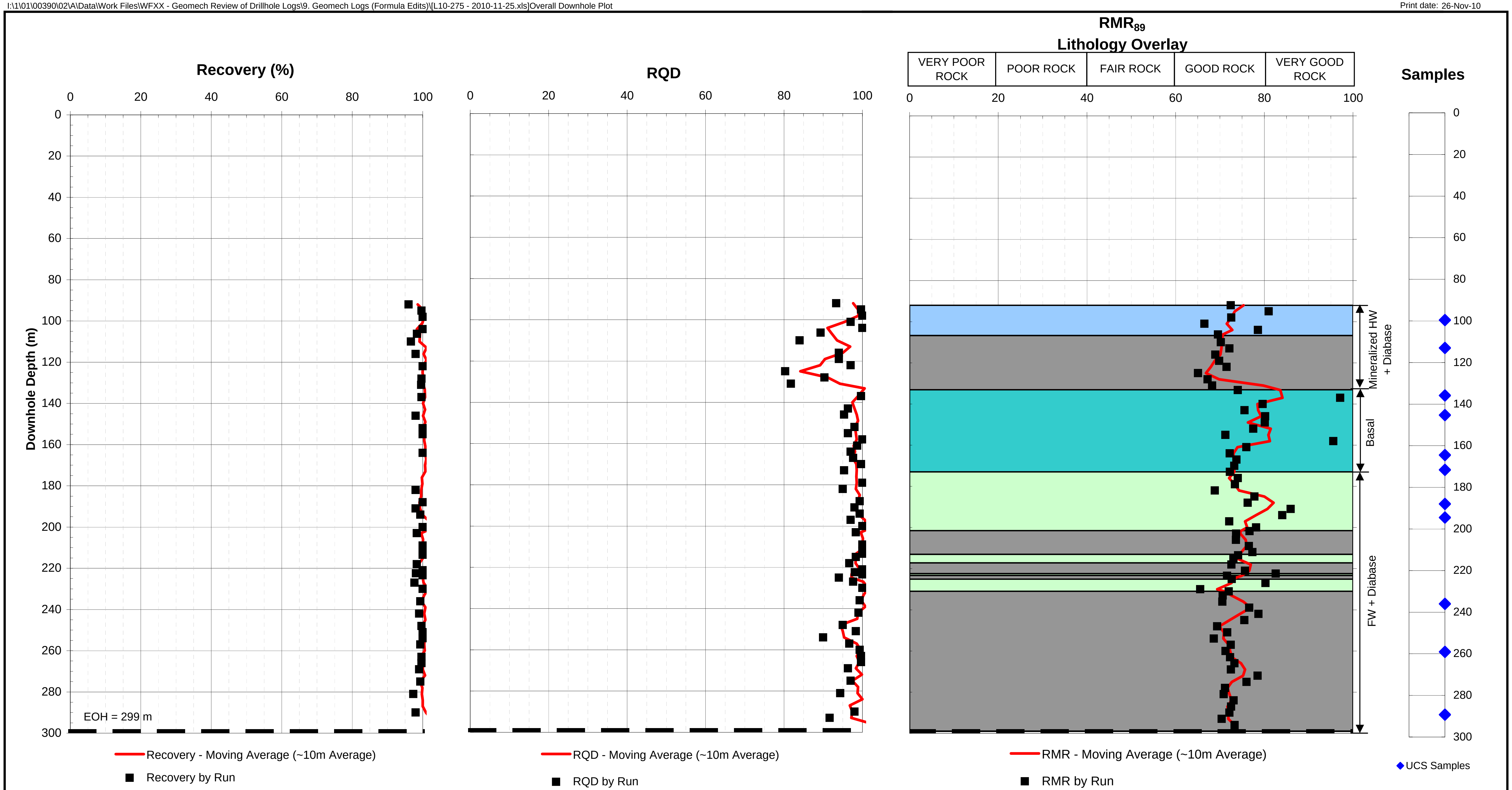
**FEASIBILITY GEOMECHANICAL PROGRAM**
**DRILLHOLE ORIENTATION RESULTS**
**L10-275**

Knight Piésold CONSULTING

| P/A NO. | REF. NO. |
|---|---|
| NB101-390/2 | NB10-00570 |

**FIGURE 10** REV 0

| 0 | 19NOV'10 | ISSUED WITH MEMO | AJ | BDP | RAM |
|---|---|---|---|---|---|
| REV | DATE | DESCRIPTION | PREP'D | CHK'D | APP'D |




**Lithology**

| | | | |
|---|---|---|---|
| Fault Zone | Diabase [90] | **Ore** | **Footwall** |
| Fault Zone Contact | **Hanging Wall** | Foyaite [75] | Foyaite II [63] |
| End of Hole (EOH) | Sodalite Cumulate [79] | Eudialyte Syenite [69] | Aegirine-Nepheline Syenite [60] |
| | Aegirine Syenite [78] | Eudialyte Cumulate [67] | Sodalite-Nepheline Syenite [55] |
| | | Aegirine Syenite II [65] | |

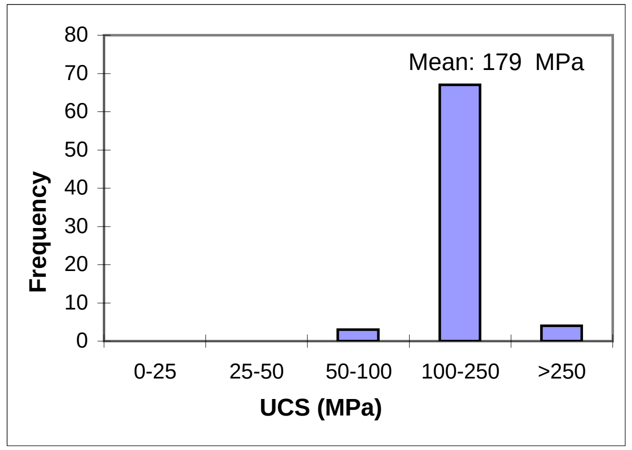
| 0 | 19NOV'10 | ISSUED WITH MEMO | AJ | BDP | RAM |
|---|---|---|---|---|---|
| REV | DATE | DESCRIPTION | PREP'D | CHK'D | APP'D |

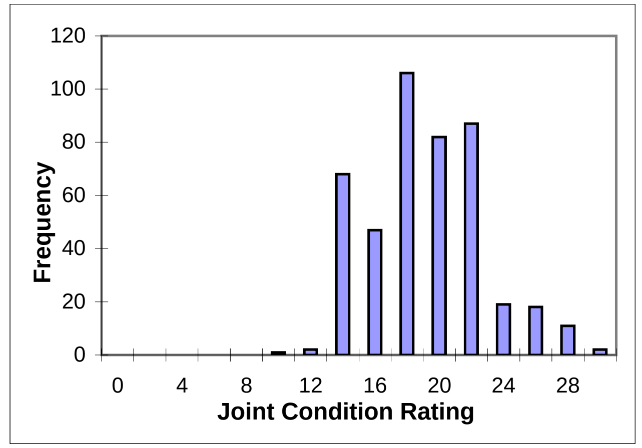
AVALON RARE METALS INC.
THOR LAKE PROJECT

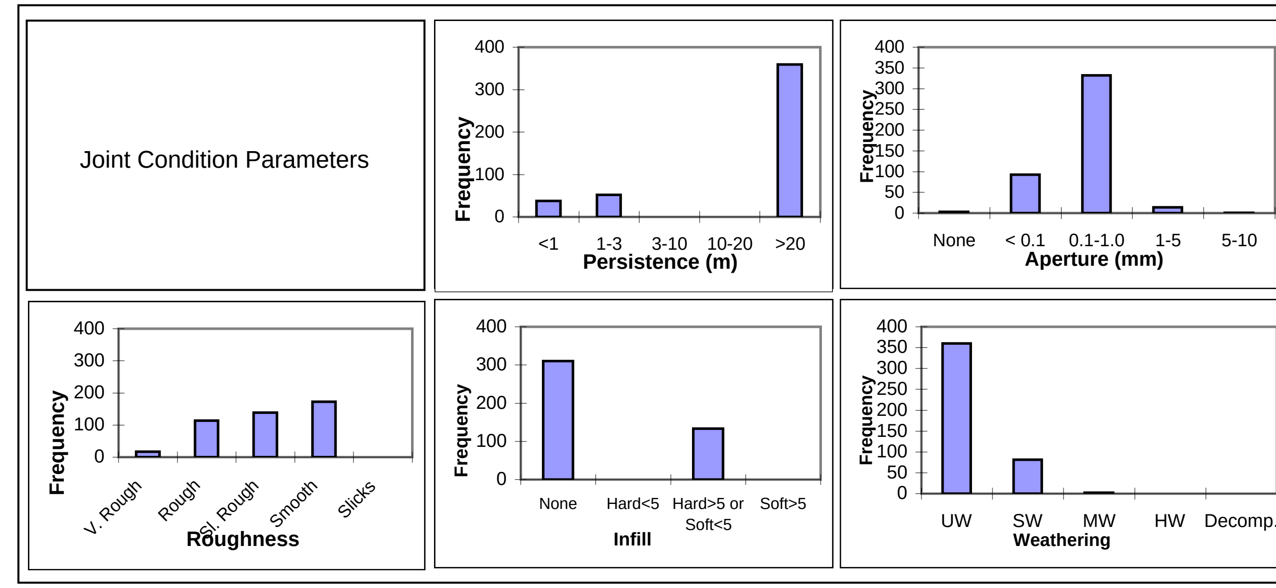
**FEASIBILITY GEOMECHANICAL PROGRAM**
**DOWNHOLE PLOTS FOR L10-275**

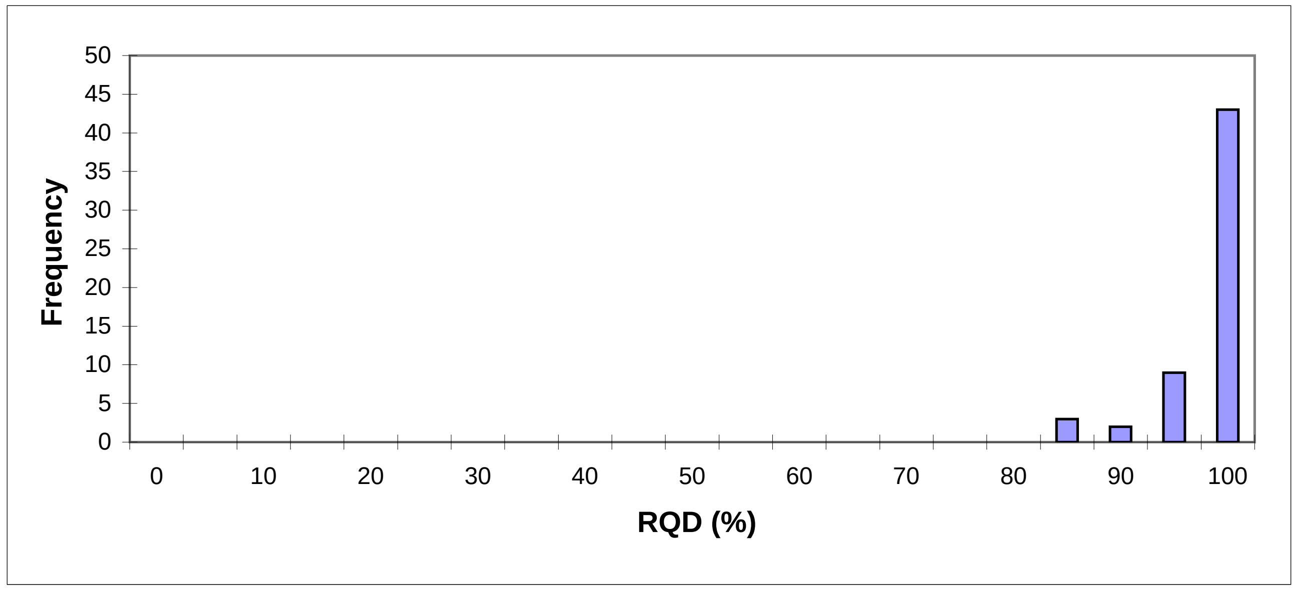
Knight Piésold CONSULTING

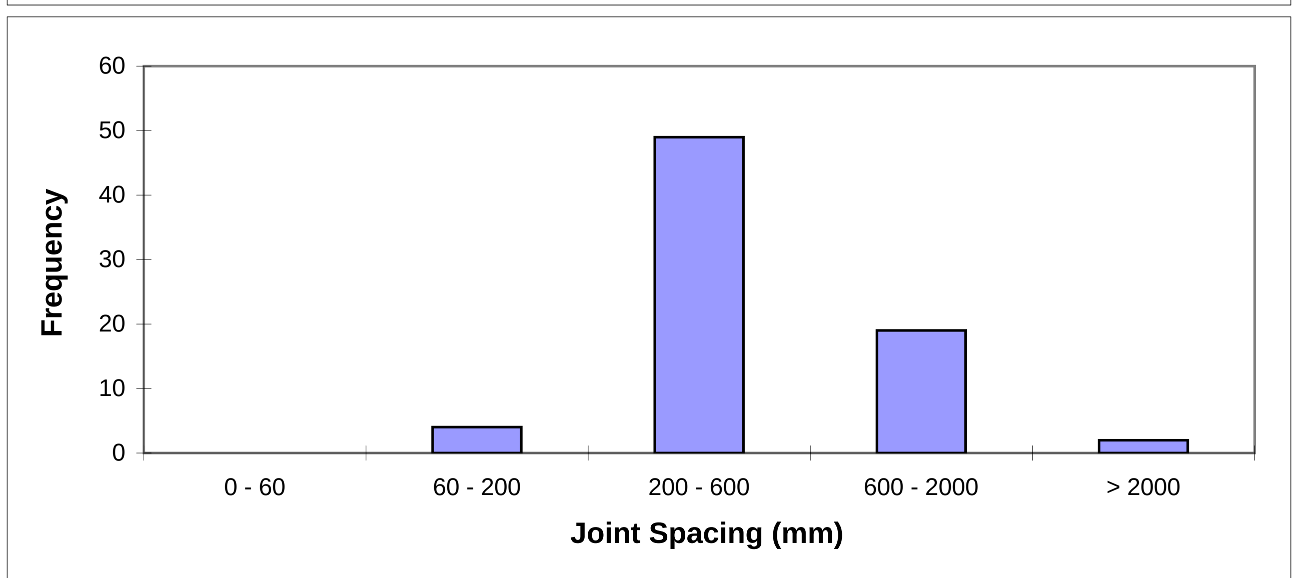
| P/A NO. | REF. NO. | |
|---|---|---|
| NB101-390/2 | NB10-00570 | |
| **FIGURE 11** | | REV 0 |

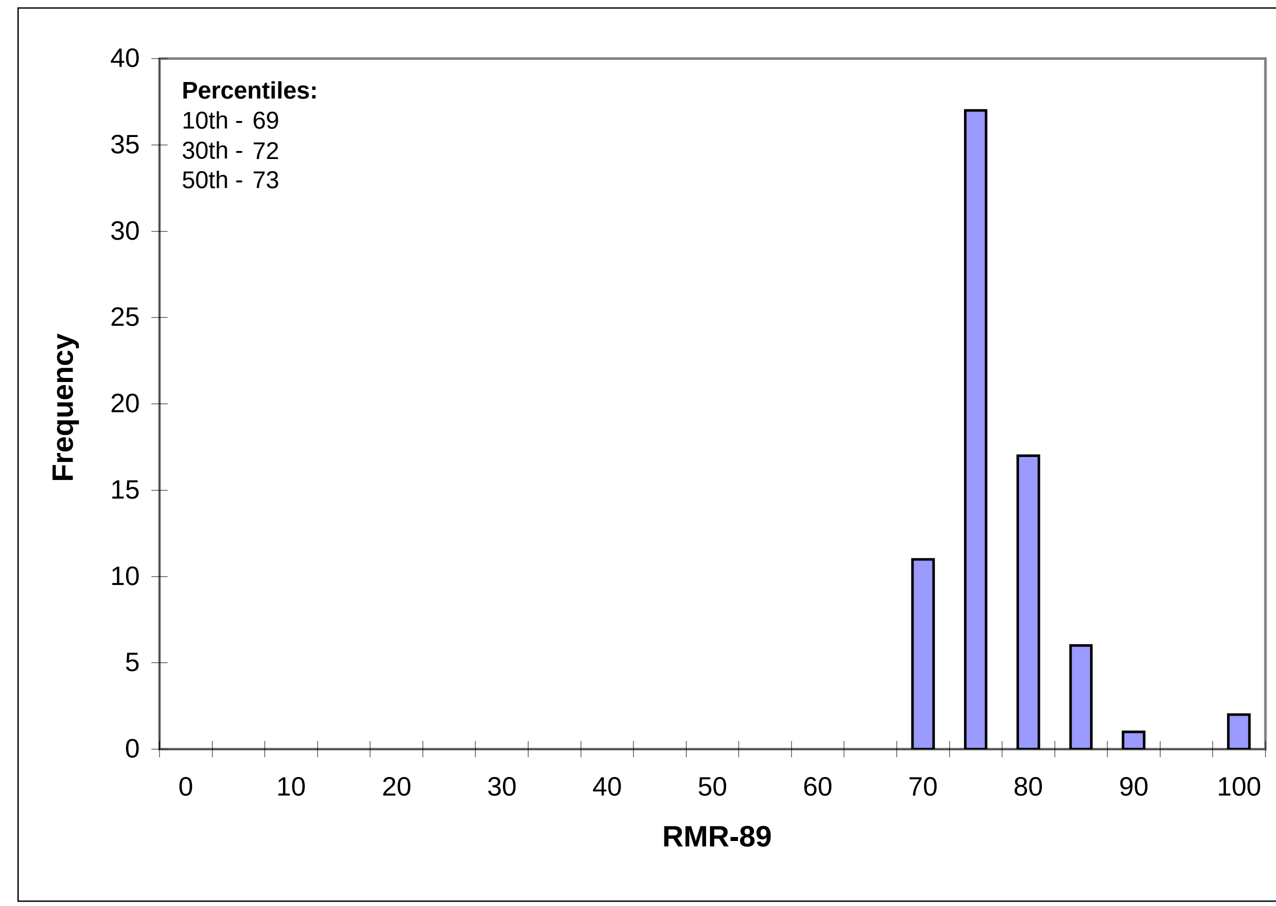



**NOTES:**

1. BINS INCLUDE PREVIOUS RANGE (I.E., BIN 60 INCLUDES VALUES FROM 55-60).
2. RQD, RMR89, JOINT SPACING, AND UCS ARE RUN BASED PARAMETERS WHILE JOINT CONDITION RATING AND PARAMETERS ARE BASED ON INDIVIDUAL DISCONTINUITIES WITHIN A LOGGING RUN.

| REV | DATE | DESCRIPTION | PREP'D | CHK'D | APP'D |
|---|---|---|---|---|---|
| 0 | 19NOV'10 | ISSUED WITH MEMO | AJ | BDP | RAM |

AVALON RARE METALS INC.

THOR LAKE PROJECT

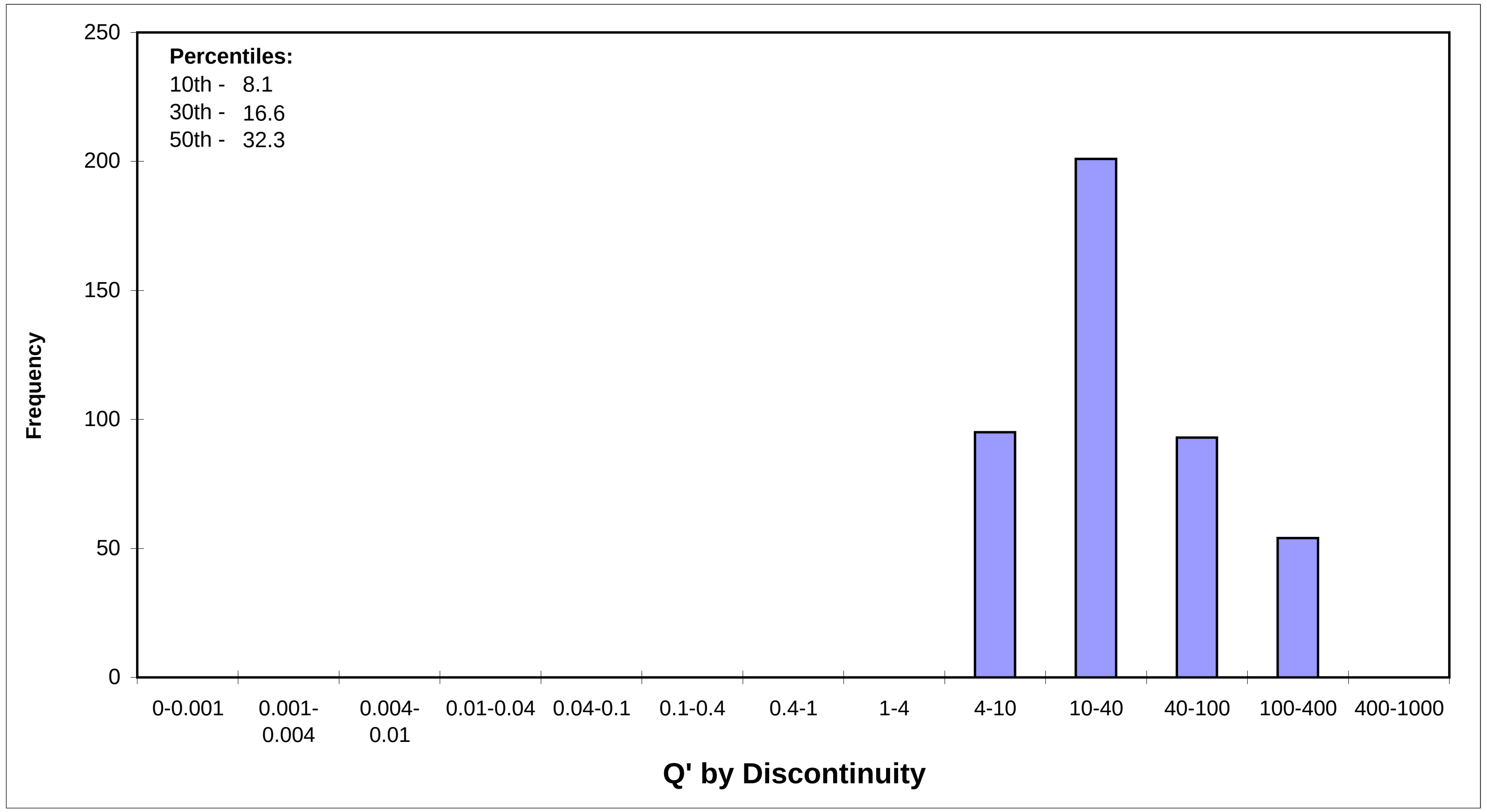
**FEASIBILITY GEOMECHANICAL PROGRAM**

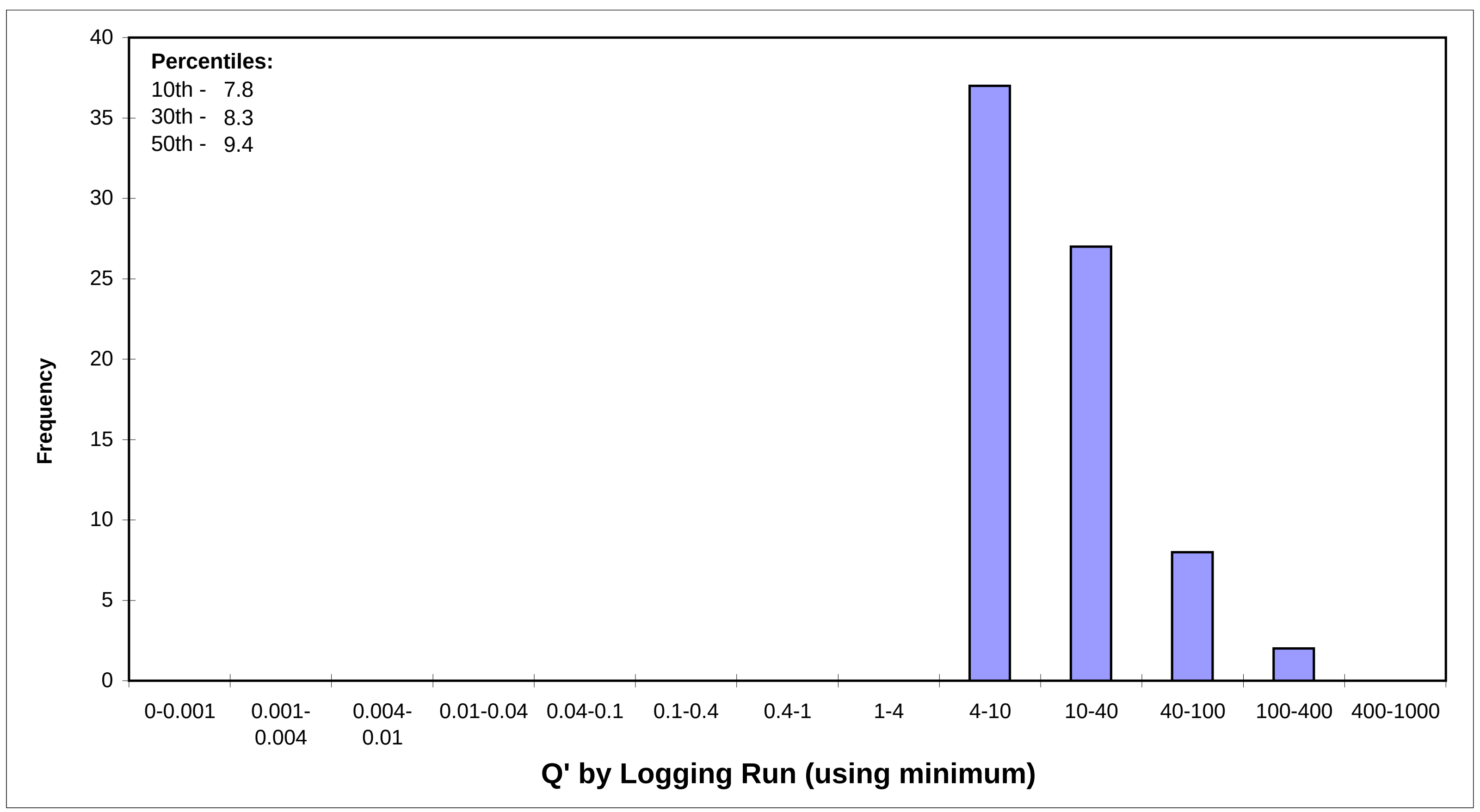
**$RMR_{89}$ PARAMETER HISTOGRAMS FOR L10-275**

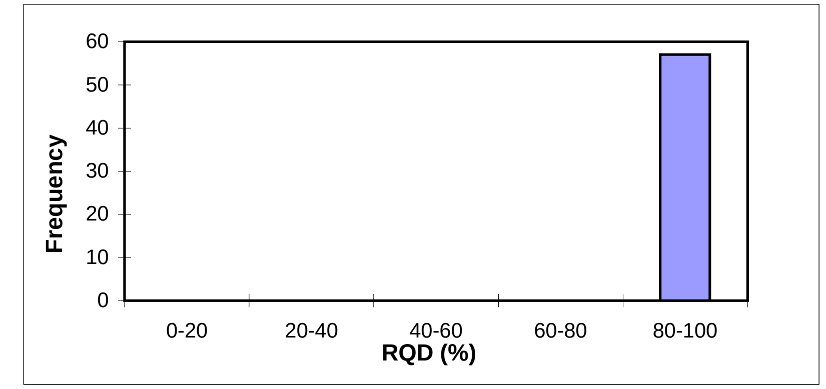
Knight Piésold CONSULTING

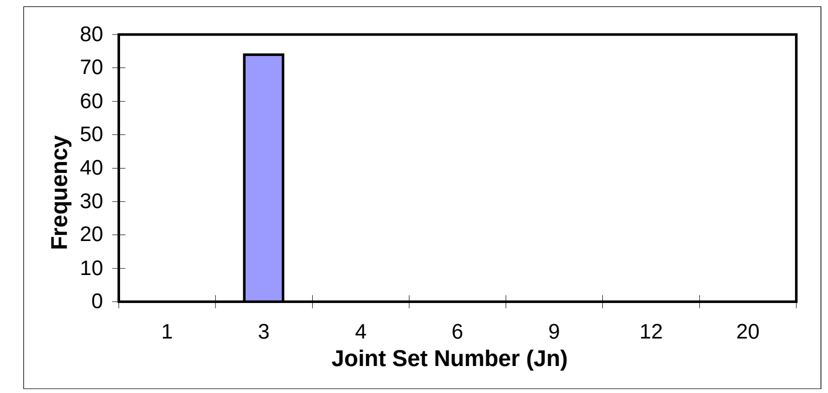
| P/A NO. | REF. NO. |
|---|---|
| NB101-390/2 | NB10-00570 |

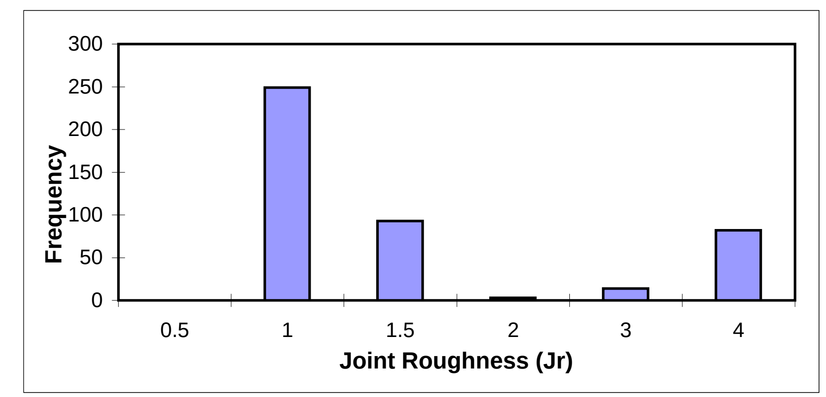
**FIGURE 12** REV 0

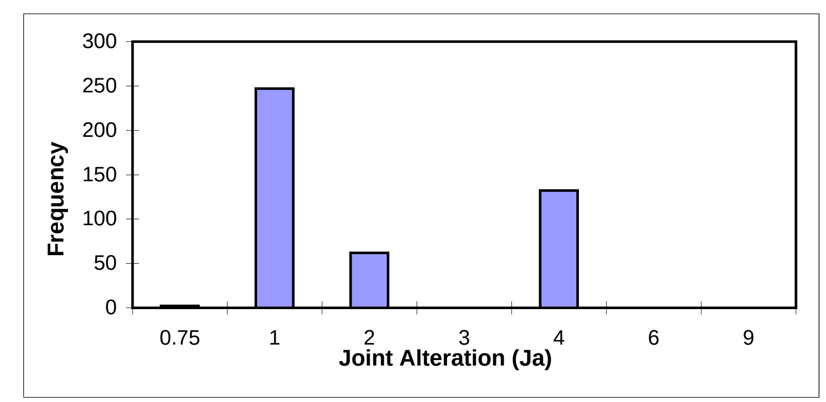



**NOTES:**
1. RQD AND Jn ARE RUN BASED PARAMETERS WHILE Jr AND Ja ARE BASED ON INDIVIDUAL DISCONTINUITIES WITHIN A LOGGING RUN.

AVALON RARE METALS INC.

THOR LAKE PROJECT

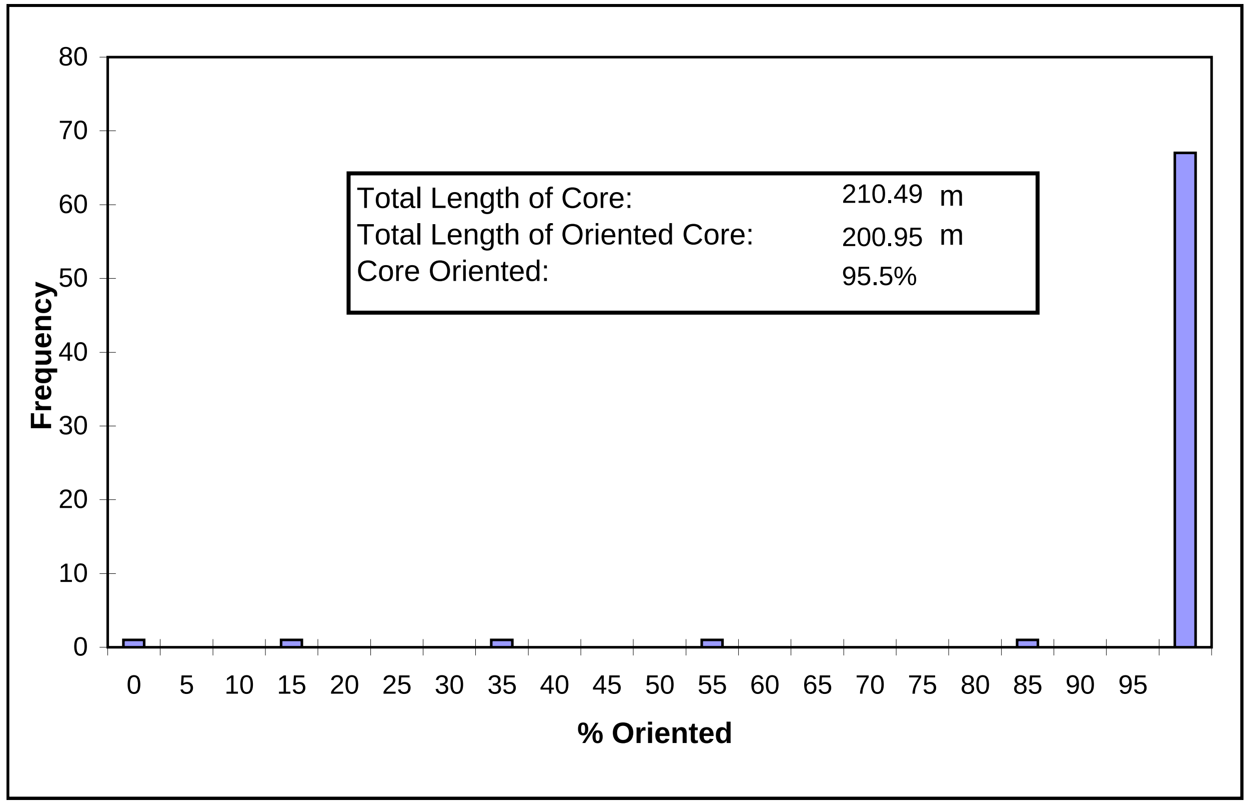
**FEASIBILITY GEOMECHANICAL PROGRAM**
**Q' PARAMETER HISTOGRAMS FOR L10-275**

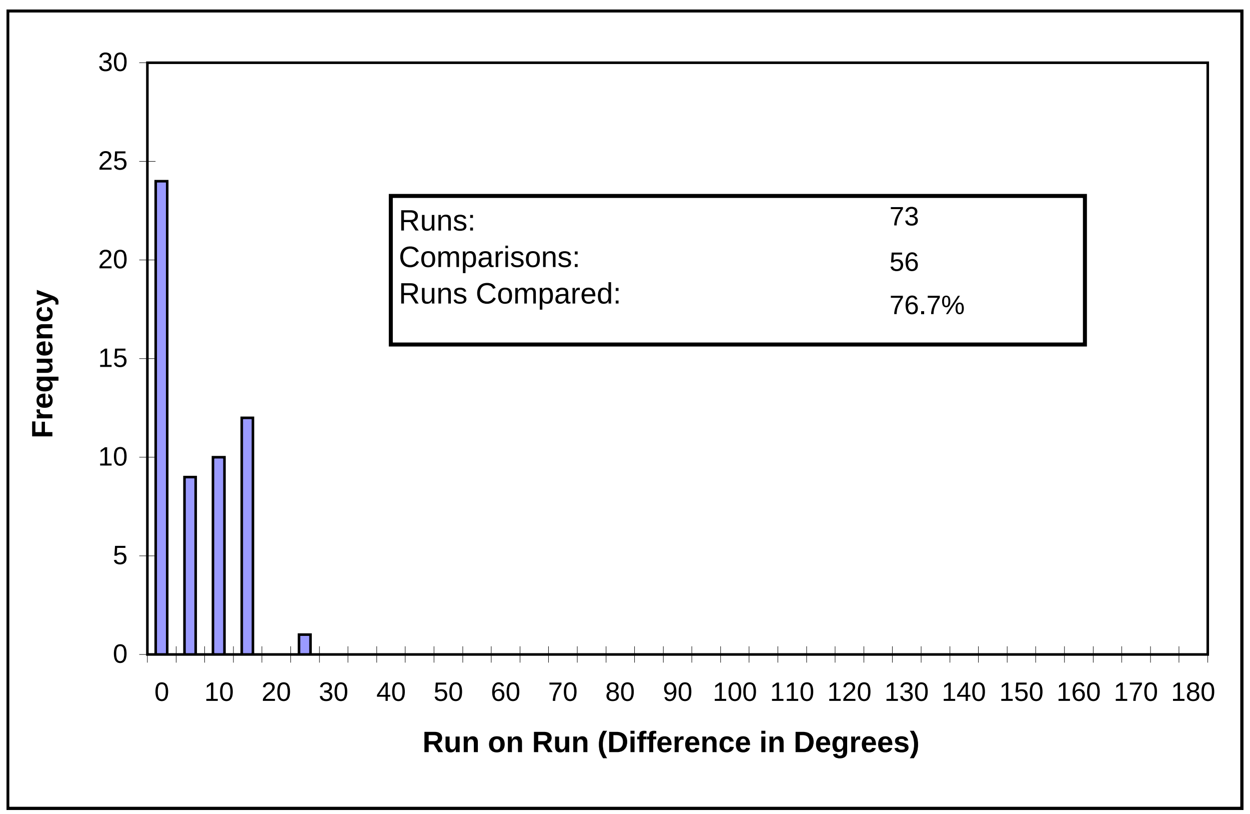
Knight Piésold CONSULTING

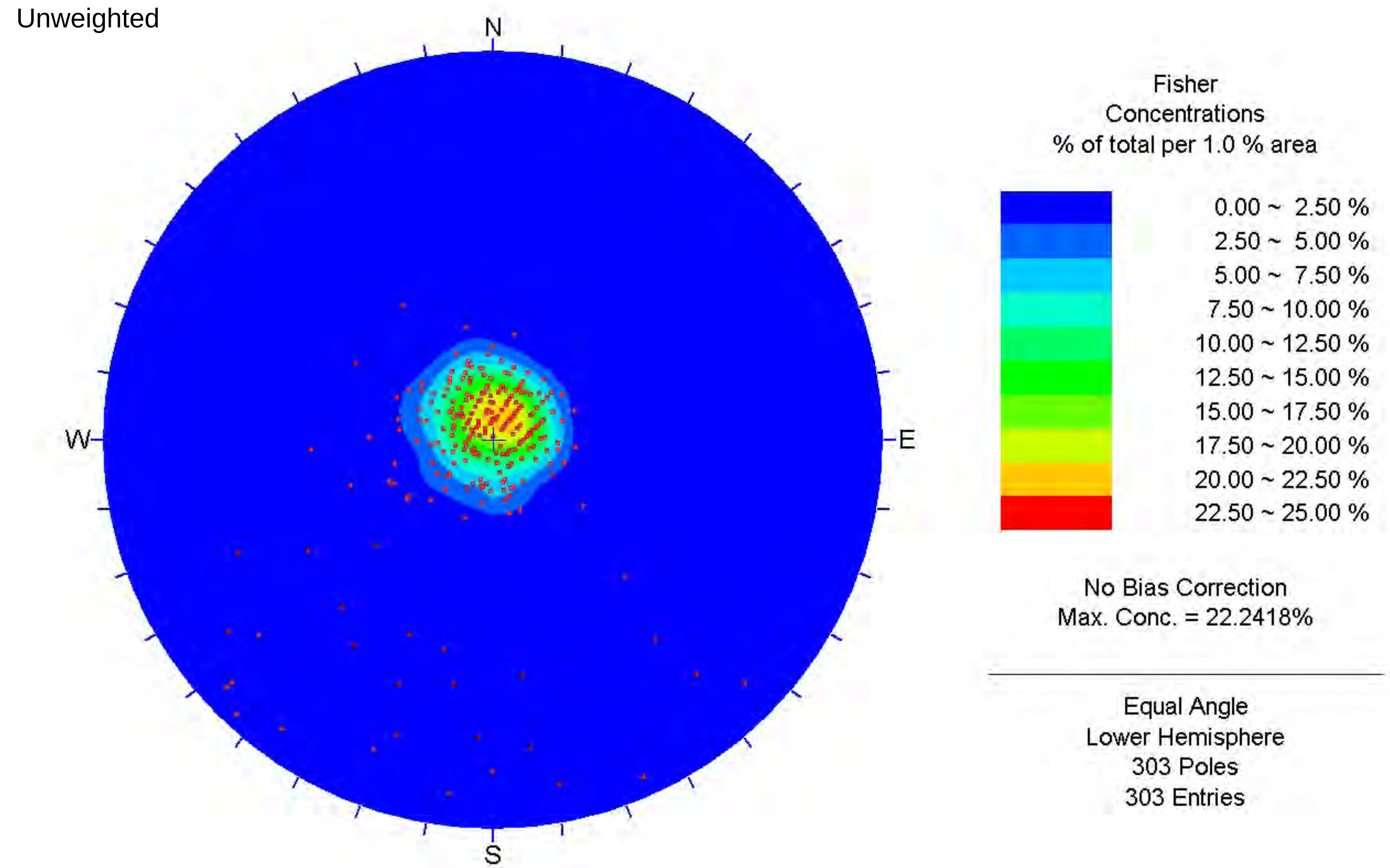
| P/A NO. | REF. NO. |
|---|---|
| NB101-390/2 | NB10-00570 |

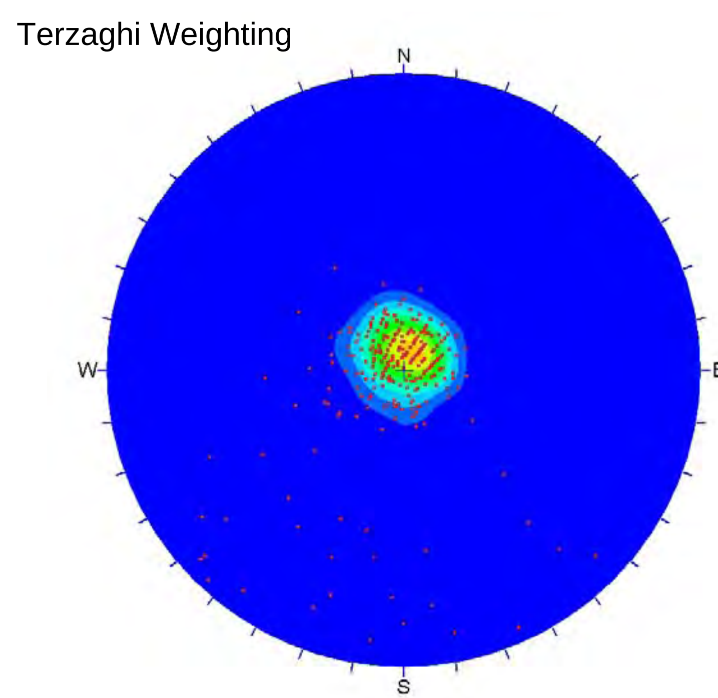
**FIGURE 13** REV 0

| | | | | | |
|---|---|---|---|---|---|
| 0 | 19NOV'10 | ISSUED WITH MEMO | AJ | BDP | RAM |
| REV | DATE | DESCRIPTION | PREP'D | CHK'D | APP'D |




**Drillhole Details**

Azimuth: 220°

Dip: -55°

Length: 251 m

AVALON RARE METALS INC.

THOR LAKE PROJECT

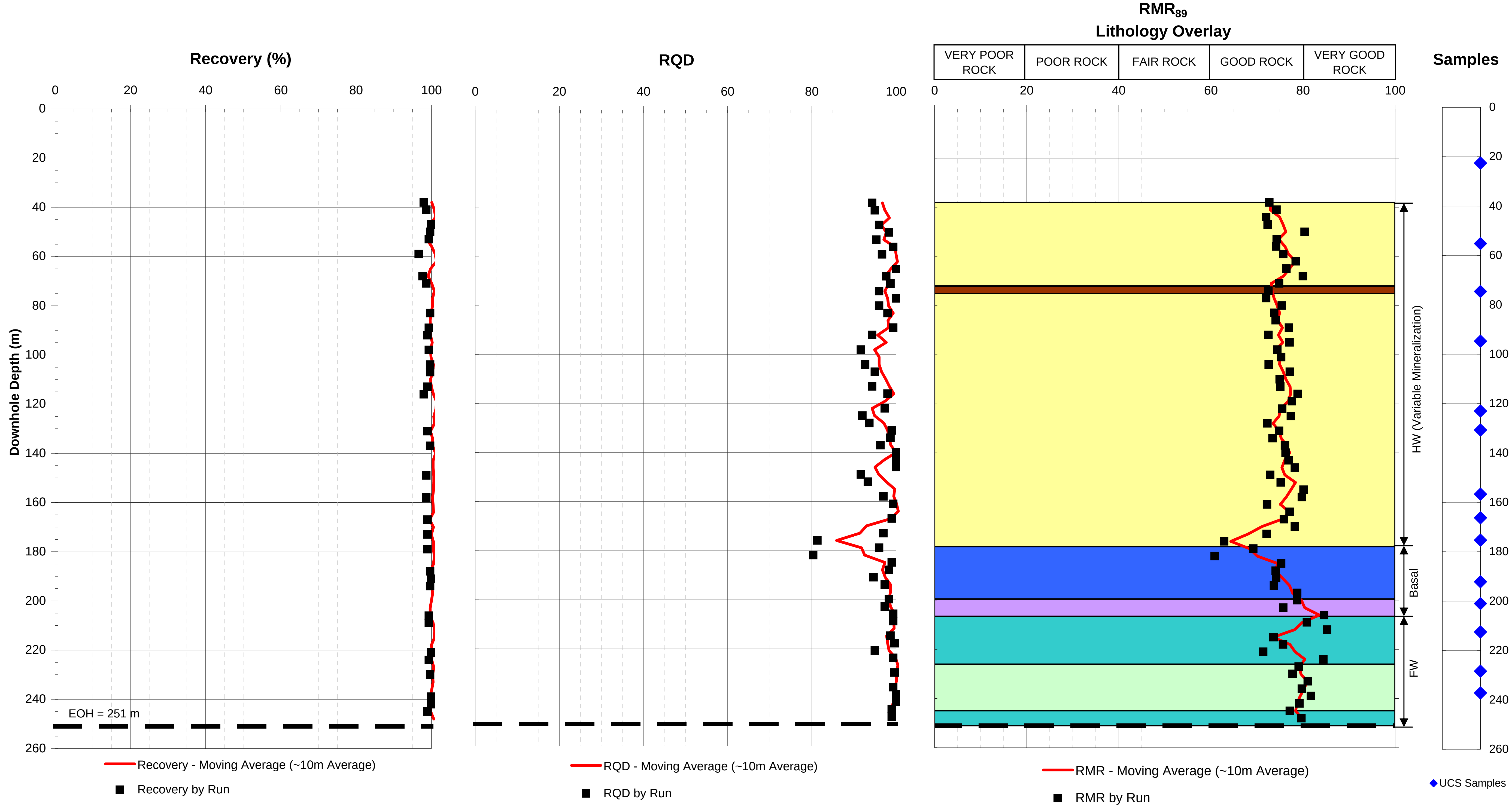
**FEASIBILITY GEOMECHANICAL PROGRAM**
**DRILLHOLE ORIENTATION RESULTS**
**L10-277**

Knight Piésold CONSULTING

| P/A NO. | REF. NO. |
|---|---|
| NB101-390/2 | NB10-00570 |

**FIGURE 14** REV 0

| | | | | | |
|---|---|---|---|---|---|
| 0 | 19NOV'10 | ISSUED WITH MEMO | AJ | BDP | RAM |
| REV | DATE | DESCRIPTION | PREP'D | CHK'D | APP'D |




**Lithology**

| | | | | |
|---|---|---|---|---|
| *Fault Zone* | *Diabase [90]* | **Ore** | **Footwall** |
| *Fault Zone Contact* | **Hanging Wall** | *Foyaite [75]* | *Foyaite II [63]* |
| *End of Hole (EOH)* | *Sodalite Cumulate [79]* | *Eudialyte Syenite [69]* | *Aegirine-Nepheline Syenite [60]* |
| | *Aegirine Syenite [78]* | *Eudialyte Cumulate [67]* | *Sodalite-Nepheline Syenite [55]* |
| | | *Aegirine Syenite II [65]* | |

AVALON RARE METALS INC.

THOR LAKE PROJECT

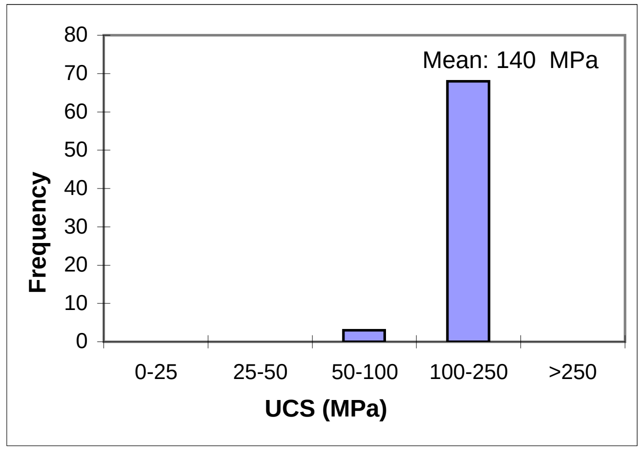
**FEASIBILITY GEOMECHANICAL PROGRAM**
**DOWNHOLE PLOTS FOR L10-277**

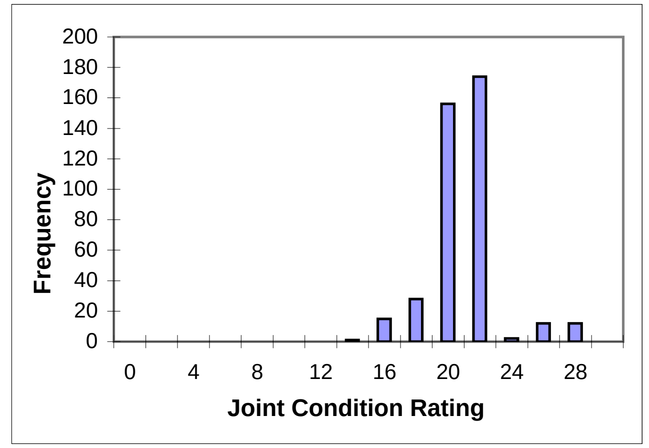
Knight Piésold CONSULTING

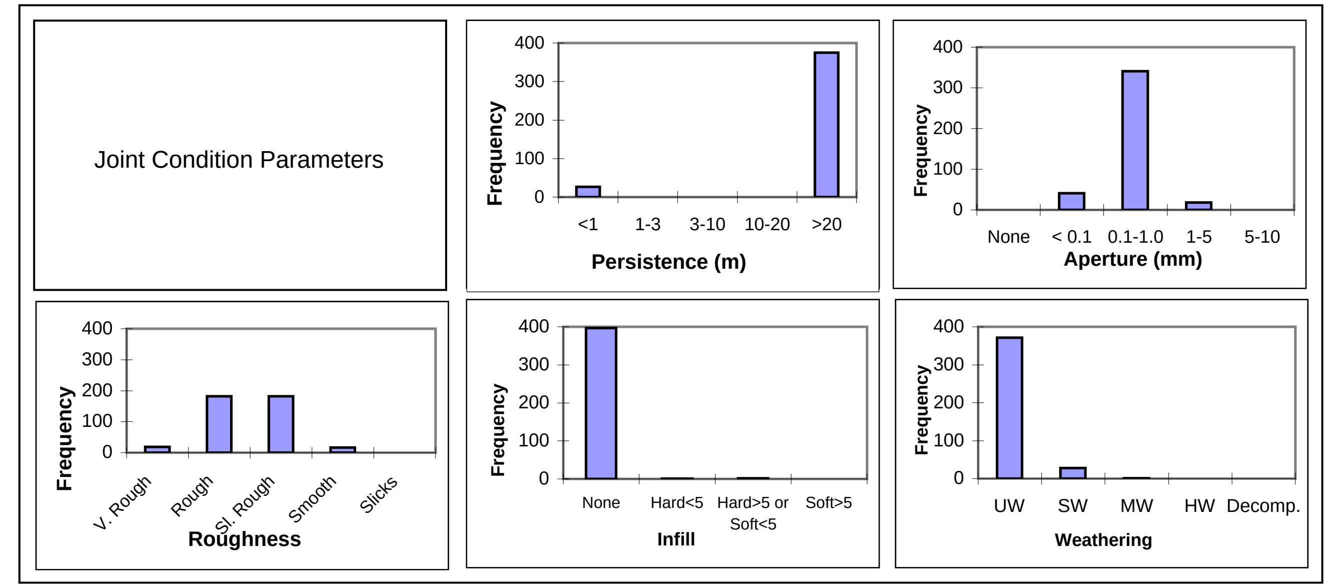
| P/A NO. | REF. NO. |
|---|---|
| NB101-390/2 | NB10-00570 |

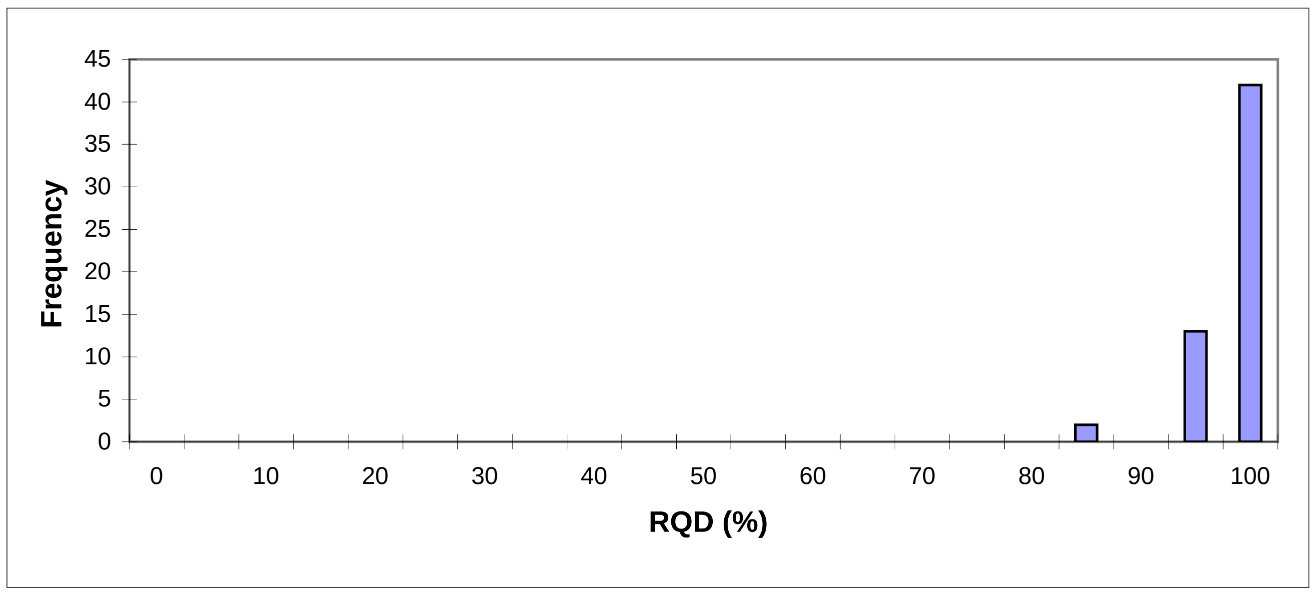
**FIGURE 15** REV 0

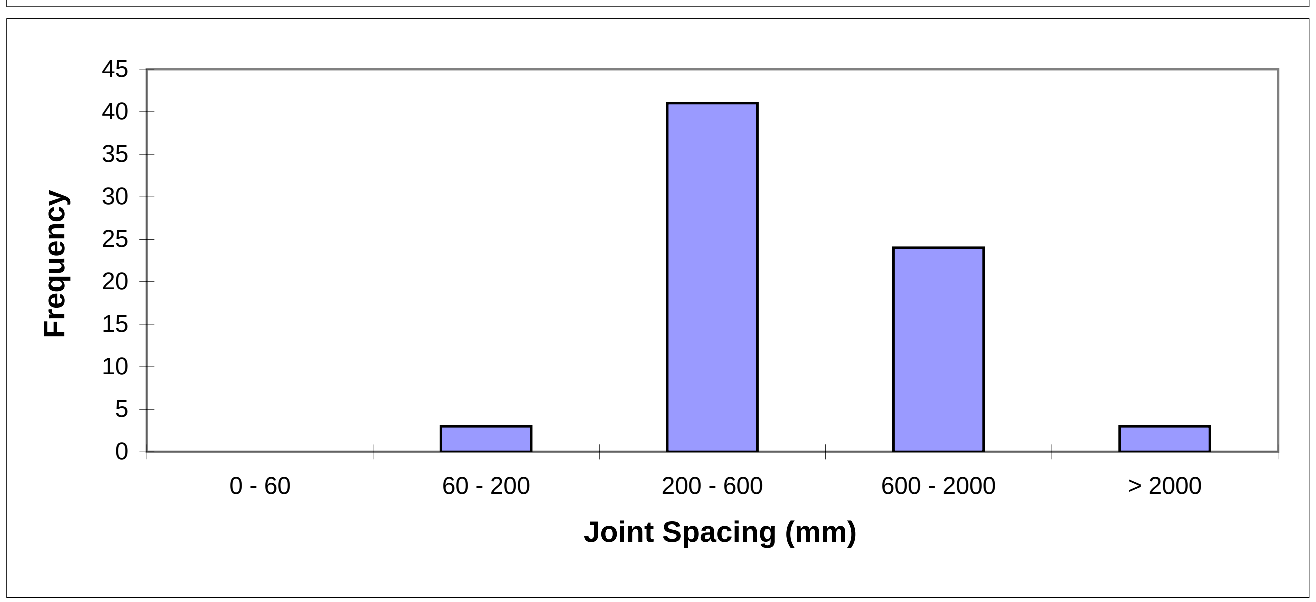
| REV | DATE | DESCRIPTION | PREP'D | CHK'D | APP'D |
|---|---|---|---|---|---|
| 0 | 19NOV'10 | ISSUED WITH MEMO | AJ | BDP | RAM |

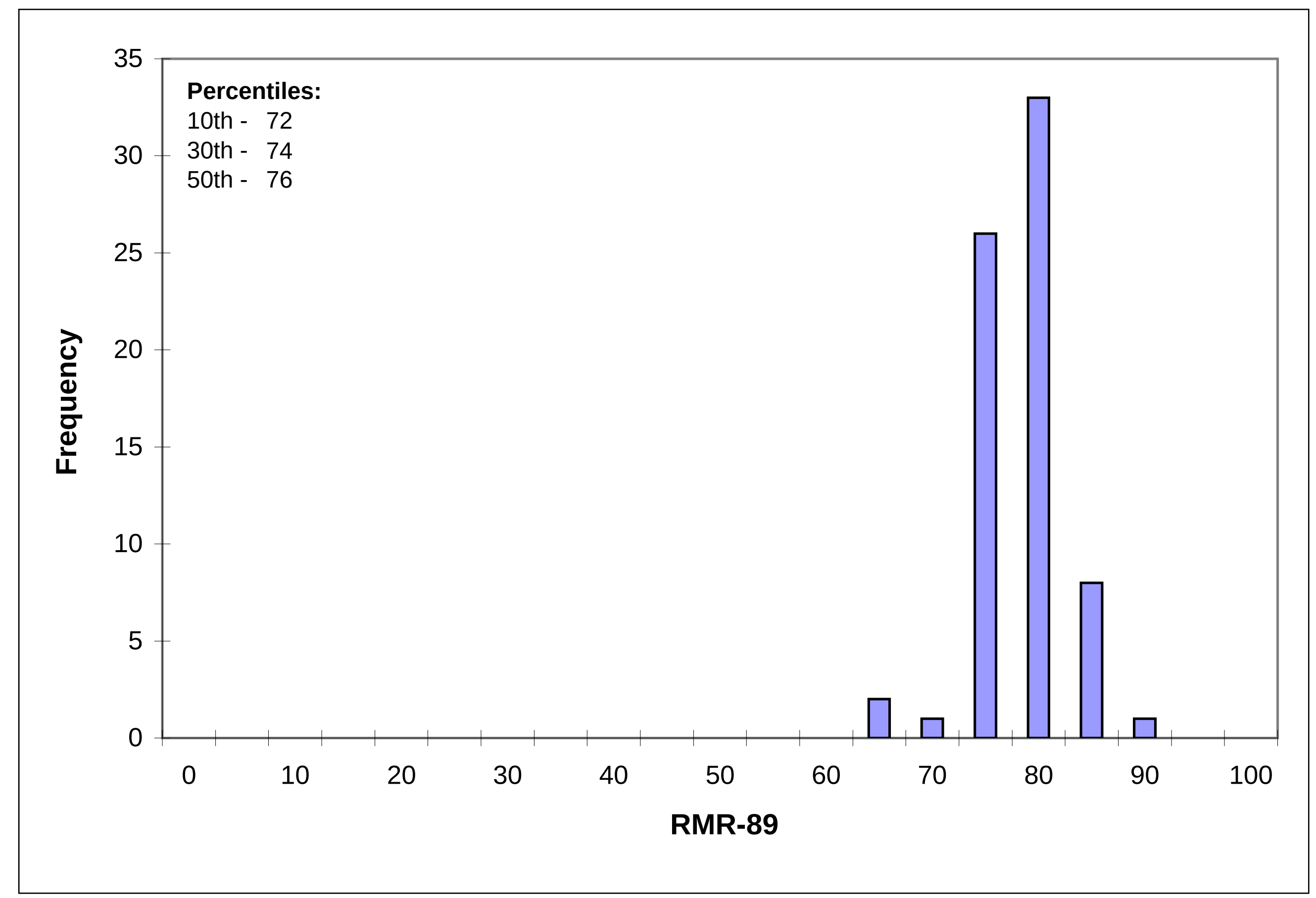



**NOTES:**
1. BINS INCLUDE PREVIOUS RANGE (I.E., BIN 60 INCLUDES VALUES FROM 55-60).
2. RQD, RMR89, JOINT SPACING, AND UCS ARE RUN BASED PARAMETERS WHILE JOINT CONDITION RATING AND PARAMETERS ARE BASED ON INDIVIDUAL DISCONTINUITIES WITHIN A LOGGING RUN.

AVALON RARE METALS INC.

THOR LAKE PROJECT

**FEASIBILITY GEOMECHANICAL PROGRAM**
**$RMR_{89}$ PARAMETER HISTOGRAMS FOR L10-277**

Knight Piésold CONSULTING

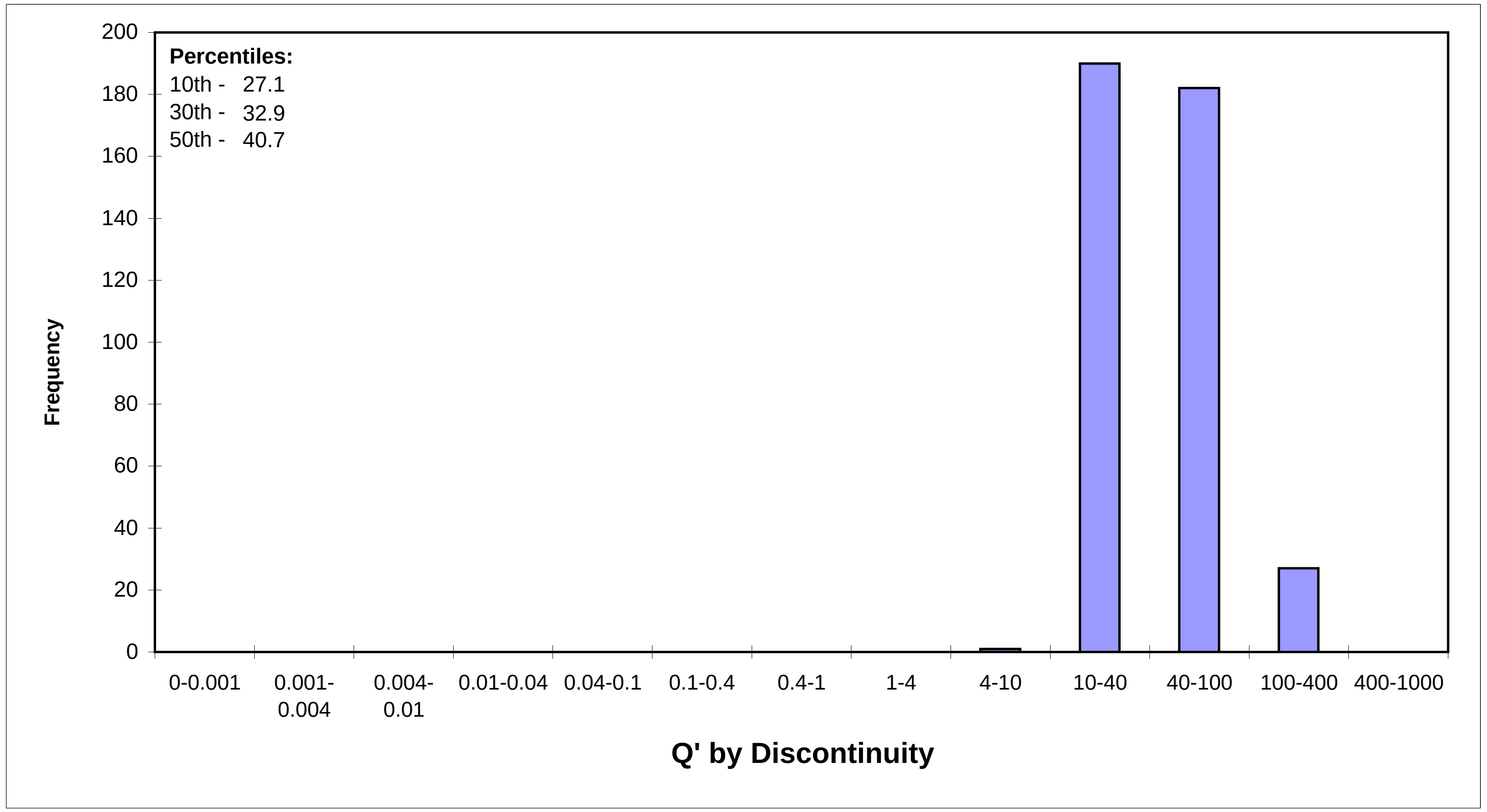
P/A NO. NB101-390/2

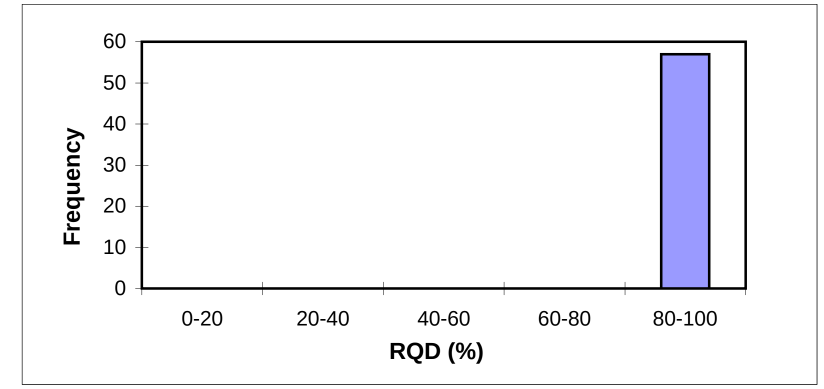
REF. NO. NB10-00570

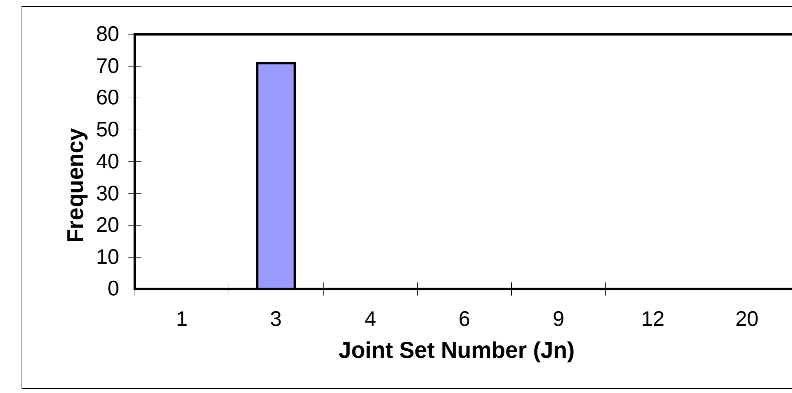
**FIGURE 16**

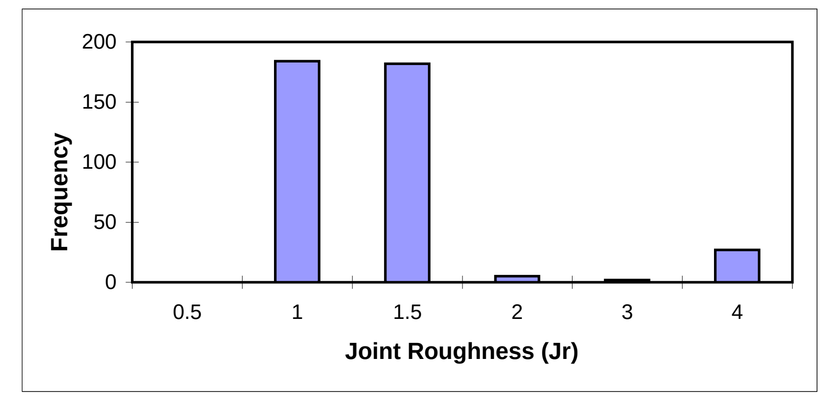
REV 0

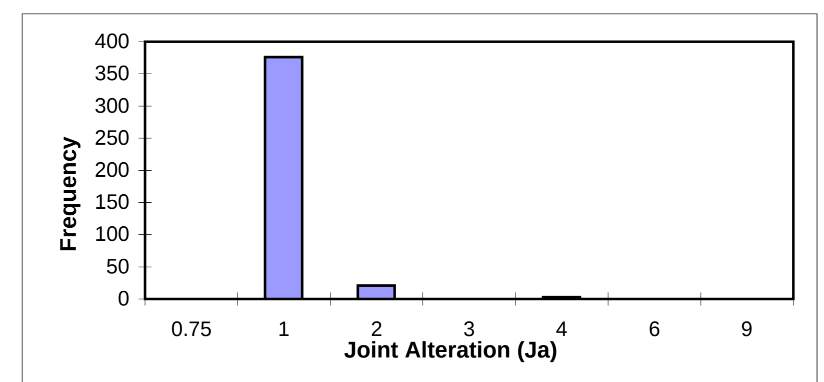
| 0 | 20OCT'10 | ISSUED WITH MEMO | AJ | BDP | RAM |
|---|---|---|---|---|---|
| REV | DATE | DESCRIPTION | PREP'D | CHK'D | APP'D |

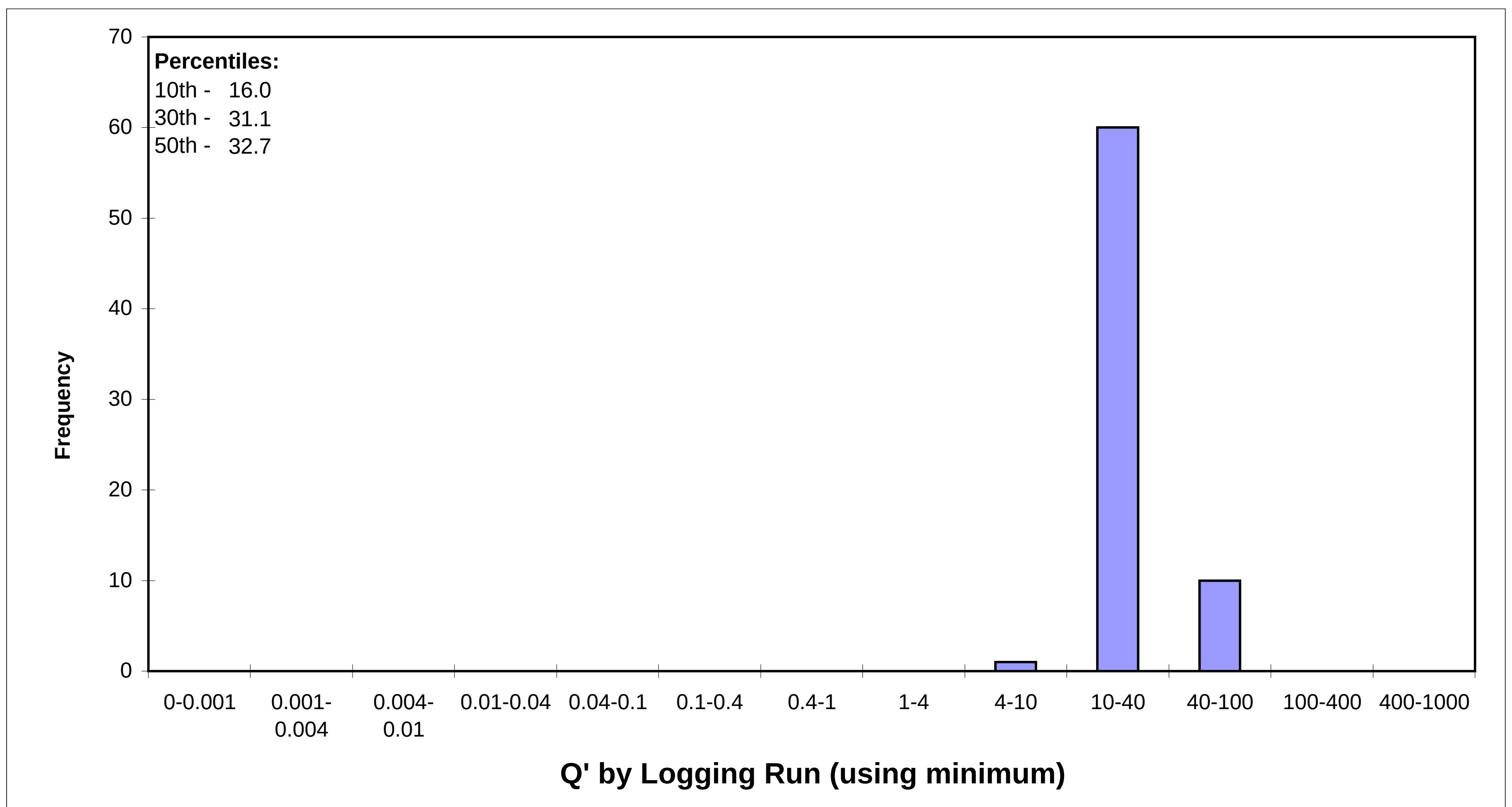



**NOTES:**
1. RQD AND Jn ARE RUN BASED PARAMETERS WHILE Jr AND Ja ARE BASED ON INDIVIDUAL DISCONTINUITIES WITHIN A LOGGING RUN.

AVALON RARE METALS INC.

THOR LAKE PROJECT

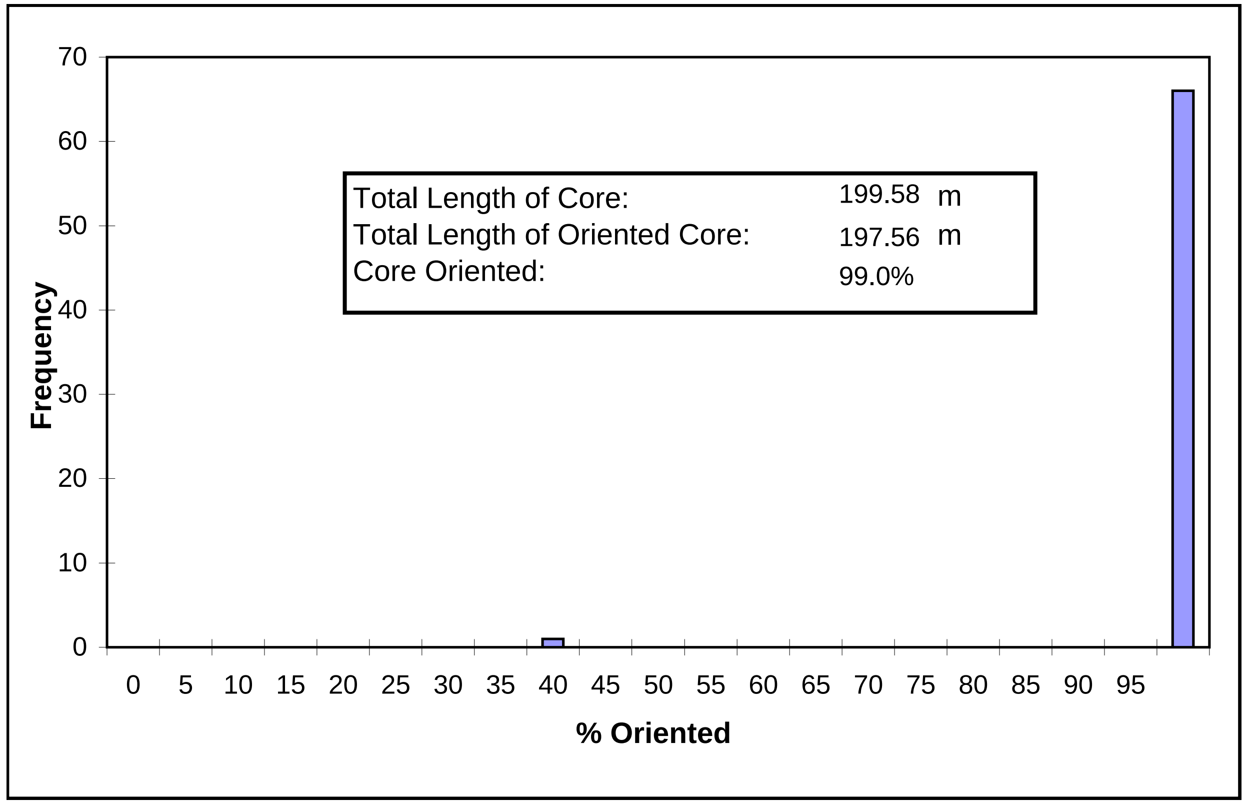
**FEASIBILITY GEOMECHANICAL PROGRAM**
**Q' PARAMETER HISTOGRAMS FOR L10-277**

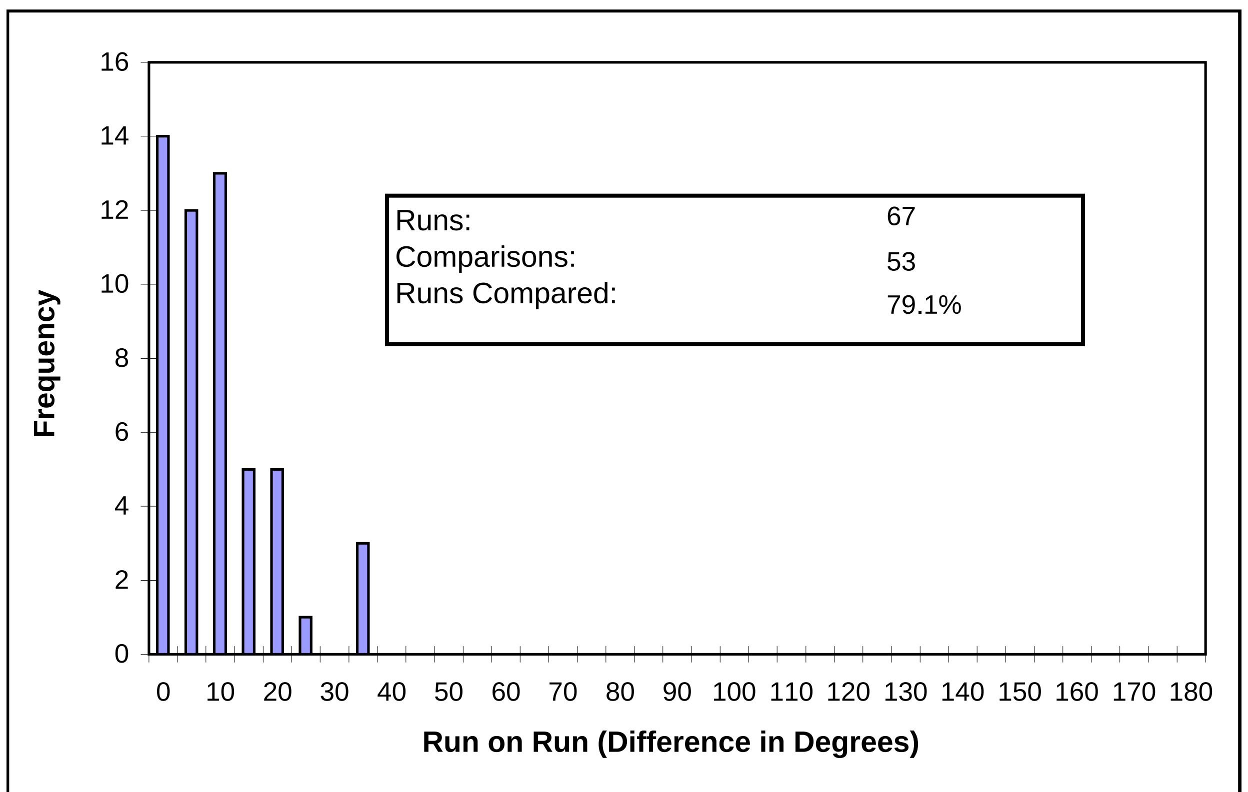
Knight Piésold CONSULTING

| P/A NO. | REF. NO. |
|---|---|
| NB101-390/2 | NB10-00570 |

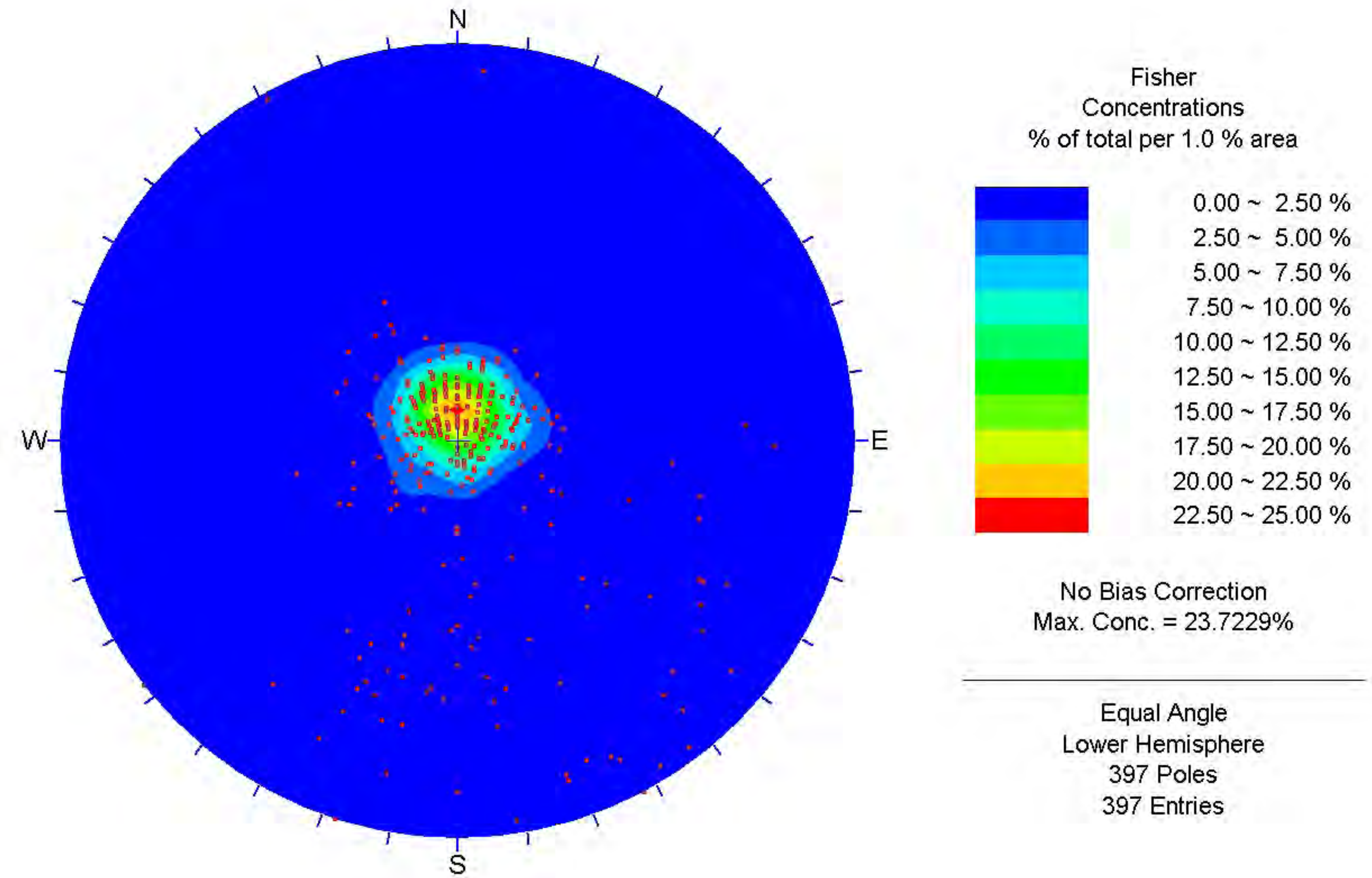
**FIGURE 17** REV 0

| REV | DATE | DESCRIPTION | PREP'D | CHK'D | APP'D |
|---|---|---|---|---|---|
| 0 | 19NOV'10 | ISSUED WITH MEMO | AJ | BDP | RAM |

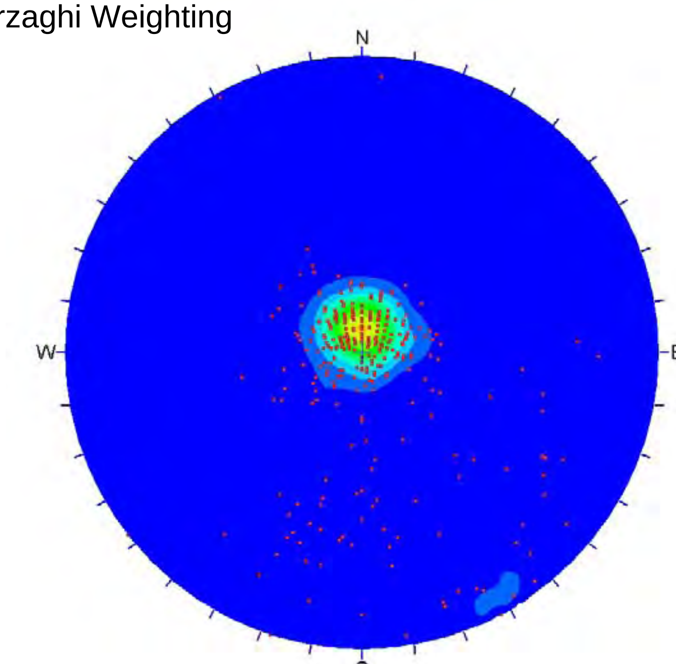



Unweighted




Terzaghi Weighting




**Drillhole Details**

Azimuth: 180°

Dip: -65°

Length: 250 m

| REV | DATE | DESCRIPTION | PREP'D | CHK'D | APP'D |
|---|---|---|---|---|---|
| 0 | 19NOV'10 | ISSUED WITH MEMO | AJ | BDP | RAM |

AVALON RARE METALS INC.

THOR LAKE PROJECT

**FEASIBILITY GEOMECHANICAL PROGRAM**
**DRILLHOLE ORIENTATION RESULTS**
**L10-279**

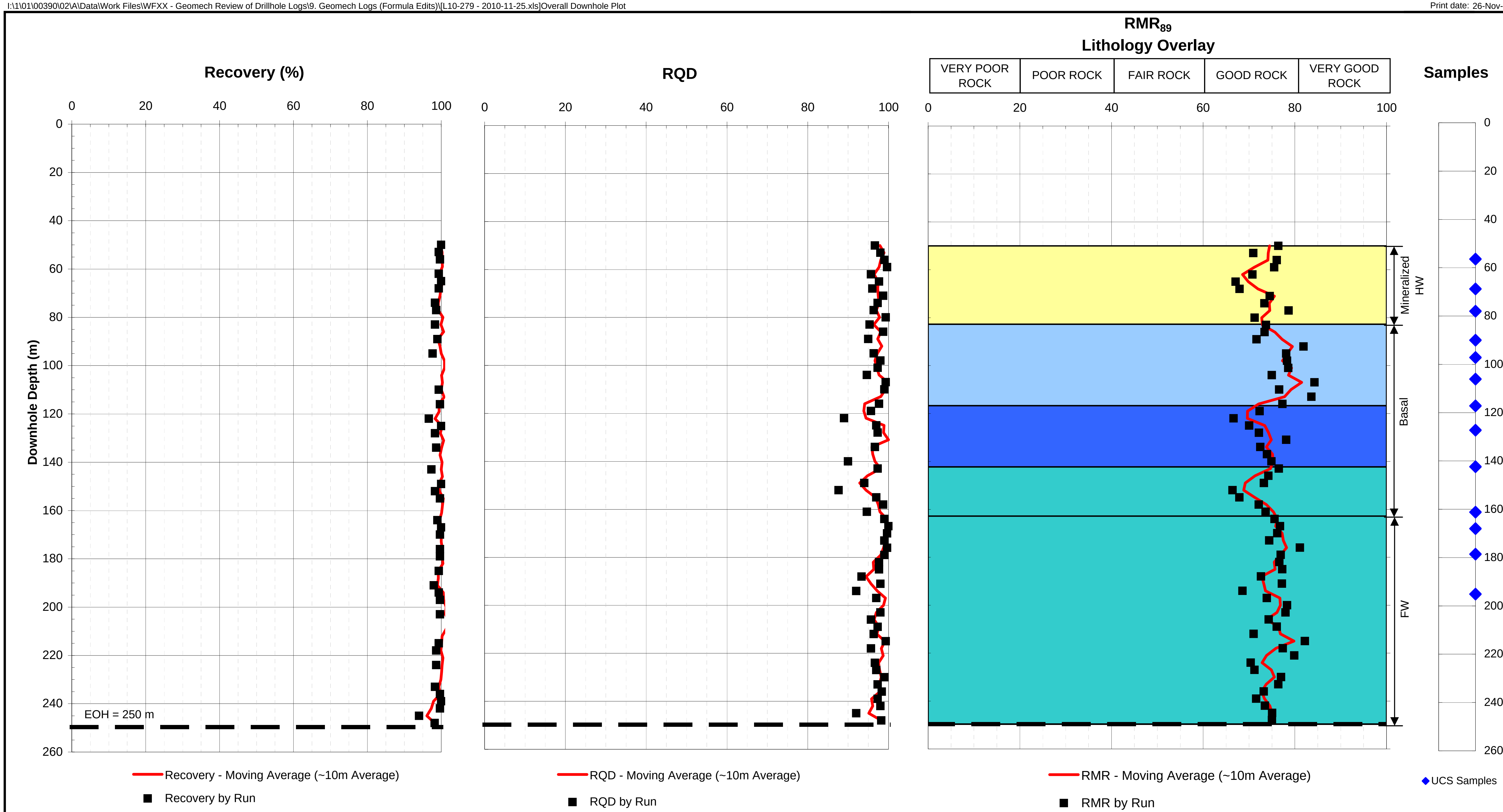
Knight Piésold CONSULTING

| P/A NO. | REF. NO. |
|---|---|
| NB101-390/2 | NB10-00570 |

**FIGURE 18** REV 0

I:\1\01\00390\02\A\Data\Work Files\WFXX - Geomech Review of Drillhole Logs\9. Geomech Logs (Formula Edits)\[L10-279 - 2010-11-25.xls]Overall Downhole Plot

Print date: 26-Nov-10




## Lithology

Fault Zone
Fault Zone Contact
End of Hole (EOH)

*Diabase [90]*

**Hanging Wall**
*Sodalite Cumulate [79]*
*Aegirine Syenite [78]*

**Ore**
*Foyaite [75]*
*Eudialyte Syenite [69]*
*Eudialyte Cumulate [67]*
*Aegirine Syenite II [65]*

**Footwall**
*Foyaite II [63]*
*Aegirine-Nepheline Syenite [60]*
*Sodalite-Nepheline Syenite [55]*

| REV | DATE | DESCRIPTION | PREP'D | CHK'D | APP'D |
|---|---|---|---|---|---|
| 0 | 19NOV'10 | ISSUED WITH MEMO | AJ | BDP | RAM |

AVALON RARE METALS INC.

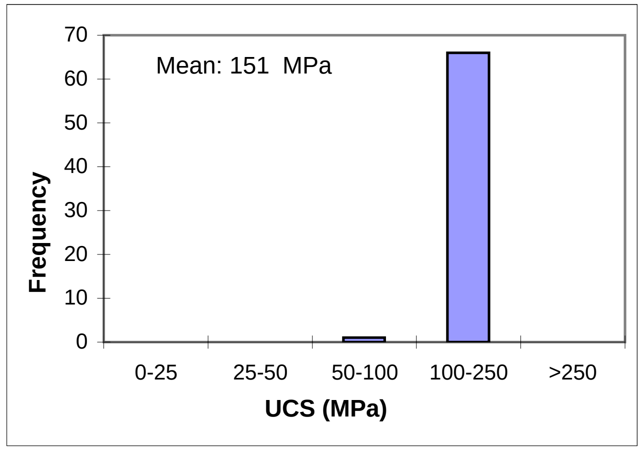
THOR LAKE PROJECT

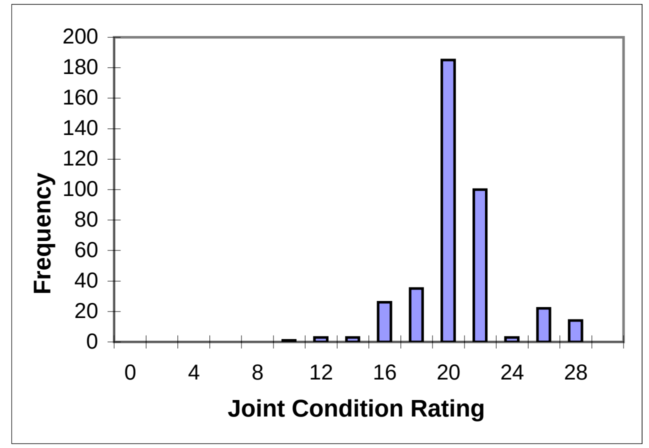
**FEASIBILITY GEOMECHANICAL PROGRAM**
**DOWNHOLE PLOTS FOR L10-279**

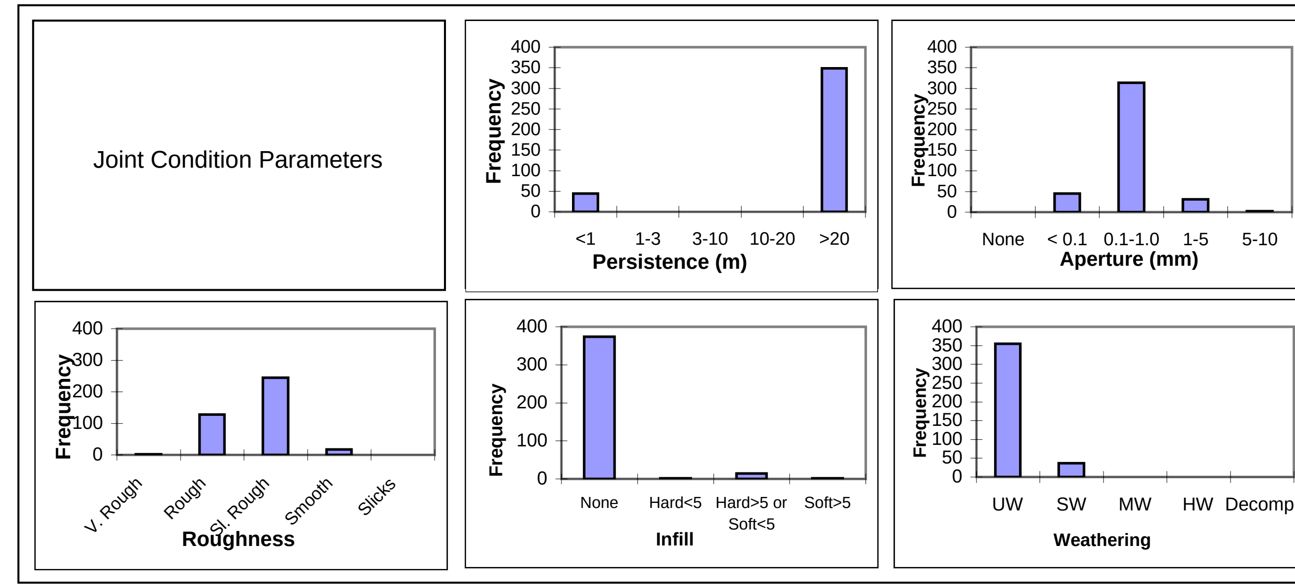
Knight Piésold CONSULTING

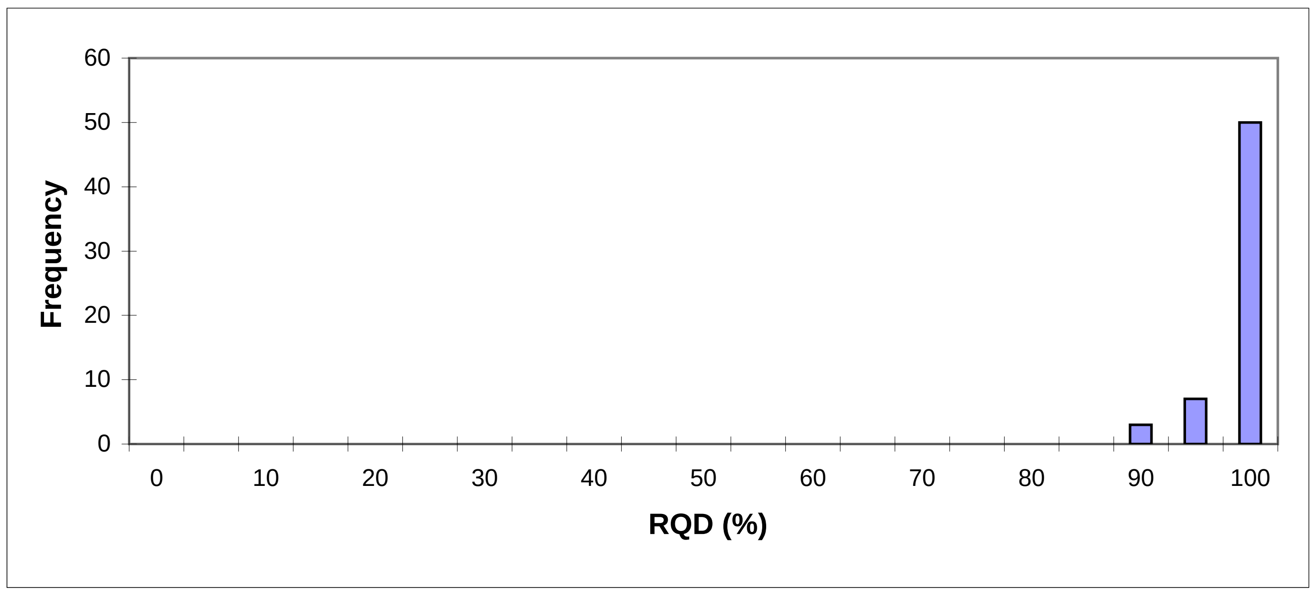
| P/A NO. | REF. NO. |
|---|---|
| NB101-390/2 | NB10-00570 |

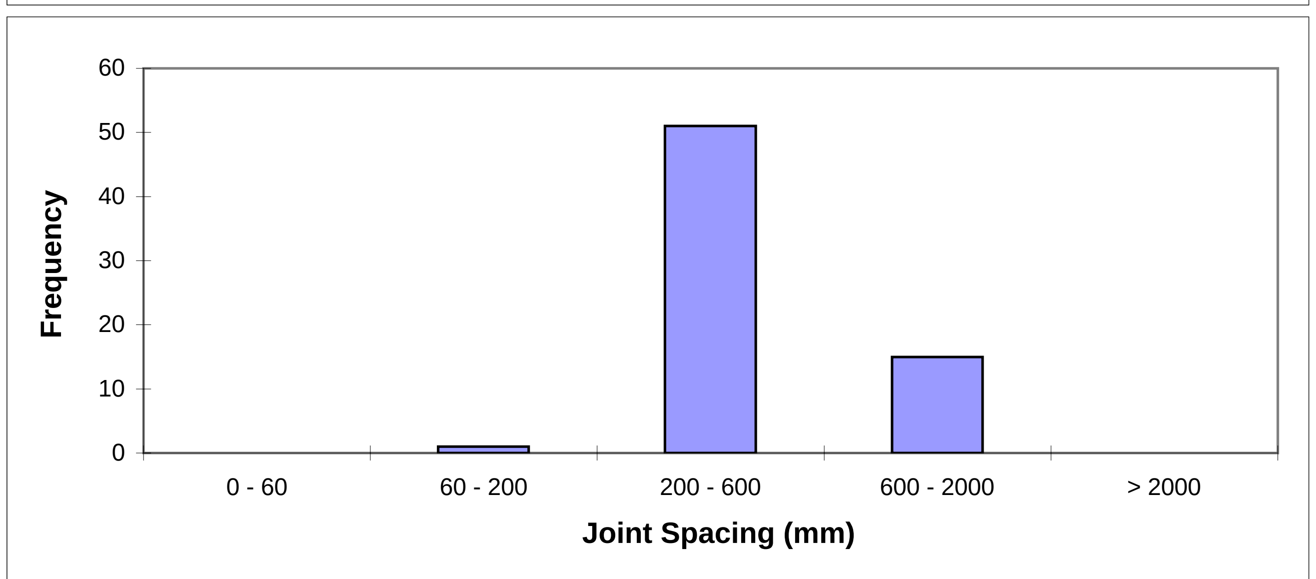
**FIGURE 19** REV 0

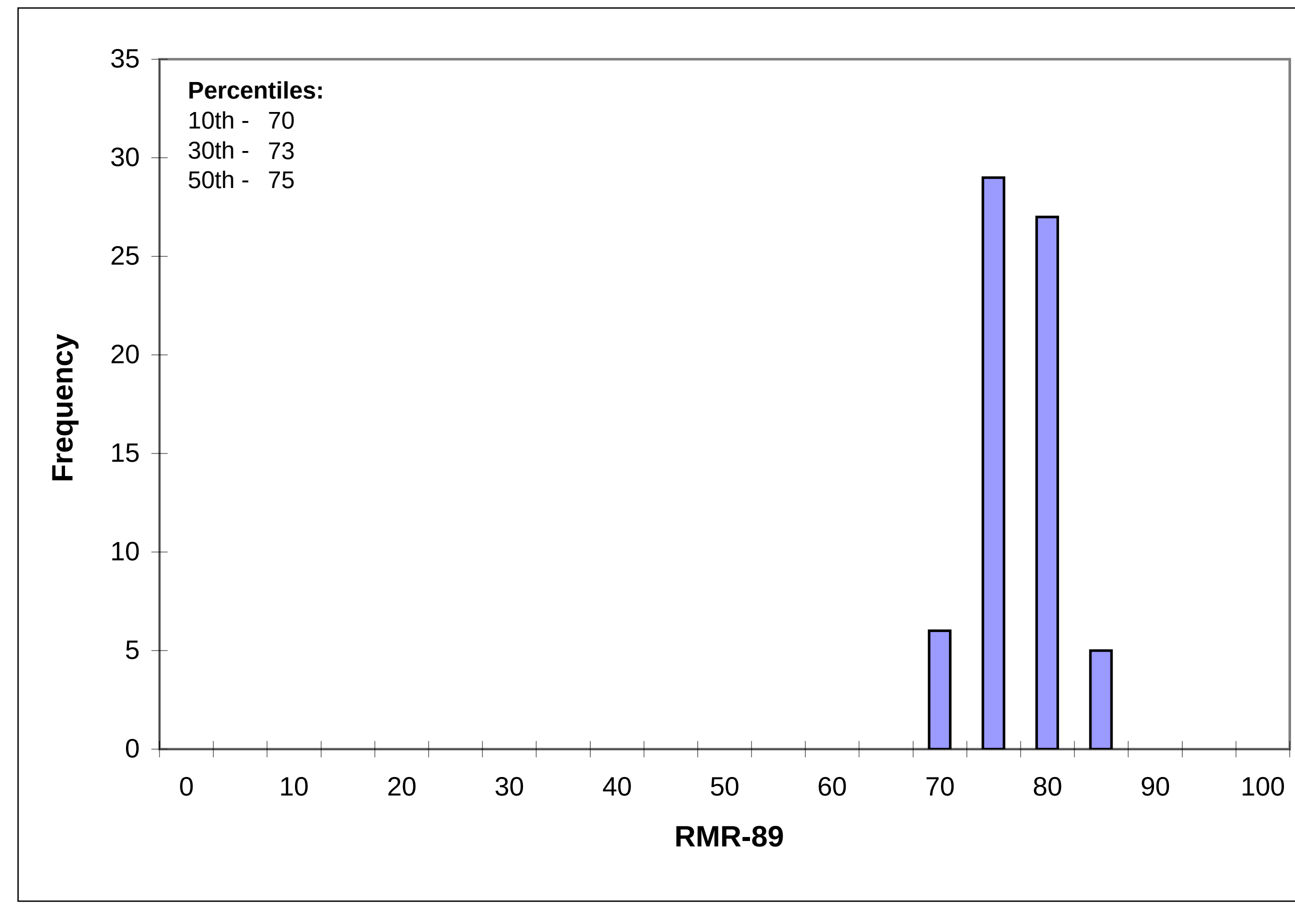



**NOTES:**

1. BINS INCLUDE PREVIOUS RANGE (I.E., BIN 60 INCLUDES VALUES FROM 55-60).
2. RQD, RMR89, JOINT SPACING, AND UCS ARE RUN BASED PARAMETERS WHILE JOINT CONDITION RATING AND PARAMETERS ARE BASED ON INDIVIDUAL DISCONTINUITIES WITHIN A LOGGING RUN.

AVALON RARE METALS INC.

THOR LAKE PROJECT

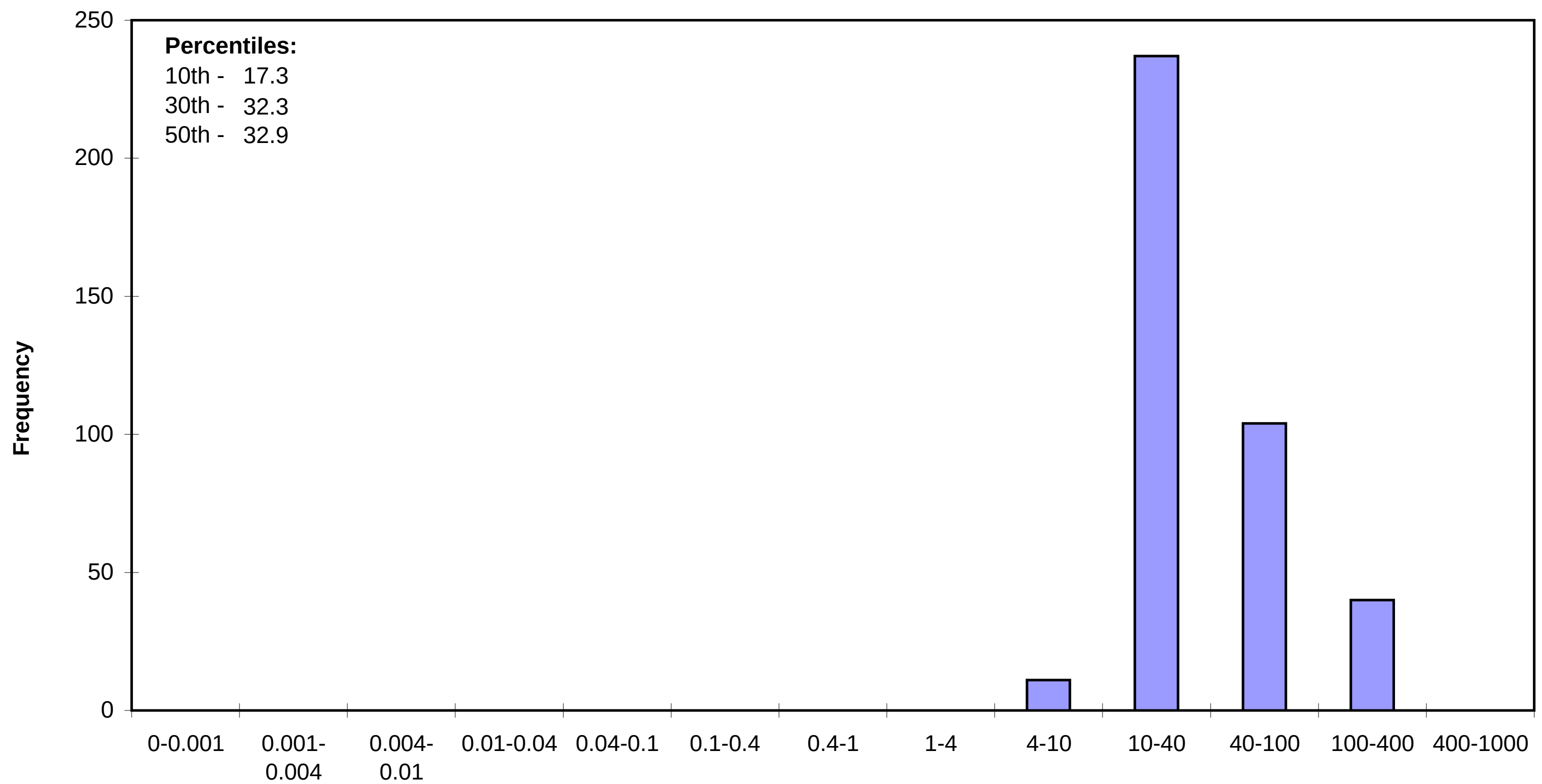
**FEASIBILITY GEOMECHANICAL PROGRAM**
**$RMR_{89}$ PARAMETER HISTOGRAMS FOR L10-279**

Knight Piésold CONSULTING

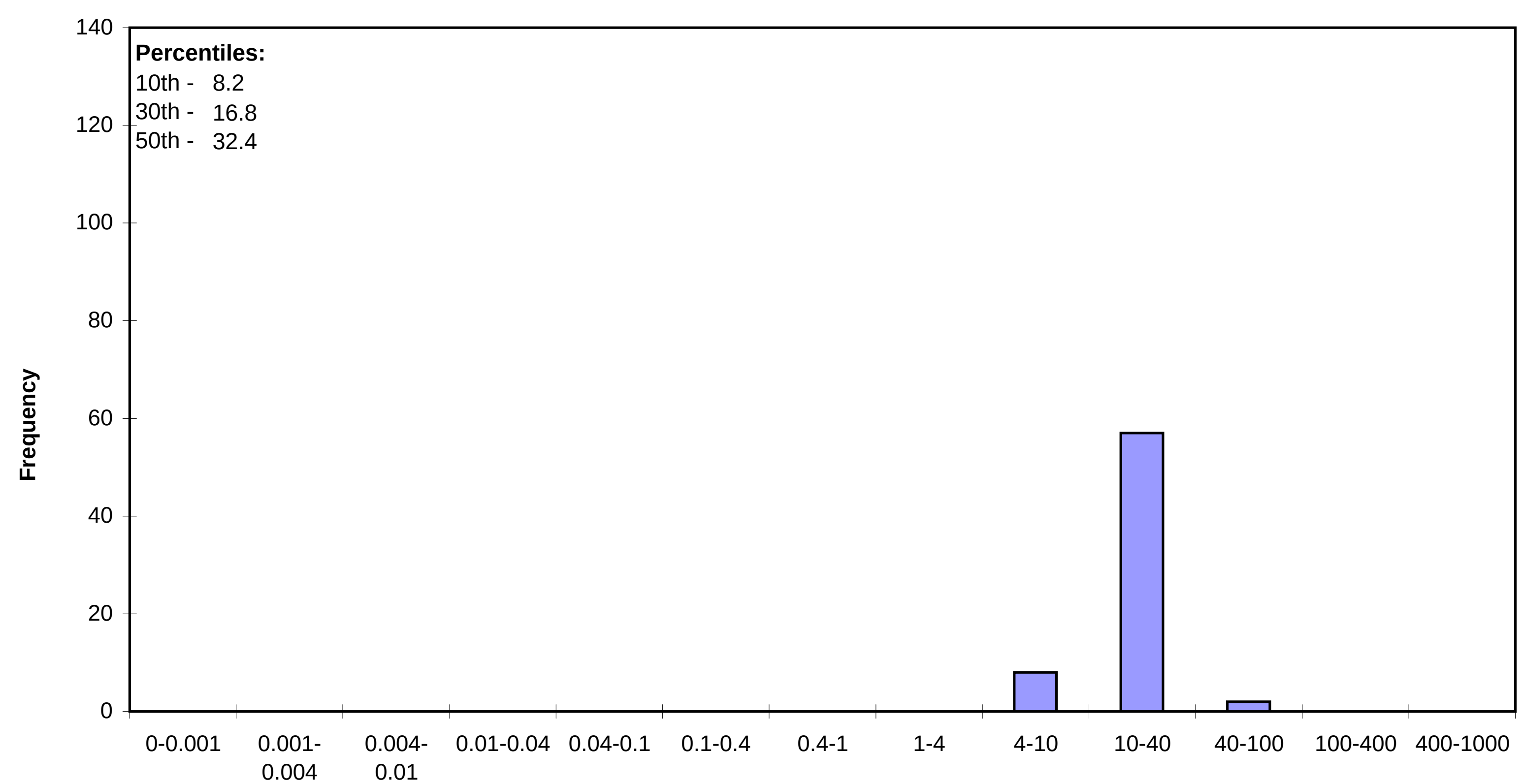
P/A NO. NB101-390/2 | REF. NO. NB10-00570

**FIGURE 20** REV 0

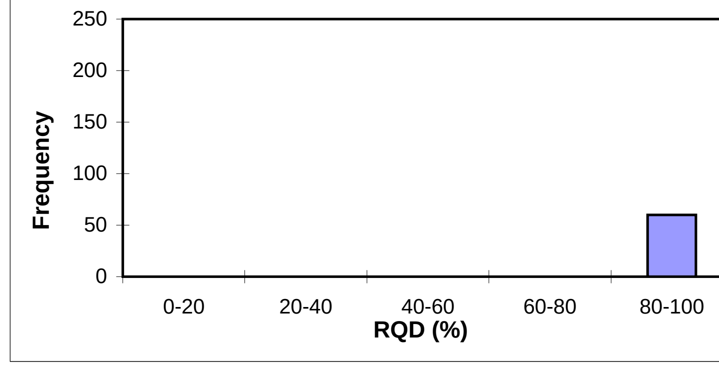
| REV | DATE | DESCRIPTION | PREP'D | CHK'D | APP'D |
|---|---|---|---|---|---|
| 0 | 19NOV'10 | ISSUED WITH MEMO | AJ | BDP | RAM |

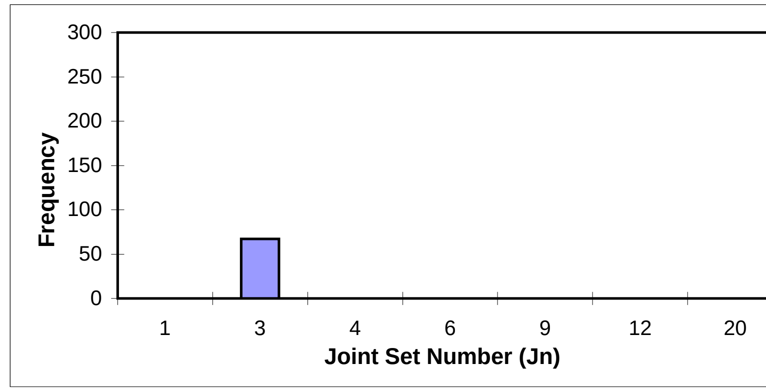


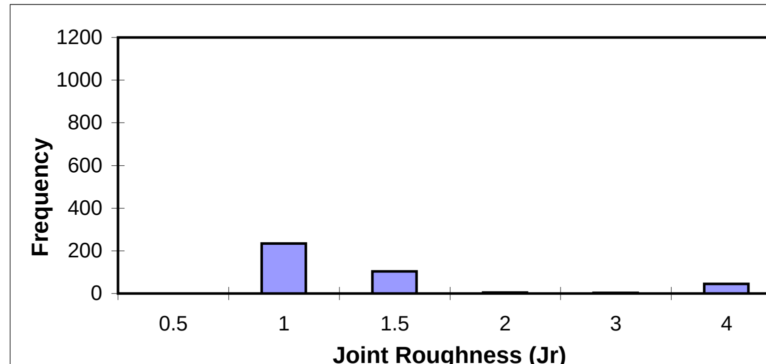

Q' by Discontinuity

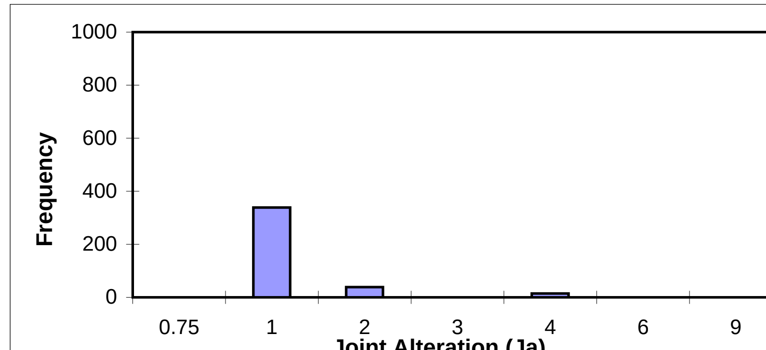



Q' by Logging Run (using minimum)




**NOTES:**

1. RQD AND Jn ARE RUN BASED PARAMETERS WHILE Jr AND Ja ARE BASED ON INDIVIDUAL DISCONTINUITIES WITHIN A LOGGING RUN.

AVALON RARE METALS INC.

THOR LAKE PROJECT

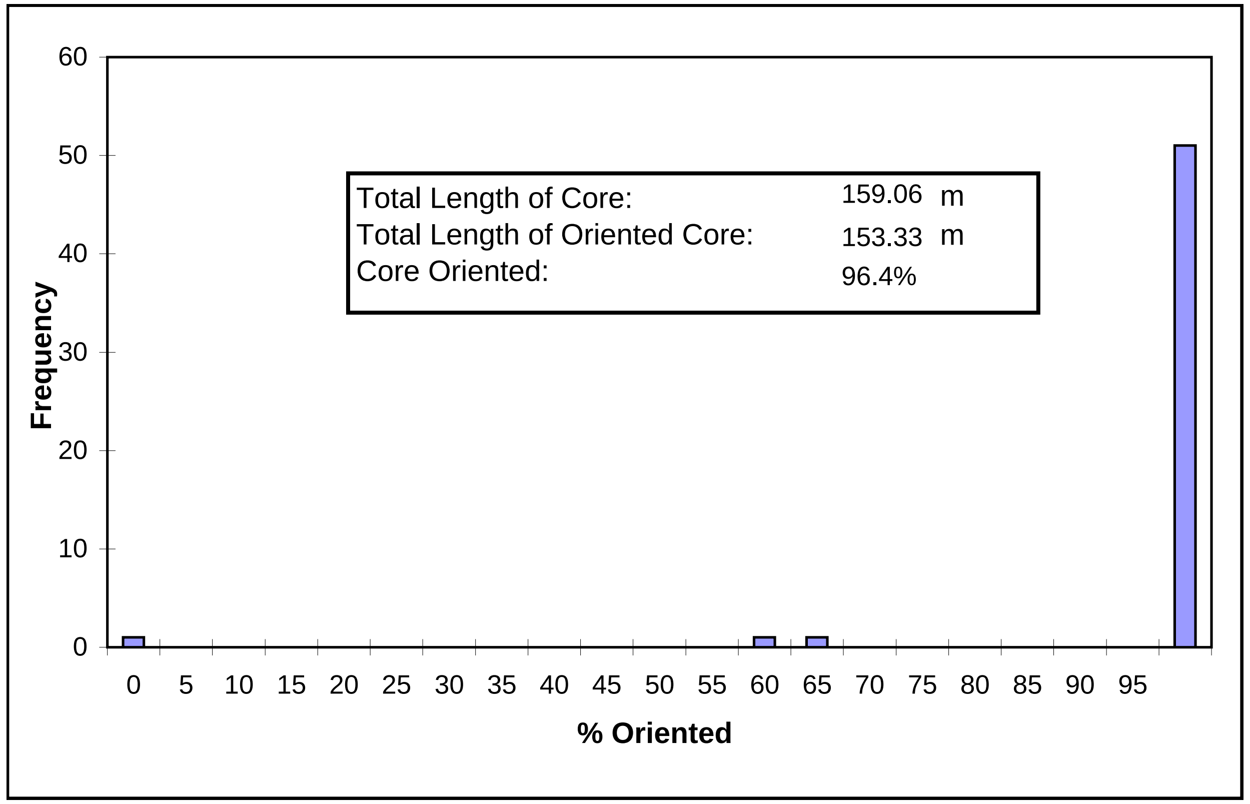
**FEASIBILITY GEOMECHANICAL PROGRAM**
**Q' PARAMETER HISTOGRAMS FOR L10-279**

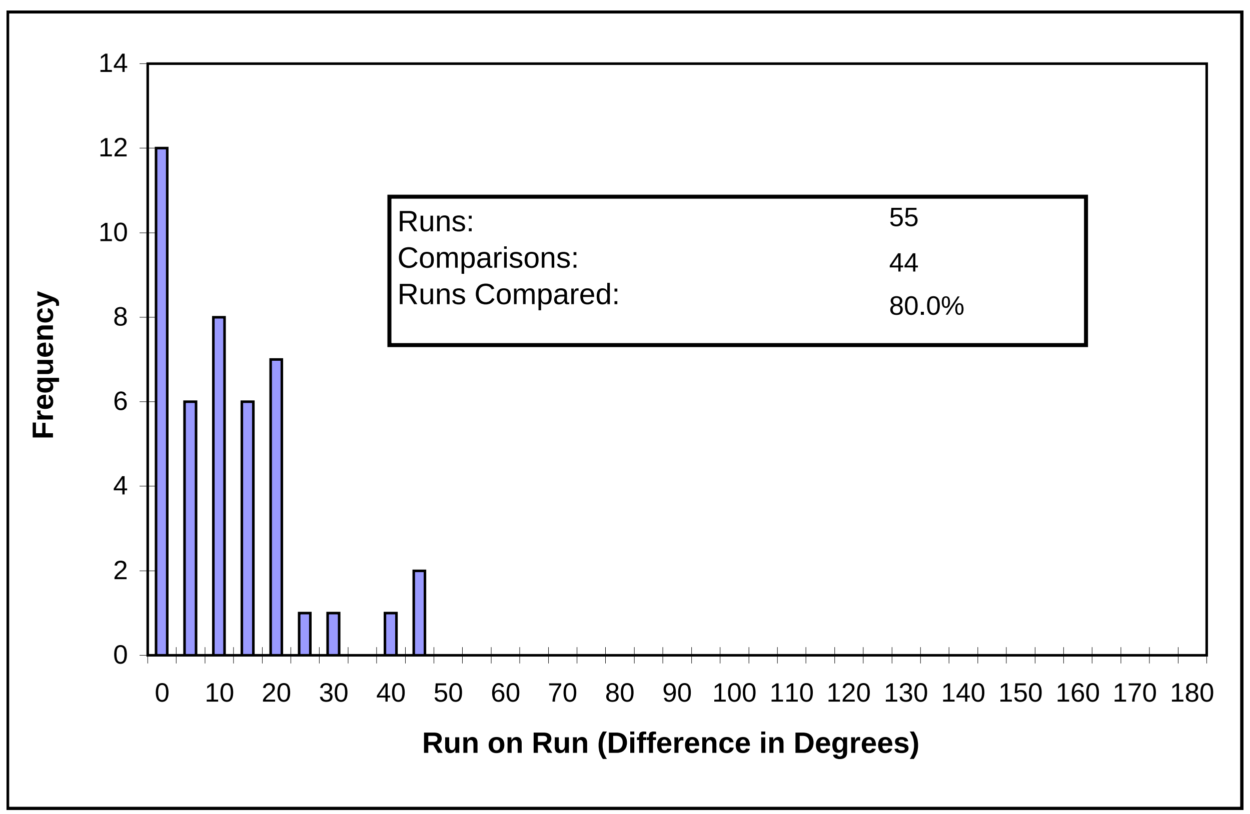
Knight Piésold CONSULTING

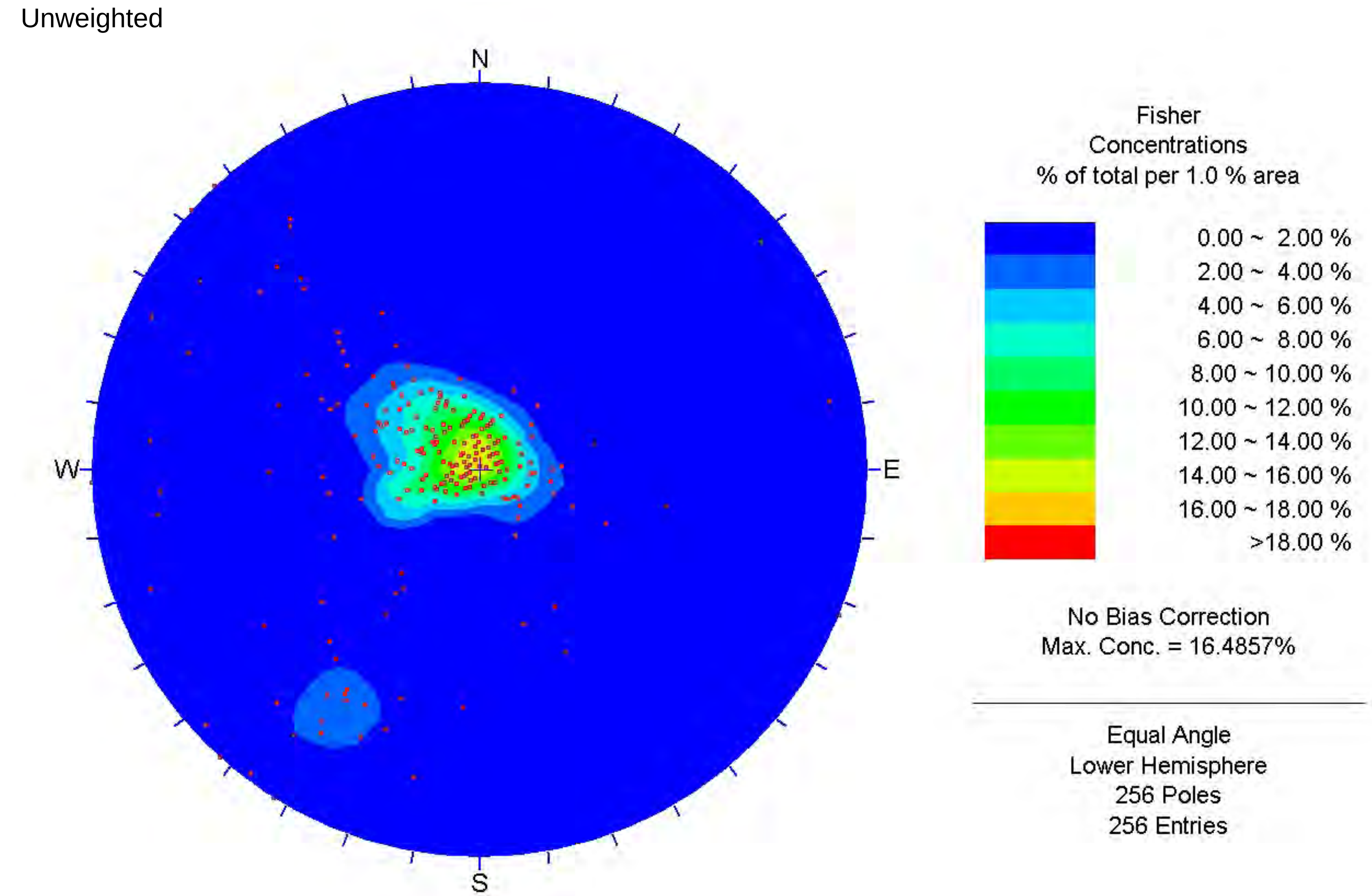
| P/A NO. | REF. NO. |
|---|---|
| NB101-390/2 | NB10-00570 |

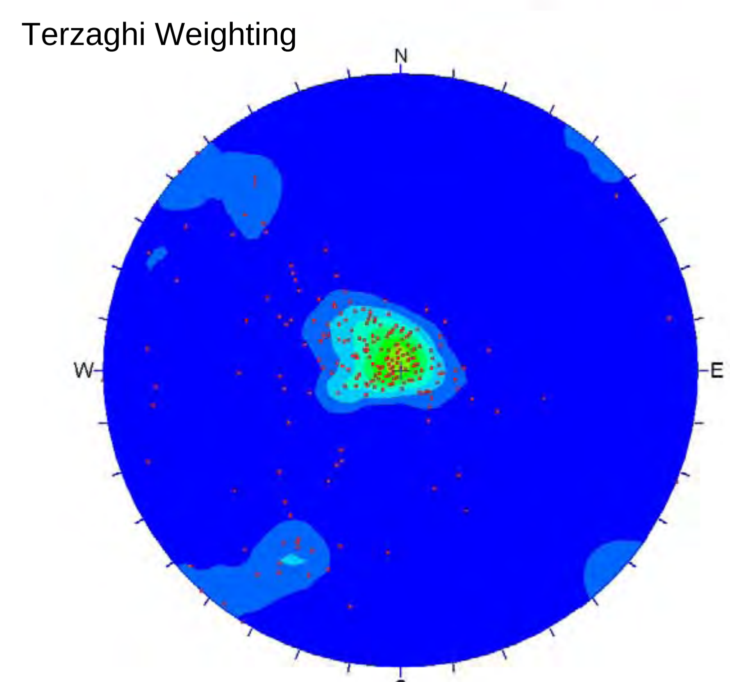
**FIGURE 21** REV 0

| 0 | 19NOV'10 | ISSUED WITH MEMO | AJ | BDP | RAM |
|---|---|---|---|---|---|
| REV | DATE | DESCRIPTION | PREP'D | CHK'D | APP'D |




## Drillhole Details

Azimuth: 250°

Dip: -65°

Length: 269 m

AVALON RARE METALS INC.

THOR LAKE PROJECT

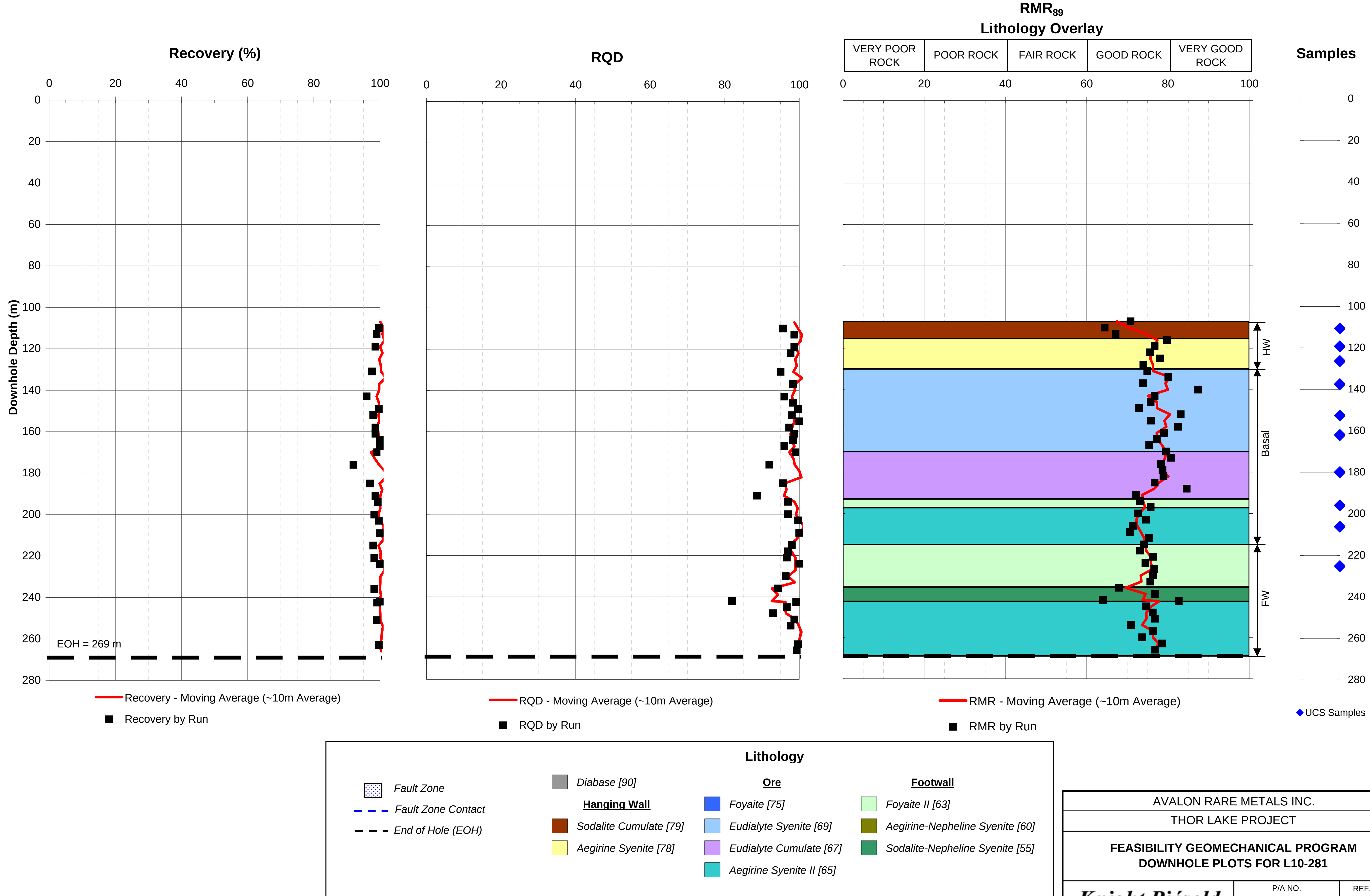
**FEASIBILITY GEOMECHANICAL PROGRAM**
**DRILLHOLE ORIENTATION RESULTS**
**L10-281**

Knight Piésold CONSULTING

| P/A NO. | REF. NO. |
| --- | --- |
| NB101-390/2 | NB10-00570 |

**FIGURE 22** REV 0

| REV | DATE | DESCRIPTION | PREP'D | CHK'D | APP'D |
| --- | --- | --- | --- | --- | --- |
| 0 | 19NOV'10 | ISSUED WITH MEMO | AJ | BDP | RAM |




AVALON RARE METALS INC.

THOR LAKE PROJECT

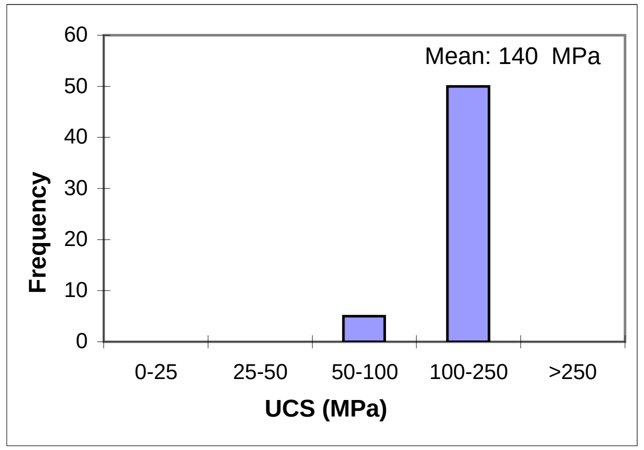
**FEASIBILITY GEOMECHANICAL PROGRAM**
**DOWNHOLE PLOTS FOR L10-281**

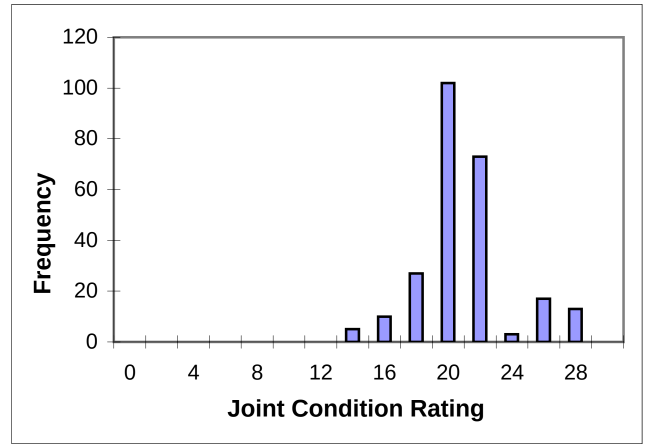
Knight Piésold CONSULTING

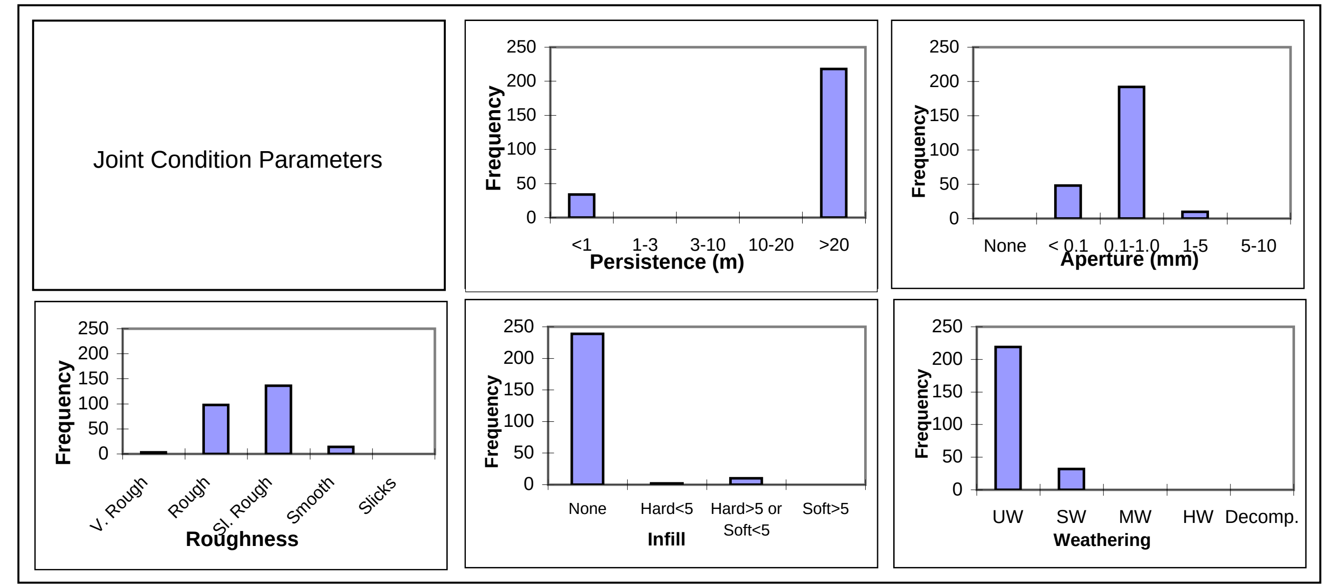
| P/A NO. | REF. NO. | REV |
|---|---|---|
| NB101-390/2 | NB10-00570 | 0 |

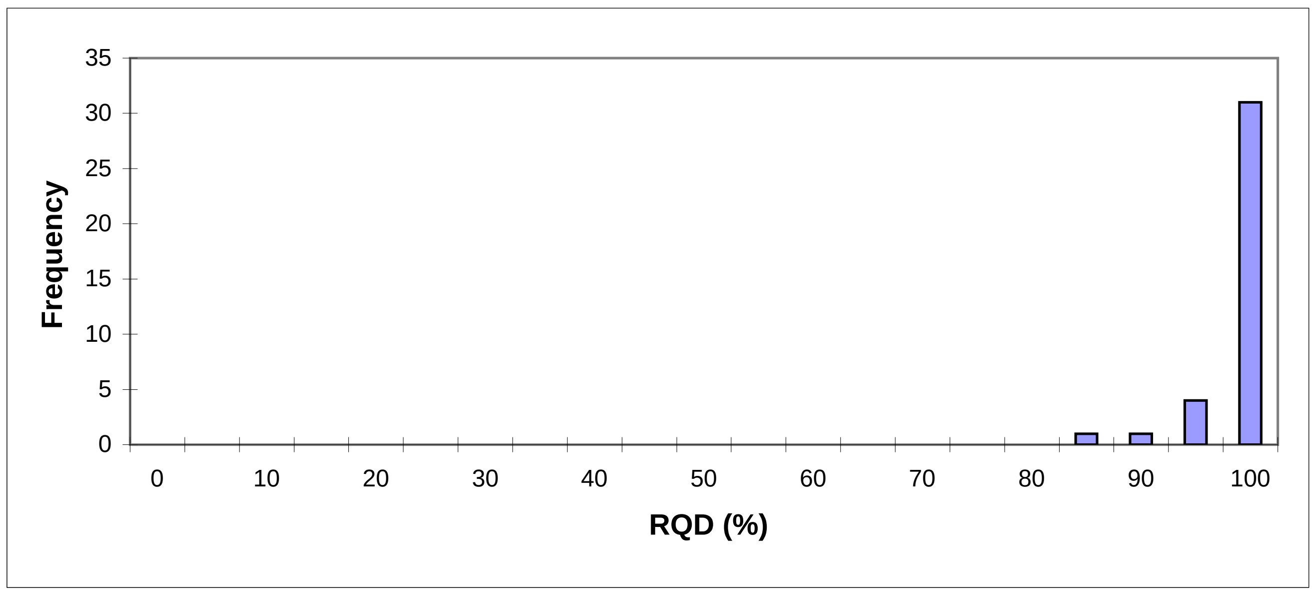
**FIGURE 23**

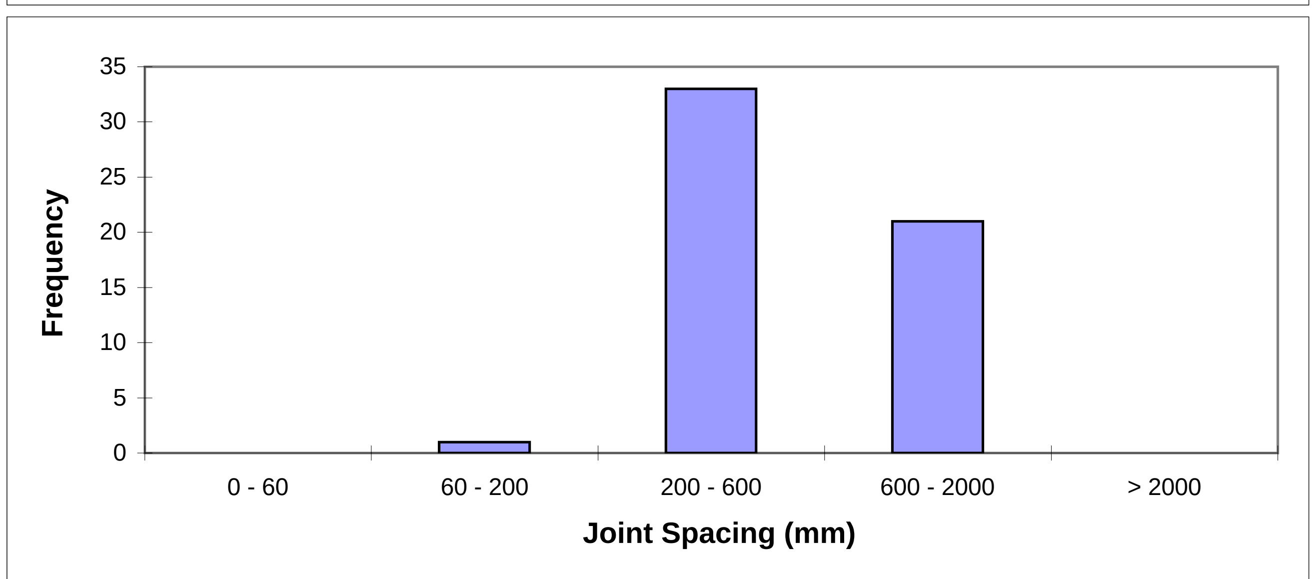
| REV | DATE | DESCRIPTION | PREP'D | CHK'D | APP'D |
|---|---|---|---|---|---|
| 0 | 19NOV'10 | ISSUED WITH MEMO | AJ | BDP | RAM |

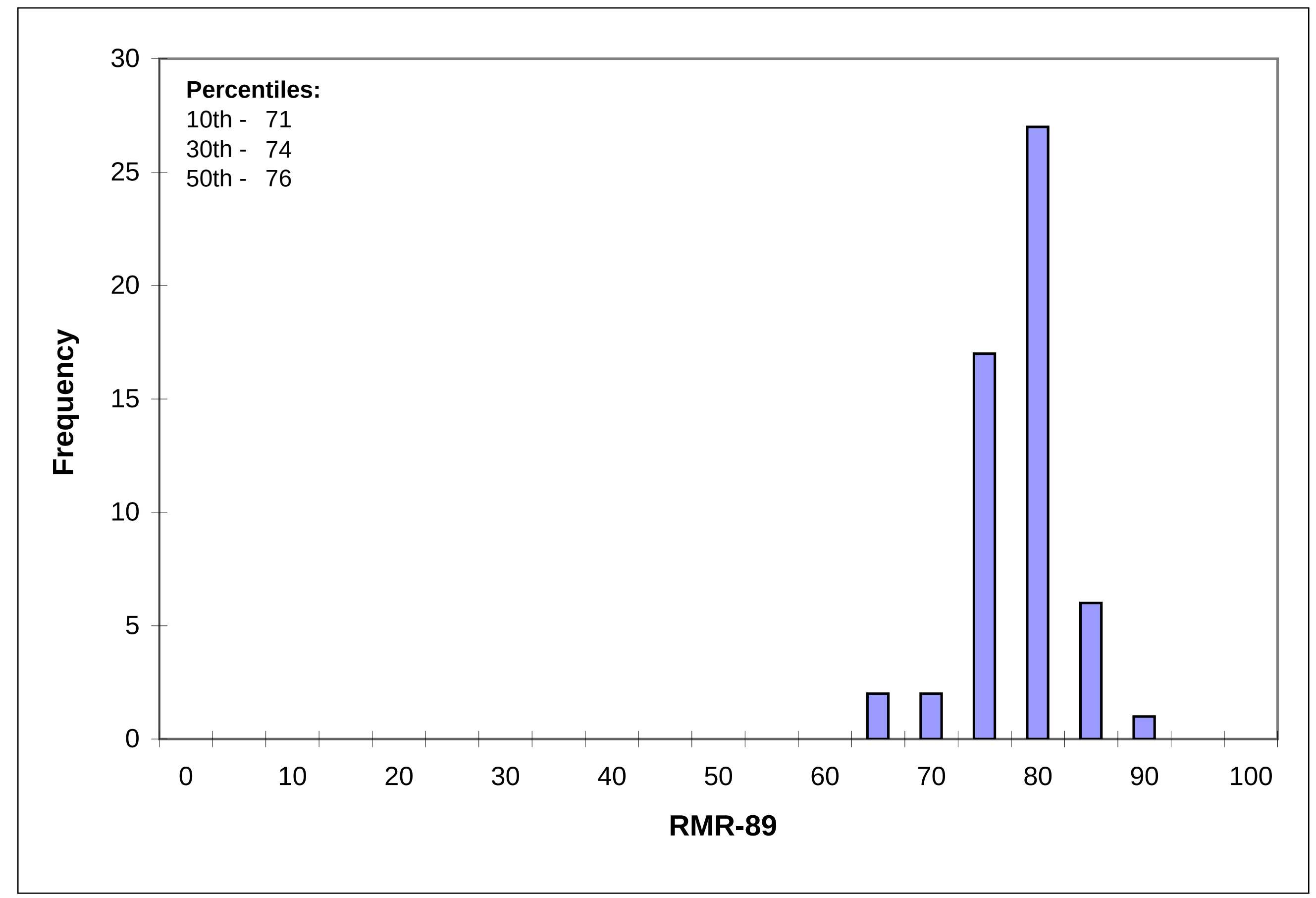



**NOTES:**
1. BINS INCLUDE PREVIOUS RANGE (I.E., BIN 60 INCLUDES VALUES FROM 55-60).
2. RQD, RMR89, JOINT SPACING, AND UCS ARE RUN BASED PARAMETERS WHILE JOINT CONDITION RATING AND PARAMETERS ARE BASED ON INDIVIDUAL DISCONTINUITIES WITHIN A LOGGING RUN.

AVALON RARE METALS INC.
THOR LAKE PROJECT

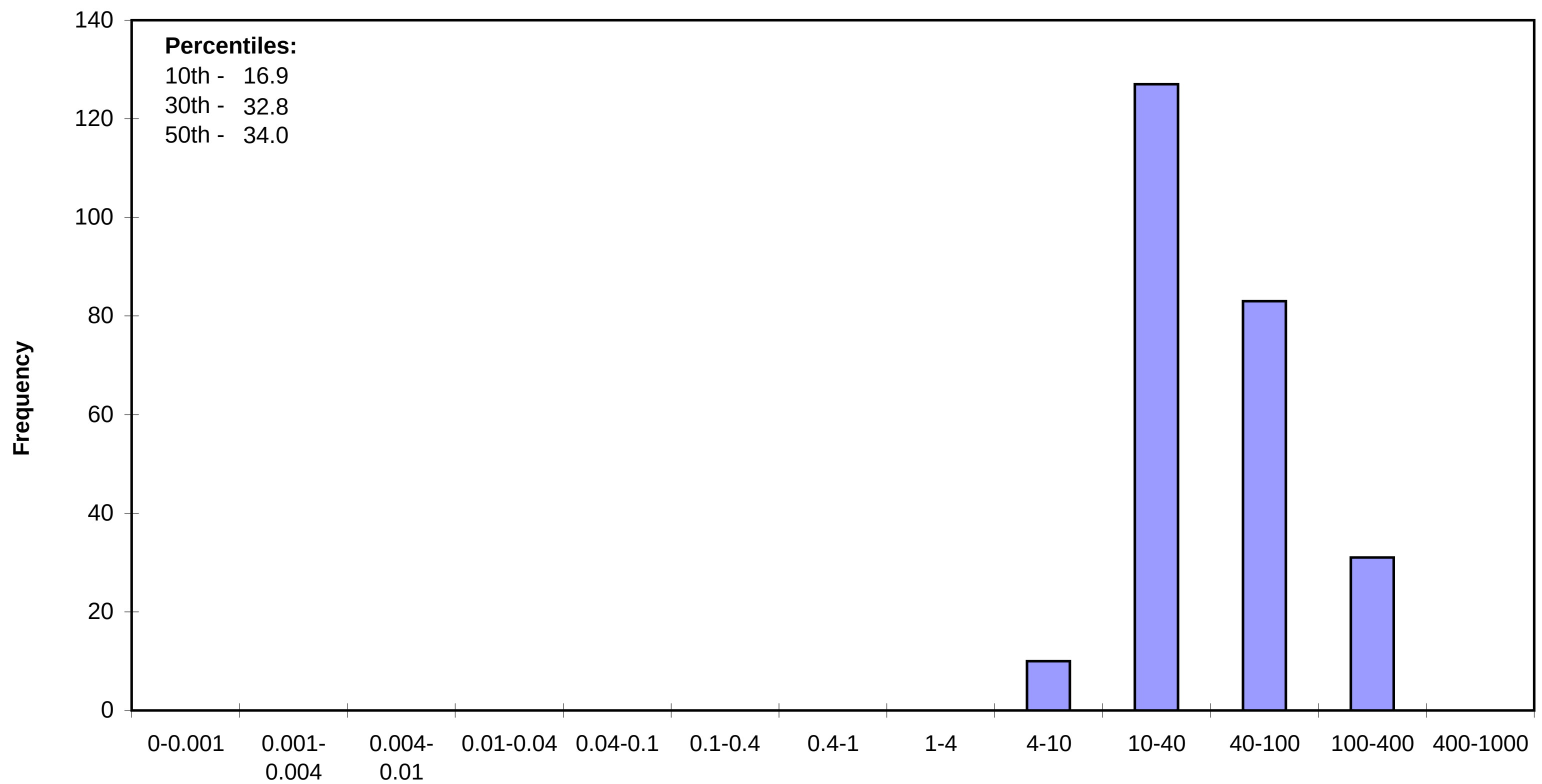
**FEASIBILITY GEOMECHANICAL PROGRAM**
**$RMR_{89}$ PARAMETER HISTOGRAMS FOR L10-281**

Knight Piésold CONSULTING

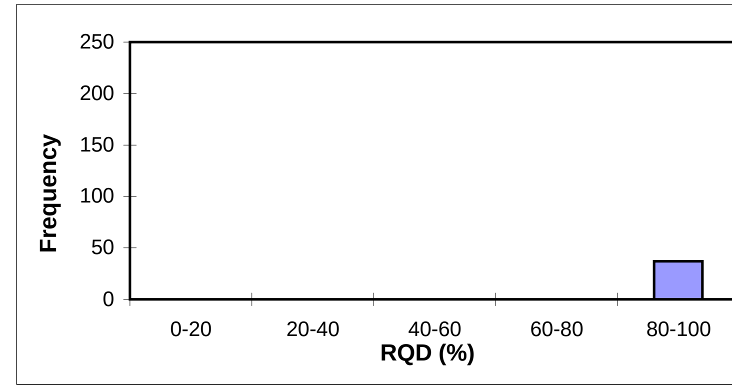
| P/A NO. | REF. NO. |
|---|---|
| NB101-390/2 | NB10-00570 |

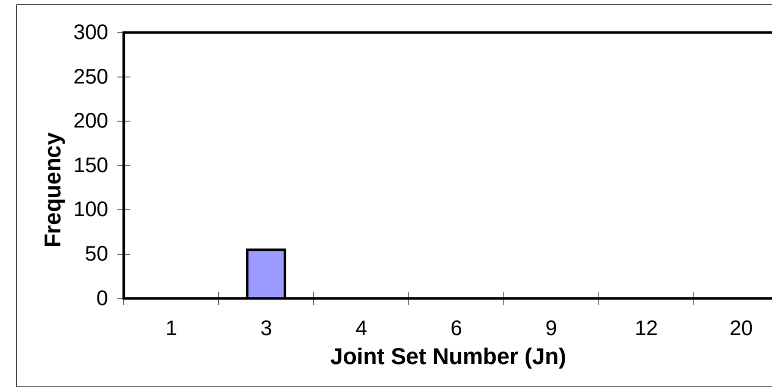
**FIGURE 24** REV 0

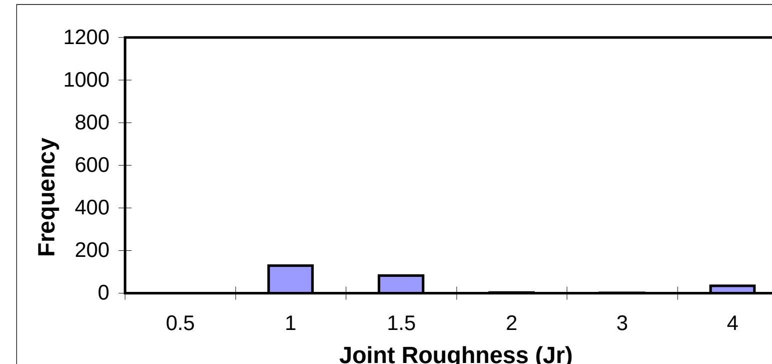
| 0 | 19NOV'10 | ISSUED WITH MEMO | AJ | BDP | RAM |
|---|---|---|---|---|---|
| REV | DATE | DESCRIPTION | PREP'D | CHK'D | APP'D |

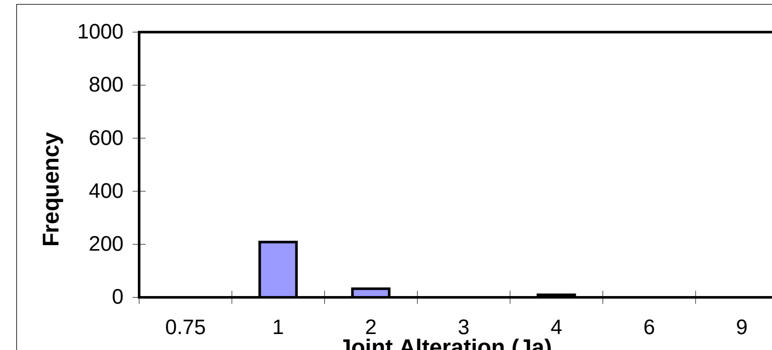


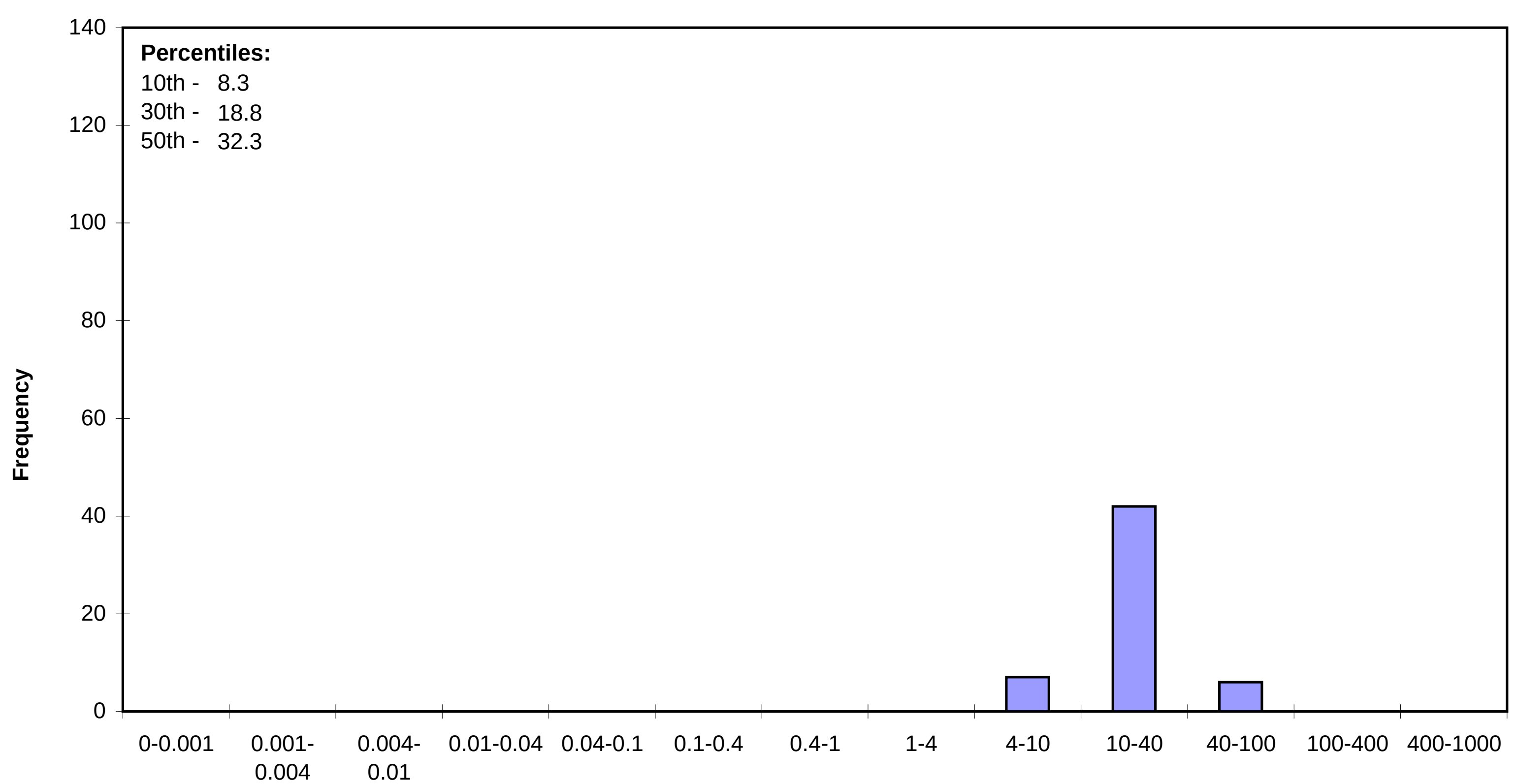

Q' by Discontinuity




Q' by Logging Run (using minimum)

**NOTES:**
1. RQD AND Jn ARE RUN BASED PARAMETERS WHILE Jr AND Ja ARE BASED ON INDIVIDUAL DISCONTINUITIES WITHIN A LOGGING RUN.

AVALON RARE METALS INC.

THOR LAKE PROJECT

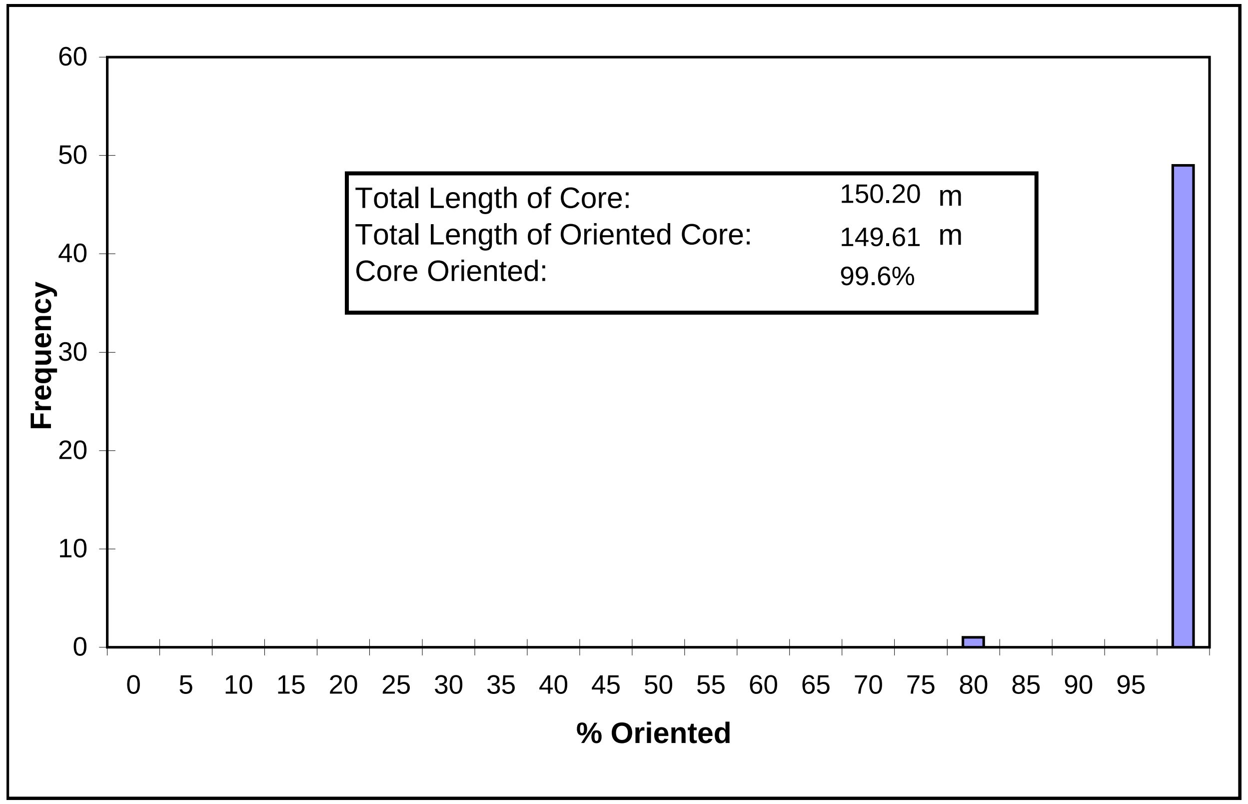
**FEASIBILITY GEOMECHANICAL PROGRAM**
**Q' PARAMETER HISTOGRAMS FOR L10-281**

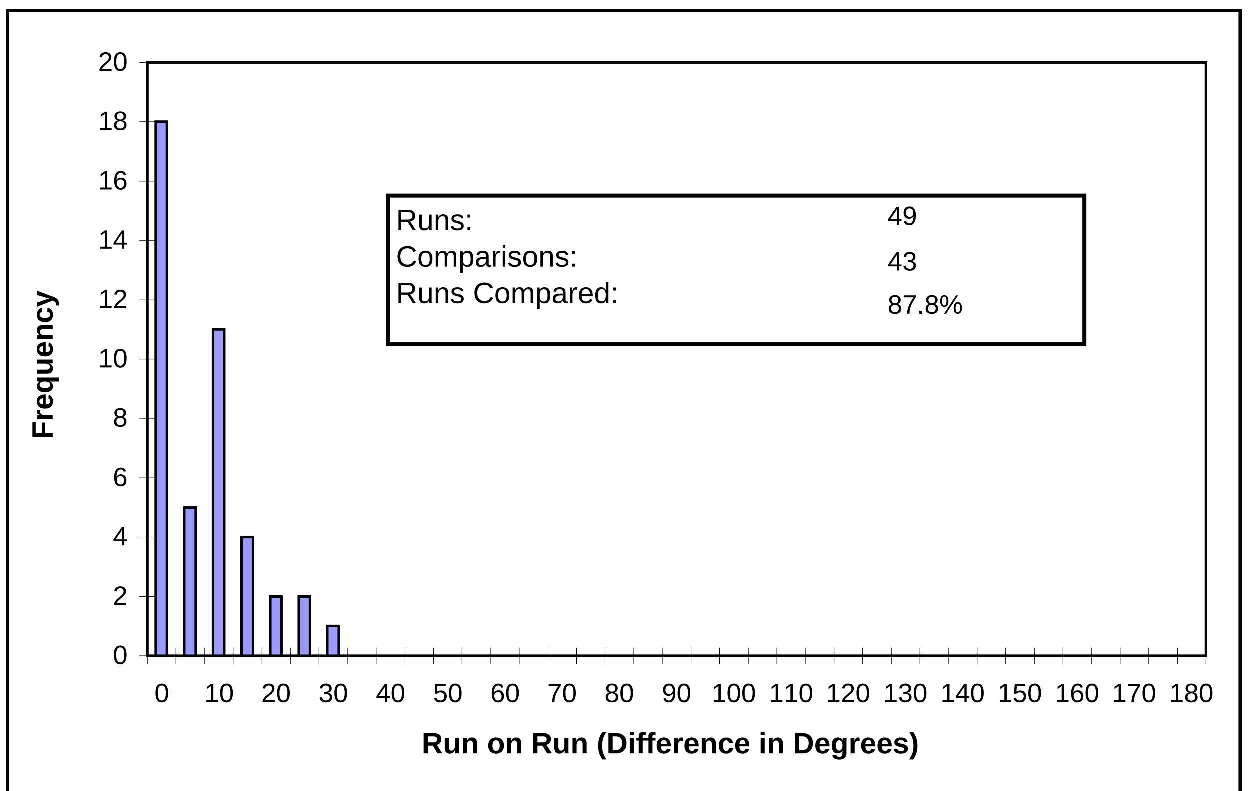
Knight Piésold CONSULTING

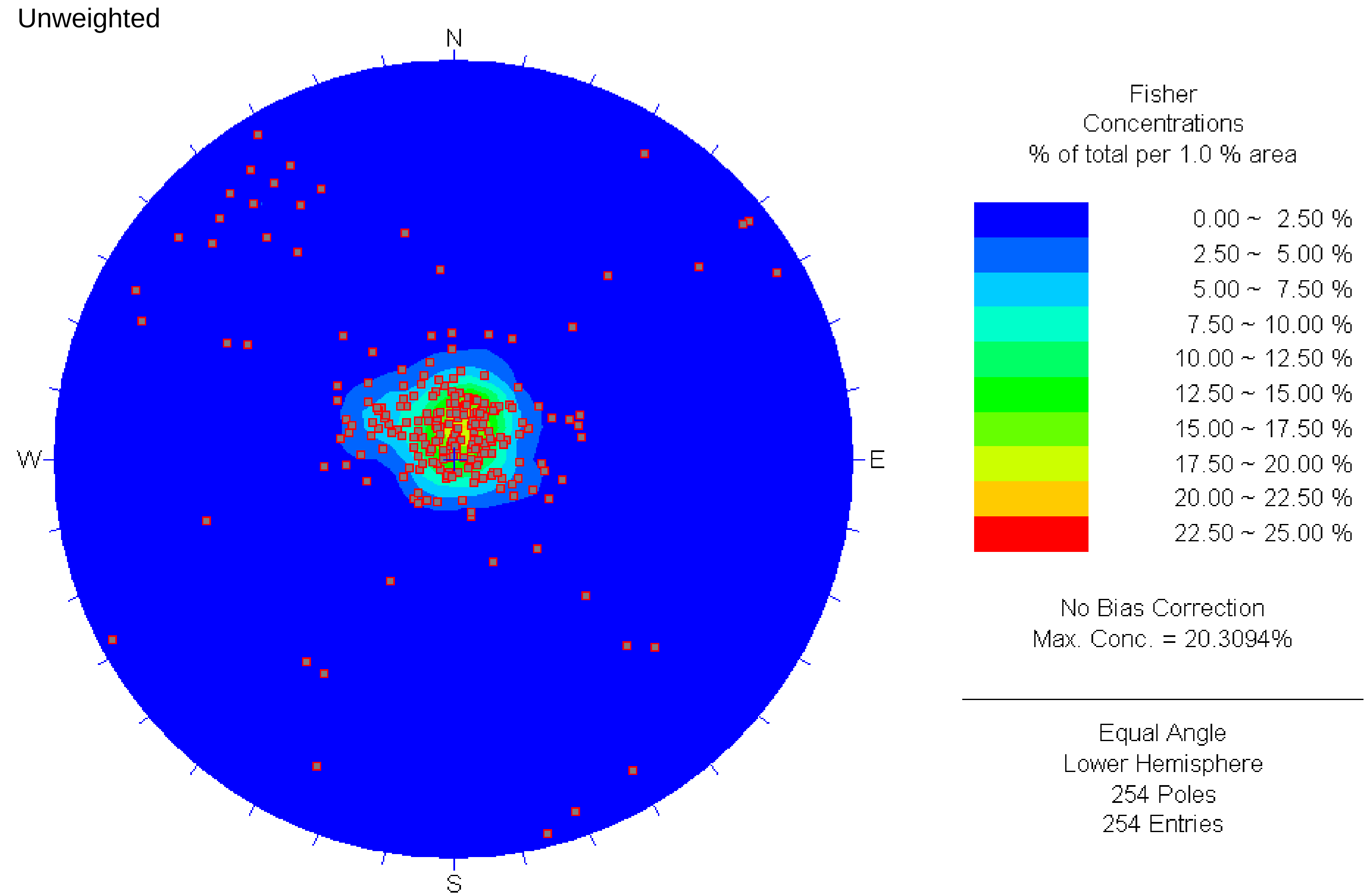
| P/A NO. | REF. NO. |
|---|---|
| NB101-390/2 | NB10-00570 |

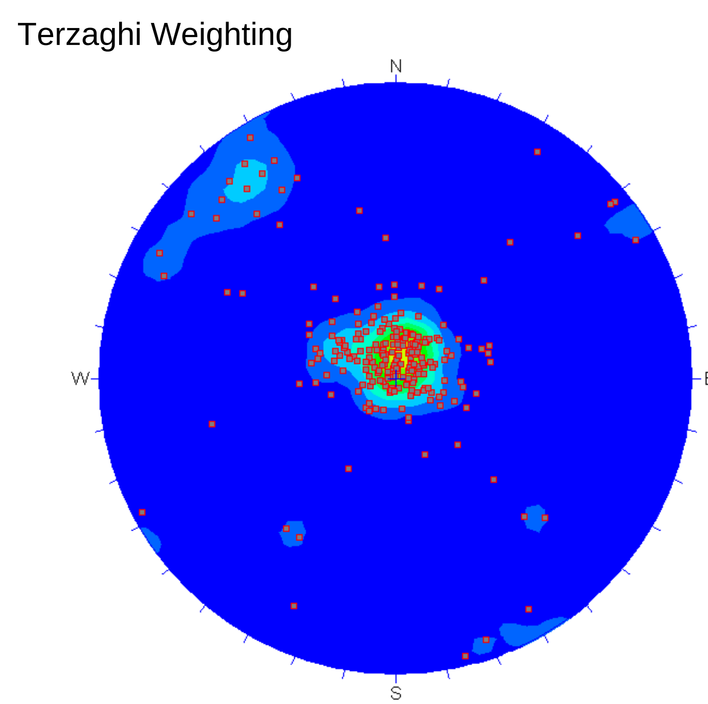
FIGURE 25 REV 0

| REV | DATE | DESCRIPTION | PREP'D | CHK'D | APP'D |
|---|---|---|---|---|---|
| 0 | 19NOV'10 | ISSUED WITH MEMO | AJ | BDP | RAM |




## Drillhole Details

Azimuth: 020°

Dip: -65°

Length: 220 m (proposed)

AVALON RARE METALS INC.

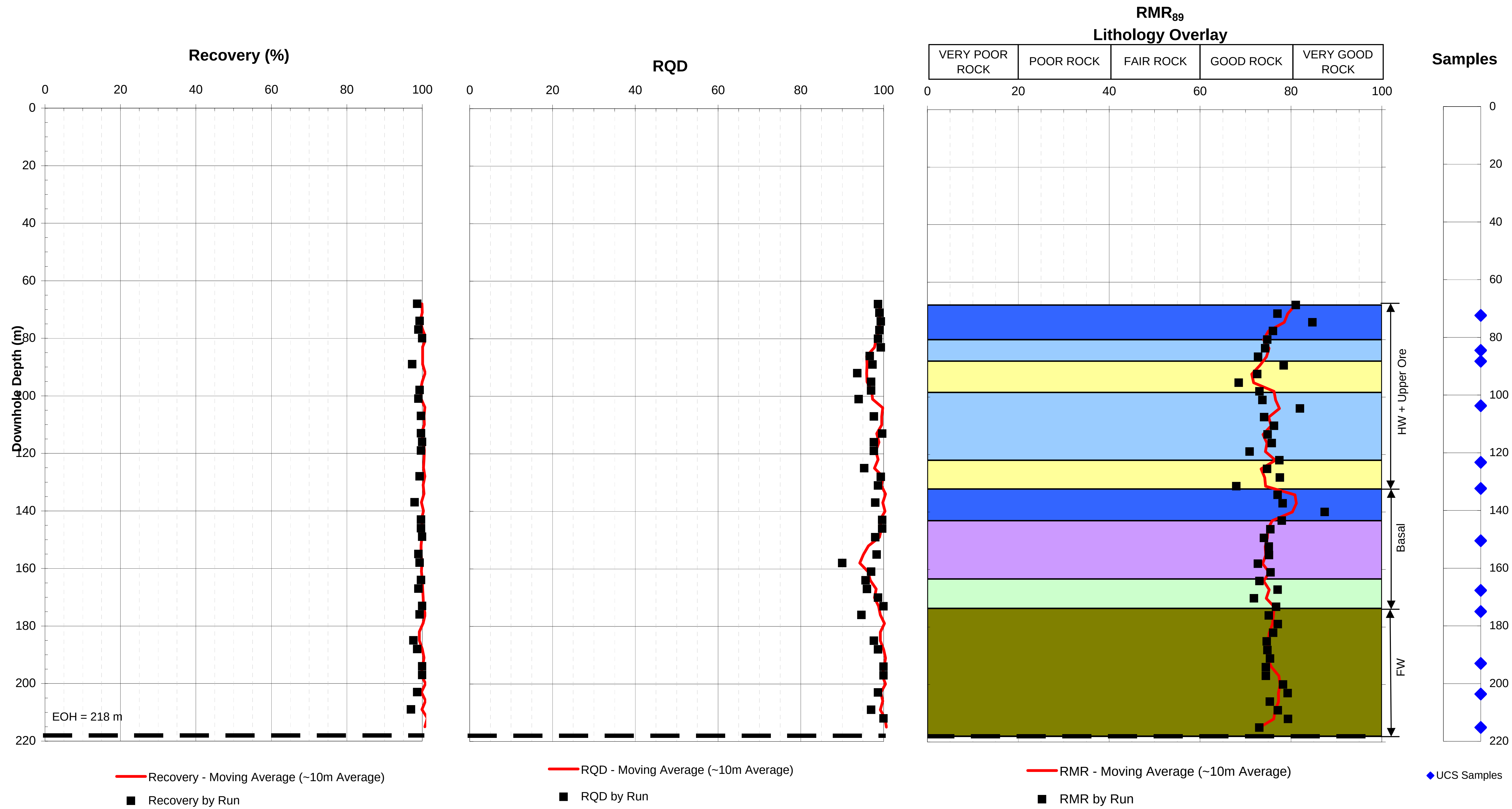
THOR LAKE PROJECT

**FEASIBILITY GEOMECHANICAL PROGRAM**
**DRILLHOLE ORIENTATION RESULTS**
**L10-283**

Knight Piésold CONSULTING

| P/A NO. | REF. NO. | |
|---|---|---|
| NB101-390/2 | NB10-00570 | |
| **FIGURE 26** | | REV 0 |

| 0 | 19NOV'10 | ISSUED WITH MEMO | AJ | BDP | RAM |
|---|---|---|---|---|---|
| REV | DATE | DESCRIPTION | PREP'D | CHK'D | APP'D |




**Lithology**

| | | | |
|---|---|---|---|
| *Fault Zone* | *Diabase [90]* | **Ore** | **Footwall** |
| *Fault Zone Contact* | **Hanging Wall** | *Foyaite [75]* | *Foyaite II [63]* |
| *End of Hole (EOH)* | *Sodalite Cumulate [79]* | *Eudialyte Syenite [69]* | *Aegirine-Nepheline Syenite [60]* |
| | *Aegirine Syenite [78]* | *Eudialyte Cumulate [67]* | *Sodalite-Nepheline Syenite [55]* |
| | | *Aegirine Syenite II [65]* | |

AVALON RARE METALS INC.
THOR LAKE PROJECT

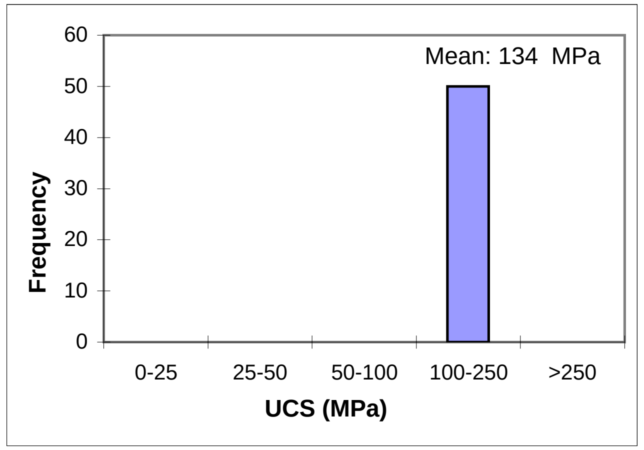
**FEASIBILITY GEOMECHANICAL PROGRAM**
**DOWNHOLE PLOTS FOR L10-283**

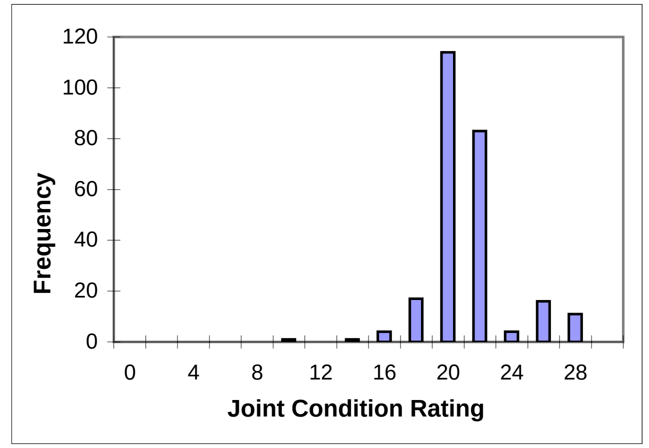
Knight Piésold CONSULTING

P/A NO. NB101-390/2 | REF. NO. NB10-00570

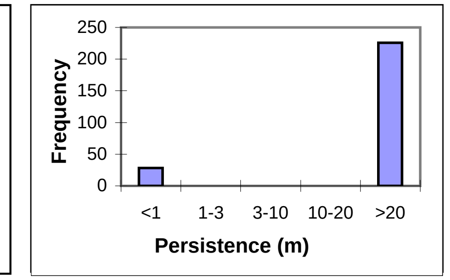
**FIGURE 27** | REV 0

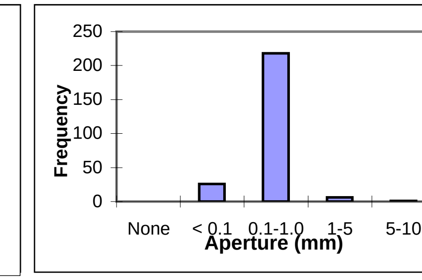
| REV | DATE | DESCRIPTION | PREP'D | CHK'D | APP'D |
|---|---|---|---|---|---|
| 0 | 19NOV'10 | ISSUED WITH MEMO | AJ | BDP | RAM |

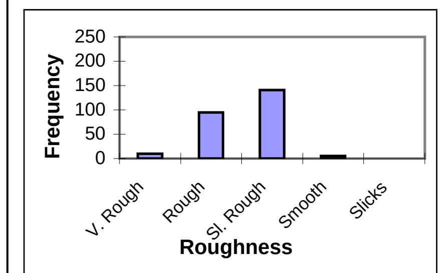


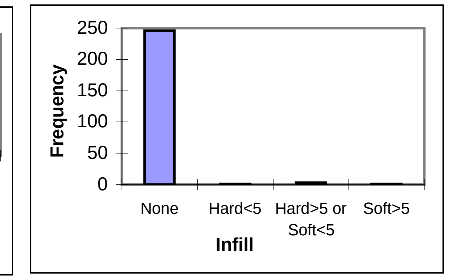



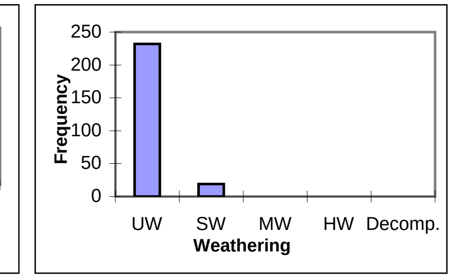

Joint Condition Parameters

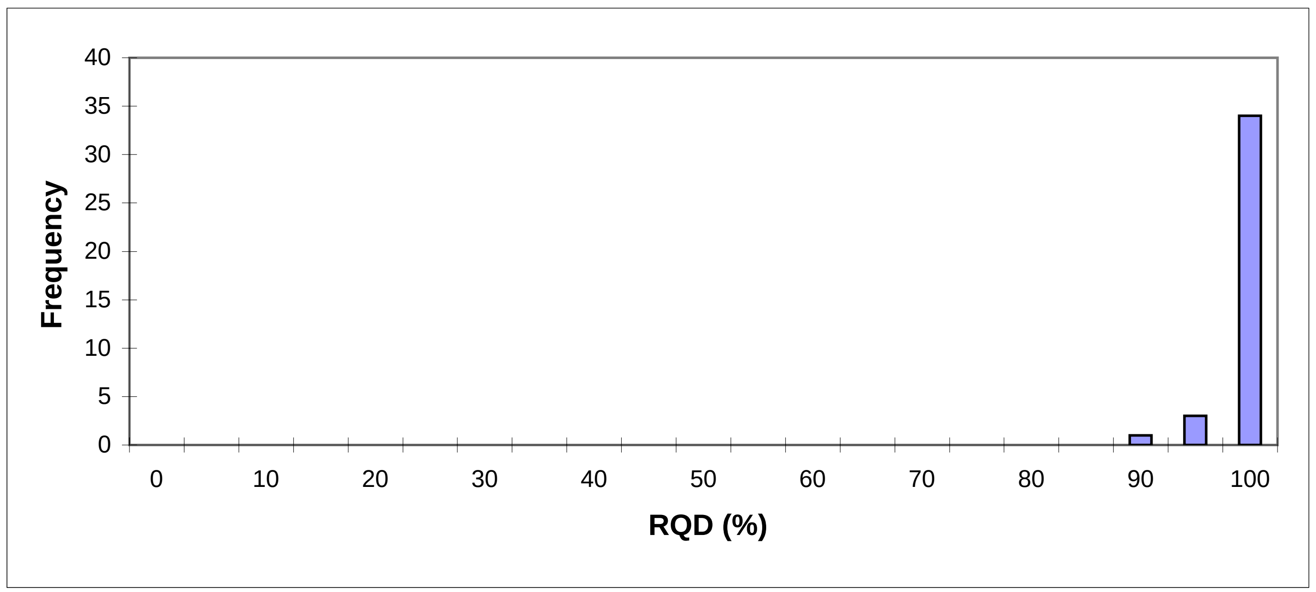


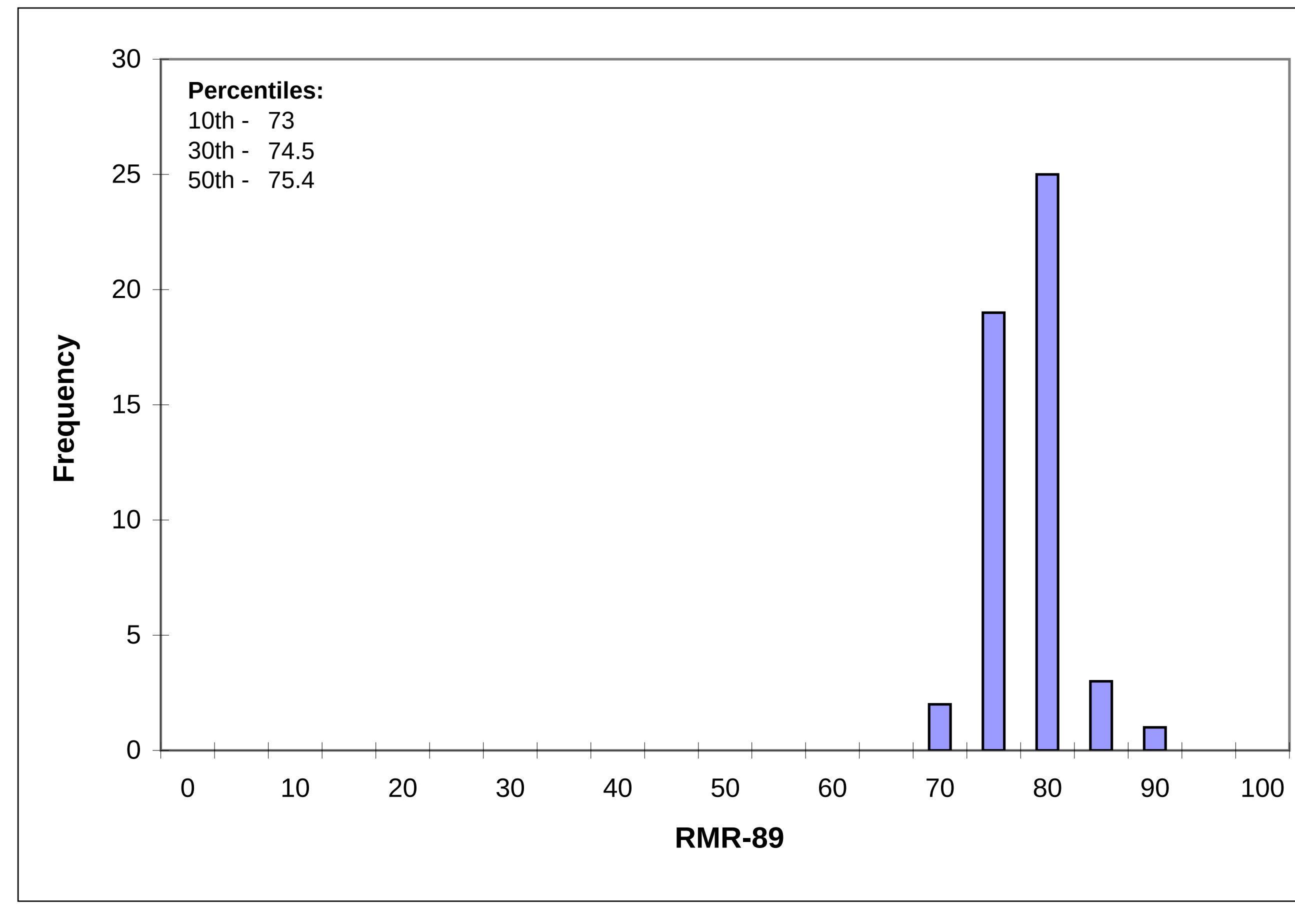



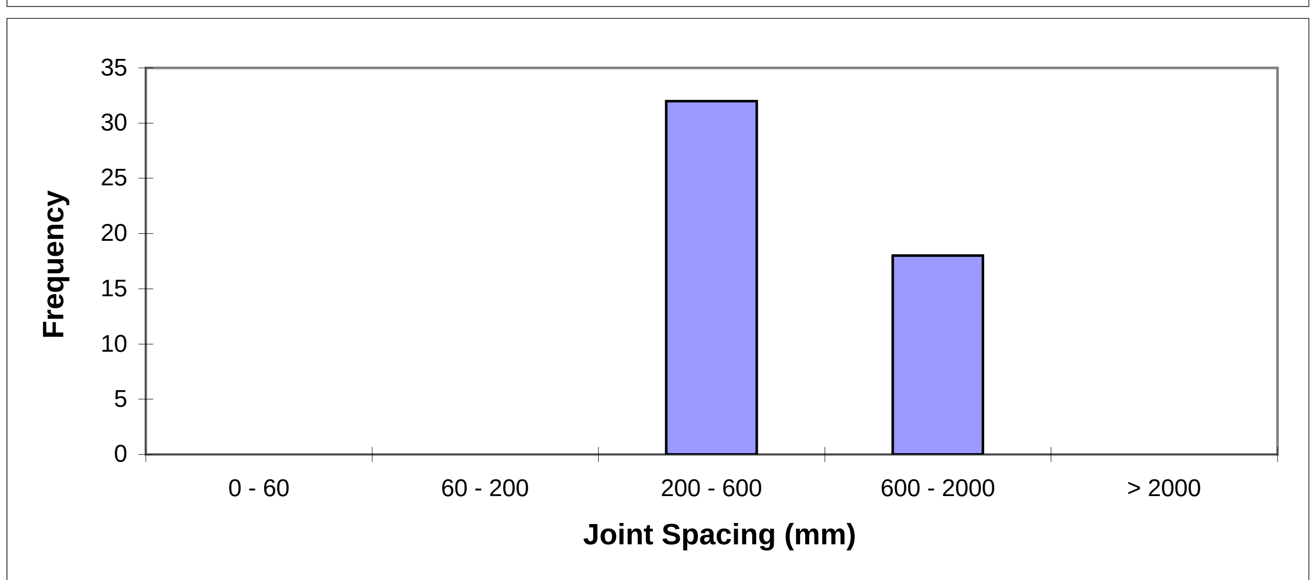




**NOTES:**

1. BINS INCLUDE PREVIOUS RANGE (I.E., BIN 60 INCLUDES VALUES FROM 55-60).
2. RQD, RMR89, JOINT SPACING, AND UCS ARE RUN BASED PARAMETERS WHILE JOINT CONDITION RATING AND PARAMETERS ARE BASED ON INDIVIDUAL DISCONTINUITIES WITHIN A LOGGING RUN.

AVALON RARE METALS INC.

THOR LAKE PROJECT

**FEASIBILITY GEOMECHANICAL PROGRAM**
**$RMR_{89}$ PARAMETER HISTOGRAMS FOR L10-283**

Knight Piésold CONSULTING

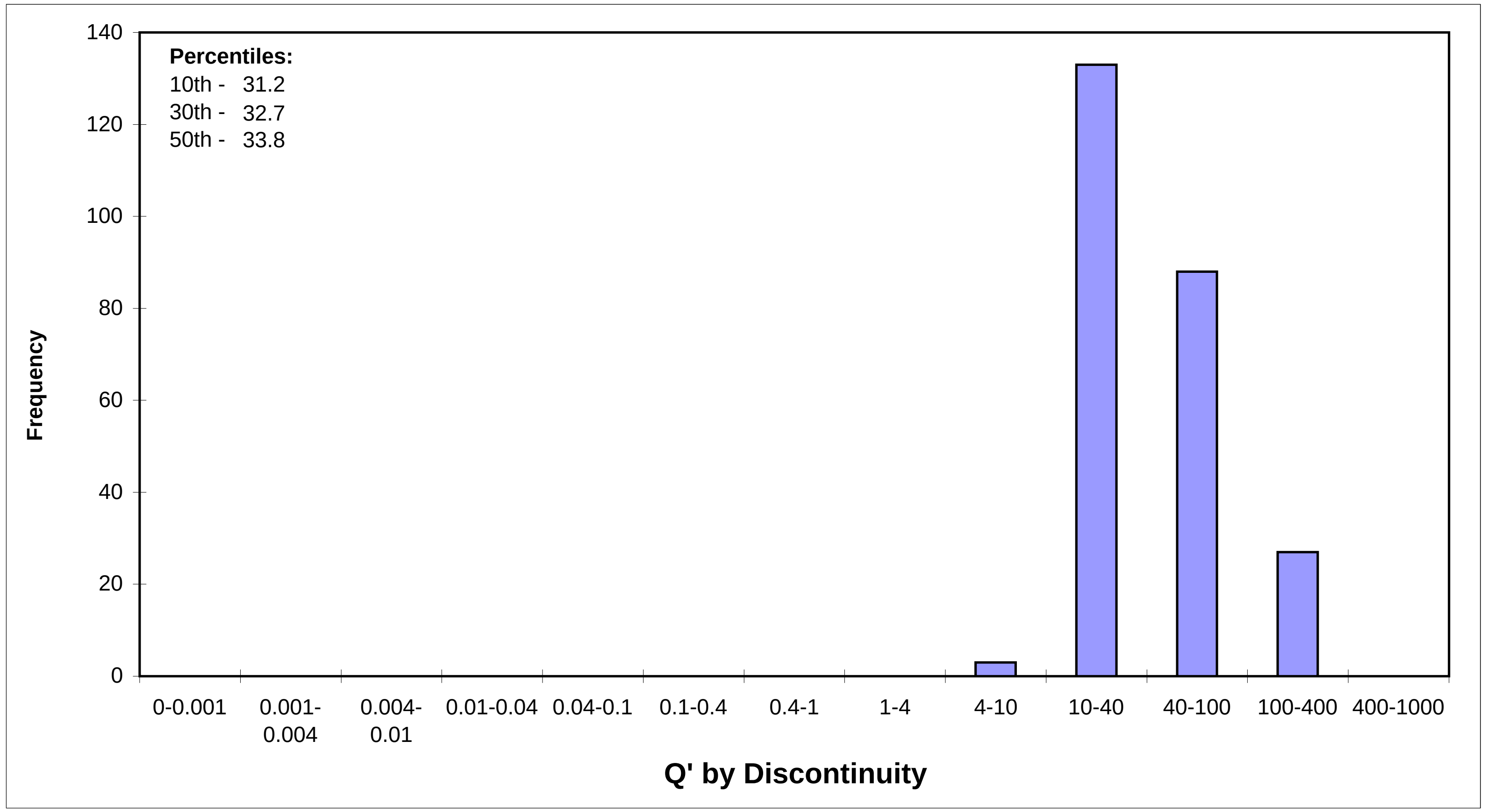
P/A NO. NB101-390/2

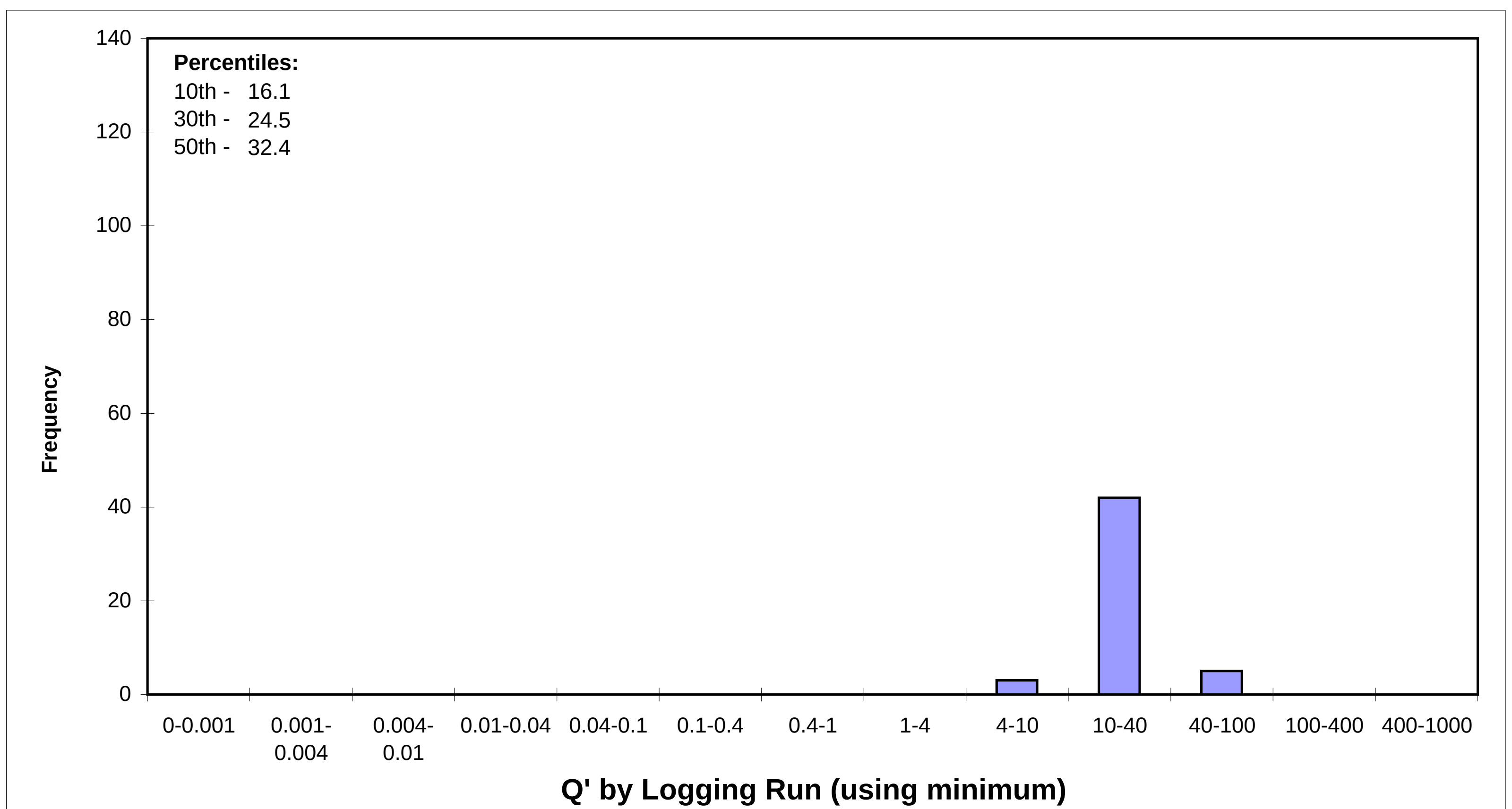
REF. NO. NB10-00570

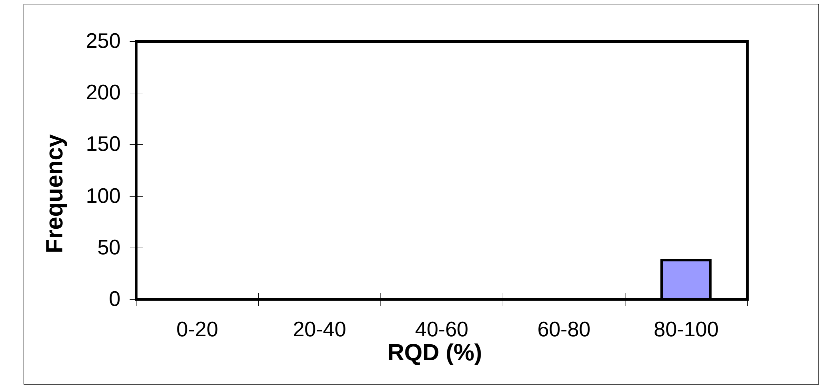
**FIGURE 28**

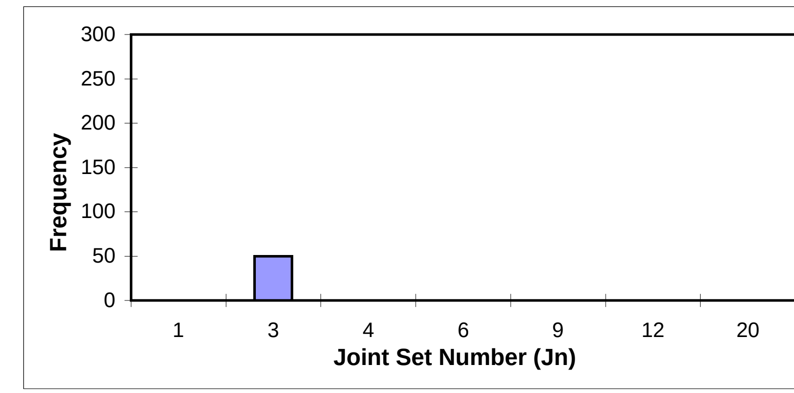
REV 0

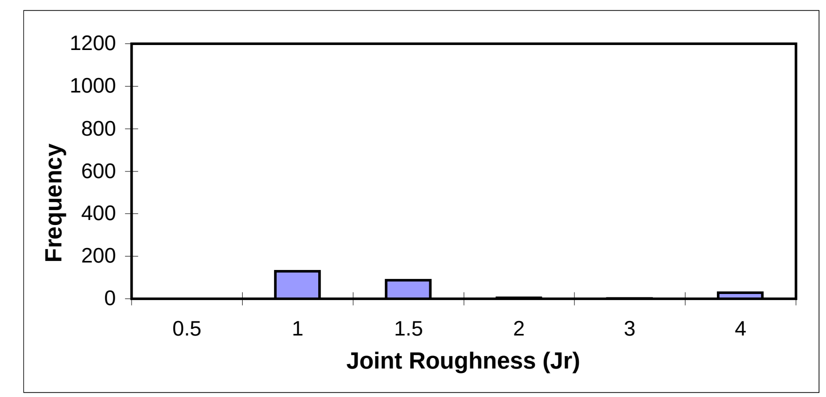
| REV | DATE | DESCRIPTION | PREP'D | CHK'D | APP'D |
|---|---|---|---|---|---|
| 0 | 19NOV'10 | ISSUED WITH MEMO | AJ | BDP | RAM |

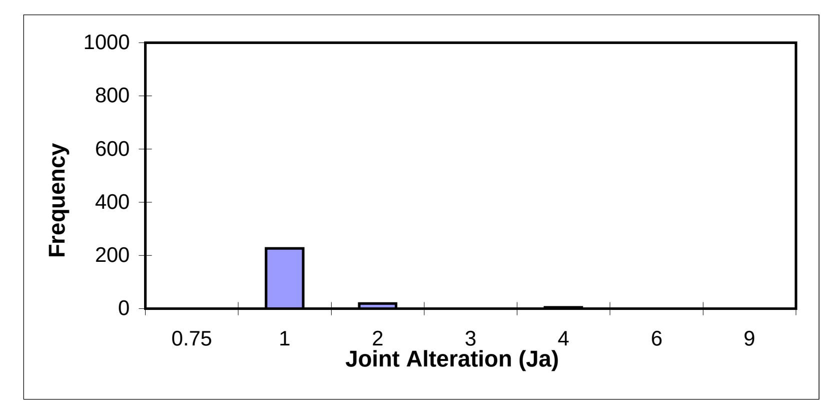



**NOTES:**

1. RQD AND Jn ARE RUN BASED PARAMETERS WHILE Jr AND Ja ARE BASED ON INDIVIDUAL DISCONTINUITIES WITHIN A LOGGING RUN.

AVALON RARE METALS INC.

THOR LAKE PROJECT

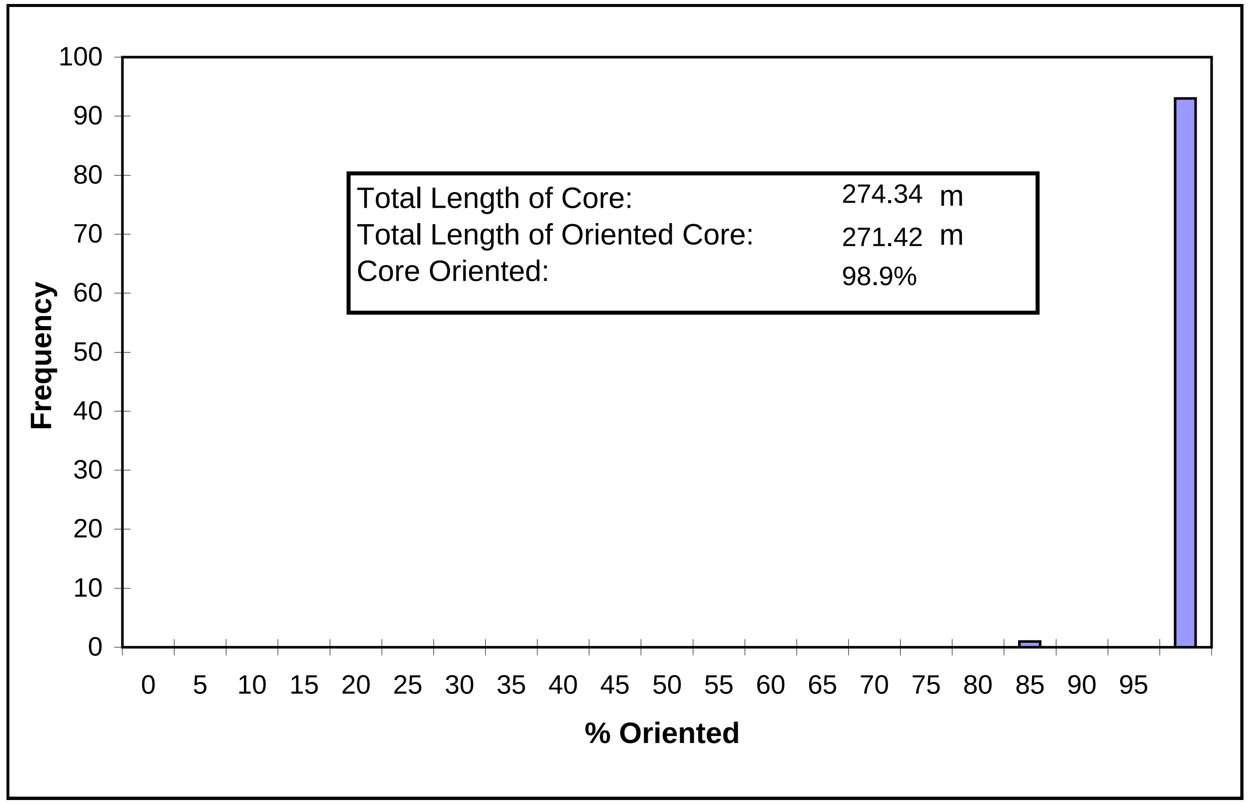
**FEASIBILITY GEOMECHANICAL PROGRAM**
**Q' PARAMETER HISTOGRAMS FOR L10-283**

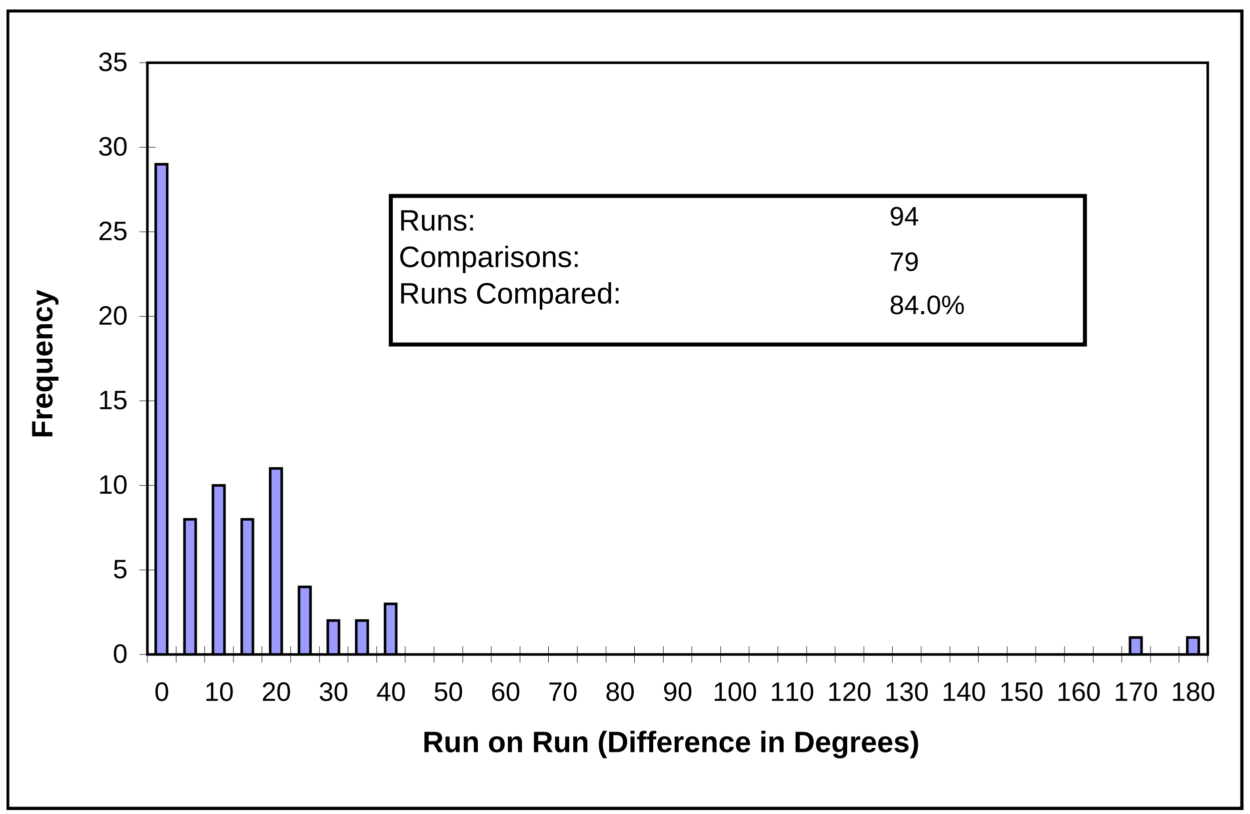
Knight Piésold CONSULTING

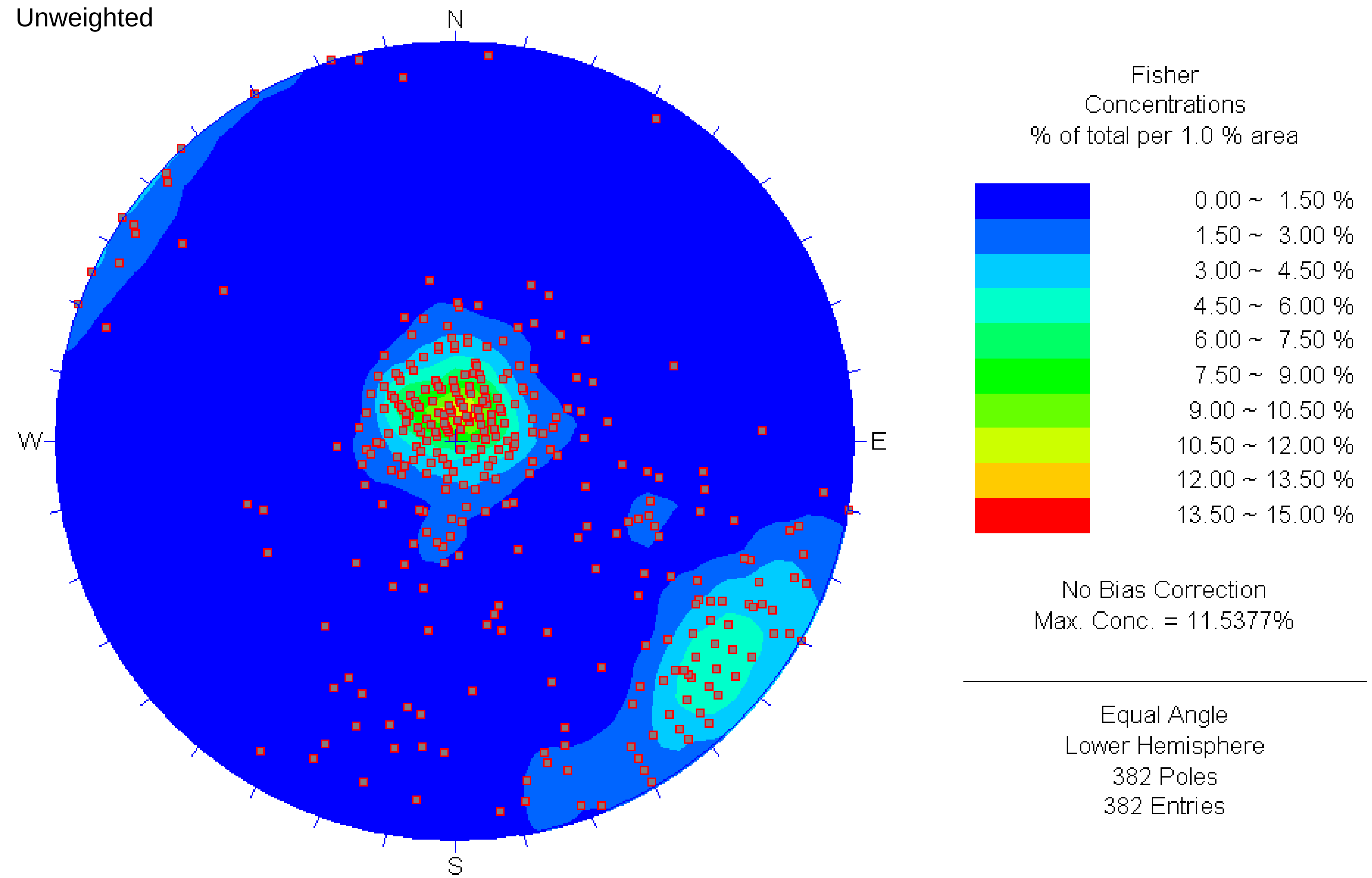
| P/A NO. | REF. NO. |
|---|---|
| NB101-390/2 | NB10-00570 |

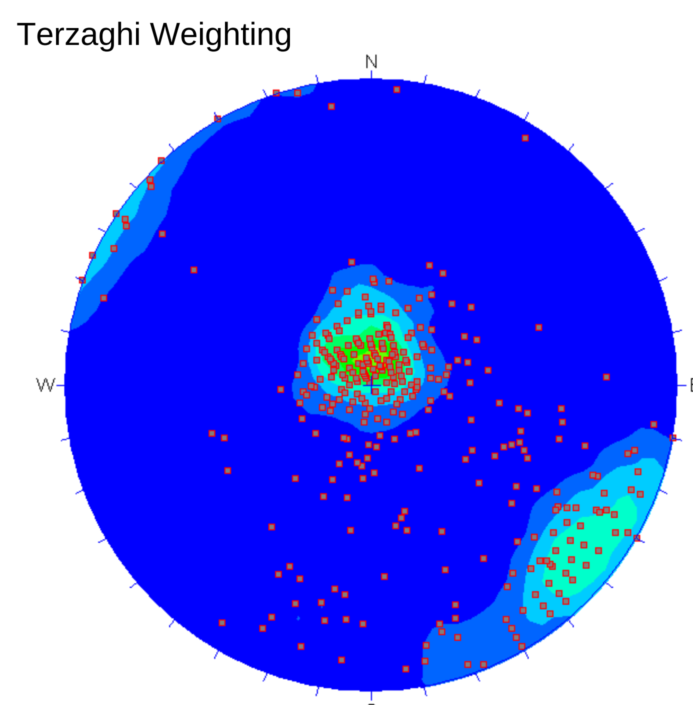
**FIGURE 29** REV 0

| 0 | 19NOV'10 | ISSUED WITH MEMO | AJ | BDP | RAM |
|---|---|---|---|---|---|
| REV | DATE | DESCRIPTION | PREP'D | CHK'D | APP'D |




## Drillhole Details

Azimuth: 150°
Dip: -55°
Length: 277.6 m

| | | | | | |
|---|---|---|---|---|---|
| 0 | 19NOV'10 | ISSUED WITH MEMO | AJ | BDP | RAM |
| REV | DATE | DESCRIPTION | PREP'D | CHK'D | APP'D |

AVALON RARE METALS INC.

THOR LAKE PROJECT

**FEASIBILITY GEOMECHANICAL PROGRAM**
**DRILLHOLE ORIENTATION RESULTS**
**L10-285**

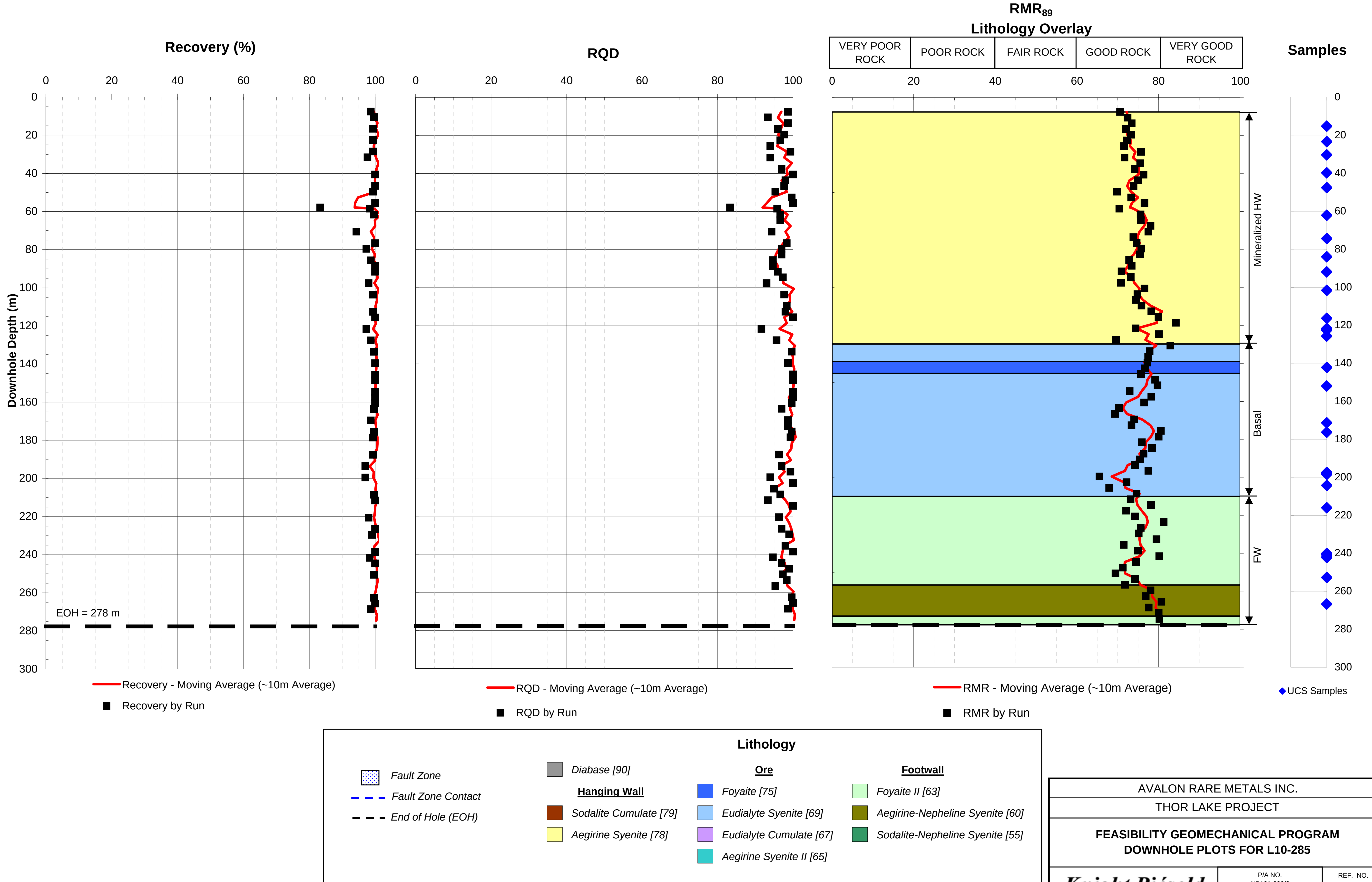
Knight Piésold CONSULTING

P/A NO. NB101-390/2

REF. NO. NB10-00570

**FIGURE 30**

REV 0




AVALON RARE METALS INC.

THOR LAKE PROJECT

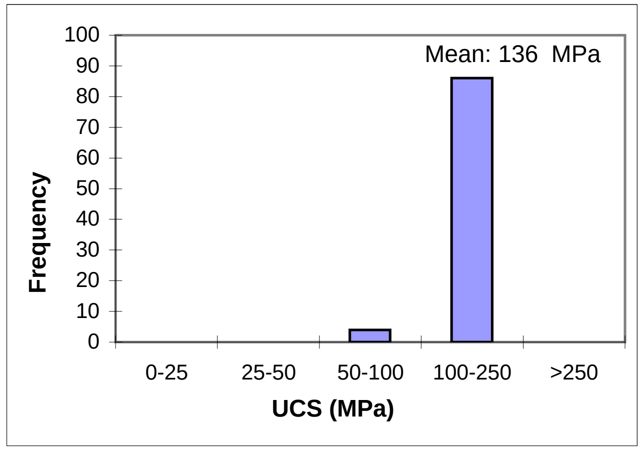
**FEASIBILITY GEOMECHANICAL PROGRAM**
**DOWNHOLE PLOTS FOR L10-285**

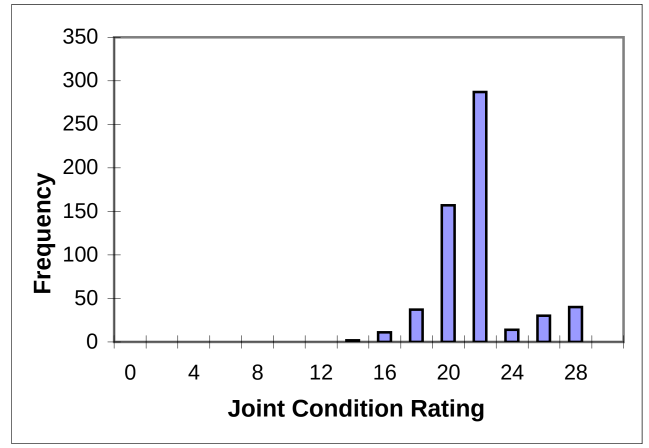
Knight Piésold CONSULTING

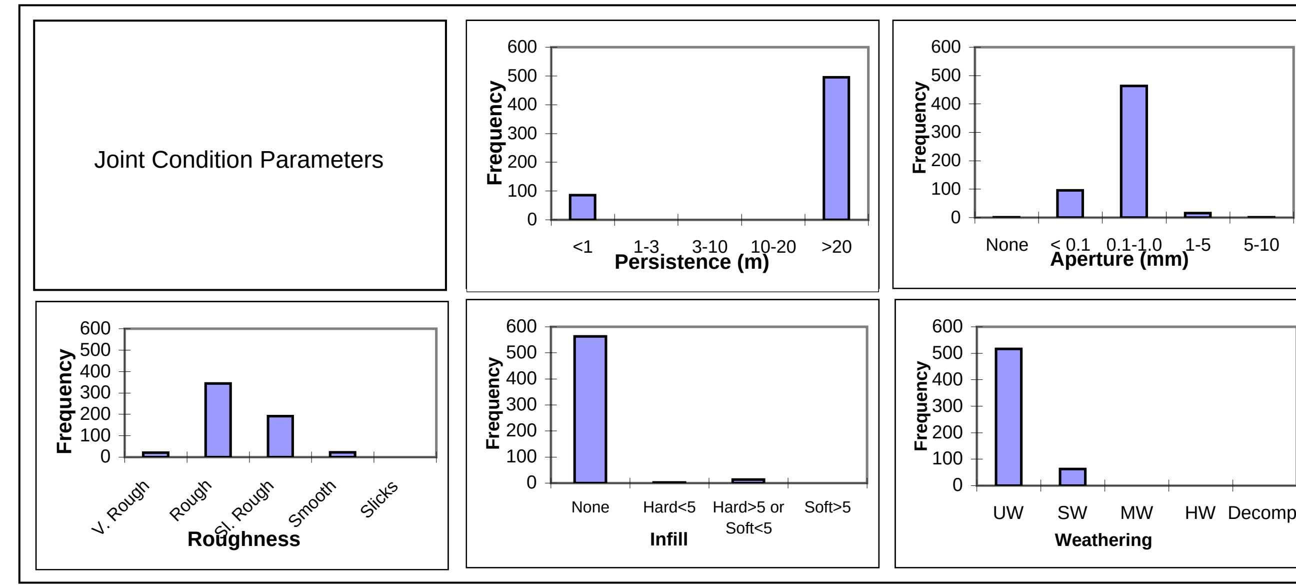
P/A NO. NB101-390/2 | REF. NO. NB10-00570

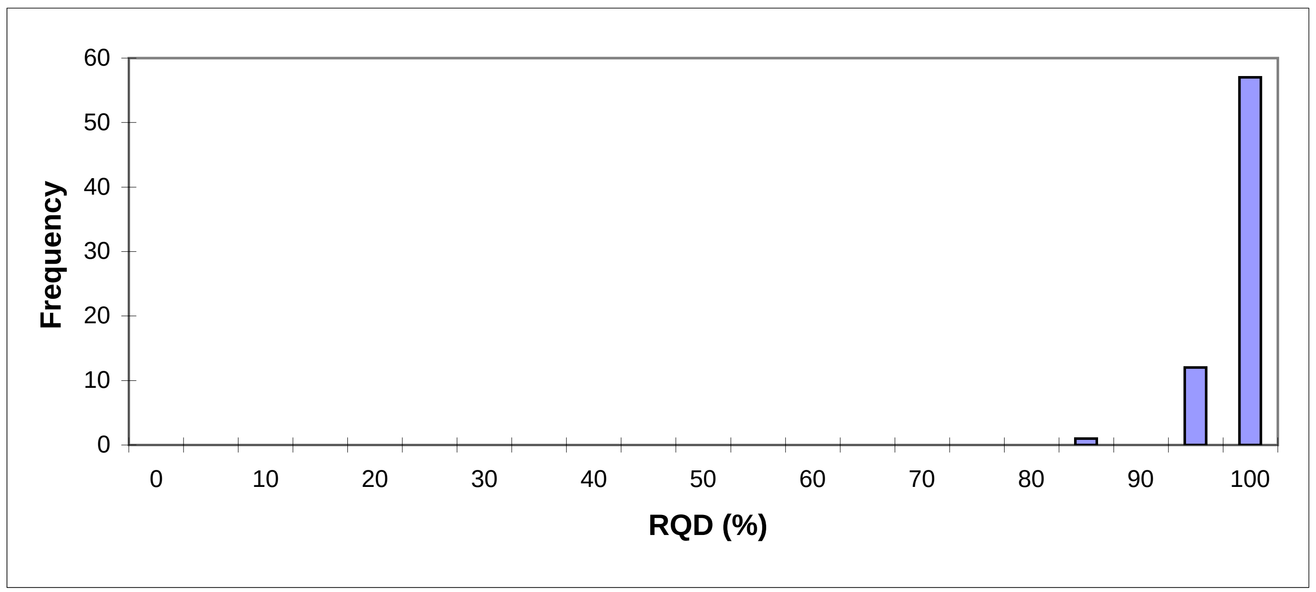
**FIGURE 31** REV 0

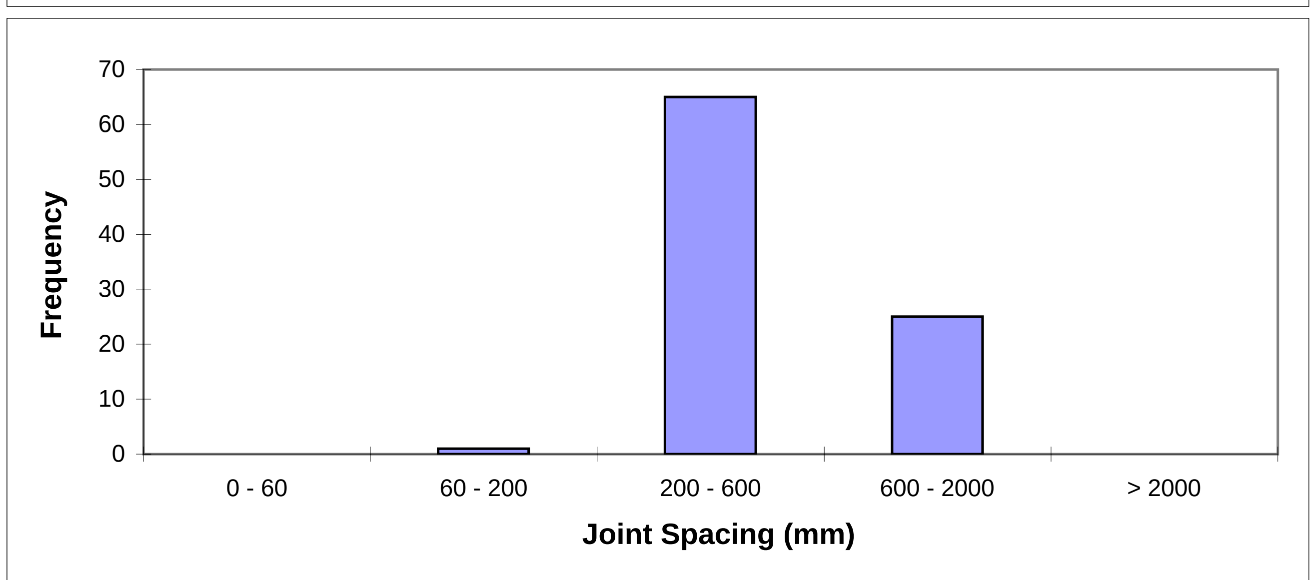
| | | | | | |
|---|---|---|---|---|---|
| 0 | 19NOV'10 | ISSUED WITH MEMO | AJ | BDP | RAM |
| REV | DATE | DESCRIPTION | PREP'D | CHK'D | APP'D |

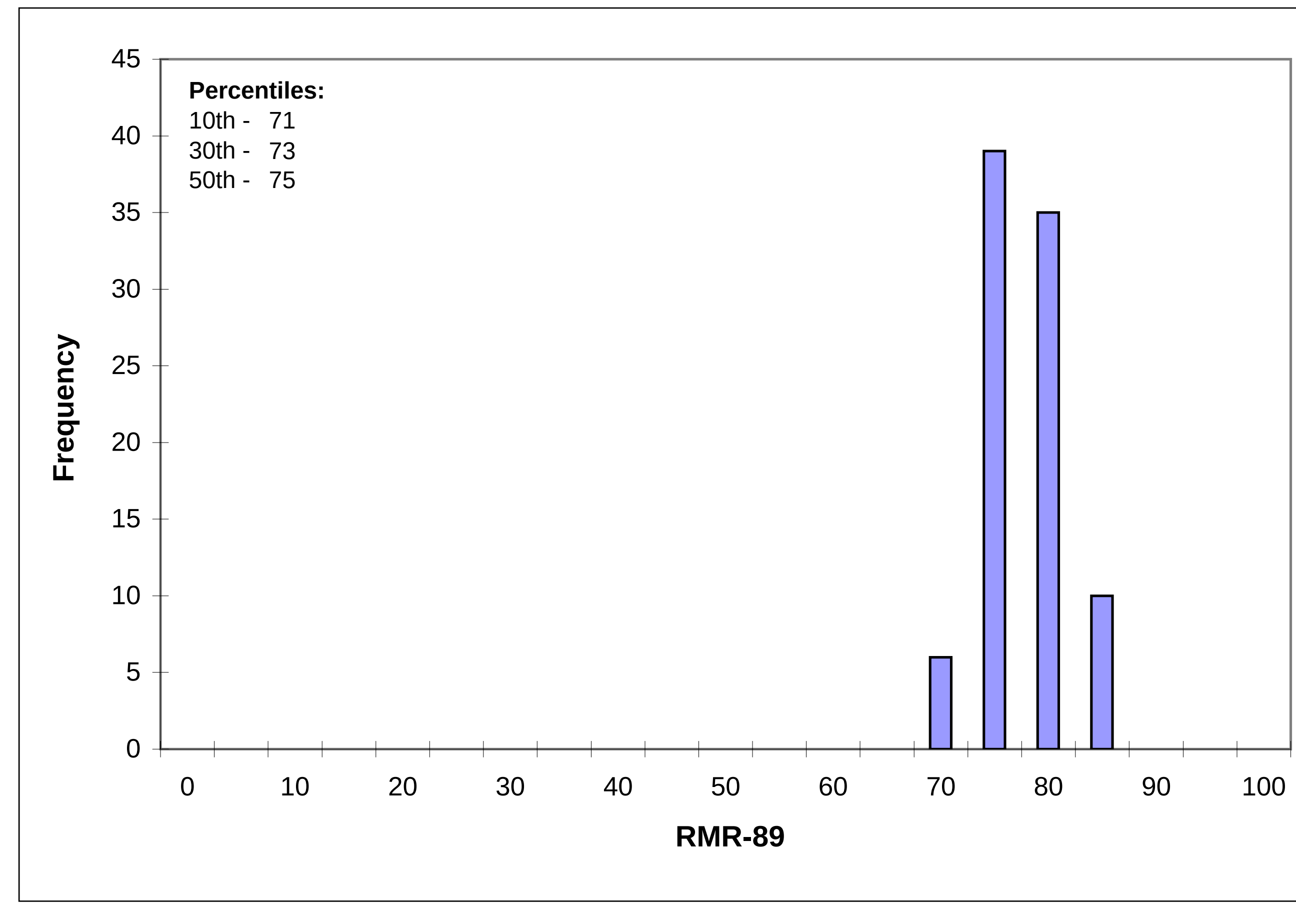



**NOTES:**

1. BINS INCLUDE PREVIOUS RANGE (I.E., BIN 60 INCLUDES VALUES FROM 55-60).
2. RQD, RMR89, JOINT SPACING, AND UCS ARE RUN BASED PARAMETERS WHILE JOINT CONDITION RATING AND PARAMETERS ARE BASED ON INDIVIDUAL DISCONTINUITIES WITHIN A LOGGING RUN.

| | | | | | |
|---|---|---|---|---|---|
| 0 | 19NOV'10 | ISSUED WITH MEMO | AJ | BDP | RAM |
| REV | DATE | DESCRIPTION | PREP'D | CHK'D | APP'D |

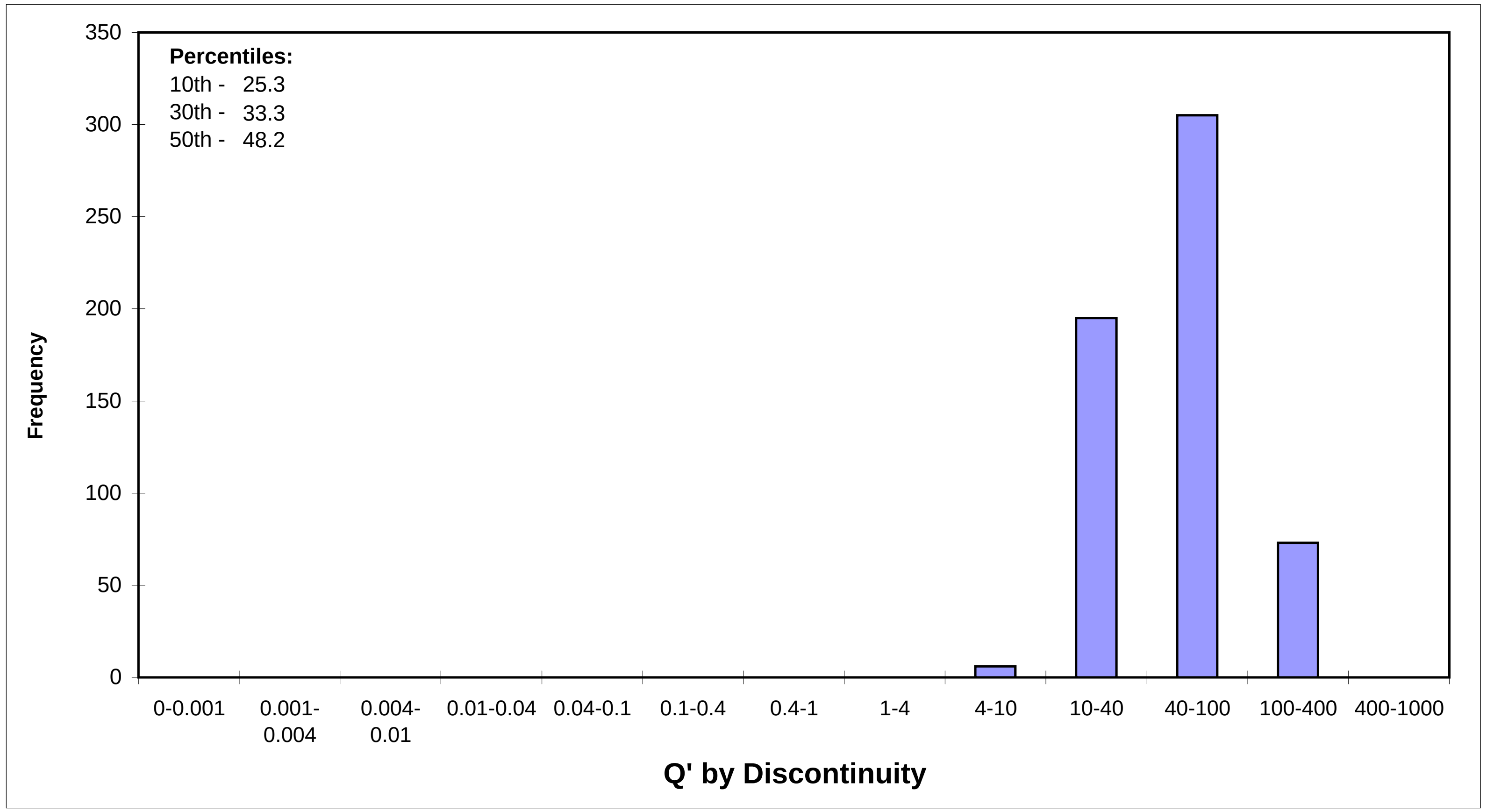
AVALON RARE METALS INC.

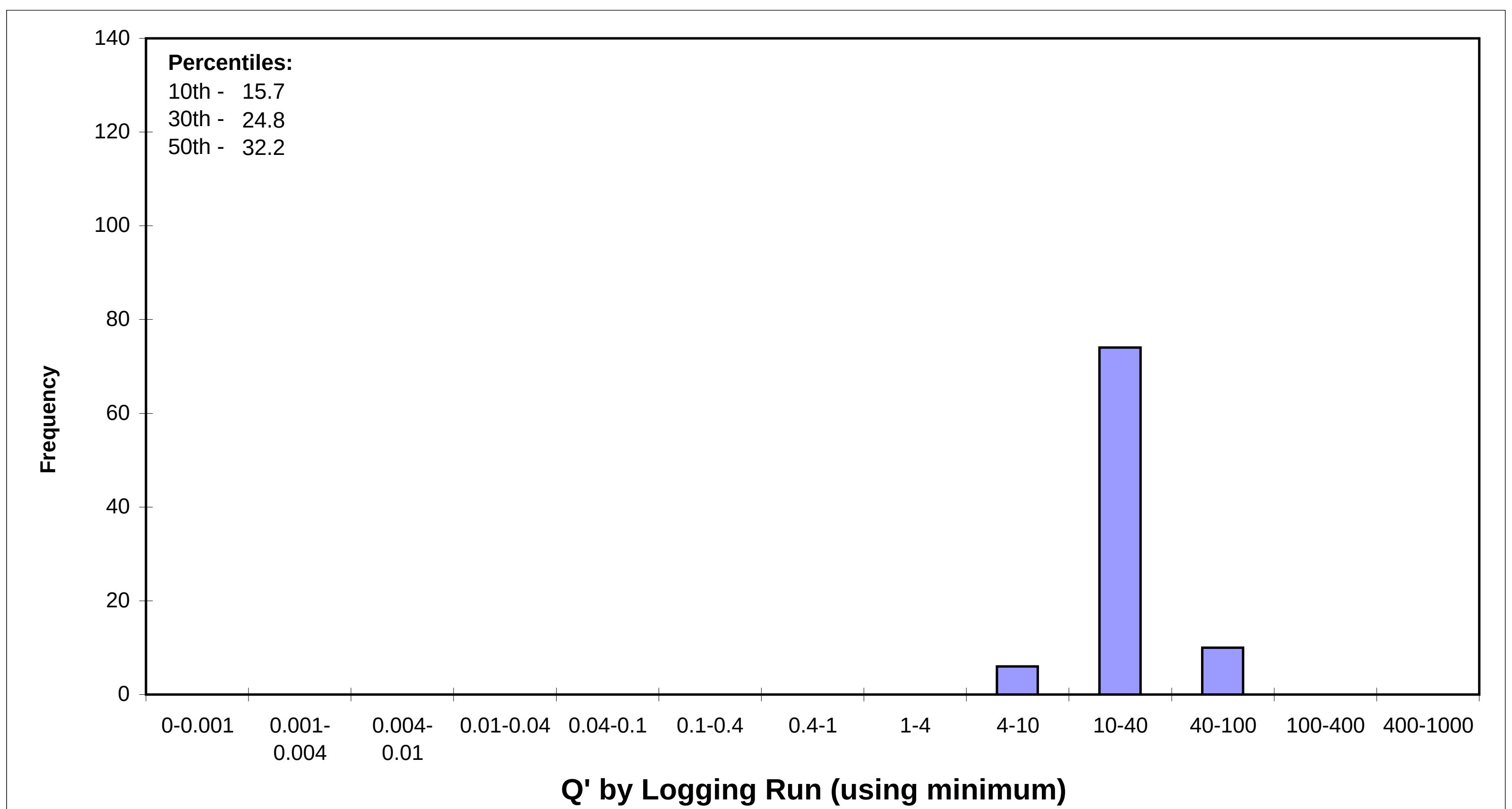
THOR LAKE PROJECT

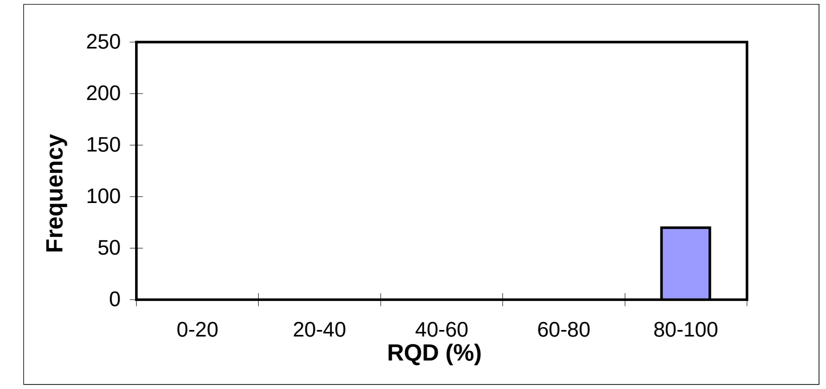
**FEASIBILITY GEOMECHANICAL PROGRAM**
**$RMR_{89}$ PARAMETER HISTOGRAMS FOR L10-285**

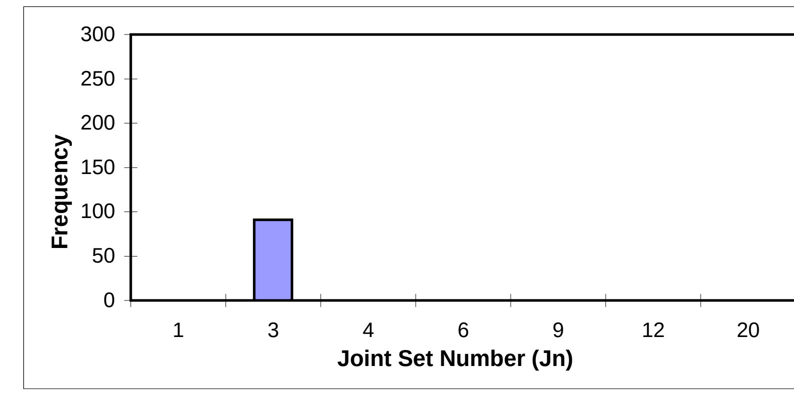
Knight Piésold CONSULTING

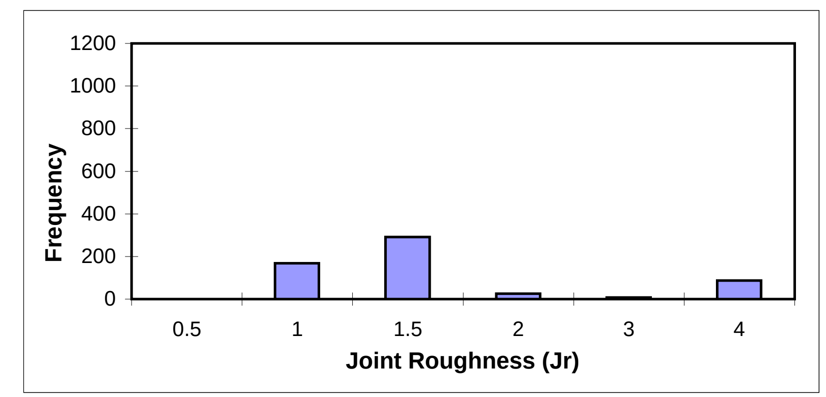
| | | |
|---|---|---|
| P/A NO. NB101-390/2 | REF. NO. NB10-00570 | |
| FIGURE 32 | | REV 0 |

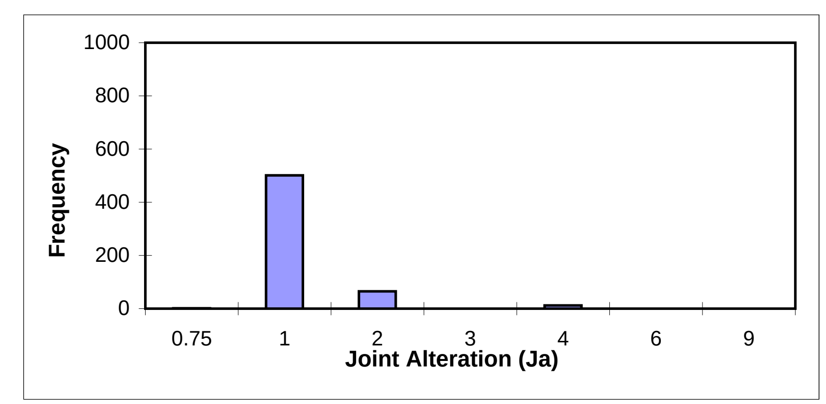



**NOTES:**
1. RQD AND Jn ARE RUN BASED PARAMETERS WHILE Jr AND Ja ARE BASED ON INDIVIDUAL DISCONTINUITIES WITHIN A LOGGING RUN.

| | | | | | | |
|---|---|---|---|---|---|---|
| 0 | 19NOV'10 | ISSUED WITH MEMO | AJ | BDP | RAM |
| REV | DATE | DESCRIPTION | PREP'D | CHK'D | APP'D |

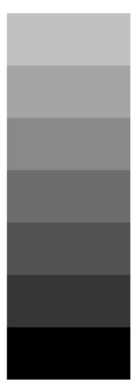
AVALON RARE METALS INC.
THOR LAKE PROJECT

**FEASIBILITY GEOMECHANICAL PROGRAM**
**Q' PARAMETER HISTOGRAMS FOR L10-285**

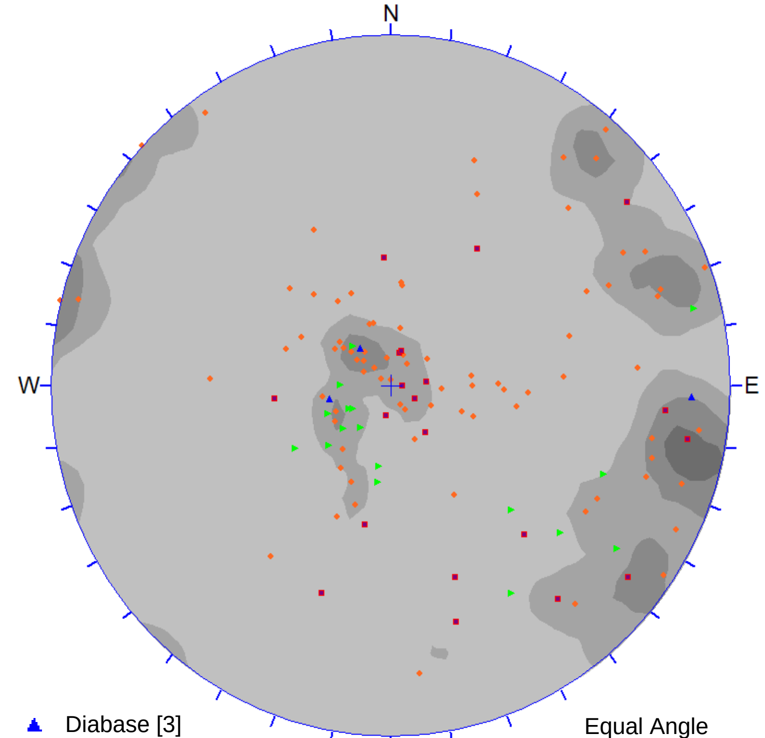
Knight Piésold CONSULTING

| P/A NO. | REF. NO. | |
|---|---|---|
| NB101-390/2 | NB10-00570 | |
| FIGURE 33 | | REV 0 |

Contour Legend



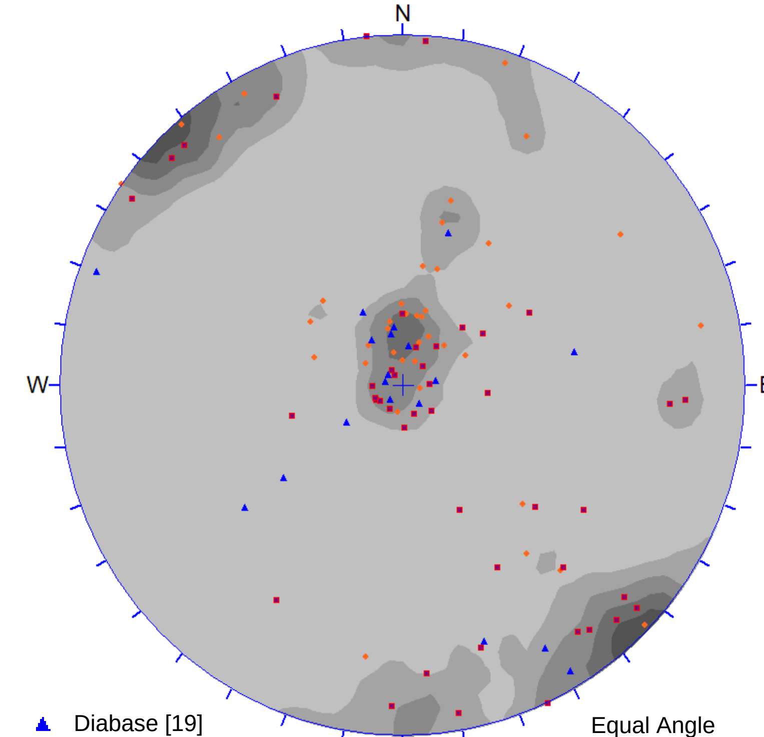

**L10-271**




Diabase [3]
Hanging Wall [82]
Basal Zone [20]
Footwall [17]

Equal Angle
Lower Hemisphere
122 Poles
122 Entries

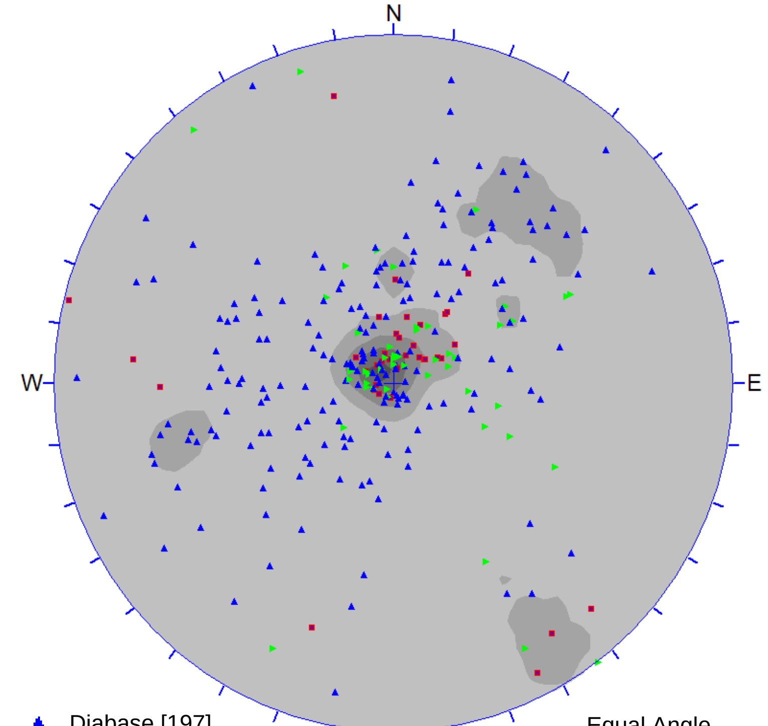
**L10-273**




Diabase [19]
Hanging Wall [40]
Basal Zone [44]

Equal Angle
Lower Hemisphere
103 Poles
103 Entries

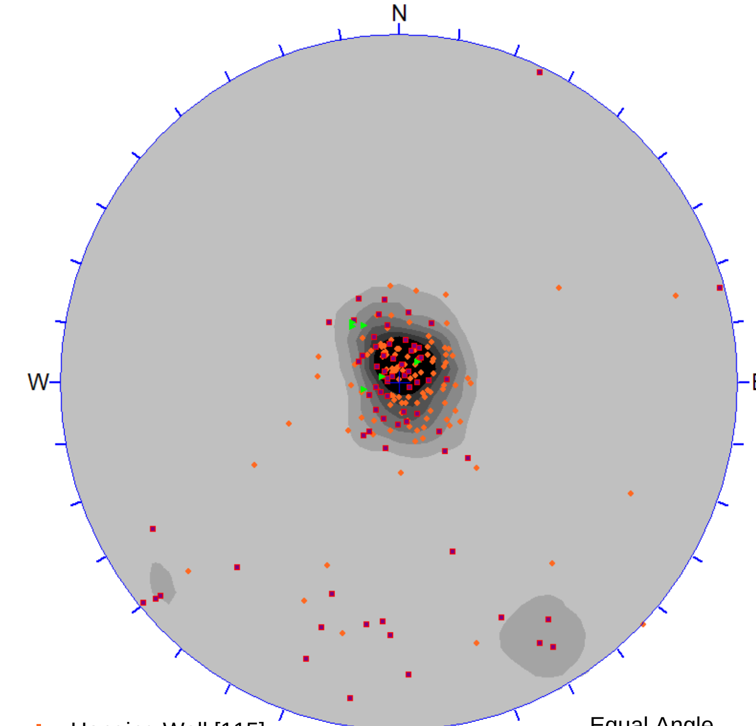
**L10-275**




Diabase [197]
Basal Zone [36]
Footwall [49]

Equal Angle
Lower Hemisphere
282 Poles
282 Entries

**L10-277** [3]




Hanging Wall [115]
Basal Zone [74]
Footwall [6]

Equal Angle
Lower Hemisphere
384 Poles
384 Entries

**NOTES:**

1. TERZAGHI WEIGHTING APPLIED TO REDUCE DIRECTIONAL BIAS.
2. ORIENTATION DATA INCLUDES ONLY THOSE OF GOOD OR VERY GOOD QUALITY AND DOES NOT INCLUDE DISCONTINUITIES THOUGHT TO BE DRILLING-INDUCED.
3. SODALITE CUMULATE IN DRILLHOLE L10-277 WAS NOT INCLUDED DUE TO INSUFFICIENT DATA (GROUPED INTO HW).

| REV | DATE | DESCRIPTION | PREP'D | CHK'D | APP'D |
|---|---|---|---|---|---|
| 0 | 19NOV'10 | ISSUED WITH MEMO | AJ | BDP | RAM |

AVALON RARE METALS INC.

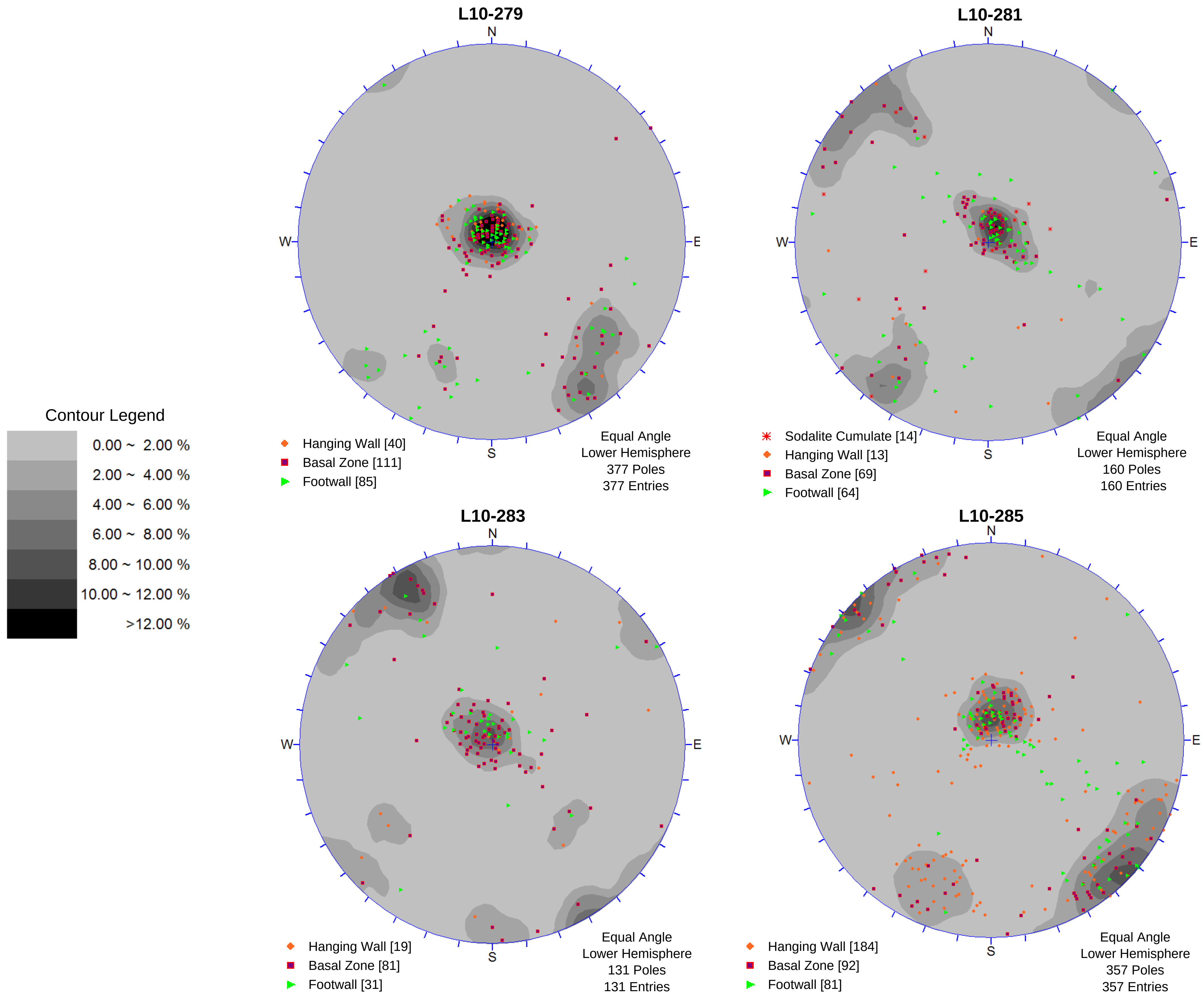
THOR LAKE PROJECT

**FEASIBILITY GEOMECHANICAL PROGRAM**
**GEOMECHANICAL DRILLHOLE STEREONETS**
**(1 of 2)**

Knight Piésold CONSULTING

| P/A NO. | Ref. No. |
|---|---|
| NB101-390/2 | NB10-00570 |

**FIGURE 34** Rev 0




**NOTES:**

1. TERZAGHI WEIGHTING APPLIED TO REDUCE DIRECTIONAL BIAS.
2. ORIENTATION DATA INCLUDES ONLY THOSE OF GOOD OR VERY GOOD QUALITY AND DOES NOT INCLUDE DISCONTINUITIES THOUGHT TO BE DRILLING-INDUCED.

| REV | DATE | DESCRIPTION | PREP'D | CHK'D | APP'D |
|---|---|---|---|---|---|
| 0 | 19NOV'10 | ISSUED WITH MEMO | AJ | BDP | RAM |

AVALON RARE METALS INC.

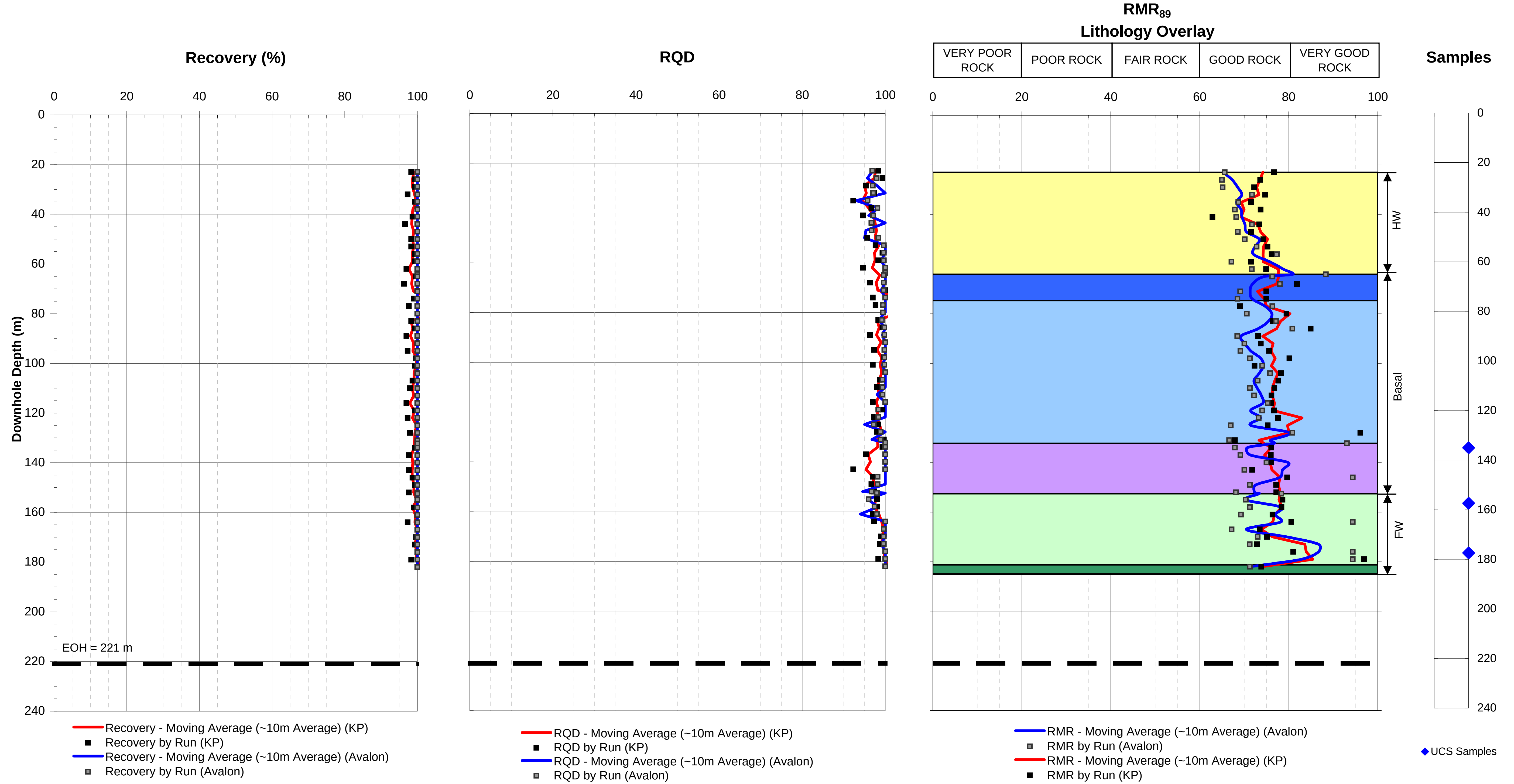
THOR LAKE PROJECT

**FEASIBILITY GEOMECHANICAL PROGRAM**
**GEOMECHANICAL DRILLHOLE STEREONETS**
**(2 of 2)**

Knight Piésold CONSULTING

| P/A NO. | Ref. No. |
|---|---|
| NB101-390/2 | NB10-00570 |

**FIGURE 35** Rev 0




**Lithology**

| | | | |
|---|---|---|---|
| *Fault Zone* | *Diabase [90]* | **Ore** | **Footwall** |
| *Fault Zone Contact* | **Hanging Wall** | *Foyaite [75]* | *Foyaite II [63]* |
| *End of Hole (EOH)* | *Sodalite Cumulate [79]* | *Eudialyte Syenite [69]* | *Aegirine-Nepheline Syenite [60]* |
| | *Aegirine Syenite [78]* | *Eudialyte Cumulate [67]* | *Sodalite-Nepheline Syenite [55]* |
| | | *Aegirine Syenite II [65]* | |

**NOTES:**

1. DRILLHOLE WAS LOGGED TO A DEPTH OF 185 m BUT WAS DRILLED TO AN END DEPTH OF 221 m.
2. DRILLHOLE WAS LOGGED BY KPL STAFF USING STANDARD LOGGING PRACTICES AND BY AVALON STAFF USING THE 2009 PRE-FEASIBILITY LOGGING PRACTICES AS PART OF A LOGGING COMPARISON.

| REV | DATE | DESCRIPTION | PREP'D | CHK'D | APP'D |
|---|---|---|---|---|---|
| 0 | 19NOV'10 | ISSUED WITH MEMO | AJ | BDP | RAM |

AVALON RARE METALS INC.

THOR LAKE PROJECT

**FEASIBILITY GEOMECHANICAL PROGRAM**
**DOWNHOLE PLOTS FOR L10-287 (KPL & AVALON LOGS)**

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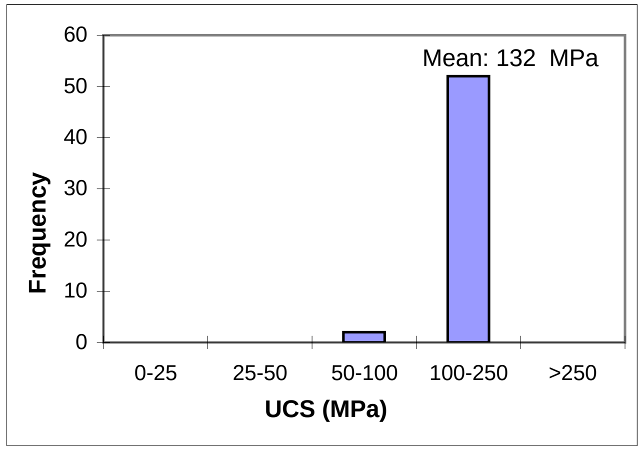
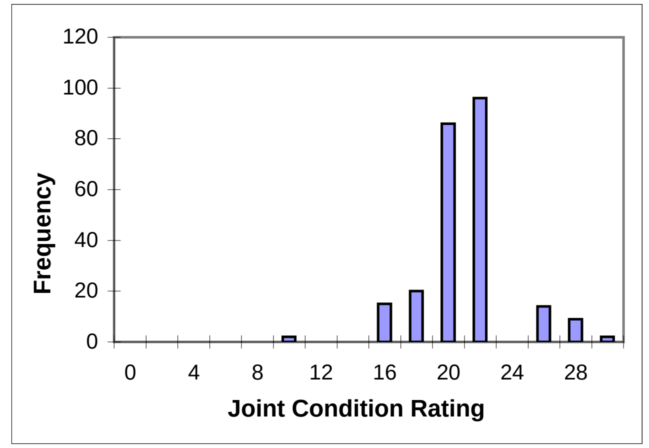
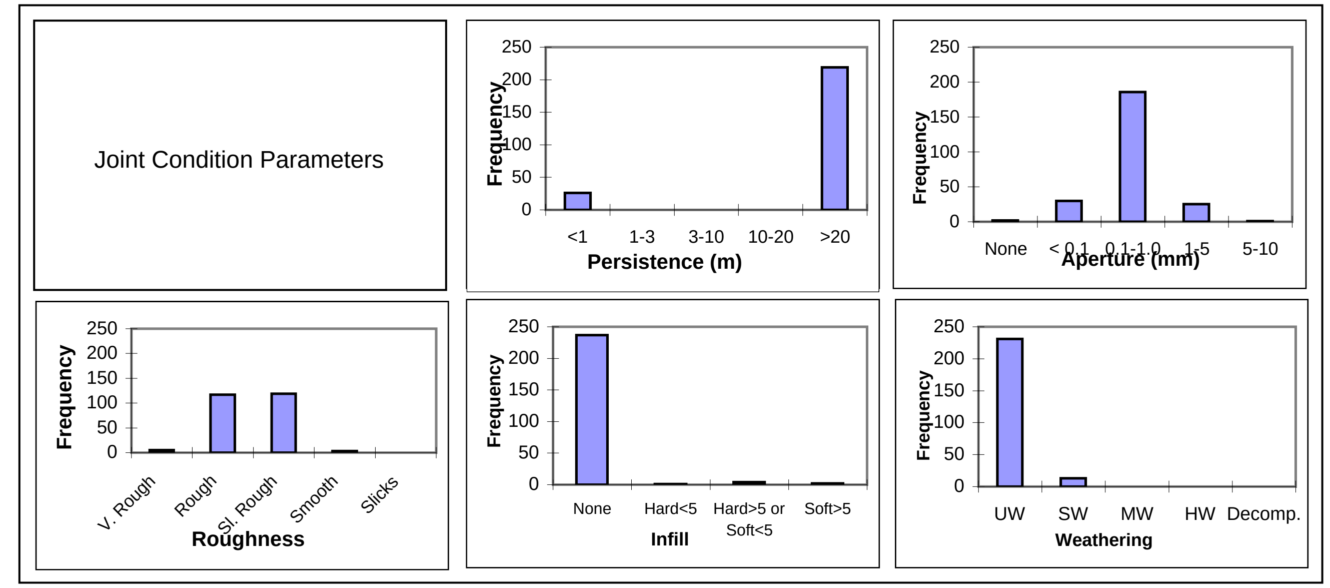
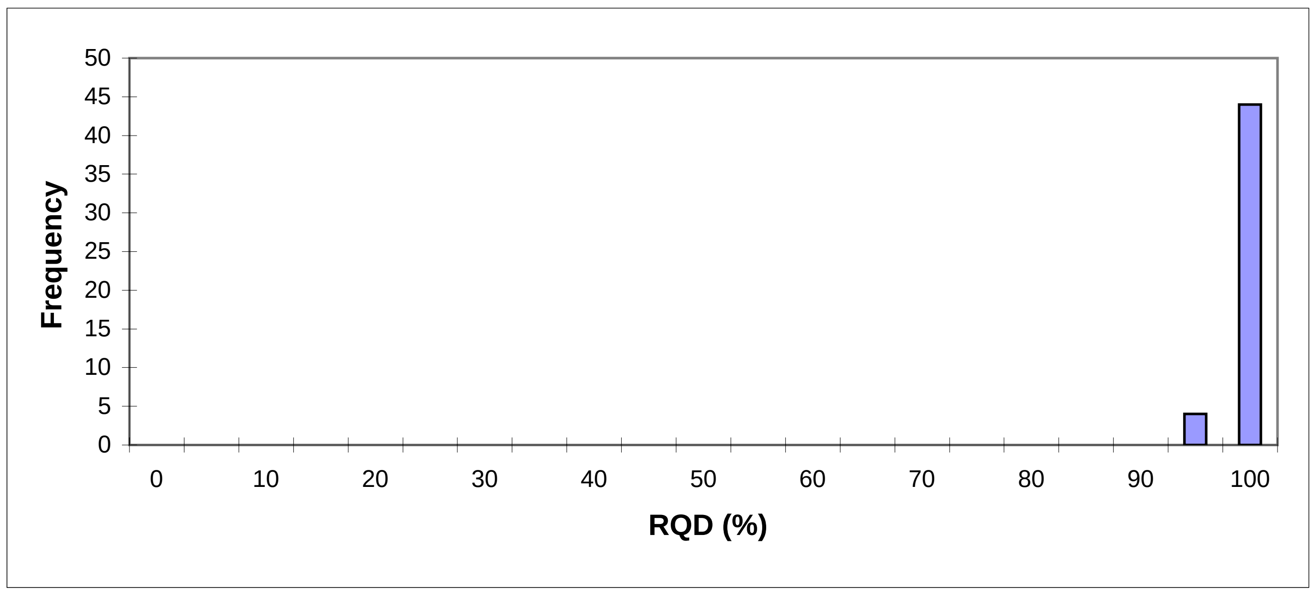
| P/A NO. | REF. NO. | REV |
|---|---|---|
| NB101-390/2 | NB10-00570 | 0 |

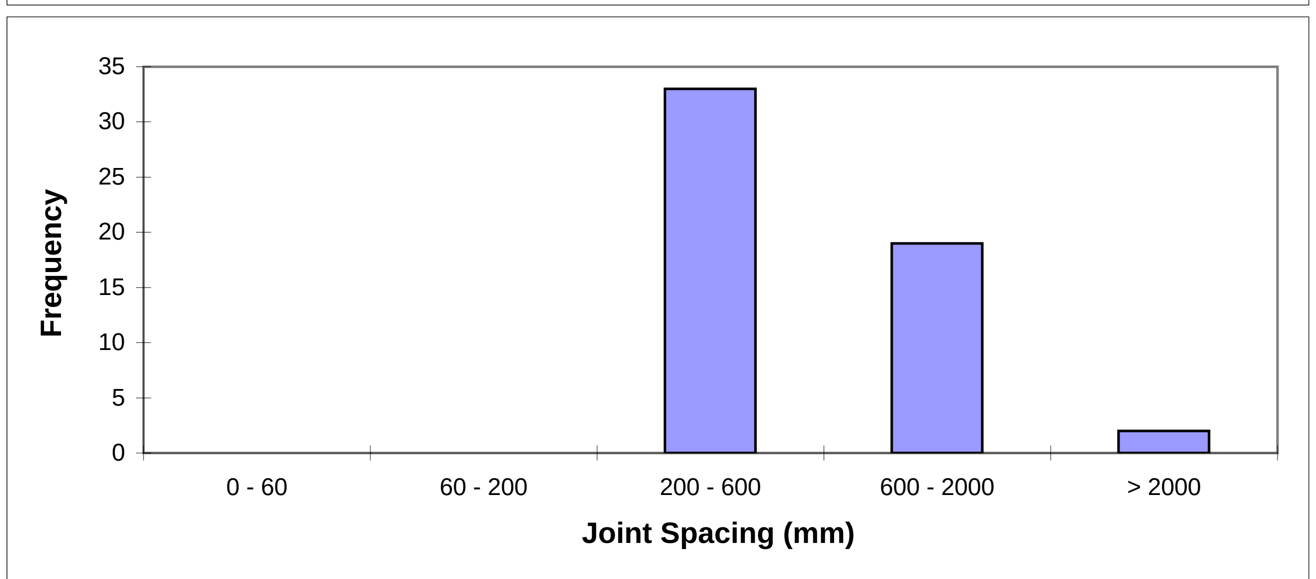
**FIGURE 36**

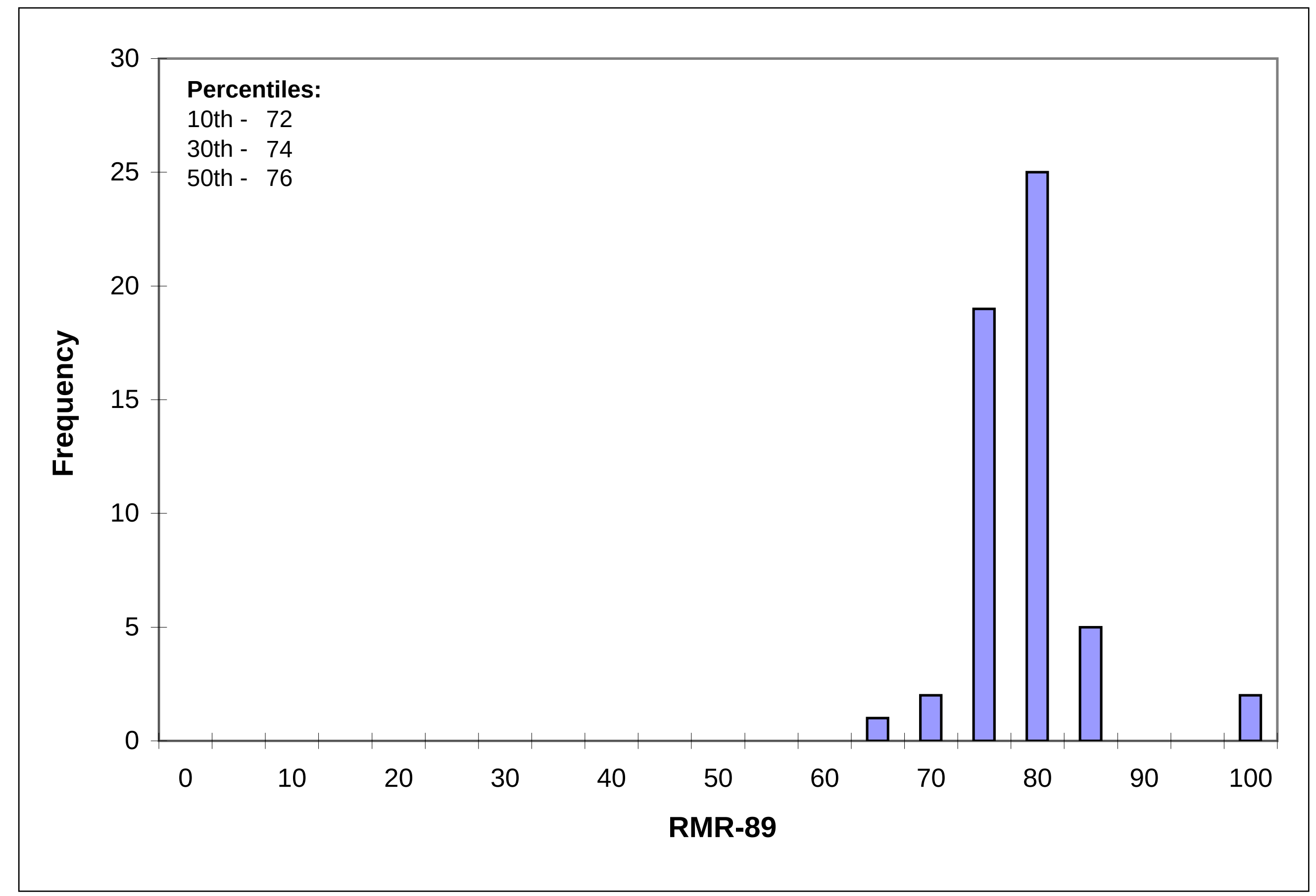


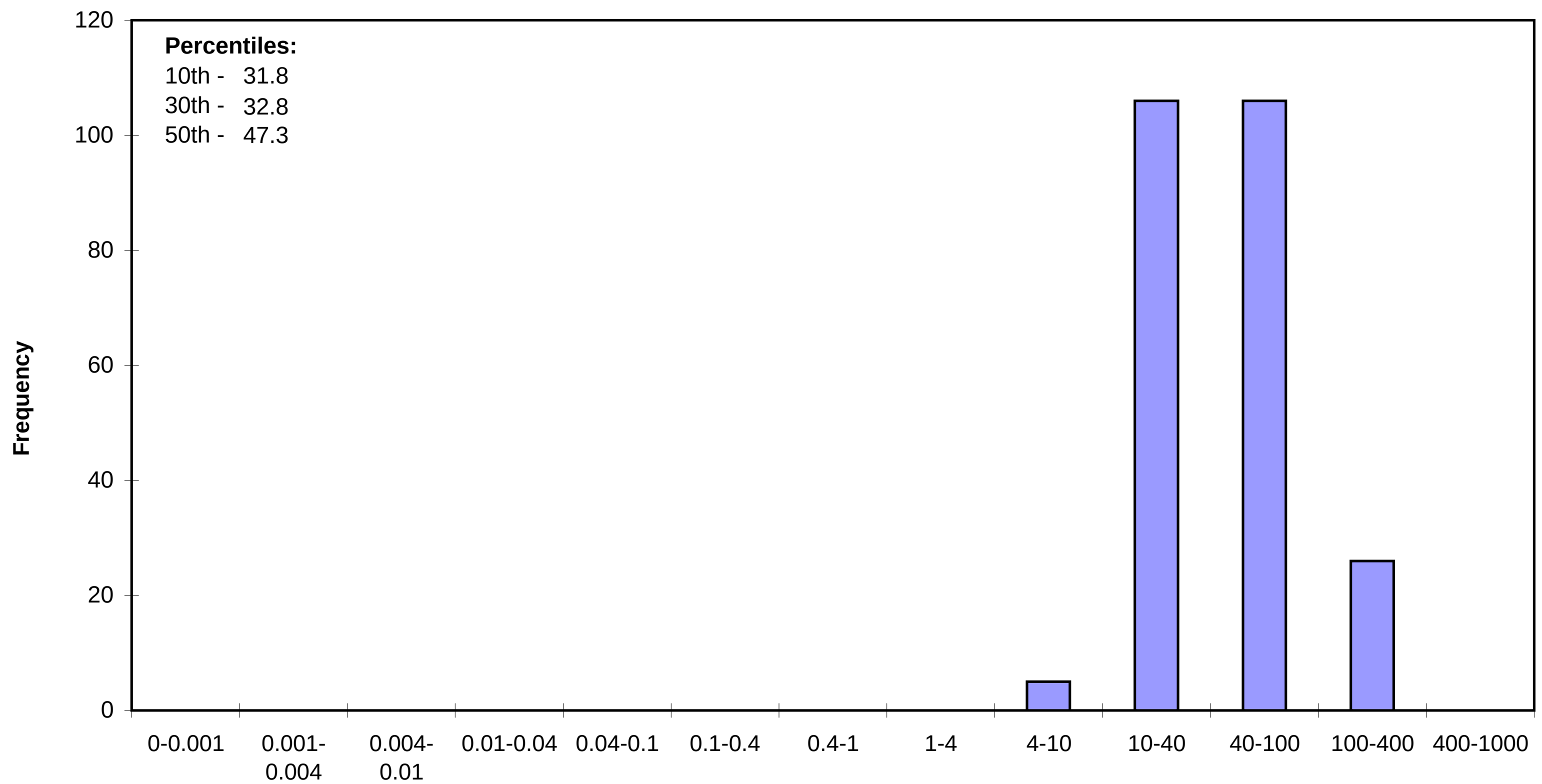




**NOTES:**

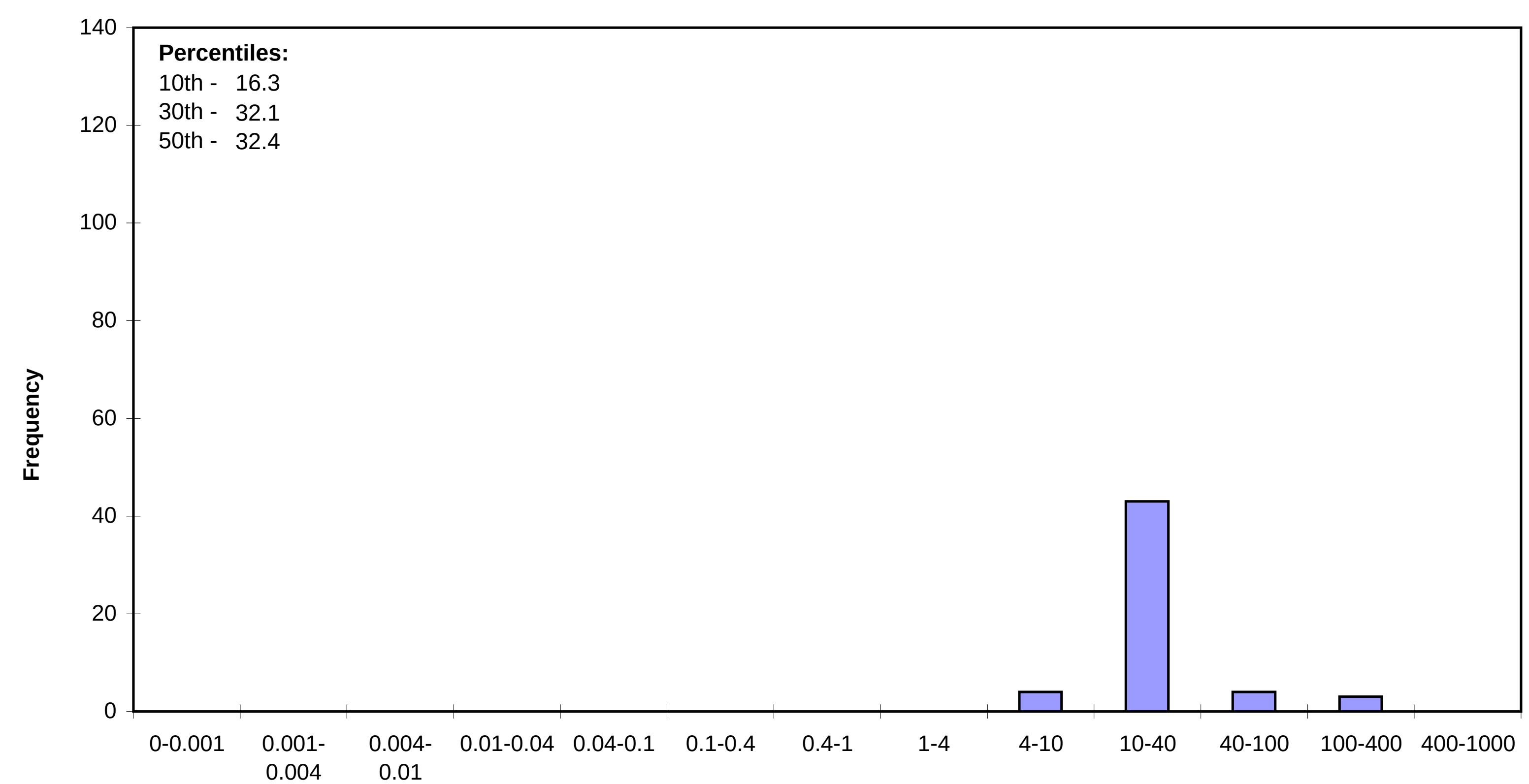
1. BINS INCLUDE PREVIOUS RANGE (I.E., BIN 60 INCLUDES VALUES FROM 55-60).
2. RQD, RMR89, JOINT SPACING, AND UCS ARE RUN BASED PARAMETERS WHILE JOINT CONDITION RATING AND PARAMETERS ARE BASED ON INDIVIDUAL DISCONTINUITIES WITHIN A LOGGING RUN.

| | |
|---|---|
| AVALON RARE METALS INC. | |
| THOR LAKE PROJECT | |
| **FEASIBILITY GEOMECHANICAL PROGRAM $RMR_{89}$ PARAMETER HISTOGRAMS FOR L10-287 (KPL)** | |
| Knight Piésold CONSULTING | P/A NO. NB101-390/2 — REF. NO. NB10-00570 |
| | **FIGURE 37** — REV 0 |

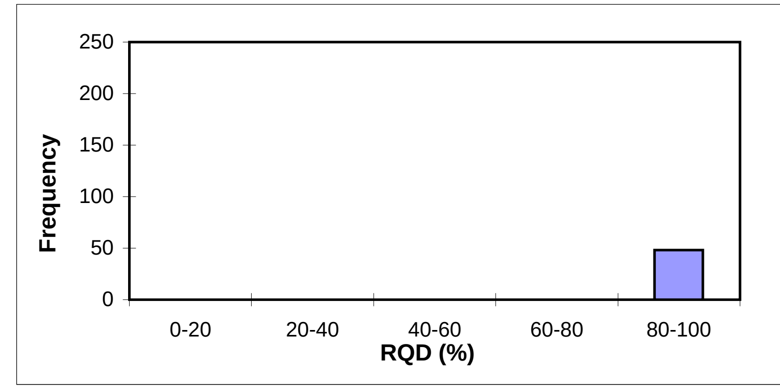
| 0 | 19NOV'10 | ISSUED WITH MEMO | AJ | BDP | RAM |
|---|---|---|---|---|---|
| REV | DATE | DESCRIPTION | PREP'D | CHK'D | APP'D |

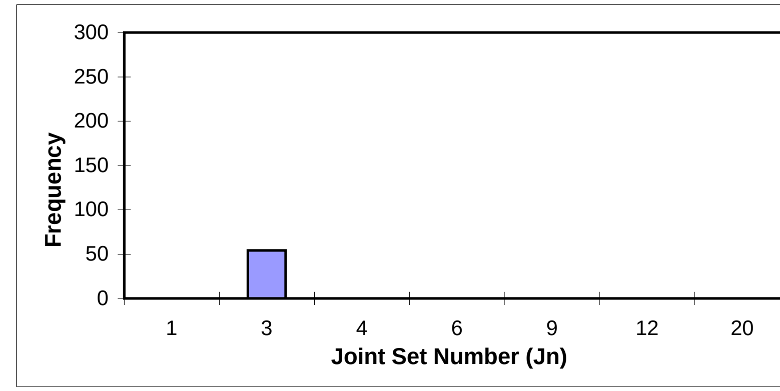


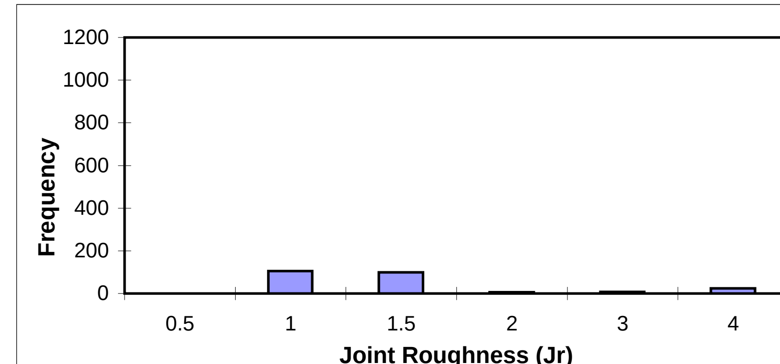

Q' by Discontinuity

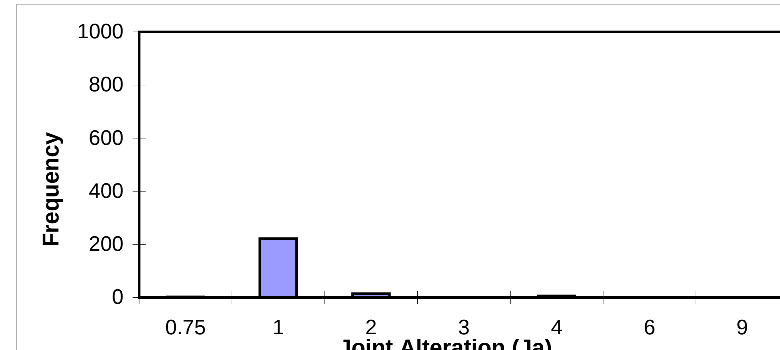



Q' by Logging Run (using minimum)



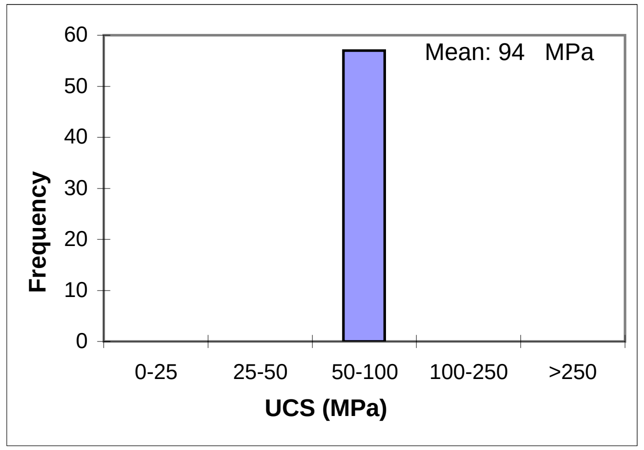



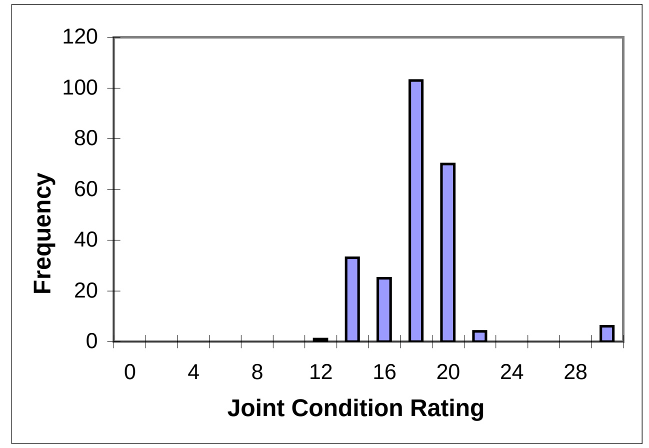




**NOTES:**
1. RQD AND Jn ARE RUN BASED PARAMETERS WHILE Jr AND Ja ARE BASED ON INDIVIDUAL DISCONTINUITIES WITHIN A LOGGING RUN.

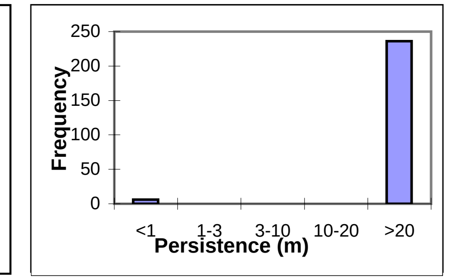
| | |
|---|---|
| AVALON RARE METALS INC. | |
| THOR LAKE PROJECT | |
| **FEASIBILITY GEOMECHANICAL PROGRAM Q' PARAMETER HISTOGRAMS FOR L10-287 (KPL)** | |
| Knight Piésold CONSULTING | P/A NO. NB101-390/2 — REF. NO. NB10-00570 |
| | **FIGURE 38** — REV 0 |

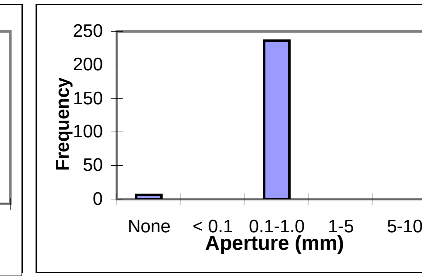
| REV | DATE | DESCRIPTION | PREP'D | CHK'D | APP'D |
|---|---|---|---|---|---|
| 0 | 19NOV'10 | ISSUED WITH MEMO | AJ | BDP | RAM |

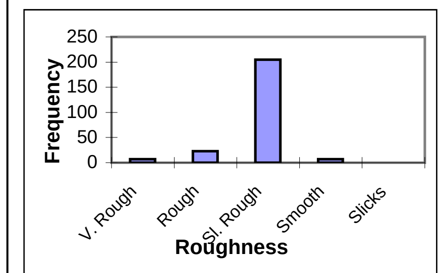


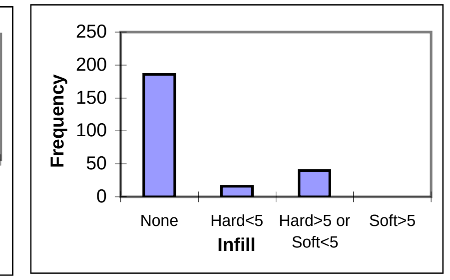



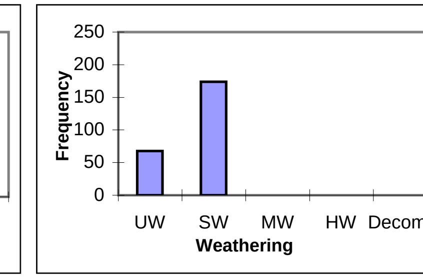

Joint Condition Parameters

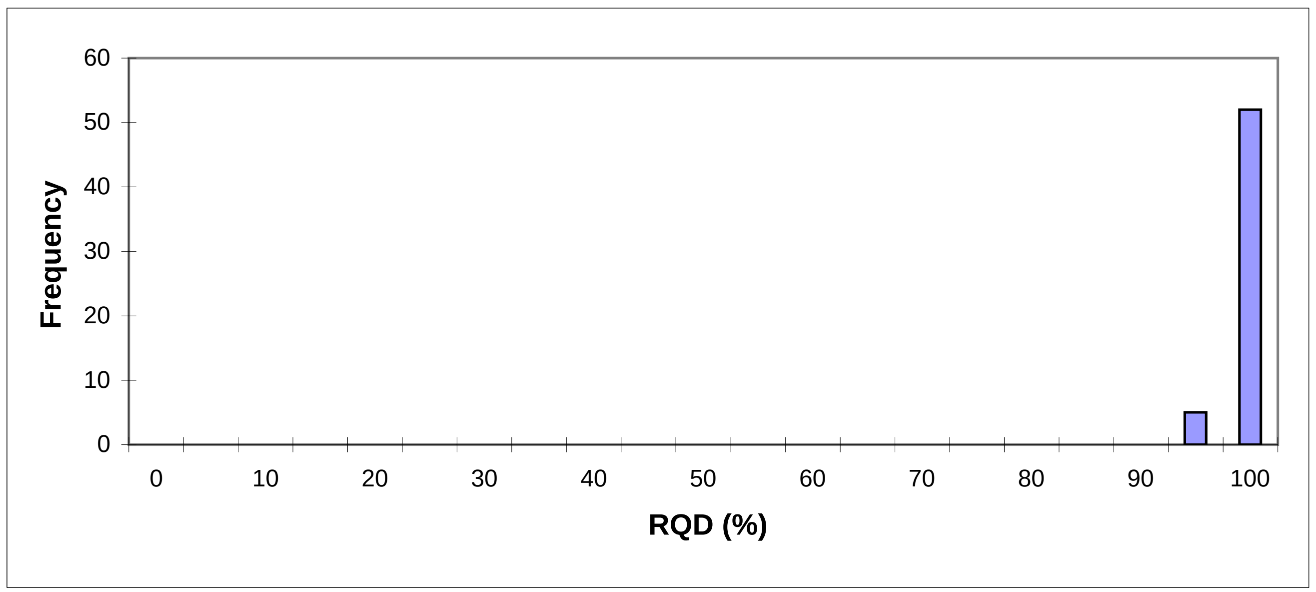


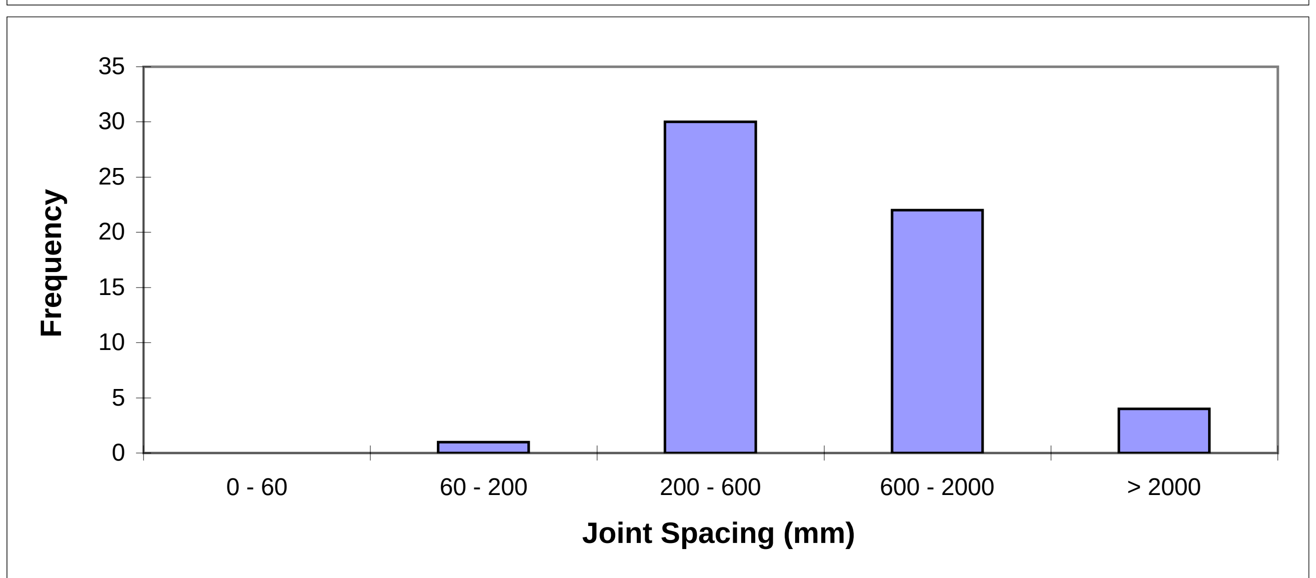



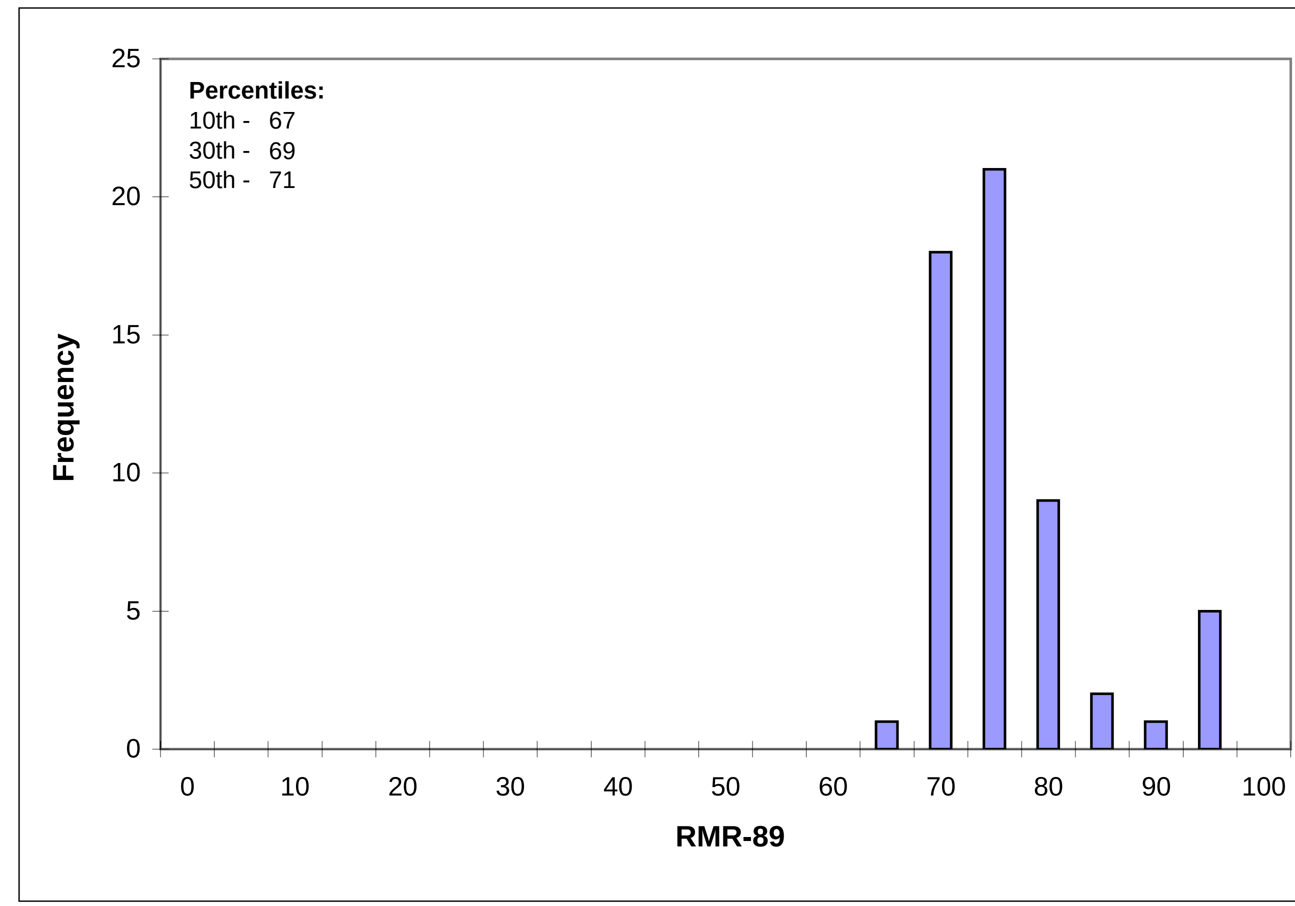




**NOTES:**

1. BINS INCLUDE PREVIOUS RANGE (I.E., BIN 60 INCLUDES VALUES FROM 55-60).
2. RQD, RMR89, JOINT SPACING, AND UCS ARE RUN BASED PARAMETERS WHILE JOINT CONDITION RATING AND PARAMETERS ARE BASED ON INDIVIDUAL DISCONTINUITIES WITHIN A LOGGING RUN.

AVALON RARE METALS INC.

THOR LAKE PROJECT

**FEASIBILITY GEOMECHANICAL PROGRAM**
**$RMR_{89}$ PARAMETER HISTOGRAMS**
**L10-287 (AVALON)**

Knight Piésold CONSULTING

| P/A NO. | REF. NO. |
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| NB101-390/2 | NB10-00570 |

**FIGURE 39** REV 0

| 0 | 19NOV'10 | ISSUED WITH MEMO | PBK | BDP | RAM |
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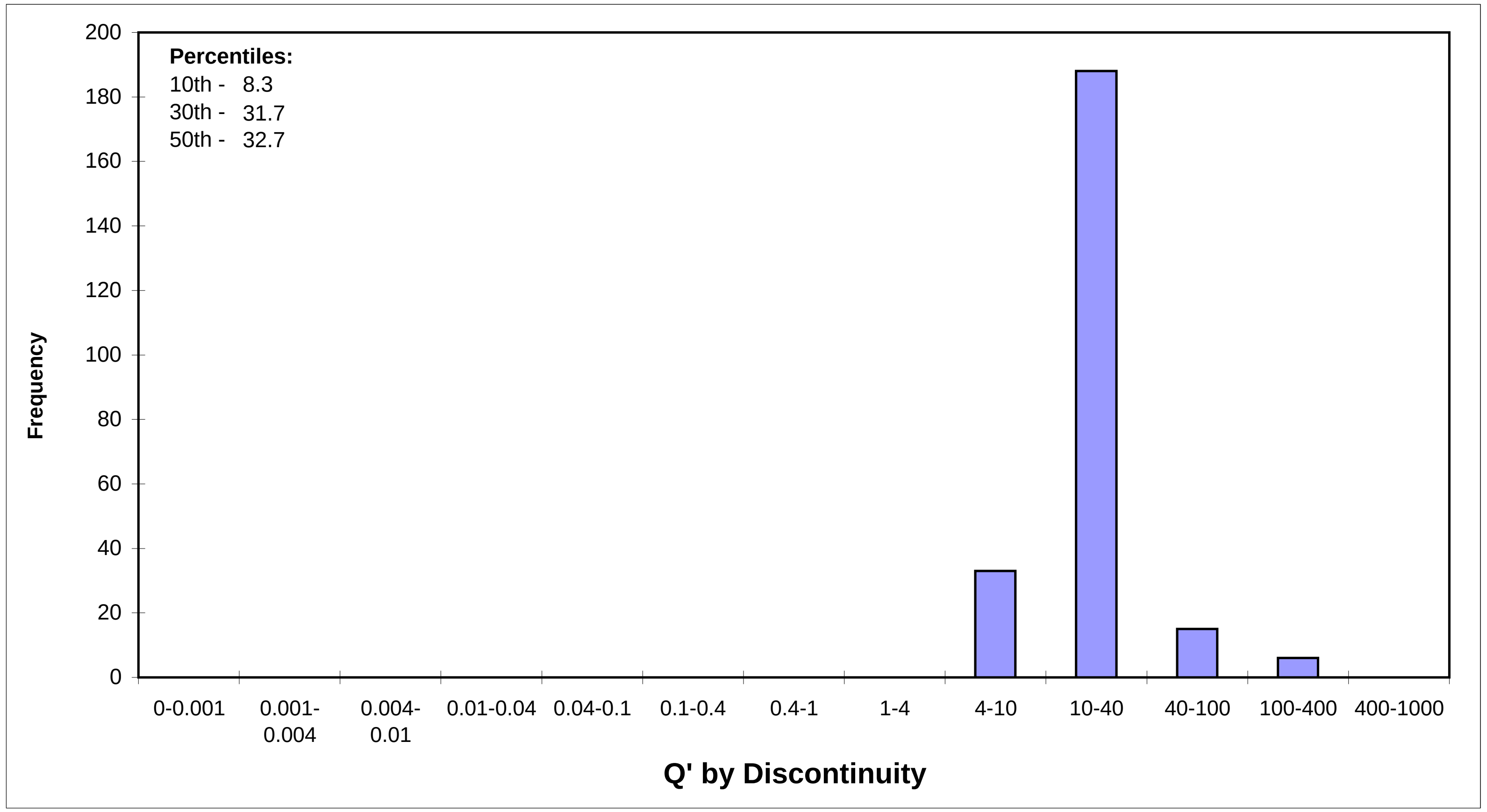


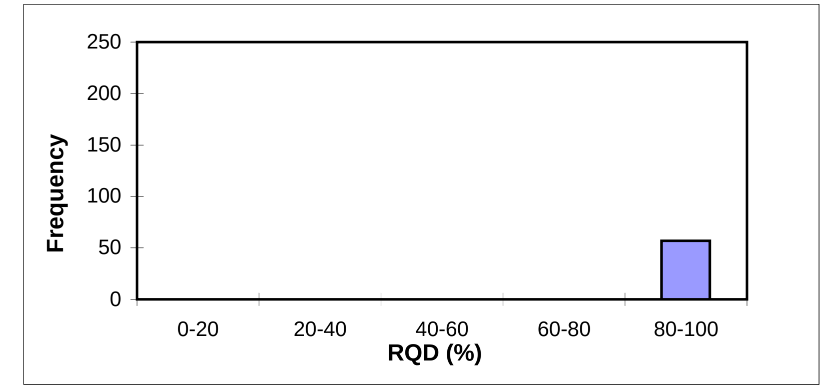


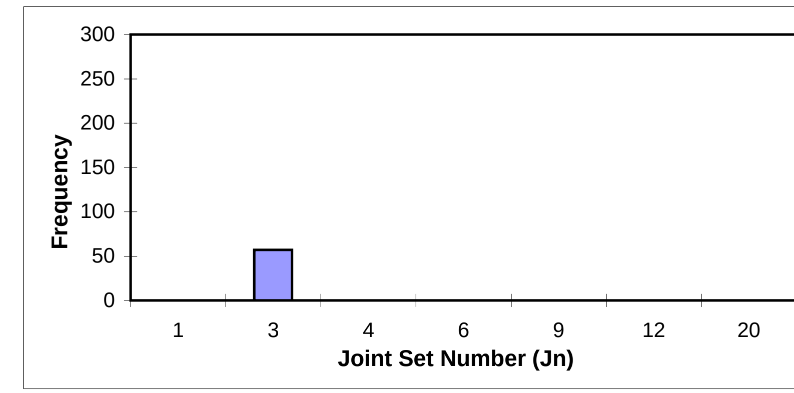


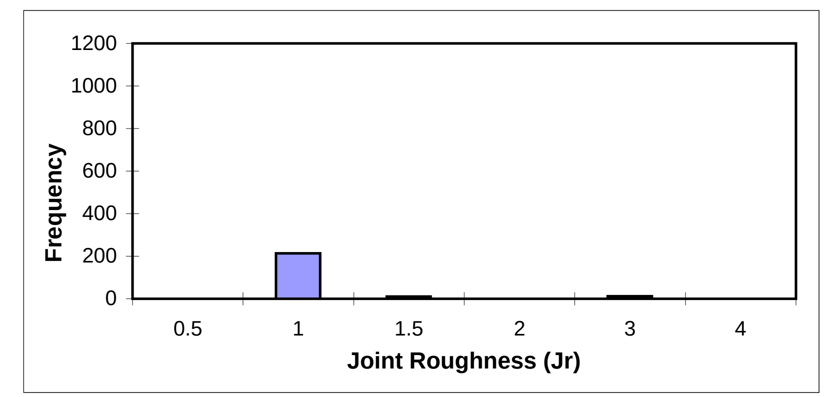


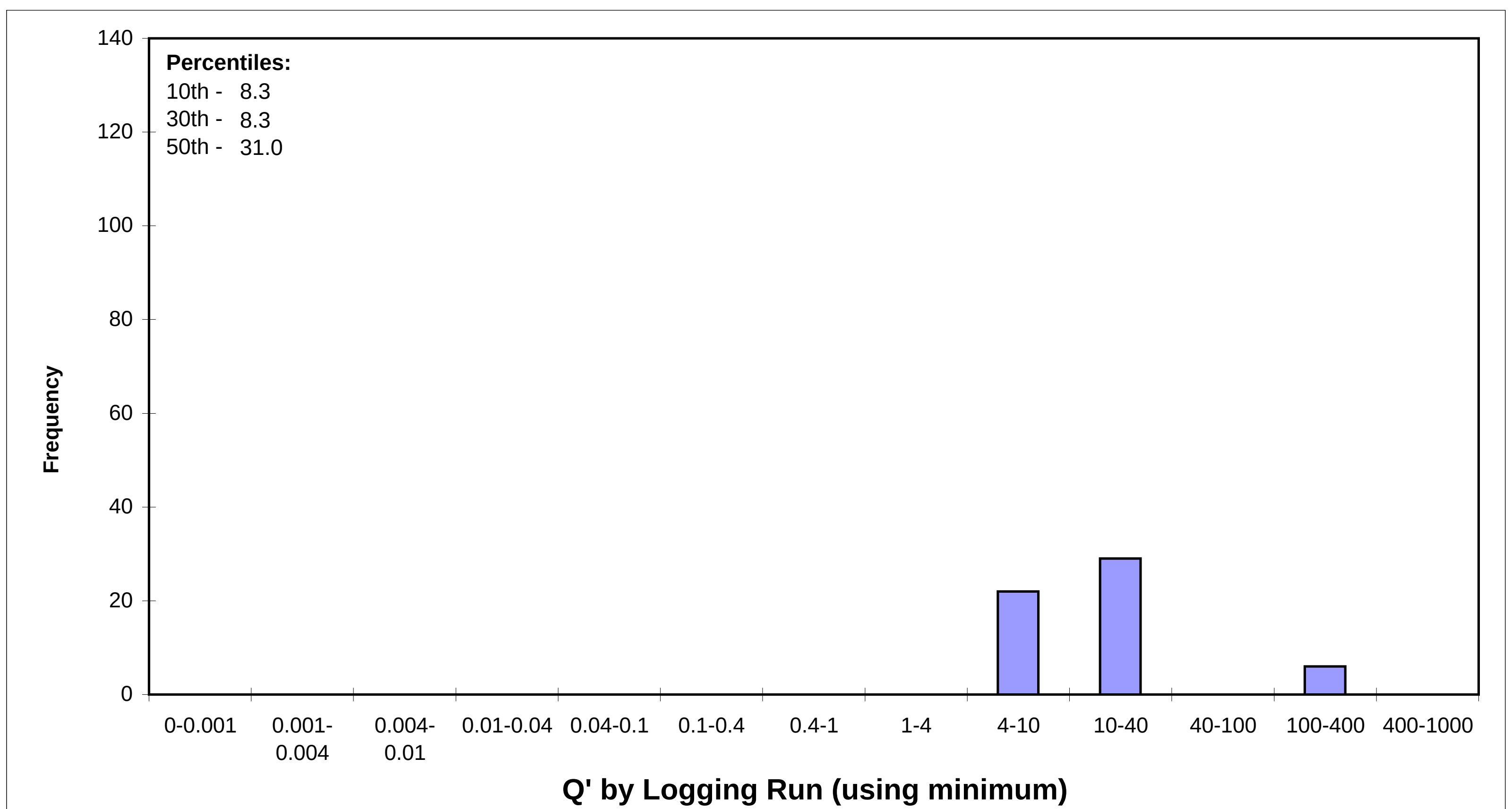


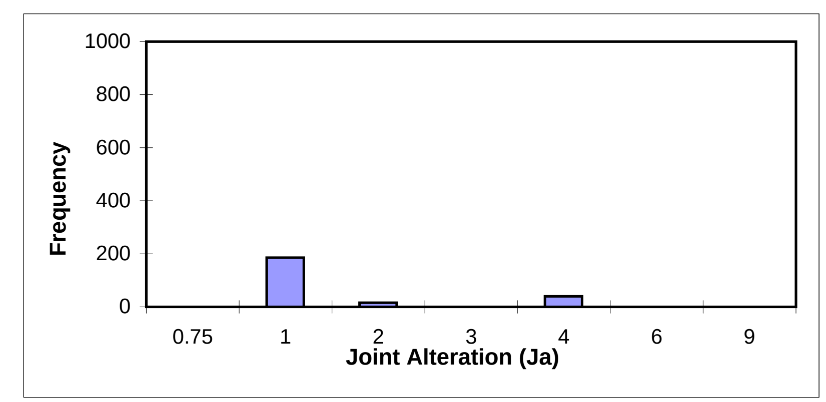


**NOTES:**

1. RQD AND Jn ARE RUN BASED PARAMETERS WHILE Jr AND Ja ARE BASED ON INDIVIDUAL DISCONTINUITIES WITHIN A LOGGING RUN.

AVALON RARE METALS INC.

THOR LAKE PROJECT

**FEASIBILITY GEOMECHANICAL PROGRAM**
**Q' PARAMETER HISTOGRAMS FOR L10-287 (AVALON)**

Knight Piésold CONSULTING

| P/A NO. | REF. NO. |
|---|---|
| NB101-390/2 | NB10-00570 |

**FIGURE 40** REV 0

| REV | DATE | DESCRIPTION | PREP'D | CHK'D | APP'D |
|---|---|---|---|---|---|
| 0 | 19NOV'10 | ISSUED WITH MEMO | AJ | BDP | RAM |

**Appendix C.10**

**Thor Lake Project - Pine Point Regional Historical Hydrogeology Summary and Groundwater Flow Model. Report NB10-00665**

Knight Piésold
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# MEMORANDUM

| | | | |
|---|---|---|---|
| To: | David Swisher | Date: | March 8, 2011 |
| Copy To: | Bill Mercer, Rick Hoos, Kevin Hawton, Cara Stapley | File No.: | NB101-390/2-A.01 |
| From: | Jordin Barclay | Cont. No.: | NB10-00665 |
| Re: | Thor Lake Project - Pine Point Regional Historical Hydrogeology Summary and Groundwater Flow Model | | |

## Introduction

As part of the Thor Lake Project, Avalon Rare Metals Inc. (Avalon) is proposing to build a Hydrometallurgical Plant at the site of the former Pine Point Mine, previously operated by Teck Cominco Metals Ltd. (formerly Cominco Ltd.), to process the flotation concentrate from the mine located north of Great Slave Lake. The Hydrometallurgical Plant Site is located on the south shore of Great Slave Lake approximately 75 km east of the town of Hay River NWT and approximately 70 km southwest of the town of Fort Resolution on Highway 5. The project site location is shown on Figure 1.

The main components of the water management plan for the proposed Hydrometallurgical Site include:

- Pumping of fresh water from an historic open pit (T-37 pit) where the water table associated with the Presqu'ile aquifer has resulted in the pit filling with water
- Disposal of tailings in an historic open pit (L-37 pit) where solids and a controlled amount of water will be stored
- Pumping of excess supernatant water from the L-37 pit to the N-42 historic open pit where the water will infiltrate the Presqu'ile aquifer

This memo presents the results of a groundwater flow model that was prepared to estimate the potential effects of the water management plan on the Pine Point regional groundwater regime. In order to develop the flow model, it was necessary to understand the hydrogeology of the Pine Point region. The hydrogeology for the Pine Point region has been previously studied by Geologic Testing Consultants (GTC, 1983) and Stevenson International Groundwater Consultants (Stevenson, 1984). The summary of historical hydrogeology information presented herein is largely based on these previous findings.

## Background Information

Regional climate, vegetation, geology and permafrost information for the Pine Point area was previously summarized in Knight Piésold Ltd. (KPL) Memo No. NB10-00488 entitled "Thor Lake Project - Pine Point Hydrometallurgical Plant Site Tailings Review".

The topography of the site can be described as flat to gently sloping, generally to the north. Topography around the proposed Hydrometallurgical Plant Site area typically ranges between 190 and 220 metres above sea level (masl) and decreases to approximately 160 masl along the south shore of Great Slave Lake.

The main topographic features in the area are the Buffalo River channel and the low northeast trending ridges that divide small tributary catchments. Raised beaches and boggy inter-beach areas form the minor topographic features.

The western side of the Pine Point area drains into the Buffalo River channel. The northern and southern parts of the area are drained by small streams that flow towards Great Slave Lake.

**Hydrogeology**

*Regional Hydrogeology*

On a regional scale, groundwater flow is believed to originate in topographic highs (recharge area) such as the Caribou Mountains. The Caribou Mountains rise approximately 600 m above the surrounding land surface and groundwater flow is more or less radially distributed. Stevenson (1984) suggested that the Caribou Mountains are underlain by near-horizontal stratified sediments. The Smokey Group Shales cap the uplands and are underlain by the Dunvegan formation, which consists of interbedded sandstones and shales. The sandstones are likely the most permeable strata in the succession and would act as a lateral drain for most of the recharge in the uplands. A relatively low permeability claystone underlies the Dunvegan formation and forms the subcrop between the Caribou Mountains and Great Slave Lake.

Groundwater flow in the Pine Point area is likely not dominated by recharge in the Caribou Mountains given that the shale and claystone formations in the vicinity of the Caribou Mountains would likely inhibit infiltration and vertical flow of groundwater and that groundwater within sandstone units likely discharges between the Caribou Mountains and Great Slave Lake. Further, additional discharge will likely occur along the Hay River valley to the northwest and the Little Buffalo River and Slave River valleys to the northeast. A smaller portion of the groundwater that is recharged on a regional scale is thought to flow north to Great Slave Lake.

Stevenson (1984) estimated that in general the recharge is approximately ten percent of the annual precipitation. It is expected that recharge will vary depending on the conditions at surface. The water table is closer to ground surface in the northern sections of the Pine Point area and artesian conditions occur in areas with confining conditions.

Additional regional hydrogeology information has been presented in KPL Memo NB10-00488.

*Hydrometallurgical Site Hydrogeology*

The Presqu'ile and Pine Point bedrock formations host the main aquifer in the Hydrometallurgical Site area, consisting of highly porous, highly fractured dolomite. Groundwater within the saturated bedrock is expected to flow along solution channels, bedding planes and fractured zones.

The hydrostratigraphic units and associated properties of the Pine Point area are provided on Table 1. The permeability of the Presqu'ile aquifer formation is very high with transmissivities in the order of $1 \times 10^{-2}$ $m^2/s$ (GTC, 1983). Groundwater in the aquifer flows along three primary pathways that vary significantly from the regional patterns. The three predominant pathways in the Presqu'ile aquifer are through high hydraulic conductivity facies, through open solution channels and karstic features, and along open joint sets.

Based on work completed by Stevenson (1984), the groundwater gradient in the Pine Point area is generally northwards towards Great Slave Lake while to the south of the Pine Point area, the groundwater gradient trends from west to east. The local gradient in the northern area is approximately 0.004 towards Great Slave Lake. The average elevation of Great Slave Lake is approximately 156 masl. Groundwater levels exposed in historic open pits around the Hydrometallurgical Site area are approximately 191 masl.

Although the Presqu'ile aquifer has a high permeability, the flow through it is thought to be slow due to the low gradient in the Pine Point area and relatively high porosity. The flow velocity is estimated to be less than 1 m per day.

Over the period between 1968 and 1982, the yearly average dewatering rate from the Presqu'ile aquifer, due to mining activities, was as high as 269,000 $m^3$/day (GTC, 1983). GTC (1983) also estimated that the maximum drawdown of the water table in response to this dewatering was approximately 20 metres; and that the source of the pumped water was the Presqu'ile aquifer and associated local and regional recharge, with none of the pumped water coming from Great Slave Lake.

Additional site hydrogeology information for the Hydrometallurgical Site has been presented in KPL Memo NB10-00488.

**Groundwater Flow Model**

A groundwater flow model (using visual MODFLOW software) was created to simulate the current hydrogeological flow conditions at the Pine Point site and to estimate the effects of implementing the water management plan for the Hydrometallurgical Site, including the pumping of water from the T-37 pit and the infiltration of excess water into the N-42 pit.

The boundary conditions used in the model included:

- Constant head boundaries to represent Buffalo River and Little Buffalo River
- River boundaries to represent Great Slave Lake and regional inflow from south of the Pine Point area
- Recharge boundary within higher permeability zones to represent infiltration of water at the model surface. Recharge was not applied to areas near Great Slave Lake where groundwater is expected to be discharging.

Several geologic units were used to define the hydrostratigraphic units on site, as presented on Table 1. The aerial extent of each geologic unit was based on the geologic plan of the area, as shown on Figure 2. The geologic units in the Hydrometallurgical Site area were simplified for the purpose of the model by representing the hydrostratigraphy as a single layer.

The model was run using steady state conditions. Hydrogeologic properties and boundary conditions were adjusted to simulate groundwater flow that is consistent with the conceptual model of the site. Modelling results were compared to existing water levels in the historic open pits nearby the proposed Hydrometallurgical Plant Site. Particle tracking was used to simulate the groundwater flow path from the N-42 pit and to estimate the travel time from the N-42 pit to Great Slave Lake.

Based on the conceptual model of the site and the steady state modelling results, groundwater flowing through the N-42 pit would take approximately 80 years to discharge into Great Slave Lake. The average groundwater velocity along the flow path from the N-42 pit to Great Slave Lake was simulated as 0.75 m/day. Within the Presqu'ile Formation, the average simulated velocity was about 0.5 m/day. The travel time estimation assumes that groundwater will not discharge to surface between the N-42 pit and Great Slave Lake. Travel time may be reduced if groundwater discharged to surface and flowed towards Great Slave Lake. Figure 3 illustrates simulated piezometric contours and particle tracking results based on current conditions for the area, as predicted by the model.

The baseline groundwater flow model was modified to include pumping of groundwater from the T-37 pit and discharge/infiltration of water into the N-42 pit. This model was completed using transient conditions where pumping and discharge/infiltration was simulated for the projected 20 year operational life. The

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simulated pumping rate from the T-37 pit was 1,950 $m^3$/day and the simulated discharge rate into the N-42 pit was 420 $m^3$/day, based on the design criteria (presented in KPL memo NB11-00102) and the water/solids balance analysis (presented in KPL memo NB11-00024).

**Conclusion**

Results of the groundwater flow model suggest that there is expected to be very little effect on the groundwater regime at the Pine Point site in response to the pumping and discharge/infiltration proposed as part of the Hydrometallurgical Site water management plan, given the rates used in the model. Groundwater drawdown in the vicinity of the T-37 pit is estimated to be approximately 1 m below the expected pre-pumping level after 20 years of pumping. Groundwater levels in the vicinity of the N-42 pit are expected to increase by approximately 0.1 m above the simulated pre-discharge conditions after 20 years of discharge/infiltration.

Particle tracing was used to track flow from the N-42 pit to Great Slave Lake during the 20 year operations life and there were no noticeable effects to the groundwater flow directions or travel times over existing conditions. Figure 4 illustrates simulated piezometric contours and particle tracking for the Pine Point area after 20 years of pumping and discharge. Figure 5 illustrates the expected groundwater drawdown in response to pumping from the T-37 pit.

We trust that this provides you with the information you require at this time. Should you have any questions or comments, feel free to contact us.

Signed: ______________________ Approved: ______________________

For Jordin Barclay
Project Hydrogeologist

Kevin Hawton, P.Eng.
Senior Engineer

References:

1. Domenico, P.A. & Schwartz, W., 1998. *Physical and Chemical Hydrogeology* Second Edition, Wiley.
2. GTC Geologic Testing Consultants, 1983. Hydrogeologic Evaluation of the Pine Point - Great Slave Lake Region

Attachments:

| | |
|---|---|
| Table 1 Rev 0 | Modelled Hydrostratigraphic Units |
| Figure 1 Rev 0 | Pine Point Area - Site Location |
| Figure 2 Rev 0 | Pine Point Area - Geological Plan |
| Figure 3 Rev 0 | Simulated Piezometric Contours and Particle Tracking Results - Baseline Conditions |
| Figure 4 Rev 0 | Simulated Piezometric Contours and Particle Tracking Results - After 20 Years of Pumping and Infiltration |
| Figure 5 Rev 0 | Expected Groundwater Drawdown Due to Pumping from T-37 pit |

/jb

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**TABLE 1**

**AVALON RARE METALS INC.**
**THOR LAKE PROJECT**

**PINE POINT REGIONAL HISTORICAL HYDROGEOLOGY SUMMARY AND GROUNDWATER FLOW MODEL**
**MODELLED HYDROSTRATIGRAPHIC UNITS**

Print Mar/08/11 16:14:48

| Hydrostratigraphic Unit | Hydraulic Conductivity (m/s) | Porosity |
|---|---|---|
| Basal Glacial Till | 1E-08 | 0.1 |
| Slave Point Formation | 5E-08 | 0.001 |
| Watt Mountain Limestones | 5E-07 | 0.01 |
| Presqu'ile Formation | 5E-04 | 0.1 |
| Sulphur Point Formation | 2E-04 | 0.01 |
| Buffalo River Shales | 5E-08 | 0.005 |
| Muskeg Evaporites | 5E-08 | 0.001 |
| Pine Point Formation | 5E-05 | 0.005 |

I:\1\01\00390\02\A\Correspondence\NB10-00665 - PP Historical Hydrogeology and GW Model\Rev 0\[Table 1 - Hydrostratigraphic Units.xlsx]Table 1

**NOTES:**

1. HYDRAULIC CONDUCTIVITY FROM GEOLOGIC TESTING CONSULTANTS (1983) AND ADJUSTED FOR MODEL SIMULATION.
2. POROSITY VALUES ARE ASSUMED BASED ON KNOWLEDGE OF THE SITE AND FROM RANGES PROVIDED IN DOMENICO AND SCHWARTZ (1998).

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| 0 | 08MAR'11 | ISSUED WITH MEMO NB10-00665 | JB | CLS | KEH |
| REV | DATE | DESCRIPTION | PREP'D | CHK'D | APP'D |


**NOTES:**

1. IMAGERY FROM NASA WORLD WIND.

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| 0 | 08MAR'11 | ISSUED WITH MEMO | CLS | SIR | KEH | KEH |

AVALON RARE METALS INC.

THOR LAKE PROJECT

**PINE POINT AREA**
**SITE LOCATION**

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| P/A NO. | REF NO. |
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| NB101-390/2 | NB10-00665 |

**FIGURE 1** REV 0

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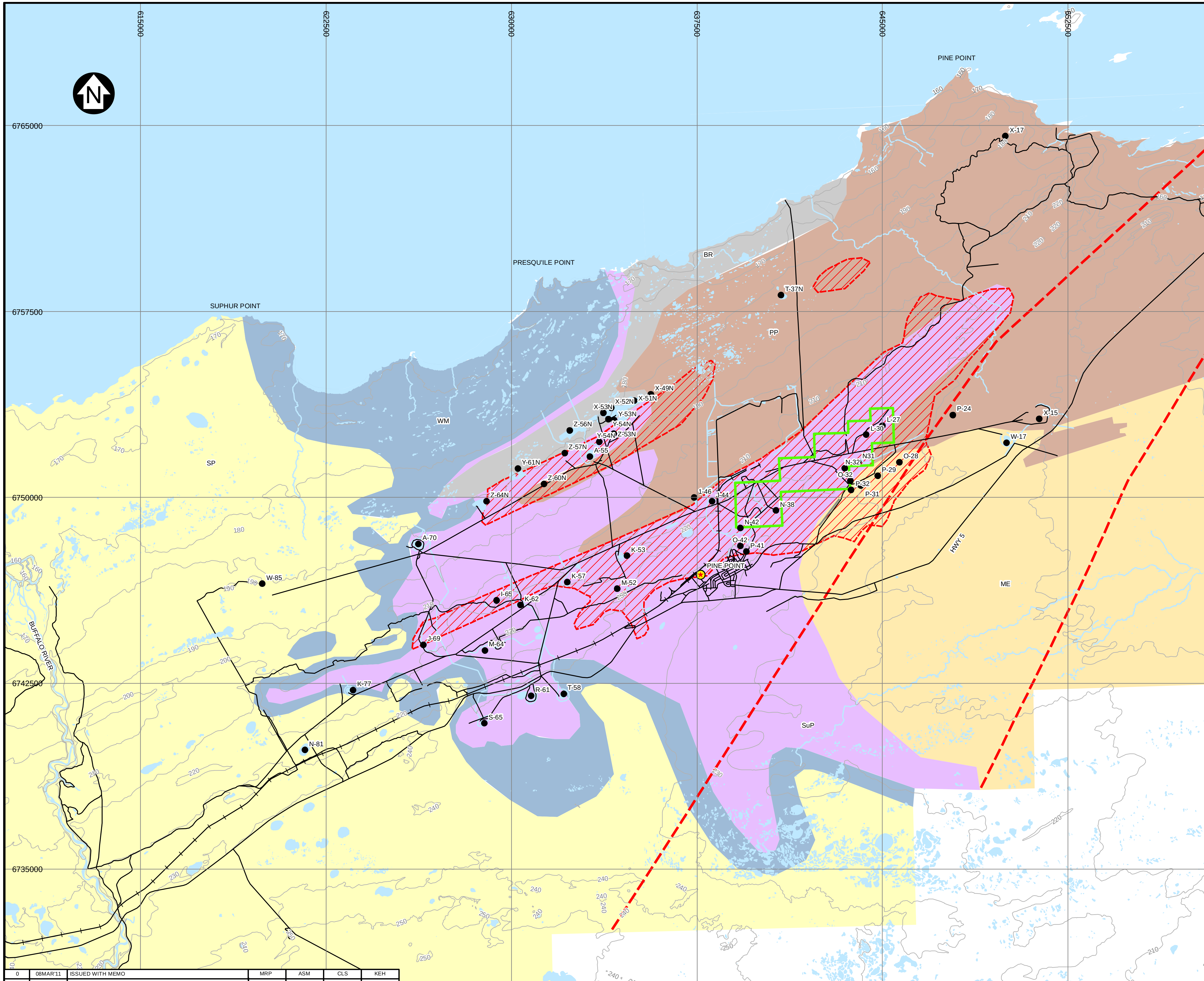
XREF FILE(S): IMAGE FILE(S): Canada - World Wind Wardrop APR 2009 - Site Location




**LEGEND:**

- WATER
- TAMERLANE CLAIM BOUNDARY
- TECK COMINCO LEASE BOUNDARY
- SP — SLAVE POINT FORMATION DOLOMITIC AND ANHYDRITE LIMESTONE
- WM — WATT MOUNTAIN FORMATION SHALE / LIMESTONE
- SuP — SULPHUR POINT FORMATION LIMESTONE AND DOLOSTONE
- Pr — PRESQU'ILE FORMATION COURSE (VUGGY) CRYSTALLINE DOLOMITE
- PP — PINE POINT FORMATION FINE CRYSTALLINE DOLOMITE
- LKR — LOWER KEG RIVER FORMATION ARGILLACEOUS LIMESTONE / DOLOSTONE
- CH — CHINCHACA FORMATION ANHYDRITE, MINOR SILTSTONE
- ME — MUSKEG EVAPORITES GYPSUM ANHYDRITE
- BR — BUFFALO RIVER FORMATION SHALE
- SUBSURFACE STRIKE-SLIP FAULT
- RIVER/STREAM/DRAINAGE
- ROAD
- RAIL BED (TRACK REMOVED)
- CONTOUR
- COMMUNITY
- HISTORIC OPEN PIT

**NOTES:**

1. BASE MAP: © HER MAJESTY THE QUEEN IN RIGHTS OF CANADA, DEPARTMENT OF NATURAL RESOURCES (2004). ALL RIGHTS RESERVED.
2. COORDINATE GRID IS SHOWN IN UTM (NAD83) ZONE 11 AND IS IN METRES.
3. CONTOUR INTERVAL IS IN METRES. CONTOUR INTERVAL IS 10 METRES.
4. CLAIM BOUNDARIES HAVE BEEN DIGITIZED AT A 1:50,000 SCALE.
5. GEOLOGY OBTAINED FROM HANNIGAN 2007, THE METALLOGENY OF THE PINE POINT MISSISSIPPI VALLEY-TYPE ZINC-LEAD DISTRICT, SOUTHERN NORTHWEST TERRITORIES, GEOLOGICAL SURVEY OF CANADA.

SCALE 1,500 750 0 1,500 3,000 4,500 6,000 7,500 m

AVALON RARE METALS INC.

THOR LAKE PROJECT

**PINE POINT AREA GEOLOGICAL PLAN**

Knight Piésold CONSULTING

| P/A NO. | REF. NO. |
|---|---|
| NB101-390/2 | NB10-00665 |

**FIGURE 2** REV 0

| REV | DATE | DESCRIPTION | DESIGN | DRAWN | CHK'D | APP'D |
|---|---|---|---|---|---|---|
| 0 | 08MAR'11 | ISSUED WITH MEMO | MRP | ASM | CLS | KEH |

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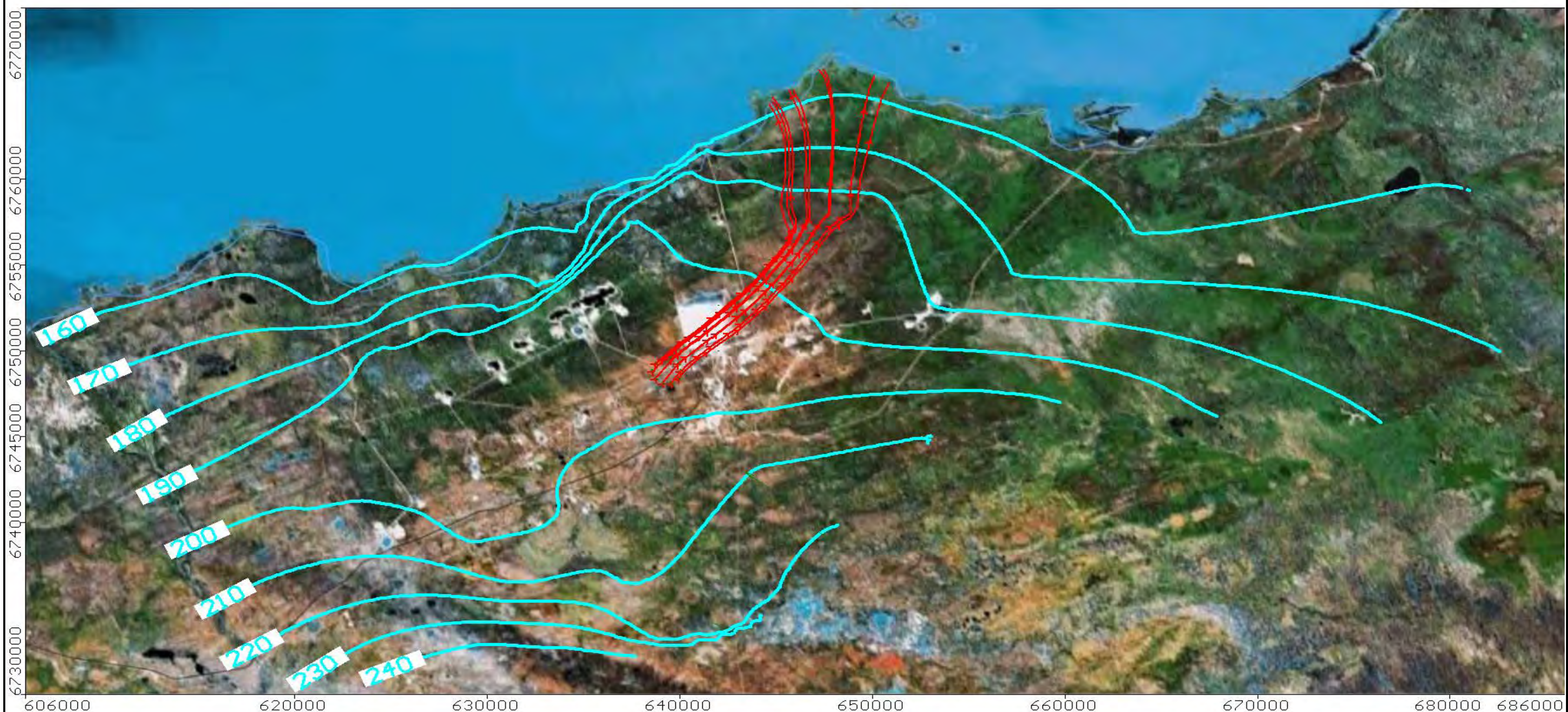



**NOTES:**

1. ARROWS ON PARTICLE TRACKS REPRESENT 10 YEARS OF TIME PASSING BETWEEN THEM.
2. BACKGROUND IMAGERY FROM GOOGLE EARTH.

| REV | DATE | DESCRIPTION | PREP'D | CHK'D | APP'D |
|---|---|---|---|---|---|
| 0 | 08MAR'11 | ISSUED WITH MEMO | JB | CLS | KEH |

AVALON RARE METALS INC.

THOR LAKE PROJECT

**SIMULATED PIEZOMETRIC CONTOURS AND PARTICLE TRACKING RESULTS - BASELINE CONDITIONS**

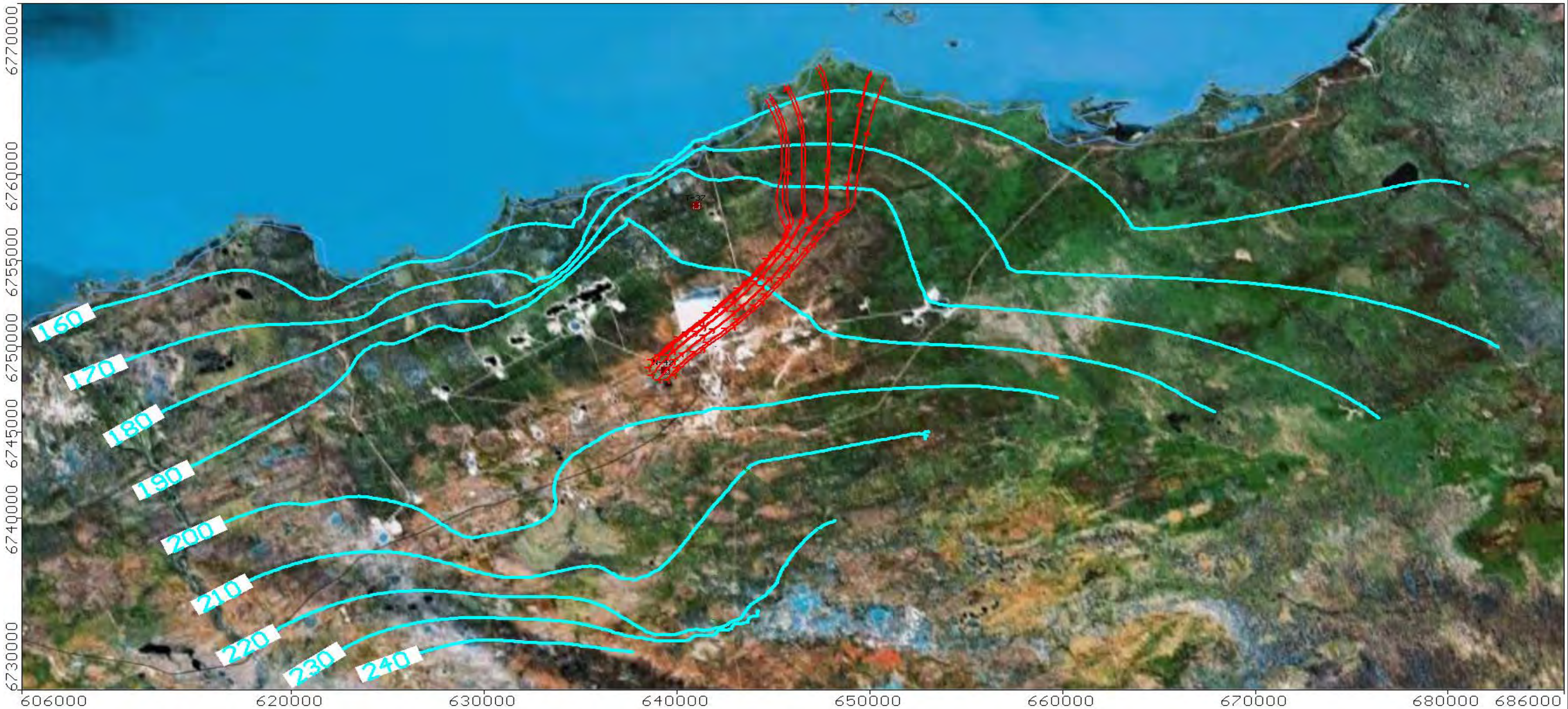
Knight Piésold CONSULTING

P/A NO. NB101-390/2

REF. NO. NB10-00665

**FIGURE 3**

REV 0




**NOTES:**

1. ARROWS ON PARTICLE TRACKS REPRESENT 10 YEARS OF TIME PASSING BETWEEN THEM.
2. BACKGROUND IMAGERY FROM GOOGLE EARTH.

| | | | | | |
|---|---|---|---|---|---|
| 0 | 08MAR'11 | ISSUED WITH MEMO | JB | CLS | KEH |
| REV | DATE | DESCRIPTION | PREP'D | CHK'D | APP'D |

AVALON RARE METALS INC.

THOR LAKE PROJECT

**SIMULATED PIEZOMETRIC CONTOURS AND PARTICLE TRACKING RESULTS - AFTER 20 YEARS OF PUMPING AND INFILTRATION**

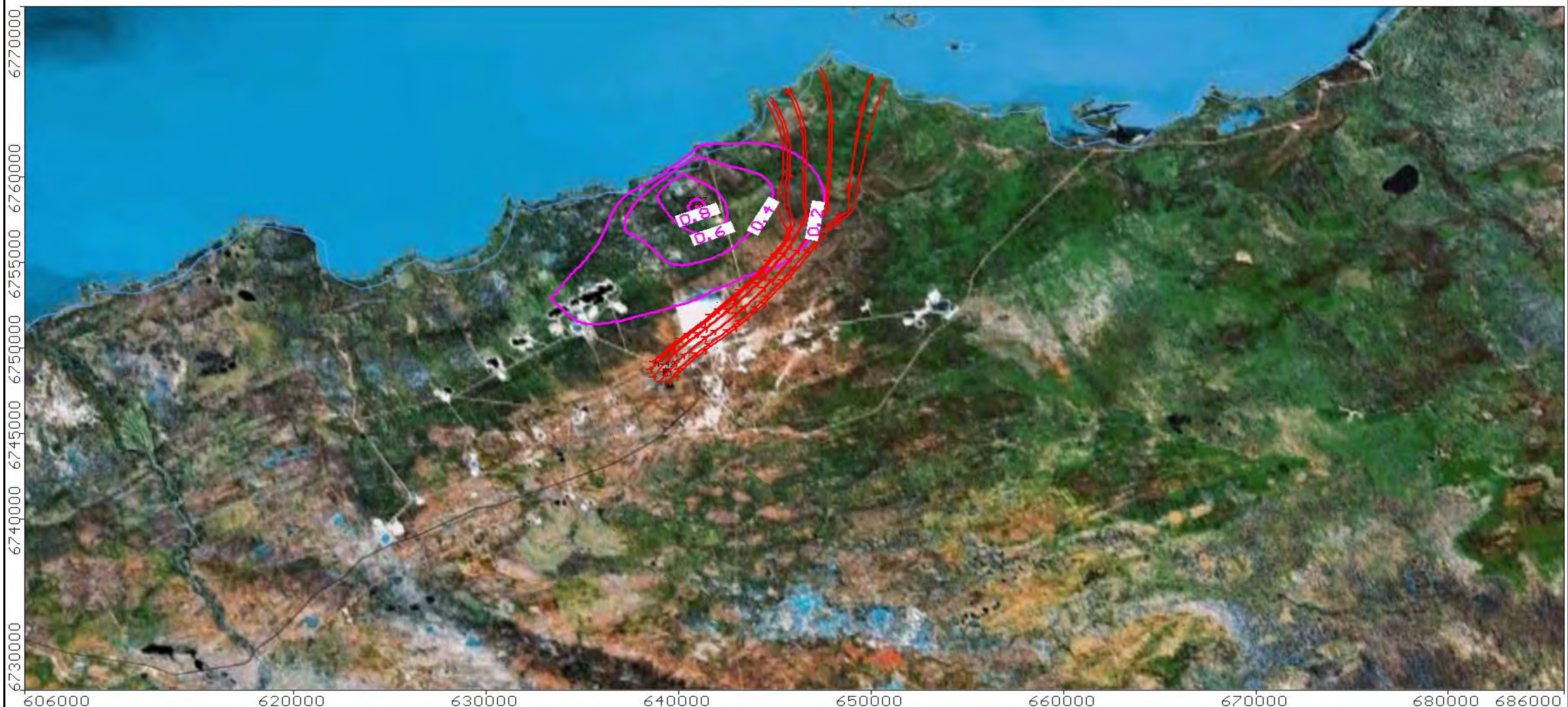
Knight Piésold CONSULTING

P/A NO. NB101-390/2

REF. NO. NB10-00665

**FIGURE 4**

REV 0




**NOTES:**

1. DRAWDOWN IS CHANGE IN WATER LEVELS (m) FROM STATIC BASELINE CONDITIONS AS A RESULT OF PUMPING WATER FROM PIT.
2. ARROWS ON PARTICLE TRACKS REPRESENT 10 YEARS OF TIME PASSING BETWEEN THEM.
3. BACKGROUND IMAGERY FROM GOOGLE EARTH.

| 0 | 08MAR'11 | ISSUED WITH MEMO | JB | CLS | KEH |
|---|---|---|---|---|---|
| REV | DATE | DESCRIPTION | PREP'D | CHK'D | APP'D |

AVALON RARE METALS INC.

THOR LAKE PROJECT

**EXPECTED GROUNDWATER DRAWDOWN DUE TO PUMPING FROM T-37 PIT**

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REF. NO. NB10-00665

**FIGURE 5**

REV 0