IMPERIAL METALS CORPORATION

Mount Polley Project

Williams Lake, B.C.

FEASIBILITY STUDY

Volume 3 of 5

- Appendix XI

Project 1867

June 1990

Wright Engineers Limited

Vancouver
Toronto
Canada

MOUNT POLLEY PROJECT

FEASIBILITY STUDY

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APPENDIX XI

GEOTECHNICAL AND TAILINGS DISPOSAL STUDIES

- **Report by Knight and Piesold Ltd.**

IMPERIAL METALS CORPORATION
MT. POLLEY PROJECT

REPORT ON GEOTECHNICAL INVESTIGATIONS AND DESIGN OF OPEN PIT, WASTE DUMPS AND TAILINGS STORAGE FACILITY

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IMPERIAL METALS CORPORATION

MT. POLLEY PROJECT

REPORT ON
GEOTECHNICAL INVESTIGATIONS AND DESIGN OF OPEN PIT, WASTE DUMPS AND TAILINGS STORAGE FACILITY

SECTION 1.0 - INTRODUCTION

1.1 GENERAL OVERVIEW

The Mt. Polley Project is located in central British Columbia approximately 56 kilometres north-east of Williams Lake. The nearest settlement is the community of Likely, which is located on the northern tip of Quesnel Lake.

The project derives it name from Mt. Polley, a low mountain with a peak elevation of 1260 metres, approximately 300 metres above the surrounding terrain. Mt. Polley is situated between Polley Lake to the east, and Bootjack Lake to the south-west. The site is presently accessible by paved road from Williams Lake to Morehead Lake, near Likely, and then by gravel forestry road for the final 10 kilometres to the site.

The project involves the mining by open pit methods of an estimated 48.8 million tonnes of copper and gold ore contained in three adjacent orebodies, at a nominal rate of 13,700 tonnes per day. An additional 26.2 million tonnes of low grade ore will also be stockpiled during operations for processing in the later stages of mine life. In addition to the ore, mining will produce 59.7 million tonnes of waste rock, which will be stored in waste rock dumps adjacent to the open pit, along with the 26.2 million tonnes of low grade ore.

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- General design features of the tailings storage facility, including initial construction requirements, water balance, operating requirements, on-going construction and final reclamation.

- Capital and on-going construction costs for the tailings storage facility based on preliminary engineering.

These items are discussed in the following sections of the report and are intended to provide input for the Stage I Report, permit applications and to become part of the overall Project Feasibility Study.

All field geotechnical work was carried out under the direction of Knight and Piesold Ltd. personnel with active involvement of Imperial Metals Corporation field personnel.

A comprehensive review of geotechnical data pertaining to the open pit was carried out by Professor C.O. Brawner. The results of the review and recommendations for open pit slope design are contained in Section 4.0 of this report, which was authored by Mr. Brawner.

Revised: February 19, 1990

SECTION 2.0 - SITE CHARACTERISTICS

2.1 HYDROMETEOROLOGY

Long and short term climate records are available for a number of locations in the general mine site area, as shown on Figure 2.1. Two recently established stations (Likely with 6 years of record and Horsefly with 11 years) are located within 40 km of the site and in similar terrain. The project area is subjected to a relatively temperate climate with warm summers and cool winters. The precipitation is well distributed throughout the year.

Climatological summaries for weather stations within the project area are included in Appendix A.

The mean annual temperature at Likely, the nearest station to the site, is 4.0°C with an extreme maximum of 33.9°C and an extreme minimum of -37°C. At Quesnel, with approximately 70 years of record, extremes are 40.6°C and -46.7°C. Frost free days in the area range from 199 at Horsefly Lake (elevation 788 m) to 244 at Barkerville (elevation 1244 m).

A preliminary estimate of the total annual and monthly distribution of precipitation for the site has been made using data from a number of stations in the area. The mean annual precipitation at Likely is 699.7 mm and at Barkerville (with over 70 years of record) is 1043.9 mm. Precipitation for the site can be expected to fall within this range. Based on a linear interpolation of data for these and other stations, the average annual precipitation at the assumed site elevation of 1000 m has been estimated as 800 mm. As data is gathered from the site, improved estimates of precipitation will be made. Data for Likely, Barkerville and the site are presented in Table 2.1.

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2.3 SEISMICITY

The Mt. Polley site is situated within an area with very low seismic activity. A seismic risk calculation based on a Cornell type probabilistic model has been developed by the Pacific Geoscience Centre. The results for the Mt. Polley site are included as Table 2.4 and are summarized as follows:

Return Period (yrs)	Probability of Exceedence in 50 years (%)	Peak Ground Acceleration (g)	Peak Ground Velocity (m/s)
100	40	.021	.043
475	10	.037	.077
1000	5	.046	.094

The project is located in a NBCC Acceleration Zone 0, and Velocity Zone 1 for structural design requirements.

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SECTION 3.0 - GEOTECHNICAL INVESTIGATIONS AND TESTING

3.1 GENERAL

The geotechnical investigation programs were developed to determine design constraints for the proposed open pit, waste dumps and tailings storage facility. The field program consisted of field mapping, test pit excavations, and diamond drilling with permeability testing. The diamond drilling program was designed as an extension to the exploration and condemnation drilling program conducted by Imperial Metals Corporation.

Laboratory and geotechnical testwork for the different areas of the project included the following:

(i) Open Pit

- Detailed logging of joint and fracture data in oriented drill core from angle drill holes and unoriented drill core from vertical exploration holes.
- Selected laboratory testwork on fault gouge material.
- Permeability testing of vertical drill holes
- Installation of pneumatic and standpipe piezometers

(ii) Waste Dumps

- Laboratory studies on the acid generation potential of waste rock

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- Discontinuity spacing and description of surface roughness
- Discontinuity orientation with respect to the core axis
- Discontinuity infilling materials
- Point load test results

Three additional inclined geotechnical drill holes, numbered MP89-152, MP89-153 and MP89-154, were also drilled. The inclined drill holes enabled oriented drill core to be obtained using an eccentrically weighted core tube which obtained impressions of the core at the top of each drill run. The drill core was obtained in a NQ double tube core barrel. The true orientation of rock discontinuities was determined from the oriented drill core.

Stereonet plots of the joint and fracture orientations measured in each of the three inclined holes have been developed by the Schmidt contouring method and are presented in Figures 3.2, 3.3 and 3.4. A combined plot of all discontinuity data is included in Figure 3.5. A summary of rock types, RQD, fracture index and unconfined compressive strength data for the three inclined geotechnical drill holes are included in Appendix B. Detailed logs of geotechnical boreholes have not been included in this report for brevity. These logs are in the possession of Imperial Metals Corporation.

The predominant rock types encountered consisted of intrusion breccia, syenodiorite and monzonite with occasional dyke rock. Several fracture zones were identified and occasional clayey or sandy zones of fault gouge were also encountered. Two samples of fault gouge were analyzed in the laboratory as follows:

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main set and strikes about 030 degrees and dips at about 18 degrees to the north-west. The discontinuities were generally rough and often healed with calcite and chlorite. However, smooth, polished and slickensided joints were also identified. The discontinuity data is discussed further in Section 4.2.

3.2.2 Permeability Testing

Permeability testing was completed in the five vertical exploration holes shown on Figure 3.1. The test apparatus consisted of a NQ double packer wireline system developed by Longyear and included a flow meter and pressure gauge for accurate monitoring of test conditions.

The test results are included on Table 3.1. In general, the measured formation permeabilities are less than 1 x 10^{-5} cm/s, but occasional zones of high permeability (10^{-4} cm/s to 10^{-3} cm/s) were encountered. These high permeability zones are often associated with zones of intensely fractured bedrock, but were also observed in zones of relatively intact core. The geometric mean of all the permeability tests is 8.4 x 10^{-6} cm/s.

3.2.3 Groundwater Monitoring

Groundwater instrumentation installed in the open pit area included the installation of three 40 mm diameter standpipe piezometers for water level measurement and groundwater sampling and two multiple installations of pneumatic piezometers for measurement of water levels and hydraulic gradients. Additional water level measurements were obtained in a few open drill holes at the site. In general, the groundwater table was measured at depths of about 30 m in the higher elevation boreholes and at about 3 to 10 m at the lower elevations. The hydraulic gradient measured in the multiple installations appears to be approximately hydrostatic. However, indicate a net acid generation potential. These samples were specifically selected from pyritic drill core.

Humidity cell results, tested by Coastech Research Inc., are also included in Appendix C. The test sample consisted of a composite material obtained from five drill holes in the north pit area, and included the pyritic samples from MP89-134. The sample was selected to provide a worst case representation of the waste rock. Test results indicate that the sample exhibited very low reactivity, with very low sulphate, acidity and conductivity values, and the pH remained stable at above 8.1.

The rock units in the area are generally alkaline and significant calcite infill of fractures and cavities in the rock mass results in a net neutralization potential of the waste materials. The samples tested by Coastech Research Inc. included some ore material which was not differentiated. Since all of the samples tested by Coastech have a net neutralization potential, the ore material is also considered to have a net neutralization potential.

3.3.2 Surficial Materials

The proposed sites are shown on Drawing No. 1621.100. In general, the sites are characterized by gently undulating topography.

The north dumps are situated on and adjacent to a relatively flat area with bedrock knobs and ridges. Colluvium, glacial till and forest litter were encountered along the flat areas, to a maximum thickness of approximately 20 metres as shown on Drawing No. 1621.100.

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Groundwater in the vicinity of the waste dumps is generally shallow with flow directions governed by the surface topography.

3.4 TAILINGS STORAGE FACILITY

3.4.1 Tailings Physical Characteristics

Tailings samples were obtained from preliminary metallurgical testwork conducted by Coastech Research Inc. on samples of drill core. A laboratory testing program was conducted on the tailings materials to provide design information for the preliminary layout of the tailings storage facility. Detailed results are included in Appendix D and selected information is summarized below.

The tailings are comprised of predominantly silt (64 percent) and fine sand (30 percent) with a trace of clay (6 percent). It is non-plastic, yellow grey in colour and has a particle specific gravity of 2.78.

A series of settling tests were completed at slurry solids contents ranging from 25 to 45 percent. The tailings particles settled rapidly and a pronounced segregation of coarse to fine material was observed. The colloidal clay fraction remained suspended in the supernatant water for several days.

The tailings initially settled to relatively low densities generally in the range of 0.9 to 1.1 tonnes/m^3. Consolidation caused by evaporative drying resulted in final densities of approximately 1.3 tonnes/m^3.

The volume of initial water recovered from the tailings depends on the initial solids content of the slurry. At 35 percent solids, the initial water recovery was about 64 percent of the total water in the slurry.

Sulphur (percent)	Paste pH	Acid Potential (kgCaCO$_3$/t)	Neutralization Potential (kgCaCO$_3$/t)	Net Neutralization Potential (kgCaCO$_3$/t)
0.02	8.22	0.6	24.6	24.0

These results indicate that the tailings are not acid producing and have a significant net neutralization potential.

A special waste classification test was conducted in accordance with the procedure published by the B.C. Ministry of the Environment, entitled "B.C. Special Waste List". The results of this testwork are included in Appendix E and summarized on Table 3.4. The test indicates that the tailings from the locked cycle tests do not exceed the B.C. Waste Management Branch regulations for special wastes. The analysis of pore water shown on Table 3.4 gives an indication of the supernatant water quality.

In addition to the special waste test, an ASTM waste extraction test using carbonic acid at pH 5.5 was carried out. The test uses carbonic acid for leaching of the tailings and is a more realistic indication of actual long term water leachable constituents under slightly acidic rainfall. Details of the test are included in Appendix E, with the results summarized on Table 3.5. The test showed very low levels of water leachable constituents in the extract, all at concentrations below the lower range concentration from the pollution control objectives for final effluent discharge. Higher concentrations of various constituents in the pore water compared to those on Table 3.4 are attributed to aging of the sample in the laboratory and are not considered representative.

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permeability glacial till materials were encountered. Further exploration is required to determine the extent of the alluvial deposits.

The foundation materials at the small dam in the topographic depression at the north-east end of Area B consist of a relatively thin layer of saturated peat overlying dense, low permeability glacial till (TPB18).

3.4.4 Laboratory Tests on Till Overburden

Laboratory tests were carried out on samples of glacial till taken from selected test pits in Area B.

Grain size distributions of minus 20 mm samples of the glacial till material are included in Figure 3.6. Cobbles and boulders generally comprise less than 10 percent of the bulk material. Additional laboratory information is as follows:

TEST PIT	TPB-1	TPB-13, 14, 16
Atterberg Limits		
LL	28.6 percent	30.0 percent
PL	18.9 percent	16.3 percent
PI	9.7	13.7 percent
Natural Moisture content	14.0 percent	-
Specific Gravity	-	2.76
Modified Proctor		
Max Dry Density	-	1935 kg/m^3
Optimum Moisture	-	13.3 percent
Laboratory Permeability	-	1.6 x 10^{-8} cm/s

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till overlies bedrock to a depth of about 5 metres. About 7.5 metres of dense grey till covers the bedrock at drill hole 236.

The bedrock immediately below the overburden is composed of a heavily fractured and weathered, soft, red-brown volcanic conglomerate with a significant clay and gouge content. The conglomerate became harder and less fractured with depth, but still crumbled when the core was split.

Clean sandy seams were occasionally encountered in the conglomerate, and in hole MP89-233 the conglomerate matrix had been leached, leaving a coarse sandy gravel. Competent purple basalt underlies the conglomerate at depth.

In summary, the bedrock geology in tailings Area B consists of a purple basalt bedrock overlain by a volcanic conglomerate with an increasing degree of weathering with decreasing depth. The overburden materials in the study area consist of alluvial sand or sandy till at depth with a dense grey surficial till blanket over most of the tailings area.

The surficial glacial till layer is locally absent along the deepest section of the proposed main dam site where alluvial silts and sand were encountered in the test pits. It was not possible to distinguish between the dense alluvial silts and glacial tills in the drilling program. Simplified geologic sections through the tailings area are included on Drawing No. 1621.004.

3.4.6 Permeability Testing

Borehole permeability testing using an inflatable packer assembly as described in Section 3.2.2 was conducted at various intervals in boreholes MP89-231 to 236. In addition, standpipe and pneumatic piezometers were

Falling head permeability tests were conducted in the standpipe piezometers installed in holes MP89-232, 233, and 235. A summary of the results is given on Table 3.7, and the permeability values range from 1.4 x 10^{-6} cm/s to 2.4 x 10^{-5} cm/s. These values confirm the packer test results as they have a similar range of values. Clearly, the permeability of the till can vary by at least an order of magnitude, depending on the exact composition of the material.

Table 3.8 presents a summary of phreatic surface readings taken in the 6 holes with piezometer installations. The piezometer readings indicate that the vertical component of groundwater flow in the majority of the tailings area is artesian and discharging upwards to the surface. Hole MP89-235, located on the ridge at the south abutment of the main dam, has a downward vertical component of flow indicating an area of local groundwater recharge.

Standpipe piezometers were sampled for water quality testing in November, 1989. Results of the analyses are shown on Table 3.9.

3.4.7 Summary of Hydrogeological Regime

The surficial glacial till blanketing the area is a low permeability unit with a mean measured permeability of 9 x 10^{-6} cm/s, and ranging in thickness from 5 to approximately 30 metres over most of the area. The measured field permeabilities may be anomalously high, as the laboratory permeability of 1.6 x 10^{-8} cm/s, as reported in Section 3.4.4, is considerably lower. Also, it was observed that ponded water remained on the surface of the glacial till for long periods after rain storms. Excavation into soils below the surface ponds indicated that the wetting front had progressed only a few centimetres.

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A second source of relatively clean sand and gravel was identified just north of Highway 115 at the Beaver Creek crossing, some 32 km by road southwest of the mill site.

SECTION 4.0 - OPEN PIT SLOPE DESIGN

4.1 FACTORS WHICH INFLUENCE PIT SLOPE STABILITY AND SLOPE ANGLE

The most important factors which influence rock slope stability of open pit mines are geologic structure, groundwater conditions and seismic acceleration forces due to blasting.

Where geologic discontinuities, (joints, bedding planes, foliation, shears, faults, etc.) singly or in combination dip out of the slope at angles near or in excess of the angle of friction of the discontinuities, a potential for failure exists. It is essential that the geologic model of discontinuities around the pit be determined and the kinematic potential for failure evaluated. Typical failure models are shown in Figure 4.1. They include circular, planar, wedge, block and toppling modes.

Where multiple bench failures can occur along discontinuities, it is normally necessary to obtain samples to perform direct shear tests along these discontinuities. The surface roughness and waviness along the discontinuity must be evaluated in the direction of sliding. This may increase the effective angle of friction by ten degrees or more. Both conditions require assessment in order to evaluate the safety factor for that portion of the slope.

The presence of groundwater in the slopes may influence stability in a number of ways:

a. Reduction in the frictional shear strength due to buoyancy.

b. Reduction in cohesion of clay gouge or clayey rock with increasing moisture content.

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This structure will lead to certain types of potential instability in each pit face depending on the face direction. The pit slope design must accommodate this potential.

East facing slopes	-	planar failure along shears, faults and contacts
North facing slopes	-	shallow wedges along joint intersections or fault contacts
South facing slopes	-	local wedges adjacent to fault contacts
West facing slopes	-	toppling

Rock joint continuity data (R.Q.D. and Joint Frequency) is shown in Appendix B, together with unconfined compressive strength data. Generally the rock strength is moderate to high so that stability will be controlled by the geologic structure. Several local zones of high fracturing and low strength were noted, i.e. - hole MP89-152, depth 180-350 feet. When the preliminary pit design has been developed, it will be necessary to evaluate rock strength data where drill holes intersect the pit walls to determine if any special design modification would be required. The west facing slopes must be evaluated in particular. If weak zones dip into these slopes, stress relief and high stress could cause subsidence and over stress the overlying rock to initiate toppling movement.

4.3 EVALUATION AND CONTROL OF GROUNDWATER

Groundwater is generally reasonably shallow below the ground surface. In some drill holes it was artesian. Consideration must be given to developing drainage of the pit walls to allow steep slopes and drainage in the pit floor to prevent pit bottom heaving. Wet blast holes will also require the use of more expensive explosives than the standard ANFO.

Igpm). This estimate does not include for removal of direct precipitation which will average approximately 13 L/s (175 Igpm) annually. The actual pit dewatering rate will be higher in the early stages of the operation when groundwater is removed from storage, and during periods of high rainfall.

Generally the most effective ways of controlling seepage into the pit is to install horizontal drain holes. They should be 20 to 30 metres (60 to 100 ft) long, drilled at a +2 to +3 degree slope and spaced about 12 metres (40 ft) apart at the toe of each double bench where seepage is encountered. In order to locate seepage zones, all blast holes which have water in them along the line holes and buffer holes should be plotted on blasting plans. The horizontal drain holes are only installed in areas where seepage is indicated.

If wet holes become a problem, a program to drill every tenth to twelfth blast hole an additional 6 to 9 metres (20 to 30 ft) deep and blast to that lower depth will provide a groundwater sink and help to lower the water table in the blast area. If this procedure is not successful, pumping wells at a number of locations around the pit may be required.

In order to continue to monitor the groundwater level conditions, a percentage of future drill holes should have piezometers installed to monitor the water table.

4.4 BLASTING CONTROL NEAR THE FINAL WALLS

Where the pit slope design angle will not be controlled by the structural geology the use of controlled blasting at the final face will normally allow an increase of 5 to 7 degrees in the slope angle. This involves the use of controlled blasting, with reasonably small diameter blast holes detonated as a pre-shear line in the harder massive rock or as a cushion or post shear line in weak or heavily fractured rock. The line holes should not be larger than 15 cm (6 inches) in diameter and spaced developed with variable test slopes and test blast patterns to develop the best blast design for the final wall. Test trial blasts will be required wherever the rock conditions change substantially.

It is recommended that double benching be used at the final wall. In order for this procedure to be successful, the upper bench face must be scaled prior to drilling the buffer holes on the next lower bench elevation. It is also important that blast holes be staggered so the bottom of the hole does not intercept the crest of the bench below. Otherwise, very fragmented bench crests will develop leading to considerable ravelling and a greater berm width.

It is recommended that the operators of front-end loaders or shovel loaders who excavate this final face be given a seminar on structural geology, particularly the identification of small planar blocks and small wedges which could fail. By recognizing these in advance, they can dig them out so that ravelling at a later date will be reduced. By minimizing this ravelling the bench width can be narrowed to increase the overall slope angle.

Do not place piles of loose rock at the outer side of berms to catch ravelling rock. This requires an excessive bench width and results in overall flatter slope angles. Berms are to catch ravelled rock. They are not intended for later access.

4.5 MONITORING

The development of slope movement will be indicated by the development of a tension crack or cracks. It is most important that periodic inspections along the crest and bench locations be performed periodically to locate such cracks.

When tension cracks are observed the initial monitoring program requires the installation of surface movement hubs or gages which will allow measurement of the catch width required for berms. Where the rock face stands up well, a 6 metre (20 foot) wide bench is suggested. If the rock is very fractured and considerable ravelling occurs the bench will have to be widened to about 8 metres (25 feet).

If areas of heavily fractured rock or faulted rock are encountered in the final slopes, more stable bench faces can frequently be developed using bulldozers and rippers rather than blasting along the final line holes. By utilizing this procedure the slope angles at Bougainville, in Papua New Guinea, for example, were steepened some 8 degrees.

4.7 PRELIMINARY PIT SLOPE DESIGN

East Facing Slope - A revised geological interpretation provided by Imperial Metals Corporation indicates the geologic structure is reasonably uniform over all three pits. Planar failures will occur locally where the structure dip is flatter than the bench face angle.

The slope angle can be developed with bench face angles of 70 degrees. The overall angle will depend on berm width, bench height and whether single or double benching will be used. See Table 4.1 and Figures 4.5 and 4.6.

West Facing Slopes - Based on existing structural geologic data the structure dips into the west facing slopes at about 45 to 75 degrees. Where the structure dip is less than about 60 degrees and does not cross major faults the bench faces can be developed at 75 degrees. The overall angle will depend on berm width, bench height and single or double benching. Where the dip angle is steeper than about 60 degrees the potential for toppling failure exists. The bench faces should be flattened to 70 degrees and berm widths should be increased by 2.0 metres.

Revised: February 15, 1990

SECTION 5.0 - WASTE DUMP LAYOUTS

5.1 WASTE ROCK PRODUCTION

The total volume of waste rock to be removed from the proposed open pits is approximately 75 million tonnes. The greatest proportion of waste rock will be removed from the west pit which is scheduled to be developed last.

Testwork carried out to determine the geochemical characteristics of the waste rock has been reported in Section 3.3.1 for 94 samples of waste rock tested, all showed a net neutralization potential except for 2 samples from Hole MP89-134 located in the north pit. These samples contained 1.5 and 2.9 percent sulphur and had net acid generating potentials of 55.0 and 13.2 kg $CaCO_3$/tonne respectively. These are very low numbers and do not imply that acid generation will occur.

5.2 WASTE DUMP LOCATIONS AND CONSTRUCTION

Several waste dump sites have been selected as shown on Drawing No. 1621.100. The dumps have been located to optimize waste rock hauling. The main north dump will contain waste from the north pit and will include the waste rock, if any, which is deemed to have a net acid generation potential.

Routine acid-base accounting will be utilized to delineate any waste rock materials which have a net acid generation potential. Any waste rock which is deemed to be potentially acid producing will be blended into the north waste rock and encapsulated by similar acid consuming materials. On-going operational monitoring will include routine water quality analyses on any springs or seeps in the vicinity of the waste dumps.

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parameters for the foundation material assume either an in-situ layer of till or unstripped topsoil and wood debris.

The stability analyses were carried out for base translational failure along the waste rock/foundation contact using a non-circular analyses. The analyses were completed for both the operational angle of repose dump slopes and for the final reclaimed slopes of 2h:1v. The results are summarized on Figure 5.3 which indicates that a minimum factor of safety of 1.2 can be achieved for the final dump slopes on all terrain at the site regardless of topsoil stripping.

5.4 RECLAMATION

Final reclamation of the waste dumps will involve spreading of topsoil and glacial till and seeding or planting as required.

SECTION 6.0 - TAILINGS STORAGE FACILITY

6.1 SITE SELECTION

A selection and evaluation of alternative tailings disposal sites was initially carried out and included a comparative assessment of the following factors:

- Capacity and filling characteristics
- Surface hydrology and downstream water usage
- Hydrogeology and groundwater flows
- Aesthetics and visual impact
- Foundation conditions and construction requirements
- Closure and reclamation requirements
- Capital and operating costs

Three possible tailings disposal sites were identified and designated as Areas A, B and C respectively. The site locations and conceptual layouts are included on Figure 6.1. A preliminary site investigation program was conducted at each site, to evaluate the environmental impacts as well as design and construction constraints. The initial site investigations included surface mapping, surficial exploration by test pitting, and evaluation of surface and groundwater regimes. Surficial soils at each of the alternative tailings locations are shown on Drawing Nos. 1621.001, 1621.002 and 1621.003.

The foundation conditions at each of the proposed tailings areas are good, as a natural liner of low permeability glacial till and/or muskeg is present. Bedrock exposures in Area A consist of competent rock, which may result in some additional foundation preparation at the embankment locations particularly where the bedrock profile is steep. Foundation preparation at Area B is expected to minimal, with a

TABLE 2.1

IMPERIAL METALS CORPORATION
MT. POLLEY PROJECT

MEAN MONTHLY AND ANNUAL PRECIPITATION

Location:	Likely B.C.	Mine Site	Barkerville
Elevation:	724 m	1000 m	1265
Location:	52° 36'N	52° 30'N	53° 4'N
	121° 32'W	121° 35'W	121° 31'W

	Mean (mm)	Std. Dev. (mm)	Mean (mm)	Std. Dev. (mm)	Mean (mm)	Std. Dev. (mm)
Jan	74.2	27.0	84.9	27.0	103.0	44.4
Feb	60.2	27.7	68.8	27.7	85.6	42.5
Mar	37.8	13.5	43.2	13.5	85.3	29.1
Apr	42.2	20.9	48.2	20.9	61.8	24.5
May	36.6	15.4	41.8	15.4	65.9	28.9
June	66.3	29.7	75.8	29.7	89.2	28.8
July	47.0	27.4	53.7	27.4	81.7	31.0
Aug	82.0	35.7	93.8	35.7	102.3	53.0
Sept	50.4	27.1	57.6	27.1	85.4	39.9
Oct	61.6	42.3	70.4	42.3	88.4	37.4
Nov	58.4	18.8	66.8	18.8	86.6	28.2
Dec	83.0	36.9	95.0	36.9	108.7	42.5
Annual	699.7	116.4	800	116.4	1043.9	112.7

Source:

Canadian Climate Normals, 1951-1980, Temperature and Precipitation Atmospheric Environment Service, Environment Canada.

TABLE 2.3

IMPERIAL METALS CORPORATION
MT. POLLEY PROJECT

ESTIMATED PAN EVAPORATION AT SITE

	Quesnel	Williams Lake	Site
May	98	88	93
June	130	124	127
July	151	144	148
August	131	129	130
September	81	77	79
October	39	38	38
Total	630	600	615

Source:

Based on computed potential evapotranspiration data by AES using Thornthwaite model, increased by an empirical factor of 1.25 to bring into line with pan evaporation data.

TABLE 2.4 (Continued)

SEISMIC RISK CALCULATION

```
SITE                                            Mt. Polley, B.C.

     ZONING FOR ABOVE SITE/ ZONAGE DU SITE CI-DESSUS

     1985 NBCC/CNBC:   ZA = 0;   ZV = 1;   V = 0.05 M/S

 ACCELERATION ZONE/ ZONE D'ACCELERATION     ZA=0
 ZONAL ACCELERATION/ ACCELERATION ZONALE  0.00 G

 VELOCITY ZONE/ ZONE DE VITESSE            ZV=1
 ZONAL VELOCITY/ VITESSE ZONALE           0.05 M/S


                 1985 NBCC/CNBC **
  SEISMIC ZONING MAPS/ CARTES DU ZONAGE SEISMIQUE

          PROBABILITY LEVEL: 10% IN 50 YEARS
      NIVEAU DE PROBABILITE: 10% EN 50 ANNEES

        ----------------------------------
         G OR M/S   ZONE     ZONAL VALUE/
                             VALEUR ZONALE
        ----------------------------------
          0.00
                     0          0.00
          0.04
                     1          0.05
          0.08
                     2          0.10
          0.11
                     3          0.15
          0.16
                     4          0.20
          0.23
                     5          0.30
          0.32
                     6*         0.40
        ----------------------------------

  * ZONE 6:  NOMINAL VALUE/ VALEUR NOMINALE  0.40;
     SITE-SPECIFIC STUDIES SUGGESTED FOR IMPORTANT PROJECTS/
     ETUDES COMPLEMENTAIRES SUGGEREES POUR DES PROJETS D'IMPORTANCE.


 ** FOR NBCC APPLICATIONS, CALCULATED ZONE VALUES AT A SITE SHOULD BE
     REPLACED BY EFFECTIVE ZONE VALUES [ZA(EFF) OR ZV(EFF)] AS SHOWN BELOW/
    POUR APPLICATIONS SELON LE CNBC, ON DOIT REMPLACER LES VALEURS ZONALES
     CALCULEES POUR UN SITE PAR LES VALEURS EFFECTIVES [ZA(EFF) OU ZV(EFF)]
     COMME MONTRE CI-DESSOUS:

      1.   IF/SI (ZA - ZV) > 1,          ===>  ZA(EFF) = ZV + 1.
 OR/OU
      2.   IF/SI (ZA - ZV) < 1,          ===>  ZA(EFF) = ZV - 1.
 OR/OU
      3.   IF/SI  ZV=0 AND/ET ZA > 0,  ===>  ZV(EFF) = 1.

        (SEE REFERENCE 2 CITED ABOVE, PAGE 677)
        (VOIR PAGE 677 DE LA REFERENCE 2 CI-DESSUS)
                                                          23-OCT-89  20:17:40
```

TABLE 3.1 (Continued)

Hole No.	Depth Interval (ft)	Measured Permeability (cm/s)
MP89-146 (Con't)	460-480	9.8×10^{-7}
	480-520	1.0×10^{-6}
	520-560	2.5×10^{-6}
	600-640	4.8×10^{-6}
	640-700	2.0×10^{-6}
MP89-147	20-50	3.2×10^{-4}
	50-80	6.8×10^{-6}
	80-120	2.6×10^{-6}
	120-160	4.0×10^{-5}
	160-200	1.4×10^{-4}
	200-240	1.8×10^{-5}
	240-280	6.2×10^{-6}
	280-320	1.8×10^{-5}
	320-360	7.5×10^{-7}
	360-400	7.5×10^{-7}
MP89-148	20-60	1.0×10^{-4}
	60-100	6.6×10^{-4}
	100-140	3.0×10^{-3}
	140-180	4.2×10^{-4}
	180-220	4.8×10^{-5}
	220-260	3.0×10^{-5}
	260-300	7.2×10^{-6}
	300-340	4.9×10^{-4}

TABLE 3.2

IMPERIAL METALS CORPORATION
MT. POLLEY PROJECT
GROUNDWATER LEVELS IN PROPOSED OPEN PIT AREA

DEPTH TO GROUNDWATER TABLE (m) IN MONITORING WELLS

Date	MP89-107	MP89-146	MP89-151
August 16, 1989	28.0	14.7	35.5
November 8, 1989	10.0	10.5	31.0

DEPTH TO PHREATIC SURFACE (m) IN MULTIPLE PNEUMATIC PIEZOMETERS

	MP89-147A	-147B	-147C	MP89-155A	-155B
Tip Depth (m)	27.6	59.0	88.8	7.8	157.7
Date					
August 2, 1989	3.2	2.6	4.5	-	-
August 15, 1989	3.5	2.4	4.6	-	-
November 12, 1989	2.2	1.6	9.2	2.7	*

* Reading beyond capacity of read-out box.

TABLE 3.3 (Continued)

Physical Test		MP89-107 Aug 10/89	MP89-107 Nov 25/89	MP89-146 Aug 10/89	MP89-146 Nov 25/89	MP89-151 Nov 25/89
Lead	Pb	0.010	<0.001	0.018	0.003	0.010
Manganese	Mn	2.08	1.24	0.10	0.011	0.038
Mercury	Hg	<0.00005	0.00005	0.00036	0.00005	0.0007
Molybdenum	Mo	0.003	0.005	0.012	0.010	0.009
Nickel	Ni	0.004	<0.001	0.004	0.001	0.004
Silver	Ag	<0.0001	0.0002	<0.0001	<0.0001	<0.0001
Zinc	Zn	0.020	<0.005	0.028	<0.005	<0.005
Dissolved Metals						
Aluminum	Al	0.064	0.010	0.36	0.065	0.058
Arsenic	As	0.0006	0.0002	0.0016	0.0010	0.0003
Cadmium	Cd	<0.0002	<0.0002	0.0003	<0.0002	<0.0002
Calcium	Ca	56.3	54.8	15.6	10.4	23.9
Chromium	Cr	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	Co	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	Cu	0.014	0.013	0.070	0.21	0.025
Iron	Fe	<0.03	<0.03	0.11	<0.03	0.03
Lead	Pb	0.001	<0.001	0.002	0.001	0.001
Magnesium	Mg	10.7	7.08	1.93	1.10	2.73
Manganese	Mn	2.03	1.17	0.036	0.007	<0.005
Mercury	Hg	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Molybdenum	Mo	0.003	0.002	0.012	0.003	0.006
Nickel	Ni	<0.001	<0.001	<0.001	<0.001	<0.001
Potassium	K	0.68	0.60	0.89	0.59	0.42
Silver	Ag	<0.0001	0.0001	<0.0001	<0.0001	<0.0001
Sodium	Na	3.87	2.44	7.18	4.64	2.24
Zinc	Zn	0.014	<0.005	0.021	0.005	0.025

Notes:

All units in mg/L except where noted otherwise.

TABLE 3.5

IMPERIAL METALS CORPORATION

MT. POLLEY PROJECT

TAILINGS WASTE EXTRACTION TEST (CARBONIC ACID)

Element	Concentration in Pore Water (ug/L)	Concentration in Extract (ug/L)	Concentration Dewatered Sample (ug/g)	Objectives for Final Effluent Discharge (1) (ug/L) Range
Antimony	36	16	0.13	250-1000
Arsenic	363	97.3	1.06	100-1000
Bismuth	<1	<1	<0.01	-
Cadmium	<1	<1	<0.01	10-100
Chromium	<10	<10	<0.06	50-300
Cobalt	<2	<2	<0.01	500-1000
Copper	2	6	0.03	50-300
Lead	2	<2	<0.01	50-200
Mercury	<0.1	<0.1	<0.00	0-5
Nickel	<2	<2	<0.01	200-1000
Zinc	4	8	0.04	200-1000

Test Conditions:

Sample: Locked Cycle Tailings

Paste pH:	9.2
Carbonic Acid pH:	5.5
Weight of solid:	117.0 g
Volume of dilution water added:	0.45 L
Volume of extract:	0.43 L

(1) Pollution Control Objectives for the Mining, Smelting and Related Industries of British Columbia (1979).

TABLE 3.7

IMPERIAL METALS CORPORATION
MT. POLLEY PROJECT

TAILINGS AREA B SITE INVESTIGATION
SUMMARY OF FALLING HEAD PIEZOMETER TEST RESULTS

Hole No.	Depth Interval (m)	Permeability (cm/s)	Material Description
MP89-232	3 to 15	2.4×10^{-5}	Overburden
MP89-233	16 to 30	1.4×10^{-6}	Overburden
MP89-235	3 to 32	7.7×10^{-6}	Bedrock and Overburden

TABLE 3.9

IMPERIAL METALS CORPORATION
MT. POLLEY PROJECT

GROUNDWATER QUALITY IN PROPOSED TAILINGS STORAGE AREA

Physical Tests		MP89-231 Nov 25/89	MP89-232 Nov 25/89	MP89-233 Nov 25/89	MP89-234 Nov 25/89	MP89-235 Nov 25/89	MP89-236 Nov 25/89
pH		7.73	7.40	7.65	8.0	7.28	8.24
Conductivity (Mmho/cm)		1226	289.	393.	422.	4280.	574.
Turbidity	NTU						
Suspended Solids							
Dissolved Solids							
Hardness	$(CaCO_3)$	182.	96.7	197.	80.2	432.	177.
Tot. N							
TOC							
DOC							
Anions and Nutrients							
Alkalinity	$(CaCO_3)$						
Sulphate	SO_4						
Chloride	C1						
O-Phosphate	P						
T-Phosphorus	P						
Nitrate	N						
Nitrite	N						
Ammonia	N						
Total Metals							
Aluminum	Al	7.88	34.1	15.4	4.77	13.1	9.80
Arsenic	As	0.0085	0.0004	0.0088	0.073	0.0079	0.014
Cadmium	Cd	<0.0002	0.015	0.0003	<0.0002	0.0003	0.0003
Chromium	Cr	0.005	0.047	0.040	0.007	0.029	0.012
Cobalt	Co	0.006	0.013	0.009	0.002	0.010	0.007
Copper	Cu	0.030	0.069	0.048	0.019	0.052	0.075
Iron	Fe	11.9	29.3	20.9	4.47	14.0	15.3

Revised January 8, 1990

TABLE 4.1

IMPERIAL METALS CORPORATION
MT. POLLEY PROJECT

PRELIMINARY PIT SLOPE DESIGN

Location	Section Design	Single Bench - 10 m				Double Bench - 20 m		
		Bench Face Angle	Top Berm Width	Bottom Berm Width	Overall Slope Angle	Bench Face Angle	Berm Width	Overall Angle
East Facing Walls 9500N - 10250 N	A	70°	6.5m	6.5m	45°	60°	8.5m	45°
East Facing Walls 10250N - North end North Facing Walls West Facing Walls Structural Dip >60°	B	70°	5m	6.5m	48°	70°	8.5m	52°
South Facing Walls West Facing Walls Structural dip <60°	C	75°	5m	6.5m	50°	75°	8.5m	55°

Note - The preliminary design slopes are based on

1 - Control of Ground water pressures with horizontal drains
2 - Use of controlled blasting within 30 meters of the final wall
3 - Haul roads on more stable west facing walls.

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TABLE 6.2
IMPERIAL METALS CORPORATION
Mt POLLEY PROJECT

TAILINGS STORAGE FACILITY

MONTH BY MONTH WATER BALANCE FOR TAILINGS MASS AND WATER DISTRIBUTION
YEAR - 1 : WET YEAR

Assumptions :-

Dry Solids to Tails = 13425 t/day
Tailings % Solids = 35%
Tailings S.G. = 2.78
Beach Runoff Coeff. = 90%
Catchment Runoff coef. = 24%
Total Catchment = 230 hectares

Initial Dry Density = 0.90 t/cu.m
Final Dry Density = 1.10 t/cu.m
Operating Days/Year = 365
* Maximum Recycle = 667350 cu.m/month
Initial Stored Vol = 0 cu.m
Evap Factor = 0.80

	MONTH	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	ANNUAL
A	Rainfall (mm/mon)	0.0	0.0	0.0	0.0	0.0	0.0	69.1	57.2	105.5	81.1	129.5	84.7	527.1
B	#Snowfall (mm/mon water equiv)	112.7	85.6	131.9	111.9	96.5	56.7	0.0	0.0	0.0	0.0	0.0	0.0	595.3
C	Pan evaporation (mm/mon)	38.0	0.0	0.0	0.0	0.0	0.0	0.0	88.0	124.0	144.0	129.0	77.0	600.0
D	Tailings beach area (ha)	4.0	5.0	13.0	18.0	25.0	35.0	45.0	50.0	60.0	65.0	70.0	75.0	
E	Outside catchment area (ha)	226.0	225.0	217.0	212.0	205.0	195.0	185.0	180.0	170.0	165.0	160.0	155.0	
	- <WATER IN> (cu.m)													
1	With slurry	758353	758353	758353	758353	758353	758353	758353	758353	758353	758353	758353	758353	9100232
2	Prec. runoff (beach)	4057	3852	15432	18128	21713	17861	27986	25740	56970	47444	81585	57173	377939
3	Prec. runoff (outside beach)	0	0	0	0	0	0	30680	281880	43044	32116	49728	31508	468956
4	Infiltration from precipitation	451	428	1715	2014	2412	1984	3109	2860	6330	5271	9065	6352	41993
5	Recovery from Pit	0	0	0	0	0	0	0	0	0	0	0	0	0
6	>>>> Total Water Input	762861	762633	775500	778495	782478	778198	820128	1068833	864697	843183	898731	853386	9989121
	- <WATER OUT> (cu.m)													
	Supernatant Recovery													
7	(+) Ini. recovery from tailings	451524	451524	451524	451524	451524	451524	451524	451524	451524	451524	451524	451524	5418284
8	(-) Underdrainage	58100	58100	58100	58100	58100	58100	58100	58100	58100	58100	58100	58100	697200
9	(-) Evap. from entire beach	1216	0	0	0	0	0	0	35200	59520	74880	72240	46200	289256
10	(+) Total precipitation runoff	4057	3852	15432	18128	21713	17861	58666	307620	100014	79559	131313	88681	846895
11	(+) Consolid. to final density	82494	82494	82494	82494	82494	82494	82494	82494	82494	82494	82494	82494	989924
12	Sub-total (Water Recovered as S/N)	478759	479769	491350	494045	497630	493778	534583	748337	516411	480596	534990	518398	6268647
	Underdrainage Recovery													
13	(+) Underdrainage	58100	58100	58100	58100	58100	58100	58100	58100	58100	58100	58100	58100	697200
14	(+) Rainfall infiltration	451	428	1715	2014	2412	1984	3109	2860	6330	5271	9065	6352	41993
15	(-) Seepage losses	5894	5894	5894	5894	5894	5894	5894	5894	5894	5894	5894	5894	70728
16	Sub-total (Water Recovered as U/D)	52657	52634	53921	54220	54619	54191	55316	55066	58536	57478	61271	58559	668465
17	Water retained in tailings	224335	224335	224335	224335	224335	224335	224335	224335	224335	224335	224335	224335	2692024
18	Evaporation From tailings	1216	0	0	0	0	0	0	35200	59520	74880	72240	46200	289256
19	Seepage losses	5894	5894	5894	5894	5894	5894	5894	5894	5894	5894	5894	5894	70728
20	Sub-total (Unrecoverable Water)	231445	230229	230229	230229	230229	230229	230229	265429	289749	305109	302469	276429	3052008
21	>>>> Total Water Accounted For	762861	762633	775500	778495	782478	778198	820128	1068833	864697	843183	898731	853386	9989121
22	Total water added to tails surface	531415	532403	545270	548265	552248	547968	589899	803403	574947	538074	596261	576957	6937112
23	Water recycled to mill from tails	531415	532403	545270	548265	552248	547968	589899	667350	667350	581724	596261	576957	6937112
24	Monthly water surplus/deficit (-)	-135935	-134947	-122080	-119085	-115102	-119382	-77452	136053	-92403	-129276	-71089	-90394	-1071092
25	Cumulative surplus	0	0	0	0	0	0	0	136053	43650	0	0	0	0
26	Makeup water required at mill**	226937	225949	213082	210087	206104	210384	168454	91002	91002	176629	162091	181396	2163120

\# Snowfall is given in equivalent depth of rainfall and is assumed to accumulate on outside catchment until May when it melts with 24% recovery

* Maximum allowable recycle from tailings area is equiv to 88 % of water associated with incoming tail slurry at assumed solids content.

** Makeup water at mill is total nonrecycled water (including that in ore) required to produce a tailings slurry at assumed solids content.

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TABLE 6.4
IMPERIAL METALS CORPORATION
Mt POLLEY PROJECT

TAILINGS STORAGE FACILITY

MONTH BY MONTH WATER BALANCE FOR TAILINGS MASS AND WATER DISTRIBUTION
YEAR - 10: AVERAGE YEAR

Assumptions :-

Dry Solids to Tails	=	13425 t/day	Initial Dry Density	=	0.90 t/cu.m
Tailings % Solids	=	35%	Final Dry Density	=	1.30 t/cu.m
Tailings S.G.	=	2.78	Operating Days/Year	=	365
Beach Runoff Coeff.	=	90%	* Maximum Recycle	=	667350 cu.m/month
Catchment Runoff coef.	=	24%	Initial Stored Vol	=	0 cu.m
Total Catchment	=	230 hectares	Evap Factor	=	0.80

	MONTH	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	ANNUAL
A	Rainfall (mm/mon)	0.0	0.0	0.0	0.0	0.0	0.0	48.2	41.8	75.8	53.7	93.8	57.6	370.9
B	#Snowfall (mm/mon water equiv)	70.4	66.8	95.0	84.9	68.8	43.2	0.0	0.0	0.0	0.0	0.0	0.0	429.1
C	Pan evaporation (mm/mon)	38.0	0.0	0.0	0.0	0.0	0.0	0.0	88.0	124.0	144.0	129.0	77.0	600.0
D	Tailings beach area (ha)	213.0	214.0	215.0	215.0	215.0	215.0	216.0	216.0	216.0	216.0	216.0	217.0	
E	Outside catchment area (ha)	17.0	16.0	15.0	15.0	15.0	15.0	14.0	14.0	14.0	14.0	14.0	13.0	
	- <WATER IN> (cu.m)													
1	With slurry	758353	758353	758353	758353	758353	758353	758353	758353	758353	758353	758353	758353	9100232
2	Prec. runoff (beach)	134957	128657	183825	164282	133128	83592	93701	81259	147355	104393	182347	112493	1549988
3	Prec. runoff (outside beach)	0	0	0	0	0	0	1620	15822	2547	1804	3152	1797	26742
4	Infiltration from precipitation	14995	14295	20425	18253	14792	9288	10411	9029	16373	11599	20261	12499	172221
5	Recovery from Pit	0	0	0	0	0	0	0	0	0	0	0	0	0
6	>>>> Total Water Input	908305	901305	962603	940888	906273	851233	864084	864463	924628	876149	964112	885142	10849183
	- <WATER OUT> (cu.m)													
	Supernatant Recovery													
7	(+) Ini. recovery from tailings	451524	451524	451524	451524	451524	451524	451524	451524	451524	451524	451524	451524	5418284
8	(-) Underdrainage	58100	58100	58100	58100	58100	58100	58100	58100	58100	58100	58100	58100	697200
9	(-) Evap. from entire beach	64752	0	0	0	0	0	0	152064	214272	248832	222912	133672	1036504
10	(+) Total precipitation runoff	134957	128657	183825	164282	133128	83592	95320	97081	149902	106197	185499	114290	1576730
11	(+) Consolid. to final density	139605	139605	139605	139605	139605	139605	139605	139605	139605	139605	139605	139605	1675256
12	Sub-total (Water Recovered as S/N)	603233	661685	716853	697310	666156	616620	628349	478046	468658	390393	495615	513646	6936566
	Underdrainage Recovery													
13	(+) Underdrainage	58100	58100	58100	58100	58100	58100	58100	58100	58100	58100	58100	58100	697200
14	(+) Rainfall infiltration	14995	14295	20425	18253	14792	9288	10411	9029	16373	11599	20261	12499	172221
15	(-) Seepage losses	5894	5894	5894	5894	5894	5894	5894	5894	5894	5894	5894	5894	70728
16	Sub-total (Water Recovered as U/D)	67201	66501	72631	70460	66998	61494	62617	61235	68579	63805	72467	64705	798693
17	Water retained in tailings	167224	167224	167224	167224	167224	167224	167224	167224	167224	167224	167224	167224	2006692
18	Evaporation From tailings	64752	0	0	0	0	0	0	152064	214272	248832	222912	133672	1036504
19	Seepage losses	5894	5894	5894	5894	5894	5894	5894	5894	5894	5894	5894	5894	70728
20	Sub-total (Unrecoverable Water)	237870	173118	173118	173118	173118	173118	173118	325182	387390	421950	396030	306790	3113924
21	>>>> Total Water Accounted For	908305	901305	962603	940888	906273	851233	864084	864463	924628	876149	964112	885142	10849183
22	Total water added to tails surface	670434	728186	789484	767769	733154	678114	690966	539281	537237	454199	568082	578351	7735259
23	Water recycled to mill from tails	667350	667350	667350	667350	667350	667350	667350	667350	667350	582672	568082	578351	7735259
24	Monthly water surplus/deficit (-)	3084	60836	122134	100419	65804	10764	23616	-128070	-130113	-213152	-99268	-88999	-272945
25	Cumulative surplus	3084	63920	186054	286473	352277	363041	386656	258587	128474	0	0	0	0
26	Makeup water required at mill**	91002	91002	91002	91002	91002	91002	91002	91002	91002	175681	190271	180001	1364973

Snowfall is given in equivalent depth of rainfall and is assumed to accumulate on outside catchment until May when it melts with 24% recovery

* Maximum allowable recycle from tailings area is equiv to 88 % of water associated with incoming tail slurry at assumed solids content.

** Makeup water at mill is total nonrecycled water (including that in ore) required to produce a tailings slurry at assumed solids content.

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TABLE 6.6
IMPERIAL METALS CORPORATION
Mt POLLEY PROJECT

TAILINGS STORAGE FACILITY

MONTH BY MONTH WATER BALANCE FOR TAILINGS MASS AND WATER DISTRIBUTION
YEAR - 10: DRY YEAR

Assumptions :-

Dry Solids to Tails	=	13425 t/day	Initial Dry Density	=	0.90 t/cu.m
Tailings % Solids	=	35%	Final Dry Density	=	1.30 t/cu.m
Tailings S.G.	=	2.78	Operating Days/Year	=	365
Beach Runoff Coeff.	=	90%	* Maximum Recycle	=	667350 cu.m/month
Catchment Runoff coef.	=	24%	Initial Stored Vol	=	0 cu.m
Total Catchment	=	230 hectares	Evap Factor	=	0.80

	MONTH	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	ANNUAL
A	Rainfall (mm/mon)	0.0	0.0	0.0	0.0	0.0	0.0	27.3	26.4	46.1	26.3	58.1	30.5	214.7
B	#Snowfall (mm/mon water equiv)	28.1	48.0	58.1	57.9	41.1	29.7	0.0	0.0	0.0	0.0	0.0	0.0	262.9
C	Pan evaporation (mm/mon)	38.0	0.0	0.0	0.0	0.0	0.0	0.0	88.0	124.0	144.0	129.0	77.0	600.0
D	Tailings beach area (ha)	213.0	214.0	215.0	215.0	215.0	215.0	216.0	216.0	216.0	216.0	216.0	217.0	
E	Outside catchment area (ha)	17.0	16.0	15.0	15.0	15.0	15.0	14.0	14.0	14.0	14.0	14.0	13.0	
	- <WATER IN> (cu.m)													
1	With slurry	758353	758353	758353	758353	758353	758353	758353	758353	758353	758353	758353	758353	9100232
2	Prec. runoff (beach)	53868	92448	112424	112037	79529	57470	53071	51322	89618	51127	112946	59567	925425
3	Prec. runoff (outside beach)	0	0	0	0	0	0	917	9720	1549	884	1952	952	15974
4	Infiltration from precipitation	5985	10272	12492	12449	8837	6386	5897	5702	9958	5681	12550	6619	102825
5	Recovery from Pit	0	0	0	0	0	0	0	0	0	0	0	0	0
6	>>>> Total Water Input	818206	861073	883268	882838	846718	822208	818238	825097	859478	816044	885801	825489	10144456
	- <WATER OUT> (cu.m)													
	Supernatant Recovery													
7	(+) Ini. recovery from tailings	451524	451524	451524	451524	451524	451524	451524	451524	451524	451524	451524	451524	5418284
8	(-) Underdrainage	58100	58100	58100	58100	58100	58100	58100	58100	58100	58100	58100	58100	697200
9	(-) Evap. from entire beach	64752	0	0	0	0	0	0	152064	214272	248832	222912	133672	1036504
10	(+) Total precipitation runoff	53868	92448	112424	112037	79529	57470	53988	61042	91167	52011	114899	60518	941399
11	(+) Consolid. to final density	139605	139605	139605	139605	139605	139605	139605	139605	139605	139605	139605	139605	1675256
12	Sub-total (Water Recovered as S/N)	522144	625476	645452	645065	612557	590498	587017	442006	409924	336207	425015	459874	6301235
	Underdrainage Recovery													
13	(+) Underdrainage	58100	58100	58100	58100	58100	58100	58100	58100	58100	58100	58100	58100	697200
14	(+) Rainfall infiltration	5985	10272	12492	12449	8837	6386	5897	5702	9958	5681	12550	6619	102825
15	(-) Seepage losses	5894	5894	5894	5894	5894	5894	5894	5894	5894	5894	5894	5894	70728
16	Sub-total (Water Recovered as U/D)	58191	62478	64698	64655	61043	58592	58103	57908	62164	57887	64756	58825	729297
17	Water retained in tailings	167224	167224	167224	167224	167224	167224	167224	167224	167224	167224	167224	167224	2006692
18	Evaporation From tailings	64752	0	0	0	0	0	0	152064	214272	248832	222912	133672	1036504
19	Seepage losses	5894	5894	5894	5894	5894	5894	5894	5894	5894	5894	5894	5894	70728
20	Sub-total (Unrecoverable Water)	237870	173118	173118	173118	173118	173118	173118	325182	387390	421950	396030	306790	3113924
21	>>>> Total Water Accounted For	818206	861073	883268	882838	846718	822208	818238	825097	859478	816044	885801	825489	10144456
22	Total water added to tails surface	580335	687954	710149	709719	673599	649089	645120	499915	472087	394094	489771	518699	7030532
23	Water recycled to mill from tails	580335	667350	667350	667350	667350	667350	667350	571444	472087	394094	489771	518699	7030532
24	Monthly water surplus/deficit (-)	-87015	20604	42799	42369	6249	-18261	-22231	-167436	-195263	-273256	-177580	-148651	-977672
25	Cumulative surplus	0	20604	63403	105772	112021	93760	71529	0	0	0	0	0	0
26	Makeup water required at mill**	178017	91002	91002	91002	91002	91002	91002	186909	286265	364259	268582	239654	2069700

Snowfall is given in equivalent depth of rainfall and is assumed to accumulate on outside catchment until May when it melts with 24% recovery
* Maximum allowable recycle from tailings area is equiv to 88 % of water associated with incoming tail slurry at assumed solids content.
** Makeup water at mill is total nonrecycled water (including that in ore) required to produce a tailings slurry at assumed solids content.

	Groundwater Quality(1)		Tailings Water Quality(2)		Objectives for Final Effluent Discharge (3)
Dissolved Metals	Average	Range	Average	Range	Range
Aluminum	0.043	0.014 to 0.13	0.67	<0.5 to 1.0	0.5 to 1.0
Arsenic	0.0122	0.0008 to 0.066	0.16	0.05 to 0.40	0.1 to 1.0
Cadmium	<0.0002	<0.0002	<0.01	<0.01	0.01 to 0.01
Calcium	52.8	16.1 to 128.0	NA		
Chromium	0.001	<0.001 to 0.002	<0.02	<0.02	0.05 to 0.3
Cobalt	<0.001	<0.001 to 0.002	<0.02	<0.02	0.5 to 1.0
Copper	0.004	<0.001 to 0.009	0.08	<0.01 to 0.24	0.5 to 1.0
Iron	0.43	<0.03 to 2.08	1.23	<0.20 to 4.60	0.3 to 1.0
Lead	0.001	<0.001 to 0.001	<0.05	<0.05	0.05 to 0.2
Magnesium	15.18	3.15 to 26.6	0.68	<0.05 to 1.55	
Manganese	0.28	0.066 to 0.78	<0.01	<0.01 to 0.06	0.1 to 1.0
Mercury	<0.00005	<0.00005 to 0.00005	<0.00005	<0.00005	NIL to 0.005
Molybdenum	0.005	0.002 to 0.009	0.76	0.08 to 2.05	0.5 to 5.0
Nickel	0.005	<0.001 to 0.013	<0.01	<0.01	0.2 to 1.0
Potassium	2.38	1.10 to 4.27	7.5	5.0 to 10.0	
Silver	<0.0001	<0.0001	<0.01	<0.01	0.05 to 0.5
Sodium	165.2	7.97 to 686.0	61.8	54.0 to 69.0	
Zinc	0.009	<0.005 to 0.025	<0.01	<0.01	0.2 to 1.0

Notes:

1. Results of analyses on 6 groundwater samples collected from piezometers in tailings area. Additional groundwater quality data are presented on Table 3.9.
2. Results of analyses on 6 samples from pilot metallurgical test program by Coastech Research Inc., February, 1990.
3. Pollution control objectives for the Mining, Smelting and Related Industries of British Columbia (1979).
4. All units in mg/l except where noted otherwise.

NA Not Available

Revised: March 21, 1990

TABLE 7.2
IMPERIAL METALS CORPORATION
MT POLLEY PROJECT

TAILINGS STORAGE FACILITY
PRELIMINARY COST ESTIMATE ONGOING CONSTRUCTION

ITEM	DESCRIPTION	UNIT	QUANT	UNIT PRICE $	AMOUNT $	SUBTOTALS $
2.	**STAGE II (YEAR 2)					
2.1	EMBANKMENT TOE DRAINS	m	1000	60	60000	
2.2	WASTE ROCK HAUL ROAD	cu m	300000	1.25	375000	
2.3	EMBANKMENT FILL	cu m	550000	3.20	1760000	
2.4	TAILINGS PIPELINE RELOCATION	LS	1	50000	50000	
2.5	RECLAMATION	LS	1	20000	20000	
2.6	ENGINEERING & SITE SUPERVISION	LS	1	181200	181200	2446200
3.	**STAGE III (YEAR 4)					
3.1	EMBANKMENT FILL	cu m	250000	3.00	750000	
3.2	TAILINGS PIPELINE RELOCATION	LS	1	50000	50000	
3.3	INSTRUMENTATION	LS	1	15000	15000	
3.4	RECLAMATION	LS	1	5000	5000	
3.5	ENGINEERING & SITE SUPERVISION	LS	1	65600	65600	885600
4.	**STAGE IV (YEAR 6)					
4.1	EMBANKMENT FILL	cu m	280000	3.00	840000	
4.2	TAILINGS PIPELINE RELOCATION	LS	1	50000	50000	
4.3	RECLAMATION	LS	1	5000	5000	
4.4	ENGINEERING & SITE SUPERVISION	LS	1	71600	71600	966600
5.	**STAGE V (YEAR 8)					
5.1	EMBANKMENT FILL	cu m	320000	3.00	960000	
5.2	TAILINGS PIPELINE RELOCATION	LS	1	50000	50000	
5.3	RECLAMATION	LS	1	5000	5000	
5.4	ENGINEERING & SITE SUPERVISION	LS	1	81200	81200	1096200
6.	**FINAL RECLAMATION (YEAR 10+)					
6.1	TAILINGS SURFACE - HYDROSEED	ha	230	5000	1150000	
6.2	FINAL SPILLWAY	LS	1	50000	50000	
6.3	REMOVE PIPEWORK	LS	1	40000	40000	
6.4	EROSION PROTECTION & MISC	LS	1	400000	400000	1640000
	TOTAL ON-GOING CONSTRUCTION AND RECLAMATION COST					7034600

15-Feb-90
F:\JOB\DATA\1621\COST2

NCI-763

IMPERIAL METALS CORPORATION
MT. POLLEY PROJECT
LOCATION OF WEATHER STATIONS

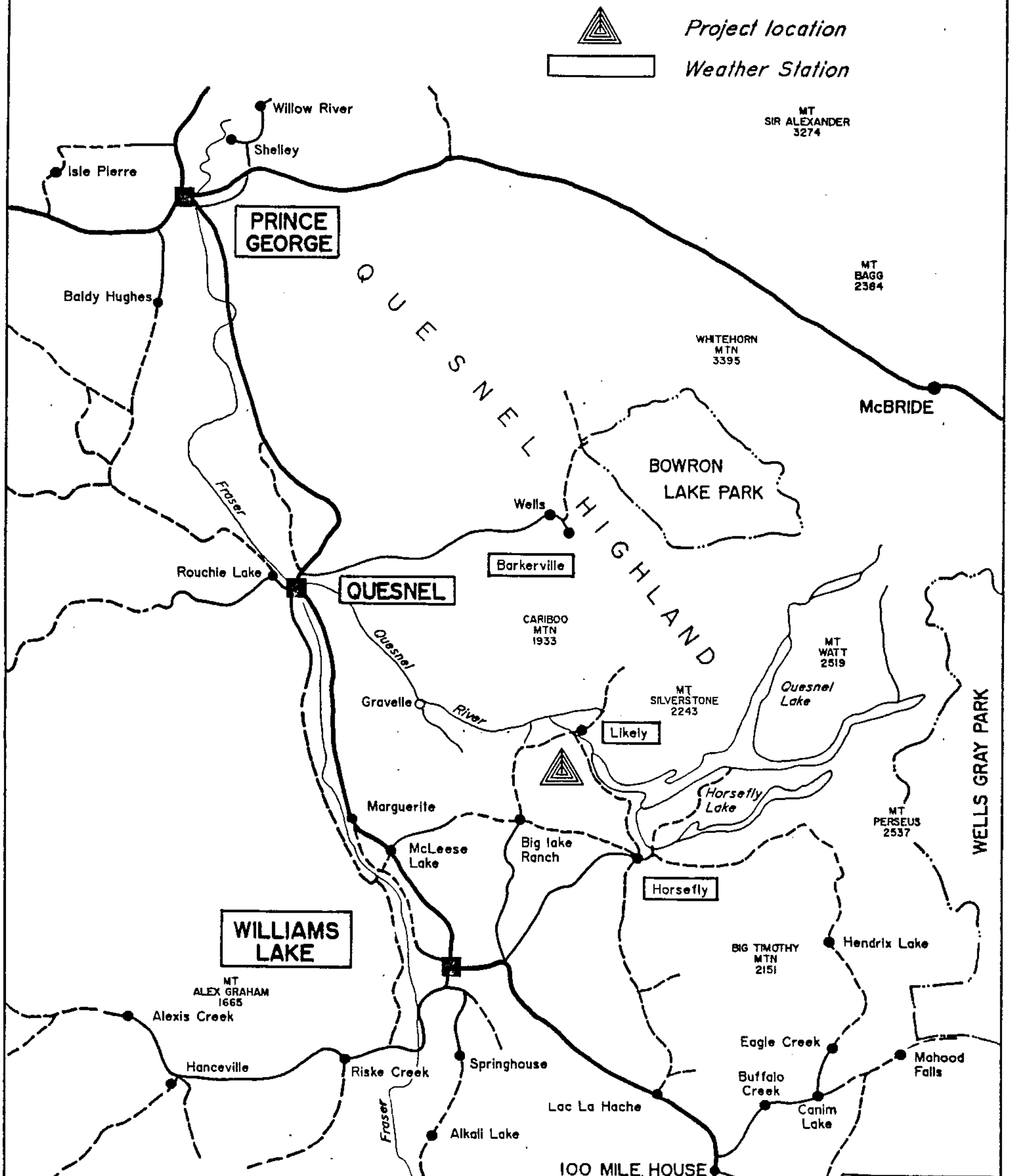

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FIGURE 2.1

NCI - 763

IMPERIAL METALS CORPORATION

MT. POLLEY PROJECT

SHORT DURATION RAINFALL INTENSITY - DURATION - FREQUENCY DATA FOR MINE SITE

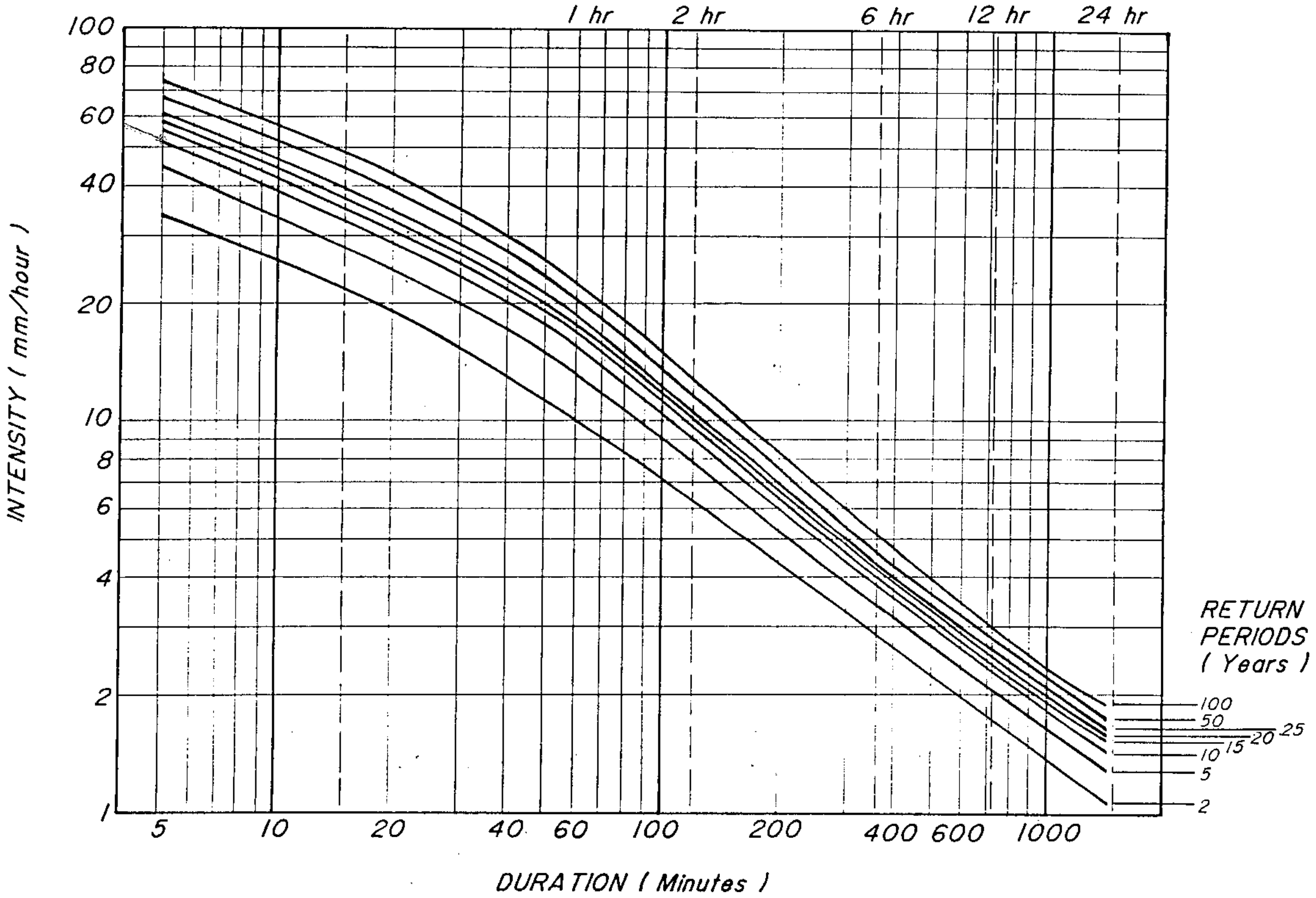

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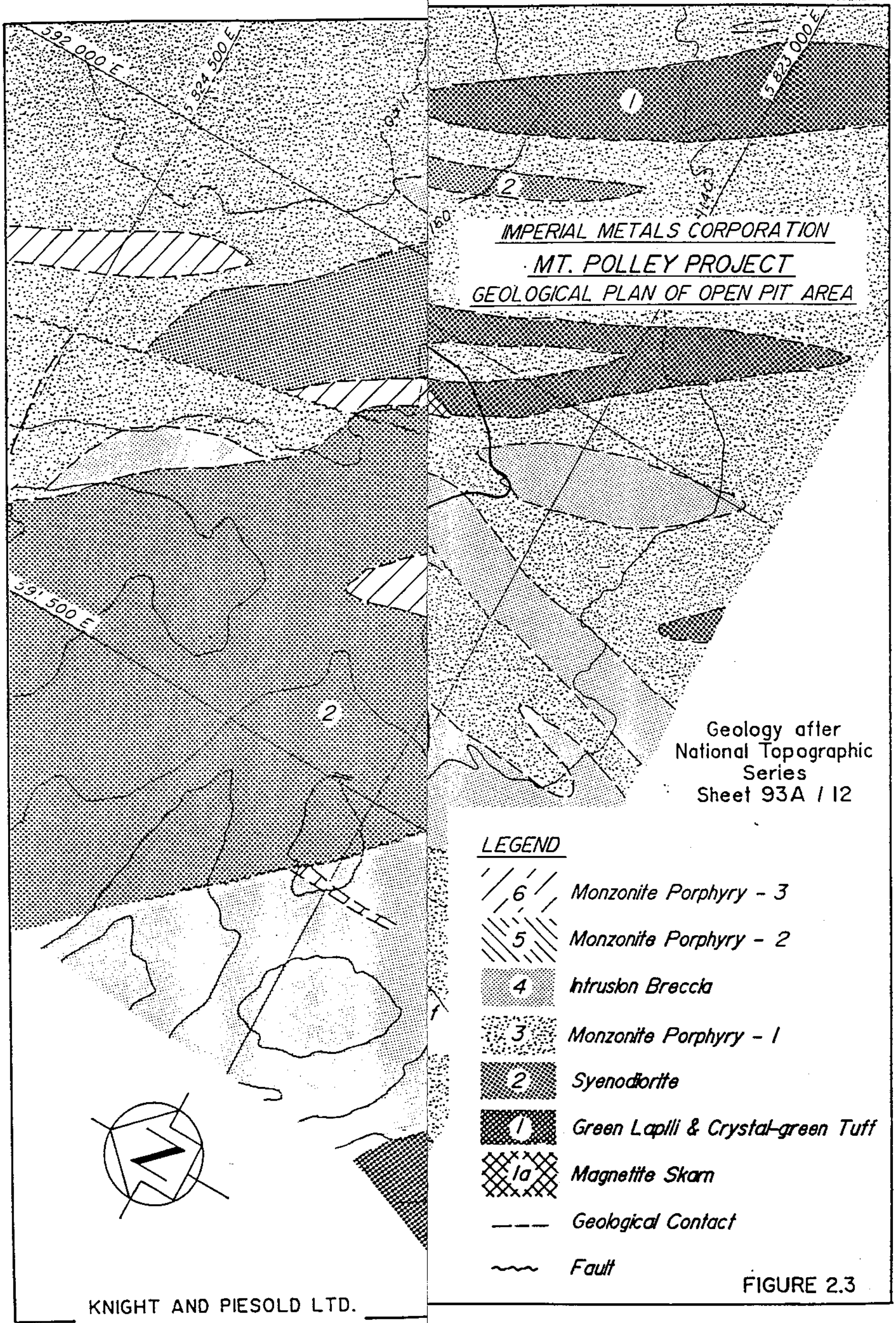
FIGURE 2.2



IMPERIAL METALS CORPORATION

MT. POLLEY PROJECT

GEOLOGICAL PLAN OF OPEN PIT AREA

FIGURE 2.3

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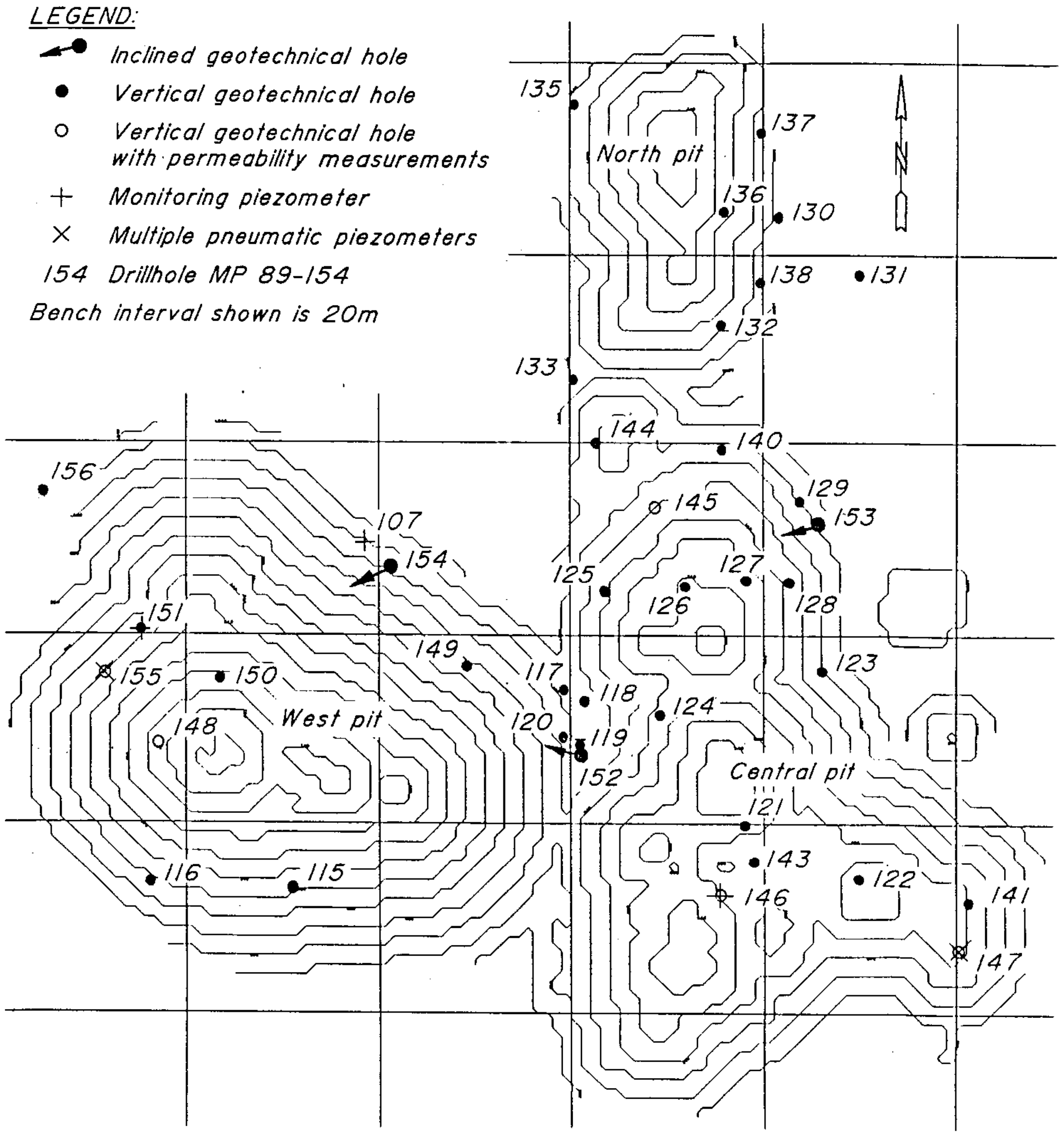
NCI-763

IMPERIAL METALS CORPORATION

MT. POLLEY PROJECT

LOCATION PLAN OF GEOTECHNICAL DRILLHOLES



Oct. 19, 1989
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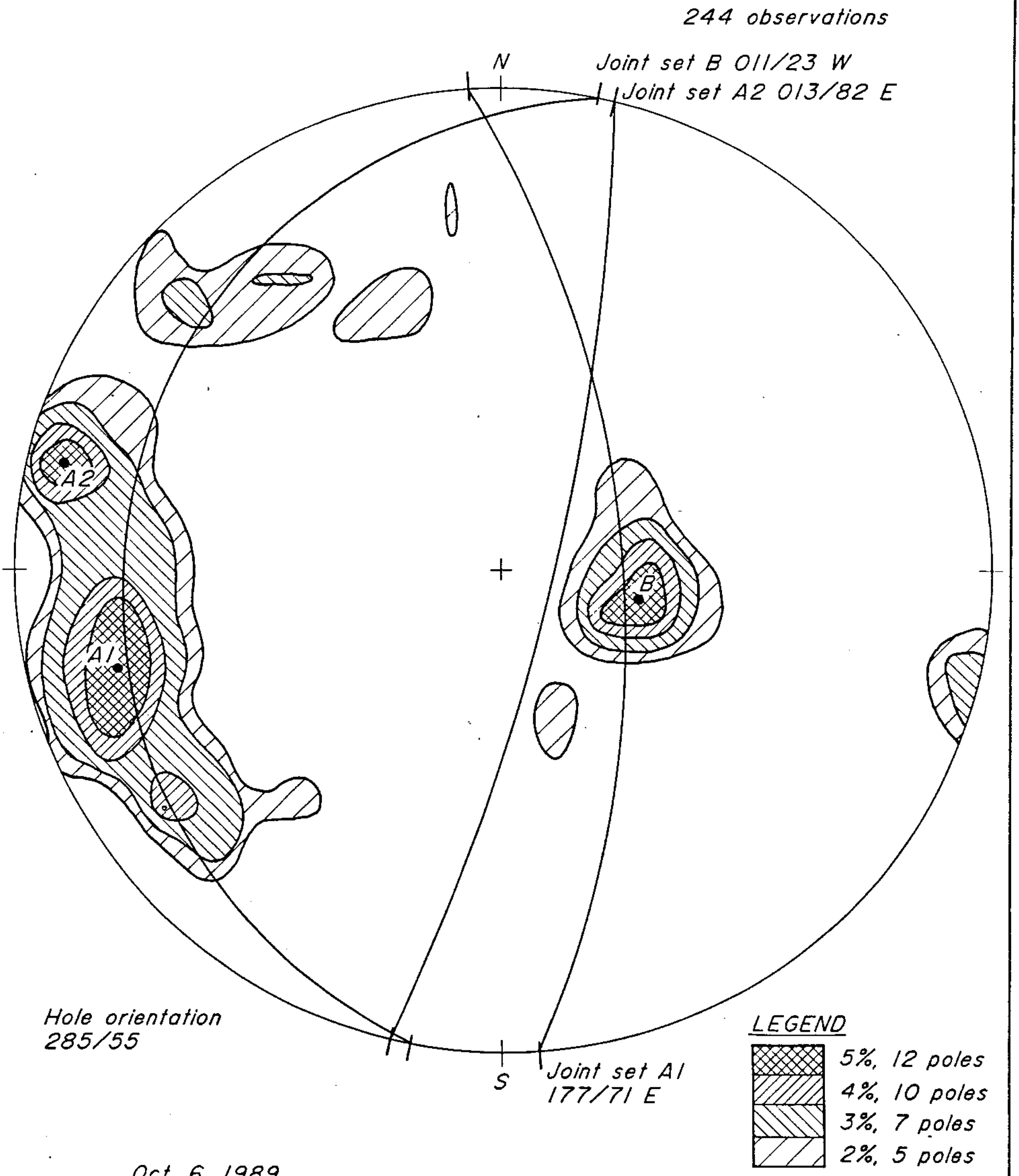
FIGURE 3.1

NCI-763

IMPERIAL METALS CORPORATION

MT. POLLEY PROJECT

SUMMARY OF JOINT DATA FOR MP89-152



Oct. 6, 1989

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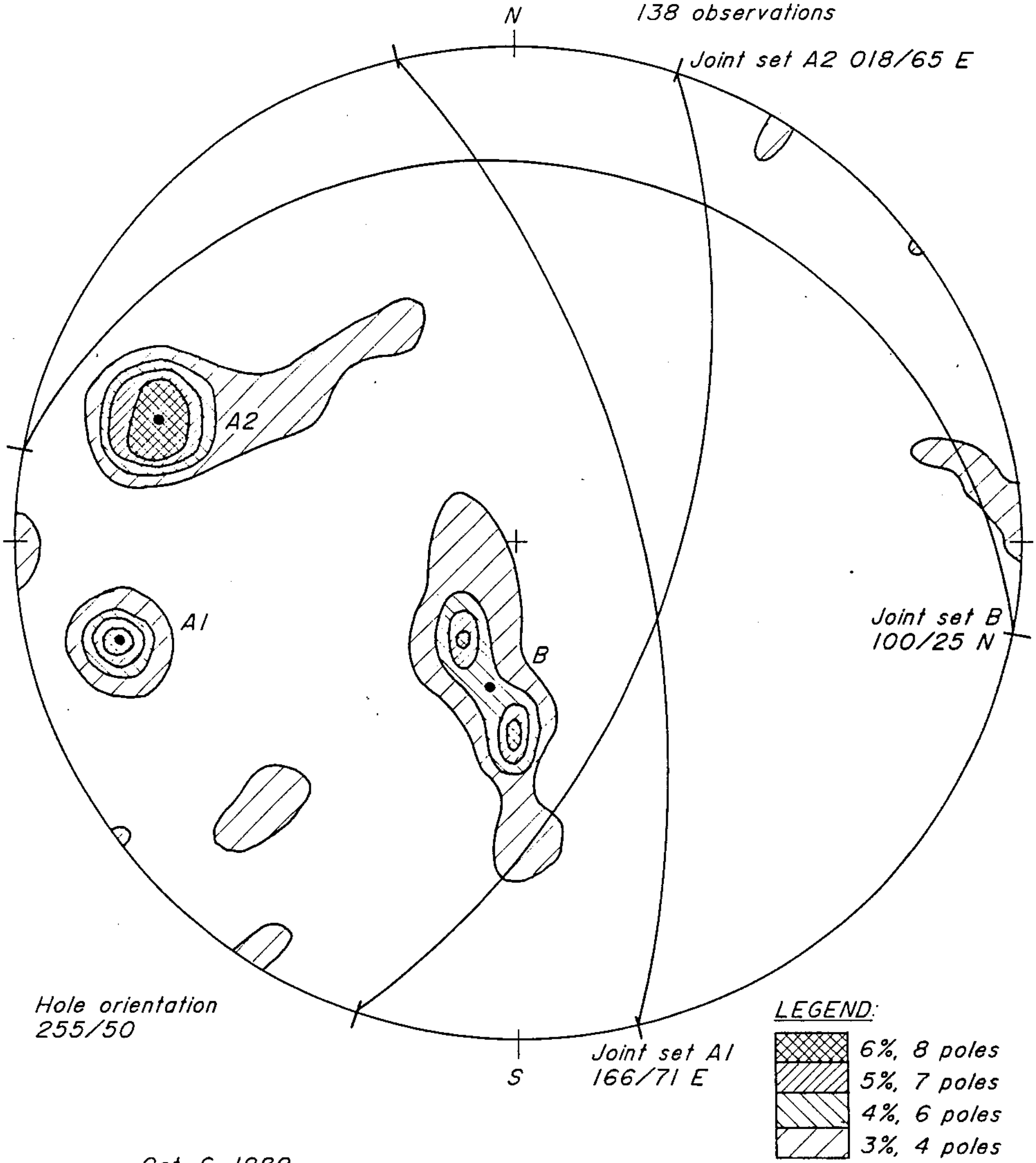
FIGURE 3.2

NCI-763

IMPERIAL METALS CORPORATION

MT. POLLEY PROJECT

SUMMARY OF JOINT DATA FOR MP89-153



Oct. 6, 1989

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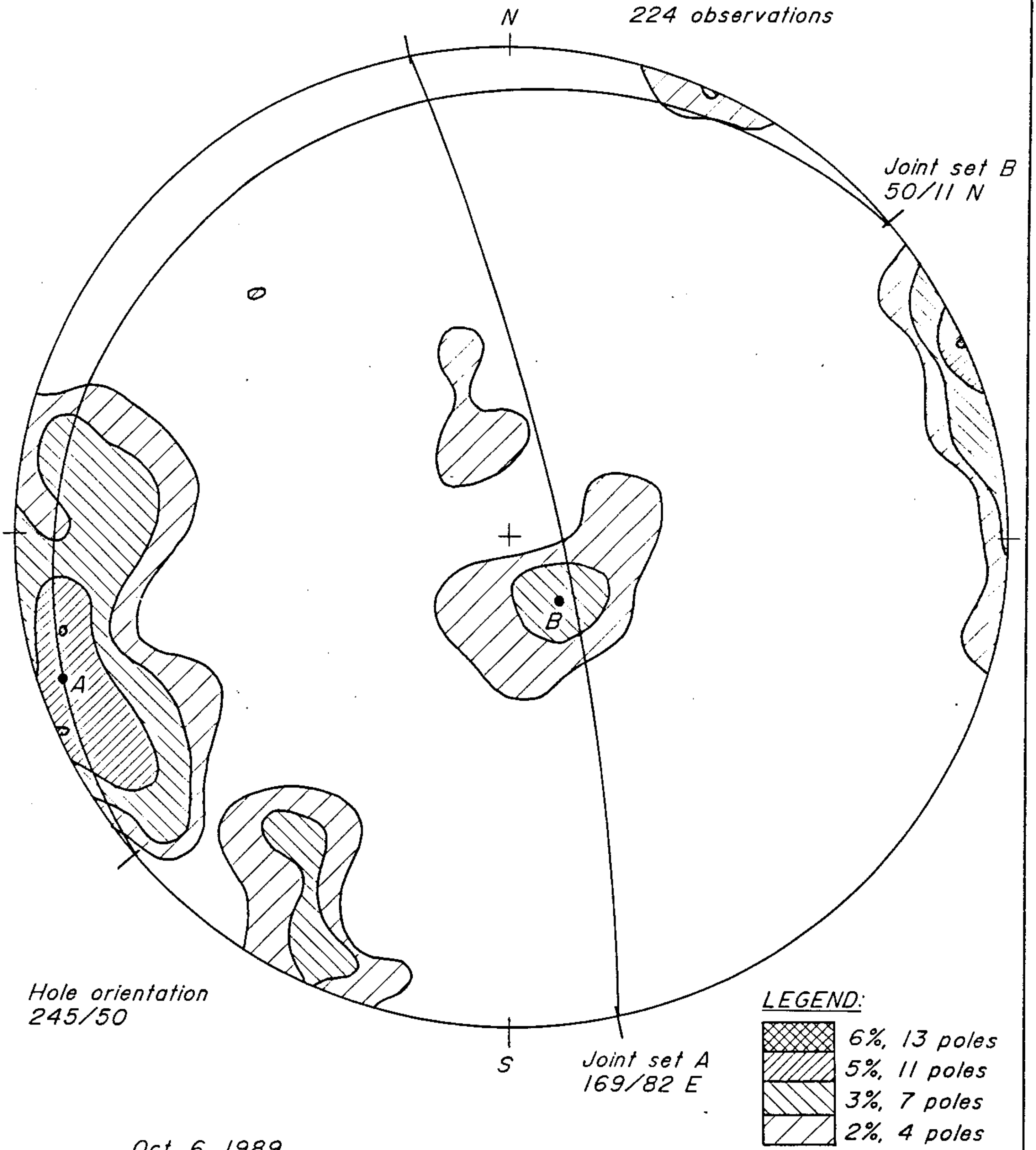
FIGURE 3.3

IMPERIAL METALS CORPORATION

MT. POLLEY PROJECT

SUMMARY OF JOINT DATA FOR MP89-154



Oct. 6, 1989

KNIGHT AND PIESOLD LTD.
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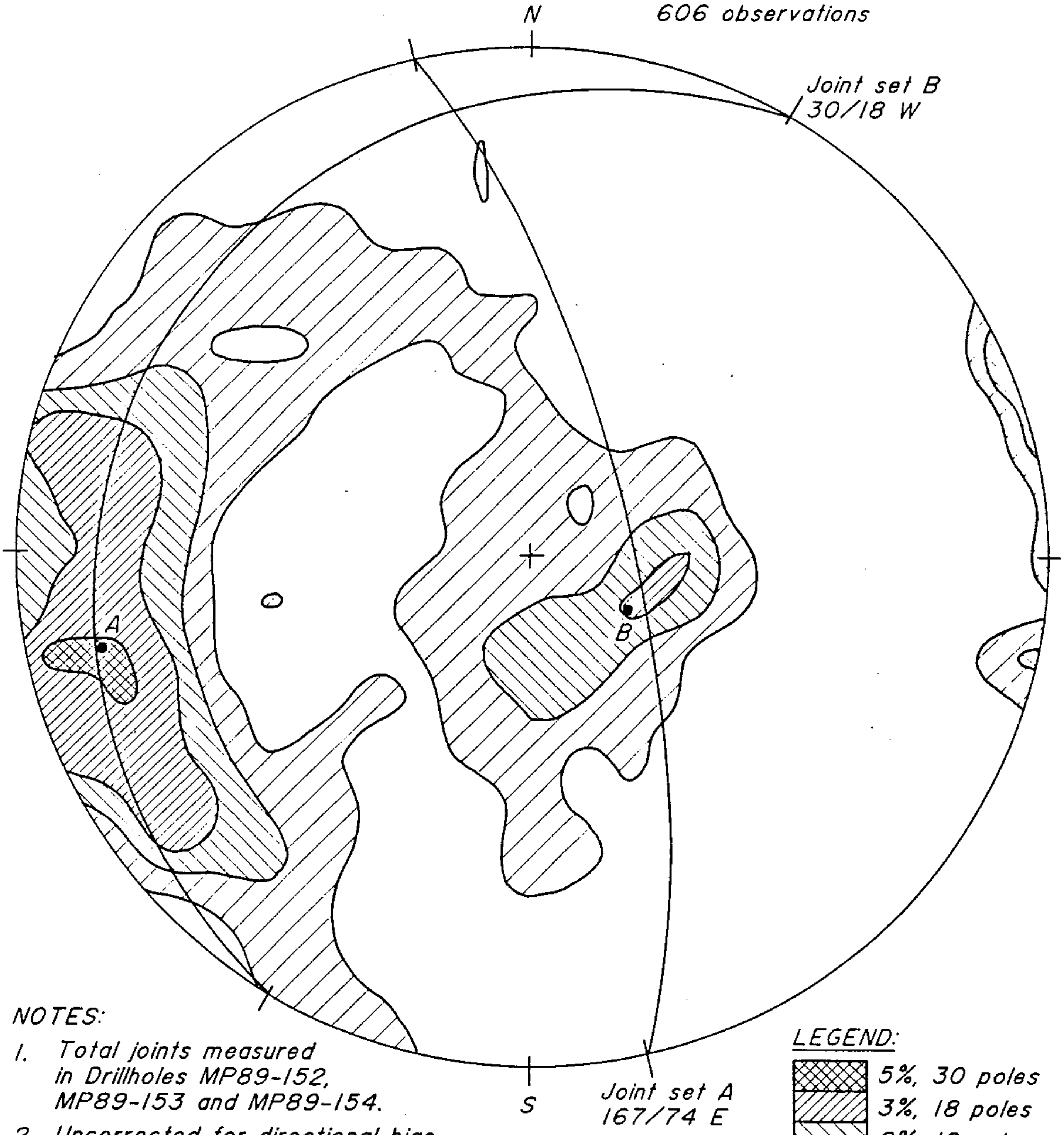
FIGURE 3.4

NCI-763

IMPERIAL METALS CORPORATION
MT. POLLEY PROJECT
SUMMARY OF JOINT DATA



NOTES:

1. Total joints measured in Drillholes MP89-152, MP89-153 and MP89-154.
2. Uncorrected for directional bias.

LEGEND:

▩ 5%, 30 poles

▨ 3%, 18 poles

▧ 2%, 12 poles

▨ 1%, 6 poles

Oct. 4, 1989

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FIGURE 3.5

KNIGHT AND PIESOLD LTD.
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UNIFIED SOIL CLASSIFICATION SYSTEM

PROJECT No. ______________
SAMPLE No. ______________
DATE ______________

PROJECT : *MT. POLLEY PROJECT*

GRADATION OF GLACIAL TILL FROM TAILINGS AREA

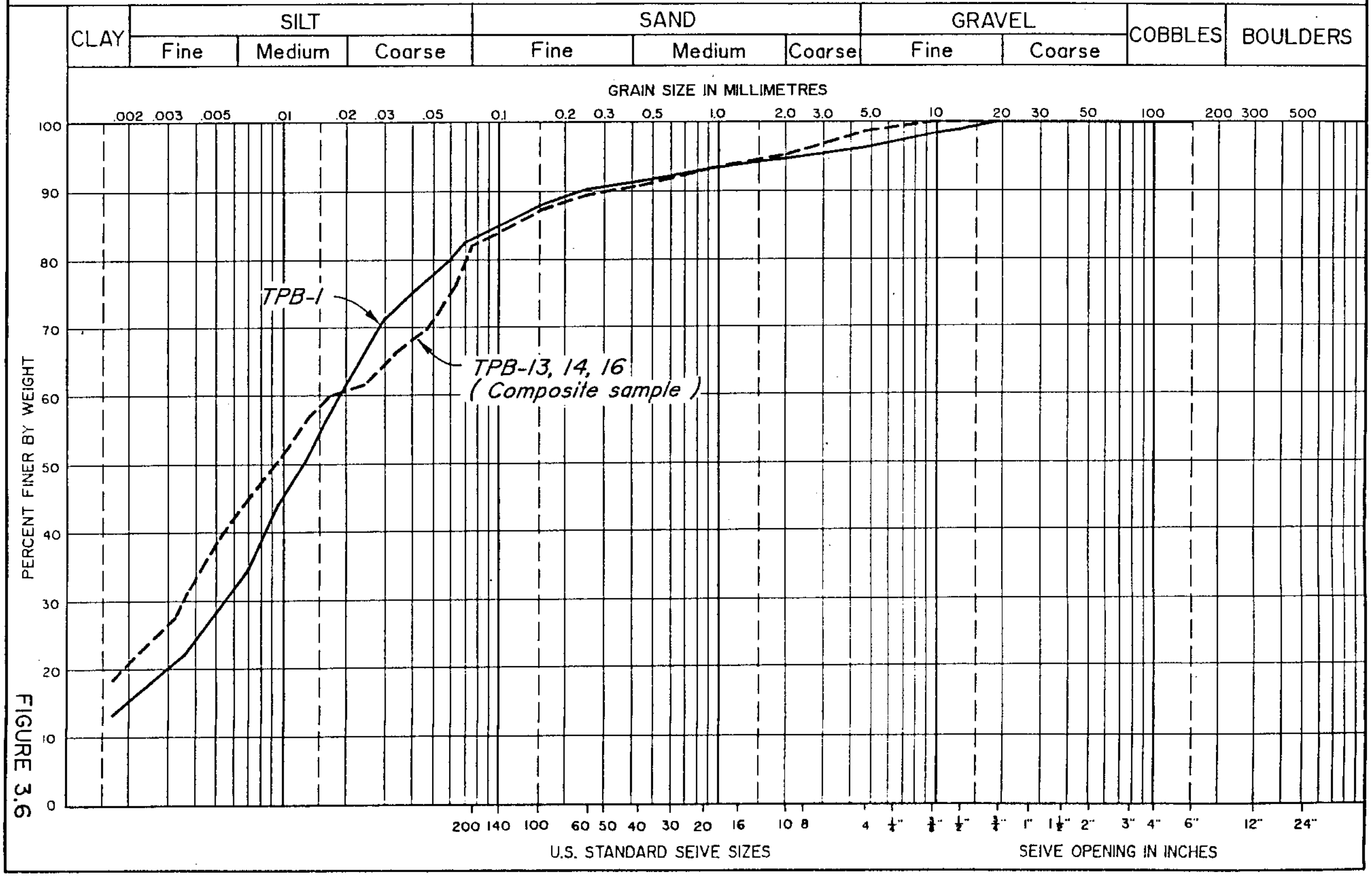
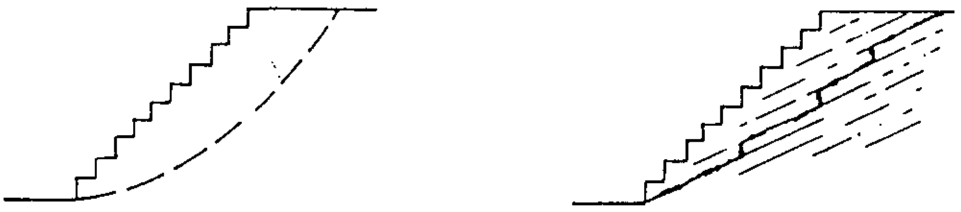


FIGURE 3.6

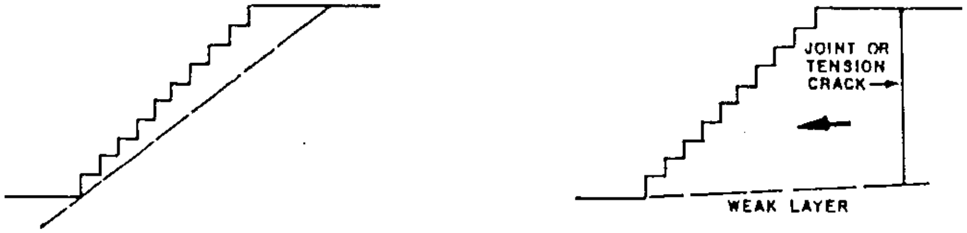
NCI-763

IMPERIAL METALS CORPORATION
MT. POLLEY PROJECT
OPEN PIT
TYPICAL FAILURE MODES



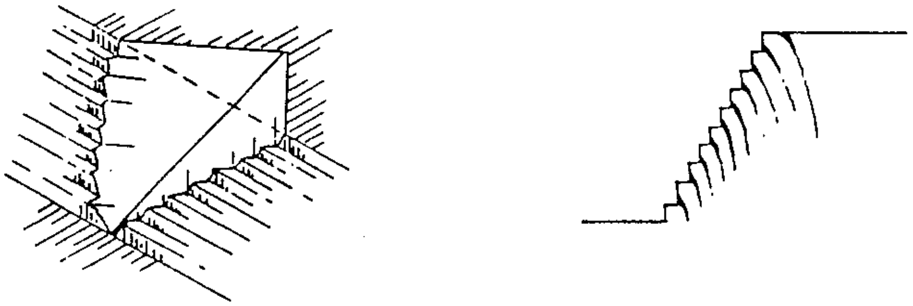
(a) Failure geometry in homogeneous rock or rock with random localized jointing.

(c) Failure combining movement along discontinuous joints and through intact rock



(c) Failure on the plane of a continuous fault, shear zone or joint.

(d) Failure as a block on a weak layer bounded at the back by a joint or tension crack.



(e) Failure as a wedge on two or more intersecting discontinuities.

(f) Failure by toppling. Most frequent where major structure dips steeply

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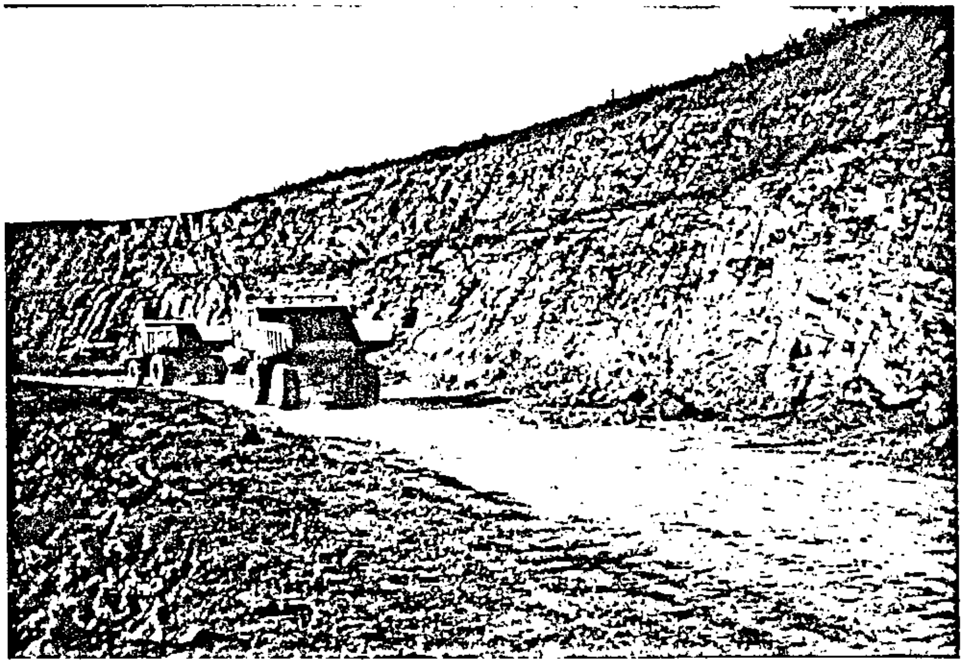
FIGURE 4.1

IMPERIAL METALS CORPORATION
MT. POLLEY PROJECT
OPEN PIT
PHOTOGRAPHS ILLUSTRATING
INFLUENCE OF BLASTING CONTROL MEASURES

Damage behind the pitwall due to excessive blast charges per delay.



Controlled pre shear blasting at the final pit face has produced a clean stable face. Gortdrum Mines, Ireland.

KNIGHT AND PIESOLD LTD.
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FIGURE 4.2

NCI-763

IMPERIAL METALS CORPORATION

MT. POLLEY PROJECT

OPEN PIT

VARIATION OF DAMAGE TO ROCK WITH WEIGHT OF CHARGE PER DELAY AND BLAST DISTANCE

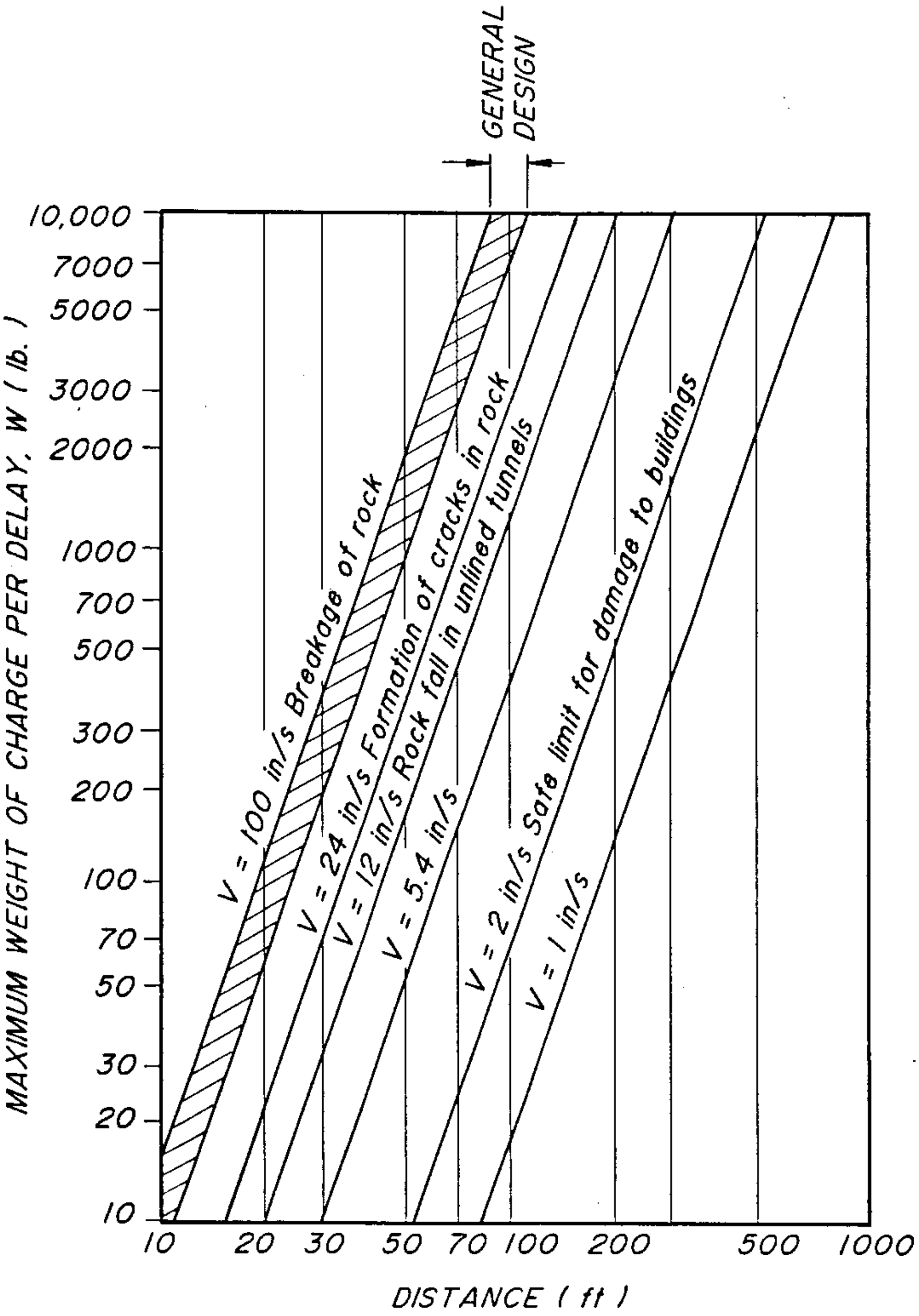

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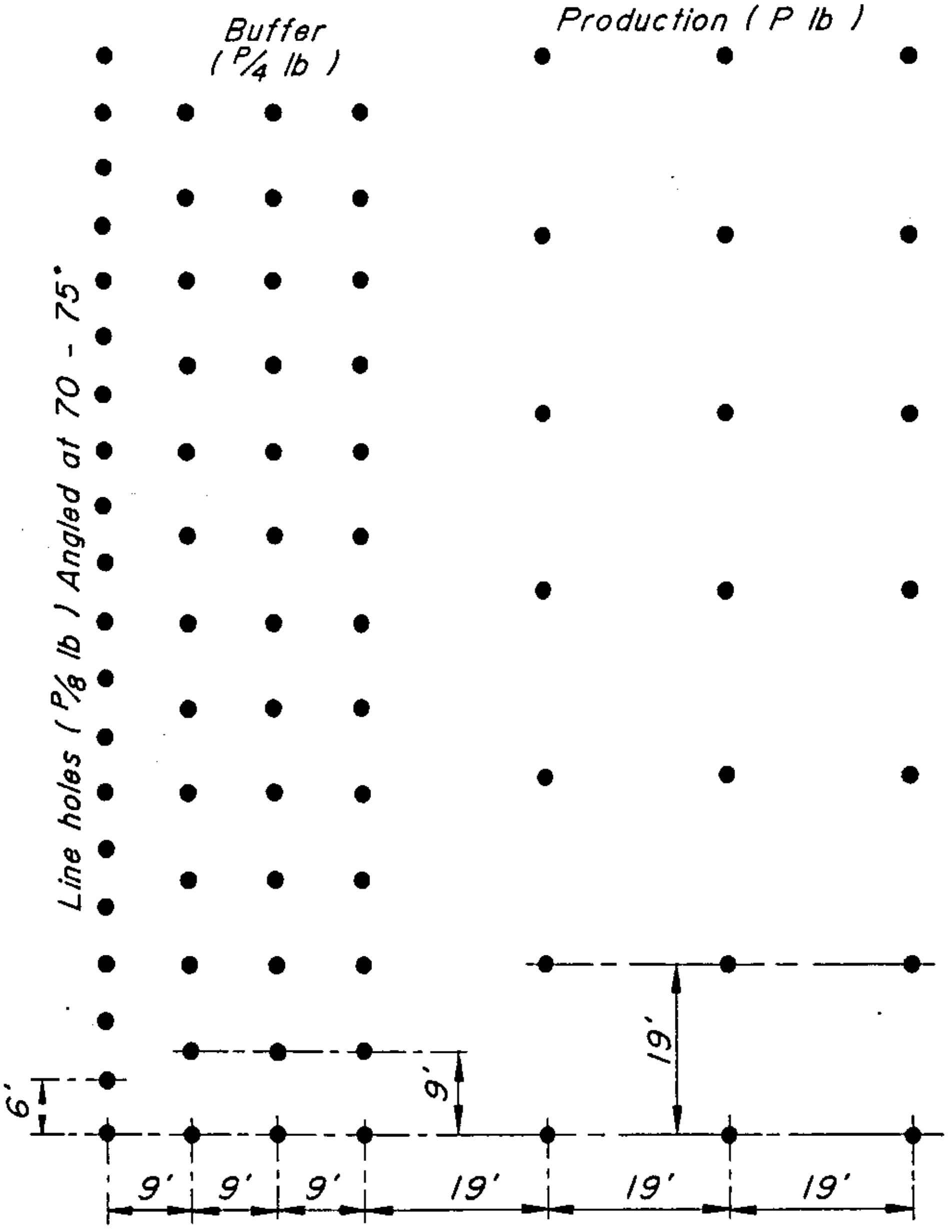
FIGURE 4.3

IMPERIAL METALS CORPORATION
MT. POLLEY PROJECT
OPEN PIT
TRIAL BLAST PATTERN



NOTES:

- Trial 1, Blast line holes as preshear line (first) - 6 holes/delay.
- Trial 2, Blast line holes as cushion line (last) - 6 holes/delay.
- Adjust lbs. of explosives per hole in buffer and line holes based on results.
- Test and adjust blast pattern at working faces for use at final faces.

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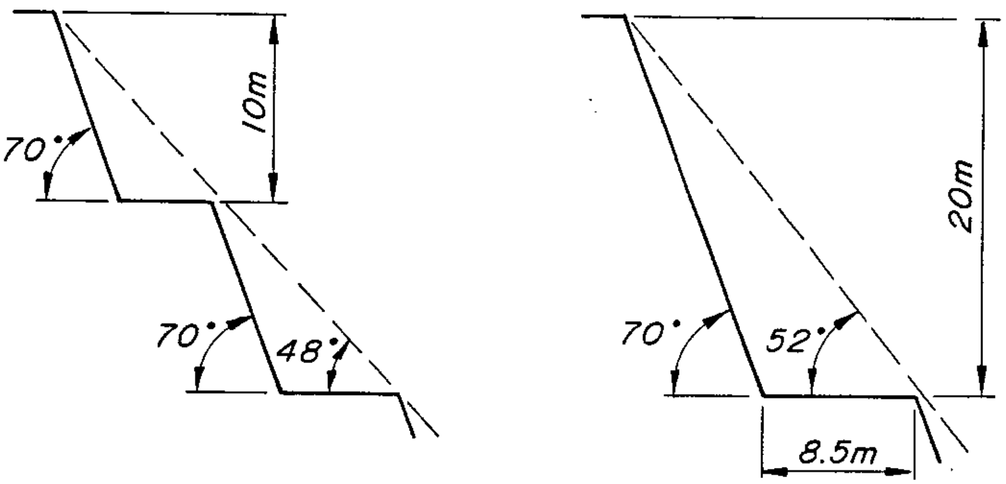
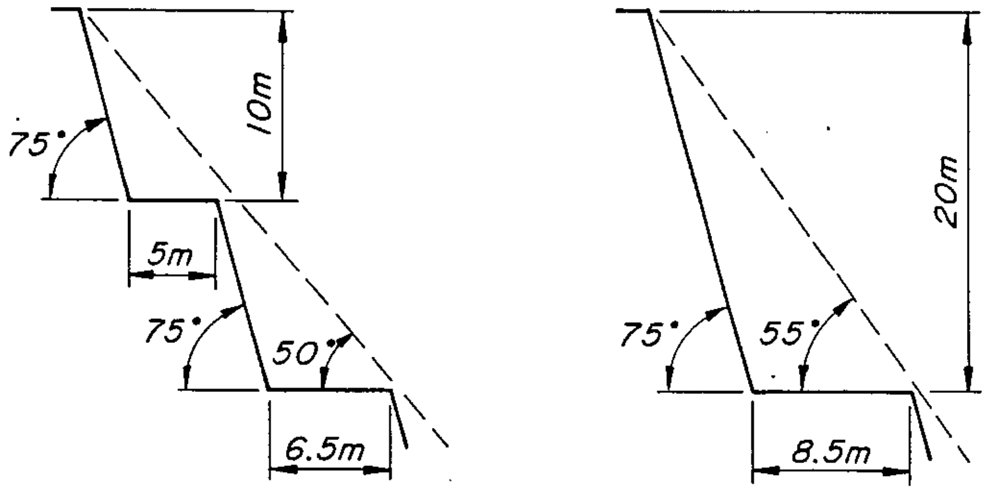
FIGURE 4.4

NCI-763

IMPERIAL METALS CORPORATION
MT. POLLEY PROJECT
OPEN PIT
SLOPE ANGLES AND BENCH DESIGN



DESIGN 'B' - EAST FACING WALLS
- NORTH FACING WALLS
- WEST FACING WALLS - STRUCTURAL DIP >60°E



DESIGN 'C' - SOUTH FACING WALLS
- WEST FACING WALLS - STRUCTURAL DIP <60°E

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FIGURE 4.5

NCI-763

IMPERIAL METALS CORPORATION
MT. POLLEY PROJECT
OPEN PIT
DESIGN SECTORS

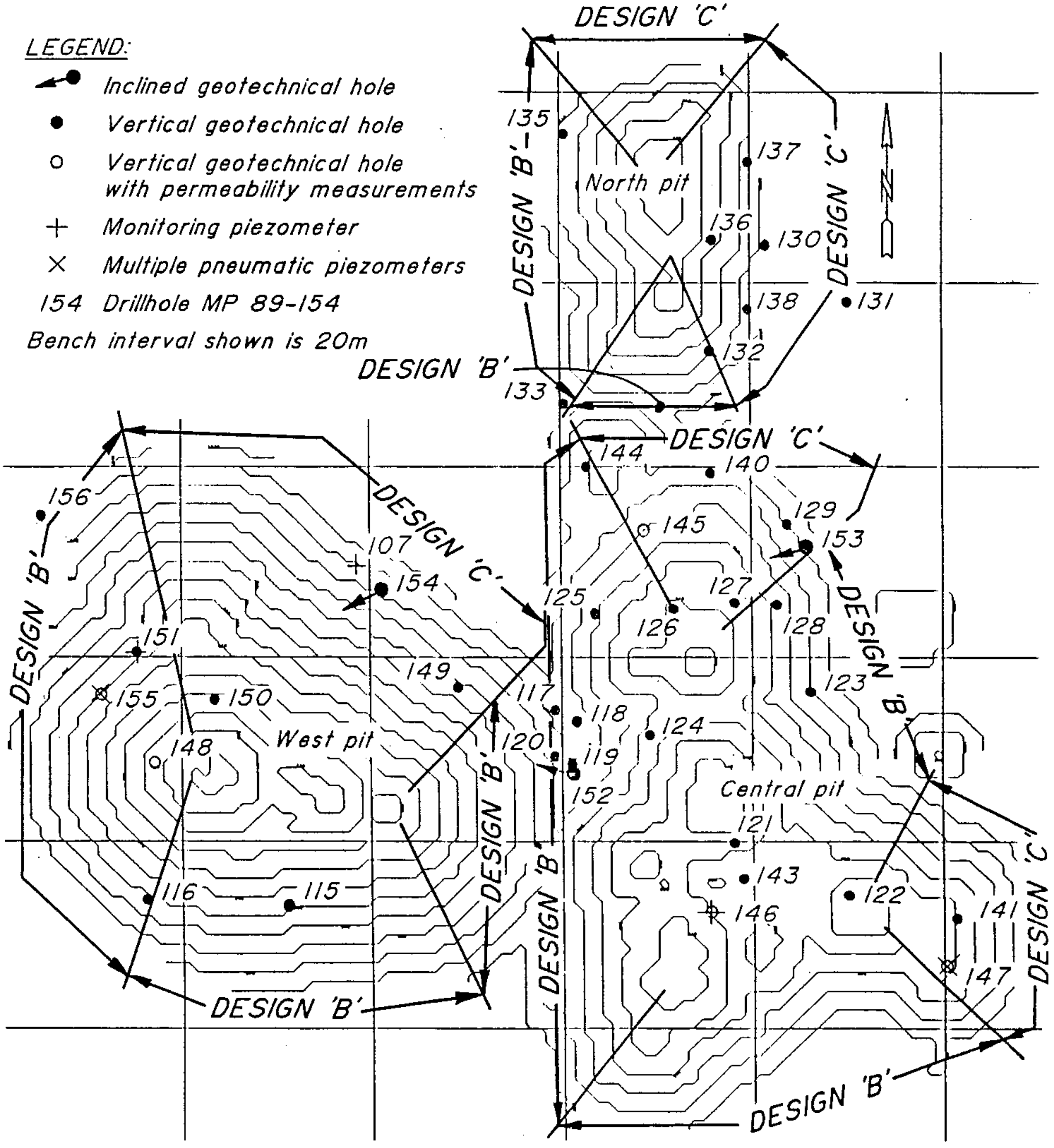

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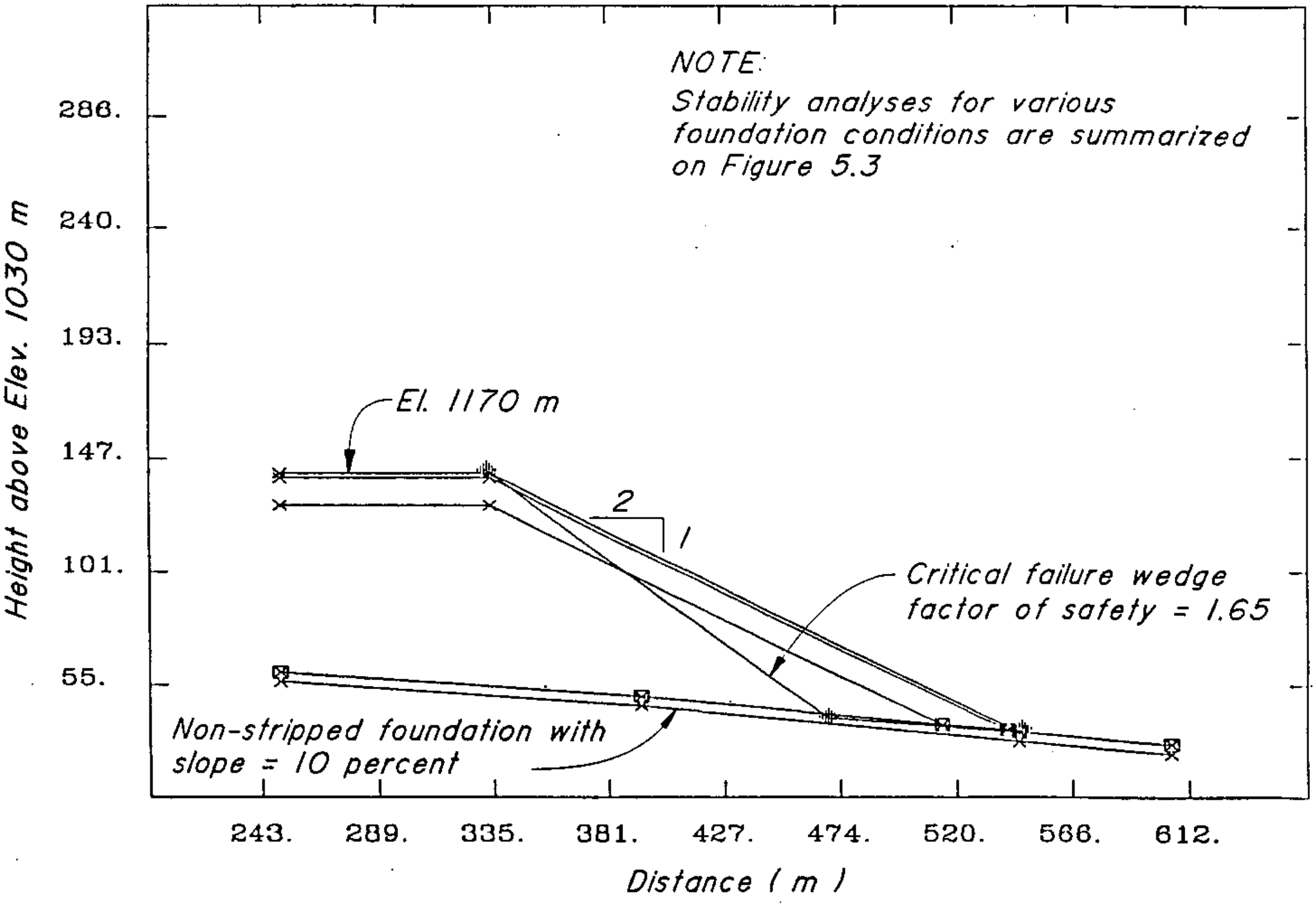
FIGURE 4.6

IMPERIAL METALS CORPORATION
MT. POLLEY PROJECT
WASTE DUMP
TYPICAL STATIC WEDGE FAILURE ANALYSIS



UNIT WEIGHT	COHESION	PHI	DESCRIPTION
21.99 KN/m^3	.00	45.00	UPPER WASTE ROCK
21.99 KN/m^3	.00	42.00	MIDDLE WASTE ROCK
21.99 KN/m^3	.00	40.00	LOWER WASTE ROCK
21.57 KN/m^3	.00	30.00	TILL
−1.00 KN/m^3	.00	.00	BEDROCK

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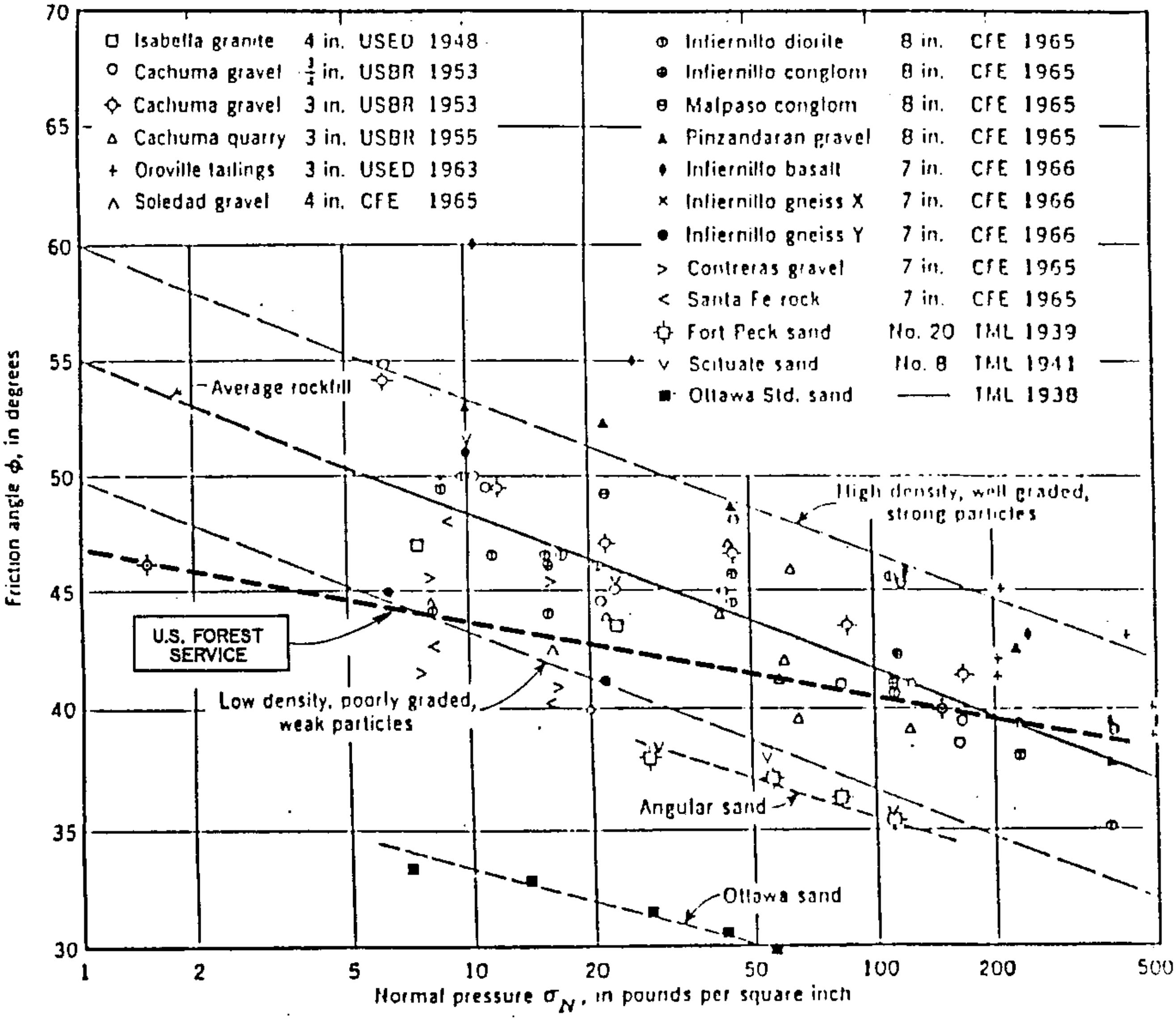
FIGURE 5.1

IMPERIAL METALS CORPORATION

MT. POLLEY PROJECT

WASTE DUMPS

SHEAR STRENGTH OF ROCKFILL



Information taken from :

REVIEW OF SHEARING STRENGTH OF ROCKFILL

By Thomas M. Leps, F. ASCE

July , 1970

BCIL 7733 KP

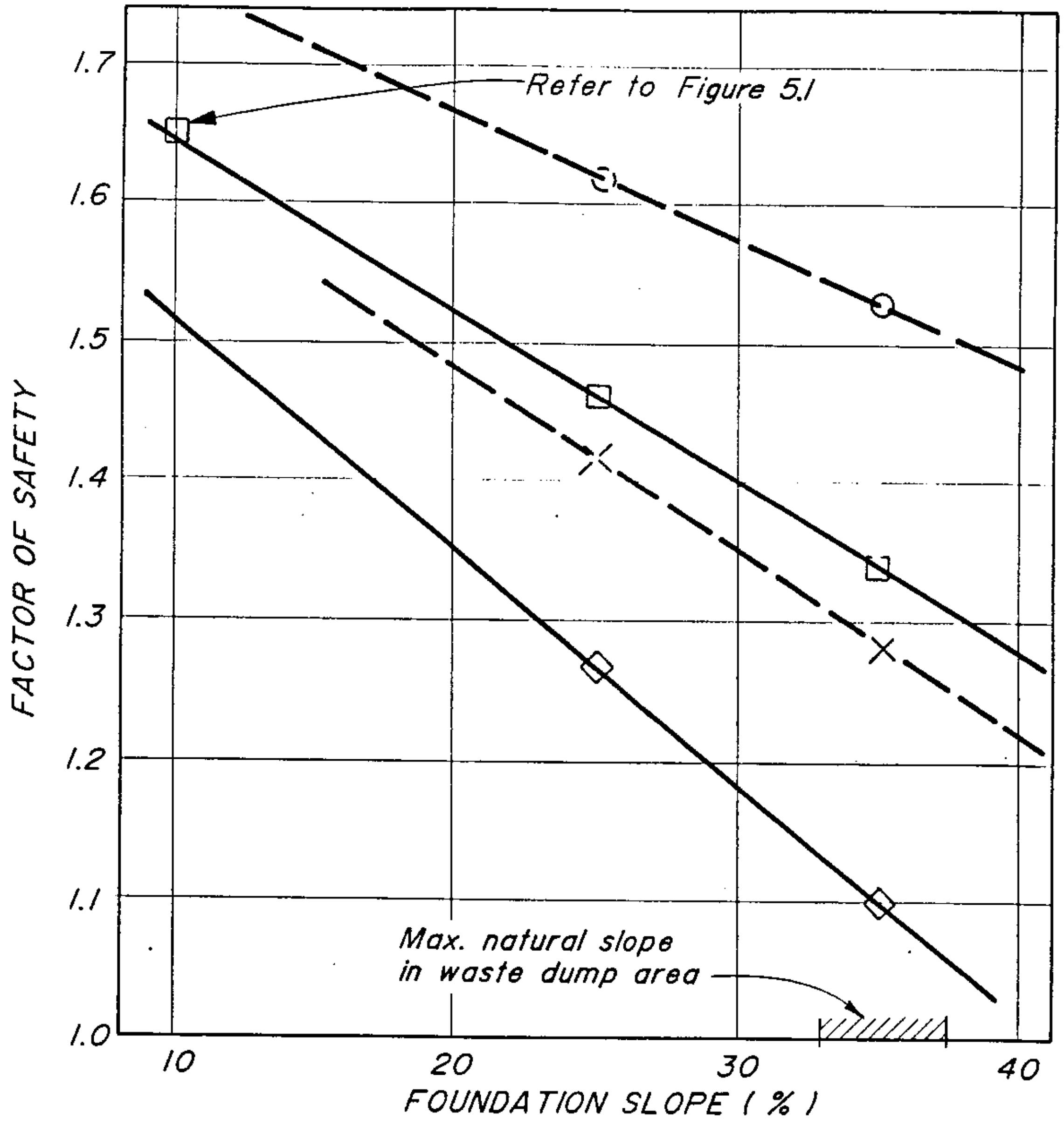
FIGURE 5.2

IMPERIAL METALS CORPORATION

MT. POLLEY PROJECT

WASTE DUMPS

STABILITY CHART



Foundation	Waste Dump Slope	
	2:1	1.3:1
Stripped (φ' = 35°)	○	×
Not stripped (φ' = 30°)	□	◇

February 20, 1990
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FIGURE 5.3

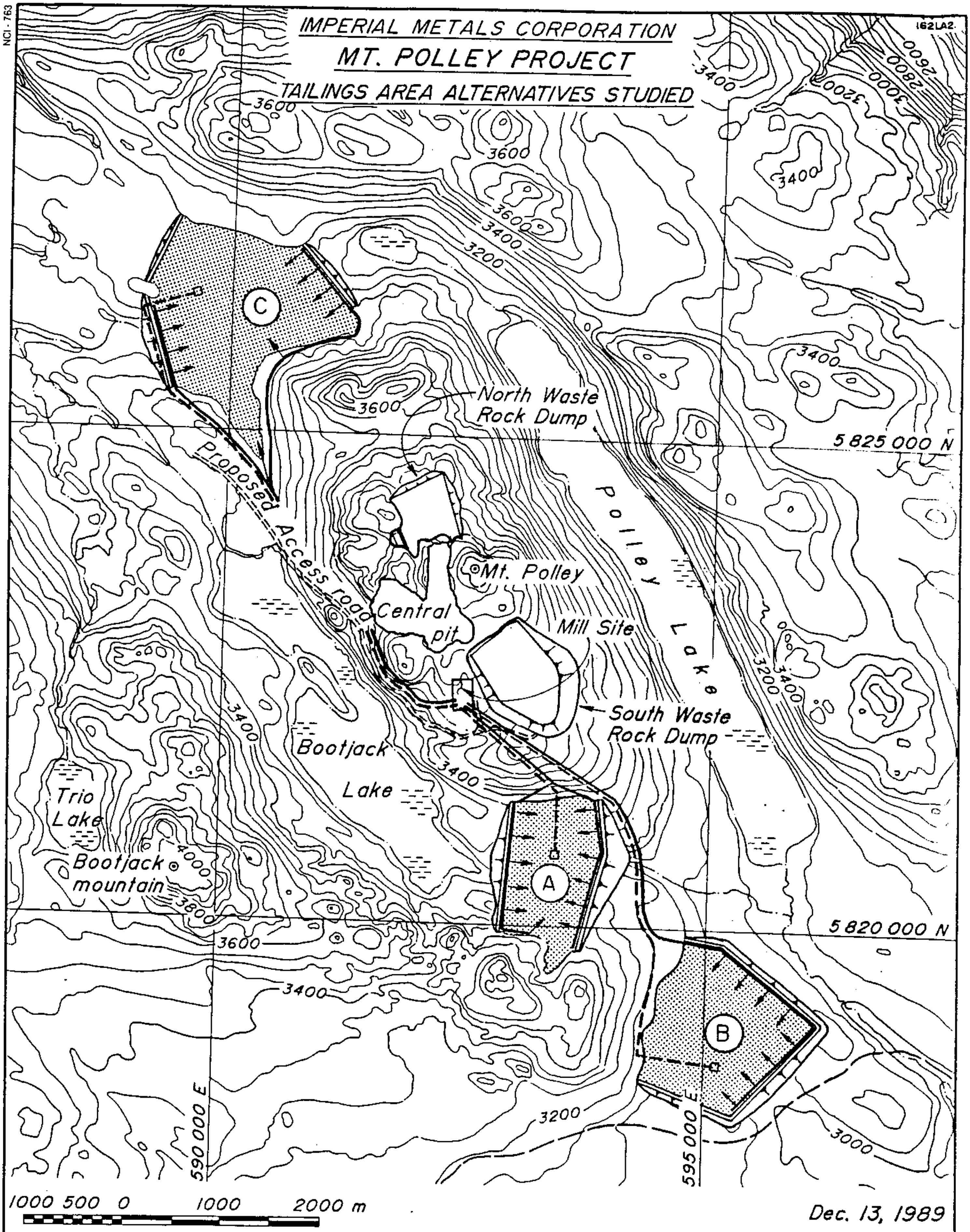
NCI-763

162LA2

IMPERIAL METALS CORPORATION

MT. POLLEY PROJECT

TAILINGS AREA ALTERNATIVES STUDIED



Dec. 13, 1989

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FIGURE 6.1

FEB. 13, 1990

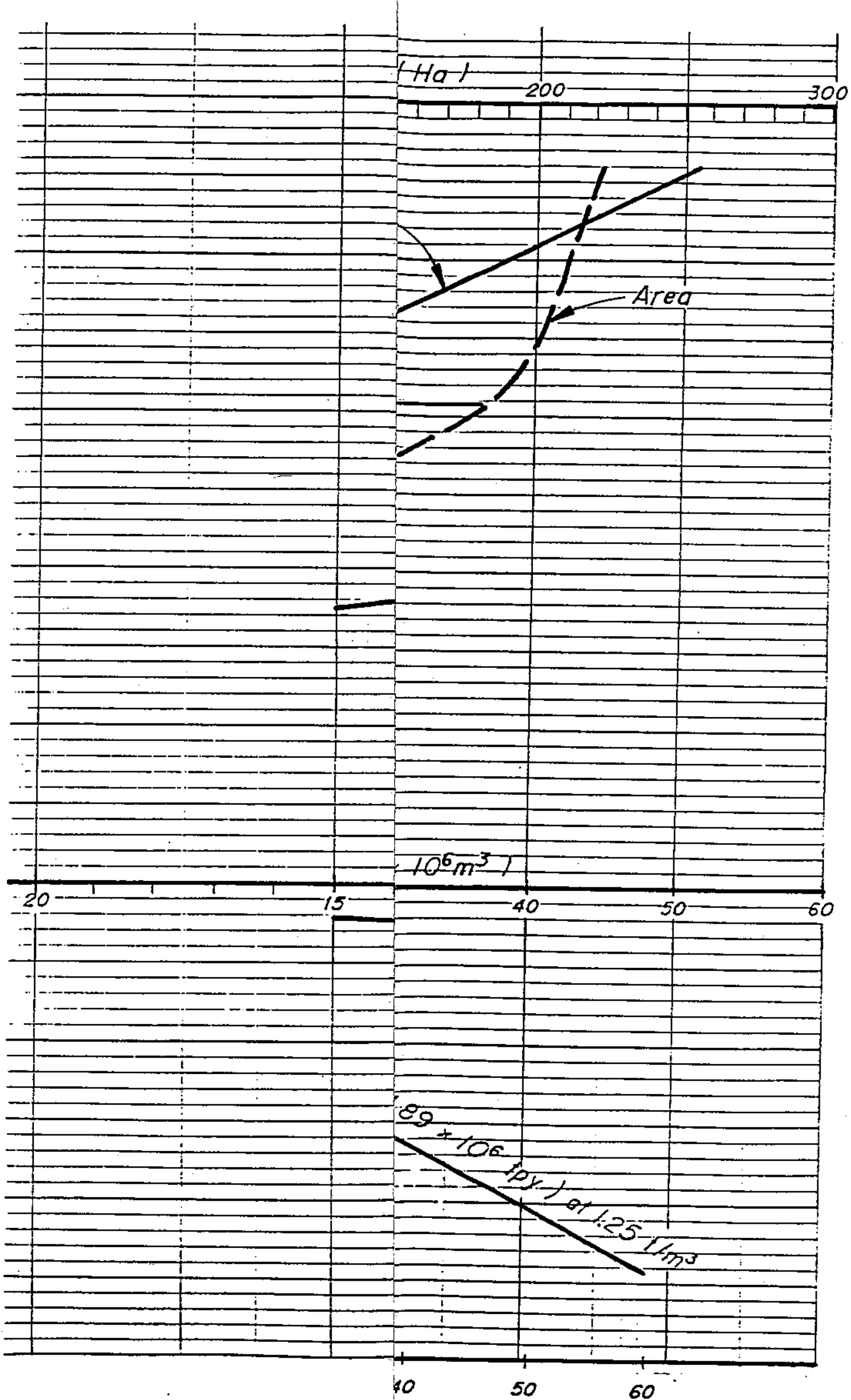

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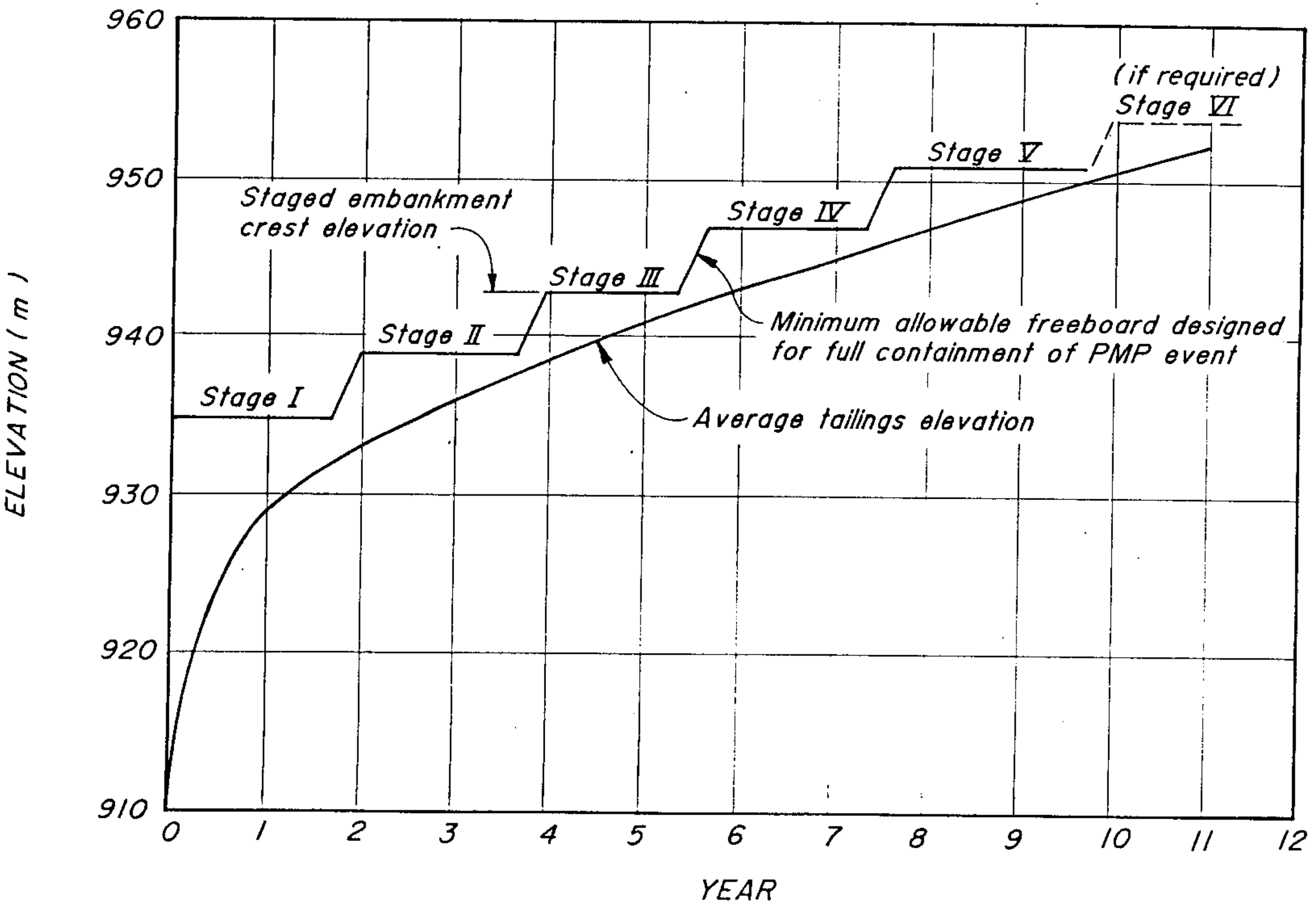
FIGURE 6.2

NCI - 763

IMPERIAL METALS CORPORATION

MT. POLLEY PROJECT

TAILINGS AREA FILLING SCHEDULE AND STAGED CONSTRUCTION



Revised Feb. 20, 1990

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FIGURE 6.3

NCI - 763

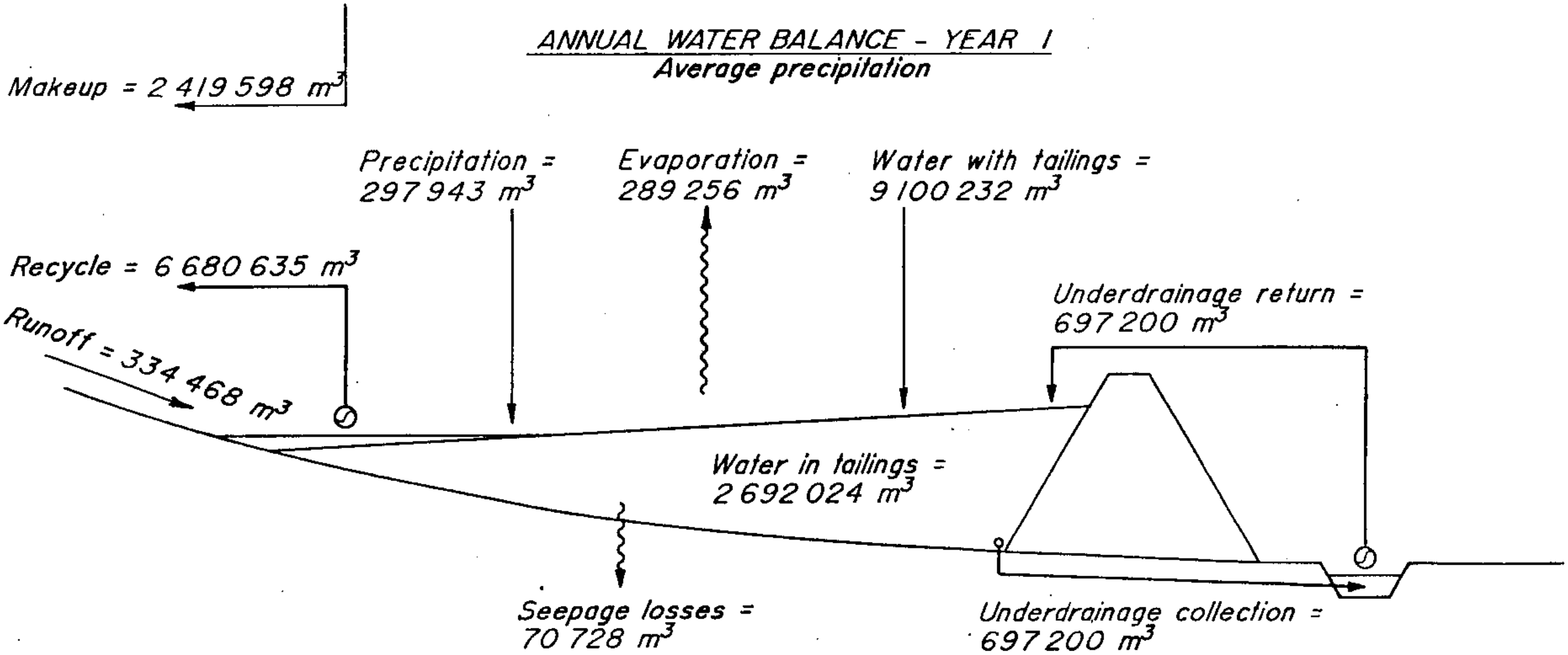
IMPERIAL METALS CORPORATION

MT. POLLEY PROJECT

TAILINGS STORAGE FACILITY

ANNUAL WATER BALANCE - YEAR 1

Average precipitation



Revised Feb. 15, 1990

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FIGURE 6.4

NCI - 763

KNIGHT AND PIESOLD LTD.
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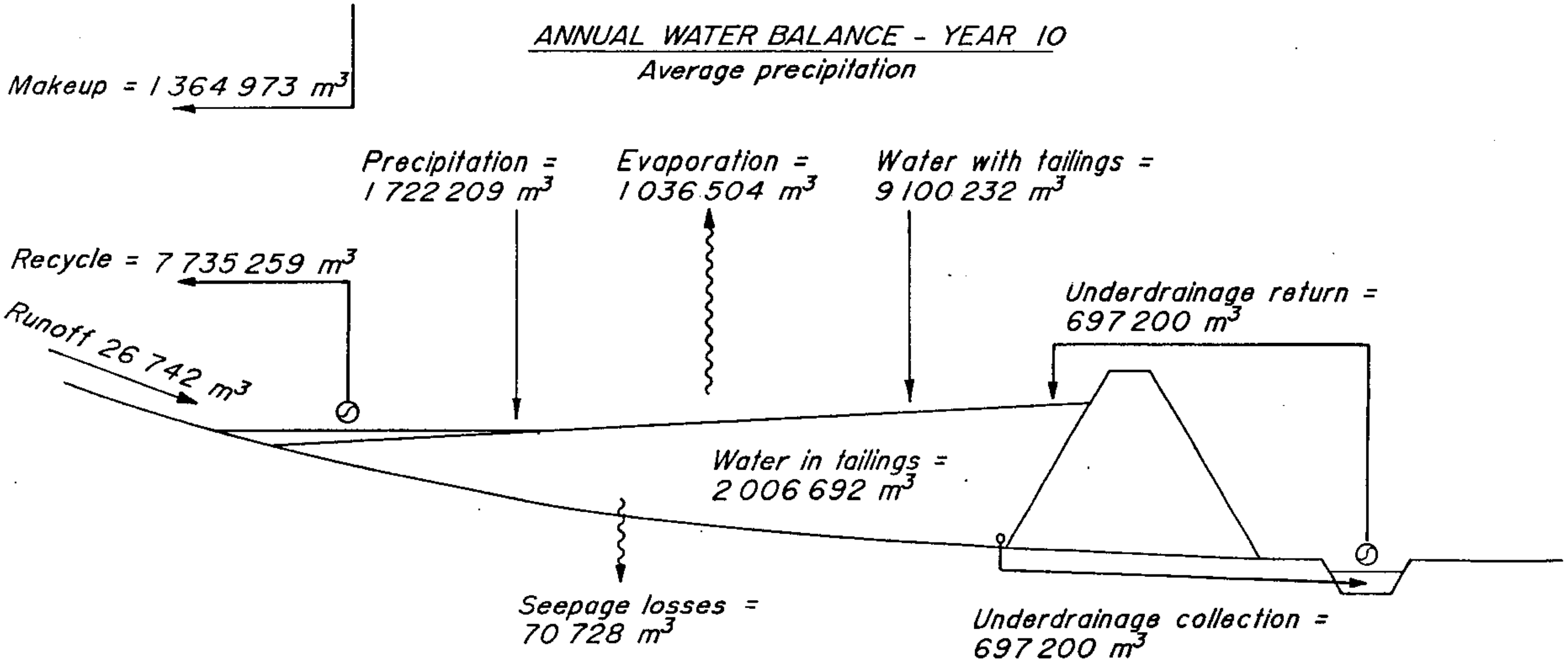
IMPERIAL METALS CORPORATION

MT. POLLEY PROJECT

TAILINGS STORAGE FACILITY

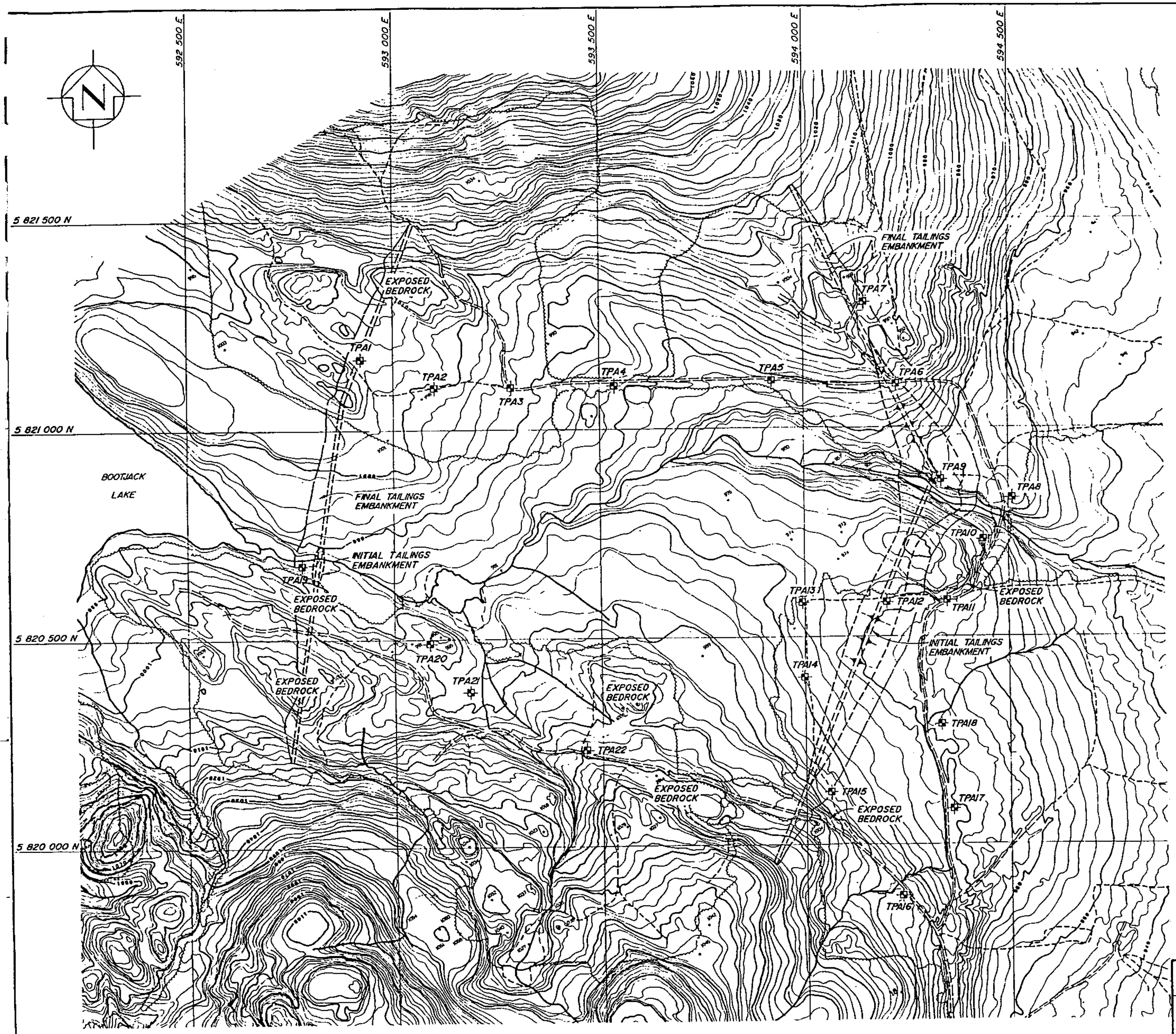
ANNUAL WATER BALANCE - YEAR 10

Average precipitation



Revised Feb. 15, 1990

FIGURE 6.5



TEST PIT	DEPTH INTERVAL (m)	MATERIAL DESCRIPTION
TPA1	0 - .15 0.15 - 0.6 0.6	TOPSOIL, organics and forest litter SAND, some silt, some gravel, glacial till BEDROCK
TPA2	0 - .15 0.15 - 1.7 1.7	TOPSOIL, brown SILTY SAND, some gravel, trace clay, glacial till BEDROCK
TPA3	0 - 2.4 2.4 - 3.4	SILTY SAND, some gravel, trace clay, glacial till. SANDY SILT, some gravel, trace to some till
TPA4	0 - 4.3	SILTY SAND, some gravel, trace clay, glacial till.
TPA5	0 - 2.6 2.6 - 2.7	SILTY SAND, some gravel, trace clay, glacial till BEDROCK, fractured, weathered, wet.
TPA6	0 - 1.8 1.8 - 3 3 - 4 4 - 5.2	SILTY SAND, some gravel, trace clay, glacial till. GRAVELLY SAND, trace to some silt, poorly sorted. SAND, some silt, some gravel, sandy glacial till. GRAVELLY SAND, some silt, glacial till.
TPA7	0 - 0.5 0.5	TOPSOIL, forest litter BEDROCK
TPA8	0 - 2.9	SAND, some gravel, some silt, glacial till
TPA9	0 - 0.5 0.5 - 1.2 1.2 - 4.3	TOPSOIL, organics and forest litter, brown GRAVELLY SAND, coarse, blue-grey SILTY SAND, some gravel, some clay, glacial till
TPA10	0 - 0.3 0.3	TOPSOIL, organics and forest litter BEDROCK
TPA11	0 - 0.5 0.5	SANDY SILT, some gravel, glacial till. BEDROCK
TPA12	0 - 0.3 0.3 - 3 3 - 5.2	TOPSOIL, organics and forest litter SILTY SAND, some gravel, trace clay, glacial till CLAYEY SILT, some sand, trace gravel, firm
TPA13	0 - 0.15 0.15 - 5.2	TOPSOIL, organics and forest litter SILTY SAND, some gravel, trace clay, glacial till
TPA14	0 - .15 0.15 - 5.2	TOPSOIL, organics and forest litter SILTY SAND, some gravel, trace clay, glacial till
TPA15	0 - 2.4 2.4 - 2.7 2.7	SILTY SAND, some gravel, trace clay, glacial till GRAVELLY SAND, some silt, well graded, wet BEDROCK
TPA16	0 - 0.3 0.3 - 5.2	TOPSOIL, organics and forest litter SILTY SAND, some gravel, trace to some clay, till
TPA17	0 - 0.3 0.3 - 3 3	TOPSOIL, organics and forest litter SILTY SAND, some gravel, trace clay, glacial till BEDROCK, fractured, weathered, pale brown
TPA18	0 - 2.4 2.4	SAND and GRAVEL, medium to coarse, BEDROCK, highly altered with iron staining
TPA19	0 - 0.3 0.3 - 0.6 0.6 - 1.4 1.4	SWAMP WATER MUSKEG, fibrous, black soil CLAYEY SILT, some sand, some gravel, till BEDROCK
TPA20	0.15 - 0.8 0.8	TOPSOIL, forest litter BEDROCK
TPA21	0 - 2.4 2.4 - 5.2	CLAYEY SILT, some sand, some gravel, till SILTY SAND, some gravel, trace clay, glacial till
TPA22	0 - 5.2	SILTY SAND, some gravel, trace clay, glacial till

LEGEND

⊕ Test Pit

SCALE 100 0 100 200 300 400 500 m

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MT. POLLEY PROJECT

TAILINGS AREA INVESTIGATIONS
AREA A TEST PIT PLAN

DATE DEC. 20, 1989
SCALE AS SHOWN
DRG. NO. 1621.001
REV. 0

DRG NO	DESCRIPTION

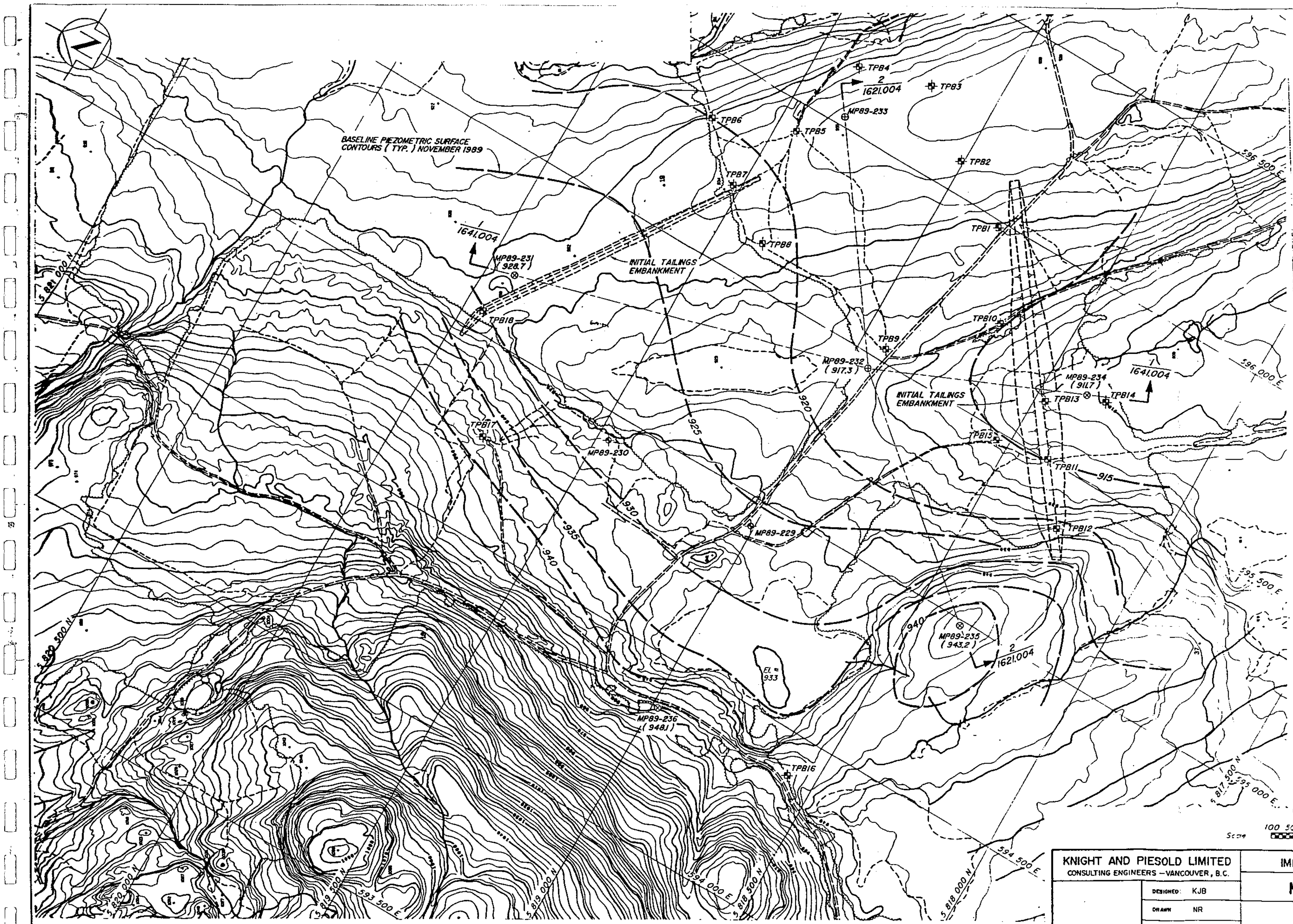
REFERENCE DRAWINGS

REV.	DATE	DESCRIPTION	APPROVED

REVISIONS

REV.	DATE	DESCRIPTION	APPROVED

REVISIONS



NOTE: Test pits and boreholes shown are field located only.

LEGEND

⌖	TPB1	Test Pit Location
⌖	MP89-229	Condemnation Drillhole
○	MP89-231	Vertical Geotechnical Hole with Permeability Measurements
+		Monitoring Standpipe Piezometer
×		Pneumatic and Standpipe Piezometers
	(917.3)	Baseline elev. of piezometer surface (m)

Scale 100 50 0 100 200 300 400 500 m

DRG NO	DESCRIPTION
1641.004	TAILINGS AREA B - GEOLOGICAL SECTIONS

REFERENCE DRAWINGS

REV.	DATE	DESCRIPTION	APPROVED

REVISIONS

REV.	DATE	DESCRIPTION	APPROVED

REVISIONS

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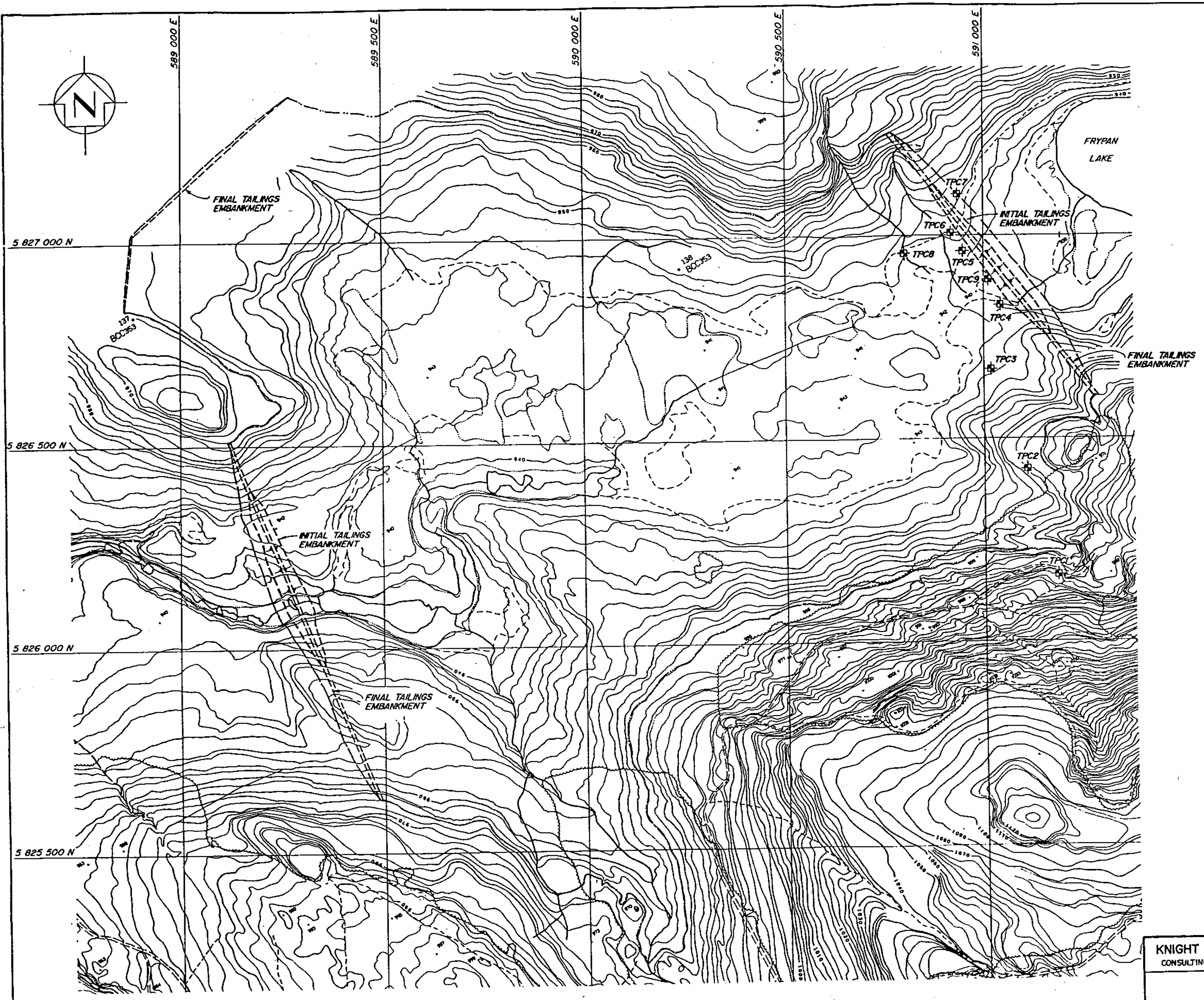
MT. POLLEY PROJECT

TAILINGS AREA INVESTIGATIONS
AREA B TEST PIT AND BOREHOLE PLAN

DATE DEC. 20, 1989
SCALE AS SHOWN
DRG NO. 1621.002
REV. 0



TEST PIT	DEPTH INTERVAL (m)	MATERIAL DESCRIPTION
TPC1	0 - 3	SILTY SAND, some gravel, trace clay, glacial till
TPC2	0 - 2.2	SILTY SAND, some gravel, trace clay, glacial till
	2.2 - 2.4	SILTY SAND, some gravel, dense, glacial till
	2.4 - 4.6	SILTY SAND, some gravel, trace clay, glacial till
	4.6 - 5.5	SANDY GRAVEL, poorly sorted, saturated
TPC3	0 - 0.3	SILTY SAND, some organics, saturated
	0.3 - 5.2	SILTY SAND, some gravel, glacial till
TPC4	0 - 1.2	PEAT and MUSKEG, dark, saturated
	1.2 - 2.1	SILTY SAND, some gravel, trace cobbles, glacial till
TPC5	0 - 5.2 m	GRAVELLY SAND, trace cobbles, alluvial
TPC6	0 - 2.4	SILTY SAND, some gravel, trace cobbles, glacial till
TPC7	0 - 0.15	ORGANICS and forest litter
	0.156 - 2.4	SILTY SAND, some gravel, trace cobbles, glacial till
TPC8	0 - 2	SAND and GRAVEL, trace silt, saturated
	2	BEDROCK
TPC9	0 - 2.4	PEAT, dark black, saturated

LEGEND

⌖ Test Pit

SCALE 100 0 100 200 300 400 500 m

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TAILINGS AREA INVESTIGATIONS

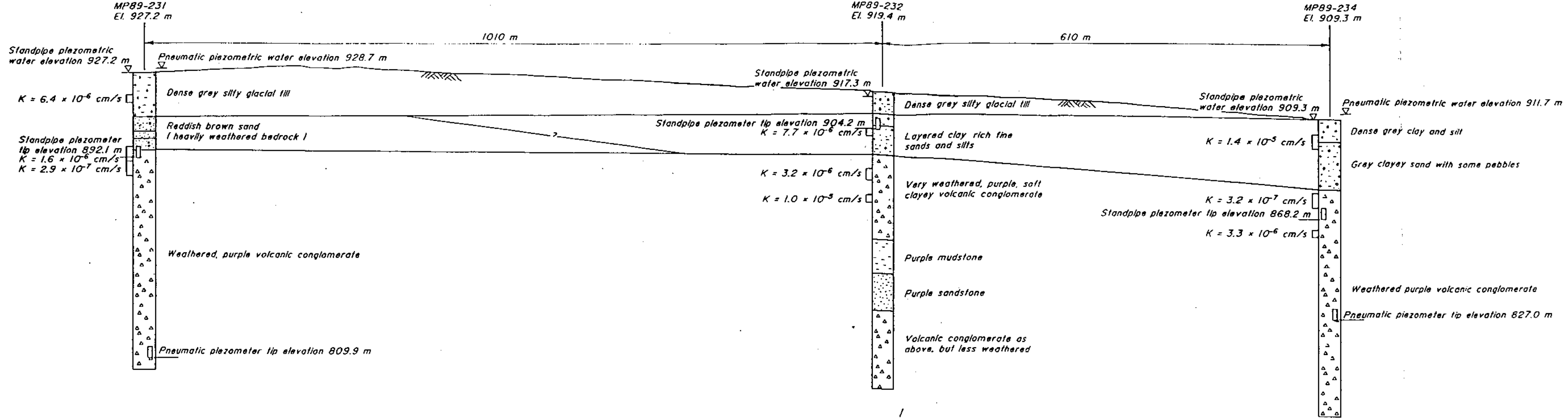
AREA C TEST PIT PLAN

DATE DEC. 20, 1989
SCALE AS SHOWN
DRG. NO. 1621.003
REV. 0

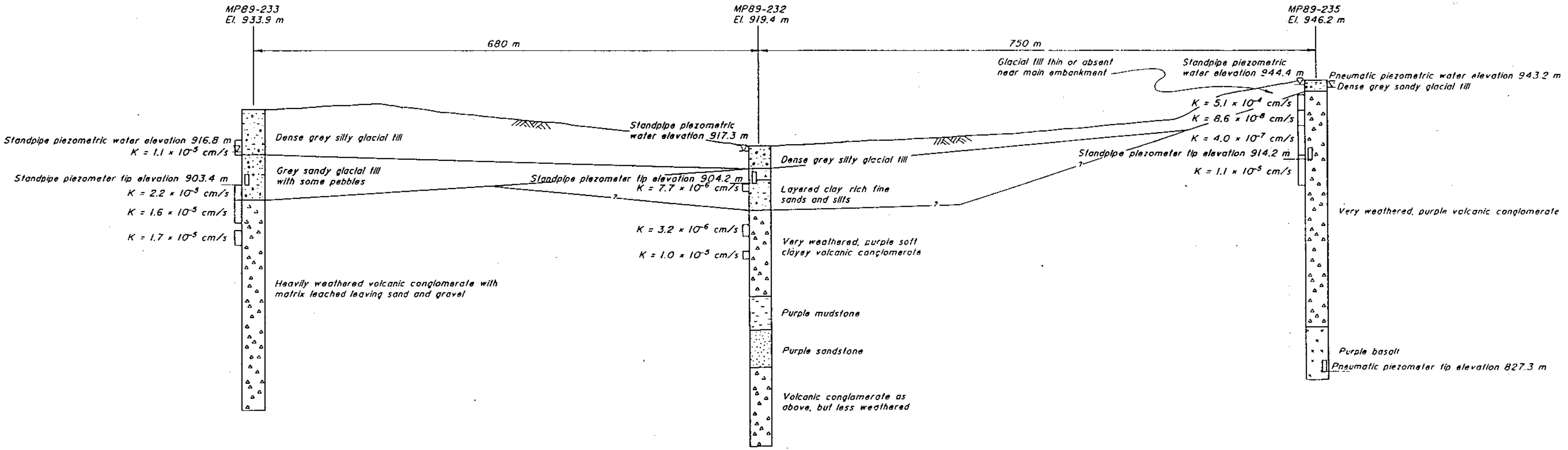
DRG NO	DESCRIPTION
REFERENCE DRAWINGS	

REV.	DATE	DESCRIPTION	APPROVED
REVISIONS			

REV.	DATE	DESCRIPTION	APPROVED
REVISIONS			



SECTION $\frac{1}{1621.002}$



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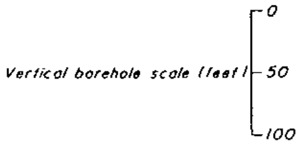

1621.002	TAILINGS AREA INVESTIGATIONS	
DRG NO	DESCRIPTION	
REFERENCE DRAWINGS		

REV.	DATE	DESCRIPTION	APPROVED	REV.	DATE	DESCRIPTION	APPROVED
REVISIONS				REVISIONS			

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CONSULTING ENGINEERS – VANCOUVER, B.C.

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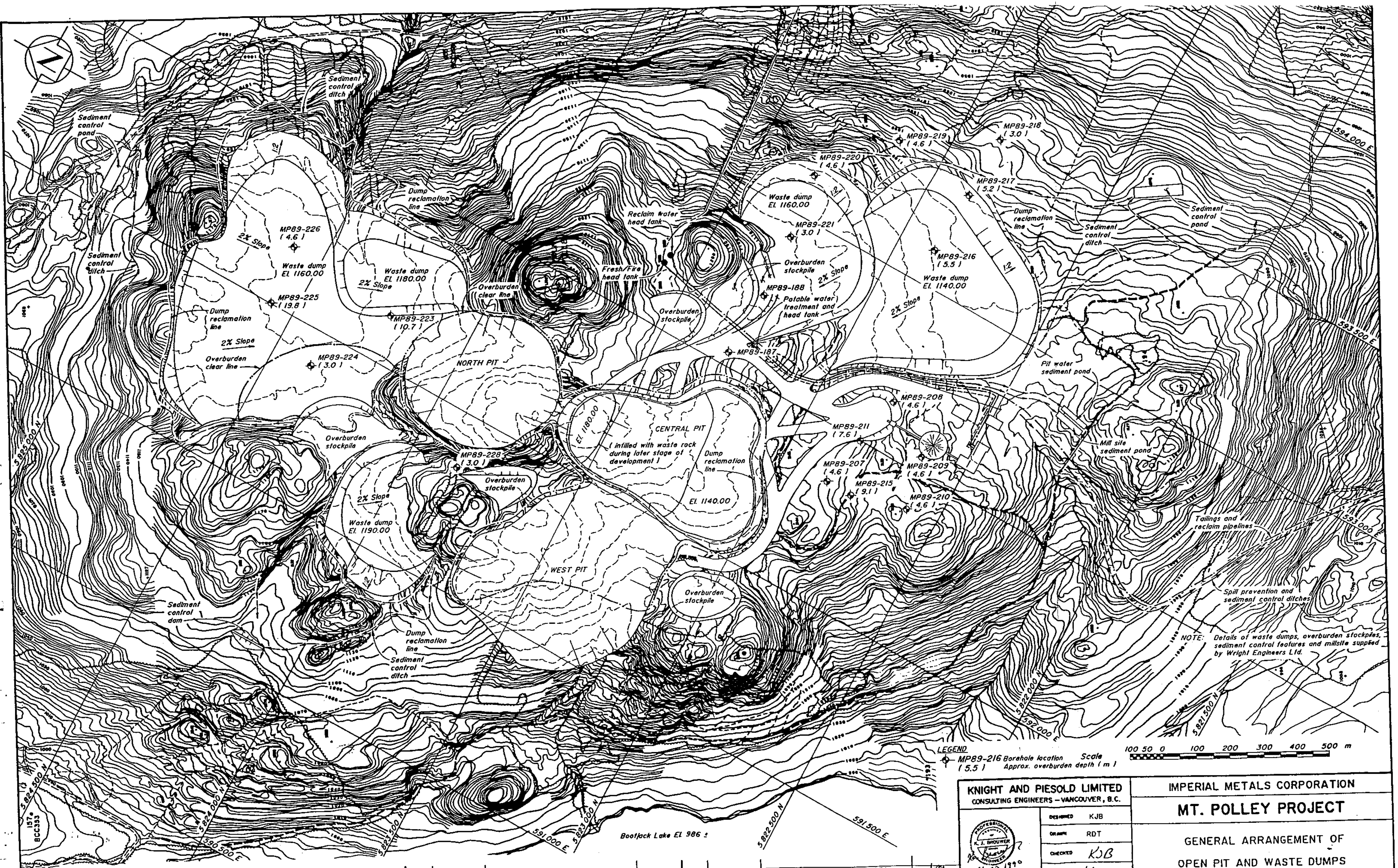
DRAWN
CHECKED
APPROVED

IMPERIAL METALS CORPORATION

MT. POLLEY PROJECT

TAILINGS AREA B
GEOLOGICAL SECTIONS

DATE DEC. 20, 1989
SCALE AS SHOWN
DRG NO. 1621.004
REV 0



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CONSULTING ENGINEERS – VANCOUVER, B.C.

PROFESSIONAL ENGINEER K. J. BROUWER
Feb 20, 1990

DESIGNED	KJB
DRAWN	RDT
CHECKED	KJB
APPROVED	

IMPERIAL METALS CORPORATION

MT. POLLEY PROJECT

GENERAL ARRANGEMENT OF
OPEN PIT AND WASTE DUMPS

DATE	SCALE	DRG. NO.	REV.
DEC. 20, 1989	AS SHOWN	1621.100	1

REVISIONS

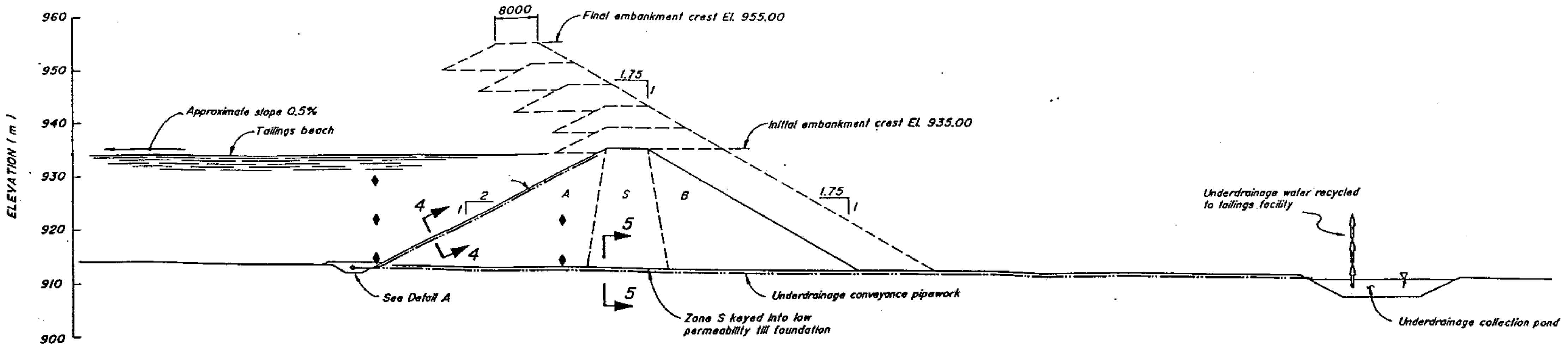
REV.	DATE	DESCRIPTION	APPROVED
1	FEB. 19, 1990	LAYOUT MODIFIED AS PER W.E.L.	

REVISIONS

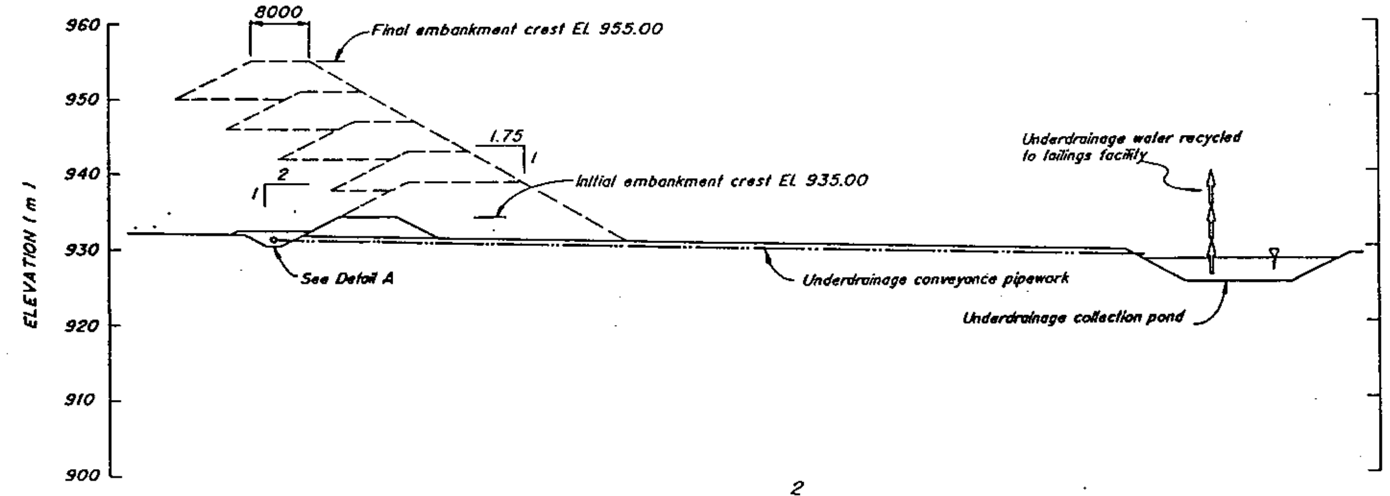
REV.	DATE	DESCRIPTION	APPROVED

REFERENCE DRAWINGS

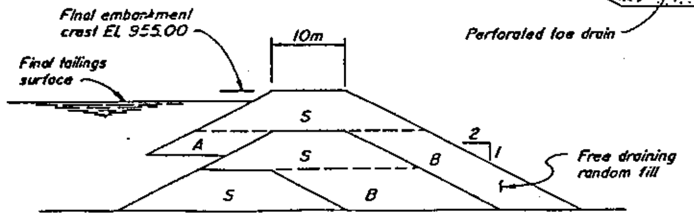
DRG NO	DESCRIPTION



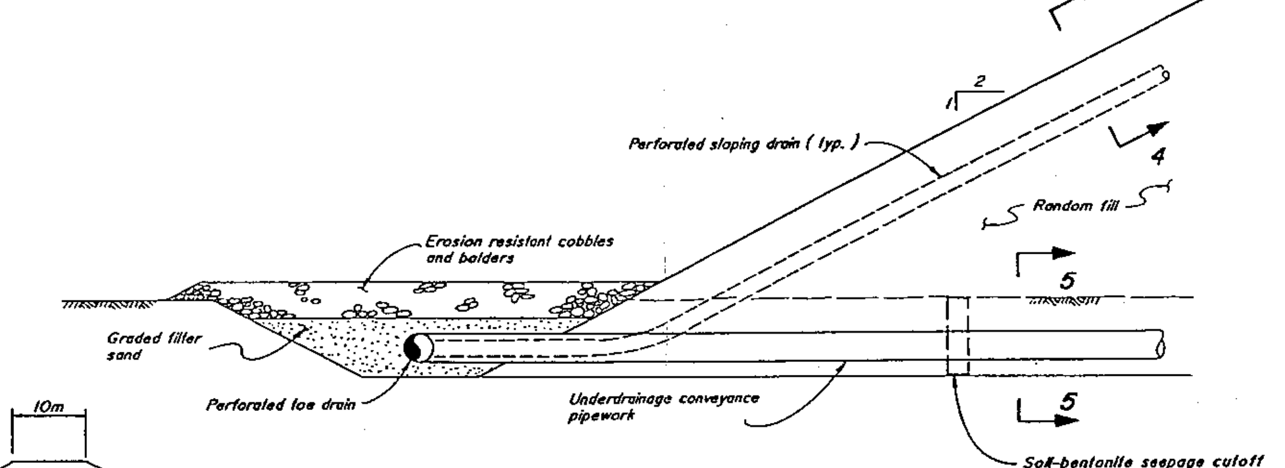
SECTION $\frac{1}{1621.101}$
MAIN EMBANKMENT
Scale A



SECTION $\frac{2}{1621.101}$
PERIMETER EMBANKMENT
Scale A



SECTION $\frac{1}{1621.103}$
SOUTH EMBANKMENT
Scale A



DETAIL A
EMBANKMENT TOE DRAIN
NTS

SUMMARY OF EMBANKMENT ZONE REQUIREMENTS

ZONE	MATERIAL	PLACEMENT	COMPACTION
S	Low permeability glacial till	300 mm layers with moisture conditioning	6 passes, 10 T vibratory padfoot roller
A	Random fill	600 mm layers	6 passes, 10 T vibratory padfoot roller
B	Random fill or waste rock	600 mm layers	6 passes, 10 T vibratory smooth drum roller

Compaction objectives:

1. Till and Random Fill: 95% of modified proctor maximum density
2. Waste Rock: 90% of maximum density as determined by roller compaction curve.

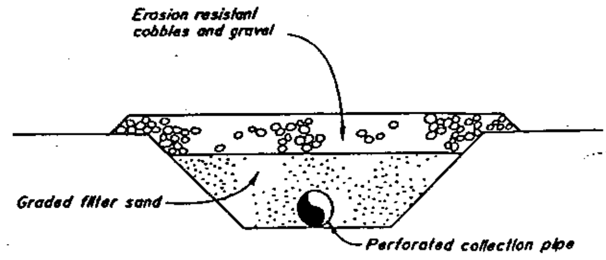
LEGEND:

◆ Piezometer installations

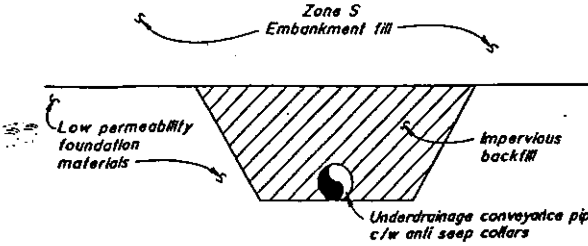
NOTE:

1. Embankment slopes to be designed on the basis of material strength parameters during final design.

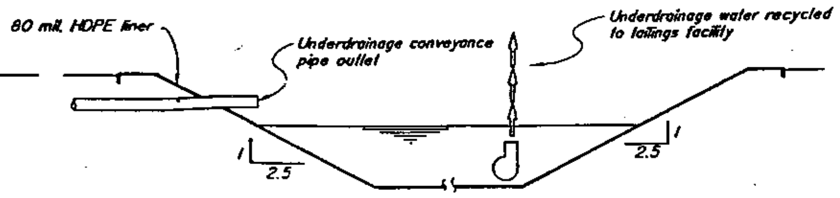
Scale A 10 5 0 10 20 30 40 50 m



SECTION 4
SLOPING DRAIN DETAIL
NTS



SECTION 5
UNDERDRAINAGE CONVEYANCE PIPE DETAIL
NTS



SCHEMATIC SECTION THROUGH
UNDERDRAINAGE COLLECTION PONDS (TYP.)
NTS

DRG NO.	DESCRIPTION
REFERENCE DRAWINGS	

REV.	DATE	DESCRIPTION	APPROVED
REVISIONS			

REV.	DATE	DESCRIPTION	APPROVED
1	FEB. 19, 1990	COLLECTION POND SIDE SLOPES CHANGED	
REVISIONS			

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PROFESSIONAL ENGINEER K. J. BROUWER
Feb 20, 1990

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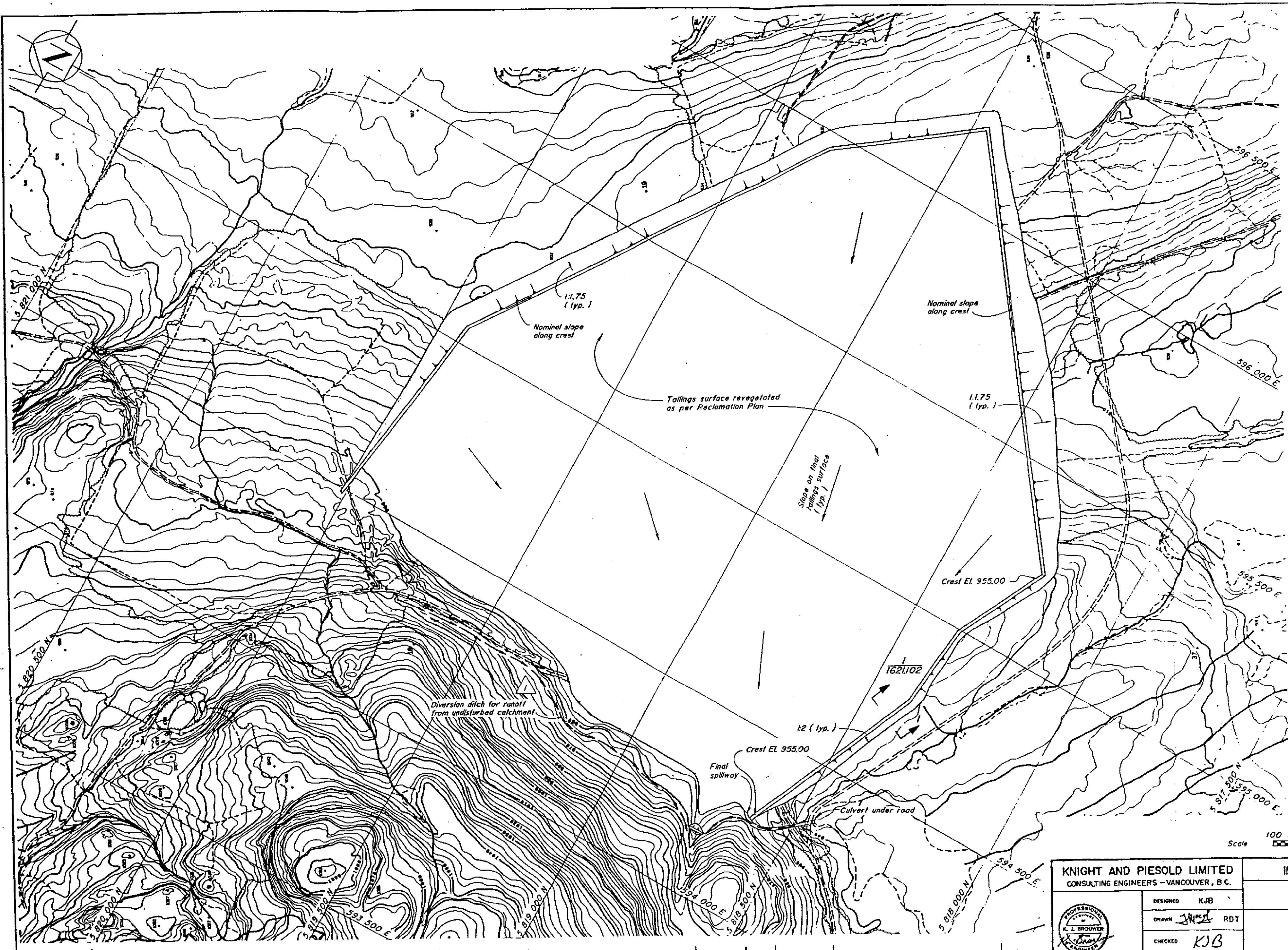
CHECKED KJB
APPROVED

IMPERIAL METALS CORPORATION

MT. POLLEY PROJECT

TAILINGS STORAGE FACILITY
EMBANKMENT SECTIONS AND DETAILS

DATE DEC. 20, 1989
SCALE AS SHOWN
DRG. NO. 1621.102
REV. 1



DRG NO.	DESCRIPTION

REFERENCE DRAWINGS

REV.	DATE	DESCRIPTION	APPROVED

REVISIONS

REV.	DATE	DESCRIPTION	APPROVED
1	FEB. 16, 1990	DIVERSION DITCH ADDED	Jm

REVISIONS

KNIGHT AND PIESOLD LIMITED
CONSULTING ENGINEERS – VANCOUVER, B.C.

PROFESSIONAL ENGINEER
K. J. BROUWER
Feb 20, 1990

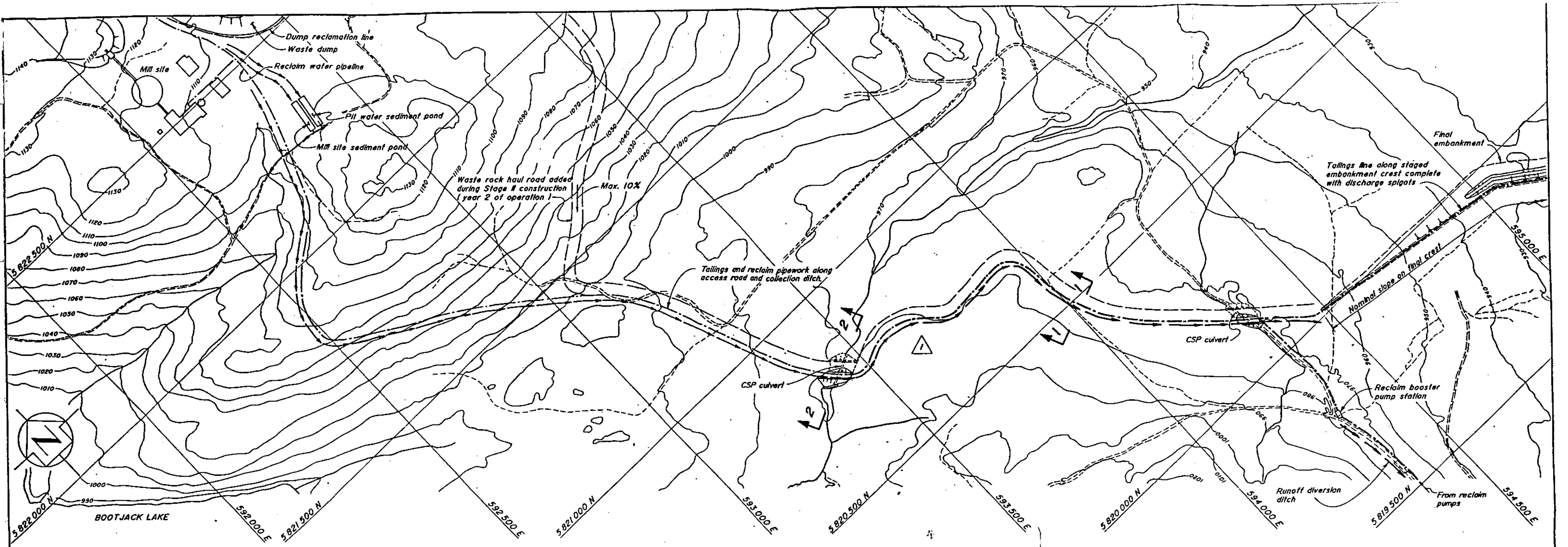
DESIGNED KJB
DRAWN RDT
CHECKED KJB
APPROVED

IMPERIAL METALS CORPORATION

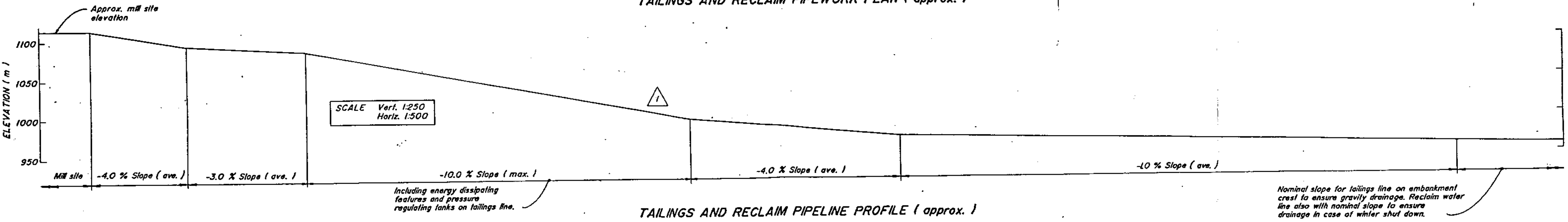
MT. POLLEY PROJECT

TAILINGS STORAGE FACILITY
FINAL ARRANGEMENT

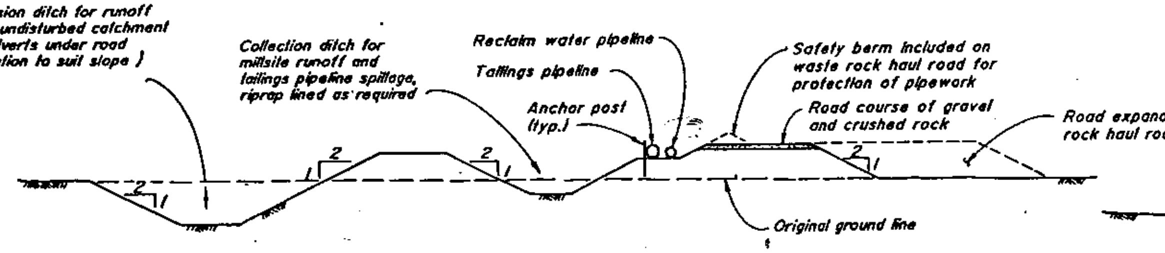
DATE DEC. 20, 1989
SCALE AS SHOWN
DRG. NO. 1621.103
REV. 1



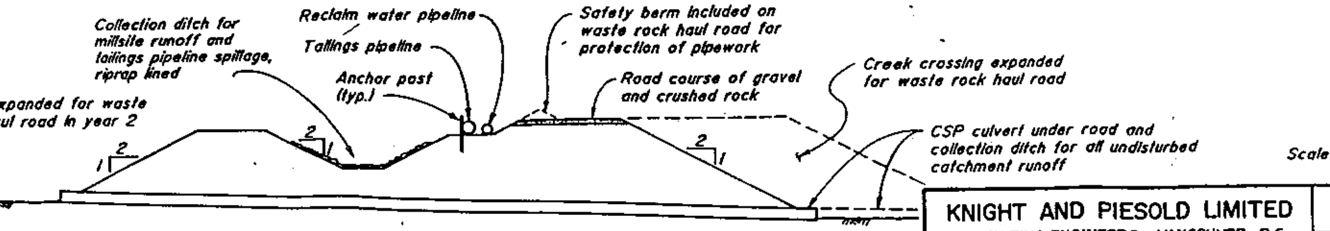
TAILINGS AND RECLAIM PIPEWORK PLAN (approx.)



TAILINGS AND RECLAIM PIPELINE PROFILE (approx.)



SECTION 1
N.T.S.



SECTION 2
N.T.S.

Scale 100 50 0 100 200 300 400 500 m

DRG. NO.	DESCRIPTION

REFERENCE DRAWINGS

REV.	DATE	DESCRIPTION	APPROVED

REVISIONS

REV.	DATE	DESCRIPTION	APPROVED
1	FEB. 16, 1990	PIPELINE ROUTE MODIFIED	JMG

REVISIONS

KNIGHT AND PIESOLD LIMITED
CONSULTING ENGINEERS – VANCOUVER, B.C.

K. J. BROUWER
Feb 20, 1990

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DRAWN JMG
CHECKED KJB
APPROVED

IMPERIAL METALS CORPORATION

MT. POLLEY PROJECT

TAILINGS AND RECLAIM WATER PIPELINES
PLAN AND DETAILS

DATE DEC. 20, 1989
SCALE AS SHOWN
DRG. NO. 1621.104
REV. 1

APPENDIX A

CLIMATOLOGICAL SUMMARIES

BRITISH COLUMBIA/COLOMBIE-BRITANNIQUE

BARKERVILLE
53° 4'N 121° 31'W 1265 m

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR	CODE	
	JAN	FÉV	MAR	AVR	MAI	JUIN	JUIL	AOÛT	SEPT	OCT	NOV	DÉC	ANNÉE	CODE	
Daily Maximum Temperature	–5.6	–0.5	1.5	6.4	12.0	16.0	19.0	18.1	13.9	7.8	0.4	–3.6	7.1	2	Température Maximale Quotidienne
Daily Minimum Temperature	–15.6	–11.3	–10.2	–5.3	–0.6	3.1	5.2	5.0	1.6	–2.3	–8.7	–12.6	–4.3	2	Température Minimale Quotidienne
Daily Temperature	**–10.7**	**–5.9**	**–4.3**	**0.5**	**5.7**	**9.6**	**12.1**	**11.5**	**7.7**	**2.8**	**–4.1**	**–8.2**	**1.4**	**2**	**Température Quotidienne**
Standard Deviation, Daily Temperature	3.6	2.9	1.9	1.9	1.6	1.7	1.3	1.6	1.9	1.6	2.7	3.3	0.8	2	Écart Type de la Température Quotidienne
Extreme Maximum Temperature	9.4	15.0	17.2	27.8	31.1	32.2	35.6	33.9	30.6	26.7	18.9	14.4	35.6		Température Maximale Extrême
Years of Record	87	86	86	89	89	88	89	90	89	89	90	88			Années de Relèves
Extreme Minimum Temperature	–46.7	–43.3	–37.2	–26.1	–15.0	–6.7	–3.9	–7.8	–13.3	–22.2	–33.3	–41.7	–46.7		Température Minimale Extrême
Years of Record	88	87	88	89	88	88	89	90	89	89	90	88			Années de Relèves
Rainfall	3.1	4.3	3.4	11.3	50.7	88.5	81.6	102.2	81.4	57.7	13.7	7.8	505.7	2	Chutes de Pluie
Snowfall	99.9	81.3	81.9	50.5	15.2	0.8	0.1	0.1	4.0	30.7	73.0	100.9	538.4	2	Chutes de Neige
Total Precipitation	**103.0**	**85.6**	**85.3**	**61.8**	**65.9**	**89.2**	**81.7**	**102.3**	**85.4**	**88.4**	**86.6**	**108.7**	**1043.9**	**2**	**Précipitations Totales**
Standard Deviation, Total Precipitation	44.4	42.5	29.1	24.5	28.9	28.8	31.0	53.0	39.9	37.4	28.2	42.5	112.7	2	Écart Type des Précipitations Totales
Greatest Rainfall in 24 hours	38.1	38.1	21.3	21.8	25.4	58.4	36.1	52.8	69.9	51.8	50.8	27.0	69.9		Chute de Pluie Record en 24 heures
Years of Record	88	88	89	91	89	89	90	90	90	90	90	88			Années de Relèves
Greatest Snowfall in 24 hours	49.8	58.4	48.3	39.6	21.8	21.6	2.5	5.1	24.4	37.6	50.8	48.3	58.4		Chute de Neige Record en 24 heures
Years of Record	88	88	89	91	89	90	90	91	90	90	89	88			Années de Relèves
Greatest Precipitation in 24 hours	49.8	58.4	48.3	39.6	27.4	58.4	36.1	52.8	71.1	51.8	50.8	48.3	71.1		Précipitation Record en 24 heures
Years of Record	88	88	89	91	89	89	90	90	90	90	90	88			Années de Relèves
Days with Rain	1	1	1	3	11	16	14	15	14	10	3	1	90	2	Jours de Pluie
Days with Snow	16	14	15	9	3	•	•	•	1	6	13	17	94	2	Jours de Neige
Days with Precipitation	17	14	16	11	13	16	14	15	14	15	15	17	177	2	Jours de Précipitation

BARRIERE
51° 11'N 120° 7'W 375 m

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR	CODE	
	JAN	FÉV	MAR	AVR	MAI	JUIN	JUIL	AOÛT	SEPT	OCT	NOV	DÉC	ANNÉE	CODE	
Daily Maximum Temperature	–4.0	2.6	8.4	15.7	21.0	24.9	27.9	27.3	21.4	12.5	3.8	–1.7	13.3	3	Température Maximale Quotidienne
Daily Minimum Temperature	–12.3	–7.8	–4.5	–0.1	4.2	8.1	9.7	9.1	5.1	0.8	–3.3	–8.5	0.0	3	Température Minimale Quotidienne
Daily Temperature	**–8.2**	**–2.6**	**2.0**	**7.8**	**12.6**	**16.6**	**18.8**	**18.2**	**13.3**	**6.7**	**0.3**	**–5.1**	**6.7**	**3**	**Température Quotidienne**
Standard Deviation, Daily Temperature	4.5	3.3	1.8	1.3	1.5	1.5	1.3	1.5	1.6	1.1	1.8	3.4	0.6	3	Écart Type de la Température Quotidienne
Extreme Maximum Temperature	11.7	15.0	20.6	32.2	37.8	39.4	40.0	38.9	32.8	27.5	21.7	12.2	40.0		Température Maximale Extrême
Years of Record	21	22	22	22	21	21	21	22	22	21	21	22			Années de Relèves
Extreme Minimum Temperature	–42.8	–34.4	–29.5	–11.7	–4.4	–1.1	2.5	–2.2	–6.7	–12.8	–24.5	–39.4	–42.8		Température Minimale Extrême
Years of Record	21	22	22	22	21	21	21	22	22	21	21	22			Années de Relèves
Rainfall	7.3	9.2	16.5	21.0	33.7	40.8	43.3	39.8	31.9	31.4	24.1	9.7	308.7	3	Chutes de Pluie
Snowfall	45.6	22.5	4.6	0.6	0.0	0.0	0.0	0.0	0.0	1.0	17.2	42.2	133.7	3	Chutes de Neige
Total Precipitation	**53.0**	**31.7**	**21.1**	**21.6**	**33.7**	**40.8**	**43.3**	**39.8**	**31.9**	**32.4**	**41.3**	**51.9**	**442.5**	**3**	**Précipitations Totales**
Standard Deviation, Total Precipitation	22.3	18.9	8.1	14.6	11.3	26.2	23.2	28.6	19.5	21.2	19.1	24.0	91.4	3	Écart Type des Précipitations Totales
Greatest Rainfall in 24 hours	20.3	30.2	13.5	15.2	23.9	27.7	43.7	42.2	22.9	23.6	15.5	12.4	43.7		Chute de Pluie Record en 24 heures
Years of Record	22	21	22	22	21	21	22	23	23	21	22	23			Années de Relèves
Greatest Snowfall in 24 hours	24.1	18.8	7.9	6.6	T	0.0	0.0	0.0	0.0	9.7	30.2	22.1	30.2		Chute de Neige Record en 24 heures
Years of Record	22	21	21	22	21	21	22	23	23	21	21	23			Années de Relèves
Greatest Precipitation in 24 hours	24.1	30.2	13.5	15.2	23.9	27.7	43.7	42.2	22.9	23.6	30.2	22.1	43.7		Précipitation Record en 24 heures
Years of Record	22	21	22	22	21	21	22	23	23	21	22	23			Années de Relèves
Days with Rain	2	4	7	7	11	10	9	9	9	9	8	4	89	3	Jours de Pluie
Days with Snow	11	7	3	•	0	0	0	0	0	•	5	10	36	3	Jours de Neige
Days with Precipitation	13	10	9	7	11	10	9	9	9	10	12	14	123	3	Jours de Précipitation

BRITISH COLUMBIA/COLOMBIE-BRITANNIQUE

LIKELY
52° 36'N 121° 32'W 724 m

	JAN JAN	FEB FÉV	MAR MAR	APR AVR	MAY MAI	JUN JUIN	JUL JUIL	AUG AOÛT	SEP SEPT	OCT OCT	NOV NOV	DEC DÉC	YEAR ANNÉE	CODE CODE	
Daily Maximum Temperature	-5.5	0.9	4.2	10.1	16.2	19.6	22.9	21.6	17.0	10.5	2.9	-2.2	9.9	8	Température Maximale Quotidienne
Daily Minimum Temperature	-14.6	-10.2	-7.6	-2.6	1.6	5.4	7.6	7.1	3.7	0.2	-5.0	-9.9	-2.0	8	Température Minimale Quotidienne
Daily Temperature	**-10.0**	**-4.5**	**-1.6**	**3.7**	**9.0**	**12.8**	**15.4**	**14.6**	**10.4**	**5.6**	**-1.1**	**-5.9**	**4.0**	**8**	**Température Quotidienne**
Standard Deviation, Daily Temperature	3.9	4.4	1.8	1.1	1.2	1.3	1.4	1.7	1.0	0.6	2.0	3.8	0.5	6	Écart Type de la Température Quotidienne
Extreme Maximum Temperature	9.5	12.2	16.0	29.4	27.5	30.0	33.9	31.7	28.0	23.5	16.7	11.0	33.9		Température Maximale Extrême
Years of Record	6	6	6	6	6	6	6	6	7	7	7	7			Années de Relèves
Extreme Minimum Temperature	-34.4	-34.5	-31.1	-13.9	-6.0	-1.5	2.8	1.5	-2.0	-6.0	-25.0	-37.0	-37.0		Température Minimale Extrême
Years of Record	6	6	6	6	6	6	6	6	7	7	7	7			Années de Relèves
Rainfall	9.5	6.0	8.5	29.1	36.9	66.3	47.0	82.0	49.8	55.5	31.6	11.8	434.0	8	Chutes de Pluie
Snowfall	62.2	51.6	32.5	14.4	0.1	0.0	0.0	0.0	0.5	5.0	26.6	69.1	262.0	8	Chutes de Neige
Total Precipitation	**74.2**	**60.2**	**37.8**	**42.2**	**36.6**	**66.3**	**47.0**	**82.0**	**50.4**	**61.6**	**58.4**	**83.0**	**699.7**	**8**	**Précipitations Totales**
Standard Deviation, Total Precipitation	27.0	27.7	13.5	20.9	15.4	29.7	27.4	35.7	27.1	42.3	18.8	36.9	116.4	6	Écart Type des Précipitations Totales
Greatest Rainfall in 24 hours	16.5	6.9	15.2	33.0	22.0	20.0	31.8	25.7	15.2	32.5	13.7	26.2	33.0		Chute de Pluie Record en 24 heures
Years of Record	6	6	6	6	6	6	6	6	6	7	7	7			Années de Relèves
Greatest Snowfall in 24 hours	15.2	14.2	25.4	7.6	0.5	T	0.0	0.0	0.0	4.3	20.3	27.4	27.4		Chute de Neige Record en 24 heures
Years of Record	6	6	6	6	6	6	6	6	6	7	7	7			Années de Relèves
Greatest Precipitation in 24 hours	16.5	14.2	25.4	38.1	22.0	20.0	31.8	25.7	15.2	32.5	20.3	27.4	38.1		Précipitation Record en 24 heures
Years of Record	6	6	6	6	6	6	6	6	6	7	7	7			Années de Relèves
Days with Rain	1	2	4	8	10	13	10	13	14	14	9	3	101	8	Jours de Pluie
Days with Snow	16	13	11	6	0	0	0	0	1	3	10	15	75	8	Jours de Neige
Days with Precipitation	15	15	13	10	11	13	10	13	14	15	14	16	159	8	Jours de Précipitation

LILLOOET
50° 42'N 121° 56'W 290 m

	JAN JAN	FEB FÉV	MAR MAR	APR AVR	MAY MAI	JUN JUIN	JUL JUIL	AUG AOÛT	SEP SEPT	OCT OCT	NOV NOV	DEC DÉC	YEAR ANNÉE	CODE CODE	
Daily Maximum Temperature															Température Maximale Quotidienne
Daily Minimum Temperature															Température Minimale Quotidienne
Daily Temperature															**Température Quotidienne**
Standard Deviation, Daily Temperature															Écart Type de la Température Quotidienne
Extreme Maximum Temperature															Température Maximale Extrême
Years of Record															Années de Relèves
Extreme Minimum Temperature															Température Minimale Extrême
Years of Record															Années de Relèves
Rainfall	23.8	17.7	14.5	21.2	23.0	22.4	25.3	32.1	36.9	39.9	30.0	32.4	319.2	8	Chutes de Pluie
Snowfall	27.5	10.8	3.8	0.9	0.0	0.0	0.0	0.0	0.0	0.0	8.3	21.9	73.2	8	Chutes de Neige
Total Precipitation	**50.9**	**28.4**	**18.8**	**22.6**	**23.0**	**22.4**	**25.3**	**32.1**	**36.9**	**39.7**	**38.1**	**53.2**	**391.4**	**8**	**Précipitations Totales**
Standard Deviation, Total Precipitation	32.0	22.4	14.5	19.7	17.0	15.2	21.5	25.4	27.6	32.9	15.0	16.3	122.8	4	Écart Type des Précipitations Totales
Greatest Rainfall in 24 hours	49.5	35.6	19.1	34.5	49.3	114.3	51.3	27.2	27.4	48.3	36.3	33.0	114.3		Chute de Pluie Record en 24 heures
Years of Record	51	55	49	52	48	50	50	51	49	49	53	49			Années de Relèves
Greatest Snowfall in 24 hours	52.1	25.4	11.9	9.9	0.0	0.0	0.0	0.0	0.0	3.8	15.2	33.0	52.1		Chute de Neige Record en 24 heures
Years of Record	50	54	50	53	51	53	52	53	52	50	51	50			Années de Relèves
Greatest Precipitation in 24 hours	52.1	35.6	19.1	34.5	49.3	114.3	51.3	27.2	27.4	48.3	36.3	33.0	114.3		Précipitation Record en 24 heures
Years of Record	50	54	49	52	48	50	50	51	49	49	52	48			Années de Relèves
Days with Rain	4	4	5	5	5	4	5	7	7	7	6	5	64	8	Jours de Pluie
Days with Snow	5	2	1	0	0	0	0	0	0	0	2	4	14	8	Jours de Neige
Days with Precipitation	8	6	6	6	5	4	5	7	7	7	8	10	79	8	Jours de Précipitation

BRITISH COLUMBIA/COLOMBIE-BRITANNIQUE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR	CODE	
	JAN	FÉV	MAR	AVR	MAI	JUIN	JUIL	AOÛT	SEPT	OCT	NOV	DÉC	ANNÉE	CODE	
WILLIAM HEAD 48° 21′N 123° 32′W 12 m															
Daily Maximum Temperature	6.3	8.3	9.4	12.0	15.3	18.2	20.5	20.1	17.1	12.9	9.4	7.5	13.1	8	Température Maximale Quotidienne
Daily Minimum Temperature	1.6	2.9	3.1	4.9	7.2	9.4	11.0	10.9	9.2	6.7	4.4	2.8	6.2	8	Température Minimale Quotidienne
Daily Temperature	**4.0**	**5.6**	**6.3**	**8.5**	**11.3**	**13.8**	**15.8**	**15.6**	**13.2**	**9.8**	**6.9**	**5.2**	**9.7**	**8**	**Température Quotidienne**
Standard Deviation, Daily Temperature	1.5	1.2	1.0	1.0	0.8	1.0	0.8	0.9	0.8	0.6	0.8	1.4	0.4	3	Écart Type de la Température Quotidienne
Extreme Maximum Temperature	14.4	16.7	16.1	21.0	28.9	29.4	28.9	31.1	25.6	20.6	17.2	16.0	31.1		Température Maximale Extrême
Years of Record	20	20	21	21	21	21	19	21	21	20	22	21			Années de Relèves
Extreme Minimum Temperature	−8.3	−7.5	−3.3	−0.6	1.1	3.9	6.5	5.0	2.2	0.0	−2.8	−13.9	−13.9		Température Minimale Extrême
Years of Record	20	20	21	21	21	21	19	21	21	21	21	21			Années de Relèves
Rainfall	151.9	100.5	71.8	43.9	31.4	19.4	14.8	23.9	44.1	80.2	126.8	157.1	865.8	8	Chutes de Pluie
Snowfall	8.6	1.1	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	5.2	17.2	8	Chutes de Neige
Total Precipitation	**160.6**	**101.6**	**73.1**	**43.9**	**31.4**	**19.4**	**14.8**	**23.9**	**44.1**	**80.2**	**127.9**	**162.5**	**883.4**	**8**	**Précipitations Totales**
Standard Deviation, Total Precipitation	65.3	49.9	36.2	23.3	24.2	12.4	13.4	19.8	26.1	55.0	59.5	60.8	166.8	3	Écart Type des Précipitations Totales
Greatest Rainfall in 24 hours	82.3	67.3	47.8	23.9	50.8	19.6	20.8	38.4	38.1	44.5	55.4	66.3	82.3		Chute de Pluie Record en 24 heures
Years of Record	19	20	20	21	21	19	19	21	20	21	22	22			Années de Relèves
Greatest Snowfall in 24 hours	12.7	7.6	14.2	T	0.0	0.0	0.0	0.0	0.0	0.0	7.6	20.3	20.3		Chute de Neige Record en 24 heures
Years of Record	19	20	20	21	21	20	19	21	21	21	20	20			Années de Relèves
Greatest Precipitation in 24 hours	82.3	67.3	47.8	23.9	50.8	19.6	20.8	38.4	38.1	44.5	55.4	66.3	82.3		Précipitation Record en 24 heures
Years of Record	19	20	20	21	21	19	19	21	20	21	22	22			Années de Relèves
Days with Rain	18	15	15	11	8	6	4	7	8	13	18	20	143	8	Jours de Pluie
Days with Snow	2	0	0	0	0	0	0	0	0	0	0	1	3	8	Jours de Neige
Days with Precipitation	19	15	15	11	8	6	4	7	8	13	18	20	144	8	Jours de Précipitation
WILLIAMS LAKE A 52° 11′N 122° 4′W 940 m															
Daily Maximum Temperature	−5.9	0.9	4.5	10.3	15.3	19.4	22.1	21.7	16.6	10.2	1.3	−3.7	9.4	3	Température Maximale Quotidienne
Daily Minimum Temperature	−14.8	−9.2	−6.4	−1.4	2.6	6.6	8.7	8.2	4.0	0.0	−6.4	−11.6	−1.6	3	Temperature Minimale Quotidienne
Daily Temperature	**−10.4**	**−4.2**	**−1.0**	**4.4**	**9.0**	**13.0**	**15.4**	**15.0**	**10.3**	**5.1**	**−2.6**	**−7.7**	**3.9**	**3**	**Température Quotidienne**
Standard Deviation, Daily Temperature	4.1	3.2	2.2	1.3	1.1	1.8	1.2	1.8	2.0	1.2	2.5	3.9	0.6	3	Écart Type de la Température Quotidienne
Extreme Maximum Temperature	12.8	12.8	17.1	28.8	30.0	32.2	34.4	32.8	30.6	23.8	16.7	11.2	34.4		Température Maximale Extrême
Years of Record	20	20	20	20	20	20	20	20	20	20	20	20			Années de Relèves
Extreme Minimum Temperature	−42.2	−32.4	−31.7	−16.7	−5.6	−2.2	0.0	−1.7	−8.9	−16.7	−28.3	−42.8	−42.8		Température Minimale Extrême
Years of Record	20	20	20	20	20	20	20	20	20	20	20	20			Années de Relèves
Rainfall	3.8	3.2	3.3	12.2	28.3	44.9	48.3	42.6	29.1	23.2	5.1	2.5	246.5	3	Chutes de Pluie
Snowfall	49.6	25.4	21.9	9.7	3.0	0.1	0.0	0.0	1.2	7.5	31.0	49.5	198.9	3	Chutes de Neige
Total Precipitation	**43.9**	**24.0**	**22.5**	**21.5**	**31.6**	**45.1**	**48.3**	**42.6**	**30.2**	**30.3**	**31.5**	**41.3**	**412.8**	**3**	**Précipitations Totales**
Standard Deviation, Total Precipitation	29.9	11.8	13.6	14.2	19.5	29.6	24.8	30.3	18.9	20.1	14.7	15.8	90.6	3	Écart Type des Précipitations Totales
Greatest Rainfall in 24 hours	15.7	14.2	5.6	20.3	19.0	26.2	34.3	29.7	24.9	37.3	9.9	8.6	37.3		Chute de Pluie Record en 24 heures
Years of Record	20	20	20	20	20	20	20	20	20	19	19	20			Années de Relèves
Greatest Snowfall in 24 hours	42.7	15.0	32.2	17.0	11.7	1.8	0.0	T	7.9	19.1	23.6	23.6	42.7		Chute de Neige Record en 24 heures
Years of Record	20	20	20	20	20	20	20	20	20	19	20	20			Annees de Relèves
Greatest Precipitation in 24 hours	42.7	14.2	32.8	24.9	22.4	26.2	34.3	29.7	27.9	37.3	17.5	17.8	42.7		Précipitation Record en 24 heures
Years of Record	20	20	20	20	20	20	20	20	20	19	20	20			Années de Relèves
Days with Rain	1	1	2	5	9	11	11	10	10	8	3	2	73	8	Jours de Pluie
Days with Snow	14	9	9	4	2	0	0	0	1	3	9	14	65	8	Jours de Neige
Days with Precipitation	14	10	10	8	10	11	11	10	10	10	12	15	131	8	Jours de Précipitation

APPENDIX B

DISCONTINUITY DATA AND POINT LOAD TEST RESULTS

APPENDIX B

IMPERIAL METALS CORPORATION
MT. POLLEY PROJECT

DISCONTINUITY DATA AND POINT LOAD TEST RESULTS

DRILLHOLE MP89-152 (285/55)

DEPTH		ROCK TYPE	R.Q.D.	FRACTURE INDEX (jt/ft)	GAUGE (psi)	COMP.STRENGTH	
from	to					(psi)	(MPa)
10	20	DIORITE	60	2.0	3200	36188	250
20	30		82	2.0	3200	36188	250
30	40		83	1.0	3500	39581	273
					2900	32796	226
40	50		68	1.5	3500	39581	273
					2800	31665	218
50	60		95	1.2			
60	70		80	2.0	1000	11309	78
70	80		88	1.0	2000	22618	156
					4000	45235	312
80	90		93	1.5	2900	32796	226
90	100		68	3.0	2000	22618	156
100	110		93	1.0	1000	11309	78
110	120		100	1.2	2200	24879	172
120	130		65	2.7			
130	140		80	1.0	2800	31665	218
140	150		80	1.2	3000	33926	234
150	160		75	1.3	3000	33926	234
160	170		97	1.7	1900	21487	148
170	180		75	1.7	2600	29403	203
180	190		80	High	400	4524	31
190	200		20	High			
200	210		40	High	1800	20356	140
220	230		20	V.High			
220	230	SYENO	40	High	400	4524	31
230	240		60	2.5	1500	16963	117
240	250		35	3.0	1000	11309	78
250	260		18	High			
260	270		35	High	200	2262	16
270	280		25	High	200	2262	16
280	290		10	High	900	10178	70
290	300		7		100	1131	8
300	310		5	High			
310	320		3	High	700	7916	55

APPENDIX B (Continued)

DRILLHOLE MP89-152 (285/55)

DEPTH		ROCK	R.Q.D.	FRACTURE	GAUGE	COMP.STRENGTH	
from	to	TYPE		INDEX (jt/ft)	(psi)	(psi)	(MPa)
630	640		92	1.0	2000	22618	156
640	650		92	0.8	800	904	762
650	660		35	1.2	300	3393	23
660	670		98	0.5	200	2262	16
					900	10178	70
670	680	IB	95	0.8	1700	19225	133
					1600	18094	125
680	690		95	0.7	400	4524	31
					1000	11309	78
690	700		87	1.3	3000	33926	234
					2000	22618	156
					1700	1922	133
700	710	DYKE	95	1.2	1200	13571	94
		IB			1000	11309	78
710	720		100	0.6	2800	31665	218
720	730		85	1.1	600	6785	47
730	740		90	1.0	1900	21487	148
740	750		50	1.0	300	3393	23
					100	1131	8
750	760		100	0.4	1300	14701	101
					1200	13571	94
760	770		90	0.6	300	3393	23
					700	7916	55
770	780		40	High	50	565	4
780	790		35	1.5	1900	21487	148
790	800		25	High	1500	16963	117
800	810		-	0.9	3200	36188	250
810	820		92	0.9	1100	12440	86
					3200	36188	250
820	830		87	1.1	2500	28272	195
830	840		80	1.1	900	10178	70
					2100	23748	164
840	850		50	High	600	6785	47
					1600	18094	125
850	860		90	1.1	2300	26010	179
					1500	16963	117
860	870		95	1.1	1100	12440	86
870	880		25	1.2	800	9047	62
880	890		96	0.5	200	2262	16
					500	5654	39

APPENDIX B (Continued)

DRILLHOLE MP89-153 (253/50)

DEPTH		ROCK	R.Q.D.	FRACTURE	GAUGE	COMP.STRENGTH	
from	to	TYPE		INDEX (jt/ft)	(psi)	(psi)	(MPa)
240	250		100	0.6	2500	28272	195
250	260		80	1.4	1100	12440	86
260	270		100	0.4	1000	11309	78
			100	0.4	1400	15832	109
270	280		100	0.4	3000	33926	234
			100	0.4	1500	16963	117
280	290		80	1.2	2600	29403	203
290	300		96	0.7	1700	19225	133
300	310		89	1.1	1400	15832	109
310	320		96	0.9	2400	27141	187
320	330		50	2.7	1300	14701	101
330	340	DYKE	80	1.2	600	6785	47
		IB			400	4524	31
340	355		83	1.0	2200	24879	172
350	360		98	0.6	1500	16963	117
360	370		100	0.6	1400	15832	109
370	380		80	1.6	1000	11309	78
380	390		100	0.4	1600	18094	125
390	400		98	0.9	2200	24879	172
400	410		100	0.3	2000	22618	156
410	420		100	0.5			
420	430		100	1.0	1300	14701	101
430	440		100	0.5	2000	22618	156
					1200	13571	94
440	450		91	0.4	1900	21487	148
450	460		96	0.6	1800	20356	140
460	470		100	0.5			
470	480		100	0.7	1200	13571	94
480	490		100	0.3	1200	13571	94
490	500		100	0.0	1200	13571	94
					1000	11309	78
					4000	45235	312
500	510		100	0.4	2500	28272	195
510	520		98	0.7	1500	16963	117
520	530		97	0.7	3000	33926	234
530	540		90	0.8	2200	24879	172
540	550		100	0.3	2200	24879	172
550	560		100	0.7	2300	26010	179
560	570		65	1.8	800	9047	62
570	580		50	2.6	300	3393	23

APPENDIX B (Continued)

DRILLHOLE MP89-154 (245/50)

DEPTH		ROCK TYPE	R.Q.D.	FRACTURE INDEX (jt/ft)	GAUGE (psi)	COMP.STRENGTH	
from	to					(psi)	(MPa)
140	150		25	3.0	350	3958	27
150	160		55	1.7	150	1696	12
160	170		55	1.0	300	3393	23
170	180		35	High			
180	190		30	High	300	3393	23
190	200		60	High			
200	210	DYKE	12	High	300	3393	23
210	220	IB	3	High	250	2827	19
220	230		3	High	50	565	4
230	240		15	High			
240	250		40	High	1100	12440	86
250	260		30	High			
260	270		45	High			
270	280		14	High			
280	290			High			
290	300	DYKE	18	High	500	5654	39
300	310	IB	5	High			
310	320		18	High	300	3393	23
320	330		45	7.5	700	7916	55
					900	10178	70
330	340		75	1.5	4100	46366	320
340	350		95	1.2	5000	56544	390
350	360		85	1.6			
360	370		94	0.9	3000	33926	234
370	380		91	1.1	2600	29403	203
380	390		40	2.2	3400	38450	265
390	400		97	1.2	4100	46366	320
					3600	40712	281
400	410		93	1.3	3000	33926	234
410	420		93	1.2	1400	15832	109
420	430		92	1.4	3500	39581	273
430	440		83	2.3			
440	450	SYENO	85	1.6	2900	32796	226
450	460		90	1.1	2800	31665	218
460	470		95	0.8			
470	480		87	1.0			
480	490		95	1.1			
490	500		94	1.2			
500	510		96	1.2			
510	520		91	1.0			

APPENDIX B (Continued)

DRILLHOLE MP89-154 (245/50)

DEPTH from	DEPTH to	ROCK TYPE	R.Q.D.	FRACTURE INDEX (jt/ft)	GAUGE (psi)	COMP.STRENGTH (psi)	COMP.STRENGTH (MPa)
900	910		100	0.4	800	9047	62
910	920		97	0.7	400	4524	31
920	930		65	1.0	1200	13571	94
930	940		100	0.6	800	9047	62
940	950		89	0.8	500	5654	39
950	960		98	0.7	1400	15832	109
960	970		90	1.4	200	2262	16
970	980		18	1.5	400	4524	31
980	990		70	1.2	2000	22618	156
990	1000		93	1.6	300	3393	23
1000	1010		15	High	100	1131	8
1010	1020		15	High			
1020	1030		85	1.5	1100	12440	86
1030	1040		85	1.5	1500	16963	117

APPENDIX C

WASTE ROCK ACID GENERATION POTENTIAL TESTWORK

(i) ENVIROCHEM SERVICES LIMITED

- acid base accounting (30 samples)

(ii) COASTECH RESEARCH INC.

- acid base accounting (64 samples)
- humidity cell testwork (composite of 7 samples)

Revised: May 7, 1990

APPENDIX C

IMPERIAL METALS CORPORATION
MT. POLLEY PROJECT

WASTE ROCK ACID GENERATION SAMPLES - NORTH-WEST GEOCHEM

Hole No.	Depth Interval (ft)	Description
MP88-31	6-100	Syenodiorite
MP88-39A	4-76, 93-103, 149-169 203-215, 241-275	Syenodiorite
MP88-39B	79-93, 123-149, 171-203	Intrusion Breccia
MP88-39C	103-123, 215-241	Monzonite Porphyry
MP88-42	14-300	Monzonite Porphyry
MP88-69	10-400	Syenodiorite
MP88-76	20-400	Syenodiorite/Plagioclase Porphyry (w/.dissem. Py)
MP88-80	30-400	Syenodiorite
MP89-100	20-30, 53-86, 110-185 205-235, 293-325, 419-469	Intrusion Breccia
MP89-107	10-583	Syenodiorite
MP89-110	10-300	Monzonite Porphyry
MP89-113	529-600	Breccia (Py)
MP89-115	38-300	Mix: Syeno/Int.Br/ Aug.Por/Monz.Por (Py)
MP89-116	44-260	Syenodiorite (Py)
MP89-117	10-400	Syenodiorite
MP89-118	10-398	Diorite
MP89-123	10-190	Syenodiorite
MP89-128A	10-170	Syenodiorite
MP89-128B	250-450	Monzonite Porphyry
MP89-128C	450-600	Intrusion Breccia
MP89-133	6-400	Alt. Diorite
MP89-134A	10-384	Intrusion Breccia (Py)
MP89-134B	384-500	Syenodiorite
MP89-135	10-505	Alt. Diorite
MP89-136	10-600	Monz. Por/Int. Breccia (Py)
MP89-139A	60-165	Syenodiorite
MP89-139B	165-280	Intrusion Breccia
MP89-141A	20-322	Monz. Porphyry
MP89-141B	322-364	Diorite (w/ 2-3% Py)
MP89-142	119-199, 262-488	Intrusion Breccia (minor py)

APPENDIX C

IMPERIAL METALS CORPORATION
MT. POLLEY PROJECT

ACID BASE ACCOUNTING ON WASTE ROCK - PART II

Sample 10	Paste pH	Total Sulphur (%)	Sulphide (%)	Acid Potential	NP1	NNP1
MP88-68A	8.7	0.20	0.15	4.7	38.7	34.0
MP88-68B	8.8	0.16	0.11	3.4	31.6	28.2
MP88-68C	9.1	0.14	0.09	2.9	20.0	17.1
MP88-68D	9.1	0.08	0.03	0.8	27.4	26.6
MP89-102A	8.8	0.04	0.00	0.0	10.1	10.1
MP89-102B	8.8	0.05	0.02	0.6	16.8	16.3
MP89-102C	8.8	0.05	0.01	0.3	25.1	24.7
MP89-102D	8.8	0.13	0.10	3.0	27.8	24.7
MP89-102E	9.0	0.21	0.16	4.9	25.2	20.3
MP89-102F	8.9	0.16	0.12	3.6	45.6	42.0
MP89-103A	8.9	0.01	0.00	0.0	17.2	17.2
MP89-103B	8.9	0.00	0.00	0.0	22.5	22.5
MP89-103C	8.9	0.00	0.00	0.0	24.8	24.8
MP89-103D	8.8	0.05	0.02	0.5	25.3	24.9
MP89-103E	9.0	0.04	0.00	0.1	15.0	14.9
MP89-103F	8.7	0.34	0.30	9.3	23.1	13.9
MP89-105A	9.2	0.08	0.05	1.6	19.4	17.8
MP89-105B	9.0	0.03	0.00	0.1	29.4	29.3
MP89-105C	9.1	0.06	0.00	0.0	22.3	22.3
MP89-105D	9.1	0.03	0.00	0.0	20.0	20.0
MP89-105E	9.2	0.08	0.05	1.5	29.2	27.7
MP89-105F	9.3	0.09	0.04	1.3	42.7	41.3

NP1: Neutralization potential based on laboratory titration
NNP1: Net neutralization potential using laboratory titration results (NP1)

Acid potential, neutralization potential and net neutralization potential reported as tonnes CaCO3 equivalent/1000 tonnes.

Sample ID	Depth Interval	Paste pH	Total Sulphur (%)	Sulphide (%)	Acid Potential	NP	NNP
MP89-106	15-100	8.9	0.06	0.04	1.2	24.3	23.1
MP89-106	100-200	8.8	0.2	0.00	0.1	16.4	16.3
MP89-106	200-300	8.9	0.4	0.2	0.6	23.6	22.9
MP89-106	300-400	8.9	0.07	0.06	1.7	24.2	22.4
MP89-106	400-500	9.3	0.03	0.02	0.7	44.2	43.5
MP89-106	500-600	9.3	0.05	0.02	0.5	8.8	8.3
MP89-108	10-100	8.2	0.01	0.00	0.0	11.0	11.0
MP89-108	100-200	8.7	0.04	0.01	0.4	16.5	16.1
MP89-108	200-300	8.7	0.02	0.01	0.3	33.2	32.9
MP89-108	300-400	8.7	0.04	0.02	0.7	23.5	22.8
MP89-108	400-500	9.0	0.04	0.00	0.0	21.5	21.5
MP89-108	500-600	9.1	0.13	0.05	1.7	37.5	35.8
MP89-121	10-100	8.7	0.07	0.05	1.4	9.4	8.0
MP89-121	100-200	9.1	0.12	0.11	3.3	15.1	11.8
MP89-121	200-300	9.3	0.14	0.11	3.4	15.5	12.1
MP89-121	300-400	9.2	0.06	0.05	1.6	20.1	18.5
MP89-121	400-500	9.3	0.13	0.12	3.7	15.8	12.1
MP89-121	500-600	9.6	0.11	0.10	3.3	19.1	15.9
MP89-122	30-100	8.0	0.04	0.01	0.3	40.4	40.1
MP89-122	100-200	8.5	0.42	0.38	11.9	38.0	26.1
MP89-122	200-300	8.7	0.21	0.19	5.9	41.9	36.0
MP89-122	300-400	8.7	0.16	0.09	2.8	46.0	43.2
MP89-122	400-500	8.8	0.12	0.09	2.8	48.4	45.6
MP89-124	10-100	9.2	0.02	0.01	0.3	29.2	28.9
MP89-124	100-200	9.3	0.02	0.00	0.0	42.7	42.7
MP89-124	200-300	8.7	0.10	0.07	2.1	9.4	7.4
MP89-124	300-400	9.1	0.18	0.15	4.6	15.1	10.6
MP89-124	400-500	8.2	0.06	0.03	0.9	16.0	15.2

NORTHWEST
GEOCHEM

#204 - 26 Bastion Square, Victoria, B.C. V8W 1H9 • (604) 393-8375 Fax: (604) 383-9354

Acid-Base Accounting
Imperial Metals - Mt. Polley Project
August 29, 1989

Sample ID	Paste pH	Total Sulphur	Total Carbon	Acid Pot.	NP 1	NP 2	NNP 1	NNP 2
MP-89- 31	8.63	0.01%	0.04%	0.3	20.1	3.3	19.8	3.0
MP-89-39A	8.93	0.01%	0.07%	0.3	19.6	5.8	19.3	5.5
MP-89-39B	9.09	0.01%	0.04%	0.3	11.5	3.3	11.2	3.0
MP-89-39C	9.11	0.01%	0.24%	0.3	25.5	20.0	25.2	19.7
MP-89- 42	7.62	0.01%	0.07%	0.3	16.9	5.8	16.6	5.5
MP-89- 69	8.56	0.01%	0.10%	0.3	19.9	8.3	19.6	8.0
MP-89- 86	8.25	0.55%	0.25%	17.2	24.9	20.8	7.7	3.6
MP-89- 80	8.19	0.05%	0.25%	1.6	31.4	20.8	29.8	19.2
MP-89-100	8.14	0.64%	0.31%	20.0	33.4	25.8	13.4	5.8
MP-89-107	8.44	0.00%	0.23%	0.3	27.4	19.2	27.1	18.9
MP-89-110	8.22	0.01%	0.14%	0.3	22.4	11.7	22.1	11.4
MP-89-113	8.15	0.17%	0.56%	5.3	48.8	46.6	43.5	41.3
MP-89-115	8.34	0.66%	0.47%	20.6	46.3	39.2	25.7	18.6
MP-89-116	8.64	0.07%	0.23%	2.2	28.9	19.2	26.7	17.0
MP-89-117	8.71	0.01%	0.13%	0.3	23.4	10.8	23.1	10.5
MP-89-118	8.33	0.01%	0.17%	0.3	27.1	14.2	26.8	13.9
MP-89-123	8.70	0.01%	0.08%	0.3	15.3	6.7	15.0	6.4
MP-89-128A	8.39	0.07%	0.17%	2.2	23.6	14.2	21.4	12.0
MP-89-128B	8.79	0.05%	0.19%	1.6	21.8	15.8	20.2	14.2
MP-89-128C	9.02	0.11%	0.26%	3.4	30.6	21.7	27.2	18.3
MP-89-133	8.61	0.01%	0.13%	0.3	22.0	10.8	21.7	10.5
MP-89-134A	8.14	2.93%	0.47%	91.6	36.6	39.2	-55.0	-52.4
MP-89-134B	8.05	1.53%	0.39%	47.8	34.6	32.5	-13.2	-15.3
MP-89-135	8.35	0.02%	0.28%	0.6	34.1	23.3	33.5	22.7
MP-89-136	8.19	1.00%	0.42%	31.3	38.6	35.0	7.3	3.7
MP-89-139A	8.51	0.06%	0.80%	1.9	65.5	66.6	63.6	64.7
MP-89-139B	8.59	0.13%	0.64%	4.1	50.3	53.3	46.2	49.2
MP-89-141A	8.43	0.16%	0.64%	5.0	59.2	53.3	54.2	48.3
MP-89-141B	7.75	0.32%	0.27%	10.0	34.2	22.5	24.2	12.5
MP-89-142	8.22	0.23%	0.24%	7.2	33.7	20.0	26.5	12.8

NP 1 : Neutralization potential based on laboratory titration
NP 2 : Neutralization potential calculated from Total Carbon

NNP 1 : Net neutralization potential using laboratory titration results (NP1)

NNP 2 : Net neutralization potential using calculated neutralization potential (NP2)

Acid potential, neutralization potential and net neutralization potential reported as tonnes CaCO3 equivalent /1000 tonnes.

Rec'd Dec 4'89

IMPERIAL METALS CORPORATION
EXPLORATORY METALLURGICAL TESTING

REPORT NO. 5

Project No. 92105

Prepared for

IMPERIAL METALS CORPORATION
800 - 601 West Hastings Street
Vancouver, BC V6B 5A6

Attention: Mr. Rad Pesalj

Distribution: Imperial Metals (2)
Wright Engineers Ltd.(M. Allan)

30 November, 1989

IMPERIAL METALS CORPORATION
EXPLORATORY METALLURGICAL TESTING

REPORT NO. 5

Project No. 92105

Prepared by

Coastech Research Inc.
80 Niobe Street
North Vancouver, BC V7J 2C9

Prepared by:

Tony Chong, B.Sc. (Eng.) ARSM
Project Engineer

Reviewed and Approved by:

P. Bradley Marchant, M.A.Sc.
President

Richard W. Lawrence, Ph.D.
Vice-President, Technical

APPENDIX 4
Acid base account test results

COASTECH RESEARCH
ACID BASE ACCOUNT REPORT

To: R. Pesalj, Imperial Metals
Project: Mt. Polley
Project No. 2105

Date: October 30, 1989

SAMPLE	SULPHUR (%)	SULPHIDE (%)	PASTE pH	ACID POTENTIAL (kg CaCO3/t)	NEUT. POTENTIAL (kg CaCO3/t)	NET NEUT. POTENTIAL (kg CaCO3/t)
68-10-100	0.20	0.15	8.7	4.7	38.7	34.0
68-100-200	0.16	0.11	8.8	3.4	31.6	28.2
68-200-300	0.14	0.09	9.1	2.9	20.0	17.1
68-300-400	0.08	0.03	9.1	0.8	27.4	26.6
102-10-100	0.04	0.00	8.8	0.0	10.1	10.1
102-100-200	0.05	0.02	8.8	0.6	16.8	16.3
102-200-300	0.05	0.01	8.8	0.3	25.1	24.7
102-300-400	0.13	0.10	8.8	3.0	27.8	24.7
102-400-500	0.21	0.16	9.0	4.9	25.2	20.3
102-500-600	0.16	0.12	8.9	3.6	45.6	42.0
103-10-100	0.01	0.00	8.9	0.0	17.2	17.2
103-100-200	0.00	0.00	8.9	0.0	22.5	22.5
103-200-300	0.00	0.00	8.9	0.0	24.8	24.8
103-300-400	0.05	0.02	8.8	0.5	25.3	24.9
103-400-500	0.04	0.00	9.0	0.1	15.0	14.9
103-500-596	0.34	0.30	8.7	9.3	23.1	13.9
105-10-100	0.08	0.05	9.2	1.6	19.4	17.8
105-100-200	0.03	0.00	9.0	0.1	29.4	29.3
105-200-300	0.06	0.00	9.1	0.0	22.3	22.3
105-300-400	0.03	0.00	9.1	0.0	20.0	20.0
105-400-500	0.08	0.05	9.2	1.5	29.2	27.7
105-500-600	0.09	0.04	9.3	1.3	42.7	41.3

Note: A negative Net Neutralization Potential indicates that a sample might become the source of acidic drainage upon weathering.

COASTECH RESEARCH INC.

COASTECH RESEARCH
ACID BASE ACCOUNT REPORT

To: R. Pesalj, Imperial Metals

Project: Mt. Polley

Project No. 2105

Date: October 30, 1989

SAMPLE	SULPHUR (%)	SULPHIDE (%)	PASTE pH	ACID POTENTIAL (kg CaCO3/t)	NEUT. POTENTIAL (kg CaCO3/t)	NET NEUT. POTENTIAL (kg CaCO3/t)
106-15-100	0.06	0.04	8.9	1.2	24.3	23.1
106-100-200	0.02	0.00	8.8	0.1	16.4	16.3
106-200-300	0.04	0.02	8.9	0.6	23.6	22.9
106-300-400	0.07	0.06	8.9	1.7	24.2	22.4
106-400-500	0.03	0.02	9.3	0.7	44.2	43.5
106-500-600	0.05	0.02	9.3	0.5	8.8	8.3
108-10-100	0.01	0.00	8.2	0.0	11.0	11.0
108-100-200	0.04	0.01	8.7	0.4	16.5	16.1
108-200-300	0.02	0.01	8.7	0.3	33.2	32.9
108-300-400	0.04	0.02	8.7	0.7	23.5	22.8
108-400-500	0.04	0.00	9.0	0.0	21.5	21.5
108-500-600	0.13	0.05	9.1	1.7	37.5	35.8
121-10-100	0.07	0.05	8.7	1.4	9.4	8.0
121-100-200	0.12	0.11	9.1	3.3	15.1	11.8
121-200-300	0.14	0.11	9.3	3.4	15.5	12.1
121-300-400	0.06	0.05	9.2	1.6	20.1	18.5
121-400-500	0.13	0.12	9.3	3.7	15.8	12.1
121-500-600	0.11	0.10	9.6	3.3	19.1	15.9
122-30-100	0.04	0.01	8.0	0.3	40.4	40.1
122-100-200	0.42	0.38	8.5	11.9	38.0	26.1
122-200-300	0.21	0.19	8.7	5.9	41.9	36.0
122-300-400	0.16	0.09	8.7	2.8	46.0	43.2
122-400-500	0.12	0.09	8.8	2.8	48.4	45.6

Note: A negative Net Neutralization Potential indicates that a sample might become the source of acidic drainage upon weathering.

COASTECH RESEARCH INC.

COASTECH RESEARCH
ACID BASE ACCOUNT REPORT

To: R. Pesalj, Imperial Metals
Date: October 30, 1989
Project: Mt. Polley
Project No. 2105

SAMPLE	SULPHUR (%)	SULPHIDE (%)	PASTE pH	ACID POTENTIAL (kg CaCO3/t)	NEUT. POTENTIAL (kg CaCO3/t)	NET NEUT. POTENTIAL (kg CaCO3/t)
124-10-100	0.02	0.01	9.2	0.3	29.2	28.9
124-100-200	0.02	0.00	9.3	0.0	42.7	42.7
124-200-300	0.10	0.07	8.7	2.1	9.4	7.4
124-300-400	0.18	0.15	9.1	4.6	15.1	10.6
124-400-500	0.06	0.03	8.2	0.9	16.0	15.2
126-10-100	0.30	0.25	8.5	7.8	25.5	17.7
126-100-200	0.31	0.27	8.6	8.6	22.5	13.9
126-200-300	0.26	0.21	8.2	6.7	52.4	45.7
126-300-400	0.17	0.14	8.4	4.4	28.0	23.6
126-400-500	0.14	0.10	8.6	3.1	15.8	12.7
126-500-600	0.05	0.03	8.2	0.9	74.5	73.6
140-10-100	0.06	0.04	8.9	1.3	26.9	25.6
140-100-200	0.14	0.11	8.8	3.3	41.3	38.0
150-10-100	0.06	0.02	8.8	0.6	19.6	19.0
150-100-200	0.06	0.04	8.7	1.4	29.4	28.0
150-200-300	0.84	0.82	8.8	25.5	84.2	58.6
150-300-400	0.67	0.64	8.8	19.9	29.1	9.2
150-400-500	0.34	0.33	8.9	10.4	26.3	15.9
150-500-600	0.47	0.46	8.8	14.3	25.9	11.5

Note: A negative Net Neutralization Potential indicates that a sample might become the source of acidic drainage upon weathering.

COASTECH RESEARCH INC.

THE PREDICTION OF
THE ACID GENERATING POTENTIAL
OF MINE WASTE MATERIALS

CURRENT TEST PROCEDURES

COASTECH RESEARCH INC

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1989

THE PREDICTION OF
THE ACID GENERATING POTENTIAL
OF MINE WASTE MATERIALS

INTRODUCTION

The disposal of mining and mineral processing wastes can have a significant environmental impact. Acidity and associated heavy metal contamination in run-off and seepage water from waste rock and tailings containing the sulphide minerals pyrite and/or pyrrhotite is a common and costly problem to mining operations throughout the world, often requiring costly remediation measures.

For new mines and new developments in existing operations, it is necessary to characterize tailings and waste rock materials prior to production to predict if AMD will be generated. Accurate prediction would reduce environmental damage and costs to the industry by allowing the implementation of sound waste management practices to both prevent acid generation and to maximize containment and effective treatment if AMD cannot be avoided. Regulatory agencies are now requiring verification that waste materials have been characterized and that AMD control measures will be implemented before permits are issued. Since AMD predictive procedures and their interpretation are by no means definitive, Coastech is involved with the development of procedures and special equipment for more reliable prediction. In this endeavour, discussions and consultation with AMD specialists from research, environmental consultants, industry, and the regulatory authorities is ongoing. The results of recent Coastech work and a discussion on prediction methods can be found in the proceedings of the Symposium on Tailings and Effluent Management held in Halifax, Nova Scotia, August 1989[1].

Predictive techniques include static tests which examine the balance between the acid producing and acid consuming components in a waste material, and kinetic tests which attempt to predict drainage quality over time. The data obtained is useful in characterizing waste materials for waste management planning, and can be used to support permitting applications. At the present time, we use a modified version of the widely used EPA acid-base account method as our standard static test, although we are familiar with and experienced in other methods if these are requested.

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[1] Lawrence, R.W. et al (1989). Assessment of predictive methods for the determination of AMD potential in mine tailings and waste rock. Proc. Intl. Symp. on Tailings and Effluent Management, Halifax, August, Pergamon Press, New York, 317-31.

Kinetic tests are usually only carried out if static testing indicates that a sample is potentially a source of AMD. However, we recommend that kinetic tests are also performed for samples which are marginal net acid consumers. Currently we are recommending that kinetic tests such as humidity cells are used as they provide a reasonable simulation of the weathering process and appear to provide an accurate prediction of the field behaviour of tailing and waste rock. On a larger scale, column leach or lysimeter tests can be carried out. We can also perform biological shake flask oxidation tests to confirm the AMD potential predicted by static procedures. This type of procedure has been widely accepted in Canada for a number of years. However, the method does not address the weathering and oxidation characteristics in the approximate pH range of 7 down to 2, nor does it provide kinetic and leachate quality data.

TEST PROCEDURES

Determination of Neutralization Potential (Acid-Base Account)

Acid-base accounting procedures based on those recommended by the U.S. Environmental Protection Agency are currently the methods of choice at Coastech[2]. The method examines the balance between acid producing components (primarily pyrite, FeS_2) and acid consuming components (carbonates and other rock types capable of neutralizing strong acids). One week is required to obtain all test and assay data

The first part of the procedure involves the determination of the paste pH of the sample and an preliminary indication of the quantity of acid consuming constituents of the sample. Excess hydrochloric acid is then added to a known weight of the sample. Once the reaction between the acid and acid consuming constituents of the sample are complete, the amount of acid consumed is determined by titrating the residual acid with alkali. This allows calculation of the neutralization capacity of the sample which can be balanced against the theoretical acid producing potential derived from sulphur assays, to give the net neutralization potential.

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[2] Sobek, A.A. et al (1978). Field and laboratory methods applicable to overburdens and minesoils. EPA 600/2-78-054, 203pp.

The EPA methods have been modified to reduce a perceived bias towards the alkaline side by carrying out the acid digestion at ambient temperature for 24 hours. Titration of the residual acid is carried out to pH 8.3 and also to pH 3.5 and pH 2.0 to allow better interpretation of kinetic oxidation tests. In addition, sulphide-sulphur analyses are used to calculate the acid potential to avoid error in assessment by neglecting the presence of sulphates such as gypsum.

Humidity Cell Tests

The humidity cell test is a kinetic test which aims to model the processes of geochemical weathering of a mining waste material. A special apparatus is used to provide simple control over air, temperature and moisture, while allowing for the removal of oxidation products which are collected and monitored. Humidity cells have been developed at Coastech to promote more rapid oxidation of sulphides contained in the waste sample. The cells allow the good aeration up through or across the sample bed of tailing or waste rock during sequential dry and moist aeration cycles, and thorough solution contact during the leach cycle.

The test procedure comprises subjecting a bed of the sample in a humidity cell to alternating cycles of dry air (3 days), moist air (3 days), and leaching (1 day). The leachates can then analyzed for a number of parameters typically including pH, redox (mV), acidity, alkalinity, sulphate, conductivity, and dissolved metals by ICP. The test generally is generally specified to run for 10 weeks although it is our experience that a longer time period is required to establish the weathering characteristics of many samples.

Lysimeter and Column Leach Tests

Lysimeters and leach columns are used to provide weathering data for waste rock and tailings on a larger scale and are often used to confirm leaching characteristics or to evaluate AMD control methods (blending, covers) on a larger scale following initial characterization in humidity cells or other kinetic test procedure. Column leach tests are usually conducted in PVC columns of 10 cm diameter x 150 cm high or larger and involves the addition of water at a specified rate to the top of the sample contained in the column. Effluent emerging from the bottom of the column is collected for the analysis of parameters such as listed for humidity cell testing. Lysimeters are columns or rectangular boxes, generally of larger surface area and shallower depth than leach columns, and are sometimes more suitable for the testing of larger quantities of material while evaluating the effect of covers, simulated water tables and other variables during weathering cycles. For larger lysimeters, the evaluation of changes in mineralogy of the sample with depth and the determination of effluent quality profiles is possible.

Shake Flask Biological Oxidation Test

The shake flask biological oxidation test determines if acid produced due to biological oxidation is sufficient to overcome the acid consuming components of the sample. The test utilizes naturally occurring sulphide-oxidizing bacteria which have the capability of breaking down minerals such as pyrite. These bacteria are maintained as stock cultures in conditions of high activity in the Coastech laboratory and facilitate the rapid assessment of the acid generating potential of a waste material. Usually four weeks is required to complete this test.

The oxidation tests are carried out using procedures based on many years of extensive experience in biological mineral oxidation systems. This ensures optimum test performance through proper selection of test conditions, availability of a selection of bacterial cultures for different waste types, and experienced interpretation of results.

The oxidation test involves the addition of sulphide-oxidizing bacteria to a slurry of the waste material at an acidic pH chosen to promote the rapid development of sulphide oxidation. The progress of oxidation is monitored by measuring pH changes which occur as pyrite is oxidized. The test is continued until oxidative activity is complete. At this time more waste sample, equal to the original weight, is added. If the pH remains within the range suitable for biological oxidation, the acid produced from the pyritic component was more than the alkaline components could consume and the sample is classified as a potential source of AMD. If, however, the acid produced is consumed so that the final pH rises to be outside the range considered to be the limit for biochemical oxidation, the sample is classified as a non-acid producer.

The test is similar to the B.C. Research Confirmation Test but has several procedural differences which have been introduced to overcome some perceived shortcomings in technique and to aid in the interpretation of the results and in the predictive assessment.

Other Weathering Tests

Other AMD prediction tests which provide a simulation of the long term weathering characteristics of mine waste materials have been shown to be effective and, for certain types of waste and modes of deposition, might be more useful than the humidity cell test. Such methods include soxhlet extraction tests and shake flask tests (non-biological). These and other tests can be carried out at Coastech to meet specific requirements.

DISCUSSION

Static and kinetic procedures can provide a good prediction of the field behaviour of many of the tailing and waste rock samples. However, static test procedures alone are not likely to provide a definitive assessment of whether a particular sample is going to produce AMD. It is more likely that a combination of static and kinetic tests will provide a more confident assessment but even then, for some samples, prediction might be uncertain. The prediction of long term weathering characteristics of a tailing or waste rock will always have some uncertainty factor if the prediction test is carried out on a convenient time scale in the laboratory. Longer term testwork can be carried out for larger waste rock sizes using column leach tests or other larger scale apparatus. Such tests can include the evaluation of various waste management scenarios such as waste rock blending and the use of till covers to minimize AMD formation and impact.

Knight and Piésold Ltd.
CONSULTING ENGINEERS

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Canada V6C 1T2

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COPY

YOUR REFERENCE
OUR REFERENCE 1621.03
NUMBER 0/0013

January 5, 1990

Mr. Tony Chong
Coastech Research Inc.
80 Niobe Street
North Vancouver, B.C.
V7J 2C9

Dear Tony,

Re: Imperial Metals Corporation
Mount Polley Project
Humidity Cell Testwork

Please conduct a humidity cell test on a composite sample of the enclosed drill core. The enclosed samples are representative of waste rock from the proposed North Pit area and are labelled as follows:

MP89-133
MP89-134A
MP89-134B
MP89-135
MP89-136
MP89-139A
MP89-139B

The test methods should be as per your standard procedures.

APPENDIX D

LABORATORY TESTWORK ON TAILINGS

TABLE D1

MT. POLLEY
TAILINGS STORAGE FACILITY

RESULTS OF UNDRAINED SETTLING TESTS ON TAILINGS

Solids content of initial slurry (%)	25	35	45
Pulp density of initial slurry (t/m^3)	1.19	1.26	1.37
Water to supernatant (% of total water)	72.9	63.6	49.8
Void ratio of settled slurry	2.33	2.12	1.90
Bulk density of settled slurry	1.54	1.57	1.62
Dry density of settled slurry (t/m^3)	0.84	0.89	0.96

KNIGHT AND PIESOLD LTD.
CONSULTING ENGINEERS

UNIFIED SOIL CLASSIFICATION SYSTEM

PROJECT No. 1621
SAMPLE No.
DATE

PROJECT : MT. POLLEY TAILINGS GRADATION

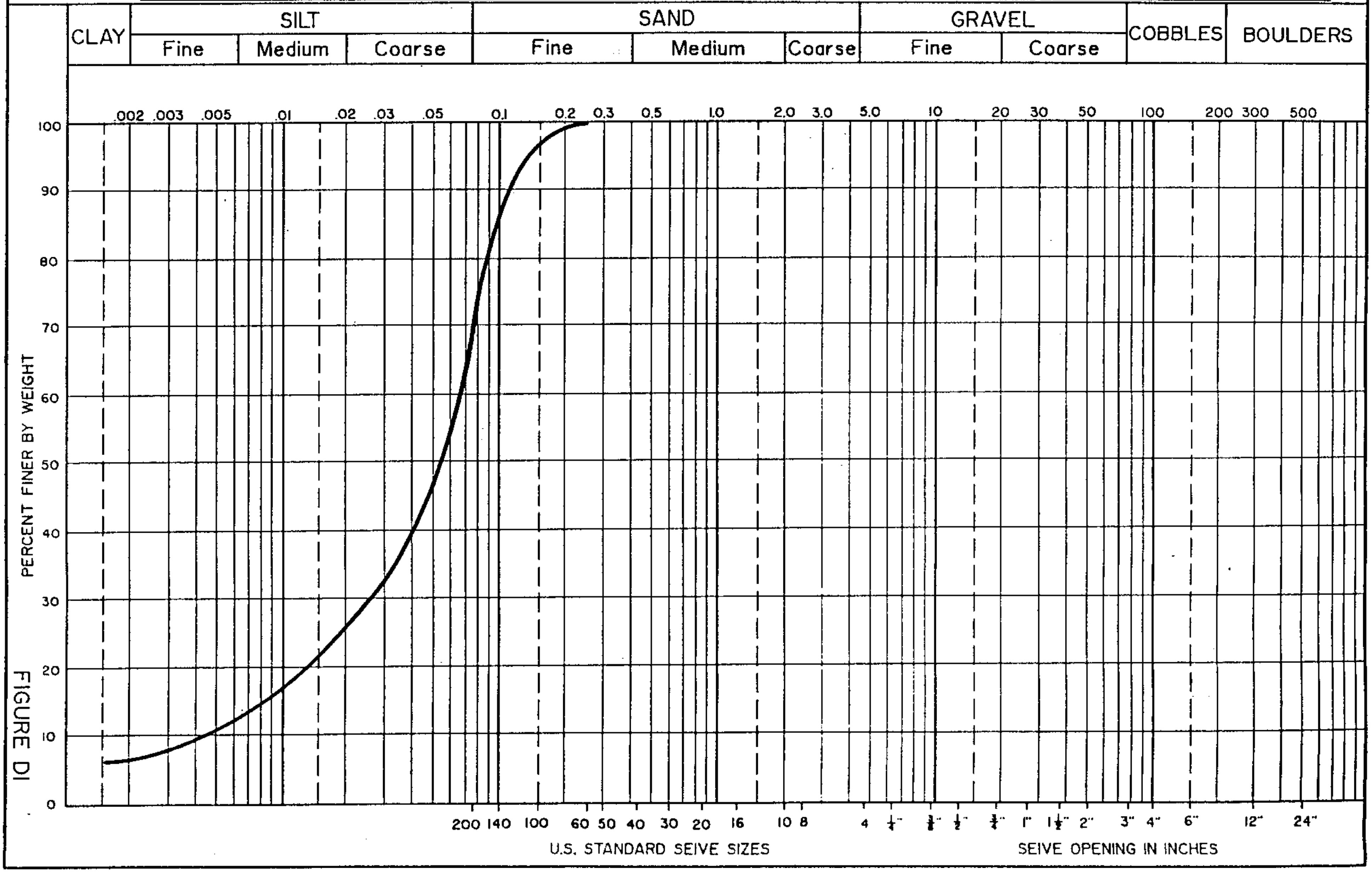
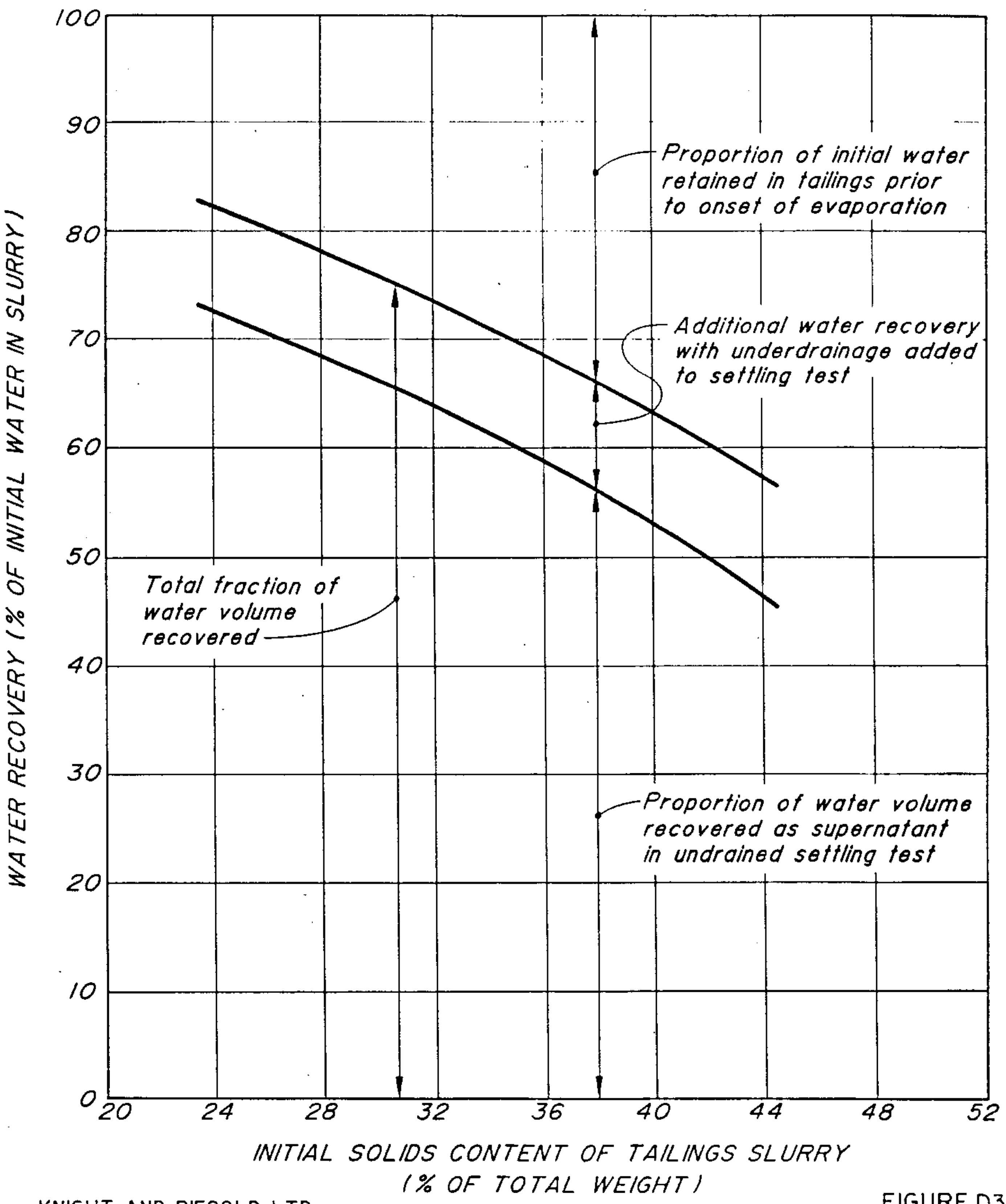


FIGURE DI

IMPERIAL METALS CORPORATION
MT. POLLEY PROJECT
TESTWORK ON TAILINGS
DRAINED SETTLING TESTS ON TAILINGS



KNIGHT AND PIESOLD LTD.
CONSULTING ENGINEERS

FIGURE D3

IMPERIAL METALS CORPORATION

MT. POLLEY PROJECT

TESTWORK ON TAILINGS

SETTLING VELOCITY ANALYSIS

% PASSING	PARTICLE DIAMETER (mm)	WATER TEMP (C)	Gs WATER	Gs SOIL	ABSOLUTE VISCOSITY (Poise)	KINEMATIC VISCOSITY (Stoke)	SETTLING VELOCITY (cm/sec)
59.3	0.0685	22.0	0.9978	2.78	0.00955	0.00957	0.4758
47.9	0.0513	22.0	0.9978	2.78	0.00955	0.00957	0.2668
39.0	0.0378	22.0	0.9978	2.78	0.00955	0.00957	0.1449
30.9	0.0276	22.0	0.9978	2.78	0.00955	0.00957	0.0772
25.2	0.0200	22.0	0.9978	2.78	0.00955	0.00957	0.0406
21.9	0.0148	22.0	0.9978	2.78	0.00955	0.00957	0.0222
17.4	0.0106	22.0	0.9978	2.78	0.00955	0.00957	0.0114
13.8	0.0076	22.0	0.9978	2.78	0.00955	0.00957	0.0059
11.0	0.0054	22.5	0.9977	2.78	0.00944	0.00946	0.0030
9.2	0.0039	23.0	0.9976	2.78	0.00933	0.00935	0.0016
8.2	0.0032	24.0	0.9973	2.78	0.00911	0.00914	0.0011
6.2	0.0016	24.0	0.9973	2.78	0.00911	0.00914	0.0003

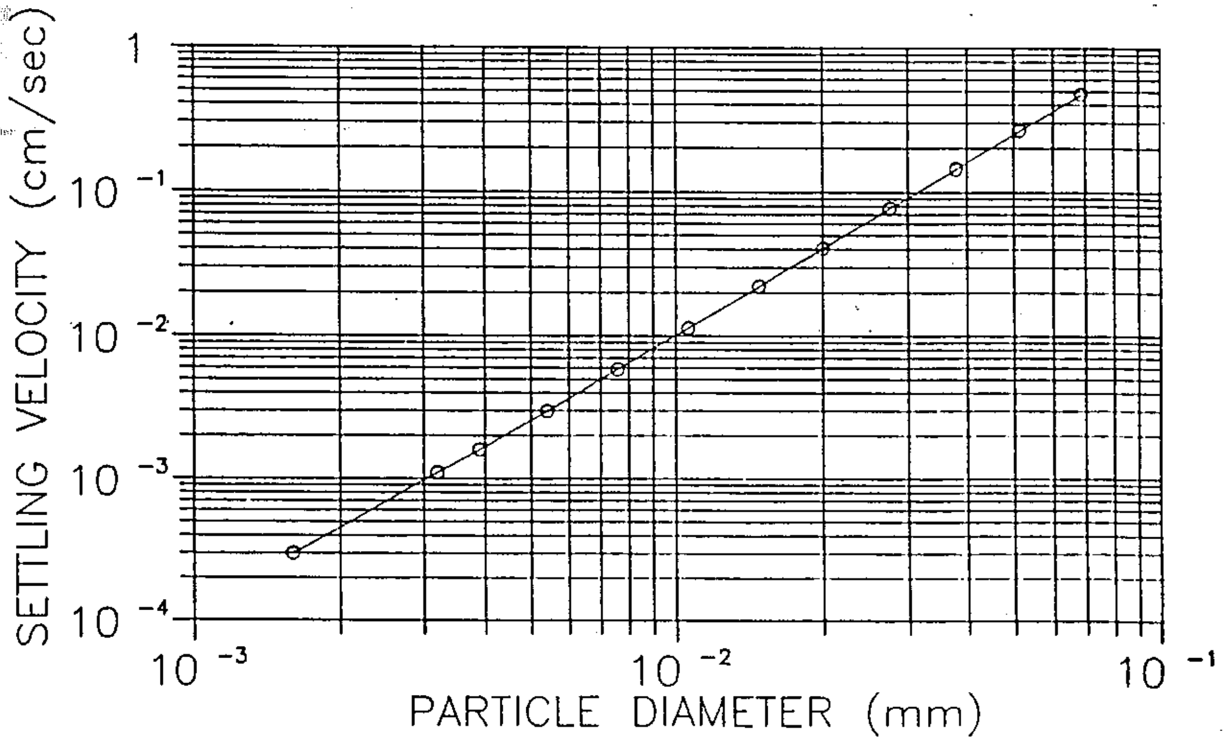


FIGURE D5.

APPENDIX E

GEOCHEMICAL TESTS ON TAILINGS

IMPERIAL METALS CORPORATION
EXPLORATORY METALLURGICAL TESTING

ADDENDUM TO
REPORT NO. 4

Project No. 92105

Prepared for

IMPERIAL METALS CORPORATION
800 - 601 W Hastings Street
Vancouver, BC V6B 5A6

Attention: Mr. Rad Pesalj

Distribution: Imperial Metals (2)
Kilborn (B. Fukahara) (1)

21 November, 1989

IMPERIAL METALS CORPORATION
EXPLORATORY METALLURGICAL TESTING

ADDENDUM TO
REPORT NO. 4

Project No. 92105

Prepared by

Coastech Research Inc.
80 Niobe Street
North Vancouver, BC V7J 2C9

Prepared by:

Tony Chong, B.Sc. (Eng.) ARSM
Project Engineer

Reviewed and Approved by:

P. Bradley Marchant, M.A.Sc.
President

Richard W. Lawrence, Ph.D.
Vice-President, Technical

SUMMARY

Acid base accounting, humidity cell weathering tests and special waste tests have been conducted on the tailings from the Phase V locked cycle tests. In addition, a 10 foot column settling test at natural pH was performed. The principal findings and conclusions are as follows:

(a) acid base account test shows the tailings to be net acid consumer with a NET NP value of 24.7 kg $CaCO_3$ (equiv) per tonne of tailings.

(b) the results from both the acetic and carbonic acid tests indicate that the tailings from the locked cycle tests did not exceed the B.C. Waste Management Branch regulations for special wastes.

(c) humidity cell testing demonstrated that the tailings exhibit very low reactivity, with very low sulphate, acidity and conductivity values, and the pH remained stable at above 7.0. The ICP data showed no significant leachability of any metals.

(d) the ultimate solids density was reached after a period of 14 days at natural pH and was calculated at 69.7% (w/w). The decant solution remained turbid at the end of the test. Previous testing indicated that pH adjustment (6.0) with acid is required to clarify the tailings decant solution.

1.0 TERMS OF REFERENCE

This is an addendum to Coastech Report No.4, Project No. 92105, September 6, 1989. This report presents the results and conclusions of the acid base account, humidity cell test, special waste tests and a 10 foot column settling test. These tests were performed on the tailings from the locked cycle tests in the Phase V testwork.

2.0 METHODS AND PROCEDURES

2.1 Acid Base Account Test

A description of the test procedure is provided in Appendix 1. In summary, excess hydrochloric acid was added to a 2.0g sample and the pulp was agitated for 24 hours at ambient temperature. Titration of the residual acid with 0.1N NaOH was then carried out to pH 8.3 to determine the neutralization potential of the tailings. The head sample was submitted for sulphide-sulphur analysis to determine the acid potential.

2.2 Humidity Cell Test

A bed of tailings from the locked cycle tests (approximately 1.0 kg) was subjected to alternating cycles of dry air (3 days), moist air (3 days), and leaching (1 day). The leachates were then analyzed for a number of parameters typically including pH, redox (mV), acidity, alkalinity, sulphate, conductivity, and dissolved metals by ICP. The test was run for 10 weeks. A description of the test procedure is presented in Appendix 1.

2.3 Special Waste Test

2.3.1 Acetic Acid

The test was conducted in according to the procedure published by the B.C. Ministry of the Environment, entitled "B.C. Special Waste List".

The tailings from the locked cycle test (approximately 35% solids) was dewatered by vacuum filtration. The filtrate, referred to as "pore water", was retained for subsequent analysis. 100 g of the filtered cake was then mixed with 1600 mL of distilled water and the pH was maintained at 5.0 for a period of 24 hours with dilute acetic acid. The pulp was agitated throughout the test.

At the end of the test, more distilled water was added so that the total volume (acid + water) was 2000 mL. The pulp was then filtered and the filtrate, referred to as "extract", together with the pore water were submitted for analysis. Total metals analyses are presented in Appendix 2.

2.3.2 Carbonic Acid

The test was conducted in accordance with the ASTM D3987 procedure.

Dilution water was prepared by bubbling carbon dioxide into a beaker of distilled water until the pH of 5.5 was obtained.

The tailings from the locked cycle test was dewatered by vacuum filtration. The filtrate (pore water) was retained for subsequent analysis. Sufficient freshly prepared dilution water was then added to the filtered cake to give a 4:1 liquid to solid ratio (i.e. 20% of solids by weight). The pulp was agitated for 20 hours prior to filtration and the filtrate (extract), together with the pore water were submitted for analysis (Appendix 2).

2.4 Settling Tests

A settling test was conducted on the tailings from the locked cycle tests at approximately 30% solids (w/w) in a 10 foot settling column to determine the ultimate settled density under hydraulic load.

3.0 RESULTS AND CONCLUSIONS

(a) Acid base accounting (Table 1) shows the tailings to be a net acid consumer with a NET NP value of 24.7 kg $CaCO_3$ (equiv) per tonne of tailings. With a sulphur content of only 0.02%, acid generation from this material is very unlikely.

(b) Tables 2 and 3 show the calculated values (ug/g) of the filtered cake from both solutions, pore water and extract, as required by B.C. Waste Management Branch regulations for special wastes. The results from both the acetic and carbonic acids indicate that the tailings from the locked cycle tests did not exceed the B.C. Waste Management Branch regulations for special wastes and are therefore exempt from classification as special waste.

(c) Humidity cell test results, shown in Tables 4 to 6 and Figures 1 to 4, demonstrate that the tailings exhibit very low reactivity, with very low sulphate, acidity and conductivity values, and the pH remained stable at above 7.0. The ICP data show no significant leachability of any metals.

(d) The settling test was allowed to run for a period of 30 days and the ultimate solids density was reached after a period of 14 days at natural pH. The solids density was calculated at 69.7% (w/w). The decant solution remained turbid at the end of the test.

TABLES

IMPERIAL METALS CORPORATION
MOUNT POLLEY PROJECT
PHASE V TESTWORK

TABLE 1
ACID-BASE ACCOUNT

SAMPLE	SULPHUR (%)	PASTE pH	ACID POTENTIAL (kg CaCO3/t)	NEUT. POTENTIAL (kg CaCO3/t)	NET NEUT. POTENTIAL (kg CaCO3/t)
Locked Cycle Tailings	0.02	8.22	0.6	24.6	24.0

NOTE: A negative Net Neutralization Potential (Net NP) indicates that the sample is a potential source of acid mine drainage.

IMPERIAL METALS CORPORATION
MOUNT POLLEY PROJECT
PHASE V TESTWORK

Table 3

"MODIFIED TEST FOR SHAKE EXTRACTION OF SOLID WASTE WITH WATER" ASTM d3987

Sample : Locked Cycle Tailings

Element	Concentration as ug/Litre in Pore Water	Concentration as ug/Litre in Extract	Concentration as ug/gram in dewatered sample	B.C. Waste Management Branch Regulations (as ug/g of dewatered sample)
Antimony	36	16	0.13	10
Arsenic	363	97.3	1.06	10
Bismuth	< 1	< 1	< 0.01	-
Cadmium	< 1	< 1	< 0.01	1
Chromium	< 10	< 10	< 0.06	10
Cobalt	< 2	< 2	< 0.01	-
Copper	2	6	0.03	30
Lead	2	< 2	< 0.01	10
Mercury	<0.1	< 0.1	< 0.00	1
Nickel	< 2	< 2	< 0.01	10
Zinc	4	8	0.04	500

< less than

Test data:

Paste pH : 9.2

Weight of solid :	117.0 g
Volume of dilution water added:	0.45 L
Volume of extract :	0.43 L

IMPERIAL METAL - MT. POLLEY

Table 5 : HUMIDITY CELL TESTING - LOCKED CYCLE TAILINGS

LEACHATE ANALYSIS

CYCLE	WATER EXTRACT ICP ANALYSIS (mg/L)															
	Al	Sb	As	Ba	Cd	Ca	Cr	Co	Cu	Fe	Pb	Mg	Mn	Mo	Ni	Zn
	0.20 *	0.20	0.20	0.01	0.010	0.05	0.015	0.015	0.010	0.015	0.050	0.01	0.005	0.030	0.025	0.005
1	< 0.20	< 0.20	<0.20	0.180	<0.010	63.1	<0.015	<0.015	0.014	<0.015	<0.050	7.08	0.07	0.110	<0.025	0.008
2	< 0.20	< 0.20	<0.20	0.180	<0.010	63.1	<0.015	<0.015	0.014	<0.015	<0.050	7.08	0.07	<0.030	<0.025	0.008
3	< 0.20	< 0.20	<0.20	0.102	<0.010	50.0	<0.015	<0.015	0.011	<0.015	<0.001	7.08	0.07	<0.030	<0.025	0.008
4	< 0.20	< 0.20	<0.20	0.102	<0.010	49.0	<0.015	<0.015	0.010	<0.015	<0.050	2.31	0.07	<0.030	<0.025	0.006
5	< 0.20	< 0.20	<0.20	0.102	<0.010	9.9	<0.015	<0.015	0.035	<0.015	<0.050	2.31	0.07	<0.030	<0.025	0.011
6	< 0.20	< 0.20	<0.20	0.110	<0.010	22.0	<0.015	<0.015	0.021	<0.030	<0.050	2.06	0.03	<0.030	<0.025	0.025
7	< 0.20	< 0.20	<0.20	0.086	<0.010	14.3	<0.015	<0.015	<0.010	<0.015	<0.050	1.79	0.03	<0.030	<0.025	<0.005
8	< 0.20	< 0.20	<0.20	0.042	<0.010	6.9	<0.015	<0.015	<0.010	<0.015	<0.050	1.17	0.02	<0.030	<0.025	<0.005
9	< 0.20	< 0.20	<0.20	0.024	<0.010	4.8	<0.015	<0.015	<0.010	<0.015	<0.050	1.37	0.02	<0.030	<0.025	<0.005
10	< 0.20	< 0.20	<0.20	0.024	<0.010	4.8	<0.015	<0.015	<0.010	<0.015	<0.050	1.37	0.02	<0.030	<0.025	<0.005

* Detection Limit in ppm

FIGURES

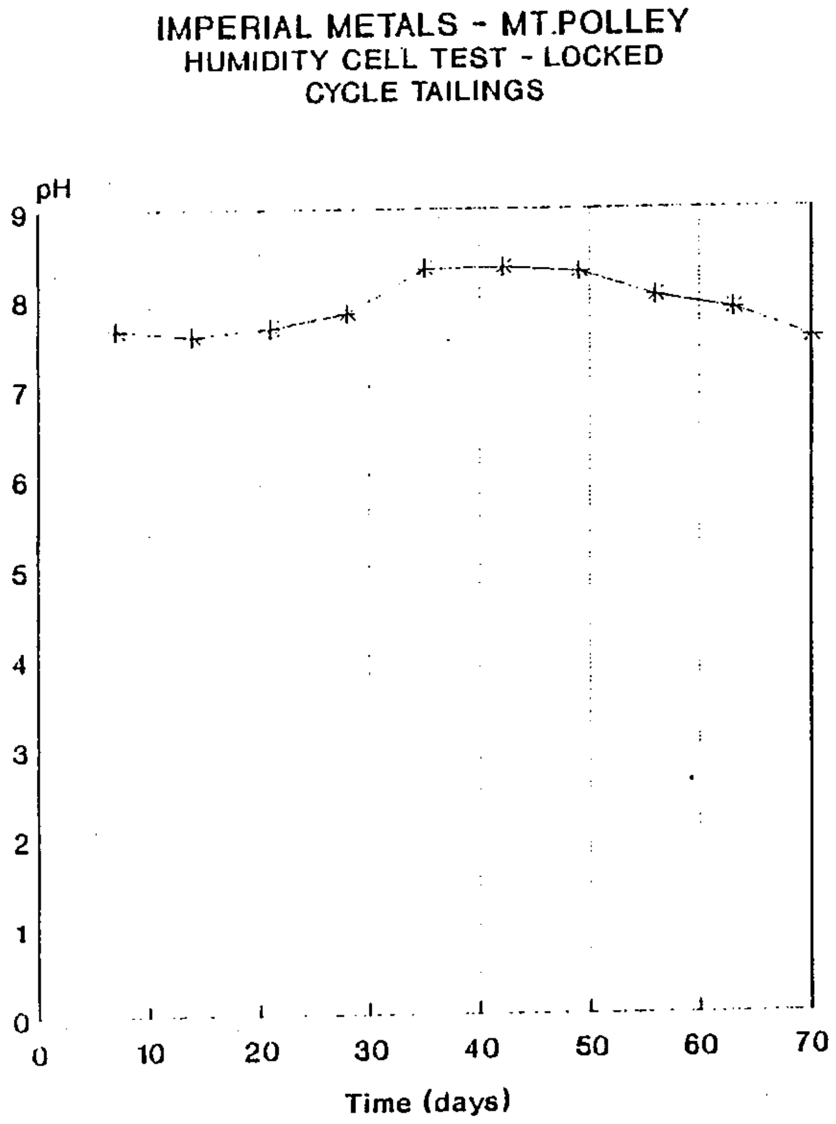


Figure 1

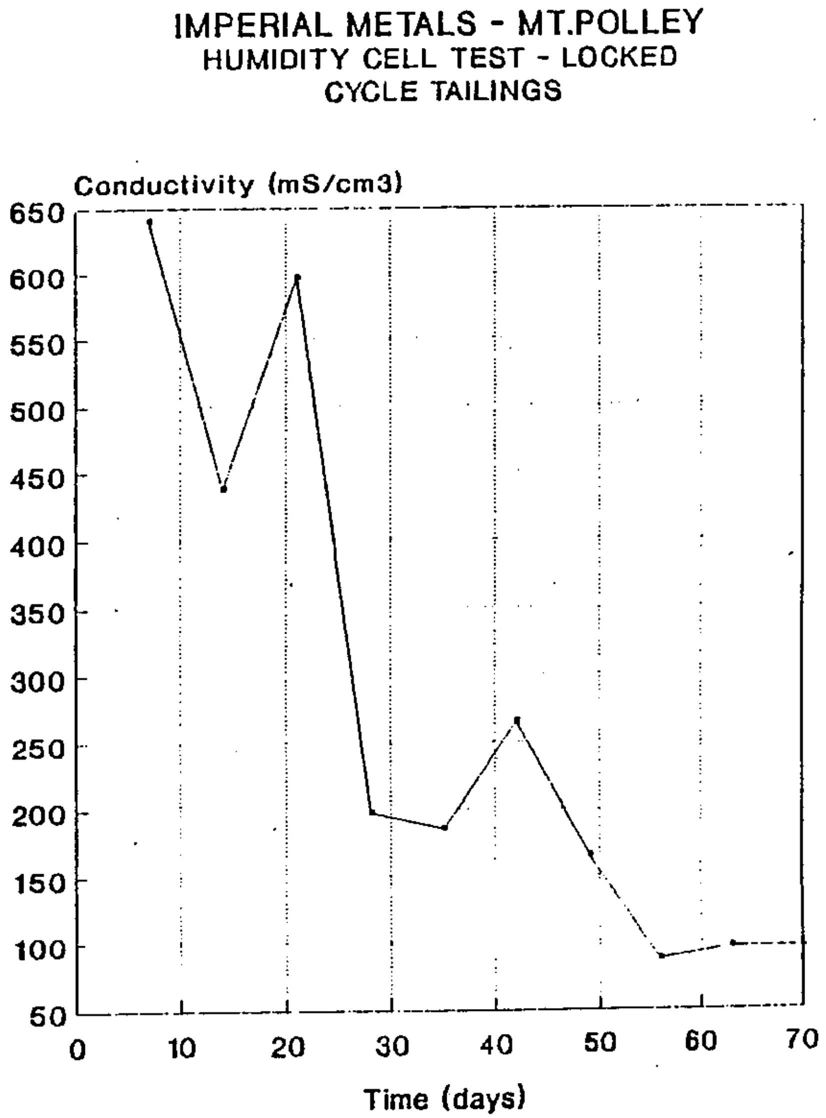
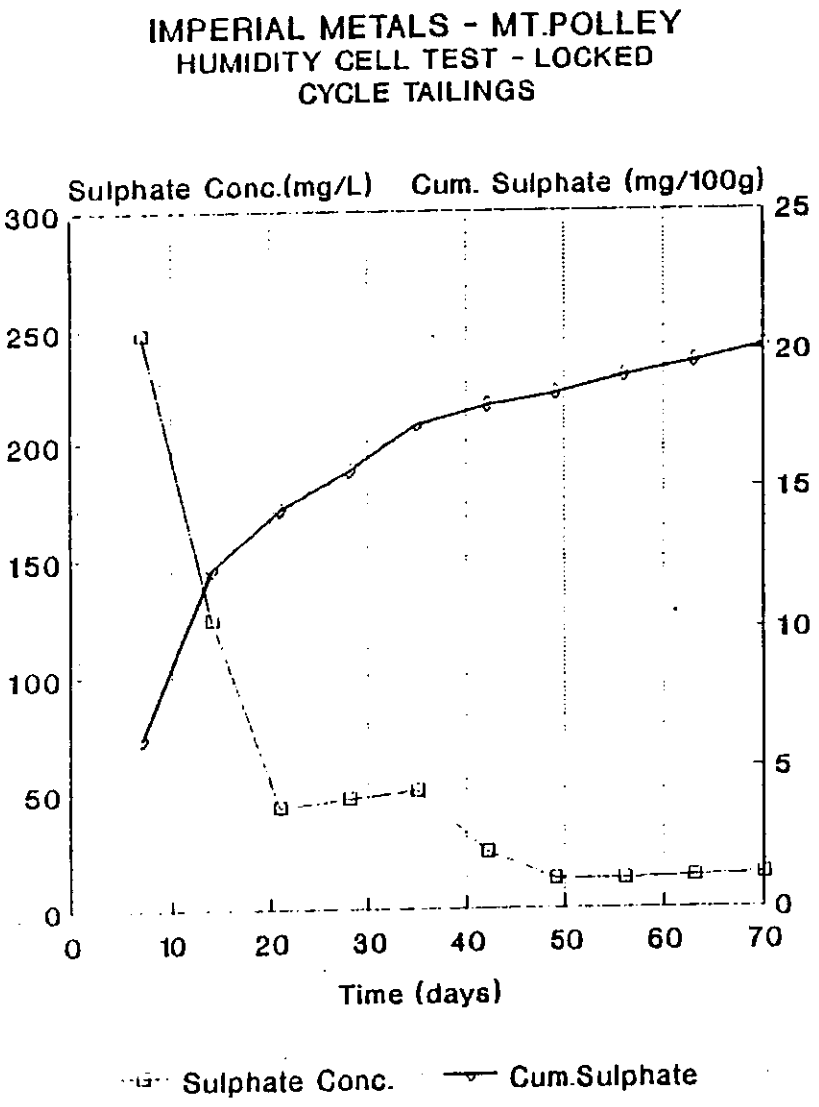
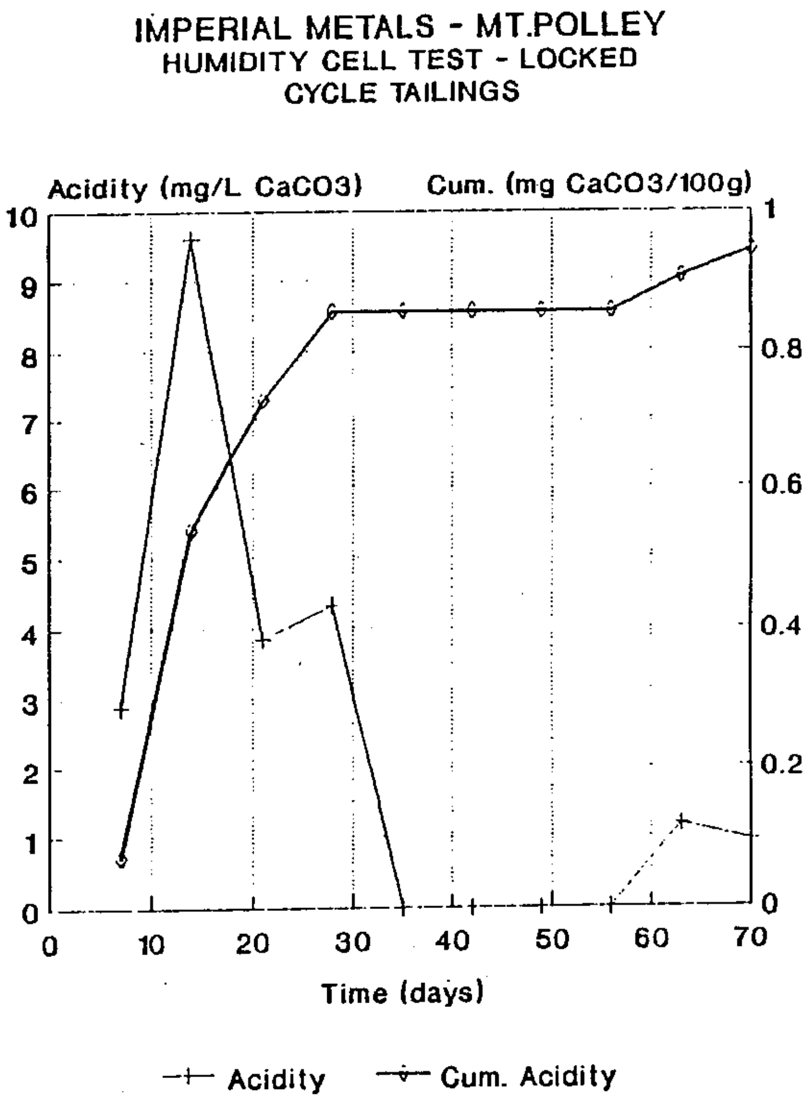


Figure 2



IMPERIAL METALS - MT.POLLEY
HUMIDITY CELL TEST - LOCKED
CYCLE TAILINGS

Figure 3



IMPERIAL METALS - MT.POLLEY
HUMIDITY CELL TEST - LOCKED
CYCLE TAILINGS

Figure 4

APPENDIX 1
COASTECH AMD PROCEDURES

THE PREDICTION OF
THE ACID GENERATING POTENTIAL
OF MINE WASTE MATERIALS

CURRENT TEST PROCEDURES

COASTECH RESEARCH INC

80 Niobe Street
North Vancouver
B.C. V7J 2C9

Ph (604) 980 5992 FAX (604) 980 2737

1989

THE PREDICTION OF THE ACID GENERATING POTENTIAL OF MINE WASTE MATERIALS

INTRODUCTION

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For new mines and new developments in existing operations, it is necessary to characterize tailings and waste rock materials prior to production to predict if AMD will be generated. Accurate prediction would reduce environmental damage and costs to the industry by allowing the implementation of sound waste management practices to both prevent acid generation and to maximize containment and effective treatment if AMD cannot be avoided. Regulatory agencies are now requiring verification that waste materials have been characterized and that AMD control measures will be implemented before permits are issued. Since AMD predictive procedures and their interpretation are by no means definitive, Coastech is involved with the development of procedures and special equipment for more reliable prediction. In this endeavour, discussions and consultation with AMD specialists from research, environmental consultants, industry, and the regulatory authorities is ongoing. The results of recent Coastech work and a discussion on prediction methods can be found in the proceedings of the Symposium on Tailings and Effluent Management held in Halifax, Nova Scotia, August 1989[1].

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The first part of the procedure involves the determination of the paste pH of the sample and an preliminary indication of the quantity of acid consuming constituents of the sample. Excess hydrochloric acid is then added to a known weight of the sample. Once the reaction between the acid and acid consuming constituents of the sample are complete, the amount of acid consumed is determined by titrating the residual acid with alkali. This allows calculation of the neutralization capacity of the sample which can be balanced against the theoretical acid producing potential derived from sulphur assays, to give the net neutralization potential.

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[2] Sobek, A.A. et al (1978). Field and laboratory methods applicable to overburdens and minesoils. EPA 600/2-78-054, 203pp.

digestion at ambient temperature for 24 hours. Titration of the residual acid is carried out to pH 8.3 and also to pH 3.5 and pH 2.0 to allow better interpretation of kinetic oxidation tests. In addition, sulphide-sulphur analyses are used to calculate the acid potential to avoid error in assessment by neglecting the presence of sulphates such as gypsum.

Humidity Cell Tests

The humidity cell test is a kinetic test which aims to model the processes of geochemical weathering of a mining waste material. A special apparatus is used to provide simple control over air, temperature and moisture, while allowing for the removal of oxidation products which are collected and monitored. Humidity cells have been developed at Coastech to promote more rapid oxidation of sulphides contained in the waste sample. The cells allow the good aeration up through or across the sample bed of tailing or waste rock during sequential dry and moist aeration cycles, and thorough solution contact during the leach cycle.

The test procedure comprises subjecting a bed of the sample in a humidity cell to alternating cycles of dry air (3 days), moist air (3 days), and leaching (1 day). The leachates can then analyzed for a number of parameters typically including pH, redox (mV), acidity, alkalinity, sulphate, conductivity, and dissolved metals by ICP. The test generally is generally specified to run for 10 weeks although it is our experience that a longer time period is required to establish the weathering characteristics of many samples.

Lysimeter and Column Leach Tests

Lysimeters and leach columns are used to provide weathering data for waste rock and tailings on a larger scale and are often used to confirm leaching characteristics or to evaluate AMD control methods (blending, covers) on a larger scale following initial characterization in humidity cells or other kinetic test procedure. Column leach tests are usually conducted in PVC columns of 10 cm diameter x 150 cm high or larger and involves the addition of water at a specified rate to the top of the sample contained in the column. Effluent emerging from the bottom of the column is collected for the analysis of parameters such as listed for humidity cell testing. Lysimeters are columns or rectangular boxes, generally of larger surface area and shallower depth than leach columns, and are sometimes more suitable for the testing of larger quantities of material while evaluating the effect of covers, simulated water tables and other variables during weathering cycles. For larger lysimeters, the evaluation of changes in mineralogy of the sample with depth and the determination of effluent quality profiles is possible.

Shake Flask Biological Oxidation Test

The shake flask biological oxidation test determines if acid produced due to biological oxidation is sufficient to overcome the acid consuming components of the sample. The test utilizes naturally occurring sulphide-oxidizing bacteria which have the capability of breaking down minerals such as pyrite. These bacteria are maintained as stock cultures in conditions of high activity in the Coastech laboratory and facilitate the rapid assessment of the acid generating potential of a waste material. Usually four weeks is required to complete this test.

The oxidation tests are carried out using procedures based on many years of extensive experience in biological mineral oxidation systems. This ensures optimum test performance through proper selection of test conditions, availability of a selection of bacterial cultures for different waste types, and experienced interpretation of results.

The oxidation test involves the addition of sulphide-oxidizing bacteria to a slurry of the waste material at an acidic pH chosen to promote the rapid development of sulphide oxidation. The progress of oxidation is monitored by measuring pH changes which occur as pyrite is oxidized. The test is continued until oxidative activity is complete. At this time more waste sample, equal to the original weight, is added. If the pH remains within the range suitable for biological oxidation, the acid produced from the pyritic component was more than the alkaline components could consume and the sample is classified as a potential source of AMD. If, however, the acid produced is consumed so that the final pH rises to be outside the range considered to be the limit for biochemical oxidation, the sample is classified as a non-acid producer.

The test is similar to the B.C. Research Confirmation Test but has several procedural differences which have been introduced to overcome some perceived shortcomings in technique and to aid in the interpretation of the results and in the predictive assessment.

Other Weathering Tests

Other AMD prediction tests which provide a simulation of the long term weathering characteristics of mine waste materials have been shown to be effective and, for certain types of waste and modes of deposition, might be more useful than the humidity cell test. Such methods include soxhlet extraction tests and shake flask tests (non-biological). These and other tests can be carried out at Coastech to meet specific requirements.

DISCUSSION

Static and kinetic procedures can provide a good prediction of the field behaviour of many of the tailing and waste rock samples. However, static test procedures alone are not likely to provide a definitive assessment of whether a particular sample is going to produce AMD. It is more likely that a combination of static and kinetic tests will provide a more confident assessment but even then, for some samples, prediction might be uncertain. The prediction of long term weathering characteristics of a tailing or waste rock will always have some uncertainty factor if the prediction test is carried out on a convenient time scale in the laboratory. Longer term testwork can be carried out for larger waste rock sizes using column leach tests or other larger scale apparatus. Such tests can include the evaluation of various waste management scenarios such as waste rock blending and the use of till covers to minimize AMD formation and impact.

APPENDIX 2
PORE WATER AND EXTRACT: TOTAL METALS ANALYSIS

Sample #	Acid used	Sample
H5002	Acetic	Pore Water
H5003	Acetic	Extract
J2193	Carbonic	Pore Water
J2194	Carbonic	Extract

Chemex Labs Ltd.
Analytical Chemists * Geochemists * Registered Assayers
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PHONE: 604-984-0221

[illegible]

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Project : 2105
Comments: ATTN: TONY CHONG

[illegible]
Total Pages :
Invoice Date: 25-OCT-89
Invoice No. : I-8928325
P.O. Number : 894155

CERTIFICATE OF ANALYSIS A8928325

PARAMETER DESCRIPTIONS	SAMPLE J2193	SAMPLE J2194								
Sample preparation code	221	221	---	---	---	---	---	---	---	---
Sample preparation code	---	---	---	---	---	---	---	---	---	---
As ppb (dissolved)	363	97.3								
Sb ppb (dissolved)	36	16								
Hg ppb (dissolved)	< 0.1	< 0.1								
Cd ppb (dissolved)	< 1	< 1								
Cr ppb (dissolved)	< 10	< 10								
Co ppb (dissolved)	< 2	< 2								
Cu ppb (dissolved)	2	6								
Pb ppb (dissolved)	2	< 2								
Ni ppb (dissolved)	< 2	< 2								
Zn ppb (dissolved)	4	8								
Bi ppb (dissolved)	< 1	< 1								

CERTIFICATION : ____________________

[redacted]

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Page
Date 24-AUG-89
Invoice # : I-8923876
P.O. # : NONE

CERTIFICATE OF ANALYSIS A8923876

SAMPLE DESCRIPTION	PREP CODE	V ug/L	Al mg/L	Be ug/L	Ca mg/L	Cu ug/L	Ag ug/L	Ti mg/L	Sr ug/L	Na mg/L	K mg/L
H 5002 PORE	-- --	< 2	< 0.2	< 1	10.0	6	< 1	< 0.2	54	26	6.6
H 5003 EXTRACT	-- --	< 2	0.2	< 1	145	1360	< 1	< 0.2	490	3.4	5.8

CERTIFICATION :

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Project :
Comments: ALSO ON CERT. A8923876

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T[redacted]ges
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Invoice No. : I-8923877
P.O. Number : NONE

** CORRECTED COPY

CERTIFICATE OF ANALYSIS A8923877

PARAMETER DESCRIPTIONS	SAMPLE H 5002	SAMPLE H 5003								
Sample preparation code	---	---	---	---	---	---	---	---	---	---
Sample preparation code	---	---	---	---	---	---	---	---	---	---
Hg ppb (total)	< 0.2	1.0								
As ppb (total)	10.6	190.0								
Sb ppb (total)	3	36								

CERTIFICATION : ______

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Project : 2105
Comments: ATTN: TONY CHONG

Pa[illegible]nber
[illegible]ages :
Invoice Date: 25-OCT-89
Invoice No. : I-8928325
P.O. Number : 894155

CERTIFICATE OF ANALYSIS A8928325

MOKE EXTRA

PARAMETER DESCRIPTIONS	SAMPLE J2193	SAMPLE J2194								
Sample preparation code	221	221	---	---	---	---	---	---	---	---
Sample preparation code	---	---	---	---	---	---	---	---	---	---
As ppb (dissolved)	363	97.3								
Sb ppb (dissolved)	36	16								
Hg ppb (dissolved)	< 0.1	< 0.1								
Cd ppb (dissolved)	< 1	< 1								
Cr ppb (dissolved)	< 10	< 10								
Co ppb (dissolved)	< 2	< 2								
Cu ppb (dissolved)	2	6								
Pb ppb (dissolved)	2	< 2								
Ni ppb (dissolved)	< 2	< 2								
Zn ppb (dissolved)	4	8								
Bi ppb (dissolved)	< 1	< 1								

CERTIFICATION : ____________

TEST PIT	DEPTH INTERVAL (m)	MATERIAL DESCRIPTION
TPB10	0 - 3.7	SILTY SAND, some gravel, trace cobbles and boulders to 45 cm, green-brown, dense to very dense, well graded, fissured, glacial till
TPB11	0 - .3	ORGANICS and forest litter, reddish brown
	0.3 - 1.8	SILTY SAND, some gravel, trace cobbles, green-brown, firm to dense, very well graded, low permeability, glacial till
	1.8 - 3.7	SILT, some sand, place brown, dense, fissured, well sorted, low permeability
	3.7 - 5.2	SAND, medium to fine, moderately sorted, clean, moist, pale brown, some silt layers
TPB12	0 - .15	ORGANICS and forest litter reddish brown
	0.15 - 1.5	SILTY SAND,some gravel, trace cobbles and boulders, well graded, dark green-brown, glacial till
	1.5 - 4	SAND, trace silt, fine, uniform, trace gravel, pale reddish brown, cross bedding, moist
	4 - 4.9	SAND, medium to fine, clean, uniform, brown

TEST PIT	DEPTH INTERVAL (m)	MATERIAL DESCRIPTION
TPB16	1.2 - 4.3	SILTY SAND, some gravel, trace cobbles, trace clay, very well graded, dense, low permeability, glacial till NB: Some water running in at top of glacial till
TPB17	0 - 4.9	SILTY SAND, some gravel, trace cobbles and boulders to 35 cm, trace clay, very well graded, dense, brown, low permeability, glacial till
TPB18	0 - 0.3	PEAT, organics and forest litter, reddish brown to black
	0.3 - 4.9	SILTY SAND, some gravel, trace cobbles and boulders, trace clay, brown, very well graded, dense, low permeability, glacial till NB: Ponded water on surface, but no groundwater encountered

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TEST HOLE LOG

TEST HOLE No. MP-89-2
SHEET 1 of 1

PROJECT Mt. Polley
LOCATION OF TEST HOLE Tailings Area B
DATE BEGUN Oct. 29, 1989 DATE FINISHED Oct. 29, 1989
PROJECT No. 1621
GROUND ELEVATION 929.1
LOGGED BY RNK & K. McN

NOTES Water loss, type and size of hole, drilling method, groundwater level, etc.	CORE RECOVERY %	RQD	DEFECT SPACING (cm)	PERMEABILITY (× 10^{-6} cm/s)	DEPTH (feet)	GRAPHIC LOG	DESCRIPTION AND CLASSIFICATION OF MATERIAL
						- o + -	- dense, grey, silty till
					50	+ - +	
NO PIEZOMETER INSTALLATIONS	40	0	5			Δ	
	95	20	↓			Δ	
	100	20					
	↓	30			100	Δ	
		40	10				
		40	↓			Δ	- weathored reddish brown volconic conglom. with rough planar to wavy joints infilled with calcite
		40					
TRICONE BIT USED TO DRILL OVERBURDEN.		60	<3		150	Δ	
		80	20			Δ	
		30	20			Δ	
		0	<3				-75 % clay and gouge
		40	<3			Δ	
		40	10				
HOLE SIZE:NQ	↓	60	50		200	× ×	
		90	↓			× ×	
		85					
		85					
		40	10		250	×	
		60	10				
		60	20			×	- purple basalt
		80	↓				
		85					
		80				×	
	↓	90			300	×	
		90				×	
		70					
		85	50			×	
		85	50		350	×	
		80	50			×	
		90	20			×	
		80	↓			×	
	↓	90					
	100	90				×	EOH

KNIGHT AND PIESOLD LTD.
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TEST HOLE LOG

TEST HOLE N mP89-23
SHEET 1 of 1

PROJECT Mt. Polley
LOCATION OF TEST HOLE Tailings Area B
DATE BEGUN Oct. 30, 1989 DATE FINISHED Oct. 30, 1989
PROJECT No. 1621
GROUND ELEVATION 929.1
LOGGED BY RNK + K. McN

NOTES Water loss, type and size of hole, drilling method, groundwater level, etc.	CORE RECOVERY %	RQD	DEFECT SPACING (cm)	PERMEABILITY (x 10⁻⁶cm/s)	DEPTH	DESCRIPTION AND CLASSIFICATION OF MATERIAL
						- dense, grey, silty till
					50	
NO	40	0	<3			
PIEZOMETER	70	30				
	40	5				
INSTALLATIONS	55	40				
					100	- very weathered soft, volcanic conglomerate
	70	20				(weathered to purple clay, sand, and gravel)
	95	35				
TRICONE BIT	100	20				
USED TO	80	35				
DRILL	100	40				
					150	
	100	30				
OVERBURDEN	95	25				
	90	40				
	70	10				
HOLE SIZE:NQ	95	15				
					200	
	100	40				
	60	10				
	80	10				
	0	0	<3			EOH
					250	
					300	
					350	

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TEST HOLE LOG

TEST HOLE N MP89-231
SHEET 1 of 1

PROJECT Mt. Polley
LOCATION OF TEST HOLE Tailings Area B
DATE BEGUN Oct. 31, 1989 DATE FINISHED Nov. 1, 1989
PROJECT No. 1621
GROUND ELEVATION 927
LOGGED BY RNK + KMcN

NOTES Water loss, type and size of hole, drilling method, groundwater level, etc.

pneumatic leads

water table at surface

1½" Ø PVC standpipe piezometer slotted to surface

sand backfill

bentonite seal

sand backfill

bentonite seal

sand backfill

pneumatic piezometer tip at 385'

CORE RECOVERY %	RQD	DEFECT SPACING (cm)	PERMEABILITY (× 10⁻⁶cm/s)	DEPTH (feet)
10			6.4	
				50
20				
50				
0				
85				100
100	70	10	1.6	
100	70			
90	50		.29	
90	20	<3		150
100	30			
	50			
	65	10		
	50			
	50			
	40			200
	40			
	35			
	50			
	60			
	70	30		250
	70	30		
	20	<3		
	70	20		
	20	<3		
	0	<3		300
	20	<3		
	90	30		
	95			
	95			350
	70			
	40	10		
	40	10		
	75	30		
80	50	10		

GRAPHIC LOG

DESCRIPTION AND CLASSIFICATION OF MATERIAL

▽ - water table at surface

- dense, grey, silty till with abundant rounded pebbles
- reddish brown coarse sand and gravel (weathered K-spar rich intrusive)
- fine beach sand with minor clay bind
- reddish brown coarse sand and gravel (weathered K-spar rich intrusive)
- purple weathered volcanic conglomerate with rough planar joints infilled with clay, hematite, or calcite (decreasing weathering down hole)
- Conglomerate strained to sandy clay gouge

EOH

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TEST HOLE LOG

TEST HOLE N mP89-23
SHEET 1 of 1

PROJECT Mt. Polley
LOCATION OF TEST HOLE Tailings Area B
DATE BEGUN Nov. 1, 1989 DATE FINISHED Nov. 4, 1989

PROJECT No. 1621
GROUND ELEVATION 919.4
LOGGED BY RNK + K Mc

NOTES Water loss, type and size of hole, drilling method, groundwater level, etc.	CORE RECOVERY %	RQD	DEFECT SPACING (cm)	PERMEABILITY ($\times 10^{-6}$ cm/s)	DEPTH (feet)	GRAPHIC LOG	DESCRIPTION AND CLASSIFICATION OF MATERIAL
							∇ water table at 7'
1½" ø PVC standpipe piezometer	15						dense, grey silty glacial till
	30						-clay rich silt, becoming coarser graind down hole
	40			7.7	50		
hole sloughed in at 50'							-layered clay rich very fine sands and silts.
	0						
	15						
	30	0	<3				
	45	0	↓				- purple weathered, soft, clayey volcanic conglomer with abundent cobbles and gravel
					100		
	90	20	↓				
	40	0	↓	3.2			← sand and clay rich volcanic mud
	90	25	10				
	95	75	30				(dominant fractures at 90° and 45° to core axis, tight, rough, and planar, with calcite infilling)
	100	25	<3	10			
	↓				150		
	↓	80	30				sandy clay gouge
	↓	80	↓				
	↓	65	↓				
	↓	75	↓				
	↓	40	10				
					200		
	↓	25	<3				
	↓	35	↓				
	↓	0	↓				-well strained purple mudstone with calcite infilled rough planar joints
	↓	35	10				
	↓	10	<3				
					250		
	↓	0	↓				-well strained purple sandstone with clay matrix
	↓	0	↓				
	↓	10	↓				
	↓	70	30				
	↓	60	↓				
					300		
	↓	60	↓				-volcanic conglomerate (as above)
	↓	70	↓				
	↓	40	10				
	↓	10	<3				
	↓	10	↓				
					350		
	↓	25	↓				
	↓	80	30				
	↓	100	↓				
	↓	100	↓				
	↓	98	↓				EOH

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TEST HOLE LOG

TEST HOLE N
mP89-23
SHEET 1 of 1

PROJECT Mt. Polley
LOCATION OF TEST HOLE Tailings Area B
DATE BEGUN Nov. 5, 1989 DATE FINISHED Nov. 6, 1989

PROJECT No. 1621
GROUND ELEVATION 933.9
LOGGED BY RNK + K Mc

NOTES Water loss, type and size of hole, drilling method, groundwater level, etc.	CORE RECOVERY %	RQD	DEFECT SPACING (cm)	PERMEABILITY (× 10⁻⁶cm/s)	DEPTH (feet)	GRAPHIC LOG	DESCRIPTION AND CLASSIFICATION OF MATERIAL
 1½" Ø PVC standpipe piezometer	5						- dense, grey silty glacial till with abundant pebbles (recovery mostly pebbl and silty clay)
	15			11	50		∇ water table at 56'
bentonite seal	0						- grey sandy glacial till with some pebbles (recovery mostly pebbles)
	10				100		
hole sloughed in at 100'	50	0	< 3	22			
	15	↓	↓				- heavily weathered volcanic conglomerate, with matrix leached to leave sand and gravel
	15	↓	↓	16			
	25	↓	↓				
	70	↓	↓		150		
	70	↓	↓				
	75	40	↓	17			
	75	40	10				
	60	0	< 3				
	95	80	10		200		
	55	10	< 3				
	70	20	< 3				
	100	35	10				
	100	45	10				
	90	30	10		250		
	90	0	< 3				
	100	↓	↓				
	100	↓	↓				
	95	↓	↓				
	80	↓	↓		300		
	70	↓	↓				
	40	↓	↓				
	40	↓	↓				
	10	↓	↓				
	40	↓	↓		350		
	70	25	10				
	30	10	10				
	20	0	< 3				
	20	0	< 3				EOH

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TEST HOLE LOG

TEST HOLE
MP89-23
SHEET 1 of

PROJECT Mt. Polley
LOCATION OF TEST HOLE Tailings Area B
DATE BEGUN Nov. 7, 1989 DATE FINISHED NOV. 9, 1989
PROJECT No. 1621
GROUND ELEVATION 909.
LOGGED BY RNK + K McN

NOTES Water loss, type and size of hole, drilling method, groundwater level, etc.	CORE RECOVERY %	RQD	DEFECT SPACING (cm)	PERMEABILITY (× 10^{-6} cm/s)	DEPTH (feet)	GRAPHIC LOG	DESCRIPTION AND CLASSIFICATION OF MATERIAL
pneumatic leads							▽ - water table at surface - dense grey clay and silt with a trace of pebbles, and rare 5cm bands of clean sa
	50			14			
1½" Ø PVC standpipe piezometer	1				50		- grey clayey sand with some pebbl
	20						
	0						
	85						
	100	35	10		100		- weathered purple volcanic conglomerat (altered to sand and gravel) defects oriented 60° and 90° to core axis
		40	10	.32		△	
		65	30				
bentonite seal		85	30			△	
		70	30				
		20	<3	3.3	150	△	
		50	50				
	10	0	< 3			△	
	90	70	30				
	100	90	30			△	- decreasing degree of weathering with depth
	90	15	< 3		200		
sand backfill	95	25				△	
	70	0					
	100	30					
bentonite seal		40				△	
sand backfill		80	10		250	△	
		80	10				
pneumatic piezometer tip at 270'		80	10			△ △	
		10	<3				
hole sloughed in at 270'		10					
		0			300	△	
		0					
		25				△	
		80	30			△	
		20	10		350		
		30	30			△	
		80				△	
		60					
		80				△	
		70				△	EOH

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CONSULTING ENGINEERS

TEST HOLE LOG

TEST HOLE No. MP89-235
SHEET 1 of 1

PROJECT Mt. Polley
LOCATION OF TEST HOLE Tailings Area B
DATE BEGUN Nov. 9, 1989 DATE FINISHED Nov. 10, 1989
PROJECT No. 1621
GROUND ELEVATION 946.2
LOGGED BY RNK + KMcN

NOTES
Water loss, type and size of hole, drilling method, groundwater level, etc.

CORE RECOVERY %	RQD	DEFECT SPACING (cm)	PERMEABILITY (× 10⁻⁶cm/s)	DEPTH (feet)	DESCRIPTION AND CLASSIFICATION OF MATERIAL
					~~water table at 6'~~
					← dense grey sandy glacial till
80	20	< 3			
100	40	10			
	70	10	510		- very weathered purple volcanic conglomerate with rough, wavy, thin clay filled fractures
	90	30		50	
	70		.086		
	85				
	95				
	70	10	.40		
	60				
	60			100	
	60				
	50		11		
	65				
	65				
	85			150	
	90	30			
	70				
	80				
	90				
	85			200	
	75				
	70				
	85				
	60			250	
	70	10			← healed shear zone
	75	30			
	85				
	90				
	60				
90	60	10		300	
100	60				
90	50				
95	50				
100	80	30		350	- purple basalt
	40	10			
	60	10			
	100	30			
	70	30			
	60	10			EOH

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CONSULTING ENGINEERS

TEST HOLE LOG

TEST HOLE N
MP89-231
SHEET 1 of 1

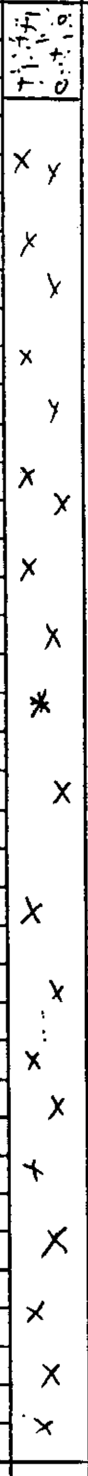
PROJECT Mt. Polley
LOCATION OF TEST HOLE Tailings Area B
DATE BEGUN Nov. 10, 1989 DATE FINISHED Nov. 11, 1989

PROJECT No. 1621
GROUND ELEVATION 944.
LOGGED BY RNK + K Wilc

NOTES
Water loss, type and size of hole, drilling method, groundwater level, etc.

CORE RECOVERY %	RQD	DEFECT SPACING (cm)	PERMEABILITY (× 10⁻⁶cm/s)	DEPTH (feet)
5				
10				
10	0	<3		
40	0		27	
60	0			50
80	10			
40	10		2.7	
70	20			
70	10	10		
95	30		2.0	100
80	25			
100	25	<3		
60	30	10		
90	15		.77	
100	60			150
80	60			
100	50			
80	20	<3		
100	35	<3		
100	45	10		200
90	20	<3		
90	15	<3		
100	40	10		
45	10	<3		
80	25	10		250
60	5	10		
70	10	<3		
80	15			
80	0			
50	0			300
30	0			
45	10			
40	0			
70	0			
90	30			350
95	45	10		
100		10		
100		<3		

GRAPHIC LOG



DESCRIPTION AND CLASSIFICATION OF MATERIAL

▽
- water table at surface.
- dense grey silty till with some pebbles

- weathered golfball syenite with thin calcite and chlorite filled tight planar, smooth fractures. Defects at 20° and 70° to core axis

EOH

PACKER TESTING CALCULATION SHEET

PROJECT: MOUNT POLLEY
LOCATION: TAILINGS AREA B
HOLE No: MP-89-231
TEST DATE: OCT. 31, 1989
COORDINATES(ft) N: S:

HOLE DIAMETER (inches): 2.98
GROUNDWATER DEPTH(ft): 0
BEDROCK DEPTH(ft): 90
TESTED BY: RNK
ANGLE FROM VERTICAL (deg): 0

TEST No.	INTERVAL (ft)		METER RDG (liters)		ELAPSED TIME (min)	FLOW RATE (lpm)	GAUGE PRESSURE (psi)	HEAD CORR'N (psi)	TEST HEAD (m)	PERMEABILITY (cm/sec)	COMMENTS
	from	to	init	final							
1	29	40	846.80	847.35	3	0.183	10.0	0.0	7.0	9.2E-06	
1	29	40	847.78	848.95	5	0.234	14.5	0.0	10.2	8.1E-06	
1	29	40	850.15	851.66	4	0.377	25.0	0.0	17.6	7.6E-06	TILL
1	29	40	851.67	852.35	4	0.170	17.0	0.0	12.0	5.0E-06	
1	29	40	852.16	852.46	4	0.075	10.0	0.0	7.0	3.8E-06	
						0.000			0.0		
2	100	120	1065.00	1066.14	4	0.285	24.0	0.0	16.9	3.7E-06	
2	100	120	1068.91	1070.57	5	0.332	52.0	0.0	36.6	2.0E-06	WEATHERED VOLCANIC
2	100	120	1073.40	1077.37	5	0.794	85.0	0.0	59.8	2.9E-06	CONGLOMERATE
2	100	120	1077.19	1078.00	5	0.162	52.0	0.0	36.6	9.8E-07	
2	100	120	1077.42	1077.60	5	0.036	23.0	0.0	16.2	4.9E-07	
						0.000			0.0		
3	120	140	1132.71	1132.86	3	0.050	25.0	0.0	17.6	6.3E-07	
3	120	140	1135.56	1135.85	5	0.058	52.0	0.0	36.6	3.5E-07	MORE COMPETENT
3	120	140	1137.03	1137.45	5	0.084	79.0	0.0	55.6	3.3E-07	VOLCANIC
3	120	140	1136.61	1136.72	5	0.022	47.0	0.0	33.1	1.5E-07	CONGLOMERATE
3	120	140	1135.17	1135.25	5	0.016	25.0	0.0	17.6	2.0E-07	
						0.000			0.0		

PACKER TESTING CALCULATION SHEET

PROJECT:	MOUNT POLLEY	HOLE DIAMETER (inches):	2.98
LOCATION:	TAILINGS AREA B	GROUNDWATER DEPTH(ft):	55.6
HOLE No:	MP-89-233	BEDROCK DEPTH(ft):	110
TEST DATE:	NOV. 5, 1989	TESTED BY:	RNK
COORDINATES(ft) N:	S:	ANGLE FROM VERTICAL (deg):	0

TEST No.	INTERVAL (ft)		METER RDG (liters)		ELAPSED TIME (min)	FLOW RATE (lpm)	GAUGE PRESSURE (psi)	HEAD CORR'N (psi)	TEST HEAD (m)	PERMEABILITY (cm/sec)	COMMENTS
	from	to	init	final							
2	40	60	5213.60	5219.00	5	1.080	12.0	0.0	25.4	9.4E-06	
2	40	60	5222.10	5232.10	5	2.000	26.0	1.0	34.5	1.3E-05	SILTY TILL
2	40	60	5234.00	5243.20	2	4.600	36.0	1.0	41.6	2.4E-05	leak at this Press
2	40	60	5251.90	5264.50	3	4.200	26.0	1.5	34.2	2.7E-05	leak at this Press
2	40	60	5265.70	5279.30	5	2.720	12.0	1.5	24.3	2.4E-05	
						0.000			0.0		
3	100	120	5323.50	5331.10	5	1.520	20.0	1.0	30.3	1.1E-05	
3	100	120	5338.00	5367.10	5	5.820	40.0	2.5	43.3	2.9E-05	HEAVILY WEATHERED
3	100	120	5379.40	5423.50	5	8.820	62.0	4.0	57.8	3.3E-05	VOLCANIC
3	100	120	5429.50	5458.60	5	5.820	40.0	2.5	43.3	2.9E-05	CONGLOMERATE
3	100	120	5460.00	5471.50	5	2.300	20.0	1.0	30.3	1.7E-05	
						0.000			0.0		
4	120	150	5524.00	5538.20	5	2.840	18.0	2.0	28.2	1.6E-05	
4	120	150	5552.50	5580.40	5	5.580	45.0	2.5	46.9	1.9E-05	HEAVILY WEATHERED
4	120	150	5603.40	5673.80	5	14.08	75.0	6.5	65.2	3.3E-05	VOLCANIC
4	120	150	5676.10	5701.90	5	5.160	47.0	2.5	48.3	1.7E-05	CONGLOMERATE
4	120	150	5698.32	5701.45	3	1.043	16.0	0.0	28.2	5.9E-06	
						0.000			0.0		
5	160	180	5928.56	5939.26	5	2.140	32.0	1.0	38.8	1.2E-05	
5	160	180	5948.91	5975.26	5	5.270	69.0	2.0	64.1	1.8E-05	HEAVILY WEATHERED
5	160	180	5997.30	6072.40	5	15.02	105.0	7.0	85.9	3.7E-05	VOLCANIC
5	160	180	6066.76	6089.40	5	4.528	62.0	2.0	59.2	1.7E-05	CONGLOMERATE
5	160	180	6084.09	6093.27	5	1.836	29.0	1.0	36.7	1.1E-05	
						0.000			0.0		

PACKER TESTING CALCULATION SHEET

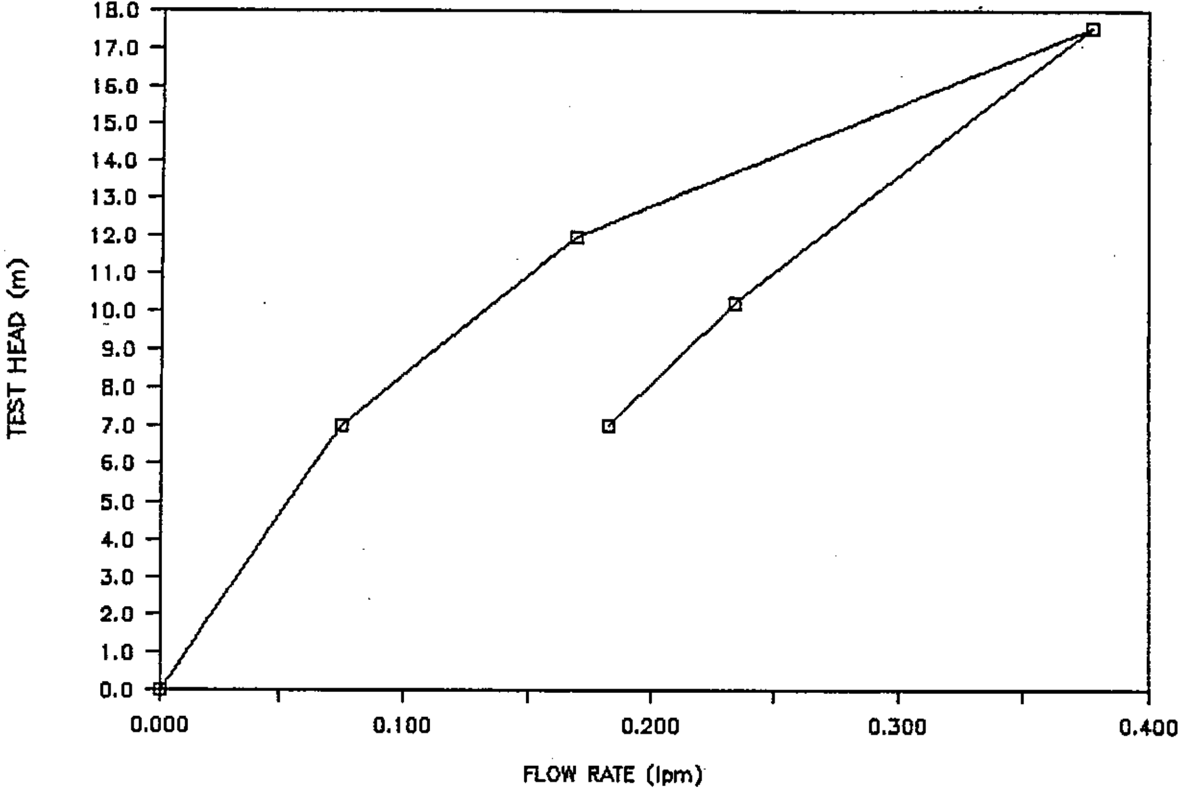
PROJECT: MOUNT POLLEY
LOCATION: TAILINGS AREA B
HOLE No: MP-89-235
TEST DATE: NOV. 9, 1989
COORDINATES(ft) N: S:

HOLE DIAMETER (inches): 2.98
GROUNDWATER DEPTH(ft): 6
BEDROCK DEPTH(ft): 15
TESTED BY: RNK
ANGLE FROM VERTICAL (deg): 0

TEST	INTERVAL		METER RDG		ELAPSED	FLOW	GAUGE	HEAD	TEST	PERMEABILITY	
No.	(ft)		(liters)		TIME	RATE	PRESSURE	CORR'N	HEAD	(cm/sec)	COMMENTS
	from	to	init	final	(min)	(lpm)	(psi)	(psi)	(m)		
1	20	40	6795.40	6879.70	5	16.86	10.0	7.5	3.6	5.7E-04	TEST COMPLETED IN
1	20	40	6919.20	7026.20	5	21.40	15.0	11.0	4.6	5.2E-04	CONTACT BETWEEN
1	20	40	7049.90	7176.20	5	25.26	19.0	13.0	6.1	5.0E-04	TILL AND BEDROCK
1	20	40	7198.20	7301.90	5	20.74	15.0	9.5	5.7	4.8E-04	(FRACTURED BEDROCK)
1	20	40	7325.70	7397.10	5	14.28	10.0	7.0	3.9	4.7E-04	
						0.00			0.0		
2	40	60	7409.86	7409.87	4	0.003	11.0	0.0	9.6	5.8E-08	
2	40	60	7409.97	7410.03	4	0.015	24.0	0.0	18.7	1.8E-07	VERY WEATHERED
2	40	60	7410.35	7410.42	5	0.014	38.0	0.0	28.6	1.1E-07	VOLCANIC
2	40	60	7410.41	7410.43	5	0.004	24.0	0.0	18.7	4.7E-08	CONGLOMERATE
2	40	60	7410.41	7410.41	5	0.000	12.0	0.0	10.3	0.0E+00	PRESS REBOUND (OMIT)
						0.000			0.0		
3	60	100	7593.12	7593.49	5	0.074	18.0	0.0	14.5	6.4E-07	
3	60	100	7593.73	7594.36	5	0.126	38.0	0.0	28.6	5.5E-07	VERY WEATHERED
3	60	100	7594.60	7595.36	5	0.152	52.0	0.0	38.4	5.0E-07	VOLCANIC
3	60	100	7595.46	7595.83	5	0.074	37.0	0.0	27.9	3.3E-07	CONGLOMERATE
3	60	100	7595.85	7595.95	5	0.020	18.0	0.0	14.5	1.7E-07	
						0.000			0.0		
4	100	140	7611.48	7617.52	5	1.208	20.0	0.5	15.6	9.6E-06	
4	100	140	7618.47	7631.33	5	2.572	40.0	1.5	28.9	1.1E-05	VERY WEATHERED
4	100	140	7633.11	7652.48	5	3.874	61.0	2.0	43.4	1.1E-05	VOLCANIC
4	100	140	7655.31	7667.80	5	2.498	38.0	1.5	27.5	1.1E-05	CONGLOMERATE
4	100	140	7669.41	7676.71	5	1.460	19.0	0.5	14.9	1.2E-05	
						0.000			0.0		

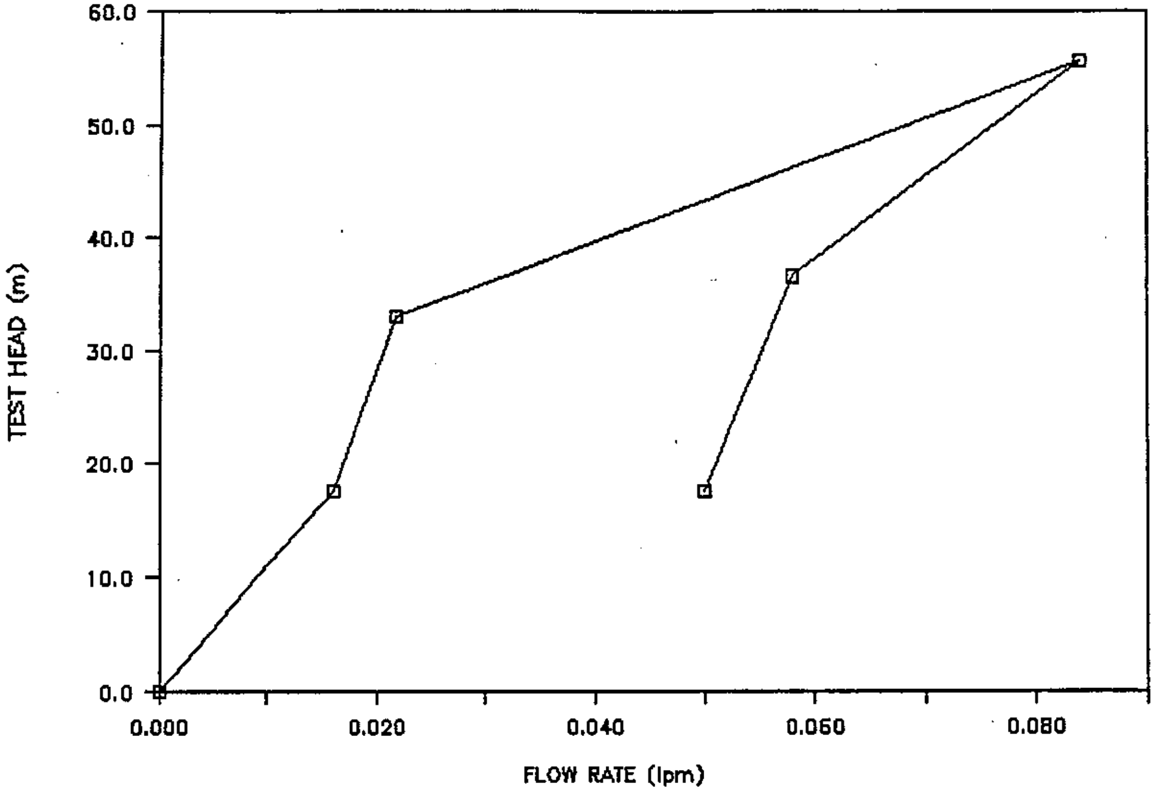
MT POLLEY PACKER TEST RESULTS

HOLE 231, TEST INTERVAL NO. 1



MT POLLEY PACKER TEST RESULTS

HOLE 231, TEST INTERVAL NO. 3



MT POLLEY PACKER TEST RESULTS

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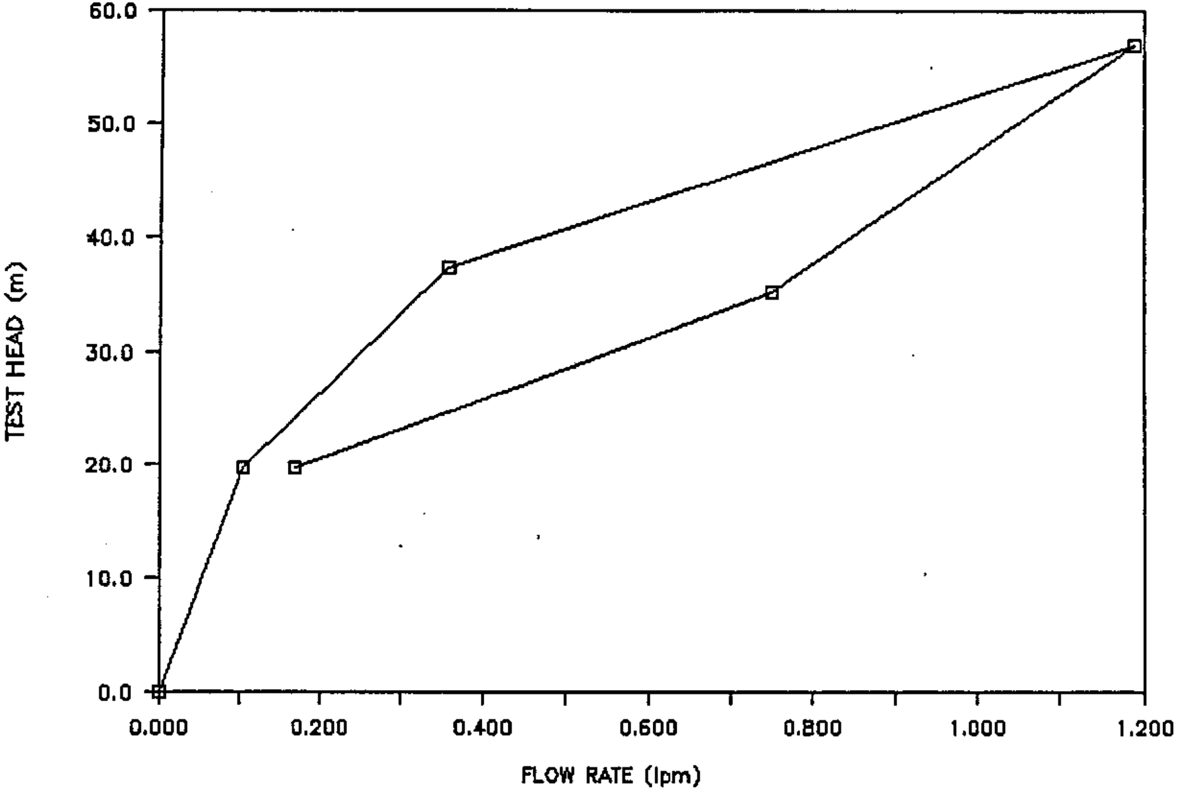

MT POLLEY PACKER TEST RESULTS

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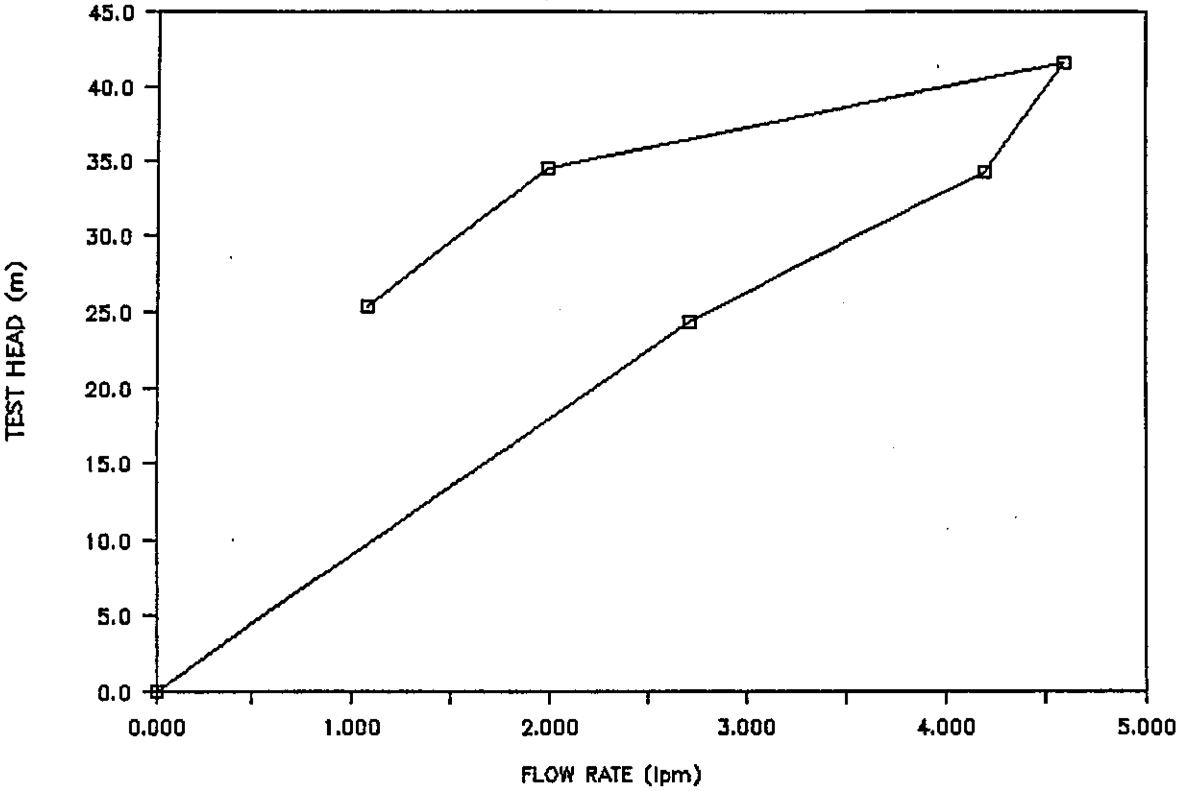

MT POLLEY PACKER TEST RESULTS

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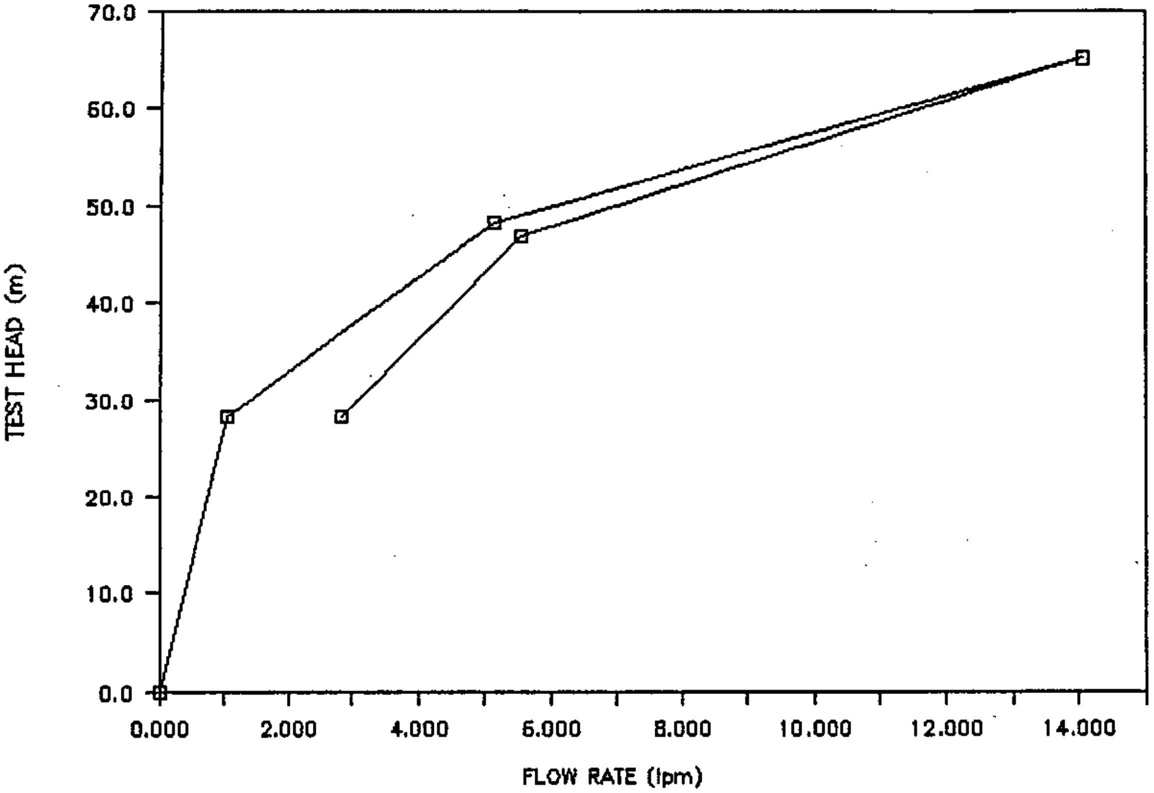

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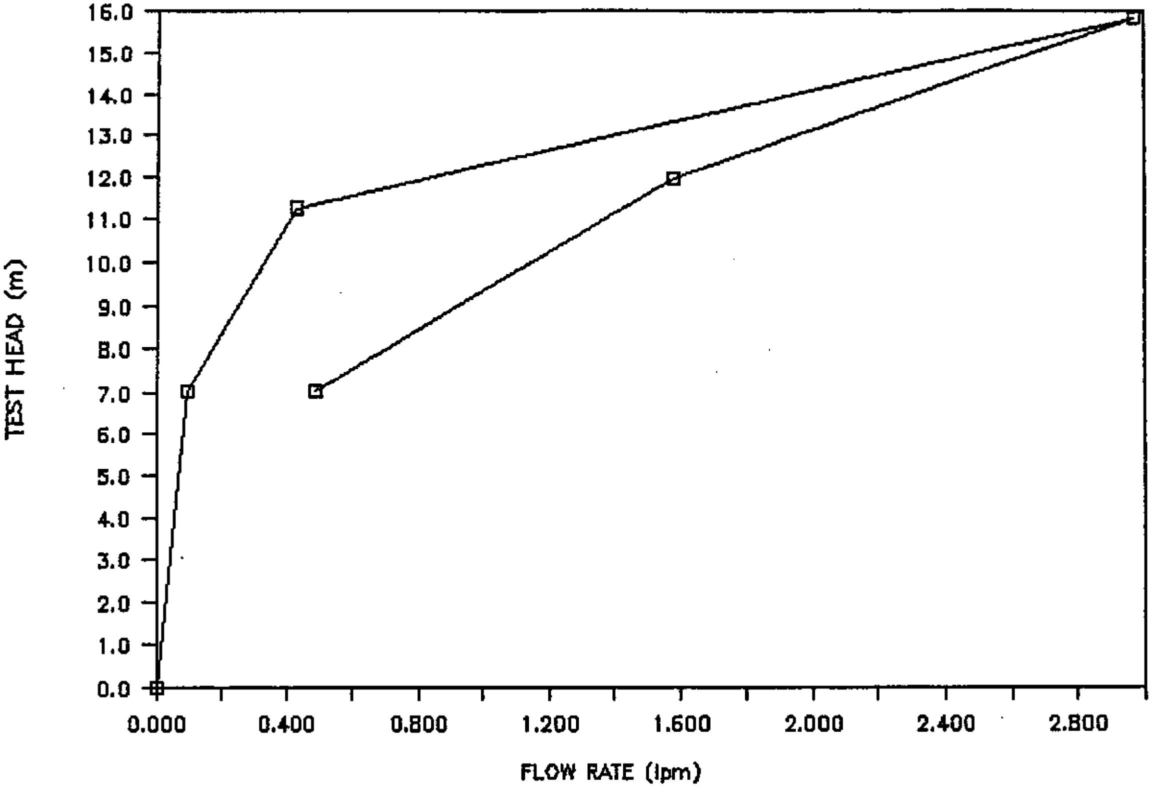

MT POLLEY PACKER TEST RESULTS

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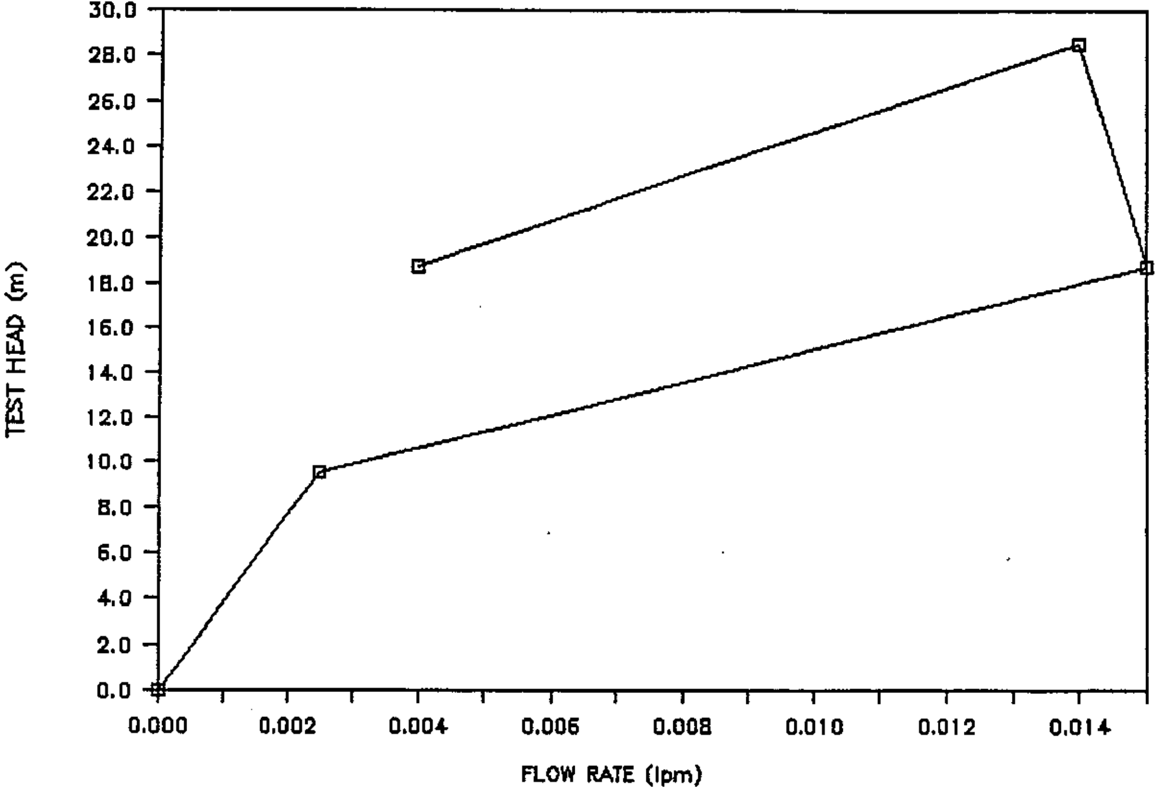

MT POLLEY PACKER TEST RESULTS

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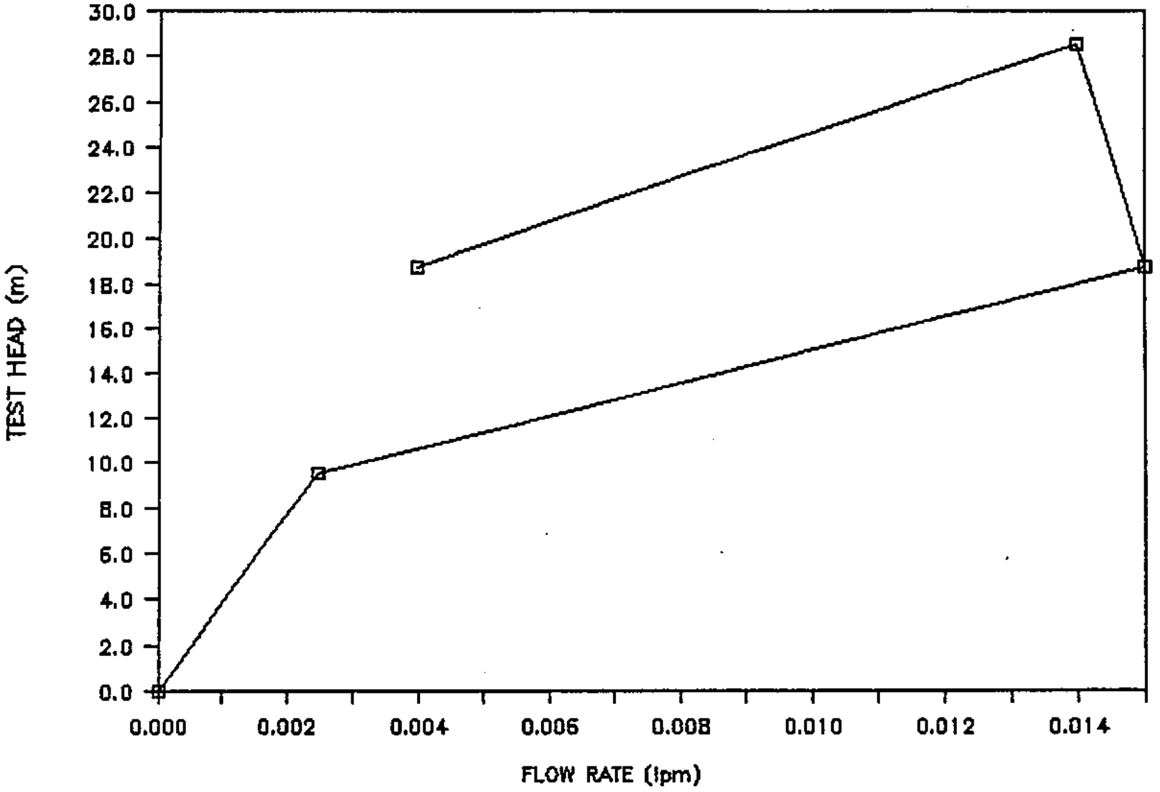
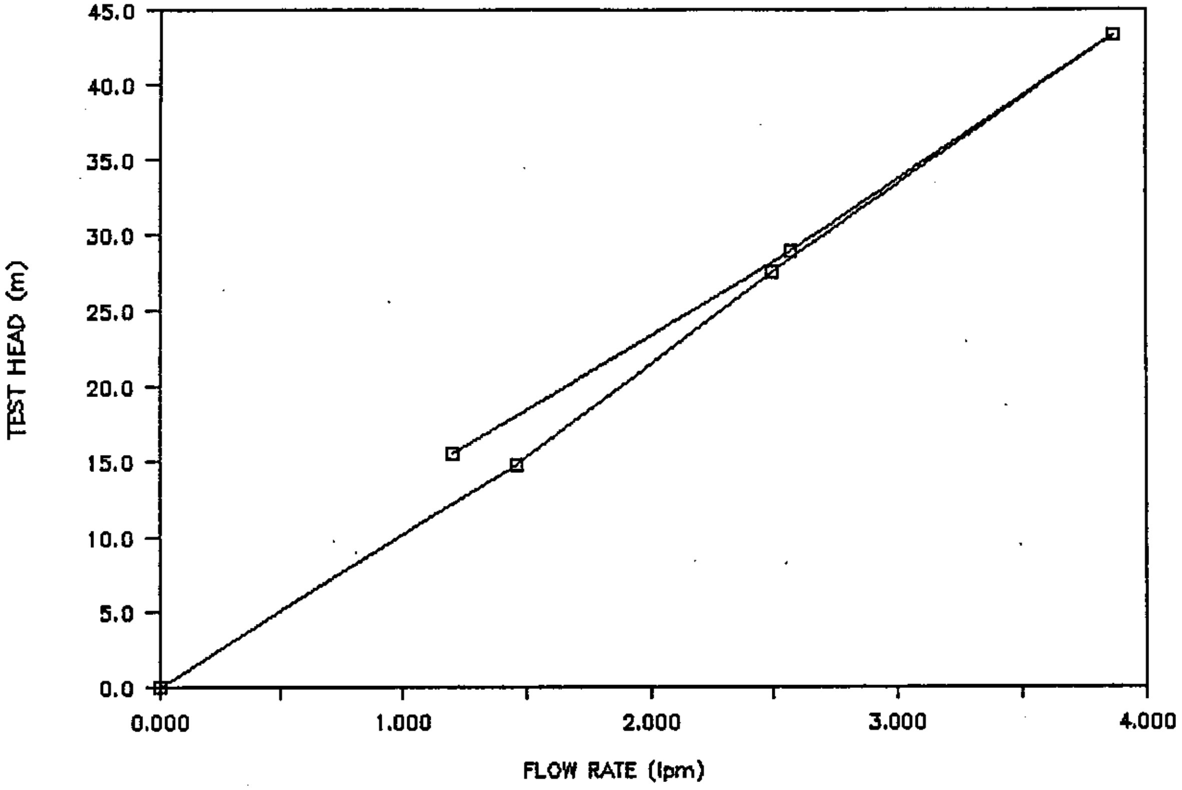


MT POLLEY PACKER TEST RESULTS

HOLE 235, TEST INTERVAL NO. 4



MT POLLEY PACKER TEST RESULTS

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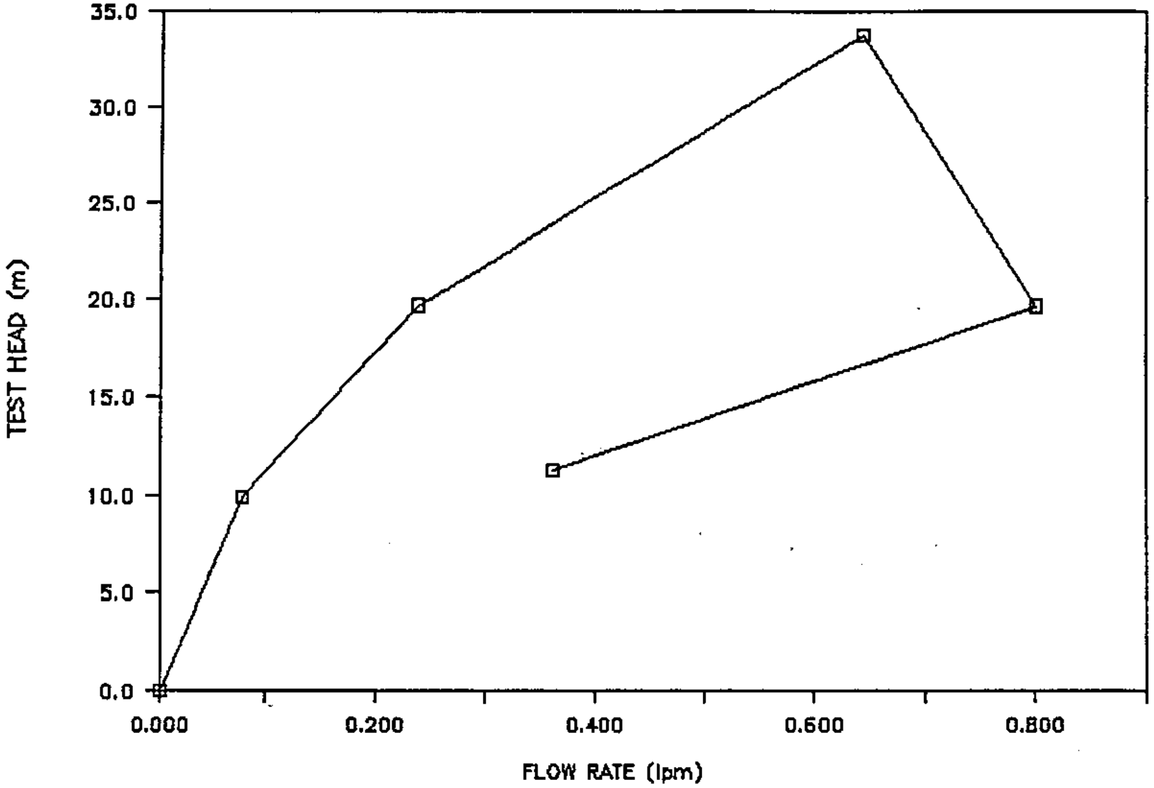

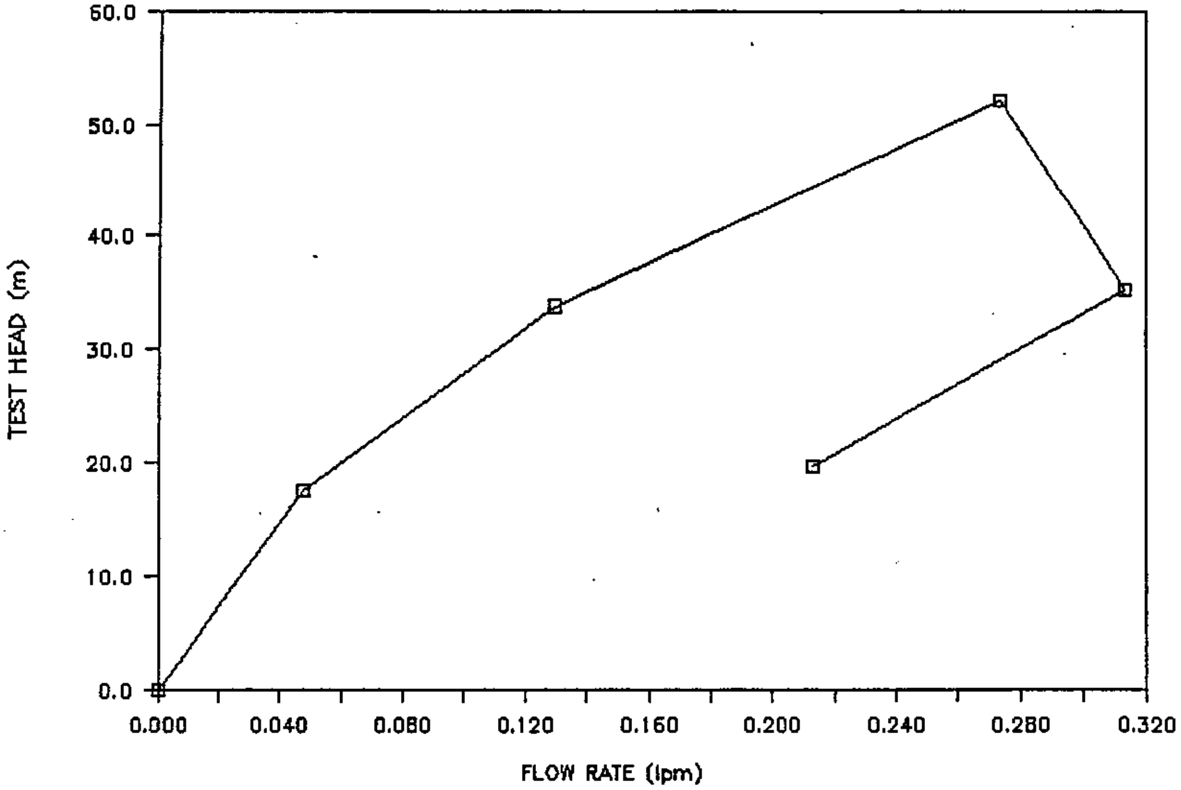

MT POLLEY PACKER TEST RESULTS

HOLE 236, TEST INTERVAL NO. 4