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Peter G. Fuller B.E., Ph.D.
Don R. Miller B.Sc., Dip.Eng.Geol.
Geoffrey K. Searle B.E. M.Eng.Sci.

CONSULTING ENGINEERS and GEOLOGISTS

BARRETT, FULLER & PARTNERS

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SPECTRUM RESOURCES LTD.
ANCHOR MINE PROJECT
PROPOSED TAILINGS AND WATER STORAGE DAMS
GEOTECHNICAL APPRAISAL

LEASES
55M/88
56M/88
57M/88
58M/88
4W/88
5W/88

RL 8713

June 1988
Job No. 10-1003

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GEOLOGISTS

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June 10th, 1988 10-1003

Spectrum Resources Ltd.,
586 Great South Road,
Greenlane
AUCKLAND 5 NEW ZEALAND

Attention: Mr. M. Baker

Dear Sir,

RE: Anchor Mine Project
Proposed Tailings and Water Storage Dams

We have pleasure in presenting our report detailing the results of the investigations and designs conducted for the above project.

Should you require any further information or assistance, please contact the undersigned.

Yours faithfully,

G. K. SEARLE

1.0 INTRODUCTION

Spectrum Resources Ltd. are conducting a feasibility study of the potential benefits in reopening the old Anchor Tin Mine near St. Helens, Tasmania. This report addresses various aspects of this study relating to water resources and waste impoundment associated with the potential development and presents preliminary designs or design information pertinent to tailings dam, water storage dam and creek diversion works.

2.0 SCOPE OF WORK

The scope of work covered by this investigation and report includes the following:

- hydrological aspects of the proposed developments
- foundation investigations at the proposed tailings dam and water storage overflow structure sites
- design of the tailings dam
- quantity estimates associated with dam construction and waste storage capacity

In conducting the above investigation and design phases of the project, constraints have been imposed by both a lack of accurate site survey data and a perceived need to minimize disturbance to the environment during the field investigation work. This has resulted in

designs, which are subsequently presented, which may require some minor modifications as further site specific data becomes available.

3.0 FIELD INVESTIGATION

An investigation of surface and subsurface conditions at the site was conducted over the period 25th - 29th April 1988, with the fieldwork involving the following:

- o excavation of a series of test pits, using an excavator, in the area of the proposed tailings storage site and at the proposed overflow structure site.
- o a geotechnical appraisal of the overall site area to determine conditions or constraints that may affect the proposed development.

The fieldwork was supervised by an Engineering Geologist, who logged the test pits and obtained samples of insitu materials as required.

The logs of the test pits are presented in the Appendix whilst the test pit locations are shown on Figure 1.

4.0 SITE CONDITIONS

The bulk of the site area has previously been worked in either open cut or alluvial mining operations hence natural soil/rock conditions have largely been covered or modified by these past works.

Available geological data indicates that the site is essentially underlain by porphyritic granites, which was confirmed by both the geological mapping and test pit data. On the ridges, the weathered granites are overlain by a relatively shallow soil cover, consisting of 0.6 - 0.8 metres of silt, whilst in the gullies, significant depths of alluvium and materials placed during past mining activities were observed. At the proposed tailings dam site, then latter materials extended to depths of up to 5 metres and consisted essentially of a boulder - cobble - gravel mixture in a dense to very dense state. Debris from past mining activities were observed within these deposits, a part of which appeared to have been placed as a structured fill layer running parallel to the creek alignment. Extremely to highly weathered granite, which classifies as a silty sand, underlies the 'alluvium'.

The proposed water storage overflow site lies within a rock cutting excavated as part of earlier mining-related construction work. Pits excavated in the base of this cutting met refusal in MW granite at depths of 0.7 metres. Examination of the walls of the cutting revealed rock conditions which varied along the line of the cutting. At the extreme northern end, adjacent to the water storage area, slightly weathered to fresh granite was exposed whilst, further south, the degree of weathering increased markedly. This latter weathering pattern i.e. EW-MW granite, formed the bulk of the abutment zones associated with the proposed weir.

During the field investigation, measurements of water

flows were obtained in Anchor Creek. These produced a flow rate, as at 27/4/88, of 125 litres per minute. As these measurements were obtained at the end of a long dry season in Tasmania, they possibly represent a base flow rate for the Anchor Creek catchment.

5.0 DESIGN CONSIDERATIONS

5.1 Hydrology

The proposed construction of a tailings dam across the existing course of Anchor Creek will necessitate diversion of the creek above the tailings storage area. This proposed diversion will pass through the water storage dam into Ariel Creek and will require excavation of a channel and construction of a diversion dam and bunds.

In order to adequately size and design the diversion works, an analysis has been conducted of potential stormwater flows arising from both the Anchor and Ariel Creek catchment areas. Use has been made of the data and procedures contained in the 1987 Edition of Australian Rainfall and Runoff in determining potential flows.

The catchment areas for both creeks lie within extremely high rainfall zones. The topography of the area, which is relatively steep and rugged, results in high runoff coefficients and relatively low storage components which should result in rapid changes in creek flows after rainfall occurrences. As no runoff coefficients or locally

proven design procedures are presented in ARR for Eastern Tasmania, calculations have been conducted using the conventional Rational Method and coefficients judged to be suitable for this area. Rainfall intensities have been determined for a number of durations and return periods, with the 1 in 100 period being used for flood flow calculations.

Based on the above, peak flood flows of 33 cusecs and 9 cusecs were calculated for Anchor and Ariel Creeks respectively. Detailed designs for the Anchor Creek diversion works should therefore be based on a flood flow of 33 cusecs whilst the storage dam and overflow structure should be able to accommodate 42 cusecs flow.

5.2 Overflow/Weir Structure

It is currently expected that the water level in the storage dam will be maintained at the existing floor level of the overflow cutting (RL 243.5) hence construction of an overflow or weir structure should not be necessary. However, consideration has been given to potential weir founding conditions to cover the possibility that a change in storage requirements may subsequently occur.

The base area of the overflow cutting is underlain, at a depth of 0.7 metres, by moderately weathered granite, upon which excavator refusal was met. No base stability problems are therefore

envisaged with any proposed weir or overflow structure.

However, the abutment areas consist of a variably weathered granite, the bulk of which lies in the extremely weathered range. This rock is of relatively low strength and may be expected to exhibit a low resistance to long term erosion forces. Whilst the rock strength is adequate for abutments supporting gravity structures, it would not be suitable for weir structures which impose significant shear loads on the abutments.

The design of gravity structures should include provision for keying into the abutment faces and for the placement of erosion protection on rock faces adjacent to the structure. Particular attention should be paid to keying impermeable membranes (e.g. concrete facing) into both the base and abutment zones of the structure.

5.3 Tailings Dam Foundations

The foundation area for the tailings dam is underlain by a shallow layer of silt or silty clay overlying either weathered granite or alluvium. The alluvium, which includes materials resulting from past mining activities, predominantly consists of a boulder-cobble-gravel-sand mixture containing a low proportion of clay fines. The alluvium is located within the Anchor Creek valley and varies in width along the valley, with the width trending to increase up the valley. At the

site of the proposed starter dam, the alluvium extends over a width of approximately 30 metres and has a depth of up to 4.0 metres.

The alluvial sediments are generally dense to very dense and may be expected to be moderately permeable, as indicated by the various seepage inflows observed in a number of test pits. Whilst strength parameters for these sediments will vary with composition, their predominantly granular nature ensures that adequate foundation stability is available for the proposed dam construction.

Stripping of the overlying silts and clays will be necessary prior to construction of the starter dam. These materials should be usable in the core zone of the sediment dam located downstream of the starter dam.

5.4 Tailings Dam Design

The proposed tailings dam will involve the upstream method of construction, in which sand dykes and an associated beach formation are constructed by spigotting from an initial rockfill starter dam, with the dykes progressively moving upstream as the dam height increases. Construction of this type of dam is feasible due to the high percentage sand fraction in the tailings and the relatively low level of contaminants in the tailings water. Dams of this type have been constructed to heights of 100 metres and at downstream batter slopes of 60

degrees to the horizontal, although the latter is not recommended. A study of operating dams indicates that downstream batters typically lie at an angle of 36 degrees, which is slightly steeper than design considerations would normally allow. Because these dams operate as flow-through structures rather than water retaining structures, their design and performance tends to be controlled less by conventional stability considerations and more by the following related factors:

- o foundation strength and potential for dispersion or piping
- o permeability of the starter dam
- o permeability of the sand tailings
- o rate of construction
- o construction controls

As samples of the mine tailings are not as yet available for testing, permeability and strength parameters for these materials have been estimated by relating the anticipated grading of the materials to data published for similar tailings materials at other mine sites. It should be noted that the minus 75 micron slimes fraction is to be removed from the tailings at the mill and that the tailings 'pumped' to the dam wall site will be essentially devoid of the fine fraction. The probable grading of these tailings,

as shown in the Appendix, lies on the mid to coarse side of the envelope of gradings generally encountered for mine tailings and is similar to that produced at the Climax mine in Colorado, U.S.A. This grading, with its relatively low fines content, results in both permeability and strength characteristics which are well suited for tailings dam construction using the upstream method. Comparisons with published data indicates that permeabilities of approximately 10^{-2} cm/sec and effective friction angles greater than 34 degrees should be available in these sands. For the relatively low tailings disposal rates involve in this project, the above permeability values will ensure the maintenance of a low phreatic surface within the sand profile.

As stated earlier, strength and 'dispersion' characteristics of the dam founding medium can have a significant effect on the performance of the dam. Whilst the strength characteristics of the alluvium are judged to be adequate, some concern may exist regarding the potential for piping to occur beneath the dam. This would be offset by the construction of a cut off trench, extending down to the granite base, which is backfilled with a graded rockfill and surrounded by a geotextile membrane.

To ensure that the phreatic surface is maintained at a low level near the face of the dam, the starter dam would be constructed using a highly permeable rockfill, with appropriate filter zones being incorporated in the upstream face to minimize the potential for piping. Gradings appropriate for the filter zones can only be

generally determined when the estimated rock fill grading and properties are known, and would require adjustment on site as actual rockfill gradings are established.

Based on projected mining production, and allowing for 50 percent of the sand tailings to be used as mine backfill, it is estimated that 550,000 cubic metres of storage will be required in the tailings dam over 7 years. This will require raising of the dam to RL 265 metres from the initial starter dam RL of 246.5 metres. The various stages of storage development are shown on Figures 2 - 5 for RLs 246.5 to 260. The final lift to RL 265 will cover the same area as that shown for RL 260, with sand walls regressing from the northern and eastern boundaries.

During the early stages of tailings disposal, it is proposed that the slimes fraction be separately deposited behind a secondary dam wall at the northern end of the basin. This will allow the development of an adequate beach area in the valley at the upstream toe of the starter dam and thus maintain structural integrity in the lower section of the dam.

Consideration of the above factors in the light of published data has resulted in the selection of a dam design profile involving 2H:1V (26 degrees) downstream batters for both rockfill and sand and 1.5H:1V for the upstream rockfill face. This downstream batter of 26 degrees is to be compared with the average 36 degree batters typically found in tailings dams as noted earlier. This design assumes that good tailings

disposal practice would be maintained throughout the life of the dam, particularly with respect to ensuring minimal slime accumulation within the structural section of the dam profile. As the slimes are to be separated from the tailings at the mill, compliance with the above should not be too onerous.

Stability analyses of the proposed dam section indicates a minimum factor of safety of 1.4 on downstream slope stability when constructed to RL 265 metres. This assumes a relatively low density (30 - 40 percent R.D.) in the sands which could be improved by applying light compaction when shaping of the sand dykes is conducted. This would improve the factor of safety to approximately 1.5. It should be noted that insitu density measurements made in typical tailings dams walls have indicated densities of 45 - 55 percent hence the above should be conservative.

5.0 SEDIMENT DAM

A sediment dam is to be constructed downstream of the starter dam, with its approximate location being shown on Figure 2. The exact location of this proposed dam will depend on further site survey data.

The purpose of this dam is to both remove sediment from the tailings dam seepage and provide a water storage area which may be used for mining or milling purposes. The dam would therefore be designed and constructed as a water retaining structure containing a spillway, with the dam core materials being obtained from stripping works for the starter dam. Provision of

a low permeability cutoff trench would also be required.

As this dam wall would be relatively low (approx. 8 metres), it would be designed in accordance with normal small dam design principles, involving a downstream batter of 3H:1V and upstream batter of 2H:1V.

APPENDIX

103016

engineering log — excavation

BFP materials testing
BARRETT, FULLER & PARTNERS

pit no: 1
sheet 1 of 1

job no: 10-1003

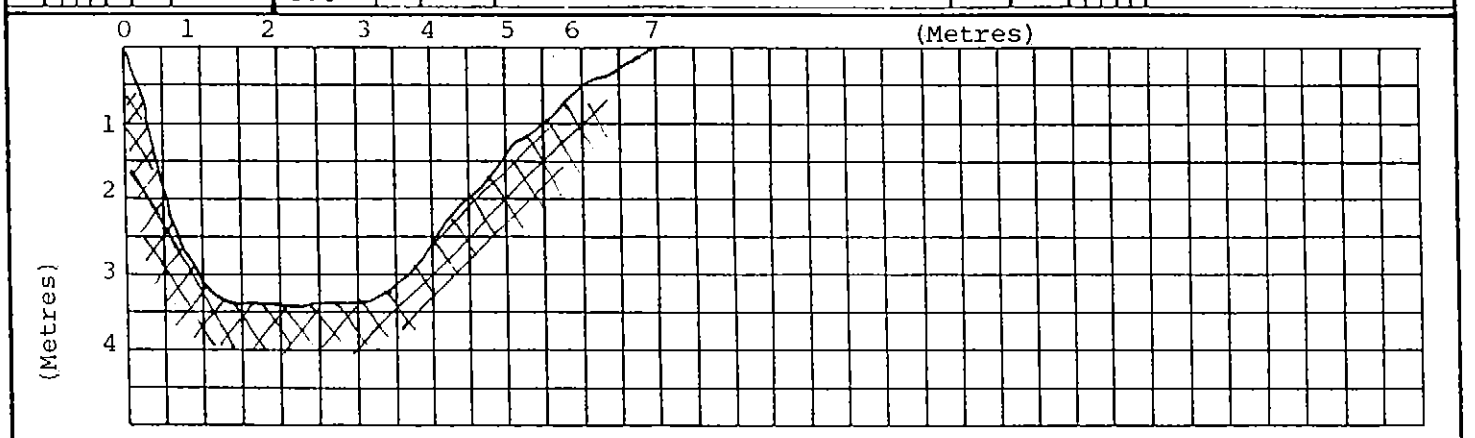
Client: Spectrum Resources Ltd
project: Proposed Anchor Tin Mine Tailings Dam
pit location: refer to figure 1

pit commenced: 26/4/88
supervised by: GB

equipment type and model: Hitachi UH038
excavation dimensions: 7.0 m long, 1.90 m wide

R.L. surface:
datum:

method	penetration 1 2 3	support	water	notes samples, tests, etc.	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency, rel. density	hand penetrometer 100 200 300 400 kPa	structure and additional observations
E		Nil	Not encountered		1.0		ML	CLAYEY SILT, brown, clay of high plasticity, some organics some fine to coarse gravel	M	L-MD		easily dug with excavator
					2.0			GRANITE, extremely to highly weathered, brown to white, evidence at jointing highly to modereately weathered pink, brown, white	M-D	D-VD		
					3.0				D	VD		
					4.0			End 3.40m EXCAVATOR REFUSAL ROCK				
					5.0							



key

method
- N natural exposure
- E existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper

support
- T timbering

penetration
1 2 3 — no resistance ranging to refusal

water
- 10 Oct, 73 water level on date shown
- water inflow
- water outflow

notes – samples and tests
- U50 – undisturbed sample 50 mm diameter
- D – disturbed sample
- N – standard penetration test: figure = result
- N* – SPT + sample
- Nc – cone penetrometer

classification symbols and soil description
based on unified classification system

moisture
- D – dry
- M – moist
- W – wet

consistency/relative density
- VS – very soft
- S – soft
- F – firm
- St – stiff
- VSt – very stiff
- H – hard
- Fb – friable
- VL – very loose
- L – loose
- MD – moderately dense
- D – dense
- VD – very dense

engineering log — excavation

BFP materials testing
BARRETT, FULLER & PARTNERS

pit no: 2
sheet 1 of 1

job no: 10-1003

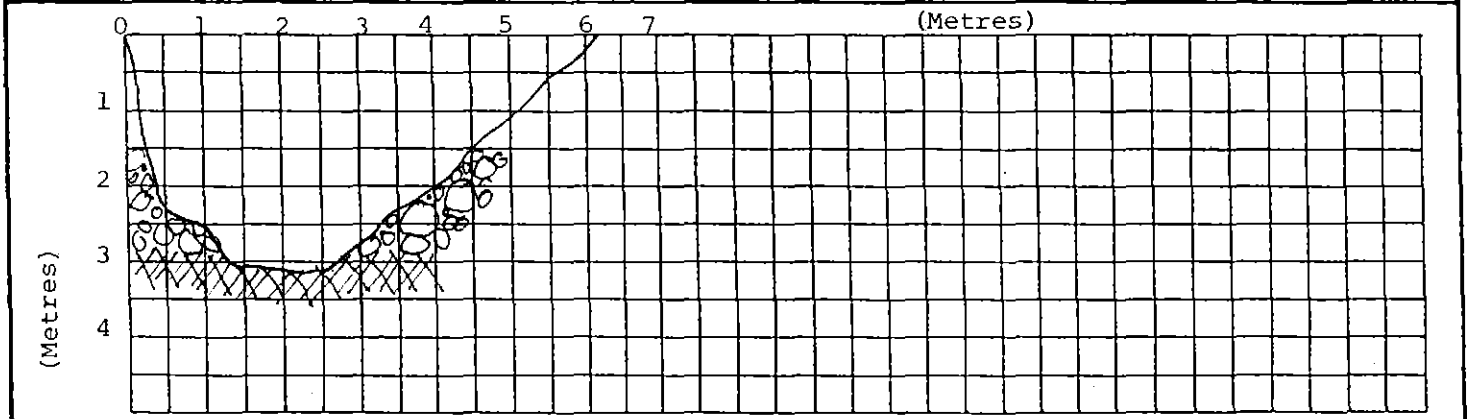
Client: Spectrum Resources Ltd
project: Proposed Anchor Tin Mine Tailings Dam
pit location: refer to figure 1

pit commenced: 26/4/88
supervised by: GB

equipment type and model: Hitachi UH038
excavation dimensions: 6.0 m long, 2.5 m wide

R.L. surface:
datum:

method	penetration 1 2 3	support	water	notes samples, tests, etc.	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency, rel. density	hand penetrometer 100 kPa 200 300 400	structure and additional observations
E		Nil	Not encountered		1.0		CL	SILTY CLAY, medium plasticity brown, some sand, fine to coarse, occasional boulder to 500m	M	St		some sand bands
					2.0			GRANITE COBBLES and BOULDERS extremely to moderately weathered, white to brown, fine to medium grained sandy clay matrix	M-W	VD		Boulders to 1.3m, clay constitutes ≈ 20% of matrix
					3.0			GRANITE, highly to slightly weathered, pink, moderately jointed	D	VD		
					4.0			END 3.10m UNABLE TO PENETRATE WITH EXCAVATOR ROCK				
					5.0							



key

method
- N natural exposure
- E existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper

support
- T timbering

penetration
- 1 2 3 no resistance ranging to refusal

water
- 10 Oct, 73 water level on date shown
- water inflow
- water outflow

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- H – hard
- Fb – friable
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- L – loose
- MD – moderately dense
- D – dense
- VD very dense

engineering log — excavation

BFP materials testing
BARRETT, FULLER & PARTNERS

pit no: 3
sheet 1 of 1

job no: 10-1003

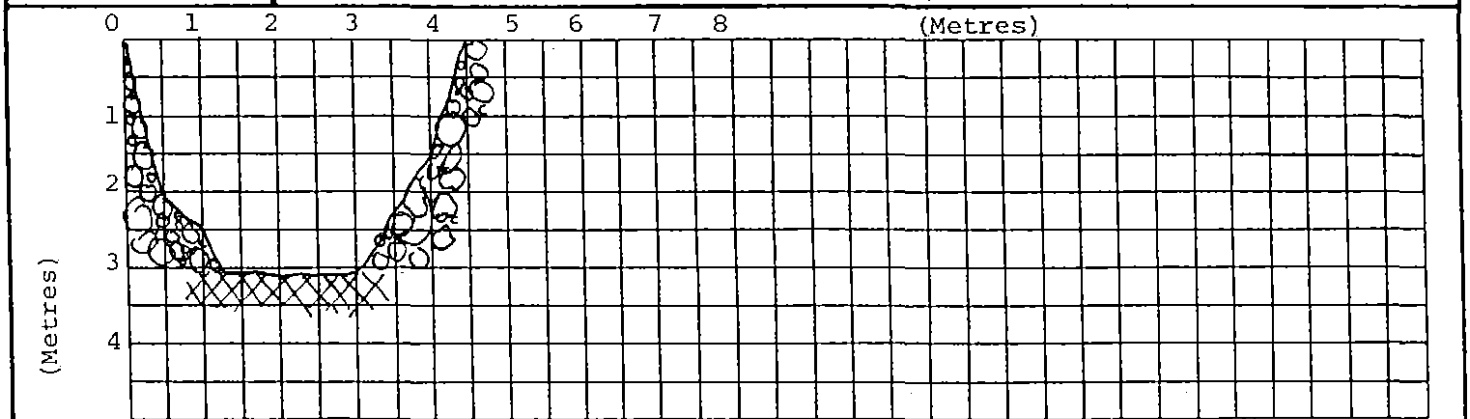
Client: Spectrum Resources Ltd
project: Proposed Anchor Tin Mine Tailings Dam
pit location: refer to figure 1

pit commenced: 26/4/88
supervised by: GB

equipment type and model: Hitachi UH038
excavation dimensions: 4.5 m long, 1.60m wide

R.L. surface:
datum:

method	penetration 1 2 3	support	water	notes samples, tests, etc.	depth metres	graphic log	classification symbol	material soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency, rel. density	hand penetrometer 100 kPa 200 300 400	structure and additional observations
E		Nil			1.0			SAND, COBBLES and GRAVEL, brown to grey	W	MD		Hole collapsing ↓ 400mm of water in pit after 5 mins.
					2.0							
					3.0							
					4.0			END 3.10m EXCAVATOR REFUSAL ROCK				probably bedrock
					5.0							



key

method
- N natural exposure
- E existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper

support
- T timbering

penetration
- 1 2 3 — no resistance ranging to refusal

water
- 10 Oct, 73 water level on date shown
- water inflow
- water outflow

notes
- U50 — undisturbed sample 50 mm diameter
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based on unified classification system

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- Fb — friable
- VL — very loose
- L — loose
- MD — moderately dense
- D — dense
- VD — very dense

103019

engineering log — excavation

BFP materials testing
BARRETT, FULLER & PARTNERS

pit no: 4
sheet 1 of 2

job no: 10-1003

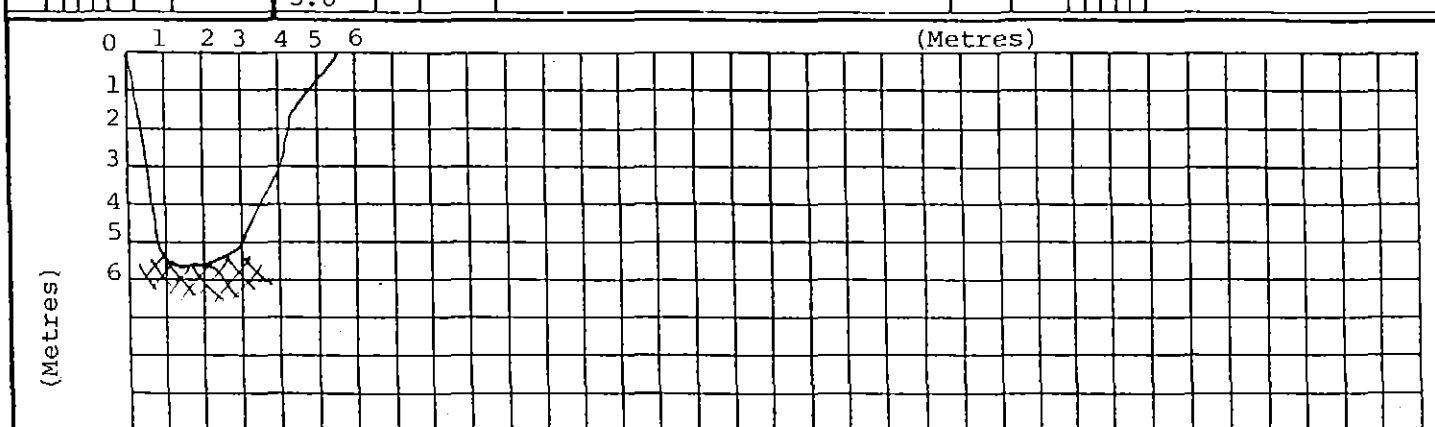
Client: Spectrum Resources Ltd
project: Proposed Anchor Tin Mine Tailings Dam
pit location: refer to figure 1

pit commenced: 26/4/88
supervised by: GB

equipment type and model: Hitachi UH038
excavation dimensions: 5.5 m long, 2.5 m wide

R.L. surface:
datum:

method	penetration 1 2 3	support	water	notes samples, tests, etc.	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency, rel. density	hand penetrometer 100 kPa 200 300 400	structure and additional observations
E		Nil			1.0			SAND, GRAVEL COBBLES and BOULDERS brown, boulders to 0.8m	M	D		trolley track and wheel
					2.0							
					3.0			CLAYEY SILTY SAND, fine to coarse, dark grey, some gravel fine to coarse, some boulders to 0.40m	W	L		organic odour some plant roots
					4.0			grey				
					5.0							



key

method
- N natural exposure
- E existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper

support
- T timbering

penetration
- 1 2 3 — no resistance ranging to refusal

water
- 10 Oct, 73 water level on date shown
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- water outflow

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- D — dense
- VD — very dense

133020

engineering log — excavation

BFP materials testing
BARRETT, FULLER & PARTNERS

pit no: 4
sheet 2 of 2

job no: 10-1003

Client: Spectrum Resources Ltd
project: Proposed Anchor Tin Mine Tailings Dam
pit location: refer to figure 1

pit commenced: 26/4/88
supervised by: GB

equipment type and model: Hitachi UH038
excavation dimensions: 5.5 m long, 2.5 m wide

R.L. surface:
datum:

method	penetration 1 2 3	support	water	notes samples, tests, etc.	depth metres	graphic log	classification symbol	material (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	moisture condition	consistency, rel. density	hand penetrometer 100 k 200 300 400	structure and additional observations
					5·0			AS ABOVE				
E		Nil	Not encountered					END 5.5m UNABLE TO PENETRATE WITH EXCAVATOR, ROCK				probably bedrock

(Metres)

(Metres)

key

method
- N natural exposure
- E existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper

support
- T timbering

penetration
- 1 2 3 — no resistance / ranging to / refusal

water
- 10 Oct, 73 water level on date shown
- water inflow
- water outflow

notes – samples and tests
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- VD – very dense

103021

engineering log — excavation

BFP materials testing
BARRETT, FULLER & PARTNERS

pit no: 5
sheet 1 of 1

job no: 10-1003

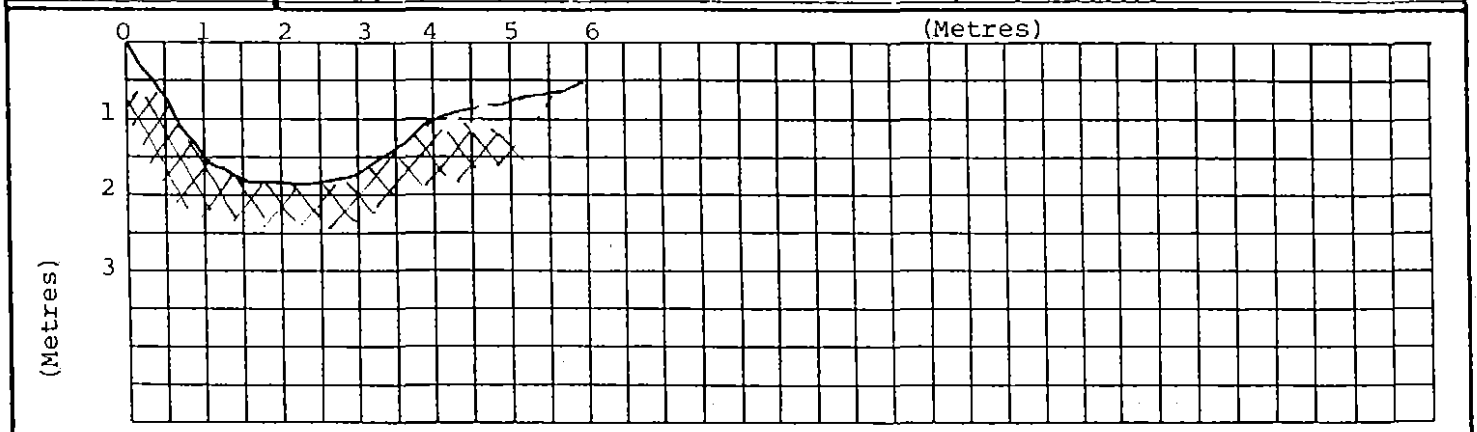
Client: Spectrum Resources Ltd
project: Proposed Anchor Tin Mine Tailings Dam
pit location: refer to figure 1

pit commenced: 27/4/88
supervised by: GB

equipment type and model: Hitachi UH038
excavation dimensions: 6.0 m long, 1.8 m wide

R.L. surface:
datum:

method	penetration 1 2 3	support	water	notes samples, tests, etc.	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency, rel. density	hand penetrometer 100 kPa 200 300 400	structure and additional observations
E		Nil	Not encountered		0		ML	CLAYEY SILT, brown, clay of medium plasticity, some fine to coarse sand, occasional cobble	M	L-MD		
					1.0			GRANITE, extremely to highly weathered, brown	D	VD		
								highly to moderately weathered, light brown	D	VD		tight jointing
					2.0			END 1.90m EXCAVATOR REFUSAL, ROCK				
					3.0							
					4.0							
					5.0							



key

method
- N natural exposure
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support
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penetration
- 1 2 3 no resistance ranging to refusal

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notes – samples and tests
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- H – hard
- Fb – friable
- VL – very loose
- L – loose
- MD – moderately dense
- D – dense
- VD – very dense

103022

engineering log — excavation

BFP materials testing
BARRETT, FULLER & PARTNERS

pit no: 6
sheet 1 of 1

job no: 10-1003

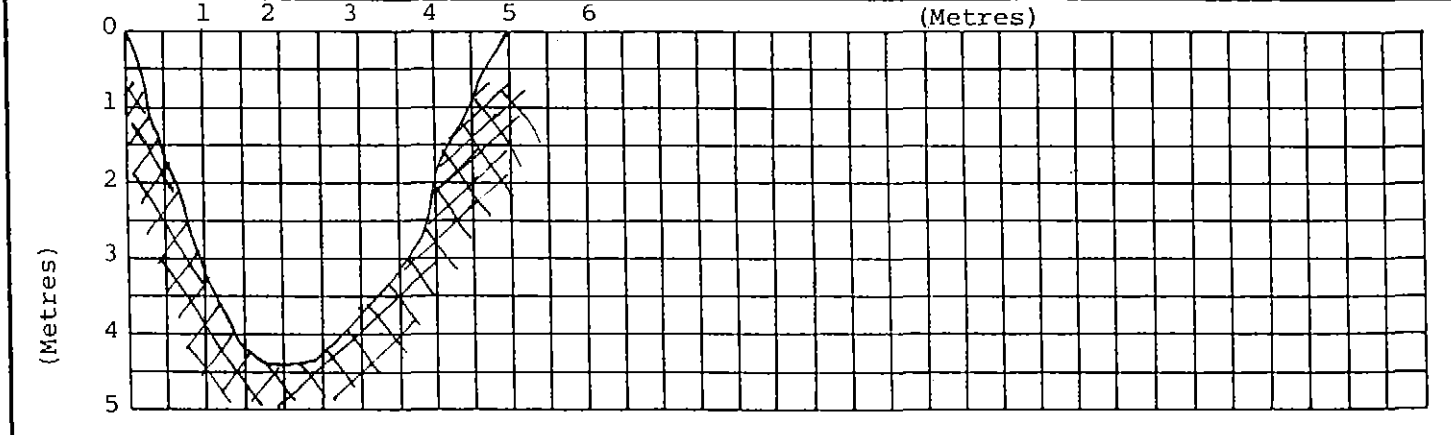
Client: Spectrum Resources Ltd
project: Proposed Anchor Tin Mine Tailings Dam
pit location: refer to figure 1

pit commenced: 27/4/88
supervised by: GB

equipment type and model: Hitachi UH038
excavation dimensions: 5.0 m long, 1.9 m wide

R.L. surface:
datum:

method	penetration 1 2 3	support	water	notes samples, tests, etc.	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency, rel. density	hand penetrometer 100 200 300 400 kPa	structure and additional observations
E		Nil	Not encountered		0		ML	CLAYEY SILT, dark brown, clay of medium plasticity	M	L		
					1.0			GRANITE, extremely weathered light brown to light grey highly to moderately weathered	D	D-VD		
										VD		
					2.0							
					3.0							
					4.0							
								END 4.50m				
					5.0							



key

method
- N natural exposure
- E existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper

support
- T timbering

penetration
- 1 2 3 no resistance ranging to refusal

water
- 10 Oct, 73 water level on date shown
- water inflow
- water outflow

notes
- U50 – undisturbed sample 50 mm diameter
- D – disturbed sample
- N – standard penetration test: figure = result
- N* – SPT + sample
- Nc – cone penetrometer

classification symbols and soil description
based on unified classification system

moisture
- D – dry
- M – moist
- W – wet

consistency/relative density
- VS – very soft
- S – soft
- F – firm
- St – stiff
- VSt – very stiff
- H – hard
- Fb – friable
- VL – very loose
- L – loose
- MD – moderately dense
- D – dense
- VD – very dense

engineering log — excavation

BFP materials testing
BARRETT, FULLER & PARTNERS

103023

pit no: 7
sheet 1 of 2

job no: 10-1003

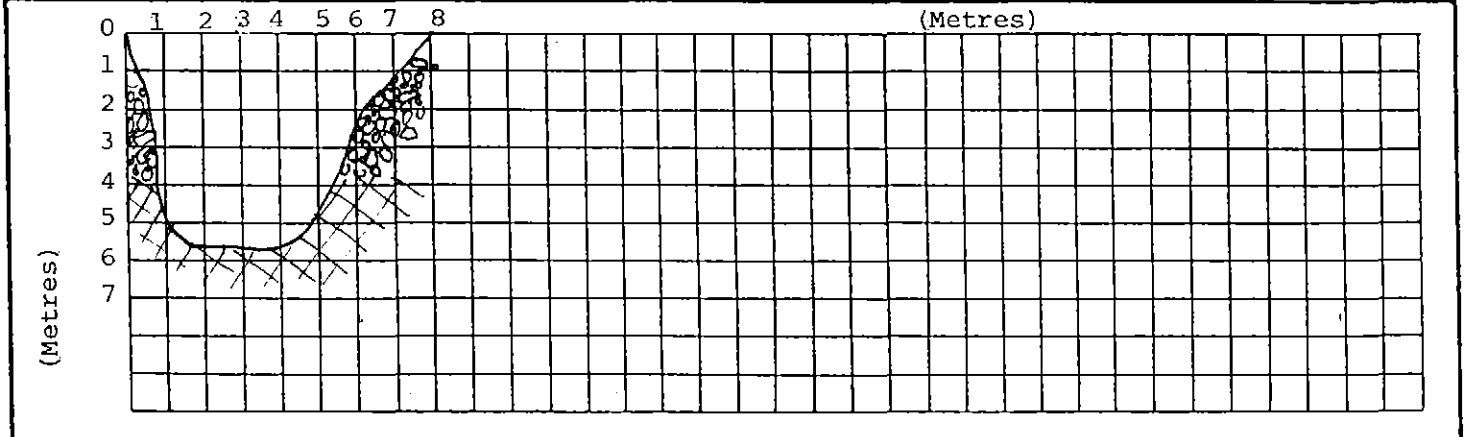
Client: Spectrum Resources Ltd
project: Proposed Anchor Tin Mine Tailings Dam
pit location: refer to figure 1

pit commenced: 27/4/88
supervised by: GB

equipment type and model: Hitachi UH038
excavation dimensions: 8.0 m long, 2.1 m wide

R.L. surface:
datum:

method	penetration 1 2 3	support	water	notes samples, tests, etc.	depth metres	graphic log	classification symbol	material (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	moisture condition	consistency, rel. density	hand penetrometer 100 200 300 400 kPa	structure and additional observations
E		Nil	Not encountered		0		ML	SANDY CLAYEY SILT, brown, medium plasticity, sand fine to coarse, some fine to coarse gravel	M	L-MD		
					1.0			COBBLES, GRAVEL and BOULDERS to 1.5m, subrounded, silty clayey sand matrix ≃20%	M	VD		
					2.0							
					3.0							
					4.0			GRANITE, extremely weathered, orange to light grey	D	VD		
					5.0							



key

method
- N natural exposure
- E existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper

support
- T timbering

penetration
- 1 2 3 — no resistance ranging to refusal

water
- 10 Oct, 73 water level on date shown
- water inflow
- water outflow

notes
- U50 — undisturbed sample 50 mm diameter
- D — disturbed sample
- N — standard penetration test: figure = result
- N* — SPT + sample
- Nc — cone penetrometer

classification symbols and soil description
based on unified classification system

moisture
- D — dry
- M — moist
- W — wet

consistency/relative density
- VS — very soft
- S — soft
- F — firm
- St — stiff
- VSt — very stiff
- H — hard
- Fb — friable
- VL — very loose
- L — loose
- MD — moderately dense
- D — dense
- VD — very dense

engineering log — excavation

BFP materials testing
BARRETT, FULLER & PARTNERS

pit no: 7
sheet 2 of 2

job no: 10-1003

Client: Spectrum Resources Ltd
project: Proposed Anchor Tin Mine Tailings Dam
pit location: refer to figure 1

pit commenced: 27/4/88
supervised by: GB

equipment type and model: Hitachi UH038
excavation dimensions: 8.0 m long, 2.1 m wide

R.L. surface:
datum:

method	penetration 1 2 3	support	water	notes samples, tests, etc.	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency, rel. density	hand penetrometer 100 kPa 200 300 400	structure and additional observations
					5.0			AS ABOVE extremely to highly weathered	D	VD		
E		Nil	Not encountered		6.0			END 5.60m LIMIT OF EXCAVATOR REACH				

(Metres)

(Metres)

key

method
- N natural exposure
- E existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper

support
- T timbering

penetration
- 1 2 3 no resistance ranging to refusal

water
- 10 Oct, 73 water level on date shown
- water inflow
- water outflow

notes
- U50 – undisturbed sample 50 mm diameter
- D – disturbed sample
- N – standard penetration test:figure = result
- N* – SPT + sample
- Nc – cone penetrometer

classification symbols and soil description
based on unified classification system

moisture
- D – dry
- M – moist
- W – wet

consistency/relative density
- VS – very soft
- S – soft
- F – firm
- St – stiff
- VSt – very stiff
- H – hard
- Fb – friable
- VL – very loose
- L – loose
- MD – moderately dense
- D – dense
- VD – very dense

engineering log — excavation

BFP materials testing
BARRETT, FULLER & PARTNERS

pit no: 8
sheet 1 of 1

job no: 10-1003

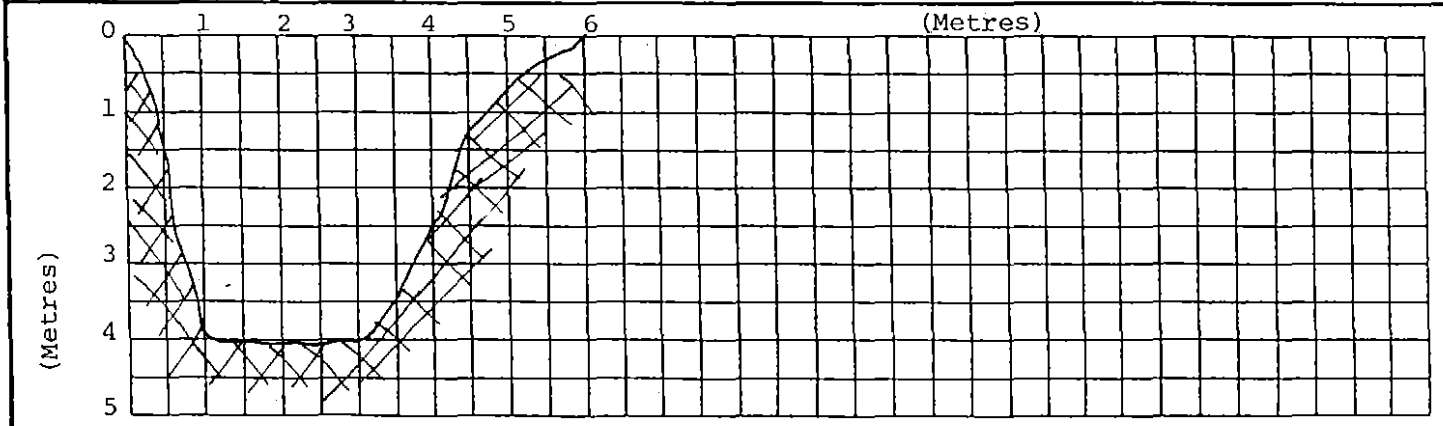
Client: Spectrum Resources Ltd
project: Proposed Anchor Tin Mine Tailings Dam
pit location: refer to figure 1

pit commenced: 27/4/88
supervised by: GB

equipment type and model: Hitachi UH038
excavation dimensions: 6.0 m long, 2.0 m wide

R.L. surface:
datum:

method	penetration 1 2 3	support	water	notes samples, tests, etc.	depth metres	graphic log	classification symbol	material (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	moisture condition	consistency, rel. density	hand penetrometer 100 200 300 400	structure and additional observations
E		Nil	Not encountered		1.0		ML	CLAYEY SILT, brown, medium plasticity, some gravel, cobbles and boulders to 0.8m	M	MD		some evidence of jointing
								GRANITE, extremely weathered orange to light grey	D	VD		
					2.0			extremely to highly weathered				
					3.0							
					4.0							
								END 4.20m				
					5.0							



key

method
- N natural exposure
- E existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper

support
- T timbering

penetration
1 2 3 — no resistance ranging to refusal

water
10 Oct, 73 water level on date shown
water inflow
water outflow

notes – samples and tests
- U50 – undisturbed sample 50 mm diameter
- D – disturbed sample
- N – standard penetration test: figure = result
- N* – SPT + sample
- Nc – cone penetrometer

classification symbols and soil description
based on unified classification system

moisture
- D – dry
- M – moist
- W – wet

consistency/relative density
- VS – very soft
- S – soft
- F – firm
- St – stiff
- VSt – very stiff
- H – hard
- Fb – friable
- VL – very loose
- L – loose
- MD – moderately dense
- D – dense
- VD – very dense

engineering log — excavation

BFP materials testing
BARRETT, FULLER & PARTNERS

103026

pit no: 9
sheet 1 of 1

job no: 10-1003

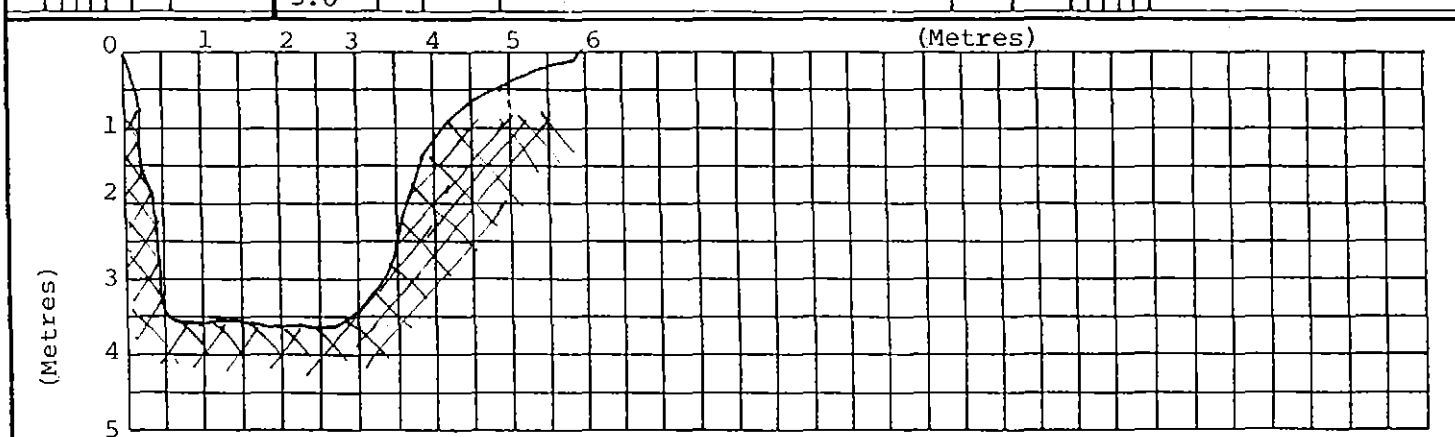
Client: Spectrum Resources Ltd
project: Proposed Anchor Tin Mine Tailings Dam
pit location: refer to figure 1

pit commenced: 27/4/88
supervised by: GB

equipment type and model: Hitachi UH038
excavation dimensions: 6.0 m long, 2.4 m wide

R.L. surface:
datum:

method	penetration 1 2 3	support	water	notes samples, tests, etc.	depth metres	graphic log	classification symbol	material (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	moisture condition	consistency, rel. density	hand penetrometer 100 200 300 400 kPa	structure and additional observations
E		Nil	Not encountered		0.0			COBBLES AND BOULDERS, sub-rounded to 0.40m, sandy silt matrix ≃ 20%	M	VD		metal pieces, trolley tracks
					1.0			GRANITE, extremely weathered orange to light grey	M-D	VD		
					2.0			extremely to moderately weathered				
					3.0							
					4.0			END 3.60m				
					5.0							



key

method
- N natural exposure
- E existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper

support
- T timbering

penetration
- 1 2 3 no resistance ranging to refusal

water
- 10 Oct, 73 water level on date shown
- water inflow
- water outflow

notes
- U50 — undisturbed sample 50 mm diameter
- D — disturbed sample
- N — standard penetration test: figure = result
- N* — SPT + sample
- Nc — cone penetrometer

classification symbols and soil description
based on unified classification system

moisture
- D — dry
- M — moist
- W — wet

consistency/relative density
- VS — very soft
- S — soft
- F — firm
- St — stiff
- VSt — very stiff
- H — hard
- Fb — friable
- VL — very loose
- L — loose
- MD — moderately dense
- D — dense
- VD very dense

engineering log — excavation

BFP materials testing
BARRETT, FULLER & PARTNERS

pit no: 10
sheet 1 of 1

job no: 10-1003

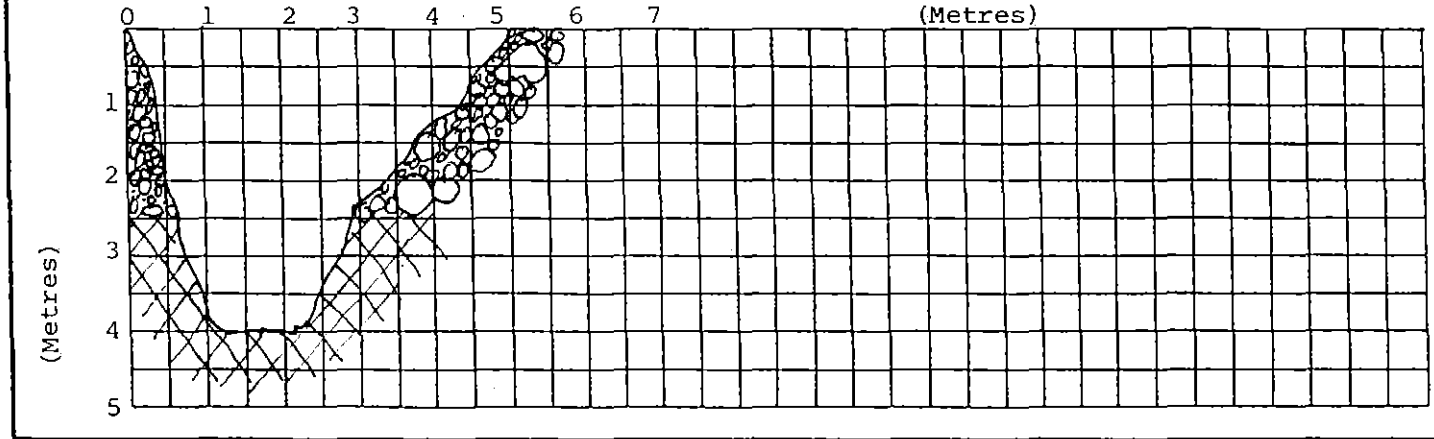
Client: Spectrum Resources Ltd
project: Proposed Anchor Tin Mine Tailings Dam
pit location: refer to figure 1

pit commenced: 27/4/88
supervised by: GB

equipment type and model: Hitachi UH038
excavation dimensions: 5.2 m long, 2.5 m wide

R.L. surface:
datum:

method	penetration 1 2 3	support	water	notes samples, tests, etc.	depth metres	graphic log	classification symbol	material soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency, rel. density	hand penetrometer 100 200 300 400 kPa	structure and additional observations
E		Nil			1.0			GRAVEL and COBBLES, sub-rounded, some BOULDERS to 2.5m, clayey sand matrix ≃ 10%	M-W	VD		
					2.0							
					3.0			GRANITE, extremely weathered, orange to light grey highly to moderately weathered	M-D	VD		some subvertical jointing
					4.0			END 4.0m EXCAVATOR REFUSAL, ROCK				
					5.0							



key

method
- N natural exposure
- E existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper

support
- T timbering

penetration
- 1 2 3 — no resistance ranging to refusal

water
- 10 Oct. 73 water level on date shown
- water inflow
- water outflow

notes – samples and tests
- U50 – undisturbed sample 50 mm diameter
- D – disturbed sample
- N – standard penetration test: figure = result
- N* – SPT + sample
- Nc – cone penetrometer

classification symbols and soil description
based on unified classification system

moisture
- D – dry
- M – moist
- W – wet

consistency/relative density
- VS – very soft
- S – soft
- F – firm
- St – stiff
- VSt – very stiff
- H – hard
- Fb – friable
- VL – very loose
- L – loose
- MD – moderately dense
- D – dense
- VD – very dense

engineering log — excavation

BFP 103028
materials testing
BARRETT, FULLER & PARTNERS

pit no: 11
sheet 1 of 1

job no: 10-1003

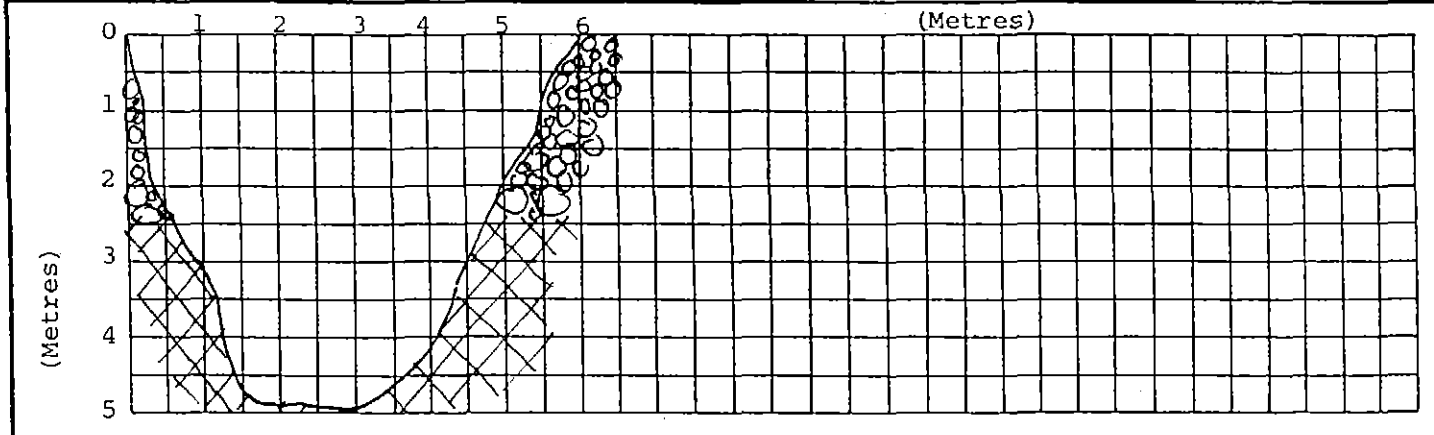
Client: Spectrum Resources Ltd
project: Proposed Anchor Tin Mine Tailings Dam
pit location: refer to figure 1

pit commenced: 27/4/88
supervised by: GB

equipment type and model: Hitachi UH038
excavation dimensions: 5.5 m long, 2.0 m wide

R.L. surface:
datum:

method	penetration 1 2 3	support	water	notes samples, tests, etc.	depth metres	graphic log	classification symbol	material (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	moisture condition	consistency, rel. density	hand penetrometer 100 200 300 400 kPa	structure and additional observations
E		Nil			0			GRAVEL, COBBLES and BOULDERS to 0.40m, subrounded and angular, sandy silt matrix ≃ 20-30%	M	VD		
					1.0							
					2.0			GRANITE, extremely weathered orange to light grey	M	D		
					3.0							
					4.0			extremely to moderately weathered	M-W			hole collapsing
					5.0			END 5.0m				



key

method
- N natural exposure
- E existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper

support
- T timbering

penetration
- 1 2 3 no resistance ranging to refusal

water
- 10 Oct, 73 water level on date shown
- water inflow
- water outflow

notes – samples and tests
- U50 – undisturbed sample 50 mm diameter
- D – disturbed sample
- N – standard penetration test: figure = result
- N* – SPT + sample
- Nc – cone penetrometer

classification symbols and soil description
based on unified classification system

moisture
- D – dry
- M – moist
- W – wet

consistency/relative density
- VS – very soft
- S – soft
- F – firm
- St – stiff
- VSt – very stiff
- H – hard
- Fb – friable
- VL – very loose
- L – loose
- MD – moderately dense
- D – dense
- VD – very dense

U50

103029

engineering log — excavation

BFP materials testing
BARRETT, FULLER & PARTNERS

pit no: 12
sheet 1 of 1

job no: 10-1003

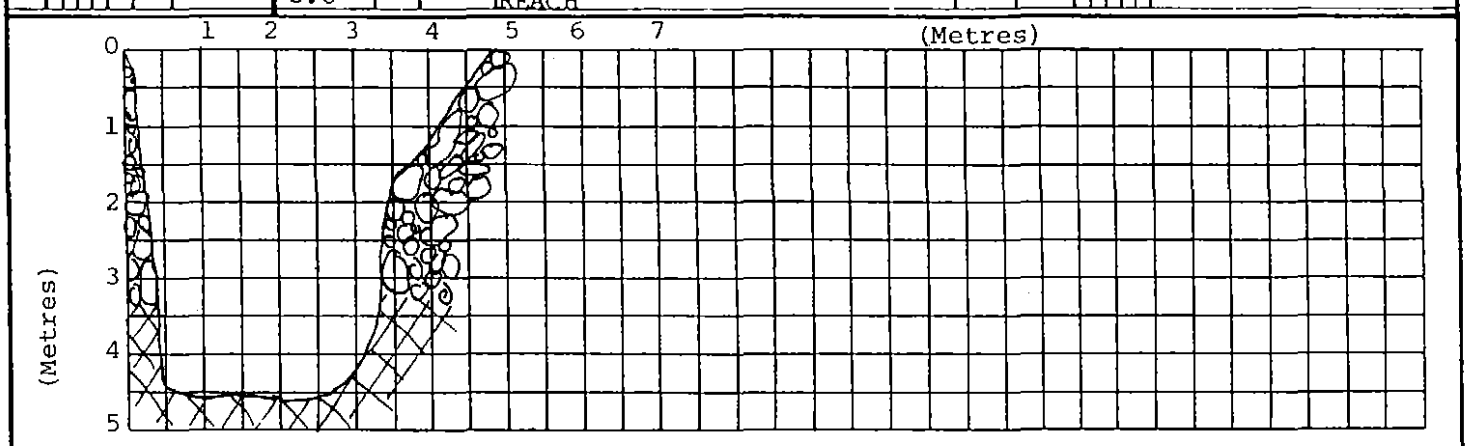
Client: Spectrum Resources Ltd
project: Proposed Anchor Tin Mine Tailings Dam
pit location: refer to figure 1

pit commenced: 28/4/88
supervised by: GB

equipment type and model: Hitachi UH038
excavation dimensions: 2.0 m long, 4.75 m wide

R.L. surface:
datum:

method	penetration 1 2 3	support	water	notes samples, tests, etc.	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency, rel. density	hand penetrometer 100 kPa 200 300 400	structure and additional observations
E		Nil			1.0			GRAVEL, COBBLES and BOULDERS subrounded sand matrix ≃20%	M-W	VD		
					2.0							
					3.0			GRANITE, extremely weathered, orange to light grey	M-D	VD		clayey sand
					4.0							
					5.0			END 4.60m LIMIT OF EXCAVATOR REACH				



key

method
- N natural exposure
- E existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper

support
- T timbering

penetration
- 1 2 3 no resistance ranging to refusal

water
- 10 Oct, 73 water level on date shown
- water inflow
- water outflow

notes — samples and tests
- U50 — undisturbed sample 50 mm diameter
- D — disturbed sample
- N — standard penetration test: figure = result
- N* — SPT + sample
- Nc — cone penetrometer

classification symbols and soil description
based on unified classification system

moisture
- D — dry
- M — moist
- W — wet

consistency/relative density
- VS — very soft
- S — soft
- F — firm
- St — stiff
- VSt — very stiff
- H — hard
- Fb — friable
- VL — very loose
- L — loose
- MD — moderately dense
- D — dense
- VD — very dense

103030

engineering log — excavation

BFP materials testing
BARRETT, FULLER & PARTNERS

pit no: 13
sheet 1 of 1

job no: 10-1003

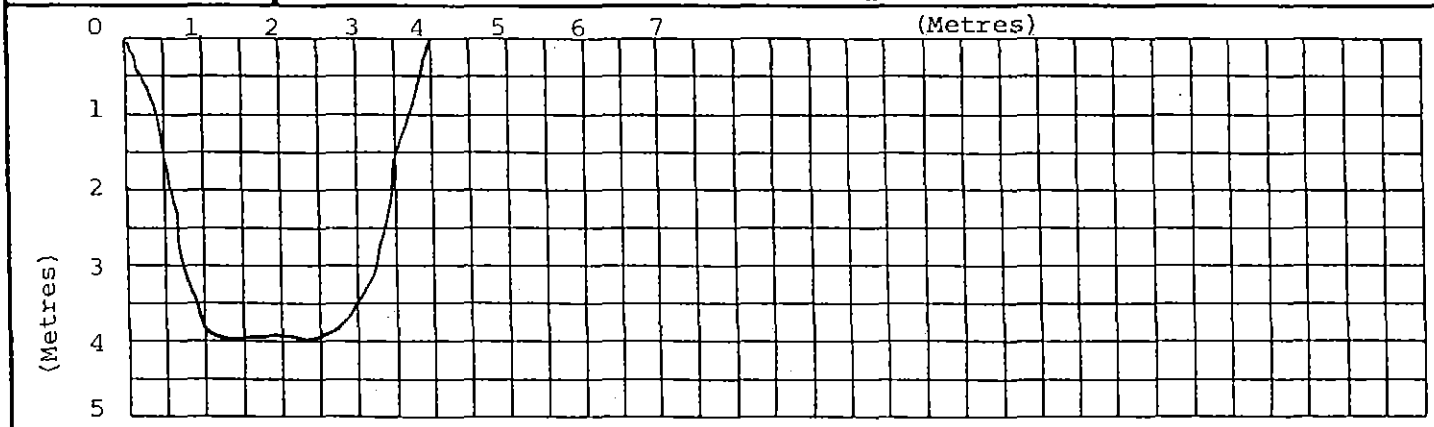
Client: Spectrum Resources Ltd
project: Proposed Anchor Tin Mine Tailings Dam
pit location: refer to figure 1

pit commenced: 28/4/88
supervised by: GB

equipment type and model: Hitachi UH038
excavation dimensions: 4.0 m long, 1.8 m wide

R.L. surface:
datum:

method	penetration 1 2 3	support	water	notes samples, tests, etc.	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency, rel. density	hand penetrometer 100 200 300 400 kPa	structure and additional observations
E		Nil	Not encountered		1.0		ML	CLAYEY SILT, dark brown to brown, medium plasticity, some sand, fine to coarse	M	L-MD		
					2.0			GRANITE, extremely weathered, orange to light grey extremely to highly weathered	M	VD		Clay sand/sandy clay
					3.0			highly to moderately weathered				
					4.0			END 3.50m				
					5.0							



key

method
- N natural exposure
- E existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper

support
- T timbering

penetration
- 1 2 3 — no resistance ranging to refusal

water
- 10 Oct. 73 water level on date shown
- water inflow
- water outflow

notes — samples and tests
- U50 — undisturbed sample 50 mm diameter
- D — disturbed sample
- N — standard penetration test: figure = result
- N* — SPT + sample
- Nc — cone penetrometer

classification symbols and soil description
based on unified classification system

moisture
- D — dry
- M — moist
- W — wet

consistency/relative density
- VS — very soft
- S — soft
- F — firm
- St — stiff
- VSt — very stiff
- H — hard
- Fb — friable
- VL — very loose
- L — loose
- MD — moderately dense
- D — dense
- VD very dense

engineering log — excavation

BFP materials testing
BARRETT, FULLER & PARTNERS

pit no: 14
sheet 1 of 1

job no: 10-1003

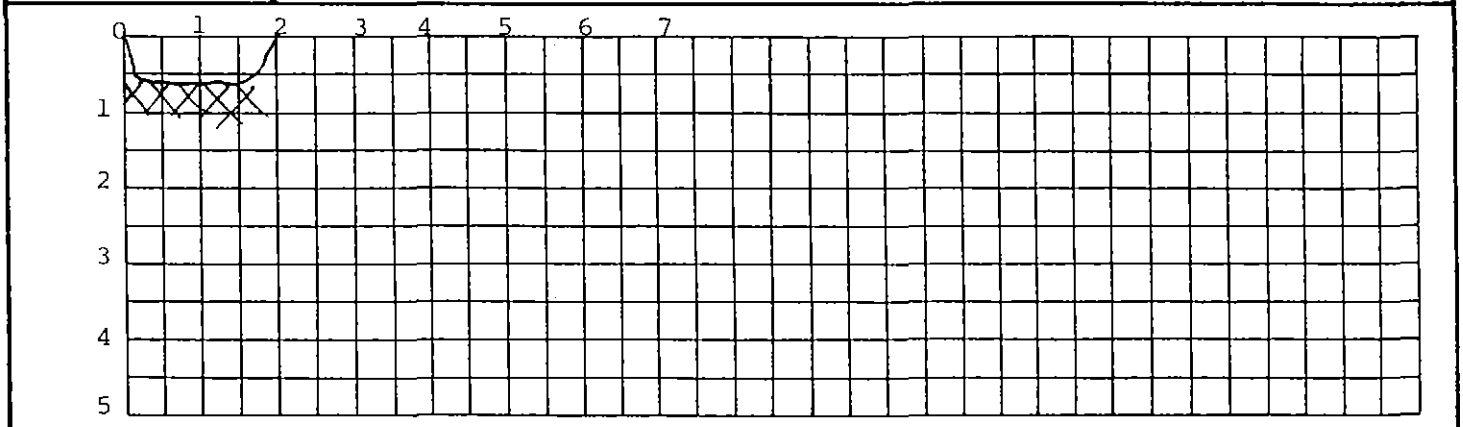
Client: Spectrum Resources Ltd
project: Proposed Anchor Tin Mine Tailings Dam
pit location: refer to figure 1

pit commenced: 28/4/88
supervised by: GB

equipment type and model: Hitachi UH038
excavation dimensions: 2.0 m long, 1.5 m wide

R.L. surface:
datum:

method	penetration 1 2 3	support	water	notes samples, tests, etc.	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency, rel. density	hand penetrometer 100 200 300 400 kPa	structure and additional observations
							CL	GRAVELLY SANDY CLAY, medium plasticity, brown, fine to coarse sand and gravel	M	MD		
E		Nil	Not encountered		1.0			END 0.70m EXCAVATOR REFUSAL, MODERATELY WEATHERED ROCK				
					2.0							
					3.0							
					4.0							
					5.0							



key

method
- N natural exposure
- E existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper

support
- T timbering

penetration
- 1 2 3 no resistance ranging to refusal

water
- 10 Oct, 73 water level on date shown
- water inflow
- water outflow

notes – samples and tests
- U50 – undisturbed sample 50 mm diameter
- D – disturbed sample
- N – standard penetration test: figure = result
- N* – SPT + sample
- Nc – cone penetrometer

classification symbols and soil description
based on unified classification system

moisture
- D – dry
- M – moist
- W – wet

consistency/relative density
- VS – very soft
- S – soft
- F – firm
- St – stiff
- VSt – very stiff
- H – hard
- Fb – friable
- VL – very loose
- L – loose
- MD – moderately dense
- D – dense
- VD – very dense

93a

engineering log – excavation

BFP materials testing
BARRETT, FULLER & PARTNERS

103033

pit no: 15
sheet 1 of 1

job no: 10-1003

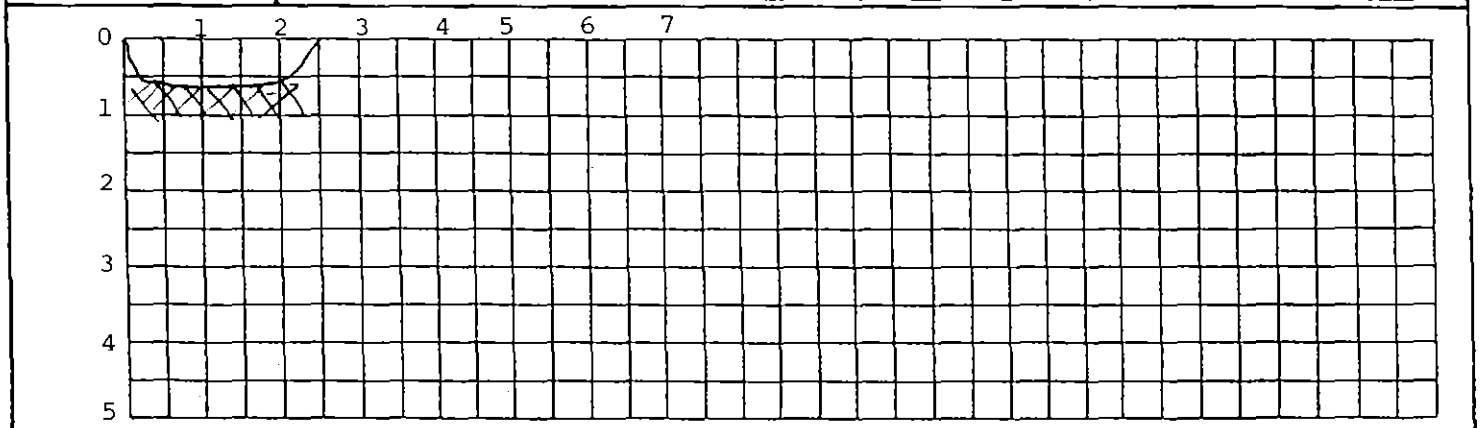
Client: Spectrum Resources Ltd
project: Proposed Anchor Tin Mine Tailings Dam
pit location: refer to figure 1

pit commenced: 28/4/88
supervised by: GB

equipment type and model: Hitachi UH038
excavation dimensions: 2.5 m long, 1.8 m wide

R.L. surface:
datum:

method	penetration 1 2 3	support	water	notes samples, tests, etc.	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency, rel. density	hand penetrometer 100 kPa 200 300 400	structure and additional observations
							ML	GRAVELLY CLAYEY SILT, brown medium plasticity, gravel fine to coarse, some fine to coarse sand	M	MD		
E		Nil	Not encountered		1.0			END 0.70m. EXCAVATOR REFUSAL SLIGHTLY TO MODERATELY WEATHERED ROCK				
					2.0							
					3.0							
					4.0							
					5.0							



key

method
- N natural exposure
- E existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper

support
- T timbering

penetration
1 2 3 – no resistance / ranging to refusal

water
10 Oct, 73 water level on date shown
water inflow
water outflow

notes
- – samples and tests
- U50 – undisturbed sample 50 mm diameter
- D – disturbed sample
- N – standard penetration test: figure = result
- N* – SPT + sample
- Nc – cone penetrometer

classification symbols and soil description
based on unified classification system

moisture
- D – dry
- M – moist
- W – wet

consistency/relative density
- VS – very soft
- S – soft
- F – firm
- St – stiff
- VSt – very stiff
- H – hard
- Fb – friable
- VL – very loose
- L – loose
- MD – moderately dense
- D – dense
- VD very dense

particle size distribution

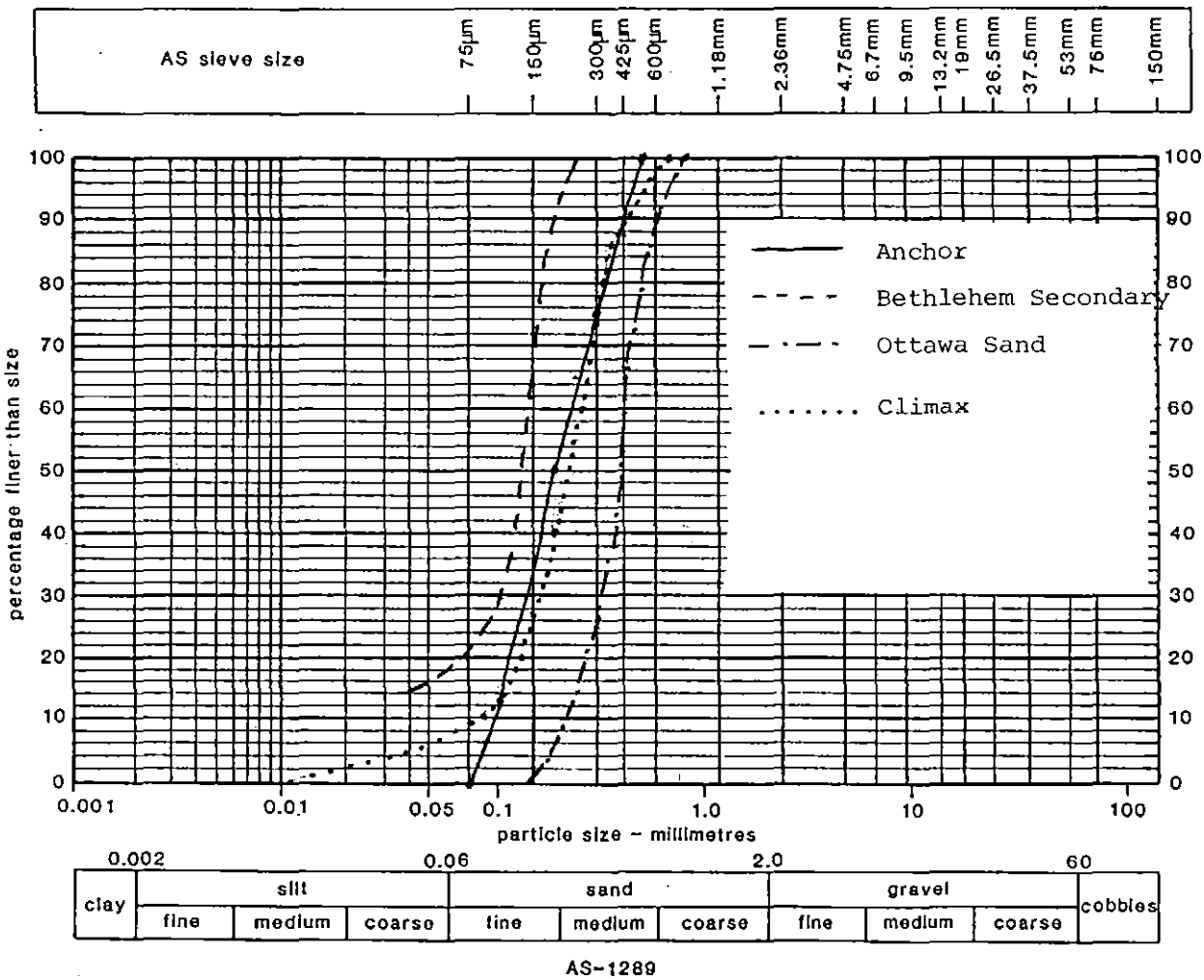
BFP materials testing

BARRETT, FULLER & PARTNERS

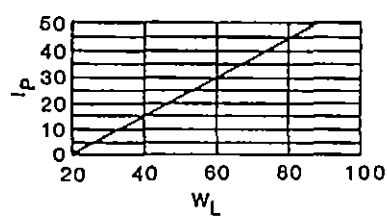
job no. 10-1003

sample N/A

client SPECTRUM RESOURCES LTD.	tested N/A
project ANCHOR TIN MINE - TAILINGS DAM	checked N/A
location TASMANIA	date 9/6/1988
sample identification / test procedure PUBLISHED AND SUPPLIED DATA	depth

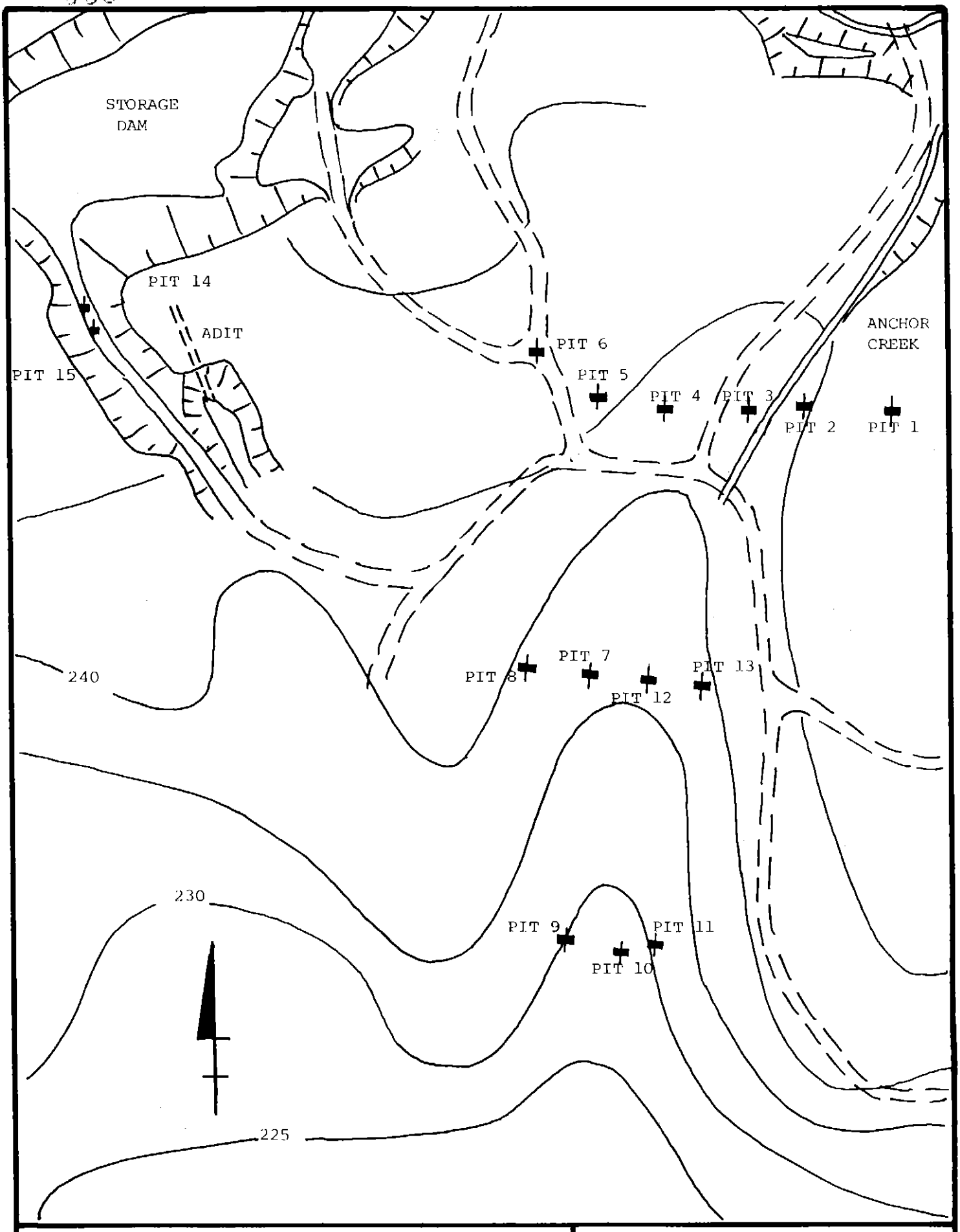


liquid limit %	
plastic limit %	
plasticity index %	
linear shrinkage %	
particle density t/m³	
natural moisture %	

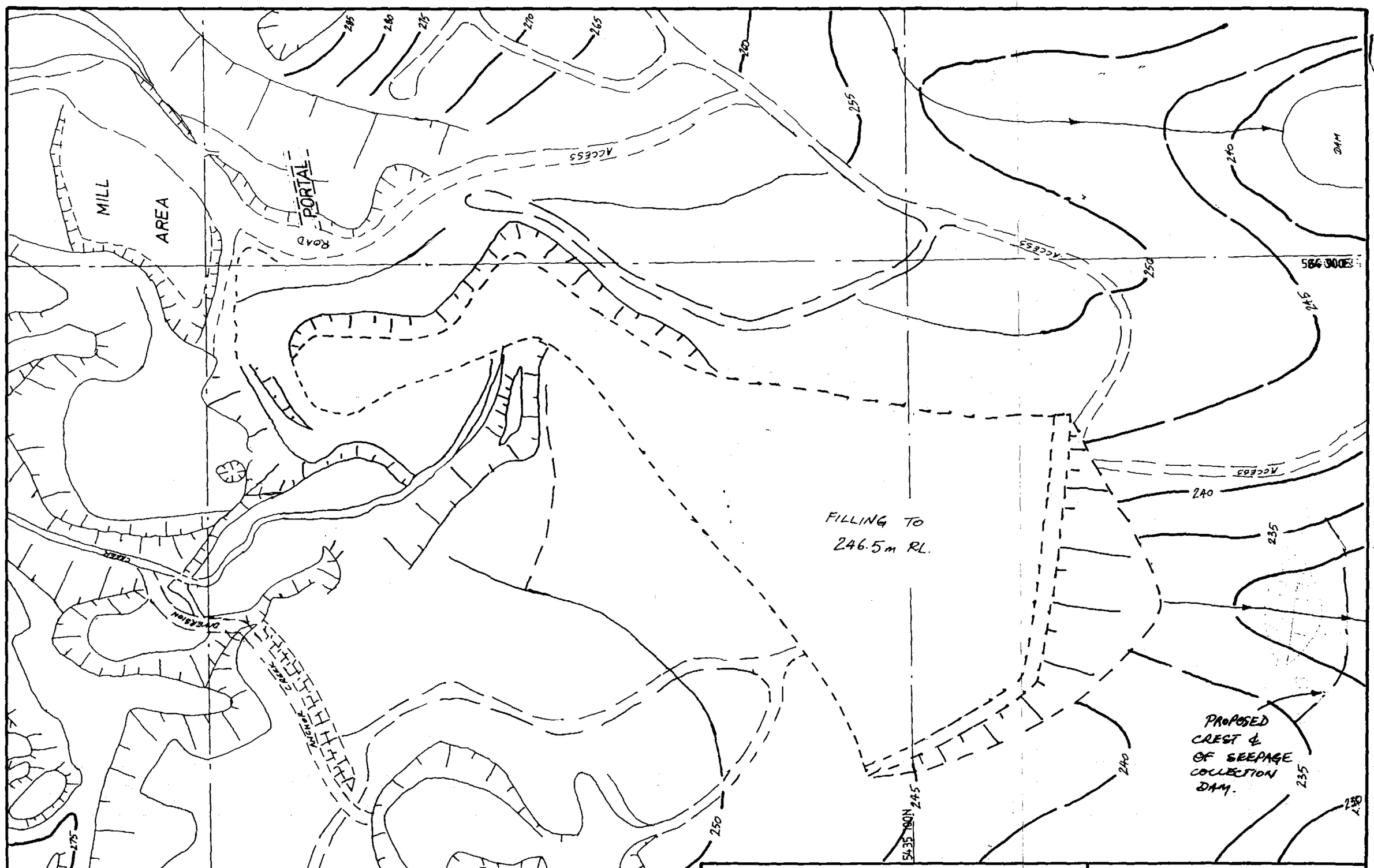


classification

Authorised Signature



CLIENT SPECTRUM RESOURCES LTD.	ANCHOR MINE PROJECT TEST PIT LOCATIONS		
BARRETT, FULLER & PARTNERS	**SCALE** NTS	**JOB No.** 10-1003	Fig. 1



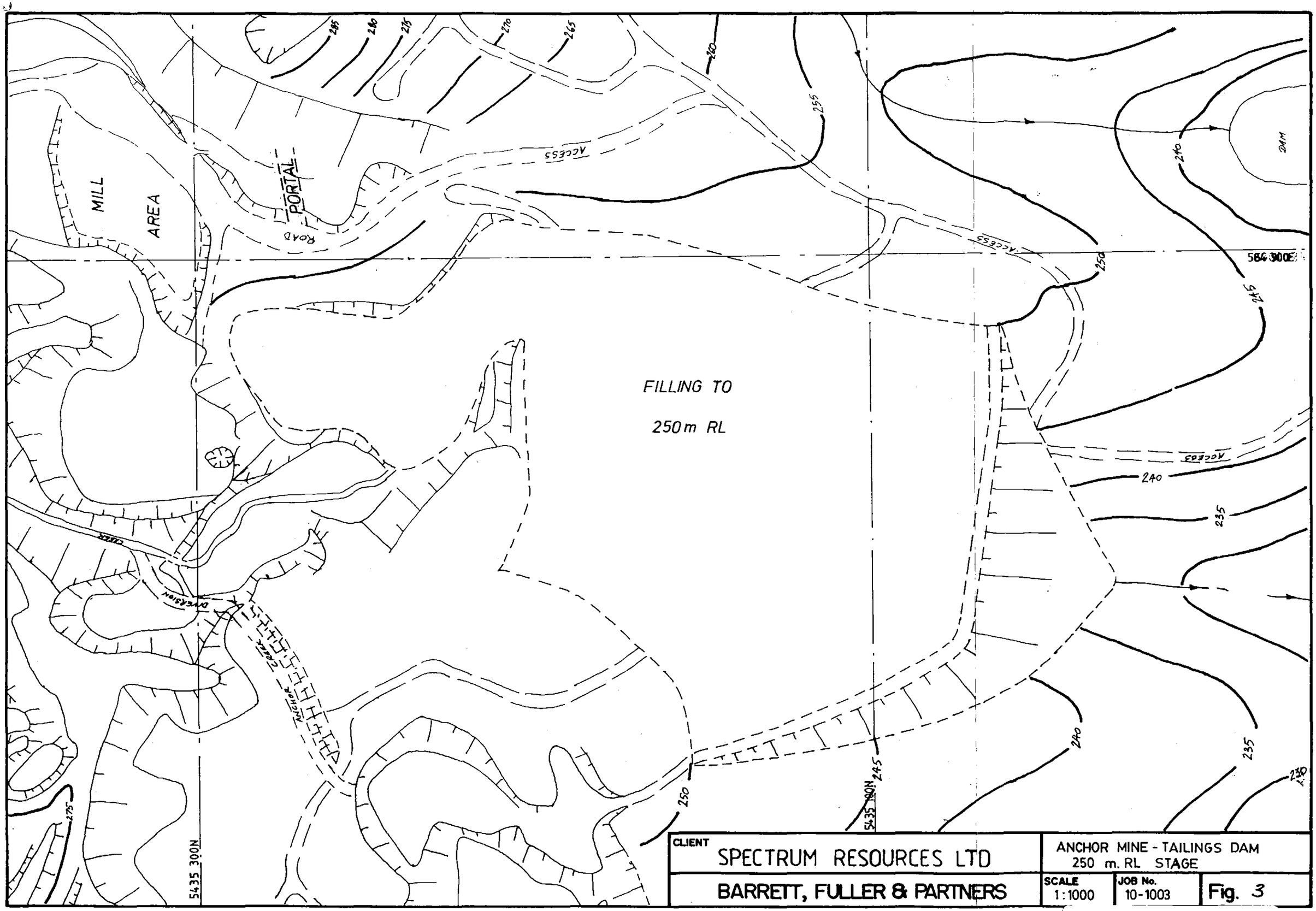
CLIENT
SPECTRUM RESOURCES LTD

BARRETT, FULLER & PARTNERS

ANCHOR MINE - TAILINGS DAM
246.5m. RL STAGE

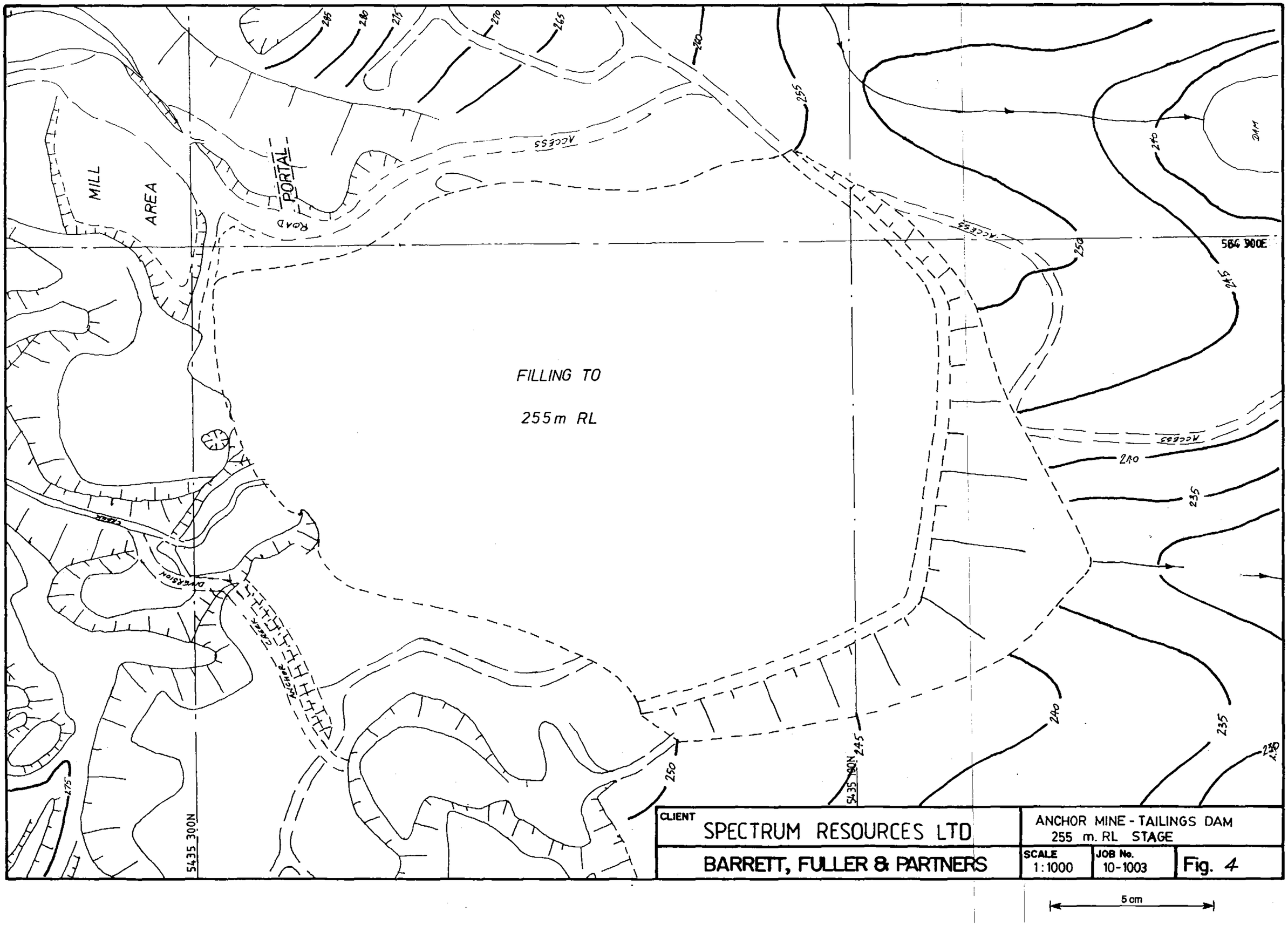
SCALE 1:1000 | JOB No. 10-1003 | Fig. 2

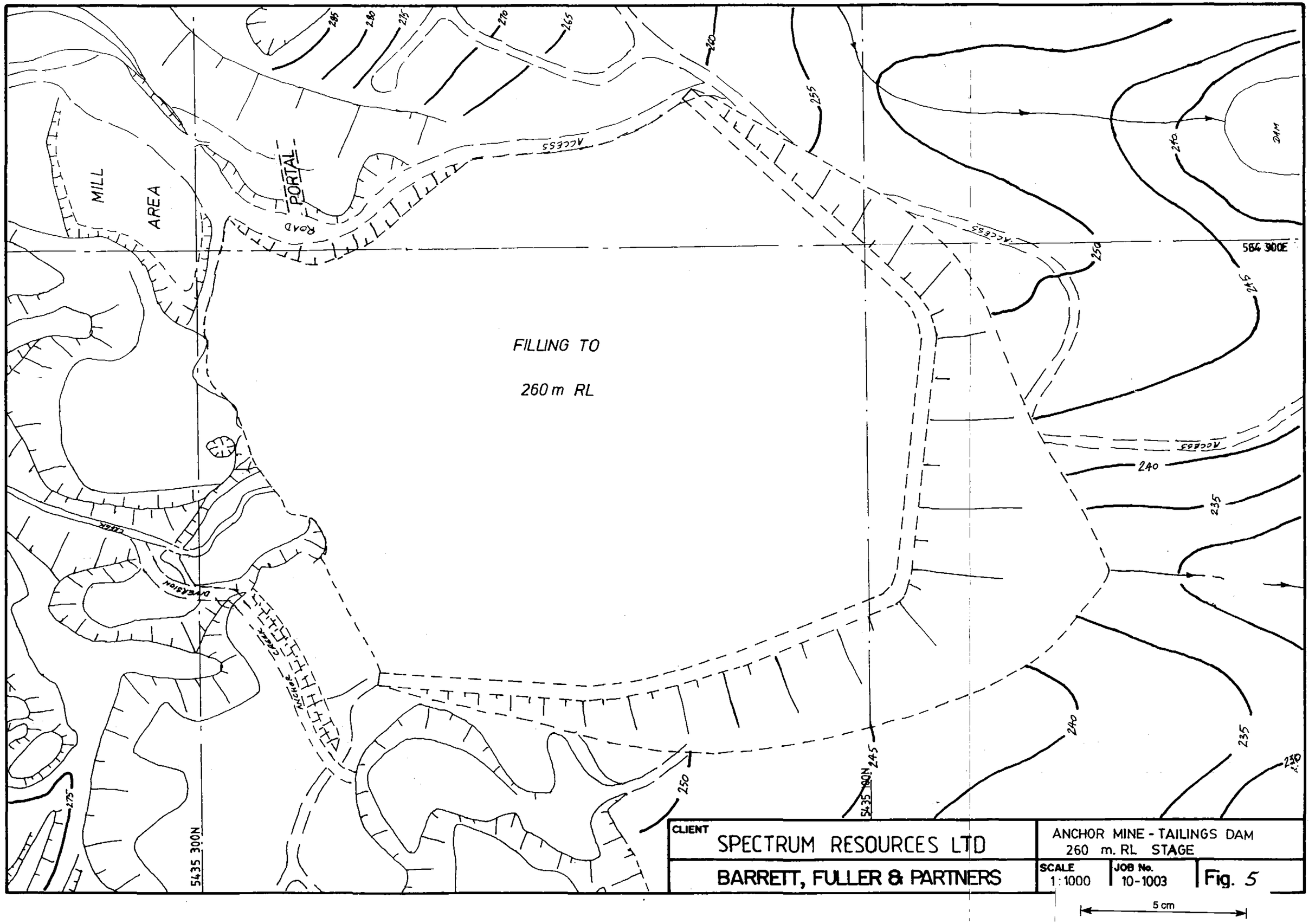
5 cm



CLIENT SPECTRUM RESOURCES LTD		ANCHOR MINE - TAILINGS DAM 250 m. RL STAGE
BARRETT, FULLER & PARTNERS	SCALE 1:1000 / JOB No. 10-1003	Fig. 3

5 cm


285
280
275
270
265
260
255
MILL
AREA
PORTAL
ROAD
ACCESS
564 900E
250
245
240
235
FILLING TO
255m RL
DIVERSION
CREEK
5435 300N
175
5435 100N
245
240
235
CLIENT
SPECTRUM RESOURCES LTD
BARRETT, FULLER & PARTNERS
ANCHOR MINE - TAILINGS DAM
255 m. RL STAGE
SCALE
1:1000
JOB No.
10-1003
Fig. 4
5 cm



CLIENT SPECTRUM RESOURCES LTD		ANCHOR MINE - TAILINGS DAM 260 m. RL STAGE
BARRETT, FULLER & PARTNERS	SCALE 1:1000 / JOB No. 10-1003	Fig. 5

5 cm