CLIENTS | PEOPLE | PERFORMANCE

Tweed Shire Council

Report for West Valley Quarry

Preliminary Study

September 2011

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

Contents

Table Index

Figure Index

Appendices

1. Introduction

Tweed Shire Council's (TSC) existing landfill, the Stotts Creek landfill, is predicted to reach capacity by 2012. As such, Council is seeking to develop new waste infrastructure to provide for the waste management requirements of the Tweed local government area (LGA) in the short term; and gain approval to develop additional waste infrastructure to meet the LGA's projected medium and long term needs.

Council is proposing to establish the Shire's new landfill facilities on existing Council owned land at Eviron Road, Eviron, within the Tweed LGA. Council has developed an overall Concept Plan for the proposed infrastructure, which outlines a staged approach to develop a landfill within the existing void space created by Quirks Quarry, the development of two further quarries to be used as landfills after exhaustion of the quarry resource, and necessary operational infrastructure such as a haul road, and other minor associated facilities as required. This proposed method of landfilling in quarry voids is consistent with the method of landfill creation in the Tweed Shire to date.

Council intends to undertake a staged approach to the development, and has thus sought two approvals from the Department of Planning:

- Project Approval for Stage 1 of the Concept Plan, which involves landfill within Quirks Quarry, development of a new quarry in the West Valley and associated infrastructure including a haul road from Stotts Creek landfill. This is referred to as the Stage 1 (Project Application); and
- Concept Plan Approval for the overall Concept Plan, which includes all components of the Stage 1 Project Application, as well as the further development of a landfill, and a quarry and landfill, which are currently proposed as Stage 2 of the Concept Plan. The 'Concept Plan' thus refers to all components of Stage 1 and Stage 2 encompassing all currently proposed waste and quarrying infrastructure.

TSC has engaged GHD to undertake this Preliminary Quarry Study for the West Valley Quarry, addressing the requirements of the Department of Primary Industries included as part of the Director General's Requirements for the Environmental Assessment of the Project. All assumptions made within this report have been identified herein, and any information that supports these assumptions is based on the conditions and aspects from sites in close proximity to the Quirks Quarry operation.

The proposed operations need to be adequately planned, developed and assessed in order to gain the appropriate approvals in order to commence site works. Items that will be assessed as part of the approval process include site rehabilitation, which also entails the determination of suitable land use options post quarry operations.

Previous studies have recognised that there may be several products that can be extracted for use; however the use of some of these products will only be suitable for specific uses on the Quirks and West Valley Sites.

2. Quarrying and Extractive Industry Development

2.1 Quarry and Extractive Industry Definitions

Extracted materials identified at the Quirks Quarry, which is adjacent to the proposed West Valley Quarry site, includes clays, gravel and rock, and it is predicted that those materials will also be encountered at West Valley Quarry. These materials are classified as extractive material, which is defined as sand, gravel, clay, soil, rock, stone or similar substances, and does not include turf. The proposed quarry operations are therefore classified as extractive industry, defined as the winning or removal of extractive materials (otherwise than from a mine) by methods such as excavating, dredging or quarrying, including the storing, stockpiling or processing of extractive materials, by methods such as recycling, washing, crushing, sawing or separating; but **does not include**:

1. Turf farming.
2. Tunnelling for the purpose of an approved infrastructure development.
3. Cut and fill operations (including the digging of foundations, ancillary to approved development).
4. The creation of a farm dam, if the material extracted in the creation of the dam is used on site and not removed from the site.

2.2 Justification of Development

In previous regional plans for the Eviron area, it was identified that there would be requirements for successive quarry developments for the Tweed Shire area. These plans include quarry operations which have since closed such as Bartlett's Quarry at the current Stott's Creek Landfill Site. Following Bartlett's Quarrying operations, it was proposed that Quirks and Eviron quarries would continue after these operations ceased.

These council-operated quarries were located within close proximity to each other, with the intention that the entire area would be relatively isolated, to allow/ensure:

- The site to be owned by the council acquired when planning was first being developed;
- The intensive activity to be undertaken with minimal impact to the community;
- That all existing neighbours are amenable to quarry activities;
- A continuity of products produced;
- Close proximity to townships, industry and tweed development areas, in order to be economical; and
- It is proposed that once quarry resources have been exhausted in the area, the area will be land-filled and potentially used as a botanic gardens corridor.

Within the initial planning of the Bartlett's, Quirks and Eviron quarry sites, these areas were zoned accordingly, to ensure the proposed plan could be executed stage by stage if required.

2.3 History of the Tweed Shire Relevant to the Proposed Quarry

Extractive industry has historically played a role in Tweed Shire, previously supplying material for highway works, as well as development and construction works linked to the growing population of the area.

There has been a long history of timber felling and cane growing, with particular reference to these activities between the Tweed River and Murwillumbah. It is expected that the Tweed's population and development will continue to grow and require maintenance. It is also expected that new developments and the associated construction works will use the quarry resources, to enable these works to progress.

2.3.1 Site Heritage

The site proposed for Quarry operations has no specific land use prior to this proposed quarry development, as the ridgeline dominated by eucalypts has been unsuitable for grazing cattle or cane growing activities.

The Bartlett's/Stott's Creek operations initially started as a quarry to be decommissioned and used for landfill once all available resource had been extracted and void space created. Currently there is limited void space remaining for landfill use at Stott's Creek. Closure planning is currently being formulated for Stott's Creek to return the landform to a suitable condition for use as part of a botanic gardens corridor.

Quirks Quarry has been operational since TSC acquired the operations. The extraction from Quirks Quarry has been operated continuously since the resource available for extraction has decreased, and another Quarry for the North and West Valley is proposed in order to fill the void that the closure of Quirks will leave. Cessation of works at Quirk's is being planned and post-quarry use for the land is being established so that rehabilitation and closure planning will be successfully integrated.

2.4 Products

The primary products to be produced at the West Valley Quarry are a range of aggregates, road base and fill materials. These products are planned for use and sale in the local area, namely for construction and development purposes. The excavated materials will be screened and crushed on site by pre-existing equipment from Quirk's and Stott's Quarry. Products that have been produced previously include road base material, fill materials and clays, as detailed below:

- 70-30 mm, 40 mm, 20 mm, 10 mm, 7 mm Drainage Aggregates;
- Cracker Dust;
- "C" Grading Type 2.1 and "B" Grading Type 2.3 Road base;
- Overburden / Fill;
- Screened topsoil (Rescreened from imported spoil); and
- Screened Sand (Rescreened from imported spoil).

2.5 Industry Structure and Economics

As the Tweed Shire and surrounding areas continue to grow and develop, there will be continued demand for building aggregates and associated products in this area, as well as further afield.

According to Council as Quirks Quarry resource is close to exhaustion, the market will require the development of Eviron Quarry. It is important that the planning of the closure of Quirks and the opening of Eviron allows seamless product supply.

The local area contains two main competitors; however these are further west of the Eviron Quarry and service the Murwillumbah town and North-Tweed area, whereas the Eviron Quarry would aim to supply

local council and the South-Tweed area, including Kingscliff, Bogangar, Cabarita, to Hastings Point (7 Year Plan Report and Tweed DCP 2008). These areas are all continuing to be developed and therefore are creating demand for fill and quarry products.

2.6 Planning

As part of the planning phase; preliminary studies and plans are being compiled to ensure that all aspects for the approval by local and state regulators can be met. These approvals are essential to enable the development of quarrying operation in the area, by allowing this prior to the absolute closure of the Quirks Quarry will allow seamless flow and availability of products during the interim.

Environmental, operational and community consultation, planning, development and reporting will be conducted to further ensure community awareness and to find any potential issues the greater community may have, or environmental aspects, which may influence the quarry development.

2.7 State and Federal Government and Agencies

As part of the TSC planning, provisions have been made in order to satisfy the greater community's needs for quarry material for development and the landfill uses outlined thereafter.

2.8 Local Government

As TSC is responsible for the construction and development of the local area, including maintaining the local areas' infrastructure, such as roads and reserves, a need for quarry material is maintained by council; and to ensure minimal cost expenditure for materials, the council requires the local development of quarries. Furthermore, by locating the proposed quarries close to previous and current operations on council-owned land minimal residents are affected by the proposed development of the North and West Valley areas.

The proposed Eviron area has correct zoning and is elevated above the floodplain, which reduces the requirement for dewatering, and reduces the risk associated with flood damage to equipment and machinery.

Due to ongoing development needs and population growth it has been identified that the quarry could be used for winning material required for various developments in and around the southern part of the Tweed Shire. Continued growth and landfill use has also been identified, and the quarry resource area can provide a suitable location for landfill and recycling purposes, once the resource is exhausted.

In summary, TSC's local strategy (referred to in 7 Year Plan Report and Tweed DCP 2008) is to create suitable quarry material that sustains the community's growth and development, whilst also identifying locations for potential landfill sites, that allow for the proper allocation, treatment and encapsulation of waste materials.

3. Tweed Shire Council Operations

TSC has developed several quarry operations required for council use and by local industry, as part of the TSC's plan to meet industry and community needs. Stott's Creek Operation, Quirks Quarry and the proposed Eviron Quarries form component parts of TSC's plan.

3.1 Stott's Creek Operations

Stott's Creek Operations include the former working quarry area (Bartlett's Quarry) and the current landfill activities. The area is zoned accordingly [5(a) Special Purpose (Garbage Depot)] and has been identified as such in the Tweed Local Environmental Plan 2000 (TLEP).

The Facility is located in close proximity to the currently operating Quirks Quarry located directly east of Stott's Creek Operations, and adjacent to the Pacific Highway. The area between the two operations consists of privately-owned properties, cane fields and the proposed West Valley Quarry site.

Significant investment of infrastructure has been input into developing the Stott's Creek Site. It has been identified that the use of pre-existing infrastructure could be both practical and cost-effective if the proposed West Valley Quarry is to be developed. This infrastructure includes security measures, a weighbridge, an office block and other staff facilities. During the Operational Phase, the Bartlett's Quarry at Stott's Creek Landfill site produced; aggregates, fill, road base and cracker dust.

The Existing Landfill operation is involved in:

- Methane capture utilisation, technology development and innovations;
- Pollution reduction and waste reduction technologies;
- Recycling technologies; and
- Landfill encapsulation.

Currently the Stott's Creek operations are nearing completion and will move towards other activities and/or start rehabilitation works on areas where works have ceased. It is predicted that landfill operations will cease some time in 2012.

3.2 Quirks Quarry Operations

Quirks Quarry has been operating since the 1950s. In 1996, TSC purchased the quarry and it began operating under the current quarry management plans. The resource at Quirks will become exhausted in 2010.

Initial resource extraction was deferred until council submitted a Quarry Management Plan, including flood study, acid sulphate soils investigation, and an investigation into haulage issues.

3.2.1 Current Operations

The current extraction licence is for a threshold of 100,000 tonnes annually (Lic No. 12777). The current operating hours for Quirks Quarry are identified in Table 1.

Table 1 Current Operating Hours for Quirk's Quarry

Operation	Operating Days	Start Times	Finish Times
Quarrying	Monday to Friday	7:00	17:00
	Saturday	7:00	12:00
Blasting	Monday to Friday	9:00	15:00
	Saturday	9:00	12:00
Hauling	Monday to Friday	7:00	17:00
	Saturday	7:00	12:00

3.2.2 Current Production

Currently a range of materials is produced at the Quirks Quarry site, including:

- 70-30 mm, 40 mm, 20 mm, 10 mm, 7 mm Drainage Aggregates;
- Cracker Dust;
- "C" Grading Type 2.1 and "B" Grading Type 2.3 Road base; and
- Overburden / Fill.

According to Council, the availability of the above materials is highly differential and can very dependent on the area of extraction and the depth that extraction is occurring within.

3.2.3 Current Equipment Fleet

The current quarry fleet utilised at Quirks Quarry is a combined fleet of hired and council-owned machinery and trucks.

Table 2 Equipment Currently Used and Required at Quirks

Council owned Equipment		**Hired Equipment**	
1	Fintec 542 Screening Plant	1.	Cat IT 62 Wheeled Loader
1	Daewoo Mega 300V Wheeled Loader	1.	Volvo L180 Wheeled Loader
		1.	Cat D7 Dozer
Other Equipment Onsite		1.	SEE Symons Cone Crusher
	Blasting equipment and associated vehicles	1.	Sumitomo SH 330-3 Excavator
	Trucks	1.	SEE Kue-Ken Jaw Crusher
1	Water truck (when required)	1.	Fintech 640 Scalper
1	Pneumatic hard rock drill	1.	25m Folding Stacker Conveyor
		1.	Finlay Hydra screen 683 Screening Plant.

3.2.4 Current Programs

The current Quarry Management Plan for Quirks Quarry incorporates multiple facets of the on-site environment and activities undertaken. Each facet and/or activity is identified within a plan to ensure regulatory compliances are maintained during operations. These plans include, but are not limited to the following:

- The Extraction plan for Quirks (method and sequence of extraction);
- Acid Sulphate Soil Plan;
- Vegetation clearing and Topsoil removal Plan;
- Sedimentation and Erosion Control Plan;
- Stormwater Management Plan;
- Dust Control Plan;
- Noise Abatement Strategies;
- Visual Protection and Enhancement (component of other plans);
- Flora and Fauna Protection Strategy;
- Archaeological Protection Strategy;
- Site Rehabilitation;
- Blasting Strategy;
- Haulage/Traffic Control Strategy;
- Fuel Storage;
- Waste Disposal; and
- Ongoing reporting and monitoring plans for environmental aspects.

Many of these plans are part of other plans and are combined to create the Quarry Management Plan, which is ultimately the overriding document pertaining to all aspects of the quarry, including its social, environmental and economic impacts on the local area.

4. Site Details

4.1 Location Details

The proposed North and West Valley Quarry areas are located approximately 1-1.5 kilometres west of the Pacific Highway. The Areas of interest are:

- Lot 1 DP 34555;
- Lot 1 DP 11159352; and
- Lot 602 DP 1001049.

These lots encapsulate the areas of development currently and for future works; these will be closely linked to the operations being undertaken at Stott's Creek, as the entire area is proposed to become a Botanic Gardens Spanning from the Eastern side of the highway to the current Stott's Creek facilities.

4.2 Site Description

The Eviron Quarry site is of varied topography, and water drains to the north-east on the site, as the ridge line lies along the south-west boundaries. The area is located above the floodplain associated with the Tweed River, which is located approximately four kilometres north-west of the Proposed Quarry.

Currently the site is closely located to the existing Quarry (Quirk's) and the Stott's landfill area.

Distances from the quarry to the local towns of the area are approximately:

- 5.5 km Cudgen;
- 5.5 km Bogangar;
- 7.5 km Kingscliff town centre; and
- 10 km Murwillumbah town centre.

4.3 Site Entrance and Access

It is proposed that the entry/exit point for the proposed quarry operations utilise a new haul road to be created between Stott's Landfill and the northern section of the proposed operations. The existing access point for Quirks Quarry onto Eviron Road will be discontinued and access will no longer be permitted from this point.

4.4 Land Use

Currently the land surrounding the proposed quarry areas is predominantly cane fields to the north and west and quarried to the east (Quirks Quarry). North of the proposed West Valley Quarry area is a privately owned small scale privately owned quarry (known as O'Keeffes Quarry).

A number of rural residential properties are located along Eviron Road to the south-east and west of the proposed quarry.

4.5 Local Waterways and Drainage

Currently several cane channels used for water drainage associated with the low lying flood plain area overlooked by the proposed Eviron Quarry site. In addition to this the Tweed River is located approximately 4 km north-west of the proposed quarry site.

Currently drainage on site travels down from the ridge line towards the flood plain and enters cut channels to then be flow to the larger local watercourses.

However some water is captured currently on the Quirks Quarry site in a holding dam and used for operations.

4.6 Waterways and Water Bodies

There are many cane channels cut into the floodplain area to the north of the site, these drain into creeks and then to the Tweed River. These are approximately:

- 4.7 km Condong Creek;
- 1.2 km Mains trust CN;
- 3.5-4 km Tweed River; and
- 3.4 km to Cudgen Lake;

4.7 Climate

Table 3 outlines the average rainfall since 1998 in the Tweed Shire Area. May through to October are predominantly the drier months of the year however some large rainfall have skewed the average of these months.

4.7.1 Murwillumbah

Murwillumbah generally experiences mild winters and summers. Average data for the area is reported in Table 3 as recorded by the official Bureau of Meteorology Weather Station, (http://www.tweed.nsw.gov.au/AboutTheTweed/RainfallChart).

Table 3 Murwillumbah Metrological Information

Data	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Temp Avg (Daily Max)	29.5	29.0	28.5	26.5	23.6	21.1	20.8	21.1	24.5	25.8	27.6	29.5	25.63
Temp Avg (Daily Min)	19.1	19.2	18.0	15.0	13.3	9.1	8.1	8.2	10.8	13.4	16.1	18.0	13.94
Sum Rain (Mean mthly)	205	222	259	171	158	99	90	60	44	106	132	155	1701
Sum Rain (Median mthly)	174	158	214	104	106	63	63	43	33	93	127	117	1295
Sum Rain (Days Mean)	15	17	18	15	14	10	10	9	9	12	13	14	156

5. Geology of the Site

The proposed West Valley Quarry will extract soils, weathered materials and rocks of the Neranleigh-Fernvale Beds (NF) from the side of a steep hill west of the Pacific Highway.

5.1 General Topography

The topography of the proposed West Valley Quarry area is a combination of low lying floodplain of the Tweed River Valley and a ridge line that borders the south-west parts of Lot 1 DP 34555; Lot 1 DP 1159352 and Lot 602 DP 1001049. The floodplains are used for sugar cane cropping and the ridges occasionally for grazing. Elevations range from 0 RL to 60m RL across the proposed quarry site.

5.2 Regional Geology

In the region of the West Valley Quarry, the Murwillumbah 1:100 000 scale geological map (GSQ, 1978) shows the site as being underlain by the Neranleigh-Fernvale Beds. This unit is Devonian-Carboniferous in age and is mapped to comprise mudstone, shale, greywacke, quartzite/chert, jasper, basic metavolcanics, pillow lava and conglomerate. The depositional environment was deep-water marine. Willmott (2010) indicates that these sediments are folded, metamorphosed and inclined moderately to steeply. Areally, these metasediments are very extensive and have been identified as far north as Yeppoon in central Queensland and as far south as Ballina in New South Wales.

Lithological descriptions are provided within Willmott (2010) as follows;

- Argillite (Mudstone): Dark grey to black, very fine-grained, hardened mudstone; buff to whitish coloured when weathered; represented in lower hills of hinterland but can form prominent ridges.
- Greywacke: Dark grey, hard, massive rocks consisting of fine to coarse angular to sub-angular rock fragments in a recrystallised groundmass; can form beds 100 to 200 m thick.
- Shale: Fine-grained detrital sediments, laminated and easily split into layers; readily weathered.
- Greenstone: Greenish-grey, fine-grained recrystallised basalt resulting from basalt lava flows on the sea bed; weathers to red coloured profiles.

In the district, the lithologies which comprise the Neranleigh-Fernvale have been commercially exploited; for example;

- Slate in the Gold Coast area has been used to decorate walls.
- Greywacke has been used as an important source of crushed rock aggregate for construction. The Ormeau Quarry situated between Brisbane and the Gold Coast has had greywacke quarried for aggregate purposes since 1981. Elsewhere in the Gold Coast, Whitlow (2000) has reported several quarry localities (Darlington ranges, north of Nerang and Andrews area) within greywacke.
- Quartzite has been worked within quarries for road gravels. Whitlow (2000) has reported sand and gravel extraction operations on the Upper Coomera river terraces and in the Pimpama region within the Gold Coast.
- Greenstone (basic metavolcanics) when fresh has been used as aggregate in a quarry within the Albert valley area in the northern part of the Gold Coast.

Low lying areas of the site are underlain by Recent to Tertiary alluvium.

5.3 Local Geology

During August 2011, GHD personnel mapped the geology of the area covered by the West Valley Quarry proposal and noted that the area contained only minor to rare outcrop or sub-outcrop of Neranleigh-Fernvale beds. A detailed geological mapping report is presented in Appendix A.

Locally, the Neranleigh-Fernvale beds consist of a combination of cherts/quartzites, siltstones and greywackes which cannot be traced over significant distances thereby precluding geological interpretation. When observed at the surface, these beds (particularly the siltstone) have moderately well to poorly defined foliation which strikes north to northwest and dips moderately to steeply westward. This foliation appears to form on bedding or lamination planes. The siltstone is the most common lithology observed in outcrop particularly in the western part of the area where a pronounced ridge is present. The other lithologies; cherts/quartzites and greywackes outcrop poorly in the area. These lithologies are mostly observed within road or drainage cuttings and as massive to blocky material often jointed, fractured with some local quartz veining.

Significant additional geological information was obtained from reviewing the Quirks Quarry to the east of the area. The Quirks Quarry contained mostly exposed siltstone with locally isolated exposure of chert/quartzite and greywacke. There are indications of local faulting and alteration (silicification) of particularly siltstone within the Quirks Quarry but lack of outcrop in close proximity to this quarry does not allow the alteration and faulting to be traced along strike.

In the northeastern section of the quarry study area, outcrop is absent as a result of historic land clearing activities and prevalence of Tertiary to Recent alluvium.

In addition to the recent geological mapping undertaken by GHD, five (5) partially cored drillholes were re-logged in January 2011. This re-logging has provided a more detailed description of the lithology and geology at the proposed West Valley Quarry area. Core from the following boreholes was provided for re-logging:

- TSCBH01 (total depth 70.25m)
- TSCBH02A (total depth 20m)
- TSCBH02B (total depth 55.3m)
- TSCBH03A (total depth 20.2m)
- TSCBH03B (total depth 60.3m)

The holes were distributed across the site, with three holes located in the northern one third of the site and two holes located in the southern one third of the site, providing data across all topographic and geomorphological terrains, from the hill crest, slopes and plain adjacent to the creek (Figure 1, Figure 2, Figure 3, Figure 4, and Figure 5)

Overall, 15 holes were attempted included two (2) holes which had to be re-drilled due to hole technical difficulties. Core recoveries within all holes drilled were generally poor with several wide zones of poor recovery observed.

Several other shallow TSCBH prefixed holes were drilled but were very shallow with an average depth of 9.4m and ranging in depth from 1.8m to 20m. Logging of these holes indicated that all holes ended in weathered Neranleigh-Fernvale with between 1 and 3 metres of Tertiary alluvial cover.

Several other diamond drill core holes were also planned to provide a large geographical spread of geological information but could not be completed primarily as statutory approvals could not be attained at that time. Significant core loss experienced within the TSCBH prefixed holes particularly within the top 20m also may have resulted in uncertainty when mapping the boundary between Tertiary or Recent alluvium and Neranleigh-Fernvale beds underneath.

Seventeen holes (hole numbers GW1-GW4, GW6-17, GW19A) were drilled to monitor groundwater levels (GW prefixed holes). Only four (4) of these holes intersected Neranleigh-Fernvale beds; 3 holes (GW1, GW3, GW15 and GW19A) intersected weathered Neranleigh-Fernvale beds and only GW19A intersected fresh Neranleigh-Fernvale beds at 14.6m in depth. The hole depths of these groundwater monitoring holes were generally less than 5m except for GW1, GW3 and GW19A which has depths of 12m, 12.5m and 56m respectively.

5.3.1 Tertiary and Recent Alluvium

Tertiary to Recent alluvium has been recorded in all the holes drilled within the West Valley Quarry area (both TSCBH and GW prefixed holes) and extends to about 20m in depth below the ground level. Intersection of alluvium is displayed best within TSCBH02A. The materials are dominated by silty to sandy clays, generally of moderate to high plasticity. Colour varies throughout, however large fragments of clay recovered in some of the chip samples suggest the base colour is grey, with yellow, orange and red mottling throughout. Alluvium mapped at the surface and within drillholes has not been distinguished as in broad terms the lithology is similar.

A significant sand layer was observed between approximately 14m and 20m (end of hole depth) within TSCBH02A where the grain size varies and a subtle upward fining sequence was also noted. The sand is generally well graded and is comprised of quartz and lithic fragments with trace silt and clay.

Due to significant core loss experienced in drilling core holes prefixed by TSCBH, it is possible that Tertiary or Recent alluvium cover logged in these holes may have been overestimated.

As a result of the drilling method and age of the samples, the in-situ density and moisture condition for these materials cannot be established with certainty from the samples remaining. It is possible that similar materials could occur beneath areas of similar topographic and geomorphological expression.

Surficial cover consisting of Tertiary to Recent alluvium is most prevalent in the central portion of the Tweed Quarry area with geological mapping undertaken in the far west of the area and within the Quirks Quarry to the far southeast indicated often less than 1m of cover.

5.3.2 Neranleigh-Fernvale Beds

The rocks within drillholes TSCBH01, TSCBH02A, TSCBH02B, TSCBH03A and TSCBH03B consist of an interbedded sequence dominated by siltstone and greywacke and rarely black or graphitic shale, with minor brecciation and variably silicified. Pyrite (sulphide) mineralisation is observed in three holes within foliation planes (TSCBH01, TSCBH03A and TSCBH03B) or in apparently local alteration zones (as displayed within TSCBH01).

Strong silicification is observed within TSCBH01 and appears to have resulted from secondary alteration. The intensity of secondary silicification is much less within TSCBH02B, TSCBH03A and TSCBH03B. The alteration observed within TSCBH01 is considered a local effect as holes drilled in relatively close proximity to TSCBH01 are much less altered.

In drill core, the weathered Neranleigh-Fernvale beds exhibit an earthy texture. Fresher material of the Neranleigh-Fernvale beds is generally grey to grey-green in colour and the depth of oxidation is approximately 20m below the ridge in the western section of the West Quarry area to much deeper further east. Weathering varies with depth and is somewhat persistent, with some leaching and discolouration along defects observed until approximately 38m below ground level in TSCBH01.

Rock strength improves below the weathered material, ranging between high and extremely high, with the quartzite being much stronger than the siltstone. Rock strength varies, generally ranging between medium and high strength, with localised areas of very high strength greywacke noted. Low strength material may be present in zones which are more deformed and hence foliated.

The greywacke is generally medium-grained with coarse lithic fragments throughout. The colour of the greywacke varies from pale brown to grey. Typically, the greywacke consists of quartz, feldspar and lithic material.

The siltstones are dark grey to grey in colour when fresh and are thinly laminated to thinly bedded and display a phyllite-like texture when broken. Soft sediment deformation and deformed bedding, is common throughout fine-grained materials interbedded with the greywacke. The siltstone is generally very strongly foliated.

A possible fault zone was noted in TSCBH03B with the greywacke occurring below a brecciated and sheared band, extending from 30.75 to 31.79m. This zone is significantly stronger than the overlying rock and also contains common defects with calcite infill. Occasional defects were noted to contain two phases of infill: calcite and quartz. Pyrite was noted to occur in places within this zone but is much less intense compared with the concentration within the black shales/siltstones of TSCBH01.

Moderately to heavily silicified rocks of the Neranleigh-Fernvale Beds occur only along the unweathered length of TSCBH01. The lithological sequence within TSCBH01 is dominated by siltstone with quartzite/chert and pyritic black shale/siltstone also present in the lower portion of the borehole.

After a further review of drillhole TSCBH01, the hole was selectively sampled from 37 to 70.25m (end of hole depth). This interval contained significant pyrite mineralisation and is commonly strongly silicified. The section of drill core was cut and sampled to analyse for a suite of trace elements in order to determine the prospectivity with respect to metal content. Table 4 shows the section of core within TSCBH01 (drilled outside of the proposed West Valley Quarry area) which was sampled. All drillholes were reviewed and this section of drill core appeared to be the most prospective section of the Neranleigh-Fernvale beds penetrated within the drill program. Assay results have been obtained for the samples listed in Table 4 and are displayed within Table 5. No significant assays were obtained with respect to gold (Au) however some anomalous zinc (Zn) and copper (Cu) was returned within TSCBH01 related to localised pyrite mineralisation and alteration not observed elsewhere within the proposed West Valley Quarry area.

Table 4 Summary of sampling intervals within TSCBH01

Sample Number	From (m)	To (m)	Drilled Length (m)	Approximate Recovered Length (m)	Lithology	Comments
TSCBH0101	37.00	39.00	2.00	1.55	Siltstone	Quartz veining throughout. Carbonaceous band at 38.80m.
TSCBH0102	39.00	40.80	1.80	1.06	Siltstone/Carbonaceous Mudstone	Pyritic
TSCBH0103	40.80	42.00	1.20	1.09	Siltstone	Quartz veining throughout. Carbonaceous bands and cherty in part.
TSCBH0104	42.00	44.40	2.40	1.24	Siltstone/Carbonaceous Shale	Quartz veining throughout. Carbonaceous bands and cherty in part. Pyritic throughout.
TSCBH0105	44.40	46.40	2.00	1.60	Chert/Quartzite	Iron Oxide staining common in veins.
TSCBH0106	46.40	48.40	2.00	1.70	Siliceous Siltstone	Minor iron oxide staining.
TSCBH0107	48.40	50.20	1.80	1.50	Siliceous Siltstone	Abundant quartz and carbonate veins and pyritic throughout.
TSCBH0108	50.20	52.40	2.20	1.45	Siliceous Siltstone	Abundant quartz and carbonate veins and pyritic throughout. Minor carbonaceous bands.
TSCBH0109	52.40	54.45	2.05	1.80	Carbonaceous Shale	Graphitic and pyritic. Iron oxide in quartz and carbonate veins.
TSCBH0110	54.45	56.50	2.05	1.05	Siltstone	Carbonaceous bands at top. Abundant pyrite throughout.
TSCBH0111	56.50	60.70	4.20	0.65	Siliceous Siltstone	Cherty in part. Minor pyrite with graphite bands.
TSCBH0112	60.70	63.30	2.60	1.40	Siltstone	Iron Oxide staining in quartz veins which occur throughout. Pyritic also throughout. Highly altered band at 61.5m.
TSCBH0113	63.30	65.50	2.20	2.20	Cherty Siltstone	Iron oxide staining common. Quartz veining throughout.
TSCBH0114	65.50	67.30	1.80	1.80	Quartzite	Abundant pyrite rich veins and also greenish stain?/mineral? With iron oxide staining. Quartz veining prevalent throughout in country rock.
TSCBH0115	67.30	68.50	1.20	1.20	Quartzite	Abundant pyrite rich veins and also greenish stain?/mineral? With iron oxide staining. Quartz veining prevalent throughout in country rock.
TSCBH0116	68.50	70.25	1.75	1.75	Quartzite	Abundant pyrite rich veins and also greenish stain?/mineral? With iron oxide staining. Quartz veining prevalent throughout in country rock.

Table 5 Summary of assay results from sampling of TSCBH01.

	Au-TL43	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41
SAMPLE	**Au**	**Ag**	**Al**	**As**	**B**	**Ba**	**Be**	**Bi**	**Ca**	**Cd**	**Co**	**Cr**	**Cu**	**Fe**	**Ga**	**Hg**	**K**	**La**
DESCRIPTION	**ppm**	**ppm**	**%**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**%**	**ppm**	**ppm**	**ppm**	**ppm**	**%**	**ppm**	**ppm**	**%**	**ppm**
TSCBH0101	<0.001	<0.2	0.69	22	<10	60	<0.5	<2	0.02	<0.5	13	20	153	1.23	<10	<1	0.01	10
TSCBH0102	<0.001	0.9	0.77	82	<10	50	<0.5	<2	0.11	<0.5	20	23	136	6.94	<10	<1	0.06	10
TSCBH0103	<0.001	<0.2	0.32	18	<10	10	<0.5	<2	0.13	<0.5	15	12	56	1.68	<10	<1	<0.01	10
TSCBH0104	<0.001	0.3	0.47	34	<10	20	<0.5	<2	0.12	<0.5	19	17	80	3.21	<10	<1	0.02	10
TSCBH0105	<0.001	0.2	0.37	31	<10	20	<0.5	<2	0.08	<0.5	15	22	70	2.89	<10	<1	0.01	10
TSCBH0106	0.001	<0.2	0.07	11	<10	<10	<0.5	<2	0.02	<0.5	3	7	10	1.22	<10	<1	<0.01	<10
TSCBH0107	0.001	<0.2	0.5	4	<10	20	<0.5	<2	0.04	<0.5	4	7	53	2.77	<10	<1	<0.01	<10
TSCBH0108	<0.001	<0.2	1.35	16	<10	40	<0.5	<2	0.28	<0.5	25	25	134	5.95	10	<1	0.02	10
TSCBH0109	<0.001	0.5	1.57	34	<10	50	0.5	<2	0.55	<0.5	45	30	242	8.15	10	<1	0.09	20
TSCBH0110	0.001	0.2	1.14	5	<10	20	<0.5	<2	0.14	<0.5	7	12	90	4.13	10	<1	0.05	10
TSCBH0111	0.001	<0.2	0.32	2	<10	10	<0.5	<2	0.09	<0.5	3	5	38	1.34	<10	<1	0.02	<10
TSCBH0112	<0.001	0.3	0.38	12	<10	20	<0.5	<2	0.22	<0.5	13	15	86	3.2	<10	<1	0.01	10
TSCBH0113	<0.001	<0.2	0.26	13	<10	20	<0.5	<2	0.44	<0.5	18	8	71	2.03	<10	<1	0.01	10
TSCBH0114	<0.001	<0.2	0.86	27	<10	30	<0.5	<2	0.2	<0.5	43	16	167	2.99	10	<1	0.01	10
TSCBH0115	<0.001	0.2	0.77	41	<10	20	<0.5	<2	0.19	<0.5	77	13	194	2.96	<10	<1	0.02	10
TSCBH0116	0.001	<0.2	1.23	8	<10	30	0.6	<2	0.32	<0.5	51	19	184	4.78	10	<1	<0.01	20
	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41
SAMPLE	**Mg**	**Mn**	**Mo**	**Na**	**Ni**	**P**	**Pb**	**S**	**Sb**	**Sc**	**Sr**	**Th**	**Ti**	**Tl**	**U**	**V**	**W**	**Zn**
DESCRIPTION	**%**	**ppm**	**ppm**	**%**	**ppm**	**ppm**	**ppm**	**%**	**ppm**	**ppm**	**ppm**	**ppm**	**%**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**
TSCBH0101	0.01	70	2	<0.01	46	4930	8	1.02	23	1	89	<20	<0.01	<10	<10	22	<10	23
TSCBH0102	0.11	323	9	0.01	67	2960	19	6.92	36	1	47	<20	<0.01	<10	<10	65	<10	57
TSCBH0103	0.14	623	1	0.01	40	880	7	0.92	10	1	35	<20	<0.01	<10	<10	40	<10	53
TSCBH0104	0.18	685	2	0.01	47	1080	7	2.42	18	1	39	<20	<0.01	<10	<10	60	<10	70
TSCBH0105	0.14	428	3	0.01	44	1140	7	2.35	15	1	36	<20	<0.01	<10	<10	49	<10	181
TSCBH0106	0.02	229	2	0.01	16	170	2	0.74	<2	<1	4	<20	<0.01	<10	<10	6	<10	45
TSCBH0107	0.24	856	1	0.01	18	380	<2	1.6	6	1	21	<20	<0.01	<10	<10	24	<10	28
TSCBH0108	0.76	1705	6	0.01	86	1660	11	3.35	16	3	63	<20	<0.01	<10	<10	91	<10	225
TSCBH0109	0.82	1365	16	0.01	132	2700	32	6.44	26	3	108	<20	0.01	<10	<10	179	<10	580
TSCBH0110	0.69	953	2	0.01	25	690	2	1.84	11	2	20	<20	0.01	<10	<10	39	<10	159
TSCBH0111	0.19	530	1	0.01	18	370	5	0.51	2	1	9	<20	<0.01	<10	<10	16	<10	100
TSCBH0112	0.21	1345	2	0.01	63	970	5	1.78	11	1	32	<20	<0.01	<10	<10	39	<10	176
TSCBH0113	0.14	1075	3	0.01	38	1890	7	0.99	6	1	31	<20	<0.01	<10	<10	89	<10	818
TSCBH0114	0.57	8180	4	0.01	100	730	17	0.5	9	3	19	<20	0.01	<10	<10	72	<10	210
TSCBH0115	0.59	2800	2	0.01	100	760	9	0.85	7	2	19	<20	<0.01	<10	<10	69	<10	133
TSCBH0116	0.75	16500	1	0.01	74	1010	19	1.21	3	3	30	<20	0.01	<10	<10	44	<10	70

Figure 1 Drillhole Locations – Site View (with Cross Sections locations)

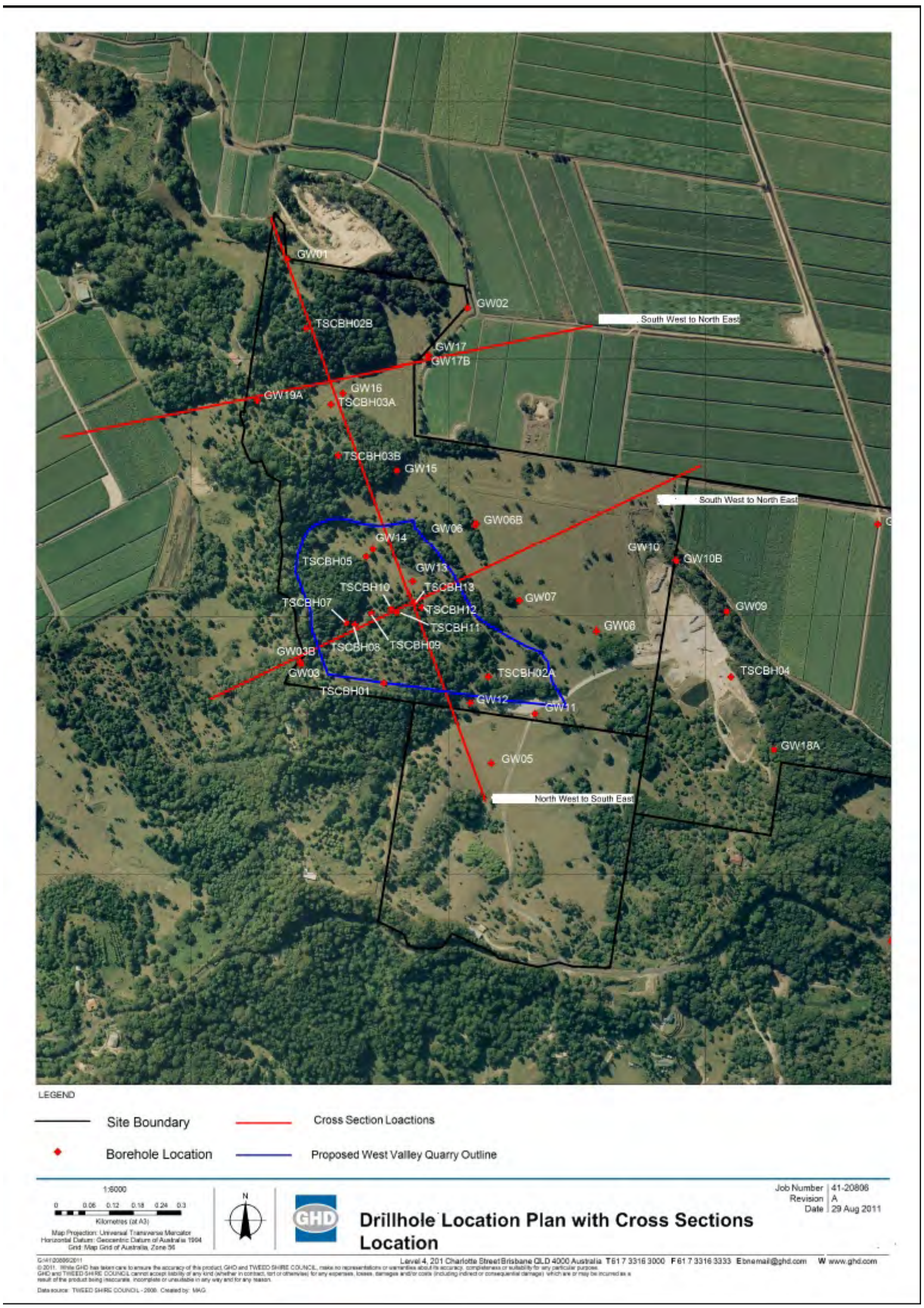


Figure 2 Cross Section North West to South East

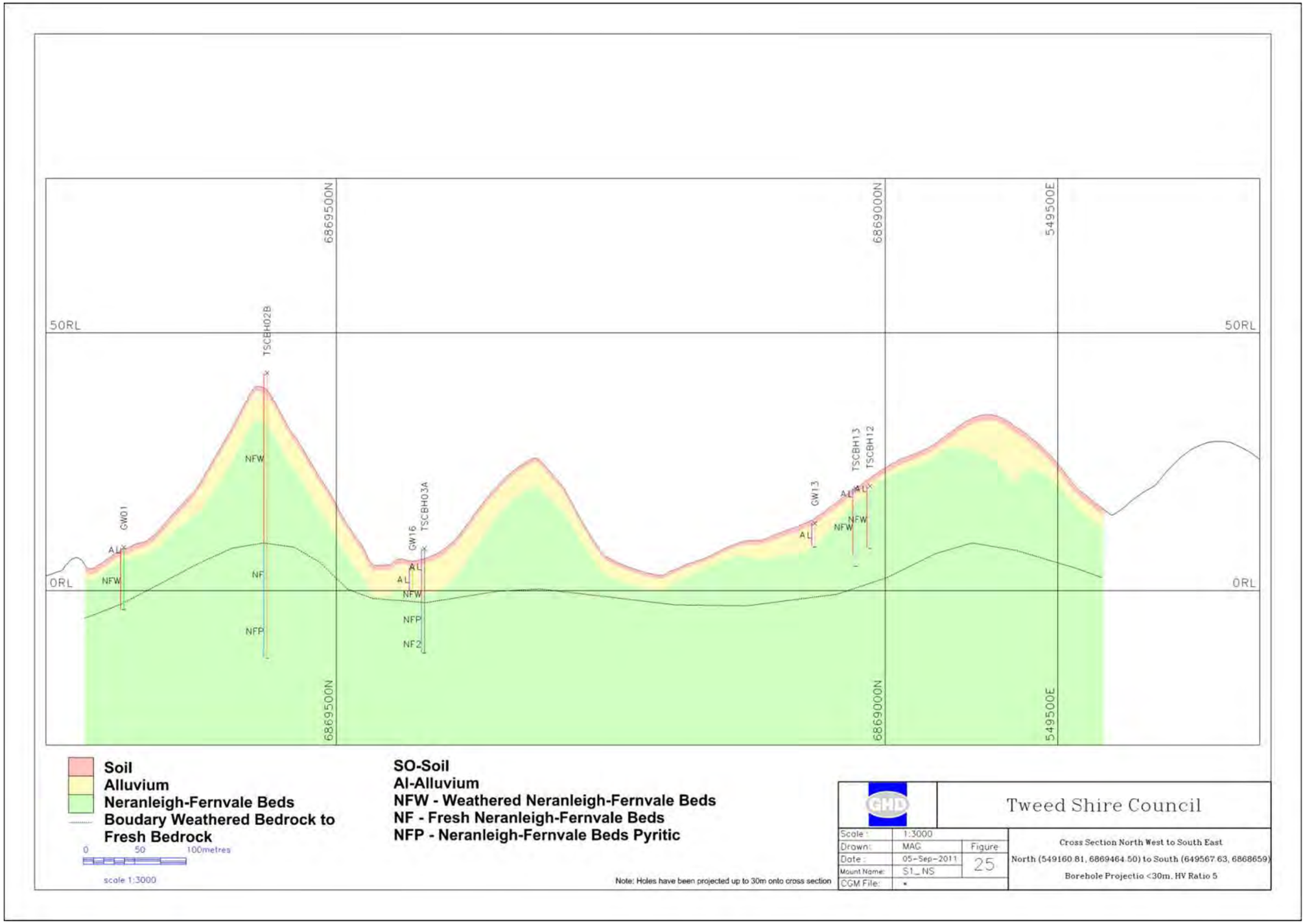


Figure 3 Cross Section South West to North East (North)

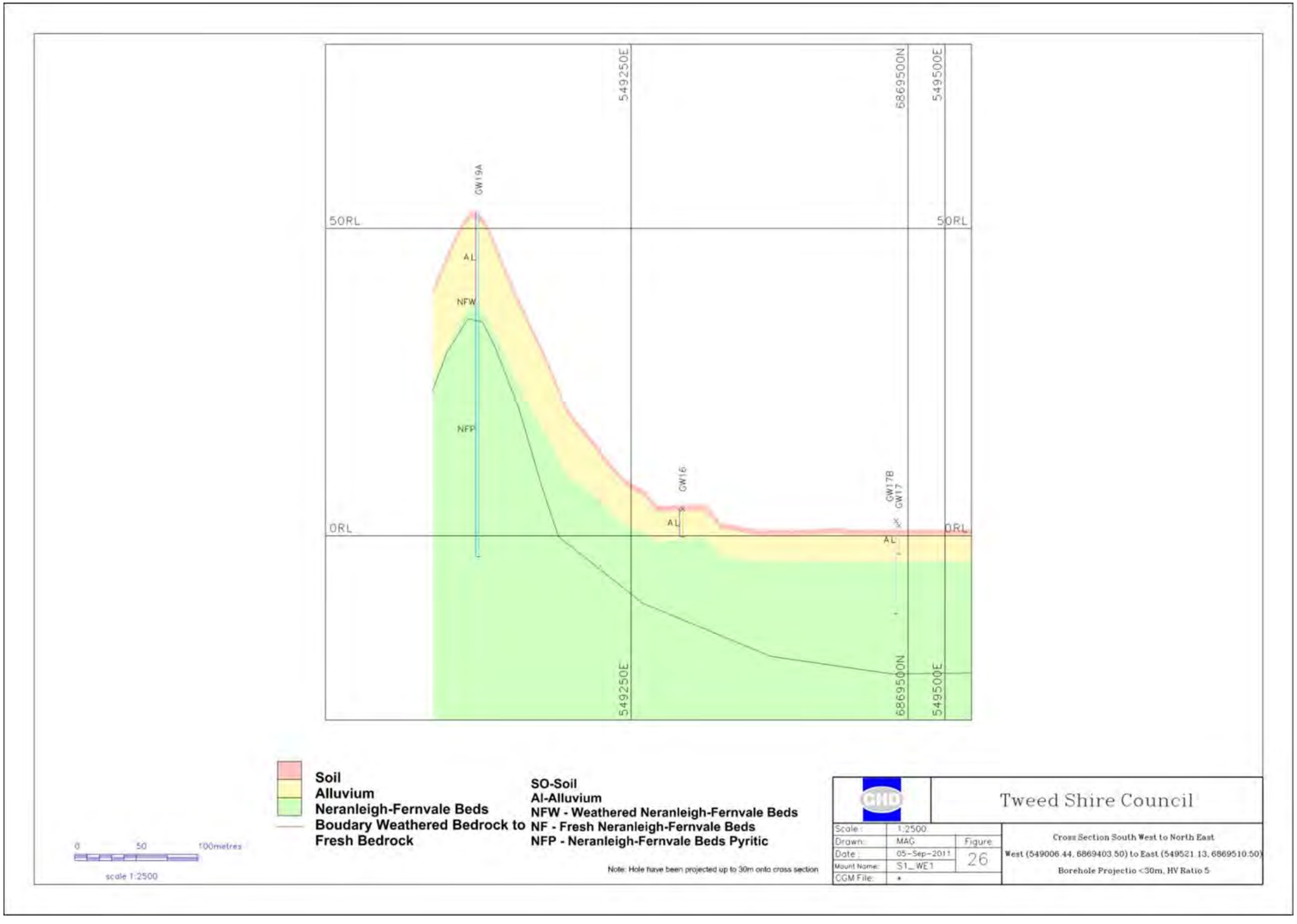


Figure 4 Cross Section South West to North East (South)

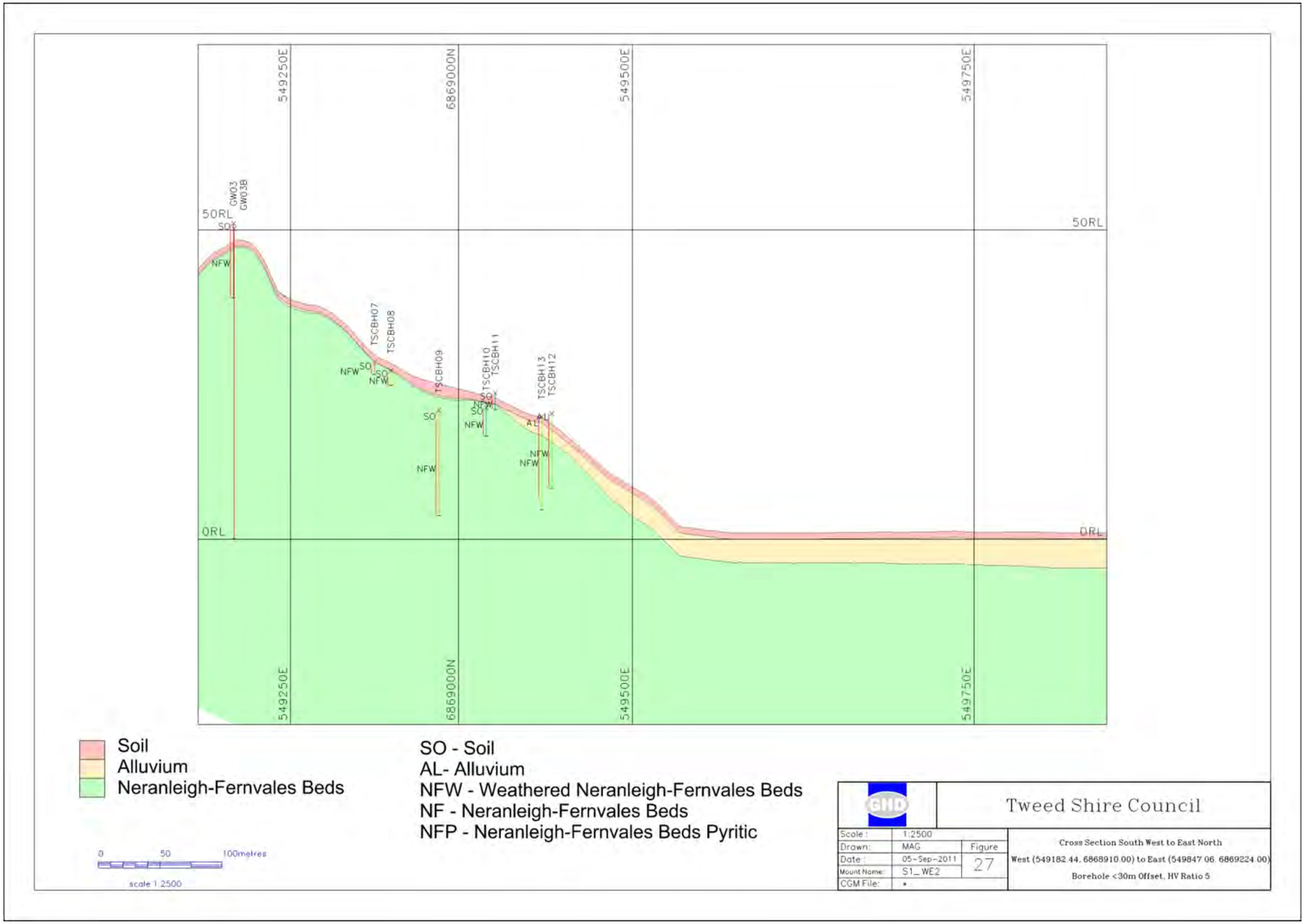
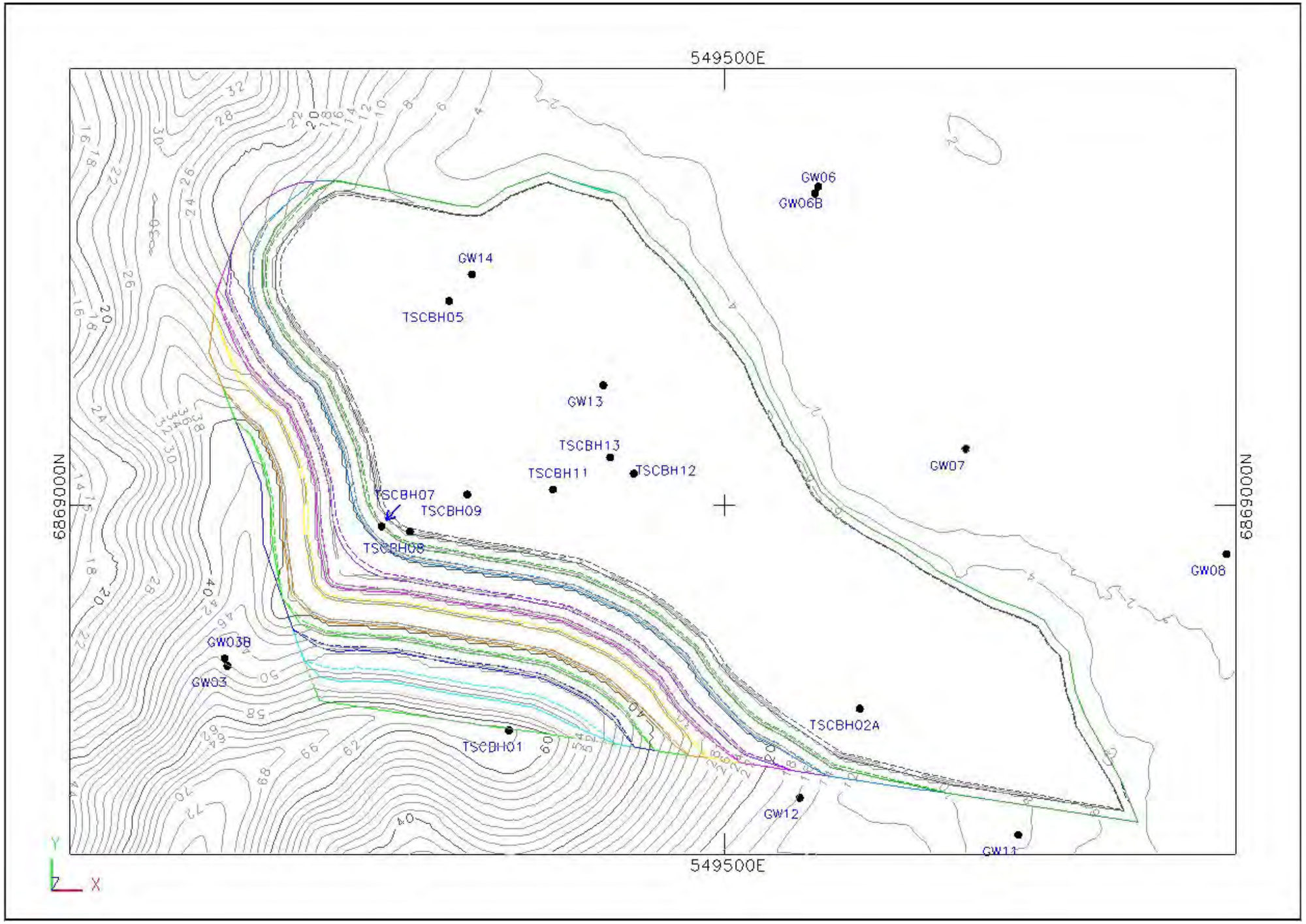


Figure 5 Drillhole Locations showing proposed West Valley Quarry



5.3.3 Stratigraphic Correlation

The entire site was found to be comprised of Neranleigh-Fernvale beds (and their weathered equivalents) and Tertiary to Recent alluvium. Individual units within the Neranleigh-Fernvale were not found to be contiguous between existing drillholes. Logged units were broadly classified based on an assumed quarry product assessment:

- SO – Residual Soils. Typically clayey and sandy to silty with variable organic content. Overburden/Fill quarry product.
- AL – Alluvium. Predominantly Silty to Sandy Clays of moderate to high plasticity. Additionally marine clay including acid sulphate soils. If extracted, Overburden/Fill quarry product.
- NFW – Weathered Neranleigh-Fernvale interbedded siltstone, chert/quartzite and greywacke. Drainage aggregate, cracker dust and road base quarry products. Locally, these beds have been silicified and when this is observed, the rocks are of moderate to high strength.
- NF – Fresh Neranleigh-Fernvale interbedded pyritic to non-pyritic greywacke and siltstone. Drainage aggregate, cracker dust and road base quarry products.

A thick section of silicified material is observed within TSCBH01 and this siliceous zone was sampled and assayed and yielded no significant results with respect to metal prospectivity. The material sampled was mostly fresh rock. Quarrying will be avoided in the vicinity of TSCBH01 where significant pyrite was intersected and is west of the proposed quarry site. The area of West Valley quarry where fresh non-pyritic interbedded greywacke and siltstone is the area being examined for quarrying purposes.

These assumed quarry products have been modelled (see Section 6) and a local stratigraphy compiled.

5.4 Drilling Summary

Findings in the five drillholes logged are summarised below with detailed Lithology Logs and Core photography presented in Appendix B and C respectively.

5.4.1 TSCBH01

The lithological sequence within drillhole TSCBH01 is predominantly siltstone with quartzite/chert and pyritic black shales/siltstones also present in the lower part of the hole. Weathered rocks exhibit chalky or earthy textures and are generally discoloured. Strength ranges between medium and high, with localised zones of soft rock. The variably weathered rock persists to about 38 m below ground level with leaching and discolouration along defects. Below the weathered material, rock strengths range between high and extremely high with the quartzite being stronger than the siltstone. Low strength material may be present in zones of strong foliation. Graphitic/carbonaceous siltstones/black shales occur below 37.78 m with local strong shearing as evidenced by strong foliation. Abundant pyrite is present in the core with the most significant concentrations in areas of carbonaceous/graphitic material. Cubic and framboidal pyrite was noted within the core. Logging of hole TSCBH01 also reveals local strong silica alteration. A significant section of this hole was sampled and assayed and returned no significant metal results.

5.4.2 TSCBH02A

Alluvium was intersected within hole TSCBH02A and extends at least to a depth of 20 m (end of hole) below ground level. Material encountered was predominately silty to sandy clays of moderate to high

plasticity. The colour of the silty to sandy clays was yellow, orange and red mottling throughout to a grey base colour. A significant sand layer at 14 to 20 m (end of hole) was logged. Grain size was variable throughout. The sandy beds exhibit a subtle fining upward trend and are generally well graded. The sandy material consists of quartz and lithic fragments with traces of silt and clay.

5.4.3 TSCBH02B

Hole TSCBH02B contains an interbedded sequence of greywacke and siltstone. The greywacke is typically medium-grained with coarse lithic fragments throughout. They are made up of quartz, feldspar and lithic material and vary from pale brown to grey in colour. The siltstones are dark grey to grey in colour when fresh and are thinly laminated to bedded and display a phyllite-like texture when broken. Soft sediment deformation and deformed bedding was noted throughout the fine grained material interbedded with the greywacke. Weathering was noted to a depth of approximately 33 m from surface. From 45 to 55 m (end of hole depth) pyritic mineralisation was noted but at significantly lower concentrations than those in the black shales/siltstones within hole TSCBH01.

5.4.4 TSCBH03A

Drillhole TSCBH03A intersected about 7 m of alluvium before continuing through the Neranleigh-Fernvale beds. The Neranleigh-Fernvale units are weathered from 7 m to about 11 m. A zone of siltstone and greywacke with pyritic mineralisation extends from about 11 m to 17 m. Non-pyritic siltstone and greywacke make up the remainder of the hole to 20.2 m (end of hole depth).

5.4.5 TSCBH03B

TSCBH03B was drilled to 61.3 m (end of hole depth) and intersected entirely Neranleigh-Fernvale beds. Material was weathered to a depth of around 34 m with fresh material observed from 34 m to the end of hole. A possible fault zone was intersected, with the greywacke occurring below a brecciated and sheared band, extending from 30.75 m to 31.79 m being stronger than the overlying rock and also containing common defects with calcite infill. Occasional defects were noted to contain two phases of infill: calcite and quartz. This fault zone appears to a localised feature.

5.4.6 Other Drilling

A further 28 drill holes consisting of a combination of diamond core holes; TSCBH04 to 13 and groundwater monitoring holes; GW1 to GW19A (except GW5 and GW18) were used to construct the resource model of the site. The samples for these boreholes were not accessible and consequently were not re-logged.

The consistency of the previous logs was assumed for re-classification for quarry product assessment however as the resource model is based on only limited drilling, the vast majority of these holes being shallow and often ended in apparent alluvial cover, the resource model should be treated with some caution.

5.5 Soil Distribution and Quality- Acid Sulphate Soils potential

Soil distribution and quality has been examined and reported. The primary issue relating to the site was the possibility of potential acid sulphate soils being unearthed. This has been examined in depth by the

Eviron Road Quarry and Landfill Environmental Assessment report, (Draft Hydrogeological and Acid Sulphate Soils Desktop Study 2009). For further detail please refer to the report referenced above.

5.6 Hydrology and Groundwater

The hydrogeology of the area has been assessed within the GHD report, (Hydrogeological and Acid Sulphate Soils desktop study 2009), for further details please refer to this document. However further monitoring wells have been installed. For further detail please refer to the report referenced.

5.7 Supply Intended Water Source

Currently at Quirks Quarry, runoff water is directed to holding areas for use on the site and for dust suppression of stockpiles.

Depending on the final workshop location and facilities linked with the site, it may be possible to link to the mains waterline, as is currently the case for Quirks Quarry.

5.8 Recommendations

5.8.1 Exploration Plan

Supplementary drilling is required to obtain additional geological data in order to improve the current geological model. Several drill holes are required throughout the West Valley quarry area and their environs to improve the geological understanding. A significant number of proposed holes will need site preparation, and subject to assessment by an experienced driller and the obtaining of relevant statutory approvals, could be drilled. (refer to Table 6 and Figure 5). The provisional hole depth of these holes is 100m and it is recommended that these holes be drilled with diamond core techniques.

Table 6 Possible Drillhole Locations (MGA Zone 56 (GDA 94))

Easting	Northing
549212.14	6869639.78
549402.14	6869575.05
549258.07	6869433.07
549274.06	6869320.96
549337.41	6869218.01
549285.21	6869144.94
549700.71	6869161.64
549690.27	6868927.79
549493.89	6868879.72
549132.80	6869514.50
549192.48	6869067.45

Easting	Northing
549223.86	6869008.46
549243.46	6868877.68

It is intended that all holes listed above in Table 5 will be drilled at an angle of approximately 60^{o} degrees toward 090^{o}(east).

In conjunction with this drilling program, a program of surface geophysics should be considered to identify the extent of subsurface sulphide such as the pyrite intersected within TSCBH01. This could entail surface electromagnetic surveying using a fixed or moving loop configuration and line spacing of 100 m. The area of the survey would cover the proposed West Valley Quarry area as displayed in Figure 4. Groundmagnetics survey could also be considered if additional structural information is required.

5.8.2 Geotechnical Investigation

A detailed geotechnical investigation is required prior to the recommendation of safe pit wall angles and/or any necessary ground support measures, and this would typically entail the following tasks:

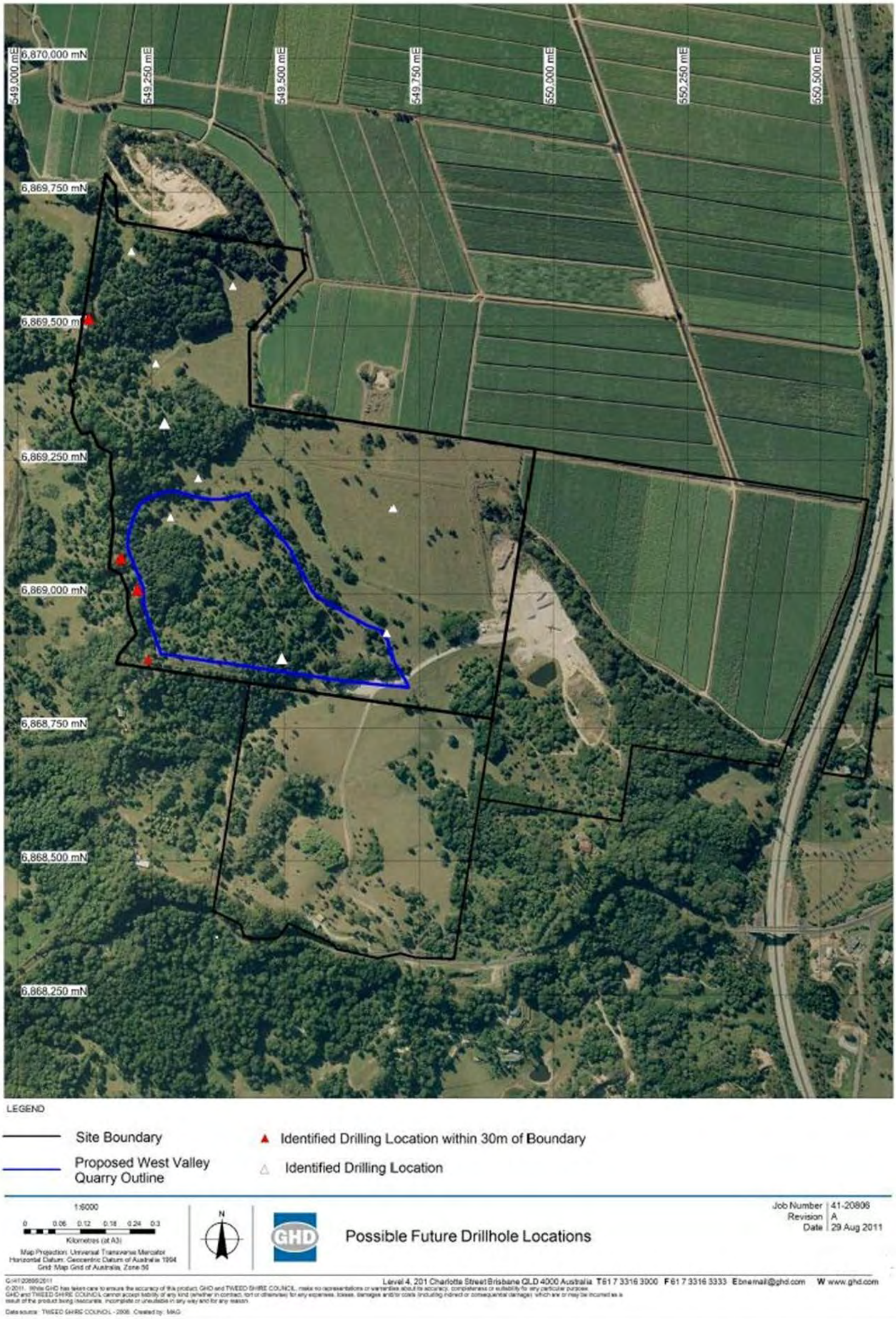
- Desktop study and initial site reconnaissance;
- Open hole (geophysical) test program;
- Core drilling program (as necessary to attain representative samples for testing);
- Laboratory test program; and
- Results reduction and geotechnical analyses.

Specifically, downhole geophysical testing this would comprise acoustic logging for structure orientation, sonic log for material strength, and a general geophysical log (calliper, verticality, gamma and density) for material condition/composition. The results of the geophysical testing within the existing drill holes would also aid in the planning associated with any subsequent core drill holes that may be required (by way of layout and inclination). Laboratory testing for intact rock and joint strength would then be recommended, and would typically comprise the following:

- Shear box testing, to determine the peak and residual shear strength parameters of the joint structures;
- Indirect Tensile Strength (ITS) testing, to determine the tensile strength of the rock mass; and
- Unconfined Compressive Strength (UCS) and Modulus testing.

Following the interpretation of all field and laboratory test results, 2-dimensional limit-equilibrium slope stability modelling would be recommended, to assess the potential for deep-seated failure of the rock mass. This should also be conducted in conjunction with stereographic analyses, to assess for the probability associated with wedge, planar or toppling failure. 3-dimensional discrete-element modelling may also be recommended, to assess any adverse failure mechanisms associated with the proposed stripping sequence. In the case of a supported slope, as part of the above-mentioned analyses the design of any necessary ground support measures, such as rock bolting or buttressing, would also be undertaken.

Figure 6 Drillhole Locations showing proposed West Valley Quarry



5.8.3 Bulk Density Investigation

As the resource model is heavily dependent on bulk and/or in-situ densities, it is strongly recommended that bulk-density measurements be undertaken as part of any future work on the project proposal.

5.8.4 Acid Mine Drainage Investigation

The pyritic mineralisation within the Neranleigh-Fernvale beds identified in core logging particularly in hole TSCBH01 has the potential to cause acid mine drainage if exposed or extracted. The pyritic material was assayed within TSCBH01 and results were displayed within Table 5. No significant metal mineralisation was indicated from the assays. Despite the lack of significant metal mineralisation and the limited spatial extent of the identified pyritic units, the proposed quarry design will still avoid this area of pyritic mineralisation during normal quarrying operations. A detailed Acid Mine Drainage assessment is recommended prior to the development of the detailed Quarry Plan of Management in the event that the material is required to be extracted.

This assessment would entail the following tasks:

- Sample collection;
- Mineralogy;
- Net Acid Generation (NAG) and Net Acid Production Potential (NAPP);
- Whole Rock geochemistry;
- Column leach.

The number of samples to be analysed will be determined based on the tonnages of each rock type. It is expected that in the order of tens of samples representing rock types present at the quarry site would be required for analysis. The actual number of samples will be confirmed once the tonnages of each type are confirmed by the follow-up geotechnical drilling outlined in Section 5.8.1, above.

Mineralogical assessment is critical, in identifying potentially acid–generating and acid-neutralising minerals present, as various sulphides have differing acid-producing potential and different carbonate minerals have different neutralising capacity.

Mineralogical analyses of the various lithological units to determine major mineralogy for assessment. The analysis undertaken is optical and X-ray Diffraction (XRD).

The samples of each rock type will be submitted for net acid generation (NAG) and net acid production potential (NAPP) testing. The oxidised leachate from the NAG test will be analysed for electrical conductivity, dissolved trace metals (ICPMS scan), major and minor ions, radioactivity and phosphorus. Where samples contain more than 2% sulphur, a sequential NAG (SNAG) test will be performed to confirm the relative acid generation and neutralising capacity of the rock.

5.9 Resource Estimates

Resource estimates are based on those available areas identified for quarrying, and are not intended to reflect mineral resources as defined by the Joint Ore Reserves Committee (JORC) Code. A geological model was generated using identified relationships between potential quarry products encountered in the boreholes and the associated regional geology. Relevant lithological units identified in both the ground

water monitoring holes and recent drilling data were used to correlate a number of material units for modelling purposes.

A plan of drill holes within the Resource area is provided in Figure 7. Representative cross-sections through the various modelled units across the conceptual pit are shown in .Figure 8, Figure 9, Figure 10, Figure 11, Figure 12 and Figure 13. Assumed quarry product units used in the modelling process are shown in these cross sections. The red line indicates the lay of the final pit area after extraction has taken place.

The cross-sections take into account the non-contiguous nature of the logged lithologies. The modelled lithological units are assumed to be consistent in stratigraphic order. To produce the resource estimates assumptions have been made to represent the resource floor as being the lowest elevation of three (3) of the more recent holes (TSCBH01, TSCBH02B, TSCBH03B) and four (4) previously drilled groundwater monitoring boreholes (GW01, GW03B, GW18A, GW19A).

All drill holes were used to aid in the modelling process, except for TSCBH01 which contains silicified and pyritic material that are not contiguous with any other units identified in drilling in the West Valley area. Note also that not all holes reached a sufficient depth to model all stratigraphic units encountered in the area.

To enable the modelling of all units, including those that were not encountered within a borehole, these were assumed to have a stratigraphic thickness of 0.0 m. This enabled modelling of all stratigraphic units in the West Valley, and estimates of the type and thickness to be encountered between known points. The Neranleigh-Fernvale Beds were the deepest unit encountered in the cored samples. To enable the modelling process it was assumed that the drillholes ended in their respective stratigraphic unit

Figure 7 Plan showing drillholes and conceptual West Valley Quarry pit outline with Cross Sections

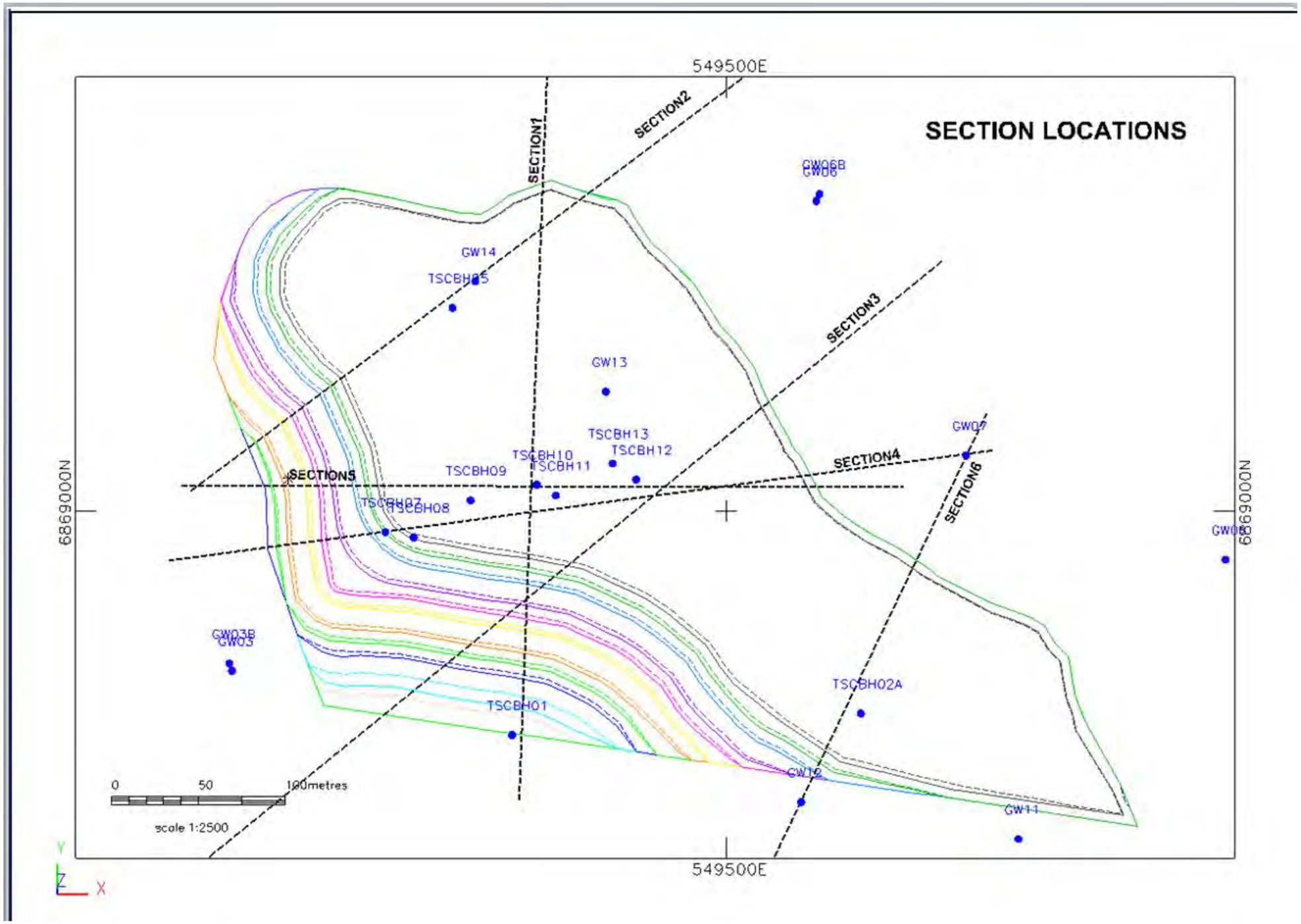


Figure 8 **Cross Section 1 as displayed with Figure 7 and also showing conceptual West Valley Quarry pit outline**

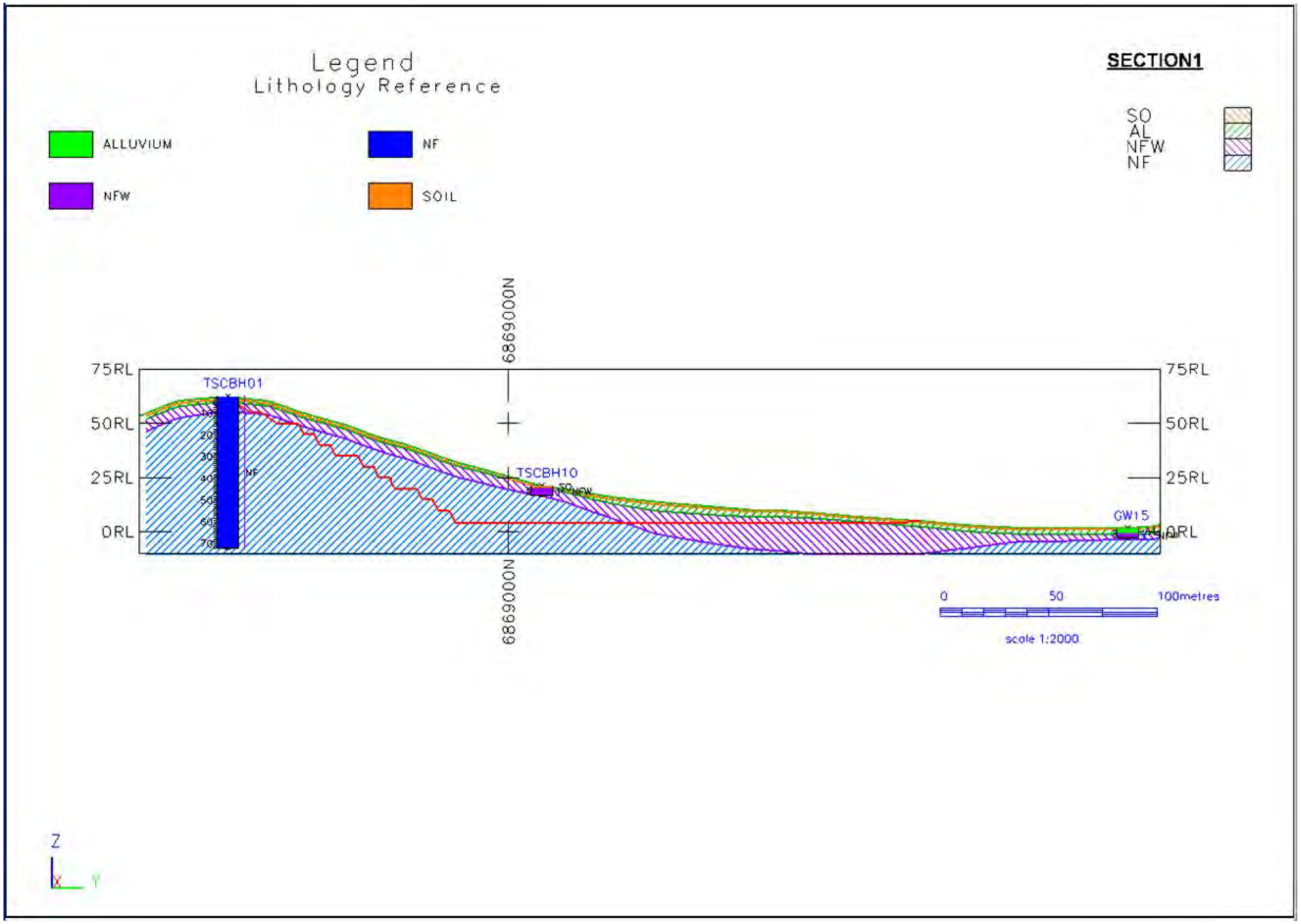


Figure 9 **Cross Section 2 as displayed with Figure 7 and also showing conceptual West Valley Quarry pit outline.**

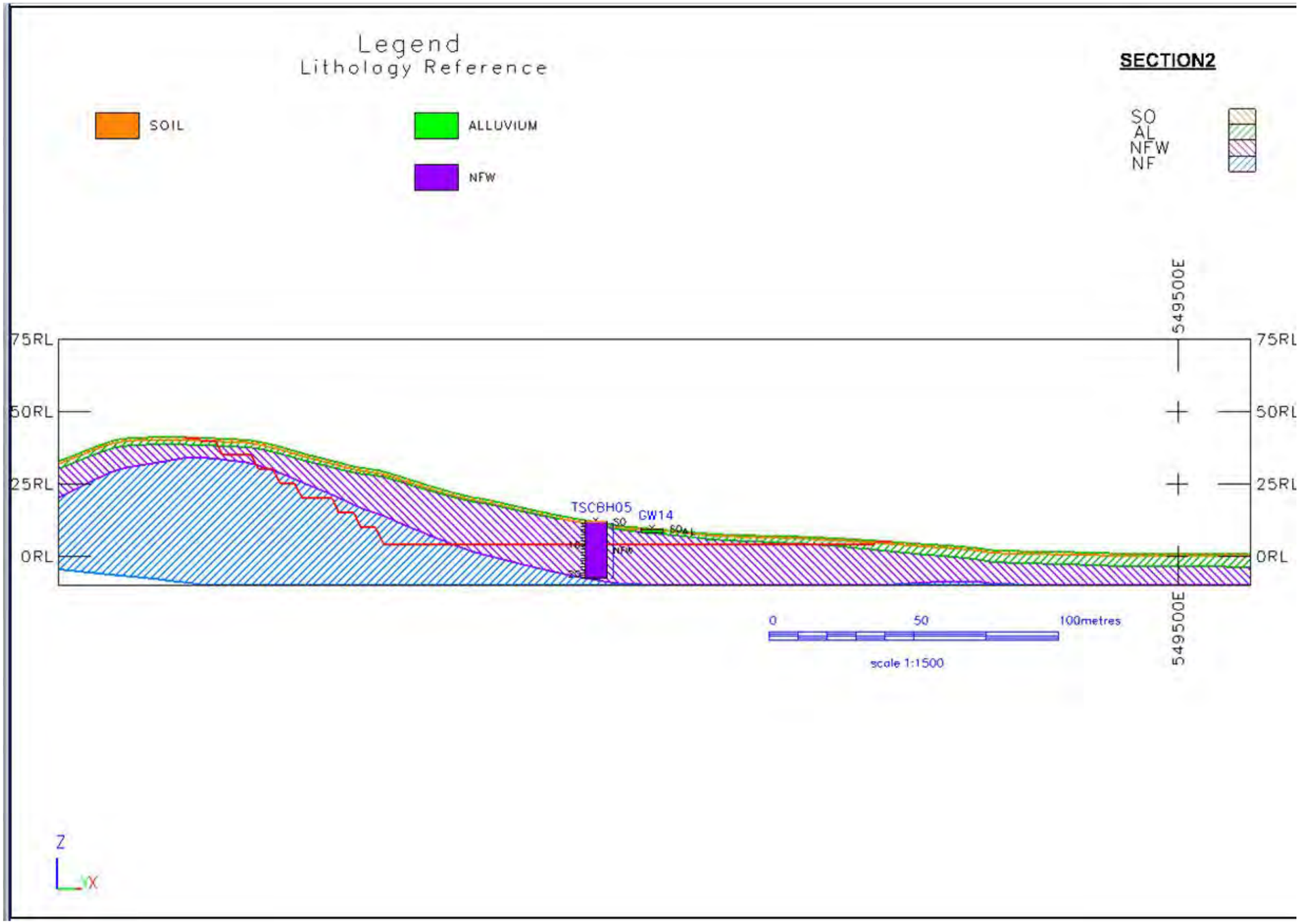


Figure 10 Cross Section 3 as displayed with Figure 7 and also showing conceptual West Valley Quarry pit outline.

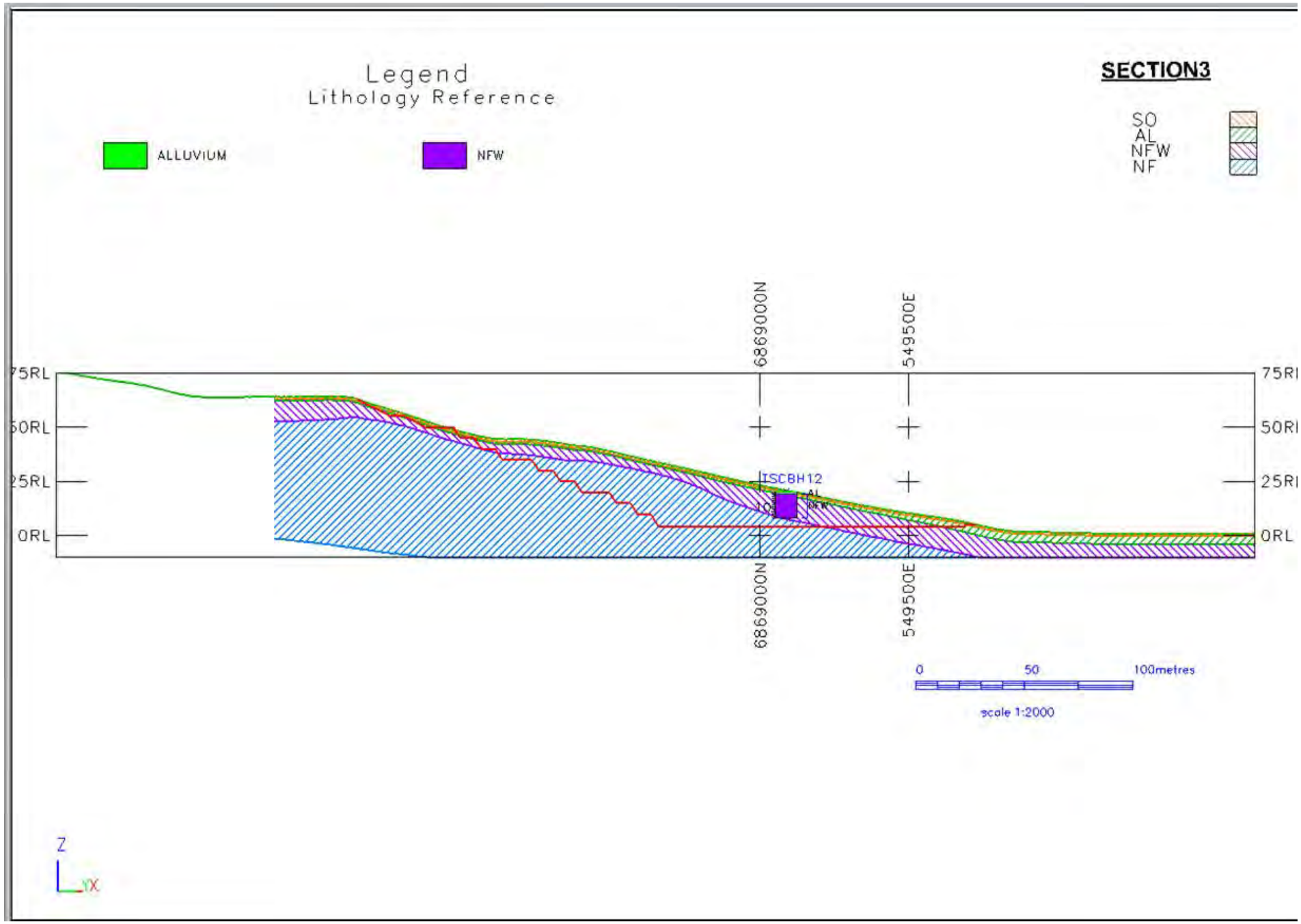


Figure 11 Cross Section 4 as displayed with Figure 7 and also showing conceptual West Valley Quarry pit outline.

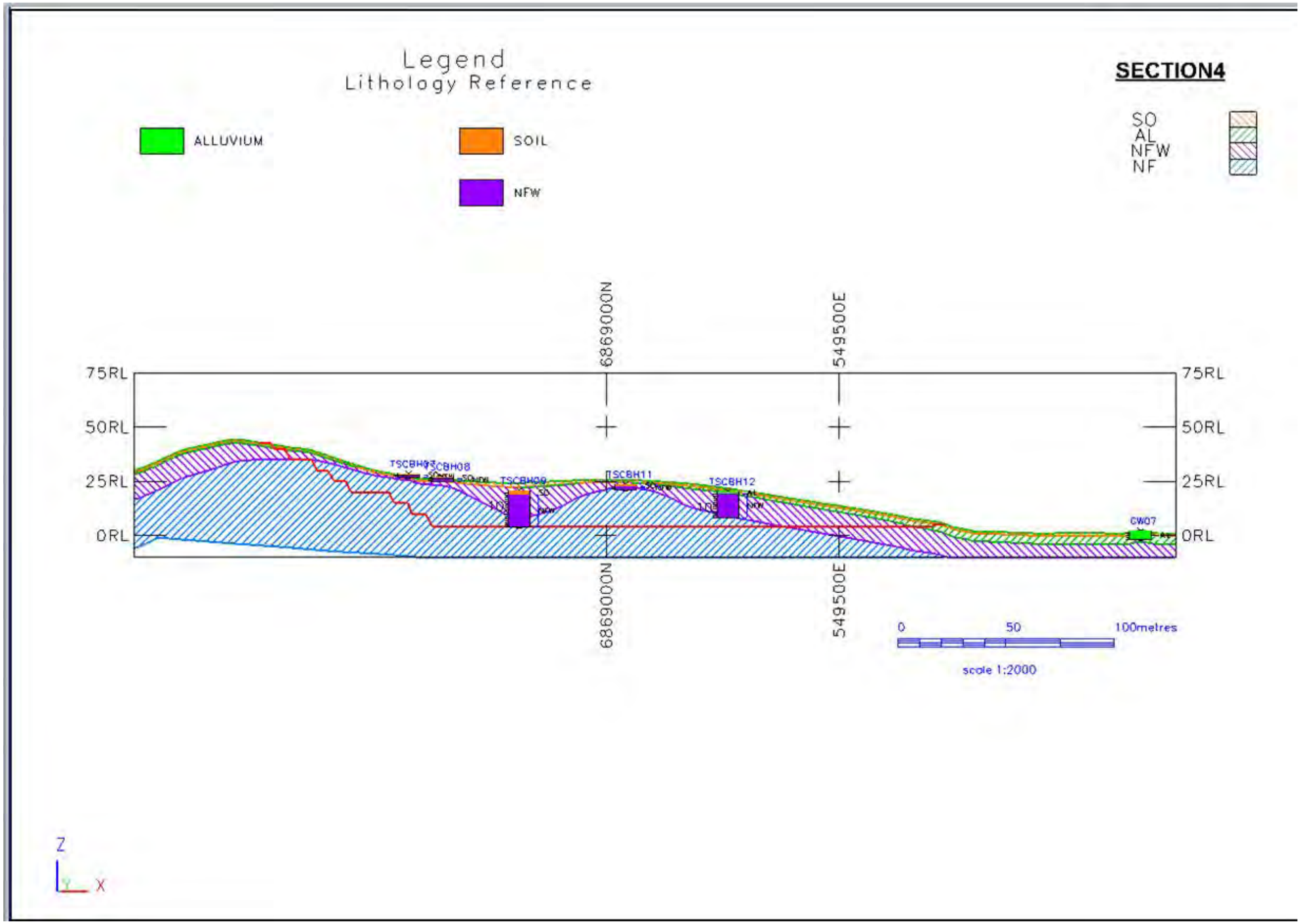


Figure 12 Cross Section 5 as displayed with Figure 7 and also showing conceptual West Valley Quarry pit outline.

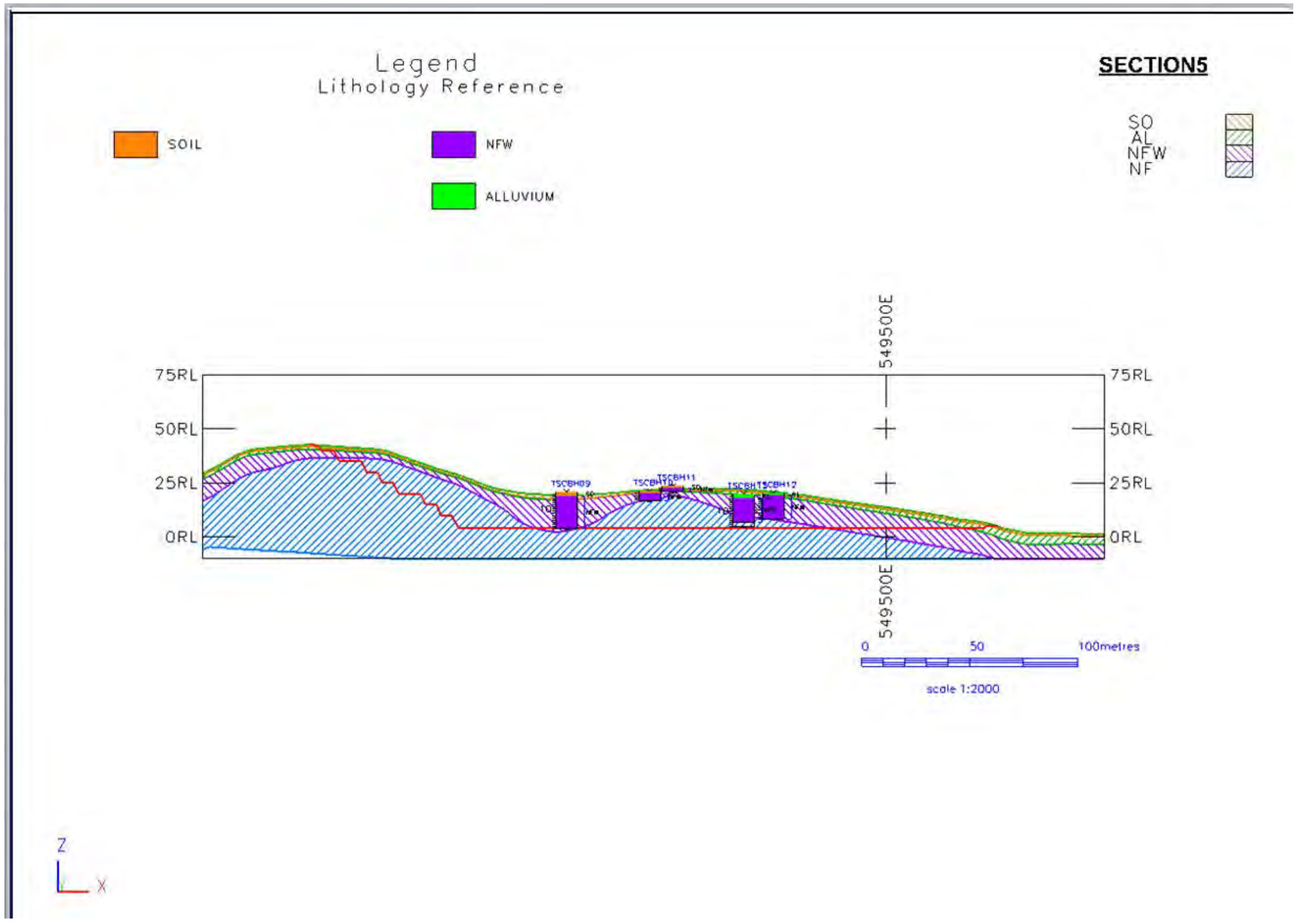
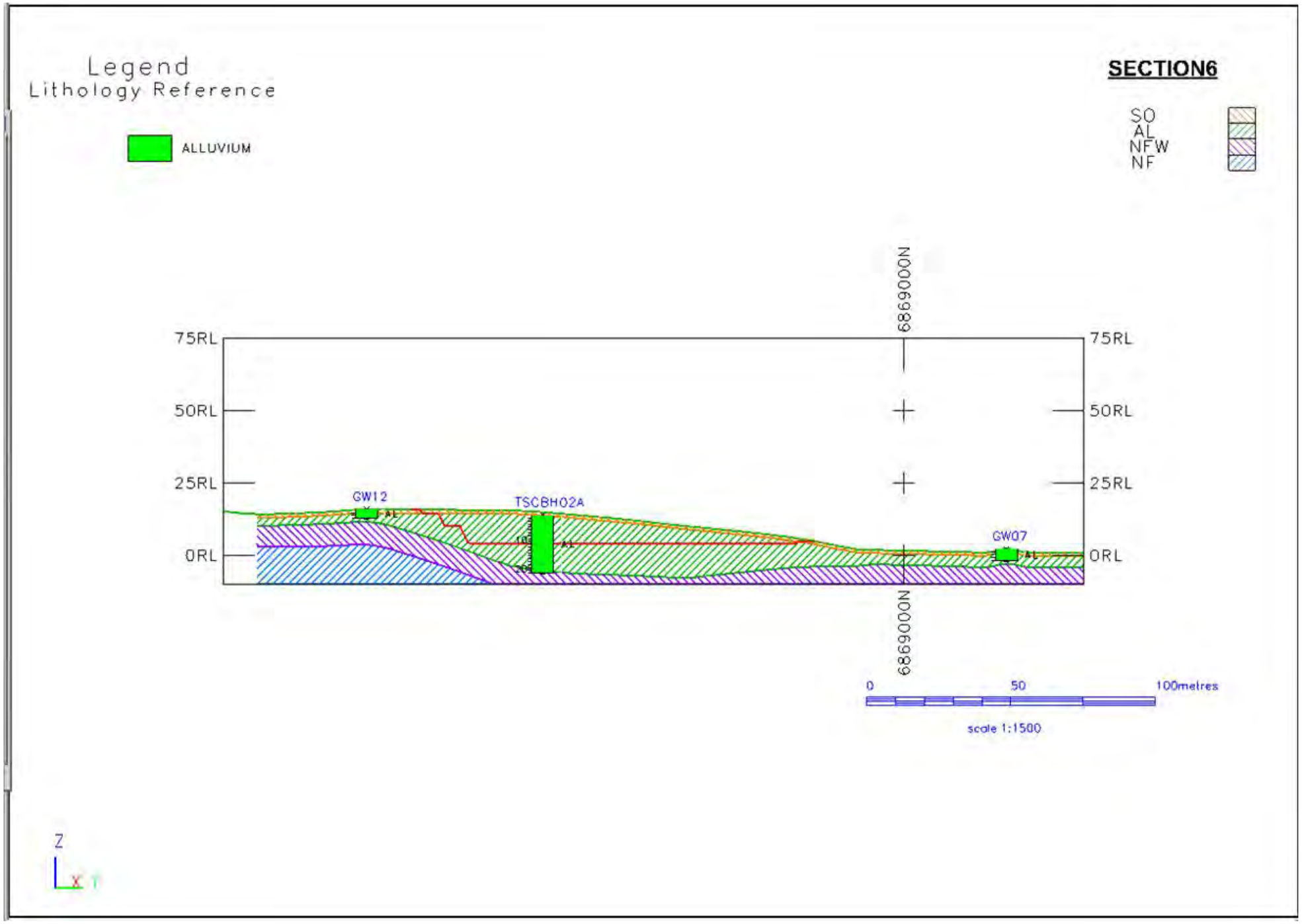


Figure 13 Cross Section 1 as displayed with Figure 7 and also showing conceptual West Valley Quarry pit outline.



It should be noted that a considerable Neranleigh-Fernvale siltstone-greywacke resource has been modelled below the adopted pit floor of RL 4.0m. The assumed quarry product layers have been modelled using logged information supplied in each hole, however in most groundwater monitoring boreholes, the interface between the clay layer and Neranleigh-Fernvale Beds was not intersected. In the shallower holes the siltstone interval has not been identified, as drilling to depth was not possible.

In the modelling process, intersections of lower layers therefore have been derived from surrounding logged thicknesses and interpolated at depths below final drill-hole depths to simulate the full stratigraphic sequence across the resource area. Similarly where layers have not been identified between logged layers, missing layers have been set to exist but their thickness has been set to zero (0) to maintain continuity of the layers over the modelled area. Further to these operations on the drillhole information, the generation of the geological model includes parameters, to interpolate between known and derived layer intercepts in each hole and extrapolate to approximately 50 metres past the last drill-hole intercept for each hole included in the modelling process.

6. Quarry Resource and Design

During the initial development of the Quarry Plan, it was identified that the area required further drilling investigations to be conducted to adequately estimate the existing resource, given that extraction would focus on the West Valley Area only. This data would take the lithological interpretations from existing groundwater monitoring holes and new cored holes to significant depth to be incorporated into a computer generated geological model for the site. The proposed holes were not completed as planned; as such the limited spatial data has been used to infer a resource and provide the base model for conceptual quarry design.

From the digital topographical surface supplied (GHD - 20806Contoursgr10m.dxf, 20806Contours1to10m.dxf & tsc_parcel.dxf, and based on MGA 94 – Zone 56 (GDA 94) TM co-ordinate system & assumed AHD level datum) and the derived geological model, a preliminary quarry pit design and extraction plan was developed. Included in this process was the development of a digital terrain model of existing surface topography from supplied information, comparison and adjustment of drill hole "collar" locations with modelled topography, land title information, and the location of environmental and physical considerations to be included in the design process.

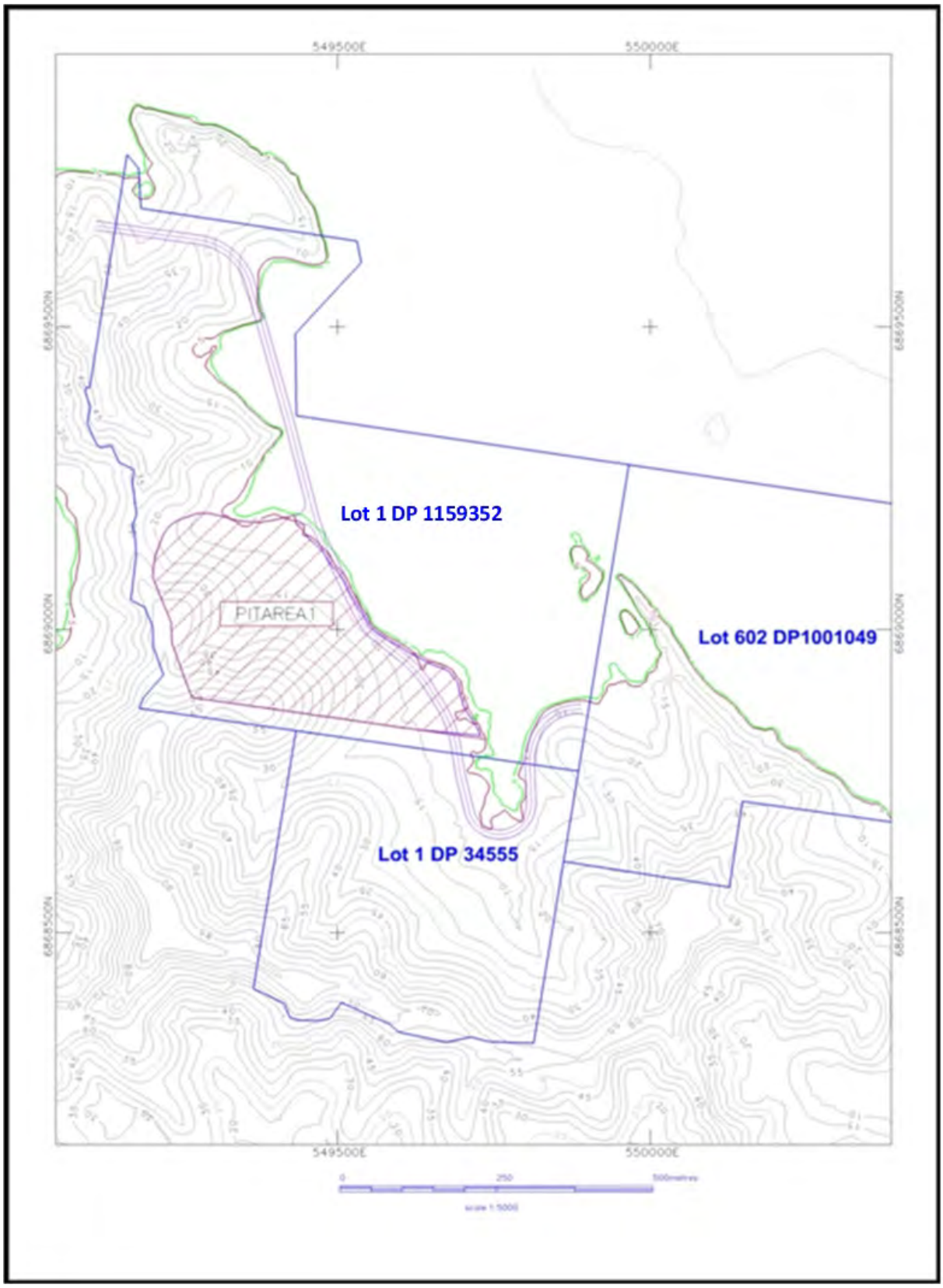
Figure 14 shows final modelled Topography contours, land title information as supplied and preliminary haul road alignment with respect to the proposed quarry footprint (PIT AREA 1). A minimum pit base level of RL 4.0m corresponding to an estimated 100 year flood level event was adopted as the limit of extraction and general alignment of the connecting haul road between existing and proposed TSC extraction areas.

The identified Blackbutt Open Forest Areas (5) and Koala habitat areas (Vegetation Map – Figure 39 Rev 0, Tweed Shire Council Eviron Road Quarry and Landfill Environmental Assessment) has been considered and precluded development in the central ridge area of the initial available land in Lot 1 on DP 1159352.

A 30m Buffer Zone between adjoining land titles and a general alignment of the pit outline to follow below the existing crest line forms the physical constraints for the PIT AREA 1 extent.

Geographic (Latitude/Longitude) GPS Collar information supplied has been converted to MGA 94 – Zone 56 (GDA 94) TM co-ordinate system, and collar levels used as supplied or derived from the digitally-modelled topography.

Figure 14 Topography Contours, Land Titles and Quarry Footprint



6.1 Resource

The resource exploration area targeted was centred in the north (North Valley) and south-west (West Valley) ridge areas of Lot 1 DP 1159352.

The resource area for PIT AREA 1 lies above the floodplain and nominal RL 4.0m (100 Year Flood Event). The higher topography represents the area of resource interest and is associated with the regional geology and north/north-westerly trending ridge line along the western boundary of Lot 1 DP 1159352.

Using Gemcom's MINEX 5 - 3D modelling platform, each drillhole was logged and identified lithological units represented stratigraphically. Interpretation of corresponding units in each drill hole was made based on correlating like lithological units in each hole. A geological model was created and shown to be thickening and thinning equating to trends in the identified lithologies.

The resource estimates are therefore based on the assumption that:

- Results from TSCBH01 have been omitted from the modelling process as the encountered pyritic black shales and siltstones and siliceous Neranleigh-Fernvale units are not contiguous with any other intersections.
- The Neranleigh-Fernvale Bed floor is represented as the lowest elevation of three (3) of the more recent holes (TSCBH01, TSCBH02B, TSCBH03B) and four (4) previously drilled groundwater holes (GW01, GW03B, GW18A, GW19A), all of which remained in the unit at final depth of drilling; and
- The Neranleigh-Fernvale Bed Unit consistently continues below the adopted pit floor (RL 4.0m).

6.2 Pit Design Constraints

The PIT AREA 1 quarry design has taken into account the following constraints:

- Environmental Assessment constraints, (Blackbutt Forest and Koala Habitat);
- Minimum Pit Floor RL 4.0m (100 Year Flood Event RL 4.0 m);
- Minimum Crest RL 5.0 m Contour (1 m freeboard to 100 Year Flood Event RL 4.0 m);
- Minimum 30 m Buffer for wildlife corridor & barrier constraint with respect to adjoining land owners;
- Pit Design constraints (Pit wall angles, safety berms and maximum bench heights);
- The location of internal quarry haul roads;
- The location of external access roads; and
- "Below Ridge Line" pit crest considerations.

The preliminary design of PIT AREA 1 does NOT take into account the following:

- The location of the quarry office/workshop facilities;
- The location of the Run of Quarry Stockpile pad;
- The location of product stockpiles;
- The location of surface drainage and sedimentation control dams;
- Mitigation strategies for dust and noise;
- Mitigation strategies for Visual amenities; and

- Location and design of external access roads.

Note: Redesign of the quarry area will be necessary if Lot 1 on DP34555 is included in final TSC Quarry Development area. The utilisation of a possible larger pit area with the opportunity to work and extract from multiple faces would then allow for extraction to occur at multiple positions on site with drilling and blasting to be done on a site scale rather than face by face in the more restricted PIT AREA 1 design.

6.3 Design Methodology

The PIT AREA 1 Quarry has been designed in horizontal benches. These benches correspond with a 5.0 m bench height from RL 55.0 m to RL 10.0 m with the final bench height being 6.0 metres down to the pit floor at RL 4.0 m. Table 5 details the approximate bench quantities that are recovered from each of these benches. A breakdown of specific material types available from each bench is detailed in the following sections.

Note: The proposed Pit Access Haul Road has been designed at 15 m wide and at a maximum grade of 10% and based on general safety requirements and the availability of medium sized local excavating equipment and trucks. This haul road is constructed prior to the commencement of quarry operations to access the higher levels of the quarry pit design. This internal haul road is removed in retreat with each bench operation. Initially 16,760 m^3 suitable fill and road building material will be required to construct this haul road. A series of 5.0 m width safety berms have been included in the design and extended to 10 m running benches at RL's 50, 35 & 20. Changes to these overall parameters would be possible, however would be subject to further geotechnical studies with respect to final slope stability constraints and mining equipment selection.

The pit crest outline is based on the above design constraints and is projected down from the crest outline intersection with the modelled topography using the bench configuration as shown in Table 7

Table 7 West Valley Quarry PIT AREA 1 Bench Configuration

Bench RL	Elevation	Slope (°)	Berm
RL 55	55	35°	5
RL 50	50	35°	10
RL 45	45	65°	5
RL 40	40	65°	5
RL 35	35	65°	10
RL 30	30	65°	5
RL 25	25	65°	5
RL 20	20	65°	10
RL 15	15	65°	5
RL 10	10	65°	5
RL 04	4	65°	5

6.3.1 Pit, Bench, Layer Resource Definition

From the above Pit design constraints and the established geological model, a preliminary PIT AREA 1 Resource report was generated for each bench showing volumes and estimated tonnages for each layer in each of the designed benches. Tonnage estimates are conservative and based on assumed densities of the modelled lithology layers (refer to Table 8 below). The bulk densities presented below are in accordance to values published on websites; www.simetric.co.uk and Berkman (2001). Additionally, further bulk density information albeit limited was obtained from several reports published detailing quarrying projects in the Tweed Shire and in the Gold Coast region.

Note: Bulk density testing of each of the modelled layers will increase confidence to the final tonnage estimates.

Table 8 Assumed Layer Density Definition

Layer Unit	Density
Soil (SO)	1.10
Alluvial Deposits(AL)	1.50
Weathered Neranleigh-Fernvale interbedded Siltstone and greywacke(NFW)	2.25
Fresh Neranleigh-Fernvale interbedded greywacke and siltstone non pyritic(NF)	2.50

Table 9 shows pit access haul road quantities in cubic metres and individual bench volumes, accumulated bench volumes and estimated tonnages.

Table 9 Quarry PIT AREA 1 Quantities by Bench

PIT AREA 1 Quarry Bench RL	Bench Volumes (Cu m)	Accumulated Volumes (Cu m)
RL 55	7,710	7,710
RL 50	9,720	17,430
RL 45	11,450	28,880
RL 40	21,160	50,040
RL 35	43,240	93,280
RL 30	53,880	147,160
RL 25	80,940	228,100
RL 20	111,380	339,480
RL 15	145,450	484,930
RL 10	199,270	684,200
RL 04	356,070	1,040,270
TOTALS	1,040,270	1,040,270

Pit Access Haul Rd	Nett	Cut	Fill
Volume (Cu M)	-13,020	3,740	16,760

Table 10 shows West Valley Quarry PIT AREA 1 Estimated Bench Tonnages for modelled units.

Table 10 West Valley Quarry PIT AREA 1 Estimated Bench Tonnages

Bench RL	SO	AL	NFW	NF
RL55	3,564	3,165	5,333	-
RL50	3,234	3,330	9,315	1,050
RL45	3,333	3,825	11,858	1,475
RL40	5,852	5,715	19,733	8,125
RL35	7,755	11,760	43,853	22,175
RL30	8,206	12,960	46,575	42,725
RL25	10,780	19,425	64,755	73,525
RL20	12,221	27,345	93,060	101,725
RL15	17,314	45,615	133,448	99,950
RL10	17,677	74,970	189,023	123,025
RL04	30,052	176,295	303,345	191,000
TOTALS	**119,988**	**384,405**	**920,295**	**664,775**

6.4 Quarry PIT AREA 1

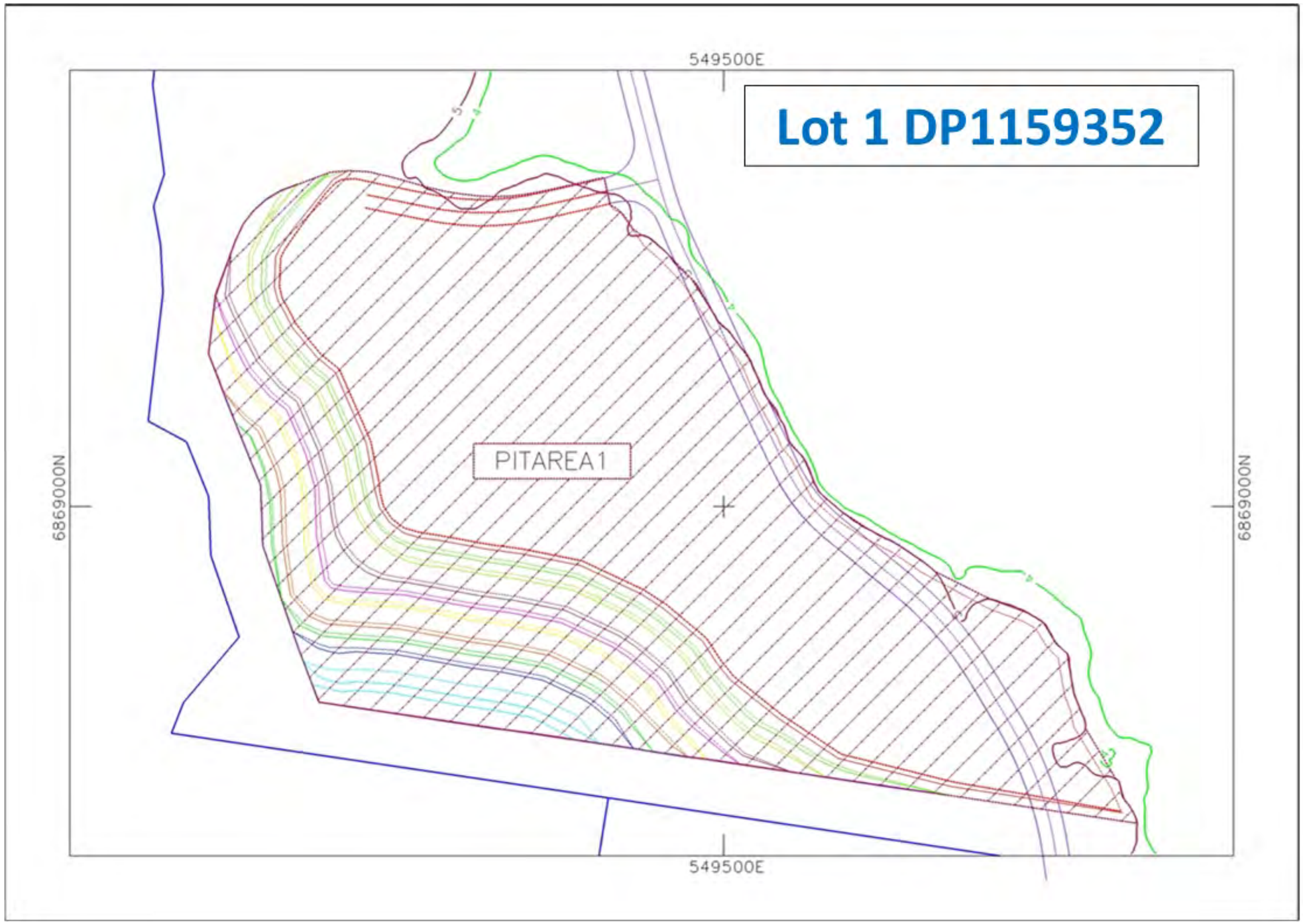
It is essential that run-off water storage facilities are established in and adjacent to the northern eastern intersection of the Pit Access Haul Road and the proposed general alignment of the connecting haul road between existing and proposed TSC extraction areas. Design and Construction of contour drains and general arrangement diversion channels to accommodate run-off and settlement of sediments from the pit area and Pit Access Haul Road is absolutely essential before commencement of any quarrying operations. Design considerations with respect to the proposed connecting haul road between existing and proposed TSC extraction areas should both prohibit water run-off from the PIT AREA 1 quarry and generally divert water to suitable storage and sedimentation dam locations.

Quarry operations are intended to commence in the South western corner of Lot 1 on DP 1 1159352 with the construction of the main pit access haul road (See Figure 15 for Isometric Plan of Quarrying Operations and Appendix D for stage plans for Quarrying Operations). Overburden material, predominantly Soil and weathered Neranleigh-Fernvale materials is removed at the lower slope angle of 35° to establish a competent pit slope and the initial bench at RL 55. Similarly benching operations to RL 50 continues with the same slope angle (35°) leaving a 5.0 m safety berm in the final pit wall and removal of internal Pit Access Haul Road to establish Bench RL 50. Successive benching operations down to the final pit floor Bench RL 04.

In general from Bench RL 55 to Bench RL 35, quarry operations do not intersect the competent materials and appear to be essentially “free dig” benches. Exposure of the modelled weathered Neranleigh-Fernvale units in Bench RL 45 may require a combination of ripping and/or drilling & blasting operations. Bench RL 30 to pit floor uncovers the siltstone layer of varying thickness and of unknown strengths. Various combinations of ripping and/or drill & blasting operations may be required in the lower benches.

Initially there is a high stripping ratio relationship of overburden (soil/weathered NF) to fresh Neranleigh-Fernvale combinations; however this ratio reduces considerably in the lower benches.

Figure 15 Stage plans for Proposed West Valley Quarry area. Different colour lines represent each bench



7. Quarry Schedule

7.1 Quarry Plan

An 11-year life-of-quarry production schedule, based on a 200,000 tonnes total material moved per year, was developed for PIT AREA 1 and is shown in Table 11.

Quarrying material from multiple benches is not possible in the upper benches given the size and working area available at the higher elevations. Multiple Bench working faces however would be possible at lower bench elevations and upper benches provided access to the internal access haul road is maintained.

Key inputs into the schedule were:

- Site preparation works have been ignored in the production schedule;
- Production rate of 200,000 total material tonnes moved per year;
- Schedule reported on an annual basis;
- Single active quarry face; and
- Sequence of operations is from Bench RL 55 down in 5.0m bench heights to Bench RL 04.

Note: Scheduling Details related to construction of the pit access haul road, water catchment and sedimentation control dams and start-up requirements of the quarry have not been considered in the 11 Year Life of Quarry Production Schedule.

Table 11 Example 11 Year Production Schedule (Tonnes)

Bench RL	YEAR1	YEAR2	YEAR3	YEAR4	YEAR5	YEAR6	YEAR7	YEAR8	YEAR9	YEAR10	YEAR11
RL55	12062	0	0	0	0	0	0	0	0	0	0
RL50	16929	0	0	0	0	0	0	0	0	0	0
RL45	20491	0	0	0	0	0	0	0	0	0	0
RL40	39425	0	0	0	0	0	0	0	0	0	0
RL35	85543	0	0	0	0	0	0	0	0	0	0
RL30	25552	84914	0	0	0	0	0	0	0	0	0
RL25	0	115086	53399	0	0	0	0	0	0	0	0
RL20	0	0	146601	87750	0	0	0	0	0	0	0
RL15	0	0	0	112250	184077	0	0	0	0	0	0
RL10	0	0	0	0	15923	200000	188772	0	0	0	0
RL04	0	0	0	0	0	0	11228	200000	200000	200000	89464
TOTALS	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	89464

For the first year of quarry production, operations are kept within the benches, RL 55 to RL 30. However as detailed in Table 12 the overburden stripping consisting of soil and weathered materials is high.

7.2 Material Production Schedule

A life-of-quarry material production schedule was also created to show the various layer unit tonnages as the PIT AREA 1 Quarry progresses.

The Material Production Schedule reports the following and is shown in Table 10 below:

- SO – Residual Soils. Typically clayey and sandy to silty with variable organic content. Overburden/Fill quarry product.
- AL – Alluvium. Predominately Silty to Sandy Clays of moderate to high plasticity. Additionally marine clay including acid sulphate soils. If extracted, Overburden/Fill quarry product.
- NFW – Weathered Neranleigh-Fernvale interbedded siltstone and greywacke. Drainage aggregate, cracker dust and road base quarry products.
- NF – Fresh Neranleigh-Fernvale interbedded non-pyritic greywacke and siltstone. Drainage aggregate, cracker dust and road base quarry products.

Note: Layers are quoted as in situ tonnes of material.

Table 12 Example 11 Year Material Schedule (Tonnes)

LAYERS	YEAR1	YEAR2	YEAR3	YEAR4	YEAR5	YEAR6	YEAR7	YEAR8	YEAR9	YEAR10	YEAR11
SO	31,944	10,780	12,221	17,314	15,923	1,754	11,228	18,824	-	-	-
AL	40,755	19,425	27,345	45,615	-	74,970	-	176,295	-	-	-
NFW	94,476	106,944	93,060	49,321	84,127	123,276	65,747	4,881	200,000	98,464	-
NF	32,825	62,851	67,374	87,750	99,950	-	123,025	-	-	101,536	89,464
TOTALS	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	89,464

7.2.1 Life-of-Quarry Schedule

As detailed in Table 12, the ratio of soil and weathered material to fresh NF units is consistently high and for most part, weathered NF predominates in each bench from year 3 to year 6.

An economic evaluation may show some merit in this earlier pre-stripping of soil/clay layers from the lower benches (RL 10 and RL 04). This strategy would smooth out the availability of the gravel/siltstone tonnages and the requirement of excessive clay removal. Pending the outcomes of this study, the life of the PIT AREA 1 Quarry, based on the 200,000 tonnes total material extraction per year is approximately 10 to 11 years.

7.3 Proposed Operating Methodology

The quarry has been scheduled to a relatively constant total movement requirement and generally quarry operations would consist of a “top/down” approach to material removal. As can be seen from Table 12, total quarry movements are from the higher benches in Years 1 and 2. Completion of these upper benches and the progressive removal of the internal access haul road, preclude any further material removal and/or access to the higher levels of the quarry.

Changes to the overall design parameters would be possible to maximise the quarry resource. These parameters changes would be subject to additional geological drilling data and further geotechnical studies with respect to final slope stability constraints, operating bench widths and specific mining equipment selection.

8. Quarry Overview

Quarry production is basically divided into a number of elements:

- Site planning and development;
- Extraction involving
  - **Drill and blast** - to provide fragmented rock for crushing; however Density of the rock may lend itself to being easily dug up using an excavator or front end loader;
  - **Load and haul** - to move the rock from the quarry to the crushing plant.
- Processing involving:
  - **Crush and screen** - to process the rock to the required product size and specification product;
  - **Product storage** - to move the rock from the plant to the final product stockpiles;
  - **Dispatch** - to move the final product from the stockpiles to the customer via the weighbridge

8.1 Overview

Planning for the extraction process is collated in three main stages:

Stage 1:

- Development approvals and licensing;
- Preliminary design and further investigations.

Stage 2:

- Detailed design;
- Operations.

By using this staged approach means that all aspects of quarrying activities may be identified and potential issues dealt with before any extraction has taken place or any hazard or accident has impacted the site.

8.2 Level of Production

The level of production for the West Valley Quarry is not to meet a demand in terms of an agreement or contract pertaining to a development in the area such as highway construction; it is to be determined by the total time allocated for these operations determined by TSC and the resource available.

It is assumed that the rate or level of production will total be approximately 200 000 tonnes. However this will be further determined by the amount of material available for extraction and what is outlined in the approvals process as appropriate for the site.

8.3 Hours of Operation

It is recommended that the hours of operation should be the same as those currently at Quirks Quarry, as outlined in Table 13, this will ensure minimal additional disturbance to local area.

Table 13 Proposed Quarry Services Operating Hours for Eviron Quarry

Operation	Operating Days	Start Times	Finish Times
Quarrying	Monday to Friday	7 00	1700
	Saturday	7 00	1200
Blasting	Monday to Friday	9 00	1500
	Saturday	9 00	1200
Hauling	Monday to Friday	7 00	1700
	Saturday	7 00	1200

8.4 Activity Sequence of Operations

The Activity sequence is the common order of in which activities would be undertaken on site. There may be some variations at times with multiple activities being undertaken simultaneously.

The sequence involved in extracting rock from the proposed quarry involves the following steps:

1. Pre strip activities and topsoil stockpiling activities.
2. Blast-hole Drilling and Blasting.
3. Extraction
   - Primary screening;
   - Primary crushing;
   - Secondary Screening and crushing where required.
4. Haulage.
5. Stockpiling.
6. Product Loading and Hauling.

These are the main activities regarding the Quarry operations, however other activities may also be undertaken on site pertaining to quality control of extracted material, dewatering as well as environmental monitoring and control measures, which need to be implemented and undertaken on a regular basis.

8.5 Extraction Timing

Timing and use will revolve around the drill and blast timetable as all quarry pit activities will cease during the loading of the drill sections and detonation activities, however these operations will be on a needs basis.

Extraction of blasted material can only take place after drilling and blasting. After the bench of blasted material is cleared the drill and blast crew will be called in periodically to drill and load the holes and conduct blasting when suitable. However the blast pattern, charge and other variables related to blast outcomes will be used to limit the amount of blasting required to extract large quantities of rock.

As some of the material to be extracted is considered ‘soft rock’ excavator and front end loader operation will have sufficient force and power to break up and extract this material without drill and blast operations.

9. Quarry Activities

9.1 Drilling

Drilling will be required for any blasting operations, drilling will allow for downhole emplacement of explosives so deeper rock can become available for use not just surface rock. Drilling and Blasting activities are closely linked and both should be undertaken on a needs basis. It is recommended that drilling and blasting to be undertaken by a rock on ground contractors who will adjust drilling and blasting patterns, sequences and detonations for the desired outcomes.

9.2 Blasting

Blasting activities seek to fragment the quarrying product and is a necessary quarry activity. The specific type of blasting activities undertaken will be dependent on the drill-hole patterns and initiation sequence to obtain correct sized material required by Council. Using blasting as a method to break and size rock always results in a percentage error created of crushed fines (extraneous material) and possible oversized rock. It is estimated that even in a good blast pattern up to 5% extraneous material and 5% oversized material may result. Over time, this percentage can be reduced, however extraneous material as a percentage of recovery is inevitable in quarry operations.

Blasting causes potential noise impacts; however counteractive measures such as reducing the Maximum Instantaneous Charge (MIC) can be used to reduce the noise caused without sacrificing fragmentation. Amendment to the type and performance of the explosive charge, as well as the type of initiation system and the duration of delays can also assist.

Blasting usually results in both overpressure and ground vibration. The generation of fly rocks is potentially dangerous and can impact on neighbours. Therefore blasting practices should be designed and managed in order to reduce the risk to staff and the greater community.

Although the blast noise is unlikely to cause hearing damage to anyone outside the direct work area, blasting noise is more commonly an annoyance noise or discomfort.

Blasting will not occur at night and will be limited to times when condition are suitable and avoided at times, as outlined below:

- Avoid at times of adverse wind condition, as this may promote the impact of blast over pressure;
- Avoid at times of temperature inversion;
- Avoid overfilling holes with blasting agent;
- Avoid firing holes in the front row which have insufficient burden; and
- Orientation of blast face.

All blasting designs contain considerations to minimise factors such as ground vibration and air blast. It is likely that the drilling and blasting at the quarry will be under taken by qualified contractors to reduce risks associated with these activities. A ‘Rock on Ground’ (ROG) contract with an explosive supplier should cover all factors associated with the supply, store, use and transport all dangerous goods, initiators and blasting materials pertaining to blasting.

9.2.1 Times and frequency of blasting

Times and frequency of blasting are as follows:

- Blasting should generally only be permitted during the hours of 9 am and 3 pm Monday to Saturday;
- Blasting should not take place on Sundays or Public Holidays; and
- Blasting will not generally take place no more than once per day.

9.2.2 Air Blast Overpressure

Considerations for air blast overpressure are as follows:

- The recommended maximum level for air blast overpressure is 115 dB (lin Peak);
- The level of 115 dB may be exceeded on up to 5% of the total number of blasts over a period of 12 months. The level should not exceed 120 dB (Lin Peak) at any time;
- The air blast overpressure values referred to apply when the measurements are performed with equipment with a lower cut off frequency of 2 Hz or less. If the instrumentation has a higher cut off frequency then a correction of 5 db should be added to the measured value; and
- Equipment with a lower cut-off frequency exceeding 10 Hz should not be used for the purpose of measuring air blast overpressure.

9.2.3 Slope Stability

It is proposed in the Quarry pit to use geotechnical engineering model slope stability as part of the mine/ quarry design including toe crest stability using back break design to prevent unsafe overhangs. This will be incorporated into all design of blast patterns and earth work plans within the quarry area, but will also be used in the event of overhang or unstable slopes after the initial blast.

In addition to this the slope angle existing on the block should properly be surveyed in order to gain data of the actual slope of the area to enable regrade activities after quarrying activities have ceased.

9.3 Extraction

Extraction will begin when rock is suitable for removal by a front end loader or excavator, usually after drill and blasting operations have been undertaken (especially when excavating hard rock).

Material blasted will be collected from the bench below using either a front end loader or excavator depending on appropriateness.

The excavator will either load a series of mobile crushing/ screening equipment directly or load haul trucks to take material to screens and crushers for processing, this will predominantly be determined onsite by space available in the ‘working pit’.

9.4 Storage, Handling and Using Explosives

As the proposed quarry is relatively small, the operators are usually not drill and blast specialists; therefore it is recommended that all handling and use of explosives is undertaken by qualified contractors. Due to the size of the site, it is suggested that no explosives can safely be stored on site, so it is recommended that the appointed contractor be responsible transport and handling of explosives to be used on site.

10. Quarry Processing Activities

Processing of quarry products and location of this activity is dependent on the access and design of the quarry area to enable these activities to be undertaken. The most cost effective way to process the material is directly from the point of extraction. This methodology can be seen in the existing Quirks Quarry.

Figure 16 Example Quarry processing activities

It is proposed that the North and West Valley quarry areas operate this way when possible, therefore reducing the overall footprint of the development.

10.1 Processing

Processing undertaken on the proposed quarry site will reflect the desire outputs, which will be variable and dependant on market needs present through continued development in the local area, council and local industry needs.

Processing will fundamentally include crushing and screening, from which products will then be segregated and stockpiled ready for use and/or delivery.

All crushing and screening processes will take place when conditions are favourable to minimise dust and reduce water requirements. Processing has a range of environmental aspects which need to be addressed from water use, and dust suppression, machine noise and stockpiling requirements.

The expected products available would be:

- 70-30 mm, 40 mm, 20 mm, 10 mm, 7 mm Drainage Aggregates;
- Cracker Dust;
- “C” Grading Type 2.1 and “B” Grading Type 2.3 Road base;
- Overburden / Fill;
- Screened topsoil (Rescreened from imported spoil); and
- Screened Sand (Rescreened from imported spoil).

However the desired products are dependent on the rock available at the North and West Valley sites. Further testing is to be undertaken on the exact products to be available from this site; however these products are currently available from the Quirks Quarry site and due to their close proximity should reflect that available at West Valley.

All components of extraction and sizing processes will create fines and dust which will have to be closely monitored for both health and environmental reasons. The dust creation will be reduced by frequent watering and sprayers near and around the main dust creation sources such as the crushing and screening areas.

10.1.1 Sampling and Testing

It is understood that TSC will be undertaking further testing and sampling of the materials from the West Valley Quarry site. It is highly recommended that further sampling be undertaken to determine identified rock properties during detail design. By determining the rock properties the type of products to be produced at the site can be confirmed, however to do so this includes a series of tests to determine:

- What would be considered Coarse Aggregate; and further testing to determine what type of coarse aggregate; using:
  - Relative Density and water absorption testing;
  - Ten percent fines value testing;
  - Particle size distribution analysis; and
  - Flakiness index analysis.
- What would be considered Fine Aggregate; and further testing to determine what type of fine aggregate using:
  - Relative Density and water absorption testing; and
  - Particle size distribution analysis.
- What would be considered Filler; and further testing to determine what type of Filler:
  - Relative Density and water absorption testing; and
  - Particle size distribution analysis.

It will also allow for increased validity of tonnage calculations as specific densities of rock intervals could be validated and/or change dependant on test results.

Further sampling and testing will also allow for the most suitable use of the extracted rock, and assist with assessment of the economic viability of the quarry prior to commencement of extraction. Other testing methods or types may be used, depending on Council’s preference and specific property/ product targeted during the testing.

10.2 Screening and Crushing

Screening is required for the sizing and separation of materials, this allows the separation of oversized materials from medium to fine materials, this separation is often enough to allow material to be stockpiled or used, however some material requires crushing to produce certain sizing for sale and use. Most material will have to undergo crushing as the TSC has a variety of sizing which it requires for sale and use. Generally the excavator or front end loader will directly load material into screens and crushers within the pit area an example of which can be seen in Figure .

10.3 Stockpiling

Several stockpiles will be located on the Eviron site as each product will be stockpiled separately even though they may be produced at the same time as several other products. Stockpiles may be required for the raw material if extraction exceeds processing capacity.

Stockpiles will be located away from the main excavation area, close to the work areas containing the screens and crushers. The stockpiled material will be maintained until the product can be loaded for haulage offsite.

Any oversized materials will be stockpiled separately according to size. This material will be graded to determine whether it will be used for other activities or stockpiled as “unusable” material.

Stockpiles may require differing levels of maintenance and stockpiles required may be varying in size dependant on the demand.

10.4 Loading and Hauling

Material will then be processed and loaded into haul trucks to be taken offsite by private customers or to specific TSC working sites and/or stockpiled until it can be removed from the site.

11. Quarry Infrastructure

11.1 Security

The landfill site has a lockable entrance gate, with 2 m high chain wire fences on either side for a distance along the northern boundary. There are no other major security fences along the western, southern and eastern boundaries of the site. The existing Quirks Quarry and North/ West valley areas are contained by fencing except towards the northern boundary where the area is cut water channels separating the Quarry land from the cane field areas; north of the existing and proposed quarries.

11.2 Construction

There are two components on site relating to construction of roads and offices/work areas. There are two options for work areas on site, continued used of pre-existing work area or establishing a site nearer to the West Valley Quarry area. It is likely that the existing facilities will remain in use as there is little area to establish facilities and work areas closer to the West Valley site. There is a need to establish large areas of land for these purposes and stockpiling of processed products, however this should be done in pit where possible to reduce the quarry's overall footprint.

11.2.1 Offices, Amenities, Workshop and Heavy Vehicle Areas

During previous meetings with the current quarry operations manager it was identified that the area in which work is under taken requires a means of storage of equipment and parts. There is also the need to secure equipment during downtimes. It was proposed that the existing Quirks facilities may require improvement but is not absolutely necessary at this point in time.

It is proposed that Royal Wolf demountable containers or similar products spanned by an arch roof would be suitable for servicing and minor repairs of equipment. An additional hardened floor bay is needed to accommodate tracked vehicles. This design also has the advantage of allowing drive-through services if desired, removing the risks of reversing equipment in the area. An installed example of this type of workshop is shown in Figure 17.

Figure 17 Workshop Configuration Example

The illustrated facility consists of a 24 m x 12 m concrete slab with customized shipping containers either side. One container is used for storage of tools and light plant equipment whilst the other is an office/storage combination. A 12 m x 12 m canopy spans the containers, protecting the facility from the environment. This canopy includes an end-wall allowing for control of airflow through the service bay area.

11.3 Fuel and Oil Services

Separate fuel and lube bays for heavy and light vehicles are required. Amenities for both maybe available at the Stott's Creek facility or the Quirks Quarry lay-down/ Site office area, however further development should be made to enable these areas to provide the aforementioned services, if a new site for these activities is not identified for the West Valley Quarry.

11.4 Maintenance

Maintenance of the quarry fleet can if required; take place on site as there will be provisions for this in the workshop and service areas. Maintenance should only take place in these areas in case of fluid spill; such as fuels and lubricants. This will ensure that environmental risks are minimised and/or eliminated in most of the quarry.

12. Quarry Haulage

12.1 Product Haul Route

The product haul route will be indicated by Council and will need strict and detailed monitoring, to minimise the adverse effects of the large trucks on the main roads.

12.1.1 Internal Roads

All internal quarry roads should follow the guidelines as identified below. In the detailed design stage some details may change but the basic principles will remain, these principles include development of the roads drainage, runoff management and channelled appropriately.

12.1.2 Design Standard for Roads

Prior to any road being constructed, a risk review should be conducted on the design or proposed configuration of the road. This shall assess the suitability of the configuration and materials used to ensure that the safety risk to vehicles using the road is of an acceptable level. The design should take the following aspects into consideration:

- Presence of overhead structures and power lines;
- Drainage;
- Layout of and access to parking areas; and
- Access from roads to adjacent dump areas.

12.1.3 Primary Haul Road Regularly Used for Two Way Traffic

All primary haul roads are to be adequately designed in accordance with good practice for heavy equipment roads and the following guidelines:

- ***Road width*** - (as defined) of the road to be at least 3.5 times the width of the largest vehicle regularly using the road;
- ***Road grade*** - generally the grade should be less than 3% (1:30) with a maximum of 10%;
- ***Road profile*** - the pavement shall be shaped so as to readily drain water and to provide a safe surface to travel. The road shall be crowned in the centre with a 2-3% cross-fall to each edge;
- ***Curvature of bends*** - In general, bend radii should be 100 metres or greater for main sections of road if a road speed of 25 km/hr is to be adopted;
- ***Intersections*** - all new intersections should be “T intersections” (angle of approach of at least 70 degrees). Where this is not possible, a risk assessment shall be conducted on the alternative design to ensure that persons can use the intersection with safety;
- ***Safety berms or barriers*** shall be installed at any point where the ‘drop off’ at the side of the road is greater than half a metre (0.5 m), as detailed in the following section. This drop off situation should be avoided wherever possible by allowing a run-off slope at the side of the road battered at an angle no steeper than 1:4.

Design berm height is ideally half wheel height but a minimum berm height of one (1.0 m) metre is recommended for internal haul roads taking into account the need for visibility from light vehicles. However where possible a runoff slope should be implemented preferentially;

- ***Guideposts*** are to be of such size, shape, robustness and visibility (reflectors added) so as to adequately define the road boundaries in all conditions. The spacing of the guideposts shall be a nominal 150 metres on the general mine/quarry site and 100 metres on the haul road. Culverts unprotected by barriers or berms should be marked with pairs of guideposts;
- ***Signage -*** traffic control and direction signage shall be installed where necessary. The signs shall comply with AS 1742 (1...14): Manual of uniform traffic control devices; and
- ***Surface material*** - haul roads should be sheeted with sufficient competent material to provide an adequate degree of traction when wet, and to enable the surface condition to be restored through normal road maintenance.

This will include the main haul route in and out of the quarry site. This does not include the haul routes to the quarry faces, although similar design will be used where there is no pre-existing road.

12.1.4 Construction of Roads

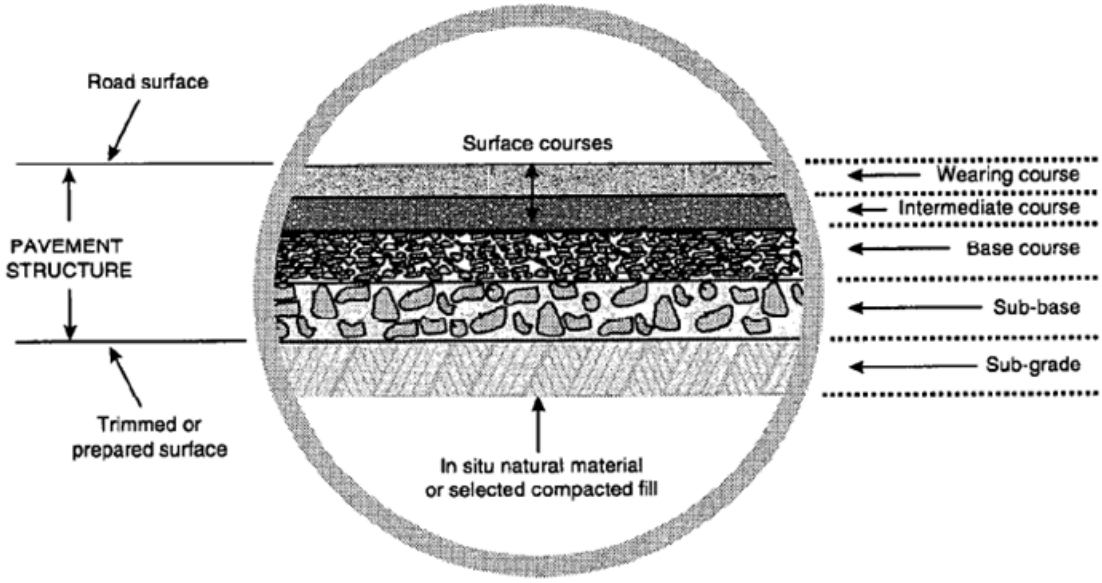
Primary haul roads should be adequately formed and constructed with foundation materials of suitable strength and compaction so as not to be readily prone to failure.

Base and top course materials are to be of adequate strength so as to not prematurely break down and become slippery when wet.

The construction process commonly used is:

- Remove the top and sub soil horizons to a suitable base material;
- Backfill and compact with the most competent overburden material readily available;
- Top course material and pavement (see Figure 18) should be competent material during stripping;
- Operations, suitable material (such as sandstone or gravels with low clay content); and
- Should be stockpiled for road construction purposes if encountered.

Figure 18 Typical Pavement Structure



Other *semi permanent and temporary* roads shall be formed and constructed out of suitable local materials so as to form a safe running surface. Use of unweathered or weathered sandstone will help form 'all weather' roads if required.

12.1.5 12.1.5 Maintenance and Dust Control of Roads- key to reduction in air pollution

All roads should be graded on a regular basis so as to maintain an adequate running surface and drainage.

From time to time the primary haul road (in particular) may require structural maintenance work that could include scarifying and re-compaction and/or resurfacing. Ongoing work is required to ensure that the road boundary is clearly defined at all times including the hours of darkness. This shall include replacement of missing or damaged guideposts and signage, where and if required.

Regular watering is required for dust control and maintenance of surface structure.

13. Fire Management Planning

Fire risks can be assessed and limited to reduce the risks to human life, infrastructure and operations, in a number of ways. A systematic fire response plans can be developed to minimise the risks associated with fire. A response plan can provide guidance within quarry operations to deal with potential fires; using a series of strategies and practical measures.

This section outlines measures to prevent the occurrence of unplanned bushfire the controlling of bushfires and minimise the potential for the spreading of bushfires in, from, or around lands under the care and control of TSC.

As part of risk reduction measures to be undertaken on site TSC shall:

- Provide adequate fire protection works on site, including the availability of trained personnel, water tankers and fire fighting equipment and annual hazard reduction measures with particular attention to boundaries of adjoining landholdings;
- Make available to the Fire Service and emergency services when required, water carts and trucks in cases of bushfire incidents on the quarry site; or adjoining sites; and
- To take all practical steps to prevent the occurrence of bushfires on their land, and to minimise the danger of the spread of bushfires on or from, their land.

13.1 Key Policy and Objectives

To ensure support for required practices and mitigation the following objectives and policies have been created:

- To prevent possible sources of fire or ignition on site where possible;
- Activities on the site are managed to minimise the risk of outbreak of fire;
- Hazard mitigation measures are in place to contain an outbreak of fire should one occur;
- To assist in the protection of the area, equipment and personnel from potential fire hazard or fire damage;
- Sufficient trained personnel, water and fire fighting equipment is available on site to suppress localised fires;
- Each outbreak of fire is investigated to identify root causal factors and to ensure that appropriate mitigation measures are instigated to prevent similar events from occurring in the future; and
- An annual report on fire management activities to assess.

13.1.1 Performance Standard

In the event of fire on site that the correct response and training has been undertaken to minimise environmental, personal and site damages/impacts.

13.2 Performance Outcomes and Actions

Performance outcomes and actions have been created to continually improve bushfire management, to ensure it is undertaken properly. These include the following targets and outcomes:

- An annual inspection and risk assessment is undertaken in time for mitigation measures to be in place prior to the commencement of the fire season;
- Perimeter fire trails are constructed and maintained to ensure access under all reasonable weather conditions;
- Water tanks/pumps and other appropriate fire fighting equipment are available on site and are maintained in good working order;
- All personnel on site receive training in basic fire fighting and are capable of providing a first response capability;
- A fire team comprising employees with additional training in fire fighting is available during operational periods;
- Employees, contractors and service providers are aware of the fire emergency procedures applicable on the site;
- Communication and liaison processes with local fire brigade are in place;
- All fires are extinguished in a quick, expedient and professional manner;
- Fire incidents investigations are completed and appropriate actions implemented; and
- The annual report on fire management activities is acceptable and appropriate

13.2.1 Employee Actions – Major Incident

If a fire on site occurs the personnel at the site must assess the situation and sound an alarm to ensure other employees can instantaneously be evacuated from site. In the case of a major fire outbreak on or around the site the following guideline should be followed:

- If a major fire on site occurs all personnel must evacuate to a safe muster point designated off site;
- All responsible personnel must account for all employees and report to the site foreman;
- The site foreman will contact the fire brigade during the evacuation of the site; and
- The site foreman will inform the fire brigade of any potential combustible chemicals and fuels on site and their location (a lock box at the front gate is also advised to aid in the communication of any important information required when fighting a fire on site.);

The main potential source of ignition and fire will be the equipment and fuel trucks (if on site).

13.2.2 Employee Actions – Minor Incident

Where a minor fire incident occurs on the Quarry site the following should be undertaken:

- All personnel inducted and working on site should be trained in fire safety, reduction and management.

Personnel dealing with the fire will:

  – Assess the size, wind direction and type of fire before extinguishing;

- Extinguish the fire.

- Inform the site foreman/supervisor
  - Source of the fire (if known);
  - How it was extinguished/type;
  - Who was involved

The site foreman will inform the local fire brigade as there may be some smoke due to the incident.

13.2.3 Potential Impacts

In producing this Fire Management Plan (FMP), the principal consideration has been to provide for the protection and safety of human life (including staff and contractors, residents and fire fighters suppressing bushfire events) and quarry property.

Bushfires also have the potential to impact upon flora and fauna of the area.

13.3 Risk Assessment

An annual bushfire risk assessment should be undertaken on the site before the bushfire season begins. The bushfire season typically occurs between October and March. However, factors such as fuel load, rainfall history and climatic conditions may bring forward or extend the bushfire season.

A bushfire risk assessment will consider:

- Fuel loads on the Quarry site;
- Advice from the Upper the Local fire brigade;
- The climatic conditions (particularly rainfall) of the preceding year; and
- Methodologies of bushfire risk assessment and Australian standards should be used and referenced to assess the potential risks.

13.3.1 Preliminary Hazard Assessment

A preliminary assessment of the hazard to building infrastructure and other assets within the lands under the care and control of the TSC should be undertaken as a priority when the initial activities on site begin as potential sources of ignition may become evident or will be reduced in some areas.

13.4 Potential Sources of Ignition

13.4.1 Quarrying Activities

Potential sources of fire or ignition on the Quarry site include:

- Ignition from equipment (metal grinding or welding);
- Ignition from unguarded exhausts of vehicles or equipment parked or travelling over dry pasture

13.4.2 Electricity Transmission Lines

Potential sources of ignition through electricity transmission lines occur due to:

- During hot weather electricity transmission lines may sag and, under windy conditions, may come in contact with each other and arc; and
- Arcing of lines may cause sparks to ignite vegetation in the vicinity of the lines
  - The risk of fire is increased if the lines are close to tall vegetation.

13.4.3 Lightning

Lightning may cause ignition of vegetation, particularly at higher elevations such as along ridgelines.

13.4.4 External Fire

As there are multiple neighbours to the site it is possible that fires started due to other operations or places may carry over to the Site.

13.4.5 Other

Other accidental causes of ignition exist which are usually to related human activity.

- Actions of employees, trespassers or neighbours;
- Vehicles accidents or fires on malfunctioning equipment and motors;
- Deliberately lit fire; and
- Fuel reduction fires.

13.5 Continual Improvement and Mitigation Measures

By continually monitoring and improving site conditions management will reduce the potential for bushfires. Additional fire awareness training and work practices will improve bushfire control and prevention.

13.5.1 Quarrying Activities

Quarrying activities have the potential to create a fire on site, the size will depend on the mitigation measures undertaken to prevent fire and the response systems implemented. Selected mitigation measures are as follows:

- All vehicles will be restricted to identified vehicle routes to reduce the risk of spark emissions;
- If a vehicle is required to traverse across grassed areas, it is to have an upward exhaust;
- Access track will be inspected and maintained when necessary;
- Existing firebreaks will be maintained;
- An area beside the access tracks will be cut or slashed extending the firebreaks;
- A cleared area will be established around above ground facilities and buildings;
- Activities that create sparks or hot particles, such as metal grinding and welding will be limited to workshops and hardstand or areas clear of vegetation;
- Access to dams and water supply will be inspected and maintained when necessary;
- All fire bans will be adhered to by employees, contractors and service providers.

13.5.2 Electricity Transmission

Electricity transmission easements will be inspected regularly to ensure regenerating vegetation does not have the potential to interfere with power lines that sag.

13.5.3 Lightning

No specific management practices are practicable to reduce the risk of lightning strike.

13.5.4 External Fire

The risk of bushfires in adjacent lands will be minimized by the provision of firebreaks along boundary fences.

13.5.5 Other

As the potential sources of ignition are unknown or unqualified, management of these potential outbreak sources are restricted and cannot be anticipated.

13.6 Fire Fighting Equipment

The Quarry site will require a wide range of facilities that will be made available to help control and extinguish bushfires. This equipment will included but is not be limited to:

- Fire hydrants;
- Fast fill hoses and connections;
- Clean water dams with maintained access points;
- Water truck/s;
- Earth moving equipment available;
- Water pumps;
- Portable radios;
- Fire alarms;
- Emergency telephones and fire extinguishers provided at vantage points within the surface facilities; and
- First aid room and supplies

All fire fighting equipment will be maintained or replaced according to Australian Standard 1851 or sooner if necessary.

13.7 Fire Training

Fire training is a key part in identifying and allowing positive action as a response to fire on site. By training personnel and key contractors this will ensure a safer work place and allow for risk minimisation as small fires will be able to be dealt with effectively. It will also allow for early evacuation in if there is a large fire which will reduce potential harm to people on site and may reduce property and infrastructure damages.

- All employees, contractors and service providers will be made aware of the fire emergency procedures applicable on the Quarry site;
- An on-site fire fighting team will be formed;
- This team of employees will receive training in the use and maintenance of fire fighting equipment and safe fire fighting techniques;
- This team will provide a first response to bushfires encountered on the quarry site land co-ordinate with fire fighting efforts of the local fire brigade in the event of larger bushfire onsite;
- The fire fighting team will receive regular training to update their skills;
- All employees on site will receive training in basic fire fighting and will be capable of providing a first response capability for bushfires.

Table 14 lists proposed controls and actions for fire management and planning.

Table 14 Proposed Controls and Actions Table for Fire Management and Plann

Control and Actions	Timing	Trigger/ Responsibility/ Monitoring/ Reporting
Annual inspection	Prior to bushfire/ bushfire season	Environmental bushfire season Environmental Officer in conjunction with Site Senior Supervisor and/or Quarry Manager
Bushfire risk assessment	Annual/ on Appointment	Annual reporting on fire management
Maintenance of fire fighting equipment	Annually and after a fire incident	Environmental officer with assistance of Local Fire Officer
Bushfire protection measures	Three- six monthly basis	Environmental Officer
Fire fighting training	Annually	Quarry personnel / Fire Officer or qualified trainer
Investigation of fire incidents	After a bushfire	Community Safety Officer of the local fire brigade
Control of bushfire		Immediate response- may be under taken by trained quarry personnel, (see actions) Secondary response- Local fire brigade, additional help may be sort from trained Quarry personnel volunteers

13.8 Monitoring

Any personnel involved in a minor fire incident must report it to the site foreman. The site foreman will record all fire incidents.

The site foreman will inform the local fire brigade as there may be some smoke due to the incident and record this contact with the fire brigade.

An incident investigation will be undertaken in both a minor and major event; this will include a variety of personnel from employees, site foreman to local and state authority's dependant on the severity and impacts of the fire. Reporting requirements are as follows:

- A report will be prepared after an incident of bushfire and will include measures to improve the FMP if necessary; and
- Annually in the form of a report on bushfire management activities and bushfire risk assessment.

This FMP will be reviewed after incidents of bushfire as well as annually after the bushfire season. The FMP will be amended after the review process, if required, to increase the effectiveness of this FMP.

The local fire brigade and other fire professionals will be consulted to ensure that any possible corrective measures be implemented on site to prevent a repeat incident if at all possible.

14. Safety Measures and Environmental Measures

Safety and environmental measures often achieve similar outcomes, but focus on different aspects of quarry operations. For example mitigation measures implemented for spills will both have safety and environmental outcomes.

A leak: is a slow discharge over time; a leak may be a drip at a joint which is not tight, worn or under pressure. However is considered under spill management.

A spill: is a large discharge over time; a spill may be from a hydraulic hose which splits or a drum which overturns.

This section largely addresses safety and environmental measures related to spill management, however it is acknowledged that there are numerous other safety and environmental issues that may arise onsite. Other environmental issues are handled within the Environmental Assessment document, and other safety measures should be considered at a preliminary design stage. All such issues and measures will be included in the West Valley Quarry Plan of Management at a later stage in the project development.

14.1 Policy

Policy on site shall reflect the best practice to ensure health and environmental outcomes these include, but are not limited to:

- To reduce potential impacts of potential spills on site; and
- To respond quickly and effectively to spills on site, without endangering or risking health and safety of employees.

14.1.1 Performance Standard

Quarry operations aim to minimise potential harm by planning and performing in such a ways as to reduce risk on site. To do this the following targets have been determined:

- Ensure the minimum risk during operations to the soil and water way;
- Ensure that any unforeseeable spill event can be dealt with swiftly reducing environmental damage to the site;
- Establish secondary precautions to reduce the extent that a spill can cause environmental harm;
- Maintain trained personnel to respond to spills, and assign key personnel to manage response; and
- A chemicals and fuel register be kept on site and a copy kept at the emergency muster point and a copy of Material Safety Data Sheets of chemicals and fuels on site appended to this register.

14.2 Bunds

Bunding high-medium risk areas of operation, to create separation of work areas is a fundamental practice when trying to limit potential environmental aspects created by works undertaken in specific areas.

Bunding can act as a barrier or deterrence to stop interaction or effects/activities of one area affecting other areas; bunding may also create or aid in on site drainage practices.

The bund will ensure capture and enclosure of stray contaminates but an additional spill kit should be located at this point for immediate clean up. This will ensure that the site and its activities remain environmentally compliant and risk and potential cost are lowered.

A bund can be a low wall, tray, speed bump, iron angle, sloping floor, drain or similar and is used to capture spilt liquid for safe and proper disposal.

Often chemicals, fuels and oils require bunding as part of their requirements for use on sites and linked to the approval process, many fuel tanks and chemical containers now have standardized self-bunding and/or internal bunds.

Note: implementation of bunds does not mean there can be no spills or potential leaks and/or spills, but the impacts will be reduced and limited.

14.3 Uncontrolled Releases

Any release of contaminants not in accordance with the conditions of the approval s must be reported by telephone to the relevant agency. Any such release must be reported as soon as practicable, but no later than 24 hours after becoming aware of the release. The relevant state agency may need to respond quickly in some cases, which is why priority needs to be given to the reporting of a spill.

14.4 Spill Management Planning

To reduce the occurrence of spillages and to assist the clean-up process of any spills, both management and staff members should be aware of spill procedures. By formalising these procedures in writing, staff members can refer to them when required thus avoiding undertaking incorrect spill procedures.

Further to aid in the awareness of correction procedures, training should be undertaken by all employees and contractors on site to ensure effective clean-up of spills.

A spill management plan can be as simple as stating the steps taken when a spill occurs (stop, contain, report, clean up and record).

A map is recommended to also be included to show the locations of spill kits or other cleaning equipment and correct evacuation procedures. This document/s could be attached to the spill kits or where other cleaning equipment is stored to ensure easy access.

14.4.1 Responding to Spills

To respond to a spill the following measures should be undertaken:

- Stop the source

If it is safe to do so, the source of the spill should be stopped immediately. This may be a simple action like upturning a fallen container.

- Contain and control the flow;

To stop the spill from expanding, absorbent materials and solid/ liquid barriers should be placed around the spill. Work from the outside to soak up the spill. It is vital that spilt liquid is not allowed to reach stormwater drains, sewer drains, natural waterways or soil.

- Report to relevant authorities;

For large scale spills that involve hazardous materials, the Fire Brigade must be alerted. If a contaminant causes pollution the quarry has a duty to report the incident to the Office of Environment and Heritage (or equivalent) (OEH).

  - Failure to report a pollution incident that has the potential to cause harm to the environment is an offence.

- Clean up;

Using information from Material Safety Data Sheets (MSDS) about the properties of the liquid spilled and the spill equipment available, spills should be cleaned up promptly.

- Record the incident.

By keeping a simple log of all spills, precautionary measures can be put in place to avoid similar accidents from occurring in the future. Recording spills demonstrates that a business is motivated to prevent pollution from spills occurring.

14.5 Minor Spills

A small spill is generally considered to be a spill of 5 litres or less providing the product is not concentrated. For concentrated products of any quantity the spill must be treated as a large spill.

To respond to a minor spill the following steps should be taken:

Assess safety. Make sure that people are kept clear, and that you have the right training and equipment to deal with the spill.

Stop the source. Providing it is safe to do so, stop the spill at its source. This may involve righting an overturned container or sealing holes or cracks in containers.

Contain and clean up the spill. The spill should be mopped up immediately.

Record the spill. Record when, what, how and where the spill occurred, clean up measures undertaken and the names of any witnesses.

Recording of the incident will require the reassessment of the management plans to ensure that changes are made to the Spill management plan to prevent a future spill.

14.6 Major Spills

A large spill is generally considered to be anything over 5 litres or concentrated chemicals of any volume, however will be determined in the site approvals process.

To respond to a major spill the following steps should be taken:

Assess safety. Make sure that people are kept clear, and that you have the right training and equipment to deal with the spill.

Consult the Material Safety Data Sheet (MSDS) or identify the substance. If information on the substance is unknown the MSDS will have instructions on how to deal with specific chemical spills.

Put on protective clothing. If necessary, put on gloves and goggles, a mask and an apron.

Stop the source. Providing it is safe to do so, stop the spill at its source. This may involve righting an overturned container or sealing holes or cracks in containers.

Contain and control the flow. The spill should be prevented from filtrating into the ground or entering the stormwater system. The outer edge of the spill should be dammed with rags, blankets, sand, sands bags, mops and/or absorbent booms.

Clean up the spill. Promptly cover the spill using absorbent materials such as the correct absorbent granules for the product (Note that some strong acids will react with some types of granules and sawdust), sand and rags, being mindful not to splash the spill.

Using a dustpan or spade, the absorbent granules or sand must then be scooped up and placed into a container. This waste material is not to be buried or thrown into the environment. The method of disposing this waste will depend on the amount and the type of chemical that was spilt.

The EPA will advise on the appropriate disposal of hazardous substances. There are several contractors that will dispose of contaminated substances and soils.

Notify the appropriate authority. If the spill does enter a stormwater drain or open ground, the EPA and your local council must be notified. If there is a hazard to health or property, call Fire and Rescue on 000 immediately.

Record the incident. Record what, how and where the spill occurred and the names of any witnesses. Also make note of what changes can be made to the spill management plan and plan of operations if applicable in preventing a future spill.

14.7 Spill Avoidance

Activities on site must be conducted in a way that prevents any potential or actual release of a contaminant to land. The benefit is that the environment is protected from contaminants that can potentially cause harm. This will allow cost savings as there will be no breaches resulting in financial penalties or by wasting of resources through actual releases.

To prevent the release of fuels, lubricants or other contaminants to land the control measures may include, but are not limited to, the following:

- Maintain all refuelling equipment in good working order;
- Use groundsheets or drip trays to capture spillage during maintenance of vehicles and any other equipment and plant;
- Where practicable, locate fuel storages within an impermeable bund;
- Where practicable, undertake refuelling and routine maintenance of vehicles within designated service areas;
- Clean up and dispose of spillages as quickly as practicable and in a manner that prevents the release of waste, contaminants or other materials to land;
- Correct liquid storage, all liquids should be stored in sealed containers that are free of leakage;

- All containers should be stored on sealed ground and in an undercover area;
- These are simple things that can be checked regularly;
- Keep sharp parts and items away from containers containing liquid to avoid damage and leaks.

14.7.1 Spill Kits

Spill kits on site ensure that an available means of cleaning up a spill are readily available and the potential impacts of a spill can be reduced. Spill kits are purpose designed units that contain several items useful for cleaning up spills that could occur. Typical items are:

- Safety gloves and appropriate protective clothing (depending on the type of chemicals held onsite);
- Absorbent pads, granules and/or pillows;
- Booms for larger spills;
- Mops, brooms and dustpans.

Spill kits are used to contain and clean up spills in an efficient manner and the site should have enough spill kits or big enough spill kits to deal with any potential spills.

Access to spill kits needs to ensure the following:

- Spill kits should be kept in designated areas that are easily accessible to all staff;
- Spill kits should be kept nearby to where a spill/s are most likely to occur- for example refuelling areas;
- Staff members should be trained in using the spill kit correctly.

14.8 Records and Corrective Actions

Recording must be undertaken after each incident and management plans should be reviewed annually or after an incident.

Reporting to OEH about an onsite incident must occur if the incident is uncontrolled and considered significant (breaching the conditions of approval and environmental non compliances associated with the activities undertaken on site).

Information about the incident needs to be recorded and written, a notice detailing the following information must be provided to OEH within 14 days of any advice provided if a breach has occurred.

The following information must be included:

- The name of the operator, including their registration certificate number;
- The name and telephone number of a designated contact person;
- Quantity and substance released;
- Person/s involved;
- The location and time of the release;
- The suspected cause of the release;
- A description of the effects of the release;

- The results of any sampling performed in relation to the release;
- Actions taken to mitigate any environmental harm caused by the release; and
- Proposed actions to prevent a recurrence of the release.

All records must be kept for 5 years and should also include and verify the provision of training programs and schedules of routine inspections

By continually improving management plans to reflect the changing nature of the site will ensure that all aspects are investigated and remediated where possible, and these changes need to be also recorded to reflect the continual improvements to management plans to ensure that due diligence can be shown.

14.9 Site Closure and Rehabilitation

The Concept Plan for Eviron Road makes provision for converting the West Valley Quarry into a fully engineered landfill, following cessation of quarrying activities. Following completion of landfill activities including capping, remediation and rehabilitation, the site will form part of the Tweed Shire Botanic Gardens.

15. References

Berkman, D.A (2001); Field Geologists' Manual AUSIMM Monograph 9, AUSIMM, Carlton, Victoria.

Geological Survey of QLD (GSQ) (1978), Murwillumbah 1:100 000 Scale Geological Map, Australia.

Willmott, W. (2010), Rocks and Landscapes of the Gold Coast Hinterland (Expanded Third Edition), Kingswood Press, Underwood, Queensland.

www.simetric.com.co.uk

Appendix A

Geology Mapping Report

CLIENTS | PEOPLE | PERFORMANCE

Tweed Shire Council

Report for West Valley Quarry

Geological Mapping

September 2011

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

This Geological Mapping Report ("Report"):

- *has been prepared by GHD Pty Ltd ("GHD") for Tweed Shire Council;*
- *may only be used and relied on by Tweed Shire Council;*
- *must not be copied to, used by, or relied on by any person other than Tweed Shire Council without the prior written consent of GHD;*
- *may only be used for the purpose of geological mapping (and must not be used for any other purpose).*

GHD and its servants, employees and officers otherwise expressly disclaim responsibility to any person other than Tweed Shire Council arising from or in connection with this Report.

To the maximum extent permitted by law, all implied warranties and conditions in relation to the services provided by GHD and the Report are excluded unless they are expressly stated to apply in this Report.

GHD expressly disclaims responsibility for any error in, or omission from, this Report arising from or in connection with any of the Assumptions being incorrect.

Subject to the paragraphs in this section of the Report, the opinions, conclusions and any recommendations in this Report are based on conditions encountered and information reviewed at the time of preparation and may be relied on until or after which time, GHD expressly disclaims responsibility for any error in, or omission from, this Report arising from or in connection with those opinions, conclusions and any recommendations.

Contents

Table Index

Figure Index

Appendices

1. Introduction

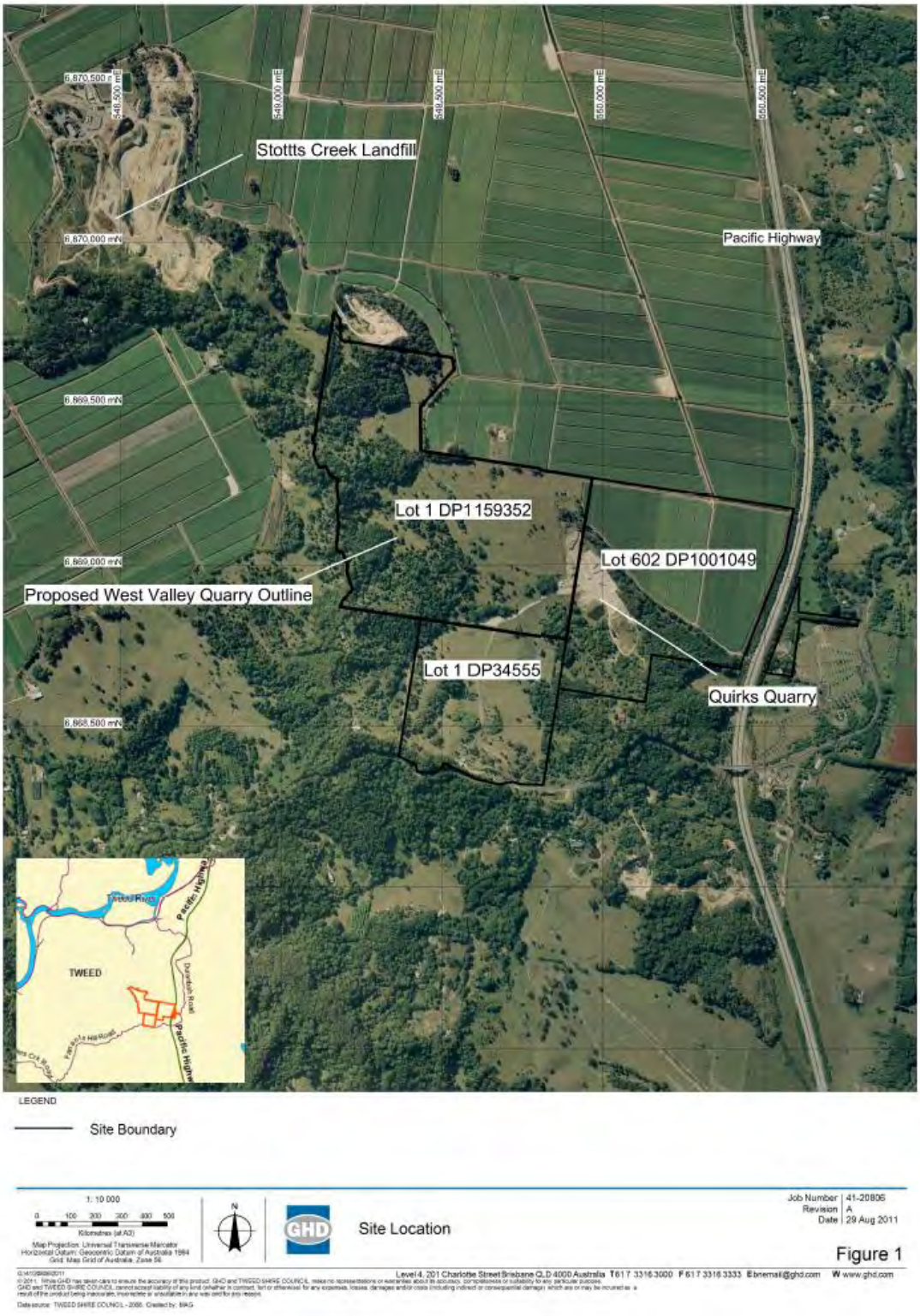
Tweed Shire Council is applying for permission to site a quarry in an area known as West Valley, adjacent to the existing Quirks Quarry and Stotts Creek Landfill sites. The potential quarry is located east of Condong and to the south of the Tweed Valley Highway, approximately 10km east of Murwillumbah (Figure 1).

In 2009, a restricted drilling program was undertaken to obtain geological data for the site. The restricted nature of the drilling program resulted in only a limited number of holes being drilled. This was due to access and permitting difficulties. Additional geological data has been requested by the New South Wales Department of Trade & Infrastructure, Regional Infrastructure & Services in order to progress the project application.

To obtain additional geological data, field mapping of the West Valley area and tenure was undertaken to assess the visible (surface) geology. This would complement the existing geological data. Additionally the mapping assignment aimed to identify possible future drilling locations. Additional sites were identified but will need to be approved by the relevant statutory authorities after suitable notice of surface disturbance has been completed.

The mapping was carried out by two GHD geologists, Dave Winterbotham and Maree Gaughan in August 2011.

Figure 1 Site Location



2. Scope of Mapping

For the purposes of the field mapping, the site was divided into two ‘zones’;

1. Quirks Quarry
2. West Valley Area

Each zone was investigated for presence of geological features (rock type, bedding, foliation, weathering, strength, grain size, alteration and any other properties or geological structures identifiable).

Location data was obtained using a Garmin GPS62. Refer to Figure 2 for GPS sample points information and Appendix A and Table 1for coordinates and field notes of waypoints.

The area covered during mapping was limited by the terrain which at times was too steep or densely vegetated to allow access by either vehicle or foot. Refer to Figure 3 for areas accessible, traversed and mapped.

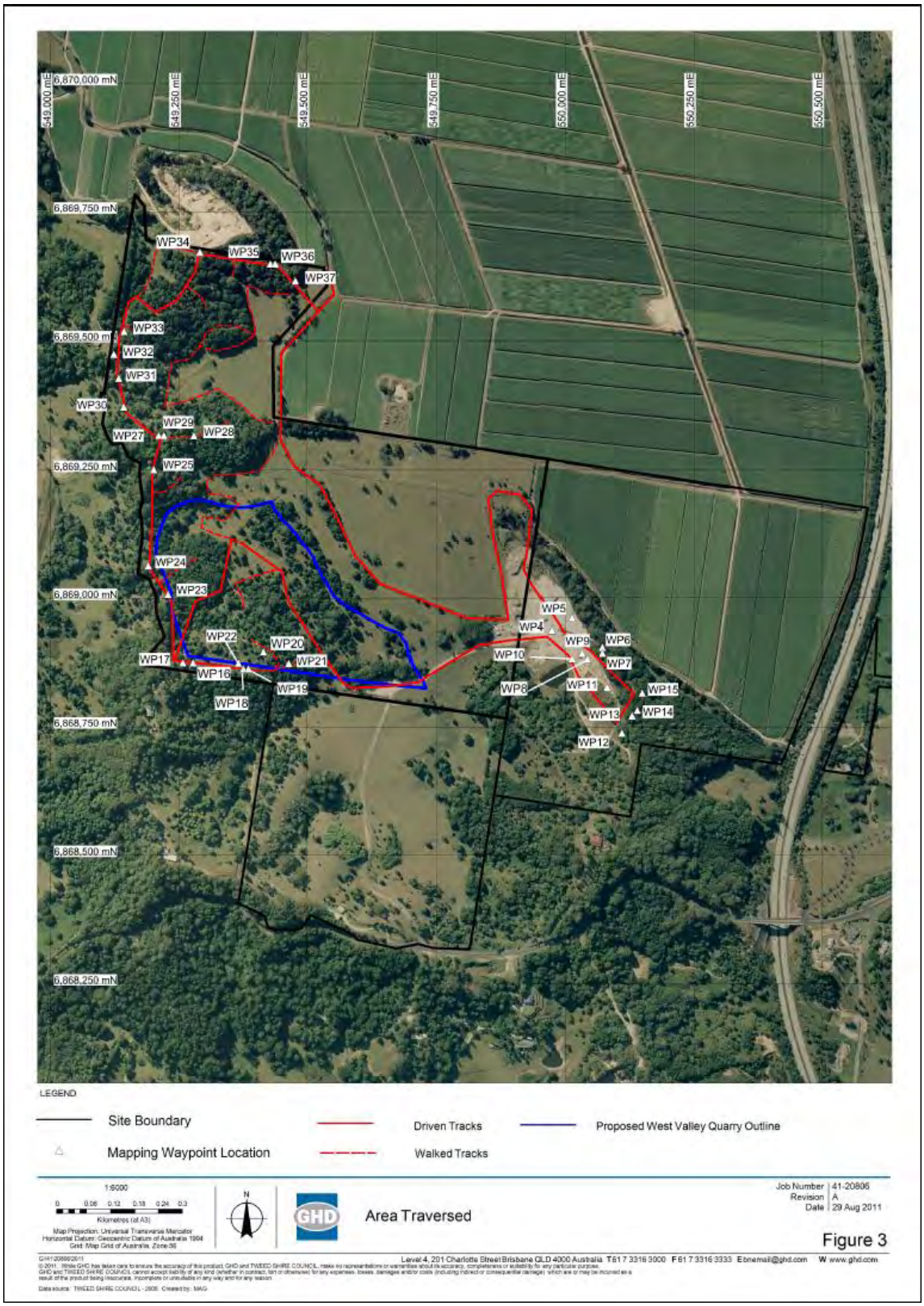
Table 1 Mapping Waypoint Coordinates

Waypoint ID	Latitude	Longitude	Elevation	MGA Zone 56 (GDA 94)	
				Easting	Northing
4	-28.3047	153.5097	3.3895	549973.7	6868938.3
5	-28.3045	153.5101	6.164616	550013	6868960.3
6	-28.305	153.5107	8.120972	550071.6	6868904.7
7	-28.3051	153.5107	8.250244	550071.5	6868893.6
8	-28.3052	153.5104	7.325806	550042.1	6868882.6
9	-28.3051	153.5103	5.737404	550032.3	6868893.7
10	-28.3052	153.5101	2.672344	550012.7	6868882.7
11	-28.3057	153.5108	10.79648	550081.1	6868827.1
12	-28.3065	153.5111	11.00139	550110.1	6868738.3
13	-28.3062	153.5113	5.691277	550129.9	6868771.5
14	-28.3061	153.5114	5.565376	550139.7	6868782.5
15	-28.3058	153.5115	8.210361	550149.6	6868815.7
16	-28.3053	153.5026	56.27272	549277.3	6868874.7
17	-28.3053	153.5024	57.36137	549257.7	6868874.8
18	-28.3054	153.5036	63.69023	549375.3	6868863.3

Waypoint ID	Latitude	Longitude	Elevation	MGA Zone 56 (GDA 94)	
				Easting	Northing
19	-28.3054	153.5037	61.90484	549385.1	6868863.2
20	-28.3051	153.504	49.614	549414.6	6868896.3
21	-28.3053	153.5045	41.61081	549463.6	6868847
22	-28.3053	153.5035	58.10786	549365.5	6868874.4
23	-28.3041	153.5021	60.23146	549228.8	6868007.9
24	-28.3036	153.5017	42.46847	549189.8	6869063.4
25	-28.3019	153.5018	27.94193	549200.4	6869251.7
27	-28.3013	153.5019	44.15691	549210.5	6869318.2
28	-28.3013	153.5026	25.22784	549279.1	6869317.9
29	-28.3013	153.502	37.94413	549220.3	6869318.1
30	-28.3008	153.5012	47.67372	549142.1	6869373.8
31	-28.3003	153.5011	47.59722	549132.5	686942.3
32	-28.2999	153.501	48.47367	549122.9	6869473.6
33	-28.2995	153.5012	45.49124	549142.7	6869517.9
34	-28.2981	153.5027	25.99124	549290.4	6869672.3
35	-28.2983	153.5041	14.81654	549427.6	6869649.6
36	-28.2983	153.5042	14.27511	549437.4	6869649.6
37	-28.2986	153.5046	8.042927	549476.5	6869616.2

Figure 2 Location and Mapping ID Sample Points

Figure 3 Area Traversed



3. Geological Data

3.1 Regional Geology

In the region of the West Valley Quarry, the Murwillumbah 1:100 000 scale geological map (GSQ, 1978) shows the site as being underlain by the Neranleigh-Fernvale Beds. This unit is Devonian-Carboniferous in age and is comprised of mudstone, siltstone, shale, greywacke, chert, jasper, basic metavolcanics, pillow lava and conglomerate. Willmott (2008) indicated that these beds were metamorphosed near the end of the Carboniferous Period. Therefore the beds of the Neranleigh-Fernvale Beds are meta-sedimentary. All reference to these beds henceforth will assume these beds have been metamorphosed.

Low lying areas of the site are underlain by Tertiary to Recent alluvium.

3.2 Quirks Quarry

Quirks Quarry began operations in the 1950's and was purchased by Tweed Shire Council in 1996. Quarry operations continue at Quirks Quarry today and an in-situ resource of approximately 69,000 cubic metres remains.

A brief exploration of the rock exposed in cut faces of Quirks Quarry was undertaken in order to identify any consistency between the rock and that identified in the West Valley area.

Rock was identified as chert to quartzite, greywacke and siltstones (Figure 4, Figure 5, Figure 6, and Figure 8). These rocks are consistent with units within the Neranleigh-Fernvale Beds.

In general, the sedimentary rocks display jointing (Figure 8), occasional faulting (Figure 9) and have in the case of siltstone undergone deformation resulting in strong foliation. The sediments also display a variable weathering profile from extremely weathered to fresh rock throughout the Quirks Quarry area (Figure 10, Figure 11, Figure 12 & Figure 13).

Figure 4 **Photograph – Waypoint 5 – East Facing – Exposed quarry face displaying siltstone top unit and Chert bottom with thin soil overburden.**

Figure 5 **Photograph – Waypoint 11 – South East Facing – Exposed quarry wall face of predominately chert with siliceous siltstone showing zones of oxidation on the side of the hill**

Figure 6 **Photograph – Waypoint 6 – North Facing Quarry Face – Siltstone with quartz and clayey bands**

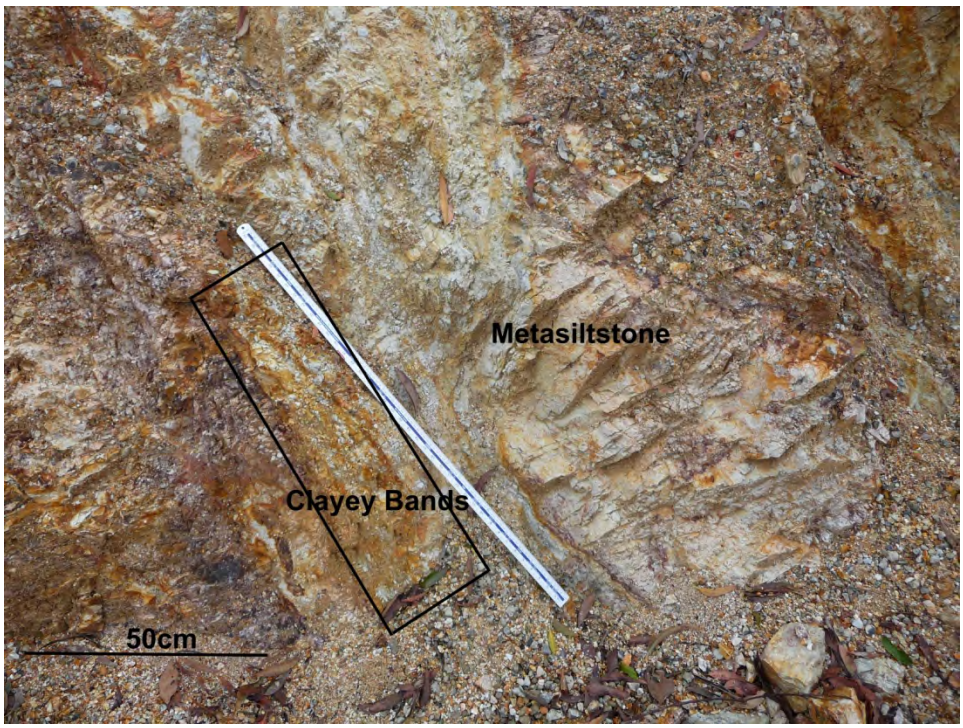


Figure 7 **Photograph – Waypoint 9 – On Quarry Floor – Chert interbedded with Siltstone**

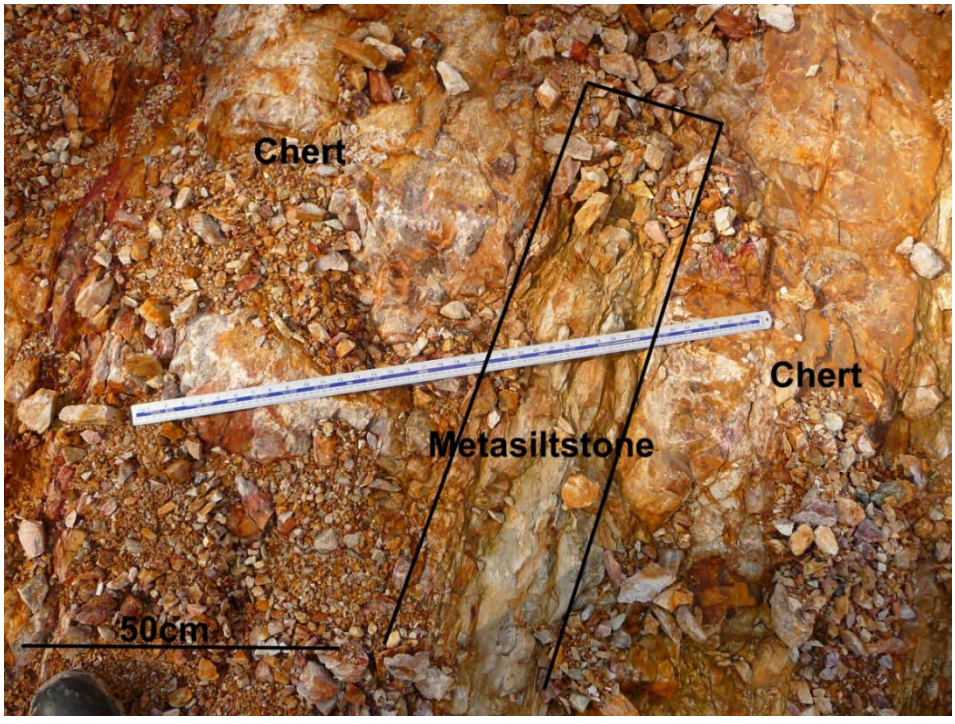


Figure 8 Photograph – Waypoint 13 – South East Facing Quarry Wall – Chert with siliceous siltstone, possible bedding (dip-dip direction) 70-300°

Figure 9 **Photograph – Waypoint 12 – South East Facing Quarry Wall, Blocky/Jointed siltstone with fault (dip-dip direction 70-315°) gouge of silts/clays**

Figure 10 Photograph – Waypoint 7 – North East Facing – Extremely weathered rock – clay with remnant rock structure of siltstone (possible mottled zone)

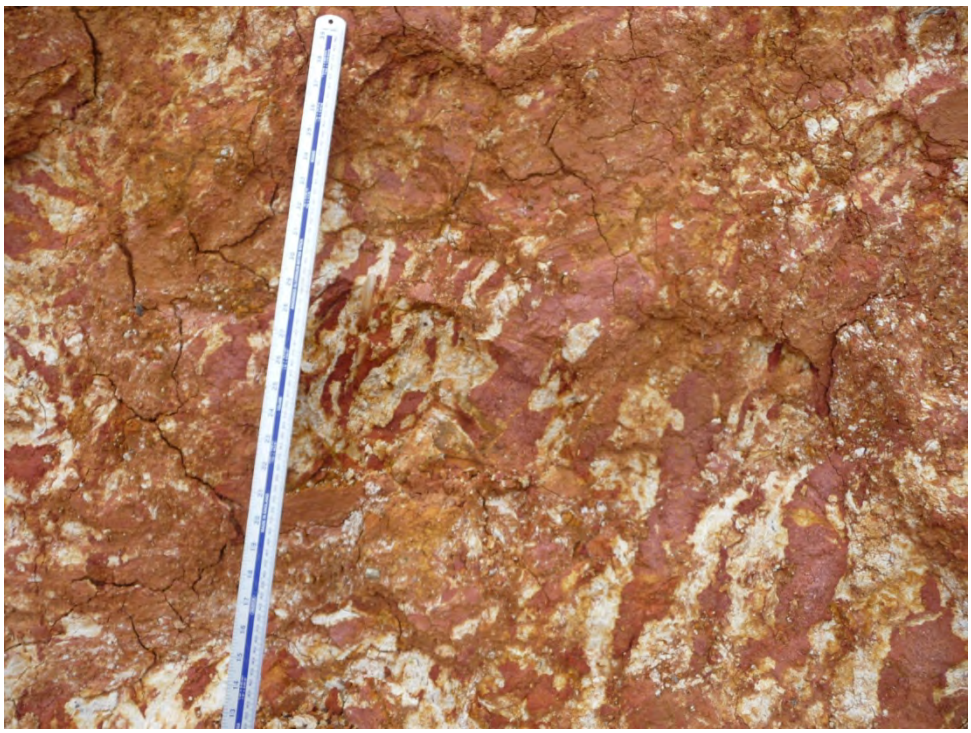


Figure 11 Photograph – Waypoint 15 – South East Facing – Extremely weather rock – clay with remnant rock structure, possible siltstone/chert

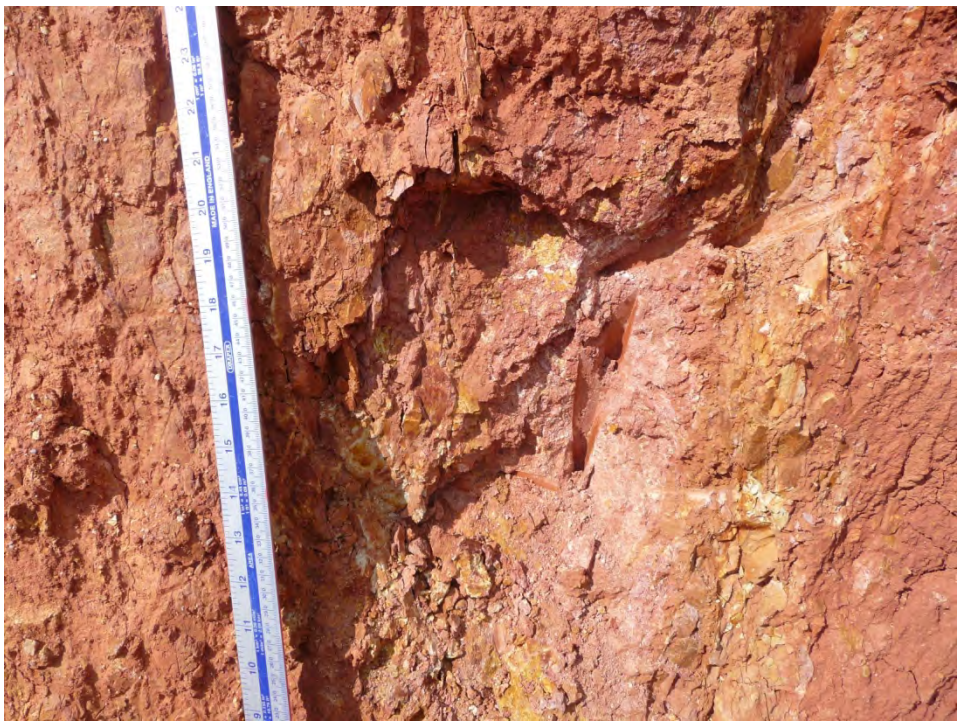


Figure 12 **Photograph - Waypoint 8 – South Facing Quarry Wall - Weathering profile showing shallow overburden with extremely weathered rock to moderately/fresh weathered rock zones.**

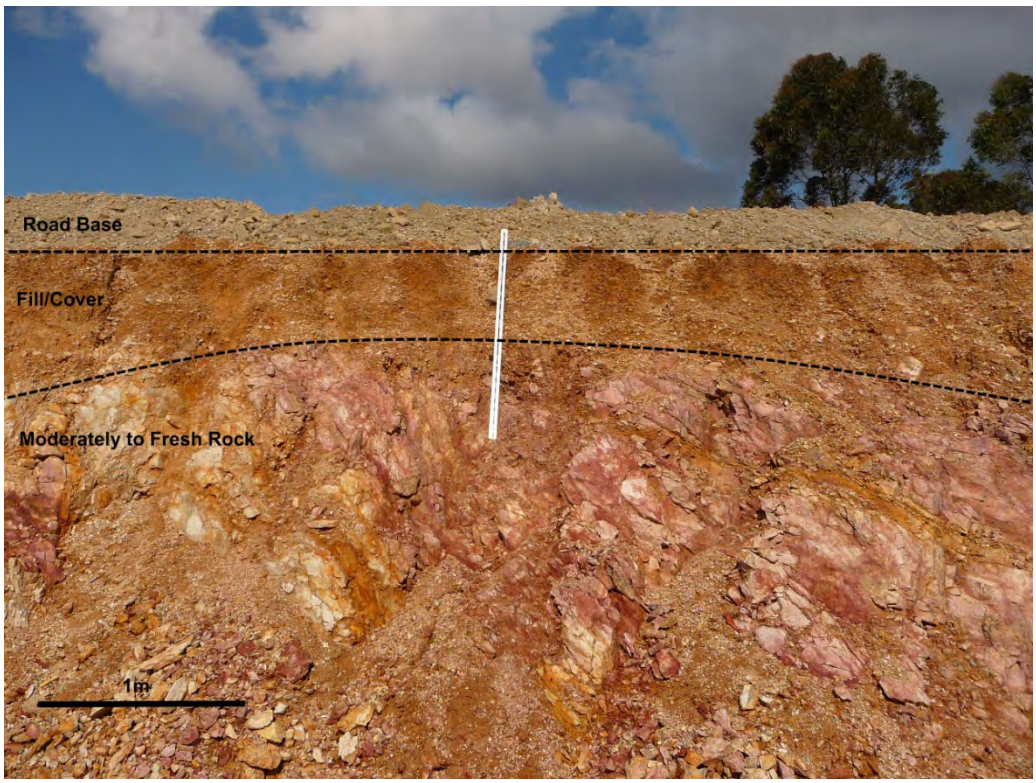
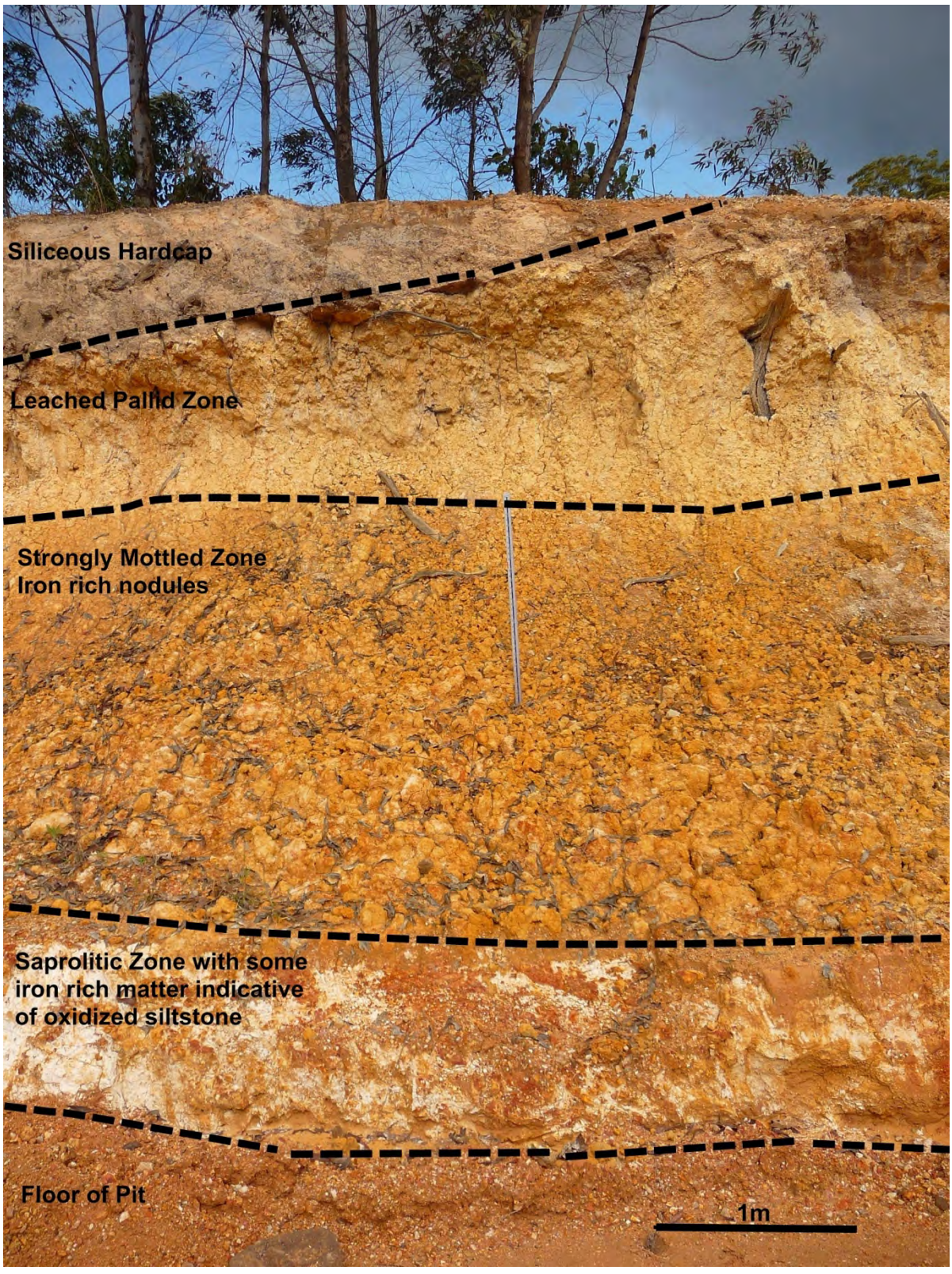


Figure 13 **Photograph - Waypoint 10 – South West Facing Quarry Wall - Weathering profile showing various weathering zones, shallow overburden with extremely weathered rock to moderately/fresh weathered rock zones**



3.3 West Valley Area

The proposed West Valley Quarry is located to the west of Quirks Quarry (Figure 1). Quirks Quarry and the majority of Lot 1//1159352 are located on ridges separated by floodplains. The West Valley area ranges in elevation from 0 to 60 m RL with terrain alternating from gentle undulating slopes to steep hills. The area is partially covered with thin to dense vegetation consisting of trees, shrubs and grasses.

In the accessible areas, the only identifiable outcrops were found in road side and drainage cuttings and on a few occasions as minor exposed outcrop on road or cleared ground (Figure 14).

Rocks in the West Valley are identified as chert to quartzite, greywacke and siltstone.

The chert in the area display variable weathering and often have interbedded highly silicified siltstone (Figure 16, Figure 18, Figure 14& Figure 15). Foliation was identified within the siltstone however due to the lack of outcropping obtaining accurate data proved difficult. Data available indicated that there was some inconsistency in foliation throughout the siltstone.

Greywacke is brown to grey with some iron staining, fine to medium grained with lithic fragments and blocky joints with dip-dip directions of 75-020°, 75-125°, and 45-280°. (Figure 17& Figure 18).

Siltstone is brown to grey, thinly laminated to thinly bedded. Also minor interbedding of chert and quartz veining are apparent within the siltstone.

Overburden identified in road cuttings varies in thickness from 10 cm to 1.5 m (Figure 20, Figure 21 & Figure 22). This overburden was also noted on the top of the ridge line. The nature of the overburden of the plains and hillside was not able to be determined due to vegetation cover.

The floodplains within the area are assumed to contain Tertiary to Recent alluvium (as noted in previous reports) as no additional information was obtained in these areas due to lack of outcrop.

Lithologies observed are consistent with units within the Neranleigh-Fernvale Beds.

Figure 14 Photograph – Waypoint 18 – Minor exposed outcrops of Chert – location of drillhole TSCBH01

Figure 15 Photograph – Waypoint 18 – Exposed outcrop of chert – foliation (dip-dip direction 20-020°)

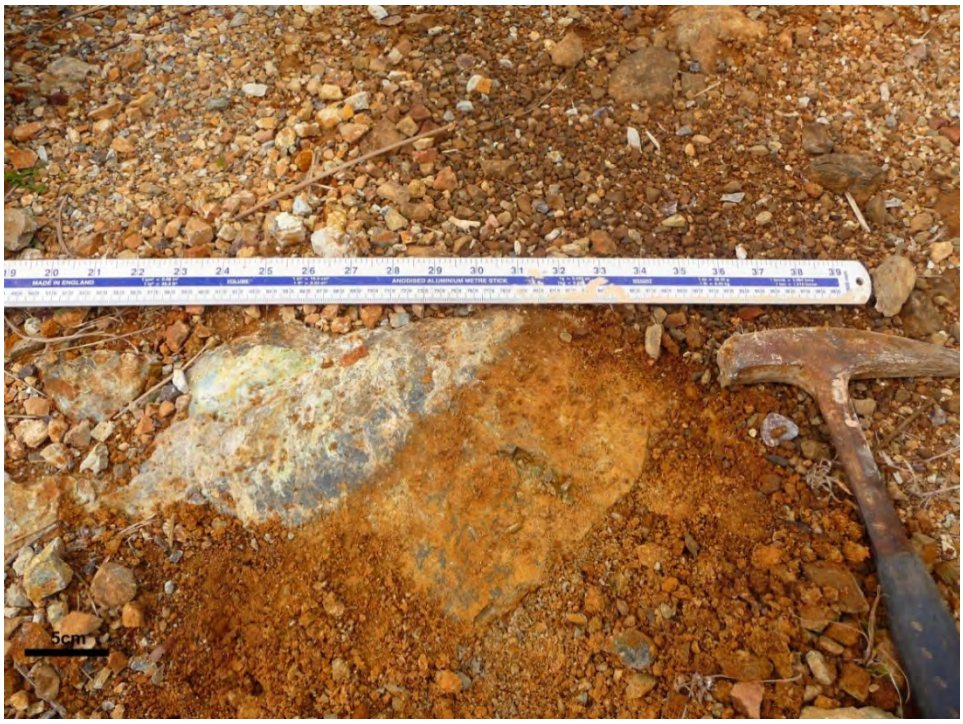


Figure 16 Photograph – Waypoint 20 – South West Facing – Chert/Quartzite to siliceous siltstone exposed in drainage cutting.

Figure 17 Photograph – Waypoint 27 – South West Facing – Greywacke in road cutting. Note blocky material.

Figure 18 Photograph – Waypoint 30 – South West Facing – Greywacke in road cutting with Blocky joints with dip-dip directions of 75-020°, 75-125° and 45-280°

Figure 19 Photograph – Waypoint 36 – Chert in a road cutting

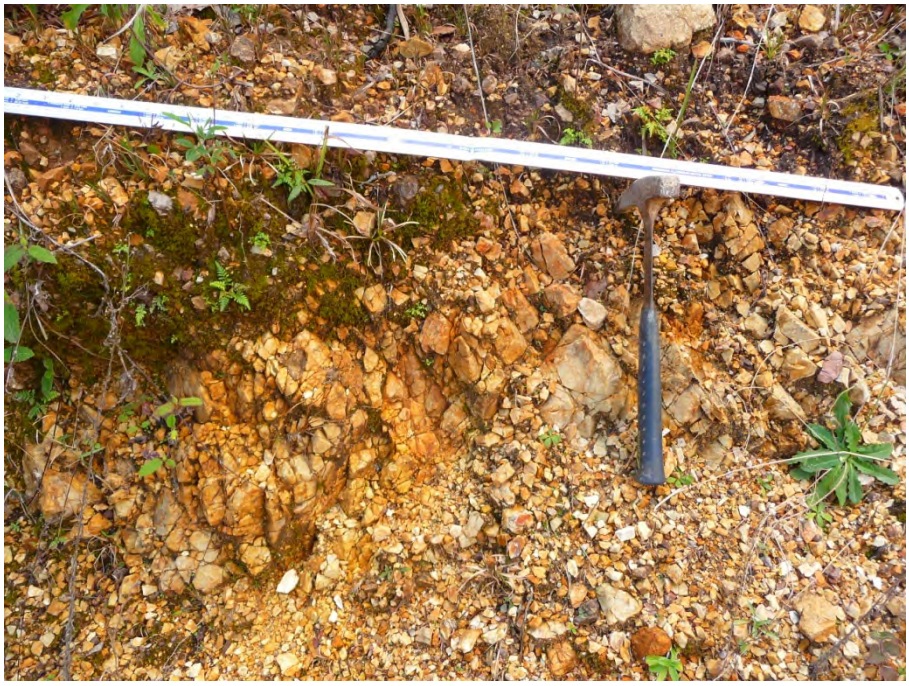


Figure 20 Photograph – Waypoint 35- North Facing – road cutting of extremely weather rock showing overburden of ~1 m Vegetation growing off cut face

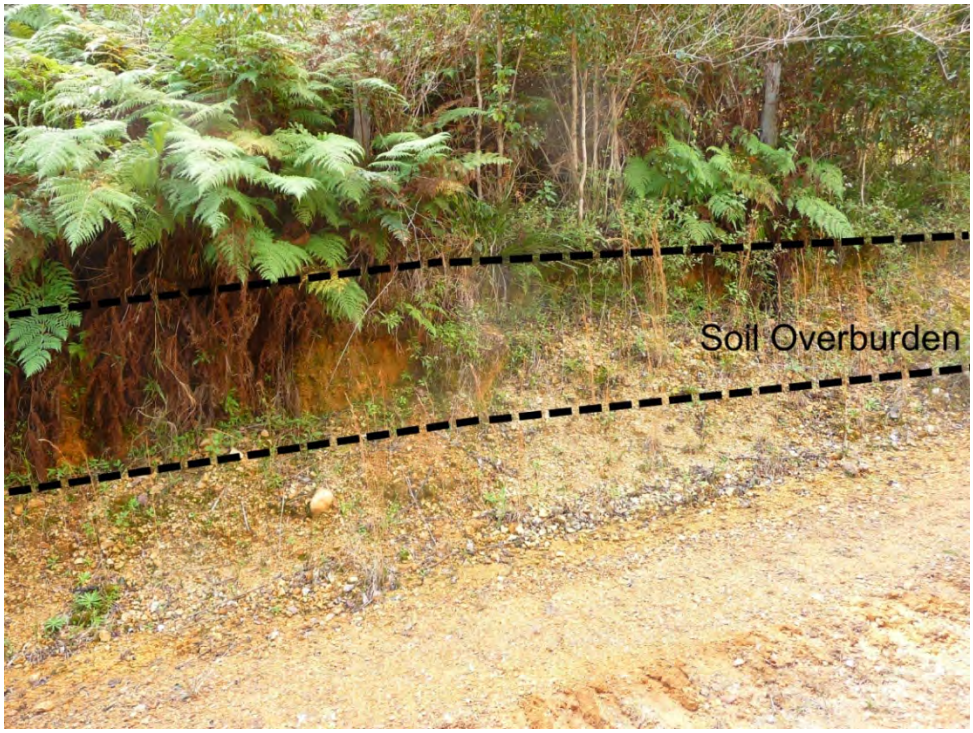


Figure 21 Photograph – Waypoint 17 – South Facing – Siltstone to siliceous siltstone in road cutting.

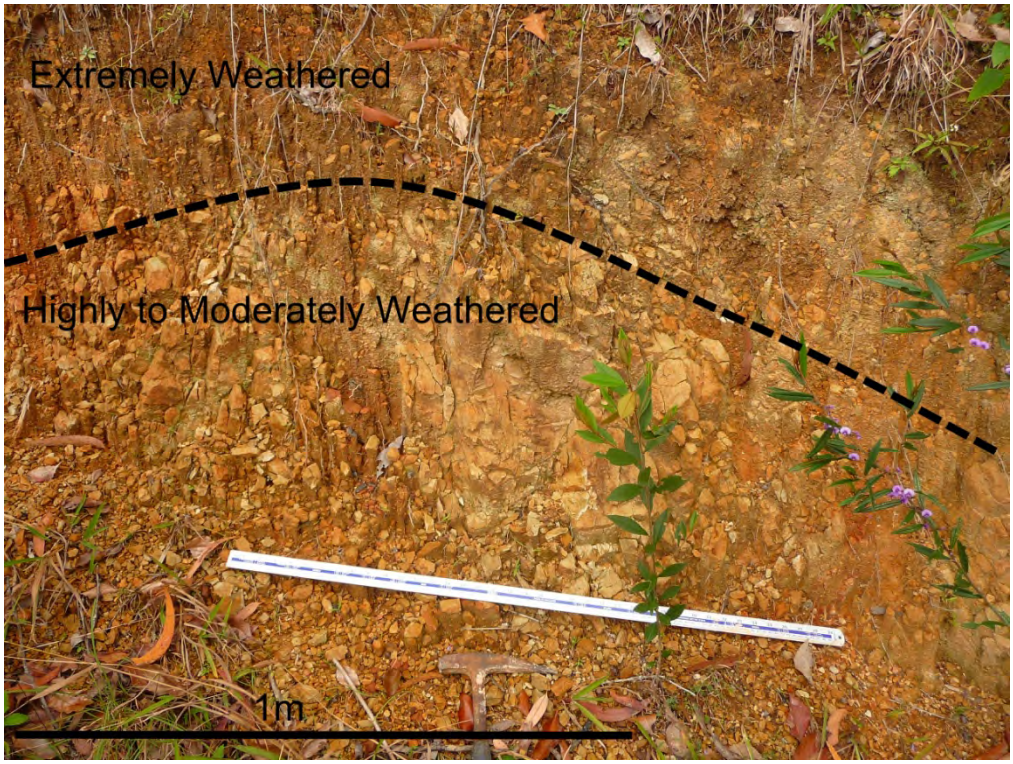
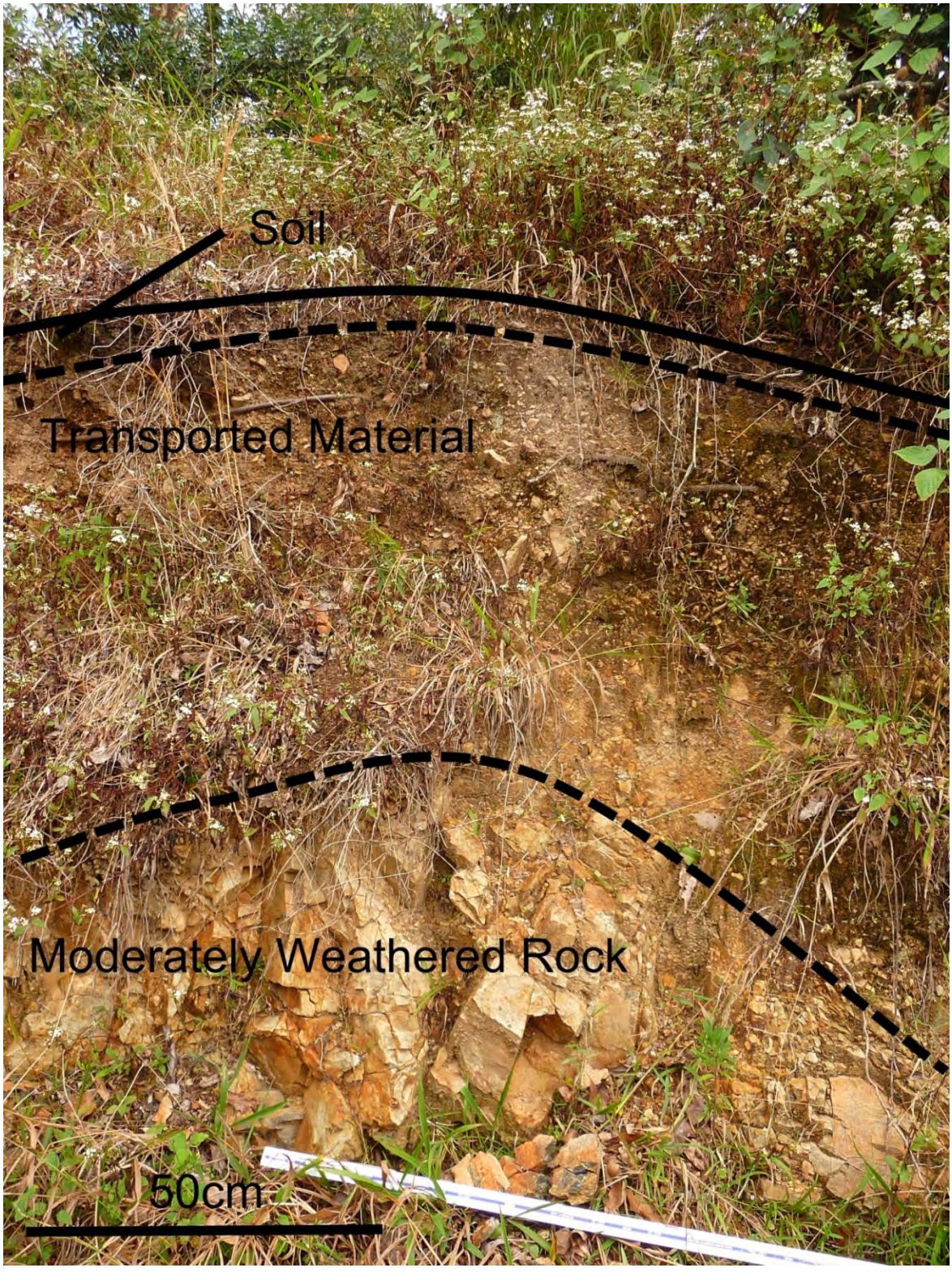


Figure 22 **Photograph – Waypoint 32 – West Facing – Weathering profile of greywacke displacing ~10 cm soil with transported material and moderately weathered rock.**



3.4 Geological Interpretation

A geological map was interpreted from the 2011 field exploration and the previous drilling of the site (Refer to Interpretative Geological Map, Figure 23, Cross Sections, Figure 25, Figure 26 and Figure 27 and Cross Sections Plan View, Figure 23).

The data available does contribute to an improved geological understanding of the area but a paucity of outcrop limits a detailed interpretation. Geological understanding of the area was enhanced however with field mapping of Quirks Quarry although it should be noted that this quarry is situated about 200 m further east. It can be confirmed that the lithologies observed are units of the Neranleigh-Fernvale Beds and that beds/foliation of the beds strike north to northwest and dip moderately to steeply west.

Observations suggest that the area has local faulting and alteration. Faulting and alteration has been mapped but appear inconsistent. Lack of outcropping has made it difficult to identify any consistent trends in bedding and dip direction. Despite this, data observed and presented in previous drilling programs indicates the units are generally dipping moderately to steeply to the west/north west. Limited outcrop of the Neranleigh-Fernvale Beds in the much of the area presented difficulties in interpreting the dipping trend of these areas.

Figure 23 Interpretative Geological Map

Figure 24 Cross Section Plan View

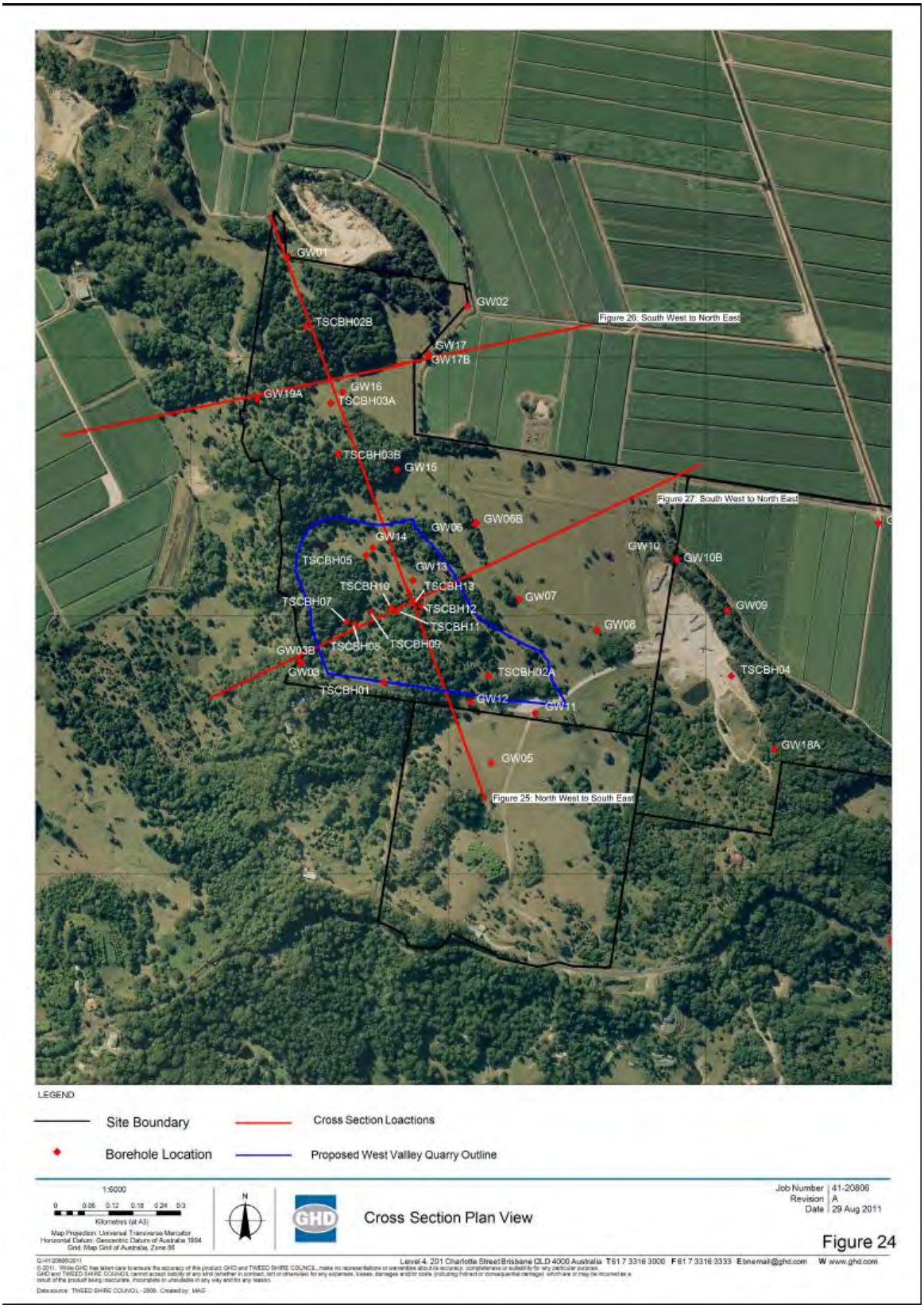


Figure 25 Cross Section North West to South East

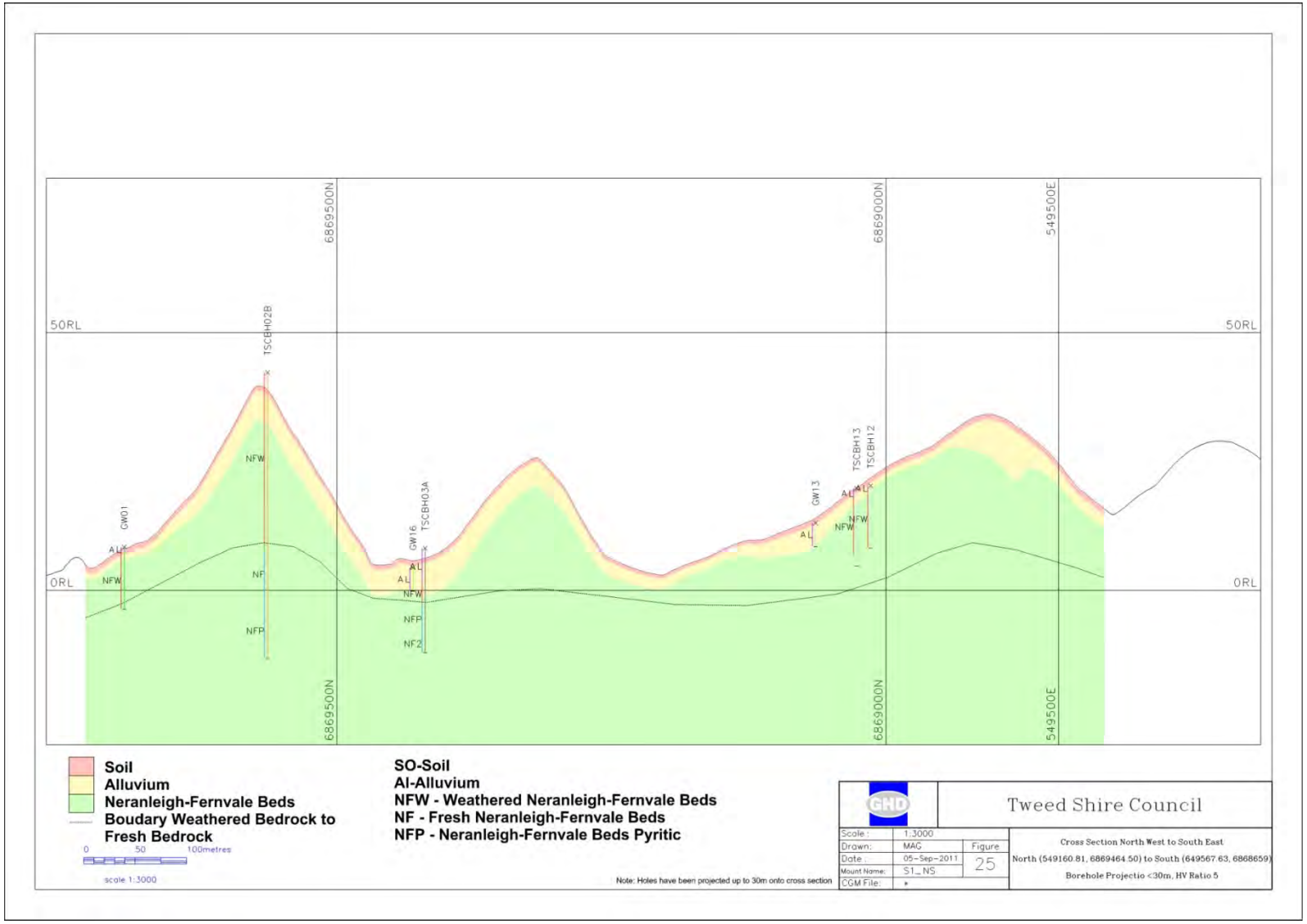


Figure 26 South West to North East Section North

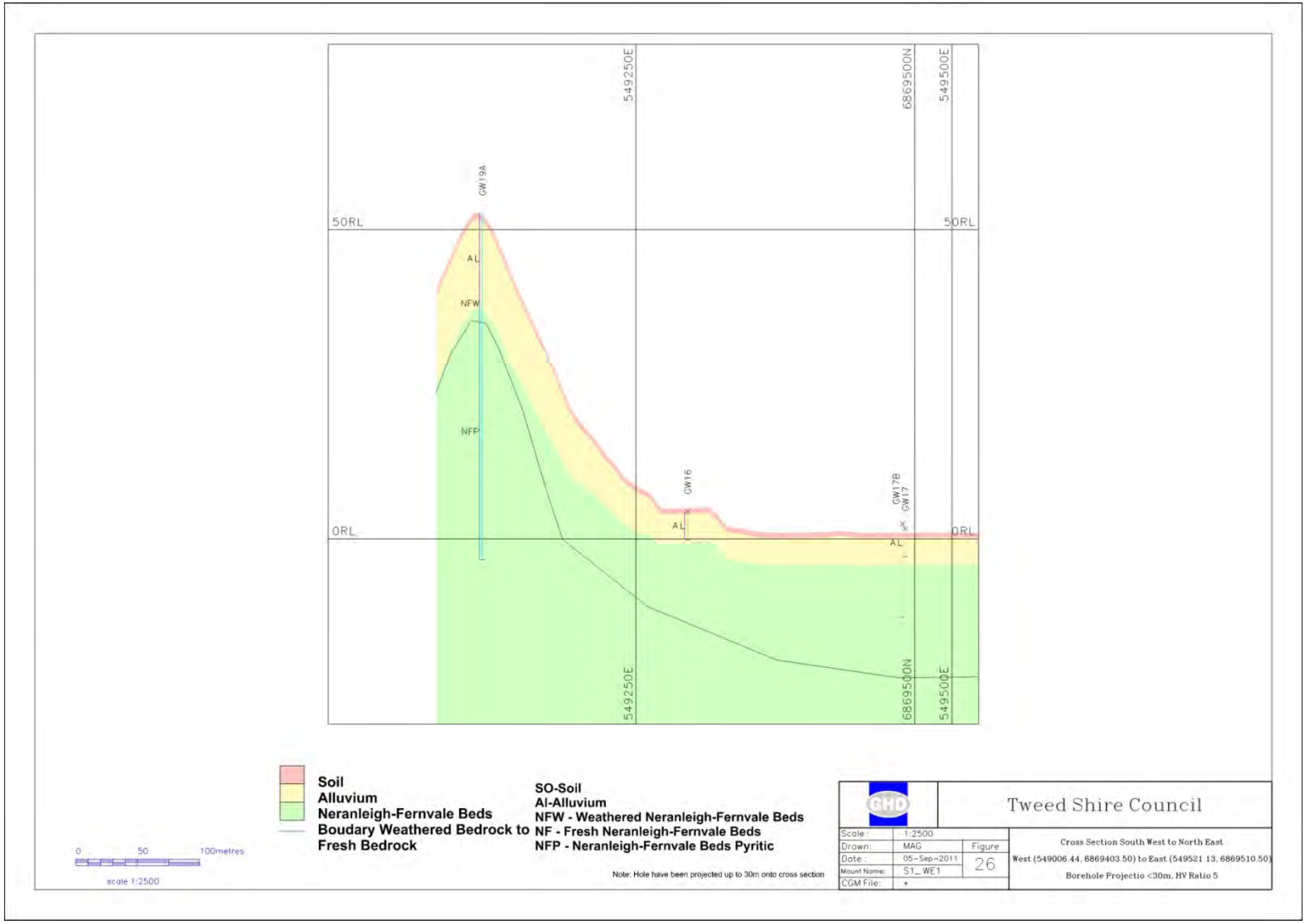
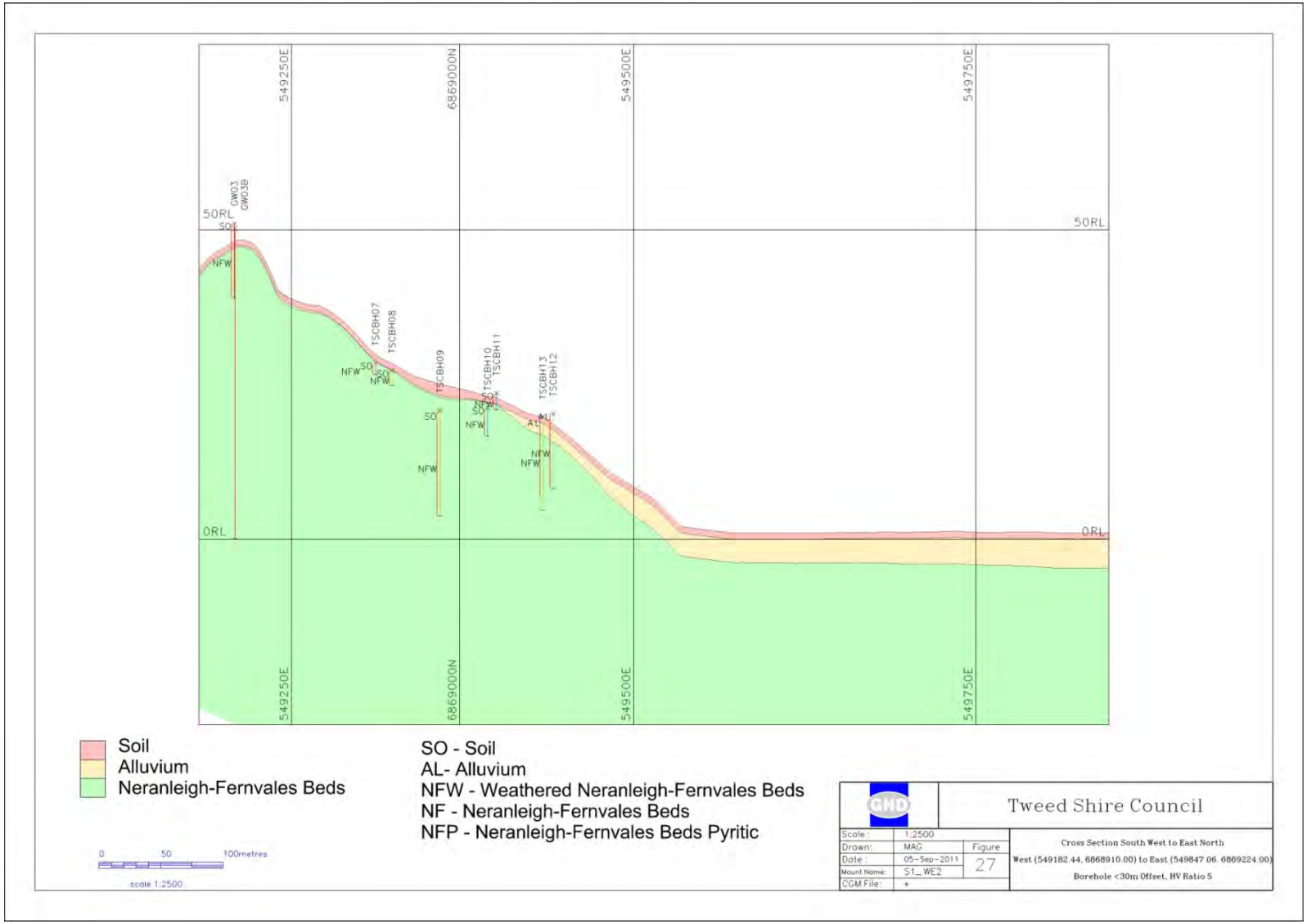


Figure 27 South West to North East Section South



3.5 Further Drilling

Supplementary drilling is required to obtain additional geological data in order to improve the current geological model and the proposed drillholes are presented in Table 2 below. Several drill holes are proposed in a large portion of the area covered with vegetation which would require clearing for drilling. Additionally, other drill sites are situated in the largely cleared areas within the eastern part of the West Valley area probably covered by Tertiary to Recent alluvium.

A significant number of drill sites will need significant site preparation, and subject to assessment by an experienced driller and the obtaining of relevant statutory approvals could be drilled. Refer to Table 2 and Figure 28 and Figure 29 for possible drillhole locations.

The provisional hole depth of these holes are 100 m and it is recommended that these holes be drilled with diamond core techniques. It is intended to drill these holes 60 degrees toward the east.

Table 2 Possible Drillhole Locations (MGA Zone 56 9GDA94))

Easting	Northing
549212.14	6869639.78
549402.14	6869575.05
549258.07	6869433.07
549274.06	6869320.96
549337.41	6869218.01
549285.21	6869144.94
549700.71	6869161.64
549690.27	6868927.79
549493.89	6868879.72
549132.80	6869514.50*
549192.48	6869067.45*
549223.86	6869008.46*
549243.46	6868877.68*

Figure 28 Drill Location Plan

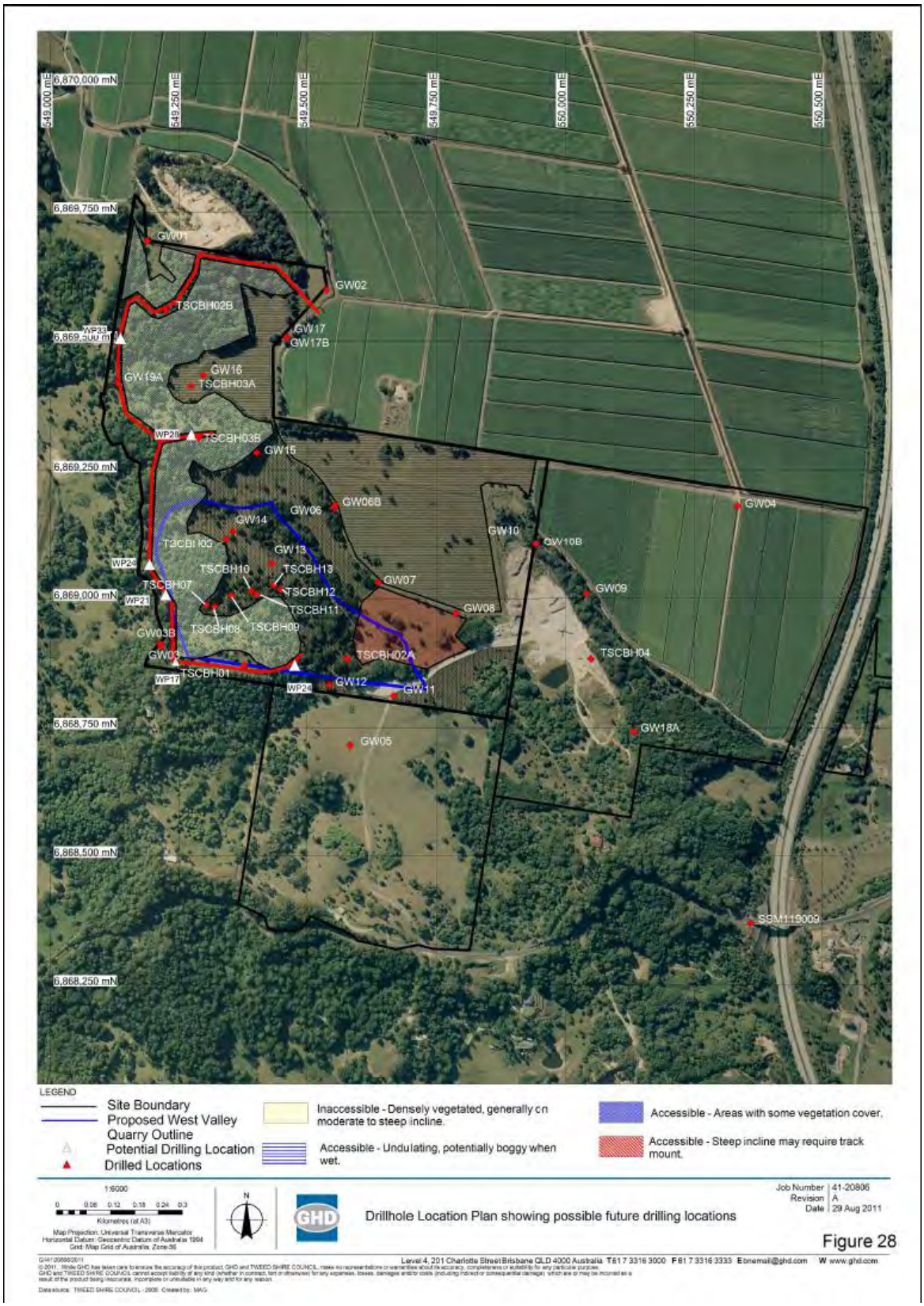
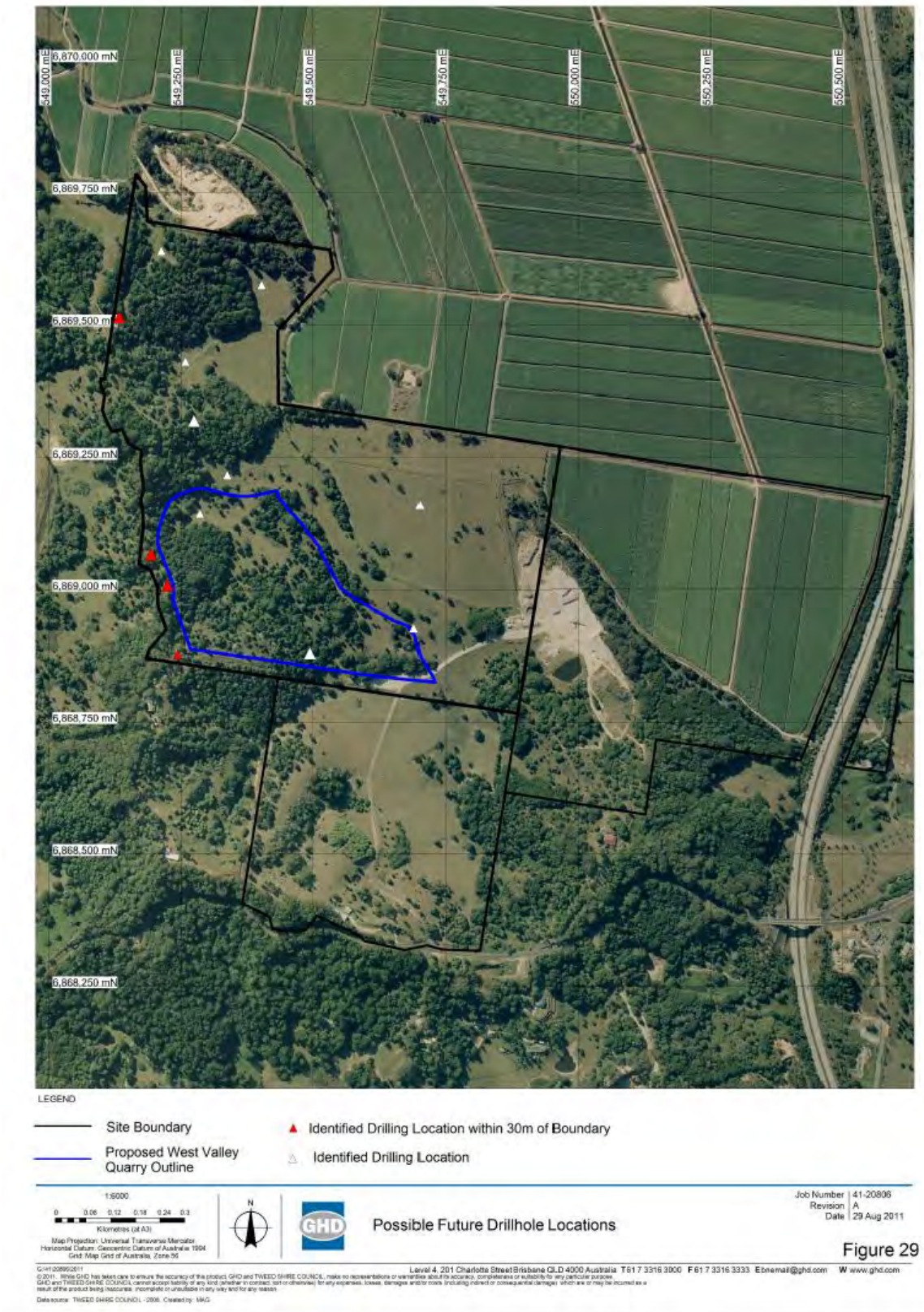


Figure 29 Possible Future Drillhole Locations



4. References

Willmott, W. (2008), Rocks and Landscapes of the Gold Coast Hinterland (Expanded Third Edition), Kingswood Press, Underwood, Queensland.

Geological Survey of QLD (GSQ) (1978), Murwillumbah 1:100 000 Scale Geological Map, Australia.

Appendix A

Data Register

Waypoint number	Photograph number	Location ID	Sampled	Sampled ID	Sample description	Site description	Other description
5	P1080026	WVQ_T1_1	Y	WVQ_T1_1	Sample base of picture siltstone with occasional clayey bands	2 rocks top weathered clayey/siltstone, bottom meta siltsone Si, Fe	View of quarry face facing E from Waypoint 5
5	P1080027	WVQ_T1_1					Closer view of quarry face pointing E from waypoint 5
	P1080028						View of fault in quarry face facing NE from location
	P1080029						Facing north from same point showing change in lithology from E to W in face
6	P1080031	WVQ_T1_2	Y	WVQ_T1_2	Meta-siltstone with occasional clayey bands		Facing N from Waypoint 6
7	P1080032	WVQ_T1_3				clayey rock prob fill	Facing NE from waypoint 7
7	P1080033	WVQ_T1_3					Facing NE from waypoint 7
8	P1080034	WVQ_T1_4				clayey rock as sample T1_2	Facing S from waypoint
9	P1080036	WVQ_T1_5				on ground - interbedded silt/chert with same rock as above, 70-050	Looking down, ruler is approx E-W
10	P1080037	WVQ_T1_6				~3m facing 240 degrees - clayey EW as above overburden ~2m soil	Facing 240 degrees, showing approx 3m overburdern at waypoint 10
11	P1080038	photo location				photolocation	Facing SE from waypoint 11
11	P1080039	photo location					Facing SE from waypoint 11
11	P1080040	photo location					Facing SE from waypoint 11
12	P1080041	WVQ_T1_7	Y	WVQ_T1_7	Greywacke/metasiltstone	possiblr greywacke/metasiltstone fault through middle - gouge clayey/silt 70-315, 3 joints/blocky	Fault gouge facing SE at waypoint 12
12	P1080042	WVQ_T1_7					Fault gouge facing SE at waypoint 12
13	P1080043	WVQ_T1_8	Y	WVQ_T1_8		as above SW facing possible bedding?? 70-300	Bedding structures facing SE at WP 13
14		WVQ_T1_9				poss fuse in wall	POSSIBLE UNEXPLODED SHOT??
15	P1080044	WVQ_T1_10	Y	WVQ_T1_10	Red clay, possible EW meta-siltstone	Red clay possible EW siltstone unit	Clay, facing SE at WP 15
15	P1080045	WVQ_T1_10					Clay, facing SE at WP 15
16		WVQ_T2_1A				BH location, near gate/house	Potential borehole location for further drilling
17	P1080046	WVQ_T2_1	Y	WVQ_T2_1	Meta-siltstone-siliceous	cut on road side-metasiltsone - Si, Fe, little overburden ~1m al or soil	Facing S cutting in roadside WP17
18	P1080047	WVQ_T2_2	Y	WVQ_T2_2	Chert/Meta-siltstone-siliceous	Possible BH of BH01, hill top, metasiltstone, foliation? 20-020	View of BH01 drill site facing W
18	P1080048	WVQ_T2_2					Outcrops in BH01 site looking down
18	P1080049	WVQ_T2_2					Outcrops in BH01 site looking down
19		WVQ_T2_3				as WVQ_T2_2 foliation maybe? 70-070	Foliation in rock dip 70 direction 070
20	P1080050	WVQ_T2_4	Y	WVQ_T2_4	Chert/Meta-siltstone-siliceous	down hill along drainage cut-hard meta silt Siliceous	Hard red outcrop in track side facing SW
20	P1080051	WVQ_T2_4					Hard red outcrop in track side facing SW
18	P1080052	WVQ_T2_2					Cutting outcrop with bedding BH01
21		WVQ_T2_5				Possible BH	Potential borehole location for further drilling - would need tracked rig and clearing for access
22		WVQ_T2_6				outcrop on hill top, maybe foliation west 60-245, east 30-110 with qtz viens	
23		WVQ_T2_7				BH location	Potential borehole location for further drilling
24		WVQ_T2_8				rock as Wp22	Potential borehole location for further drilling
25		WVQ_T2_9	Y	WVQ_T2_9	Greywacke		
27	P1080053	WVQ_T2_11	Y	WVQ_T2_11	Greywacke	Sanstone?Siltstone?	Hard material in cutting facing SW WP27

27	P1080054	WVQ_T2_11					Hard material in cutting facing SW WP27
28		WVQ_T2_12				BH location on road	Potential borehole location for further drilling
29	P1080055	WVQ_T2_13	Y	WVQ_T2_13	Chert/Greywacke with quartz viens	possible insitu - possible but not likely foliation N-S 175 strike, meta siltstone	Subcrop of hard grey material in floor of track WP29
30	P1080056	WVQ_T2_14	Y	WVQ_T2_14	Greywacke	Road cutting-sandstone?siltstone? Blocky, joints 75-020, 75-125, 45-280	Facing SW view of cutting in track at WP30
31	P1080057	WVQ_T2_15				near current hole-blue stone surround possible from BH	Blue metal cuttings showing a lot of hard fresh rock in waterbore, WP31
31	P1080058	WVQ_T2_15					Blue metal cuttings showing a lot of hard fresh rock in waterbore, WP31
32	P1080059	WVQ_T2_16	Y	WVQ_T2_16	Greywacke	same rock as WVQ_T2_14, ~1.5m overburden	Facing W cutting WP32
32	P1080060	WVQ_T2_16					Facing W cutting WP32
32	P1080061	WVQ_T2_16					Facing W cutting WP32
33		WVQ_T2_17				BH location	Potential borehole location for further drilling
34	P1080062	WVQ_T2_18				Red clay on road appears local	Clay in track WP34
35	P1080063	WVQ_T2_19	Y	WVQ_T2_19	Chert siliceous some quartz present	possible contact clay/siltstone clay west. Qtz east	Clay to left, qz or chert to right, facing N at WP35
36	P1080064	WVQ_T2_20	Y	WVQ_T2_20	Chert siliceous some quartz present	Quatzite/chert, joints dominate 85-090, other 75-140, 55-080	Qz or chert outcrop WP36
37	P1080065	WVQ_T2_21				On road-meta siltstone w/ quartz veins	Quartzy, metasiltstone, subcrop in track WP37
37	P1080066	WVQ_T2_21					Quartzy, metasiltstone, subcrop in track WP37

GHD

201 Charlotte Street Brisbane QLD 4000
GPO Box 668 Brisbane QLD 4001
T: (07) 3316 3000 F: (07) 3316 3333 E: bnemail@ghd.com.au

Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	M Gaughan	F Carrello	F. Carrell	F Carrello	F. Carrell	22/09/11

Appendix B

Lithology Logs

Notes on Logging

TSCBH01 (Cored)

TSCBH02A (Partly Cored)

TSCBH02B (Partly Cored)

TSCBH03A (Partly Cored)

TSCBH03B (Partly Cored)

TSCBH04 – BH13 (Open Hole)

Notes on Logging

The data and information contained herein is based on observations made during the inspection of material recovered from partially cored boreholes that were drilled in 2009. This information is provided as an update to the original logging and is based entirely on the existing 2009 core, some of which has been lost or disturbed since drilling. The core was in good condition with minor deterioration of some unconsolidated/alluvial materials present in TSCBH02A.

Rock Quality Designation (RQD) and the Total Core Recovery (TCR) were calculated based on the run markers provided in the core trays.

All information provided herein is based only on visual and tactile assessment of the core and requires confirmation by standard and certified laboratory methods.

Borehole Number			BH 03A
Box	1	of	3
Depth	7.80	to	12.94

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council

Borehole Number			BH 03A
Box	2	of	3
Depth	12.94	to	17.70

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council

GHD CLIENTS | PEOPLE | PERFORMANCE

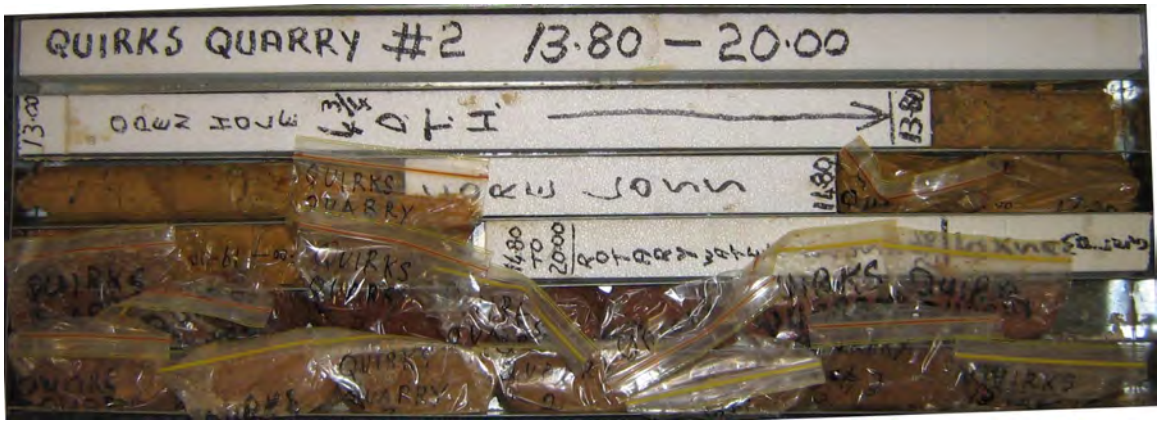
Borehole Number			BH 03A
Box	3	of	3
Depth	17.70	to	20.20 E.O.H.

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council

GHD CLIENTS | PEOPLE | PERFORMANCE

Borehole Number			BH 02A
Box	1	of	1
Depth	13.80	to	20.00

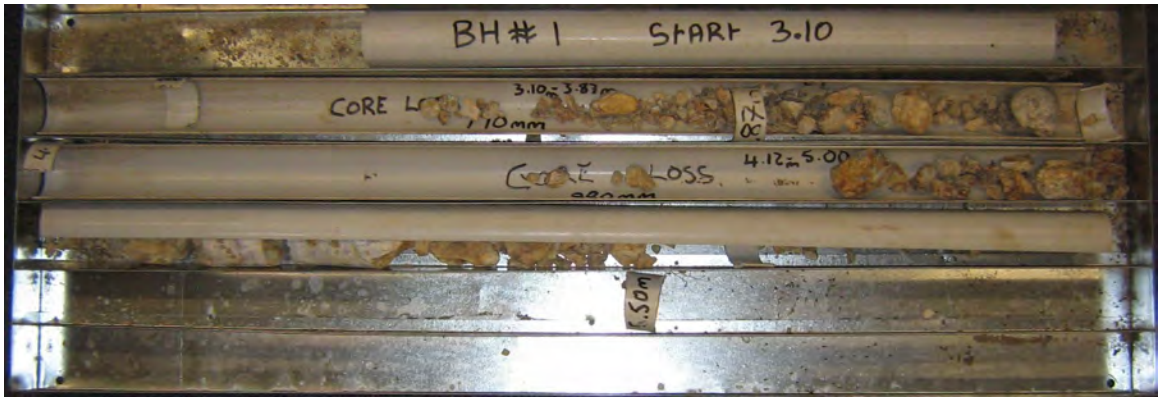
Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council



GHD CLIENTS | PEOPLE | PERFORMANCE

Borehole Number			BH 01
Box	1	of	9
Depth	3.10	to	5.50

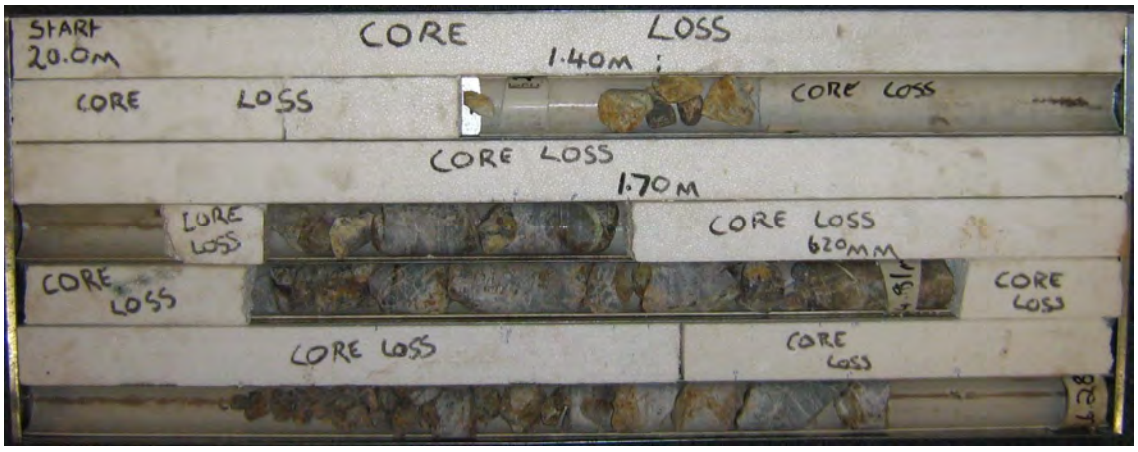
Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council



GHD CLIENTS | PEOPLE | PERFORMANCE

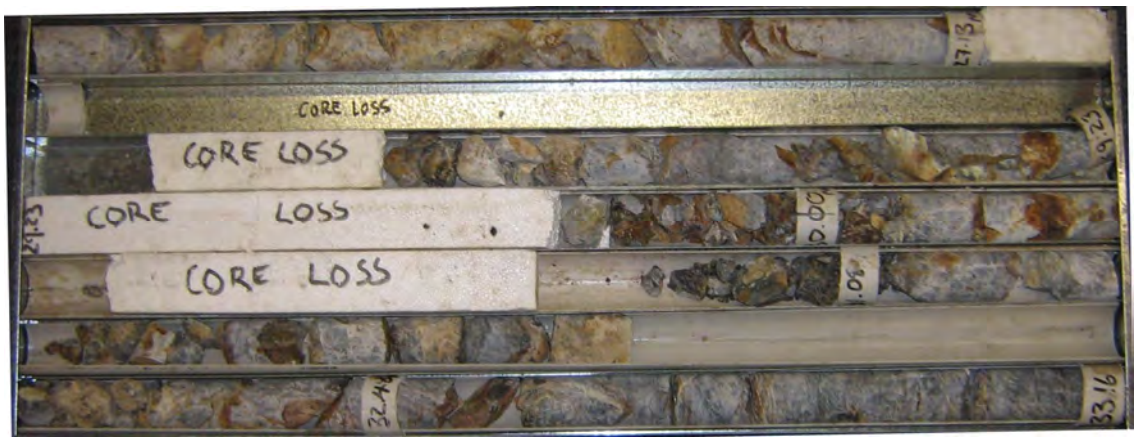
Borehole Number			BH 01
Box	2	of	9
Depth	20.00	to	26.28

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council



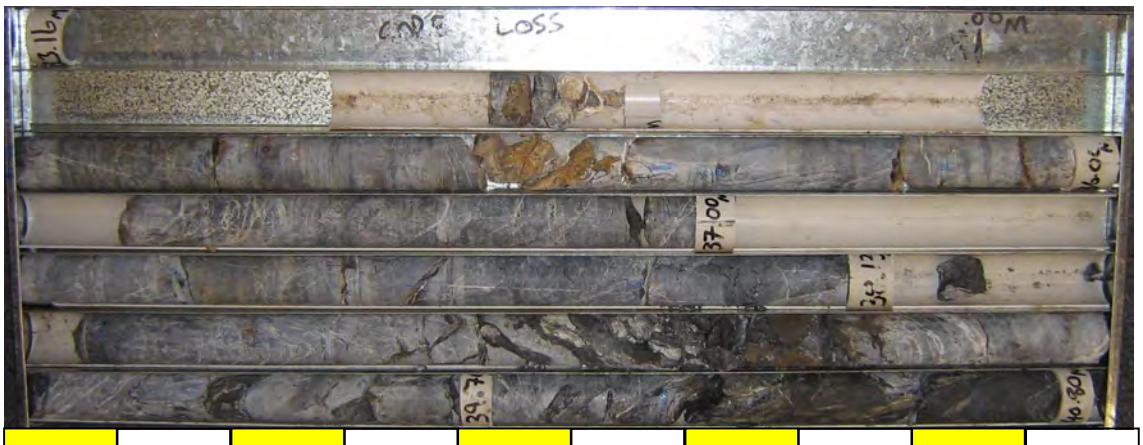
Borehole Number			BH 01
Box	3	of	9
Depth	26.28	to	33.16

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council



Borehole Number			BH 01
Box	4	of	9
Depth	33.16	to	40.80

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council



Borehole Number			BH 01
Box	5	of	9
Depth	40.80	to	47.20

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council

Borehole Number			BH 01
Box	6	of	9
Depth	47.20	to	52.15

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council

GHD CLIENTS | PEOPLE | PERFORMANCE

Borehole Number			BH 01
Box	7	of	9
Depth	52.15	to	56.70

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council

GHD CLIENTS | PEOPLE | PERFORMANCE

Borehole Number			BH 01
Box	8	of	9
Depth	56.70	to	64.30

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council

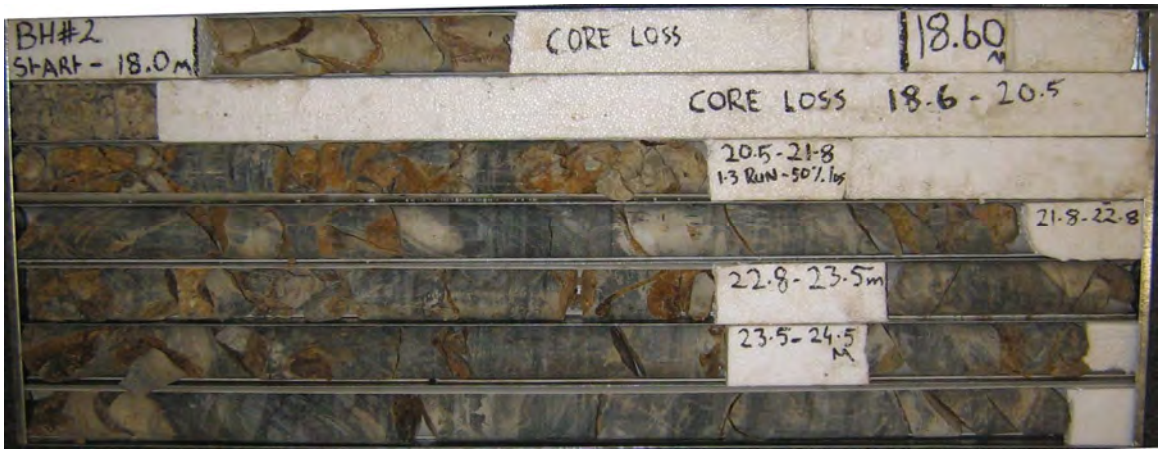
GHD CLIENTS | PEOPLE | PERFORMANCE

Borehole Number			BH 01
Box	9	of	9
Depth	64.30	to	70.25 E.O.H.

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council

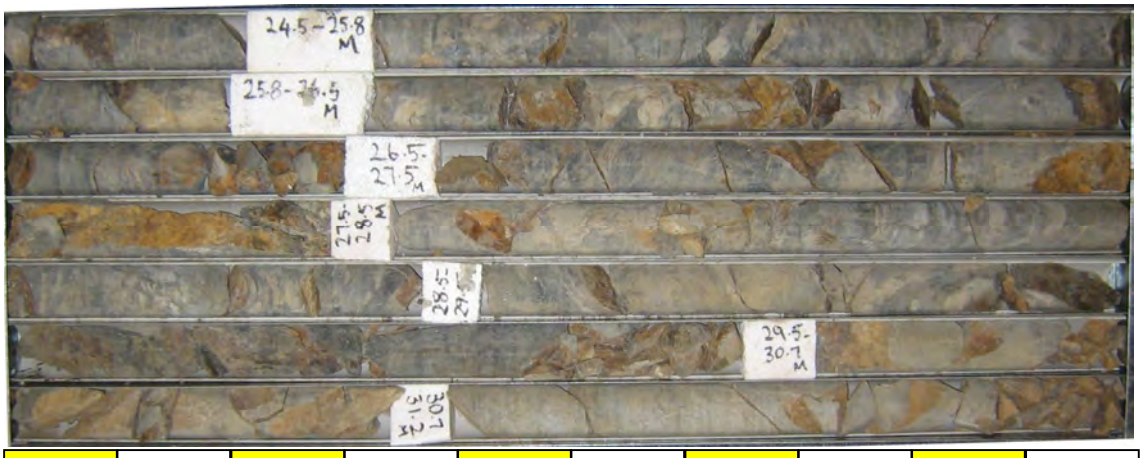
Borehole Number			BH 02B
Box	1	of	6
Depth	18.00	to	24.50

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council



Borehole Number			BH 02B
Box	2	of	6
Depth	24.50	to	31.20

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council



CLIENTS | PEOPLE | PERFORMANCE

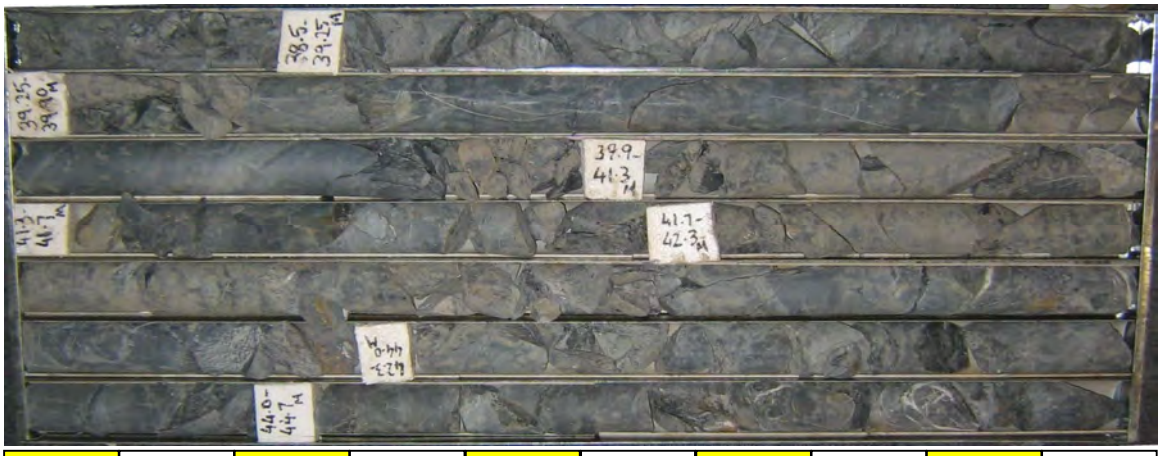
Borehole Number			BH 02B
Box	3	of	6
Depth	31.20	to	38.50

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council

CLIENTS | PEOPLE | PERFORMANCE

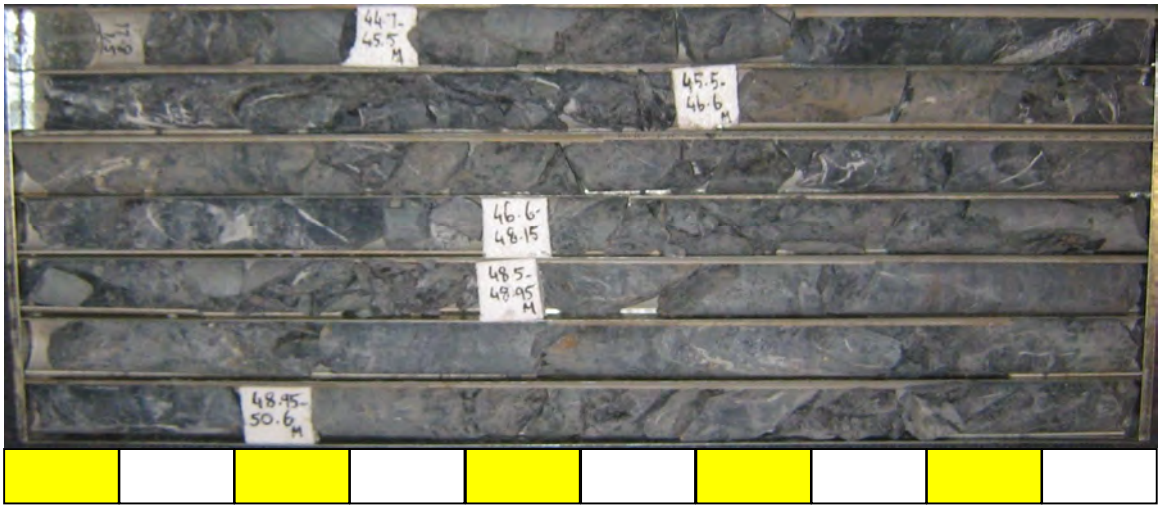
Borehole Number			BH 02B
Box	4	of	6
Depth	38.50	to	44.70

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council



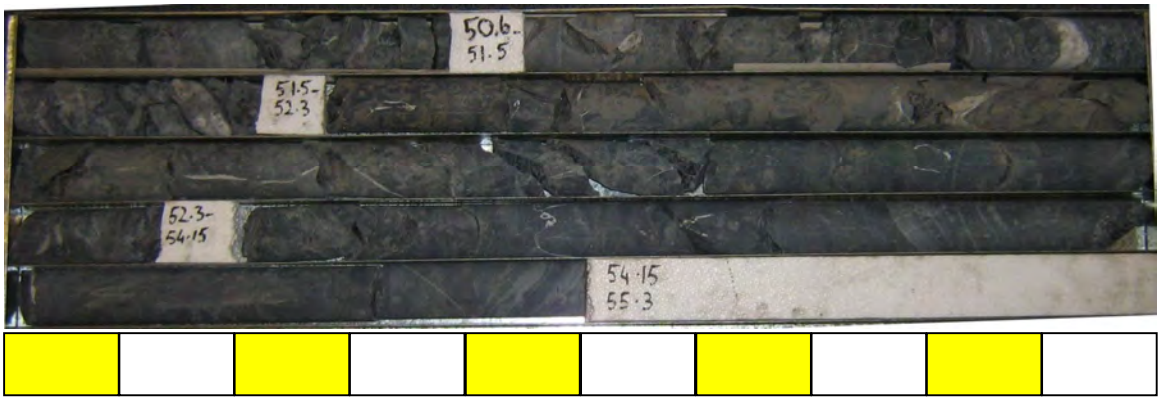
Borehole Number			BH 02B
Box	5	of	6
Depth	44.70	to	50.60

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council



Borehole Number			BH 02B
Box	6	of	6
Depth	50.60	to	54.15 E.O.H

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council



Borehole Number			BH 03B
Box	1	of	9
Depth	13.00	to	17.50

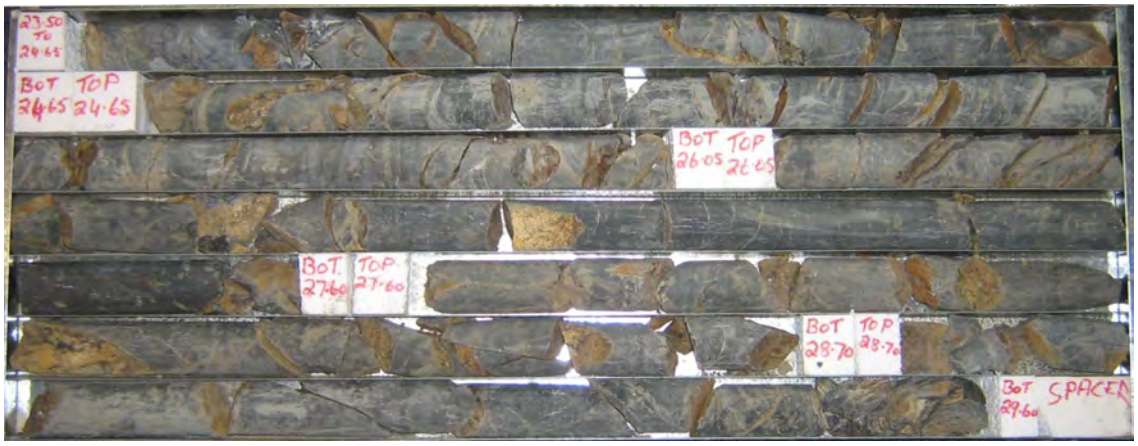
Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council

Borehole Number			BH 03B
Box	2	of	9
Depth	17.50	to	23.50

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council

Borehole Number			BH 03B
Box	3	of	9
Depth	23.50	to	29.60

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council



Borehole Number			BH 03B
Box	4	of	9
Depth	29.60	to	35.65

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council

CLIENTS | PEOPLE | PERFORMANCE

Borehole Number			BH 03B
Box	5	of	9
Depth	35.65	to	40.30

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council

CLIENTS | PEOPLE | PERFORMANCE

Borehole Number			BH 03B
Box	6	of	9
Depth	40.30	to	46.30

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council

Borehole Number			BH 03B
Box	7	of	9
Depth	46.30	to	52.70

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council

Borehole Number			BH 03B
Box	8	of	9
Depth	52.70	to	57.20

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council

CLIENTS | PEOPLE | PERFORMANCE

Borehole Number			BH 03B
Box	9	of	9
Depth	57.20	to	60.30

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council

Appendix C

Borehole Core Photographs

TSC BH01

TSC BH02A

TSC BH02B

TSC BH03A

TSC BH03B

GHD | MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-12**

Sheet 1 of 3

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 448, **N** 6869 018
Ground Surface Elevation: **Total Depth:** 15.0m
Commenced: 01-May-09 **Completed:** 01-May-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

Logged:	L. McAnally	15-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
0				Rotary Chip	Dry				RESIDUAL SOIL Dark reddish brown, organic, silty, clayey, soft.	EW		100						0
1					Moist	1.0			CLAY Browny to yellow, silty, sandy, low to medium plasticity, cohesive, inorganic, soft to firm, alluvial.	HW		100						1
2										HW								2
3				Rotary Chip								100						3
4						4.0			CLAY Browny to yellow (mottled grey), silty, low to medium plasticity, occasionally sandy, cohesive, inorganic, soft to firm, alluvial to completely weathered siltstone.	HW		100						4
5																		5

COREHOLE 412080603_TSCBH-01-TSCBH13.GPJ GHDPER.GDT 10/5/09

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-12**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 448, **N** 6869 018
Ground Surface Elevation: **Total Depth:** 15.0m
Commenced: 01-May-09 **Completed:** 01-May-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

Logged:	L. McAnally	15-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
6				Rotary Chip	Wet				CLAY Browny to yellow (mottled grey), silty, low to medium plasticity, occasionally sandy, cohesive, inorganic, soft to firm, alluvial to completely weathered siltstone.	HW		100					6
										HW								
7				Rotary Chip	Moist							100						7
8				Rotary Chip	Wet	8.0			CLAY Browny to yellow (mottled grey), silty, low to medium plasticity, occasionally sandy, cohesive, inorganic, soft to firm/firm, alluvial to completely weathered siltstone.	HW								8
9												100						9
10																		10

COREHOLE 412080603_TSCBH-01-TSCBH13.GPJ GHDPER.GDT 10/5/09

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-12**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 448, **N** 6869 018
Ground Surface Elevation: **Total Depth:** 15.0m
Commenced: 01-May-09 **Completed:** 01-May-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

Logged:	L. McAnally	15-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
11				Rotary Chip	Moist				CLAY Browny to yellow (mottled grey), silty, low to medium plasticity, occasionally sandy, cohesive, inorganic, soft to firm/firm, alluvial to completely weathered siltstone.	HW		100					11
12				Rotary Chip	Wet	12.0			CLAY Browny to yellow (mottled grey), silty, medium plasticity, occasional to common sandy, inorganic, cohesive, firm, alluvial to completely weathered siltstone.	HW		100					12
13				Rotary Chip	Moist							100						13
14										HW		100						14
15						15.0			Termination Depth = 15m									15

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-11**

Sheet 1 of 1

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 401, **N** 6869 009
Ground Surface Elevation: **Total Depth:** 2.6m
Commenced: 30-Apr-09 **Completed:** 30-Apr-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Core Barrel: NMLC
Bit Condition: Blade

Logged:	L. McAnally	15-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
0				Rotary Chip	Dry				Dark red to brown, gravelly to silty clay, moist, loose, soft.	EW		100						0
1				Rotary Chip	Dry	1.0			Brown to orange, gravel to clayey, silty, low plasticity, non-cohesive.	EW		100						1
2				Rotary Chip	Moist	2.0			Brown orange, clayey, soft to firm, non-cohesive.	HW		100						2
						2.6			Termination Depth = 2.6m									
3																		3
4																		4
5																		5

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-10**

Sheet 1 of 1

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 391, **N** 6869 015
Ground Surface Elevation: **Total Depth:** 4.5m
Commenced: 30-Apr-09 **Completed:** 30-Apr-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Core Barrel: NMLC
Bit Condition: Blade

Logged:	L. McAnally	15-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
0				Rotary Chip	Dry				RESIDUAL SOIL Dark reddish brown.	EW		100						0
1				Rotary Chip	Dry	1.0			CLAY Brown orange, silty, gravelly, dry, firm to soft, low to medium plasticity, alluvial.	HW		100						1
2				Rotary Chip	Dry	2.0			2.00m: Increasing gravel.	HW		100						2
3				Rotary Chip	Dry					HW		100						3
4				Rotary Chip	Moist	4.0			CONGLOMERATE to SANDSTONE Dark brown, silty, clayey, moist, moderately hard.	HW		100						4
						4.5			Termination Depth = 4.5m									
5																		5

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-09**

Sheet 1 of 4

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 352, **N** 6869 006
Ground Surface Elevation: **Total Depth:** 17.0m
Commenced: 30-Apr-09 **Completed:** 30-Apr-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted **Inclination:** Vertical
Drilling Fluid:
Core Diameter (mm):

Logged:	L. McAnally	09-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
0				Rotary Chip	Moist				RESIDUAL SOIL Dark brown, high in clay (medium plasticity), organic.	EW								0
1																		1
2						2.0			CLAY Red brown, orange to brown mottled, silty, medium plasticity, cohesive, sandy in part (fine to coarse), alluvial.									2
3				Rotary Chip	Moist													3
4						4.0			CLAY Orange to brown, medium to high plasticity, silty, cohesive, sandy in part (fine), alluvial.	HW								4
5																		5

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-09**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 352, **N** 6869 006
Ground Surface Elevation: **Total Depth:** 17.0m
Commenced: 30-Apr-09 **Completed:** 30-Apr-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted **Inclination:** Vertical
Drilling Fluid:
Core Diameter (mm):

Logged:	L. McAnally	09-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
6				Rotary Chip	Wet				CLAY Orange to brown, medium to high plasticity, silty, cohesive, sandy in part (fine), alluvial.	HW								6
7				Rotary Chip	Moist													7
8						8.0			CLAY Orange to brown, medium plasticity, increasing sand content (fine to medium), cohesive, alluvial.									8
9				Rotary Chip	Wet													9
10																		10

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-09**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 352, **N** 6869 006
Ground Surface Elevation: **Total Depth:** 17.0m
Commenced: 30-Apr-09 **Completed:** 30-Apr-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted **Inclination:** Vertical
Drilling Fluid:
Core Diameter (mm):

Logged:	L. McAnally	09-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
11				Rotary Chip	Moist				CLAY Orange to brown, medium plasticity, increasing sand content (fine to medium), cohesive, alluvial.	HW								11
12				Rotary Chip	Wet	12.0			CLAY Orange brown, cohesive, medium plasticity, sandy (fine to medium), alluvial.									12
13				Rotary Chip														13
14				Rotary Chip	Moist													14
15						15.0												15

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-09**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 352, **N** 6869 006
Ground Surface Elevation: **Total Depth:** 17.0m
Commenced: 30-Apr-09 **Completed:** 30-Apr-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted **Inclination:** Vertical
Drilling Fluid:
Core Diameter (mm):

Logged:	L. McAnally	09-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
16				Rotary Chip		16.0			SILT to CLAY Orange brown, completely weathered, medium plasticity, cohesive, inorganic, alluvial.	EW								16
									SILT to CLAY Orange brown, completely weathered, low plasticity, inorganic, cohesive, granular to gravelly in part.									
17						17.0			Termination Depth = 17m									17
18																		18
19																		19
20																		20

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-08**

Sheet 1 of 1

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 320, **N** 6868 985
Ground Surface Elevation: **Total Depth:** 2.3m
Commenced: 30-Apr-09 **Completed:** 30-Apr-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Core Barrel: NMLC
Bit Condition: Blade

Logged:	L. McAnally	08-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
0				Rotary Chip	Moist				RESIDUAL SOIL Organic.	EW		100						0
1				Rotary Chip	Moist	1.0			GRAVEL Dark brown to red, moist, clayey, medium cohesion, sandy.	HW		100						1
2				Rotary Chip	Dry	2.0 2.3			CONGLOMERATE Brown reddish, clayey, moderately hard, silty in part, dry.	HW		100						2
									Termination Depth = 2.3m									
3																		3
4																		4
5																		5

COREHOLE 412080603_TSCBH-01-TSCBH13.GPJ GHDPER.GDT 10/5/09

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-07**

Sheet 1 of 1

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 303, **N** 7868 988
Ground Surface Elevation: **Total Depth:** 1.8m
Commenced: 30-Apr-09 **Completed:** 30-Apr-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

Logged:	L. McAnally	15-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
0				Rotary Chip	DRY	1.0			Dark brownish red, highly clayey, moist, organic.	EW		100						0
1				Rotary Chip	DRY	1.8			Brown orange, mottled, highly clayey sandy and silt, moist, moderately hard to low plasticity where clay.			100						1
									Termination Depth = 1.8m									
2																		2
3																		3
4																		4
5																		5

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-06**

Sheet 1 of 3

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E , N
Ground Surface Elevation: **Total Depth:** 13.5m
Commenced: 24-Apr-09 **Completed:** 24-Apr-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

Logged:	L. McAnally	12-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
0				Rotary Chip	DRY				RESIDUAL SOIL Dark red brown, gravelly, organic, silty and sandy, alluvial, low cohesion, low plasticity (where clayey).	EW								0
1												100						1
2										EW								2
												100						
3						3.0			CLAY Brown to red, mottled orange brown, silty, sandy to granular in part (fine to coarse), alluvial, cohesive, low to medium plasticity.	HW								3
												100						
4										HW								4
												100						
5																		5

COREHOLE 412080603_TSCBH-01-TSCBH13.GPJ GHDPER.GDT 10/5/09

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-06**

Sheet 2 of 3

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E , N
Ground Surface Elevation: **Total Depth:** 13.5m
Commenced: 24-Apr-09 **Completed:** 24-Apr-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

Logged:	L. McAnally	12-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
6				Rotary Chip		6.0			CLAY Brown to red, mottled orange brown, silty, sandy to granular in part (fine to coarse), alluvial, cohesive, low to medium plasticity.	HW		100						6
									CLAY Orange brown, silty, occasional sand (fine to medium), medium cohesion, medium plasticity, alluvial.	HW								
7												100						7
8										HW								8
												100						
9						9.0			CONGLOMERATE Orange brown, mottled grey, silty, sand (fine to medium), occasional pebbles, granular, low cohesion, clayey (low to medium plasticity), alluvial. End of samples at 13.50 meters. Refusal on blades.	HW		100						9
10																		10

COREHOLE 412080603_TSCBH-01-TSCBH13.GPJ GHDPER.GDT 10/5/09

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-06**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E , N
Ground Surface Elevation: **Total Depth:** 13.5m
Commenced: 24-Apr-09 **Completed:** 24-Apr-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

Logged:	L. McAnally	12-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
11				Rotary Chip					CONGLOMERATE Orange brown, mottled grey, silty, sand (fine to medium), occasional pebbles, granular, low cohesion, clayey (low to medium plasticity), alluvial. End of samples at 13.50 meters. Refusal on blades.	HW		100						11
12										HW								12
13						13.5						100						13
14									Termination Depth = 13.5m									14
15																		15

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-05**

Sheet 1 of 4

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 342, **N** 6869 117
Ground Surface Elevation: **Total Depth:** 20.0m
Commenced: 23-Apr-09 **Completed:** 23-Apr-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

Logged:	L. McAnally	10-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
0					Moist				RESIDUAL SOIL Dark red brown, gravelly, alluvial, high in clay.			100						0
1						1.0			CLAY Red brown, sandy in part (fine), alluvial, high in silt, medium plasticity.			100						1
2										HW								2
3												50						3
4						4.0			CLAY Brown to red, silty, low to medium plasticity, cohesive (medium), sandy in part (fine to medium), alluvial.	HW		100						4
5																		5

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-05**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 342, **N** 6869 117
Ground Surface Elevation: **Total Depth:** 20.0m
Commenced: 23-Apr-09 **Completed:** 23-Apr-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

Logged:	L. McAnally	10-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
6					Wet				CLAY Brown to red, silty, low to medium plasticity, cohesive (medium), sandy in part (fine to medium), alluvial.	HW		100						6
										HW								
7												100						7
8						8.0			CLAY Brown to red, mottled yellow brown, gravel in part, sandy (fine to medium), high silt, non-cohesive, medium plasticity.	HW								8
9												100						9
10																		10

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-05**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 342, **N** 6869 117
Ground Surface Elevation: **Total Depth:** 20.0m
Commenced: 23-Apr-09 **Completed:** 23-Apr-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

Logged:	L. McAnally	10-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
11					Moist				CLAY Brown to red, mottled yellow brown, gravel in part, sandy (fine to medium), high silt, non-cohesive, medium plasticity.	HW		100					11
12						12.0			CLAY Yellow brown, high in silt, sandy tending from fine to medium to granular in part, non-cohesive, low to medium plasticity.	HW							12
13												100						13
14										HW								14
15												100						15

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-05**

Sheet 4 of 4

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 342, **N** 6869 117
Ground Surface Elevation: **Total Depth:** 20.0m
Commenced: 23-Apr-09 **Completed:** 23-Apr-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

Logged:	L. McAnally	10-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
16						16.0			CLAY Yellow brown, high in silt, sandy tending from fine to medium to granular in part, non-cohesive, low to medium plasticity.	HW		100						16
									CONGLOMERATE-SANSTONE Mottled brown orange, fine to loose sand, granular in part, high silt content, alluvial, inorganic, non-cohesive, occasional clay.	HW								
17												100						17
18										HW								18
19												100						19
20						20.0			Termination Depth = 20m									20

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-04**

Sheet 1 of 6

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 550 049, **N** 6868 883
Ground Surface Elevation: **Total Depth:** 30.0m
Commenced: 23-Apr-09 **Completed:** 23-Apr-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

Logged:	L. McAnally	10-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
0				Rotary Chip	Moist				RESIDUAL SOIL Red brown to brown, silty, highly clayey, gravel in part, organic, low plasticity where clayey, low cohesion.	EW								0
1												100						1
2										EW			100					2
3						3.0												3
				Rotary Chip	Wet				CLAY Light orange brown to brown, silty, low medium plasticity, low cohesion, inorganic, alluvial.	HW		100					
4										HW								4
												50						
5																		5

COREHOLE 412080603_TSCBH-01-TSCBH13.GPJ GHDPER.GDT 10/5/09

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-04**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 550 049, **N** 6868 883
Ground Surface Elevation: **Total Depth:** 30.0m
Commenced: 23-Apr-09 **Completed:** 23-Apr-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

Logged:	L. McAnally	10-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
6					Moist	5.8			CLAY Light orange brown to brown, silty, low medium plasticity, low cohesion, inorganic, alluvial.	HW		50						6
									5.80m: Slightly silty.	HW								
7						7.0			CLAY Light orange to brown, silty, inorganic, low to medium plasticity, low to medium cohesion, alluvial, sandy (fine to medium).			50						7
8										HW								8
9												100						9
						9.8			9.80m: Gravel in part.									
10																		10

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-04**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 550 049, **N** 6868 883
Ground Surface Elevation: **Total Depth:** 30.0m
Commenced: 23-Apr-09 **Completed:** 23-Apr-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

Logged:	L. McAnally	10-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
11				Rotary Chip	Wet				9.80m: Gravel in part.	HW		100						11
12						12.0			CLAY Orange brown to brown, inorganic, highly silty, low plasticity, low cohesion, alluvial, sandy in part (fine to medium).	HW								12
13												100						13
14				Rotary Chip						HW		100						14
15																		15

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-04**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 550 049, **N** 6868 883
Ground Surface Elevation: **Total Depth:** 30.0m
Commenced: 23-Apr-09 **Completed:** 23-Apr-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

Logged:	L. McAnally	10-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
16				Rotary Chip	Moist	15.8			CLAY Orange brown to brown, inorganic, highly silty, low plasticity, low cohesion, alluvial, sandy in part (fine to medium). 15.80m: Gravel in part.	HW		100						16
17					Moist	16.0			CLAY Red to brown, mottled yellow brown, inorganic, highly silty, gravelly, occasional sand (fine to medium), medium plasticity, alluvial, moist to wet.	HW		100						17
18					Wet					HW								18
19					Moist							100						19
20						20.0												20

COREHOLE 412080603_TSCBH-01-TSCBH13.GPJ GHDPER.GDT 10/5/09

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-04**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 550 049, **N** 6868 883
Ground Surface Elevation: **Total Depth:** 30.0m
Commenced: 23-Apr-09 **Completed:** 23-Apr-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

Logged:	L. McAnally	10-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
21					Wet				CLAY Yellow brown, silty, sandy (fine to medium).	HW		100						21
22										HW								22
23					Moist							100						23
24						24.0			CLAY Yellow brown, mottled grey to yellow, completely weathered silt to silt in part, occasional sandy (fine to medium), medium plasticity, alluvial.	HW		100						24
25																		25

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-04**

Sheet 6 of 6

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 550 049, **N** 6868 883
Ground Surface Elevation: **Total Depth:** 30.0m
Commenced: 23-Apr-09 **Completed:** 23-Apr-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

Logged:	L. McAnally	10-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
26					Wet				CLAY Yellow brown, mottled grey to yellow, completely weathered silt to silt in part, occasional sandy (fine to medium), medium plasticity, alluvial.	HW		100						26
										HW								
27												100						27
28						28.0												28
					Moist				CLAY Light brown to yellow, silty to completely weathered silt, highly sandy (fine to medium), low plasticity, alluvial.	HW							
29												100						29
30						30.0			Termination Depth = 30m									30

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-03B**

Sheet 1 of 13

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 288, **N** 6869 315
Ground Surface Elevation:
Date Tested:
Total Depth: 60.3m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	13-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
0				Rotary Chip	Wet	1.0			CLAY Dark brown, silty, low to medium plasticity, low cohesion, alluvial, organic.	EW		100						0
1				Rotary Chip	Moist	3.0			CLAY Light yellow brown, silty, occasional sand (fine), medium plasticity, low cohesion, alluvial, inorganic.	EW HW		100 100						1
2																		2
3				Rotary Chip	Dry				CLAY Light yellow brown, very silty, granular to gravelly in part, occasional sand, low plasticity, low cohesion, inorganic.	HW		100						3
4										HW		100						4
5																		5

COREHOLE 412080603_TSCBH-01-TSCBH13.GPJ GHDPER.GDT 10/5/09

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-03B**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 288, **N** 6869 315
Ground Surface Elevation:
Date Tested:
Total Depth: 60.3m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	13-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
6				Rotary Chip	Moist				CLAY Light yellow brown, very silty, granular to gravelly in part, occasional sand, low plasticity, low cohesion, inorganic.	HW		100					6
										HW		100					
7						7.0			CLAY Light yellow brown.	HW		100					7
8				Rotary Chip	Dry					HW		100					8
9				Rotary Chip		9.0			SILTSTONE Yellow brown to yellow grey, high in clay (low to medium plasticity), occasional sand (fine to medium).	HW		100					9
10																		10

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-03B**

Sheet 3 of 13

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 288, **N** 6869 315
Ground Surface Elevation:
Date Tested:
Total Depth: 60.3m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):

Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	13-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
11				Rotary Chip					SILTSTONE Yellow brown to yellow grey, high in clay (low to medium plasticity), occasional sand (fine to medium).	HW		100						11
										HW		100						
12						12.0			12.00m: Yellow grey.	HW		100						12
13					Dry	13.0			SANDSTONE Grey to brown, medium to coarse grained, indurated, slightly metamorphosed, fractured, moderate to hard, quartz veins.	HW		100	11				13.00, Abundant joints, 30° angle 13.70, Joints very broken up approximately 5cm, 30°, PLN, iron stained	13
14				Rotary Coring		14.5			CORE LOSS.	HW		100	5					14
15																		15

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-03B**

Sheet 4 of 13

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 288, **N** 6869 315
Ground Surface Elevation:
Total Depth: 60.3m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	13-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
16				Rotary Coring		16.4			Intermixed to Interbedded SANDSTONE and SILTSTONE Grey to dark grey, indurated, 60% sand, 40% silt, fractured, quartz veining throughout iron staining, slightly metamorphosed.	HW		100	5				15.30, Joints very broken up approximately 5cm, 40°, PLN, iron stained	16
						16.7			SANDSTONE Grey, medium to coarse grained, iron staining, fractured, indurated.	HW								
17						17.1			Dark grey to brown, indurated, sandy in part, slightly metamorphosed.			100	51				16.68, JT, 30°, QZ infill (2mm), PLN	17
						17.5			Grey to brown, mottled, indurated, medium to coarse grained, well sorted, massive, quartz veining, iron staining.								17.10, QZ veining, healed, PLN	
18						18.0			Mottled grey brown, silty, indurated, fine to coarse grained, slightly metamorphosed, massive structure.	HW		106					17.75, JT, 30°, PL, MD, IN	18
						18.4			Mottled grey brown, indurated, fine to coarse grained, slightly metamorphosed, massive, poorly sorted.									
						18.7			CORE LOSS.									
						18.9			Mottled grey brown, silty (fine to medium), altered, indurated, carbonaceous.	HW		125	0				18.65-19.00, BK	
19						19.2			Dark brown grey, sandy (fine), carbonaceous, thin to thick bedding/bed frequently disturbed, indurated.	HW		100	0				19.00-19.50, BK	19
									Mottled brown grey, silty, indurated, fine to coarse grained, massive, poorly sorted, quartz veining.	MW		100	10				19.80, JT, 15°, PL-ST, @80	
20																		20

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-03B**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 288, **N** 6869 315
Ground Surface Elevation:
Date Tested:
Total Depth: 60.3m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	13-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
21				Rotary Coring					Mottled brown grey, silty, indurated, fine to coarse grained, massive, poorly sorted, quartz veining.	MW		100	10				20.20, JT, 30°, PL, FM, IS	21
										MW							20.40, JT, 40°, PL, FM, IS, muddy	
																	20.70-21.20, BK	
												100	0					
																	21.20, JT, 15°, FM, 05°, subvertical	
						21.5												
22									Interbedded SILTSTONE and SANDSTONE Medium bedding, fine to coarse grained, carbonaceous, slightly metamorphosed, indurated.	MW							21.50, JT, 5°, 35°, PL, IS, FM, healed, muddy 21.60, JT, 10°, PL, 30°, PL, IS, FM, muddy 21.70, JT, 15°, PL, 45°, PL, IS, FM, muddy 21.80, JT, 23°, PL, 60°, PL, IS, FM, muddy 21.90, JT, 30°, PL, 45°, PL, IS, FM, muddy 22.00, JT, 12°, PL, 30°, PL, IS, FM, muddy 22.10, JT, 50-60°, PL, 30°, PL, IS, FM, muddy	22
												100	26					
						22.6												
23									SANDSTONE Medium to coarse grained, silty in part, massive, veined, jointed, broken in part, carbonaceous, indurated, alluvial.	MW							22.60, JT, 66°, PL, IS, FM, muddy	23
																	22.80, JT, 84°, PL, IS, FM, muddy 22.90, JT, 98°, PL, IS, FM, muddy 23.00, JT, 05°, PL, IS, FM, muddy 23.10, JT, 30°, PL, FM@38, muddy 23.20, JT, 30°, PL, FM@44, muddy	
												100	42					
																	23.40-23.70, BK	
										MW		100	0					
						23.7												
24									SILTSTONE Medium grey to grey, sandy (medium), carbonaceous, broken in part, irregular bedding, calcite in breaks, indurated.	MW								24
												100						
						24.7												
25									SILTSTONE Grey brown, sandy (fine to medium), jointed, veined, broken in part, carbonaceous, poorly sorted, indurated.	MW		86						25

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-03B**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 288, **N** 6869 315
Ground Surface Elevation:
Total Depth: 60.3m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):

Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	13-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
									SILTSTONE Grey brown, sandy (fine to medium), jointed, veined, broken in part, carbonaceous, poorly sorted, indurated.	MW		86					25.80, 30°, MD-PL, QZ VN (12mm thick)	
26						26.0			Grey orange, sandy (medium), alluvial, carbonaceous, metamorphosed, iron staining, thinly to thickly bedded (disturbed), broken in part, jointed.	MW		100	0				26.20, JT, 45°, PL, IS-MD, FM	26
27						27.6			Dark grey to dark grey orange, highly carbonaceous, metamorphosed, iron staining, thinly to thickly bedded (disturbed), alluvial, sandy (fine), indurated, broken in part/jointed.	MW		100	0					27
28										MW		100	0				28.40, JT, 45°, PL, IS, FM	28
29						29.1			Dark grey, iron staining, sandy, highly carbonaceous, broken in part, metamorphosed, indurated.	MW		100	0				29.10, JT, 40°, UND, IS, FM 29.20, JT, 40°, PL, IS, FM 29.30, JT, 45°, PL, IS, FM 29.40, JT, 35°, PL, UND, IS, FT, FM, 30° closed 29.50-29.70, BK	29
										MW		100	0				29.70-30.75, BK	
30																		30

Rotary Coring

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-03B**

Sheet 7 of 13

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 288, **N** 6869 315
Ground Surface Elevation:
Date Tested:
Total Depth: 60.3m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	13-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
									Dark grey, iron staining, sandy, highly carbonaceous, broken in part, metamorphosed, indurated.	MW		100	0					
						30.8												
31									SILTSTONE Sandy (medium to coarse), carbonaceous, metamorphosed, quartz veining, iron staining, thinly to thickly interbedded (disturbed), broken in part, indurated.	MW		100	0				30.75-31.30, BK	31
										MW								
32				Rotary Coring								100	18				31.75, QZ veining, varied directions on 30°	32
										MW							32.70-33.50, BK	
33												100	60					33
										MW							33.50, QZ veining, multidirectional at 70°	
												100	33					
34						34.0			Grey to blue, metamorphosed, occasionally sandy (fine), carbonaceous, irregular bedding, iron staining, indurated.								34.20, BK, JT, CL/QZ infill 34.40, JT, 55°, PL, QZ, FM 34.50, JT, 61°, PL, QZ, FM 34.60, JT, 71°, PL, QZ, FM 34.70, JT, 79°, PL, QZ, FM	34
										SW		100	43					
35																		35

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-03B**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 288, **N** 6869 315
Ground Surface Elevation:
Date Tested:
Total Depth: 60.3m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	13-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
36				Rotary Coring		36.0			Grey to blue, metamorphosed, occasionally sandy (fine), carbonaceous, irregular bedding, iron staining, indurated.	SW		100	43				35.00, JT, 52°, PL, QZ, FM 35.15, JT, 15°, PL, QZ, FM 35.20, JT, 22°, PL, QZ, FM 35.40, JT, 34°, PL, offset 10mm/closed	36
										SW							35.65-35.80, BK	
									SILTSTONE Grey blue to dark grey, iron staining, irregular bedding, metamorphic, quartz veining common, broken in part, occasional pyrite on breaks/joints, indurated.			100	10				36.00-36.60, BK	
37										SW							37.00, QZ veins (2-5mm thick), multidirectional	37
38																	38.00-38.20, BK	38
										SW							38.20-38.40, BK	
																	38.80-39.00, BK	
39						39.0			Coaly.	SW								39
						39.5											39.40-39.60, BK	
									SILTSTONE Grey blue to dark grey, carbonaceous, irregular bedding (disturbed), metamorphic, coaly laminae, occasional pyrite on breaks/joints, indurated.									
40																		40

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-03B**

Sheet 9 of 13

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 288, **N** 6869 315
Ground Surface Elevation:
Total Depth: 60.3m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):

Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	13-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
41				Rotary Coring					SILTSTONE Grey blue to dark grey, carbonaceous, irregular bedding (disturbed), metamorphic, coaly laminae, occasional pyrite on breaks/joints, indurated.	SW SW SW							41.20, QZ VN infill with calcite, closed 300mm thick 41.50, JT, 45°, PL, OP, FM, QZ infill 41.70, JT, 70°, PL, VN, PR @ 47 and 48, QZ infill, closed	41
42						42.0			SILTSTONE Dark blue grey, metamorphic, occasional sand (fine to medium), carbonaceous, muddy, pyritic.								42.00, JT, 15°, PL, FM, QZ 42.40, JT, 30°, PL, VN, CL, 200mm thick 42.70-48.20, BK	42
43						43.0			MUDSTONE Dark grey to dark brown, silty, carbonaceous.	SW								43
44						43.5			SILTSTONE Dark blue grey, metamorphic, sand (fine), carbonaceous, irregularly bedded (disturbed), indurated, veining (quartz), joints/calcite and calcite pyritic.									44
45																	44.90, JT, 14°, PL, OP, FM, CB-QZ	45

COREHOLE 412080603_TSCBH-01-TSCBH13.GPJ GHDPER.GDT 10/5/09

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-03B**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 288, **N** 6869 315
Ground Surface Elevation:
Date Tested:
Total Depth: 60.3m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	13-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
46				Rotary Coring		46.3			SILTSTONE Dark blue grey, metamorphic, sand (fine), carbonaceous, irregularly bedded (disturbed), indurated, veining (quartz), joints/calcite and calcite pyritic.	SW SW							45.50, QZ veins 10mm thick 45.70, JT, PL, CM, QZ, subvertical	46
47						48.0			SILTSTONE Blue grey, metamorphosed, rare sand (fine), carbonaceous, coaly to muddy in part, fractured, broken in part, indurated, quartz veining.	SW							47.70, JT, 40°, PL, FM, QZ 47.80, JT, 45°, PL, FM, QZ	47
48																		48
49									SILTSTONE Blue grey, metamorphosed, rare sand (fine to medium), carbonaceous, occasionally coaly, indurated, occasionally muddy, irregularly bedded.	SW SW							49.00-49.30, BK	49
50						50.0												50

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-03B**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 288, **N** 6869 315
Ground Surface Elevation:
Date Tested:
Total Depth: 60.3m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	13-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
51				Rotary Coring					SILTSTONE Grey to dark grey, metamorphic, carbonaceous, tending to sandy (fine to medium), carbonaceous laminae, rare coal laminae, indurated.	SW							50.50-51.30, BK	51
										SW								
																	51.30, JT, 50°, CC, FM, QZ 51.40, JT, 50°, CB, FM, QZ	
52										SW								52
53										SW							53.00, JT, 30°, PL, FM, QZ 53.10, JT, 50°, QZ vein 2mm 53.20, JT, 30°, QZ vein 2mm	53
						53.5			SANDSTONE Grey to blue grey, fine to coarse grained, metamorphosed, quartz veining, some chlorite, occasional iron staining, carbonaceous laminae, indurated.	SW								
54																	54.00, Carbonaceous laminae/offset 54.30, JT, PL, OP, FM, QZ	54
55																	54.70, JT, 45°, PL, CL, QZ	55

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-03B**

Sheet 12 of 13

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 288, **N** 6869 315
Ground Surface Elevation:
Total Depth: 60.3m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	13-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
56				Rotary Coring		56.0			SANDSTONE Grey to blue grey, fine to coarse grained, metamorphosed, quartz veining, some chlorite, occasional iron staining, carbonaceous laminae, indurated.	SW							55.40, JT, 35°, PL, FM, QZ 55.60-55.70, BK	56
57									SANDSTONE Grey to blue, fine to coarse grained, metamorphic, quartz veining, occasional chlorite, occasional carbonaceous laminae, iron staining, breaks and joints with quartz.	SW							56.00, JT, 40°, PL, CL, QZ, healed 56.20, JT, 30°, QZ VN, subvertical 56.40, JT, 35°, FM, QZ 56.80, JT, PL, CL, FM, QZ 57.20, JT, 40°, FM, QZ infill, calcite 57.40, JT, 40°, PL, QZ, healed, closed 57.60, JT, 45°, PL, QZ vein 5mm 57.80, VN, ST, CL, QZ	57
58						58.0			SANDSTONE Grey to grey blue, medium to coarse grained, metamorphosed, silty in part, occasionally carbonaceous, quartz veins - 100mm spacing.	SW		100	46				58.20, JT, 45°, PL, FM, QZ, chlorite	58
59						59.5			SANDSTONE Grey to grey blue, fine to coarse grained, muddy, silty, metamorphosed, occasionally carbonaceous, occasional joints and quartz/calcite.	SW		100	100				58.80, JT, 30°, PL, FM, QZ, chlorite 59.20-59.30, BK	59
60										SW		100	77					60
										SW		100	0				59.90-60.30, BK	

COREHOLE 412080603_TSCBH-01-TSCBH13.GPJ GHDPER.GDT 10/5/09

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-03B**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 288, **N** 6869 315
Ground Surface Elevation:
Date Tested:
Total Depth: 60.3m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):

Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	13-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
										SW		100	0				60.00, JT, 60°, PL, IS, FM, QZ	
						60.3			Termination Depth = 60.3m									
61																		61
62																		62
63																		63
64																		64
65																		65

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-03A**

Sheet 1 of 5

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 274, **N** 6869 414
Ground Surface Elevation:
Date Tested:
Total Depth: 20.2m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):

Inclination: Vertical
Core Barrel: NMLC
Bit Condition: Blade / Fair

Logged:	L. McAnally	15-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
0				Rotary Chip					RESIDUAL SOIL Mottled dark brown, clayey, loose to very loose sand, dry, soft, organic.	EW		100						0
1						1.0			CLAY Reddish brown, silty, sandy, dry, soft to firm, organic in part.	EW		100						1
2						2.0			CLAY Reddish brown, silty, gravelly, dry, firm to stiff, inorganic.	HW		100						2
3						3.0			CLAY Reddish brown, silty, firm to stiff.	HW		100						3
4						4.0			CLAY Yellow brown, silty, dry, firm.	HW		100						4
5						5.0												5

COREHOLE 412080603_TSCBH-01-TSCBH13.GPJ GHDPER.GDT 10/5/09

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-03A**

Sheet 2 of 5

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 274, **N** 6869 414
Ground Surface Elevation:
Date Tested:
Total Depth: 20.2m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):

Inclination: Vertical
Core Barrel: NMLC
Bit Condition: Blade / Fair

Logged:	L. McAnally	15-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
6				Rotary Chip		6.0			CLAY Yellow brown, silty, dry, firm.	HW		100						6
7				Rotary Chip		7.0			CLAY Grey brown, very silty, gravelly, dry, firm.	HW		100						7
				Rotary Chip		7.8			SILTSTONE Grey brown, clayey, gravelly, dry, low to medium strength. BEGIN CORE at 7.18 meters.	HW		100						
8				Rotary Coring					SILTSTONE Dark grey-orange, medium to coarse sand, indurated, carbonaceous, occasional irregular beds (disturbed), iron oxide staining.	HW HW HW							7.80, Highly fractured, friable in part 7.80-8.73, Broken, fractured, indurated, stepped 8.30-8.58, Subvert joint, ST, UN	8
				Rotary Coring		8.5			8.50m: Common Drilling Induced (DI) breaks.								8.70, JT, PLN, indurated, weathered 8.70-8.90, Some DI breaks 8.76, JT, PLN, indurated, weathered	
9				Rotary Coring		9.7			9.70m: Frequent DI breaks.	HW							9.17, JT, W at 45°, PL, indurated 9.20, JT, W at 45°, PL, indurated 9.55, JT, W at 20°, PL, indurated 9.60, JT, W at 30°, PL, indurated 9.60-9.70, Frequent DI breaks 9.70, JTx5 spacing, 300mm at 50°	9
10				Rotary Coring		10.0												10

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-03A**

Sheet 3 of 5

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 274, **N** 6869 414
Ground Surface Elevation:
Total Depth: 20.2m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):

Inclination: Vertical
Core Barrel: NMLC
Bit Condition: Blade / Fair

Logged:	L. McAnally	15-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
11				Rotary Coring		10.3			10.00m: Increasing carbonaceous traces.	MW							9.74-9.76, JT, W at 65°, PL, indurated 9.84-9.86, JT, W at 60°, PL, indurated 9.90-10.11, W, PL, indurated 10.14-10.63, JTx10, PL, W, 300mm spacing at 45° 10.2-10.50, Frequent DI breaks	11
						10.7			10.25m: Frequent DI breaks.									
						11.0			10.70m: Frequent micro faulting; sandy tending towards massive.								10.88-11.20, JTx5 at 50°, muddy infill CP, medium faulting	
						11.2			Carbonaceous wisps/ coal traces.									
						11.4			CARBONACEOUS MUDSTONE Dark grey black, coaly/altered/jointed/broken.	Wk							11.15-11.44, Broken	
12									SILTSTONE Dark grey to grey, coaly/indurated, carbonaceous wisps/traces/altered, occasionally sandy.	Wk								12
						12.7			12.72m: Broken frequently.								12.50-12.78, DI breaks	
						12.9			No recovery.			0						
13									SILTSTONE Dark grey, sandy, carbonaceous, abundant breaks/joints, fine bedding, quartz veining, very fine, fractured, indurated.	Fr							13.00-13.25, DI kbreaks	13
																	13.55-13.64, JT, 30°, PL, carbonaceous to muddy infill 13.69-13.75, JT, 30°, PL, muddy halo	
14						14.0			14.00m: Frequent DI breaks.								14.00-14.20, Frequent DI break	14
																	14.30-14.40, DI break	
																	14.45-14.55, DI break	
																	14.75-15.00, DI break	
15																		15

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-03A**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 274, **N** 6869 414
Ground Surface Elevation:
Total Depth: 20.2m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):

Inclination: Vertical
Core Barrel: NMLC
Bit Condition: Blade / Fair

Logged:	L. McAnally	15-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
						15.0			No recovery.	Fr		0						
						15.3			SILTSTONE Dark gey, sandy in part, carbonaceous, rare quartz veining, fractured/indurated.	Fr							15.65-15.75, 2xJ, 20°, (infill) muddy/ PL, 300mm spacing
16												109						16
																	16.50-16.80, Frequent DI break	
						16.8			No recovery.			0						
17				Rotary Coring					SILTSTONE Dark grey to grey, carbonaceous, muddy/sandy in part, fractured in part, occasionally sandy, common veining of calcite and quartz, irregularly bedded in part, rare pyrite in broken rock.	Fr							16.90-17.00, JTx2, 20°, QZ infill/ PL, 200mm spacing	17
																	17.85-18.02, JT, 45°, QT-CC infill, PL	
18						18.0			18.00m: Carbonaceous wisps, occasional rootlets.	Fr		257						18
						18.7			SILTSTONE Dark grey to grey, carbonaceous/muddy, altered/indurated/irregularly bedded in part, occasional veining of calcite and quartz (second/ primary), occasional pyrite in broken rock.	Fr							18.90-19.20, Frequent DI breaks	
19												100						19
						19.6			No recovery.			0						
						19.7				Fr		200					19.70-19.90, Frequent DI breaks	
						19.9												
20												0						20

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-03A**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 274, **N** 6869 414
Ground Surface Elevation:
Date Tested:
Total Depth: 20.2m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):

Inclination: Vertical
Core Barrel: NMLC
Bit Condition: Blade / Fair

Logged:	L. McAnally	15-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
						20.2			SILTSTONE Dark grey to grey, carbonaceous, sandy, fractured, irregularly bedded, calcite quartz veining. No recovery. Termination Depth = 20.2m			0						
21																		21
22																		22
23																		23
24																		24
25																		25

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-02B**

Sheet 1 of 12

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 225, **N** 6869 560
Ground Surface Elevation:
Date Tested:
Total Depth: 55.3m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	17-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
				Rotary Chip		0.5			RESIDUAL SOIL Yellow to brown, clayey, silty, gravel in part, organic, dry , soft.	EW		100						
						1.0			GRAVELLY CLAY Yellow brown, silty, low cohesion, dry.	EW		100						
1						2.0			CLAY Yellow to brown, silty, sandy in part, common gravel.	HW		100						1
2						3.0			2.00m: Common sand, fine to medium, occasional gravel.	HW		100						2
3						4.0			CLAY Yellow to brown, silty, highly sandy, low to medium plasticity, low cohesion.	HW		100						3
4				Rotary Chip	Moist				4.00m: Common sand, fine to medium.	HW								4
				Rotary Chip	Wet							100						
5						5.0												5

COREHOLE 412080603_TSCBH-01-TSCBH13.GPJ GHDPER.GDT 10/5/09

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-02B**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 225, **N** 6869 560
Ground Surface Elevation:
Date Tested:
Total Depth: 55.3m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	17-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
6				Rotary Chip	Dry	5.5			5.00m: Decreased plasticity (low plasticity).	HW		100						6
									SILT Mottled yellow to brown, highly clayey, gravel, grey, medium to low cohesion, completely weathered to clay.	EW		100						
						6.5				EW		100						
7									CLAY Yellow to brown, silty, sandy, low to medium cohesion.	HW		100						7
						7.0			7.00m: Increasingly silty, low to medium plasticity.	HW		100						
8				Rotary Chip	Dry	8.0			CLAY Yellow to brown, silty, sandy, low to medium cohesion, medium plasticity, high in part.	HW		100						8
9				Rotary Chip	Dry					HW		100						9
10						10.0												10

GHD | MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-02B**

Sheet 3 of 12

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 225, **N** 6869 560
Ground Surface Elevation:
Total Depth: 55.3m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):

Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	17-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
11				Rotary Chip	Dry				CLAY Yellow to brown, silty, low sandy, low to medium plasticity, low to medium cohesion.	HW		100						11
										HW		100						
12				Rotary Chip	Dry	12.0			CLAY Yellow to brown, mottled grey, highly silty, low to medium plasticity, low cohesion.	HW		100						12
13				Rotary Chip	Dry					HW		100						13
14				Rotary Chip	Dry	14.0			14.00m: Increasing SILT, grey to yellow grey.	HW		100						14
						14.5			SILTSTONE Yellow brown to yellow grey mottled, highly sandy, silty, highly clayey, low cohesion.	HW		100						
15						15.0												15

COREHOLE 412080603_TSCBH-01-TSCBH13.GPJ GHDPER.GDT 10/5/09

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-02B**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 225, **N** 6869 560
Ground Surface Elevation:
Total Depth: 55.3m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	17-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
				Rotary Chip	Dry				15.00m: Low plasticity.	HW		100						
16						16.0												16
				Rotary Chip	Dry				SILTSTONE Yellow to grey, clayey, silty, low plasticity, low cohesion.	HW		100						
17						17.0												17
				Rotary Chip	Dry				SILTSTONE Yellow grey, clayey, silty, low to medium plasticity, low cohesion, dry. End of chips at 18.00 meters. Begin core.	MW		100						
18						18.0											18.00-18.27, BK	18
				Rotary Coring					SANDSTONE Brown grey, silty, medium to coarse grained, indurated.	MW		45	0				
						18.3			No recovery.			0	0					
						18.6											18.60-18.7, BK	
						18.7			SANDSTONE Brown grey, medium to coarse grained, indurated.	MW								
19									No recovery.									19
						19.9											19.90-20.10, BK	
20										MW		10	0					20

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-02B**

Sheet 5 of 12

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 225, **N** 6869 560
Ground Surface Elevation:
Total Depth: 55.3m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	17-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
				Rotary Coring		20.5			SANDSTONE Brown grey, medium to coarse grained, silty, iron staining, indurated.	MW		10	0				20.20-20.50, BK	
						21.0			No recovery.			0	0					
21									SILTSTONE Dark grey to orange, sandy (fine to medium), slightly metamorphosed, carbonaceous, occasional to common joints (rare quartz on joints).	MW		100					21.07, JT, 30°, PL, muddy 21.20, JT, 40°, PL, muddy 21.46, JT, 50°, PL, muddy 21.52, JT, 50°, PL, muddy 21.55, JT, 50°, PL, muddy 21.65, BK, QZ veins/heal	21
22										MW		100	31				22.37, JT, 50°, PL, muddy, firm	22
23						23.0			SANDSTONE Orange grey, medium to coarse grained, silty, iron staining, indurated, carbonaceous in part.			100	84				22.85, JT, 45°, PL, muddy, firm	23
24						24.5				MW		100	72				23.50-23.80, BK 24.04, JT, 45°, PL, muddy, firm 24.30, JT, 45°, PL, neutral	24
25						25.0			SILTSTONE Grey to blue, mottled orange grey, sandy, indurated.	MW		100	0				24.50, JT, 50°, PL, muddy, firm 24.55, JT, 55°, PL, muddy, firm 24.65, JT, 45°, PL, firm 24.94, JT, 55°, PL, firm	25

COREHOLE 412080603_TSCBH-01-TSCBH13.GPJ GHDPER.GDT 10/5/09

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-02B**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 225, **N** 6869 560
Ground Surface Elevation:
Date Tested:
Total Depth: 55.3m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	17-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
26				Rotary Coring					SILTSTONE Grey to blue, mottled orange grey, sandy (fine to medium), iron staining, muddy in fill, carbonaceous in part, broken in part, slightly metamorphosed/altered, tending to sand in part.	MW		100	0				25.70, JT, 40°, PL, infill, muddy, firm	26
										MW		100	34				26.40-26.60, BK	
										MW							26.65, JT, 60°, PL, weat coat, firm 26.76, JT, 55°, PL, MD IN, firm	
27						27.0						100	0					27
									SILTSTONE Grey to blue, mottled orange grey, sandy (medium), carbonaceous, slightly metamorphosed, broken in part, indurated.								27.30-27.50, BK	
										MW								
28												100	10				28.20-28.50, BK	28
						28.5				MW								
									SANDSTONE Grey orange, silty, medium to coarse grained, carbonaceous in part, muddy in part, indurated.								28.80-29.20, BK	
29												100	45					29
																	29.40-29.50, BK	
										MW		100	0					
30						30.0												30

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-02B**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 225, **N** 6869 560
Ground Surface Elevation:
Total Depth: 55.3m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	17-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
31				Rotary Coring		31.0			SANDSTONE Orange grey, silty, medium to coarse grained, carbonaceous in part, indurated.	MW		100	0				30.15, JT, 70°, PL from 44-49 35° PL, indurated, firm 30.30-30.70, BK	31
										MW		100	42					
									SANDSTONE Grey to orange, silty, medium to coarse grained, indurated.	MW		41	19				31.50-31.80, BK	
32						31.8			CORE LOSS.			0	0					32
						32.6			SANDSTONE Grey to orange, silty, medium to coarse grained, slightly metamorphosed, indurated.	MW		100	0				32.55-33.00, BK	
										MW		100	0					
33						33.0												33
						33.1			CORE LOSS.			0	0					
									SANDSTONE Orange grey, silty, occasionally carbonaceous, slightly metamorphosed, tending towards siltstone, iron staining, indurated.	MW		75	0				33.10-33.40, BK	
										MW		100	0					
34										MW		100	0					34
										MW		100	0					
										SW							34.80-35.20, BK	
35						35.0												35

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-02B**

Sheet 8 of 12

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 225, **N** 6869 560
Ground Surface Elevation:
Total Depth: 55.3m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	17-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
36				Rotary Coring		36.0			SILTSTONE Grey to blue grey, mottled grey brown, sandy (fine to medium), carbonaceous, slightly metamorphosed, iron staining, quartz veining.	SW		117	46				35.35, QZ VN 20mm, subvertical -20°, closed/healed, offset veins either rock	36
									SANDSTONE tending to SILTSTONE Grey to brown grey, fine to medium grained, carbonaceous, iron staining, indurated.	SW							36.00-37.00, QZ VN 2-5mm	
37						37.0			SILTSTONE Grey to grey blue, sandy (fine to medium), carbonaceous, indurated, slightly metamorphosed, microfaulted, irregular bedding (distrubed in part), iron staining.	SW							37.00-38.00, QZ VN 2-5mm	37
38										SW							38.25-38.90, BK	38
39						39.0			SILTSTONE Grey to grey blue, sandy (fine to medium), carbonaceous in part, indurated, metamorphosed, altered, quartz veining and calcite, irregular bedding (distrubed in part), pyrite on breaks/joints.	SW		15	47				38.94, JT, 40°, PL, CC IN, firm 39.50, JT, 55°, PL, carbonaceous, firm 39.75, JT, 40°, ST, carbonaceous, firm	39
40										SW		100	67					40

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-02B**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 225, **N** 6869 560
Ground Surface Elevation:
Total Depth: 55.3m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	17-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
41				Rotary Coring	Dry	41.0			SILTSTONE Grey to grey blue, sandy (fine to medium), carbonaceous in part, indurated, metamorphosed, altered, quartz veining and calcite, irregular bedding (distrubed in part), pyrite on breaks/joints.	SW		100	67				40.10-40.30, BK 40.19, JT, 40°, ST, carbonaceous, firm 40.50-40.70, BK	41
42									SILTSTONE Grey to blue grey, sandy (medium), carbonaceous in part, indurated, metamorphosed, quartz veining and calcite, pyrite breaks and joint surface, 37' d - fractured, irregular bedding.	SW SW		100	0				41.40, PL, CC, firm 41.45, PL, CC, firm 42.00-43.00, QZ VN, MF, multidirectional	42
43				Rotary Coring		43.0			SILTSTONE Grey to blue grey, sandy (medium), carbonaceous, indurated, metamorphosed, quartz veining and calcite, pyrite on breaks and joint surface, irregular bedding (thin to thick), occasional iron staining.	SW		100	0				43.00-44.00m: QZ VN, MF, multidirectional	43
44										SW		100	0					44
45						45.0				SW								45

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-02B**

Sheet 10 of 12

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: **E** 549 225, **N** 6869 560
Ground Surface Elevation:
Date Tested:
Total Depth: 55.3m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	17-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
46				Rotary Coring					SILTSTONE Grey to dark grey, sandy (medium), carbonaceous, metamorphosed, quartz veining and calcite, breaks and joint, irregular bedding, occasional iron staining.	SW							45.20, QZ VN, 30mm thick, QZ vein heavily multidirectional (MF)	46
										SW								
										SW								
47																	47.00-48.00, BK	47
												6	0					
48				Rotary Coring		48.0			SILTSTONE Dark grey to blue grey, sandy (medium to fine), carbonaceous, metamorphosed, quartz veining, occasional calcite, irregular bedding.	SW							48.50-49.00, QZ VN 2mm apart	48
49										SW								49
50						50.0												50

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-02B**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 225, **N** 6869 560
Ground Surface Elevation:
Date Tested:
Total Depth: 55.3m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	17-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
51				Rotary Coring					SILTSTONE Dark grey to blue grey, sandy in part (fine), carbonaceous, metamorphosed, quartz veining, occasional calcite, irregular bedding, occasionally disturbed bed, microfaulting.	SW								51
										SW								
										SW								
52						52.0			SILTSTONE Grey to grey blue, slightly sandy (fine to medium), carbonaceous, metamorphosed, microfaulting.	SW							52.00-53.00, QZ VNS throughout 2mm-5mm thick, multidirectional	52
53						53.0			SILTSTONE Dark grey to grey blue, sandy (fine), carbonaceous, metamorphosed, quartz veining/quartz or joint/break, thickly massive bedding.									53
54						54.2			CORE LOSS.	SW		100	0					54
55																		55

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-02B**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 225, **N** 6869 560
Ground Surface Elevation:
Date Tested:
Total Depth: 55.3m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):

Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	17-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
						55.3			CORE LOSS.	SW		100	0					
									Termination Depth = 55.3m									
56																		56
57																		57
58																		58
59																		59
60																		60

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-02A**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 577, **N** 6868 883
Ground Surface Elevation:
Total Depth: 20.0m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley Truck

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

Logged:	L. McAnally	09-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
0				Rotary Chip	Moist				CLAY Red brown, alluvial, very silty, occasional sand (fine to medium), low to medium plasticity, low cohesion, moist, inorganic.									0
1																		1
2																		2
3																		3
4						4.0			CLAY Red brown, alluvial, very silty, occasional sand (fine to medium) sand, low to medium plasticity, low cohesion, inorganic.									4
5																		5

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-02A**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 577, **N** 6868 883
Ground Surface Elevation:
Total Depth: 20.0m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley Truck

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

Logged:	L. McAnally	09-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
6				Rotary Chip					CLAY Red brown, alluvial, very silty, occasional sand (fine to medium) sand, low to medium plasticity, low cohesion, inorganic.									6
7																		7
8						8.0			CLAY Orange brown, very silty and completely weathered, inorganic, alluvial, rare sand (fine), medium plasticity, low cohesion. END OF CHIP SAMPLES at 13.00 meters.									8
9																		9
10																		10

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-02A**

Sheet 3 of 4

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 577, **N** 6868 883
Ground Surface Elevation:
Total Depth: 20.0m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley Truck

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

Logged:	L. McAnally	09-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
11				Rotary Chip					CLAY Orange brown, very silty and completely weathered, inorganic, alluvial, rare sand (fine), medium plasticity, low cohesion. END OF CHIP SAMPLES at 13.00 meters.									11
12																		12
13					Moist	13.0			CLAY Yellow red, silty, low plasticity, low cohesion.									13
14				Core OH		13.8			CLAY Yellow brown, silty, low to medium palsticity.	HW							13.80-14.80, BK, no structure	14
15						14.5 14.8			CORE LOSS. CLAY Yellow brown, very silty, alluvial.	HW		65	0					15

COREHOLE 412080603_TSCBH-01-TSCBH13.GPJ GHDPER.GDT 10/5/09

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-02A**

Sheet 4 of 4

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 577, **N** 6868 883
Ground Surface Elevation:
Total Depth: 20.0m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley Truck

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

Logged:	L. McAnally	09-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
16				Rotary Chip					CLAY Yellow brown, very silty, alluvial.	HW								16
										HW								
17																		17
18						18.0			CLAY Yellow brown, inorganic, alluvial, very soft to soft, occasional gravel, sand (fine to medium), silty, low to medium plasticity, low cohesion.									18
19																		19
20						20.0			Termination Depth = 20m									20

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-01**

Sheet 1 of 15

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 376, **N** 6868 871
Ground Surface Elevation:
Total Depth: 70.3m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
0									No recovery.									0
						1.0												
1									No recovery.			0	0					1
						2.0												
2									No recovery.									2
						3.0												
3				Rotary Coring					CLAY Red brown, silty, gravelly.	EW							3.00-3.10, BK	3
									No recovery.									
						3.9												
4									CLAY-CONGLOMERATE Mottled red brown, silty, occasional sandy, low plasticity, low cohesion.	EW		100	0				3.87-4.12, BK	4
						4.1												
									No recovery.			0						
5						5.0												5

COREHOLE 412080603_TSCBH-01-TSCBH13.GPJ GHDPER.GDT 10/5/09

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-01**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 376, **N** 6868 871
Ground Surface Elevation:
Total Depth: 70.3m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):

Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
				Rotary Coring		5.5			CLAY-CONGLOMERATE Mottled red brown.	EW		100	0				5.00-5.50, BK	
				Rotary Chip					CHIP SAMPLES CLAY-CONGLOMERATE Mottled grey orange, silty, low to medium plasticity, low cohesion.	HW		100					
6																		6
												100						
7																		7
												100						
8						8.0			CLAY Low to medium plasticity. Matrix - pebble sized - granular clasts, mottled orange grey, alluvial, inorganic, moist, cohesive, silty (occasional), sandy (fine to coarse).	HW								8
												100						
9																		9
												100						
10																		10

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-01**

Sheet 3 of 15

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 376, **N** 6868 871
Ground Surface Elevation:
Total Depth: 70.3m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):

Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
11				Rotary Chip		11.0			CLAY Low to medium plasticity. Matrix - pebble sized - granular clasts, mottled orange grey, alluvial, inorganic, moist, cohesive, silty (occasional), sandy (fine to coarse).	HW		100						11
12									CONGLOMERATE-CLAY MATRIX tending to CLAY (Cl) Pebbly - granular clasts, mottled orange grey, alluvial, inorganic, moist, silty and sandy (medium to coarse), cohesive-low plasticity.			100						12
13												100						13
14						14.0			CONGLOMERATE-CLAY MATRIX tending to CLAY Mottled orange grey, pebbly - granular clasts, cohesive, low plasticity, silty and sandy (medium).	HW		100						14
15												100						15

COREHOLE 412080603_TSCBH-01-TSCBH13.GPJ GHDPER.GDT 10/5/09

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-01**

Sheet 4 of 15

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 376, **N** 6868 871
Ground Surface Elevation:
Date Tested:
Total Depth: 70.3m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
16				Rotary Chip		16.0			CONGLOMERATE-CLAY MATRIX tending to CLAY Mottled orange grey, pebbly - granular clasts, cohesive, low plasticity, silty and sandy (medium).	HW		100						16
						16.5			SILT Dark grey, orange, clayey, low plasticity, completely weathered, sandy in part.			100						
17									CONGLOMERATE-CLAY MATRIX Mottled orange grey, carbonaceous in part, cohesive, low plasticity, silty, pebbly clasts (occasional), sandy (medium), moist, alluvial.									17
18																		18
19						19.0			CONGLOMERATE-CLAY MATRIX tending to CLAY Mottled orange grey, silty, low plasticity, cohesive, alluvial, moist.									19
20						20.0												20

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-01**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 376, **N** 6868 871
Ground Surface Elevation:
Total Depth: 70.3m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
						20.4			CORE LOSS.									
									1.40M			71	0					
21						21.4												21
						21.5			CLAY Orange grey/carbonaceous, silty/gravelly.	HW							21.40-21.50, BK	
									CORE LOSS.									
22						22.0			1.70M			17	0					22
23						23.0												23
									CORE LOSS.									
						23.2			SILTSTONE Dark grey blue, laminated, chloritic.	HW							23.20-23.55, BK, microfaulted	
						23.6			CORE LOSS.									
24						24.2			SILTSTONE Mottled grey brown, fine to medium sand, slightly metamorphosed, quartz veining, carbonaceous, indurated.	MW		51	10				24.17-24.81, BK	24
						24.8			CORE LOSS.			86	0					
25																		25

COREHOLE 412080603_TSCBH-01-TSCBH13.GPJ GHDPER.GDT 10/5/09

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-01**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 376, **N** 6868 871
Ground Surface Elevation:
Date Tested:
Total Depth: 70.3m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
									CORE LOSS.									
						25.9												
26									SILTSTONE Mottled grey brown, fine to medium sand, slightly metamorphosed, quartz veining, broken in part, carbonaceous, indurated.	MW		86	0				25.85-27.15, BK	26
27						27.2												27
				Rotary Coring					CORE LOSS.									
28												25	0					28
						28.7												
29									SILTSTONE Mottled grey brown, sandy (medium), slightly metamorphosed, carbonaceous, quartz veining, jointed, indurated.	MW							28.70-29.23, BK	29
						29.2												
									CORE LOSS.									
						29.7												
										MW							29.70-30.20, BK	
30																		30

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-01**

Sheet 7 of 15

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 376, **N** 6868 871
Ground Surface Elevation:
Total Depth: 70.3m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
						30.2			SILTSTONE Mottled grey brown, sandy (medium), slightly metamorphosed, carbonaceous, quartz veining, indurated.	MW							
									CORE LOSS.									
31						31.0			SILTSTONE, as above.	MW							31.00-32.00, BK	31
						31.4			CORE LOSS.									
						31.8			SILTSTONE, as above.									
32				Rotary Coring														32
33						33.0												33
						33.2			SANDSTONE Mottled brown grey, medium to coarse, very silty, indurated, slightly metamorphosed, occasional carbonaceous.	MW							
									No recovery.									
34																		34
35																		35

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-01**

Sheet 8 of 15

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 376, **N** 6868 871
Ground Surface Elevation:
Date Tested:
Total Depth: 70.3m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
35				Rotary Coring		35.2			No recovery.	MW							35.00-35.18, JT, SPC, QZ	
									SANDSTONE tending to SILTSTONE.			100	26				35.80-36.10, JT, 15°, SPC QZ, BK	
36						36.2				Wk								36
									CORE LOSS.			59	0				36.50-36.80, BK	
						36.5			SILTSTONE Grey to dark grey, sandy (fine to medium), carbonaceous, metamorphosed, indurated, broken.									
37						37.0			CORE LOSS.			55	60					37
						37.5			SILTSTONE, as above.									
38						38.1			CORE LOSS.								38.00-39.00, QZ VN 38.10-38.50, BK	38
						38.5			SILTSTONE Dark grey, slightly coaly in part.			79	11					
39										SW							39.00-40.00, QZ VN	39
						39.7			CORE LOSS.			100	55					
40																		40

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-01**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 376, **N** 6868 871
Ground Surface Elevation:
Total Depth: 70.3m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):

Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
						40.2			CORE LOSS.	SW		100	55				40.00-40.20, BK	
41						41.0			SILTSTONE Coaly, highly carbonaceous, low in sand.									41
									SILTSTONE Grey to dark grey blue, metamorphose, carbonaceous, coaly, quartz veining, medium sand (occasional), irregular bedding (disturbed).								41.00-42.00, QZ VN (2mm), multidirectional, pyritic common	
42						42.1			CORE LOSS.									42
				Rotary Coring		42.4			SILTSTONE Dark grey to blue grey, sandy (medium), metamorphosed, carbonaceous, coaly in part, irregular bedding disturbed, quartz veining, quartz on joints.									
43																	43.00-44.00, QZ VN (2mm), multidirectional joints, pyrite common	43
44						44.9			CORE LOSS.									44
45																		45

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-01**

Sheet 10 of 15

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 376, **N** 6868 871
Ground Surface Elevation:
Total Depth: 70.3m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):

Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
						45.3			CORE LOSS.	SW								
									SILTSTONE Dark grey to blue grey, medium grained sand, metamorphosed, carbonaceous, coaly in part, irregular bedding disturbed, quartz veining, quartz on joints.									
46						46.4			CORE LOSS.									46
						46.8			SILTSTONE Dark grey, coal, carbonaceous, metamorphosed, irregular bedding (disturbed), jointed, microfaulted, occasional sandy, pyritic in breaks/joints (occasional).			100	51					
47				Rotary Coring														47
48												100	0					48
												100	0					
49										SW		100	88					49
												100	0					
50																		50

COREHOLE 412080603_TSCBH-01-TSCBH13.GPJ GHDPER.GDT 10/5/09

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-01**

Sheet 11 of 15

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 376, **N** 6868 871
Ground Surface Elevation:
Date Tested:
Total Depth: 70.3m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
51				Rotary Coring					SILTSTONE Dark grey, coal, carbonaceous, metamorphosed, irregular bedding (disturbed), jointed, microfaulted, occasional sandy, pyritic in breaks/joints (occasional).	SW		100	0					51
												100	0					
												60						
						51.5												
52									SILTSTONE Dark grey, coal, carbonaceous, metamorphosed, irregular bedding (disturbed), jointed, microfaulted, occasionally sandy, muddy in part, pyritic in breaks/joints (occasional).								51.70-52.10, BK	52
												100	0					
53												100	0					53
												100	0					
54												100	14					54
												100	23					
55						55.0												55

COREHOLE 412080603_TSCBH-01-TSCBH13.GPJ GHDPER.GDT 10/5/09

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-01**

Sheet 12 of 15

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 376, **N** 6868 871
Ground Surface Elevation:
Total Depth: 70.3m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
						55.3			SILTSTONE Dark grey, coal, carbonaceous, broken, quartz on break and joints, occasional sand (fine to medium), metamorphosed, irregular bedding (disturbed), microfaulting.	SW		100	0				
						55.4			CORE LOSS.			50	0				
						55.7						50	0				
						55.8			CORE LOSS.								
56						56.2												56
									CORE LOSS.			127 53	0 0				
						56.5												
57										SW		85	13				57.00-57.30, BK	57
						57.3			CORE LOSS.								57.30-58.00, BK 57.30-57.60, QZ VN (2mm), multidirectional	
				Rotary Coring					SILTSTONE Dark grey, metamorphosed, jointed and broken, coaly carbonaceous, rare sand (fine to medium), pyritic on joints and breaks, irregular bedding (disturbed), muddy in parts, quartz veins.			37	0				57.60-58.00, BK	
58												11	0				58.00-58.60, QZ VN (2mm), multidirectional	58
																	58.60-59.00, BK	
59												17	0				59.00-59.50, QZ VN (2mm), multidirectional	59
												100	0					
60						60.0												60

COREHOLE 412080603_TSCBH-01-TSCBH13.GPJ GHDPER.GDT 10/5/09

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-01**

Sheet 13 of 15

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 376, **N** 6868 871
Ground Surface Elevation:
Date Tested:
Total Depth: 70.3m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
						60.2			CORE LOSS.	SW		25	0					
												66	0					
												100	0					
						60.9												
61									CORE LOSS.			0	0					61
						61.3											61.20-62.50, BK	
									SILTSTONE Grey to dark grey, metamorphosed, coaly, carbonaceous, rare sand (fine to medium), pyritic on joints and breaks, irregular bedding (disturbed), quartz veins.			83	0					
62												100	0					62
												40	0					
63				Rotary Coring								67	0					63
												100	28					
64												100	24					64
												100	28				64.62, JT, Closed 45°, joints side, QZ VN	
65						65.0												65

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-01**

Sheet 14 of 15

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 376, **N** 6868 871
Ground Surface Elevation:
Total Depth: 70.3m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
66				Rotary Coring					SILTSTONE Grey to blue grey, metamorphosed, carbonaceous, coaly in part, rare sand (medium), joints/ microfaulting.	SW		100	28				65.50-65.60, JT/ VN sets, 5-10mm spacing	66
												100	78					
67												100	70				67.35-67.44, JT, 45°, CH, PL, OP, FM	67
												100	62					
68						68.0			SILTSTONE Grey to grey blue, highly metamorphosed, carbonaceous, coaly in part, rare sand (medium to coarse), jointed, microfaulted, quartz veins/ on joints.								68.00, JT, 45°, PL, OP, FM, CB INF, QZ VN	68
69												100	83					69
												100	59					
70																		70

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-01**

Sheet 15 of 15

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 376, **N** 6868 871
Ground Surface Elevation:
Date Tested:
Total Depth: 70.3m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
						70.3			Termination Depth = 70.25m	SW		100	59					
71																		71
72																		72
73																		73
74																		74
75																		75

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-13**

Sheet 1 of 3

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 434, **N** 6869 027
Ground Surface Elevation: **Total Depth:** 13.0m
Commenced: 01-May-09 **Completed:** 01-May-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

Logged:	L. McAnally	15-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
0				Rotary Chip	Wet				Orangey brown to brown, inorganic, silty, sandy, fine to medium, low to non-cohesive, low plasticity.	EW		100						0
1										HW		100						1
2						2.0			CLAY Orangey to brown, silty, sandy, soft to firm, low to medium plasticity, low to non-cohesive.	HW		100						2
3					Moist													3
4				Rotary Chip		4.0			CLAY Orangey to brown, sandy (highly silty), low plasticity, soft to firm.	HW		100						4
5																		5

COREHOLE 412080603_TSCBH-01-TSCBH13.GPJ GHDPER.GDT 10/5/09

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-13**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 434, **N** 6869 027
Ground Surface Elevation: **Total Depth:** 13.0m
Commenced: 01-May-09 **Completed:** 01-May-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

Logged:	L. McAnally	15-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
6				Rotary Chip	Dry	6.0			CLAY Orangey to brown, sandy (highly silty), low plasticity, soft to firm.	HW		100						6
7				Rotary Chip	Dry	8.0			CLAY Orangey to brown, silty, low plasticity, soft to firm.	HW		100						7
8				Rotary Chip	Moist				CLAY Orangey to brown, silty, sandy in part, low plasticity, soft to firm.	HW		100						8
9				Rotary Chip	Moist													9
10						10.0												10

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-13**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 434, **N** 6869 027
Ground Surface Elevation: **Total Depth:** 13.0m
Commenced: 01-May-09 **Completed:** 01-May-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

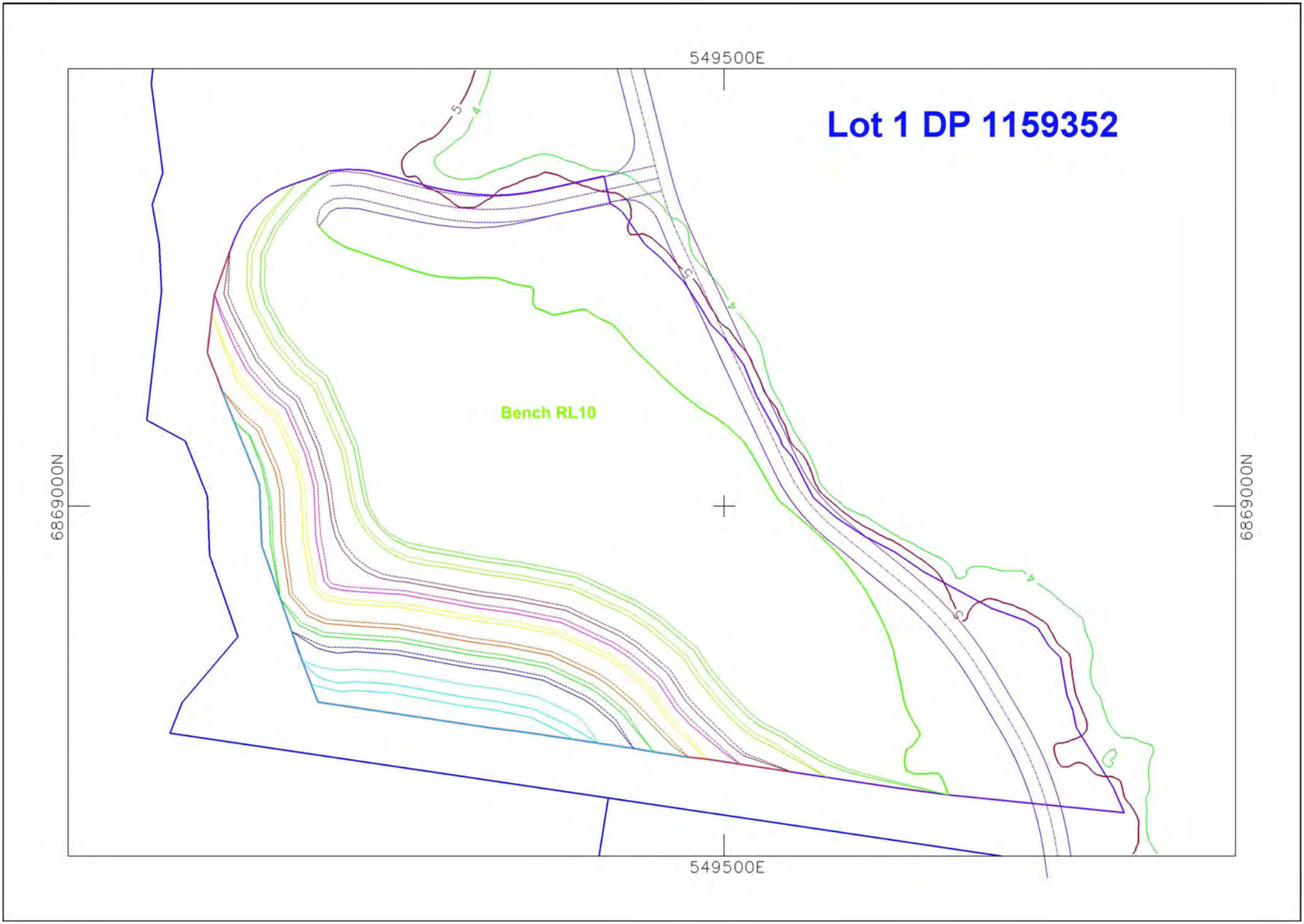
Logged:	L. McAnally	15-Jun-09
Processed:	ED	05-Oct-09
Checked:		

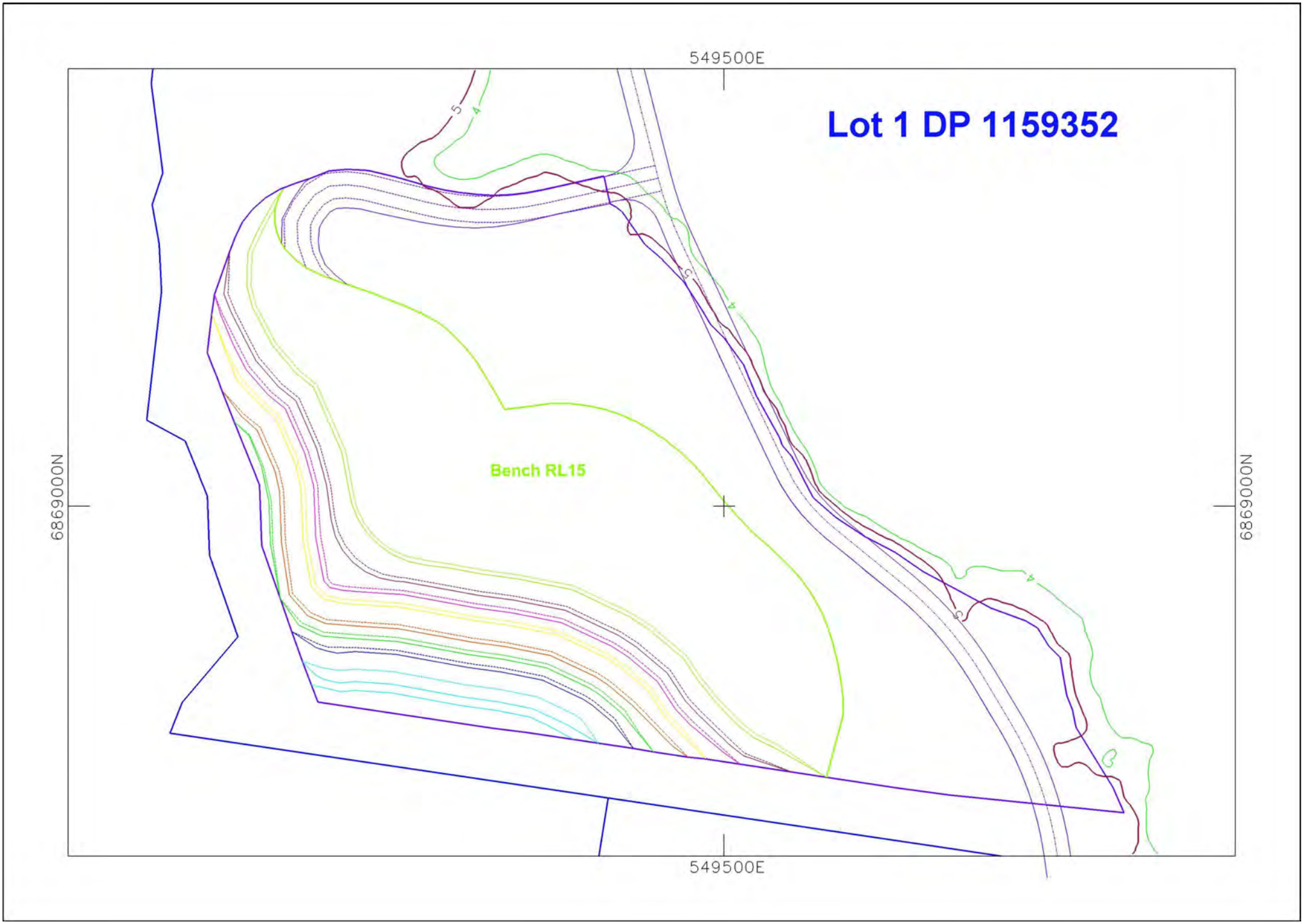
Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
11				Rotary Chip	Wet				CLAY Orangey brown, silty, low plasticity, low cohesion.	HW		100						11
12				Rotary Chip		12.0			CLAY Orangey brown, silty, firm, low plasticity, very wet.	HW		100						12
13						13.0			Termination Depth = 13m									13
14																		14
15																		15

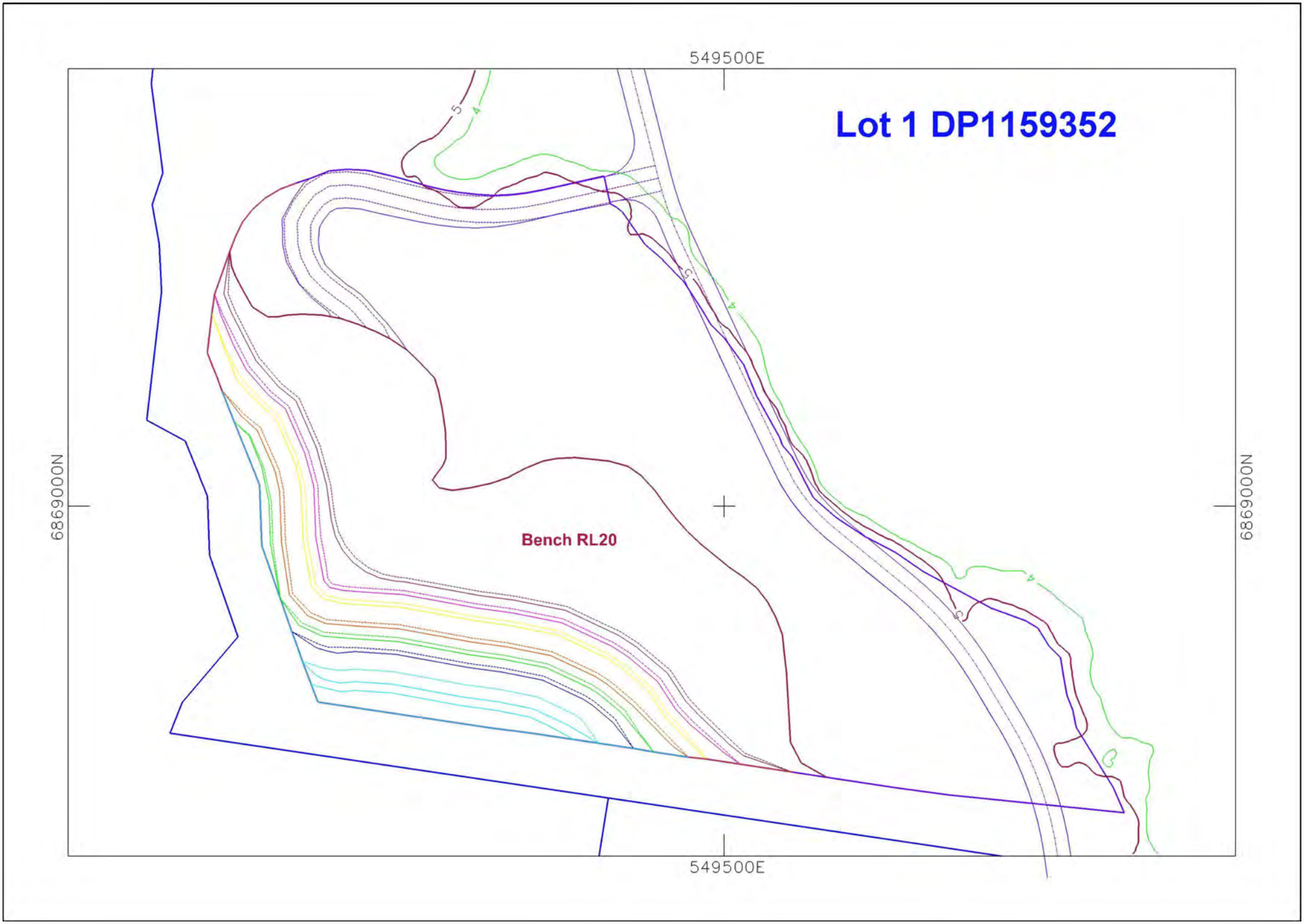
Appendix D

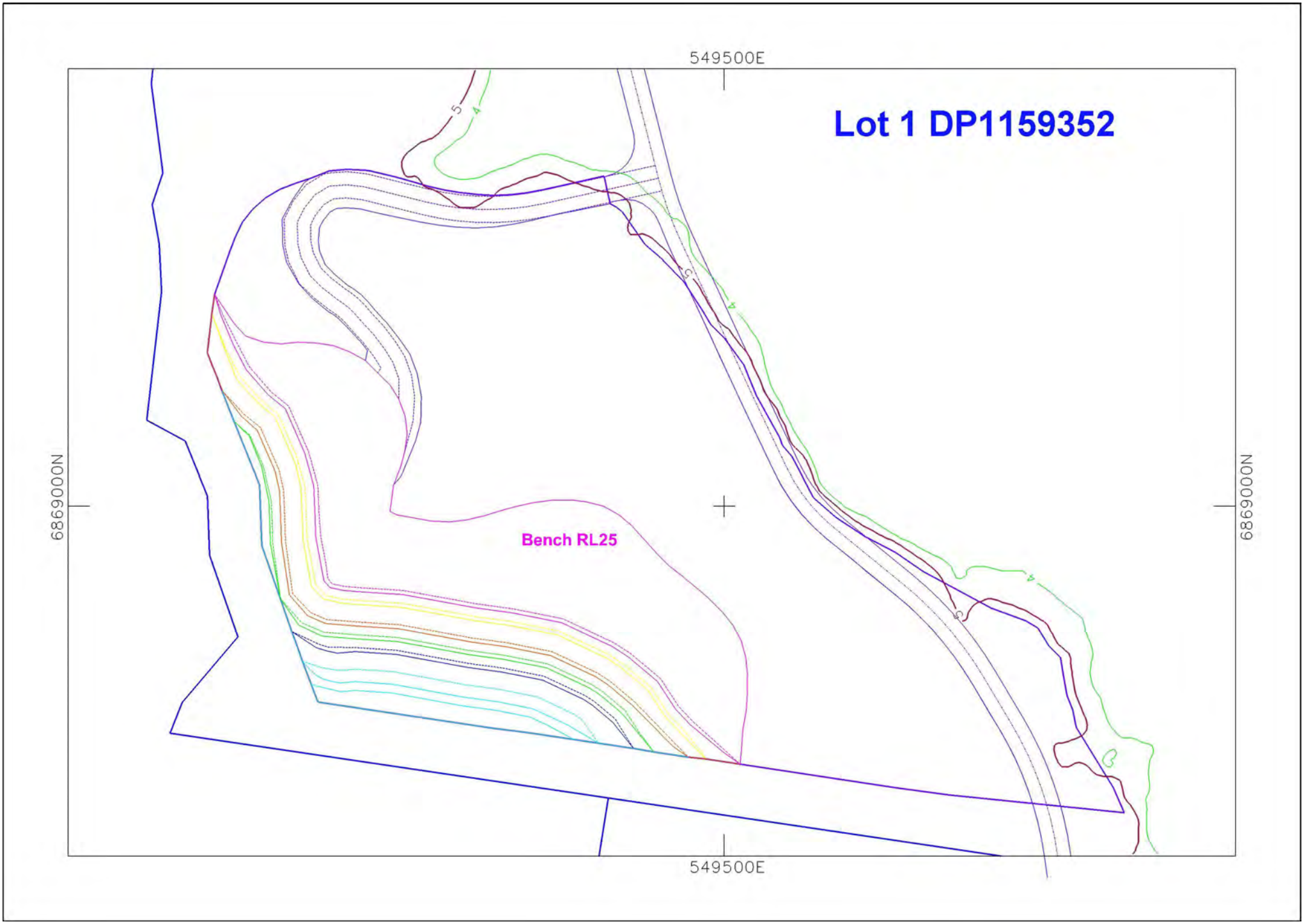
Figures and Diagrams

West Valley Quarry Schedule Plans

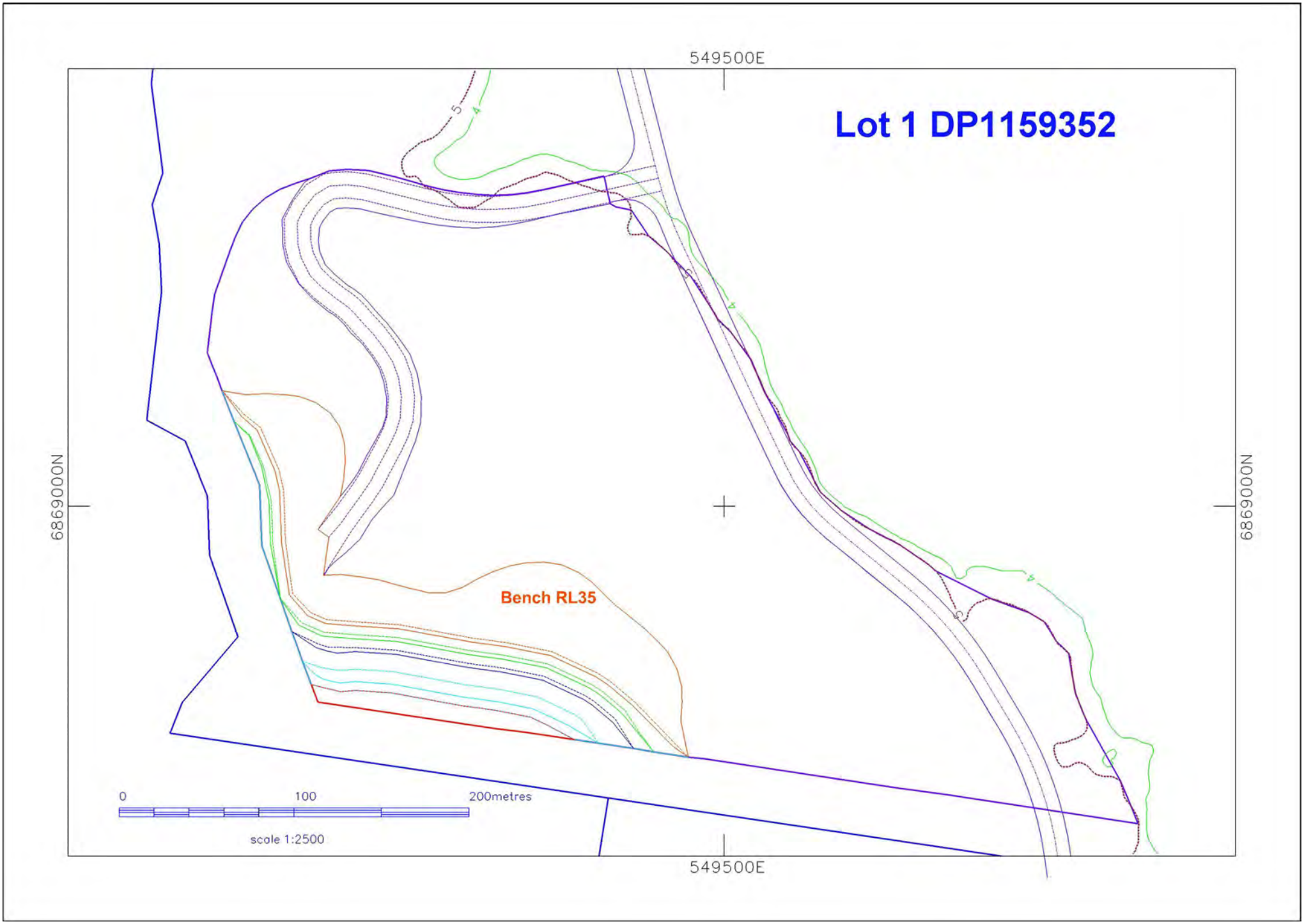

549500E
Lot 1 DP 1159352
Bench RL10
6869000N
6869000N
549500E

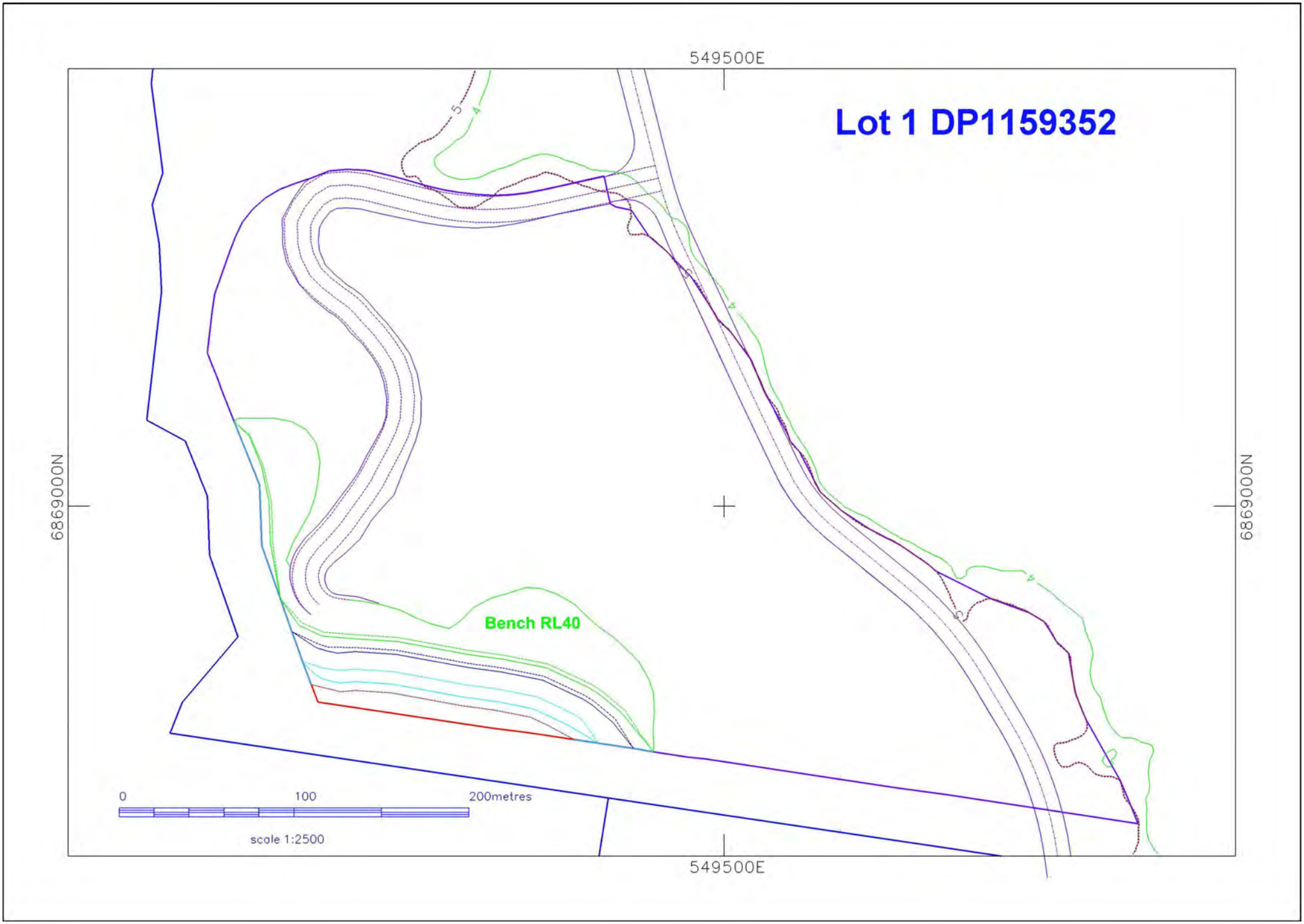

549500E
Lot 1 DP 1159352
Bench RL15
6869000N
6869000N
549500E

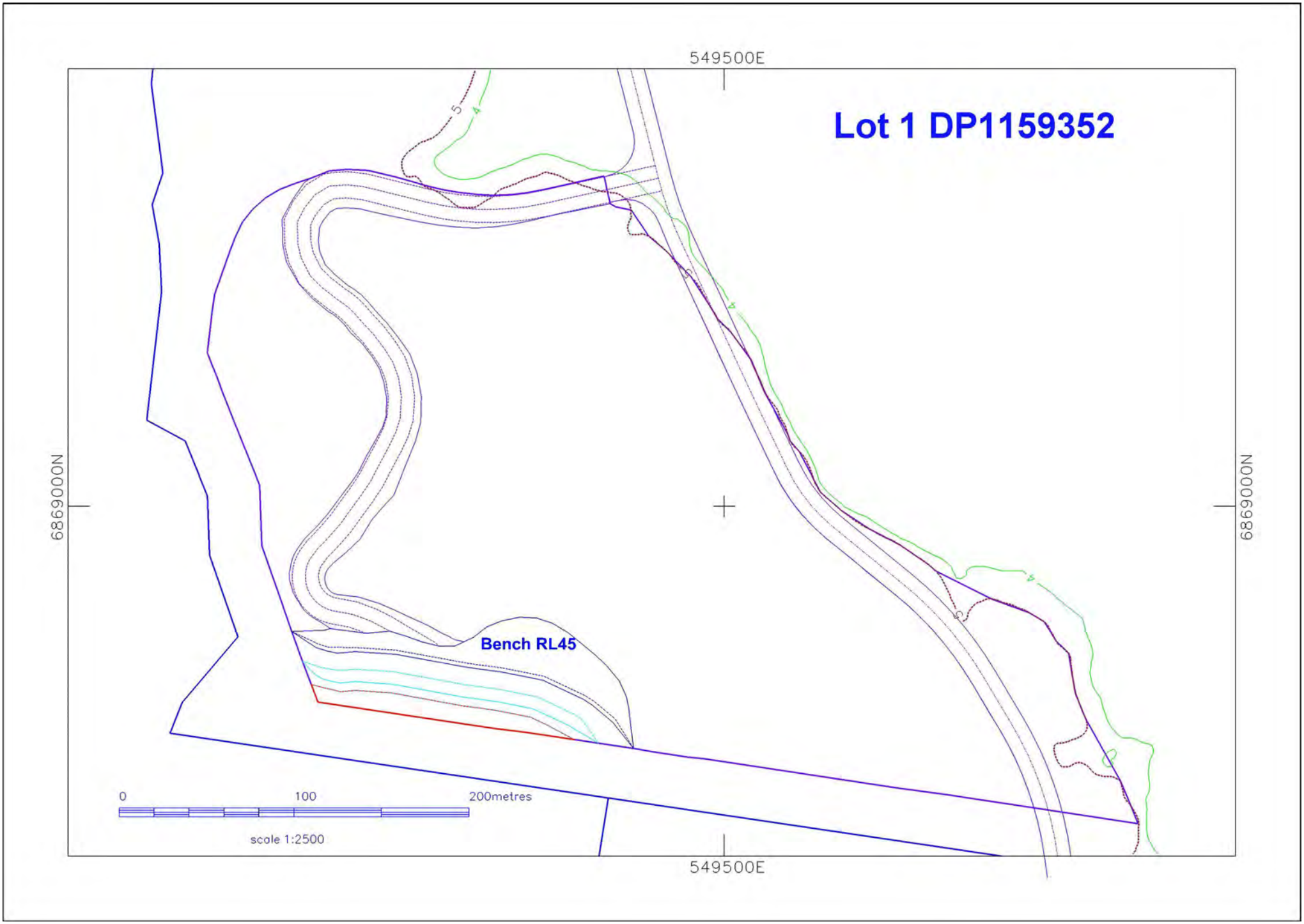

549500E
Lot 1 DP1159352
6869000N
Bench RL20
549500E

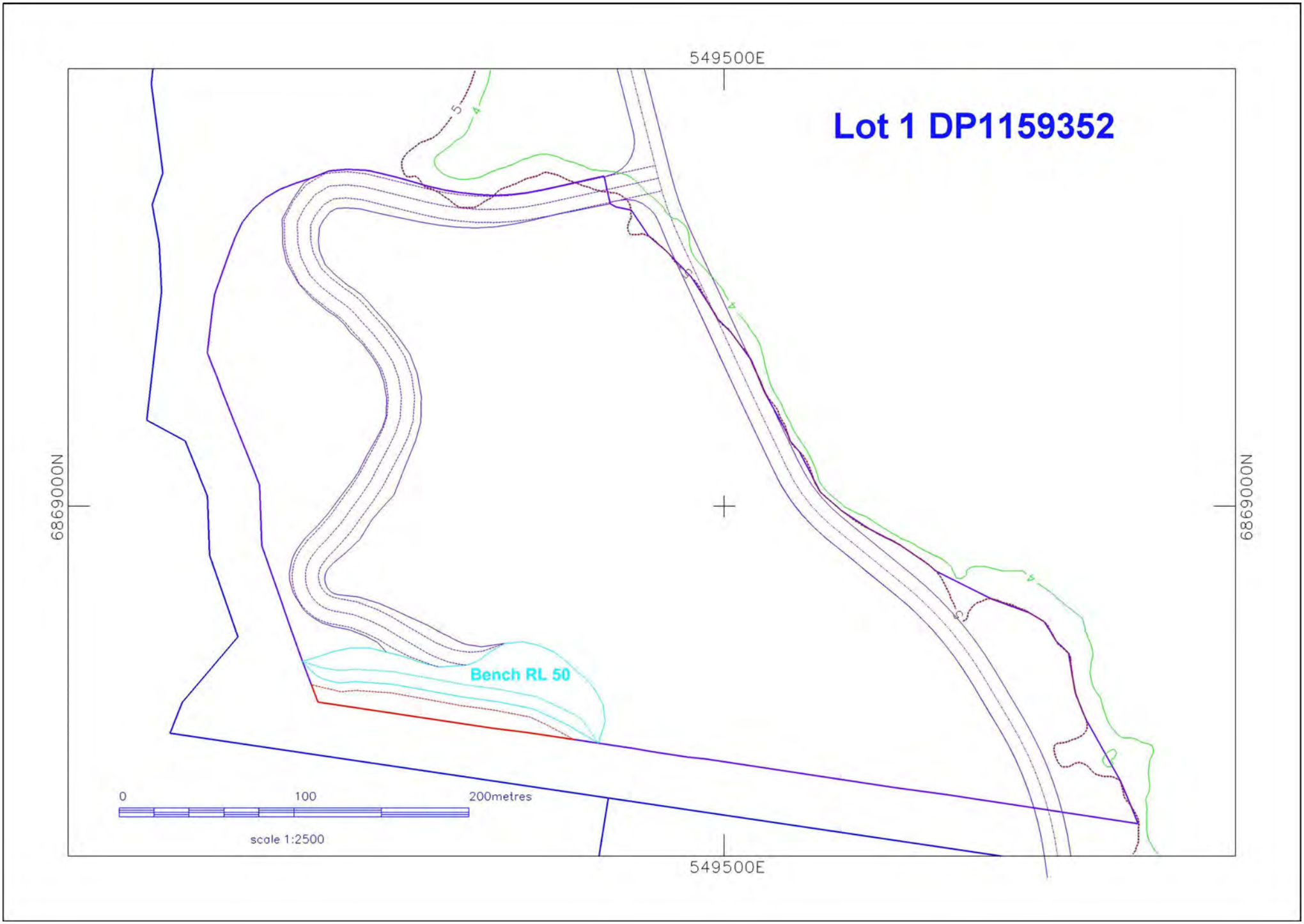

549500E
Lot 1 DP1159352
6869000N
Bench RL25
549500E

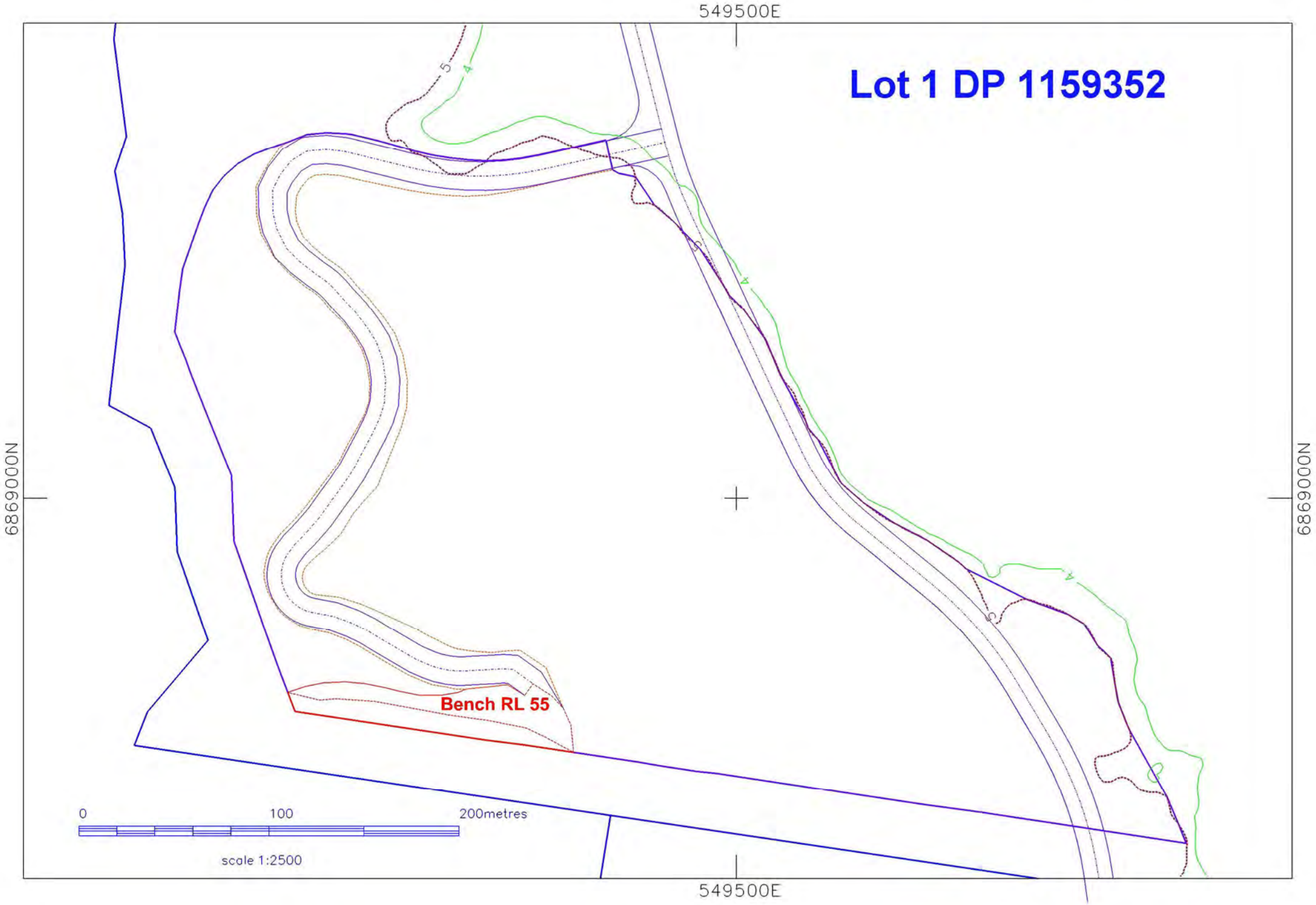

549500E
Lot 1 DP1159352
6869000N
6869000N
Bench RL30
0
100
200metres
scale 1:2500
549500E

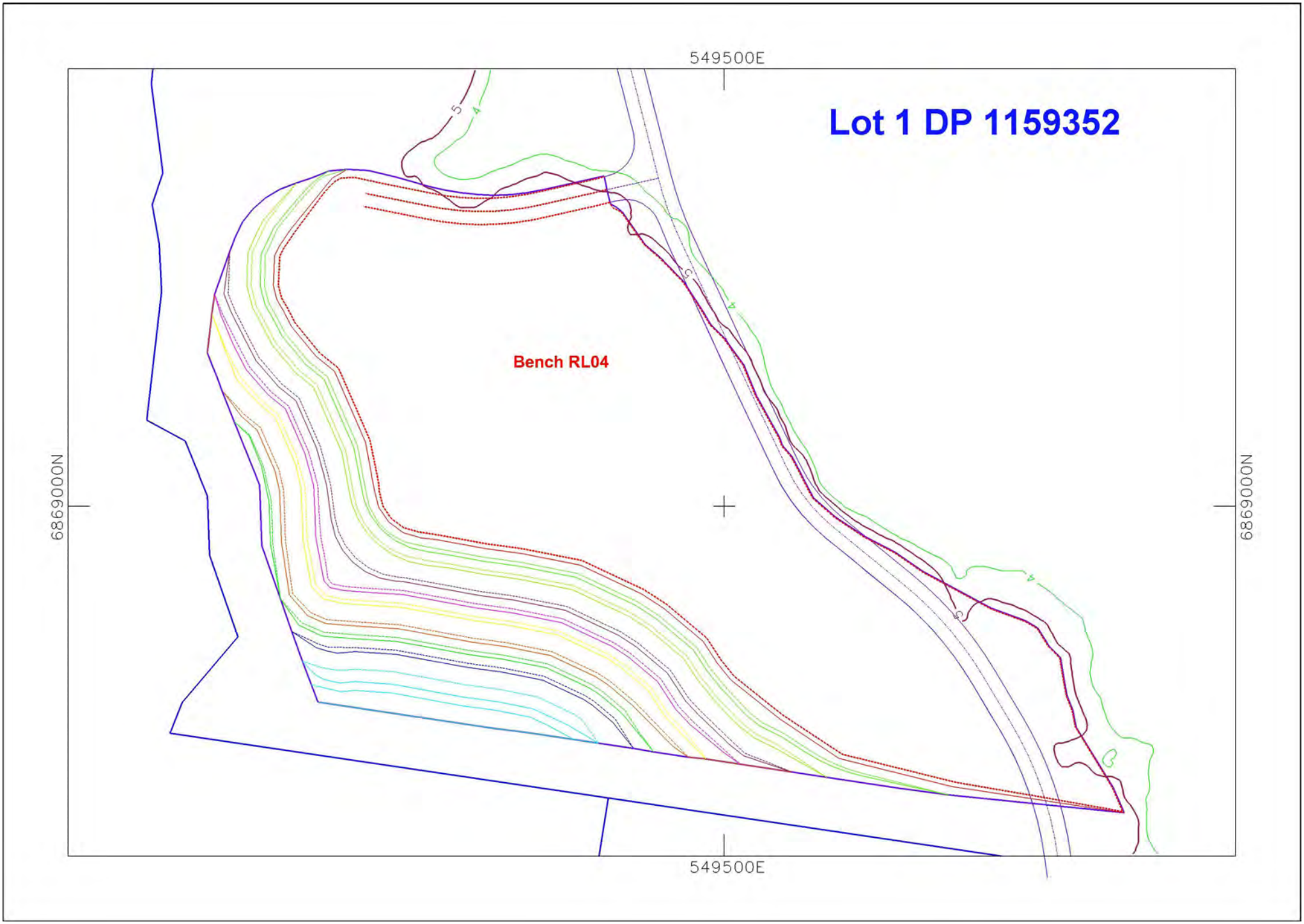

549500E
Lot 1 DP1159352
6869000N
6869000N
Bench RL35
0
100
200metres
scale 1:2500
549500E


549500E
Lot 1 DP1159352
6869000N
6869000N
Bench RL40
0
100
200metres
scale 1:2500
549500E


549500E
Lot 1 DP1159352
6869000N
6869000N
Bench RL45
0
100
200metres
scale 1:2500
549500E


549500E
Lot 1 DP1159352
6869000N
6869000N
Bench RL 50
0
100
200metres
scale 1:2500
549500E


549500E
Lot 1 DP 1159352
6869000N
6869000N
Bench RL 55
0
100
200metres
scale 1:2500
549500E


549500E
Lot 1 DP 1159352
Bench RL04
6869000N
6869000N
549500E

GHD

201 Charlotte Street Brisbane QLD 4000
GPO Box 668 Brisbane QLD 4001
T: (07) 3316 3000 F: (07) 3316 3333 E: bnemail@ghd.com.au

Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	L McAnally	D Holgate D Stolberg	Signed	A Marszalek	Signed	13/11/09
1	C Coles et al	I Reid A Marszalek	Signed	J Haines	Signed	18/1/11
2	M Gaughan	F Carrello	F. Carrello	F Carrello	F. Carrello	22/9/11