IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of Resource Consent Applications by Hydro Developments Ltd for the Stockton Plateau Hydro Scheme being:

RC08//149 - West Coast Regional Council &
RC08/131 – Buller District Council

Date: July 2009

STATEMENT OF EVIDENCE OF ANTHONY BLACK ON BEHALF OF HYDRO DEVELOPMENTS LTD

Hydro Developments Limited : Resource Management Act Consent Hearing

Evidence of Anthony Richard Black

Dated : July 2009-07

1. Preamble

My name is Anthony Richard Black. I am a resident of Charleston and have lived on the "Coast" some twenty years. I have formal qualifications in geology and geochemistry and have in excess of 25 years, post-graduate experience. I hold an "A" grade tunnel manager's ticket, unrestricted blasting tickets for surface and underground operations and professional indemnity and public liability insurance for the above. I am the principle of a specialist ground engineering company, called Geotech Limited (hereafter referred to as Geotech). Geotech has some 30 employees spread between underground and surface operations. Within the Geotech team is a core of very experienced men. We have developed, by drill and blast methods, an underground mine within the urban area of Reefton and I will expand on experience gained in this area later in this report. Geotech has worked at Stockton for nearly four years and has long-standing and extensive familiarity and knowledge of the mine and surrounding area.

2. Project History

My involvement in hydroelectric power (hereafter referred to as HEP) generation potential within the Buller stretches back to my arrival on the West Coast. The "Coast" has reasonably modest scale HEP potential, but gaining consents under the Conservation Act (1987) and the Resource Management Act (1991) is difficult.

The HEP potential of the Buller is well documented in a report prepared by Tonkin & Taylor Ltd (hereafter referred to as Tonkin & Taylor) in 1982 (report number 4264, phase II) entitled *Assessment of Local Hydro potential: Buller Region*. It was commissioned by the Buller Electric Power Board (hereafter referred to as BEPB). Interestingly, larger schemes were reserved for the Ministry of Works and Development. I have studied and evaluated most schemes in the report in some depth and have developed my own ranking of the developments in terms of their probable success.

In the mid 1990's, I was asked by Colin Reynolds, then CEO of the BEPB, to provide a geographic and geologic overview of the Mokihinui River to civil engineers from Downer Limited (hereafter referred to as Downer). Effectively, I sold to the engineers from Downer the concept of a large HEP scheme on the Ngakawau River which I considered had lesser geotechnical and consenting issues than those associated with the Mokihinui. The proposed Ngakawau scheme, with an extensive tunnel network, had potential in the order of 750MW installed capacity. As part of this larger scheme, a modification to a small scheme (identified by Tonkin & Taylor) on the Mangatini Stream was initiated. Both schemes were located within the proposed Ngakawau Ecological Area controlled by the Minister of Conservation. Ultimately, application was made to the Minister of Conservation for access to the proposed Ecological Area. Access was denied and a subsequent High Court challenge to gain access was lost.

During this process, local survey company Chris J Coll Surveying Limited (hereafter referred to as Chris J Coll Surveying) was employed by the BEPB to survey a change of boundary to the proposed Ngakawau Ecological Area. Ultimately, both BEPB and Downer lost interest in the area. However, Chris and Jan Coll (the owners of Chris J Coll Surveying) continued to pursue the boundary redefinition required for the modest Mangatini scheme.

Independent of efforts by the Colls to keep the Mangatini scheme alive, I became interested in the concept as I had been ranking the Tonkin & Taylor schemes in terms of probability of obtaining consent coupled with project economics. I considered the highly degraded Mangatini Stream as an ideal location for a HEP scheme.

Chris, Jan and I formed Hydro Developments Limited (hereafter referred to as HDL) in 1997 as a mechanism to pursue development of the Mangatini HEP scheme. Matt and Brian Kidson were later brought into the team to provide engineering experience and financial input. In 2003, the Minister of Conservation (under the Labour government) approved gazettal of the Ngakawau Ecologic Area with boundaries modified to enable development of the small HEP scheme on the Mangatini. This was most exciting.

In 2005, Geotech was awarded the contract to remove the western Stockton ridgeline for Solid Energy New Zealand (SENZ). The work-force assembled to work on this high profile, environmentally-sensitive project involved a large number of engineers. John Easther was one of these engineers. After project managing the early ridgeline project, SENZ appointed John to manage the Cypress, Millerton and Number Two Push Back projects. John has an extensive knowledge of Stockton Plateau water management issues. As my acquaintance with John developed, it became evident that he had skills that were needed by HDL. John joined HDL and developed the “whole-of-catchment-rehabilitation” concept, which is the scheme we are presenting today.

The scheme HDL proposes to develop is a modern triple-bottom-line project embracing environmental, community and profit considerations. This is why the scheme has received endorsement from Labour, National, the Greens as well as Forest & Bird, Federated Mountain Clubs, the West Coast Conservation Board and a considerable number of other groups and individuals interested in local environmental and community concerns. Throughout the development of the project, the Department of Conservation (DoC) has also supported the “whole-of-catchment-rehabilitation” concept.

3. Acid Mine Drainage (AMD) Formation

During sediment deposition in the sea, sulphur is reduced from aqueous sulphate to form the iron sulphide mineral pyrite. Once uplifted/exhumed from the seabed by tectonic lift and exposure to oxygen (generally dissolved in descending rain water), pyrite breaks down to form various iron oxides (seen as the staining on **Exhibit 1**). The liberated sulphur effectively forms sulphuric acid. This is a natural process.

Mining rapidly shatters the pyritic rock mass and produces an order of magnitude increase in the reaction interface available which causes a corresponding jump in acid production. This process is called Acid Mine Drainage (AMD). In warm, high rainfall areas, the effects of AMD last in excess of one hundred years. In colder and arid climates, AMD lasts longer due to slowed reaction kinetics.

4. Project Design

HDL's scheme consists of a number of lakes and fluid conduits designed to capture the AMD waters of the Stockton Plateau and harness their energy for HEP generation. This water capture removes degraded watercourses from an otherwise typical West Coast river. The scheme has been engineered around and complements the physical environment by the choice of optimum geotechnical sites, prudent design and utilisation of the vast knowledge base that already exists regarding Stockton.

Exhibit 1 is a piece of Brunner Coal Measures (BCMs) muddy sandstone unit from a previously abandoned state coal mine "orphan" site in the New Mine/Fly Creek area (see **Figure 1**). Note that the fracture surfaces are "painted" with red, green and yellow iron oxides which are strong, visible evidence of iron oxidation. This will have been viewed on the site visit. This site is one of the many "orphan" sites that will be addressed by the project.

Figure 1. Past mining by State Coal at the New Mine/Fly Creek "orphan site" has led to subsidence which has generated intense AMD. The AMD is degrading St Patrick Stream and, ultimately, the Ngakawau River. This AMD would be captured by HDL (Photo supplied by HDL).

AMD destroys the terrestrial aquatic environment and leaches heavy metals from rocks, thus further polluting the environment (Sengupta, 1993). Typically, AMD affected streams are very clear. Surplus positively charged hydronium ions react with negatively charged clays, forming coagulated clays that gravity-settle. Normally, clays below 2 microns remain in perpetual suspension due to Brownian motion caused by like negatively charged particles repelling one another. In low-flow conditions, clear streams would be evident on visiting the site. With elevated flows, sediment loss from the mine overwhelms the process described above.

The large retention ponds incorporated into the project design will reduce sediment loss into the larger environment, but strong action at the source is required. Once installed, HDL's project will still require good mining practice within SENZ's coal mining licence area. The present high-end commitment to good mining practice will need to be practised by the workforce, who may see the scheme as able to cope with poor or lazy mining practice. The upside is that future mine design and mining methods can increase scheme output through water retention and diversion.

5. Regional Geology

Geological maps map the age of rocks. **Figure 2** is a geological map showing the geology of the Buller Coalfield. In the project area, the deepest and oldest rocks are Karamea batholith and derivatives, then BCMs and then the younger Kaiata mudstones.

The dominant lithology is basement Karamea batholith (red stippled unit “k”) which is overlaid by BCMs (olive green unit “br”), which are in turn overlaid by Kaiata mudstone (light brown coloured unit “rk”). Some form of the Karamea granite batholith underlies the entire project area.

Although BCMs occupy a large footprint area, they are a thin, essentially surficial unit some 40-60 metres thick in the west and 15-30m thick in the east (Sherwood and Baillie, 1982). Thus, tunnels do not have to be deep to travel in the basement granite under the BCMs.

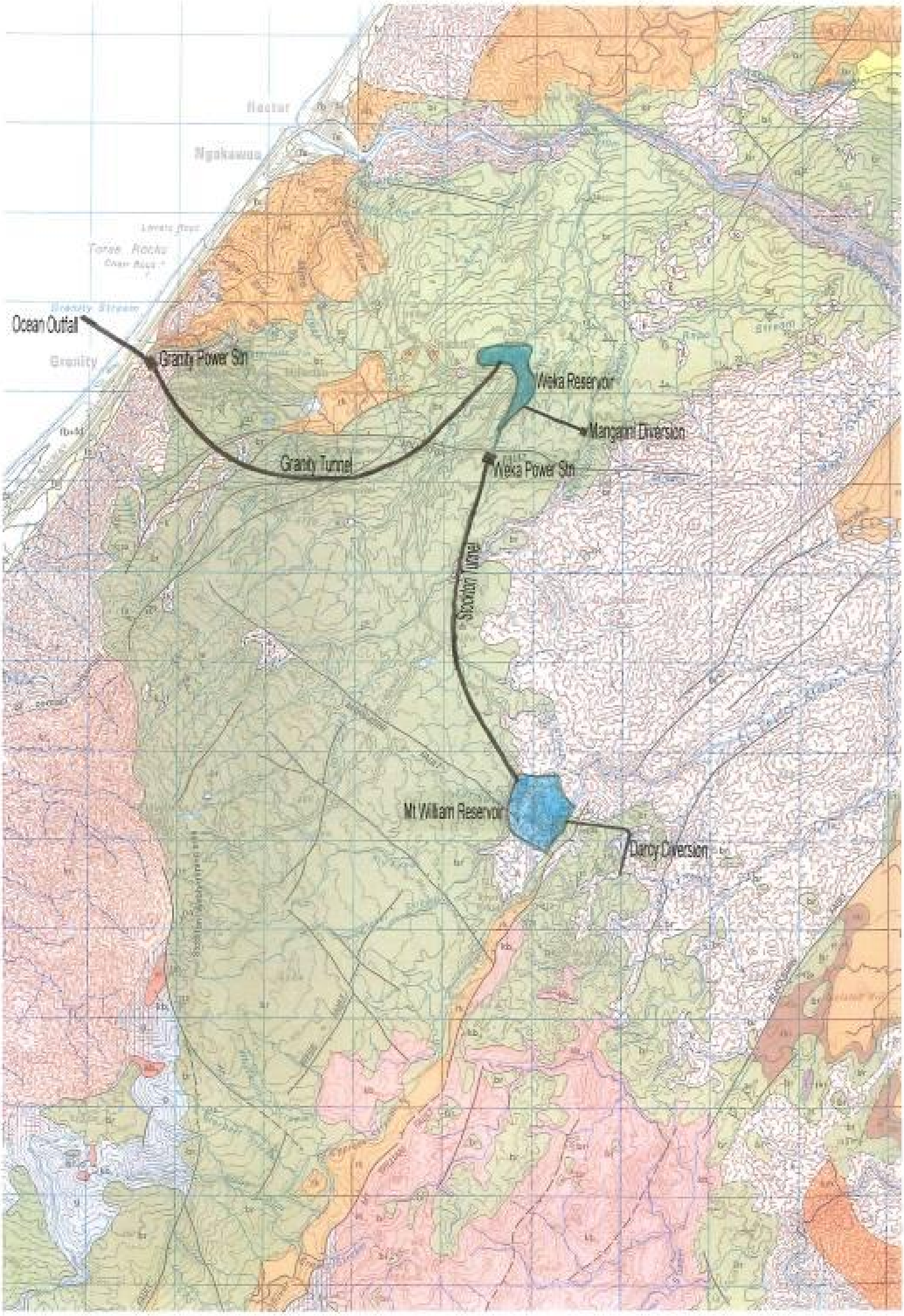

Figure 2. Institute of Geological & Nuclear Sciences geological map of regional geology and key infrastructural elements (Nathan, 1996).

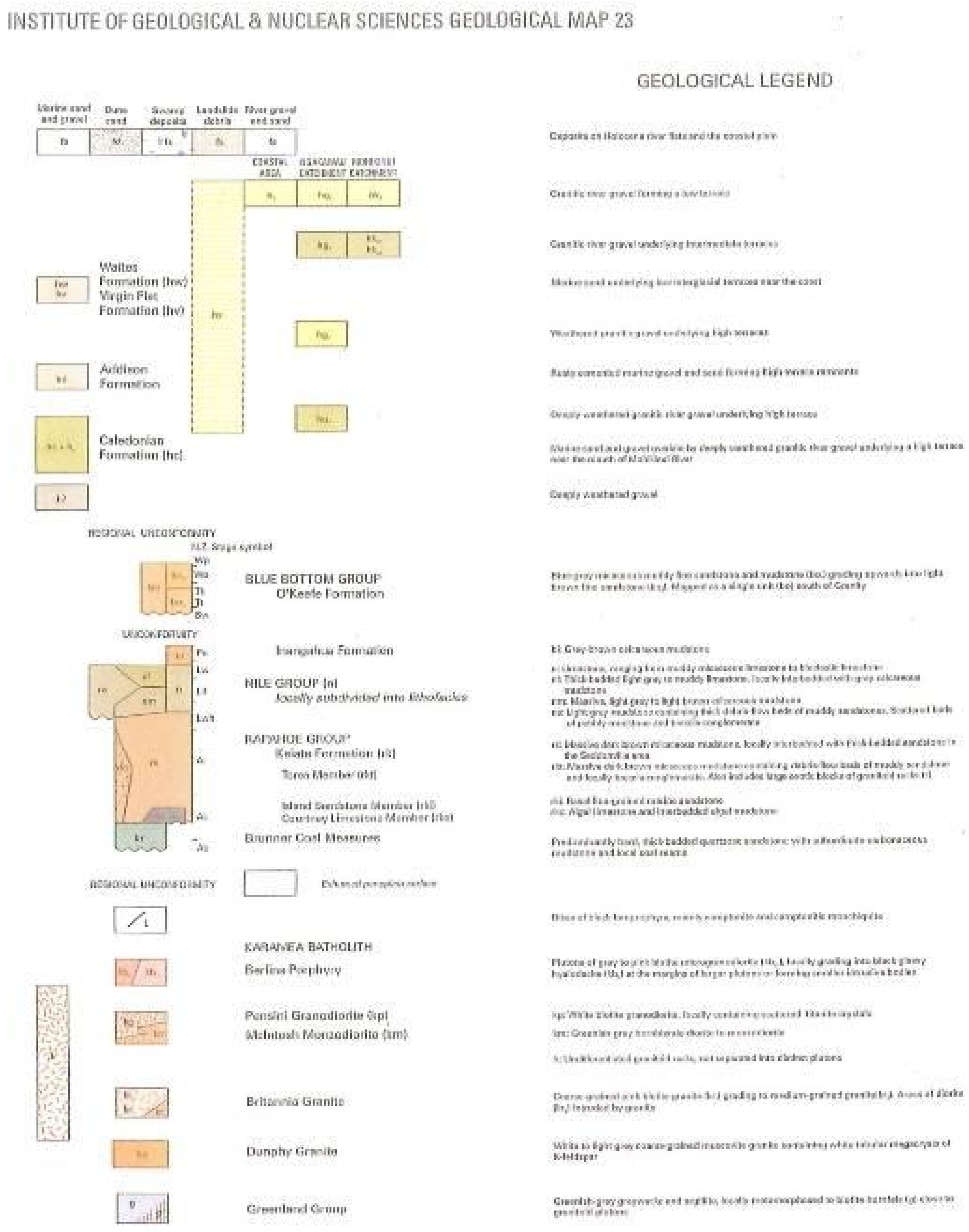

Figure 3. Key to Institute of Geological & Nuclear Sciences geological map of regional geology and key infrastructural elements (Nathan, 1996).

6. Geotechnical Requirements

The economic importance of world class coking coal on the Stockton Plateau has led to over 3500 exploration diamond drill holes having been drilled. Consequently, the geology of the BCMs and the underlying basement lithologies are well understood.

However, prudence dictates geotechnical drilling of key infrastructural sites and a small seismic/ground penetrating radar survey along the coastal micro-tunnelling route. All key sites are located in basement granite which offers excellent engineering properties provided it has not suffered acid attack, weathering or structural degradation from tectonics (see **Exhibit 2** which is fresh granite from the Stockton Plateau). There is a range of granites that will be encountered. The granite exhibits have a strong, sound rock mass rating but are variable. The exhibited samples were taken from the floor of the historic Millerton incline tunnel. They are rounded from floor water abrasion but show no signs of AMD degradation. This tunnel is of approximately 2m x 2.5m sectional area and is unsupported, although surface related defects are present.

Proposed drilling will specify diamond coring of HQ diameter (96mm), or better, to provide an accurate understanding of rock mass ratings (RMR) and rock quality designations (RQD). Localised, open-hole, rotary, percussive drilling will be employed to determine granite quarry boundaries.

Although HDL's project is "green fields" in terms of hydroelectric potential from Stockton Plateau, extensive geologic mapping, drilling and literature are publicly available. In addition, Geotech has first-hand operational experience both above and below ground in the project area, having worked in basement water tunnels under Millerton. This knowledge and site experience has been employed to minimise any geotechnical risk associated with the project.

7. Key Infrastructural Elements

From the project headwaters to the marine discharge, the key elements of the scheme are:

- Darcy diversion tunnel;
- St Patrick Stream dam and saddle dams forming the Mt William Reservoir;
- Stockton tunnel from the Mt William Reservoir to the Weka Reservoir and powerhouse two;
- Mangatini to the Weka Reservoir diversion conduit;

- Weka dam and saddle dams forming the Weka Reservoir;
- Mine Creek diversion tunnel;
- Granity tunnel from the Weka Reservoir to powerhouse one;
- Marine outfall.

7.1 Darcy Diversion Tunnel

This tunnel will be driven at minimal cross-sectional dimension. The tunnel will be driven west to east with the portal collared in a thin veneer of BCMs and will rapidly pass through the Mt William fault into clean granite. The Mt William fault has a throw of 100m to 120m, dips east and has an associated 20 to 50m wide tectonised fault zone (Barry and MacFarlane, 1980). Recent diamond drilling (in 2008) proximal to the portal site has been conducted by SENZ and sufficient data is available for design purposes.

7.2 Mt William Reservoir/Dams

Drilling, and ultimately pitting, will be required to confirm site-specific geologic observations of Coulter and McMoran (2007). Diamond drilling will concentrate on confirming there are no underlying structural defects in the basement granite. The main dam mass is keyed directly into basement granite. Wing walls/saddle dams are required. These low dams will be keyed into BCMs. Diamond drilling will be required to confirm the quality of the BCMs/basement interface. Acid rock drainage and weathering could weaken this interface by forming clay alteration of feldspar in the granite.

This reservoir will contain some 7 million cubic metres of water behind roller compacted concrete (RCC) dams made from local basement granite (McMoran et al., 2008). Approximately 250,000 cubic metres of RCC will be required. This material will be quarried by drill, blast and crush methods within the reservoir footprint. Open-hole drilling will be employed to ensure quarrying of fresh, competent granite. Size analysis and testing of the crushed product will be required to confirm design requirements can be met. Product fining could be achieved by crushing BCMs quartz sandstone, if required.

7.3 Stockton Tunnel

This tunnel will be collared in granite but, as it moves west, will enter basal BCMs. The

BCMs/granite interface will require definition by diamond drilling. Extensive drilling along the route has been undertaken for coal, so only infill drilling will be required. Historic high level tunnels are present along some of the route and have stood the test of time without ground support. Mapping of these tunnels will add structural data. This tunnel will not encounter the main structural features of Stockton (see **Figure 4**). The tunnel would “daylight” in the prominent, up-thrust scarp formed by the Millerton fault. The actual, axial trace of this fault is north of the tunnel portal and erosion has cleaned off the scarp back to competent rock. South of the scarp (and potentially in BCMs) will be the number two powerhouse. The powerhouse area will require diamond drilling to confirm structure and lithology.

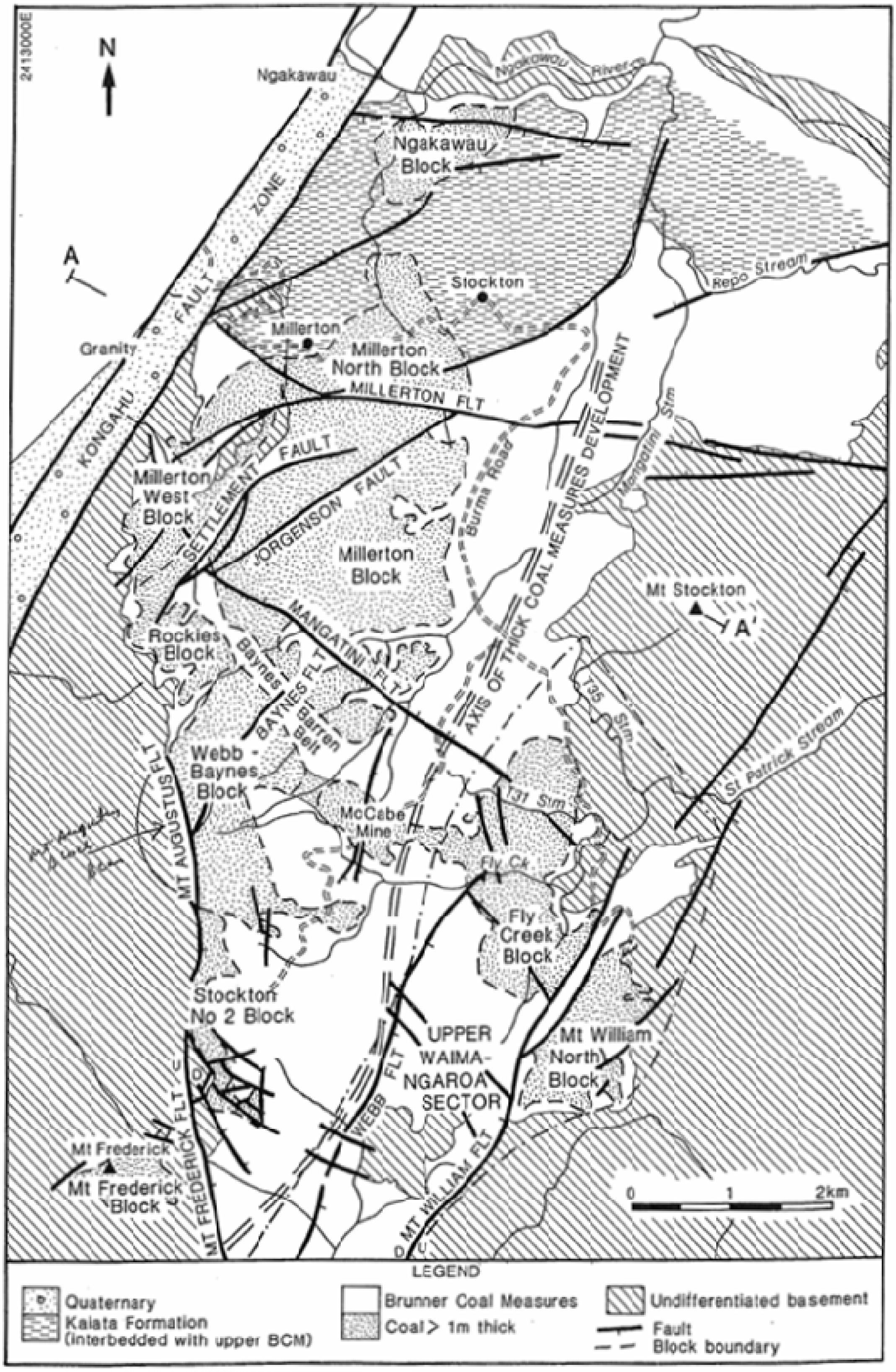

Figure 4. Coal resource geology and estimate area (Todd, 1989).

7.4 Mangatini to the Weka Reservoir Conduit

Water will be channeled via a tunnel into the Weka reservoir. It is possible that the outlet section of the tunnel will need to be replaced with a short section of open channel conduit. It is not possible to tunnel without sufficient surface cover (as a rule of thumb, this figure is approximately 2.5 times the tunnel height). In this event, a trapezoidal section will be formed with the walls formed by precision, smooth-wall blasting.

As the Mangatini gorge is steep-sided, a low weir will be required to divert flow into the tunnel. Although this infrastructure will be in BCMs, the unit is competent, with well defined bedding. Tunnel overpressure will be very modest (less than 1 mpa) but, due to potential for bedding plane failures, roof support will be required. Systematic roof bolting will be employed.

In both the tunnel and canal, smooth-wall blasting will be required as the BCMs are very vulnerable to blast gas overpressure causing damage along bedding planes and joints. In addition to smooth-wall blasting, burden relief of 15 msec/m will reduce blast damage considerably. This order of timing will be employed in engineering blasts.

7.5 Weka Reservoir/Dams

The Weka reservoir will hold some 3.5 million cubic metres of water behind RCC dams. Material (granite) for these structures will be quarried in the reservoir floor and northern wall. This granite is not mapped on the GNS map series due to its small area, but was identified by first pass geologic mapping undertaken by HDL. The main dam is located in granite while saddle dams will be keyed into BCMs overlying granite. Coring will be required to confirm the Weka gorge dam foundation integrity. Saddle dams will require the BCMs/basement granite contact to be investigated for acid attack and shearing on the contact. The above holes will be in the order of 25 to 50 metres deep.

A diamond drill hole approximately 200m deep and collared in granite will be required. This hole will reveal the raised boring/shaft sinking conditions in the drop shaft that will form the pressurised outlet. Drilled accurately, this hole could be the pilot hole for raise boring/shaft sinking.

7.6 Mine Creek Diversion Tunnel

A small tunnel, nominally 3m wide and 3.5m high, will be driven from Sandy Creek into the headwaters of the historically degraded Mine Creek. Due to the small drivage distances involved and small water flows, a sectional area as low as 2m x 2.5m is possible. This tunnel will be in quartz rich BCMs sandstones. These sandstones will be crushed to provide fines in the RCC dams. With a small cross sectional area and only 1.5 mpa overpressure, no geotechnical difficulties are envisaged.

7.7 Granity Tunnel

This tunnel will be driven in basement granite, well below the BCMs (see **Figure 5**). Granite has historically performed well under drivage. Tunnels of similar dimension to that proposed have stood the test of time at Stockton. Several kilometres of unsupported granite tunnels in excess of one hundred years old are present below the Stockton Plateau.

Minimising exposure to major structural features such as the Millerton fault, Jorgensen fault and the Settlement fault will require good surface mapping and, possibly, some angled drilling. Project planning is based on hitting perpendicular to the fault direction, thus minimising difficult drivage that would involve acid resistant ground support methods and products.

Although long, tight drivage in competent granite with only 10.6 mpa overpressure is not difficult, issues such as ventilation, mucking and reticulation of services will be rate determining issues, not ground support. Drop shafts from the surface offer the opportunity to ease ventilation issues and ultimately tap degraded surface waters from Granity and Miller Creek. Light lining of these shafts would be required in the upper BCMs. It is unlikely the basal granite would require any ground support, although plastic lining has been budgeted for.

The Granity portal will be collared south and on the up-thrown side of the "Granity Creek fault" as mapped by Laird and Hope (see **Figure 6**). By staying south of this fault, the portal will avoid Kaiata mudstone and Torea Breccia.

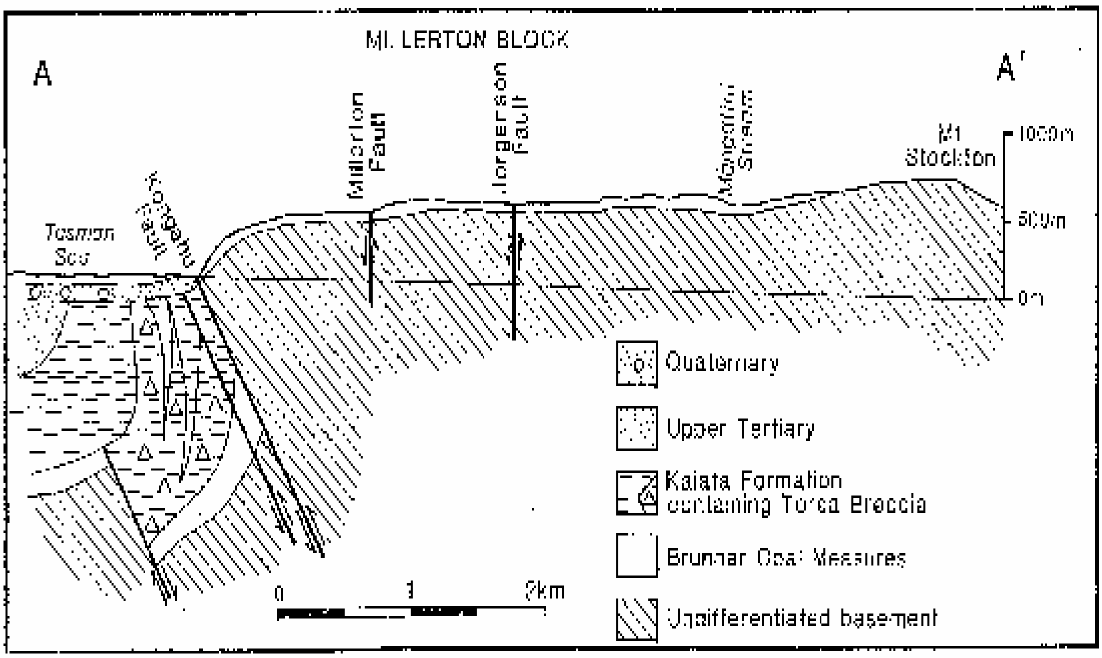

Fig. 6: Schematic cross section of the Stockton Sector (after Laird and Hope, 1968).

Figure 5. Schematic cross section of the Stockton sector produced after Laird and Hope (Barry and MacFarlane, 1988).

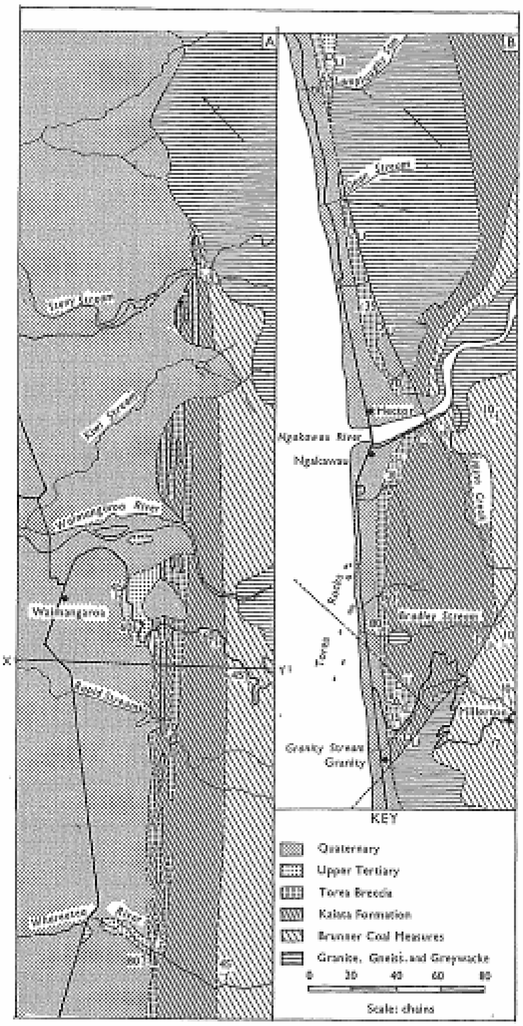

Figure 6. Torea Breccia and Papahaua Overfold (Laird and Hope, 1968).

Technically, portal establishment and drivage to sound outcrop in “living” granite basement are considered among the most difficult aspects of the project. Despite considerable surface exploration, we have been unable to find outcrop near or about the preferred portal site. It is probable that “spilling” (a tunneling method for driving through ground that is so weak that it is not free standing after excavation) through fresh, angular granite talus will be required. Horizontal diamond drilling will be employed to determine lengths and likely block sizes. A further complicating factor is the need for a minimal footprint at and about the portal. Ground stabilisation using grouted tendons and bars has been budgeted for in addition to full concrete lining until fresh competent granite is encountered.

7.8 Marine Outfall

Excellent mapping by Laird and Hope (1968) has given a high level of confidence that micro-tunnelling along the proposed route will not hit difficulties such as the Torea Rocks. Localised talus and slope debris from the escarpment may require movement of the primary jacking pit to the west.

Slight orientation changes may be required to the pipeline route if ground penetrating radar and shallow seismic surveying finds the presence of Torea Breccia or random rock floaters. Test pitting and geophysical survey will confirm exact route orientation. Ground mapping and literature research to date indicates high-energy, Quaternary marine sands and gravels.

The proposed micro-tunnel will be buried within surficial marine sediments and historic beaches. Drilling for a proposed deep water jetty further south indicated that there will be no lithological problems. Marine surveying (undertaken by registered surveyor Chris Coll) of approximately 1 square kilometre centred around the HDL proposed discharge point, identified a sandy bottom and a regular 1-in-10 gradient seawards. No rocks were identified. The bathymetry is consistent with that of the drilled jetty site further south.

8. Construction Experience

In 2001, Geotech won the contract to develop the Terrace Coal Mine in Reefton. Prior to this development, the mine was a 5000 tpa, traditional, five-man operation. Development of the Terrace Mine involved driving 230 metres (with a sectional area of 3.2m x 2.5m) by drill and blast to intersect old workings. Once in the old mine, several kilometres of drives were established within the coal measures. All spoil and coal was trucked through residential Reefton. It is important to note that the yearly trucking volumes from the Terrace Mine exceeded the total volume proposed to be trucked by HDL out of Granity (refer to SENZ's public production figures).

Geotech was the first crew to use load haul dumps (LHDs), i.e. free steer loaders, not a rail system and systematic rock bolting and shotcrete for ground support in the Reefton Coal field. The tools and equipment sizes that were used are the same that are required for the HDL project at Granity. This was achieved immediately adjacent to residential Reefton. At project inception, there were no bunds or visual barriers between the mining operation and houses on two of the boundaries of the mine site. Over time, an earth bund was built and vegetated. This investment was successful in creating an attractive visual barrier to the stark, industrial area.

We learnt a great deal from this project that will stand us in good stead for the project being discussed today. Initially, project commencement at Terrace Mine operated on one shift per day, six days per week and during normal working hours. Blasting was vibration controlled by design along with a rigorous blast sign-off protocol. A very similar approach will be employed by HDL. There were no vibration or noise issues but local miner and “Wag” Garth Reeves caused concern by telling adjacent property owners that Geotech was heading under their homes and that mine subsidence would “get them”. This obviously caused them concern. However, fears were allayed by an underground trip by all concerned. This trip and subsequent site visits established good relations with neighbours.

Once in coal, SENZ escalated the operation, increasing to two shifts per day. Night shift caused noise and light problems that resulted in complaints. Both issues were readily resolved. LHDs were fueled and taken underground at the end of day shift and remained underground all night. Stone bays were constructed underground that held the nightly production. With the LHDs staying underground, the extensive surface lighting was no longer needed.

Trucking from the site (at the rate of some 80,000 cubic metres per year) on narrow Reefton streets caused some initial concern among residents, particularly as regards traffic frequency and vibration issues. These initial concerns never became an issue but loss of coal onto the roads did. The hauling trucks frequently left the mine site with wet, coal-covered tyres and this coal was then deposited on the streets of Reefton. These coal fines were subsequently ground down by traffic, ultimately dried and turned to nuisance dust. This was a real problem and was resolved by the use of an effective truck wheel wash (that cleaned fugitive coal from the truck tyres), yard cleanliness and sprinklers. The mine site also had a large yard that in fine weather could generate fugitive dust. A good sprinkler system eliminated this problem.

From my experience, good early site planning and communication with potentially affected parties is a sound investment. This philosophy will be integral to HDL's operations.

9. Project Benefits

The benefits from HDL’s proposal are strong and multi-faceted. Good environmental outcomes are a cornerstone of “clean green” New Zealand. Project developers will see that, through “green projects”, they can enjoy good and mutually beneficial relationships with organizations with whom they are normally adversarial. Difficult and slow consenting is a major impediment to project development in New Zealand. If environmentally “modern” triple-bottom-line schemes have an easier and rapid consenting path, investment money will be channeled their way.

Locally generated, sustainable power is a good infrastructural development. It assists with under-pinning the local economy and retaining regional competitiveness into the future. On the West

Coast, reliable, economic power is needed for important and developing industries such as farming and tourism and is essential to manufacturing industries such as cement production or other, new alternatives.

Project construction will occur in a time of softness in the local economy. This is a short term benefit and will sustain the economy until farming and tourism are back on a strong footing. As a local employer, I expect Geotech to grow and provide strong employment and economic benefits to the Buller region. Other local companies will also benefit from the project and be in a strong position to be involved in future, local enterprise.

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