

EL13/2019 Tribute Exploration Licence— Final Report

6 April 2021 – 22 November 2022

Joe Booth
Hydro Tasmania
4 Elizabeth St
Hobart TAS 7000

31 July 2023

Hydro Tasmania document control

Title		Version:	V1.1
EL13/2019 Tribute Exploration Licence— Final Report		Document owner:	Joe Booth
		Date created:	July 2023
Reviewed:	Matt Ferguson	Date approved:	16/08/2023
Approved:	Joe Booth	Signed:	Signed electronically

Contents

1.0	Executive Summary	4
2.0	Summary Activity Map	5
3.0	Introduction	7
4.0	Review of previous work	8
5.0	Exploration completed during the reporting period	15
6.0	Discussion of Results	17
7.0	Conclusions	20
8.0	Future exploration	21
9.0	Environmental Management	22
10.0	Expenditure	23
11.0	References	24
12.0	Appendices	25
12.1	Appendix 1 - Borehole logs	25
12.2	Appendix 2 - Borehole photographs	25
12.3	Appendix 3 - Environmental Impact Assessment	25

List of Figures

Figure 2.1: Location of EL13/2019, near Lake Murchison	5
Figure 2.2: Location of recent investigations conducted within EL13/2019.	6
Figure 4.1: Geological map of the area between Lake Plimsoll and Lake Murchison	9
Figure 4.2: Factual surface geological map of the Quinn Creek tunnel diversion area	12
Figure 4.3: Existing Tribute power tunnel (purple) and location of boreholes (green dot) in area of Quinn Creek diversion overlain on geological map	13
Figure 4.4: Tertiary valley model for the Quinn Creek tunnel deviation area	13
Figure 4.5: Interpretive cross section of the Quinn Creek tunnel diversion area showing the Tertiary valley model	14
Figure 4.6: Alternative structural interpretation for the Quinn Creek tunnel deviation area	14
Figure 5.1: Location of Tribute exploration sites	16
Figure 6.1: Draft Interpretive cross-section showing proposed drill hole traces (TR-BH02A and TR-BH02B) onto interpreted Quinn Creek Fault location	18

List of Tables

Table 4.1: Geological history of the Tribute area summarised from Corbett et al. (2014).	11
Table 5.1: Recent Hydro Tasmania Investigations	15
Table 6.1 Borehole TR-BH02A and TR-BH02B Summary rock logs	19

1.0 Executive Summary

Hydro Tasmania is currently investigating the development of a pumped hydro energy storage (PHES) in Tasmania as part of the Battery of the Nation initiative. Currently, feasibility studies are being undertaken at three sites to assess their suitability for the development of a PHES. Lake Cethana, Lake Rowallan and between Lake Murchison and Lake Plimsoll have all been identified as suitable sites. A critical component of the feasibility study is determining the geology and geotechnical properties at key locations across the project footprint and to identify adequate quantities of suitable construction materials including aggregate for concrete production, earth and rock fill for dam construction and sub-surface ground conditions for construction of shafts, tunnels and an underground power station. Category 3 (Construction Materials) Exploration Licences were sought to cover the respective project footprints.

Geological mapping, drilling and test pitting investigations were planned to inform the development of a geological model to allow progression of engineering designs for the general arrangement of the scheme. A total of 4 boreholes totalling 1,028.1m, were completed within the lease area.

Investigations undertaken at the Tribute PHES site have provided sufficient information to inform an adequate understanding of the geology of the area between Lake Plimsoll and Lake Murchison, however Cethana PHES was selected as the preferred project to progress to final feasibility. Deep storage capacity, greater cost and technical certainty, environmental and social sustainability and flexibility in sizing and capacity make Cethana the preferred option to take to final feasibility.

Investigations and interpretation conducted at Tribute as part of the Battery of the Nation PHES Study were not exhaustive and this site still retains the potential to develop a PHES in the future, however limited further work was planned whilst the Cethana PHES project is being prioritised and Hydro Tasmania decided to relinquish the lease.

This report aims to meet Hydro Tasmania's reporting obligations in relation to the issuing of Exploration Licence EL13/2019, in the vicinity of Lake Murchison for the final period 6 April 2021 to 22 November 2022.

2.0 Summary Activity Map

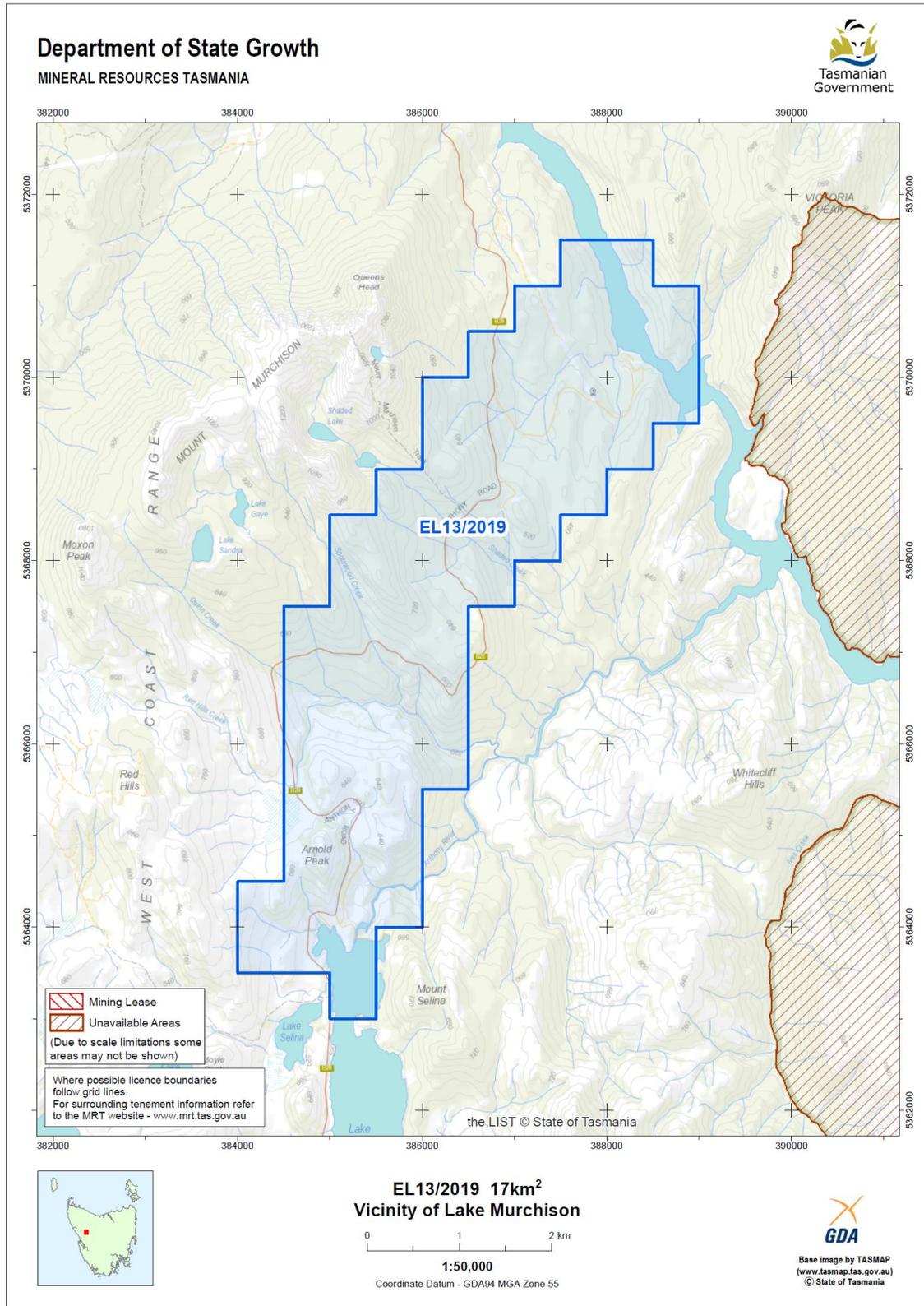


Figure 2.1: Location of EL13/2019, near Lake Murchison

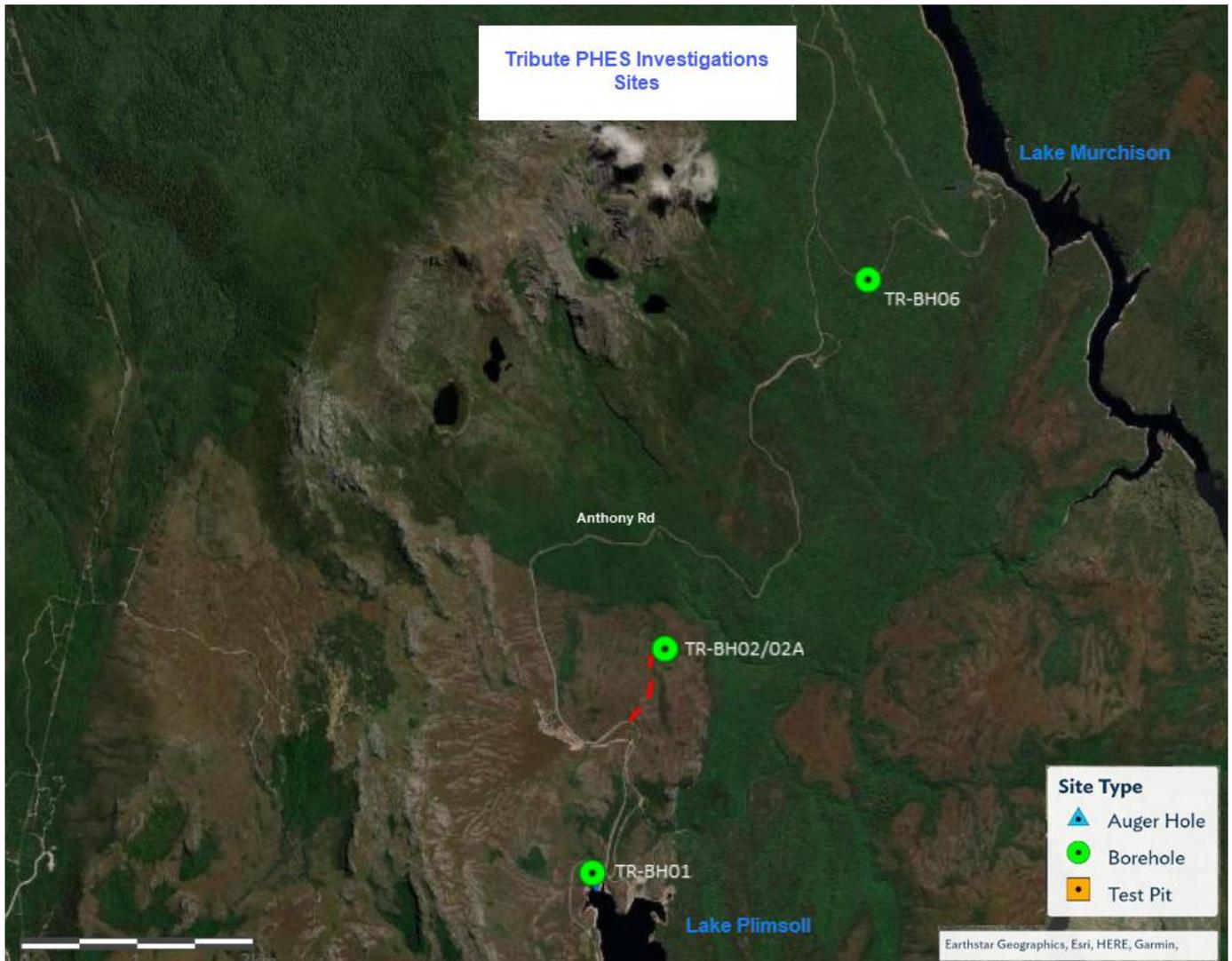


Figure 2.2: Location of recent investigations conducted within EL13/2019.

3.0 Introduction

Hydro Tasmania is currently investigating the development of a pumped hydro energy storage (PHES) in Tasmania as part of the Battery of the Nation initiative. Currently, feasibility studies are being undertaken at three sites to assess their suitability for the development of a PHES. Lake Cethana, Lake Rowallan, Lake Murchison and Lake Plimsoll have all been identified as suitable sites. A critical component of the feasibility study is the undertaking of investigations to determine geotechnical and geological conditions for construction of key components of the PHES. As well as identifying adequate quantities of suitable construction materials including aggregate for concrete production, earth and rock fill for dam construction and sub-surface ground conditions for construction of shafts, tunnels and an underground power station.

This report forms the final report to meet Hydro Tasmania's reporting obligations in relation to Licence number 13/2019, in the vicinity of Lake Murchison for the period 6 April 2021 to 22 November 2022.

4.0 Review of previous work

Work conducted in relation to the Tribute PHES began with a scoping study and shortlisting of 14 potential PHES sites around Tasmania. A Pre-Feasibility Study of the Tribute PHES was completed in early 2019 and followed into Feasibility Study in July 2019. Investigations as part of the Feasibility Study commenced in March 2020, prior to the granting of EL13/2019 and continued into the report period.

Previous work includes detailed desk-top analysis of existing geological data as well as geological mapping diamond drilling completed up until the granting of EL13/2019.

Geological mapping of the area between Lake Plimsoll and Lake Murchison comes from Mineral Resources Tasmania (MRT) 1:25,000 geological maps of Selina and Tullah. A geological map of the Tribute PHES area is shown in Figure 4.1.

The Lake Plimsoll reservoir and existing Tribute power tunnel and power station are sited on the eastern side of the far northern portion of the West Coast Range, with the majority of the scheme bound to the north and south by Mount Murchison and Mount Julia, respectively. The Tribute scheme utilises the tributaries to the northeast flowing Anthony River, and also captures runoff from large parts of the western side of the Mount Julia-Mount Murchison area via diversion of the upper reaches of the Henty and Langdon Rivers eastwards into the Anthony catchment. The proposed Tribute Pumped Hydro Energy Storage system follows the alignment of the existing Tribute power tunnel.

The Mount Julia-Mount Murchison area immediately above and to the west of the Tribute power tunnel are principally comprised of Cambrian Owen Group sandstones and conglomerates. The Anthony River valley cuts into Cambrian Mount Read Volcanics sedimentary, volcanic and intrusive rocks, and the low relief area to the east of Mount Murchison comprises the Cambrian Murchison Granite. Proterozoic metasedimentary rocks also occur in the lower reaches and to the east of the Anthony River, but the scheme's alignment does not traverse these rocks.

Pleistocene glaciations modified the mountains and formed blankets of boulder-gravel-sand deposits throughout the area.

Thick forest is developed in the Anthony River valley where underlain by Cambrian Mount Read Volcanics, above the power station area on the Cambrian Murchison Granite, and in some glacial deposits on the eastern flank of the Mount Julia-Mount Murchison area. Elsewhere dense alpine grass and shrub growth results in a highly irregular and difficult to traverse surface; there is minimal area clear of vegetation in the scheme area.

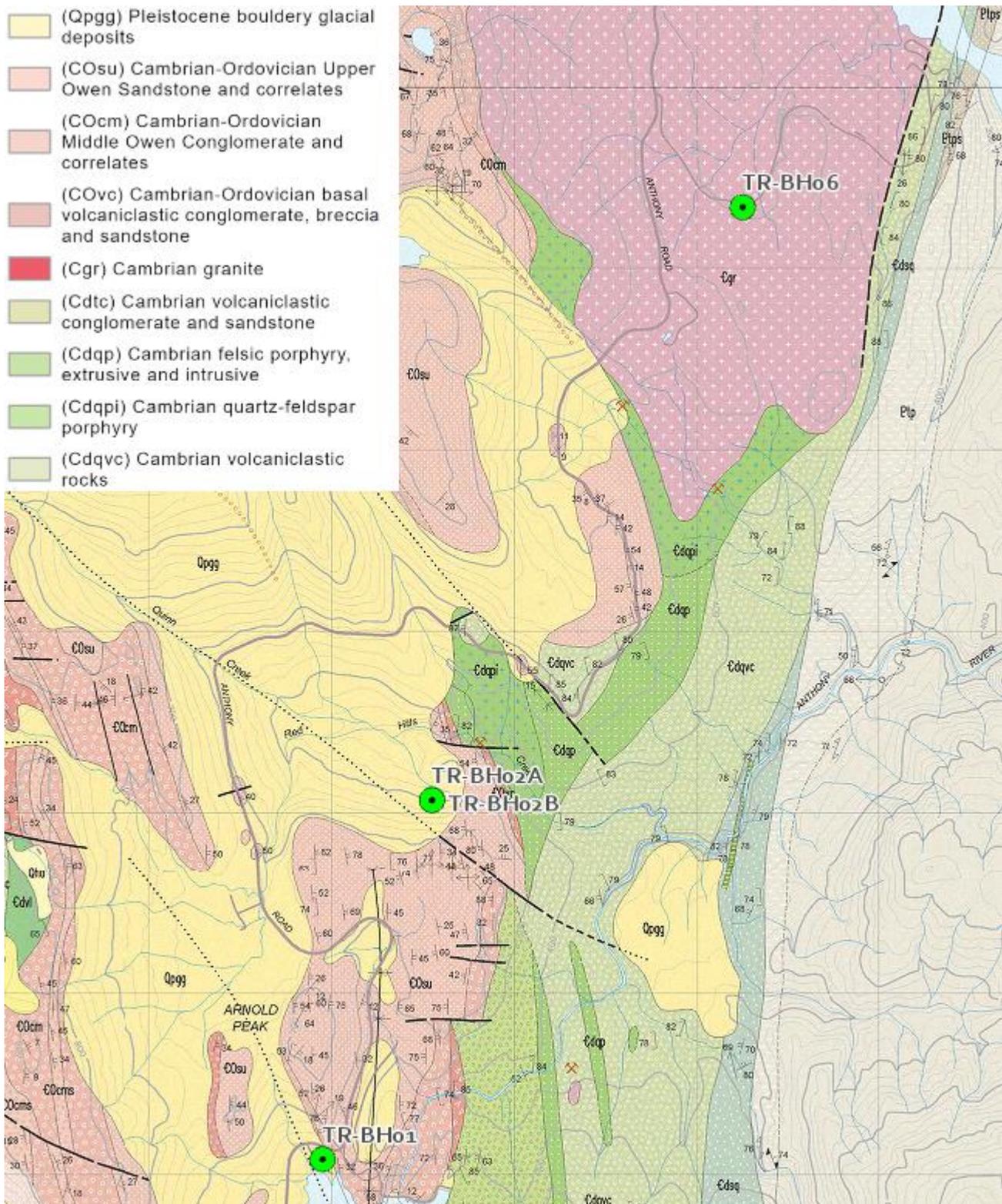


Figure 4.1: Geological map of the area between Lake Plimsoll and Lake Murchison (MRT 1:25,000)

Table 4.1 below summarises the geological history and general stratigraphy around the Lake Plimsoll to Lake Murchison area.

Period, age and regime details	Event	Resulting deposit or feature
<p>Holocene 0 – 10 ka Current and recent depositional regimes Derived from all older material Qha</p>	<p>Continued erosion of river banks and the toes of slopes during major flood events Some climate variation</p>	<p>Sands, gravels, cobbles and boulders in river beds Swampy and water saturated areas</p>
<p>Quaternary/Pleistocene 10 ka – 2.58 Ma Ancient glacial-periglacial depositional and weathering regimes Derived from all older material Qpgg</p>	<p>Glacial and periglacial processes Four glacial events since 60 ka At least eight glacial events since 1 Ma</p>	<p>Variable thickness bouldery glacial deposits Solifluction deposits formed by downslope movement during freezing and thaw Out-wash gravels</p>
<p>Cenozoic/Tertiary 2.58 Ma – 66 Ma Ancient weathering and erosion regimes and poorly understood sediment depositional regimes Derived from all older material Not differentiated at surface</p>	<p>Continuing weathering and erosion of the landscape, forming the slopes of the present valleys and deposits in restricted, small basins (Quinn Creek?) Lake deposits –clays in poorly drained flats and valleys</p>	<p>Deposition of Tertiary sediments in valleys, possible reworking and/or lithification of some sediments</p>
<p>Silurian to Cretaceous Generally quiescent</p>	<p>Prolonged weathering and erosion</p>	<p>Formation of an extensive erosion surface Far-field tectonic events Depositional periods missing from geological record in area</p>
<p>Cambrian-Ordovician Late Cambrian mountain building event COsu, COcm, COvc</p>	<p>Erosion of Proterozoic basement rocks and deposition of Owen Group in fault basins and half-grabens Gordon Group limestone deposition above the Haulage Unconformity, over the Owen Group</p>	<p>Owen Group sandstones, conglomerates, and siltstones Gordon Group limestones</p>

Period, age and regime details	Event	Resulting deposit or feature
Cambrian 506 Ma – 493 Ma Mountain building event/arc-continent collision and extensional phase/volcanism and sedimentation Cdqp, Cdqpi, Cdqvc	Post arc-continent collision volcanism and intervening sedimentation and reworking of volcanic deposits	Deposition of the eastern Mount Read Volcanics sequence comprising 2.5 km thick complex of porphyritic felsic lavas, intrusions and volcanoclastics

Table 4.1: Geological history of the Tribute area summarised from Corbett et al. (2014).

The existing headrace tunnel of the Tribute scheme encountered a section of very poor ground conditions in the area of Quinn Creek. A surface geological map of the area is shown in Figure 4.2

A tunnel diversion was constructed for this zone as it was not possible to excavate and support through this material. The lithologies in the vicinity of the diversion comprise tens of metres of formations of alternating conglomerate, conglomeratic sandstone, and minor sandstone.

Several potential geological models were explored in the evaluation of the Quinn Creek area subsurface feature in work during and following construction as shown in Figure 4.4, Figure 4.5 and Figure 4.6.

- As more data became available from drilling, interpretations favoured a model where two oblique faults crossed and then intersected within ~200 m of the initial tunnel design line, or alternatively, where a single fault zone crossed the tunnel alignment.
- Between these faults or to the north of the fault zone is a zone of silt, clay, sand and limestone which contained water under pressure at the tunnel level.
- Potential geological origins for this zone include a Cenozoic paleovalley concealed beneath glacial deposits, or weathered sedimentary rocks distinct from those recognised elsewhere.
- This zone included materials reported as ‘adversely orientated, relatively closely bedded, slightly to moderately weathered sandstone containing interbeds of weak to very weak, highly to completely weathered siltstone that required full support.
- In addition, groundwater inflows increased with an increased risk of flooding if the pumping system broke down’.

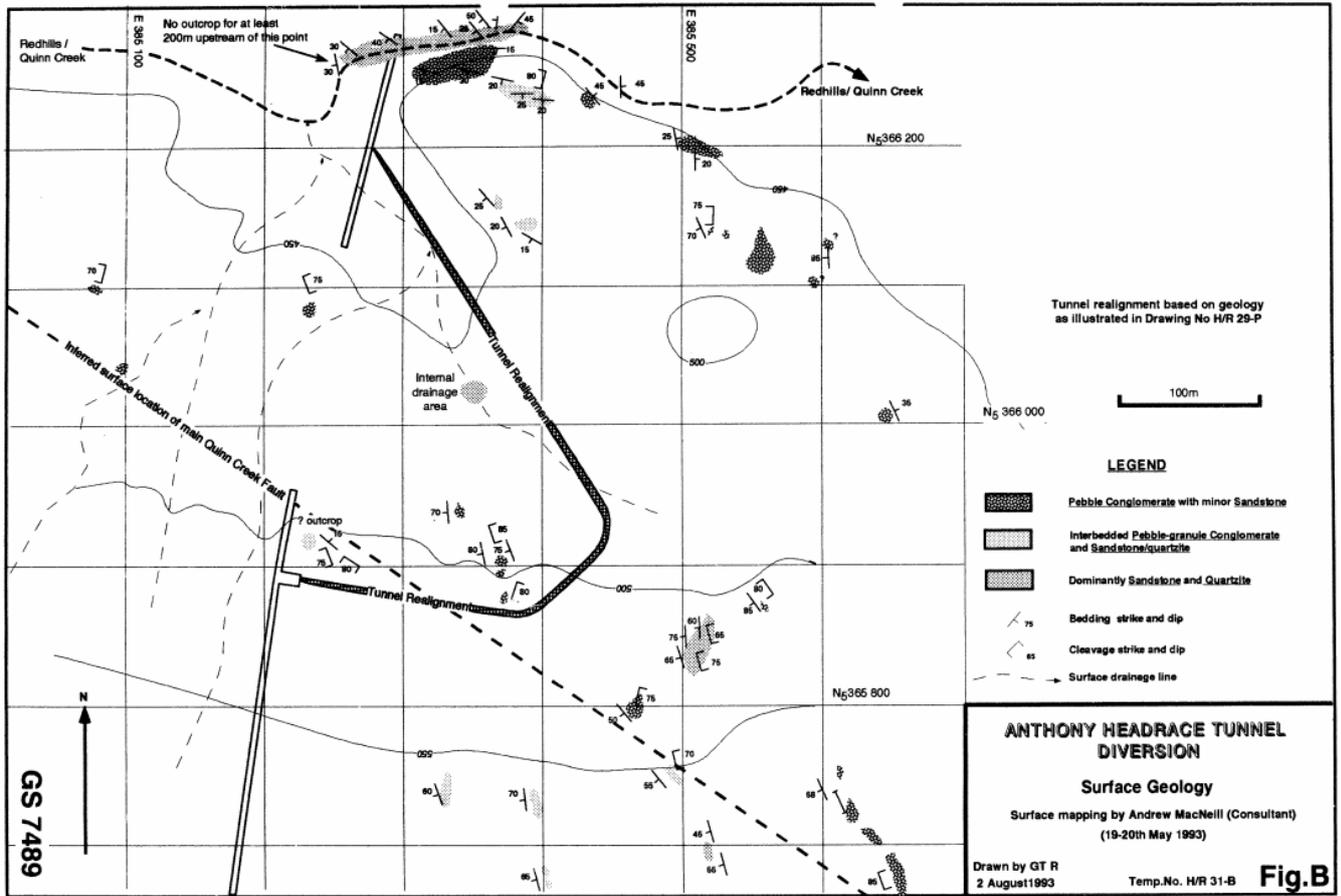


Figure 4.2: Factual surface geological map of the Quinn Creek tunnel diversion area

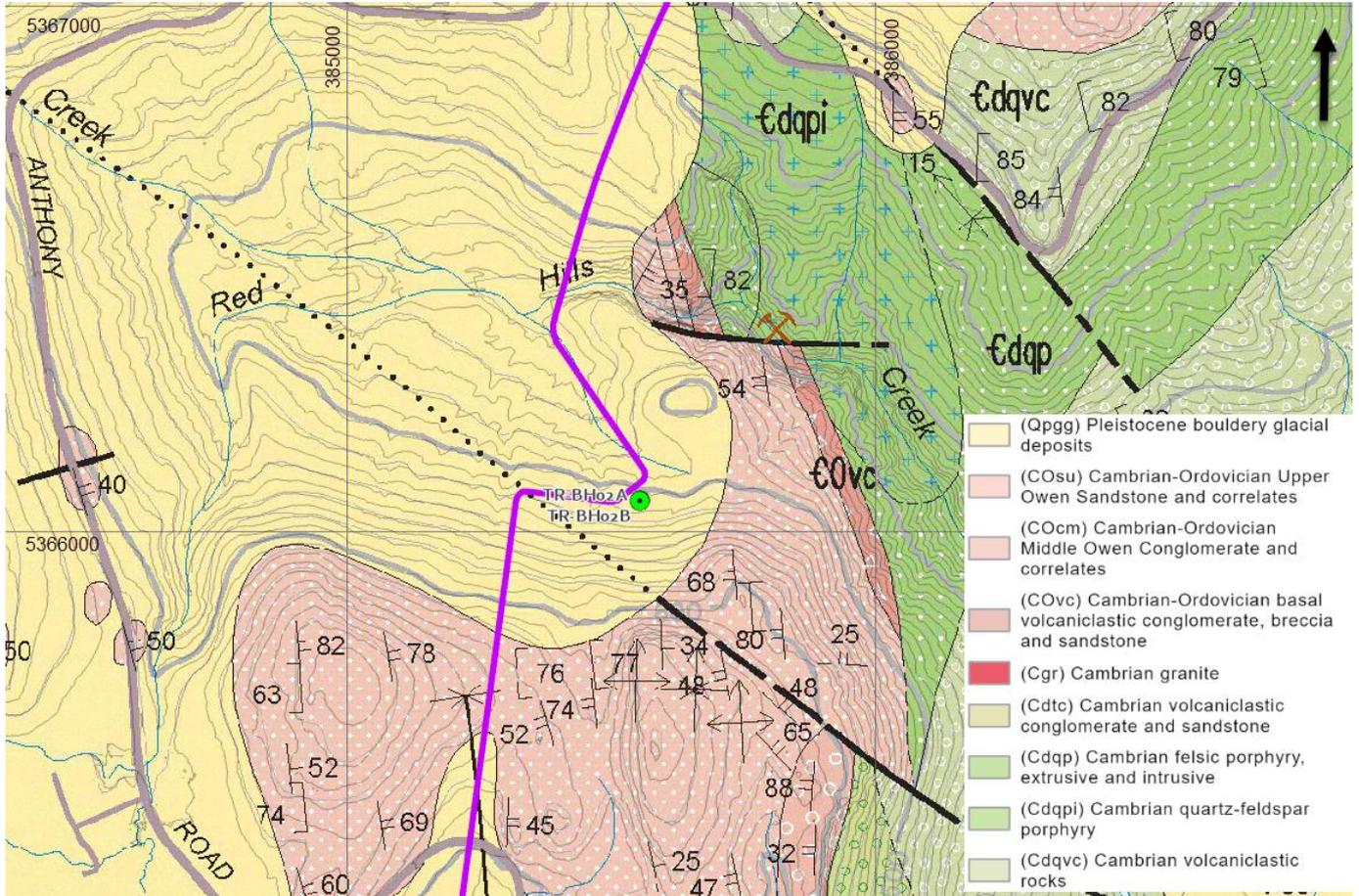


Figure 4.3: Existing Tribute power tunnel (purple) and location of boreholes (green dot) in area of Quinn Creek diversion overlain on geological map

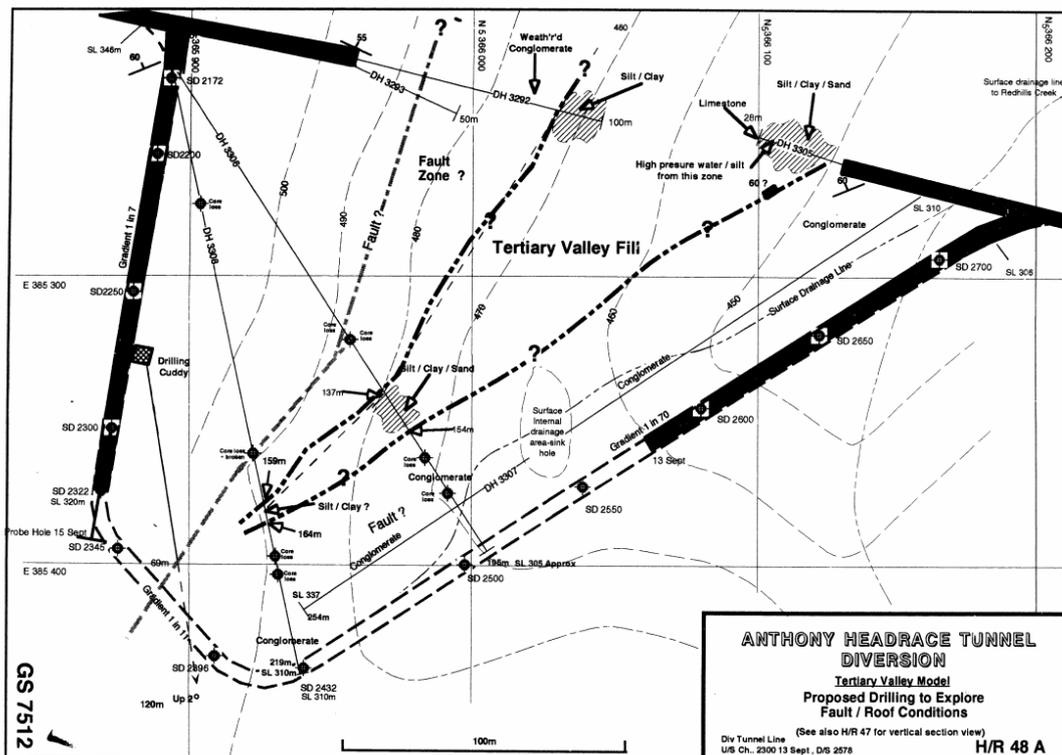


Figure 4.4: Tertiary valley model for the Quinn Creek tunnel deviation area

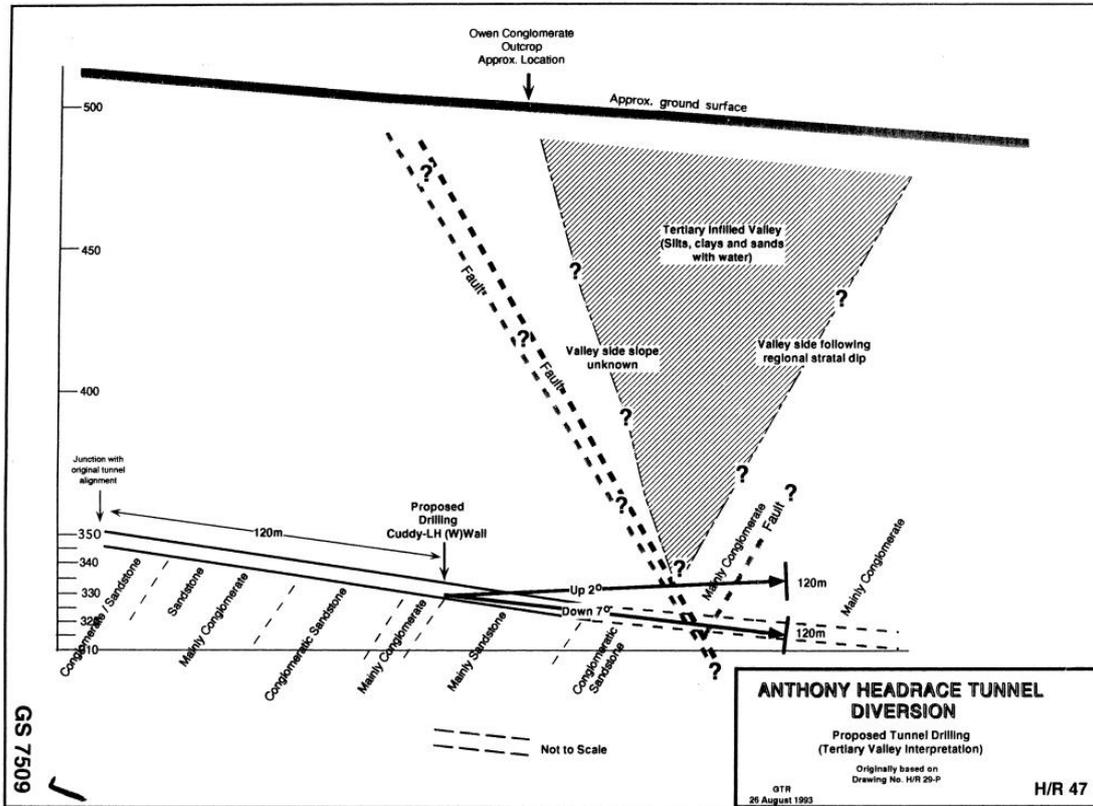


Figure 4.5: Interpretive cross section of the Quinn Creek tunnel diversion area showing the Tertiary valley model

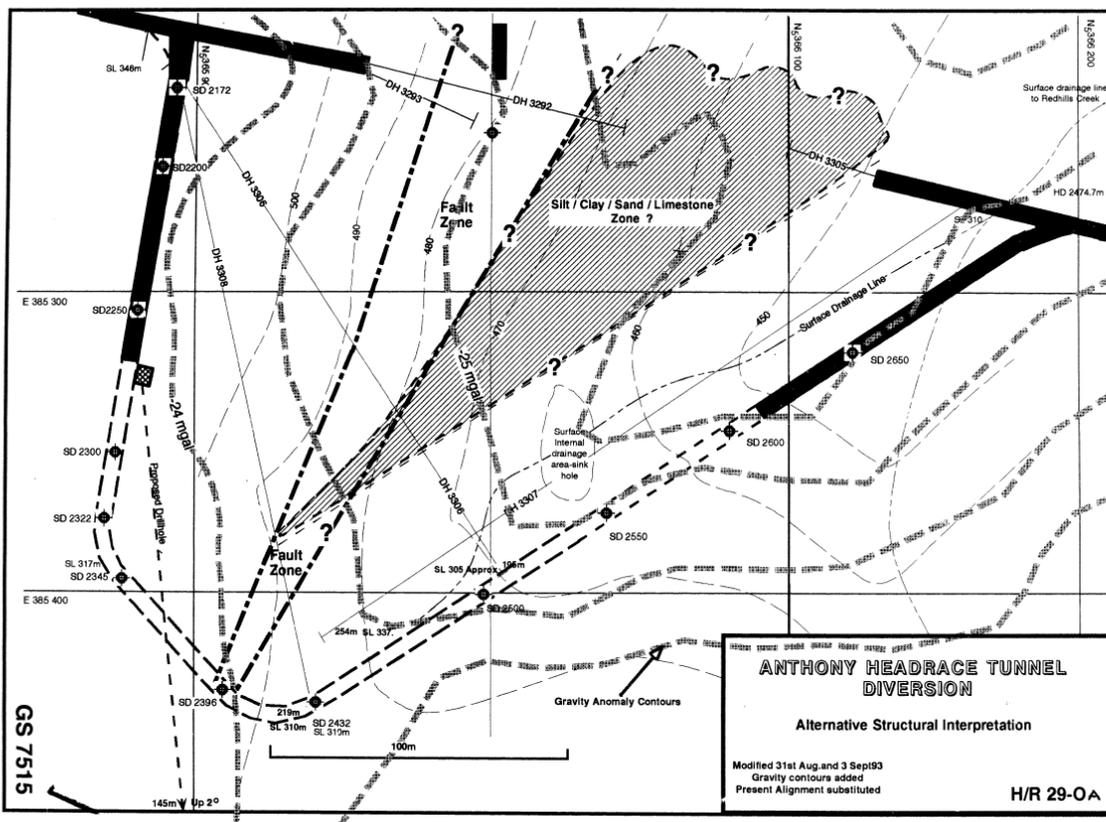


Figure 4.6: Alternative structural interpretation for the Quinn Creek tunnel deviation area

5.0 Exploration completed during the reporting period

Geological and geotechnical investigations conducted as part of the Tribute PHES Feasibility Study consisted of 4 diamond drill holes for a total of 1,028.1m.

- Borehole logs and core photographs are included in Appendix 1 and Appendix 2 respectively.

A summary of investigations including GDA94 coordinates is included in Table 5.1 below:

Hole ID	Objective	Comments	Elevation (m)	Easting (m)	Northing (m)	Orientation (true north)	Orientation (magnetic north)	Inclination (from horz.)	Expected depth (m)	Final depth (m)
TR-BH01	Cored borehole to Investigate area around Lake Plimsoll intake	Casing expected to be required in surficial and highly weathered material	527	384953	5364075	-	-	-90	55	54.6
TR-BH02A	Cored borehole to Investigate area around Quinn Creek Fault (East of diversion)	Casing expected to be required in surficial and highly weathered material	504	385553	5366060	-	-	-90	344	402.0
TR-BH02B	Cored borehole to Investigate area around Quinn Creek Fault (East of diversion)	follow up angled hole to position Quinn Creek fault	504	385552	5366058	180	166.3	-70	390	371.5
TR-BH06	Cored borehole to Investigate area around proposed power station cavern	Casing expected to be required in surficial and highly weathered material	403	387198	5369334	130	116	-80	265	200

Table 5.1: Recent Hydro Tasmania Investigations

Drilling of TR-BH02A and 02B was designed to intersect the interpreted Quinn Creek Fault Zone in order to determine ground conditions in the area for constructability assessment of the power tunnel for the Tribute PHES.

TR-BH01 was drilled at the northern end of Lake Plimsoll to inform constructability of the upper intake structure. TR-BH06 was targeting the proposed power station location and expected to be drilled to at least 265m. The hole was put on hold at 200m awaiting in situ stress testing by overcoring, which was to be conducted by a subcontractor. Unfortunately due to border closures associated with the Covid-19 pandemic this testing was unable to be completed. The hole has been capped and left open in order for in situ stress testing to be conducted in the future should investigations recommence at the Tribute PHES site.

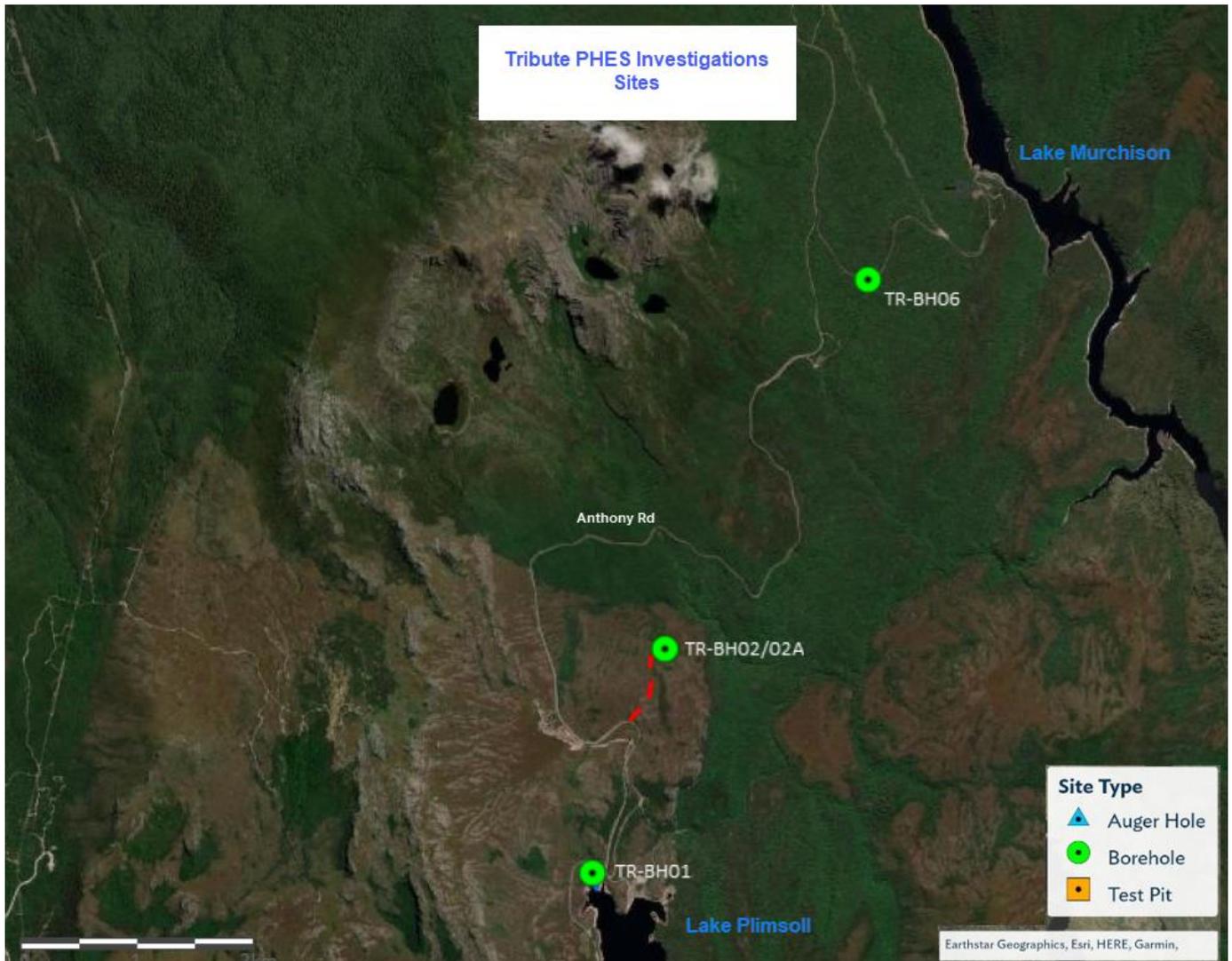


Figure 5.1: Location of Tribute exploration sites

6.0 Discussion of Results

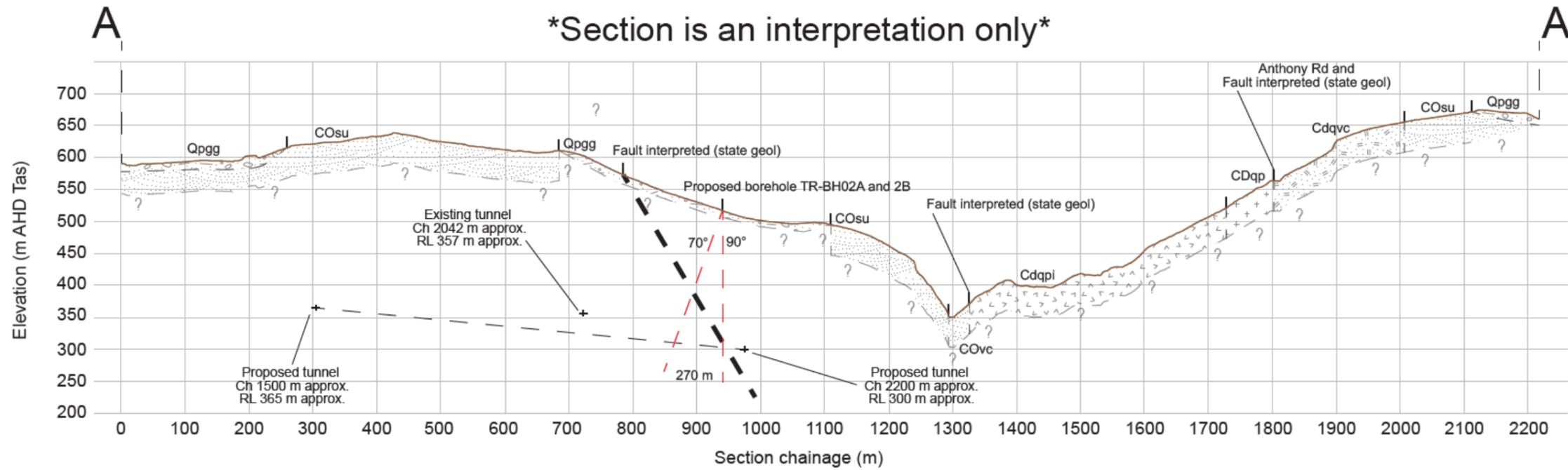
The Tribute PHES water conveyance alignment was designed to run adjacent to the existing Tribute power tunnel. As discussed in the review of previous work (Section 4.0) a significant fault zone was interpreted to have been intersected by the existing tunnel.

An interpretive cross-section of the intersection of the fault zone and Tribute PHES power tunnel with planned drillholes plotted is shown in Figure 6.1.

Summary drill logs are shown in Table 6.1. Although several small fractured zones are present, the most significant fault zone was logged in TR-BH02B at 364.6m. It was logged as being ~1.2m wide, highly fractured, slickensided with quartz gravel and clay seams. No other structures with the characteristics expected of the Quinn Creek Fault Zone were intersected.

Although the Quinn Creek Fault Zone was not definitively intersected, there still remains a number of interpretations. It could be that the alignment and orientation of the interpreted fault was incorrect and that drilling was positioned such that it missed the fault zone altogether. Alternatively, given that the diversion of the original tunnel did not intersect large areas of clay, broad sheared or intensely fractured zones or significant groundwater, it may be that the fault zone pinches out to the south-east and no major structure is present.

Additional drilling or geophysical surveys in the future may be considered to increase confidence in the geological model and de-risk any potential construction.



Section is an interpretation only

LEGEND

- Qpgg** – Pleistocene glacial deposits. Mainly comprised of sub-angular to rounded boulders and cobbles in an angular coarse sand/gravel matrix, and includes Owen Conglomerate erratics to 64 m². Deposits on the order of 1000 m² are interpreted near the headrace service tunnel portal. Data sourced from drawing A2-06346.
- COsu** – Cambrian Upper Owen Sandstone, varies from sandstone to conglomerate. In addition to COcm – Middle Owen Conglomerate and minor COvc – Correlates of Jukes Conglomerate.
 - Sandstone - fine to medium grained, pink/purple, bedded with 200-1000 mm spacing and common phylitic bands to 100 mm, strong to very strong. The rock mass is generally blocky (grade II). Data sourced from drawing A1-08172.
 - Pebbly sandstone to granule-pebble conglomerate - medium to coarse grained, pink, purple and grey, 100-1000 mm beds, strong to very strong and fresh. Some cross bedding. Variable quantities of sub-rounded quartzite clasts reaching 20 mm in diameter. Joint spacing mainly 400-1500 mm. East-west vertical joints are planar and smooth and other joints are planar or irregular and rough. Rock mass in generally massive, of grade I/II. Data sourced from A2-06346 and A1-08172.
 - Conglomerate - comprising angular to rounded quartzite clasts generally to 100-250 mm diameter, rarely to 300 mm, and commonly clast supported. The rock mass in generally fresh to slightly weathered, massive (grade I), and strong to very strong. Data sourced from A1-08172, A1-08464, A1-08968.
 - Interbeds of siltstone, thin to very thin, fresh to highly weathered, weak to very weak.

- Cdqvc** – Cambrian felsic porphyry (intrusive and extrusive), eastern quartz-phyrlic sequence. Quartz-feldspar phyrlic, includes RHYOLITE, ANDESITE, and PORPHYRY. Occur as extensive bodies and layers within Cdqvc.
 - Rhyolitic tuffs (Anthony scheme volcanic rock group) - green/grey, quartz phyrlic, well developed pervasive foliation, strong to very strong. Blocky rock mass, generally of grade II. Data sourced from drawing A1-08172.
 - Volcanics, undifferentiated. Dark grey-black, mainly fresh, strong. Data sourced from B1-08140.
- Cdqpi** – Cambrian quartz-feldspar porphyry (mainly intrusive), eastern quartz-phyrlic sequence. Occur as bodies in Cdqpi and possibly Cdqvc.
 - Quartz-feldspar porphyry - fine grained, pink/cream, very strong. The rock mass is blocky to massive and generally of grade I/II rock. Data sourced from A1-08172.
 - Quartz-feldspar porphyry - dark grey, pink and green mottled, fresh, very strong, joint spacing 50-100. Data sourced from B1-06982.
 - Granite - mottled pink and white dark grey chlorite bands, fresh, very strong, joint spacing 50-200, Data sourced from B1-06982.
- Cdqvc** – Cambrian sedimentary rocks (dominantly), eastern quartz-phyrlic sequence. Quartz-feldspar phyrlic. Likely included as part of 'rhyolitic tuffs' during scheme investigations and described above in Cdqp.
 - Conglomerate and sandstone, volcaniclastic. Strong and slightly to moderately weathered. Data sourced from drawing A1-08464.

Cross section start point (A)
385144.1 mE
5365232.9 mN
590.9 m

Cross section end point (A')
386309.9 mE
5367115.9 mN
660.0 m

Notes:
Note 1: Section is an interpretation only. Abrupt changes may be present which are not represented in the section.

DRAWN	M. Ferguson
CHECKED	J. Booth
DESIGNED	M. Ferguson
CHECKED	J. Booth
APPROVED	?
DATE	?
CLIENT APPROVED	
DATE	

NO PART OF THIS DRAWING MAY BE REPRODUCED, STORED IN A RETRIEVAL SYSTEM OR TRANSMITTED IN ANY MANNER WITHOUT THE EXPRESS PERMISSION OF ENTURA.

TITLE

Tribute headrace tunnel
Quinn Creek area - with diversion
Section A - A'

DRG No.	Appendix 6a - Quinn Ck diversion	REV. 0.1	A3
---------	----------------------------------	----------	----

Figure 6.1: Draft Interpretive cross-section showing proposed drill hole traces (TR-BH02A and TR-BH02B) onto interpreted Quinn Creek Fault location

BHID	Depth From	Depth To	Rock Type	Comments
TR-BH02A	0	3	Topsoil and colluvium	including small sections of core loss
TR-BH02A	3	17.6	Interbedded sandstone/conglomerate	
TR-BH02A	17.6	26.8	Sandstone	minor siltstone and conglom interbeds
TR-BH02A	26.8	45.8	Interbedded sandstone/conglomerate	
TR-BH02A	45.8	72.3	Sandstone	minor conglom interbeds typically <1m, minor siltstone interbeds
TR-BH02A	72.3	104.23	Interbedded sandstone/conglomerate	
TR-BH02A	104.23	206.6	Sandstone	minor conglom interbeds typically <1m thick
TR-BH02A	206.6	402	Conglomerate	Pink-grey med grained rounded EOH

BHID	Depth From	Depth To	Rock Type	Comments
TR-BH02B	0	3.4	Topsoil and colluvium	including small sections of core loss
TR-BH02B	3.4	289	Sandstone (variably fg-mg-cg)	minor siltstone and conglom interbeds
TR-BH02B	289	304.8	Interbedded sandstone/conglomerate	
TR-BH02B	304.8	329.2	Conglomerate	minor sandstone interbeds
TR-BH02B	329.2	371.5	Sandstone (variably fg-mg-cg)	minor conglom interbeds. 1.2m Flt zone at 364.5m. EOH

Table 6.1 Borehole TR-BH02A and TR-BH02B Summary rock logs

7.0 Conclusions

Investigations undertaken at the Tribute PHES site provided sufficient information to inform an adequate understanding of the geology of the area between Lake Plimsoll and Lake Murchison, however Cethana PHES was selected as the preferred project to progress to final feasibility. Deep storage capacity, greater cost and technical certainty, environmental and social sustainability and flexibility in sizing and capacity make Cethana the preferred to finalise feasibility.

Investigations and interpretation conducted at Tribute as part of the Battery of the Nation PHES Study were not exhaustive and this site still retains the potential to develop a PHES, however no further work was planned whilst the Cethana PHES project is being prioritised and Hydro Tasmania decided to relinquish the lease.

8.0 Future exploration

Investigations across EL13/2019 have adequately informed a geological model of the Tribute PHES area to the level of detail required by the Feasibility Study. No further exploration activity is expected to be undertaken in the foreseeable future within EL13/2019. Further review and interpretation of the existing geological data at Tribute may be undertaken but in the absence of any on-ground activity it was decided to relinquish EL13/2019.

9.0 Environmental Management

Hydro Tasmania maintains a detailed Health Safety and Environment Policy. Environmental Management at the Tribute PHES site included, ecological and cultural heritage surveys that formed the basis for a detailed Environmental Impact Assessment (EIA). The EIA, in conjunction with the MRT Exploration Code of Practice and the drilling contractors Environmental Management Plan (EMP), informed the general investigations philosophy, the main points are summarised below:

- Where possible existing access tracks were used to minimise surface disturbance.
- Helicopter portable drill rig and foot access track used in the Quinn Creek area of the Tyndall Reserve
- Drill pad size was limited to the minimum safe area for effective set up and operation of the drill rig and associated equipment.
- Only approved biodegradable drilling muds were used as additives to the drilling water, with the exception of minor amounts of rod grease to maintain effective operation of the drill rig.
- Drilling water was discharged to ground via in-ground excavated recirculation/settling sumps to minimise impact of drill cuttings and approved drilling muds/additives entering the environment.
- All excavations (test pits and drill sumps) were backfilled and drill holes capped.

More detail can be found in Appendix including:

- HT HSE Policy
- TDS EMP
- Hydro Tasmania EIA's and associated supporting documents.

Drilling in the Quinn Creek area required low impact strategies to access the drill site within the Tyndall Reserve. An approximately 1.5km long foot access track was cut from Anthony Road to the drill pad, both of which were trimmed, covered with geo-fabric and overlain with hardwood woodchips to maintain the integrity of the track and provide improved protection of soil and vegetation.

The Quinn Creek drill site was audited by MRT (David Gatehouse) on 28/05/2020 and internally by a Hydro Tasmania Environmental Representative on 02/06/2020 . Feedback from the visits is also included in Appendix .

Upon completion of the drilling the geo-fabric and woodchips were collected into bulka-bags and helicoptered out of the site. Upon completion of rehabilitation representatives from Parks and Wildlife Service visited the site and were extremely satisfied with the final results.

10.0 Expenditure

No additional expenditure was committed to Tribute in the final year of the lease.

11.0 References

Corbett, K.D., Quilty, P., Calver, C.R., 2014. Geological Evolution of Tasmania: Geological Society of Australia Special Publication.

Walton, R. J. and Litterbach, N., 1990. Rock stress measurements by overcoring at the Anthony Power Station, Tasmania, CSIRO Division of Applied Geomechanics Internal Report - New Series No. 24.

12.0 Appendices

12.1 Appendix 1 - Borehole logs

(Attached Separately)

12.2 Appendix 2 - Borehole photographs

(Attached Separately)

12.3 Appendix 3 - Environmental Impact Assessment

(Attached Separately)