REGIONAL INFRASTRUCTURE DEVELOPMENT
NORTH REGION

GULF REGION STUDY

Preliminary Geotechnical Assessment of Dam & Weir Sites on Bundock Creek & Gilbert River

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SUMMARY

Inspections of high priority weir and dam sites on the Gilbert River and Bundock Creek were carried out in March 1999 for the Gulf Region Study. These sites had been identified in an earlier engineering assessment. This report sets out the current state of geotechnical knowledge for each of the sites.

Construction of weirs or dams is geotechnically feasible at all of the sites that were inspected. Nevertheless, the sites at North Head and Prestwood have significant engineering problems.

The right abutment at North Head damsite is an alluvial terrace about 500 m wide. This material is highly permeable and will require removal below the core of an earth-cored rockfill structure. The bedrock profile below the alluvial terrace is unknown. Earthfill materials suitable for a clay core may be in short supply.

The Prestwood weir site appears to be bypassed by an anabranch of the Gilbert River. Survey would be required to determine the effect on storage capacity.

Geotechnical investigations will be necessary for engineering feasibility studies. Estimated total cost for the Bundock Creek, North Head and Green Hills sites is $44 500. This is made up $6000 for establishment, $30 500 for fees and $8000 for expenses. The fees include ground survey costs.

1.0 INTRODUCTION

As part of a study of potential water infrastructure options in the Upper Herbert River catchment, geotechnical inspections were carried out in late March 1999. Those taking part were Mr. Geoff Eades, State Water Projects (SWP), Mr Jason Douglas, Resource Management, Mareeba and Mr Geoff Meadows, Environmental Protection Agency.

Inspections were limited to the high priority sites identified in the report on Engineering Assessment of Storage Options (1998).

This report gives an account of the results of the inspections as well as proposing the geotechnical investigations necessary for preliminary feasibility studies.

2.0 BUNDOCK CREEK DAMSITE AMTD 48KM

2.1 General

A dam has been proposed on Bundock Creek; a tributary of the Einasleigh River. The site is located about 17 km south of 'Lyndhurst' homestead. The proposed dam is 14 m high with an estimated volume of 170 000 m^3 of earth and rock fill. The proposed reservoir would be augmented by water diverted from a weir on the Einasleigh River into Lava Creek – a tributary of Bundock Creek.

2.2 Regional Geology

The site is underlain by the Dido Granodiorite; a foliated granitic rock of late Pre-Cambrian age. This intrudes the high grade metamorphic rocks (gneiss and granulite) of the Einasleigh Metamorphics of Archaean age. The metamorphic rocks form prominent strike ridges to the east and west of the site.

Most of the reservoir area is within alluvium or colluvium overlying granite. Arenite, shale and limestone of the Bundock Creek Formation overlie the granite to the south of the damsite. Porphyritic rhyolite intrudes the Bundock Creek Formation forming steep mountains such as Mt Remarkable.

To the west of the reservoir area are basalt flows that flowed down the ancestral Einasleigh River valley. The present river now flows along the western margin of the basalt.

2.3 Site Geology and Topography

At the damsite, the left abutment consists of high strength foliated granite that rises from the floodplain at a slope of about 20°. Rock outcrop is common.

The valley section is about 500m wide and the creek flows through the middle of the valley in a northerly direction. Alluvial and colluvial deposits of silty sand and clay underlie the valley (Figure 1).

The creek bed is about 50m wide and contains bars of sandy gravel with a maximum particle size of 20mm. Immediately upstream of the axis, foliated granite outcrops in the creek bed. The foliation dips at about 70° towards the northwest. The rock is slightly weathered and of very high strength with joints parallel and normal to the foliation.

The right abutment slopes at about 10° and is covered with open woodland. Rock outcrops are distinctly weathered and low to medium strength. A saddle to the east of the right abutment coincides with an aerial photograph lineament.

2.4 Geotechnical Considerations

For a conventional earth-cored rockfill dam, the foundation material below the rockfill zones should have a shear strength equal to or greater than the rockfill. It is unlikely that this criterion would be achieved by alluvial materials at the site. These materials would either have to be removed from the embankment foundations or weighting zones placed at the embankment toe.

Foundations for the central core should be non-erodible, groutable rock. These criteria would be met by slightly weathered or better granite. Such conditions probably occur at relatively shallow depths on the left abutment and in the valley section. The depth of weathering may be greater on the right abutment.

The zoned earth-cored rockfill dam will have either a central overflow spillway or a spillway on the right bank. A spillway on the right bank could also serve as a quarry for rockfill and concrete aggregate. This is a possible advantage over a central spillway. However, the saddle on the right bank that would be the obvious location for the spillway is cut by a north trending lineament. This may indicate a sheared zone implying deeper weathering and possibly unsuitable material for rockfill.

If feasibility studies show that a central spillway is the preferred option, a quarry would have to be established. A possible site is located about 1km upstream on the left bank. The quarry would be used as a source of rockfill and aggregate. Alternatively, sufficient aggregate may be obtained from alluvial materials within the stream channel.

Both pervious and impervious earthfill materials should be available from within the reservoir area.

3.0 NORTH HEAD DAMSITE AMTD 398KM

3.1 General

The damsite is located on the Gilbert River about 7km upstream of "North Head" homestead. The proposed dam is an earth-cored rockfill structure about 18 m high with an estimated earth and rock fill volume of 670 000 m^3. A spillway could be placed on either the left bank or in the river as a central overflow type.

An alternative site was also inspected about 2km downstream at AMTD 396km. The abutments of the latter site consist of massive sandstone and conglomerate Rotation of separated joint blocks has made the abutments unstable. Accordingly the downstream site is considered unsuitable.

3.2 Regional Geology

The oldest rocks in the region belong to the Etheridge Group of Pre-Cambrian Age. There are two formations within the Etheridge Group that are adjacent to the damsite. These are the Robertson River Formation and the Dead Horse metabasalt member. The Robertson River Formation is composed of cleaved shale and siltstone. Metamorphic grade increases towards the east causing the rocks to become phyllitic then schistose in character. The Dead Horse metabasalt member represents basaltic flows and pyroclastics that have been metamorphosed up to amphibolite facies.

The Etheridge Group is uncomformably overlain by the Hampstead Sandstone of Jurassic age. This unit forms spectacular mesa and "gorge" country in the region. Bedding is sub-horizontal and massive.

3.3 Site Geology and Topography

The geological units at each of the damsites are shown on Figure 2

The left abutment of the upstream damsite slopes at about 15° and is underlain by slightly weathered to distinctly weathered meta-dolerite with a thin soil cover. The rock when slightly weathered or better is extremely high strength, slightly altered and contains quartz veins.

The stream section consists of fresh meta-dolerite overlain by a thin veneer of sand and gravel.

The right abutment rises gradually from the streambed (Plate 1). It is underlain by an unknown thickness of terrace alluvium ranging in composition from gravel and cobbles to silty sand. About 500m from the stream channel the soils change from alluvial to residual in character. Scattered quartzite outcrops occur amongst gravel surface litter indicating shallow bedrock.

3.4 Geotechnical Considerations

The proposed dam is technically feasible but there are significant problems with the right abutment. The alluvium will have to be excavated to bedrock for the clay core and possibly the rockfill zones as well. This involves excavation for at least 500m through the right bank to an unknown depth.

Either of the spillway options would be feasible. The left bank spillway option would have the advantage of serving as a quarry for rockfill and concrete aggregate. The central overflow option may minimise river diversion problems during construction.

Rockfill construction materials would be available from the spillway excavation or from a special purpose quarry on the left bank. Gravel and cobbles from the right bank terrace may also be suitable for this purpose.

Earthfill materials suitable for the earth core may be difficult to locate in the reservoir area. Materials at the surface of alluvial terraces are silty sand and clayey soils may be in short supply.

Sand for filter zones and concrete is available from the streambed within the reservoir area.

4.0 GILBERT RIVER REGULATING WEIRS

4.1 General

The area of potentially benefited soils occurs below "Prestwood" adjacent to the Gilbert River. Regulating structures are required near the upper end and near the middle of the benefited area to effectively control flows for "run-of-river" abstraction.

There are a number of potential sites at the upper end of the area. These include AMTD 338km and AMTD 333km near "Green Hills" and AMTD 321km near "Prestwood". There is only one potential site at the lower end at AMTD 279km near "Rockfields". The proposed weirs are 7 m high at each of the sites.

4.2 Regional Geology

The sites adjacent to "Green Hills" are underlain by dacitic or rhyolitic ignimbrite belonging to the Cumberland Range Volcanics of Carboniferous Age. The "Prestwood" weir site is underlain by the Prestwood Microgranite; an intrusion that is genetically related to the Cumberland Range Volcanics.

The Rocklands weir site is underlain by the Gilbert River Sandstone of Cretaceous Age that unconformably overlies the older rock types.

4.3 Green Hills Weirsite AMTD 338km

Rhyolitic ignimbrite outcrops on both banks of the river (Figure 3). The rock is slightly weathered and extremely high strength. Soil cover is absent or very thin. The banks slope at about 10^0 from the flat river bed.

The river is about 200m wide and is occupied by a continuous sheet of sand and gravel. The thickness of this unit is not known.

The site appears ideal for either a roller compacted or mass concrete structure. Construction materials could be obtained from the river alluvium and a quarry in the ignimbrite

4.4 Weirsite AMTD 333km

This site was not inspected on the ground but is similar in terms of rock types and topography to the Green Hills site described above.

4.5 Prestwood Weirsite AMTD 321km

The abutments are composed of porphyritic microgranite that slopes about 5 – 10° from the river bed. The microgranite has weathered to form a bouldery rubble at the ground surface.

The river is about 200 – 300m wide and is occupied by a continuous sheet of sand and gravel. The thickness of this unit is not known.

Although the site would be suitable for a roller compacted concrete structure, the capacity of the structure may be limited. Geological maps and inspection from the air suggest a major anabranch bypasses the site on the right bank. Somerset Creek flows into this anabranch downstream of the site. Survey would be required to confirm this potential problem.

4.6 Rockfields Weirsite AMTD 279km

This site is immediately upstream of the Gulf Development Road bridge.

The right abutment slopes gradually from the riverbed at about 2 to 5^0. Sandstone outcrops on this bank. It is distinctly weathered and of low to medium strength.

The left abutment and river section are composed of alluvial materials. Auger drilling carried out upstream of the bridge (RID, 1998) shows that clean sand and gravel, clayey sand and cemented sand underlie the bed section and the left bank. The thickness of clean sand ranges from 6 to 12 m. Particle size analyses were carried out on 1 m samples of clean sand and gravel taken from percussion holes. As these samples were taken under saturated conditions, most fine material, if present was washed from the sample in the drilling process. Nevertheless, observation of drilling water indicated that very little clayey or silty fines were

present. The average grain size of the samples is about 4 mm and the maximum particle size is about 40 mm.

The site would be suitable for either a sheet piling weir or a concrete weir founded on compacted sand and sandstone. For the sheet piling weir, sheet piles would be driven to the clayey sand layer or installed in a trench excavated in the sandstone. For the concrete alternative only two rows of sheet piles would be required; at the upstream and downstream ends of the weir.

5.0 PINNACLES DAMSITE, MITCHELL RIVER AMTD 410KM

5.1 General

A damsite has been proposed on the Mitchell River about 12km east-northeast of "Bellevue" and immediately upstream of the remains of OK Bridge on the Mungana-Maytown Road.

A concrete faced rockfill dam has been proposed with a roller compacted concrete dam as an alternative. The maximum height of the dam is 38m above bed level.

5.2 Regional Geology

Basement rocks in the area belong to the Hodgkinson Formation of Devonian Age. These consist mainly of interbedded arenite and mudstone deposited in a deep marine environment. In addition, the formation contains lenses of conglomerate, metabasalt, chert.and rare limestone. The chert forms elongate lenses usually less than 100m wide but possibly extending several kilometres. The formation has been affected by several deformational events. The most significant was a major compressional event that resulted in the production of numerous thrust slices. The rocks developed a slaty cleavage sub parallel to bedding during this event.

5.3 Site Geology and Topography

The right abutment rises steeply at about 40^0 from the river bed. The rock is massive or bedded chert of extremely high strength (Plate 2). The bedded chert is often sheared but the sheared zones are usually rehealed by silicification. Downstream and upstream of the damsite the rocks consist of deformed mudstone and chert (Figure 4). Deformation has been sufficiently intense to form a phyllitic fabric containing concordant lenses of chert. The foliation in the phyllitic rocks dips downstream at steep angles (50° towards 210^0 M).

The most significant defects in the right abutment are stress relief joints sub-parallel to the ground surface.

In the middle of the river is an island composed of massive chert. The upstream face is almost vertical and the sides facing each abutment slope between 40 and 45^0. A major sheared zone (Plate 3) up to 2m wide bisects the island. The zone trends across the proposed axis at an acute angle such that it would be upstream of the axis on the right bank but could affect the proposed structure on the left bank

and on the island. Difficult access conditions prevented a detailed inspection of the sheared zone but it may contain sheared phyllite.

Other defects affecting the chert in the island are stress relief joints sub-parallel to the ground surface.

The left abutment slopes at 20 – 25^0 from the river bed. Massive chert is the main rock type and this grades into phyllitic mudstone upstream and downstream of the site. The sheared zone observed on the island may be traced to the left bank where it dips steeply downstream (63^o towards 205^o M).

5.4 Geotechnical Assessment

The site appears suitable for either a concrete faced rockfill dam or a roller compacted concrete dam although the latter may be the better alternative for the following reasons:

- There is no obvious spillway site
- Chert is the obvious source of rockfill but is in the form of a relatively thin dipping layer. Selective quarrying may be required in the spillway cut to obtain clean rockfill for the zone behind the concrete face.

On the other hand, sand and gravel deposits appear to be relatively abundant upstream and downstream of the site. However these deposits could not be inspected at the time of the site visit because of high river flows.

For a roller compacted concrete dam the foundation needs to be non-erodible and groutable. The massive, extremely high strength chert will meet these criteria. The major issue will be determining the depth of stripping necessary to remove rock loosened by stress relief. The presence of the sheared zone is not necessarily a critical factor. Nevertheless, it will require treatment in the form of excavation and backfilling with concrete.

For a concrete faced rockfill dam the plinth foundation needs to be non-erodible and groutable and the rockfill foundation should have a shear strength similar to the rockfill. The main issue for the plinth foundation will be determining the depth of stripping necessary to remove rock loosened by stress relief. For the rockfill zones stripping of loose alluvial deposits only will be required.

6.0 GEOTECHNICAL INVESTIGATIONS

Geotechnical investigations may be required in future for engineering feasibility studies. For the sites described in this report, relatively non-intrusive investigations, including geological mapping, seismic refraction surveys and materials investigations with a backhoe, should be adequate. This is because the foundation rocks are high strength, non-erodible and groutable.

The estimate is based on geological mapping and seismic refraction surveys along the dam and spillway axes at Bundock Creek and North Head and along the axis at the Green Hills sites. Reconnaissance investigations for clay and sand deposits

using a backhoe would also be carried out at Bundock Creek and North Head sites. The estimate also includes the cost of ground survey. No investigations have been proposed for the "Rocklands" weirsite or the Pinnacles damsite. Results of the groundwater drilling are adequate in the case of the "Rocklands" site and the Pinnacles site is too remote to accurately estimate costs.

Estimated fees are as follows:

Establishment/disestablishment	$6000
Fees (geological mapping, seismic and ground survey, materials investigation, lab. testing, reporting)	$30 500
Expenses (vehicle and equipment hire, travelling)	$8 000
TOTAL	$44 500

7.0 REFERENCES

Regional Infrastructure Development (1998)	Gulf Region Study: Engineering assessment of storage options, Dept of Natural Resources
Regional Infrastructure Development (1998)	Gulf Region Study: Gilbert River bed sand investigation exploratory drilling programme September-October 1998, Dept of Natural Resources

PLATE 1
North Head Damsite-
View from left abutment
towards right abutment

PLATE 2
The Pinnacles Damsite-
Left bank

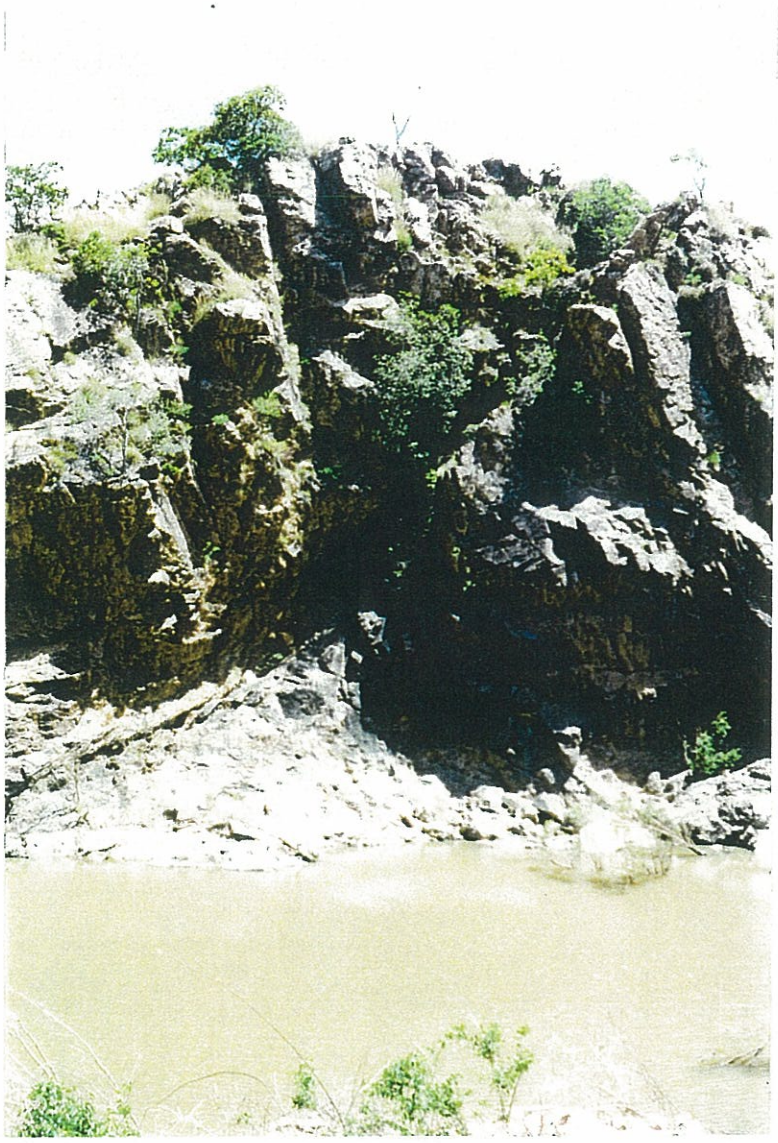
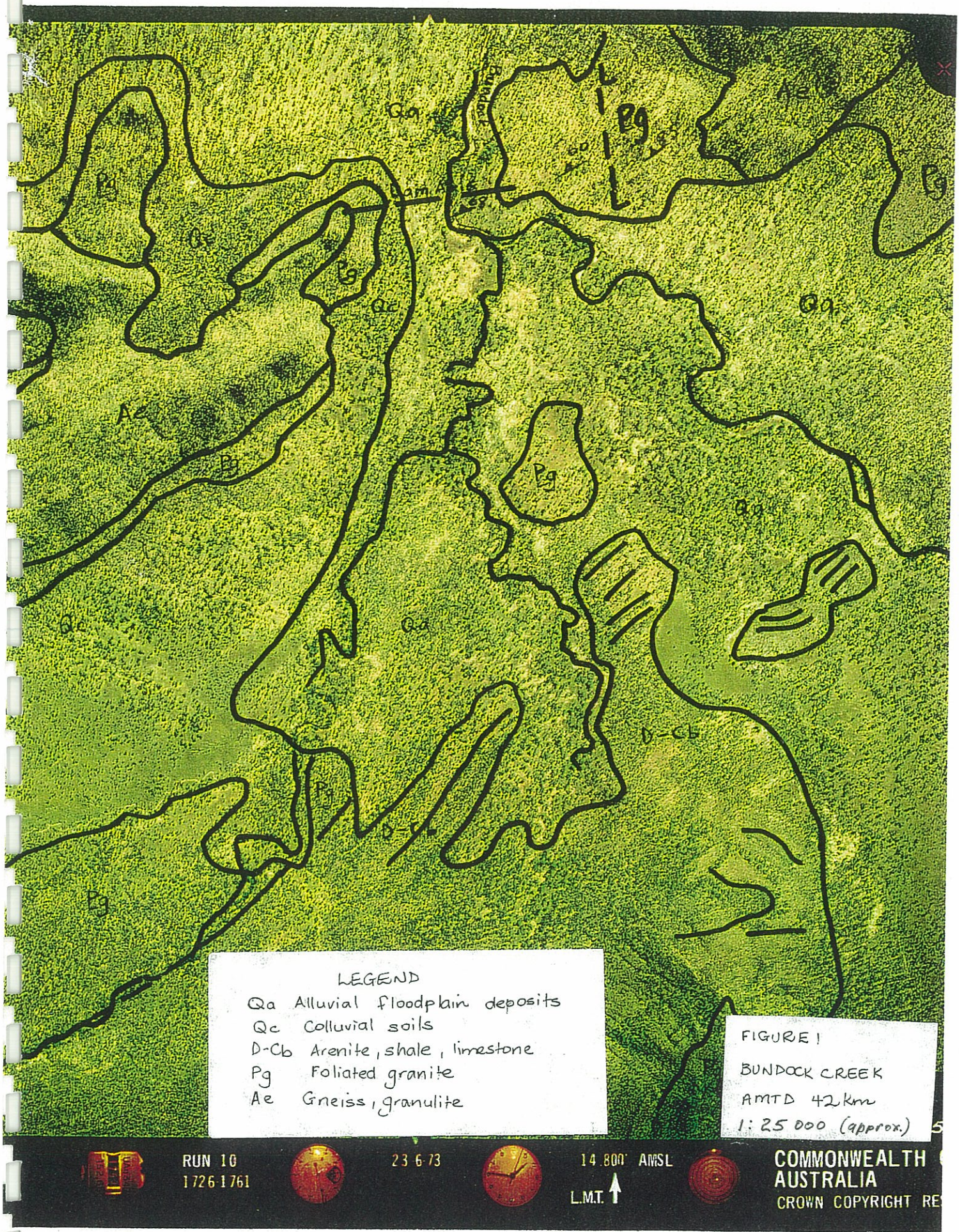


PLATE 3
The Pinnacles Damsite- Sheared zone in the massive chert- midstream island

PLATE 4 - The Pinnacles Damsite- massive chert outcrop right bank


Qa
Pg
Ae
Qc
D-Cb
LEGEND
Qa Alluvial floodplain deposits
Qc Colluvial soils
D-Cb Arenite, shale, limestone
Pg Foliated granite
Ae Gneiss, granulite
FIGURE 1
BUNDOCK CREEK
AMTD 42km
1:25 000 (approx.)
RUN 10
1726-1761
23 6 73
14 800' AMSL
L.M.T.
COMMONWEALTH
AUSTRALIA
CROWN COPYRIGHT RE

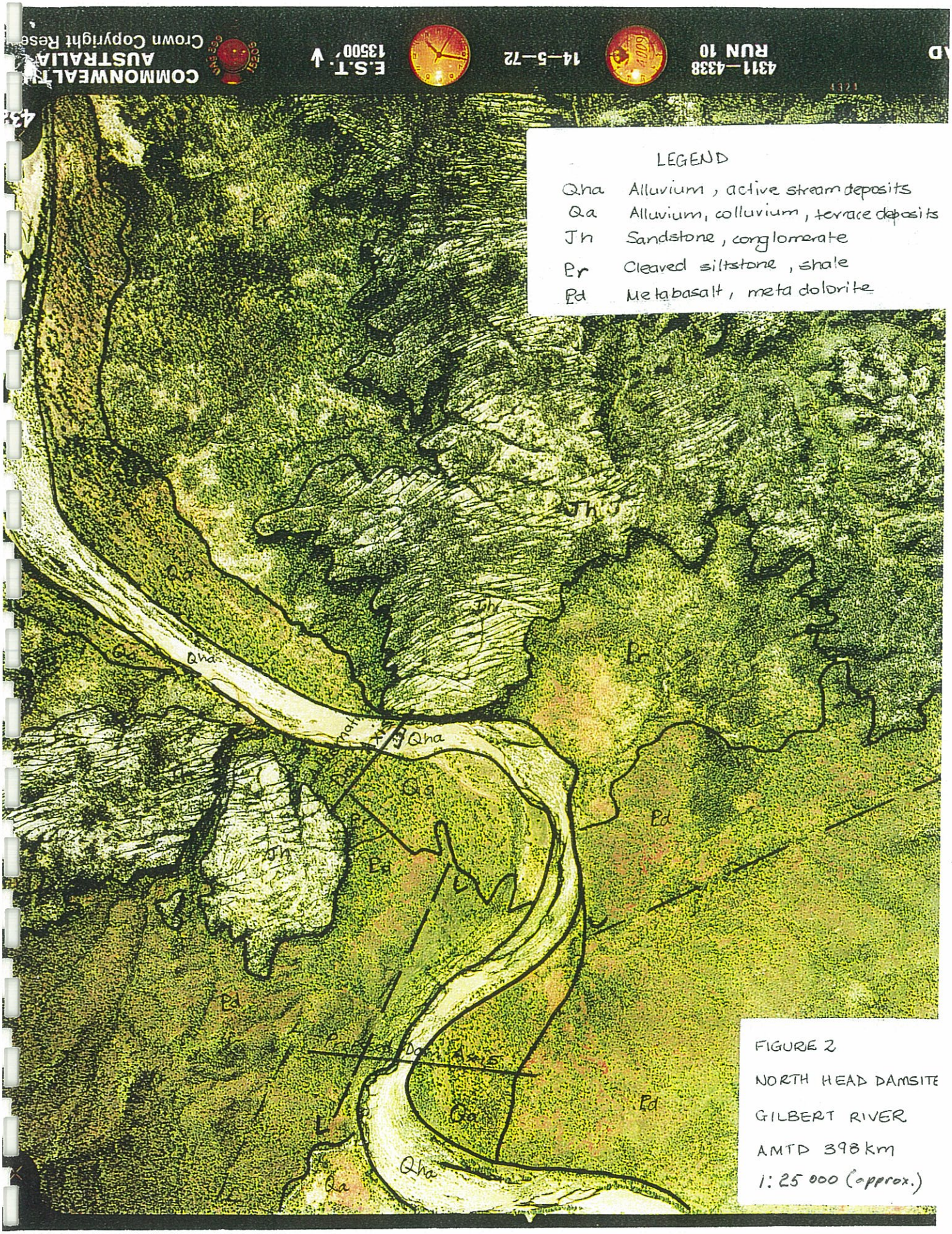
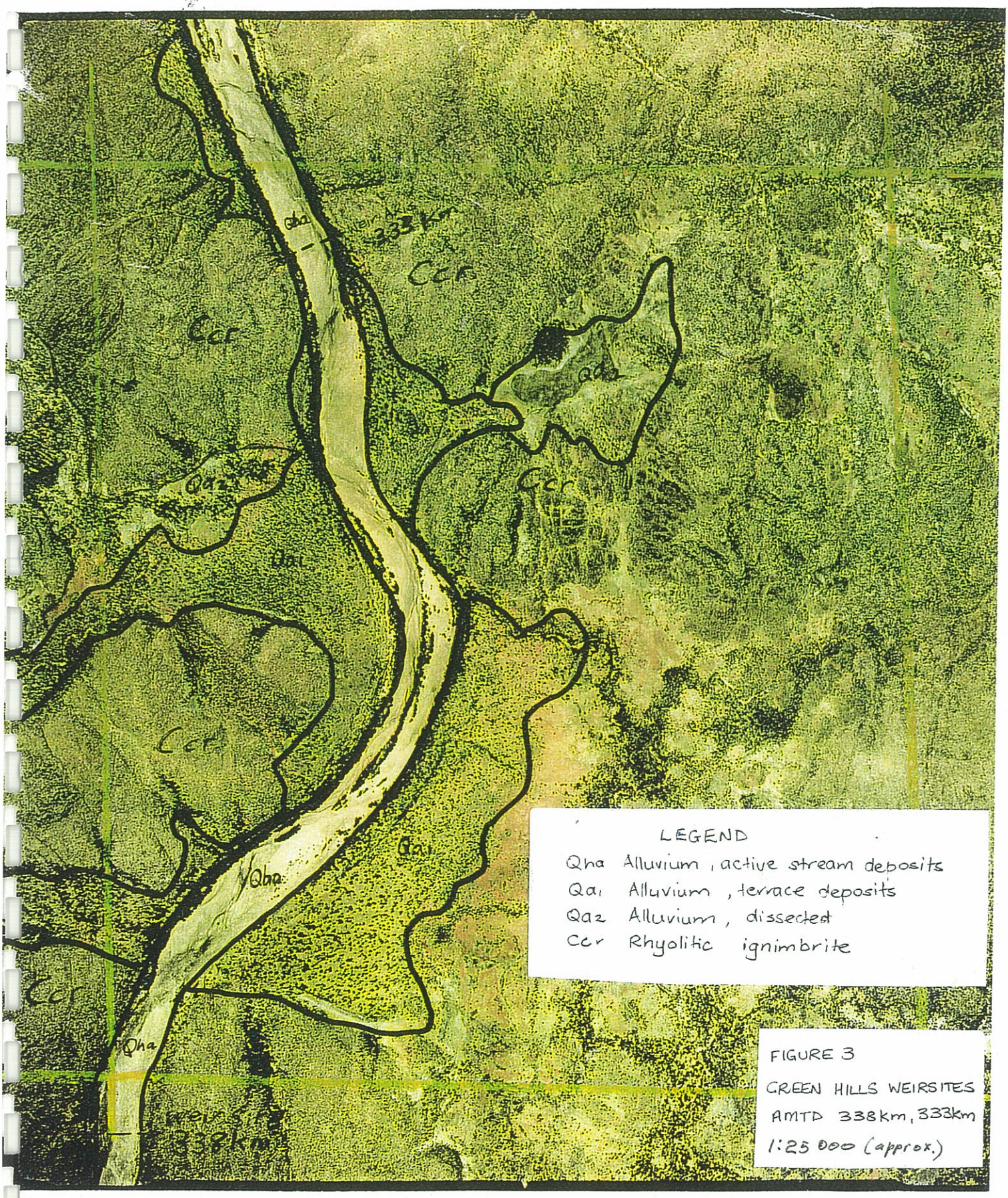


FIGURE 2
NORTH HEAD DAMSITE
GILBERT RIVER
AMTD 398 km
1:25 000 (approx.)



LEGEND

Qha Alluvium, active stream deposits
Qa1 Alluvium, terrace deposits
Qa2 Alluvium, dissected
Ccr Rhyolitic ignimbrite

FIGURE 3
GREEN HILLS WEIRSITES
AMTD 338km, 333km
1:25 000 (approx.)