Australasian Groundwater and
Environmental Consultants Pty Ltd

Report on

Ulan Mona Creek Investigation Plan

Prepared for
Ulan Coal Mines Limited

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Table of contents

Page No.

List of figures

List of appendices

Report on

Ulan Mona Creek Investigation Plan

1 Introduction

Ulan Coal Mine Complex (Ulan) is operated by Ulan Coal Mines Limited (UCML), which is a joint venture between Glencore Coal Assets Australia (Glencore) and Mitsubishi Development. The Ulan mine is in the central west of New South Wales near the town of Ulan, which is approximately 38 km north-northeast of Mudgee.

UCML has committed to collecting more data in the Mona Creek area and to allow establishment of existing conditions for these systems. Ulan has committed to commissioning an appropriately qualified and experienced hydrogeologist to design a monitoring program which will be implemented within 12 months of approval of Modification 4 (MOD4).

Ulan has proposed to install at least three (and up to five) monitoring bores in the Mona Creek alluvium in the area north of UWLW6-UWLW8. One of the bores will be located close to PB2 (private bore likely screened in the Triassic units) in order to compare any potential impacts to the fractured rock aquifer and the overlying alluvial aquifer. The need for a second fractured rock bore, directly below the alluvium, to form a bore cluster of an alluvial aquifer bore and a fractured rock bore, will be reviewed as part of design of the monitoring program. The deep and shallow monitoring will aim to assess hydraulic connectivity of the Mona Creek alluvium. Further, the information obtained from the monitoring wells can be used to support refinement of the groundwater model, such that it includes a shallow alluvium structure, appropriate to the regional conceptualisation approach. Furthermore, a review of the extent of saturated alluvium in Mona Creek (closer to the Talbragar River) will be undertaken as part of the alluvium bore planning.

Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) was commissioned by UCML to undertake a scope that satisfies the above objective.

2 Scope

In order to satisfy the objective, AGE undertook the following scope tasks:

- site visit, including:
  - meeting with Geoff Mitchell (land owner) and discussion regarding alluvium and modelling;
  - Mona Creek site walkover for data collection for modelling purposes; and
  - preparation of brief memo summarising discussion points and findings (completed as separate letter – refer Appendix A).
- investigation plan:
  - review of drilling data available for the area;
  - review of alluvium extents in the area based on publicly available data and the current groundwater model;
  - review the need for drillholes, test pits and monitoring bores to investigate the alluvium extents and conditions; and
  - development and preparation of an investigation plan for implementation by site.

3 Legislative framework

The key relevant policy relating to the Mona Creek alluvium is the Aquifer Interference Policy [AIP] (2012). The NSW AIP defines the regime for protecting and managing the impacts of aquifer interference activities on NSW's water resources and strikes a balance between the water needs of towns, farmers, industry and the environment. The NSW AIP summarises the requirement for assessing minimum impact for a large-scale coal project.

The key requirements of the AIP are to:

- ***Account for, or prevent, the take of water.*** *Where a proposed activity will take water from an aquifer or connected surface water source, adequate arrangements must be in place to account for this water. It is the proponent's responsibility to enable this to be estimated to a suitable level of accuracy, and to ensure necessary water licences are obtained and held.*
- ***Address the 'minimal impact considerations'****. Aquifer interference activities can adversely impact groundwater and connected surface water sources by decreasing groundwater pressure and/or lowering the water table; deteriorating groundwater and surface water quality either due to pollution or increases in salinity; by affecting the health or viability of a groundwater dependent ecosystem (GDE) or impacting on a culturally significant site (CSS). The AIP provides objective, measurable thresholds for considering the degree of impact an activity may have on the water table, groundwater pressure and water quality changes. The assessment criteria differ between aquifer types (e.g. alluvial, porous, fractured) and whether the aquifer is deemed 'highly' or 'less' productive on the basis of natural water quality and extraction yields.*
- ***Propose remedial actions****. Where impacts are greater than those that were predicted as part of* the relevant approval, proposed remedial actions shall be in specified to manage those impacts.

Under the AIP groundwater sources have been divided into "highly productive" and "less productive" sources. A highly productive groundwater source is defined by the AIP as a groundwater source which has been declared in Regulations and datasets, based on the following criteria:

a) has a total dissolved solids (TDS) concentration less than 1,500 mg/L; and
b) contains water supply works that can yield water at a rate greater than 5 L/s.

"Highly productive" groundwater sources are further grouped by geology into alluvial, coastal sands, porous rock, and fractured rock. "Less productive" groundwater sources include aquifers that cannot be defined as "highly productive" according the yield and water quality criteria. That said, no highly productive alluvial aquifers have been identified in the Mona Creek area.

4 Mona Creek hydrogeology

4.1.1 Hydrogeological units

The hydrogeology for the site has been described by MER (2015) for the MOD3 application. The description offered in MER (2015) of the hydrogeological regime is relevant to the Mona Creek area. The primary groundwater sources in the region are:

- **The unconsolidated alluvial aquifers** along the creek lines in some areas host shallow unconfined aquifers of limited extent. The alluvial aquifers on site are associated with tributaries of the Talbragar and Goulburn Rivers. MER (2015) states "*Quaternary and Recent alluvium east of the* [Great] *Divide is more localised and comprised of sands, silts and clays. Groundwater contained within these sediments occurs at depths of about 5 m to 10 m with estimated saturated thicknesses (of alluvium) in the range of 10 m to 20 m* [this refers to the alluvium of the Talbragar River]. *Minor occurrences of alluvium in the upper reaches of Mona Creek and Broken Back Creek were identified in late 2008 and piezometers were installed in shallow exploration boreholes as part of the UCML regional groundwater monitoring program. Alluvium at these locations is commonly less that 5 m this and comprised of sandy, silty deposits with limited saturated thickness. Most test holes were found to be damp or dry*".

  The exact extents of the Mona Creek alluvium are uncertain; however, a number of monitoring bores were installed as part of the groundwater monitoring network and most test holes were found to be dry or only damp. From this it can be concluded that Mona Creek alluvium is not used for significant groundwater extraction. Horizontal hydraulic conductivity of the alluvial aquifers are interpreted to range between 0.01 m/day and 10 m/day, with storativity values for the unconfined units ranging from 1% to 10%.

- **The shallow regolith and weathered rock profile** that may host perched unconfined groundwater during extended wet periods.

- **Deeper hard rock aquifers** that contain the Permian coal measures and the Triassic and Jurassic units can be unconfined, semi-confined and confined aquifers where groundwater is held predominantly as interstitial storage. Groundwater flow rates likely vary considerably. Higher flow rates are expected within the Triassic sandstones, and potentially the Jurassic sandstones, which are porous and permeable; whereas, the remaining units are likely to be relatively impermeable (MER 2015). The contribution of the Triassic and Jurassic units to the underlying Permian coal measures increases to the northwest, where these units are more substantial. Water yields from the weathered and deeper hard rock aquifers within the Ulan Mine Complex are low and have slow groundwater movement. There has been extensive depressurisation of these hard rock aquifers within and surrounding the Ulan Mine Complex as a result of previous and current mining operations.

4.1.2 Recharge/discharge

Recharge to the Mona Creek alluvium and adjacent Triassic sandstones is sourced predominantly via rainfall and run-off. Infiltration rates to the unconsolidated sand is likely to be between 3% and 10%. Water inflows into the underground mine are likely to be drawn predominantly from the deep hardrock aquifers. Recharge to groundwater is "*sustained by rainfall infiltration with estimates of recharge to deep hardrock strata varying from 0% to 2% of annual rainfall. Recharge to the groundwater systems generally occurs in areas where the regolith is well developed or where alluvial deposits have accumulated. The Goulburn River and Talbragar River act as regional drainage sinks*" (MER, 2009).

Groundwater contribution to the adjoining surface water systems is through "*minor contributions of baseflows from slightly deeper hardrock systems (as upward leakage possibly via springs) and are more likely to dominate the extended dry periods when flows are frequently less than 0.5 ML/day*" (MER 2009). Historical streamflow records indicate a long-term average flow rate in the Goulburn River at Ulan (just upstream of the mine) of around 2 ML/day, although the gauge data also indicates significant variation due to climate. This historical gauging has also indicated that prior to mining, the river experienced very low to "ceased to flow" conditions, usually in extended dry periods.

4.1.3 Groundwater dependent ecosystem/assets

Ecological surveys have been undertaken on site to assess the potential for GDEs. No significant GDEs have been mapped within the project approval boundary.

4.1.4 Groundwater water quality

No groundwater quality for the Mona Creek alluvium is available. Water quality of the Triassic is generally good and the aquifer is targeted as a water source. The 2018 UCML monitoring data from PZ06C (a Triassic monitoring bore adjacent Mona Creek) had electrical conductivity values of between 320 µS/cm and 336 µS/cm.

5 Desktop study results

The desktop study was completed to assess the presence/absence of alluvium through the review of published and publicly available datasets. The datasets are presented graphically with the outline of Mona Creek as reference in Figure 5.1 to Figure 5.7. Details of the desktop study findings are outlined in the paragraphs below.

Figure 5.1 shows the spatial extents adjacent Mona Creek of highly productive alluvium as defined in the AIP DPI-Water (2012a) and shown in the map produced by DPI-Water (2012b). The figure shows that Mona Creek and the adjacent section of the Talbragar River is <u>not</u> classified as a highly productive groundwater source. Highly productive alluvium is alluvium with yields of greater than 5 L/sec and with a salinity of less than 1,500 mg/L.

In 2015, the CSIRO published regolith maps indicating likely thicknesses of regolith across Australia. Regolith is considered to be the weathered and permeable rock profile that is most likely to contribute recharge to the underlying and/or adjacent rock units. Alluvium can often be detected in the CSIRO regolith maps; however, the regolith maps often show the combined thickness of alluvium and the underlying weathered rock. Figure 5.2 shows the estimated thickness of regolith along Talbragar River, Mona Creek and associated tributaries. On Figure 5.2, the 15 m regolith thickness is highlighted, and this extent is considered to be the best approximation of the potential limit of alluvium in Mona Creek, based on this desktop study. Analysis of the data set shows that the regolith is up to 23 m thick in the northern parts of Mona Creek (adjacent the confluence with the Talbragar River). Typical thicknesses of regolith identified in the CSIRO Mapping range between 7 m and 19 m in Mona Creek and it is likely that a proportion of this thickness will be alluvium and/or colluvium.

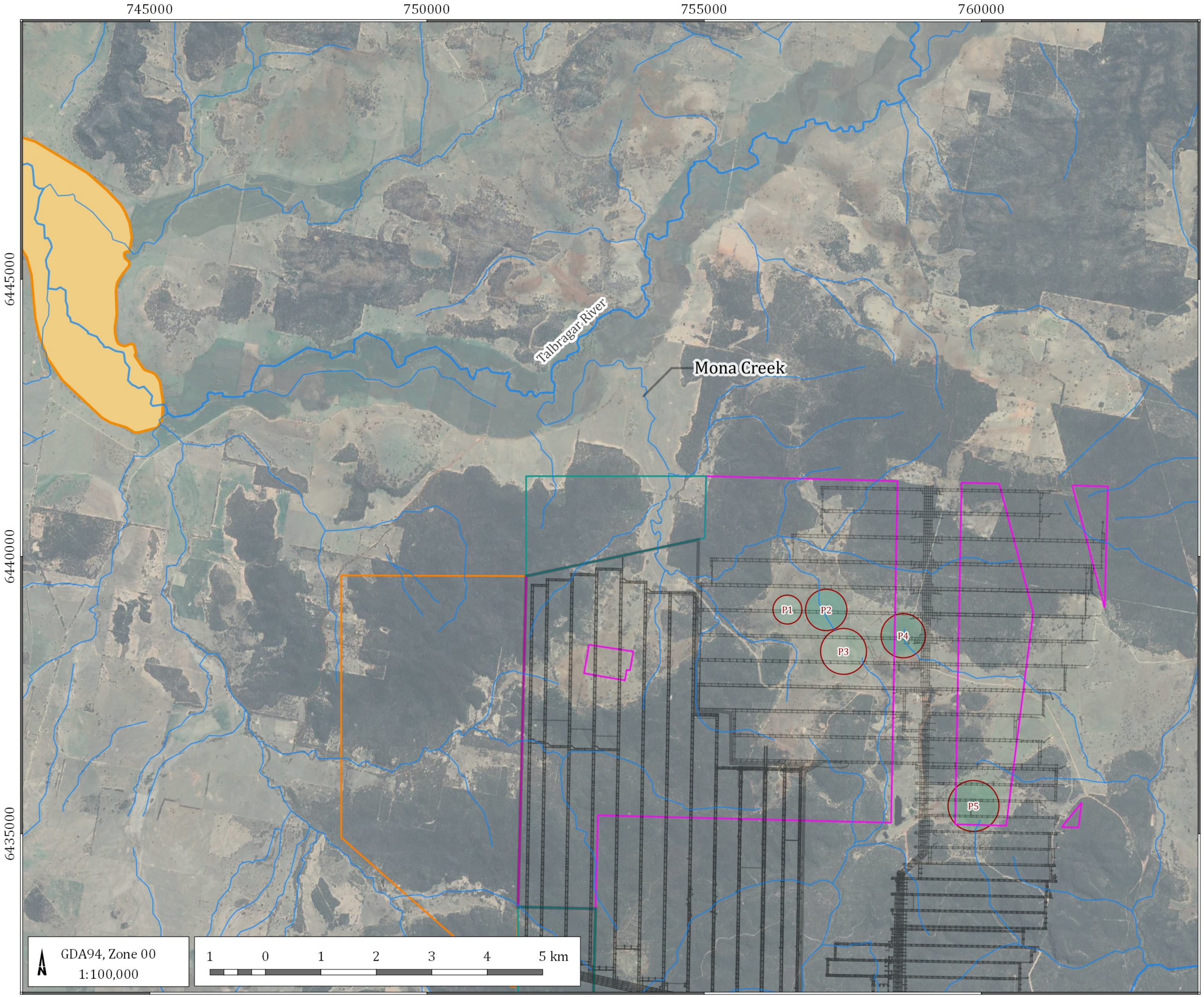
In 2015, detailed radiometric surveys (Uranium, Thorium and Potassium distribution) were undertaken across the Hunter Valley by Geoscience Australia. The survey data is publicly available; however, previous experience (AGE, 2017) has shown that results are not sufficiently detailed to define the extent of the alluvium, with a generic distribution noted for Uranium, Thorium and Potassium. For this reason, radiometric data was not included as part of this desktop study.

In 2017, the OEH published the ASC and GSG datasets (OEH 2017a and OEH 2017b), which synthesised the best land and soil information from across New South Wales into a series of state-wide maps. These include dominant soil types (ASC and GSG, dominant Land and Soil Capability (LSC), dominant Inherent Soil Fertility, Hydrologic Soil Group, Data Confidence and Modelled soil properties. The ASC and GSG datasets characterise the soils in the vicinity of Mona Creek as Natric Kurosols/Sololoths and the soils of the land outside of the creek areas as Rudosols and Tenosols/ Earthy Sands soils (Figure 5.3 and Figure 5.4, respectively). Natric Kurosols/Sololoths are defined as having a strong texture contrast between the A and B horizons, and these horizons tend to be acid and alkaline, respectively. These soils tend to be dispersive and prone to be eroded with the energy occurring in in creek channels, making their presence or absence an indicator of the nature of the material (alluvium vs soil).

Figure 5.5 shows the soil groups classified by the Office of Environment & Heritage (2013) as Biophysical Strategic Agricultural Land (BSAL). BSAL soils can sometimes be used to identify alluvium due to the arable nature of BSAL soils and their locations associated with water ways and flood plains. The map indicates there are no soils that are classified as BSAL soils within the Mona Creek area.

In 2017, the OEH also published the Soil Landscape Regolith Stability (SLRS) map (OEH 2017c) which shows the estimated coherence potential of soils. SLRS maps can be used to identify alluvium as it is more erodible due to its low coherence (when wet). Figure 5.6 does not highlight any areas of low coherence soils.

Hydrological Soil Groups (HGS) categorise soils based on their potential infiltration rates. Infiltration rates can be indicative of alluvium as soils with higher infiltration rates tend to have low clay/silt content making the material more permeable. The HGS mapping characterises the hill slopes adjacent Mona Creek as Category A soil; whereas, Mona Creek itself has not been classified (Figure 5.7). OEH (2017) describes category A soils as "*soils having high infiltration rates, even when thoroughly wetted and consisting chiefly of deep, well to excessively-drained sands or gravels. These soils have a high rate of water transmission*". This description describes the colluvium slopes observed during the site walkover.



LEGEND

water courses Ulan

Major

Minor

Mine area

Underground mine plan

Exploration licences

EL5573

EL7542

EL8687

Bobadeen Irrigation System

Bobadeen Irrigation System

Groundwater productivity (AIP 2012)

Alluvial - highly productive

UCML - Mona Creek Investigation Plan (G1844P)

Highly productive alluvium

DATE

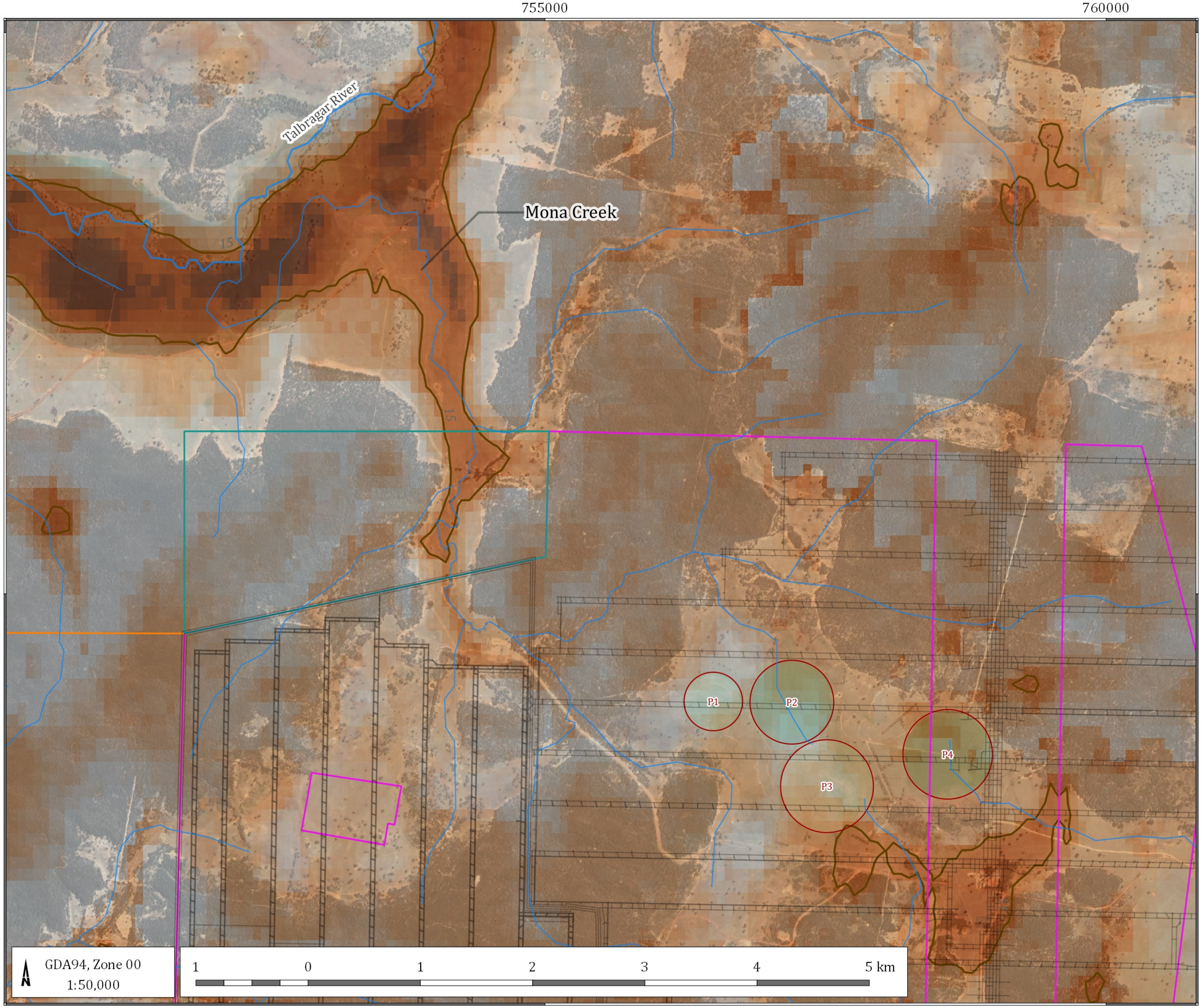
12/03/2019

AGE

FIGURE No:

5.1

N:\Groundwater Jobs\G1844P.Ulan mona Ck walkover and drill plan\3_GIS\Workspaces\G1844P.Mona Creek\05.01_G1844P_Mine disturbance and AIP highly productive alluvium.qgs



LEGEND

water courses Ulan

- Major
- Minor

Mine area

- Underground mine plan

Exploration licences

- EL5573
- EL7542
- EL8687

Bobadeen Irrigation System

- Bobadeen Irrigation System

Regolith thickness (m)

- 1
- 2
- 5
- 10
- 12
- 15
- 20
- 22
- 25
- Contour line - greater than 15 m regolith thickness

UCML - Mona Creek Investigation Plan (G1844P)

Depth of regolith

DATE
12/03/2019

AGE

FIGURE No:
5.2

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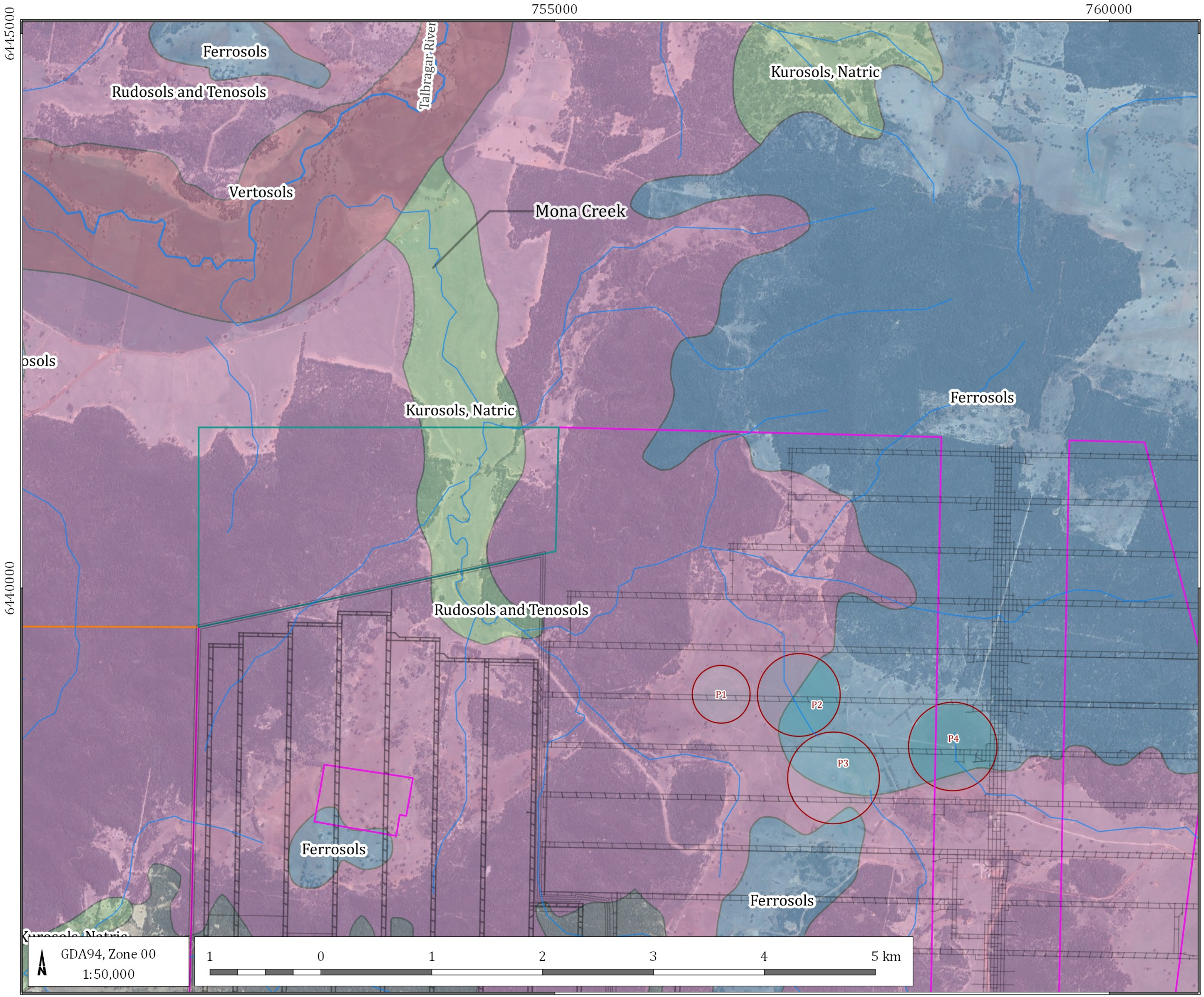

LEGEND

water courses Ulan

Major

Minor

Mine area

Underground mine plan

Exploration licences

EL5573

EL7542

EL8687

Bobadeen Irrigation System

Bobadeen Irrigation System

Australian Soil Classification

Kurosols, Natric

Ferrosols

Rudosols and Tenosols

Tenosols

Vertosols

UCML - Mona Creek Investigation Plan (G1844P)

Australian Soil Classification (ASC)

DATE

12/03/2019

FIGURE No:

5.3

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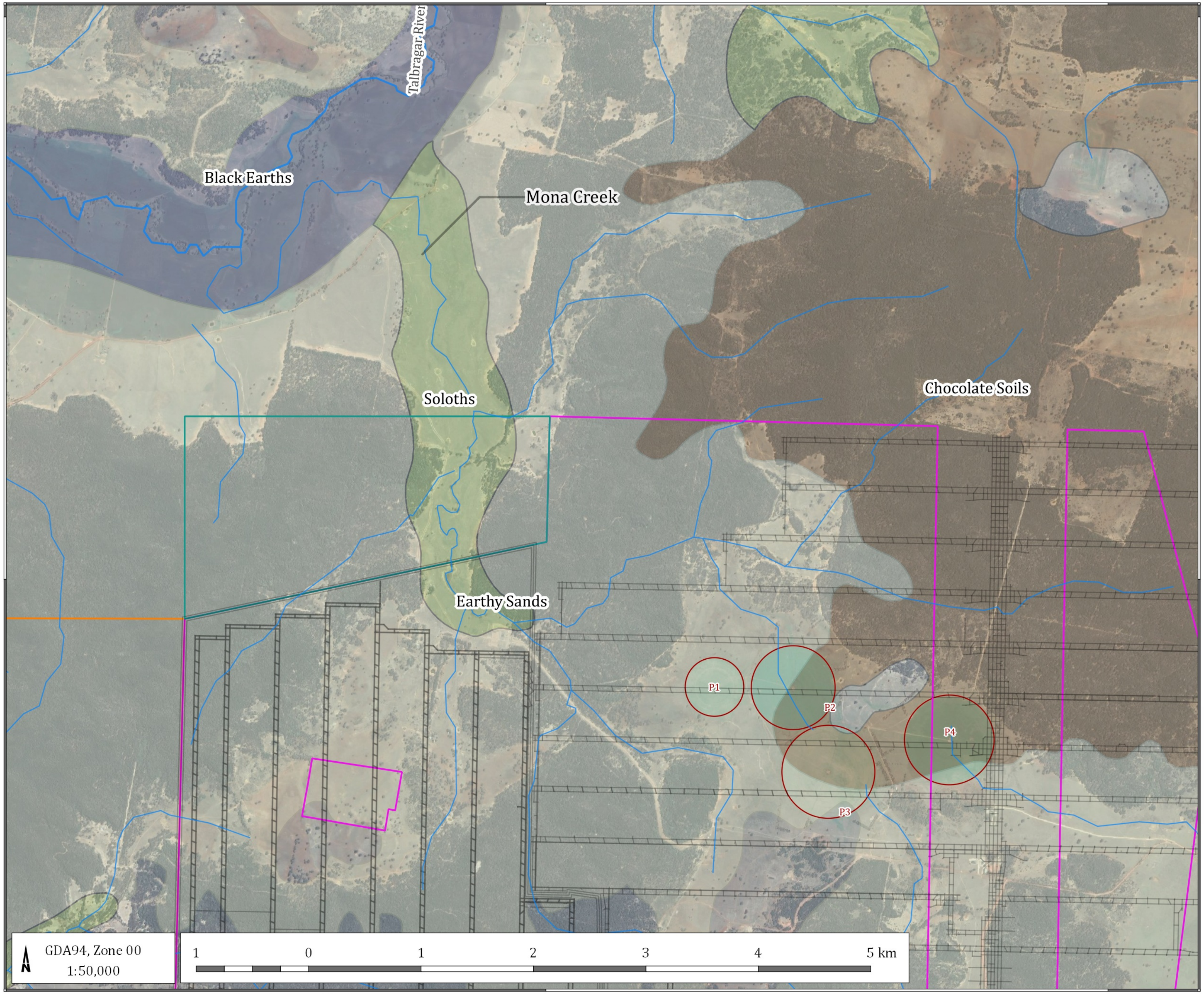

LEGEND

water courses Ulan

- Major
- Minor

Mine area

- Underground mine plan

Exploration licences

- EL5573
- EL7542
- EL8687

Bobadeen Irrigation System

- Bobadeen Irrigation System

NSW Greater Soil Groups (GSG)

- Solodic Soils
- Soloths
- Black Earths
- Chocolate Soils
- Earthy Sands

UCML - Mona Creek Investigation Plan (G1844P)

Greater Soil Groups

DATE
12/03/2019

AGE

FIGURE No:
5.4

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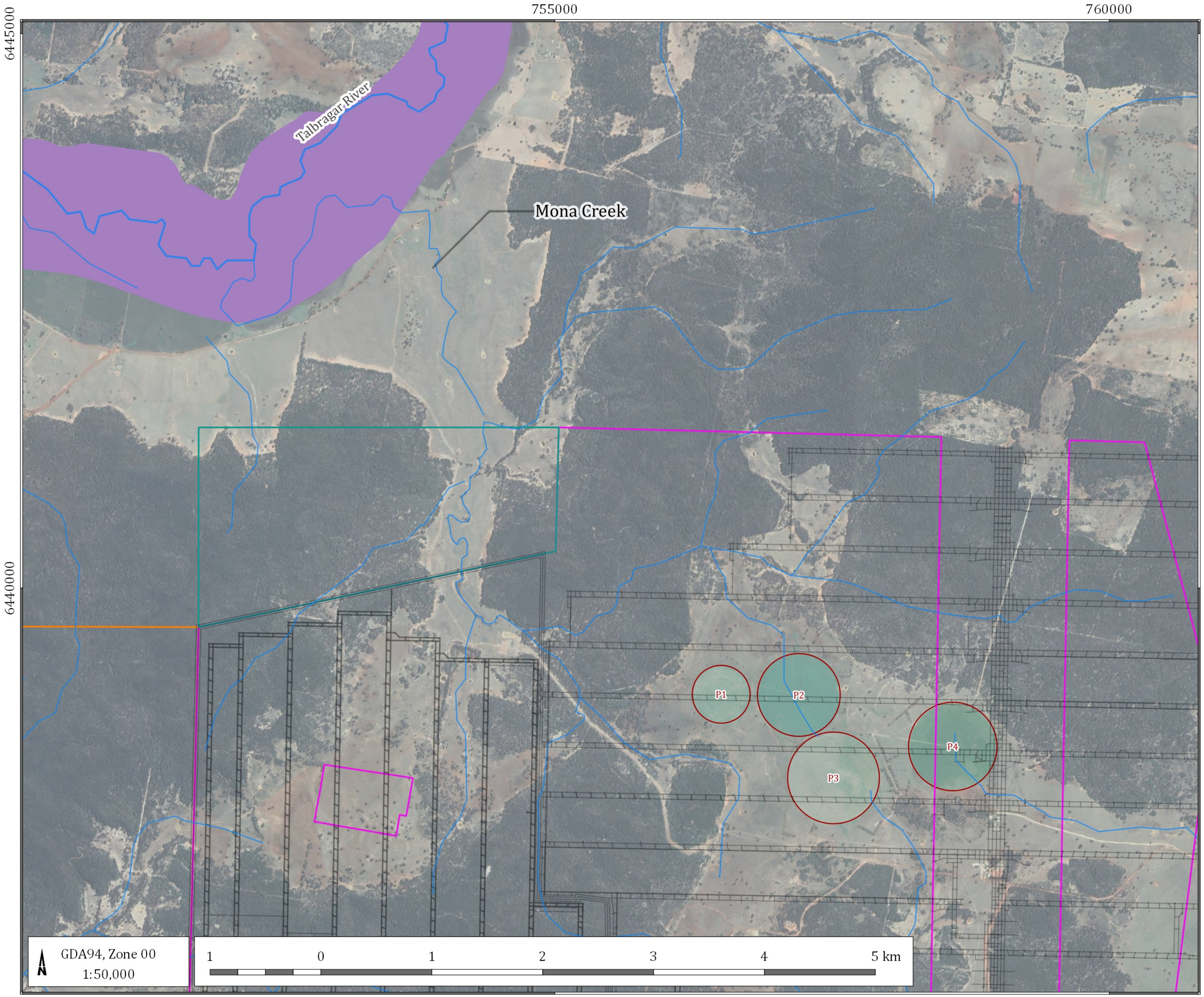

LEGEND

water courses Ulan

Major

Minor

Mine area

Underground mine plan

Exploration licences

EL5573

EL7542

EL8687

Bobadeen Irrigation System

Bobadeen Irrigation System

BSAL land

BSAL land

UCML - Mona Creek Investigation Plan (G1844P)

BSAL classification

DATE

12/03/2019

FIGURE No:

5.5

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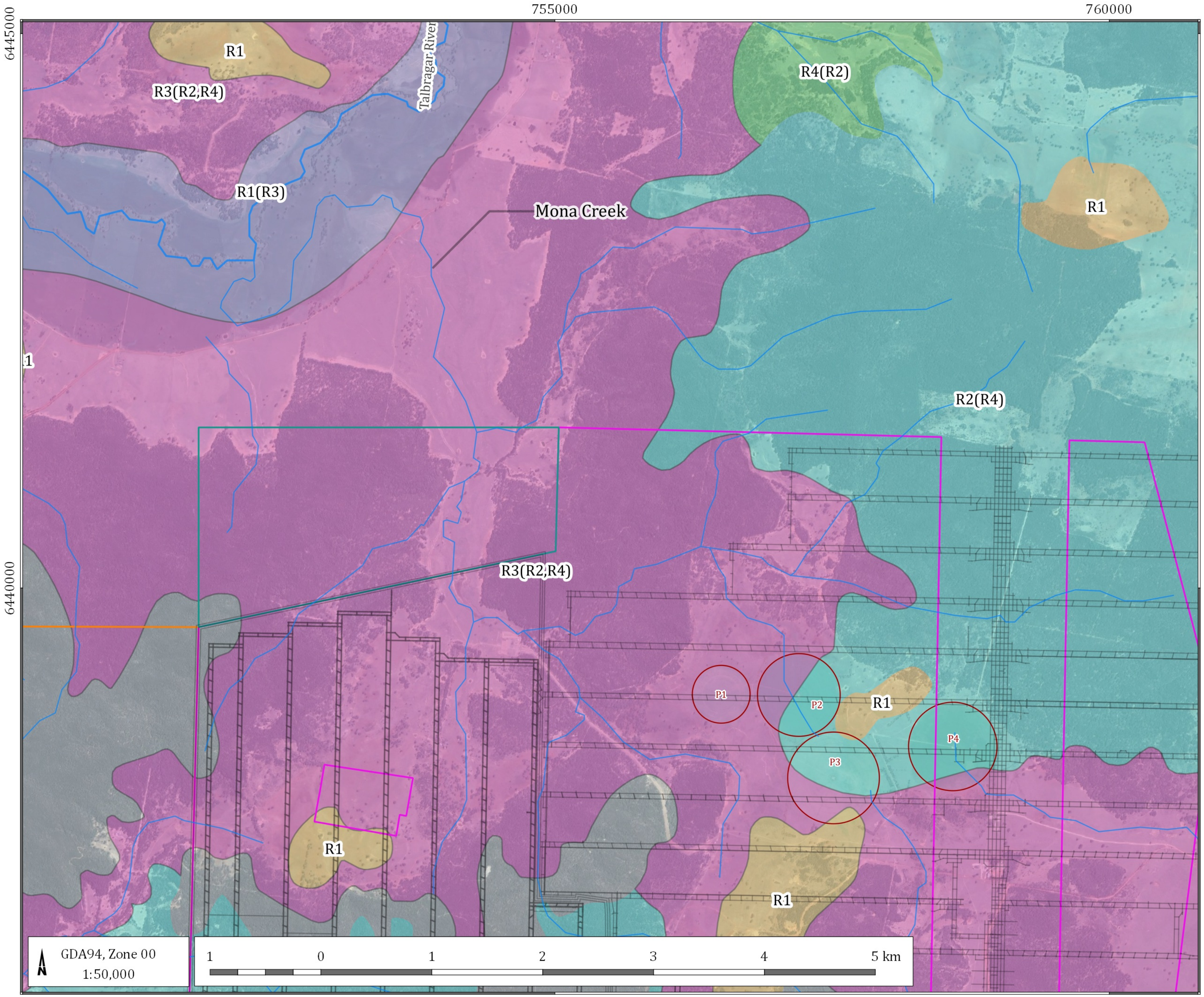

LEGEND

water courses Ulan

- Major
- Minor

Mine area

- Underground mine plan

Exploration licences

- EL5573
- EL7542
- EL8687

Bobadeen Irrigation System

- Bobadeen Irrigation System

Soil Regolith Stability

- R1
- R1(R3)
- R2(R4)
- R3(R2,R4)
- R4(R2)

UCML - Mona Creek Investigation Plan (G1844P)

Soil Regolith Stability

DATE
11/03/2019

AGE

FIGURE No:
5.6

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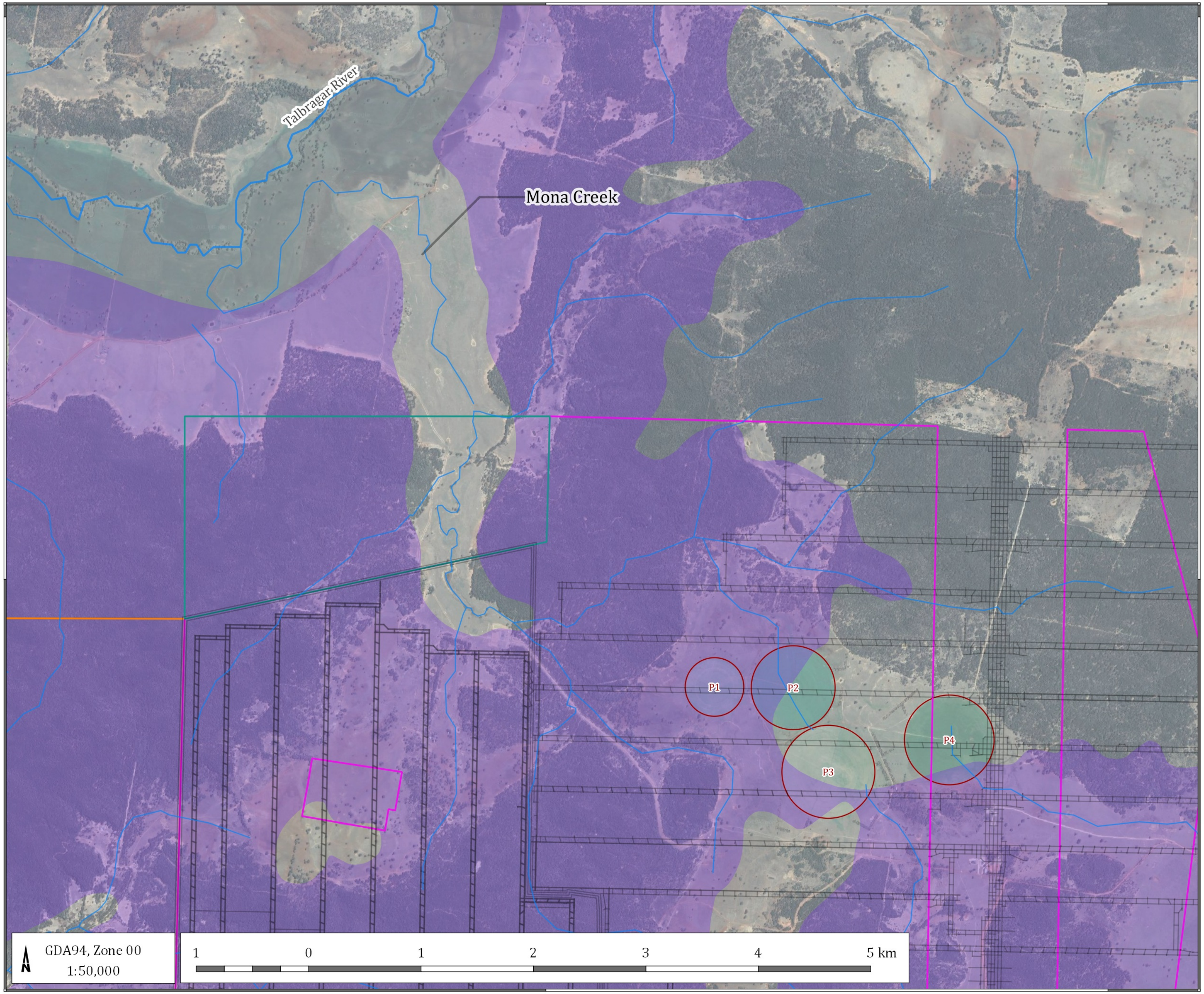

LEGEND

water courses Ulan

Major

Minor

Mine area

Underground mine plan

Exploration licences

EL5573

EL7542

EL8687

Bobadeen Irrigation System

Bobadeen Irrigation System

NSW Hydrologic Soil Groups

Category A soil - high infiltration potential

UCML - Mona Creek Investigation Plan (G1844P)

NSW Hydrologic Soil Groups

DATE

11/06/2019

FIGURE No:

5.7

\\age-main01\ntldata\Groundwater Jobs\G1844P.Ulan mona Ck walkover and drill plan\3_GIS\Workspaces\G1844P.Mona Creek\05.01_G1844P_Mine disturbance and AIP highly productive alluvium.qgs

6 Field observations

The following notes are related to the Mona Creek area inspection:

- The Mona Creek area is characterised by a shallow valley, up to 800 m wide near the confluence with the Talbragar River, bound by rocky sandstone outcrops and cliffs.
- The base of the valley, within 1.5 km of Blue Springs Road, is likely to host potentially saturated alluvium. The alluvium in the lower reaches of Mona Creek is likely to be only a few metres thick (3 m to 5 m) and between 150 m and 500 m wide. The middle reaches of the creek, as far up-stream as the UWLW06 Pleuger pump station may potentially host some limited alluvium of variable thickness, which is not likely to be saturated. The alluvium[1], if present, is likely less than 3m thick and laterally extends between ~5 m and 150 m in width.
- The sandstone that comprise the cliff lines appears to extend out under the valley floor and sub crop up to 400 m from the tree line. Mona Creek is likely to be incised into the sandstone that forms the rocky outcrops of the cliff lines (refer Figure 6.1). These subcrops of sandstone may host localised bodies of "perched" groundwater based on the low permeability of the bedding structures. The subcropping sandstone is covered with 2 m to 3 m of soil/colluvium[2] derived from the sandstone itself.
- The "stepped" nature of the valley (as far as the UWLW06 Pleuger pump station) is likely a reflection of the sandstone subcrops, colluvium and alluvium (refer Figure 6.2).
- Up-stream of the UWLW06 Pleuger, the Mona Creek valley becomes very narrow with what is likely to be only a very shallow cover of colluvium, talus scree and slope creep. Mona Creek (in this area) is likely to not host an alluvial aquifer.

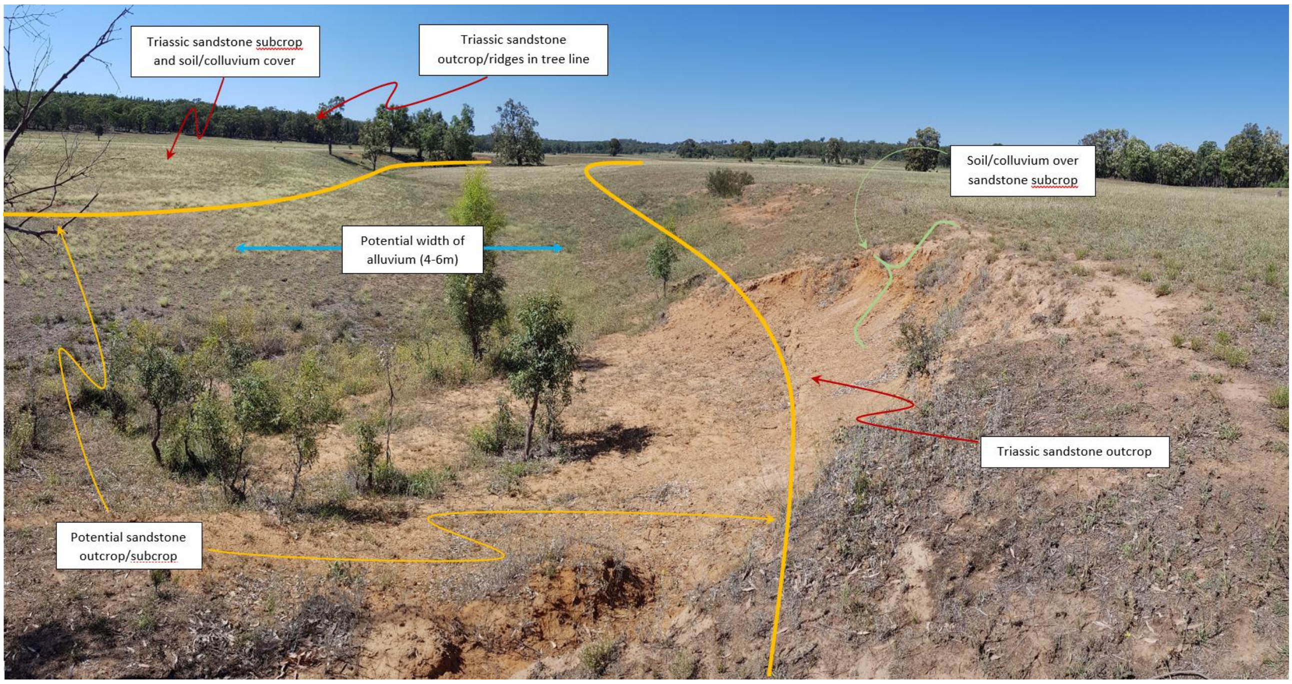

Figure 6.1 View of Mona Creek with sandstone outcrop in creek bank

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[1] Alluvium is defined as water transported sediment that shows water flow and/or transport structures.

[2] Colluvium is material transported/deposited by rain-wash and/or slope creep. Colluvium tends to be relatively low permeability material that collects at the base of slopes and/or in surface depressions.

The cross-section shown in Figure 6.2 is an interpreted section across Mona Creek. The stepped nature of the Triassic sandstone can be seen underlying the Mona Creek alluvial/colluvial material. The bedding planes in this type of sandstone tend to be lower permeability and can cause groundwater to perch in localised areas. This may be how shallow test pits undertaken by the landowner may have intersected groundwater. The shallow Triassic sandstone sub-crops may also host groundwater within its mass, whether in the pore space of the rock or within the fractures, joints and bedding/cross-bedding planes. The alluvium does not appear to extend up-stream of UWLW06 Plueger pump station (refer Figure 6.3).

The groundwater within the Triassic units is likely to be recharging the alluvium to some degree due to the water level in PB2 (private bore likely screened in the Triassic units) being at a higher elevation that the base of Mona Creek. The groundwater that may be on the “stepped” sandstone is also likely to be flowing toward the alluvium.

The colluvial sediment (slope creep) that has accumulated on the stepped sandstone is derived from the sandstone cliffs and ridges that surround Mona Creek. The material is likely to be unconsolidated and low in clay/fines. It is also likely to be very permable due to the lack of fines. The alluvium (water transported sediment) is generally accumulated in the creek line. The alluvium can be seen in the air photos and is characterised by vegetation that is greener than that over the colluvial material and sandstone outcrop. An interpreted (from air photos) alluvium extent is shown on Figure 6.3. the extent shown in Figure 6.3 requires ground truthing via a physical investigation method.

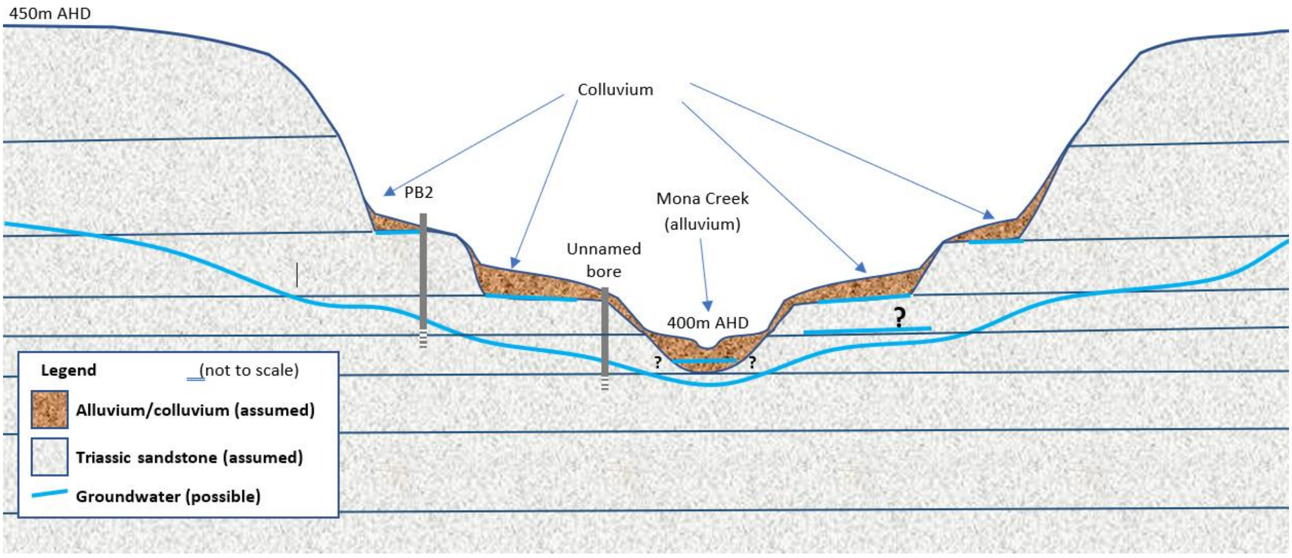
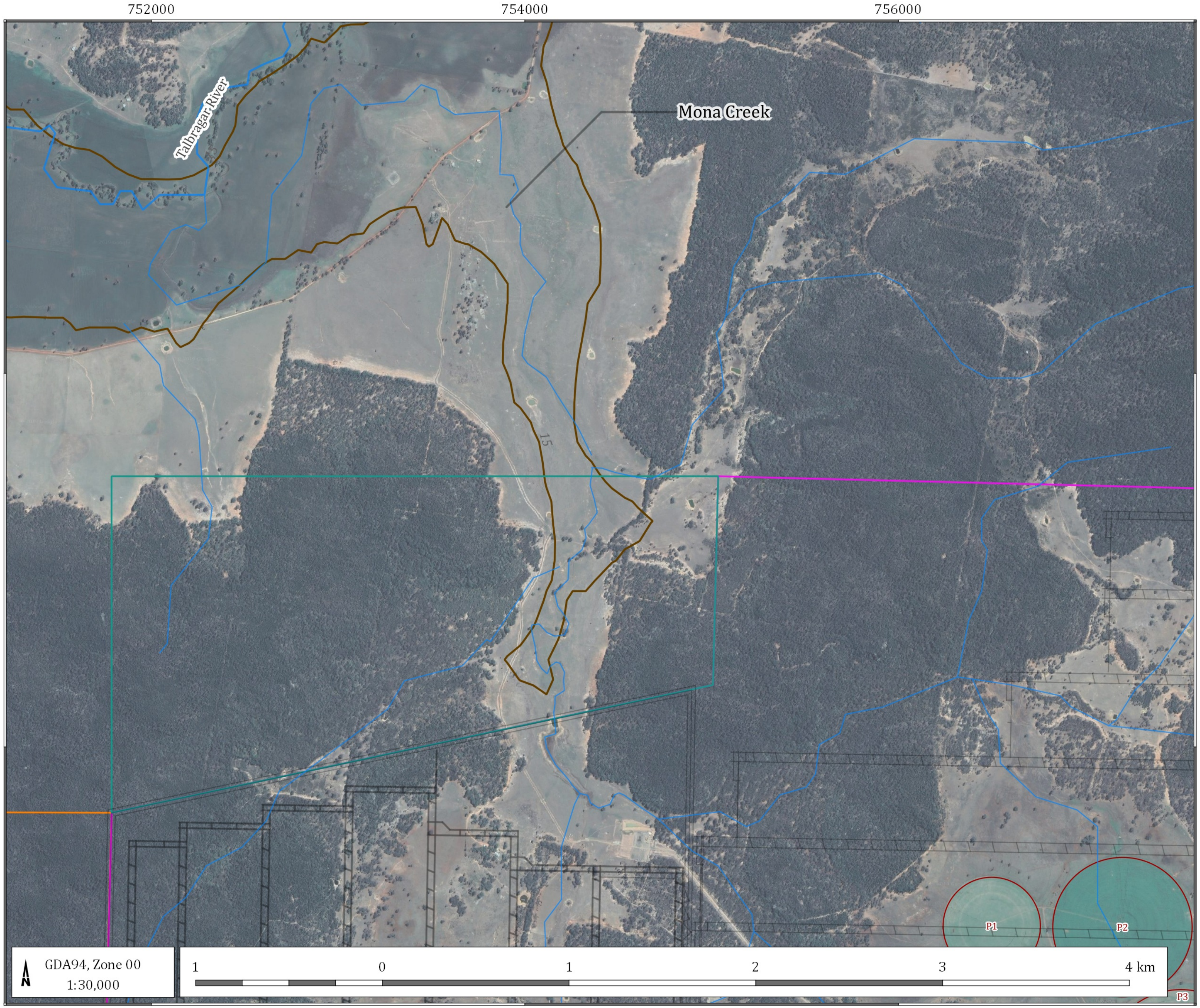


Figure 6.2 Schematic cross-section of Mona Creek



LEGEND

Depth of regolith - greater than 15 m contour

water courses Ulan

Major

Minor

Mine area

Underground mine plan

Exploration licences

EL5573

EL7542

EL8687

Bobadeen Irrigation System

Bobadeen Irrigation System

UCML - Mona Creek Investigation Plan (G1844P)

Potential Mona Creek alluvium extent (from CSIRO regolith remote sensing data)

DATE

11/06/2019

FIGURE No:

6.3

\\age-main01\ntldata\Groundwater Jobs\G1844P.Ulan mona Ck walkover and drill plan\3_GIS\Workspaces\G1844P.Mona Creek\05.01_G1844P_Mine disturbance and AIP highly productive alluvium.qgs

7 Discussion

For the purposes of this investigation, alluvium was defined as water transported sediment that showed water flow and/or transport structures. Alluvium is generally sandy and of moderate to high permeability. Colluvium is material that was transported/deposited by rain-wash and/or slope creep. Colluvium tends to be low permeability material that collects at the base of slopes and/or in surface depressions.

Deposition of sedimentary material within the Mona Creek valley appears to occur primarily within the narrow base of the valley. The alluvium potentially extends as far as UWLW06 Pleuger pump station. It is unclear whether the alluvium hosts any water permanently. The upper reaches of Mona Creek (as far as the catchment crest) does not appear to host any alluvium. Any alluvium present in the Mona Creek valley is not classified as a “highly productive” groundwater sources under the AIP (2012).

The sides of the Mona Creek valley are covered with colluvial material derived from the Triassic sandstone ridges and cliffs that lie adjacent the creek. The colluvium is underlain with Triassic sandstone that may host a water table aquifer and/or a perched aquifer.

8 Recommendations

In order to investigate the alluvium further and to better define the extent and depth of alluvium, one or more of the following may be undertaken:

- geophysical investigation;
- monitoring bore installation; and/ or
- exploratory drillholes.

These tasks will be undertaken as a phased investigation with the preceding task informing the following task(s). The first task should be a non-intrusive geophysical investigation (deep ground penetrating radar [DGPR]) of the Mona Creek valley. The DGPR investigation will assess the 3D extents of the alluvium and attempt to identify areas of colluvium and sub-cropping Triassic sandstone. The DGPR will also be used to attempt to identify groundwater levels in the various geological units in the survey area.

Following the geophysical survey, we may propose to install nested alluvium/sandstone monitoring bores. Where appropriate, at each location, separate alluvium bores and sandstone bores will be installed. These bores will target areas identified as alluvium and potentially water bearing sandstone/colluvium. These bore nests are intended to investigate the state of saturation of each unit at the same location along the creek line.

Areas that may be highlighted by the geophysical investigation as requiring intrusive investigation will be targeted using exploratory drillholes. The drillholes will be used to assess the extent of the Mona Creek alluvium and assess whether the underlying sandstone hosts groundwater. Where groundwater is intersected in the exploratory drillholes a monitoring bore will be installed.

9 References

Department of Planning and Infrastructure (2012), *"Upper Hunter Strategic Regional Land Use Plan".*

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Appendix A Mona Creek site walkover memo

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CC/AMD:kc (G1844P.Ulan Mona Ck Site Visit Notes)
30 January 2019

Attention: Robyn Stoney

Ulan Coal Mine Limited

via email

Dear Robyn,

RE: Ulan Coal - Mona Creek Site Visit Notes

1 Introduction

Ulan Coal Mines Limited (UCML) has committed to collecting more hydrogeological data in the Mona Creek area to allow establishment of existing groundwater conditions for these systems. Ulan commissioned Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) undertake the investigation and design a monitoring program which will be implemented within 12 months of approval of Modification 4 (MOD4).

The following is a summary of the initial site visit and notes relating to the conversation with the landowner – Mr Geoff Mitchell.

Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) was contacted by Lucy Stuart on 10 December 2018 (Stuart/Conte) to request that AGE submit a proposal for the above work.

2 Scope

The scope for the work undertaken as part of the initial site visit included:

- meeting with Geoff Mitchell (land owner) and discussion regarding alluvium and modelling;
- Mona Creek site walkover for data collection for modelling purposes; and
- preparation of brief memo summarising discussion points and findings.

3 Method

The site visit was undertaken on 17 and 18 January 2019 by Principal Hydrogeologist – Costante Conte.

The meeting with Geoff Mitchell (GM) was undertaken on the property owned by GM and attended by Robyn Stoney and Lucy Stuart of UCML. The meeting was intended to collect anecdotal evidence of the presence of groundwater in the Mona Creek valley and adjoining tributaries.

Following the meeting with GM, Lucy Stuart and Costante Conte undertook a walk-over of the creek area. The walk-over began at the down-stream limit of Mona Creek (at Blue Springs Road), close to the confluence with the Talbragar River. The Mona Creek area was inspected from the lower reaches of the creek to the top of the main creek line's catchment. Figure 3.1 shows the approximate location of the site walk-over.

Figure 3.1 Mona Creek site walk-over path (not to scale)

4 Observations

4.1 Meeting with Geoff Mitchell

The following are points of note made by Geoff Mitchell.

- GM stated that the alluvium has always been very productive and that there have been no mine baseline studies undertaken prior to mining.
- Test pits (three to four) have been undertaken in the past to test areas for potential groundwater supply sites. One test pit close to the tree line on the north-eastern side of the Mona Creek area intersected water at 3 m to 4 m below ground level (mBGL). GM stated that the test pit appeared to be very productive/high yielding; however, the yield was not tested.
- Several test bores were drilled in the Mona Creek area. One water bore is still accessible – refer Figure 4.1.
- GM identified a timber lined well (likely excavated by hand) on the adjacent property (owned by UCML). The base of the well was 3.5 mBGL and was dry at the time of inspection. The well head was at ground level and was likely susceptible to inflow of detritus during rainfall; therefore, the total depth of the well may be less than at the time of its construction.
- The Mona Creek area is exposed to flood conditions during high rainfall periods. GM stated that the creek can flow with 5 feet (1.53 m) of water.
- GM believes that insufficient development of baseline groundwater conditions has been undertaken to date, stating that the upper reaches of the Mona Creek catchment has been impacted by the mining of UWLW05.

Figure 4.1 Approximate location of water bore and well (not to scale)

4.2 Site walk-over

The following notes are related to the Mona Creek area inspection:

- The Mona Creek area is characterised by a shallow valley, up to 800 m wide near the confluence with the Talbragar River, bound by rocky sandstone outcrops and cliffs.
- The base of the valley, within 1.5 km of Blue Springs Road, is likely to host potentially saturated alluvium. The alluvium in the lower reaches of Mona Creek is likely to be only a few metres thick (3 m to 5 m) and between 150 m and 500 m wide. The middle reaches of the creek, as far up-stream as the UWLW06 Pleuger pump station may potentially host some limited alluvium of variable thickness, which is not likely to be saturated. The alluvium[1], if present, is likely less than 3m thick and laterally extends between ~5 m and 150 m in width.
- The sandstone that comprise the cliff lines appears to extend out under the valley floor and sub crop up to 400 m from the tree line. Mona Creek is likely to be incised into the sandstone that forms the rocky outcrops of the cliff lines (refer Figure 4.2). These subcrops of sandstone may host localised bodies of "perched" groundwater based on the low permeability of the bedding structures. The subcropping sandstone is covered with 2 m to 3 m of soil/colluvium[2] derived from the sandstone itself.
- The "stepped" nature of the valley (as far as the UWLW06 Pleuger pump station) is likely a reflection of the sandstone subcrops, colluvium and alluvium.
- Up-stream of the UWLW06 Pleuger, the Mona Creek valley becomes very narrow with what is likely to be only a very shallow cover of colluvium, talus scree and slope creep. Mona Creek (in this area) is likely to not host an alluvial aquifer.

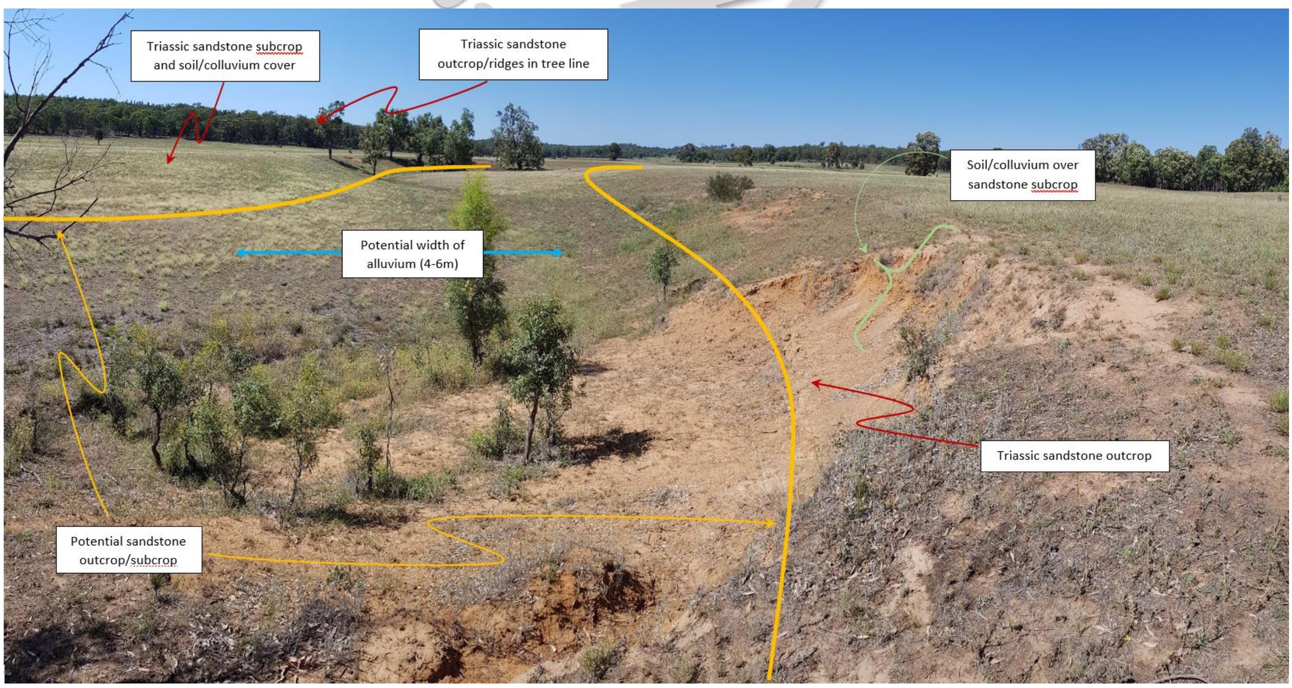

Figure 4.2 View of Mona Creek with sandstone outcrop in creek bank

[1] Alluvium is defined as water transported sediment that shows water flow and / or transport structures.

[2] Colluvium is material transported/deposited by rain-wash and/or slope creep. Colluvium tends to be relatively low permeability material that collects at the base of slopes and / or in surface depressions.

5 Suggested approach to drilling and investigation

We suggest continuing the assessment of the Mona Creek area with the following tasks:

- Review locations for potential test pits. The tests pits will likely need to be in the creek line to determine whether alluvium is present at different locations within the creek. The test pits will also target areas of potential water identified by Geoff Mitchell.
- Review locations for potential clustered monitoring bores, concentrating on areas of potential alluvium and sandstone subcrop based on this letter report.
- UCML to review access requirement of test pits and drilling locations adjacent to Mona Creek.
- Undertake a cost benefit analysis of a geophysical investigation to assess the extent of alluvium and subcropping sandstone.

6 Closure

If you have any queries, please do not hesitate to call.

Yours sincerely,

Costante Conte
Principal hydrogeologist/NSW manager
Australasian Groundwater and Environmental Consultants Pty Ltd