

MEMORANDUM

Date: 31/01/2014

Author: Rebecca Richards

TITLE: Structural and geological interpretation and assessment of Groundwater Monitoring Bore locations.

1. INTRODUCTION

ABM will be installing 17 water monitoring bores on MLA29822 and surrounding tenements as part of a wider water monitoring programme for the proposed Twin Bonanza 1 Mine. Because the majority of the proposed disturbance has not occurred, true pre-mine or “background” data may still be collected from the proposed monitoring bores in the period prior to full-scale mining activity.

This memo focuses on the 12 water monitoring bores on MLA29822, which will be installed (pending authorisation) in 2014. These bores focus on monitoring the currently active bore Corsair and planned infrastructure.

The initial groundwater monitoring sites were proposed by consultants Soil and Water Group (SWG) in 2013 as part of the mine planning and the EIS (Earth Systems, 2013 and Soil and Water Group, 2013). These sites have been selected according to the Australian Guidelines for Water Quality Monitoring and Reporting (ARMCANZ, 2000) so that representative samples of the un-impacted (native or control) and potentially impacted groundwater may be collected both in the pre-mine period and throughout the life of mine. The monitoring program has been designed as a “Before-After, Control-Impact” (BACI) program, with priority applied to early detection, and assessment of biodiversity or ecosystem level response. Refer to the Water Management Plan (Soil and Water Group, 2013) for further details.

2. AIM / OBJECTIVES

The aim of this memo is to optimise the indicative locations proposed by SWG through structural and geological interpretation and assessment. Table 1 outlines the SWG proposed 17 Groundwater monitoring bores, their indicative locations and key target parameters.

Table 1. Proposed Groundwater monitoring bores.

ID	General Location	Easting	Northing	Type	Aquifer
CB	Corsair's Bore	516550	7770180	Production bore	Bedrock
WB	Wilson's Bore	513529	7767170	Production bore	Palaeochannel
TB	Timmy's Bore	509507	7764901	New production bore	Palaeochannel
A01	4.1 km north of site	517374	7772534	Analogue	Bedrock
A02	3.7 km north of site	516995	7772128	Analogue	Palaeochannel
A03	3.7 km northwest of site	514335	7772882	Analogue	Palaeochannel
BF01	1 km up-gradient of TB	509830	7765915	Monitoring bore	Palaeochannel
BF02	200 m up-gradient of TB	509559	7765126	Monitoring bore	Palaeochannel
BF03	200 m adjacent to TB	509726	7764848	Monitoring bore	Palaeochannel
BF04	200 m down-gradient of TB	509444	7764705	Monitoring bore	Palaeochannel
M01	Down-gradient of WRD1	515432	7768610	Monitoring bore	Palaeochannel
M02	Down-gradient of WRD1	515115	7767679	Monitoring bore	Palaeochannel
M03	Down-gradient of TD / WRD2	515115	7766395	Monitoring bore	Palaeochannel
M04	Down-gradient of TD / WRD2	515525	7765687	Monitoring bore	Palaeochannel
M05	Northwest of WRD 1	515417	7768518	Monitoring bore	Bedrock
M06	Southwest of TD	515794	7765681	Monitoring bore	Bedrock
M07	Central to the site	516269	7767033	Monitoring bore	Bedrock
M08	Northeast of pits	516738	7768477	Monitoring bore	Bedrock
M09	Southeast of WRD 2	516951	7766088	Monitoring bore	Bedrock
M10	200 m down-gradient of WB	513277	7767141	Monitoring bore	Palaeochannel

Each of these falls into one of the following categories:

1. The existing production bores (3)
2. Four monitoring Bores (M01 M04) are intended to intercept the primary potential contaminant pathways down-gradient from the site.
3. Five deep bores within the vicinity of the site will also be monitored (M05 M09).
4. Three “background” or “analogue” sites (A01 – A03) are intended to provide monitoring data for areas similar to those being monitored within the TBGP.
5. Four monitoring bores (BF01 – BF04) are proposed for the palaeochannel borefield, in the vicinity of Timmy's Bore, with another located adjacent to Wilson's Bore (M10).

The existing production bores and, monitoring bores BF01-04 and M10 are outside the scope of this memo (Figure 1).

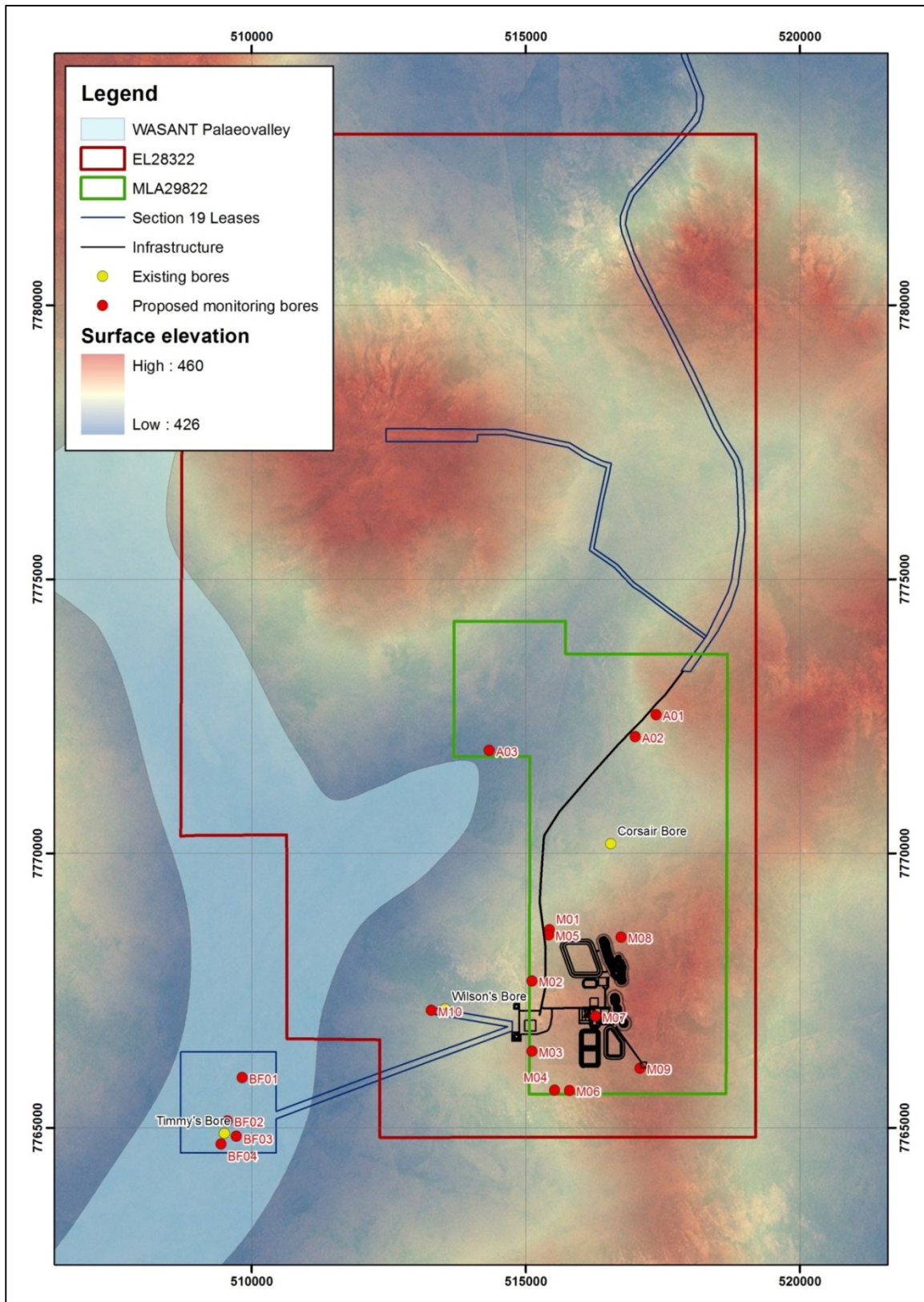


Figure 1. SWG proposed Groundwater monitoring locations.

SWG designed the four monitoring Bores (M01 M04) with the intention to intercept the primary potential contaminant pathways down-gradient from the site. These will be installed in the surficial aquifer, which constitutes the upper catchment of paleochannel

system. The properties and extent of this surficial aquifer are not well known at this stage, and these locations are therefore preliminary; they have been proposed within the intended mineral lease area, and as far downslope as possible. If it is determined that no surficial aquifer system is present this far up-slope, then these monitoring locations may be moved down-slope and additional access agreements may be necessary.

Five deep bores within the vicinity of the site will also be monitored (M05 M09). One of these monitoring bores (M07) will be installed central to the site (adjacent to the Plant and CRD), while the other four will be installed around all four sides of the infrastructure to enable monitoring of groundwater flow in all directions.

In addition, several continuous control sites (or “analogues”) will be established in areas outside of the potential influence of site activities to monitor background levels throughout the life of mine. The three “background” or “analogue” sites (A01 – A03) are intended to provide monitoring data for areas similar to those being monitored within the TBGP. These are located in areas outside of the potential influence of site activity, and will provide a means of distinguishing measured changes in the primary monitoring bores (M01 – M04) from natural fluctuations or variability. Bore A01 will be installed into the bedrock aquifer, while bores A02 and A03 will be installed within the palaeochannel aquifer at similar landscape positions to the monitoring bores.

6. METHODOLOGY

The groundwater monitoring bores applicable to the immediate project (within the bounds of the ML) were extracted from the data set (Table 2, Figure 2). Bore A1 which fell slightly outside the lease was moved to within the bounds of the Mineral Lease whilst maintain the paleochannel target and prospective geology.

Table 2. Proposed Groundwater monitoring bores within ML.

ID	General Location	Type	Easting	Northing	Type	Aquifer
A01	4.1 km north of site	Deep	517374	7772534	Analogue	Bedrock
A02	3.7 km north of site	Shallow	516995	7772128	Analogue	Palaeochannel
A03	3.7 km northwest of site	Deep	514335	7772882	Analogue	Palaeochannel
M01	Down-gradient of WRD1	Shallow	515432	7768610	Monitoring bore	Palaeochannel
M02	Down-gradient of WRD1	Shallow	515115	7767679	Monitoring bore	Palaeochannel
M03	Down-gradient of TD / WRD2	Shallow	515115	7766395	Monitoring bore	Palaeochannel
M04	Down-gradient of TD / WRD2	Shallow	515525	7765687	Monitoring bore	Palaeochannel
M05	Northwest of WRD 1	Deep	515417	7768518	Monitoring bore	Bedrock
M06	Southwest of TD	Deep	515794	7765681	Monitoring bore	Bedrock
M07	Central to the site	Deep	516269	7767033	Monitoring bore	Bedrock
M08	Northeast of pits	Deep	516738	7768477	Monitoring bore	Bedrock
M09	Southeast of WRD 2	Deep	516951	7766088	Monitoring bore	Bedrock

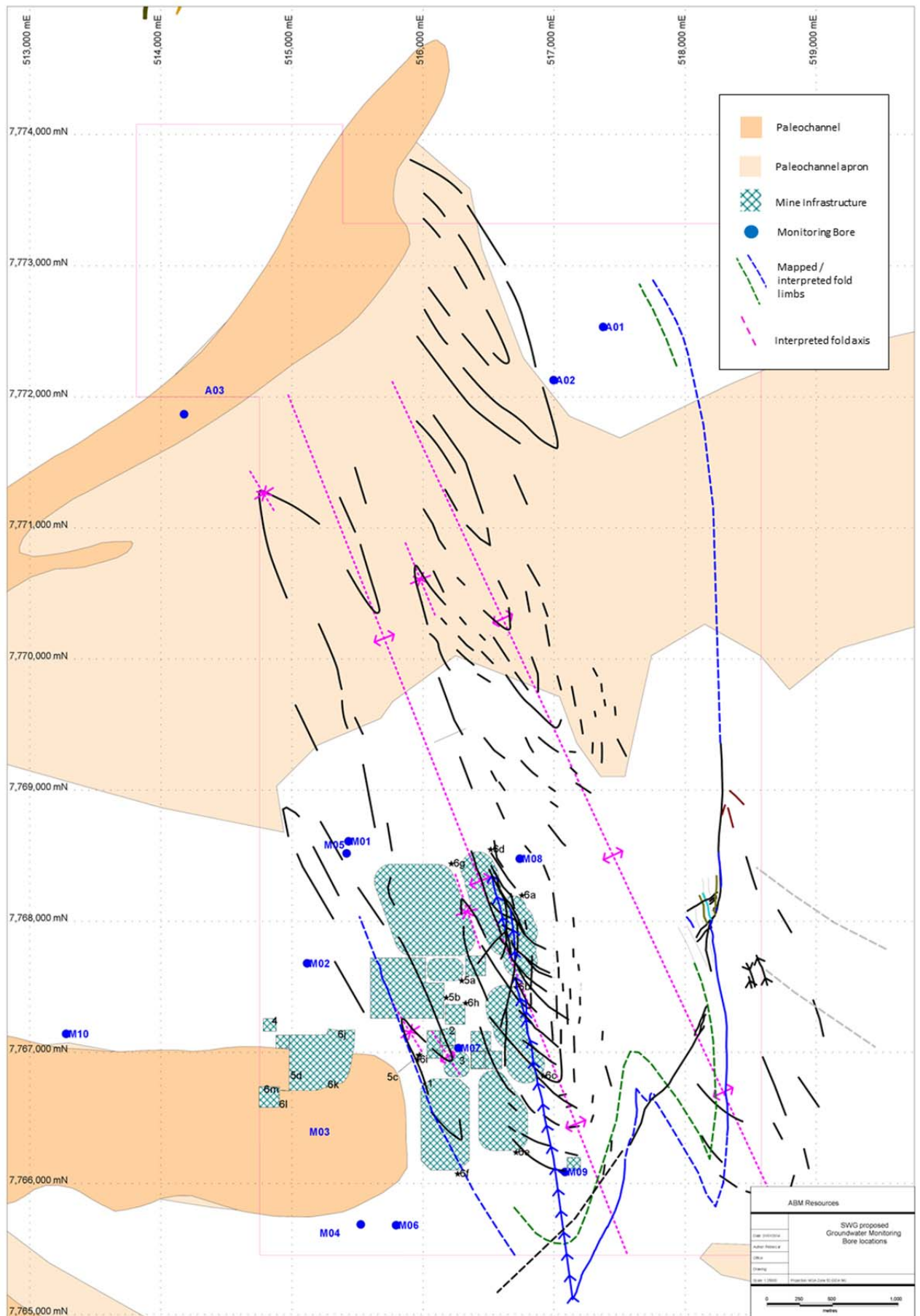


Figure 2. Soil & Water Group proposed groundwater monitoring bore locations and ABM's structural interpretations.

Monitoring bore locations were then assessed against the following spatial, geological and geophysical data (figure 2) and subsequent interpretations in MapInfo:

1. Paleochannels
 - a. derived from satellite imagery (geoeye) and geophysics interpretation – Rodney Boucher (palaeochannel.tab)
2. Two Regional structural interpretations (in-house) based in regional aeromagnetics (fold_airmag_2004.tab & interp.tab).
3. Local (EL28322) structural interpretation (Dr Rodney Boucher)
 - a. Combination of Field Mapping, structural observations and geoeye satellite imagery interpretation (interp_2)

7. RESULTS

The “background” or “analogue” sites (A01 – A03) are intended to provide monitoring data for areas similar to those being monitored within the Twin Bonanza Gold project (MLA29822). A01 lies outside of the paleochannel and is intended to act as an analogue site to the fractured bedrock aquifer at depth. The bore lies within the folded sedimentary packages to the north and it is inferred that it will predicted to intersect the bedrock aquifer through permeability contrasts between sediment packages within the fold structure.

The following analogue bore holes were defined as requiring adjustment based on location within the ML and in relation to specified targets (Figure 3):

1. A02 – moved to within bounds of paleochannel apron
2. A03 – moved to within ML lease boundary, ensuring the bore remains within the paleochannel

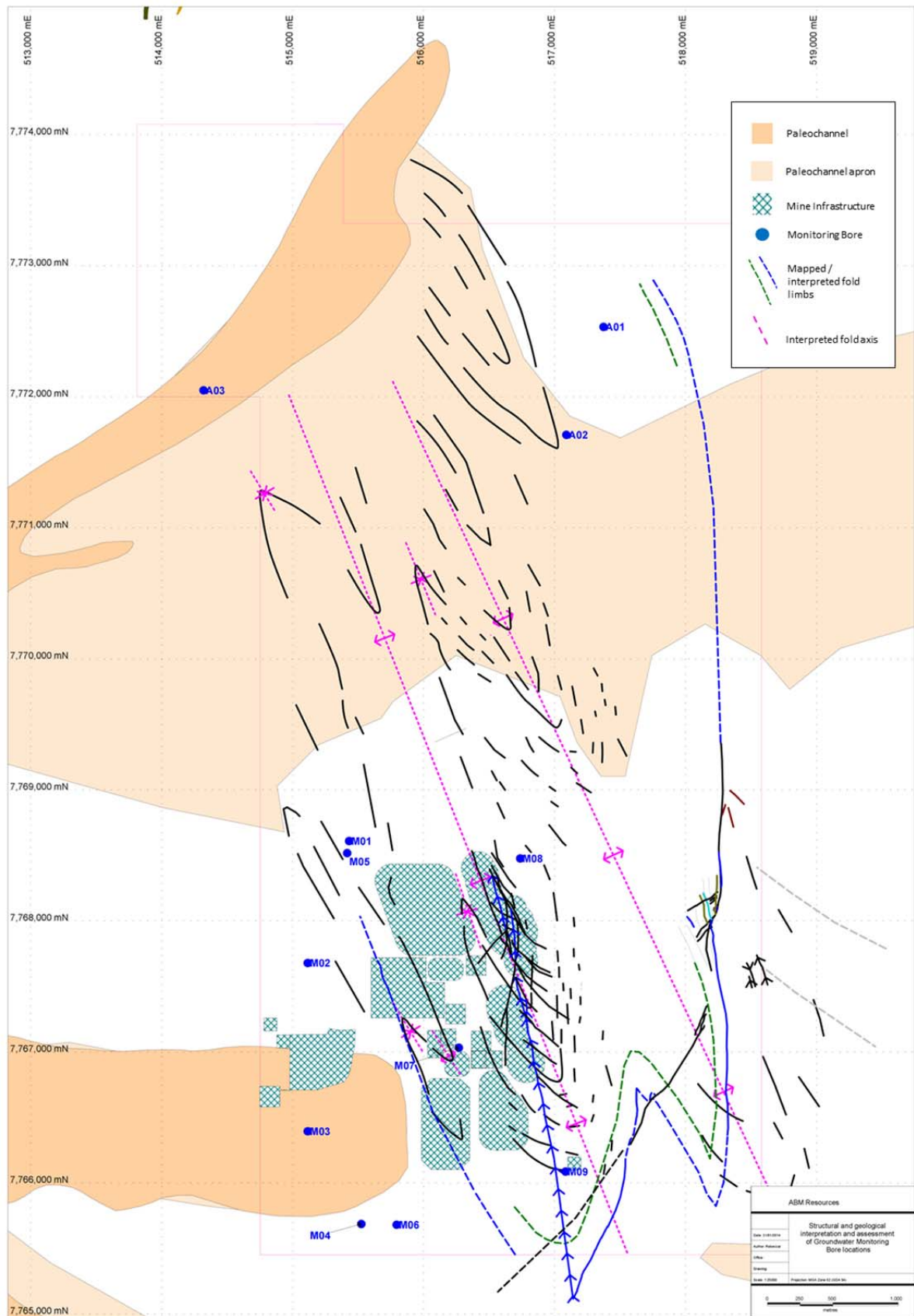


Figure 3. Final Monitoring bore locations for 2014.

The shallow Monitoring bores (M01-4) were confirmed as optimal locations for intersecting the paleochannel down gradient of mine infrastructure. M01, M02 and M04 were not within the modelled paleochannel but in the paleochannel catchment (upstream) contributing to the paleochannel water volumes. These locations were deemed optimal with the present data available.

The deep monitoring bores (M05-09) were confirmed as ideal locations for intersecting the fractured bedrock aquifer at depth. Details of the aquifer are limited and until further information is obtained these locations are indicative; details of their position in relation to the geology and geophysics are detailed below:

1. M05, northwest of the Waste Rock Dump (WRD2), is positioned along a mapped structure interpreted as a fault and therefore should intersect the fractured bedrock aquifer.
2. M07 and M09 both lie along the limbs of a fold axis and are predicted to intersect the bedrock aquifer through permeability contrasts between sediment packages within the fold structure.
3. M06 and M08 are indicative at best and have no supporting geological and geophysical interpretation. More data and interpretation is required prior to installation. These bores are designed to monitor the groundwater to the southwest of the tailings dam (TD) and northwest of the pits and therefore are critical to groundwater quality assessment for the Mine Site – particularly for leachates.

The results are detailed in Table 3.

Table 3. Revised locations of the monitoring bores.

ID	General Location	Type	Easting	Northing	Type	Aquifer	Comments
A01	4.1 km north of site	Deep	517374	7772534	Analogue	Bedrock	Indicative location - more data required, within prospective folded sedimentary packages
A02	3.7 km north of site	Shallow	517090	7771710	Analogue	Palaeochannel	MOVED to within bounds of paleochannel apron
A03	3.7 km northwest of site	Deep	514320	7772050	Analogue	Palaeochannel	MOVED within ML lease bounds and remains in paleochannel
M01	Down-gradient of WRD1	Shallow	515432	7768610	Monitoring bore	Palaeochannel	Target hit - not within modelled paleochannel but in catchment and shallow target obtained
M02	Down-gradient of WRD1	Shallow	515115	7767679	Monitoring bore	Palaeochannel	Target hit - not within modelled paleochannel but in catchment and shallow target obtained
M03	Down-gradient of TD / WRD2	Shallow	515115	7766395	Monitoring bore	Palaeochannel	Target hit
M04	Down-gradient of TD / WRD2	Shallow	515525	7765687	Monitoring bore	Palaeochannel	Target hit - not within modelled paleochannel but in catchment and shallow target obtained
M05	Northwest of WRD 1	Deep	515417	7768518	Monitoring bore	Bedrock	Target hit - mapped structure interpreted as a fault
M06	Southwest of TD	Deep	515794	7765681	Monitoring bore	Bedrock	Indicative location - more data required
M07	Central to the site	Deep	516269	7767033	Monitoring bore	Bedrock	Target hit - lie along the limbs of a fold axis
M08	Northeast of pits	Deep	516738	7768477	Monitoring bore	Bedrock	Indicative location - more data required
M09	Southeast of WRD 2	Deep	516951	7766088	Monitoring bore	Bedrock	Target hit - lie along the limbs of a fold axis

8. CONCLUSION / RECOMMENDATIONS

The monitoring bores (A02 and A03) have been relocated to optimise the monitoring target. The remainder of the bores are satisfactory in their existing location and have not been moved. Due to a lack of data, bores M06, M08, and A01 require further in-depth desktop studies to establish the effectiveness of their location prior to installation.

9. REFERENCES

ANZECC and ARMCANZ (2000): Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Environment Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand. Canberra, ACT.

ARMCANZ, A. a. (2000): Australian Guidelines for Water Quality Monitoring and Reporting. In National Water Quality Management Strategy. October. Canberra, ACT.

Earth Systems (2013): Preliminary groundwater resources assessment for the Old Pirate Gold Project, Tanami Desert, Northern Territory. Prepared for ABM Resources NL by Earth Systems.

Soil and Water Group (2013): Water Management Plan for the Twin Bonanza Project. Prepared for ABM Resources NL by Soil and Water Group.

MEMORANDUM

Date: 26/03/2014

Author: Pascal Hill, after Rebecca Richards

TITLE: Addendum - Structural and geological interpretation and assessment of Groundwater Monitoring Bore locations.

3. INTRODUCTION

In January 2014, Rebecca Richards prepared a memorandum outlining details of 12 water monitoring bores proposed for MLA29822, these bores are designed to monitor the currently active bore at Corsair and planned infrastructure.

The initial groundwater monitoring sites were proposed by consultants Soil and Water Group (SWG) in 2013 as part of the mine planning and the EIS (Earth Systems, 2013 and Soil and Water Group, 2013). These sites have been selected according to the Australian Guidelines for Water Quality Monitoring and Reporting (ARMCANZ, 2000) so that representative samples of the un-impacted (native or control) and potentially impacted groundwater may be collected both in the pre-mine period and throughout the life of mine. The monitoring program has been designed as a “Before-After, Control-Impact” (BACI) program, with priority applied to early detection, and assessment of biodiversity or ecosystem level response. Refer to the Water Management Plan (Soil and Water Group, 2013) for further details.

In Table 3 of Richards’ memo, two proposed locations, being M06 and M08 were noted as having indicative locations, with more data required. Essentially, deep monitoring holes are required within the SW and NE extents of the Old Pirate Mining footprint, however specific locations were not defined by SWG.

4. AIM / OBJECTIVES

The aim of this memo is to outline the revised locations of proposed holes M06 and M08, and to define the parameters and assumptions under which these holes have been repositioned.

Table 4. Proposed Groundwater monitoring bores.

ID	General Location	Easting	Northing	Type	Aquifer
CB	Corsair's Bore	516550	7770180	Production bore	Bedrock
WB	Wilson's Bore	513529	7767170	Production bore	Palaeochannel
TB	Timmy's Bore	509507	7764901	New production bore	Palaeochannel
A01	4.1 km north of site	517374	7772534	Analogue	Bedrock
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M02	Down-gradient of WRD1	515115	7767679	Monitoring bore	Palaeochannel
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M04	Down-gradient of TD / WRD2	515525	7765687	Monitoring bore	Palaeochannel
M05	Northwest of WRD 1	515417	7768518	Monitoring bore	Bedrock
M06	Southwest of TD	515794	7765681	Monitoring bore	Bedrock
M07	Central to the site	516269	7767033	Monitoring bore	Bedrock
M08	Northeast of pits	516738	7768477	Monitoring bore	Bedrock
M09	Southeast of WRD 2	516951	7766088	Monitoring bore	Bedrock
M10	200 m down-gradient of WB	513277	7767141	Monitoring bore	Palaeochannel

Each of these falls into one of the following categories:

10. The existing production bores (3)
11. Four monitoring Bores (M01 M04) are intended to intercept the primary potential contaminant pathways down-gradient from the site.
12. Five deep bores within the vicinity of the site will also be monitored (M05 M09).
13. Three “background” or “analogue” sites (A01 – A03) are intended to provide monitoring data for areas similar to those being monitored within the TBGP.
14. Four monitoring bores (BF01 – BF04) are proposed for the palaeochannel borefield, in the vicinity of Timmy's Bore, with another located adjacent to Wilson's Bore (M10).

The existing production bores and, monitoring bores BF01-04 and M10 are outside the scope of this memo (Figure 1), as are M01 – M05, M07 and M09.

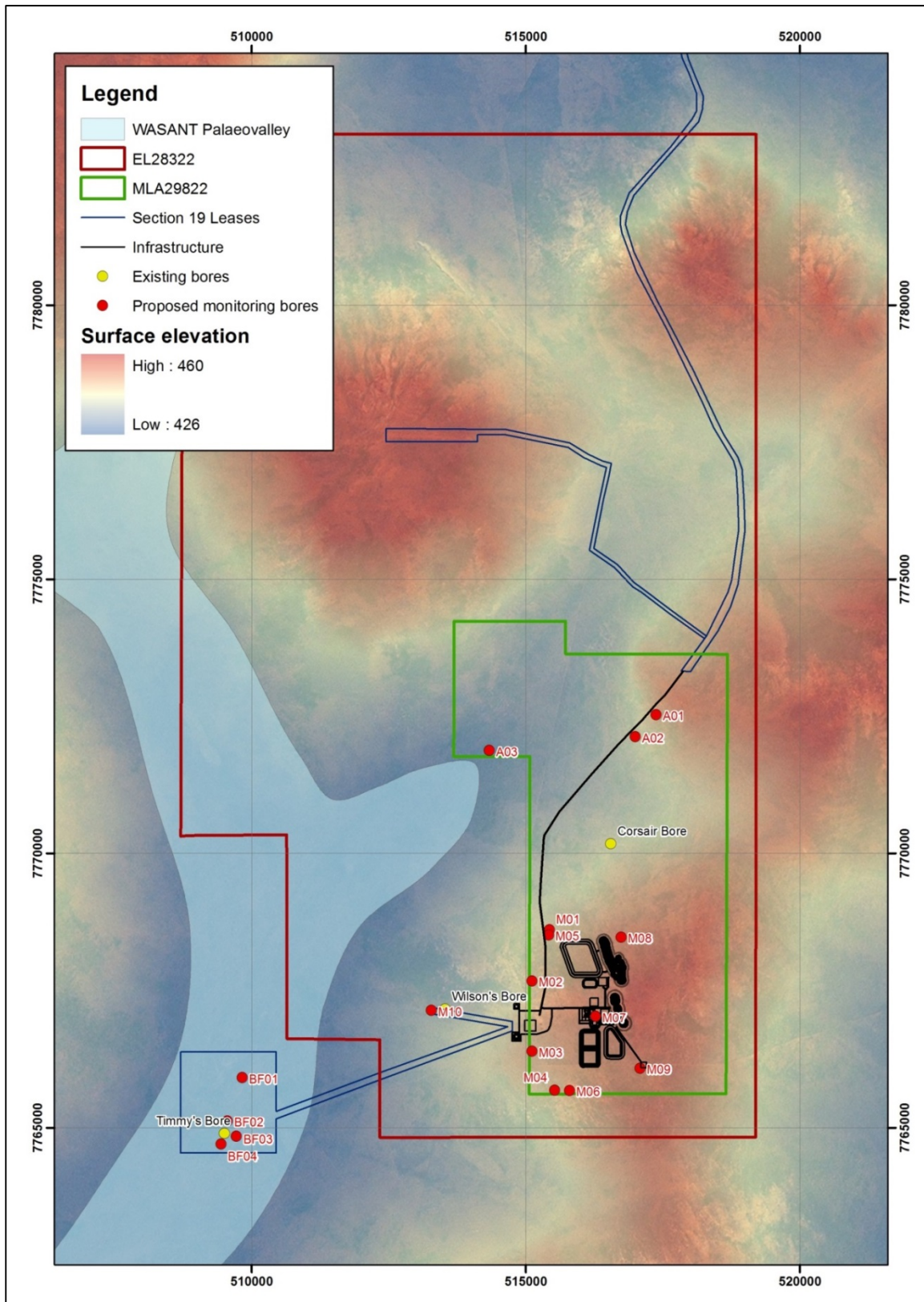


Figure 4. SWG proposed Groundwater monitoring locations.

SWG designed five deep bores within the vicinity of the site (M05 – M09). One of these locations (M07) is installed central to the site (adjacent to the Plant and CRD), while the

other four are designed around all four sides of the infrastructure to enable monitoring of groundwater flow in all directions.

15. METHODOLOGY

Two of the initial waterbore locations have been revised. Both revisions have been based on the potential for structural interactions within the target areas. First-pass bore locations were aimed at situating 4 deep bores peripheral to the Old Pirate operational footprint, to the NW, NE, SE and SW (M05, M08, M09 and M06 respectively). Holes M05 and M09 were targeted on existing known geological features (brittle structural zones).

Holes M06 and M08 did not have sufficient geological support at the time that Richards prepared the original memorandum.

Review of geological mapping, and subsequent interpretation, completed by Boucher in 2011 / 2012, shows that hole M08 (Original) fell close to a likely fault zone in the north of the target area. Mapped NW-SE trending structural offsets in the Bandit prospect area can be extrapolated NW to correlate with NW-SE features observed in mapping at Argo. M08 (Revised) has been translated to the NE to fall within the anticipated margin of this extrapolated fault zone.

Likewise, hole M06 (Original) fell proximal to an extrapolation of features mapped some 4.5km south of Golden Hind. Features are mapped immediately north of M06 (Revised) that support the extrapolation over what seems a considerable distance. The structural feature falls on the western limb of the gross anticline, and as such, there is strong scope for the feature to have significant lateral extent (c.f. mineralisation known at The Western Limb)

16. RESULTS

Following review of geological data, the revised locations for proposed monitoring bores M06 and M08 (hereafter M06a and M08a) are presented below, in Tables 2i and 2ii, and in Figure 3.

Table 5i. Proposed Groundwater monitoring bores within ML.

ID	General Location	Type	Easting	Northing	Type	Aquifer
M06	Southwest of TD	Deep	515794	7765681	Monitoring bore	Bedrock
M08	Northeast of pits	Deep	516738	7768477	Monitoring bore	Bedrock

Table 6ii. Revised Groundwater monitoring bores within ML.

ID	General Location	Type	Easting	Northing	Type	Aquifer
M06a	Southwest of TD	Deep	515930	7765680	Monitoring bore	Bedrock
M08b	Northeast of pits	Deep	516769	7768534	Monitoring bore	Bedrock

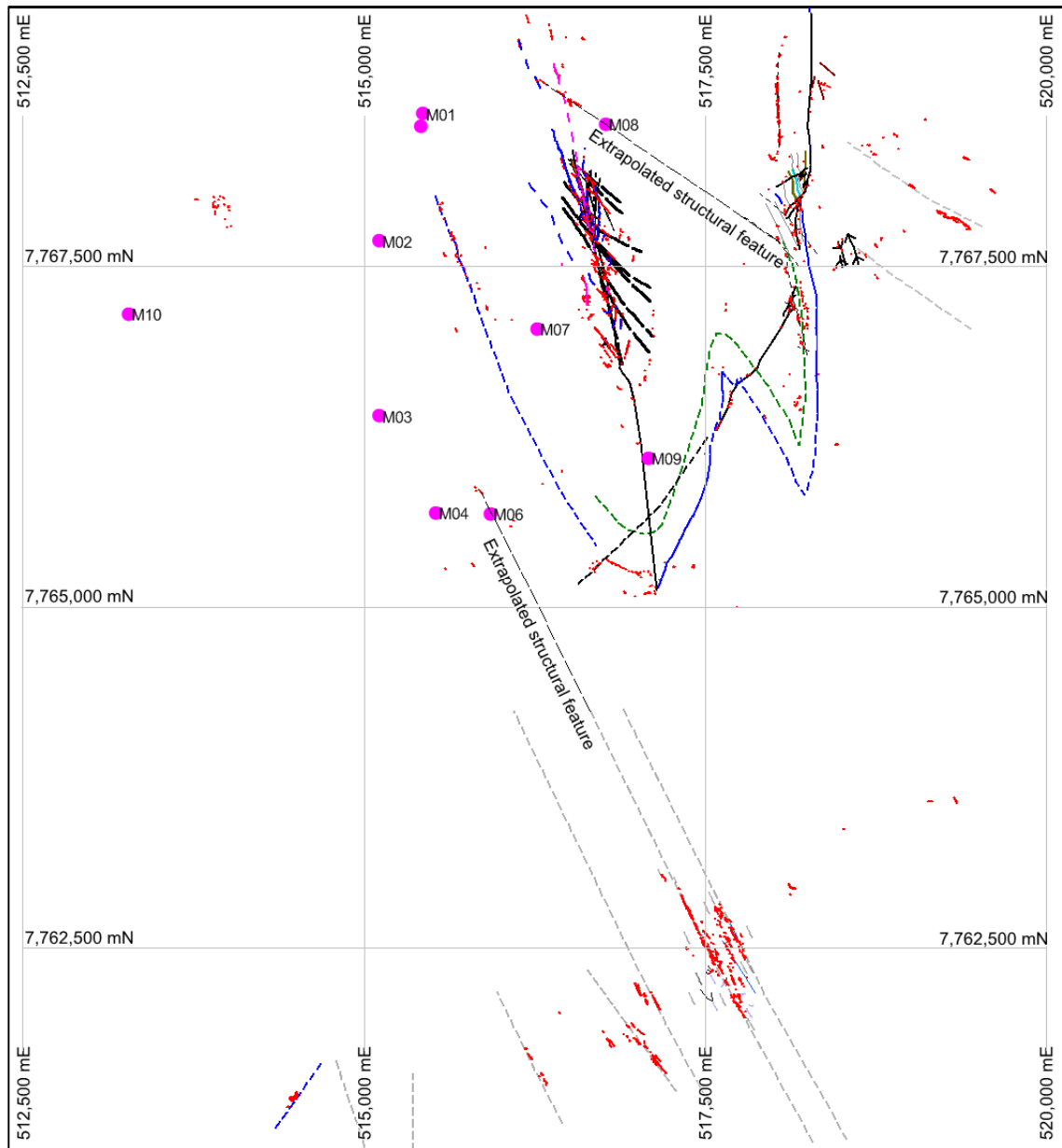


Figure 5. Geological support for relocation of M06 and M08. Note lines showing extrapolation of observed structures, and revised locations of M06 and M08.

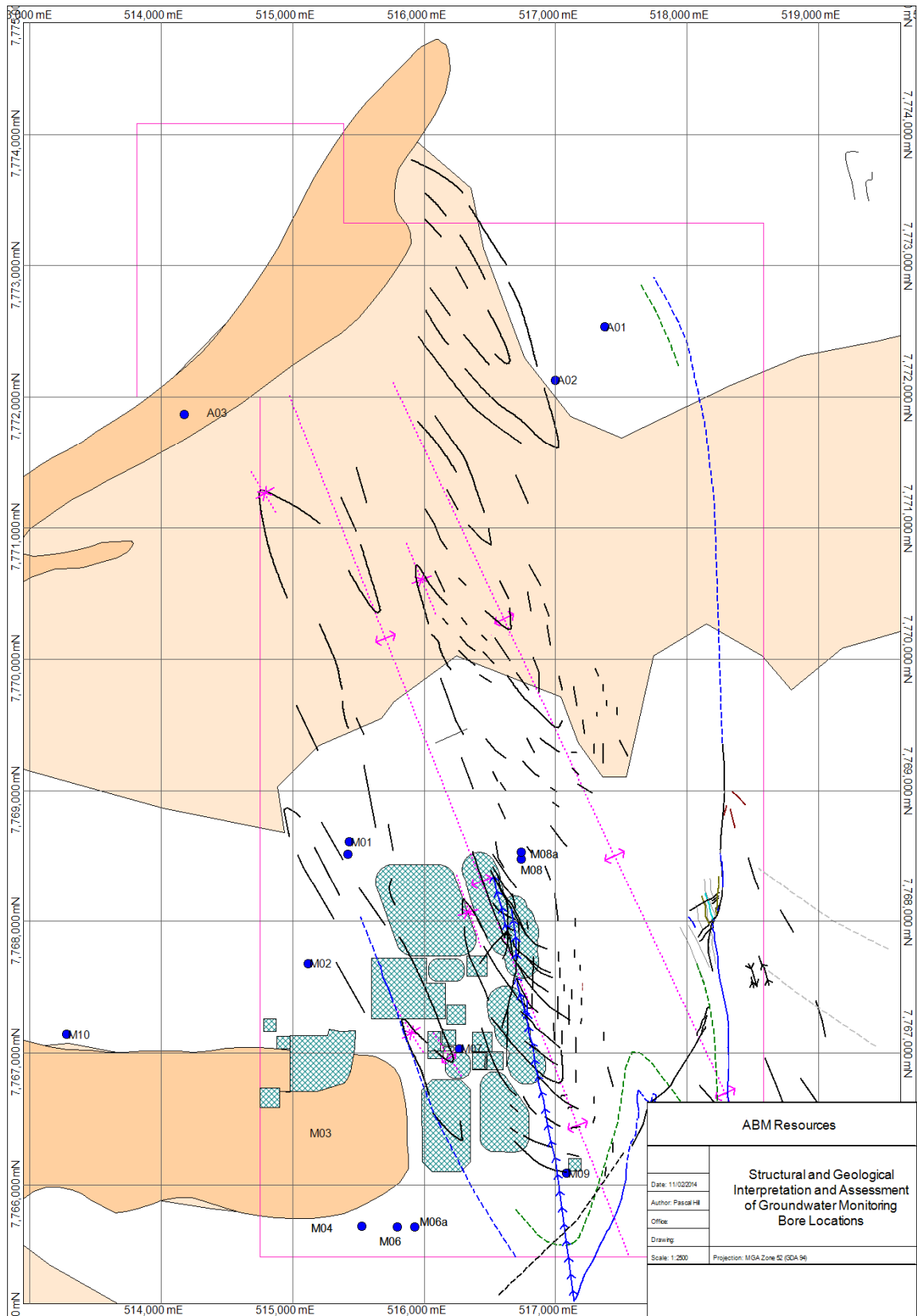


Figure 6. Final Monitoring bore locations for 2014.

The shallow Monitoring bores (M01-4) were previously confirmed as optimal locations for intersecting the paleochannel down gradient of mine infrastructure. M01, M02 and

M04 were not within the modelled paleochannel but in the paleochannel catchment (upstream) contributing to the paleochannel water volumes. These locations were deemed optimal with the present data available.

The deep monitoring bores (M05 and 09) were previously confirmed as ideal locations for intersecting the fractured bedrock aquifer at depth. Details of the aquifer are limited and until further information is obtained these locations are indicative; details of their position in relation to the geology and geophysics are detailed below:

4. M05, northwest of the Waste Rock Dump (WRD2), is positioned along a mapped structure interpreted as a fault and therefore should intersect the fractured bedrock aquifer.
5. M07 and M09 both lie along the limbs of a fold axis and are predicted to intersect the bedrock aquifer through permeability contrasts between sediment packages within the fold structure.
6. M06 and M08 have now been relocated to intersect potential extensions of observed structural features, while retaining positions close to the original design parameters. The revised hole positions will require external review.

The results are detailed in Table 3.

Table 7. Revised locations of the monitoring bores.

ID	General Location	Type	Easting	Northing	Type	Aquifer	Comments
A01	4.1 km north of site	Deep	517374	7772534	Analogue	Bedrock	Indicative location - more data required, within prospective folded sedimentary packages
A02	3.7 km north of site	Shallow	517090	7771710	Analogue	Palaeochannel	MOVED to within bounds of paleochannel apron
A03	3.7 km northwest of site	Deep	514320	7772050	Analogue	Palaeochannel	MOVED within ML lease bounds and remains in paleochannel
M01	Down-gradient of WRD1	Shallow	515432	7768610	Monitoring bore	Palaeochannel	Target hit - not within modelled paleochannel but in catchment and shallow target obtained
M02	Down-gradient of WRD1	Shallow	515115	7767679	Monitoring bore	Palaeochannel	Target hit - not within modelled paleochannel but in catchment and shallow target obtained
M03	Down-gradient of TD / WRD2	Shallow	515115	7766395	Monitoring bore	Palaeochannel	Target hit
M04	Down-gradient of TD / WRD2	Shallow	515525	7765687	Monitoring bore	Palaeochannel	Target hit - not within modelled paleochannel but in catchment and shallow target obtained
M05	Northwest of WRD 1	Deep	515417	7768518	Monitoring bore	Bedrock	Target hit - mapped structure interpreted as a fault
M06a	Southwest of TD	Deep	515930	7765680	Monitoring bore	Bedrock	Indicative location - more data required
M07	Central to the site	Deep	516269	7767033	Monitoring bore	Bedrock	Target hit - lie along the limbs of a fold axis
M08a	Northeast of pits	Deep	516769	7768534	Monitoring bore	Bedrock	Indicative location - more data required
M09	Southeast of WRD 2	Deep	516951	7766088	Monitoring bore	Bedrock	Target hit - lie along the limbs of a fold axis

17. CONCLUSION / RECOMMENDATIONS

The monitoring bores M06 and M08 were previously given indicative positions. These bore locations have been assessed based on geological observations, and revised locations have been presented.

Further external review is anticipated prior to finalisation of the bore drilling programme, and these two revised position will be scrutinised prior to initiation of the drilling works.

18. REFERENCES

ANZECC and ARMCANZ (2000): Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Environment Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand. Canberra, ACT.

ARMCANZ, A. a. (2000): Australian Guidelines for Water Quality Monitoring and Reporting. In National Water Quality Management Strategy. October. Canberra, ACT.

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