FORTESCUE METALS GROUP LTD

PILBARA IRON ORE AND INFRASTRUCTURE PROJECT

ASSESSMENT OF WATER SUPPLY DEVELOPMENT FOR THE STAGE A PORT & NORTH-SOUTH RAILWAY

JULY 2004

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EXECUTIVE SUMMARY

Water supplies approximately 1,000 m^3/d will be required along the railway alignment for conditioning of fill material during construction of the Stage A railway. Based upon Aquaterra's experience on similar projects a spacing between water supply locations of not more than 15 km is desirable.

A review of available information was completed to identify locations of existing bores within 10 km of the alignment, which could be targeted for supply of construction water, either by:

- constructing one or more new bores to meet the expected total or, alternatively;
- using the existing bore (subject to agreement by the owning authority) augmented as required by additional bores.

Bores with recorded salinities of greater than 10,000 mg/L were omitted as possible supply locations.

Over 50 potential bore locations were identified at spacings not exceeding 15 km, which included bores installed for railway or road construction purposes and stock bores. The source aquifers comprised both alluvial aquifers (mainly on the coastal plain and Fortescue River valley) and fractured rock aquifers within the regional granite terrain, Fortescue Group and Marra Mamba Iron Formation.

Impacts from the supply of process water relate to reduction in groundwater levels in response to pumping. These could potentially impact upon:

- subterranean fauna, e.g. stygofauna
- phreatophytic (groundwater dependant) vegetation
- Other groundwater users.

It is unlikely that such effects will eventuate given the short-term of abstraction for railway construction. Indeed, work and operating experience elsewhere in the Pilbara has shown that groundwater dependent ecosystems are tolerant of significant short-term fluctuations in groundwater levels, resulting both from climatic variability and pumping, without adverse environmental consequences.

The main environmentally sensitive areas are the Fortescue Marsh and fractured/vuggy rocks that may support subterranean fauna. The Fortescue Marsh is associated with alluvial deposits/aquifers. Analyses of likely responses during pumping indicate that drawdowns are unlikely to extend more than 250 m from the production sites. Groundwater levels are expected to recover within 4 to 5 weeks after the cessation of pumping.

Effects upon fractured rock aquifers during groundwater production are likely to be limited to the permeable fracture zones, which because of their depth and limited extent are unlikely to significantly affect local vegetation. Similarly, studies elsewhere in the Pilbara have shown that stygofauna populations can tolerate significant short-medium term fluctuations in groundwater levels. As such, the short-term nature of the abstractions associated with the railway construction are unlikely to result in a long-term significant impact.

To assist in managing groundwater extraction, the following is recommended.

- Groundwater levels and pumping rates should be monitored during operation of any production bore to prevent localised dewatering of fractured rock or calcrete aquifers and to measure production bore performance.
- Measurements of groundwater TDS and pH would be taken before and after each production bore had been used.
- Contingency should be made to source water from alternative supplies should any groundwater production site show unacceptable impacts to pumping.
- As part of the optimisation of the potential list of potential bore sites (Section 4.4), a list of existing bores vulnerable to the short-term impacts from abstraction of railway construction water should be prepared. Contingencies for augmenting these existing supplies should be developed, which could include:
  - development of suitable alternative sources less vulnerable to impacts from supply of railway construction water
  - installation of infrastructure to augment the existing supply from the railway water supply bore.

TABLE OF CONTENTS

SECTION 1 - INTRODUCTION

1.1 Background

Fortescue Metals Group Ltd (FMG) is undertaking Feasibility Studies and Public Environmental Reviews (PERs) for their East Pilbara Iron Ore Project (Figure 1). Aquaterra Consulting Pty Ltd (Aquaterra) has been engaged by FMG to carry out the hydrogeological components for these investigations.

The Project comprises the following:

- four mining areas and a number of potential satellite ore bodies;
- two railway lines;
- loading facilities at Port Hedland.

Three of the mining areas, Mt Nicholas, Mt Lewin and Christmas Creek, are located in the eastern Chichester Ranges. These deposits comprise mineralised Mara Mamba Formation, which outcrop northeast and east of the Fortescue River valley. The fourth area, located within the Mindy Mindy Creek valley approximately 25 km east of Hope Downs, comprises enriched Channel Iron Deposits (CID).

The two proposed railway lines connect the Mindy Mindy and Chichester Range mining areas to the Port Hedland loading facility, and comprise a north-south railway and east-west railway respectively. The loading facility at Port Hedland includes a rail loop, stockpile area, conveyor and berthing facilities.

The project environmental impact assessment has been divided into two stages. Stage A includes the north-south railway line and port facility, and Stage B the east-west railway line and mining areas.

This report presents the results of the water supply investigation for the Stage A railway route, which comprises Sections A, B, C, D and E from Port Hedland to the Junction (approximately 246 km) and Sections J, K and L from the Junction to the proposed Mindy Mindy minesite (approximately 100 km).

1.2 Study Objectives

Water supplies during construction of the railway route are required to condition fill (transition and sub-ballast) material for compaction and dust suppression. This study involved the following:

- confirmation of likely water demands;
- identification of potential groundwater sources and drilling targets along the proposed route;
- characterisation of the aquifer types associated with the groundwater sources identified;
- identification of the existing beneficial uses for the groundwater resources identified, including any sensitive ecosystems;
- assessment of the likely impact upon existing beneficial uses and identification of options to mitigate these impacts.

SECTION 2 - METHODOLOGY

2.1 General

The approach comprised:

- A review of the available information.
- Estimation of likely water supply requirements during railway construction.
- Identification of potential groundwater supplies along the Stage A railway route and characterisation of target aquifers.
- Assessment of likely unacceptable impacts upon the groundwater environment, including impacts upon exiting groundwater users, from groundwater extraction during construction of the Stage A railway.

2.2 Data Review

Data sources used during the study included published data (maps published reports and geological notes) and information held on the Department of Environment's (DoE) WIN database. In addition, we have also drawn on Aquaterra's previous experience in the area.

2.3 Construction Water Requirements

The construction water requirements, including likely demand and bore spacing, were estimated based upon Aquaterra's previous experience on similar projects, which include:

- Robe River Iron Associates' West Angelas railway water supply
- Water supplies for the upgrade of BHP Billiton's Newman to Port Hedland railway.
- Desk studies for water supplies for BHP Billiton's Yandi spur line.
- Water supplies for BHP Billiton's Area C spur line.

2.4 Potential Groundwater Supplies

A list of potential bore sites was developed based upon existing bores identified from the WIN database and, along sections where suitable bores were not identified, an assessment of potential aquifers using available general geological and hydrogeological data.

Geological and hydrogeological data were used to characterise the subsurface conditions along the alignment and classify aquifer types (i.e. alluvial or fractured rock aquifers). Where available, water quality records were also checked to assess the suitability of the groundwater for use during construction.

2.5 Assessment of Unacceptable Impacts

An assessment of the likely unacceptable impacts from groundwater extraction during construction of the Stage A railway were made based upon the following criteria:

- historic use of any existing supply
- aquifer type
- sensitivity of the associated groundwater environment.

Where insufficient data was available to adequately assess the sensitivity of the groundwater environment, recommendations are made for additional assessments (data collection and analysis) during subsequent investigations and during bore operation.

SECTION 3 – CONSTRUCTION WATER REQUIREMENTS

3.1 Construction Water Demand

Based upon Aquaterra's previous experience on similar projects, we estimate a total water demand of about 1,000 m^3/d will be required at each supply point along the railway alignment. The duration of pumping will vary depending upon the volume of fill material serviced by each supply point. However, bores are generally operated for about 4 to 5 weeks.

3.2 Bore Spacing

The spacing between each supply point will be a function of:

- water demands along the railway route
- the cost of developing a suitable groundwater supply
- the cost of transporting water along the alignment.

At this time, the optimum spacing between supply points cannot be finalised. However, experience on similar projects suggests spacings of between 5 and 15 km are generally desirable.

SECTION 4 – WATER SUPPLY LOCATIONS

4.1 General Description of Route

The Stage A railway route has been divided into four groundwater areas:

i. Chainages 0 to 66,000 m – coastal plain alluvial deposits

ii. Chainage 66,000 m to 216,000 m – regional granite terrain

iii. Chainage 216,000 to 254,000 m – Fortescue Group and Marra Mamba Iron Formation

iv. Chainage 254,000 to 346,000 m – Wittenoom Formation.

The alluvial deposits of the coastal plain generally comprise clay silt and sand, with minor gravel. The deposits range in thickness from about 15 to 50 m, generally being thickest along drainage lines. In the southern part of the groundwater area extensive areas of calcrete have been mapped. Generally groundwater occurrences are associated with sand and gravel units within the alluvium, augmented by weathered basement and/or calcrete.

Regional granite comprises medium to coarse grained biotite granodiorite, common pegmatite veining. Groundwater is mostly associated with fracturing and intrusions of pegmatite and/or dolerite rocks.

The Fortescue Group comprises the Tumbiana Formation, a sequence of reworked volcano-clastic rocks, carbonates and chert; interbedded with thin dolomitic limestone; Meddina Basalt and Jeerinah Formation. The Jeerinah Formation consists of a basal quartz sandstone (Woodiana Member) and a sequence of interbedded carbonaceous pelite, chert and minor sandstone (Geological Survey of WA, 1997). Generally the groundwater occurs within fractured rock aquifers.

The Marra Mamba Formation comprises chert, shale and banded iron formation (BIF). Groundwater yields from the Marra Mamba Formation occur predominantly where the formation is mineralised. Local permeability may also occur associated with fault/fracture zones.

The Wittenoom Formation comprises the West Angela and Paraburdoo Members, a sequence of dolomite, pelite and chert; and the Bee Gorge Member, a sequence of pelite and minor chert and carbonaceous units. Groundwater occurrence within the formation occurs generally in the Paraburdoo Member dolomite, where it is weathered. Locally, significant yields can also be obtained from both the West Angela Member (where it is manganiferous) and the Bee Gorge Member (where it is associated with fractures/faults).

Where the Stage A railway route crosses the Wittenoom Formation it is mostly overlain by the alluvial deposits of the Fortescue River. The alluvial deposits consist of interbedded clay, silt, sand and gravel with recorded thicknesses of over 50 m. These deposits form local alluvial aquifers. Along the valley sides, where the alluvial deposits are either thin or absent, groundwater occurrence is associated with fractured dolomite and dissolution features.

4.2 Existing Bore Sites

Information stored on the DoE's WIN database was used to identify existing bores within approximately 10 km of the Stage A railway alignment (Appendix A and Figures 2 to 6).

The bores identified include:

- bores installed by BHP Billiton for construction and maintenance of their existing railway line;
- bores installed by the Main Roads Western Australia;
- stock bores installed by pastoralists.

Generally bores located along the alluvial plain south of Port Hedland as far as chainage 66,000 m draw groundwater from alluvial sediments or calcrete horizons. These bores are mostly shallow (less than 50 m depth) with modest to low yields, i.e. less than 500 m^3/d, and near surface groundwater levels. Recorded salinities vary from about 400 to 8,000 mg/L total dissolved solids (TDS).

Bores along the granite terrain between chainage 66,000 and 216,000 m generally source groundwater from fractured rock aquifers, commonly associated with quartz veining, or pegmatite or dolerite intrusions. A few bores draw groundwater from shallow alluvium and calcrete. Bore yields vary between minor flows (10 m^3/d) and flows in excess of 1,000 m^3/d. Groundwater levels range between 1 and 21 m below ground level (m bgl). Groundwater quality within the granitic terrain is generally good (1,000 mg/L TDS or less).

Within the Fortescue Group and Marra Mamba Iron Formation, chainage 216,000 to 254,000 m, bores intersect fractured rock aquifers within a variety of lithological units (chert, pelite, grantite and basalt). Yields of up to 900 m^3/d have been recorded for the bores along this section of the alignment. Salinity has only been recorded at one location, indicating fresh groundwater (less than 1,000 mg/L TDS).

Bores along the section between chainage 254,000 m and the end of the Stage A railway spur at Mindy Mindy generally draw groundwater from alluvial deposits associated with the Fortescue River, apart from a few bores located near the northern limit of the river valley where the alluvium is thin or absent. In these northern areas bores have been completed into fractured fresh-rock, commonly dolomite or chert breccia. Yield for bores intersecting fractured rock aquifers vary greatly (10 to 700 m^3/d). Bores into the Fortescue River alluvium, however, commonly intersect gravel and sand units and production rates are more predictable, commonly ranging from 200 to 500 m^3/d.

4.3 Potential Railway Water Supply Locations

Information on existing bores (Section 4.2) was used to prepare a list of potential railway supply bore-sites (see Table 1)

Table 1
Potential Production Bore Locations

Site ID	MGA Coordinate		Chainage (km)	Off-set (km)	Bore Depth (m)	Bore Yield (m3/d)	SWL (m bgl)	Target Aquifer
	(mE)	(mN)						
A-1	664,857	7,742,197	13	2	30	300	11	Sand and gravel alluvium
A-2	664,010	7,734,761	21	1	30	300	16	Calcrete, sand and gravel alluvium
A-3	668,735	7,727,787	28	4	20	200	10	Sand and gravel alluvium
A-4	668,011	7,720,678	37	3	30	300	10	Sand and gravel alluvium
A-5	664,703	7,716,302	40	0.5	20	300	6	Calcrete, sand and gravel alluvium

Site ID	MGA Coordinate		Chainage (km)	Off-set (km)	Bore Depth (m)	Bore Yield (m3/d)	SWL (m bgl)	Target Aquifer
	(mE)	(mN)						
A-6	673,639	7,710,069	50	3	35	300	10	Fractured dolerite dyke
A-7	673,796	7,701,814	57	4	50	400	10	Fractured rock
A-8	669,700	7,693,995	64	3	20	300	2	Calcrete
A-9	675,244	7,696,271	66	3	50	300	10	Fractured dolerite/ granite
A-10	675,439	7,693,798	68	3	40	400	10	Fractured dolerite dyke
A-11	671,491	7,691,091	70	2	20	300	2	Calcrete
A-12	673,525	7,687,678	73	0.5	50	700	10	Fractured granite
A-13	674,723	7,686,232	75	0.5	50	600	10	Fractured granite
A-14	671,912	7,672,694	88	4	50	1000	10	Fractured granite
A-15	680,873	7,670,621	94	1	50	500	10	Calcrete underlain by fractured granite
A-16	682,517	7,670,134	96	2	50	1000	10	Gravel underlain by fractured granite
A-17	689,481	7,660,316	107	7	50	200	10	Fractured quartz pegmatite
A-18*	684,500	7,680,000	118	3	70	300	10	Fractured granite
A-19	692,631	7,644,766	124	4	50	500	10	Fractured quartz schist
A-20	695,475	7,635,574	134	3	50	500	10	Weathered pegmatite and granite
A-21	698,983	7,630,539	139	5	20	200	2	Calcrete
A-22	700,380	7,621,610	149	3	20	200	2	Calcrete and weathered granite
A-23	698,064	7,615,182	155	0	50	300	10	Fractured granite
A-24	696,276	7,608,006	162	0	50	400	18	Weathered granite
A-25	695,112	7,606,800	164	1	50	300	11	Fractured granite
A-26	694,816	7,604,726	166	0.5	50	300	20	Fractured granite
A-27	685,960	7,599,342	172	7	70	500	15	Fractured granite
A-28	692,440	7,598,243	173	1	50	600	15	Weathered granite
A-29	697,443	7,586,754	185	0.5	60	1000	15	Fractured pegmatite
A-30	701,069	7,579,486	193	0.5	50	400	15	Weathered granite and pegmatite
A-31	702,472	7,577,622	195	0	50	300	15	Fractured granite
A-32	708,333	7,568,322	207	0.5	50	200	15	Fractured pegmatite
A-33*	709,000	7,561,000	217	0	50	200	15	Fractured dolomite/ karst features
A-34	705,866	7,555,751	223	1	50	300	15	Fractured basalt
A-35	709,443	7,546,395	231	5	50	700	10	Fractured pelite
A-36*	720,400	7,547,300	242	0	50	200	10	Fractured sandstone
A-37	709,443	7,546,395	252	3	50	900	5	Weathered pegmatite
A-38	708,452	7,542,014	254	1	60	300	5	Alluvium underlain by pelite
A-39	704,153	7,532,016	264	4	60	700	6	Weathered chert
A-40	704,834	7,526,725	269	2	50	700	6	Alluvium?
A-41	705,300	7,522,595	273	0.5	40	300	12	Alluvium?
A-42	709,519	7,518,012	279	2	40	200	14	Alluvium?
A-43*	715,800	7,513,000	288	2	50	300	14	Alluvium?
A-44	723,534	7,506,043	298	0.5	50	400	15	Sand and gravel alluvium
A-45	726,495	7,502,730	303	0.5	50	1000	9	Sand and gravel alluvium
A-46	731,283	7,501,506	309	1	50	600	21	Alluvium?
A-47	732,597	7,499,343	311	1	50	600	21	Alluvium?
A-48	734,618	7,499,917	311	3	40	1000	15	Alluvium?
A-49	734,882	7,498,858	312	2	40	1000	15	Alluvium?
A-50	735,837	7,498,928	313	3	30	400	18	Alluvium?
A-51	738,516	7,498,639	315	5	50	900	17	Calcrete
A-52	743,859	7,494,381	323	5	80	200	37	Alluvium?

Notes: GWL = groundwater level
Sites in bold are existing railway or road construction supply bores
* denotes infill bores identified using background information

The sites presented in Table 1 were identified based upon the following criteria:

- a minimum supply of 200 m^3/d
- a maximum distance between locations of 15 km.

Along sections where bore yields were not recorded, background information such as lithology, geological structure, bore use and recorded anecdotal information were used to select infill bore sites.

It is intended that the total demand requirement (1,000 m^3/d) will be met by either:

- constructing one or more new bores to meet the expected total or, alternatively;
- using the existing bore (subject to agreement by the owning authority) augmented as required by additional bores.

In preparing the schedule of potential water supply locations, it was assumed that suitable water supplies will be available at the start and end of the route at Port Hedland (from scheme water or existing production bores) and Mindy Mindy (from dewatering test bores for the mine) respectively.

4.4 Optimisation of Bore Locations

As part of the forthcoming Bankable Feasibility Level Study for the project, a bore optimisation study will be completed to rationalise the list of potential sites. Optimisation will be carried out by adjusting the configuration of sources in conjunction with the use of transfer pipelines and/or tankers, with the aim of minimising expenditure.

For the purposes of the PER, it has been assumed that each of the potential bore locations has an equal likelihood of being developed for construction water supply purposes. Therefore, all potential sites have been included in the PER assessment.

5.1 General

Potential impacts from the supply of process water relate to reduction in groundwater levels in response to pumping. These could potentially impact upon:

- subterranean fauna, eg stygofauna
- phreatophytic (groundwater dependant) vegetation
- Other groundwater users.

It is unlikely that such effects will eventuate given the short-term of abstraction for railway construction. Indeed, anecdotal evidence from work and operating experience elsewhere in the Pilbara has shown that groundwater dependent ecosystems are tolerant of significant short-term fluctuations in groundwater levels, resulting both from climatic variability and pumping, without adverse environmental consequences.

Locations and details of existing bores were identified using the DoE's WIN database (Section 4.2). These sources and their associated aquifers have been targeted for supply of water during railway construction. It is therefore almost certain that abstraction of construction water will impact upon nearby groundwater users (should they require groundwater use at the same time as FMG). If this is the case FMG will negotiate with affected parties to reach agreed outcomes, which do not result in any cumulative groundwater impacts..

5.2 Historic Bore Use

The majority of the bores presented in Table 1 were constructed to supply water for construction and ongoing maintenance of BHP Billiton's main railway between Newman and Port Hedland. Similarly, three bores included in the table were installed by the Main Roads Western Australia for construction and maintenance purposes.

These bores have historically been operated in a manner consistent with that proposed by FMG, i.e. short duration pumping at bore duty rates up to a maximum of around 1,000 m^3/d. It is therefore expected that similar impacts will be observed during FMG's planned extraction during railway construction.

5.3 Aquifer Characterisation

Generally alluvial aquifers occur within Groundwater Areas i and iv (Section 4.1), associated with alluvial deposits along the coastal plain and within the Fortescue River valley. Alluvial aquifers commonly have high aquifer storage (specific yield and specific storage) and moderate hydraulic conductivity; and show radial drawdown responses to groundwater extraction. Based upon the results of a simple block model, the likely radial drawdown extent during the period of production from an alluvial aquifer is likely to be less than 250 m, assuming:

i. Unconfined conditions.
ii. Nominal aquifer thickness of 40 m.
iii. Specific yields of between 0.05 and 0.25.
iv. Hydraulic conductivity of between 0.5 and 10 m/d.
v. A pumping rate of 1,000 m^3/d for 30 days.

Modelling results also indicate groundwater levels are likely to recover to within 2 m (without allowance for groundwater recharge) within 4 to 6 weeks after the discontinuation of pumping.

In Groundwater Areas ii and iii, fractured rock aquifers are likely to predominate. Fractured rock aquifers are generally associated with fresh rock and have high hydraulic conductivity and low aquifer storage. These aquifers are commonly heterogenous and drawdowns tend to propagate preferentially along more permeable fracture zones. The drawdown can to extend many hundreds of metres along the fractures, but only a few metres across strike.

Because of the lower drawdowns across strike and their deeper occurrence within fresher rock (commonly overlain by weathered or alluvial material), the drawdown impacts upon phreatophytic vegetation during short-term pumping of fractured rock aquifers are likely to be minimal

5.4 Groundwater Management

Because of the short duration of pumping during the construction of the railway, it is unlikely that there will be any long-term impacts upon groundwater levels. Most of the bore sites identified during this investigation have been installed for supply of water during either railway or road construction previously and, therefore, have historically been operated for short periods without apparent adverse impacts upon the groundwater environment.

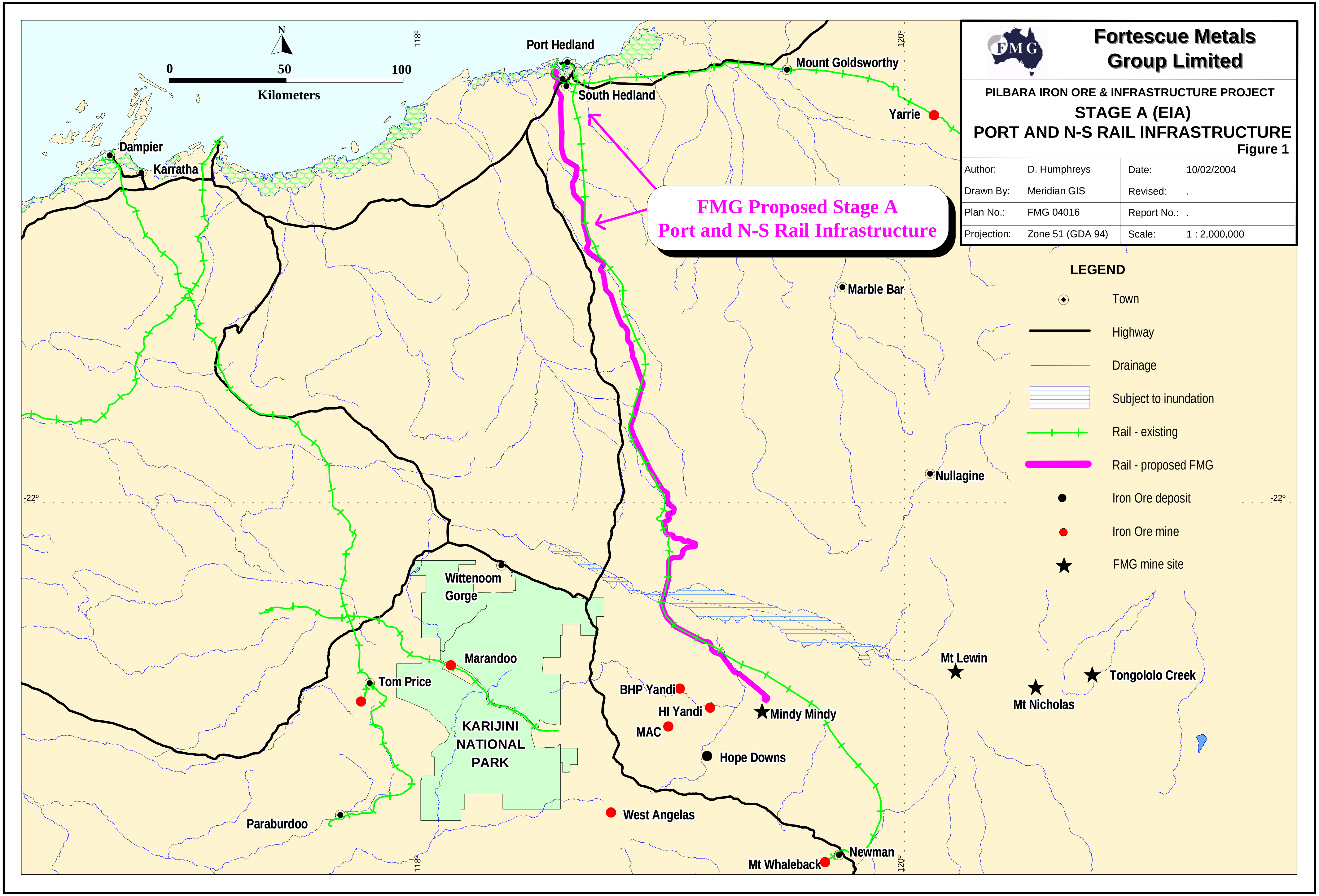
The main environmentally sensitive areas are the Fortescue Marsh and fractured/vuggy rocks that may support subterranean fauna. The Fortescue Marsh is associated with alluvial deposits/aquifers. Analyses of likely responses during pumping indicate that drawdowns are unlikely to extend more than 250 m from the production sites. Groundwater levels are expected to recover within 4 to 5 weeks after the cessation of pumping.

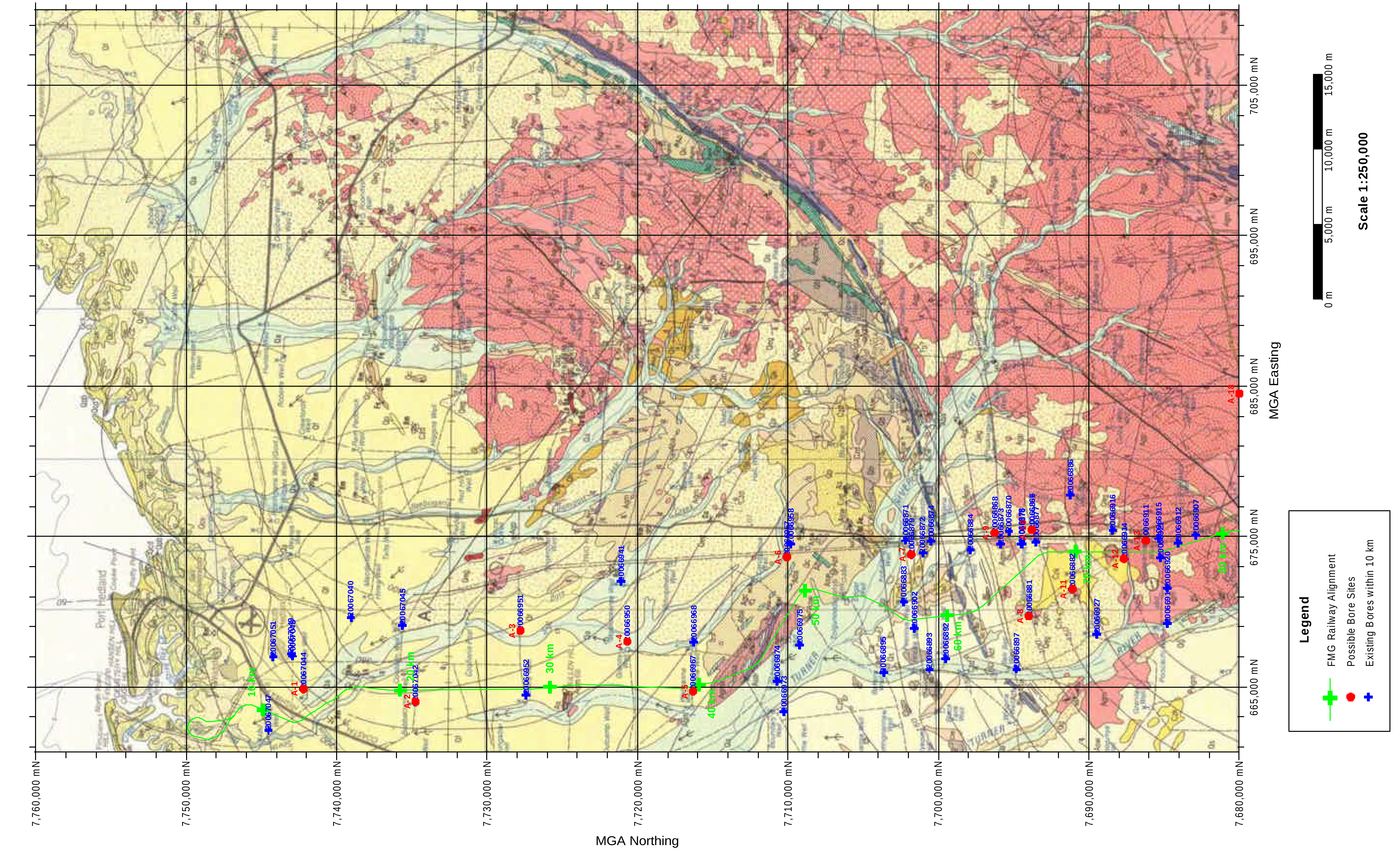
Effects upon fractured rock aquifers during groundwater production are likely to be limited to the permeable fracture zones, which because of their depth and limited extent are unlikely to significantly affect local vegetation. Similarly, studies elsewhere in the Pilbara have shown that stygofauna populations can tolerate significant short-medium term fluctuations in groundwater levels. As such, the short-term nature of the abstractions associated with the railway construction are unlikely to result in a long-term significant impact.

To assist in managing groundwater extraction, the following is recommended.

- Groundwater levels and pumping rates should be monitored during operation of any production bore to prevent localised dewatering of fractured rock or calcrete aquifers and to measure production bore performance.
- Measurements of groundwater TDS and pH would be taken before and after each production bore had been used.
- Contingency should be made to source water from alternative supplies should any groundwater production site show unacceptable impacts to pumping.

- As part of the optimisation of the potential list of potential bore sites (Section 4.4), a list of existing bores vulnerable to the short-term impacts from abstraction of railway construction water should be prepared. Contingencies for augmenting these existing supplies should be developed, which could include:
  - development of suitable alternative sources less vulnerable to impacts from supply of railway construction water
  - installation of infrastructure to augment the existing supply from the railway water supply bore.


Fortescue Metals Group Limited
PILBARA IRON ORE & INFRASTRUCTURE PROJECT
STAGE A (EIA)
PORT AND N-S RAIL INFRASTRUCTURE
Figure 1
Author: D. Humphreys
Date: 10/02/2004
Drawn By: Meridian GIS
Revised: .
Plan No.: FMG 04016
Report No.: .
Projection: Zone 51 (GDA 94)
Scale: 1 : 2,000,000
LEGEND
Town
Highway
Drainage
Subject to inundation
Rail - existing
Rail - proposed FMG
Iron Ore deposit
Iron Ore mine
FMG mine site
FMG Proposed Stage A
Port and N-S Rail Infrastructure
N
0
50
100
Kilometers
118°
120°
-22°
Port Hedland
South Hedland
Mount Goldsworthy
Yarrie
Dampier
Karratha
Marble Bar
Nullagine
Wittenoom Gorge
Marandoo
Tom Price
KARIJINI NATIONAL PARK
Paraburdoo
BHP Yandi
HI Yandi
MAC
Mindy Mindy
Hope Downs
West Angelas
Newman
Mt Whaleback
Mt Lewin
Mt Nicholas
Tongololo Creek



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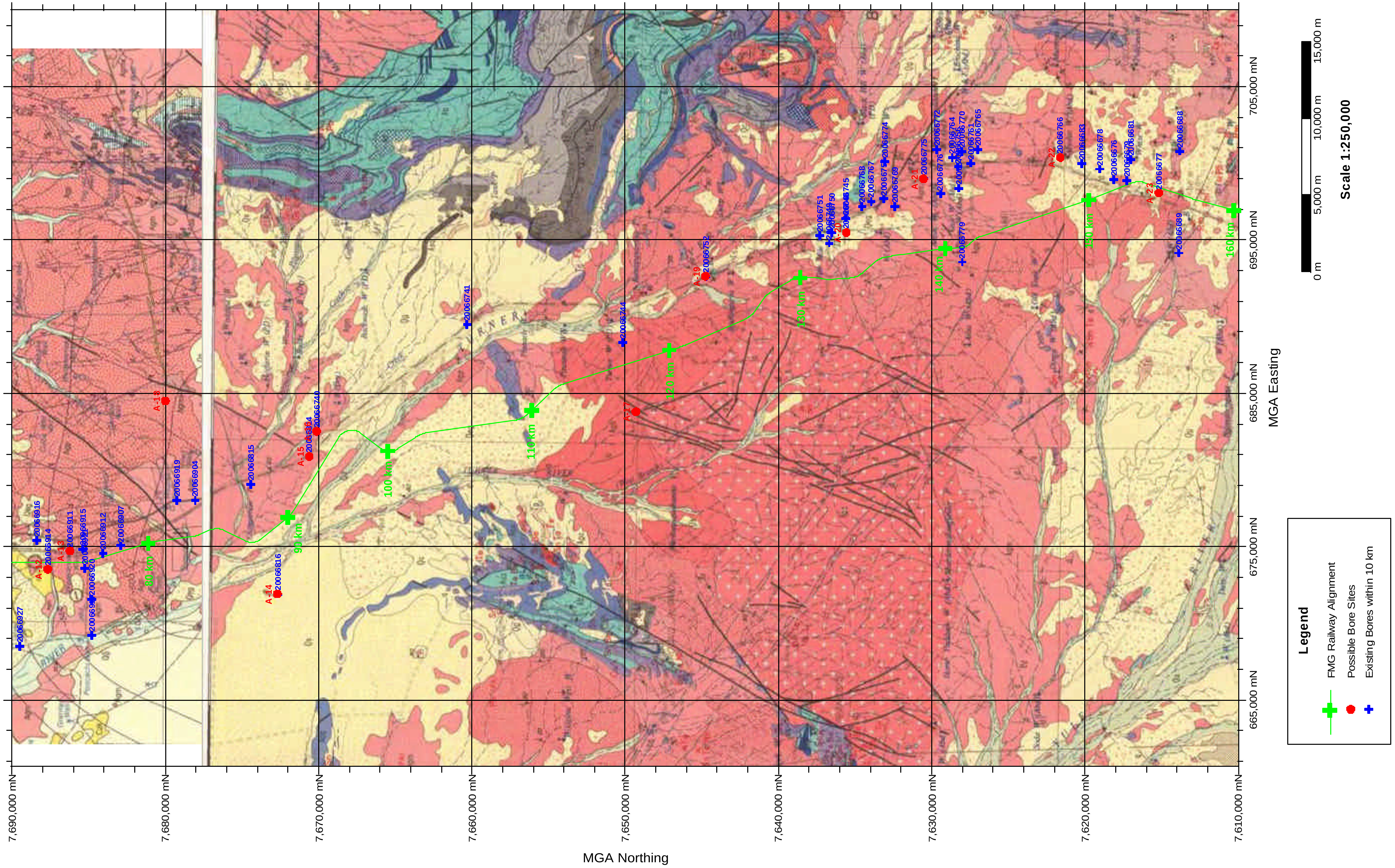
Bore Locations, Map 1
Figure 2



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17/5/04

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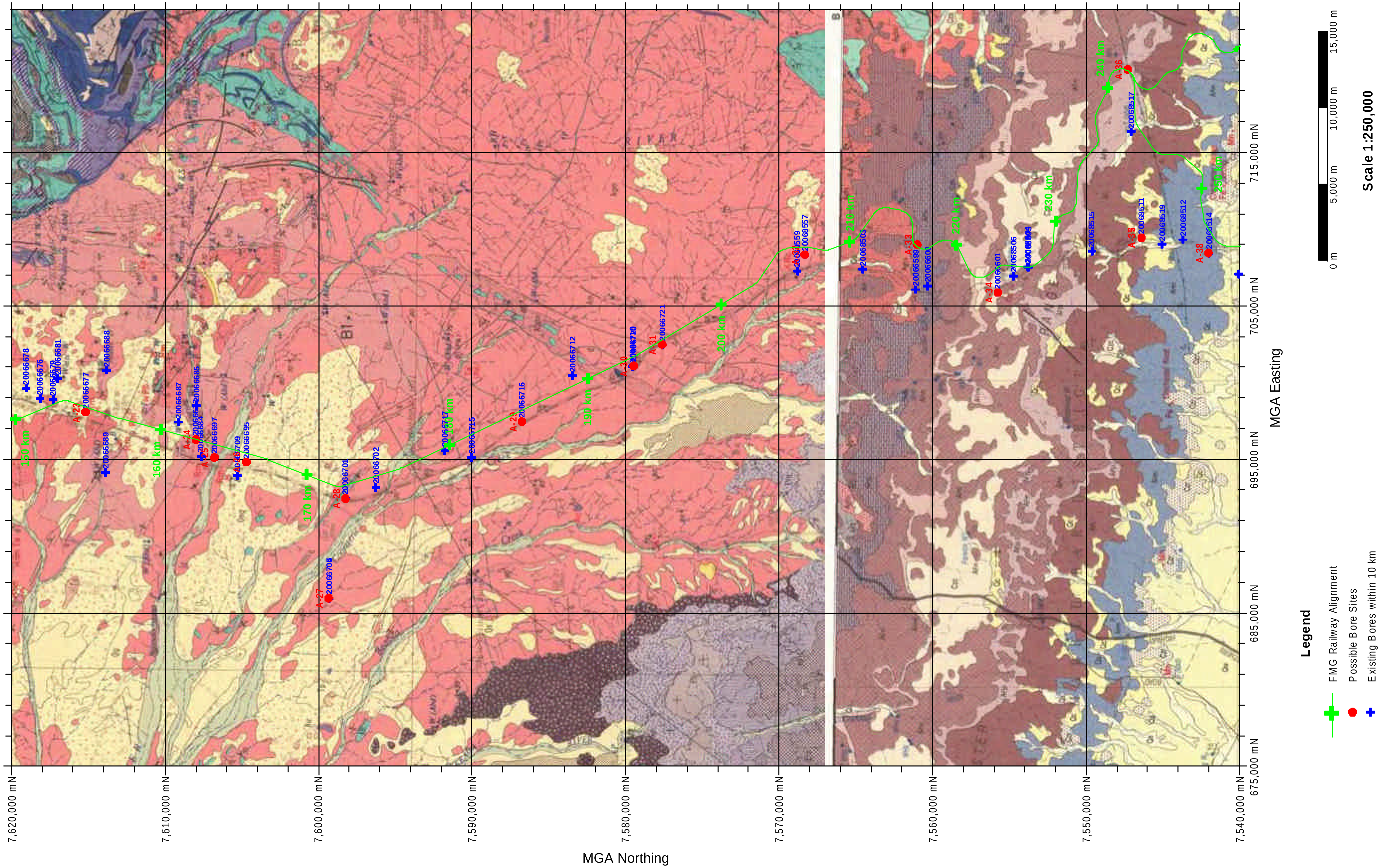
East Pilbara Iron Ore Project
Fortescue Metals Group Ltd

Bore Locations, Map 2
Figure 3



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17/5/04

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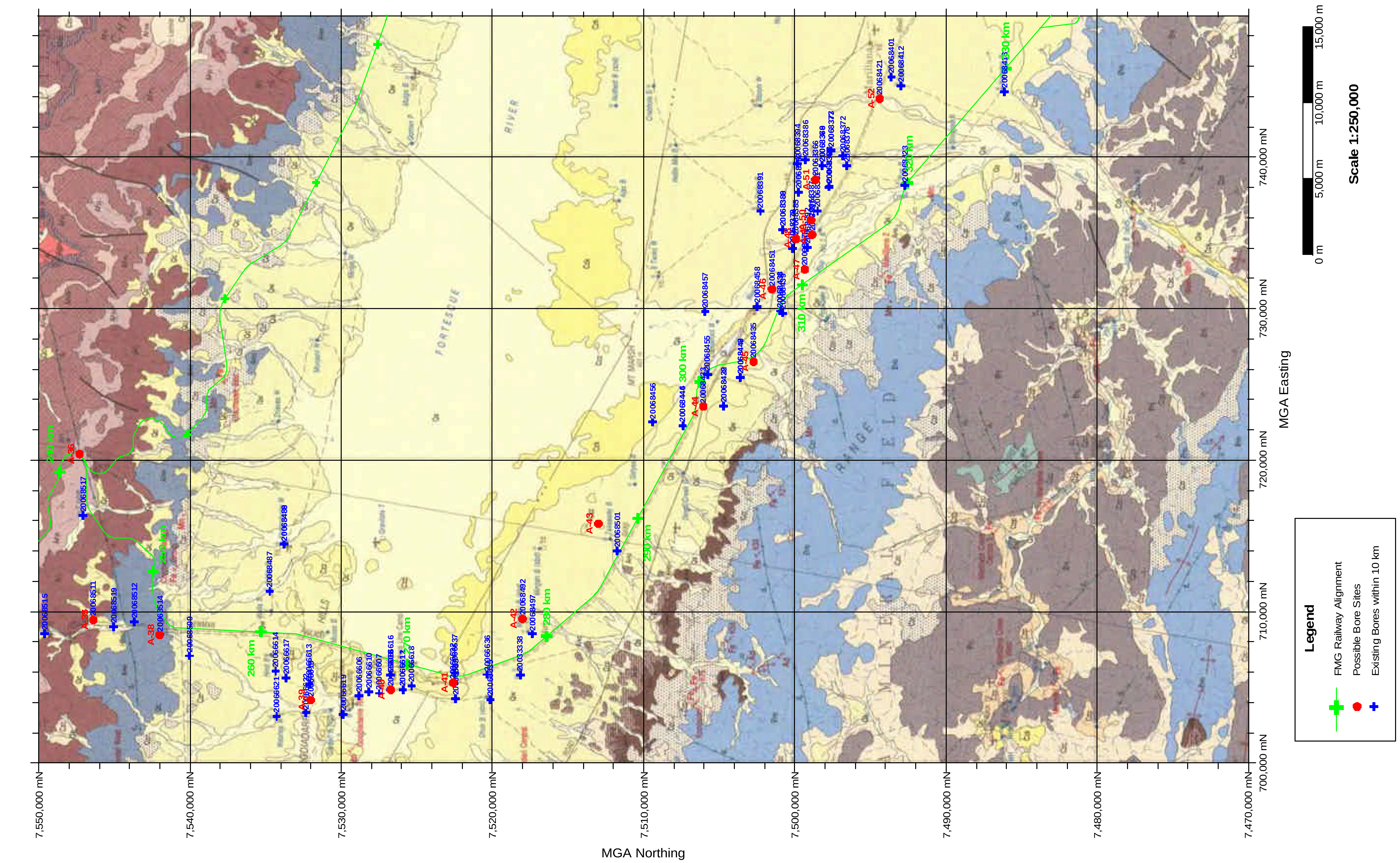
Bore Locations, Map 3
Figure 4



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17/5/04

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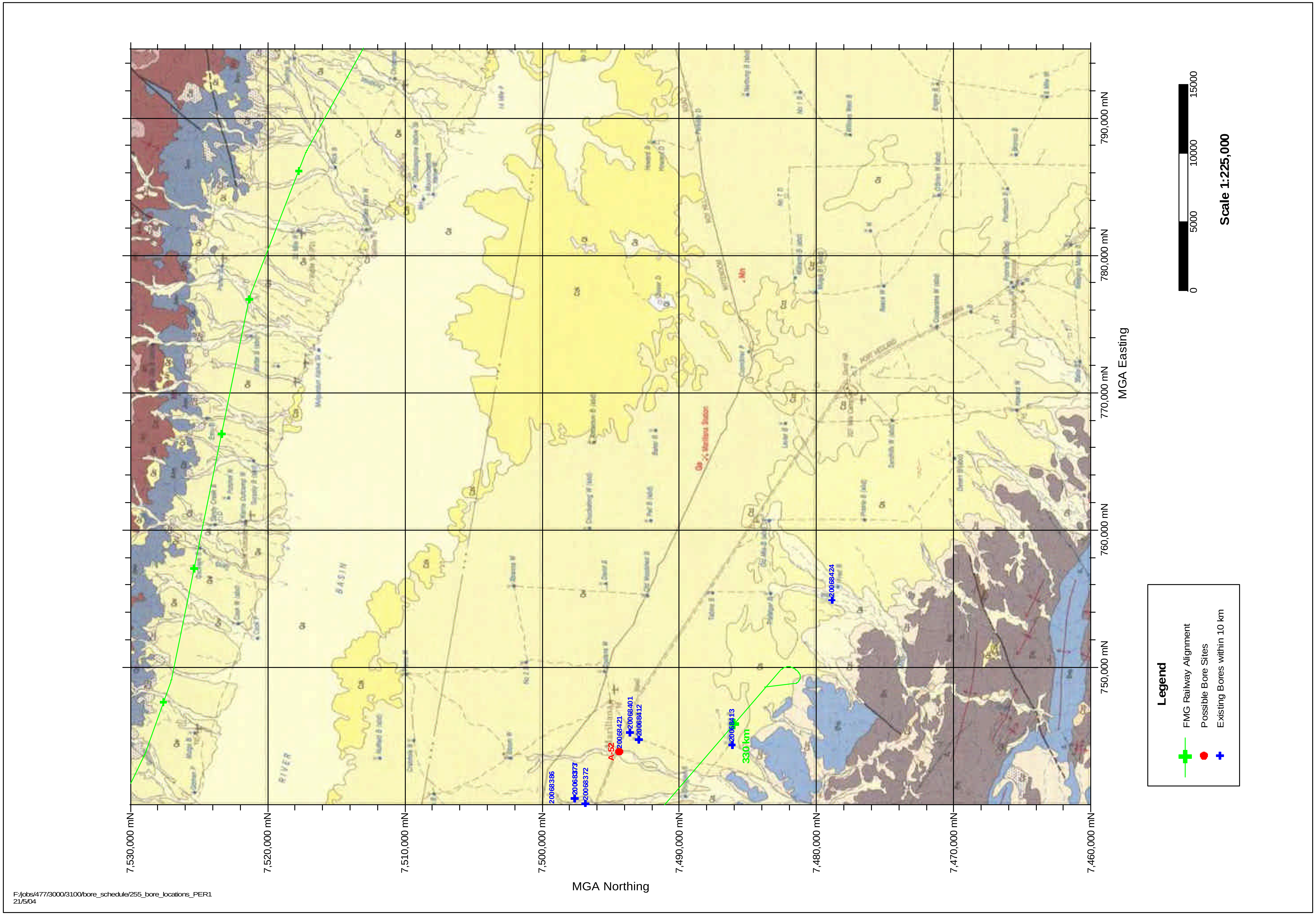
Bore Locations, Map 4
Figure 5



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Bore Locations, Map 5
Figure 6

APPENDIX A

EXISTING BORE LOCATIONS

WIN Site	Location - MGA Grid		Chainage	Off-set	Yield	Depth	SWL	TDS	Lithology
ID	(mE)	(mN)	(km)	(km)	(m3/d)	(m)	(mbgl)	(mg/L)	
20,067,047	662,092	7,744,533	12	1	-	9	4	6,000	Calcrete and clay
20,067,051	667,002	7,744,209	10	4	-	21	-	-	Clay underlain by sand
20,067,048	667,026	7,742,916	13	4	30	14	-	1,000	Sand and gravel
20,067,049	667,183	7,743,021	13	4	200	14	-	4,000	Silt and sand
20,067,044	664,857	7,742,197	13	2	-	15	11	3,000	Sand and gravel
20,067,040	669,623	7,739,052	17	5	20	37	-	-	
20,067,045	669,096	7,735,648	20	4	-	15	11	800	Weathered granite
20,067,042	664,010	7,734,761	21	1	-	20	16	4,000	Calcrete, sand and gravel
20,066,951	668,735	7,727,787	28	4	-	21	-	2,000	Sand underlain by weathered and fresh granite
20,066,952	664,438	7,727,435	28	0.5	-	21	-	3,000	Sand and clay underlain by weathered and fresh granite
20,066,941	671,998	7,721,082	37	7	-	17	-	2,000	Sand underlain by weathered and fresh granite
20,066,950	668,011	7,720,678	37	3	-	25	-	1,000	Sand and gravel underlain by weathered and fresh granite
20,066,967	664,703	7,716,302	40	0.5	-	14	-	3,000	Sand and calcrete underlain by shist
20,066,968	667,987	7,716,270	40	3	-	17	-	8,000	Sand and gravel underlain by weathered and fresh granite and sandstone
20,066,973	663,325	7,710,264	44	4	-	12	4	400	Shale
20,066,974	665,350	7,710,739	44	2	-	13	7	3,000	Shale
20,066,975	667,786	7,709,245	47	2	30	13	9	6,000	Shale
20,066,883	670,630	7,702,295	57	1	-	5	1	5,000	Alluvium
20,066,895	665,936	7,703,651	57	4	-	-	8	900	Alluvium
20,066,871	674,720	7,702,187	57	5	20	87	-	-	Gravelly clay
20,066,879	673,796	7,701,814	57	4	400	46	-	-	Weathered jasperlite????
20,066,872	673,879	7,701,043	57	4	10	38	-	-	Dolerite
20,066,957	673,639	7,710,069	50	3	300	30	-	-	Dolerite
20,066,958	674,465	7,709,821	50	3	300	35	-	-	Dolerite
20,066,874	674,660	7,700,515	59	5	30	38	-	-	Calcrete and granite
20,066,902	668,899	7,701,621	58	0.5	-	-	8	-	Alluvium
20,066,893	666,174	7,700,598	58	3	-	19	9	2,000	Sand, clay and gravel underlain by granite
20,066,892	666,853	7,699,514	59	3	-	15	7	2,000	Sand, clay and gravel
20,066,884	674,075	7,697,863	65	3	-	12	6	1,000	Calcrete and clay
20,066,897	666,174	7,694,802	63	5	-	13	8	1,000	Alluvium underlain by shist
20,066,881	669,700	7,693,995	64	3	-	17	2	2,000	Calcrete and granite
20,066,868	675,244	7,696,271	66	3	300	37	-	-	Dolerite dyke
20,066,873	674,465	7,695,850	66	2	10	38	-	-	Dolerite
20,066,870	675,316	7,695,309	67	2	100	30	-	-	Granite and dolerite
20,066,878	674,484	7,694,520	67	1	20	38	-	-	Interbedded quartz, granite and dolerite
20,066,876	674,482	7,694,425	67	1	30	38	-	-	Dolerite
20,066,866	675,439	7,693,798	68	2	400	29	14	-	Quartz dyke
20,066,867	675,439	7,693,798	68	2	-	35	-	-	Quartz dyke
20,066,877	674,600	7,693,512	68	1	100	46	-	-	Quartz
20,066,886	677,752	7,691,263	69	4	-	8	2	-	
20,066,882	671,491	7,691,091	70	2	-	18	3	800	Calcrete and fresh and weathered granite
20,066,927	668,492	7,689,494	71	6	-	12	4	1,000	Calcrete and fresh and weathered granite

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ID	(mE)	(mN)	(km)	(km)	(m3/d)	(m)	(mbgl)	(mg/L)	
20,066,916	675,405	7,688,417	72	1	-	24	10	400	
20,066,914	673,525	7,687,678	73	0.5	700	18	10	500	Fractured weathered granite and quartz
20,066,911	674,723	7,686,232	75	0.5	600	24	-	-	Quartz and granite
20,066,915	674,849	7,685,395	76	1	-	17	4	900	Sand underlain by fractured weathered and fresh granite and quartz
20,066,921	673,574	7,685,246	76	0.5	-	-	10	-	
20,066,920	671,574	7,684,801	76	2	-	-	4	-	
20,066,917	669,224	7,684,794	76	5	-	-	6	-	Calcrete and alluvium
20,066,912	674,563	7,684,066	77	0.5	20	38	-	-	Quartz and granite
20,066,907	675,055	7,682,897	78	0.5	10	30	-	-	Chert
20,066,919	678,020	7,679,281	82	2.2	-	-	3	-	Granite
20,066,904	677,996	7,678,056	84	2.1	10	30	-	-	Granite
20,066,816	671,912	7,672,694	88	3.7	1000	24	10	400	Fractured weathered and fresh granite and quartz
20,066,815	679,037	7,674,432	90	3.2	10	17	4	900	Pegmatite
20,066,814	680,873	7,670,621	94	1	500	18	10	500	Calcrete and granite
20,066,740	682,517	7,670,134	96	1.5	1000	34	-	-	Gravel, possibly underlain by fractured granite
20,066,741	689,481	7,660,316	107	6.6	200	38	-	-	Fractured quartz pegmatite
20,066,744	688,328	7,650,164	117	1.4	-	5	3	750	Alluvium
20,066,752	692,631	7,644,766	124	3.7	500	30	-	-	Fractured quartz and schist
20,066,751	695,291	7,637,302	131	3	-	-	4	-	
20,066,749	694,794	7,636,688	132	2	-	13	12	700	
20,066,750	695,475	7,636,532	132	3	-	-	4	-	
20,066,748	695,475	7,635,574	134	3	500	30	-	-	Weathered granite and pegmatite
20,066,745	696,418	7,635,624	135	3	100	36	-	-	Weathered granite
20,066,768	697,192	7,634,544	135	4	50	30	-	-	Granite and quartz
20,066,767	697,515	7,633,948	135	4	90	30	-	-	Granite and pegamatite
20,066,757	697,673	7,633,136	135	4	100	37	-	-	Quartz
20,066,774	700,112	7,633,062	136	6	-	6	3	1,000	
20,066,769	697,179	7,632,404	137	3	50	30	-	-	Granite and quartz
20,066,775	698,983	7,630,539	139	5	-	5	2	400	Calcrete
20,066,776	697,999	7,629,435	140	3	-	8	1	400	
20,066,779	693,562	7,628,008	141	1	-	14	8	1,000	
20,066,772	700,893	7,629,662	142	6	-	3	2	600	
20,066,777	698,374	7,628,228	143	3	-	11	7	2,000	
20,066,764	700,391	7,628,662	143	6	-	30	-	-	Dolerite
20,066,756	699,755	7,628,277	143	5	20	30	-	-	Dolerite dyke
20,066,770	700,771	7,628,032	143	6	10	34	-	-	Quartz pegmatite
20,066,761	700,008	7,627,436	143	5	40	30	-	-	Quartzite, dolerite and granite
20,066,765	700,896	7,626,986	144	5	100	38	-	-	Fractured quartz pegmatite
20,066,766	700,380	7,621,610	149	3	200	30	-	-	Calcrete and weathered granite
20,066,683	699,979	7,620,195	150	2	-	8	2	5,000	Granite
20,066,678	699,624	7,619,044	151	2	30	30	-	-	Weathered to fresh granite
20,066,676	698,921	7,618,134	152	0.5	20	30	-	-	Granite and quartz

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ID	(mE)	(mN)	(km)	(km)	(m3/d)	(m)	(mbgl)	(mg/L)	
20,066,679	698,869	7,617,290	153	0	200	35	-	-	Fractured quartz pegmatite
20,066,681	700,226	7,617,010	153	2	-	19	16	700	
20,066,677	698,064	7,615,182	155	0	300	34	-	-	Fractured granite and quartz
20,066,688	700,792	7,613,820	155	3	-	17	9	700	
20,066,689	694,144	7,613,871	157	4	-	8	8	800	
20,066,687	697,418	7,609,124	161	1	-	8	7	700	
20,066,685	698,468	7,607,984	162	2	-	6	6	1,000	
20,066,673	696,276	7,608,006	162	0	400	34	18	-	Weathere granite
20,066,684	695,178	7,607,668	163	1	-	7	7	1,000	
20,066,697	695,112	7,606,800	164	1	300	30	-	-	Fractured granite and quartz
20,066,709	693,915	7,605,318	166	1	-	-	15	-	Granite
20,066,695	694,816	7,604,726	166	0.5	300	30	21	-	Granite and quartz
20,066,704	685,960	7,599,342	172	7	300	61	20	-	Pegmatite and granite
20,066,705	685,960	7,599,342	172	7	500	52	9	-	Pegmatite and granite
20,066,701	692,440	7,598,243	173	1	600	34	-	-	Weathered granite and schist
20,066,702	693,165	7,596,243	175	1	60	38	-	-	Quartz dyke
20,066,717	695,551	7,591,761	180	0	40	38	-	-	Fractured pegmatite
20,066,715	695,132	7,590,008	181	1	300	43	-	-	Fractured pegmatite
20,066,716	697,443	7,586,754	185	0.5	1000	44	-	-	Fractured pegmatite
20,066,712	700,421	7,583,472	189	0.5	10	38	-	-	Dolerite
20,066,719	701,045	7,579,545	193	0.5	80	38	-	-	Dolerite
20,066,720	701,069	7,579,486	193	0.5	400	30	-	-	Weathered granite and pegmatite
20,066,721	702,472	7,577,622	195	0	300	30	-	-	Fractured pegmatite
20,068,559	707,261	7,568,803	206	1	80	30	-	-	Granite and quartz pegmatite
20,068,557	708,333	7,568,322	207	0.5	200	30	-	-	Fractured pegmatite
20,068,503	707,368	7,564,566	210	2	50	38	-	-	Quartz pegmatite
20,066,599	706,063	7,561,087	217	3	60	46	-	-	Pelite (blue slate)
20,066,600	706,266	7,560,317	217	3	-	30	-	-	Mica schist granite
20,066,601	705,866	7,555,751	223	1	300	30	-	-	Fractured basalt
20,068,506	706,925	7,554,722	224	0.5	40	-	-	-	
20,068,505	707,528	7,553,755	226	0	-	30	15	-	
20,068,504	707,557	7,553,843	226	0	0	46	-	-	Basalt
20,068,515	708,541	7,549,630	229	3	-	-	14	-	
20,068,511	709,443	7,546,395	231/252	5-Apr	700	30	-	-	Pelite (slate)
20,068,517	716,336	7,547,082	244	0.5	-	8	-	-	
20,068,519	708,991	7,545,036	252	3	900	30	5	400	Weathered and fresh pegmatite
20,068,512	709,309	7,543,709	252	2	300	30	6	-	Pelite (blue slate)
20,068,514	708,452	7,542,014	254	1	300	38	-	-	Alluvium underlain by pelite (blue slate)
20,068,509	707,077	7,540,031	256	2	200	30	-	-	Pelite (grey slate)
20,068,487	711,361	7,534,728	260	3	50	-	24	-	
20,068,488	714,437	7,533,771	261	6	50	-	12	-	
20,066,614	706,054	7,534,335	261	3	100	37	-	-	Fractured chert breccia

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ID	(mE)	(mN)	(km)	(km)	(m3/d)	(m)	(mbgl)	(mg/L)	
20,066,621	703,090	7,534,271	261	6	50	-	15	-	
20,066,617	705,599	7,533,651	262	3	100	22	-	-	
20,066,613	705,242	7,532,111	264	3	-	15	7	-	Dolomite chert breccia
20,066,622	703,310	7,532,324	264	5	50	-	5	-	
20,066,615	704,153	7,532,016	264	4	700	37	6	-	Weathered chert
20,066,619	703,217	7,529,891	267	4	50	-	-	-	
20,066,606	704,421	7,528,838	267	3	20	49	6	-	
20,066,610	704,685	7,528,181	268	3	-	22	6	-	
20,066,607	704,605	7,527,496	269	2	100	14	6	-	
20,066,616	705,838	7,526,723	269	1	200	16	-	-	
20,066,608	704,834	7,526,725	269	2	700	53	6	-	
20,066,611	704,833	7,525,924	269	2	500	31	21	-	Silty gravel (alluvium)
20,066,612	704,833	7,525,924	269	2	200	31	15	-	Silty sandy gravel (alluvium)
20,066,618	705,099	7,525,343	270	1	-	-	-	-	
20,066,632	705,300	7,522,595	273	0.5	300	38	12	-	
20,066,633	704,246	7,522,433	273	2	200	37	-	-	
20,066,637	705,931	7,522,478	273	0	-	-	-	100,000	
20,066,636	705,842	7,520,356	275	0.5	-	-	-	-	
20,066,635	704,188	7,520,139	275	2	10	17	-	-	
20,033,338	705,800	7,518,164	277	1	-	-	-	-	
20,068,497	708,512	7,517,359	279	1	10	18	-	-	
20,068,492	709,519	7,518,012	279	2	200	39	14	-	
20,068,501	714,001	7,511,766	287	0	-	-	-	600	
20,068,489	714,437	7,533,771	292	2	10	16	8	-	
20,068,456	722,503	7,509,417	296	2	-	-	-	12,040	
20,068,444	722,290	7,507,414	298	0.5	300	31	16	-	Gravel and clayey silt
20,068,446	722,290	7,507,414	298	0.5	300	31	20	-	Coarse gravel and clayey silt
20,068,433	723,534	7,506,043	298	0.5	400	54	15	-	
20,068,429	723,548	7,504,732	298	2	300	43	12	-	
20,068,432	723,548	7,504,732	298	2	400	31	-	-	
20,068,455	725,629	7,505,781	301	0	10	10	-	-	
20,068,457	729,810	7,505,925	302	4	-	-	-	2,000	
20,068,434	729,848	7,500,963	302	2	300	34	9	-	
20,068,448	725,442	7,503,606	302	1	500	35	11	-	Coarse gravel and clayey silt
20,068,449	725,442	7,503,606	302	1	200	35	11	-	Coarse gravel and clayey silt
20,068,447	725,443	7,503,612	302	1	200	35	11	-	Coarse gravel and clayey silt
20,068,435	726,495	7,502,730	303	0.5	1000	53	9	-	
20,068,458	730,153	7,502,498	307	1	-	-	-	39,000	
20,068,438	729,848	7,500,963	308	0.5	100	39	4	-	
20,068,439	729,708	7,500,809	308	0.5	90	43	-	-	
20,068,451	731,283	7,501,506	309	1	600	52	21	-	
20,068,391	736,424	7,502,272	310	6	10	21	7	-	

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ID	(mE)	(mN)	(km)	(km)	(m3/d)	(m)	(mbgl)	(mg/L)	
20,068,375	732,597	7,499,343	311	1	600	54	21	-	
20,068,379	733,966	7,500,168	311	2	800	37	14	-	Graded gravels, poorly cemented
20,068,378	733,966	7,500,168	311	2	500	33	14	-	Graded gravels, poorly cemented
20,068,389	735,201	7,500,806	311	4	100	37	-	-	
20,068,388	735,201	7,500,806	311	4	40	38	18	-	Gravelly sand and silt
20,068,385	734,618	7,499,917	311	3	1000	36	15	-	
20,068,392	734,046	7,499,192	312	2	10	27	-	-	
20,068,374	734,882	7,498,858	312	2	1000	36	15	-	
20,068,387	735,837	7,498,928	313	3	400	30	18	-	Gravelly silt and calcrete
20,068,382	737,670	7,499,762	313	5	70	42	25	-	Sand and clayey gravel
20,068,381	736,446	7,498,494	313	3	100	42	25	-	Sand and clayey gravel
20,068,394	739,603	7,499,830	314	7	10	27	18	-	
20,068,366	738,516	7,498,639	315	5	900	46	17	-	Calcrete
20,068,386	739,835	7,499,320	315	7	100	67	35	-	
20,068,383	738,079	7,497,719	315	4	80	42	29	-	
20,068,367	738,042	7,497,752	315	4	200	53	20	-	
20,068,369	739,467	7,498,175	315	6	200	43	27	-	
20,068,370	739,460	7,498,175	315	6	70	43	27	-	
20,068,368	739,467	7,498,175	315	6	200	42	27	-	
20,068,373	740,442	7,497,621	316	6	100	43	24	-	
20,068,377	740,455	7,497,620	316	6	100	43	30	-	
20,068,372	740,096	7,496,843	320	5	20	43	26	-	Calcrete
20,068,376	739,426	7,496,586	320	4	10	67	35	-	
20,068,423	738,164	7,492,720	320	0	10	34	29	-	
20,068,421	743,859	7,494,381	323	5	200	77	37	-	
20,068,401	745,276	7,493,608	325	5	-	-	28	-	
20,068,412	744,725	7,492,965	325	5	10	34	-	700	
20,068,413	744,346	7,486,160	329	1	10	46	-	-	
20,068,424	754,894	7,478,882	336	6	10	40	34	-	