Exxaro Grootegeluk Short-Term Stockpiles Amendment Project

Groundwater Report

Project Number:

EXX3666

Prepared for:

Exxaro Reductants (Pty) Ltd

June 2016

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EXECUTIVE SUMMARY

Exxaro Coal (Pty) Ltd (Exxaro), Grootegeluk Coal Mine (Grootegeluk) is contracted to supply coal to Eskom's Medupi and Matimba power stations, both in Lephalale, Limpopo Province. Off-take of Eskom coal has slowed due to construction delays and thus Exxaro requires additional stockpiling space to accommodate the excess coal on site. Digby Wells was requested by Exxaro Coal (Pty) Ltd to carry out for the proposed Short Term Stockpile Amendment at the Grootegeluk Mine.

Digby Wells Environmental (Digby Wells) was appointed by Exxaro (Pty) Ltd, Grootegeluk to amend the environmental authorisations for the Grootegeluk Infrastructure Expansion Project in 2014. The permitting documents were submitted to Limpopo Department of Economic Development, Environment and Tourism (LEDET) and Department of Mineral Resources (DMR).Exxaro were granted an Environmental Authorisation in October 2014 and August 2015.

The approved uses of the stockpile areas will need to be changed to also utilise the laydown Area, GG10B, and multiproduct stockyard footprints to stock excess Eskom-grade coal only (in the form of a compacted coal stockpile), for an approximate period of five years, until Medupi station is fully operational. These changes will also include the extension of the GG10B Stockyard footprint by approximately 12.8 hectares (ha) by including the current D8 rail loop area, which will be decommissioned with the construction of the new loadout area, also referred to as the extension area. The assumed grade of coal to be placed on this proposed consolidated stockpile area has been classified as Type 3 waste, requiring a Class C liner.

Monitoring data shows that sulphate is one of the main contaminants of concerns in the groundwater at the mine site. However, the leachate tests conducted on the coal samples showed that the sulphate is unlikely to leach at more than 445 mg/L. This is within the WUL limit of 600 mg/L.

Based on the findings of the geochemistry report and the analytical model, the risk of contamination to sensitive receptors is considered low, however it is crucial that the appropriate liner system is installed and the monitoring is undertaken to ensure that the levels of contamination remain below the levels stipulated within the approved WUL and that contamination to sensitive receptors is avoided were possible.

Borehole AV2S was the only potential receptor identified in the area. The risk to this receptor is reduced and is based on the analytical modelling and geochemistry results. The borehole is also located approximately 2 km from the proposed stockpile area, further reducing any risks. However, monitoring is recommended to be conducted to ensure that no impact occurs during and after the period that the stockpile is in place.

As per the minimum requirements (DWS, 1998) and NEM:WA Regulations (2013), a Class C liner design allows for an outflow rate of approximately 8.64×10^{-4} m/d.

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1 Introduction

Exxaro Coal (Pty) Ltd (Exxaro), Grootegeluk Coal Mine (Grootegeluk) is contracted to supply coal to Eskom's Medupi and Matimba power stations, both in Lephalale, Limpopo Province. Off-take of Eskom coal has slowed due to delays in construction and thus Exxaro requires additional stockpiling space to accommodate the excess coal on site. Digby Wells was requested by Exxaro Coal (Pty) Ltd to carry out for the proposed Short Term Stockpile Amendment at the Grootegeluk Mine.

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1.1 Project Description

Exxaro has an operational mine, namely Grootegeluk Coal Mine. Exxaro owns multiple mining operations, including Grootegeluk Coal Mine (hereafter Grootegeluk), which has been in operation since 1982 in the Limpopo Province (Plan 1 and Plan 2, Appendix A) Grootegeluk is located approximately 18 km outside of Lephalale and was contracted to supply coal to Eskom's Matimba power station and later the Medupi power station. Off-take of Eskom coal has slowed and Exxaro requires additional stockpiling space to accommodate the excess coal on site.

Exxaro applied to expand certain infrastructure within the mine boundary area, referred to as the Grootegeluk Coal Mine Infrastructure Expansion Project. Exxaro submitted Applications in terms of the National Environmental Management Act (NEMA), 1998 (Act No. 107 of 1998) and Minerals and Petroleum Resources Development Act (MPRDA), 2002 (Act No. 28 of 2002) to include the following activities / expansions within the mine boundary:

- Expansion of the rail loop, load out stations and associated infrastructure;
- Expansion of the existing coal stockyard and stockpiles;
- Expansion of the fuel storage depot;
- Expansion of beneficiation plants and associated infrastructure;

- New road and conveyors to fines recovery area;
- New gate and hard park area; and
- Expansion of ancillary infrastructure and new 33 kV power line.

The aforementioned 2014 amendment was also associated with the expansion of the existing coal product stockpiles. The following stockpiles and stockyards were included in the applications and approved:

- GG 6/2 stockyard;
- GG 10 stockyards;
  - Conical Stock pile;
  - Stockyard A and
  - Stockyard B;
- Multi-product overflow stockyard

The Grootegeluk Coal Mine Infrastructure Expansion Project was authorised in terms of the NEMA and the Environmental Impact Assessment Regulations of 2010[1], (which have been repealed). The Limpopo Department of Economic Development, Environment and Tourism (LEDET), and the Record of Decision are dated 27 October 2014, with reference number 12/1/9/1-W89 (Plan 1 and Plan 2, Appendix A). The Department of Mineral Resources (DMR) Environmental Management Programme (EMP) Amendment approval was granted on the 28 August 2015.

Exxaro proposed a phased authorisation approach for the amendments that are being requested. Exxaro proposes to amend the existing Authorisation relevant to the Grootegeluk Mine Infrastructure Expansion Project (which included the expansion of the GG10 Stockyards and several other stockpile areas).

The purpose of these amendments is to allow Exxaro to legally stockpile Eskom-grade coal currently being mined from the upper coal benches at the Grootegeluk Mine. In summary the two phases included the following:

- Phase 1: Amendment of the GG10A stockyard for temporary use - The amendment of the GG10A stockyard area with the capacity of 400,000m^3 to include the alternative of a temporary 2 Mt compacted Power Station Coal Stockpile in the same footprint area.
- Phase 2: Amend the GG10B stockyard area - The amendment of the GG10B stockyard to include the additional area inside the loop not originally included. To also amend the use of the multi-product overflow stockpiles to stacking and loading

[1] Dated 18 June 2010

areas. The additional 1.1mil stockpiles area in the footprint of the original Coke and Co-gen area will need to be included as an additional area.

Further to what has been noted above regarding the requested amendment, Exxaro received approval from Department of Water Affairs (DWS) and DMR for Phase 1 of the project on the 5th May 2016 and 7th July 2016 respectively. This part of the project and associated specialist studies conducted is in support of the Phase 2 amendment that is being requested for in terms Section 31 of the 2014 NEMA Regulations applies as this is an amendment to an existing Environmental Authorisation. Thus the information contained within this specialist report is specific to the Phase 2 amendment process, however does make reference to Phase 1 with respect to the areas assessed. The assumed grade of coal to be placed on the proposed stockpile areas has been classified as Type 3 waste, requiring a Class C liner (Digby Wells, 2016).

1.2 Report Objectives

The objectives of this report are:

- To update the existing conceptual site model;
- To construct an analytical model which will determine the potential impacts associated with using the proposed areas; and
- Compile a groundwater impact assessment report utilising the analytical model results.

1.3 Terms of Reference

The following terms of reference were adopted as part of this groundwater study:

- Identification of potential impacts to groundwater resources as a result of the proposed stockpiling activities;
- Undertake a gap analysis on the current water monitoring programme based on the proposed new infrastructure location; and
- Recommendations for update of the groundwater monitoring programme in light of the associated activities, if required.

1.4 Site Description

1.4.1 Rainfall

Grootegeluk Coal Mine is located in the summer rainfall zone with warm summers and moderate, dry winters. The area has an average rainfall of 437 mm per annum, falling mainly between October and March (http://en.climate-data.org/location/26819/).

1.4.2 Topography and Drainage

The elevation of Grootegeluk Coal Mine varies from 900 to 940 metres above mean sea level (mamsl).

The Mine's mining right area falls within the quaternary catchments of A42J and A42E, of the Limpopo Water Management Area. The surface drainage is generally to the north towards the Limpopo River and northeast towards the Mokolo River.

1.4.3 Regional Geology

The regional geology where the Grootegeluk mining area is located, as defined by ERM (2012) is described as follows:

Grootegeluk exploits coal from the Waterberg Coalfield, which extends westwards into Botswana. The Waterberg Coalfield covers an area of approximately 88 kilometres (km) from east to west and 40 km from north to south. The coalfield is fault bounded and forms a graben structure. The Eenzaamheid fault forms the southern boundary, with rocks of the Waterberg Group occurring to the south and the Karoo formations to the north. The northern boundary is delineated by the Zoetfontein fault with Archaean granite outcropping north of the fault.

The coalfield is further subdivided by the Daarby fault that delineates a shallower, western part of the coal field, which is suitable for opencast mining and a deep north-eastern part which is unsuitable for opencast mining. The Zoetfontein fault was tectonically active before and during Karoo deposition, while the Eenzaamheid and Daarby faults, as most of the other faulting in the Waterberg Coalfield, are younger than the Karoo sequence.

Sedimentation occurred in a shallow east-west striking trough and the general direction of transport was ENE-WSW. Karoo sediments are deposited on the Waterberg Group in the southern portion of the coalfield, while the basement rocks to the north of the Zoetfontein fault are Archaean rocks. The paleo-floor in the eastern portion consists of granite and basic rocks of the Bushveld Igneous Complex. Relatively few dolerite dykes outcrop in the south-eastern portion of the coalfield and no sills have been intersected in any of the exploration boreholes.

Three major structures traverse the Waterberg area, i.e. Zoetfontein, Daarby and Eenzaamheid faults, as well as several minor faults and fractures.

The Zoetfontein fault is a high angled east northeast – west southwest striking major fault. Significant post-Karoo displacement is evident and it is known to be seismically active. This resulted in the extensive down throw to the north and sinistral horizontal movement. The basement complex consists of Archaean granite and gneiss, outcropping to the north of fault zone.

The Daarby fault is a major northeast, then northwest trending fault. It is assumed to be part of one set of events as both legs exhibit the same throw and throw direction; thus both faults have been combined into one name. The Daarby fault has a down throw of 360 metres (m) to the north and the fault dips at an angle of between 50º and 60º to the north, bringing up-thrown Beaufort and Ecca Groups to the south into contact with the down-thrown Letaba, Clarens, Elliott and Molteno Formations.

The Eenzaamheid fault, situated south of the Daarby fault, has a throw of 250 m to the north bringing the up-thrown Waterberg Group on the southern side of the fault into contact with the down-thrown Beaufort and Ecca Groups on the northern side of the fault. The dip angle of the Eenzaamheid fault is near vertical. Evidence of a possible link between the Eenzaamheid and Daarby faults exists from exploration boreholes on the farm Turfvlakte.

Various step faults, classed as minor faulting, are associated with the Daarby and Eenzaamheid faults. From the interpretation of exploration data and water boreholes drilled on Grootegeluk Coal Mine, these have varying strikes, dips, throws and throw directions. Details with regard to minor faulting is confined to the Grootegeluk Coal Mine mining area and has been derived and interpreted from exploration drilling results, cross correlations across the mining lease area and mapping within the open pit excavation.

2 Previous Investigations

A number of hydrogeological studies have been undertaken at Grootegeluk Coal Mine. The following hydrogeological reports have been used as reference to update the conceptual model and for input to the analytical calculations:

- Groundwater Report for the proposed Grootegeluk Coal Mine Expansion Areas (Digby Wells Environmental, September 2014);
- Thabametsi Phase 1 Pit Hydrogeological Investigation (Groundwater Consulting Services, June 2014);
- Grootegeluk Coal Mine Groundwater Qualities (Leon Roux, January 2013);
- Grootegeluk Coal Mine Groundwater Baseline Final Report (Environmental Resource Management, December 2012);
- Coke and Cogeneration Plant – Grootegeluk Coal Mine Hydrogeological Assessment and Numerical Groundwater Model. Final Report (Jones & Wagener, November 2012);
- Char Plant Expansion – Groundwater Scoping Report, (Environmental Resources Management, January 2012); and
- Char Plant Expansion – Groundwater Numerical Model: Technical Report, (Environmental Resources Management, January 2012).

3 Methodology

The groundwater risk assessment is conducted with the primary purpose of assessing the potential risk of contamination the Grootegeluk stockpile activities may have on the local groundwater environment. This is conducted considering the hydrogeological conceptual model. An analytical model was compiled to quantify the potential extent of the impact of the stockpiles on the groundwater environment.

Recommendations are made based on the outcome of the impact assessment.

3.1 Desktop Assessment

During this task pre-existing documentation was reviewed. All relevant data was incorporated into the report and utilised to characterise the hydrogeological system.

3.2 Analytical Modelling

Analytical modelling was conducted by approximating the real hydrogeological setting with a mathematical model and solving the defined set of governing equations. A number of simplifying assumptions regarding the ground-water system are necessary to obtain an analytical solution. The assumptions are defined in section 4.3.2.

3.3 Impact Assessment

The impact rating process is designed to provide a numerical rating of the various environmental impacts identified for various project activities. The significance rating process follows the established impact/risk assessment formula:

$$\text{Significance} = \text{Consequence x Probability}$$

where

$$\text{Consequence} = \text{Severity} + \text{Spatial scale} + \text{Duration}$$

and

$$\text{Probability} = \text{Likelihood of an impact occurring}$$

The weight assigned to the various parameters for positive and negative impacts in the formula is presented in below Table 3-1.

Impacts are rated prior to mitigation and again after consideration of the mitigation measure proposed in the Environmental Management Programme (EMP). The significance of an impact is then determined and categorised into one of four categories, as indicated in Table 3-2.

Table 3-1: Impact Rating

RATING	INTENSITY/ REPLACEABILITY		EXTENT	DURATION/REVERSIBILITY	PROBABILITY
	Negative impacts	Positive impacts			
7	Irreplaceable damage to highly valued items of great natural or social significance or complete breakdown of natural and / or social order.	Noticeable, on-going natural and / or social benefits which have improved the overall conditions of the baseline.	International The effect will occur across international borders.	Permanent: The impact is irreversible, even with management, and will remain after the life of the project.	Definite: There are sound scientific reasons to expect that the impact will definitely occur. >80% probability.
6	Irreplaceable damage to highly valued items of natural or social significance or breakdown of natural and / or social order.	Great improvement to the overall conditions of a large percentage of the baseline.	National Will affect the entire country.	Beyond project life: The impact will remain for some time after the life of the project and is potentially irreversible even with management.	Almost certain / Highly probable: It is most likely that the impact will occur. <80% probability.
5	Very serious widespread natural and / or social baseline changes. Irreparable damage to highly valued items.	On-going and widespread benefits to local communities and natural features of the landscape.	Province/ Region Will affect the entire province or region.	Project Life (>15 years): The impact will cease after the operational life span of the project and can be reversed with sufficient management.	Likely: The impact may occur. <65% probability.
4	On-going serious natural and / or social issues. Significant changes to structures / items of natural or social significance.	Average to intense natural and / or social benefits to some elements of the baseline.	Municipal Area Will affect the whole municipal area.	Long term: 6-15 years and impact can be reversed with management.	Probable: Has occurred here or elsewhere and could therefore occur. <50% probability.
3	On-going natural and / or social issues. Discernible changes to natural or social baseline.	Average, on-going positive benefits, not widespread but felt by some elements of the baseline.	Local Local extending only as far as the development site area.	Medium term: 1-5 years and impact can be reversed with minimal management.	Unlikely: Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur. <25% probability.
2	Minor natural and / or social impacts which are mostly replaceable. Very little change to the baseline.	Low positive impacts experience by a small percentage of the baseline.	Limited Limited to the site and its immediate surroundings.	Short term: Less than 1 year and is reversible.	Rare / improbable: Conceivable, but only in extreme circumstances. The possibility of the impact materialising is very low as a result of design, historic experience or implementation of adequate mitigation measures. <10% probability.
1	Minimal natural and / or social impacts, low-level replaceable damage with no change to the baseline.	Some low-level natural and / or social benefits felt by a very small percentage of the baseline.	Very limited Limited to specific isolated parts of the site.	Immediate: Less than 1 month and is completely reversible without management.	Highly unlikely / None: Expected never to happen. <1% probability.

Table 3-2: Significance threshold limits

Score	Description	Rating
< 35	An acceptable impact for which mitigation is desirable but not essential. The impact by itself is insufficient even in combination with other low impacts to prevent the development being approved. These impacts will result in either positive or negative short term effects on the social and/or natural environment.	Negligible
36 – 72	An important impact which requires mitigation. The impact is insufficient by itself to prevent the implementation of the project but which in conjunction with other impacts may prevent its implementation. These impacts will usually result in either a positive or negative medium to long-term effect on the social and/or natural environment.	Minor
73 – 108	A serious impact, if not mitigated, may prevent the implementation of the project (if it is a negative impact). These impacts would be considered by society as constituting a major and usually long-term change to the (natural and/or social) environment and result in severe effects or beneficial effects.	Moderate
> 108	A serious impact, which if negative, may be sufficient by itself to prevent implementation of the project. The impact may result in permanent change. Very often these impacts are immitigable and usually result in very severe effects or very beneficial effects.	Major

4 Hydrogeological Conceptual Model

A conceptual model is a simplified, but representative description of the groundwater system that illustrates the interaction of the sources, pathways and receptors on site. Risk of contamination will occur in the event of the presence and, most critically, the linkage between three components in a system as shown in Figure 4.1. The components are described below:

- The sources, representing all entities of the system that contribute to groundwater quality and/or quantity;
- The pathways are the aquifers through which the groundwater and contaminants migrate; and
- The receptors are humans, stream or natural ecosystems that depend on the groundwater and will be impacted negatively if the water is contaminated.

A detailed understanding of these components must be established in order to identify the linkage (or a lack of) between the source and the receptor via the pathway. The risk may only be approximated if the system proves to have a linkage between the components. The absence of a linkage means that migration of contaminants from the source to the receptor is not facilitated and therefore the risk of potential receptors being impacted is eliminated.

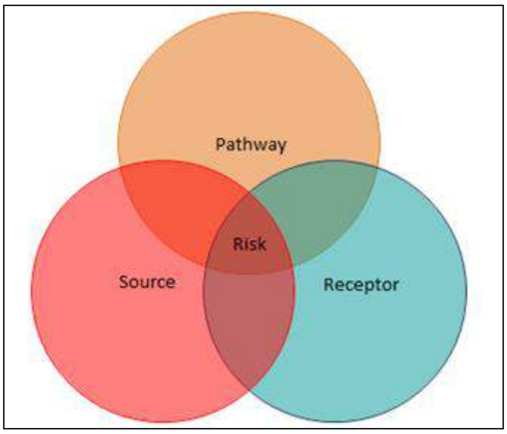

Figure 4.1: Simplified risk assessment criteria

4.1 Source Term

Monitoring data shows that sulphate is one of the main contaminants of concerns in the groundwater at the mine site. Previously it was also used for mass transport simulation and groundwater impact assessment (ERM, 2012; Digby Wells, 2016). In line with this, sulphate has been used in this study for the assessment of the potential impact of the proposed stockpiles.

Leachate tests were conducted by Digby Wells (2016) to simulate the leachate potential of the coal that would be placed on site, with the solution type and pH determined based on guidelines or the expected conditions on site. The tests showed that sulphate will be released from the stockpile at a maximum concentration of 445 mg/L. This is below the Water Use License (WUL) of the mine which is set at 600 mg/L. Further discussion on geochemical test work conducted is available within the Digby Wells' geochemical report (2016).

All four samples taken are classed as acid generating (Rock type I). This is however normal for coal deposits and is the same in most deposits. Surface water management of storm water and runoff from the stockpiles are crucial in managing any acidic water and leachate from toe seepage. These specific stockpiles at Grootegeluk will however be compacted and will only be in operation for short period (5 years) and with the low rainfall in the area the risk of high volumes of AMD formation is low. Although the mean annual precipitation (MAP) in the Grootegeluk area is low, in some months high intensity rainfall can occur. With the compaction of the coal during the stockpiling process[2] the permeability will be decreased

[2] Based on information provided by Exxaro the coal will be compacted in line with stockpile management guidelines. The coal will be compacted down to 101% of the natural density and lead to a reduced permeability.

and runoff increased. This last mentioned process will allow lower infiltration, but if high intensity rainfall events do take place for an extended period some AMD formation can potentially be observed as suggested by the lab tests.

4.2 Pathway (Aquifer)

The aquifer underlying the stockpile area is a potential pathway for the migration of contaminants. The regional aquifer systems within the project area, as defined by ERM (2012) are described as follows:

- Top weathered aquifer to a depth of approximately 30 m; and
- Fractured aquifer from approximately 30 m to 120 m.

A number of aquifer tests were conducted in the project area over the years. For increased accuracy, results from boreholes located in and within close proximity (no more than 400 m) of the proposed stockpile area have been considered.

The average (harmonic mean) transmissivity value is approximately 3.23 m^2/d. Considering the aquifer thickness of approximately 120 m, the hydraulic conductivity is estimated to be 0.023 m/d. The location of the boreholes is presented in Plan 5, Appendix A.

Measurements conducted in 2014 shows that groundwater levels (in and around the proposed stockpile area) range from 4 to 14 m.

Groundwater levels measured in 2014 (from boreholes WB34, WB59 and WB50) indicate a local groundwater flow direction of south to north (Plan 6, Appendix A).

4.3 Potential Receptors

The identified potential receptors are discussed below.

4.3.1 Private boreholes

Digby Wells carried out a hydrocensus in 2014, within a 2 km radius of the mine. Two private boreholes (AV1S and AV2S shown in Plan 6, Appendix A) were identified as potential receptors, located east northeast in relation to the stockpile area.

Borehole AV1S is no longer in use and therefore not considered as a receptor, however borehole AV2S is used to supply water to a shooting ranch (as confirmed by the hydrocensus conducted by Digby Wells, 2014). Information about these boreholes is listed in Table 4-1. The rest of the boreholes in the area form part of Exxaro's groundwater monitoring network and water quality within these boreholes should be in line with the conditions stipulated within the Water Use Licence.

Table 4-1: Private boreholes in the Grootegeluk Mine area

BH Name	Cape, LO27			Groundwater Level		Comment	Distance from Stockpiles
	X	Y	Z	m bgl	mamsl		
AV1S	58370.26	-2614698	885.43	24.3	861.13	Not in use	2 km

BH Name	Cape, LO27			Groundwater Level		Comment	Distance from Stockpiles
	X	Y	Z	m bgl	mamsl		
AV2S	58663	-2614726	885.43	18.53	866.9	Domestic use	2 km

4.3.2 Aquifer

The aquifer is identified as a potential receptor as it is a natural resource that has to be managed sustainably.

5 Analytical Model

An analytical groundwater model was used to predict the potential impact of the proposed stockpile. The stockpile layout considered during calculations is presented in Plan 3, Appendix A.

The analytical model is based on Darcy's Law which is:

$$q = Ki \qquad (1)$$

$$K = \frac{T}{b} \qquad (2)$$

Where:

q = seepage rate, also referred to as the outflow rate (m/d);

K = hydraulic conductivity (m/d);

T = aquifer transmissivity (m^2/d) calculated from the aquifer testing;

i = hydraulic gradient; and

b = aquifer thickness (m)

The hydraulic gradient from stockpile is assumed to be one since the flow will mainly be vertical. Therefore the magnitude of the seepage rate would be equal to the hydraulic conductivity.

5.1 Class C Liner

WSP (2015) classified the coal material as a Type 3 waste and should be disposed of or stored at a facility with a Class C liner or a system with similar properties. As per the minimum requirements (DWS, 1998) and NEM:WA Regulations (2013), a Class C liner design allows for an outflow rate of approximately 8.64 x 10^{-4} m/d. Exxaro is in the process of investigating alternative liner systems that would be in line with the Class C liner requirements and may be more cost effective to construct. A conceptual design for a Class C liner as given by the NEM: WA guidelines (DEA 2013) is shown in Figure 5.1.

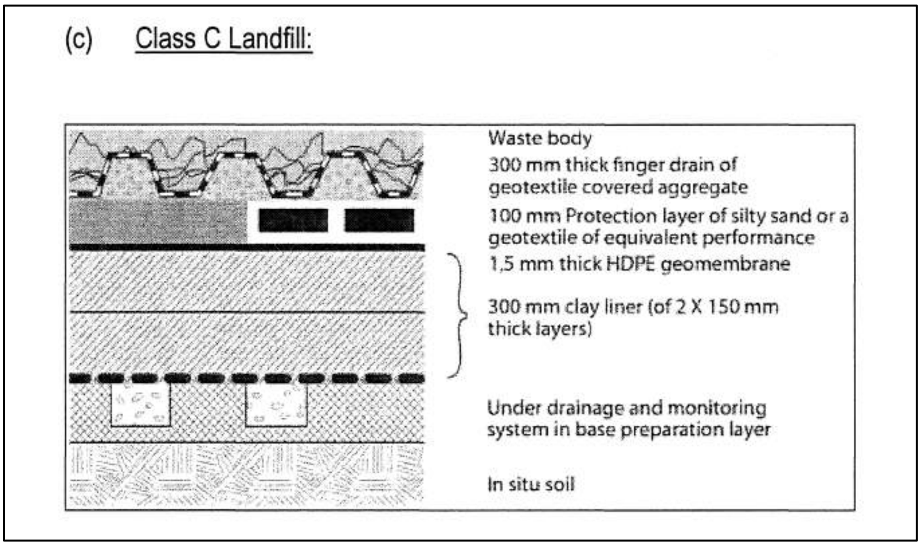

Figure 5.1: Minimum design requirement for a Class C liner (DEA, 2013)

6 Impact Assessment

The impact assessment is conducted with the primary purpose of assessing the potential risk of contamination associated with the proposed stockpiles on the groundwater. Ratings are conducted by evaluating each activity individually.

6.1 Project Activities Assessed

Groundwater impacts may potentially arise from the following activities:

- Utilising the Laydown Area, GG10 Stockyard B, and Multiproduct Stockyard footprints (to stock excess Eskom-grade coal) to stockpile coal for approximately 5 years; and
- Extending GG10 Stockyard B footprint by approximately 12.8 ha.

6.2 Potential Impacts of Infrastructure

The potential impacts of the proposed infrastructure relate to leachate emanating from the stockpiles and migrating into the local aquifer where it might reach sensitive receptors such as humans that make use of groundwater.

6.3 Site Clearing Impacts

6.3.1 Impact Description: Removal of topsoil and vegetation

The activity has no impact on the groundwater as the water table is 4 m bgl (at the shallowest point). However, in the unlikely event that the site clearing extends beyond 4 m, the impact to the groundwater will increase. The impact could either be in the form of increased natural groundwater recharge or enhanced seepage rate from the stockpile.

6.3.1.1 Impact Description Management/ Mitigation Measures

The following mitigation measures are recommended:

- Vegetation and top soil removal not to take place below 4 m;
- If the stockpile area is low-lying and site clearing intercepts the water table, it is recommended to rather build up the area with soil to ensure that the construction takes place above the water table; and
- Groundwater monitoring to assess the time water level and quality impacts.

6.3.1.2 Impact Ratings

This impact is rated as shown in Table 6-1.

Table 6-1: Removal of topsoil and vegetation

IMPACT DESCRIPTION: Removal of topsoil and vegetation			
Dimension	**Rating**	**Motivation**	**Significance**
Pre-Mitigation			
Duration	Short term: Less than 1 year (2)	Equal to the duration of the construction phase which will be a short period	Negligible (-20)
Extent	Limited (1)	The impacts will be limited to the stockpile area	
Intensity x type of impact	Negative (2)	This will have impacts on groundwater recharge rate in the area of the stockpiles only	
Probability	Likely (4)	It may occur depending on the depth at which the removal will extend to, 4 m provides for relatively sufficient thickness to work with	
Mitigation/ Management actions			
■ If the stockpile area is low-lying and site clearing will intercept the water table, levelling of the area with soil is recommended to ensure that the construction takes place above the water table. ■ Groundwater monitoring around and downstream of the stockpiles.			
Post-Mitigation			
Duration	Short term: Less than 1 year (2)	Equal to the duration of the construction phase which will be a short period	Negligible (-4)
Extent	Limited (1)	Impacts reduced to isolated parts	
Intensity x type of impact	Negative (1)	Impacts reduced to isolated parts therefore intensity reduced significantly	
Probability	Probable (1)	Likelihood of impacts occurring is minimal	

6.3.2 Impact Description: Hydrocarbon spillage

Hydrocarbon spillage may occur as a result of oil or fuel spillages from site machinery may collect in the soils.

The water table in the project area is relatively shallow; it is possible that the spilled organic compounds can reach the groundwater environment. During rainfall events, hydrocarbon compounds from oil and fuel in the soils may migrate to the aquifers with water infiltrating through these polluted areas.

6.3.2.1 Impact Description Management/ Mitigation Measures

The following mitigation measures are recommended:

- Machinery should be maintained properly, diesel or other chemicals be handled appropriately and not spilled. Re-fuelling protocols must also be followed to ensure no diesel is spilled during filling;
- Reservoirs must be in a bunded area;
- If a considerable amount of fluid is accidentally spilled, the contaminated soil should be scraped off and disposed at an acceptable dumping facility; and
- Groundwater monitoring, to assess water quality.

6.3.2.2 Impact Ratings

This impact is rated in Table 6-2.

Table 6-2: Hydrocarbon spillage

IMPACT DESCRIPTION: Siltation of runoff leading to siltation of storage dams and conveyance channels			
Dimension	**Rating**	**Motivation**	**Significance**
Pre-Mitigation			
Duration	Short term: Less than 1 year (2)	Equal to the duration of the construction phase which will be a short period	Negligible (-24)
Extent	Limited (2)	The impacts will be limited to the site	
Intensity x type of impact	Negative (2)	This will have impacts on groundwater quality. Very little change to the baseline.	
Probability	Likely (4)	It may occur depending on protocol followed on-site	
Mitigation/ Management actions			

IMPACT DESCRIPTION: Siltation of runoff leading to siltation of storage dams and conveyance channels			
Dimension	**Rating**	**Motivation**	**Significance**
Pre-Mitigation			
■ Machinery should be maintained properly and re-fuelling protocols must also be followed. ■ Reservoirs must be in a bunded area. ■ In the event of accidental spillage, the contaminated soil should be scraped off and disposed at an acceptable dumping facility. ■ Groundwater monitoring.			
Post-Mitigation			
Duration	Short term: Less than 1 year (2)	Equal to the duration of the construction phase which will be a short period	Negligible (-4)
Extent	Limited (1)	Impacts reduced to isolated parts	
Intensity x type of impact	Negative (1)	Impacts reduced to isolated parts therefore intensity reduced significantly	
Probability	Probable (1)	Likelihood of impacts occurring is minimal	

6.4 Stockpile Seepage

6.4.1 Impact Description: Groundwater Contamination from Stockpile Leachate Migrating to Aquifer

The geochemistry study (Digby Wells, 2016) identified Mn as a potential contaminant of concern that would seep from the stockpile. However, at the expected rate of seepage and low rainfall at Grootegeluk, the element should not leach out at these concentrations given by the laboratory tests which simulate a worst case scenario.

In the event that any leachate seeps from the stockpile, it could migrate to the aquifer. A liner has been proposed that will reduce the rate and volume of leachate entering the aquifer.

With the compaction of the coal during the stockpiling process[3] the permeability will be decreased and runoff increased. This last mentioned process will allow lower infiltration, but if high intensity rainfall events do take place for an extended period some AMD formation can potentially be observed as suggested by the lab tests contained within the geochemistry report (Digby Wells 2016).

[3] Based on information provided by Exxaro the coal will be compacted in line with stockpile management guidelines. The coal will be compacted down to 101% of the natural density and lead to a reduced permeability.

6.4.2 Impact Description Management/ Mitigation Measures

The following mitigation measures are recommended:

- Coal stockpile compaction to reduce the hydraulic conductivity of the material, therefore reducing seepage rates inhibiting leachate migration. Based on information provided by Exxaro the coal will be compacted in line with stockpile management guidelines. The coal will be compacted down to 101% of the natural density and lead to a reduced permeability.
- Installation of a liner as recommended according to the type of leachate predicted to emanate from the stockpiles (based on geochemical studies); and
- Groundwater monitoring to keep a record of the groundwater levels and quality.

6.4.3 Impact Ratings

This impact is rated in Table 6-3.

Table 6-3: Stockpile leachate seepage

IMPACT DESCRIPTION: Groundwater Contamination from Stockpile Leachate Migrating to Aquifer			
Dimension	**Rating**	**Motivation**	**Significance**
Pre-Mitigation			
Duration	Project Life (>15 years) (5)	Project Life of approximately 5 years	Minor (-44)
Extent	Municipal Area (4)	The impacts may extend beyond development site area	
Intensity x type of impact	Minor- negative (2)	Comparing baseline water quality and geochemistry results: Very little change to the baseline groundwater quality will be encountered, as leachate is not quantified as contamination	
Probability	Likely (4)	Without appropriate mitigation leachate will discharge into local aquifer, however no serious changes to baseline groundwater quality as the leachate is not quantified as contamination	
Mitigation/ Management actions			
▪ Coal compaction to reduce the permeability of the material. ▪ Installation of a liner recommended according to the type of material stocked. ▪ Groundwater monitoring.			
Post-Mitigation			
Duration	Project Life (>15 years) (5)	Project Life of approximately 5 years	Negligible (-30)
Extent	Municipal Area (3)	The impacts will extend as far as development site area	

Intensity x type of impact	Minor- negative (2)	Comparing baseline water quality and geochemistry results: Very little change to the baseline groundwater quality will be encountered, as leachate is not quantified as contamination	
Probability	Likely (3)	Leachate discharge into local aquifer highly reduced, impacts remain minimal leachate is not quantified as contamination	

7 Groundwater Monitoring Plan

Groundwater monitoring is a tool to have in place for a number of reasons:

- complaining with WUL conditions;
- keeping record of the site conditions; and
- For informed decision making based on site conditions.

This practice provides for early detection of water quality deterioration and thereafter implementation of management measures, avoiding harmful impacts to the affected parties and the operators of the activities (in the event that contamination does emanate from the stockpiles).

Furthermore, for verification and increased confidence in the geochemistry results, it is advised that continuous monitoring of the groundwater quality be conducted. This will provide for a sufficient database to assess the potential impact of the stockpiles on the groundwater environment in terms of quality.

Existing boreholes are recommended to be used for monitoring. They are located in suitable places which will be sufficient for monitoring purposes of the proposed activities. The recommended monitoring boreholes are: boreholes WBR15, WBR28, WB33 and WB35 (shown in Plan 7, Appendix A).

8 Conclusions and Recommendations

Monitoring data shows that sulphate is one of the main contaminants of concerns in the groundwater at the mine site. However, the leachate tests conducted on the coal samples showed that the sulphate is unlikely to leach at more than 445 mg/L. This is within the WUL limit of 600 mg/L. Based on the findings of the geochemistry report and the analytical model, the risk of contamination to sensitive receptors is considered low, however it is crucial that the appropriate liner system is installed and the monitoring is undertaken to ensure that the levels of contamination remain below the levels stipulated within the approved WUL and that contamination to sensitive receptors is avoided were possible.

Borehole AV2S was the only potential receptor identified in the area. The risk to this receptor is reduced and is based on the analytical modelling and geochemistry results. The borehole is also located approximately 2 km from the proposed stockpile area, further reducing any risks. However, monitoring is recommended to be conducted to ensure that no impact occurs during and after the period that the stockpile is in place.

As per the minimum requirements (DWS, 1998) and NEM:WA Regulations (2013), a Class C liner design allows for an outflow rate of approximately 8.64 x 10^{-4} m/d.

Exxaro proposes to construct and utilise an alternative barrier system with outflow rates equivalent to those of the recommended Class C Liner. A liner of the same outflow rates as the Class C liner will impose the same barrier effect associated with leachate migrating from the stockpiles to the groundwater environment through the Class C liner. This alternative liner system may be more cost effective for Exxaro to construct and further investigation is being undertaken regarding this.

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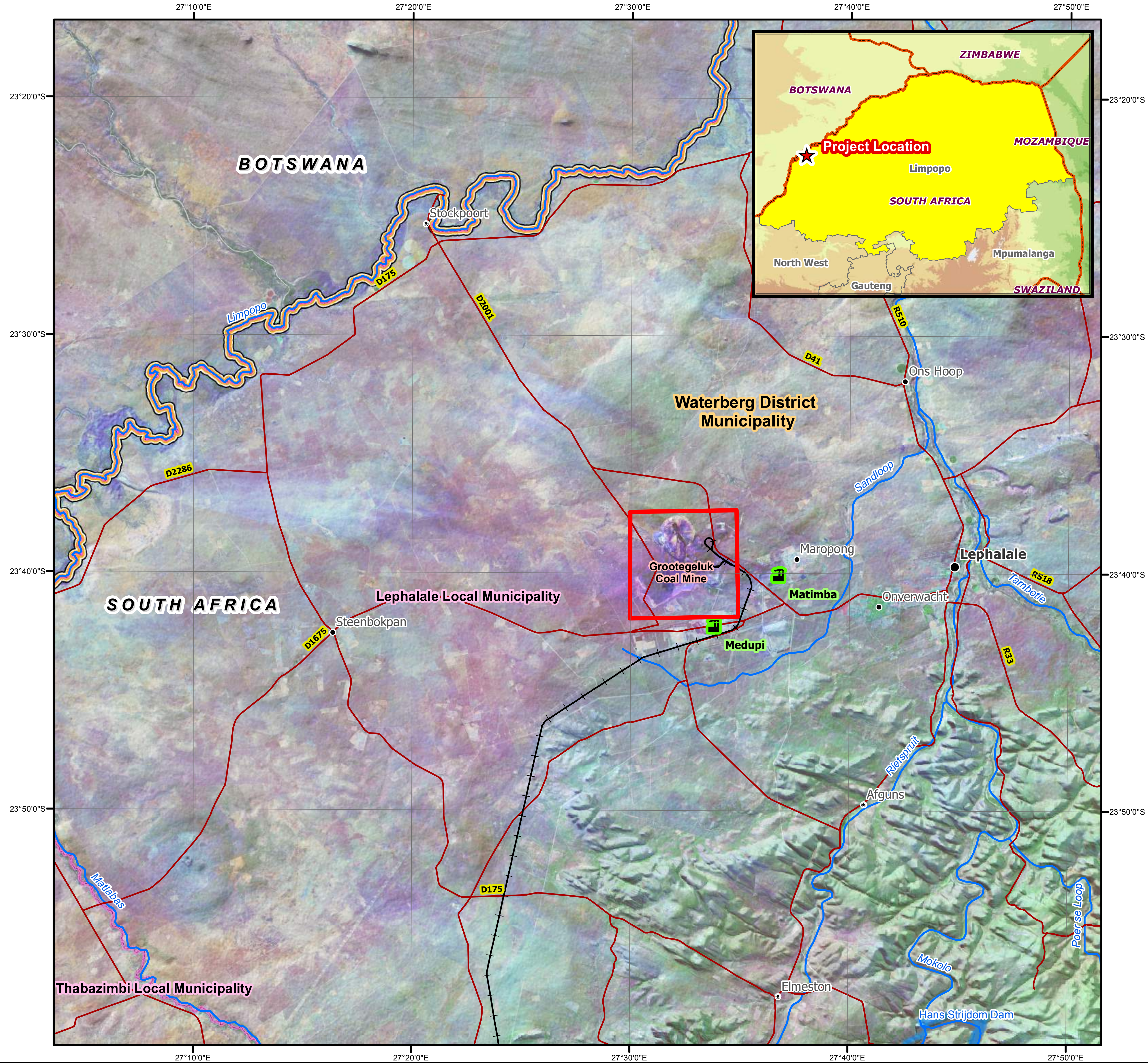
Appendix A: Plans



Plan 1

Exxaro Grootegeluk Amendment Project

Regional Setting

Legend

- Grootegeluk Location
- Major Town
- Settlement
- Power Station
- Existing Railway Line
- Main Road
- National Road
- River
- Dam
- Local Municipal Boundary
- District Municipal Boundary
- International Boundary

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Plan 2

Exxaro Grootegeluk Amendment Project

Local Setting

Legend

- Proposed Infrastructure Footprint
- Settlement
- Power Station
- Main / Secondary Road
- Other Access Road
- Tracks & Footpaths
- Existing Railway Line
- Non-Perennial River
- Dam
- Wetland
- Perennial Pan
- Non-Perennial Pan
- Farm Boundary

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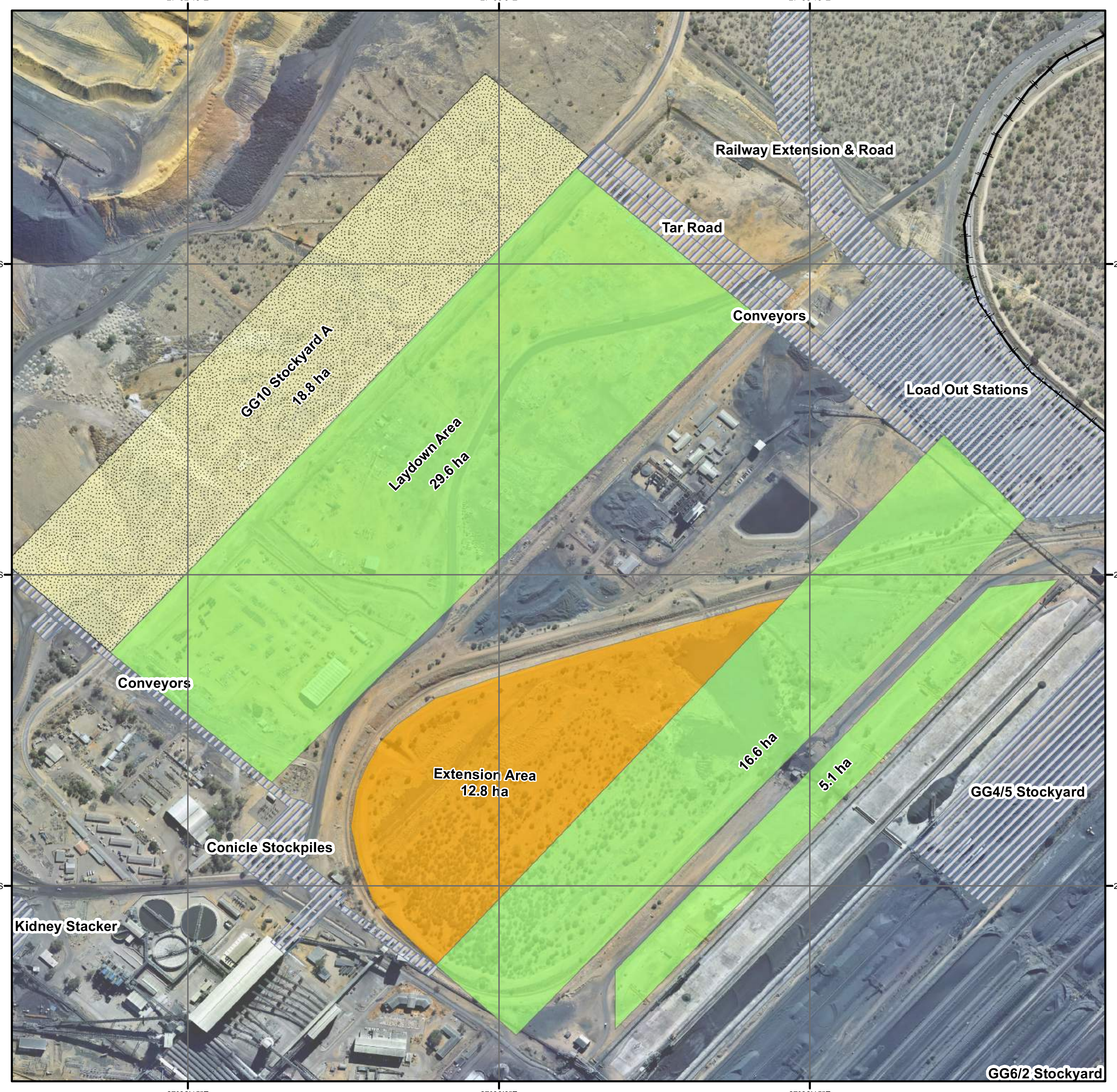

Plan 3

Exxaro Grootegeluk Amendment Project

Infrastructure Expansion

Legend

Proposed Infrastructure

- GG10 Stockyard A
- Infrastructure Amendment Project
- Extension Area

Existing Infrastructure

- Existing Railway Line
- Existing Infrastructure

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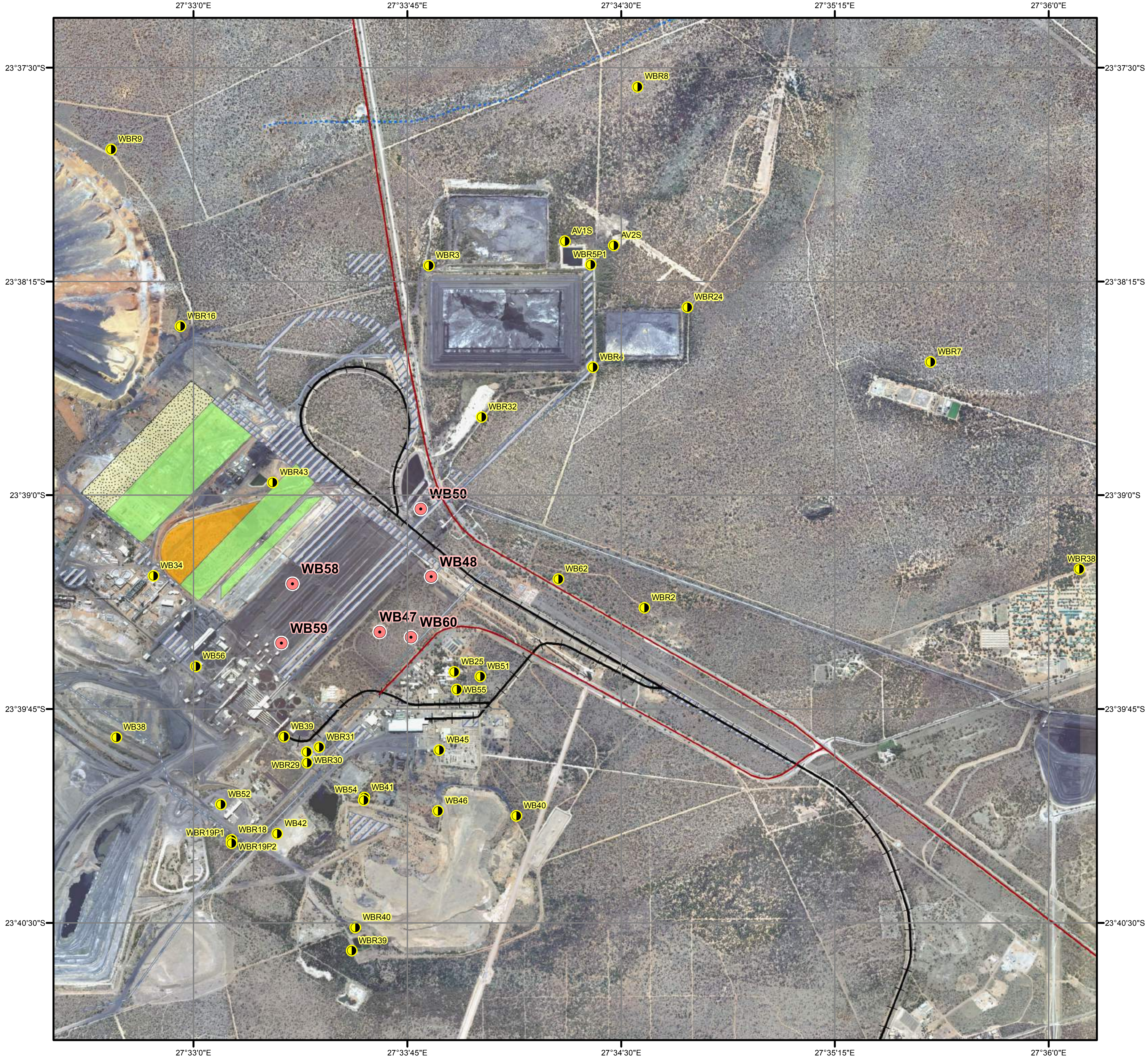

Plan 4

Exxaro Grootegeluk Amendment Project

Existing Groundwater Quality Monitoring Boreholes

Legend

- Existing Groundwater Quality Monitoring Boreholes
- Existing Monitoring Boreholes
- Main / Secondary Road
- Non-Perennial River

Proposed Infrastructure

- GG10 Stockyard A
- Infrastructure Amendment Project
- Extension Area

Existing Infrastructure

- Existing Railway Line
- Existing Infrastructure

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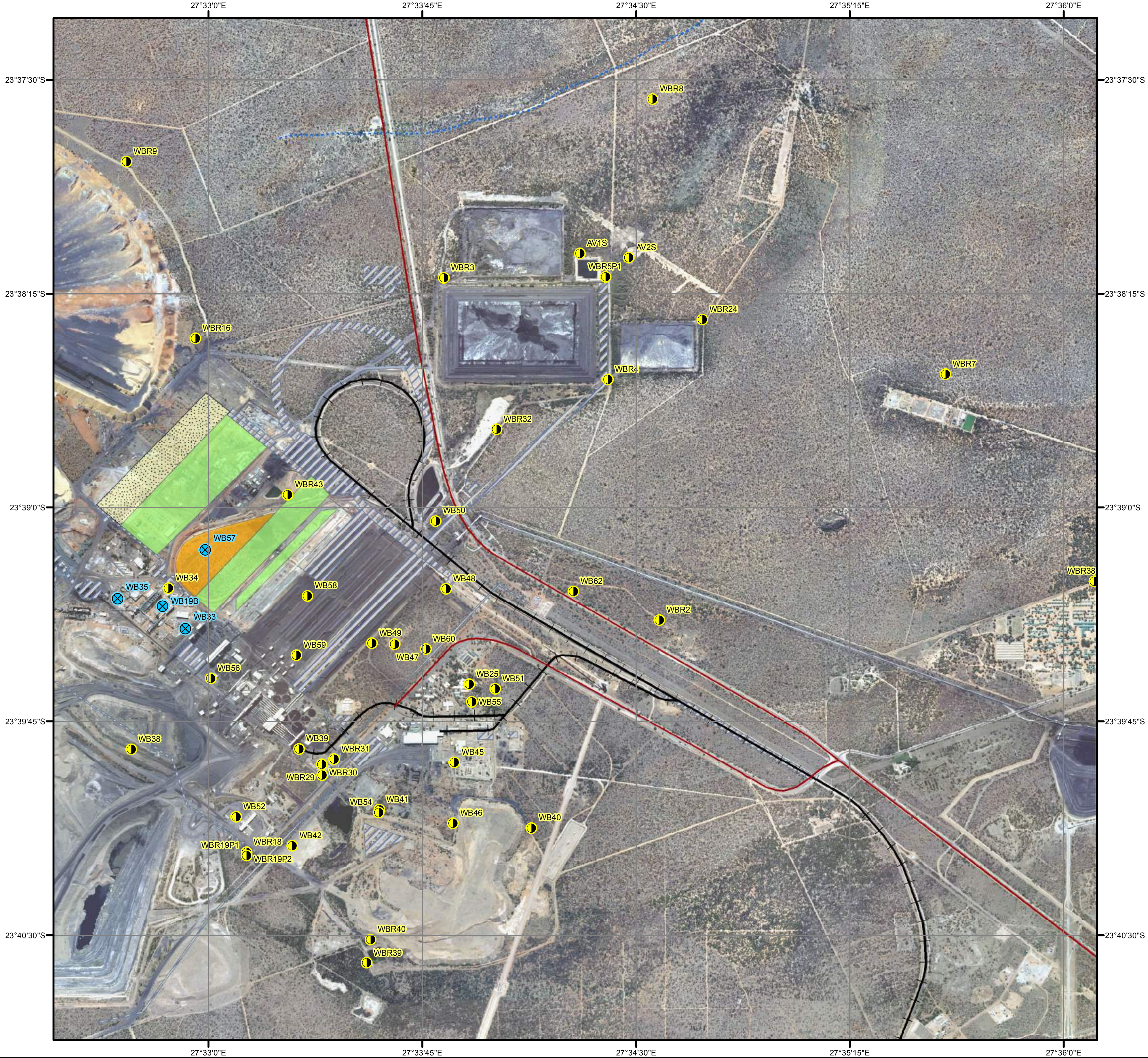
Plan 5

Exxaro Grootegeluk Amendment Project

Borehole Locality



Legend

- Aquifer Tested Boreholes
- Monitoring Boreholes
- Main / Secondary Road
- Non-Perennial River

Proposed Infrastructure

- GG10 Stockyard A
- Infrastructure Amendment Project
- Extension Area

Existing Infrastructure

- Existing Railway Line
- Existing Infrastructure

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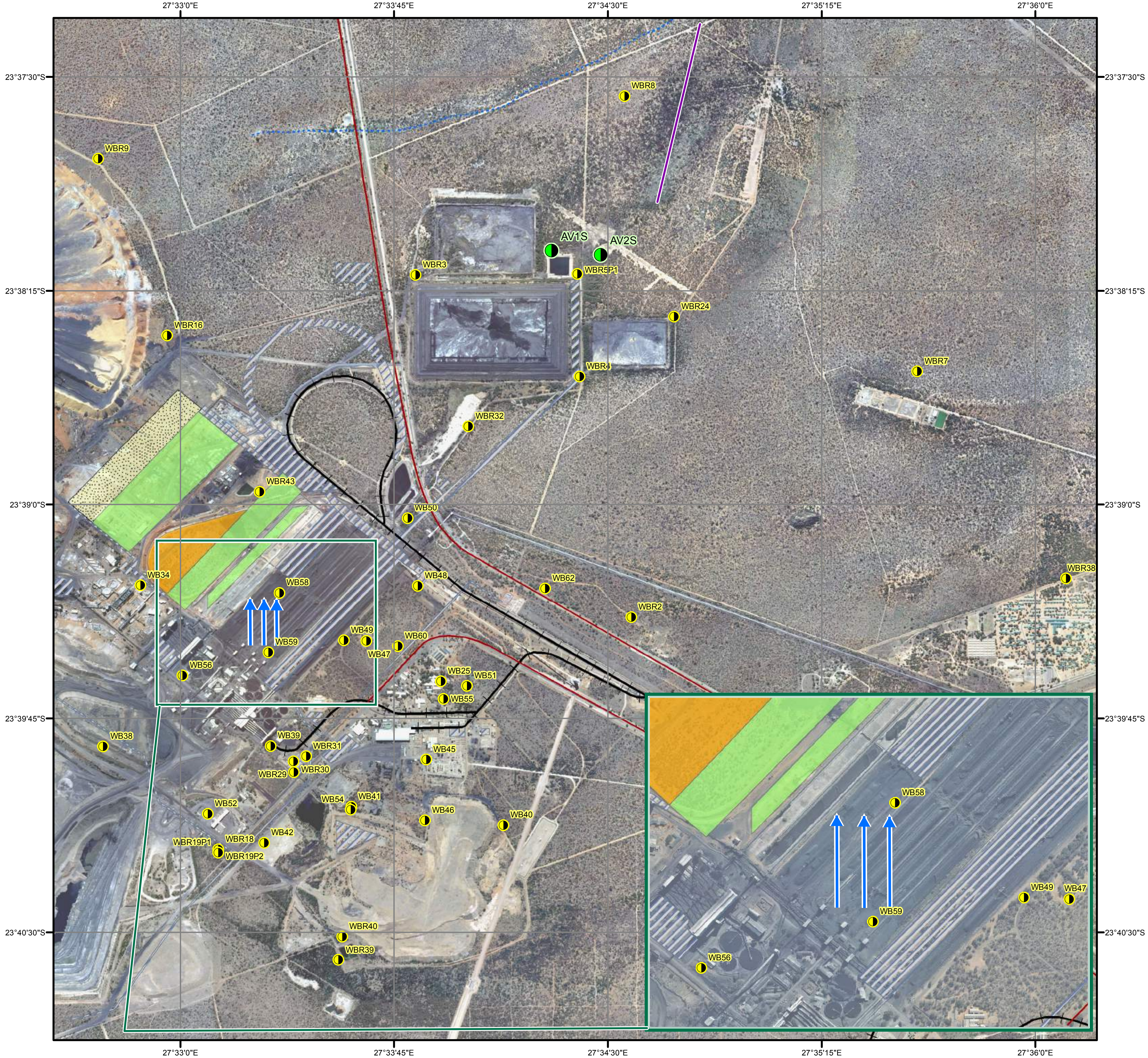

Plan 6

Exxaro Grootegeluk Amendment Project

Private Borehole Location

Legend

- Private Boreholes
- Existing Monitoring Boreholes
- Groundwater Flow Direction
- Main / Secondary Road
- Non-Perennial River

Proposed Infrastructure

- GG10 Stockyard A
- Infrastructure Amendment Project
- Extension Area

Existing Infrastructure

- Existing Railway Line
- Existing Infrastructure

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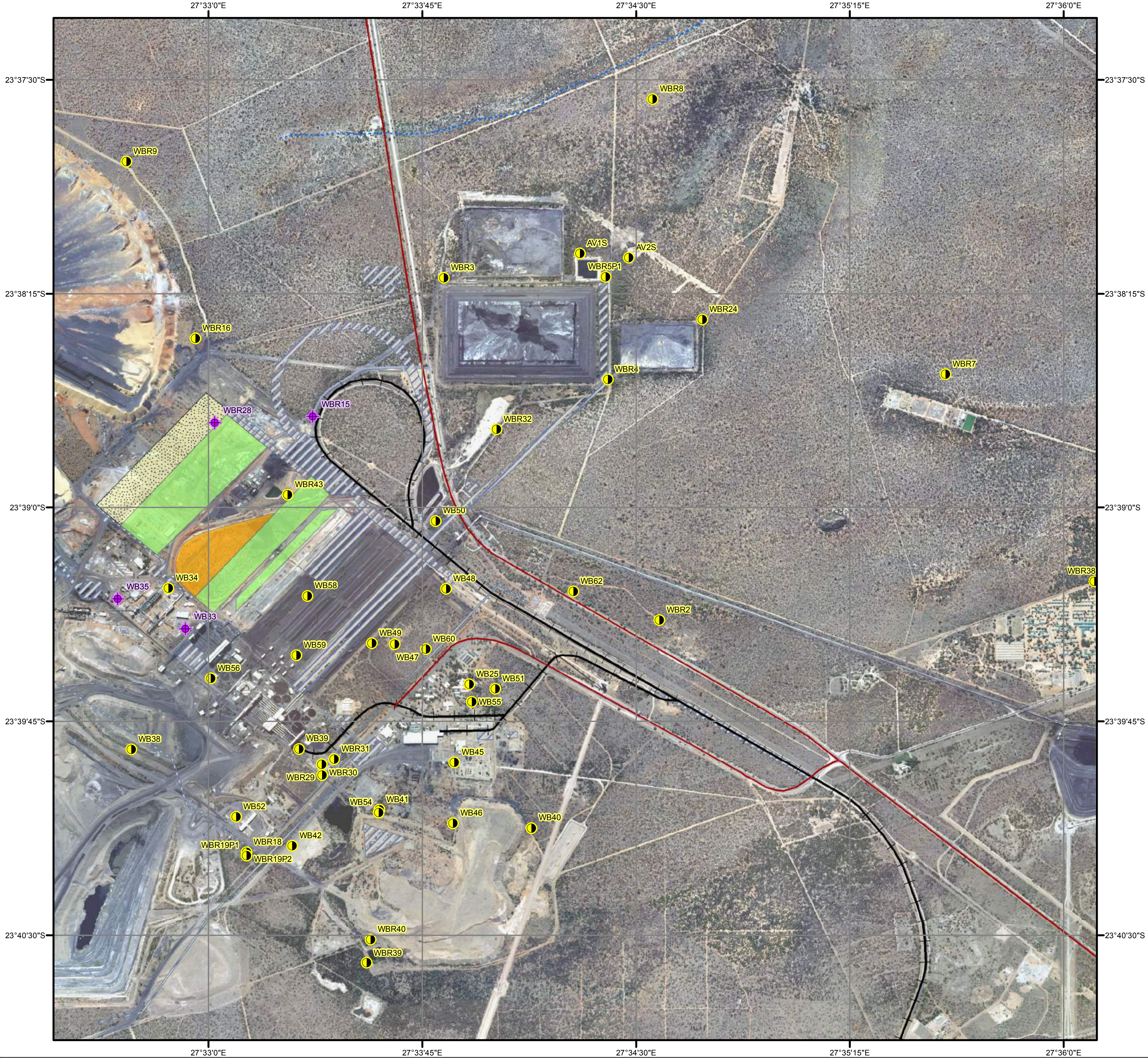

Plan 7

Exxaro Grootegeluk Amendment Project

Proposed Monitoring Boreholes

Legend

- Proposed Monitoring Boreholes
- Existing Monitoring Boreholes
- Main / Secondary Road
- Non-Perennial River

Proposed Infrastructure

- GG10 Stockyard A
- Infrastructure Amendment Project
- Extension Area

Existing Infrastructure

- Existing Railway Line
- Existing Infrastructure

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