Carmichael Coal Mine and Rail Project
Supplementary Environmental Impact Statement

Volume 4, Appendix C3a – MCU Application Laydown Areas

Containing

- Part 6 – Environmentally Relevant Activities
- Part 7 – Transport and Traffic
- Part 8 – Civil Plans and Drawings
- Part 9 – Ecology

PART

6

ENVIRONMENTALLY RELEVANT ACTIVITIES

- Information in Support of an Application for an Environmentally Relevant Activity 8 (Chemical Storage) prepared by Cardno
- Information in Support of an Application for an Environmentally Relevant Activity 63 (Sewage Treatment) prepared by Cardno

Carmichael Coal Mine and Rail Project

Information in Support of Development Application-ERA 8

7803-04

Prepared for
Adani Mining Pty Ltd

23 July 2013

Cardno
Shaping the Future

Contact Information

Cardno (QLD) Pty Ltd
ABN 57 051 074 992

Level 11 Green Square North Tower
515 St Paul's Terrace
Fortitude Valley QLD 4006
Locked Bag 4006 Fortitude Valley

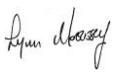
Telephone: 07 3369 9822
Facsimile: 07 3369 9722
International: +61 7 3369 9822

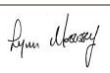
cardno@cardno.com.au.
www.cardno.com.au.

Document Information

Prepared for	Adani Mining Pty Ltd
Project Name	Carmichael Coal Mine and Rail Project
File Reference	I:\7803-04 HRP - Adani\wp\Reports\Final reports ERA8 and 63 for Issue\Adani ERA 8 Supporting Information V1 Final.docx
Job Reference	Carmichael Coal Mine and Rail Project
Date	23 July 2013

Document Control

Version	Date	Description of Revision	Prepared By	Prepared (Signature)	Reviewed By	Reviewed (Signature)
A	12 July 2013	Draft	SCB		LAM	
1	23 July 2013	Final	SCB	S Brown	LAM	

Version	Reason for Issue	Approved for Release By	Approved (Signature)	Approved Release Date
A	For client comment	LAM		12 July 2013
1	For approval	LAM		23 July 2013

Executive Summary

Adani is proposing to develop a 60 million tonne (product) per annum (Mtpa) thermal coal mine in the north Galilee Basin approximately 160 kilometres (km) north–west of the town of Clermont, Central Queensland. All coal will be railed via a privately owned rail line connecting to the existing QR National rail infrastructure, and shipped through coal terminal facilities at the Port of Abbot Point and the Port of Hay Point (Dudgeon Point expansion). The Carmichael Coal Mine and Rail Project (the Project) will have an operating life of approximately 90 years. The Project comprises of two major components:

> The Project (Mine): a greenfield coal mine over EPC1690 and the eastern portion of EPC1080, which includes both open cut and underground mining, on-mine infrastructure and associated mine processing facilities (the Mine) and the Mine (offsite) infrastructure.

> The Project (Rail): a greenfield rail line connecting the Mine to the existing Goonyella and Newlands rail systems to provide for the export of coal via the Port of Hay Point (Dudgeon Point expansion) and the Port of Abbot Point, respectively, including:

  – Rail (west): a 120 km dual gauge portion from the Mine site running west to east to Diamond Creek; and

  – Rail (east): a 69 km narrow gauge portion running east from Diamond Creek connecting to the Goonyella rail system south of Moranbah.

This document considers the Rail (west), referred to by Adani as SP1 and associated construction depot, refuelling facilities, material storage areas, flash butt welding facility, concrete batching plants and sewage treatment plant (STP), including a land disposal (effluent irrigation) area.

The Rail (east) is not within the scope of this report.

A number of construction related activities will be temporarily carried out during the project construction period at various locations along SP1 in order to assist and support the Carmichael Coal Rail Project (CCRP) construction works, which are proposed to be ongoing for a period of two years. Following construction it is expected that these facilities/activities will be discontinued and decommissioned. These activities include:

> concrete batching;

> vehicle and equipment maintenance in a vehicle workshop;

> flash-butt welding and grinding of rails;

> chemical storage and refuelling of vehicles and equipment;

> material and equipment laydown and storage; and

> onsite sewage treatment, land disposal and/or reuse of effluent.

Fuel and chemical storage and refuelling activities are required for the powering of the flash butt welding, sewage treatmnet plan (STP) and concrete batching facilities, operation and refuelling of construction vehicles at the construction depot.

During operational phase a rolling stock maintenance facility will operate in order to provision the refuelling and maintenance of coal trains which will also require the powering of diesel generators associated with operational office and maintentance facilities and a small sewage treatment plant. The fuel storage to be located at this facility will be in excess of 1,000,000L of fuel.

Therefore, collectively for the Project, fuel storage is requried to occur at multiple locations along SP1 and is above the threshold for ERA 8 (>50t). These fuel storage activities collectively therefore consitute an Envrionmentally Relevant Activity and are the subject of this additional report *Carmicheal Coal Mine and Rail Project-Supporting Information ERA 8*.

Cardno (Qld) Pty Ltd (Cardno) has been commissioned by Adani to prepare supporting information and an associated Site Based Management Plan (SBMP) for the Chemical Storage and Refueling Activities for the coal rail facilities specified above in support of an application for ERA 8. This SBMP is intended to form the

basis of the application for environmental authority in accordance with the *Environmental Protection Act 1994*, while at the same time providing information in support the Development Application for Material Change of Use (MCU) being sought from Isaac Regional Council. This document will also be provided to the Coordinator General as part of the Supplementary Environmental Impact Statement (EIS) submission for the Carmichael Coal Mine and Rail Project.

The supporting information contained in this document provides further information on the proposed fuel and chemical storage activities, the site and how the activities are to be conducted to facilitate best environmental practice. This report and SBMP identify the environmental management measures which will be adopted onsite to address potential environmental impacts associated with the proposed ERA 8.

Secondary activities to be conducted at or near the Construction depot such as boiler making/engineering and concrete batching activities do not constitute ERAs as defined in Schedule 2 of the EP Reg and as such are self-regulated. ERA 63 is also required to be carried out with respect to the development at the construction depot and construction office and are the subject of a separate ERA 63 supporting information report *Carmicheal Coal Mine and Rail Project-Supporting Information ERA 63*. It should be noted with reference to the main fuel storage location at the rollingstock maintenance facility that ERA 63 for the proposed office sewage treatment is not triggered at the site and the matter of sewage treatment proposals at this facility will be addressed under the *Queensland Plumbing and Wastewater code* in correspondence with Isaac Regional Council. Management of non-ERA activities at all project sites and all businesses are still required to meet the general environmental duty to prevent environmental harm under the *Environmental Protection Act 1994* (EP Act). Therefore, stand-alone and integrated Environmental Management Plans have also been prepared for the project in order to provide best environmental practice principles and management guidelines at the construction depot for any activities which do not consitutute an environmentally relevant activity. Environmental management measures for these activities have been addressed separetely in the Cardno document *Carmicheal Coal Mine and Rail Project-Construction Depot Integrated Environmental Management Plan*.

Table of Contents

Tables

Figures

Appendices

1 Proposed Activities

Adani is proposing to develop a 60 million tonne (product) per annum (Mtpa) thermal coal mine in the north Galilee Basin approximately 160 kilometres (km) north-west of the town of Clermont, Central Queensland.

All coal will be railed via a privately owned rail line connecting to the existing QR National rail infrastructure, and shipped through coal terminal facilities at the Port of Abbot Point and the Port of Hay Point (Dudgeon Point expansion). The Carmichael Coal Mine and Rail Project (the Project) will have an operating life of approximately 90 years. The Project comprises of two major components:

> The Project (Mine): a greenfield coal mine over EPC1690 and the eastern portion of EPC1080, which includes both open cut and underground mining, on-mine infrastructure and associated mine processing facilities (the Mine) and the Mine (offsite) infrastructure.

> The Project (Rail): a greenfield rail line connecting the Mine to the existing Goonyella and Newlands rail systems to provide for the export of coal via the Port of Hay Point (Dudgeon Point expansion) and the Port of Abbot Point, respectively, including:

  – Rail (west): a 120 km dual gauge portion from the Mine site running west to east to Diamond Creek; and

  – Rail (east): a 69 km narrow gauge portion running east from Diamond Creek connecting to the Goonyella rail system south of Moranbah.

This document considers the Rail (west) and associated construction depot, refuelling facilities, material storage areas, flash butt welding facility, concrete batching plants and sewage treatment plant (STP), including a land disposal (effluent irrigation) area.

As part of this rail line Adani propose the development of multiple chemical storage and refuelling sites along the rail corridor, including a refuelling site at the concrete batching facility near Construction Camp 3 referred to as BP7, fuel storage facilities at GenSet locations at batching plants along the alignment located at the four remaining concrete batching facilities, the Construction Depot and the Rolling Stock Maintenance Facility to cater the operational phase (“the activity”).

This report and accompanying SBMP is intended to support an application for Material Change of Use for Environmentally Relevant Activity for Chemical Storage (ERA 8) associated with development of the rail line and associated activities. The location of the various proposed activities listed above is shown in Figure 1.

2 Site Characteristics, Constraints and Existing Environmental Values

2.1 Location

The Rail alignment is a greenfield rail line located within a nominal 95 metre (m) wide corridor that runs from the terminal facilities within the boundary of the proposed Mine to connect with the Wotonga Blair Athol Branch Railway of the existing QR National Goonyella Coal Rail System south of Moranbah. The alignment is approximately 120km long and runs west to east. Laydown areas including the construction depot, maintenance facility and concrete batching plants will be constructed outside the rail corridor area.

The Project (Rail) sits wholly within the Isaac Regional Council (IRC) Local Government Area (LGA).

The location of each of the fuel storage areas is identified on Figure 1.

2.2 Climate

Historical climatic data and statistics for the Twin Hills Post Office (Bureau of Meteorology (BOM) Station #036047) was identified during the EIS (GHD, 2012a) as being representative of the climatic conditions experienced at the western end of the rail project area (SP1). Monthly mean temperatures at this station indicated daytime summer temperatures generally in the low to mid 30°C, with winter overnight temperatures dropping to between 5°C and 10°C. The temperature records were reported to show values ranging from -3.2°C to 43.8°C. 'Hot days', with temperatures exceeding 35°C could be expected up to 75 days per year. 'Frost days', with temperatures below 2°C can be expected up to 10 days per year (GHD 2012a, V3:S3:p3-2).

The annual mean rainfall is dominated by the warm months producing convectively driven rainfall. Rainfall occurring during the summer months (December through to February, inclusive) is shown to account for 50% of the annual mean rainfall at the Twin Hills station. Twin Hills has an annual average of 610mm over an 80 year record. The range of annual rainfalls at Twin Hills is 218mm to 1,477mm per year (GHD 2012a, V3:S3:p3-4).

Conclusions in the EIS determined that in any month of the year, there can be zero rainfall and there are pronounced variations in rainfall, including the persistence of both 'dry' years and 'wet' years (GHD 2012a, V3:S3:p3-4).

The dataset for this station comprised 80 years of data, operating between 1905 and 1985. The station was closed in 1985.

Historical climatic data was also obtained from the two open BOM stations, Bulliwallah (BOM Station #036010) and Clermont (Clermont Airport Qld BOM Station #035124), which are considered representative of the climatic conditions experienced at the construction depot. Table 2-1 shows that mean monthly rainfall and maximum temperature are greatest in January, November and December. For the Clermont and Bulliwallah weather observation sites, the mean annual maximum temperature is 28.95°C and rainfall is 599.70mm.

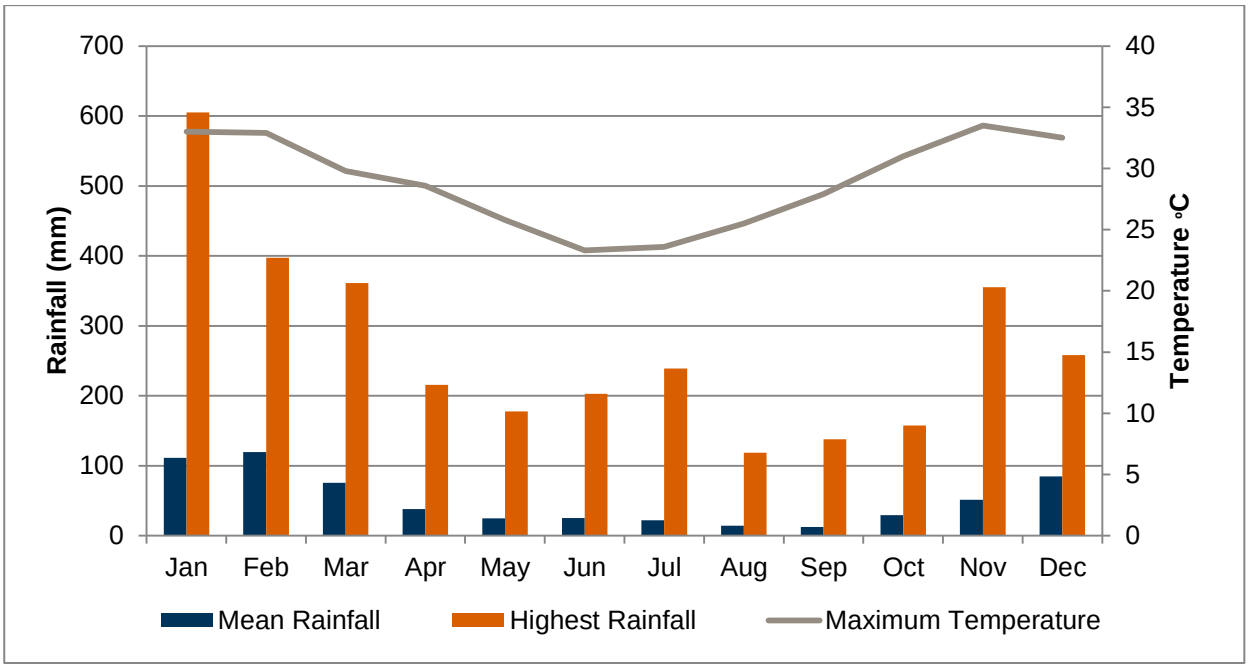


Table 2-1 Climatic Data for Clermont

Historical climatic data was obtained from the Bureau of Meteorology (BOM) for Moranbah (Moranbah Water Treatment Plant BOM station #034038). Table 2-2 shows that mean monthly rainfall and maximum temperature are greatest in January and December. For the assessed Moranbah weather observation site, the mean annual maximum temperature is 29.7 °C and rainfall is 616.00mm. These matters will be required to be considered when planning and managing the activities.

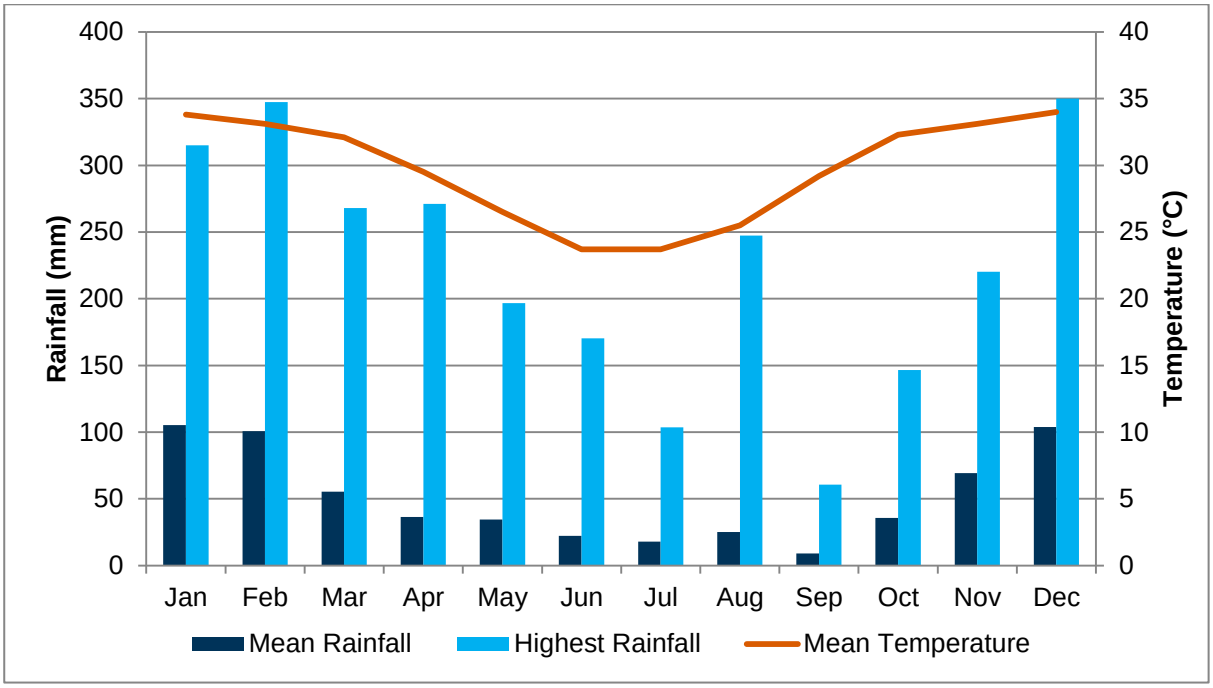


Table 2-2 Climate data for Moranbah

Wind data obtained from Twin Hills BOM station presented in the EIS showed that wind directions in the vicinity of SP1 predominantly range between northeast to southeast at speeds between 2m/s to 4m/s and that convective conditions tended to dominate throughout the daytime during both summer and winter.

However temperature inversions were identified as developing on the majority of nights (GHD 2012a, V3;S7;p.7-7). The potential for temperature inversions will need to be considered in the development and implementation of odour control measures for the Sewage Treatment Plant (STP).

The average daily solar radiation was reported to range between 21 and 24MJ/m^2 and average daily sunshine hours (annually) of between 8 and 9 hours (GHD 2012a, V3;S3;p.3-6). This factor will be relevant for the water balance calculations for the irrigation area.

2.3 Land Use and Topography

The Construction Depot site is currently used for grazing activities. Pursuant to the Belyando Shire Planning Scheme (within Isaac Regional Council area) the site is zoned as Rural (IRC 2013). The topography of the construction depot site is generally flat, with generally low relief (slope gradient range - 0.8% to 1.5%) associated with the minor drainage lines crossing the western side of the site and draining towards Gowrie Creek to the southwest. Natural surface elevations range from approximately 215m Australian Height Datum (AHD) in the southeast corner to 206m AHD in the north and 201m AHD within the bed of the drainage line intercepting the south-western corner of the site.

Land use surrounding the construction depot is primarily agricultural, used for broad acre cattle grazing. The Gregory Developmental Road is a State controlled road. During the EIS the site was mapped as being agricultural land class C1 – land suitable for sown pastures with moderate limitations and was located within the Western Cropping Boundary, but was not identified as being Strategic Cropping Land (GHD 2012a, V3:S4:pp48-49).

The maintenance facility site is currently used for rural grazing. Pursuant to the Belyando Shire Planning Scheme the site is zoned as Rural. The topography of the development sites is generally flat without non-distinctive topographical features. Natural surface elevations in the area to be used as a maintenance yard range from approximately 209m to 212m AHD.

The concrete batching plants are located strategically to provide concrete for use in preparation of rail bridge infrastructure and are therefore within easy access of the waterways to be catered. Natural elevations at these sites vary, however are similar to the natural surface elevations along the SP1 railway generally. The concrete batching facilities are designed to be temporary in nature and may be dismantled in emergency conditions.

2.4 Soils and Geology

During the EIS the geology underlying the construction depot and surrounding area was mapped as Quaternary Alluvium, including sands, silts, clays and alluvium and the Australian Soil Classification mapping presented for the site showed that vertosols are the dominant soil type mapped at the construction depot site, with kandosols expected to be present at the southern boundary of the site (GHD 2012a, V3:S4:pp.4-34 and 4-44).

Information presented in the EIS indicated that the dominant land systems and soil types mapped at the construction depot site are:

> Islay land system, comprising vertosol soil type; and

> Disney land system, comprising kandosol soil type.

The Islay land system is associated with gidgee plains with gilgaied clay soils on acid clay exposed within the tertiary weathered zone. The Islay land system is mostly found within the Belyando catchment, where the tertiary land surface and weathered zone have been partially removed. Due to the salinity and/or alkalinity, moderate erosion and low and unreliable rainfall, the Islay land system has a land capability class of 3.

Vertosols consist of clay soils with shrink-swell that exhibit strong cracking when dry and at depth have slickensides and/or lenticular structural aggregates. Although many soils exhibit gilgai microrelief, this feature is not used in their definition. Vertosols are mapped as dominating the landscape in the Project (Rail) area. Based on the Queensland Combined Soils Database presented in the EIS, possible soil profile characteristics, for the Islay land system are detailed in Table 2-3.

Table 2-3 Islay Land System Soil Characteristics (Vertosol)

Depth (m)	Texture Grade	CEC (cmol/kg)	EC (dS/m)	ESP (%)	pH	Total N (cmol/kg)	Total P (cmol/kg)
0-0.07	Silty Clay	43.33	0.14	1.84	8.1	0.11	0.03
0.07-0.66	Silty Clay	40.45	0.34	1.78	8	0.06	0.03
0.66-1.09	Silty Clay	48.33	0.59	23.5	8.7	0.02	0.02

Table Note: CEC cation exchange capacity; EC electrical conductivity; ESP exchangeable sodium percentage; N – nitrogen; P – phosphorus

(Source: GHD 2012b, p2-26).

The Disney land system is characterised by small lateritic mesas with ironbark and red or yellow earths on Tertiary sandstone, surrounding lowlands with box and brigalow and texture contrast soils on weathered Drummond Basin sediment.

The Disney land system has a potential use for limited cultivation and/or pasture improvement, and is susceptible to moderate erosion. The land system has a land capability class of 4 due to shallow soils, salinity and/or alkalinity, with gilgai micro relief in parts.

Kandosols consist of weak or massive sub-soil structure, a clay content of greater than 15% in the B horizon, no strong texture contrast and no carbonate throughout the profile.

Based on the Queensland Combined Soils Database presented in the EIS, the soil profile characteristics are detailed in Table 2-4 for the Disney land system.

Table 2-4 Disney Land System Soil Characteristics (Kandosol)

Depth (m)	Texture Grade	CEC (cmol/kg)	EC (dS/m)	ESP (%)	pH	Total N (cmol/kg)	Total P (cmol/kg)
0-0.27	Sandy Loam	7	0.14	2.3	6.7	0.08	0.01
0.27-0.9	Sandy Clayey Loam	15	0.8	44	9.3	0.05	0.01
0.9-1.19	Sandy Clayey Loam	18	0.97	40	6.5	0.01	0.01

Table Note: CEC cation exchange capacity; EC electrical conductivity; ESP exchangeable sodium percentage; N – nitrogen; P – phosphorus

(Source: GHD 2012b, pp2-29-2-30).

Extensive site specific soil and geotechnical investigations have not been conducted for the purposes of the development application. The site has not been mapped within the Belyando Shire Planning Scheme as being at risk of the occurrence of acid sulfate soils (ASS) as it is located inland and above 20m AHD. ASS is not considered to be a risk factor in non-coastal areas and on land above 20m AHD.

Slope lengths across the site vary, but are estimated to be approximately 50m, giving the site an overall erosion risk rating of very low.

2.5 Waterways and Ambient Water Quality

The construction depot is located within a broad, relatively flat plain within the Belyando River catchment. The drainage lines (tributaries of Gowrie Creek) that intercept the western side of the site are ephemeral. Data presented in the EIS indicated that a flood event within the Belyando River system occurs generally at least once per year, as recorded at the Gregory Developmental Road gauge during the 57 year period (1949 to 2006, excluding no data years 1972 to 1976). Rivers and creeks within the catchment were assessed as

responding quickly to storm flow events, with rivers and creeks filling rapidly and overflowing onto the adjoining floodplains where flooding could persist for a number of days (GHD 2012a, V3;S3;p.3-7).

Based on the regional hydraulic analysis undertaken by Calibre Operations Pty Ltd and summarised in the Drainage Design Report (Ref. No. CARP12033-REP-C003), the proposed construction depot site may be partially or fully inundated during a 50 year Average Recurrence Interval (ARI) storm event.

Stormwater from the existing catchment of the maintenance facility likely discharges to North Creek located approximately 1.5km to the southeast, a tributary of the Belyando River.

The maintenance facility site is not located within a designated flood or floodplain area and is not considered likely to be subject to flooding or surface water intrusion based on the elevation of the selected location.

Stormwater from the catchment of the maintenance facility discharges to the Belyando River Sub-Basin. Pursuant to the findings of the Carmichael Mine and Coal Rail Project EIS, the northern tributaries of the Belyando River are listed as having a range of Environmental Values including:

> aquatic ecosystems;

> irrigation;

> farm supply/use;

> stock water;

> other values (floodplain); and

> cultural and spiritual values.

Relevant Water Quality Objectives (WQOs) for the catchment are not currently defined in the *Queensland Water Quality Guidelines 2009* (QWQG, 2006), however it is anticipated that to support and protect relevant environmental values for waters in the Belyando River Sub-Basin typical water quality objectives would be expected to be similar to those for the nearby Isaac River Catchment as shown in Table 2-5 below.

Table 2-5 Isaac River Water Quality Objectives

Water Quality Parameter	Water Quality Objective (for slightly to moderately disturbed lowland streams)
Ammonia Nitrogen	>20 µg/L
Oxidised Nitrogen (Nitrite and Nitrate)	<60 µg/L
Organic Nitrogen	<420 µg/L
Total Nitrogen	<500 µg/L
Filterable Reactive Phosphorous	<20 µg/L
Total Phosphorous	<50 µg/L
Chlorophyll-*a*	<5.0 µg/L
Dissolved Oxygen	85 – 110 % sat.
Turbidity	<50 NTU
Suspended Solids	<55 mg/L
pH	6.5-8.5
Oils and Grease	No visible films or odours
Litter/Gross Pollutants	No anthropogenic material greater than 5mm in any dimension

It is anticipated generally that discharge quality to creeks within this catchment will be required to be such as to enable the WQOs for streams in dry tropics to be achieved. These are expected to be similar to those specified in the table above and are due to be published in early 2013.

A Stormwater Management Strategy has been developed for the Maintenance Yard and Construction Depot (Refer Appendix A) to provide an overview of the stormwater management aspects to support the Material

Change of Use application for the maintenance yard and construction depot sites required as part of the rail construction.

A similar Stormwater Strategy has been developed for the Concrete Batching Facilities. These strategy documents are also provided in Appendix A.

2.6 Groundwater

Observed depths to groundwater presented in the EIS indicated that groundwater is typically encountered between 15m and 75m below ground level and interaction between surface water and groundwater resources in the Project (Rail) area is likely to be limited to major watercourses including the Belyando River and Mistake Creek, both of which are downstream of the site (GHD 2012b, p3-3).

Data reported during the EIS indicated that bores within the Mistake Creek alluvium remained dry therefore there is no yield data available for the shallow alluvial deposits. Yields of up to 3.43 L/s have been recorded in the Tertiary-aged sedimentary aquifer. Yields in the bedrock aquifers are typically lower and range from 0.4 L/s to 0.75L/s of slightly brackish water (up to 2000 microS/cm). Saline water was reported in two bores with EC values of 45,000 microS/cm (Anakie Metamorphic Group) and 53,100 microS/cm (Mt Hall Formation) on RN 12030176 reported a pH value of 7.5 (GHD 2012c, p2-10).

Recharge of alluvium underlying the creeks and rivers was determined during the EIS to be likely to occur during the wet season when surface water levels are highest. Recharge of Tertiary-aged aquifers is via rainfall recharge at outcrop areas and from percolation through alluvial deposits during peak flow of surface water. The underlying Permian and Cambrian aquifers are recharged through leakage from alluvial and Tertiary sediments and via direct recharge at outcrop areas. Groundwater is thought to flow towards the low-lying rivers that dominate the CCMRP area with the ridge between the Belyando River and Suttor River catchments forming a possible groundwater divide (GHD 2012c, p2-16).

No springs have been identified in the vicinity (<10km) from the construction depot site and groundwater dependent ecosystems were identified during the EIS as including riparian vegetation associated with major waterways such as the Belyando River and Mistake Creek, where permanent waterholes persist throughout the dry season. This was concluded to indicate a base flow connection to groundwater in these areas (GHD 2012c, p.2-17).

Stock and domestic use of groundwater comprise sensitive receptors for any bores less than 10km from the construction depot. The risk of contamination or impact on resource availability during construction was assessed to be low, with the highest risk of impact being for bores located less than 1km from construction zone (GHD 2012c, p.2-17). No bores have been identified <1km from construction depot.

2.7 Vegetation

Observations presented during the EIS indicated that in the vicinity of the proposed construction depot, a combination of broad acre pastures of rough native grassland with scattered shrubs and areas of dense acacia woodlands (GHD 2012a, V3:S4:p4-7). Drainage lines associated with the western side of the construction depot comprise wooded and degraded/non-wooded riparian zones along the banks of the drainage lines (GHD 2012a, V3:S4:p4-14).

The maintenance facility site contains vegetation consisting predominantly of medium length grass with sparse scatterings of native trees. The site is considered to be of relatively low ecological value and has some mapped remnant vegetation in it the surrounds but is not currently anticipated to be situated in a high ecological constraint area. There are no areas of high value regrowth vegetation mapped within the site's vicinity; however, North Creek is mapped as a 3rd order regrowth watercourse far south of the site.

Based on an inspection of the relevant trigger maps, the site is not considered to contain any Referrable Wetlands or Areas of High Ecological Significance.

The site is considered to be in a low to medium risk bushfire area according to *Belyando Shire Planning Scheme* Risk Hazard Mapping.

Impacts on flora or fauna arising from the proposed redevelopment works are therefore very unlikely.

To minimise the potential environmental impact on Flora and Fauna, control measures will be implemented on site. Further detail on the proposed mitigation measures are outlined in the site based management plan in Section 5 of this document.

2.8 Nearest Residential Receptors

Data presented in the EIS indicated that the predicted construction noise for combined plant operation for civil works (including operation of concrete batching plants) had been calculated at increasing distances from the CCMRP. The assessment concluded that noise generated by construction plant would dissipate over distance. Predicted noise levels over distance for civil works were estimated (refer Table 2-6).

Table 2-6 Predicted Noise Levels Over Distance – Civil Works

Activity	Overall sound power level dB(A)	Distance						
		50m	100m	250m	500m	1,000m	2,000m	3,000m
Civil works[1]	119	77dB(A)	71dB(A)	63dB(A)	57dB(A)	51dB(A)	45dB(A)	41dB(A)

Table Note: [1] excludes pile driving impact noise

(Source: GHD 2012a, V3;S9; p.9-16)

During the EIS, in the absence of air quality objectives for deposited dust in the EPP (Air) the assessment of deposited dust adopted the NSW Office of Environment and Heritage (OEH) impact assessment criterion incremental contribution of deposited dust at sensitive receptor locations of 2g/m^2/month (insoluble solids, annually averaged), as well as a maximum total deposited dust level of 4g/m^2/month (insoluble solids, annually averaged inclusive of background. It was noted in the EIS that the NSW Approved Methods assessment criteria of 4g/m^2/month is equivalent to 130mg/m^2/day, while the Queensland DEHP recommended amenity guideline is 120mg/m^2/day averaged over one month (GHD 2012a, V3;S7;pp7-2 to 7-3).

It was noted in the EIS that the location of the CCMRP is in a remote area of Central Queensland, separated from population centres and the prevailing conditions in the vicinity of the construction depot are characteristic of a dry, inland environment, meaning that 'natural' dust loads can be present periodically throughout the year due to livestock movement, vehicle traffic associated with the nearby Gregory Developmental Road and wind driven dust across the plains where there is little topographic or vegetation relief (GHD 2012a, V3;S7;p7-4).

It was determined during the EIS that due to the inland location and lack of concentrated emission sources such as industrial, urban, combustion sources intensive animal husbandry or wastewater treatment/disposal, the ambient background levels of gaseous pollutants and odorous compounds was considered to be negligible to nil (GHD 2012a, V3;S7;p7-5).

There is the potential for indirect impacts on the residents' amenities associated with changes to traffic conditions along the Gregory Developmental Road during construction. Potential impact relating to traffic will be addressed and managed through the implementation of a Construction Traffic Management Plan for the CCMRP.

The nearest residential dwellings to the STP, fuel storage facility and concrete batching plant will be the construction camp accommodation blocks located approximately 12km to the east of the activities. These blocks are located at an adequate distance from the activities to provide for adequate noise level reduction from these sources. The nearest residence to the construction depot is the Disney homestead which is located approximately 7.5km north-west. This should also be at an adequate distance from the activities to provide for adequate noise level reduction.

3 Proposed ERA Information

3.1 Fuel Storage Activities

Vehicle refuelling and chemical storage facilities will occur at several locations along the railway. The following facilities form part of the ERA 8 application for fuel and chemical storage:

> Rolling stock maintenance facility;

> Construction depot;

> Concrete batching plant adjacent to Construction Camp 3 (BP7); and

> 4 additional concrete batching plants and various locations.

The locations of these sites are provided in Figure 1.

The following table shows the distance to nearest residence and nearest watercourse at each facility.

Table 3-1 Facility Characteristics

Facility ID	Facility Type	Nearest Surface Water Feature (m)	Nearest Residence or building structure (m)
MF1	Maintenance Facility-Rolling stock	Approx. 1.5km south east of site	1.7km south west
LF1	Construction Depot	Overland flow path running through western portion of site. A small tributary located approximately north east of the site.	Structure 4km to the south (a residential homestead is located at Disney 7.5km to the North east).
BP8	Concrete Batching Plant	1.2kmto the east.	4km to the south east
BP7	Concrete Batching Plant	100m to the west	3.2km to the south
BP6	Concrete Batching Plant	900m to the north	4km to the south
BP5	Concrete Batching Plant	3.5km to the north	3km south west
BP4	Concrete Batching Plant	100m to the west	2km to the south

Fuel storage activities for the construction camps required to construct the project are outside the scope of this report.

A description of the proposed facilities at each facility follows.

3.1.1 Maintenance Facility – Rolling Stock

The Maintenance Facility – Rolling Stock is located approximately 30km from the mine site and has an approximate footprint area of 280ha and comprises:

> traffic and workshop tracks;

> locomotive provisioning;

> locomotive and wagon maintenance; and

> administration and train crew depot.

Typical facilities for locomotive maintenance include:

> two locomotive provisioning facilities with the capability for fuelling, lubricating oil top up, engine coolant top up and sanding;

> locomotive maintenance and repair building comprising two roads with pits and platforms for access to underbody, equipment room and roof with a footprint of approximately 2,200m^2;

> one locomotive jacking system for bogie, wheel and traction motor replacement;

> two bridge cranes (10 t and 30 t) for major component replacement; and

> underfloor wheel lathe for re-profiling locomotive wheels.

Typical facilities for wagon maintenance include:

> one full train length road for operational maintenance and repair;

> wagon maintenance and repair building comprising two workshop roads each equipped with wagon jacking systems for tandem coal wagons and vehicle progression systems, inbound and outbound storage roads with a footprint of approximately 1,680m^2; and

> bogie repair building comprising workstations and two bridge cranes with a footprint of approximately 560m^2.

Typical warehouse and storage areas include:

> component storage with a footprint of approximately 300m^2; and

> Wheel and bogie storage with a footprint of approximately 1,500m^2.

Diesel storage in this area will consist of 1,050,000L for the refuelling of rolling stock and vehicles, and 60,000L will be stored for the fuelling of GenSets to power offices and workshops which is a total storage capacity of 1,110,000L for the Maintenance Facility. This fuel storage will consist of a tank farm arrangement with a separate fuel tank to supply the GenSet located adjacent to the STP and office facility.

While there is a proposed sewage treatment activity proposed for this facility, the anticipated sizing of this plant is calculated as less than 21EP and therefore does not trigger ERA 63 for sewage treatment. As such the approvals for the matter of the sewage treatment plant will be dealt with under the *Queensland Plumbing and Wastewater Code* in correspondence with local Council.

Refer Figure 2 for the rolling stock maintenance facility layout.

3.1.2 Construction Depot

The construction depot has a footprint area of approximately 115ha, which incorporates:

> bridge girder stacking area;

> pipe culvert segment stacking area;

> concrete batching plant;

> ballast stockyard;

> sleeper stacking area;

> chemical storage and refuelling areas;

> material and equipment laydown and storage; and

> on-site STP and effluent irrigation areas.

The lot is bound to the:

> north by undeveloped land;

> east by the Gregory Developmental Road;

> south by the proposed project rail alignment (currently undeveloped land); and

> west by undeveloped land.

The site is intercepted by tributaries of Gowrie Creek that drains west to the Belyando River catchment.

Diesel storage in this area will consist of 60,000L for the refuelling of vehicles and operations, and 60,000L will be stored for the fuelling of GenSets to power offices and workshops which is a total storage capacity of 120,000L for the construction depot.

An ERA 63 is triggered for the sewage treatment facility at the site and this matter is dealt with in the additional Cardno report *Carmichael Coal Mine and Rail Project – Information in Support of Development Application ERA 63, July 2013*.

Refer Figure 3.

3.1.3 Concrete Batching Plants

There are five proposed Concrete Batching Plants along the rail line. The concrete batching plant activities are expected to occupy a total area of 4.6ha (dimensions - 230m x 200m) each site (Refer Figure 1).

Concrete batching plants are proposed to be mobilised to multiple sites along the rail corridor and will utilise mobile concrete batching plant equipment. Minimal bulk earthworks are anticipated for the preparation of each site prior to establishment of the concrete batching plant facilities. Concrete batching activities will include concrete batching, delivery and storage of associated raw materials, distribution of pre-mixed concrete, stockpile of aggregates, cements and admixtures, maintenance materials and equipment and operation of a truck washing bay with settlement tanks.

Each concrete batching plant will be provisioned to store fuel to power a GenSet to supply power to the plant. The concrete batching plant adjacent to Construction Camp 3 will also have the facility for refuelling for construction vehicles. Diesel storage in this area will consist of 60,000L for the refuelling of vehicles and operations, and 60,000L will be stored for the fuelling of GenSets to power concrete batching activities which is a total storage capacity of 120,000L for the Concrete Batching Plant adjacent to Construction Camp 3 (BP7).

The fuel storage at the other four concrete batching plant locations will have 60,000L each for the powering of the GenSets.

Additionally there will be a requirement to store minor quantities of any chemicals onsite for plant maintenance. These chemicals will be stored in roofed, bunded and impervious areas; these are unlikely to amount to significant volumes.

Concrete batching no longer constitutes an Environmentally Relevant Activity (ERA) as defined in Schedule 2 of the *Environmental Protection Regulation 2008*, and as such these proposed sites are now self-regulated. However, all businesses are still required to meet the general environmental duty to prevent or minimise environmental harm pursuant to the *Environmental Protection Act 1994*.

A stormwater management strategy has been developed for the concrete batching facilities. This report has been provided in Appendix A.

3.2 Fuel Storage Details

The proposed chemical storages include a bulk fuel storage tank for both vehicle refuelling and generators (GenSet) for the supply of electricity, and equipment refuelling during construction phase. Locomotive refuelling and GenSet usage for the supply of electricity will occur at the maintenance facility only during operational phase. It should be noted therefore the fuel storages required for the project will be of both a temporary and permanent nature and the design intent of permanent and temporary storages differs on that basis.

Any fuel storage tank proposed for a chemical storage area is anticipated to be an aboveground proprietary double lined tank manufactured by Transtank Pty Ltd or similar specification. Each single tank will have the capacity to store the total volume proposed (60,000L or $60m^3$ in the case of 4 concrete batching plants, 2x60,000L in the case of the construction depot and concrete batching plant near Construction Camp 3 and 10x100,000L plus 1x60,000L in the case of the maintenance facility) of diesel. The proposed tank will be a self-bunded (i.e. double-skinned or double-lined tank) tank which complies with or exceeds *AS1692-2206* and *AS1940-2004* requirements amongst other (for full description of compliance with Australian Standards refer to the Transtank website www.transtank.com), and being double walled/lined, will not require installation within a tank bund. The tank will be integrated with a single fuel delivery hose, an overflow protection valve with warning alarm and a bunded fill point (overflow bunding). The tank will be protected from vehicular collisions by guardrails and bollards.

A small amount of diesel will also be stored in the GenSet providing power to refuelling facilities. The GenSet will have the capacity to store generally one day's operation and is designed to siphon diesel from the diesel storage tank via piping. Piping is to be aboveground and run from the bulk storage tank to the GenSet. The GenSet consists of a fully enclosed system, with a double lined tank, inlet solenoid valves and overfill/return valves to return diesel to the diesel storage tank. Mobile refuelling trucks shall be utilised to refuel mobile generators and machinery deployed within the CCRP construction site, remote from designated refuelling locations during construction phase.

The refuelling activities which occur at locations where construction and operational fuel is stored are expected to generate minor discharges, with the quantity and nature of the discharge related to risk and likelihood of spills, refuelling tanker compartment size as well as the effectiveness of the spill response. There will be permanent and temporary refuelling stations. Based on the types of activities in question within refuelling compound, best practice environmental management for permanent facilities would be expected to involve a bunded refuelling area and a first flush capture system for fuel-contaminated stormwater (including provision for treatment prior to release), to be sized and arranged to local requirements based on catchment stormwater quantity to be treated and pollutant load reduction. Detailed design for the works has not yet been completed however the indicative arrangement for the compound stormwater system is likely to be as follows.

> All ground surfaces beneath permanent tank and fuel dispensing areas shall be impervious (i.e. concrete or asphalt) and refuelling areas bunded to local requirements (i.e. rollover bunds) to prevent contamination from spills, refuelling and vehicular activities. Temporary facilities will have gravel or compacted clay ground surfaces. Spill kits will be provided for a rapid spill clean-up response, and all operators of the fuel storage and refuelling facility will be trained on its proper and effective use.

> Diversion drains will be installed to direct stormwater around the potentially contaminated fuel dispensing area and the refuelling pad area will be impervious or lined to improve ease of removal of contaminants.

> The ground surface beneath the permanent refuelling areas (as identified on Figure 2, 3, 4 and 5) shall be impervious (i.e. concrete or asphalt) to assist with management of contamination as a result of the unlikely event of tanker rupture. In the event of fuel tank rupture at the maintenance facility, a stormwater sump and valve system, located downstream of the fuel tank and refuelling area, is intended to be incorporated into the design of the refuelling compound to capture any fuel spillages, if required. The valve is to be closed whilst refuelling occurs to prevent discharge of contaminant to the stormwater. Any discharges to the stormwater sump will be disposed of accordingly via a suitably certified waste disposal facility. Additionally, spill kits will be provided for a rapid spill clean-up response, and all tanker refuelling operators will be trained on its proper and effective use.

> At temporary storage facilities spill containment will be by standard spill response and any contaminated soil will be excavated and appropriately disposed of, as required.

> Tanks would be constructed and maintained above the Q100 flood level.

It is anticipated that the double bunded, double lined nature of the storage tanks would mitigate the risk of a major fuel spill in the event of tank rupture.

Given the nature of the containment systems for the fuel storage areas, the fuel storage itself is not ordinarily expected to generate any discharges. Refer to Element 5 of the SBMP for environmental management details.

4 Potential Environmental Impacts

There are potential environmental and public health impacts associated with the refuelling and chemical storage activities as presented. The potential impacts associated with the operation of the activities are identified as follows:

> odour emissions and gaseous chemical release;

> noise from operation of equipment; and

> release of contaminants to land, surface water or groundwater due to fuel tanker rupture, tank leakage or diesel spill.

The potential impacts associated with the contaminant releases are identified below:

> contamination of land, surface water or groundwater due to tank leakage or rupture;

> contamination of land, surface water or groundwater due to diesel spills;

> odour emission from fuel storage infrastructure and spilled fuels;

> noise emission from vehicle refuelling;

> public health risks due to uncontrolled access to plant and equipment, volatile organic compounds or solvents; and

> public health risks due to fire from ignition or explosion of flammable liquids.

Environmental and public health impacts associated with accidental release of diesel or changes in the ambient environment will be minimised through adherence to the mitigation and control measures proposed in the Site Based Management Plan (Section 5).

5 Site Based Management Plan

This Site Based Management Plan (SBMP) identifies the management strategies to be adopted to ensure the activity is managed in accordance with best practice environmental management (BPEM).

The purpose of this SBMP is to demonstrate that persons carrying out the ERA have in place a structured framework to:

> set the environmental objectives or standards to be achieved;

> identify the potential environmental harm that may occur from the operation of the ERA and establish and document control measures to prevent this harm as far as practicable;

> identify extraordinary factors that may cause environmental harm, and establish contingency plans to deal with these;

> ensure that all persons carrying out the activities are aware of the environmental risks, and are trained in the measures and contingency plans to deal with them;

> ensure the effectiveness of the measures and contingency plans as required, by implementing monitoring of environmental performance;

> ensure record keeping to assist in the communication of environmental performance throughout the organisation and to DEHP; and

> ensure periodic reviews of environmental performance and continual improvement.

The SBMP is to be adopted by Adani Mining Pty Ltd in the planning and management of the ERA.

5.1 Preamble to the Site Based Management Plan

5.1.1 Legislation and Policy Framework

The primary environmental legislation relevant to this SBMP is the *Environmental Protection Act 1994* (EP Act) and subordinate legislation, specifically the *Environmental Protection Regulation 2008* (EP Reg) and the *Waste Reduction and Recycling Act 2011* and sub-ordinate legislation. The EP Act protects environmental values through development and implementation of environmental protection regulations and policies.

The *Environmental Protection (Waste Management) Regulation 2000* ensures protection of the environment through the minimisation of the impact of waste on the environment and establishing an integrated framework for minimising and managing waste under the principles of ecologically sustainable development.

The *Environmental Protection (Air) Policy 2008* (EPP Air) ensures protection of ambient air quality and specifies indicators and air quality goals for control of the release of airborne contaminants.

The *Environmental Protection (Noise) Policy 2008* (EPP Noise) specifies an acoustic quality objective for protection of the well-being and amenity of individuals and the community in residential areas.

The *Environmental Protection (Water) Policy 2009* (EPP Water) ensures protection of environmental values from activities that may result in the release of contaminants to waterways or stormwater drains.

The *Work Health and Safety Act 2011* ensures protection of all personnel and the environment when storing and handling dangerous goods.

5.1.2 Terminology

Contractor refers to any party of company performing works associated with the operation of an ERA and includes all employees of the Contractor and sub-contractors.

Council or **IRC** refers to the Isaac Regional Council.

DEHP or **Administering Authority** refers to the Department of Environment and Heritage Protection.

Environmental Harm refers to any adverse effect, or potential adverse effect (whether temporary or permanent and of whatever magnitude, duration or frequency) on an environmental value, and includes environmental nuisance.

Operator refers to Adani Mining Pty Ltd or any party or company responsible for the operation of the ERA to achieve compliance with this EMP and for ensuring all statutory requirements are understood and permits obtained. It is anticipated that the Operator with respect to this ERA will be the principal construction Contractor.

Plant refers to all matters associated with the operation of the STP and associated infrastructure.

SBMP refers to this Site Based Management Plan.

Site refers to the proposed development located on part of Lot 4 on SP116046.

Operation refers to all matters associated with the operation of the ERA at the proposed site.

Regulatory Authority refers to the local government, state government or commonwealth government agencies responsible for the enforcement of best environmental practice principles related to the ERA.

5.2 Objectives

The objectives of this SBMP are to minimise adverse impacts on the environment by:

> ensuring all environmental safeguards are carried out correctly; and

> managing site activities effectively.

5.3 SBMP Structure

The components of this SBMP include strategies to manage the following elements.

> Air quality (odours and dusts).

> Noise management.

> Storage and use of hazardous materials.

> Stormwater control and water quality.

> Waste management.

> Environmental emergencies.

> Complaints Management.

> STP Operation.

> Effluent Quality Management.

> Irrigation Management.

Each element of the SBMP includes the following key components.

> ***Rationale***: identification of the element to be managed and the potential environmental impact of activities associated with each element.

> ***Objective/Targets***: identification of the environmental objective(s) and target(s) to be achieved in line with the rationale and in compliance with applicable legislation.

> ***Implementation Strategy***: management measures to be implemented in order to achieve the stated objectives and targets and to ensure impact mitigation.

> ***Performance Indicators***: measurable indicators and standards set to assess the efficiency of management measures and determine compliance with the SBMP.

> ***Monitoring***: monitoring requirements to measure compliance with the performance indicators and frequency of monitoring.

> ***Record Keeping***: details of record keeping requirements over the life of the SBMP.

> ***Reporting and Review***: the requirements for reporting of monitoring results and review of management measures where required.

> ***Corrective Action***: measures to be undertaken should monitoring indicate non-compliance with performance indicators

5.3.1 Environmental Commitment

Adani Mining Pty Ltd is responsible for ensuring that its activities are undertaken in an environmentally sustainable manner and aims to minimise environmental impacts and continuously improve its environmental performance.

The preparation of this SBMP forms an integral part of the commitment to minimise the environmental risks of its activities.

5.3.2 Responsibilities and Training

The Operator or representative assumes responsibility through its Operations Manager and other relevant line managers for the implementation of this SBMP.

All persons employed in the operation of the site shall be instructed as to Adani Mining Pty Ltd.'s corporate responsibilities and their individual responsibilities as set out in this SBMP and as provided by the EP Act, including:

> **General Environmental Duty** – whereby a person in the performance of their duties shall not do so in a manner which will cause, or is likely to cause, environmental harm unless the person takes all reasonable and practical measures to prevent or minimise such harm.

> **Duty to Notify Environmental Harm** – whereby if a person in the performance of their duties becomes aware that serious or material environmental harm is caused or may be caused by their activity or by someone else's activity, that person must as soon as practicable report the nature and circumstances of the relevant event to the Operator whereupon the Operator must immediately notify DEHP.

> **Compliance with SBMP** – whereby a person in the performance of their duties shall do so in a manner that ensures that the provisions of this SBMP are complied with.

All personnel entering the site will be inducted as necessary, with particular emphasis on environmental control measures and emergency response.

5.3.2.1 Site Induction

It is the responsibility of the Operations Manager to ensure all site personnel receive appropriate awareness training and environmental induction prior to commencement of works.

The induction shall include instruction regarding the following environmental objectives and policies:

1. Due diligence, including:
    > development, establishment and operation of a pollution prevention system;
    > ensuring that appropriate personnel receive reports;
    > ensuring all personnel know the environmental laws and their responsibilities; and
    > ensuring appropriate personnel personally deal with system failures.
2. Duty of Care:
    > all management and staff have an environmental duty of care. Where deemed appropriate for short term personnel and contractors, the Operations Manager may elect to provide a brief environmental explanation/induction and control access to the site.

The Operations Manager shall maintain a signed register of all inductees and monitor the existing workforce to ascertain whether additional training is required.

5.3.3 Environmental Audits and Reviews

Environmental performance shall be monitored throughout the project to determine if and when additional environmental auditing activities are required.

The SBMP shall be reviewed and updated as required on changes to the activity, with the updated copy kept onsite.

5.3.4 Environmental Records

The results of any monitoring from the operation of the development and any corrective actions taken in respect thereof shall be recorded in the environmental management records for the site pursuant to this SBMP.

A copy of the latest copy of the SBMP, relevant development approvals and environmental records shall be retained onsite in the site office.

All environmental records shall be kept for a period of five years.

5.3.5 Environmental Non-Compliance

Adani Mining Pty Ltd and its representatives shall assume responsibility for implementation of this SBMP. Where the Operator becomes aware of a site or operational condition that does not comply with stated performance indicator(s) of this SBMP, there is a requirement for corrective action to be undertaken.

A Corrective Action Request (CAR) form is to be completed and authorised where appropriate in general compliance with the example CAR form provided in Appendix A of this document. The Operator is also required to maintain a register of CARs, which shall demonstrate that appropriate actions have been completed within a suitable timeframe.

It is the responsibility of management to notify DEHP in the event of a notifiable incident/complaint (as defined in s320 of the EP Act).

In some instances, further investigation or monitoring may be required to establish whether the Operator has failed to adequately implement the SBMP, or has failed to comply with relevant legislation, guidelines and statutes. In these instances, an independent party, such as a Consultant, shall carry out the investigation or monitoring.

5.4 ELEMENT 1: Vehicle Refuelling and Chemical Storage Operation Management

Rationale

Vehicle refuelling sites require well-coordinated operational procedures to ensure efficient production of the end product and minimal environmental harm. Appropriate process planning and practices will ensure that the operation of the vehicle refuelling sites is undertaken in a safe and appropriate manner.

Objective/Target

To ensure that vehicle refuelling and chemical storage sites are operated in a well organised manner in the aim of minimising any impacts to receiving environments.

To minimise the likelihood of accidents, vandalism or emergency incidents occurring at each site arising as a result of the sites being un-manned.

Implementation Strategy

> The Operator shall provide an induction program for new employees, site visitors and contractors including risk management principles.

> Staff shall be made aware of their general environmental duty obligations under the EP Act.

> The vehicle refuelling sites shall only be operated by persons who have undergone sufficient training to be capable of operating the facility safely and efficiently.

> Only authorised persons shall be permitted to access the vehicle refuelling and chemical storage sites at all times. Adani has internal staff and external contractors on call to deal with incidents 24 hours/day.

> All vehicle refuelling and chemical storage sites are to be adequately fenced and locked to prevent entry to unauthorised personnel.

> 24hr contact details (emergency services and staff) are to be provided at the entrance to all vehicle refuelling and chemical storage sites.

> Alarms are to be installed and maintained and where possible linked to a telemetry system for response by Adani staff or external contractor. All alarms must operate without mains power.

> All plant and equipment is maintained and operated in a proper and efficient manner and in accordance with manufacturer specifications.

> Inspection of plant equipment, tanks and components, including housekeeping shall be undertaken regularly to ensure good working order.

> Spill and First Aid kits to be provided, maintained and routinely checked.

Performance Indicators

No complaints of vandalism or potential site risk complaints received from workers or other persons.

Investigation and reporting, through the Adani incident reporting process, of all incidents/complaints and identified non-conformances resulting in a release of contaminants to the environment.

Monitoring

Weekly inspections of the vehicle refuelling and chemical storage sites shall be undertaken for monitoring of plant operations and inspections of plant equipment and components. Weekly monitoring shall include visual inspections of all infrastructure including fences, tanks, bowsers, refuelling pad, bollards, fire equipment, sumps and any stormwater diversion bunding.

Record Keeping

A written record of all equipment inspections, incidents/complaints and any repairs/maintenance actions undertaken shall be maintained in onsite files.

A written record of all monitoring and remediation measures relating to notifiable incidents resulting in or potentially resulting in environmental harm shall be maintained in onsite files and provided to the Regulatory Authority on request. This should include details of corrective actions and/or repairs undertaken.

Records shall be maintained of all monitoring results.

Reporting and Review

Inspection and monitoring results to be routinely re-evaluated to ensure best practice environmental measures are continually being incorporated.

The Operator shall report any notifiable incidents resulting in or potentially resulting in environmental harm to Adani and the Regulatory Authority as soon as is practicable after the notifiable incident occurs.

The Operator shall make all records available for inspection by relevant authorities on request.

Corrective Action

In the event of non-compliance with performance indicators the following corrective actions are to be implemented.

> Identification of the incident source(s).

> Implementation of appropriate mitigation measures as determined by the Operator within an agreed timeframe.

> Notification of complete corrective actions.

> Review of implementation strategy to ensure sufficiency and prevention of recurrence.

The Operator shall implement the corrective action(s) as required within the agreed time frame noted on the CAR.

5.5 ELEMENT 2: Air Quality Management (Odour and Emissions)

Rationale

Air emissions and associated odours from each site may be produced from vehicle movements, exhaust emissions, fuel storage and refuelling activities amongst others.

Objective/Target

To minimise activities resulting in the introduction of excessive fumes and dust to the local atmosphere as far as practicable, and comply with performance indicators.

Implementation Strategy

All vehicles and equipment shall be operated and maintained in accordance with the manufacturer's specifications.

Refuelling shall only occur in the defined area, and fuel and oil storage areas shall be maintained and operated to minimise emissions to the atmosphere via leakages or spills.

The fuel storage area shall be maintained in a neat and tidy condition at all times.

Spilt product shall be cleaned up using dry methods as quickly as practicable to prevent wind-blown materials and fumes.

Tank integrity shall be tested and maintained in accordance with the manufacturer's specifications.

Tank leak tests shall be conducted regularly in accordance with the manufacturer's specifications.

All chemicals to be stored as per the Material Safety Data Sheets (MSDS) requirements.

All permanent refuelling areas are to be sealed with an impervious surface.

Performance Indicators

No air quality (odour, particulate matter, dust) complaints received from nearby sensitive places.

Monitoring

At the request of the Regulatory Authority (other than a complaint which is frivolous or vexatious) being lodged about unreasonable air emissions, monitoring shall be undertaken for the relevant emission type (e.g. dust/volatile organic compounds/odour).

Record Keeping

The Operator shall maintain a record at each site of:

> all complaints received in relation to air quality;

> all tank integrity testing and leak tests conducted; and

> any monitoring results undertaken including details of corrective actions and/or repairs undertaken.

The Operator shall make all records available for inspection to the Regulatory Authority upon request.

Reporting And Review

Environmental monitoring results shall be submitted to the Regulatory Authority upon request.

Corrective Action

In the event of non-compliance with performance indicators the following corrective actions are to be implemented.

> Identification of the contaminant source(s).

> Implementation of appropriate mitigation measures as determined by the Operator within an agreed timeframe.

> Notification of complete corrective actions.

> Review of implementation strategy to ensure sufficiency and prevention of recurrence.

The Operator shall implement the corrective action(s) as required within the agreed time frame noted on the CAR.

5.6 ELEMENT 3: Noise Management

Rationale

Operation of the fuel storage facility will involve the use of equipment and vehicles that will produce noise (e.g. tanker refuelling, generator noise, and pumps, etc.) which may have a potential impact on the acoustic environment through the emission of nuisance noise affecting surrounding noise sensitive receivers.

Objective/Target

To control noise generated by the activity and to ensure acceptable levels of noise amenity at the closest sensitive receptors to prevent nuisance complaints.

No receipt of noise complaints from nearby noise sensitive receptors as a result of refuelling operations.

Implementation Strategy

All noise generating equipment shall be operated and maintained in accordance with the manufacturer's specifications to minimise noise emissions.

Ensure that silencers fitted to air compressors, pumps, fans and blowers and other noisy machinery are effective.

All vehicles are to be maintained in accordance with manufacturer's specifications to reduce noise emissions.

All vehicles entering or leaving the site shall be operated and maintained in a manner which ensures that the noise levels produced by the vehicles are within the appropriate limits.

Trafficked areas shall be sealed and kept in good condition to minimise noise from vehicle movement.

Should complaints about noise be received, the Operator is to undertake corrective actions as required. The Operator is committed to conduct noise monitoring should there be a monitoring request by the Regulatory Authority.

Performance Indicators

No noise complaints received from nearby sensitive receptors.

Recording and reporting through Adani incident/complaint reporting process for all noise related complaints.

Monitoring

At the request of the Regulatory Authority in response to a reasonable noise complaint, noise monitoring shall be undertaken.

Noise monitoring will be undertaken in accordance with the requirements of the Regulatory Authority and latest edition of DEHP's *Noise Measurement Manual*.

Record Keeping

The Operator shall maintain records at the site office of:

> all complaints received in relation to noise emissions as a result of refuelling activities; and

> any monitoring results undertaken including details of corrective actions and/or repairs undertaken.

Reporting And Review

Noise monitoring results shall be submitted to the Regulatory Authority upon request.

Corrective Action

In the event of non-compliance with performance indicators the following corrective actions are to be implemented.

> Identification of the source(s) and timing of nuisance noise.

> Implementation of appropriate mitigation measures to reduce nuisance issue as determined by the Operator within an agreed timeframe.

> Notification of complete corrective action(s).

> Review of implementation strategy to ensure sufficiency and prevention of recurrence.

The Operator shall implement the corrective action(s) as required within the agreed time frame noted on the CAR.

5.7 ELEMENT 4: Storage and Use of Hazardous Materials

Rationale

Hazardous materials are substances that, because of their chemical, physical or biological properties, can potentially cause harm to people, property and the environment.

Fuel and oil have the potential to enter the environment in a number of different ways including inappropriate use, leaks and spills. These substances require careful storage and handling to ensure no adverse impacts are caused to human health, property or the environment.

Other hazardous substances such as solvents, chemicals and oils may also be stored onsite in small quantities and while these present a lesser risk, still need to be managed appropriately.

Objective/Target

To reduce the risk of potential environmental harm or incidence caused through the storage and use of hazardous materials.

To comply with the legislative requirements and relevant Australian Standards and Material Safety Data Sheets (MSDS) for the handling of hazardous materials.

Implementation Strategy

The type, quantity, Material Safety Data Sheet (MSDS) and storage location of all hazardous materials, along with all emergency contacts, shall be kept in a dedicated register on site.

Hazardous materials shall be used only in accordance with the manufacturer's instructions.

Tank integrity shall be tested and maintained in accordance with the manufacturer's instructions.

The aboveground tank refilling operations are to be supervised by a competent fuel supplier contractor at all times.

The handling and storage of dangerous goods shall be in accordance with standards contained in AS1940-2004 *Storage and Handling of Flammable and Combustible Liquids*. An up-to-date copy of AS1940-2004 and any tank operation and maintenance shall be kept on site at all times.

The facility shall maintain absorbent materials, spill kits, fire extinguishers and other containment equipment in clearly identified and unobstructed positions for ready deployment in the event of a spill. Material used to clean spills shall be disposed of in appropriate lidded containers.

Bulk hazardous materials (including hazardous waste materials) in containers of 20L or greater are to be stored within bunded areas and only disposed of by a licensed contractor.

Performance Indicators

Hazardous materials are handled and stored in accordance with *AS1940-2004 Storage and Handling of Flammable and Combustible Liquids* and the *Work Health & Safety Act 2011* legislation.

No spills or leaks as a result of inappropriate handling and storage of hazardous materials.

No oil films or surfactants observed on any stormwater discharges from each site.

Monitoring

Regular inspections of stormwater discharges to identify oil films or surfactants following significant rainfall events.

Record Keeping

Records are to be maintained of routine inspections, inventory checks, discrepancies, investigations into any identified discrepancies and subsequent corrective actions.

The Operator is to keep copies of all waste tracking documents relating to regulated wastes removed from each site. Waste tracking documentation shall include the volume of regulated waste material removed and the final destination of the waste.

All records are to be made available for inspection by the relevant Regulatory Authority on request.

Reporting And Review

Operators shall report all environmental incidents in accordance with Adani incident/complaint reporting process.

Operators shall notify the Regulatory Authority of any notifiable incidents resulting in or potentially resulting in environmental harm.

The Operator shall regularly evaluate procedures for fuel and hazardous materials storage and refuelling, and may implement further strategies to ensure significant problems do not emerge.

Corrective Action

Emergency response procedures shall be implemented in the event of an emergency in accordance with Element 7- Chemical Storage (Environmental Emergencies) of this SBMP.

In the event of non-compliance relating to hazardous materials handling and storage the following corrective actions are to be implemented.

> Investigate details of the cause of the non-compliance, incident, or complaint.

> Response to complainant, if relevant, outlining procedure for corrective actions and proposed timeframe for implementation of corrective actions.

> Increase rate of inspections and maintenance of bunds and containment systems.

> Implementation of appropriate mitigation measures as determined through the CAR process and within the agreed timeframe noted on the CAR.

> Review of implementation strategy to ensure adequacy and prevention of recurrence.

> Conduct validation monitoring, as appropriate.

> Document non-compliance and any corrective and/or preventative actions taken.

The Operator shall implement the corrective action(s) as required within the agreed time frame noted on the CAR.

5.8 ELEMENT 5: Water Quality & Stormwater Control

Rationale

Management of stormwater runoff from the fuel storage areas is necessary to ensure local receiving waters are not adversely impacted by contaminated stormwater. Impacts from the fuel storage areas could include the release of contaminants through inappropriate or unauthorised activities, uncontrolled stormwater runoff, fuel or oil spills and accidental or emergency discharges during tank filling operations.

Objective/Target

To manage facility operations to ensure no contaminants are discharged or released from each site to any waters, or bed and banks of any waterways.

Implementation Strategy

Ensuring any stormwater runoff that has been in contact with any contaminants at the site shall not be released (discharged) outside the boundary of the site.

Hardstand areas in the fuel storage area and tanker refuelling are to be cleaned by sweeping rather than hosing where possible.

Fuel delivery shall be supervised and carefully conducted to prevent tank overfilling and spillage. Fuel delivery activities and transport of dangerous goods must only be conducted by licensed persons.

Spills and leaks are to be cleaned up as soon as practicable, and prevented from accessing any stormwater drains. Any leaks and bund integrity compromise must be fixed as soon as practicable.

Spill kits, absorbent material and other containment equipment must be maintained in clearly identified and unobstructed locations ready for use in the event of a spill.

Any stormwater drains, sumps, pits and pipes must be clean and free from potential blockages (e.g. litter, sediments, organic matter, solids, etc.).

Visual inspections shall be carried out during significant rainfall events in order to identify any visible signs of hydrocarbon contaminated stormwater or contaminated run-off leaving the sites.

Provision of clean water diversion (bunds) will be installed around the vehicle refuelling pad to prevent contaminated stormwater runoff from the site at permanent refuelling sites. Refuelling areas at temporary construction refuelling sites will provide earthen bunds in order to contain minor spillages.

Provision of an overflow protection valve with warning alarm system, and a bunded fill point (overflow bunding) for the aboveground fuel tank to prevent overfilling.

Provision of guardrails and bollards to the aboveground tank to protect the tank from collisions.

Installation of a sump with a containment valve for use during tanker refuelling, to prevent entry to stormwater in the event of tanker rupture or tank overfilling.

Performance Indicators

Compliance with *EPP (Water) Policy 2009.*

All stormwater conveyance and treatment devices are functioning appropriately.

No visible oil, grease or litter in stormwater discharges.

Discharge of stormwater from the sites must achieve the following criteria:

> pH 6.5 – 8.5;

> suspended solid concentrations do not exceed 50mg/L;

> +/- 10% background limits;

> dissolved oxygen is maintained at >80% saturation; and

> no visible oil films and/or surfactants on any stormwater discharges from the sites.

Monitoring

Reviews shall be carried out at a frequency of not less than monthly to assess the effectiveness of the stormwater management system and shall include the following tasks.

> Visually inspect stormwater discharges to ensure no hydrocarbons or other contaminants are being discharged from the sites.

> Monitoring of all treatment devices for maintenance requirements shall be undertaken as per the manufacturer's requirements but not less than monthly.

Record Keeping

The Operator shall maintain records at each site of:

> all complaints received in relation to water quality as a result of refuelling activities; and

> any monitoring results undertaken including details of corrective actions and/or repairs undertaken.

Reporting And Review

Operators shall report all environmental incidents in accordance with Adani's incident/complaint reporting process.

Operators shall notify the Regulatory Authority of any notifiable incidents resulting in or potentially resulting in environmental harm.

The Operator shall regularly evaluate procedures for fuel and hazardous materials storage and refuelling, and may implement further strategies to ensure significant problems do not emerge.

Corrective Action

In the event of a fuel or oil spill, emergency procedures shall be implemented in accordance with Element 7 – Chemical Storage (Environmental Emergencies) of this EMP.

An incident and/or failure resulting in a corrective action may include:

> contaminated stormwater discharged from the sites to receiving waters; and

> poorly maintained or damaged control devices.

Should non-compliance or an incident occur, any source(s) of contamination is to be located immediately, and the following measures implemented.

> Investigate details of non-compliance/incident.

> Isolation of contaminant, if possible, until remedial measures are fully implemented. Appropriate mitigation measures may require consultation with relevant experts (where required).

> Increase rate of inspections, maintenance and clean-outs as appropriate.

> Review of implementation strategy to ensure adequacy and prevention of recurrence.

> Conduct validation monitoring, as appropriate.

> Document non-compliance and any corrective and/or preventative actions taken.

The Operator shall implement the corrective action(s) as required within the agreed time frame noted on the CAR.

5.9 ELEMENT 6: Waste Management

Rationale

Appropriate storage and handling of all wastes associated with the activity conducted onsite is required to ensure that environmental harm is not caused through the release of contaminants to the receiving environment.

Objective/Target

To ensure procedures are implemented during operations to minimise any adverse environmental impacts associated with the storage, management and disposal of waste materials.

Implementation Strategy

The Operator shall maintain a regular waste removal schedule and document all waste removed for disposal.

The Operator shall provide appropriate methods for the collection and lawful disposal of any wastes produced at each site during operations including:

> location of waste receptacles in designated areas suitable for collection by waste disposal vehicles;

> collection and disposal of all waste of by appropriately licensed contractors at appropriate intervals;

> location of waste containers in convenient locations to encourage use; and

> facilities for the reception of wastes shall include provision for a range of materials likely to be produced, specifically spilt fuel collection materials, and shall be well labelled and sign posted.

Implement the waste management hierarchy of avoidance, reuse, recycling, energy recovery and disposal.

Wastes are to be segregated as far as practicable for reuse and recycling (e.g. cardboard, plastics, metals, etc.).

All wastes are to be stored securely in roofed or sealed waste receptacles to prevent rainwater ingress.

Waste oil generated from spills, leaks and waste oil or contaminated stormwater water collecting in bunds is to be stored separately from other wastes and in a bunded container or area and recycled if practicable.

No burning of waste relating to the activity is to be conducted onsite or offsite.

All regulated waste removed from the sites must be removed by a person who holds a current authority to transport such waste under the provisions of the *Environmental Protection Act 1994*.

Performance Indicators

No uncontrolled release of waste from the site.

Compliance with all relevant legislation and approvals for the site.

Monitoring

Waste collection areas shall be inspected daily to ensure wastes are stored appropriately and waste pickups arranged as required.

Record Keeping

Copies are to be kept of all waste tracking documents relating to regulated wastes removed from the sites. Waste tracking documents shall include the volume of material removed and final destination of waste.

All records are to be made available for inspection by the relevant Regulatory Authority on request.

Reporting And Review

Maintenance of waste tracking documentation, as required.

Maintain a register of all wastes removed from each site, their quantity, type and disposal locations.

Corrective Action

In the event of non-compliance relating to waste management the following corrective actions are to be actioned:

> investigate details of non-compliance and/or incident;

> implementation of appropriate mitigation measures as determined in consultation with relevant experts (where required) and within the agreed timeframe noted on the CAR; and

> sign off and recording of the CAR.

The Operator shall implement the corrective action(s) as required within the agreed time frame noted on the CAR.

5.10 ELEMENT 7: Environmental Emergencies

Rationale

The most likely environmental emergencies which may occur on site are fuel spills and fire. Operational and emergency procedures and safety management systems will minimise the potential health and safety risks associated with operating the facility.

Objective/Target

To minimise impacts to the natural and built environment and human health arising as a result of emergencies and/or incidents.

Implementation Strategy

Signs provided to inform staff of necessary actions in the case of a spill or fire.

Spill kits maintained onsite.

In the case of a chemical/fuel spill to land.

1. Stop the leak/spill at the source (if safe to do so)
2. Raise the alarm (notify site supervisor / Environmental Manager)
3. Immediately enclose the spill area with temporary bunding (containment socks, sand bags, etc.) to prevent spreading.
4. Immediately block off any stormwater drains to prevent contamination of waters.
5. Apply bulk absorbent over the spilt material.
6. Let the absorbent material absorb the spilt material.
7. Collect the absorbent spilt material using appropriate tools (e.g. shovel or vacuum truck). Remediation may include removal of topsoil layer for spills on unsealed surfaces.
8. Place saturated absorbent into a container for disposal in an authorised land fill.
9. Repeat points 5 to 8 until area is clean.
10. Collect all contaminated materials and dispose of in a dedicated metal bin with tight fitting lid labelled accordingly for disposal in an authorised landfill.
11. Inspect and re-stock the spill kits as required.

In the case of fire:

> sound the alarm;

> ring 000: Notify the fire brigade and give your name, location, type of fire (explosion, fuel fire, etc.), and details of injuries, if any. Notify ambulance and/or police service, if necessary;

> notify all relevant staff;

> evacuate the site to the assembly point and count heads - ensure the safety and wellbeing of everyone, and notify a senior member of staff if anyone is missing;

> keep the public away at a safe distance;

> turn off computers, power, gas bottles, and fuel sources, if safe to do so;

> isolate the fire by shutting off doors and windows, closing hatches and/or vents, if safe to do so. Do not close off your means of escape;

> fight the fire, if the fire is small and you are not in immediate danger. DO NOT TAKE RISKS;

> if available, an extra staff member should be sent to the roadway to direct the fire brigade;

> take action to minimise or contain environmental damage, if safe to do so; and

> immediately after the fire is over, make diary notes detailing your involvement in the emergency.

As soon as practicable after becoming aware of any emergency or incident that results in the significant release of contaminants not in accordance with the conditions of the DA, the Regulatory Authority must be notified of the release by telephone or facsimile. Details shall include:

> the location of the emergency or incident;

> the Registered Operator Number;

> the name and telephone number of the designated contact person;

> the time of the release;

> the time the Operator became aware of the release;

> the suspected cause of the release;

> the environmental harm caused, threatened, or suspected to be caused by the release; and

> actions taken to prevent any further release and mitigate any environmental harm caused by the release.

Within 21 days following the initial notification of a significant emergency or incident written advice must be provided to the Regulatory Authority detailing:

> proposed actions to prevent a recurrence of the emergency or incident;

> outcomes/actions taken to prevent or minimise environmental harm; and

> results of environmental monitoring.

Accurate record keeping of daily procedures will be kept to ensure that communication lines are followed in regard to operational activities.

Performance Indicators

Environmental harm from emergency and incident situations is minimised through implementation of emergency procedures.

Monitoring

Stocks of fire-fighting and spill management equipment shall be checked on a monthly basis, and re-stocked as required.

Staff induction and training shall be undertaken as necessary to ensure all staff are trained in appropriate emergency management procedures.

Emergency Plans must be maintained, periodically reviewed and fire/evacuation drills regularly conducted.

Record Keeping

Records shall be maintained of all monitoring results.

Reporting And Review

Notifiable incidents must be reported to the Regulatory Authority as soon as practicably possible.

Corrective Action

Following an environmental emergency event the following corrective actions are to be implemented.

> Investigate details of non-compliance and/or incident.

> Implementation of appropriate mitigation measures as determined in consultation with relevant experts (where required) and within the agreed timeframe noted on the CAR.

> Sign off and recording of the CAR.

The Operator shall implement the corrective action(s) as required within the agreed time frame noted on the CAR.

5.11 ELEMENT 8: Complaint and Incident Mitigation

Rationale

The activity of the refuelling sites has the potential to adversely affect the amenity adjacent land uses and the values of adjacent areas of environmental sensitivity and can cause public complaints.

Objectives

To minimise any adverse impacts that the refuelling sites operations may have on sensitive environmental areas and the amenity of adjacent sensitive areas.

Tasks/Actions

Provide contact details of the relevant person to be contacted in relation to any enquiries concerning the environmental and amenity impact of refuelling sites operations.

Maintain and record all complaints received from surrounding land users in a designated area (i.e. site office).

Appropriately manage complaints, conduct required investigations and respond to complainants within a reasonable timeframe.

Performance Indicators

No complaints received from surrounding land users and sensitive receptors.

Appropriate signage is established on site to inform surrounding land users of the contact details to lodge complaints.

A register of complaints is established and maintained, and all relevant complaints/enquiries are responded to within a suitable timeframe.

Monitoring

Conduct regular inspections of the complaints management procedures and records to ensure these are effective as required.

Record Keeping

Maintain a record at each site of all enquiries/complaints received in relation to the refuelling sites operations including complainant details, nature of enquiry, investigations undertaken, conclusions formed and corrective actions undertaken.

The Operator shall make all records available for inspection by the relevant Regulatory Authority upon request.

Reporting and Review

The Operator shall make all records available for inspection by the relevant Regulatory Authority upon request.

Corrective Action

Following a complaint and non-compliance with the stated performance indicators, the following corrective actions are to be implemented.

> Investigate details of complaint and/or non-compliance or incident.

> Implementation of appropriate mitigation measures as determined in consultation with relevant experts (where required) and within the agreed timeframe noted on the CAR.

> Sign off and recording of the CAR.

The Operator shall implement the corrective action(s) as required within the agreed time frame noted on the CAR

6 References

GHD (2012a) Carmichael Coal Mine and Rail Project Environmental Impact Statement accessed via www.dsdip.qld.gov.au/assessments-and-approvals/Carmichael-coal-mine-and-rail-project on 21/06/2013.

GHD (2012b) Carmichael Coal Mine and Rail Project Soils Assessment (Rev 2) accessed via www.dsdip.qld.gov.au/assessments-and-approvals/Carmichael-coal-mine-and-rail-project on 21/06/2013.

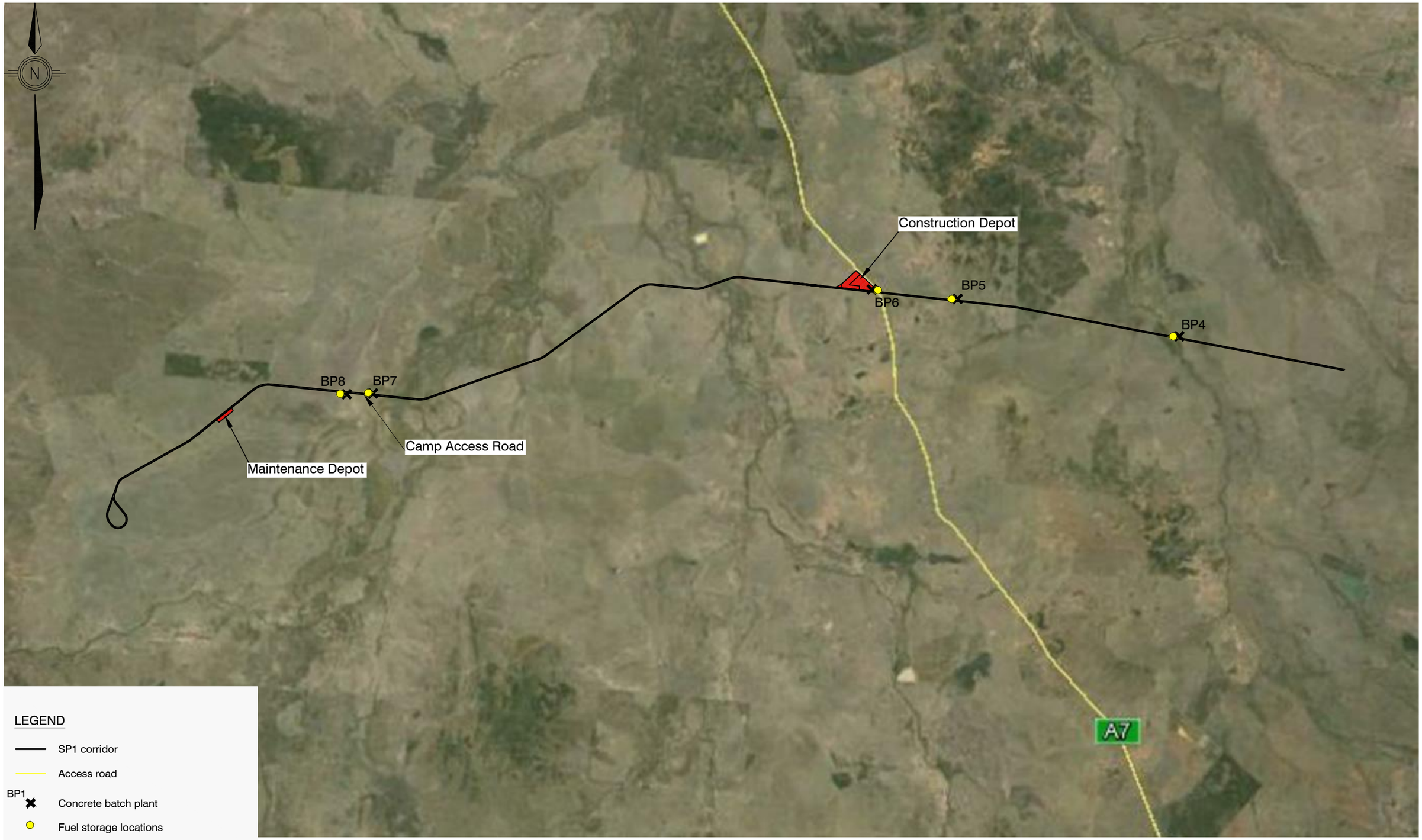
GHD (2012c) Carmichael Coal Mine and Rail Project Hydrogeology Report (Rev 1) accessed via www.dsdip.qld.gov.au/assessments-and-approvals/Carmichael-coal-mine-and-rail-project on 21/06/2013.

Isaac Regional Council (IRC) (2013) Belyando Shire Planning Scheme accessed via www.isaac.qld.gov.au on 21/06/2013.

Carmichael Coal Mine and Rail Project

FIGURES

Cardno
Shaping the Future



Aerial image sourced from Google Earth

Rev: 0 | Drawn: J.M. | Checked: L.M. | Date: 22/07/2013

Scale 1:300,000 (A3)

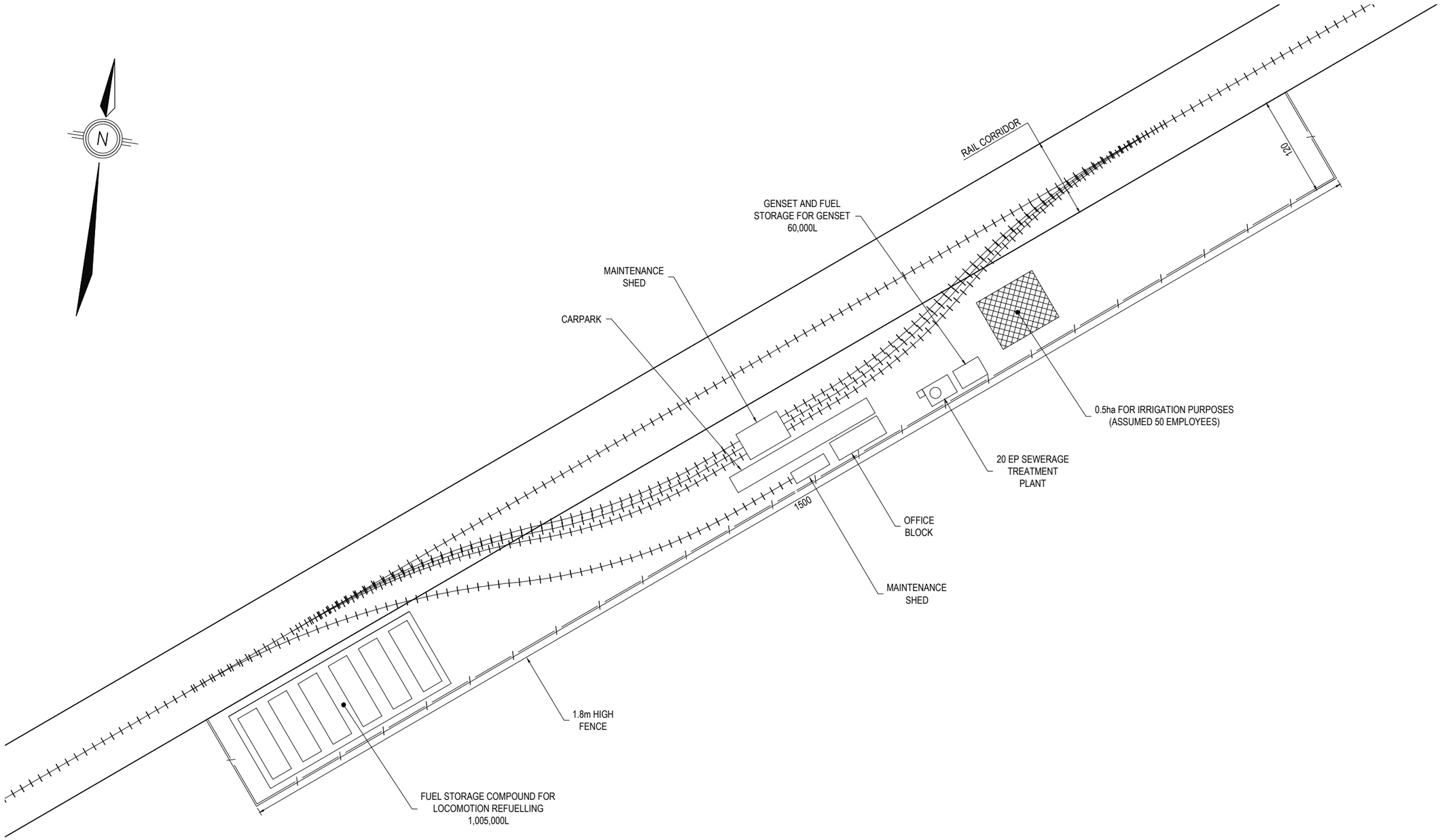
FIGURE 1
LOCATION PLAN OF FUEL STORAGE LOCATIONS

Project No.: 7803/04

Adani Mining Pty Ltd

CAD FILE: I:\7803-04 HRP - Adani\Acad\Information in support of development applications (ERA8)\Figure 1 - Location Plan of Fuel Storage Locations_v2.dwg
XREF's: DCDB

PRINT DATE: 22 July, 2013 - 2:30pm



50 0 50 100 150 200 250m
1:5000

Scale 1:5,000 (A3)

FIGURE 2
MAINTENANCE FACILITY INDICATIVE LAYOUT

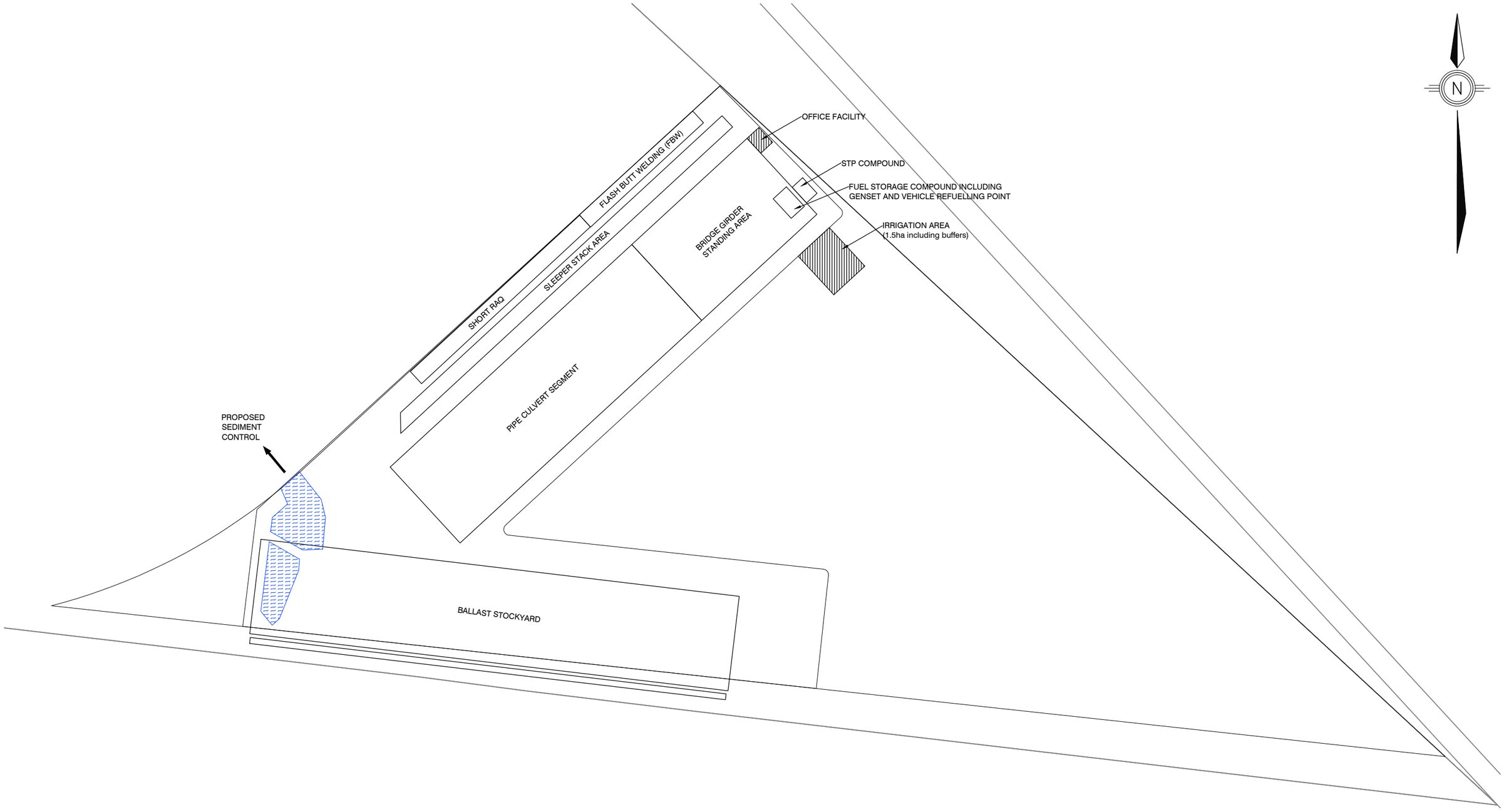
Rev: 0 | Drawn: M.H | Checked: L.M. | Date: 12/07/2013

Project No.: 7803/04

Adani Mining Pty Ltd

CAD FILE: \\Bnesan01p\env$\7803-04 HRP - Adani\Acad\Information in support of development applications (ERA8)\Figure 2 - Maintenance Facility Typical Layout.dwg
XREF's: 790344-X-BASE

PRINT DATE: 12 July, 2013 - 11:10am



LEGEND

Sediment/detention basin

100 0 100 200 300 400 500m
1:10,000

Scale 1:10,000 (A3)

FIGURE 3
CONSTRUCTION DEPOT LAYOUT

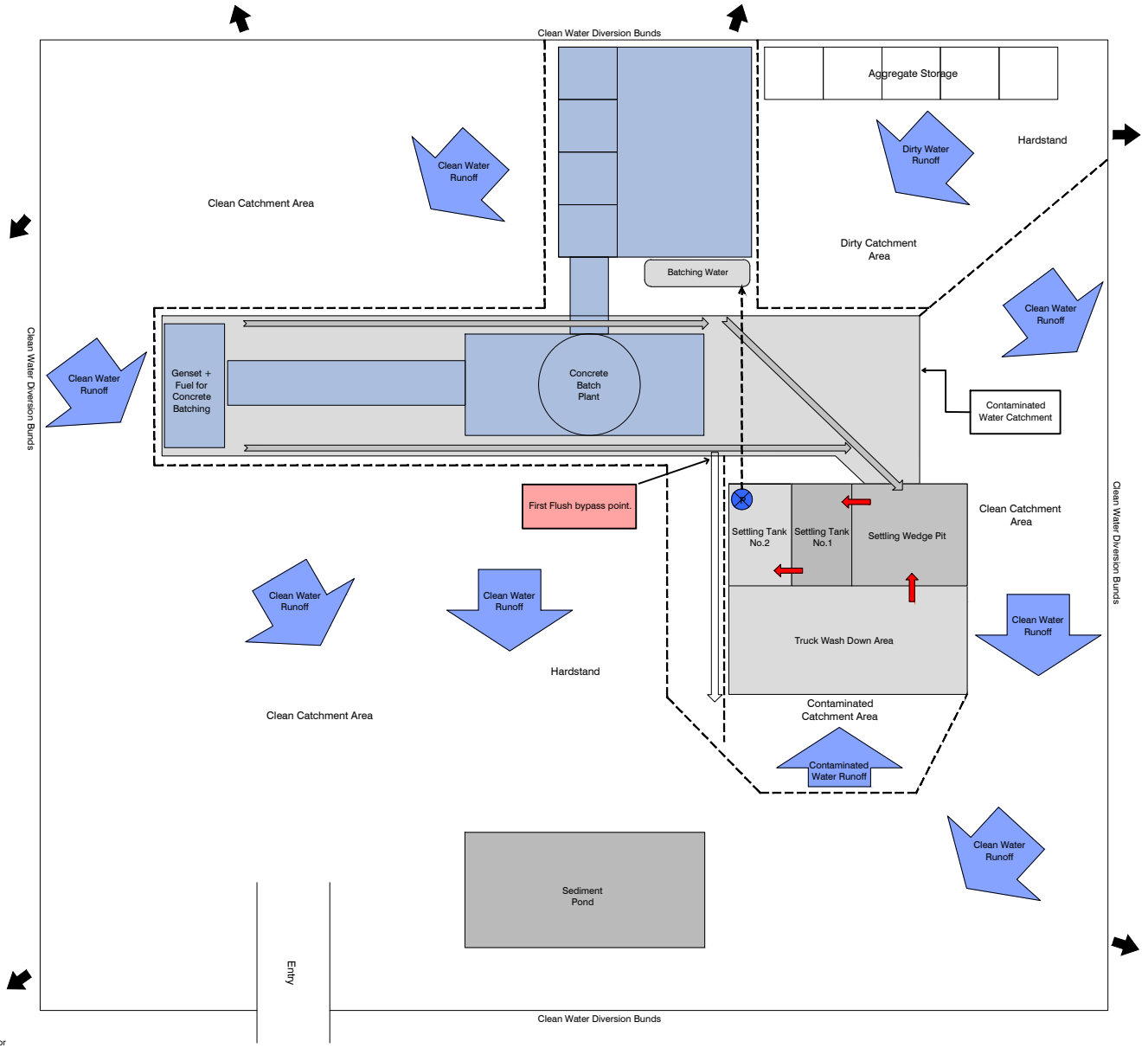
Rev: 0 | Drawn: J.M. | Checked: L.M. | Date: 22/07/2013

Project No.: 7803/04

Adani Pty Ltd

CAD FILE: I:\7803-04 HRP - Adani\Acad\Information in support of development applications (ERA8)\Figure 3 - Constructiuon depot layout_v2.dwg
XREF's: DCDB

PRINT DATE: 22 July, 2013 - 1:47pm



(A4)

FIGURE 4
TYPICAL CONCRETE BATCHING PLANT LAYOUT

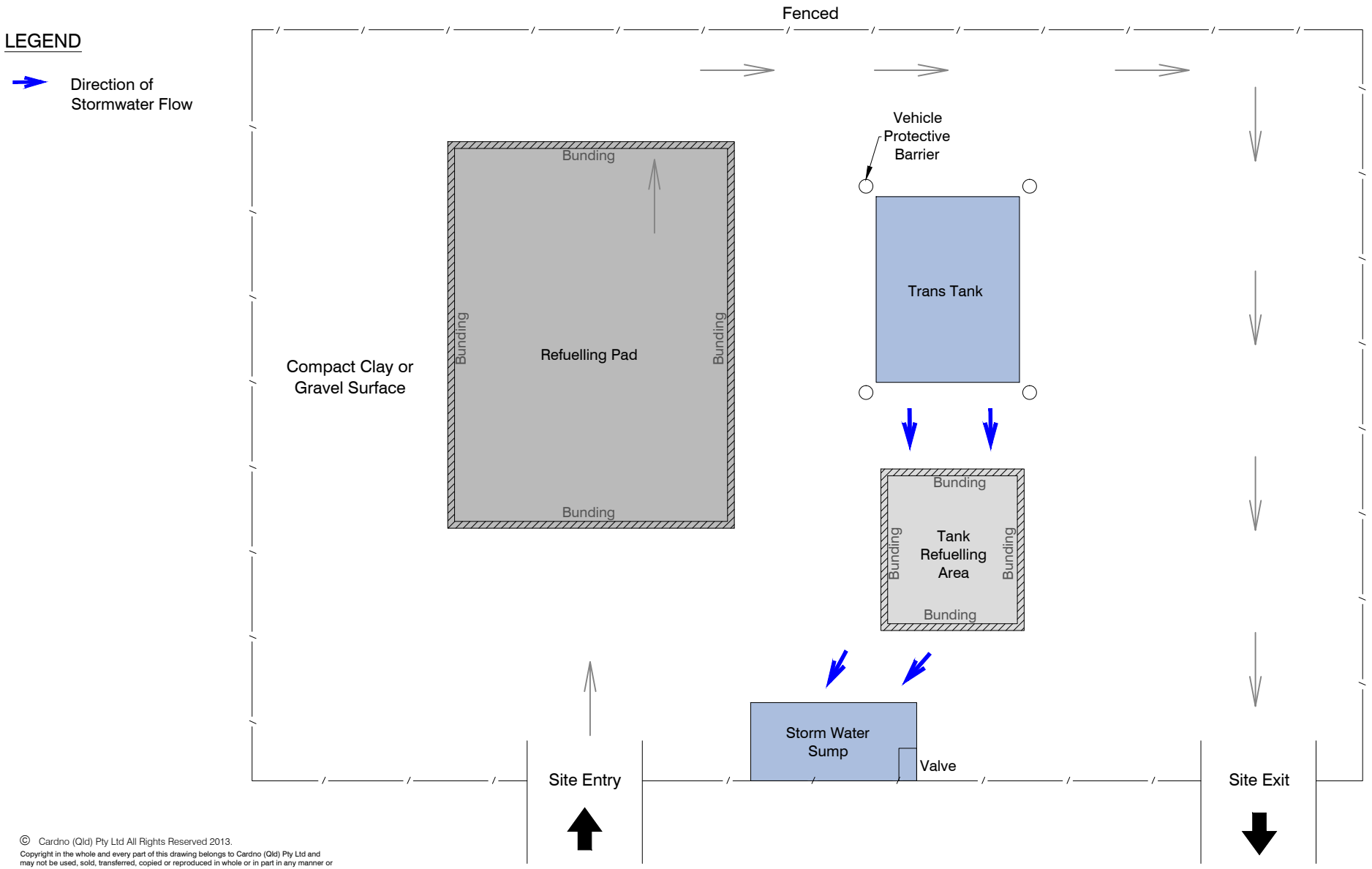
Rev: 0 | Drawn: M.H | Checked: L.M. | Date: 12/07/2013

Project No.: 7803/04

Adani Mining Pty Ltd

CAD FILE: \\Bnesan01p\env$\7803-04 HRP - Adani\Acad\Information in support of development applications (ERA8)\Figure 4 -Typical concrete batching plant layout.dwg
XREF's:

PRINT DATE: 12 July, 2013 - 10:35am



(A4)

FIGURE 5

TYPICAL REFUELLING COMPOUND LAYOUT

Rev: 0 | Drawn: J.M. | Checked: L.M. | Date: 22/07/2013

Project No.: 7803/04

Adani Mining Pty Ltd

CAD FILE: I:\7803-04 HRP - Adani\Acad\Information in support of development applications (ERA8)\Figure 5 - Typical refuelling compound layout_v2.dwg
XREF's:

PRINT DATE: 22 July, 2013 - 1:38pm

Carmichael Coal Mine and Rail Project

APPENDIX A

Stormwater Management Strategy

Cardno
Shaping the Future

Stormwater Management Strategy

Carmichael Coal Rail SP1 Maintenance Yard and Construction Depot

721769

Prepared for
Adani Mining Pty Ltd

19/07/2013

Cardno
Shaping the Future

Document Information

Prepared for	Adani Mining Pty Ltd
Project Name	Carmichael Coal Rail SP1 Maintenance Yard and Construction Depot
File Reference	P:\721769 Adani\02 Project Management\Reports\Maintenance yard\130719 Maintenance Yard SWMS V5.docx
Job Reference	721769
Date	19/07/2013

Contact Information

Cardno (Gold Coast)
Trading as Cardno (QLD) Pty Ltd
ABN 57 051 074 992

Level 2 Podium Level
Emerald Lakes Town Centre
1/3321 Central Place
Carrara QLD 4211

P.O. Box 391
Nerang Qld 4211
Australia

Telephone: 07 5539 9333
Facsimile: 07 5538 4647
gco@cardno.com.au
www.cardno.com.au

Document Control

Version	Date	Author	Author Initials	Reviewer	Reviewer Initials
1	22/04/2013	Scott Walter		Carlo de Byl	
2	31/05/2013	Scott Walter		Carlo de Byl	
3	28/06/2013	Scott Walter		Carlo de Byl	
4	12/07/2013	Scott Walter		Carlo de Byl	
5	19/07/2013	Scott Walter		Rod Barry	

Table of Contents

Appendices

Tables

1 Introduction

This conceptual Stormwater Management Strategy (SWMS) report has been prepared on behalf of Adani Mining Pty Ltd for the proposed Carmichael Coal Rail project maintenance yard and the construction depot area located along the proposed SP1 rail allignment (the subject site).

The intent of this strategy is to provide an overview of the stormwater management aspects to support the Material Change of Use application for the maintenance yard and construction depot sites required as part of the rail construction. This SWMS report includes detailed policies, performance criteria and procedures to minimise the impact of the development on the physical and social environment.

This SWMS intends to address the operational phase of the work sites. The maintenance yard is expected to be required for the life of the rail line, while the construction depot is expected to have a design life of approximately 2 years, which is the expected construction time of the rail line.

2 Existing Site and Proposed Development

2.1 Existing Site Description

The Carmichael Coal Rail maintenance yard and construction depot areas are located between approximately 100km and 160km west of Moranbah, Queensland in the Isaac Regional Council. Approximate levels for each of the sites have been obtained from a review of available aerial contour information. A summary of the details of each of the sites is included in **Table 2-1** below. There is an existing overland flowpath running through the proposed Construction depot area. An overland flowpath through the site will need to be included to ensure that runoff from the upstream catchment is adequately conveyed through the site.

Table 2-1 Maintenance Yard and Construction Depot Area Location Details

Plant	Area	Lot number	Distance west of Moranbah	Chainage along Track	Site Elevation (RL)	Approximate Grade
Maintenance Yard*	41.4 ha	662PH1491	157km	Ch 165 000	207.5m - 209m	0.1%
Construction Depot*	113.3 ha	4SP116046	106km	Ch 110 000	197m - 207m	1-2%

*Based on the regional hydraulic analysis undertaken by Calibre Operations Pty Ltd and summarised in the Drainage Design Report (Ref. No. CARP12033-REP-C003), these sites may be partially or fully inundated during a 50 year ARI storm event. At the maintenance yard is expected to remain in service for the long term, more accurate survey and flood levels should be obtained to assess the flood immunity of the site. Refer to Section 8 for possible emergency flood management strategies for these sites.

Refer to Cardno Sketch 721769 SK02 (Appendix B) for the locality plan showing an indicative location of the maintenance yard and construction depot and Cardno Sketch numbers 721769 SK14 and SK17 (Appendix B) for plans of each site showing the topography.

2.2 Developed Site Description

It is proposed to establish the maintenance yard and a construction depot area to support the construction and maintenance of the proposed railway linking the Carmichael Coal Mine with the port terminals situated to the east. The developed sites will contain temporary structures, storage areas and a basic road network with minimal sealed areas.

As minimal bulk earthworks are anticipated in order to construct each of the sites, the developed condition site topography is expected to generally resemble the existing conditions.

Refer to Cardno Sketch numbers 7903/44/001/SK005 and SK007 (Appendix A) for the typical development layout of each of the sites.

3 Performance Criteria

The establishment and operation of the construction depot area has been considered a construction site for the lifetime of the rail construction project, which is expected to be 2 years.

For the maintenance yard area, it is anticipated that the operation of the facility will continue beyond the construction phase of the railway alignment and continue to be in use for the life of the rail line. Based on the expected finished surface treatment and the types of activities expected to be undertaken on site to maintain the rolling stock, the types of pollutants anticipated to be generated from the site are expected to be similar to that of a construction site. As the life span of the maintenance yard will be longer, a more permanent treatment regime will be implemented. Based on this, the construction and operational phases of the maintenance yard area will be governed by the performance criteria as outlined below.

3.1 Construction Phase

The *'Queensland Water Quality Guidelines (2009)'* (QWQ guidelines) (which is referenced by the *Environmental Protection (Water) Policy (2009)*, a subordinate document of the *Environmental Protection Act (1994)*) provides a summary of design objectives for the management of stormwater quality and flow for the construction phase of developments in Queensland. This summary provided in Table 8.2.1 of the QWQ guidelines outlines design objectives for a number of pollutants including sediment, nutrients, litter and hydrocarbons.

Based on the above information, the release criteria for controlled runoff events or pumped discharges from any construction site is to be as shown in **Table 3-1** below.

Table 3-1 Controlled Discharge Performance Criteria

Parameter	Release Criteria	Criteria Type
Total Suspended Solids	< 50 mg/L	Maximum
Coarse Sediments	To be retained on site	Descriptive
Turbidity (NTU)	< 10% above receiving water	Maximum
Nutrients (N and P)	Manage through Sediment Control	Descriptive
pH	6.5-8.5	Range
Litter	No visible litter washed from site	Descriptive
Hydrocarbons	No visible sheen on receiving water	Descriptive
Dissolved Oxygen	> 6 mg/L	Minimum
Stormwater drainage/flow management	Peak flows for 1-year and 100-year ARI event to match the pre-development condition of the site	Maximum

For the management of sediments, Table 8.2.1 of the QWQ guidelines outlines the following:

> Testing of suspended solids and pH within any temporary sedimentation basins is to occur prior to any controlled discharges.

> Testing of turbidity within the temporary sediment basins and the receiving waters is to be performed before the controlled discharging of the sediment basins. If the turbidity of the sediment basin is greater than 10% above the receiving waters, further dosing with gypsum or a suitable alternative is required until acceptable levels are reached (refer to *Table B17 – Characteristics of Various Flocculating Agents, Appendix B of IECA's 'Best Practice Erosion and Sediment Control',* (2008)).

3.2 Operational Phase

The maintenance yard is to remain in use for a longer period. As such, the stormwater quality objectives for maintenance yard area have been taken from the Queensland Governments '*Urban Stormwater Quality Planning Guidelines (Dec 2010)'* which provides design objectives for the management of stormwater quality

for the various regions of the state. The site falls in the Western Districts region according to Figure 2.5 in the Urban Stormwater Quality Planning Guidelines (2012) and Table 2.2 of the same document lists the minimum reductions in mean annual loads from unmitigated development as:

- 85% reduction in total suspended solids (TSS);
- 70% reduction in total phosphorus load (TP);
- 45% reduction in total nitrogen load (TN); and
- 90% reduction in gross pollutant load.

4 Stormwater Management Strategy

4.1 Stormwater Quality

Based on the lifespan of the maintenance yard and construction depot area, and the sites' proximity to the adjacent railway corridor construction area, the primary objective of the proposed stormwater quality management strategy will be to control soil erosion on site and minimise sediment discharge to the downstream receiving local water courses using appropriate best management practices.

Refer to Cardno Sketch numbers 721769 SK14 and SK17 (Appendix B) for an indicative layout of the stormwater quality management measures proposed to be adopted to treat the contributing local catchment areas of each of the sites.

4.1.1 Available Management Practices

A wide range of stormwater quality improvement devices are available to achieve the best practice stormwater management of runoff from a developed site. **Table 4-1** lists the common stormwater quality improvement devices, including their treatment efficiencies and the constraints of their use.

Table 4-1 Stormwater Management Practices

Treatment Technique	Pollutant Removal Efficiency (1)							Scale (2)	Constraints
	Litter & Debris	Coarse Sediment	Fine Sediment	Nutrients: Dissolved	Nutrients: Particulate	Metals	Hydrocarbons		
Litter baskets / racks	L-M							Local	Requires frequent maintenance
Sediment basins	L	M-H	L-M		L	L	L	Regional	Aesthetic and safety issues
Gross pollutant traps	H	H	L		L	L	L	Local/ Regional	Requires regular maintenance
Filter strips / buffer strips	L	M	L-M	L	L-M	L-M	L	Lot/Local	Requires flat terrain
Grass / vegetated swales	L	M-H	L-M	L	L-M	L-M	L	Local	Requires flat terrain
Extended detention basins	M	H	L-M	L	M	M	L	Regional	Requires pre-treatment, Large land area required
Infiltration trenches	L	M-H	M	L-M	M	M	M	Local	Requires pre-treatment
Bio-retention systems	L	M-H	M	L	M	M	L-M	Local	Requires pre-treatment
Porous pavements		L-M	L-M	L	M	M	M	Local	Not appropriate for steep sites and heavy traffic

Treatment Technique	Pollutant Removal Efficiency (1)							Scale (2)	Constraints
	Litter & Debris	Coarse Sediment	Fine Sediment	Nutrients: Dissolved	Nutrients: Particulate	Metals	Hydrocarbons		
Constructed wetlands	M-H	H	M	H	H	M-H	M	Regional	Requires pre-treatment, Not appropriate for steep sites, Large land area required
Community education								Regional	Community participation

Information Source: Queensland Urban Drainage Manual Table 11.05.4 (Typical pollutant removal efficiencies of treatment systems (2007). Benefit Ranking: L = Low Benefit, M = Medium Benefit, H = High Benefit.

Notes:

(1) Removal rates are provided for information only with the efficiency rating subject to adequate design. The actual removal rates used for detailed water quality modelling purposes should be in accordance with *MUSIC Modelling Guidelines Version 1.0 – 2010* prepared by Water by Design.

(2) Scales: Lot – less than 1 ha; Local – 1 to 10 ha; Regional – greater than 10 ha.

Given the features of the subject sites, a number of the measures listed in **Table 4-1** above would not be considered appropriate to be incorporated into the stormwater treatment train for the maintenance yard and construction depot area.

Provided below is information on a number of the listed stormwater quality improvement devices including the suitability of these devices to be incorporated into the development of the subject site to treat stormwater runoff from the proposed maintenance yard and construction depot area.

Litter Baskets/Racks

Litter baskets and trash racks are generally located upstream of other treatment measures such as extended detention basins or constructed wetlands. They are primarily used as a pre-treatment device for stormwater runoff, removing litter, debris and other gross pollutants from the runoff before it discharges into other secondary and tertiary treatment devices located downstream. The use of litter baskets or trash racks may be appropriate for use within the maintenance yard upstream of any permanent water treatment device.

Litter baskets are generally incorporated into the pipe drainage system. Due to the relatively flat grades expected across the sites, the incorporation of pipe drainage within the maintenance yard and construction depot is expected to be limited. Therefore it is not intended to use litter baskets within the maintenance yard and construction depot sites.

In the event that high levels of gross pollutants are being generated from the maintenance yard and construction depot areas, trash racks could be incorporated at the locations where concentrated surface flows are discharging into the sediment basins to provide some pre-treatment.

Gross Pollutant Traps (GPT) / Oil & Grit Separators

GPT / Oil and Grit Separators incorporated into the stormwater treatment train can contribute to the effective removal of solid pollutants, sediments and hydrocarbons from stormwater runoff from driveway and roadway areas of the proposed development site.

Generally GPTs and Oil and Grit Separators shall be designed to treat flows generated by the 3 month Average Recurrence Interval (ARI) rainfall event.

As the general operation of the maintenance yard is expected to include works such as maintaining heavy machinery including diesel locomotives it is recommended that oil and grit separators are incorporated into

the maintenance yard to collect runoff from any sealed hardstand areas where such maintenance is carried out.

Sediment Basins

During the construction phase of the development sediment loads are expected to be higher due to areas being cleared and exposed for the construction of roads and holding areas as well as the placement of machinery. It is recommended that as part of the erosion and sediment control plan prepared for the construction phase of the development some form of sediment basin will be utilised to help manage sediment transport off-site.

The use of sediment basins is considered appropriate for the maintenance yard and construction depot area.

Vegetated Filter Strips / Buffer Strips

Filter / buffer strips can be either areas of planted vegetation or strips of retained vegetation left in its natural state. These vegetated areas may provide both an effective way of reducing peak flows and improving stormwater runoff quality. During the construction phase of the development the retention of existing vegetation in-conjunction with other erosion control measures can assist to stabilise exposed areas. In the case of the proposed development areas that grade away from proposed pipe drainage networks, buffer strips are considered one of the key stormwater management techniques, particularly where no other stormwater treatment techniques are possible. Upon completion of the maintenance yard and construction depot area construction works any exposed, non-trafficable areas should be turfed, seeded, landscaped or stabilised as soon as possible to reduce the risk of erosion.

It should be noted that in order for buffer strips to be effective, flow must be overland and not concentrated. Therefore, flow spreaders may be required in conjunction with buffer strips to ensure optimal performance, particularly for those areas which drain away from proposed pipe drainage networks.

The use of vegetated filter / buffer strips is considered appropriate for this development.

Grassed / Vegetated Swales

Grassed / vegetated swales are designed to treat stormwater runoff by ensuring sufficient detention time to allow the removal of nutrients and fine sediments. This is achieved through filtration and infiltration. Hydrocarbon removal will also be achieved through filtration and attachment to vegetation where biological breakdown of the hydrocarbons can occur.

Swale lengths and widths can vary dependent on the site conditions, however to operate most effectively swales need to be located on relatively flat grades no steeper than 4-5%. The use of vegetated swales is limited in steep slope areas, unless suitable scour protection measures are incorporated.

Due to the relatively flat grades expected across the sites, the treatment and use of grassed / vegetated swales is considered appropriate for the treatment and conveyance of surface flows within the maintenance yard and construction depot sites.

Infiltration Trenches

Infiltration trenches are predominantly dry shallow grassed areas that trap the first flush runoff. The trapped runoff then infiltrates through the filtration medium removing fine sediment and nutrients. The base of the infiltration trench should be lined with an adequately designed sub-surface perforated pipe drainage network to convey filtered runoff to the trench outlet before discharging to the downstream receiving environment.

The use of infiltration trenches is considered appropriate for these sites subject to the availability of appropriate filter media and the ability to be properly drained.

Bio-retention Systems

Similar to vegetated swales, bio-retention systems are designed to treat stormwater runoff by ensuring sufficient detention time to allow the removal of nutrients and fine sediments. This is achieved through filtration, plant uptake, adsorption and biological degradation. Hydrocarbon removal will also be achieved through filtration and attachment to vegetation where the biological breakdown of hydrocarbons can occur.

Bio-retention systems contain an infiltration filter media, typically filled with sandy loam. All runoff collected within the system for the design storm event must pass through this filter. The filter media must be capable of sustaining vegetation growth as the vegetation is responsible for much of the uptake of nutrients within the system. The base of the bio-retention systems should be lined with an adequately designed sub-surface perforated pipe drainage network to convey the filtered runoff to the system outlet before discharging to the receiving system.

Bio-retention systems can be used in both flat areas and in steeper areas by stepping the system. Bio-retention systems can also be incorporated into the base of detention basins combining both stormwater quality and quantity into one area.

As the vegetation in the basins takes around 2 years to properly establish, the use of bio-retention systems is not considered appropriate for the construction depot site, however it may be suitable for the maintenance yard.

Porous Pavements

Porous pavements vary with design, but generally incorporate a surface material consisting of a grid / lattice system, modular clay / concrete blocks, or open-graded asphalt / concrete pavements with much of the fine aggregate material omitted. The surface material is bedded on a coarse sand filter layer constructed over a gravel drainage layer. The use of porous pavements can assist in the removal of fine particulate matter, hydrocarbons, nutrients and soluble pollutants from stormwater runoff.

Porous pavements are suited most to areas of low traffic volume and low runoff volume. Porous pavements are most effective when used at grades of less than 5%. Because of this, porous pavements are recommended to be used in the parking areas only.

Due to the high levels of sediments expected to be generated from the maintenance yard and construction depot sites, the use of porous pavements is not considered appropriate for these development areas.

Rainwater Tanks

In addition to providing a low cost supply of water to assist in reducing demand on water supply, rainwater tanks can also provide a reduction in peak flow rates from rainfall events with the provision of additional storage volume.

The use of rainwater tanks is only considered appropriate for these developments if there are suitable roof areas from which to collect rainwater runoff.

Level Spreader Devices

For roof area drainage that cannot be connected to a piped drainage network the concentrating of roof water runoff at a single discharge outlet can lead to erosion and scour problems. By utilising a level spreader at the outlet to disperse the overflows over a larger area, the flows will be less concentrated and velocities will be reduced, reducing the risk of erosion and the incidence of re-suspension of sediments. Level / flow spreaders should be located away from high pedestrian traffic areas and be directed towards vegetated buffer strips or other landscaped areas.

The use of level spreader devices is only considered appropriate for this development in instances where piped outlets from rainwater tanks or small roof and hardstand areas are not directly connected to a receiving pipe drainage network.

Constructed Wetlands

Constructed wetlands are a water quality treatment system comprising of an inlet pond to remove coarse sediments, and a macrophyte zone to remove fine particulates and soluble pollutants. Additionally, constructed wetlands also provide landscape value, passive recreation, wildlife habitat and flood control.

Wetlands are particularly useful on sites constrained by water and environmental sensitivity as they can be incorporated as an upstream component of existing waterbodies and environmentally sensitive aquatic features.

The dominant feature of the wetland is the macrophyte zone which comprises of vegetated marshes, shallow and deep pools.

Wetlands require reasonably large flat areas of land. Currently, bio-retention systems provide superior performance with a reduced footprint compared to wetlands. Given the relatively low rainfall and high evaporation that occurs in the region, there are also concerns in relation to constructed wetlands being dry for prolonged periods. Therefore this type of treatment device is not considered appropriate for the maintenance yard or construction depot area.

4.1.2 Adopted Strategy

Based on the site constraints the following stormwater quality improvement devices and management practices are considered appropriate to be incorporated in the development of the maintenance yard and construction depot area:

Rainwater tanks and level spreader devices

Due to the flat grades encountered over the sites, it may not be possible to direct all roof area drainage to a piped drainage network that will be able to free drain to the nominated stormwater treatment and detention basins. Therefore in these instances it is suggested that the roof area drainage discharge to rainwater tank with a level spreader device attached to the outlet. As indicated above, this would assist in dispersing the outflows over a larger area to reduce the risk of erosion and the incidence of re-suspension of sediments.

Vegetated Swales

As grades across the sites are generally less than 2% the use of vegetated swales for stormwater treatment is considered appropriate. As noted above, due to the relatively flat grades across the subject site vegetated swales may be used for conveyance purposes throughout much of the site as an alternative to conventional piped drainage which is expected to be limited by depth.

Oil and Grit Separators

As works in the maintenance yard are expected to include maintenance work on heavy machinery and diesel locomotives, there is a high likelihood of oil and grease contaminating stormwater runoff. Specific maintenance areas should be included in the maintenance yard and all runoff from these areas should be directed to a suitable oil and grit separator to remove hydrocarbon contaminants prior to discharge from the site.

Any planned refuelling areas to be incorporated into the maintenance yard need to be designed in such a manner to help reduce the possibility of hydrocarbons mixing with stormwater runoff. In order to minimise rainfall and runoff entering the refuelling area it is recommended that the refuelling area be covered by an impermeable roof structure, and the ground area be surrounded by a trafficable bund. A grated trench drain should be provided within the bunded refuelling area to capture any runoff or hydrocarbon spills and convey the potentially contaminated runoff towards an oil and grit separator or hydrocarbon spill containment unit.

Sediment Basins

The primary target of this stormwater management strategy is to control soil erosion and minimise sediment transport from the maintenance yard and construction depot area. This type of device is considered the most appropriate control device for construction depot area.

With the lifespan of the construction depot anticipated to be approximately 2 years, the use of alternative devices such as bio-retention basins are limited as these types of devices generally take a period of approximately 2 years to appropriately establish.

The flexibility in the shape of sediment basins combined with the efficient pollutant retention rates for sediments that these systems provide make sediment basins ideal for the construction depot site.

Bio-retention Basins

Similar to the sediment basins, the flexibility in the shape of bio-retention basins combined with the efficient pollutant retention rates for pollutants that these systems provide make bio-retention basins ideal for the maintenance area. Once established, the plant life present in the basins provides a more efficient system than sediment basins, making them ideal for treating the maintenance area. This makes bio-retention areas ideal for the maintenance yard as the planted area will have time to properly establish.

In addition to the above listed stormwater management practices, other principals of water sensitive urban design that can be incorporated into the development of the sites include:

- Retention of existing drainage features, where possible;
- Protection of natural systems by limiting development to non-sensitive areas and providing adequate buffers between development and natural systems;
- Non-worsening of peak flow rates from site.

It should be noted that this stormwater management strategy has been based on preliminary layouts. Although stormwater treatment practices have been recommended for use in certain areas throughout the subject site, a number of treatment measures may be appropriate and the key principles of the stormwater management strategy will remain applicable despite potential layout changes.

Should the detailed design bring about changes to the proposed layout, Section 4.1.1 of this stormwater management strategy provides a list of alternative treatment practices that may be suitable for the site and could potentially be designed to meet the nominated water quality objectives. The key aim of this stormwater management strategy is that the practices listed as suitable for the site should be used in a manner which results in best practice stormwater management measures being incorporated into the development.

4.1.3 On-site Fuel Storage

It is expected that a generator will be provided at both the maintenance yard and construction depot sites to provide power to the sites. A fuel storage tank of approximately 60,000 litres will also be provided near the generator sites to provide fuel storage for the generator and refuelling of vehicles. The maintenance yard will also have an additional 1,050,000 litres of fuel storage for the refuelling of the diesel locomotives. All fuel storage tanks must be located within a bunded containment area, sized in accordance with the relevant state or local guidelines to ensure all hydrocarbons are contained, should a spill or leak occur. All fuel storage tanks should be located above the nominated flood level. The refuelling area should be surrounded by a trafficable bund to capture any runoff or hydrocarbon spills and convey the potentially contaminated runoff towards a containment area.

4.2 Stormwater Quantity

The intent of this stormwater quantity strategy for the maintenance yard and construction depot area is to manage runoff generated from the local contributing catchment areas (i.e. the subject site area) only. Based on this, it is proposed to construct perimeter bunds along the upstream boundaries of the subject site to divert the local external contributing catchment areas around the sites.

A regional hydrologic and hydraulic assessment of the railway corridor was undertaken by Calibre Operations Pty Ltd, with the outcomes of this investigation documented in their Drainage Design report (Ref. No. CARP12033-REP-G-100 Rev 0, dated Dec 2012).

The purpose of this stormwater quantity management strategy is to avoid impacts on the downstream receiving properties and infrastructure, by ensuring that the peak flows discharging from the developed condition maintenance yard and construction depot area are equivalent to, or less than the peak flows expected from the existing condition site. It is proposed to incorporate an on-site detention basin into each of the sites to control the developed condition peak flows discharging from the subject site for rainfall events up to and including the 100 year ARI event for the local catchment.

To control the peak rates of discharge from the proposed detention basins it will be necessary for the outlet arrangements to be designed to maintain peak flows equivalent to the existing condition peak discharges. It is noted that where a free draining piped outlet cannot be provided to drain the proposed detention basin within the footprint of the maintenance yard and construction depot areas, a pump system may need to be provided if a free draining outlet cannot be provided external to the sites.

The proposed detention basin will also be utilised as a sediment retention basin for water quality purposes. All water trapped within the sediment / detention basin is to be tested for compliance with the release criteria outlined in **Table 3-1** prior to a controlled release from the site or alternatively the water could be used for dust suppression or irrigation.

Due to the flat nature of the sites, not all stormwater runoff generated will be able to be conveyed to the proposed on-site detention basin with the use of a conventional pit and pipe drainage system. As a result it is proposed to use drainage swales to convey runoff to the nominated detention basin locations.

The indicative location and minimum size of the proposed basins are shown on Cardno Sketch numbers 721769 SK14 and SK17 (Appendix B). Calculations for the sizing of the detention basins can be found in Section 6 of this report.

5 Stormwater Quality Assessment

As outlined above, the lifespan for the construction depot area is anticipated to be only approximately 2 years and therefore has been considered as a construction site for the lifetime of the rail construction project while the maintenance facility is permanent for the life of the rail line.

The works to be carried out on the sites have the potential to increase the level of sediment laden runoff discharging from the site for the lifespan of the construction project. Based on this, the following assessment for each site has been undertaken to determine the on-site sediment retention storage requirements that will be necessary to retain the expected soil loss generated. Refer to Cardno Sketch numbers 721769 SK14 and SK17 (Appendix B) for the subject site local catchment areas adopted for the preliminary on-stormwater quality assessment.

5.1 Soil Loss Calculations

Data obtained from the Australian Soil Resource Information System on the 12th October 2012 indicated that the soils on the subject sites are expected to be medium clays with an approximate clay content of 40 – 50%. The data obtained was from the national soil grid. This soil type is considered to be a dispersive soil (type D) and based on the Revised Universal Soil Loss Equation (RUSLE) the predicted soil loss rate has been estimated for each of the disturbed catchment areas.

Catchment parameters for the disturbed area of the subject site were based on existing contour information. These catchment parameters have been summarised in **Table 5-1** below.

Table 5-1 Catchment Parameters

Catchment No.	Internal / Site Catchment Area (ha)	Approx. Average Site Slope
Maintenance Yard North	33.6	0.1%
Maintenance Yard South	7.8	0.12%
Construction Depot North	70.1	0.8%
Construction Depot South	39.4	1.5%

The results of the soil loss assessment using the revised soil loss equation are summarised in **Table 5-2** below. For more detailed information refer to the sediment loss calculations provided in Appendix C of this report.

Table 5-2 Soil Loss Parameters

Catchment	Rainfall Erosivity Factor (R)	Soil Erodibility Factor (K)	Slope Length / Gradient Factor (LS)	Erosion Control Practice Factor (P)	Ground Cover (C)	Soil Loss (A) (t/ha/yr)	Sediment Storage Volume (m^3)
Maintenance Yard North	2411	0.02	0.17	1.3	1.0	10.7	45.9
Maintenance Yard South	2411	0.02	0.17	1.3	1.0	10.7	10.7
Construction Depot North	2411	0.02	0.17	1.3	1.0	10.7	95.8
Construction Depot South	2411	0.02	0.34	1.3	1.0	21.3	101.7

Based on the information above, the soil loss within each of the disturbed areas has been estimated to be equivalent to Soil Loss Class 1 (0 to 150 tonnes/ha/yr), which classifies the sites as very low erosion risks, as outlined in Table 3.1 of the 'Best Practice Erosion and Sediment Control (2008)' guidelines prepared by the International Erosion Control Association – Australasia.

5.2 Sediment Basin Calculations

In conjunction with the above information, the calculations for the total sediment basin volume have been carried out and shown in **Table 5-3** below.

Table 5-3 Sediment Basin Calculations

Basin	Volumetric Runoff Coefficient (Cv)	Catchment Area of Basin (A)	5 day total rainfall depth (R) [85%ile, 5day	Settling Zone Volume (10xCvxAxR)	Total Basin Volume (m^3)
Maintenance Yard North	1.0	33.6	32.5	10920	10966
Maintenance Yard South	1.0	7.8	32.5	2535	2546
Construction Depot North	1.0	70.1	32.5	22783	22878
Construction Depot South	1.0	39.4	32.5	12805	12913

A comparison of the total storage volumes required for sediment retention and for on-site detention will be carried out in Section 6 of this report. This comparison will be made to determine which design conditions will be considered as the critical case.

5.3 MUSIC Assessment of the Maintenance Yard

5.3.1 Approach

The water quality assessments were undertaken utilising MUSIC Version 5.00.11 in accordance with Healthy Waterways '*MUSIC Modelling Guidelines*' (Version 1.0 2010).

The reduction criteria are listed in section 3 of this report. When modelling the bio-retention basin, the interim bio-retention node has been used, in accordance with Appendix 3 of the Urban Stormwater Quality Planning Guidelines.

The catchment extents adopted for the MUSIC model are shown on Cardno Sketch number 721769 SK14 (Appendix B), with the details of the catchment areas and adopted bio-retention areas detailed in Table 5-4 and Table 5-5 below.

Table 5-4 Modelled Areas

Parameter	Northern Catchment	Southern Catchment
Catchment Area	33.6	7.8
% Impervious	90	90
Impervious Area Properties		
Rainfall Threshhold (mm/day)	1.0	1.0
Pervious Area Properties		
Soil Storage Capacity (mm)	18	18
Initial Storage (%of Capacity)	10	10
Field Capacity (mm)	80	80
Infiltration Capacity Coefficient A	243	243
Infiltration Capacity Coefficient B	0.6	0.6
Groundwater Properties		
Initial Depth (mm)	50	50
Daily Recharge Rate (%)	0	0
Daily Baseflow Rate (%)	31	31
Daily Deep Seepage Rate (%)	0	0

Table 5-5 Modelled Areas

Parameter	Northern Bio-retention Basin	Southern Bio-retention Basin
Inlet Properties		
Low Flow Bypass (cumecs)	0	0
High Flow Bypass (cumecs)	100	100
Storage Properties		
Extended Detention Depth (m)	0.3	0.3
Surface Area (m^2)	4800	1200
Exfiltration Rate (mm/hr)	0.0	0
Infiltration Properties		
Filter Area (m^2)	4800	1200
Filter Depth (m)	0.5	0.5
Filter Median Particle (mm)	0.45	0.45
Saturated Hydraulic Conductivity (mm/hr)	200	200
Depth below underdrain pipe (% of filter depth)	0	0
Outlet Properties		
Overflow Weir Width (m)	2.0	2.0

The rainfall data used in the modelling was the Twin Hills station 36047 obtained from the Bureau of Meteorology. A ten year period between 1965 and 1975 was assessed. The potential evapotranspiration details were also obtained from Bureau of Meteorology.

The stormwater quality improvement devices assessed in the MUSIC model include the following treatment devices:

> Bio-Retention Systems.

The following assumptions were made in the modelling:

- A 6 minute time step was adopted to ensure accurate assessment of the proposed treatment devices;
- The pollutant generation parameters are adopted from Healthy Waterways '*MUSIC Modelling Guidelines*' (Version 1.0, 2010) for lumped catchments;
- No flow routing was assumed, which provides a conservative estimate of treatment device efficiency;
- Default MUSIC pollutant removal efficiencies were adopted for all treatment devices.

5.3.2 Results

Table 5-6 below presents the outcomes from the MUSIC modelling compared to the required load based reductions.

Table 5-6 Pollutant Load Reductions

Pollutant	Annual Load (kg/yr)		Load Reduction - Mitigated to Post-Dev (kg/yr)	Percentage Load Reduction - Mitigated to Post-Dev (%)	Required Load Reduction	Meet Load Reduction Requirement?
	Post-Development	Mitigated				
TSS	26500	3380	23120	87.3%	85%	✓
TP	68.5	18.6	49.9	72.8%	70%	✓
TN	434	238	196	45.2%	45%	✓
GP	4750	0	4750	100%	90	✓

The above results indicate that the proposed treatment train is predicted to meet the required water quality load based reductions outlined in the Urban Stormwater Quality Planning Guidelines as mentioned in Section 3.2 of this report.

The model layout and results are provided below.

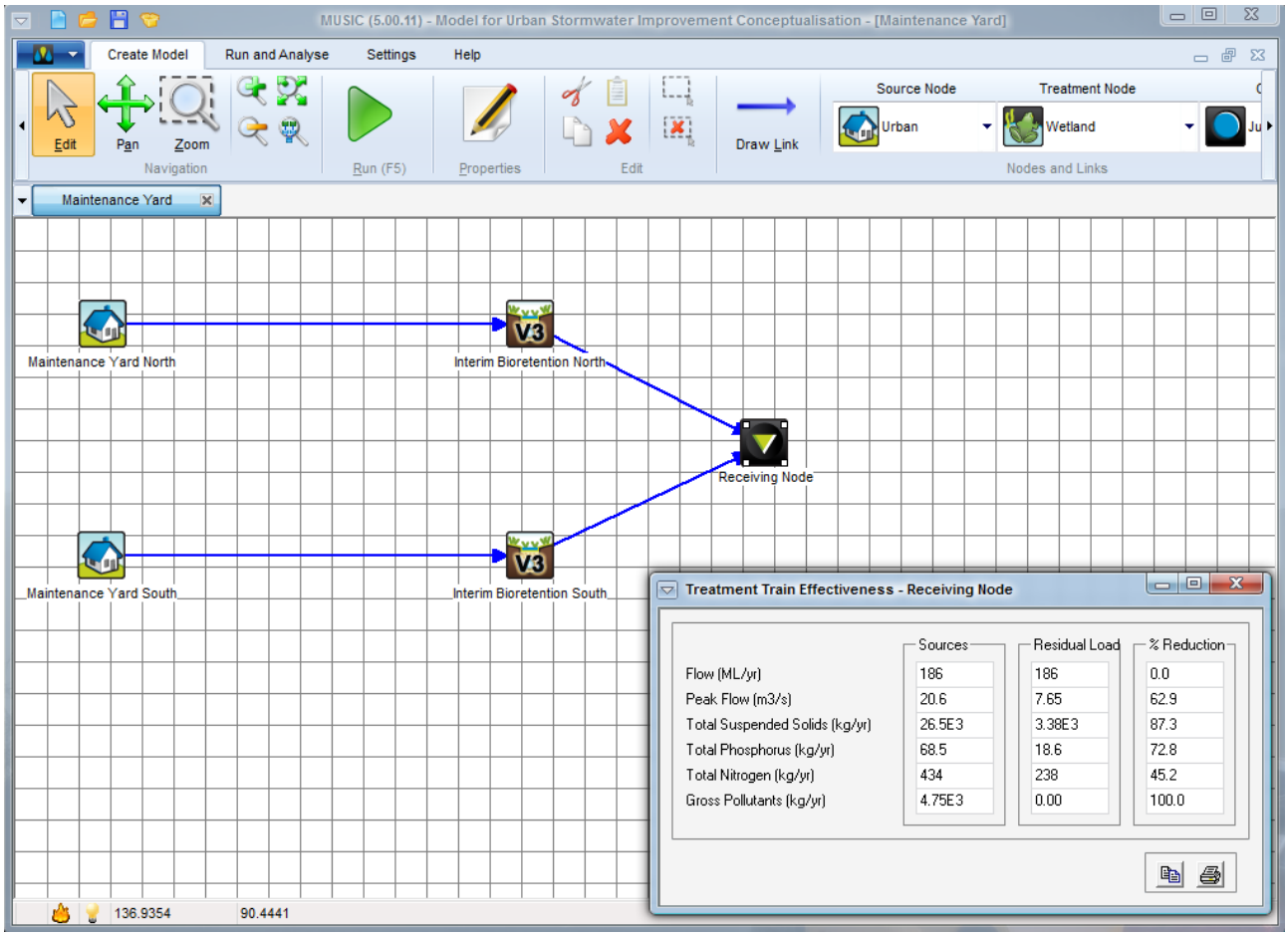


Figure 5.1 MUSIC Model Layout and Results

6 Stormwater Quantity Assessment

The local catchment peak discharges from the maintenance yard and construction depot area are expected to increase in comparison to the existing condition peak flows as a result of the proposed developments. This expected increase in peak discharge is the result of the increase in the percentage of impervious area and the reduction in flow travel time post development. Based on this, the following assessments of the pre-development and post development local catchment flows for each site have been undertaken to determine if there is an increase in post development flows from the subject sites, and estimate the on-site detention storage requirements that may be necessary to attenuate any increase in flows discharging off-site. Refer to Cardno Sketch numbers 721769 SK14 and SK17 (Appendix B) for the subject site local catchment areas adopted for the preliminary on-site detention assessment.

6.1 Existing Conditions

The Rational Method was used to estimate the existing condition peak flow rates discharging from each of the local catchment areas for the maintenance yard and construction depot.

The Coefficient of Runoff value for the pre-developed site conditions was determined from Tables 4.05.3(a) *(Table of C_{10} values)* and 4.05.3(b) *(C_{10} values for Zero Fraction Impervious)* of the Queensland Urban Drainage Manual 2007 (QUDM). Based on available data of the subject site, the existing condition of the maintenance yard and construction depot area was considered to have a fraction impervious of 0.0 and a land description equivalent to poor grass cover / low density pasture. A resultant C_{10} value of 0.66 was adopted for the pre-development site conditions.

A rainfall intensity frequency duration (IFD) chart was developed for the maintenance yard and construction depot areas using the design rainfall IFD data available from the Bureau of Meteorology (BOM) website.

The Time of Concentration value for each of the existing site conditions was determined in accordance with Section 4.06 of QUDM. The overland sheet flow and channel flow travel times were calculated separately then combined to provide a total time of concentration for each of the sites. The pre-development flow travel time was estimated based on the parameters shown in **Table 6-1** below.

Table 6-1 Existing Surface Parameters for Time of Concentration Calculations

Parameter		Maintenance Yard North	Maintenance Yard South	Construction Depot North	Construction Depot South
Sheet Flow	Slope Length	50 m	50 m	50	50 m
	Surface Grade	0.5%	0.5%	0.5%	0.7%
	Adopted t_c	14 min	14 min	14 min	14 min
Channel Flow	Slope Length	1400 m	420 m	1500 m	1100 m
	Surface Fall	1.5 m	0.5 m	5 m	9 m
	Adopted t_c	84 min	42 min	60 min	36 min
Total t_c		98 min	56 min	74 min	50 min

A summary of the parameters determined to estimate the pre-development 2, 5, 10, 20, 50 and 100 year ARI peak flow rates from the local catchment areas of each of the maintenance yard and construction depot are provided in **Tables 6-2** to **6-5** below.

Table 6-2 Maintenance Yard North Existing Condition Discharge Parameters

Parameter	2 yr	5 yr	10 yr	20 yr	50 yr	100 yr
Coefficient of Runoff	0.56	0.63	0.66	0.69	0.76	0.79
Area (ha)	33.6	33.6	33.6	33.6	33.6	33.6
Time of Concentration (min)	98	98	98	98	98	98
Rainfall Intensity (mm/hr)	27	36	41	47	56	64
Discharge (m^3/s)	1.41	2.11	2.53	3.04	3.97	4.73

Table 6-3 Maintenance Yard South Existing Condition Discharge Parameters

Parameter	2 yr	5 yr	10 yr	20 yr	50 yr	100 yr
Coefficient of Runoff	0.56	0.63	0.66	0.69	0.76	0.79
Area (ha)	7.8	7.8	7.8	7.8	7.8	7.8
Time of Concentration (min)	56	56	56	56	56	56
Rainfall Intensity (mm/hr)	41.5	55	61	70	84	94
Discharge (m^3/s)	0.50	0.75	0.87	1.05	1.38	1.61

Table 6-4 Construction Depot North Existing Condition Discharge Parameters

Parameter	2 yr	5 yr	10 yr	20 yr	50 yr	100 yr
Coefficient of Runoff	0.56	0.63	0.66	0.69	0.76	0.79
Area (ha)	69.5	69.5	69.5	69.5	69.5	69.5
Time of Concentration (min)	74	74	74	74	74	74
Rainfall Intensity (mm/hr)	34.2	46	53	61	72.5	81
Discharge (m^3/s)	3.70	5.57	6.75	8.16	10.62	12.38

Table 6-5 Construction Depot South Existing Condition Discharge Parameters

Parameter	2 yr	5 yr	10 yr	20 yr	50 yr	100 yr
Coefficient of Runoff	0.56	0.63	0.66	0.69	0.76	0.79
Area (ha)	37.2	37.2	37.2	37.2	37.2	37.2
Time of Concentration (min)	50	50	50	5	5	50
Rainfall Intensity (mm/hr)	43.9	57	65	76	90	101
Discharge (m^3/s)	2.54	3.69	4.43	5.44	7.06	8.27

6.2 Developed Condition

Similar to the existing condition flows, the Rational Method was used to estimate the peak flow rates discharging from each of the developed condition local catchment areas for the maintenance yard and construction depot.

As discussed above, the Coefficient of Runoff value for the developed site conditions was determined from Table 4.05.3(a) of QUDM. Based on the proposed use of the sites, a fraction impervious of 0.90 has been adopted, with a resultant C_{10} value of 0.86 to be used for the post-development site conditions.

The time of concentration value for the developed site conditions was determined for the contributing local catchment area in accordance with Section 4.06 of QUDM.

Due to the flat grades expected across the development sites, surface drainage is expected to be limited to the use of swale drains / open channels. Pipe drainage is expected to be limited to cross culverts utilised under roadways and footpaths to maintain trafficability during lower ARI events. A summary of the parameters used in calculating the time of concentration for the maintenance yard and construction depot areas is included in **Table 6-6** below.

Table 6-6 Developed Surface Parameters for Time of Concentration Calculations

Parameter		Maintenance Yard North	Maintenance Yard South	Construction Depot North	Construction Depot South	Construction Depot West
Sheet Flow	Slope Length	50 m	50 m	50 m	50 m	50 m
	Surface Grade	0.5%	0.5%	0.5%	0.7%	0.5%
	Adopted t_c	8 min	8 min	8 min	8 min	8 min
Channel Flow	Slope Length	1400 m	420 m	1500 m	1100 m	370 m
	Surface Fall	1.5 m	0.5 m	5 m	9 m	2 m
	Adopted t_c	112 min	56 min	80 min	48 min	32 min
Total t_c		120 min	64 min	88 min	56 min	40 min

A summary of the parameters determined to calculate the 2, 5, 10, 20, 50 and 100 year ARI developed peak flow ratess (with no detention) from the contributing local catchment area of the maintenance yard and construction depot are provided in **Table 6-7** to **Table 6-10** below.

Table 6-7 Maintenance Yard North Developed Condition Discharge Parameters

Parameter	2 yr	5 yr	10 yr	20 yr	50 yr	100 yr
Coefficient of Runoff	0.73	0.82	0.86	0.90	0.99	1.0
Area (ha)	33.6	33.6	33.6	33.6	33.6	33.6
Time of Concentration (min)	120	120	120	120	120	120
Rainfall Intensity (mm/hr)	24	31.3	35.7	41.4	49	55
Discharge (m^3/s)	1.64	2.39	2.87	3.49	4.52	5.13

Table 6-8 Maintenance Yard South Developed Condition Discharge Parameters

Parameter	2 yr	5 yr	10 yr	20 yr	50 yr	100 yr
Coefficient of Runoff	0.73	0.82	0.86	0.90	0.99	1.0
Area (ha)	7.8	7.8	7.8	7.8	7.8	7.8
Time of Concentration (min)	64	64	64	64	64	64
Rainfall Intensity (mm/hr)	38	50	57	66	79	88
Discharge (m^3/s)	0.60	0.89	1.06	1.29	1.69	1.91

Table 6-9 Construction Depot North Developed Condition Discharge Parameters

Parameter	2 yr	5 yr	10 yr	20 yr	50 yr	100 yr
Coefficient of Runoff	0.73	0.82	0.86	0.90	0.99	1.0
Area (ha)	69.5	69.5	69.5	69.5	69.5	69.5
Time of Concentration (min)	88	88	88	88	88	88
Rainfall Intensity (mm/hr)	30.8	40	45.5	52.5	63	72
Discharge (m^3/s)	4.35	6.31	7.55	9.15	12.03	13.9

Table 6-10 Construction Depot South Developed Condition Discharge Parameters

Parameter	2 yr	5 yr	10 yr	20 yr	50 yr	100 yr
Coefficient of Runoff	0.73	0.82	0.86	0.90	0.99	1.0
Area (ha)	37.2	37.2	37.2	37.2	37.2	37.2
Time of Concentration (min)	56	56	56	56	56	56
Rainfall Intensity (mm/hr)	41.4	54.4	61.4	71.4	85.2	95.2
Discharge (m^3/s)	3.13	4.59	5.46	6.66	8.71	9.84

A comparison of the existing condition peak flows with the developed condition peak flows found that there is generally expected to be an increase in the peak flows discharging off site due to the increase in impervious area on site.

On-site detention is proposed to be incorporated into the development works. This is to avoid impacts on downstream properties and infrastructure and to maintain the existing peak flow rate of runoff discharging from the developed site for all rainfall events up to and including the local catchment 100 year ARI event. The proposed on-site detention will help control the rate of discharge leaving the site.

6.3 Preliminary On-Site Detention

A preliminary assessment of the on-site detention storage requirements for the maintenance yard and construction depot area has been carried out using the initial sizing techniques outlined in Section 5.05.1 of QUDM. Based on the comparison of results outlined in Section 6.2 above, it will be necessary to incorporate on-site detention storage in order to maintain peak outflows equivalent to the existing conditions.

The on-site detention storage proposed for each site will be sized to maintain the equivalent pre-developed condition peak flows for local catchment rainfall events up to and including the 100 year ARI rainfall event. To control the peak rates of discharge from the nominated storage volume it will be necessary for the outlet arrangements to be designed to maintain the existing peak flows.

A comparison of the existing and developed condition peak flows for each site indicated that either the 50 year or 100 year ARI storm event resulted in the greatest increase in peak discharge in each case. The results of the preliminary on-site detention analysis indicated the approximate detention storage volume required for each site to detain the increase in stormwater discharge and maintain the equivalent pre-developed peak flow discharging off site for events up to and including the 100 year ARI storm event. A summary of the volumes required for each site are provided in **Table 6-11** below.

Table 6-11 Minimum Detention requirements

Parameter	Required Volume (m^3)	Storm Event
Maintenance Yard North	10675	50 year
Maintenance Yard South	3189	50 year
Construction Depot North	21517	100 year
Construction Depot South	15644	50 year

It should be noted that the volume outlined may be subject to change if the final catchment areas differ from those adopted for this assessment. The stage storage characteristics and outlet configuration of the detention basin will be verified as part of the detailed design for the maintenance yard and construction depot area.

It is proposed to incorporate the stormwater detention and treatment into one common basin. A comparison of the total storage volumes required for sediment retention as outlined in Section 5 of this report, and for on-site detention as outlined in section 6.3 above has indicated that the volume required for on-site detention is the greatest in most cases. There is one case where the sediment basin settling volume required is greater than detention volume. The minimum total storage volume adopted for each of the catchment areas is listed in **Table 6-12**, along with whether the detention or the sediment control volume was the critical volume. Refer to Cardno Sketch numbers 721769 SK14 and SK17 (Appendix B) for the indicative layout and configuration of the stormwater treatment and detention basin for the maintenance yard and construction depot area. As the maintenance yard will be treated with bio-retention basins rather than sediment basins, the size of the basins will be determined by the combined bio-retention and detention requirements.

In accordance with Section 5.11 of QUDM it is recommended that any ponding within the basin should be limited to 1.2 metres at the deepest point above the basin invert if there is perceived to be a public safety issue. For deeper basins, suitable safety provisions such as refuge mounds within large basins, fences and warning signs should be provided.

Table 6-12 Minimum Storage Volume requirements

Parameter	Required Volume (m^3)	Dictating event
Maintenance Yard North	10675*	50 year Detention
Maintenance Yard South	3189*	50 year Detention
Construction Depot North	22878	Sediment Control
Construction Depot South	15644	50 year Detention

*Detention volume to be provided in addition to bio-retention storage volume requirements.

6.4 Other Drainage Issues

6.4.1 Diversion of External Catchments

As the intent of this strategy is to manage the runoff from the maintenance yard and construction depot areas only, it is proposed to construct perimeter bunds along the upstream boundaries of the sites to divert the local external contributing catchment areas around the camp site. Refer to Cardno Sketch numbers 721769 SK14 and SK17 (Appendix B) for the indicative locations of the external catchment diversion bunds proposed for the maintenance yard and construction depot area. The final alignment and profile required for the diversion bunds will be confirmed as part of the detailed design of each of sites.

For the Construction depot, a number of overland flowpaths have been identified running through the site that convey runoff from external catchments. In order to maximise the use of the construction depot, it is proposed to re-align the overland flowpath further to the west. The grades in this area are fairly flat with differences in levels across the area in the vicinity of 1-2m. The relocated channel would need to enter and exit the site at the existing locations, and flowpath designed to ensure the changes do not increase flooding issues to the adjacent properties. Refer to Cardno Sketch number 721769 SK17 (Appendix B) for the indicative locations of the identified external catchment overland flow paths. It will not be possible to divert these flows around the proposed sites therefore an allowance will need to be made to divert these external flows through the sites, separate from the internal flows. The exact location, size and configuration of these external catchment overland flow paths should be confirmed as of the detailed design. No treatment or detention allowance has been made for the external catchment runoff. It is noted that the irrigation area for the sewerage treatment plant may be located within one of the external catchments. As it is only proposed to irrigate during dry weather, and irrigation levels should be set to ensure all irrigated water will soak in to the ground with no runoff, it is not expected that the irrigation process will increase the pollutant loading in the stormwater runoff.

7 Monitoring and Maintenance Schedules

7.1 Monitoring Schedule

A monitoring program will be established for the stormwater management devices as outlined below and shown in **Table 7-1**, **Table 7-2**, **Table 7-3, Table 7-4, Table 7-5** and **Table 7-6**.

Due to the remote location of the sites, the turn-around time for the suspended solids test results may delay the release of captured surface runoff from the sediment basins. Measuring the turbidity may be an acceptable alternative, although this requires the correlation between turbidity and suspended solids to be established individually for each site. The relationship between the turbidity and suspended solids varies between soil types, so this will need to be determined by measuring both parameters over the course of at least six events. Graphing the results and determining for each site a line of best fit should provide a turbidity/suspended solids relationship suitable for estimating the turbidity level that corresponds to the suspended solids release criteria for each site. Once this has been established, suspended solids testing samples should continue to be collected prior to any controlled release, however the release may occur prior to the results being returned. Should the suspended solids test results be outside the release criteria given in Section 3 of this report, the acceptable turbidity level must be adjusted to reduce the chance of future non-compliance. The turbidity within the basins can be measured a number of ways, including a secchi disk or a water quality probe.

Table 7-1 Monitoring Program for Sediment Basins

MONITORING ACTIVITY	FREQUENCY
Inspect sediment basin	- During construction - After each runoff event - Prior to “stop work” or “site shutdown”
Inspect submerged inflow pipes	After each runoff event
Testing of Suspended Solids, pH, and Dissolved Oxygen	- Prior to controlled release - Immediately following rain events > 25mm in a 24 hour period

To maximise the effectiveness of the stormwater management measures for the roof drainage areas that do not connect directly to a piped drainage system, the following activities are suggested to regularly visually monitor the condition of the rainwater tanks and level spreader outlets.

Table 7-2 Monitoring Program for Rainwater Tanks

MONITORING ACTIVITY	FREQUENCY
Observe water surcharging from surcharge weir/pipe/pit of tank	After major storm events > 25mm in 24 hrs
Inspect silt / litter trap	After major storm events > 25mm in 24 hrs or 3 monthly
Inspect structural integrity / condition of device	6 monthly

Table 7-3 Monitoring Program for Level Spreader Devices

MONITORING ACTIVITY	RECOMMENDED FREQUENCY
Inspect for incidents of erosion / scour of soils at outlet receiving environment	After major storm events > 25mm in 24 hrs or 3 monthly
Inspect for weed inundation / litter accumulation	3 monthly
Inspect for excessive wear & damage of receiving environment	
Inspect for build-up of sediments at outlet	
Inspect health of vegetation at outlet	

In the case of vegetated buffers and vegetated swales, the collection of water quality samples is unlikely to yield valuable results. Given this, no sample based monitoring is recommended for these treatment systems. Instead, an inspection based monitoring and maintenance scheme as detailed below is considered appropriate for these types of devices.

Table 7-4 Monitoring Program for Vegetated Swales

MONITORING ACTIVITY	FREQUENCY
Inspect for erosion / scour of invert & batters	After major storm events > 25mm in 24 hrs or 3 monthly
Inspect for weed inundation / litter & debris accumulation	3 monthly
Inspect for inappropriate access, excessive wear & damage to invert & batters	3 monthly
Inspect for build-up of sediments	3 monthly
Inspect condition of vegetation such as vegetation health & density	3 monthly
Inspect condition of inlet & outlet structures	After major storm events > 25mm in 24 hrs or 3 monthly

Table 7-5 Monitoring Program for GPT / Oil & Grip Separators

MONITORING ACTIVITY	FREQUENCY
Discharge Water Quality	After major storm events > 25mm in 24 hrs or 6 monthly
Debris / litter in trash rack / basket, blockages in device	3 monthly and / or after major storm events
Structural condition of device	3 monthly
Gross pollutant / coarse sediment accumulation within device	3 monthly
Odour within device	3 monthly

Table 7-6 Monitoring Program for Bio-retention Basins

MONITORING ACTIVITY	FREQUENCY
Inspect for erosion / scour of invert & batters	After major storm events > 25mm in 24 hrs or 3 monthly
Inspect for weed inundation / litter & debris accumulation	3 monthly
Inspect for inappropriate access, excessive wear & damage to invert & batters	3 monthly
Inspect for build-up of sediments	3 monthly
Inspect the condition of vegetation such as vegetation health and density	3 monthly
Inspect condition of vegetation such as vegetation health & density	3 monthly

7.2 Maintenance Schedule

The on-going performance of the stormwater management devices will be dependent on the maintenance conducted.

The maintenance programs as outlined below and detailed in **Table 7-7, Table 7-10, Table 7-9, Table 7-10, Table 7-11** and **Table 7-12** are to be implemented for the stormwater treatment devices.

Table 7-7 Maintenance Program for Sediment Basins

MAINTENANCE ACTIVITY	FREQUENCY
Clean out accumulated sediment	Every 2 years as per sediment basin calculations or as required by results of monitoring
Check visible pipes for leaks	6 monthly or as required by results of monitoring
Check fill material for settlement	6 monthly or as required by results of monitoring
Remove all trash from basin and riser	6 monthly or as required by results of monitoring
De-silt submerged inflow pipes	6 monthly or as required by results of monitoring

Sediment basins must be operated and maintained in an effective operational condition. These structures must not be allowed to accumulate sediment volumes in excess of forty per cent (40%) sediment storage design capacity. Where sedimentation basins are used a marker shall be placed within the basin to show the level above which the design storage capacity occurs. Materials removed from sediment retention devices must be disposed of in a manner approved by the consent authority that does not cause pollution.

Table 7-8 Maintenance Program for Rainwater Tanks

MAINTENANCE ACTIVITY	FREQUENCY
Clean out silt / litter trap	6 monthly or as required by results of monitoring
Remove debris from surcharge weir / pipe / pit	
Dewater and clean out / de-silt tank	As required by monitoring

Table 7-9 Maintenance Program for Level Spreader Devices

MAINTENANCE ACTIVITY	FREQUENCY
Repairs to landscaping / level spreaders	As required by monitoring
Watering, re-vegetating, grass cutting of receiving environment	
Removal of litter, debris, weeds & excessive sediment build up within receiving environment	

Table 7-10 Maintenance Program for Vegetated Swales

MAINTENANCE ACTIVITY	FREQUENCY
Repairs to swale profile	As required by results of monitoring
Irrigating, infilling of vegetation to maintain sufficient cover	As required by results of monitoring
Removal of litter, debris, weeds & excessive sediment build up	6 monthly or as required by results of monitoring
Mowing / pruning of swale vegetation to maintain optimal vegetation height	As required by results of monitoring

Reforming of any swale profile will be required when the design flow area of the swale is reduced by 25%.

Table 7-11 Maintenance Program for GPT / Oil & Grit Sepatator

MAINTENANCE ACTIVITY	FREQUENCY
Remove sediment / litter / hydrocarbons	3 monthly and as required by monitoring

Table 7-12 Maintenance Program for Bio-retention Basins

MAINTENANCE ACTIVITY	FREQUENCY
Repairs to swale profile	As required by results of monitoring
Irrigating, infilling of vegetation to maintain sufficient cover	As required by results of monitoring
Removal of litter, debris, weeds & excessive sediment build up	Monthly or as required by results of monitoring
Mowing / pruning of swale vegetation to maintain optimal vegetation height	As required by results of monitoring
Tilling of filter media area if evidence of clogging	As required by results of monitoring

8 Emergency Flood Management Strategies

A regional flooding analysis to assess the impacts of the proposed Carmichael Rail Alignment on the existing major floodplains, river and creek crossings was undertaken by Calibre Operations Pty Ltd for the Carmichael Coal Mine and Rail project. Based on the results of the investigation (included in the Drainage Design Report (Reference No.CARP12033-REP-G-100, dated Dec 2012)), and the Hydrology Drawings, the construction depot and possibly the maintenance yard were identified as being partially inundated during a 50 year ARI storm event.

For the areas that may be inundated during a 50 year ARI storm event, it is recommended that the contractor operating the facility consider developing an Emergency Flood Management Strategy to minimise the risk to people, equipment and infrastructure during flood events.

The following information provides some strategies that the contractor may consider when developing an Emergency Flood Management Plan for the construction facility areas at risk of inundation. Procedures for flood emergency management in the case of a flood emergency could include communication based management or flood gauge based management. Strategies for remaining on site during a flood emergency have not been considered for the maintenance yard and construction depot site as no habitable buildings are expected to be incorporated into these areas.

Due to the remote location of these areas, flood gauged based management strategies may not be available to many of the facility sites. Based on this, a communication based management plan may be more appropriate for the sites.

Any materials that have the potential to cause environmental harm such as fuel, cement etc. should be either stored above the appropriate flood level or be able to be moved off site in a timely manner if the need arises.

8.1 Communication Based Management Strategies

Communication based management strategies generally rely on regular flood warnings and river height bulletins issued by the Bureau of Meteorology (BoM). These warnings and bulletins are sent to radio stations for broadcast, and to local authorities, police and emergency services. Flood warnings, river height bulletins and other weather related information is available on the BoM website and through telephone recorded information services.

The contractor should consider identifying the names of the creek and river systems that have the potential to inundate the sites as well as site access roads and tracks, and determine if the BoM has a warning system monitoring the identified watercourse. If available, the contractor should then document the appropriate contact details to enable access to the identified warning systems.

To gain more information on flood warning, the contractor may also consider registering the sites with the local council, the local branch of the state emergency services department and any local disaster management centres.

The contractor should ensure that all staff accessing the facility are informed of the flood characteristics of the site and surrounding area, the emergency evacuation protocols and processes and the site evacuation routes in the event of a flood emergency.

If a flood event has been forecast for the area by the BoM or other local authority, then the contractor may want to consider some of the following procedures as part of the emergency evacuation protocols and processes for the sites.

> Securing the site by cleaning up materials and storing equipment / machinery that have the potential to be carried away during a flood event.

> Moving equipment / machinery that can be relocated off site to higher ground.

> Evacuate the facility site while low hazard level access is still available off site.

8.2 Flood Gauge Based Management Strategies

Flood gauge based management strategies generally incorporate the same communication based strategies as outlined above, however where flood gauges may be established for adjacent creek or river systems defined flood level information could be available.

The contractor may then consider utilising the available flood level information to set trigger levels for various actions to occur on site as part of the emergency evacuation protocols and processes developed for the construction facility.

9 Conclusions

In preparing this conceptual stormwater management strategy, preliminary water quality and quantity assessments were undertaken for maintenance yard and construction depot area.

The objectives of this stormwater management strategy were to meet the performance criteria outlined in **Table 3-1** of this report. The outcome of this preliminary investigation has recommended the inclusion of a number of stormwater quality and quantity management measures detailed herein and summarised as follows:

> Numerous vegetated swales for treatment and conveyance purposes as indicatively shown on Cardno Sketch numbers 721769 SK14 and SK17 (Appendix B); and

> Constructed sediment basins or bio-retention basins as described in Sections 5 and 6, and indicatively shown on Cardno Sketch numbers 721769 SK14 and SK17 (Appendix B).

The detailed design of the treatment and detention devices will need to comply with the information outlined within this stormwater management strategy, and with the relevant authority guidelines.

10 References

Department of Environment and Resource Management 2009, *Queensland Water Quality Guidelines (2009)*, Version 3 September 2009, Brisbane, QLD

Department of Natural Resources and Water 2007, *Queensland Urban Drainage Manual 2007 (QUDM)*, Volume 1 Second Edition 2007, Brisbane, QLD

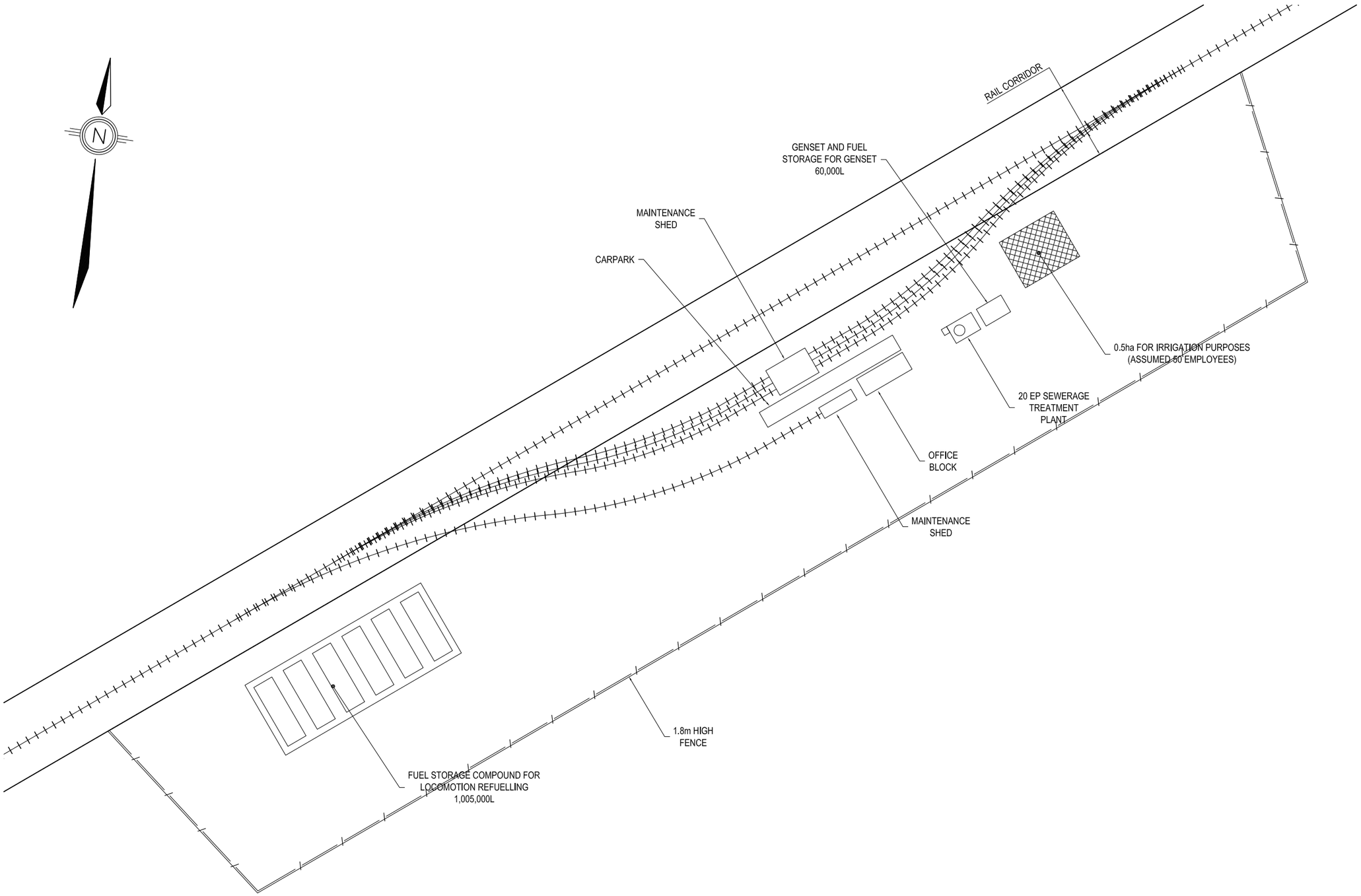
International Erosion Control Association (Australasia) 2008, *Best Practice Erosion and Sediment Control*, November 2008, Picton, NSW

Water by Design 2010, *MUSIC Modelling Guidelines Version 1.0 – 2010*, Brisbane, QLD

APPENDIX A

REFERENCE DRAWINGS

Cardno
Shaping the Future



50 0 50 100 150 200 250m
1:5000

Scale 1:5,000 (A3)

FIGURE 2
MAINTENANCE FACILITY INDICATIVE LAYOUT

Rev: 0 | Drawn: M.H | Checked: L.M. | Date: 12/07/2013

Adani Mining Pty Ltd

CAD FILE: P:\721769 Adani\03 Design\Cad\Brls Drawings\Figure 2 - Maintenance Facility Typical Layout.dwg
XREF's: 790344-X-BASE

Project No.: 7803/04

PRINT DATE: 18 July, 2013 - 5:07pm

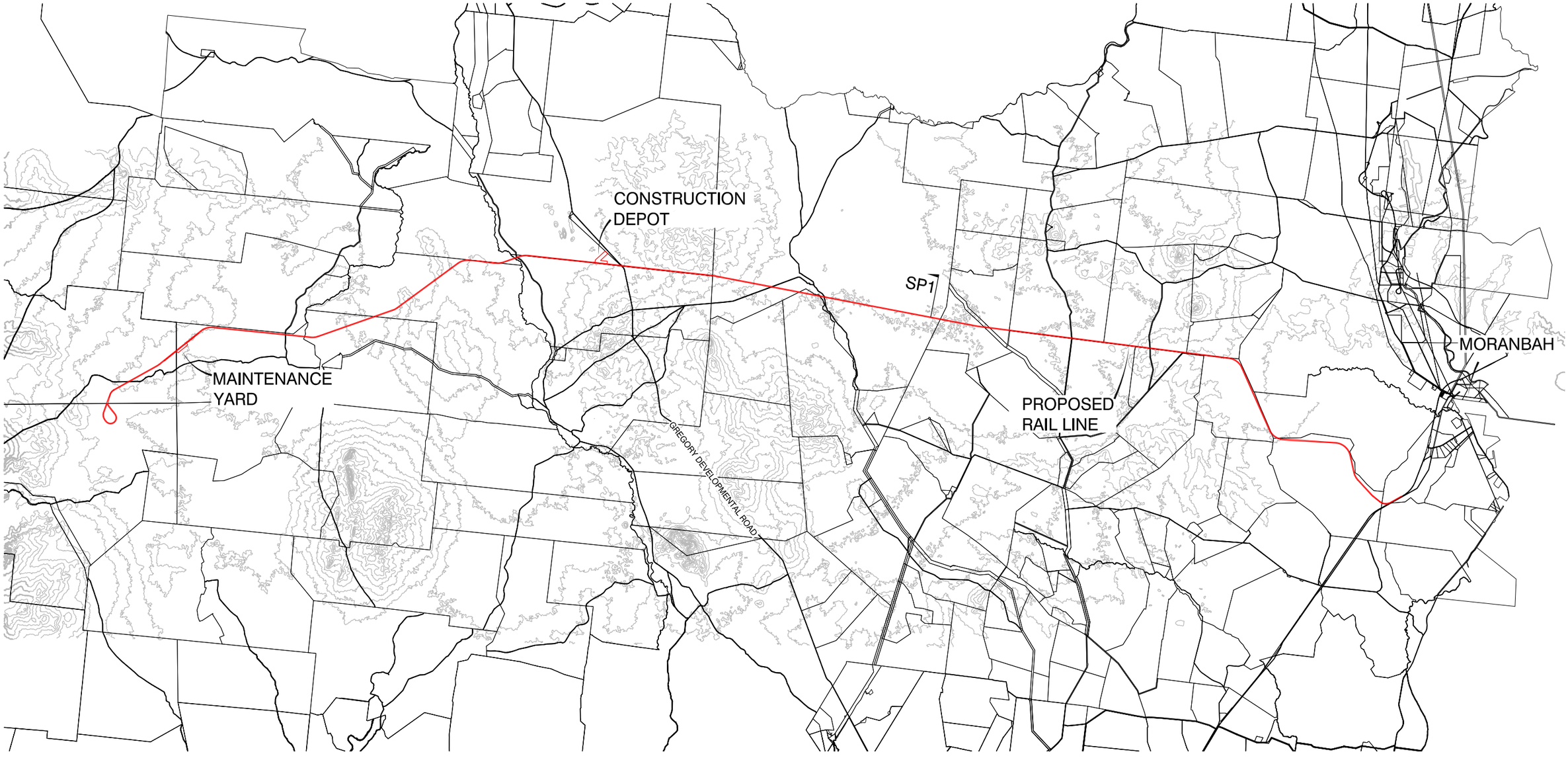
APPENDIX B

FIGURES & SKETCHES

Cardno
Shaping the Future

Cardno (Qld) Pty Ltd | ABN 57 051 074 992
Level 2 Podium Level - emerald Lakes Town Centre
1/3321 Central Place, Gold Coast, Qld 4211
PO Box 391, Carrara, Qld 4211
Tel:07 5539 9333 Fax:07 5538 4647
Email: GCO@cardno.com.au Web: www.cardno.com.au

Cardno
Shaping the Future



-10 -5 0 5 10 15 20km
SCALE @ A3 1:500,000

Adani Mining Pty Ltd
Carmichael Coal Mine Rail

Locality Plan for the Maintenance Yard and Construction Depot

Date: April 2013
Drawing Number: Sketch 721769 - 002
Revision: B

DATE PLOTTED: 12 July 2013 11:18 AM
CAD FILE: P:\721769 Adani\03 Design\Cad\03 Sketches\721769 Sk01-03 Locality Plans.dwg

Cardno (Qld) Pty Ltd | ABN 57 051 074 992
Level 2 Podium Level - emerald Lakes Town Centre
1/3321 Central Place, Gold Coast, Qld 4211
PO Box 391, Carrara, Qld 4211
Tel:07 5539 9333 Fax:07 5538 4647
Email: GCO@cardno.com.au Web: www.cardno.com.au

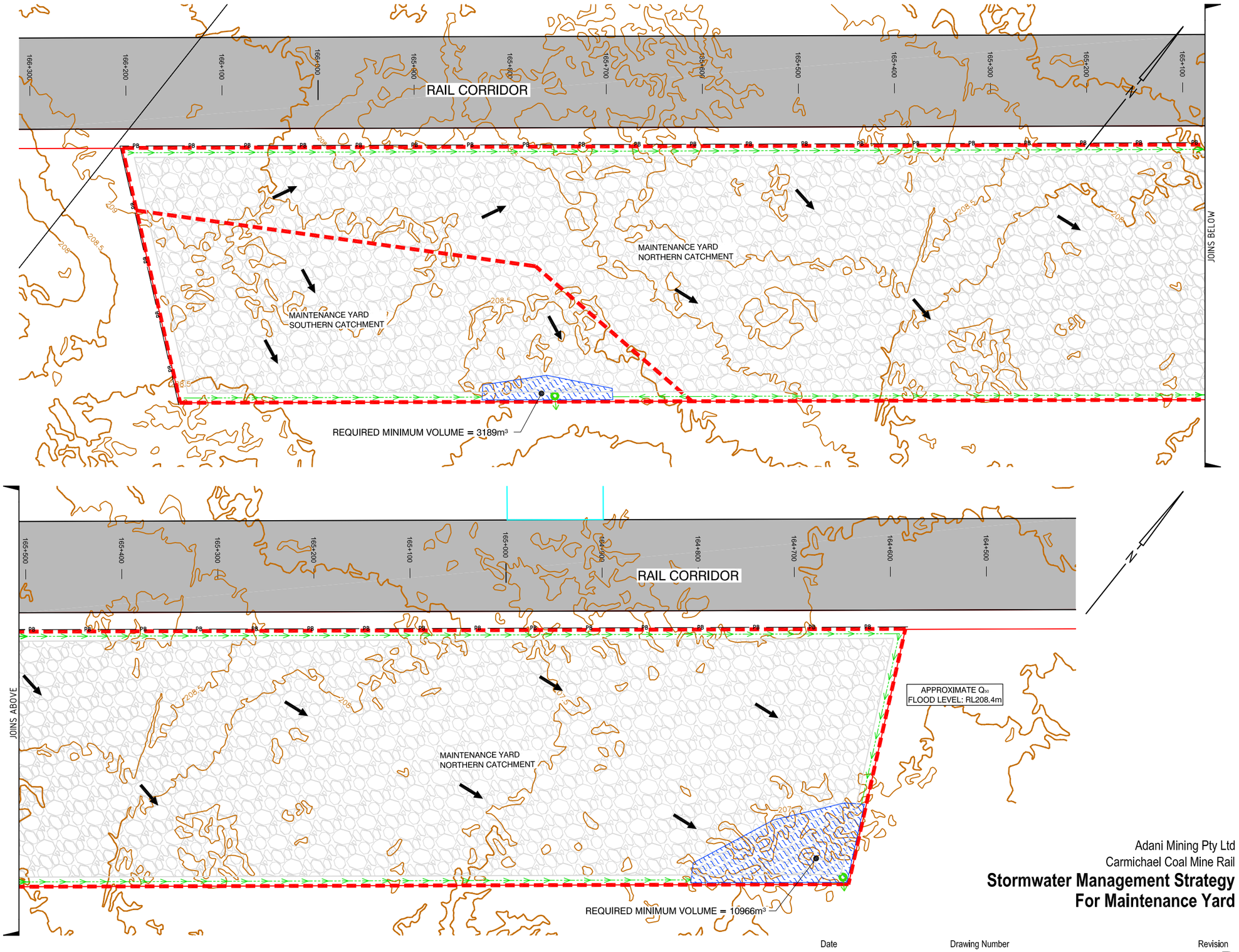
Cardno® Shaping the Future

LEGEND

- EXISTING SURFACE CONTOURS (0.5m INTERVALS)
- DEVELOPED CATCHMENT BOUNDARY
- VEGETATED SWALES (INDICATIVE ONLY)
- PB — PERIMETER BUND
- OVERLAND FLOW DIRECTION
- PROPOSED CONSTRUCTION FACILITY AREA
- PROPOSED SEDIMENT/DETENTION BASIN AND OUTLET (INDICATIVE ONLY) REFER NOTE 7.

NOTES:

1. CONTOURS ARE BASED ON AERIAL SURVEY. DETAILED SURVEY WILL BE REQUIRED TO CONFIRM CONTRIBUTING CATCHMENT AREAS FOR DETAILED DESIGN.
2. WHERE THE ROOF AREA DRAINAGE CANNOT BE PROVIDED WITH A FREE DRAINING CONNECTION TO THE PROPOSED SEDIMENT/DETENTION BASIN THE ROOF AREA DRAINAGE TO DISCHARGE TO RAINWATER TANK WITH A LEVEL SPREADER ATTACHED TO OUTLET.
3. SOME MINOR RE-GRADING WILL BE REQUIRED ONCE EXACT SITE CONDITIONS ARE DETERMINED.
4. WHERE A FREE DRAINING PIPED OUTLET CANNOT BE PROVIDED TO DRAIN THE SEDIMENT/DETENTION BASIN WITHIN THE FOOTPRINT OF THE CONSTRUCTION FACILITY AREA, A PUMP WILL NEED TO BE PROVIDED. ALTERNATIVELY APPROVAL WILL NEED TO BE SOUGHT TO PROVIDE A FREE DRAINING PIPED OUTLET EXTERNAL TO THE EXTENTS OF THE SITE.
5. ALL WATER TRAPPED WITHIN THE SEDIMENT/DETENTION BASIN IS TO BE TESTED FOR COMPLIANCE WITH THE RELEASE CRITERIA OUTLINED IN THE SWMS PRIOR TO A CONTROLLED RELEASE OFF-SITE.
6. CONSTRUCT DIVERSION BUND TO DIVERT EXTERNAL LOCAL CONTRIBUTING CATCHMENTS AROUND THE CONSTRUCTION FACILITY SITE. EXTENT AND SIZE OF THE BUND TO BE CONFIRMED AS PART OF THE DETAILED DESIGN. VELOCITY CONTROL MEASURES TO BE PROVIDED AT THE DOWNSTREAM END OF DIVERSION BUNDS TO DISPERSE CONCENTRATED FLOWS.
7. BASIN SPILLWAY LOCATION AND SIZE TO BE CONFIRMED AS PART OF THE DETAILED DESIGN.
8. REGIONAL Q50 FLOOD LEVEL DERIVED FROM RESULTS OF REGIONAL FLOODING INVESTIGATION UNDERTAKEN BY CALIBRE OPERATIONS PTY LTD FOR THE CARMICHAEL COAL MINE AND RAIL PROJECT, AND SUMMARISED IN THE DESIGN REPORT, REFERENCE NO. CARP12033-REP-C-003 (DATED DEC 2012)



80 40 0 80 160
SCALE @ A3 1 : 4000

Adani Mining Pty Ltd
Carmichael Coal Mine Rail

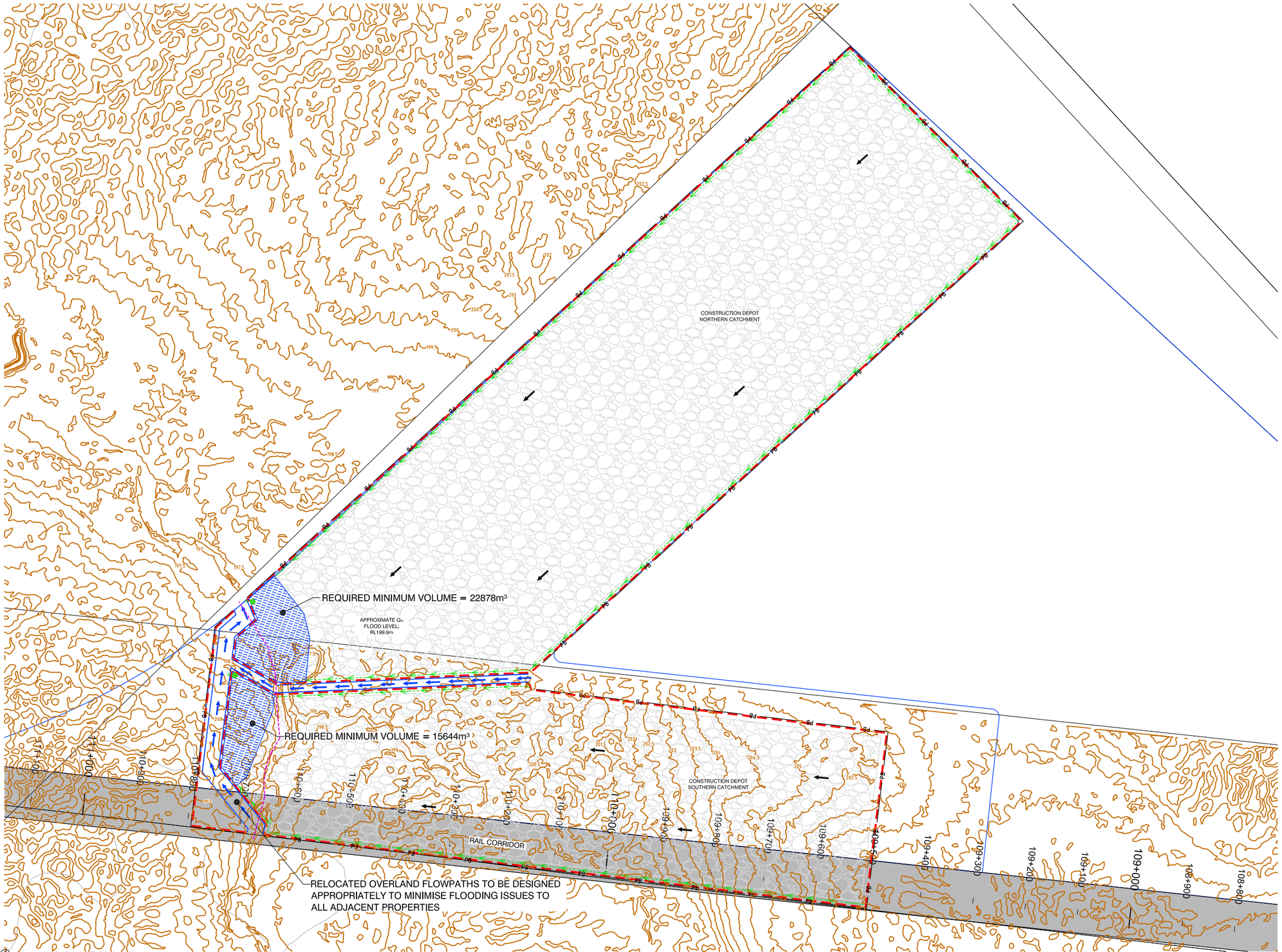
Stormwater Management Strategy For Maintenance Yard

Date: April 2013
Drawing Number: Sketch 721769 - 014
Revision: B

DATE PLOTTED: 12 July 2013 11:57 AM
CAD FILE: P:\721769 Adani\03 Design\Ca\03 Sketches\721769 Sk14-17 Maint SW Treatment.dwg

Cardno (Qld) Pty Ltd | ABN 57 051 074 992
Level 2 Podium Level - emerald Lakes Town Centre
1/3321 Central Place, Gold Coast, Qld 4211
PO Box 391, Carrara, Qld 4211
Tel:07 5539 9333 Fax:07 5538 4647
Email: GCO@cardno.com.au Web: www.cardno.com.au

Cardno® Shaping the Future



LEGEND

- EXISTING SURFACE CONTOURS (0.5m INTERVALS)
- DEVELOPED CATCHMENT BOUNDARY
- VEGETATED SWALES (INDICATIVE ONLY)
- PB — PERIMETER BUND
- EXISTING OVERLAND FLOWPATH
- OVERLAND FLOW DIRECTION
- PROPOSED CONSTRUCTION FACILITY AREA
- PROPOSED SEDIMENT/DETENTION BASIN AND OUTLET (INDICATIVE ONLY) REFER NOTE 7.

NOTES:

1. CONTOURS ARE BASED ON AERIAL SURVEY. DETAILED SURVEY WILL BE REQUIRED TO CONFIRM CONTRIBUTING CATCHMENT AREAS FOR DETAILED DESIGN.
2. WHERE THE ROOF AREA DRAINAGE CANNOT BE PROVIDED WITH A FREE DRAINING CONNECTION TO THE PROPOSED SEDIMENT/DETENTION BASIN THE ROOF AREA DRAINAGE TO DISCHARGE TO RAINWATER TANK WITH A LEVEL SPREADER ATTACHED TO OUTLET.
3. SOME MINOR RE-GRADING WILL BE REQUIRED ONCE EXACT SITE CONDITIONS ARE DETERMINED.
4. WHERE A FREE DRAINING PIPED OUTLET CANNOT BE PROVIDED TO DRAIN THE SEDIMENT/DETENTION BASIN WITHIN THE FOOTPRINT OF THE CONSTRUCTION FACILITY AREA, A PUMP WILL NEED TO BE PROVIDED. ALTERNATIVELY APPROVAL WILL NEED TO BE SOUGHT TO PROVIDE A FREE DRAINING PIPED OUTLET EXTERNAL TO THE EXTENTS OF THE SITE.
5. ALL WATER TRAPPED WITHIN THE SEDIMENT/DETENTION BASIN IS TO BE TESTED FOR COMPLIANCE WITH THE RELEASE CRITERIA OUTLINED IN THE SWMS PRIOR TO A CONTROLLED RELEASE OFF-SITE.
6. CONSTRUCT DIVERSION BUND TO DIVERT EXTERNAL LOCAL CONTRIBUTING CATCHMENTS AROUND THE CONSTRUCTION FACILITY SITE. EXTENT AND SIZE OF THE BUND TO BE CONFIRMED AS PART OF THE DETAILED DESIGN. VELOCITY CONTROL MEASURES TO BE PROVIDED AT THE DOWNSTREAM END OF DIVERSION BUNDS TO DISPERSE CONCENTRATED FLOWS.
7. BASIN SPILLWAY LOCATION AND SIZE TO BE CONFIRMED AS PART OF THE DETAILED DESIGN.
8. REGIONAL Q50 FLOOD LEVEL DERIVED FROM RESULTS OF REGIONAL FLOODING INVESTIGATION UNDERTAKEN BY CALIBRE OPERATIONS PTY LTD FOR THE CARMICHAEL COAL MINE AND RAIL PROJECT, AND SUMMARISED IN THE DESIGN REPORT, REFERENCE NO. CARP12033-REP-C-003 (DATED DEC 2012)

150 0 150 300
SCALE @ A3 1 : 7500

Adani Mining Pty Ltd
Carmichael Coal Mine Rail

Stormwater Management Strategy For Construction Depot

Date: Junel 2013
Drawing Number: Sketch 721769 - 017
Revision: B

DATE PLOTTED: 19 July 2013 3:47 PM
CAD FILE: P:\721769 Adani\03 Design\Cad\03 Sketches\721769 Sk14-17 Maint SW Treatment.dwg

APPENDIX C

WATER QUALITY CALCULATIONS

Cardno
Shaping the Future

VOLUME OF SEDIMENT BASIN: TYPE D SOILS

PROJECT: Carmichael Coal Mines Maintenance Yard
JOB No:- 7217/69
DESIGNER:- SW
DATE:- 12/Apr/13

Sediment Storage Zone Volume

Input Value	Catchment/Basin Name		
	Maintenance Yard North	Maintenance Yard South	
S	10.5	10.5	
R (Calculated)	2411.4	2411.4	
R (from chart)			
R (adopted)	2411.4	2411.4	
K	0.02	0.02	
LS	0.17	0.17	
P	1.3	1.3	
C	1	1	
A - Soil Loss (tonnes/ha/yr)	10.7	10.7	
Volume (m^3/ha/yr)	8.2	8.2	
Disturbed Area (ha)	33.6	7.8	
Calculated Soil Loss (m^3/yr)	275.52	63.96	
Sediment Storage Zone (m^3)*	45.9	10.7	

*Assumes regeneration after 2 months

Settling Zone Volume

Cv	1	1	
Catchment Area (ha)	33.6	7.8	
R(y%ile, 5day) (mm)	32.5	32.5	
Settling Zone (m^3)	10920	2535	
Basin Vol. per Hectare (m^3)	326	326	

Preliminary Basin Sizing

Depth of Basin (m)	1	1	
Total Basin Vol (m^3)	10966	2546	
Approx. Width (m)	60	29	
Approx. Length (m)	181	87	

VOLUME OF SEDIMENT BASIN: TYPE D SOILS

PROJECT: Carmichael Coal Mines Construction Depot
JOB No:- 7217/69
DESIGNER:- SW
DATE:- 19/Jul/13

Sediment Storage Zone Volume

Input Value	Catchment/Basin Name		
	Construction Depot North	Construction Depot South	
S	10.5	10.5	
R (Calculated)	2411.4	2411.4	
R (from chart)			
R (adopted)	2411.4	2411.4	
K	0.02	0.02	
LS	0.17	0.34	
P	1.3	1.3	
C	1	1	
A - Soil Loss (tonnes/ha/yr)	10.7	21.3	
Volume (m^3/ha/yr)	8.2	16.4	
Disturbed Area (ha)	70.1	39.4	
Calculated Soil Loss (m^3/yr)	574.82	646.16	
Sediment Storage Zone (m^3)*	95.8	107.7	

*Assumes regeneration after 2 months

Settling Zone Volume

Cv	1	1	
Catchment Area (ha)	70.1	39.4	
R(y%ile, 5day) (mm)	32.5	32.5	
Settling Zone (m^3)	22783	12805	
Basin Vol. per Hectare (m^3)	326	328	

Preliminary Basin Sizing

Depth of Basin (m)	1	1	
Total Basin Vol (m^3)	22878	12913	
Approx. Width (m)	87	66	
Approx. Length (m)	262	197	

APPENDIX

D

WATER QUANTITY CALCULATIONS

Cardno
Shaping the Future

Carmichael Coal Mine Rail SP1
Maintenance Yard North - 50 year ARI flow

Existing Case

Area	33.6	ha
C_{10}	0.66	
$F_{50}xC_{10}$	0.76	
C_{50}	0.76	
Time of conc	98	mins
Intensity	56	mm/hr
Flow	3.97	m^3/s
Total Flow	3.97	m^3/s
Volume	23326.2	m^3

Sheet flow - 50m over 0.5% grade, poorly grassed - 14 mins
Channel flow - 1400m, 1.5m fall, natural channel - 84 mins
Total 98 mins

Developed Case

Area	33.6	ha
C_{10}	0.86	
$F_{50}xC_{10}$	0.99	
C_{50}	0.99	
Time of conc	120	mins
Intensity	49	mm/hr
Flow	4.52	m^3/s
Total Flow	4.52	m^3/s
Volume	32565.8	m^3

Sheet flow - 50m over 0.5% grade, compacted earth surface - 8 mins
Channel flow - 1400m, 1.5m fall, grassed swales - 112 mins
Total 120 mins

Detention Basin Sizing (preliminary)

Peak inflow	4.52	m^3/s
Peak outflow	3.97	m^3/s
Volume	43421.06	m^3
r	0.12	

Required storage volume

Culp	Boyd	Carroll	Basha	Maximum
2216.56	5337.47	2411.62	3777.02	5337.47

Peak flow only factor: 2

Required volume is - 10675 m^3.

Assuming a rectangular basin with 1 in 2 side slopes,
required surface area is:

Depth (m)	Length (m)	Width (m)	Area (m^2)	Volume (m^3)
0.0	44.0	149.0	6556.0	
1.5	50.0	155.0	7750.0	10729.5

Carmichael Coal Mine Rail SP1
Maintenance Yard South - 50 year ARI flow

Existing Case

Area	7.8	ha
C_{10}	0.66	
$F_{50}xC_{10}$	0.76	
C_{50}	0.76	
Time of conc	56	mins
Intensity	84	mm/hr
Flow	1.38	m^3/s
Total Flow	1.38	m^3/s
Volume	4641.4	m^3

Sheet flow - 50m over 0.5% grade, poorly grassed - 14 mins
Channel flow - 420m, 0.5m fall, natural channel - 42 mins
Total 56 mins

Developed Case

Area	7.8	ha
C_{10}	0.86	
$F_{50}xC_{10}$	0.99	
C_{50}	0.99	
Time of conc	64	mins
Intensity	79	mm/hr
Flow	1.69	m^3/s
Total Flow	1.69	m^3/s
Volume	6500.5	m^3

Sheet flow - 50m over 0.5% grade, compacted earth surface - 8 mins
Channel flow - 420m, 0.5m fall, grassed swales - 56 mins
Total 64 mins

Detention Basin Sizing (preliminary)

Peak inflow	1.69	m^3/s
Peak outflow	1.38	m^3/s
Volume	8667.33	m^3
r	0.18	

Required storage volume

Culp	Boyd	Carroll	Basha	Maximum
727.15	1594.67	781.37	1160.91	1594.67

Peak flow only factor: 2

Required volume is - 3189 m^3.

Assuming a rectangular basin with 1 in 2 side slopes,
required surface area is:

Depth (m)	Length (m)	Width (m)	Area (m^2)	Volume (m^3)
0.0	22.0	82.0	1804.0	
1.5	28.0	88.0	2464.0	3201.0

Carmichael Coal Mine Rail SP1
Construction Depot North - 100 year ARI flow

Existing Case

Area	70.1	ha
C_{10}	0.66	
$F_{100}xC_{10}$	0.79	
C_{100}	0.79	
Time of conc	74	mins
Intensity	81	mm/hr
Flow	12.49	m^3/s
Total Flow	12.49	m^3/s
Volume	55463.7	m^3

Developed Case

Area	70.1	ha
C_{10}	0.86	
$F_{100}xC_{10}$	1.03	
C_{100}	1.00	
Time of conc	88	mins
Intensity	72	mm/hr
Flow	14.02	m^3/s
Total Flow	14.02	m^3/s
Volume	74025.6	m^3

Detention Basin Sizing (preliminary)

Peak inflow	14.02	m^3/s
Peak outflow	12.49	m^3/s
Volume	98700.8	m^3
r	0.11	

Required storage volume

Culp	Boyd	Carroll	Basha	Maximum
4367.91	10758.39	4767.31	7563.15	10758.39

Peak flow only factor: 2

Required volume is - 21517 m^3.

Assuming a rectangular basin with 1 in 2 side slopes,
required surface area is:

Depth (m)	Length (m)	Width (m)	Area (m^2)	Volume (m^3)
0.0	64.0	210.0	13440.0	
1.5	70.0	216.0	15120.0	21420.0

Carmichael Coal Mine Rail SP1
Construction Depot South - 50 year ARI flow

Existing Case

Area	39.4	ha
C_{10}	0.66	
$F_{50}xC_{10}$	0.76	
C_{50}	0.76	
Time of conc	50	mins
Intensity	90	mm/hr
Flow	7.48	m^3/s
Total Flow	7.48	m^3/s
Volume	22428.5	m^3

Developed Case

Area	39.4	ha
C_{10}	0.86	
$F_{50}xC_{10}$	0.99	
C_{50}	0.99	
Time of conc	56	mins
Intensity	85.2	mm/hr
Flow	9.22	m^3/s
Total Flow	9.22	m^3/s
Volume	30986.2	m^3

Detention Basin Sizing (preliminary)

Peak inflow	9.22	m^3/s
Peak outflow	7.48	m^3/s
Volume	41315.0	m^3
r	0.19	

Required storage volume

Culp	Boyd	Carroll	Basha	Maximum
3594.51	7821.84	3858.72	5708.17	7821.84

Peak flow only factor: 2

Required volume is - 15644 m^3.

Assuming a rectangular basin with 1 in 2 side slopes,
required surface area is:

Depth (m)	Length (m)	Width (m)	Area (m^2)	Volume (m^3)
0.0	64.0	144.0	9216.0	
1.5	70.0	150.0	10500.0	14787.0

Stormwater Management Strategy

Carmichael Coal Rail SP1 Concrete Batching Plants

721769

Prepared for
Adani Mining Pty Ltd

19/07/2013

Cardno
Shaping the Future

Document Information

Prepared for	Adani Mining Pty Ltd
Project Name	Carmichael Coal Rail SP1 Concrete Batching Plants
File Reference	P:\721769 Adani\02 Project Management\Reports\Conc Batch Plant\130717 Conc Batching Plant SWMS V5.docx
Job Reference	721769
Date	19/07/2013

Contact Information

Cardno (Gold Coast)
Trading as Cardno (QLD) Pty Ltd
ABN 57 051 074 992

Level 2 Podium Level
Emerald Lakes Town Centre
1/3321 Central Place
Carrara QLD 4211

P.O. Box 391
Nerang Qld 4211
Australia

Telephone: 07 5539 9333
Facsimile: 07 5538 4647
gco@cardno.com.au
www.cardno.com.au

Document Control

Version	Date	Author	Author Initials	Reviewer	Reviewer Initials
1	22/03/2013	Scott Walter		Carlo de Byl	
2	31/05/2013	Scott Walter		Carlo de Byl	
3	21/06/2013	Scott Walter		Carlo de Byl	
4	12/07/2013	Scott Walter		Carlo de Byl	
5	19/07/2013	Scott Walter	SW	Carlo de Byl	CD

Table of Contents

Appendices

Tables

1 Introduction

This conceptual Stormwater Management Strategy (SWMS) report has been prepared on behalf of Adani Mining Pty Ltd for the five proposed Carmichael Coal Rail Project Concrete Batching Plants located along the proposed SP1 rail allignment (the subject site).

The intent of this strategy is to provide an overview of the stormwater management aspects to support the Material Change of Use application for the concrete batching plants required as part of the rail construction. This SWMS report includes detailed policies, performance criteria and procedures to minimise the impact of the development on the physical and social environment.

This SWMS intends to address the operational phase of the concrete batching plants that are expected to have a design life of approximately 2 years.

2 Existing Site and Proposed Development

2.1 Existing Site Description

The five Carmichael Coal Rail Project Concrete Batching Plant sites are located between approximately 80km and 150km west of Moranbah, Queensland in the Isaac Regional Council. Approximate levels for each of the sites have been obtained from a review of available aerial contour information. A summary of the details of each of the sites is included in **Table 2-1** below.

Table 2-1 Concrete Batching Plant Location Details

Plant	Area	Lot number	Distance west of Moranbah	Chainage along Track	Site Elevation (RL)	Approximate Grade
BP4*	4.6 ha	10BL49	80km	Ch 82 500	206m - 206.5m	0.5%
BP5*	4.6 ha	4SP116046	98km	Ch 101 100	225m - 227m	1.0%
BP6	4.6 ha	4SP116046	105km	Ch 108 200	209m - 210m	0.5%
BP7	4.6 ha	662PH1491	145km	Ch 152 200	199m - 200m	0.5%
BP8	4.6 ha	662PH1491	147km	Ch 154 400	204.5m - 206m	0.5%

*Based on the regional hydraulic analysis undertaken by Calibre Operations Pty Ltd and summarised in the Drainage Design Report (Ref. No. CARP12033-REP-C003), this site may be partially or fully inundated during a 50 year ARI storm event. Refer to Section 8 for possible emergency flood management strategies for these sites.

Refer to Cardno Sketch 721769 SK01 (Appendix B) for the locality plan showing an indicative location of the concrete batching plants and Cardno Sketch numbers 721769 SK04 to SK08 (Appendix B) for a plan of each of the Concrete Batching Plant sites showing the topography.

2.2 Developed Site Description

It is proposed to establish a concrete batching plant on each site to support the construction of the proposed railway linking the Carmichael Coal Mine with the port terminals situated to the east. The developed sites will contain temporary structures, storage areas and a basic road network with minimal sealed areas.

As minimal bulk earthworks are anticipated in order to construct each of the batching plants, the developed condition site topography is expected to generally resemble the existing conditions.

Refer to Cardno sketch number 7903/44/001/SK003 (Appendix A) for the typical development layout for the batching plant sites.

3 Performance Criteria

The establishment and operation of the batching plant sites has been considered as a construction site for the lifetime of the rail construction project, which is expected to be 2 years.

Based on this, the construction and operational phases of the batching plant sites will be governed by the same performance criteria as outlined below.

The *'Queensland Water Quality Guidelines (2009)'* (QWQ guidelines) (which is referenced by the *Environmental Protection (Water) Policy (2009)*, a subordinate document of the *Environmental Protection Act (1994)*) provides a summary of design objectives for the management of stormwater quality and flow for the construction phase of developments in Queensland. This summary provided in Table 8.2.1 of the QWQ guidelines outlines design objectives for a number of pollutants including sediment, nutrients, litter and hydrocarbons.

Based on the above information, the release criteria for controlled runoff events or pumped discharges from the construction site is to be as shown in **Table 3-1** below.

Table 3-1 Controlled Discharge Performance Criteria

Parameter	Release Criteria	Criteria Type
Total Suspended Solids	< 50 mg/L	Maximum
Coarse Sediments	To be retained on site	Descriptive
Turbidity (NTU)	< 10% above receiving water	Maximum
Nutrients (N and P)	Manage through Sediment Control	Descriptive
pH	6.5-8.5	Range
Litter	No visible litter washed from site	Descriptive
Hydrocarbons	No visible sheen on receiving water	Descriptive
Dissolved Oxygen	> 6 mg/L	Minimum
Stormwater drainage/flow management	Peak flows for 1-year and 100-year ARI event to match the pre-development condition of the site	Maximum

For the management of sediments, Table 8.2.1 of the QWQ guidelines outlines the following:

> Testing of suspended solids and pH within any temporary sedimentation basins is to occur prior to any controlled discharges.

> Testing of turbidity within the temporary sediment basins and the receiving waters is to be performed before the controlled discharging of the sediment basins. If the turbidity of the sediment basin is greater than 10% above the receiving waters, further dosing with gypsum or a suitable alternative is required until acceptable levels are reached (refer to *Table B17 – Characteristics of Various Flocculating Agents, Appendix B of IECA's 'Best Practice Erosion and Sediment Control',* (2008)).

4 Stormwater Management Strategy

4.1 Stormwater Quality

Based on the limited lifespan of the concrete batching plants and the sites' proximity to the adjacent railway corridor construction area, the primary objective of the proposed stormwater quality management strategy will be to control soil erosion on site and minimise sediment discharge to the downstream receiving local water courses using appropriate best management practices.

Refer to Cardno sketch numbers 721769 SK04 to SK08 (Appendix B) for an indicative layout of the stormwater quality management measures proposed to be adopted to treat the contributing local catchment areas of each of the concrete batching plant sites.

4.1.1 Available Management Practices

A wide range of stormwater quality improvement devices are available to achieve the best practice stormwater management of runoff from a developed site. **Table 4-1** lists the common stormwater quality improvement devices, including their treatment efficiencies and the constraints of their use.

Table 4-1 Stormwater Management Practices

Treatment Technique	Pollutant Removal Efficiency (1)							Scale (2)	Constraints
				Nutrients					
	Litter & Debris	Coarse Sediment	Fine Sediment	Dissolved	Particulate	Metals	Hydrocarbons		
Litter baskets / racks	L-M							Local	Requires frequent maintenance
Sediment basins	L	M-H	L-M		L	L	L	Regional	Aesthetic and safety issues
Gross pollutant traps	H	H	L		L	L	L	Local/ Regional	Requires regular maintenance
Filter strips / buffer strips	L	M	L-M	L	L-M	L-M	L	Lot/Local	Requires flat terrain
Grass / vegetated swales	L	M-H	L-M	L	L-M	L-M	L	Local	Requires flat terrain
Extended detention basins	M	H	L-M	L	M	M	L	Regional	Requires pre-treatment, Large land area required
Infiltration trenches	L	M-H	M	L-M	M	M	M	Local	Requires pre-treatment
Bio-retention systems	L	M-H	M	L	M	M	L-M	Local	Requires pre-treatment
Porous pavements		L-M	L-M	L	M	M	M	Local	Not appropriate for steep sites and heavy traffic

Treatment Technique	Pollutant Removal Efficiency (1)							Scale (2)	Constraints
	Litter & Debris	Coarse Sediment	Fine Sediment	Nutrients: Dissolved	Nutrients: Particulate	Metals	Hydrocarbons		
Constructed wetlands	M-H	H	M	H	H	M-H	M	Regional	Requires pre-treatment, Not appropriate for steep sites, Large land area required
Community education								Regional	Community participation

Information Source: Queensland Urban Drainage Manual Table 11.05.4 (Typical pollutant removal efficiencies of treatment systems (2007). Benefit Ranking: L = Low Benefit, M = Medium Benefit, H = High Benefit.

Notes:

(1) Removal rates are provided for information only with the efficiency rating subject to adequate design. The actual removal rates used for detailed water quality modelling purposes should be in accordance with *MUSIC Modelling Guidelines Version 1.0 – 2010* prepared by Water by Design.

(2) Scales: Lot – less than 1 ha; Local – 1 to 10 ha; Regional – greater than 10 ha.

Given the features of the subject sites, a number of the measures listed in **Table 4-1** above would not be considered appropriate to be incorporated into the stormwater treatment train for the concrete batching plant sites.

Provided below is information on a number of the listed stormwater quality improvement devices including the suitability of these devices to be incorporated into the development of the subject site to treat stormwater runoff from the proposed concrete batching plant sites.

Litter Baskets/Racks

Litter baskets and trash racks are generally located upstream of other treatment measures such as extended detention basins or constructed wetlands. They are primarily used as a pre-treatment device for stormwater runoff, removing litter, debris and other gross pollutants from the runoff before it discharges into other secondary and tertiary treatment devices located downstream.

Litter baskets are generally incorporated into the pipe drainage system. Due to the relatively flat grades expected across the sites, the incorporation of pipe drainage within the batching plant areas is expected to be limited. Therefore it is not intended to use litter baskets within the batching plant sites.

In the event that high levels of gross pollutants are being generated from the batching plant areas, trash racks could be incorporated at the locations where concentrated surface flows are discharging into the sediment basins to provide some pre-treatment.

Gross Pollutant Traps (GPT) / Oil & Grit Separators

GPT / Oil and Grit Separators incorporated into the stormwater treatment train can contribute to the effective removal of solid pollutants, sediments and hydrocarbons from stormwater runoff from roadways and other hardstand areas of proposed developments.

Generally GPTs and Oil and Grit Separators shall be designed to treat flows generated by the 3 month Average Recurrence Interval (ARI) rainfall event.

As the incorporation of pipe drainage within the sites is expected to be limited, it is not intended to use GPT's / Oil & Grit Separators within the concrete batching plants.

Sediment Basins

During the construction phase of the development sediment loads are expected to be higher due to areas being cleared and exposed for the construction of roads and holding areas as well as the placement of machinery. It is recommended that as part of the erosion and sediment control plan prepared for the construction phase of the development some form of sediment basin will be utilised to help manage sediment transport off-site.

The use of sediment basins is considered appropriate for the concrete batching plant development.

Vegetated Filter Strips / Buffer Strips

Filter / buffer strips can be either areas of planted vegetation or strips of retained vegetation left in its natural state. These vegetated areas may provide both an effective way of reducing peak flows and improving stormwater runoff quality. During the construction phase of the development the retention of existing vegetation in-conjunction with other erosion control measures can assist to stabilise exposed areas. In the case of the proposed development areas that grade away from proposed pipe drainage networks, buffer strips are considered one of the key stormwater management techniques, particularly where no other stormwater treatment techniques are possible. Upon completion of the concrete batching plant construction works any exposed non-trafficable areas should be turfed, seeded, landscaped or stabilised as soon as possible to reduce the risk of erosion.

It should be noted that in order for buffer strips to be effective, flow must be overland, and not concentrated. Therefore, flow spreaders may be required in conjunction with buffer strips to ensure optimal performance, particularly for those areas which drain away from proposed pipe drainage networks.

The use of vegetated filter / buffer strips is considered appropriate for this development.

Grassed / Vegetated Swales

Grassed / vegetated swales are designed to treat stormwater runoff by ensuring sufficient detention time to allow the removal of nutrients and fine sediments. This is achieved through filtration and infiltration. Hydrocarbon removal will also be achieved through filtration and attachment to vegetation where biological breakdown of the hydrocarbons can occur.

Swale lengths and widths can vary dependent on the site conditions, however to operate most effectively swales need to be located on relatively flat grades no steeper than 4-5%. The use of vegetated swales is limited in steep slope areas, unless suitable scour protection measures are incorporated.

Due to the relatively flat grades expected across the sites, the use of grassed / vegetated swales is considered appropriate for the treatment and conveyance of surface flows within the batching plant sites.

Infiltration Trenches

Infiltration trenches are predominantly dry shallow grassed areas that trap the first flush runoff. The trapped runoff then infiltrates through the filtration medium removing fine sediment and nutrients. The base of the infiltration trench should be lined with an adequately designed sub-surface perforated pipe drainage network to convey filtered runoff to the trench outlet before discharging to the downstream receiving environment.

The use of infiltration trenches is considered appropriate for these sites subject to the availability of appropriate filter media and the ability to be properly drained.

Bio-retention Systems

Similar to vegetated swales, bio-retention systems are designed to treat stormwater runoff by ensuring sufficient detention time to allow the removal of nutrients and fine sediments. This is achieved through filtration, plant uptake, adsorption and biological degradation. Hydrocarbon removal will also be achieved through filtration and attachment to vegetation where the biological breakdown of hydrocarbons can occur.

Bio-retention systems contain an infiltration filter media, typically filled with sandy loam. All runoff collected within the system for the design storm event must pass through this filter. The filter media must be capable of sustaining vegetation growth as the vegetation is responsible for much of the uptake of nutrients within the system. The base of the bio-retention systems should be lined with an adequately designed sub-surface

perforated pipe drainage network to convey the filtered runoff to the system outlet before discharging to the receiving system.

Bio-retention systems can be used in both flat areas and in steeper areas by stepping the system. Bio-retention systems can also be incorporated into the base of detention basins combining both stormwater quality and quantity into one area.

As the vegetation in the basins takes around 2 years to properly establish, the use of bio-retention systems is not considered appropriate for these sites.

Porous Pavements

Porous pavements vary with design, but generally incorporate a surface material consisting of a grid / lattice system, modular clay / concrete blocks, or open-graded asphalt / concrete pavements with much of the fine aggregate material omitted. The surface material is bedded on a coarse sand filter layer constructed over a gravel drainage layer. The use of porous pavements can assist in the removal of fine particulate matter, hydrocarbons, nutrients and soluble pollutants from stormwater runoff.

Porous pavements are suited most to areas of low traffic volume and low runoff volume. Porous pavements are most effective when used at grades of less than 5%. Because of this, porous pavements are recommended to be used in the parking areas only.

Due to the high levels of sediments expected to be generated from the batching plant sites, the use of porous pavements is not considered appropriate for these development areas.

Rainwater Tanks

In addition to providing a low cost supply of water to assist in reducing demand on water supply, rainwater tanks can also provide a reduction in peak flow rates from rainfall events with the provision of additional storage volume.

The use of rainwater tanks is only considered appropriate for these developments if there are suitable roof areas from which to collect rainwater runoff.

Level Spreader Devices

For roof area drainage that cannot be connected to a piped drainage network the concentrating of roof water runoff at a single discharge outlet can lead to erosion and scour problems. By utilising a level spreader at the outlet to disperse the overflows over a larger area, the flows will be less concentrated and velocities will be reduced, reducing the risk of erosion and the incidence of re-suspension of sediments. Level / flow spreaders should be located away from high pedestrian traffic areas and be directed towards vegetated buffer strips or other landscaped areas.

The use of level spreader devices is only considered appropriate for this development in instances where piped outlets from rainwater tanks or small roof and hardstand areas are not directly connected to a receiving pipe drainage network.

Constructed Wetlands

Constructed wetlands are a water quality treatment system comprising of an inlet pond to remove coarse sediments, and a macrophyte zone to remove fine particulates and soluble pollutants. Additionally, constructed wetlands also provide landscape value, passive recreation, wildlife habitat and flood control.

Wetlands are particularly useful on sites constrained by water and environmental sensitivity as they can be incorporated as an upstream component of existing waterbodies and environmentally sensitive aquatic features.

The dominant feature of the wetland is the macrophyte zone which comprises of vegetated marshes, shallow and deep pools.

Wetlands require reasonably large flat areas of land. Currently, bio-retention systems provide superior performance with a reduced footprint compared to wetlands. Given the relatively low rainfall and high evaporation that occurs in the region, there are also concerns in relation to constructed wetlands being dry

for prolonged periods. Therefore this type of treatment device is not considered appropriate for the concrete batching plant sites.

4.1.2 Adopted Strategy

Based on the site constraints the following stormwater quality improvement devices and management practices are considered appropriate to be incorporated in the development of the concrete batching plant sites:

Rainwater tanks and level spreader devices

Due to the flat grades encountered over the sites, it may not be possible to direct all roof area drainage to a piped drainage network that will be able to free drain to the nominated stormwater treatment and detention basins. Therefore in these instances it is suggested that the roof area drainage discharge to rainwater tank with a level spreader device attached to the outlet. As indicated above, this would assist in dispersing the outflows over a larger area to reduce the risk of erosion and the incidence of re-suspension of sediments.

Vegetated Swales

As grades across the sites are generally less than 2% the use of vegetated swales for stormwater treatment is considered appropriate. As noted above, due to the relatively flat grades across the subject site vegetated swales may be used for conveyance purposes throughout much of the site as an alternative to conventional piped drainage which is expected to be limited by depth.

Sediment Basins

As the primary target of this stormwater management strategy is to control soil erosion and minimise sediment transport from the concrete batching plant sites this type of device is considered the most appropriate control device for the concrete batching plant sites.

With the lifespan of the batching plants anticipated to be approximately 2 years, the use of alternative devices such as bio-retention basins are limited as these types of devices generally take a period of approximately 2 years to appropriately establish.

The flexibility in the shape of sediment basins combined with the efficient pollutant retention rates for sediments that these systems provide make sediment basins ideal for the sites.

In addition to the above listed stormwater management practices, other principals of water sensitive urban design that can be incorporated into the development of the sites include:

> Retention of existing drainage features, where possible;

> Protection of natural systems by limiting development to non-sensitive areas and providing adequate buffers between development and natural systems;

> Non-worsening of peak flow rates from site.

It should be noted that this stormwater management strategy has been based on a preliminary layout. Although stormwater treatment practices have been recommended for use in certain areas throughout the subject site, a number of treatment measures may be appropriate and the key principles of the stormwater management strategy will remain applicable despite potential layout changes.

Should the detailed design bring about changes to the proposed layout, Section 4.1.1 of this stormwater management strategy provides a list of alternative treatment practices that may be suitable for the site and could potentially be designed to meet the nominated water quality objectives. The key aim of this stormwater management strategy is that the practices listed as suitable for the site should be used in a manner which results in best practice stormwater management measures being incorporated into the development.

4.1.3 On-site Fuel Storage

It is expected that a generator will be provided at each concrete batching plant location to power the batching plant. A fuel storage tank of approximately 60,000 litres will also be provided near the generator sites to provide fuel storage for the generator and refuelling of vehicles. All fuel storage tanks must be located within a bunded containment area, sized in accordance with the relevant state or local guidelines to ensure all

hydrocarbons are contained, should a spill or leak occur. All fuel storage tanks should be located above the nominated flood level. The refuelling area should be surrounded by a trafficable bund to capture any runoff or hydrocarbon spills and convey the potentially contaminated runoff towards a containment area.

4.2 Stormwater Quantity

The intent of this stormwater quantity strategy for the five concrete batching plant sites is to manage runoff generated from the local contributing catchment area (i.e. the subject site area) only. Based on this, it is proposed to construct perimeter bunds along the upstream boundaries of the subject site to divert the local external contributing catchment areas around the concrete batching plant sites.

A regional hydrologic and hydraulic assessment of the railway corridor was undertaken by Calibre Operations Pty Ltd, with the outcomes of this investigation documented in their Drainage Design report (Ref. No. CARP12033-REP-G-100 Rev 0, dated Dec 2012).

The purpose of this stormwater quantity management strategy is to avoid impacts on the downstream receiving properties and infrastructure, by ensuring that the peak flows discharging from the developed condition concrete batching plant site areas are equivalent to, or less than the peak flows expected from the existing condition site. It is proposed to incorporate an on-site detention basin into each of the sites to control the developed condition peak flows discharging from the subject site for rainfall events up to and including the 100 year ARI event for the local catchment.

To control the peak rates of discharge from the proposed detention basins it will be necessary for the outlet arrangement to be designed to maintain peak flows equivalent to the existing condition peak discharges. It is noted that where a free draining piped outlet cannot be provided to drain the proposed detention basins within the footprint of the concrete batching plant site areas, a pump system may need to be provided if a free draining outlet cannot be provided external to the sites.

The proposed detention basin will also be utilised as a sediment retention basin for water quality purposes. All water trapped within the sediment / detention basin is to be tested for compliance with the release criteria outlined in **Table 3-1** prior to a controlled release from the site or alternatively the water could be used for dust suppression or irrigation.

Due to the flat nature of the sites, not all stormwater runoff generated will be able to be conveyed to the proposed on-site detention basins with the use of a conventional pit and pipe drainage system. As a result it is proposed to use drainage swales to convey runoff to the nominated detention basin locations.

The indicative location and minimum size of the proposed basins are shown on Cardno sketch numbers 721769 SK04 to SK08 (Appendix B). Calculations for the sizing of the detention basins can be found in Section 6 of this report.

5 Stormwater Quality Assessment

As outlined above, the lifespan for the concrete batching plant sites is anticipated to be only approximately 2 years and therefore has been considered as a construction site for the lifetime of the rail construction project.

The works to be carried out on the sites have the potential to increase the level of sediment laden runoff discharging from the site for the lifespan of the construction project. Based on this, the following assessment for each site has been undertaken to determine the on-site sediment retention storage requirements that will be necessary to retain the expected soil loss generated. Refer to Cardno sketch numbers 721769 SK04 to SK08 (Appendix B) for the local catchment areas adopted for the preliminary stormwater quality assessment.

5.1 Soil Loss Calculations

Data obtained from the Australian Soil Resource Information System on the 12th October 2012 indicated that the soils on the subject sites are expected to be medium clays with an approximate clay content of 40 – 50%. The data obtained was from the national soil grid. This soil type is considered to be a dispersive soil (type D) and based on the Revised Universal Soil Loss Equation (RUSLE) the predicted soil loss rate has been estimated for each of the disturbed catchment areas.

Catchment parameters for the disturbed areas of the subject sites were based on existing contour information. These catchment parameters have been summarised in **Table 5-1** below.

Table 5-1 Catchment Parameters

Catchment No.	Internal / Site Catchment Area (ha)	Approx. Average Site Slope (%)
BP4	4.6	0.5
BP5	4.6	1.0
BP6	4.6	0.5
BP7	4.6	0.5
BP8	4.6	0.5

The results of the soil loss assessment using the revised soil loss equation are summarised in **Table 5-2** below. For more detailed information refer to the sediment loss calculations provided in Appendix C of this report.

Table 5-2 Soil Loss Parameters

Catchment No.	Rainfall Erosivity Factor (R)	Soil Erodibility Factor (K)	Slope Length / Gradient Factor (LS)	Erosion Control Practice Factor (P)	Ground Cover (C)	Soil Loss (A) (t/ha/yr)	Sediment Storage Volume (m^3)
BP4	2411	0.02	0.17	1.3	1.0	10.7	6.3
BP5	2411	0.02	0.17	1.3	1.0	10.7	6.3
BP6	2411	0.02	0.17	1.3	1.0	10.7	6.3
BP7	2411	0.02	0.17	1.3	1.0	10.7	6.3
BP8	2411	0.02	0.17	1.3	1.0	10.7	6.3

Based on the information above, the soil loss within each of the disturbed areas has been estimated to be equivalent to Soil Loss Class 1 (0 to 150 tonnes/ha/yr), which classifies the sites as very low erosion risks, as outlined in Table 3.1 of the 'Best Practice Erosion and Sediment Control (2008)' guidelines prepared by the International Erosion Control Association – Australasia.

5.2 Sediment Basin Calculations

In conjunction with the above information, the calculations for the total sediment basin volume have been carried out and shown in **Table 5-3** below.

Table 5-3 Sediment Basin Calculations

Basin No.	Volumetric Runoff Coefficient (Cv)	Catchment Area of Basin (A)	5 day total rainfall depth (R) [85%ile, 5day	Settling Zone Volume (10xCvxAxR)	Total Basin Volume (m^3)
BP4	1.0	4.6	32.5	1495	1501
BP5	1.0	4.6	32.5	1495	1501
BP6	1.0	4.6	32.5	1495	1501
BP7	1.0	4.6	32.5	1495	1501
BP8	1.0	4.6	32.5	1495	1501

A comparison of the total storage volumes required for sediment retention and for on-site detention will be carried out in Section 6 of this report. This comparison will be made to determine which design conditions will be considered as the critical case.

6 Stormwater Quantity Assessment

The local catchment peak discharges from each of the concrete batching plant sites are expected to increase in comparison to the existing condition peak flows as a result of the proposed developments. This expected increase in peak discharge is the result of the increase in the percentage of impervious area and the reduction in flow travel time post development. Based on this, the following assessments of the pre-development and post development local catchment flows for each site has been undertaken to determine if there is an increase in post development flows from the subject sites, and estimate the on-site detention storage requirements that may be necessary to attenuate any increase in flows discharging off-site. Refer to Cardno sketch numbers 721769 SK04 to SK08 (Appendix B) for the local catchment areas adopted for the preliminary on-site detention assessment.

6.1 Existing Conditions

The Rational Method was used to estimate the existing condition peak flow rates discharging from each of the local catchment areas for the concrete batching plant sites.

The Coefficient of Runoff value for the pre-developed site conditions was determined from Tables 4.05.3(a) *(Table of C_{10} values)* and 4.05.3(b) *(C_{10} values for Zero Fraction Impervious)* of the Queensland Urban Drainage Manual 2007 (QUDM). Based on available data of the subject sites, the existing condition of the concrete batching plant sites was considered to have a fraction impervious of 0.0 and a land description equivalent to poor grass cover / low density pasture. A resultant C_{10} value of 0.66 was adopted for the pre-development site conditions.

A rainfall intensity frequency duration (IFD) chart was developed for the concrete patching plant areas using the design rainfall IFD data available from the Bureau of Meteorology (BOM) website.

The Time of Concentration value for each of the existing site conditions was determined in accordance with Section 4.06 of QUDM. The overland sheet flow and channel flow travel times were calculated separately then combined to provide a total time of concentration for each of the sites. The pre-development flow travel time was estimated based on the parameters shown in **Table 6-1** below.

Table 6-1 Existing Surface Parameters for Time of Concentration Calculations

Parameter		BP4	BP5	BP6	BP7	BP8
Sheet Flow	Slope Length	50 m	50 m	50 m	50 m	50 m
	Surface Grade	0.5%	1.0%	0.5%	0.5%	0.5%
	Adopted t_c	14 min	12 min	14 min	14 min	14 min
Channel Flow	Slope Length	250 m	250 m	250 m	250 m	250 m
	Surface Fall	0.5 m	1.5 m	1 m	0.5 m	0.5 m
	Adopted t_c	24 min	16 min	19 min	24 min	24 min
	Total t_c	38 min	28 min	33 min	38 min	38 min

A summary of the parameters determined to estimate the pre-development 2, 5, 10, 20, 50 and 100 year ARI peak flow rates from the local catchment areas of each of the concrete batching plant sites of the subject site are provided in **Table 6-2** to **Table 6-6** below.

Table 6-2 BP4 Existing Condition Discharge Parameters

Parameter	2 yr	5 yr	10 yr	20 yr	50 yr	100 yr
Coefficient of Runoff	0.56	0.63	0.66	0.69	0.76	0.79
Area (ha)	4.6	4.6	4.6	4.6	4.6	4.6
Time of Concentration (min)	38	38	38	38	38	38
Rainfall Intensity (mm/hr)	50	66	75	88	104	117
Discharge (m^3/s)	0.36	0.53	0.63	0.78	1.01	1.18

Table 6-3 BP5 Existing Condition Discharge Parameters

Parameter	2 yr	5 yr	10 yr	20 yr	50 yr	100 yr
Coefficient of Runoff	0.56	0.63	0.66	0.69	0.76	0.79
Area (ha)	4.6	4.6	4.6	4.6	4.6	4.6
Time of Concentration (min)	28	28	28	28	28	28
Rainfall Intensity (mm/hr)	59	77	88	102	121	136
Discharge (m^3/s)	0.42	0.62	0.74	0.90	1.17	1.38

Table 6-4 BP6 Existing Condition Discharge Parameters

Parameter	2 yr	5 yr	10 yr	20 yr	50 yr	100 yr
Coefficient of Runoff	0.56	0.63	0.66	0.69	0.76	0.79
Area (ha)	4.6	4.6	4.6	4.6	4.6	4.6
Time of Concentration (min)	33	33	33	33	33	33
Rainfall Intensity (mm/hr)	54	71	81	95	112	126
Discharge (m^3/s)	0.39	0.57	0.68	0.84	1.09	1.28

Table 6-5 BP7 Existing Condition Discharge Parameters

Parameter	2 yr	5 yr	10 yr	20 yr	50 yr	100 yr
Coefficient of Runoff	0.56	0.63	0.66	0.69	0.76	0.79
Area (ha)	4.6	4.6	4.6	4.6	4.6	4.6
Time of Concentration (min)	38	38	38	38	38	38
Rainfall Intensity (mm/hr)	50	66	75	88	104	117
Discharge (m^3/s)	0.36	0.53	0.63	0.78	1.01	1.18

Table 6-6 BP8 Existing Condition Discharge Parameters

Parameter	2 yr	5 yr	10 yr	20 yr	50 yr	100 yr
Coefficient of Runoff	0.56	0.63	0.66	0.69	0.76	0.79
Area (ha)	4.6	4.6	4.6	4.6	4.6	4.6
Time of Concentration (min)	38	38	38	38	38	38
Rainfall Intensity (mm/hr)	50	66	75	88	104	117
Discharge (m^3/s)	0.36	0.53	0.63	0.78	1.01	1.18

6.2 Developed Condition

Similar to the existing condition flows, the Rational Method was used to estimate the peak flow rates discharging from each of the developed condition local catchment areas for the concrete batching plant sites.

As discussed above, the Coefficient of Runoff value for the developed site conditions was determined from Table 4.05.3(a) of QUDM. Based on the proposed use of the sites, a fraction impervious of 0.90 has been adopted, with a resultant C_{10} value of 0.86 to be used for the post-development site conditions.

The Time of Concentration value for the developed site conditions was determined for the contributing local catchment area in accordance with Section 4.06 of QUDM.

Due to the flat grades expected across the development sites, surface drainage is expected to be limited to the use of swale drains / open channels. Pipe drainage is expected to be limited to cross culverts utilised under roadways and footpaths to maintain trafficability during lower ARI events. A summary of the parameters used in calculating the time of concentration for each of the concrete batching plant sites is included in **Table 6-7**.

Table 6-7 Developed Surface Parameters for Time of Concentration Calculations

Parameter		BP4	BP5	BP6	BP7	BP8
Sheet Flow	Slope Length	50 m	50 m	50 m	50 m	50 m
	Surface Grade	0.5%	1.0%	0.5%	0.5%	0.5%
	Adopted t_c	8 min	7 min	8 min	8 min	8 min
Channel Flow	Slope Length	250 m	250 m	250 m	250 m	250 m
	Surface Fall	0.5 m	1.5 m	1 m	0.5 m	0.6 m
	Adopted t_c	16 min	11 min	13 min	16 min	16 min
Total t_c		24 min	18 min	21 min	24 min	24 min

A summary of the parameters determined to calculate the 2, 5, 10, 20, 50 and 100 year ARI developed peak flow ratess (with no detention) from the contributing local catchment areas of the concrete batching plant sites are provided in **Table 6-8** to **Table 6-12** below.

Table 6-8 BP4 Developed Condition Discharge Parameters

Parameter	2 yr	5 yr	10 yr	20 yr	50 yr	100 yr
Coefficient of Runoff	0.73	0.82	0.86	0.90	0.99	1.0
Area (ha)	4.3	4.3	4.3	4.3	4.3	4.3
Time of Concentration (min)	24	24	24	24	24	24
Rainfall Intensity (mm/hr)	63	83	95	110	131	147
Discharge (m^3/s)	0.59	0.87	1.04	1.27	1.66	1.88

Table 6-9 BP5 Developed Condition Discharge Parameters

Parameter	2 yr	5 yr	10 yr	20 yr	50 yr	100 yr
Coefficient of Runoff	0.73	0.82	0.86	0.90	0.99	1.0
Area (ha)	4.3	4.3	4.3	4.3	4.3	4.3
Time of Concentration (min)	18	18	18	18	18	18
Rainfall Intensity (mm/hr)	72	94	108	126	150	168
Discharge (m^3/s)	0.67	0.98	1.19	1.45	1.90	2.15

Table 6-10 BP6 Developed Condition Discharge Parameters

Parameter	2 yr	5 yr	10 yr	20 yr	50 yr	100 yr
Coefficient of Runoff	0.73	0.82	0.86	0.90	0.99	1.0
Area (ha)	4.3	4.3	4.3	4.3	4.3	4.3
Time of Concentration (min)	21	21	21	21	21	21
Rainfall Intensity (mm/hr)	67	88	101	117	140	157
Discharge (m^3/s)	0.63	0.92	1.11	1.35	1.77	2.01

Table 6-11 BP7 Developed Condition Discharge Parameters

Parameter	2 yr	5 yr	10 yr	20 yr	50 yr	100 yr
Coefficient of Runoff	0.73	0.82	0.86	0.90	0.99	1.0
Area (ha)	4.3	4.3	4.3	4.3	4.3	4.3
Time of Concentration (min)	24	24	24	24	24	24
Rainfall Intensity (mm/hr)	63	83	95	110	131	147
Discharge (m^3/s)	0.59	0.87	1.04	1.27	1.66	1.88

Table 6-12 BP8 Developed Condition Discharge Parameters

Parameter	2 yr	5 yr	10 yr	20 yr	50 yr	100 yr
Coefficient of Runoff	0.73	0.82	0.86	0.90	0.99	1.0
Area (ha)	4.3	4.3	4.3	4.3	4.3	4.3
Time of Concentration (min)	24	24	24	24	24	24
Rainfall Intensity (mm/hr)	63	83	95	110	131	147
Discharge (m^3/s)	0.59	0.87	1.04	1.27	1.66	1.88

A comparison of the existing condition peak flows with the developed condition peak flows found that there is generally expected to be an increase in the peak flows discharging off site due to the increase in impervious area and the reduction in flow travel time on site.

On-site detention is proposed to be incorporated into the development works. This is to avoid impacts on downstream properties and infrastructure and to maintain the existing peak flow rate of runoff discharging from the developed site for all rainfall events up to and including the local catchment 100 year ARI event. The proposed on-site detention will help control the rate of discharge leaving the site.

6.3 Preliminary On-Site Detention

A preliminary assessment of the on-site detention storage requirements for each of the concrete batching plant sites has been carried out using the initial sizing techniques outlined in Section 5.05.1 of QUDM. Based on the comparison of results outlined in Section 6.2 above, it will be necessary to incorporate on-site detention storage in order to maintain peak outflows equivalent to the existing conditions.

The on-site detention storage proposed for each site will be sized to maintain the equivalent pre-developed condition peak flows for local catchment rainfall events up to and including the 100 year ARI rainfall event. To control the peak rates of discharge from the nominated storage volume it will be necessary for the outlet arrangements to be designed to maintain the existing peak flows.

A comparison of the existing and developed condition peak flows for each site indicated that the 100 year ARI storm event resulted in the greatest increase in peak discharge in each case. The results of the preliminary on-site detention analysis indicated the approximate detention storage volume required for each site to detain the increase in the 100 year ARI discharge and maintain the equivalent pre-developed 100 year ARI peak flow discharging off site. A summary of the volumes required for each site are provided in **Table 6-13** below.

Table 6-13 Detention requirements

Parameter	BP4	BP5	BP6	BP7	BP8
Required Volume (m^3)	2666	2219	2456	2666	2666

It should be noted that the volume outlined may be subject to change if the final catchment areas differ from those adopted for this assessment. The stage storage characteristics and outlet configuration of the detention basin will be verified as part of the detailed design for each of the concrete batching plants.

It is proposed to incorporate the stormwater detention and treatment into one common basin. A comparison of the total storage volumes required for sediment retention, as outlined in Section 5 of this report, and for on-site detention has indicated that the volume required for on-site detention is more critical in each case. Therefore the total storage volume adopted for each of the concrete batching plant sites for the stormwater treatment and detention basin is a minimum listed in **Table 6-13**. Refer to Cardno sketch numbers 721769 SK04 to SK08 (Appendix B) for the indicative layout and configuration of the stormwater treatment and detention basin for each of the concrete batching plant sites.

In accordance with Section 5.11 of QUDM it is recommended that any ponding within the basin should be limited to 1.2 metres at the deepest point above the basin invert if there is perceived to be a public safety issue. For deeper basins, suitable safety provisions such as refuge mounds within large basins, fences and warning signs should be provided.

6.4 Other Drainage Issues

6.4.1 Diversion of External Catchments

As the intent of this strategy is to manage the runoff from the concrete batching plant site areas only, it is proposed to construct perimeter bunds along the upstream boundaries of the subject site to divert the local external contributing catchment areas around the sites. Refer to Cardno sketch numbers 721769 SK04, SK06 and SK07 (Appendix B) for the indicative locations of the external catchment diversion bunds proposed for the concrete batching plant sites. The final alignment and profile required for the diversion bunds will be confirmed as part of the detailed design of each of the concrete batching plants.

7 Monitoring and Maintenance Schedules

7.1 Monitoring Schedule

A monitoring program will be established for the stormwater management devices as outlined below and shown in **Table 7-1, Table 7-2, 0** and **Table 7-4**.

Due to the remote location of the site, the turn-around time for the suspended solids test results may delay the release of captured surface runoff from the sediment basin. Measuring the turbidity may be an acceptable alternative, although this requires the correlation between turbidity and suspended solids to be established individually for each site. The relationship between the turbidity and suspended solids varies between soil types, so this will need to be determined for each site by measuring both parameters over the course of at least six events. Graphing the results and determining a line of best fit should provide a turbidity/suspended solids relationship suitable for estimating the turbidity level that corresponds to the suspended solids release criteria. Once this has been established, suspended solids testing samples should continue to be collected prior to any controlled release, however the release may occur prior to the results being returned. Should the suspended solids test results be outside the release criteria given in Section 3 of this report, the acceptable turbidity level must be adjusted to reduce the chance of future non-compliance. The turbidity within the basins can be measured a number of ways, including a secchi disk or a water quality probe.

Table 7-1 Monitoring Program for Sediment Basins

MONITORING ACTIVITY	FREQUENCY
Inspect sediment basin	- During construction - After each runoff event - Prior to “stop work” or “site shutdown”
Inspect submerged inflow pipes	After each runoff event
Testing of Turbidity, Suspended Solids, pH, and Dissolved Oxygen	- Prior to controlled release - Immediately following rain events > 25mm in a 24 hour period

To maximise the effectiveness of the stormwater management measures for the roof drainage areas that do not connect directly to a piped drainage system, the following activities are suggested to regularly visually monitor the condition of the rainwater tanks and level spreader outlets.

Table 7-2 Monitoring Program for Rainwater Tanks

MONITORING ACTIVITY	FREQUENCY
Observe water surcharging from surcharge weir/pipe/pit of tank	After major storm events > 25mm in 24 hrs
Inspect silt / litter trap	After major storm events > 25mm in 24 hrs or 3 monthly
Inspect structural integrity / condition of device	6 monthly

Table 7-3 Monitoring Program for Level Spreader Devices

MONITORING ACTIVITY	RECOMMENDED FREQUENCY
Inspect for incidents of erosion / scour of soils at outlet	After major storm events > 25mm in 24 hrs or 3 monthly
Inspect for weed inundation / litter accumulation within the receiving environment	3 monthly
Inspect for excessive wear & damage of receiving environment	
Inspect for build-up of sediments at outlet	
Inspect health of vegetation at outlet	

In the case of vegetated buffers and vegetated swales, the collection of water quality samples is unlikely to yield valuable results. Given this, no sample based monitoring is recommended for these treatment systems. Instead, an inspection based monitoring and maintenance scheme as detailed below is considered appropriate for these types of devices.

Table 7-4 Monitoring Program for Vegetated Swales

MONITORING ACTIVITY	FREQUENCY
Inspect for erosion / scour of invert & batters	After major storm events > 25mm in 24 hrs or 3 monthly
Inspect for weed inundation / litter & debris accumulation	3 monthly
Inspect for inappropriate access, excessive wear & damage to invert & batters	3 monthly
Inspect for build-up of sediments	3 monthly
Inspect condition of vegetation such as vegetation health & density	3 monthly
Inspect condition of inlet & outlet structures	After major storm events > 25mm in 24 hrs or 3 monthly

7.2 Maintenance Schedule

The on-going performance of the stormwater management devices will be dependent on the maintenance conducted.

The maintenance programs as outlined below and detailed in **Table 7-5**, **Table 7-6**, **Table 7-7** and **Table 7-8** are to be implemented for the stormwater treatment devices.

Table 7-5 Maintenance Program for Sediment Basins

MAINTENANCE ACTIVITY	FREQUENCY
Clean out accumulated sediment	Every 2 years as per sediment basin calculations or as required by results of monitoring
Check visible pipes for leaks	6 monthly or as required by results of monitoring
Check fill material for settlement	6 monthly or as required by results of monitoring
Remove all trash from basin and riser	6 monthly or as required by results of monitoring
De-silt submerged inflow pipes	6 monthly or as required by results of monitoring

Sediment basins must be operated and maintained in an effective operational condition. These structures must not be allowed to accumulate sediment volumes in excess of forty per cent (40%) sediment storage design capacity. Where sedimentation basins are used a marker shall be placed within the basin to show

the level above which the design storage capacity occurs. Materials removed from sediment retention devices must be disposed of in a manner approved by the consent authority that does not cause pollution.

Table 7-6 Maintenance Program for Rainwater Tanks

MAINTENANCE ACTIVITY	FREQUENCY
Clean out silt / litter trap	6 monthly or as required by results of monitoring
Remove debris from surcharge weir / pipe / pit	
Dewater and clean out / de-silt tank	As required by monitoring

Table 7-7 Maintenance Program for Level Spreader Devices

MAINTENANCE ACTIVITY	FREQUENCY
Repairs to landscaping / level spreaders	As required by monitoring
Watering, re-vegetating, grass cutting of receiving environment	
Removal of litter, debris, weeds & excessive sediment build up within receiving environment	

Table 7-8 Maintenance Program for Vegetated Swales

MAINTENANCE ACTIVITY	FREQUENCY
Repairs to swale profile	As required by results of monitoring
Irrigating, infilling of vegetation to maintain sufficient cover	As required by results of monitoring
Removal of litter, debris, weeds & excessive sediment build up	6 monthly or as required by results of monitoring
Mowing / pruning of swale vegetation to maintain optimal vegetation height	As required by results of monitoring

Reforming of any swale profile will be required when the design flow area of the swale is reduced by 25%.

8 Emergency Flood Management Strategies

A regional flooding analysis to assess the impacts of the proposed Carmichael Rail Alignment on the existing major floodplains, river and creek crossings was undertaken by Calibre Operations Pty Ltd for the Carmichael Coal Mine and Rail project. Based on the results of the investigation (included in the Drainage Design Report (Reference No.CARP12033-REP-C-003, dated Dec 2012)), and the Hydrology Drawings, a number of the concrete batching plant locations were identified as being partially inundated during a 50 year ARI storm event.

For the areas that may be inundated during a 50 year ARI storm event, it is recommended that the contractor operating the facility consider developing an Emergency Flood Management Strategy to minimise the risk to people, equipment and infrastructure during flood events.

The following information provides some strategies that the contractor may consider when developing an Emergency Flood Management Plan for the construction facility areas at risk of inundation. Procedures for flood emergency management in the case of a flood emergency could include communication based management or flood gauge based management. Strategies for remaining on site during a flood emergency have not been considered for the concrete batching plant sites as no habitable buildings are expected to be incorporated into these construction facility areas.

Due to the remote location of many of the concrete batching plant areas, flood gauged based management strategies may not be available to many of the facility sites. Based on this, a communication based management plan may be more appropriate for the sites.

Any materials that have the potential to cause environmental harm such as fuel, cement etc. should be either stored above the appropriate flood level or be able to be moved off site in a timely manner if the need arises.

8.1 Communication Based Management Strategies

Communication based management strategies generally rely on regular flood warnings and river height bulletins issued by the Bureau of Meteorology (BoM). These warning and bulletins are sent to radio stations for broadcast, and to local authorities, police and emergency services. Flood warnings, river height bulletins and other weather related information is available on the BoM website and through telephone recorded information services.

The contractor should consider identifying the names of the creek and river systems that have the potential to inundate the concrete batching plants as well as site access roads and tracks, and determine if the BoM has a warning system monitoring the identified watercourse. If available, the contractor should then document the appropriate contact details to enable access the identified warning systems.

To gain more information on flood warning, the contractor may also consider registering the construction facility area with the local council, the local branch of the state emergency services department and any local disaster management centres.

The contractor should ensure that all staff accessing the facility are informed of the flood characteristics of the site and surrounding area, the emergency evacuation protocols and processes and the site evacuation routes in the event of a flood emergency.

If a flood event has been forecast for the area by the BoM or other local authority, then the contractor may want to consider some of the following procedures as part of the emergency evacuation protocols and processes for the facility site.

> Securing the site by cleaning up materials and storing equipment / machinery that have the potential to be carried away during a flood event.

> Moving equipment / machinery that can be relocated off site to higher ground.

> Evacuate the facility site while low hazard level access is still available off site.

8.2 Flood Gauge Based Management Strategies

Flood gauge based management strategies generally incorporate the same communication based strategies as outlined above, however where flood gauges may be established for adjacent creek or river systems defined flood level information could be available.

The contractor may then consider utilising the available flood level information to set trigger levels for various actions to occur on site as part of the emergency evacuation protocols and processes developed for the concrete batching plant facilities.

9 Conclusions

In preparing this conceptual stormwater management strategy, preliminary water quality and quantity assessments were undertaken for the five concrete batching plant sites.

The objectives of this stormwater management strategy were to meet the performance criteria outlined in **Table 3-1** of this report. The outcome of this preliminary investigation has recommended the inclusion of a number of stormwater quality and quantity management measures detailed herein and summarised as follows:

> Numerous vegetated swales for treatment and conveyance purposes as indicatively shown on Cardno sketch numbers 721769 SK04 to SK08 (Appendix B); and

> Constructed sediment basins as described in Sections 5 and 6, and indicatively shown on Cardno sketch numbers 721769 SK04 to SK08 (Appendix B).

The detailed design of the treatment and detention devices will need to comply with the information outlined within this stormwater management strategy, and with the relevant authority guidelines.

10 References

Department of Environment and Resource Management 2009, *Queensland Water Quality Guidelines (2009)*, Version 3 September 2009, Brisbane, QLD

Department of Natural Resources and Water 2007, *Queensland Urban Drainage Manual 2007 (QUDM)*, Volume 1 Second Edition 2007, Brisbane, QLD

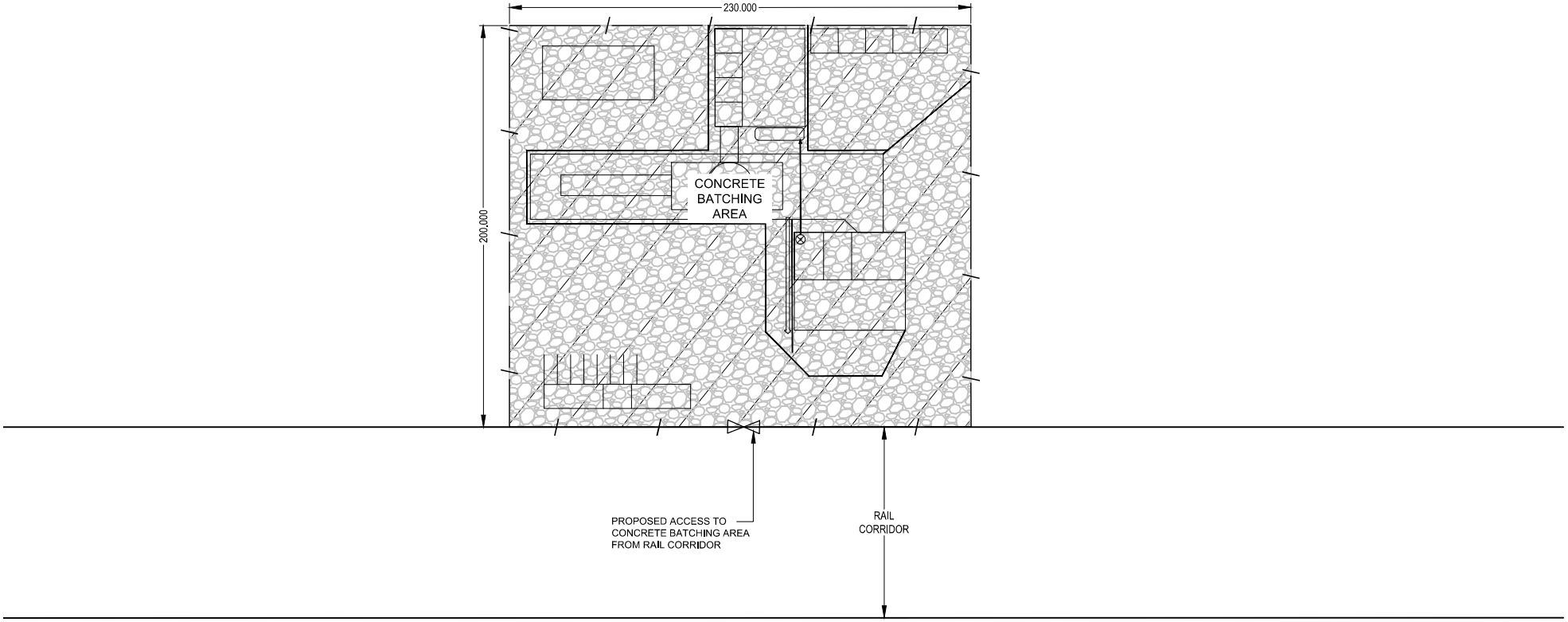
International Erosion Control Association (Australasia) 2008, *Best Practice Erosion and Sediment Control*, November 2008, Picton, NSW

Water by Design 2010, *MUSIC Modelling Guidelines Version 1.0 – 2010*, Brisbane, QLD

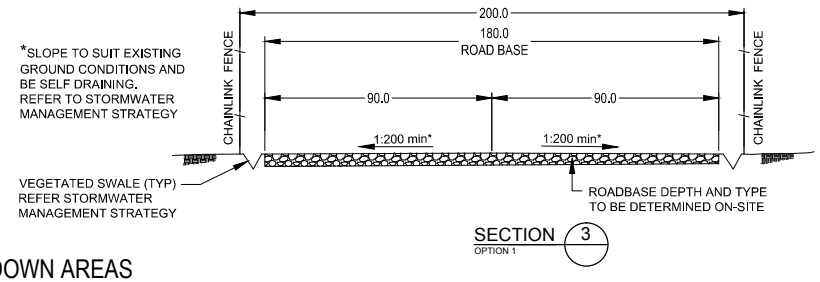
APPENDIX A

REFERENCE DRAWINGS

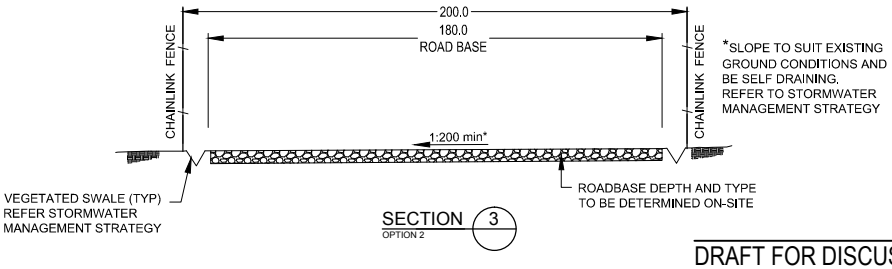
Cardno
Shaping the Future



PLAN VIEW



SECTION 3
OPTION 1



SECTION 3
OPTION 2

ADANI RAIL LAYDOWN AREAS

TYPICAL CONCRETE BATCH LAYDOWN AREA

DRAFT FOR DISCUSSION

30 0 30 60 90 120 150m
1:3000 - A4

Cardno (Qld) Pty Ltd ACN: 051 074 992
Level 11, North Tower, 515 St Paul's Terrace, Fortitude Valley 4006
Locked Bag 4006, Fortitude Valley Qld 4006
Phone (07) 3369 9822 Fax (07) 3369 9722
Email: cardno@cardno.com.au Web: www.cardno.com.au
Quality Endorsed Company

REF NUMBER: 7903/44/001/SK-003(P3)
DATE: 18/04/2013

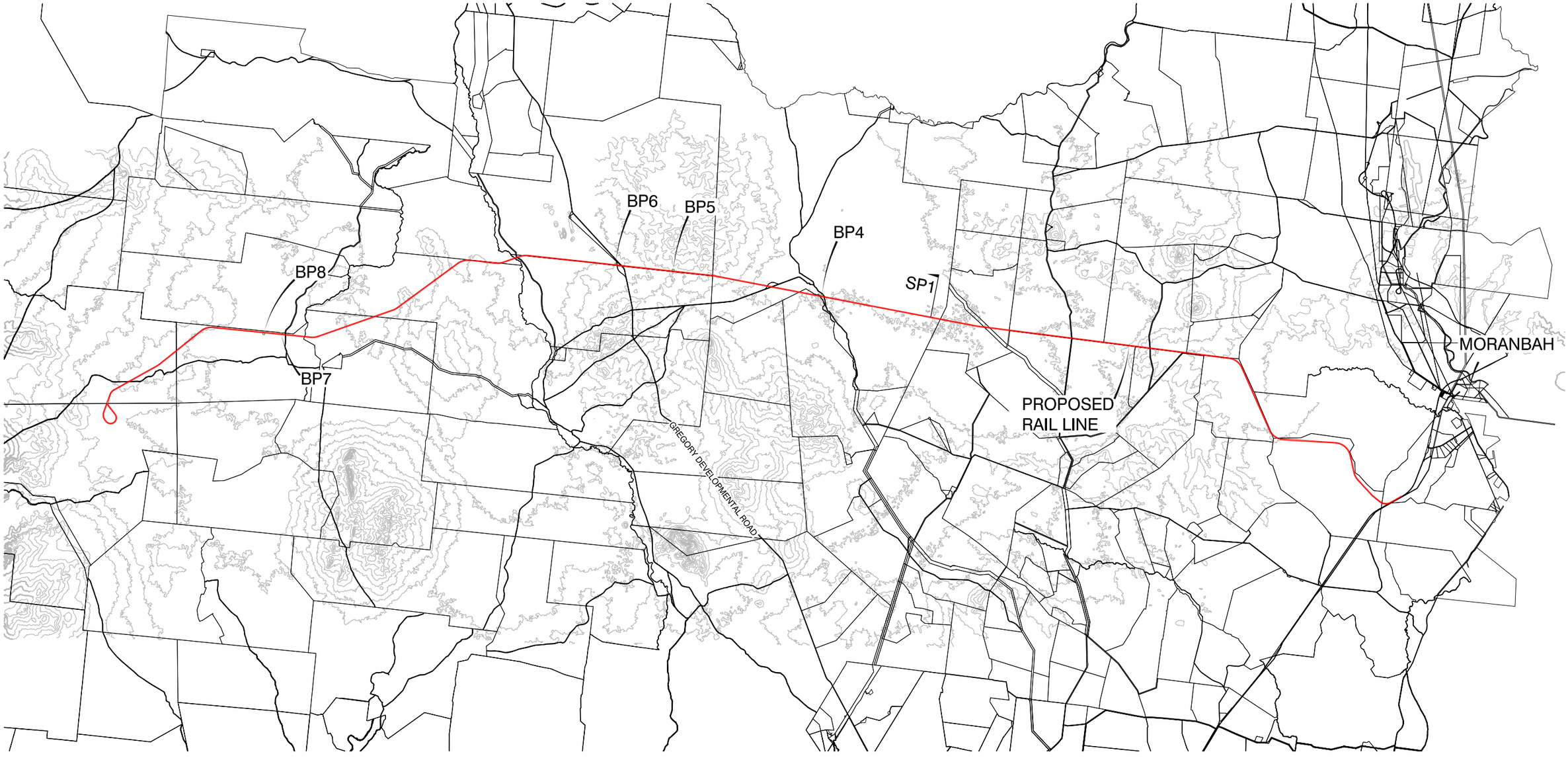
APPENDIX B

FIGURES & SKETCHES

Cardno
Shaping the Future

Cardno (Qld) Pty Ltd | ABN 57 051 074 992
Level 2 Podium Level - emerald Lakes Town Centre
1/3321 Central Place, Gold Coast, Qld 4211
PO Box 391, Carrara, Qld 4211
Tel:07 5539 9333 Fax:07 5538 4647
Email: GCO@cardno.com.au Web: www.cardno.com.au

Cardno
Shaping the Future



-10 -5 0 5 10 15 20km
SCALE @ A3 1:500,000

Adani Mining Pty Ltd
Carmichael Coal Mine Rail

Locality Plan for the Concrete Batching Plant Locations

Date: April 2013
Drawing Number: Sketch 721769 - 001
Revision: C

DATE PLOTTED: 12 July 2013 11:17 AM
CAD FILE: P:\721769 Adani\03 Design\Cad\03 Sketches\721769 Sk01-03 Locality Plans.dwg

Cardno (Qld) Pty Ltd | ABN 57 051 074 992
Level 2 Podium Level - emerald Lakes Town Centre
1/3321 Central Place, Gold Coast, Qld 4211
PO Box 391, Carrara, Qld 4211
Tel:07 5539 9333 Fax:07 5538 4647
Email: GCO@cardno.com.au Web: www.cardno.com.au

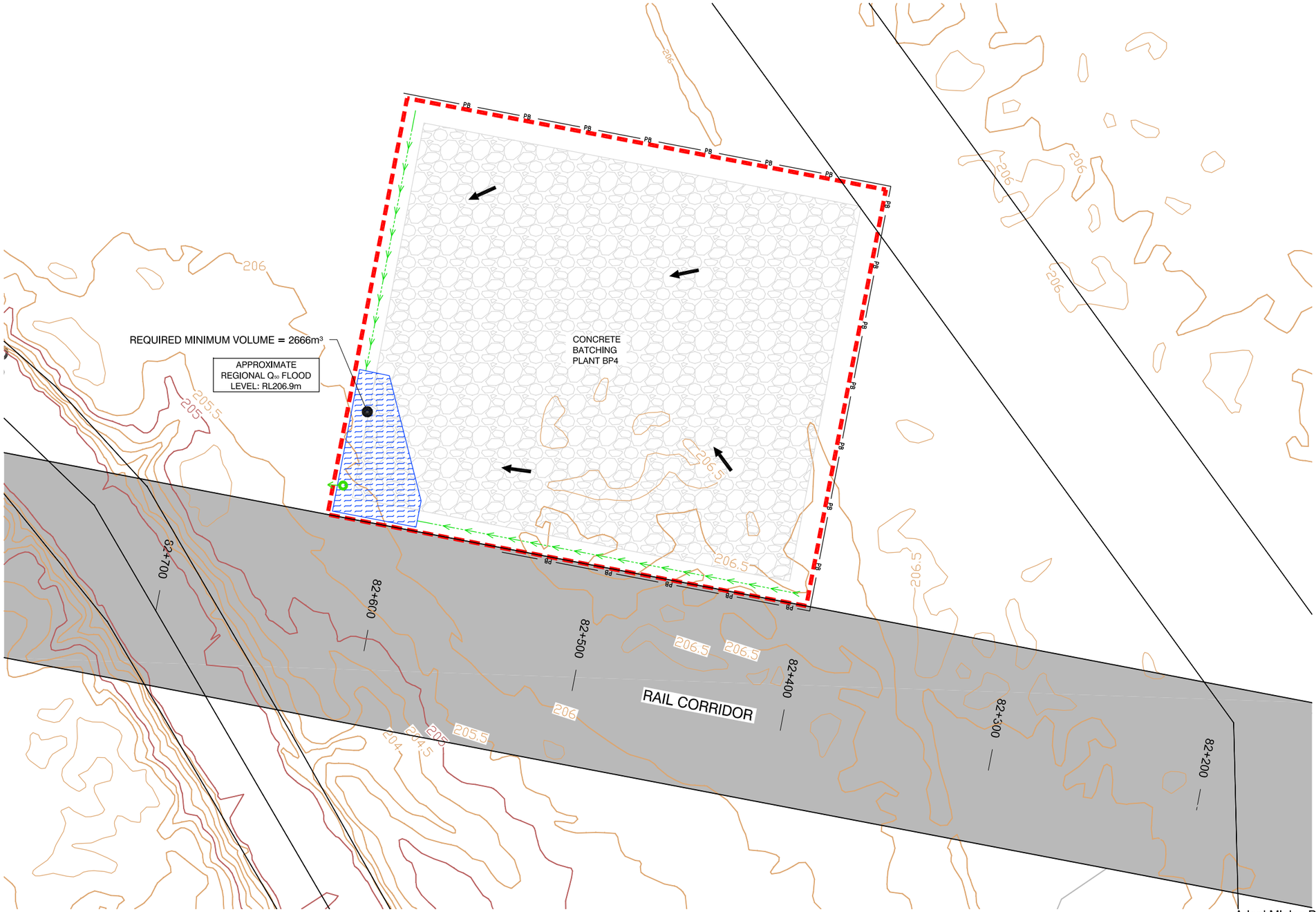
Cardno® Shaping the Future

LEGEND

- EXISTING SURFACE CONTOURS (0.5m INTERVALS)
- DEVELOPED CATCHMENT BOUNDARY
- VEGETATED SWALES (INDICATIVE ONLY)
- PB — PERIMETER BUND
- OVERLAND FLOW DIRECTION
- PROPOSED CONCRETE BATCHING PLANT AREA
- PROPOSED SEDIMENT/DETENTION BASIN AND OUTLET (INDICATIVE ONLY) REFER NOTE 7.

NOTES:

1. CONTOURS ARE BASED ON AERIAL SURVEY. DETAILED SURVEY WILL BE REQUIRED TO CONFIRM CONTRIBUTING CATCHMENT AREAS FOR DETAILED DESIGN.
2. WHERE THE ROOF AREA DRAINAGE CANNOT BE PROVIDED WITH A FREE DRAINING CONNECTION TO THE PROPOSED SEDIMENT/DETENTION BASIN THE ROOF AREA DRAINAGE TO DISCHARGE TO RAINWATER TANK WITH A LEVEL SPREADER ATTACHED TO OUTLET.
3. SOME MINOR RE-GRADING WILL BE REQUIRED ONCE EXACT SITE CONDITIONS ARE DETERMINED.
4. WHERE A FREE DRAINING PIPED OUTLET CANNOT BE PROVIDED TO DRAIN THE SEDIMENT/DETENTION BASIN WITHIN THE FOOTPRINT OF THE CONSTRUCTION FACILITY AREA, A PUMP WILL NEED TO BE PROVIDED. ALTERNATIVELY APPROVAL WILL NEED TO BE SOUGHT TO PROVIDE A FREE DRAINING PIPED OUTLET EXTERNAL TO THE EXTENTS OF THE SITE.
5. ALL WATER TRAPPED WITHIN THE SEDIMENT/DETENTION BASIN IS TO BE TESTED FOR COMPLIANCE WITH THE RELEASE CRITERIA OUTLINED IN THE SWMS PRIOR TO A CONTROLLED RELEASE OFF-SITE.
6. CONSTRUCT DIVERSION BUND TO DIVERT EXTERNAL LOCAL CONTRIBUTING CATCHMENTS AROUND THE CONSTRUCTION FACILITY SITE. EXTENT AND SIZE OF THE BUND TO BE CONFIRMED AS PART OF THE DETAILED DESIGN. VELOCITY CONTROL MEASURES TO BE PROVIDED AT THE DOWNSTREAM END OF DIVERSION BUNDS TO DISPERSE CONCENTRATED FLOWS.
7. BASIN SPILLWAY LOCATION AND SIZE TO BE CONFIRMED AS PART OF THE DETAILED DESIGN.
8. REGIONAL Q50 FLOOD LEVEL DERIVED FROM RESULTS OF REGIONAL FLOODING INVESTIGATION UNDERTAKEN BY CALIBRE OPERATIONS PTY LTD FOR THE CARMICHAEL COAL MINE AND RAIL PROJECT, AND SUMMARISED IN THE DESIGN REPORT, REFERENCE NO. CARP12033-REP-C-003 (DATED DEC 2012)



40 20 0 40 80
1 : 2000
SCALE @ A3

Adani Mining Pty Ltd
Carmichael Coal Mine Rail

Stormwater Management Strategy For Concrete Batching Plant BP4

Date: April 2013
Drawing Number: Sketch 721769 - 004
Revision: B

DATE PLOTTED: 12 July 2013 12:20 PM
CAD FILE: P:\721769 Adani\03 Design\Cad\03 Sketches\721769 Sk04-08 Conc SW Treatment.dwg

Cardno (Qld) Pty Ltd | ABN 57 051 074 992
Level 2 Podium Level - emerald Lakes Town Centre
1/3321 Central Place, Gold Coast, Qld 4211
PO Box 391, Carrara, Qld 4211
Tel:07 5539 9333 Fax:07 5538 4647
Email: GCO@cardno.com.au Web: www.cardno.com.au

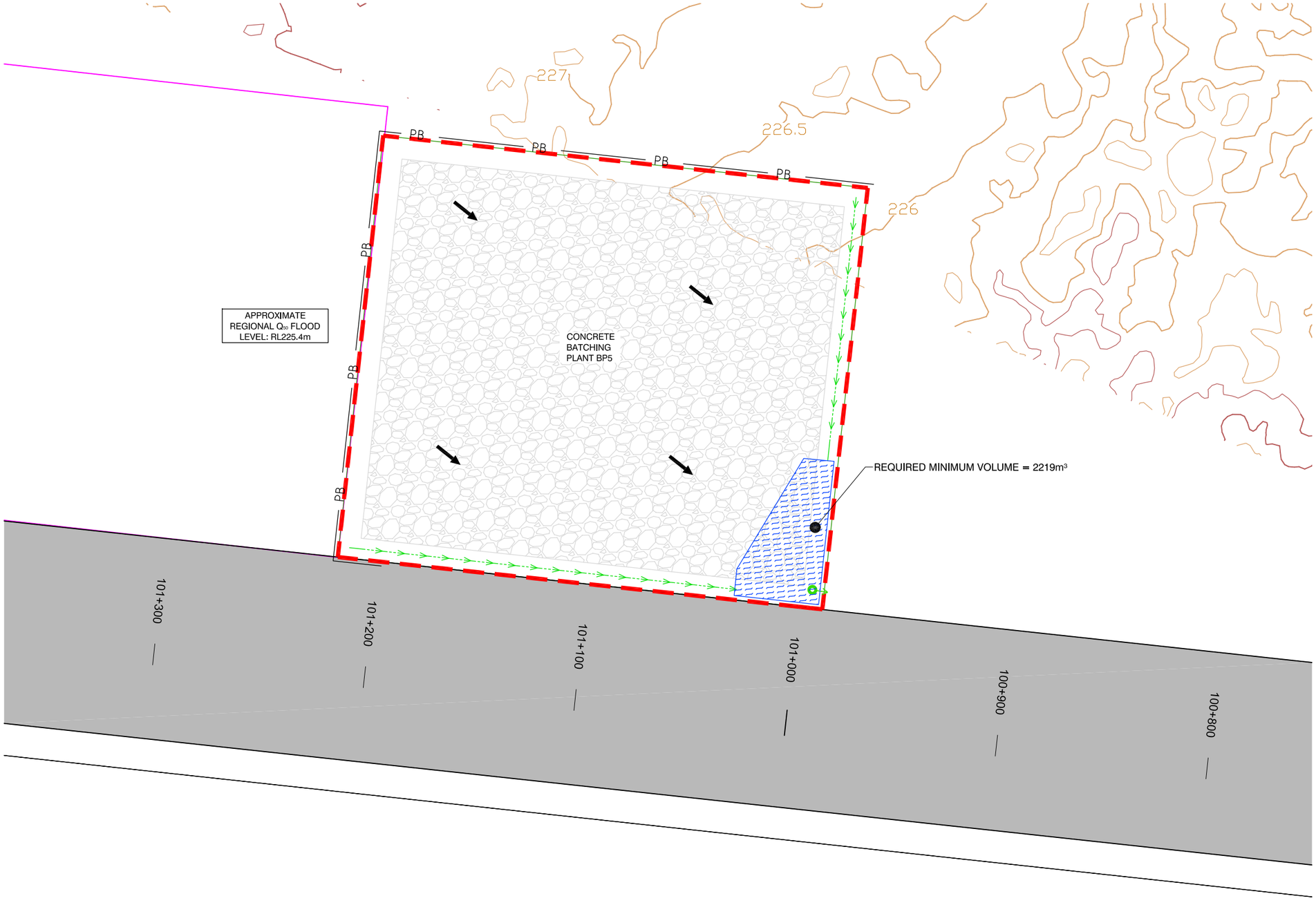
Cardno® Shaping the Future

LEGEND

- EXISTING SURFACE CONTOURS (0.5m INTERVALS)
- DEVELOPED CATCHMENT BOUNDARY
- VEGETATED SWALES (INDICATIVE ONLY)
- PB — PERIMETER BUND
- OVERLAND FLOW DIRECTION
- PROPOSED CONCRETE BATCHING PLANT AREA
- PROPOSED SEDIMENT/DETENTION BASIN AND OUTLET (INDICATIVE ONLY) REFER NOTE 7.

NOTES:

1. CONTOURS ARE BASED ON AERIAL SURVEY. DETAILED SURVEY WILL BE REQUIRED TO CONFIRM CONTRIBUTING CATCHMENT AREAS FOR DETAILED DESIGN.
2. WHERE THE ROOF AREA DRAINAGE CANNOT BE PROVIDED WITH A FREE DRAINING CONNECTION TO THE PROPOSED SEDIMENT/DETENTION BASIN THE ROOF AREA DRAINAGE TO DISCHARGE TO RAINWATER TANK WITH A LEVEL SPREADER ATTACHED TO OUTLET.
3. SOME MINOR RE-GRADING WILL BE REQUIRED ONCE EXACT SITE CONDITIONS ARE DETERMINED.
4. WHERE A FREE DRAINING PIPED OUTLET CANNOT BE PROVIDED TO DRAIN THE SEDIMENT/DETENTION BASIN WITHIN THE FOOTPRINT OF THE CONSTRUCTION FACILITY AREA, A PUMP WILL NEED TO BE PROVIDED. ALTERNATIVELY APPROVAL WILL NEED TO BE SOUGHT TO PROVIDE A FREE DRAINING PIPED OUTLET EXTERNAL TO THE EXTENTS OF THE SITE.
5. ALL WATER TRAPPED WITHIN THE SEDIMENT/DETENTION BASIN IS TO BE TESTED FOR COMPLIANCE WITH THE RELEASE CRITERIA OUTLINED IN THE SWMS PRIOR TO A CONTROLLED RELEASE OFF-SITE.
6. CONSTRUCT DIVERSION BUND TO DIVERT EXTERNAL LOCAL CONTRIBUTING CATCHMENTS AROUND THE CONSTRUCTION FACILITY SITE. EXTENT AND SIZE OF THE BUND TO BE CONFIRMED AS PART OF THE DETAILED DESIGN. VELOCITY CONTROL MEASURES TO BE PROVIDED AT THE DOWNSTREAM END OF DIVERSION BUNDS TO DISPERSE CONCENTRATED FLOWS.
7. BASIN SPILLWAY LOCATION AND SIZE TO BE CONFIRMED AS PART OF THE DETAILED DESIGN.
8. REGIONAL Q50 FLOOD LEVEL DERIVED FROM RESULTS OF REGIONAL FLOODING INVESTIGATION UNDERTAKEN BY CALIBRE OPERATIONS PTY LTD FOR THE CARMICHAEL COAL MINE AND RAIL PROJECT, AND SUMMARISED IN THE DESIGN REPORT, REFERENCE NO. CARP12033-REP-C-003 (DATED DEC 2012)



40 20 0 40 80
SCALE @ A3 1 : 2000

Adani Mining Pty Ltd
Carmichael Coal Mine Rail

Stormwater Management Strategy For Concrete Batching Plant BP5

Date: April 2013
Drawing Number: Sketch 721769 - 005
Revision: B

DATE PLOTTED: 12 July 2013 2:14 PM
CAD FILE: P:\721769 Adani\03 Design\Cad\03 Sketches\721769 Sk04-08 Conc SW Treatment.dwg

Cardno (Qld) Pty Ltd | ABN 57 051 074 992
Level 2 Podium Level - emerald Lakes Town Centre
1/3321 Central Place, Gold Coast, Qld 4211
PO Box 391, Carrara, Qld 4211
Tel:07 5539 9333 Fax:07 5538 4647
Email: GCO@cardno.com.au Web: www.cardno.com.au

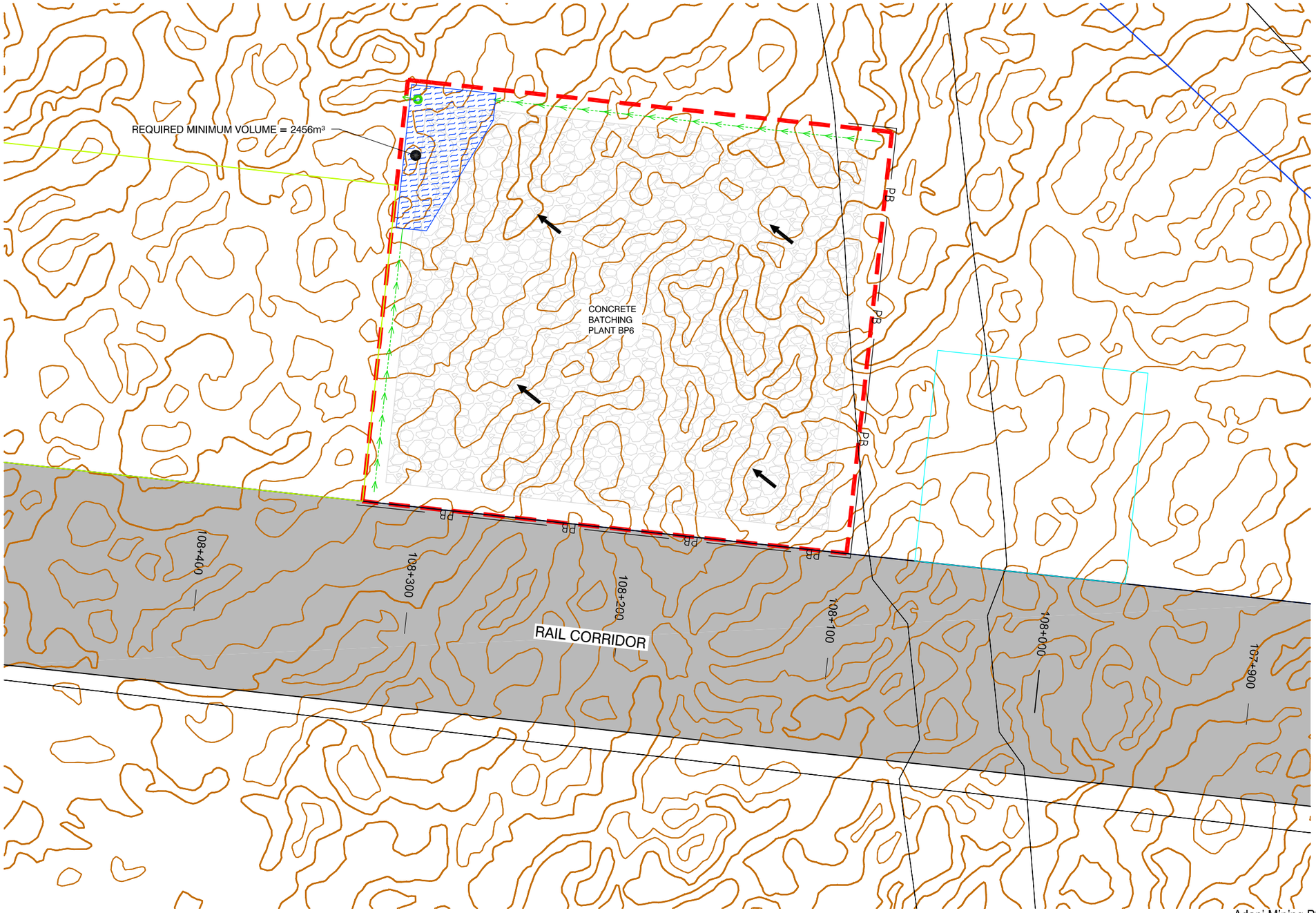
Cardno® Shaping the Future

LEGEND

- EXISTING SURFACE CONTOURS (0.5m INTERVALS)
- DEVELOPED CATCHMENT BOUNDARY
- VEGETATED SWALES (INDICATIVE ONLY)
- PB — PERIMETER BUND
- OVERLAND FLOW DIRECTION
- PROPOSED CONCRETE BATCHING PLANT AREA
- PROPOSED SEDIMENT/DETENTION BASIN AND OUTLET (INDICATIVE ONLY) REFER NOTE 7.

NOTES:

1. CONTOURS ARE BASED ON AERIAL SURVEY. DETAILED SURVEY WILL BE REQUIRED TO CONFIRM CONTRIBUTING CATCHMENT AREAS FOR DETAILED DESIGN.
2. WHERE THE ROOF AREA DRAINAGE CANNOT BE PROVIDED WITH A FREE DRAINING CONNECTION TO THE PROPOSED SEDIMENT/DETENTION BASIN THE ROOF AREA DRAINAGE TO DISCHARGE TO RAINWATER TANK WITH A LEVEL SPREADER ATTACHED TO OUTLET.
3. SOME MINOR RE-GRADING WILL BE REQUIRED ONCE EXACT SITE CONDITIONS ARE DETERMINED.
4. WHERE A FREE DRAINING PIPED OUTLET CANNOT BE PROVIDED TO DRAIN THE SEDIMENT/DETENTION BASIN WITHIN THE FOOTPRINT OF THE CONSTRUCTION FACILITY AREA, A PUMP WILL NEED TO BE PROVIDED. ALTERNATIVELY APPROVAL WILL NEED TO BE SOUGHT TO PROVIDE A FREE DRAINING PIPED OUTLET EXTERNAL TO THE EXTENTS OF THE SITE.
5. ALL WATER TRAPPED WITHIN THE SEDIMENT/DETENTION BASIN IS TO BE TESTED FOR COMPLIANCE WITH THE RELEASE CRITERIA OUTLINED IN THE SWMS PRIOR TO A CONTROLLED RELEASE OFF-SITE.
6. CONSTRUCT DIVERSION BUND TO DIVERT EXTERNAL LOCAL CONTRIBUTING CATCHMENTS AROUND THE CONSTRUCTION FACILITY SITE. EXTENT AND SIZE OF THE BUND TO BE CONFIRMED AS PART OF THE DETAILED DESIGN. VELOCITY CONTROL MEASURES TO BE PROVIDED AT THE DOWNSTREAM END OF DIVERSION BUNDS TO DISPERSE CONCENTRATED FLOWS.
7. BASIN SPILLWAY LOCATION AND SIZE TO BE CONFIRMED AS PART OF THE DETAILED DESIGN.
8. REGIONAL Q50 FLOOD LEVEL DERIVED FROM RESULTS OF REGIONAL FLOODING INVESTIGATION UNDERTAKEN BY CALIBRE OPERATIONS PTY LTD FOR THE CARMICHAEL COAL MINE AND RAIL PROJECT, AND SUMMARISED IN THE DESIGN REPORT, REFERENCE NO. CARP12033-REP-C-003 (DATED DEC 2012)



40 20 0 40 80
1 : 2000
SCALE @ A3

Adani Mining Pty Ltd
Carmichael Coal Mine Rail

Stormwater Management Strategy For Concrete Batching Plant BP6

Date: April 2013
Drawing Number: Sketch 721769 - 006
Revision: B

DATE PLOTTED: 12 July 2013 2:43 PM
CAD FILE: P:\721769 Adani\03 Design\Cad\03 Sketches\721769 Sk04-08 Conc SW Treatment.dwg

Cardno (Qld) Pty Ltd | ABN 57 051 074 992
Level 2 Podium Level - emerald Lakes Town Centre
1/3321 Central Place, Gold Coast, Qld 4211
PO Box 391, Carrara, Qld 4211
Tel:07 5539 9333 Fax:07 5538 4647
Email: GCO@cardno.com.au Web: www.cardno.com.au

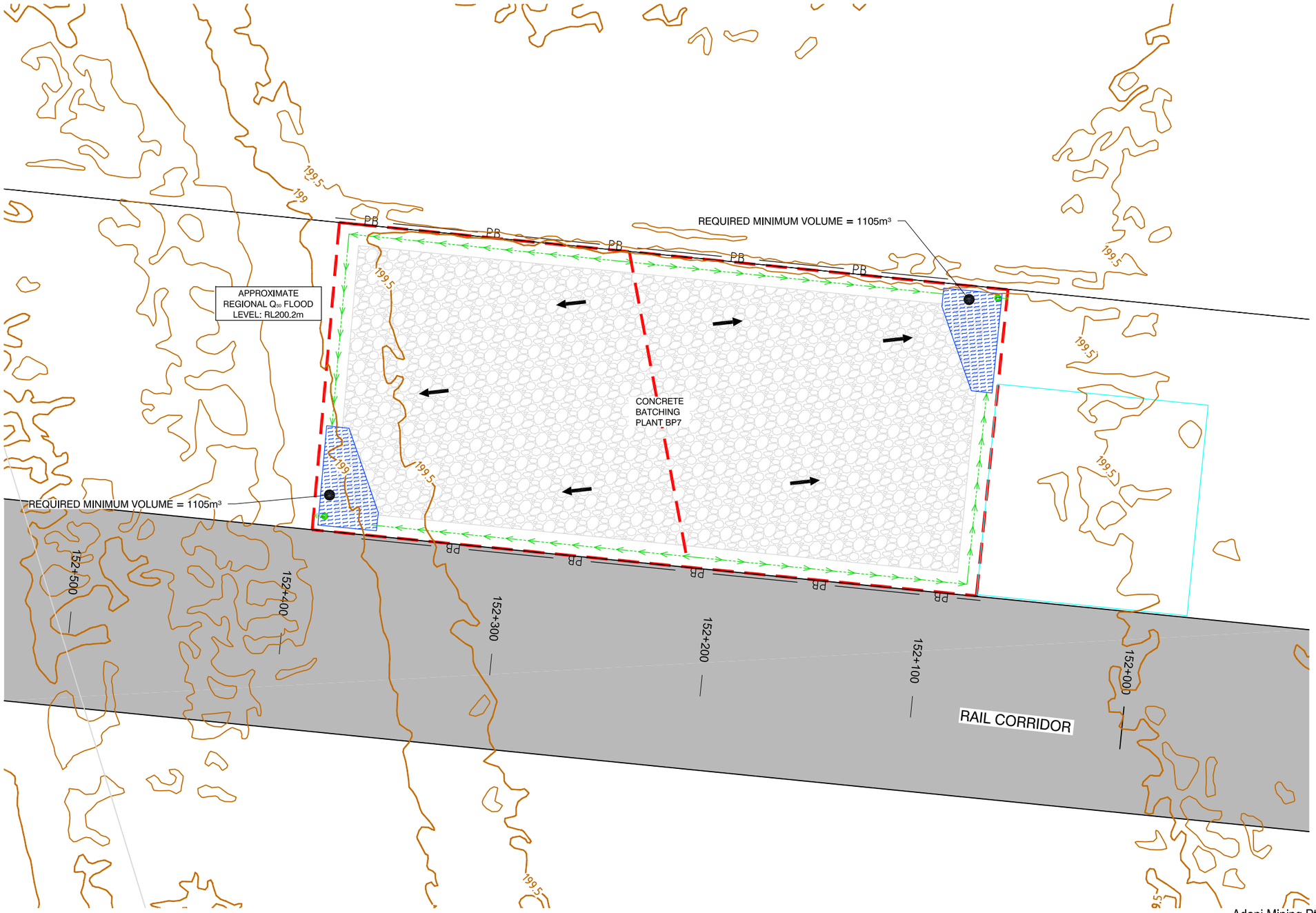
Cardno® Shaping the Future

LEGEND

- EXISTING SURFACE CONTOURS (0.5m INTERVALS)
- DEVELOPED CATCHMENT BOUNDARY
- VEGETATED SWALES (INDICATIVE ONLY)
- PB — PERIMETER BUND
- OVERLAND FLOW DIRECTION
- PROPOSED CONCRETE BATCHING PLANT AREA
- PROPOSED SEDIMENT/DETENTION BASIN AND OUTLET (INDICATIVE ONLY) REFER NOTE 7.

NOTES:

1. CONTOURS ARE BASED ON AERIAL SURVEY. DETAILED SURVEY WILL BE REQUIRED TO CONFIRM CONTRIBUTING CATCHMENT AREAS FOR DETAILED DESIGN.
2. WHERE THE ROOF AREA DRAINAGE CANNOT BE PROVIDED WITH A FREE DRAINING CONNECTION TO THE PROPOSED SEDIMENT/DETENTION BASIN THE ROOF AREA DRAINAGE TO DISCHARGE TO RAINWATER TANK WITH A LEVEL SPREADER ATTACHED TO OUTLET.
3. SOME MINOR RE-GRADING WILL BE REQUIRED ONCE EXACT SITE CONDITIONS ARE DETERMINED.
4. WHERE A FREE DRAINING PIPED OUTLET CANNOT BE PROVIDED TO DRAIN THE SEDIMENT/DETENTION BASIN WITHIN THE FOOTPRINT OF THE CONSTRUCTION FACILITY AREA, A PUMP WILL NEED TO BE PROVIDED. ALTERNATIVELY APPROVAL WILL NEED TO BE SOUGHT TO PROVIDE A FREE DRAINING PIPED OUTLET EXTERNAL TO THE EXTENTS OF THE SITE.
5. ALL WATER TRAPPED WITHIN THE SEDIMENT/DETENTION BASIN IS TO BE TESTED FOR COMPLIANCE WITH THE RELEASE CRITERIA OUTLINED IN THE SWMS PRIOR TO A CONTROLLED RELEASE OFF-SITE.
6. CONSTRUCT DIVERSION BUND TO DIVERT EXTERNAL LOCAL CONTRIBUTING CATCHMENTS AROUND THE CONSTRUCTION FACILITY SITE. EXTENT AND SIZE OF THE BUND TO BE CONFIRMED AS PART OF THE DETAILED DESIGN. VELOCITY CONTROL MEASURES TO BE PROVIDED AT THE DOWNSTREAM END OF DIVERSION BUNDS TO DISPERSE CONCENTRATED FLOWS.
7. BASIN SPILLWAY LOCATION AND SIZE TO BE CONFIRMED AS PART OF THE DETAILED DESIGN.
8. REGIONAL Q50 FLOOD LEVEL DERIVED FROM RESULTS OF REGIONAL FLOODING INVESTIGATION UNDERTAKEN BY CALIBRE OPERATIONS PTY LTD FOR THE CARMICHAEL COAL MINE AND RAIL PROJECT, AND SUMMARISED IN THE DESIGN REPORT, REFERENCE NO. CARP12033-REP-C-003 (DATED DEC 2012)



40 20 0 40 80
SCALE @ A3 1 : 2000

Adani Mining Pty Ltd
Carmichael Coal Mine Rail

Stormwater Management Strategy For Concrete Batching Plant BP7

Date: April 2013
Drawing Number: Sketch 721769 - 007
Revision: C

DATE PLOTTED: 12 July 2013 12:24 PM
CAD FILE: P:\721769 Adani\03 Design\Cad\03 Sketches\721769 Sk04-08 Conc SW Treatment.dwg

Cardno (Qld) Pty Ltd | ABN 57 051 074 992
Level 2 Podium Level - emerald Lakes Town Centre
1/3321 Central Place, Gold Coast, Qld 4211
PO Box 391, Carrara, Qld 4211
Tel:07 5539 9333 Fax:07 5538 4647
Email: GCO@cardno.com.au Web: www.cardno.com.au

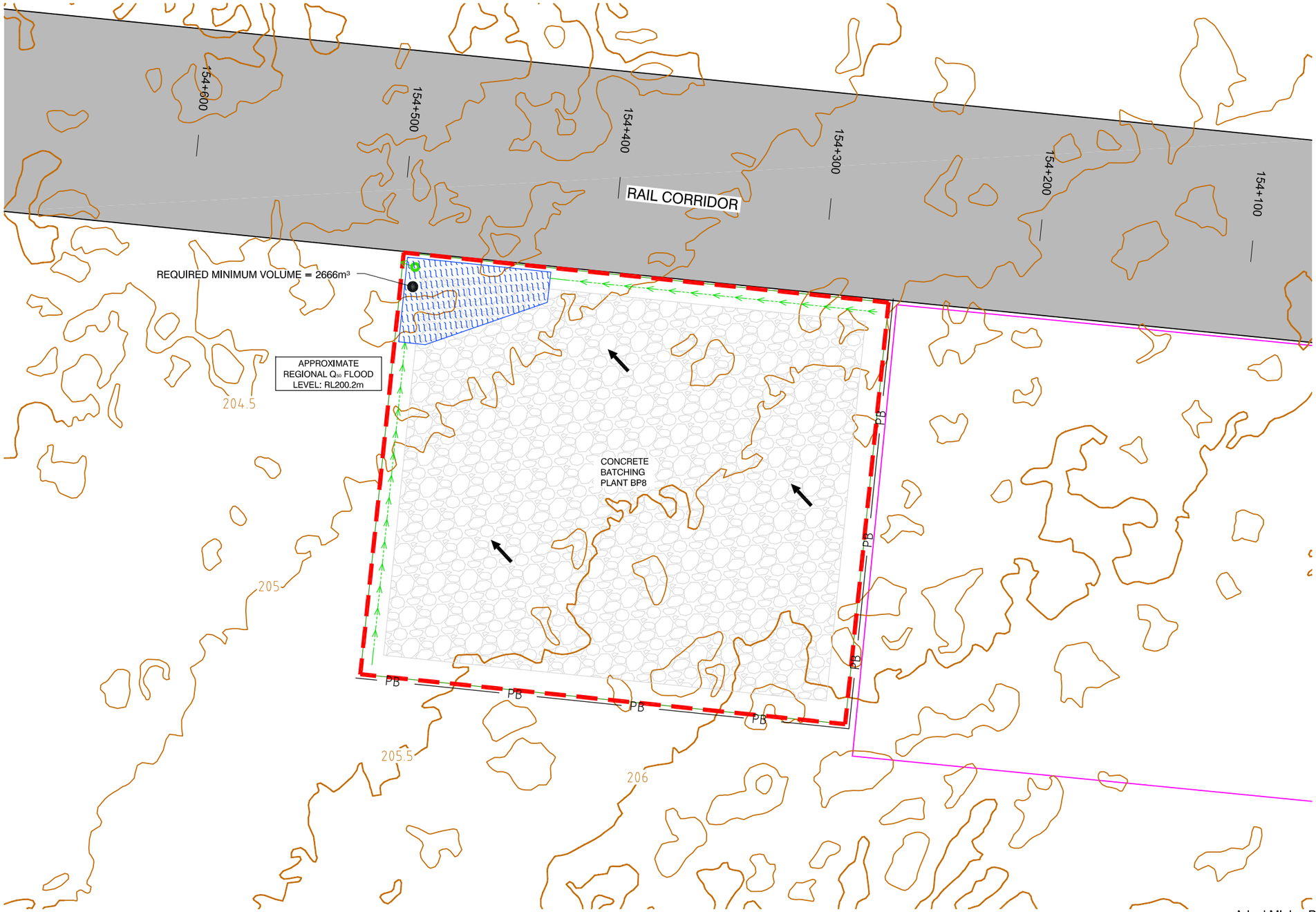
Cardno® Shaping the Future

LEGEND

- EXISTING SURFACE CONTOURS (0.5m INTERVALS)
- DEVELOPED CATCHMENT BOUNDARY
- VEGETATED SWALES (INDICATIVE ONLY)
- PB — PERIMETER BUND
- OVERLAND FLOW DIRECTION
- PROPOSED CONCRETE BATCHING PLANT AREA
- PROPOSED SEDIMENT/DETENTION BASIN AND OUTLET (INDICATIVE ONLY) REFER NOTE 7.

NOTES:

1. CONTOURS ARE BASED ON AERIAL SURVEY. DETAILED SURVEY WILL BE REQUIRED TO CONFIRM CONTRIBUTING CATCHMENT AREAS FOR DETAILED DESIGN.
2. WHERE THE ROOF AREA DRAINAGE CANNOT BE PROVIDED WITH A FREE DRAINING CONNECTION TO THE PROPOSED SEDIMENT/DETENTION BASIN THE ROOF AREA DRAINAGE TO DISCHARGE TO RAINWATER TANK WITH A LEVEL SPREADER ATTACHED TO OUTLET.
3. SOME MINOR RE-GRADING WILL BE REQUIRED ONCE EXACT SITE CONDITIONS ARE DETERMINED.
4. WHERE A FREE DRAINING PIPED OUTLET CANNOT BE PROVIDED TO DRAIN THE SEDIMENT/DETENTION BASIN WITHIN THE FOOTPRINT OF THE CONSTRUCTION FACILITY AREA, A PUMP WILL NEED TO BE PROVIDED. ALTERNATIVELY APPROVAL WILL NEED TO BE SOUGHT TO PROVIDE A FREE DRAINING PIPED OUTLET EXTERNAL TO THE EXTENTS OF THE SITE.
5. ALL WATER TRAPPED WITHIN THE SEDIMENT/DETENTION BASIN IS TO BE TESTED FOR COMPLIANCE WITH THE RELEASE CRITERIA OUTLINED IN THE SWMS PRIOR TO A CONTROLLED RELEASE OFF-SITE.
6. CONSTRUCT DIVERSION BUND TO DIVERT EXTERNAL LOCAL CONTRIBUTING CATCHMENTS AROUND THE CONSTRUCTION FACILITY SITE. EXTENT AND SIZE OF THE BUND TO BE CONFIRMED AS PART OF THE DETAILED DESIGN. VELOCITY CONTROL MEASURES TO BE PROVIDED AT THE DOWNSTREAM END OF DIVERSION BUNDS TO DISPERSE CONCENTRATED FLOWS.
7. BASIN SPILLWAY LOCATION AND SIZE TO BE CONFIRMED AS PART OF THE DETAILED DESIGN.
8. REGIONAL Q50 FLOOD LEVEL DERIVED FROM RESULTS OF REGIONAL FLOODING INVESTIGATION UNDERTAKEN BY CALIBRE OPERATIONS PTY LTD FOR THE CARMICHAEL COAL MINE AND RAIL PROJECT, AND SUMMARISED IN THE DESIGN REPORT, REFERENCE NO. CARP12033-REP-C-003 (DATED DEC 2012)



40 20 0 40 80
SCALE @ A3 1 : 2000

Adani Mining Pty Ltd
Carmichael Coal Mine Rail

Stormwater Management Strategy For Concrete Batching Plant BP8

Date: April 2013
Drawing Number: Sketch 721769 - 008
Revision: B

DATE PLOTTED: 12 July 2013 12:25 PM
CAD FILE: P:\721769 Adani\03 Design\Cad\03 Sketches\721769 Sk04-008 Conc SW Treatment.dwg

APPENDIX C

WATER QUALITY CALCULATIONS

Cardno
Shaping the Future

VOLUME OF SEDIMENT BASIN: TYPE D SOILS

PROJECT: Carmichael Coal Mines
SP1 Concrete Batching Plants
JOB No:- 7217/69

DESIGNER:- SW
DATE:- 12/Apr/13

Sediment Storage Zone Volume

Input Value	Catchment/Basin Name				
	BP4	BP5	BP6	BP7	BP8
S	10.5	10.5	10.5	10.5	10.5
R (Calculated)	2411.4	2411.4	2411.4	2411.4	2411.4
R (from chart)					
R (adopted)	2411.4	2411.4	2411.4	2411.4	2411.4
K	0.02	0.02	0.02	0.02	0.02
LS	0.17	0.17	0.17	0.17	0.17
P	1.3	1.3	1.3	1.3	1.3
C	1	1	1	1	1
A - Soil Loss (tonnes/ha/yr)	10.7	10.7	10.7	10.7	10.7
Volume (m^3/ha/yr)	8.2	8.2	8.2	8.2	8.2
Disturbed Area (ha)	4.6	4.6	4.6	4.6	4.6
Calculated Soil Loss (m^3/yr)	37.72	37.72	37.72	37.72	37.72
Sediment Storage Zone (m^3)*	6.3	6.3	6.3	6.3	6.3

*Assumes regeneration after 2 months

Settling Zone Volume

Cv	1	1	1	1	1
Catchment Area (ha)	4.6	4.6	4.6	4.6	4.6
R(y%ile, 5day) (mm)	32.5	32.5	32.5	32.5	32.5
Settling Zone (m^3)	1495	1495	1495	1495	1495
Basin Vol. per Hectare (m^3)	326	326	326	326	326

Preliminary Basin Sizing

Depth of Basin (m)	1	1	1	1	1
Total Basin Vol (m^3)	1501.3	1501.3	1501.3	1501.3	1501.3
Approx. Width (m)	22	22	22	22	22
Approx. Length (m)	67	67	67	67	67

APPENDIX

D

WATER QUANTITY CALCULATIONS

Cardno
Shaping the Future

Concrete Batch Plant 4 - 100 year ARI flow

Existing Case

Area	4.6	ha
C_{10}	0.66	
$F_{100}xC_{10}$	0.79	
C_{100}	0.79	
Time of conc	38	mins
Intensity	117	mm/hr
Flow	1.18	m^3/s
Total Flow	1.18	m^3/s
Volume	2699.6	m^3

Sheet flow - 50m over 0.5% grade, poorly grassed - 14 mins
Channel flow - 250m, 0.5m fall, natural channel - 24 mins
Total 38 mins

Developed Case

Area	4.6	ha
C_{10}	0.86	
$F_{100}xC_{10}$	1.03	
C_{100}	1.00	
Time of conc	24	mins
Intensity	147	mm/hr
Flow	1.88	m^3/s
Total Flow	1.88	m^3/s
Volume	2704.8	m^3

Sheet flow - 50m over 0.5% grade, compacted earth surface - 8 mins
Channel flow - 250m, 0.5m fall, earthern table drains - 16 mins
Total 24 mins

Detention Basin Sizing (preliminary)

Peak inflow	1.88	m^3/s
Peak outflow	1.18	m^3/s
Volume	3606.40	m^3
r	0.37	

Required storage volume

Culp	Boyd	Carroll	Basha	Maximum
772.84	1333.04	807.85	1052.94	1333.04

Peak flow only factor: 2

Required volume is - 2666 m^3.

Assuming a rectangular basin with 1 in 2 side slopes,
required surface area is:

Depth (m)	Length (m)	Width (m)	Area (m^2)	Volume (m^3)
0.0	19.0	78.0	1482.0	
1.5	25.0	84.0	2100.0	2686.5

Concrete Batch Plant 5 - 100 year ARI flow

Existing Case

Area	4.6	ha
C_{10}	0.66	
$F_{100}xC_{10}$	0.79	
C_{100}	0.79	
Time of conc	28	mins
Intensity	136	mm/hr
Flow	1.38	m^3/s
Total Flow	1.38	m^3/s
Volume	2312.2	m^3

Sheet flow Sheet flow - 50m over 1.0% grade, poorly grassed - 12 mins
Channel flo Channel flow - 250m, 1.5m fall, natural channel - 16 mins
Total 38 mi Total 28 mins

Developed Case

Area	4.6	ha
C_{10}	0.86	
$F_{100}xC_{10}$	1.03	
C_{100}	1.00	
Time of conc	18	mins
Intensity	168	mm/hr
Flow	2.15	m^3/s
Total Flow	2.15	m^3/s
Volume	2318.4	m^3

Sheet flow Sheet flow - 50m over 1.0% grade, compacted earth surface
Channel flo Channel flow - 250m, 1.5m fall, earthern table drains - 11 min
Total 24 mi Total 18 mins

Detention Basin Sizing (preliminary)

Peak inflow	2.15	m^3/s
Peak outflow	1.38	m^3/s
Volume	3091.20	m^3
r	0.36	

Required storage volume

Culp	Boyd	Carroll	Basha	Maximum
635.15	1109.30	664.79	872.23	1109.30

Peak flow only factor: 2

Required volume is - 2219 m^3.

Assuming a rectangular basin with 1 in 2 side slopes,
required surface area is:

Depth (m)	Length (m)	Width (m)	Area (m^2)	Volume (m^3)
0.0	19.0	78.0	1482.0	
1.5	25.0	84.0	2100.0	2686.5

Concrete Batch Plant 6 - 100 year ARI flow

Existing Case

Area	4.6	ha
C_{10}	0.66	
$F_{100}xC_{10}$	0.79	
C_{100}	0.79	
Time of conc	33	mins
Intensity	126	mm/hr
Flow	1.28	m^3/s
Total Flow	1.28	m^3/s
Volume	2524.7	m^3

Sheet flow - 50m over 0.5% grade, poorly grassed - 14 mins
Channel flow - 250m,1m fall, natural channel - 19 mins
Total 33 mins

Developed Case

Area	4.6	ha
C_{10}	0.86	
$F_{100}xC_{10}$	1.03	
C_{100}	1.00	
Time of conc	21	mins
Intensity	157	mm/hr
Flow	2.01	m^3/s
Total Flow	2.01	m^3/s
Volume	2527.7	m^3

Sheet flow - 50m over 0.5% grade, compacted earth surface - 8 mins
Channel flow - 250m, 1m fall, earthern table drains - 13 mins
Total 21 mins

Detention Basin Sizing (preliminary)

Peak inflow	2.01	m^3/s
Peak outflow	1.28	m^3/s
Volume	3370.27	m^3
r	0.36	

Required storage volume

Culp	Boyd	Carroll	Basha	Maximum
707.68	1228.07	740.20	967.87	1228.07

Peak flow only factor: 2

Required volume is - 2456 m^3.

Assuming a rectangular basin with 1 in 2 side slopes,
required surface area is:

Depth (m)	Length (m)	Width (m)	Area (m^2)	Volume (m^3)
0.0	20.0	69.0	1380.0	
1.5	26.0	75.0	1950.0	2497.5

Concrete Batch Plant 7 - 100 year ARI flow

Existing Case

Area	4.6	ha
C_{10}	0.66	
$F_{100}xC_{10}$	0.79	
C_{100}	0.79	
Time of conc	38	mins
Intensity	117	mm/hr
Flow	1.18	m^3/s
Total Flow	1.18	m^3/s
Volume	2699.6	m^3

Sheet flow - 50m over 0.5% grade, poorly grassed - 14 mins
Channel flow - 250m, 0.5m fall, natural channel - 24 mins
Total 38 mins

Developed Case

Area	4.6	ha
C_{10}	0.86	
$F_{100}xC_{10}$	1.03	
C_{100}	1.00	
Time of conc	24	mins
Intensity	147	mm/hr
Flow	1.88	m^3/s
Total Flow	1.88	m^3/s
Volume	2704.8	m^3

Sheet flow - 50m over 0.5% grade, compacted earth surface - 8 mins
Channel flow - 250m, 0.5m fall, earthern table drains - 16 mins
Total 24 mins

Detention Basin Sizing (preliminary)

Peak inflow	1.88	m^3/s
Peak outflow	1.18	m^3/s
Volume	3606.40	m^3
r	0.37	

Required storage volume

Culp	Boyd	Carroll	Basha	Maximum
772.84	1333.04	807.85	1052.94	1333.04

Peak flow only factor: 2

Required volume is - 2666 m^3.

Assuming a rectangular basin with 1 in 2 side slopes,
required surface area is:

Depth (m)	Length (m)	Width (m)	Area (m^2)	Volume (m^3)
0.0	19.0	78.0	1482.0	
1.5	25.0	84.0	2100.0	2686.5

Concrete Batch Plant 8 - 100 year ARI flow

Existing Case

Area	4.6	ha
C_{10}	0.66	
$F_{100}xC_{10}$	0.79	
C_{100}	0.79	
Time of conc	38	mins
Intensity	117	mm/hr
Flow	1.18	m^3/s
Total Flow	1.18	m^3/s
Volume	2699.6	m^3

Sheet flow - 50m over 0.5% grade, poorly grassed - 14 mins
Channel flow - 250m, 0.5m fall, natural channel - 24 mins
Total 38 mins

Developed Case

Area	4.6	ha
C_{10}	0.86	
$F_{100}xC_{10}$	1.03	
C_{100}	1.00	
Time of conc	24	mins
Intensity	147	mm/hr
Flow	1.88	m^3/s
Total Flow	1.88	m^3/s
Volume	2704.8	m^3

Sheet flow - 50m over 0.5% grade, compacted earth surface - 8 mins
Channel flow - 250m, 0.5m fall, earthern table drains - 16 mins
Total 24 mins

Detention Basin Sizing (preliminary)

Peak inflow	1.88	m^3/s
Peak outflow	1.18	m^3/s
Volume	3606.40	m^3
r	0.37	

Required storage volume

Culp	Boyd	Carroll	Basha	Maximum
772.84	1333.04	807.85	1052.94	1333.04

Peak flow only factor: 2

Required volume is - 2666 m^3.

Assuming a rectangular basin with 1 in 2 side slopes,
required surface area is:

Depth (m)	Length (m)	Width (m)	Area (m^2)	Volume (m^3)
0.0	19.0	78.0	1482.0	
1.5	25.0	84.0	2100.0	2686.5

Carmichael Coal Mine and Rail Project

Information in Support of Development Application-ERA 63

7803-04

Prepared for
Adani Mining Pty Ltd

23 July 2013

Cardno
Shaping the Future

Contact Information

Cardno (QLD) Pty Ltd
ABN 57 051 074 992

Level 11 Green Square North Tower
515 St Paul's Terrace
Fortitude Valley QLD 4006
Locked Bag 4006 Fortitude Valley

Telephone: 07 3369 9822
Facsimile: 07 3369 9722
International: +61 7 3369 9822

cardno@cardno.com.au.
www.cardno.com.au.

Document Information

Prepared for	Adani Mining Pty Ltd
Project Name	Carmichael Mine Coal and Rail Project
File Reference	I:\7803-04 HRP - Adani\wp\Reports\Final reports ERA8 and 63 for Issue\ERA 63 Supporting Information Construction Depot V2 Final.docx
Job Reference	7803-04
Date	23 July 2013

Document Control

Version	Date	Description of Revision	Prepared By	Prepared (Signature)	Reviewed By	Reviewed (Signature)
1	12 July 2013	Version 1	MH	M Harrison	LAM	L Morrissey
2	23 July 2013	Final	SCB	S Brown	LAM	

Version	Reason for Issue	Approved for Release By	Approved (Signature)	Approved Release Date
1	For approval	LAM	L Morrissey	12 July 2013
2	Final for issue	LAM		23 July 2013

Executive Summary

Adani is proposing to develop a 60 million tonne (product) per annum (Mtpa) thermal coal mine in the north Galilee Basin approximately 160 kilometres (km) north–west of the town of Clermont, Central Queensland. All coal will be railed via a privately owned rail line connecting to the existing QR National rail infrastructure, and shipped through coal terminal facilities at the Port of Abbot Point and the Port of Hay Point (Dudgeon Point expansion). The Carmichael Coal Mine and Rail Project (CCRP) (the Project) will have an operating life of approximately 90 years. The Project comprises of two major components:

> The Project (Mine): a greenfield coal mine over EPC1690 and the eastern portion of EPC1080, which includes both open cut and underground mining, on-mine infrastructure and associated mine processing facilities (the Mine) and the Mine (offsite) infrastructure.

> The Project (Rail): a greenfield rail line connecting the Mine to the existing Goonyella and Newlands rail systems to provide for the export of coal via the Port of Hay Point (Dudgeon Point expansion) and the Port of Abbot Point, res pectively, including:

  – Rail (west): a 120 km dual gauge portion from the Mine site running west to east to Diamond Creek (SP1); and

  – Rail (east): a 69 km narrow gauge portion running east from Diamond Creek connecting to the Goonyella rail system south of Moranbah (SP2).

The following activities will be temporarily carried out during the construction phase at various locations along SP1 in order to assist and support the CCRP construction works, which are proposed to be ongoing for a period of two years. Following construction it is expected that these facilities/activities will be discontinued and decommissioned. These activities include:

> concrete batching;

> vehicle and equipment maintenance in a vehicle workshop;

> flash-butt welding and grinding of rails;

> chemical storage and refuelling of vehicles and equipment;

> material and equipment laydown and storage; and

> onsite sewage treatment, land disposal and/or reuse of effluent.

Adani proposes to develop a temporary construction depot along SP1 to be located as part of Lot 4 on SP116046. The location of the construction depot occupies a site area of approximately 113.85ha. The site is located on the western side of the Gregory Developmental Road, within the Isaac Regional Council area and is shown on Figure 1. The construction depot will consist of the following facilities (refer Figure 2):

> bridge girder stacking area;

> pipe culvert segment stacking area;

> concrete batching plant;

> ballast stockyard;

> sleeper stacking area;

> chemical storage and refuelling areas;

> flash-butt welding facility; and

> STP and land disposal (effluent irrigation) area.

The above activities include:

> Boiler making or engineering associated with the flash butt welding facility. The desciption of this activity and its environmental management guidelines are addressed separately in the document *Carmicheal Coal Mine and Rail Project-Construction Depot Integrated Environmental Management Plan.*

> Concrete batching. Concrete batching activities will also occur at multiple other locations along SP1. The description of this activity and its environmental management guidelines are addressed separately in the document *Carmicheal Coal Mine and Rail Project-Construction Depot Integrated Environmental Management Plan.*

> Fuel and chemical storage and refuelling activities. Fuel and chemical storage and refuelling activities are required for the powering of the flash butt welding and concrete batching facilities, operation and refuelling of construction vehicles, operation and refuelling of coal trains (rolling stock maintenance) and powering of diesel generators associated with office facilities and Sewage Treatment Plants. Therefore fuel storage occur at multiple locations along SP1 and above the threshold for ERA 8 (>50t). These fuel storage activities collectively therefore constitute an Envrionmentally Relevant Activity and are the subject of an additional report *Carmicheal Coal Mine and Rail Project-Supporting Information ERA 8*. The description of this activity and its Site Based Management Plan (SBMP) are addressed in the aforementioned document.

> Sewage treatment. The sewage treatment and treated effluent irrigation activities proposed will be consistent with ERA 63 (1)(a) - operating 1 or more sewage treatment works at a site that have a total daily peak design capacity of at least 21 equivalent persons (EP) as defined in Schedule 2 of the *Environmental Protection Regulation 2008* (EP Reg). Onsite sewage treatment activities above 21 EP constitute an Environmentally Relevant Activity (ERA), and as such will require an Environmental Authority and be a current Registered Operator to undertake the activity.

Cardno (Qld) Pty Ltd (Cardno) has been commissioned by Adani to prepare supporting information and an associated Site Based Management Plan (SBMP) for the Construction Depot Sewage Treatment Plant in support of an application for ERA 63. This SBMP is intended to form the basis of the application for environmental authority in accordance with the *Environmental Protection Act 1994*, while at the same time providing information in support the Development Application for Material Change of Use (MCU) being sought from Isaac Regional Council. This document will also be provided to the Coordinator General as part of the Supplementary Environmental Impact Statement (EIS) submission for the Carmichael Coal Mine and Rail Project.

The supporting information contained in this document provides further information on the proposed STP and effluent irrigation activities at the Construction Depot, the site characteristics and how the activities are to be conducted to facilitate best environmental practice. This report and SBMP identify the environmental management measures which will be adopted onsite to address potential environmental impacts associated with the proposed ERA 63 activity at the construction depot for SP1. This report does not specify the arrangements for a second STP to be located at the rail maintenance facility at SP1. This is because the STP at the rolling stock maintenance facility will be below the 21 EP threshold for ERA 63 to apply. It is anticipated that the approval to operate the rollingstock maintenance facility will be dealt with under the requirements of the *Queensland Plumbing and Wastewater Code* in separate corrspondence with Council.

Secondary activities to be conducted at or near the Construction Depot such as boiler making/engineering and concrete batching activities do not constitute ERAs as defined in Schedule 2 of the EP Reg and as such are self-regulated. However management of these activities at the site and all businesses are still required to meet the general environmental duty to prevent environmental harm under the Environmental Protection Act 1994 (EP Act). Therefore, stand-alone and integrated Environmental Management Plans have also been prepared in order to provide best environmental practice principles and management guidelines at the construction depot for any activities whichdo not consitutute an envrionmntally relevant activity. As such environmental management measures for these activities have been addressed separetely in the Cardno document *Carmicheal Coal Mine and Rail Project-Construction Depot Integrated Environmental Management Plan* (not provided).

Table of Contents

Tables

Figures

Appendices

1 Proposed Activities

This report relates to the proposed development of a sewage treatment plant to service a rail construction depot, which is required for the construction of a new rail corridor along SP1 as part of the proposed CCMRP. The activities proposed to be undertaken at the construction depot include:

> concrete batching;

> vehicle and equipment maintenance in a vehicle workshop;

> flash-butt welding and grinding of rails;

> chemical storage and refuelling of vehicles and equipment;

> material and equipment laydown and storage; and

> on-site sewage treatment, land disposal and/or reuse of effluent.

The STP and effluent irrigation area is expected to occupy a total area of approximately 2ha located in the northern extent of the construction depot. The effluent irrigation area is expected to require a footprint of 1.5ha (refer Figure 2). The irrigation area is proposed to be seeded with grasses compatible with the ecological assessment and recommendations for the site.

This report and accompanying SBMP is intended to support an application for Material Change of Use for Environmentally Relevant Activity for a 44EP temporary STP (ERA 63) associated with development on part of Lot 4 on SP116046 (“the site”). The layout of the various proposed activities listed above is shown in Figure 2.

2 Site Characteristics, Constraints and Existing Environmental Values

The proposed sewage treatment activity is located within a construction depot as part of Lot 4 on SP116046. The construction depot has a footprint area of 113.85ha, which incorporates:

> bridge girder stacking area;

> pipe culvert segment stacking area;

> concrete batching plant;

> ballast stockyard;

> sleeper stacking area;

> chemical storage and refuelling areas;

> material and equipment laydown and storage; and

> on-site STP and effluent irrigation areas.

The lot is bound to the:

> north by undeveloped land;

> east by the Gregory Developmental Road;

> south by the proposed project rail alignment (currently undeveloped land); and

> west by undeveloped land.

The site is intercepted by tributaries of Gowrie Creek that drains west to the Belyando River catchment.

Onsite sewage treatment and subsequent land disposal of the treated effluent through irrigation is required for the construction depot as the site is not currently sewered.

2.1 Climate

Historical climatic data and statistics for the Twin Hills Post Office (Bureau of Meteorology (BOM) Station #036047) was identified during the EIS (GHD, 2012a) as being representative of the climatic conditions experienced at the western end of the rail project area (SP1). Monthly mean temperatures at this station indicated daytime summer temperatures generally in the low to mid 30°C, with winter overnight temperatures dropping to between 5°C and 10°C. The temperature records were reported to show values ranging from -3.2°C to 43.8°C. 'Hot days', with temperatures exceeding 35°C could be expected up to 75 days per year. 'Frost days', with temperatures below 2°C can be expected up to 10 days per year (GHD 2012a, V3:S3:p3-2).

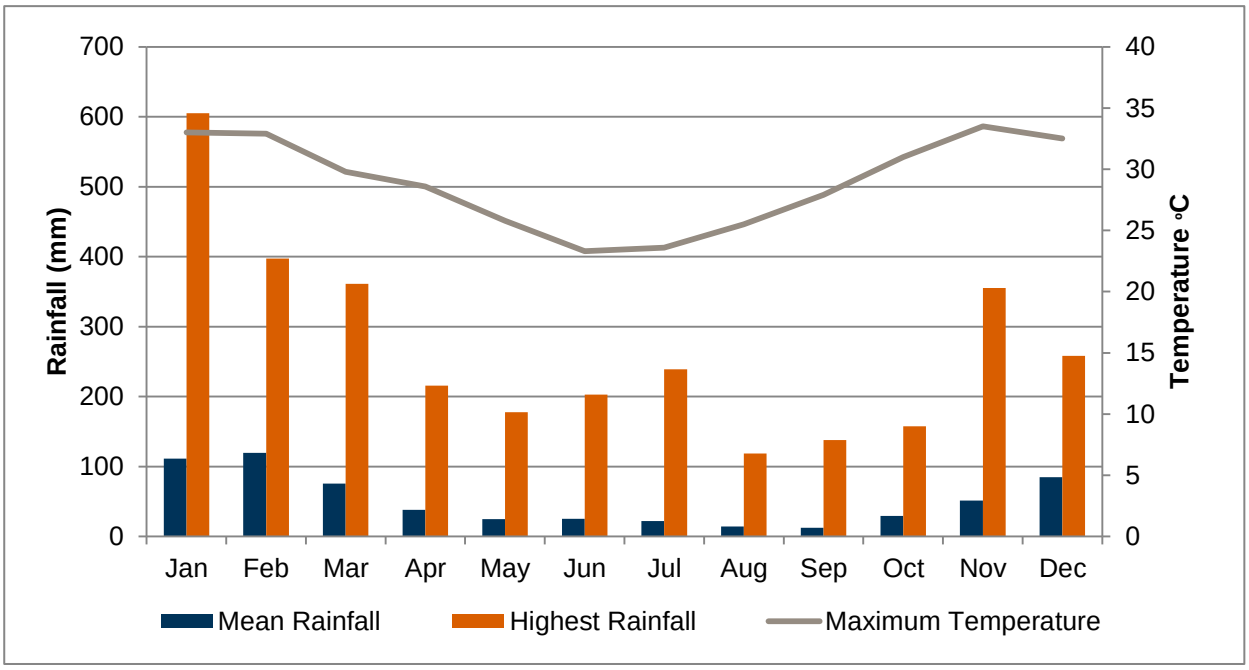
The annual mean rainfall is dominated by the warm months producing convectively driven rainfall. Rainfall occurring during the summer months (December through to February, inclusive) is shown to account for 50% of the annual mean rainfall at the Twin Hills station. Twin Hills has an annual average of 610mm over an 80 year record. The range of annual rainfalls at Twin Hills is 218mm to 1,477mm per year (GHD 2012a, V3:S3:p3-4).

Conclusions in the EIS determined that in any month of the year, there can be zero rainfall and there are pronounced variations in rainfall, including the persistence of both 'dry' years and 'wet' years (GHD 2012a, V3:S3:p3-4).

The dataset for this station comprised 80 years of data, operating between 1905 and 1985. The station was closed in 1985.

Historical climatic data was also obtained from the two open BOM stations, Bulliwallah (BOM Station #036010) and Clermont (Clermont Airport Qld BOM Station #035124), which are considered representative

of the climatic conditions experienced at the construction depot. The graph below shows that mean monthly rainfall and maximum temperature are greatest in January, November and December. For the Clermont and Bulliwallah weather observation sites, the mean annual maximum temperature is 28.95°C and rainfall is 599.70mm.



Climate Data

Wind data obtained from Twin Hills BOM station presented in the EIS showed that wind directions in the vicinity of SP1 predominantly range between northeast to southeast at speeds between 2m/s to 4m/s and that convective conditions tended to dominate throughout the daytime during both summer and winter. However temperature inversions were identified as developing on the majority of nights (GHD 2012a, V3;S7;p.7-7). The potential for temperature inversions will need to be considered in the development and implementation of odour control measures for the STP.

The average daily solar radiation was reported to range between 21 and 24MJ/m^2 and average daily sunshine hours (annually) of between 8 and 9 hours (GHD 2012a, V3;S3;p.3-6). This factor will be relevant for the water balance calculations for the irrigation area.

2.2 Land Use and Topography

The site is currently used for grazing activities. Pursuant to the Belyando Shire Planning Scheme the site is zoned as Rural (IRC 2013). The topography of the construction depot site is generally flat, with generally low relief (slope gradient range - 0.8% to 1.5%) associated with the minor drainage lines crossing the western side of the site and draining towards Gowrie Creek to the southwest. Natural surface elevations range from approximately 215m Australian Height Datum (AHD) in the southeast corner to 206m AHD in the north and 201m AHD within the bed of the drainage line intercepting the south-western corner of the site.

Land use surrounding the construction depot is primarily agricultural, used for broad acre cattle grazing. The Gregory Developmental Road is a State controlled road. During the EIS the site was mapped as being agricultural land class C1 – land suitable for sown pastures with moderate limitations and was located within the Western Cropping Boundary, but was not identified as being Strategic Cropping Land (GHD 2012a, V3:S4:pp48-49).

2.3 Soils and Geology

During the EIS the geology underlying the construction depot and surrounding area was mapped as Quaternary Alluvium, including sands, silts, clays and alluvium and the Australian Soil Classification mapping presented for the site showed that vertosols are the dominant soil type mapped at the construction depot

site, with kandosols expected to be present at the southern boundary of the site (GHD 2012a, V3:S4:pp.4-34 and 4-44).

Information presented in the EIS indicated that the dominant land systems and soil types mapped at the construction depot site are:

> Islay land system, comprising vertosol soil type; and

> Disney land system, comprising kandosol soil type.

The Islay land system is associated with gidgee plains with gilgaied clay soils on acid clay exposed within the tertiary weathered zone. The Islay land system is mostly found within the Belyando catchment, where the tertiary land surface and weathered zone have been partially removed. Due to the salinity and/or alkalinity, moderate erosion and low and unreliable rainfall, the Islay land system has a land capability class of 3.

Vertosols consist of clay soils with shrink-swell that exhibit strong cracking when dry and at depth have slickensides and/or lenticular structural aggregates. Although many soils exhibit gilgai microrelief, this feature is not used in their definition. Vertosols are mapped as dominating the landscape in the Project (Rail) area. Based on the Queensland Combined Soils Database presented in the EIS, possible soil profile characteristics, for the Islay land system are detailed in Table 2-1.

Table 2-1 Islay Land System Soil Characteristics (Vertosol)

Depth (m)	Texture Grade	CEC (cmol/kg)	EC (dS/m)	ESP (%)	pH	Total N (cmol/kg)	Total P (cmol/kg)
0-0.07	Silty Clay	43.33	0.14	1.84	8.1	0.11	0.03
0.07-0.66	Silty Clay	40.45	0.34	1.78	8	0.06	0.03
0.66-1.09	Silty Clay	48.33	0.59	23.5	8.7	0.02	0.02

Table Note: CEC cation exchange capacity; EC electrical conductivity; ESP exchangeable sodium percentage; N – nitrogen; P – phosphorus

(Source: GHD 2012b, p2-26).

The Disney land system is characterised by small lateritic mesas with ironbark and red or yellow earths on Tertiary sandstone, surrounding lowlands with box and brigalow and texture contrast soils on weathered Drummond Basin sediment.

The Disney land system has a potential use for limited cultivation and/or pasture improvement, and is susceptible to moderate erosion. The land system has a land capability class of 4 due to shallow soils, salinity and/or alkalinity, with gilgai micro relief in parts.

Kandosols consist of weak or massive sub-soil structure, a clay content of greater than 15% in the B horizon, no strong texture contrast and no carbonate throughout the profile.

Based on the Queensland Combined Soils Database presented in the EIS, the soil profile characteristics are detailed in Table 2-2 for the Disney land system.

Table 2-2 Disney Land System Soil Characteristics (Kandosol)

Depth (m)	Texture Grade	CEC (cmol/kg)	EC (dS/m)	ESP (%)	pH	Total N (cmol/kg)	Total P (cmol/kg)
0-0.27	Sandy Loam	7	0.14	2.3	6.7	0.08	0.01
0.27-0.9	Sandy Clayey Loam	15	0.8	44	9.3	0.05	0.01
0.9-1.19	Sandy Clayey Loam	18	0.97	40	6.5	0.01	0.01

Table Note: CEC cation exchange capacity; EC electrical conductivity; ESP exchangeable sodium percentage; N – nitrogen; P – phosphorus

(Source: GHD 2012b, pp2-29-2-30).

Extensive site specific soil investigations have not been conducted for the purposes of the development application. Therefore the irrigation scenarios present conservative assumptions relating the irrigation activity conditions, including irrigation of clay soils, allowing for up to 100m^2 per person for land application effluent disposal. However, desktop analysis of available data and previous reports completed during the EIS were used to identify land systems and soil types previously mapped. The potential impacts to soils and geology of the proposed irrigation scheme are the subject of a separate detailed assessment report with MEDLI modelling prepared by GHD.

The site has not been mapped within the Belyando Shire Planning Scheme as being at risk of the occurrence of acid sulfate soils (ASS) as it is located inland and above 20m AHD. ASS is not considered to be a risk factor in non-coastal areas and on land above 20m AHD.

Slope lengths across the site vary, but are estimated to be approximately 50m, giving the site an overall erosion risk rating of very low.

2.4 Waterways and Ambient Water Quality

The construction depot is located within a broad, relatively flat plain within the Belyando River catchment. The drainage lines (tributaries of Gowrie Creek) that intercept the western side of the site are ephemeral. Data presented in the EIS indicated that a flood event within the Belyando River system occurs generally at least once per year, as recorded at the Gregory Developmental Road gauge during the 57 year period (1949 to 2006, excluding no data years 1972 to 1976). Rivers and creeks within the catchment were assessed as responding quickly to storm flow events, with rivers and creeks filling rapidly and overflowing onto the adjoining floodplains where flooding could persist for a number of days (GHD 2012a, V3;S3;p.3-7).

Based on the regional hydraulic analysis undertaken by Calibre Operations Pty Ltd and summarised in the Drainage Design Report (Ref. No. CARP12033-REP-C003), the proposed construction depot site may be partially or fully inundated during a 50 year Average Recurrence Interval (ARI) storm event.

2.5 Groundwater

Observed depths to groundwater presented in the EIS indicated that groundwater is typically encountered between 15m and 75m below ground level and interaction between surface water and groundwater resources in the Project (Rail) area is likely to be limited to major watercourses including the Belyando River and Mistake Creek, both of which are downstream of the site (GHD 2012b, p3-3). Refer Figure 1 for nearby registered groundwater bores.

Data reported during the EIS indicated that bores within the Mistake Creek alluvium remained dry therefore there is no yield data available for the shallow alluvial deposits. Yields of up to 3.43 L/s have been recorded in the Tertiary-aged sedimentary aquifer. Yields in the bedrock aquifers are typically lower and range from 0.4 L/s to 0.75L/s of slightly brackish water (up to 2000 microS/cm). Saline water was reported in two bores with EC values of 45,000 microS/cm (Anakie Metamorphic Group) and 53,100 microS/cm (Mt Hall Formation) on RN 12030176 reported a pH value of 7.5. (GHD 2012c, p2-10).

Recharge of alluvium underlying the creeks and rivers was determined during the EIS to be likely to occur during the wet season when surface water levels are highest. Recharge of Tertiary-aged aquifers is via rainfall recharge at outcrop areas and from percolation through alluvial deposits during peak flow of surface water. The underlying Permian and Cambrian aquifers are recharged through leakage from alluvial and Tertiary sediments and via direct recharge at outcrop areas. Groundwater is thought to flow towards the low-lying rivers that dominate the CCMRP area with the ridge between the Belyando River and Suttor River catchments forming a possible groundwater divide (GHD 2012c, p2-16).

No springs have been identified in the vicinity (<10km) from the construction depot site and groundwater dependent ecosystems were identified during the EIS as including riparian vegetation associated with major waterways such as the Belyando River and Mistake Creek, where permanent waterholes persist throughout the dry season. This was concluded to indicate a base flow connection to groundwater in these areas (GHD 2012c, p.2-17).

Stock and domestic use of groundwater comprise sensitive receptors for any bores less than 10km from the construction depot. The risk of contamination or impact on resource availability during construction was

assessed to be low, with the highest risk of impact being for bores located less than 1km from construction zone (GHD 2012c, p.2-17). No bores have been identified <1km from construction depot.

2.6 Vegetation

Observations presented during the EIS indicated that in the vicinity of the proposed construction depot a combination of broad acre pastures of rough native grassland with scattered shrubs and areas of dense acacia woodlands (GHD 2012a, V3:S4:p4-7). Drainage lines associated with the western side of the construction depot comprise wooded and degraded/non-wooded riparian zones along the banks of the drainage lines (GHD 2012a, V3:S4:p4-14).

2.7 Nearest Residential Receptors

The nearest residential receptor is located more than 3km to the northwest of the construction depot. The site conditions in the vicinity of this residence are predominantly rural and as such construction depot activities resulting in noise emissions, odour/dust emissions and light emissions beyond the boundary of the construction depot have the potential to result in impacts affecting amenity at this location. However, given that the distance to the residence is greater than 3km from the construction depot and the residence is shielded to a degree by topographical features (elevation), it is unlikely that activities at the construction depot will result in direct adverse impacts at the residence.

Data presented in the EIS indicated that the predicted construction noise for combined plant operation for civil works (including operation of concrete batching plants) had been calculated at increasing distances from the CCMRP. The assessment concluded that noise generated by construction plant would dissipate over distance. Predicted noise levels over distance for civil works were estimated (refer Table 2-3).

Table 2-3 Predicted Noise Levels Over Distance – Civil Works

Activity	Overall sound power level dB(A)	Distance						
		50m	100m	250m	500m	1000m	2000m	3000m
Civil works[1]	119	77dB(A)	71dB(A)	63dB(A)	57dB(A)	51dB(A)	45dB(A)	41dB(A)

Table Note: [1] excludes pile driving impact noise

(Source: GHD 2012a, V3;S9; p.9-16)

During the EIS, in the absence of air quality objectives for deposited dust in the EPP (Air) the assessment of deposited dust adopted the NSW Office of Environment and Heritage (OEH) impact assessment criterion incremental contribution of deposited dust at sensitive receptor locations of 2g/m^2/month (insoluble solids, annually averaged), as well as a maximum total deposited dust level of 4g/m^2/month (insoluble solids, annually averaged inclusive of background. It was noted in the EIS that the NSW Approved Methods assessment criteria of 4g/m^2/month is equivalent to 130mg/m^2/day, while the Queensland DEHP recommended amenity guideline is 120mg/m^2/day averaged over one month (GHD 2012a, V3;S7;pp7-2 to 7-3).

It was noted in the EIS that the location of the CCMRP is in a remote area of Central Queensland, separated from population centres and the prevailing conditions in the vicinity of the construction depot are characteristic of a dry, inland environment, meaning that 'natural' dust loads can be present periodically throughout the year due to livestock movement, vehicle traffic associated with the nearby Gregory Development Road and wind driven dust across the plains where there is little topographic or vegetation relief (GHD 2012a, V3;S7;p7-4).

It was determined during the EIS that due to the inland location and lack of concentrated emission sources such as industrial, urban, combustion sources intensive animal husbandry or wastewater treatment/disposal, the ambient background levels of gaseous pollutants and odorous compounds was considered to be negligible to nil (GHD 2012a, V3;S7;p7-5).

There is the potential for indirect impacts on the residents' amenities associated with changes to traffic conditions along the Gregory Developmental Road during construction. Potential impact relating to traffic will

be addressed and managed through the implementation of a Construction Traffic Management Plan for the CCMRP.

3 Proposed ERA Information

3.1 Sewage Treatment Activities

An onsite package STP, storages and effluent irrigation scheme will be required to treat and dispose of all wastewater flows from the construction depot as the site is not currently sewered. It is anticipated that there will be a maximum of 100 construction workers at any given time on site, with expected flows to consist of domestic sewerage from toilets, office crib facilities located within the construction depot site and washroom facilities. The operational life of the STP is expected to be for the duration of the construction phase, up to 2 years.

The anticipated daily usage of the STP will be from the following personnel:

> Office/Stores: 1 crew – 14 people

> Storage personnel for pipes - 4 people

> Storage personnel for girders - 4 people

> Ballast stockpile personnel - 4 people

> Plant/Fuel farm - 10 people

> Mobile office - 4 people

60 people for the track laying/flash butt welding (FBW) plant/ballast train loading/ track material handling.

A total of 100 people therefore will intermittently utilise the office facility, of which about 25 people will be working nightshift in loading track relaying train/ballast train/FBW night shift and some truck movements delivering pipes/girder.

For the purposes of this approval, the proposed STP, irrigation areas and effluent storage requirements have been conservatively estimated based on experience and knowledge with similar sites and developments. It is anticipated that the detailed design of the STP, effluent irrigation areas and effluent storage will be finalised using the modelling tool MEDLI, on completion of a sustainability study and land capability assessment for the proposed irrigation area. These studies are the subject of a separate investigation report prepared by GHD.

The flows expected to the STP are approximately those for a 44EP STP plant, based on a conservatively high estimate of daily flow per capita of 90L/person/day based on similar data usage data for educational settings (i.e. higher than expected volumes to be used in calculating the reference design). As such the reference STP will have the capacity to treat up to 8.8kL/day of wastewater. It is anticipated that due to the short duration of the STP operation that there will be minimal inflow and infiltration to the system required to be treated.

Effluent reuse is proposed via a combination of surface irrigation and possible alternate usage for dust suppression on the Adani rail construction site, with effluent from the package treatment plant to be treated to a Class A standard. Nutrient removal and disinfection capabilities will be such as to provide effluent suitable for irrigation of public open spaces.

The final plant specification to be chosen by Adani Mining Pty Ltd is subject to confirmation, however the reference case of a 44EP plant has been proposed for consideration for approval purposes as it is likely to represent the eventual scale of development. The nominated wastewater flows of 8.8kL/day gives an approximation of the likely irrigation requirements and management requirements for the STP.

The methodology of derived flow calculations are shown in Appendix A.

3.2 Elements of the Proposed STP

Proposed details of the wastewater treatment system are included in Table 3-1.

Table 3-1 STP Information

Parameter	Details
Maximum Plant Capacity (kL/day)	Plant to treat up to 8.8kL/day (peak dry weather flow)
Expected Sewage Volumes (L/person/day)	60-90L/person/day (adjusted in accordance with attendance patterns)
Equivalent Persons (EP)	44 EP (8.8kL/200)
Treatment Type	Proprietary Package Treatment Plant
Annual Irrigation Volume Generated (ML/year)	3.21 ML/year (sewage effluent volume may be adjusted downwards for reduced effluent volume as a result of reduced water due to reuse for dust suppression)
Nutrient Output	10 mg/L Nitrogen: 5 mg/L Phosphorous
Effluent Class	Class A
Storage (no of days)	7 days
Storage Volume for 7 days storage (Total)	61,600L

Note: These parameters have been based on concept design and once contract is awarded should the parameters change significantly, MEDLI modelling will be revised in order to justify any proposed approval revisions if necessary.

The contract for supply, installation and operation of the STP has not been awarded, however it is envisaged that the STP will be a proprietary package treatment plant incorporating, chemical and biological nutrient removal, filtration and disinfection using Sodium Hypochlorite and/or Ultra Violet light (UV) system as required.

Construction of the proposed STP is expected to involve the following works:

> installation of an automated STP with instrumentation and monitoring equipment above 100 year ARI (with flood immunity provided where required);

> construction of an enclosed building for housing STP equipment;

> installation of pumps as required for the transfer of wastewater from site facilities to the STP inlet and treated effluent from the STP to the nominated irrigation area;

> installation of wet weather storage tank equipped with isolation valves;

> installation of wastewater pipelines site facilities to the STP inlet and treated effluent pipelines from the STP to the irrigation area; and

> installation of a metered or manual irrigation system to the designated irrigation area.

A description of the elements of a typical STP follows:

Element 1: Inlet Works

Incoming sewage will be received into the treatment plant through the inlet works. The inlet works will consist of a screenings and grit removal system as appropriate.

Element 2: Bioreactor Tank

The screen-degritted waste will flow to a bioreactor tank through either a gravity feed or pump flow to a bioreactor tank. The bioreactor chamber/tank will consist of aerobic zones for the aerobic biological reduction of BOD5 and nitrogen. The reactor is likely to have aeration blowers, submersible mixers and return activated sludge pumps.

Element 3: Sludge Tank

Waste sludge from the treatment process will be tankered offsite for further treatment.

Element 4: Filtration

Clarified supernatant from the aerobic zone of the bioreactor will be treated in the filtration unit to satisfy turbidity requirements.

Element 5: UV Disinfection

If required to achieve A Class quality a system of UV disinfection may additionally be fitted to the STP. Filtered effluent water from the filtration unit will pass through the UV system if required to achieve disinfection rates. Any UV system will be designed to provide minimum dose level of 40mw/cm^2 at peak flows, incorporating continuous intensity monitoring, lamp failure alarms and auto wiping mechanism.

Element 6: Chlorination

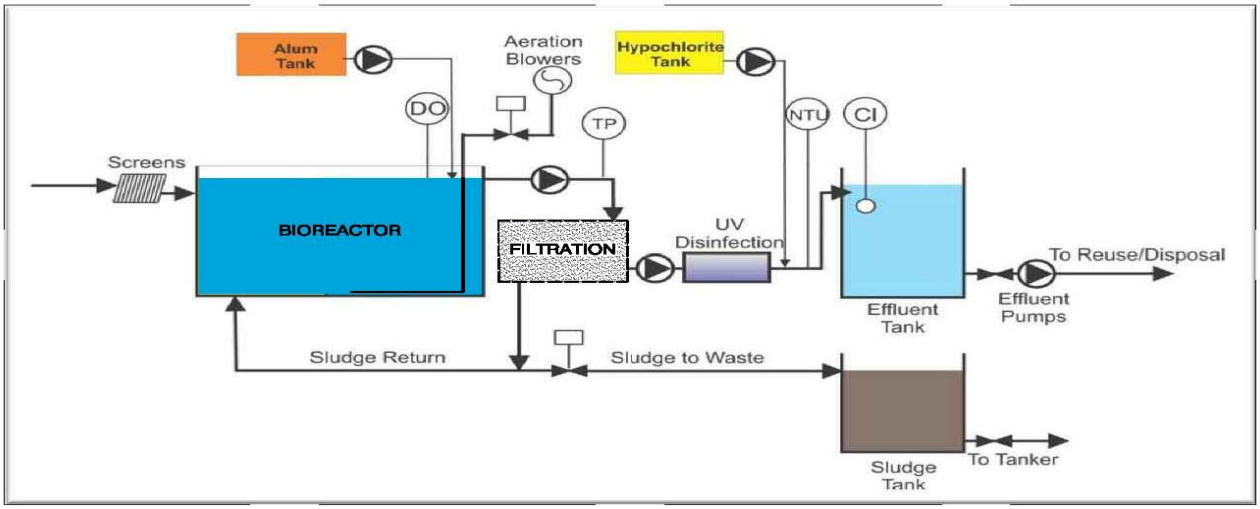
The final effluent will be dosed with Sodium Hypochlorite for disinfection before storage/reuse or transfer for irrigation.

3.3 STP Process Flow

A package plant which will provide the stated level of treatment, methodology and compliance to the aforementioned standards, is readily available. The ultimate design, upgrade and layout considerations will be finalised as part of a comprehensive performance based supply chain process. In the interim and for the purposes of the application a generalised process flow diagram is shown below for the treatment system.

The STP will utilise Programmable Logic Control liked with Supervisory Control and Data Acquisition (SCADA) computer interface system to provide point and click operation and value entry controls. Remote monitoring and alarming systems will be in place regarding process and effluent parameters to be monitored.

Typical Layout for the Proprietary Package Treatment Process



3.3.1 Effluent Quantity

As discussed the peak flow to the STP per day has been calculated as 8kL/day based on a total expected number of 100 construction depot personnel with a variable usage pattern at the facility.

Peak Daily Capacity Flow = 44 EP x 200L/EP/day

= 8.8kL/day

The plant capacity (in accordance with the stated thresholds of the EP Reg 2008) of the plant is therefore expected to be 44EP using 200L/EP/day. This activity will generate 3.21 ML/year approximately of effluent to be irrigated/disposed to land or recycled.

The effluent may also be used within the CCMRP construction areas for dust suppression during construction, which may further reduce the volume of effluent required to be irrigated, thereby reducing overall water demand for the construction activities and reducing the volume of treated effluent requiring disposal to land.

3.3.2 Effluent Quality

Effluent will be treated to comply with the quality specified for Class A effluent suitable for irrigation of sites requiring unrestricted public access and for general dust suppression usage in accordance with the *Public Health Regulation 2005* and *National Water Quality Management Strategy Australian Guidelines for Water Recycling: Managing Health and Environmental Risks 2006.*

The expected effluent quality discharges are shown in Table 3-2 below.

Table 3-2 Expected Effluent Quality Discharge

Parameter	Quality Required	Release Limit
pH	6.5-8.5	range
Turbidity	< 2 NTU	maximum
Total Dissolved Solids	< 300mg/L	maximum
Total Suspended Solids	<30mg/L	maximum
Biochemical Oxygen Demand	<20mg/L	maximum
Total Nitrogen	< 10 mg/L	maximum
Total Phosphorous	< 5 mg/L	maximum
Residual Chlorine	0.5-1.0 mg/L free chlorine	range
Escherichia coli	< 10 cfu/100ml*	maximum

*cfu = colony forming units

The STP is to be designed with an emergency overflow/return valve so that treated effluent can be returned to the inlet if the quality of the treatment effluent fails to meet the quality criteria for disposal by land irrigation or for use as dust suppressant within the CCMRP construction site.

In the event that monitoring indicates inadequate treatment of wastewater, appropriately qualified service technicians are to be contacted to service and repair the STP equipment as necessary.

3.3.3 Noise and Odour

The closest sensitive receptors (work locations within the construction depot boundary) are anticipated to be located more than 1km distance from the proposed location of the STP. The STP is not expected to generate noise or odour levels at a nuisance level due to the system being fully enclosed and the pumps submersible. In order to provide for mitigation of noise and odour it is anticipated the STP will be arranged in such a manner that appropriate noise reduction at the nearest sensitive residence (>3km) will be achieved, and that visual screening will be provided to limit any potential for the perception of odour from the STP.

3.3.4 Waste Disposal

Wastes identified for the STP include the following:

> sludge;

> grit/screenings; and

> wastewater pumped out from wet weather storage tank.

Grit, screenings and sludge shall be removed from site and disposed of to an appropriately licenced facility.

Wastewater pumped out from the wet weather storage tank during emergencies shall be collected by a licensed regulated waste transporter and disposed of at IRC's STP or other suitable disposal location.

3.4 Irrigation System

Treated effluent from the STP is to be irrigated on seeded pastures/grasses and buffer areas located on the site. Based on Cardno's experience with similar sites for similar developments, the Total Land Area required for the irrigation scheme is estimated to be up to 1.5ha to include approximately 1.0ha irrigation space, buffers to the scheme and appropriate setback as well as adequate provision for treated effluent storage tanks. Irrigation design will be confirmed using the MEDLI modelling tool in a separate irrigation investigation prepared by GHD in connection with the construction depot STP.

Treated effluent shall be stored in the wet weather storage tank via a diversion valve during wet weather periods until conditions are appropriate for irrigation.

The proposed STP wet weather storage tank and irrigation areas will be located approximately 1km from a tributary of Gowrie Creek. Additionally an appropriate setback of 20m will be maintained from drainage lines, and drainage swales in the design of the irrigation system and irrigation shall not occur during rainfall events. Overflows are not expected to occur from the activity due to the adequate storage capacity of the system, however off site tankering will be adopted as a contingency in the event that there is a risk of an overflow occurrence.

The potential impacts to groundwater shall be considered as part of the effluent disposal management plan for the scheme. The management of potential groundwater impacts will occur through the confirmation of irrigation parameters, and the establishment of irrigation scheme in such a manner so as to prevent nutrient leaching to groundwater.

Recycled water use shall be carried out in accordance with the requirements of the National Water Quality Management Strategy Australian Guidelines for Water Recycling: Managing Health and Environmental Risks in terms of the level of treatment, effluent quality, effluent monitoring and monitoring frequency and specified controls and requirements where appropriate.

Thus it is anticipated that under normal circumstances there would be no discharge to waters from the STP as the treated effluent generated would be irrigated to land with minimal runoff, used as recycled water or held in wet weather storage during wet weather conditions.

3.5 Wet Weather Storage and Emergencies

The proposed wet weather storage tanks shall be lined, and sized to provide approximately 7 days treated effluent storage. Treated effluent shall be stored in the wet weather storage tanks via a diversion valve during wet weather periods. When treated effluent levels reach 90% capacity (i.e. within 10% of the top of the storage tank), alarms shall be triggered indicating the level where action is required to prevent a potential overflow. Effluent storage dimensions will be confirmed using the MEDLI modelling tool at a later date.

Notwithstanding, a contingency is in place for the unlikely event that an overflow from the wet weather storage tank could occur from extreme wet weather conditions (over 7 days). In this event an appropriately licensed tanker removal contractor shall be engaged to collect and dispose of treated effluent and dispose at a Council STP such as Moranbah or Clermont or similar suitably licenced facility.

It should be noted that the wet weather storage capacity for treated effluent provided includes several storage tanks rather than a single tank. Hence in the unlikely event of a treatment plant failure it is proposed that an isolation valve be used to manually isolate an empty effluent storage tank which can be temporarily used to store untreated sewage in emergencies prior to vacuum truck removal to a suitable offsite disposal location.

In addition to isolation of an effluent storage tank in emergencies, provisioning will be made for back-up generator to be available on site to run the STP in the event of a power failure to the STP. Package treatment plant provisioning for approximately 2 hours influent storage will be made at the head of the plant to allow reactivation time for activation of contingency in the event of treatment plant failure.

4 Irrigation Activity Details

4.1 Proposed Irrigation Scheme

Sufficient land area is available on the site which is suitable for irrigation for the 44EP STP. Suitable land areas which may be used for the irrigation scheme are shown in Figure 2.

The proposed irrigation areas and effluent storage dimensions shall be confirmed following detailed design of the STP using the modelling tool MEDLI and findings and recommendations from the land capability/sustainability study, however for the purposes of approval a conservative irrigation area estimate of 100m^2 per person has been calculated and proposed.

In support of this proposal, the maximum flow possible to the plant from this development stage is estimated to be 8.8kL/day under ADWF conditions. The flow contribution from wet weather inflow and infiltration is expected to be negligible over the life of the STP as this is a temporary STP with a proposed life span of two years.

An effluent with a median TN concentration of 10mg/L and TP concentration of 5mg/L has been proposed and the irrigation scheme proposed is considered to be adequate for land disposal of treated effluent through irrigation at this concentration, based on Cardno's experience with similar projects and the mapped soil types and generalised soil characteristics presented in the EIS.

Under clay soil conditions an irrigation area of up to 1.0ha is likely to be optimal for disposal of effluent (subject to the outcomes of the MEDLI modelling) with a wet weather treated effluent storage volume of 61,600L (sufficient for approximately 7 days irrigation storage for wet weather). The final application/irrigation rate is specified in the GHD MEDLI assessment report prepared in addition to this report.

With this area and storage volume, approximately 90% of the effluent would be recycled, and no significant leaching of nitrogen or phosphorus would be expected.

Irrigation is most likely to occur by means of subsurface drip irrigation. An automatic scheduling system with soil-moisture monitoring and automatic shutoff during rain periods is preferred for larger irrigation schemes by DEHP, however given the limited scale of this scheme, manual shutoff and management systems are considered appropriate. Irrigation should not occur during rain periods, and should be avoided in areas when and where ponding occurs.

The proposed irrigation parameters for the site are shown in Table 4-1 below.

Table 4-1 Proposed Irrigation Parameters

Parameter	Clay
Irrigation trigger	Soil water deficit >10mm
Irrigation application	To drained upper limit
Grass species	Kikuyu (or equivalent pasture)
Nutrient concentration (mg/L	10:5 N:P
Holding tank size (L)	61,600
Soil type	Clay

Note: The nutrient concentrations have been based on concept design and once STP supplier contract is awarded should the parameters change significantly, MEDLI modelling will be revised in order to justify proposed approval revisions if necessary.

4.2 Water Balance

Considering parameters such as irrigation scheduling, irrigation area, plant type and storage volumes, it is considered that the correct management of the activity generate minimal overflows from the effluent storage tanks.

The combination that produced an acceptable outcome in terms of the above requirements is summarised below.

> Estimated Effluent Production: 3.21ML/year (plant caters up to 100 persons for 90L/person/day).

> Buffer Storage capacity: Approximately 7 days wet-weather storage.

> Application Rate: Up to 3.21 ML/ha/year over 1.0ha (the system includes no contribution from infiltration and rainfall directly on the buffer storage as tank is enclosed).

> Vegetation Irrigated: Kikuyu (or equivalent grass or pasture). It would be assumed that occasional slashing and removal of the grass off-site would be practised.

> Irrigation schedule: Irrigate to drained upper limit when soil water deficit 10mm. No irrigation occurs if soil is saturated, and/or rainfall is occurring.

Under the above conditions, approximately 90% of the effluent was recycled (thereby producing a 10% rate of overflow of the system which is acceptable).

According to NSW DECC guidelines for managing STP overflows, where medium strength treated effluent is used for irrigation (as in the case here), overflow of the buffer storage is acceptable, provided it occurs in less than 25% of years (i.e. is sufficient to prevent 75th percentile of years overflows), therefore the balance between the irrigation rate and the storage capacity of the system is considered acceptable.

4.3 Selection of Irrigation Areas and Irrigation Management

The proposed irrigation area has been selected to enable colocation with the STP and to provide separation distance from active work areas within the construction depot as a means of mitigating potential odour nuisance emissions generated by the facility.

Potential impacts associated with the operation of the proposed effluent irrigation scheme may include the following.

> Contamination of the receiving environment (including land, groundwater and surface waters) as a result of an untreated or treated effluent spill.

> Contamination of the receiving environment (including land, groundwater and surface waters) as a result of failure of components used in the effluent irrigation scheme.

> Sedimentation of receiving waters as a result of the erosion and sediment wash-off from the irrigation area, as a result of degradation of the vegetation cover.

Mitigation of these impacts will be achieved through implementation of proposed management measures and periodic monitoring of the receiving environment.

Generally, management measures will consist of effluent quality and quantity monitoring, infrastructure inspection and environmental monitoring in order to minimise the environmental risk associated with the operation of the effluent irrigation scheme.

The following procedural requirements shall be complied with during operation of the effluent irrigation scheme.

1. Irrigation shall be restricted to the maximum rate used in the analyses that are carried out to size the irrigation area.
2. Only treated effluent of the appropriate standard shall be used for irrigation. Should the quality of effluent be determined by testing to be unsuitable for land irrigation, the effluent is to be pumped back into the inlet balancing storage tank for re-treatment.
3. Adequate buffer distances to watercourses shall be maintained.

4. Meters will be installed in the area to determine the soil moisture at the commencement of irrigation, to eliminate the possibility of surface water ponding or runoff occurring where appropriate.
5. There is to be no effluent irrigation during rain events. Irrigation shall only re-commence a minimum of 4 hours following cessation of rainfall.
6. There is to be no ponding of effluent at the irrigation area. Should ponding occur, irrigation shall cease until such time as the soil moisture content has sufficiently reduced to eliminate further ponding.
7. Appropriate signage indicating that recycled water is not suitable for drinking shall be provided and maintained at every accessible outlet from the treated effluent distribution system. Signs shall be easily visible and maintained regularly. Signage shall also be provided and maintained at the irrigation area informing of the use of treated effluent for land irrigation.
8. To avoid overflow of the wet weather storage, when and if the storage level rises to within 10% of its overflow level the contingency arrangements for the possible necessity for offsite removal to increase freeboard will be activated.
9. The irrigation area shall be maintained in a well-grassed state to minimise the risk of erosion and sediment wash-off during storm events. Where necessary, turf, pasture grass or trees will be replaced to maintain the vegetation cover.

The effluent disposal management plan shall be developed based on the results of the MEDLI modelling and findings and recommendations of the land capability/sustainability study currently being carried out. The plan shall detail the implementation of this irrigation strategy.

5 Potential Environmental Impacts

Table 5-1 details the potential impacts on the operation of the STP and effluent irrigation area resulting from site characteristics and constraints relevant to the construction depot site.

Table 5-1 Potential Impacts of Site Characteristic on STP Operation and Land Disposal of Treated Effluent

Parameter/Issue	ERA 63 Components Most Likely Affected	Potential Impacts	Potential Adaptation Outcomes
Temperature extremes	STP and irrigation equipment and power supply	Increase in humidity may affect equipment function and power supply.	Alarms installed on critical plant and equipment.
Temperature inversions	STP Irrigation area	Odours	Proposed STP and irrigation area has been located approximately 500m from the office area within the construction depot.
Intense rainfall events	Irrigation	Reduced irrigation capability. Increased nutrient load in runoff.	Reuse of treated effluent for dust suppression to maintain treated effluent volumes at low level. Cease irrigation during rainfall events. Commence irrigation a minimum of 4 hours after rainfall has ceased.
Rain days	Irrigation	Reduced irrigation capability Increased volume of treated effluent requiring storage.	Reuse of treated effluent for dust suppression to maintain treated effluent volumes at low level.
Flooding	STP Irrigation area	Damage to STP. Inundation of irrigation area / reduced irrigation capability. Increased volume of treated effluent requiring storage.	STP location at or above Q100 flood level. Irrigation area located at or above Q50 flood level. Maintain site stormwater diversion and drainage lines clear of debris and sediment build-up.
High wind events	Irrigation	Increased risk of wind drift of treated effluent spray downwind of irrigation area.	Maintain buffer areas. Cease irrigation when wind speeds are >8m/s.
Humidity	STP and irrigation equipment and power supply	Increase in humidity may affect equipment function and power supply.	Alarms installed on critical plant and equipment.
Bushfires	STP and associated infrastructure	Damage to STP and associated infrastructure. Increased fire loads resulting from irrigation of Kikuyu.	Firebreak around irrigation area. Land management practices to be negotiated with adjacent landholders to maintain and manage firebreaks and reduce fuel loads in irrigation area. Bushfire management plan will be implemented.
Land use conflicts	STP and irrigation area	Loss of Class C1 agricultural land.	Co-locate STP and irrigation area to minimise footprint of the facility. Avoid locating facilities in area that requires vegetation clearing.

Parameter/Issue	ERA 63 Components Most Likely Affected	Potential Impacts	Potential Adaptation Outcomes
Contaminants released to land	STP operation / overflow release and fuel / chemical storage Treated effluent storage Irrigation	Increased nutrient concentration in soils. Increased N levels in grazing pasture. Release of pathogens to grazing land. Release of contaminants (hydrocarbons and chemicals) from spills at storage and transfer locations.	Designated irrigation area only to be used for land application of treated effluent. Land area designated is sufficient for volume and quality of effluent to be irrigated based on MEDLI modelling results. Fencing of irrigation area to exclude access by stock and unauthorised persons. Buffer distances enforced. Slashing and removal of vegetation within the designated irrigation area and buffer areas. Restricted use specifications for slashed vegetation from irrigation and buffer areas (eg unsuitable for stock feeding). Implement waste management plan. Implement emergency management plan.
Contaminants release to surface waters	STP operation / overflow release and fuel / chemical storage Treated effluent storage Irrigation	Increased nutrient load to surface water. Release of pathogens to surface water. Sedimentation of drainage lines. Release of contaminants (hydrocarbons and chemicals) from spills.	Alarms installed on critical plant and equipment. Monitoring of plant and equipment and receiving environment. Implement and maintain stormwater control designs. Implement waste management plan. Implement emergency management plan.
Physical and chemical soil condition	STP surrounds Irrigation area	Increased erosion of exposed soils in STP area. Increased erosion of soils in irrigation area. Degradation and damage of soil condition resulting from increased salt concentrations in soil profile. Exposure/disturbance of sodic subsoils resulting in exposed erodible surface soils, surface crusting and hard setting affecting establishment and growth of vegetation in irrigation area.	Monitoring of plant and equipment and receiving environment. Implement and maintain stormwater control designs. Implement erosion and sediment control measures in accordance with Best Practice Erosion and Sediment Control manual (IECA 2008). Implement Construction EMP, ESCP, Soil Management Plan and Effluent Disposal Management Plan.
Lighting	STP Irrigation area	Increase in visual amenity and fauna impacts due to lighting of the STP.	Adopt directional lighting design. Rationalisation of lighting to be only what is required to maintain safe access in the vicinity of the STP. No irrigation shall occur at night. Secure fencing around irrigation area to prevent unauthorised

Parameter/Issue	ERA 63 Components Most Likely Affected	Potential Impacts	Potential Adaptation Outcomes
			access at night.
Groundwater	STP Irrigation Chemical storage and refuelling	Degradation of groundwater. Contamination of groundwater.	AS1940-2004 design and MSDS compliance for containment structures for storage – sealed/lined surfaces, hardstand areas, bunded areas, containerised storage. Storage and handling areas away from existing bores, creeks and major watercourses (eg >1km) – protection from spills. Spill kits and booms at storage and handling locations and in mobile vehicles, plant and equipment.

There are potential environmental and public health impacts associated with the onsite treatment, storage and disposal of effluent and fuel storage activities as presented. The potential impacts associated with the operation of the ERAs are identified as follows:

> odour emissions and gaseous chemical release;

> noise from operation of equipment; and

> release of contaminants to land, surface water or groundwater due to effluent or sludge spill, fuel tanker rupture, tank leakage or diesel spill.

The potential impacts associated with the contaminant releases are identified below:

> contamination of land, surface water or groundwater due to poor effluent quality;

> contamination of land, surface water or groundwater due to incorrect effluent irrigation application rates;

> contamination of land, surface water or groundwater due to uncontrolled effluent and untreated stormwater discharge;

> contamination of land, surface water or groundwater due to tank leakage or rupture;

> contamination of land, surface water or groundwater due to diesel spills;

> sedimentation of receiving waters as a result of the erosion and sediment wash-off from the irrigation area, as a result of degradation of the vegetation cover;

> over nitrification or salination of soils through excessive nutrient loadings and salinity loadings;

> degradation of soil structure and increases in sodicity over time leading to reduction in agricultural/landscaping use value of the soils;

> odour emission from STP and irrigation areas;

> odour emission from fuel storage infrastructure and spilled fuels;

> public health risks due to uncontrolled access to plant and equipment, volatile organic compounds or solvents or exposure to irrigation spray aerosols; and

> public health risks due to fire from ignition or explosion of flammable liquids.

Environmental and public health impacts associated with release of untreated effluent and diesel or changes in the ambient environment will be minimised through adherence to the mitigation and control measures proposed in this SBMP (refer Section 6).

6 Site Based Management Plan

This Site Based Management Plan (SBMP) identifies the management strategies to be adopted to ensure the activity is managed in accordance with best practice environmental management (BPEM).

The purpose of this SBMP is to demonstrate that persons carrying out the ERA have in place a structured framework to:

> set the environmental objectives or standards to be achieved;

> identify the potential environmental harm that may occur from the operation of the ERA and establish and document control measures to prevent this harm as far as practicable;

> identify extraordinary factors that may cause environmental harm, and establish contingency plans to deal with these;

> ensure that all persons carrying out the activities are aware of the environmental risks, and are trained in the measures and contingency plans to deal with them;

> ensure the effectiveness of the measures and contingency plans as required, by implementing monitoring of environmental performance;

> ensure record keeping to assist in the communication of environmental performance throughout the organisation and to DEHP; and

> ensure periodic reviews of environmental performance and continual improvement.

The SBMP is to be adopted by Adani Mining Pty Ltd in the planning and management of the ERA.

6.1 Preamble to the Site Based Management Plan

6.1.1 Legislation and Policy Framework

The primary environmental legislation relevant to this SBMP is the *Environmental Protection Act 1994* (EP Act) and subordinate legislation, specifically the *Environmental Protection Regulation 2008* (EP Reg) and the *Waste Reduction and Recycling Act 2011* and sub-ordinate legislation. The EP Act protects environmental values through development and implementation of environmental protection regulations and policies.

The *Environmental Protection (Waste Management) Regulation 2000* ensures protection of the environment through the minimisation of the impact of waste on the environment and establishing an integrated framework for minimising and managing waste under the principles of ecologically sustainable development.

The *Environmental Protection (Air) Policy 2008* (EPP Air) ensures protection of ambient air quality and specifies indicators and air quality goals for control of the release of airborne contaminants.

The *Environmental Protection (Noise) Policy 2008* (EPP Noise) specifies an acoustic quality objective for protection of the well-being and amenity of individuals and the community in residential areas.

The *Environmental Protection (Water) Policy 2009* (EPP Water) ensures protection of environmental values from activities that may result in the release of contaminants to waterways or stormwater drains.

The *Work Health and Safety Act 2011* ensures protection of all personnel and the environment when storing and handling dangerous goods.

6.1.2 Terminology

Contractor refers to any party of company performing works associated with the operation of an ERA and includes all employees of the Contractor and sub-contractors.

Council or **IRC** refers to the Isaac Regional Council.

DEHP or **Administering Authority** refers to the Department of Environment and Heritage Protection.

Environmental Harm refers to any adverse effect, or potential adverse effect (whether temporary or permanent and of whatever magnitude, duration or frequency) on an environmental value, and includes environmental nuisance.

Operator refers to Adani Mining Pty Ltd or any party or company responsible for the operation of the ERA to achieve compliance with this EMP and for ensuring all statutory requirements are understood and permits obtained. It is anticipated that the Operator with respect to this ERA will be the principal construction Contractor.

Plant refers to all matters associated with the operation of the STP and associated infrastructure.

SBMP refers to this Site Based Management Plan.

Site refers to the proposed development located on part of Lot 4 on SP116046.

Operation refers to all matters associated with the operation of the ERA at the proposed site.

Regulatory Authority refers to the local government, state government or commonwealth government agencies responsible for the enforcement of best environmental practice principles related to the ERA.

6.2 Objectives

The objectives of this SBMP are to minimise adverse impacts on the environment by:

> ensuring all environmental safeguards are carried out correctly; and

> managing site activities effectively.

6.3 SBMP Structure

The components of this SBMP include strategies to manage the following elements.

> Air quality (odours and dusts)

> Noise management

> Storage and use of hazardous materials

> Stormwater control and water quality

> Waste management

> Environmental emergencies

> Complaints Management

> STP Operation

> Effluent Quality Management

> Irrigation Management

Each element of the SBMP includes the following key components.

> ***Rationale***: identification of the element to be managed and the potential environmental impact of activities associated with each element.

> ***Objective/Targets***: identification of the environmental objective(s) and target(s) to be achieved in line with the rationale and in compliance with applicable legislation.

> ***Implementation Strategy***: management measures to be implemented in order to achieve the stated objectives and targets and to ensure impact mitigation.

> ***Performance Indicators***: measurable indicators and standards set to assess the efficiency of management measures and determine compliance with the SBMP.

> ***Monitoring***: monitoring requirements to measure compliance with the performance indicators and frequency of monitoring.

> ***Record Keeping***: details of record keeping requirements over the life of the SBMP.

> ***Reporting and Review***: the requirements for reporting of monitoring results and review of management measures where required.

> ***Corrective Action***: measures to be undertaken should monitoring indicate non-compliance with performance indicators.

6.3.1 Environmental Commitment

Adani Mining Pty Ltd is responsible for ensuring that its activities are undertaken in an environmentally sustainable manner and aims to minimise environmental impacts and continuously improve its environmental performance.

The preparation of this SBMP forms an integral part of the commitment to minimise the environmental risks of its activities.

6.3.2 Responsibilities and Training

The Operator or representative assumes responsibility through its Operations Manager and other relevant line managers for the implementation of this SBMP.

All persons employed in the operation of the site shall be instructed as to Adani Mining Pty Ltd.'s corporate responsibilities and their individual responsibilities as set out in this SBMP and as provided by the EP Act, including:

> **General Environmental Duty** – whereby a person in the performance of their duties shall not do so in a manner which will cause, or is likely to cause, environmental harm unless the person takes all reasonable and practical measures to prevent or minimise such harm.

> **Duty to Notify Environmental Harm** – whereby if a person in the performance of their duties becomes aware that serious or material environmental harm is caused or may be caused by their activity or by someone else's activity, that person must as soon as practicable report the nature and circumstances of the relevant event to the Operator whereupon the Operator must immediately notify DEHP.

> **Compliance with SBMP** – whereby a person in the performance of their duties shall do so in a manner that ensures that the provisions of this SBMP are complied with.

All personnel entering the site will be inducted as necessary, with particular emphasis on environmental control measures and emergency response.

6.3.2.1 Site Induction

It is the responsibility of the Operations Manager to ensure all site personnel receive appropriate awareness training and environmental induction prior to commencement of works.

The induction shall include instruction regarding the following environmental objectives and policies:

1. Due diligence, including:
    > development, establishment and operation of a pollution prevention system;
    > ensuring that appropriate personnel receive reports;
    > ensuring all personnel know the environmental laws and their responsibilities; and
    > ensuring appropriate personnel personally deal with system failures.
2. Duty of Care:
    > all management and staff have an environmental duty of care. Where deemed appropriate for short term personnel and contractors, the Operations Manager may elect to provide a brief environmental explanation/induction and control access to the site.

The Operations Manager shall maintain a signed register of all inductees and monitor the existing workforce to ascertain whether additional training is required.

6.3.3 Environmental Audits and Reviews

Environmental performance shall be monitored throughout the project to determine if and when additional environmental auditing activities are required.

The SBMP shall be reviewed and updated as required on changes to the activity, with the updated copy kept onsite.

6.3.4 Environmental Records

The results of any monitoring from the operation of the development and any corrective actions taken in respect thereof shall be recorded in the environmental management records for the site pursuant to this SBMP.

A copy of the latest copy of the SBMP, relevant development approvals and environmental records shall be retained onsite in the site office.

All environmental records shall be kept for a period of five years.

6.3.5 Environmental Non-Compliance

Adani Mining Pty Ltd and its representatives shall assume responsibility for implementation of this SBMP. Where the Operator becomes aware of a site or operational condition that does not comply with stated performance indicator(s) of this SBMP, there is a requirement for corrective action to be undertaken.

A Corrective Action Request (CAR) form is to be completed and authorised where appropriate in general compliance with the example CAR form provided in Appendix B of this document. The Operator is also required to maintain a register of CARs, which shall demonstrate that appropriate actions have been completed within a suitable timeframe.

It is the responsibility of management to notify DEHP in the event of a notifiable incident/complaint (as defined in s320 of the EP Act).

In some instances, further investigation or monitoring may be required to establish whether the Operator has failed to adequately implement the SBMP, or has failed to comply with relevant legislation, guidelines and statutes. In these instances, an independent party, such as a Consultant, shall carry out the investigation or monitoring.

6.4 STP Elements

6.4.1 Element 1: STP Operation

6.4.1.1 Rationale

This Element details the operational requirements of the STP to minimise environmental harm, minimise pollutant loads to land and minimise discharges to water during operation. Effluent irrigation management is addressed in a separate irrigation management element within this plan.

Operation of the STP and effluent disposal system will be conducted in accordance with the manufacturer's management and maintenance procedures to ensure operational standards are maintained and protection of environmental values is achieved. Maintenance and management measures are required to ensure no significant impacts occur to receiving environments.

6.4.1.2 Objective/Target

To ensure that the STP and effluent disposal system is operated in accordance with appropriate operations and management procedures, and that the release criteria are met.

6.4.1.3 Implementation Strategy

> The Operator will be a Registered Operator pursuant to the EP Act.

> Operational staff shall be educated in the safe use of recycled water and procedures for the operation of the STP.

> The Operator shall provide an induction program for new employees, site visitors and contractors including risk management principles.

> Staff shall be made aware of their general environmental duty obligations under the EP Act and the relevant conditions of the Environmental Authority pertaining to the ERA.

> The STP shall only be operated by persons who have undergone sufficient training to be capable of operating the facility safely and efficiently.

> An alarm system shall be installed as part of the STP to inform the Operator of the STP failure. In the event that the Operator is not present onsite a 24 hour on-call system shall be established to ensure alerts raised are addressed at the earliest opportunity.

> Only authorised persons shall be permitted to access the STP at all times.

> The wet weather storage tank shall be appropriately designed and sized to prevent infiltration, stratification and algal blooms.

> Stormwater quality at the STP is to comply with stormwater quality objectives for the development in accordance with the Queensland Water Quality Guidelines 2009 and stormwater infrastructure is to be maintained in good working order as per Element 4.

> Fittings with connections to the effluent irrigation system shall be colour coded and be distinguished from those of the potable water system to prevent cross connection. The pipe colour coding system shall be as follows:

- recycled water = purple pipes;
- fire suppression water = blue pipes; and
- potable water = steel or black PVC.

> Bursts within the irrigation system shall be isolated and repaired as soon as practicable.

6.4.1.4 Performance Indicators

No complaints received relating to the establishment or operation of the STP.

Investigation and reporting of all incidents/complaints and identified non-compliances resulting in a release of contaminants to the environment.

6.4.1.5 Monitoring

Weekly inspections of the plant shall be undertaken for monitoring of plant operations and inspections of plant equipment and components. Weekly monitoring shall include visual inspections of all irrigation system infrastructure including all visible pipelines and fittings, the treated effluent storage tanks, all pumps infrastructure and connections and any stormwater diversion banks surrounding the irrigation area.

An annual audit of compliance on completion or decommissioning of the activity whichever is sooner, with conditions of development approval shall be undertaken.

6.4.1.6 Record Keeping

A written record of all equipment inspections and any repairs/maintenance actions undertaken shall be maintained and provided to the Administering Authority on request.

A written record of all complaints, monitoring and remediation measures shall be maintained and provided to the Administering Authority on request. This should include details of corrective actions and/or repairs undertaken.

Records shall be maintained of all monitoring results. These monitoring results shall be forwarded to DEHP as part of the annual report.

6.4.1.7 Reporting and Review

The Operator shall report any non-compliance or emergency situations to DEHP as soon as practicable after the emergency situation occurs.

The Operator shall make all records available for inspection by Regulatory Authorities on request.

6.4.1.8 Corrective Action

Non compliances with this element shall include:

> overflows, exfiltration and other effluent spill;

> consistent failure to reach the required effluent quality criteria; and

> STP offline due to equipment failure.

Should there be non-compliance with the stated performance indicator the following corrective actions are to be implemented.

> Identification of the cause of the non-compliance.

> Implementation of appropriate mitigation measures as determined by the Operator.

> Relevant validation monitoring to confirm that the nominated corrective actions have been effective.

The Operator shall implement the corrective action(s) as required within the agreed time frame noted on the CAR.

6.4.2 Element 2: Effluent Quality Management

6.4.2.1 Rationale

The processes involved in treatment of effluent within the STP have the potential to cause environmental impacts to water if improperly managed. Spills and leakages may occur during operations of the STP which may result in release of contaminants to receiving water environments.

The storage and irrigation of treated effluent has the potential to impact on the quality of surface waters in the locality of the STP and effluent irrigation areas. While the intention is to reuse all treated effluent, there will be occasions when extended wet weather periods result in an overflow of wet weather storage. The water quality management and effluent disposal strategy for the STP is to provide a wet weather storage tanks which are unlikely to overtop. This element identifies the requirements for managing the quality of effluent and preventing releases of contaminants to water.

6.4.2.2 Objective/Target

To minimise and manage impacts to receiving water environments as a result of contaminant/effluent release and ensure that Water Quality Objectives are met.

6.4.2.3 Implementation Strategy

> Effluent quality monitoring instrumentation shall be provided for determining the quality of the treated effluent for parameters. Laboratory tests shall be conducted for remaining effluent quality parameters which cannot be measured onsite.

> Stormwater diversion drains shall be constructed in such a manner as to prevent stormwater contact with areas of the site where potentially contaminating activities have occurred.

> The treatment facility shall be maintained in accordance with manufacturers requirements so that the highest quality of effluent is produced and to ensure minimal risk of failure.

> The Operator shall inspect all infrastructure over the facility on a weekly basis to ensure any defects are identified and actions can be taken promptly.

6.4.2.4 Performance Indicators

Quality of effluent released from the STP is to comply with the following target values.

Table 6-1 Expected Effluent Quality Discharge

Parameter	Quality Required	Release Limit
pH	6.5-8.5	range
Turbidity	< 2 NTU	maximum
Total Dissolved Solids	< 300mg/L	maximum
Total Suspended Solids	<30mg/L	maximum
Biochemical Oxygen Demand	< 20 mg/L	maximum
Total Nitrogen	< 10 mg/L	maximum
Total Phosphorous	< 5 mg/L	maximum
Residual Chlorine	0.5-1.0 mg/L free chlorine	range
Escherichia coli	< 10 cfu/100ml*	maximum

*cfu = colony forming units

6.4.2.5 Monitoring

Monitoring of treated effluent shall be undertaken according to the following programme.

Table 6-2 Monitoring Programe

Parameter	Location	Frequency
Turbidity (NTU) and Residual Chlorine	Outlet of the STP	Continuous
BOD, DO, SS, pH, TN, TP and Faecal Coliforms	Outlet of the STP	Monthly
BOD, DO, SS, pH, TN, TP and Faecal Coliforms	Point of outtake from wet weather storage to irrigation system	Monthly
BOD, DO, SS, pH, TN, TP and Faecal Coliforms	Overflow point from the wet weather storage tank	During any overflow event
BOD, DO, SS TN, TP, Faecal Coliforms	Drainage lines adjacent to the irrigation areas (if applicable)	Monthly where there is sufficient rainfall in the preceding 24 hours to cause run-off from the irrigation area (minimum rainfall required to cause run-off should be 30mm or greater) where flows are occurring

Weekly monitoring of the condition of all infrastructure within the facility shall be undertaken to ensure any defects are identified and corrective actions undertaken. During the weekly inspection, visual inspection of the condition of all above ground distribution infrastructure over the site shall be undertaken including all visible distribution pipes and pump sheds on a weekly basis.

6.4.2.6 Record Keeping

The Operator shall maintain a record of any identified infrastructure defects or failure in relation effluent quality management including any corrective actions undertaken.

The Operator shall maintain a record of any monitoring results undertaken including details of corrective actions and/or repairs undertaken.

6.4.2.7 Reporting and Review

The Operator shall submit annual reports of all monitoring data to DEHP as specified in the approval conditions.

6.4.2.8 Corrective Action

Non compliances of this element shall include:

> failure to reach the required effluent quality criteria;

> poorly maintained stormwater control devices; and

> contaminated waters discharging from the site to receiving waters.

Should there be non-compliance with the stated performance indicator the following corrective actions are to be implemented.

> Identification of the cause of the non-compliance.

> Implementation of appropriate mitigation measures as determined by the Principal and Consultant in consultation with the Operator.

> Relevant validation monitoring to confirm that the nominated corrective actions have been effective.

The Operator shall implement the corrective action(s) as required within the agreed time frame noted on the CAR.

6.4.3 Element 3: Odour and Noise

6.4.3.1 Rationale

Operation of the STP and effluent disposal system may result in emissions of odour and noise from plant and equipment. Such emissions may cause amenity impacts to surrounding land users. Adequate maintenance and management of the facilities will be required to ensure impact mitigation.

6.4.3.2 Objective/Target

To maintain and manage the STP and effluent disposal system to prevent emissions that may result in health or amenity impacts.

To comply with the stated performances indicators for noise and odour levels in the locality of the works.

6.4.3.3 Implementation Strategy

6.4.3.3.1 Odour

> All tanks within the STP facility shall be adequately sealed to minimise emission of odour.

> The effluent disposal areas shall be managed to prevent release of aerosols beyond the boundaries of the irrigation areas.

> Should complaints about odour be received, the operator of the STP shall investigate the cause of the odour and undertake corrective actions as required.

> Actions shall include visiting the complainant's locality to determine appropriate mitigation measures and the validity of the complaint. In the event of a dispute, an independent party such as a Consultant shall conduct odour monitoring if necessary.

6.4.3.3.2 Noise Emissions

> The proposed STP and associated equipment shall be fitted with noise minimisation equipment to minimise noise emissions if required. Equipment shall be securely fixed to mounting plates to prevent vibration.

> Should complaints about noise be received, the Operator of the STP shall investigate the cause of the noise and undertake corrective actions as required.

> Actions shall include visiting the complainant's locality to determine appropriate mitigation measures and the validity of the complaint. In the event of a dispute, an independent party such as a Consultant shall conduct noise monitoring if necessary.

6.4.3.4 Performance Indicators

Emissions of odour and noise shall not cause a nuisance at any sensitive place. In the event that complaints are received these will be investigated as soon as practicable and corrective actions identified.

6.4.3.5 Monitoring

Weekly inspections of the plant shall be undertaken for monitoring of plant operation and inspection of plant equipment and components.

Complaint driven noise monitoring shall be carried out at the request of the Administering authority only.

6.4.3.6 Record Keeping

The Operator shall maintain a record of all complaints received in relation to odour and noise disturbance including complainant details, nature of the complaint and corrective actions undertaken.

The Operator shall maintain a record of any monitoring results undertaken including details of corrective actions and/or repairs undertaken.

6.4.3.7 Reporting and Review

A written record of all inspections and maintenance actions undertaken shall be maintained and provided to regulatory authorities on request.

A written record of all complaints and subsequent odour monitoring and remediation measures shall be maintained and provided to regulatory authorities on request.

The Operator shall submit annual reports of all monitoring data to DEHP as specified in the approval conditions.

6.4.3.8 Corrective Action

Should a complaint relating to excessive emission of noise or odour from the works site be received the following corrective actions are to be implemented:

> response to complainant outlining procedure for corrective action;

> identification of the source(s) of the excessive emission of noise or odour;

> implementation of appropriate mitigation measures as determined by the Consultant in consultation with the Operator;

> relevant validation monitoring of noise or odour concentrations at nominated locations; and

> notification of complainant that complaint has been closed out, with details of corrective actions undertaken.

The Operator shall implement the corrective action(s) as required within the agreed time frame noted on the CAR.

6.4.4 Element 4: Solid Waste Management from STP

6.4.4.1 Rationale

Waste management is to focus on appropriate methods to avoid, reuse, recycle and dispose of waste materials generated as a result of the works.

6.4.4.2 Objective/Target

Comply with the provisions of the *Waste Reduction and Recycling Act 2011*.

6.4.4.3 Implementation Strategy

The Contractor shall have due regard for the waste management hierarchy detailed in the EPP Waste. The waste management hierarchy lists the types of waste management practices in preferred order of adoption, as detailed below.

> Waste avoidance

> Waste re-use

> Waste recycling

> Energy recovery from waste

> Waste disposal

Grit and screenings shall be removed from site and disposed of to landfill.

Sludge materials shall be disposed of to an off-site facility and shall be collected by licensed regulated waste transporters.

6.4.4.4 Performance Indicators

Comply with the provisions of the *Waste Reduction and Recycling Act 2011* and the *EP (Waste Management) Regulations 2000*.

Lawful disposal of all sludge, grit and screenings to a licenced waste management facility.

6.4.4.5 Monitoring

Weekly inspections of the plant shall be undertaken for monitoring of plant operation and waste removal requirements.

Weekly inspection of waste collection devices to monitor effectiveness of waste removal.

6.4.4.6 Record Keeping

Records shall be maintained of the method of disposal of all waste. These records shall be made available to DEHP as required.

Records shall be maintained of removal of sludge and grit and screening materials and regulated waste certificates shall be kept at the site for the duration of the project and at Adani's head office for 3 years following project completion.

6.4.4.7 Reporting and Review

The Operator shall make all records available for inspection by relevant authorities on request.

6.4.4.8 Corrective Action

Should there be non-compliance with the stated performance indicator the following corrective actions are to be implemented:

> identification of the cause of the non-compliance;

> implementation of appropriate mitigation measures as determined by the Consultant in consultation with the Operator; and

> relevant validation monitoring to confirm that the nominated corrective actions have been effective.

The Operator shall implement the corrective action(s) as required within the agreed time frame noted on the CAR.

6.4.5 Element 5: STP Hazardous Material Storage and Handling

6.4.5.1 Rationale

Effluent treatment to achieve Class A effluent will involve disinfection by chlorine dosing. Maintenance of the STP will involve the storage of Hydrochloric Acid (UN No. 1789), Alum flocculent and Sodium Hypochlorite.

The site is required to be managed to prevent impacts on human health and the receiving environment as a result of accidental release or spillage of hazardous substances.

6.4.5.2 Objective/Target

To effectively manage the safe storage, handling and disposal of dangerous or hazardous materials within the site in accordance with the *Work Health and Safety Act 2011* and MSDS requirements.

6.4.5.3 Implementation Strategy

Storage is in accordance with the product's MSDS, which are to be displayed with each hazardous substance.

A sufficient supply of sodium hypochlorite and other chemicals required for the operation of the STP is to be maintained.

Where hazardous substances are transferred into, or from, a container:

> spill containment is provided that can hold at least the quantity of the largest container;

> the transfer is done in a manner that avoids splashing or spillage of the substance;

> the place where the transfer occurs is set aside for that purpose, is not within the storage area, and free of obstructions;

> spill clean-up equipment is kept close by;

> the container receiving the substance cannot be damaged by the transferred substance; and

> the receiving container does not require marking.

6.4.5.4 Performance Indicators

Chemical storage areas are inspected and maintained accordingly to ensure no uncontrolled release from the storage area.

6.4.5.5 Monitoring

Weekly inspections of hazardous material storage areas to monitoring compliance with MSDS requirements effectiveness/operation of containment measures.

6.4.5.6 Record Keeping

A written record of all inspections and maintenance actions undertaken is maintained and provided to regulatory authorities on request.

6.4.5.7 Reporting and Review

A register is maintained of all hazardous substances stored in a central location within the site. The register shall include a copy of all associated MSDS.

6.4.5.8 Corrective Action

Non-compliance with the element culminating in corrective action may include:

> inadequate storage of hazardous materials;

> chemical spills during transfer or unloading; or

> human health impacts from poor storage and ventilation and handling of hazardous materials.

The Contractor shall implement the corrective action as required within the agreed time frames noted on the CAR.

6.5 Effluent Disposal Elements

6.5.1 Element 6: Irrigation Management

6.5.1.1 Rationale

Effluent irrigation may result in the release of contaminants to soils surface waters and groundwater. Management measures are required to ensure no significant impacts occur to soils, surface waters or groundwater within the irrigation areas and the receiving environment. Class A treated effluent is to be irrigated into the designated irrigation area in such a way as to prevent environmental harm to waters, including groundwater, soils or plant cover.

This Element provides requirements to ensure that efficient and appropriate application of treated effluent occurs within the bounds of the site and to ensure that the effluent irrigation system and irrigation area are maintained in a proper condition.

6.5.1.2 Objective/Target

To protect the environmental values of the receiving environment including of the soil, surface water and groundwater.

6.5.1.3 Implementation Strategy

> A system which restricts irrigation to land during unsuitable soil conditions shall be installed (i.e. manual or automated) which triggers or restricts irrigation from the irrigation management system and effluent storage tanks.

> Only treated effluent of the required standard shall be used for irrigation.

> All external stormwater runoff upslope of the land application area is to be diverted around the irrigation area via appropriate bunding and/or diversion drains.

> A buffer distance of 20m is to be applied and maintained from the effluent irrigation area to stormwater infrastructure (i.e. swales).

> Irrigation shall be limited to that which is sufficient to wet the soil to its undrained limit to prevent effluent runoff or ponding.

> Corrective actions shall be undertaken if the vegetation within the irrigation area is determined to be visibly degraded.

> Use of nitrogen fertiliser within irrigation areas shall be limited and applied only as required. Nitrogen deficiency shall be indicated by vegetation monitoring. Use of phosphorus based fertiliser shall be restricted.

> Erosion control measures shall be installed on areas of exposed soils.

> Irrigation shall be restricted to the maximum rate used in the analyses that are carried out to size the irrigation area.

> Visual inspection of the area will be undertaken to determine the soil moisture at the commencement of irrigation, to eliminate the possibility of surface water ponding or runoff occurring.

> There is to be no effluent irrigation during rain events. Irrigation shall only re-commence a minimum of 4 hours following cessation of rainfall. A rain sensor shall be installed to trigger the ceasing of irrigation during rainfall.

> There is to be no ponding of effluent at the irrigation area. Should ponding occur, irrigation shall cease until such time as the soil moisture content has sufficiently reduced to eliminate further ponding.

> Appropriate signage indicating that recycled water is not suitable for drinking shall be provided and maintained at every accessible outlet from the treated effluent distribution system. Signs shall be easily visible and maintained regularly. Signage shall also be provided and maintained at the irrigation area informing of the use of treated effluent for land irrigation.

> When and if the storage level rises to within 10% of its overflow level an alarm will sound which indicates the necessity for tanker removal.

> The irrigation area shall be maintained in a well-grassed state to minimise the risk of erosion and sediment wash-off during storm events. Where necessary, turf, pasture grass or trees will be replaced to maintain the vegetation cover.

6.5.1.4 Performance Indicators

Degradation of soil quality within irrigation areas shall indicate non-compliance with this SBMP.

Degradation of water quality within receiving environments shall indicate non-compliance with this SBMP.

Visible areas of soil erosion and poor vegetation health within irrigation areas shall indicate non-compliance with this SBMP.

Signs of soil erosion or sodicity shall indicate non-compliance with this SBMP.

6.5.1.5 Monitoring

Soil conditions shall be monitored at nominated sampling locations within each of the irrigation sites (refer to Figure 2). Samples from representative sites within the irrigation areas shall be collected from each of the topsoil and sub-soil strata every two years or on completion of the project, whichever is the sooner.

Soils monitoring shall include analysis of soil pH, Sodium Adsorption Ratio, Calcium/Magnesium Ratio, Exchangeable Cations, Total Cations, Electrical Conductivity, Nitrogen, Phosphorous, Calcium, Magnesium, Chloride and Sodium.

A daily recording of the volume of treated effluent released to the irrigation areas shall be recorded from the irrigation metering system.

Monthly monitoring shall include a visual inspection of the condition of the vegetation and evidence of soil erosion within irrigation areas.

6.5.1.6 Record Keeping

The Operator shall maintain accurate record of all effluent quality and quantity monitoring data and records shall be retained on the premises.

Accurate records shall be maintained of all monitoring results. These monitoring results shall be forwarded to DEHP as part of the annual report.

Any signs of soil erosion or deterioration of vegetation health shall be noted and appropriate corrective actions taken and recorded.

Records shall be maintained of any failure of irrigation system components and of any repairs or corrective actions undertaken.

6.5.1.7 Reporting and Review

The Operator shall make all records available for inspection by relevant authorities on request.

6.5.1.8 Corrective Action

Should there be non-compliance with the stated performance indicator the following corrective actions are to be implemented:

> identification of the cause of the non-compliance;

> implementation of appropriate mitigation measures as determined by the Consultant in consultation with the Operator; and

> relevant validation monitoring to confirm that the nominated corrective actions have been effective.

The Operator shall implement the corrective action(s) as required within the agreed time frame noted on the CAR.

Corrective action for this item may include the application of suitable soil amendments and ongoing monitoring of heavy metal accumulation in order to rectify deterioration associated with irrigation.

6.5.2 Element 7: Complaint and Incident Management

6.5.2.1 Rationale

The operation of the STP and effluent disposal scheme has the potential to result in unplanned situations such as the uncontrolled release of effluent. Contingency procedures are required to provide for effective management of these situations.

Accidental spillage/leakage or release of contaminated material to receiving environments shall indicate non-compliance with this SBMP.

6.5.2.2 Objective/Target

To prevent degradation of the receiving environment.

To prevent the risk of health impacts on the public.

6.5.2.3 Implementation Strategy

6.5.2.3.1 Minor Effluent Spills

Should a minor effluent spill occur during the operation of the facilities the following response procedure shall be implemented.

> An assessment of the size and origin of the spill is to be made by the Operator.

> Actions shall be taken to safely stop further release of effluent from the process train. Actions may include the isolation of valves or pumps within the process train.

> Actions shall be taken to safely contain the spilled effluent and prevent the release of the effluent to the receiving environment. Actions may include, for example, the use of sandbags or earth bunding.

> Actions shall be taken to safely pump any captured effluent back into the balancing influent tank for treatment.

> An assessment shall be made of the size of the spill and of the requirement to notify DEHP.

6.5.2.3.2 Major Effluent Spills

Should a major effluent spill occur during the operation of the facilities the following response procedure shall be implemented.

> An assessment of the size and origin of the spill is to be made by the Operator.

> If it is possible, actions shall be taken to safely stop any further release of effluent.

> Actions shall be taken to notify DEHP of the effluent spill and an emergency spill response shall be co-ordinated in conjunction with DEHP.

> Actions shall be taken to safely contain the effluent if this is possible. Actions may include, for example, the use of sandbags or earth bunding to aid in containing the effluent.

Clean-up of the site shall be undertaken as quickly as is practicable and appropriate actions shall be taken as instructed by DEHP.

6.5.2.3.3 Complaints Management

The Operator shall implement the following procedure should a community complaint be received which relates directly to the operation of the STP and effluent disposal scheme.

> Complete a complaint register form.

> Determine if the complaint is valid and if further action is required.

> Determine whether notification to DEHP is required.

> The complainants shall be notified within 24 hours advising of actions that will be taken.

> If the issue cannot be investigated and finalised within 24 hours, then information regarding the preliminary assessment of the complaint and a date when a full response will be available shall be provided within 24 hours.

> The complaint response must be signed off by the Operator indicating that it has been dealt with satisfactorily.

> Should the investigation of a complaint reveal a non-conformance with the requirements of DEHP, then a non-conformance is to be raised and the corrective action process initiated.

6.5.2.3.4 Environmental Incidents

The Operator shall make an assessment of any events that may be considered an environmental incident.

The Operator shall notify DEHP of any incidents that have cause of environmental harm.

An Environmental Incident Form shall be completed for any environmental incidents.

All Environmental Incident Forms shall be completed as non-conformances and corrective action initiated.

6.5.2.4 Performance Indicators

Complaints and incidents are dealt with expeditiously and in accordance with this procedure.

6.5.2.5 Monitoring

Annually review and complaints and incident register and compile data regarding root cause of complaints and incidents.

6.5.2.6 Record Keeping

Maintain register of environmental complaints and incidents and record investigation findings on file.

6.5.2.7 Reporting and Review

This SBMP element shall be continually reviewed and maintained to ensure that the best possible contingency situation management procedures are in place.

The Principal shall report any emergency situations to DEHP as soon as is practicable after the emergency situation occurs.

6.5.2.8 Corrective Action

Should there be non-compliance with the stated performance indicator the following corrective actions are to be implemented:

> identification of the cause of the non-compliance;

> implementation of appropriate mitigation measures as determined by the Consultant in consultation with the Operator; and

> relevant validation monitoring to confirm that the nominated corrective actions have been effective.

The Operator shall implement the corrective action(s) as required within the agreed time frame noted on the CAR.

7 References

GHD 2013a MEDLI Assessment for Construction Camp 1 report prepared by GHD, July 2013.

GHD 2013b MEDLI Assessment for Construction Camp 2 report prepared by GHD, July 2013.

GHD 2013c MEDLI Assessment for Construction Camp 3 report prepared by GHD, July 2013.

GHD 2013d MEDLI Assessment for Construction Depot report prepared by GHD, July 2013.

GHD 2013e On-Site Wastewater Land Application report for Maintenance Depot prepared by GHD, July 2013.

GHD (2012a) Carmichael Coal Mine and Rail Project Environmental Impact Statement accessed via www.dsdip.qld.gov.au/assessments-and-approvals/Carmichael-coal-mine-and-rail-project on 21/06/2013.

GHD (2012b) Carmichael Coal Mine and Rail Project Soils Assessment (Rev 2) accessed via www.dsdip.qld.gov.au/assessments-and-approvals/Carmichael-coal-mine-and-rail-project on 21/06/2013.

GHD (2012c) Carmichael Coal Mine and Rail Project Hydrogeology Report (Rev 1) accessed via www.dsdip.qld.gov.au/assessments-and-approvals/Carmichael-coal-mine-and-rail-project on 21/06/2013.

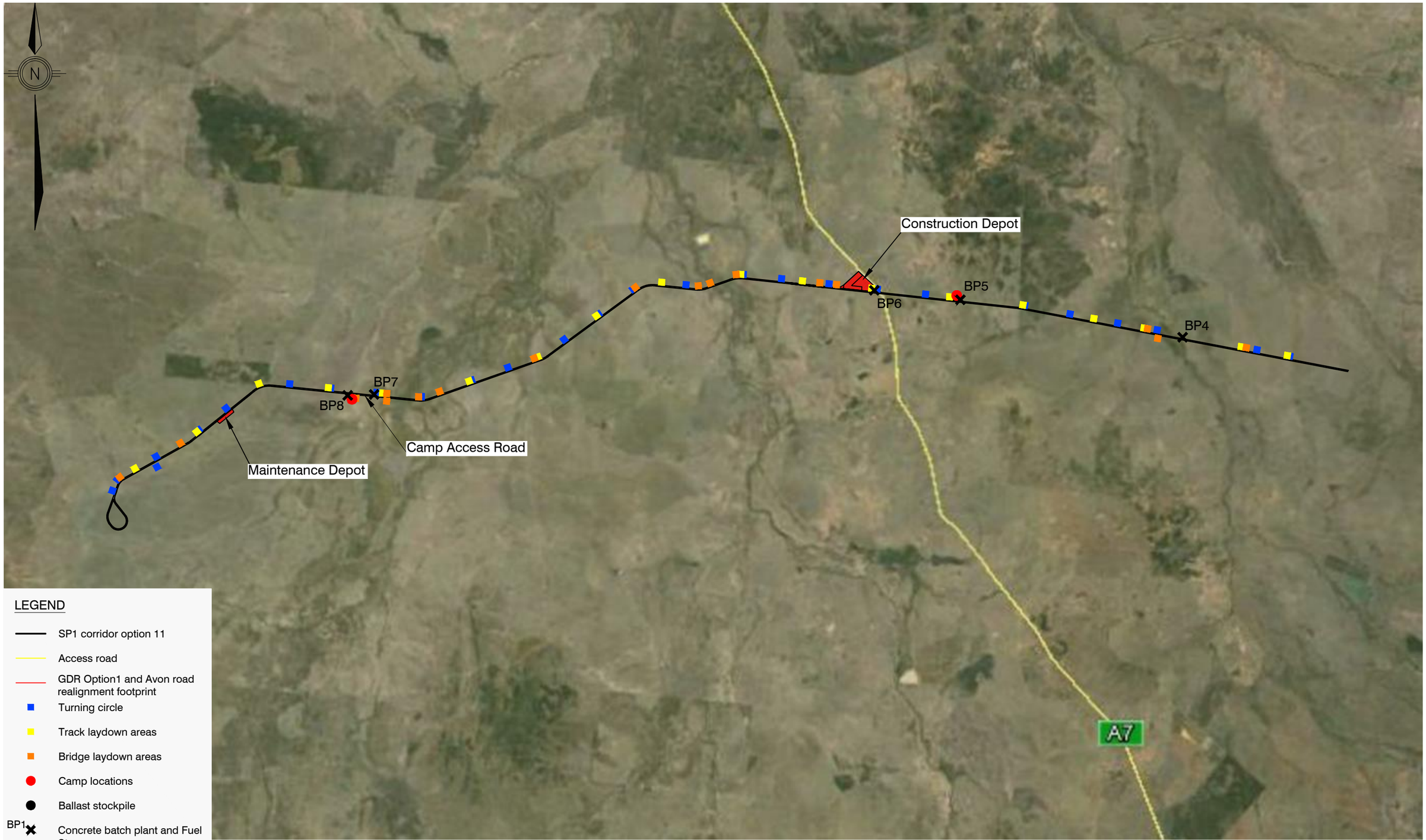
Isaac Regional Council (IRC) (2013) Belyando Shire Planning Scheme accessed via www.isaac.qld.gov.au on 21/06/2013.

Carmichael Mine Coal and Rail Project

FIGURES

Cardno
Shaping the Future

Cardno



LEGEND

- SP1 corridor option 11
- Access road
- GDR Option1 and Avon road realignment footprint
- Turning circle
- Track laydown areas
- Bridge laydown areas
- Camp locations
- Ballast stockpile
- BP1 Concrete batch plant and Fuel Storages

3 0 3 6 9 12 15km
1:300,000

Scale 1:300,000 (A3)

FIGURE 1
RAIL SP1 ALIGNMENT - SITE LOCATION

Aerial image sourced from Google Earth

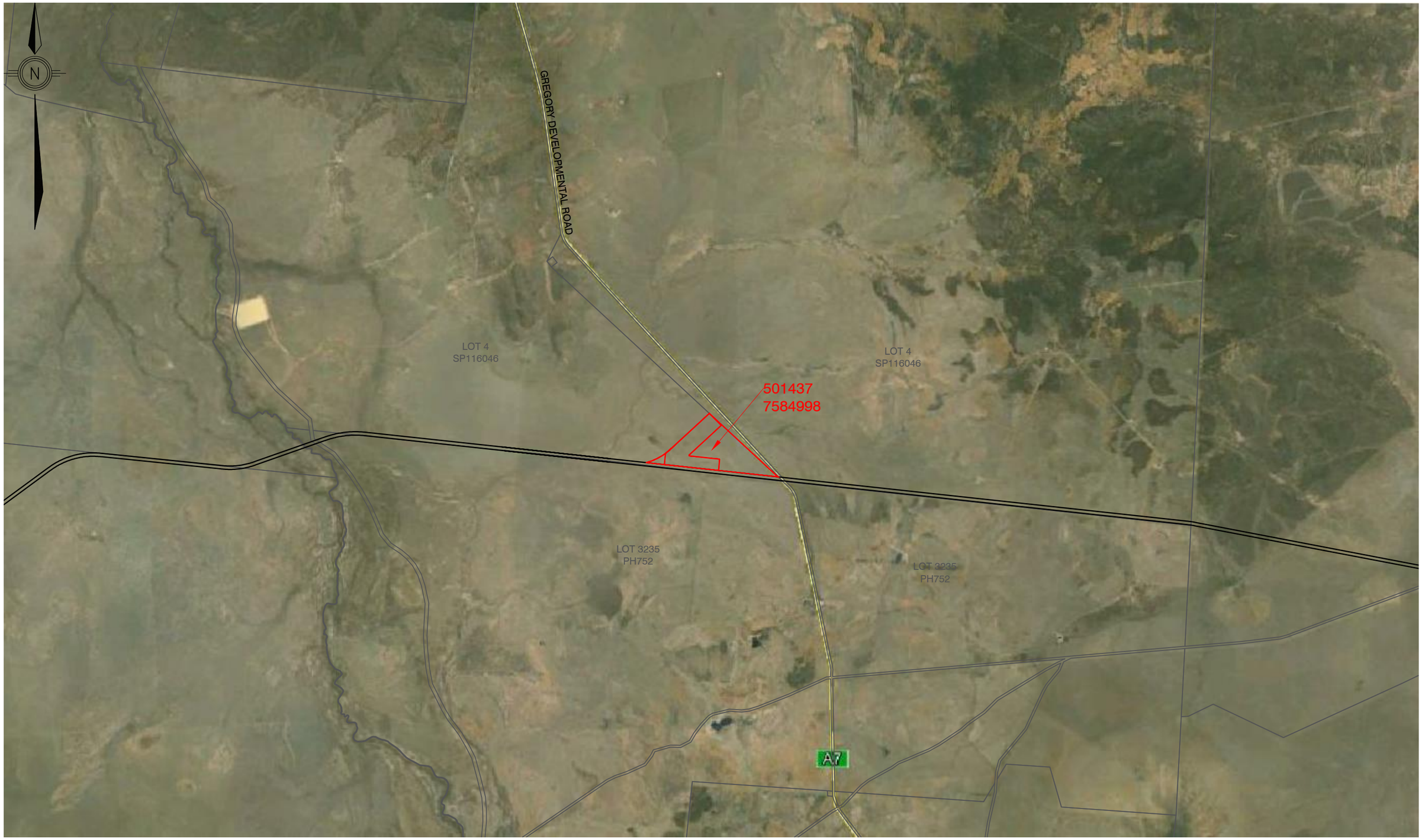
Rev: 0 | Drawn: J.M. | Checked: L.M. | Date: 22/07/2013

Project No.: 7803/04

Adani Pty Ltd

CAD FILE: I:\7803-04 HRP - Adani\Acad\Information in support of development application (ERA63)\Figure 1 - Rail SP1 aligment site location_v2.dwg
XREF's: DCDB

PRINT DATE: 22 July, 2013 - 2:27pm



1 0 1 2 3 4 5km
1:100,000

Scale 1:100,000 (A3)

FIGURE 2
CONSTRUCTION DEPOT AND STP LOCATION

Aerial image sourced from Google Earth

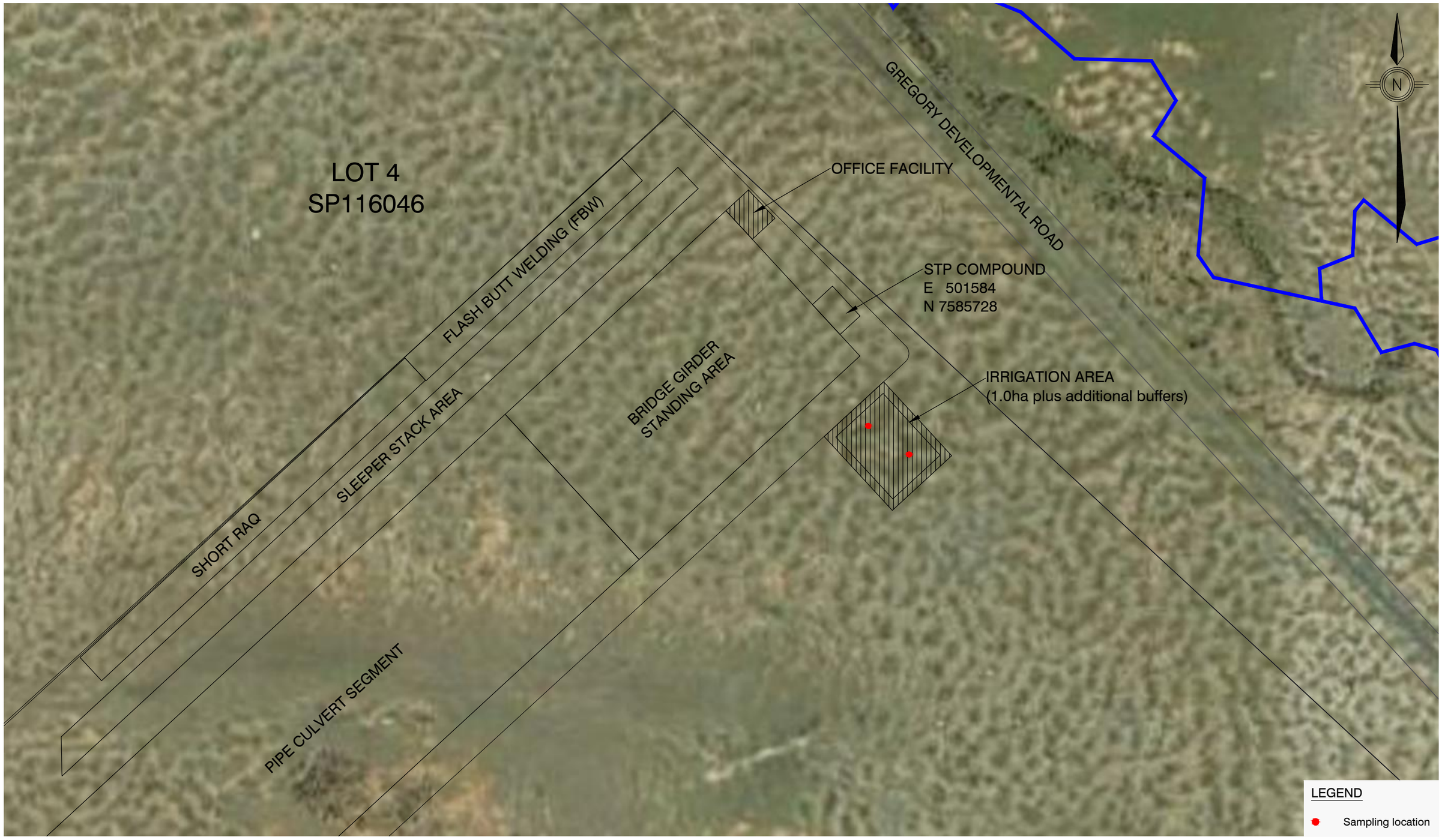
Rev: 0 | Drawn: J.M. | Checked: L.M. | Date: 08/07/2013

Project No.: 7803/04

Adani Pty Ltd

CAD FILE: I:\7803-04 HRP - Adani\Acad\Infromation in support of development application (ERA63)\Figure 2 - Conctruction depot location.dwg
XREF's: DCDB

PRINT DATE: 10 July, 2013 - 9:37am



Scale 1:5,000 (A3)

FIGURE 3
IRRIGATION AREA AND INDICATIVE MONITORING LOCATIONS

Rev: 0 | Drawn: J.M. | Checked: L.M. | Date: 09/07/2013

Project No.: 7803/04

Adani Pty Ltd

CAD FILE: I:\7803-04 HRP - Adani\Acad\Information in support of development application (ERA63)\Figure 3 - Irrigation area and indicative monitoring locations.dwg
XREF's: DCDB

PRINT DATE: 22 July, 2013 - 1:44pm

Carmichael Mine Coal and Rail Project

APPENDIX A

Wastewater Treatment Plant Flow Calculations

Cardno
Shaping the Future

Construction Depot - Adani
Facilities

- Basic Cafeteria
- Tea/coffee vend machine
- Showers
- Toilets

Staff

	Persons	Notes
Office/stores	14	DEWS Planning Guidelines for Water Supply and Sewerage 2013
storage for pipes	4	Table A
stroage for girders	4	Need development with similar usage patterns ie attended for typical business hours (although shifts are most probably 12 hours 7am - 7pm-7am)
ballast stockpile	4	Only similar development in Table A is education that provides sewage flows per person
Plant/fuel farm	10	Tertiary education assumes 50-90 L/student/day. (For 100 staff = 5000 - 9000 L/day)
Mobile office	4	Better estimate when looking at expected usage of showers, toilets and basins, cafeteria/kitchen. Make some assumptions
Labourers	60	
TOTAL	**100**	

Shift split

Day	75
Night	25

Wastewater Source

	Usage/shift/person	Litres/use	Males	Females	Total Flow L/day	Comment
Toilets Full Flush	1	4.5	80	20	450	Usage based on LEED, water use based on 3 star toilet
Toilets Half Flush	5	3		20	300	Usage based on an adjustment of figures at ANZ building, water use based on 3 star toilet. Female staff only. Assume 80 % male staff
Urinals	10	2	80		1600	Usage based on the Bond, water use based on Duravit urinals at the Bond. Male staff only
			Toilets and Urinals Sub-Total		**2350**	L/day

	Usage/shift/person	Litres/use	Males	Females	Total Flow L/day	
Showers	1	54	80	20	5400	Based on 6 minutes duration (Green Staf Office Design V3), 9 litres/min (3 star shower) and assuming 100% of staff have 1 shower/shift
Bathroom taps	10	0.95	80		760	Based on 0.5 min duration (0.3 mins Green Star Office Design V3) plus allowance for type of work, and 10 uses per day (toilet + urinal usage males only) Fixture water use 1.9 L/min based on 3 star
Bathroom taps	6	0.95		20	114	Based on 0.5 min duration (0.3 mins Green Star Office Design V3) plus allowance for type of work, and 6 uses per day (females only) Fixture water use 1.9 L/min based on 3 star
			Showers and Taps Sub-Total		**6274**	L/day

	Usage/shift/person	Litres/use	Staff	Total Flow L/day	
Kitchen Taps	1	1.8	100	180	6 L/min water use based on the Bond, 0.3 minutes /use assumed
			Kitchen Tap Sub-Total	**180**	
			TOTAL FLOW TO STP	**8804**	Litres/day (Comment - consistent with tertiary education usage in Table A of Planning Guidelines)

Carmichael Mine Coal and Rail Project

APPENDIX B

Corrective Action Request form

Cardno
Shaping the Future

CORRECTIVE ACTION REQUEST

Report No: _____

Date: _____

DETAILS OF NON-CONFORMANCE: Inspected by:
DETAILS OF PROPOSED ACTION Passed to Principal (as applicable): y/n Date: Reply required by:
CONSULTANT/PRINCIPAL ADVICE (as required): Date action required by (if applicable): Signed (by Principal or Principal's representative): Date:
AUTHORITY TO PROCEED Sign: Date:
ACTION CARRED OUT Sign: Date:
ELEMENT RE-INSPECTED BY Sign: Date:
COPY ISSUED TO PRINCIPAL Date: Sign:

PART

7

TRANSPORT AND TRAFFIC

> Laydown Area Transport Assessment Strategy prepared by Cardno

Laydown Area Assessment Strategy

Carmichael Coal Mine and Rail Project

750890

Prepared for
Adani

22 July 2013

Cardno
Shaping the Future

Document Information

Prepared for	Adani
Project Name	Carmichael Coal Mine and Rail Project
File Reference	Document2
Job Reference	750890
Date	22 July 2013

Contact Information

Cardno (Qld) Pty Ltd
ABN 57 051 074 992

Level 11 Green Square North Tower
515 St Paul's Terrace
Locked Bag 4006
Fortitude Valley Qld 4006

Telephone: 07 3369 9822
Facsimile: 07 3369 9722
International: +61 7 3369 9822

transportqld@cardno.com.au
www.cardno.com.au

Document Control

Version	Date	Author	Author Initials	Reviewer	Reviewer Initials
DRAFT	04/02/2013	Alice Shi	AXS	Andy Johnston	ASJ
FINAL	22/07/13	Alice Shi	AXS	Andy Johnston	ASJ

Executive Summary

Adani is proposing to construct a coal mine west of Moranbah along with an associated rail line, within the Isaac Regional Council. As part of the construction and maintenance of the rail project, a number of laydown areas are required along the length of the rail corridor. The associated traffic and road impacts related to these laydown areas will require management via a road use management plan.

This assessment strategy aims to provide an assessment framework from which Adani, Council and TMR can discuss, in order to develop the final road management plan. It is noted that this strategy has been developed to reassure Council and TMR that a robust and appropriate framework is in place for the eventual management of the road network.

To aid in a clear reading of this document, as assessment methodology flow chart has been provided. The assessment criteria covered in this strategy include road facilities, intersection design considerations, stock route crossings and level crossings.

Table of Contents

Tables

Figures

Appendices

1 Introduction

Cardno has been commissioned by Adani to provide an assessment strategy for the future development of a Road Use Management Plan for the Carmichael Coal Mine and Rail Project. The project will deliver a 189km rail line which connects the proposed coal mine to the Goonyella system at Wotonga Blair Athol Branch Railway south of Moranbah. The local government area for the project is the Isaac Regional Council (IRC).

1.1 Purpose

The Road Use Management Plan will focus on the rail component of the project. It has been decided that the project will be split into two sections for the purpose of lodging separate development applications, SP1 (west portion) and SP2 (east portion). This document relates to the assessment of the western section, which encompasses 120km of rail line beginning at the coal mine.

This assessment strategy will provide a framework for assessment criteria, pertaining to the applicable road design standards, between Adani and Council. In particular, the purpose of this framework is to provide Council and TMR with greater confidence that the specific development road impacts will be appropriately assessed once detailed planning has been undertaken. As such, a high level assessment of the project has been undertaken, offering insight into relevant road parameters, intersection design and rail crossing treatments. A more detailed Traffic Impact Assessment has been prepared for the Carmichael Coal Mine and is available in Appendix P of the Carmichael Coal Mine and Rail Supplementary EIS.

It is acknowledged that, due to the nature of the project, the majority of facilities impacting upon roads will be incurred at the construction stages. This means the road impacts brought about by the project will be temporary, and according to the client issued project description, will last for approximately two years.

As a result, the mitigation measures recommended herein have accounted for the temporary nature of the impacts. As such, Adani will provide a make-good clause on all works. The information provided herein is based on a fit for purpose basis.

1.2 Principles

The TMR document *Guidelines for Assessment of Road Impacts of Development* (GARID) has been based upon the *Transport Infrastructure Act 1994* which has enabled TMR to impose conditions to mitigate road impacts. Similar to TMR's principle to ensure that the safety, efficiency and future planning of the road network are not compromised, this assessment strategy will aim to support these principles.

GARID puts forth a quantitative methodology for determining whether significant impacts are brought upon by a development. It states that if the development causes traffic to increase by 5% or more compared to the existing levels, then the impact is deemed significant and appropriate analyses must be undertaken. It is noted, however, that in some circumstances, this 5% trigger may not be appropriate.

This measure of significance is not applicable to level crossings. An appropriate methodology, in accordance with the ALCAM method, is detailed in **Section 8.1.2**.

1.3 Limitations

Cardno has undertaken this assessment strategy in accordance with the usual care and thoroughness of the consulting profession. The assessment is based on accepted traffic engineering practices and standards applicable at the time of undertaking the assessment.

The adopted assessment methodology and sources of information utilised by Cardno are outlined within this document and at Appendix A. Cardno has made no independent verification of the supplied project information or road condition data beyond the agreed scope of works. Within the extent of the assessment scope no indications were found however that the supplied project planning information or existing road condition data relied upon in undertaking the assessment was inaccurate.

The assessment was undertaken in January 2013 and is based upon the road conditions encountered and project information available at the time. Cardno disclaims responsibility for any changes to project planning or road conditions that may occur after completion of the assessment.

2 Project Description

The rail project has been identified to extend 189km between the proposed mine site east towards the Goonyella rail system. SP1, the western portion of the rail corridor, may link to the proposed Galilee Coal Project alignment and the Alpha Coal Project alignment. Along the 120km of track pertaining to SP1, there will be 68 laydown areas, including turning circle areas, track laydown areas and bridge laydown areas. Table 2-1 details the proposed laydown facilities.

Table 2-1 Laydown Areas

Construction Element	Quantity
Turning circle area	27
Track laydown area	18
Bridge laydown area	15
Concrete batching plant	5
Ballast stockpile	1
Laydown facility area	1
Maintenance yard	1
Total	**68**

Additionally, four construction camp sites will be located along the rail length, with three planned within SP1. Access roads will be required to assist in the servicing of the rail works. It is understood that the primary access roads will be located adjacent to the rail corridor to minimise disruption for landowners and public infrastructure. Access points will be used for the transportation of water, personnel, fuel and materials.

2.2 Laydown Areas

The laydown areas associated with the project are required to facilitate in the construction and maintenance of the rail system. Client supplied information has advised that the most intensive road impacts will occur during the construction stage when a significant number of drop-offs for materials will be required. With regards to SP1, the western portion of the rail line, 68 laydown sites will be located along the length of the project as laydown areas.

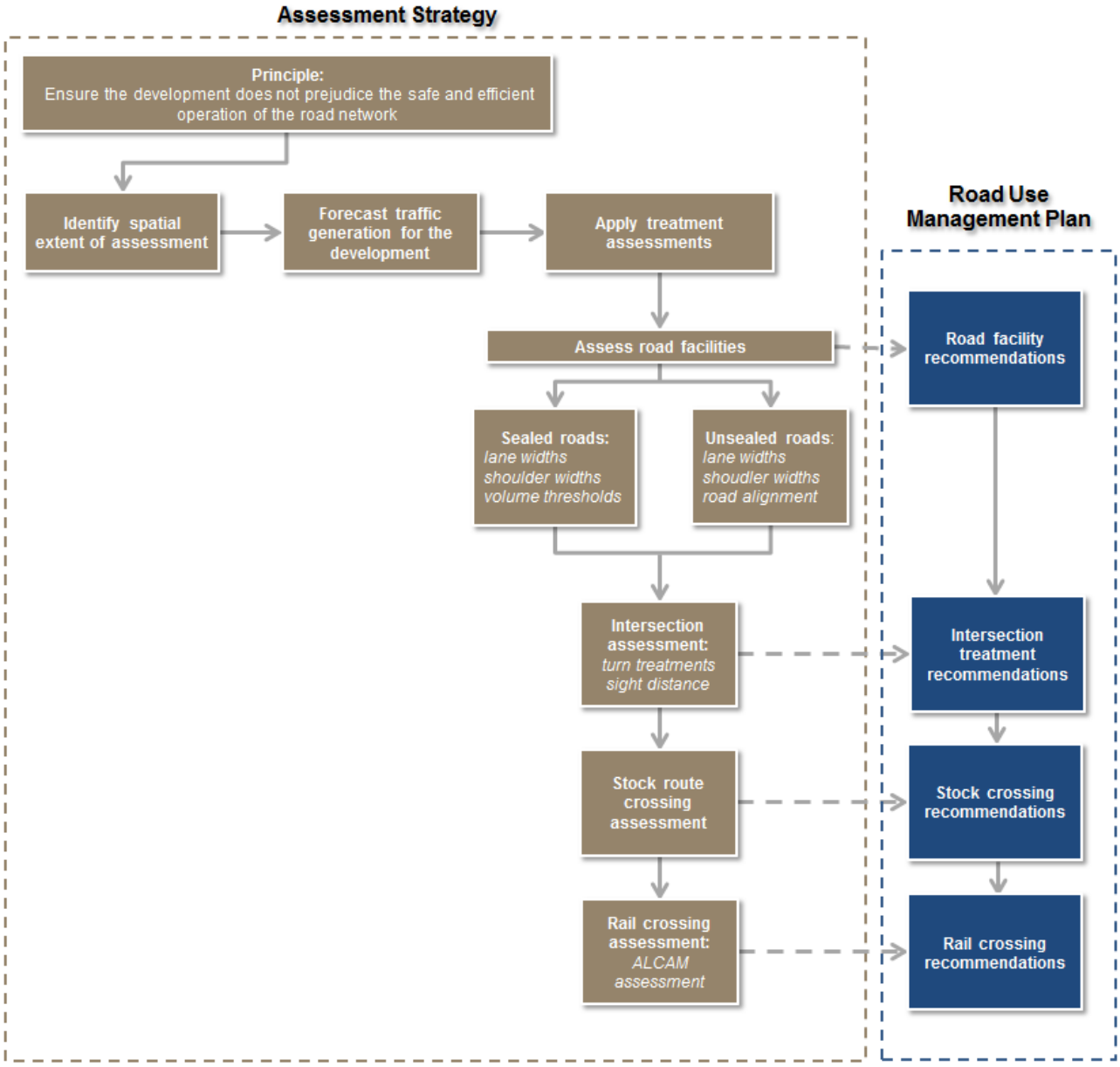
The increased number of vehicle movements associated with the laydown areas may contribute significantly to the level of road impacts on the affected roads, given the limited number of existing trips. It is understood that deliveries to/from laydown areas will be serviced by roads while construction of the rail line will be conducted via a mechanised tracklaying method.

It is recommended that the location of laydown areas be carefully considered to be positioned as close to the rail works as possible, so as to minimise the strain on the road network. However, it is acknowledged that other factors, such as the presence of watercourses and permanent structures, will contribute to the final location of laydown areas.

3 Assessment Methodology

The following flow chart on Figure 3-1 demonstrates the assessment methodology to be undertaken in developing a road use management plan. The segments outlined under Assessment Strategy are outlined within this document. Once a detailed planning assessment has been undertaken, the data can be applied in accordance with this strategy to develop a robust Road Use Management Plan.

Figure 3-1 Assessment Methodology



4 Study Area Road Network

Identify spatial extent of assessment

Gregory Development Road is the main State Controlled Road directly affected by the project. It is a two lane, two way road. Kilcummin-Diamond Downs Road is an IRC Controlled Road within the project alignment; however control is resumed by TMR south of the rail line. These two roads are the only sealed roads to cross the rail line. It has been advised that these roads currently carry in the order of 300 vehicles per day (vpd) with a high proportion of heavy vehicles (>25-30%).

Assuming that materials will be transported from Mackay, other State Controlled Roads which are likely to be affected are the Peak Downs Highway between Mackay and Moranbah, and sections of the Bruce Highway close to Mackay. These roads will offer the most direct route from Mackay. Alternative routes which may possibly be used for the transportation of materials include the use of the following State Controlled Roads between Mackay, Sarina and Moranbah:

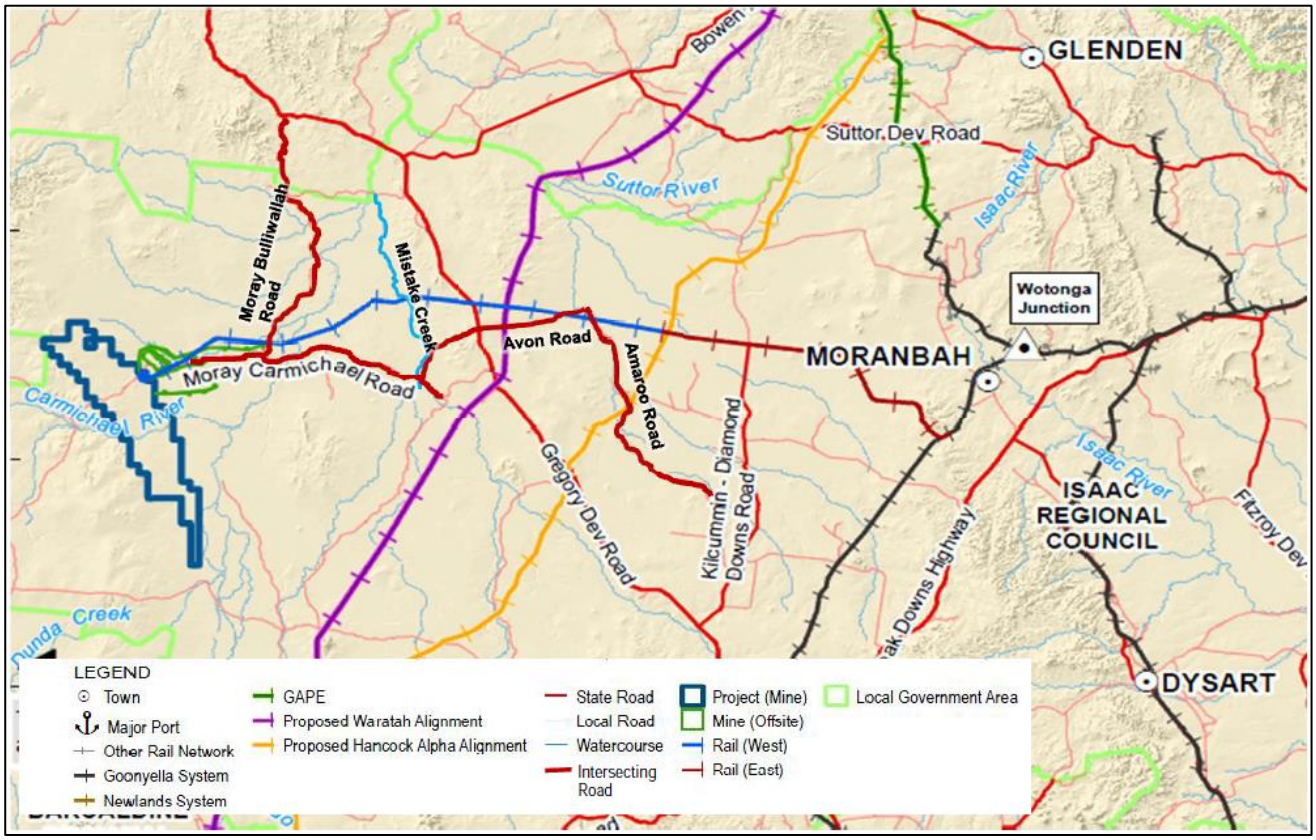
> Marlborough-Sarina Road
> Oxford Downs-Sarina Road
> Homebush Road
> Eton-Homebush Road

Local roads which will be intersected by the project are:

> Kilcummin-Diamond Downs Road
> Amaroo Road
> Avon Road
> Moray Bulliwallah Road
> Moray Carmichael Road

Figure 4-1 indicates the locations of these intersecting roads. It is noted that Moray Carmichael Road will be realigned to run parallel on the southern side of the rail line and as such, will not intersect with the project.

Figure 4-1 Rail Project Study Area



Three stock routes cross the rail project at the following locations:

- Kilcummin-Diamond Downs Road (Stock route M399BELY03)
- Amaroo Road (Stock route U402BELY03)
- Mistake Creek (Stock route U401BELY02)

5 Road Assessment Criteria

In the absence of more detailed information, a framework has been developed to assist in the design of access roads. The framework identifies industry standard thresholds for lane and shoulder widths among other parameters, with respect to road capacity and safety.

5.1 Road Facilities

Assess road facilities

Road facilities are typically classified into two broad categories being:

- **Uninterrupted flow road** facilities are categorised as those on which traffic conditions are the result of interactions between vehicles in the traffic stream and the geometric and environmental characteristics of the road. Uninterrupted flow road facilities have no fixed elements external to the traffic stream such as traffic signals which cause interruption to the traffic flow. Rural roads are typically categorised as uninterrupted flow facilities.
- **Interrupted flow road** facilities are categorised as those on which traffic conditions are the result of fixed elements such as traffic control signals, roundabouts, stop signs or other types of control which cause traffic to stop periodically, irrespective of the total amount of traffic utilising the facility. Urban roads are predominately categorised as interrupted flow facilities.

It is reinforced that uninterrupted and interrupted in this context are traffic engineering terms used to categorise road facilities and they do not describe the actual quality of travel on a road.

The typical traffic volume thresholds where detailed assessment is required for these road types are discussed in detail in the following sections.

5.1.1 Uninterrupted Single Lane Sealed Road Thresholds

Guide to Road Design Part 3: Geometric Design published by Austroads is considered a best practice manual. This manual states that where traffic volumes are less than 150vpd and particularly where terrain is open, single lane carriageways are acceptable.

The width of the traffic lane on a single lane road should be at least 3.7m, as a width less than this can result in excessive shoulder wear. A width greater than 4.5m but less than 6.0m may lead to opposing vehicles trying to pass on the seal, increasing the potential for head-on collisions.

Table 5-1 details the minimum design standards recommended for single lane sealed roads.

Table 5-1 Volume Thresholds for Uninterrupted Single Lane Sealed Roads

Element	Design AADT (vpd) 1-150
Traffic Lane Widths (m)	3.7 (1 x 3.7)
Minimum Shoulder Seal (m)	0
Total Shoulder (m)	2.5
Total Carriageway (m)	8.7

5.1.2 Uninterrupted Two Lane Sealed Road Thresholds

Table 5-2 details the uninterrupted two lane sealed road capacity thresholds at which a detailed assessment of the project's traffic impacts are warranted. A lane width of 3.5m ensures that one or both opposing vehicles must have their outer wheels on the shoulders while passing, reducing the potential for head-on collisions. The total width of seal should not be less than 7.2m to allow for adequate passing width.

The threshold capacity values are based on guidance presented in both *Guide to Road Design Part 3: Geometric Design* and *Guide to Traffic Management Part 3: Traffic Studies and Analysis,* both published by Austroads.

Table 5-2 Volume Thresholds for Uninterrupted Two Lane Sealed Roads

Element	AADT (vpd)			
	150-500	**500-1,000**	**1,000-3,000**	**>3,000**
Traffic Lane Widths (m)	6.2 (2 x 3.1)	6.2 (2 x 3.1) (min) 7.0 (2 x 3.5) (desirable)	7.0 (2 x 3.5)	7.0 (2 x 3.5)
Minimum Shoulder Seal (m)	0.5	0.5	1.0	1.5
Total Shoulder (m)	1.5	1.5	2.0	2.5
Total Carriageway (m)	9.2	9.2 – 10.0	11.0	12.0

At each volume level in Table 5-2, the cross-section of the existing road should be assessed against the cross-section recommended by Austroads.

5.1.3 Uninterrupted Two Lane Unsealed Road Thresholds

TMR's *Road Planning and Design Manual* states that the theoretical capacity of an unsealed gravel surface road is approximately 50% of that of a comparative sealed road (similar carriageway cross-section, etc). Further, the TMR's manual states that the theoretical capacity of a natural earth surfaced road is approximately 40% of that of a comparative sealed road. These theoretical capacity reduction factors however, do not account for environmental considerations such as dust nuisance and safety. It is these amenity factors, as opposed to capacity constraints, which typically prompt a road authority to seal a road.

The *Unsealed Roads Manual Guidelines to Good Practice* prepared by ARRB Transport Research Ltd, which is referenced extensively in the *Road Planning and Design Manual*, is considered to provide best practice guidance for the design of Australian unsealed roads. The manual states that typically it is difficult to justify sealing a road carrying less than 100vpd and that sealing is usually justified when traffic volumes exceed 250vpd. The guide states that between these threshold vehicle volumes, an economic assessment of the benefit of sealing a road is usually warranted.

Table 5-3 summarises the adopted threshold volumes for unsealed roads. A more detailed analysis of unsealed road standards is included at Appendix A.

Table 5-3 Volume Thresholds for Uninterrupted Two Lane Unsealed Roads

AADT (vpd)		
<100	**100-250**	**>250**
Unsealed appropriate	Economic benefit assessment of sealing warranted	Sealing typically warranted

5.1.4 Uninterrupted Multi-Lane Road Thresholds

It is anticipated that there will be no uninterrupted multi-lane roads within the project development area, therefore thresholds have not been developed for this type of facility.

5.1.5 Interrupted Flow Road Facility

The project is not anticipated to generate significant traffic volumes in urban areas, therefore thresholds have not been derived for interrupted flow facilities.

5.2 Road Design Guidelines

There are a number of different road design guidelines and standards that can be adopted and applied to the roads within the project development area. These are summarised in the following sections.

5.2.1 Austroads Road Design Guidelines

Table 5-4 summarises the road dimensions recommended by Austroads in the *Rural Road Design Manual* for undivided sealed roads based upon design Annual Average Daily Traffic (AADT) volumes.

Table 5-4 Austroads Recommended Rural Road Widths

Design AADT Volume (vpd)	No. of Lanes	Road Seal Width	Shoulder Seal Width	Total Shoulder Width
1 – 150	1	3.7m	0m	2.5m
150 – 500	2	6.2m	0.5m	1.5m
500 – 1,000	2	6.2m (minimum) 7.0m (desirable)	0.5m	1.5m
1,000 – 3,000	2	7.0m	1.0m	2.0m
3,000+	2	7.0m	1.5m	2.5m

Note: vpd = vehicles per day

5.2.2 TMR Road Design Guidelines

The TMR *Road Planning and Design Manual* specifies the required road widths of traffic lanes and sealed shoulders for two lane, two-way rural roads. The required road widths are based on AADT volumes and expected traffic growth and are summarised in Table 5-5.

Table 5-5 TMR Recommended Rural Road Widths

Road Seal Width	Expected Growth Rates (vpd)		
	Low Growth (<3%p.a.)	**Reasonable Growth (3-6%p.a.)**	**High Growth (>6%p.a.)**
6.0m (minimum)	<700vpd	<500vpd	<300vpd
6.5m (minimum)	700 – 1,700vpd	500-1,200	300 – 900vpd
7.0m (minimum)	>1,700vpd	>1,200	>900vpd

Note: vpd = vehicles per day

The required shoulder seal width is based upon AADT volumes with the minimum widths as follows:

- 0.5m shoulder seal width for AADT <2,000vpd.
- 1.0m shoulder seal width for AADT >2,000vpd.

6 Intersection Assessment Criteria

Intersection assessment: *turn treatments sight distance*

The geometry and control of intersections significantly utilised by project traffic should be appropriate to safely and efficiently accommodate traffic demands. These thresholds are applicable to intersections on the external road network and at site access locations.

The geometry of priority-controlled intersections is typically driven by safety and design vehicle considerations as opposed to capacity constraints. For example, protected short right turn lanes are usually provided to reduce the incidence of rear end crashes, rather than to allow more vehicles to pass through the intersection (i.e. to allow greater capacity).

6.1 Turn Treatments

Turn warrants provide guidance where deceleration lanes and turning lanes should be used based on traffic volumes. They were produced by identifying the threshold at which the benefits of providing a higher level of treatment (the reduction in estimated crash costs) are equal to additional construction costs associated with the treatment. The benefits and costs of a higher level of treatment were compared to a base case, the minimum turn treatments, to develop the curves presented in Figure 6.1. It is noted that the curves are based on peak hour volumes.

Figure 6-1 Warrants for Turn Treatments (Design Speed ≥100km/h)

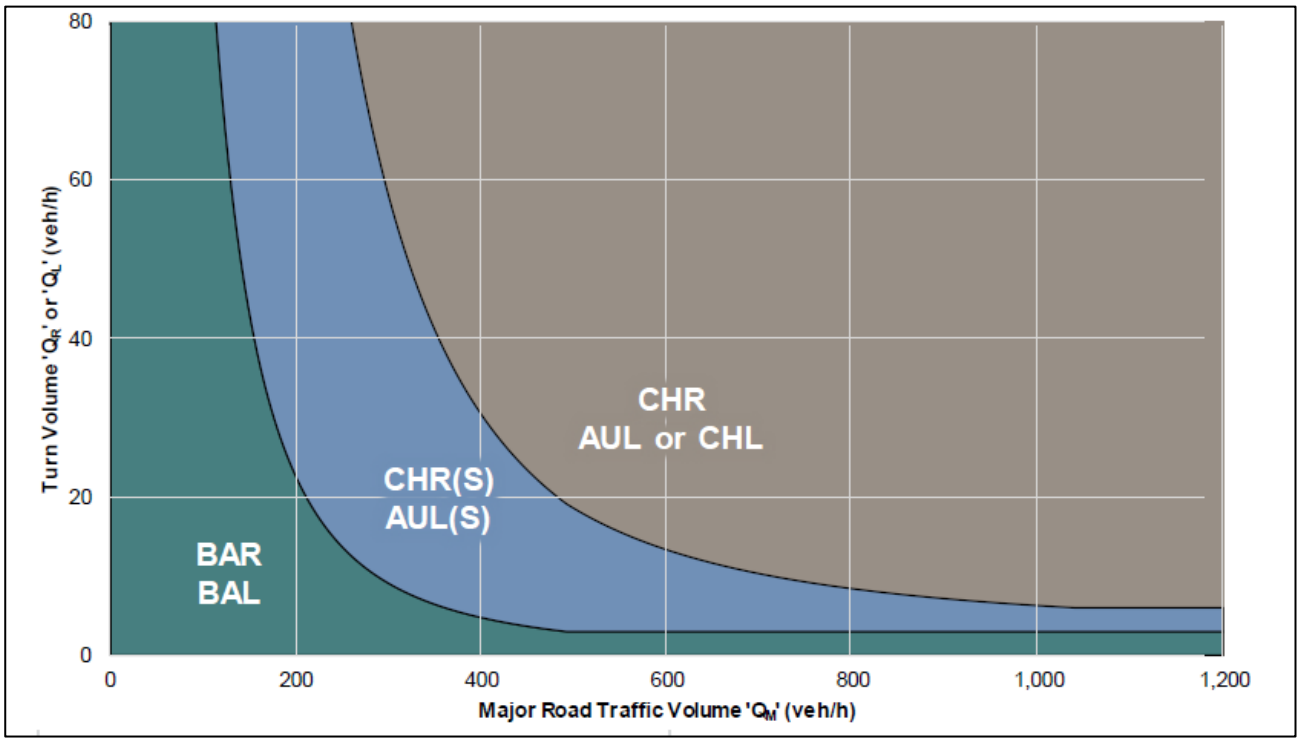


Table 6-1 details the threshold intersection volumes at which various intersection turn treatments are warranted. These treatments are only considered applicable to intersections at which the project is forecasted to have a significant impact for a significant period of time (i.e. increases vehicle volumes by greater than 5% for at least one year).

To facilitate a practical tool mindful of data limitations, the intersection turn treatment thresholds are based on daily volumes as opposed to peak hour volumes. The volume thresholds are conservatively based on the turn treatment warrants presented in the *Road Planning and Design Manual* prepared by TMR.

Table 6-1 Intersection Turn Treatment Thresholds (Volume >5% for >1 year)

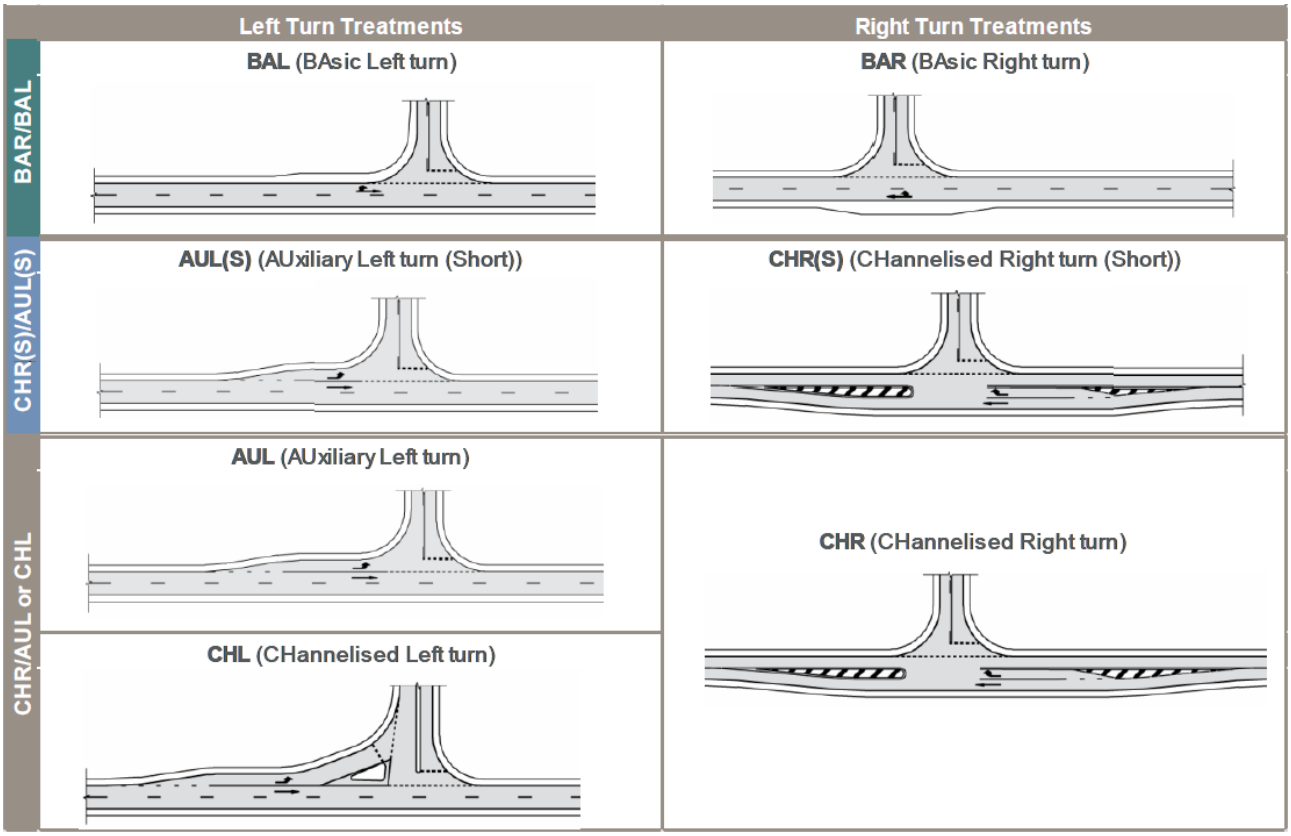
Minor Approach AADT (vpd)	Major Approach AADT (vpd)		
	<2,000	**2,000-4,000**	**>4,000**
<100	BAL/BAR	BAL/BAR	BAL/BAR
>100	BAL/BAR	AUL(S)/CHR(S)	CHR

The meanings of these treatments are explained below:

- **BAL:** Basic Left turn treatment for an intersection, being a left turn shared with the through lane with shoulder widening; allows a through vehicle, having slowed, to pass turning vehicles
- **BAR:** Basic Right turn treatment for an intersection, being a right turn shared with the through lane with shoulder widening; allows a through vehicle, having slowed, to pass turning vehicles
- **AUL(S):** Auxiliary lane treatment (short lane length) for an intersection involving the provision of an auxiliary lane
- **CHR(S):** Channelised right-turn treatment (short lane length) for an intersection, being a short separate lane for right turning vehicles
- **CHR:** Channelised right-turn treatment for an intersection, being a separate lane for right turning vehicles

Figure 6-2 presents indicative configurations for the treatments, as defined by Austroads.

Figure 6-2 Turn Treatment Formations



Source: Austroads 2010

As stated previously, the turn warrant curves and hence the thresholds are based upon a cost-benefit analysis between the costs of construction and the benefits to the community of avoiding likely crashes in the absence of the applicable turn treatment. This cost-benefit analysis is based on the assumption that the intersection will have a 10 or 50 year life, for right turn and left turn treatments respectively, and as such, the associated costs have been apportioned over that period. Given that the impact of the development will only affect these sites for a short time, in this case two years at most, then the curves will be overstated. As a result, the above stated thresholds in Table 5.1 will result in a conservative design.

Given the temporary nature of the sites, it is likely that only basic treatments, i.e. BAL and BAR treatments, will be sufficient. Additionally, it may be cost efficient to construct temporary treatments. For example, when providing a BAR treatment, it may be satisfactory to construct an unsealed passing shoulder rather than a sealed one. However, it is noted that all intersections will need to be individually assessed with regards to safety and efficiency once more detailed information is provided.

6.2 Sight Distance

The Austroads *Guide to Road Design Part 4A: Unsignalised and Signalised Intersections* states that a fundamental factor to the safety of intersections is the ability of drivers to:

> recognise the presence of an intersection in time to slow down or stop in a controlled and comfortable manner
> see vehicles approaching in conflicting traffic streams and give way where required by law or avoid a crash in the event of a potential conflict

Intersection safety performance is therefore largely dependent upon adequate sight distance in relation to both horizontal and vertical geometry for all drivers approaching and entering the intersection. Consequently, sight distance is a key consideration in the location and design of intersections.

The two basic types of sight distance outlined in Austroads are:

> Approach Sight Distance (ASD)
> Safe Intersection Sight Distance (SISD)

The calculation of sight distances are based upon the driver height and height of obstruction. It is noted that although the higher driver height for truck drivers provides better sight distance, the poor braking abilities of larger vehicles greatly diminishes this effect.

6.2.1 Sealed Roads

The Austroads guides generally refer to sealed roads as these are more commonly designed. This section relates to the sight distance requirements for sealed roads.

6.2.1.1 Approach Sight Distance

Approach Sight Distance (ASD) relates to the minimum level of sight distance which must be available on the minor road approaches to all intersections to ensure that drivers are aware of the presence of an intersection. For truck drivers, which will be the predominant users of the access roads, the ASD is numerically equivalent to the Stopping Sight Distance (SSD) outlined in *Guide to Road Design Part 3: Geometric Design*.

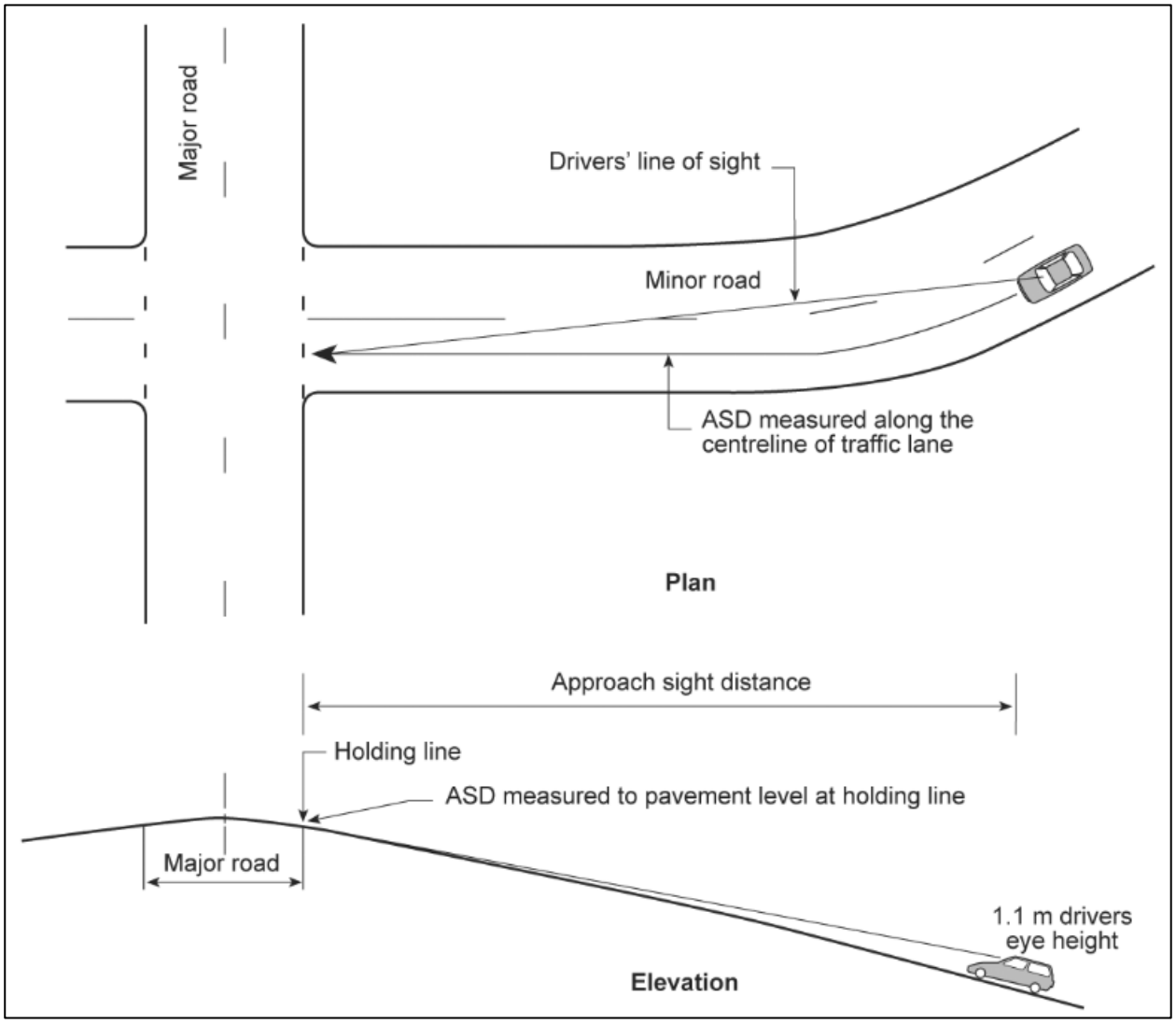
The threshold values for minimum SSD requirements are reported in Table 6-2. It has been assumed that a 2.0 second reaction time is applicable.

Table 6-2 Truck Stopping Sight Distance Requirements

Operating Speed (km/h)	SSD for Single unit trucks, Semi-trailers and B-doubles (m)
40	44
50	62
60	82
70	105
80	131
90	160
100	191
110	225

The method of measuring the approach sight distance at an intersection is detailed on Figure 6-3. It is noted that for trucks, the applicable driver height is 2.4m and the object height is the pavement height (0.0m).

Figure 6-3 Application of Approach Sight Distance



Source: Austroads Guide to Road Design Part 4A: Unsignalised and Signalised Intersections

6.2.1.2 Safe Intersection Sight Distance

Safe Intersection Sight Distance (SISD) is the minimum distance which should be provided on the major road at any intersection. SISD provides sufficient distance for a driver on a major road to observe a vehicle on a minor road approach moving into a potential collision situation and to decelerate to a stop before reaching the collision point.

Table 6-3 presents the minimum SISD for trucks, using values provided in Austroads for the calculation. Wherever it is possible, an SISD larger than that required is recommended. It is noted that the object height for SISD is 1.25m.

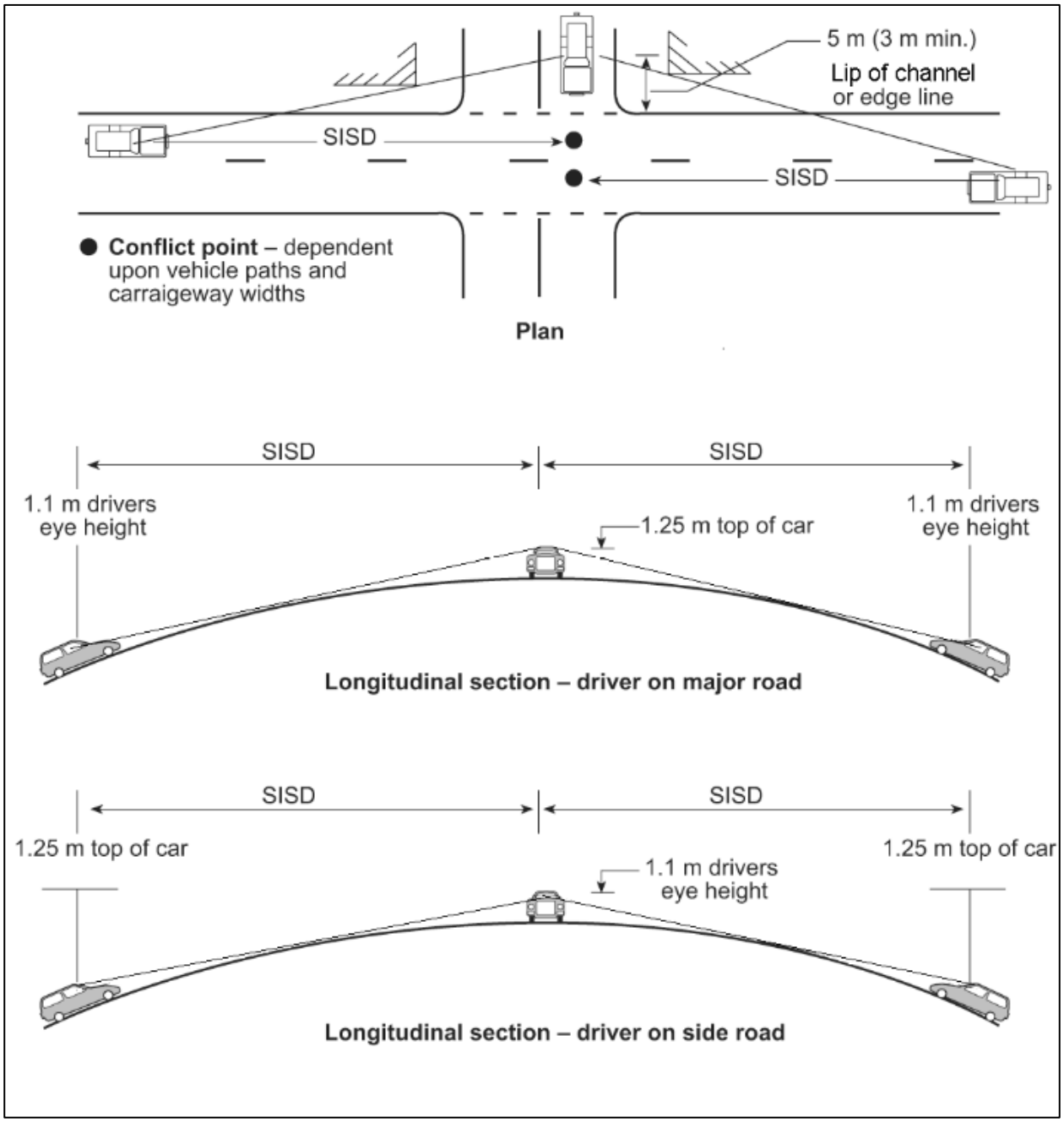
Table 6-3 Truck Safe Intersection Sight Distance Requirements

Operating Speed (km/h)	SISD for Trucks (m)
40	82
50	110
60	142
70	178
80	216
90	256

Operating Speed (km/h)	SISD for Trucks (m)
100	303
110	351
120	403
130	458

The method of measuring the SISD is depicted on Figure 6-4.

Figure 6-4 Application of Safe Intersection Sight Distance



Source: Austroads Guide to Road Design Part 4A: Unsignalised and Signalised Intersections

6.2.2 Unsealed Roads

The *Unsealed Roads Manual: Guidelines to Good Practice* (USRM) published by ARRB in 2009 provides the best practice standards for unsealed roads. More detailed standards for unsealed roads are included in the literature review at Appendix A.

7 Stock Route Crossing Criteria

Stock route crossing assessment

The Queensland Stock Route Network is a network of facilities established to facilitate the movement of livestock on foot between grazing areas and markets. The network consists of areas for stock to travel along as well as areas for livestock to rest overnight including water facilities and holding yards.

Over time the use of these facilities has evolved and the network is now also used for animal agistment, recreational horse riding and for the provision of services such as electricity or telecommunications. These routes provide other general benefits for the community as they also enable the movement of wildlife and provide a landscape buffer.

As previously mentioned, the affected stock routes for the project are as follows:

> Kilcummin-Diamond Downs Road (Stock route M399BELY03)
> Amaroo Road (Stock route U402BELY03)
> Mistake Creek (Stock route U401BELY02)

Initial assessment of these routes has resulted in some proposed treatments. The Kilcummin-Diamond Downs Road crossing will be separated by a culvert, while the Amaroo Road crossing will be grade separated with a rail over road treatment whereby the stock route travels under the rail line. It is proposed that sufficient clearance be provided for stock to pass under the waterway bridge for the Mistake Creek crossing. However, it is stressed that these treatments are subject to negotiations with IRC, DTMR and landholders and as a result may change.

Management strategies relating to the disruption of stock routes include:

> Where there are to be permanent disruptions to the stock route network, DERM requires realignment or replacement of corridors of similar width and suitable country type to allow for the uninterrupted flow of travelling stock.
> The stock route network (all or part) disturbed or affected by the proposed works should be rehabilitated upon completion of the project. Where revegetation is required, native vegetation, including pastures, must be used to return the area to its natural state.
> Any required works to be identified in ongoing Road Use Management Plans prepared to support the project.

8 Rail Crossing Criteria

8.1 Level Crossings

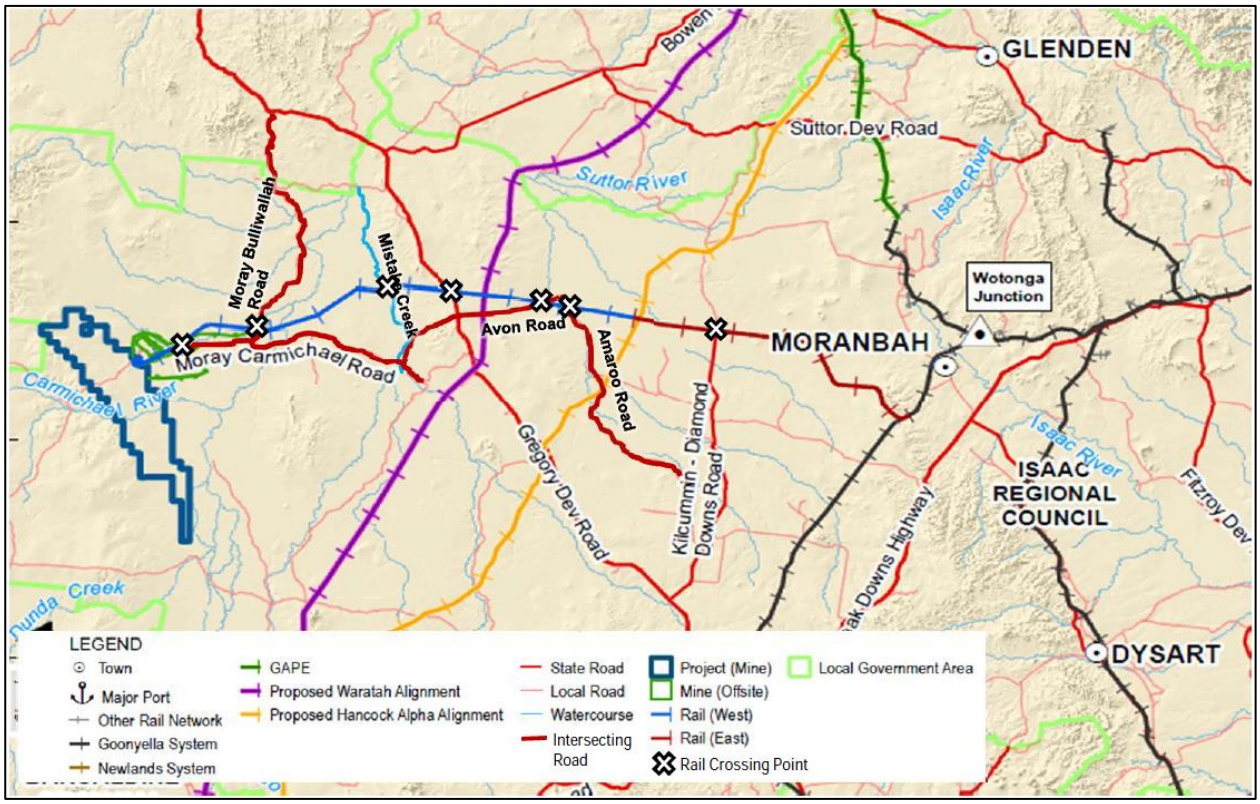
Rail crossing assessment: *ALCAM assessment*

Supplied data has stated that there will be a number of proposed road crossings, located at the following places:

- Kilcummin-Diamond Downs Road
- Amaroo Road
- Avon Road
- Gregory Development Road
- Mistake Creek
- Moray Bulliwallah Road
- Moray Carmichael Road

Figure 8-1 presents the indicative locations of these crossing points.

Figure 8-1 Railway Crossings



Rail crossings may be treated with a hierarchy of control dependant on the prevailing conditions. The *Road Planning and Design Manual* and the *Manual of Uniform Traffic Control Devices: Part 7 – Railway Crossings* provide detailed guidance on how to appropriately treat rail crossings, considering the specifics of each individual location. The detailed design guidance presented within these manuals has been summarised into a simplified framework for strategic planning purposes.

The treatment and control devices provided at rail crossings can be broadly defined into three categories, described in the following sections:

- Passively protected level crossings (least cost)
- Actively protected level crossings (moderate cost)
- Grade-separated railway crossings (high cost)

These categories of rail crossing are discussed further at Appendix A.

As the proposed crossings are yet to be constructed, the most appropriate level of crossing treatments for each location are yet to be decided. However, the implementation of the Australian Level Crossing Assessment Model (ALCAM) will be able to assist in designing an appropriate crossing.

8.1.2 ALCAM Assessment Methodology

The Australian Level Crossing Assessment Model is used to produce a Risk Score for level crossings based on the physical characteristics of a level crossing and the existing warning and control devices. It is primarily a tool for rating level crossing safety in a comparative manner.

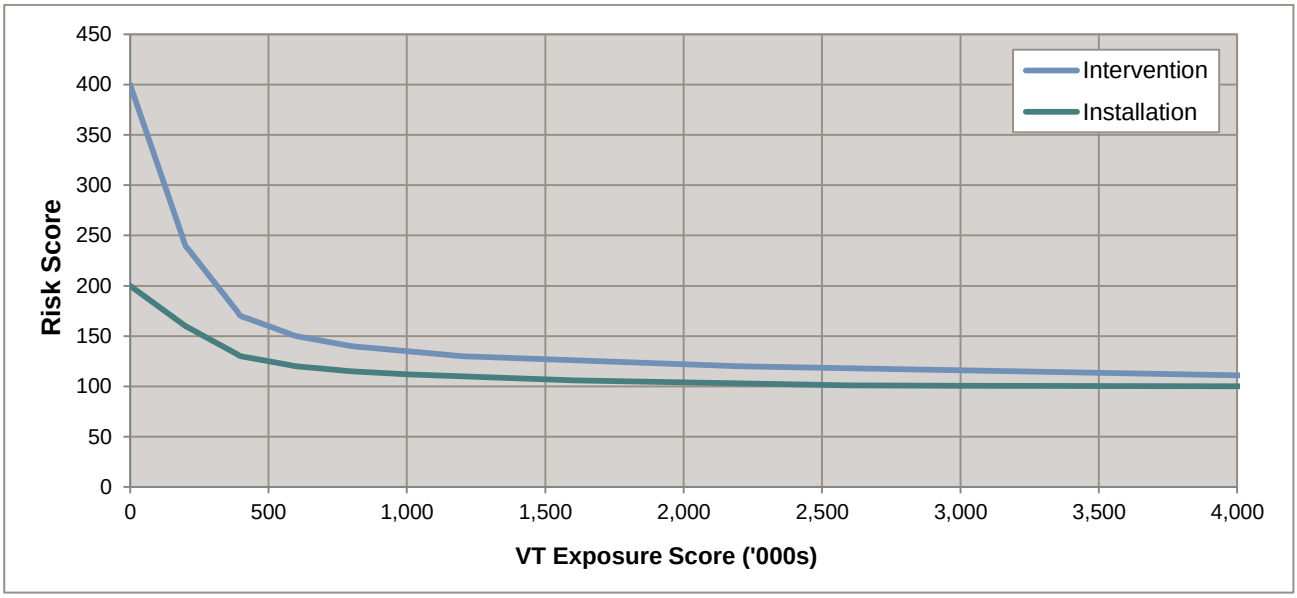
It should be noted that the ALCAM assessment methodology is a conservative assessment tool. As such, and taking into account the temporary nature of the major impacts, we would suggest that we use the ALCAM only when the vehicle impacts are in excess of 5%.

To compare the Risk Scores for a range of crossings, a reference score is used that can provide an indicative assessment of the risk relative to the consequence of a collision. Two reference scores are used: Installation Limit Score and the Intervention Limit Score. It is noted that these scores are not used to determine whether or not a crossing is 'safe' but rather how the Risk Score compares with the level of risk that may be acceptable at other crossings with a similar traffic and road environment profile.

The Installation Limit Score indicates a level below which the level crossing risk is likely to be within acceptable limits. The Intervention Limit Score indicates a level above which there is likely to be safety hazards that require priority attention to mitigate the level of risk.

The Installation and Intervention Limit Score Thresholds have been reproduced from the *Australian Level Crossing Assessment: Model Assessment Handbook* (2007) on Figure 8-2.

Figure 8-2 Installation and Intervention Limit Score Thresholds



Source: Australian Level Crossing Assessment Model: Crossing Assessment Handbook

The VT Exposure Score is calculated based on the traffic level (average road and rail vehicles per day) and is then modified by an Environmental Factor (or Consequence Multiplier) which is related to the severity of the consequence if an incident was to occur. The VT exposure score is therefore calculated by multiplying the road vehicles per day by the rail vehicles per day and then multiplying by the Environmental Factor.

8.1.3 Impact of Project

The impact of project traffic on the level crossing risk will need to be assessed by considering how the increased traffic volumes associated with the project could increase the current Risk Score and VT Exposure Score. The level crossing Risk Score can be reduced by increasing safety measures pertaining to the control details, road geometry, road traffic control, road vehicles, rail vehicles, crossing geometry and visibility.

Of the three factors that contribute to the VT Exposure Score (road traffic, rail traffic and consequence value), the road traffic will increase as a result of the project during construction, while rail traffic will also increase during the life of the project.

9 Summary

This assessment strategy has aimed to provide a framework for assessment criteria between Adani and Isaac Regional Council once sufficiently detailed data is readily available to undertake a detailed analysis. As such, a high level assessment of the project has been undertaken, offering insight into relevant road parameters, intersection design and rail crossing treatments.

It is acknowledged that, due to the nature of the project, the majority of facilities impacting upon roads will be incurred at the construction stages. This means the road impacts brought about by the project will be temporary, and according to the client issued project description, will last for approximately two years.

As a result, the recommendations provided have accounted for the temporary nature of the impacts. As such, Adani will provide a make-good clause on all works. The information provided within this assessment strategy is based on a fit for purpose basis.

The overriding principles which guide this assessment strategy, adopted from the TMR *Guidelines for Assessment of Road Impacts of Developments* (GARID), are safety, efficiency and the future planning of the road network. GARID has advised that development impacts will be deemed significant if the traffic generated by the development will increase the existing traffic by 5% or more. If the impact is significant then appropriate analyses must be undertaken.

Best practice standards have been consulted and recommended, from industry publications including the Austroads guides and TMR *Road Planning and Design Manual*. These recommended standards cover the following areas:

- Sealed traffic lane and shoulder width recommendations
- Intersection turn treatment warrants
- Sight distance requirements
- Stock crossing recommendations
- Level crossing treatment assessment methods

It is noted that standards for unsealed roads are provided in Appendix A.

Once more detailed project information is attained a Road Use Management Plan (RMP) will be developed. It is anticipated that the recommendations within the RMP will be based upon the framework set by this assessment strategy.

Carmichael Coal Mine and Rail Project

APPENDIX A
LITERATURE REVIEW

Cardno
Shaping the Future

Literature Review

The Isaac Regional Council is yet to develop a consolidated Planning Scheme for the three shires - Belyando, Broadsound and Nebo. Given the location of the development area, the relevant Planning Scheme for the rail project is the Belyando Shire Planning Scheme, which has been referred to in order to ascertain the standards required for road design. The Belyando Shire Planning Scheme defers to the Austroads guides, Queensland Streets and the Manual of Uniform Traffic Control Devices (MUTCD) with regards to the standards for roads.

Throughout this assessment strategy, reference has been made to the Austroads guides and TMR's Road Planning and Design Manual to present the best practice standards used within Queensland by industry professionals. In addition to these documents, this literature review refers significantly to the Unsealed Roads Manual: Guidelines to Good Practice (USRM) prepared by ARRB.

The USRM has been referred to in the Austroads Part 3: Geometric Design standards for the design of unsealed roads. Austroads does not include extensive information on unsealed roads and as such, the more reliable USRM standards have been used.

Unsealed Road Characteristics

In rural locations, given the low volume of vehicles it is highly likely that drivers are usually familiar with the road. Studies have shown that crashes are extremely rare. However, as capacity is not the critical factor on these roads, emphasis is placed on a safe design.

Drivers adjust their speed to the perceived physical limitations of the road rather than the posted speed limit. As such, the geometric design of rural roads is very important to reinforce the desired speed limit and should be designed for the operating speed, which is the 85th percentile speed of drivers on the road.

The USRM references Austroads for the unsealed road classification system, which provides a system for the functional hierarchy of rural unsealed roads. The traffic volume is expressed in average daily traffic (ADT) which represents the peak season traffic. Table 9-1 presents the road descriptions for each of the four classes while Figure 9-1 provides examples of each class.

Table 9-1 Unsealed Road Classification System

Road Class	Class Type	Service Function Description	Road Type Description
4A	Main road >150 ADT	This type of road is used for major movements between population centres and connection to adjacent areas. High traffic volumes occur and the road can carry large vehicles.	▪ All weather road predominantly two lane and unsealed. Can be sealed if economically justified ▪ Operating speed standard of 50-80 km/h according to terrain ▪ Minimum carriageway width is 7m
4B	Minor road 150-500 ADT	This type of road is used for connection between local centres of population and links to the primary network. Roads may or may not be sealed depending on the importance and the function of the road.	▪ All weather two-lane road formed and gravelled or single-lane sealed road with gravel shoulders ▪ Operating speed standard of 30–70 km/h according to terrain ▪ Minimum carriageway width is 5.5 m.
4C	Access road 10-50 ADT	Provides access to low use areas or individual rural property sites and forest areas. Caters for low travel speed and a range of vehicles and may be seasonally closed.	▪ Substantially a single lane two-way generally dry-weather, formed (natural materials) track/road ▪ Operating speeds standard of < 20–40 km/h according to terrain ▪ Minimum carriageway width is 4 m ▪ May be restricted to four-wheel drive vehicles

Road Class	Class Type	Service Function Description	Road Type Description
4D	Tracks <10 ADT	Provides primarily for four-wheel drive vehicles. Mainly used for fire protection purposes, management access and limited recreational activities.	▪ Predominantly a single-lane two-way earth track (unformed) at or near the natural surface level ▪ Predominantly not conforming to any geometric design standards ▪ Minimum cleared width is 3 m

Source: Unsealed Roads Manual: Guidelines to Good Practice (2009)

Figure 9-1 Examples of Unsealed Road Classifications

Source: Unsealed Roads Manual: Guidelines to Good Practice (2009)

Given that unsealed roads have lower surface friction compared to that of sealed roads, to compensate for this in terms of safety, better geometric design standards are necessary. Geometric design standards are usually governed by the function of the road, traffic volumes, vehicle types, terrain and cost considerations. Examples of standards which significantly enhance the safety of roads include larger curve radii and longer sight distances. Guidelines for these unsealed road standards are highlighted in Table 9-2.

Table 9-2 Guidelines for the Main Geometric Design Standards for Unsealed Roads

Road Classification	4A Main			4B Minor			4C Access			4D Tracks		
Terrain	**Flat**	**Rolling**	**M'tain**	**Flat**	**Rolling**	**M'tain**	**Flat**	**Rolling**	**M'tain**	**Flat**	**Rolling**	**M'tain**
Operating speed (km/h)	80	70	50	70	50	30	60	40	20	N/A	N/A	N/A
Number of traffic lanes	2	2	2	2	2	2	1	1	1	1	1	1
Minimum traffic lane width (m)	3.5	3	3	3	3	3	3	3	3	3	3	3
Minimum shoulder width (m)	1	1	0.5	0.5	0.5	0.5	1.5	1	0.5	0	0	0
Minimum carriageway width (m)	9	8	7	7	7	7	6	5	4	3	3	3
Minimum formation width (inc. verges) (m)	11	10	9	9	9	9	8	7	6	3	3	3
Minimum radius curve (m)	320	250	140	250	100	35	170	60	15	N/A	N/A	N/A
Minimum stopping sight distance (m)	150	120	70	120	70	30	90	50	30	N/A	N/A	N/A
Maximum vertical grade (%)	6	8	12	6	8	12	6	8	12	N/A	N/A	N/A

It is noted that considering the nature of the roads for the Carmichael Mine and Rail Project will require a significant proportion of heavy vehicle volumes, the lane widths stated in the table above should be increased by 500mm per lane to allow for the increased tracking width.

Where the traffic volume for roads is less than 150vpd, it is acceptable to provide a single lane two way road as the occurrence of passing vehicles is low. If it is not considered cost effective to widen the carriageway, a basic width of 5.5m should be sufficient to allow for two 2.5m wide vehicles to pass with 0.5m clearance.

Table 9-3 provides suggested typical minimum unsealed road widths.

Table 9-3 Minimum Unsealed Road Widths

Description	One-lane Two-way Road	Two-lane Two-way Road
Traffic lane	3.0	3.5
Shoulder	0.5	1.0
Carriageway	7.0	5.5
Table drain	1.0	1.0

Austroads suggest consideration should be given to the future upgrading opportunities of the road. In particular, if a narrow carriageway (5.0 to 6.0m) is designed for an unsealed road, sealing it will require road significant widening. However, where traffic volumes are likely to require a carriageway width of 8.0 to 8.5m, sealing will be easier given minimal road widening will be necessary.

Road Alignment

Generally, it is considered safer and better to opt for a good standard of road alignment rather than a good quality road pavement, as the costs associated with realigning a road in the future are much greater than that of upgrading the pavement. Road alignment factors include superelevation, curve radii and sight distance.

Superelevation refers to the tilting of the road cross section to slope down towards the inside of a curve. It relates to the tendency of vehicles travelling around a curve to move towards the outer side of the curve. This is due to the sideways friction force between tyres and the road and the gravity force due to the mass of the vehicle. The USRM stipulates that a maximum superelevation of 4-6% is considered appropriate, however the 6% limit is discouraged given the risk of slow moving heavy vehicles to deviate into the inside curve and the increased scouring and erosion effects. As such, 4-5% is preferred.

The radius of a curve is particularly important for obtaining adequate sight distance and maintaining the standard of the road. When vehicles negotiate tight curves, surface gravel may be dislodged resulting in higher maintenance costs. Typical minimum curve radii are set out in Table 9-4, which assumes a maximum superelevation of 5%.

Table 9-4 Minimum Curve Radii for Unsealed Roads

Operating Speed (km/h)	Minimum radius of curve (m)
50	120
60	180
70	260
80	340
90	460
100	565

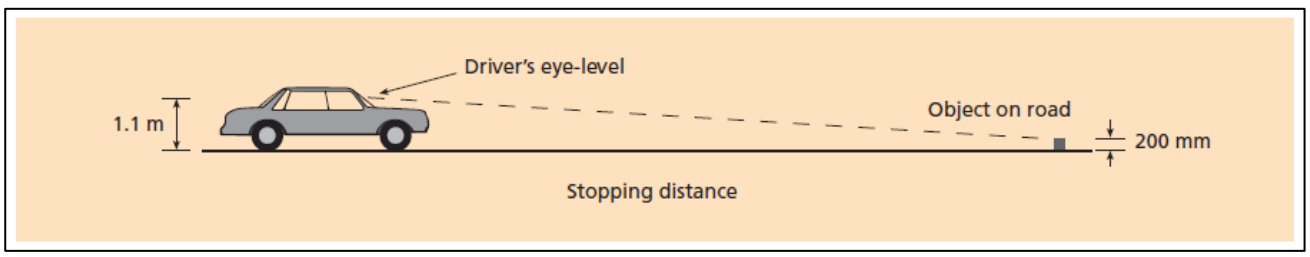
Sight Distance

The sight distance values found in the Austroads guides are generally for sealed roads which have a better coefficient of friction than unsealed roads. It has been noted in the USRM that due to the reduced friction of unsealed roads, the sight distance values from Austroads should be increased to allow for this performance difference. Guidelines in the USRM suggest that it is generally accepted to increase the sight distances by 30-50%. In particular, it is suggested that the stopping sight distance (SSD) values are generally increased by 25%; however they should be increased by 40% when applied to single-lane two-way roads.

Single-lane two-way roads should provide road widening at critical locations, such as at crest curves to allow for safe passing manoeuvres. In addition to warning signage, extra safety precautions may be used, such as sealing the crest and placing a double barrier line. Sealing the crest of vertical curves may also be useful in dusty conditions, where visibility can be reduced to zero.

Stopping Sight Distance (SSD) refers to the minimum distance for a driver to stop before colliding with an object on the road. It is measured from a driver eye height of 1.1m to an object of 200mm height, as depicted on Figure 9-2.

Figure 9-2 Stopping Sight Distance



Source: Unsealed Roads Manual: Guidelines to Good Practice (2009)

The values presented in Table 9-5 refer to the SSD requirements with respect to the operating speed of the road and the reaction time of a typical driver using the road.

Table 9-5 Stopping Sight Distance Requirements on Unsealed Roads

Operating Speed (km/h)	Stopping Sight Distance (m)		
	Normal Design		Restricted Design
	Reaction time = 2.5 sec	Reaction time = 2.0 sec	Reaction time = 1.5 sec
50	Reaction time is excessive for low speed environments	65	60
60		90	80
70		115	105
80	160	145	Reaction time is too low for high speed environments
90	195	185	
100	245	-	

Intersection Design

For rural locations, the main concern for intersection design is safety as the predominant accident type is that which occurs between two vehicles. Considering this, it is preferable for intersections to be located away from high embankments, bridges, culverts, streams, and not on small radius curves, steep grades or superelevated curves.

In accordance with Austroads standards, the USRM states that intersecting roads should be positioned at between 70 and 90° to allow for good visibility. Additionally, it is preferred that intersections be spaced as far apart as possible with adequate signposting for warnings at critical locations.

Intersection Sight Distance

The sight distance requirements presented in **Section 6.2** of this report relate to sealed roads. Table 9-6 provides a guide to the various sight distance requirements for unsealed roads. As reported in Section 6.2, there are two main types of sight distances that need to be applied at intersections – Approach Sight Distance (ASD) and Safe Intersection Sight Distance (SISD).

Approach Sight Distance relates to the minimum level of sight distance which must be available on the minor road approaches to all intersections to ensure that drivers are aware of the presence of an intersection.

Safe Intersection Sight Distance is the minimum distance which should be provided on the major road at any intersection. SISD provides sufficient distance for a driver on a major road to observe a vehicle on a minor road approach moving into a potential collision situation and to decelerate to a stop before reaching the collision point.

Table 9-6 Minimum Intersection Sight Distance Requirements for Unsealed Roads

Speed (km/h)	ASD (m)	SISD (m)
40	32	70
50	45	90
60	65	115
70	85	140
80	105	175
90	130	205
100	155	235

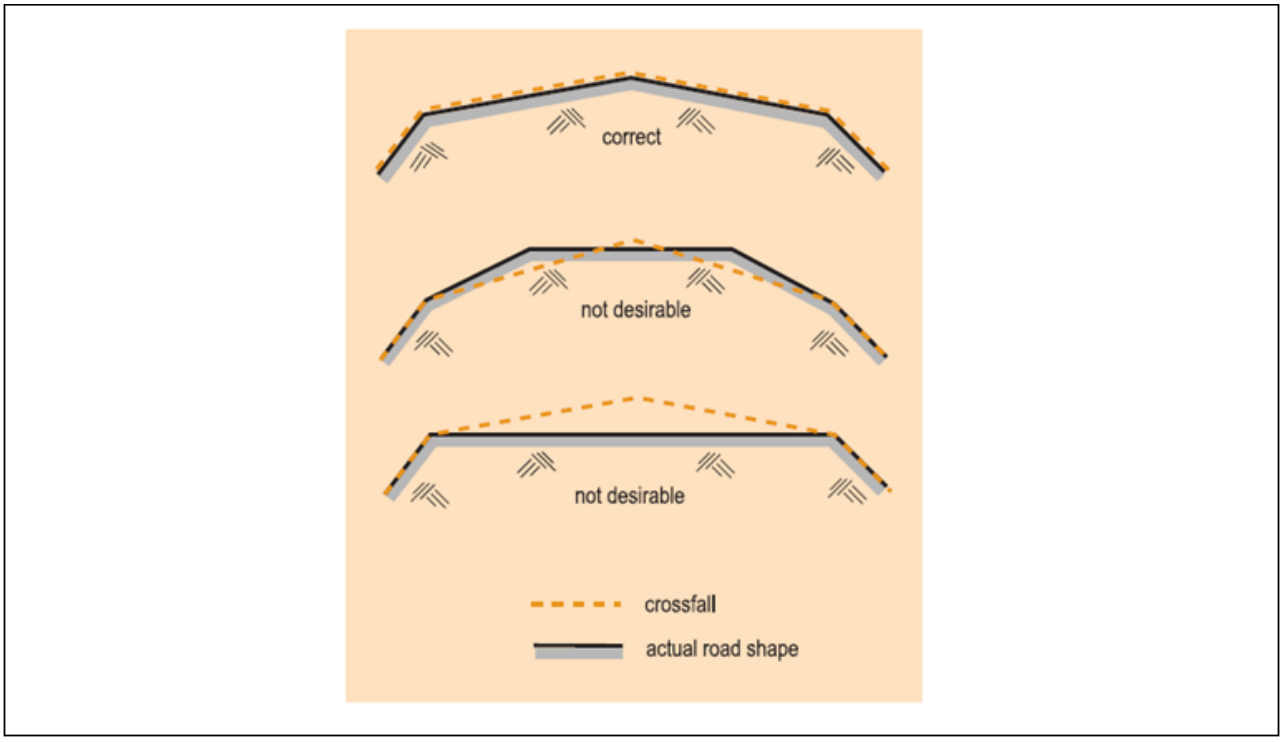
Drainage

Drainage is one of the most important factors in maintaining traffic loads on unsealed roads. To ensure adequate drainage is provided, a suitable cross-fall must be designed, along with appropriately located drains beside the road. Poor drainage design can lead to serious maintenance issues such as erosion and the formation of potholes.

Cross-fall

It is important to maintain 4-6% cross-fall on straight sections to prevent pooling which can lead to potholes. If the cross-fall is too high, scouring and erosion may occur. Figure 9-3 indicates the proper design of cross-falls for two-lane roads.

Figure 9-3 Correct Shape of a Two-lane Road



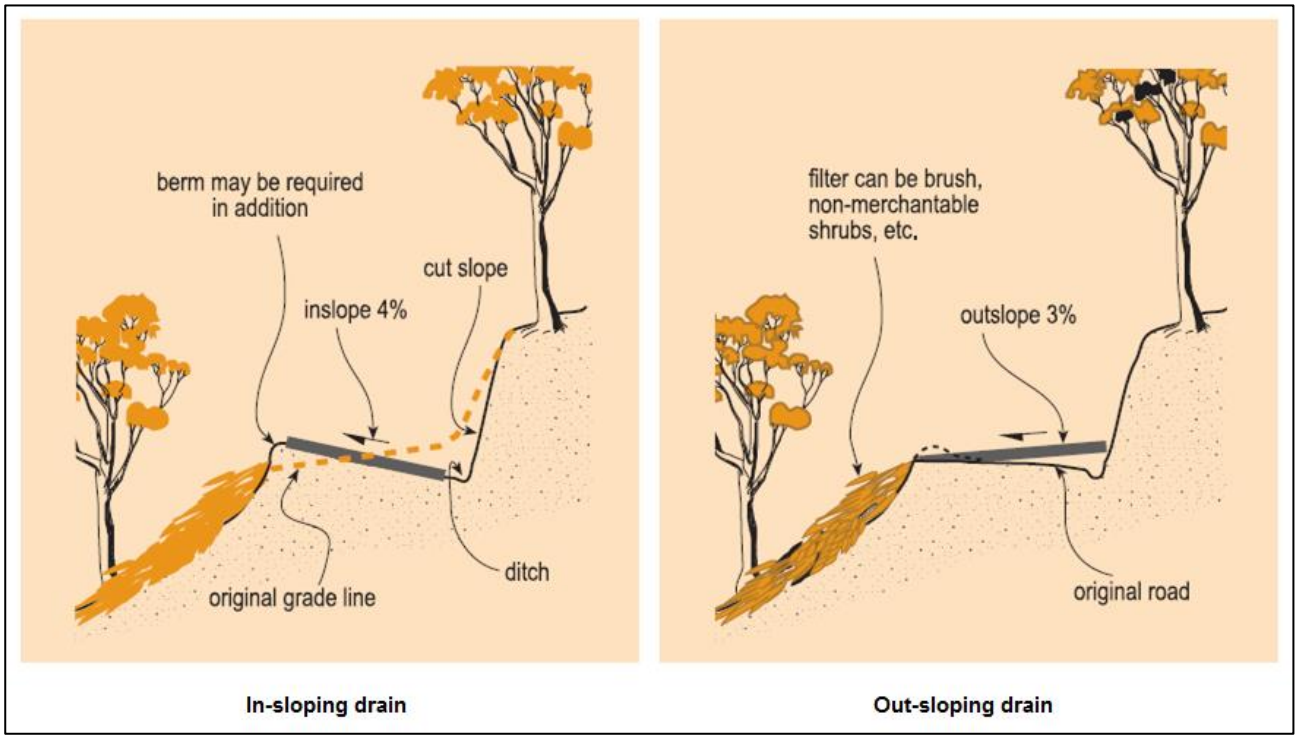
Source: Unsealed Roads Manual: Guidelines to Good Practice (2009)

Table Drains

Table drains, also referred to as drainage ditches, run parallel to the road and are usually placed in cut sections and at grade sections to collect discharged water. It is important to note that the lowest point in the pavement must be well above the free water level in the table drains, with a distance of at least 0.5m being preferred.

Instead of using table drains on both sides of the road, in-slopes or out-slopes may be used to eliminate drains from one side of the road. Figure 9-4 highlights the design of in-sloping and out-sloping drains.

Figure 9-4 In-sloping and Out-sloping Drains



Source: Unsealed Roads Manual: Guidelines to Good Practice (2009)

Level Crossing Treatments

As discussed within the report, the three types of rail crossing treatments are:

> Passice protection
> Active protection
> Grade separated

Passive Protection

Passive protection at a rail crossing is the control of road vehicles by devices that do not activate during the approach or passage of a train. Passive protection requires drivers to detect the approach or presence of a train by direct observation.

Typical methods of passive protection are summarised in Table 9-7.

Table 9-7 Summary of Passive Rail Crossing Devices

Device	Use
Give way signs	The minimum level of control at any railway level crossing on public roads
Stop signs	Used in situations where all vehicles are required to stop at the crossing because approaching vehicles have restricted sight distance to approaching trains
Advance warning signs	An additional advance warning device

Active Protection

Active protection at a rail crossing is the control of road vehicles by devices such as flashing lights, gates or barriers or a combination of these, where the devices are activated prior to and during the passage of a train, by the train. Active protection does not require drivers to directly detect the approach or presence of a train.

Typical methods of active protection are summarised in Table 9-8.

Table 9-8 Summary of Active Rail Crossing Devices

Device	Use
Flashing signals	Standard sign and signal assembly is used at actively protected level crossings
Gates	Used in conjunction with the flashing light assembly for increased protection
Boom barriers	Used in conjunction with the flashing light assembly for increased protection

Grade Separated

Grade separated crossings physically separate the rail line from the road by either elevating or lowering the rail corridor above or below the road. This ensures that no interaction occurs between the two modes of transport. Although this method is the safest option, it is also the most costly.

PART

8

CIVIL PLANS AND DRAWINGS

> Civil Engineering Drawings prepared by Cardno

CONSTRUCTION FACILITY AREA
Option-I Area - 113.85 Ha

4SP116046
DISNEY
MA, PJ & TJ Kirkwood

4SP116046
DISNEY
MA, PJ & TJ Kirkwood

GREGORY DEVELOPMENTAL ROAD

SHORT RAIL (400m x 40m)

SLEEPER STACK AREA (1500m x 40)

FSHC / LWR (400m x 40m)

TEMP LINE

BRIDGE GIRDER STACKING AREA (500m x 270m)

PIPE CULVERT SEGMENT STACKING AREA (850m x 270m)

BOUNDARY

Total Area - 113 ha

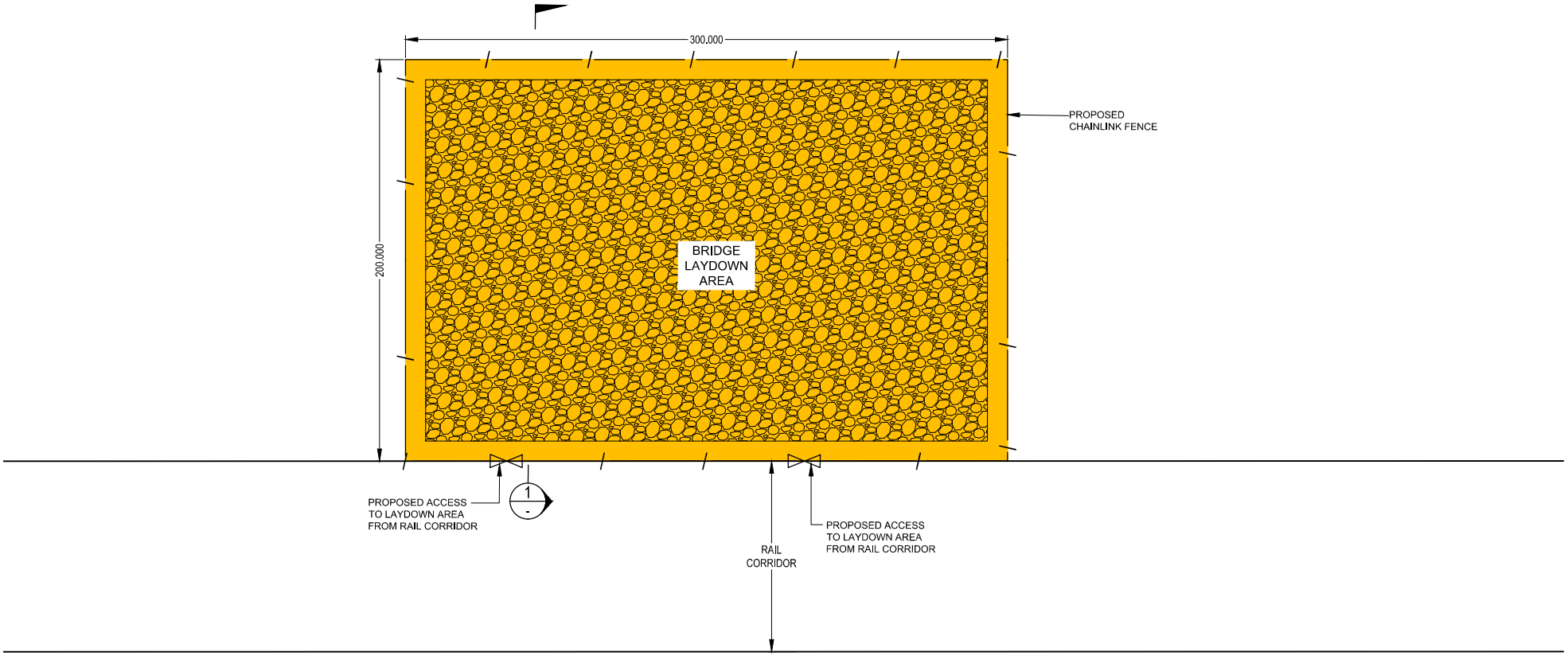
BALLAST STOCK YARD (1250m x 250m)

BALLAST LINE

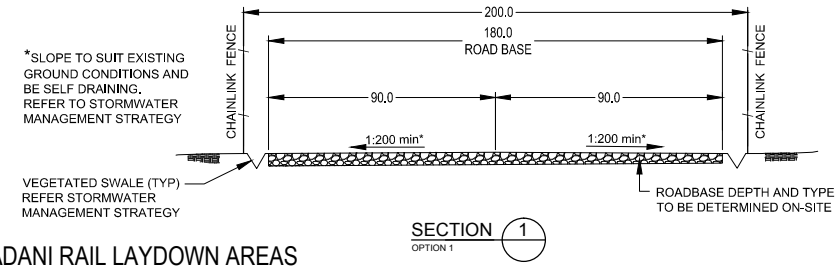
3235PH752
OLD TWIN HILLS
EF & PR Dennis

Legend :
Proposed NGBR Alignment
Proposed NGBR Construction Depot

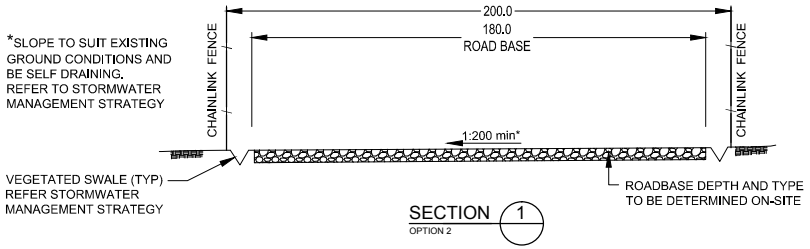
Date : 07-06-2013



PLAN VIEW



SECTION 1
OPTION 1



SECTION 1
OPTION 2

ADANI RAIL LAYDOWN AREAS

TYPICAL BRIDGE LAYDOWN AREA

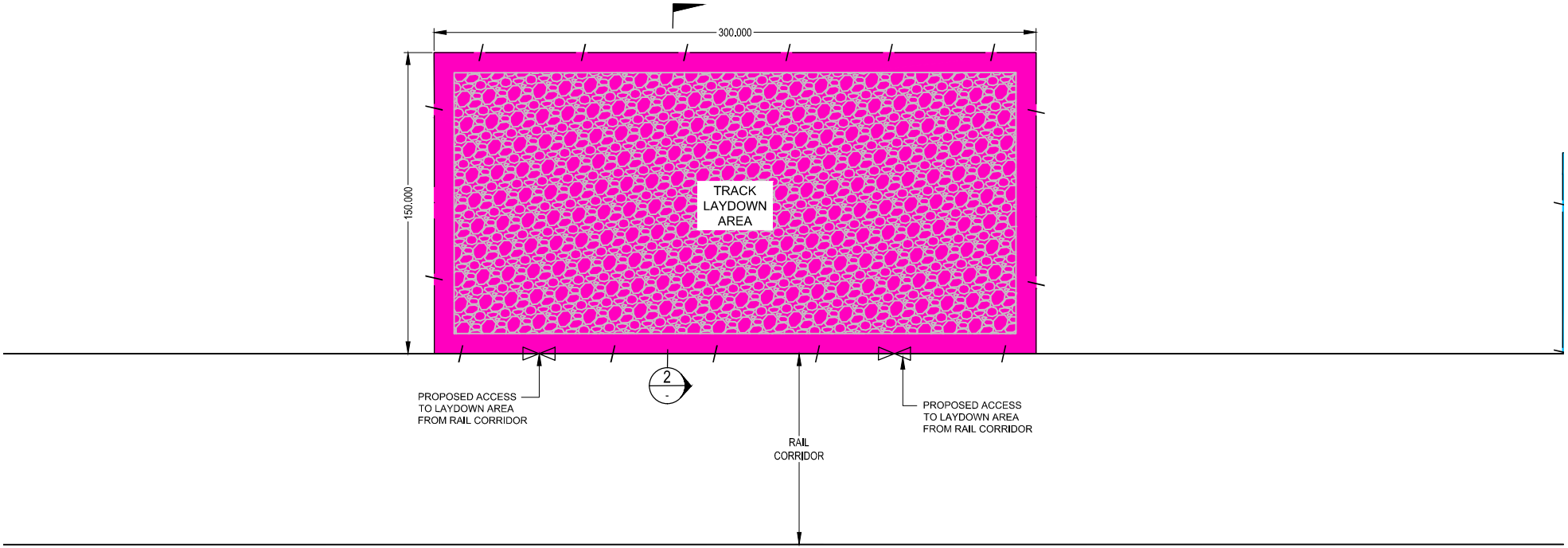
DRAFT FOR DISCUSSION

30 0 30 60 90 120 150m
1:3000 - A4

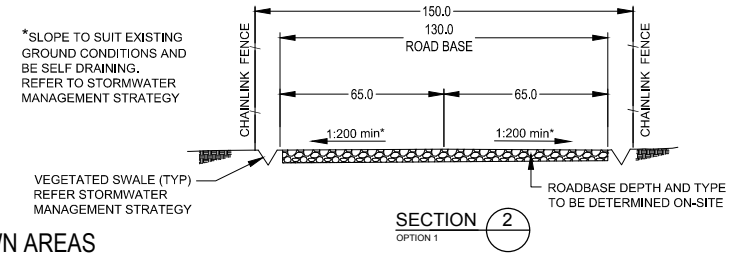
Cardno (Qld) Pty Ltd ACN: 051 074 992
Level 11, North Tower, 515 St Paul's Terrace, Fortitude Valley 4006
Locked Bag 4006, Fortitude Valley Qld 4006
Phone (07) 3369 9822 Fax (07) 3369 9722
Email: cardno@cardno.com.au Web: www.cardno.com.au

Quality Endorsed Company

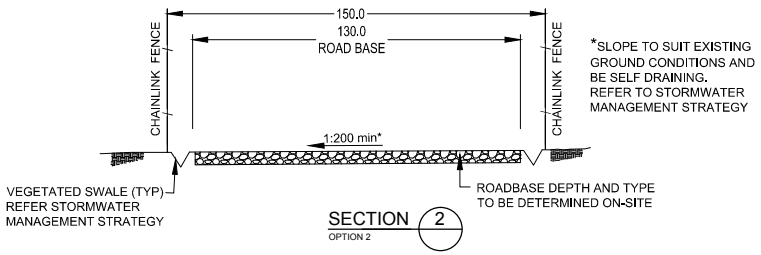
REF NUMBER: 7903/44/001/SK-001(P3)
DATE: 18/04/2013



PLAN VIEW



SECTION 2
OPTION 1



SECTION 2
OPTION 2

ADANI RAIL LAYDOWN AREAS

TYPICAL TRACK LAYDOWN AREA

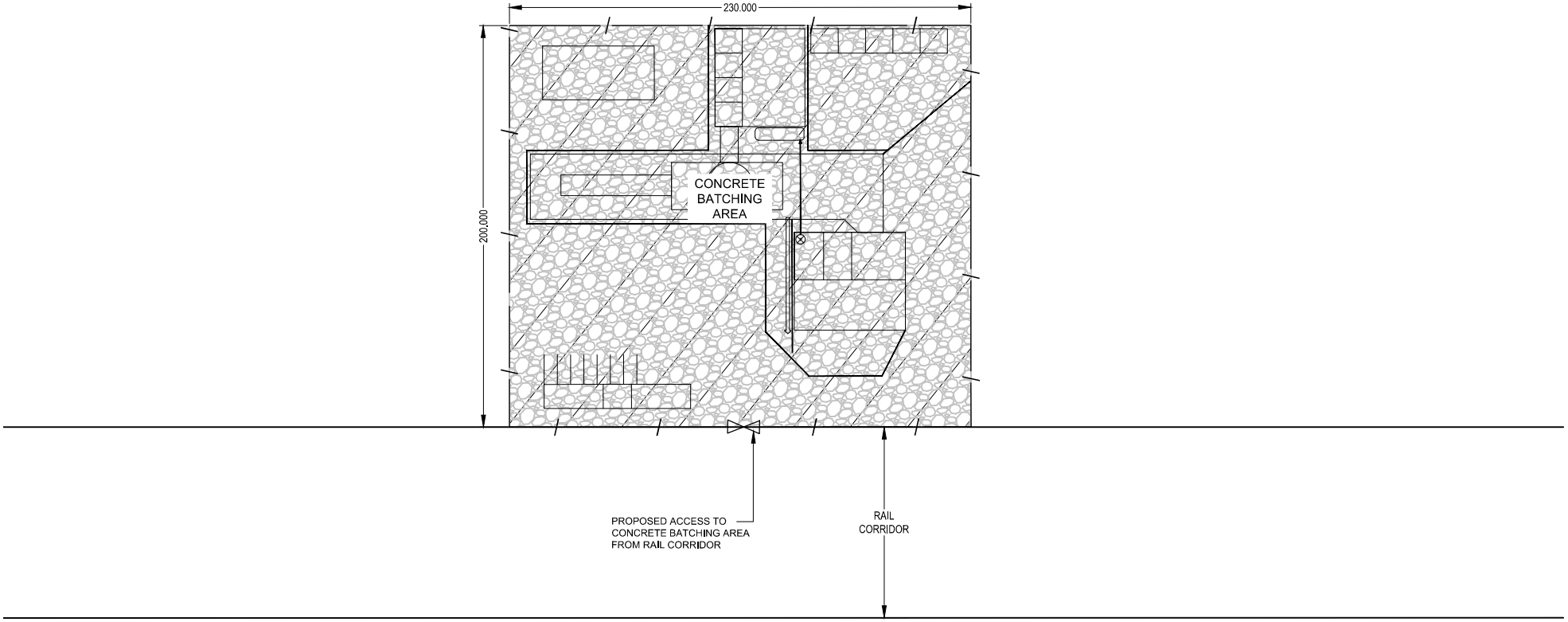
DRAFT FOR DISCUSSION

30 0 30 60 90 120 150m
1:3000 - A4

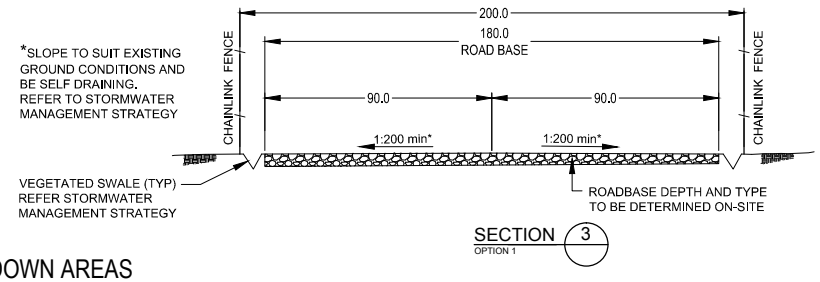
Cardno (Qld) Pty Ltd ACN: 051 074 992
Level 11, North Tower, 515 St Paul's Terrace, Fortitude Valley 4006
Locked Bag 4006, Fortitude Valley Qld 4006
Phone (07) 3369 9822 Fax (07) 3369 9722
Email: cardno@cardno.com.au Web: www.cardno.com.au

Quality Endorsed Company

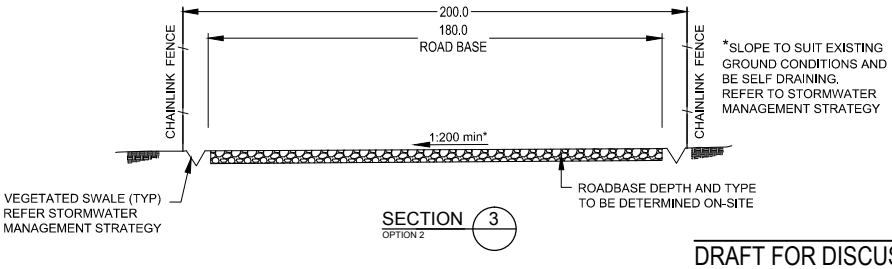
REF NUMBER: 7903/44/001/SK-002(P3)
DATE: 18/04/2013



PLAN VIEW



SECTION 3
OPTION 1



SECTION 3
OPTION 2

ADANI RAIL LAYDOWN AREAS

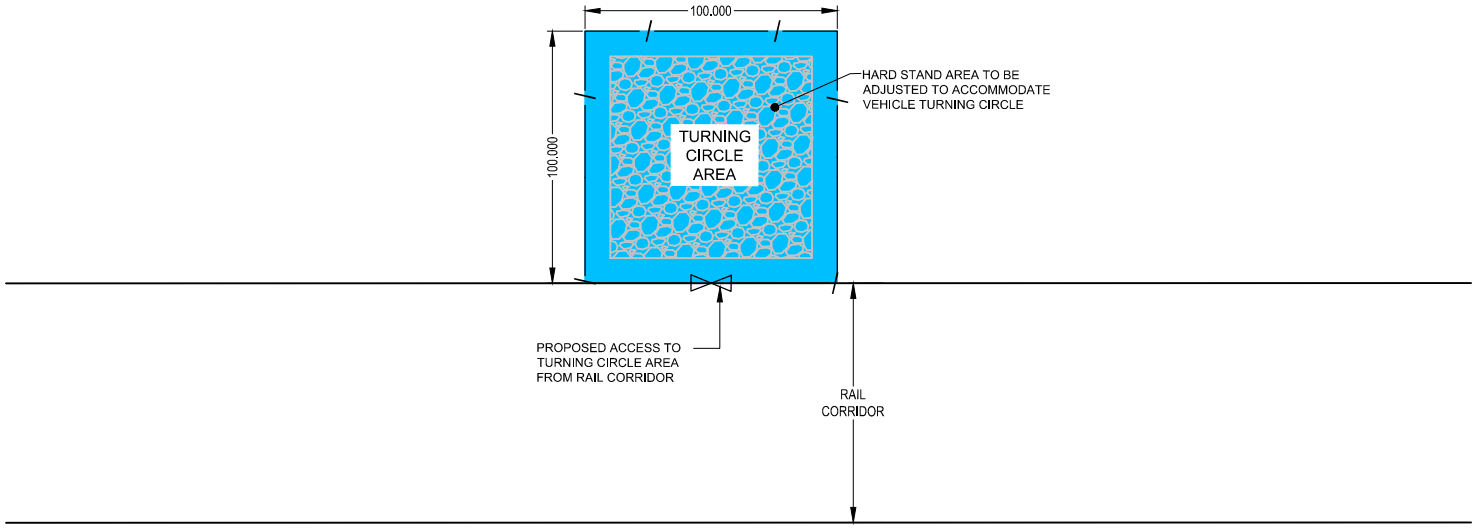
TYPICAL CONCRETE BATCH LAYDOWN AREA

DRAFT FOR DISCUSSION

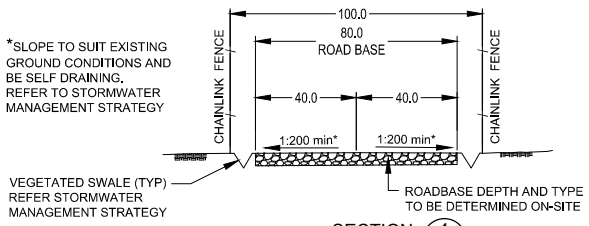
30 0 30 60 90 120 150m
1:3000 - A4

Cardno (Qld) Pty Ltd ACN: 051 074 992
Level 11, North Tower, 515 St Paul's Terrace, Fortitude Valley 4006
Locked Bag 4006, Fortitude Valley Qld 4006
Phone (07) 3369 9822 Fax (07) 3369 9722
Email: cardno@cardno.com.au Web: www.cardno.com.au
Quality Endorsed Company

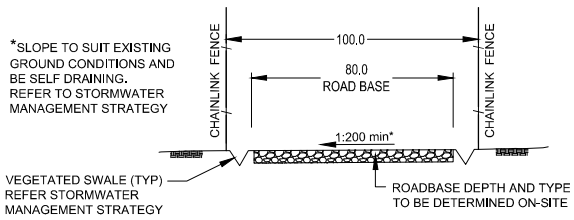
REF NUMBER: 7903/44/001/SK-003(P3)
DATE: 18/04/2013



PLAN VIEW



SECTION 4
OPTION 1



SECTION 4
OPTION 2

ADANI RAIL LAYDOWN AREAS

TYPICAL TURNING CIRCLE AREA

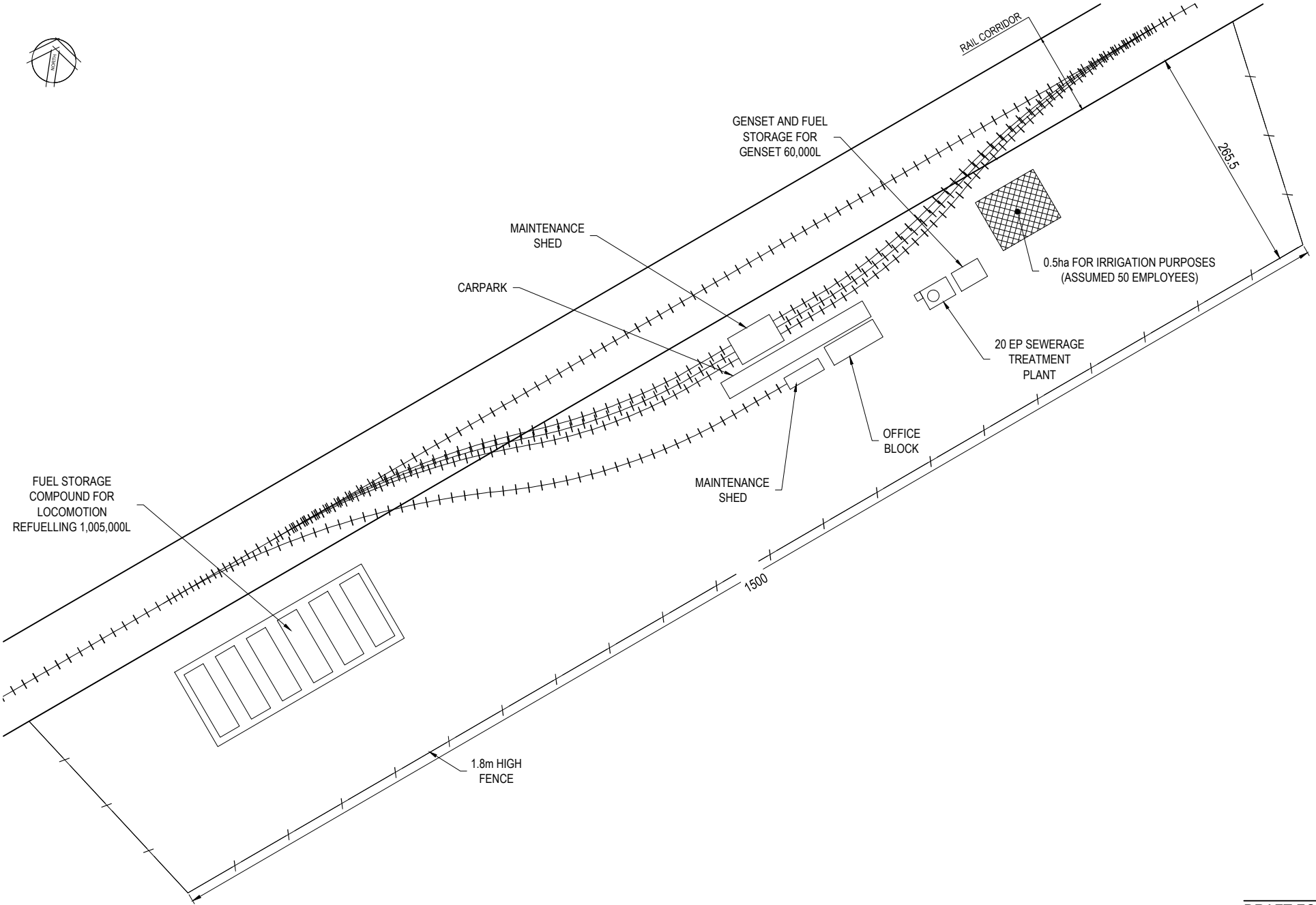
DRAFT FOR DISCUSSION

30 0 30 60 90 120 150m
1:3000 - A4

Cardno (Qld) Pty Ltd ACN: 051 074 992
Level 11, North Tower, 515 St Paul's Terrace, Fortitude Valley 4006
Locked Bag 4006, Fortitude Valley Qld 4006
Phone (07) 3369 9822 Fax (07) 3369 9722
Email: cardno@cardno.com.au Web: www.cardno.com.au

Quality Endorsed Company

REF NUMBER: 7903/44/001/SK-004(P3)
DATE: 18/04/2013



ADANI RAIL LAYDOWN AREAS

MAINTENANCE YARD TYPICAL LAYOUT

DRAFT FOR DISCUSSION

0 100 200 300 400m

1:6000 - A4

Cardno (Qld) Pty Ltd ACN: 051 074 992
Level 11, North Tower, 515 St Paul's Terrace, Fortitude Valley 4006
Locked Bag 4006, Fortitude Valley Qld 4006
Phone (07) 3369 9822 Fax (07) 3369 9722
Email: cardno@cardno.com.au Web: www.cardno.com.au

Quality Endorsed Company

REF NUMBER: 7903/44/001/SK-005(P2)
DATE: 19/07/2013

The contents of this plan are conceptual only. All areas and dimensions are approximate and subject to relevant studies, Survey, Engineering and Council approval.

L:\7903-44 Adani Laydown Areas\001 Design\Design and Documentation\Acad\Drawings\790344-Laydown Areas

PART

9

ECOLOGY

> Ecological Assessment prepared by Saunders Havill

1.1 Legislation

The *Vegetation Management Act 1999* (VM Act), in conjunction with the *Sustainable Planning Act 2009* (SP Act), regulates the clearing of native vegetation. Under the SP Act, operational work that is the clearing of native vegetation is to be assessed against the purposes of the VM Act.

The Department of Natural Resources and Mines administers the VM Act and will assess any clearing required for the Project against the relevant Regional Vegetation Management Code for Ongoing Clearing Purposes. Native vegetation that occurs in a mapped Regional Ecosystem (RE) or that meets the structural and species requirements to be mapped as a RE will be assessed under this process.

Under the VM Act all remnant vegetation are categorised as either "endangered", "of concern" and "not of concern" REs. The type of vegetation clearing applications required for the Project is dependent on the type of vegetation present within the Project area.

1.2 Clearing native vegetation / ecology

As detailed within the SEIS, Volume 3, Chapter 5 (Nature Conservation), the Project (Rail) will require removal of remnant vegetation within the Brigalow Belt Bioregion and Desert Uplands Bioregion, including endangered REs, of concern REs, and least concern REs.

The application for clearing of native vegetation will be assessed against the set of performance criteria in Part S (Requirements for clearing for significant projects) of the *Regional Vegetation Management Code for Brigalow Belt and New England Bioregions* and the *Regional Vegetation Management Code for Western Bioregions*.

The purpose of performance requirements in the codes is to "regulate the clearing of vegetation in a way that conserves remnant vegetation that are REs, does not cause land degradation, prevents the loss of biodiversity and maintains ecological processes." The Regional Vegetation Management Codes offer an acceptable solution for each of the performance criteria listed. Where these acceptable solutions cannot be met, offsetting can be offered as an alternative solution for meeting the performance requirements. SEIS, Volume 1, Chapter 10 describes the Offsets Strategy for the Project.

Under the VM Act, section 21, a Property Vegetation Management Plan (PVMP) must be provided by the applicant. For a PVMP to be lodged it will be necessary for a site

visit to take place in order to produce a Property Map of Assessable Vegetation (PMAV).

The PVMP and PMAV are submitted for the Project (Rail) as part of the operational works application for clearing of native vegetation. These have been mapped and assessed against the relevant regional vegetation management codes for the Project (Rail) and were included in the EIS in Volume 4, Appendix AA1 (Property Map of Assessable Vegetation for the Project (Rail) west) and AA2 (Property Map of Assessable Vegetation for the Project (Rail) east). Updated versions of the PMAVs are included in this SEIS, Volume 4, Appendix J7 (PMAV).

Associated applications included in this SEIS, Volume 4, Appendix C3 (Rail approval applications) are Regional Vegetation Management Code responses and Vegetation Clearing Permits for the Project (Rail). For the Project (Rail) west, assessment against the Regional Vegetation Management Code were undertaken for the laydown and temporary works areas.

1.3 Laydown areas for bridges and tracks, maintenance yards, construction depot and turning circles

The following applications for the Project (Rail) laydown areas for bridges and tracks, maintenance yards, construction depots and turning circles are included in Appendix C3 (Rail approval applications):

- amend RE mapping under the VM Act (PVMP)
- clearing permit (protected plants) under the NC Act
- tampering with breeding places of least concerned fauna (NC Act)
- tampering with breeding places of iconic and Endangered, Vulnerable and Rare plants (NC Act).