ENGENY
WATER MANAGEMENT

WARATAH COAL

Mine Site Water Management System

Galilee Coal Project SEIS Technical Report

November 2012

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ENGENY WATER MANAGEMENT

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Abbreviations

AEP – Annual Exceedance Probability

ARI – Average Recurrence Interval

AWBM – Australian Water Balance Model

BOM – Bureau of Meteorology

CHPP – Coal Handling and Preparation Plant

DEHP – Department of Environment and Heritage Protection

DERM – Department of Environment and Resource Management

DNRM – Department of Natural Resources and Mines

DSA – Design Storage Allowance

EIS – Environmental Impact Statement

EPC – Exploration Permit Coal

HDPE – High Density Polyethylene

IFD – Intensity Frequency Duration

MGA – Map Grid of Australia

Mtpa – Million Tonnes Per Annum

MIA – Mine Industrial Area

MLA – Mining Lease Application

MRL – Mandatory Reporting Level

SEIS – Supplementary Environmental Impact Statement

ROM – Run of Mine

1. INTRODUCTION

Waratah Coal has commissioned Engeny Water Management (Engeny) to undertake an assessment of the flood impacts associated with the Galilee Coal Project mine site (hereafter referred to as the project). This report provides conceptual level assessment of the project site water management system to support the submission of the SEIS and address stakeholder concerns raised during the EIS public consultation process.

1.1 Background

Waratah Coal proposes to mine 1.4 billion tonnes of raw coal from existing tenements (EPC 1040 and EPC1079) approximately 30 km north of Alpha within the Galilee Basin. The annual ROM coal production will be 56 Mtpa to produce 40 Mtpa of saleable export steaming coal to international markets. The processed coal will be transported by a new standard gauge railway system approximately 453 km in length that runs from the project site to the existing Port of Abbot Point.

The mine will consist of a combination of open cut mining and longwall underground mining. Open cut operations will involve dragline and truck and shovel operations producing 20 Mtpa ROM with coal delivered to the CHPP via heavy vehicle access roads. The underground mines will operate via continuous mines and longwall shearers producing 36 Mtpa ROM delivered to the CHPP via a conveyor system. The CHPP will be capable of producing 40 Mtpa of product coal which will be stockpiled adjacent to the CHPP for train load out. Co-disposal of coarse rejects and tailings will be utilised with disposal in the tailings dam and box cut spoil areas. Additional mine infrastructure will include:

- Mine infrastructure area consisting of administration buildings, parking areas workshop and lay down areas;
- Vehicle equipment and wash down facilities;
- A 2,000 person accommodation village and wastewater treatment plant;
- Light vehicle access roads and site access roads;
- Raw water storage for CHPP vacuum pumps, potable water supply and fire fighting;
- Environmental control dams, sediment dams, pit dewatering and underground dewatering dams and flood protection levees;
- Rail loop and train load out facilities.

The proposed mine infrastructure layout is included in Appendix A.

1.2 Scope of Works

This report has been prepared to determine the requirements for a mine water management system and assess the performance of the system in terms of protection of downstream environmental values in receiving waterways. The proposed works have been undertaken to address DEHP and specific stakeholder concerns raised during the EIS public consultation process. The following scope of works has been adopted to address these concerns:

- Identify regulatory requirements for mine water management.
- Develop site water management design objectives to prevent adverse impact on downstream water quality and quantity while maintaining efficient mining operations;
- Undertake a review of existing downstream conditions and water uses to assess the performance of the water management system.
- Undertake an analysis of catchment areas and expected water quality to determine storage capacities of water containment structures.
- Develop a water balance model of the proposed mine water management system using long term historical climate data to assess the system performance in terms of containment of mine affected water and re-use of water to meet mine water demands.
- Identify the need for external water sources to meet mine water demands.

1.3 Study Area

The project tenements (EPC 1040 and part of EPC 1079) cover an approximate area of 1,059 km² and are located in the south-east parts of the Barcaldine Regional Council local authority in Queensland. The contributing catchment covers an approximate area of 1,316 km² and typically drains in a north-easterly direction through the tenement areas. The majority of the tenement areas drain to the Belyando and Burdekin River basin via Lagoon Creek while the western edge of EPC 1079 drains to the Cooper Creek basin. The existing land uses within the project catchments are primarily defined as rural production with some conservation and natural environments.

The climate zone in the vicinity of the mine site is classified as Grassland (BOM, 2012), which has hot dry summers and warm dry winters. The average annual rainfall in region is 532 mm (Alpha Post Office) with a clearly defined wet and dry season. The tenement areas have both minor and major creeks flowing through them. These include Tallarenha, Beta, Saltbush, Malcolm and Lagoon Creeks. These creeks systems are typically ephemeral and can experience expansive flooding after sustained periods of heavy rain.

2. BACKGROUND INFORMATION

2.1 Water Management System Design Objectives

In order to reduce impacts on downstream water quality and quantity as well as maintain mine productivity, it is essential that mine water management is appropriately planned and implemented. It is intended that mine water be managed to minimise the potential for contamination of receiving waters.

The design objectives of the proposed site water management system include.

- To ensure sufficient quantities of water can be obtained for site usage.
- To ensure the segregation of “dirty” water from “clean” water.
- To ensure the containment of “contaminated” water.
- To minimise the accumulation of water in open cut pits by way of drainage diversions.
- To maximise the use of “dirty” and “contaminated” water for dust suppression or other purposes and minimise the necessity for importing raw water.
- To minimise the volume of mine affected water discharged from the mine site.

A site water management system has been developed with the focus on the separation of “clean” and “dirty” water. The site has significant operational requirement for water in underground workings, coal preparation, dust suppression and other raw water demands. Water requirements will be preferentially sourced from “dirty” water run-off collected on site where appropriate. The water within the mine site has been characterised into the following four classes:

- Contaminated water – surface runoff from the CHPP, ROM and stockpile areas and water contained within open cut pits. This water is likely to be saline and may also be acidic (low pH) depending on the presence of acid forming material. This water may also contain hydrocarbons of other contaminants such as metals. Runoff from these areas will be managed to prevent discharge to receiving waterways as well as meet on site water demands.
- Dirty water – surface runoff from spoil dumps and rehabilitated spoil areas that could contain sediments but typically not with elevated contaminant levels (e.g. salts, metals, low pH). This runoff will be directed to sedimentation dams for settling of suspended solids and on-site reuse, with discharge to receiving waters only occurring during significant rainfall events.
- Clean water – Surface runoff from natural catchments. Surface runoff from natural catchments will not be contained onsite and will pass through the site via creek diversions and bunding of open cut pits. For the purposes of this study, water

produced from dewatering of underground mine workings and aquifer pre-drainage is assumed to be low salinity and suitable for re-use as water supply for underground mining.

- Raw water – Water imported from a reliable external water source that is suitable for uses that require a high specification of water quality (e.g. CHPP vacuum pumps, industrial washdown use and potable supply). It is expected that raw water for the project will be able to be supplied from a proposed SunWater pipeline from the Burdekin River to the Galilee Basin. Raw water for the project may initially need to be sourced from regional groundwater supplies until the pipeline from the Burdekin River is operational.

Sizing of storages to meet the site water management objectives is discussed further in Section 4 with an assessment of the system performance undertaken in Section 5 using a water balance modelling approach.

2.2 Project Sequencing

A 25 year production schedule has been developed to provide 20 Mtpa ROM from the open cut pits. Excavation for three of the four pits will commence in year 1 of operations. Snapshots of the open cut mining schedule have been prepared for the following years of operation and are shown in Appendix B:

- Year 1;
- Year 5;
- Year 10;
- Year 20;
- Year 25 (final void).

The water management system has been developed for each of these years of open cut operations to reflect the changes in catchment areas with progression of the pits. Additional dams will need to be constructed or relocated throughout the life of the mine to cater for additional disturbance or underground mine subsidence. The underground mine operations typically progress at the same rate through 30 years of operations and therefore water requirements will typically not change through life of mine.

2.3 Relevant Legislation and Guidelines

2.3.1 Environmental Protection Act 1994

The *Environmental Protection Act 1994*, administered by DEHP is the overarching legislation defining the identification of environmental values through the Environmental Protection (Water) Policy 2009*.* The proposed creek diversions have been designed and will be operated to minimise environmental impact downstream to maintain existing environmental values. The Act also controls the use of regulated structures such as dams and levees through the *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams* (DERM, 2012a).

2.3.2 Sustainable Planning Act 2009

The *Sustainable Planning Act 2009* seeks to achieve sustainable planning outcomes through managing the process by which development takes place, managing the impacts of development on the environment and continuing the coordination and integration of local, regional and state planning.

2.3.3 Manual for Assessing Hazard Categories and Hydraulic Performance of Dams

The *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams* (DERM, 2012a) sets out requirements for hazard category assessment and certification of the design of dams and other land-based containment structures, constructed as part of environmentally relevant activities under the *Environmental Protection Act 1994*. The manual has been used to ascertain design criteria for regulated dams and assessment of the hazard categories of these structures.

2.3.4 Preparation of Water Management Plans for Mining Activities

The guideline, *Preparation of Water Management Plans for Mining Activities* (DERM, 2010) outlines the matters that should be considered and the principles to be followed, in the development of a mining project water management plan. This guideline has been used for the development and documentation of the site water management system.

2.3.5 Model Water Conditions for Coal Mines in the Fitzroy Basin

The purpose of these guidelines (DERM, 2012b) is to provide a set of model conditions to form the basis of water related environmental protection commitments given in an environmental management plan for coal mining activities. Although these guidelines relate directly to mining within the Fitzroy River Basin (Bowen Basin) they have been considered through the development of the site water management system as the principles are considered to relevant to mining activities in the Galilee Basin.

2.4 Previous Reports

This report has been prepared utilising data or results provided in the following previous reports which were prepared as part of the Galilee Coal Project EIS or feasibility studies:

- *China First – Groundwater Assessment* (E3 Consult, 2010a) – This report was prepared as a part of the EIS to assess the current status of groundwater and the potential impacts to groundwater as a result of the project. The groundwater testing results from this report have been used to predict groundwater quality.
- *China First – Surface Water Assessment* (E3 Consult, 2010b) – This report outlines the existing surface water quality within the mine site, identifies possible impacts of mine water quality and mitigation measures associated with the project The relevant sections of the report relating to the mine have been used to assist in the desktop geomorphic review;
- *Water Balance Report for Six New Coal Mines* (AMEC, 2010) – This report was prepared as a part of feasibility studies. The report provides estimates for site water demands and sources including groundwater inflows to underground mines and open cut pits, underground mine demand as well as CHPP water requirements;
- *Tallarenha Creek Dam Yield Assessment* (Engeny, 2011) – This report was prepared by Engeny to assess the feasibility of the construction of dam on Tallarenha Creek to supply water to the project. The report included a calibrated catchment yield assessment of Tallarenha Creek which has been utilised to estimate catchment runoff from the project. The Tallarenha Creek dam is no longer part of the proposed mine infrastructure. Instead raw water for the project is expected to be supplied from the Burdekin River and/or groundwater.

3. EXISTING ENVIRONMENT

3.1 Rainfall

Daily rainfall data for mine site was sourced from the Silo Patched Point dataset facility for the existing BOM rainfall station at Alpha Post Office (035000). Two additional stations including Surbiton Station (036139) and Betanga (035087) were also analysed to assess the suitability for representing site rainfall conditions. Alpha Post Office was chosen as being the most suitable source due to the quality of data and the length of record (1889 to 2011). The historical annual rainfall for Alpha Post office is summarised in Figure 3.1.

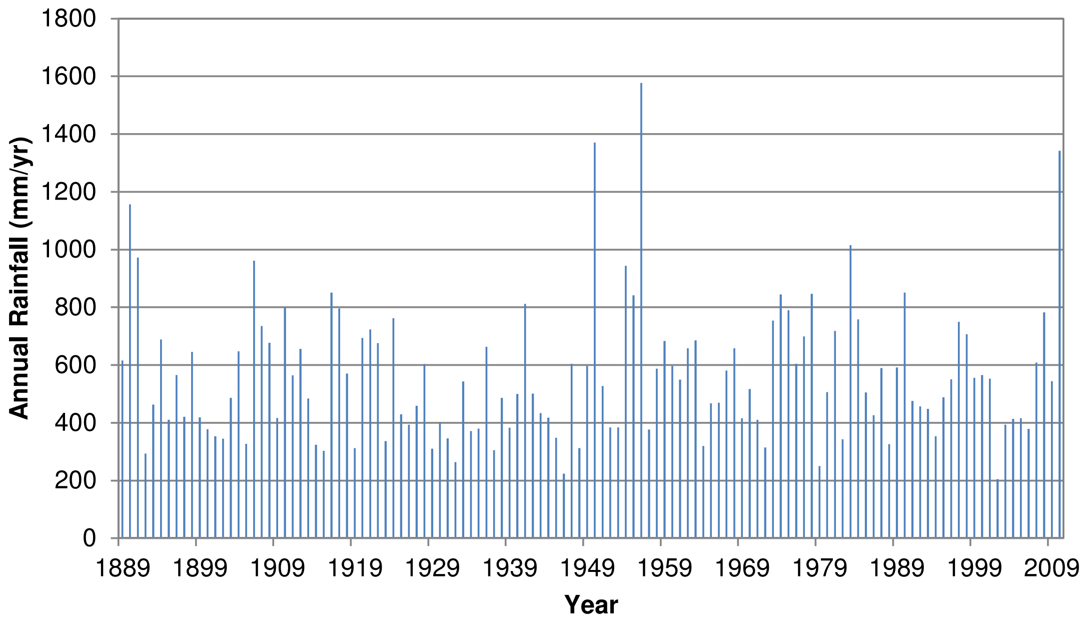

Figure 3.1 Annual Rainfall Totals (Alpha Post Office)

Review of the annual rainfall totals yields the following statistics:

- Average annual rainfall 563 mm
- Maximum annual rainfall of 1577 mm in 1956
- Minimum annual rainfall of 205 mm in 2002

Dams that contain mine affected water are required to contain an entire wet season (critical wet period) of rainfall in accordance with the *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams* (DERM, 2012a). The duration of the critical wet period is 3 months (90 days) for the mine site based on Figure 1of the Manual.

The critical wet period rainfall for each water year was derived from the 122 years of rainfall data for the Alpha Post Office rain gauge. The AEP for each of the rainfall totals was determined using a Log Pearson Type III distribution with the results summarised in Figure 3.2.

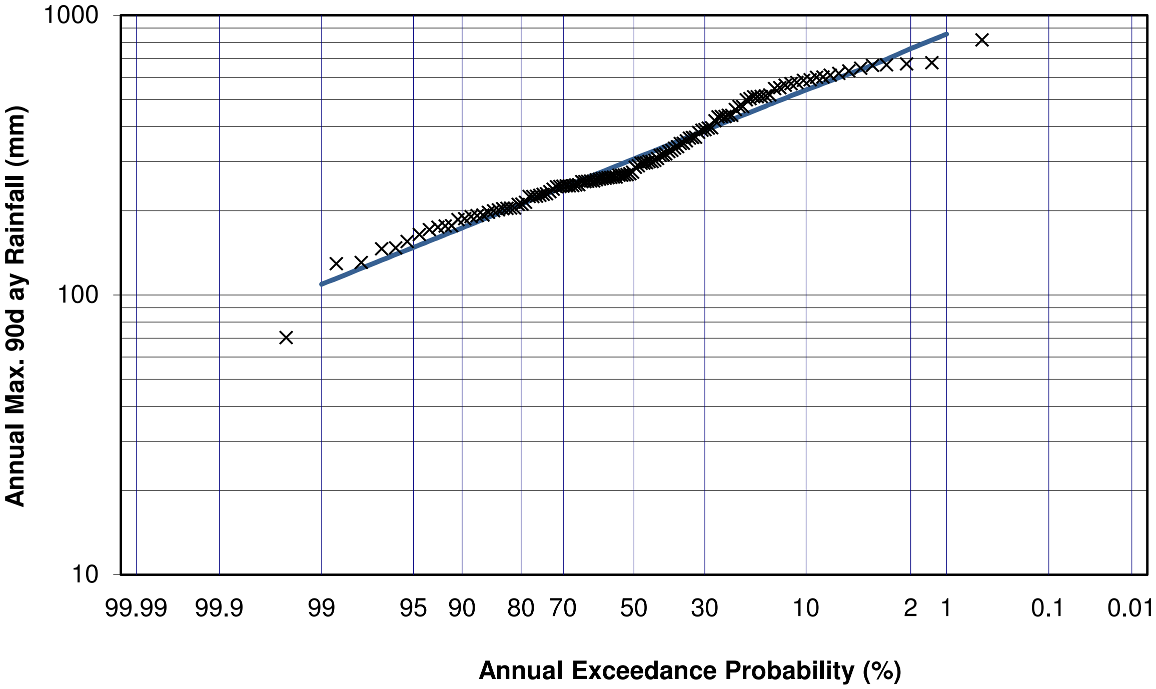

Figure 3.2 Critical Wet Period Rainfall

Based on the water containment requirements for regulated dams the design wet season rainfall depths are summarised below:

- 1:100 AEP – 850 mm;
- 1:20 AEP – 625 mm.

3.2 Evaporation

Daily evaporation data for project was extracted from the Alpha Post Office Patched Point dataset for the pan evapotranspiration, lake evaporation and potential evaporation. These parameters have been used to derive estimates for open water evaporation (Morton's lake evaporation) and soil moisture evapotranspiration on a monthly basis. A summary of the adopted evaporation estimates is provided in Table 3.1.

Table 3.1: Average Monthly Evaporation for Mine Site

Month	Average Pan Evaporation (mm)	Lake Evaporation Factor[1]	Evpotranspiration Factor[1]
January	256	0.80	1.08
February	204	0.85	1.12
March	211	0.82	1.15
April	161	0.81	1.20
May	120	0.81	1.25
June	92	0.85	1.34
July	102	0.85	1.34
August	137	0.83	1.28
September	186	0.79	1.20
October	240	0.77	1.14
November	254	0.76	1.10
December	273	0.77	1.07
Annual	180	0.81	1.20

1. Pan factor is the ratio of evaporation or evapotranspiration rate pan evaporation rate.

3.3 Catchment Hydrology

The MLA has a significant contributing catchment area of approximately 1,316 km². There are a number of waterway systems intersecting the subject site with Lagoon Creek being the ultimate watercourse discharging from the MLA. These watercourses eventually discharge into the Belyando River approximately 75 km downstream of the MLA. There is also a small portion of the MLA which discharges to the Cooper Creek basin.

There are no stream flow gauging stations on Lagoon Creek. Stream gauging stations on adjacent waterways have been utilised to understand the hydrological regime of the existing watercourses. The Department of Natural Resources and Mines (DNRM) currently operate stream flow gauging stations on the nearby Native Companion Creek and Mistake Creek located 30 km east and 58 km west of the MLA respectively. Statistics of gauged annual flows for these stations are summarised in Table 3.2.

Table 3.2: Annual Stream Flow Statistics in Vicinity of MLA

Percentile	Native Companion Creek[1]		Mistake Creek[2]	
	Annual Flow (ML)	Annual Runoff Depth (mm)[3]	Annual Flow (ML)	Annual Runoff Depth (mm)[3]
10th Percentile	1,670	0.4	22	0.3
25th Percentile	7,023	1.7	32	0.5
50th Percentile	16,239	4.0	193	2.9
75th Percentile	47,042	11.6	890	13.5
90th Percentile	155,140	38.2	2,286	34.6
Mean	58,094	14.3	803	12.2

1. 4,065 km² catchment area.
2. 66 km² catchment area.
3. Annual flow divided by catchment area.

The stream gauging data for Native Companion Creek and Mistake Creek indicates that an average annual runoff depth of 12 to 14 mm (approximately 2 % of mean annual rainfall) is representative of catchments in the vicinity of the MLA.

3.4 Downstream Environment

The DEHP regional ecosystems database has been used to assess the importance of ecosystems within the vicinity of the mine site. The DERM regional ecosystem database classifies the status of remnant vegetation throughout Queensland as Endangered, Of Concern, or Not of Concern as well as providing additional supporting information on the vegetation characteristics. Review of this mapping indicates there are no “Of Concern” or “Endangered” ecosystems directly downstream of the MLA. There are a number of regional ecosystems which are “Of concern” and “Endangered” located along the Belyando River approximately 90 km north of the MLA.

Water extracted downstream is primarily used for agricultural purposes, however also includes riparian stock and domestic entitlements. There are no surface water licenses along Lagoon Creek or Sandy Creek. There are a number of surface water licenses attached to properties along the Belyando River up-gradient of the Galilee Coal Mine. The surface water licenses along the Belyando River downstream of the Galilee Coal Mine are listed in Table 3.3. These licenses include water extraction for irrigation use.

The only major water impoundment structure downstream of the MLA is Burdekin Falls Dam, some 350 km north of the MLA. It is unlikely that water is used in the vicinity of the mine site for recreational purposes due to the ephemeral nature of the waterways. Hancock Coal are developing the Alpha Coal project immediately downstream (to the north of) the proposed Galilee Coal Mine.

Table 3.3: Surface water licenses along Belyando River downstream of the Galilee Coal Mine

License Number	License Type	Purpose	Property Description
48434F	License to take water	Domestic Supply	L1/PER207046
55005A	License to take water	Irrigation	L3/SP112964
55006A	License to interfere by impounding – Embankment or Wall	Impound Water	L3/SP112964
96640A	License to take water	Irrigation, Waterharvesting	L3/SP112964

3.5 Surface Water Quality

Water quality characterisation of the existing watercourses was undertaken for the EIS (E3 Consult, 2010b). The results indicate that the streams are generally in good health with physio-chemical parameters outside of expected ranges attributed to the surrounding rural land uses and ephemeral nature of the waterways. The watercourses have been described as slightly to moderately disturbed (E3 Consult, 2010b) under the Queensland Water Quality Guideline classification. Key points from the water quality characterisation include:

- Dissolved salts were generally compliant with the Queensland Water Quality Guidelines with some marginal exceedances in isolated locations which was attributed to the ephemeral nature of the system;
- pH was compliant for median, 20^{th} and 80^{th} percentile values with some minor exceedances which was attributed to natural fluctuations;
- All metals were generally compliant with the Queensland Water Quality Guidelines except for Copper which consistently exceeded limits during both wet and dry season conditions. These exceedances have been attributed to the geological characteristics of the catchment.

3.6 Groundwater Quality

Groundwater quality characterisation was previously undertaken for the EIS phase of the project (E3 Consult, 2010a). One round of water quality sampling was undertaken on existing bores during the dry season of 2010. The results of this testing suggest the groundwater is typically of good quality despite a high salt concentration and some minor exceedances in metal concentrations also noted. The results of this sampling are provided in Table 3.4.

Table 3.4: Groundwater Quality Data (E3 Consulting, 2010a)

	EC (µS/cm)	pH	Sulphate (mg/L)
Minimum	400	5.3	5
10th Percentile	644	6.0	13
Median	3,480	6.9	107
90th Percentile	9,334	7.7	230
Maximum	14,050	8.1	612

Further work is currently being undertaken to characterise the groundwater quality that will be intercepted by open cut and underground mining operations. This characterisation will assist in determining the suitability for on-site re-use. This work will also assist in further determining the design requirements for the site water management system.

3.7 Geochemistry

There is currently no geochemical characterisation of overburden available and open-cut interburden material within the MLA. Geochemical characterisation for the Alpha Coal project directly to the north of the MLA indicates the majority of spoil material will be non-acid forming (SRK Consulting, 2010). This study also indicated the potential for salt movement from spoil under rainfall conditions (SRK Consulting, 2010). For the purposes of this study is has been assumed that all spoil material associated with the Galilee Coal project will be non-acid forming with the potential for salt generation.

If future geochemical characterisation reveals the presence of acid generating material or other contaminants of concern the water management strategy will be reassessed accordingly.

4. WATER STORAGE REQUIREMENTS

4.1 Overview

The site water management system has been developed based on the current open cut mining schedule for Year 1, 5, 10, 20 and 25. As the area of disturbance associated with open cut operations increases the number of dams required will also increase. The indicative number of dams required throughout the life of mine is summarised in Table 4.1. Plans showing the proposed dam locations and indicative footprints are provided in Appendix B. The design basis for the different types of water storage structures are described in the following Sections.

Table 4.1: Mine Water Storage Requirements – Number of Structures

Mine Stage	Box-Cut Spoil Sediment Dams	Pit Spoil Sediment Dams	Environmental Dams	Underground Dewatering Dams	Clean Water Dams	Return Water Dams
Year 1	11	0	2	2	2	1
Year 5	14	11	2	2	2	1
Year 10	15	18	2	2	2	1
Year 20	15	19	2	2	2	1
Year 25	15	19	2	2	2	1

4.2 Box Cut Sediment Dams

Sediment dams will be provided within the box-cut spoil areas prior to Year 1 of operations and will be designed for retention of stormwater runoff to maximise settling of suspended solids and re-use of water to meet on-site demands. During the construction phase of the project it is intended that this water will be reused for construction related purposes such as dust suppression. Upon commencement of actual mine operations it is intended that the box cut spoil areas will be progressively rehabilitated. The sediment load from the contributing catchments is expected to drop significantly as ground cover increases. This good quality water is intended to be reused as a water supply for underground mining operations.

Design parameters for the box cut spoil sediment dams are summarised below while the design dam capacities are provided in Table 4.2. The sediment dams will only discharge to receiving waterways during large rainfall events, however the dams will provide a sediment removal function even when discharging. The following design parameters have also been adopted for the purposes of water balance modelling:

- Maximum depth of 5 m, 2:1 length to width ratio and 1V:3H side slopes.
- Water storage volume based on the maximum contributing catchment area (over the life of mine) and the 1:10 AEP 24 hour duration rainfall depth[1] assuming a 50% volumetric runoff coefficient.
- Additional sediment storage volume assumed at 20% of settling volume[2].
- Re-use of water in dams for supply to underground mines.

Table 4.2: Box Cut Spoil Sediment Dam Storage Capacities

Dam ID	Maximum Catchment Area (ha)	Volume (ML)	Total Volume (ML) (inc. Sediment Storage)
SD1	94	62	74
SD2	236	155	186
SD3	146	96	115
SD4	81	53	64
SD5	103	67	81
SD6	178	117	141
SD7	187	123	147
SD8	179	118	141
SD9	304	200	240
SD10	116	76	91
SD11	228	150	180
SD12	52	34	41
SD13	96	63	76
SD14	86	56	68
SD15	303	199	239

[1] 132 mm based on BOM Rainfall IFD Data System (BOM, 2012).
[2] Sediment storage volume assumed to full for water balance modeling.

4.3 Clean Water Dams

Two clean water dams will be required as balancing storages associated with the mine's raw water supply network. One clean water dam (CWD1) will be located adjacent to the CHPP with the second clean water dam (CWD2) located adjacent to underground portals to supply water to the underground mines. Both storages have been nominally sized at 120 ML which is in excess of two weeks supply for the underground mine and CHPP in the event of pipeline or pump failure. The following design parameters have also been adopted for the purposes of water balance modelling:

- Dams to be a 'turkey's nest' configuration to prevent contamination from external catchment inflows.
- Maximum depth of 5 m, 1:1 length to width ratio and 1V:3H side slopes.
- Both dams to be HDPE lined to prevent seepage losses.

4.4 Pit Spoil Sediment Dams

Sediment dams are proposed to be located within the spoil areas associated with the open cut pits. The number of dams required will increase with the progression of each open cut pit high wall. It has been assumed that these spoil areas will also be progressively rehabilitated which will likely improve runoff quality. Water captured within these dams will be utilised as water supply for dust suppression operations to limit the potential for overflow. Sizing of the dams has been based on the assumption that spoil will be non acid forming and of low salinity, with the dams sized for removal of suspended sediments through natural sedimentation. If the results of future geochemical investigations reveal otherwise, the sizing methodology will be revisited. The following design considerations have been adopted for the purpose of sizing:

- Maximum depth of 5 m, 2:1 length to width ratio and 1V:3H side slopes;
- Sediment storage volume based on the maximum contributing catchment area (over life of mine) and the 1:10 AEP 24 hour duration rainfall depth[3] assuming a 50% volumetric runoff coefficient.
- Additional sediment storage volume assumed at 20% of settling volume[4].
- Re-use of water in dams for dust suppression.

Table 4.3 summarises the pit spoil sediment dam storage capacities based on the maximum catchment area over the mine life.

[3] 132 mm based on BOM Rainfall IFD Data System (BOM, 2012).
[4] Sediment storage volume assumed to full for water balance modeling.

Table 4.3: Pit Spoil Sediment Dam Design Capacities

Dam ID	Maximum Catchment Area (ha)	Volume (ML)	Total Volume (ML) (inc. Sediment Storage)
RSD1	231	152	182
RSD2	211	139	167
RSD3	402	265	317
RSD4	293	193	232
RSD5	306	201	241
RSD6	512	337	404
RSD7	459	302	362
RSD8	344	226	272
RSD9	199	131	157
RSD10	149	98	118
RSD11	470	309	371
RSD12	468	308	369
RSD13	452	297	356
RSD14	274	180	217
RSD15	400	263	316
RSD16	544	358	429
RSD17	310	204	245
RSD18	276	182	218
RSD19	125	82	99

4.5 Return Water Dam

A return water dam (RWD) is required to manage excess water from the CHPP. The return water dam will be required to be constructed as a 'turkeys nest' dam or with catchment diversions to prevent external catchment inflow and reduce the risk of overflow.

The return water dam has been nominally sized at 180 ML which will be refined further during the detailed design phase of the project.

4.6 Pit Dewatering Dams

Pit dewatering dams will be provided as the primary destination for water pumped from open cut pits. Each of the open cut pits will have a dedicated pit dewatering dam. Up until year 10 of operations these dams will be located to the west of the high wall side of pits. At approximately year 15 of operations, each of the four pit dewatering dams will be required to be relocated within spoil dumps on the low wall side to allow pit progression to the west. The pit dewatering dams have been nominally sized based on containment of all wet season inflows to the open cut pits using the Design Storage Allowance (DSA) approach specified in the *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams* (DERM, 2012a). The following parameters have been adopted for sizing of the pit dewatering dams:

- Maximum depth of 5 m, 2:1 length to width ratio and 1V:3H side slopes.
- DSA volume based on the maximum contributing catchment area (over the mine life) and the 1:20 AEP 3 month critical wet period rainfall[5] over the open cut pit areas.
- The annual groundwater inflow rate is based on an estimated inflow rate of 140 ML per annum per kilometre of high wall (AMEC, 2010).
- Re-use of water in dams for dust suppression.

Table 4.4: Pit Dewatering Dam Storage Capacities

Dam ID	Maximum Pit Area (ha)	1:20 AEP 3 Month Inflow (ML)	3 Month Groundwater Inflow (ML)	Minimum Storage Volume (ML)	Adopted Volume (ML)
PD1	460	2,877	300	3,177	3,500
PD2	303	1,895	400	2,295	2,500
PD3	137	856	300	1,156	1,500
PD4	624	3,901	200	4,101	4,500

The total calculated volume of the pit dewatering dams has been rounded up to the nearest 500 ML for the purposes of water balance modelling. This is due to the uncertainty of groundwater inflow rates and quality. These volumes will be revised during detailed design based on revised groundwater inflows rates and adopted standard of operation for in-pit flooding. Pit dewatering dams will be required to be constructed as

[5] 625mm based on Alpha Post Office rainfall data.

'turkeys nest' dams or with catchment diversions to prevent external catchment inflow and reduce the risk of overflow.

4.7 Underground Dewatering Dams

Groundwater dewatering will include aquifer pre-drainage (to minimise groundwater inflows to underground and open cut mines) and dewatering of underground operations. These dewatering operations will be managed through two dams (UGD1 and UGD2). These dams will store water from groundwater dewatering operations and water pumped from the box cut spoil sediment dams. Water contained in the underground dewatering dams will be used to meet water supply requirements for the underground mines. The final adopted volumes for the underground dewatering dams are 1000 ML and 1500 ML for UGD1 and UGD2 respectively and are based on storage of pumped inflows from the box cut spoil sediment dams such that the water supply to the underground mines is maximised. The dams will be constructed as 'turkey's nests' or with catchment diversions to prevent external catchment inflow and contamination.

4.8 Environmental Dams

Environmental dams will be required to manage contaminated runoff from the ROM, product stockpiles and industrial areas. It is expected that runoff from these areas will have potential to be highly saline and contain other contaminants such as metals and hydrocarbons. As a consequence these dams have been sized based on containment of wet season runoff from the contributing catchment area (i.e. Design Storage Allowance). Water captured within these dams will be transferred to the pit dewatering dams via the Return Water Dam. Two environmental dams are proposed, (ED1) located adjacent to the CHPP to manage runoff from CHPP, ROM, product stockpiles and the MIA, with an additional small environmental dam (ED2) proposed to be located adjacent to the second ROM stockpile within the infrastructure corridor. This dam will also manage any coal spillage from conveyers and surge bins. The environmental dam requirements are summarised in Table 4.5 with the final adopted volume being the maximum volume required to prevent discharges as determined from water balance modelling.

Table 4.5: Environmental Dam Design Capacities

Dam ID	Catchment Area (ha)	1:20 AEP 3 Month Wet Season Inflow (ML)	Final Adopted Volume (ML)
ED1	424	2,753	1,500
ED2	76	575	200

4.9 Regulated Dams Hazard Assessment

A preliminary hazard assessment has been undertaken for the proposed dams to provide input into the dam sizing calculations.

In accordance with the *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams, Version 1* (DERM, 2012a), the hazard category of a structure can be based on a number of factors, including the potential for environmental harm caused as a result of ‘failure to contain’ and ‘dam break’ scenarios and dam volume and contaminant concentrations.

4.9.1 Hazard Category Based on ‘Failure to Contain’

‘Failure to Contain’ is defined as “spills or releases from the dam that may be due to any cause other than a ‘dam break’”. The hazard assessment must consider the likely harm to humans, the general environment, stock and other economic factors, caused as a result of ‘failure to contain’ (undertaken in accordance with the definitions of harm provided in Table 1 of the DERM Manual – refer Table 4.6).

4.9.2 Hazard Category Based on ‘Dam Break’

‘Dam Break’ is defined as “collapse of the dam structure due to any possible cause”. Where the dam is categorised by the following criteria a dam break analysis must be included in the hazard category assessment unless there are valid reasons for not doing so;

- More than 8m in height with a storage capacity of more than 500 ML; or
- More than 8m in height with a storage capacity of more than 250 ML and a catchment area that is, more than three times its maximum surface area at full supply level.

The dam failure assessment must consider the likely harm to humans, the general environment, stock and other economic factors (undertaken in accordance with the definitions of harm provided in Table 2 of the DERM Manual – refer Table 4.7.

Table 4.6: Hazard Category Assessment – Failure to Contain Scenarios

Environmental Harm	Hazard Category		
	High	Significant	Low
Categories of harm			
Loss of life or harm to humans	Location such that contamination of waters used for human consumption would occur, and consumption of contaminated waters by humans with consequent loss of life or serious impact on human health is expected or possible.	Location such that contamination of waters used for human consumption would occur, and consumption of contaminated waters by humans with consequent lesser impact on human health is expected.	Location such that there is no contamination of waters used for human consumption expected, or a lesser impact on human health is possible but not expected.
General environmental harm	Location such that harm to significant environmental values is expected. Such values might include the presence of protected areas, protected or endangered flora or fauna, the presence of riverine environments, or productive land used for grazing or agricultural cropping.	Location such that environmental values are of lesser significance or harm is possible but not expected.	Location such that there will be no harm to environmental values of significance, or only trivial harm is possible.
Loss of stock	Location such that consumption of contaminated waters by stock with consequent loss of life or harm is expected.	Location such that consumption of contaminated waters by stock with consequent loss of life or harm is possible but not expected.	Location such that there is no contamination of waters used for stock watering or accessible to stock expected.
General economic loss or property damage	Location such that harm (other than a different category of harm specified above) in the failure path would be expected for any of the following types of third party assets : (a) urban development assets of communities such as houses and offices; (b) mine and gas production; (c) industrial or commercial assets; (d) significant agricultural assets; (e) water resources; or (f) an important utility.	Location such that harm (other than a different category of harm as specified above) in the failure path would be either: (a) possible, but not expected, for any of the items listed in the 'high' hazard category for general economic loss or property damage; or (b) expected, in relation to a minor utility.	Location such that either: (a) no harm or only trivial harm in the failure path would be expected or possible in relation to any of the items listed in the 'high' hazard category for general economic loss or property damage; or (b) harm would be possible but not expected in relation to a minor utility.

Table 4.7: Hazard Category Assessment - Dam Break Scenarios

Environmental Harm	Hazard Category		
	High	Significant	Low
Categories of harm			
Loss of life or harm to humans	Location such that people are routinely present in the failure path and if present loss of life or harm is expected. Location such that contamination of waters used for human consumption would occur, and consumption of contaminated waters by humans with consequent loss of life or serious impact on human health is expected or possible.	Location such that people are routinely present in the failure path and if present loss of life or harm is possible but not expected. Location such that contamination of waters used for human consumption would occur, and consumption of contaminated waters by humans with consequent lesser impact on human health is expected.	Location such that people are not routinely present in the failure path. No contamination of waters used for human consumption expected.
General environmental harm	Location such that harm to significant environmental values is expected. Such values might include the presence of protected areas, protected or endangered flora or fauna, the presence of riverine environments, or productive land used for grazing or agricultural cropping.	Location such that environmental values are of lesser significance or harm is possible but not expected.	Location such that there will be no harm to environmental values of significance, or only trivial harm is possible.
Loss of stock	Location of stock such that loss of stock expected. Consumption of contaminated waters by stock with consequent loss or harm is expected.	Location of stock such that loss of stock possible but not expected. Consumption of contaminated waters by stock with consequent loss or harm is possible but not expected.	Stock not in path of dam break flood. Contaminated water not available to stock or no harm expected from consumption.
General economic loss or property damage	Location such that harm (other than a different category of harm specified above) in the failure path would be expected for any of the following types of third party assets: (a) Urban development assets of communities such as houses and offices; (b) Mine and gas production; (c) Industrial or commercial assets; (d) Significant agricultural assets; (e) Water resources; or (f) An important utility.	Location such that harm (other than a different category of harm as specified above) in the failure path would be either: (a) Possible, but not expected, for any of the items listed in the 'High' hazard category for general economic loss or property damage; or (b) Expected, in relation to a minor utility.	Location such that either: (a) No harm or only trivial harm in the failure path would be expected or possible in relation to any of the items listed in the 'High' hazard category for general economic loss or property damage, or (b) Harm would be possible but not expected in relation to a minor utility.

4.9.3 Hazard Category Based on Contaminant Concentrations and Minimum Volume

The minimum hazard category for a structure is at least 'significant' hazard category and therefore will be a regulated structure if that structure will contain, or could potentially contain, contaminants at concentrations which exceed the values or range shown in Table 3 of the DERM Manual at any time when the contained volume equals the dam volume (the level at which it will overflow across the spillway), and the dam volume is greater than that indicated in the Table 3 of the DERM Manual (refer Table 4.8).

Table 4.8: Contaminant Concentrations and Minimum Volumes for Regulated Dams

Contaminant	Liquor	Total Solids	Dam Crest Volume
Arsenic	1.0 mg/L	500 mg/kg	2.5 ML
Boron	5.0 mg/L	15,000 mg/kg	2.5 ML
Cadmium	0.01 mg/L	100 mg/kg	2.5 ML
Cobalt	1.0 mg/L	500 mg/kg	2.5 ML
Copper	1.0 mg/L	5,000 mg/kg	2.5 ML
Lead	0.5 mg/L	1,500 mg/kg	2.5 ML
Mercury	0.002 mg/L	75 mg/kg	2.5 ML
Nickel	1.0 mg/L	3,000 mg/kg	2.5 ML
Selenium	0.02 mg/L	150 mg/kg	2.5 ML
Zinc	20 mg/L	35,000 mg/kg	2.5 ML
Cyanide (un-ionised HCN)	10 mg/L	2,500 mg/kg	2.5 ML
pH	5 to 9 (range)	Net acid generation pH < 4.5	2.5 ML
TPH C6 – C36	90 mg/L	-	2.5 ML
TPH C6 – C14	60 mg/L	-	2.5 ML
Benzene	0.1 mg/L	-	2.5 ML
Phenol	3 mg/L	-	2.5 ML
Benzo(a)Pyrene	0.001 mg/L	-	2.5 ML
Chloride	2,500 mg/L	-	25 ML
Fluoride	2.0 mg/L	-	25 ML
Sulphate	1,000 mg/L	-	25 ML
Salinity (electrical conductivity)	4,000 µS/cm	-	25 ML

4.9.4 Hazard Assessment Results

Hazard assessments have been undertaken for all proposed dams that form a part of the water management system excluding tailings storage facilities. A total of 6 of the 45 dams proposed are expected to be classified as regulated structures in accordance with the *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams* (DERM, 2012a). A summary of the results is provided in Table 4.9. Further detailed hazard assessments and subsequent compliance assessment will be undertaken during detailed design to determine hydraulic performance requirements for regulated dams.

Table 4.9: Regulated Dam Hazard Category Assessment Summary

Dam	Volume (ML)	Expected Water Quality	Failure to Contain	Dam Break
SD1 to SD15	41-240	Expected Dischargeable Quality	Low	Low
RSD1 to RSD 19	99-429	Expected Dischargeable Quality	Low	Low
ED 1	1,500	EC>4000µS/cm, Sulphate>1000mg/L, Metals & Hydrocarbons, pH Unknown	Significant	Significant
ED 2	200	EC>4000µS/cm, Sulphate>1000mg/L, Metals & Hydrocarbons, pH Unknown	Significant	Significant
PD1	3,500	EC>4000µS/cm, Sulphate>1000mg/L, pH Unknown	Significant	Significant
PD2	2,500	EC>4000µS/cm, Sulphate>1000mg/L, pH Unknown	Significant	Significant
PD3	1,500	EC>4000µS/cm, Sulphate>1000mg/L, pH Unknown	Significant	Significant
PD4	4,500	EC>4000µS/cm, Sulphate>1000mg/L, pH Unknown	Significant	Significant
UGD1	1,000	EC<4000µS/cm, pH≈7, Sulphate<1000mg/L	Low	Low
UGD2	1,500	EC<4000µS/cm, pH≈7, Sulphate<1000mg/L	Low	Low
CWD1	120	Potable Water	Low	Low
CWD2	120	EC<4000µS/cm, pH≈7, Sulphate<1000mg/L	Low	Low
RWD1	180	EC>4000µS/cm, Sulphate>1000mg/L, Metals & Hydrocarbons, pH Unknown	Significant	Significant

5. WATER BALANCE MODELLING

Water balance models have been developed of mine operation including Year 1, 5, 10, 20 and 25. The purpose of these models is to assess the performance of the site water management system including potential loss of production due to pit flooding. The water balance model is based on a daily time step using the 122 years of rainfall and evaporation data for Alpha Post Office.

The model accounts for all expected water sources and demands based on information available at the time of the investigation. Internal water transfers and pumping rates have been assumed and are considered suitable for this conceptual level assessment. It is expected that the water balance model will undergo further development during the detailed design phase of the project once additional information becomes available.

5.1 GoldSim Software

The site water balance models have been developed using the GoldSim software. GoldSim is a commercial software package developed and distributed by the GoldSim Technology Group. GoldSim is a user-friendly, highly graphical program for modelling complex systems to support management and decision making in business, engineering and science. It is a general purpose modelling program used in a wide range of applications such as environmental systems, engineered systems, and business, financial, and economic systems.

The software was specifically designed to quantitatively address the inherent uncertainty which is present in real-world systems. GoldSim provides powerful tools for representing uncertainty in processes, parameters and future events, and for evaluating such systems in a computationally efficient manner. Although it was specifically designed for carrying out dynamic, probabilistic simulations of complex systems, it can also be readily applied to simpler static and/or deterministic simulations.

The GoldSim simulation environment is highly graphical and completely object-orientated. Models can be created, documented, and presented by creating and manipulating graphical objects representing the components of the system, data and relationships between the data. Version 10.50 of the GoldSim Pro software was used to create the water balance model for the project.

5.2 Catchment Runoff

The AWBM model is a catchment water balance model used to relate daily runoff to daily rainfall and evapotanspiration. The model represents the catchment using three surface stores to simulate partial areas of runoff. The water balance of each surface store is calculated independently of the others. The model calculates the water balance of each partial area at daily time steps. At each time step, rainfall is added to each of the three surface stores and evapotranspiration is subtracted from each store. If the value of water in the store exceeds the capacity of the store, the excess water becomes runoff. Part of this runoff becomes recharge of the baseflow store if there is baseflow in the streamflow.

The parameters used to define the AWBM are as follows:

- Partial area fractions (A1, A2 and A3) represented by the three surface stores.
- Surface store capacities (C1, C2 and C3) in millimetres.
- Baseflow index (BFI). Surface runoff = (1-BFI)xExcess. Baseflow recharge = BFIxExcess;
- Daily baseflow recession constant (Kb). Baseflow = (1-Kb)xBaseflow store.
- Daily surface flow recession constant (Ks). Surface runoff = (1-Ks)xSurface routing store.

A schematic of the AWBM process is summarised in Figure 5.1.

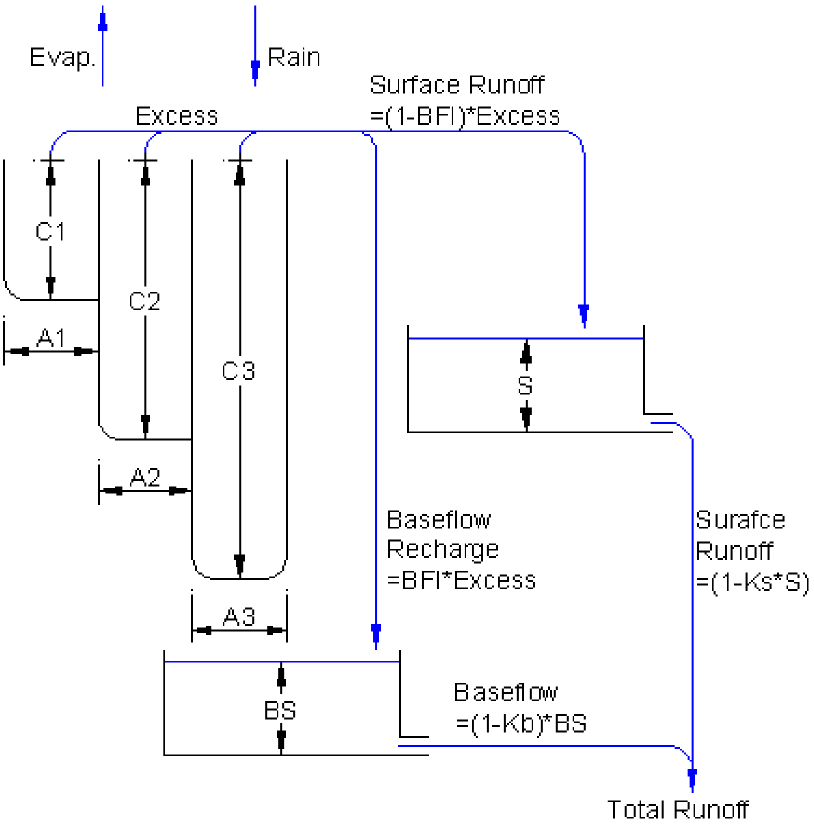

Figure 5.1 AWBM Runoff Model Schematic

Three catchment types have been adopted to describe the different runoff characteristics from different land use types. A summary of the different catchment types along with details of the AWBM parameter derivation is provided below:

- Natural Catchment – AWBM parameters determined from calibration against gauged stream flows for Native Companion Creek (Gauging Station No. 120305A).
- Spoil/Rehabilitated Catchment – AWBM parameters sourced from published information and existing knowledge of mines within the Bowen Basin.
- Hardstand/Pit Catchment – AWBM parameters sourced from published information and existing knowledge of mines within the Bowen Basin.

The calibration of the AWBM parameters for natural catchment areas involved the prediction of stream flows in Native Companion Creek for the period of available stream flow gauging data (January 1968 to October 2011). The predicted stream flows were compared against the stream gauging data and the AWBM model parameters were adjusted to provide a reasonable comparison between the gauged and modelled stream flow characteristics.

The modelled flow duration curve for Native Companion Creek is shown in Figure 5.2 and shows a good comparison to the gauged flow statistics. The modelled cumulative stream flow volume during the period January 1969 to October 2010 is displayed in Figure 5.3. Although there are differences in the modelled and gauged stream flows for individual flow events, the modelled total stream flow volume during the period is similar to the gauged volume.

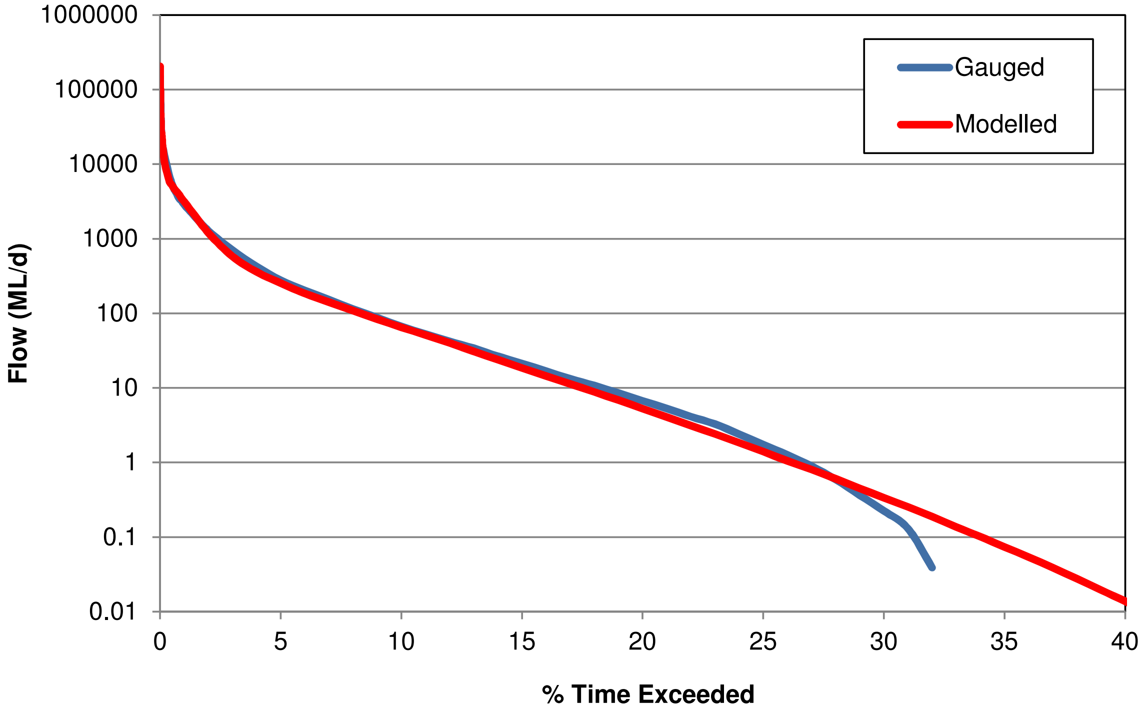

Figure 5.2 Modelled Flow Duration Curve for Native Companion Creek

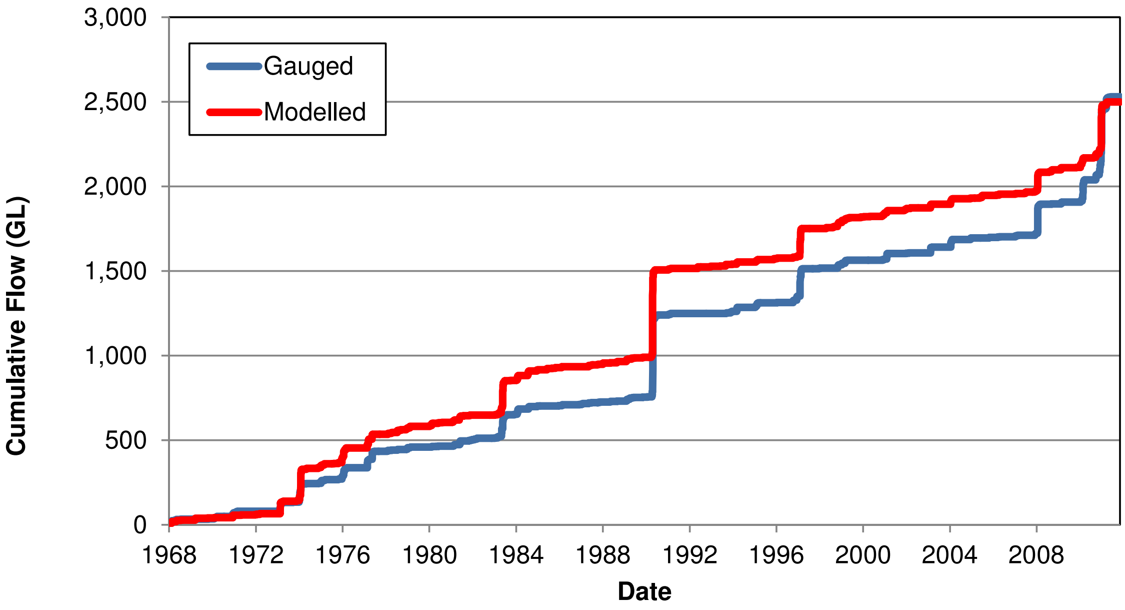

Figure 5.3 Modelled Cumulative Stream flows for Native Companion Creek

A summary of the AWBM parameters adopted for the various land uses is summarised in Table 5.1 while the statistics of the annual catchment runoff are provided in Table 5.2.

Table 5.1: Adopted AWBM Land Use Parameters

AWBM Parameter	Natural	Spoil & Rehabilitated Spoil	Hardstand & Pit
C1 (mm)	25	10	5
C2 (mm)	195	50	20
C3 (mm)	500	120	40
A1	0.05	0.134	0.134
A2	0.475	0.433	0.433
A3	0.475	0.433	0.433
BFI	0.4	0.35	0
K_b	0.8	0.6	0
K_s	0	0.1	0.1

Table 5.2: AWBM Catchment Runoff Statistics

	Natural	Spoil & Rehabilitated	Hardstand & Pit
10th Percentile Runoff (mm)	0.8	9.5	26.7
50th Percentile Runoff (mm)	5.0	40.5	102.9
90th Percentile Runoff (mm)	23.6	182.0	308.3
Mean Runoff (mm)	10.4	71.0	140.3
10th Percentile Annual Runoff Coefficient (%)	0.2	2.7	7.3
50th Percentile Annual Runoff Coefficient (%)	1.1	8.6	22.2
90th Percentile Annual Runoff Coefficient (%)	2.8	24.0	40.2
Mean Runoff Coefficient (%)	1.6	11.1	23.1

5.3 Catchment Areas

Contributing catchment areas for the water balance model have been estimated based on the mine staging plans for Year 1, 5, 10, 20 and 25 to capture the change in area and land use with open cut pit progression. A summary of these catchment areas is provided within Table 5.3 with plans detailing the changes in Appendix B. Natural catchments located on the high wall side of pits have been assumed to be diverted around the pit through the use of diversion bunds/drains and have been incorporated into the total Lagoon Creek catchment area for each stage.

Table 5.3: Catchment Area Summary

Catchment ID	Land Use	Catchment Area (ha)				
		Year 1	Year 5	Year 10	Year 20	Year 25
SD1	Rehabilitated	86	94	94	94	94
SD2	Rehabilitated	210	236	236	60	236
SD3	Rehabilitated	139	146	146	228	146
SD4	Rehabilitated	81	76	76	52	76
SD5	Rehabilitated	103	95	94	86	95
SD6	Rehabilitated	178	176	176	86	172
SD7	Rehabilitated	187	172	172	303	172
SD8	Rehabilitated	179	179	179	236	179
SD9	Rehabilitated	304	304	304	146	298
SD10	Rehabilitated	116	60	60	76	60
SD11	Rehabilitated	-	228	228	95	228
SD12	Rehabilitated	-	52	52	172	52
SD13	Rehabilitated	96	87	86	172	86
SD14	Rehabilitated	-	86	86	179	86
SD15	Rehabilitated	-	-	-	298	300
RSD1	Spoil	-	194	231	231	231
RSD2	Spoil	-	154	198	211	211
RSD3	Spoil	-	350	388	402	402
RSD4	Spoil	-	247	293	279	279
RSD5	Spoil	-	69	135	283	306
RSD6	Spoil	-	132	229	448	512
RSD7	Spoil	-	-	198	395	459
RSD8	Spoil	-	20	69	273	344
RSD9	Spoil	-	-	-	135	199
RSD10	Spoil	-	-	52	130	149
RSD11	Spoil	-	-	139	386	470
RSD12	Spoil	-	-	125	383	468
RSD13	Spoil	-	-	104	359	452
RSD14	Spoil	-	34	75	168	274

Catchment ID	Land Use	Catchment Area (ha)				
		Year 1	Year 5	Year 10	Year 20	Year 25
RSD15	Spoil	-	-	74	223	400
RSD16	Spoil	-	169	237	373	544
RSD17	Spoil	-	60	104	204	310
RSD18	Spoil	-	60	117	215	276
RSD19	Spoil	-	-	16	77	125
ED1	Hardstand	424	424	424	424	424
ED2	Hardstand	76	76	76	76	76
OC1 North	Pit	375	310	367	440	460
OC1 South	Pit	268	327	408	624	612
OC2 North	Pit	80	199	236	261	303
OC2 South	Pit	-	72	104	132	137
Lagoon Creek	Natural	122,800	120,812	119,310	116,285	114,999

5.4 Site Water Demands

Site water demands have been obtained from a variety of mine planning studies that have been undertaken as part of the EIS and SEIS phases of the project. These estimates are considered preliminary and the site water management system will be required to be updated once more robust information is obtained during the detailed design phase of the project. The current site water demands are summarised in the following Sections.

5.4.1 Site Dust Suppression

Water demand for open cut mine haul road dust suppression was estimated by PAE Holmes (2012) for 75% and 80% dust emission control efficiency using more than 120 years of historical rainfall and evapotranspiration data. Predicted dust suppression water demands were 1,100 ML/d (average) to 1,300 ML/d (maximum) for 75% emission control efficiency and 1,400 ML/d (average) to 1,700 ML/d (maximum) for 80% emission control efficiency.

A constant annual dust suppression water demand of 1,500 ML/d was adopted for the water balance modelling.

5.4.2 Underground Mine Water Demand

Water is required within the longwall underground mining operations for cooling of equipment and dust suppression. The annual demand for the underground operations is estimated at 2,400 ML/year (AMEC, 2010). At this stage it is proposed to reuse groundwater from underground dewatering and aquifer pre-drainage for use in underground mines. This will also be supplemented by clean runoff from rehabilitated box cut spoil areas.

For the purposes of water balance modelling it has been assumed that although the water will likely be saline, it will be suitable for use. Previous trials using contaminated water within the Hunter Valley indicate limited impact to machinery from corrosion or scaling (Xstrata, 2012). If further geochemical and groundwater characterisation indicate the water is not suitable for direct use additional options will be explored including treatment of this water or the importation of additional raw water to the project.

5.4.3 Raw Water Demands

Raw water demands for the mine are estimated as follows:

- 2,000 ML/year for the CHPP vacuum pumps.
- 350 ML/year for wash downs within the Mine Industrial Area.
- 150 ML/year for potable and fire fighting purposes.

Potable water for the mine construction phase, including demand for the construction camp has not been included in the water balance modelling. It is likely this water demand will be met through contracted potable water suppliers carting from an offsite source. Inflows back into the site water management system from the onsite sewage treatment plant have also been excluded from water balance modelling as the volume is considered insignificant. A recycle ratio of 80% has been assumed for MIA wash down water with the runoff reporting to Environmental Dam 1.

5.4.4 Sprinkler Use

Investigation of water demands and sources for the proposed mine indicates that there will typically be a surplus of water to manage at the mine (i.e. water sources exceed water demands). Potential options to dispose of excess mine water to minimise excessive accumulation of water in the open cut pits include:

- Use of sprinkler/fan systems to dispose of excess water through irrigation and enhanced evaporation.
- Controlled release of mine affected water during periods of high flow in receiving waterways.
- Treatment and re-use of mine affected water to meet the mine's raw water demands (as an alternative to importing raw water).

For the purpose of the water balance modelling, use of sprinklers/fans to dispose of excess mine affected water has been assumed. This is a technique that has been widely used in recent years in Queensland mines. Possible water disposal configurations include:

- Pumping water through a fan (similar to a snow making machine) and directing the spray mist over a dam or pit area. Water is disposed of via enhanced evaporation.
- Sprinkler irrigation of spoil areas with drainage to direct excess sprinkler runoff back into dams or pits. Water is disposed of via enhanced evapotanspiration.

A maximum excess water disposal rate of 5,000 ML/year is required for the final years of mining, with smaller disposal rates required in the earlier years of mining.

5.5 Water Sources

The following Sections identify the proposed water sources and provide estimates on annual inflows to the system (excluding catchment runoff). At current these estimates are considered preliminary and the site water management system will be required to be updated once more robust information is obtained during the detailed design phase of the project.

5.5.1 CHPP Excess Water

The China First Project is designed to process 56 Mtpa of coal at a rate of 8,000 tonnes per hour. The coal handling and preparation plants (CHPPs) will produce product coal, rejects (coarse and fine) and tailings. The nominal split of these products is:

- 56 Mtpa ROM feed.
- 40 Mtpa product coal.
- 10.7 Mtpa coarse and fine rejects.
- 5.3 Mtpa tailings.

The tailings will be dewatered using Phoenix filter press conveyors. The tailings paste and rejects will be trucked to disposal cells in the spoil piles.

The quantity of water required to wash 56 Mtpa of coal is 11,200 ML/year. Water will be entrained in the product coal, rejects and tailings paste streams with water generated in the filter pressing of tailings returned to the Return Water Dam. A water balance for the CHPPs is shown in Figure 5.4 and indicates that with a filter pressed tailings system the CHPPs will generate 1,070 ML/year of excess water. Excess water from the CHPPs will be transferred to other mine affected water storages for re-use and disposal.

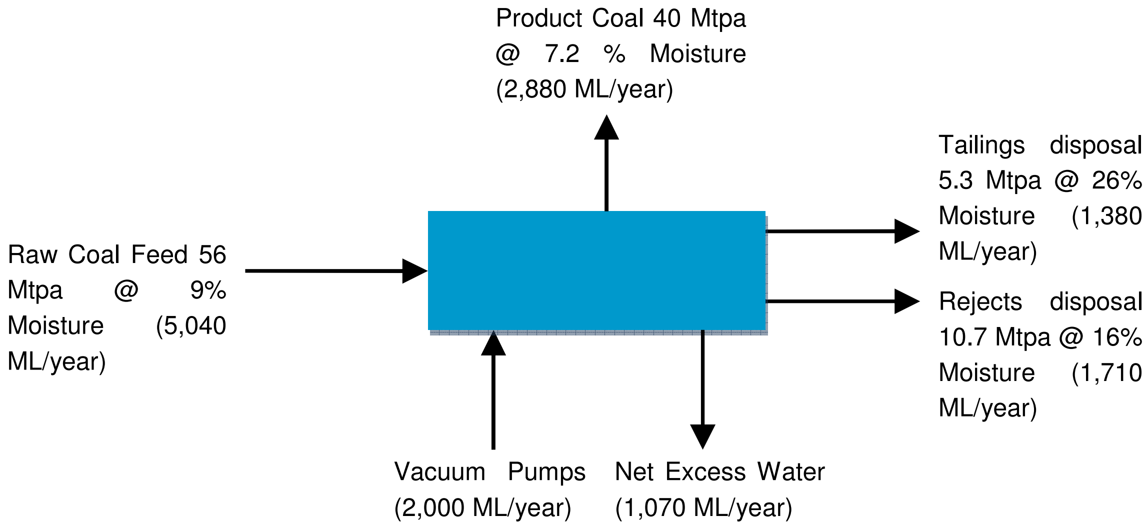

Figure 5.4 CHPP Water Balance

5.5.2 Raw Water Supply

In the initial EIS submission for the Galilee Coal Project a raw water storage was proposed to be constructed on Tallarenha Creek within the MLA. This dam is no longer included in the project. Waratah Coal had also applied for an annual allocation of 2,500 ML/year from the Connors River Dam Project which was being developed by SunWater.

The Connors River Dam Project is no longer proceeding and SunWater is currently investigating the feasibility of a pipeline to supply water from the Burdekin River to the Galilee Basin. This pipeline is unlikely to be constructed in time for the commencement of mining at the Galilee Coal Project.

A raw water supply of 2,500 ML/year is required for the mine. The following raw water supply options have been identified for the mine:

- Initial temporary supply: Raw water supply from a borefield in the vicinity of the mine.
- Ultimate permanent supply: Raw water supply from the proposed SunWater pipeline from the Burdekin River to the Galilee Basin.

Additional investigations will be required to confirm the feasibility of these proposed raw water sources. A potential contingency measure for the mine raw water supply is the operation of a water treatment plant at the mine to produce low salinity water from excess mine affected water. The initial water balance investigations for the mine indicate that there will be sufficient excess mine affected water to provide a raw water supply of 2,500 ML/year via a water treatment plant.

5.5.3 Underground Dewatering

Dewatering is required to facilitate longwall underground mining operations with the extracted water to be reused onsite as a water source for underground mining. Estimated underground dewatering requirements are summarised in Table 5.4 (AMEC, 2010).

Table 5.4: Estimated Steady State Dewatering Requirements of Underground Mines

Mine	Year 1-20 (ML/yr)	Year 20-25 (ML/yr)
UG1	470	630
UG2	470	630
UG3	630	630
UG4	315	315
Total	**1,885**	**2,205**

5.5.4 Open Cut Groundwater Inflow

Annual groundwater inflow volumes into open cut pits have been estimated at 140 ML/year per kilometre of highwall (AMEC, 2010) resulting in a total annual inflow of 2,065 ML/year (Year 1) to 3,600 ML/year (Year 25). The estimated inflows for each of the open cut pits are summarised in Table 5.5.

Additional groundwater investigation work is currently being undertaken by Waratah Coal to determine the adequacy of the current inflow estimates. Upon completion of this work the inflow estimates and subsequent design of the water management system will be revised accordingly.

Table 5.5: Estimated Steady State Inflows into Open Cut Pits

Pit	Year 1 Inflow (ML/yr)	Year 5 Inflow (ML/yr)	Year 10 Inflow (ML/yr)	Year 20 Inflow (ML/yr)	Year 25 Inflow (ML/yr)
OC1 North	808	900	900	900	900
OC1 South	756	903	1,015	1,200	1,200
OC2 North	501	900	900	900	900
OC2 South	0	340	600	600	600
Total	**2,065**	**3,043**	**3,415**	**3,600**	**3,600**

5.5.5 Aquifer Pre-drainage

Pre-drainage of aquifers is required to limit inflows into underground operations and open cut pits. It is proposed to utilise a series of bore fields to intercept aquifers and extract groundwater in front of underground headings and adjacent to open cut pits. Initial pre-drainage flow rates are estimated at 500 ML/year, reducing to 200 ML/year after five years of mining (AMEC, 2010).

5.6 Model Assumptions

The following assumptions have been adopted within the water balance model for this conceptual level of assessment:

- The model operates on a daily time step.
- Model simulation spans the historical period from 1889 to 2011, using rainfall data from the Alpha Post Office rain gauge.
- Seepage from dams that are not proposed to be lined has nominally been assumed at 1mm per day.
- The water balance of the CHPP and tailings system has been assumed as a separate closed system with only input and output values modelled.
- Pumps have been assumed to operate on a 100% duty cycle. This will be revised as part of detailed design to reflect possible pump down time.
- Overflows from all dams have been assumed to be directed to the creek diversions. This will be refined further during detailed design as it is likely dams could overflow into each other before final discharge.
- Site water demands are given first priority before any internal transfer.
- No minimum pumping volume has been applied to storages.
- Sumps with a nominal volume of 100 ML have been included within pit storage curves.

5.7 Internal Water Transfers

Internal water transfers are required within the water management system to facilitate delivery of water to meet site water demands and prevent limit discharge of poor quality water. A summary of the internal water transfers is provided in provided in Table 5.6 with a schematic detailing the linkages provided in Appendix C.

Table 5.6: Internal Water Transfer Summary

Source	Destination	Transfer Rate (L/s)	Operating Rules
Raw Water Pipeline	CWD1	N/A	No inflows from pipeline >80 % capacity
OC1N	PD1	300	No pumping when PD1 >80 % capacity
OC1S	PD4	300	No pumping when PD4 >80 % capacity
OC2N	PD2	300	No pumping when PD2 >80 % capacity
OC2S	PD3	300	No pumping when PD3 >80 % capacity
RSD1-RSD4, RSD10-RSD13	PD1	150[1]	No pumping when PD1 >80 % capacity
RSD5-RSD9	PD4	150[1]	No pumping when PD4 >80 % capacity
RSD18 & RSD19	PD3	150[1]	No pumping when PD3 >80 % capacity
RSD14-RSD17	PD2	150[1]	No pumping when PD2 >80 % capacity
SD1-SD5, SD11-SD14	UGD1	150[2]	No pumping when UGD1 >80 % capacity
SD6-SD10, SD15	UGD1	150[2]	No pumping when UGD2 >80 % capacity
ED1	RWD	150	No pumping when RWD >80 % capacity
ED2	RWD	150	No pumping when RWD >80 % capacity
UGD1	CWD2	150	No pumping when CWD2 >80 % capacity
UGD2	CWD2	150	No pumping when CWD2 >80 % capacity
UGD1	PD2	150	No pumping when PD2 >80 % capacity No pumping when UGD1 <50 % capacity
UGD2	PD4	150	No pumping when PD2 >80 % capacity No pumping when UGD1 <50 % capacity
PD1	PD3	150	No pumping when PD3 >80 % capacity
PD2	PD3	150	No pumping when PD3 >80 % capacity
PD4	PD3	150	No pumping when PD3 >80 % capacity
PD3	Dust Suppression	N/A	Pumped as required to meet dust suppression demand
PD3	Sprinkler Use	N/A	Pumped as required to meet sprinkler demand
RWD	PD3	300	No pumping when PD3 >80 % capacity
CWD2	Underground	N/A	Pumped as required to meet underground mine demand

1. Represents 150 L/s from each individual pit spoil sediment dam.
2. Represents 150 L/s from each individual box cut spoil sediment dam.

6. WATER MANAGEMENT SYSTEM PERFORMANCE

6.1 Overall Site Water Balance

To understand the impact of climatic variability on the site water management system a summary of the overall site water balance for typical dry, median and wet rainfall years has been undertaken. The results have been represented in terms of water year (September – August) to account for wet season inflows. The results for the 10th percentile (dry) year are summarised in Table 6.1 with an annual rainfall total of 317 mm.

Table 6.1: Overall Site Water Balance – 10th Percentile Rainfall Year (1952-53)

	Volume (ML/yr)				
	Year 1	Year 5	Year 10	Year 20	Year 25
Inflows					
Catchment Inflows	957	1,578	2,229	3,000	3,284
Underground Dewatering (inc. aquifer pre-drainage)	2,385	2,085	2,085	2,085	2,405
Groundwater Inflows to Pits	2,065	3,043	3,414	3,600	3,600
CHPP Excess Water	1,070	1,070	1,070	1,070	1,070
Raw Water Supply	2,500	2,500	2,500	2,500	2,500
Total	**8,977**	**10,276**	**11,298**	**12,255**	**12,859**
Outflows					
Underground Demand	2,400	2,400	2,400	2,400	2,400
Dust Suppression	1,500	1,500	1,500	1,500	1,500
Sprinkler Use	260	1,521	3,726	4,630	4,863
Raw Water Use	2,500	2,500	2,500	2,500	2,500
Evaporation	691	1,500	2,874	4,160	4,722
Seepage	112	243	502	744	840
Overflows	0	0	0	0	0
Total	**7,463**	**9,664**	**13,502**	**15,934**	**16,826**

The results for the 50th percentile (median) year are summarised in Table 6.2 with an annual rainfall total of 508 mm.

Table 6.2: Overall Site Water Balance – 50th Percentile Rainfall Year (1981-82)

	Volume (ML/yr)				
	Year 1	Year 5	Year 10	Year 20	Year 25
Inflows					
Catchment Inflows	1,321	2,069	2,750	4,032	4,452
Underground Dewatering (inc. aquifer pre-drainage)	2,385	2,085	2,085	2,085	2,405
Groundwater Inflows to Pits	2,065	3,043	3,414	3,600	3,600
CHPP Excess Water	1,070	1,070	1,070	1,070	1,070
Raw Water Supply	2,500	2,500	2,500	2,500	2,500
Total	**9,341**	**10,767**	**11,819**	**13,287**	**14,027**
Outflows					
Underground Demand	2,400	2,400	2,400	2,400	2,400
Dust Suppression	1,500	1,500	1,500	1,500	1,500
Sprinkler Use	247	1,616	2,836	4,219	4,343
Raw Water Use	2,500	2,500	2,500	2,500	2,500
Evaporation	870	1,150	1,750	3,746	4,607
Seepage	142	184	286	670	771
Overflows	0	0	0	0	0
Total	**7,658**	**9,350**	**11,272**	**15,035**	**16,121**

The results for the 90th percentile (wet) year are summarised in Table 6.3 with an annual rainfall total of 873 mm. The results of this analysis indicate the site water management system will typically only discharge water from sediment dams in high rainfall years. It is expected that this water will be of dischargeable quality.

Table 6.3: Overall Site Water Balance – 90th Percentile Rainfall Year (1940-41)

	Volume (ML/yr)				
	Year 1	Year 5	Year 10	Year 20	Year 25
Inflows					
Catchment Inflows	6,566	10,765	13,620	18,399	20,332
Underground Dewatering (inc. aquifer pre-drainage)	2,385	2,085	2,085	2,085	2,405
Groundwater Inflows to Pits	2,065	3,043	3,414	3,600	3,600
CHPP Excess Water	1,070	1,070	1,070	1,070	1,070
Raw Water Supply	2,500	2,500	2,500	2,500	2,500
Total	**14,586**	**19,463**	**22,689**	**27,654**	**29,907**
Outflows					
Underground Demand	2,400	2,400	2,400	2,400	2,400
Dust Suppression	1,500	1,500	1,500	1,500	1,500
Sprinkler Use	3,137	3,781	4,082	4,315	4,644
Raw Water Use	2,500	2,500	2,500	2,500	2,500
Evaporation	1,636	3,392	3,945	4,448	5,093
Seepage	324	716	809	890	1,027
Overflows	0	0	0	149	70
Total	**11,497**	**14,289**	**15,236**	**16,202**	**17,234**

The water balance model results indicate that there is expected to be sufficient water to meet all mine water demands, even during dry years. The mine site will have a positive water balance in the majority of years and use of sprinklers will be required to dispose of excess mine affected water. Alternatively, it may be possible to treat excess mine affected water to meet the mine's raw water demands. This will eliminate the need for an external raw water supply and will reduce the amount of excess water that will need to be disposed of using sprinklers. Additional investigations of water treatment may be undertaken pending the outcome of other investigations into the proposed external raw water sources.

6.2 Storage Overflows

Regulated dams that form part of the contaminated water system have been sized to prevent any discharge over the historical simulation period. This is achieved through appropriate dam sizing and maximising re-use of mine affected water. Sediment dams will discharge typically under large magnitude and short duration storms due to the limited available volume which is based on a 10 year ARI rainfall event. The water released from these dams is expected to be of dischargeable quality with discharges occurring infrequently which is consistent with the water management system design approach. Table 6.4 summarises the percentage of overflow days from the sediment dams throughout the entire water balance model simulation.

Table 6.4: Sediment Dam Overflow Frequency

Storage	Average Frequency of Storage Overflows (%)[1]				
	Year 1	Year 5	Year 10	Year 20	Year 25
Box Cut Spoil Sediment Dams	0.7	1.0	1.2	2.4	1.8
Pit Spoil Sediment Dams	-	0.2	0.7	1.5	1.6

1. Percentage of days that overflow occurred from storages over duration of model simulation.

The predicted annual volume of overflows from the box cut and pit spoil sediment dams is provided in Figure 6.1 and Figure 6.2 respectively. Overflows from the sediment dams will occur in 20% to 25% of years.

6.3 In-Pit Flooding

Open cut pits have been represented within the water balance model with storage curves derived from pit earthworks models for the various years of operation. This has enabled the extent and duration of in-pit flooding to be quantified. The results detailing the probability of pit floor flooding is summarised in Figure 6.3.

The results show that flooding of open cut pits has the potential to impact open cut mining operations particularly in the latter years of mining. Potential options to reduce the duration of in-pit flooding include:

- Increased sprinkler use;
- Controlled discharges of mine affected water during periods of high flow in receiving waterways; and
- Increased water storage capacity in dams or reserve previously mined pit areas for mine water storage.

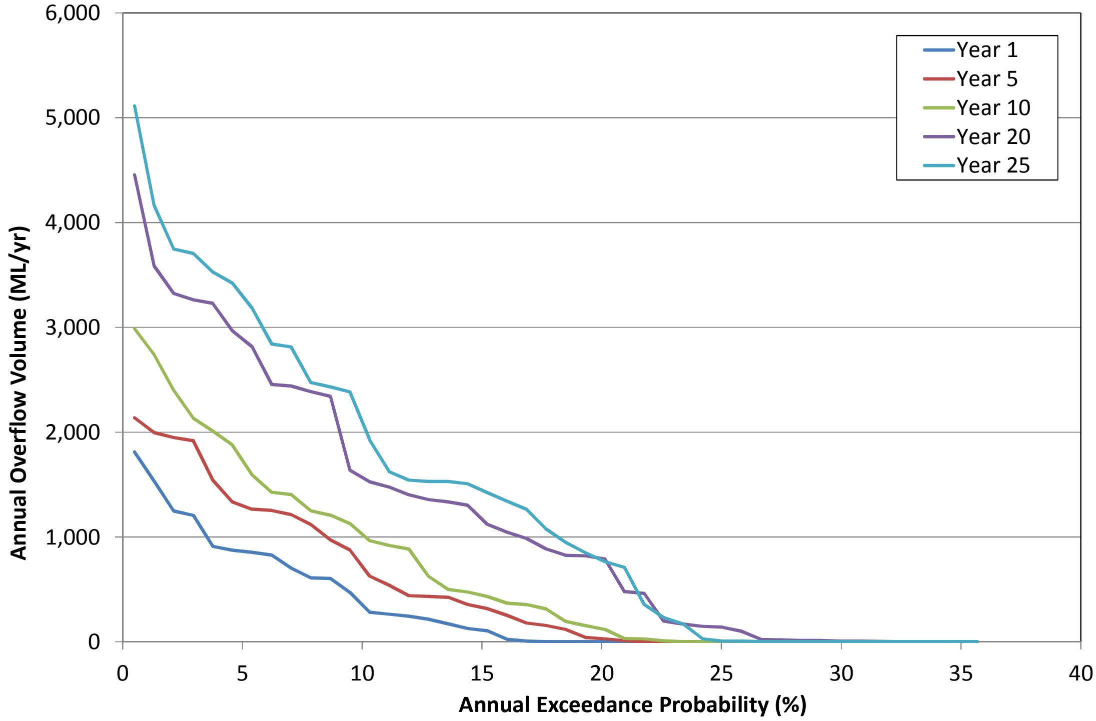

Figure 6.1 **Overflow from Box Cut Spoil Sediment Dams**

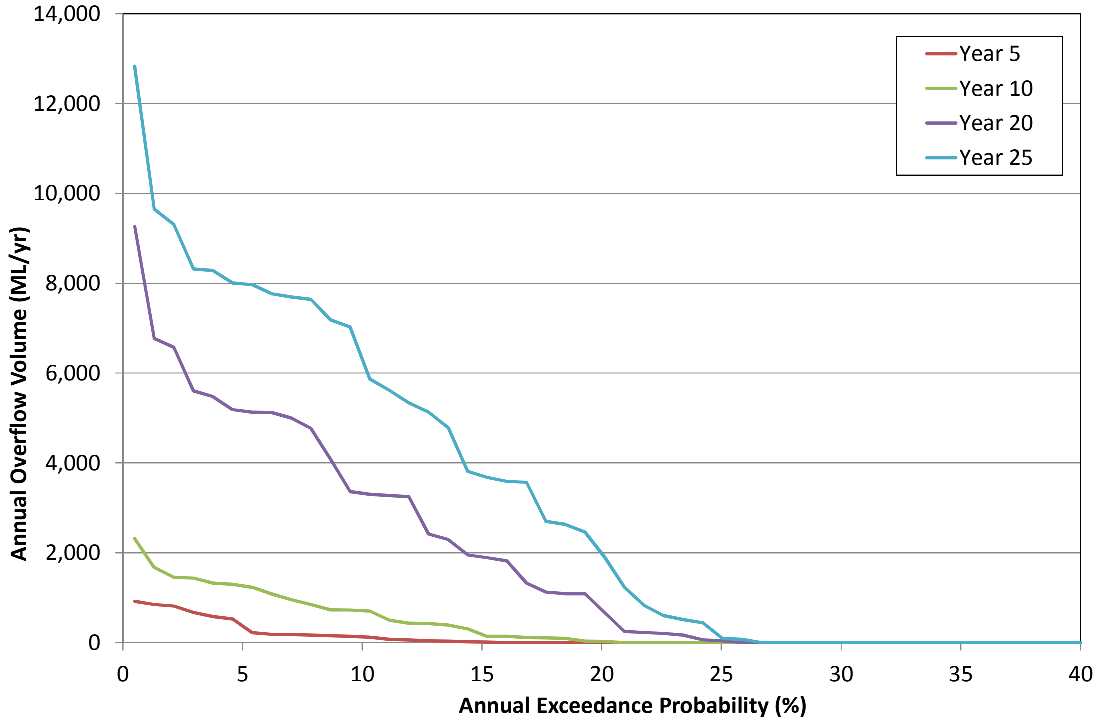

Figure 6.2 **Overflow from Pit Spoil Sediment Dams**

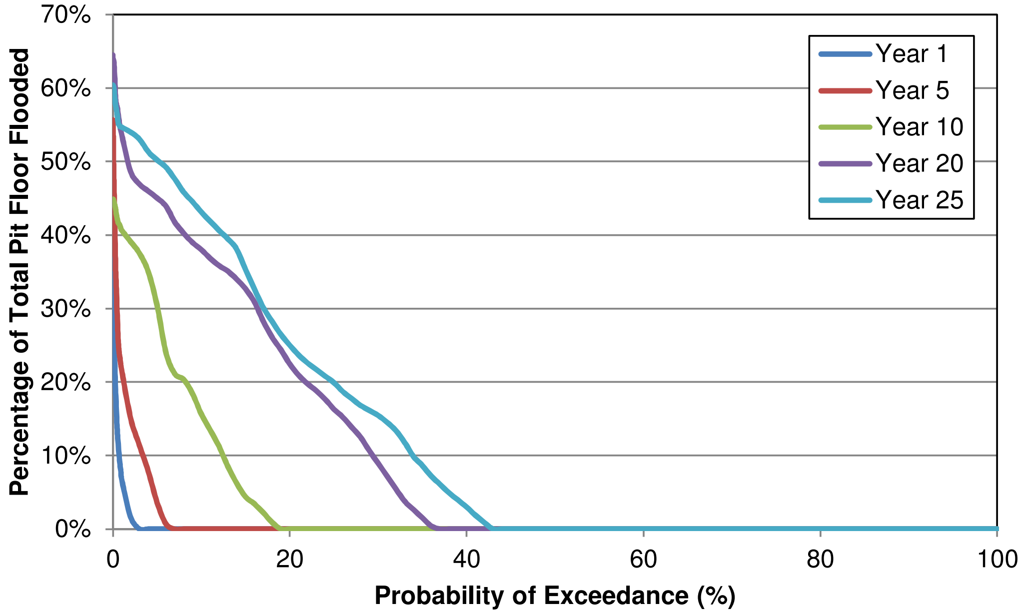

Figure 6.3 **Probability of Open Cut Pit Flooding**

7. CONCLUSIONS

This report provides conceptual level assessment of the mine water management requirements to support the submission of the SEIS and address stakeholder concerns raised during the public consultation process of the EIS submission for the Galilee Coal Project mine site. The following key points in relation to the site water management system have been summarised below:

- A site water management system has been developed with the focus on the separation of “clean” and “dirty” water. Mine affected water will be preferentially sourced to meet onsite demands and limit the potential for discharge.
- It is proposed to minimise external raw water requirements for the mine by re-using groundwater extracted during dewatering activities and runoff collected in sediment dams as a source for water for underground mining operations.
- The site water management system design approach will need to be revised if future geochemical characterisation indicates that open cut spoil material will generate excessively saline or acidic runoff. Review of the geochemical characterisation for the Alpha Coal Project suggests that spoil material will be generally benign. Runoff control dams for spoil dumps have been designed as sediment dams that will overflow in large rainfall events. Overflows from sediment dams will be minimised by re-use of water collected in the dams.
- Current water demands and groundwater inflow rates are based on preliminary information. During detailed design the site water management system design and water balance modelling will be refined to reflect more accurate estimates.
- The results of the long term historical water balance modelling indicates that dams containing contaminated water will not discharge over the 122 year modelling period. Discharges from the site water management system will only occur from sediment dams in high rainfall years or infrequent high intensity events. This water is expected to be of dischargeable quality due to rehabilitation of spoil areas and sediment removal in the dams.
- There is expected to be sufficient water to meet all mine water demands, even during dry years. Raw water for the mine is proposed to be sourced initially from a borefield in the vicinity of the mine and ultimately from a proposed SunWater pipeline from the Burdekin River to the Galilee Basin. Additional investigations are required to confirm the feasibility of these raw water sources.
- The mine site will have a positive water balance in the majority of years and use of sprinklers will be required to dispose of excess mine affected water. Alternatively, it may be possible to treat excess mine affected water to meet the mine’s raw water demands which will eliminate the need for an external raw water supply and will reduce the amount of excess water that will need to be disposed of using sprinklers.

- Flooding of open cut pits has the potential to impact open cut mining operations during high rainfall years in the latter stages of mining. Further investigations into additional water disposal or re-use strategies should be undertaken during detailed design.

8. QUALIFICATIONS

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b. Engeny has used reasonable endeavours to inform itself of the parameters and requirements of the project and has taken reasonable steps to ensure that the works and document is as accurate and comprehensive as possible given the information upon which it has been based including information that may have been provided or obtained by any third party or external sources which has not been independently verified.

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WATER MANAGEMENT

APPENDIX A

Mine Infrastructure Layout

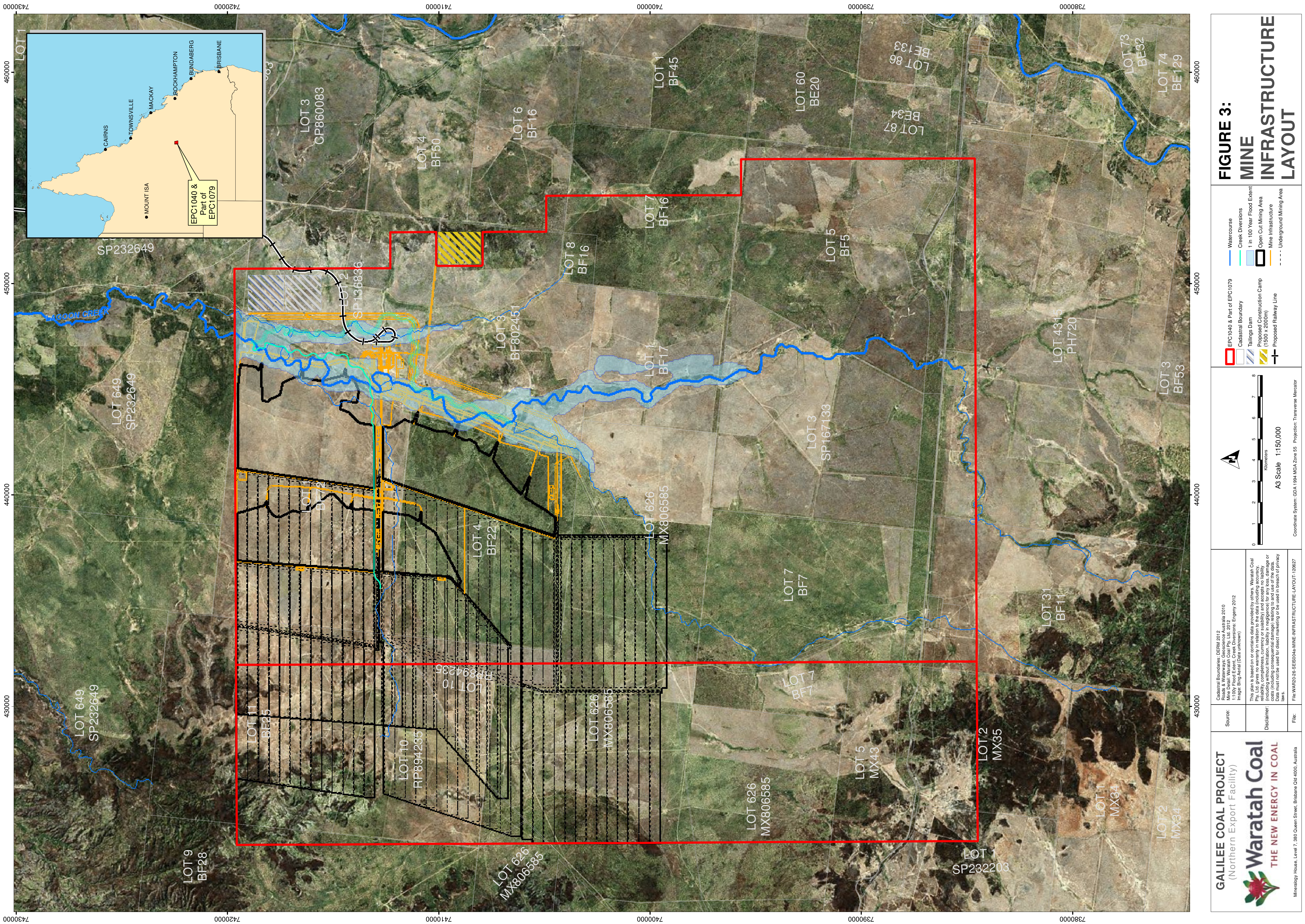
FIGURE 3:
MINE INFRASTRUCTURE LAYOUT
GALILEE COAL PROJECT
(Northern Export Facility)
Waratah Coal
THE NEW ENERGY IN COAL
A3 Scale 1:150,000
LAGOON CREEK
EPC1040 & Part of EPC1079

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APPENDIX B

Mine Site Water Management System Layout Plans

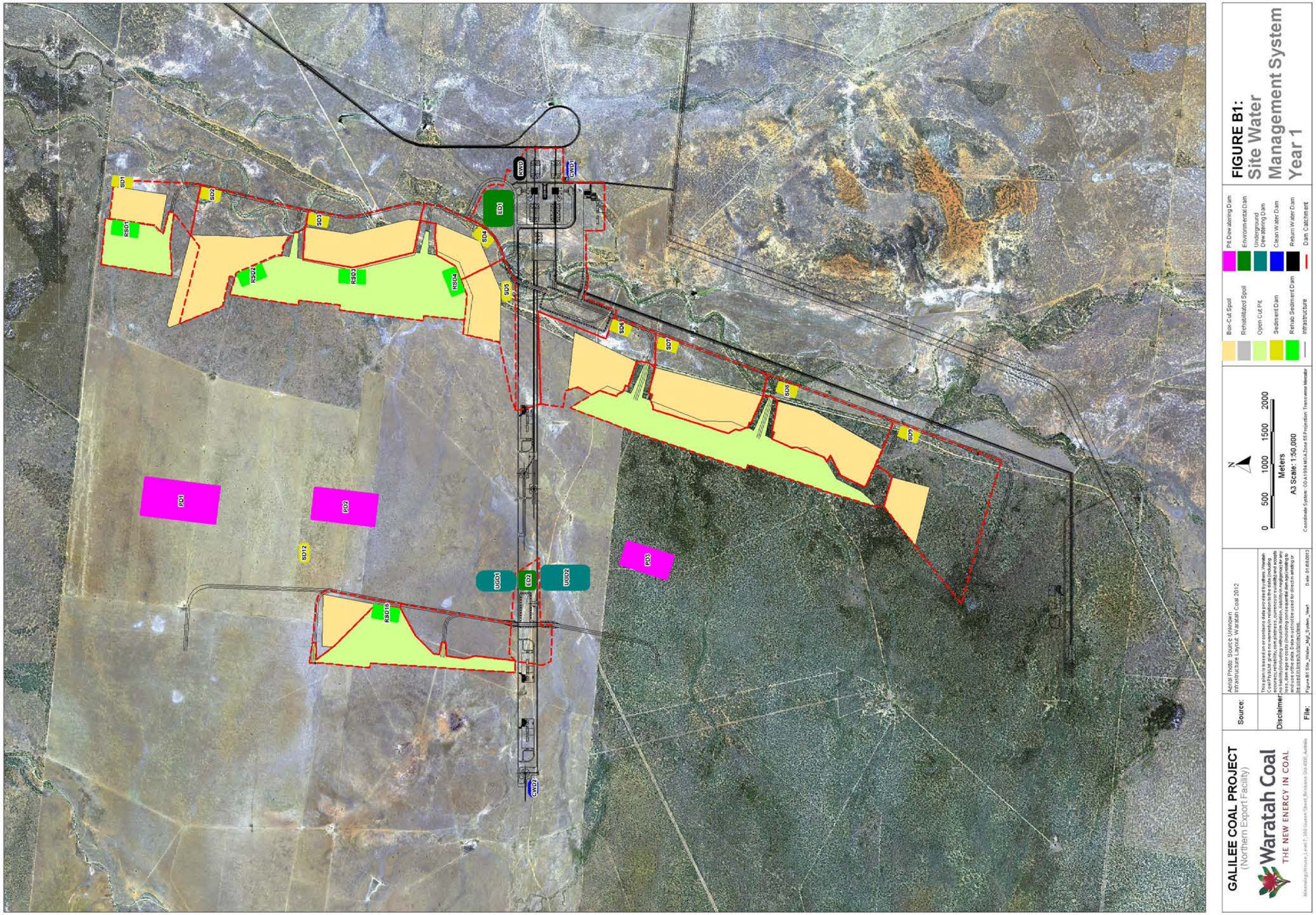
FIGURE B1:
Site Water Management System Year 1
Box-Cut Spoil
Rehabilitated Spoil
Open Cut Pit
Sediment Dam
Rehab Sediment Dam
Infrastructure
Pit Dewatering Dam
Environmental Dam
Underground Dewatering Dam
Clean Water Dam
Return Water Dam
Dam Catchment
0 500 1000 1500 2000
Meters
A3 Scale: 1:50,000
Source:
Aerial Photo: Source Unknown
Infrastructure Layout: Waratah Coal 2012
Disclaimer:
File:
GALILEE COAL PROJECT
(Northern Export Facility)
Waratah Coal
THE NEW ENERGY IN COAL
SD1
SD2
SD3
SD4
SD5
SD6
SD7
SD8
SD9
SD12
RSD1
RSD2
RSD3
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RWD
CWD1
CWD2

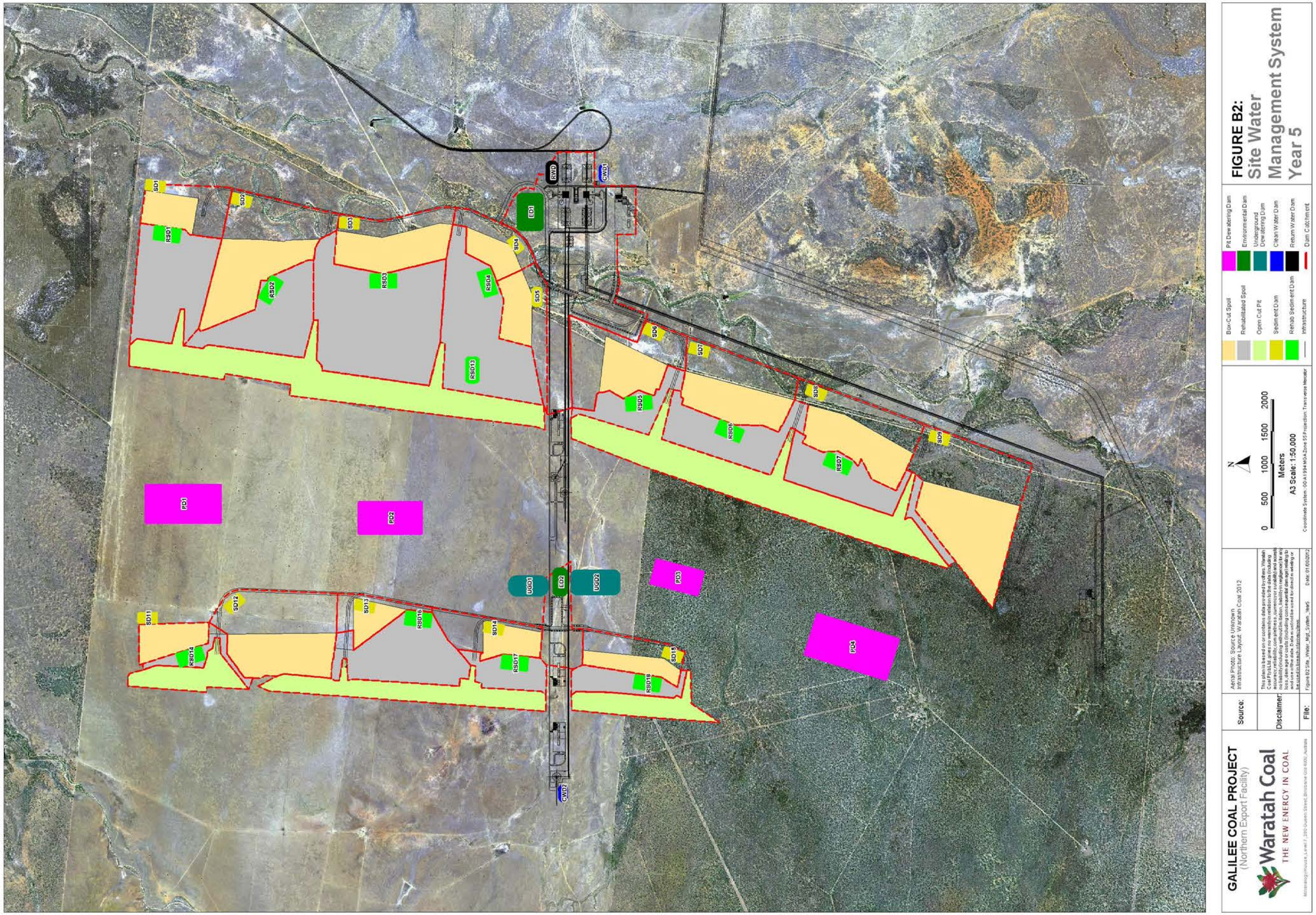
FIGURE B2:
Site Water Management System Year 5
Pit Dewatering Dam
Environmental Dam
Underground Dewatering Dam
Clean Water Dam
Return Water Dam
Dam Catchment
Box-Cut Spoil
Rehabilitated Spoil
Open Cut Pit
Sediment Dam
Rehab Sediment Dam
Infrastructure
0 500 1000 1500 2000
Meters
A3 Scale: 1:50,000
Source:
Aerial Photo: Source Unknown
Infrastructure Layout: Waratah Coal 2012
Disclaimer:
File:
GALILEE COAL PROJECT
(Northern Export Facility)
Waratah Coal
THE NEW ENERGY IN COAL
PD1
PD2
PD3
PD4
ED1
ED2
UGD1
UGD2
RWD
CWD1
CWD2

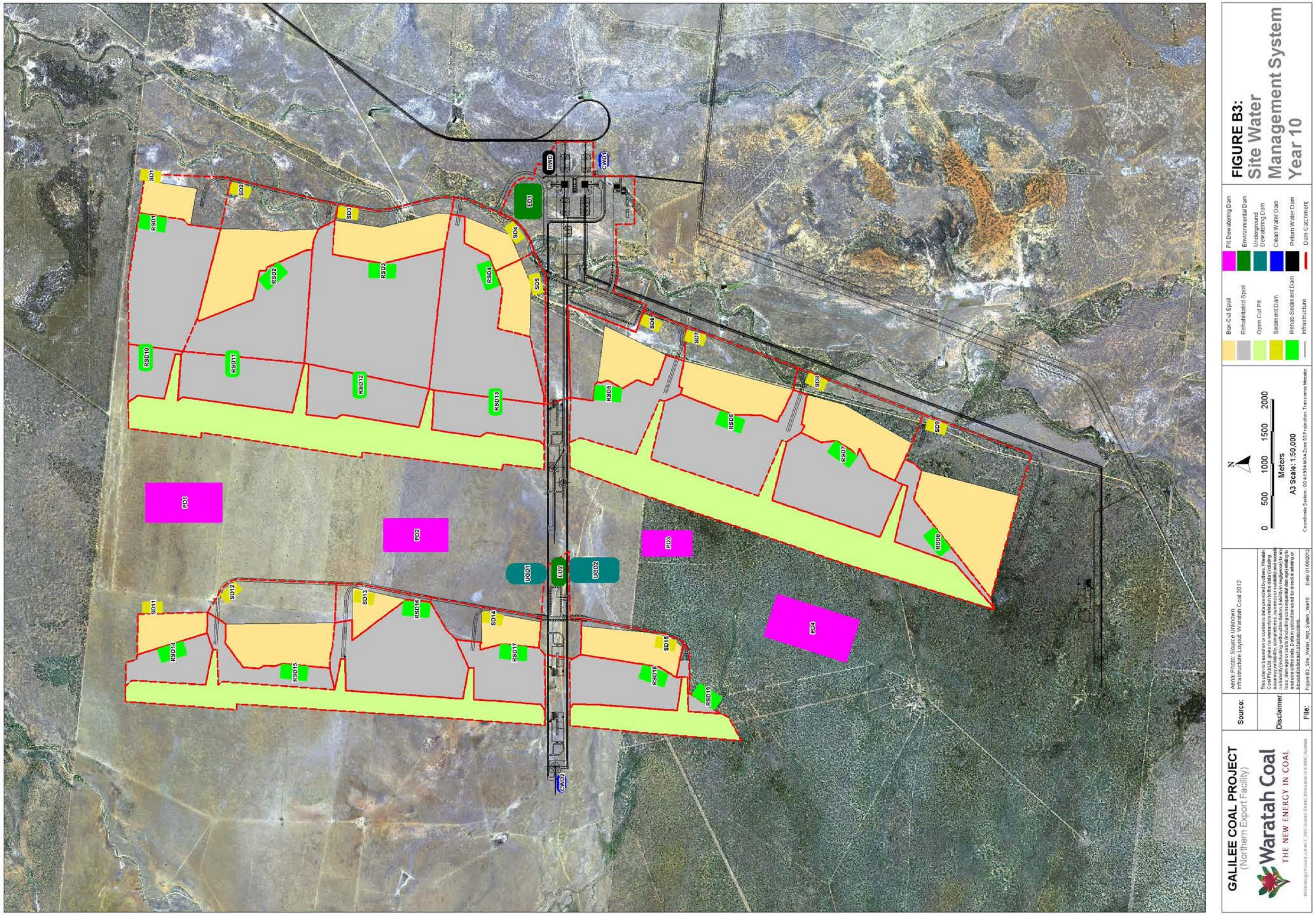
GALILEE COAL PROJECT
(Northern Export Facility)
Waratah Coal
THE NEW ENERGY IN COAL
Source:
Aerial Photo: Source Unknown
Infrastructure Loyout: Waratah Coal 2012
Disclaimer:
This plan is based on or contains data provided by others. Waratah Coal Pty.bLtd. gives no warranty in relation to the data (including accuracy, reliability, completness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to and use of the data. Data must not be used for direct marketing or be used in breach of privacy laws.
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Figure B3_Site_Water_Mgt_System_Year10
Date: 01/08/2012
N
0 500 1000 1500 2000
Meters
A3 Scale: 1:50,000
Coordinate System: GDA1994 MGA Zone 55 Projection: Transverse Mercator
Box-Cut Spoil
Rehabilitated Spoil
Open Cut Pit
Sediment Dam
Rehab Sediment Dam
Infrastructure
Pit Dewatering Dam
Environmental Dam
Underground Dewatering Dam
Clean Water Dam
Return Water Dam
Dam Catchment
FIGURE B3:
Site Water
Management System
Year 10
SD1
SD2
SD3
SD4
SD5
SD6
SD7
SD8
SD9
SD11
SD12
SD13
SD14
SD15
RSD1
RSD2
RSD3
RSD4
RSD5
RSD6
RSD7
RSD8
RSD10
RSD11
RSD12
RSD13
RSD14
RSD15
RSD16
RSD17
RSD18
RSD19
PD1
PD2
PD3
PD4
UGD1
UGD2
ED1
ED2
RWD
CWD1
CWD2

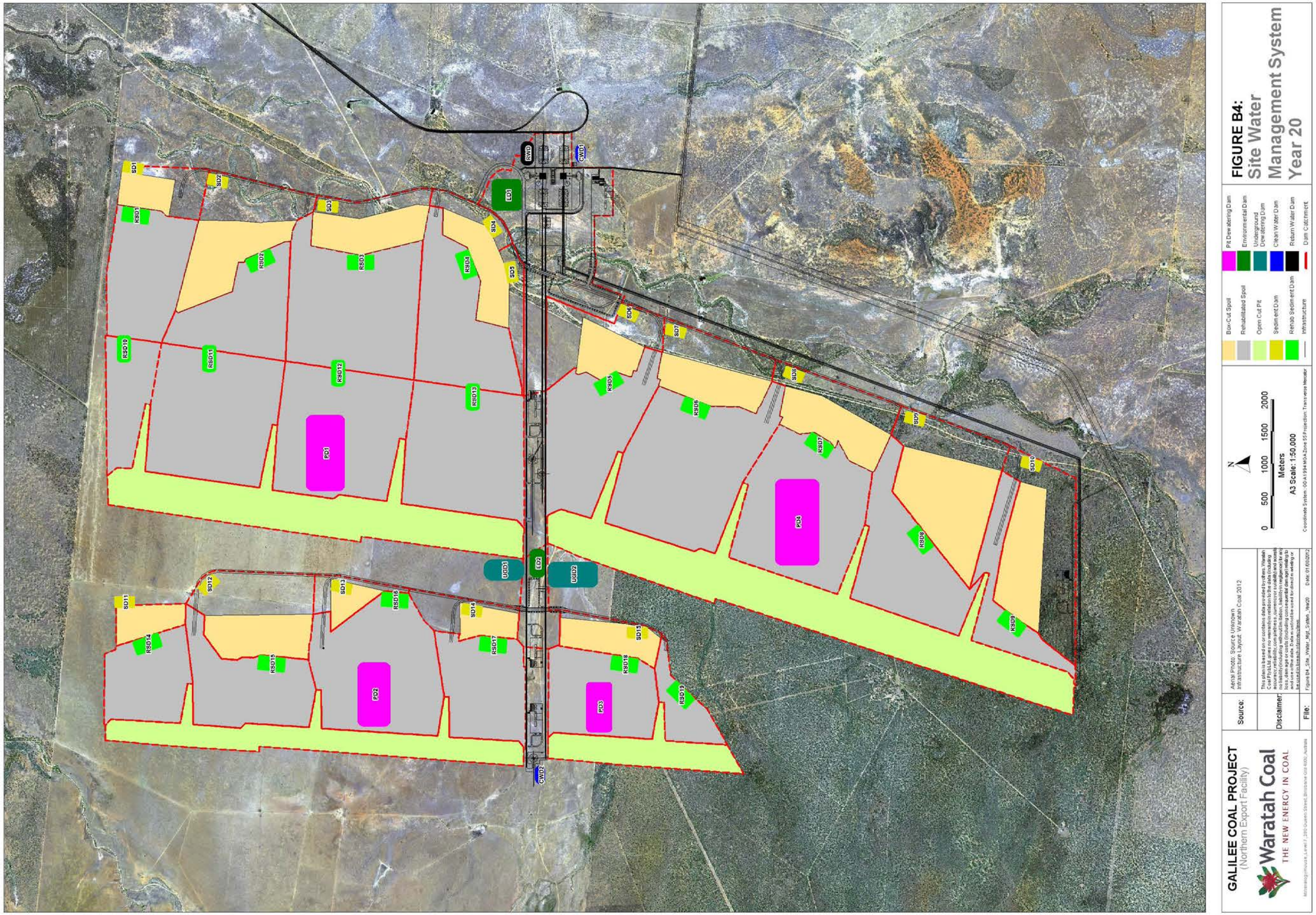
FIGURE B4:
Site Water Management System Year 20
Box-Cut Spoil
Rehabilitated Spoil
Open Cut Pit
Sediment Dam
Rehab Sediment Dam
Infrastructure
Pit Dewatering Dam
Environmental Dam
Underground Dewatering Dam
Clean Water Dam
Return Water Dam
Dam Catchment
N
0 500 1000 1500 2000
Meters
A3 Scale: 1:50,000
Coordinate System: GDA 1994 MGA Zone 55 Projection: Transverse Mercator
Source: Aerial Photo: Source Unknown
Infrastructure Layout: Waratah Coal 2012
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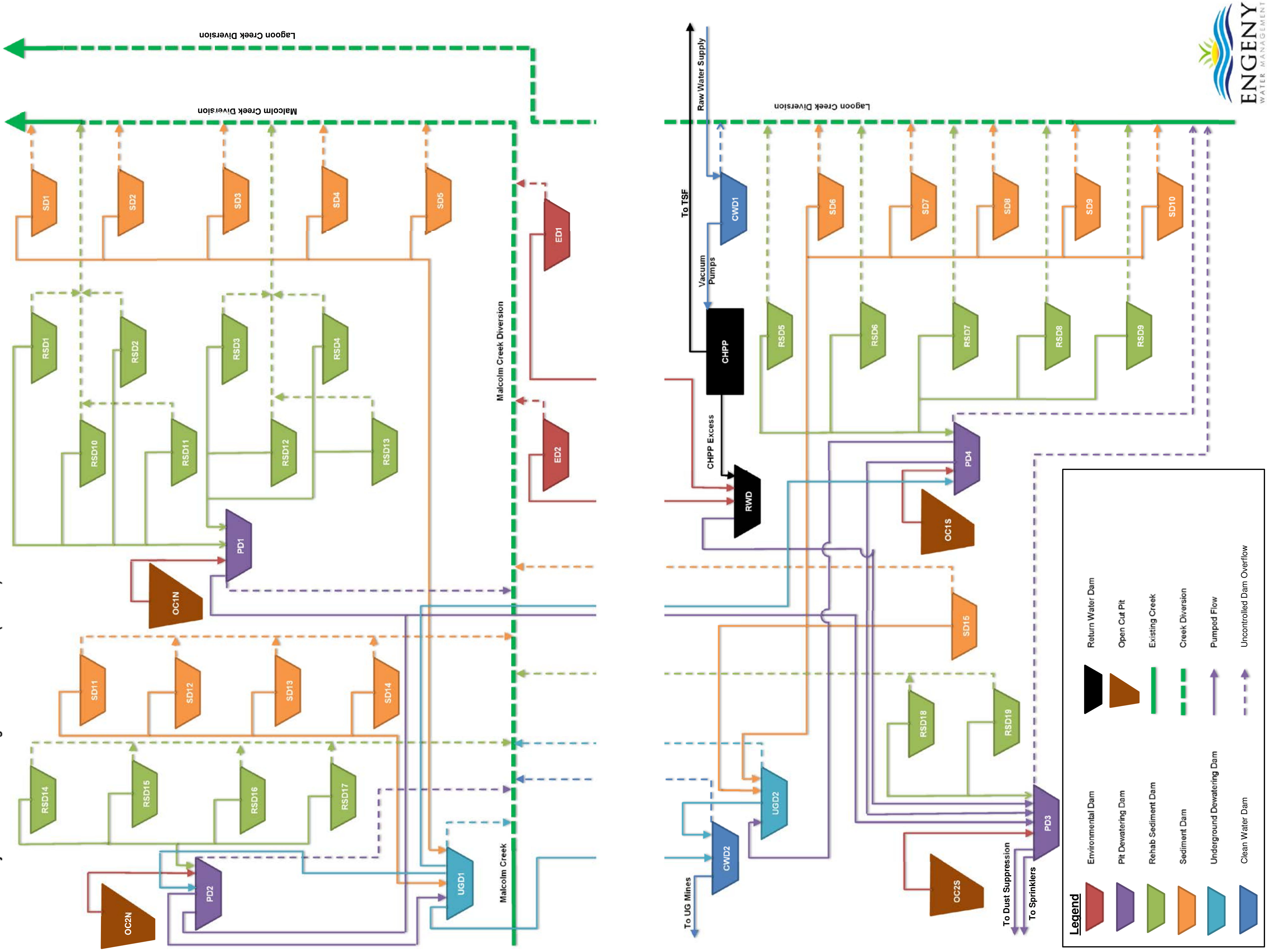
Date: 01/08/2012
GALILEE COAL PROJECT
(Northern Export Facility)
Waratah Coal
THE NEW ENERGY IN COAL
PD1
PD2
PD3
PD4
ED1
ED2
UGD1
UGD2
RWD
CWD1
CWD2


FIGURE B5:
Site Water Management System Year 25
Pit Dewatering Dam
Environmental Dam
Underground Dewatering Dam
Clean Water Dam
Return Water Dam
Dam Catchment
Box-Cut Spoil
Rehabilitated Spoil
Open Cut Pit
Sediment Dam
Rehab Sediment Dam
Infrastructure
0 500 1000 1500 2000
Meters
A3 Scale: 1:50,000
Source:
Aerial Photo: Source Unknown
Infrastructure Layout: Waratah Coal 2012
Disclaimer:
File:
GALILEE COAL PROJECT
(Northern Export Facility)
Waratah Coal
THE NEW ENERGY IN COAL
PD1
PD2
PD3
PD4
ED1
ED2
UGD1
UGD2
RWD
CWD1
CWD2

APPENDIX C

Mine Water Management System Schematic (Year 25)

Galilee Coal Project - Site Water Management Schematic (Year 25)



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