HANCOCK PROSPECTING PTY LTD

Alpha Coal Project Supplementary Environmental Impact Statement

L | Coal Mine – Site Water Management System and Water Balance Technical Report

Alpha Coal Project - Site water management system and water balance technical report

11 April 2011

HANCOCK COAL PTY LTD

PARSONS BRINCKERHOFF

Parsons Brinckerhoff Australia Pty Limited
ABN 80 078 004 798

Level 3
51–55 Bolton Street
NEWCASTLE NSW 2300
PO Box 1162
NEWCASTLE NSW 2300
Australia
Telephone +61 2 4929 8300
Facsimile +61 2 4929 8382
Email newcastle@pb.com.au

2123204A-RPT009-D-mk

Certified to ISO 9001, ISO 14001, AS/NZS 4801

Revision	Details	Date	Amended By
00	Original EIS	19 August 2010	L Tickle
A	Final Draft EIS	3 September 2010	L Tickle
B	Final EIS	14 September 2010	L Tickle
C	Draft SEIS	1 April 2011	L Tickle
D	Final SEIS	11 April 2011	M Kijlstra

Author: Leigh Tickle/Doeleman, Team Manager – Surface Water ....

Signed: ....

Reviewer: Dr. Mohand Amghar, Principal Water Engineer............................

Signed: ....

Approved by: Martin Kijlstra, Principal Water Engineer......................................

Signed: ....

Date: 11 April 2011..

Distribution: Hancock Coal Pty Ltd, PB File, PB Library..................................

Please note that when viewed electronically this document may contain pages that have been intentionally left blank. These blank pages may occur because in consideration of the environment and for your convenience, this document has been set up so that it can be printed correctly in double-sided format.

Contents

Page number

Glossary **v**

Executive summary **1**

1. Introduction **1**

1.1 Background 1

1.2 Scope of works 1

2. Design objectives and criteria **2**

2.1 Water management system design objectives 2

2.2 Relevant legislation and guidelines 2

2.2.1 DME technical guidelines - uncontaminated runoff criteria 3
2.2.2 DME technical guidelines - contaminated runoff criteria 4
2.2.3 DERM Manual for Assessing Hazard Categories and Hydraulic Performance of Dams 4
2.2.4 Code of Environmental compliance for high hazard dams containing hazardous waste 5

2.3 Adopted design criteria 6

2.3.1 Sediment dams 9
2.3.2 Environmental dams (or 'regulated dams') 10
2.3.3 Referrable dams 10

3. Existing environment **12**

3.1 Climate data 12

3.2 Stream flow data 14

3.3 Catchment description 15

3.4 Surface water license holders 17

3.5 Surface runoff 20

3.5.1 Sacramento model 20
3.5.2 Australian Water Balance Model 23

4. Proposed water management system **25**

4.1 Water segregation 25

4.2 Clean water system 25

4.3 Contaminated water management system 26

4.4 Dirty water management system 27

4.5 Staging of the water management system 29

4.6 Erosion and sediment controls during construction 37

5. Site water balance modelling 38

5.1 Modelling approach 38

5.1.1 GoldSim model 38

5.2 Model assumptions 38

5.3 Model data 39

5.3.1 Catchments 39

5.3.2 Dam sizes 41

5.3.3 Transfer rates 42

5.3.4 Operating rules 43

5.4 Water inputs 44

5.4.1 Surface water runoff 44

5.4.2 Groundwater 45

5.4.3 Imported water 45

5.5 Water demands 45

5.5.1 Coal handling and preparation plant 46

5.5.2 Haul road and hardstand watering 46

5.5.3 Workshop and vehicle wash 47

5.5.4 Potable water 47

5.5.5 Demand summary 47

5.6 Other losses 48

5.6.1 Evaporation 48

5.6.2 Seepage from dams 48

5.7 Results 48

6. Potential impacts and mitigation measures 53

6.1 Site water demand 53

6.2 Wet weather impacts on mining 54

6.3 Dam performance 56

6.4 Impacts on downstream flow 59

7. Conclusions 61

8. Limitations 62

9. References 63

List of tables

Page number

Table 2-1: Toxicity concentrations for determination of hazard category 3

Table 2-2: Design ARI for DSA based on hazard category from DME Technical Guidelines 4

Table 2-3: Hazard category from DERM Manual for Assessing Hazard Categories and Hydraulic Performance of Dams 5

Table 3-1: Summary climate statistics Alpha (1889 to 2009) 13

Table 3-2: Three month wet period rainfall depths for Alpha 14
Table 3-3: Stream flow gauging station 14
Table 3-4: Existing subcatchment breakdown 17
Table 3-5: Adopted Sacramento model parameters for baseline catchment 21
Table 3-6: Adopted AWBM parameters 24
Table 3-7: Annual runoff depths from various landuse types 24
Table 4-1 Locations of release points 28
Table 4-2: Total number of dams over life of the Project 29
Table 5-1: Summary of catchment areas 39
Table 5-2: Change in landuse for the water management system and TSF/decant dam catchments 40
Table 5-3: Sediment dam capacities 41
Table 5-4: Environmental/pit dewatering dam capacities 42
Table 5-5: Estimated borefield extraction rates 45
Table 5-6: CHPP make-up water demand estimates 46
Table 5-7: Dust suppression demand estimates 46
Table 5-8: MIA demand estimates 47
Table 5-9: Potable water demand estimates 47
Table 5-10: Water demand summary 48
Table 5-11: Annual site water balance - 10^{th} percentile dry year 49
Table 5-12: Annual site water balance - 50^{th} percentile median year 50
Table 5-13: Annual site water balance - 90^{th} percentile wet year 51
Table 6-1: Imported water requirement for a dry year 53
Table 6-2: Maximum in-pit stored volumes 54
Table 6-3: Median annual flow in Sandy Creek at study catchment outlet 59

List of figures

Page number

Figure 3-1: Annual rainfall for Alpha – Data Drill (1889 to 2009) 12
Figure 3-2: Three month wet period frequency curve for Alpha – Data Drill (1900 to 2009) 13
Figure 3-3: Flow duration curve for Belyando River (GS 120301B) 15
Figure 3-4: Existing study catchment 18
Figure 3-5: License permit holders 19
Figure 3-6: Schematic layout of Sacramento model (Source: CRC for Catchment Hydrology, 2004) 20
Figure 3-7: Comparison of predicted and gauged cumulative runoff depth for Belyando River at Gregory Development Road 22
Figure 3-8: Schematic layout of AWBM runoff model (Source: CRC for Catchment Hydrology, 2004) 23
Figure 4-1: Water management system feasibility for Year 1 31
Figure 4-2: Water management system feasibility for Year 5 32
Figure 4-3: Water management system feasibility for Year 10 33
Figure 4-4: Water management system feasibility for Year 20 34
Figure 4-5: Water management system feasibility for Year 30 35
Figure 4-6: Schematic of overall water management system feasibility 36
Figure 6-1: Annual imported water requirement over the 110 year water balance simulation for Year 30 53
Figure 6-2: Frequency of in-pit flooding over the 110 year water balance simulation for Year 30 55
Figure 6-3: In-pit flooding over the 110 year water balance simulation for Year 30 55
Figure 6-4: Volume stored in ED1 over the 110 year water balance simulation for Year 30 57
Figure 6-5: Volume stored in ED2 over the 110 year water balance simulation for Year 30 57
Figure 6-6: Volume stored in ED8 over the 110 year water balance simulation for Year 30 58
Figure 6-7: Volume stored in ED9 over the 110 year water balance simulation for Year 30 58

Appendices

Appendix A Licensed water users
Appendix B Borefield updates and criteria confirmation meeting minutes
Appendix C Additional water balance plots

Glossary

AEP	Annual Exceedance Probability: The probability that a given rainfall total accumulated over a given duration will be exceeded in any one year (see footnote).
AMDT	Adopted Middle Thread Distance: The distance from the mouth of the watercourse or the confluence of the watercourse with the main watercourse measured along the middle of the watercourse.
Afflux	Rise in flood level caused by a hydraulic structure.
AGD84	The coordinate reference system used in Australia prior to the introduction of GDA94.
AMG	Australian Map Grid — Cartesian co-ordinate system derived from a Universal Transverse Mercator projection of latitudes and longitudes on the Australian Geodetic Datum (AGD) (now superseded).
ARF	Areal Reduction Factors.
ARR	Australian Rainfall and Runoff.
Attenuation	The reduction of flood peaks due to storage effects.
Australian Height Datum (AHD)	The datum used for determining elevations in Australia which uses a national network of bench marks and tide gauges, and has set mean sea level as zero elevation. Elevations in metres above Australian Height Datum are annotated with the suffix m AHD (see below).
Average Recurrence Interval (ARI)	The average, or expected, value of the periods between exceedances of a given rainfall or a stream flow over a given duration (see footnote).
BoM	Bureau of Meteorology.
Catchment	The area of land which collects and transfers runoff into a waterway.
CL	Continuous loss.
Confluence	Area where two or more waterways come together to form one waterway.
Critical storm duration	The critical storm duration is the duration of rainfall that will result in the highest peak flood levels at a particular location.
DEM	Digital Elevation Model.
DERM	Queensland Department of Environment and Resource Management.
DIP	Queensland Department of Infrastructure and Planning.
Discharge	Instantaneous rate of flow measured in volume per unit time (such as m^3/s).
Downstream (d/s)	In the direction of flow of a stream or river i.e. away from the source.
DTM	Digital Terrain Model.
EIS	Environmental Impact Statement.
EP Act	Queensland *Environment Protection Act 1994.*
EPP	Environmental Protection (Water) Policy 2009.
Erosion	The process by which soil and rocks are loosened, worn away and removed from parts of the Earth's surface. Includes removal of debris supplied to the streams by slope wash, mass movement, and gullies.
FFA	Flood frequency analysis.
Flood plain	That portion of a river valley that is covered during periods of high flood water.

Flow	Quantity of fluid measured over a period of time (such as ML/day).
Frequency	A measure of the number of occurrences per unit of time.
GDA94	Geocentric Datum of Australia. The coordinate reference system currently used in Australia to define co-ordinate systems.
GDR	Great Dividing Range.
GEV	Generalized Extreme Value.
Groundwater	Water found underground in porous rock or soil strata.
HPPL	Hancock Prospecting Pty Ltd.
Headwaters	Upstream Section of a river before it is joined by main tributaries. Typically smaller in width and flow than the main Section of the river.
HEC-RAS	A computer program that models water flow hydraulics of rivers and channels.
Hydraulic analysis	Refers to the assessment of flood levels, flows and velocities in waterways, creeks and rivers.
Hydrograph	A record of the discharge of a creek, stream or river over time.
Hydrological analysis	Refers to the estimation of flows that enter waterways, creeks and rivers.
Hydrology	The study of the occurrence, distribution, and chemistry of all waters of the earth.
IFD	Intensity Frequency Duration of rainfall.
IL	Initial loss.
Impervious Surfaces	Artificial structures such as pavements and building roofs, which replace naturally pervious soil.
Left/Right Bank	Defined for a watercourse with the observer facing downstream.
Log Pearson Type III flood frequency curve	A method described in Australian Rainfall and Runoff to relate flood peaks to annual exceedance probability.
m AHD	Metres (above the) Australian Height Datum. Refers to the number of metres above Australia's theoretical reference surface, approximately equivalent to the height above sea level.
MGA	Map Grid of Australia – current Cartesian co-ordinate system for use in Australia derived from a Universal Transverse Mercator projection of latitudes and longitudes on the Geocentric Datum of Australia (GDA).
MIKE FLOOD	A computer program that combines the MIKE11 and MIKE21 programs.
MIKE11	A one dimensional computer program that performs a hydraulic analysis of rivers, channels and water bodies.
MIKE21	A two dimensional computer program that performs a hydraulic analysis of rivers, channels and water bodies.
ML	Megalitre (1,000,000 litres).
MLA	Mining Lease Application.
MRRM	Main Roads Rational Method.
PB	Parsons Brinckerhoff .
Peak discharge	The maximum discharge or flow during a flood.
Photogrammetry	Remote sensing technology used to determine geometric properties about objects from photographic images.

Pluviograph	A rain gauge which automatically records, usually in graph form, the cumulative amount of rainfall with reference to time.
PMF	Probable Maximum Flood.
Rainfall Intensity	Depth of rainfall per unit time.
Rational Method	A procedure for determining peak discharge, which corresponds to a critical storm duration and specified catchment characteristics.
Reach	Portion of a stream channel between two specified points.
Recharge	The process involving the infiltration of water from the surface to groundwater.
RORB	A computer program that models urban and rural stormwater drainage by analysing rainfall and runoff in any land use area.
Runoff	The portion of rainfall which becomes surface flow.
SEIS	Supplementary EIS.
SP Act	Sustainable Planning Act 2009.
SRTM	Shuttle Radar Topographic Mission.
Temporal	Relating to time as distinguished from space.
Topography	Concerned with local detail in general, including relief and vegetative and human-made characteristics.
Tributary	A stream or river that does not reach the sea but joins another major river (parent river), swelling its discharge. Sometimes described in terms of “left bank” or “right bank”, referring to the bank of the parent river that the tributary connects to.
Upstream (u/s)	In the opposite direction of the flow of a stream or river, i.e. towards the source.
Water Act	Water Act 2000.
Weir	A small overflow type dam in a stream or river, generally used to raise the water level or divert its flow.

Probabilities, ARI and AEP

For the purpose of this report, the Average Recurrence Interval (ARI) is generally used. It is recognised that other references to flood frequency are commonly used, however the ARI reference appears more widely understood by the public and has therefore been adopted in this report.

See http://www.bom.gov.au/hydro/has/ari_AEP.shtml. The Average Recurrence Interval (ARI) and Annual Exceedance Probability (AEP) are both a measure of the rarity of an event. With ARI expressed in years, the relationship is:

AEP = 1 – exp(-1/ARI)

This results in the following conversions:

ARI (years)	Percent Annual Exceedance Probability (% AEP)	Fraction Annual Exceedance Probability (AEP)
1	63.5	0.632
2	39.3	0.393
5	18.1	0.181
10	9.5	0.095
20	4.9	0.049
50	2	0.02
100	1	0.01
1,000	0.1	0.001
3,000	0.03	0.0003

1. Introduction

1.1 Background

This Site Water Management System and Water Balance Technical Report is a revision of the Technical Report submitted with the Project Environmental Impact statement (EIS) submission (September 2010) and incorporates responses to the comments from various stakeholders and statutory authorities. This Site Water Management System and Water Balance Technical Report accompanies the Supplementary EIS (SEIS) submission.

The Alpha Coal Project (the Project) comprises the development of thermal coal resources located approximately 170 km west of Emerald, and 50 km north of the town of Alpha in the Galilee Basin. The coal reserves for this Project exist within the mining lease application (MLA) 70426. The coal resources will be developed by open cut mining with related infrastructure. Coal will be mined at a peak rate of around 40 million tonnes per annum (Mtpa) run of mine (ROM) coal. The coal will be crushed, sized and washed, with product coal transported by rail to Abbot Point. The Project covers an area of approximately 33,706 ha and will be developed by Hancock Prospecting Pty Ltd (HPPL).

Parsons Brinckerhoff Australia Pty Ltd (PB) has been commissioned by Hancock Coal Pty Ltd (HCPL) to prepare a site water management system feasibility design and water balance for the Project.

1.2 Scope of works

This section outlines the Site Water Management System and Water Balance scope of works undertaken for the Project EIS/SEIS. Key features include:

- development of a feasibility design for the surface water management system for the Year 1, 5, 10, 20 and 30 landforms
- diversion of runoff from undisturbed catchments around the mine site
- partial segregation of water within the mine site based on quality
- onsite reuse of dirty and contaminated water, with contaminated water preferentially reused
- sufficient storage capacity within site dams for sediment control, so that runoff from overburden dumps can be released to the creek system following settling if water quality criteria is met and this water is not required for reuse onsite
- undertake a water balance of the mine site to estimate runoff volumes, identify potential overflows, and identify potential water deficits/surpluses for the Year 1, 5, 10, 20 and 30 landforms.

Other aspects of surface water assessment and management are dealt with in the Flooding Technical Report (Volume 2, Appendix K), Stream Morphology Technical Report (Volume 2, Appendix J), and Water Quality Technical Report (Volume 2, Appendix M) in the SEIS.

2. Design objectives and criteria

2.1 Water management system design objectives

The *Terms of Reference for an Environmental Impact Statement – Alpha Coal Project* sets the following key water management strategy objectives:

- maintenance of sufficient quantity and quality of surface waters to protect existing beneficial downstream uses of those waters (including maintenance of in-stream biota)
- maintenance or replication of the existing geomorphic condition of local watercourses
- minimisation of impacts on flooding levels and frequencies both upstream and downstream of the Project.

The first of these points is the most relevant to water management and water balance, with the greatest risk for potential off-site impacts on water quality being the discharge of pit water, process water, coal stockpile and potentially overburden runoff prior to rehabilitation. These water sources may contain contaminant concentrations that exceed acceptable limits for the preservation of downstream environmental values.

In line with leading industry practice, the objectives of the water management system design for the Project are to:

- separate and divert clean water away from the mine site
- minimise the volume of pit water (surface runoff draining to pit and groundwater seepage) generated by the Project
- avoid the need for discharge of contaminated water under normal operating conditions through preferential onsite reuse of contaminated water stores
- provide sufficient onsite storage to give an acceptable level of risk of accidental off-site discharge of contaminated water during significant rainfall events (no unplanned discharge under modelled historical conditions)
- provide sufficient onsite storage to settle coarse suspended solids from dirty water (from overburden dumps and other disturbed areas) during design rainfall events, through the application of the relevant guideline sediment dam storage capacity
- preferentially reuse all mine water, including environmental and sedimentation water, on site, while providing the flexibility to release sediment dam water to the creek, depending on the site water balance, stored water quality, and natural flows in the creek.

2.2 Relevant legislation and guidelines

Various legislation and guidelines provide information about site water management. The over arching legislation is the Water Act 2000, which aims to provide for the sustainable management of water and other resources. Environmental values and water quality objectives are set out in the Environmental Protection (Water) Policy 2009.

The Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland (Technical Guidelines) were prepared for the former Department of Minerals and Energy (DME) and published in 1995, but are now administered by the Department of Environment and Resource Management (DERM). The Technical Guidelines require that the design of a site water management system for any mining and processing operation should be based on effective risk management measures for the purpose of protection of the environment.

It is understood that DERM intends to replace the Technical Guidelines with the Manual for Assessing Hazard Categories and Hydraulic Performance of Dams (DERM, 2009). The Manual is currently in draft format (Version 1.1) and has not yet been finalised.

A combination of the DME Technical Guidelines and the DERM Manual for Assessing Hazard Categories and Hydraulic Performance of Dams has been used to size storages for this Project. Discussions will be held with DERM to confirm design criteria during detailed design.

2.2.1 DME technical guidelines - uncontaminated runoff criteria

Based on the Flora and Fauna Assessment and Aquatic Ecology Assessment prepared for the Project by AustralAsian Resource Consultants Pty Ltd (2010), the receiving waters in the vicinity of the Project site are considered sensitive. The Poplar Box Open Woodland, Gidgee Open Woodland, Fringing Riparian Woodland and Thozet's Box Open Woodland vegetation communities were identified and are listed as 'Of Concern' under the DERM Biodiversity Status. The regional ecosystem of Fringing Riparian Woodland along the south eastern most watercourse within the Project site is also listed a 'Of Concern' under the *Queensland Vegetation Management Act 1999*. Twenty-four avian species listed as Migratory and/or Marine under the *Environment Protection and Biodiversity Conservation Act 1999* were identified. The southern Squatter Pigeon was identified and is listed as 'Vulnerable' under both the *Environment Protection and Biodiversity Conservation Act 1999* and Schedule 3 of the *Nature Conservation Wildlife Regulation 2006*. The Little Pied Bat was identified and is listed as 'Near Threatened' under Schedule 5 of the *Nature Conservation Wildlife Regulation 2006*.

In the Technical Guidelines, design risk criteria are selected based on the appropriate hazard category for the structure under consideration. The selection of the hazard category is based on the potential outcomes of the failure to contain the waste water (i.e. the toxicity of the waste and the attributes of the receiving environment). The Technical Guidelines refer to uncontaminated or contaminated runoff. For the purposes of selecting a hazard category for this assessment, uncontaminated waste has been taken to mean Low-Toxicity waste as defined in the Technical Guidelines according to Table 2-1.

Table 2-1: Toxicity concentrations for determination of hazard category

Category	Concentration
Toxic	>100 x drinking water standard (NHMRC)
Sub-Lethal	10-100 x drinking water standard (NHMRC)
Low-Toxicity	<10 x drinking water standard (NHMRC)

Source: *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland* (DME, 1995)

Non-environmentally sensitive receiving waters are defined as having *"no environmental features of significance or no environmental damage expected"* and *"no sensitive ecology within 5 km".*

For uncontaminated runoff flowing/discharging into environmentally sensitive receiving waters, the Technical Guidelines recommend that runoff should be retained in a sediment dam designed to hold the 10 year ARI 24-hour storm above design maximum sediment deposit levels. The dam will be designed to by-pass when full. The contents of this dam will be drawn down within 10 days, by releasing/pumping the water to environmental dams for on site storage and/or reuse, or alternatively by releasing the water to the environment, depending on stored water quality release conditions.

2.2.2 DME technical guidelines - contaminated runoff criteria

The Technical Guidelines require that sufficient reserve storage should be available in all dams to contain the Design Storage Allowance (DSA). The DSA is the storage required at 1st November each year that will be filled by the process inputs and the runoff from the three month critical wet period if it should occur.

The cumulative rainfall data having the required ARI for the three month wet period is assessed from meteorological monthly decile analysis data (refer to Section 3.1). The runoff calculation assumes that no catchment losses occur. Design ARI by hazard category is summarised in Table 2-2.

Table 2-2: Design ARI for DSA based on hazard category from DME Technical Guidelines

Hazard for failure impacts	Hazard	AEP	ARI
Approaches a no discharge case and may involve the loss of cyanide tailings and the dam wall. Loss of life could be expected	High	0.001	1,000
Toxic waste discharge with riparian users downstream (within 5 km) sensitive ecology (within 5 km) or the contamination of significant ground water resources	High	0.005	500
Discharge of toxic waste with no downstream riparian users (within 5 km) or no significant ecology (within 5 km)	High	0.01	100
Discharge of sub-lethal wastes with significant riparian users (within 5 km), sensitive ecology (within 5 km) or contamination of groundwater resource	Significant	0.02	50
Discharge of sub-lethal wastes with no riparian users (within 5 km), no sensitive ecology (within 5 km) and no contamination of groundwater resource	Significant	0.05	20
Discharge of low-toxicity wastes and the minimum standard for unlicensed discharge of waste from the site	Low	0.1	10

Source: *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland* (DME, 1995)

The Mandatory Reporting Level (MRL) is defined as the available storage volume below the spillway crest, equivalent to the lower of the ARI (design risk) 72-hour storm or the ARI wave allowance. DERM must be advised when the level is reached/exceeded.

2.2.3 DERM Manual for Assessing Hazard Categories and Hydraulic Performance of Dams

The DERM Manual for Assessing Hazard Categories and Hydraulic Performance of Dams requires that the DSA be sized for the 100 year ARI critical wet period decile analysis for a high hazard category, and the 20 year ARI critical wet period decile analysis for a significant hazard category. The categories of harm for high, significant and low hazard categories are summarised in Table 2-3.

Table 2-3: Hazard category from DERM Manual for Assessing Hazard Categories and Hydraulic Performance of Dams

Categories of Harm	Hazard category		
	High	**Significant**	**Low**
General environmental harm	Location such that harm to a significant environmental value is likely, or serious environmental harm is possible. Such a value might include the presence of protected or endangered flora or fauna.	The environmental value is of lesser significance and harm is possible but not likely, or material environmental harm is possible.	No environmental values of significance, or only trivial environmental harm is possible.
Loss 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 or harm is likely.	Location such that contamination of waters used for human consumption would occur, and consumption of contaminated waters by humans with consequent loss or harm is possible.	No contamination of waters used for human consumption expected.
Loss of stock	Location such that consumption of contaminated waters by stock with consequent loss or harm is likely.	Location such that consumption of contaminated waters by stock with consequent loss or harm is possible.	Contaminated water not available to stock or no harm expected from consumption.
General economic loss	Serious harm to communities, industrial, commercial or agricultural facilities, important utilities, or water resources in the failure path.	Material harm to industry, secondary roads, minor railways, public utilities, or water resources in the failure path.	Trivial harm to environmental values such as environmental nuisance arising from minor spills.

Source: *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams (Version 1.1) (DERM, 2009)*

2.2.4 Code of Environmental compliance for high hazard dams containing hazardous waste

The Environmental Protection Authority (EPA) (now DERM) developed a Code of Environmental Compliance for Environmental Authorities for High Hazard Dams Containing Hazardous Waste.

The Code defines hazardous waste as *“any substance, whether liquid, solid or gaseous, derived by or resulting from, the processing of minerals that tends to destroy life or impair or endanger health”*. The Code notes that such dams are *“primarily used for storing process water, recycling treatment liquors and for tailings disposal.”*

A dam is a high hazard dam if it contains hazardous waste and one or more of the following situations occur:

1. In the event of dam failure or overflow, the dam's content would have one of the more of the following actions:
   - flow to a sensitive or commercial place
   - flow to a riverine area containing permanent water
   - contaminate a water supply for human consumption
   - contaminate a water supply for stock.
2. The dam is located within a:
   - declared catchment or sub artesian area
   - watercourse and the dam's surface area exceeds 1 ha.
3. The dam has a surface area greater than 2 ha.

Under this definition, it is possible that the following Project dams will be designated hazardous waste dams, and be regulated by DERM:

- Tailings storage facility (TSF) and any associated process water dams.
- Environmental dams receiving water contaminated by mine operations.

2.3 Adopted design criteria

A Geochemical Characterisation of the Project has been undertaken by SRK Consulting Australasia Pty Ltd (2010), including overburden, coal handling and process plant (CHPP), waste and raw coal materials. The Geochemical Characterisation report concluded:

"Composition of Waste Material

As a portion of the total mass of waste the lithology groups were Remainder (Rem) 63%, Clay and Soil 24%, Sand and Gravel 10% and Carbonaceous was 3%.

Acidity, Salinity and Potential Acid and Metalliferous Drainage (AMD)

The potential for acid generation was initially assessed using the conservative Net Potential Ratio (NPR) and AMIRA methods and there was general agreement in the sample classification using the two schemes. However, a significant number of Potentially Acid Forming (PAF) and Uncertain (UC) samples had total sulphur contents of less than 0.1% and therefore had the potential to produce a maximum of 3 kg(H_2SO_4)/t acid. They were considered as a very low risk of contributing to acid production.

Non Acid Forming (NAF) material or material classed as very low risk of contributing to acid production made up 90.4% of the total mass of the waste. A further 3.9% was classed as UC and therefore, 5.7% of the waste was classed as PAF. Of the 5.7% classed as PAF material, 1.1% was from the Carbonaceous group, 3.8% was Rem and 0.8% was Clay and Soil.

As the Carbonaceous material made up a relatively small fraction of the total mass of waste the fraction of the Carbonaceous material that was PAF and not very low risk was relatively high (35% compared with 6% for the Rem material).

The majority of the coal roof and floor and coarse and fine washery waste samples were PAF. Significant fractions of Carbonaceous and Rem roof and floor materials were also UC or PAF. Therefore, the roof and floor materials should be kinetically tested to further quantify their potential effects on water quality and consideration should be given to strategically mining and managing these materials to control their impact on drainage waters.

Metal Solubility

Simple leach tests were carried out on 75 samples at a solid to liquid ratio of 1:3 over a period of 24 hours (Price, 2009). On the basis of simple leach extraction test results, waters contacting the overburden and interburden waste were generally expected to remain circum neutral. Salinity release (probably sourced from contained pore water) would be expected to occur over the short term (as a short term flush) but would be expected to diminish in the longer term.

While the leach extraction test results cannot be used to directly estimate the water quality that would be released from the mine waste materials, the results can be used to indentify solutes that could potentially be released at significant concentrations.

Although 16 samples contained solutes that exceeded ANZECC (2000) stock water guideline values the majority of these were for only 1 or 2 samples. Guideline values for Al, As, Cd, Co, F, and SO_4 were exceeded once (in separate samples), Ni exceeded the guideline value in two samples and Se in eight samples. For the few samples where guideline values were exceeded a higher concentration was exhibited from the overburden and interburden than from the roof and floor, coal and coal washery waste.

Dispersivity

The fresh carbonaceous mudstone, shale and sandstones were generally non-dispersive, but when weathered do show slightly dispersive behaviour.

The clay and soils were dispersive, with all samples giving dispersive or slightly dispersive results.

The coal and washery waste materials were generally nondispersive, but one sample (sooty coal) did give a dispersive result.

The Rem group was examined for each rock type. The claystone, mudstone and siltstone showed a large variability in dispersivity results for both weathered and fresh rock, with approximately equal numbers of samples showing dispersive, slightly and non-dispersive results. The sandstones and tuffs showed a lower potential for dispersion, with samples showing mostly non-dispersive behaviour, but with some slightly dispersive results.

Material Sampling

Acid Neutralising Capacity (ANC)

Experimental variography shows spatial correlation from 5000 m to 7000 m in all groups except the Fresh carbonaceous group. This indicates that current spacing is probably adequate for interpolation or extrapolation of ANC values at un-sampled locations for all groups except the fresh carbonaceous.

Sample spacing for ANC within the coal is adequate as the omnidirectional model range is approximately equal to the north south sample spacing of 5000 m and therefore probably suitable for interpolating total S values at locations not sampled.

Total Sulphur

Statistical and experimental variogram studies showed that for total S:

- *Of the overburden wastes the fresh Carbonaceous and fresh Rem materials had the highest total S contents.*
- *Sample spacing in the coal was adequate (spacing was about 1000 m) for interpolating total S values at unsampled locations.*
- *For the fresh materials (excluding coal) considered together, the current sample spacing in the east west direction may be sufficient but because the total S is highly variable over short distances the sample spacing in the north south direction is probably too wide to interpolate values at unsampled locations.*
- *In the overall weathered, fresh Rem and the fresh Carbonaceous materials current drill spacing is insufficient to interpolate or extrapolate total S values at unsampled locations. Thus, the most representative value at an unknown location is the average total S value.*

Although sample spacing may be too large to interpolate total S values at unsampled locations in some materials, statistical analysis of the total S content of all samples showed for a mining block of 100 x 100 x 2 m that:

- *The probability of a block of fresh carbonaceous material having an average total S content greater than 0.3 wt% (i.e. approximately the average crustal abundance of S) was only 6%.*
- *For the fresh Rem material its was <1%. For fresh Rem there was also <1% chance of the average total S content of block being greater than 0.1 wt%.*

<u>Kinetic Columns</u>

Kinetic leach columns were operated for coal and coarse/fine reject samples as bulk materials may represent some tangible risk of acid generation at the Project and will need to be well managed. Five samples comprising three samples of coarse reject, one sample of blended raw coal and a composite sample of fine tailings. The columns have been operated over a period of eight weeks to date although laboratory results are currently only available for five weeks. Initial indications from test work to date may be summarised as follows:

- *Acid generation is occurring from coarse reject samples DLL_S1.60+0.25 and DU_S1.60+0.250 mm which have acidic leachate at pH 3.6 and pH 4.4 respectively.*
- *The pH of the leachate from the remaining columns is in the near neutral to mildly acidic range between pH 5.3 and 6.*
- *The concentration of sulphate from the coarse rejects columns has declined from greater than 300 mg/L to around 100 mg/L.*
- *The sulphate concentration in the leachates from the fine tailings is erratic ranging between 12 and 254 mg/L.*

These data provide an initial indication of the materials characteristics. This and data obtained from continued column operation will be used to assess depletion rates of acid forming and acid neutralising materials. These rates and site conditions would subsequently be used in predictions of water quality for the site."

Based on the above conclusions, the following minimum design criteria have been set for the purposes of feasibility design.

2.3.1 Sediment dams

Based on the conclusions of the Geochemical Characterisation of the Project (SRK Consulting Australasia Pty Ltd, 2010), it is considered unlikely that leachate/runoff from overburden dumps would be contaminated. However, as soils are dispersive, runoff is likely to have elevated suspended solids concentrations. This is based on the assumption that areas of particularly sodic or saline materials are managed in accordance with the measures described in Volume 2 Section 16. Sediment dams have therefore been sized in accordance with the criteria recommended in the Technical Guidelines for the discharge of uncontaminated runoff to environmentally sensitive receiving waters (refer to Section 2.2.1).

For the Project, 'Wet' sediment dams are proposed. Wet dams comprise a 'settling zone' for temporary treatment storage and a 'sediment zone' for storage of sediment. The 'settling zone' has been sized to store runoff from the 10 year ARI 24-hour duration storm. The 'sediment zone' has been sized to a nominal 20% of the 'settling zone'. A runoff coefficient of 0.5 for disturbed areas has been adopted for sediment dam sizing purposes.

As there is the potential for overburden runoff to have elevated salinity and/or metals, provision will be made for a manually operated valve on all sediment dam outlet pipes (to the environment) to prevent discharge if water quality is unsuitable. Sediment dam water is preferentially reused on site, and therefore an additional 'reuse zone' will be provided in sediment dams to cater for the storage of reuse water.

Typical design features of proposed sediment dams are as follows:

- 'sediment zone' for sediment storage sized at 20% of 'settling zone'
- 'reuse zone' for storage of water for possible onsite reuse sized at 20% of 'settling zone'
- 'settling zone' for temporary treatment storage
- outlet structure to allow the release of water stored in the 'settling' and 'reuse' zones
- free draining discharge pipe under the main haul road, with valve arrangement to allow manual operation of pipe (for 'final' sediment dams only)
- select clay fill embankment with 1:3 (V:H) slopes
- embankment crest 5 m wide with gravel capping and 3% cross-fall
- spillway at top water level to safely convey the 1,000 year ARI peak flow
- freeboard between top-water-level and top-of-bank
- scour protection at the discharge pipe outlet (to the environment)

- pump and pipeline system to transfer water to the ‘final’ sediment dams for release to the creek system, or for pumping to environmental dams for onsite reuse (where a free draining discharge pipe is not practical).

2.3.2 Environmental dams (or ‘regulated dams’)

Environmental dams (or ‘regulated dams’) are typically hazardous dams controlled by specific operating criteria. Environmental dams are split into two categories based on the runoff source:

1. Environmental dams (receiving water from the CHPP, MIA, coal stockpiles and dump stations etc)

2. Pit dewatering dams (receiving water from the pit sumps and borefield).

The DERM Manual for Assessing Hazard Categories and Hydraulic Performance of Dams (Version 1.1) (DERM, 2009) has been used to select design criteria for environmental dams assuming a ‘significant’ hazard category (refer to Section 2.2.3). Discussions will be held with DERM to confirm this design criteria.

Environmental dams have been sized to capture the 20 year ARI 3-month critical wet period rainfall (with a runoff coefficient of 1.0) for the purposes of feasibility design. Critical wet period rainfall depths are provided in Section 3.1.

The requirements described in Section 2.2.3 have not been specifically applied to pit dewatering dams as these are ‘turkeys nest’ dams with minimal local catchments. However, for the purposes of feasibility design, pit dewatering dams have been sized to achieve no discharge when operated as part of the overall site water management system under historical climate conditions, as determined through daily water balance modelling.

2.3.3 Referrable dams

A referrable dam is one that would, in the event of failure, put population at risk. This is determined by conducting a failure impact assessment. Such a dam is assigned a Category 1 or Category 2 failure impact rating, and is considered 'referrable' under the provisions of the *Water Supply (Safety and Reliability) Act 2008* and the *Water Act 2000*.

Dams that have not already been assessed as having a Category 2 failure impact rating must be assessed every 5 years if they are more than 8 m high and have:

- a storage capacity of more than 500 ML, or

- a storage capacity of more than 250 ML and a catchment area more than three times the maximum surface area of the dam at full supply level.

If there is no population at risk, a dam is not referrable and is not subject to the referrable dam provisions of the *Water Supply (Safety and Reliability) Act 2008*.

Development permits are required for all new referrable dams and for all modifications to existing referrable dams to increase the storage capacity by more than 10%.

Dams containing hazardous waste are not considered referrable dams under the *Water Act 2000* and are instead regulated under the *Environmental Protection Act 1994*. Under the definition of hazardous waste in the *Environmental Protection Act 1994*, it is possible that the site environmental dams may be deemed hazardous waste dams.

The final configuration of the site dams will be established during detailed design, and will depend on the availability of construction materials and the relative costs of excavation and embankment construction. Under the currently proposed water management system for the Project, there are numerous dams and/or flood levees that may meet the criteria for undertaking a failure impact assessment.

3. Existing environment

This section provides an overview of the existing surface water environment at the Project site, focusing on climate and rainfall-runoff characteristics. Other surface water information and assessment is provided in the Flooding Technical Report, Stream Morphology Technical Report, and Water Quality Technical Report.

3.1 Climate data

Climate data used in the water balance model was based on 110 years (1900-2009) of patched-point daily data. The patched-point data was sourced from the Data Drill database, developed by DERM. Data Drill accesses grids of data interpolated (using splining and kriging techniques) from point observations by the Bureau of Meteorology (BoM). The patched-point data is considered superior to site observations for modelling purposes because it draws on a greater dataset, both spatially and in time.

Annual rainfall for the site is provided in Figure 3-1. Summary statistics for rainfall and evaporation are presented in Table 3-1.

Figure 3-1: Annual rainfall for Alpha – Data Drill (1889 to 2009)

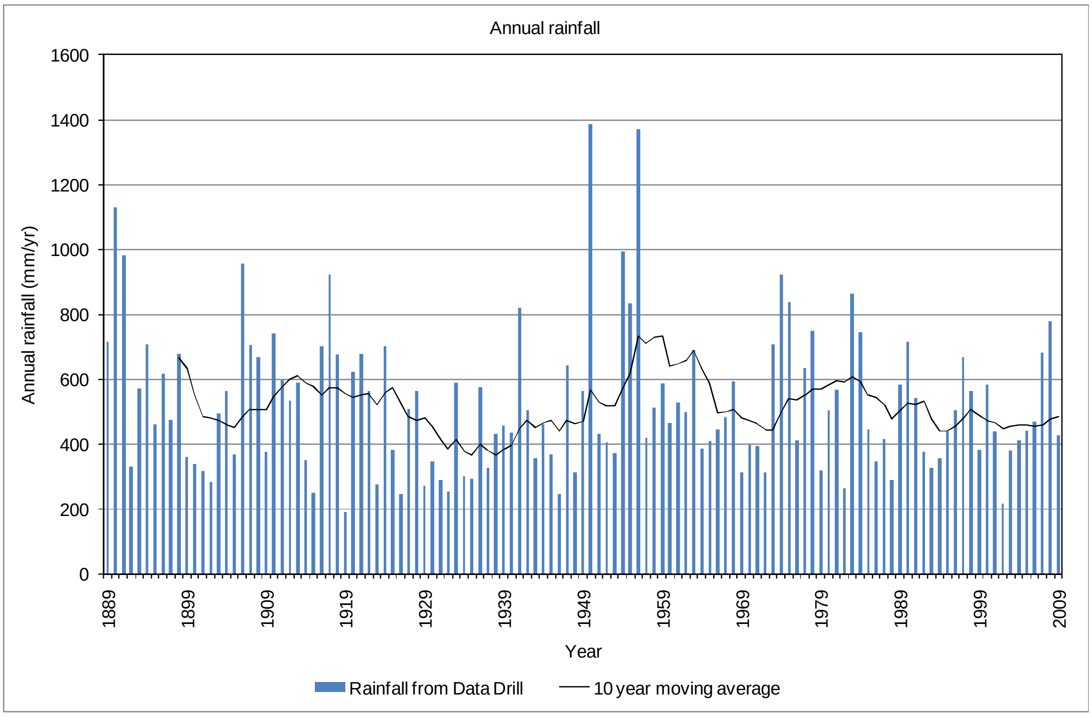


Table 3-1: Summary climate statistics Alpha (1889 to 2009)

Statistic	Annual rainfall (mm)	Annual evaporation (mm)	Annual potential evapotranspiration (mm)
10th percentile	293	2,187	1,656
50th percentile (median)	477	2,293	1,772
90th percentile	779	2,385	1,869
99th percentile	1322	2523	1944
Mean	526	2,292	1,767
Minimum	190	1,810	1,518
Maximum	1,385	2,657	1,977
Standard deviation	220	103	86

A three month wet period decile analysis was undertaken for the Project area. This was done by calculating the maximum cumulative rainfall depth for any consecutive three month period within each water year (i.e. July to June) for the 110 year period from 1900 to 2009. A Log Pearson III probability distribution was fit to the 110 year data set. The frequency curve is provided in Figure 3-2. Rainfall depths for various ARI's are provided in Table 3-2.

Figure 3-2: Three month wet period frequency curve for Alpha – Data Drill (1900 to 2009)

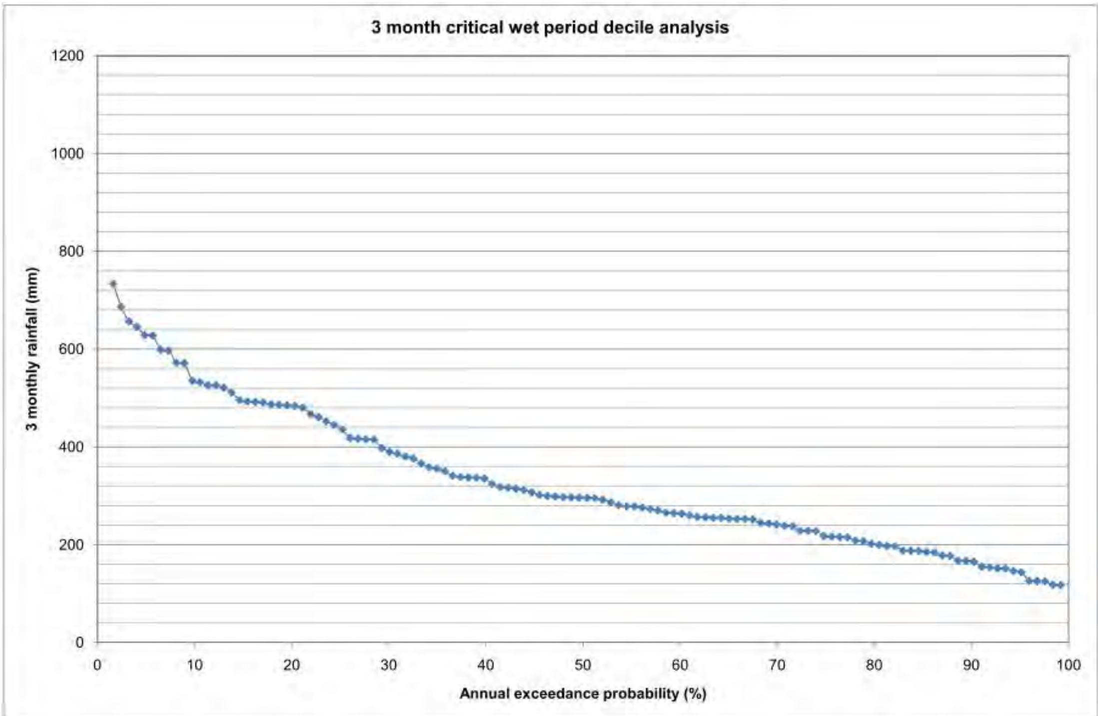


Table 3-2: Three month wet period rainfall depths for Alpha

AEP (%)	ARI (years)	Rainfall depth (mm)
10%	10	533
5%	20	627
2%	50	751
1%	100	847
0.5%	200	946
0.1%	1,000	1,187

Design intensity-frequency-duration rainfall data was also prepared for the Project area in accordance with the method outlined in Australian Rainfall and Runoff (The Institution of Engineers Australia, 2001).

3.2 Stream flow data

There are no stream gauging stations operating within the study catchment. However, five stream gauges have operated near the Project area by DERM. Details of these gauges are provided in Table 3-3. In relation to the Project, The Bellyando River gauge is approximately 180 km north of the Project area and includes the Sandy and Lagoon Creeks within it's direct catchment, Native Companion Creek is the closest to the project site, running parallel to the east of the Project at a distance of approximately 16 km. Mistake Creek is located further east at a distance of approximately 60 km.

Table 3-3: Stream flow gauging station

Location	Gauge number	Period of record
Operational gauges		
Belyando River at Gregory Development Road	120301B	From 1976
Native Companion Creek at Violet Grove (16 km East)	120305A	From 1967
Mistake Creek at Twin Hills (60 km east)	120309A	From 1976
Discontinued gauges		
Belyando River at Mt Douglas	120301A	1949 – 1975
Mistake Creek at Charlton	120306A	1968 – 1993

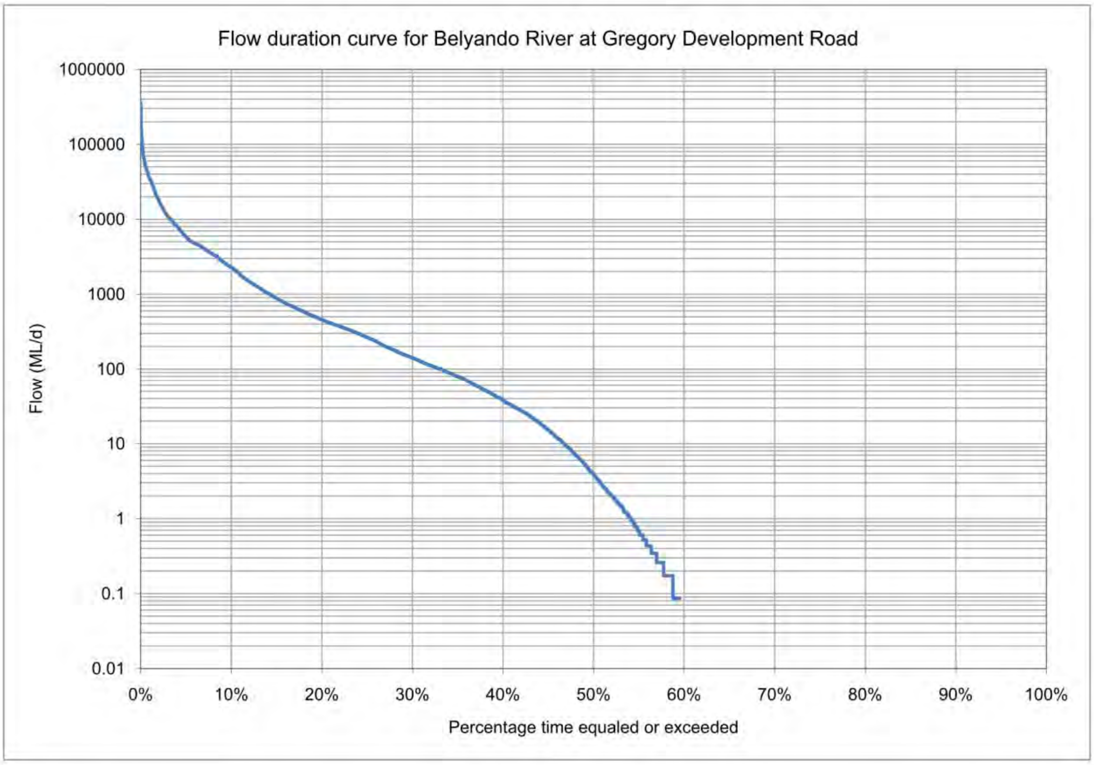
Source: DERM database

The Belyando River at Gregory Development Road streamflow record has been used for calibration of the rainfall-runoff models used in the water balance analysis. This station was selected as it is located downstream of the site on the Belyando River, and the study catchment makes up part of the Belyando River catchment at that location.

The mean annual flow in the Belyando River at Gregory Development Road was 603,784 ML/yr for the period 1976 to 2009. The median flow was 369,146 ML/yr. The minimum and maximum recorded flows are 48,611 ML/yr and 3,286,773 ML/yr respectively.

A daily flow duration curve for the Belyando River at Gregory Development Road is provided in Figure 3-3 for the period 1976 to 2009. The contributing catchment area is 35,411 km^2. The curve shows that while the highest recorded mean daily flow was 362,187 ML/day (which occurred in January 2008), for 50% of the time flows were less than 3.9 ML/day, and for 40% of the time, there was no flow.

Figure 3-3: Flow duration curve for Belyando River (GS 120301B)



3.3 Catchment description

The study area comprises the catchment of Lagoon Creek from its headwaters to Sandy Creek at the confluence with Middle Creek. The study area comprises a number of creeks, including Lagoon, Spring, Sandy, Little Sandy (also known as Sandy), Greentree (also known as Sandy), Rocky, Well, and Middle Creeks. These creeks are all tributaries of the Belyando River system and its alluvial floodplain. Flooding is associated with flows in Lagoon Creek and in the minor creeks draining the MLA area to Lagoon Creek. The region is characterised by predominantly large rural properties with cattle grazing and cropping being the most common land use.

A summary of the existing catchment areas included in the model is provided in Surface water license holders

A search of the State of Queensland Water Entitlements System has been undertaken to identify surface water license holders in the Burdekin region. The results of the search are shown in Figure 3-5, and further details are provided in Appendix A.

The search indicated that there are no surface water license holders on Lagoon Creek downstream of the Project. The closest license holder downstream of the Project is located on the Belyando River near Gregory Development Road, which is approximately 175km downstream of the MLA boundary. This is a license to take water for domestic supply (Licence Number 48434F).

Other license holders are located in closer proximity to the Project, but are not on downstream watercourses and have therefore not been considered further in this report.

Figure 3-4 and in Table 3-4.

Table 3-4: Existing subcatchment breakdown

Catchment	Area (ha)
Greentree Creek	19,731
Lagoon Creek	186,081
Little Sandy Creek	8,225
Rocky Creek	5,369
Well Creek	20,926
Sandy Creek	27,167
Middle Creek	5,087
Total	**272,585**

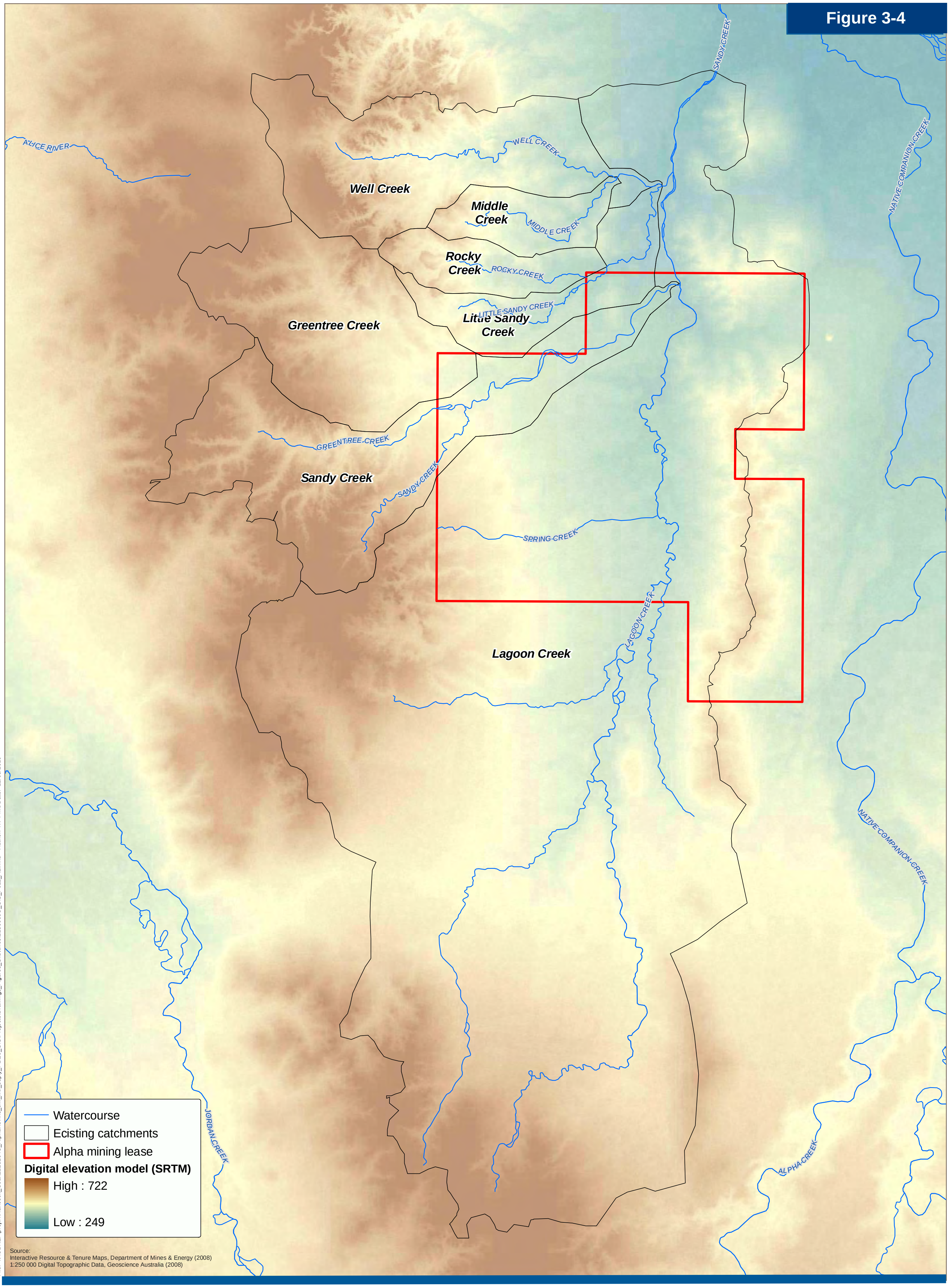
3.4 Surface water license holders

A search of the State of Queensland Water Entitlements System has been undertaken to identify surface water license holders in the Burdekin region. The results of the search are shown in Figure 3-5, and further details are provided in Appendix A.

The search indicated that there are no surface water license holders on Lagoon Creek downstream of the Project. The closest license holder downstream of the Project is located on the Belyando River near Gregory Development Road, which is approximately 175km downstream of the MLA boundary. This is a license to take water for domestic supply (Licence Number 48434F).

Other license holders are located in closer proximity to the Project, but are not on downstream watercourses and have therefore not been considered further in this report.

Figure 3-4



File: \\AUBNEF\proj\H\Hancock_Coal\2123204C_AlphaKevins_cnr_wtr_suply_P110_GIS\Projects\Drawings_Figures_Sketches\2136669C_GIS_F011_A1.mxd Author: TK Print Date: 12/08/2010

0 4 8 12 16 20
Kilometres

PARSONS BRINCKERHOFF

ALPHA COAL PROJECT

Existing Catchment Plan

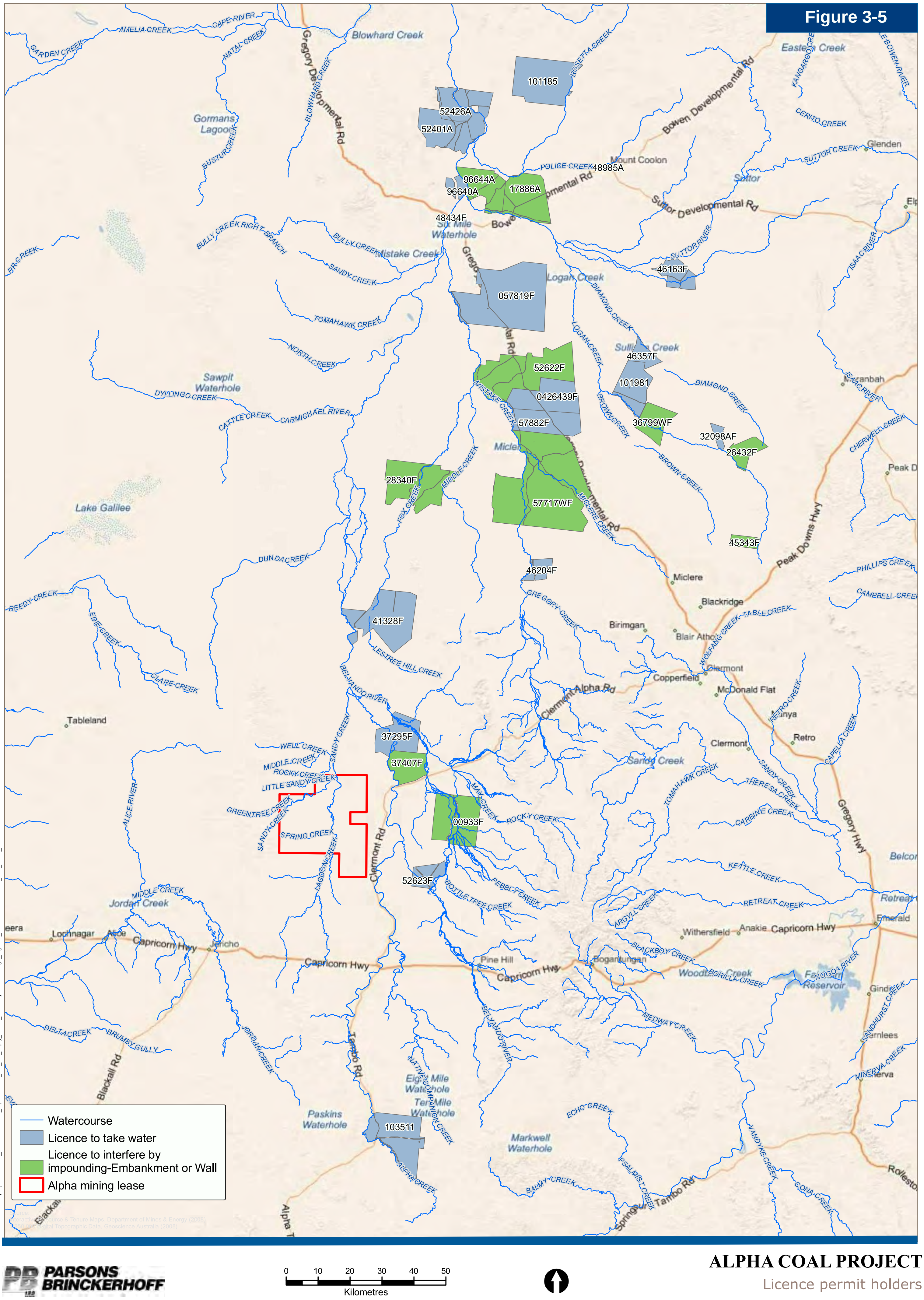


Figure 3-5

ALPHA COAL PROJECT

Licence permit holders

PARSONS BRINCKERHOFF

File: \\AUBNEF\proj\H\Hancock_Coal\2123204C_AlphaKevins_cnr_wtr_suply_P110_GIS\Projects\Drawings_Figures_Sketches\2136669C_GIS_F020_A1.mxd Author: TK Print Date: 02/09/2010

3.5 Surface runoff

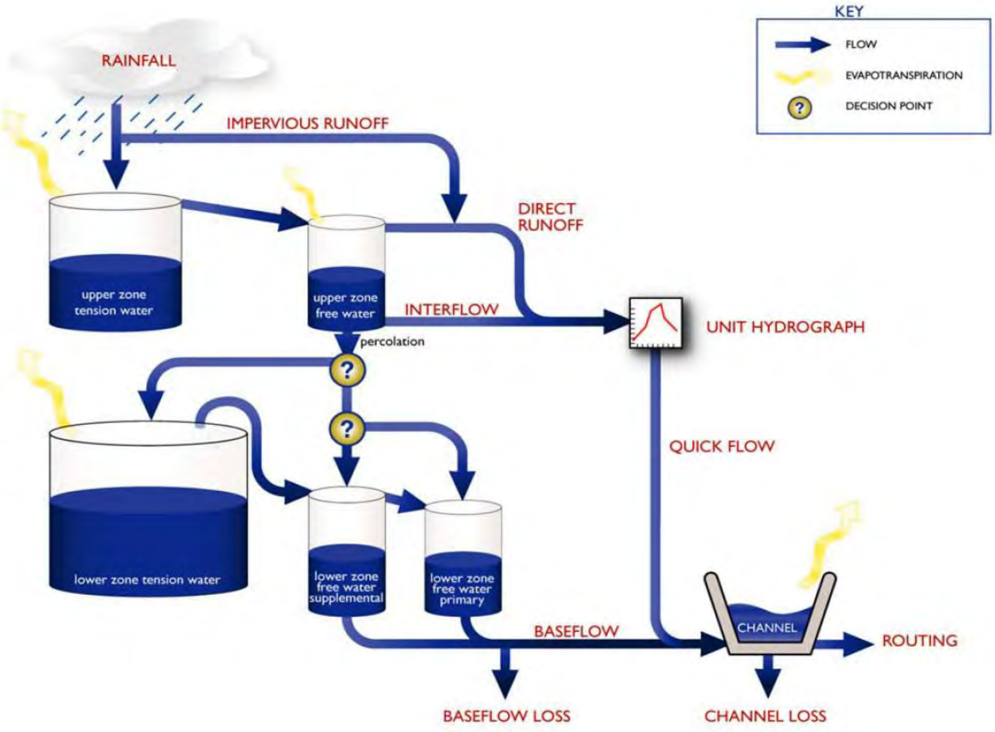
The volume of surface water runoff has been estimated using two rainfall-runoff models that have been incorporated into the water balance model – the Sacramento model, and the Australian Water Balance Model (AWBM).

3.5.1 Sacramento model

The Sacramento model was used to generate a daily time series of runoff from undisturbed and rehabilitated catchments.

The Sacramento model was developed by Burnash, Ferral and McGuire in 1973. It is an explicit soil-moisture accounting-type model developed by the United States National Weather Service and the California Department of Water Resources, and was originally used for flood forecasting applications. The Sacramento model consists of a number of storages connected by catchment processes. The model components and the relationships between them are shown in Figure 3-6.

Figure 3-6: Schematic layout of Sacramento model (Source: CRC for Catchment Hydrology, 2004)



Rainfall on the catchment is considered as falling on one of two types of surface, permeable areas or impervious areas which are linked to the channel system. Runoff is produced from impervious areas in any rainfall event. The permeable area, by contrast, produces runoff only when the rainfall is sufficiently heavy. In this portion, initial soil moisture storage, the upper zone tension storage, must be filled before water is available to enter other storages. This represents the depth of precipitation required to meet interception requirements and is water bound closely to soil particles. When this tension storage is filled, water is accumulated in the upper zone free water storage, from where it is free to drain to deeper storages or to move laterally to appear in the stream channel as interflow.

The vertically draining water, or percolation, can enter one of three lower zone storages, the lower zone tension storage (the depth of water held closely by the soil particles) or one of the two lower zone free water storages, primary and supplemental (that are available for drainage as base flow or subsurface outflow). The two free water storages fill simultaneously but drain independently at different rates to produce the variable base-flow recession.

Evaporation occurs from surface water areas at the Annual potential evapotranspiration rate (refer Table 3.1), but in other areas, varies with both evapo-transpiration demand and the volume and distribution of tension water storage.

The surface runoff and interflow are routed to the catchment outlet by a non-dimensional unit hydrograph. In catchments where significant nonlinearities may be present, such as extensive floodplains that may alter the mean travel times, a layered Muskingum routing technique, effectively introducing a number of linear storage-discharge relationships, can be used.

To implement the model in a given catchment, a set of 18 parameters must be defined. These parameters define the generalised model for a particular catchment. The parameters are usually derived for a gauged catchment by a process of calibration where the recorded streamflows are compared with calculated streamflows. The parameters are adjusted to produce the best match between the means and standard deviations of the daily streamflows, to match the difference in peak flow discharge.

Sacramento parameters adopted for the undisturbed catchments of the Project area are provided in Table 3-5. These parameters were determined from calibrating the predicted flows for the baseline ‘undisturbed’ catchment to the Belyando River at Gregory Development Road (station 120301B) streamflow record.

Table 3-5: Adopted Sacramento model parameters for baseline catchment

Parameter	Description	Adopted value
ADIMP	The additional fraction of pervious area, which develops impervious characteristics under soil saturation, conditions.	0.15
LZFPM	Lower Zone Free Water Primary Maximum, the maximum capacity from which primary base flow can be drawn.	350
LZFSM	Lower Zone Free Water Supplemental Maximum, the maximum volume from which supplemental baseflow can be drawn.	5
LZPK	The ratio of water in LZFPM, which drains as baseflow each day.	0.02
LZSK	The ratio of water in LZFSM which drains as baseflow each day.	0.35
LZTWM	Lower Zone Tension Water Maximum, the maximum capacity of lower zone tension water. Water from this store can only be removed through evapotranspiration.	200
PCTIM	The impervious fraction of the basin, and contributes to direct runoff.	0.025
PFREE	The minimum proportion of percolation from the upper zone to the lower zone directly available for recharging the lower zone free water stores.	0.0
REXP	An exponent determining the rate of change of the percolation rate with changing lower zone water storage.	3.3

Parameter	Description	Adopted value
RSERV	Fraction of lower zone free water not available for transpiration purposes.	0.3
SARVA	A decimal fraction representing that portion of the basin normally covered by streams, lakes and vegetation that can deplete streamflow by evapotranspiration.	0.001
SIDE	The decimal fraction of observed base flow, which leaves the basin, as groundwater flow.	0.5
SSOUT	The volume of the flow which can be conveyed by porous material in the bed of stream.	0.002
UZFWM	Upper Zone Free Water Maximum, this storage is the source of water for interflow and the driving force for transferring water to deeper depths.	150
UZK	The ratio of water in UZFWM, which drains as interflow each day.	0.4
UZTWM	Upper Zone Tension Water Maximum. The maximum volume of water held by the upper zone between field capacity and the wilting point which can be lost by direct evaporation and evapotranspiration from soil surface. This storage is filled before any water in the upper zone is transferred to other storages.	220
ZPERC	Proportional increase in percolation from saturated.	15

A comparison of predicted and gauged cumulative runoff depths is provided in Figure 3-7 for the period 1977 to 2009 (recorded data).

Figure 3-7: Comparison of predicted and gauged cumulative runoff depth for Belyando River at Gregory Development Road

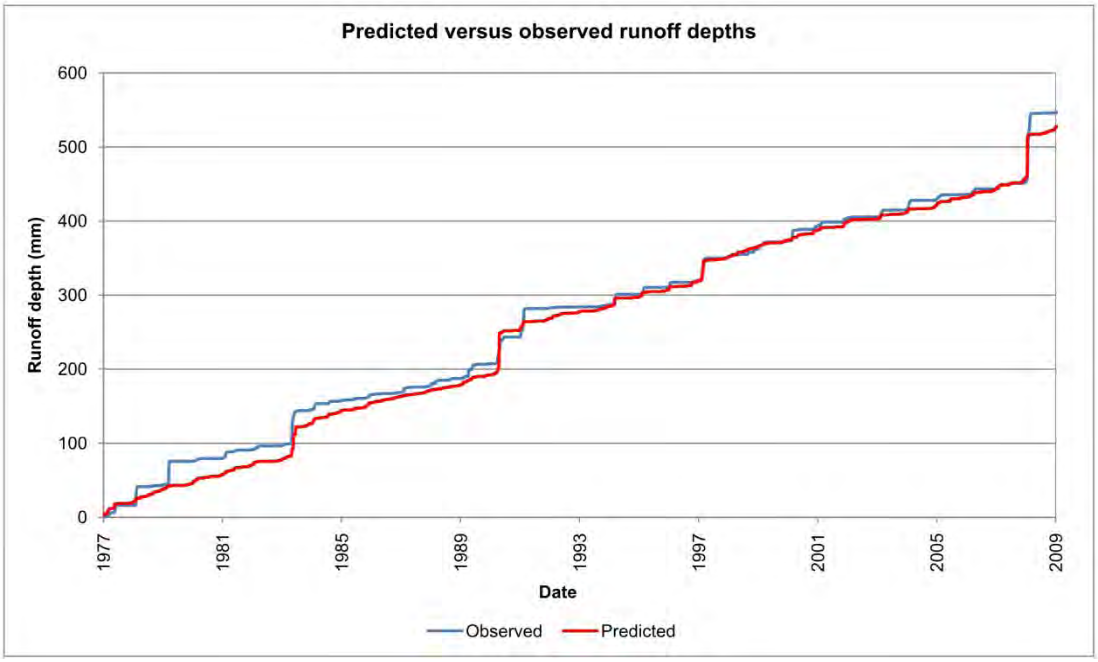


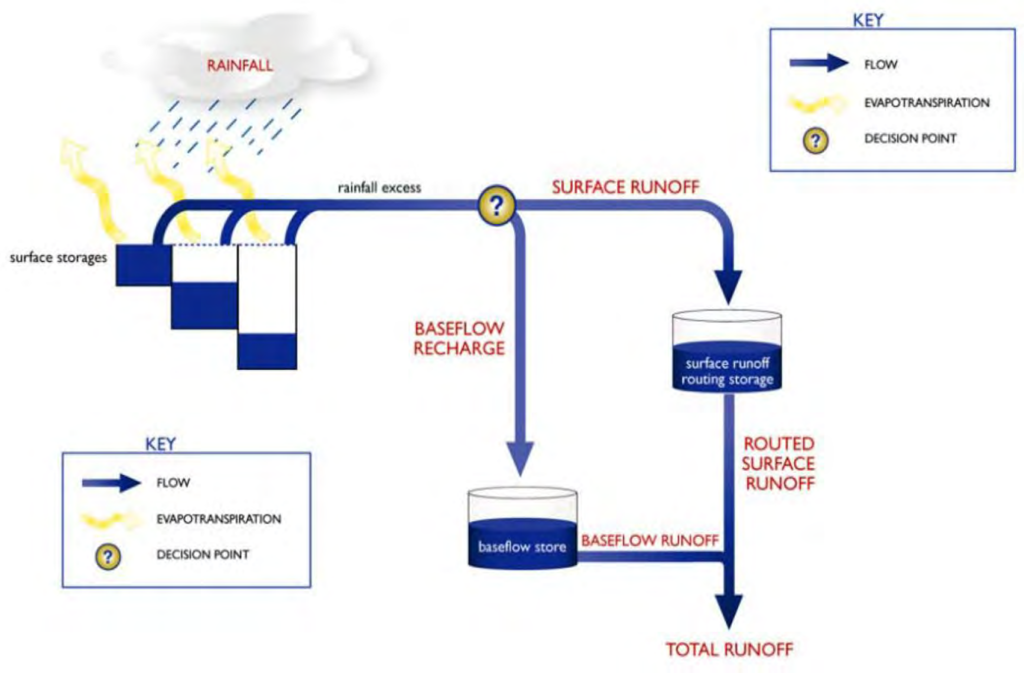
Figure 3-7 shows that annual runoff depths predicted by the Sacramento model are generally lower than the gauged runoff depths, but compare reasonably well. The mean annual runoff depth predicted by the Sacramento model was 16.3 mm/yr (3.3% of mean annual rainfall) for the period 1977 to 2009. The mean annual runoff depth at the gauging station was 17.1 mm/yr (3.4% of mean annual rainfall) for the period 1977 to 2009.

3.5.2 Australian Water Balance Model

The Australian Water Balance Method (AWBM) (Boughton, 1993) was used to derive catchment runoff time series from disturbed catchments for use in the water balance.

AWBM is a partial area saturation overland flow model. The use of partial areas divides the catchment into regions that produce runoff (contributing areas) during a rainfall-runoff event and those that do not. These contributing areas vary within a catchment according to antecedent catchment conditions, allowing for the spatial variability of surface storage in a catchment. The use of the partial area saturation overland flow approach is simple, and provides a good representation of the physical processes occurring in most Australian catchments (Boughton, 1993). This is because daily infiltration capacity is rarely exceeded, and the major source of runoff is from saturated areas. A schematic layout of AWBM is provided in Figure 3-8.

Figure 3-8: Schematic layout of AWBM runoff model (Source: CRC for Catchment Hydrology, 2004)



AWBM parameters for disturbed catchment types were derived by adjusting the surface storage capacity to achieve the assumed catchment yield. The catchment yield was estimated based on typical yields observed from other mine sites around Australia and on mine sites in Central Queensland. A summary of the adopted parameters from each catchment type is provided in Table 3-6.

Table 3-6: Adopted AWBM parameters

Parameter	Description	Landuse			
		Industrial	Open pit	Active spoil	Rehabilitated spoil
BFI	Baseflow index	0	0	0.103	Sacramento model used
K	Baseflow recession constant	1	1	1	
A1	Partial area	0.134	0.2	0.136	
A2	Partial area	0.433	0.2	0.27	
A3	Partial area	0.433	0.6	0.594	
C1	Surface storage capacity	2.3	5	50	
C2	Surface storage capacity	22.9	70	100	
C3	Surface storage capacity	45.7	90	500	

The quantities of runoff resulting from the various types of landuses in the water balance model over 110 years of water balance simulation are summarised in Table 3-7.

Table 3-7: Annual runoff depths from various landuse types

Landuse	Annual runoff depth (mm/yr)			
	Mean	10th percentile	50th percentile	90th percentile
Undisturbed	18.4	6.7	11.2	41.9
Rehabilitated spoil	18.4	6.7	11.2	41.9
Industrial	141.7	26.7	103.6	307.1
Open pit	89.3	16.5	56.5	222.2
Unrehabilitated active spoil	19.4	0.0	6.7	65.9

4. Proposed water management system

4.1 Water segregation

Where practical, it is proposed to segregate water within the mine site according to its quality to minimise the stored volumes of water with high concentrations of contaminants. This would allow containment of water requiring treatment (e.g. settling suspended sediment) and water suitable for direct discharge (e.g. undisturbed catchments) to be diverted.

Five water classifications have been nominated for the mine site, as described below:

- **Process water management system** – managing process water that has been used in the CHPP. This includes the TSF, decant dam and return water system.
- **Clean water system** – separating clean runoff from undisturbed areas from the contaminated and dirty water management systems, and diverting it to the creek system. This type of water has low turbidity and low salinity.
- **Contaminated water management system** – managing runoff from the open pit and other areas that could contribute contaminants, such as the MIA, CHPP, coal stockpiles and dump stations.
- **Dirty water management system** – treating runoff from overburden dumps and other disturbed areas that could contain sediment.
- **Groundwater management system** – groundwater will be extracted from the aquifer using a borefield to minimise seepage into the pit. Bore water will be stored in environmental dams for onsite reuse. Bore water is expected to be of reasonably high quality.

Contaminated, dirty and clean water management systems are discussed in the following sections. This report does not assess the groundwater or process water management systems (in particular, the build up of tailing fines in the TSF and the adequacy of this facility has not been assessed). The groundwater management system is discussed in the Groundwater Technical Report (Volume 2, Appendix N and O of the SEIS). The TSF and decant dam are discussed in the Project's TSF Technical Report (Volume 2, Appendix T of the SEIS). Based on this Report, it has been assumed that only one cell of the TSF would be operational at a time, and that only one cell would be actively undergoing rehabilitation at a time. The other cells would be either undisturbed or rehabilitated, with runoff being released to the creek system.

4.2 Clean water system

Clean water runoff from undisturbed catchments will be diverted around the mine site to minimise the site water inventory and maintain pre-development discharges into Lagoon Creek/Sandy Creek.

The clean water system comprises:

- Diversion of Lagoon, Sandy and Spring Creek around/through the mine site, including an intermediate diversion drain for Sandy and Spring Creek. Levees will be provided parallel to the diversion drain and creek to control flow and prevent waters entering the pit area. The design criteria for pit flood immunity is the 3,000 year ARI storm event (equivalent to 1% chance of failure over the 30 year life of the mine). The design of creek diversions is described in the Flooding Technical Report.

- Highwall dams, levees and additional intermediate diversion drains west of the pit to capture and divert from undisturbed catchments. These structures have not been included in the feasibility water management system, but will be developed as part of the detailed design phase of the Project and implemented as part of ongoing mining operations.
- Raw water dam to store water imported to the site.
- A pump and pipeline system from the raw water dam to deliver stored water to either:
  - CPP (for processing of ROM coal into product coal)
  - MIA (for vehicle wash and workshop)
  - ROM dump and transfer stations (for dust suppression via sprayers)
  - water treatment plant (for potable applications).

At mine closure, clean water runoff from the rehabilitated spoil areas will be released back into Lagoon Creek. The land form will be amended as part of rehabilitation works, to make natural drainage possible. Water from rehabilitated areas will be released once rehabilitation success criteria are met.

4.3 Contaminated water management system

While water will be carefully managed to minimise the volume discharging to the open mine pits, some water will make its way into the pits either via direct rainfall, runoff from and seepage through overburden dumps, or small undisturbed catchments upslope of pits within the pre-strip area. It has been assumed that levees, highwall dams and additional intermediate diversion drains will be provided as part of ongoing mining operations to capture and divert runoff from the undisturbed catchment adjacent to the pit.

The contaminated water management system comprises:

- small sumps in the pit floor to collect and contain local surface water runoff from the pit floor, high wall, low wall and end walls
- pit dewatering pumps and associated dewatering pipelines to transfer pit water to the nearest pit dewatering dam, if necessary via a small staging dam
- a drainage system to convey runoff from disturbed areas to the nearest environmental dam
- environmental and pit dewatering dams to store and contain contaminated water from the above sources. Care has been taken in the location of storages and the layout of the drainage system to minimise the areas draining to these dams, so as to minimise the storage requirements and reduce the risk of uncontrolled spilling during rainfall events.

- a return water pump and pipeline 'backbone' system connecting the environmental and pit dewatering dams to deliver stored water to either
  - other environmental dams (west of Lagoon Creek)
  - a nearby truck fill station (for haul road dust suppression)
  - the CPP
  - the tailings decant dam.
- a borefield to minimise groundwater seepage into the pit and provide water for use in the mine processes.

Water captured in the contaminated water management system will be used as a priority to meet demands in order to minimise the volume of stored water and therefore the risk of off-site discharge. Imported water will only be used to meet demands when there is a water deficit or high quality water is required.

During extended wet periods, the pits will provide temporary storage for surplus contaminated water. This will occur once the pit dewatering dams and associated environmental water storage systems have reached their active storage capacity.

4.4 Dirty water management system

Dirty water runoff from disturbed areas, such as overburden dumps, will be captured in sediment dams to encourage suspended solids to settle. Following settling, water in sediment dams will be either preferentially transferred to environmental dams for onsite reuse, or, if all storages have reached their active storage capacity, released to Lagoon Creek, subject to the site water balance, quality of the stored water and the release conditions. It is envisaged that sediment dam water will be reused onsite during dry and median periods, and only released to the creek during prolonged wet periods when there is not adequate capacity in environmental dams to store additional water.

If sediment dam water is released to Lagoon Creek, release would occur at one of four licensed discharge points located at SD1a, SD2b, SD4b and SD6b (refer Figures 4.1 to 4.5).

"It is proposed to adopt a flow trigger based on one third of the 1 in 2 year ARI peak flood flow for Lagoon Creek. The Flooding Technical Report (Volume 2, Appendix K of the SEIS) indicates that the 1 in 2 year ARI peak flood flow for Lagoon Creek is ~30 m^3/s. Therefore, a practical flow trigger for controlled releases from the Alpha Project is 10m^3/s. These results are pending further assessment (model).

For events with flows exceeding 10 m^3/s, Native Companion Creek Violet Grove gauge station data shows that flow recession periods, after the flow falls below 10 m^3/s, extends typically for 2 to 5 days. Therefore, the 10 m^3/s flow trigger allows sufficient post-event flushing of the creek.

The Project will only make controlled releases on rare occasions (i.e.: site water surplus and upstream flow above 10m3/s), a practical dilution ratio of 1:10 is recommended. This would allow a release rate of 1m^3/s. "

For further details regarding the release conditions, refer to the Water Quality technical report (Volume 2, Appendix M of the SEIS).

In the event that sediment dams fill to capacity during large storm events, they will overflow to the pit (via the pit haul roads).

Sediment dams will allow time for coarse sediments to settle and, if necessary, allow a suitable flocculent to be added to remove fine or dispersive sediment to meet allowable turbidity discharge limits. As runoff from overburden dumps could potentially have elevated salinity and/or metals, provision will be made for a manually operated valve on all outlet pipes to prevent discharge if water quality is unsuitable. Additional capacity has also been provided in the 'reuse zone' of sediment dams to cater for this water.

The dirty water management system comprises:

- a drainage system to convey runoff from the overburden dump to the nearest sediment dam
- sediment dams to capture water from the overburden dump
- a pump and pipeline system to transfer captured water to the 'final' sediment dams (SD1a, SD2b, SD4b and SD6b) which can either release water to the creek, or to environmental dams for onsite reuse (where a free draining discharge pipe is not practical).
- four 'final' sediment dams (SD1a, SD2b, SD4b and SD6b) located immediately west of the main haul road. These dams have the provision to discharge to Lagoon Creek via gravity outlet pipes beneath the main haul road, and will be the only release points from the dirty water management system to the creek. The four release points locations are listed in Table 4.1.

Table 4-1 Locations of release points

Sedimentation Dam	Easting	Northing
SD1a	447833.212E	7421245.759N
SD2b	448272.883E	7426055.228N
SD4b	448697.600E	7434017.172N
SD6b	449801.265E	7442445.707N

- stream flow gauging station to determine and record stream flows in Lagoon Creek upstream of the site
- the discharge of water from the 'final' sediment dams (SD1a, SD2b, SD4b and SD6b) to Lagoon Creek will only take place during periods of natural flow events. Discharge should not exceed 20% of the flow in Lagoon Creek, as measured at the gauging station. Water quality criteria for discharges to Lagoon Creek are provided in the Water Quality Technical Report.

Sediment dams are to be maintained in a drawn-down state as much as practical, so that sufficient capacity is available in the 'settling zone' to capture water from subsequent storm events. If sediment dam water is to be reused onsite, it will be transferred to environmental dams for storage.

4.5 Staging of the water management system

The components of the water management system would evolve as the Project expands, to be compatible with the mine landform and schedule. This development of the mine water management system over the mine's 30-year life is illustrated through snapshots at five stages of the mine landform:

- Year 1
- Year 5
- Year 10
- Year 20
- Year 30.

These landforms were adopted as representative of the Project during the life of the operation. Staging plans (MinOp Consulting Pty Ltd, 24 February 2010) were provided by HCPL for the years 2013, 2014, 2015, 2016, 2017, 2022, 2027, 2032, 2037 and 2043. The 2014 staging plan was adopted for Year 1, the 2017 staging plan was adopted for Year 5, the 2022 staging plan was adopted for Year 10, the 2032 staging plan was adopted for Year 20 and the 2043 staging plan was adopted for Year 30.

Feasibility water management system plans are provided in Figure 4.1 to Figure 4.5 for the Year 1, 5, 10, 20 and 30 landforms. The plans show the mine progression, areas of disturbance, areas of rehabilitation, and the required water management structures for each landform. A schematic diagram showing the general connectivity between water sources, demands and storages is provided in Figure 4.6.

Excluding the process water and bore water management systems, a total of 22 water management dams are required to manage water supply and runoff from the site over the life of the Project. Dam staging is summarised in Table 4-2.

Table 4-2: Total number of dams over life of the Project

	Environmental dams				
	CHPP, MIA, ROM dump	Pit dewatering	Sediment dams	Raw water dams	Total
Year 1	4	5	11	1	21
Year 5	4	5	12	1	22
Year 10	4	5	12	1	22
Year 20	4	5	12	1	22
Year 30	4	5	12	1	22

Note: Bore water collection dams have been excluded. The TSF and decant dam have been excluded.

It has been assumed that dams will be constructed to their maximum capacity when they are first commissioned. In practice, there may be opportunities for staging storage capacities without compromising the system's security when catchment areas increase as the mine develops.

Figure 4-1: Water management system feasibility for Year 1

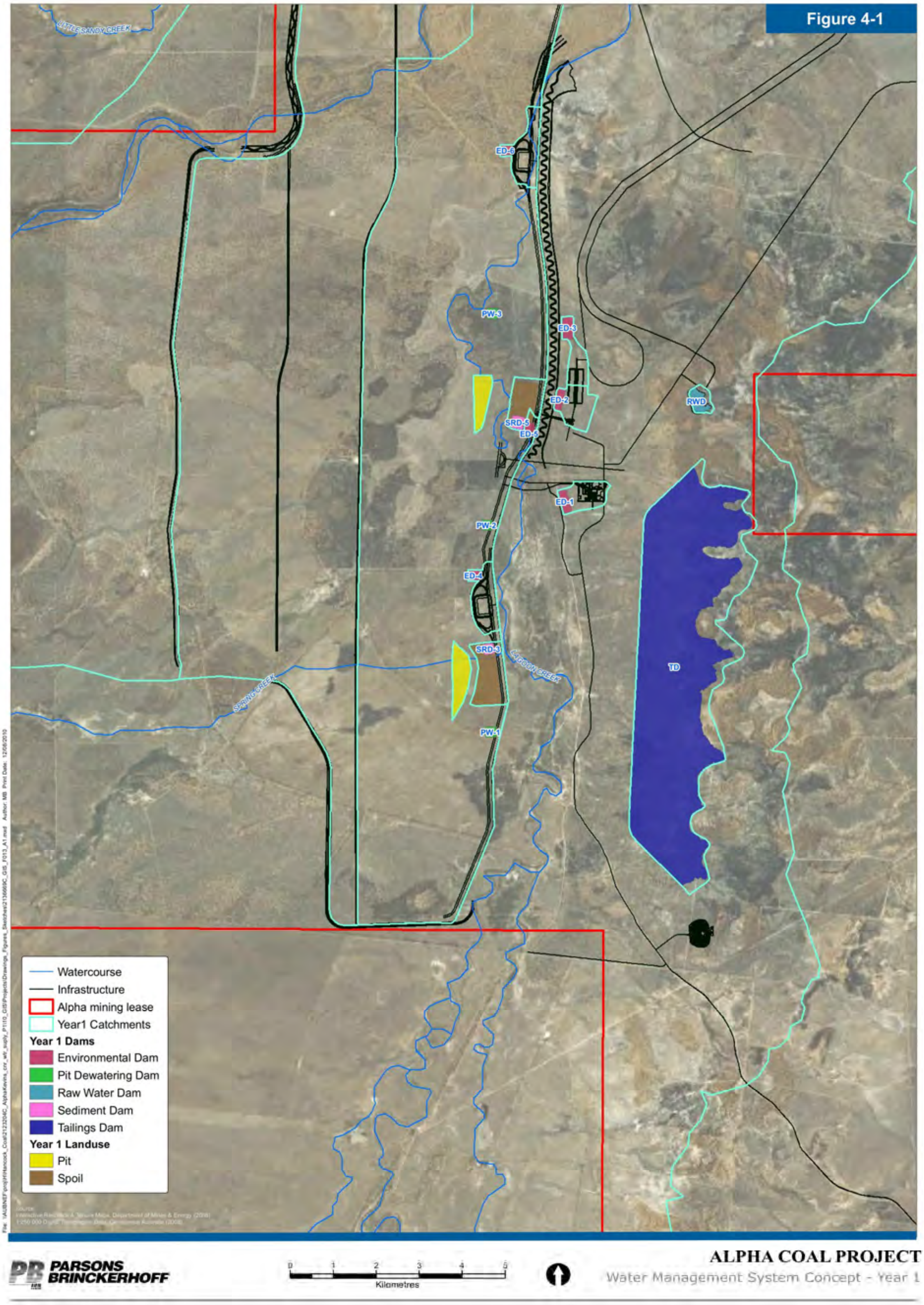


Figure 4-2: Water management system feasibility for Year 5

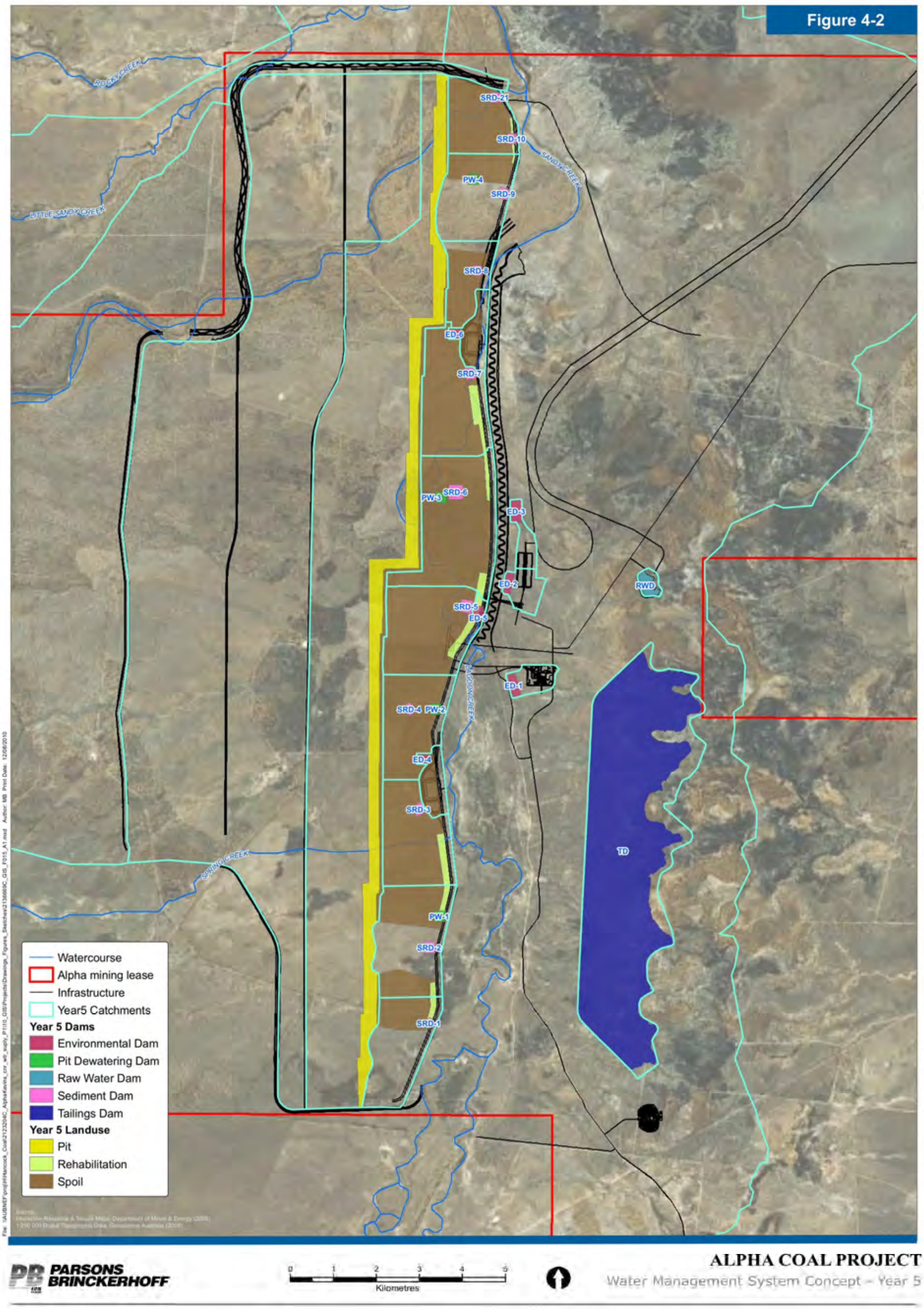


Figure 4-3: Water management system feasibility for Year 10

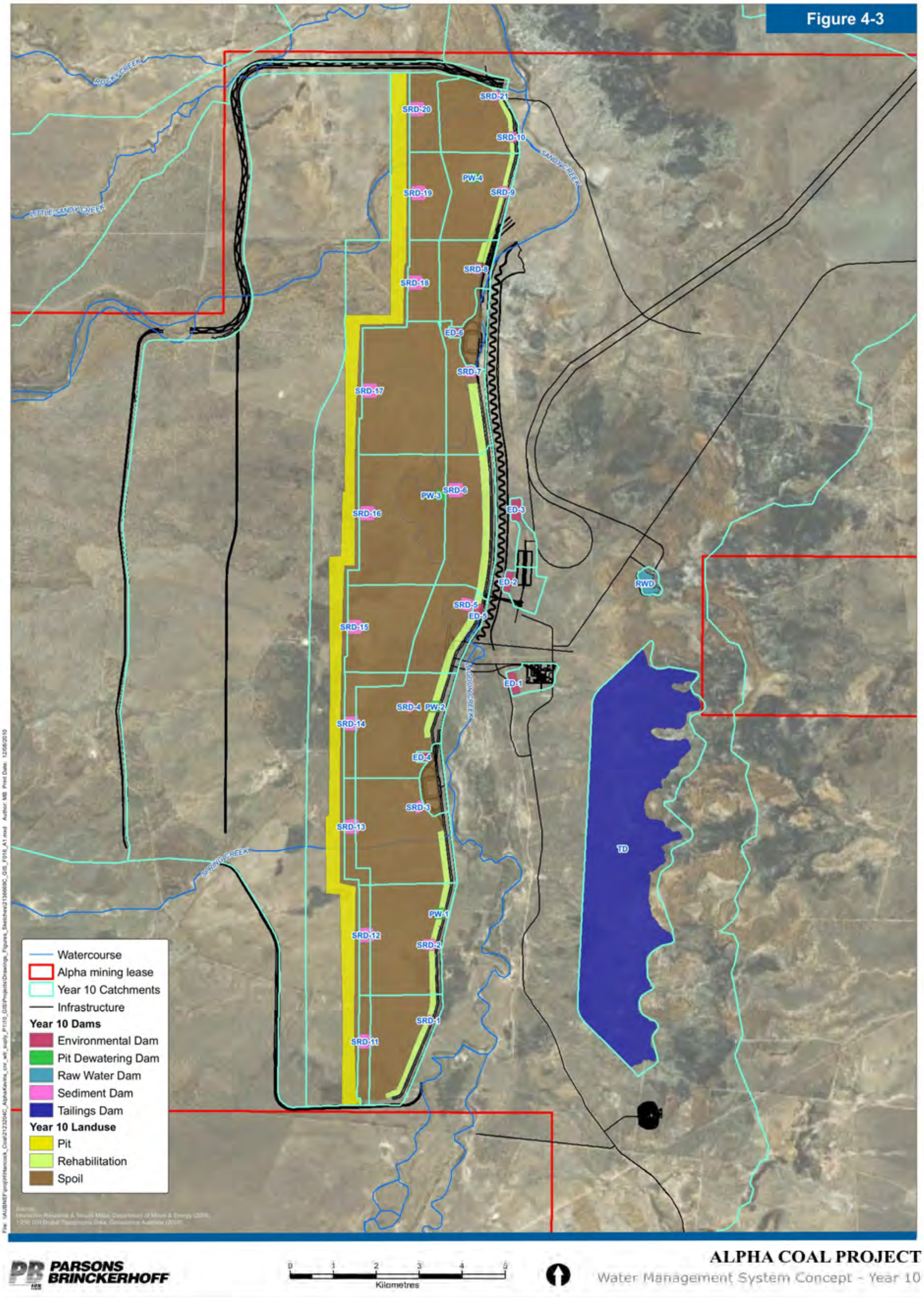


Figure 4-4: Water management system feasibility for Year 20

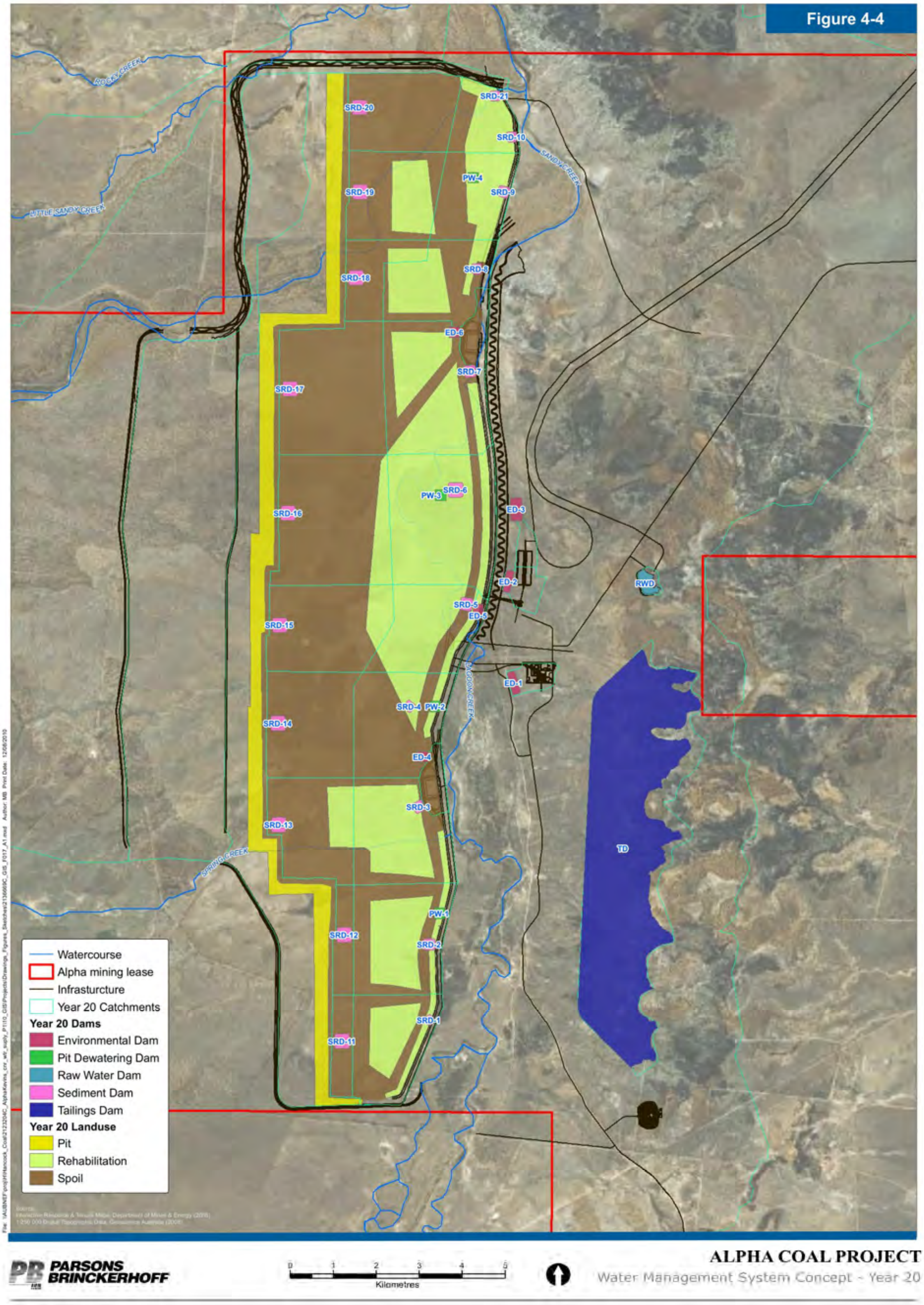


Figure 4-5: Water management system feasibility for Year 30

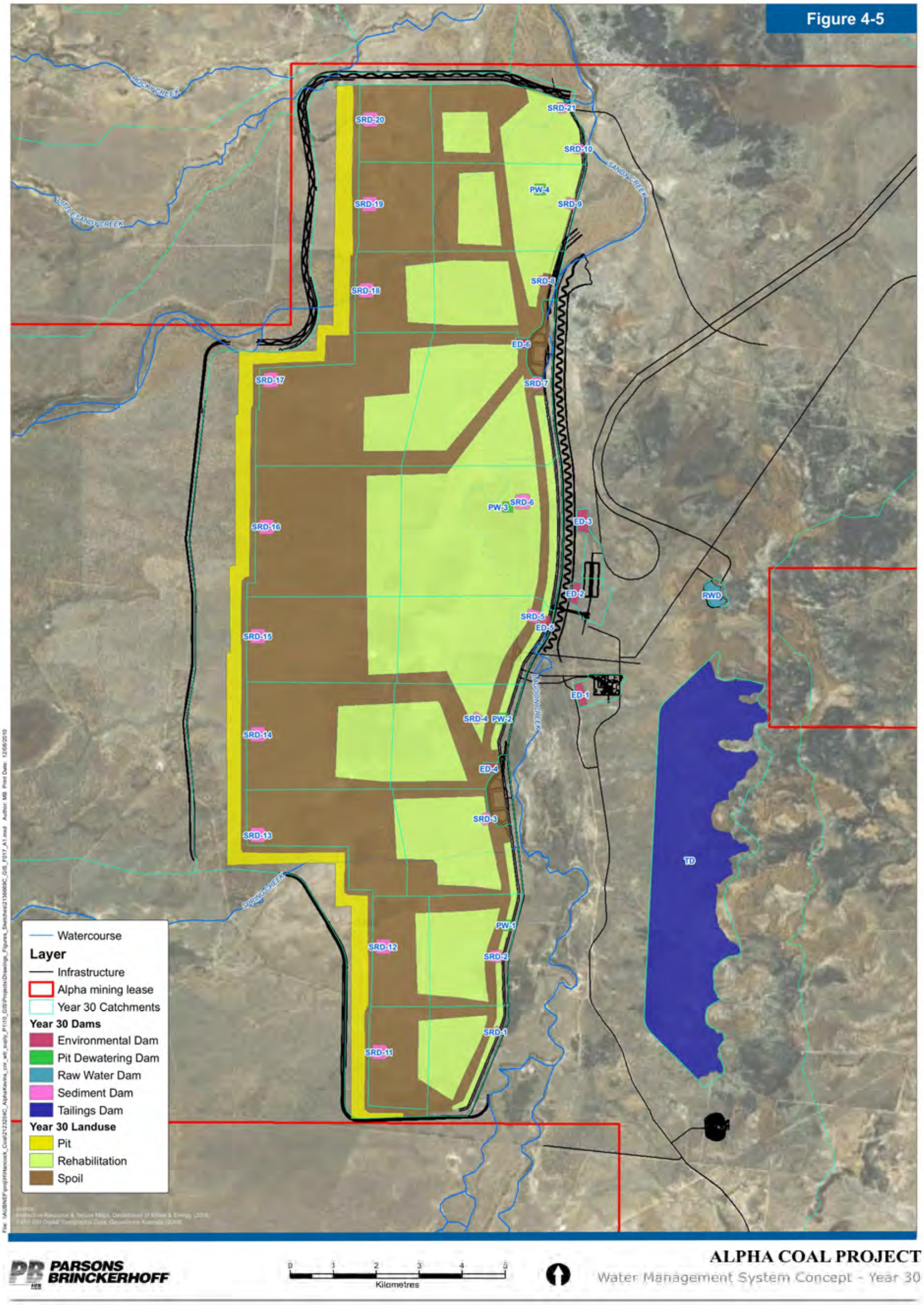
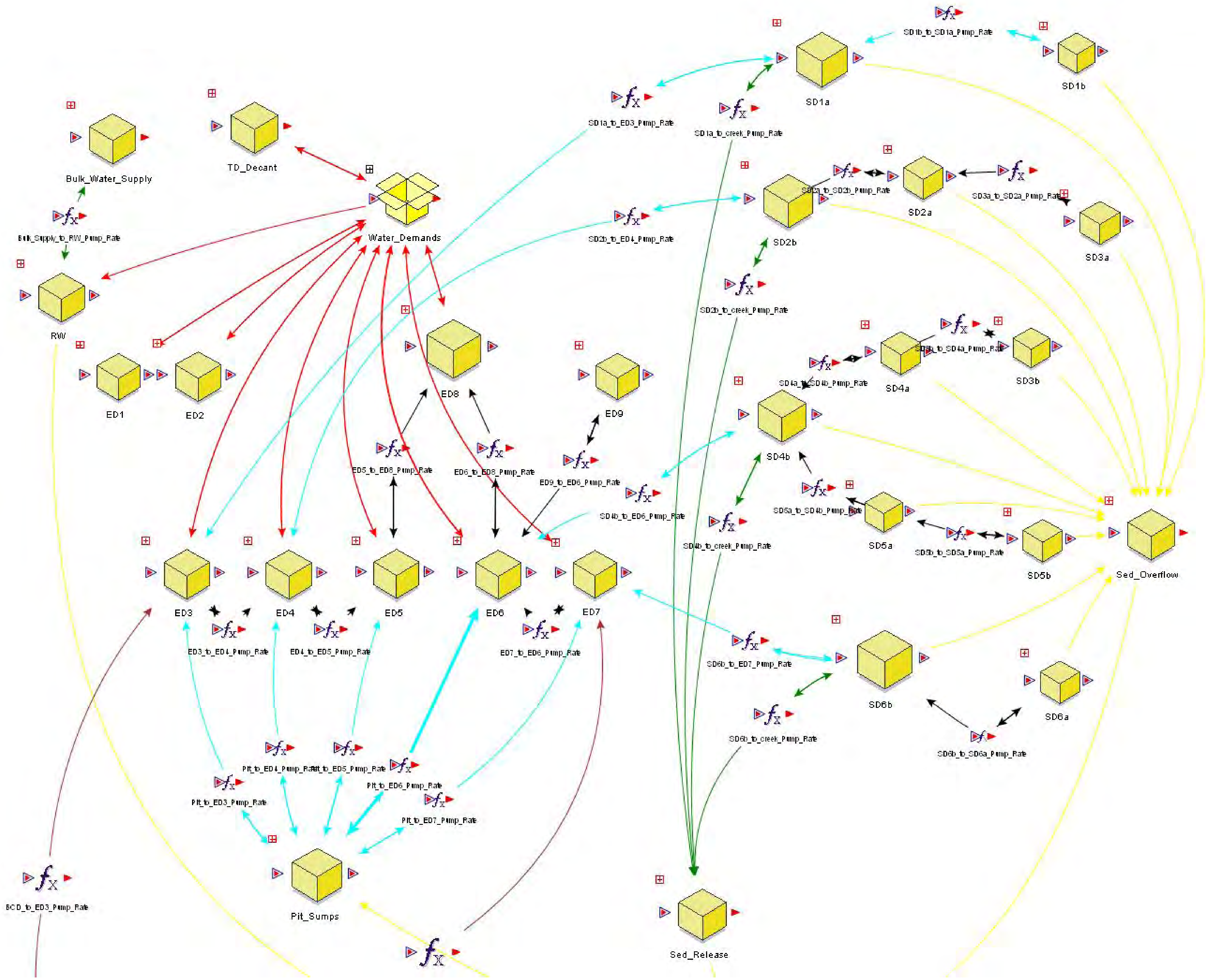


Figure 4-6: Schematic of overall water management system feasibility



4.6 Erosion and sediment controls during construction

An Erosion and Sediment Control Plan (ESCP) will be prepared and implemented prior to construction of mine infrastructure. The plan will be in accordance with appropriate statutory requirements, including conditions of the Environmental Authority. Controls will be established to a standard consistent with the *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland* (DME, 1995).

The ESCP will include:

- identification of soil and water management issues, including existing site conditions, soil and climatic data, erosion prone areas, location of the nearest and other relevant environmentally sensitive areas
- clear understanding and application of proposed control measures including the following actions - minimise disturbance, provide temporary and permanent drainage measures as early possible, identification of suitable erosion and sediment controls for the site, implement effective revegetation
- drawings to accompany the ESCP identifying the development and staging of works of temporary erosion and sediment control measures, including measures to cope with heavy rainfall events to aid in limiting unforseen construction delays due to wet weather
- compliance with the recognised approval processes
- maintain and supervise implementation of the ESCP, and undertake scheduled inspections of the implementation of the ESCP
- undertake monitoring of the effectiveness of the ESCP including diary notes/logbook entries of control techniques used on-site, and water quality sampling both upstream and downstream of disturbed areas.

Erosion and sediment controls include:

- where possible, avoid disturbance to natural watercourses and riparian areas, and reinstate any disturbed areas
- reduce or limit overland flow runoff volume and velocity by minimising catchment size, increasing flowpath length, and providing for water infiltration into soils
- during the construction phase, early planning and construction of temporary drainage systems will minimise erosion and avoid delays in initial earthworks
- diversion of upslope water to reduce on-site erosion by limiting catchment size, thereby reducing total volume of contaminated runoff requiring treatment and reduced downtime following prolonged rain events
- install permanent drainage structures as early as possible, including stabilised drainage outlets

5. Site water balance modelling

5.1 Modelling approach

A water balance has been undertaken for the Project's water management system in order to assess the performance of the system and to estimate annual runoff volumes and identify likely water deficit and surplus. The water balance has also been used to identify possible overflows from sediment dams, environmental dams and pit dewatering dams.

The current water balance model includes only operating rules, suitable appropriate to feasibility design. Operating rules will be upgraded when further water quality, groundwater and geochemistry data becomes available.

The proposed water management system will be refined and optimised as detailed design proceeds, and water quality, geochemistry, groundwater and runoff characteristics are confirmed from ongoing monitoring programs. Sensitivity analyses will be undertaken to changes in these characteristics during detailed design.

5.1.1 GoldSim model

A water balance model of the Project was developed in GoldSim, a widely used platform for mine site water balance studies. The model was developed for the Year 1, 5, 10, 20 and 30 landforms and was routed for 110 years of climate data based on a daily time step.

The network diagram presented in Figure 4.6 shows the SEIS water management layout and interconnectivity of storages for the mine site.

5.2 Model assumptions

The water balance model has been developed and refined to a level of detail suitable for feasibility design and cost estimation of water management infrastructure. Some assumptions and simplifications were incorporated into the model that may limit its applicability for other applications:

- pump rating curves have not been discretely modelled, and therefore the model does not represent delays that could occur when transporting water around the site
- runoff parameters have been selected using experience on other similar projects with limited quantitative data to assess the runoff characteristics of disturbed mine site catchments
- the accumulation of tailings fines deposited in the TSF has not been included in the water balance model. This report does not assess the adequacy of the TSF
- while the model assesses the performance of the system under historical extremes that may reasonably be expected to reoccur in the future, it does not specifically quantitatively incorporate the impact of future climate change on runoff
- borefield extraction rates should be considered provisional only. Groundwater modelling and borefield optimisation will be performed during detailed design and could potentially result in different extraction rates than those presented in Section 5.4.2

- evaporation is set to zero on days of rainfall. Whilst this is a conservative approach for assessing dam overflows, it is not a conservative approach for assessing water supply deficits and may underestimate the requirement for water from external sources.
- it is assumed that water captured in sediment dams will be transferred to environmental dams for onsite reuse where there is a site water deficit and adequate capacity in environmental dams to store this additional water.

This report presents a feasibility water management system that will be refined and optimised as detailed design proceeds, and the runoff quantity and quality characteristics of the overburden are better understood.

5.3 Model data

5.3.1 Catchments

Catchment boundaries for the water management system were delineated using the feasibility mine plans, and by making reasonable assumptions about the likely destination of runoff.

It has been assumed that all undisturbed areas ahead of the progressing pit will be diverted to Spring Creek and Sandy Creek, with the exception of a 100 m wide pre-strip. This would be achieved by providing additional intermediate diversion drains, levees, highwall dams and pump-out facilities (from highwall dams to the creek system), if required. The provision of these structures will be investigated during detailed design.

Catchment boundaries are shown on the feasibility water management system plans provided in Figure 4-1 to Figure 4.5 for the Year 1, 5, 10, 20 and 30 landforms. A summary of catchment areas is provided in Table 5-1.

Table 5-1: Summary of catchment areas

Structure	Catchment area (ha)				
	Year 1	Year 5	Year 10	Year 20	Year 30
Water management system					
ED1 (MIA)	59	59	59	59	59
ED2 (CHPP)	106	106	106	106	106
ED3	11	11	11	11	11
ED4	4	4	4	4	4
ED5	6	6	6	6	6
ED6	32	32	32	32	32
ED7	6	6	6	6	6
ED8	144	144	144	144	144
ED9	157	157	157	157	157

Structure	Catchment area (ha)				
	Year 1	Year 5	Year 10	Year 20	Year 30
SD1a	211	169	250	373	544
SD1b	220	231	270	522	732
SD2a	342	296	359	610	785
SD2b	305	223	328	547	695
SD3a	223	206	316	541	678
SD3b	303	201	400	596	738
SD4a	365	237	485	627	875
SD4b	174	63	85	156	355
SD5a	-	108	205	543	662
SD5b	189	130	229	534	642
SD6a	362	209	284	554	815
SD6b	296	325	437	611	803
Pit	1,340	2,380	2,793	3,328	4,263
RW	223	223	223	223	223
Sub total	*5,078*	*5,526*	*7,189*	*10,290*	*13,335*
TSF and decant dam					
TSF	510	746	746	497	581
TDD	47	47	47	47	47
Sub total	*557*	*793*	*793*	*544*	*628*
Undisturbed catchment					
Creek system	266,950	266,267	264,602	261,753	258,623
Sub total	*266,950*	*266,267*	*264,602*	*261,753*	*258,623*
Total	**272,586**	**272,586**	**272,586**	**272,586**	**272,586**

The area draining to the water management system and TSF/decant dam catchments increases over the life of the Project, as the pits and spoil dump expands. The change in landuse breakdown is summarised in Table 5-2.

Table 5-2: Change in landuse for the water management system and TSF/decant dam catchments

Landuse	Area (ha)				
	Year 1	Year 5	Year 10	Year 20	Year 30
Undisturbed	2,410	536	513	508	450
Rehabilitated spoil	0	477	649	1,242	7,002
Industrial (CHPP, MIA)	94	94	94	94	94
Open pit	935	935	1,351	1,604	1,575
Unrehabilitated spoil	1,416	3,261	4,359	6,619	3,991
Raw water dam	223	223	223	223	223
TSF/decant dam	557	793	793	544	628
Total	**5,635**	**6,319**	**7,982**	**10,834**	**13,963**

Note: Table excludes undisturbed catchment areas diverted around the site.

The contributing catchment inflow was modelled for each storage in the water balance model by summing the products of unit runoff depth time-series (derived using the rainfall-runoff models) and the corresponding partial catchment areas.

5.3.2 Dam sizes

Sediment dam capacities adopted in the water balance model are summarised in Table 5-3. Capacities are based on the criteria for discharge of uncontaminated runoff to sensitive receiving waters (refer to Section 2.2), with an allowance for sediment and reuse water storage.

Table 5-3: Sediment dam capacities

Structure	Maximum catchment area (ha)	Capacity (ML)			
		Settling zone	Sediment zone (20%)	Reuse zone (20%)	Total
SD1a	544	345	69	69	483
SD1b	732	464	93	93	650
SD2a	785	498	100	100	697
SD2b	695	441	88	88	617
SD3a	678	430	86	86	602
SD3b	738	468	94	94	655
SD4a	875	555	111	111	777
SD4b	355	225	45	45	315
SD5a	662	420	84	84	588
SD5b	642	407	81	81	570
SD6a	815	517	103	103	723
SD6b	803	509	102	102	713

It may be possible to reduce the size of individual dams by providing the required storage volume in multiple dams. This will be investigated during detailed design.

Environmental dam capacities adopted in the water balance model are summarised in Table 5-4. For comparison purposes, estimated runoff volumes for various design storm events are also provided in Table 5-4. Environmental dams capturing runoff from the CHPP, MIA and ROM dump station catchments (ED1, ED2, ED8 and ED9) were sized for the 20 year ARI 3-month critical wet period rainfall (refer to Section 2.2 for criteria). The pit dewatering dams (ED3, ED4, ED5, ED6 and ED7) will have a ‘turkeys nest’ configuration, and have minimal catchment area receiving mainly pumped inflows from the pit sumps. The pit dewatering dams were therefore preliminarily sized based on the results of historical water balance modelling, to achieve no discharge and to provide a reasonable level of pit dewatering when operated as part of the overall water management system over the 110-year simulation. ED2 to ED7 have therefore been nominally sized at 1000 ML, providing a minor buffer for modelling purposes.

Table 5-4: Environmental/pit dewatering dam capacities

Dam	Maximum local catchment area (ha)	Volume (ML)					
		10yr ARI 24-hour (R=127mm)	50yr ARI 72-hour (R=256mm)	20yr ARI 3-month (R=627mm)	50yr ARI 3-month (R=751mm)	Maximum modelled volume	Adopted volume
Environmental dams							
ED1	59	75	151	370	443	166	370
ED2	106	134	271	665	796	304	665
ED8	144	183	369	903	1,081	824	903
ED9	157	199	402	984	1,179	275	984
Pit dewatering dams							
ED3	11	14	28	69	83	936	1000
ED4	4	5	10	25	30	912	1000
ED5	6	8	15	38	45	913	1000
ED6	32	41	82	201	240	924	1000
ED7	6	8	15	38	45	976	1000

Note: Capacities for sediment dams exclude volumes for sediment accumulation

Dam capacities provided in Table 5-4 exclude sediment storage. Appropriate allowances for sediment storage will be made at the detailed design stage.

Stage-storage relationships for dams in were included in the water balance model and were estimated based on an assumed depth of 5.5 m and side slopes of 1:3 (V:H). This assumption will be refined at the detailed design stage, once the final configuration of site dams is established.

A volume of 500 ML has been adopted for the Raw Water Dam. A volume of 4,000 ML has been adopted for the Tailings Decant Dam (comprising 3500 ML DSA and 500 ML for process water storage). No limit has been applied in the water balance model on the volume of in-pit sump storage.

5.3.3 Transfer rates

The following transfer rates were adopted in the water balance model (achieved by either gravity feed or pumping):

- pit sump to ED3, ED4, ED5, ED6 and ED7 – 25.9 ML/day each (300 L/s) (note: ED6 receives pumping from 2 sumps)
- transfer between ED3, ED4, ED7 and ED9 – 12.95 ML/day each (150 L/s)
- transfer between ED5, ED6 and ED8 – 17.37 ML/day each (200 L/s)
- transfer between sediment dams – 12.95 ML/day each (150 L/s)
- sediment dam to ED3, ED4, ED6 and ED7 – 12.95 ML/day each (150 L/s)
- SD1a, SD2b, SD4b and SD6b to creek – 12.95 ML/day each (150 L/s).

For water balance modelling purposes, it has been assumed that bore water will be pumped to ED3 and ED7 at a rate equal to the daily extraction rate from the aquifer. The rate to ED3 and ED7 is equal.

5.3.4 Operating rules

Operating rules are subject to ongoing development and refinement. The operating rules are designed to provide compliance under “worst case” conditions, and therefore assume the worst case for all conditions (even though in reality they would not all occur at the same time). Refer to Figure 4.6 for the Water Management schematic.

The following operating rules have been assumed for water balance modelling:

- Pumping from pit sumps to ED4, ED5 and ED6 stops when the dam exceeds 85% capacity. Pumping from pit sumps to ED3 and ED8 stops when the dam exceeds 90% capacity. During extended wet periods, water will be stored in the mine pits once these pit dewatering dams have reached the trigger capacity.
- The borefield pumps to ED3 and ED7 and stops if the dams exceed 97.5% capacity.
- When ED8 falls below 25% capacity, ED5 and ED6 pump into ED8. ED3 pumps to ED4, ED4 pumps to ED5, ED7 pumps to ED6, ED9 pumps to ED6 to provide this water in ED5 and ED6 when ED8 falls below 25% capacity. Pumping to ED8 from other environmental dams stops when they exceed 80% capacity. Pumping to ED4, ED5 and ED6 from other environmental dams stops when they exceed 90% capacity.
- The ‘sediment zone’ of both environmental and sediment dams is 100% full of sediment throughout the simulation, as is standard for water balance modelling.
- Sediment dam overflows are included in the model. All sediment dams overflow to the pit (via the haul roads).
- Water captured in the ‘settling’ and ‘reuse’ zones of sediment dams is pumped to the ‘final’ sediment dams. Water captured in the ‘settling’ and ‘reuse’ zones of the ‘final’ sediment dams SD1a, SD2b, SD4b and SD6b is pumped to the nearest environmental dam when the volume of the environmental dam is less than 60% capacity. When the dam is greater than 60% capacity, water is discharged to the creek (this maintains capacity in the environmental dams for pit dewatering during wet periods). It is assumed that the quality of water stored in sediment dams will meet discharge criteria following settling of suspended solids. Pumping into sediment dams stops when the sediment dam exceeds 95% capacity.
- Demands for the truck fill stations are sourced from pit dewatering dams ED3, ED4, ED6 and ED7. The truck fill station demand has been divided evenly between these four dams. If adequate water is not available from a pit dewatering dam, the raw water dam is used to satisfy the demand.
- The CHPP demand is sourced from the following dams (in order of priority):
    1. Tailings decant dam (receiving water from environmental dams ED1 and ED8)
    2. Environmental dam ED2 (fed through the back bone pipeline by other environmental dams)

3. Sedimentation dams (discharging to environmental dams that feed into the backbone pipeline)

4. Raw water dam.

It has been assumed that water will only be pumped from ED1 and ED8 to the tailings decant dam when it is required in the CHPP. This is considered to be a conservative approach for sizing environmental dams, as the capacity of the tailings decant dam is maintained for the DSA.

- The MIA, CH and potable water demands are always sourced from the raw water dam (as high quality water is required).

- The six pit sumps have been introduced in the water balance model. From the pits water is pumped to ED3, ED4, ED5, ED6, and ED8. ED4 receives water from two pits. ED3, ED5, ED6, and ED8 receive water from one pit only.

- The pump rates provided in Section 5.3.3 have been adopted in the water balance model. It has been assumed these rates would not be limited by pump/pipeline capacity.

- An average daily dust suppression demand has been applied in the water balance model irrespective of rainfall.

- When the raw water dam falls below 50% capacity, imported water is pumped into the dam. No limit has been applied in the model on the volume of imported water available to the site. If a raw water buffer is deemed desirable, then the 50% trigger may be increased.

The current model includes only the above basic operating rules (suitable for feasibility design), however, it is recommended that these are refined once new groundwater and geochemistry data becomes available. This would allow water quality to be modelled, improve the reliability of water quality prediction, and maintain storages with spare capacity to contain storm events (for turbidity control). Operating rules will be further developed to manage competing interests, including water retention to use around the site, water retention for dilution, and maintaining spare capacity to contain storm events.

5.4 Water inputs

Water inputs for the Project comprise:

- surface water runoff

- groundwater (either extracted from the dewatering borefield or from seepage into the mining void)

- imported water.

5.4.1 Surface water runoff

Output results from the rainfall-runoff models were used as input to the water balance model. Rainfall-runoff models are described in Section 3.3.

5.4.2 Groundwater

Groundwater will be extracted using a borefield in order to minimise seepage into the mine pits. Extracted groundwater would be discharged to several bore water collection dams, which would transfer water to ED3 and ED7 for onsite reuse.

Preliminary borefield extraction rate estimates are provided in Table 5-5. Extraction rates are based on the borefield configuration described in the Groundwater Technical Report in Volume 5, Appendix G, and a subsequent meeting with the groundwater consultant. The extraction rate of 2,838 ML/yr is equivalent to 1.5 L/s 24 hours a day from 60 bores. Meeting minutes from the ‘Alpha Borefield Strategy and Plan – Updates and Criteria Confirmation’ meeting held on 2 February 2011 are provided in Appendix B.

Table 5-5: Estimated borefield extraction rates

Year	Extraction rate (ML/yr)
Year 1	2,838
Year 5	2,838
Year 10	2,838
Year 20	2,838
Year 30	2,838

It has been assumed that seepage into the pit would be negligible with the operation of the borefield.

Borefield extraction rates will be refined following further groundwater investigations. The effect of experiencing larger than expected extraction rates would be an increase to the borefield system capacity and a decrease in imported water required to meet demands during a water deficit. An increased borefield system capacity would also take up additional storage capacity in the pit dewatering dams, which would result in an increased volume stored in pit during prolonged wet periods. The effect of experiencing lower than expected extraction rates would be an increase in imported water required to meet demands.

5.4.3 Imported water

Raw water will be imported to the mine site to meet demands during a water deficit, and also to provide a high quality water source (e.g. potable applications, workshop, vehicle wash, sprayers). Imported water will be stored in the raw water dam.

Various water supply options have been identified by HCPL. These options will be further investigated by HCPL and do not form part of the scope of this technical report.

5.5 Water demands

Mine water demands for the Project comprise:

- CHPP make-up water
- Haul road and hardstand watering (dust suppression)
- Workshop and vehicle wash (MIA)

- Potable water
- Miscellaneous uses, such as construction water.

5.5.1 Coal handling and preparation plant

CHPP make-up water requirements, net of tailings return water, are provided in Table 5-6. Coal processing rates are also provided.

Table 5-6: CHPP make-up water demand estimates

Year	ROM coal processed (Mt/yr)	CPP make-up water (ML/yr)	CH make-up water (ML/yr)	Total CHPP make-up water (ML/yr)
Year 1	26.5	4,579	151	4,730
Year 5	40.0	6,904	227	7,131
Year 10	40.0	6,904	227	7,131
Year 20	40.0	6,904	227	7,131
Year 30	40.0	6,904	227	7,131

Source: Thiess Sedgman Joint Venture (2010), Sedgman Ltd (2010)

Make-up water for the CPP will be sourced from contaminated water as a priority. It is understood that contaminated water will be of a suitable quality for this purpose. Make-up water for CH will be sourced from the raw water dam, as contaminated water is not suitable for use in the sprayers.

The tailings management system has been excluded from the water balance model, as the CHPP make-up demand is net of tailings return water.

5.5.2 Haul road and hardstand watering

Mine water will be used for dust suppression on haul roads and hardstand areas. A summary of the dust suppression demands is provided in Table 5-7.

Table 5-7: Dust suppression demand estimates

Year	Haul road and hardstand (ML/yr)
Year 1	1,829
Year 5	1,998
Year 10	2,209
Year 20	2,630
Year 30	3,052

Source: BFS (PB, 2011)

Haul road and hardstand dust suppression calculations have assumed a watering rate of 5.0 $L/m^2/d$, with 10 non-watering days per year. This is considered to be conservatively high.

Water for dust suppression of haul road and hardstand areas will be sourced from environmental dams ED3, ED4, ED6 and ED7 as a priority (at truck fill stations). It is understood that contaminated water will be of suitable quality for this purpose. The water balance analysis has assumed that dust suppression water will be applied evenly throughout the year (irrespective of rainfall depth).

5.5.3 Workshop and vehicle wash

Water will be required in the MIA for use in the vehicle wash and workshop. A summary of the MIA demands is provided in Table 5-8.

Table 5-8: MIA demand estimates

Year	MIA demand (ML/yr)
Year 1	258
Year 5	389
Year 10	389
Year 20	389
Year 30	389

Source: BFS (PB, 2011)

Water for the MIA will be sourced from the raw water dam, as contaminated water is not suitable for this use.

5.5.4 Potable water

Potable water is required in the administration building, amenities and accommodation village. A summary of the potable water demands is provided in Table 5-9.

Table 5-9: Potable water demand estimates

Year	Potable water demand (ML/yr)
Year 1	200
Year 5	200
Year 10	200
Year 20	200
Year 30	200

Source: BFS (PB, 2011)

Imported water to the site will be used for potable applications (refer to Section 5.4.3). Imported water will be stored in the raw water dam, and would be treated in an onsite potable water treatment plant (PWTP) prior to use for potable applications. Wastewater will be treated onsite in a packaged wastewater treatment plant. Treated effluent (Class A) will be discharged to the tailings decant dam.

Potable water has been included in the water balance, however, treated effluent has not been included as volumes are not expected to be significant when compared to other inputs to the system.

5.5.5 Demand summary

A summary of the water demands is provided in

Table 5-10. The demand increases over the life of the Project, with the peak occurring in Year 30.

Table 5-10: Water demand summary

Year	CPP make-up water (ML/yr)	CH make-up water (ML/yr)	Dust suppression (ML/yr)	MIA demand (ML/yr)	Potable water demand (ML/yr)	Total site demand (ML/yr)
Year 1	4,579	151	1,829	258	200	7,017
Year 5	6,904	227	1,998	389	200	9,718
Year 10	6,904	227	2,209	389	200	9,929
Year 20	6,904	227	2,630	389	200	10,350
Year 30	6,904	227	3,052	389	200	10,772

5.6 Other losses

5.6.1 Evaporation

Evaporation estimates were based on Data Drill sourced evaporation data. A 'pan factor' correction was applied to account for the difference between measured 'pan evaporation' and evaporation that occurs from an open water body. Pan evaporation is measured in a small dish that takes extra heat in through the sides of the pan and tends to overestimate lake evaporation. Evaporation rates from large water bodies are also diminished by the accumulation of humidity above the water surface (amongst other factors). A pan factor of 0.83 was adopted for this assessment based on consideration of the spread of values presented in the Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland, 1995.

DERM requires that evaporation is arbitrarily set to 0 mm on days of rainfall, and has been applied to the model. This is considered an extremely conservative approach for assessing dam overflows, however, this requirement has been applied on other recent projects at the request of DERM and is therefore assumed to apply to the Alpha Coal Project.

Evaporative surface area has been determined based on the stage-storage relationships presented in Section 5.3.2 and Table 3-1.

5.6.2 Seepage from dams

Some water will be lost from dams as a result of seepage through the foundation. Site dams should have low seepage losses and, depending on the subsoils, an engineered liner may be required. Water balance modelling has assumed seepage losses to be negligible.

5.7 Results

Model results are summarised in Table 5-11, Table 5-12 and Table 5-13. The tables provide results for 10th percentile (dry), 50th percentile (median) and 90th percentile (wet) rainfall years based on 110 years of water balance simulation. The 10th, 50th and 90th percentile rainfall depths are 293 mm, 477 mm and 779 mm, respectively (refer to Section 3.1 for climate data and statistics). Calender years 1931, 1944 and 2008 have been adopted as representative 10th, 50th and 90th percentile rainfall years respectively. The apparent imbalance in the results tables is a result of carry over storage being available to satisfy demands between the various calendar years of the model simulation.

Table 5-11: Annual site water balance - 10th percentile dry year

		Baseline	Year 1	Year 5	Year 10	Year 20	Year 30
Catchment area							
WMS	Ha	-	5,078	5,526	7,189	10,290	13,335
TSF/TDD	Ha	-	557	793	793	544	628
Undisturbed catchment	Ha	272,586	266,950	266,267	264,602	261,753	258,623
Total	***Ha***	**272,586**	**272,586**	**272,586**	**272,586**	**272,586**	**272,586**
Proportion of catchment in WMS and TSF/TDD		0.0%	2.1%	2.3%	2.9%	4.0%	5.1%
WMS and TSF/TDD Runoff							
Natural	ML/yr	-	175	71	70	61	60
Open pit	ML/yr	-	106	106	153	182	178
Industrial	ML/yr	-	14	14	14	14	14
Spoil	ML/yr	-	0	0	0	0	0
Rehabilitated	ML/yr	-	17	58	69	99	477
Total	***ML/yr***	**-**	**312**	**249**	**306**	**357**	**730**
Undisturbed catchment	ML/yr	17,739	17,373	17,328	17,220	17,034	16,831
Inflows to WMS							
Borefield	ML/yr	-	2,838	2,838	2,838	2,838	2,838
Imported water	ML/yr	-	4,856	7,537	7,770	8,120	8,236
Outflows from WMS							
Dam evaporation (net of rain)	ML/yr	-	944	883	944	949	977
Demand	ML/yr	-	7,017	9,718	9,929	10,350	10,772
Sediment dam release (to creek)	ML/yr	-	0	0	0	0	0

Table 5-12: Annual site water balance - 50th percentile median year

		Baseline	Year 1	Year 5	Year 10	Year 20	Year 30
Catchment area							
WMS	Ha	-	5,078	5,526	7,189	10,290	13,335
TSF/TDD	Ha	-	557	793	793	544	628
Undisturbed catchment	Ha	272,586	266,950	266,267	264,602	261,753	258,623
Total	***Ha***	**272,586**	**272,586**	**272,586**	**272,586**	**272,586**	**272,586**
Proportion of catchment in WMS and TSF/TDD		0.0%	2.1%	2.3%	2.9%	4.0%	5.1%
WMS and TSF/TDD Runoff							
Natural	ML/yr	-	287	117	114	100	99
Open pit	ML/yr	-	443	443	640	760	746
Industrial	ML/yr	-	93	93	93	93	93
Spoil	ML/yr	-	83	178	244	372	220
Rehabilitated	ML/yr	-	27	94	113	163	781
Total	***ML/yr***	**-**	**932**	**925**	**1,204**	**1,488**	**1,938**
Undisturbed catchment	ML/yr	29,029	28,429	28,357	28,179	27,876	27,543
Inflows to WMS							
Borefield	ML/yr	-	2,838	2,838	2,838	2,838	2,838
Imported water	ML/yr	-	4,274	6,838	6,993	7,071	7,265
Outflows from WMS							
Dam evaporation (net of rain)	ML/yr	-	785	687	876	763	960
Demand	ML/yr	-	7,017	9,718	9,929	10,350	10,772
Sediment dam release (to creek)	ML/yr	-	0	0	0	0	0

Table 5-13: Annual site water balance - 90th percentile wet year

		Baseline	Year 1	Year 5	Year 10	Year 20	Year 30
Catchment area							
WMS	Ha	-	5,078	5,526	7,189	10,290	13,335
TSF/TDD	Ha	-	557	793	793	544	628
Undisturbed catchment	Ha	272,586	266,950	266,267	264,602	261,753	258,623
Total	***Ha***	**272,586**	**272,586**	**272,586**	**272,586**	**272,586**	**272,586**
Proportion of catchment in WMS and TSF/TDD		0.0%	2.1%	2.3%	2.9%	4.0%	5.1%
WMS and TSF/TDD Runoff							
Natural	ML/yr	-	1,812	737	722	635	623
Open pit	ML/yr	-	2,256	2,256	3,261	3,871	3,801
Industrial	ML/yr	-	316	316	316	316	316
Spoil	ML/yr	-	958	2,057	2,819	4,303	2,546
Rehabilitated	ML/yr	-	172	597	714	1,028	4,934
Total	***ML/yr***	**-**	**5,515**	**5,964**	**7,832**	**10,153**	**12,221**
Undisturbed catchment	ML/yr	183,481	179,688	179,229	178,108	176,190	174,083
Inflows to WMS							
Borefield	ML/yr	-	2,838	2,838	2,838	2,838	2,838
Imported water	ML/yr	-	544	2,448	1,826	1,204	738
Outflows from WMS							
Dam evaporation (net of rain)	ML/yr	-	785	907	1,049	936	1,119
Demand	ML/yr	-	7,017	9,718	9,929	10,350	10,772
Sediment dam release (to creek)	ML/yr	-	751	829	1,658	3,147	4,015

6. Potential impacts and mitigation measures

6.1 Site water demand

The water balance results indicate an annual water deficit throughout the life of the Project, and imported water will be required to make-up the deficit. External water supply options for the Project are outlined in Section 5.4.3.

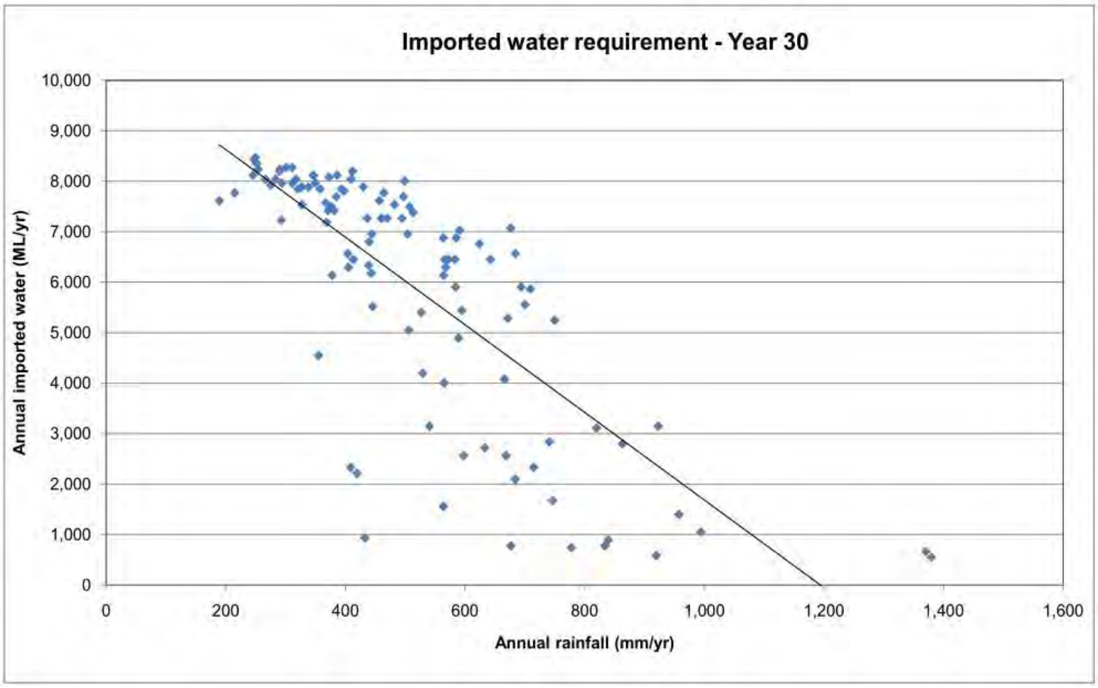
The requirement for imported water during a representative 10th percentile (dry) year is summarised in Table 6-1.

Table 6-1: Imported water requirement for a dry year

Year	Imported water (ML/yr)
Year 1	4,856
Year 5	7,537
Year 10	7,770
Year 20	8,120
Year 30	8,236

Of the snapshot landform years modelled, the requirement for imported water is greatest in Year 30, when demands are highest. A plot of annual imported water requirement versus annual rainfall depth is provided in Figure 6-1 for Year 30. Plots for Years 1, 5, 10 and 20 are given in Appendix C.

Figure 6-1: Annual imported water requirement over the 110 year water balance simulation for Year 30



The plot in Figure 6-1 shows that the maximum annual requirement for imported water was approximately 8,469 ML/yr for the Year 30 landform, over the 110 year water balance simulation using historical rainfall and evaporation data. This occurred under prolonged dry conditions, when a year with approximately 250 mm/yr rainfall was preceded by a year with approximately 350 mm/yr rainfall. The data scatter on the plot may be attributed to the inter-relationship of the annual volume of available water to the distribution of rainfall throughout the year, total rainfall, soil wetness/dryness and carry over storage.

Note that a moderate volume of imported water is required for demands that need high quality water such as potable applications, workshop, vehicle wash, sprayers, irrespective of the mine water balance. For wet periods, some of this water is sourced from the local catchment of the raw water dam.

6.2 Wet weather impacts on mining

Small water volumes will be able to be stored in in-pit sumps without interruption to mining activities. However, during extended wet periods, with standard capacity dewatering systems, relatively large volumes of water will accumulate in-pit and may interrupt mining activities.

The maximum in-pit storage volumes (combined pit sumps) over the 110 year water balance simulation are provided in Table 6-2. Plots for Years 1, 5, 10 and 20 are given in Appendix C.

Table 6-2: Maximum in-pit stored volumes

Year	Maximum volume (ML/yr)
Year 1	2,028
Year 5	2,909
Year 10	3,749
Year 20	5,209
Year 30	7,462

Of the snapshot landforms modelled, the in-pit stored volume is greatest in Year 30 when the pit catchment area is largest. The maximum volume in the combined pits was 7,462 ML over the 110 year water balance model simulation (equivalent to an average of 1,244 ML in each of the 6 pit sumps). The frequency of in-pit flooding over the 110 year water balance simulation for Year 30 of the Project is illustrated by the plots provided in Figure 6-2 and Figure 6-3.

Figure 6-2: Frequency of in-pit flooding over the 110 year water balance simulation for Year 30

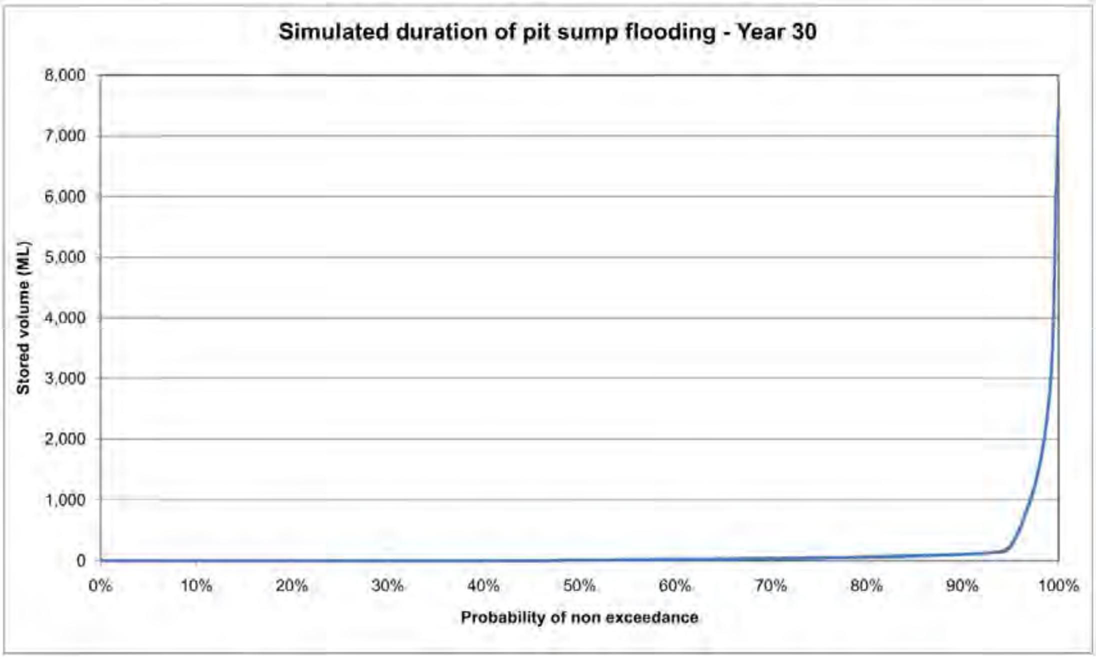
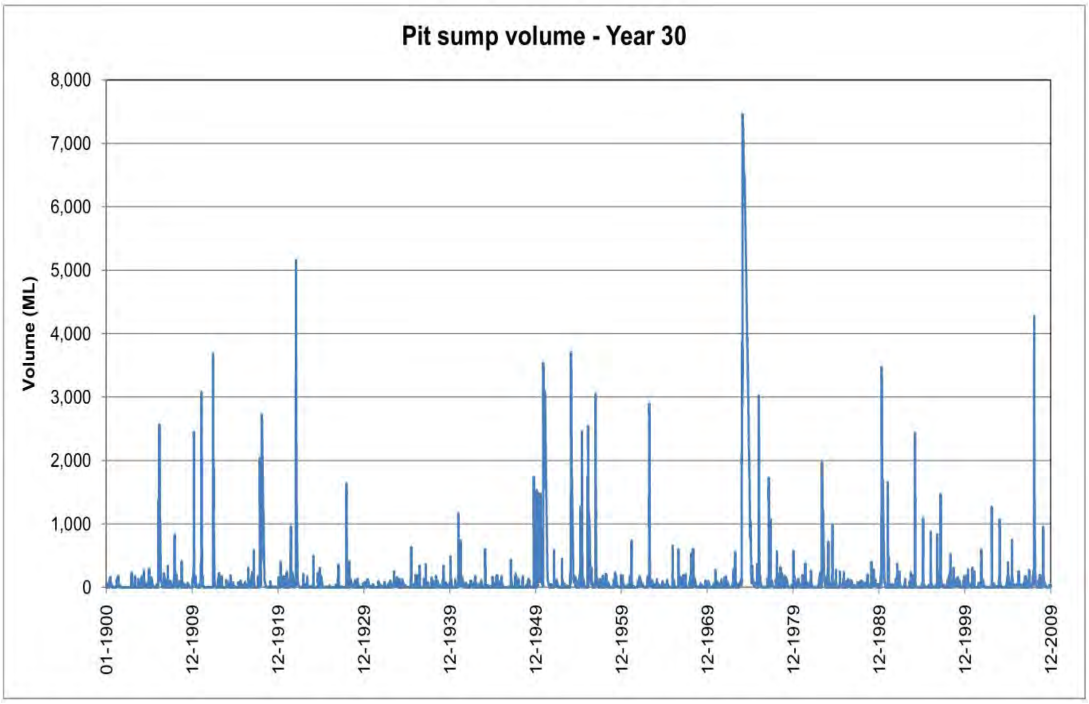


Figure 6-3: In-pit flooding over the 110 year water balance simulation for Year 30



The pit dewatering dam sizes have been chosen to provide a reasonable level of pit availability over the 110 year water balance simulation. The plots for the Year 30 landform in Figure 6-2 and Figure 6-3 show that the pit dewatering system will generally be able to maintain dry pits, but during extended wet periods, mining may be interrupted by in-pit flooding. Large volumes of water are only stored in-pit infrequently and negligible water (less than 106 ML in the combined sumps) is stored in-pit 90 % of time over the 110 year water balance simulation.

For the representative 90th percentile wet year for the Year 30 landform, there were a total of 29 days where there was more than 1,000 ML in the combined pit pumps (i.e. more than 167 ML in each of the six pit sumps on average). The representative 90th percentile wet year was 2008, and from Figure 6-3 it can be seen that the maximum volume stored in the combined pit sumps was approximately 4,260 ML for 2008.

During extended wet periods, the rate of pit dewatering exceeds the rate at which water is reused onsite and dewatering ceases because pit dewatering environmental dams are full. During these periods, water storage will be provided in inactive areas of the pits when mining is focused on active pit areas. This would allow dewatering of rainfall runoff from active pit areas to continue during wet periods, and would minimise interruptions to mining. Appropriate locations for in-pit storage will be identified during detailed design.

6.3 Dam performance

Environmental and pit dewatering dams have been sized to achieve no discharge when operated as part of the overall water management system under historical climate conditions, as determined through water balance modelling.

Pumping to pit dewatering dams from the pit will cease when a maximum operating level is achieved (refer to Section 5.3.4 for assumed operating rules). This will maintain adequate freeboard in these dams, so that small runoff events from the local catchment and pumping from the borefield will not cause the dams to overflow following extended periods of pit dewatering.

The performance of environmental dams ED1, ED2, ED8 and ED9 are shown in Figure 6-4 to Figure 6-7 for the Year 30 landform. These dams capture contaminated runoff from the CHPP, MIA and ROM dump stations. ED8 is the main environmental dam receiving water pumped from the other environmental dams and pit dewatering dams west of the main haul road, and then pumping it onto the Tailings Decant Dam for onsite reuse.

Figure 6-4: Volume stored in ED1 over the 110 year water balance simulation for Year 30

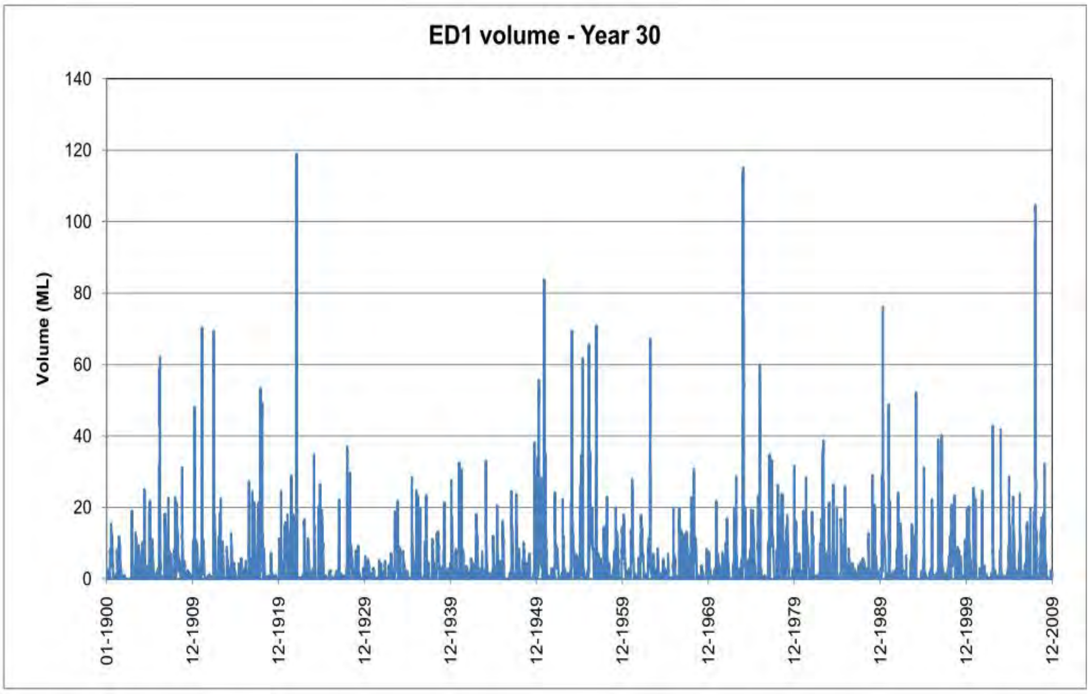


Figure 6-5: Volume stored in ED2 over the 110 year water balance simulation for Year 30

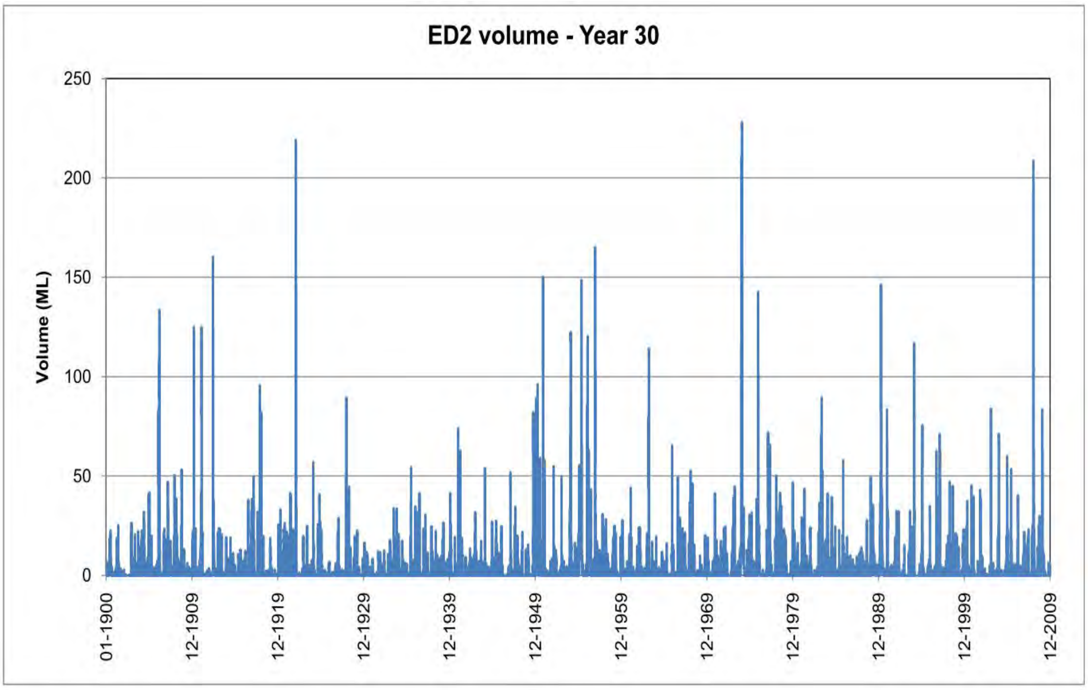


Figure 6-6: Volume stored in ED8 over the 110 year water balance simulation for Year 30

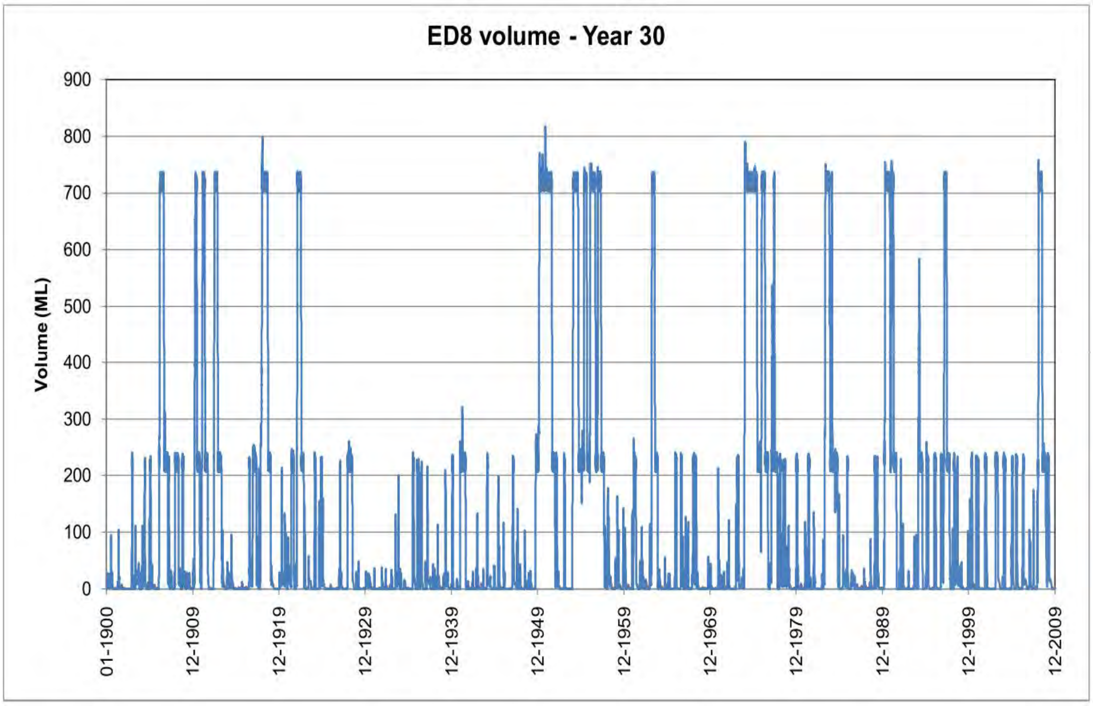
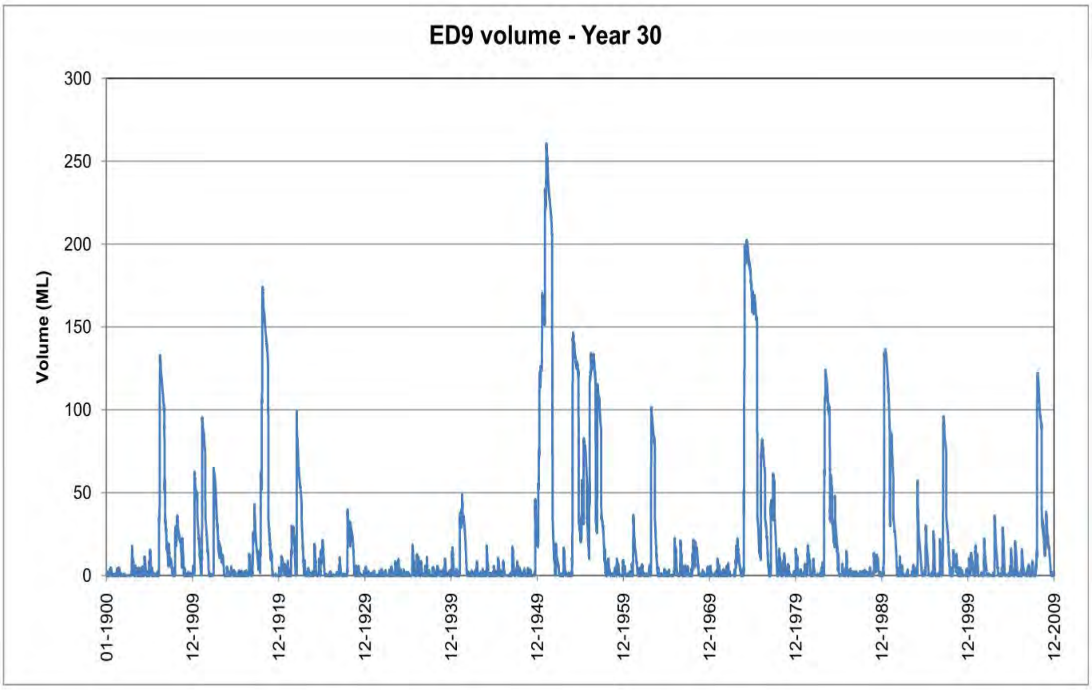


Figure 6-7: Volume stored in ED9 over the 110 year water balance simulation for Year 30



The maximum modelled volumes of the snapshot landforms modelled are provided in Table 5-4 (refer to Section 5.3.2). Note that for some dams the maximum modelled volumes are higher for the earlier landforms, as water demands and therefore dam outflows are lower. From the maximum modelled volumes in Table 5-4, it can be seen that none of the proposed environmental or pit dewatering dams overflow during the 110 year daily water balance model simulation for the Year 1, 5, 10, 20 and 30 landforms. As such, there is not expected to be any uncontrolled discharge of contaminated water from the sites water management system. Contaminated runoff will be reused onsite in the mining process. As discussed in Section 6.2, storage will be provided in-pit during extended wet periods, until pit dewatering dams have capacity to receive dewatering.

Although environmental dams are not expected to overflow, spillways will be provided for these dams in the event that there is an emergency. Spillways from environmental dams east of the main haul road (ED1 and ED2) will discharge to Lagoon Creek. Spillways from the pit dewatering dams and environmental dams (ED3, ED4, ED5, ED6, ED7, ED8 and ED9) west of the main haul road would discharge to the pit (via the pit haul roads).

As stated previously the operational rules incorporated into the model are limited, and further refinement will be undertaken during detailed design once water quality objectives have been finalised, and geochemistry, groundwater and runoff characteristic data is updated.

6.4 Impacts on downstream flow

The water management system has been designed to maintain flows in the creek system by diverting runoff from undisturbed areas around the mine site as much as practical. However, the evaporation and use of water captured in the site water management system results in a reduction in the volume of runoff to the creek system.

Predicted median annual flows in Lagoon Creek at the study catchment outlet are provided in Table 6-3, based on the 110 year daily water balance simulation. The study catchment outlet is located approximately 3.5 km downstream of the MLA boundary.

Table 6-3: Median annual flow in Sandy Creek at study catchment outlet

		Baseline	Year 1	Year 5	Year 10	Year 20	Year 30
Undisturbed catchment runoff	ML/yr	29,029	28,429	28,357	28,179	27,876	27,543
Release from WMS	ML/yr	-	0	0	0	0	0
Total runoff to creek	***ML/yr***	***29,029***	***28,429***	***28,357***	***28,179***	***27,876***	***27,543***
Change	*ML/yr*	-	*-600*	*-672*	*-850*	*-1,153*	*-1,486*
% Change	*%*	-	*-2.1%*	*-2.3%*	*-2.9%*	*-4.0%*	*-5.1%*

Table 6-3 shows that the median runoff volume to the creek system decreases over the life of the Project, as the area draining to the water management system increases. A decrease in baseline median annual runoff volumes of approximately -1,486 ML/yr are predicted by Year 30 as a result of the Project. This is equivalent to a reduction of -5.1% in baseline median flows in Sandy Creek at the study catchment outlet, however only a small reduction of -0.4% in the Belyando River at Gregory Development Road. The baseline median flow at the Belyando River at Gregory Development Road gauging station is 369,146 ML/yr (refer to section 3.2).

As discussed in Section 3.4, a search of the State of Queensland Water Entitlements System indicated that there are no licensed surface water users on Lagoon Creek downstream of the Project. The closest license holder downstream of the Project is located on the Belyando River near Gregory Development Road. This is approximately 175 km downstream of the MLA boundary, and is unlikely to be significantly impacted by the predicted -0.4% reduction in median flows as a result of the Project.

Once mining ceases and disturbed areas are rehabilitated, some decrease in flow downstream of the site is expected to remain as the final void catchment will continue to retain some runoff. The final rehabilitated landform will be shaped to minimise the area draining to the final void as much as practical.

7. Conclusions

This Water Management System and Water Balance Technical Report has been prepared as part of the SEIS submission for the Project and is an update from the report submitted with the EIS in September 2010. The site water management system presented in this report has been developed to provide some operational flexibility and has been designed to segregate clean, dirty and contaminated water types.

Clean water from undisturbed catchments will be diverted around the mine site to Greentree and Lagoon Creeks as much as practical. This will assist to maintain flows in the creek system.

Dirty water runoff from disturbed areas, such as overburden dumps, will be directed to sediment dams to encourage settling. This water potentially contains elevated levels of suspended solids. Following settling, water in sediment dams will be preferentially transferred to environmental dams for onsite reuse. Sediment Water will only be released to the creek during prolonged wet periods when there is not adequate capacity available in environmental dams to store additional water. If sediment dam water is released to Lagoon Creek, release would occur at one of four licensed discharge points located at SD1a, SD2b, SD4b and SD6b. Discharge would only take place if water quality criteria is met (refer to the Water Quality Technical report, and would not exceed 10% of the upstream flow in Lagoon Creek.

Contaminated runoff captured in-pit will be pumped to pit dewatering dams. Contaminated runoff from the CHPP, MIA and coal stockpile pads will be pumped to environmental dams. This water potentially contains high levels of suspended solids, elevated salinity levels, and other contaminants. Contaminated water will not be discharged to Lagoon Creek, and will instead be used to meet site demands as a priority. To minimise groundwater seepage into the pit, groundwater will be extracted using a borefield.

The water balance has been analysed for the proposed water management system to predict annual runoff volumes and to identify likely water deficits and surpluses. GoldSim software was used to develop a water balance model that simulated expected operations at various mine stages (snapshot landform Years 1, 5, 10, 20 and 30) using historical daily rainfall and evaporation data.

The reuse and evaporation of water captured in the site water management system results in a reduction in the volume of runoff to the creek system. Runoff volumes will decrease over the life of the Project as the area draining to the water management system increases. The water balance predicted a decrease in baseline median annual runoff volumes to Lagoon Creek of approximately -1,486 ML/yr by Year 30. This is equivalent to a reduction of -5.1% in baseline median flows in Sandy Creek at the study catchment outlet, however only a small reduction of -0.4% in the Belyando River at Gregory Development Road. The predicted -0.4% reduction is unlikely to significantly impact the closest downstream surface water licence holder, located on the Belyando River near Gregory Development Road.

The water balance predicted a water deficit throughout the life of the mine. Imported water will be required to make-up the deficit. Of the snapshot landform years modelled, the requirement for imported water peaks in Year 30, with a requirement of 8,236 ML/yr for a 10^{th} percentile (dry) year.

8. Limitations

The current water balance model includes only operating rules, suitable for feasibility design. Operating rules will be upgraded when further water quality, groundwater and geochemistry data becomes available. Operating rules will be developed to manage competing interests including water retention for use around site, water retention for dilution and maintaining spare capacity for containment of storm events.

The proposed water management system will be refined and optimised as detailed design proceeds, and water quality, geochemistry, groundwater and runoff characteristics are confirmed from ongoing monitoring programs. Sensitivity analyses will be undertaken to changes in these characteristics during detailed design.

9. References

AustralAsian Resource Consultants Pty Ltd, 2010, *Alpha Coal Project – Aquatic Ecology Assessment*

AustralAsian Resource Consultants Pty Ltd, 2010, *Alpha Coal Project – Flora and Fauna Assessment*

Boughton, W. C, 1993, *A Hydrograph-based Model for Estimating the Water Yield of Ungauged Catchments*

CRC for Catchment Hydrology, 2004, *Rainfall Runoff Library User Guide*

Department of Minerals and Energy, 1995, *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland*

Department of Environment and Resources Management, 2009. *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams (Version 1.1)*

JBT Consulting Pty Ltd, 2010, *Alpha Coal Project – Review of Mine Dewatering Requirements*

Queensland Government, 2009, *Burdekin Basin Resource Operations Plan*

MinOp Consulting Pty Ltd, 24 February 2010. Mine staging plans and rehabilitation areas (.dxf files)

SRK Consulting (Australasia) Pty Ltd, 2010, *Geochemical Characterisation of Alpha Project*

The Institution of Engineers Australia, 2001, *Australian Rainfall and Runoff*

Appendix A

Licensed water users

Table A-1: Surface water license holders in the Burdekin region

Licence number	Licence type	Purpose	Allocation volume (ML)	Allocation area (ha)	Location parcel	Attached parcel	Watercourse
52426A	Licence to take water	Waterharvesting			22/SP218335	22/SP218335	Suttor River
57220A	Licence to take water	Waterharvesting					Suttor River
57382A	Licence to take water	Waterharvesting					Suttor River
96640A	Licence to take water	Irrigation, Waterharvesting		650	3/SP112964	3/SP112964	Suttor River
46163F	Licence to take water	Irrigation, Waterharvesting		40	4/DC93	4/DC93	Suttor River
52401A	Licence to take water	Irrigation, Stock Intensive, Waterharvesting		317	5078/PH955	5078/PH955	Suttor River
96644A	Licence to interfere by impounding-Embankment or Wall	Impound Water			1/SP116044, 3/SP112964	1/SP116044, 3/SP112964	Suttor River
45019A	Licence to take water	Irrigation		50	3/SP112964	3/SP112964	Suttor River
55019A	Licence to interfere by diversion-Other	Divert the Course of Flow					Suttor River
57383A	Licence to take water	Waterharvesting					Suttor River
185466	Licence to interfere by diversion-Channel	Divert the Course of Flow					Suttor Creek
176585	Licence to interfere by diversion-Channel	Divert the Course of Flow					Suttor Creek
405184	Licence to take water	Mining	14		136/SM804305		Sellheim River
405603	Licence to take water	Mining	14				Sellheim River
34908A	Licence to interfere by impounding-Embankment or Wall	Impound Water			136/SM804305	136/SM804305	Ut Sellheim River
14922A	Licence to take water	Irrigation		30	10/GF50	1/MPH13796, 10/GF50	Cape River
26147A	Licence to take water	Irrigation		10	14/GF179	14/GF179	Cape River
54174A	Licence to take water	Irrigation	162		12/GF50	12/GF50	Cape River
54217A	Licence to take water	Irrigation	250		3/GF65	3/GF65	Cape River

Table A-1: Surface water license holders in the Burdekin region

Licence number	Licence type	Purpose	Allocation volume (ML)	Allocation area (ha)	Location parcel	Attached parcel	Watercourse
54447A	Licence to take water	Rural	360		2/RP902027	2/RP902027	Cape River
96629A	Licence to take water	Irrigation, Waterharvesting		15	3/GF65	3/GF65	Cape River
52490A	Licence to take water	Mining	25				Cape River
70867A	Licence to take water	Irrigation	90		13/CP908303	13/CP908303	Cape River
54907A	Licence to take water	Domestic Supply	1.5		402/GF200	402/GF200	Homestead Creek
60648A	Licence to take water	Irrigation	48		4/GF63	4/GF63	Homestead Creek
60758A	Licence to take water	Irrigation	18		1/MPH527	1/MPH527	Betts Creek
60899A	Licence to take water	Irrigation	4		11418/MPH34817	11418/MPH34817	Betts Creek
85693A	Licence to take water	Irrigation	2		2/MPH13598	2/MPH13598	Betts Creek
85699A	Licence to take water	Irrigation	4.5		3/CP903940	3/CP903940	Betts Creek
39675A	Licence to take water	Irrigation	50		1/MPH21404	1/MPH21120, 1/MPH21352, 1/MPH21404, 1/MPH33845, 2/MPH21783, 2/MPH33845, 3/MPH21120	Betts Creek
404311	Licence to take water	Any	59		19/GF102		Betts Creek
48994A	Licence to take water	Irrigation		16	1/GF26	1/GF26	Betts Creek
54111A	Licence to take water	Domestic Supply, Irrigation	10		7/RP889531	7/RP889531	Betts Creek
85692A	Licence to take water	Irrigation	2		1/MPH13598	1/MPH13598	Betts Creek
35350A	Licence to interfere by impounding-Excavation	Impound Water			5078/PH955	5078/PH955	Ut Grahame Creek
101185	Licence to take water	Waterharvesting			1/SM837228		Rosetta Creek
101186	Licence to take water	Waterharvesting			1/SM837228		Rosetta Creek
48985A	Licence to take water	Domestic Supply, Mining	150		4/AP7703		Police Creek
96794A	Licence to take water	Domestic Supply	0.9		52/M7213	1/MPH34382	Police Creek

Table A-1: Surface water license holders in the Burdekin region

Licence number	Licence type	Purpose	Allocation volume (ML)	Allocation area (ha)	Location parcel	Attached parcel	Watercourse
181582	Licence to take water	Domestic Supply	0.9		A/AP19948	23/M7212, 24/M7212, 25/M7212, 26/M7212, 27/M7212	Police Creek
49034A	Licence to take water	Domestic Supply, Stock	50		4/AP7703	4/AP7703, 6/SM99	Police Creek
49035A	Licence to interfere by impounding-Embankment or Wall	Impound Water			4/AP7703	4/AP7703	Police Creek
49045A	Licence to take water	Domestic Supply	1.5		307/MPH20088	4/SM81	Police Creek
49047A	Licence to take water	Domestic Supply	3		71/MPH13513	7/SM71	Police Creek
55005A	Licence to take water	Irrigation		80	3/SP112964	3/SP112964	Belyando River Anabranch
55006A	Licence to interfere by impounding-Embankment or Wall	Impound Water			3/SP112964	3/SP112964	Belyando River Anabranch
96640A	Licence to take water	Irrigation, Waterharvesting		650	3/SP112964	3/SP112964	Belyando River Anabranch
00933F	Licence to interfere by impounding-Embankment or Wall	Impound Water			3308/PH485	3308/PH485	Belyando River
52623F	Licence to take water	Waterharvesting			48/BE62	48/BE62	Belyando River
48434F	Licence to take water	Domestic Supply			1/PER207046	3/AY29	Belyando River
37295F	Licence to take water	Stock			1/BF51	1/BF51	Ut Belyando River
057819F	Licence to take water	Waterharvesting			4/SP116046	4/SP116046	Mistake Creek
57717WF	Licence to interfere by impounding-Embankment or Wall	Impound Water			10/BL58	10/BL58	Mistake Creek
57882F	Licence to take water	Waterharvesting			2/CP882192	2/CP882192	Mistake Creek
0426439F	Licence to take water	Waterharvesting			5070/PH1056	5070/PH1056	Mistake Creek
41235F	Licence to take water	Waterharvesting			2/CP882192	2/CP882192	Mistake Creek

Table A-1: Surface water license holders in the Burdekin region

Licence number	Licence type	Purpose	Allocation volume (ML)	Allocation area (ha)	Location parcel	Attached parcel	Watercourse
46204F	Licence to take water	Irrigation, Waterharvesting		200	2/RU78	2/RU78	Mistake Creek
57746WF	Licence to interfere by impounding-Embankment or Wall	Impound Water			2/RU78	2/RU78	Mistake Creek
57883F	Licence to take water	Waterharvesting			2/CP882192	2/CP882192	Mistake Creek
57884F	Licence to take water	Waterharvesting			2/CP882192	2/CP882192	Mistake Creek
41234F	Licence to take water	Irrigation		150	2/CP882192	2/CP882192	Mistake Creek
57718WF	Licence to interfere by impounding-Embankment or Wall	Impound Water			10/BL58	10/BL58	Mistake Creek
57847F	Licence to take water	Waterharvesting			4/SP116046	4/SP116046	Mistake Creek
52670F	Licence to interfere by diversion-Channel	Divert the Course of Flow			2/CP882192	2/CP882192	Mistake Creek
0426441F	Licence to take water	Irrigation		300	5070/PH1056	5070/PH1056	Pelican Lagoon
52622F	Licence to interfere by impounding-Embankment or Wall	Impound Water			656/SP138788	656/SP138788	Pelican Lagoon
174169	Licence to interfere by impounding-Embankment or Wall	Impound Water			5070/PH1056	5070/PH1056	Pelican Lagoon
41328F	Licence to take water	Stock			7/DR34	3500/PH748	Fox Creek
28340F	Licence to interfere by impounding-Embankment or Wall	Impound Water			2/SP104491	2/SP104491	Fox Creek
37407F	Licence to interfere by impounding-Embankment or Wall	Impound Water			1/BF27	1/BF27	Belyando River (Anabranch)
103511	Licence to take water	Waterharvesting			7/DM40	7/DM40	Alpha Creek
37488F	Licence to interfere by impounding-Embankment or Wall	Impound Water			1/BF51	1/BF51	Belyando River (Longreach Channel)
101981	Licence to take water	Waterharvesting			1/SP210553	1/SP210553	Logan Creek

Table A-1: Surface water license holders in the Burdekin region

Licence number	Licence type	Purpose	Allocation volume (ML)	Allocation area (ha)	Location parcel	Attached parcel	Watercourse
104710	Licence to take water	Stock	15		1/BL54	5/BL41	Logan Creek
101980	Licence to interfere by impounding-Embankment or Wall	Impound Water			1/SP210553		Logan Creek
32098AF	Licence to take water	Waterharvesting			3/RP617023	3/RP617023	Logan Creek
36799WF	Licence to interfere by impounding-Embankment or Wall	Impound Water			2/DC174	2/DC174	Logan Creek
45343F	Licence to interfere by impounding-Embankment or Wall	Impound Water			3/SP167241	3/SP167241	West Logan Creek
45342F	Licence to take water	Irrigation		200	3/SP167241	3/SP167241	West Logan Creek
46357F	Licence to take water	Waterharvesting			6/SP125740	6/SP125740	Diamond Creek
57803F	Licence to interfere by impounding-Embankment or Wall	Impound Water			6/SP125740	6/SP125740	Diamond Creek
26432F	Licence to interfere by impounding-Excavation	Impound Water			1/RP613564	1/RP613564	Ut Diamond Creek
104711	Licence to take water	Irrigation		8	4/DC93	4/DC93	Eaglefield Creek
52668F	Licence to interfere by impounding-Embankment or Wall	Impound Water			4/DC93	4/DC93	Eaglefield Creek
17886A	Licence to interfere by impounding-Embankment or Wall	Impound Water			2/SM77	2/SM77	Ut Suttor River

Appendix B

Borefield updates and criteria confirmation meeting minutes

HANCOCK COAL PTY LTD

MEETING:	**Alpha Borefield Strategy and Plan - updates and criteria confirmation**
LOCATION:	**Board Room, Level 8, 307 Queen St, Brisbane**
DATE:	**Wednesday 2nd Feb 2011 – 10:00am**
ATTENDEES:	Greg Kukla (GK), Gerard Madam (GM), John Bradley (JBT), Martti Kankkunen (MK), Ken Stapleton (KS), Bob Durant (BD), Michael Barnes (MB), Phil de Yong (PdY)
Apologies:	Gavin Wray (GW)
Distribution:	TBA
Meeting Chaired / Recorded By:	Gerard Madam / Michael Barnes
Attachments:	None.

REF	DISCUSSION	ACTION BY	ACTION DATE
	High level mining schedule confirmed by MK and KS – via the pre-strip method, mining will hit coal in mid 2013, and begin to mine coal at the end of 2013/start 2014	Note	
	General hydrogeo comment by JBT – based on results during the current extended wet period, it appears even more so that the aquifer in question is not recharging through the Colinlea sandstone outcrop on the eastern edge of the MLA. Rather, it is continuing to become more likely that groundwater is moving in a SW to NE direction. **JBT to ensure in the groundwater BFS write-up that the necessary data to-date, and modelling undertaken (or to be undertaken) is sufficient for BFS-level requirements.**	Note JBT	 22/2
	MK informed the meeting of the 300ML enviro dam currently being constructed for the Test Pit operation. It was agreed that this dam could be used as a bore water collection and storage dam during the construction phase. Design drawing of this dam was obtained by MB from Allan Watson 3/2/11	Note	
	The question was raised if once the test pit project was completed if the remaining void was potentially available for use as a water storage device. **MK to determine via MineOp/Thiess if this is available.**	MK	15/2
	GK asked the question of JBT to approach the groundwater early construction requirements based on whether there was any need at all in groundwater activities. If this could be proven so (to de-risk the pre-stripping operations etc) what was the minimum amount of scope required to undertake this, as well as least invasive schedule impact with pre-stripping. **JBT to ensure justification is in the BFS groundwater report write-up.** JBT concluded that the dewatering bores should be planned to run for 6mths to take the pressure off the coal seam. So under the current agreed schedule, allow bores to begin pumping at the start of 2013. **PB to ensure the borefields pilot dewatering trial is included in the execution (EPCM) schedule.**	Note JBT PdY	 22/2 11/2
	JBT confirmed that the best way forward is still the same staged scenario of two lines of bores, more or less along the alignments shown on the current o/a layout. Individual bores still to be located at 400m centres. **JBT to rationalise alignments, bore numbers and schedule timing for each hole, as part of the borefields strategy report.** **MB to include revised borefield configuration into latest plot plan.**	 JBT MB	 16/2 18/2
	The meeting agreed to the initial few bores (5-12) needed for water	Note	

	supply during the construction phase were to be located near the identified 300ML dam, currently being used as an emergency storage for the test pit.		
	Construction water supply will now be based predominantly on these strategic bores and this dam, with augmentation and possible terminal storage capacity provided by the existing farmer's dam off Degulla Rd near Wendouree homestead, as well as via bringing forward the TSF construction. **JBT to ensure both points above are included in the strategy report.**	Note JBT	 18/2
	JBT confirmed that the bore dewatering rate should be taken at 2-3L/s after the first month of pumping. They should then maintain a reduced rate of 1.5L/s thereafter. Bores can be taken at ~80m deep in the east of the site and ~150m deep in the west. Estimated construction time for the bores would be ~5 days.	Note	
	GM highlighted that any further groundwater-related modelling that assisted in DERM gaining more comfort with the TSF BFS engineering and design should be identified and undertaken quickly. JBT noted that this hadn't been done as yet for the TSF. **JBT to run a Seep/W model on the TSF with all current known inputs taken into consideration.** **MB to arrange for natural surface x-sections to be sent to JBT to enable this.**	 JBT MB	 11/2 complete
	JBT believed it was in HCPL's advantage to include DERM in the TSF Seep/W presentation (yet to be done). **GM to provide JBT the HCPL stakeholder engagement SEIS schedule to gain DERM's buy-in on the TSF engineering solutions on their current concerns.** **JBT to assist in presenting TSF case to DERM representatives.**	GM TSF	11/2 21/2
	Meeting Closed: 11.30am		
	Date of Next Meeting:		

Appendix C

Additional water balance plots

Figure C-1: Imported water requirement based on 110 year water balance simulation – Year 1

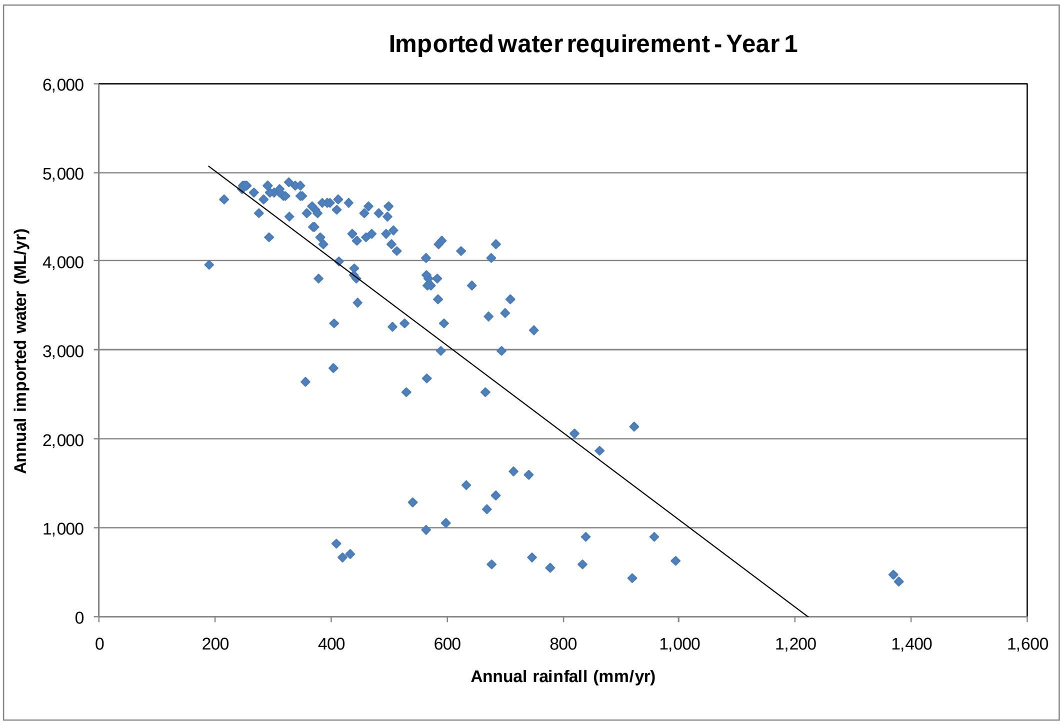


Figure C-2: Imported water requirement based on 110 year water balance simulation – Year 5

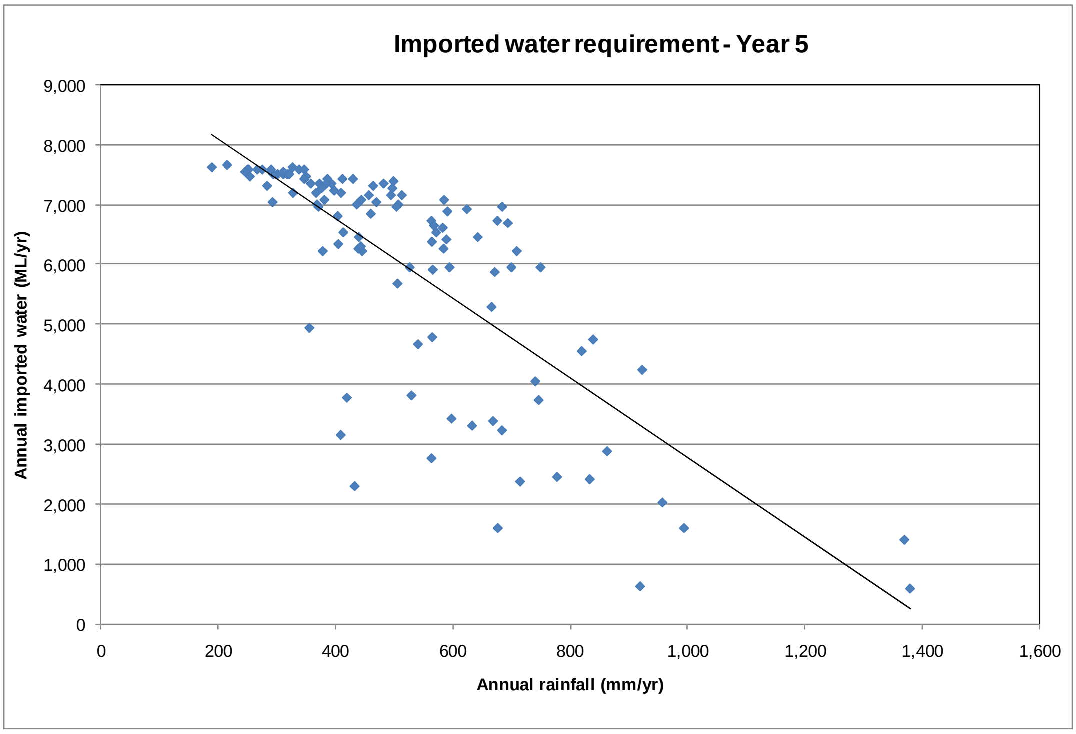


Figure C-3: Imported water requirement based on 110 year water balance simulation – Year 10

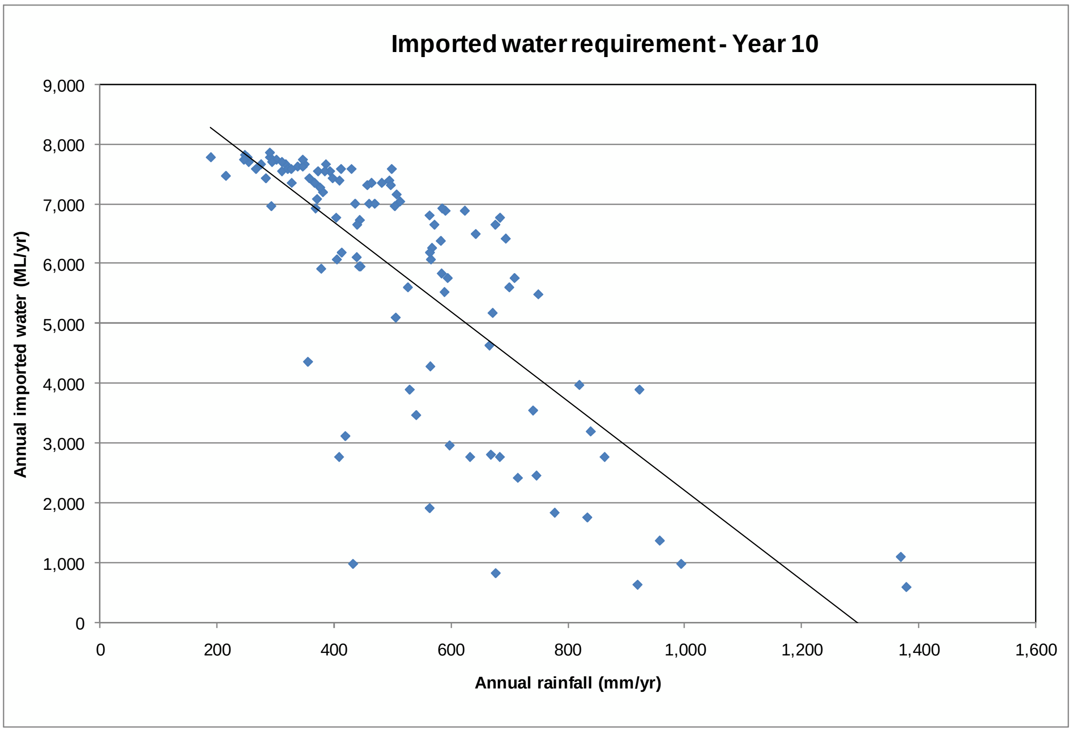


Figure C-4: Imported water requirement based on 110 year water balance simulation – Year 20

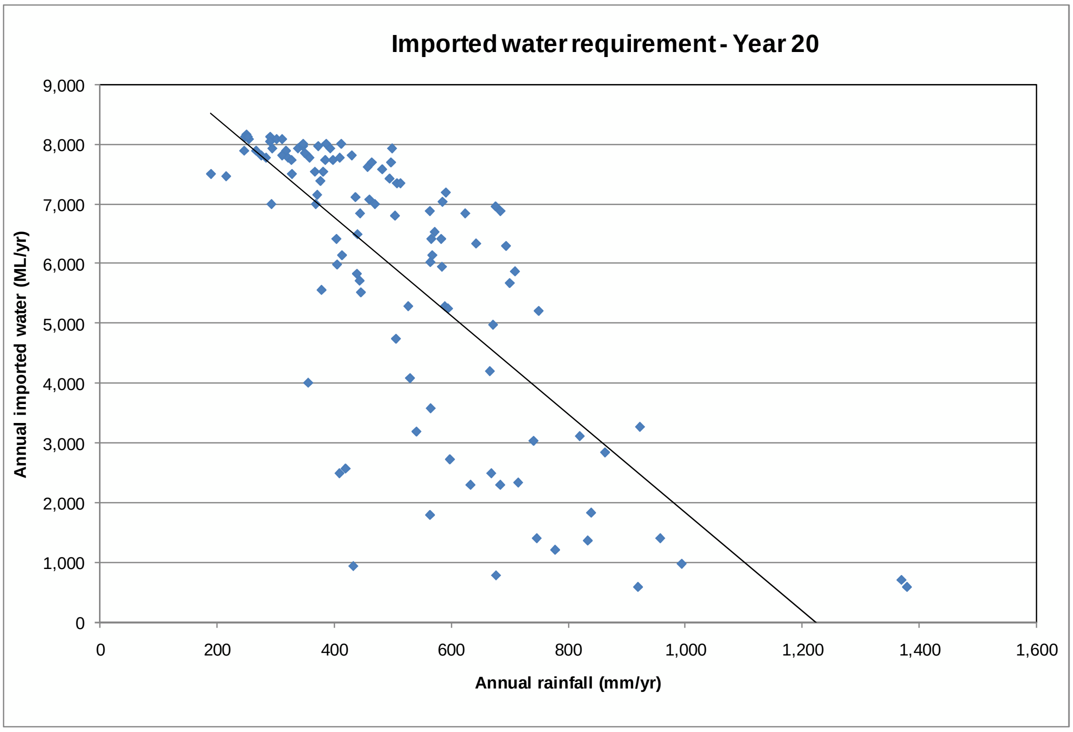


Figure C-5: Imported water requirement based on 110 year water balance simulation – Year 30

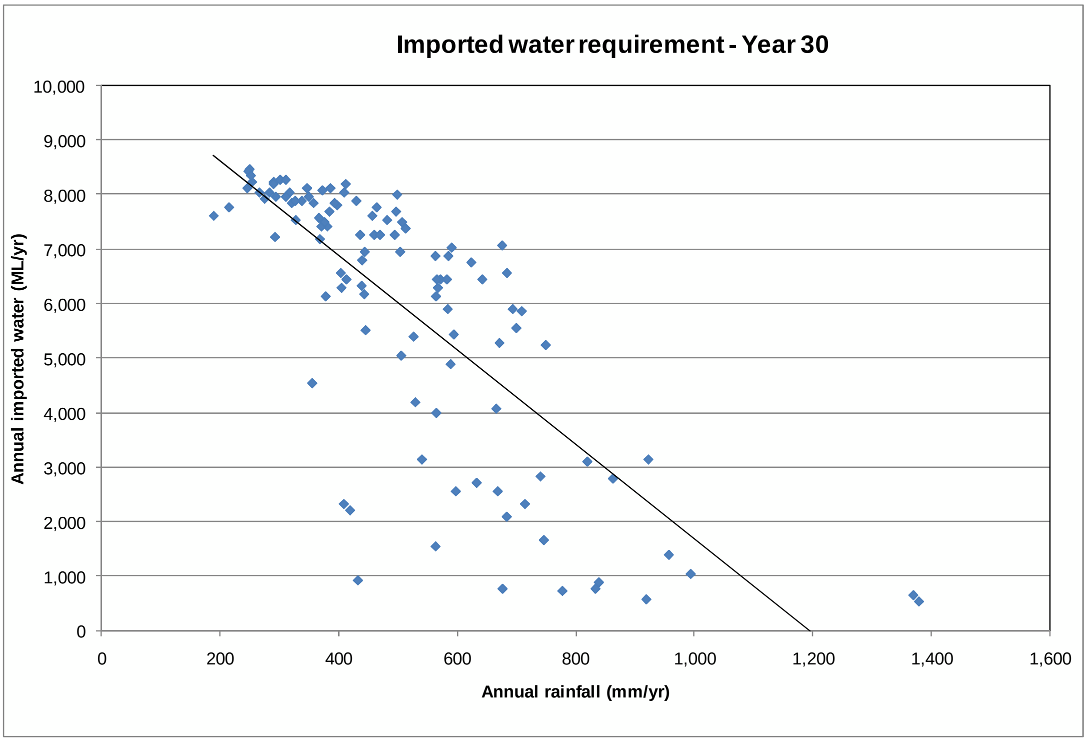


Figure C-6: Frequency of pit flooding based on 110 year water balance simulation – Year 1

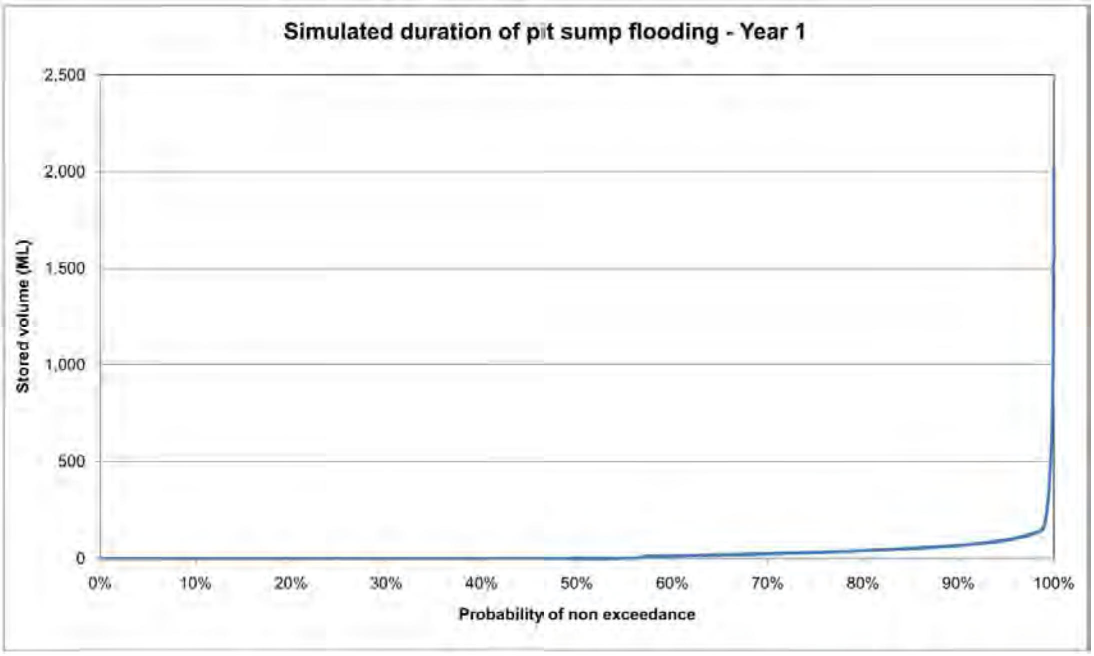


Figure C-7: Frequency of pit flooding based on 110 year water balance simulation – Year 5

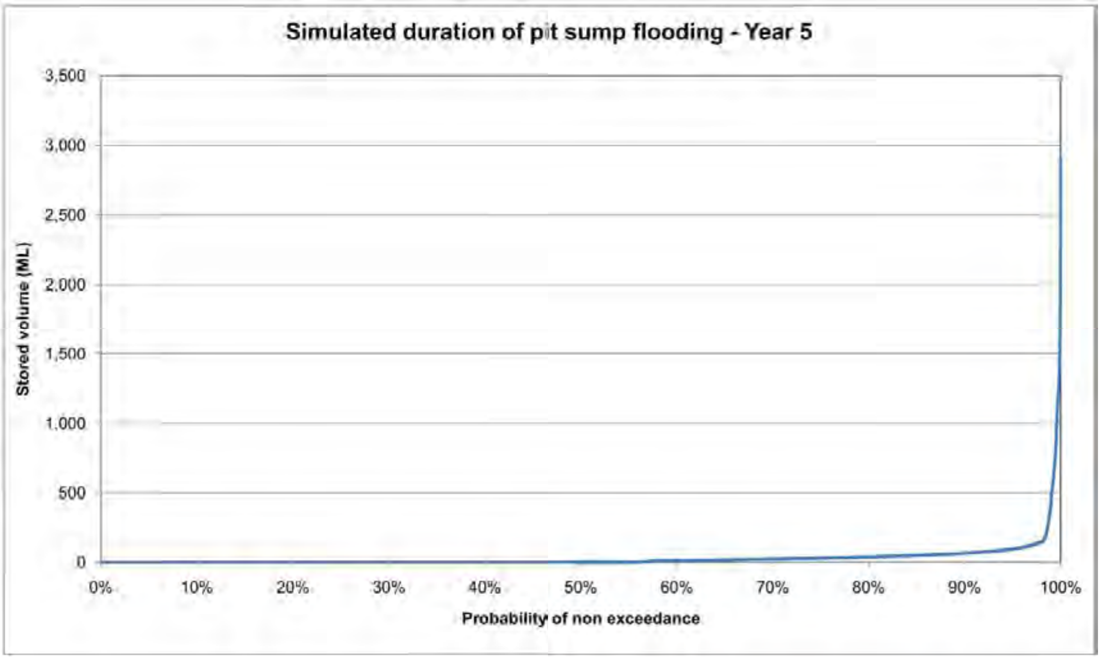


Figure C-8: Frequency of pit flooding based on 110 year water balance simulation – Year 10

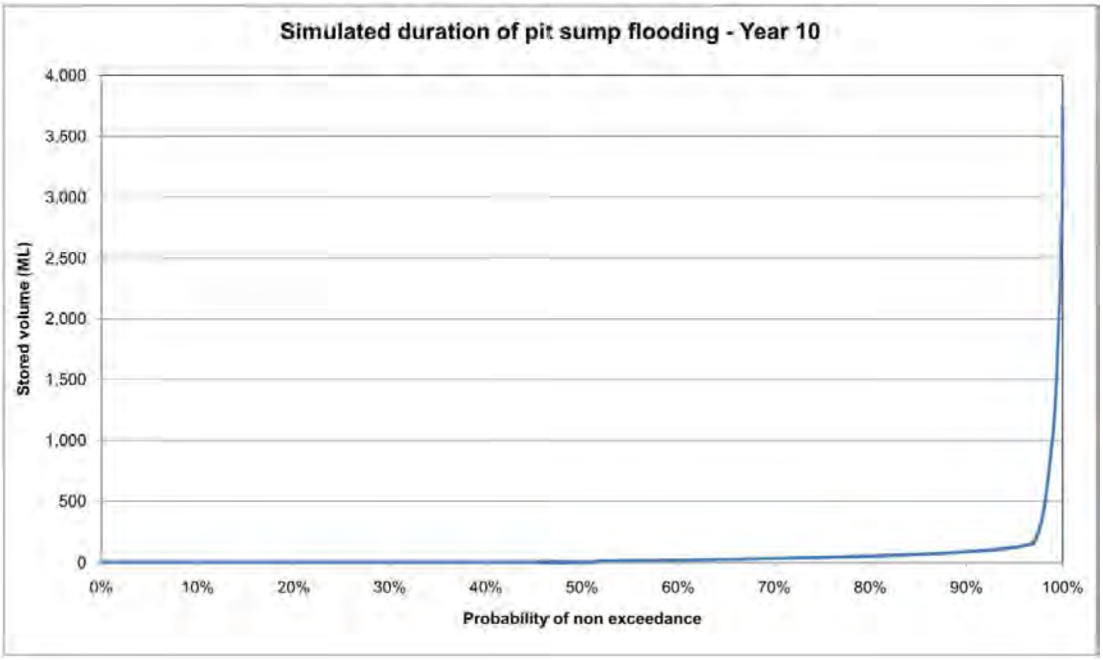


Figure C-9: Frequency of pit flooding based on 110 year water balance simulation – Year 20

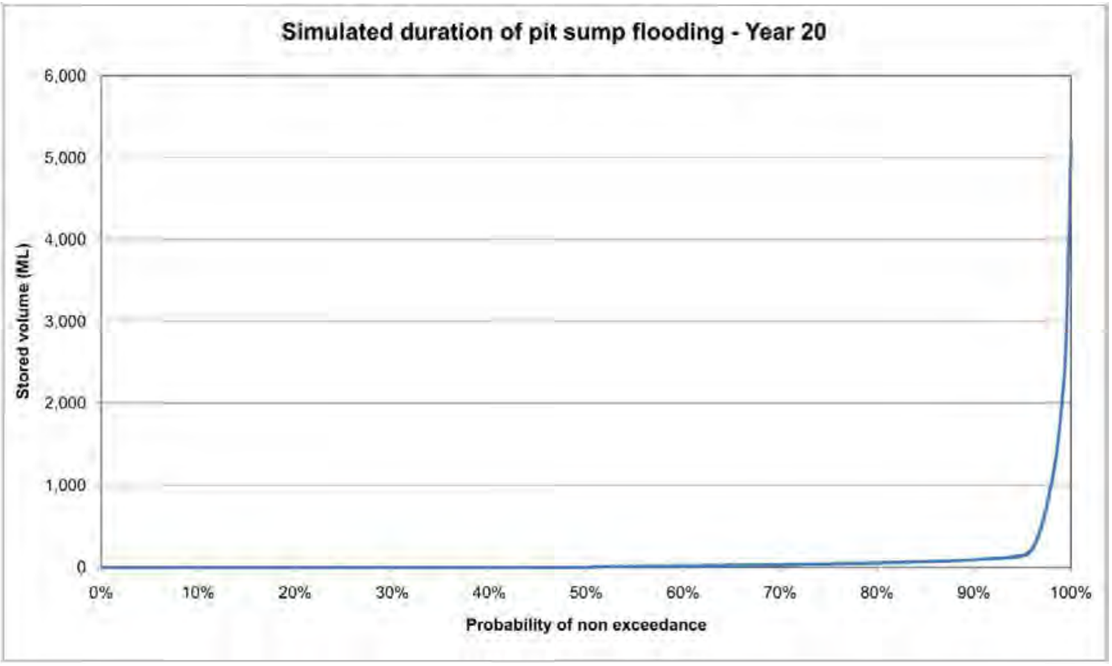


Figure C-10: Frequency of pit flooding based on 110 year water balance simulation – Year 30