PROJECT:	GUJ1 R1
DRAWN:	A. DAWKINS
DATE:	23 Nov 2012
SCALE:	1:1000

GUJARAT NRE COKING COAL PTY LTD
MAJOR EXPANSION PROJECT
BELLAMBI, NSW

LIZARD CREEK MAPPING

GeoTerra

FIGURE LC-17

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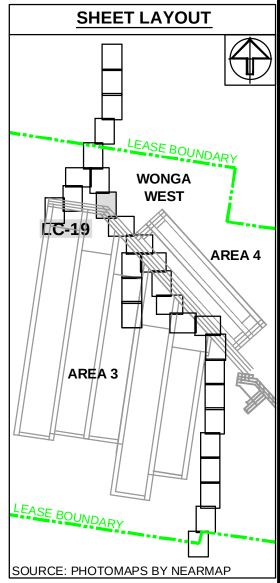
GUJARAT NRE COKING COAL PTY LTD
MAJOR EXPANSION PROJECT
BELLAMBI, NSW

LIZARD CREEK MAPPING

GeoTerra

FIGURE LC-18



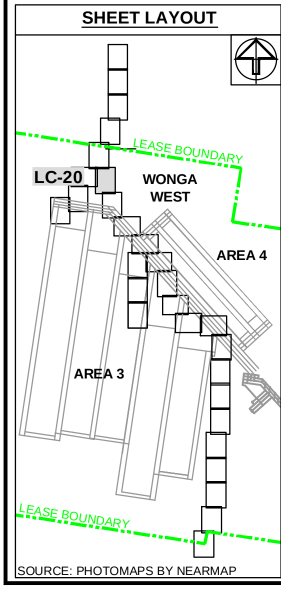
PROJECT:	GUJ1 R1
DRAWN:	A. DAWKINS
DATE:	23 Nov 2012
SCALE:	1:1000

GUJARAT NRE COKING COAL PTY LTD
MAJOR EXPANSION PROJECT
BELLAMBI, NSW

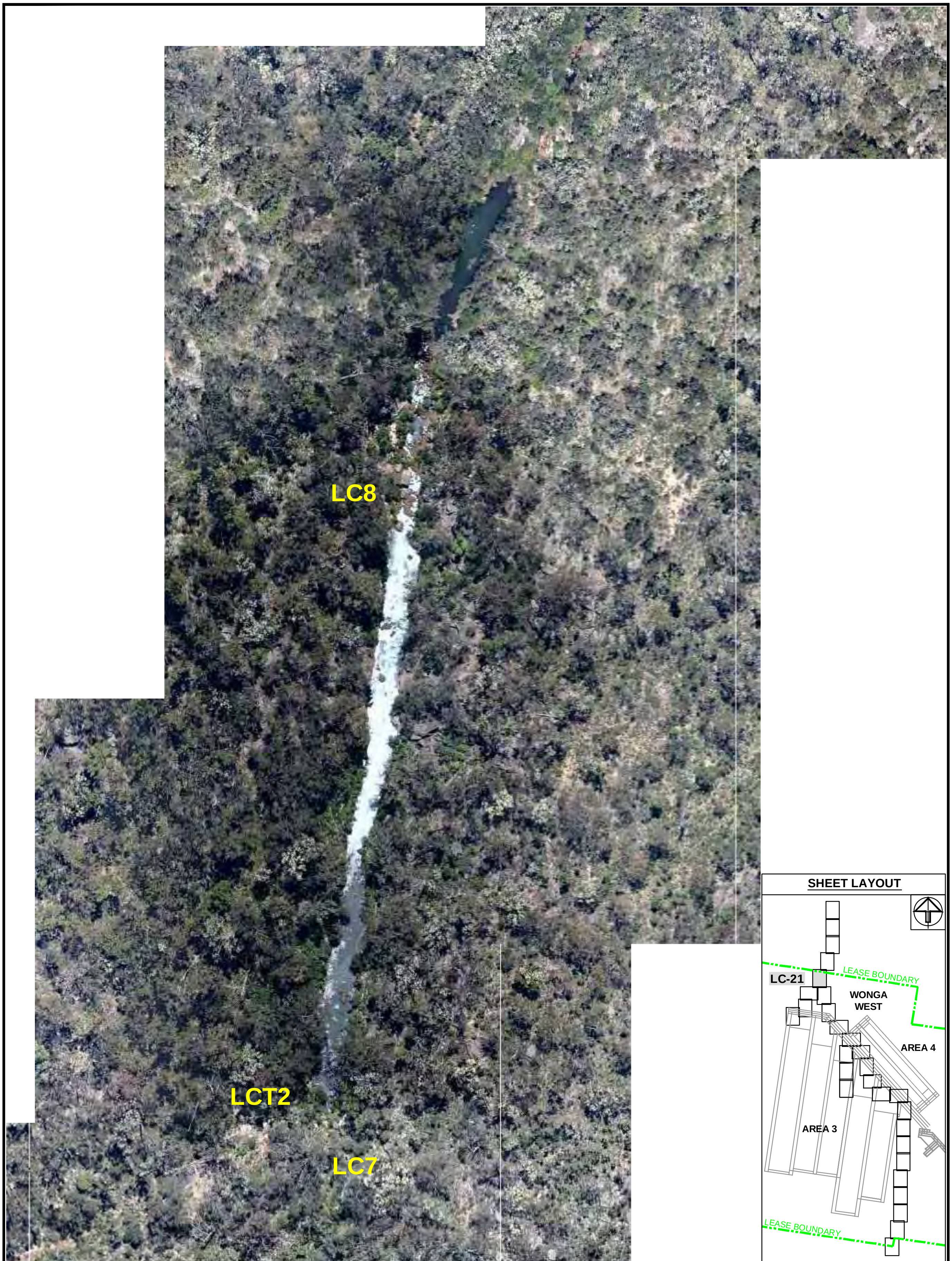
LIZARD CREEK MAPPING

GeoTerra

FIGURE LC-19



PROJECT:	GUJ1 R1	GUJARAT NRE COKING COAL PTY LTD MAJOR EXPANSION PROJECT BELLAMBI, NSW	GeoTerra
DRAWN:	A. DAWKINS		
DATE:	23 Nov 2012		
SCALE:	1:1000	LIZARD CREEK MAPPING	FIGURE LC-20



PROJECT:	GUJ1 R1
DRAWN:	A. DAWKINS
DATE:	23 Nov 2012
SCALE:	1:1000

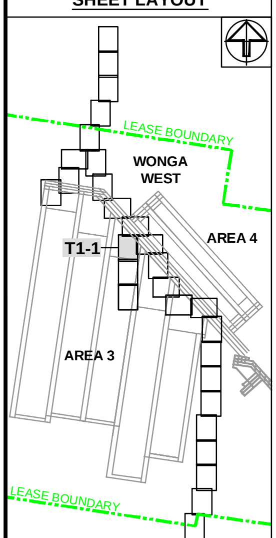
GUJARAT NRE COKING COAL PTY LTD
MAJOR EXPANSION PROJECT
BELLAMBI, NSW

LIZARD CREEK MAPPING

GeoTerra

FIGURE LC-21

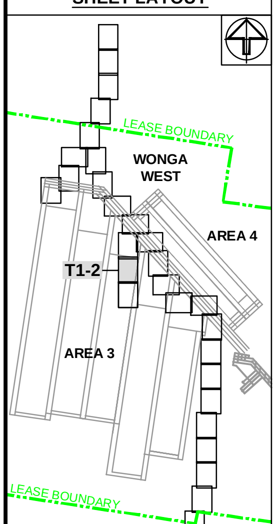
SHEET LAYOUT



SOURCE: PHOTOMAPS BY NEARMAP

PROJECT:	GUJ1 R1	GUJARAT NRE COKING COAL PTY LTD MAJOR EXPANSION PROJECT BELLAMBI, NSW	GeoTerra
DRAWN:	A. DAWKINS		
DATE:	23 Nov 2012		
SCALE:	1:1000	LIZARD CREEK MAPPING	FIGURE T1-1

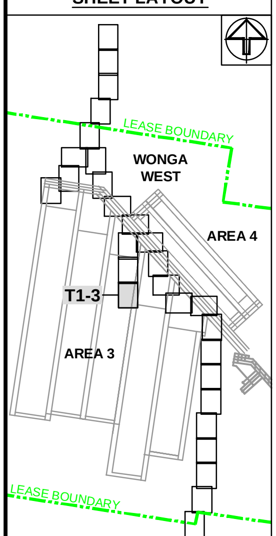
SHEET LAYOUT



SOURCE: PHOTOMAPS BY NEARMAP

PROJECT:	GUJ1 R1	GUJARAT NRE COKING COAL PTY LTD MAJOR EXPANSION PROJECT BELLAMBI, NSW	GeoTerra
DRAWN:	A. DAWKINS		
DATE:	23 Nov 2012		
SCALE:	1:1000	LIZARD CREEK MAPPING	FIGURE T1-2

SHEET LAYOUT



SOURCE: PHOTOMAPS BY NEARMAP

PROJECT:	GUJ1 R1
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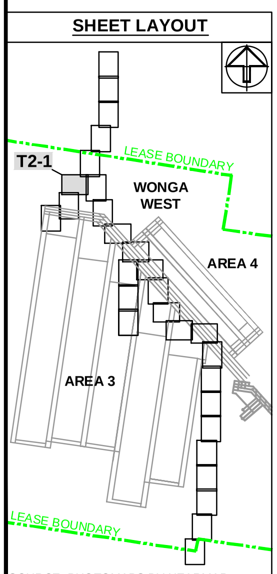
GUJARAT NRE COKING COAL PTY LTD
MAJOR EXPANSION PROJECT
BELLAMBI, NSW

LIZARD CREEK MAPPING

GeoTerra

FIGURE T1-3



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GUJARAT NRE COKING COAL PTY LTD
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BELLAMBI, NSW

LIZARD CREEK MAPPING

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FIGURE T2-1

SOURCE: PHOTOMAPS BY NEARMAP

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GUJARAT NRE COKING COAL PTY LTD
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BELLAMBI, NSW

LIZARD CREEK MAPPING

GeoTerra

FIGURE T2-2

SOURCE: PHOTOMAPS BY NEARMAP

PROJECT:	GUJ1 R1	GUJARAT NRE COKING COAL PTY LTD MAJOR EXPANSION PROJECT BELLAMBI, NSW
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DATE:	23 Nov 2012	
SCALE:	1:1000	LIZARD CREEK MAPPING

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FIGURE T2-2

PROJECT:	GUJ1 R1	GUJARAT NRE COKING COAL PTY LTD MAJOR EXPANSION PROJECT BELLAMBI, NSW
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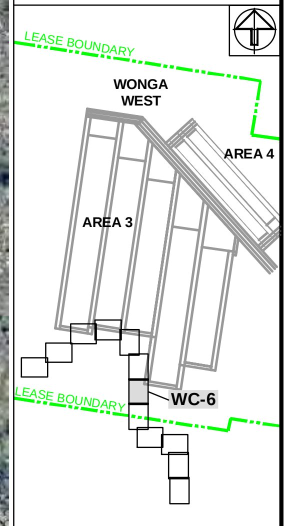
SCALE:	1:1000	WALLANDOOLA CREEK MAPPING

GeoTerra

FIGURE WC-5

SHEET LAYOUT



SOURCE: PHOTOMAPS BY NEARMAP

PROJECT:	GUJ1 R1
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SCALE:	1:1000

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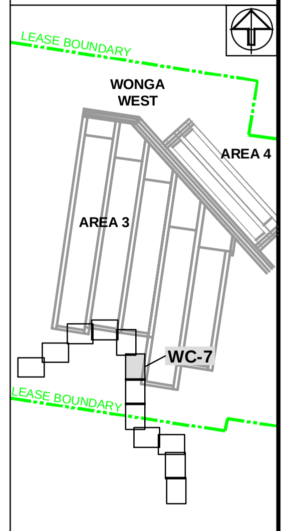
MAJOR EXPANSION PROJECT
BELLAMBI, NSW

WALLANDOOLA CREEK MAPPING

GeoTerra

FIGURE WC-6

SHEET LAYOUT



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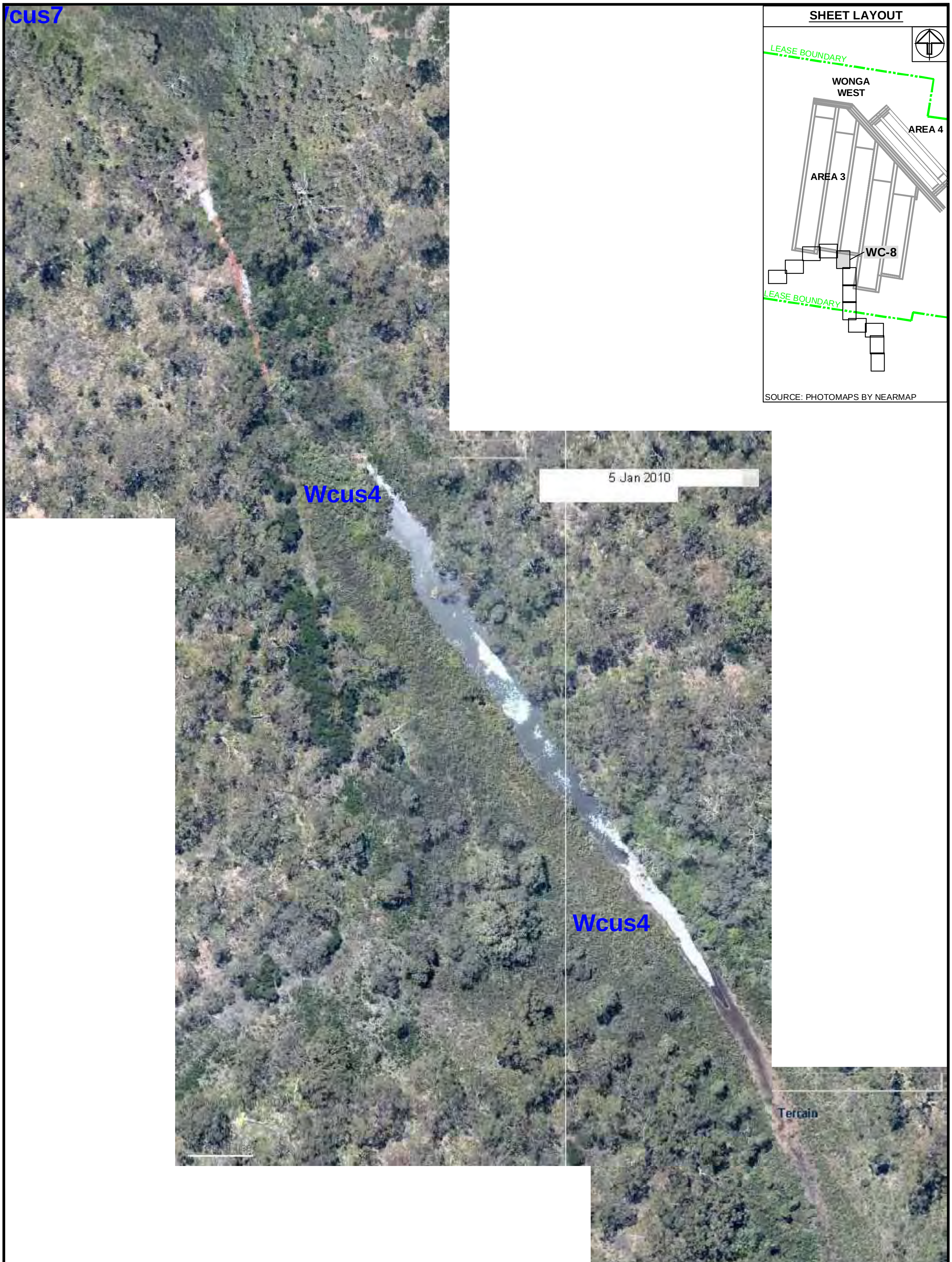
PROJECT:	GUJ1 R1	GUJARAT NRE COKING COAL PTY LTD MAJOR EXPANSION PROJECT BELLAMBI, NSW
DRAWN:	A. DAWKINS	
DATE:	23 Nov 2012	
SCALE:	1:1000	WALLANDOOLA CREEK MAPPING

GeoTerra

FIGURE WC-7



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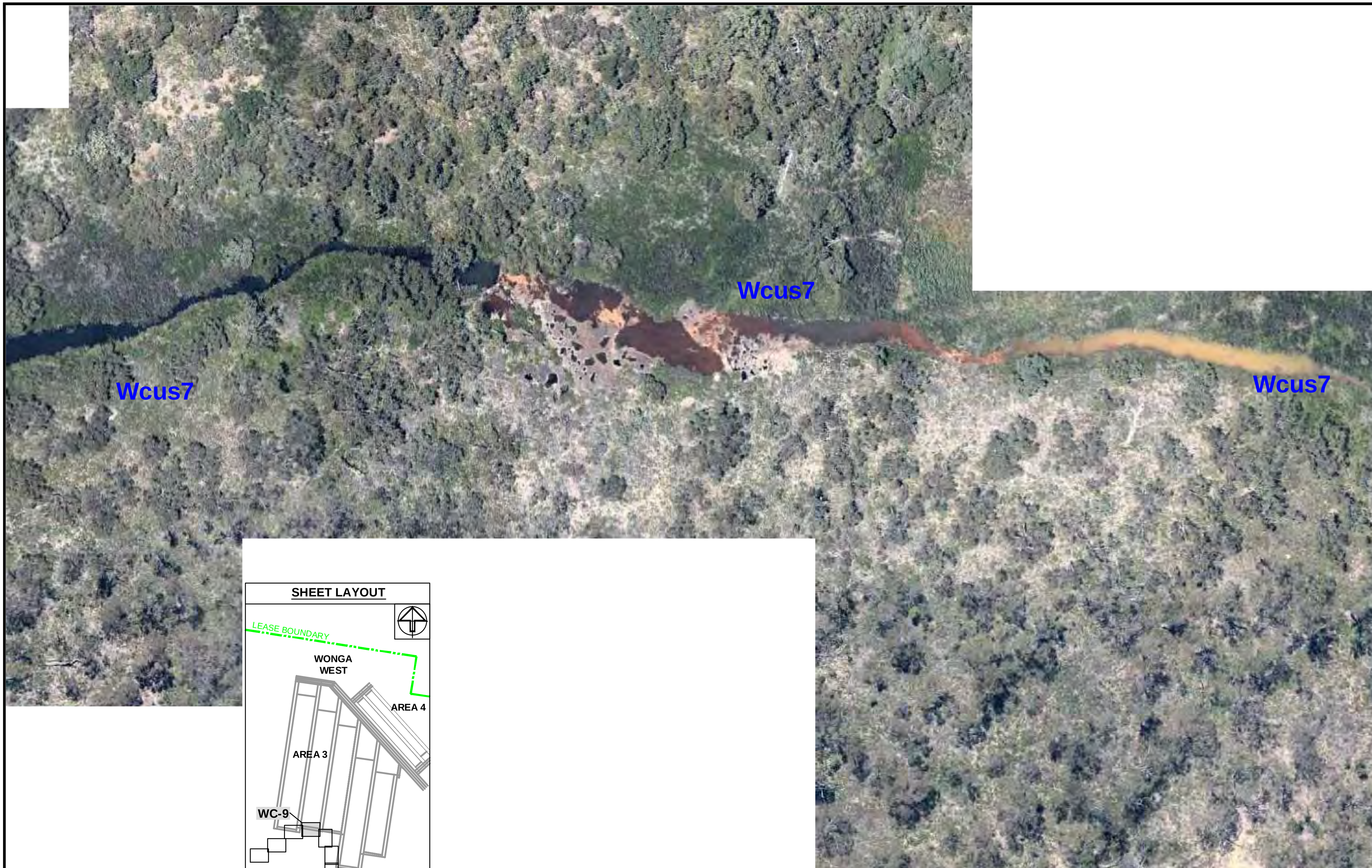
DRAWN:	A. DAWKINS
DATE:	23 Nov 2012
SCALE:	1:1000

GUJARAT NRE COKING COAL PTY LTD
MAJOR EXPANSION PROJECT
BELLAMBI, NSW

WALLANDOOLA CREEK MAPPING

GeoTerra

FIGURE WC-8



SOURCE: PHOTOMAPS BY NEARMAP

PROJECT:	GUJ1 R1
DRAWN:	A. DAWKINS
DATE:	23 Nov 2012
SCALE:	1:1000

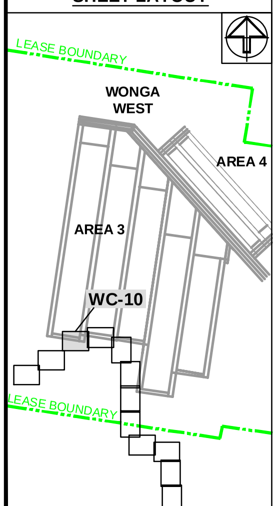
GUJARAT NRE COKING COAL PTY LTD
MAJOR EXPANSION PROJECT
BELLAMBI, NSW

WALLANDOOLA CREEK MAPPING

GeoTerra

FIGURE WC-9

SHEET LAYOUT



SOURCE: PHOTOMAPS BY NEARMAP

PROJECT:	GUJ1 R1
DRAWN:	A. DAWKINS
DATE:	23 Nov 2012
SCALE:	1:1000

GUJARAT NRE COKING COAL PTY LTD
MAJOR EXPANSION PROJECT
BELLAMBI, NSW

WALLANDOOLA CREEK MAPPING

GeoTerra

FIGURE WC-10

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DATE:	23 Nov 2012	
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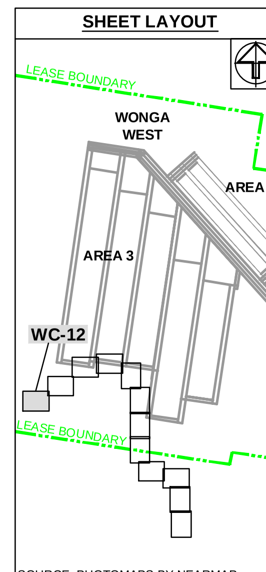
GUJARAT NRE COKING COAL PTY LTD
MAJOR EXPANSION PROJECT
BELLAMBI, NSW

WALLANDOOLA CREEK MAPPING

GeoTerra

FIGURE WC-11



PROJECT:	GUJ1 R1	GUJARAT NRE COKING COAL PTY LTD MAJOR EXPANSION PROJECT BELLAMBI, NSW WALLANDOOLA CREEK MAPPING	GeoTerra FIGURE WC-12
DRAWN:	A. DAWKINS		
DATE:	23 Nov 2012		
SCALE:	1:1000		

Report

Water Management Report Gujarat NRE No. 1 Colliery Major Works Part 3A

Prepared for Gujarat NRE Coking Coal Limited (NRE) (Client)

By Beca Pty Ltd (Beca)
ABN: 85 004 974 341

7 February 2011

Revision History

Revision Nº	Prepared By	Description	Date
A	Johanna Schortinghuis	Draft For use in 3 A approval submission	2 July 2010
B	Johanna Schortinghuis	Update of draft with additional information	8 July 2010
C	Johanna Schortinghuis	Update of draft with comments from NRE	13 July 2010
D	Deepika Jaduram	Update of draft with comments from site visit and NRE	22 October 2010
E	Dianne Thomas	Incorporate ERM and Gujarat comments	14 November 2010
F	Deepika Jaduram	Final revision incorporating required changes by client and ERM	29 November 2010
G	Dianne Thomas	Revised to include ERM and Olsen comments	13 December 2010
H	Dianne Thomas	Revised to reflect 3.1ML/d water yield from Wongawilli and Bulli not 4.2ML/d. Expand on irrigation reuse at shaft #4 and soil moisture monitoring.	25 January 2011
I	Tiffany Chan	Revised to incorporate ERM comments on executive summary and Figure 10	7 February 2011

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Appendices

1 Executive Summary

Gujarat NRE Coking Coal Limited (NRE) is seeking approval for the expansion of mining operations and upgrade of associated surface facilities at the NRE No. 1 Colliery in the Southern Coalfield. NRE's current mining operations involving the NRE No. 1 Colliery and No. 4 Shaft site are focused on mining the Bulli seam, which is the top most coal seam. The proposed expansion plan is to expand the mining operation into the Wongawilli coal seam, which will have different mine water production rates.

The purpose of this document is to describe current water management practices at NRE's No. 1 Colliery and Shaft No. 4 sites and outline changes to onsite water management that form part of the proposed mine expansion. This report will form part of the Environmental Assessment prepared by ERM under Part 3A of the Environmental Planning and Assessment Act (EP&A Act).

It is anticipated that no alterations to the existing discharge licence will be required as a result of the proposed expansion and upgrade works. Discharge will continue to occur in accordance with current licence conditions, as outlined in Section 3.5. It is anticipated that there will be no significant change in the discharge water quality. Therefore future discharge water quality should continue to be similar to background water quality that is characteristic of creeks in the area. Treatment prior to discharge will consist of solids removal to remove sediments and coal fines.

Expansion of mining operations to include the Wongawilli seam will change the water flows at the mine.

The anticipated total water production from mining operations at the end of this project is shown in table 3. Water make from Bulli and Wongawilli seams will total 3.1ML/d. 1.1ML/d from Bulli and 2.0ML/d from Wongawilli.

It is expected that the total water demand for mining operations will be 4.2 ML/d, which is 2 ML/d above the current water use. Demand is more than the 3.1ML/d estimated to be extracted during mining and will require water from external sources. The preferred source will be bulk raw water from Sydney Catchment Authority.

The existing thickener tank will remain for treatment of the dirty stormwater and mine water. Any treated water that is not reused on site will be discharged into Bellambi Gully. It is proposed that the sludge from the existing thickening tank will be diverted from being re-circulated in the treatment process via Dam 1. Instead the sludge will be dewatered and the solids cake will go to stockpile, with the filtrate water being recycled back into the mine process water system. Dewatering technologies such as a centrifuge or recessed-plate filter press will be investigated further for sludge dewatering at the mine.

The proposed modifications at the Russell Vale and Shaft No. 4 sites include:

- increased water used on site when mining the Wongawilli seams;
- increase water use at Russel Vale and Shaft No. 4 when mining personnel move between the sites;
- new 6ML dam below stockpile at Russell Vale to enhance sediment control;
- improve solids dewatering and disposal.

2 Site Expansion Project Summary

2.1 Project Background

NRE is seeking approval for the expansion of its existing operations and upgrade of associated surface facilities at its' Russell Vale site. This upgrade will have an estimated capital investment value of $250 million. It will include the following activities:

- coal extraction (from the Bulli, Balgownie and Wongawilli seams) ramping up to coal production of up to 3 million tonnes per annum (mpta) with a projected mine life of at least 18 years;
- upgrade of existing mine infrastructure and services at Russell Vale, including surface conveyors and coal handling infrastructure, coal sizing, screening, crushing and load-out facilities, site noise and dust controls and a stockpile for run-of-mine (ROM) coal;
- continued use of No. 4 Shaft for mine access (for men and material), bath house, offices and parking area, there is the potential to relocate to Russel Vale during mining of Wongawilli east;
- essential maintenance and refurbishment of existing ventilation shafts and power and water supply arrangements;
- upgrade of all site water management including mine water and stormwater controls;
- continued road haulage of the unwashed coal to Port Kembla Coal Terminal for shipment to India, using the existing haulage route; and
- progressive site rehabilitation.

Extensive underground mining has been undertaken within the project application area, dating from the late nineteenth century.

NRE's current mining operations involving the Russell Vale and No. 4 Shaft sites are focused on mining the Bulli seam, which is the top most coal seam. The proposed plan is to expand the mining operation into the Wongawilli coal seam, which is lower down in the southern coal seam measures and will have different mine water production from the Bulli seam coal.

Pursuant to provisions of State Environmental Planning Policy – Major Projects 2005, the Project requires approval under Part 3A of the EP&A Act. This report provides water management information for expansion of the coal mining operation of the NRE Colliery at Russel Vale and access Shaft No. 4.

2.2 Operating Environment

NRE No. 1 Colliery Coal mine is located at Russell Vale, which is approximately 8 km north of Wollongong and 70 km south of Sydney, within the local government areas of Wollongong and Wollondilly in the Illawarra region of NSW. The location is shown in Figure 1.

The site includes the Illawarra Escarpment. The escarpment reaches up to 400m AHD elevation and slopes steeply down to the foothills at approximately 30m AHD. The steep slopes of the escarpment are heavily vegetated.

The Russell Vale site is located on the lower slopes and foothills of the escarpment at approximately 140m AHD elevation. The Russell Vale site is bounded by the Princes Highway to the east, residential areas of Russell Vale and Corrimal to the north and south respectively and the Woronora Plateau to the west. The Russell Vale golf course (former waste disposal area) also bounds the site to the north.

The underground lease area lies under the Woronora Plateau west of the escarpment. The surface land of the plateau is covered by native bush land and the Cataract Dam, with perennial creeks, ephemeral tributary streams and upland headwater swamps.

In addition to the Russell Vale site, NRE has surface leases at one access shaft (No. 4 Shaft) and four ventilation shaft sites (No. 1, 2, 3 and 5 Shafts) across the mine operations.

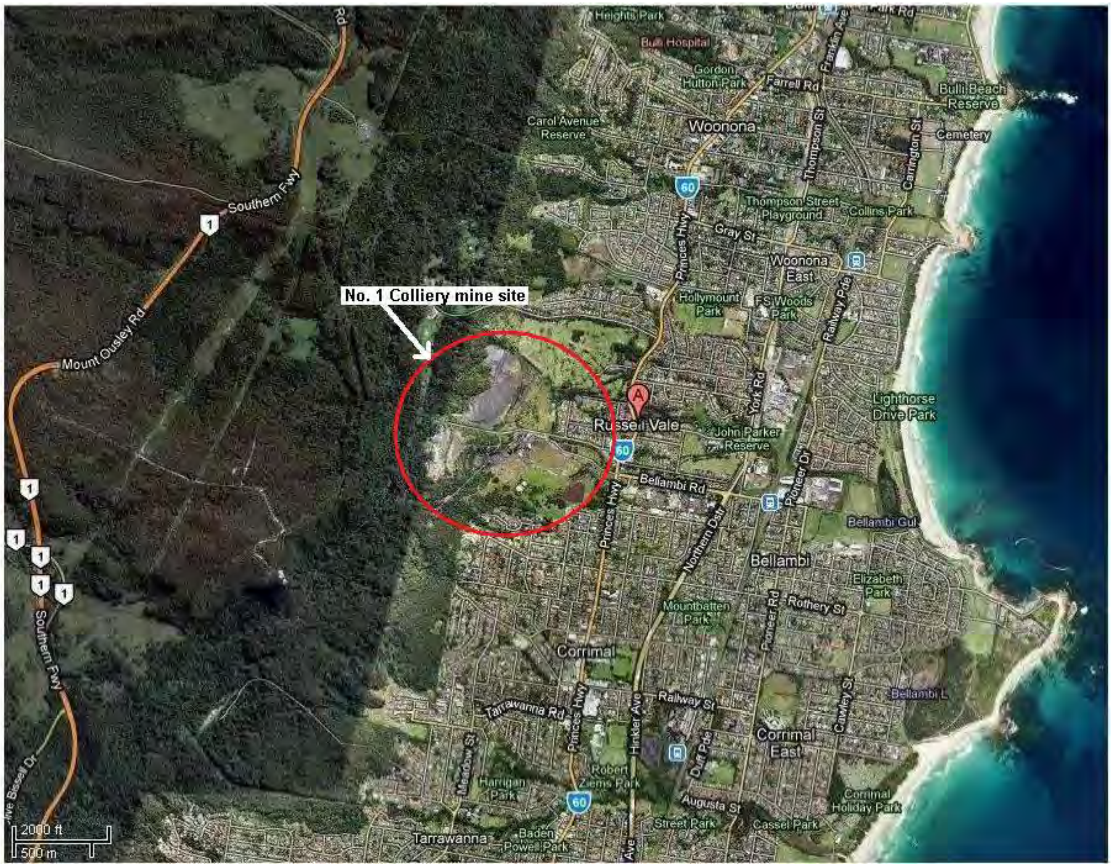


Figure 1 – Location of Gujarat NRE's No. 1 Colliery

3 Description of Existing Water Management System – Russell Vale and No. 4 Shaft

Sections 3.1 to 3.5 describe current water management practices at NRE's surface facilities at Russell Vale. Section 3.6 describes current water management practices at No. 4 Shaft.

The water management system at NRE's No. 1 Colliery mine site at Russell Vale consists of the following components:

- Potable water;
- Waste water;
- Process and mine water;
- Stormwater; and
- Licensed discharge of treated water.

Dirty stormwater management is designed to mitigate a 1 in 10 year storm event. Mine water and dirty stormwater are mixed together in the stormwater control dam and treated together in the thickener. These systems are described in more detail following.

3.1 Potable Water at Russell Vale

Potable water supplied by Sydney Water is primarily used for surface facilities including the administration building, bath houses, truck washer, workshop and toilets, and is generally not used for mining operations.

While infrequently used, there is provision to supply emergency supplies of potable water to the mine process water system. A simplified illustration of the potable water system is shown in figure 2. It should be noted that while there is a potable water connection to the Truck Washer, it predominantly uses process water. Used water is recovered from the truck washer and routed to Dam 2 for reuse onsite, and is not discharged to sewer.

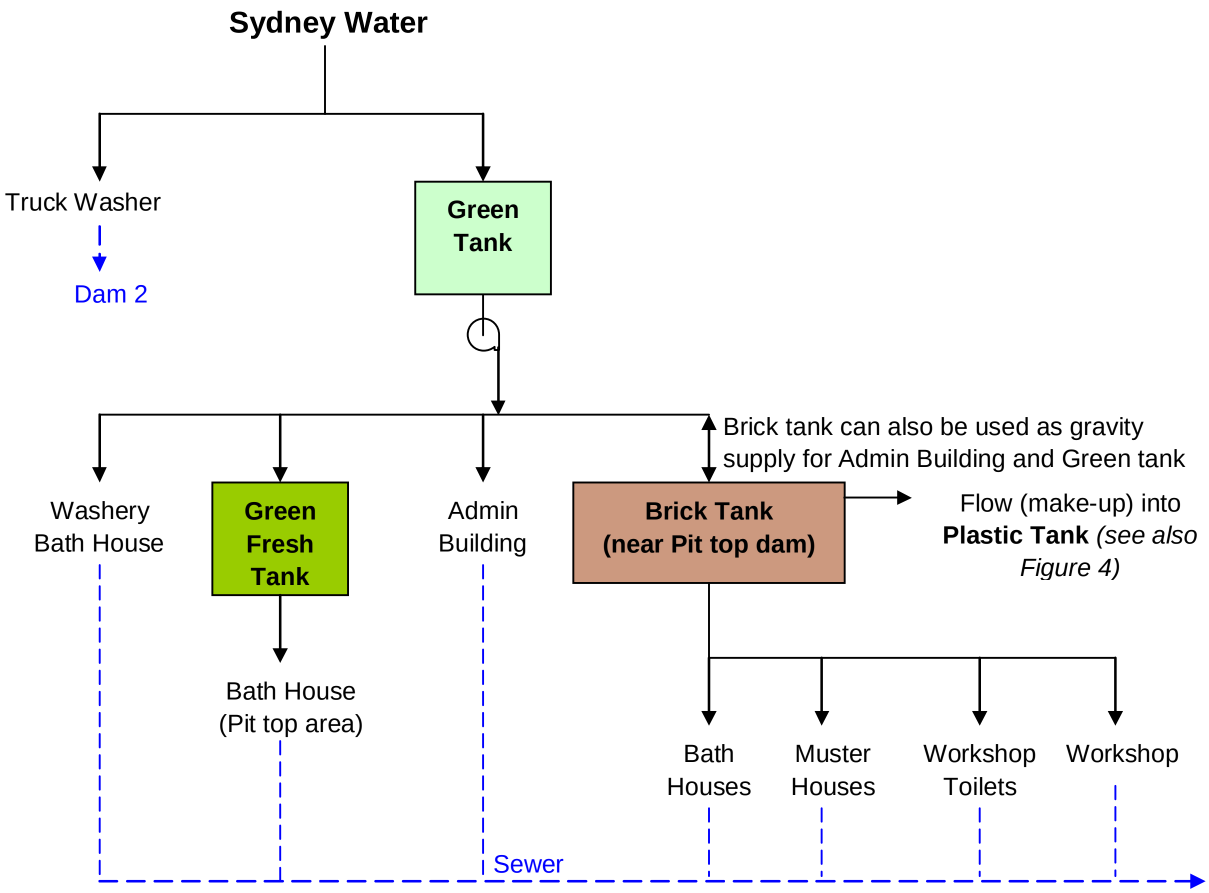


Figure 2 - Schematic of the current potable water supply and sewer discharge for NRE No. 1 Colliery

(blue dotted lines indicate sewer discharge).

3.2 Waste Water at Russell Vale

Black and grey water generated at the Russell Vale site is discharged to the Sydney Water sewerage system, as indicated on Figure 2.

3.3 Process and Mine Water at Russell Vale

3.3.1 Process Water Use

Process water is generally used to supply underground mine workings, fire water, truck filling points for site dust suppression, wash-down and on the stock piles, as illustrated in Figure 3. On average, current daily process water use on site is approximately 2.4 ML/d.

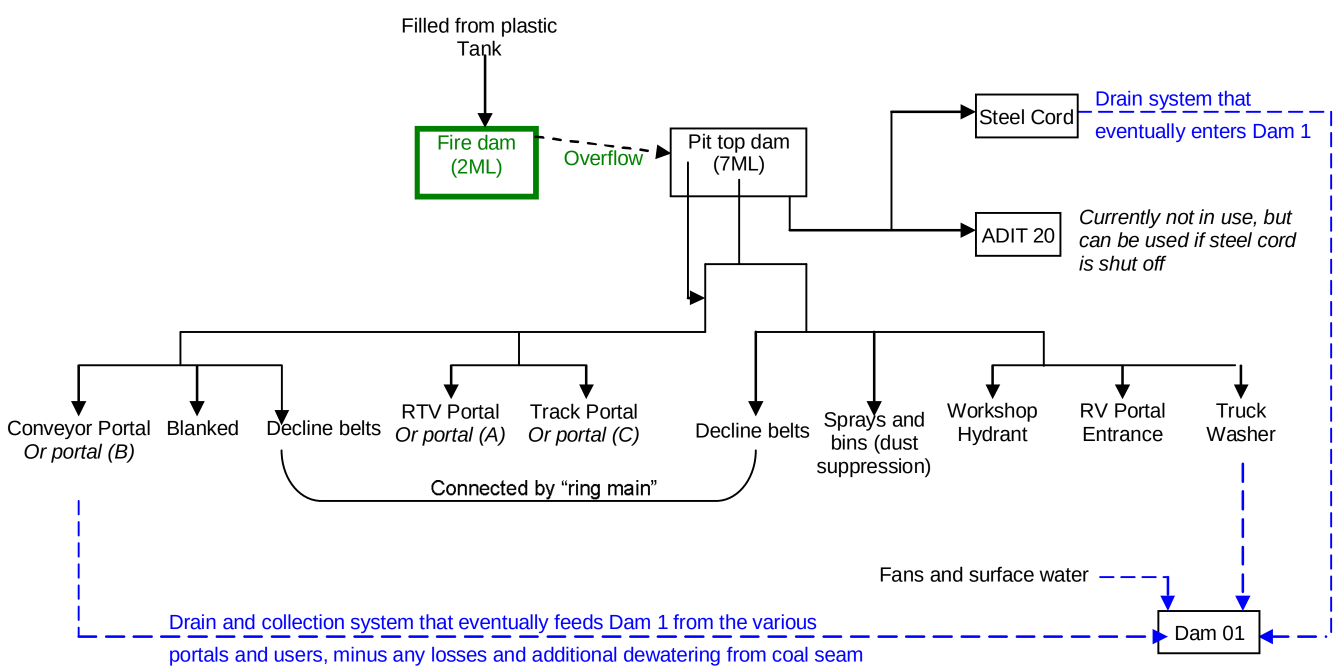


Figure 3 - Schematic of the current process water supply for NRE Russell Vale Colliery

(The black dotted lines denote overflow, and the blue dotted lines denotes 'un-processed' water, which can include used process water and water from the coal seams).

3.3.2 Process Water Supply

Process water supply is made up of a combination of the following water sources, as shown in Figure 4:

- Clean raw water from Corrimal Springs (approximately 0.1 ML/d);
- Mine dewatering water from No. 4 Shaft (also referred to as RV track portal) (approximately 0.5 to 1 ML/d);
- Treated water from the Thickener Tank (approximately 1.7 ML/d); and
- Potable water from the Brick Tank (generally not used)

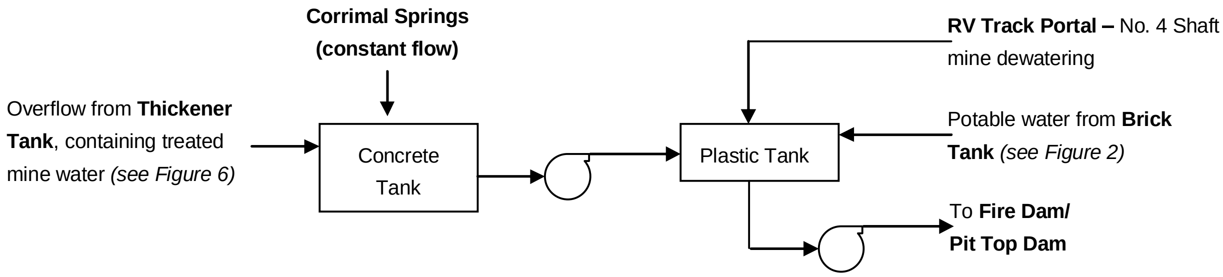


Figure 4 – Schematic of Process Water Supply

Excess water from mine dewatering from No. 4 Shaft (shown as RV track portal in figure 4) is routed to the Plastic Tank when storage dams at the No. 4 shaft site have reached full capacity. This allows excess water to be used onsite for process needs and ultimately treated and discharged, as required, from the Russell Vale site.

Corrimal Springs is a natural spring which flows to the surface within NRE's site. The spring is captured by directing the water flow of approximately 0.1 ML/day to the concrete tank for use on site. This arrangement is understood to have been in place for over 50 years.

Potable water from the Brick Tank can also be routed to the Plastic Tank for process use. Potable water is generally not used to supply process water however may be drawn on during emergencies to allow make-up of the Pit Top Dam.

3.3.3 Process Water Treatment and Discharge

The following used process waters and mine dewatering streams are combined with stormwater runoff from disturbed areas for treatment prior to reuse onsite, or discharge to Bellambi Gully as required:

- Mine dewatering water;
- Waste water from ventilation fan scrubbers;
- Truck wash water; and
- Sludge from the Thickener Tank.

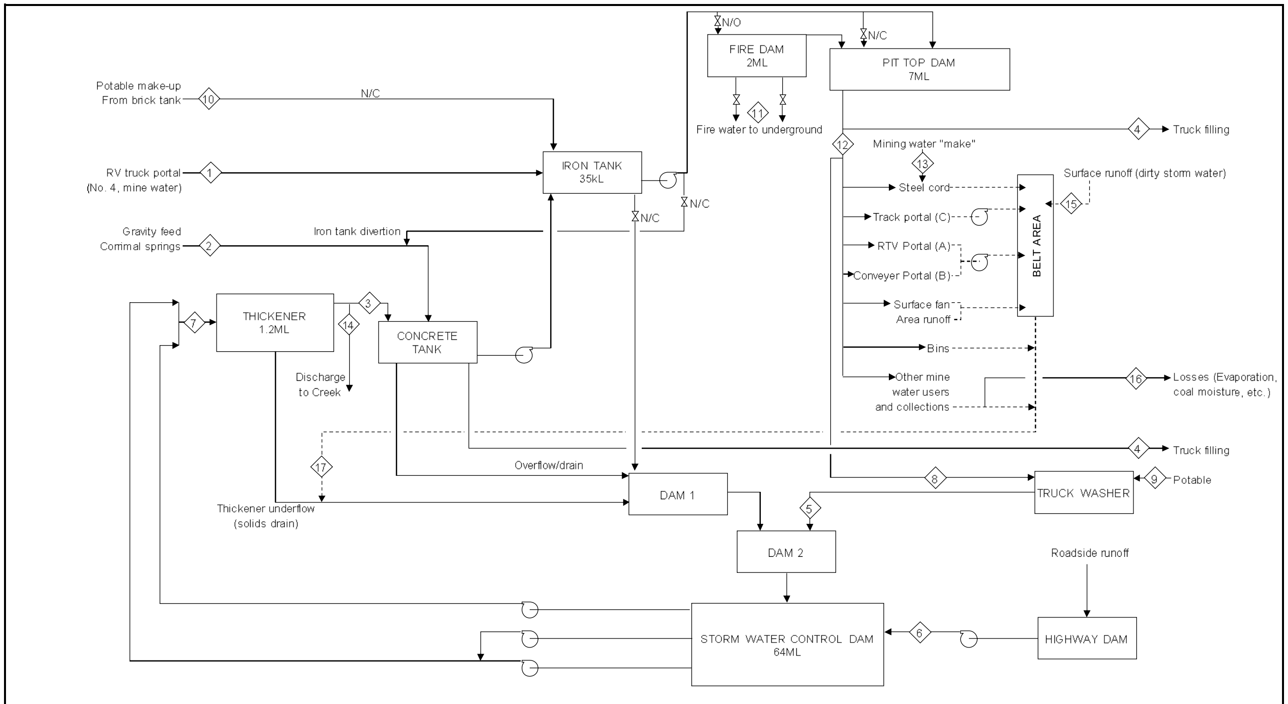
3.3.4 Site Process Water Balance

A summary of water use on site is shown below in Figure 5. This figure combines the various aspects of water on site into an overall flow diagram and flow balance. As limited flow information was available; the balance presented is for the average case only and is based on the following assumptions:

- Supply and recovery of water to and from the mine is not a simple distribution and was therefore simplified to show only the total combined supply (labelled stream 12) and return (stream 17) of water to and from the mine. To account for any future balances, provision was made to allow for additional mine water make-up (stream 13 that could result from mining a wetter seam) as well as any storm water or other surface water drains (stream 15) that might enter the system.
- The balance assumes flows for dry weather conditions. That is no flow from the Highway Dam (stream 6) and dirty storm water (stream 15).

- The balance assumes no flow from potable water make-up (stream 10) and no net "mine water make" or pump out (stream 13) from the mining of roadways in the Wongawilli seam (known as 'Wonga Mains'). This is consistent with flow meter results communicated that indicate <0.1ML/day.
- The overall balance assumes continuous average normal flows for a 24 hour working day (except for the flows shown for stream 7 that is based on 0, 1 or 2 pumps running to meet the other "continuous stream" flows).
- The balance assumes non-continuous flows are successfully buffered by intermediate holding volumes in dams and tanks.
- The RV track portal pump out provided as a range of 0.5 to 1ML/day (0.5ML/day assumed normal and 1ML/day assumed as maximum for stream 1).
- Corrimal springs make-up (stream 2) rate assumed as 0.1ML/day.
- Thickener Tank overflow (stream 3) estimated from hydraulic difference between Thickener Tank and Concrete Tank with existing piping connection and valve fully open.
- Truck filling (stream 4) estimated from 13kL trucks at 10 trucks per day
- Stock pile (truck filling) and truck wash daily consumption was quoted as 9kL/h. The difference between this and truck filling is assumed to be truck wash (stream 8).
- Potable water to truck wash (stream 9) is assumed to be 25% of the mine water that is supplied to the truck wash.
- Water loss (stream 16) through evaporation, coal moisture, etc. from the system was assumed to be 5% of the water supply to the mine (stream 12).
- The balance of water was assumed to be discharged to the gully (stream 14).

The water balance shows that currently during dry weather conditions approximately 15kL/h of water could be discharged to the gully. This compares favourably with the 20kL/h hour average calculated from actual discharge data for the period July 2008 to June 2009. It is believed that the difference is probably made up of a small amount each for stream 13 (mine water make) and 15 (dirty storm water) respectively that was assumed to be zero for the purposes of this balance.



STREAM NUMBER			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
STREAM NAME / PARAMETER			RV TRACK PORTAL PUMPOUT	CORRIMAL SPRINGS	CLARIFIER OVERFLOW	TOTAL TRUCK FILLING	TRUCK WASH COLLECT	WATER FROM HIGHWAY DAM	WATER FROM STORM WATER DAM	MINE WATER TO TRUCK WASH	POTABLE WATER TO TRUCK WASH	POTABLE WATER TO MINE USE	FIRE WATER TO MINE	MINE WATER SUPPLY	MINE WATER "MAKE"	DISCHARGE TO CREEK	DIRTY STORM WATER	SYSTEM WATER LOSSES	NETT WATER FROM MINE
CONTINUOUS OR INTERMITTENT																			
FLOW RATE	NORMAL	m^3/h	20.8	3.6	70.9	5.4	4.5	0.0	150.0	3.6	0.9	0.0	0.0	89.9	0.0	15.4	0.0	4.5	81.8
	NORMAL	ML/day	0.5	0.1	1.7	0.1	0.1	0.0	3.6	0.1	0.0	0.0	0.0	2.2	0.0	0.4	0.0	0.1	2.0
pH		-	8.7						9.1				8.7	8.9		9			
CHLORIDES		mg/litre	NA						NA				NA	NA		NA			
SULFATE (SO4)		mg/litre	NA						NA				NA	NA		NA			
CARBONATES (As CaCO3)		mg/litre	130						110				190	190		110			
APPEARANCE (TURBIDITY)		NTU	110						570				79	85		27			
ELECTRICAL CONDUCTIVITY		μS/cm	3700						1900				3700	3000		2100			
TSS		mg/litre	29						120				79	24		27			
TDS		mg/litre	2300						1200				2300	2200		1300			

Figure 5- Current Russell Vale flow diagram and balance summary

3.4 Stormwater at Russell Vale

Stormwater generated onsite is segregated into two streams, clean and dirty. Dirty stormwater consists of runoff from catchments that contain disturbed areas such as the coal stockpile area, unsealed roads and other disturbed mine areas. Clean stormwater consists of rainfall runoff from vegetated and clean hardstand areas where the risk of stormwater contamination is low.

3.4.1 Clean Stormwater

Clean stormwater catchments primarily consist of naturally vegetated escarpment. Clean stormwater is also generated from some operational areas that do not include stockpiling and haulage of coal. Clean rainfall runoff is collected in clean stormwater pipelines and transported across the site around and underneath the existing stockpile area to the western-most point of the site where it is discharged to Bellambi Gully.

The stormwater drainage system including description of stormwater sub-catchments is described in the "Gujarat NRE Stormwater Hydrology Review" (Beca, 2010) which is included in Appendix A of this report. The diversions described in the Hydrology report have been proposed and are subject to separate approval. These diversions will attenuate storm flow across the site, reducing the peak flow during storm events. The diversions will also reduce the chance of blockages and uncontrolled flows as the pipe flows are being replaced with channels, which are easier to inspect and maintain. These were covered in the previous NRE Part 3A submission to the Department of Planning (DoP) (No: 10 0046).

3.4.2 Dirty Storm Water

Dirty stormwater consists of runoff from disturbed catchments and includes:

- Runoff from unsealed surfaces;
- Run off from the ROM coal stockpile area;
- Roadside water runoff from the Highway dam; and
- First flush from the hardstand area in front of the portals.

Dirty stormwater is combined with mine dewatering water and used process water and in Dams 1 and Dam 2, prior to being routed to the 64ML Storm Water Control Dam (SWCD), as illustrated Figure 6, where it is stored prior to treatment for reuse or discharge from site. Dam 1 and Dam 2 provide holding volume to aid solids settling prior to discharge to the SWCD.

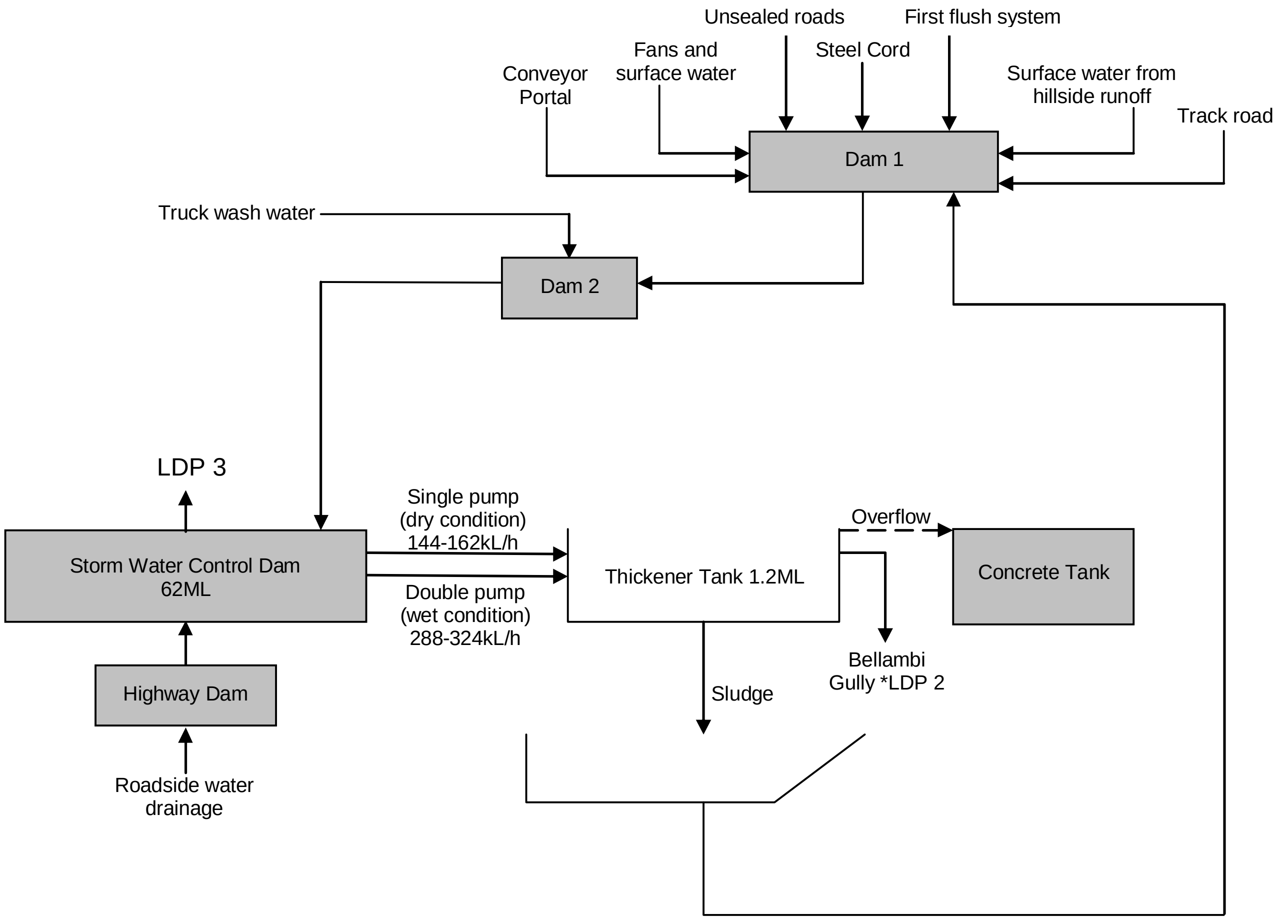


Figure 6 – Schematic of the current dirty stormwater flows and storages

From the SWCD, water is pumped to the Thickener Tank where suspended solids are removed with addition of flocculent/coagulant. Treated water from the Thickener Tank then flows either to:

- The concrete tank to be pumped via the plastic tank to the Fire Dam and Pit Top Dam for use as fire water and process water; or
- Licensed discharge point 2 (LDP 2) into Bellambi Gully under Environmental Protection Licence (EPL) 12040.

Solids from the Thickener Tank are returned to Dam 1. Accumulated solids are periodically removed (approximately every 3 to 4 months) from storage dams to maintain the required dam capacity.

The level of the SWCD is maintained with at least 30ML available volume to allow sufficient free capacity to contain stormwater flows resulting from a 10 year annual recurrence interval (ARI) storm event.

3.5 Environmental Protection Licence

NRE currently holds an Environmental Protection Licence (EPL12040) for operations at the NRE No. 1 Colliery. With regard to discharges to water, the EPL defines three licensed discharge points from the site (1, 2 and 3) and applicable concentration and volume limits.

Licence discharge point 1 (LDP1) consists of underground drainage from coal stockpile and forested area, and is located outside the lease area to the north of the main mine operations in the Russell Vale emplacement area. LDP1 is located at the concrete weir on the energy dissipater in Rath's Gully. The licence allows 50kL/day to be discharged from LDP1. No concentration limits apply to LDP1.

Licence discharge point 2 (LDP2) permits discharge of treated stormwater runoff and mine water from the Russell Vale site to Bellambi Gully. The discharge point is located downstream of the Thickener Tank at a pipe outlet. The licence requires water discharged from LDP2 to comply with the water quality limits shown in Table 1.

Table 1- Environmental Protection Licence Concentration Limits for LDP2

Pollutant	Units	100th Percentile Concentration Limit
Oil and Grease	mg/L	10
pH	pH units	6.5 – 9.2
Total Suspended Solids	mg/L	50

The licence allows discharge of 2.5ML/day from LDP2 under dry weather conditions. The licence makes provision for wet weather under Section L4.2 Note 2: "For 72 hours following wet weather conditions, water may be discharged in excess of 2,500kL/day from Point 2, in order to allow the dam level to be quickly reduced to a safe level provided all practical measures are taken to minimise additional pollution caused by the wet weather."

NRE monitors effluent discharged from LDP2 in accordance with licence requirements and submits a performance report and compliance statement to the Department of Environment, Climate Change and Water quarterly and annually. The 2009 annual report and compliance statement is provided in Appendix D.

It should be noted that reuse of process and mine water within the mining operation is the preferred and primary destination for water collected in the SWCD in order to minimise use of potable water onsite, and that discharge via LDP2 to Bellambi Gully is considered a secondary option.

Licence discharge point 3 (LDP3) refers to discharge of water that seeps through the dam wall immediately downstream of the SWCD. The SWCD is registered with the Dam Safety Committee (DSC), and the dam wall is designed to be permeable and slowly filter and discharge water. No volume or concentration limits apply to LDP3.

3.5.1 Water Quality Management Measures

Prior to discharge water is treated in the thickener (clarifier) on site. TSS is reduced to less than 50mg/L under the operating licence.

Chemicals are stored in accordance with Australian Standard requirements. Dosing of flocculent is metered and monitored on site using a computer controlled dosing system. Trigger points are built in to the system to ensure that 'over-dose' or 'under-dose' of flocculent is managed. Chemical use is kept to a minimum. The chemical dosing system and treatment plant are audited monthly to confirm system is operating as designed. *Info Tronix* completed the September 2010 audit.

3.6 Water Management at Shaft No. 4

There are five shafts within the Project area, four are exclusively ventilation shafts (1, 2, 3 and 5) and one shaft (Shaft No. 4) is for man, materials and ventilation.

Shaft No. 4 and associated facilities are located on the surface lease approximately 10 km northwest of the Russell Vale Site and surrounded by native bushland within the Sydney Catchment Authority Metropolitan Special Area. Site facilities at Shaft No. 4 include winder, offices, bath-house, stores, workshop, car parking, water management facility, sewage treatment plant, electrical substation and explosives magazine. Currently there are a total of 225 employees at the No. 4 Shaft site, spread over 3 shifts. Facilities at Shaft No. 4 are designed to accommodate far in excess of these personnel figures (approximately 1000 persons).

Proposed water management at Shaft No. 4 is described below and illustrated in Figure 7.

Potable water for drinking will continue to be supplied to the site using bottled drinking water. Other water uses will be sourced from Cataract Dam and treated prior to use in the offices and wash house.

As there is no Sydney Water sewage connection at the No. 4 Shaft site, black and grey water is treated onsite prior to disposal or reuse. Grey water refers to the wastewater generated from bath houses and general surface cleaning and is treated in a Pasveer wastewater treatment facility (referred to as Pasveer No. 1). Black water, consisting of sewage from toilets, urinals and hand basins is treated in a separate Pasveer wastewater treatment facility (referred to as Pasveer No. 2). Treated grey water is stored in the main collector dam prior to disinfection and use underground. Treated black water is disposed of via spray irrigation on site.

Oily water from the workshop enters the oil arrestor pit where grease and oil is trapped. From here the clean underflow water is transferred to the main collector dam for reuse.

Storm water generated onsite enters a collection chamber prior to release to the catchment, with overflow from this chamber directed to the first flush dam (which mainly collects storm water run-off from the car park) and to the main collector dam.

Process water supply for underground process use and fire fighting is provided from the main collector dam. Surplus process water flows to Russell Vale via underground pipes and pumps. Process water stored in the main collector dam consists of:

- Underground workings dewatering;
- Treated water from the workshop oil arrestor pit;
- Treated grey water from Pasveer No. 1;
- Excess stormwater that overflows from the stormwater collection chamber.

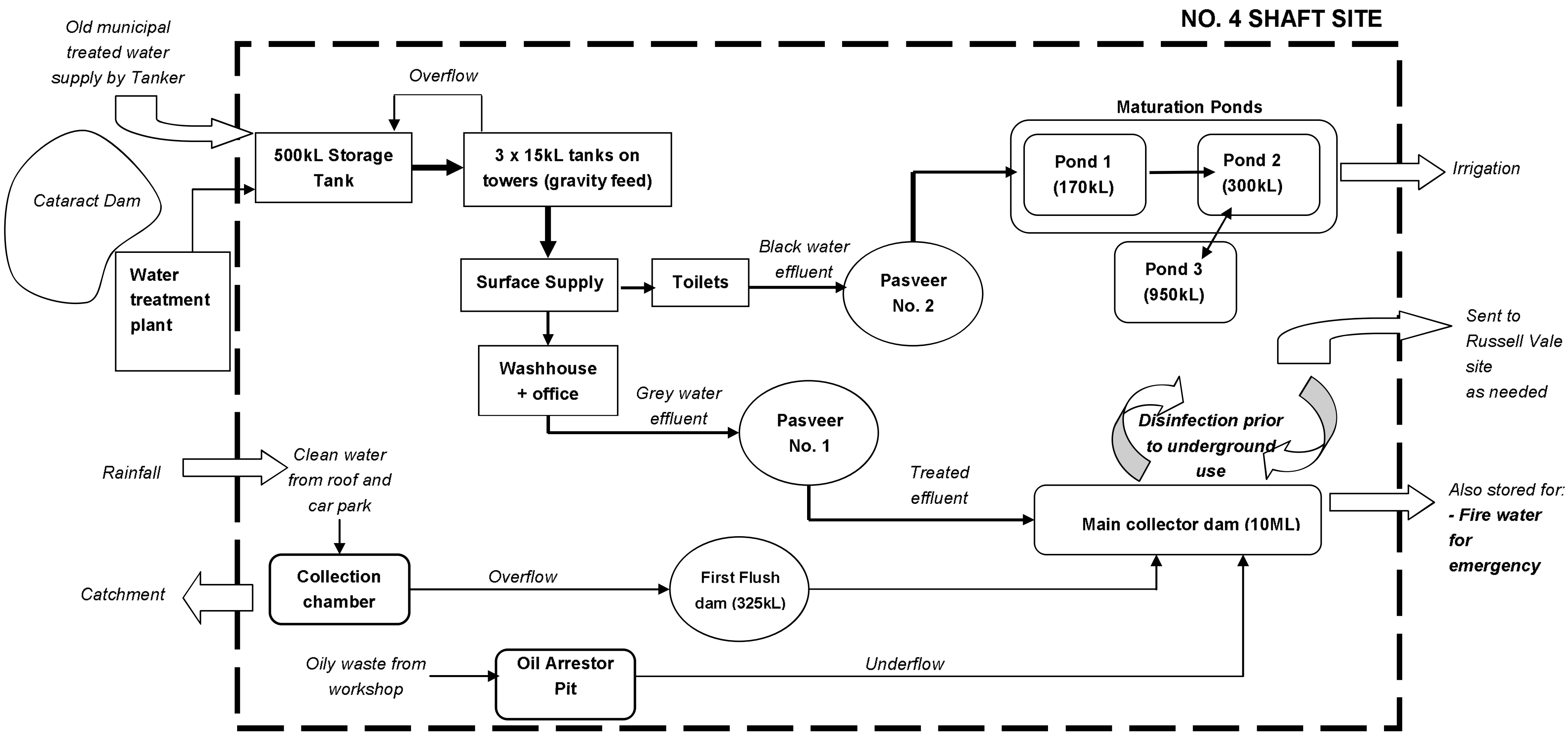


Figure 7- Schematic of the water flow and management system at Shaft No. 4

Note: this schematic does not show any valves or pipe sizes

3.6.1 Cataract Dam Water Treatment

As noted above non-drinking water for use in the main building is sourced from Cataract Dam. Bottled water is supplied for drinking purposes.

The water quality from Cataract Dam is generally in accordance with the Australian Drinking Water Guidelines except for pathogens. Pathogens need to be removed using a disinfection process to protect the health of people washing in this water. Cataract Dam water occasionally has high levels of turbidity, which can compromise the effectiveness of disinfection.

In order to cater for these characteristics of the source water, additional treatment measures are implemented to protect worker health. Water treatment consists of:

- Filtration of the raw water supply to remove solids; and
- Disinfection to kill pathogens.

3.6.2 Black water

Waste water from the toilet facilities will continue to be treated in the No. 2 Pasveer ditch and maturation ponds. Following stabilisation in the maturation ponds, the water is then used to irrigate a grassed area on site with an approximate total utilisation area of 0.25 ha.

As shown in figure 7, there are two maturation ponds in series with a total storage capacity of 470kL. The third 950kL pond is for wet weather storage. 30 days storage is required in the maturation ponds for treatment. 30 days storage is 222kL. This leaves 248kL in the second maturation pond and 950kL in the third pond for wet weather storage. Treated effluent needs to be stored during periods of low evaporation, which occur over winter. The volume of water stored in the second and third ponds will vary over the year, with the volume stored reduced over summer to allow less irrigation over winter. Appendix D demonstrates how pond 2 and pond 3 volumes will increase over winter.

Appendix D shows the irrigation calculations for Shaft #4. At 7.4kL per day production, there is162 days or 5.3 months storage in the working volumes of ponds 2 & 3. This provides significant contingency on the 740kL storage required under average conditions. If long term rain patterns change and additional effluent disposal is required, there is room on the site for additional irrigation areas.

During periods of unusually prolonged precipitation and low evaporation, if the ponds approach a full capacity, treated effluent should be tankered offsite to prevent overflow from these storages. This should be commenced at about 96% capacity – which allows 5 days additional storage in pond 3. Following discussion with NRE personnel, this is understood to have happened only three times in the past 30 years.

The existing treated black water system complies with the Department of Environment and Conservation (NSW) October 2004 Environmental Guidelines for the use of Effluent by Irrigation. The guidelines suggest that for municipal re-use, irrigating on open space, parks, as dust suppression, and on construction/mine sites, the level of treatment should be secondary treatment with pathogen removal. Pathogen removal can be either disinfection or detention. The guideline also stipulates irrigation should be undertaken when there is no public access to the irrigated area. At the Shaft No. 4 site there is secondary treatment in the Pasveer channel, pathogen reduction in the maturation ponds and the area has no human access during irrigation. The area is only accessed to monitor the irrigation system and maintain the grass.

Regular soil testing and monitoring will be undertaken for black water irrigation to determine the condition of the soil, and monitor any effects over time of black water for use in irrigation.

It is preferred to continue to use the spray irrigation system as this enhances evaporation and increases the volume of water that can be disposed on site.

The irrigation area is managed to prevent effluent runoff beyond the irrigation area. Effluent will be stored in the third maturation pond during periods of low evaporation or high precipitation.

Soil testing will be conducted to determine the existing soil conditions, and to inform any soil conditioning to be made prior to irrigation. Soil conditions will also be routinely monitored during irrigation activities. To assist with any potential of over-irrigation and/or runoff from the application areas to the Sydney catchment land the irrigation management actions shown in Table 2 below will be implemented.

Table 2 – Irrigation Management Guidelines

Weather condition	Irrigation Condition	Effluent Management
Dry and sunny (<0.25mm/day rainfall)	Check soil moisture and record moisture content **If moisture content is low**, irrigate between 10am-3pm until soil is sufficiently moist	Cease irrigation when soil is sufficiently moist Record moisture content immediately after irrigation
Light sparse rain (<5mm/day rainfall)	Check soil moisture and record moisture content* **If soil is relatively dry**, irrigate between 10am-3pm until soil is sufficiently moist	Cease irrigation when soil is sufficiently moist or when heavy rainfall occurs Record moisture content immediately after irrigation
Moderate - Heavy rain (>5mm/day rainfall)	No irrigation allowed	Store effluent in maturation ponds until wet weather ceases

Scheduled irrigation events should be monitored on a weekly basis, as appropriate, for a number of parameters, such as:

- the weather condition
- visible condition of the lawn
- soil moisture content via soil moisture indicator probe
- the time taken for that particular irrigation event

Soil moisture can be measured with a probe. Soil moisture probes are proprietary units that measure the availability of moisture in the soil by either measuring the water pressure across a ceramic (commonly ceramic units are used) probe, or by using an electrical conductivity meter to measure when water forms a contact across the probe. Alternatively, a visual inspection by digging a small hole in the root zone will quickly determine if the soil is water logged. Other indicators are water appearing on the surface when you walk across it. Over irrigation is unusual, as it is difficult to maintain an over irrigated lawn.

Water conservation practices will help to minimise the volumes of black water generated. It is proposed that a water audit and conservation plan should be done in order to achieve this.

To provide additional contingency, and to ensure compliance with DEC guidelines for the management of treated black water, augmentation and improvements to the existing irrigation area are proposed. The existing irrigation area is cleared land located within the current lease. Current irrigation operations do not fully utilise this cleared area, providing scope for increased irrigation should it be required. The area can also be fenced. The irrigation area is visually monitored during irrigation. It drains to the main collector dam in the unlikely event of over irrigation.

3.6.3 Grey Water

Grey water (non-toilet wastewater from the surface) will continue to be treated in the No. 1 Pasveer ditch and then stored in the main collector dam for reuse underground. Disinfection with chlorine will take place immediately prior to normal underground use to minimise potential exposure of workers to pathogens as well as minimise organic smells developed during lengthy periods of stagnancy. Any potentially larger quantities of water use required for emergency purposes, i.e. fire fighting, can bypass the treatment system and use the untreated grey water.

3.6.4 Main collector dam

The safe working level of the main collector dam has been reviewed (Water management for shaft No. 4, Beca, 2010). Based on the proposed freeboard of 2.0m depth, the main collector dam can allow approximately 4.5ML capacity for major rainfall event storage. This equates to a 10 year storm event up to the maximum of 72 hour duration, and a 100 year annual recurrence interval (ARI) storm for 24 hour duration.

Mine water will continue to be recycled from underground to the main collector dam, with excess water disposed underground to Russell Vale.

4 Description of modifications to Water Management System

As described previously, current mining operations at the NRE No. 1 Colliery mine site are focused on mining coal from the Bulli Seam and it is now proposed to mine the Wongawilli coal seam. The layers for these seams are shown in figure 8 below. The Wongawilli seam will have different water production rates compared with the Bulli Seam. Therefore, a revision to the current water management system for the NRE No. 1 Colliery is proposed.

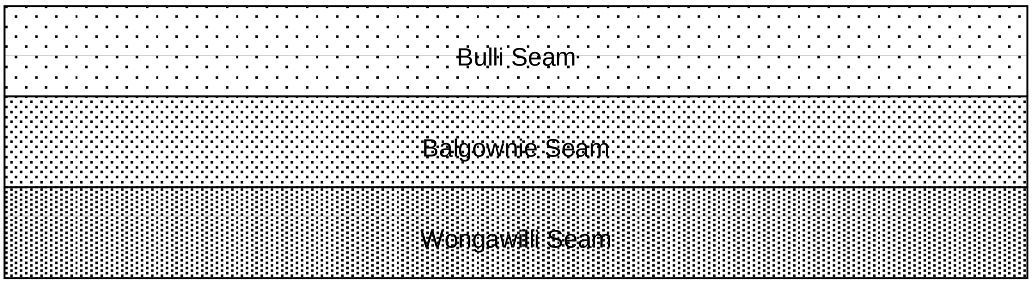


Figure 8 – Schematic showing layers of coal seams in the Russell Vale area.

In addition, several opportunities for improvement and to create efficiencies in the current water management system have been identified for inclusion in the development proposal. This section describes the changes proposed to the current water management system.

4.1 Potable Water at Russell Vale

The expansion of the mining operation may require additional water to be supplied to the site at times when the seam is dry and mining equipment water needs are not met by water collected on site. Potable water supplied by Sydney Water will continue to be used for surface facilities including the administration building, bath houses, truck washer, workshop and toilets. If additional water is required for mining operations, the preference is to negotiate provision of raw bulk water from the Sydney Catchment Authority, otherwise potable water will need to be drawn from the Sydney Water supply.

The expansion of the mine operation will have a minor effect on the volume of potable water used for hygiene and food preparation as the number of people permanently working on site fluctuates. Currently there are 143 employees at the Russell Vale site. It is anticipated that during mining of the Wongawilli seam this will increase to 310 employees. During mining of the Wongawilli west seam, personnel will relocate to the No. 4 Shaft site, and the number of expected employees at Russell Vale will drop to 66.

Existing potable water use at Russell Vale is 33 kL/day. This is expected to increase to 66 kL/day due to the increased mining operations. The existing provision for emergency potable supply from the potable water tank (Brick Tank) to the process water system will be maintained.

4.2 Waste Water at Russell Vale

The process of handling black and grey water at the Russell Vale site will not change. There will be some increases in discharge corresponding to increased potable water use as described in the previous section. Sewage will continue to be discharged to the Sydney Water sewerage system.

4.3 Process and Mine Water

The sections below describe proposed changes and improvements to the process and mine water system as a result of the proposed development.

4.3.1 Process Water Use

Key future process water uses will continue to consist of underground mine workings, fire water, dust suppression and wash-down.

It is anticipated that the future mining operation will increase the demand for process water supplied to the underground mining operations and equipment. Key uses for process water at the Gujarat NRE No. 1 Colliery over the life of the project are:

- 5 Continuous Miners 5.9kL/h each
- Long Wall Equipment 126kL/h
- Coal Stockpile infrastructure 12.5kL/h

In addition, above ground process water uses are truck washing and dust suppression. Demand for these above ground uses are anticipated to increase in line with mine production to approximately 27kL/hr. Trucks operate on average 9 hours a day.

This results in a total requirement of approximately 4.2ML/day of process water supply to operations at NRE Russell Vale Colliery.

4.3.2 Process Water Supply

Process water supply is made up of a combination of the following water sources, as shown in Figure 9:

- Cataract Dam (for surplus mine water demand);
- Clean raw water from Corrimal Springs (approximately 0.1ML/d);
- Mine dewatering; and
- Potable water (Truck Washer and Emergency Supply)

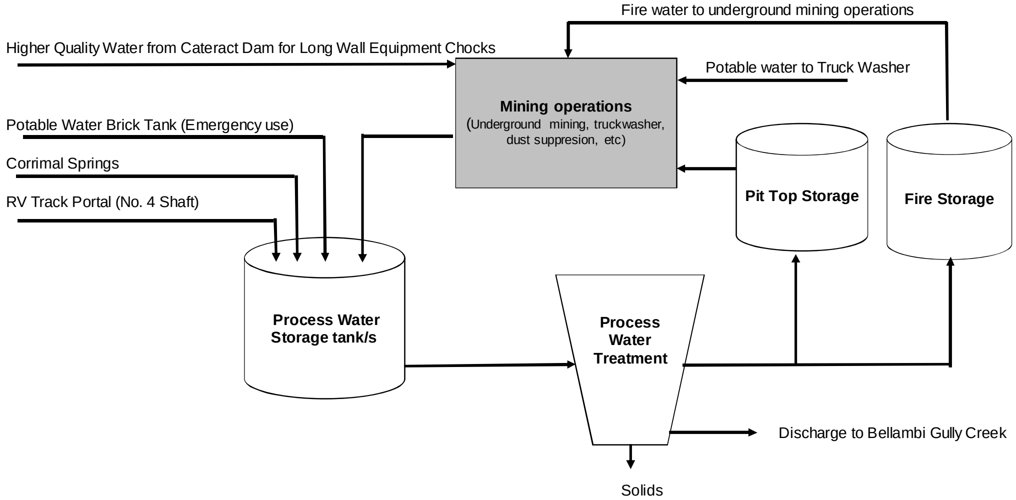


Figure 9 – Schematic of Future Process Water Supply Sources

Mine Dewatering

Groundwater modelling conducted for NRE (Golder Associates 2010) shows water make from future dewatering from mining the Wongawilli seams will be less than mine water make from the Bulli seam under current operations. Golder Modelling indicates that inflow into the proposed Wongawilli Seam workings at the end of project are as shown in Table 3 below.

Table 3 – Model-Generated Inflow Rates (ML/d)*

	Current Bulli Seam Workings	Last phase of mining Wongawilli Seam Workings	Last phase of mining Wongawilli and Bulli Seam Workings
Wonga East	0.2	1.2	1.4
Wonga West	0.9	0.8	1.7

*This table was taken from a report by Golder Associates 2010

NRE estimates derived from modelling outcomes show the annualised daily water inflow rate will be approximately 3.1ML/day at the end of project. This groundwater inflow will be less than process water demand and will result in no mine water discharge from site during dry weather conditions. There will however, be a need to buy between 2.0 – 4.2ML/d of water from Sydney Water or Sydney Catchment authority during the life of this project.

Expected mine water quality is shown in Table 4.

Table 4 - Expected Water Quality from Wongawilli Seam

Parameter	Units	Expected Water Quality
pH	pH units	8.9
Electrical Conductivity (EC)	µS/cm	2910
Total Dissolved Solids	mg/L	1780
Alkalinity (as $CaCO_3$)	mg/L	1520
Total Suspended Solids (TSS)	mg/L	902
Turbidity	NTU	1240
Total Kjeldahl Nitrogen	mg/L	8.4
Total Phosphorus	mg/L	0.27

Long Wall Equipment Process Water Supply to Chocks

Water for use in the new Long Wall Equipment Chocks must satisfy a higher quality standard than the general process water quality suitable for other process water uses. The recommended water quality for supply to the Long Wall Equipment Chocks in Table 5 has been supplied by the manufacturer Joy Mining Equipment.

Table 5 - Underground product water specification (for mining operations)

Parameter	Units	Required Water Quality
pH	pH units	6.5 -8.0
Chloride (Cl^-)	mg/L	<220
Sulfate (SO_4^{2-})	mg/L	<400
Carbonates (as $CaCO_3$)	mg/L	0-250
Appearance		Clear
Electrical Conductivity (EC)	µS/cm	800
Total Suspended Solids (TSS)	mg/L	0

The process water treatment system is designed to remove solids from the water stream and does not include any processing step to treat salinity, alkalinity and pH. The expected process water quality will not achieve this water quality standard and increases the risk of scaling and corrosion of the Long Wall equipment.

For this reason 1.7kL/hr will be sourced from a higher quality water source from Cataract Dam to protect the Long Wall Equipment Chocks against scaling and corrosion. Cataract Dam Water quality is described below in table 6.

Table 6 - Cataract Dam Water Quality

Parameter	Unit	Average water quality
pH	pH unit	7.4
Total Dissolved Solids (TDS)	mg/l	71
Conductivity	µS/cm	98
Carbonate	mg/l	<2
Total Suspended Solids (TSS)	mg/l	20
Turbidity	TNU	2.4

4.3.3 Process Water Treatment

The existing water treatment process including the thickener will be retained to treat combined mine water and dirty stormwater streams. No change is treatment of these water streams is proposed. NRE confirm that the current infrastructure has adequate capacity to treat future predicted flows.

4.4 Storm Water at Russell Vale

4.4.1 Clean Storm Water

Although the impervious area and associated flow rates will be unchanged as result of the expansion of the mining operation, NRE has identified an opportunity to improve stormwater management and control, through engineering upgrades and realignment of the clean storm water flow paths on the site.

Changes will be made to improve the management of water from steep Bellambi Gully areas of the site that have experienced significant erosion. This work will aim at reducing the velocity of water flowing down the gully. The longer channel runs and storage in the newly constructed dissipation dam, prior to discharge, significantly reduces potential energy and hence erosion potential. The drawings in Appendix A describe the proposed changes that include a realignment of a major section of the stormwater drainage line on the site.

The replacement of piped drainage with channel drainage reduces the risk of uncontrolled flows across the site. These uncontrolled flows are associated with blocked drainage pipes. NRE will take appropriate actions to ensure drains are effective with regular maintenance of the channels.

The implementation of this re-aligned channel will minimise the likelihood of potential downstream impacts, such as those from the 1998 floods occurring in the future and has been assessed under the preliminary works EA report submitted to DoP (No:10 0046). The minimisation of potential downstream impacts will be achieved through both the maintenance and upgrade of existing diversions and flow paths (such as those in the upper sub-catchments) and the proposed implementation of open channels and diversions around NRE's proposed stockpile area.

The existing and proposed channel re-alignment and drains will be lined as shown in the "Gujarat NRE Stormwater Hydrology Review" (Beca 2010) and after any further geotechnical advice as required. The channels will be maintained regularly to minimise scouring during major flow events. This will consist of regular inspection and repair of all reno mattress areas, and all shotcrete areas are to be inspected for undermining and eddies, which could lead to erosion if left unaddressed.

4.4.2 Dirty Storm Water

The existing water treatment facility the Thickener Tank will be retained for treatment of dirty storm water prior to reuse or discharge from site.

A dry and wet basin arrangement with better access for maintenance will be implemented to minimise sediment transportation to the SWCD which must maintain a minimum of 30ML spare capacity (or 35ML if only one pump is to operate) at all times to minimise the chance of a major storm surcharging to Bellambi Gully.

The dry and wet basin will be a new 6ML sediment control dam to catch flows from the stockpile area. This new dam will improve stormwater flow attenuation and solids removal. This dam will be kept dry most of the time to facilitate solids removal, and allow ample capacity for storm flow containment.

The existing discharge point will remain unchanged. Under normal operating conditions, the only discharge will be treated stormwater. The discharge quality and quantity of the treated storm water will meet the current licence conditions and be of similar quality to the background water quality in Bellambi Gully and other creeks in the area.

The purpose of the provision for discharge into Bellambi Gully is to cope with storm events, specifically to empty the stormwater control dam after a major event to provide buffer capacity for future mine and stormwater flows into the dam. The discharge is treated water, and is surplus to the water that can be re-used in mining operations.

4.4.3 Treatment of Solids

To enhance operation of the water system it is proposed to establish a solids treatment process facility to divert the solids stream that currently runs from the Thickener Tank into Dam 1, which then feeds back into the Thickener Tank. It is proposed that the solids stream from the thickener tank will be dewatered and returned to product stockpiles.

A number of dewatering technologies are available for this purpose. The following dewatering options were identified:

- Vacuum filter;
- Belt-filter press;
- Recessed-plate filter press;
- Centrifuge;

A multi-criteria assessment (MCA) was undertaken, based on the following aspects:

- Footprint space requirement
- Operability requirements
- Energy requirements
- 25% solids possible
- Continuous or batch operation
- Suitability for coal fines

This MCA is described in table 7 below.

Table 7 - Evaluation of Dewatering Technologies

Technology	Footprint Space Req.	Operability Req.	Energy Req.	25% solids possible	Continuous or batch operation	Suitability for coal fines
Vacuum Filter	Small	Med	Med	Yes	Continuous	No
Belt-Filter	Small	Low	Med	Yes	Continuous	Yes
Recessed-plate filter press	Small	Low	Low	Yes	Batch	Yes
Centrifuges	Small	Med	Med	Yes	Continuous	Yes

Operability considerations included the following items:

- Lubrication and repair of mechanical components
- Cleaning requirements – flushing
- Chemical dosing and monitoring requirements
- Cloth/media/filter changes
- The number of mechanical components

In determining the level of energy requirement the following aspects were considered:

- Power requirements
- Pump requirements (VSD requirements)
- Electrical controls
- Whether the technology is fully or partially automated
- Running time

All the technologies considered can be used for the application of treating water with coal fines. Most of the technologies have the potential to produce sludge cake with low water content.

Vacuum filters would not be suitable for an application with coal fines, as they rely on the use of filter material in a vessel, which would not be effective.

The belt filter is similar to the recessed filter, in that they both engage mechanical processes but the belt filter solids produced are not as dry as those produced by the recessed-plate filter press.

The centrifuge engages a different type of capture mechanism where there is no direct positive action to trap solids in the chamber. Instead it relies on chemical dosing and decanting action to draw solids away.

The following two options will be investigated further for dewatering the sludge stream from the existing thickening tank that treats the storm water and process water from the mine:

- Recessed –plate filter press
- Centrifuge

Recessed-plate filter press dewatering is a batch process; however this can be automated using a PLC. This technology is able to produce good quality dry solids, without the use of additive chemicals. Solids in the sludge stream are mechanically compacted, providing for a forgiving dewatering process.

Centrifuge dewatering, on the other hand, is a continuous operation that relies on decanting action to compact the solids. This requires very sensitive chemical dosing to achieve the desired dewatered solids moisture content. Because of this an interim receptacle will be necessary to ensure the chemical dosing is accurate. It is possible that the filtrate will need further treatment if it is to be re-used and/or discharged to the environment, depending on the effect the chemicals have on the water quality. Filtrate water from the dewatering process is likely to be re-circulated or pumped. A particular water quality will need to be maintained to ensure safety to people and the environment, and also to protect mechanical seals (preventing accelerated maintenance as a result of poor water quality affecting pump seals etc.)

Generally mechanical dewatering processes will be selected by first bench testing with the specific vendors' equipment. Analyses, solid content and characteristics of the solids stream from the current operation will be required to progress selection of the preferred treatment option, which will be subject to analyses and vendor bench scale testing.

As part of the evaluation criteria cost comparisons will need to be made (both capital and operational expenditure) to determine the most cost–efficient and economical technology for this particular application. Costs are generally relative to the volume (more specifically the weight) being processed by the technology, therefore consideration should be made as to the filtrate and solids quality desired from this process.

Consideration will also need to be made to the capacity requirements, which will include determining the rate at which the dewatering will take place and the frequency of such activity.

4.5 Site Water Balance

A summary of water use on site for the future development is shown below in Figure 10. This figure combines the various aspects of water on site into an overall flow diagram and flow balance. Changes in the flow due to the future development are included in this balance. The balance presented is for the average case only. The following information and assumptions were used and/or made to arrive at the balance presented in Figure 10:

- Higher quality water for the Chocks of the Long Wall Equipment will be provided by using raw water sourced from the Cataract Dam. The demand for higher quality water is estimated on 1.7kL/h (41kL/day).
- Alternative uses for water discharged were not included in the diagram and balance presented in Figure 5. I.e. water is only treated to meet water quality conditions for one of 2 destination or end uses. These include:
  - Treated dirty storm water discharged to Bellambi Gully at the existing discharge point (LDP2) meeting the current licence conditions.
  - Treated process water reused in mining operations or discharged to Bellambi Gully at a future discharge point subject to future permit conditions.
- It is planned that solids from the dirty storm water and process water primary solid removal process will be combined for further treatment and concentration of the solids.

In addition to the general assumptions above, the specific assumptions that are in line with the balance presented in Figure 10, together with some additional information and specific assumptions related to the future operation are presented below:

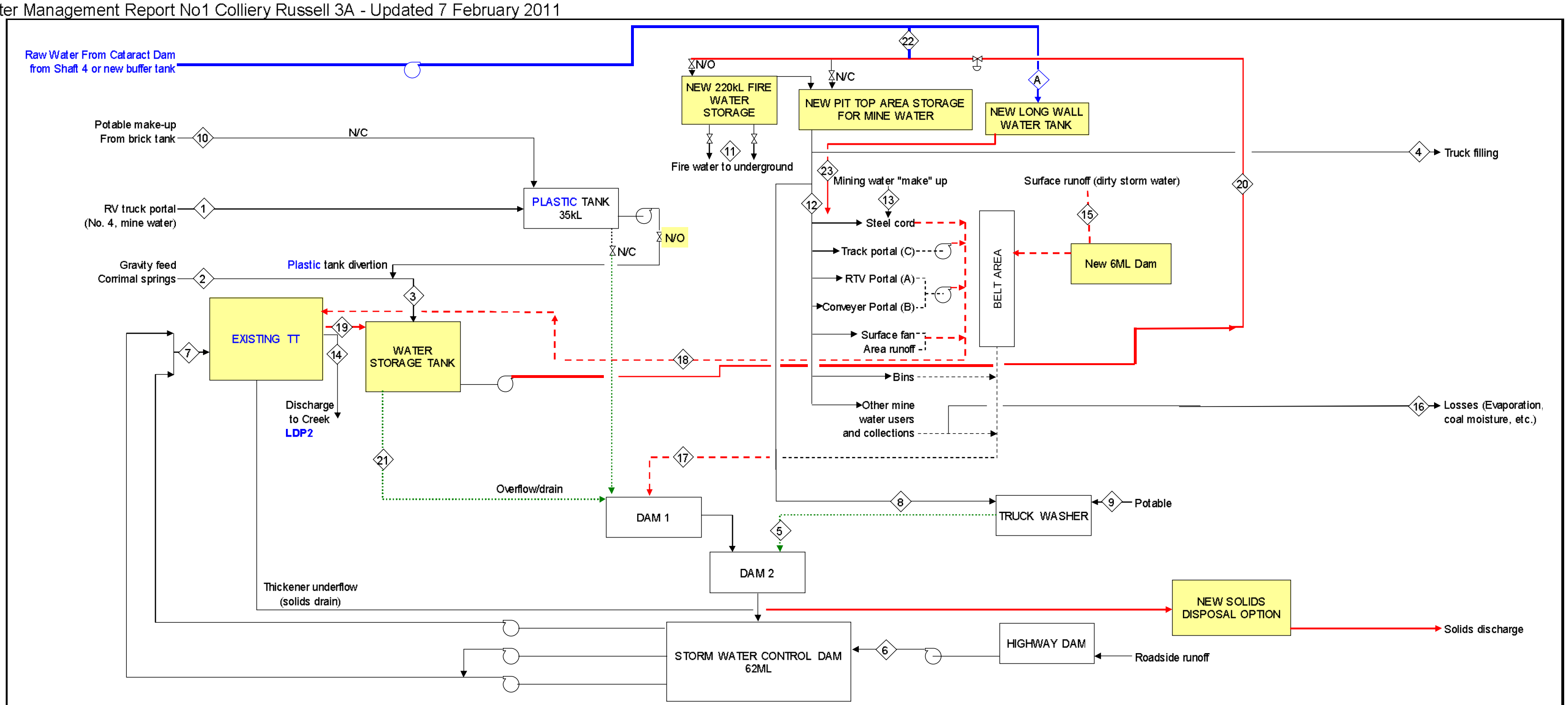
- The balance presented is for the maximum estimated case for dry weather conditions.
- The balance assumes flows for dry weather conditions, i.e. no flow from the Highway Dam (stream 6) and dirty surface run off (stream 15)
- The balance assumes no flow from potable water make-up (stream 10)
- 4.2 ML/day (stream 12) is water supplied underground for dust suppression and equipment operation
- The overall balance assumes continuous average normal flows for a 24 hour working day for the Process Water System. The Dirty Storm Water System is based on 0, 1 or 2 pumps running to keep the Storm Water Control Dam under the 50% full level to meet the required storage capacity for a 10 year average recurrence interval (ARI) rain event.
- The balance assumes non-continuous flows are successfully buffered by intermediate holding volumes in dams and tanks.
- RV track portal pump out provided as a range of 0.5 to 1ML/day (0.5ML/day assumed normal and 1ML/day assumed as maximum for stream 1).
- Corrimal springs make-up (stream 2) rate assumed as 1L/s (3.6m^3/hr.)
- Truck filling (stream 4) estimated assuming 30 trucks per day with capacity of 13kL for dust suppression.
- Stock pile dust suppression (truck filling) and truck wash daily consumption was quoted as 27kL/h. The difference between this and the truck filling is assumed to be truck wash (stream 8).
- Potable water to truck wash (stream 9) is assumed to be 25% of the process water that is supplied to the truck wash.
- Water loss (stream 16) through evaporation, coal moisture, etc. from the system was assumed to be 5% of the water supply to the mine operations (stream 12).
- 10% of the water supplied to mine operations is assumed to be not recoverable or collectable to the new mine water storage tank/s and that this will be routed (as part of stream 17) through existing drains to Dam 1.
- The solid side of balance is not included (initially assumed negligible in the overall balance).
- The balance of water was assumed to be discharged to the gully (stream 14).

The future flow diagram and balance is presented in Figure 10. New or changed processing steps are highlighted in yellow and new or changed lines are shown in red. The diagram does not show all detailed processing steps and equipment within the relevant blocks.

4.6 Shaft No. 4 changes

The number of employees at the No. 4 Shaft site will fluctuate when the new work commences. Some employees will move from the Shaft No. 4 site to the Russell Vale site at the start of mining the Wonga east seam. It is anticipated there will be 111 employees at Shaft No. 4 during this time. They will progressively move back to Shaft no. 4 as the mining progresses to the Wonga west seam, where there is expected to be up to 355 employees. There is not expected to be any modifications to the facilities at Shaft No. 4, as these were originally designed for a larger number of people working at this site (approximately 1000 persons).

The third maturation pond will be used as a wet weather storage facility for treated black water. This 950kL storage will be drawn down over summer and other periods of high evaporation. The volume stored will be allowed to build up during periods of low evaporation. The irrigation area will be monitored as described earlier. The existing irrigation area is currently underutilised. This provides available irrigation area for periods of peak load, and if additional space is required for effluent disposal during wet weather.



STREAM NUMBER			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	A
STREAM NAME / PARAMETER			RV TRACK PORTAL PUMPOUT ***	CORRIMAL SPRINGS	PLASTIC TANK AND CORRIMAL WATER DIVERTED TO NEW TANK	TOTAL TRUCK FILLING	TRUCK WASH COLLECT	WATER FROM HIGHWAY DAM	WATER FROM STORM WATER CONTROL DAM	MINE WATER TO TRUCK WASH	POTABLE WATER TO TRUCK WASH**	POTABLE WATER TO MINE USE**	FIRE WATER TO MINE	MINE WATER SUPPLY	MINE WATER "MAKE" UP	TREATED DIRTY STORM WATER DISCHARGE TO CREEK LDP2	DIRTY STORM WATER	SYSTEM WATER LOSSES	MINE WATER NOT TO TREATMENT	MINE WATER TO TREATMENT	TREATED WATER TO STORAGE	TREATED WATER TO STORAGE	TREATED MINE WATER OVERFLOW TO DAM	TOP UP WATER	RAW WATER TO LONG WALL CHOCKS*	RAW WATER TO LONG WALL STORAGE TANK*
CONTINUOUS OR INTERMITTENT																										
FLOW RATE	MAX	ML/day	1.0	0.1	1.1	0.4	0.3	0.1	0.0	0.3	0.09	0.0	0.0	4.2	0.00	0.0	0.0	0.3	0.6	3.1	3.1	4.8	0.0	0.0	0.041	0.041
	MAX	m^3/h	41.7	3.6	45.3	16.3	14.3	6.0	0.0	10.8	3.6	0.0	0.0	175.0	0.00	0.0	0.0	12.5	25.0	129.2	129.2	200.0	0.0	0.0	1.7	1.7
pH		-	8.2	-					9.1		8	8	8.7	8.9		9				8.99					8.2	8.2
CHLORIDES		mg/litre	NA	-					NA		21.5	21.5	NA	NA		NA										
SULFATE (SO4)		mg/litre	NA	-					NA		4	4	NA	NA		NA										
CARBONATES (As CaCO3)		mg/litre	10	-					110		46	46	190	190		110			1520	1520					10	10
APPEARANCE (TURBIDITY)		NTU	5.2	-					570		0.2	0.2	79	85		27			1240	1240					5.2	5.2
ELECTRICAL CONDUCTIVITY		µS/cm	110	-					1900		14	14	3700	3000		2100			2910	2910			110		110	110
TSS		mg/litre	200	-					120				79	24		27			902	902					200	200
TDS		mg/litre	120	-					1200		87	87	2300	2200		1300			1780	1780					120	120
Total phosphorus		mg/litre	0.009	-							0.007	0.007							0.27	0.27					0.009	0.009
Total nitrogen		mg/litre	0.26	-							0.13	0.13							(8.4 Nkjd)	(8.4 Nkjd)					0.26	0.26

* The highest values are taken from the available Cataract Dam water quality data
** Potable Water Quality Data from Sydney water, Illawarra Water Filtration Plant
*** Potential raw water supply from Cataract dam

#DIV/0! #DIV/0!

Figure 10 Water uses at NRE No. 1 Colliery at end of project

Note information is approximate only and will be confirmed when production commences.

4.7 Environmental Protection Licence

No alterations to the existing conditions for discharge from LDP2 are anticipated to be required as a result of the proposed expansion and upgrade works. LDP2 will continue to act as the discharge point from the Russell Vale site for treated stormwater, and discharge will occur in accordance with current licence conditions.

5 Assessment of potential Impacts on receiving water

This section describes the impacts of water management practices at NRE No. 1 Colliery on the quantity and quality of surface water in the project area, specifically considering the discharge of treated process water and storm water into Bellambi Gully. The discharges to the environment from the site will not require a change to the existing EPL conditions. The discharges that run into Bellambi Gully continue through the gully to the outlet at the sea as shown in figure 11. None of the discharges from the mine flow into Bellambi Lagoon, or any other lagoon in the area.

Figure 11 - Flow path of Bellambi Gully

5.1 Water Quality

The water quality in Bellambi Gully is variable. The gully is a disturbed urban creek. Water sample results taken by NRE are shown in Appendix C. Water quality from Wollongong Council samples for Bellambi Gully and other local creeks are provided in Table 9.

Table 8 provides a comparison between water quality in Bellambi Gully, NRE No. 1 discharge water quality, ANZECC Guidelines and NRE EPL.

Table 8 - Water Quality Comparison

Analyte	Units	Russell Vale Discharge LDP2***	EPL 12040 Concentration Limits LDP2	Bellambi Gully*	ANZECC** Guidelines
pH	pH unit	7.1-9	6.5-9.2	8.1-9.2	6.5-8(9)
Oil & Grease	mg/L	<0.1	10	<0.1	NS
Total Dissolved Solids	mg/L	1100-1900	NS	1220-1900	125-2200
Total Kjeldahl Nitrogen	mg/L	0.4-1.1	NS	0.4-0.9	0.5
Total Phosphorus	mg/L	0.03-0.12	NS	0.08-0.3	0.05
Total Suspended Solids (TSS)	mg/L	13-27	50	1-52	NS

*from Wollongong Northern Coastal Creeks and Lagoons report by WBM January 2006 and NRE testing
** Australian and New Zealand Environment Conservation Council's Guidelines for Fresh and Marine Water Quality, lowland rivers (ANZECC)
*** for more details see appendices B & C
NS: Not Specified

The Bellambi Gully water quality results are consistent with the findings reported in "Wollongong Northern Coastal Creeks and lagoons by WBM 2005" which investigated the water quality in the region. Water quality from Wollongong Council samples for Bellambi Gully and other local creeks are provided in Table 9.

Table 9 - Water Quality in the Region (from "Wollongong Northern Coastal Creeks and Lagoons by WBM 2005)

Pollutant	Flanagan's Creek	Collins Creek	Bellambi Gully	ANZECC* guideline
pH	6.6-8.4	7.5-8.6	7-9	6.5-8
Total Dissolved Solids (TDS)	400-288	1000	1000-7000	125-2200
TKN mg/L	0.1 – 0.55	0.2 – 1.6	0.2-0.9	0.5
TP mg/L	0-0.11	0.1-1.5	0.02-0.3	0.05

*Australian New Zealand Environment Conservation Council 2000 marine and freshwater guidelines for lowland rivers

Table 9 demonstrates that background water quality levels for creeks in the Wollongong area have nutrient, pH and TDS levels that exceed ANZECC guidelines. This is likely to be influenced by the urban nature of the catchment and tidal influence. The area around the gully downstream of the EPL has been cleared with a small section near Bellambi beach being returned to a more natural state.

The upper catchment of the Bellambi Gully on the western site of the Princess Highway contains the Gujarat NRE No. 1 Colliery, the golf course (former waste disposal area) and areas of urban development. The middle and lower catchment of the Bellambi Gully catchment consist of large areas of urban developments including recreational facilities such as public parks, reserves and schools. The Gully also runs through or near private property including some light industrial units.

Nutrient levels in Bellambi Gully are higher than ANZECC freshwater guidelines for lowland rivers in the creek presumably due to urban runoff. Current discharge concentrations for TP are less than background levels in the creek. Algae growth or other biological growth is more pronounced in stagnant water. Discharging some water through the creek can reduce this stagnation, and the associated algal growth.

Literature review also characterised the water quality in Bellambi Gully by elevated pH, conductivity, BOD_5, COD, ammonia, suspended solids, nutrients, copper and zinc. Faecal coliform levels generally exceed the primary recreational contact guidelines. The low macro invertebrate diversity is indicative of an urbanised catchment, water quality problems and/or loss of riparian habitat.

Water quality testing in 1994 (Anthony 1994, for Wollongong City Council) indicated that the various tributaries within the catchment were contaminated by pollutants, indicated by high levels of pH, conductivity (possible due to lithology), Biochemical Oxygen Demand (BOD_5), Chemical Oxygen Demand (COD) and ammonia, in both dry and wet weather (Anthony 1994). In particular, during wet weather periods, high levels of *E.Coli* bacteria.

Both Table 8 and Table 9 show that the water quality at Russell Vale LDP2 sometimes exceeds ANZECC freshwater guidelines for lowland rivers. However these tables also indicate the water quality at the Russel Vale LDP2 is similar to the background water quality in the gully and other creeks in the area.

5.2 Water Quantity

The natural flow through Bellambi Gully is highly variable. The low lying area east of the Princes Highway is cleared of natural vegetation. The catchment is small and the gully reacts quickly to rainfall events rising rapidly and falling to a trickle for extended periods.

5.2.1 Erosion Potential

There is the potential for the erosion of Bellambi Gully as a result of discharge into the gully. The gully is highly urbanised and vegetated (in some areas it is concrete lined). Water discharged by the mine will be a significantly smaller flow when compared with the flows in the gully during high rainfall events. The flow from the mine site is approximately $0.003m^3/s$. The 1 in 5 year rainfall event produces a discharge of $17m^3/s$ from the catchment above the EPL discharge point (LDP2). Therefore the $0.003m^3/s$ discharged from the mine is inconsequential in comparison to the $17m^3/s$ discharged from the catchment above the mine's LDP2. Any potential erosion associated with mine water discharge is insignificant compared with the erosion potential of flows into the gully during heavy rainfall events.

5.2.2 Management measures

Stormwater from hard surfaces is diverted into the Storm Water Control Dam (SWCD) via a number of earthen channels and concrete pipes. The water is stored in the SWCD prior to treatment and discharge via controlled valve at LDP2. This reduces solids, but also holds the water in the dam, reducing flow rates through Bellambi Gully during storms of intensity less than 1 in 10 year event.

The SWCD is kept at a level that allows flow attenuation prior to discharge to environment. This reduces erosion potential by reducing the peak flow during storm events up to 1 in 10 year events.

The SWCD is registered with the Dam Safety Committee (DSC). The dam has a controlled gabion lined spillway for events greater than 1 in 10 years.

5.3 Flooding Risk

Wollongong has a warm temperate climate. The relatively high rainfall in the region and steep topography creates many small high velocity waterways including the Bellambi Gully. The Bellambi Gully catchment is 427ha and the total creek length is 4.3km (WBM Oceanics Australia for Wollongong City Council, June 2005,). The NRE site is approximately 22.4% (96ha) of the catchment of the Bellambi Gully, of this 76ha is uncleared.

Downstream of NRE's LDP2, the Gully comprises either culverts under main transport structures and roads, or disturbed creek bed, through urban areas. Bellambi Gully flows from LDP2, under the Princes Highway, past several industrial premises, under the northern distributer, through residential streets, under the railway line, through Holy Spirit High School grounds, and then flows out into the ocean. The gully length is approximately 3km from LDP2 to Bellambi Beach.

In general, the flows in the Bellambi Gully consist of storm water run-off in the catchment and the discharge of treated mine water at the licence discharge point (LDP2). In dry weather the gully receives on average approximately 0.4 ML/d from the NRE site under existing operations. After the upgrades to the site, this will be zero.

In wet weather the gully could receive up to maximum 7.2 ML/d for not longer than a 72 hour period from the NRE site under the existing licence. The existing capacity of the stormwater control dam is sufficient to contain and successfully manage all 10 year ARI storm event for 72 hours (assuming 50% normal operation level and treating the maximum flow of 300kL/h during a storm event). The stormwater control dam is a mechanism for the attenuation of stormwater flow in a storm event, and as such assists in reducing the likelihood of any flood risk.

Figure 12 shows the frequency of high and low flow discharges per year from LDP2 to Bellambi Gully. It is demonstrated in figure 12 that the discharge is less than 0.5ML/day for most of the year. The occurrence of discharge events greater then 2.5ML/day has been less than 10 days per year in the years 2007 to 2009.

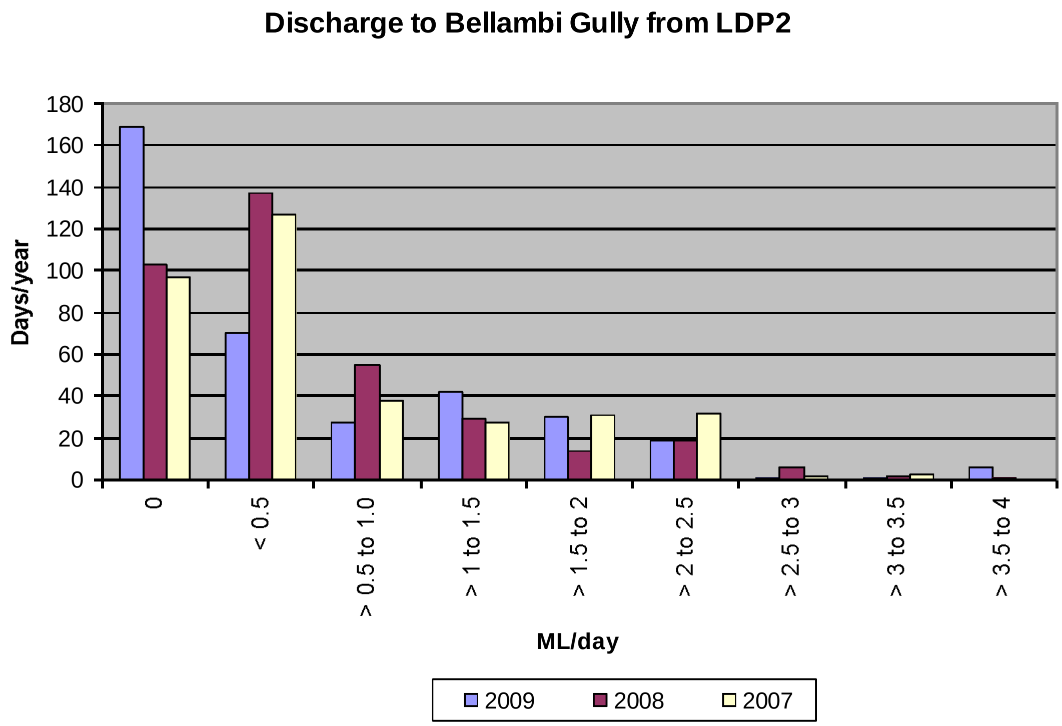


Figure 12 – discharge volume date from NRE to Bellambi Gully

The wall of the storm water control dam is designed to be permeable and slowly filter and discharge water. The flow rate through the dam wall is monitored by NRE, although not as a licence requirement. The dam wall seepage is collected and measured using a V-notch weir. The average instantaneous flow rate is 0.42L/s.

A preliminary study of the Bellambi Gully catchment has confirmed that the existing concrete culvert (2.4m wide x 1.5m high) at the Princes Highway is inadequate for a 10 year ARI event. During such an event it is likely backwaters would accumulate until they spill over the Princes Highway. It would seem that the culvert is undersized and this may contribute to the flooding potential risk upstream of the Princess Highway.

The proposed changes to mining operations at the Gujarat NRE No. 1 Colliery will not add to flooding potential. Diversions proposed under separate approval will reduce energy in the stormwater and the management of the SWCD attenuates flows smaller than a 1 in 10 year event.

6 Mitigation Measures

NRE propose a number of mitigation measures to improve water management at the NRE No. 1 site, these are presented in table 10 below.

Table 10 – Mitigation Measures and Summary Improvements to Water Management Systems

Water system	Mitigation Measure	Improvement / benefit
Process water treatment at Russell Vale	Investigate treatment of solids removed from process water	• Solids will be mechanically dewatered and removed form site providing additional dam storage on site and reducing chance of overflows.
Dirty stormwater treatment	Optimise performance of existing thickener for solids removal from dirty stormwater	• Improve quality of discharged effluent to Bellambi Gully
Dirty stormwater treatment	Construct a new 6ML storage dam to collect runoff from stockpile area.	• Minimise transport of sediment to the Storm Water Control Dam • Improve storage capacity at SWCD due to reduced solids settling
Site water use	Water Efficiency audit. Complete a study of water use on site, and determine if less water can be used.	• Reduce water use • Reduce use of higher quality water

7 Conclusion

Expansion of mining operations to include the Wongawilli seam in addition to the Bulli seam will increase the mine water flows at the Gujarat NRE No. 1 Colliery. It is predicted that there will not be sufficient quantities of water inflow to the mine to meet increased process water demand.

At the end of project the water production from mining operations is expected to be 3.1ML/day, which is 1.1ML/d less than demand.

At start of mining Wongawilli seams, water produced from mining operations will be less than at the end of mining and additional water will need to be provided to supplement the site's water requirements.

The main change to surface water management is the construction of a 6ML dam to collect run off from the new stockpile.

It is anticipated that discharge into Bellambi Gully will be in line with current practice, and as such the existing licence will still be applicable for the increased mining operations.

It is proposed that the sludge from the existing thickening tank be diverted from Dam 1. Instead the sludge will be dewatered and the solids cake will be added to the ROM coal product, if appropriate, with the overflow water being recycled back into the mine process water system. This will improve the efficiency and economy of the treatment processes and the solids output.

Appendix A

Gujarat NRE Stormwater Hydrology Review and Stormwater Diversion Drawings

Report

Gujarat NRE Stormwater Hydrology Review

Edited for Part 3A submission

Prepared for Gujarat NRE (Client)

By Beca Pty Ltd (Beca)
ABN: 85 004 974 341

19th October 2010

Revision History

Revision Nº	Prepared By	Description	Date
A	Paul Irwin	Preliminary Draft – For Information	30/09/2009
B	Paul Irwin	Preliminary Draft 2 – For Information	02/10/2009
C	Paul Irwin	Issued for Information	15/10/2009
D	Paul Irwin	Final Issue	25/11/2009
E	Dianne Thomas	Edited for Part 3 Approval for use by ERM.	26/05/2010
F	Paul Irwin	Update Methodology	08/09/2010
G	Paul Irwin	Update Basin Information	19/10/2010

Document Acceptance

Action	Name	Signed	Date
Prepared by	Paul Irwin		19.10.10
Reviewed by	Dianne Thomas		19.10.10
Approved by	Dianne Thomas		19.10.10
on behalf of	Beca Pty Ltd		

Introduction

During 1998 the Illawarra experienced a major storm event which caused considerable flooding throughout the region. Review of the rainfall data for this event taken from the Russel Vale catchment confirms that this storm was a statistical 100 year average recurrence interval (ARI) event when compared to BoM statistical models.

Although the mine operators at the time had in place a number of diversion drains, settlement and piped stormwater systems, these proved inadequate due mostly to maintenance, inadequate design, and lack of redundancy factors of safety. This resulted in large quantities of escarpment runoff water diverting through the existing coal stockpile.

As this coal stockpile drained to the dirty water treatment and collection system, this system was overwhelmed and resulted in black water and coal washing down the Bellambi Creek and through a number of private properties causing considerable damage.

This study will attempt to review and address these existing inadequacies as well as propose new measures to minimise the likelihood of future failures.

Stormwater Methodology

As the mine upgrade is primarily to underground activities and to a limited extent the surface areas, it's expected that the proposed mine upgrade will not result in a significant change in impervious areas when compared to the existing site. This study therefore is intended to calculate the flowrates and flowpaths of the existing catchments to Bellambi Creek with the aim of producing a stormwater management concept to form the basis of future detailed design.

As stated above, the primary cause of the failure of the stormwater management system in the past (i.e. the 1998 storms) was due to blockages and diversion of the primary clean water through the dirty water and coal stockpile areas. This was primarily a result of inadequate sizing of diversion drains, poor maintenance, and insufficient erosion protection. The intention of this study is therefore to provide a concept for the management of this stormwater coming from the upper catchments reducing the risk of this situation reoccurring into the future.

The guide for the collection, storage, and treatment of dirty water within the site is primarily through the application of recommendations outlined in both Managing Urban Stormwater: soils and construction volume 1 (Landcom 2004) and Managing Urban Stormwater: soils and construction volume 2E mines and quarries (Dept. Of Environment and Change 2008). As per these outlines the primary focus of the concept is that clean upper catchment flows should be diverted around the operational area "dirty water" flows to minimise the required dirty water treatment volume. Further consideration was also given to flooding studies and additional literature where relevant and as appropriate.

It should be noted that the intention of the concept is to provide a solution which will significantly reduce the possibility of blockage and diversion of the clean water flow through the dirty water areas and propose minimum basin and treatment area for the dirty water collected from operational areas on site. This concept will therefore maintain the existing flowrates generated by the subject site to Bellambi Creek via the existing RTA culvert under the Princes Highway. The concept will propose options for the reduction in potential blockages due to debris on the Russell Vale site, which would have contributed heavily to the downstream flooding. However, it will not reduce the flowrate or propose options for any upgrades and/or maintenance that may be required downstream of the site not owned by or in the control of Gujarat NRE.

Each of the catchments has been modelled using an ILSAX hydrological model within the DRAINS application using the latest Bureau of Meteorology IFD data for the subject site.

The ILSAX storage parameters used were 1mm of storage for both paved and supplementary areas, and 5mm of storage for pervious areas. A soil type 3 was selected as clays are present in the upper escarpment. This will be conservative for the middle and lower catchments which are freer draining fill.

Rainfall data used as per the BoM IFD information was:

- 2yr1hr 47.22
- 2yr12hr 11.43
- 2yr72hr 4.51
- 50yr1hr 107.86
- 50yr12hr 28.25
- 50yr72hr 9.58
- G 0.00
- F2 4.28
- F50 15.81

Storms modelled for the purposes of the preliminary design of channels and pipes were the 5, 10, and 100 year frequency events (Q5, Q10, Q100 respectively).

Storm durations modelled within each Annual Recurrence Interval (ARI) were 5min, 10min, 20min, 30min, 45min, 1hr, 1.5hr, 2hr, 3hr, 4.5hr, and 6hr with the Dirty Water storage basin being assessed up to a 72 hour duration 10yr ARI event.

Based on these flows, site observations, and survey information Hec-Ras channel models and DRAINS piped flow models have been produced for the preliminary design of the proposed stormwater treatments.

Catchments

Catchment Zones

The subject site consists of three major catchment zones depending on their location and broadly their land use and grade. These three catchment zones are defined as:

Upper Catchments – This zone is characterized by predominantly natural escarpment and steep heavily vegetated slopes with thick undergrowth. The Upper Catchments include a number of small dams for use within the mines and also a number of unsealed access roads and fire trails.

This catchment zone is considered to be 100% clean water with no coal stockpiling or conveyor activities within any of its subcatchments.

Middle Catchments – This zone includes the workshop, offices, a number of existing and proposed portals, and a network of access roads between the stockpile and the Upper

Catchments. It is characterized by steep batters of both natural slopes and mine tailing material and with the exception of Subcatchment M7 will not be exposed to coal stockpiling, conveyor operations, or hauling in the proposed mine upgrade.

The catchment M1 is also used to store plant and materials and has both a sealed and gravel surface which although not used for the storage or transportation of coal has the potential for light contamination during initial runoff.

Lower Catchments – This zone is dominated by the coal stockpile and haul areas, truck loading facility and settlement basins. It is also the location of the clean water discharge point to Bellambi Creek.

Sub-Catchments

Each of the above zones has then been broken down into sub-catchments based on their location within the overall catchment plan and their dirty water or clean water characteristics.

As stated above, each of these sub-catchments have been reviewed, modelled, and recommendations made based on preliminary plans and information provided in meetings with the client.

<u>Note</u>: All flow rates and areas are for individual subcatchments and <u>not</u> a cumulative total and are subject to change upon final design and detail following Part 3A approval.

Subcatchment U1

10.69ha

100% pervious

Clean Water (CW) catchment.

Q5: $2.83m^3/s$

Q10: $3.58m^3/s$

Q100: $6.39m^3/s$

This sub-catchment is a natural escarpment catchment which is dominated by heavy trees and undergrowth with a number of unsealed access roads and fire trails. The sub-catchment also includes two open dams which are used for underground water supply, these dams do not collect or store water from the natural catchment and are instead fed by pump from the lower catchments. As the dams do not intercept a larger catchment than their own surface area they are not at risk of overtopping during a major event provided adequate freeboard is maintained.

The current catchment drains by sheet flow in a general easterly direction and in minor events will be contained within the unsealed access road swale drains. Which eventually discharge into the existing southern stormwater channel. However the capacity of these roads to contain major events is limited and will result in overtopping of these flows down the catchment grade and through M7 (which is a Dirty Water catchment).

In order to ensure that all major storm events reach the stormwater channel a diversion drain is required to be constructed along grade. The grade of this channel should be kept to a minimum to limit scouring and generally following the contour of the catchment from south to north.

A Hec-Ras channel flow model was constructed assuming a trapezoidal channel and the flow rates up to and including the Q100 flow indicated above. In order to limit the impact of minor land slips, local settlement, obstructions and poor maintenance a freeboard of at least 500mm should be allowed for in the sizing of this channel.

The length of the channel will be approximately 170m and a longitudinal grade of 2% has been assumed to limit velocities and scour.

Based on the above parameters a trapezoidal channel of base width 2.0m (minimum) and minimum depth 1.5m with 1:2 side slopes is required. It is not advisable to reduce this width or depth along the length of the channel as it is possible (though unlikely) that a majority of the flow rate will enter the channel at its southern extent in the event that a roadside drain fails towards the southern extent of the catchment.

This approximate channel location and details have been shown in the sketch plans provided.

Subcatchment U2

9.76ha

100% pervious

Clean Water (CW) catchment.

Q5:	2.50m3/s
Q10:	3.13m3/s
Q100:	5.66m3/s

As with U1, this subcatchment is a natural escarpment catchment which is dominated by heavy trees and undergrowth with a number of unsealed access roads and fire trails.

The current catchment drains by sheet flow in a general easterly direction until intercepted by the access road which then discharges to an existing diversion drain. In the event that the roadside swales are breached and water continues east, this diversion drain is intended to direct flows to the southern stormwater channel.

The capacity of this existing diversion drain upon inspection was reduced due to very dense undergrowth which had choked up the channel. Upon clearing of this channel it was also apparent that local settlement and land slip had reduced the cross section of this drain in several locations.

The channel was then surveyed and a Hec-Ras model of the existing drain was produced. The Hec-Ras model makes the assumption that in future events the channel will remain clear of undergrowth and lantana through regular maintenance.

The Hec-Ras analysis of the existing diversion drain has concluded that in its current maintained form there is insufficient capacity between chainages 140 and 304 to contain a 100yr ARI event which would result in overtopping of this drain to M1 and subsequently lead to erosion of the drain and an increase of flows to M1.

The cause of this section of channels insufficient capacity was due to a combination of insufficient cross section due to slump and design and a very flat longitudinal grade.

This section of the diversion drain therefore requires upgrading to achieve a consistent grade from Ch140 to Ch304 which matches in with existing at each extent. Due to the change in elevation along this length of 164m a longitudinal grade of 2.75% is required to minimise upstream and downstream alterations.

An alternative Hec-Ras model of the diversion drain, including the upgraded trapezoidal section was then created. Based on the above parameters a trapezoidal channel of base width 2.0m (minimum) and minimum depth 1.25m with 1:2 side slopes is required at a minimum slope of 2.75%.

This channel location and preliminary details have been included in the sketch plans provided.

Subcatchment U3

8.63ha

100% pervious

Clean Water (CW) catchment.

Q5:	2.21m3/s
Q10:	2.77m3/s
Q100:	5.00m3/s

As with U1 and U2, this subcatchment is a natural escarpment catchment which is dominated by heavy trees and undergrowth with a number of unsealed access roads and fire trails.

The southern section of the catchment drains by sheet flow in a general easterly direction until intercepted by the access road, this is then channelled in the roadside drainage to the north and into an existing diversion drain. This diversion drain has been maintained by the mine operator and in the event of failure drains to subcatchment U4.

The capacity of this existing diversion drain on the steep grades is adequate for major events and historically discharges to the northern valley/channel system on the adjacent lot.

As this catchment historically discharges into the adjacent northern valley it does not form part of the stormwater model for the Russel Vale site. This channel should be regularly maintained and free from obstructions, weeds, lantana, and undergrowth to ensure its continued capacity. Emphasis should also be placed on the maintenance of the existing access road in the southern portion of this site to ensure that the swales and cross fall are even and free from obstructions.

Subcatchment U4

0.50ha

100% pervious

Clean Water (CW) catchment.

Q5:	0.226m3/s
Q10:	0.274m3/s
Q100:	0.459m3/s

This subcatchment is located east of the U3 catchment and is the site of the original electrical power station of the mine. The power station is no longer in use and there are no significant structures or impervious areas within the catchment to increase runoff intensity. The natural soil in this location is comprised of a high percentage of ash and fine silty materials and is therefore highly prone to erosion.

As with subcatchment U3 this subcatchment historically drains to the north via an existing diversion drain which has recently been maintained by the mine operator. This diversion drain has been oversized to allow for redundancy of the U3 diversion drain in the event of failure. The capacity of this existing diversion drain on the steep grades would be adequate for major events.

As this catchment historically discharges into the adjacent northern valley it does not form part of the stormwater model for the Russel Vale site. This channel should be regularly maintained and free from obstructions, weeds, lantana, and undergrowth to ensure its continued capacity. As with U3 emphasis should also be placed on the maintenance of the existing access road in the southern portion of this site to ensure that the swales and cross fall are even and free from obstructions.

Subcatchment U5

0.4ha

100% pervious

Clean Water (CW) catchment.

Q5:	0.189m3/s
Q10:	0.237m3/s
Q100:	0.367m3/s

As with U3, this subcatchment is a natural escarpment catchment which is dominated by heavy trees and undergrowth with a section of unsealed access roads and fire trails. This is adjacent to the M2 subcatchment which comprises of the mine office building, carpark and substation.

As with subcatchment U3 this subcatchment historically drains to the north via an existing diversion drain which is required to be upgraded and maintained by the mine operator. This diversion drain is the last line of diversions to the northern catchment before the substation and so a concrete diversion channel is proposed to ensure that major storm events will not cause damage to the mines power supply.

A Hec-Ras model of the proposed channel upgrade has been prepared assuming a rectangular section using concrete culverts. A conservative catchment area of 1ha was assumed to allow for redundancy of the U4 catchment diversion drain. This has resulted in a design section of 1m wide by 0.5m depth with a factor of safety of 2 on the existing grade.

As this catchment historically discharges into the adjacent northern valley it does not form part of the stormwater model for the Russel Vale site. This channel should be regularly maintained and free from obstructions to ensure its continued capacity. Emphasis should also be placed on the maintenance of the existing access road in the southern portion of this site to ensure that the swales and cross fall are even and free from obstructions.

Subcatchment M1

1.89ha

55% Pervious

45% Paved

First Flush (FF) catchment.

Q5:	1.89m3/s
Q10:	2.28m3/s
Q100:	3.92m3/s
DW:	0.02m3/s maximum flow

Subcatchment M1 is characterised by both a section of natural escarpment slopes located below the U2 and U3 catchment and also the workshop and mine portal area. Although the workshop and mine portal area (and surrounding roads) are not proposed for the stockpiling or haul of coal, due to the presence of plant and machinery for service (or entry/exit to the pit) on the hardstand areas there is potential for minor contaminants to be on the surface within this area.

Due to the potential for contaminants the existing M1 catchment drains to a piped stormwater pit system with restricted first flush outflow. The existing first flush system includes at the pit invert a 100mm diameter pipe and 200mm high weir. The first flush of stormwater which falls on the paved component of the M1 catchment is diverted down this line to the Dirty Water drainage system. As the flow rate within this catchment increases during a major event the water level increases until it spills over the 200mm high weir and enters the 225mm diameter Clean Water pipe which discharges east to the southern stormwater channel. In a major storm event, with 1m of head the maximum flow rate of the Dirty Water first flush pipe is 0.02m3/s.

In a major event this 225mm diameter pipes capacity is exceeded and water is then directed overland to the primary stormwater channel at the base of the U1/U2 catchment where it then drains to the M3 subcatchment.

It is also important to construct a crest perpendicular to the access road to subcatchment M3 which will prevent overland flows from spilling down this road. Additional flows down this road would increase the flow rate in the southern channel of M3 which although it has the capacity would generate potential erosion to the M3 access road due to steep grades. The location of this crest has been shown on sketch SK5.

The U1 and U2 catchments drain to the M1 subcatchment via the southern stormwater channel. The eastern extent of this channel (to the west of the culvert crossing location) is heavily eroded due to steep grades and the high erodability of the coal seam in this location. In order to minimise future erosion a number of options have been considered:

Sprayed Concrete ('shotcrete') Lining – This method provides a relatively smooth and high capacity channel lining which is not prone to blockage. However, the subgrade in this location consists of a highly erodible natural soil which, through the action of eddies in cracked sections has a tendency to become undermined in high velocity flow areas. It is therefore not an ideal long term solution in a high velocity/flow location.

Gabion Basket – The construction of a stepped gabion basket channel is a good solution hydraulically as it has considerable energy dissipation characteristics and low maintenance. Disadvantages to gabion basket construction are the considerable earthworks required to install a stepped basket structure with benching, batters, and footing systems requiring substantial remodelling of the hillside.

Reno Mattress – The installation of a reno mattress (underlain with geofabric) is an alternative to gabion baskets. Instead of a stepped basket structure on a solid foundation the channel can instead be smoothed out and lined with a geofabric which is then covered in a layer of large crushed rock under a heavy duty galvanised steel mattress (size of rocks to be dependant on flow velocity and to be determined at detailed design stage). Reno mattresses have the added advantage of the ability to conform to the shape of the channel more naturally. Disadvantages of reno mattresses are that they are not as tolerant to the action of vertical cascading water (such as that on a waterfall or vertical drop) and still require regular maintenance.

For the lining of this section of channel it is recommended that a reno mattress be installed to the entire length of the eroded channel section. In addition to this the existing trash rack structure is to be maintained and cleaned out regularly.

Subcatchment M2

1.28ha

34% Pervious

66% Paved

Clean Water (CW) catchment.

Q5:	0.528m3/s
Q10:	0.625m3/s
Q100:	0.995m3/s

This subcatchment consists of the office building, and carparking facilities as well as a small section of natural catchment to the west. Sheet flows and concentrated flows from the small section of natural catchment are captured above ground and directed via piped stormwater to the M8 Catchment.

There is no mine operations in this section of the subject site and so it is assumed that all surface runoff will be considered as clean water. There is potential for some sediment load to come from the carpark area, this water will bypass the energy dissipater at the base of the stormwater channel, but in all low flows will pass through the lower existing weirs and ponds n Bellambi Creek before exiting the site which will allow for any light sediments to be removed, however it is therefore recommended that consideration be given to providing a bitumen sprayed seal to the carpark.

The M2 catchment drains overland in all events to its north eastern corner due to bunding along its eastern carpark edge. A number of options were considered, including regrading of the north eastern extent of this catchment to drain to the M3 catchment and then through to the southern channel. This option was rejected as it unnecessarily increased the flow through the M3 catchment with no net benefit. An alternative option of extending the proposed piped stormwater from M8 to the eastern extent of M2 would provide a safe and efficient passage of runoff and provide a failsafe overland flowpath (in the unlikely event of blockage) down the access road kerb and gutter.

Subcatchment M3

3.31ha

100% Pervious

Clean Water (CW) catchment.

Q5:	0.734m3/s
Q10:	0.923m3/s
Q100:	1.73m3/s

This subcatchment consists of an existing steep man made batter and set down area for materials, items of plant, and deliveries as well as an access road which links this area to the workshop area. The set down area and batters are free from coal and the mine operators have confirmed that there will be no dirty plant left in this area (dirty plant will be confined to the M1 catchment which has a first flush system).

Surface runoff from the northern extent of M3 collects along its access road which runs generally at a minimum longitudinal grade of 1.75%. Based on a basic check of capacity (manning's flow model) this longitudinal grade and an assumed crossfall of a minimum 3% and a 1m wide 250mm deep swale the roadway has capacity to contain a Q100 event (half of total catchment flow was assumed for northern half of catchment). Despite this, it is recommended that a minimum 0.5m bund be maintained along the length of this access road to ensure that obstructions within the flowpath (such as a poorly located piece of plant) do not result in water cascading to M5.

Beyond the roadway stormwater then enters a piped culvert which discharges to a broad channel. The capacity of this pipe is critical and its blocking would result in an increase of flows into M5. Based on a manning's calculations this pipe should be a minimum of 650mm diameter and at a grade of not less than 2% to withstand the Q100 flow however due to the unpredictable nature of the materials being set down in this area there is potential for blockage of this pipe from floating debris (such as packaging or wooden pallets).

It is therefore advisable regardless of pipe capacity to maintain the existing piped culvert, but also provide a failsafe overland flowpath between the roadway and the broad channel. This can be achieved by constructing a higher crest in the access road to M5.

The southern portion of the M3 subcatchment then drains to a broad channel which is approximately 9m wide at its narrowest point. This channel is bunded to the east to prevent flows from entering the M5 catchment. The substantial cross section of this channel has more than adequate capacity for the Q100 event. In addition to its capacity the broad base of this channel provides a low flow filtration of sediments and runoff from this catchment and set down area.

The M3 catchment then drains to the southern stormwater channel which contains flows from the U1, U2, and M1 catchments. This section of the southern stormwater channel is highly eroded due to steep grades and the previous relocation of this channel along a ridgeline. As with the western portion of the southern stormwater channel in M1, it is recommended that a reno mattress be employed in this location to the entire length of this channel between the M1 and M5 catchments.

The junction with the M3 channel flows currently requires a vertical drop of 3-4m which is causing considerable additional erosion at this node. For reasons discussed in M1 above, it is recommended that a gabion drop structure be constructed at this node to ensure that no further erosion occurs. The sizing and detail of this drop structure will be determined at detailed design stage.

Beyond the spillway to the southern stormwater channel subcatchment then passes under the proposed conveyor crossing. This crossing was the site of a key failure in the 1998 storms in which debris caused blockage in the piped crossing and diverted the majority of the upper catchment flows. In order to minimise the risk of future major events overtopping this crossing it is recommended that an open channel or culvert structure be employed.

The option of an open gabion lined channel and concrete box culvert was assessed, however as this crossing will include a road overpass as well as the dirty water pipeline passing underneath minimising cross section whilst maximising flow is a priority. For this reason a box culvert was employed. The combined catchment flow rate through this section of the southern stormwater channel are below, and a minimum longitudinal grade of 10% has been assumed:

Q5: 7.69m3/s

Q10: 9.66m3/s

Q100: 17.3m3/s

In order to convey the above flow rates with a 0.5m freeboard in the Q100 event a minimum cross section of approximately 2.5m wide by 1.75m deep is recommended as per the sketches, this will allow for approximately 0.5m of freeboard above the Q100 water level. In addition to this it is recommended that the adjacent downstream ridgeline be extended to the roadside and the road and adjacent area to the south be graded towards the south. This regrading and extension of the ridgeline will provide a redundancy in the event of blockage of the culvert where water will re-enter the southern stormwater channel rather than continue down the belt decline towards the dirty water channel.

Subcatchment M4

0.30ha

100% Pervious

Clean Water (CW) catchment.

Q5:	0.149m3/s
Q10:	0.181m3/s
Q100:	0.300m3/s

This is a small component of heavily vegetated natural slope adjacent to the M7 conveyor portal catchment.

This catchment will be experiencing reduced flows with the collection of the M7 Dirty Water and drains to the M5 catchment. There are no works proposed for this catchment.

Subcatchment M5

1.98ha

100% Pervious

Clean Water (CW) catchment.

Q5:	0.874m3/s
Q10:	1.10m3/s
Q100:	1.98m3/s

This subcatchment consists entirely of steep man made batters and access roads. As with M3 the access roads are not proposed to be used for the haul of coal and all slopes are vegetated with grass. All stormwater on M5 is collected and channelled along its eastern extent. This channel is directly adjacent to the steep batter of the M6 subcatchment and so it is important that this stormwater is contained during a major event.

The M5 stormwater channel is very flat at its northern extent and increases gradually to a grade of approximately 6%. In order to effectively transport stormwater this area should be regraded to a minimum of 1% and a trapezoidal cross section of approximately 0.5m depth, 1m base, and 1:4 batters be provided. In addition to this a bund should be constructed and maintained along the eastern edge of this subcatchment adjacent to the batter slope of M6 to minimise the possibility of overland flow down this batter which could lead to erosion.

The entry to the proposed diversion drain is located adjacent to the steep batter of the M6 subcatchment. This batter is of concern due to geotechnical considerations and therefore it is important that flows are efficiently transported away. For this reason it is recommended that the proposed M5 channel be shotcreted to minimise infiltration of flows to the batter.

In addition to shotcreting of the channel, stabilisation and seeding of the steep batter slope should be undertaken to minimise the likelihood of any surface erosion in future rainfall events.

Subcatchment M6

1.36ha

100% Pervious

Clean Water (CW) catchment.

Q5: 0.368m3/s

Q10: 0.470m3/s

Q100: 0.818m3/s

This subcatchment, as with M5 is characterised by steep man made batters and an access road. M6 is also directly adjacent to the coal stockpile catchment L2 and is the final Clean Water catchment on the southern stormwater channel before the entry to the diversion drain. M6 carries overland flow via a channel along its eastern extent adjacent to the batter to L2. The average longitudinal grade of the M6 channel is to be regraded to a minimum of 1% and in order to contain the Q100 flow a swale of approximately 0.5m depth with 1:4 batters is recommended. As with M5 it is also recommended that a bund be constructed and maintained adjacent to the eastern extent of this subcatchment in order to minimise the possibility of diversion of flows down the steep batter.

At its southern extent the flows from the M6 subcatchment join with those of the M5 catchment and then pass under the conveyor to the southern stormwater channel. This combined flow of 2.798m3/s in the Q100 event is to be constructed at a minimum grade of 5%. A Hec-Ras model of the proposed channel has resulted in a rectangular box culvert channel of approximate base width 1.5m wide by 1.0m deep which will provide a 0.5m depth of freeboard above the Q100 limit (i.e. factor of safety of 2).

As with subcatchment M3, the road adjacent to the culvert crossing is recommended to be regraded towards the southern stormwater channel to provide a redundancy overland flowpath to the southern stormwater channel in the event of blockage of the box culvert.

As with M5, this diversion drain is located adjacent to the steep batter of the L2 subcatchment. This batter is of concern due to geotechnical considerations and therefore it is important that flows are efficiently transported away. For this reason it is recommended that the channel be shotcreted to minimise infiltration of flows to the batter. In addition to shotcreeting of the channel, stabilisation and seeding of the steep batter slope should be undertaken to minimise the likelihood of any surface erosion in future rainfall events.

Subcatchment M7

1.73ha

100% Pervious

Dirty Water (DW) catchment.

Q5:	0.654m3/s
Q10:	0.778m3/s
Q100:	1.290m3/s

The M7 subcatchment is located at the southern extent of the subject site and is the location of the conveyor portal outlet from underground operations. Although conveyor design is placing emphasis on the clean transportation of coal from the portal to the stockpile, as a precaution this area has been assumed as Dirty Water to minimise the impact of localised coal spills and dust from the conveyor systems and maintenance.

Dirty Water runoff from this catchment is to be graded towards and along the access road (which is to be sealed) and directed to a piped stormwater system which will carry the Dirty Water down to the stockpile area and sediment basins. By piping this water we can ensure that it will remain separate from the clean water system.

Subcatchment M8

1.78ha

95% Pervious

5% Paved

Clean Water (CW) catchment.

Q5:	0.473m3/s
Q10:	0.615m3/s
Q100:	1.09m3/s

The M8 subcatchment runs along the northern extent of the subject site adjacent to the access road. The subcatchment is characterised by a long narrow natural ridge and a sealed roadway. The roadway is not proposed to be used for the haul of coal and is primarily an access for the office and U3 catchment. The existing stormwater which runs off the road and the ridge enters a road side swale which is heavily eroded and in need of maintenance or replacement.

As all water entering this catchment is free from coal it is to be considered Clean Water and is proposed to be collected via a piped stormwater system which will transport the water through the L2 subcatchment into an existing section of the Clean Water diversion pipeline which is to remain (east of stockpile).

As the natural soil in this location is that of a ridgeline and also passes through a naturally exposed coal seam it is highly erodible and showing considerable scour in many locations. This scouring is also resulting in degradation of the pavement edge adjacent to this drain. As discussed with the mine operators, it is advised that this section of drainage be piped underground and the road regraded towards a kerb and gutter system with kerb inlet pits at a maximum of 50m spacing.

The alternative of kerb and gutter is an open swale with grated surface inlet pits, however to address the issue of scouring the swale would require shotcrete treatment and regular maintenance to inspect for undercutting and erosion of the shotcrete.

Kerb and gutter adjacent to the pavement also provides a solid edge for pavement which will minimise erosion and degradation of this edge from the action of vehicles and prolong the life of the pavement.

Subcatchment L1

4.84ha

100% Pervious

Clean Water (CW) catchment.

Q5:	0.738m3/s
Q10:	0.951m3/s
Q100:	1.940m3/s

This catchment consists of the ridge and slope immediately adjacent to the clean water diversion channel which runs past the proposed stockpile area.

A number of options have been considered for the diversion of stormwater around the stockpile site, with emphasis being placed on the requirement for the channel to remain at a higher level than the adjacent stockpile area. The reason for this was to ensure that even in the event of heavy rainfall occurring during a full stockpile (i.e. during a rare shipping delay) the slumped stockpile would not be able to spill into the clean water diversion drain.

In addition to the elevation requirement an existing dam on the ridge adjacent to this drain is strongly recommended by the geotechnical engineer to be removed and the slope regraded to ensure that slope stability in major rainfall events (minimising the chance of land slip obstructing channel). Three channel alignment options were proposed to the mine operators including expected regraded contours of slope which are presented in sketch SK6. The option of a channel commencing at elevation RL65 has been selected as a conservative option in the absence of a final design for the stockpiles however it is recommended that the slope stability of this area be of particular attention to the detailed design of this channel on the hillside.

Design requirements of the client for this section of channel are that it needs to be wide enough to drive up and maintain (min 2.5m wide) be resistant to erosion, and be able to convey the 1:100 year storm event with a safety margin of 0.5m freeboard.

Options investigated included a gabion lined trapezoidal channel, grass lined channel, concrete box culvert, and earth channel with shotcrete coating. Grades considered ranged from 1% minimum to a 5% maximum.

Due to the requirement to maintain a level above the stockpile (which at the time of writing has not been finalised) and also to minimise velocities in the channel, a maximum grade of 1% was decided upon adjacent to the stockpile and the option of a concrete box culvert for minor storm flow was chosen. The proposed design will incorporate a concrete box culvert section of approximate dimensions 2.5m wide by 1.2m high which has capacity to deal with a 10year ARI event, this box culvert then opens to a trapezoidal channel of 1m depth which provides capacity for a 100year ARI storm with a freeboard of 0.5m. This structure is recommended to be constructed into the newly regraded slope which will minimise the likelihood of failure (rather than a cut/fill balanced bund arrangement. A detail of this preliminary cross section option can be seen on sketch SK4.

As the length of this channel is approximately 530m and the elevation change between its extents is approximately 25m in the conservative option chosen (in the absence of stockpile elevations) a 1% grade is not appropriate for the entire length of the site. For this reason it is suggested that the channel be steepened to a maximum of 5% grade beyond the stockpile and if compatible with the stockpile the main channel grade increased to 2%. This will reduce the required section of the channel but will substantially increase flow velocities. If it is assumed that 180m of channel is to be constructed at 5% grade, with the remaining 350m at 1% there will need to be a total of 12.5m in vertical drop structures along the length of the channel, or alternatively at 2% for the length of the stockpile a vertical drop of 9m.

Subcatchment L2

12.07ha

90% Pervious

10% Paved

Dirty Water (DW) catchment.

Q5: 2.84m3/s

Q10: 3.52m3/s

Q100: 6.51m3/s

This catchment consists primarily of the coal stockpile, truck loading bay, and surrounding dirty areas. It is the primary generator of dirty water within the site and the final catchment before entry of dirty water to the sediment basins.

Stormwater collected from this catchment as well as stormwater collected from the M7 and M1 (first flush) catchments is directed via a piped stormwater system to the proposed sediment basins. The sizing and location of this piped system will be detailed in construction issue drawings and is dependent heavily on the location, elevation, and size of proposed stockpiles and infrastructure on site.

The proposed sediment collection system will allow for settlement of fine and coarse sediments through two basins of combined surface area of up to 8500m2 at a minimum depth of 0.5m (i.e. providing a minimum of 4250m3). This preliminary design is based on the requirement of approximately 300m3/ha of storage and using the Soils and Construction Handbook Volume 1 (Blue Book). Basins should be constructed such that easy draining and access is available to the mine operators for clearing and maintenance. Due to the dispersive nature of the sediments, following coarse settlement the dirty water will then pass through to the storage dam for further treatment.

The existing 62ML storage dam is to continue to be used for storage of dirty water for treatment prior to discharge to the creek or reuse on site. Sizing and assessment of this basin has been based on hydrographs for the base of this catchment and the requirement to contain all storms up to and including a 10yr ARI event. The facility has the ability to pump out of this dam at between 150-300kl/hr via two pumps which are fed to clarifiers which treat the dirty water prior to reuse or discharge to the creek during storm events.

The total capacity of this basin is highly dependent on its level of silts and fines which were not fully captured in settlement basins 1 & 2 (due to the nature of the low density of coal fines suspending in water for extended periods).

In order for the mine to ensure that all storms up to a 10year event can be contained/treated within the site, a minimum of 30ML of capacity should be maintained within the basin at all times. This is assuming a pump rate of 300kL/hr; an increase to 35ML capacity is required if pumping at 150kl/hr is only available. It is important that pumping be available in the dam at all times as spare capacity in a dry spell can easily be used up in the weeks leading to a major storm.

The above storage capacity is well in excess of the requirements of the Soils and Construction, Volume 2E Mines and Quarries guideline, which specifies that for sites with highly dispersive soils and an operation life greater than 3 years that a storage for the 90th percentile 5 day rainfall event be allowed for. Based on Table 6.3a of Volume 1 of this guide 60.8mm of rainfall over the combined dirty water catchment area of 19.92ha is required; this equates to a minimum storage of 12.11ML, well below the minimum 30ML capacity proposed.

Channel Treatments

The southern drainage channel is characterised by a steep grade and in a number of areas appears to contain highly erodible soils and coal seams. This appears to have been a major contributor to a number of the blockages experienced during the 1998 event where large rocks, plants, and debris were washed downstream until they lodged in pipes or culverts.

Due purely to the grade and velocities within the varying soil conditions it is recommended that further detailed geotechnical assessment be undertaken following the Part 3A approval and prior to detailed civil design along the length of the southern stormwater channel. The purpose of this investigation will be to determine which areas of the channel are stable (and possibly on bedrock) and only require maintenance and which areas require reno mattress reinforcement.

Based on investigations following our own site inspection it is recommended that a reno mattress or gabion be placed in at least the following areas:

- Subcatchment M1 – (Reno mattress) Directly west of culvert crossing extending beyond coal seams and highly eroded steep channel section.
- Subcatchment M1 – (Gabion basket drop structure) Directly east of culvert crossing where channel drops into M3 subcatchment.
- Subcatchment M3 – (Gabion basket drop structure) Southern extent of M3 channel at junction of southern stormwater channel.
- Subcatchment M3 – (Reno mattress) Approximately 50m adjacent to culvert crossing of conveyor road.
- Subcatchment M5 – (Gabion basket drop structure) Directly downstream of conveyor road culvert crossing.
- Subcatchment M5 – (Reno mattress) M5 to M6 connection swale.
- Subcatchment M6 – (Reno mattress) Approximately 50m adjacent to headwall inlet to stockpile diversion channel.
- Subcatchment M6 – (gabion basket drop structure) Southern extent of M6 channel at junction of southern stormwater channel.

It should be reinforced that if we are to ensure that in the event of a major storm the only way to minimise any potential blockage of the channel is to ensure that the entire southern channel be stabilised. If areas other than those above are considered geotechnically stable it is still advised that these areas be cleared of large rocks and vegetation, trimmed, compacted and stabilised with either shotcrete or preferably a reno mattress.

Maintenance

The above recommended treatments should be regularly inspected (at least annually) to ensure that all gabions, reno mattresses, shotcrete, and banks are free from slumps and damage. This should include inspection of any damage to the basket of rock mattresses and gabions and if required repair of damaged sections. Shotcrete in particular should be checked for holes or damage in the flowpath of the creek as their presence can often lead to the undermining of the channel through the action of piping and eddies which will eventually lead to the failure of the channel, for this reason reno mattress (underlain with geofabric) is preferred as it will conform to slips and settlement more dynamically than rigid shotcrete.

In addition to the above treated sections of channel, all open grass lined channels and batters should be kept free from trees, heavy weeds (such as lantana) and any blockages (branches, rocks, etc.).

Bellambi Creek and Princes Hwy Culvert Crossing

Following diversion of clean water around the stockpile and dirty areas this water then enters Bellambi Creek at the eastern extent of the site where it continues east combined with additional lower catchment flows before passing under the Princes Highway via an existing concrete Culvert of dimensions 2.4m wide by 1.5m high. It is important to note that the proposed stormwater concept will not alter the flowrate of stormwater to this lower catchment, however due to the treatment of the flowpath around the site the likelihood of blockages in this catchment will be significantly reduced.

A preliminary study of this catchment has confirmed that the existing culvert is inadequate for even a Q10 event during which backwaters would accumulate until they spill over the Princes Highway. From site observations, it is not clear whether the low point of this road crossing is located at the culvert crossing and visibly appears to be further north. This would result in flood waters potentially flowing through the adjacent workshop and business before re-entering Bellambi Creek due to a man made bund adjacent to the creek (possibly as a reaction to flooding in the 1998 event).

In order to reduce this risk the RTA should consider the upgrading of the existing culvert crossing, as well as regrading to ensure that waters quickly divert back to the creek. The existing Bellambi Creek east of the Princes Highway culvert crossing should be maintained by the relevant authority to be free from heavy undergrowth and weeds to ensure that this does not contribute to blockage of the culvert (resulting in overtopping of the Princes Highway).

In addition to this, it is recommended that the mine operators clear all obstructions from the Bellambi creek west of the Princes Highway culvert such as undergrowth, trees in invert and banks, weeds and crossings to minimise the chance of blockage to the existing culvert. The flowpath of the existing Bellambi Creek west of the Princes Highway is also currently inhibited by an existing small piped culvert crossing which serves as an access for the mine operators to the south eastern portion of the site. It is recommended that this crossing be removed and a low level causeway crossing be erected instead. This would have the dual benefit of slowing velocities in minor flow events, whilst not causing a major obstruction in a major event. Although flooding of this area will not affect mine operations, this areas maintenance should minimise future flooding possibilities from minor storms.

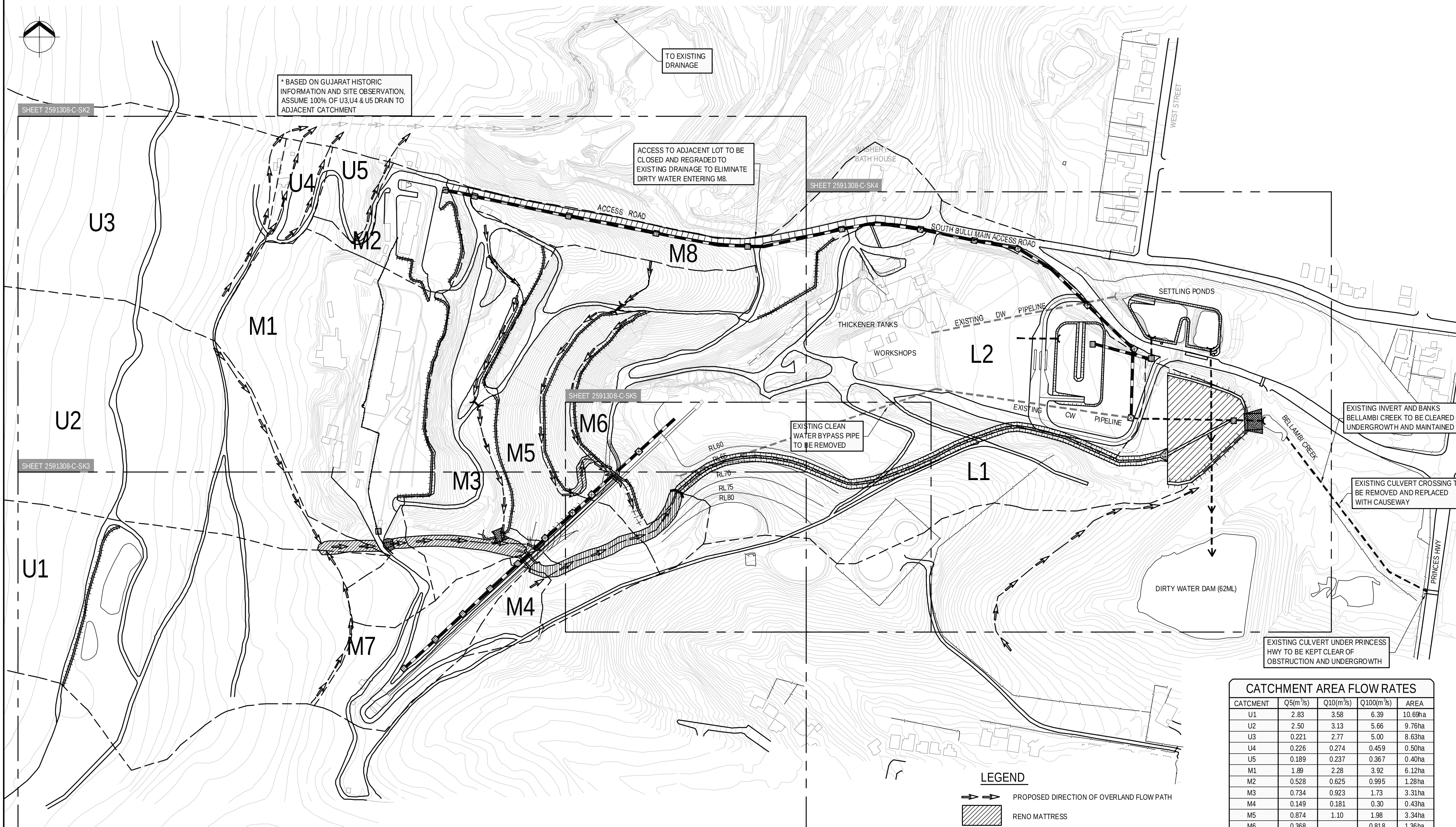
Conclusion

Although there is no increase in impervious area or flow intensities across the site, this is an opportunity to improve stormwater performance in a major event. In accordance with the recommendations of *Managing Urban Stormwater: soils and construction volumes 1 and 2E*; the stormwater concept proposes a number of measures which will minimise the likelihood of a failure such as 1998 occurring in the future, through both the maintenance and upgrade of existing diversions and flowpaths (such as those in the upper subcatchments) and the recommendation of open channels and diversions around the stockpile area with settlement basins, scour protection, and clearing of undergrowth.

It should also be noted that downstream of the site there are issues that may result in substantial impacts on the community due to flooding. These are the road culvert under the Princes Highway giving rise to a potential choke point and also the state of the Bellambi Creek East of the Princes Highway that has been significantly altered, with the potential to restrict the flow of water along its length.

It is recommended that the existing and proposed diversion channels and drains be lined as recommended above in consultation with geotechnical advice and maintained regularly to minimise scouring during major flow events. All reno mattress areas should be regularly inspected and repaired where necessary, and all shotcrete areas are to be inspected for undermining and eddies which could lead to erosion if left unaddressed.

Appendix 1) – Hydrology Review Sketches



CATCHMENT AREA FLOW RATES

CATCMENT	Q5(m^3/s)	Q10(m^3/s)	Q100(m^3/s)	AREA
U1	2.83	3.58	6.39	10.69ha
U2	2.50	3.13	5.66	9.76ha
U3	0.221	2.77	5.00	8.63ha
U4	0.226	0.274	0.459	0.50ha
U5	0.189	0.237	0.367	0.40ha
M1	1.89	2.28	3.92	6.12ha
M2	0.528	0.625	0.995	1.28ha
M3	0.734	0.923	1.73	3.31ha
M4	0.149	0.181	0.30	0.43ha
M5	0.874	1.10	1.98	3.34ha
M6	0.368		0.818	1.36ha
M7	0.654	0.778	1.29	1.73ha
M8	0.473	0.615	1.09	1.78ha
L1	0.738	0.951	1.94	4.84ha
L2	2.84	3.52	6.51	12.07ha

FOR INFORMATION
NOT FOR CONSTRUCTION

No.	Revision	By	Chk	Appd	Date
B	CONCEPT DESIGN - NOT FOR CONSTRUCTION	AS	SM		8/10/09
A	CONCEPT DESIGN - ISSUED FOR REVIEW	AS	SM		23/7/09

Drawing Originator: Beca

Original Scale (A1) 1:2000	Design	PI	23/7/09	Approved For Construction*
	Drawn	AS	23/7/09	
Reduced Scale (A3) 1:4000	Dsg Verifier	SM	29/9/09	
	Dwg Check			Date

* Refer to Revision 1 for Original Signature

Client: GUJARAT NRE

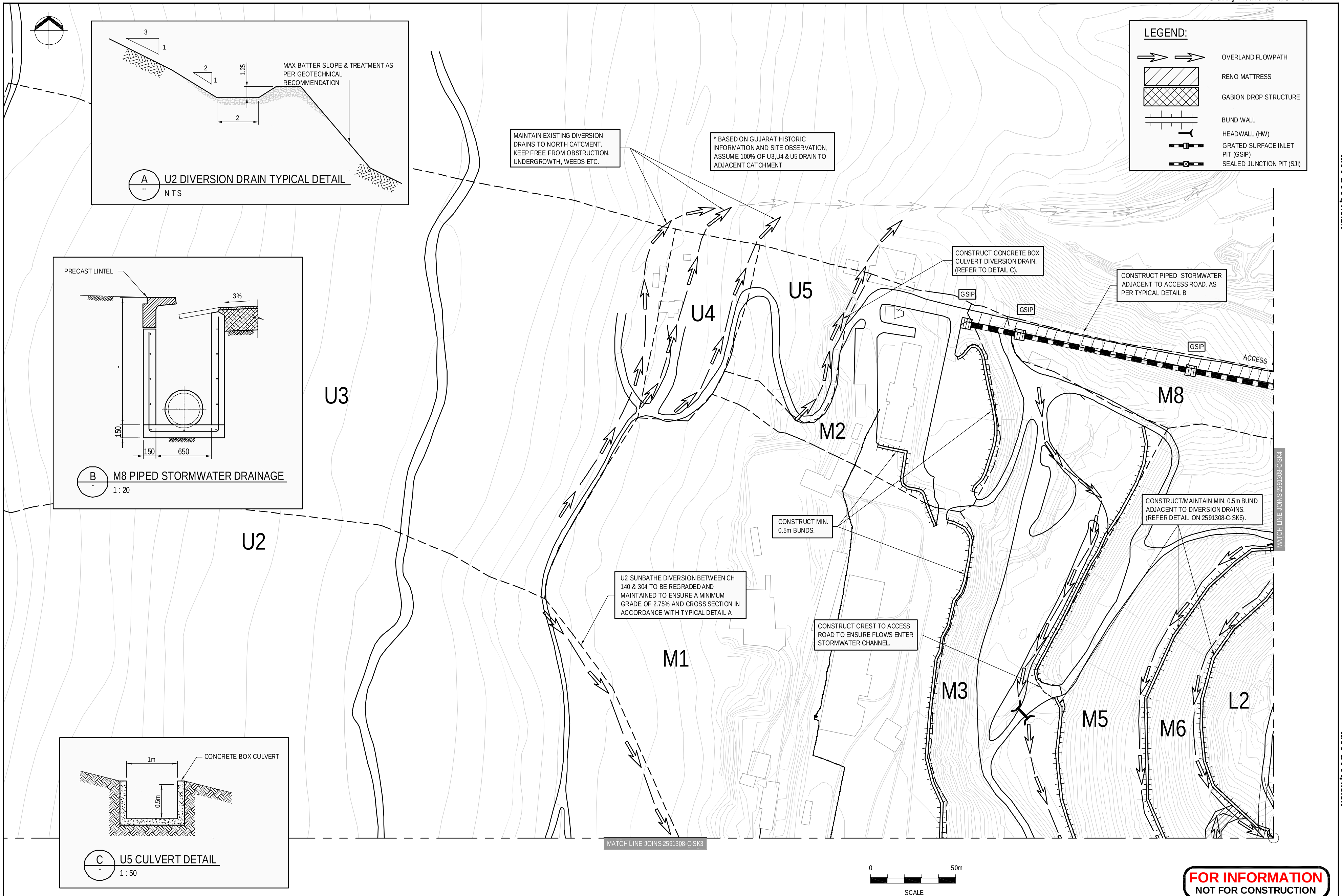
Project: GUJARAT NRE No. 1 HYDROLOGICAL INVESTIGATION

Title: GENERAL SITE LAYOUT WITH CATCHMENT AREAS & FLOW RATES

Discipline: CIVIL

Drawing No. 2591308-C-SK1 Rev. B

Drawing Plotted: 04 May 2010 13:48



FOR INFORMATION
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No.	Revision	By	Chk	Appd	Date
B	CONCEPT DESIGN - NOT FOR CONSTRUCTION	AS	SM		8/10/09
A	CONCEPT DESIGN - ISSUED FOR REVIEW	SK	SM		23/7/09

Drawing Originator: Beca

Original Scale (A1) 1:1000
Reduced Scale (A3) 1:2000

		Date
Design	PI	23/7/09
Drawn	SK	23/7/09
Dsg Verifier	SM	29/9/09
Dwg Check		

Approved For Construction*

* Refer to Revision 1 for Original Signature

Client: GUJARAT NRE

Project: GUJARAT NRE No. 1
HYDROLOGICAL INVESTIGATION

Title: SITE LAYOUT DETAIL
1 OF 4 - NORTH WEST

Discipline: CIVIL

Drawing No. 2591308-C-SK2

Rev. B

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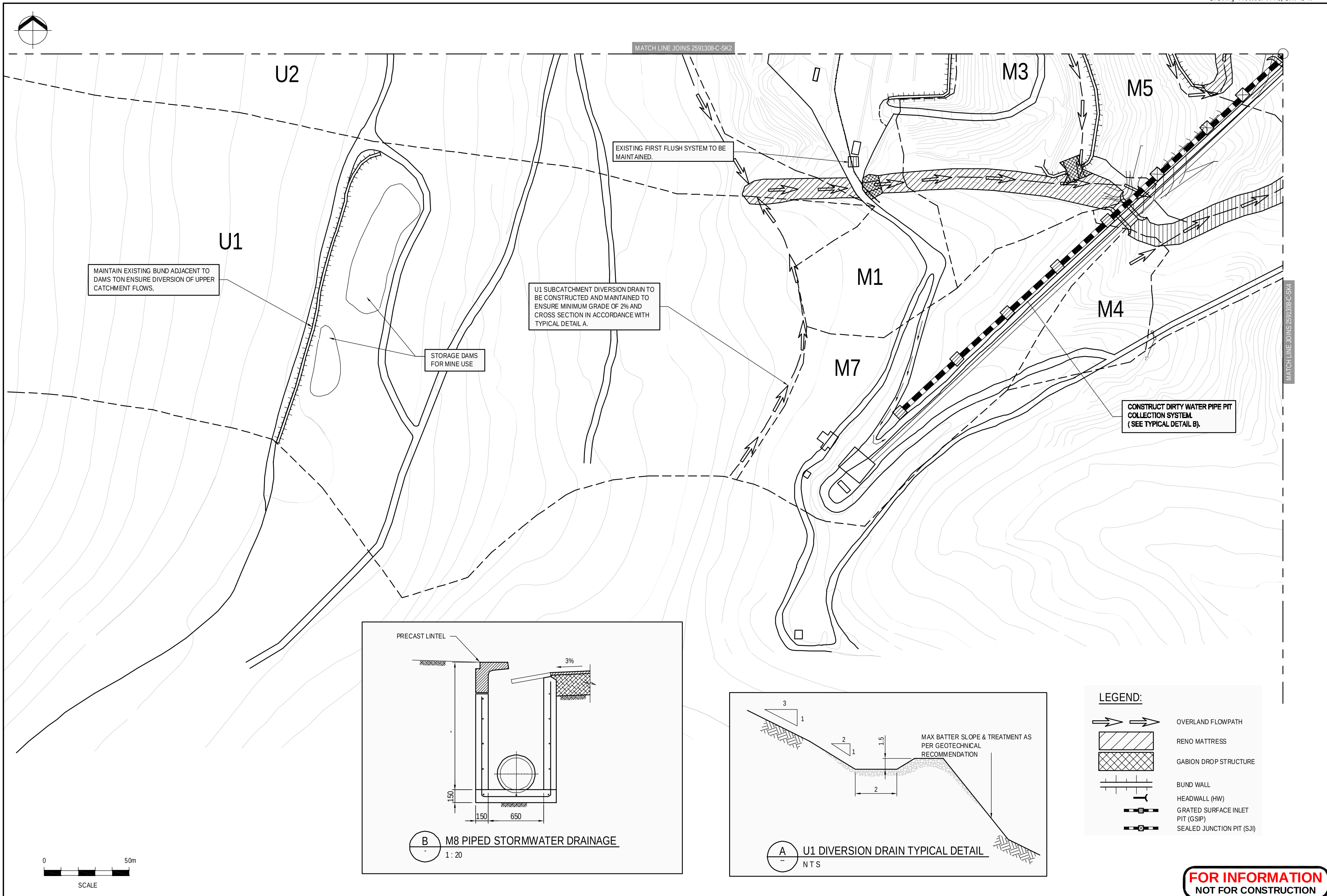

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A	CONCEPT DESIGN - ISSUED FOR REVIEW	SK	SM		23/7/09

Drawing Originator: Beca

Original Scale (A1) 1:1000 Reduced Scale (A3) 1:2000	Design	PI	23/7/09
	Drawn	SK	23/7/09
	Dsg Verifier	SM	29/9/09
	Dwg Check		

Approved For Construction* — Date

* Refer to Revision 1 for Original Signature

Client: GUJARAT NRE

Project: GUJARAT NRE No. 1 HYDROLOGICAL INVESTIGATION

Title: SITE LAYOUT DETAIL 2 OF 4 - SOUTH WEST

Discipline: CIVIL

Drawing No. 2591308-C-SK3 Rev. B

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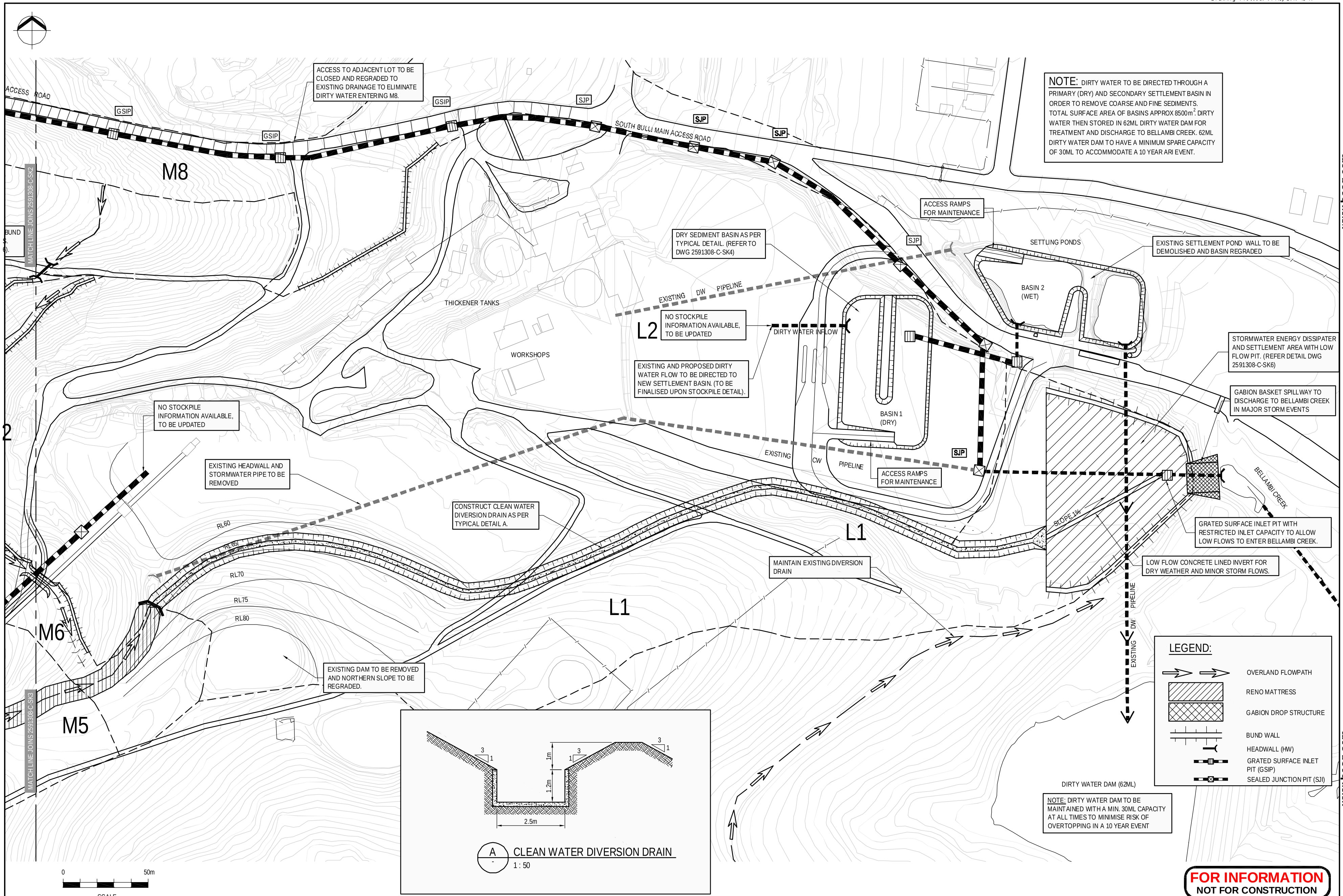
Document No. 2591308-C-SK3.dwg

Drawing Plotted: 04 May 2010 13:49



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No.	Revision	By	Chk	Appd	Date
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A	CONCEPT DESIGN - ISSUED FOR REVIEW	SK	SM		23/7/09

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Reduced Scale (A3) 1:2000	Drawn	SK	23/7/09	
	Dsg Verifier	SM	29/9/09	
	Dwg Check			Date

* Refer to Revision 1 for Original Signature

Client: GUJARAT NRE

Project: GUJARAT NRE No. 1 HYDROLOGICAL INVESTIGATION

Title: SITE LAYOUT DETAIL 3 OF 4 - EAST

Discipline: CIVIL

Drawing No. 2591308-C-SK4 — Rev. B

Document No. 2591308-C-SK4.dwg

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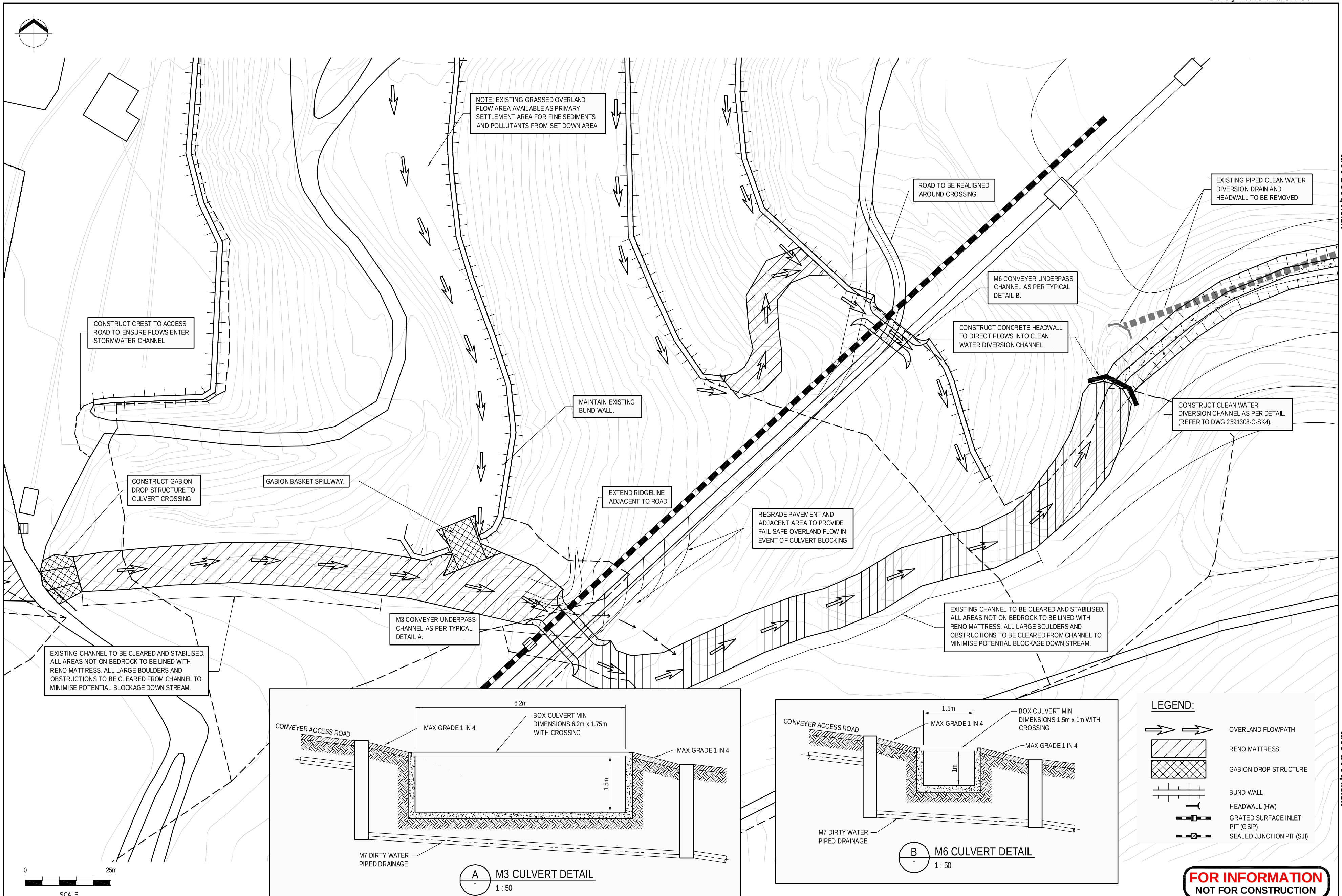

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No.	Revision	By	Chk	Appd	Date
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A	CONCEPT DESIGN - ISSUED FOR REVIEW	SK	SM		23/7/09

Drawing Originator: Beca

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	Drawn	SK	23/7/09
Reduced Scale (A3) 1:1000	Dsg Verifier	SM	29/9/09
	Dwg Check		

Approved For Construction* — Date

* Refer to Revision 1 for Original Signature

Client: GUJARAT NRE

Project: GUJARAT NRE No. 1 HYDROLOGICAL INVESTIGATION

Title: SITE LAYOUT DETAIL 4 OF 4 - CLEAN WATER CHANNEL

Discipline: CIVIL

Drawing No. 2591308-C-SK5 — Rev. B

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Drawing Plotted: 04 May 2010 13:50

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A	CONCEPT DESIGN - ISSUED FOR REVIEW	SK	SM		23/7/09

Drawing Originator: Beca

Original Scale (A1) 1:500	Design	PI	23/7/09	Approved For Construction*
	Drawn	SK	23/7/09	
Reduced Scale (A3) 1:1000	Dsg Verifier	SM	29/9/09	
	Dwg Check			Date
	* Refer to Revision 1 for Original Signature			

Client: GUJARAT NRE

Project: GUJARAT NRE No. 1 HYDROLOGICAL INVESTIGATION

Title: PROPOSED DAM WALL REGRADE AND CHANNEL OPTIONS

Discipline: CIVIL

Drawing No. 2591308-C-SK6 Rev. B

Document No. 2591308-C-SK6.dwg

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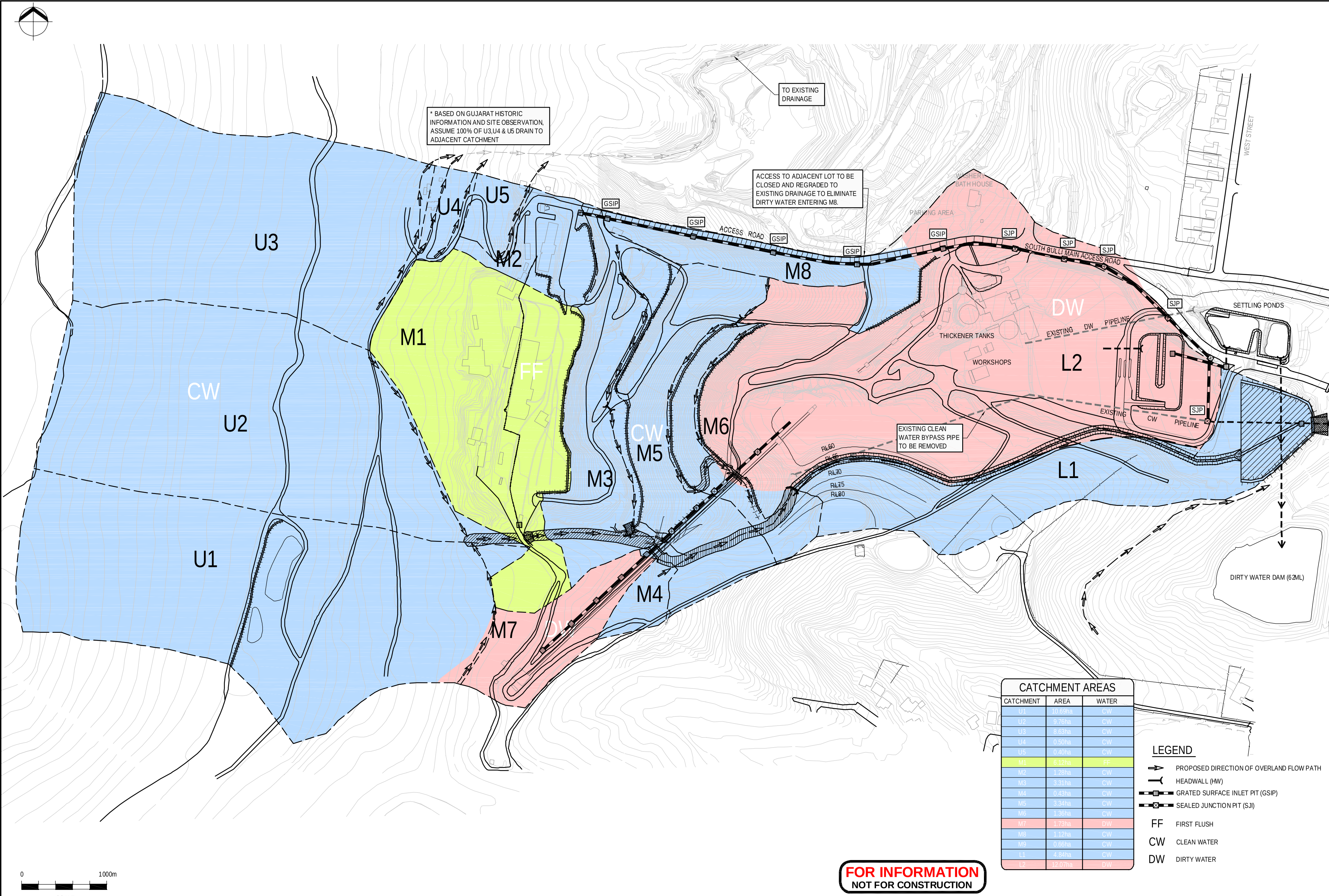

CATCHMENT AREAS

CATCHMENT	AREA	WATER
U1	10.69ha	CW
U2	9.76ha	CW
U3	8.63ha	CW
U4	0.50ha	CW
U5	0.40ha	CW
M1	6.12ha	FF
M2	1.28ha	CW
M3	3.31ha	CW
M4	0.43ha	CW
M5	3.34ha	CW
M6	1.36ha	CW
M7	1.73ha	DW
M8	1.12ha	CW
M9	0.66ha	CW
L1	4.84ha	CW
L2	12.07ha	DW

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B	CONCEPT DESIGN - NOT FOR CONSTRUCTION	AS	SM		8/10/09
A	CONCEPT DESIGN - ISSUED FOR REVIEW	SK	SM		23/7/09

Drawing Originator: Beca

Original Scale (A1) 1:2000
Reduced Scale (A3) 1:4000

Design	PI	23/7/09
Drawn	SK	23/7/09
Dsg Verifier	SM	29/9/09
Dwg Check		

Approved For Construction*
Date
* Refer to Revision 1 for Original Signature

Client: GUJARAT NRE

Project: GUJARAT No. 1 HYDROLOGICAL INVESTIGATION

Title: SITE LAYOUT CLEAN/DIRTY WATER REGIONS

Discipline: CIVIL

Drawing No. 2591308-C-SK7 Rev. B

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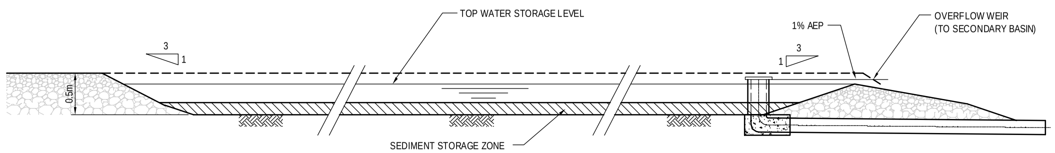

1 TYPICAL SECTION DETAIL - DRY SEDIMENT POND
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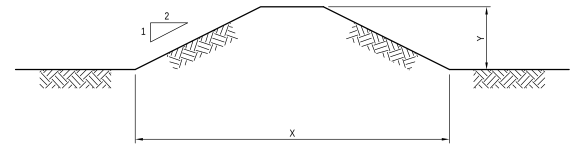
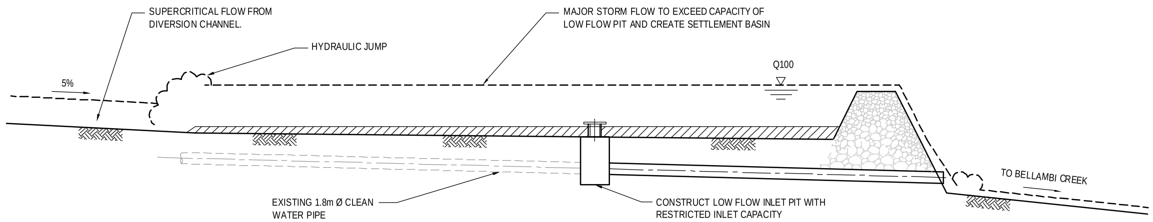


3 DETAIL - TYPICAL EARTH BUND
1 : 20



2 CLEAN WATER SETTLEMENT BASIN
N T S

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Drawing Originator: Beca

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	Drawn	SK	23/7/09	
Reduced Scale (A3) 1:40	Dsg Verifier	SM	29/9/09	
	Dwg Check			Date
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Client: GUJARAT NRE

Project: GUJARAT NRE No. 1
HYDROLOGICAL INVESTIGATION

Title: DETAILS SHEET

Discipline: CIVIL

Drawing No. 2591308-C-SK8 Rev. B

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Appendix B

Bellambi Gully Water Quality Samples

Appendix B

Table B1 - Water Quality samples of the discharge into Bellambi Creek (from Post-Thickener Tank line); note: oil and grease is not monitored.

Parameters	Units	Sample (23/01/09)	Sample (18/02/09)	Sample (04/03/09)	Sample (01/04/09)	ANZECC Guidelines, unless specified	Comments
Alkalinity	Mg $CaCO_3$/L	790	650	700	950	**NA**	
Ammonia	mg/L	<0.02	<0.02	<0.02	<0.02	**0.9**	95% protection level
Bicarbonate	Mg $CaCO_3$/L	700	540			**NA**	
BOD5	mg O_2/L		5	<2	<2	**<15**	Lowland River discharge
Carbonate as CaCO3	mg/L	91	110			**NA**	See *Alkalinity* comments
COD	mg/L		28	32	24	**<40**	Lowland River discharge
Conductivity	µS/cm	1600	1600	1600	2100	**125-2000**	Lowland River discharge
Enterococcus	cfu/100mL		130	2000	60	**NA**	
pH	pH units	8.8	9	9	9	**6.5-9.2**	**EPL licence requirement**
Thermo tolerant coliforms	cfu/100mL		300	2800	80	**<0.02** **100**	Lowland river discharge Low effect on livestock drinking water
Total coliforms	cfu/100mL		10000	2500	400	**NA**	Microbial growth evident
Total dissolved solids	mg/L	750	890	870	1300		
Total organic carbon	mg/L	6	6	6	11	**NA**	
Total phosphorus	mg/L	0.03	0.03	0.03	0.05	**0.025**	Lowland river discharge
Total suspended Solids	mg/L	13	20	22	27	**<50**	**EPL licence requirement**
Turbidity	NTU		26	33	27	**1-20**	Assumed for lakes and reservoirs category
Hardness	mg/L			40	42	**20-100**	Fouling potential >350mg $CaCO_3$/L
UV Transmissivity @ 254nm					51		

Table B2 – V Notch Weir at Storm Water Control Dam

Analyte	Units	22/1/2010	2/10/2010
pH	pH	7.1	7.74
Conductivity	µS/cm @ 25°C	1700	1200
Oil and Grease	mg/L	-	-
TSS	mg/L	2	164
Turbidity	NTU	-	1010
TKN	mg N/L	0.4	-
TP	mg/L	0.07	-

Appendix C

NRE Russell Vale Bellambi Gully Creek Water Quality Samples

Table C1 – Bellambi Gully Creek at Gladstone Street Russel Vale

Analyte	Units	22/1/2010	3/04/2010	13/4/2010
pH	pH	8.1	8.49	8.97
Conductivity	µS/cm @ 25°C	1900	1240	1360
Oil and Grease	mg/L	<0.1	-	-
TSS	mg/L	23	12	2
Turbidity	NTU	-	66.3	11.1
TKN	mg N/L	0.9	0.5	0.5
TP	mg/L	0.13	0.08	0.09

Table C2 – Bellambi Gully Creek at West-side of Culvert at Princess Highway Russel Vale

Analyte	Units	22/1/2010	3/04/2010	13/4/2010
pH	pH	8.8	8.58	7.32
Conductivity	µS/cm @ 25°C	1800	1220	1510
Oil and Grease	mg/L	<0.1	-	-
TSS	mg/L	6	26	10
Turbidity	NTU	-	152	34.2
TKN	mg N/L	0.9	0.4	0.5
TP	mg/L	0.08	0.08	0.09

Table C3 – Bellambi Gully Creek – water upstream of LDP 2 Russel Vale

Analyte	Units	3/04/2010	13/4/2010
pH	pH	8.46	8.79
Conductivity	µS/cm @ 25°C	1060	1160
Oil and Grease	mg/L	-	-
TSS	mg/L	4	2
Turbidity	NTU	21.3	6.4
TKN	mg N/L	0.4	0.4
TP	mg/L	0.04	0.04

Table C4 – Water discharge to Bellambi Gully Creek at LDP2 Russel Vale

Analyte	Units	22/1/2010	23/02/2010	3/03/2010	4/09/2010
pH	pH	9.1	8.6	8.77	9.03
Conductivity	µS/cm @ 25°C	1900	1100	1240	1280
Oil and Grease	mg/L	<0.1	<5	<10	<5
TSS	mg/L	21	9	16	8
Turbidity	NTU	39	33.3	26.4	19.2
TKN	mg N/L	1.1	0.4	0.4	0.4
TP	mg/L	0.12	0.11	0.07	0.21

Appendix D

Irrigation calculations for treated Blackwater effluent disposal at Shaft #4

The following table shows irrigation rates for treated Blackwater at Shaft #4.

Month	Days	Effluent (m3)	Rainfall (mm)	Rainfall (m3)	Pan Evaporation (mm)	Crop Factor (Pasture)	Evapotranspiration (mm)	Volume of evaporation (m3)	Percolation (m3)	Available for Irrigation (m3)	Storage change for each month
Jan	31	229.4	67.1	301.95	175	0.7	122.5	551.25	67.5	316.8	0
Feb	28	207.2	68.5	308.25	175	0.7	122.5	551.25	67.5	310.5	0
Mar	31	229.4	67.2	302.4	125	0.7	87.5	393.75	67.5	158.85	70.55
Apr	30	222	47.4	213.3	100	0.6	60	270	67.5	124.2	97.8
May	31	229.4	32	144	80	0.5	40	180	67.5	103.5	125.9
Jun	30	222	34.8	156.6	80	0.45	36	162	67.5	72.9	149.1
Jul	31	229.4	26.1	117.45	60	0.4	24	108	67.5	58.05	171.35
Aug	31	229.4	25.1	112.95	80	0.45	36	162	67.5	116.55	112.85
Sep	30	222	37.1	166.95	125	0.55	68.75	309.375	67.5	209.925	12.075
Oct	31	229.4	49.8	224.1	150	0.65	97.5	438.75	67.5	282.15	0
Nov	30	222	55.5	249.75	175	0.7	122.5	551.25	67.5	369	0
Dec	31	229.4	53.2	239.4	200	0.7	140	630	67.5	458.1	0
TOTAL		**2701**		**2537.1**				**4307.625**	**810**	**2580.525**	**739.625**

Notes:

Effluent flow rate is based on a daily generation of 7.4kL/d black water
Rainfall (mm), averaged for Picton, NSW, available from the Bureau of Meteorology website
Pan evaporation (mm) estimated from the Bureau of Meteorology, http://www.bom.gov.au/jsp/ncc/climate_averages/evaporation/index.jsp
Crop factor, assumed for pasture using the DEC 2003 guidelines
Evapotranspiration (mm), calculated by multiplying pan evaporation with crop factor
Evapotranspiration (m^3), converted by multiplying with the available irrigation area (4,500m^2)
Percolation (m^3), 15mm per month, in accordance with DEC guidelines (4,500m^2)
Available for Irrigation (m^3), the amount of effluent that can be irrigated, determined by the equation: evaporation + percolation – rainfall
Storage at start of month (m^3), the amount of excess effluent that must be stored per year.

Available storage is approximately 1,200kL. Irrigation rates can be increased by increasing area under irrigation. During prolonged wet weather, treated effluent can be trucked offsite.