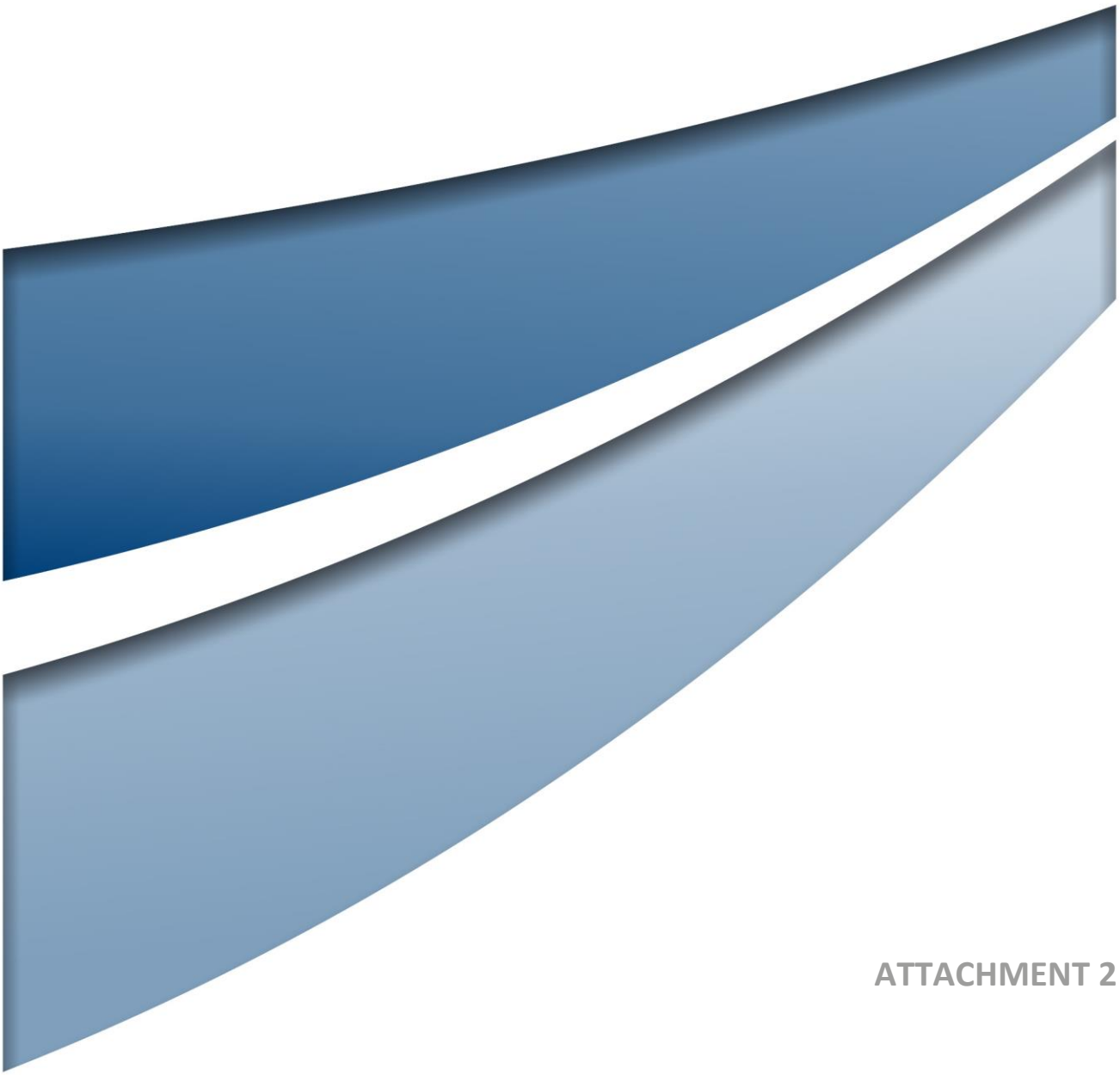

ATTACHMENT 2

Wollongong Coal Limited

Bellambi Gully Flood Study

NA82014089 – Ver 06

Prepared for
Wollongong Coal Limited

January 2015

WOLLONGONG COAL

Cardno
Shaping the Future

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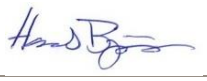
1	For Review	HAB		6/6/2014
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Appendices

1 Introduction

1.1 Background

Wollongong Coal Limited (WCL) has engaged Cardno (NSW/ACT) Pty Ltd to undertake a flood study for Bellambi Gully to determine the existing flood conditions at the Russell Vale Colliery site and recommend potential flood mitigation measures.

A hydrological assessment of the site was previously carried out in 2009 by BECA. The main outcome of the study suggests that stormwater conveyance through the site may be improved through diversion of flows from Bellambi Gully around coal stockpile areas. Maintenance measures were also recommended as methods to improve the conveyance of the existing channel and minimise the likelihood of failure.

This study aims to present alternative mitigation measures for WCL to undertake in order to reduce flooding impacts downstream of the site, particularly those associated with coal stockpile washouts as a result of flooding.

1.1.1 Site Description

The Russell Vale Colliery site is located within the Southern Coalfields Region of NSW. The site is approximately 8 km north of Wollongong and 70 km south of Sydney and lies within the local government areas (LGAs) of Wollongong and Wollondilly in the Illawarra region.

The Russell Vale Colliery site is located on the lower slopes and foothills of the Illawarra Escarpment. The vicinity surrounding the site to the north, south and east is mainly comprised of residential properties of Russell Vale, Bellambi and Corrimal respectively. The Russell Vale golf course is situated to the north of the site. The west and east of the site is directly bounded by the Woronora Plateau and Princes Highway respectively.

The site study area includes the Illawarra Escarpment and extends towards the Bellambi Creek approximately 250m west of the Princes Highway.

1.1.2 Bellambi Gully

The total Bellambi Gully catchment area is 427 ha and the total creek length is 4.3km. Runoff originating from the Illawarra Escarpment flows down the heavily vegetated steep slopes of the escarpment to the Russell Vale Colliery site at the foothills, where it enters the Bellambi Gully watercourse. Some reaches of the watercourse are conveyed by pipes and constructed channels within the site.

The main Bellambi Gully watercourse within the site connects to an 1800 mm diameter clean-water pipeline (approx. 660 m in length) before discharging into Bellambi Creek. Another 600 mm diameter pipe collects a fraction of the upstream stormwater runoff and also connects to the 1800 mm diameter clean-water pipeline. The site stormwater captured by the pipe bypasses the main stockpile area, and discharges to the licensed discharge point (LDP2) into Bellambi Creek approximately 250 m to the west of the Princes Highway.

Bellambi Creek flows underneath the Princes Highway via a 2.4 m W x 1.5 m H box culvert. Flows are conveyed via a number of culvert structures under roads and rail ultimately discharging at Bellambi Beach. The length of the creek from the colliery discharge point to the ocean outfall is approximately 3 km.

1.2 Scope of Work

The scope of work consists of the following:

> Review existing flood studies relevant to the catchment;

> Compile and review topographic survey and ALS information of the study area and develop a Digital Terrain Model (DTM);

> Identify sub-catchments and peak flows derived in previous flood studies (5, 10 and 100 year ARI from BECA 2009);

> Develop a 1D flood model (configure parameters, baseline conditions and incorporate existing culvert structures) and simulate to establish existing conditions;

> Identify key areas to be addressed based on flood modelling results;

> Identify opportunities for flood mitigation such as vegetation management, channel / culvert upgrades etc. with consideration of site constraints; and

> Incorporate alternative flood mitigation measures and quantify improvements to flooding/ conveyance.

2 Available Data

2.1 Previous Studies

2.1.1 Combined Catchments of Whartons, Collins and Farrahars Creeks, Bellambi Gully and Bellambi Lake Flood Study (Lyall & Associates Consulting Water Engineers, 2011)

The flood study combines the Whartons, Collins and Farrahars Creeks catchment area along with the Bellambi Gully and Bellambi Lake catchments. The flood study is referred to as the Combined FS in this report.

The study was undertaken to assess and define the flood behaviour within the study area under current conditions. The information obtained from the assessment forms the basis of the Floodplain Risk Management Plan for the study area.

The flood behaviour was assessed using hydrological and hydraulic computer modelling. Sensitivity analyses were also carried out to verify the parameters adopted and assumptions made in the development of the hydraulic model. The flood information obtained from the analysis was presented in terms of flows, levels and velocities ranges between the 5 to 500 year Average Recurrence Interval (ARI) storm events including the Probable Maximum Flood (PMF).

2.1.2 Water Management Report No.1 Colliery Russell Vale (BECA, 2010)

A Water Management Report for the operation of Wollongong Coal Limited (previously known as Gujarat NRE), No.1 Colliery at Russell Vale was prepared by BECA in 2010. The information presented in the report includes the current and future water management at the Russell Vale and Shaft No. 4 sites, water balance for the Russell Vale site, the collection and treatment of mine water and dirty storm water, the quantity and quality of water discharged to Bellambi Gully as well as the impacts in terms of water quality discharged to Bellambi Gully.

The report recommends further investigation of water treatment and reuse on site, including the management of solids from the water treatment plant site and also recommends improving the stormwater conveyance across the site to reduce the risk of failure to the current system.

2.1.3 Gujarat NRE Stormwater Hydrology Review (BECA, 2009)

A hydrological investigation of the clean stormwater system at the Russell Vale mine site was undertaken by BECA. The stormwater system on site was deemed inadequate following the 1998 flood event which resulted in large quantities of runoff diverting through the existing coal stockpile originating from the steep escarpment slopes.

The objective of the assessment was to review the existing stormwater system, identify inefficiencies in the system and propose measures and potential upgrades to the current system to reduce the likelihood of future failures.

The proposed measures include the maintenance and upgrade of existing diversion channels and flowpaths, the construction of open channels and diversion drains around the proposed stockpile area, and the maintenance and implementation of scour protection devices in areas susceptible to erosion. Some of the recommended measures suggested have since been undertaken on site.

The hydrological investigation report produced from this assessment was included in the appendix of the Water Management Report (BECA, 2010).

2.2 Survey

2.2.1 Detailed Site Survey

A detailed site survey was undertaken in 2010 by Wollongong Coal Limited (WCL) and provided in **Appendix A**. The survey includes the escarpment to the west and extends towards Princes Highway to the east of the WCL Russell Vale Colliery site.

2.2.2 Aerial Laser Survey (ALS) Data

The ALS data tile W3066194 collected by AAM between May 2005 and October 2006 was used to define catchment boundaries and to represent the existing surface beyond the extent of the detailed site survey.

An updated laser survey of the site, collected in May 2014 was used to better define the current site topography specifically through the stockpile area. This survey was used to model the existing site conditions in the hydraulic analysis.

3 Hydrological Data

3.1 Sub-Catchment Topology

Sub-catchments delineated from the previous study by BECA (2009) were based on the proposed scenario catchments (**Appendix A**). As such, peak flows derived from the previous study were re-assessed and delineated based on the detailed site survey and ALS data to represent the existing conditions on site. Stormwater runoff from the north western sub-catchments discharges towards the north while the remaining sub-catchments discharge towards the stormwater systems. The stormwater systems are separated into the dirty water (DW) and clean water (CW) systems.

The two stormwater systems are as follows:

1. DW – runoff primarily from the stockpile area and along the conveyor portal are directed to the dirty water stormwater system to be treated before discharging into Bellambi Creek.

2. CW – runoff through the southern extent of the site flows through the natural Bellambi Gully watercourse before connecting to the 1800 mm diameter main stormwater pipeline. Runoff generated through the centre and along the northern access road falls towards the stockpile area where it enters a 600 mm diameter pipe. The pipe then connects to the 1800mm diameter main stormwater pipeline. The main stormwater pipeline is 660 m long and conveys the upstream runoff towards the Bellambi Creek licensed discharge point (LDP2), approximately 250 m upstream of Princes Highway.

3.2 Design Storms

Peak flows presented in the BECA report were used as a basis for this assessment (review of these flows is beyond the scope of this assessment). Peak flows of the upstream catchments entering the multiple discharge points downstream were determined, and are presented in **Table 3-1**.

Table 3-1 Peak Flows

Catchments (BECA)	Area (ha)	Discharge Location	Adopted Peak Flows (m^3/s)		
			5 year ARI	10 year ARI	100 year ARI
U1	10.69	CW	2.83	3.58	6.39
U2	9.76	CW	2.5	3.13	5.66
U3	8.63	North	2.21	2.77	5
U4	0.5	North	0.226	0.274	0.459
U5	0.4	North	0.189	0.237	0.367
M1	6.12	DW & CW	1.89	2.28	3.92
M2	1.28	North	0.528	0.625	0.995
M3	3.31	CW	0.734	0.923	1.73
M4	0.43	CW	0.149	0.181	0.3
M5	3.34	CW	0.874	1.1	1.98
M6	1.36	CW	0.368	0.47	0.818
M7	1.73	DW	0.654	0.778	1.29
M8	1.78	CW	0.473	0.615	1.09
L1	4.84	CW	0.738	0.951	1.94
L2	12.07	DW	2.84	3.52	6.51

4 Hydraulic Analysis

4.1 Selection of Hydraulic Model

4.1.1 Model Parameters

A HECRAS 1D steady-state hydraulic model was developed for the site, using ALS data and detailed site survey. Runoff generated from the site is conveyed beneath the stockpile area before discharging into Bellambi Creek. As such, the upstream model boundary was established within the stockpile area and extends towards the Bellambi Creek discharge. A plan view of the model is presented in **Appendix B**.

The Manning's n roughness values along the channel were adopted from the Combined FS report (Lyall & Associates, 2011) and are presented in **Table 4-1.**

Table 4-1 Manning's 'n' Roughness Values

Surface Type (Combine FS)	Surface Type (Cardno)	Manning's 'n' Value
Asphalt, river bed or pillowcrete	Roads, stockpile area, creek bed	0.02
Grass or lawns	Grassed areas	0.045
Dense vegetation	Dense vegetated areas	0.135

Building structures within the modelling extents were represented as obstructions. Tailwater levels were adopted from the Collins Creek Flood Study (Lyall & Associates, 2011) and taken immediately downstream of the discharge location within Bellambi Creek. Tailwater levels for the modelled storm events are presented in **Table 4-2**.

Table 4-2 Downstream Tailwater Levels (Bellambi Creek Discharge)

Storm Event	Tailwater Levels
5 year ARI	30 m AHD
10 year ARI	30 m AHD
100 year ARI	30 m AHD

4.1.2 Modelling Approach

Three main pipes located within the stockpile area were identified to receive the DW and CW flows from the upslope catchments. **Table 4-3** presents the pipe capacities, the total flows and the corresponding contributing catchments for the DW and CW pipes in the 5, 10 and 100 year ARI storm events.

The full capacities for the pipes (no blockage assumed) were determined using the Manning's Equation. Flows in excess of the pipe's capacity were modelled as overland flows at the pipe inlets in the 1d hydraulic model.

The 450 mm DW pipe underneath the stockpile area was formerly designed to receive the first flush flow from catchment M1 as well as stormwater flows from catchments L1 and L2. However, based on the information presented in the report by BECA (2009), the maximum flow rate of the DW first flush pipe in catchment M1 is 0.02 m^3/s, which is lower than the 5 year ARI catchment flows. Hence, it was assumed that all the designed flows from M1 bypasses the first flush system and are completely captured by the CW system.

The report also states that flows from catchment M7 should be considered "dirty". Based on the topographical data, it has been confirmed that flows from M7 are currently directed to the 450 mm DW pipe.

Flows from catchments M5, M6 and M8 as well as flows within the north extent of catchments M1 and M3 are directed towards the 600mm CW pipe. The main 1800 mm CW pipe receives flows from the 600 mm CW pipe as well as catchments M4, U1, U2 and the remaining flows within the south extents of catchments M1 and M3.

Table 4-3 Steady State Flows

Pipe Type	Contributing Catchments	Pipe Capacity (m^3/s)	Peak Flow Rate (m^3/s)		
			5 year ARI	10 year ARI	100 year ARI
450 mm DW	M7, L1 and L2.	0.817	4.23	5.25	9.74
600 mm CW	North of M1 and M3. M5, M6 and M8.	1.63	3.03	3.79	6.71
1800 mm CW	M1, M3, M4, M5, M6, M8, U1 and U2.	24.9	9.82	12.28	21.89

Based on the values presented in **Table 4-3**, it can be seen that the 450 mm DW and 600 mm CW pipes do not have sufficient capacity to convey flows exceeding and including the 5 year ARI event. Runoff is generated from the excess flows, causing coal stockpile washout in all modelled scenarios (see **Section 4.1.3** for details of scenarios).

However, the 1800 mm CW pipe has adequate capacity to receive the upstream catchment flows including flows from the 600 mm CW pipe.

4.1.3 Model Scenarios

The model was established based on the three scenarios presented in **Table 4-4**.

Table 4-4 Model Scenarios

Scenario	Details
1	This model is based on the event where the stormwater systems are completely blocked, i.e. catchment flows are entirely conveyed as overland flows.
2	A conservative model is established as the second scenario where a 20% blockage was applied to the receiving stormwater pipes (i.e. CW and DW systems within the stockpile area). Flows exceeding the capacity of the pipes were modelled as overland flows.
3	The third modelled scenario is based on the event where the stormwater systems are fully functional i.e. CW and DW pipes are flowing full. Flows exceeding the capacity of the pipes were modelled as overland flows.

4.2 Modelling Results

Results generated indicate that flooding within the site is significant, and is mainly contained within the stockpile area in all modelled scenarios. Flooding within the site remains significant in the third modelled scenario (i.e. unblocked) although the majority of flows are captured within the stormwater pipes.

Runoff from the stockpile area overtops the access road near the settling ponds and continues as sheet flow downstream towards Bellambi Lane in all modelled scenarios. Overtopping flows conveyed along Bellambi Lane have the potential to convey coal stockpile washouts downstream. Flood modelling results are included in **Appendix B** while the flood extents maps for the modelled scenarios are presented in **Appendix C**.p

5 Flood Mitigation

5.1 Proposed Flood Mitigation Measures

Based on the flood assessment results and information gathered from the site inspection, flooding caused by site runoff can be alleviated by optimising the existing structures in addition to implementing upgrades on site.

The key flooding issues identified and the corresponding proposed mitigation measures are presented as follows. The locations of the proposed mitigations are presented in **Appendix D** (refer numbers 1-5).

1. **Raise stockpile area access road, install new culvert and formalize open channel**

   The location where the overflow occurs should be upgraded to prevent coal washout downstream. Flooding can be contained within the site by raising the stockpile area access road and installing a culvert. The access road should be constructed with a low point (sag) to allow for overtopping of flows in excess of the culvert capacity. The culvert would connect to the proposed grass-lined swale on the east side of the stockpile area access road before discharging into Bellambi Creek.

2. **Debris control structures at the 1800mm pipe inlet and the M3 Culvert**

   The probability of blockage of the 1800 mm pipe, and the M3 culvert (near the conveyor) can be reduced by implementing a Debris Control Structure (DCS) at the respective inlets. Additionally, rehabilitation and opening up of the M3 culvert will further reduce the probability of blockage of the M3 culvert. This would increase the efficiency of the stormwater systems and reduce occurrence of overflows from the natural Bellambi Gully watercourse into the stockpile area.

   The efficiency of the DCS's can be improved by inclusion of a Debris Control Management Procedure (DCMP) in the existing Surface Water Management Plan. The DCMP would include measures to ensure the DCS is maintained regularly with additional maintenance both before predicted storms and after storm events.

3. **Formalisation of the 600 mm clean stormwater**

   The existing 600 mm clean stormwater pipe has a capacity of 1.6 m^3/s (6% slope), which is not sufficient to convey the 100 year ARI catchment runoff (6.7 m^3/s). However, the operation of the pipe inlet can be improved by formalising the swale in the vicinity of the inlet. The swale functions to capture the clean water (CW) flows from the upslope catchments (M5, M6, M8 and north of M1 and M3) and convey it towards the CW pipeline system. Formalisation of the swale will provide sufficient capacity to capture the CW flows and ensure CW does not overtop into the stockpile area.

   A Manning's calculation confirms that upgrading to an 825 mm diameter pipe would convey flows up to the 100 year ARI storm, between the pipe inlet and the 1800 mm pipe. This can be considered as an additional measure, and would likely present challenges in implementation due to the coal stockpiles and existing structures.

4. **Maintenance to existing structures**

   It was observed in the site inspection that the existing debris control screens (trash racks) were fully blocked with rocks and boulders conveyed from the upstream creek banks.

   Appropriate maintenance should be carried out immediately upstream and downstream of the existing debris control structures within the Bellambi Gully to avoid any blockage of the system. Blockage of these upstream culverts tends to lead to uncontrolled surface flows into the stockpile area.

5. Upgrade through roads

To decrease the amount of clean stormwater runoff entering the stockpile area, culverts may be installed across the access road along the northern boundary of the site to direct flows from the catchment M8 directly towards Bellambi Creek.

This option is considered as an alternative and can decrease runoff conveyed towards the existing 600 mm CW pipe, which has a limited capacity (as discussed in Option 3).

5.2 Discussion

It was proposed in the Stormwater Hydrology Review report (BECA, 2009) that the clean water system be diverted around the stockpile area through a proposed diversion channel. Implementation would require that diversion drains, land grading, bunds and road crests be constructed within the steep batters and access roads within the upstream catchments to ensure that all clean water flows be directed towards the proposed diversion channel. Reno mattresses and drop structures using gabion basket within catchments M1, M3, M5 and M6 were also proposed to improve the efficiency of the stormwater conveyance through the site. Implementation of the proposed measures would require annual inspections and ongoing maintenance to the existing and proposed structures. Geotechnical assessment would be required to determine the stability of the proposed channel realignment area prior to any detailed design works. Given the significant capital and maintenance costs associated with this approach, the potential for alternative approaches have been explored in this report.

Based on the assessments undertaken, it was demonstrated that the existing stormwater system is adequate for managing flows on site (except the capacity of the 600 mm CW pipe); on the condition that maintenance is undertaken regularly. The alternative measures explored in this report were focused on providing more effective structures through optimising the existing stormwater systems on site. Flood modelling was undertaken to confirm the validity of the alternative measures proposed and are discussed in **Section 5.3**. Factors to be considered when implementing the measures are discussed in the following sections.

5.2.1 Blockage

Mitigation Option 2 proposes the design and construction of debris control structures at the M3 culvert (near the conveyor) and the 1800 mm diameter culvert. According to Council's blockage policy, both culverts should be considered blocked for the 100 year ARI flood event. The implication of assuming these culverts as blocked is that clean water would be diverted from the existing watercourse, down the conveyor portal and through the coal stockpile before being discharged into Bellambi Creek (see **Table 4-3** for culvert capacity and 100 year ARI flows from contributing catchments). However, if the inlets are rehabilitated and an additional DCS constructed and maintained as part of a DCMP, it is considered likely that the culverts will remain relatively free of debris. As such, clean-water flows would avoid the coal stockpile area, reducing the potential for pollution of the downstream watercourse.

5.2.2 Water Quality

Water quality requirements are beyond the scope of this report. Notwithstanding, given the importance of runoff water quality leaving the site (and that water quality issues are somewhat connected to flooding issues in this case), this section has been compiled to provide a preliminary discussion of the potential water quality implications resulting from the proposed flood mitigation methodology.

A 6ML dry sediment basin near the proximity of the stockpile access road as proposed in Appendix C (Stormwater Hydrology Review) of the Water Management Report (BECA, 2010) is currently being assessed by Wollongong Coal Limited. The Stormwater Hydrology Review (BECA, 2009) advises that all existing and proposed dirty water from the site up to the 10 year ARI event should be directed into the dry sediment basin for treatment before discharging through the licensed discharge point (LDPs) at Bellambi Creek.

It is noted that some site discharge will still flow through the coal stockpiles even in the 20% blockage scenario. Based on the previous submission, the sizing and assessment of this basin has been based on hydrographs for the entire stockpile area and the requirement to contain all storms up to and including a 10 year ARI event. However, further investigations will be required to confirm that the basin size

will be adequate to treat excess flows not captured by the 20% blocked dirty and clean stormwater pipes within the stockpile area.

5.2.3 Earthworks

The embankment upstream of the proposed culvert should be excavated to allow unrestricted conveyance towards the structure. Additionally, the embankment downstream of the culvert will have to be excavated for the construction of the swale. Further modelling and surface design should be undertaken in subsequent design phases. We also recommend detailed survey of the current site be undertaken prior to any design works.

5.3 Hydraulic Modelling of the Proposed Scenario

Flood modelling was undertaken to confirm the validity of the alternative measures proposed. The proposed culvert and grass lined swale discussed for mitigation Option 1 (refer **Section 5.1**) was modelled using a HEC-RAS steady state hydraulic model, incorporating 100 year ARI flows provided in the BECA Stormwater Hydrology Review report (BECA, 2009).

Existing structures were modelled as per Council's DCP (2009). 25% blockage was applied to the proposed 6m span Reinforced Concrete Box Culvert (RCBC), while 100% blockage was applied to all culverts upstream. The proposed culvert would consist of (1x) 6000W x 1200H RCBC. The proposed access road slopes 3% towards the proposed low point, which is approximately 16 m west of Bellambi Lane. The proposed swale has been adequately sized to convey the 100 year ARI flow towards Bellambi Creek in the event where the upstream structures are fully blocked.

5.3.1 Modelling Results

Results indicate that the 100 year ARI flows overtop the culvert and flow across the access road at the low point before discharging into the proposed swale downstream. This demonstrates that the proposed upgrades are effective in eliminating flooding on Bellambi Lane. However, it should be noted that although the model represents the worst case scenario for the site (i.e. assuming existing structures upstream are fully blocked), the suggested measures to maintain and upgrade the existing structures should nonetheless be carried out for optimum operations of the stormwater system.

The flood extents map is presented in **Appendix F** and a typical cross section detail of the proposed RCBC and swale is presented in **Appendix G**.

6 Conclusions

The following can be concluded from the Bellambi Gully flood assessment:

1. Runoff generated within the site is currently conveyed under the stockpile area before discharging into Bellambi Creek.
2. Three scenarios were modelled to assess flooding throughout the site. The models represent events where the stormwater pipes are completely blocked, 20% blocked and fully operational.
3. Results indicate that flooding within the site is significant in all modelled scenarios; however overland flows are mainly contained within the stockpile area in all modelled storm events.
4. Modelling results indicate that overland flows currently overtop the access road and continue as sheet flow downstream towards Bellambi Lane in all modelled scenarios.
5. The proposed mitigation measures are aimed to reduce clean runoff entering the stockpile area, while conveying all site runoff in a controlled way to Bellambi Creek.
6. Mitigation measures suggested for the site are as follows:
    - Upgrading the stockpile area access road and installing a 6m span culvert to convey the site runoff across the access road, into a proposed grass-lined swale before discharging into Bellambi Creek.
    - Implementing a debris control structure at the 1800 mm diameter pipe and M3 culvert opening to reduce probability of blockage within the system due to debris from upstream catchment.
    - Formalising the swale in the vicinity of the existing 600 mm clean water inlet. This would provide increased temporary storage for stormwater which helps to manage peak flows from the upstream catchment and to ensure all the clean water runoff is captured before entering the stockpile area.
    - Upgrading the existing 600 mm diameter clean water pipe to an 825 mm diameter pipe should be considered although the other proposed mitigation measures does not rely on this upgrade (and was not modelled in the proposed scenario model).
    - Appropriate maintenance should be carried out immediately upstream and downstream of the existing debris control structures within the Bellambi Gully to minimise the potential for blockage of the system.
    - Culverts may be installed across the access road along the northern boundary of the site to direct flows from catchment M8 directly towards Bellambi Creek, in order to reduce clean water runoff conveyed into the stockpile area.
7. Flood mitigation measures presented in this report may provide an alternative to the measures presented in the Stormwater Hydrology Review (BECA, 2009), with the exception of water quality measures (e.g. sediment basin) which have not been considered in this report.
8. Further investigations should be undertaken to confirm that the dry sediment basin proposed in the Stormwater Hydrology Review (BECA, 2009) will be adequate to treat excess flows not captured by the 20% blocked dirty and clean stormwater pipes within the stockpile area before discharging into Bellambi Creek (design of treatment measures to achieve this is beyond the scope of this report).
9. 25% blockage was applied to the proposed 6 m RCBC, while 100% blockage was applied to all culverts upstream as per Council's blockage policy in the DCP (2009). The results demonstrate that the proposed road upgrade, 6m culvert and swale are adequate to convey the 100 year ARI flows.
10. Although the solution has been designed for a worst case scenario where existing structures upstream are fully blocked, the suggested measures should nonetheless be carried out to maintain and upgrade the existing structures for optimum operations on site.

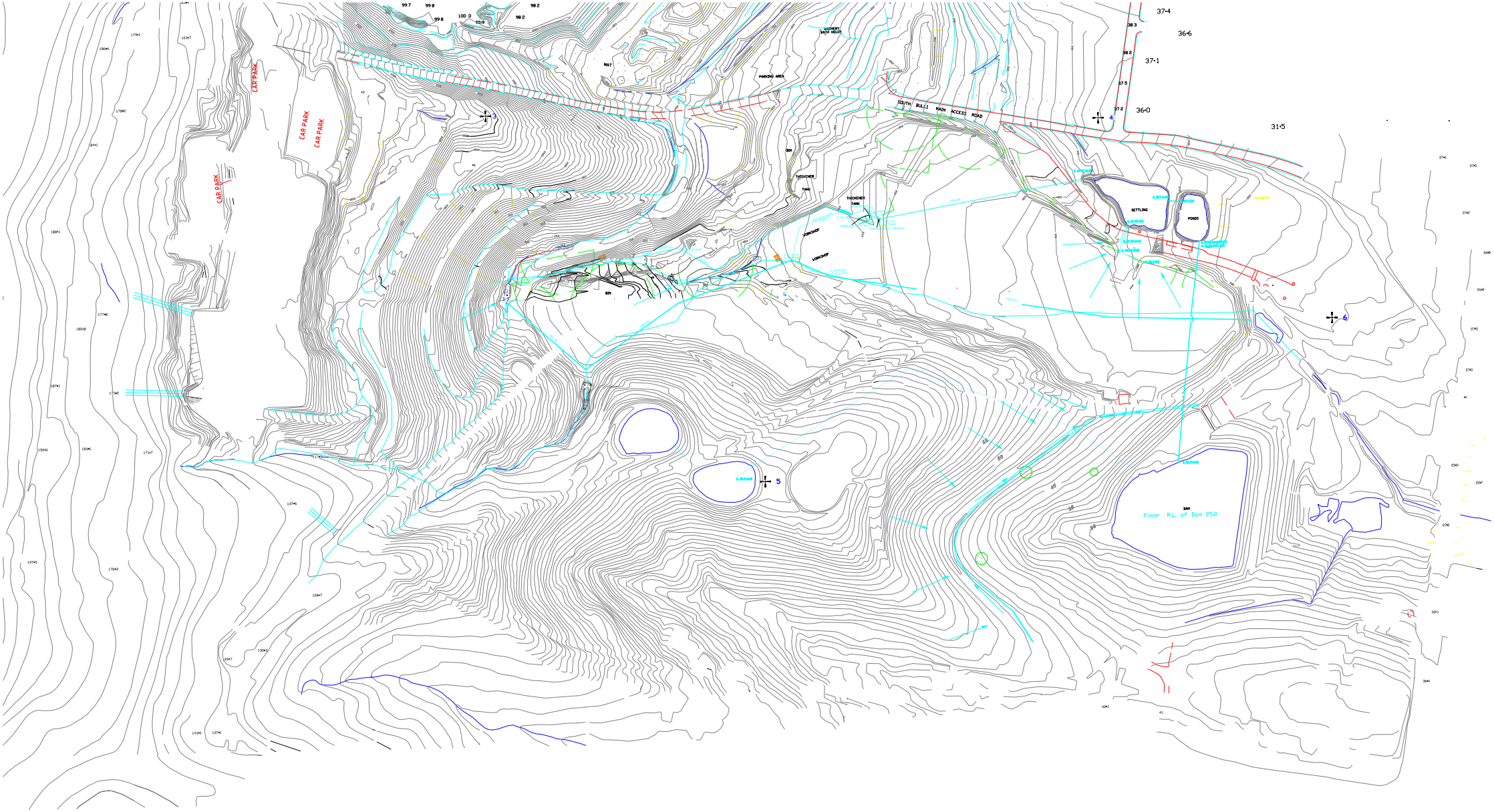
11. Designs presented in this report are preliminary only. Detailed survey of the current site is required prior to any subsequent design works.

Bellambi Gully Flood Study

APPENDIX A
AVAILABLE INFORMATION

Cardno
Shaping the Future

Site Survey


CAR PARK
CAR PARK
CAR PARK
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THICKENER TANK
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SETTLING
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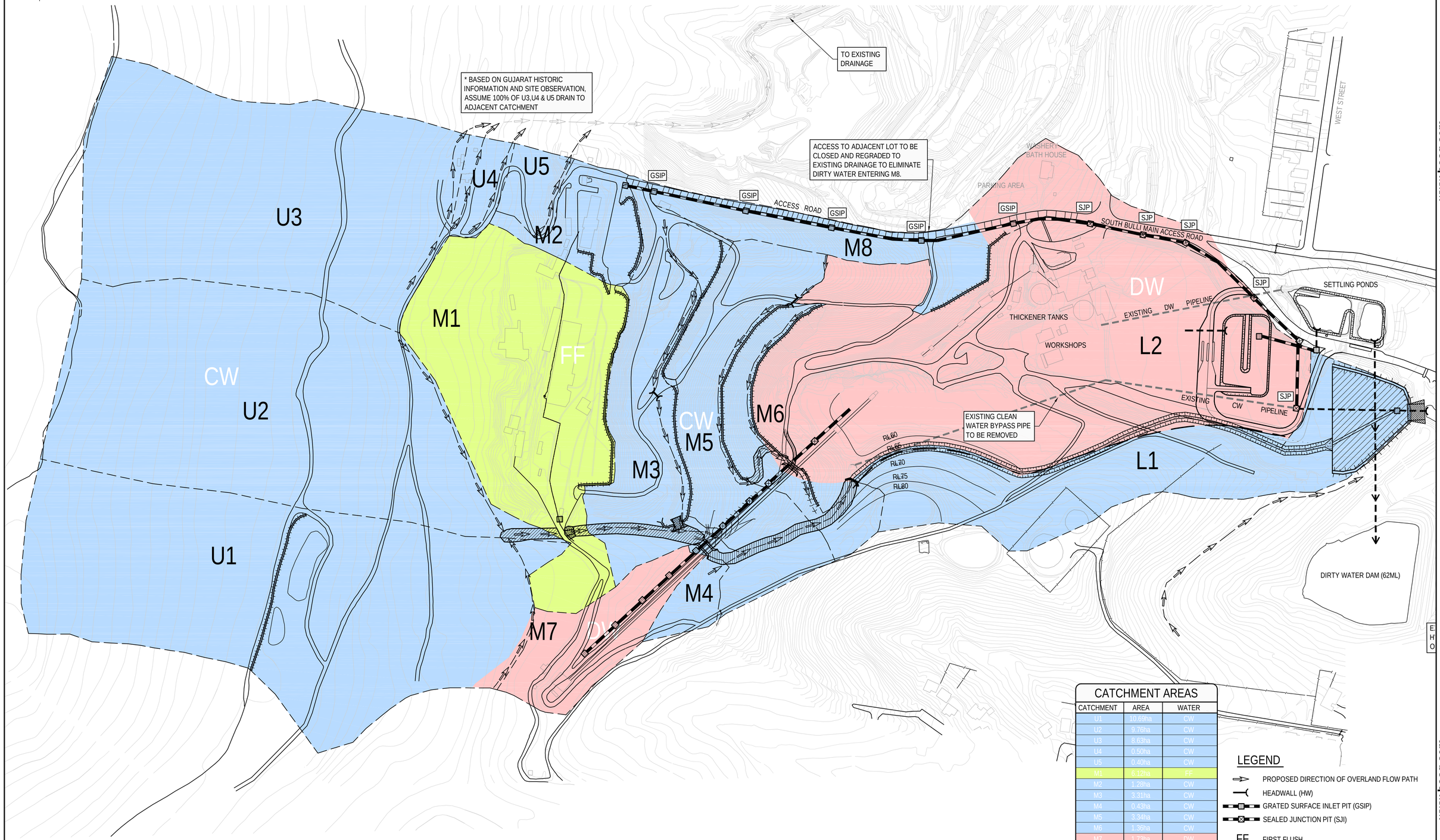

CATCHMENT AREAS		
CATCHMENT	AREA	WATER
U1	10.69ha	CW
U2	9.76ha	CW
U3	8.63ha	CW
U4	0.50ha	CW
U5	0.40ha	CW
M1	6.12ha	FF
M2	1.28ha	CW
M3	3.31ha	CW
M4	0.43ha	CW
M5	3.34ha	CW
M6	1.36ha	CW
M7	1.73ha	DW
M8	1.12ha	CW
M9	0.66ha	CW
L1	4.84ha	CW
L2	12.07ha	DW

LEGEND

- PROPOSED DIRECTION OF OVERLAND FLOW PATH
- HEADWALL (HW)
- GRATED SURFACE INLET PIT (GSIP)
- SEALED JUNCTION PIT (SJI)
- FF FIRST FLUSH
- CW CLEAN WATER
- DW DIRTY WATER

FOR INFORMATION
NOT FOR CONSTRUCTION

0 1000m
SCALE

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

Design	PI	23/7/09	Approved For Construction*
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 No. 1 HYDROLOGICAL INVESTIGATION

Title: SITE LAYOUT CLEAN/DIRTY WATER REGIONS

Discipline: CIVIL

Drawing No.: 2591308-C-SK7

Rev.: B

DO NOT SCALE

IF IN DOUBT ASK.

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