SYDNEY CONSTRUCTION MATERIALS

SURFACE WATER MANAGEMENT PLAN

NEWNES JUNCTION SAND & KAOLIN EXTRACTION PROJECT

HUGHES TRUEMAN

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1.0 INTRODUCTION

In the light of comments received on the original EIS and the preparation of a revised quarry plan, Hughes Trueman was commissioned by Sydney Construction Materials to review and update the water management plan covering the operational and rehabilitation phases of the project, and final landform.

The revised quarry plan allows the extraction to take place in a manner that permits drainage to be directed into the pit throughout the extraction and rehabilitation processes, and a free draining site to be created once rehabilitation is complete. This arrangement will allow the site to store sufficient water to meet all on-site water needs throughout the life of the project, primarily for dust suppression and watering of newly established rehabilitation plantings. The proposed system will also be capable of retaining all runoff from storms in excess of the 100 year average recurrence interval (ARI), 72 hour storm. There will be no uncontrolled discharge from the site during operational and rehabilitation phases of the project. Any discharge will only be by means of controlled flow from the water treatment plant.

This report describes the features of the surface water management system and presents the results of detailed water balance analysis using the long term rainfall records from Lithgow. The analysis demonstrates the ability of the system to provide a reliable water supply for on-site purposes while ensuring that no uncontrolled stormwater discharge occurs from the site.

2.0 REVISED EXTRACTION PLAN

The original extraction plan as shown in the EIS has been revised to accommodate the use of a surface miner as the primary extraction unit and scrapers to deliver the material to the stockpiling area rather than dozers, front end loaders and trucks. The revised method allows the noise criteria to be met at all stages of mining. As the excavation expands, final slope batters and berms are formed and progressively rehabilitated in the same way as previously proposed. Figures 1 to 10 (located at the end of this chapter) have been prepared by MineConsult and set out the staging of extraction and the associated facilities. Further details of the staging plan as it relates to water management are provided in Chapter 3 below.

The sequence of the benches remains largely unchanged; however the starting point will be to the west and moving progressively to the east and south while the size of each bench is larger given that it will be worked at the same level throughout. A key feature of the new extraction method is the ability to slope the floor of the pit very accurately which will facilitate in pit drainage. The extraction process will create a graded surface that slopes at approximately 1% in a westerly direction towards the back of the pit throughout the project except for the final phase of Stage 4 when the slope will be reversed in preparation for the final landform. The extraction method also allows for windrowed material to remain in pit where required in order to contain runoff as well as reduce runoff velocity.

3.0 WATER MANAGEMENT SYSTEM – OPERATIONAL PHASE

The main consequence of the new extraction method will be to increase the exposed area more rapidly than set out in the EIS. However the lack of benches within the working pit will significantly enhance the ease of construction of in-pit storage and the control runoff within the pit. The original design allowed for a series of water retention pits to be constructed on the western end of each working bench. Water from these pits then flowed into the main retention ponds on the northern end of the pit adjacent to the treatment plant. Originally it was proposed that these retention ponds, with a combined capacity of 57 ML, would overflow back into the pit in the event of a storm greater than the design storm occurred.

Under the revised extraction plan, a single main retention pond will be located on the northern end of the pit. This retention pond will serve as:

- the main collection point for stormwater runoff;
- the storage for supply of water for dust suppression and watering for vegetation establishment;
- the primary settlement pond for water that will be pumped to the water treatment plant for treatment to a standard suitable for use by the village and plant nursery or discharge into the natural creek system.

The new extraction method creates a series of windrows of excavated material as the surface miner passes over the pit floor. These windrows are then collected by a scraper which delivers the material to the stockpiling area. This process essentially creates a series of absorption banks within the pit which will reduce runoff velocity in times of rainfall. The windrows are created along the contour (essentially north to south) and therefore against the natural flow of water (east to west). The windrows will serve several purposes including:

- Act as “contour banks” that will reduce the length of uninterrupted slope and hence reduce the erosion capacity of overland flow. This will reduce the erosion potential within the working area and reduce the overall solids loading entering the retention pond;
- Pond water behind the bank and allow settling of the coarser sand fraction.

3.1 Overview of Water management System

The key philosophy underlying the design and operation of the water management system is that there will be <u>no uncontrolled discharge of water from the site</u>. The only water discharged into the northern creek that drains into the World Heritage Area will be treated in a water treatment plant and discharged at a controlled rate.

Although most of the features of the site water management system remain the same as those set out in the EIS, for the sake of clarity the sections below summarise the features of the system and their functioning at various stages in the extraction process. Further details of the design and operation of individual facilities are set out in subsequent sections of this report.

3.1.1 Site Preparation Stage

The site preparation stage of the project (shown on Figure 2) will involve the establishment of the site infrastructure including the following water management facilities:

- Construction of a small in-pit retention pond to collect runoff from the working surface for transfer by pumping to the main retention pond located outside the pit.
- Construction of a main retention pond (32 ML) in a location and with sufficient capacity to subsequently serve Stage 1 of the extraction process.
- Construction of a lower retention pond (10 ML) located so as to collect runoff from the haul road and maintenance facility.
- Construction of a clean water diversion channel located on the ridge above the high wall. This diversion channel will convey clean runoff from the hillside above the pit into the creek channel located towards the southern end of the final pit extent (shown as a dotted line on Figure 2).
- Construction of a water treatment plant capable of treating 1 ML/day to a suitable standard for discharge to the World Heritage Area and for use in the village of Newness Junction and the plant nursery.
- Construction of a pipeline from the treatment plant to a storage tank located on the hilltop to the west of the pit. This tank will act as a reservoir for water supply to the village and the plant nursery.
- Construction of a collection drain approximately along the 1032 m contour as shown on Figure 2 to divert runoff from the hill side into the main retention pond for provision of water for dust suppression during the early stages of quarry development.

The water management facilities will be operated in the following manner:

- Runoff collected in the small in-pit retention pond will be pumped to the main retention pond for storage and settlement of coarse sediments. The exception to this would be in the event of an extreme rainfall event when the main retention pond was nearly full. Under these circumstances, water would be allowed to temporarily pond within the working area (which will slope down from east to west at about 1% providing about 4 ML of in-pit storage at this stage). Under no circumstances would sediment laden water from the working area be transferred to the main retention pond so as to cause an overflow of untreated water from the main retention pond.
- Water in the main retention pond will be retained and pumped as required to the lower retention pond and used for dust suppression purposes or treated for use by the village or plant nursery, or discharged into the northern creek that drains to the World Heritage Area. If water level in the main retention pond rises above the design storage zone level (see Section 3.2 for

further details), water will be pumped for treatment and discharge in order to return the water level to the design storage level as soon as practicable.

- Runoff from the area of the haul road and conveyor will be collected in the lower retention pond and given first priority for use for dust suppression or treatment and re-use or discharge to the creek flowing into the World Heritage Area, according to the requirements at the time.

3.1.2 STAGE 1

Stage 1 will involve the downward excavation of the working area as product is extracted and the consequent expansion of the excavation area from an area of about 1.6 ha at the end of the Site Preparation stage to about 10 ha at the end of Stage 1 as shown in Figure 3. During this stage, the water management system will remain essentially the same as for the Site Preparation stage. The main differences will be:

- As a result of the expanded area combined with the slope downward from east to west at about 1%, the available storage capacity within the excavation pit to retain runoff from extreme storms will increase to approximately 50 ML.
- The main retention pond will be retained at a total capacity of 32 ML.
- The lower retention pond will be retained at a total capacity of 10 ML.

Water will continue to be drawn from the lower retention pond for dust suppression and treatment as described for the Site Preparation stage. Similarly, water will be transferred from the in-pit retention pond to the main retention pond except when there is a risk of overflow from the main retention pond. When water level rises above the design storage zone level in the main retention pond (see Section 3.2 for definition of zones within the retention pond) , water will be pumped for treatment and discharge to restore the water level to the designated storage level as soon as practical after a storm.

3.1.3 STAGE 2

The configuration of the site and the water management facilities at the end of Stage 2 are shown on Figure 4. At the completion of Stage 2, the working area will have expanded to about 18 ha. This stage will involve the following alterations to the water management facilities:

- Construction of a new main retention pond (45 ML capacity) in the north western corner of the excavation.
- Extension of the clean water diversion channel around the southern end of the pit and then linking back to the southern creek that drains to the World Heritage Area.

The enlargement of the excavation area will provide in-pit water storage capacity of approximately 220 ML in addition to the volume stored in the main retention pond.

The main retention pond will continue to be operated in a manner that seeks to restore the water level to the design storage level as soon as practicable after a storm

3.1.4 Stage 3

The main change to occur between the end of Stage 2 and the end of Stage 3 will be a further lowering of the working area and a corresponding increase in the excavation area to about 20.4 ha as shown on Figure 5. The water management facilities will remain the same as for Stage 2. The total available water storage within the pit above the level of the main retention pond will be about 350 ML.

3.1.5 Stage 4

During Stage 4 the extent of the pit will only increase slightly (by about 0.5 ha), as shown on Figure 6. The main changes will be the lowering of the base of the pit and the gradual reworking of the slope of the floor so that, by the end of Stage 4, the pit will slope towards the north eastern corner in preparation for final rehabilitation and the provision of a free draining outlet from the site after rehabilitation is complete. In order to preserve sufficient in-pit water storage capacity to retain all runoff from exceptionally heavy storms, a minimum low wall height of 2 m will be retained on the eastern side of the pit. This will provide a minimum of 120 ML of in-pit storage above the level of the main retention pond.

The main changes in the water management system during Stage 4 will be:

- The pre-existing low level retention pond on the eastern side of the pit will be enlarged to provide sufficient capacity (22.5 ML) to meet the water supply requirements.
- For this final stage of operations only, and in order to minimise any backfilling required of the retention pond prior to rehabilitation of the site, no separate provision will be made for a sediment settlement zone within the retention pond. Any water in excess of the water storage requirements will be allowed to pond in the pit. While this may cause some interruption to mining operations, it will only affect a small proportion the pit in the lowest part. The ability of the treatment plant to treat and discharge 1 ML/day will allow normal operations to be restored rapidly.
- Drainage from the stockpiling conveyor and maintenance facilities will continue to be directed into the enlarged retention pond.
- As the surface level is gradually altered to slope towards the east, the former main retention pond will be subsumed as the extraction of material occurs from the area surrounding the retention pond.
- All water for dust suppression and treatment will be sourced from the remaining retention pond.

3.2 Design of the Main Retention pond

As noted above, the main retention pond will serve as a storage reservoir for on-site water needs and as a primary settlement pond for water that will subsequently be treated prior to discharge from the site, or reuse by the village or plant nursery. Any runoff in excess of that retained within the retention pond will be temporarily stored within the extraction area, but will be prevented from draining off-site by the storage capacity available as a result of grading of the extraction surface.

For design purposes, four different water and sediment storage zones have been designated. In sequence, starting from the bottom of the retention pond, these are:

- **Sediment storage zone** which has been designed using the design criteria set out in Chapter 6 and Appendix A of the latest edition of *"Managing Urban Stormwater: Soils and Construction"* (Landcom, 2004). The required settlement storage capacity, allowing for retention of all sediment over the life of the retention pond will increase in proportion to the disturbed area with a requirement of 2.5 ML (2,500 m^3) at the end of Stage 4 of extraction.
- **Water storage zone** which has been designed to provide sufficient capacity to provide for the on-site water needs. The required volume has been established using a long term water balance analysis (see Section 3.5). The required storage volume at the end of Stage 4 of extraction is 18 ML.
- **Sediment settlement zone** which has been designed on the basis of settlement basins for Type F or Type D soils as set out in *"Managing Urban Stormwater: Soils and Construction"* (Landcom, 2004). The adopted design criteria for this component of the retention pond are the most conservative listed, namely:
  - 20 day 95^{th} percentile rainfall 135 mm
  - Volumetric runoff coefficient 0.8

  The design capacity of the sediment settlement zone for the end of Stage 3 is 22 ML.
- **Surcharge zone** which will accommodate all excess runoff from the site in the event of extreme rainfall events such as the 100 year ARI 72 hour storm (307 mm). This runoff will be temporarily stored within the pit above the level of the top of the retention pond. The adequacy of the pit to accommodate the excess runoff is demonstrated by the water balance analysis set out in Section 3.5.

The capacity of the main retention pond will increase progressively as extraction progresses, as shown in Table 1.

Table 1: Main Retention pond Capacity for Various Stages of Extraction

	Stage				
	Preparation	1	2	3	4
Disturbed Area (ha)	1.6	10.0	18.0	20.4	20.9
Sediment storage zone (ML)	0.5	2.5	2.5	2.5	2.5
Water storage zone (ML)	13.0	16.0	17.5	18.0	18.0
Sediment settlement zone (ML)	1.7	10.8	19.5	22.0	2
Required pond capacity (ML)	20.2	31.3	40.0	42.5	20.5
Proposed pond capacity (ML)	32	32	45	45	22.5

Table 2 compares the available surcharge water storage capacity within the pit with the volume of runoff that would occur from a 100 year ARI 72 hour design storm. The surcharge storage capacity within the pit arises because of the proposed 1% downward slope from east to west which forms a wedge shaped storage area with the lowest sections of the pit along the western high wall. As the base of the pit is lowered and width of the pit enlarges, so the width and depth of water that can be stored below the level of the eastern edge of the pit increases. Table 2 shows that, even if the main retention pond was full at the commencement of a 100 year ARI 72 hour design storm, there would be ample excess water storage capacity within the pit. In practice (see water balance analysis in Section 3.5), the average water level in the retention pond will be close to the level corresponding to the water storage zone. Therefore, the volume of the sediment settling zone can also be expected to be available for the retention of runoff from a major storm event.

Table 2: Comparison Between In-pit Storage Volume and 100 year ARI 72 Hour Design Storm Volume

	Stage			
	1	2	3	4
100 year ARI runoff volume (ML)	25	45	50	52
Surcharge zone capacity (ML)	50	220	350	70

3.3 Design of the Lower Retention pond

The lower retention pond will act as the capture point for runoff from the area immediately north of the pit. This area contains the haul road leading to the main office and stockpile area, the stockpiling conveyor, the maintenance area and topsoil stockpiles. The total area draining to the lower retention pond is about 3.5 ha. The lower retention pond will also act as a balancing storage for water transferred from the main retention pond.

Water retained in the lower retention pond will be given priority for providing:

- water for dust suppression,
- water for vegetation establishment,

- water for treatment and discharge off-site or transfer to the storage tank for use in the village or by the plant nursery.

The capacity of the lower retention pond will be 10 ML comprising:

- 7.2 ML temporary holding capacity to accommodate runoff from the contributing catchment resulting from a 100 year ARI, 72 hour storm (307 mm of rainfall);
- 2 ML balancing storage for water transferred from the main retention pond. This is equivalent to two day's pumping to the treatment plant;
- 0.8 ML allowance for sediment accumulation.

Because the lower retention pond will act as the primary distribution point for serving various water needs, the water level will be maintained at a low level in order to maintain the design "air space" for runoff capture. Even in the event of a 100 year ARI storm, it would only require 7 days operation of the treatment plant to restore the design "air space".

3.4 WATER TREATMENT PLANT

As stated in the EIS, the slowest settling, most mobile particles in the runoff from the extraction area will be those that consist of the finest kaolin clays, and therefore the most valuable material on site. The treatment plant designed by Worley International Pty Limited will be capable of extracting this fine component. In order to achieve maximum efficiency from the treatment plant, settlement of the coarser fraction will primarily occur within the main retention pond.

We were advised that the plant proposed could meet the required discharge standard of 15 mg/L of suspended solids. Testing of the groundwater contained in the EIS showed that the other water quality parameters would be acceptable so long as the water was not allowed to pond for too long. Evaporation would concentrate naturally occurring minerals and salts within the water and would then need to be diluted with fresh rainwater prior to disposal.

The treatment plant will only be operated periodically. This will occur immediately after stormwater runoff fills the main retention pond above the storage zone level. Because the treatment will only occur in response to runoff, there will be minimal loss by evaporation leading to concentration of minerals and salts in water that is subsequently discharged.

3.5 WATER BALANCE ANALYSIS

In order to verify the performance of the proposed water management system, a daily water balance model has been developed specifically for this site. The model accounts for all the important water related processes occurring on the site including:

- Runoff from the disturbed area that contributes water to the retention pond,
- Rainfall onto, and evaporation from, the water surface in the retention pond,

- Extraction of water for dust suppression purposes,
- Pumping water for treatment and discharge once the water level in the retention pond was above the designated storage zone.

In the model, extraction of water for dust suppression was assessed on the basis of climatic conditions. Dust suppression watering was assumed to occur on all days except when cumulative rainfall exceeded evaporation. Using this method, the assessed annual volume of water required for dust suppression at the end of Stage 4 is 18.5 ML/year, which is slightly more that the average of 50,000 L/day (18 ML/year) documented in the EIS.

Pumped water for treatment and discharge was assumed to occur whenever the water level in the retention pond was above the designated storage zone. Treatment was assumed to occur at a rate of 1 ML/day.

3.5.1 CLIMATIC DATA

The following climatic data was obtained from the Bureau of Meteorology for use in the water balance analysis:

- **Rainfall**
  Lithgow (63224) — 1/4/1889 – 18/5/2005
  (1/1/1940 – 31/5/1965) missing
  (88 years complete)
- **Pan Evaporation**
  Bathurst Agricultural Research Station (63005) — 1/1/1973 – 31/12/2003 (31 years)

Table 3 below summarises the monthly rainfall and evaporation data for the area. It can be seen that average rainfall is fairly uniformly distributed throughout the year, while evaporation, as expected, shows a distinct summer dominance.

Table 3: Monthly and Annual Rainfall and Evaporation

Month	Rainfall (mm)				Evap
	Average	Percentile			Average
		10%	50%	90%	(mm)
1	92.9	25.4	79.8	176.4	181
2	84.3	12.1	65.6	175.3	133
3	85.1	22.1	68.8	155.8	124
4	63.9	11.6	50.6	128.7	86
5	65.1	18.1	46.8	131.2	60
6	67.4	17.5	53.3	145.4	51
7	67.9	15.0	51.3	140.3	56
8	62.9	15.9	46.6	116.5	77
9	59.4	20.4	53.5	104.7	99
10	67.2	19.5	58.9	133.6	137
11	69.6	18.0	65.4	139.2	154
12	75.6	18.6	65.2	143.6	178
Year	859	623	860	1,087	1,336

For water balance modelling purposes, the 30 year period 1973 to 2002 was adopted because both rainfall and evaporation records were available for the whole period. In order to verify the fact that this period is representative of the longer term records a number of checks were carried out on the annual total rainfall as well as rainfall sequences from 1 day to 60 days duration. Tables 4 and 5 summarise the statistics for these two periods. For comparative purposes Table 5 also includes the 50 and 100 year ARI rainfall estimates for Newnes Junction derived from the rainfall intensity:duration data contained in Volume 2 of *"Australian Rainfall & Runoff"* (1987).

Table 4: Highest Rainfall Years in the Lithgow Record

Year	Rainfall (mm)
1990	1363.1
1978	1345.0
1973	1296.5
1893	1266.0
1934	1229.9

Table 4 shows that three of the top five rainfall years at Lithgow are included in the period 1973 -2002 which has been adopted for water balance analysis.

Table 5: Maximum Cumulative Rainfall (mm) over Consecutive Days

Days of	Historic Record		Australian Rainfall & Runoff	
Rainfall	1889-2004	1973-2002	50 year ARI	100 year ARI
1	179	179	195	214
2	268	268	252	273
3	310	310	279	307
4	332	332		
5	338	338		
10	342	342		
15	359	359		
20	360	360		
30	385	385		
45	465	461		
60	595	488		

The data in Table 5 shows two noteworthy features:

- The rainfall during the period 1973 – 2002 contains the highest periods of rainfall for durations up to 30 days that occurred in the whole historic record. In other words, the period 1973 – 2003 contains rainfall data that is representative of the wettest periods that have been recorded at Lithgow.
- For a three day rainfall event, the 1973 – 2004 historic record contains a sequence of wet days that are slightly above the three day 100 year ARI rainfall derived from "*Australian Rainfall and Runoff*". It follows that if the water management system can handle the runoff from the 1973 – 2002 historic rainfall sequence it could also cope with the 100 year ARI three day rainfall.

3.5.2 STORMWATER RUNOFF

For runoff estimation purposes, a rainfall:runoff model developed by the CRC for Catchment Hydrology (Mudgway et al, 1997) has been adopted for this site. The advantage of this model is that it specifically accounts for variation in the impervious fraction of the catchment. The model results mimic the real world and exhibit a variation in the volumetric runoff coefficient depending on the daily rainfall, a small proportion of rainfall is converted into runoff in a low rainfall day and a high proportion on a very wet day. For modelling purposes, it has been assumed that the disturbed area catchment draining to the retention pond will act as though it was 90% impervious. With this degree of imperviousness, the model predicts a volumetric runoff coefficient of 0.85 for a rainfall of 100 mm/day. This is higher than the value of 0.80 adopted for determination of sediment zone capacity and indicates that the adopted model can be expected to generate large volumes of runoff from heavy storms that would test the ability of the water management system to store runoff without uncontrolled discharge.

3.5.3 GROUNDWATER SEEPAGE

In line with the findings of the groundwater study (Kalf & Associates 2003), the long term groundwater seepage into the pit has been taken to be 0.2 ML/day, of which it has been assumed that half would evaporate from the face of the high wall. For water balance modelling purposes, it has also been assumed that the seepage rate is approximately proportional to the area of the exposed high wall (as shown on Figures 3 – 6). Two scenarios for groundwater contribution have been assessed:

- Groundwater seepage is ignored (ie the most critical conditions for running short of water for dust suppression and vegetation establishment purposes).
- Groundwater seepage is included in the analysis (ie the most critical conditions where water levels in the retention ponds and pit are likely to be highest).

3.5.4 WATER BALANCE ANALYSIS

The water balance model has been run for the site preparation stage and all four stages of the extraction process, in order to assess the ability of the water management system to:

- Retain all runoff within the site and only allow discharge by means of pumped water for treatment;
- Provide a high degree of reliability for supply of water for dust suppression and vegetation establishment purposes.

For each stage of the project the catchment area included in the model includes the working extraction pit area, the high wall, the soil stockpile areas to the west of the pit and the haul road and conveyor area. A summary of the main statistics for each Stage of extraction is provided in Table 6 for situations in which groundwater seepage flow is ignored. Figures 11 – 15 are graphs of the water level variation in the retention pond and pit that would occur over a 30 year climate sequence (assuming that there was no change in the site layout in the meantime) and assuming that groundwater made a contribution to the total water supply from the extraction pit. As noted above, the scenarios shown in Figures 11 – 15 represent those conditions in which water levels in the retention ponds and pit are likely to be greatest.

Table 6: Summary of Performance of the Water Management System

Stage >	Prep	1	2	3	4
Catchment area (ha)	16.5	17.0	24.5	26.9	27.2
Effective percentage impervious	50%	90%	90%	90%	90%
Pan factor	0.85	0.85	0.85	0.85	0.85
Dust suppression area	1.5	3.0	3.0	3.0	3.0
Discharge treatment rate (ML/day)	1	1	1	1	1
Minimum storage for treatment to occur	12.6	16.8	17.5	18.0	18.0
Width of pit storage area (m)	50	150	280	350	350
Length of pit storage area (m)	300	400	400	400	600
Average runoff (ML/year)	38.8	61.0	87.9	96.5	97.4
Total pond volume (ML)	42	42	50	50	22.5
Water Consumed for Dust Suppression (ML/year)	9.3	18.6	18.5	18.5	18.5
Days per year watering for dust suppression occurs	124	124	125	125	125
Water treated for discharge (ML/year)	20.2	33.1	58.1	66.7	68.7
Days per year water treated for discharge	20.2	33.1	58.1	66.7	68.7
Maximum storage in record (ML)	44.4	52.8	76.6	85.8	87.5
Maximum storage area (ha)	1.45	3.08	4.69	5.42	8.90
Maximum water depth above pond (m)	0.48	0.77	1.17	1.35	1.48
Maximum days water level above pond level	5	14	29	37	74
Minimum storage in record (ML)	0	0	0	0	0.8
Average days empty per year	2.1	1.6	0.8	0.4	0.0

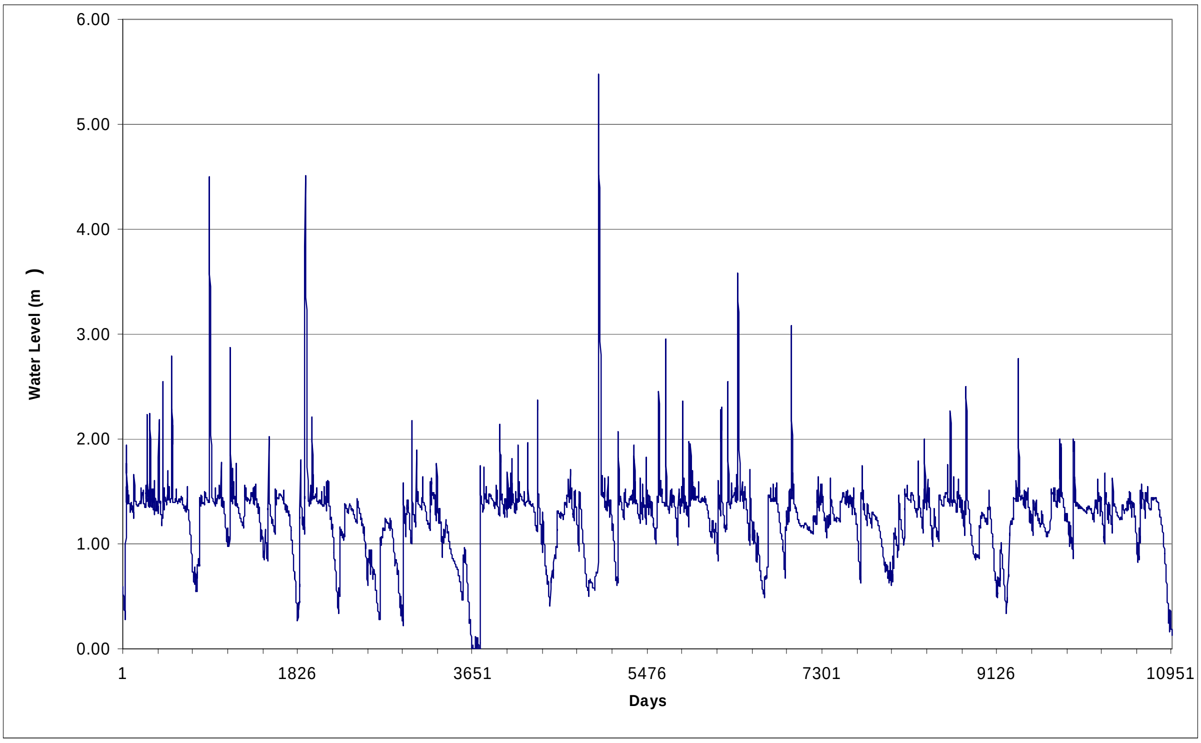

Figure 11
Pond Water Level Variation over 30 Years – Site Preparation Conditions

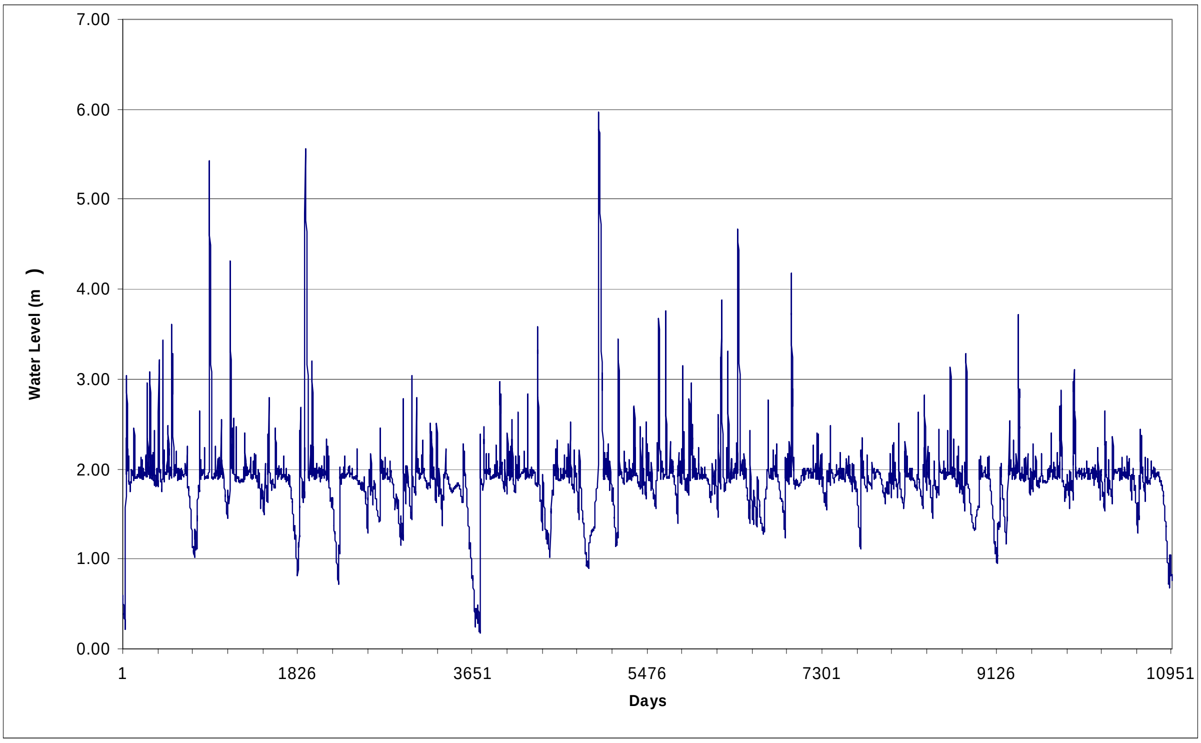

Figure 12
Pond Water Level Variation over 30 Years – Stage 1 Conditions

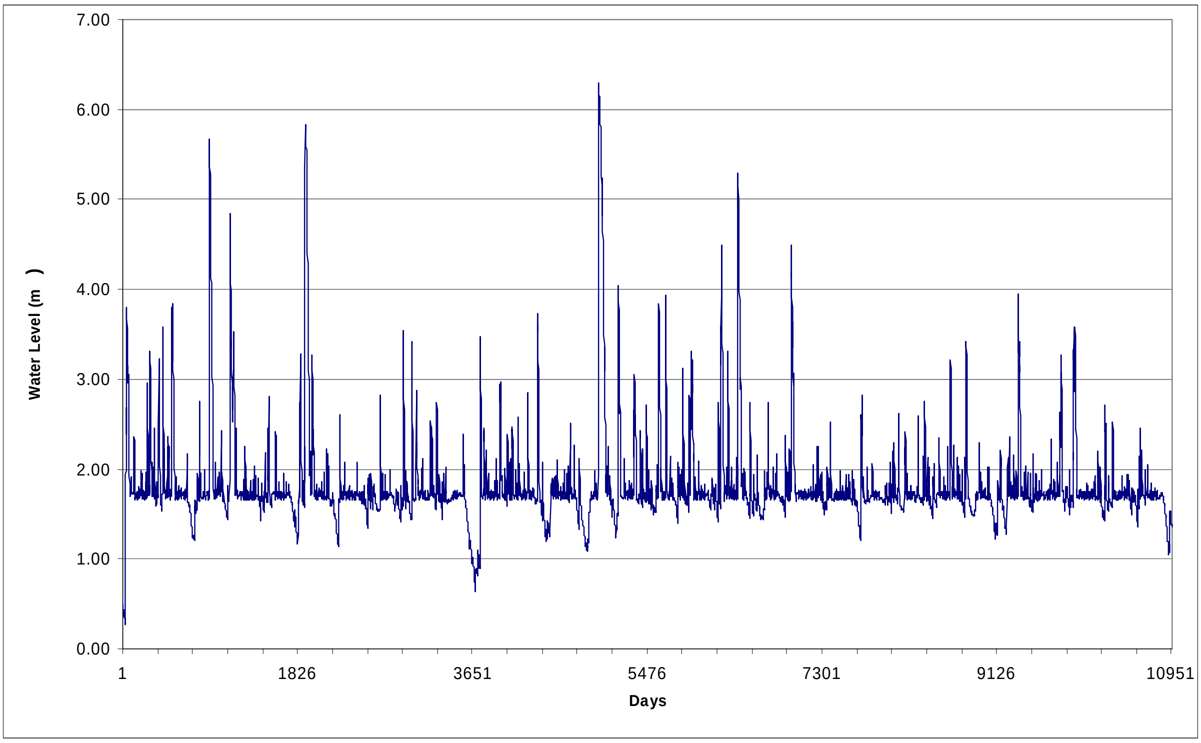

Figure 13
Pond Water Level Variation over 30 Years – Stage 2 Conditions

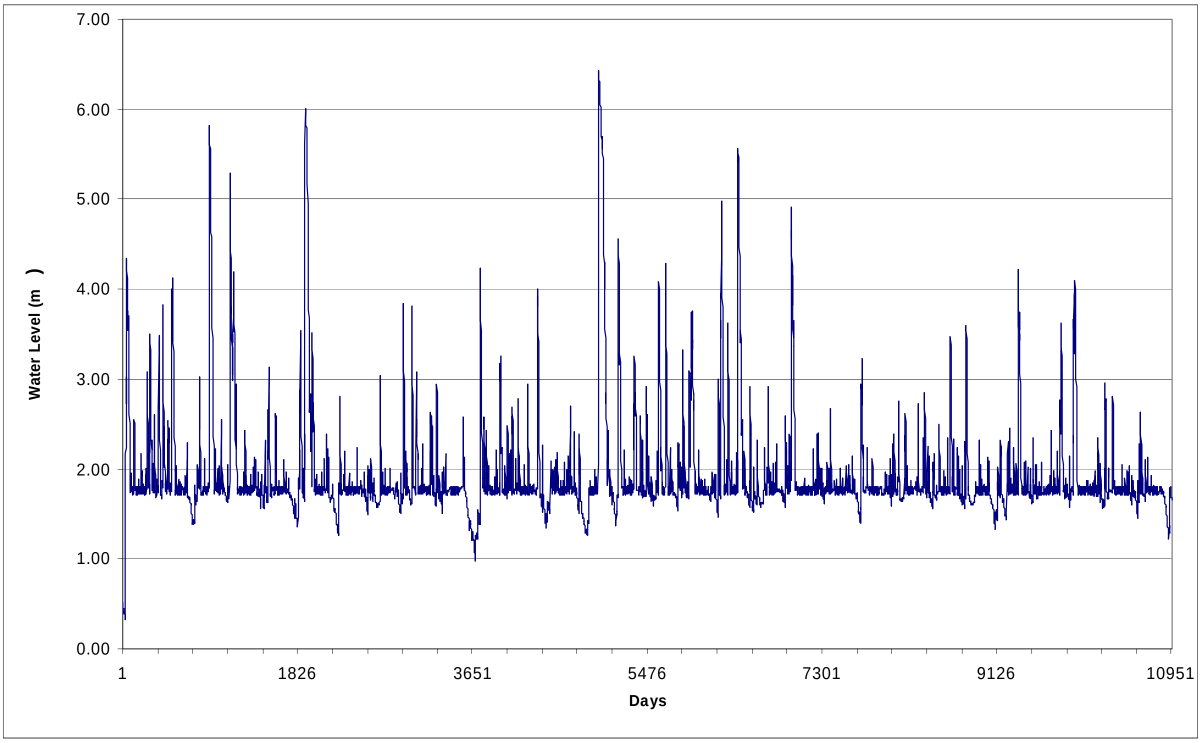

Figure 14
Pond Water Level Variation over 30 Years – Stage 3 Conditions

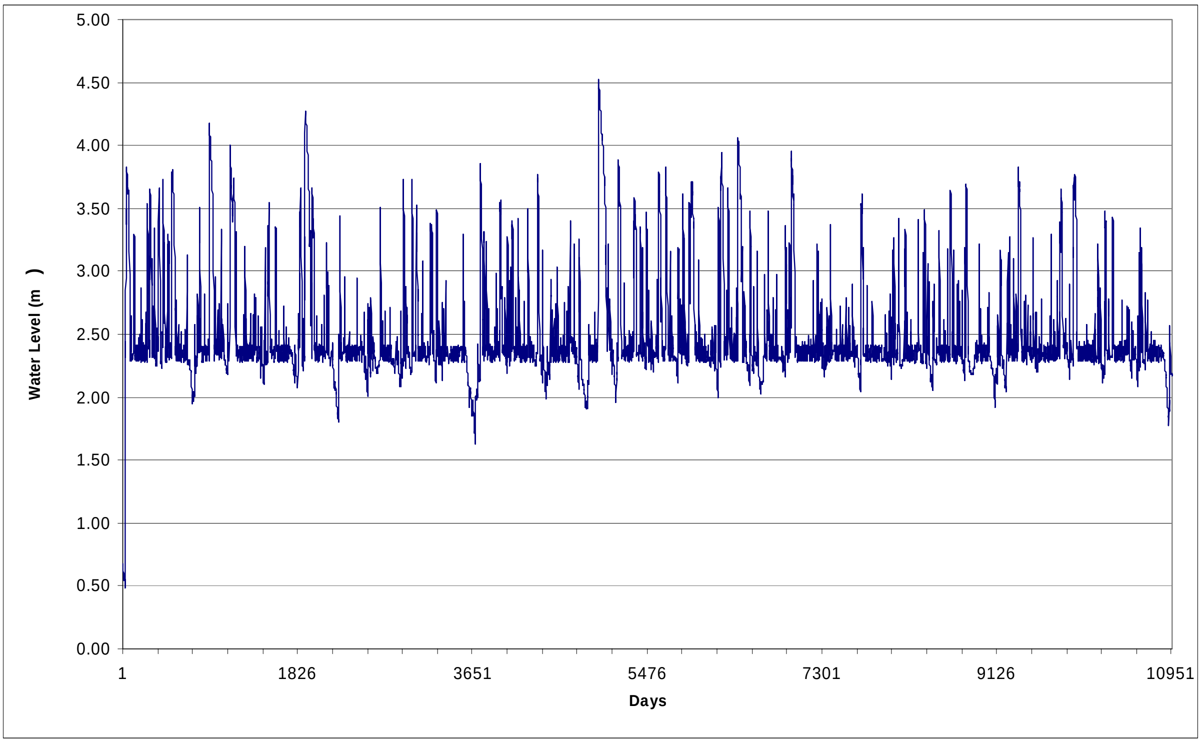

Figure 15
Pond Water Level Variation over 30 Years – Stage 4 Conditions

The summary statistics in Table 6 and Figures 11 – 15 show the following key aspects of the expected performance of the water management system:

- During all stages, the total storage capacity of the site will be in excess of the 1 in 100 year, 72 hour storm event. Even during Stage 4, when there is the largest contributing catchment and only a relatively small retention pond (in preparation for rehabilitation), the maximum depth of ponded water above the edge of the retention pond would be about 1.5 m, corresponding to a maximum volume of excess stored water of about 65 ML. This volume compares to the total volume of the pit below the eastern lip of about 120 ML at this Stage of the project. There would therefore be a large factor of safety against any uncontrolled discharge draining into the adjoining World Heritage Area. During Stages 2 and 3 the available in-pit storage (220 ML and 350 ML respectively) is about 10 times the maximum required storage outside the retention pond (27 ML and 36 ML respectively).
- If a rainfall sequence occurred that led to storage of about 65 ML above the level of the retention pond during Stage 4, it would only take eight weeks of operation of the treatment plant to remove all water from the section of the working area that had been inundated (about 9 ha). For Stages 2 and 3 the maximum require time would be four to five weeks.
- For all Stages the water management system has sufficient capacity to provide the estimated water required for dust suppression and vegetation establishment.

3.6 Water Reuse Options

After removal of solids, the expected water quality would be suitable for discharge offsite. Due to the nature of the sandstone resource and lack of mineralisation, groundwater inflows are generally potable and are in fact used for domestic drinking water and commercial bottled water operations. This fact allows for greater reuse options should the site not be allowed to discharge. Options available include supplying an on site nursery which will be developed in conjunction with Lithgow Nurseries and developing a water supply system for Newnes Junction.

Although other reuse options may be developed, the water pollution control system as provided in the EIS and further clarified in this report, should not preclude discharge offsite if the necessary water quality criteria are met.

3.7 Clean Water Diversion Channels

Two sections of clean water diversion channel will be developed as permanent features of the landscape which will continue to function after extraction has been completed. The first section will be constructed during site preparation (see Figure 2). It will run in a southerly direction approximately parallel to the western edge of the pit, and discharge into the southern creek that discharges from the extraction pit area. This channel will intercept clean runoff from a catchment area of about 8 ha located to the west of the pit.

As a result of the proposal to avoid a small swampy area within the southern drainage line, a second diversion channel will be constructed as part of the Stage 2 works (see Figure 4) to redirect clean water runoff from the catchment area from above the pit. This diversion channel, which has a total catchment area of about 16 ha, will commence at about the same location as the first channel joins the southern creek and convey water around the southern end of the pit.

Both channels will be designed to convey the 100 year ARI peak flow for the catchment concerned (approximately 4 m^3/s and 6.5 m^3/s respectively). The routes of both channels will require excavation in rock and in some places the channel will need to be cut 2-3 m deep in order to achieve a satisfactory grade. In other locations, the channels are required to convey water down grades in excess of 10%. In these locations it is likely that constructed drop structures will be required to control velocity and prevent scour of the friable sandstone.

3.8 MAINTENANCE AREA

A small maintenance area will be established near the eastern end of the conveyor. This area will include a workshop for maintenance of machinery and re-fuelling facilities. All maintenance work will be conducted within the workshop. The fuel storage area will be appropriately bunded in accordance with DEC requirements for spill containment. The hardstand area outside the workshop and adjacent to the refuelling facility will be sealed and graded so as to drain all runoff to a oil trap before discharging into the drainage system connected to the lower retention pond.

3.9 SOIL STOCKPILES

A number of soil stockpiles will be established around the western and northern edges of the pit. As described in the EIS these stockpiles will be protected with sediment fencing and planted with a cover crop to ensure stabilisation. Surface drainage in the vicinity of the stockpiles will be configured so as to direct runoff into the pit.

4.0 WATER MANAGEMENT SYSTEM – REHABILITATION PHASE

4.1 OVERVIEW

At the completion of operations, the extraction pit will have a floor level grading from RL 989.5 m AHD on the eastern side adjacent to the retention pond to 993 m AHD on the western side. The final major operational activity will be to excavate sufficient extra material to refill the remaining retention pond (located on the eastern side of the pit) to a level consistent with the surrounding excavated area. A small retention pond (about 20 m^3) will be retained to provide an extraction point for water to be pumped to the treatment plant.

During the initial phase of rehabilitation the water management system will continue to operate in a similar manner to the final operational phase with off site discharge only occurring by means of water discharged from the treatment plant. The treatment plant will be operated so as to retain a wetland swamp area with water up to a maximum of 0.5 m deep in the centre of the remnant depression.

Once vegetation establishment has reached a stage where there is judged to be minimal erosion (approximately 5 years), the site will be reconfigured to permit free drainage of water from the site once the wetland/swamp is filled to a depth of 0.5 m. A channel will be excavated through the rock at an elevation of 990 m AHD (0.5 m above the base of the wetland swamp) to allow free drainage from the pit into the existing northern creek that drains into the World Heritage Area.

4.2 PROPOSED WETLAND

As noted above, the wetland would be formed as a shallow depression with the low point in the location of the final retention pond in the north east corner of the pit. The area surrounding the location of the final retention pond will be graded at flatter grades (typically 0.5%) than used elsewhere in the pit (1.0%) in order to create a free form shallow depression with a total area of about 4 ha. It is anticipated that sedges and other wetland plants endemic to the area will colonise this wetland area to form a swamp ecosystem analogous to that in Gooches Crater (see Figure 16).

Once a channel has been excavated to allow overflow from the wetland to discharge off-site, the wetland will be dependant on water supply from the contributing catchment of about 24 ha. The water balance model developed for the operational phases of the project (see Section 3.5) has been modified to account for the expected runoff characteristics of the rehabilitated catchment and used to assess the wetting and drying behaviour of the wetland as a result of surface runoff (Figure 17). (Note that in practice, it is anticipated that some groundwater seepage will assist in maintaining water within the wetland for longer than shown by the analysis).

The main aspects of the water balance analysis are summarised in Table 7.

Figure 16
Gooches Crater

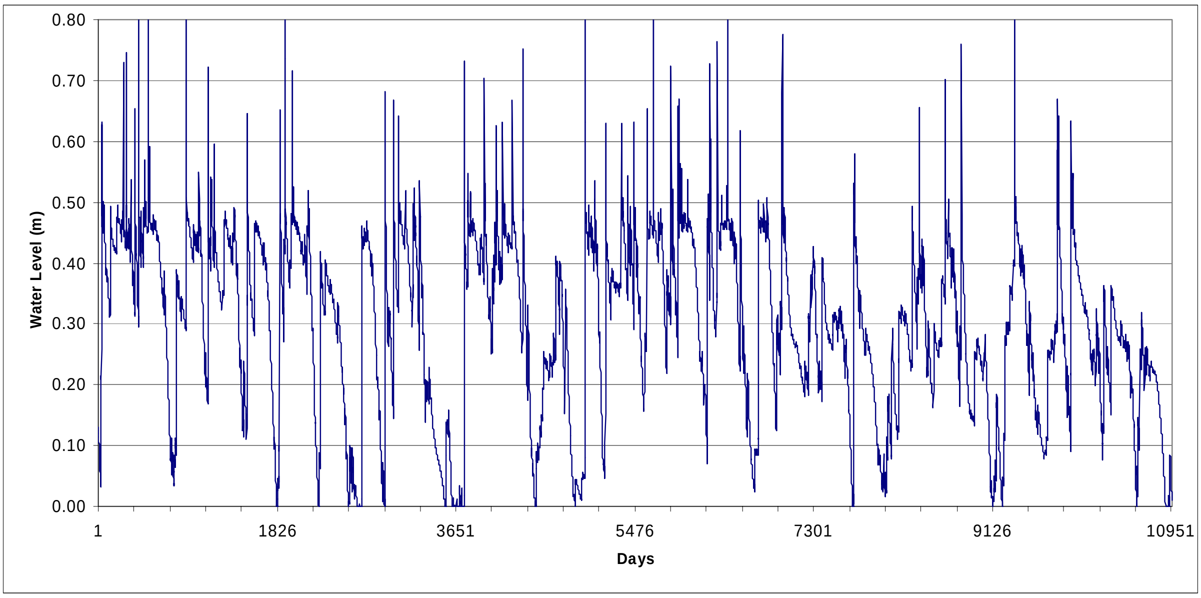

Figure 17
Water Level Variation over 30 Years – Wetland after Rehabilitation

Table 7: Hydrologic Behaviour of the Wetland System

Catchment area (ha)	24
Effective percentage impervious	20%
Pan factor	0.85
Overflow level above lip of main pond	0.5
Total storage at overflow (ML)	7.40
Average Runoff (ML)	34.1
Average overflow (ML/year)	16.7
Days per year overflow occurs	8
Maximum storage in record (ML)	7.4
Maximum storage area (ha)	5.14
Minimum storage in record (ML)	0.0
Average days empty per year	6

The data in Table 7 and Figure 17 shows that the water level in the wetland system would vary significantly, but that the wetland would dry out relatively infrequently. On occasions when the wetland did dry out it would only remain dry for a relatively short period of time.

5.0 CONCLUSIONS

The analysis presented in this report demonstrates that, during the operational stages, the proposed water management system is capable of:

- Ensuring that no uncontrolled runoff can leave the site even in the event of a 100 year ARI three day storm.
- Treating and discharging excess water collected on site.
- Providing an adequate supply of water for dust suppression and other purposes.

As part of the final rehabilitation a wetland swamp area will be created in the north –eastern corner of the site. During the rehabilitation stage of the project, the water treatment plant will be retained and operate in the same manner as during the operational phase. Following successful establishment of vegetation and consequent reduction in sediment loads in runoff, the treatment plant will be decommissioned. At the same time the site will be converted to be free draining by the construction of a small channel to allow overflow from the wetland to drain into the northern creek.

6.0 REFERENCES

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