Report on:

SURFACE WATER MANAGEMENT

Prepared for

METAGO ENVIRONMENTAL ENGINEERS (PTY) LTD

PROJECT NO. 341-001
REPORT NO. 5/10

OCTOBER 2010

Metago
Environmental Engineers (Australia) Pty Ltd

* *Tailings dam engineering and management*
* *Municipal and industrial waste management*
* *Risk based environmental control*
* *Environmental Management Systems*
* *Acid mine drainage*
* *Environmental impact assessment*

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Revision	Date	Description	Issuer
R0	13 Oct 10	Draft for Discussion	GMcP

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SURFACE WATER MANAGEMENT

1 INTRODUCTION

The Husab Project belonging to Swakop Uranium Pty Ltd (Swakop Uranium) is located approximately 60km north east of Walvis Bay, Namibia.

The uranium mineralised alaskites at the Husab site are covered by approximately 1m to 70m of overburden. Generally the site area is characterised by a flat peneplain surface with sands and gravels. A catchment divide splits the area so that part of the site drains to the Khan River and part drains via a number of small natural water channels to the Swakop River.

The catchment area up-contour of the potential mine site is some 34,500ha or 345km^2. The site will potentially occupy 3,170ha or 31.7km^2.

The potential mine site lies within the Namib-Naukluft National Park placing a particular onus on Swakop Uranium to minimise the environmental impact of mining on local flora and fauna. Specifically it is essential to preserve stormwater flow through the natural drainage system to ensure survival of local flora.

Therefore, a flood assessment is required which will:

- Determine the alignment and the size of stormwater diversion systems that will divert stormwater flow around the site and then discharge it back into natural water channels on the plain.
- Determine layout of runoff containment systems to manage runoff that will arise on the site but which has to be captured as it may be contaminated. This water will be used in the processing plant.

This report documents flood assessments which have entailed the following activities:

- Derivation of a representative rainfall record.
- Development and calibration of a probabilistic storm water management model.

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- Simulation of floods and flood events using the stormwater management model.
- Assessment of stormwater diversion capacity requirements from the simulation results.
- Re-distribution of diverted stormwater back into natural water channels.
- Assessment of stormwater runoff control measures within the proposed mine site area

It is important to note that the work documented in this report is based on the longest available rainfall records which are from Rössing Uranium Mine. This mine is located 5km to the north of the Husab project site. These records only cover 22 years.

It should further be noted that catchment boundaries have been determined from available detailed survey information as well as digital terrain data obtained from Google Earth. The nature of surfical cover over the potential mine site and catchment areas has been estimated from available aerial photography and Google Earth images.

2 HYDROLOGICAL SETTING

2.1 CATCHMENT CHARACTERISTICS

The project site is located on sand and gravel plains to the south of the Khan River. The gravel plains comprise alluvium that has variably cemented through calcretisation. The plains are intruded by dolerite dykes that form ridges some rising 70m above the gravel plains.

There are no deep channels incised into the plan. Flow during rainfall runoff is predominantly overland flow moving into shallow ravines.

2.1.1 Topography

The slope of the catchment area is generally 1:125 (0.8%). The slope steepens within the potential mine site area to 1:110 (0.9%). Across the catchment the slopes are gentle but dominated by shallow natural watercourses and the occasional dolerite ridge. Mounded areas form where the alluvial cover is more severely cemented.

2.1.2 Welwitschias

Below the potential mine site area are the renowned Welwitschia Plains so called because of the proliferation of the rare *Welwitschia Mirabilis* plant which grows predominantly in and adjacent to the shallow natural watercourses but is also generally scattered over the plains. The sources of water for this ancient plant are thought to include water from infiltrated surface runoff or deeper groundwater sources. An important aspect of any surface water management plan will be that of ensuring current surface water runoff patterns are preserved after establishment and closure of the potential mine.

2.2 SITE LAYOUT

The potential site layout is indicated in Figure 1.

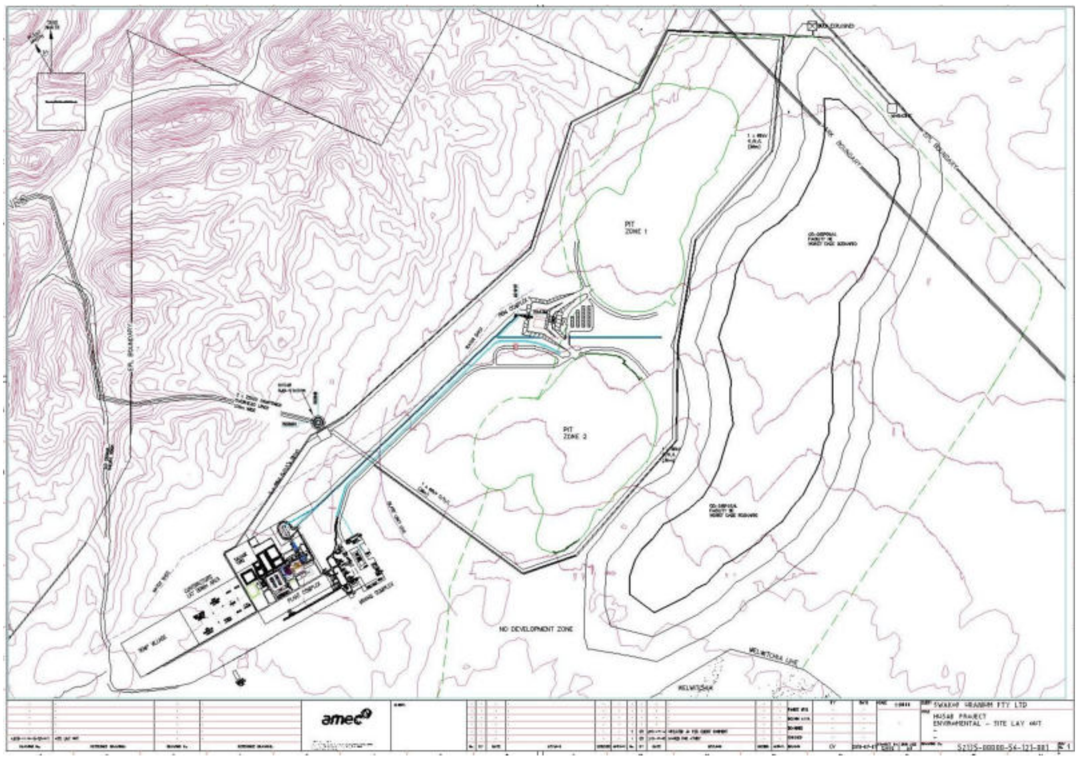


Figure 1: Proposed mine site layout

2.3 RAINFALL DATA

2.3.1 Rainfall distribution in Namibia

Figure 1 below demonstrates that annual rainfall and rainfall variability in Namibia in the area surrounding the Husab project site vary in a regular manner with distance from the coastline.

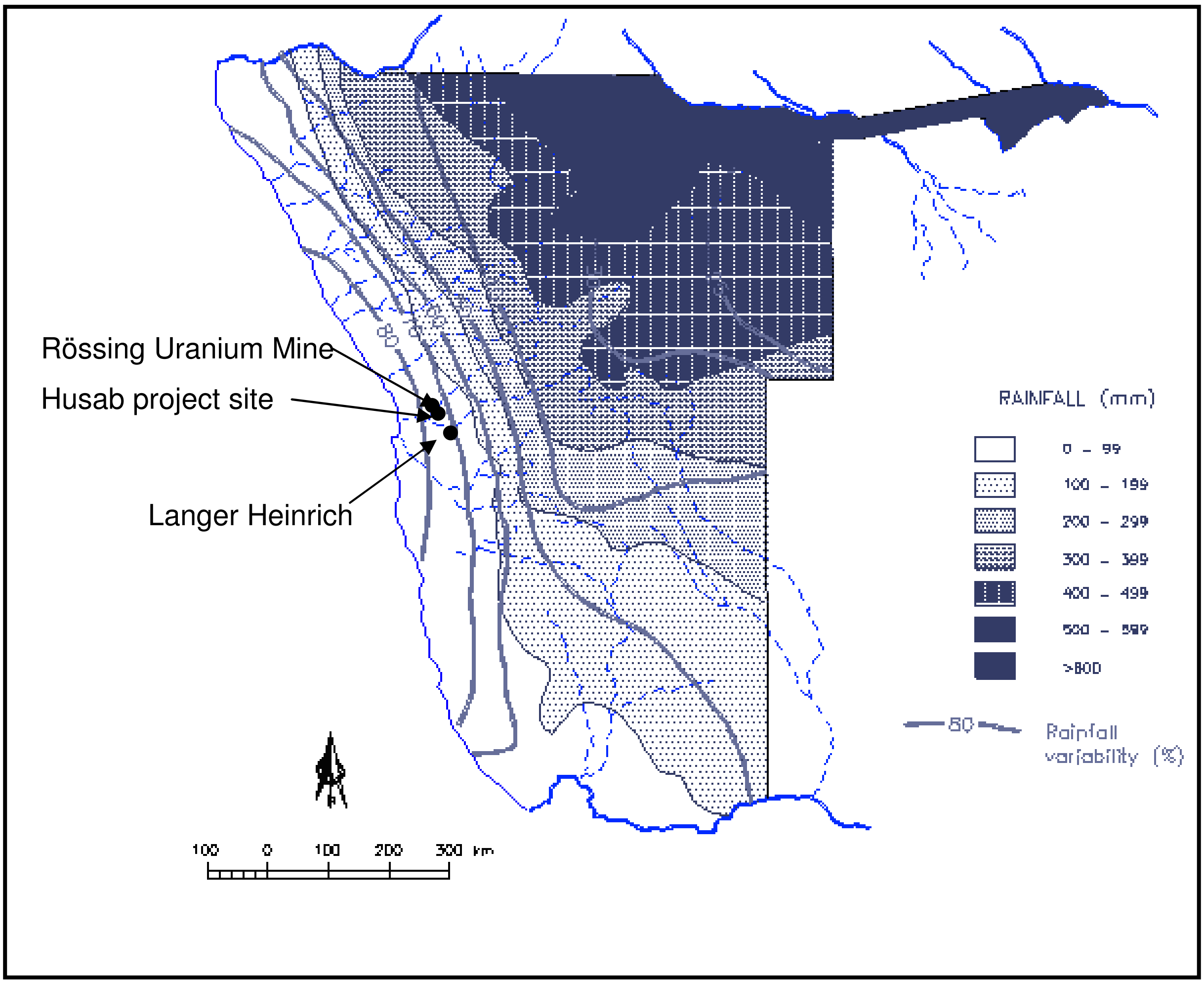


Figure 2: Rainfall variation with distance from the Namibian coast[1]

It is evident that rainfall data from Rössing Uranium Mine (RUL) and Langer Heinrich Uranium Mine (LHU) is likely to provide representative data for the Husab project site.

2.3.2 Available raingauge data

Daily rainfall records have been provided by RUL, from 1987 to April 2009, as well as by LHU, from February 2007 to April 2009. It can be established from these records that rain occurs at least once per year.

In March 2008 RUL installed a tipping bucket system which enabled the measurement of storm intensity with time. This data has been recorded and the

[1] Wardell-Johnson, Grant. 2000. Biodiversity and Conservation on Namibia into the 21st Century. Pages 17-45 in B. Fuller and I. Prommer, *Population-Development-Environment in Namibia: Background Readings.* Laxenburg, Austria: IIASA, IR-00-031.

records have been provided by RUL up to April 2009. This data has been complemented by similar data from LHU from March 2007.

3 DEVELOPMENT OF LONG TERM RAINFALL DATA

3.1 EXTRAPOLATION TO A 1000 YEAR RECORD

The 22 year daily Rössing Rainfall record was extrapolated to a 1000 year rainfall record using SCL (Stochastic Climate Library), a library of stochastic models developed by the Australia Bureau of Meteorology for generating climatic data. The resulting data was used to produce statistics on the probability of severe rainfall events, suggesting that there was a 10% probability of exceeding 6mm of rain in a single day and a 1% probability of exceeding 17mm of rain in a day. The 1 in 10,000 case used to assess the most extreme realistic conditions as a basis for safety factors produced a total rainfall depth estimated at 40mm in a single event.

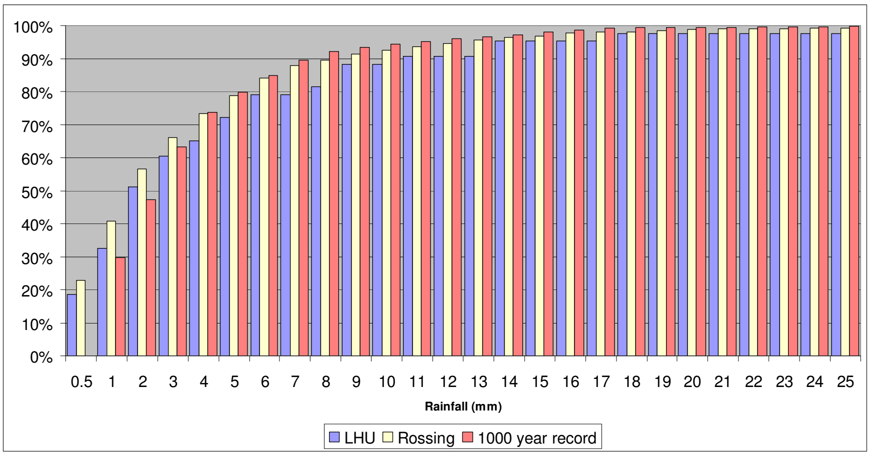


Figure 3: Comparison of values generated by the synthetic rainfall record to the available rainfall record

It is evident from Figure 3 that the long term record generally over-estimates the rainfall beyond rainfall of about 4mm.

The long term synthetic record indicates 9,903 days of rain over the 1,000 years which indicates a 2.7% probability of rain on any given day.

The above data was also used in assessing the probability distribution used to generate rainfall figures for simulation purposes described below.

3.2 FITTING AN EXTREME EVENT PROBABILITY DENSITY FUNCTION

In order to facilitate probabilistic storm simulation rainfall data for all days on which precipitation was recorded a range of probability density functions was assessed to determine that which best fitted the long term synthetic rainfall record. It was found that a gamma distribution produced a convincing match to the rainfall patterns observed, having the desired characteristics of varying over positive values between zero and infinity with the majority of values close to zero.

Figure 4 below shows the comparison between the actual records from RUL and Langer Heinrich and those produced by the gamma distribution.

From the gamma distribution it emerges that precipitation on days where positive rainfall was recorded was an average of 3.15 mm with a standard deviation of 4.72.

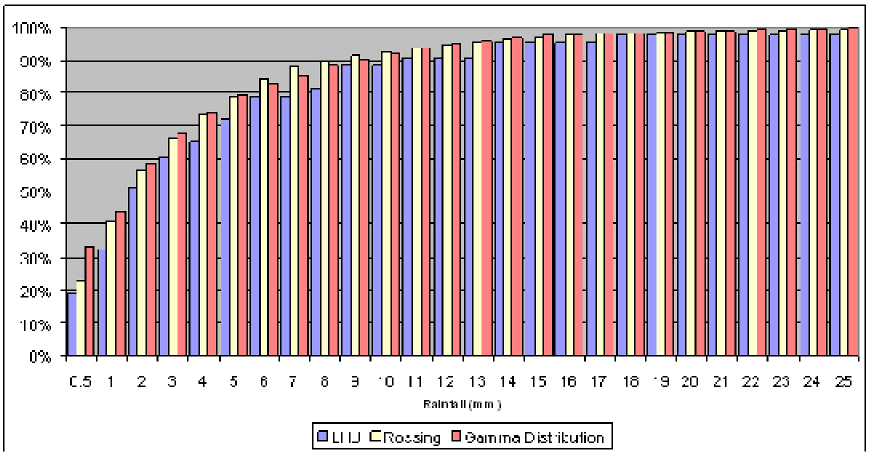


Figure 4: Comparison of values generated by gamma distribution to the available rainfall record

It is evident from a comparison of Figure 3 and Figure 4 that the gamma distribution generally approximates lower rainfall rates better than the long term synthetic record on which it is based. The gamma distribution indicates that there is a 10% probability that rainfall will exceed 8.7mm, a 5% probability it will exceed 12.6mm, a 1% probability (recurrence interval 1: 100) that it will exceed 27.2mm and a 0.01% probability (recurrence interval 1 : 10,000) that it will exceed 50.1mm.

3.3 THE PROBABILITY OF RAINFALL

The long term records backed up by the 1,000 year synthetic data indicate that, for all practical purposes, it is certain that rainfall will occur on at least 1 day of the year every year. In fact the synthetic record indicates that over a 1,000 year period rain will occur on 9,902 days which indicates that on average rain will occur 9 times each year.

3.4 STORM HYDROGRAPHS

To estimate flood peaks it is necessary to define a flood hydrograph which describes the variation in rainfall intensity over the duration of a storm. The tipping bucket data from RUL and LHU has been used to derive statistics on the rainfall, rainfall duration and from these the average rainfall intensity. To construct a hydrograph it has been necessary to estimate the time to reach the flood peak since the available data is at time intervals that are too large to enable the calculation of the variation of storm intensity over time. It has been assumed that the peak flow occurs after one quarter of the total storm duration.

4 SURFACE WATER MANAGEMENT

4.1 REQUIREMENTS

There are two requirements for the surface water management at the Husab project site:

- The mine site needs to be isolated from flow from the catchment up-contour of the site.
- Stormwater that accumulates within the mine site may be contaminated and therefore needs to be captured.

The first requirement can be met by incorporating a diversion channel around the site. However, the Welwitschia plains are dependent on the runoff and therefore flow regimes need to be preserved as far as practicable. It is therefore necessary to incorporate a pond as well as a pipe or trench network to re-distribute the water back to the natural watercourses in the same proportion as the catchments above these streams.

The second requirement means that all runoff inside the diversion ie the “dirty” water, has to report to a stormwater collection pond from where it will be recovered for use in the mine processing plant.

These aspects are discussed in more detail in the ensuing sections.

4.2 STORM WATER MANAGEMENT MODEL

The USEPA runoff model, SWMM, has been used to for stormwater management modelling. The kinematic wave option for calculating flood peaks and the total volume of flow has been selected.

The model is most sensitive to variability in the following parameters:

- Storm intensity.
- The suction head in the surficial soils over the catchment.
- The saturated permeability of the surficial soils over the catchment.
- Manning's roughness for overland flow.

Since it is impractical to accurately estimate these parameters over the entire 345km^2 with insufficient information on soils and their properties a probabilistic methodology has been adopted. Expected values and standard deviations for the above four parameters have been estimated from assessments of aerial photography as well as from literature. The Point Estimate Method which entails modelling multiple combinations of mean plus and minus standard deviations has been used and, for the four main variables, has entailed multiple separate model runs. The Point Estimate Method yields the expected value and standard deviation of the flood peak as well as the flood volume. By applying minima of zero and maxima of 3 times the standard deviation to each result, and by applying a beta distribution it is possible to derive a histogram of the resulting flood peak and total flow volume from the identified catchments above the potential mine site.

A number of stormwater management facilities have been designed to separate clean and dirty stormwater and to divert clean stormwater back into the natural watercourses into which the water would have flowed prior to mining activities on the site. Details of analyses and designs for each of the facilities are set out in the sections that follow.

4.3 CLEAN STORMWATER DIVERSION CHANNEL

A clean stormwater diversion channel will divert stormwater around the mine site and will discharge stormwater into the stream paths from which the water was diverted. Figure 5 below shows three sub-catchments from which clean stormwater will be collected and diverted.

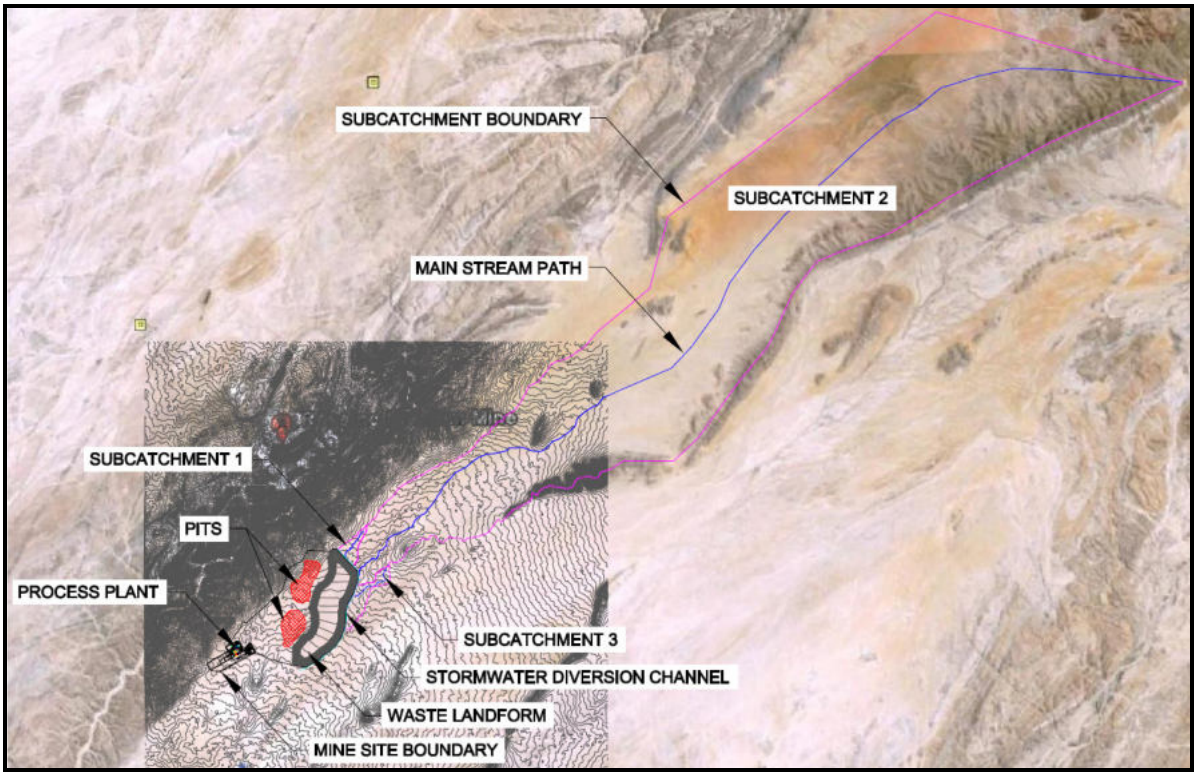


Figure 5: Clean Stormwater Diversion Channel and Sub-catchments 1, 2 & 3

The sub-catchment area characteristics are outlined in Table 1 below.

Table 1: Clean Stormwater Diversion Channel Sub-catchment Area Characteristics

Sub-catchment No.	Area (ha)	Assumed impermeable area (%)	Width (m)	Average slope (%)
1	155.5	10	612	0.8
2	34,069.1	15	4,804	0.8
3	299.2	20	966	1.0

Figure 6 indicates a schematic of the SWMM model for the clean stormwater diversion channel.

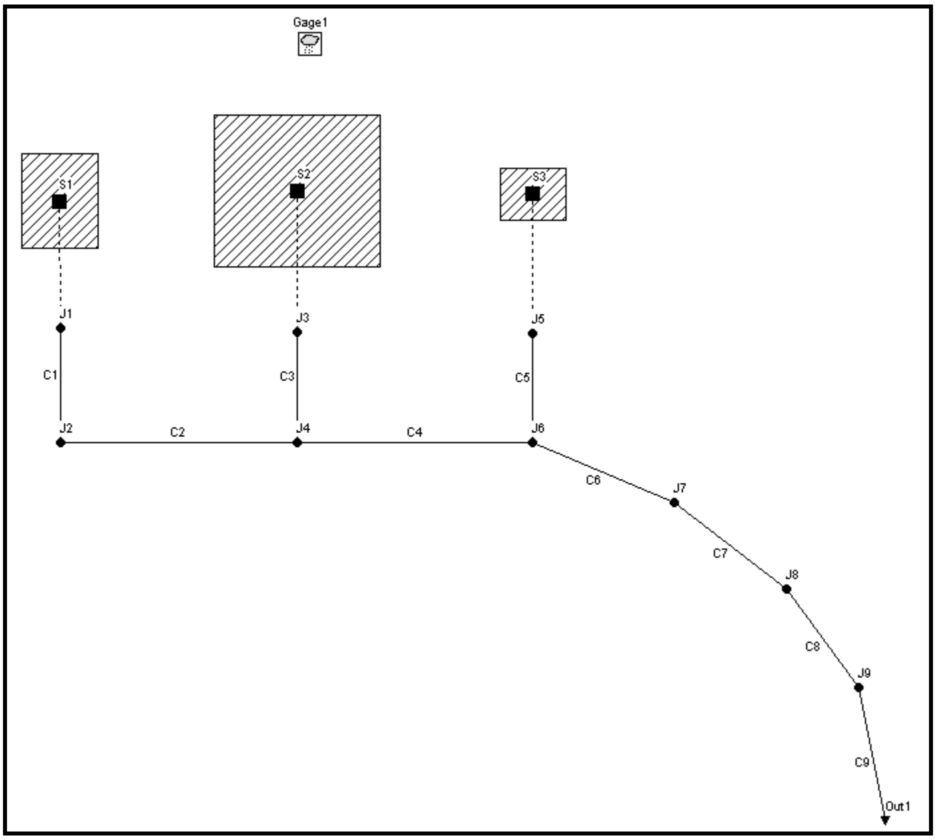


Figure 6: Schematic of SWMM Model for Clean Stormwater Diversion Channel

In Figure 6, the objects marked by letter S represent sub-catchments. The objects marked by letter J represent junctions with different elevations, which are the dividing points between model channel segments denoted by letter C. Each channel segment is assigned certain geometry. Segments C1, C3 and C5 represent natural channels. Segments C2, C4, C6, C7, C8 and C9 represent constructed channels. The typical geometry of the channel, used in this flood assessment, is shown below in Figure 7:

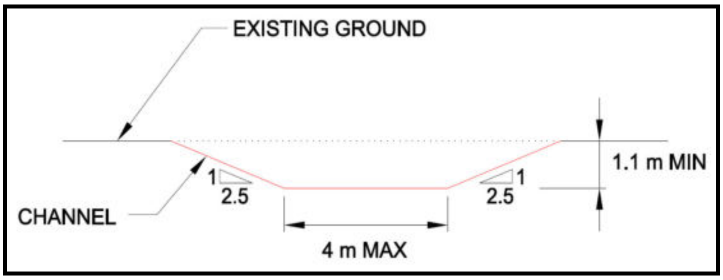


Figure 7: Typical Cross Section through Clean Stormwater Diversion Channel

Results of the SWMM simulations and spreadsheet calculations on maximum flow rates and total volumes of water at different locations along the channel are shown in Figure 8.

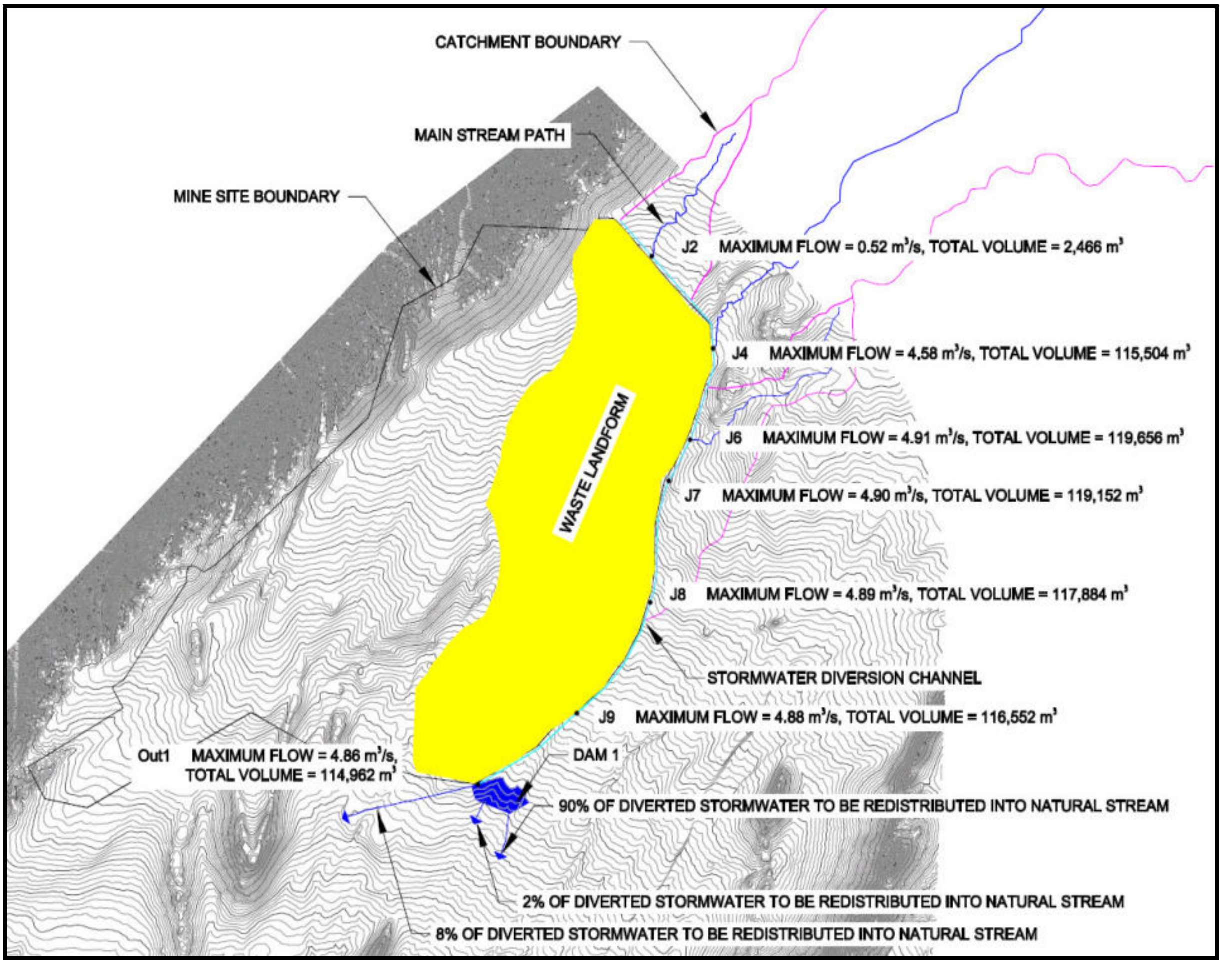


Figure 8: Maximum Flow Rates and Total Volumes of Water in the Clean Stormwater Diversion Channel

Results of the SWMM simulations and spreadsheet calculations from Figure 8 are summarised in Table 2 below.

Table 2: Clean Stormwater Diversion Channel: maximum flows and total volumes

Location	Maximum flow, m^3/s	Total volume, m^3
J2	0.52	2,466
J4	4.58	115,504
J6	4.91	119,656
J7	4.90	119,152
J8	4.89	117,884
J9	4.88	116,552
Out1	4.86	114,962

4.4 DIRTY STORMWATER DIVERSION CHANNEL 1

Dirty water runoff from the waste landform will be diverted into reclaim ponds to prevent it from re-entering the environment. The waste landform area has been divided into a number of sub-catchments. The sub-catchment area characteristics are outlined in Table 3 below.

Table 3: Dirty Stormwater Diversion Channel 1 Sub-catchment Area Characteristics

Sub-catchment No.	Area (ha)	Assumed impermeable area (%)	Width (m)	Average slope (%)
1	30.4	3	380	18.7
2	86.4	3	447	17.3
3	164.2	3	849	13.5
4	154.8	3	655	12.2
5	281.1	3	797	14.2
6	47.5	3	275	13.8
7	820.4	3	1200	11.0
8	519.7	5	617	2.4

Figure 9 shows a schematic of the SWMM model for Dirty Stormwater Diversion Channel 1.

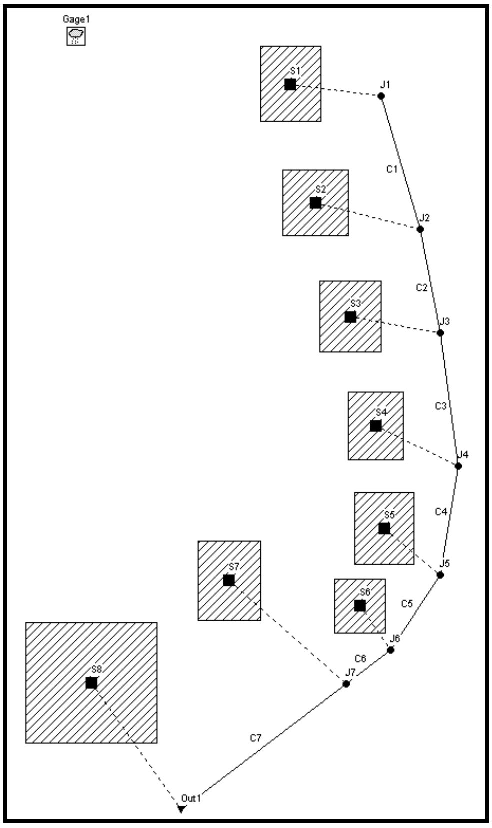


Figure 9: Schematic of SWMM Model for Dirty Stormwater Diversion Channel 1

The objects in Figure 9 marked by letter S represent sub catchments. The objects marked by letter J represent junctions with different elevations, which are dividing points between model channel segments denoted by letter C. In this model all segments represent constructed channels. The typical geometry of the channel, used in this flood assessment, is indicated in Figure 10.

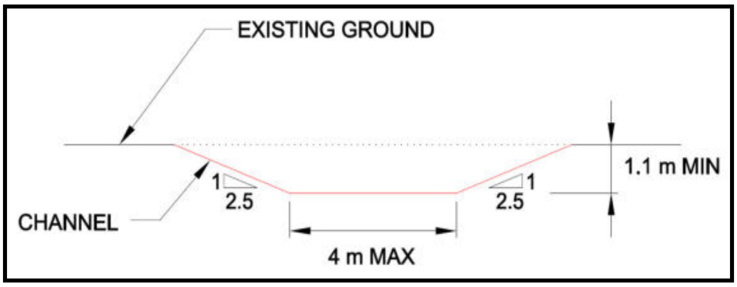


Figure 10: Typical Cross Section through Dirty Stormwater Diversion Channel 1

Results of the SWMM simulations and spreadsheet calculations on maximum flows and total volumes of water at different locations along Channel 1 are shown in Figure 11.

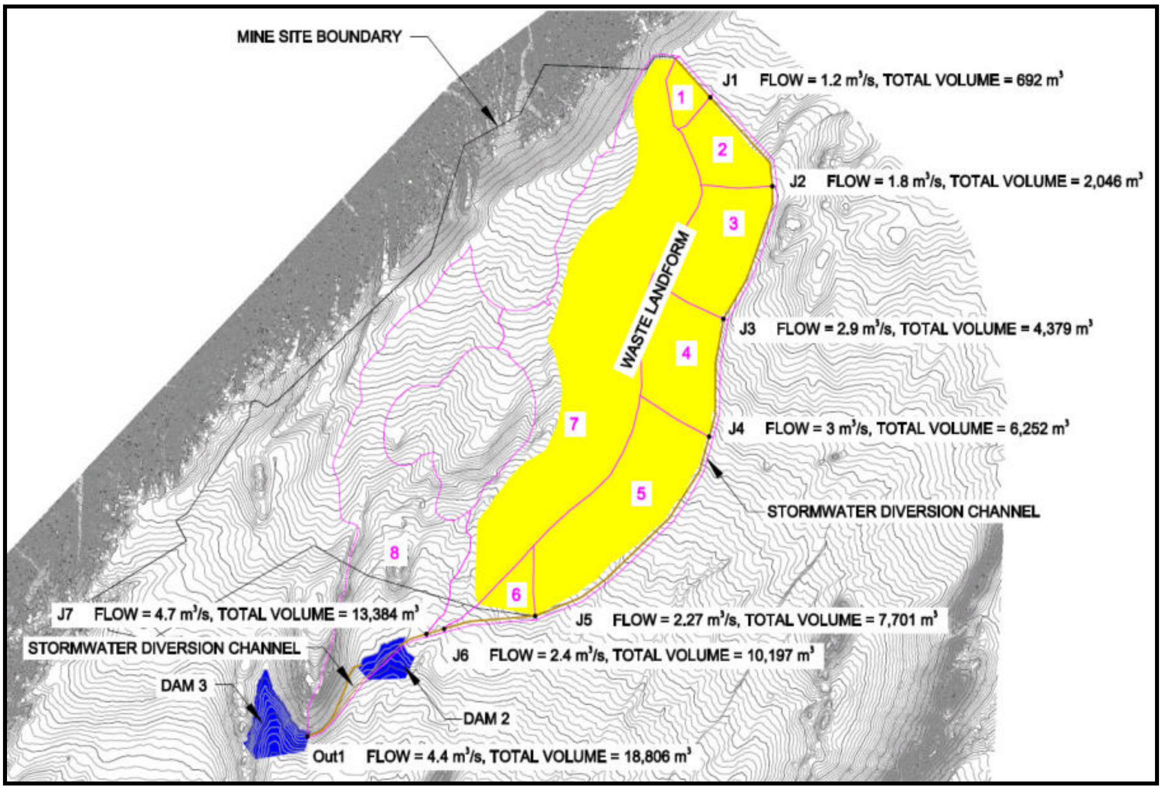


Figure 11: Maximum Flows and Volumes of Water in the Dirty Stormwater Diversion Channel 1

Results of the SWMM simulations and spreadsheet calculations from Figure 11 are summarised in Table 4 below.

Table 4: Dirty Stormwater Diversion Channel 1: maximum flows and total volumes

Location	Maximum flow, m^3/s	Total volume, m^3
J1	1.20	692
J2	1.80	2,046
J3	2.90	4,379
J4	3.00	6,252
J5	2.27	7,701
J6	2.40	10,197
Out1	4.40	18,806

4.5 DIRTY STORMWATER DIVERSION CHANNEL 2

Dirty water from the western portion of the potential mine site, excluding the area of process plant, will discharge into a dirty water reclaim pond to prevent contaminated water from re-entering main stream paths. The area was subdivided into three sub-catchments. The sub-catchment areas and details are outlined in Table 5 below.

Table 5: Dirty Stormwater Diversion Channel 2 sub-catchment characteristics

Sub-catchment No.	Area (ha)	Assumed impermeable area (%)	Width (m)	Average slope (%)
1	50.7	10	1,690	0.5
2	106.1	10	939	0.9
3	246.9	5	991	1.0

Figure 12 shows a schematic of the SWMM model for dirty stormwater diversion Channel 2.

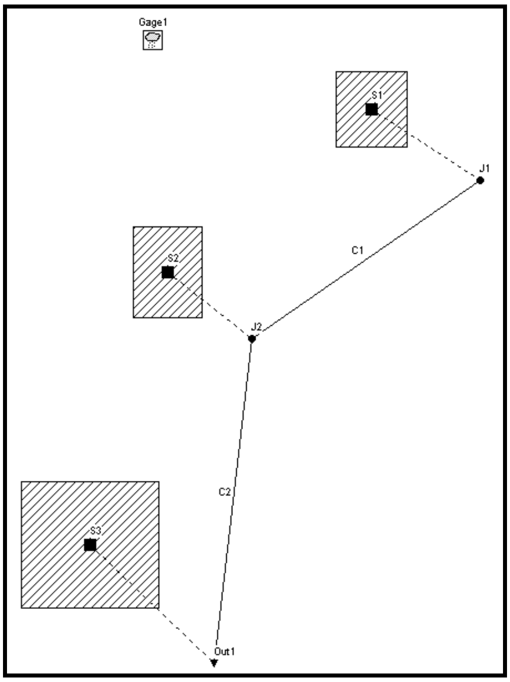


Figure 12: Schematic of SWMM model for stormwater diversion Channel 2

The objects in Figure 12 marked by letter S represent sub catchments. The objects marked by letter J represent junctions with different elevations, which are dividing points between model channel segments, denoted by letter C. In this model all segments represent constructed channels. Typical geometry of the constructed channel used in this flood assessment is shown below in Figure 13.

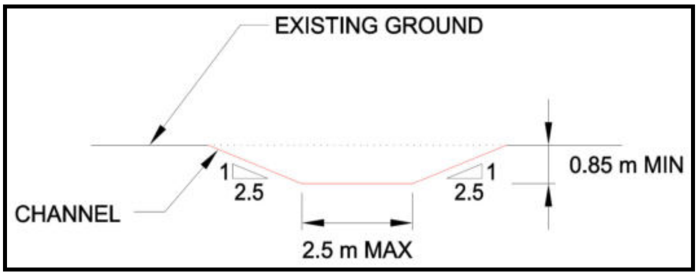


Figure 13: Typical cross section through constructed channel segment

Results of the SWMM simulations and spreadsheet calculations on maximum flow rates and volumes of water for different locations of the channel are shown in Figure 14.

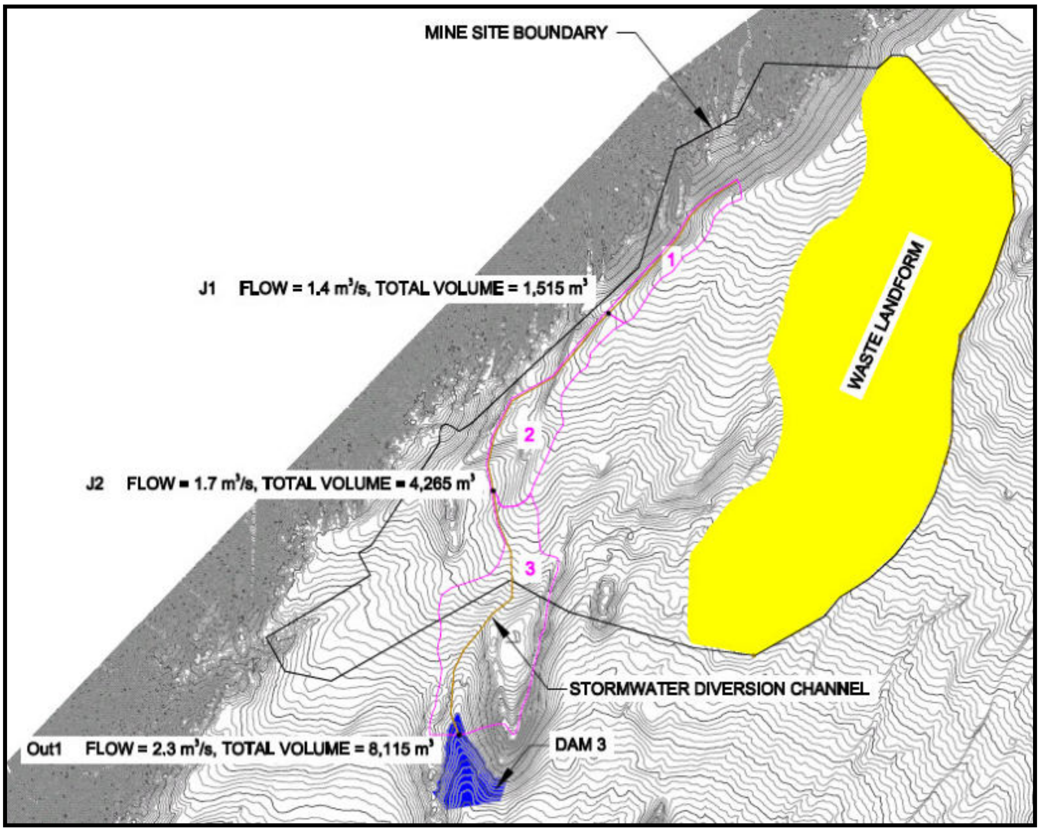


Figure 14: Maximum flows and total volumes of water in dirty stormwater diversion Channel 2

Results of the SWMM simulations and spreadsheet calculations from Figure 14 are summarised in Table 6 below.

Table 6: Dirty Stormwater Diversion Channel 2: maximum flows and total volumes

Location	Maximum flow, m^3/s	Total volume, m^3
J1	1.40	1,515
J2	1.70	4,265
Out1	2.30	8,115

4.6 RE-DISTRIBUTION OF STORMWATER RUNOFF

It is essential for survival of Welwitschia plants to re-distribute stormwater runoff diverted around the site through the diversion channel in proportion to original runoff collected in natural watercourses before establishment of the mine. There are 3 main watercourses feeding the discharge point of the channel. Two of these watercourses originate upstream of the potential mine site and one within the site.

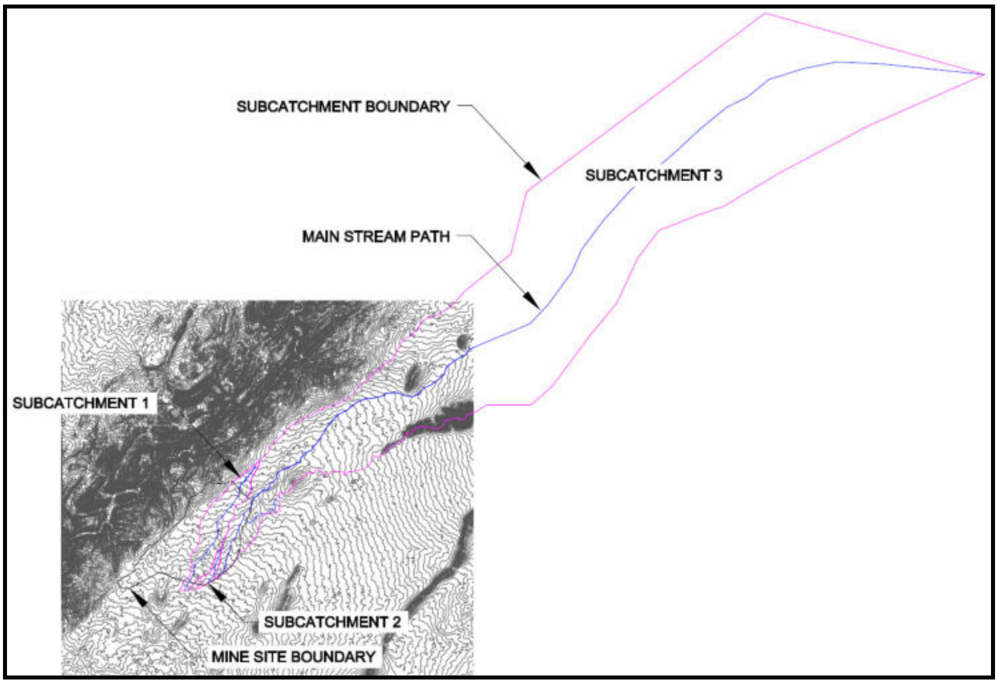


Figure 15: The main natural watercourses affected by mining

SWMM modelling has been used to determine the natural stormwater discharge from each of the three watercourses. The characteristics for each of the three catchments are presented in Table 7 below.

Table 7: Catchment characteristics

Catchment No.	Area (ha)	Assumed impermeable area (%)	Width (m)	Average slope (%)
1	1,181	10	947	0.8
2	119	10	440	0.9
3	34,869	15	4,754	0.8

The same Point Estimate Method-based probabilistic methodology that has been applied in the channel catchment modelling has been used to determine volume of discharge from each of the ten watercourses. The results are presented in Table 8 below.

Table 8: Maximum stormwater discharge volumes from catchments 1 to 3

Catchment No.	Percent of total, %	Total volume of discharge, m^3	95 percentile volume of discharge, m^3
1	8	9,714	8,684
2	2	2,293	2,032
3	90	109,222	96,539
Total	**100**	**121,229**	**107,256**

Hydrological modelling of stormwater diversion channel as documented in Section 4.3 indicated a reduction in flow of 5.2% of the total predicted discharge as a result of isolation of the potential mine site. This means that of the original 121,229 m^3, 114,962 m^3 will be discharged from catchments 1 to 3. This flow should be re-distributed through pipes or trenches to the original water courses as indicated in Table 9: Distribution of stormwater to main natural watercourses.

Table 9: Distribution of stormwater to main natural watercourses

Catchment No.	Percent of total, %	Total volume of discharge, m^3	95 percentile volume of discharge, m^3
1	8	9,212	8,684
2	2	2,174	1,928
3	90	103,575	91,549
Total	**100**	**114,962**	**101,711**

5 SUMMARY AND CONCLUSIONS

Arising from the assessments documented in this report the following conclusions are drawn:

- Surface water runoff from the catchment above the potential mine site will be diverted around the site and the flow re-distributed to the natural flow channels in the same proportions as the original catchments.
- Surface water runoff within the potential mine site area will be channelled and retained in two storage dams from where it will be used to offset fresh water intake to the process plant.
- Design flow rates for the channels have been estimated using probabilistic analysis of both the rainfall as well as the runoff characteristics which take into

account the risk of failure of the channel. A design flow of maximum 5 m^3/s has been applied in the design of the diversion channel.

- Development of the mine site would reduce stormwater flow to Welwitchia plains by 5.2%

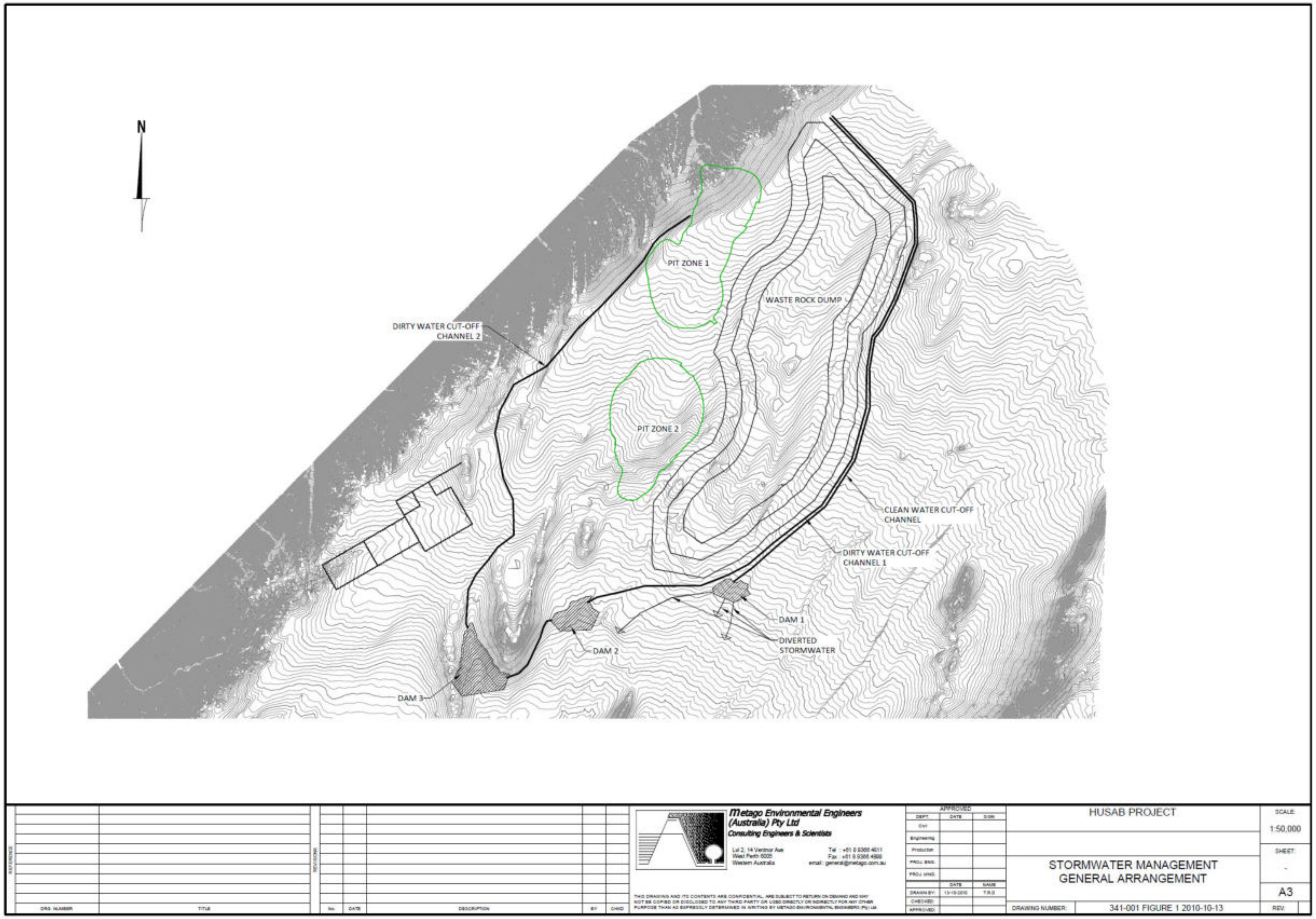
6 RECOMMENDATIONS

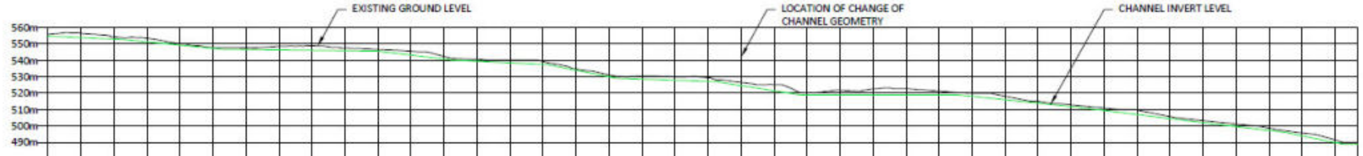
It is recommended that the channel sizes and alignments set out in this report be carried forward to detailed design of the stormwater control works.

It is further recommended that careful consideration be given to stability and erosional performance of new waste rock landform layout to minimise the potential for erosion which will fill the Dirty Stormwater Diversion Channel 1.

Dr G I McPHAIL PrEng MIEAust CPEng **Dr N NAZAROV**
For and on behalf of
Metago Environmental Engineers (Australia) Pty Ltd

Appendix 1: Channel drawings

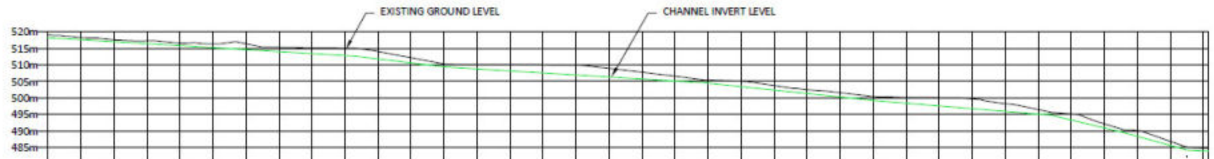

N
PIT ZONE 1
WASTE ROCK DUMP
DIRTY WATER CUT-OFF CHANNEL 2
PIT ZONE 2
CLEAN WATER CUT-OFF CHANNEL
DIRTY WATER CUT-OFF CHANNEL 1
DAM 1
DIVERTED STORMWATER
DAM 2
DAM 3
Metago Environmental Engineers (Australia) Pty Ltd
Consulting Engineers & Scientists
HUSAB PROJECT
SCALE: 1:50,000
STORMWATER MANAGEMENT
GENERAL ARRANGEMENT
A3
DRAWING NUMBER: 341-001 FIGURE 1 2010-10-13



DESIGN SURFACE LEVEL (RLm)	553.78	552.87	551.21	549.22	547.23	546.44	546.20	545.95	545.71	545.46	543.10	540.75	539.39	538.44	537.49	533.92	529.90	528.50	527.80	527.10	524.59	521.48	519.00	519.00	519.00	519.00	519.00	518.13	516.00	513.87	511.74	509.37	506.93	504.49	502.06	499.66	497.27	494.02	489.93	
NATURAL SURFACE (RLm)	556.37	554.09	553.40	550.02	547.82	547.54	548.53	548.76	547.32	546.51	545.43	542.30	540.71	540.10	539.15	534.66	531.06	530.30	529.89	529.39	526.51	525.12	520.09	521.82	522.59	522.67	521.25	520.05	518.15	515.03	512.86	510.88	509.71	505.76	503.23	501.21	498.77	495.85	491.55	
CHAINAGE(m) 0.00	200.00	400.00	600.00	800.00	1000.00	1200.00	1400.00	1600.00	1800.00	2000.00	2200.00	2400.00	2600.00	2800.00	3000.00	3200.00	3400.00	3600.00	3800.00	4000.00	4200.00	4400.00	4600.00	4800.00	5000.00	5200.00	5400.00	5600.00	5800.00	6000.00	6200.00	6400.00	6600.00	6800.00	7000.00	7200.00	7400.00	7600.00	7800.00	7933.07

SECTION A - LONG SECTION THROUGH DIRTY WATER CUT-OFF CHANNEL 2

SCALE
Horizontal 1:25,000
Vertical 1:2,500



DESIGN SURFACE LEVEL (RLm)	517.62	517.02	516.42	515.82	515.22	514.62	514.02	513.42	512.82	511.81	510.60	509.39	508.75	508.14	507.53	506.92	506.31	505.70	505.08	504.41	503.39	502.37	501.34	500.32	499.29	498.43	497.59	496.76	495.92	495.08	493.32	490.93	488.37	485.56	483.92	
NATURAL SURFACE (RLm)	518.29	517.63	517.34	516.54	516.37	516.36	515.37	515.19	515.07	514.10	512.19	510.28	510.09	510.07	510.04	510.00	508.99	507.79	506.59	505.40	505.07	503.72	502.50	501.57	500.43	500.19	500.08	499.75	498.23	496.49	495.15	492.18	490.12	486.81	484.79	
CHAINAGE(m) 0.00	100.00	200.00	300.00	400.00	500.00	600.00	700.00	800.00	900.00	1000.00	1100.00	1200.00	1300.00	1400.00	1500.00	1600.00	1700.00	1800.00	1900.00	2000.00	2100.00	2200.00	2300.00	2400.00	2500.00	2600.00	2700.00	2800.00	2900.00	3000.00	3100.00	3200.00	3300.00	3400.00	3500.00	[illegible]

SECTION B - LONG SECTION THROUGH CLEAN WATER CUT-OFF CHANNEL 2

SCALE
Horizontal 1:12,500
Vertical 1:1,250

Metago Environmental Engineers (Australia) Pty Ltd
Consulting Engineers & Scientists
Lvl 2, 14 Ventnor Ave
West Perth 6005
Western Australia

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DRAWN BY:	1-10-2010	T.R.S
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HUSAB PROJECT

STORMWATER MANAGEMENT
LONG SECTIONS

DRAWING NUMBER: 341-001 FIGURE 2 2010-10-13

SCALE: AS SHOW
SHEET: -
A3
REV:

DRG. NUMBER | TITLE | No. | DATE | DESCRIPTION | BY | CHKD

CHAINAGE(m) 0.00	200.00	400.00	600.00	800.00	1000.00	1200.00	1400.00	1600.00	1800.00	2000.00	2200.00	2400.00	2600.00
DESIGN SURFACE LEVEL (RLm)	578.12	576.75	575.41	574.63	573.84	573.05	570.90	567.89	564.88	563.61	563.12	562.48	561.39
NATURAL SURFACE (RLm)	580.13	578.64	576.31	575.68	575.18	575.01	575.00	570.00	566.66	564.82	564.77	564.87	566.94

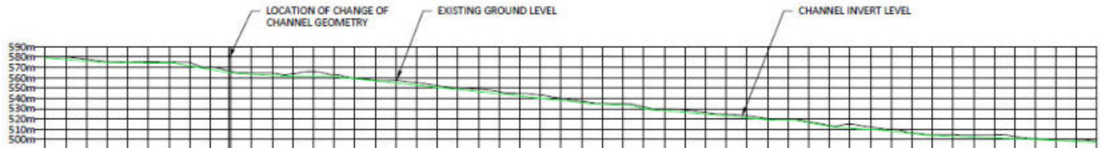
CHAINAGE(m)	2800.00	3000.00	3200.00	3400.00	3600.00	3800.00	4000.00	4200.00	4400.00	4600.00	4800.00	5000.00	5200.00
DESIGN SURFACE LEVEL (RLm)	560.31	559.22	557.62	555.77	553.71	551.65	549.59	547.53	545.47	543.41	541.35	539.28	537.22
NATURAL SURFACE (RLm)	564.94	561.22	559.01	558.83	556.99	553.85	551.31	549.83	547.73	544.96	544.14	541.13	538.50

CHAINAGE(m)	5400.00	5600.00	5800.00	6000.00	6200.00	6400.00	6600.00	6800.00	7000.00	7200.00	7400.00	7564.89
DESIGN SURFACE LEVEL (RLm)	535.15	533.09	531.02	528.96	527.17	525.38	523.59	521.80	520.01	518.21	516.38	
NATURAL SURFACE (RLm)	535.92	535.22	533.65	530.01	529.12	526.85	524.87	523.46	521.31	519.96	518.02	

SECTION C

SCALE
Horizontal 1:25,000
Vertical 1:2,500

LONG SECTION THROUGH CLEAN WATER CUT-OFF CHANNEL



CHAINAGE(m) 0.00	200.00	400.00	600.00	800.00	1000.00	1200.00	1400.00	1600.00	1800.00	2000.00	2200.00	2400.00	2600.00
DESIGN SURFACE LEVEL (RLm)	577.82	576.24	574.66	574.51	574.37	574.22	571.48	568.03	564.84	563.26	562.26	561.59	561.45
NATURAL SURFACE (RLm)	580.06	578.00	575.51	575.00	575.15	575.01	575.00	569.96	566.20	564.82	564.65	563.79	565.85

CHAINAGE(m)	2800.00	3000.00	3200.00	3400.00	3600.00	3800.00	4000.00	4200.00	4400.00	4600.00	4800.00	5000.00	5200.00
DESIGN SURFACE LEVEL (RLm)	561.06	558.99	556.92	554.85	552.79	550.73	548.66	546.60	544.54	542.36	540.13	537.90	535.67
NATURAL SURFACE (RLm)	563.14	559.36	557.54	557.40	555.47	552.42	550.27	548.86	546.40	544.87	543.16	540.08	537.12

CHAINAGE(m)	5400.00	5600.00	5800.00	6000.00	6200.00	6400.00	6600.00	6800.00	7000.00	7200.00	7400.00	7600.00	7800.00
DESIGN SURFACE LEVEL (RLm)	534.01	533.49	530.45	527.97	526.31	524.66	522.90	521.08	519.25	518.71	516.38	512.96	511.18
NATURAL SURFACE (RLm)	535.28	534.99	531.70	529.92	528.74	526.12	524.86	523.22	520.36	520.03	517.35	513.64	515.00

CHAINAGE(m)	8000.00	8200.00	8400.00	8600.00	8800.00	9000.00	9200.00	9400.00	9600.00	9800.00	10000.00	10188.00
DESIGN SURFACE LEVEL (RLm)	509.95	508.36	505.79	503.79	503.06	502.34	501.61	500.89	500.06	499.12	498.19	
NATURAL SURFACE (RLm)	512.27	510.02	506.38	505.01	504.91	504.13	504.47	503.04	500.85	500.06	499.86	

SECTION D

SCALE
Horizontal 1:40,000
Vertical 1:4,000

LONG SECTION THROUGH DIRTY WATER CUT-OFF CHANNEL 1

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HUSAB PROJECT

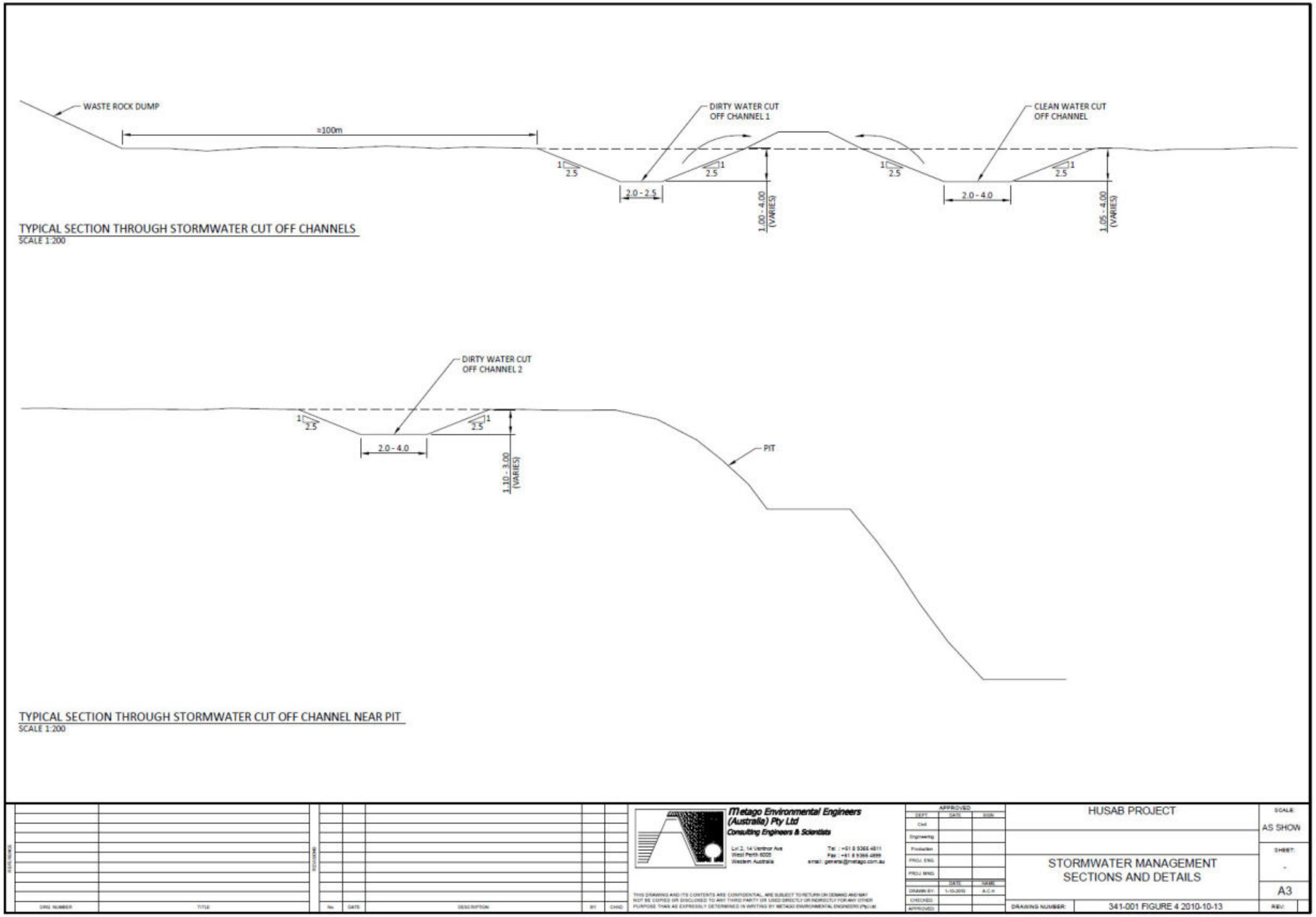
STORMWATER MANAGEMENT
LONG SECTIONS

SCALE: AS SHOW

SHEET: -

A3

DRAWING NUMBER: 341-001 FIGURE 3 2010-10-13


WASTE ROCK DUMP
≈100m
DIRTY WATER CUT OFF CHANNEL 1
CLEAN WATER CUT OFF CHANNEL
1
2.5
2.0 - 2.5
1.00 - 4.00 (VARIES)
2.0 - 4.0
1.05 - 4.00 (VARIES)
TYPICAL SECTION THROUGH STORMWATER CUT OFF CHANNELS
SCALE 1:200
DIRTY WATER CUT OFF CHANNEL 2
1.10 - 3.00 (VARIES)
PIT
TYPICAL SECTION THROUGH STORMWATER CUT OFF CHANNEL NEAR PIT
SCALE 1:200
Metago Environmental Engineers (Australia) Pty Ltd
Consulting Engineers & Scientists
HUSAB PROJECT
STORMWATER MANAGEMENT SECTIONS AND DETAILS
AS SHOW
A3
341-001 FIGURE 4 2010-10-13

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