HEATHGATE RESOURCES

SUPPORTING REPORT B

Hydrology

R E P O R T

Beverley Uranium Mine EL 3251- Hydrological Study Part 1

Prepared for

Heathgate Resources

Grenfell Street
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URS

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Contents

List of Tables, Figures, Plates & Appendices

Tables

Figures

Appendices

Introduction

SECTION 1

URS Australia Pty Ltd (URS) has been engaged by Heathgate Resources Pty Ltd (Heathgate) to investigate and report on the surface hydrology associated with the southern portion of EL 3251 surrounding the existing mine operation area.

In undertaking this investigation, URS has relied on both topographic information derived from satellite photographs, as well as ground-truthing of the site. As well as this, reference has been made to earlier work undertaken by consultants on Heathgate's behalf, to ensure that the current study is broadly consistent with findings previously made on the site.

Our investigation has been confined to the southern portion of EL 3251, defined by the rectangular shape shown on Figure 1 in green hatching. A previous study (Tonkin 1998) investigated the two Creeks; 4-Mile Creek and Jenny Creek, in the northern part of the Lease. This study considers Mulga Creek, through the centre of the area, and Paralana Creek which is largely contained outside the Lease area, but which enters it for a short distance near the south-eastern corner.

A flood-routing model and backwater curve analysis model are established for the Creeks, defining extent of flooding during both a 1 in 10 year Average Recurrence Interval (ARI) and 1 in 100 year ARI event.

The study concludes that the extent of flooding during both ARI events is quite similar, with relatively low velocities associated with flood flows. It is proposed that a risk-based approach is appropriate in determining the location of facilities within floodplains, recognising both the risk of inundation as well as the consequences of inundation, given considerations of velocity of flow.

Rainfall

Beverley Mine is located in an arid region of South Australia, in the Northern Flinders Ranges. The area is characterised by low, but highly variable, average rainfall. Recording stations are widely scattered and the length of record is relatively short. Though further information has been gathered in the time since previous studies, Australian Rainfall and Runoff (ARR 1987) still defines the manner in which rainfall is estimated across Australia, based on analysis from these stations.

As a result of the mine's establishment, a weather station has been constructed at the site, however the very short length of these records means that deriving meaningful data for event prediction is likely to be subject to large uncertainty. Tonkin (1998) utilised ARR rainfall estimation techniques and this is still considered appropriate for the current study.

Events of varying duration and recurrence interval were derived using the procedure outlined in ARR, for use in predictive modelling using the RORB flood routing model. This model is described in detail in Section 5 of this report, but essentially flow estimates are derived using inputs of catchment characteristics and rainfall information.

The present study assesses a range of recurrence interval events up to and including the 1 in 100 year flood, which is assumed to be generated by the critical 1 in 100 year rainfall event. In addition, areal reduction factors, described in ARR, have been applied, representing an assumed reduction in total rainfall falling over a larger area, as the rainfall data derived by ARR is assumed to occur as a point rainfall. Taken over large areas, it is demonstrable that total rainfall experienced in a catchment will reduce from the point estimates in proportion to area. Therefore a larger reduction will apply to larger catchments; a smaller reduction to smaller catchments.

In the analysis reported here, the areal reduction factor is applied to the total rainfall within the RORB model directly.

Rainfall information, for input into the RORB model, can be found in Appendix A, derived for the location of the mine site using the methodology outlined in ARR.

Beverley Mine is located to the east of the Northern Flinders Ranges, approximately 550 km north of Adelaide and 35 km west of the northern end of Lake Frome.

A series of water courses, rising in the Ranges, flow is an easterly direction, eventually discharging into the Lake. Between the Ranges and the Lake, many small flow channels are cut into the topography, rising in the low foothills of the area, at about elevation 100 m AHD, then also flowing in an easterly direction toward Lake Frome. As these channels merge and join, increasing catchment areas contributing result in larger flows being experienced during major storm events.

The Beverley Mineral Lease is crossed by many such ephemeral streams, whose channels vary in size from shallow depressions at their source, to large, flat expanses of braided channels, flowing across the flat topography.

To the south, beyond the Lease boundary, Paralana Creek drains a significant catchment which rises in the Ranges. As it travels generally beyond the southern boundary, it branches at a point near the Paralana Outstation, with one branch flowing to the south-east, and a second to the north-east. This branch enters the Lease near the south-eastern corner, joining with Mulga Creek, prior to discharging across the eastern boundary of the Lease and flowing toward Lake Frome.

Within the Lease, Mulga Creek rises along the western boundary in a series of small channels spread from south to north across the Lease. These various branches gradually join together in a series of increasingly larger streams, which become wider as they reach the flatter land toward the eastern side of the Lease.

In general slopes of channels in the western part of the Mineral Lease are 10 % in grade, but as they travel east, these grades become flatter, being generally of 0.5 %. Correspondingly flow decreases in velocity, but increases in depth and spread of flood flows.

At the bifurcation of flow in Paralana Creek, two flow directions are created. It is difficult to determine the proportion of flow that will travel in each of the two directions. An estimate of the flow toward the north-east, which enters the Mineral Lease, has been made from consideration of the flow channel present within the Lease boundary (Figure 2).

Observations of channel form were made during a visit to the site conducted in March, 2006. At this time no flow was observed in any creeks, as rain had not been experienced in the area in the period either before or during this visit. A series of photos were taken of many of the channels throughout the Lease, and these were subsequently used to confirm channel characteristics, including roughness parameters used in the backwater curve analysis described later in this report.

Catchment areas were determined by topographical analysis of 1:250,000-scale plans of the area. However contour intervals were considered too large to provide sufficient accuracy for detailed catchment definition. To supplement this source, digital photos supplied by Heathgate of satellite images of the Lease and surrounding areas, with contour information determined by stereography, were used to correlate information and confirm assumptions.

Figure 1 shows the catchment areas of Paralana Creek and Mulga Creek on a regional scale.

Each catchment was divided into a series of sub-areas, simplifying subsequent input into the hydrological model. These sub-areas are shown in Figures 2 and 3, corresponding to natural catchment draining into the various streamlines throughout the area of both the Mineral Lease, as well as the larger catchment area to the west, extending to the Northern Flinders Ranges.

In general, the two main drainage systems are called the Paralana Creek and Mulga Creek catchments, though each has many tributaries and smaller drainage lines that combine to form the larger system.

Analysing the two main systems, the following catchment areas are derived.

Drainage System	Area (km^2)
Paralana (including both arms)	208
Mulga	47

Table 3.1 Drainage System Areas

3.1.1 Paralana Creek bifurcation

Paralana Creek is a complex drainage system which bifurcates to the south of the Mineral Lease, prior to crossing the southern boundary and joining with Mulga Creek. An estimate of the flow entering the Mineral Lease has been made considering channel section, bed grade and flow depth.

It is estimated that the capacity of flow within the channel entering the Mineral Lease is approximately 250 m^3/sec, which corresponds to a bank-full plus 1 m overbank depth flow. Consequently it has been assumed that during a 1 in 100 year flood event, this quantum of flow joins together with the Mulga Creek catchment flow.

For a flow of lesser recurrence interval, such as a 1 in 10 year flow, it has been assumed that a lesser flow of 100 m^3/sec, corresponding to the estimated bank-full flow, enters the Mineral Lease area from the south.

Little information relating to streamflow records exists in the immediate vicinity of the Mineral Lease, which includes Four-Mile Creek, Jenny Creek, Paralana Creek and Mulga Creek.

However, as reported in Tonkin (1998), streamflow records of short duration do exist for some of the rivers and creeks in the Northern Flinders Ranges. Analysis of these in that earlier report provided some assistance in developing regional regression equations, but this was found to be of limited value.

However, application of the relations derived in Tonkin (1998) yield the following flow rates for the two catchments considered as part of this study.

Catchment	1 in 10 year ARI Flow Rate m^3/sec	1 in 100 year ARI Flow Rate m^3/sec
Paralana Creek	201	491
Mulga Creek	48	112

Table 4.1 Peak Flow Estimates based on Regional Regression Equations

The method of developed by Gerney is still considered to of use in deriving flow estimates. This method, developed in 1962, relates flow to area through the following relation;

$$Q = 2.19 \,.\, c \,.\, A \,.\, (K + d \,.\, \log (0.5 * (1 + Y)/(1+ 112 \,.\, \sqrt{A} / (c \,.\, K))^{0.74}$$

Where:

Q : Peak flow (m^3/sec)

A : Catchment area (km^2)

c : Parameter derived by Gerney based on rainfall intensity

d : Parameter derived by Gerney based on rainfall intensity

K : Coefficient related to catchment slope and imperviousness

Y : Recurrence interval (Years)

The method of Gerney was derived for an early Environmental Impact Statement (AMDEL, 1982) for the Beverley site, and is considered appropriate for flow estimation using parameters derived during that study. Parameter values adopted were as follows:

c : 10.0

d : 2.0

K : 0.95

Based on application of the Gerney Method, a tabulation of flow rates for both Paralana Creek and Mulga Creeks, immediately upstream of their confluences, is given. Taken from the catchment analysis described in Section 3, it is noted that the areas of the two catchments are 208 and 47 km^2 respectively.

Creek	Peak Flow (m^3/sec) for ARI				
	5 yr	10 yr	20 yr	50 yr	100 yr
Paralana	193	246	303	382	442
Mulga	76	97	119	149	173

Table 4.2 : Peak Flow Estimates based on Gerney Method

Estimates for Paralana Creek are made assuming the whole of the catchment is contributing to flow. As is noted above, Paralana Creek is a braided creek system, with numerous channels interweaving across the floodplain. At a point south of the Mineral Lease, Paralana Creek bifurcates into two flow paths, one heading to the north-east, the other to the south-east.

These estimates using the Gerney Method will later be compared with estimates derived using RORB, to ultimately determine flows to be used in backwater curve analysis.

In addition to flow estimates derived using the Gerney Method and Regional Relationships, described above, application of the rainfall runoff routing model RORB Ver. 4 (RORB), has been made to estimate flow rates for various recurrence interval events.

RORB is a rainfall excess model, generating flow via application of rainfall excess over defined sub-catchment areas. Losses are abstracted from the rainfall hyetograph according to an input loss model, with on-going losses throughout the rain event also input as part of parameter selection.

Flows which are thus generated are routed along flow reaches, with application of a reach storage function of the form,

$$S = 3600 \cdot Q^{m}$$

where:

S : Reach Storage

Q : Reach Flow

m : constant related to non-linearity of storage (typically taken to be 0.8)

As the computed flow passes along the drainage channel, additional inflow is added to the developed hydrograph, representing local inflow of each sub-area.

The catchment model can be established with any degree of complexity, with predicted outflow hydrographs able to be extracted at any point in the network.

A series of points have been identified in the current study, at which flow hydrographs were derived for subsequent use in predicting flood plains through the application of a backwater curve program.

5.1 Input Parameters

The application of RORB requires input of a number of parameters to generate runoff hydrographs. These parameters have been the subject of research over a long period, however specific application to catchments of the Northern Flinders Ranges is limited.

Summarising, RORB requires that a loss model be applied to the rainfall, generally consisting of an Initial Loss (IL), which is abstracted from the beginning of the rainfall event; and a Continuing Loss (CL), which is applied at a constant rate over the duration of the rain event.

In addition to this, parameter k_c, which is a function of reach delay, and hence has a significant impact on the "peakiness" of the resulting flow hydrograph, must be determined for input.

Parameter "m", previously mentioned, is taken to be a constant 0.8 in most applications of the RORB model. Only for the most extreme events, such as the Probable Maximum Flood (PMF), would "m" be taken as 1.0, generating a linear relationship between reach storage S, and reach inflow, Q.

RORB can be executed in a number of different forms. It can be run, using known rainfall and runoff from a catchment, for calibration of the input parameters, such that the shape of the recorded hydrograph is matched as closely as possible. By varying parameters accordingly, the shape and peak flow of the output hydrograph can be matched to the actual recorded hydrograph, and parameter values determined.

These parameters, thus determined, can then be used to re-run the model for different rainfall inputs, such as the ARR-derived storms, to make estimation of generated flood flows.

5.1.1 Initial Loss/Continuing Loss

Work undertaken by Kemp (1989) proposes a Loss Model using the inputs:

Initial Loss : 20 mm

Continuing Loss : 7 mm/hr

for use in the Northern Flinders Ranges. ARR (1997) provides limited guidance for selection of Loss Model parameters, suggesting a median initial loss of 15 mm ad a continuing loss of 4 mm/hr for the Arid Zone of South Australia, in which the Beverley Mineral Lease is located.

Calibration by Tonkin (1998) incorporating the results of Kemp, suggest that the following values be used for RORB analysis:

10 Year ARI : 12 mm Initial Loss, 5 mm/hr Continuing Loss

50 Year ARI : 18 mm Initial Loss, 5 mm/hr Continuing Loss

100 Year ARI : 20 mm Initial Loss, 5 mm/hr Continuing Loss

These values will be adopted for the present analysis.

5.1.2 k_c parameter

Kemp (1993) investigated k_c for a range of catchments across South Australia, dividing these into Arid and Humid (near-coastal) locations, determined by rainfall. A relationship was derived for catchments with average annual rainfall of less than 320 mm; applicable to the study area.

Arid catchments yielded the following relation for k_c, based on area and rainfall:

$$k_c = 7.06 \,.\, (RF/1000)^{2.79} \,.\, A^{0.71}$$

where:

kc : empirical coefficient applicable to the entire network

RF : average rainfall (mm/annum)

A : catchment area (km^2)

A number of the analysed catchments were located in the vicinity of the Mineral Lease area, with catchment areas both greater and smaller than the Paralana Creek catchment. The Mulga Creek catchment area however, falls below any of the analysed catchments.

Tonkin (1998) undertook an analysis of kc, also with input from Kemp, as well as calibration results for Arcoona Creek. A curve fitted to the results yielded the following relation for kc, subsequently applied in the Tonkin study (1998).

$$k_c = 0.091 \, . \, A^{0.741}$$

where k_c and A have the same meaning as above.

In applying these two equations to the present study, it can be seen that there is little difference between the calculated k_c values, as shown in the following Table.

Catchment	k_c=7.06.(RF/1000)$^{2.79}$.A$^{0.71}$	k_c=0.091.A$^{0.741}$
Paralana Creek	4.6	4.79
Mulga Creek	1.6	1.6

Table 5.1 Estimated k_c Values

Values consistent with the previous Tonkin report will be adopted for this study, as the difference between the two estimates is small.

5.2 RORB Catchment Data

As previously described, each of the two catchments; Paralana Creek and Mulga Creek; has been divided into sub-areas for input into the RORB model. Figures 2 and 3 detail the sub-area boundaries, areas and corresponding flow path lengths for subsequent establishment of the RORB model.

Though the two flow paths ultimately join, as least in part, near the eastern boundary Mineral Lease area, the two have been treated as separate for the purposes of determining catchment flows. This is a conservative approach in that it calculates the peak flow in each catchment, assuming different storm events occurring over the two catchments.

This reflects the fact that the nature of a storm cell producing the rainfall event could be a system moving from west to east, resulting in an event on the westerly Paralana Creek catchment commencing before an event on the Mulga Creek catchment. In relative terms, it is expected that the Paralana Creek catchment will have a longer duration event as its critical storm, due to its larger area and its greater length.

For the peak flood flows in the two catchments to coincide therefore, a storm event would be required to commence on the larger Paralana Creek catchment and move easterly to then fall on the Mulga Creek catchment in a manner than caused the two peak flows to arrive at the junction of the two flow paths simultaneously. A conservative assumption is made here, that this does occur, so that peak flows in both Creek systems will be taken as input to the backwater curve modelling described in the next Section.

Areas and stream lengths are taken from the sub-area plans, and formulated into a RORB input file, which is then used to undertake the analysis of the catchment. Catchment files for both Paralana Creek and Mulga Creek can be found in Appendix B.

5.3 RORB model simulations

With the input of the catchment files described above, together with ARR-derived rainfall, the loss model and k_c value, estimated flows for the catchment can be derived. As RORB produces a flow hydrograph at each point of interest, incorporating delay due to reach storage effects, a range of duration rainfall events must be simulated on the catchment, to determine which of the events is the critical event; i.e. which rain storm produces the peak flow within the catchment.

For the analysis undertaken for both the Paralana Creek and Mulga Creek catchments, events of duration 10 minutes to 72 hours have been simulated, allowing the peak flow event to be identified. In determining peak flows, each catchment has been simulated separately, using its specific k_c value, though the loss model used in both catchments is identical.

As expected, the results show that shorter duration events are more critical in the Mulga Creek catchment (approximately the 2 hour event), with longer duration events are critical for the Paralana Creek catchment (approximately the 6 hour event at the confluence). Results are summarised in detail in Appendix C, but the following table shows the flow values estimated before applying the bifurcation in the Paralana Creek catchment, described in Section 3.1.1 above. The results reported for Mulga Creek are at a series of points which are identified on Figure 3.

Flow Location	1 in 10 Year ARI Flow m^3/sec	1 in 100 Year ARI Flow m^3/sec
Paralana Creek at confluence	165	384
Mulga Creek		
P8	55	118
P10	104	249
P12	106	255
M5	26	50
M7	59	121

Table 5.2 Calculated Flows using RORB

Application of the estimated split of flow at the bifurcation reduces the flow in Paralana Creek to 250 m^3/sec and 100 m^3/sec for the 1 in 100 year and 1 in 10 year ARI events respectively, and these flows have been algebraically added to the Mulga Creek flows to derive flows for use in the HEC-RAS analysis, described below.

It should be noted that the flow predictions made here are subject to a wide error band. When assessing the input information, particularly rainfall inputs to the RORB model, it is acknowledged that a high degree of uncertainty surrounds rainfall estimates, based on the small number of recording stations and the length of available record.

5.4 Adopted Flows

When comparing the estimates produced by the three methods discussed; Regional Regression equations; Gerney and RORB, it is apparent that the RORB flow estimates are straddled by the other methods. Tabulating the three methods, before application of bifurcation flow, so that all catchment areas are consistent, flows are as shown in Table 5.3 below.

Catchment	Regional Regression m³/sec	Gerney m³/sec	RORB m³/sec
Paralana Creek			
10 year ARI	201	246	165
100 year ARI	491	442	384
Mulga Creek			
10 year ARI	48	97	106
100 year ARI	112	173	255
Combined Flow downstream of confluence, allowing for bifurcation (S. 3.1.1)			
10 year ARI			212
100 year ARI			510

Table 5.3 Comparison of Flow Estimates

It is apparent that a divergence in the flow estimates using the three methods. In general it is noted that RORB estimates are higher than the other methods for the Mulga Creek catchment, and lower for the Paralana Creek catchment.

When reviewing the background to the three methods, Regional Regression equations derived by Tonkin (1998) are based on a small sample of gauging stations and relatively few years of records at each station. The results appear to be too wide-spread to provide a useful basis for estimating flows in the two catchments of concern.

The Gerney method produces results that range between -32% and + 49% of the RORB flows, however for the 1 in 100 year ARI predictions, these differences reduce to -32% and +15% of the RORB flows.

Given that the RORB input parameters are based on analysis of a range of catchment sizes, into which the two catchments fit, these flows are proposed as the flows to be used for the backwater curve analysis.

It is noted that the Paralana Creek catchment is affected, in peak flow estimation, by the extended length of its channel to the east of the Flinders Ranges part of the catchment. This length has the effect, in the model, of introducing significant channel storage, relative to the peak flow, thus attenuating the peak flow with relatively less catchment area contributing to increasing the flow through the reach.

Analysis of the model shows that flow in fact is greater, during both the 10 year and 100 year ARI events, a points further to the west in the catchment, even with smaller catchment areas. This result highlights the attenuating effect of the channel storage, which acts to reduce the estimate of peak flow. However visual assessment of the creek channels on the flatter margins of the catchment, near the southern boundary of the Mineral Lease, suggest that this effect is likely, given the shallow bed grade, the width of channel and the extensive nature of overbank storage potential.

6.1 Introduction

First-order estimation of flood plain extent within the Mulga Creek catchment has been undertaken using HEC-RAS, an industry standard, one-dimensional, backwater curve analysis package. The package uses step-wise solution of the energy equation to predict water surface profiles for a range of open-channel flow situations.

It is particularly applicable to the present study, given the detail of available input information and the extent of channel requiring modelling.

HEC-RAS requires, as input, data defining channel cross-sectional shape, roughness and flowrate, to enable it to predict water surface levels associated with the flow.

Preparation of a Digital Terrain Model (DTM), using satellite imagery, has enabled the definition of the landform, from which cross-sections can be taken. However it is the case that the degree of accuracy of contour information to closely define the flowpath channel is relatively coarse. As a consequence predicted water surface levels are sufficient for planning purposes, however it must be expected that actual events may vary significantly from these levels.

Provided account is taken to ensure that any construction within predicted floodplains is located beyond the channel of any flowpath, and is able to withstand expected velocities across the overbank area, floodplain maps derived from such an analysis will provide valuable information.

It is noted that flooding associated with Paralana Creek is largely contained to the area outside the Mineral Lease. However, to allow for the effect of additional flow occurring downstream of the confluence of Paralana Creek and Mulga Creek, and the consequent increase in predicted water surface that would occur in Mulga Creek as a result of greater water depth downstream of the confluence, the estimated flow in Paralana Creek has been assessed and incorporated into the HEC-RAS model.

6.2 Cross-sectional information

To undertake the HEC-RAS analysis, development of cross-sectional information along flowpaths of interest is necessary. Contour information, drawn from a DTM of the site, was used to identify cross-section locations, as well as to prepare the cross-sectional shape itself.

In conjunction with this, a visual inspection of much of the Mineral Lease area, and areas to the south, was undertaken, to confirm assumptions regarding channel roughness and form.

A series of digital photographs were obtained to allow office-based assessment of general roughness.

Cross-sections are generally located at points of major flow change, such as significant bends, and at relatively regular intervals along individual creek lines.

Figure 4 shows the location of all cross-sections taken.

Once cross-sectional information is extracted from the DTM, a visual check is made of the resulting profiles, to determine any irregularities, prior to entering information into the HEC-RAS program. On the basis of the site inspection and review of photographs, a single roughness value of 0.05 has been selected to apply across the full cross-section, reflecting the stone-lined nature of the upper part of the catchment, and the winding and vegetated nature of the lower parts of the catchment.

Review of Figure 4 indicates that cross-sections have been taken along the full length of Mulga Creek main channel and tributaries, extending to the western boundary of the Mineral Lease. Paralana Creek has been analysed for the length contained within the Mineral Lease boundary, extending to the eastern boundary of the Lease, beyond the confluence of the two Creeks.

6.3 HEC-RAS Modelling

With the input of cross-sectional information, flow data has been entered to the model, which was simulated for both the 1 in 10 year ARI and the 1 in 100 year ARI events.

Flood plain maps have been prepared for both events; Figure 6 for the 1 in 10 year ARI event and Figure 7 for the 1 in 100 year ARI event. In addition, Figure 5 combines the two floodplain extents, to allow comparison of the additional extent of flooding associated with the 1 in 100 year ARI flood.

It is noted, by analysis of Figure 5, that the extents of flooding are quite similar, indicating that the increased flow depth associated with the larger flow, does not result in a significantly greater extent of flooding.

During simulation runs, it was observed that the HEC-RAS program identified, as a result of large energy changes at cross-sections, the need for additional cross-sections. Given the nature of the input information, it was decided to use the interpolation feature of the program, rather than extract further sections from the DTM. This approach is supported by the on-site assessment, where it was observed that changes in cross-section occurred gradually, rather than abruptly, which is reflected in the interpolation between two adjacent sections occurring as a gradual change from one section to the next.

This process was found to resolve the internal warnings.

6.4 HEC-RAS Results

Of interest is both the extent of flooding, as shown on the floodplain maps, and the velocity of flow occurring during a flood event.

Summary tables from the two HEC-RAS model runs are included in Appendix D for reference. These tables show the predicted water surface level at each cross-section, the analysed flowrate and the predicted average flow velocity.

It should be noted, with regard to velocity, that the average velocity represents an average taken over the full cross-section. It can be expected, particularly in the event of overbank flow, that the velocity in the channel proper will be higher than in the overbank flow. Therefore the velocities tabulated in Appendix D would be expected to be in excess of the velocity that would be experienced on the bank of the channel.

However, review of the predicted results shows that maximum average velocity is approximately 1.3 m/sec at one location, with the majority of velocities less than 1 m/sec for both the 1 in 10 year ARI and the 1 in 100 year ARI flood events.

6.5 Accuracy of Results

It has been noted that some uncertainty exists in the prediction of both flowrates used in the HEC-RAS modelling, as well as in the determination of cross-sectional information along flow paths. However, it is apparent from comparison of the predicted water surfaces for both the 1 in 10 year and the 1 in 100 year ARI events, that a significant increase in flow (more than 100%) results in only a small increase in predicted inundation area.

It can be expected that this principle will extend to flows in excess of the 1 in 100 year flood flow, due to the flat, wide nature of the overbank region. Significant increase in flow can be accommodated with small increase in water depth.

It should also be noted that the large increase in flow between the 1 in 10 year and the 1 in 100 year ARI events also produced only a small increase in average velocity. Again this principle can be expected to extend for flows in excess of the 1 in 100 year ARI flow.

6.6 Comments on resultant flood risk

In assessing the impact of predicted flood risk on potential operations within the floodplain, recognition must be made of the likelihood of a flood event occurring. For example, if activities are to be located within a floodplain for a period of 12 months only, such as URS understands is the case for piping and extraction equipment associated with the In-situ Leaching (ISL) process, a lower flood standard may be appropriate. Over a 12–month period, the probability of operations within the 100 year floodplain being inundated is 1%, while within a 1 in 10 year ARI floodplain it is 10%.

However operational facilities that are to remain in one place for a much longer period, for example 15 years, would be exposed to a higher level of probability of inundation if located within a floodplain. Within a 1 in 100 year floodplain, a facility with a 15 year life would have a probability of 14% of being inundated, which although still unlikely, is clearly higher.

Consideration of risk should also be tempered with consequence of inundation. As has been discussed, flow velocities within the floodplain, be it either the 1 in 10 year or 1 in 100 year ARI floodplain, are relatively low; generally 1 m/sec or less. Provided design of equipment was able to sustain flow of such a velocity, location of equipment within the 1 in 10 year floodplain for 12 month periods could be considered appropriate, with more long-term equipment located beyond the 1 in 10 year ARI floodplain.

References

1 B. C. Tonkin and Associates (1998), *Surface water hydrology study for the Beverley Mineral Lease Site in South Australia*, June, 1998

2 *Australian Rainfall and Runoff*, The Institution of Engineers, Australia, 1987

3 Kemp, D. J. (1993)*, Generalised RORB Parameters for Southern , Central and Western Australia,* WATERCOMP, The Institute of Engineers, Melbourne, 1993

4 AMDEL (1982), *South Australian Uranium Corporation – Beverley Uranium Project Draft Environmental Impact Statement,* July, 1982

5 Laurenson and Mein (1990), *RORB Version 4 – Runoff Routing Program User Manual,* Monash University*,* 1990

6 Bureau of Meteorology (2006), South Australian Climate Data website

Limitations

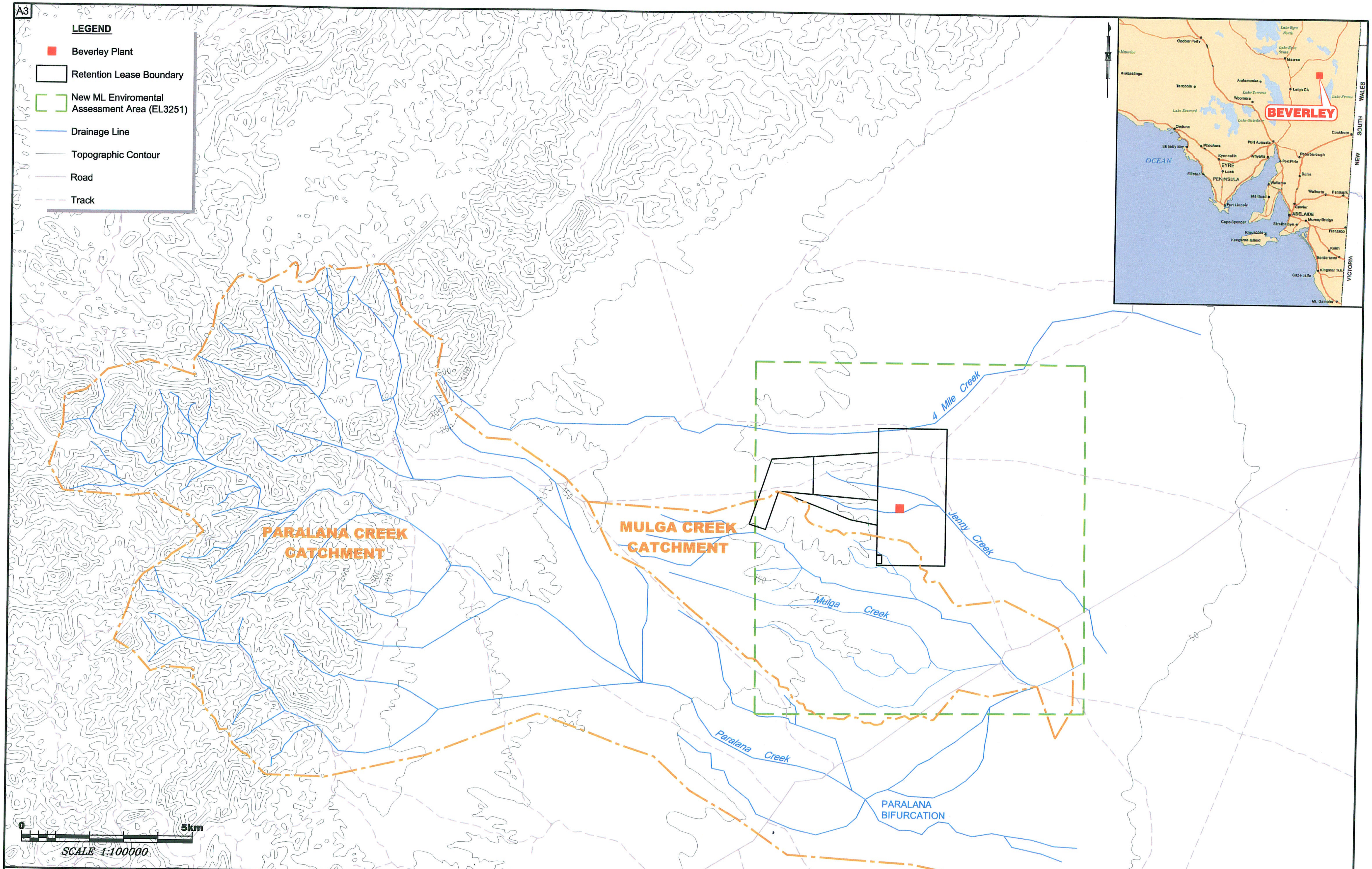
URS Australia Pty Ltd (URS) has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of Heathgate Resources P/L and only those third parties who have been authorised in writing by URS to rely on the report. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report. It is prepared in accordance with the scope of work and for the purpose outlined in the Proposal dated December, 2005.

The methodology adopted and sources of information used by URS are outlined in this report. URS has made no independent verification of this information beyond the agreed scope of works and URS assumes no responsibility for any inaccuracies or omissions. No indications were found during our investigations that information contained in this report as provided to URS was false.

This report was prepared between March and May, 2006 and is based on the conditions encountered and information reviewed at the time of preparation. URS disclaims responsibility for any changes that may have occurred after this time.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

Figures



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25 North Terrace
Hackney S.A. 5069

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Rev	By	Appd	Date	REVISION RECORD
A	SCS	JA	05/2006	DRAFT ISSUE FOR CLIENT REVIEW

Designed: MP
Drawn: SCS
Checked: JA
Approved:
Scales: AS SHOWN

Client: **HEATHGATE RESOURCES PTY. LTD.**

Project Title: SURFACE WATER HYDROLOGY STUDY FOR THE BEVERLEY RETENTION LEASE SITE SOUTH AUSTRALIA

Drawing Title: LOCATION PLAN SHOWING BEVERLEY RETENTION LEASES AND SURROUNDS

Status: **DRAFT**

Datum:

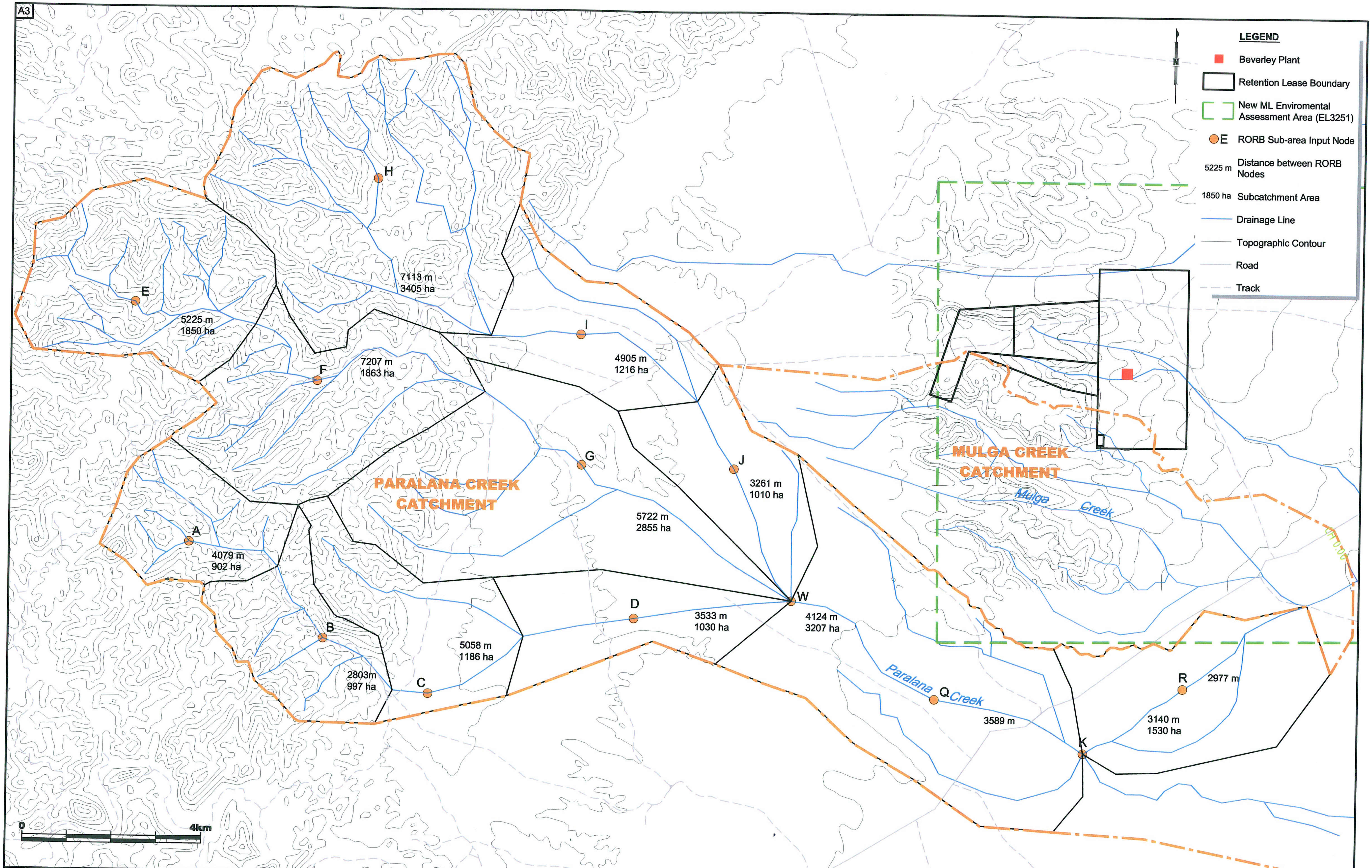
Date: MAY 2006

CAD File Number: 42656422-001-01.dwg

Job Number: 42656422

Drawing Number: 1

Rev: A



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Rev	By	Appd	Date	REVISION RECORD
A	SCS	JA	05/2006	DRAFT ISUE FOR CLIENT REVIEW

Designed: MP
Drawn: SCS
Checked: JA
Approved:
Scales: AS SHOWN

Client: **HEATHGATE RESOURCES PTY. LTD.**

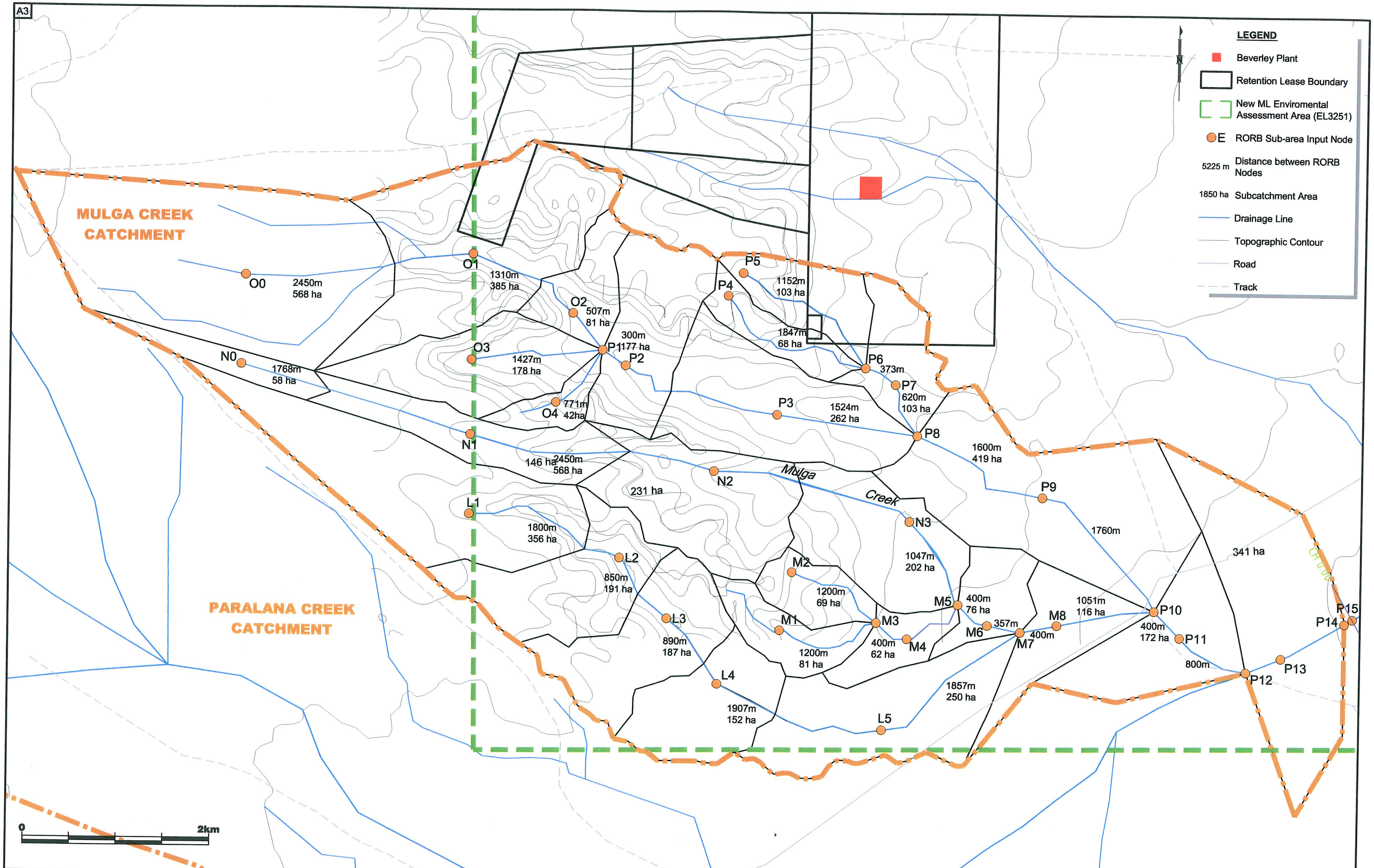
Project Title: SURFACE WATER HYDROLOGY STUDY FOR THE BEVERLEY RETENTION LEASE SITE SOUTH AUSTRALIA

Drawing Title: PARALANA CREEK RORB CATCHMENT PLAN AND FLOW CALCULATION LOCATIONS

Status: **DRAFT**

Datum:
Date: MAY 2006

CAD File Number: 42656422-001-02.dwg
Job Number: 42656422
Drawing Number: 2
Rev: A



A	SCS	JA	05/2006	DRAFT ISSUE FOR CLIENT REVIEW
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Designed MP
Drawn SCS
Checked JA
Approved
Scales AS SHOWN

Client
HEATHGATE RESOURCES PTY. LTD.

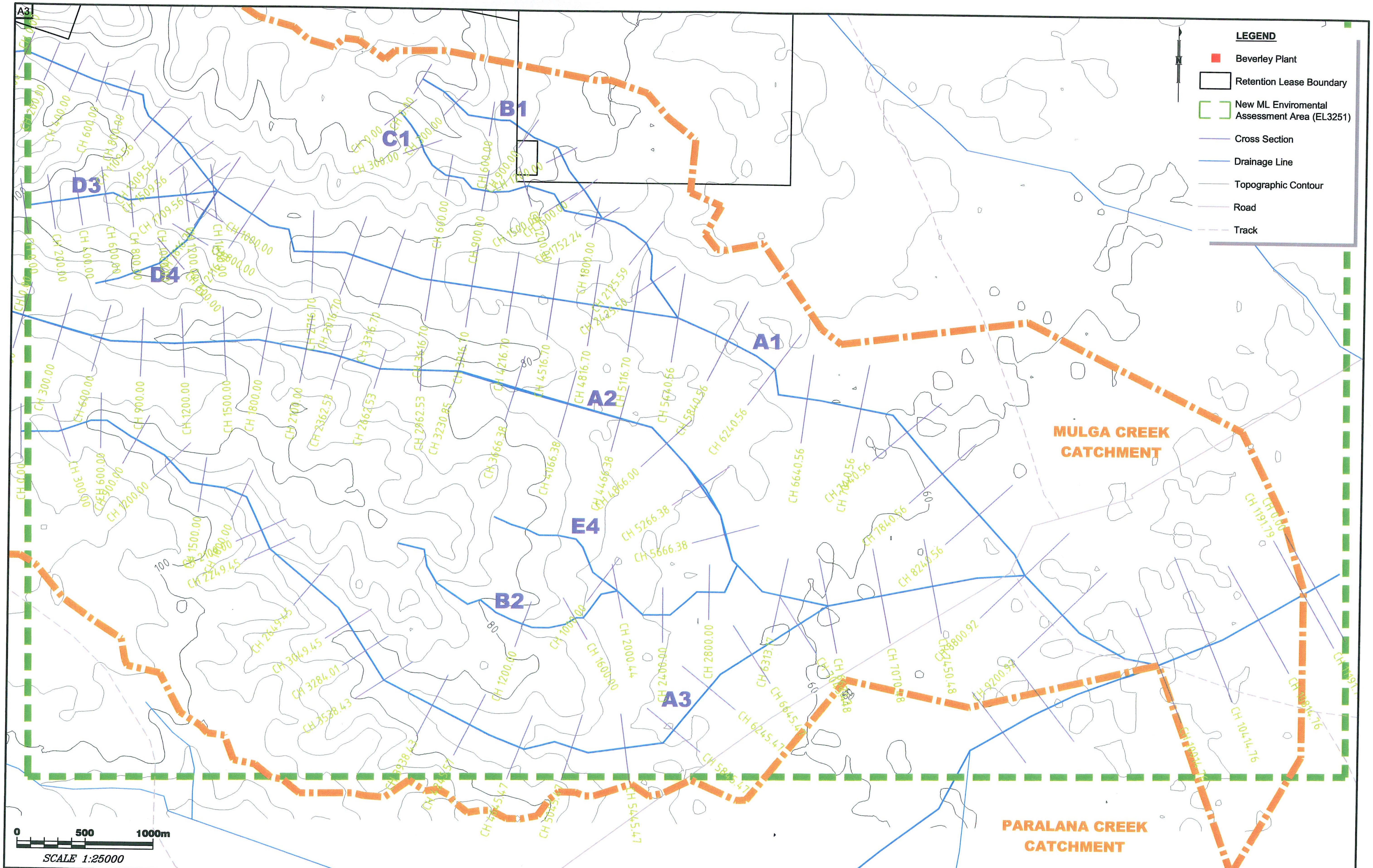
Project Title:
SURFACE WATER HYDROLOGY STUDY FOR THE BEVERLEY RETENTION LEASE SITE SOUTH AUSTRALIA

Drawing Title:
MULGA CREEK RORB CATCHMENT PLAN AND FLOW CALCULATION LOCATIONS

Status
DRAFT

Datum
Date MAY 2006

CAD File Number: 42656422-001-03.dwg
Job Number: 42656422
Drawing Number: 3
Rev A



A	SCS	JA	05/2006	DRAFT ISSUE FOR CLIENT REVIEW	
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Designed MP
Drawn SCS
Checked JA
Approved
Scales AS SHOWN

Client

HEATHGATE RESOURCES PTY. LTD.

Project Title:
SURFACE WATER HYDROLOGY STUDY FOR THE BEVERLEY RETENTION LEASE SITE SOUTH AUSTRALIA

Drawing Title:
CROSS SECTION PLAN

Status
DRAFT

Datum

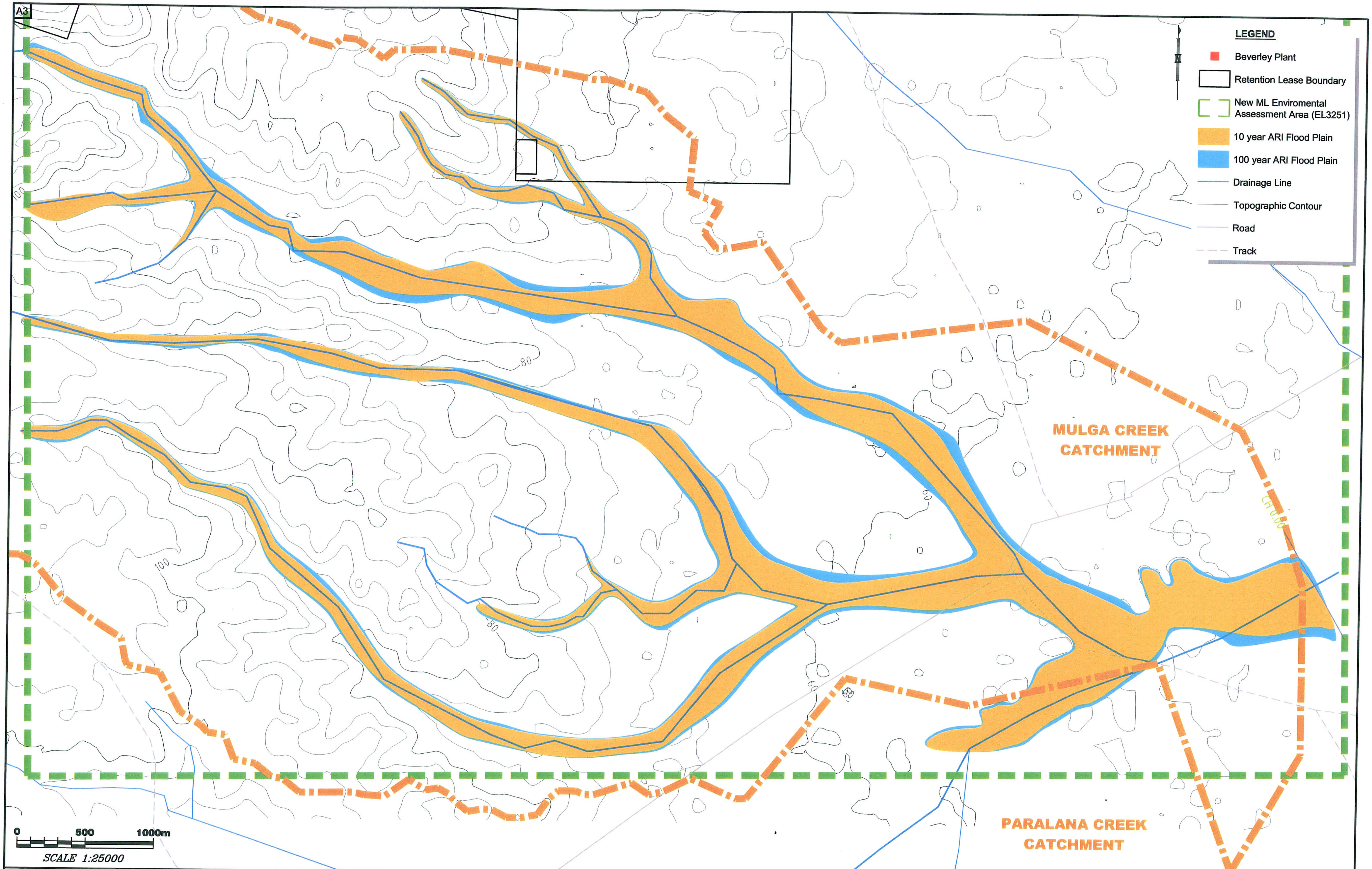
Date
MAY 2006

CAD File Number:
42656422-001-07.dwg

Job Number:
42656422

Drawing Number:
4

Rev
A



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Rev	By	Appd	Date	REVISION RECORD
A	SCS	JA	05/2006	DRAFT ISUE FOR CLIENT REVIEW

Designed: MP
Drawn: SCS
Checked: JA
Approved:
Scales: AS SHOWN

Client: **HEATHGATE RESOURCES PTY. LTD.**

Project Title: SURFACE WATER HYDROLOGY STUDY FOR THE BEVERLEY RETENTION LEASE SITE SOUTH AUSTRALIA

Drawing Title: 10 YEAR ARI AND 100 YEAR ARI FLOOD PLAIN

Status: **DRAFT**

Datum:

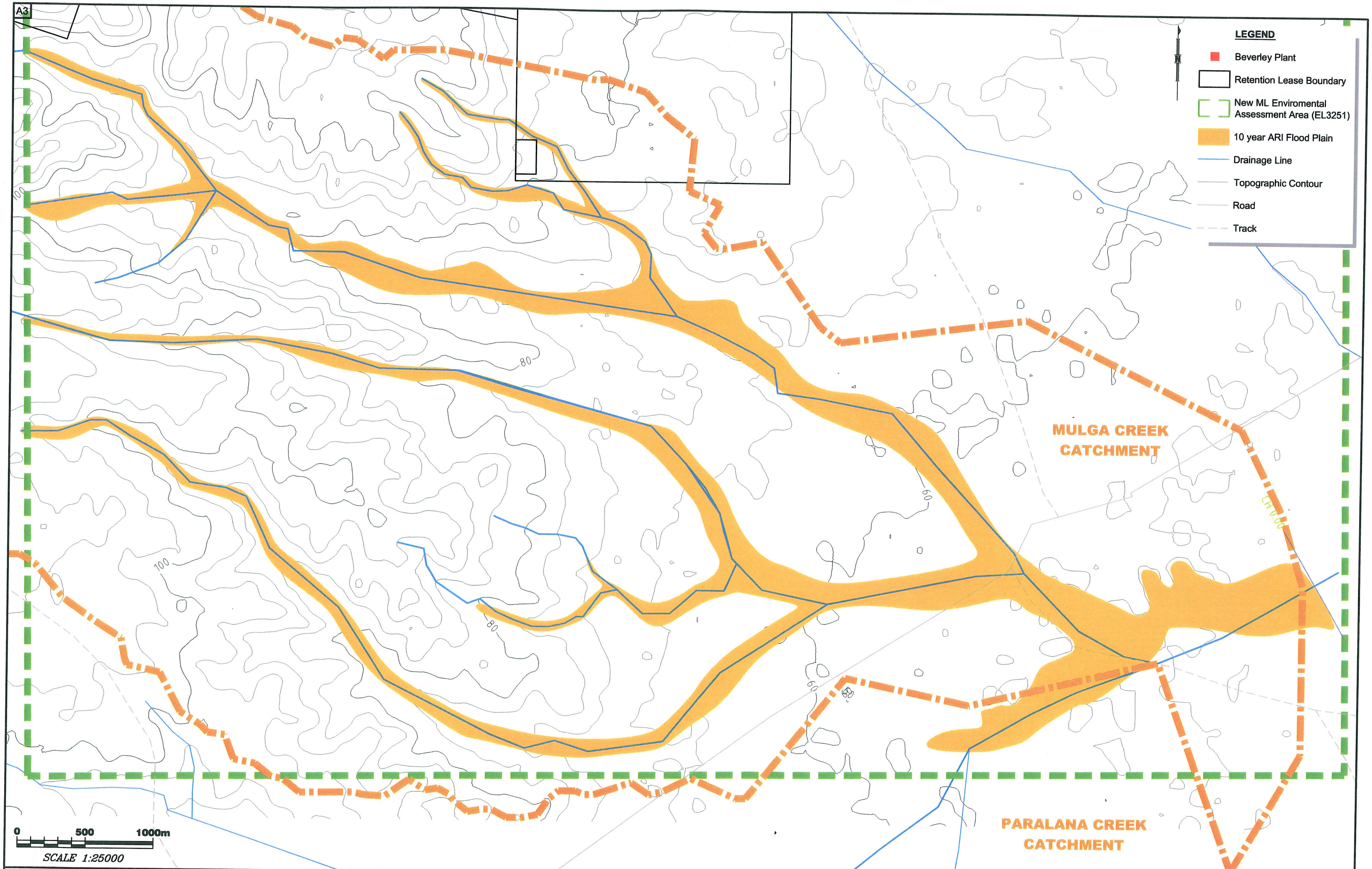
Date: MAY 2006

CAD File Number: 42656422-001-04.dwg

Job Number: 42656422

Drawing Number: 5

Rev: A



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25 North Terrace
Hackney S.A. 5069
Tel. 08 8366 1000
Fax. 08 8366 1001

Rev	By	Appd	Date	REVISION RECORD
A	SCS	JA	05/2006	DRAFT ISUE FOR CLIENT REVIEW

Designed	MP
Drawn	SCS
Checked	JA
Approved	
Scales	AS SHOWN

Client: **HEATHGATE RESOURCES PTY. LTD.**

Project Title: SURFACE WATER HYDROLOGY STUDY FOR THE BEVERLEY RETENTION LEASE SITE SOUTH AUSTRALIA

Drawing Title: 10 YEAR ARI FLOOD PLAIN

Status: **DRAFT**

Datum:

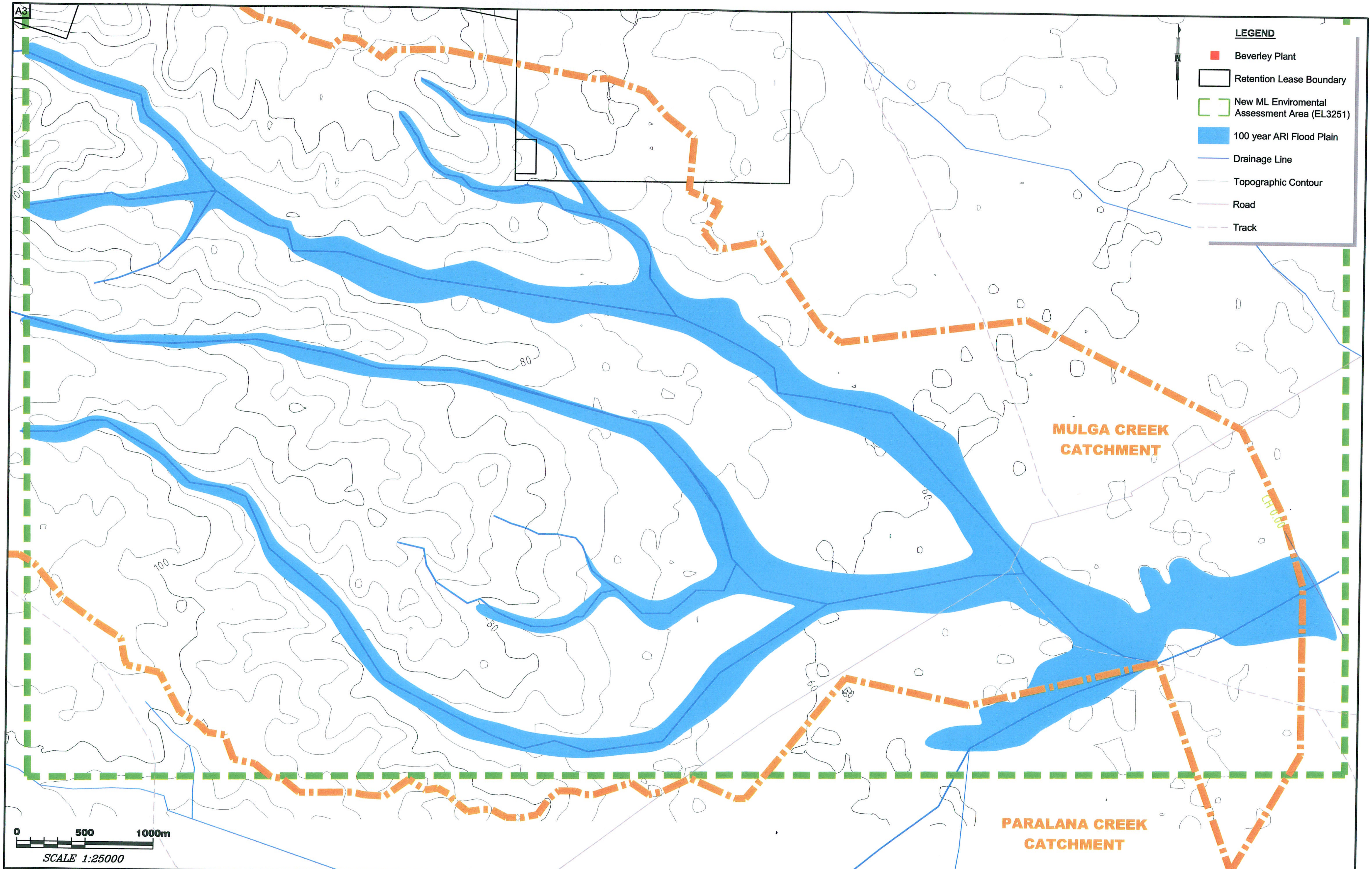
Date: MAY 2006

CAD File Number: 42656422-001-05.dwg

Job Number: 42656422

Drawing Number: 6

Rev: A



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25 North Terrace
Hackney S.A. 5069
Tel. 08 8366 1000
Fax. 08 8366 1001

Rev	By	Appd	Date	REVISION RECORD
A	SCS	JA	05/2006	DRAFT ISUE FOR CLIENT REVIEW

Designed	MP
Drawn	SCS
Checked	JA
Approved	
Scales	AS SHOWN

Client: **HEATHGATE RESOURCES PTY. LTD.**

Project Title: SURFACE WATER HYDROLOGY STUDY FOR THE BEVERLEY RETENTION LEASE SITE SOUTH AUSTRALIA

Drawing Title: 100 YEAR ARI FLOOD PLAIN

Status: **DRAFT**

Datum:

Date: MAY 2006

CAD File Number: 42656422-001-05.dwg

Job Number: 42656422

Drawing Number: 7

Rev: A

Appendix A
ARR IFD Rainfall Data

IFD ANALYSIS BASED ON AUSTRALIAN RAINFALL & RUNOFF (1987)

Site name: Beverley Mine, South Australia

Site latitude = 30.18 degrees S
longitude = 139.55 degrees E
skewness = .00

2-year ARI, 1 hour intensity = 18.65 mm/hr
12 hour intensity = 3.00 mm/hr
72 hour intensity = .70 mm/hr

50-year ARI, 1 hour intensity = 50.10 mm/hr
12 hour intensity = 9.00 mm/hr
72 hour intensity = 2.10 mm/hr

IFD Table for Various ARIs and Durations

Duration	1 yr	2 yr	5 yr	10 yr	20 yr	50 yr	100 yr	200 yr	500 yr
5 min	47.12	63.40	91.90	110.44	133.81	166.08	191.81	218.84	256.76
6 min	44.03	59.25	85.94	103.30	125.19	155.42	179.54	204.88	240.43
10 min	35.70	48.07	69.84	84.03	101.92	126.64	146.37	167.11	196.23
12 min	32.89	44.29	64.40	77.51	94.04	116.89	135.13	154.31	181.25
15 min	29.59	39.87	58.03	69.87	84.80	105.45	121.94	139.29	163.65
18 min	27.04	36.44	53.08	63.94	77.62	96.56	111.69	127.61	149.97
20 min	25.63	34.54	50.33	60.64	73.64	91.63	106.00	121.12	142.37
24 min	23.29	31.40	45.79	55.20	67.05	83.46	96.58	110.38	129.79
30 min	20.63	27.83	40.62	48.99	59.54	74.15	85.83	98.12	115.41
45 min	16.38	22.11	32.34	39.04	47.48	59.18	68.55	78.42	92.30
1.0 hr	13.81	18.65	27.31	33.00	40.16	50.10	58.05	66.44	78.24
1.5 hr	10.30	13.95	20.58	24.96	30.47	38.13	44.29	50.80	59.98
2.0 hr	8.33	11.30	16.76	20.38	24.94	31.30	36.41	41.83	49.47
3.0 hr	6.16	8.38	12.51	15.28	18.75	23.62	27.54	31.71	37.60
4.5 hr	4.55	6.20	9.33	11.43	14.08	17.80	20.80	24.00	28.54
6.0 hr	3.67	5.01	7.58	9.31	11.49	14.56	17.05	19.71	23.48
9.0 hr	2.71	3.71	5.66	6.98	8.64	10.99	12.90	14.94	17.84
12.0 hr	2.19	3.00	4.60	5.69	7.06	9.00	10.58	12.27	14.69
18.0 hr	1.60	2.20	3.37	4.17	5.18	6.60	7.77	9.01	10.78
24.0 hr	1.28	1.76	2.70	3.34	4.15	5.29	6.22	7.21	8.63
30.0 hr	1.08	1.48	2.27	2.80	3.48	4.44	5.22	6.05	7.24
36.0 hr	.93	1.28	1.96	2.42	3.00	3.83	4.50	5.22	6.25
48.0 hr	.73	1.01	1.54	1.91	2.36	3.01	3.55	4.11	4.92
72.0 hr	.51	.70	1.07	1.33	1.65	2.10	2.47	2.86	3.43

IFD Polynomial: ln I = a + b*ln(D) + c*ln(D)**2 + d*ln(D)**3 + e*ln(D)**4 + f*ln(D)**5 + g*ln(D)**6
where duration D is in hrs and average intensity I is in mm/hr

ARI	a	b	c	d	e	f	g	Max % error
1	2.6074046	-.6612269	-.0601313	.0108041	.0020431	-.0006609	.0000102	1.82
2	2.9083210	-.6572279	-.0582640	.0108785	.0018321	-.0006757	.0000184	1.77
5	3.2913396	-.6460153	-.0530041	.0110872	.0012382	-.0007171	.0000416	1.62
10	3.4811857	-.6401532	-.0502542	.0111964	.0009277	-.0007388	.0000537	1.55
20	3.6782233	-.6353130	-.0479836	.0112865	.0006713	-.0007567	.0000637	1.48
50	3.8999380	-.6298665	-.0454287	.0113879	.0003828			

```
 -.0007768     .0000749   |    1.41
100 |    4.0477840    -.6262347    -.0437250     .0114555     .0001904
 -.0007902     .0000824   |    1.37
200 |    4.1831016    -.6229106    -.0421656     .0115174     .0000143
 -.0008025     .0000893   |    1.32
500 |    4.3471099    -.6188817    -.0402757     .0115924    -.0001991
 -.0008174     .0000976   |    1.27
```

Overland Flow Travel Time Aid
Table of t*I**0.4 where t = time in min and I = intensity in mm/h

Duration	1 yr	2 yr	5 yr	10 yr	20 yr	50 yr	100 yr	200 yr	500 yr
5 min	23.38	26.33	30.54	32.87	35.49	38.70	40.99	43.21	46.06
6 min	27.23	30.66	35.58	38.30	41.36	45.10	47.77	50.37	53.70
7 min	30.97	34.88	40.49	43.59	47.08	51.34	54.40	57.35	61.15
8 min	34.63	39.01	45.29	48.76	52.67	57.45	60.87	64.18	68.44
9 min	38.21	43.04	49.98	53.82	58.14	63.41	67.20	70.85	75.56
10 min	41.71	46.99	54.57	58.77	63.49	69.25	73.39	77.38	82.52
12 min	48.50	54.64	63.47	68.36	73.86	80.58	85.39	90.05	96.04
14 min	55.04	62.01	72.05	77.60	83.85	91.48	96.96	102.25	109.06
16 min	61.36	69.13	80.33	86.53	93.50	102.02	108.13	114.04	121.64
18 min	67.48	76.03	88.36	95.18	102.86	112.23	118.96	125.47	133.83
20 min	73.41	82.72	96.15	103.58	111.94	122.16	129.48	136.57	145.68
22 min	79.19	89.24	103.73	111.76	120.79	131.82	139.72	147.38	157.22
24 min	84.83	95.59	111.13	119.74	129.41	141.24	149.72	157.93	168.48
26 min	90.32	101.79	118.35	127.53	137.84	150.45	159.49	168.23	179.48
28 min	95.70	107.85	125.42	135.15	146.09	159.46	169.04	178.32	190.26
30 min	100.96	113.79	132.34	142.61	154.16	168.28	178.41	188.21	200.82
40 min	125.82	141.84	165.08	177.97	192.44	210.13	222.82	235.11	250.92

Appendix B
RORB Catchment Files

Paralana Creek Catchment RORB File

```
Beverley Mine, Arkaroola
1,                  ALL NATURAL
1,4.079,-99,        sub-area A (reach length 4.079 km)
2,2.803,-99,        sub-area B
2,5.058,-99,        sub-area C
2,3.533,-99,        sub-area D
3,                  store sum at W
1,5.225,-99,        sub-area E
2,7.207,-99,        sub-area F
2,5.722,-99,        sub-area G
3,                  store sum at W
1,7.113,-99,        sub-area H
2,4.905,-99,        sub-area I
2,3.261,-99,        sub-area J
4,                  add stored hydrograph to running hydrograph at W
4,                  add stored hydrograph to running hydrograph at W
5,4.124,-99,        route running hydrograph through next reach storage Q
2,3.589,-99,        sub-area Q
7,
Point K
5,3.140,-99,        route running hydrograph through next reach storage R
2,1.530,-99,        sub-area R
7,
Point R
0
C areas
9.02,9.97,11.86,10.30,18.50,18.63,28.55,34.05,12.16,10.10,32.07,15.30,-99, AREA (SQ.
km)
0,-99,              all pervious
```

Mulga Creek Catchment RORB File

```
Beverley Mine, Arkaroola
1,                        ALL NATURAL
1,1.800,-99,              sub-area L1 (reach length 1.8 km)
2,0.850,-99,              sub-area L2
7,
Point L2
2,0.890,-99,              sub-area L3
7,
Point L3
2,1.907,-99,              sub-area L4
7,
Point L4
2,1.857,-99,              sub-area L5
7,
Point L5
3,                        store sum at M7
1,1.200,-99,              sub-area M1
3,                        store sum at M3
1,1.200,-99,              sub-area M2
4,                        add stored hydrograph to running hydrograph at M3
7,
Point M3
5,0.400,-99,              route running hydrograph through next reach storage M4
2,0.720,-99,              sub-area M4
7,
Point M4
3,                        store sum at M5
1,1.768,-99,              sub-area N0
2,2.663,-99,              sub-area N1
7,
Point N1
2,2.204,-99,              sub-area N2
7,
Point N2
2,1.047,-99,              sub-area N3
7,
Point N3
4,                        add stored hydrograph to running hydrograph at M5
7,
Point M5
5,0.400,-99,              route running hydrograph through next reach storage M6
2,0.357,-99,              sub-area M6
7,
Point M6
4,                        add stored hydrograph to running hydrograph at M7
7,
Point M7
5,0.400,-99,              route running hydrograph through next reach storage M8
2,1.051,-99,              sub-area M8
7,
Point M8
3,                        store sum at P10
1,2.450,-99,              sub-area O0
2,1.310,-99,              sub-area O1
7,
Point O1
2,0.507,-99,              sub-area O2
7,
Point O2
3,                        store sum at P1
1,1.427,-99,              sub-area O3
3,                        store sum at P1
1,0.771,-99,              sub-area O4
4,                        add stored hydrograph to running hydrograph at P1
4,                        add stored hydrograph to running hydrograph at P1
7,
Point P1
5,0.300,-99,              route running hydrograph through next reach storage P2
```

```
2,1.800,-99,            sub-area P2
7,
Point P2
2,1.524,-99,            sub-area P3
7,
Point P3
3,                      store sum at P8
1,1.847,-99,            sub-area P4
3,                      store sum at P6
1,1.152,-99,            sub-area P5
4,                      add stored hydrograph to running hydrograph at P6
7,
Point P6
5,0.373,-99,            route running hydrograph through next reach storage P7
2,1.800,-99,            sub-area P7
7,
Point P7
4,                      add stored hydrograph to running hydrograph at P8
7,
Point P8
5,1.600,-99,            route running hydrograph through next reach storage P9
2,1.760,-99,            sub-area P9
7,
Point P9
4,                      add stored hydrograph to running hydrograph at P10
7,
Point P10
5,0.400,-99,            route running hydrograph through next reach storage P11
2,0.800,-99,            sub-area P11
7,
Point P11
5,0.0001,-99,           route running hydrograph through next reach storage P12
7,
Point P12
5,0.400,-99,            route running hydrograph through next reach storage P13
2,0.777,-99,            sub-area P13
7,
Point P13
5,0.0001,-99,           route running hydrograph through next reach storage P14
7,
Point P14
5,0.100,-99,            route running hydrograph through next reach storage P15
7,
Point P15
0
C areas
3.56,1.91,1.87,1.52,2.50,0.81,0.69,0.62,0.58,1.46,~~2.31~~,2.02,0.76,1.16,5.68,3.85,
0.81,1.78,0.42,1.77,2.62,0.68,1.03,1.03,4.19,1.72,3.41,-99, AREA (SQ. km)
0,-99,          all pervious
```

Appendix C
Summary RORB output files

Paralana Creek 1 in 100 Year ARI RORB Output

RORBWin Batch Run Summary
****

Program version 5.24 (last updated 8th October 2005)

Date run: 19 May 2006 18:19

Catchment file   : J:\Jobs\42656422\RORB\Paralana\paralana_new.cat
Rainfall location: Beverley-Z5 (SA)
Temporal pattern : AR&R87 Volume 2 for zone 5 (unfiltered).
Spatial pattern : Uniform
Areal Red. Fact. : Based on ARR87 Bk II, Figs 1.6 and 1.7
Loss factors   : Constant with ARI

Parameters: kc = 4.79 m = 0.80

Loss parameters	Initial loss (mm)	Cont. loss (mm/h)
	20.00	5.00

Peak	Description
01	Calculated hydrograph, Point K
02	Calculated hydrograph, Point R

Run	Dur	ARI	Rain(mm)	ARF	Peak01	Peak02
1	10m	100y	24.44	0.57	0.0	0.0
2	15m	100y	30.50	0.57	0.0	0.0
3	20m	100y	35.33	0.57	0.0	0.0
4	25m	100y	39.42	0.57	31.6	28.9
5	30m	100y	42.93	0.57	65.5	58.0
6	45m	100y	51.42	0.57	144.0	138.6
7	1h	100y	58.05	0.58	210.5	203.0
8	1.5h	100y	66.44	0.58	282.2	273.4
9	2h	100y	72.83	0.59	359.0	346.5
10	3h	100y	82.63	0.60	355.7	355.0
11	4.5h	100y	93.62	0.63	374.9	379.1
12	6h	100y	102.32	0.66	377.9	384.4
13	9h	100y	116.08	0.72	345.4	359.1
14	12h	100y	126.99	0.77	322.9	337.1
15	18h	100y	139.81	0.82	279.1	301.0
16	24h	100y	149.24	0.86	271.8	288.5
17	30h	100y	156.49	0.87	268.8	280.5
18	36h	100y	162.17	0.89	234.3	229.8
19	48h	100y	170.17	0.91	185.1	181.7
20	72h	100y	177.79	0.95	99.2	110.1

Elapsed Run Time (hh:mm:ss) = 00:00:01

Paralana Creek 1 in 10 Year ARI RORB Output

RORBWin Batch Run Summary
****

Program version 5.24 (last updated 8th October 2005)
Copyright Monash University and Sinclair Knight Merz

Date run: 19 May 2006 18:20

Catchment file   : J:\Jobs\42656422\RORB\Paralana\paralana_new.cat
Rainfall location: Beverley-Z5 (SA)
Temporal pattern : AR&R87 Volume 2 for zone 5 (unfiltered)
Spatial pattern : Uniform
Areal Red. Fact. : Based on ARR87 Bk II, Figs 1.6 and 1.7
Loss factors   : Constant with ARI

Parameters: kc = 4.79 m = 0.80

Loss parameters	Initial loss (mm)	Cont. loss (mm/h)
	12.00	5.00

Peak	Description
01	Calculated hydrograph, Point K
02	Calculated hydrograph, Point R

Run	Dur	ARI	Rain(mm)	ARF	Peak01	Peak02
1	10m	10y	14.01	0.57	0.0	0.0
2	15m	10y	17.45	0.57	0.0	0.0
3	20m	10y	20.19	0.57	0.0	0.0
4	25m	10y	22.51	0.57	5.6	5.4
5	30m	10y	24.49	0.57	16.3	13.9
6	45m	10y	29.27	0.57	48.9	47.0
7	1h	10y	33.00	0.58	69.7	67.1
8	1.5h	10y	37.43	0.58	75.4	72.7
9	2h	10y	40.77	0.59	102.9	99.2
10	3h	10y	45.83	0.60	110.9	107.2
11	4.5h	10y	51.45	0.63	127.1	118.6
12	6h	10y	55.86	0.66	123.3	124.3
13	9h	10y	62.79	0.72	147.1	143.3
14	12h	10y	68.25	0.77	165.7	164.5
15	18h	10y	75.13	0.82	113.1	108.4
16	24h	10y	80.20	0.86	146.9	145.1
17	30h	10y	84.10	0.87	104.4	101.5
18	36h	10y	87.15	0.89	93.5	91.2
19	48h	10y	91.45	0.91	78.0	76.7
20	72h	10y	95.54	0.95	33.9	36.7

Elapsed Run Time (hh:mm:ss) = 00:00:01

Mulga Creek 1 in 100 Year ARI RORB Output

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RORBWin Batch Run Summary
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Program version 5.24 (last updated 8th October 2005)
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Date run: 03 May 2006 14:22

Catchment file    : J:\Jobs\42656422\RORB\Mulga\mulga.cat
Rainfall location: Beverley-Z5 (SA)
Temporal pattern : AR&R87 Volume 2 for zone 5 (unfiltered)
Spatial pattern  : Uniform
Areal Red. Fact. : Based on ARR87 Bk II, Figs 1.6 and 1.7
Loss factors     : Constant with ARI


Parameters:  kc =     1.59    m = 0.80

Loss parameters      Initial loss (mm)   Cont. loss (mm/h)
                           20.00              5.00

Peak  Description
  01  Calculated hydrograph,  Point L2
  02  Calculated hydrograph,  Point L3
  03  Calculated hydrograph,  Point L4
  04  Calculated hydrograph,  Point L5
  05  Calculated hydrograph,  Point M3
  06  Calculated hydrograph,  Point M4
  07  Calculated hydrograph,  Point N1
  08  Calculated hydrograph,  Point N2
  09  Calculated hydrograph,  Point N3
  10  Calculated hydrograph,  Point M5
  11  Calculated hydrograph,  Point M6
  12  Calculated hydrograph,  Point M7
  13  Calculated hydrograph,  Point M8
  14  Calculated hydrograph,  Point O1
  15  Calculated hydrograph,  Point O2
  16  Calculated hydrograph,  Point P1
  17  Calculated hydrograph,  Point P2
  18  Calculated hydrograph,  Point P3
  19  Calculated hydrograph,  Point P6
  20  Calculated hydrograph,  Point P7
  21  Calculated hydrograph,  Point P8
  22  Calculated hydrograph,  Point P9
  23  Calculated hydrograph,  Point P10
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24 Calculated hydrograph, Point P11
25 Calculated hydrograph, Point P12
26 Calculated hydrograph, Point P13
27 Calculated hydrograph, Point P14
28 Calculated hydrograph, Point P15

Run	Dur	ARI	Rain(mm)	ARF	Peak01	Peak02	Peak03	Peak04	Peak05	Peak06	Peak07
1	10m	100y	24.44	0.69	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	15m	100y	30.50	0.69	3.0	3.0	2.0	1.8	1.1	0.8	0.5
3	20m	100y	35.33	0.69	14.2	16.7	12.1	11.2	4.4	4.4	2.9
4	25m	100y	39.42	0.69	22.8	28.6	22.9	21.3	7.3	7.9	5.2
5	30m	100y	42.93	0.69	31.8	37.7	31.8	30.3	9.7	10.4	6.9
6	45m	100y	51.42	0.69	41.2	53.5	52.3	53.8	12.4	15.5	10.5
7	1h	100y	58.05	0.69	46.8	60.4	59.4	65.0	13.6	17.4	12.1
8	1.5h	100y	66.44	0.70	35.3	46.6	49.8	58.7	10.2	13.7	10.1
9	2h	100y	72.83	0.70	38.8	51.1	56.7	67.3	10.9	14.9	11.7
10	3h	100y	82.63	0.71	39.4	49.6	54.0	60.8	11.5	14.0	10.7
11	4.5h	100y	93.62	0.74	32.3	43.6	47.5	53.8	8.8	12.8	9.9
12	6h	100y	102.32	0.77	29.0	37.5	42.4	53.1	8.3	10.7	8.9
13	9h	100y	116.08	0.82	26.2	35.3	39.5	45.0	7.1	10.3	8.4
14	12h	100y	126.99	0.86	25.3	34.1	38.2	43.4	6.9	9.9	8.1
15	18h	100y	139.81	0.89	15.5	20.6	23.0	27.5	4.3	5.9	5.1
16	24h	100y	149.24	0.91	16.6	22.0	24.9	29.9	4.6	6.4	5.5
17	30h	100y	156.49	0.92	11.2	15.3	19.0	24.2	3.0	4.4	4.3
18	36h	100y	162.17	0.93	9.5	12.9	16.2	20.8	2.6	3.8	3.6
19	48h	100y	170.17	0.95	7.0	9.6	12.3	15.9	1.9	2.8	2.8
20	72h	100y	177.79	0.98	4.8	6.3	7.0	8.5	1.3	1.8	1.6

Run	Dur	ARI	Rain(mm)	ARF	Peak08	Peak09	Peak10	Peak11	Peak12	Peak13	Peak14
1	10m	100y	24.44	0.69	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	15m	100y	30.50	0.69	1.2	2.4	3.2	2.3	4.0	3.6	4.3
3	20m	100y	35.33	0.69	6.2	10.6	15.0	13.5	24.0	22.2	20.9
4	25m	100y	39.42	0.69	10.9	17.6	25.4	25.2	45.0	42.1	34.8
5	30m	100y	42.93	0.69	14.3	24.2	34.3	35.0	64.3	58.9	47.2
6	45m	100y	51.42	0.69	21.6	33.8	49.2	51.8	104.7	102.1	65.2
7	1h	100y	58.05	0.69	24.9	38.1	55.4	59.3	120.6	121.5	73.7
8	1.5h	100y	66.44	0.70	20.9	30.8	44.2	48.0	104.5	108.2	57.3
9	2h	100y	72.83	0.70	24.2	35.7	50.3	54.5	120.5	124.5	63.3
10	3h	100y	82.63	0.71	22.1	33.0	46.9	51.4	112.2	114.2	61.9
11	4.5h	100y	93.62	0.74	20.5	30.6	43.4	47.3	98.9	102.6	54.2
12	6h	100y	102.32	0.77	18.6	26.6	37.3	40.9	94.0	101.7	47.3
13	9h	100y	116.08	0.82	17.5	25.9	36.2	39.5	84.5	82.2	44.4
14	12h	100y	126.99	0.86	16.9	25.0	34.9	38.1	81.5	79.4	42.8
15	18h	100y	139.81	0.89	10.7	15.9	21.9	23.4	50.9	50.4	26.2
16	24h	100y	149.24	0.91	11.6	17.2	23.6	25.3	55.2	55.1	28.1

17	30h	100y	156.49	0.92	9.0	13.1	17.6	19.3	43.6	46.3	19.8
18	36h	100y	162.17	0.93	7.7	11.2	14.9	16.5	37.3	39.9	16.7
19	48h	100y	170.17	0.95	5.8	8.4	11.2	12.5	28.4	30.7	12.5
20	72h	100y	177.79	0.98	3.3	5.0	6.8	7.2	15.7	15.6	8.1

Run	Dur	ARI	Rain(mm)	ARF	Peak15	Peak16	Peak17	Peak18	Peak19	Peak20	Peak21
1	10m	100y	24.44	0.69	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	15m	100y	30.50	0.69	3.7	5.0	3.2	2.9	1.2	0.6	3.4
3	20m	100y	35.33	0.69	20.9	27.5	19.6	17.6	4.6	3.8	20.6
4	25m	100y	39.42	0.69	37.0	46.9	36.2	32.8	7.7	7.1	38.9
5	30m	100y	42.93	0.69	48.0	61.5	51.0	46.9	10.3	10.1	54.7
6	45m	100y	51.42	0.69	70.0	87.1	82.4	82.4	13.2	15.9	96.6
7	1h	100y	58.05	0.69	78.5	98.2	95.2	99.2	14.5	18.1	116.1
8	1.5h	100y	66.44	0.70	61.6	76.0	79.4	88.7	11.0	14.9	103.2
9	2h	100y	72.83	0.70	68.6	83.9	90.2	101.4	11.9	17.1	118.2
10	3h	100y	82.63	0.71	64.2	81.3	87.1	91.7	12.4	16.1	107.8
11	4.5h	100y	93.62	0.74	59.3	72.2	74.7	82.1	9.8	14.5	94.7
12	6h	100y	102.32	0.77	49.7	62.0	69.2	80.3	9.1	12.7	92.9
13	9h	100y	116.08	0.82	48.7	59.1	62.5	66.6	8.0	12.1	78.7
14	12h	100y	126.99	0.86	47.0	57.1	60.4	64.3	7.7	11.7	76.0
15	18h	100y	139.81	0.89	28.2	34.6	36.3	40.6	4.8	7.1	47.7
16	24h	100y	149.24	0.91	30.4	37.1	39.5	44.3	5.1	7.7	52.0
17	30h	100y	156.49	0.92	21.7	26.1	30.8	36.3	3.5	5.8	42.1
18	36h	100y	162.17	0.93	18.4	22.1	26.4	31.1	2.9	5.0	36.1
19	48h	100y	170.17	0.95	13.8	16.5	20.1	23.8	2.2	3.8	27.6
20	72h	100y	177.79	0.98	8.6	10.6	11.0	12.5	1.5	2.2	14.7

Run	Dur	ARI	Rain(mm)	ARF	Peak22	Peak23	Peak24	Peak25	Peak26	Peak27	Peak28
1	10m	100y	24.44	0.69	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	15m	100y	30.50	0.69	3.0	5.9	5.8	5.8	5.7	5.7	5.7
3	20m	100y	35.33	0.69	17.3	36.3	35.9	35.9	35.4	35.4	35.4
4	25m	100y	39.42	0.69	32.9	69.0	68.3	68.3	67.5	67.5	67.6
5	30m	100y	42.93	0.69	46.8	98.4	97.4	97.4	96.5	96.5	96.3
6	45m	100y	51.42	0.69	84.0	177.0	175.4	175.4	174.3	174.3	174.1
7	1h	100y	58.05	0.69	110.9	226.1	227.6	227.6	228.5	228.5	229.1
8	1.5h	100y	66.44	0.70	105.7	212.1	213.6	213.6	219.0	219.0	218.7
9	2h	100y	72.83	0.70	127.6	249.0	254.7	254.7	264.4	264.5	264.8
10	3h	100y	82.63	0.71	115.2	223.1	230.3	230.3	239.4	239.4	239.1
11	4.5h	100y	93.62	0.74	99.6	202.2	203.5	203.5	209.7	209.7	210.1
12	6h	100y	102.32	0.77	102.2	203.8	207.2	207.2	211.8	211.8	211.5
13	9h	100y	116.08	0.82	85.0	161.3	171.8	171.8	181.8	181.8	181.8
14	12h	100y	126.99	0.86	76.3	150.0	155.3	155.3	164.5	164.5	164.7
15	18h	100y	139.81	0.89	56.7	106.6	113.5	113.5	121.9	121.9	122.2
16	24h	100y	149.24	0.91	54.5	109.5	108.0	108.0	111.2	111.2	110.6
17	30h	100y	156.49	0.92	50.0	96.4	99.5	99.5	105.3	105.3	105.4

18	36h	100y	162.17	0.93	43.1	83.1	86.0	86.0	91.1	91.1	91.1
19	48h	100y	170.17	0.95	33.3	63.9	66.5	66.5	70.4	70.4	70.5
20	72h	100y	177.79	0.98	16.1	31.7	31.6	31.6	33.2	33.2	33.0

Elapsed Run Time (hh:mm:ss) = 00:00:01

Mulga Creek 1 in 10 Year ARI RORB Output

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RORBWin Batch Run Summary
*************************

Program version 5.24 (last updated 8th October 2005)
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Date run: 03 May 2006 14:21

Catchment file    : J:\Jobs\42656422\RORB\Mulga\mulga.cat
Rainfall location: Beverley-Z5 (SA)
Temporal pattern : AR&R87 Volume 2 for zone 5 (unfiltered)
Spatial pattern  : Uniform
Areal Red. Fact. : Based on ARR87 Bk II, Figs 1.6 and 1.7
Loss factors     : Constant with ARI


Parameters:  kc =     1.59    m = 0.80

Loss parameters     Initial loss (mm)   Cont. loss (mm/h)
                          12.00              5.00

Peak  Description
  01  Calculated hydrograph,  Point L2
  02  Calculated hydrograph,  Point L3
  03  Calculated hydrograph,  Point L4
  04  Calculated hydrograph,  Point L5
  05  Calculated hydrograph,  Point M3
  06  Calculated hydrograph,  Point M4
  07  Calculated hydrograph,  Point N1
  08  Calculated hydrograph,  Point N2
  09  Calculated hydrograph,  Point N3
  10  Calculated hydrograph,  Point M5
  11  Calculated hydrograph,  Point M6
  12  Calculated hydrograph,  Point M7
  13  Calculated hydrograph,  Point M8
  14  Calculated hydrograph,  Point O1
  15  Calculated hydrograph,  Point O2
  16  Calculated hydrograph,  Point P1
  17  Calculated hydrograph,  Point P2
  18  Calculated hydrograph,  Point P3
  19  Calculated hydrograph,  Point P6
  20  Calculated hydrograph,  Point P7
  21  Calculated hydrograph,  Point P8
  22  Calculated hydrograph,  Point P9
  23  Calculated hydrograph,  Point P10
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24 Calculated hydrograph, Point P11
25 Calculated hydrograph, Point P12
26 Calculated hydrograph, Point P13
27 Calculated hydrograph, Point P14
28 Calculated hydrograph, Point P15

Run	Dur	ARI	Rain(mm)	ARF	Peak01	Peak02	Peak03	Peak04	Peak05	Peak06	Peak07
1	10m	10y	14.01	0.69	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	15m	10y	17.45	0.69	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	20m	10y	20.19	0.69	3.7	4.1	2.9	2.6	1.2	1.0	0.7
4	25m	10y	22.51	0.69	7.5	9.0	7.0	6.4	2.4	2.4	1.6
5	30m	10y	24.49	0.69	11.7	13.5	10.8	10.0	3.7	3.6	2.4
6	45m	10y	29.27	0.69	18.0	22.8	20.5	20.2	5.5	6.4	4.2
7	1h	10y	33.00	0.69	21.9	27.6	25.9	26.8	6.4	7.8	5.3
8	1.5h	10y	37.43	0.70	18.2	22.8	22.9	24.9	5.4	6.7	4.6
9	2h	10y	40.77	0.70	19.6	25.0	25.8	29.1	5.7	7.4	5.2
10	3h	10y	45.83	0.71	22.1	27.7	27.4	30.1	6.5	7.8	5.4
11	4.5h	10y	51.45	0.74	19.5	24.2	27.2	29.4	5.8	7.0	5.5
12	6h	10y	55.86	0.77	16.7	21.6	21.1	26.5	4.8	6.2	4.7
13	9h	10y	62.79	0.82	16.8	22.9	26.0	29.4	4.5	6.7	5.4
14	12h	10y	68.25	0.86	17.9	24.4	27.9	31.5	4.8	7.2	5.8
15	18h	10y	75.13	0.89	8.3	11.2	12.9	15.4	2.3	3.2	2.8
16	24h	10y	80.20	0.91	9.6	12.9	15.1	18.2	2.6	3.8	3.3
17	30h	10y	84.10	0.92	4.4	6.1	7.9	10.3	1.2	1.8	1.8
18	36h	10y	87.15	0.93	4.1	5.3	6.8	8.9	1.2	1.5	1.5
19	48h	10y	91.45	0.95	3.7	4.8	5.2	6.9	1.1	1.4	1.1
20	72h	10y	95.54	0.98	1.8	2.3	2.5	3.0	0.5	0.7	0.6

Run	Dur	ARI	Rain(mm)	ARF	Peak08	Peak09	Peak10	Peak11	Peak12	Peak13	Peak14
1	10m	10y	14.01	0.69	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	15m	10y	17.45	0.69	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	20m	10y	20.19	0.69	1.5	2.7	3.8	3.2	5.6	5.2	5.3
4	25m	10y	22.51	0.69	3.4	5.6	8.0	7.7	13.7	12.7	11.0
5	30m	10y	24.49	0.69	5.0	8.8	12.3	12.0	21.2	19.7	17.1
6	45m	10y	29.27	0.69	8.8	14.1	20.5	21.3	40.8	38.5	27.8
7	1h	10y	33.00	0.69	10.9	17.2	25.0	26.5	51.3	50.8	33.7
8	1.5h	10y	37.43	0.70	9.4	14.4	21.1	22.7	45.8	46.5	27.8
9	2h	10y	40.77	0.70	10.7	16.0	23.3	25.2	52.9	54.0	30.5
10	3h	10y	45.83	0.71	11.4	18.2	26.0	25.7	55.7	57.4	34.5
11	4.5h	10y	51.45	0.74	11.3	16.5	23.5	26.5	55.9	54.3	30.2
12	6h	10y	55.86	0.77	9.9	15.2	21.4	22.1	46.1	51.6	27.2
13	9h	10y	62.79	0.82	11.3	16.7	23.4	25.7	55.1	54.0	28.6
14	12h	10y	68.25	0.86	12.1	17.8	25.0	27.5	59.1	58.0	30.6
15	18h	10y	75.13	0.89	5.9	8.7	12.0	12.9	28.4	28.6	14.2
16	24h	10y	80.20	0.91	6.9	10.2	13.9	15.1	33.4	33.8	16.5

17	30h	10y	84.10	0.92	3.7	5.3	7.1	8.0	18.2	19.9	7.9
18	36h	10y	87.15	0.93	3.2	4.6	6.0	6.8	15.7	17.4	6.8
19	48h	10y	91.45	0.95	2.4	3.6	5.0	5.1	12.0	13.6	6.1
20	72h	10y	95.54	0.98	1.2	1.8	2.5	2.6	5.7	5.6	3.0

Run	Dur	ARI	Rain(mm)	ARF	Peak15	Peak16	Peak17	Peak18	Peak19	Peak20	Peak21
1	10m	10y	14.01	0.69	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	15m	10y	17.45	0.69	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	20m	10y	20.19	0.69	4.9	6.7	4.6	4.1	1.2	0.9	4.8
4	25m	10y	22.51	0.69	11.6	14.8	11.1	10.0	2.5	2.1	11.8
5	30m	10y	24.49	0.69	17.1	22.0	17.1	15.4	3.9	3.3	18.2
6	45m	10y	29.27	0.69	29.4	37.1	32.2	30.6	5.8	6.3	36.4
7	1h	10y	33.00	0.69	35.5	44.9	41.4	41.2	6.8	7.9	48.1
8	1.5h	10y	37.43	0.70	30.0	37.1	36.2	38.1	5.7	6.9	44.3
9	2h	10y	40.77	0.70	32.9	40.7	41.2	44.3	6.1	7.8	51.7
10	3h	10y	45.83	0.71	35.7	45.4	44.5	45.6	7.0	8.0	53.6
11	4.5h	10y	51.45	0.74	32.6	39.5	43.3	43.9	6.2	8.2	52.0
12	6h	10y	55.86	0.77	28.7	35.8	34.7	40.4	5.2	6.7	46.6
13	9h	10y	62.79	0.82	31.7	38.3	41.3	43.6	5.1	7.9	51.5
14	12h	10y	68.25	0.86	33.8	40.9	44.2	46.8	5.4	8.5	55.3
15	18h	10y	75.13	0.89	15.5	18.8	20.5	23.0	2.6	3.9	26.9
16	24h	10y	80.20	0.91	18.0	21.8	24.1	27.1	3.0	4.6	31.7
17	30h	10y	84.10	0.92	8.7	10.4	13.0	15.4	1.4	2.4	17.8
18	36h	10y	87.15	0.93	7.4	8.8	11.2	13.4	1.3	2.1	15.5
19	48h	10y	91.45	0.95	6.4	8.0	8.6	10.4	1.2	1.6	12.0
20	72h	10y	95.54	0.98	3.2	3.9	4.0	4.5	0.6	0.8	5.3

Run	Dur	ARI	Rain(mm)	ARF	Peak22	Peak23	Peak24	Peak25	Peak26	Peak27	Peak28
1	10m	10y	14.01	0.69	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	15m	10y	17.45	0.69	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	20m	10y	20.19	0.69	4.0	8.4	8.3	8.3	8.2	8.2	8.2
4	25m	10y	22.51	0.69	9.9	20.8	20.5	20.5	20.4	20.4	20.4
5	30m	10y	24.49	0.69	15.4	32.2	31.9	31.9	31.6	31.6	31.6
6	45m	10y	29.27	0.69	31.0	65.3	64.6	64.6	63.9	63.9	63.8
7	1h	10y	33.00	0.69	42.6	89.5	88.5	88.5	87.7	87.7	87.7
8	1.5h	10y	37.43	0.70	42.4	87.1	86.7	86.7	86.9	86.9	86.9
9	2h	10y	40.77	0.70	51.2	103.1	103.9	103.9	105.6	105.6	105.6
10	3h	10y	45.83	0.71	51.9	101.8	105.9	105.9	108.8	108.8	108.7
11	4.5h	10y	51.45	0.74	51.3	104.2	106.3	106.3	106.7	106.7	106.6
12	6h	10y	55.86	0.77	51.1	102.7	105.2	105.2	106.7	106.7	106.6
13	9h	10y	62.79	0.82	47.9	101.1	98.2	98.2	103.9	103.9	104.0
14	12h	10y	68.25	0.86	50.8	108.8	103.8	103.8	104.8	104.8	105.1
15	18h	10y	75.13	0.89	28.0	56.5	55.8	55.8	57.1	57.1	56.9
16	24h	10y	80.20	0.91	33.3	67.1	66.6	66.6	68.3	68.3	68.0
17	30h	10y	84.10	0.92	21.6	41.4	43.2	43.2	45.7	45.7	45.8

18	36h	10y	87.15	0.93	18.9	36.3	38.0	38.0	40.3	40.3	40.4
19	48h	10y	91.45	0.95	14.9	28.5	30.2	30.2	32.1	32.1	32.2
20	72h	10y	95.54	0.98	5.7	11.2	11.1	11.1	11.6	11.6	11.5

Elapsed Run Time (hh:mm:ss) = 00:00:01

Appendix D
Summary HEC-RAS output tables

1 in 100 Year ARI HEC-RAS Output

HEC-RAS Plan: Plan 02 Profile: 100Y

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
D4	O4-P1	0	100Y	0.03	105.92	106.00	105.99	106.02	0.035358	0.45	0.07	1.49	0.69
D4	O4-P1	-200	100Y	0.03	102.11	102.15	102.15	102.16	0.034422	0.28	0.11	5.04	0.62
D4	O4-P1	-400	100Y	0.03	95.20	95.26	95.24	95.26	0.007127	0.16	0.19	6.27	0.30
D4	O4-P1	-600	100Y	0.03	93.64	93.66	93.66	93.66	0.004315	0.07	0.42	32.94	0.20
D4	O4-P1	-800	100Y	0.03	88.45	88.69	88.47	88.69	0.000000	0.00	10.56	72.65	0.00
D3	O3-P1	0	100Y	6.35	96.98	97.23	97.14	97.25	0.007534	0.54	11.85	69.05	0.41
D3	O3-P1	-200	100Y	6.35	95.64	95.79		95.80	0.012623	0.43	14.87	179.61	0.47
D3	O3-P1	-400	100Y	6.35	93.01	93.19		93.20	0.014420	0.56	11.39	101.86	0.53
D3	O3-P1	-600	100Y	6.35	89.75	90.00		90.02	0.009249	0.56	11.28	71.29	0.45
D3	O3-P1	-800	100Y	6.35	87.86	88.17		88.18	0.005346	0.54	11.76	52.40	0.36
D3	O3-P1	-1200	100Y	6.35	86.91	87.35		87.35	0.000341	0.16	39.57	138.04	0.10
C1	P4-P6	0	100Y	12.70	98.97	99.35	99.21	99.38	0.006683	0.66	19.18	74.45	0.42
C1	P4-P6	-600	100Y	12.70	94.87	95.19		95.24	0.023285	1.01	12.53	65.52	0.74
C1	P4-P6	-1200	100Y	12.70	80.02	80.31	80.20	80.32	0.006988	0.52	24.26	138.49	0.40
C1	P4-P6	-1500	100Y	12.70	77.88	78.11	78.06	78.14	0.019647	0.82	15.55	98.93	0.66
B2	M1-M3	-800	100Y	13.10	80.95	81.22	81.15	81.25	0.015355	0.74	17.59	106.72	0.59
B2	M1-M3	-1200	100Y	13.10	74.86	75.18		75.21	0.009306	0.73	18.07	78.41	0.48
B2	M1-M3	-1600	100Y	13.10	71.20	71.44	71.44	71.50	0.046168	1.10	11.89	91.58	0.98
B2	M3-M4	-2000.44	100Y	16.50	66.12	66.63	66.45	66.66	0.006274	0.76	21.66	64.95	0.42
B2	M3-M4	-2400	100Y	16.50	63.77	64.03		64.04	0.004479	0.43	38.21	208.58	0.32
B2	M3-M4	-2800	100Y	16.50	61.28	62.22		62.23	0.000223	0.19	85.86	166.17	0.09
B1	P5-P6	0	100Y	6.35	98.00	98.26	98.20	98.29	0.012798	0.77	8.24	41.49	0.55
B1	P5-P6	-600	100Y	6.35	90.51	90.75		90.78	0.018314	0.72	8.85	64.86	0.62
B1	P5-P6	-1200	100Y	6.35	79.01	79.38	79.27	79.40	0.006806	0.56	11.40	58.09	0.40
B1	P5-P6	-1500	100Y	6.35	77.11	77.33	77.26	77.35	0.013522	0.67	9.50	61.68	0.54
B1	P6-P7	-1752.23	100Y	12.70	73.95	74.32		74.34	0.008785	0.67	18.87	87.77	0.46
B1	P6-P7	-2125.59	100Y	17.10	70.90	71.24		71.26	0.011239	0.70	24.52	129.97	0.51
B1	P6-P7	-2425.50	100Y	17.10	67.46	68.19		68.20	0.000498	0.28	61.78	126.51	0.13
A3	L1-L2	0	100Y	45.60	106.22	106.77	106.67	106.84	0.014551	1.17	38.98	115.47	0.64
A3	L1-L2	-300	100Y	45.60	101.43	102.25		102.34	0.012584	1.32	34.46	76.05	0.63
A3	L1-L2	-600	100Y	45.60	97.59	98.75		98.78	0.002518	0.77	59.04	87.40	0.30
A3	L1-L2	-900	100Y	45.60	97.08	97.75		97.80	0.009148	1.02	44.56	113.88	0.52
A3	L1-L2	-1200	100Y	45.60	94.11	94.95		95.03	0.009822	1.24	36.89	74.89	0.56
A3	L1-L2	-1500	100Y	45.60	91.20	91.99		92.08	0.010002	1.27	35.99	71.35	0.57
A3	L1-L2	-1800	100Y	45.60	88.37	89.05		89.09	0.005093	0.85	53.35	115.10	0.40
A3	L1-L2	-2100.00	100Y	45.60	86.72	87.49		87.53	0.005346	0.94	48.76	95.34	0.42
A3	L1-L2	-2249.44	100Y	45.60	86.00	86.62		86.67	0.008938	1.05	43.48	105.23	0.52
A3	L1-L2	-2649.45	100Y	58.00	82.41	83.22		83.25	0.003800	0.81	71.39	133.44	0.35
A3	L1-L2	-3049.45	100Y	58.00	80.93	81.44		81.49	0.016541	1.00	58.20	241.31	0.65
A3	L1-L2	-3284.00	100Y	58.00	76.57	78.07		78.08	0.000497	0.43	135.01	142.64	0.14
A3	L1-L2	-3538.42	100Y	57.10	76.98	77.67		77.72	0.007605	1.02	56.03	125.43	0.49
A3	L1-L2	-3938.43	100Y	57.10	73.96	74.59		74.65	0.009558	1.09	52.30	125.37	0.54
A3	L1-L2	-4245.56	100Y	57.10	70.90	72.04		72.05	0.000822	0.48	119.61	157.43	0.17
A3	L1-L2	-4645.47	100Y	57.10	70.69	71.46		71.49	0.005202	0.70	81.27	239.04	0.38
A3	L1-L2	-5045.47	100Y	57.10	68.72	69.33		69.38	0.008489	1.00	57.37	144.51	0.50
A3	L1-L2	-5445.47	100Y	64.90	65.09	66.03		66.07	0.004698	0.95	68.25	118.12	0.40
A3	L1-L2	-5845.47	100Y	64.90	63.29	64.21		64.24	0.003404	0.81	80.28	139.19	0.34
A3	L1-L2	-6245.47	100Y	64.90	62.05	62.84		62.85	0.001194	0.45	145.52	280.71	0.20
A3	L1-L2	-6645.47	100Y	64.90	61.30	62.14		62.18	0.004647	0.85	76.49	155.79	0.39
A3	L1-L2	-7045.47	100Y	64.90	60.18	61.06		61.06	0.000296	0.23	283.64	523.16	0.10
A2	N1-N2	0	100Y	11.50	110.07	110.47	110.34	110.50	0.006857	0.65	17.62	71.22	0.42
A2	N1-N2	-300	100Y	11.50	108.00	108.40		108.43	0.011847	0.76	15.16	73.74	0.53
A2	N1-N2	-600	100Y	11.50	104.21	104.69		104.74	0.013055	0.93	12.38	47.72	0.58
A2	N1-N2	-900	100Y	11.50	100.57	101.08		101.10	0.003425	0.52	22.24	75.73	0.30
A2	N1-N2	-1200	100Y	11.50	99.63	99.93		99.96	0.016512	0.80	14.39	83.02	0.61
A2	N1-N2	-1500	100Y	11.50	94.10	94.54		94.58	0.010142	0.91	12.61	41.39	0.53
A2	N1-N2	-1800	100Y	11.50	91.01	91.49		91.53	0.010599	0.86	13.39	49.74	0.53
A2	N1-N2	-2100	100Y	11.50	87.95	88.33		88.35	0.007327	0.65	17.73	76.05	0.43
A2	N1-N2	-2362.53	100Y	11.50	85.67	86.09		86.13	0.012307	0.86	13.31	54.74	0.56
A2	N1-N2	-2662.53	100Y	23.70	82.37	82.96		83.01	0.010273	0.97	24.39	73.46	0.54
A2	N1-N2	-2962.53	100Y	23.70	79.51	79.89		79.92	0.006298	0.70	34.05	117.25	0.41
A2	N1-N2	-3230.85	100Y	23.70	77.76	78.23		78.26	0.006837	0.75	31.70	104.30	0.43
A2	N1-N2	-4066.38	100Y	23.70	72.08	72.54		72.57	0.005998	0.68	34.81	119.44	0.40
A2	N1-N2	-4866.00	100Y	36.30	67.20	67.70		67.74	0.011573	0.90	40.54	150.96	0.55
A2	N1-N2	-5666.38	100Y	36.30	62.19	62.90		62.93	0.005508	0.78	46.54	122.20	0.40
A2	M5-M6	-5913.38	100Y	52.80	61.17	61.95		61.96	0.001588	0.45	116.82	273.52	0.22
A2	M5-M6	-6313.17	100Y	56.90	60.39	61.45		61.45	0.000727	0.40	143.34	226.96	0.16
A2	M7-M8	-6670.48	100Y	116.90	59.63	60.48		60.55	0.007553	1.11	105.53	207.43	0.50
A2	M7-M8	-7070.48	100Y	120.60	56.64	57.86		57.88	0.001506	0.69	173.63	205.13	0.24
A2	M7-M8	-7470.48	100Y	120.60	56.00	57.43		57.44	0.000512	0.41	292.62	336.42	0.14
A1	O1-O2	0	100Y	70.80	94.53	95.27	95.12	95.35	0.012677	1.31	54.04	121.74	0.63
A1	O1-O2	-200	100Y	70.80	92.00	92.92		92.96	0.004575	0.97	73.33	121.58	0.40
A1	O1-O2	-400	100Y	70.80	91.13	91.99		92.04	0.004781	0.97	72.72	123.07	0.40
A1	O1-O2	-600	100Y	70.80	90.14	91.13		91.16	0.003041	0.85	83.06	122.22	0.33
A1	O1-O2	-800	100Y	70.80	89.54	90.33		90.40	0.008886	1.15	61.46	128.68	0.53
A1	O1-O2	-1109.56	100Y	70.80	86.65	87.69		87.74	0.004938	1.06	67.11	103.14	0.42
A1	O1-O2	-1309.56	100Y	74.70	85.73	86.58		86.66	0.008992	1.29	57.92	103.28	0.55
A1	O1-O2	-1509.56	100Y	74.70	83.92	85.36		85.37	0.000802	0.54	137.76	147.02	0.18
A1	P1-P2	-1816.7	100Y	94.20	83.99	84.59		84.66	0.011430	1.20	78.74	188.17	0.59
A1	P1-P2	-2716.7	100Y	94.20	78.42	79.41		79.48	0.005968	1.15	81.98	127.78	0.46
A1	P1-P2	-3016.7	100Y	94.20	76.68	78.80		78.81	0.000142	0.28	336.37	264.31	0.08
A1	P1-P2	-3316.7	100Y	94.20	77.36	78.71		78.72	0.000619	0.42	226.40	296.16	0.15
A1	P1-P2	-3616.7	100Y	94.20	77.36	78.16		78.23	0.014997	1.17	80.22	241.63	0.65
A1	P1-P2	-3916.7	100Y	98.00	72.48	73.76		73.79	0.003172	0.75	130.94	241.72	0.32
A1	P1-P2	-4516.7	100Y	98.00	70.64	71.57		71.65	0.011214	1.22	80.63	185.45	0.59
A1	P1-P2	-4816.7	100Y	98.00	67.54	68.95	68.27	68.97	0.001680	0.74	132.11	153.42	0.26
A1	P8-P9	-5440.56	100Y	113.80	65.88	67.13		67.17	0.005341	0.96	118.42	222.12	0.42
A1	P8-P9	-5840.56	100Y	113.80	63.71	65.21		65.23	0.002216	0.65	174.77	303.81	0.27
A1	P8-P9	-6240.56	100Y	113.80	63.25	64.25		64.28	0.003378	0.82	139.06	235.43	0.34
A1	P8-P9	-6640.56	100Y	113.80	61.85	62.94		62.97	0.002824	0.76	149.84	248.05	0.31
A1	P8-P9	-7040.56	100Y	121.70	60.50	61.52		61.57	0.004599	0.92	132.01	235.55	0.39
A1	P8-P9	-7440.56	100Y	121.70	58.38	59.89		59.90	0.001154	0.53	228.37	328.64	0.20
A1	P8-P9	-7840.56	100Y	121.70	58.01	58.93		58.96	0.002346	0.74	164.45	246.23	0.29
A1	P8-P9	-8240.56	100Y	121.70	56.09	57.60		57.65	0.002261	0.95	127.84	127.60	0.30

HEC-RAS Plan: Plan 02 Profile: 100Y (Continued)

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
A1	P10-P11	-8800.92	100Y	239.40	55.42	56.89		56.91	0.001039	0.54	441.09	570.77	0.20
A1	P10-P11	-9200.92	100Y	243.60	55.00	56.25		56.29	0.003071	0.79	307.21	507.65	0.33
A1	P10-P11	-9600.92	100Y	243.60	53.18	55.76		55.76	0.000146	0.29	842.32	643.41	0.08
A1	P10-P11	-10014.7	100Y	500.50	53.14	55.66		55.68	0.000960	0.66	752.95	677.91	0.20
A1	P10-P11	-10414.7	100Y	510.30	52.88	55.31		55.33	0.000677	0.64	792.07	575.11	0.18
A1	P10-P11	-10814.7	100Y	510.30	52.43	54.75		54.81	0.002575	1.08	471.99	429.18	0.33
A1	P10-P11	-11191.7	100Y	510.60	50.49	53.86		53.90	0.001647	0.88	577.78	508.39	0.26
A1	P10-P11	-11291.7	100Y	510.60	51.97	53.61	53.09	53.67	0.004007	1.08	471.89	597.19	0.39

1 in 10 Year ARI HEC-RAS Output

HEC-RAS Plan: Plan 02 Profile: 10Y

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
D4	O4-P1	0	10Y	0.01	105.92	105.98	105.96	105.98	0.028141	0.32	0.03	1.03	0.58
D4	O4-P1	-200	10Y	0.01	102.11	102.14		102.14	0.027018	0.20	0.05	3.49	0.52
D4	O4-P1	-400	10Y	0.01	95.20	95.24	95.23	95.24	0.009952	0.14	0.07	3.90	0.33
D4	O4-P1	-600	10Y	0.01	93.64	93.65	93.66	93.65	0.002485	0.04	0.24	28.39	0.14
D4	O4-P1	-800	10Y	0.01	88.45	88.60	88.47	88.60	0.000000	0.00	4.52	52.67	0.00
D3	O3-P1	0	10Y	3.35	96.98	97.17	97.09	97.18	0.007450	0.43	7.73	61.45	0.39
D3	O3-P1	-200	10Y	3.35	95.64	95.76		95.77	0.010730	0.33	10.22	162.49	0.42
D3	O3-P1	-400	10Y	3.35	93.01	93.15		93.16	0.014388	0.46	7.30	87.11	0.51
D3	O3-P1	-600	10Y	3.35	89.75	89.94		89.95	0.010082	0.47	7.11	62.49	0.45
D3	O3-P1	-800	10Y	3.35	87.86	88.08		88.09	0.005131	0.44	7.64	45.10	0.34
D3	O3-P1	-1200	10Y	3.35	86.91	87.22		87.22	0.000487	0.15	22.48	114.49	0.11
C1	P4-P6	0	10Y	6.70	98.97	99.25	99.15	99.27	0.006724	0.55	12.18	62.68	0.40
C1	P4-P6	-600	10Y	6.70	94.87	95.11		95.15	0.025523	0.87	7.69	53.99	0.74
C1	P4-P6	-1200	10Y	6.70	80.02	80.24	80.17	80.25	0.007079	0.43	15.57	120.45	0.38
C1	P4-P6	-1500	10Y	6.70	77.88	78.04	78.01	78.07	0.022234	0.70	9.61	85.03	0.66
B2	M1-M3	-800	10Y	6.30	80.95	81.14	81.10	81.16	0.015098	0.62	10.22	81.38	0.56
B2	M1-M3	-1200	10Y	6.30	74.86	75.09		75.10	0.009586	0.58	10.85	67.20	0.46
B2	M1-M3	-1600	10Y	6.30	71.20	71.38	71.37	71.42	0.045823	0.90	6.98	72.10	0.93
B2	M3-M4	-2000.44	10Y	7.30	66.12	66.47	66.33	66.49	0.006141	0.60	12.23	52.07	0.39
B2	M3-M4	-2400	10Y	7.30	63.77	63.94		63.95	0.005088	0.34	21.28	180.49	0.32
B2	M3-M4	-2800	10Y	7.30	61.28	61.99		61.99	0.000173	0.14	50.99	126.88	0.07
B1	P5-P6	0	10Y	3.35	98.00	98.19	98.14	98.21	0.013046	0.63	5.32	36.70	0.53
B1	P5-P6	-600	10Y	3.35	90.51	90.69		90.71	0.018496	0.62	5.42	49.99	0.60
B1	P5-P6	-1200	10Y	3.35	79.01	79.31	79.20	79.32	0.006295	0.46	7.35	47.74	0.37
B1	P5-P6	-1500	10Y	3.35	77.11	77.26	77.21	77.28	0.016384	0.59	5.70	51.86	0.57
B1	P6-P7	-1752.23	10Y	6.70	73.95	74.24		74.25	0.008203	0.54	12.35	75.38	0.43
B1	P6-P7	-2125.59	10Y	8.30	70.90	71.14		71.16	0.011749	0.59	13.97	97.29	0.50
B1	P6-P7	-2425.50	10Y	8.30	67.46	67.94		67.94	0.000783	0.26	32.24	103.30	0.15
A3	L1-L2	0	10Y	21.20	106.22	106.61	106.53	106.66	0.015424	0.94	22.52	96.47	0.62
A3	L1-L2	-300	10Y	21.20	101.43	102.04		102.10	0.012678	1.07	19.77	60.15	0.60
A3	L1-L2	-600	10Y	21.20	97.59	98.45		98.46	0.002205	0.60	35.44	69.69	0.27
A3	L1-L2	-900	10Y	21.20	97.08	97.57		97.60	0.009444	0.82	25.77	93.58	0.50
A3	L1-L2	-1200	10Y	21.20	94.11	94.73		94.78	0.009733	0.99	21.52	61.00	0.53
A3	L1-L2	-1500	10Y	21.20	91.20	91.77		91.82	0.009883	1.00	21.30	60.12	0.53
A3	L1-L2	-1800	10Y	21.20	88.37	88.84		88.86	0.005186	0.68	31.16	95.96	0.38
A3	L1-L2	-2100.00	10Y	21.20	86.72	87.26		87.29	0.005209	0.73	29.15	81.51	0.39
A3	L1-L2	-2249.44	10Y	21.20	86.00	86.43		86.46	0.008930	0.84	25.37	86.31	0.49
A3	L1-L2	-2649.45	10Y	26.30	82.41	82.98		83.00	0.003681	0.62	42.14	114.25	0.33
A3	L1-L2	-3049.45	10Y	26.30	80.93	81.30		81.34	0.016759	0.88	29.92	151.22	0.63
A3	L1-L2	-3284.00	10Y	26.30	76.57	77.76		77.77	0.000292	0.28	93.69	125.78	0.10
A3	L1-L2	-3538.42	10Y	27.10	76.98	77.47		77.50	0.007584	0.81	33.25	103.90	0.46
A3	L1-L2	-3938.43	10Y	27.10	73.96	74.40		74.44	0.009649	0.87	31.16	105.78	0.51
A3	L1-L2	-4245.56	10Y	27.10	70.90	71.75		71.75	0.000672	0.35	76.45	135.26	0.15
A3	L1-L2	-4645.47	10Y	27.10	70.69	71.25		71.27	0.004950	0.65	41.83	133.93	0.37
A3	L1-L2	-5045.47	10Y	27.10	68.72	69.16		69.19	0.008668	0.79	34.47	125.67	0.48
A3	L1-L2	-5445.47	10Y	30.00	65.09	65.77		65.80	0.004663	0.75	39.99	98.25	0.38
A3	L1-L2	-5845.47	10Y	30.00	63.29	63.94		63.96	0.003254	0.64	46.78	110.99	0.32
A3	L1-L2	-6245.47	10Y	30.00	62.05	62.61		62.61	0.001346	0.36	84.12	248.25	0.20
A3	L1-L2	-6645.47	10Y	30.00	61.30	61.91		61.93	0.004075	0.67	44.48	115.82	0.35
A3	L1-L2	-7045.47	10Y	30.00	60.18	60.82		60.82	0.000302	0.18	167.70	454.05	0.09
A2	N1-N2	0	10Y	5.70	110.07	110.37	110.29	110.39	0.006769	0.52	10.89	60.67	0.39
A2	N1-N2	-300	10Y	5.70	108.00	108.30		108.32	0.012184	0.64	8.89	56.78	0.52
A2	N1-N2	-600	10Y	5.70	104.21	104.59		104.62	0.011789	0.73	7.81	40.03	0.53
A2	N1-N2	-900	10Y	5.70	100.57	100.96		100.97	0.003370	0.42	13.62	62.96	0.29
A2	N1-N2	-1200	10Y	5.70	99.63	99.85		99.87	0.016962	0.66	8.66	68.21	0.59
A2	N1-N2	-1500	10Y	5.70	94.10	94.41		94.44	0.010608	0.74	7.71	35.84	0.51
A2	N1-N2	-1800	10Y	5.70	91.01	91.38		91.40	0.010067	0.68	8.36	42.25	0.49
A2	N1-N2	-2100	10Y	5.70	87.95	88.23		88.24	0.007349	0.53	10.83	63.70	0.41
A2	N1-N2	-2362.53	10Y	5.70	85.67	85.99		86.01	0.013612	0.72	7.95	46.60	0.55
A2	N1-N2	-2662.53	10Y	11.80	82.37	82.82		82.85	0.010264	0.79	14.96	61.57	0.51
A2	N1-N2	-2962.53	10Y	11.80	79.51	79.78		79.79	0.006511	0.55	21.36	106.67	0.39
A2	N1-N2	-3230.85	10Y	11.80	77.76	78.10		78.12	0.006835	0.61	19.45	87.57	0.41
A2	N1-N2	-4066.38	10Y	11.80	72.08	72.42		72.43	0.006042	0.56	21.00	96.65	0.38
A2	N1-N2	-4866.00	10Y	17.50	67.20	67.58		67.61	0.010983	0.71	24.56	123.94	0.51
A2	N1-N2	-5666.38	10Y	17.50	62.19	62.73		62.75	0.005126	0.63	27.72	94.68	0.37
A2	M5-M6	-5913.38	10Y	24.60	61.17	61.73		61.74	0.001695	0.38	64.95	208.20	0.22
A2	M5-M6	-6313.17	10Y	27.00	60.39	61.17		61.18	0.000679	0.31	86.30	185.49	0.15
A2	M7-M8	-6670.48	10Y	57.00	59.63	60.25		60.29	0.007568	0.92	62.16	162.45	0.47
A2	M7-M8	-7070.48	10Y	54.70	56.64	57.47		57.48	0.001523	0.54	100.80	173.87	0.23
A2	M7-M8	-7470.48	10Y	54.70	56.00	57.05		57.06	0.000568	0.32	170.94	310.80	0.14
A1	O1-O2	0	10Y	32.80	94.53	95.06	94.94	95.11	0.012807	1.05	31.11	97.82	0.60
A1	O1-O2	-200	10Y	32.80	92.00	92.64		92.67	0.004520	0.76	42.90	100.07	0.37
A1	O1-O2	-400	10Y	32.80	91.13	91.73		91.76	0.004816	0.77	42.78	104.18	0.38
A1	O1-O2	-600	10Y	32.80	90.14	90.84		90.86	0.002925	0.66	50.02	105.94	0.30
A1	O1-O2	-800	10Y	32.80	89.54	90.10		90.15	0.009117	0.94	34.99	101.73	0.51
A1	O1-O2	-1109.56	10Y	32.80	86.65	87.38		87.42	0.004763	0.84	38.96	81.77	0.39
A1	O1-O2	-1309.56	10Y	33.60	85.73	86.31		86.37	0.008879	1.02	33.04	83.36	0.52
A1	O1-O2	-1509.56	10Y	33.60	83.92	84.99		85.00	0.000581	0.38	87.90	124.43	0.15
A1	P1-P2	-1816.7	10Y	43.00	83.99	84.40		84.44	0.011272	0.93	46.22	159.34	0.55
A1	P1-P2	-2716.7	10Y	43.00	78.42	79.10		79.15	0.005885	0.92	46.81	101.04	0.43
A1	P1-P2	-3016.7	10Y	43.00	76.68	78.49		78.49	0.000062	0.17	257.34	234.32	0.05
A1	P1-P2	-3316.7	10Y	43.00	77.36	78.43		78.43	0.000460	0.29	148.25	266.50	0.12
A1	P1-P2	-3616.7	10Y	43.00	77.36	77.89		77.97	0.016011	1.25	34.46	99.52	0.68
A1	P1-P2	-3916.7	10Y	44.40	72.48	73.40		73.43	0.003207	0.69	64.72	137.25	0.32
A1	P1-P2	-4516.7	10Y	44.40	70.64	71.28		71.34	0.010270	1.06	41.73	109.73	0.55
A1	P1-P2	-4816.7	10Y	44.40	67.54	68.54	68.03	68.56	0.001612	0.58	76.04	122.61	0.24
A1	P8-P9	-5440.56	10Y	52.60	65.88	66.72		66.77	0.005492	0.96	55.02	106.20	0.42
A1	P8-P9	-5840.56	10Y	52.60	63.71	64.79		64.81	0.001598	0.60	87.35	133.61	0.24
A1	P8-P9	-6240.56	10Y	52.60	63.25	63.96		63.98	0.003424	0.67	78.48	181.08	0.32
A1	P8-P9	-6640.56	10Y	52.60	61.85	62.65		62.67	0.002314	0.59	88.85	184.07	0.27
A1	P8-P9	-7040.56	10Y	48.70	60.50	61.21		61.24	0.004690	0.72	67.71	177.90	0.37
A1	P8-P9	-7440.56	10Y	48.70	58.38	59.52		59.53	0.000996	0.40	122.76	246.32	0.18
A1	P8-P9	-7840.56	10Y	48.70	58.01	58.62		58.64	0.002200	0.53	92.17	218.06	0.26
A1	P8-P9	-8240.56	10Y	48.70	56.09	57.16		57.18	0.001647	0.64	76.12	108.78	0.24

HEC-RAS Plan: Plan 02 Profile: 10Y (Continued)

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
A1	P10-P11	-8800.92	10Y	101.30	55.42	56.50		56.51	0.001043	0.42	240.69	457.54	0.19
A1	P10-P11	-9200.92	10Y	100.80	55.00	55.86		55.88	0.003308	0.71	141.74	291.56	0.33
A1	P10-P11	-9600.92	10Y	100.80	53.18	55.08		55.08	0.000147	0.22	450.70	508.68	0.08
A1	P10-P11	-10014.7	10Y	208.97	53.14	55.00		55.01	0.000691	0.51	408.75	426.10	0.17
A1	P10-P11	-10414.7	10Y	211.87	52.88	54.66		54.67	0.000535	0.46	457.75	457.00	0.15
A1	P10-P11	-10814.7	10Y	211.87	52.43	54.19		54.22	0.002852	0.85	250.48	355.39	0.32
A1	P10-P11	-11191.7	10Y	211.87	50.49	53.33		53.35	0.000881	0.60	352.72	346.34	0.19
A1	P10-P11	-11291.7	10Y	211.87	51.97	53.15	52.70	53.19	0.004002	0.89	238.79	406.54	0.37