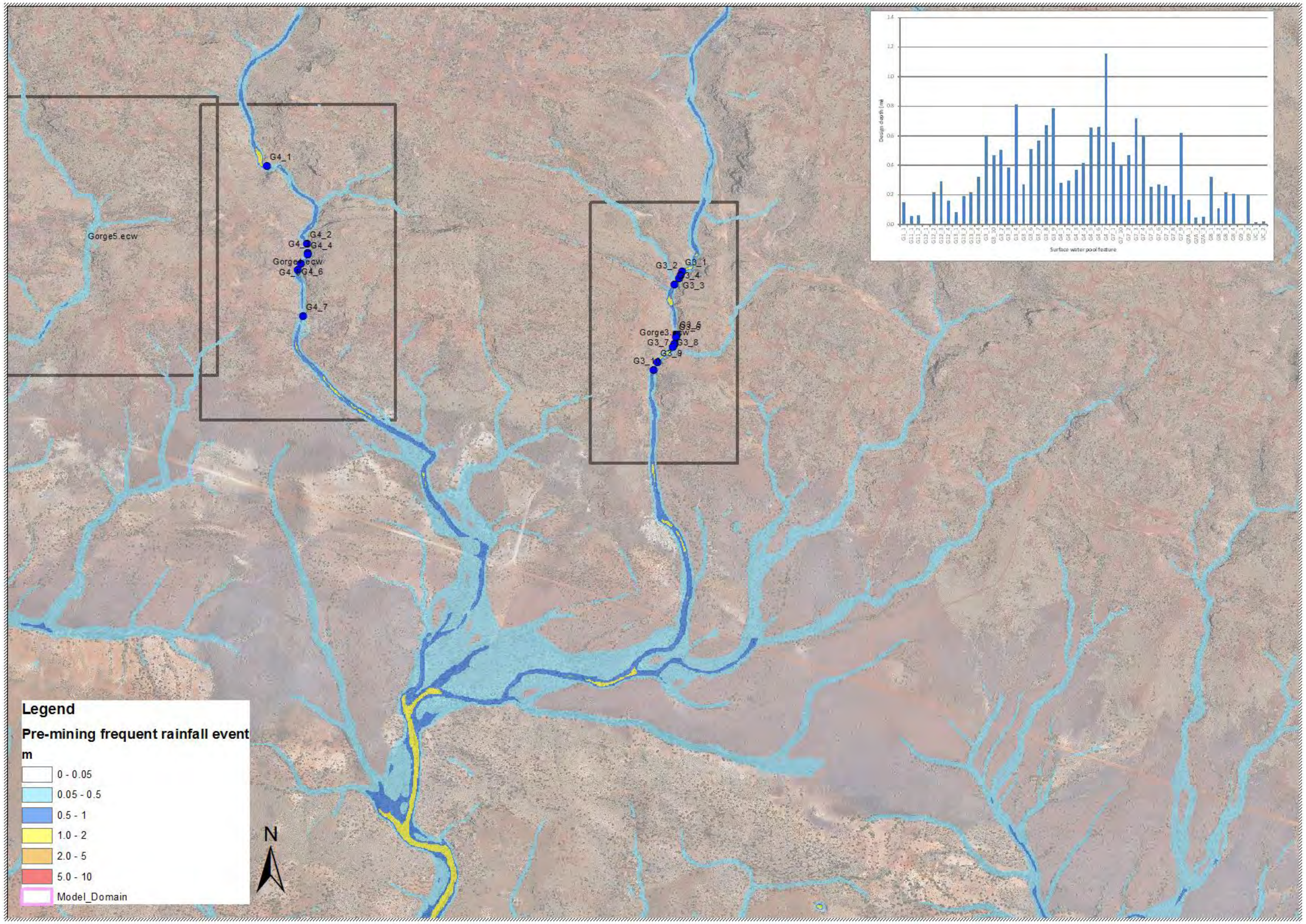

Figure 8-10 pre mining frequent flood event depth map

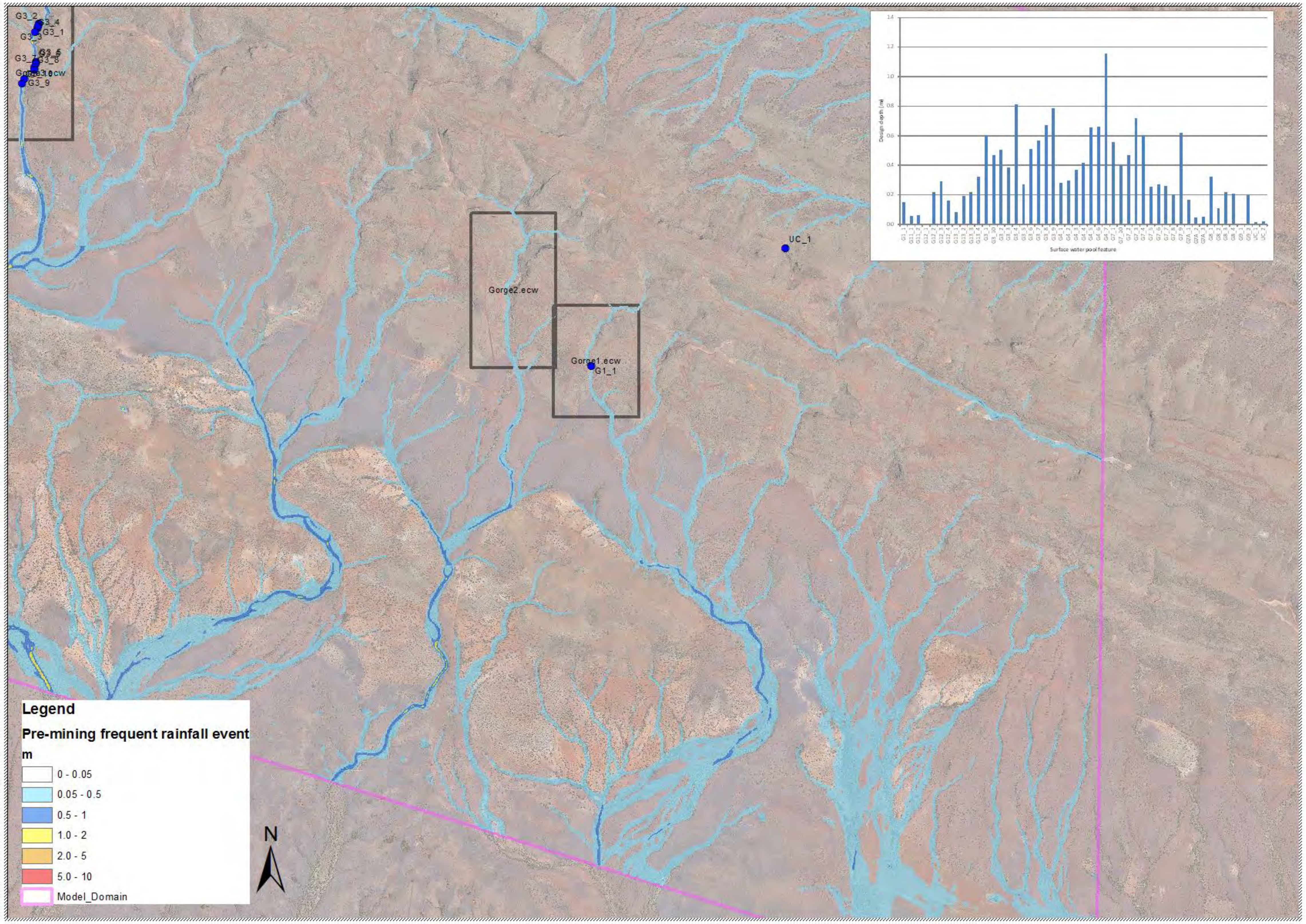

Figure 8-11 pre mining frequent flood event depth map

8.4.5 Paraburdoo

The 2016 Paraburdoo LoM hydraulic model consists of most recent available topographic survey for the area overlain by the 2016 planned Life of Mine pits, dumps, etc.

The hydraulic modelling highlights the heavily modified landscape as a result of mining. As such, the hydrology within the local proximity is altered. Localised upstream ponding at haul road and light vehicle access roads is evident in the major creeks. The modelled depths are shown in Figure 8-12.

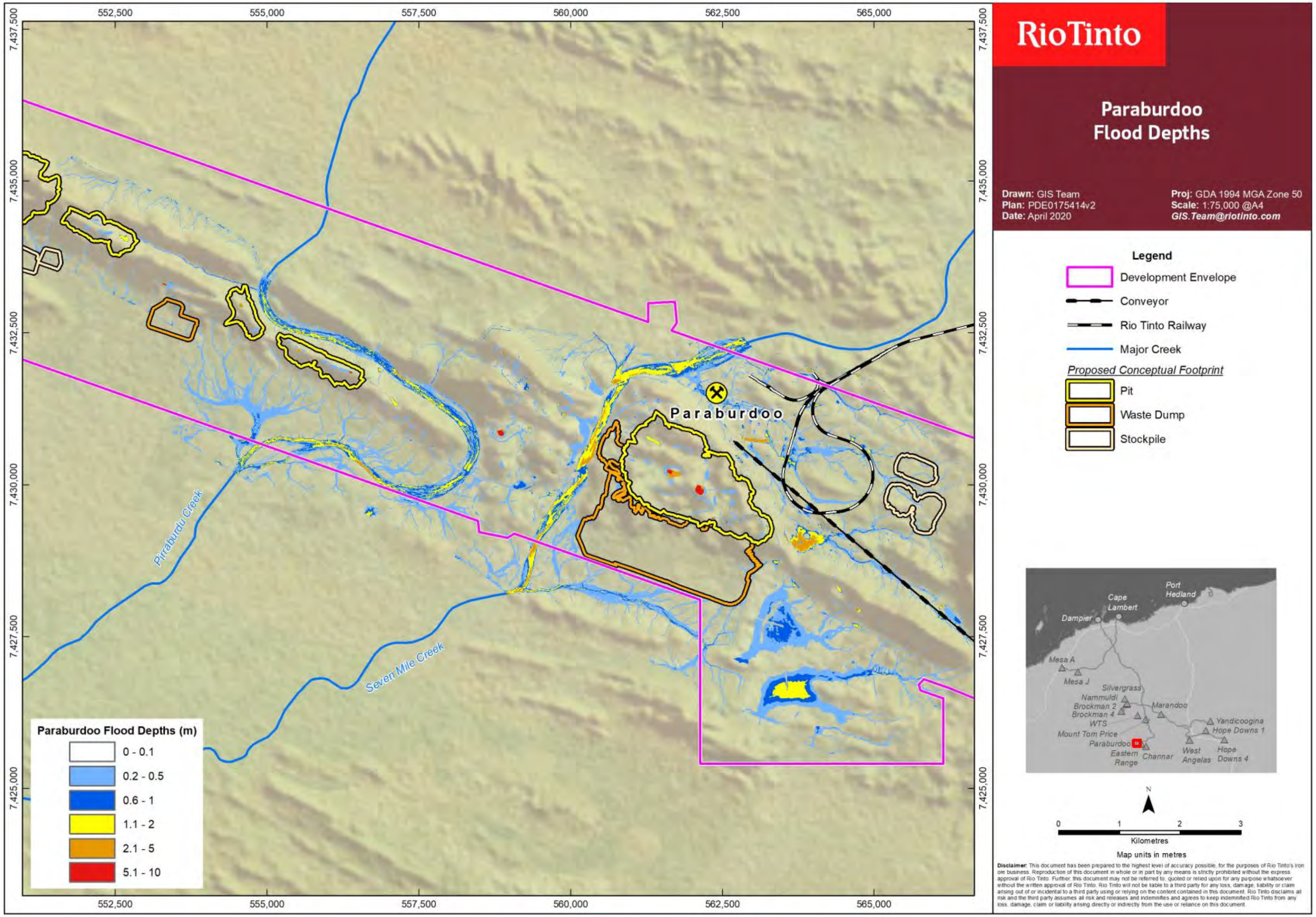

Figure 8-12: Paraburdoo 2016 LoM hydraulic model

8.4.6 Eastern Range

For the Eastern Range model shown below, the end of mining scenario based on the 2016 Life of Mine plan has been used. This LoM does not include any development at 42EE or 47E and those areas are free draining. Ponding at 42E is shown for areas which previously drained to the gully between 42E and 42EE.

The model predicts maximum depths (shown in Figure 8-13) between 1 and 2 metres in the creeks with extreme velocities (~3 m/s), reflecting the steep terrain in the area.

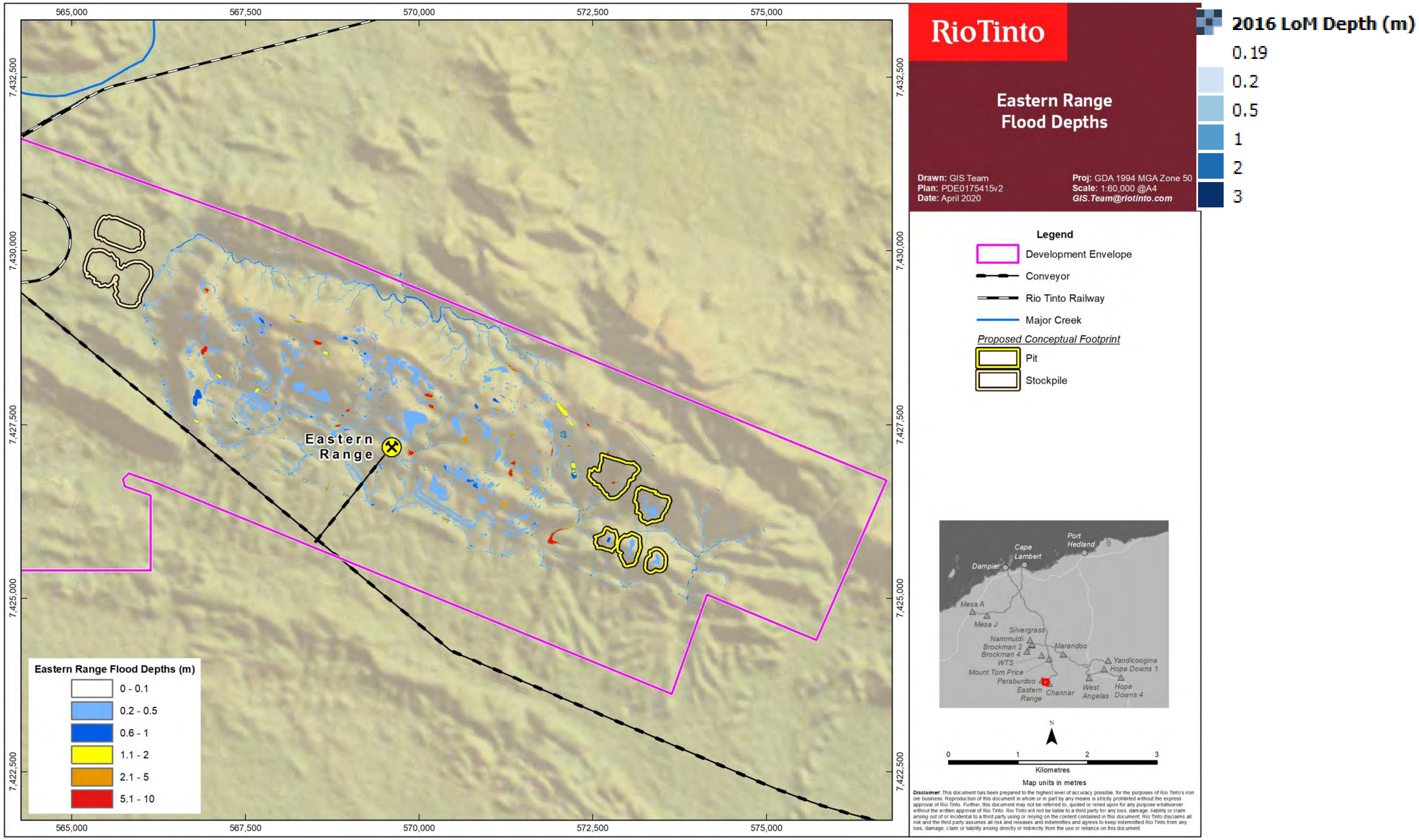

Figure 8-13 Environmental rainfall runoff regime at Eastern Range (frequent event) – LOM Scenario

Surface Water Management at the Site

The Rio Tinto Iron Ore Surface Water Management Strategy sets out two key objectives; the first addresses the impacts water has on the site, the second is to prevent adverse impacts on the natural function and environmental value of watercourses, water quality and sheet flow downstream from the mine area. This is achieved by minimising disruption to natural flows, preventing erosion and preventing contamination of surface and ground water.

The project comprises of three key areas that have the potential to require surface water management, based on either managing a risk to production, safety or asset integrity or adverse environmental outcomes resulting from development. The areas have been grouped as follows:

- Pits and Dumps at Western Range, 4EE at Paraburdoo and 42EE and 47E at Eastern Range,

- Civil Infrastructure for the transport of personnel and ore between Western Range and Paraburdoo, including crossings of Seven Mile Creek and Pirraburdu Creek,

- Infrastructure for managing surplus water at Paraburdoo and Western Range.

The risks relevant to each part of the development and proposed mitigation are described in the sections below.

9. Design for general surface water management

Under the Rio Tinto risk standard, risks can be assessed on either the likelihood of occurrence each year, or the likelihood of occurrence over the life of an asset. Based on Life of Mine (LoM) mine plans, WR and 4EE have approximately an 18 year life (2023-2041). The design criteria applied for the Preliminary Engineering Study (PES) is provided in Table 9-2. The probabilities of exceeding a specific AEP flood event 5, 10, 15, 18, 20 and 30 year design lives are provided in Table 9-1. Mine infrastructure protection is usually provided for an event probability of approximately 20% over the life of asset. Using this approach critical infrastructure is recommended consider withstanding a 1 % AEP (100 year ARI) flood event.

A 1% AEP will have a 17% probability of having their capacity exceeded during the 18 year operational life

Note that staging of the mine and infrastructure has not been considered in the assessment, and certain pits/dumps/ mine infrastructure etc. may be exposed to additional flood risk.

Table 9-1: Annual exceedance probability for design events (AEP) for a given design life

Design life (years)	Probability of design AEP being exceeded (%)							
	50 % (AEP)	20 % (AEP)	10 % (AEP)	5 % (AEP)	2 % (AEP)	1 % (AEP)	0.5 % (AEP)	0.2 % (AEP)
5	97	67	41	23	10	5	2	1
10	100	89	65	40	18	10	5	2
15	100	96	79	54	26	14	7	3
18	100	98	85	60	30	17	9	4
20	100	99	88	64	33	18	10	4
30	100	100	96	79	45	26	14	6

Table 9-2: Design Criteria adopted for the study

<table>
<tr><th colspan="4">Design Flows</th></tr>
<tr><th colspan="2" rowspan="2">Infrastructure</th><th colspan="2">Crush and Convey</th></tr>
<tr><th>AEP (%)</th><th>Freeboard (mm)</th></tr>
<tr><td colspan="2">Conveyor</td><td>1% AEP</td><td>500</td></tr>
<tr><td colspan="2">Process Plant</td><td>1% AEP</td><td>500</td></tr>
<tr><td rowspan="2">Mine Haul Roads & Mine LV Roads</td><td>Culverts</td><td>20% AEP</td><td>500</td></tr>
<tr><td>Floodway</td><td>20% AEP</td><td>300mm Overtopping the Road</td></tr>
<tr><td rowspan="2">Mine Maintenance Haul Roads & Mine LV Roads</td><td>Culverts</td><td>50% AEP</td><td>500</td></tr>
<tr><td>Floodway</td><td>50% AEP</td><td>300mm Overtopping the Road</td></tr>
<tr><td rowspan="2">Site LV Access Road and Internal LV Access Road</td><td>Culverts</td><td>20% AEP</td><td>500</td></tr>
<tr><td>Floodway</td><td>20% AEP</td><td>300mm Overtopping the Road</td></tr>
</table>

Design Flows			
Infrastructure		**Crush and Convey**	
		AEP (%)	**Freeboard (mm)**
Early Haulage HV Road	Culverts	20% AEP	500
	Floodway	20% AEP	300mm Overtopping the Road
Maintenance Access Tracks		NA	NA
Construction Accommodation Village – Bulk Pad		2% AEP	500
NPI Facility – Bulk Pad		2% AEP	500

9.1 Storm water and wet season management

Storm water and wet season management strategy concepts have been developed as part of the study process. The main aim of the strategy is to protect mine assets and maintain production from excessive rainfall through the wet season. This includes all non-permanent infrastructure (i.e. bunds, sumps) required for the initial mining area (IMA) and pit protection.

Annual flood risk assessments are undertaken prior to each wet season after mining commences to quantify and communicate the risk of flooding, following the procedures described in Guidelines for Mine Site Flood Risk Assessment (RTIO-PDE-0057648).

9.2 Environmental Flow Consideration

Waterway crossings have the potential to block low flows. This is combined with an adverse engineering design outcome, whereby ponding against an engineered embankment can affect its structural integrity. For the proposed development, all floodways will either be combined with low flow culverts, or be built at-grade. Where windrows are necessary for safety reasons, drainage through the windrows will be included. This approach will ensure the continuation of low flows in major creeks crossed by roads and conveyors as part of the development.

10. Surface Water Management for Pits and Dumps

Inadequate management of surface water in and around pits and dumps can result in:

- Production delays resulting from time taken to remove surface water to pit areas,
- Adverse production and safety outcomes, arising from disruptions to the LV/HV road network,

- Altered downstream hydrological regime, as contributing catchment areas are altered by pits and dumps,

- Adverse geotechnical outcomes where water flows over the pit edge or ponds against waste dumps, and

- Sedimentation from pits and dumps, where blasting and dozing practices can leave unconsolidated fines material around the perimeter of pits.

Based on the proposed development, the occurrence and management of these issues are discussed below.

10.1 Western Range

Western Range mine pits are positioned on a regional catchment divide. Surface water reporting to pits is mainly from incident rainfall or runoff from small local catchments. Ponded water is likely to dissipate via infiltration and evaporation. However there is the potential for surface water runoff along haul roads, following significant rainfall events. Due to the steepness of the catchments, high velocity runoffs are likely to be generated thus increasing the sediment load into the environment and creating potentially hazardous conditions along haul roads. For each of the pits deposits described in this section, estimated runoff volumes predicted to reach the pits for a range of rainfall event magnitudes are presented in Appendix A.

10.1.1 Deposit 66W

West of deposit 66W is a large tributary of Six Mile Creek that would represent a significant flood risk should any mine infrastructure extend to this area. Deposit 66W is located on a regional catchment divide. Flood risk to pits will likely result from direct rainfall and runoff from minor elevated areas. Sediment laden runoff from ex-pit landforms (waste dumps and landbridges) may occur, and can be mitigated through appropriate placement of sumps and catch bunds. Refer Figure 10-1. Deposit 36W/50W

Deposit 36W/50W is situated very close to a regional and local catchment divide. Flood risk to pits will likely result from direct rainfall and runoff from minor elevated areas. Sediment laden runoff from ex-pit landforms (waste dumps and landbridges) may occur, and can be mitigated through appropriate placement of sumps and catch bunds. Refer Figure 10-2.

10.1.2 Deposits 27W, 20W, 14W-16W

14W, 16W and 20W lie on top of a ridge immediately south of Pirraburdu Creek (shown below). 27W lies further west on the same ridge line and sits at the headwaters of a small gully which drains into Pirraburdu Creek just south of Ratty Springs. Sediment laden runoff from ex-pit landforms (waste dumps and landbridges) may occur, and can be mitigated through appropriate placement of sumps and catch bunds .Refer Figure 10-3.

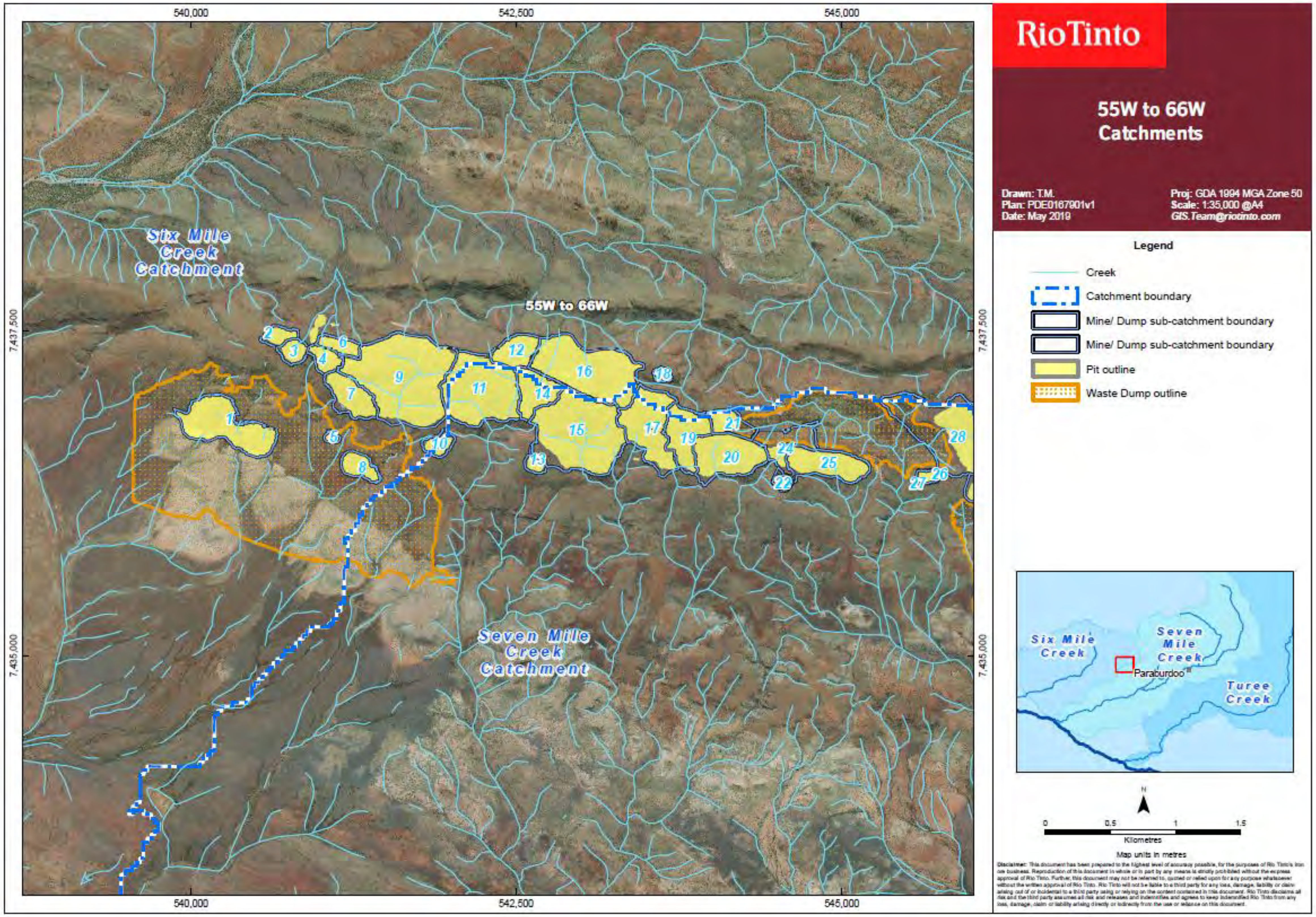

Figure 10-1 Surface water catchments for management associated with deposit 55-66W

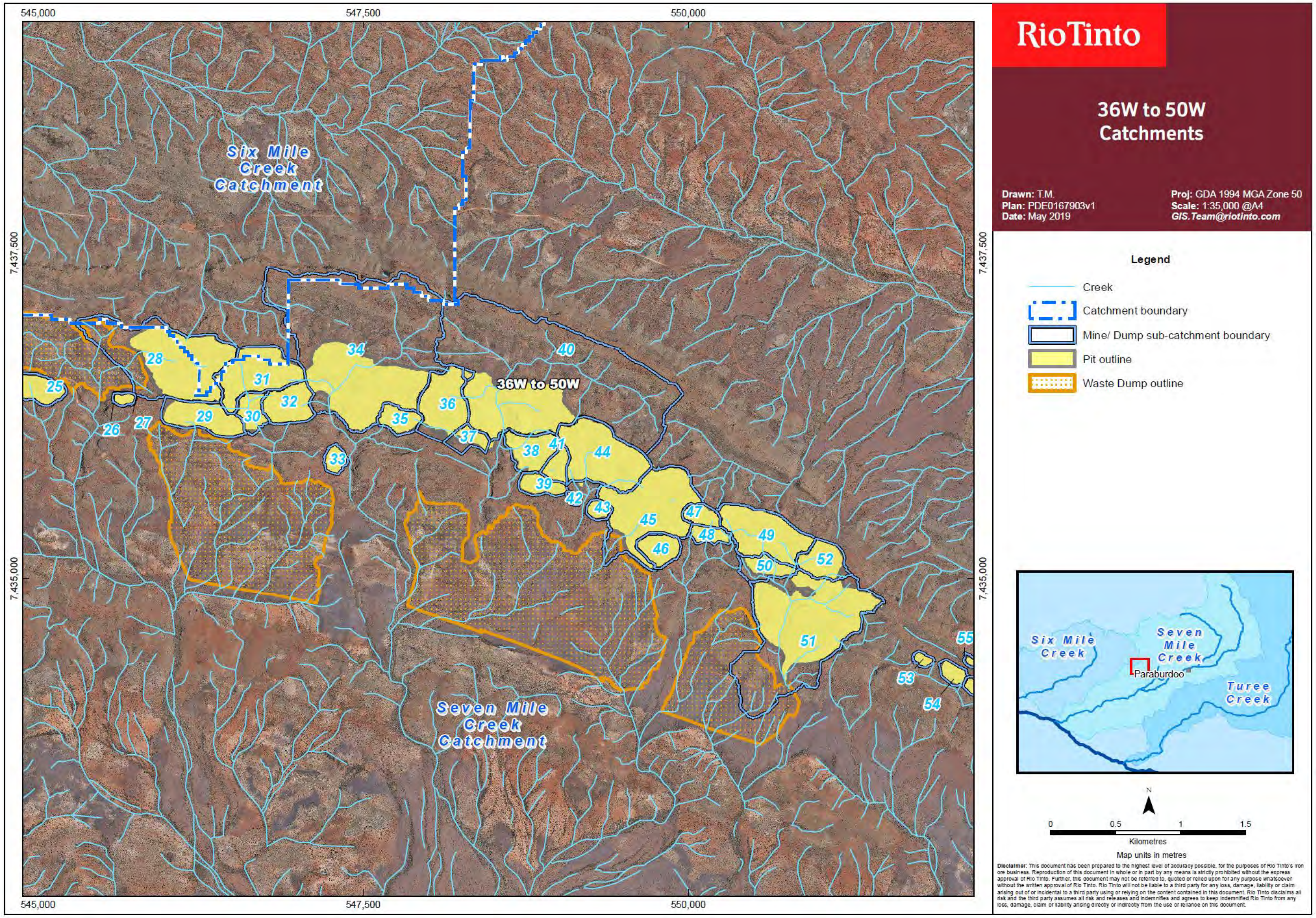

Figure 10-2: Surface water catchments for management associated with deposit 36-50W

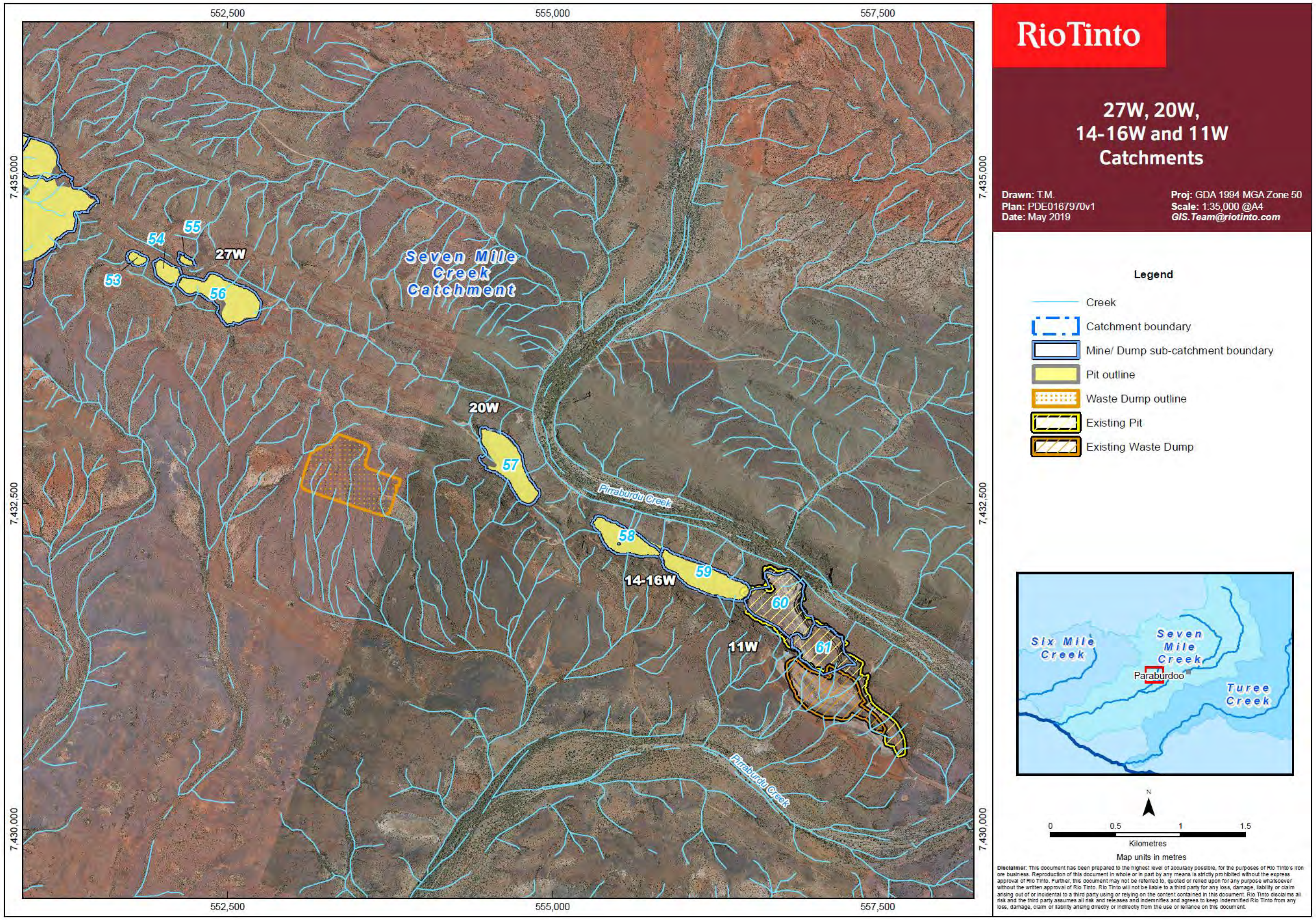

Figure 10-3: Surface water catchments for management associated with deposit 27W,20W and 14-16W

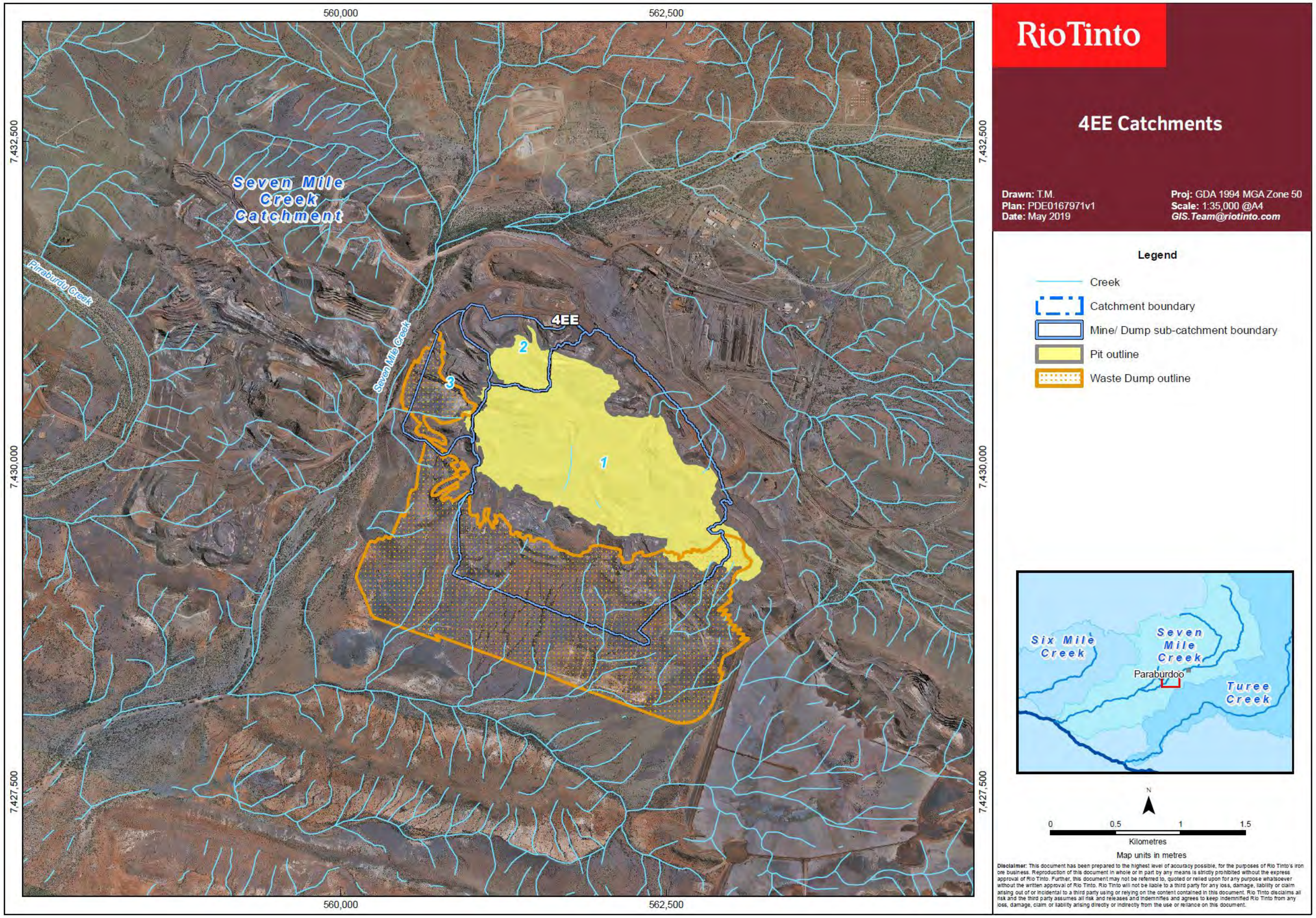

Figure 10-4: Surface water catchments for management associated with deposit 4EE

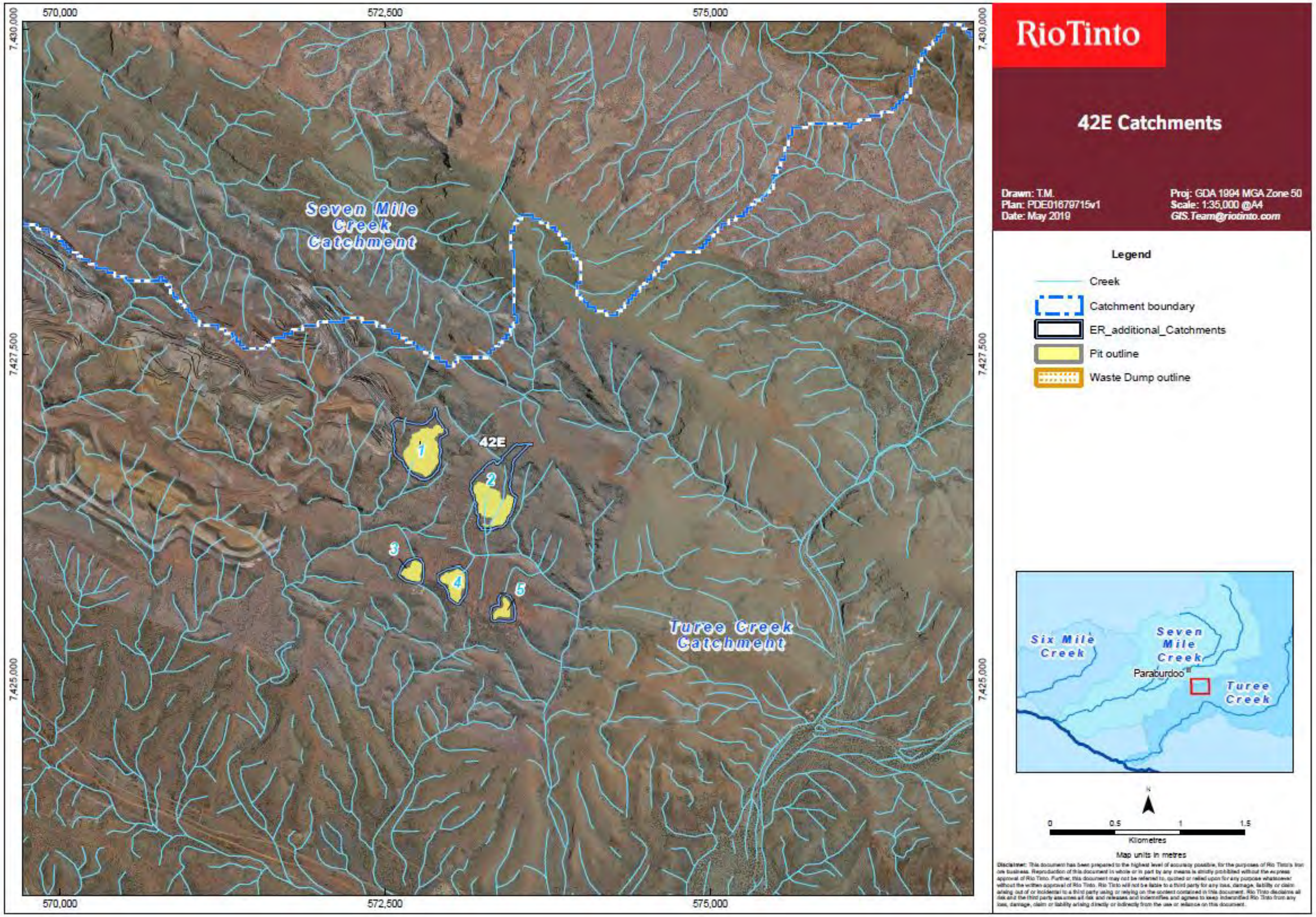

Figure 10-5: Surface water catchments for management associated with deposits 42EE & 47E

10.2 Paraburdoo (4EE)

The catchment area reporting to the 4EE pit is circa 3km^2 and active surface water management will be required. It is likely that a dedicated sump and pump approach will be required to manage rainfall reaching the base of the pit, particularly in the later stages of mining. Risk exposure depends on the preferred mining approach and the likely number of active benches during each wet season. When staging information is available, indicative sump and pump infrastructure will be assessed.

10.3 Eastern Range (42E and 47EE)

The 42EE and 47E development is shown in Figure 10-6. The proposed pits typically lie on catchment divides with no or minimal upstream areas. Two landbridges are proposed which traverse two small creeks, which in turn host a series of significant pools.

The 42EE landbridge blocks a 0.2km^2 catchment. At closure this landbridge is expected to be rehabilitated, with a flat top with no upstream impoundment. Whether this landform sheds water post closure would depend on the final closure landform, including treatment of the top and batters.

The 47E landbridge blocks a 1.9 km^2 catchment, which includes a series of significant pools, including ERP5, which lies 400 metres upstream. The creek falls 5 metres between ERP5 and the proposed landbridge location. Analysis shows that the volume of a 1:2 AEP flood event could potentially reach up to 5.5 metres in depth, meaning that ERP5 may be subject to periodic inundation arising from construction of the landbridge. No other pools lie below 434mAHD, the level assessed to which a 1:500 AEP rainfall event may potentially reach. At closure, the landbridge near the creek is proposed to be removed to re-establish free drainage, with other sections to be while battered down and rehabilitated.

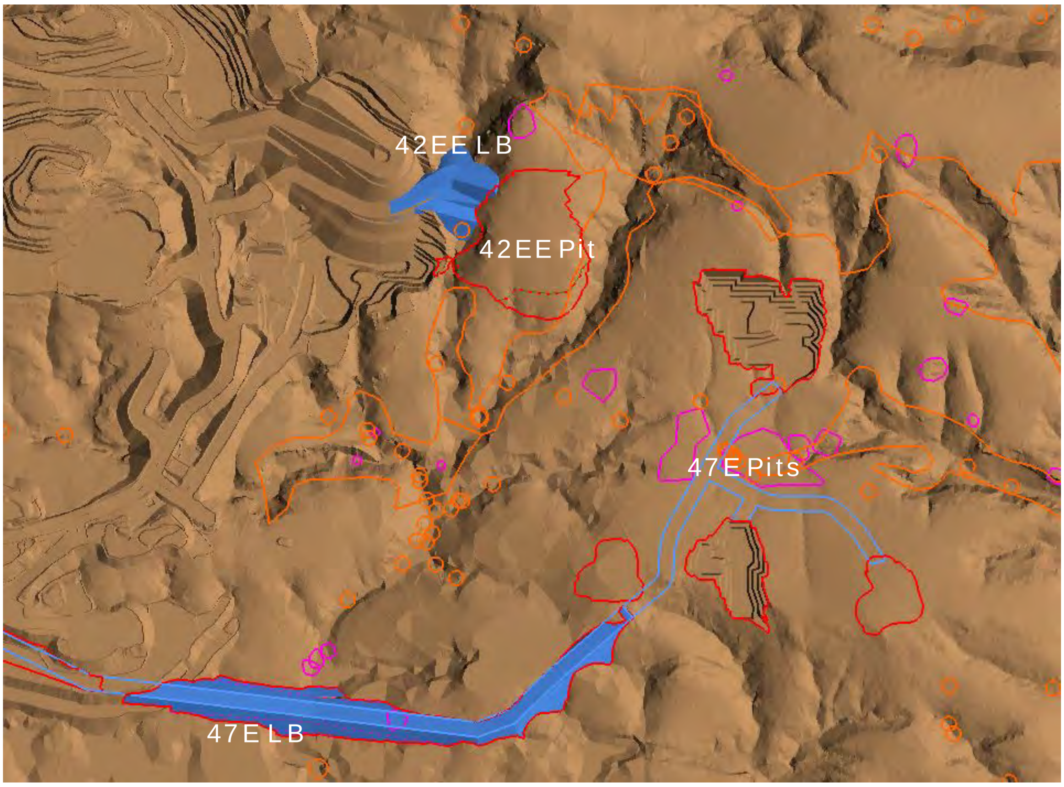

Figure 10-6: 42EE and 47E development

11. Surplus Water Management

Several below water table pits are being mined at Western Range and Paraburdoo. Based on the life of mine site water balance, periods of water surplus have been identified. Where practical, surplus water will be used on site. In other cases, disposal options close to the dewatered pits have been investigated.

11.1 Paraburdoo (4EE)

Based on the life of mine site water balance, a possible period of water surplus has been identified, primarily driven by below water table mining in the 4EE pit. A series of surplus water disposal options have been investigated, including discharge into one or both of Seven Mile Creek and Pirraburdu Creek. The water balance and disposal options considered include:

- 4 separate in pit disposal locations,
- A series of discharge to creek options, and
- Borefield re-injection.

For creek discharge, two options are under consideration, being discharge to Pirraburdu Creek and Seven Mile Creek, downstream of a haul road.

In ephemeral creeks such as these, surplus discharge could have the effect of establishing a length of effectively permanent flow, where by the flow rate is equivalent to the rate of infiltration into the river bed over the length of flow. The extent of discharge water persisting as surface flow is referred to herein as the discharge extent.

A 2D hydraulic model was developed to estimate what the maximum rate of flow would be required to maintain the discharge extent would remain within Rio Tinto tenements. The model setup includes assumptions where:

- Surplus discharge in both creek systems operate as a disconnected losing stream (see Figure 11-1)
- Soil properties taken from Australian Atlas of Soil Properties, with infiltration rates adjusted by clay content of combined A and B horizon, ranging from 3.0mm/hr to 6.1mm/hr.

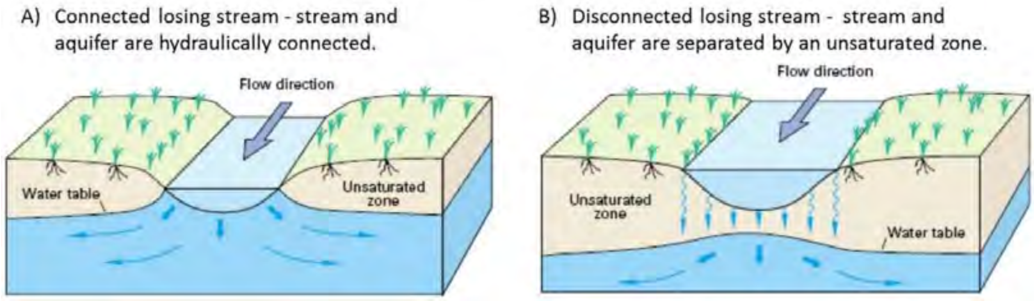

Figure 11-1 Generalised Surface and Ground Water interaction in a losing stream (after Alley, et al, 1999)

The model was built using the TUFLOW two-dimensional (2D) HPC software package (release TUFLOW.2017-09-AC-w64). The TUFLOW HPC solver enables simulation of high-resolution flood hydraulics across the full study area whilst maintaining practical simulation times. The model examined two river reaches up to 20km long, focussing on the low flow channel.

Source-area boundary conditions were used to reperesent the proposed discharge locations. A uniform Manning's N of 0.05 was applied to the whole domain. The model was not used to represent rainfall (as rainfall excess or rain on grid), evaporation or upstream inflows.

11.1.1 Discharge Extent Estimates in Dry Conditions

Allowable discharge rates (where surface flows remains on tenement) have been estimated by interpolating between a range of modelled flow rates listed in Table 1.

In dry conditions, it has been estimated that the discharge extent would remain on Rio Tinto tenements for:

- A 1.7 GL/yr. rate of discharge into Pirraburdu Creek (equivalent to 50 litres per second)

- A 0.8 GL/yr. rate of discharge into Seven Mile Creek (equivalent to 30 litres per second)

These results have been based on interpolation around the modelled 1GL/yr. and 2GL/yr. flow rates shown in Figure 11-2.

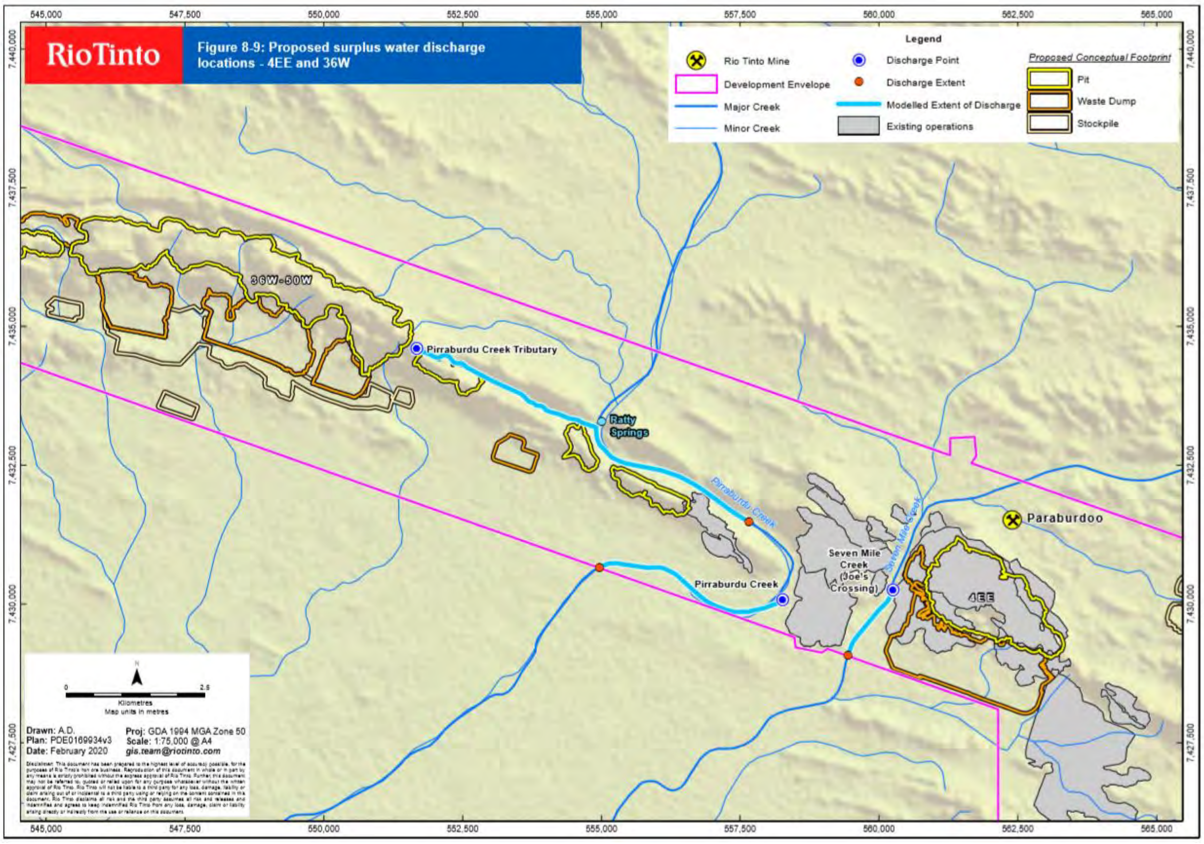

Figure 11-2 - Discharge Extent Modelling for Pirraburdu and Seven Mile Creek

11.1.2 Low Flow Event Comparison

2D hydraulic modelling of a typical frequent flood event demonstrates the relative insignificance of surplus discharge during wet conditions. Figure 11-3 shows a 2GL/yr. discharge scenario in Pirraburdu Creek against a flood with an estimated 50% Annual Exceedance Probability. The model results show that frequent flood events are far more extensive and typically 1.5 metres deeper than the surplus discharge. Based on a time to peak less than 4.5 hours and assuming a total event length of 18 hours, the volume of a 50% AEP flood would be approximately 2.4GL. The surplus discharge volume over that same 18 hour period would be equivalent to 0.15% of the flood event volume.

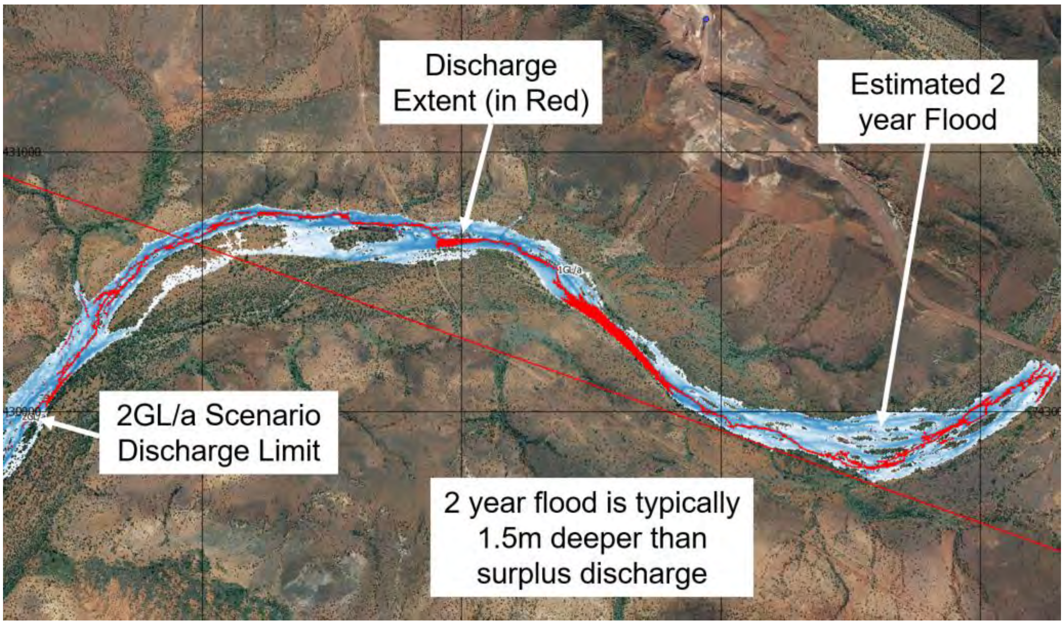

Figure 11-3 - 2GL/yr. Discharge Extent versus a 50% AEP Flood Event

11.2 Western Range

Two of the Western Range pits may require dewatering and result in discharge of extracted groundwater to the environment. The discharges would be sourced directly from the pits, rather than being routed through the plant, as with the 4EE case. The duration of the surplus discharge is considerably shorter than 4EE with below water table mining unlikely to persist for longer than 2 years. The anticipated flow rates are:

- A 0.6 GL/yr. rate of discharge required from the 36W pit (equivalent to 20 litres per second), and
- A 0.3 GL/yr. rate of discharge required from the 66W pit (equivalent to 10 litres per second).

A simpler, but more conservative approach has been used to estimate the discharge extent and identify appropriate discharge points. A uniform rate of 2km of discharge extent for every 1 ML per day of discharge. This is based on observations at other Pilbara mine sites where the discharge extent typically varies between 0.5 and 2km for each 1 ML per day of discharge. This results in a predicted discharge extent of:

- 3.5km for the 36W pit discharge (based on a discharge rate of 1.7 ML/d), and
- 1.7km for the 66W pit discharge (based on a discharge rate of 0.85 ML/d).

These are conservative estimates and if the conditions at Pirraburdu and Seven Mile Creek discharge points reflect those of the 36W and 66W discharge points, the discharge extents would be less than half that listed above.

A further assumption is that no flow is infiltrated within the range itself. This is based on observations at Western Range of deeply incised gullies and gorges with exposed bedrock in places.

The proposed discharge points and estimated discharge extents are shown in Figure 11-2 (for 36W) and Figure 11-4 (for 66W). Included are those sections of discharge extent within the range where infiltration is expected to be minimal. For both pits (including each of the 66W options) the discharge extent stays within the tenure boundary.