



Surface Water Assessment

Eastern Range – 42 East, 47 East and 50E areas

May 2019

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Introduction

This report has been prepared to support the Greater Paraburdoo Iron Ore Hub approval under Part IV of the *Environmental Protection Act 1986*, and specifically to characterise baseline hydrological conditions in the 42 East (47E), 47 East (47E) and 50 East (50E) areas at Eastern Range.

A key focus of the assessment has been identifying surface water features within the gorge areas of Eastern Range. While the Pilbara is an arid environment where potential evaporation losses far exceed rainfall, surface water is known to persist in some conditions. Social and environmental values are frequently associated with water features that persist between rainfall events and between wet seasons.

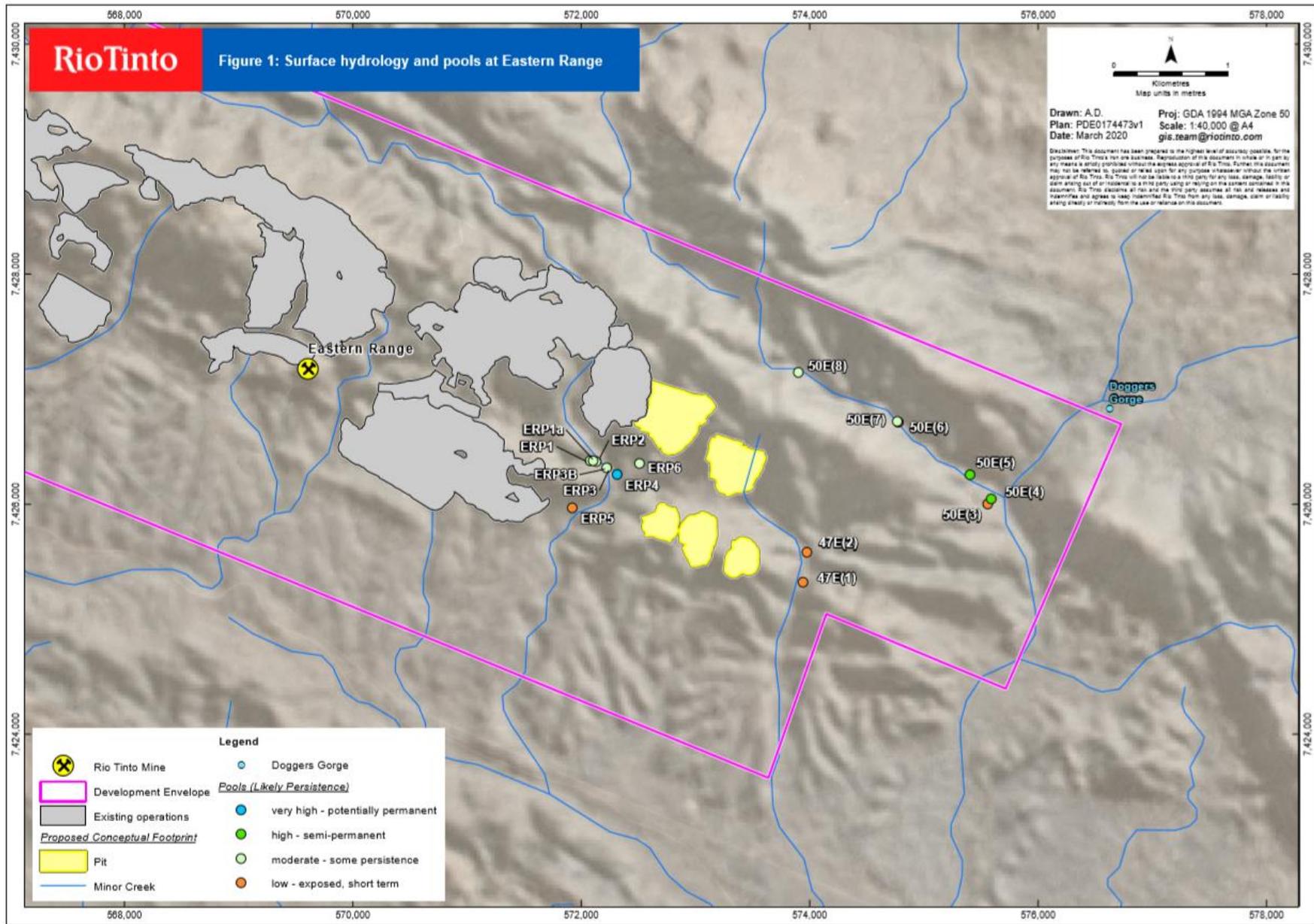


Figure 1 Eastern Range Surface Hydrology

Eastern Range Hydrology

The Eastern Range mine is located in the Ashburton River Basin (78780 km²) in the in Western Pilbara.

There are no nearby streamflow gauges, with the nearest Department of Water gauge (Broken Springs-Site 706004) closed in 1980, having operated from 1974. Rio Tinto deployed numerous pressure transducers and remote sensing cameras, installed in local creeks around the Greater Paraburdoo Iron Ore Hub Proposal to monitor water levels from rainfall events, with further information discussed in the following sections.

Within the Eastern Range area the surface water regime is influenced by the steeply incised gullies hosted within the ridgeline. These gullies form headwaters to tributaries of the Seven Mile and Turee Creeks, with the majority flowing in a southerly direction, refer Figure 1.

Whilst surface runoff in these gullies is ephemeral, the geology supports numerous interconnected pools, some of which have been identified as Heritage areas of water significance during previous surveys. The persistence of the pools is likely to be ephemeral or intermittent and with season and local site characteristics (e.g. substrate), fed by runoff from the upper catchments after rainfall. Due to the steep topography at Eastern Range, surface water runoff in the gullies is expected to have a relatively high velocity.

Desktop Assessment

A series of datasets collected by Rio Tinto or obtained from third parties were reviewed. The objective of the desktop assessment was to:

- Map catchments and flow paths,
- Identify potential surface water features including pools,
- Identify any associations between topography, cultural significance and the occurrence of surface water,

The datasets and their application for this assessment are described in Table 1. Based on the desktop review, potential surface water features were listed and prioritised for in field inspection, with remote sensing through drone capture completed on the 6th and 16th April 2019.

Catchment mapping was completed based on the LiDAR derived topographic datasets.

Daily rainfall data for the Q1 2019 period is presented in Appendix B. General climate data for Eastern Range and the wider Pilbara region is discussed in the Western Range & 4 East Extension PFS Surface Water Management Plan.

Table 1: Existing Rio Tinto Data sources

Data Type	Source	Last Update	Use	Limitations
Heritage Areas	Rio Tinto	Live Dataset	Includes flags to mark observed water features (W)	Eastern Range surveys completed in 2001, 2002 and 2014
Aerial Imagery	Rio Tinto	2017	Visually inspected to identify surface water features	Limited visibility in the 50Egorge (shadow, vegetation and overhang obscured visibility)
Site Scale Photogrammetry and imagery	Rio Tinto	March 2017	Site wide High resolution aerial image draped on a 3D surface was visually inspected to identify surface water features	Covered the 47E and 50E gorges. Limited visibility in gorges (shadow, vegetation and overhang obscured visibility)
		6 th April 2019	As above	No rainfall observed in days prior - Captured 47E gorge only
		16 th April 2019	As above	Rainfall observed in days prior- Captured 50E gorge only
Topographic Data	Rio Tinto	LiDAR capture from 2017	Map local catchments, assess rainfall runoff routing, identify depressions and potential ponding locations	
Rainfall	Bureau of Meteorology	Daily updates	Used to validate site observations, e.g. pool locations identified after wet periods.	Located at Paraburdoo Airport (~30km from Western Range), indicative of regional rainfall, likely to vary from actual
	Channar Site Weather Station			Located near the Channar Crusher approximately 5kms south east of area of interest

Observations and Analysis Results

Hydrologic Setting

Eastern Range comprises of parallel east-west trending Joffre, Whaleback Shale, and Dales Gorge Members. This is illustrated by the conceptual north-south cross section shown in Figure 1. Drainage in the 47E and 50E gorges presents a dendritic drainage patterns, with main direction of flow directions in the north-east to south-west, and north-west to south-east directions respectively, refer Figure 1 and Appendix A.

The lateral drainage tends to form steep, pebbly and gravelly creek beds, with occasional boulders. Pool features are not typically associated with lateral drainage.

In some gorge areas, high velocity flows appear to have stripped out the gravel layer leaving only exposed bedrock.

A previous investigation was undertaken in 2011 by Rio Tinto to conceptualise the mode of occurrence of the pools west of the assessment threshold. This included Python Pool in 24East gorge, MOC pools in the 32-37East gorge, and ERP pools in the 42East gorge. The pools are situated at ~100m above the assumed groundwater level (~350m AHD).

The investigation determined the source of water in the pools was incident rainfall and surface water flow from upper catchment that collects in sheltered depressions within impermeable bedrock where evaporation is minimal. Chloride and isotope data suggested there was no groundwater flow between the pools (RTIO-PDE-0143526). These pools were therefore deemed not dependent on local groundwater, however they may be sensitive to catchment change.

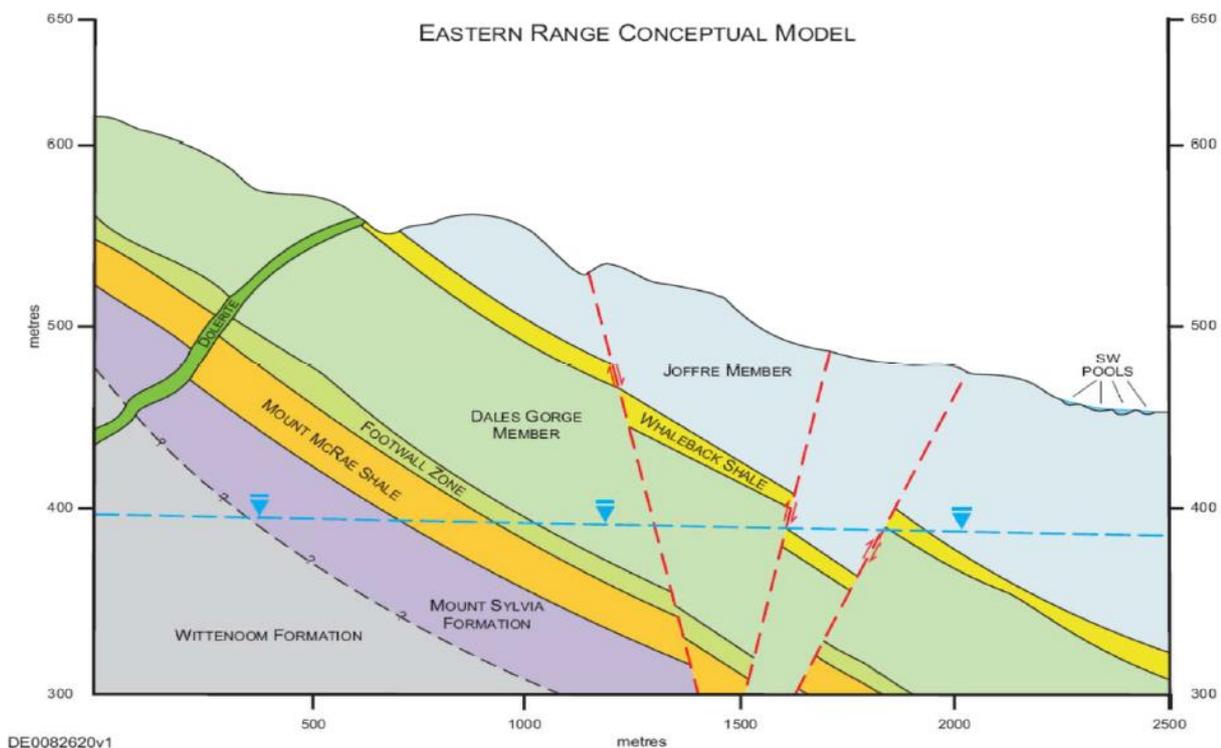


Figure 2: Conceptual Hydrogeological Cross Section of Eastern Range.

Known Water Features

Previous desktop and field investigations have identified surface water features around the Eastern Range mining area. This includes pools within north-south trending gorges, analogous to those observed at Western Range. These pools are summarised below.

24 East Gorges - The flow path commences in the north western upper reaches of Eastern Range tenure adjacent to the 23E deposit and flows south combining with the 32East gully and through the sealed haul road via a bank of culverts, then south westerly and joins Turee Creek approximately 30kms downstream. Python Pool (23EPB1) is located within this gully system (approximately 567076E, 7427545N).

32East Gorges - The flow path commences in the north western upper reaches of Eastern Range tenure separating the 23E-24E deposits from the 32E deposits and flows south westerly combining with the 24East gully and through the sealed haul road via a bank of culverts and joins Turee Creek approximately 30kms downstream. A borrow pit from mining operations has formed a depression within the creek channel.

32-37East Gorges - The flow paths commence mid tenure within the upper reaches and flow in a southerly direction through the sealed haul road via a bank of culverts, then flowing south westerly through significant meanders to combine with the 24East and 32East gully flow paths joining Turee Creek approximately 30kms downstream. A series of surface water pools (MOC pools) are located within this gully system noted for environmental and Heritage significance.

No elements of the proposal are within the catchments of the pools associated with the gorges between the 24E and 37E deposits.

42 East Gorges – The upper catchment to the 42E gorges originates in the north-east of the mining tenement and flows in a southerly direction through the gorges, before flowing south easterly towards the confluence of Stony Creek and Turee Creek approximately 6kms downstream. A series of surface water pools (ERP1, ERP1a, ERP2, ERP3, ERP3b, ERP4, ERP5 and ERP6) are located within this gully system. The 42 East gorge pools are downstream of the existing 42E pit and the proposed 42EE deposit. The catchments of some pools (ERP1 to ERP3b) have already been modified by existing mining operations and will not be further impacted by the proposal. The remaining pools (ERP4 to ERP6) are not predicted to be directly impacted by the proposal, however catchments will be reduced as a result of the development of the 42EE deposit (Appendix D).

Photogrammetric Survey

Imagery derived from the photogrammetric survey is shown in Appendix A. The imagery is validated by multiple aerial captures of surface water occurrence. The images do not completely remove the issue of shadow and overhang, however pools can be seen and in some cases, small exposed pools formed by recent rain are evident in the imagery.

Pools Assessment

The photogrammetric survey identified eight potential new pools in the 47E and 50E gorges at Eastern Range. Features were given a unique identifier and have been confirmed through aerial imagery on at least one occurrence.

Two pools were identified in a gorge referred to as the 47E gorge (47E_1 and 47E_2). Development of the proposed 47E pits will result in minor reductions in contributing catchment area of these pools.

Six pools were identified in a gorge referred to as the 50E gorge (50E_3 to 50E_8). These pools will not be directly or indirectly impacted by the proposal as no mining is proposed in the 50E area.

Pool locations associated with the proposal (42E, 47E and 50E gorge pools) and the likely persistence of each pool are listed in Appendix C.

A qualitative assessment of pool persistence was completed. Each of the pools were assigned a value of very high, high, moderate, low or very low likelihood of persisting as a water body between wet seasons. Pools were assigned a higher likelihood of persistence based on physical properties including larger depths, surface areas, contributing catchments and shading. Field observations, particularly those where pools contained water over multiple site visits, were taken as indicative of high persistence. Field observations are available for the 42E gorge pools. For 47E and 50E gorge pools, persistence was assessed based on desktop information.

The assessment identified a series of pools. Whilst a number are exposed and ephemeral, the persistence of other pools suggests that surface water is present in Eastern Range between average wet seasons. The majority of pool features that have been identified are likely to be short lived, shallow pools exposed to direct sunlight. A qualitative assessment identified four pools which were typically deep and well shaded, with a high or very high likelihood of persisting between average wet seasons.

Water Quality

Water Quality sampling has yet to be undertaken for pools in 47E and 50E gorges. Water quality for other pools across the Paraburdoo region is discussed in *Greater Paraburdoo Surface Water Quality – Paraburdoo, Eastern Range and Western Range, June 2019* (RTIO-PDE-0168870).

Key Findings

Pool Setting -Pools at Eastern Range are associated with gorges and drainage lines creates sheer drops where high velocities and scour have formed pools. More persistent pools are associated with higher sheer drops where shading is more abundant and erosion has formed larger scour holes.

The assessment applied a similar method to the Western Range surface water assessment (RTIO-PDE-0166792), and located eight additional pools across two gorges. The majority of pool features that have been identified are likely to be short lived, shallow pools exposed to direct sunlight. A qualitative assessment identified four pools which were typically deep and well shaded, with a high or very high likelihood of persisting between average wet seasons.

Pools 50E_4 and 50E_5 were the largest in surface area (according to March 2017 aerial imagery) and also have the largest catchments.

Pool Abundance – based on previous (2017) and new information (April 2019), the prevalence of pools at Eastern Range appears to be similar to Western Range.

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RTIO-PDE-0143526 - Eastern Ranges Surface Pools Hydrochemical and Isotopic Conceptual Model

RTIO-PDE-0168870- Greater Paraburdoo Surface Water Quality – Paraburdoo, Eastern Range and Western Range

RTIO-PDE-0166792- Western Range Surface Water Assessment

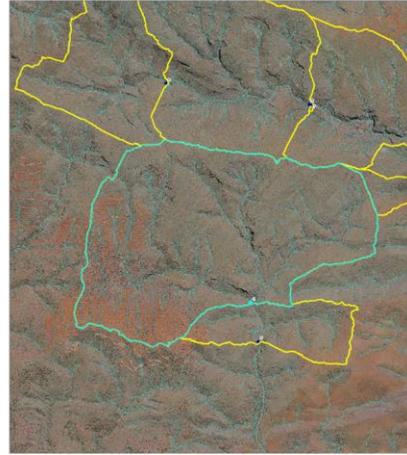
Appendix A – Photogrammetry and Aerial Imagery Capture

Pool 47E_1



Approx. 3m x 1m pool

RioTinto



Upper Catchment ~ 1.9km²

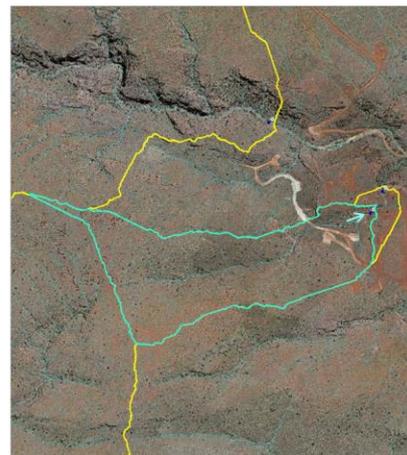
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Pool 47E_2



Approx. 2m x 1m pool

RioTinto



Upper Catchment ~ 0.1km²

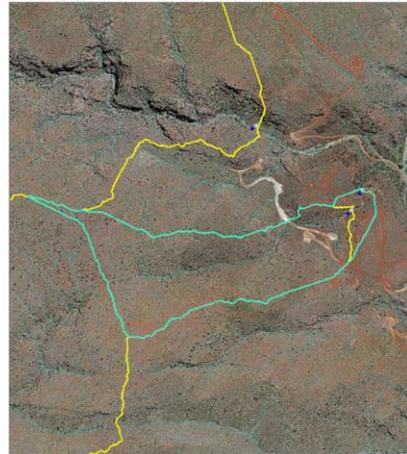
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Pool 50E_3



Approx. 2m x 1m pool

RioTinto



Upper Catchment ~ 0.1km²

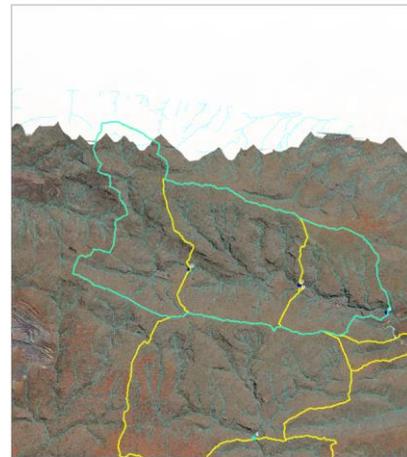
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Pool 50E_4



Approx. 5m x 5m pool

RioTinto



Upper Catchment ~ 2.6km²

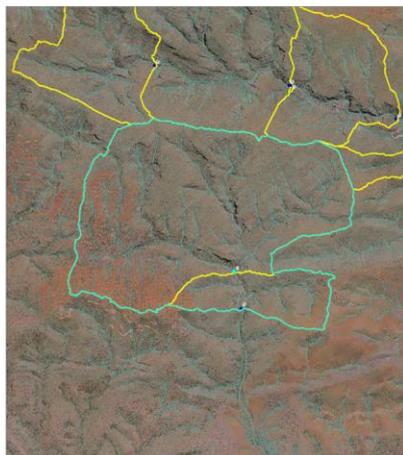
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Pool 50E_5



Approx. 10m x 3m pool

RioTinto



Upper Catchment ~ 2.2km²

| © Rio Tinto 2017

Pool 50E_6



Approx. 3m x 2m pool

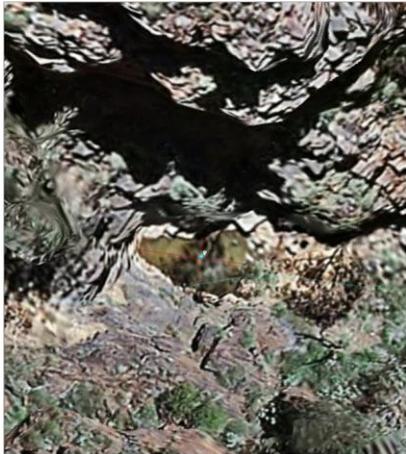
RioTinto



Upper Catchment ~ .0.9km²

| © Rio Tinto 2017

Pool 50E_7



Approx. 3m x 2m pool

RioTinto



Upper Catchment ~ 2.0km²

| © Rio Tinto 2017

Pool 50E_8



Approx. 9m x 2m pool

RioTinto



Upper Catchment ~ 2.0km²

| © Rio Tinto 2017

Appendix B - Eastern Range Antecedent Daily Rainfall for 16th April Aerial Imagery Capture

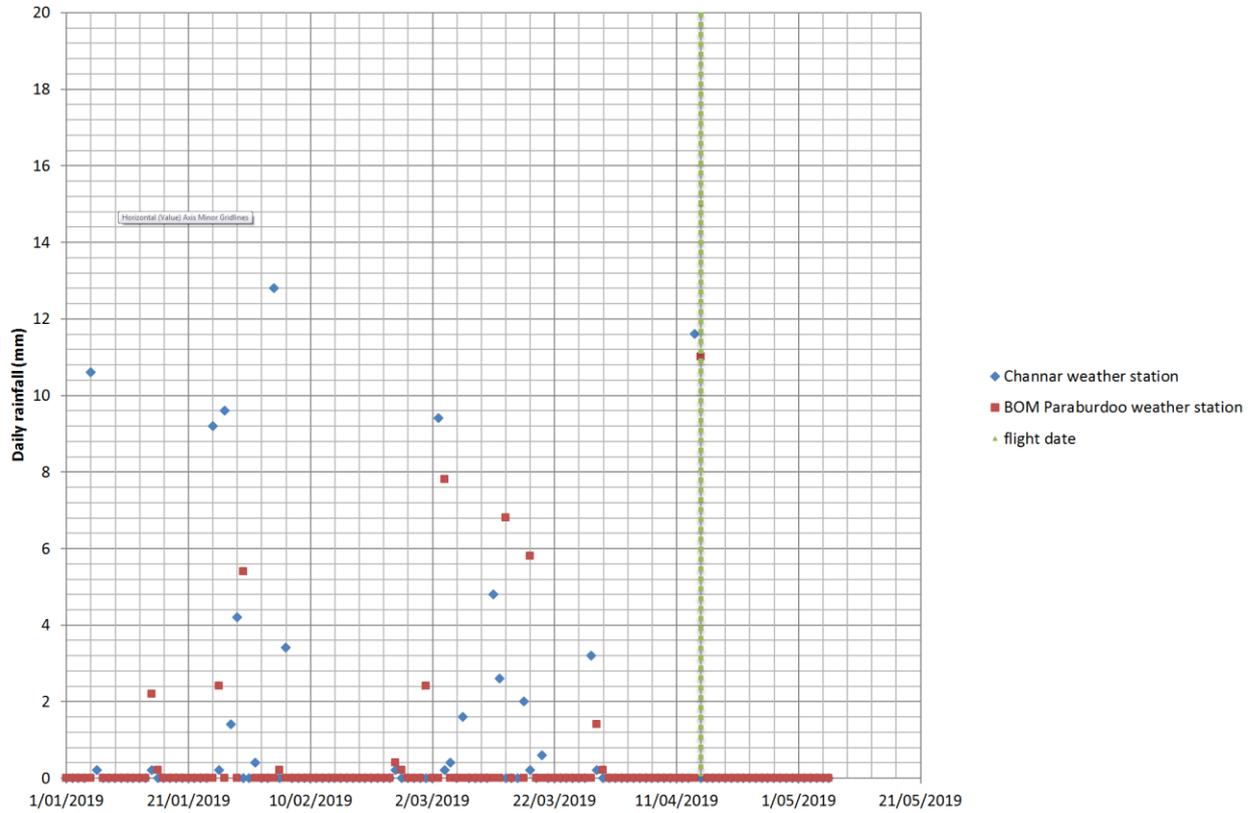


Figure 3: Antecedent rainfall records at closest Rainfall stations to the 50E gorges.

Appendix C – Pool Locations Associated with the Proposal

Gorge	Label	mE	mN	Impact	Likely Persistence
42E	ERP1	572079	7426376	Catchment reduced. No new impact	Moderate – Some persistence
42E	ERP1a	572104	7426377	Catchment reduced. No new impact	Moderate – Some persistence
42E	ERP2	572133	7426371	Catchment reduced. No new impact	Moderate – Some persistence
42E	ERP3	572244	7426315	Catchment reduced. No new impact	Very High – Potentially permanent
42E	ERP3B	572225	7426316	Catchment reduced. No new impact	Moderate – Some persistence
42E	ERP4	572316	7426259	Some catchment reduction	Very High – Likely permanent
42E	ERP5	571924	7425966	Some catchment reduction	Low – Some persistence
42E	ERP6	572512	7426354	Some catchment reduction	Moderate – Some persistence
47E	47E_1	573944	7425320	Minor catchment reduction	Low – Exposed, short term
47E	47E_2	573977	7425582	Minor catchment reduction	Low – Exposed, short term
50E	50E_3	575560	7426001	No direct or catchment impacts	Low – Exposed, short term
50E	50E_4	575591	7426044	No direct or catchment impacts	High – Semi-permanent
50E	50E_5	575406	7426255	No direct or catchment impacts	High – Semi-permanent
50E	50E_6	574780	7426712	No direct or catchment impacts	Low – Exposed, short term
50E	50E_7	574768	7426718	No direct or catchment impacts	Moderate – Some persistence
50E	50E_8	573903	7427144	No direct or catchment impacts	Moderate – Some persistence