# Technical Memorandum

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| **Date** | 14 December 2022 |
| **To** | WAIO Environment Approvals |
| **From** | Water Planning - Water Engineering |
| **CC** | Superintendent Environmental Approvals |
| **Subject** | Western Ridge: Surface water impact assessment update |

## 1 Purpose

To update the surface water impact assessment undertaken by AQ2 (AQ2 2021; Appendix A) for the Western Ridge Proposal, to include discussion on climate and update the predictions of changes to surface water availability for the current Indicative Footprint.

## 2 Climate

The eco-hydrological change assessment undertaken for the Strategic Proposal (BHP Billiton 2016; Appendix 7 *Main Report and Maps* and *Appendix F Ecohydrological Conceptualisation for the Eastern Pilbara Region*) provides a summary of climate and climate variability in the Pilbara, based on the CSIRO Pilbara Water Resource Assessment (WRA), for which a number of reports were published in 2015. The analyses undertaken for the Strategic Proposal included data up to 2013.

The climate in the Pilbara is semi-arid characterised by high temperatures and low, irregular rainfall. BHP noted in the Strategic Proposal documentation that the Pilbara experienced a relatively 'wet period' from the mid-1990s, shown by the 1995 - 2013 period compared to the previous long-term period at Ethel Gorge using the SILO enhanced climate database (BHP Billiton 2016; Appendix 7 Main Report). There are Bureau of Meteorology and Department of Water and Environmental regulation rainfall stations at Newman, less than 3 km to the north-east of Western Ridge. However, for consistency, BHP has used the SILO data at Western Ridge for rainfall and temperature as it provides a long-term data set (Queensland Government 2022).

Figure 1 shows that the average annual rainfall since 2014 is lower (325 mm/year) than the mean of 408 mm/year from 1995 to 2013. However, it is the same as the average of 325 mm/year for the CSIRO Pilbara WRA baseline period 1961-2012 (which climate change scenarios were compared against, and higher than the long term average (291 mm). This is also reflected in the 10-year moving average. Therefore, although there has only been nine years of data since the 'wet' period referred to in the eco-hydrological change assessment, there does not appear to be a step change to a dry phase.

The annual average daily maximum temperature shows an increasing trend since the early 1980s, with an average increase of approximately 0.9°C in the 10-year moving average since the early 1980s (Figure 2). Interestingly, the 'wet' period of very high rainfall occurred during the period of temperature rise.

### 2.1 Future climate predictions

The CSIRO Pilbara WRA used the period 1961 to 2012 as the baseline climate period (Scenario A) to compare future climate scenarios (Scenario Cs) as the recent record is likely to be more representative of future climate than early records. The CSIRO Pilbara WRA uses a high emissions scenario (representative concentration pathway RCP8.5) and mid-range scenario (RCP4.5) for predictions. RCP4.5 represents increased emissions of greenhouse gases until about 2040 and then reductions due to the implementation of mitigation, whereas RCP8.5 represents a future with little curbing of emissions and rapidly rising greenhouse gas concentrations. The WRA considered two periods for projected changes to rainfall, temperature and areal potential evaporation (areal PE): C30 to represent changes by 2030 (period 2021 to 2040) and C50 to represent changes by 2050 (period 2041 to 2060). For each of the periods, scenarios were run for the 10$^{th}$, 50$^{th}$ and 90$^{th}$ percentile rainfall totals (Cdry, Cmid and Cwet) (Charles *et al*, 2015).

The discussion in this document uses RCP4.5 (assuming there will be emissions reductions from about 2040). The range of projected annual rainfall changes for the Upper Fortescue region for the selected dry and wet scenarios from the 18 global climate models (GCMs) for RCP4.5 is between -6.2 % (Cdry) to 3.6% (Cwet) with a median (Cmid) of -0.2% for 2030 and between -7.1 % (Cdry) to 4.9% (Cwet) with a median (Cmid) of 0.2% for 2050 (McFarlane (ed.), 2015), emphasising the uncertainty in future rainfall predictions.

The median projected warming relative to the historical climate (mid-point in 1986) for RCP4.5 is 1.5°C for 2030 and 2.1°C for 2050. The areal PE changes are more consistent than those obtained for rainfall as they are a function of the consistently increasing trend in temperature projected by the GCMs. The range of projected annual PE changes for the Upper Fortescue region for RCP4.5 is 3.3% to 3.8% for 2030 and 4.0% to 4.7% for 2050 (McFarlane (ed.), 2015). Projections indicate that the Pilbara will become warmer and may become slightly drier by 2030 and 2050, although wetter projections cannot be discounted. There is not sufficient confidence in the projections to allow quantification of the probabilities of the wet or dry scenarios occurring in the future. (Charles *et al*, 2015). Therefore, it is not clear whether it will be wetter or drier. In general, the GCMs suggest that a drier future climate is more probable than a wetter climate (McFarlane (ed.) 2015).

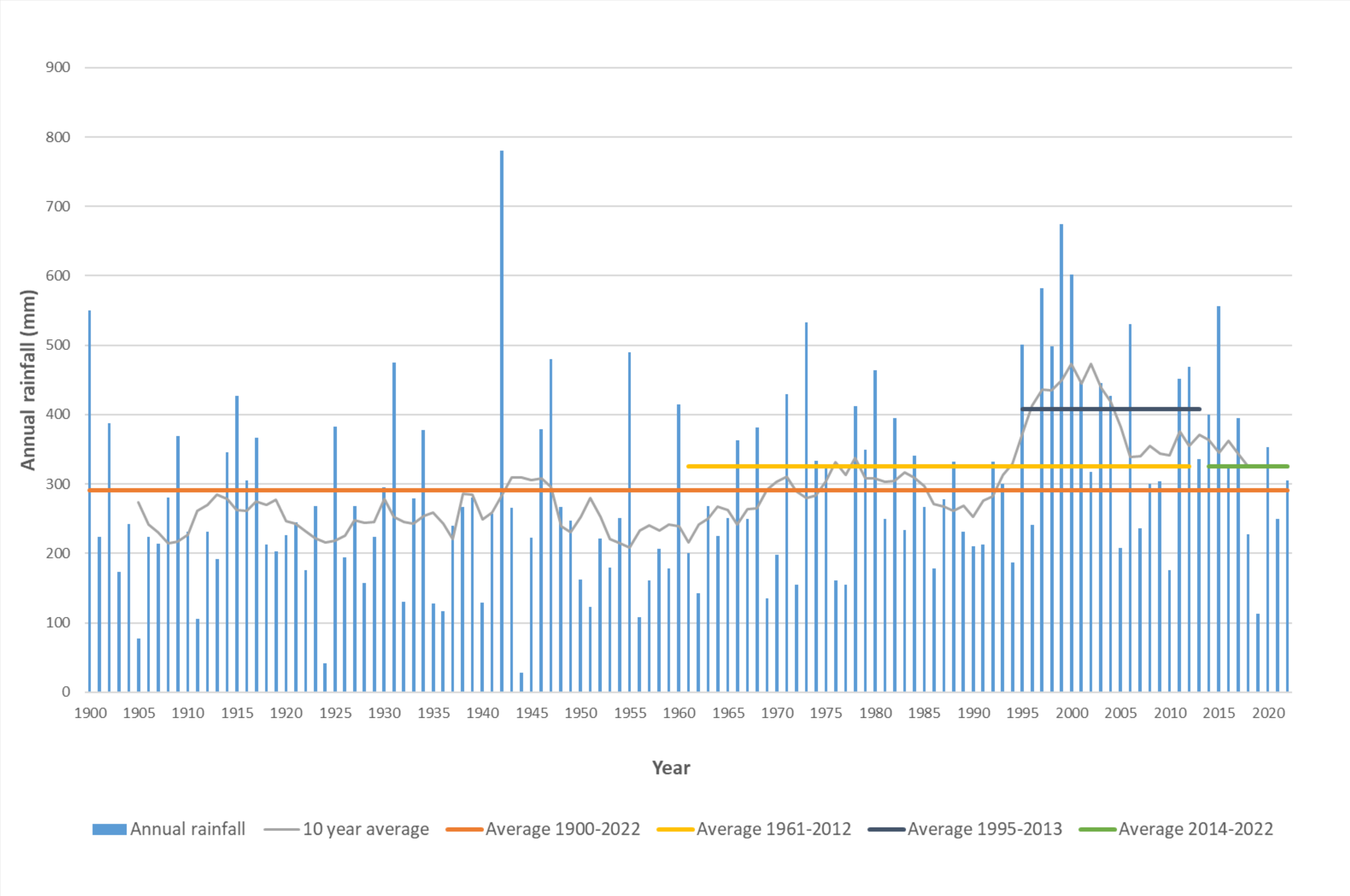



**Figure 1 SILO annual rainfall at Western Ridge**

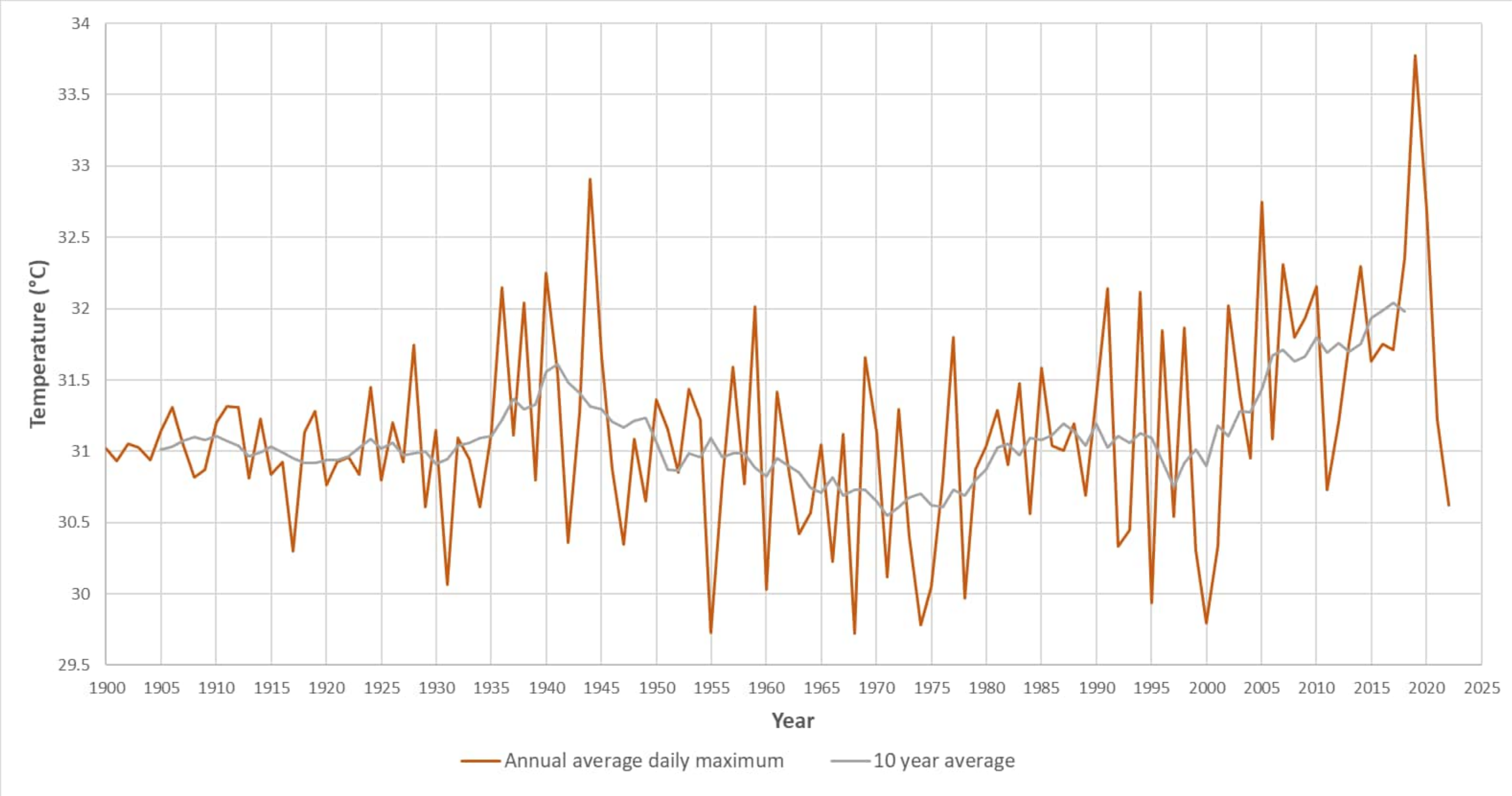



**Figure 2 SILO temperature at Western Ridge**

# 3 Surface water availability

## 3.1 Climatic influences on surface water availability

Western Ridge is located in the Fortescue regional subcatchment (Figure 3). Despite the higher rainfall in the higher elevation Hamersley Ranges west of Newman, the Upper Fortescue region has a lower runoff coefficient (runoff as a percentage of rainfall) than other regions in the Pilbara, with a mean annual runoff coefficient approximately 5% at the gauged catchment on the Upper Fortescue River (upstream of Western Ridge) (McFarlane (ed.) 2015).

Figure 4 shows the annual runoff and rainfall at the Fortescue River - Newman gauging station (708011), upstream of Western Ridge (and Ophthalmia Dam). Whilst there has not been the very high annual rainfall and runoff produced from the large cyclones around 1999/2000, rainfall and runoff from 2014 onwards since the wet period (1995-2013) is generally higher than for the 15 year period (1980-1994) preceding the wet period. Hence there does not appear to be a trend in rainfall and/or runoff decrease to date or return to a ‘dry’ phase.

The CSIRO Pilbara WRA modelled the response of surface water runoff under the projected future climate scenarios (as discussed in Section 2.1). For each 1% change in rainfall, runoff changes by about 3%. Local recharge from streambeds generally reduces by a much lower percentage than the same reduction in runoff. The analysis for the Upper Fortescue region shows that historical annual runoff for the Whaleback Creek catchment is between 15 and 20 mm/y. The 2030 and 2050 RCP4.5 Cwet scenarios remain within this range, with relative decreases for the Cmid and Cdry scenarios (10-15 mm/yr) (McFarlane (ed.), 2015). Given the uncertainty in the future rainfall predictions (Section 2.1) and that there does not appear to be a trend in rainfall and/or runoff decrease to date or return to a ‘dry’ phase, BHP has not made any quantitative changes related to climate to the calculations of surface water availability.

## 3.2 Changes to surface water availability

The developed conditions assume that any rainfall and external inflows contributing to the pits (Figure 5) will remain within the pits (unless pumped out). The developed conditions also assume that any rainfall contributing to the OSAs will be attenuated in crest bunding, toe capture drains and sediment basins. Therefore, no rainfall or runoff contributing to the pits or OSAs would contribute to peak flows in the impacted subcatchments. The local catchment contributing to Nankunya (Figure 5) is outside the Development Envelope and will not be impacted by changes to surface water flows.

Three mine scenarios were considered for the modelling to predict changes in surface water availability. These scenarios considered the following existing and planned major diversions (Figure 5):

- OB35 Phase 1 Diversion – existing diversion of Southern Creek that was constructed in 2020 to enable the safe mining of the approved and operational OB35 pit. It diverts the upper half of the Southern Creek catchment southwards into the Fortescue River catchment.

- OB35 Phase 2 Diversion – proposed to divert Southern Creek to the west over a backfilled section of the OB35 pit, to minimise creek runoff entering the OB35 pit (not part of the Western Ridge Proposal).

- Southern Creek Diversion - planned diversion of Southern Creek to the north of and around proposed Silver Knight (SC-1) and Eastern Syncline mine pits (SC-2).

The three mine scenarios modelled were:

- LOM Unmitigated – assumes the full life of mine (LOM) development (pits and OSAs), with the existing OB35 Phase 1 diversion but without implementation of the proposed OB35 Phase 2 Diversion or the Southern Creek Diversion.

- LOM Option 1 – assumes the LOM development with the implementation of the proposed Southern Creek Diversion.
- LOM Option 2 – assumes the LOM Option 1 but without the development of the Bill's Hill OSA (which occupies a large portion of the Southern Creek catchment).

Since AQ2 undertook the surface water impact assessment in 2021, BHP has revised the proposed mining disturbance footprint (Figure 5). BHP considers that any changes to peak flows and flood extents estimated by AQ2 as a result of the changes to the proposed mining areas will be minor. Therefore, this update relates only to changes to surface water availability from the loss of catchment area.

Table 1 and Table 2 present the modelled potential reduction in catchment and surface water availability for the three mine scenarios (at the local and regional scale respectively).

**Table 1: Potential reduction in surface water availability (local catchments)**

| Local catchment | Local catchment area (ha) | Mine scenario | Reduction in local catchment area (ha) | Reduction in local catchment (%) |
|---|---|---|---|---|
| Southern Creek subcatchment[1] | 2,987 | LOM Unmitigated | 2,482 | 83% |
| | | LOM Option 1 (Post-development) | 1,993 | 67% |
| | | LOM Option 2 (Post-development) | 1,637 | 55% |
| Impacted Whaleback Creek subcatchment[2] | 5,203 | All | 394 | 7.6% |
| Impacted Fortescue subcatchment[3] | 23,510 | All | 267 | 1.1% |

1. Catchment of Southern Creek drainage line (tributary of Whaleback Creek), located within Whaleback Creek subcatchment
2. Whaleback Creek subcatchment upstream of confluence with Southern Creek drainage line
3. Catchment of upper Fortescue River tributary, located within Fortescue subcatchment

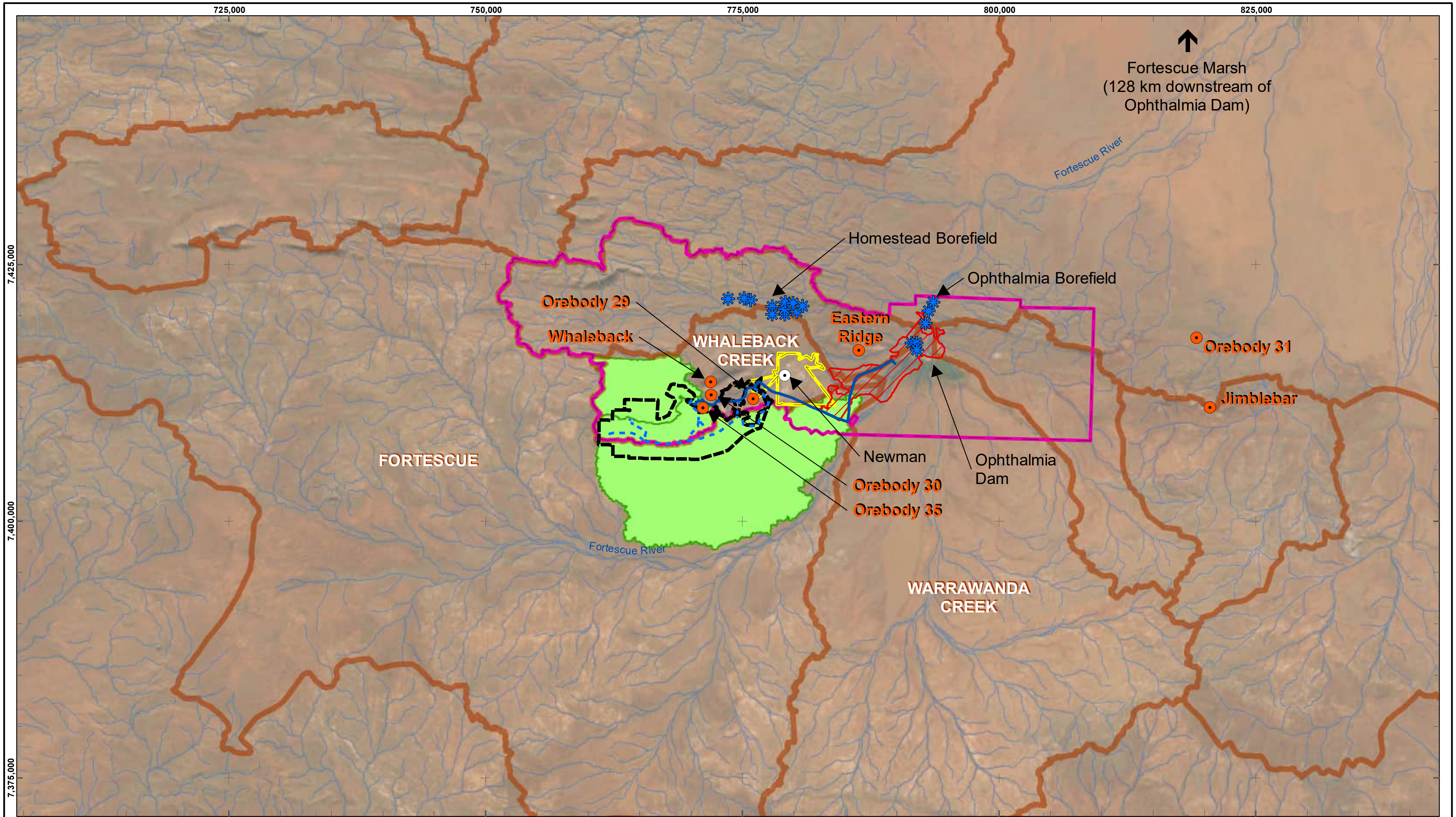
**Table 2: Potential reduction in surface water availability (local catchments)**

| Regional catchment | Regional catchment area[1] (ha) | Mine scenario | Reduction in regional catchment area[2,3,4] (ha) | Reduction in regional catchment (%) |
|---|---|---|---|---|
| Whaleback Creek subcatchment | 20,400 | LOM Unmitigated | 2,876 | 14% |
| | | LOM Option 1 (Post-development) | 2,387 | 12% |
| | | LOM Option 2 (Post-development) | 2,031 | 10% |
| Fortescue subcatchment | 288,400 | All | 267 | 0.1% |
| Ophthalmia Dam subcatchments[5] | 435,300 | LOM Unmitigated | 3,143 | 0.7% |
| | | LOM Option 1 (Post-development) | 2,654 | 0.6% |
| | | LOM Option 2 (Post-development) | 2,298 | 0.5% |

1. From *Pilbara Public Environmental Review Strategic Proposal* Appendix 7 (BHP Billiton 2016)
2. Reduction in Regional Whaleback Creek subcatchment area includes Southern Creek and Impacted Whaleback Creek local catchments
3. Reduction in Regional Fortescue subcatchment area includes Southern Creek and Impacted Whaleback Creek local catchments
4. Reduction in Regional Total Ophthalmia Dam subcatchment areas includes Southern Creek, Impacted Whaleback Creek and Impacted Fortescue local catchments
5. DWER Ophthalmia Dam hydrographic subcatchment - total of Whaleback, Fortescue and Warrawanda subcatchment areas (20,400 ha +288,400 ha + 126,500 ha)

At the local scale, the Western Ridge Proposal will alter local flow paths and runoff volumes and small, ephemeral drainage lines within the Development Envelope. The potential reduction in catchment area associated with the Proposal at the local scale is approximately 55% to 83% of the Southern Creek subcatchment, approximately 8% of the impacted Whaleback Creek subcatchment and approximately 1% of the impacted Fortescue subcatchment.

At the regional scale, the potential reduction is approximately 10 to 14% of the Whaleback Creek subcatchment, approximately 0.1% of the Fortescue subcatchment and less than 1% of the total catchment area contributing to Ophthalmia Dam (DWER Ophthalmia Dam hydrographic subcatchment). BHP notes that this reduction may be less or more if the future climate is wetter or drier.




- BHP operations
- Development Envelope
- Local subcatchments
- Regional subcatchments
- Ethel Gorge TEC
- Existing OB29/30/35 surplus water pipeline
- Newman Drinking Water Reserve P3
- Newman Drinking Water Reserve P1
- Potable Water Borehole
- Proposed Western Ridge surplus water pipeline
- Waterways

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# WESTERN RIDGE

## Regional hydrology

**PLANNING & STANDARDS - IRON ORE**

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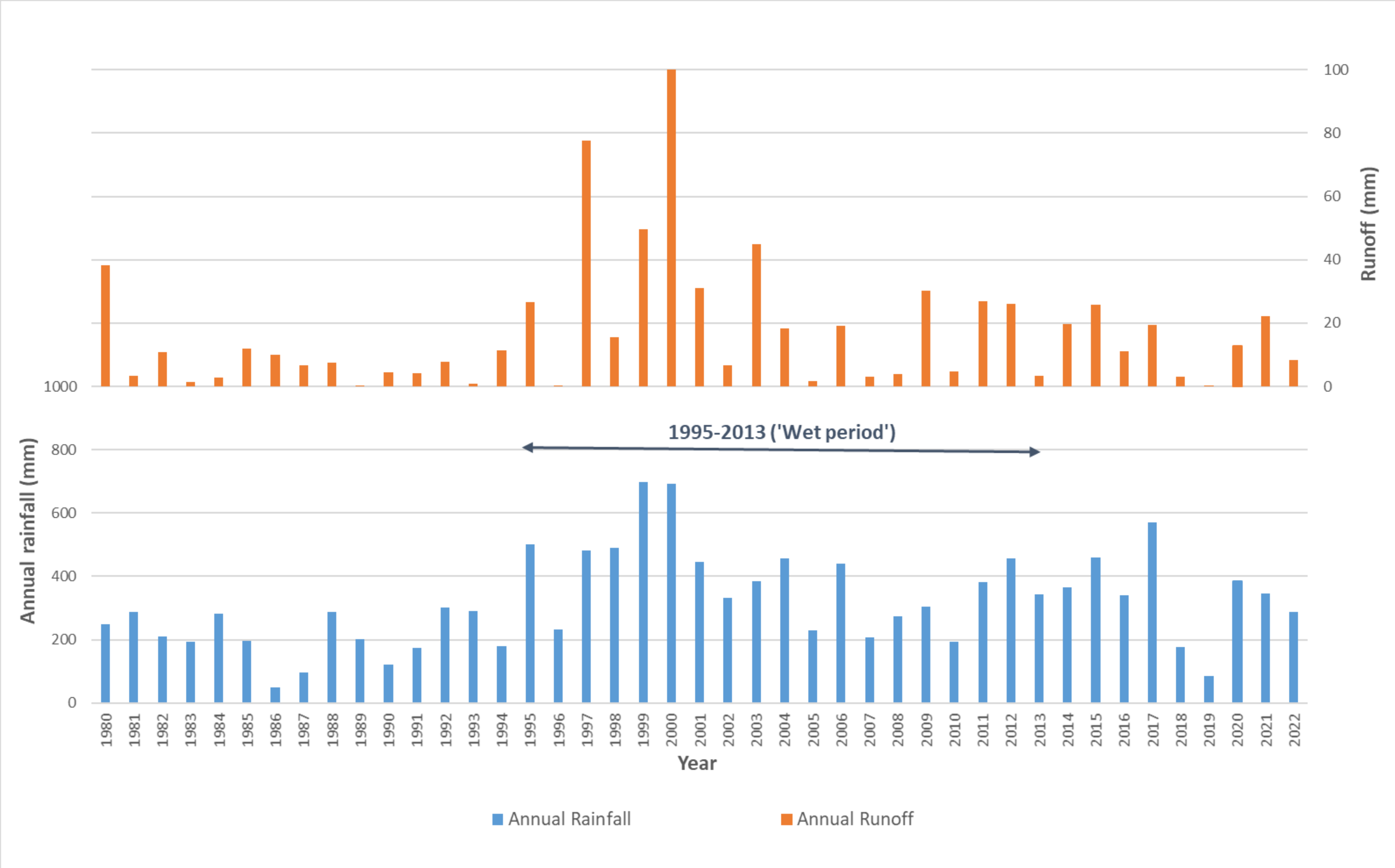
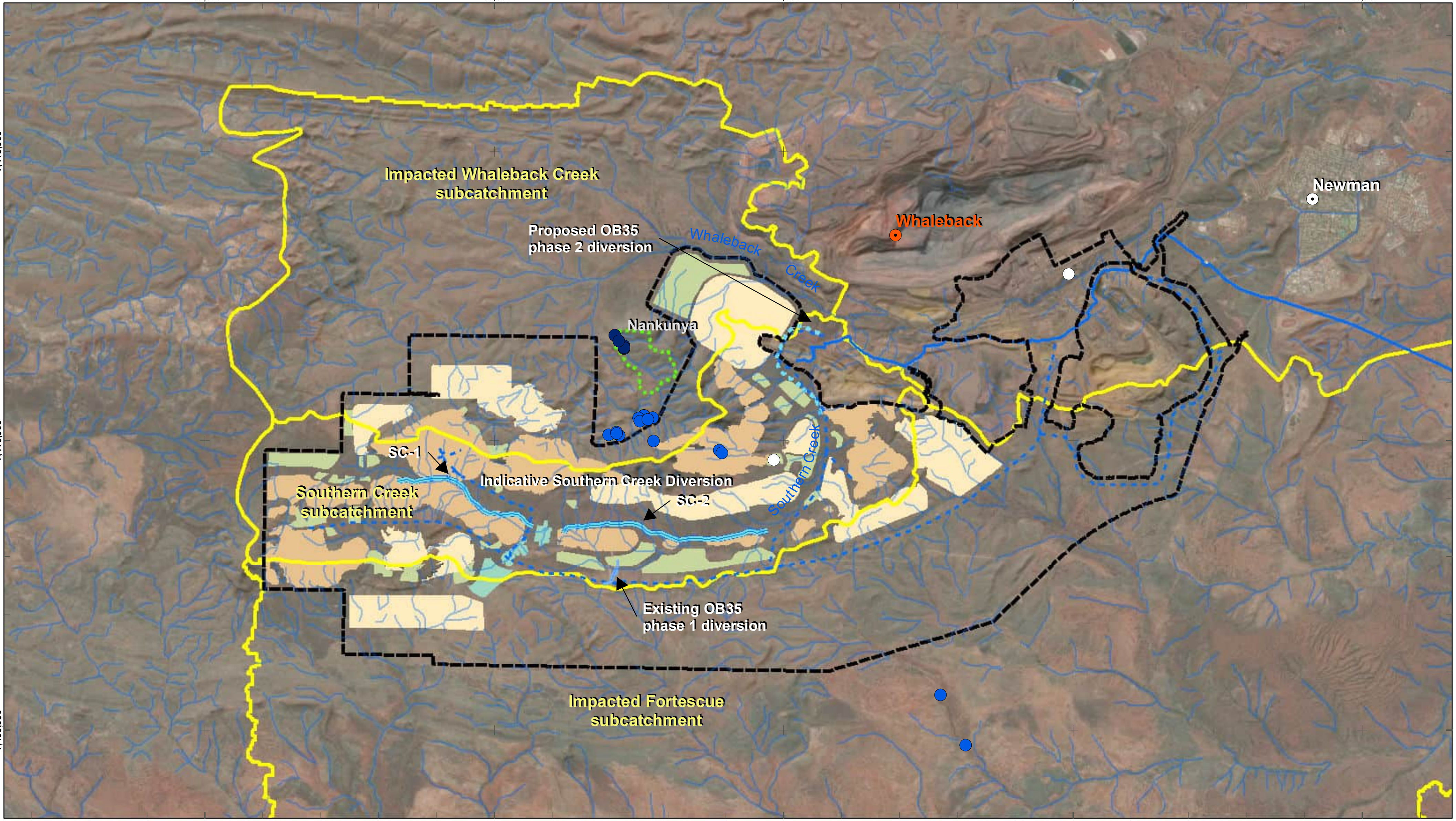



**Figure 4 Annual rainfall and runoff at Fortescue River - Newman station**




BHP operations
Development Envelope
Waterways
Existing OB29/30/35 surplus water pipeline
Nankunya catchment
Proposed Western Ridge surplus water pipeline
Indicative Southern Creek Diversion
Local subcatchments

Surface water feature
Artificial
Semi-permanent to permanent
Temporary

Proposed mining disturbance
OSA
Pit
ROM Pad
Topsoil storage

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# WESTERN RIDGE
## Local hydrology

PLANNING & STANDARDS - IRON ORE

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# 4 References

AQ2 (2021) *Surface Water Environmental Impact Assessment Newman Hub (Western Ridge)*. Report prepared for BHP.

BHP Billiton Iron Ore Pty Ltd (2016) *SEA Hydrology Ecohydrological Change Assessment*, ERD Appendix 7 Main Reports and maps, BHP, Perth, WA.

Charles SP, Fu G, Silberstein RP, Mpelasoka F, McFarlane D, Hodgson G, Teng J, Gabrovsek C, Ali R, Barron O, Aryal SK and Dawes W (2015) *Hydroclimate of the Pilbara: past, present and future. A technical report to the Government of Western Australia and industry partners from the CSIRO Pilbara Water Resource Assessment.* CSIRO Land and Water, Australia.

McFarlane DJ (ed.) (2015) *Pilbara Water Resource Assessment: Upper Fortescue region. A report to the Government of Western Australia and industry partners from the CSIRO Pilbara Water Resource Assessment.* CSIRO Land and Water, Australia.

Queensland Government (2022) SILO enhanced climate database hosted by the Science Delivery Division of the Queensland Government's Department of Science, Information, Technology, Innovation and the Arts (DSITIA) (https://www.longpaddock.qld.gov.au/silo/. Accessed 14 December 2022)

# 5 Appendices

Appendix A: *Surface Water Environmental Impact Assessment Newman Hub (Western Ridge)*. Separate document.