Ecological Risk Assessment

Norilup and Salt Water Gully Dams

Talison Lithium Pty Ltd

20 March 2025

→ **The Power of Commitment**

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1. Introduction

1.1 Overview

Recent water balance modelling of the Greenbushes Mine Site determined there will be shortfalls in the process water supply over the next few years (GHD 2023). To augment the supply, Talison Lithium Pty Ltd (Talison) intends to transfer water from the existing Norilup Dam and an existing farm dam on Salt Water Gully (SWG). In future, Talison also intends to construct the proposed SWG Dam downstream of the existing farm dams to facilitate increased transfers from SWG.

To determine the potential of these water sources to augment the process water supply, GHD Pty Ltd (GHD) undertook a water take study that determined the flow durations at the dam sites with a view of establishing the likely allocation limits (GHD 2024a). This study determined that the average annual supply from Norilup Dam and SWG Dam was 133 ML/year and 132 ML/year respectively.

Talison acknowledge that transferring water from Norilup Dam and SWG Dam to augment the process water supply may alter the hydrology of downstream waterways. As part of Talison's due diligence considerations, GHD was engaged to investigate the potential risks to ecological values downstream of the dams due to alterations in the hydrology. The risks to downstream water users were also considered as part of the study (the Study).

1.2 Purpose of this Report

The purpose of this report is to present the findings of the risk assessments of the potential impacts to ecological values and water users in waterways downstream of Norilup Dam and SWG Dam. Ultimately, the Study aimed to assess if the use of the dams as water sources to augment the process water supply will result in unacceptable risks to the ecological health and water users of the downgradient waterways due to changes in hydrology.

1.3 Approach to Study

To assess ecological and water user risks associated with changes to hydrology in waterways downstream of Norilup and SWG dams, this Study considered three main components that are illustrated in **Figure 1**. Further details on the approach for each of the three main components considered in this Study are outlined in **Section 2** through to **Section 5**.

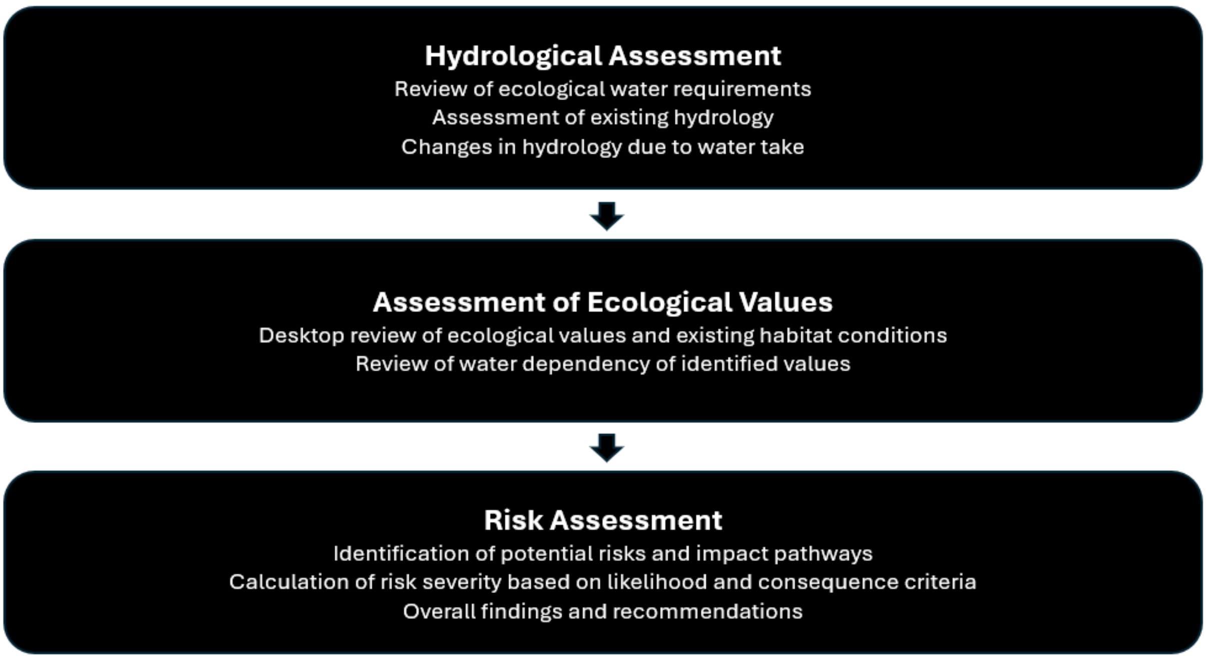

Figure 1: General Approach Adopted in this Risk Assessment Study

1.4 Scope and Limitations

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1.5 Assumptions

The assumptions associated with this Study and ultimately the risks to ecological values and downstream water users include:

- The findings of this Study are based on a desktop assessment only and no site visits or fieldwork were undertaken.
- The Study focusses on surface water values only and no assessment of impacts to groundwater or associated fauna (i.e., stygofauna) or groundwater users has been included.
- The Study has taken a broad catchment-scale approach with identified ecological values and water users considered present in the reaches downgradient of Norilup Dam (see **Figure 2**) and downgradient of SWG Dam (see **Figure 3**). This is a conservative approach in identifying risks as some ecological values and water users may not be present in all reaches.
- Water users in the assessed reaches has not been quantified with the assessment of risks based on the fact that landholders and other stakeholders use surface water for a range of domestic, irrigation and stock purposes. The identified risk rating may be lower than stated in this report if only small quantities (compared to waterway flow) of water are required and abstracted. That is, although flow may be reduced due to water take, there may be sufficient remaining to provide a source of water for landholders and other stakeholders.
- In all water take scenarios (see **Section 2.4**), the proposed SWG Dam was assumed to not overflow. This assumption is based on the outcomes of GHD's review of Talison's process water supply security which projected process water supply shortages and no overflows from the said dam until 2030 (GHD 2024b).

1.6 Study Area

The Study Area is within Blackwood River catchment which, according to the Department of Water and Environment Regulation (DWER), is 22,594 km^2 in extent and extends 300 km inland from the river mouth near Augusta (DWER 2024a). The catchment is the largest in the southwest of Western Australian. Climate is characterised by cool and wet winters, warm to hot and dry summers, and average annual rainfall ranges from 1,100 mm in the west to 400 mm in the east (De Silva et al. 2000; DWER 2024a).

The Blackwood River catchment includes the upper, middle and lower/coastal sub-catchments, with Norilup and SWG dams located within the middle sub-catchment. Land use in the middle sub-catchment includes intensive horticulture, viticulture, dairy and beef farming, and the milling of timber (De Silva et al. 2000; DWER 2024a).

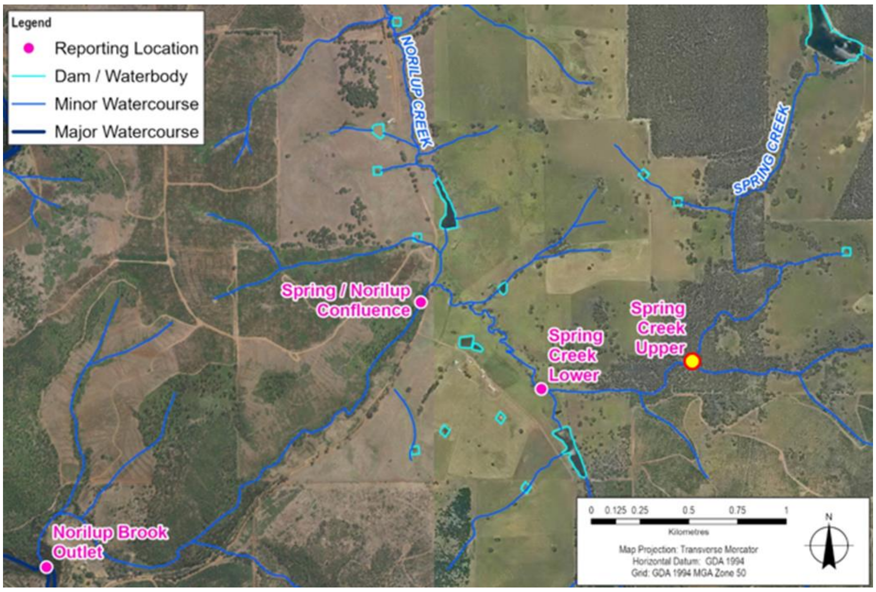

Figure 2: Locations of Assessed Reaches Downgradient of Norilup Dam

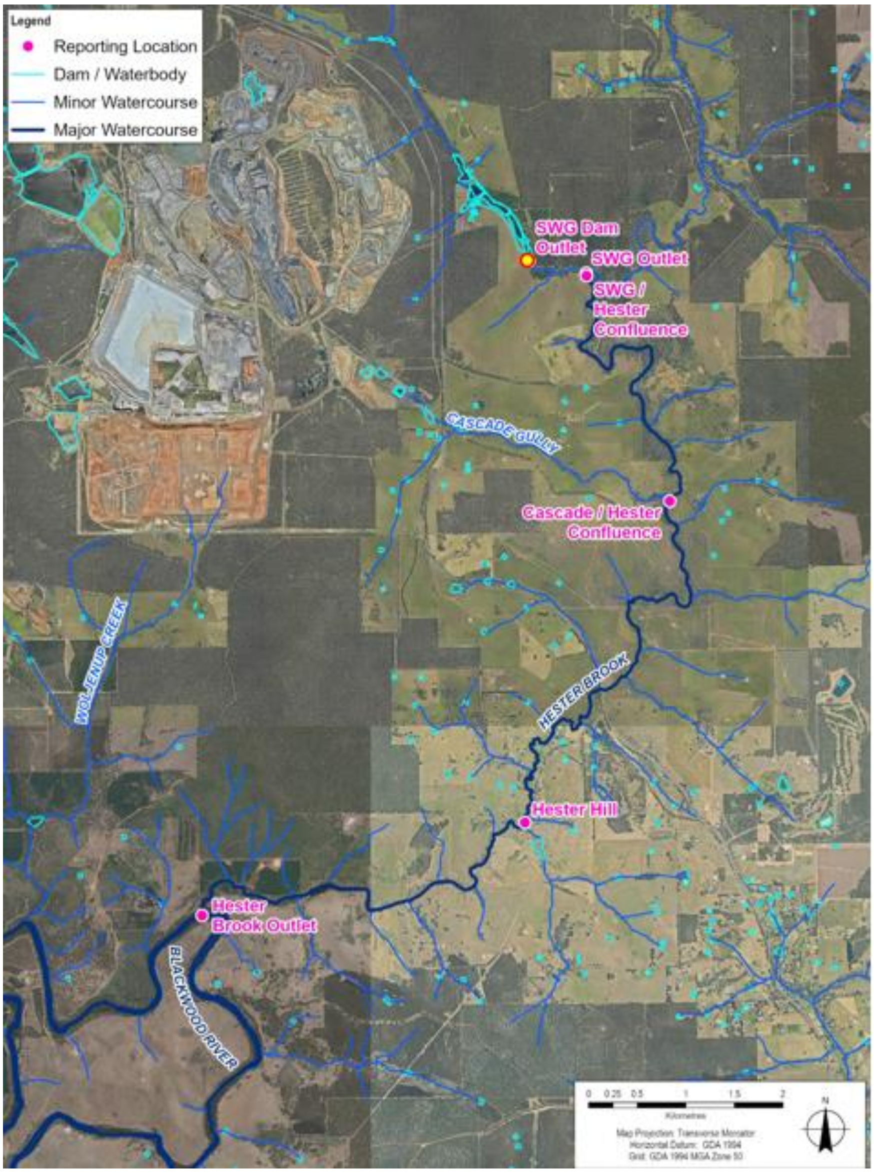

Figure 3: Location of Assessed Reaches Downgradient of Salt Water Gully Dam

Approximately 40% of the middle sub-catchment is covered in native vegetation, with 26% within State Forest or conservation estates (DWER 2024a). Elsewhere, the vegetation is fragmented and occurs as small remnants or along natural waterways and road reserves. As a consequence, much of the middle sub-catchment has issues with dryland salinity and the salinisation of waterways (Morgan et al. 2003; DWER 2024a).

The major tributaries in the middle Blackwood sub-catchment are Mullalyup Brook, Hester Brook, Gnowergerup Brook, Four Mile Gully, Dinninup Brook and Boyup Brook. Norilup Dam is located on Spring Creek that generally flows in a southwest direction before meeting Norilup Creek (see **Figure 2**). SWG Dam is located on Salt Water Gully, which discharges into Hester Brook (see **Figure 3**). Hester Brook and Norilup Creek are both tributaries of the Blackwood River.

2. Hydrology

2.1 Approach

Historical streamflows for the previous 20 years (2004 to 2023) were simulated at each reporting location (i.e., reach) using the Australian Water Balance Model (AWBM) and are shown in **Figure 2** and **Figure 3**. This approach is consistent to that adopted in previous water balance assessments undertaken for the Talison mine site by GHD. The catchment areas delineated for each reporting location are summarised in **Table 1**.

Table 1: Cumulative Catchment Areas for Nominated Reaches

Reach	Catchment area (ha)			
	Mine-affected / Cleared	External / Forested	Hardstand	Total
Salt Water Gully				
SWG Dam Outlet	180	932	-	1,112
SWG Outlet	180	1,071	-	1,251
SWG / Hester confluence	180	14,235	-	14,416
Cascade / Hester Confluence	221	15,210	-	15,431
Hester Hill	221	17,170	-	17,391
Hester Brook Outlet	221	18,284	-	18,505
Norilup Brook				
Spring Creek Upper	211	427	-	638
Spring Creek Lower	758	680	2	1,440
Spring / Norilup confluence	1,257	933	7	2,196
Norilup Brook Outlet	1,363	1,248	7	2,618

The input parameters to the AWBM were derived from the following GHD studies:

- Eastern Catchments Hydrology Study: Water and Mass Balance Modelling (GHD 2023).
- Talison Water Balance Assessment: Norilup Dam, Cemetery Dam, and Salt Water Gully Water Take Study (GHD 2024a).

The impacts of the existing farm dams immediately upstream of the proposed SWG Dam outlet were considered by representing them as a single lumped 300 ML storage. A daily water balance was subsequently performed on the lumped storage to determine its outflows. The total dam water surface area was noted to not vary seasonally and was fixed at 7.6 ha as measured from historical aerial imagery.

Norilup Dam is noted to overflow seasonally in both winter and spring and these overflows have been reflected in the simulated streamflows. Historical dam overflow records are only available from October 2018 to September 2024, which were too short to yield meaningful statistics for the purposes of this assessment.

To this end, the available spill records were analysed against various climate and derived variables, including rainfall, evaporation and runoff from the different surface types noted in **Table 1**. From this analysis, it was found that the mine-affected runoff was a reasonable proxy for overflows from the Norilup Dam. Assuming a linear relationship (see **Figure 4**), the runoff estimated from the AWBM was used to generate a long-term overflow record, which is then applied onto the downstream streamflow sequences.

The simulated streamflows are presented as monthly boxplots which should be interpreted as outlined in **Figure 5**.

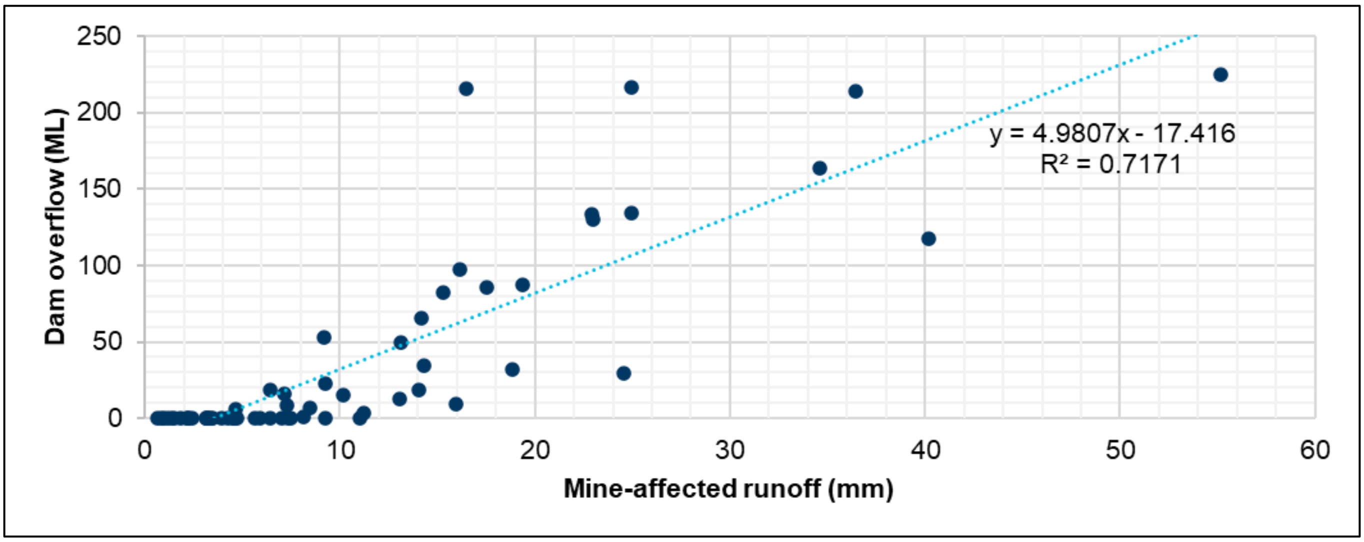

Figure 4: Relationship between dam overflows and mine-affected runoff

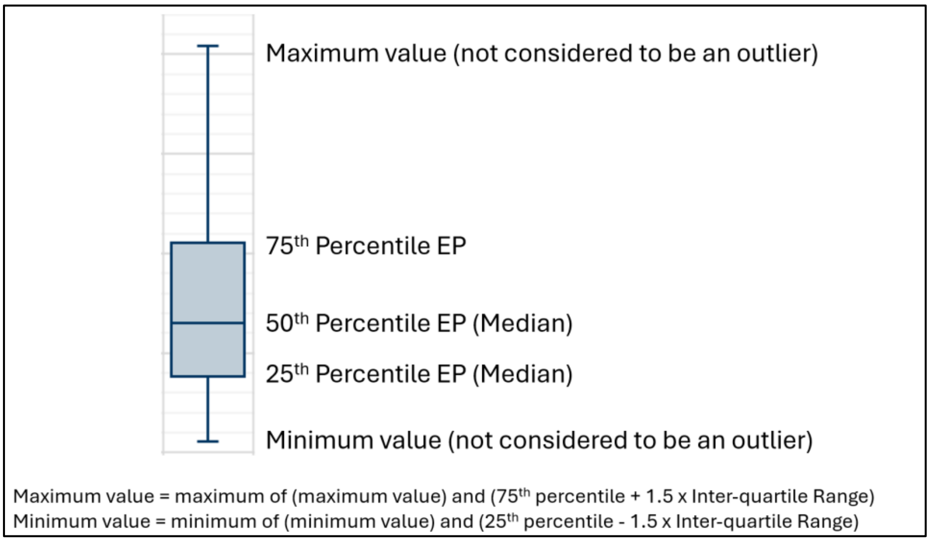

Figure 5: Boxplot Interpretation

2.2 Ecological Water Requirements

The main purpose of this Study is to determine if using the dams as water sources to augment the mine process water supply will result in unacceptable risks to the ecological health of the waterways and downstream water users due to changes in hydrology. As such, it is useful to first outline the Ecological Water Requirements (EWRs) and components of a flow regime that sustain waterway health.

As discussed by DWER (2024b), the EWRs that sustain the health of waterways requires consideration of the flow regime (quantity and timing of flows), water levels, and water quality. These factors, along with the presence of available habitat, play a pivotal role in the functioning of aquatic ecosystems. A conceptual model of ecological flows demonstrating the interactions between hydrology, habitat, and waterway health is provided in **Figure 6**.

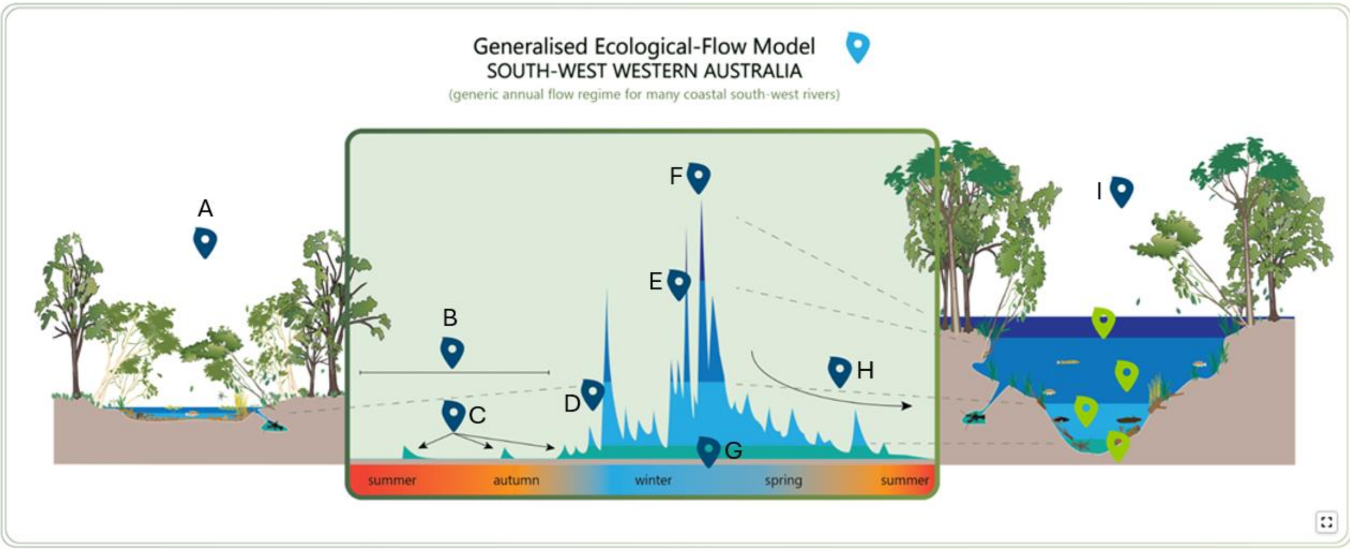

Figure 6: Conceptual Ecological Flow Model for Southwest Western Australia (DWER 2024b)

The letters depicting each habitat or flow component in **Figure 6** are explained as follows:

– **Habitats:**
  - **A - Riffles and runs**: Often an important seasonal habitat for fish (e.g., spawning and nursery areas) and macroinvertebrates.
  - **I - Permanent pools:** Dry-season refuge for species requiring permanent habitat that may support large numbers of aquatic species that have retreated from drying areas. Often depositional areas that require periodic scouring of sediment and organic matter during high flows, and often rely on freshening flows through dry season to maintain water quality.

– **Flow components:**
  - **B - Dry Season low to no flow periods**: Often occurs between late spring and autumn and may result in complete drying or low flows, although permanent pools may be present that support aquatic species adapted to these conditions. For example, most fish retreat to habitats such as refuge pools, crayfish may burrow to maintain connection with groundwater, and macroinvertebrates deploy several mechanisms to tolerate drought. Despite this, small changes in the flow regime such as increasing no flow periods can be detrimental (e.g., drying of refuge pools).
  - **C - Dry and early season freshening flows**: Periodic flow events through summer and autumn that provide flows for aquatic species constrained to dry season refuge areas. It plays a critical role in maintaining water quality and depth in permanent refuge areas (e.g., pools) though dry season. Flow events later in dry season, combined with reduced temperature and changes to diurnal period, are a cue for the coming wet season which will trigger various physical and behavioural changes in aquatic species (e.g., fish prepare for migrations to spawning grounds).
  - **D - Active channel flows**: Occur after onset of winter rains, typically through spring, and provide consistent flows in the active channel that are critical to support variety of waterway functions. Riffles and runs become inundated providing macroinvertebrate habitat as well as pathways for aquatic species to move between habitats (and away from resource and predation pressures of refuge pools). Can support fish migrations or provide breeding areas for non-migratory species.
  - **E - Bankfull flows**: Inundate channel to top of banks, typically following large rainfall events during peak of wet season. Increase connectivity and provide additional access to more distant foraging and spawning/nursery areas. Plays an important role in creating and maintain morphology such as scouring sediment and organic matter from refuge pools and channel, thereby creating additional channel features such as benches. Also provides later connectivity to riparian vegetation and other habitats.
  - **F - Overbank flows**: Flows that exceed channel capacity and provide water to off-channel areas such as wetlands and floodplains that may be important for fish and frogs. Lateral connections also provide

access to new food resources for aquatic species and allows them to negotiate barriers present at lower flows. Riparian and floodplain vegetation also require occasional inundation for successful recruitment and dispersal. They also assist in creating and maintaining channel morphology, and transport large woody debris and organic material that provide habitat and food for aquatic species. They are critical to instream processes although they may not occur every year.

- **G - Baseflow:** Refers to the flow sustained between rainfall events through delayed pathways such as subsurface flows.
- **H - Recession flows:** The period of flow recession at the end of the wet season and leading into the dry season that is critical for many species to retreat into larger, deeper and more permanent refuge areas. As such, the rate and period of flow decline is important to ensure species have the necessary flow signals, water depths and pathways to precent standing in unsuitable areas.

2.3 Existing Conditions

The conceptual ecological flow model provided in **Figure 6** is based on waterways in southwest Western Australia that experience a Mediterranean climate with cool and wet winters, and hot and dry and summers (DWER 2024b). Although in some years there is deviation away from this model due to climate, the waterways considered in this Study generally have a similar hydrological regime. This is demonstrated by the monthly ranges of the simulated daily streamflows in the furthest downstream reaches from Norilup and SGW Dams under existing conditions (i.e., in the absence of any water take) with increased flow during winter and little flow during summer (see **Figure 7**).

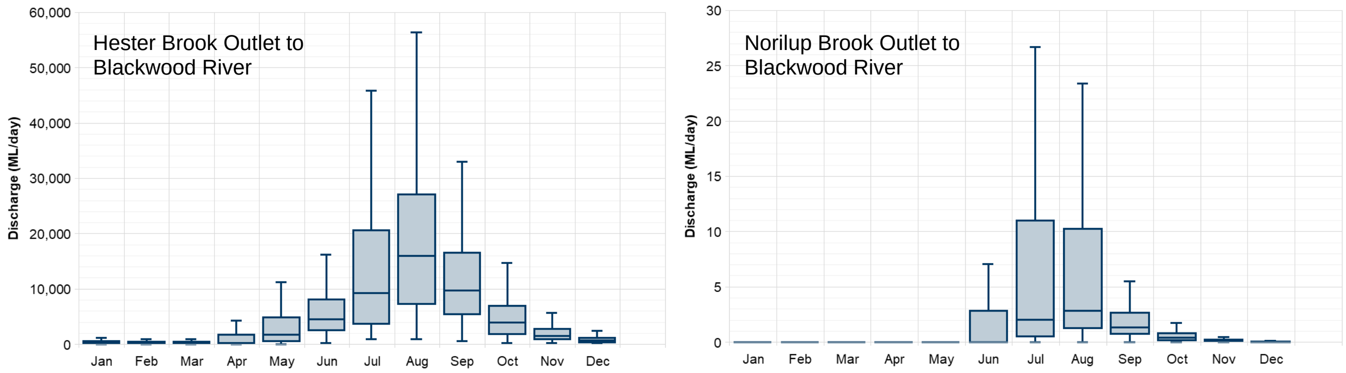

Figure 7: Boxplots Indicating Ranges of Daily Flows at Hester and Norilup Brooks (2004 to 2023)

GHD (2024a) found a similar pattern related to the historical inflows to Norilup and SWG dams (see **Figure 8**). Monthly statistics of the daily simulated flows indicate:

– The highest inflows occur in the winter months between July and September.
– June and October also have substantial inflows, but less than the median inflows during July to September.
– There are negligible inflows in the summer and shoulder months (November to May).

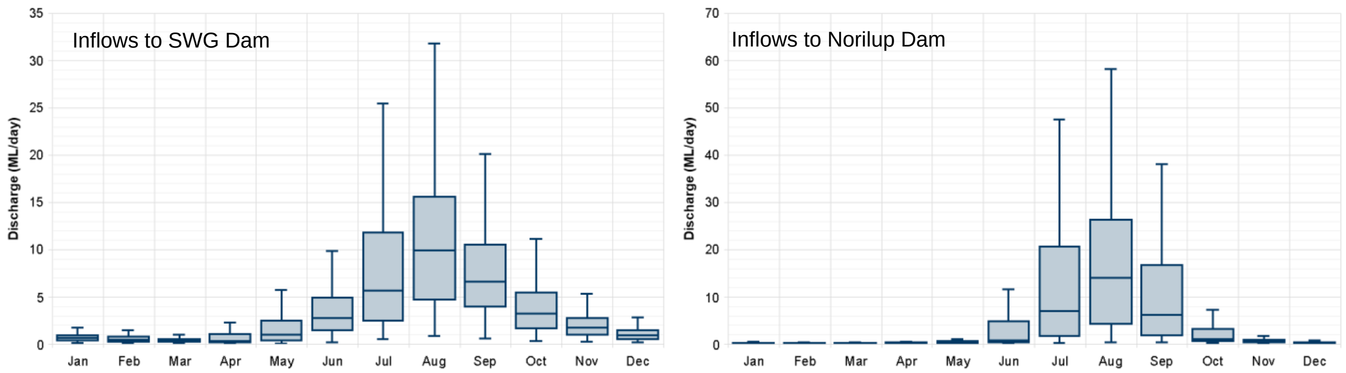

Figure 8: Boxplots Indicating Ranges of Daily Flows into SWG and Norilup Dams (2004 to 2023)

Based on this, the habitats and flow components discussed in **Section 2.2** are likely important in maintaining ecosystem health in waterways downstream of Norilup and SWG dams. Furthermore, given the inflows to the two dams also reflect the same hydrological patterns, further regulation of flows due to water take has the potential to impact the health of waterways by shifting the flow regime away from the normal historical patterns.

2.4 Changes Due to Water Take and Bypass

2.4.1 Salt Water Gully Dam

Three water take and bypass scenarios were simulated for SWG to determine changes in hydrology:

– Streamflows with no water take (i.e., the proposed SWG Dam is not present).

– Streamflows with water take at the proposed SWG Dam.

– Streamflows with water take at the proposed SWG Dam and a 20% bypass flow.

The no water take scenario reflects the current conditions, including the existing farm dams located just upstream of the proposed SWG Dam outlet. Streamflow modelling (as described in **Section 2.1**) indicates that these farm dams have minimal impact on the streamflow regime due to the small volumes (estimated to be at most 300 ML) compared to their inflows (median of about 134 ML/day).

Figure 9 compares the simulated streamflow at the proposed SWG Dam outlet with and without the existing farm dams. Considering the negligible difference between results (i.e., on average, less than 0.5% daily), assessing a scenario without these dams was deemed unwarranted.

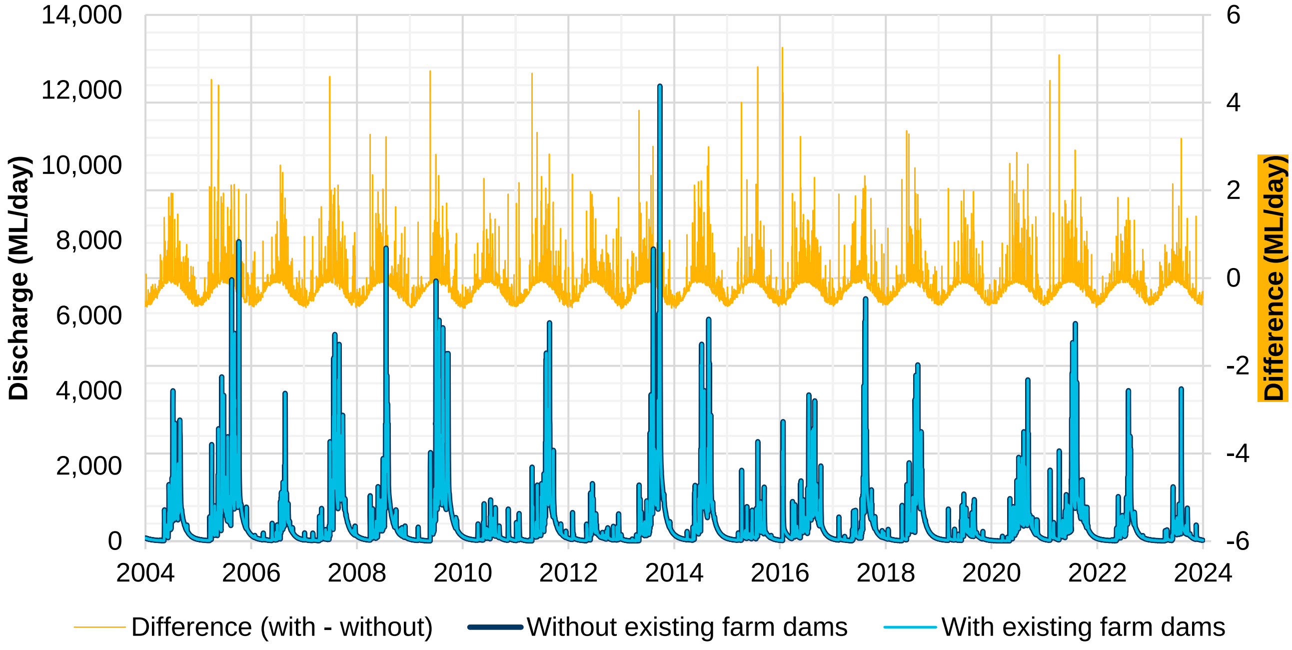

Figure 9: Simulated Daily Streamflow at the Proposed SWG Dam Outlet

Each of the scenarios listed above were assessed at the proposed SWG Dam outlet, and the five reaches downstream of the dam (see **Figure 3**). Box plots of the monthly ranges of the simulated daily streamflows for the three scenarios are presented in **Appendix A** for each reach and assessments thereof provided therein.

In summary, the most significant changes to hydrology are noted in the reach of SWG between the dam outlet and the confluence with Hester Brook. With water take and no bypass, median summer and winter flows are reduced to a maximum of ~5% and ~11% of existing conditions respectively. While a bypass increases the flows by a further ~20%, the median summer and winter flows do not exceed ~24% and ~29% of the existing conditions respectively. Within reaches further downstream, at least ~73% of the existing median summer flows and ~92% of winter flows are retained without a bypass. The bypass contributes a maximum of an additional ~13% and ~2% to the median summer and winter flows respectively.

2.4.2 Norilup Dam

Norilup Dam is an existing structure which does not include facilities to release water downstream, and retrofitting a bypass arrangement is not proposed. Water has been taken occasionally from Norilup Dam in the past. As such, the hydrological regimes in the reaches downstream of the dam have been impacted for a significant length of time and, as a result, the associated ecosystems have adapted or vanished. To this end, the assessment of the hydrological conditions is limited to the current conditions (i.e., streamflows with occasional water take) which have been assessed against the simulated inflows to Norilup Dam (see **Figure 8**). These comparisons of flows provide an insight into how the dam regulates downstream water flow under current conditions. They do not assess how downstream water flow will change due to further water take as was done for SWG.

Streamflows for the current conditions were assessed at the four reaches downstream of Norilup Dam (see **Figure 2**). Box plots of the monthly ranges of the simulated daily streamflows are presented in **Appendix B** for each reach and assessments thereof provided therein.

Although the seasonal pattern in flows downstream of Norilup Dam are retained, they are of a much lower magnitude than would occur in the absence of the dam. As would be expected, the impact to the flow regime is greatest in the upper Spring Creek reach, with other sources of water increasing the flows in reaches further downstream. However, there is still a noticeable effect of flow regulation at the most downstream reach (i.e., outlet of Norilup Brook to Blackwood River). Median summer and winter flows are only ~4% and ~17% of the Norilup Dam inflows respectively in the upper Spring Creek reach, which increases to ~13% and ~50% respectively at the Norilup Brook confluence with the Blackwood River.

The results discussed above suggest that there is a greater impact on streamflows during summer and the dryer periods of the year. However, there is already negligible streamflow in the summer and the shoulder months from November to May (GHD 2024) and the median inflows are only 0.22 ML/day. Consequently, there is little flow in waterways downstream of Norilup Dam with the regulation of flows mainly reducing flows during the wetter periods of the year.

3. Ecological Values

3.1 Approach

A desktop assessment was undertaken to identify the ecological values in the Study Area. The Protected Matters Search Tool (PMST) and Atlas of Living Australia (ALA) databases were interrogated to identify additional values within a 10 km buffer of the Study Area. In addition, ecological surveys and assessments commissioned by Talison were reviewed to identify values known to be present in the Study Area.

3.2 Threatened Species

3.2.1 Overview

The searches of the PMST and ALA databases identified the presence of 15 species listed under either the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and/or the Western Australian *Biodiversity Conservation Act 2016* (BC Act) within a 10 km buffer of the Study Area. A list of these species is provided in **Table 2**. Of these, only the two invertebrate species and the one fish species are aquatic fauna that are water dependent. SLR (2024b) indicates that only Carter's Freshwater Mussel (*Westralunio carteri*) and Rakali (Water-rats - *Hydromys chrysogaster*) are likely to occur within the Study Area.

Table 2: Search Results of PMST and ALA Databases

Scientific Name	Common Name	Count	EPBC Act status	BC Act Status	Source
Invertebrates					
Cherax tenuimanus	Yabbies	2	CE	CE	ALA
Westralunio carteri	Carter's Freshwater Mussel	3	V	V	ALA, PMST
Fish					
Galaxias occidentalis	Western Galaxias	5	CE		ALA
Mammals					
Bettongia penicillata ogilbyi	Woylie		E		PMST
Dasyurus geoffroii	Chuditch, Western Quoll		V		PMST
Dasyurus geoffroii fortis	Western Quoll	2	V	V	ALA
Hydromys chrysogaster	Water-rat (Rakali)	2		Priority 4	ALA
Isoodon fusciventer	Southwestern Brown Bandicoot	5		Priority 4	ALA
Macrotis lagotis	Bilby	3	V	V	ALA
Myrmecobius fasciatus	Numbat	1	E	E	ALA, PMST
Notamacropus irma	Western Brush Wallaby	5		Priority 4	ALA
Pseudocheirus occidentalis	Western Ringtail Possum	1	CE	CE	ALA, PMST
Setonix brachyurus	Quokka		V		PMST
Reptiles (snakes)					
Notechis scutatus	Tiger Snake	1	V		ALA
Pseudonaja affinis	Dugite	14		Priority 4	ALA
CE = Critically Endangered, E = Endangered, V = Vulnerable					

The mammals and reptiles identified in the database searches may be indirectly impacted by changes in hydrology through pathways such as a loss of drinking water sources. However, except for Water-rats (Rakali), they have not been considered further in this Study that focuses on water dependent species. Rakali were considered as they have more of a direct relationship with waterways than the other mammals.

3.2.2 Carter's Freshwater Mussel

Carter's Freshwater Mussel has undergone a severe decline in range in Western Australia over the last 50 years (Klunzinger et al. 2015) but are known to occur in the Blackwood River catchment and the ALA database includes a record in Hester Brook.

The species habitat preferences include fine grained substrates and the presence of woody debris, in areas close to river banks (Ma et al. 2022). The preference for fine substrates differs to many other freshwater mussel species that are reported to prefer coarser substrates. The fine substrate preference for Carter's Freshwater Mussel may be due to the need to burrow into the substrate to survive droughts during cease-to-flow periods that are common in Western Australian waterways (Ma et al. 2022). Fine substrates may also contain more organic matter as a food source for filter-feeding mussels (Lara and Parada 2009). The presence of woody debris may assist the species in avoiding rapid flows where they may be washed away (Strayer 1999; Maloney et al. 2012) and also provide better food resources (Morales et al. 2006). Being close to the banks of waterways may also be hypoxia-avoidance strategy, with deeper habitats more likely to contain reduced dissolved-oxygen saturations, as a result of water column stratification (Quinlan et al. 2015).

The larval stage of this species (known as glochidia) relies on host fish for recolonisation of waters with the glochidia released by females in strings of mucus that attached to fish (TSSC 2018). Confirmed host species for glochidia includes Freshwater Cobbler, Western Pygmy Perch and Gambusia (Klunzinger et al. 2012; 2015). As such, barriers to the free passage of fish, including low flows due to damming or abstraction, may also restrict the distribution of the mussels.

Primary threats to the species include the loss of habitat due to the regulation of waterway flows and salinisation (TSSC 2018; Ma et al. 2022). Secondary threats include nutrient pollution, loss of suitable host species, cattle tramping and predation by feral pigs (TSSC 2018). Carter's Freshwater Mussel can potentially survive the drawdown of river pools; however, it is unable to withstand extreme drying without shade for more than 5 days, and also appears intolerant of salinity greater than ~3,000 uS/cm (Klunzinger et al. 2014).

3.2.3 Rakali (Water Rats)

Rakali has a broad distribution across the southwest of Western Australia and is also found in all other Australian states and territories, as well as Papua New Guinea and Indonesian West Papua (DWER 2023). Although recent surveys did not observe this species (SLR 2023, 2024), the ALA includes several records in Cascade Gully and Hester Brook. Biologic (2011, 2018) determined that due to suitable habitat it is likely Rakali are present in the Greenbushes area, including along Hester Brook.

Rakali are typically associated with permanent waters including rivers and streams but will venture into temporary waterways in search of food (Scott and Grant 1997). They also utilise a wide variety of man-made waterbodies or modified habitats such as irrigation channels, reservoirs and farm dams (Watts and Aslin 1981). In Western Australia, Rakali have been found to prefer feeding in relatively shallow water near the banks (Harris 1978; Speldewinde et al. 2013) and places where reed beds or other low-growing vegetation provide plenty of cover on or near the banks (Smart et al. 2011; Speldewinde et al. 2013). Breeding can occur throughout the year, but more typically in spring. They build nests at the ends of tunnels dug into banks near tree roots or in hollow logs, with some found in dense stands of reeds (Speldewinde et al. 2013; Williams and Serena 2018).

General threats to their distribution include habitat reduction through the loss or degradation of streamside habitat, flood mitigation and loss of waterway flows, and salinisation (Smart et al. 2011; Speldewinde et al. 2013). Other threats include salinisation, the drying of waterways during cease-to-flow periods, and predation (DWER 2024c).

3.3 Invertebrates

Recent aquatic ecosystem monitoring (SLR 2023, 2024) has determined the Study Area contains relatively diverse macroinvertebrate communities that are dominated by insects (80% of taxa), with other taxa scarce and mainly water mites and aquatic snails. Most macroinvertebrate taxa were common, ubiquitous species, with distributions extending across southwestern Australia, Australasia, and the world (i.e., cosmopolitan species). Fourteen southwest WA endemic species were recorded in the macroinvertebrate samples, namely:

– Beetles - *Batrachomatus nannup, Limbodessus inornatus, Sternopriscus browni, Sternopriscus marginatus*
– Midgefly larvae - *Polypedilum nubifer, Stempellina australiensis*
– Dragonfly larvae - *Procordulia affinis, Austrosynthemis cyanitincta*
– Stonefly larvae - *Newmanoperla exigua*
– Caddisfly larvae - *Lectrides parilis, Notalina* spp. AV14, *Notoperata tenax*
– Amphipods - *Perthia acutitelson*
– Shrimp - *Palaemonetes australis*.

Some Ephemeroptera, Plecoptera and Trichoptera (EPT) taxa that are considered sensitive to water quality impacts were recorded in the Study Area. However, low SIGNAL2 scores suggest that the community composition is mostly composed of bugs tolerant to water quality impacts (SLR 2023). Several other crayfish species are also known in the study area including:

– Marron (*Cherax cainii*)
– Yabby (*Cherax destructor*)
– Koonac (*Cherax preissii*).

3.4 Fish

Five native fishes have been recorded in the broader Study Area during the most recent monitoring program (SLR 2024a). These were the Western Pygmy Perch (*Nannoperca vittata*), Western Minnow (*Galaxias occidentalis*), Nightfish (*Bostockia porosa*), Bluespot goby (*Pseudogobius olorum*), and Freshwater Cobbler (*Tandanus bostocki*).

Western Pygmy Perch are a common and widespread species endemic to the southwest of Western Australia. SLR (2024a) recorded 660 individuals across 13 sites. The species occurs in a range of flowing and non-flowing freshwater habitats, usually amongst aquatic vegetation, and will tolerate slightly brackish waters and temperatures between 2ºC and 32ºC (Bray and Thompson 2019; NFA 2024). Spawning occurs in small side creeks and flooded streams from July to November, with a peak spawning period in September and October (Bray and Thompson 2019). However, an extended spawning season between July to February has also been reported (NFA 2024). Risks to this species includes habitat loss due to salinisation, land clearing, eutrophication, competition, and predation (IUCN 2019a).

The most abundant native fish found is the Western Minnow with SLR (2024a) recording 723 individuals across 9 sites. This species inhabits streams, swamps, lakes, and rivers and are typically found swimming in schools in the upper water column. They prefer clear freshwater but can tolerate acidic, brackish, and tannin-stained conditions. Mark-recapture has demonstrated that this fish migrates at least 5 km upstream with the help of their slender body shape and ability to leap from the water (DWER 2024d). It spends it entire life in freshwater (Gomon and Bray 2020).

Eighteen Nightfish were also recorded across two sites (SLR 2024a). This species prefers still and slow-moving waters with in-stream habitats of rocks and woody debris. It moves upstream to breed in August and September as winter rains begin and temperatures and daylight length increase (DWER 2024e; Thompson and Bray 2024). One of the threats to this species is the invasive Eastern Gambusia (*Gambusia holbrooki*) by fin-nipping. Additionally, the European perch (*Perca fluvatilis*) poses a threat due to predation. Aside from invasive species, threats to the species includes drying habitats due to climate change and salinisation (IUCN 2019b).

SLR (2024a) recorded 33 Bluespot Gobies across two sites. It has preference from estuaries to freshwater areas to hypersaline lakes and mangroves at depths of 0-3 m. This species may occur in areas where secondary salinisation has occurred. This species spawns between spring and autumn in upper reaches of estuaries depositing eggs amongst aquatic vegetation (DWER 2024f; Bray and Gomon 2022).

Freshwater Cobblers are nocturnal and prefer deep, slow-flowing waters in streams, large rivers, creeks, dams, and lakes. This species can migrate over 8 km or more and are tolerant of brackish conditions. Mass movement upstream is usually observed during night and periods of higher water levels (i.e., winter) to either feed or spawn. Spawning usually occurs during spring and summer after migration. The larvae of Carter's freshwater mussels are commonly found on its fins and body appearing as small white pimple-like spots (DWER 2024h; Gomon and Bray 2016).

3.5 Turtles and Frogs

The native Southwest Long Necked Turtle (*Chelodina colliei*) was recorded by SLR (2024a) with 12 individuals found across four sites. This species lives in a broad range of seasonal and permanent freshwater habitats including lakes and rivers bust spends most of its life in wetlands. Moreover, it is capable of living in urban and agricultural environments. Breeding occurs within wetlands during winter and spring, while nesting occurs during spring and summer. Nesting is cued by seasonal rain-bearing low pressure systems, barometric pressure, and air temperatures above 17°C. They have the ability to colonise other habitats during wetter months and aestivate during dry periods (DWER 2024g).

Frog species were also recorded by SLR (2024a) which included Motorbike Frogs (*Litoria moorei*), Slender Tree Frogs (*Litoria adelaidensis*), and Bleating Froglets (*Crinia pseudinsignifera*). Motorbike Frogs often occur in swamps, lakes, farm dams, garden ponds, and on vegetated watercourses. It breeds through spring to summer and often calls from floating vegetation or within reed beds (Western Australia Museum 2014a). Slender Tree Frogs are found in permanent and season waters (i.e., streams, dams, and shallow soaks). They are more often found in vertical reeds and sedges. Breeding begins from winter to early spring, and they often call from elevated perches or from the base of dense vegetation (Western Australia Museum 2014b). Bleating Froglets are common around dams, lakes, temporary swamps, and inundated roadside verges. Breeding takes place from winter into early spring but may start in autumn in the far south of its range. Eggs are often found in small clumps at the edge of soaks, swamps, streams, and pools on outcrops (Western Australia Museum 2014c).

3.6 Wetlands of National and International Importance

There are no Ramsar, Directory of Important Wetlands in Australia (DIWA), or Environmental Protection Policy (EPP) listed wetlands within the immediate vicinity of the Study Area. The closest Ramsar site, the Vasse-Wonnerup System, is located more than 50 km away towards the coastline and will not be affected changes in hydrology.

3.7 Groundwater Dependent Ecosystems

No Groundwater Dependent Ecosystems (GDEs) were identified in Cascade Gully or along Hester Brook downstream of the confluence of these waterways (Bureau of Meteorology's Groundwater Dependent Ecosystems Atlas).

3.8 Habitat Conditions

The habitat conditions in each of the reaches assessed in the hydrology analysis (see **Section 2**) documented by SLR (2024a) in their spring 2023 aquatic ecosystem monitoring report have been summarised in **Appendix C**. The habitat conditions are required to inform the risk assessment and the potential impacts to habitat due to changes in hydrology.

4. Downstream Water Use

Talison (2023) completed a survey of water uses in the catchments downstream of the Mine Site in 2020 (see **Figure 10**). The survey included 37 different landholders and included landholders downstream of both Norilup and SWG Dams. The survey results have been included in the risk assessment to identify how the altered hydrology in the waterways downstream of Norilup and SWG dams may impact water use. A summary of the survey results is:

- 31 properties have a residence and 27 have rainwater tanks as a source for drinking water.
- Five properties have springs as a source for drinking water with 2 properties having this as their only source (an additional property also had a well).
- Two properties use surface water as a drinking water source (limited to Maranup Brook and Winter Creek).
- 32 properties have dams with the number of dams per property ranging from 1 to 14.
- 25 properties have a surface waterway on the property, including Norilup Creek, SWG, Hester Brook, and Blackwood River.
- Several of those 25 properties access or store water from Norilup Creek, Hester Brook, and Blackwood River for domestic, irrigation, stock watering, or recreation uses.
- On a scale of 0 (no reliance) to 5 (total reliance), the 25 properties that directly access or store water had an average score of 4.2 with no responses indicating they had zero reliance on the water.
- Many responses indicated that low flows and associated increases in salinity and algal blooms limit their use of water at times.
- Nine properties have groundwater bores with the number of bores ranging from 1 to 3.
- The properties with groundwater bores use the water for domestic, irrigation, and stock watering.
- On a scale of 0 (no reliance) to 5 (total reliance), the nine properties that have groundwater bores had an average score of 4.1 with no responses indicating they had zero reliance on the groundwater.
- Many responses indicate that low groundwater levels limited their use of bore water at times.

The above demonstrates that surface and groundwater resources in the area are important to the local community. Further, the community is aware of issues impacting waterway health that is conveyed through comments provided by landholders as part of the survey, including:

- *"[Water] quality and flow rate are all important and are not to be tampered with."*
- *"The water quality on our property is of utmost importance all year round, any degradation would be catastrophic."*
- *"Any issues with the water quality and quantity will be of great consequence to our business."*
- *"Good flows all year are important. Very important resource for business and household."*
- *"…reduced water flow into salt water gulley, will inadvertently affect our water supply."*

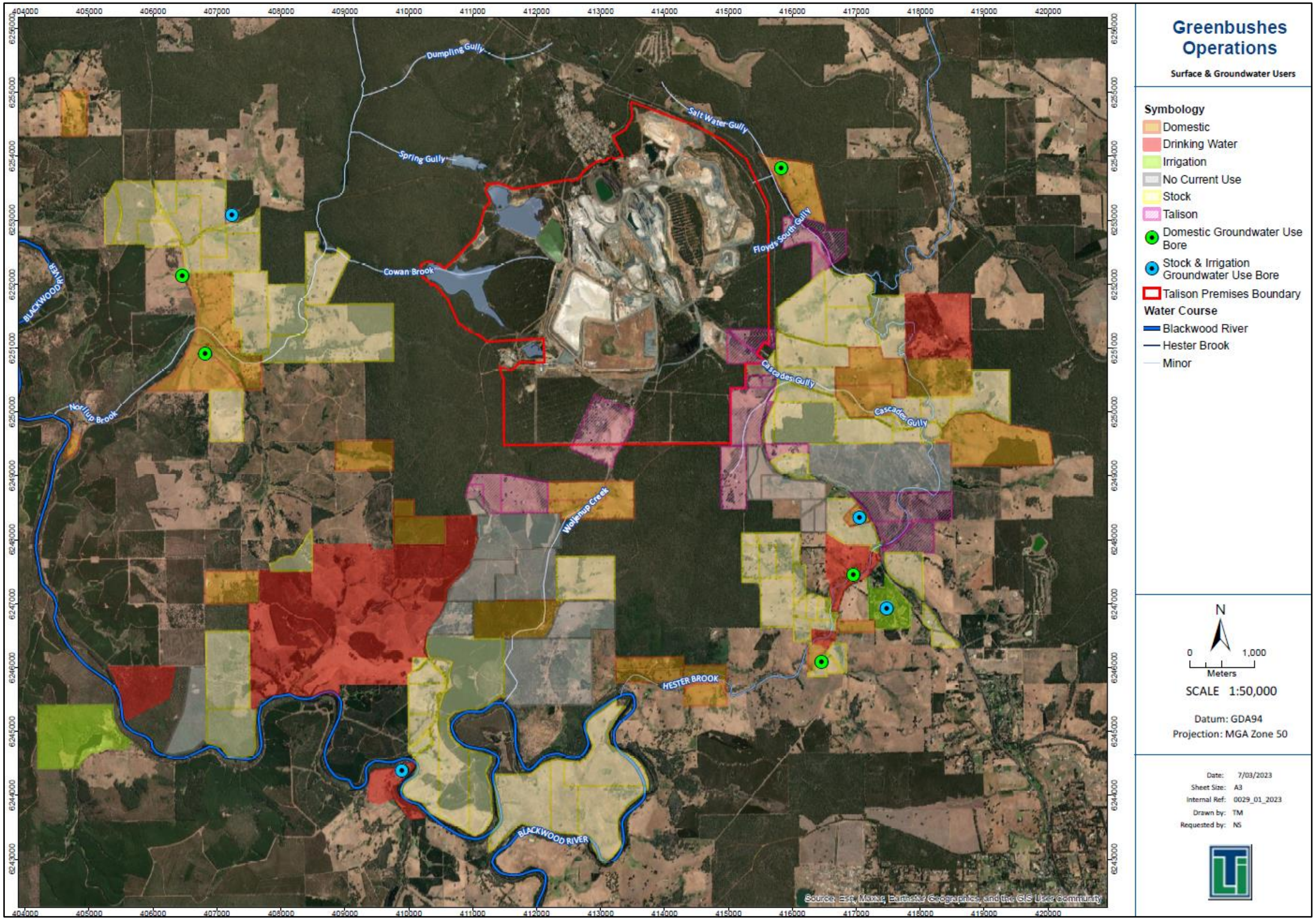

Figure 10: Results of Water Use Survey (Talison, 2023)

5. Risk Assessment

5.1 Approach

The approach to the risk assessment was broadly consistent with the *Guideline – Risk Assessments* (DWER 2020). This guideline was adopted since it describes how DWER applies regulatory controls for works approvals and licences granted under the *Environmental Protection Act 1986* (EP Act). As such, the findings from the risk assessment could be used to inform future approvals and licence applications by Talison if required. Based on DWER (2020) the general approach to the risk assessment was to:

- Identify risk events though source-pathway-receptor analysis.
- Use consequence criteria (**Table 3**) and likelihood criteria (**Table 4**) to determine a risk rating (**Table 5**).
- Determine the need for treatment of risks (**Table 6**), suitable controls and a residual risk rating.

Table 3: Consequence Criteria

Consequence	Criteria
Severe	Onsite impacts: catastrophic Offsite impacts local scale: high-level or above Offsite impacts wider scale: mid-level or above Mid to long-term or permanent impact to an area of high conservation value or special significance Specific Consequence Criteria (for environment) are significantly exceeded
Major	Onsite impacts: high level Offsite impacts local scale: mid-level Offsite impacts wider scale: low-level Short-term impact to an area of high conservation value or special significance Specific Consequence Criteria (for environment) are exceeded
Moderate	Onsite impacts: mid-level Offsite impacts local scale: low-level Offsite impacts wider scale: minimal Specific Consequence Criteria (for environment) are at risk of not being met
Minor	Onsite impacts: low-level Offsite impacts local scale: minimal Offsite impacts wider scale: not detectable Specific Consequence Criteria (for environment) likely to be met
Slight	Onsite impact: minimal Specific Consequence Criteria (for environment) met

Table 4: Likelihood Ratings

Rating	Criteria
Almost certain	The risk event is expected to occur in most circumstances
Likely	The risk event will probably occur in most circumstances
Possible	The risk event could occur at some time
Unlikely	The risk event will probably not occur in most circumstances
Rare	The risk event may only occur in exceptional circumstances

Table 5: Risk Rating Matrix

Likelihood	Consequence				
	Slight	Minor	Moderate	Major	Severe
Amost certain	Medium	High	High	Extreme	Extreme
Likely	Medium	Medium	High	High	Extreme
Possible	Low	Medium	Medium	High	Extreme
Unlikely	Low	Medium	Medium	Medium	High
Rare	Low	Low	Medium	Medium	High

Table 6: Risk Treatment

Risk rating	Acceptability	Treatment
Extreme	Unacceptable	Risk event will not be tolerated, and application may be refused by regulators.
High	May be acceptable subject to multiple regulatory controls	Risk event may be tolerated. Regulators may apply multiple regulatory controls, including both outcome-based and management conditions.
Medium	Acceptable, generally subject to regulatory controls	Risk event is tolerable. Regulators may apply some regulatory controls, including outcome-based conditions where practicable and appropriate.
Low	Acceptable, generally nor controlled	Risk event is acceptable. Generally, regulators will not apply regulatory controls.

The risk assessment matrices and results are included as appendices as follows:

– **Appendix D**: SWG Dam.
– **Appendix E**: Norilup Dam.
– **Appendix F**: Downstream water uses.

Note that the risk assessment is high level and conservative in that it assumes that the aquatic values identified in **Section 3**, and the other downstream water users identified in **Section 4**, are present or possibly present in all the reaches considered in the hydrological assessment in **Section 2**.

5.2 Risks to Ecological Values

5.2.1 Salt Water Gully Dam

For SWG Dam, the hydrology assessment determined that highest risks due to changes in hydrology will occur in the most upstream reach between the SWG Dam and the confluence of SWG with Hester Brook. Further downstream, flows are more comparable to existing conditions due to incremental flows from other areas (e.g., tributaries and groundwater). As a result, the risk assessment has not been undertaken for all reaches downstream of SWG Dam and was only undertaken for the most upstream reach (i.e., in SWG between the dam and confluence with Hester Brook) and for all other reaches combined (i.e., in Hester Brook downstream of the confluence with SWG).

Medium to high inherent risks were identified in SWG between the dam and confluence with Hester Brook due to water take with no bypass. This is due to the loss of all flows immediately downstream of SWG dam, with only ~3% to ~5% of summer flows and ~11% of winter flows remaining at the end of the reach. In summary, the main risks to the health of the waterway due to change in hydrology may occur due to the following:

- A loss of riffle and/or run habitats that are a known habitat type in the reach (high risk) and pool habitats (medium risk).
- A loss of habitat and connectivity due to cease-to-flow periods or low flows that could impact macroinvertebrate communities (high risk) and the native fish (high risk).

- A loss of habitat and connectivity due to cease-to-flow periods or low flows that could impact the threatened Carter's Freshwater Mussel and Rakali (medium risk).

Riffles and runs provide crucial habitats for various aquatic organisms, including macroinvertebrates and fish, and may be essential for feeding, breeding, and shelter. SLR (2024a) determined that they support a diverse range of macroinvertebrates, and the Western Pygmy Perch have also been recorded in the reach. The loss of these habitats can also impact water quality given riffles assist in aerating water, thereby increasing dissolved oxygen. They also provide areas of high primary production that supports the food web by providing habitat for algae and other microorganisms that form the base of the aquatic food chain. Overall, the loss of riffles and runs can disrupt the balance of aquatic ecosystems and affect a range of components including water quality and the survival of various species.

Pool habitats are not a major component of this reach (SLR, 2024a), which reduces the likelihood of an impact, but may they be present during higher flow periods. Similarly, the likelihood of risks to threatened species have been reduced as their presence within the reach has a possible likelihood.

A 20% bypass would provide additional water to the reach and result in a decrease in the likelihood of impacts for riffle and/or runs, and pool habitats. Although the overall flow conditions at the end of the reach (SWG Outlet) are reduced compared to current conditions (i.e., median summer flows ~22 to 24% and winter ~29%), these low flows are not uncommon for the waterway (see **Appendix A**). The residual risks to all sensitive receptors is medium with a 20% bypass.

Further downstream, the risks to all ecological values in the absence of a bypass were determined to be medium given changes in hydrology are not as substantial due to incremental inflows. At least ~73% of summer flows and ~92% of winter flows would remain. With a 20% bypass flow, all residual risks are reduced to a low residual risk as the majority of both summer and winter flows would remain.

5.2.2 Norilup Dam

As discussed in **Section 2.4.2**, the hydrological assessment of Norilup Dam was based on extent to which the dam regulates downstream flows as water is already diverted on occasion, and there is no bypass planned.

The hydrological assessment determined that flow downstream of Norilup Dam has been impacted for a significant length of time. For example, in the most upstream reach between the dam and Spring Creek Upper, median flows in summer and winter only around 4% and 17% of the inflows to the dam respectively. Due to this, the associated ecosystems downgradient of the dam have already been impacted due to flow regulation and the flora and fauna in this reach have previously adapted to these conditions or vanished.

The main existing risks to the health of the waterway due to presence of Norilup Dam may occur due to the following:

- A loss of riffle and/or run habitats that are a known habitat type in the reach and pool habitats
- A loss of habitat and connectivity due to cease-to-flow periods or low flows that could impact macroinvertebrate communities and the native fish
- A loss of habitat and connectivity due to cease-to-flow periods or low flows that could impact the threatened Carter's Freshwater Mussel and Rakali.

Given the above, it is expected that further water take from the dam is unlikely to further impact on the aquatic ecosystem and waterways health. The inherent and residual risks for the downgradient waterways are considered low.

5.3 Risks to Downstream Water Users

Surface water was identified to be important to the local community as a source of drinking water, irrigation, stock watering, recreation, and other domestic uses. The community is also well aware of issues impacting waterway health due to changes in hydrology.

The inherent risks to water users, although conservative, were determined to be high in waterways downstream of both SWG and Norilup dams. This is due to the major influence that water take has on the hydrology and presence of surface water. Even with a 20% bypass in SGW, the reduced flow and surface water may impact the ability of landholders and other stakeholders to access water.

6. Conclusions and Recommendations

6.1 Conclusions

Inflows to SWG Dam and Norilup Dam are indicative of waterways that experience a Mediterranean climate with cool and wet winters, and hot and dry and summers. As a result, the waterways in the Study Area have increased flow during winter and little or even no flow during summer. Under natural conditions, aquatic ecosystems have evolved and adapted to intermittent flow though several strategies including:

- Some macroinvertebrates can enter a state of dormancy during dry periods, while other can rapidly recolonise once water returns.
- Biofilms can show significant plasticity, can adjust their structure and function in response to changing water availability, and maintain ecosystem processes like respiration even during cease-to-flow periods.
- Some fish and other aquatic fauna may migrate to areas of permanent water during cease-to-flow periods and return once flow resumes.
- Certain species of Crayfish and Mussels burrow into the sediment to avoid desiccation and retain moisture.
- Some species of flora and fauna have developed mechanisms to withstand a lack of water, such as producing protective coatings or reducing metabolic rates.
- Many species have short life cycles and can reproduce rapidly once favourable conditions return.
- Intermittent streams often contain a mix of species with different tolerances to drying, ensuring that some members of the community can survive and maintain ecosystem functions during dry periods.
- Multiple species often perform similar ecological roles and assist in maintaining ecosystem processes continue even if some species are temporarily lost.

These adaptations help maintain the resilience and functionality of aquatic ecosystems despite the adverse conditions posed by intermittent flow or cease-to-flow periods. The waterways considered in this study are likely to contain a range of flora and fauna species that have such adaptations as described above due to the natural flow regime. While this may prevent significant impacts and risks associated with low and cease-to-flow periods, an increase in the duration of such periods and a shift away from a natural flow regimes can reduce the health of aquatic ecosystems. This may occur by:

- Droughts leading to reduced water levels, causing waterways to dry up and fragment into isolated pools, and reducing habitat availability for aquatic species.
- A loss of connectivity between that can severely impact species that rely on continuous flow for migration, breeding, and feeding.
- Drought conditions can decimate macroinvertebrates taxa such as shrimps, stoneflies, and caddisflies that may struggle to recolonize even after water levels return to normal, leading to long-term changes in the ecosystem.
- Reduced water flow can lead to poorer water quality, as pollutants become more concentrated, and the natural flushing of contaminants is reduced.
- Lower water levels can increase sedimentation in streams, which can smother habitats and reduce the availability of clean, oxygenated water.

Based on the above, it can be inferred that the aquatic ecosystems considered in this Study have some capacity to tolerate low flows and cease-to-flow periods. However, the hydrological analysis has determined that water take from SWG Dam will have a major influence on hydrology that present a range of risks to the health of the downstream waterways. While the seasonality of flows will be retained, they will be of a much lower magnitude.

The risks to ecological values and waterway health are reduced with a 20% bypass used as a treatment measure. There will still be reductions in flow, particularly during the warmer periods of the year, but these flows are not uncommon for this reach in SWG based on historic flows. In addition, reduced flows would likely present risks to downstream water users. While this may not be significant, landholders and other stakeholders may not look favourably on further regulation of waterways in the Study Area.

For Norilup Dam, the downstream waterways are already severely impacts due to historical regulation of flows and occasional water take. The hydrological analysis determined that this has dramatically reduced the magnitude of flows in the downstream reaches. Future water take from the dam is unlikely to further impact waterway health given reaches downstream of the dam have been impacted for a significant length of time and, as a result, the associated ecosystems have adapted or vanished.

6.2 Recommendations

The Study adopted a desktop and high-level conservative approach to assessing potential risks to ecological values and water users downstream of Norilup and SWG dams. Given some high inherent risks were identified, these may not be tolerated by regulators should Talison apply for approvals and/or licences. The use of a 20% bypass was found to reduce these risks to an acceptable level, although additional regulatory controls may be applied by regulators.

The Study has also been undertaken in line with the scope and limitations listed in **Section 1.4** and the assumptions listed in **Section 1.5**. The following recommendations are made to increase the rigour of the assessment:

– The assessment has used a conservative broad catchment-scale approach with identified ecological values and water users considered present in all study reaches. Further interrogation of the survey data and allocation of all values to specific sites or areas should be undertaken. A likelihood assessment for the presence of other values (e.g., threatened species) would also determine if these should be considered further if deemed present in a reach. This would allow for a more site/reach specific risk assessment to be undertaken and better inform the risks for each reach.

– The hydrological assessment examined monthly median flows for each study reach based on the last 20 years of historical data which didn't not consider dry versus wet years. The impacts of water take may be greater in dry years, so it is recommended that consideration be given to the differences between wet and dry years (and cumulative effects of climate change).

– Habitat mapping, under a range of flows, would increase the understanding of how available habitat changes and potential risks and impacts of water take. Similarly, monitoring or an assessment of changes in water quality and ecological values under a range of flows would also increase understanding.

– No assessment consideration has been given to groundwater resources and associated fauna (i.e., stygofauna) in this study. An assessment of whether the waterways are gaining or losing streams and the subsequent risks and impacts to water resources and stygofauna should be considered.

– To further assess the potential impacts to water users, the water extracted for the different uses should be quantified and related to surface water flow to determine if the water resource becomes limited for users and if the extraction of water further contributes to low flows or cease-to-flow events in the waterways. The location of each water user should also be identified to determine the potential effects of abstraction on the reaches compared in this study.

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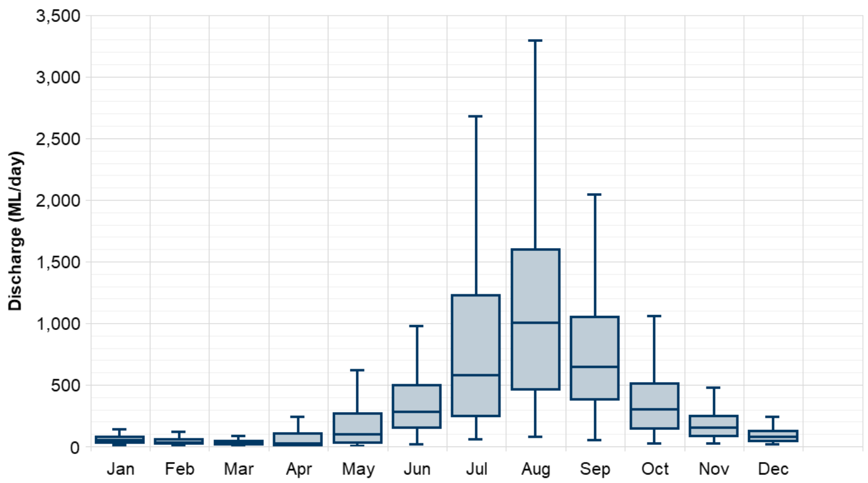
Appendices

Appendix A

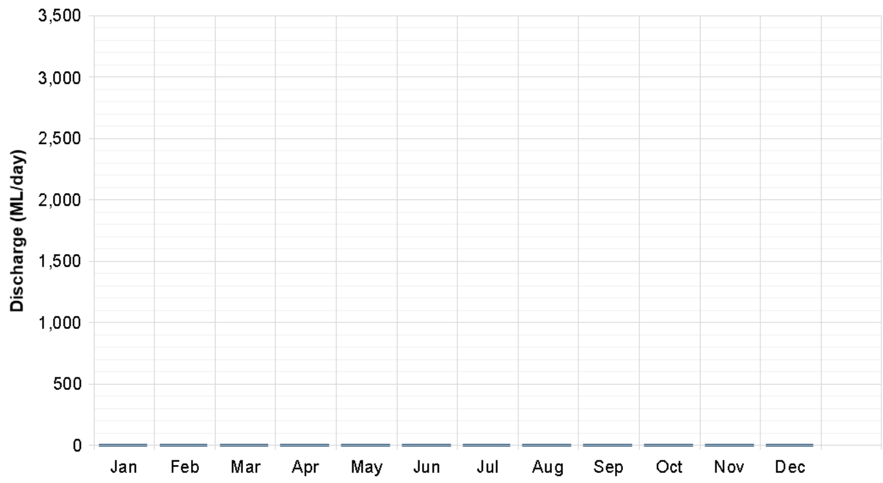
Salt Water Gully Dam Historical Flow Assessment

Hydrological Assessment at SWG Dam Outlet

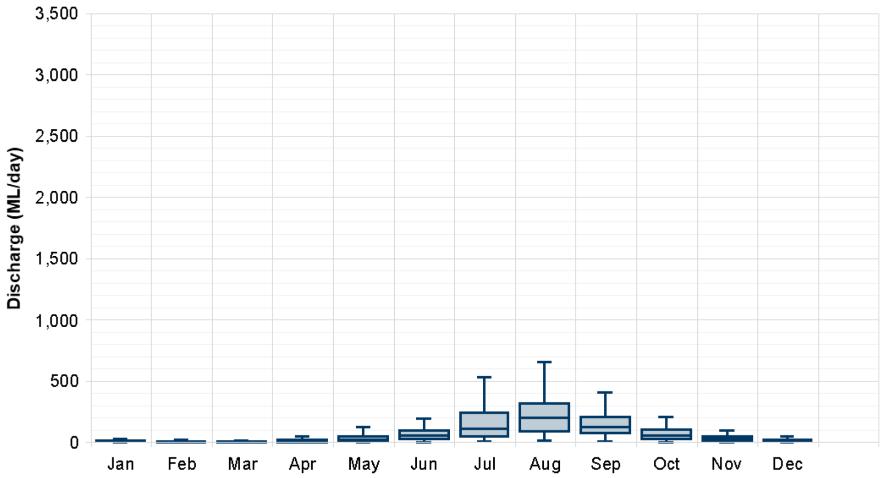
SWG Dam Outlet – No Water Take



SGW Dam Outlet – Water Take No Bypass



SGW Dam Outlet – Water Take and 20% Bypass



Summary

No Water Take

Under existing conditions (i.e., no water take) there is continuous flow immediately downstream of the dam with median flows ranging from 29 ML/day in April to over 1,000 ML/day in August.

Water Take and No Bypass

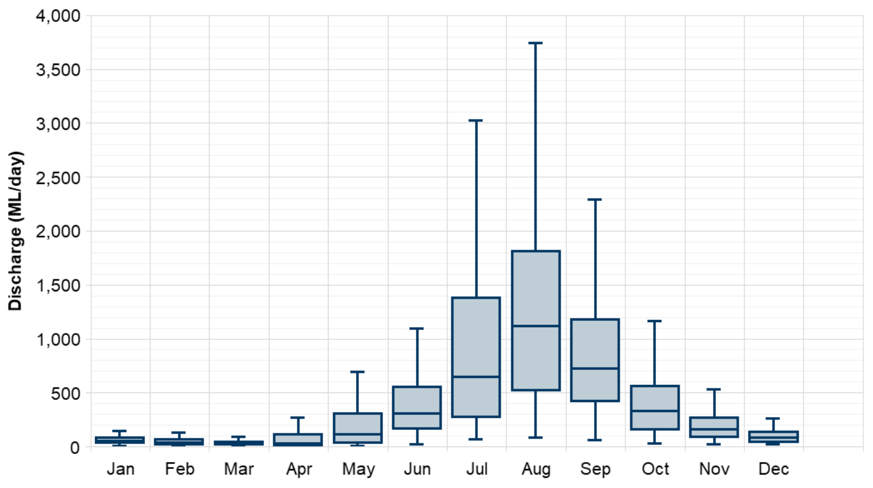
There is no flow with water take no bypass.

Water Take and 20% Bypass

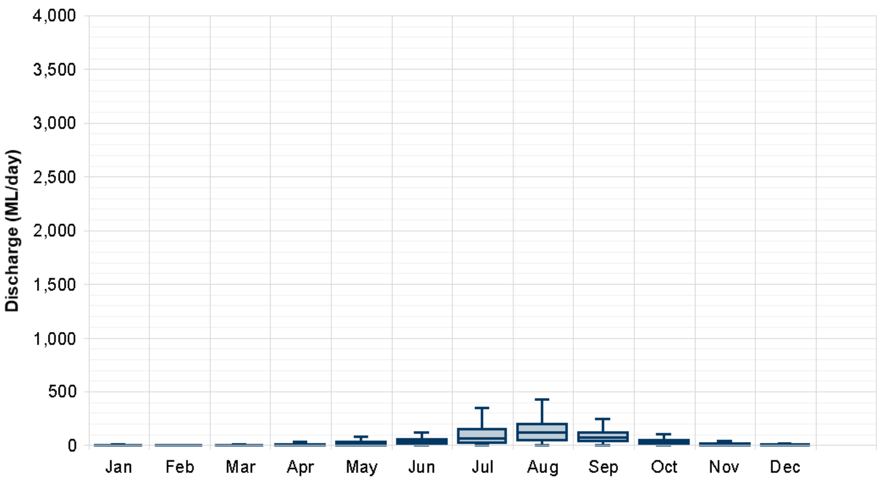
With water take and a 20% bypass, median flows immediately downstream of the dam are ~20% of the existing flow conditions.

Hydrological Assessment at SWG Outlet

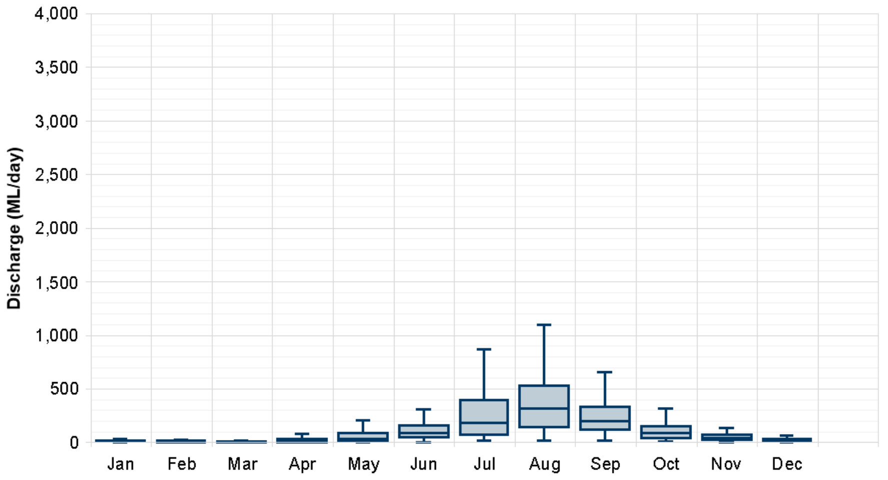
SWG Outlet – No Water Take



SGW Outlet – Water Take No Bypass



SGW Outlet – Water Take and 20% Bypass



Summary

No Water Take

Under existing conditions (i.e., no water take) there is continuous flow in SWG at the SWG Outlet with median flows ranging from 31 ML/day in April to over 1,123 ML/day in August.

Water Take and No Bypass

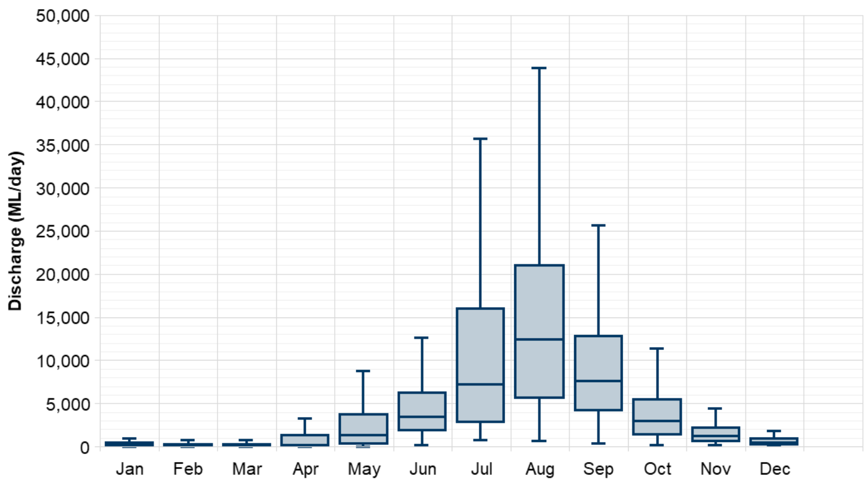
With water take and no bypass, flow is retained in all months but is noticeably reduced compared to existing conditions. ~3 to ~5% of the existing conditions median flow is present during summer and ~11% of the existing conditions median flow is present during winter.

Water Take and 20% Bypass

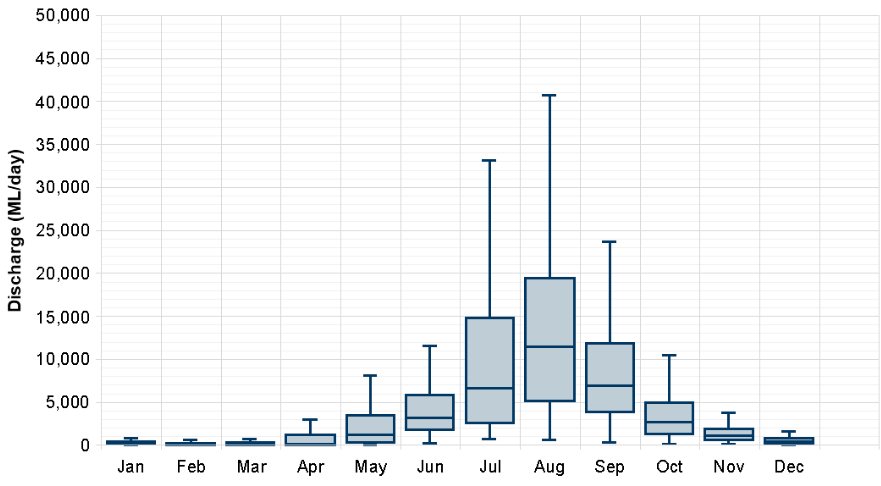
With water take and a 20% bypass, additional flow is provided but median summer flows are only ~22 to 24% of existing flow conditions and winter flows are only ~29% of existing flow conditions.

Hydrological Assessment in Hester Brook at SWG Confluence

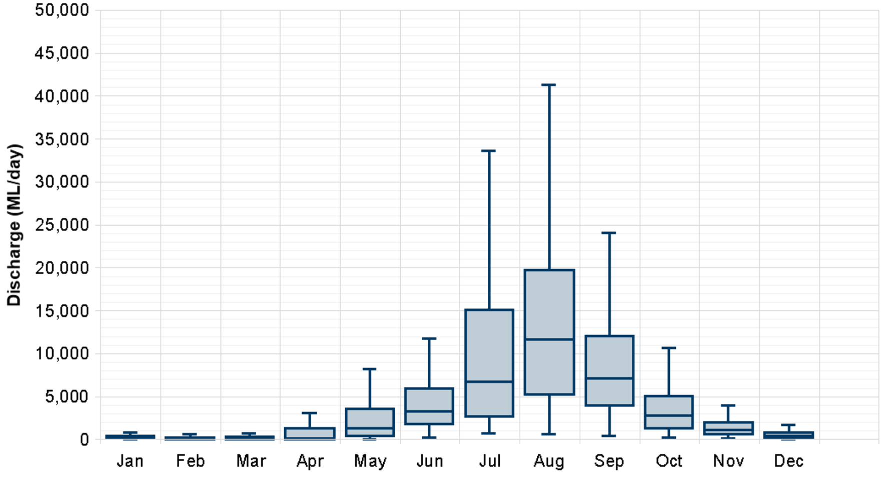
Hester / SWG Confluence – No Water Take



Hester / SWG Confluence – Water Take No Bypass



Hester / SWG Confluence – Water Take and 20% Bypass



Summary

No Water Take

Under existing conditions (i.e., no water take) flow is noticeably higher than in the upstream SWG due to contributions from Hester Brook. There is continuous flow at the confluence with median flows ranging from 134 ML/day in April to almost 12,500 ML/day in August.

Water Take and No Bypass

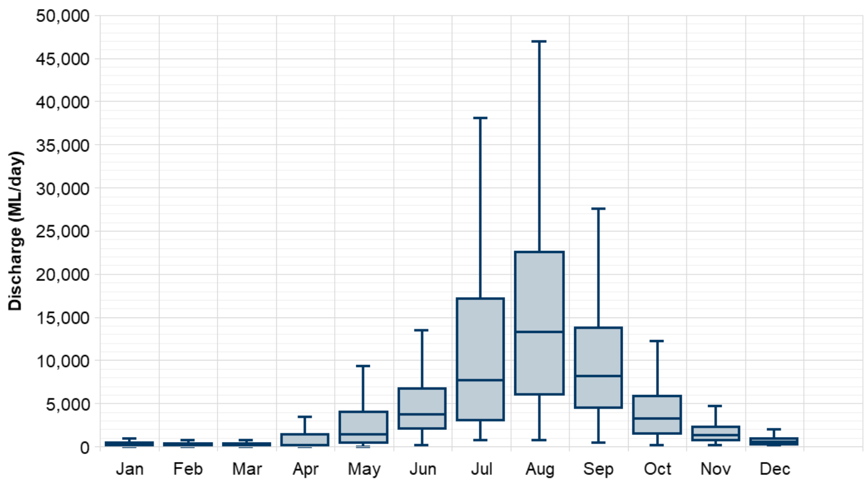
With water take and no bypass, flow is retained in all months but is reduced compared to existing conditions. ~73 to ~85% of the existing conditions median flow is present during summer and ~92 to ~93% of the existing conditions median flow is present during winter.

Water Take and 20% Bypass

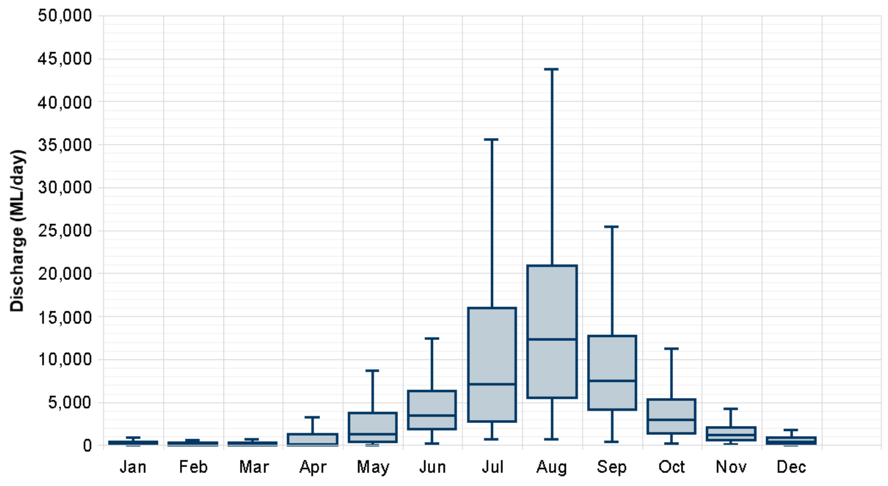
With water take and a 20% bypass, additional flow is provided, and median summer flows are ~78 to ~88% of existing flow conditions and the median winter lows are ~94% of existing flow conditions.

Hydrological Assessment in Hester Brook at Cascade Gully Confluence

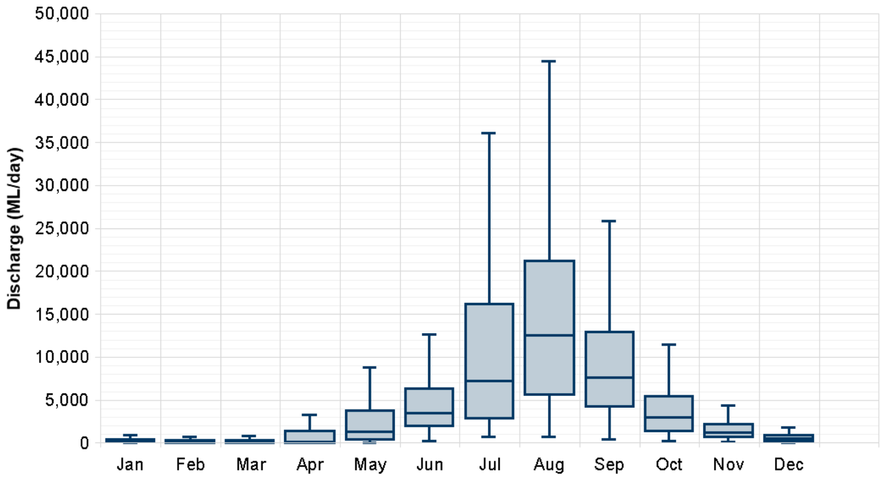
Hester / Cascade Confluence – No Water Take



Hester / Cascade Confluence – Water Take No Bypass



Hester / Cascade Confluence – Water Take and 20% Bypass



Summary

No Water Take

Under existing conditions (i.e., no water take) there is some further contribution of flow from Cascade Gully and other tributaries.

Under existing conditions (i.e., no water take) there is continuous flow at the confluence of Hester Brook with Cascade Gully with median flow ranging from 147 ML/day in March to over 13,300 ML/day in August.

Water Take and No Bypass

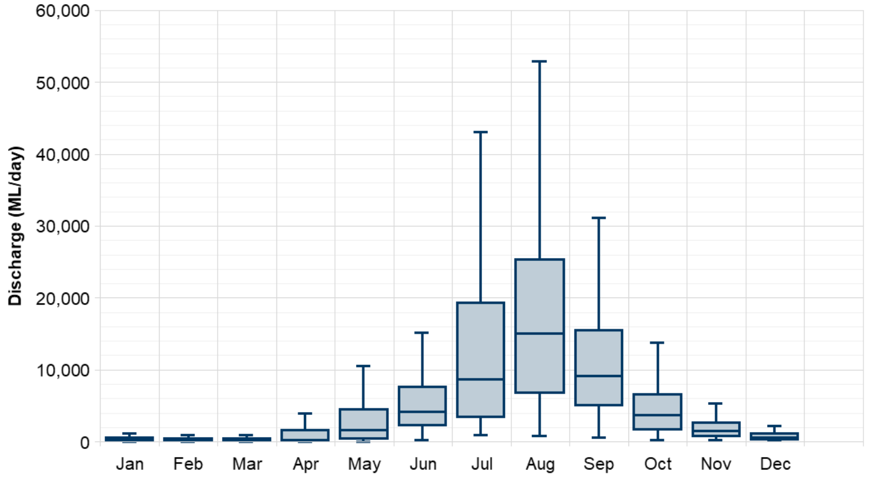
With water take and no bypass, flow is retained in all months but is reduced compared to existing conditions. ~80% to ~86% of the existing conditions median flow is present during summer and ~93% of the existing conditions median flow is present during winter.

Water Take and 20% Bypass

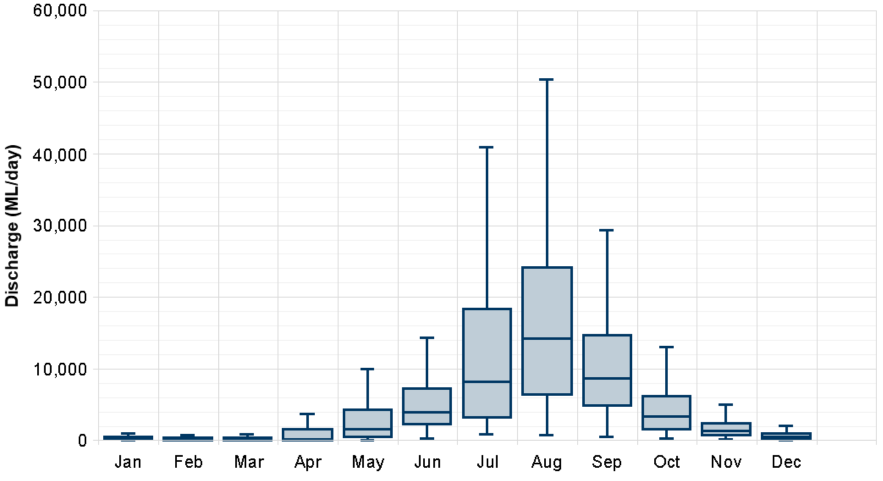
With water take and a 20% bypass, additional flow is provided, and median summer flows are ~80% to ~89% of existing flow conditions and the median winter lows are ~94% of existing flow conditions.

Hydrological Assessment in Hester Brook at Hester Hill

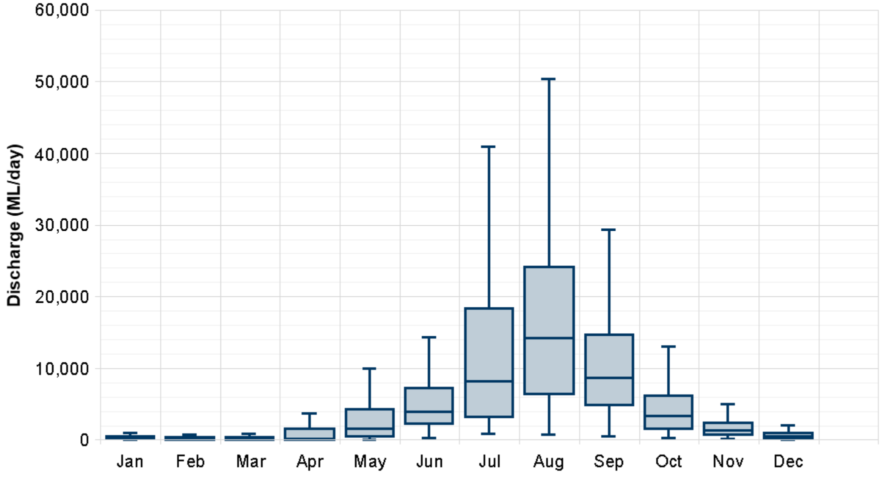
Hester Hill – No Water Take



Hester Hill – Water Take No Bypass



Hester Hill – Water Take and 20% Bypass



Summary

No Water Take

Under existing conditions (i.e., no water take) there is some further contribution of flow from tributaries downstream of the Cascade Gully and Hester Brook confluence. There is continuous flow at Hester Hill with median flows ranging from 162 ML/day in March to over 15,000 ML/day in August.

Water Take and No Bypass

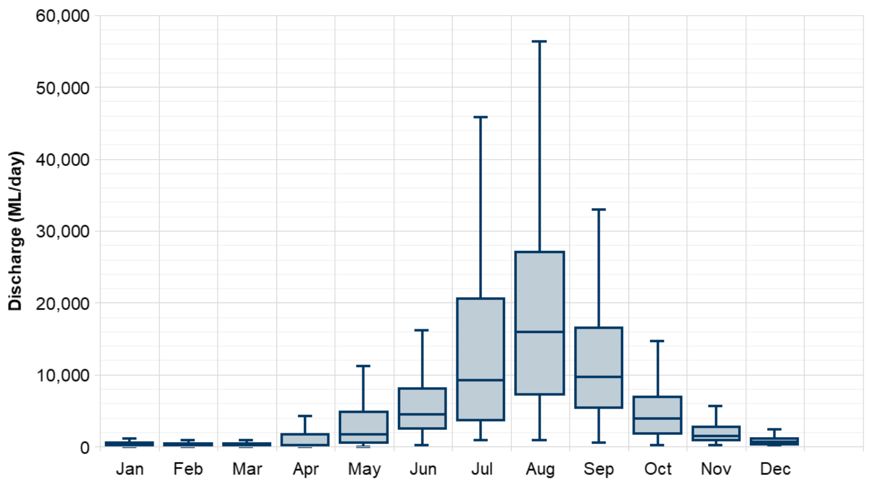
With water take and no bypass, flow is retained in all months but is reduced compared to existing conditions. ~77% to ~87% of the existing conditions median flow is present during summer and ~93% to ~94% of the existing conditions median flow is present during winter.

Water Take and 20% Bypass

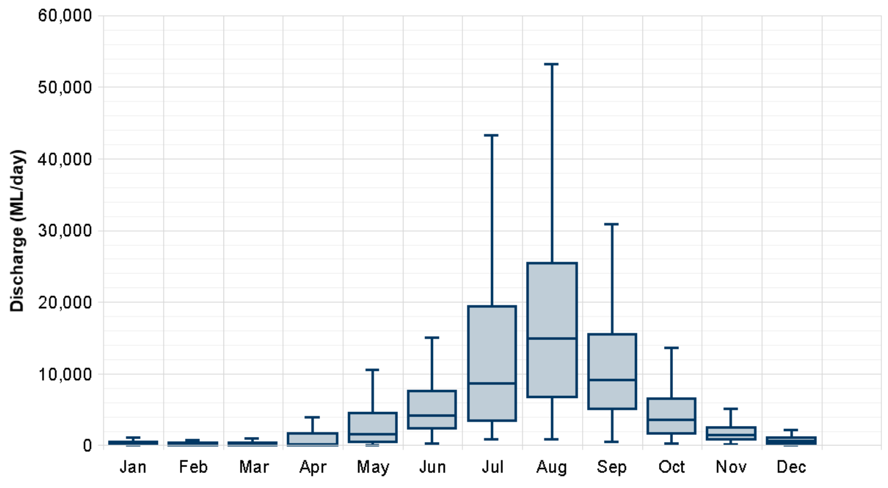
With water take and a 20% bypass, additional flow is provided, and median summer flows are ~82% to ~90% of existing flow conditions and the median winter lows are ~95% of existing flow conditions.

Hydrological Assessment in Hester Brook Outlet to Blackwood River

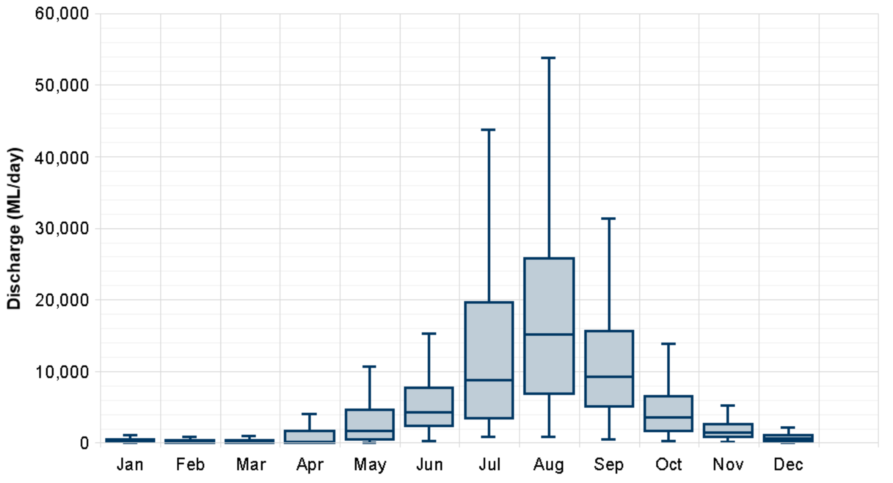
Hester Brook Outlet – No Water Take



Hester Brook Outlet – Water Take No Bypass



Hester Brook Outlet – Water Take and 20% Bypass



Summary

No Water Take

Under existing conditions (i.e., no water take) there is some further contribution of flow from tributaries downstream of Hester Hill. There is continuous flow at Hester Brook Outlet with median flow ranging from 170 ML/day in March to almost 16,000 ML/day in August.

Water Take and No Bypass

With water take and no bypass, flow is retained in all months but is reduced compared to existing conditions. ~78% to ~88% of the existing conditions median flow is present during summer and ~94% of the existing conditions median flow is present during winter

Water Take and 20% Bypass

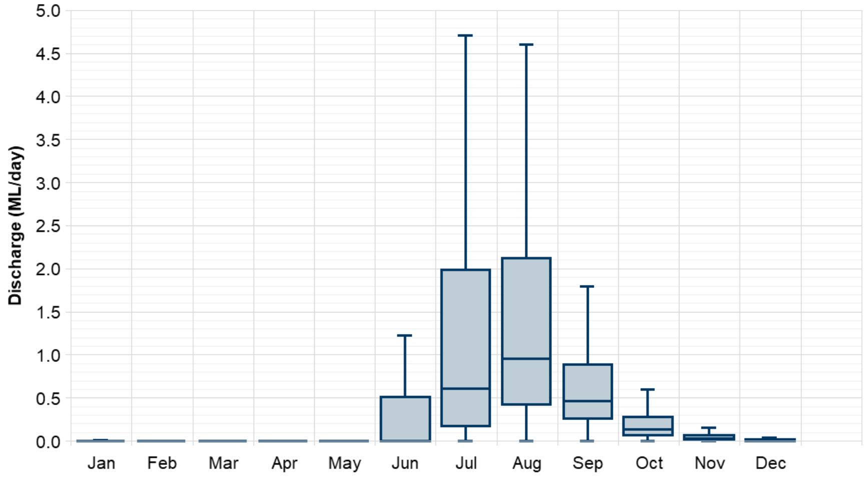
With water take and a 20% bypass, additional flow is provided, and median summer flows are ~83% to ~91% of existing flow conditions and the median winter lows are ~95% of existing flow conditions.

Appendix B

Norilup Dam Historical Flow Assessment

Hydrological Assessment of Reaches Downstream of Norilup Dam

Upper Spring Creek



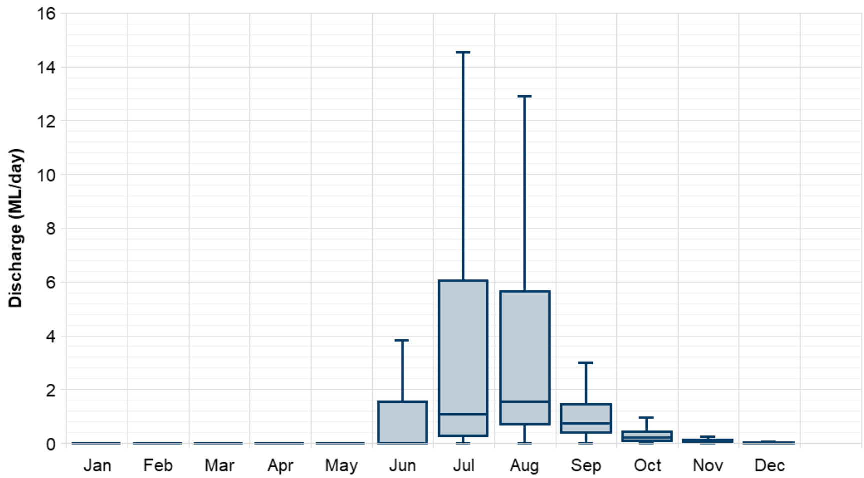
Summary

There are very little inflows to Norilup Dam between November and May (see **Figure 8**) and median inflows during summer are ~0.2 ML/day. Higher flows typically occur from June to October when the median winter inflows are ~5.7 ML/day.

Despite the potential for contributions of water from tributaries or groundwater inputs downstream of Norilup Dam, there are lower flows at the upper Spring Creek reach compared to the inflows to the dam. Median summer flows in the reach are a maximum of ~0.01 ML/day and a maximum of ~1.0 ML/day during winter.

Norilup Dam appears to have a major influence on the hydrology of the upper Spring Creek reach, with median flows in summer and winter only ~4% and ~17% of the inflows to the dam respectively.

Lower Spring Creek

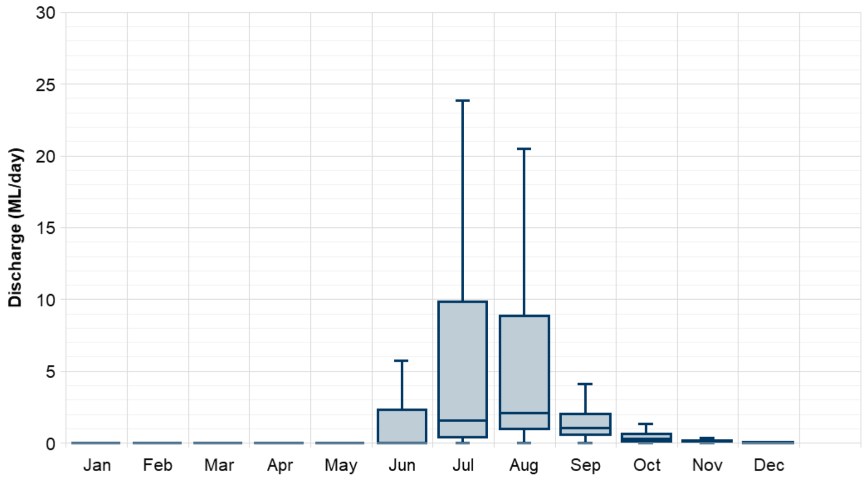
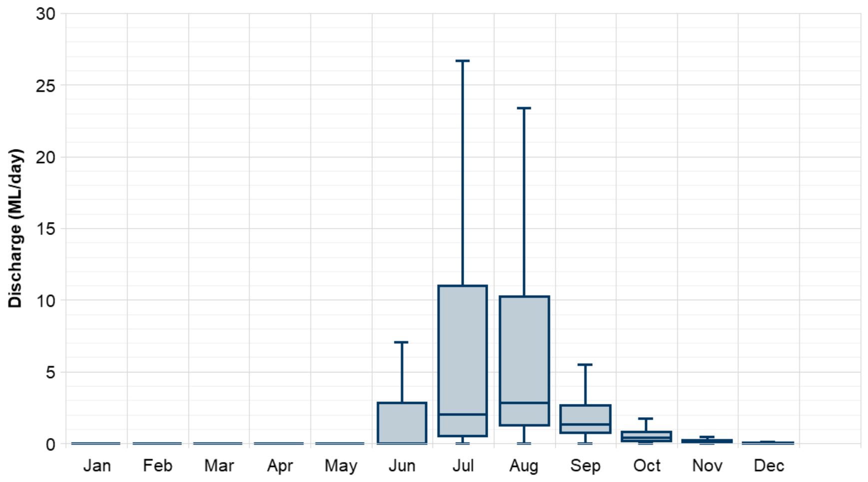


Summary

There are very little inflows to Norilup Dam between November and May (see **Figure 8**) and median inflows during summer are ~0.2 ML/day. Higher flows typically occur from June to October when the median winter inflows are ~5.7 ML/day.

Despite the potential for contributions of water from tributaries or groundwater inputs downstream of Norilup Dam, there are lower flows in the lower Spring Creek reach compared to the inflows to the dam. Median summer flows in the reach are a maximum of ~0.01 ML/day and a maximum of ~1.5 ML/day during winter.

Norilup Dam appears to have a major influence on the hydrology of the lower Spring Creek reach, with median flows in summer and winter only ~4% and ~27% of the inflows to the dam respectively.

Spring/Norilup Confluence	Summary
	There are very little inflows to Norilup Dam between November and May (see **Figure 8**) and median inflows during summer are ~0.2 ML/day. Higher flows typically occur from June to October when the median winter inflows are ~5.7 ML/day. Despite the potential for contributions of water from tributaries or groundwater inputs downstream of Norilup Dam, there are lower flows at the Spring Creek and Norilup Creek confluence compared to the inflows to the dam. Median summer flows at the confluence are a maximum of ~0.02 ML/day and a maximum of ~2.1 ML/day during winter. Norilup Dam appears to have a major influence on the hydrology of Spring Creek and subsequently Norilup Creek, with median flows at the confluence in summer and winter only ~9% and ~37% of the inflows to the dam respectively.
Norilup Brook Outlet to Blackwood	**Summary**
	There are very little inflows to Norilup Dam between November and May (see **Figure 8**) and median inflows during summer are ~0.2 ML/day. Higher flows typically occur from June to October when the median winter inflows are ~5.7 ML/day. Despite the potential for contributions of water from tributaries or groundwater inputs downstream of Norilup Dam, there are lower flows in Norilup Brook at the outlet to Blackwood River compared to the inflows to the dam. Median summer flows at the outlet are a maximum of ~0.03 ML/day and a maximum of ~2.8 ML/day during winter. Norilup Dam appears to have a major influence on the hydrology of Spring Creek and subsequently Norilup Creek, with median flows in summer and winter at the Norilup Creek outlet only ~13% and ~50% of the inflows to the dam respectively.

Appendix C

Habitat Conditions

Habitat Conditions Downstream of SWG Dam

Reach	Habitat	Photographs
SWG Dam to Hester Brook / SWG Confluence: SLR (2024a) assessed one site in the reach, HES-C ~750 m upstream of the confluence with Hester Brook.	Low-lying area with dense exotic grasses and other weeds surrounded by sparse native trees and pine trees. Continuous channel approximately 1.5 m wide and 0.5 m deep. Multiple short riffle sections. Slow flow supplied by a series of small waterfalls originating from a dam culvert approximately 50 m upstream. Overall clear water free of tannins with isolated patches of algae in slower flowing sections. Large, persistent sediment plumes in areas where sediment recently disturbed. Evidence of direct livestock access with pugging holes along banks and fencing preventing access to channel. Livestock access primary visible source of disturbance.	
Hester Brook / SWG Confluence to Cascade Gully / Hester Brook Confluence: SLR (2024a) assessed two sites in the reach, HES-E, ~3.4 km downstream of HES-C, and HES-F ~550 m downstream of HES-E.	**HES-E** A moderate-fast flowing continuous channel approximately 1.5 m wide and 1 m deep. Large woody debris covered around 15% of the surface area. Dense blackberries dominate the riparian zone. Water moderately turbid and mineral substrates a mix of moderately coarse sand and clay. Both banks showed evidence of mild-moderate erosion. No evidence of cattle access. **HES-F** A 3 m wide channel with slow to moderate flow and depth of 1.5 m. Multiple riffle sections. Large woody covers around 20% of the surface area. Water moderately turbid with the substrate mostly composed of fine sand and gravel. Evidence of direct livestock. Erosion is evident where the downstream portion of the reach was altered by large woody debris.	 HES-E  HES-F

Reach	Habitat	Photographs
Hester Brook / Cascade Gully Confluence to Hester Hill: SLR (2024a) assessed two sites in the reach, HES-FA ~930 m downstream of HES-F, and HES-G ~2.24km downstream of HES-FA.	**HES-FA** Channel is 2.5 m wide with a depth of 0.5 m with slow to moderate flow. Water moderately turbid and substrate composed of coarse and fine sands. Exotic grasses and blackberry dominate the banks with erosion evident. No livestock access. **HES-G** Channel around 2.5 m wide with a depth of 1.5 m. Water moderately fast flowing and turbid. Sediment mostly composed of sand and clay. Bank vegetation sparsely composed of grasses, blackberry, herbaceous plants, and some large trees. Heavily impacted by cattle with evidence of access. Fire damage also noted.	 
Hester Hill to Hester Brook outlet to Blackwood River SLR (2024a) assessed one site in the reach, HES-H ~5.97 km downstream of HES-G.	A 3 m wide channel with a depth of 0.7 m fed through a pipe and fish ladder connected to Hester DS Dam directly upstream of the site. Water slow flowing and moderately turbid with substrate composed of sand and clay. Large woody debris makes up 5% of the surface area. Riparian vegetation blackberries, grasses, and *Melaleuca* trees. Cattle access not evident though runoff from the agricultural land upstream is likely source of contamination.	

Habitat Conditions Downstream of Norilup Dam

Reach	Habitat	Photographs
Norlup Dam to Spring Creek / Norilup Brook Confluence SLR (2024a) assessed one site in the reach, NDS-B near the confluence.	Site in middle of a paddock with channel 1.5 m wide and 1m deep. Multiple riffle sections broken by medium-sized pools. Slow-flowing and slightly turbid with sediment a mix of sand and clay. Very steep banks. Cattle access evident. Agricultural runoff and cattle access likely source of contamination.	
Spring Creek / Norilup Brook Confluence to Norilup Brook outlet to Blackwood River SLR (2024a) assessed one site in the reach, NDS-C ~370m upstream of the Blackwood River confluence.	Located on Norilup Creek around 2.98 km downstream of NDS-B and 370 m upstream of Blackwood River. Channel around 3 m wide and 1 m deep with slightly turbid slow-flowing water. Substrate mix of fine sand, clay, gravel, and pebbles. Large wood debris covered 20% of surface area.	

Appendix D

Salt Water Gully Dam Ecological Risk Assessment

Appendix H - Ecological Risk Register

Risk ID	Reach	Pathway / Risk Event	Potential receptors or risk entities				Inherent Risk				Residual Risk		
			Details of sensitive receptor	Location / proximity	Resultant harm	Supporting evidence	Likelihood	Consequence	Risk Level	Treatment measures / existing controls	Likelihood	Consequence	Risk Level
SWG1	SWG Dam Outlet to SWG Outlet	Water take with no bypass reduces flow in reach	Habitat - Riffles and/or runs	Known habitat type within reach	Loss of riffles and/or runs due to cease-to-flow periods or low flows	Under existing conditions continous flow in the reach. With water take and no bypass all flow is lost immediately downstream of the dam outlet, with only 3 to 5% of summer flows and 11% of winter flows remaining at downstream end of reach.	Almost Certain	Minor	High	A 20% bypass to provide flows downstream is proposed as a treatment measure but there are no existing controls	Possible	Minor	Medium
SWG2			Habitat - Pools and/or refuge pools	Habitat type not reported within reach, but may be present during higer flow periods	Loss of pools and/or refuge pools due to cease-to-flow periods or low flows		Possible	Minor	Medium		Unlikely	Minor	Medium
SWG3			Macroinvertebrate communities	Diverse community within reach	Loss of habitat or connectivity for macroinvertebrates due to cease-to-flow periods or low flows		Almost Certain	Moderate	High		Possible	Moderate	Medium
SWG4			Fish	Known within reach and an abundant species in broader area	Loss of habitat or connectivity for fish due to cease-to-flow periods or low flows		Almost Certain	Moderate	High		Possible	Moderate	Medium
SWG5			Threatened species - Carter's Freshwater Mussel & Rakali	Assumed present within reach	Loss of habitat or connectivity for threatened species due to cease-to-flow periods or low flows		Possible	Moderate	Medium		Unlikely	Moderate	Medium
SWG1	SWG Dam Outlet to SWG Outlet	Water take with 20% bypass reduces flow in reach	Habitat - Riffles and/or runs	Known habitat type within reach	Loss of riffles and/or runs due to cease-to-flow periods or low flows	Under existing conditions continous flow in the reach. With water take and 20% bypass flow immediately downstream of the dam outlet is around 20% of existing conditions. At the end of the reach, median summer flows are only 22 to 24% of existing flow conditions and winter 29%.	Possible	Minor	Medium	There are no treatment measures proposed but the 20% bypass is considered an existing control	Possible	Minor	Medium
SWG2			Habitat - Pools and/or refuge pools	Habitat type not reported within reach, but may be present during higer flow periods	Loss of pools and/or refuge pools due to cease-to-flow periods or low flows		Unlikely	Minor	Medium		Unlikely	Minor	Medium
SWG3			Macroinvertebrate communities	Diverse community within reach	Loss of habitat or connectivity for macroinvertebrates due to cease-to-flow periods or low flows		Possible	Moderate	Medium		Possible	Moderate	Medium
SWG4			Fish	Known within reach and an abundant species in broader area	Loss of habitat or connectivity for fish due to cease-to-flow periods or low flows		Possible	Moderate	Medium		Possible	Moderate	Medium
SWG5			Threatened species - Carter's Freshwater Mussel & Rakali	Assumed present within reach	Loss of habitat or connectivity for threatened species due to cease-to-flow periods or low flows		Unlikely	Moderate	Medium		Unlikely	Moderate	Medium
SWG1	SWG Outlet to Hester Brook Outlet	Water take with no bypass reduces flow in reach	Habitat - Riffles and/or runs	Known habitat type within reach	Loss of riffles and/or runs due to cease-to-flow periods or low flows	Under existing conditions continous flow in the reach. With water take and no bypass some flow is lost in these downstream reaches, with at least 73% of summer flows and 92% of winter flows remaining.	Unlikely	Minor	Medium	A 20% bypass to provide flows downstream is proposed as a treatment measure but there are no existing controls	Rare	Minor	Low
SWG2			Habitat - Pools and/or refuge pools	Habitat type not reported within reach, but may be present during higer flow periods	Loss of pools and/or refuge pools due to cease-to-flow periods or low flows		Unlikely	Minor	Medium		Rare	Minor	Low
SWG3			Macroinvertebrate communities	Diverse community within reach	Loss of habitat or connectivity for macroinvertebrates due to cease-to-flow periods or low flows		Unlikely	Minor	Medium		Rare	Minor	Low
SWG4			Fish	Known within reach and an abundant species in broader area	Loss of habitat or connectivity for fish due to cease-to-flow periods or low flows		Unlikely	Minor	Medium		Rare	Minor	Low
SWG5			Threatened species - Carter's Freshwater Mussel & Rakali	Assumed present within reach	Loss of habitat or connectivity for threatened species due to cease-to-flow periods or low flows		Unlikely	Moderate	Medium		Rare	Minor	Low
SWG1		Water take with 20% bypass reduces flow in reach	Habitat - Riffles and/or runs	Known habitat type within reach	Loss of riffles and/or runs due to cease-to-flow periods or low flows	Under existing conditions continous flow in the reach. With water take and 20% bypass some flow is lost in these downstream reaches, with at 78-88% of summer flows and 94% of winter flows remaining .	Rare	Minor	Low	There are no treatment measures proposed but the 20% bypass is considered an existing control	Rare	Minor	Low
SWG2			Habitat - Pools and/or refuge pools	Habitat type not reported within reach, but may be present during higer flow periods	Loss of pools and/or refuge pools due to cease-to-flow periods or low flows		Rare	Minor	Low		Rare	Minor	Low
SWG3			Macroinvertebrate communities	Diverse community within reach	Loss of habitat or connectivity for macroinvertebrates due to cease-to-flow periods or low flows		Rare	Minor	Low		Rare	Minor	Low
SWG4			Fish	Known within reach and an abundant species in broader area	Loss of habitat or connectivity for fish due to cease-to-flow periods or low flows		Rare	Minor	Low		Rare	Minor	Low
SWG5			Threatened species - Carter's Freshwater Mussel & Rakali	Assumed present within reach	Loss of habitat or connectivity for threatened species due to cease-to-flow periods or low flows		Rare	Minor	Low		Rare	Minor	Low

Appendix E

Norilup Dam Ecological Risk Assessment

Appendix H - Ecological Risk Register

Risk ID	Reach	Pathway / Risk Event	Potential receptors or risk entities				Inherent Risk				Residual Risk		
			Details of sensitive receptor	Location / proximity	Resultant harm	Supporting evidence	Likelihood	Consequence	Risk Level	Treatment measures / existing controls	Likelihood	Consequence	Risk Level
Nor1	Norilup Dam to Spring Creek Upper	Water take with no bypass further reduces flow in reach	Habitat - Riffles and/or runs	Known habitat type within reach	Loss of riffles and/or runs due to cease-to-flow periods or low flows	There are very little inflows to Norilup Dam between November and May and median inflows during summer are only 0.22 ML/day. Higher flows typically occur from June to October and median winter inflows are 5.65 ML/day. Norilup Dam appears to have a major influence on the hydrology of Spring Creek Upper, with median flows in summer and winter only around 4% and 17% of the inflows to the dam, respectively. Given the dam already reduces flow in the reach, water take with no bypass unlikely to further cause impacts.	**Unlikely**	Slight	Low	There are no proposed treatment measures for Norilup Dam (i.e., no bypass) and no existing controls. Water has historically been diverted from the dam since construction.	**Unlikely**	Slight	Low
Nor2			Habitat - Pools and/or refuge pools	Habitat type not reported within reach, but may be present during higer flow periods	Loss of pools and/or refuge pools due to cease-to-flow periods or low flows		**Unlikely**	**Slight**	Low		**Unlikely**	Slight	Low
Nor3			Macroinvertebrate communities	Diverse community within reach	Loss of habitat or connectivity for macroinvertebrates due to cease-to-flow periods or low flows		**Unlikely**	Slight	Low		**Unlikely**	Slight	Low
Nor4			Fish	Not reported in most recent SLR (2024) monitoring but expected in reach	Loss of habitat or connectivity for fish due to cease-to-flow periods or low flows		**Unlikely**	Slight	Low		**Unlikely**	Slight	Low
Nor5			Threatened species - Carter's Freshwater Mussel & Rakali	Assumed present within reach	Loss of habitat or connectivity for threatened species due to cease-to-flow periods or low flows		**Unlikely**	Slight	Low		**Unlikely**	Slight	Low
Nor1	Spring Creek Upper to Spring Creek Lower	Water take with no bypass further reduces flow in reach	Habitat - Riffles and/or runs	Known habitat type within reach	Loss of riffles and/or runs due to cease-to-flow periods or low flows	There are very little inflows to Norilup Dam between November and May and median inflows during summer are only 0.22 ML/day. Higher flows typically occur from June to October and median winter inflows are 5.65 ML/day. Norilup Dam appears to have a major influence on the hydrology of Spring Creek Lower, with median flows in summer and winter only around 4% and 27% of the inflows to the dam, respectively. Given the dam already reduces flow in the reach, water take with no bypass unlikely to further cause impacts.	**Unlikely**	Slight	Low		**Unlikely**	Slight	Low
Nor2			Habitat - Pools and/or refuge pools	Habitat type not reported within reach, but may be present during higer flow periods	Loss of pools and/or refuge pools due to cease-to-flow periods or low flows		**Unlikely**	Slight	Low		**Unlikely**	Slight	Low
Nor3			Macroinvertebrate communities	Diverse community within reach	Loss of habitat or connectivity for macroinvertebrates due to cease-to-flow periods or low flows		**Unlikely**	Slight	Low		**Unlikely**	Slight	Low
Nor4			Fish	Not reported in most recent SLR (2024) monitoring but expected in reach	Loss of habitat or connectivity for fish due to cease-to-flow periods or low flows		**Unlikely**	Slight	Low		**Unlikely**	Slight	Low
Nor5			Threatened species - Carter's Freshwater Mussel & Rakali	Assumed present within reach	Loss of habitat or connectivity for threatened species due to cease-to-flow periods or low flows		**Unlikely**	Slight	Low		**Unlikely**	Slight	Low
Nor1	Spring Creek Lower to Spring/Norilup Confluence	Water take with no bypass further reduces flow in reach	Habitat - Riffles and/or runs	Known habitat type within reach	Loss of riffles and/or runs due to cease-to-flow periods or low flows	There are very little inflows to Norilup Dam between November and May and median inflows during summer are only 0.22 ML/day. Higher flows typically occur from June to October and median winter inflows are 5.65 ML/day. Norilup Dam appears to have a major influence on the hydrology of Spring Creek at the confluence with Norlipu Creek, with median flows in summer and winter only around 9% and 37% of the inflows to the dam, respectively. Given the dam already reduces flow in the reach, water take with no bypass unlikely to further cause impacts.	**Unlikely**	Slight	Low		**Unlikely**	Slight	Low
Nor2			Habitat - Pools and/or refuge pools	Habitat type not reported within reach, but may be present during higer flow periods	Loss of pools and/or refuge pools due to cease-to-flow periods or low flows		**Unlikely**	Slight	Low		**Unlikely**	Slight	Low
Nor3			Macroinvertebrate communities	Diverse community within reach	Loss of habitat or connectivity for macroinvertebrates due to cease-to-flow periods or low flows		**Unlikely**	Slight	Low		**Unlikely**	Slight	Low
Nor4			Fish	Not reported in most recent SLR (2024) monitoring but expected in reach	Loss of habitat or connectivity for fish due to cease-to-flow periods or low flows		**Unlikely**	Slight	Low		**Unlikely**	Slight	Low
Nor5			Threatened species - Carter's Freshwater Mussel & Rakali	Assumed present within reach	Loss of habitat or connectivity for threatened species due to cease-to-flow periods or low flows		**Unlikely**	Slight	Low		**Unlikely**	Slight	Low
Nor1	Norilup Confluence to Norilup Brook Outlet	Water take with no bypass further reduces flow in reach	Habitat - Riffles and/or runs	Known habitat type within reach	Loss of riffles and/or runs due to cease-to-flow periods or low flows	There are very little inflows to Norilup Dam between November and May and median inflows during summer are only 0.22 ML/day. Higher flows typically occur from June to October and median winter inflows are 5.65 ML/day. Norilup Dam appears to have a major influence on the hydrology of at the Norilup Brook Outlet , with median flows in summer and winter only around 13% and 50% of the inflows to the dam, respectively. Given the dam already reduces flow in the reach, water take with no bypass unlikely to further cause impacts.	**Unlikely**	Slight	Low		**Unlikely**	Slight	Low
Nor2			Habitat - Pools and/or refuge pools	Habitat type not reported within reach, but may be present during higer flow periods	Loss of pools and/or refuge pools due to cease-to-flow periods or low flows		**Unlikely**	Slight	Low		**Unlikely**	Slight	Low
Nor3			Macroinvertebrate communities	Diverse community within reach	Loss of habitat or connectivity for macroinvertebrates due to cease-to-flow periods or low flows		**Unlikely**	Slight	Low		**Unlikely**	Slight	Low
Nor4			Fish	Not reported in most recent SLR (2024) monitoring but expected in reach	Loss of habitat or connectivity for fish due to cease-to-flow periods or low flows		**Unlikely**	Slight	Low		**Unlikely**	Slight	Low
Nor5			Threatened species - Carter's Freshwater Mussel & Rakali	Assumed present within reach	Loss of habitat or connectivity for threatened species due to cease-to-flow periods or low flows		**Unlikely**	Slight	Low		**Unlikely**	Slight	Low

Appendix F

Downstream Water Users Risk Assessment

Appendix H - Ecological Risk Register

Risk ID	Waterways	Pathway / Risk Event	Potential receptors or risk entities				Inherent Risk				Residual Risk		
			Details of sensitive receptor	Location / proximity	Resultant harm	Supporting evidence	Likelihood	Consequence	Risk Level	Treatment measures / existing controls	Likelihood	Consequence	Risk Level
SWG6	Salt Water Gully Hester Brook	Water take with no bypass reduces flow in reach	Water users	Range of water users within study area for purposes including domestic, irrigation and stock supply	Loss of surface water flow resulting in impacts to water users	Median surface water flows during summer only 0% to 88% and during winter only 0% to 94% compared to existing conditions	**Likely**	**Major**	**High**	A 20% bypass to provide flows downstream is proposed as a treatment measure but there are no existing controls	**Possible**	**Major**	**High**
SWG6	Salt Water Gully Hester Brook	Water take with 20% bypass reduces flow in reach	Water users	Range of water users within study area for purposes including domestic, irrigation and stock supply	Loss of surface water flow resulting in impacts to water users	Median surface water flows during summer 20% to 91% and during winter only 20% to 95% compared to existing conditions	**Possible**	**Major**	**High**	There are no treatment measures proposed but the 20% bypass is considered an existing contro	**Possible**	**Major**	**High**
Nor6	Spring Creek Norilp Creek	The dam impacts flow and water take with no bypass further reduces flow in reach	Water users	Range of water users within study area for purposes including domestic, irrigation and stock supply	Loss of surface water flow resulting in impacts to water users	Median surface water flows during summer 4% to 13% of inflows, and during winter only 20% to 50% of inflows	**Likely**	**Major**	**High**	There are no proposed treatment measures for Norilup Dam (i.e., no bypass) and no existing controls. Water has historically been diverted from the dam since construction.	**Likely**	**Major**	**High**

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