Irrigation Price Review Submission

Appendix K

OD Hydrology: Giru Benefited Area

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OD Hydrology

Giru Benefited Area

Conceptual aquifer model development, validation and scenario assessment

Prepared for: **SunWater Limited**

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Executive Summary

This report described the approach, results and key outcomes associated with the development and application of a conceptual modelling tool for the simulation of the GBA alluvial aquifer, including surface water/groundwater interactions, supplementation and extractive use.

Model development, validation and scenario assessment indicate a series of important outcomes with respect to the current operation and behaviour of the GBA system, as well as the natural, sustainable/reliable yield of the aquifer.

Long-term water balance

Based on model calibration and validation, long-term water balance outcomes under current operational and demand conditions indicate:

- Surface water and groundwater in the GBA is highly connected and effectively behaves as a single, integrated water source. The use of water via bores versus extraction from weirs or direct from the Haughton River is unlikely to lead to any material difference in aquifer behaviour, or supplementation requirements to meet weir water level operational requirements.
- Average, long-term supplemented release of approximately 32,500 ML/a (i.e. release to the Haughton River).
- Approximately 20% 'losses' between release point at Haughton balancing storage and Val Bird Weir.
- Long-term average natural rainfall recharge of the aquifer is estimated to be of the order of 7,000 ML/a.
- Long-term average aquifer recharge from the Haughton River is estimated to be of the order of 16,000 ML/a.
- An average, long-term GBA extraction/use of approximately 34,500 ML/a.

Long-term modelling outcomes under unsupplemented conditions indicate:

- Pre-supplementation (i.e. pre-1989) usage was likely 50%-70% of current (17,000-24,000 ML/a) levels;
- This level of demand would have been less reliable than existing demand and likely unsustainable due to potential for significant aquifer drawdown and potential saltwater intrusion.

Simulated results, coupled with recorded bore water levels, indicate that the supplementation of the GBA aquifer has created a highly reliable and robust water supply, which shows good control of aquifer levels to meet the dual outcomes of providing an increased volume of water available for irrigation, as well as management of aquifer water levels to ensure a sustainable system over the long-term.

Natural (unsupplemented) yield

Scenario assessment of an unsupplemented aquifer under varying levels of demand indicates a sustainable, reliable supply of approximately 30% to 50% of current demands (10,000-17,000 ML/a), dependent on the level of reliability sought.

For example, while modelling indicates sufficient supply over the simulation period under 17,000 ML/a demand, there are periods of significant aquifer drawdown (> 2m) in five (5) of the thirty-eight (38) years simulated years for an unsupplemented scheme.

In terms of exhibiting similar reliability as existing supplied (as defined by aquifer drawdown behaviour), modelling indicates a natural 'yield' of approximately 10,000 ML/a, which showed no instances of greater than 2m aquifer drawdown throughout the simulation period, and generally aquifer behaviour to that of the supplemented system.

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1 Introduction

SunWater secured funding from the National Infrastructure Development Fund (NWIDF) to review the Haughton Channel operations for potential capacity and efficiency gains. The supplemented supply to the Giru Benefited Groundwater Area (GBA) was identified as an important area to review as part of the project as it is ultimately supplemented from the Haughton Main Channel (HMC). The objectives of this review specifically relevant to the GBA are:

1. Understanding the interaction between the groundwater and surface water within the GBA and considering if an alternative operating regime for the GBA could generate additional capacity/reliability in the HMC while retaining the agreed level of service to GBA customers.; and
2. Ensuring operation of the GBA is equitable and in compliance with the Resource Operations Plan and SunWater's operating rules.

Historically, operation of the GBA has supported two key outcomes. Firstly, direct supplementation of available groundwater in the area via the highly connected surface water/groundwater system (Haughton River, Ironbark Creek, Healys Lagoon and the Reedbeds). Secondly, sustainable management of groundwater levels in order to prevent either water level rise in the area and/or significant groundwater level drawdown and potential saltwater intrusion.

As such, access to the supplemented water availability within the aquifer was encouraged through the use of groundwater extraction bores. In the 2012 Price Path the Queensland Competition Authority (QCA) set the cost of water at 50% of the scheme price, acknowledging the best available data indicating some 19,700ML of natural yield annually within the scheme.

Anecdotally, it is reported that there has been a transition, by GBA irrigators, from the use of groundwater bores to direct access to surface water via stream offtakes. The aim of this project is to review the historical and current operational practices of water users within Giru Benefitted Area to determine if there has been a shift in practice from groundwater extraction to direct surface water extraction, and the implications of this change if determined. The report also provides modelled scenarios demonstrating the potential impact on the aquifer at varying levels of supplementation.

This report describes the approach, results and key outcomes associated with the development and application of a conceptual modelling tool for the simulation of the GBA alluvial aquifer, including surface water/groundwater interactions, supplementation and extractive use.

2 Background

SunWater owns and operates the Burdekin Haughton Water Supply Scheme (BHWSS) which supplies water to some 80,000 hectares of highly productive irrigation area located near Ayr in Northern Queensland. The scheme supplies water from the 1,860,000 ML capacity Burdekin Falls Dam via some 400 km of delivery channels and pipelines.

The BHWSS as it exists now (shown schematically in Figure 1, and spatially in Figure 2 below) was first developed in the 1980s and represents a major contributor to the agricultural production of Queensland (and Australia). The system supplies water for the irrigation farms in the lower Burdekin River region, supplements the urban and industrial needs of Townsville/Thuringowa, as well as provides supplementation of groundwater levels/supplies within the Lower Burdekin Water (LBW) managed area in the delta of the Burdekin River and the Giru Benefitted Area (GBA) near Giru on the Haughton River.

Supplementation of the GBA is undertaken via release from the Haughton balancing storage into the Haughton River to manage water levels within Val Bird Weir and Giru Weir. The maintenance of weir water levels in this way supplements the natural 'yield' of the GBA through the direct connection between the Haughton River and surrounding alluvial aquifer.

This highly inter-connected surface water/groundwater behaviour within the GBA is recognised within the regulation of water use within the GBA, with all supplemented and unsupplemented water use treated as surface water. The Water Plan (Burdekin Basin) 2007 states that *"Water in an aquifer under a watercourse or under land adjacent to a watercourse, in the Giru Benefited Groundwater Area, is declared to be water in the watercourse."*

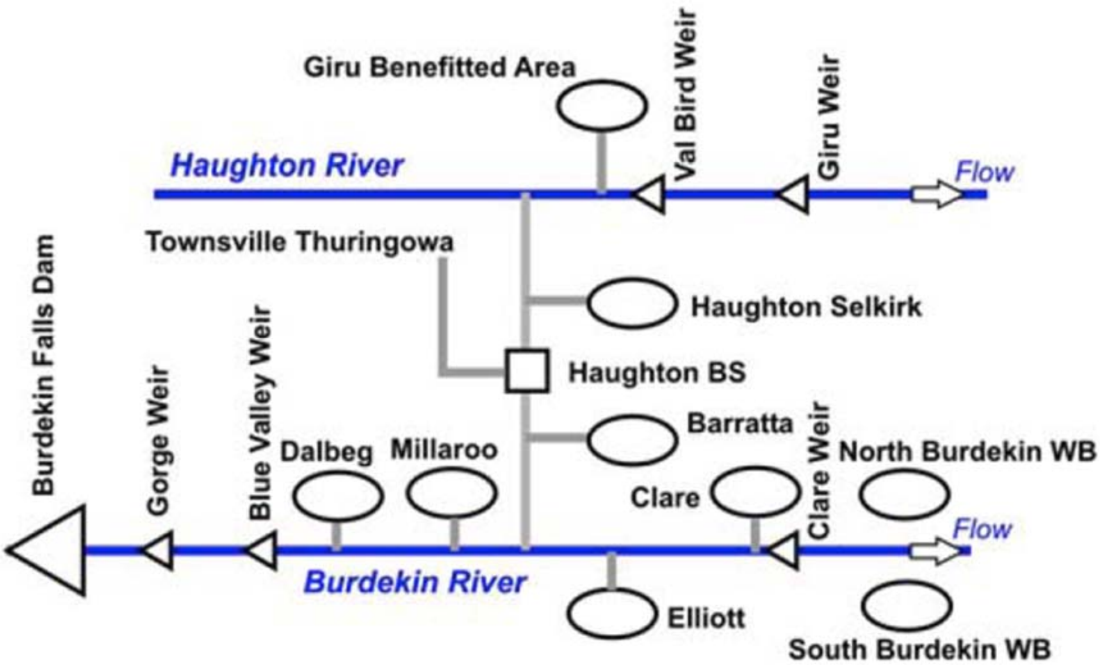


Figure 1 – Schematic of BHWSS

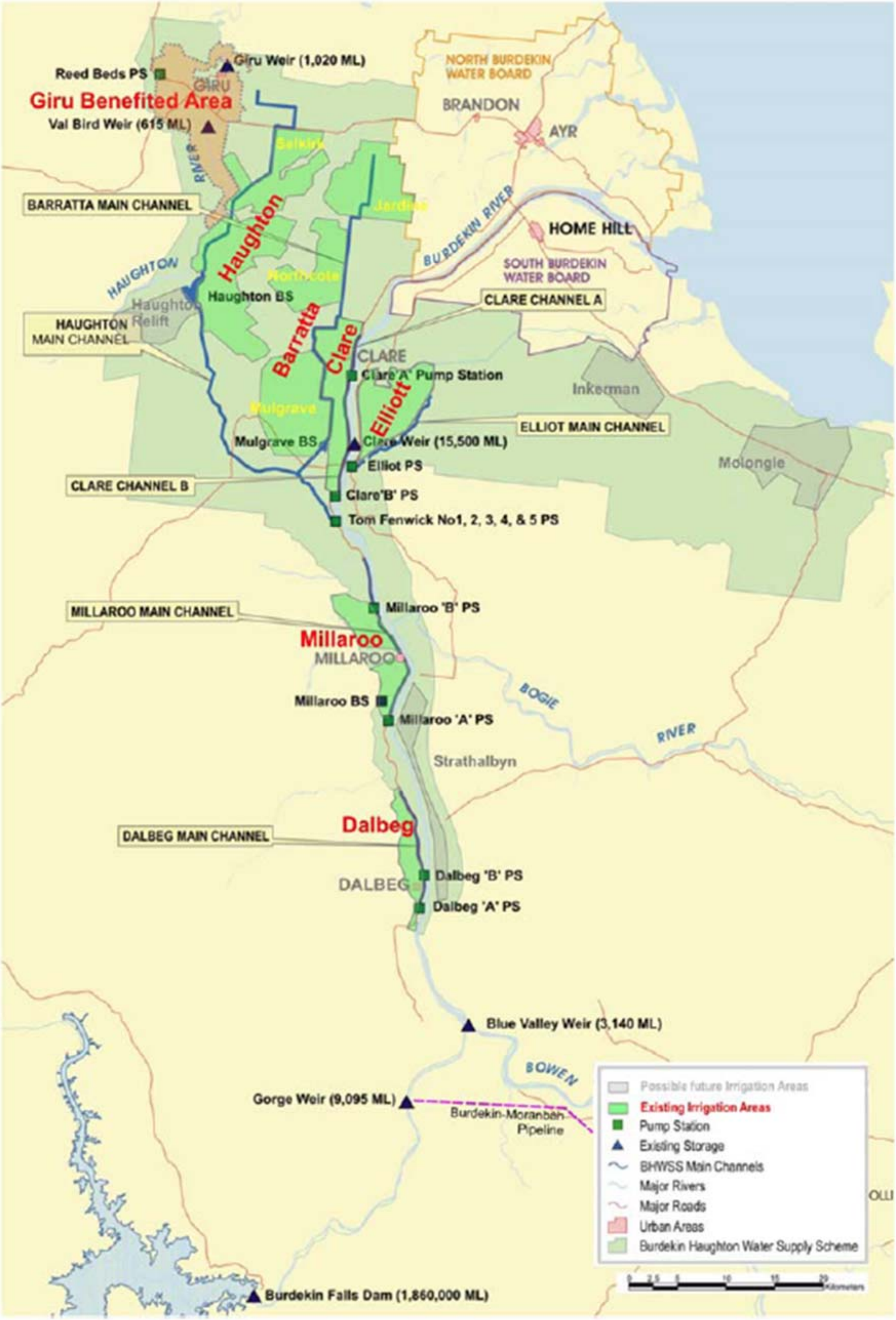


Figure 2 –BHWSS

3 Approach/methodology

In order to ensure that SunWater are basing operational decisions on robust, demonstrably justifiable understanding of the system and impacts on all users, the following Scope of Work was undertaken:

1. Evaluation of the level of compliance achieved between the GBA and the Burdekin Resource Operations Plan 2009 (ROP) Operating Rules; and,
2. A yield assessment to determine the natural yield being captured and utilised in the system.

The study comprises two distinct components:

(i) Data review and analysis: To provide insight into the operation of the GBA supplementation/aquifer management system within the overarching BHWSS.

(ii) Model development and assessment: To provide further understanding of the physical surface water/groundwater interaction behaviour of the GBA system and allow initial assessment of natural versus supplemented 'yield' and irrigation supply reliability.

Data review and analysis was undertaken based on operational information provided by SunWater (for the period 1/1/2016 to 31/12/2017) as well as a range of additional data sources, including climatic data, hydrologic/streamflow data, etc. Summary details of data used and analyses undertaken is provided in the relevant sections to follow.

Water balance assessment has been undertaken via development of a conceptual GBA system water balance model, which simulates the key inflows, outflows and storages within the scheme. The model has been developed as an excel-based spreadsheet model and operates on a daily time-step.

4 Review of volumetric releases

Review of volumetric releases was undertaken to assess:

1. Volume of water released into the Haughton River upstream of Val Bird for supplementation of GBA supply; and,
2. Volume of water released both to the system (for maintenance of weir operating levels) and from the system (in response to environmental flow considerations) in compliance with requirements defined within the relevant operations documents.

The following sections provide a summary of data review.

4.1 Review of volumetric releases to the Giru Benefitted Area

Daily volumetric release data from the Haughton Balancing storage to the Haughton River for the purposes of supplementing the Giru Benefited Area (GBA) was obtained from SunWater for the most recent two (2) year period, along with natural streamflow data for Haughton River and Majors Creek upstream of the release point. Figure 3 below shows daily release and natural flow over the 2-year period and illustrates the role of release in supplementing the Haughton River during periods of low to no natural flow.

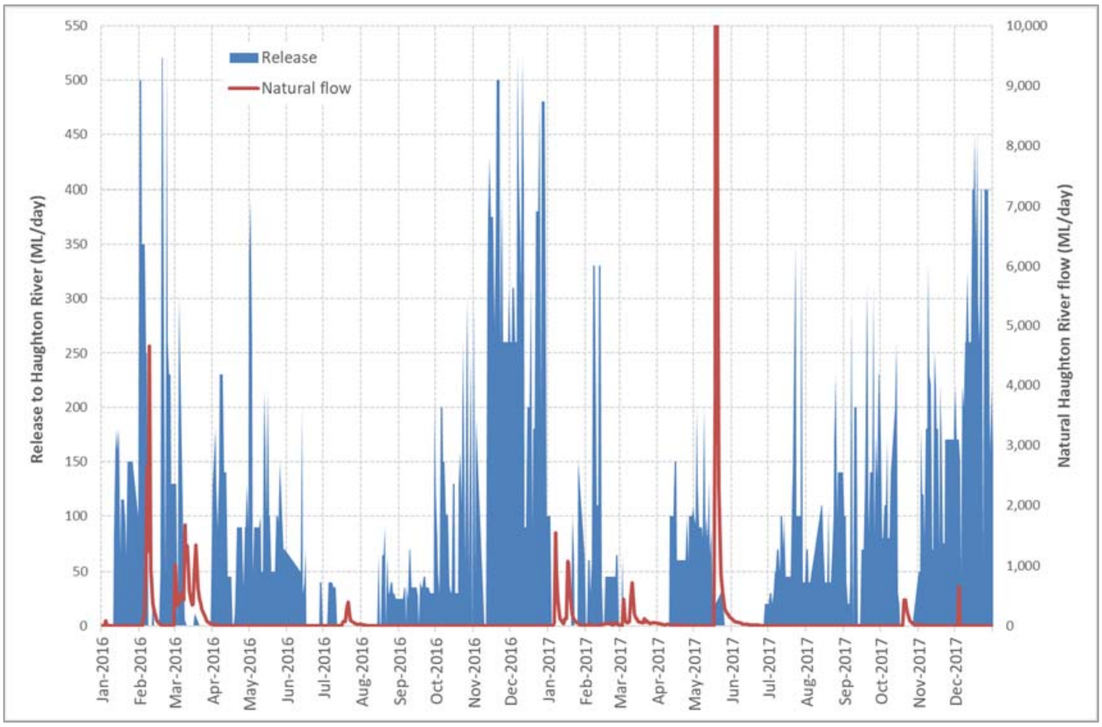


Figure 3 –Daily GBA supplemented release

In total, some 68,000 ML was released from Haughton balancing storage into the Haughton River for supplementation of the GBA over the 2-year period, with a peak daily release of 520 ML/day. It is important to note that this release is specifically for water entitlements within the GBA only, and usage of water by entitlement holders along the Haughton River upstream of the GBA accounted for separately and is not included in this value.

Releases were undertaken generally in response to periods of high demand in the GBA (most notably November to January), with some periods of lower release rates during the natural dryer periods in which natural loss processes (evaporation, aquifer discharge, etc) lead to a requirement for weir level supplementation (generally between July and October.

A point of note is that further data has been requested and is being obtained/collated by SunWater, with the proposed purpose of assessing change in actual release behaviour over the full period of available information.

4.2 Compliance with Burdekin water planning requirements

Water resources within the Burdekin Basin are managed under the Water Plan (Burdekin Basin) 2007 ('the Burdekin Water Plan'). The purposes of the Burdekin Water Plan comprise:

(a) to define the availability of water in the plan area;

(b) to provide a framework for sustainably managing water and the taking of water;

(c) to identify priorities and mechanisms for dealing with future water requirements;

(d) to provide a framework for establishing water allocations;

(e) to provide a framework for reversing, where practicable, degradation that has occurred in natural ecosystems;

(f) to regulate the taking of overland flow water.

A key element of the Burdekin Water Plan as it relates to the GBA is that all supplemented and unsupplemented water use are treated as surface water. The Water Plan (Burdekin Basin) 2007 states that *"Water in an aquifer under a watercourse or under land adjacent to a watercourse, in the Giru Benefited Groundwater Area, is declared to be water in the watercourse"*. This effectively recognises the direct connection between surface water and groundwater within the area.

While the Water Plan defines the overarching objectives and frameworks for the management of water resources in the Burdekin Basin, the specific rules and operational approaches required to implement the Water Plan and meet it's objectives are defined in a series of operational and licencing documents, comprising:

- Burdekin Basin Water Management Protocol (May 2017) ('the Protocol').
- Burdekin Haughton Water Supply Scheme Operations Manual ('the Operations Manual').
- Burdekin Haughton Water Supply Scheme Resource Operations Licence (the ROL').

The above three (3) documents define the specific rules and details associated with the use, movement and/or change of water allocations, overarching rules for the operation of the various key storages and other infrastructure within the BHWSS including water sharing rules, and the specific detail and licencing conditions associated with the specific infrastructure within the scheme.

With respect to the GBA, the following operational rules are defined against which compliance has been assessed:

- Operating levels of storages as defined in Chapter 2 of the Operations Manual; and,
- Minimum stream flow requirements as defined within Attachment 2 of the ROL.

An important point to note is that the above assessment is not intended to represent a comprehensive compliance audit against all requirements (e.g. water quality, monitoring, reporting, etc), but rather an analysis of the key physical operational elements of the GBA against the operating rules within the relevant water planning documents.

4.2.1 Operating levels of storages

Chapter 2 of the Operations Manuals defines the operating rules which apply to the BHWSS as a whole, and specific storages/infrastructure within it. Specific to the GBA, operational rules are set for the Val Bird and Giru Weirs within Section 4 'Operating levels of storages' (reproduced in Table 1 below).

Table 1 – Section 4 of BHWSS Operations Manual

4 Operating levels of storages

(1) The minimum operating levels and nominal operating levels for Burdekin Falls Dam, Clare Weir, Val Bird Weir and Giru Weir are specified in table 1.

(2) The resource operations licence holder must not release water from a storage unless the release is necessary to achieve one or more of the following—

(a) meet minimum stream flow requirements in attachment 2 section 3 of the resource operations licence;

(b) supply water to a water allocation holder or a distribution operations licence holder; or

(c) maintain a downstream storage at its nominal operating level.

(3) Despite subsection (2), the resource operations licence holder must not release or supply water from a storage when the water level in that storage is at or below its minimum operating level.

(4) For this section—

minimum operating level means the operating level below which water cannot be used to supply water users, either because there is insufficient hydraulic gradient or because of poor water quality for environmental reasons.

nominal operating level means the level that the weir was designed to operate at.

Table 1 – Operating levels of storages

Storage	Minimum operating level (m AHD)	Nominal operating level (m AHD)
Burdekin Falls Dam	124.00	Not applicable
Clare Weir	13.68	Not applicable
Val Bird Weir	3.82	6.20
Giru Weir	2.25	3.00

Specific requirements for the operation of Val Bird and Giru weirs are:

- Val Bird Weir operating levels:
  - Nominal operating level (NOL): 6.2 m AHD.
  - Minimum operating level (MOL): 3.82 m AHD.
- Giru Weir operating levels:
  - NOL: 3.0 m AHD.
  - MOL: 2.25 m AHD.
- Release from either weir only allowed to:
  - (i) Meet minimum flow requirements (described further in Section 0 below);
  - (ii) Supply water to allocation holders; or,
  - (iii) Maintenance of downstream storage at NOL.
- No release from any storage below the MOL.

The operation behaviour of Val Bird and Giru Weirs is shown below in Figure 4 and Figure 5, respectively. As shown in Figure 4, Val Bird weir has been operated within the requirements of the Operations Manual, with a balance of natural flow and supplemented releases used to maintain a controlled water level at or above the NOL. A similar maintenance of Giru Weir water level within the requirements of the Operations Manual is shown in Figure 5.

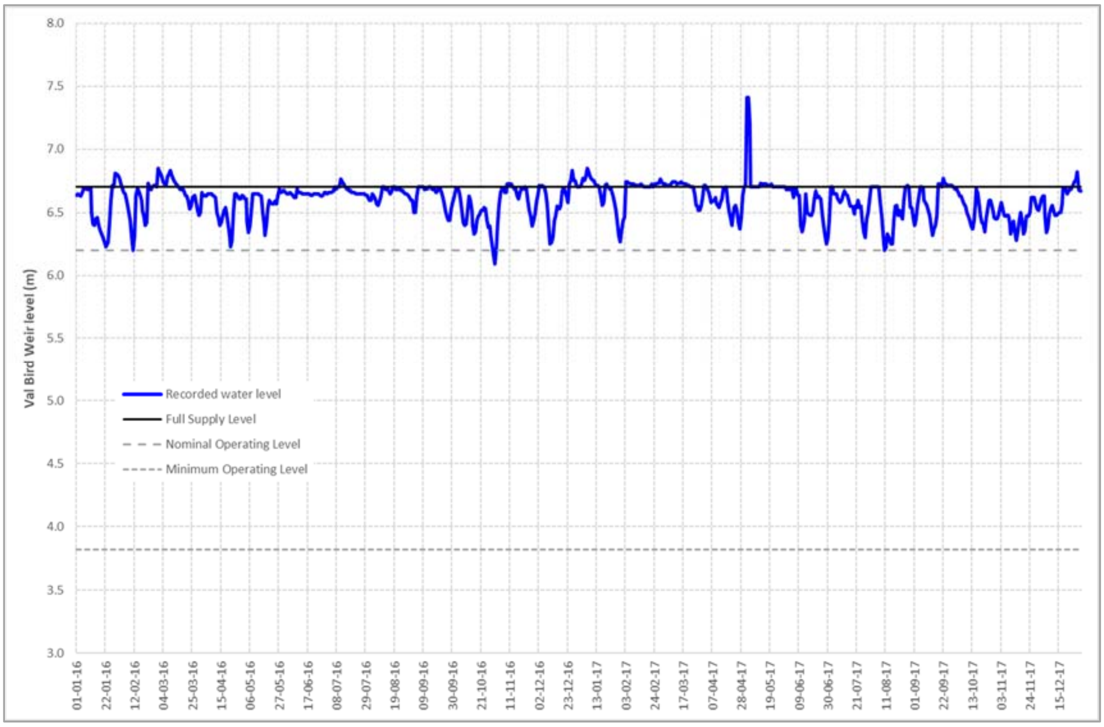


Figure 4 –Val Bird Weir water level behaviour

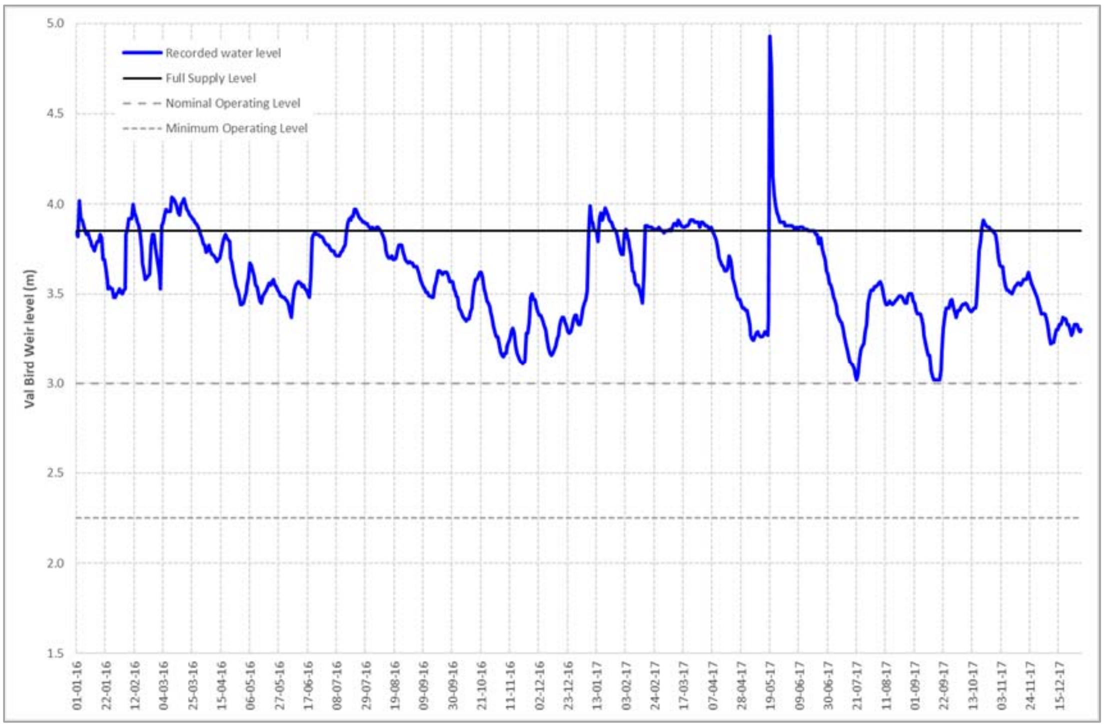


Figure 5 –Giru Weir water level behaviour

System operational efficiencies are sought through allowing the water level in both weirs to draw down towards the NOL in order to maximise use of natural flow and minimise uncontrolled overflow.

4.2.2 Minimum stream flow requirements

Attachment 2 of the ROL defines the conditions under which the licenced infrastructure within the BHWSS, and system as a whole, are to be operated.

Specific to the GBA, operational rules are set for the Val Bird and Giru Weirs within Section 3 of Attachment 2 'Environmental Management Rules' (reproduced in Table 2 below).

Table 2 – Section 3 of Attachment 2 to BHWSS ROL

3 **Minimum stream flow requirements**

(1) The nodes at which minimum stream flow requirements are to be measured are described in attachment 2 table 1.

(2) The licence holder must ensure that there is a minimum stream flow—

(a) at Node 1—equal to the cumulative daily flows recorded at the flow monitoring Node A and the flow monitoring Node B, up to 360 ML/day and

(b) at Node 2—equal to the cumulative daily flows recorded at the flow monitoring Node C and the flow monitoring Node F, up to 40 ML/day.

(3) The licence holder may meet the minimum stream flow requirements by utilising a combination of the following—

(a) natural flows; and

(b) releases from Burdekin Falls Dam, Clare Weir, Val Bird Weir and Giru Weir .

(4) In meeting the requirements of subsection (2)(a), the licence holder must collaborate with the distribution operations licence holder on appropriate release strategies for the Lower Burdekin.

(5) The licence holder must prepare and maintain operating procedures that demonstrate that arrangements are in place to achieve the requirements of subsection (2).

(6) In this section—

Node 1, is defined in the Water Plan (Burdekin Basin) 2007, but can be considered as the mouth of the Burdekin River at AMTD 6.0 km.

Node 2, is defined in the Water Plan (Burdekin Basin) 2007, but can be considered as the Haughton River at Giru Weir (AMTD 15.6 km).

Table 1 – Flow monitoring nodes and locations

Flow monitoring node	Description
Node A	Sellheim gauging station on the Burdekin River (120002C) 299.0 km AMTD
Node B	Red Hill Creek gauging station on the Bowen River (120219A) 36.8 km AMTD
Node C	Mount Piccaninny gauging station on the Haughton River (119005A) 58.1 km AMTD
Node F	Major Creek gauging station on the Major Creek (119006A) 8.7 km AMTD

4 **Quality of water released**

When releasing from Burdekin Falls Dam, the resource operations licence holder must—

(a) draw water from the inlet level that optimises the quality of water released; and

(b) prepare and maintain operating procedures that demonstrate arrangements are in place to achieve the requirements of subsection (a).

Specific requirements for the maintenance of minimum stream flows in the Haughton River are:

- Passing of sum of recorded flows at:
  - Haughton River at Mt Piccaninny (GS119005a); and,
  - Major Creek at gauging station (GS119006a).
- Maximum passflow requirement = 40 ML/day.

The upstream stream flow and passflow behaviour of GBA system is shown below in Figure 6 (all flows) and Figure 7 (flows < 500 ML/day).

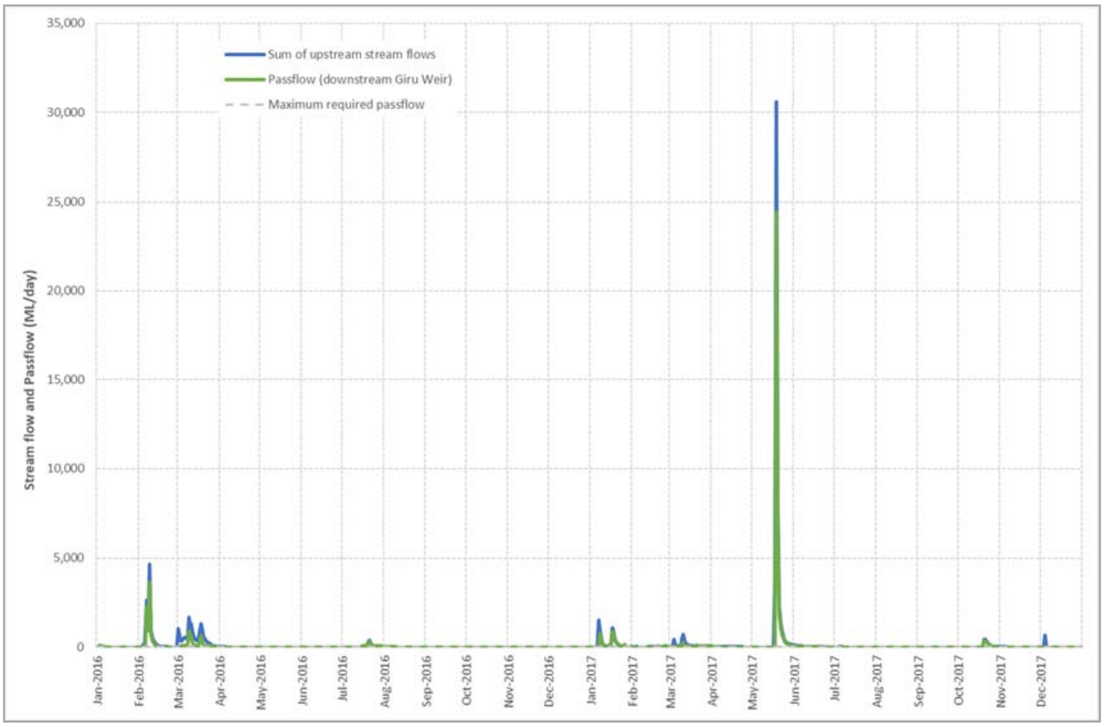


Figure 6 –Recorded streamflow and passflow

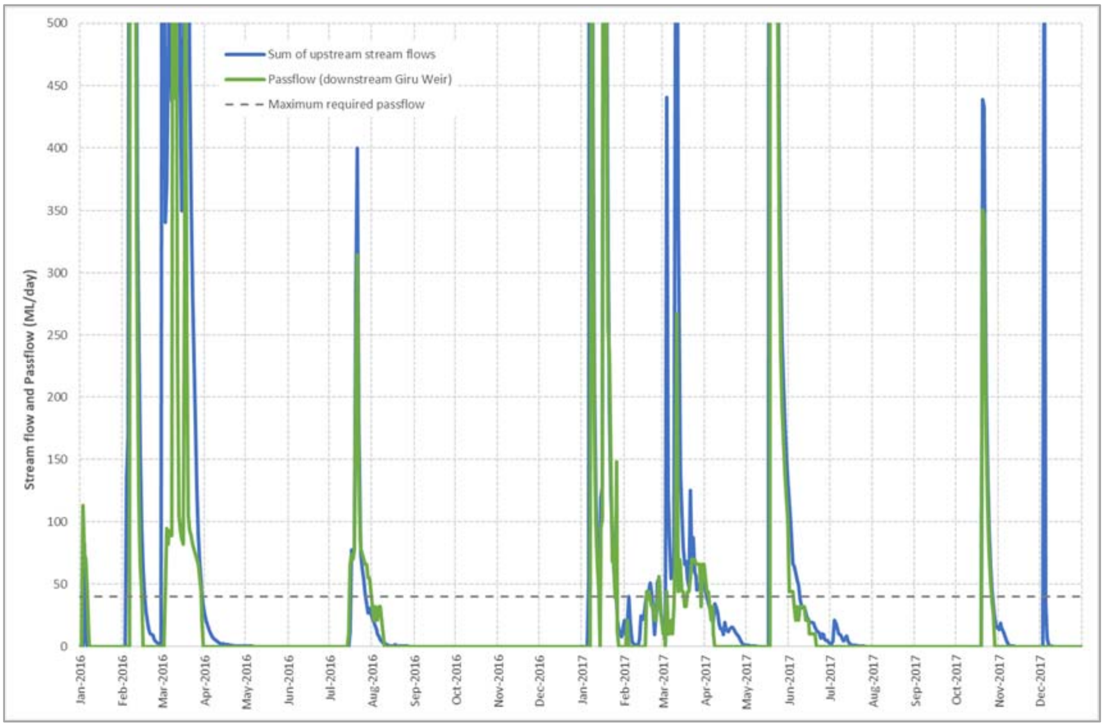


Figure 7 –Recorded streamflow and passflow (flows < 500 ML/day)

As shown in Figure 6, natural flows within Haughton River and Major Creek generally lead to flow passing over Giru Weir, consistent with the intent of the ROL. However, Figure 7 shows that during low and receding flows, the maintenance of flows downstream of Giru Weir has not always achieved prior to the end of the 2017 calendar year.

In recognition of this operational failing, SunWater have commissioned the addition of a controlled outlet valve on Giru Weir, which directly addresses the previous lack of operational flexibility to meet the ROL minimum stream flow condition.

5 Assessment of Natural Yield

Assessment of the GBA system yield was undertaken to determine the natural yield being captured and utilised in the system. This component of the study comprised the development of a conceptual GBA system water balance model for application to the initial assessment of the system under a range of operational and water use/demand scenarios.

5.1 Model development

Model development was undertaken to provide an understanding of the overall water balance behaviour of the Haughton River and connected alluvial aquifer which make up the GBA supply source.

The model has been developed as an excel-based spreadsheet model and operates on a daily time-step, with simulation of the main system inflows/outflows as well as surface water/groundwater interactions (i.e. aquifer recharge/discharge), water use and storage water level changes (weirs and aquifer) from day-to-day and over time.

The model was developed in a series of stages comprising:

(i) Conceptualisation and ‘calibration’ against short-term (2-year) recorded operational data;

(ii) Validation against long-term (40+years) bore water level data within the GBA; and,

(iii) Scenario assessment with modification of operational and water demand parameters.

The operational behaviour and performance of the GBA system was then simulated based on the validated model with simulation of a range of scenarios based on different operational and demand assumptions.

5.1.1 Conceptualisation, calibration and validation

Initial conceptualisation of the water balance model comprised simulation of main system inflows/outflows as well as surface water/groundwater interactions (i.e. aquifer recharge/discharge). Inputs to the model included:

- Recorded Haughton River and Major Creek streamflow;
- BOM rainfall and evaporation;
- Recorded supplemented releases from Haughton balancing storage to Haughton River;
- Recorded extractions/usage, including
- Recorded weir water levels

Model validation comprise comparison of simulated aquifer behaviour against long-term bore water level data for a range of available bores within the GBA (see Figure 8 below). Comparison of model versus recorded bore water level behaviour was undertaken for nine (9) bores as listed in Table 3 below.

Figure 8 –GBA and available bore water level data

Table 3 – Recorded historical bore water level data

Bore Number	Latitude	Longitude	Period of available data
11900005	-19.5055	147.0653	17/04/1969 – 17/11/2017
11900006	-19.5068	147.0664	18/04/1969 – 11/10/2011
11900014	-19.5509	147.0544	16/07/1965 – 17/11/2017
11900021	-19.5597	147.0793	23/11/1964 - 17/11/2017
11900042	-19.509	147.0982	26/01/1971 – 17/11/2017
11900054	-19.5202	147.0556	31/03/1965 – 17/11/2017
11900058	-19.541	147.088	16/03/1965 – 01/01/2018
11900059	-19.5567	147.1064	19/01/1971 – 17/11/2017
11900063	-19.5655	147.1003	15/05/1967 – 17/11/2017

When comparing simulated and recorded bore water level data, it is important to note that the model effectively simulates average/aggregated water levels, while recorded data will show often quite location specific behaviour.

Figure 9 and Figure 10 below show approximately 30 years of recorded versus simulated aquifer water level data under supplemented scheme conditions (i.e. post-1989) for two bores, selected on the basis of being located (i) centrally within the aquifer (11900058); and (ii) distant from the Haughton River (11900054). It was reasoned that selection of bores on this basis would illustrate average/aggregate aquifer water level behaviour.

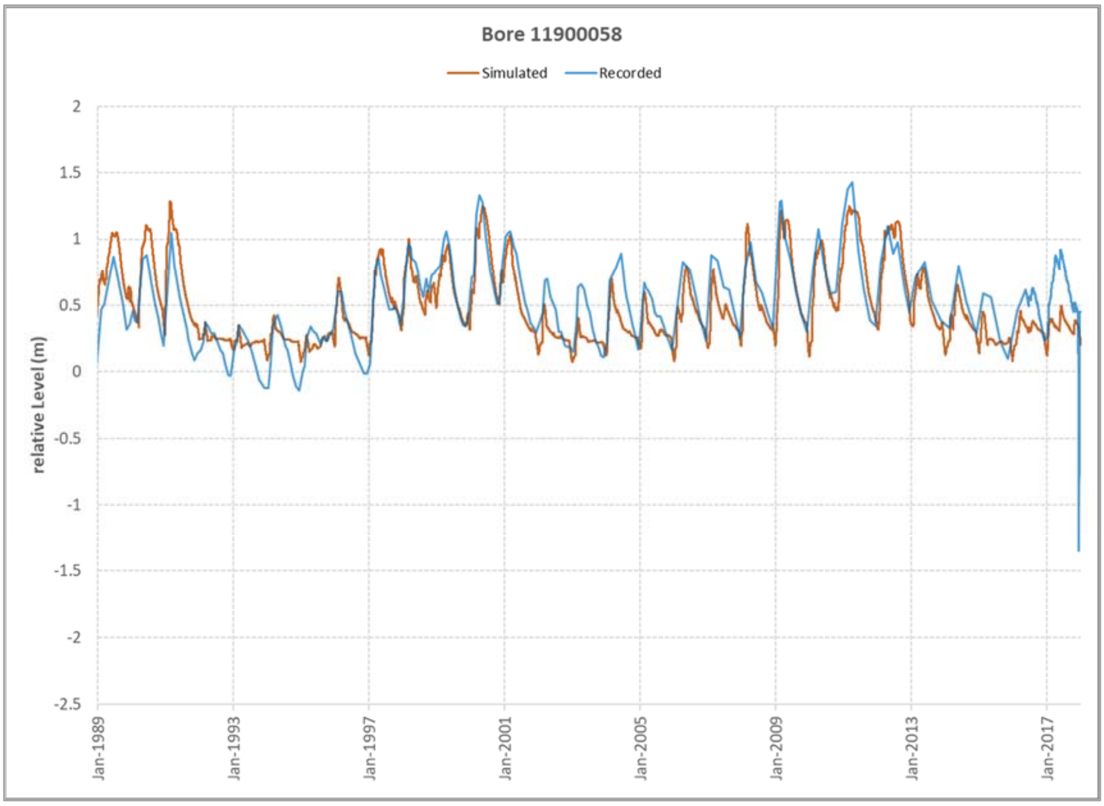


Figure 9 –Recorded (11900058) vs simulated aquifer water level (post-supplementation)

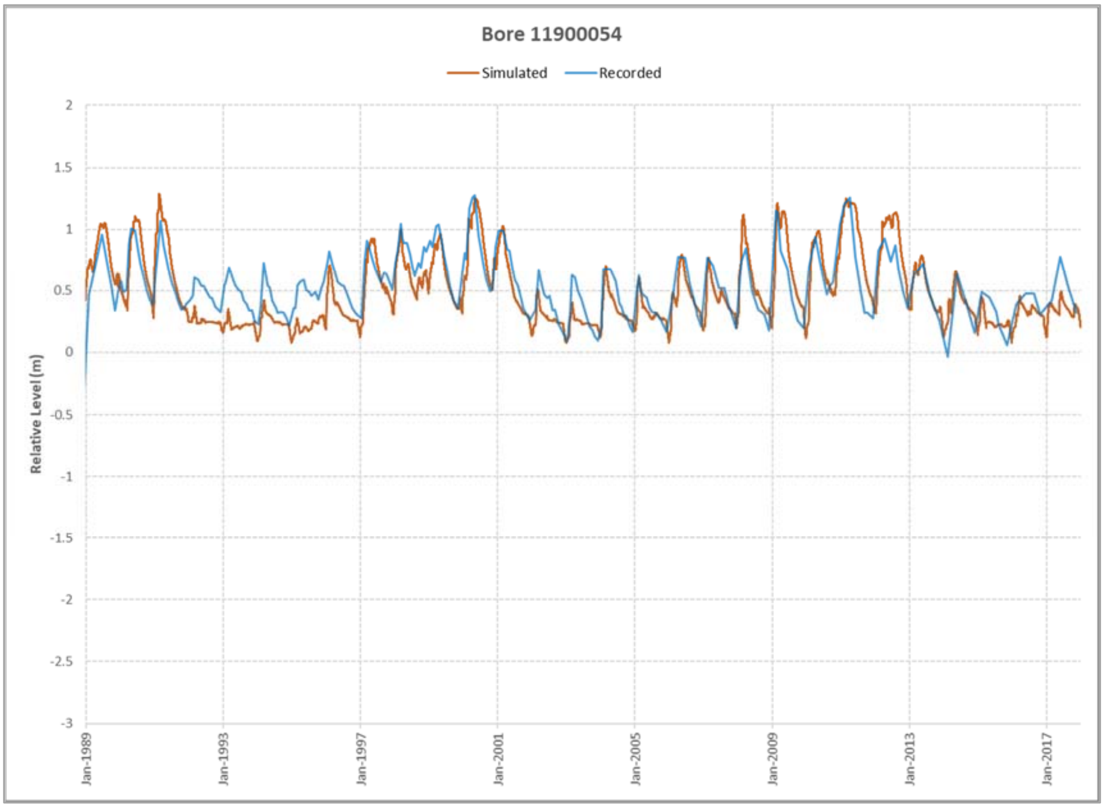


Figure 10 –Recorded (11900054) vs simulated aquifer water level (post-supplementation)

Figure 11 and Figure 12 below show some fifteen years of overlapping recorded versus simulated aquifer water level data under pre-supplemented scheme conditions (i.e. pre-1989) for the same two bores, under an assumed demand of approximately 50% of current demands. Simulation of aquifer behaviour pre-1974 is limited by available recorded streamflow data.

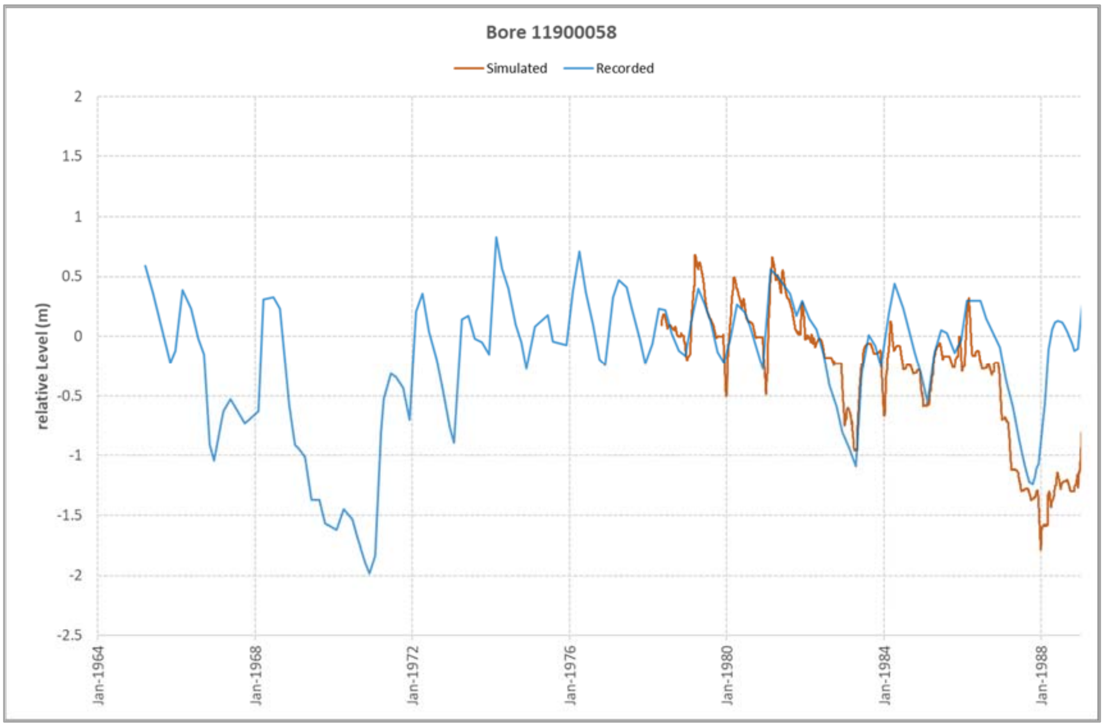


Figure 11 –Recorded (11900058) vs simulated aquifer water level (pre-supplementation)

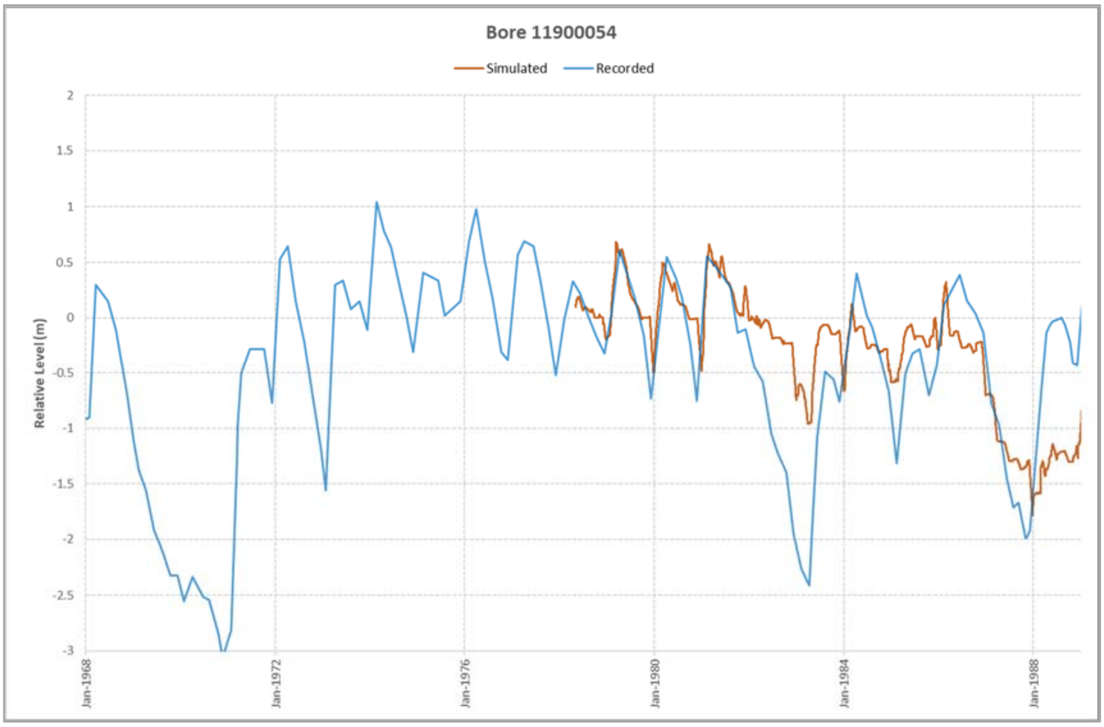


Figure 12 –Recorded (11900054) vs simulated aquifer water level (pre-supplementation)

Comparative information for all available data for all bores is provided in Attachment A, noting again the simulated data in intended to represent behaviour post-1989 only.

A key insight provided by the above figures is that validation results indicate pre-1989 demands of the order of 50%-70% of current demands (as indicated by bore water level behaviour), with lower reliability/sustainability of the system due to the increased likelihood of periods of extended aquifer drawdown and potential saltwater intrusion.

5.1.2 Scenario assessment

Initial scenario assessment was undertaken for a range of operational and demand/use assumptions, comprising:

- Base Case (existing/recent conditions): Supplemented scheme as per current operational approach and rules, with approximately 34,500 ML/a long-term average demand.
- Scenario 1 (natural system, full demand): Simulation of the GBA with no supplementation (i.e. natural aquifer/surface water availability only) and 34,500 ML/a long-term average demand.
- Scenario 2 (natural system 50% demand): GBA with no supplementation and 17,250 ML/a long-term average demand.
- Scenario 3 (natural system, 30% demand): GBA with no supplementation and 10,350 ML/a long-term average demand.

Each of the scenarios was independently modelled, with key results extracted for comparison of supply volume and reliability outcomes. The following sections provides a summary of results, as well as a description of key outcomes of the assessment.

5.2 Scenario assessment results

The following series of tables and charts provide summary results and illustrative examples of the fundamental behaviour and characteristics of the GBA aquifer as simulated scenario under assumptions as above. In particular the information seeks to provide insight into:

- The natural climatic and hydrologic variability of the Haughton River and connected alluvial aquifer;
- Characteristics (current and potential) of aquifer behaviour both with and without supplementation;
- Potential variability of aquifer water level behaviour under a range of scenarios; and,
- Long-term potential 'yield' of the aquifer under supplemented and natural conditions.

It is important to note that the results presented are considered representative of the overall, aggregate behaviours of the aquifer and available water use, and are not intended to provide specific detail and differentiation between individual bores.

5.2.1 Long-term water balance results

Table 4 below provides a summary of key long-term water balance results for the range of scenarios assessed.

Table 4 – Summary long-term water balance results (all value average annual in ML/a)

Parameter	Supplemented (Base case)	Unsupplemented		
		100% of current usage (Scenario 1)	50% of current usage (Scenario 2)	30% of current usage (Scenario 3)
Natural streamflow (Haughton R & Major Creek)	321,869	321,869	321,869	321,869
Natural aquifer recharge	7,278	7,278	7,278	7,278
Supplemented release	32,195	0	0	0
Surface water recharge (Haughton R to aquifer)	26,918	16,778	16,506	16,060
Losses[(1)]	70,812	64,374	64,374	64,374
GBA Demand	34,583	34,583	17,292	10,375
Extraction/supply	34,583	27,934	17,292	10,375
Extraction/supply (% of demand)	100%	81%	100%	100%
Aquifer discharge	19,226	28	8,670	14,060
System spill (Giru Weir overflow)	238,016	240,018	240,128	240,227
Number of years[(2)] with > 2 m drawdown	0	37	5	0
Number of years[(2)] with some shortfall	0	13	0	0

Notes: **(1)** Includes losses associated with natural flows
(2) Out of 39 simulated water years (July 1978 to June 2017)

5.2.2 Simulated supply

Figure 13 to Figure 16 illustrate the simulated annual supply and shortfall (i.e. demand not able to be met) for the each of the scenarios assessed. Points of note include:

- Reliable supply (no shortfall) of full demand with supplemented operation (Figure 13);
- Significant shortfall supplying full demand without supplemented supply (Figure 14);
- Reliable supply of 50% of demand (or less) without supplemented supply (Figure 15 and Figure 16).

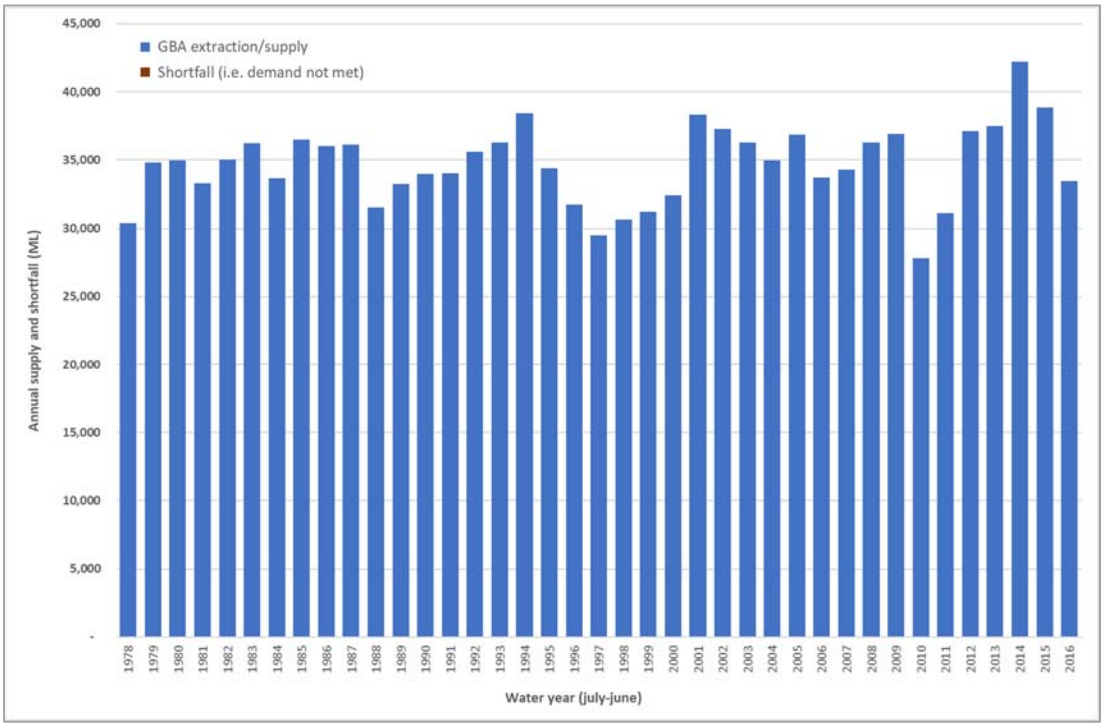


Figure 13 –Simulated annual GBA water use (Base case)

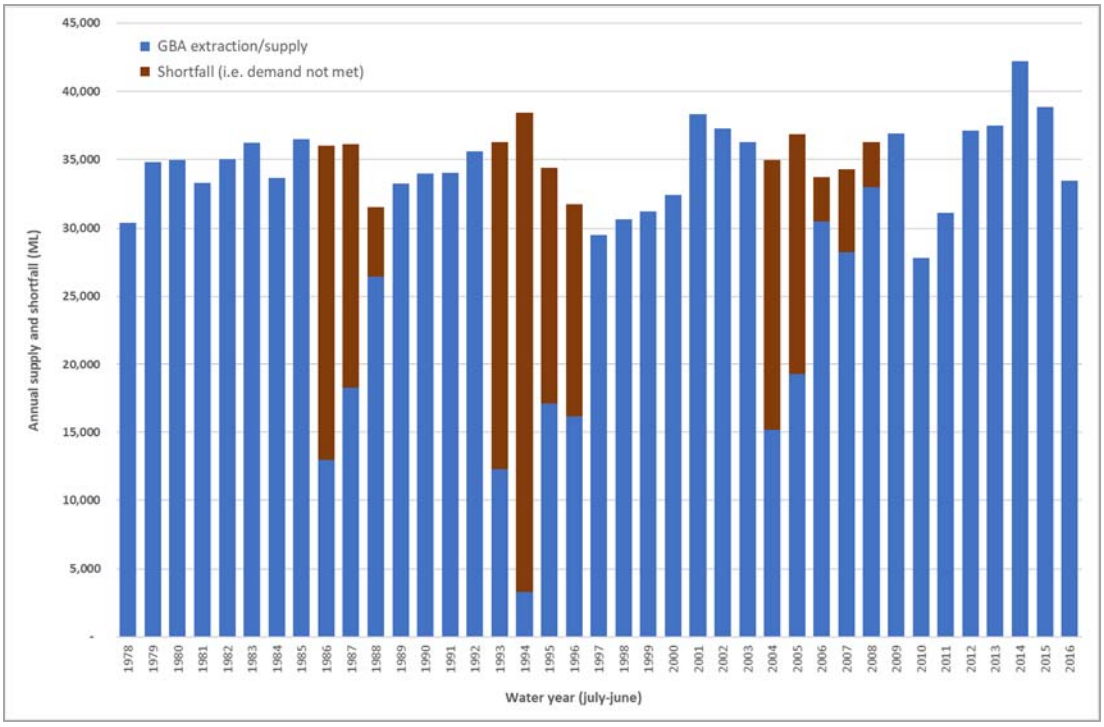


Figure 14 –Simulated annual GBA water use (Scenario 1)

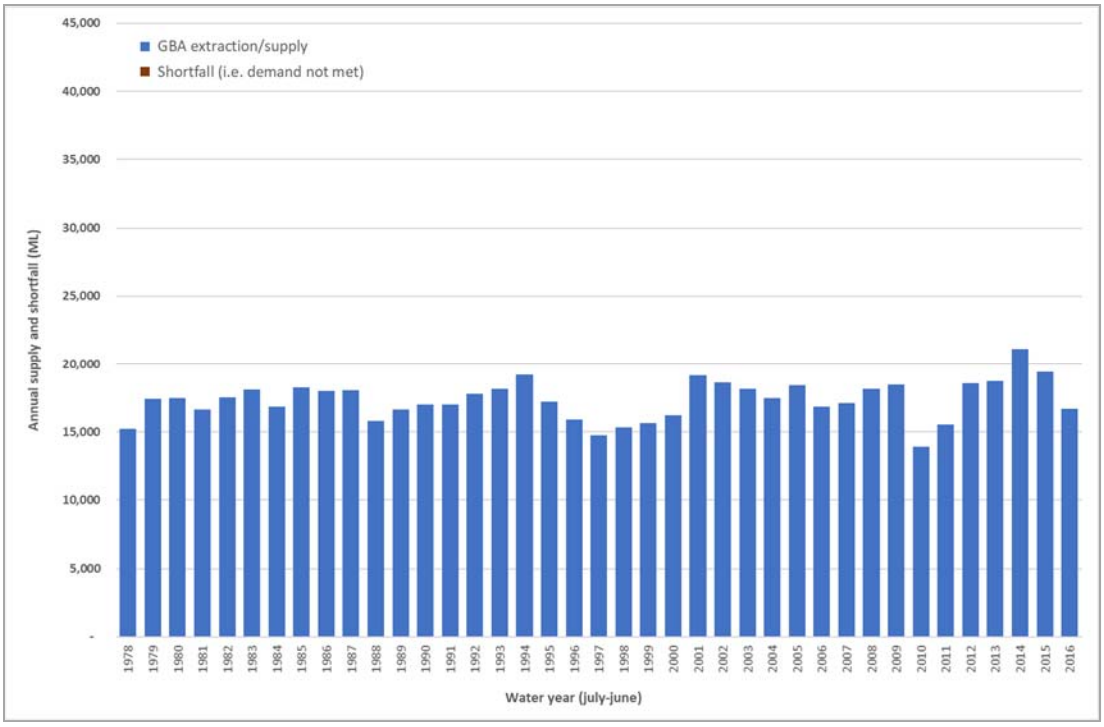


Figure 15 –Simulated annual GBA water use (Scenario 2)

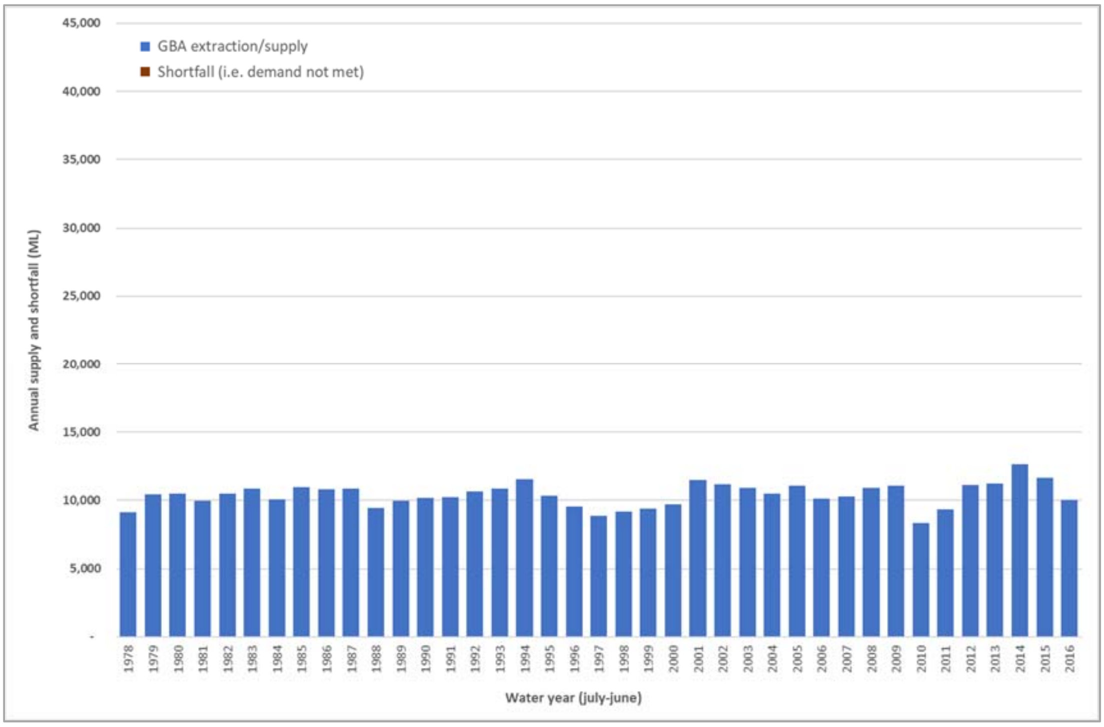


Figure 16 –Simulated annual GBA water use (Scenario 3)

The above figures show the series of annual simulated GBA extraction/supply over the period of simulation. The variability in diversion from year to year is a direct outcome of the overall climatic/hydrological characteristics of the area, and in particular changes in irrigation demands from year to year. Periods of between 3 and 5 years with relatively high rainfall and correspondingly low crop demands are interspersed with short to medium-term periods with comparatively low rainfall/high demand conditions.

5.2.3 Simulated aquifer behaviour

Figure 17 to Figure 20 below illustrate simulated aquifer water level behaviour over the period of simulation for each of the scenarios assessed. Key points of note are the rapid 'fill' and 'drawdown' of the aquifer, showing significant increase in level over a period of days/weeks in response to significant rainfall/flow recharge events, as well as rapid drawdown during peak demand/growing phase.

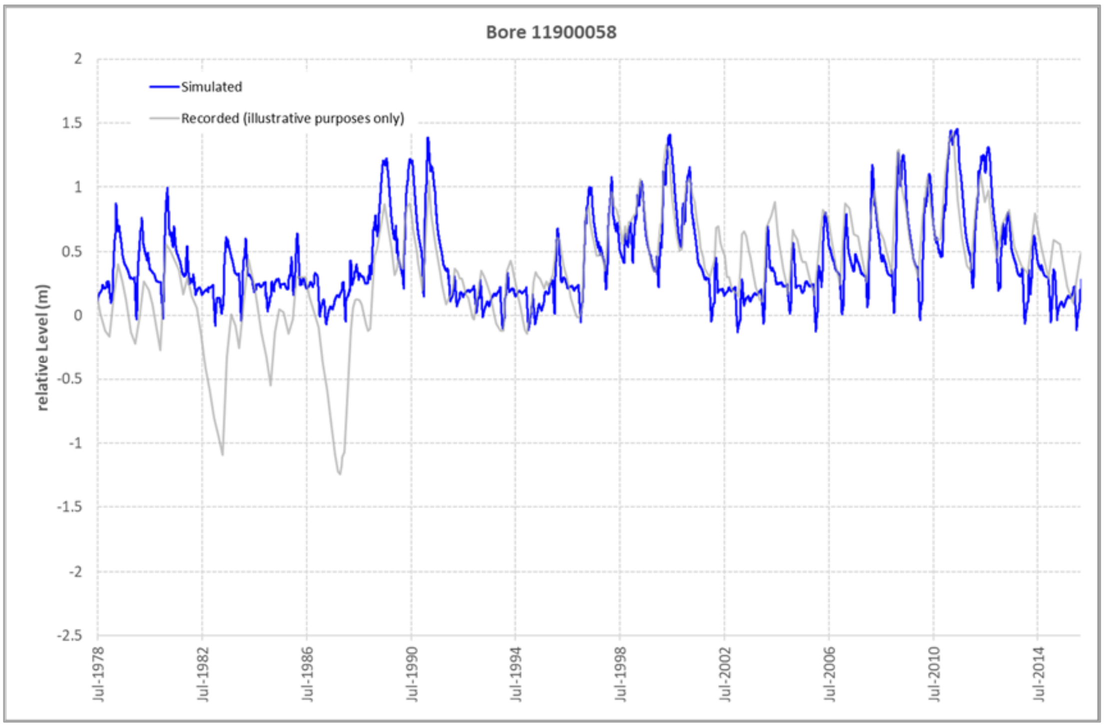


Figure 17 –Simulated aquifer water level behaviour (Base case)

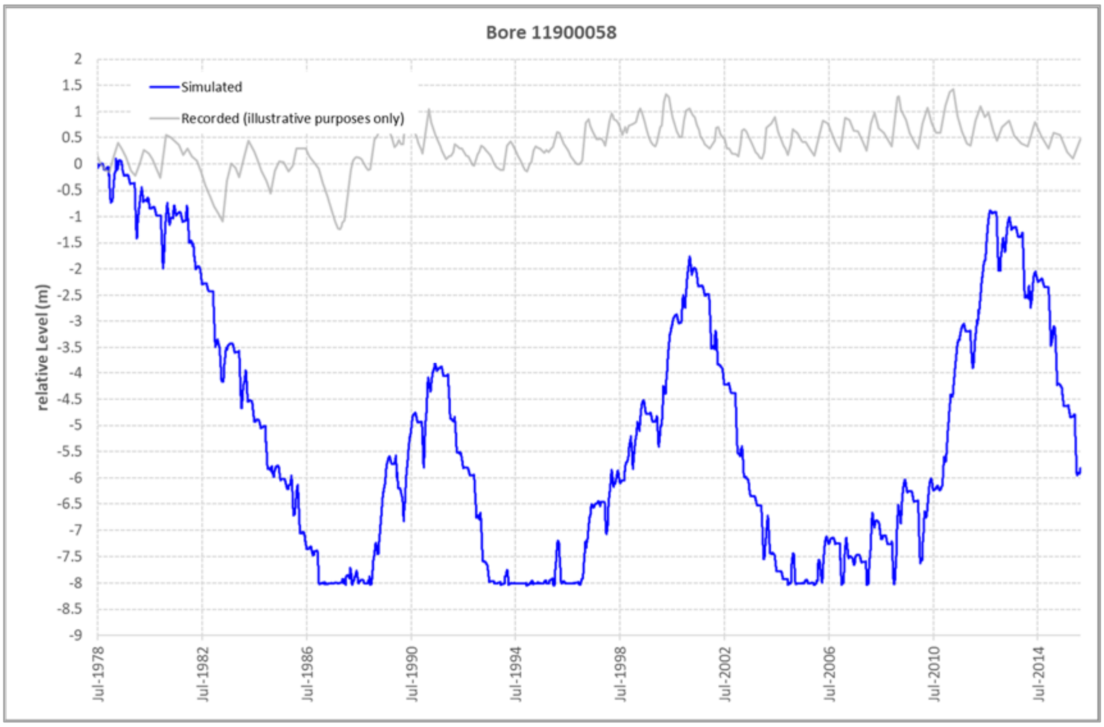


Figure 18 –Simulated aquifer water level behaviour (Scenario 1)

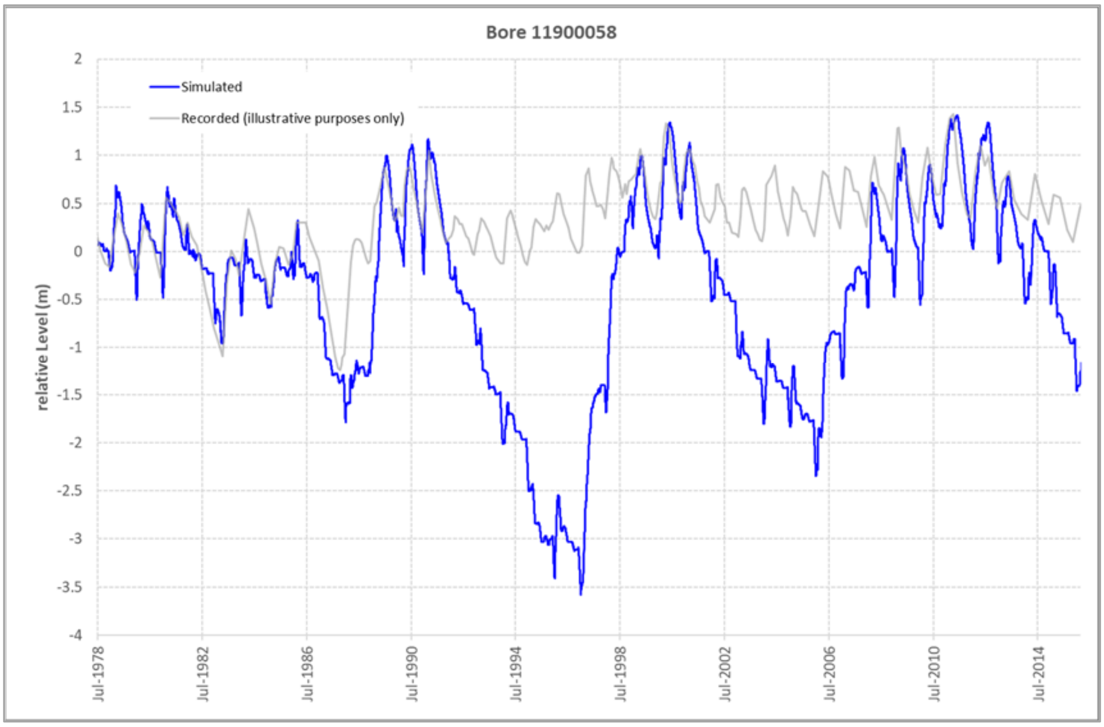


Figure 19 –Simulated aquifer water level behaviour (Scenario 2)

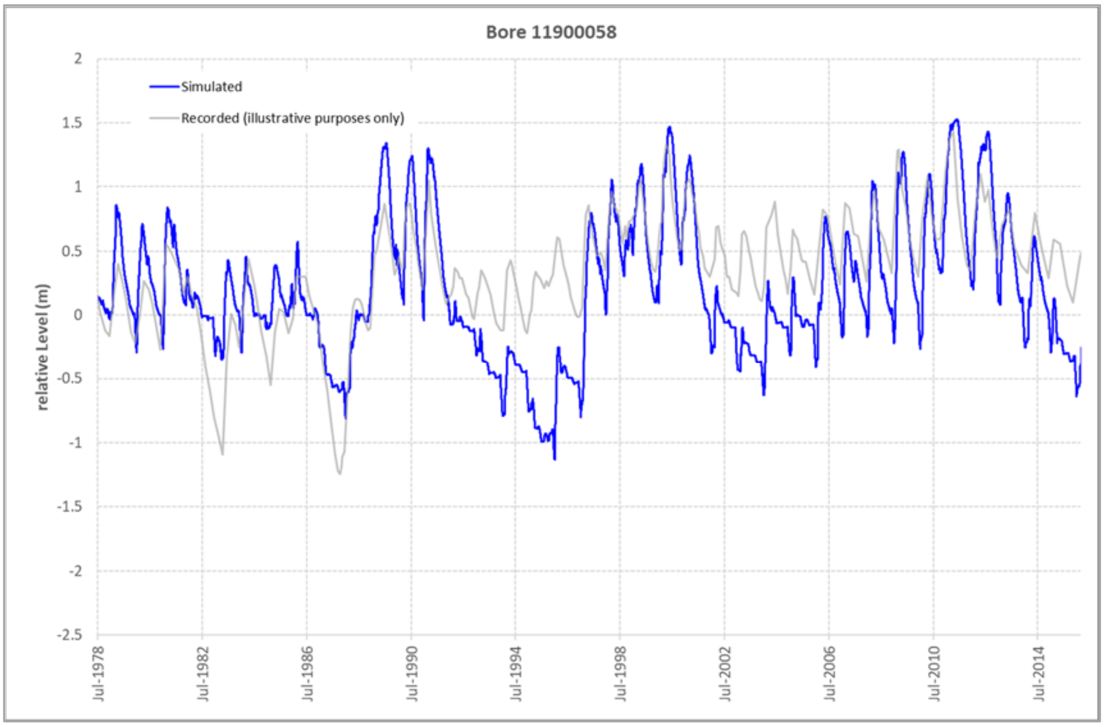


Figure 20 –Simulated aquifer water level behaviour (Scenario 3)

A significant point of note from the above figures is that under Scenario 1 (Figure 18, full demand with no supplementation) the aquifer is effectively exhausted, indicating that the natural, sustainable/reliable 'yield' of the aquifer is significantly less than current demands.

Further assessment of non-supplemented aquifer behaviour under decreasing demands (Figure 19 and Figure 20) indicate that the natural sustainable/reliable yield of the aquifer is of the order of 10,000 -17,000 ML/a (approximately 30%-50% of current demand), dependent on the required level of reliability and availability of access to deeper (> 2m) aquifer levels).

6 Key outcomes

Model development, validation and scenario assessment indicate a series of important outcomes with respect to the current operation and behaviour of the GBA system, as well as the natural, sustainable/reliable yield of the aquifer.

6.1.1 *Long-term water balance*

Based on model calibration and validation, long-term water balance outcomes under current operational and demand conditions (Column 2 of Table 4 above) indicate:

- Surface water and groundwater in the GBA is highly connected and effectively behaves as a single, integrated water source. The use of water via bores versus extraction from weirs or direct from the Haughton River is unlikely to lead to any material difference in aquifer behaviour, or supplementation requirements to meet weir water level operational requirements.
- Average, long-term supplemented release of approximately 32,500 ML/a (i.e. release to the Haughton River).
- Approximately 20% 'losses' between release point at Haughton balancing storage and Val Bird Weir.
- Long-term average natural rainfall recharge of the aquifer is estimated to be of the order of 7,000 ML/a.
- Long-term average aquifer recharge from the Haughton River is estimated to be of the order of 16,000 ML/a.
- Current conditions indicate an average, long-term GBA extraction/use of approximately 34,500 ML/a.

Long-term modelling outcomes under unsupplemented conditions indicate:

- Pre-supplementation (i.e. pre-1989) usage was likely 50%-70% of current (17,000-24,000 ML/a) levels;
- This level of demand would have been less reliable than existing demand and likely unsustainable due to potential for significant aquifer drawdown and potential saltwater intrusion.

Simulated results, coupled with recorded bore water levels, indicate that the supplementation of the GBA aquifer has created a highly reliable and robust water supply, which shows good control of aquifer levels to meet the dual outcomes of providing an increased volume of water available for irrigation, as well as management of aquifer water levels to ensure a sustainable system over the long-term.

6.1.2 Natural (unsupplemented) yield

Scenario assessment of an unsupplemented aquifer under varying levels of demand indicates a sustainable, reliable supply of approximately 30% to 50% of current demands (10,000-17,000 ML/a), dependent on the level of reliability sought.

For example, while modelling indicates sufficient supply over the simulation period under 17,000 ML/a demand, there are periods of significant aquifer drawdown (> 2m) in five (5) of the thirty-eight (38) years simulated years for an unsupplemented scheme (Figure 21).

In terms of exhibiting similar reliability as existing supplied (as defined by aquifer drawdown behaviour), modelling indicates a natural 'yield' of approximately 10,000 ML/a, which, as indicated in Figure 21, shows no instances of greater than 2m aquifer drawdown, and generally aquifer behaviour to that of the supplemented system.

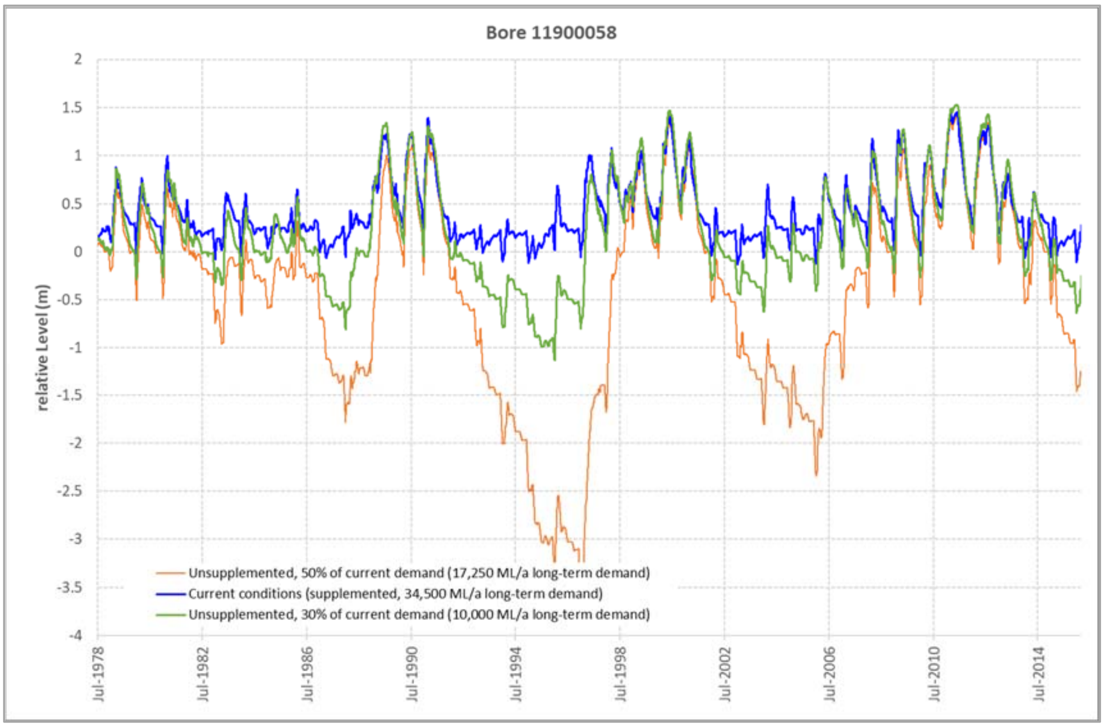


Figure 21 –Simulated aquifer water level behaviour (natural yield assessment)

6 References

Department of Natural Resources and Mines (2017), *Burdekin Basin Water Management Protocol, May 2017*. Compiled by Water Policy, Department of Natural Resources and Mines. State of Queensland, 2017

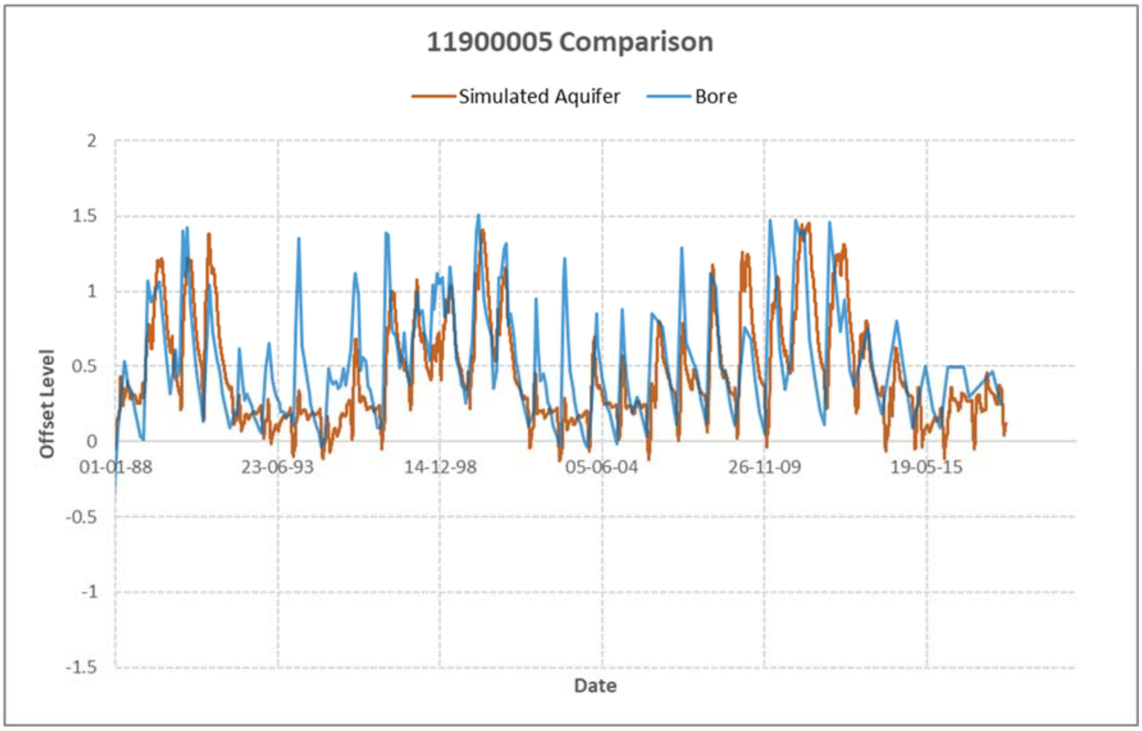
Department of Natural Resources and Mines (2017), *Burdekin Haughton Water Supply Scheme Resource Operations Licence*. Document No. W2T007-v5. The State of Queensland, Department of Natural Resources and Mines, 2017

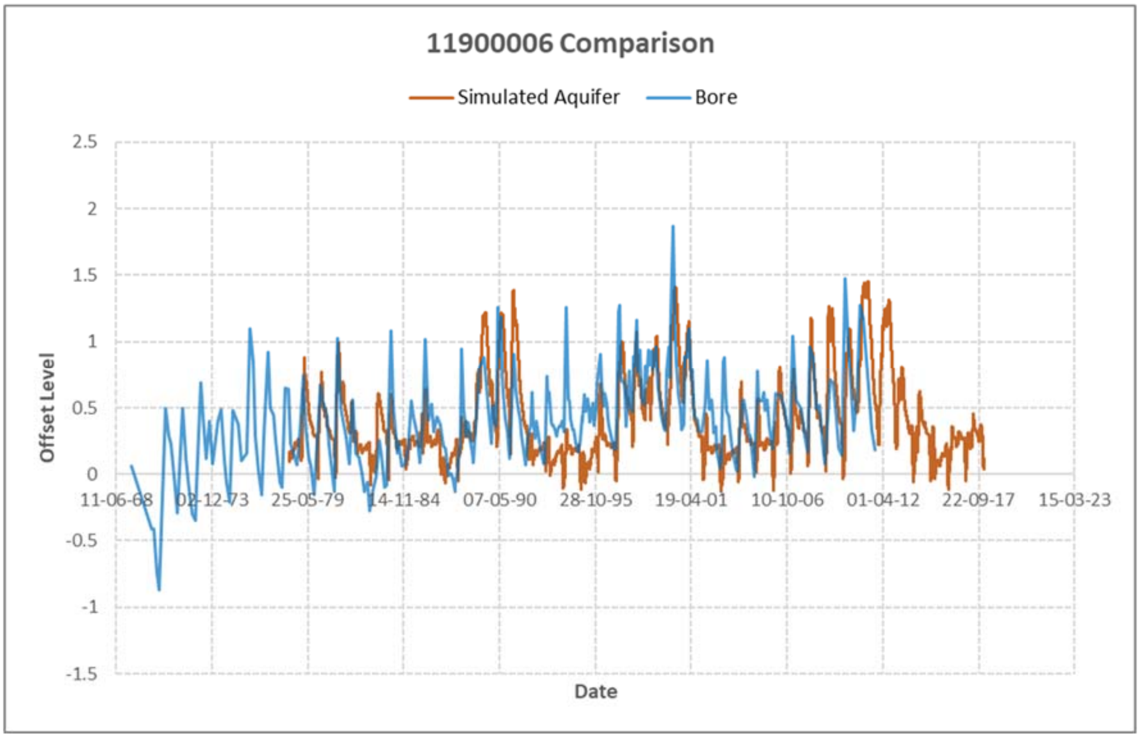
Department of Natural Resources and Mines (2017), *Burdekin Haughton Water Supply Scheme Operations Manual, May 2017*. Compiled by Water Policy, Department of Natural Resources and Mines. State of Queensland, 2017

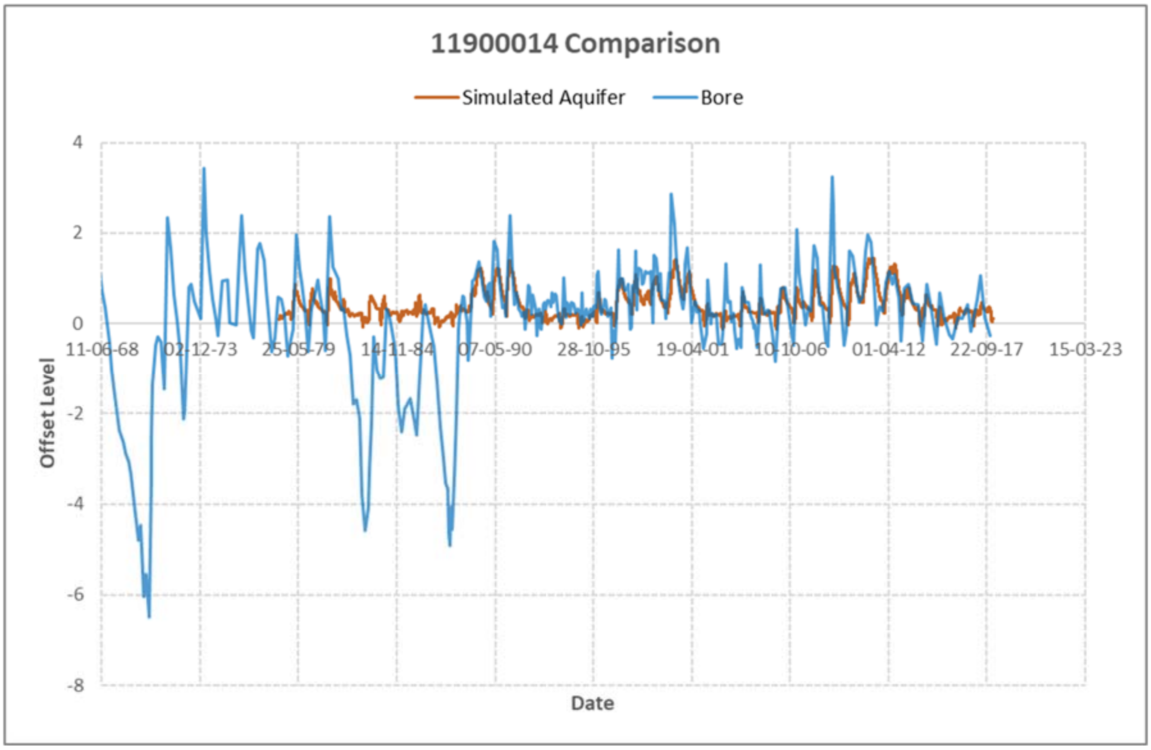
State of Queensland (2017), *Water Plan (Burdekin Basin) 2007*. Current as at 2 September 2017.

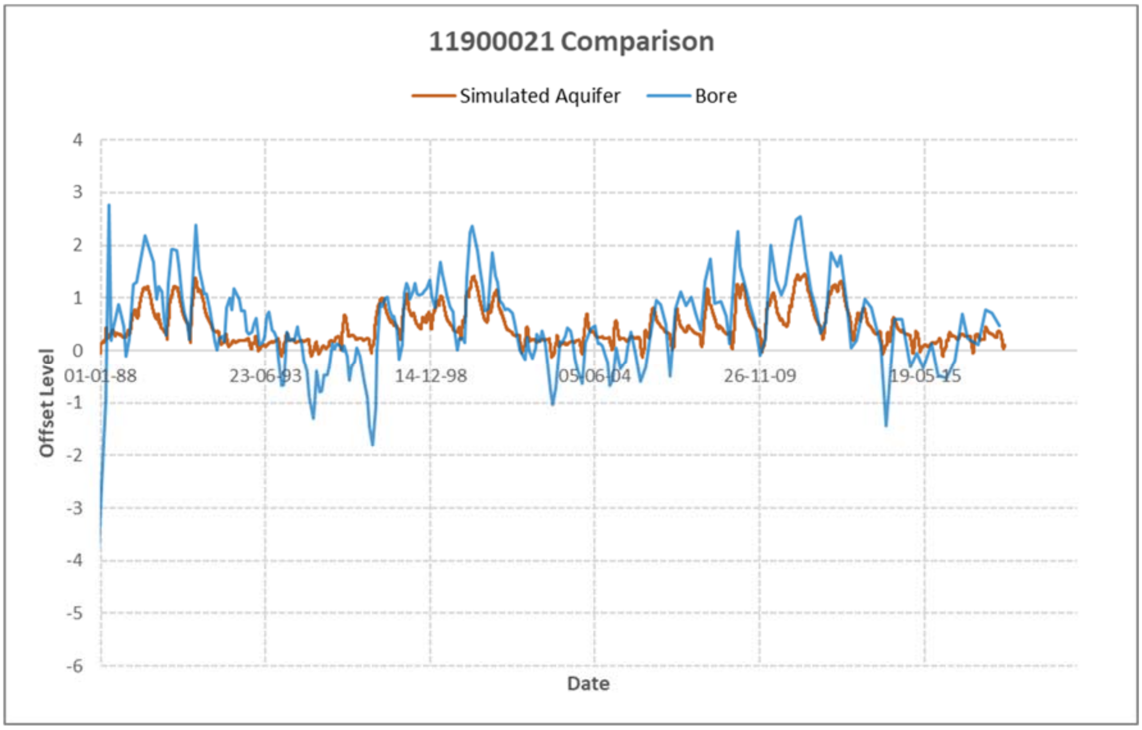
Attachments

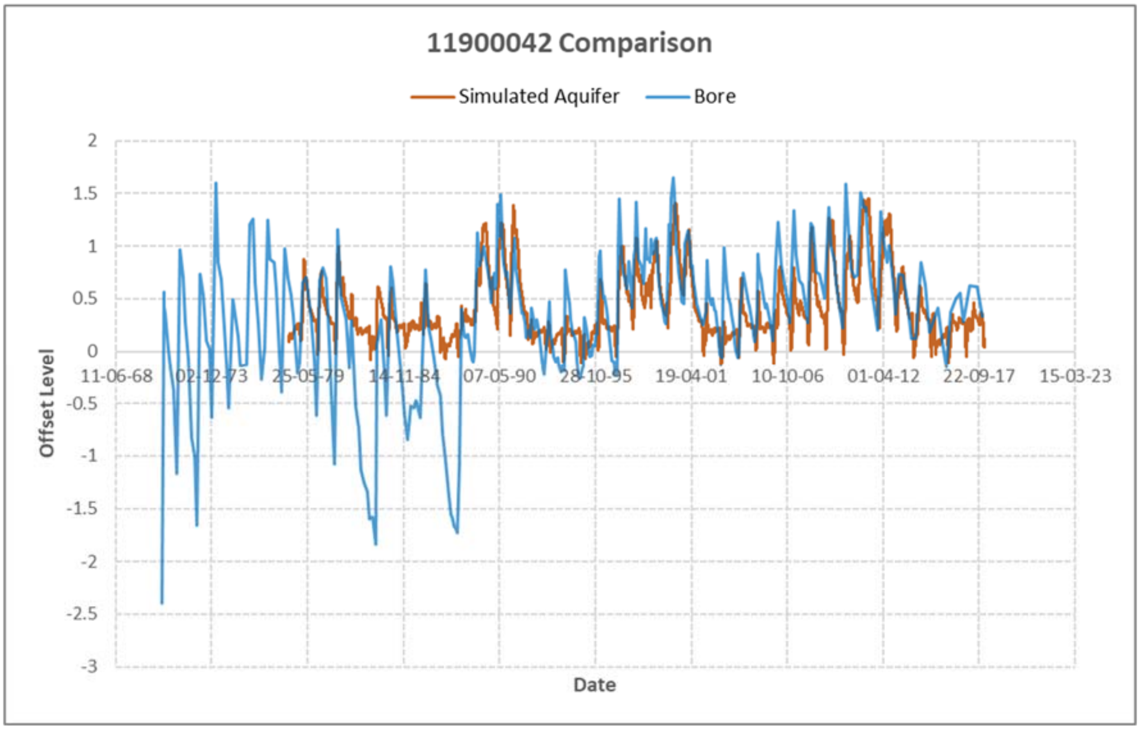
Attachment A– Recorded versus simulated aquifer water levels






11900014 Comparison
Simulated Aquifer
Bore
4
2
0
-2
-4
-6
-8
11-06-68
02-12-73
25-05-79
14-11-84
07-05-90
28-10-95
19-04-01
10-10-06
01-04-12
22-09-17
15-03-23
Offset Level
Date


11900021 Comparison
Simulated Aquifer
Bore
4
3
2
1
0
-1
-2
-3
-4
-5
-6
01-01-88
23-06-93
14-12-98
05-06-04
26-11-09
19-05-15
Offset Level
Date



11900042 Comparison
Simulated Aquifer
Bore
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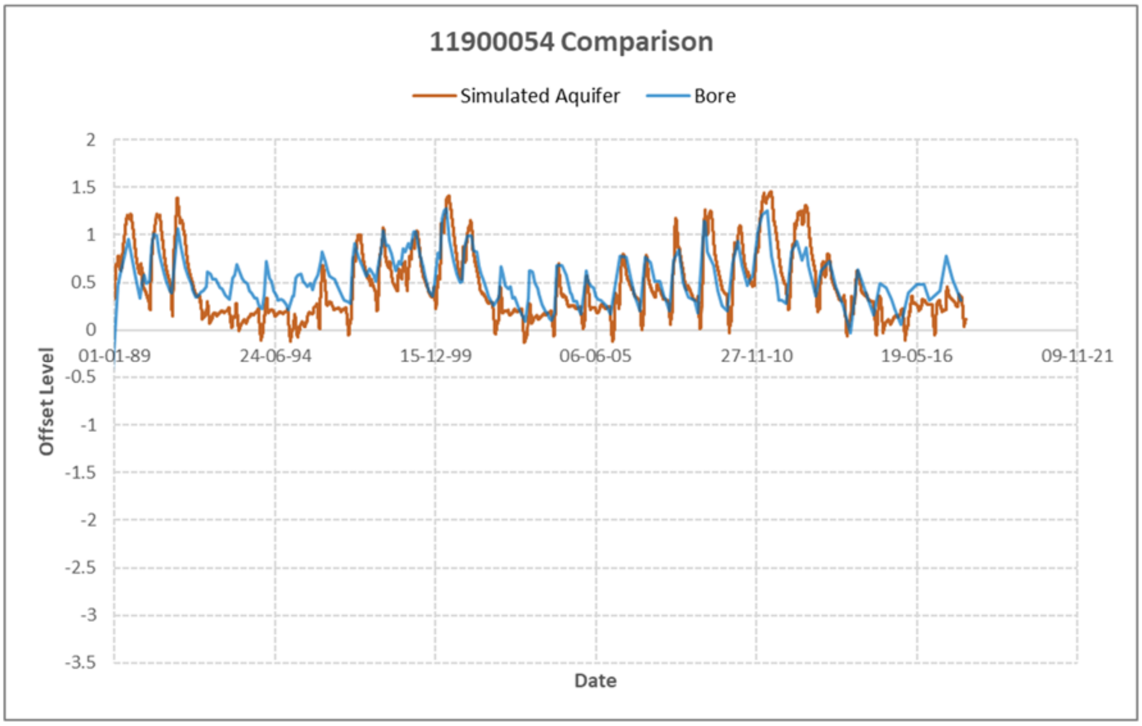
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
11-06-68
02-12-73
25-05-79
14-11-84
07-05-90
28-10-95
19-04-01
10-10-06
01-04-12
22-09-17
15-03-23
Offset Level
Date



11900054 Comparison
Simulated Aquifer
Bore
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-1.5
-2
-2.5
-3
-3.5
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24-06-94
15-12-99
06-06-05
27-11-10
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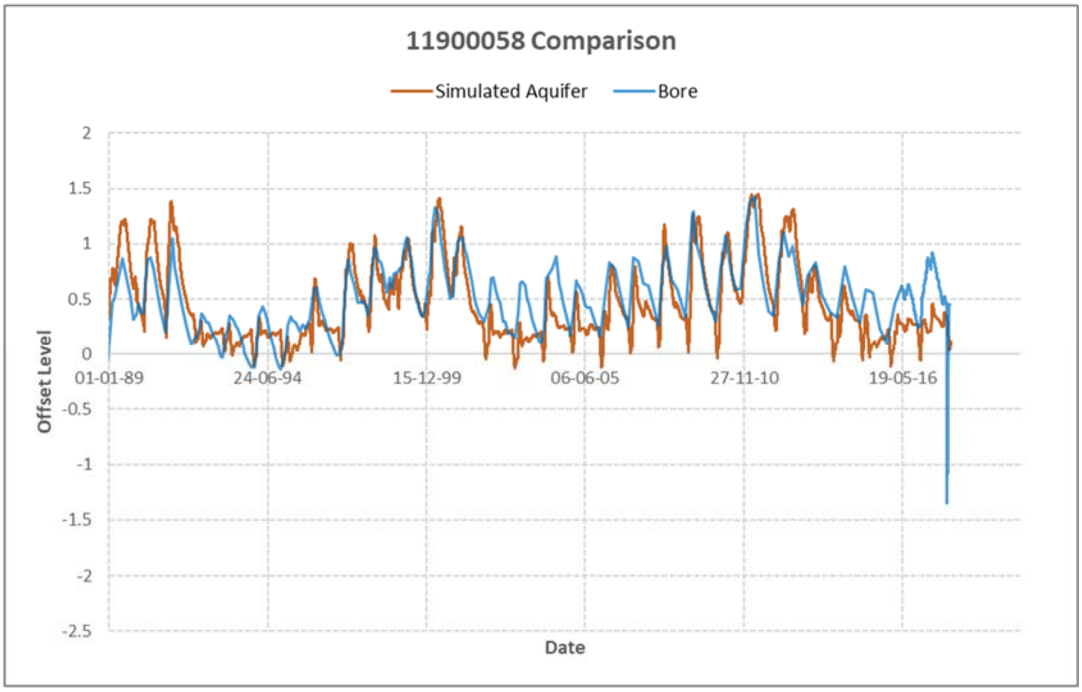
09-11-21
Offset Level
Date


11900058 Comparison
Simulated Aquifer
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0.5
0
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-1
-1.5
-2
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Offset Level
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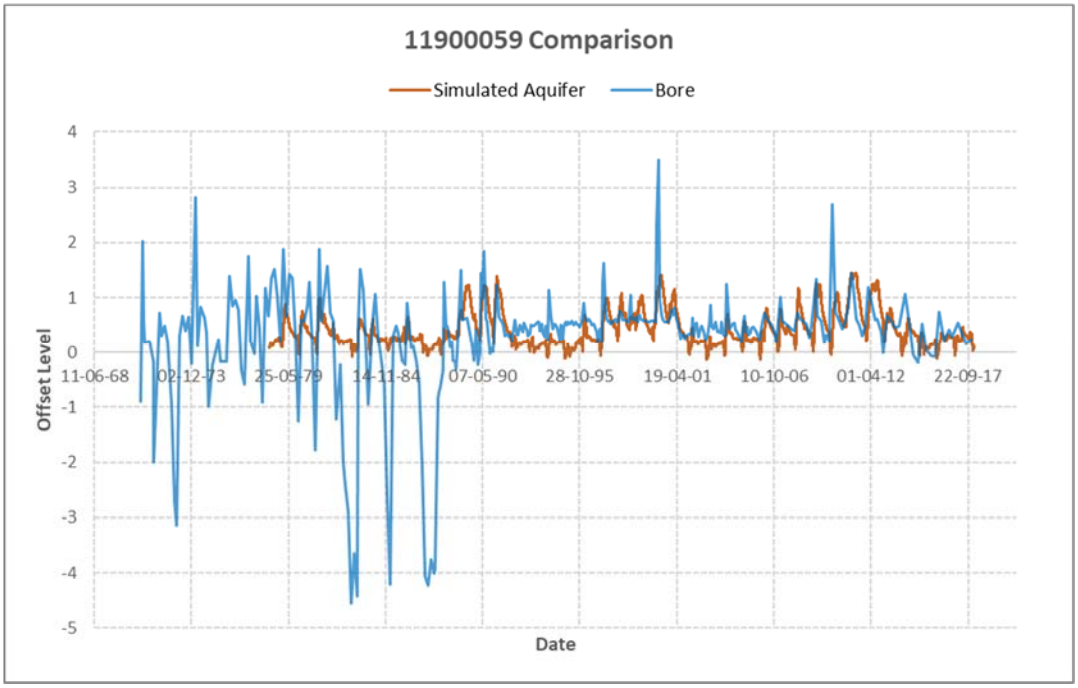
06-06-05
27-11-10
19-05-16
Date


11900059 Comparison
Simulated Aquifer
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0
-1
-2
-3
-4
-5
Offset Level
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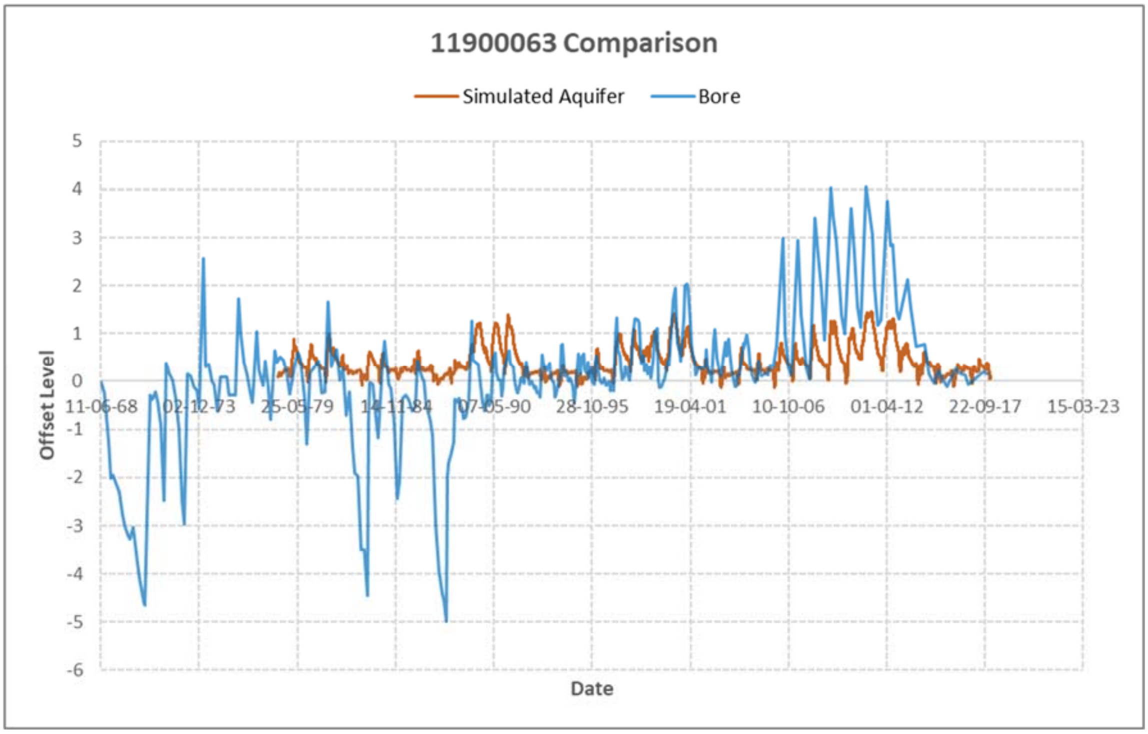
02-12-73
25-05-79
14-11-84
07-05-90
28-10-95
19-04-01
10-10-06
01-04-12
22-09-17
Date


11900063 Comparison
Simulated Aquifer
Bore
Offset Level
Date
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-2
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-6
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02-12-73
25-05-79
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22-09-17
15-03-23