Uley South 2023 groundwater model scenarios

Department for Environment and Water
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DEW Technical report 2024/4

Government of South Australia
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Acknowledgement of Country

We acknowledge and respect the Traditional Custodians whose ancestral lands we live and work upon and we pay our respects to their Elders past and present.

We acknowledge and respect their deep spiritual connection and the relationship that Aboriginal and Torres Strait Islanders people have to Country.

We also pay our respects to the cultural authority of Aboriginal and Torres Strait Islander people and their nations in South Australia, as well as those across Australia.

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Summary

Groundwater modelling results show that, even when rainfall and subsequent recharge are low, groundwater pumping rates of up to 3.5 GL/y in the Uley South Basin mitigates the risk of ongoing groundwater level decline.

Ongoing pumping of 5 GL/y under dry climate scenarios results in ongoing groundwater level decline. Associated with these declines are enhanced risk of seawater intrusion.

1 Introduction and purpose

The Uley South Basin is the primary source of municipal supply on the Eyre Peninsula and will remain so until the construction of a desalination plant by SA Water to augment this supply.

Historically, groundwater level decline in the central part of the Uley South Basin has corresponded to rising groundwater salinity in groundwater supply wells. Since, 2015, rainfall and groundwater recharge has generally been below long-term average and, despite some above average rainfall in 2021, groundwater levels have remained below pre-2015 levels.

Consequently, SA Water has commissioned the Department for Environment and Water (DEW) to investigate potential future groundwater level trends, under various climate and pumping conditions, across eight scenarios using the Uley South groundwater model (DEW, 2020).

2 Modelling approach

All details regarding the model conceptualisation, construction and calibration of the Uley South groundwater model can be found in DEW (2020a) with subsequent scenario reports (DEW, 2020b, DEW, 2021a, b, DEW, 2023).

Eight scenarios to assess the impact of different pumping operations under different climate assumptions were developed in collaboration with SA Water and are detailed in Table 2.1. All scenarios have been run from 2023 to 2050.

The National Centre for Groundwater Research and Training (NCGRT) has previously studied the relationship between groundwater level and salinity in the Uley South Basin town water supply wells. Consequently, after consultation with SA Water, it was proposed that NCGRT would do an updated assessment based on the outputs of these new modelled scenarios. NCGRT will present the results of their analysis in a separate report.

Scenario	Pumping	Recharge
Set one – 2015-19 rainfall/recharge		
1	Pumping at 5 GL/a until Dec 2025, followed by reduction in pumping to 3.5 GL/a from Jan 2026 until 2050	Recharge based on average of dry conditions 2015-2019
2	Pumping at 5 GL/a until Dec 2027, followed by reduction in pumping to 3.5 GL/a from Jan 2028 until 2050	Recharge based on average of dry conditions 2015-2019
3	Continued pumping at 5 GL/a until 2050	Recharge based on average of dry conditions 2015-2019
4	Pumping at 5 GL/a until Dec 2029, followed by reduction in pumping to 3.5 GL/a from Jan 2030 until 2050	Recharge based on average of dry conditions 2015-2019
Set two – climate change impacts		
1a	Pumping at 5 GL/a until Dec 2025, followed by reduction in pumping to 3.5 GL/a from Jan 2026 until 2050	Recharge based on average of dry conditions 2015-2019 with climate change impacts based on RCP8.5
2a	Pumping at 5 GL/a until Dec 2027, followed by reduction in pumping to 3.5 GL/a from Jan 2028 until 2050	Recharge based on average of dry conditions 2015-2019 with climate change impacts based on RCP8.5
3a	Continued pumping at 5 GL/a until 2050	Recharge based on average of dry conditions 2015-2019 with climate change impacts based on RCP8.5
4a	Pumping at 5 GL/a until Dec 2029, followed by reduction in pumping to 3.5 GL/a from Jan 2030 until 2050	Recharge based on average of dry conditions 2015-2019 with climate change impacts based on RCP8.5

Table 2.1. Uley South model scenarios

2.1 Inputs

2.1.1 Recharge

After discussion with SA Water two sets of scenarios were run using the Uley South model. The first set of model scenarios utilised the low groundwater recharge period from 2015–19 repeated into the future (Figure 2.1). The second set of scenarios explored the impact of climate change, using Representative Concentration Pathway (RCP) 8.5 (IPCC 2014), on groundwater recharge.

Where only one climate projection is utilised then it is recommended that RCP 8.5 is utilised (DEW 2022). This climate projection predicts an average change in annual rainfall of -12.5 % by 2050 for the Eyre Peninsula (DEW, 2022). This change of -12.5% by 2050 is relative to the baseline period of 1986-2005. The change in rainfall is converted to a change in recharge by applying a scaling factor of 3.2, such that a -12.5% change in rainfall results in a -40% change in recharge by 2050. This is consistent with previous climate change scenario work on the Uley South model (DEW, 2020a).

As these changes are relative to the baseline which ended in 2005 and the model scenarios commence in 2023, plotting a decline of 40% from 2023 to 2050 is not suitable. This is because a linear declining trend of 40% across the period from 2005 to 2050 translates to a declining trend of 24% for the period 2023-2050. Consequently, the model scenarios simulate recharge decreasing by 24% between 2023-2050, where the decline is applied to the 2015-19 average recharge (Figure 2.1).

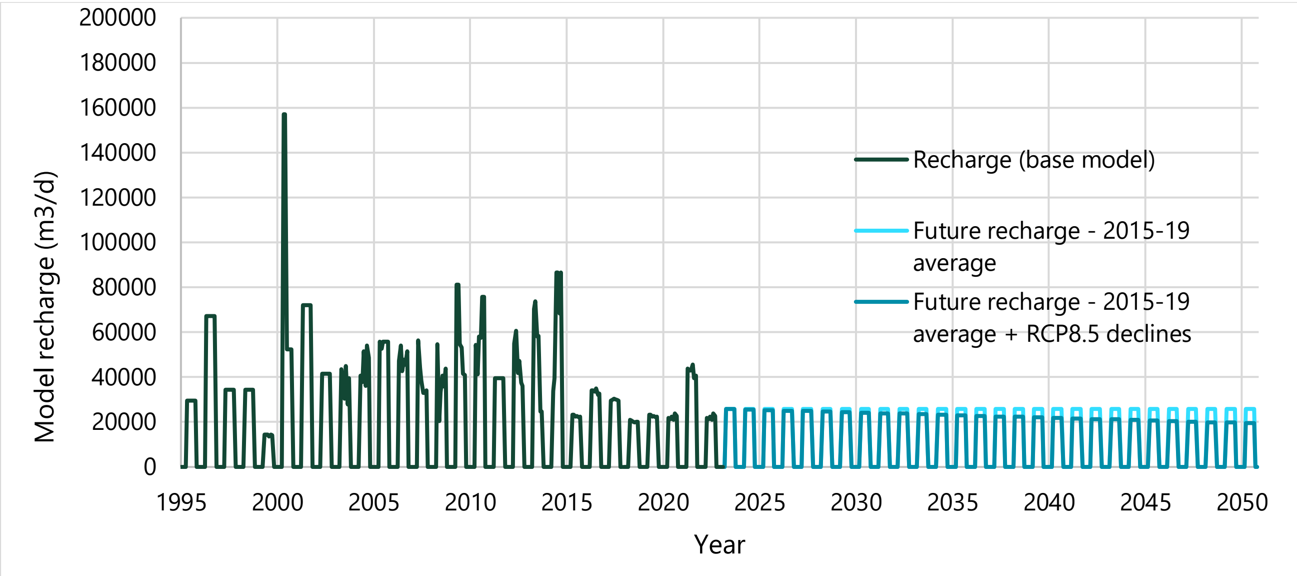

Figure 2.1. Recharge in the Uley South groundwater model

2.1.2 Pumping

Pumping in the model was updated to April 2023 using metered data supplied by SA Water. For all scenarios, monthly pumping volumes were based on the general pattern observed in Uley South (higher pumping in summer, lower pumping in winter), and volumes for individual wells were assigned proportionately based on SA Water's 'control philosophy' pumping rates.

3 Results

3.1 Groundwater level – set one

Where recharge from 2015-19 is repeated into the future, model results show an expected pattern for groundwater level. In scenarios where pumping is reduced to 3.5 GL/y (scenarios 1, 2, 4), groundwater levels typically recover following the reduction. The timing of recovery varies depending on the timing of pumping reduction, then all converge on the same trend thereafter. Where pumping is kept at 5 GL/y (scenario 3), groundwater levels do not recover (Figure 3.1).

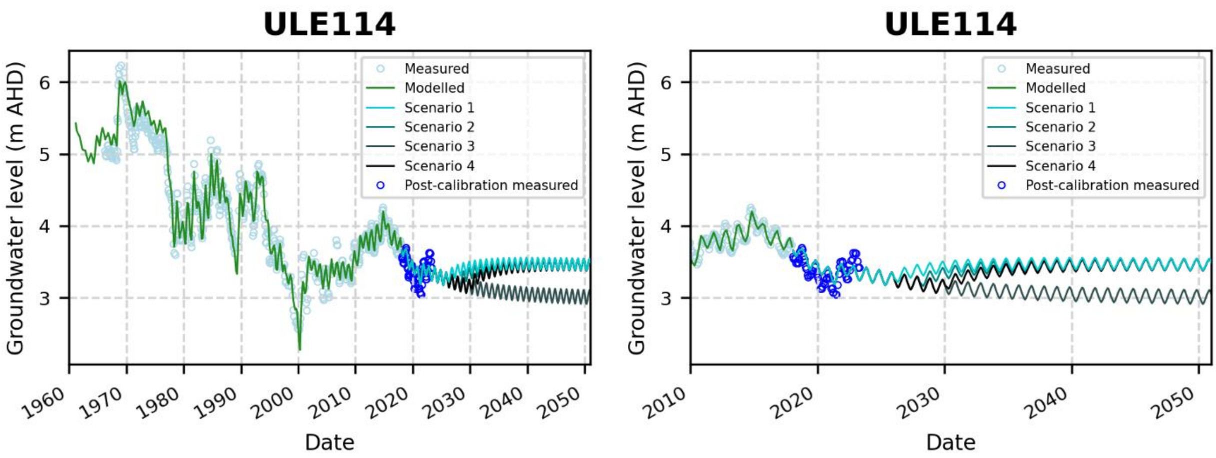

Figure 3.1. Measured and Modelled groundwater levels at ULE114 for scenarios 1 to 4 – showing all historical data and focus on 2010-2050

3.2 Groundwater level – set two

Under the scenarios 1a, 2a and 4a, assuming climate change impacts on recharge using RCP 8.5, groundwater levels continue to decline even after some recovery when pumping reduces. When pumping remains at 5 GL/y (scenario 3a), groundwater levels decline towards the lowest levels on record (Figure 3.2). Hydrographs for all monitoring wells which are located adjacent to pumping wells are shown in Appendices.

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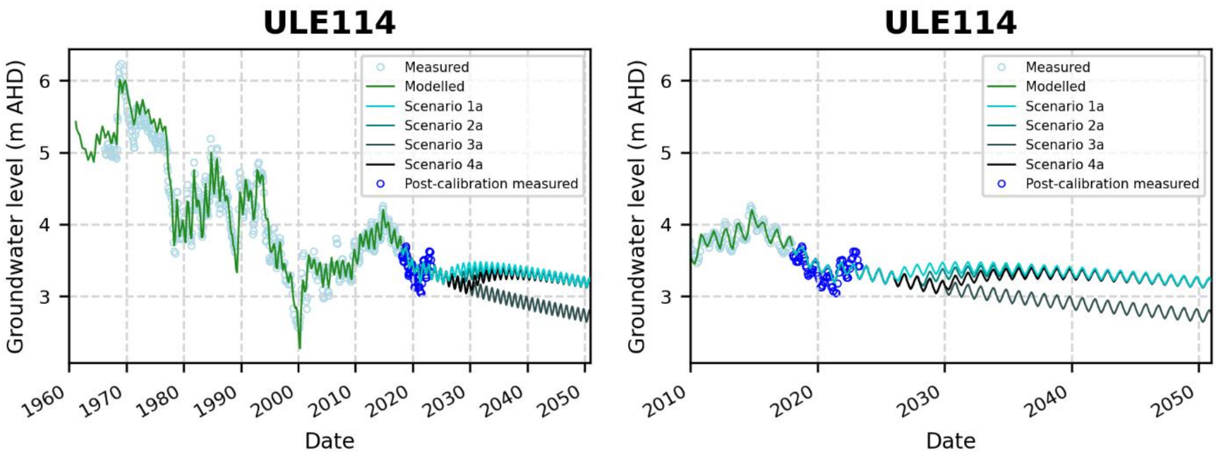


Figure 3.2. Measured and Modelled groundwater levels at ULE114 for scenarios 1a to 4a – showing all historical data and focus on 2010-2050

3.3 Seawater intrusion – set one

The model simulates the position and movement of the seawater interface using the Seawater Intrusion 2 (SWI2) package (Bakker et al., 2013). Results from SWI2 modelling of the movement of the seawater interface are presented in the same way as previous scenario reports (DEW 2021a, b, DEW2023) – the depth of the interface in observation well SLE069 and the position of the interface toe at 2050.

Where recharge from 2015-19 is repeated into the future (scenarios 1 to 4), results show that when pumping remains at 5 GL/y there is further inland movement of the seawater interface (scenario 3 in Figure 3.3). Results are generally similar for all scenarios in which pumping is reduced to 3.5 GL/y and differences at 2050 are not visible when mapped (scenarios 1, 2 and 4 in Figure 3.3 and 3.4).

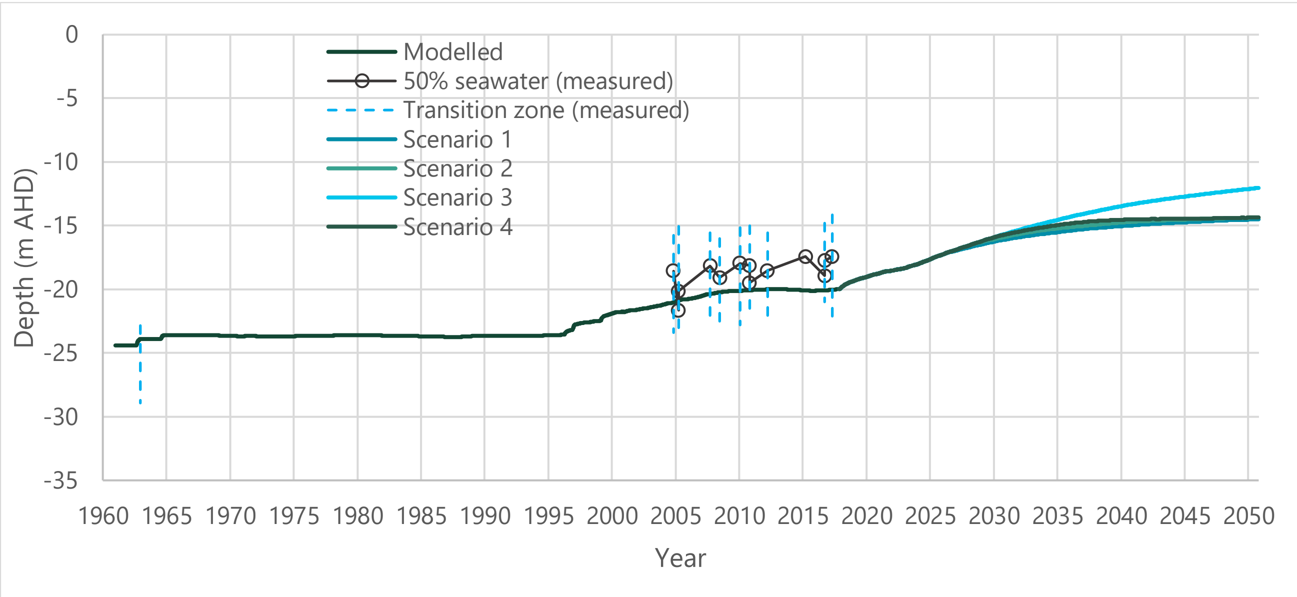


Figure 3.3. Modelled position of the seawater interface at SLE069 in scenarios 1-4

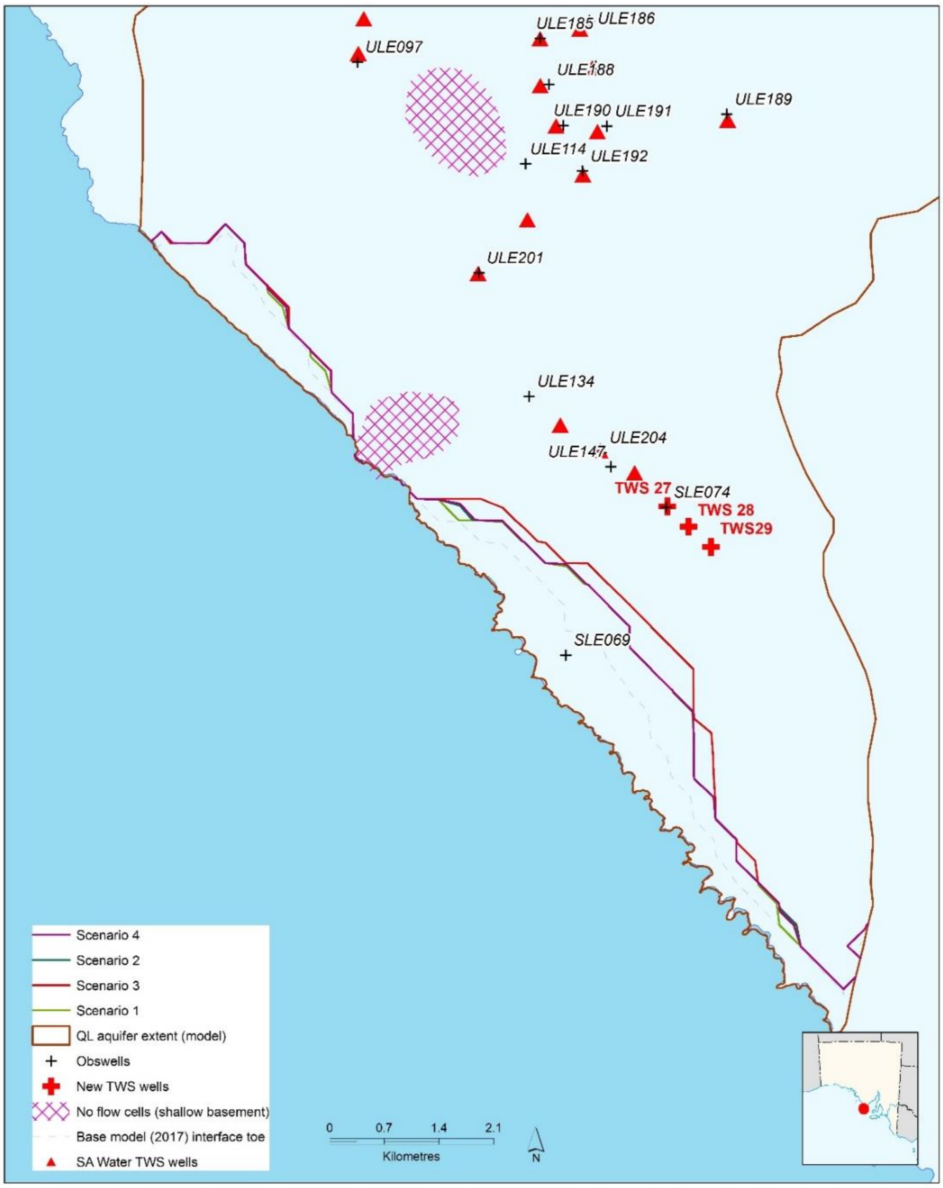


Figure 3.4. Modelled position of the seawater interface toe at 2050, scenarios 1-4

3.4 Seawater intrusion – set two

Under the scenarios 1a to 4a, assuming climate change impacts on recharge (RCP 8.5), there is greater inland movement in the seawater interface (Figure 3.5 and 3.6). This difference is apparent in comparing results of scenario 3 and 3a (Figure 3.7).

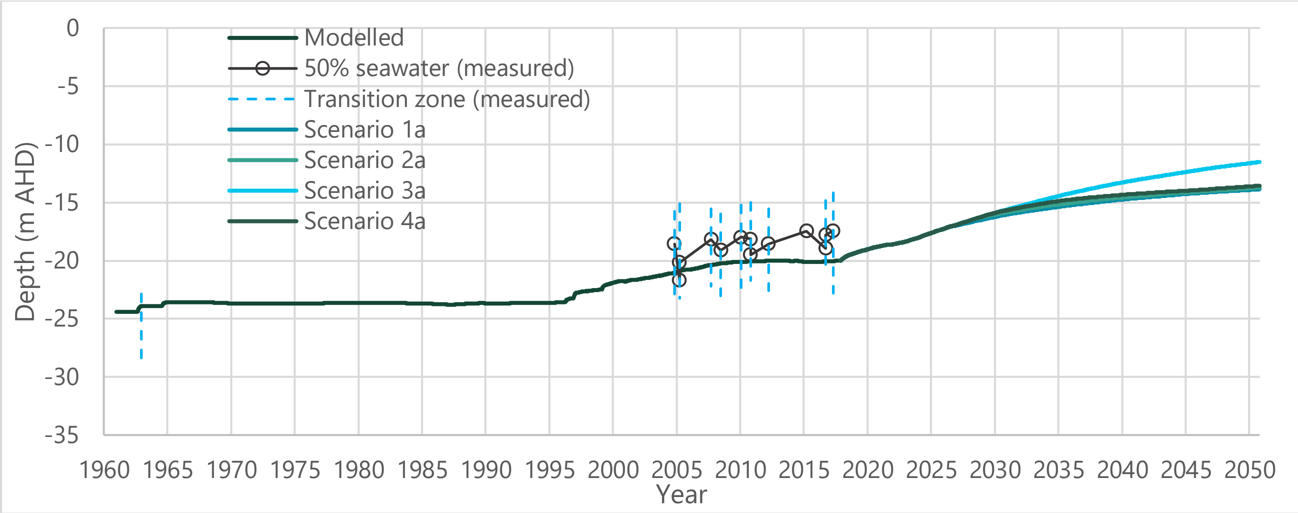


Figure 3.5. **Modelled position of the seawater interface at SLE069 in scenarios 1a-4a**

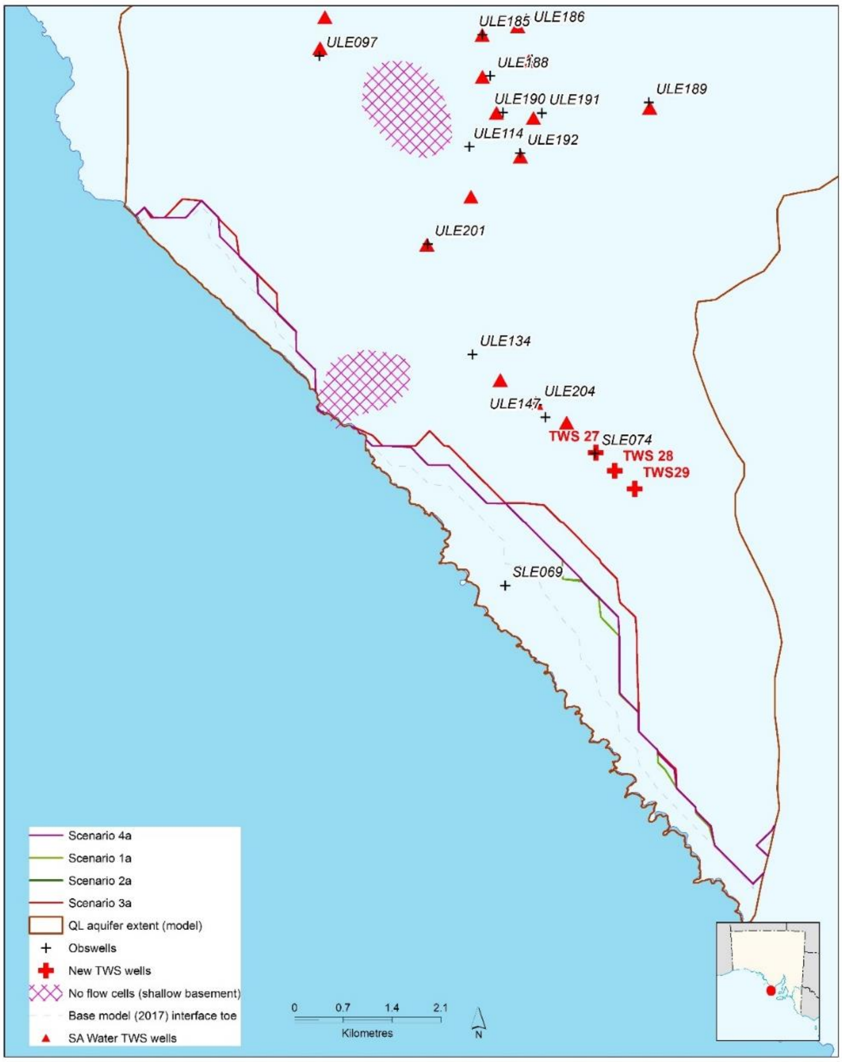


Figure 3.6. **Modelled position of the seawater interface toe at 2050, scenarios 1a-4a**

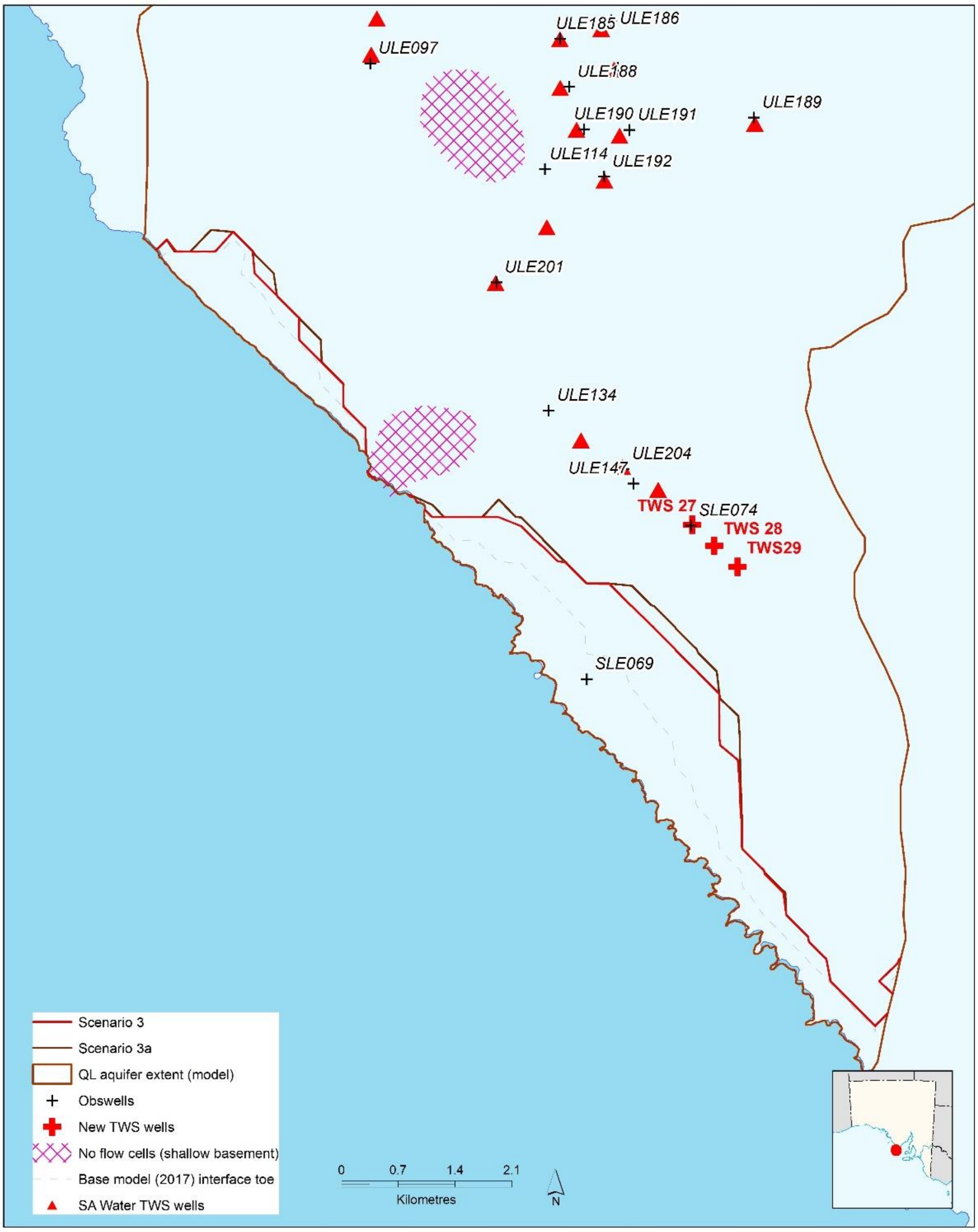


Figure 3.7. Modelled position of the seawater interface toe at 2050, scenarios 3 and 3a

4 Model assumptions and limitations

Assumptions and limitations associated with the Uley South groundwater model have been reported previously (DEW, 2020a,b, 2021a,b). Relevant to the current scenarios, the following assumptions and limitations are acknowledged.

1. The model has monthly stress periods; hence supply well pumping rates are constant for the month. In reality, pumps will come on and off during a month depending on demand.
2. Climate change assumptions have been applied to recharge in scenarios 1a-4a (set two) in a relatively simplified way, and further work could be done to test further options relating to the potential impact of climate change on groundwater recharge.
3. The model has not been re-calibrated to additional data collected since December 2017.

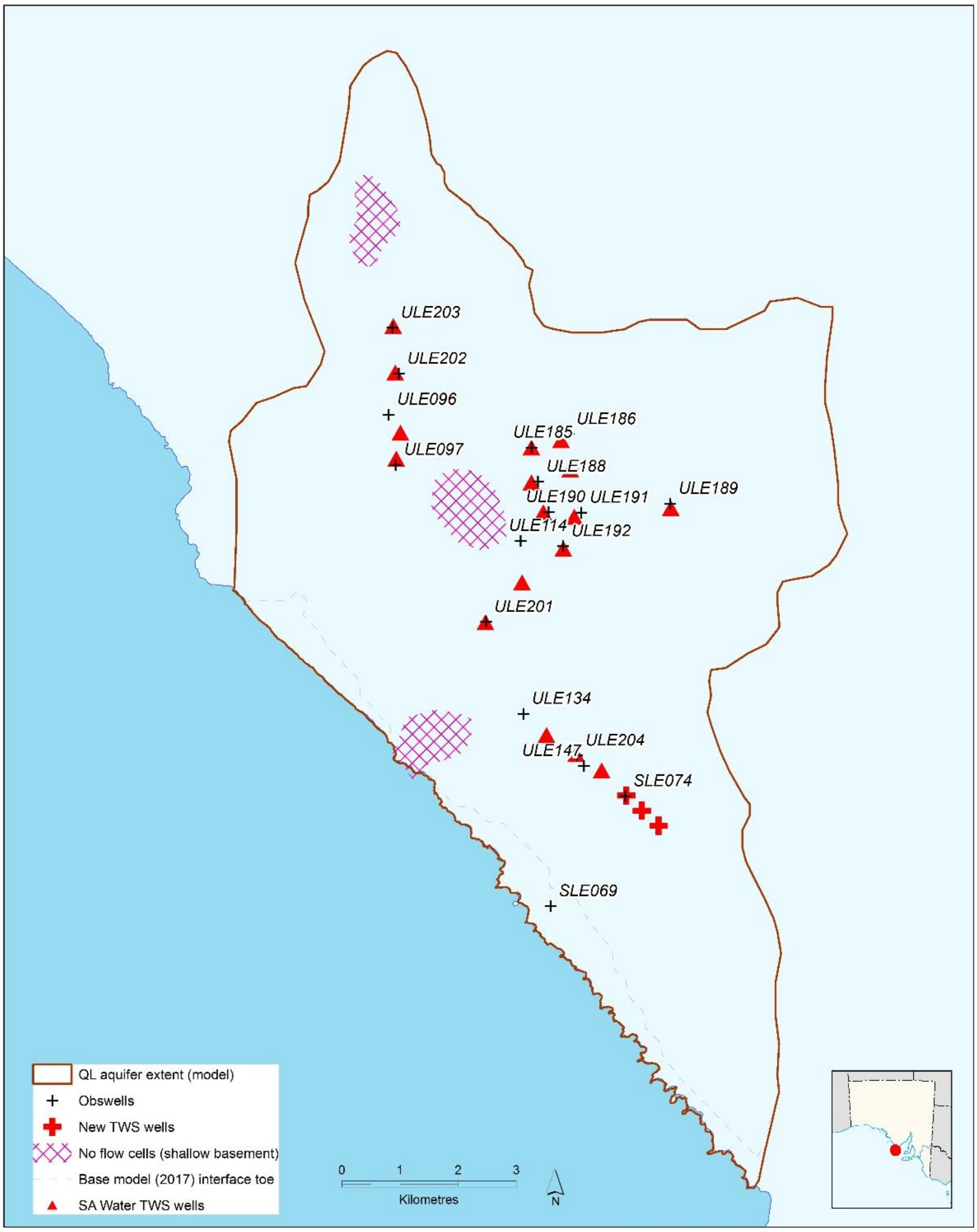
5 Conclusions

Eight groundwater model scenarios have been run using the Uley South groundwater model (DEW 2020a). Results show that reduced pumping to 3.5 GL/y in the Uley South Basin mitigates the risk of ongoing groundwater level decline when rainfall and recharge are low. The timing of pumping reduction leads to small differences in groundwater level recovery over the short term. Ongoing pumping of 5 GL/y results in ongoing groundwater level decline. Associated with these declines are enhanced risk of seawater intrusion. The declines are greatest in scenario set two, where rainfall and recharge are reduced under climate change (RCP 8.5).

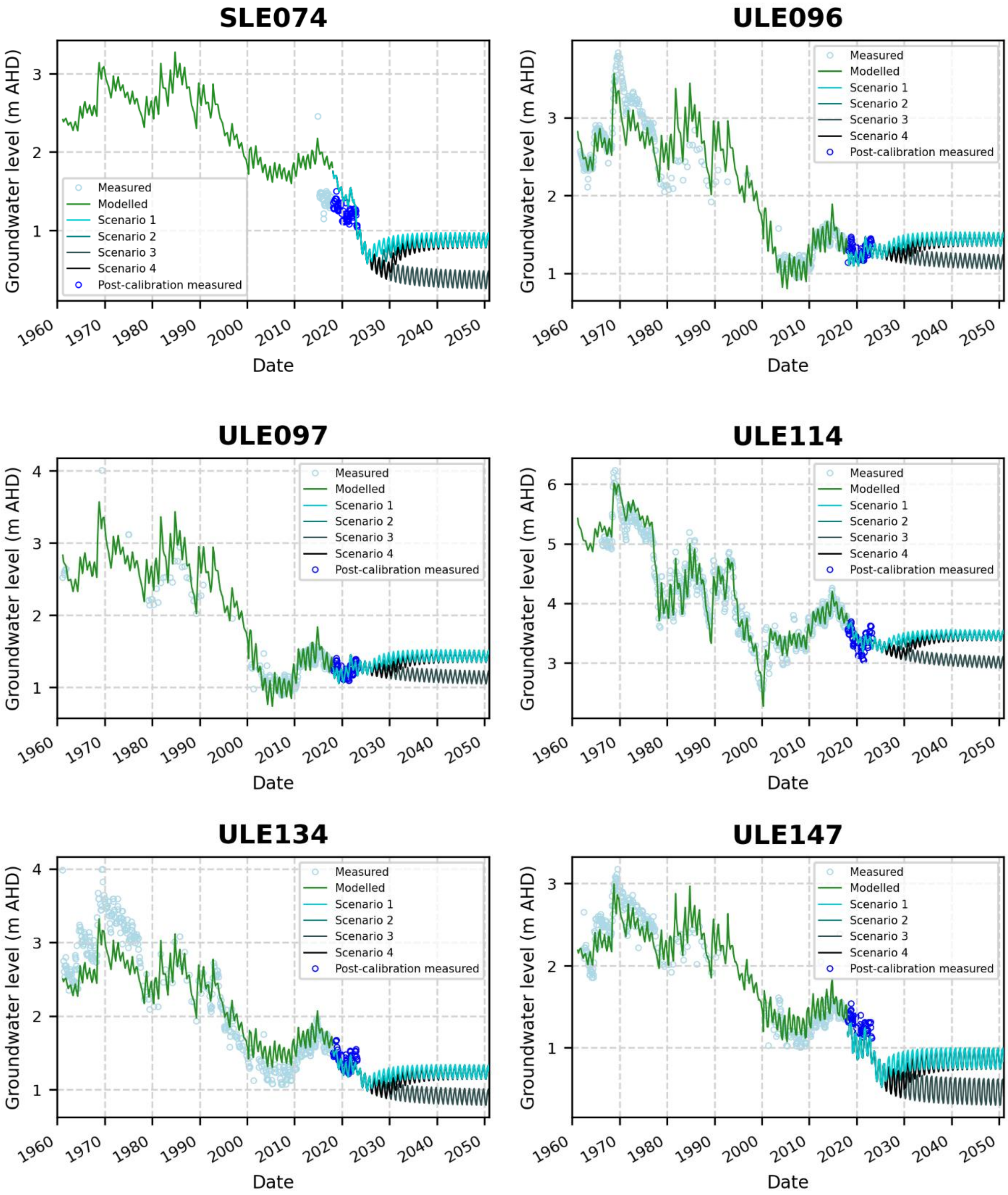
In parallel with this work, the NCGRT have been assessing the relationship between groundwater level and salinity increases in supply wells in Uley South. To assess likely salinity impacts in SA Water's supply wells into the future, model results in observation wells close to pumping wells are provided in this report for further risk assessment work by SA Water and NCGRT.

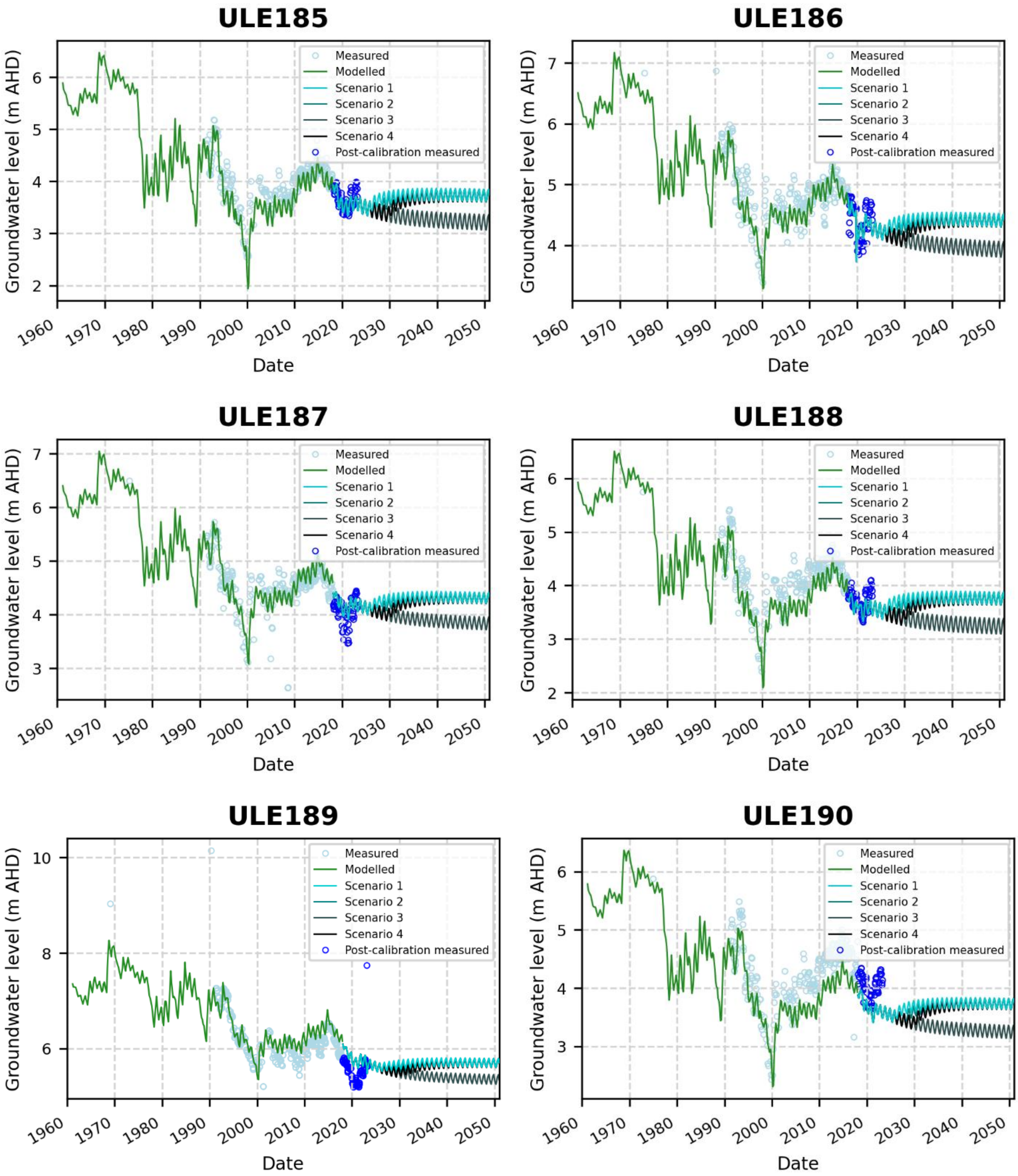
6 Appendices

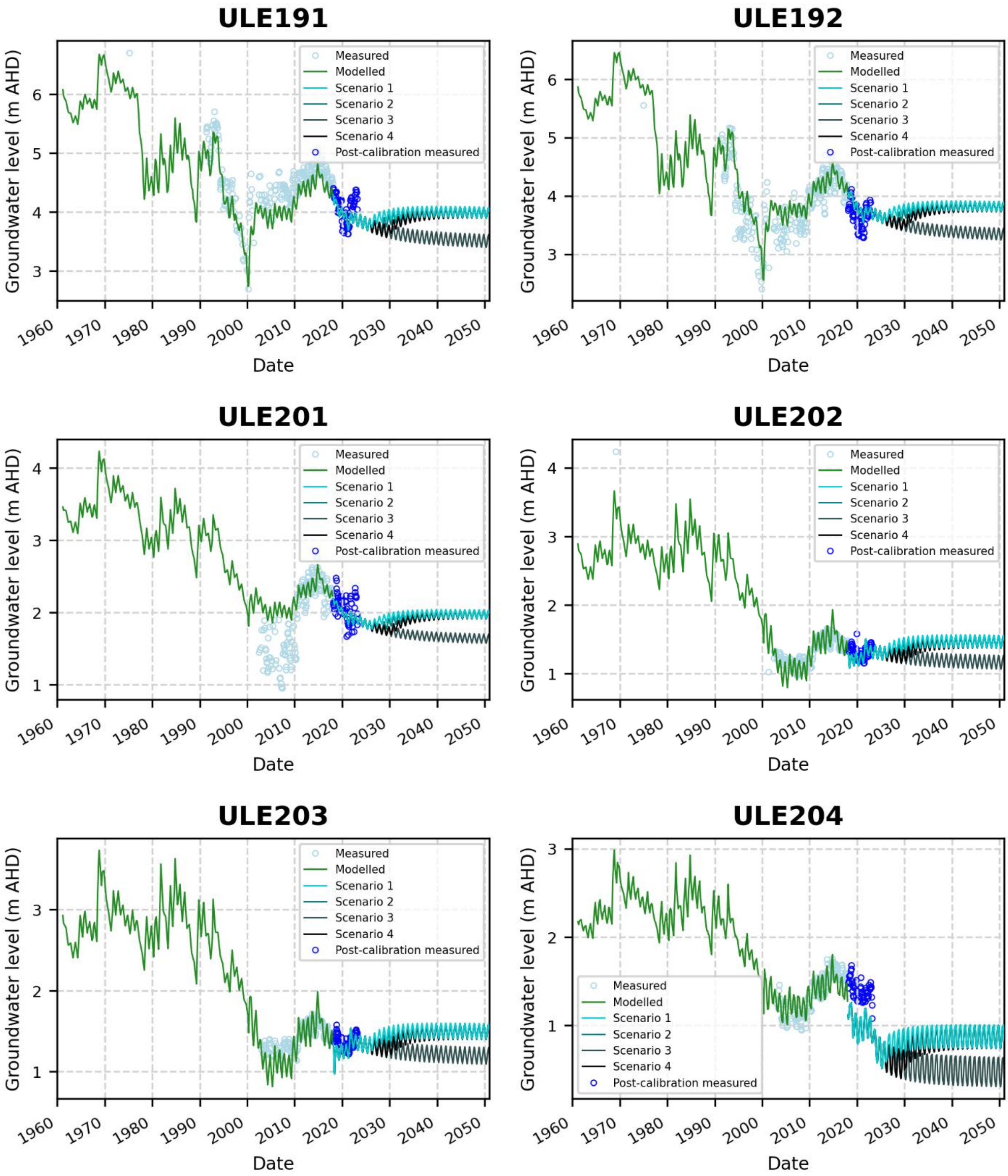
A. Observation well locations



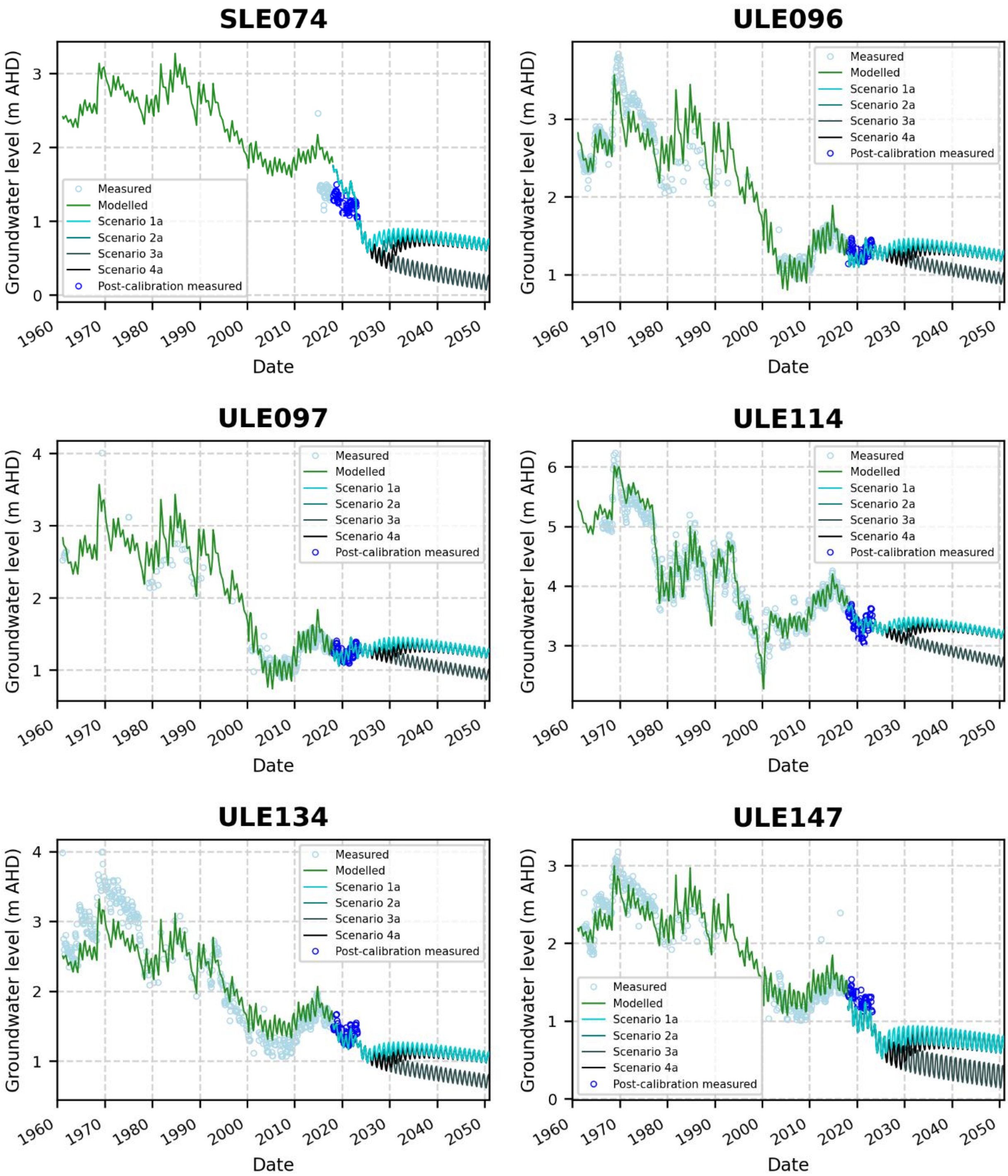
B. Groundwater levels scenario set one (1–4)

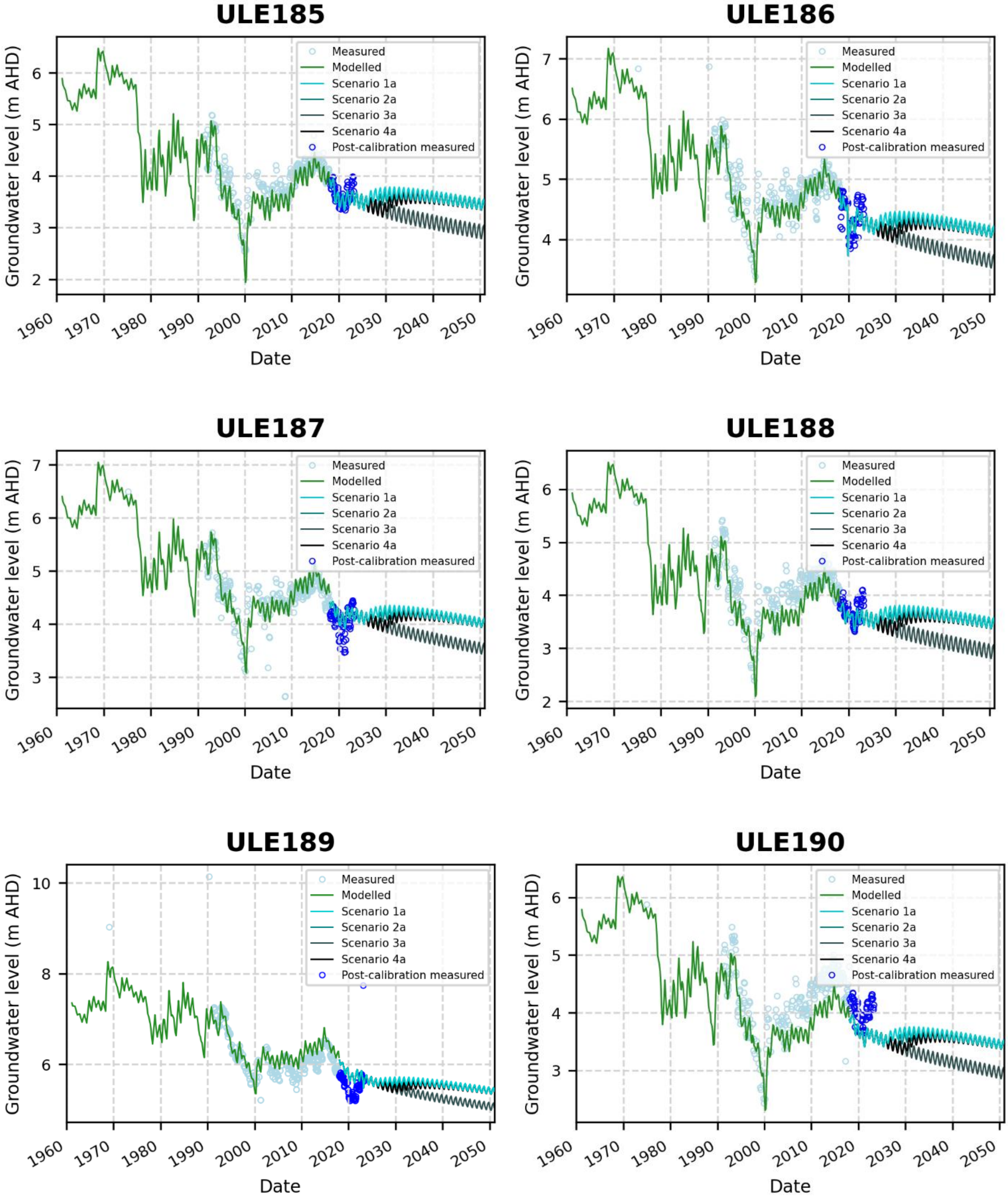



ULE185
ULE186
ULE187
ULE188
ULE189
ULE190
Measured
Modelled
Scenario 1
Scenario 2
Scenario 3
Scenario 4
Post-calibration measured
Groundwater level (m AHD)
Date
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050


ULE191
ULE192
ULE201
ULE202
ULE203
ULE204
Groundwater level (m AHD)
Date
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
Measured
Modelled
Scenario 1
Scenario 2
Scenario 3
Scenario 4
Post-calibration measured

C. Groundwater levels scenario set one (1–4)




ULE185
ULE186
ULE187
ULE188
ULE189
ULE190
Measured
Modelled
Scenario 1a
Scenario 2a
Scenario 3a
Scenario 4a
Post-calibration measured
Groundwater level (m AHD)
Date
1960
1970
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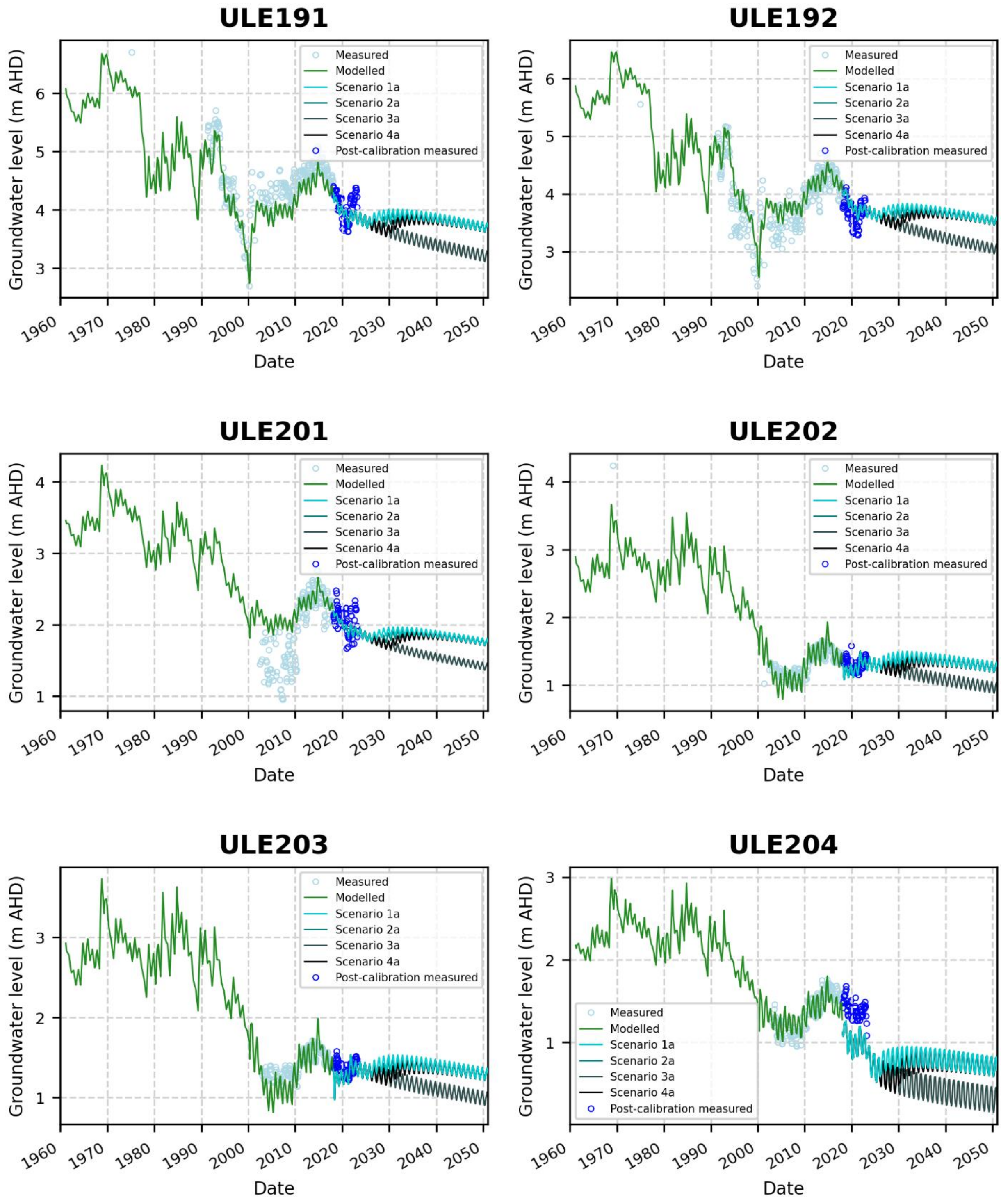
2050


ULE191
ULE192
ULE201
ULE202
ULE203
ULE204
Groundwater level (m AHD)
Date
Measured
Modelled
Scenario 1a
Scenario 2a
Scenario 3a
Scenario 4a
Post-calibration measured
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050

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