A303 Amesbury to Berwick Down

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8.25 – Supplementary Groundwater Model Runs to Annex 1 Numerical Model Report

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Supplementary Groundwater Model Runs to Annex 1 Numerical Model Report

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1 Introduction

1.1 The groundwater aspects of the Environmental Statement (ES) comprised a Groundwater Risk Assessment (GRA) appendix (Highways England, October 2018. A303 Amesbury to Berwick Down TR010025. 6.3 Environmental Statement Appendices. Appendix 11.4 Groundwater Risk Assessment [APP-282]) which drew on findings from groundwater model scenarios presented in its Annex 1.

1.2 Subsequent to the findings of the additional ground investigations presented in A303 – Amesbury to Berwick Down Stage 4 – Implications of 2018 Ground Investigations to the Groundwater Risk Assessment, and the review comments on the GRA provided by the Environment Agency and Wiltshire Council, additional supplementary model runs were undertaken.

1.3 The issues raised by reviewers included running the model for a long duration (i.e. the full Wessex Basin model) to test whether the impacts of the tunnel do not incrementally increase with time; confirming that the short period models used do accurately reflect the full Wessex Basin model at the time slices used; and conducting sensitivity runs of model parameters following the findings of the additional ground investigations, in particular, changes to storage properties.

1.4 This report compares the findings from the Annex 1 Numerical Modelling Report with the results from a series of additional supplementary model runs to clarify the GRA and the conclusions of the ES.

2 Model Duration

2.1 Model Setup

2.1.1 The Wessex Basin model run time is 1965 to 2016. The period 1965 to 1969 is a warm up period containing climate sequences for an average year which means the model can be well calibrated at periods of interest early in the simulation, such as the 1976 drought.

2.1.2 For the A303 modelling, short duration models were created to represent a drought low flow period (1976) and a peak groundwater level period (2014) to predict the impacts of the tunnel for environmental risks at low river flows and for groundwater flooding risks. An average period model was also created to simulate the impacts during average summer low flows, simulating the effects of the tunnel most of the time.

2.1.3 The stress periods used in the short duration models from the Wessex Basin model are given in Table 1.

Table 1 Short Duration Model Stress Period Setup

Model	Stress Period Start	Stress Period End
Peak period	1/12/13 stress period 1761	1/6/14 stress period 1779
Average period	11/4/94 stress period 1054	1/4/96 stress period 1125
Drought period	11/9/75 stress period 385	11/3/77 stress period 439

2.1.4 These short duration models enabled the tunnel to be represented more accurately with the proportion of saturated thickness of aquifer being different at different water table elevations.

2.2 Calibration of Short Duration Model and Wessex Basin Model

2.2.1 The modified aquifer properties used in the A303 short duration modelling were incorporated into the regional Wessex Basin model to demonstrate that the short duration models, which use the preceding stress period groundwater levels as starting heads to 'hot-start' the model, did not give anomalous results at the period of interest for the GRA, compared to the full model run.

2.2.2 Figure 1 shows the short duration model and full length model at the peak groundwater level period in 2013-14 at the regional observation borehole at Berwick Down. Small differences can be seen at the start of the short model run that will relate to the 'hot-start' approach and different numerical solver settings. The model was started three months earlier than the peak level time of interest so that any small differences would be corrected, as can be seen in the close match of the two models at the peak period.

2.2.3 Locations of groundwater level and river flows referred to in this report are given in Appendix A.

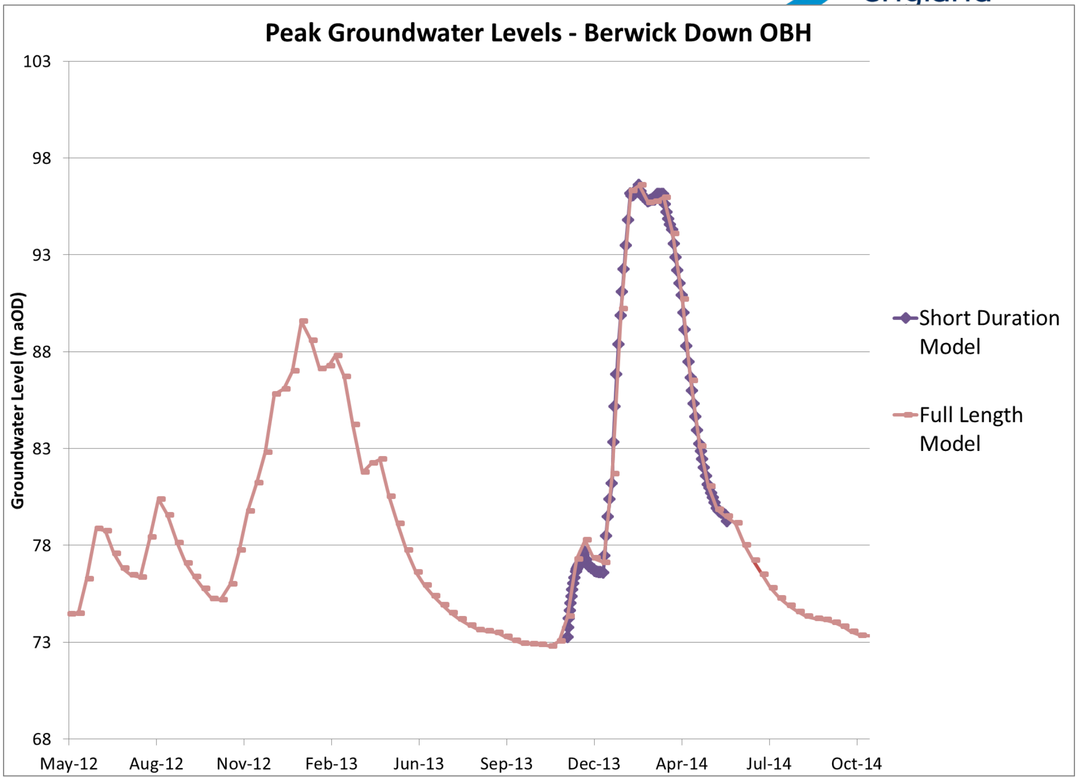


Figure 1 Berwick Down Peak Groundwater Levels

2.2.4 Along the proposed tunnel alignment borehole P1 shows only very small differences in the peak groundwater level between the full length model and the short duration A303 model.

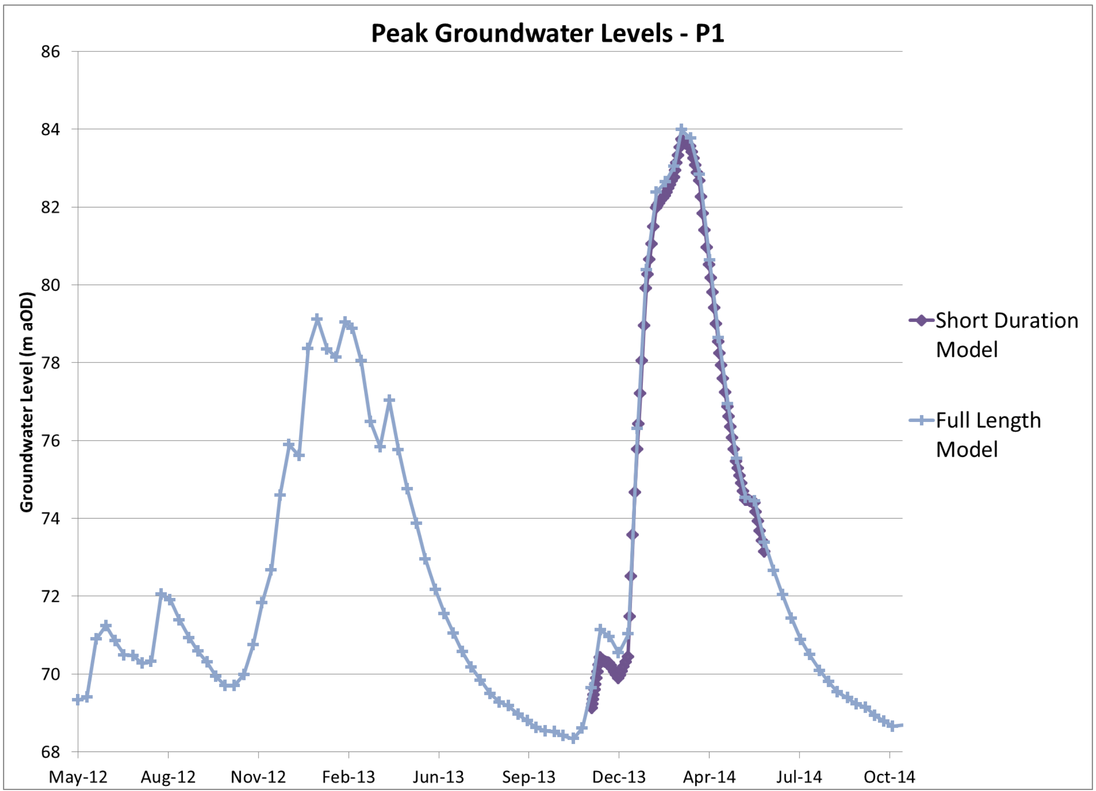


Figure 2 P1 Peak Groundwater Levels

2.2.5 Similarly low flows show differences at the start of the simulation of the short period model but these differences converge to only a small difference at the lowest flows. The differences also relate to the different numerical solver settings that would be found in different modelling codes and interfaces. The A303 short duration model is conservative in that flows are simulated as lower than the full length model.

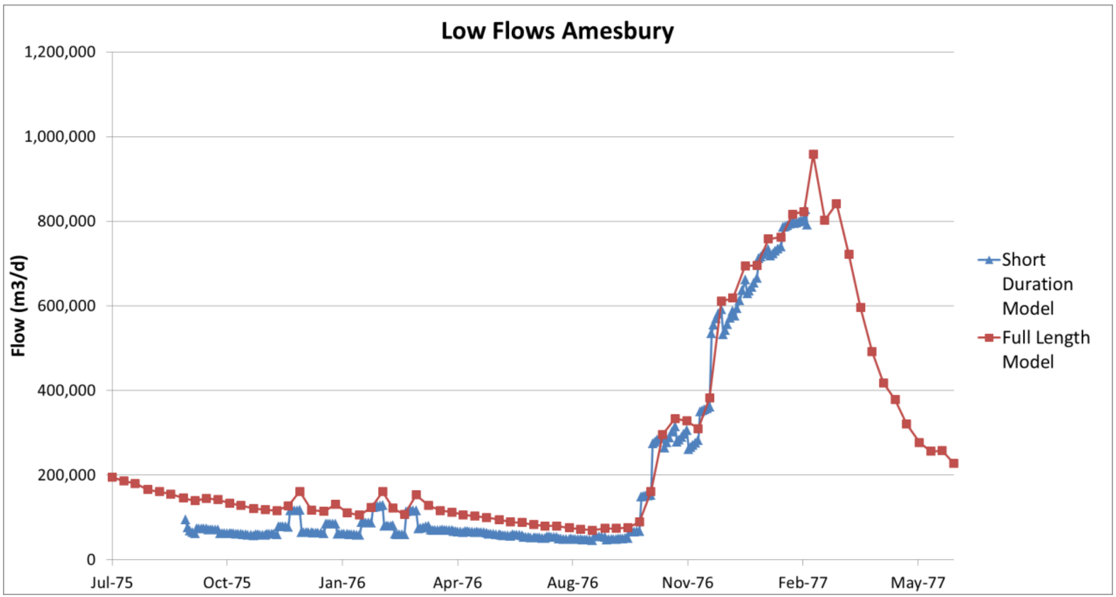


Figure 3 Avon at Amesbury Low Flows

2.2.1 The South Newton gauge on the River Wylye downstream of the River Till shows a similar pattern. Flows are very similar at the lowest flow period of interest.

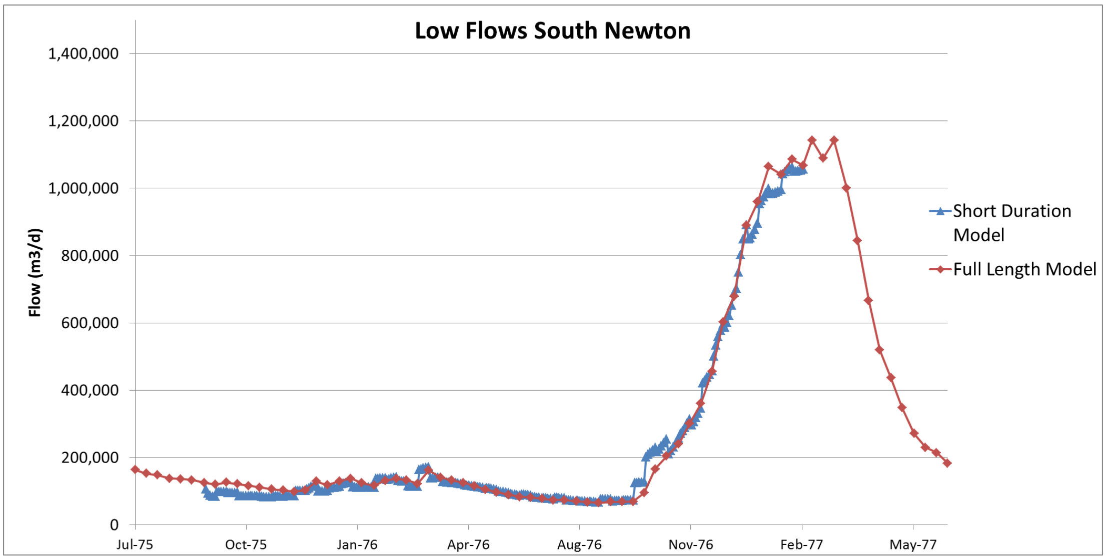


Figure 4 Wylye at South Newton Low Flows

2.2.2 The 1976 drought was selected as the worst case for potential river flow impacts but every year will have a different flow recession signature, and so the ecology is not dependent on one particular flow recession type and therefore it is not necessary to match the entire seasonal flow pattern at one moment in time for this impact assessment.

2.2.3 The variety in flow recessions is shown in Figure 5 from gauged flows over a series of drought and average years. It can be seen that the difference between the Wessex Basin model and short duration model in 1976 is significantly smaller than the natural variation across years.

2.2.4 The difference between the A303 short duration model and the gauged flows in 1976-77 is not visible on the scale of typical flows. They appear to be overlapping, hence the difference is very small compared to the natural variation.

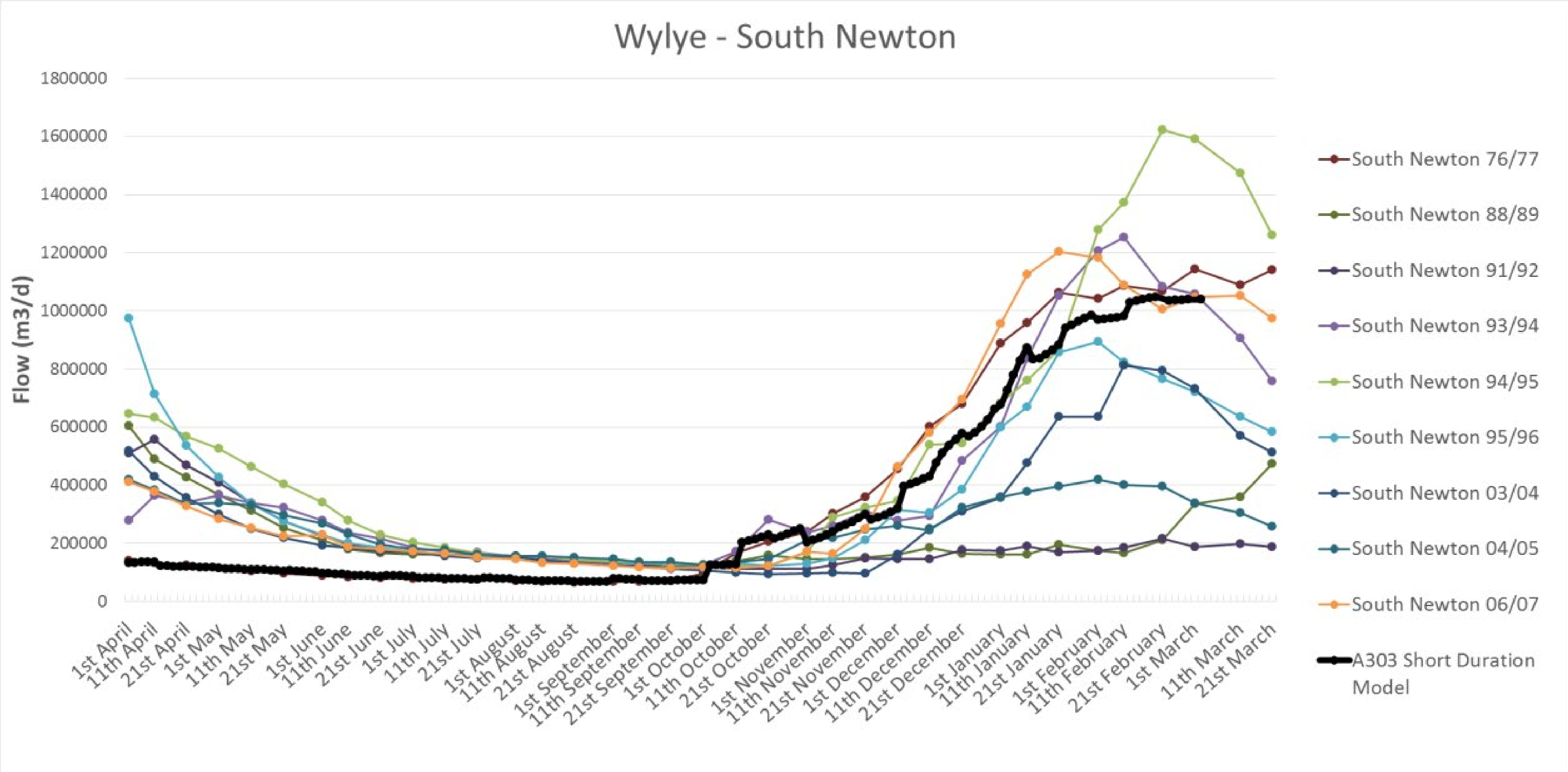


Figure 5 River Wylye at South Newton - Series of Dry and Average Years

2.3 Long Term Impact Assessment with Wessex Basin Model

2.3.1 One theme of the reviewers' comments was to question whether in years following the short duration models, the impact remained the same or gradually changed. That is, would flow reductions gradually increase each year with the tunnel in place and would the water table rise more during each winter peak, leading over time to a risk of flooding and environmental impact not observed in the short duration models.

2.3.2 The average tunnel model was used to simulate the presence of the tunnel over the full length model to observe whether flows and groundwater levels were stable or the difference compared to the baseline was gradually increasing.

2.3.3 Groundwater levels at P1 immediately upstream of the tunnel can be seen to maintain a stable difference between the baseline and the 'with tunnel' scenario, varying seasonally. There is no long term incremental change in impact.

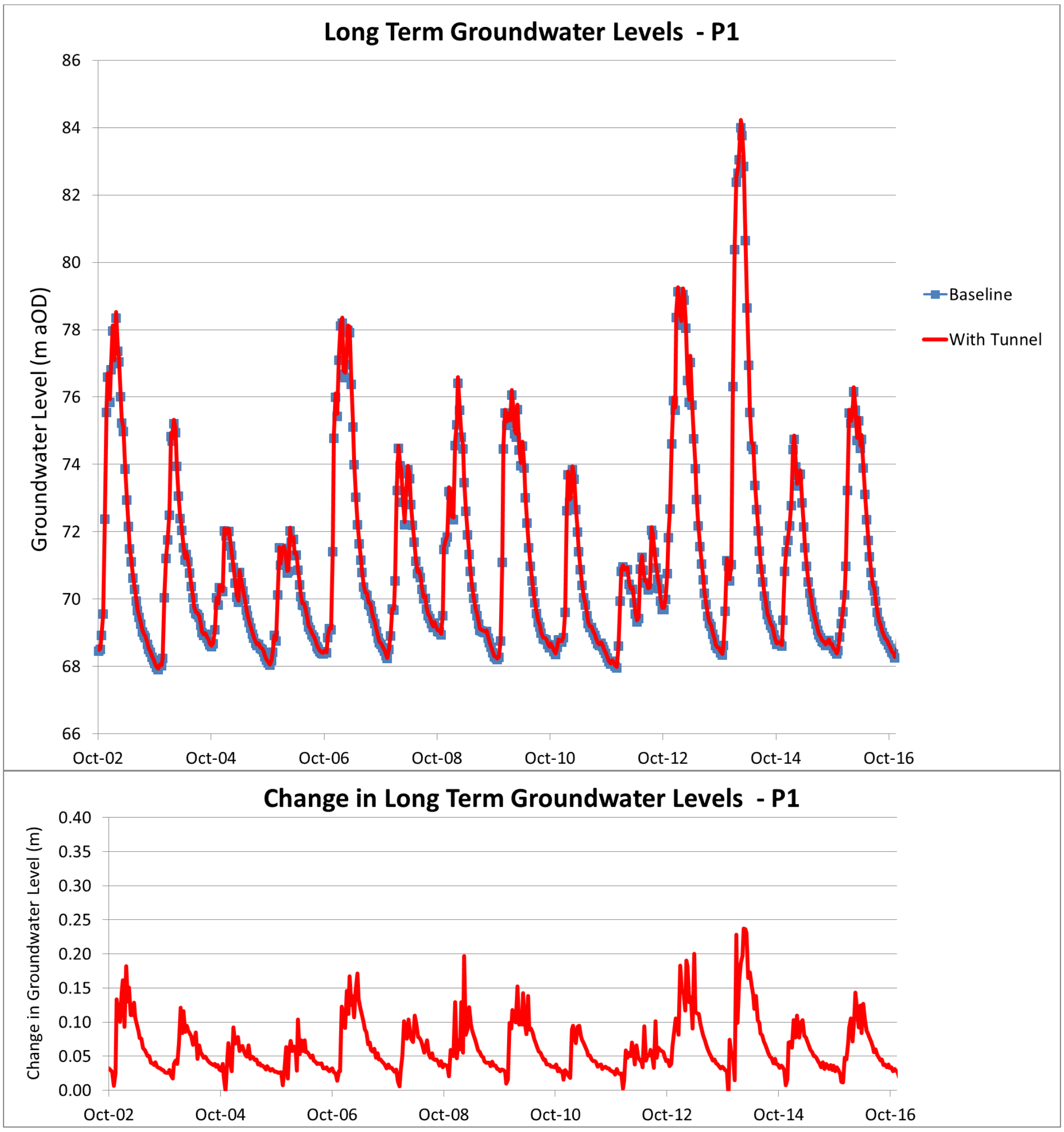


Figure 6 Effect of Tunnel on Groundwater Levels at P1

2.3.4 River flows for the River Wylye at South Newton can be seen to maintain a stable difference between the baseline and the 'with tunnel' scenario, varying seasonally. There is no long term incremental change in impact.

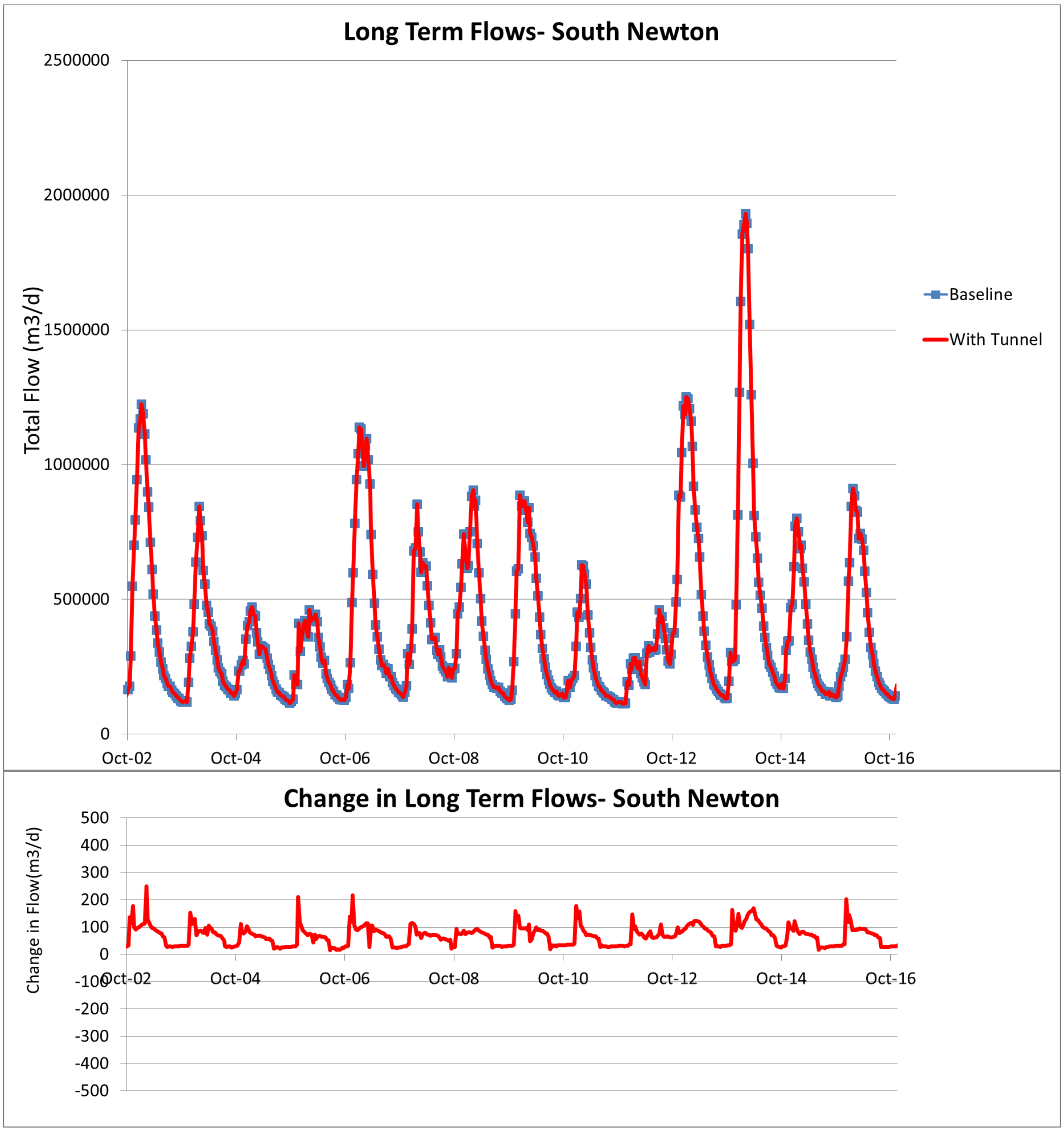


Figure 7 Effect of Tunnel on River Wylye Flows at South Newton

2.3.5 Therefore the short duration A303 model presented in the Annex 1 Numerical Modelling Report, based on short duration models with aquifer properties modified from the Wessex Basin model; has been shown to be stable over longer run times.

2.3.6 The short duration models show small differences in groundwater level and river flows at the start of the simulation compared to the full length model, which converge to a small difference at the point in time of interest. These differences are much smaller than the natural variation each year.

2.3.7 Therefore these differences are not considered to affect predictions for flood risk or for changes to riverine ecology and does not change the impact assessment presented in the GRA.

3 Alternative Calibration Parameters

3.1 Aquifer Properties

3.1.1 The A303 – Amesbury to Berwick Down Stage 4 – Implications of 2018 Ground Investigations to the Groundwater Risk Assessment identified that the Chalk aquifer in the area of interest has lower aquifer storage parameters than those used in the Wessex Basin model.

3.1.2 The Wessex Basin model contains two storage property zones in the Chalk in the area, with the western zone set to 0.005 and the eastern zone; covering part of Stonehenge Down, Stonehenge Valley, and Coneybury Hill, set to 0.015. Further zones are present in the river valleys with a storage value of 0.1 representing additional storage in river terrace gravels and alluvium.

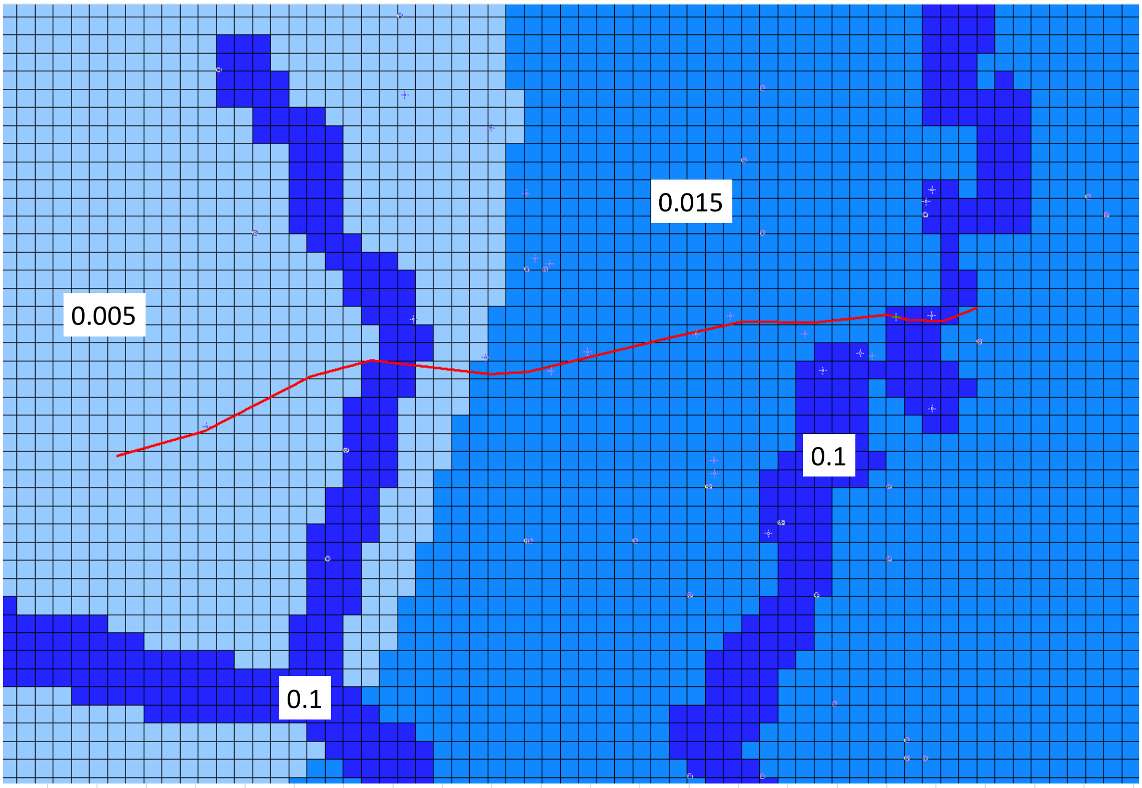


Figure 8 Storage Zones in Wessex Basin Model

3.1.3 A new model was created with the average storage value from the pumping tests applied to the western storage zone and eastern zone. No changes were made to the zone boundaries and extents, and therefore is the minimum change from the Wessex Basin model, consistent with the approach to changes to hydraulic conductivity in the GRA modelling.

3.1.4 The modified aquifer storage was incorporated into a new model retaining the Wessex Basin model VKD profile. The VKD model with lower storage may produce similar results to the lower hydraulic conductivity setup used in the GRA modelling. These runs would test the sensitivity of the calibration to hydraulic conductivity and storage changes, and hence the significance of each property type.

3.1.5 Therefore three models were compared; the original Wessex Basin model with VKD giving high transmissivity and its high storage compared to the pumping test results; the A303 model without VKD, giving lower transmissivity but retaining the high storage of the Wessex Basin model; and the Wessex Basin model with VKD giving high transmissivity, but with the lower storage values from the pumping tests.

3.2 Calibration

3.2.1 The VKD model setup of the Wessex Basin model gives lower groundwater levels than observed, as described in Annex 1 Numerical Modelling Report. Decreasing the hydraulic conductivity by removing the VKD profile in the A303 model raised groundwater levels to a level approximating the observed levels.

3.2.2 A new model was created by reducing storage to the average of the pumping tests of 0.002 in the western zone and 0.004 in the eastern zone, while retaining the VKD profile.

3.2.3 This caused groundwater levels to increase as expected, but not significantly. Groundwater levels remain 5m below the peak (Figure 9).

3.2.4 Each model is calibrated below the observed levels at the start of the winter rise in water levels and does not rise steeply enough compared to the observed.

3.2.5 As discussed in the Annex 1 Numerical Modelling Report, the ‘no-VKD’ model raises groundwater levels above the observed peak. This could have been improved by modifying the ‘k-base’ but as the calibration was conservative it was preferred to stay as close to the Wessex Basin model as possible by just preventing the VKD gradient increasing the hydraulic conductivity with elevation, which in the Wessex Basin model leads to transmissivities above those calculated from pumping tests.

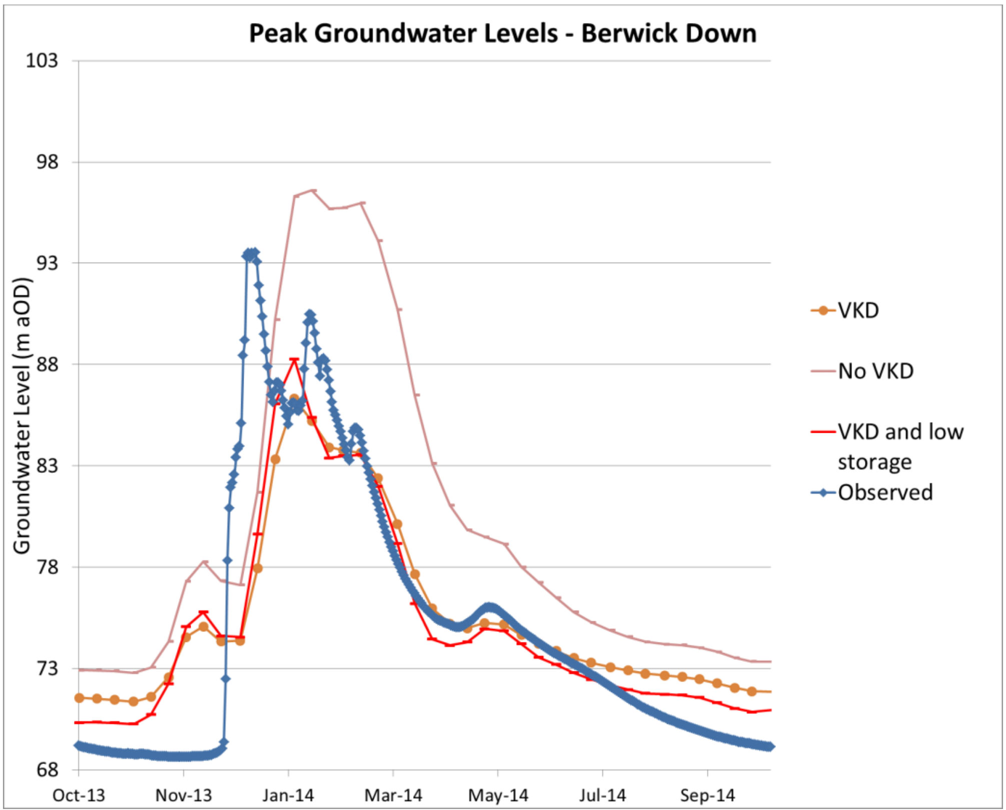


Figure 9 Comparison of groundwater levels at Berwick Down with average storage values from pumping tests

3.2.6 The lower end of the range of results from the pumping tests was then set up to run with the VKD model to attempt to raise groundwater levels further toward the observed. The storage values used were 0.0012 in both eastern and western zones.

3.2.7 The results were that groundwater levels increased marginally but not enough to be considered as good a calibration as the 'no-VKD' model.

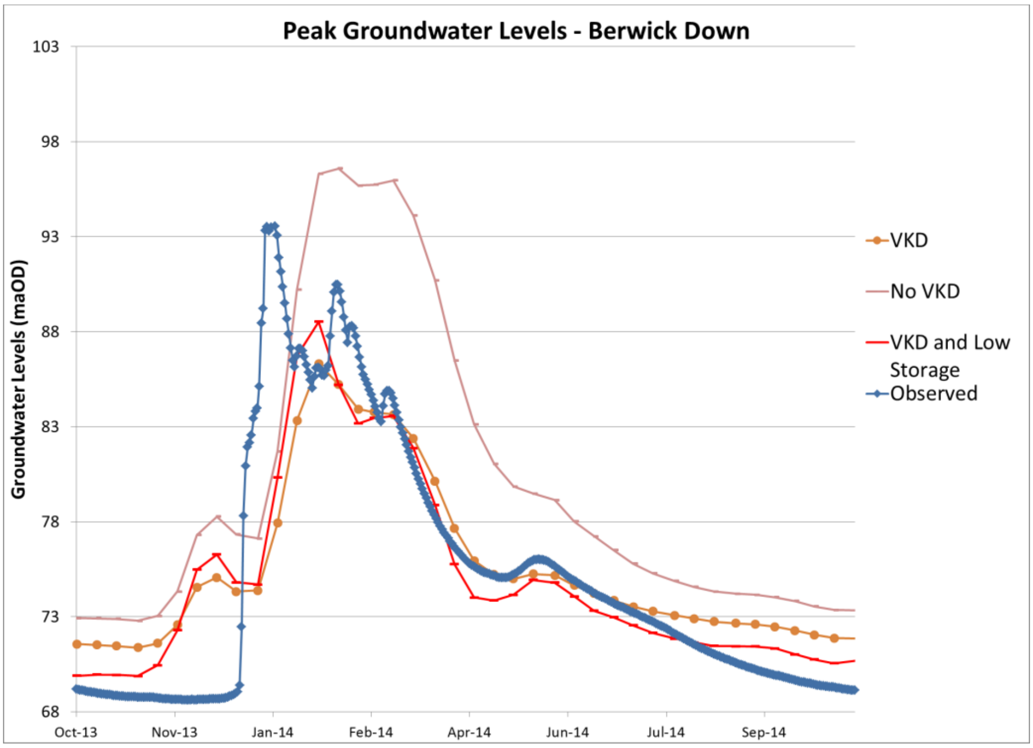


Figure 10 Comparison of groundwater levels at Berwick Down with low end of range storage values from pumping tests

3.2.8 Therefore the model is not as sensitive to changes to storage properties as it is to hydraulic conductivity. The low end of the range of storage values combined with the hydraulic conductivity of the Wessex Basin model does not change the calibration significantly.

3.2.9 The Wessex Basin model is more sensitive to changes in hydraulic conductivity, which by removing the VKD gradient give transmissivities close to those calculated from pumping tests.

3.2.10 The low storage values combined with small incremental increases in the 'base K' (without VKD) is likely to find the best calibration within the model structure, though limited incremental increases could be made while remaining within the range of transmissivities calculated locally in pumping tests.

3.2.11 The model setup used in Annex 1 Numerical Modelling Report still offers the best calibration for groundwater flood risk assessment and the calibration is unlikely to improve measurably within the current model scale and structure. The differences between modelled and observed are more likely to due to local scale heterogeneity than model properties.

3.2.12 The low storage with VKD model simulates flows lower than observed and lower than the VKD and no-VKD model setups in the River Avon. The short duration model with no VKD gives the closest simulation to the Wessex Basin model and the observed at the lowest flows, while the no VKD setup in the Wessex Basin model gives higher low flows.

3.2.13 The simulation shows that the VKD and low storage run gives a poorer calibration for low flow environmental impacts than the short duration model used in Annex 1 Numerical Modelling Report, and the original Wessex Basin model.

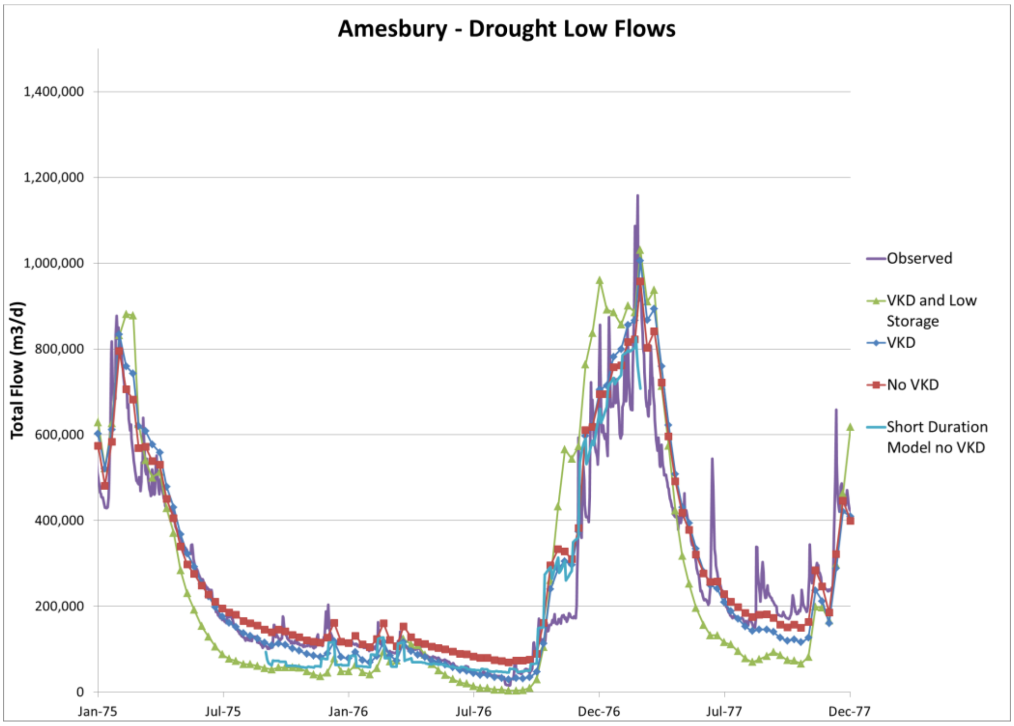


Figure 11 Comparison of River Avon Flows at Amesbury with different model parameters

3.2.14 The findings for the South Newton gauge on the River Wylye below the confluence with the River Till shows very little difference between the observed flows, the Wessex Basin model, and the no-VKD models whether from the short duration model or when input to the full-length Wessex Basin model. The model with VKD and low storage simulates lower flows than the other models and the observed, being overall a poorer calibration.

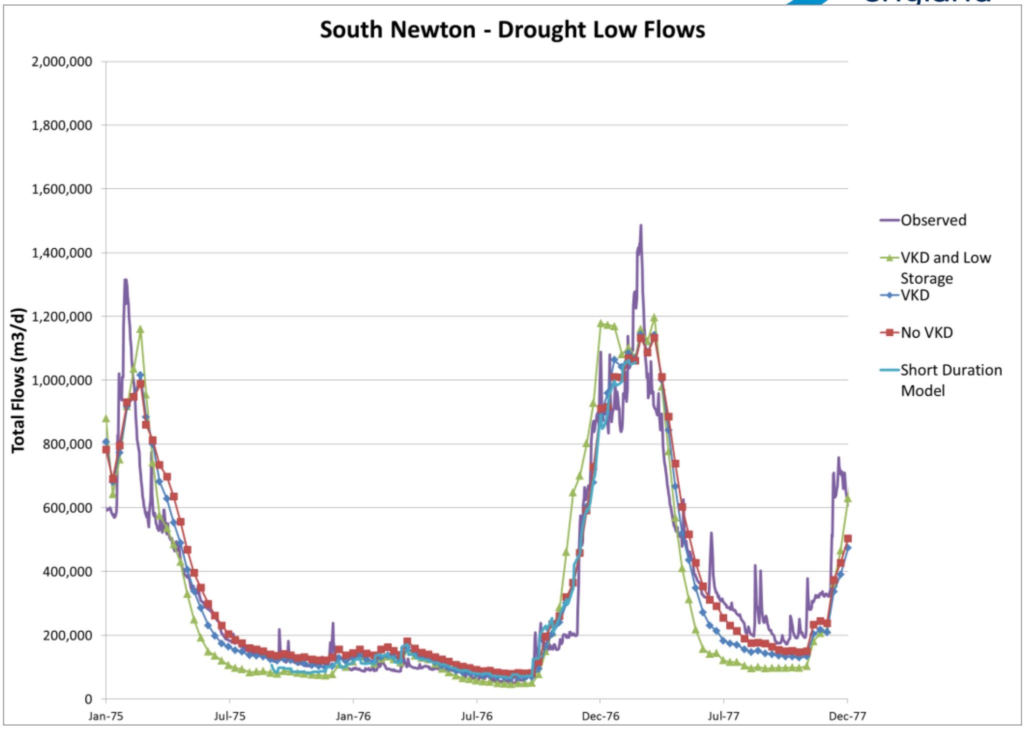


Figure 12 Comparison of River Wylye Flows at South Newton with different model parameters

3.2.15 Overall the model calibration given in Annex 1 Numerical Modelling Report shows small differences with the observed flows and other model setups within a narrow range, with the flow recession through the spring of 1976 similar to the observed and Wessex Basin model.

3.2.16 Therefore changes in aquifer properties have not led to an improvement in the model calibration for low flow environmental impacts used in Annex 1 Numerical Modelling Report.

4 Impact of Tunnel in Different Models

4.1 Groundwater Flood Risk

4.1.1 The peak period predicted water table rise presented in the Annex 1 Numerical Modelling Report is given in Figure 13.

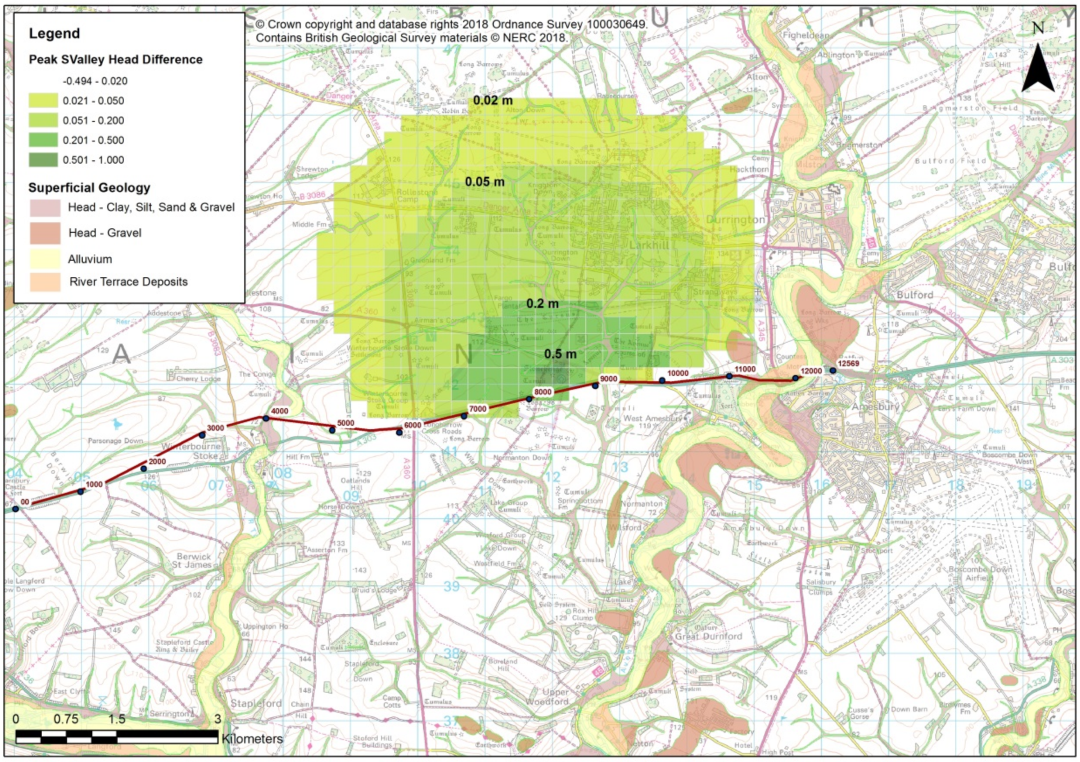


Figure 13 Rise in Groundwater Level at Peak Period – no VKD short duration model from Annex 1

4.1.2 Figure 14 shows the peak period for the best alternative model calibration, using the Wessex Basin model VKD setup with the low end of the range of storage values from the pumping tests. An average period tunnel was used as an impediment to flow as the model period is 40 years and so approximates the impediment for almost all of the time (Figure 4.1 in Annex 1 shows that the highest groundwater levels used in the short duration model are estimated to have only occurred three times since 1970).

4.1.3 The rise in water table is little different in magnitude overall, with a reduced rise in the vicinity of Stonehenge Down. The small changes to the extent of the contour area relates to the different aquifer properties, and because the average tunnel length of impediment was used for the full Wessex Basin model period.

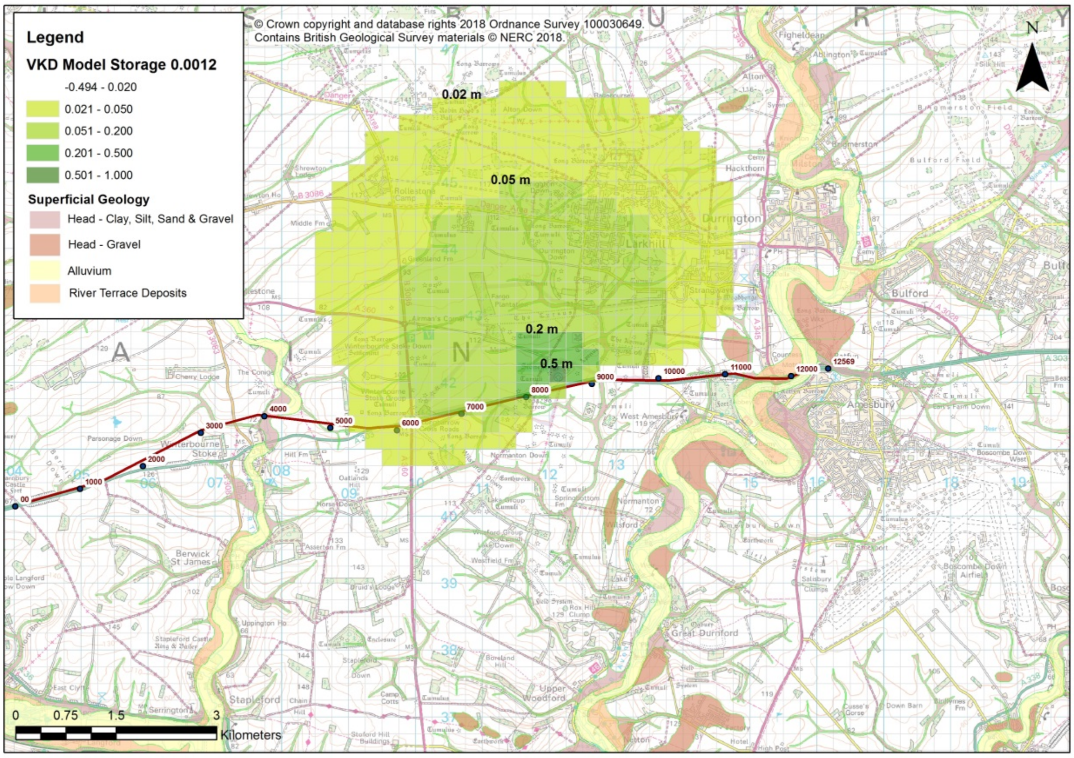


Figure 14 Rise in Groundwater Level at Peak Period – VKD and Low Storage model

4.1.4 Figure 15 shows the predicted water table rise at the peak period using the original Wessex Basin model, with VKD and higher storage values than those calculated in pumping tests in the study area.

4.1.5 It shows a reduced water table rise because the aquifer is simulated as being more permeable and able to store more groundwater, hence having lower groundwater levels than observed, and therefore it is easier for groundwater to flow and the tunnel is less of an impediment to flow.

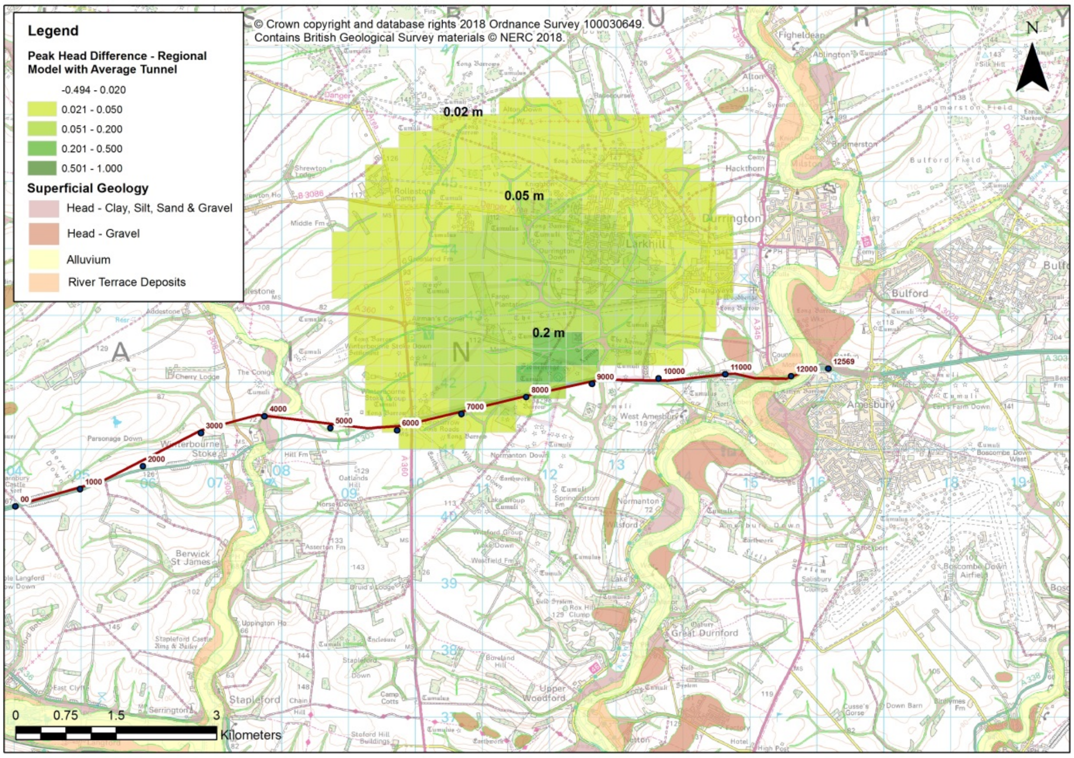


Figure 15 Rise in Groundwater Level at Peak Period – Wessex Basin Model (VKD and High Storage)

4.1.6 The model used in Annex 1 Numerical Modelling Report remains the most conservative for the impact assessment. Each model shows a similar magnitude and extent of impact of the tunnel in causing water levels to rise during peak groundwater level periods.

4.1.7 Therefore possible alternative model calibrations do not affect the findings of the GRA for groundwater flood risk.

4.2 Environmental Flows Risk

4.2.1 The VKD and low storage model alternative simulated lower flows than the no-VKD model used in Annex 1 Numerical Modelling Report, and so although not as well calibrated to low flows, represents a worst case for impact assessment.

4.2.2 Figure 16 presents the flows with and without a tunnel impediment for the River Avon at Amesbury. There is a negligible difference to drought low flows.

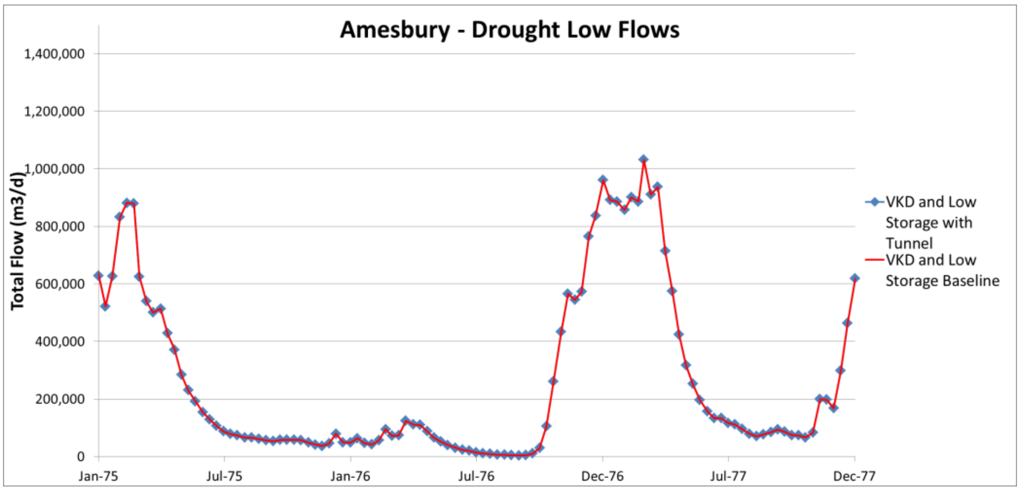


Figure 16 Low Flows in River Avon

4.2.3 Figure 17 presents the flows with and without a tunnel impediment for the River Wylye at South Newton. There is a negligible difference to drought low flows.

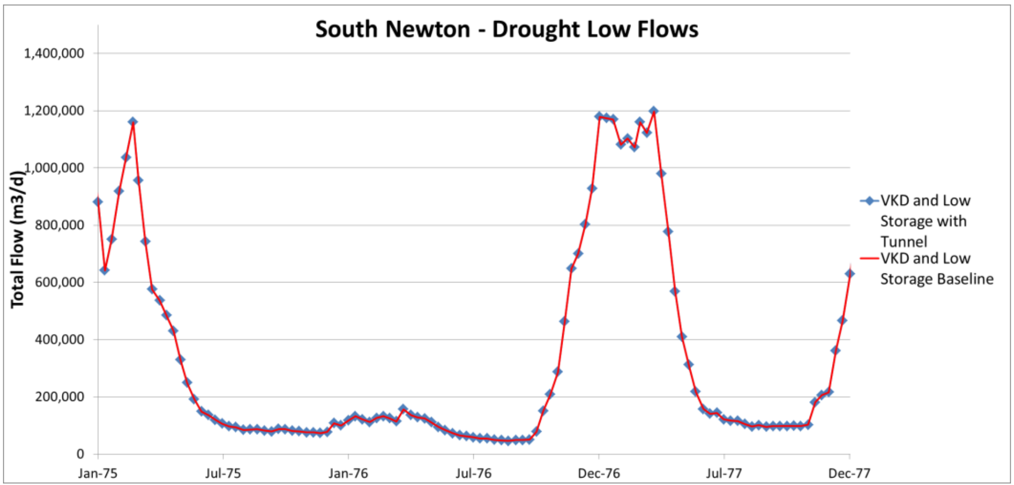


Figure 17 Low Flows in River Wylye

4.2.4 The impacts to flow from the tunnel from the Wessex Basin Model itself (VKD and higher storage) are presented in Figure 18 and Figure 19. As with the low storage model there is negligible difference in drought low flows at the River Avon at Amesbury and the River Wylye at South Newton.

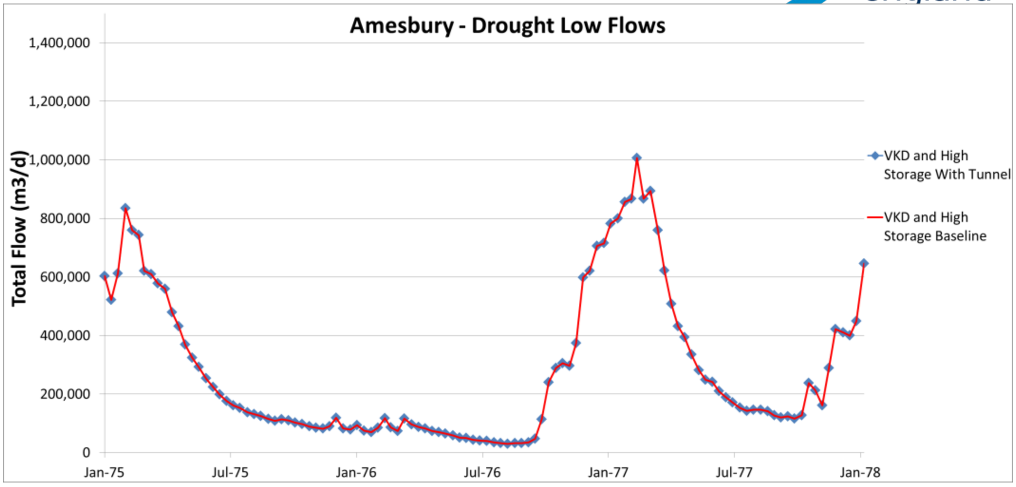


Figure 18 Low Flows in River Avon in Wessex Basin Model

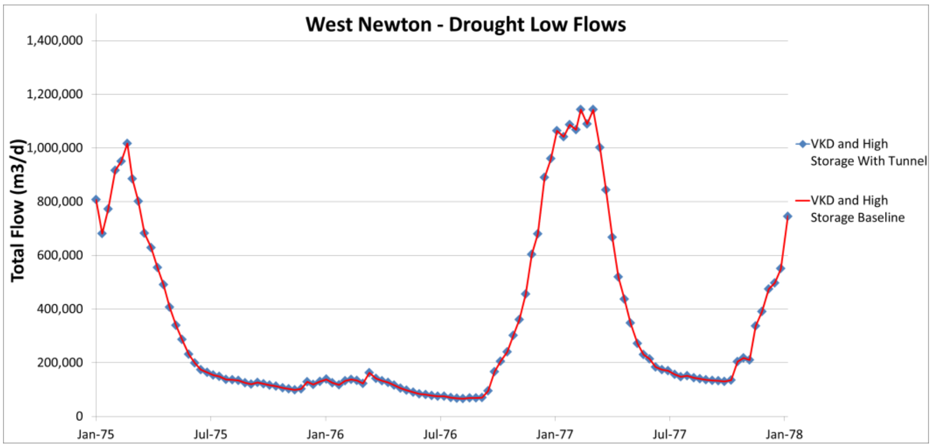


Figure 19 Low Flows in River Wylye in Wessex Basin Model

4.2.5 Flow accretion plots from the VKD and low storage model for the River Avon and River Wylye are presented in Figure 20 and Figure 21.

4.2.6 There is negligible difference in drought low flows between the baseline and tunnel results along the profile of the River Avon. The magnitude of change is similar to that presented in Annex 1 Numerical Model report.

4.2.7 Note that the River Avon flow profile is different to that presented in Annex 1 Numerical Model report, with flows decreasing from Upavon village for over 15km. This occurs in the VKD low storage model in each drought period, which is not supported by the spot flow data.

4.2.8 Spot flow data across a range of time periods shows a similar pattern to that given in Annex 1 Numerical Model report, with the lowest flow periods having a flat to gradual rise. No spot flows were available for 1976 to confirm if flow is lost over this length of river.

4.2.9 This supports the discussion in Section 3 that the low storage model does not give a better flow calibration than the A303 short duration models or the Wessex Basin model.

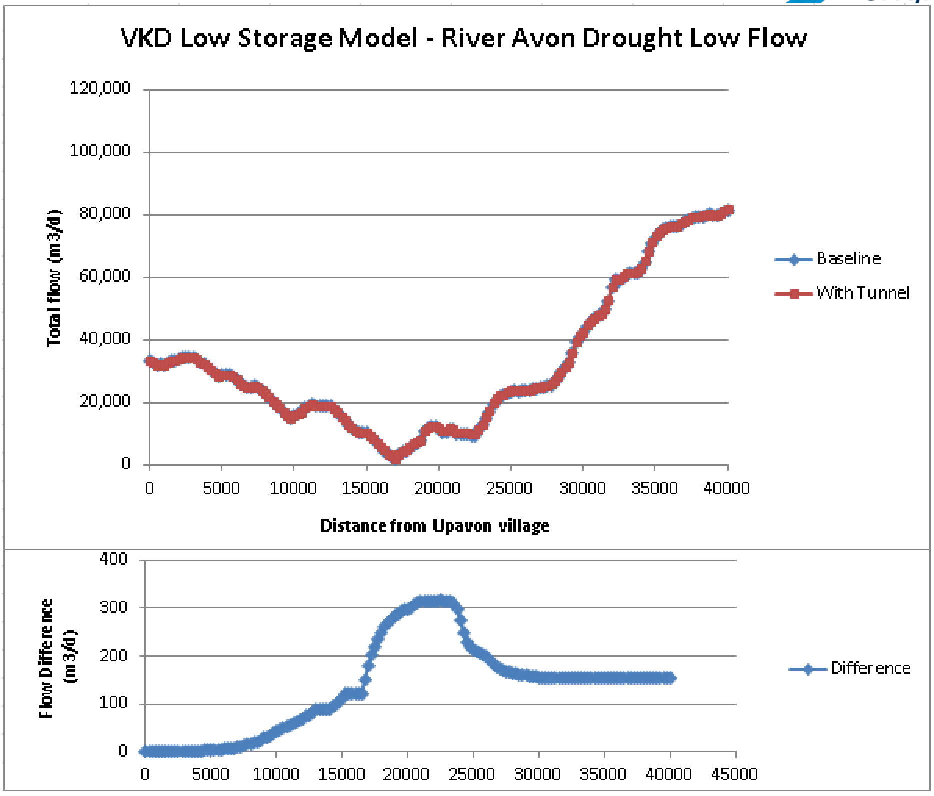


Figure 20 Accretion Plot for Low Flows in River Avon in low storage model

4.2.10 There is negligible difference in drought low flows between the baseline and tunnel results along the profile of the River Till-Wylye. The magnitude of change is very similar to the A303 model findings in Annex 1 Numerical Modelling Report, except that a small gain is flow is predicted in the River Wylye.

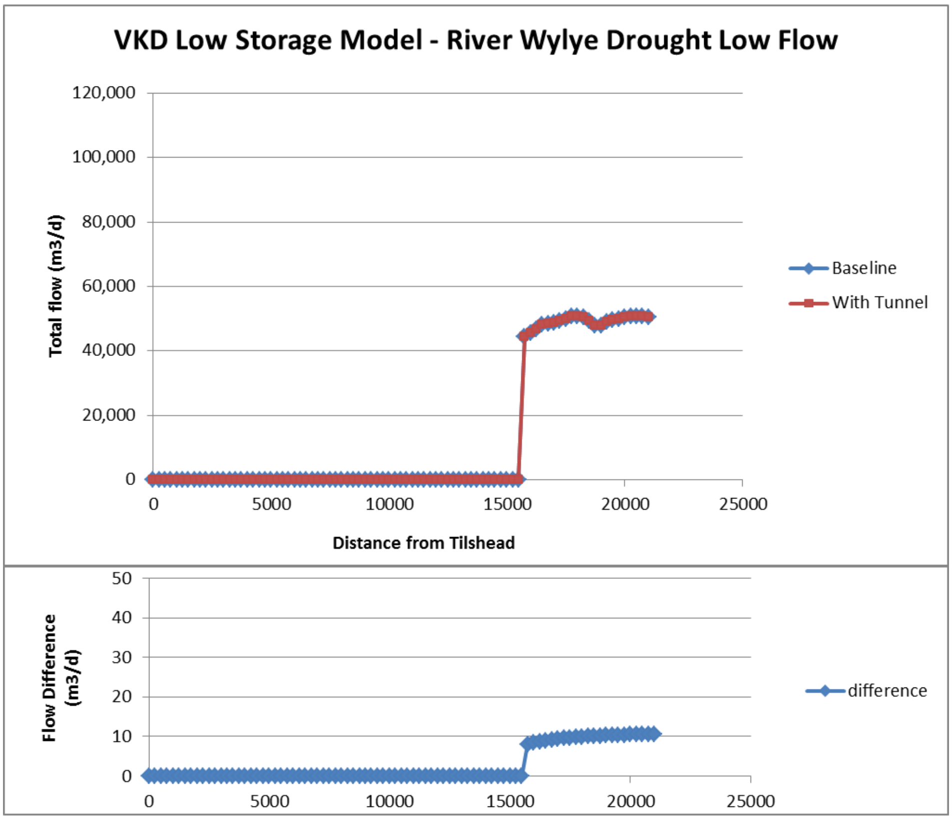


Figure 21 Accretion Plot for Low Flows in River Wylye in low storage model

4.2.11 Flow accretion plots from the Wessex Basin Model (VKD and higher storage) for the River Avon and River Wylye are presented in Figure 22 and Figure 23.

4.2.12 There is negligible difference in drought low flows between the baseline and tunnel results along the profile of the River Avon. The magnitude of change is similar to that presented in Annex 1 Numerical Model report.

4.2.13 In the Wessex Basin model the pattern of accretion is also different than for the no-VKD model presented in Annex 1 Numerical Model report in 1976. However at other drought periods (1992, 1997, 2005) the accretion pattern is more in line with that of the spot flows.

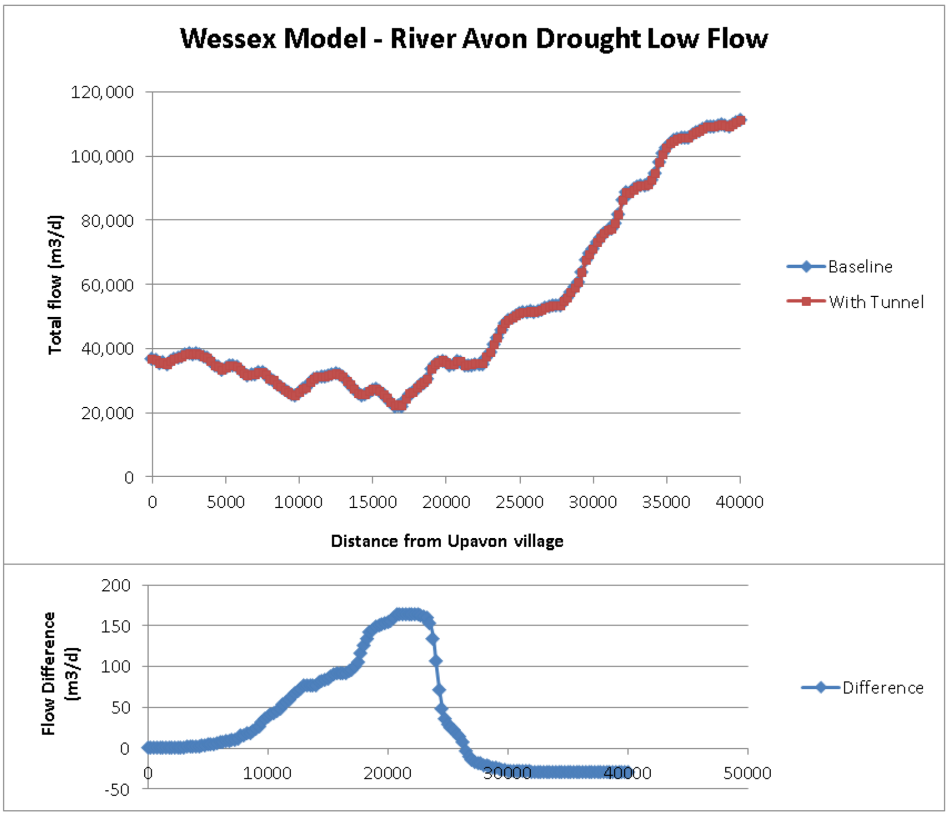


Figure 22 Accretion Plot for Low Flows in River Avon in the Wessex Basin Model

4.2.14 There is negligible difference in drought low flows between the baseline and tunnel results along the profile of the River Till-Wylye. The magnitude of change is very similar to the A303 model findings in Annex 1 Numerical Modelling Report. In common with the VKD-low storage model, there is a small gain in flow predicted in the River Wylye.

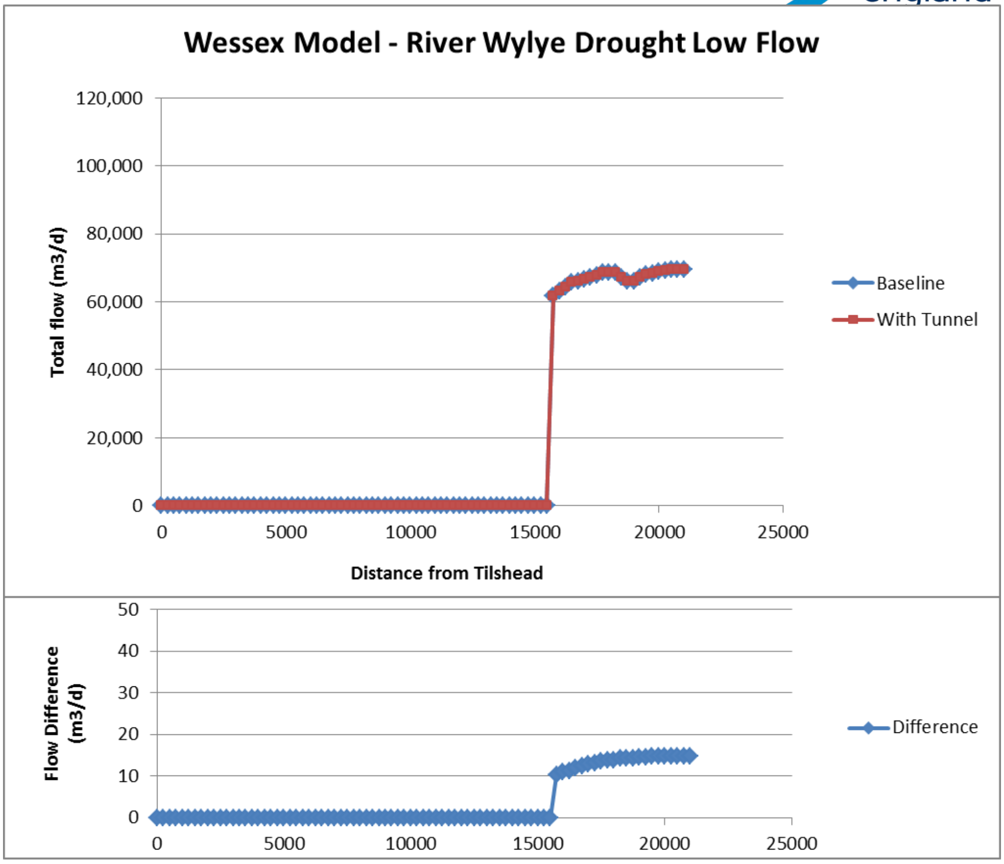


Figure 23 Accretion Plot for Low Flows in River Wylye in the Wessex Basin Model

4.2.15 For additional consideration of river flow impact to the River Avon, the 2005 drought flows were also compared with the modelled tunnel where the typical pattern of accretion is simulated in the Wessex Basin model.

4.2.16 During the 2005 drought, the Wessex Basin model predicts a tunnel impact across the River Avon accretion profile that is very similar to the impact described in Annex 1 Numerical Modelling Report, with a gain in flow to approximately Amesbury gauging station followed by a loss of flow downstream of Amesbury. The magnitude of change is similar to that of the no-VKD model, being up to approximately 0.05% of flow.

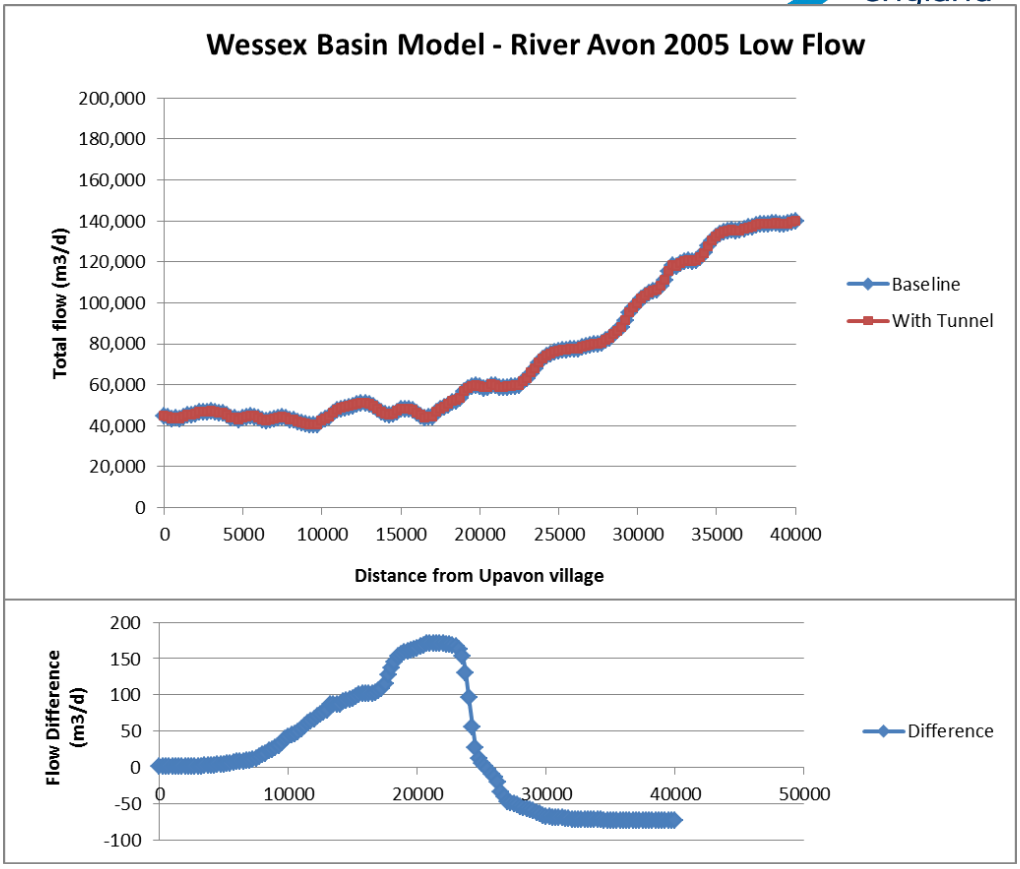


Figure 24 Accretion Plot for Low Flows in River Avon in the Wessex Basin Model

4.2.17 Therefore each model predicts a different river flow profile and change in flow from the baseline of imposing a tunnel as an impediment to flow. However, the scale of change is very similar in each model, in the order of 0.05% of flow.

4.2.18 Therefore the different model setups used in determining the potential impact of the tunnel on river flows have reached the same conclusion.

4.3 Climate Change Model Run

Starting Conditions

4.3.1 It was noted that the climate change runs conducted in Annex 1 Numerical Modelling Report used the same starting conditions as the other scenarios modelled. This meant that climate change was not built-in to the starting conditions for the climate change model, but used the historic groundwater levels.

4.3.2 This could mean that the climate change groundwater level prediction is under estimated due to the starting conditions being lower than might be expected under climate change.

4.3.3 An additional peak period climate change model run was undertaken to assess whether the predictions in Annex 1 Numerical Modelling Report were appropriate and whether the findings in the GRA would remain valid.

4.3.4 The peak groundwater levels in the climate change model used in Annex 1 Numerical Modelling Report were set as starting conditions, which represent the highest groundwater levels recorded plus 20% additional recharge. This is considered to be very conservative as it assumes groundwater levels in the late autumn when they tend to be at a low point, are actually above the highest recorded levels.

4.3.5 The model was then run with the historic 2013-14 recharge sequence with an additional 20% as per Annex 1 Numerical Modelling Report.

4.3.6 The modelled groundwater levels for the climate change baseline were output in the tunnel area. It can be seen that the starting conditions are approximately 10m higher. Levels then fall while there is not sufficient recharge to maintain such high levels until significant recharge occurs from January onwards.

4.3.7 Groundwater levels between the original climate change model and the new higher starting heads converge toward the peak, with the new model peaking approximately 2m higher than the model used in Annex 1 Numerical Modelling Report.

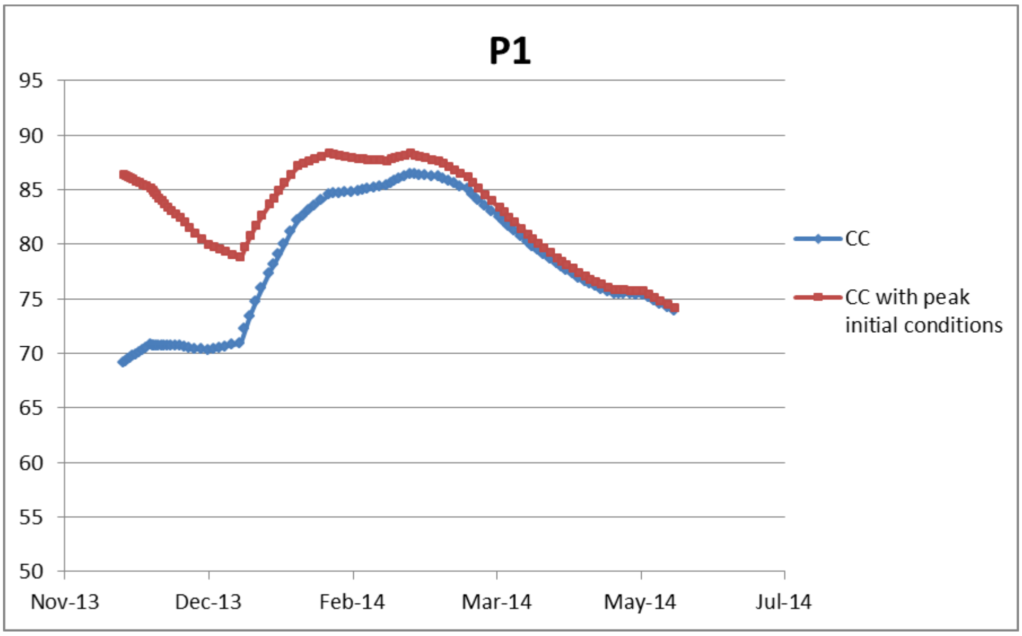


Figure 25 Groundwater Levels at P1 with peak groundwater level starting conditions

4.3.8 The tunnel was then imposed on the new model with higher starting heads. The tunnel causes no significant additional rise in groundwater levels. This is because the high the groundwater level the more groundwater can flow over the tunnel. The degree of impediment the tunnel causes does not increase significantly as groundwater levels rise above the 2014 recorded peak.

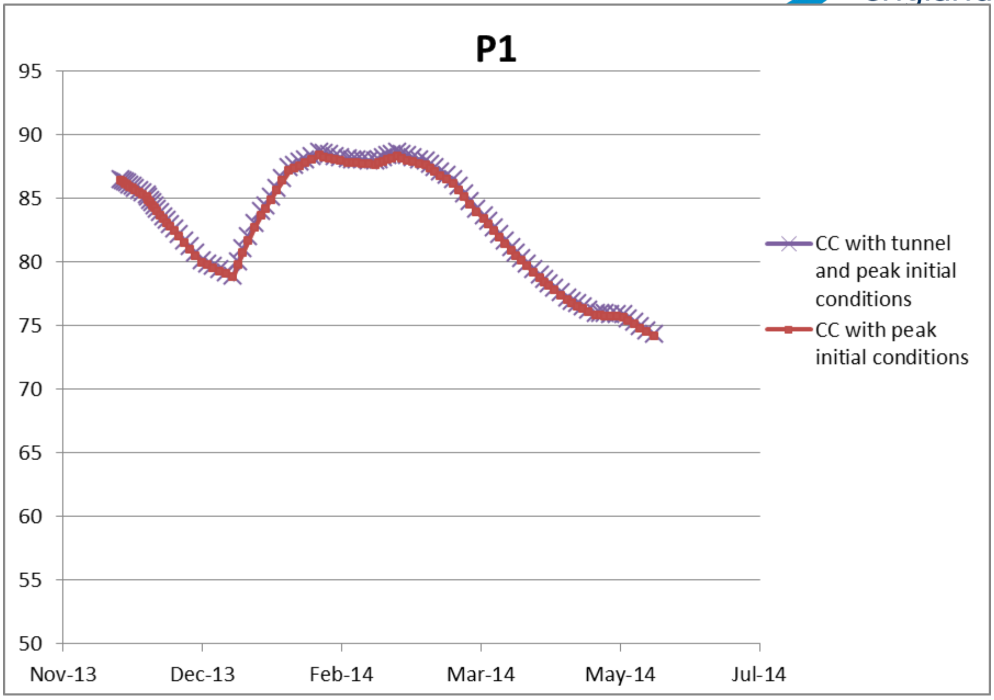


Figure 26 Groundwater Levels at P1 with peak period starting conditions and tunnel

4.3.9 Therefore changing starting conditions for the climate change model has not changed the conclusions regarding flood risk in the GRA.

Percentage of additional recharge

4.3.10 A specific query raised on climate change modelling was the difference between groundwater modelling additional recharge compared to fluvial and pluvial additional rainfall percentages.

4.3.11 The different flooding mechanisms used different percentage increases in rainfall (or recharge where appropriate) to suit the different flooding processes.

4.3.12 The proportion of any rainfall event that becomes recharge to the aquifer will vary with the antecedent conditions and the intensity of the rainfall event. An intense rainfall event may lead to significant runoff and little recharge, while a summer storm may not generate recharge if there is a significant soil moisture deficit. In winter rainfall will become recharge when the soil zone has become saturated.

4.3.13 The groundwater modelling assumed that the increase in rainfall may generate a 20% increase in recharge when considering winter groundwater flood risk. This was considered to be a reasonable estimate for groundwater flood risk considering the expected variability after any rainfall event.

4.3.14 Pluvial modelling of general surface water runoff allowed for a 40% increase in rainfall intensity and so an upper estimate of the climate change effect on groundwater was made with an additional model run using an increase in recharge of 40%, even though this is significantly more than the total rainfall used in the pluvial model. The fluvial model uses a 40% uplift to the peak recorded flow and so does not directly use rainfall as an input parameter.

4.3.15 The additional rainfall calculated for the pluvial model is 46.4mm over a 6 hour storm event. The groundwater model climate change run of a 20% increase in recharge is an average of 100mm across the model area over the 2013-14 water year (largely in the recharge season November to March covering the period of the short duration peak model).

4.3.16 The change in groundwater levels as a result of the impediment to flow caused by the tunnel under a 40% additional recharge condition was little different to the effect of the tunnel under the baseline climate.

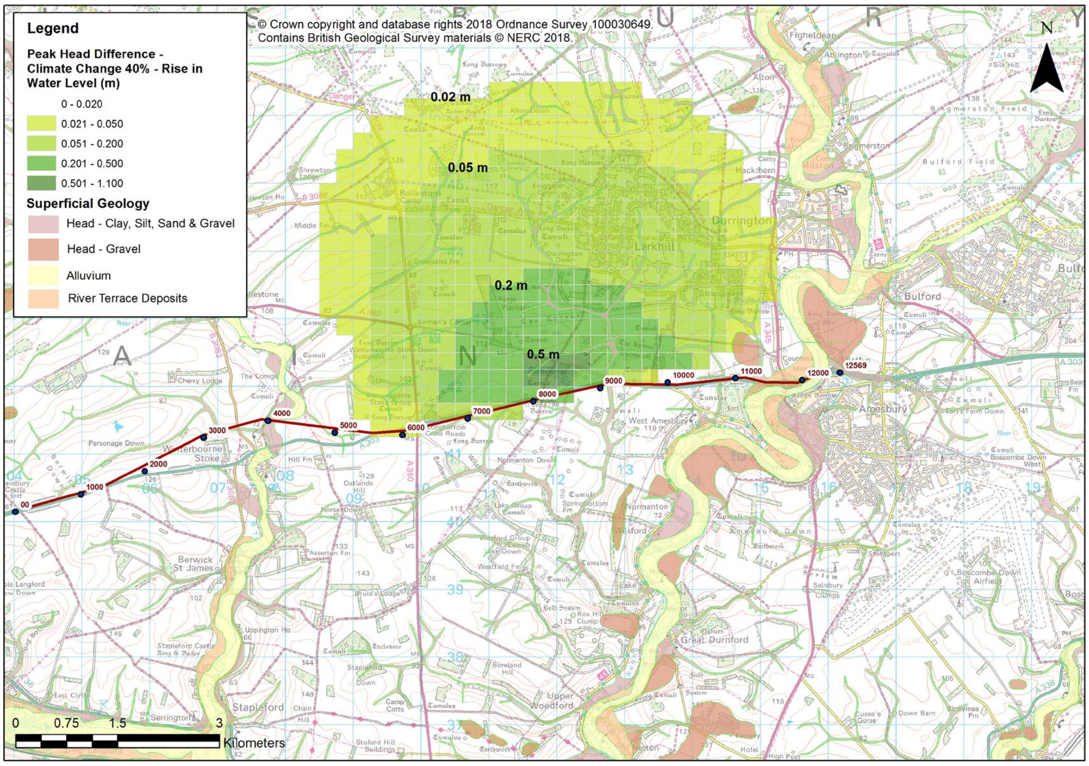


Figure 27 Change in groundwater level with tunnel when representing climate change with 40% additional recharge

4.3.17 The total recharge with the 20% increase was compared to the recharge over the whole Wessex Basin model period (1964-2016) to assess whether it represented an extreme event, which found that the climate change recharge scenario represents a 1 in 2861 year event (or probability 0.99965 percentile). The 2013-14 recharge calculated by the recharge model is a 1 in 90 year recharge event.

4.3.18 UKCP09 climate change projection data for South West England indicates a 15.9% increase in rainfall over winter (see Chapter 14 Climate Change [APP-052]), which is an increase of 63.72 mm average, or 93.65mm at high estimate for Boscombe Down. The recharge applied to the groundwater model climate change scenario is higher than these estimates if 100% infiltration of rainfall is assumed.

5 Conclusions

5.1.1 The short duration models show differences at the start of the simulation compared to the Wessex Basin model. However, the time between the start of the model simulation and the periods of interest (low flow and high flow) is sufficiently long for these differences to have converged.

5.1.2 There is no long term incremental change in impact when using the full length of the Wessex Basin model compared to the short duration models used in Annex 1 Numerical Modelling Report.

5.1.3 The changes in aquifer properties have not led to changes in the model calibration used in Annex 1 Numerical Modelling Report.

5.1.4 The findings of the additional confirmatory model runs show that the alternative models predict the same significance of impact to flood risk, environmental flows and groundwater users as the models used in Annex 1 Numerical Modelling Report.

5.1.5 There are no significant changes to the effects of the tunnel in the confirmatory climate change model runs as a result of changing starting conditions, or using a higher rate of additional recharge, compared to the recharge rate used in Annex 1 Numerical Modelling Report.

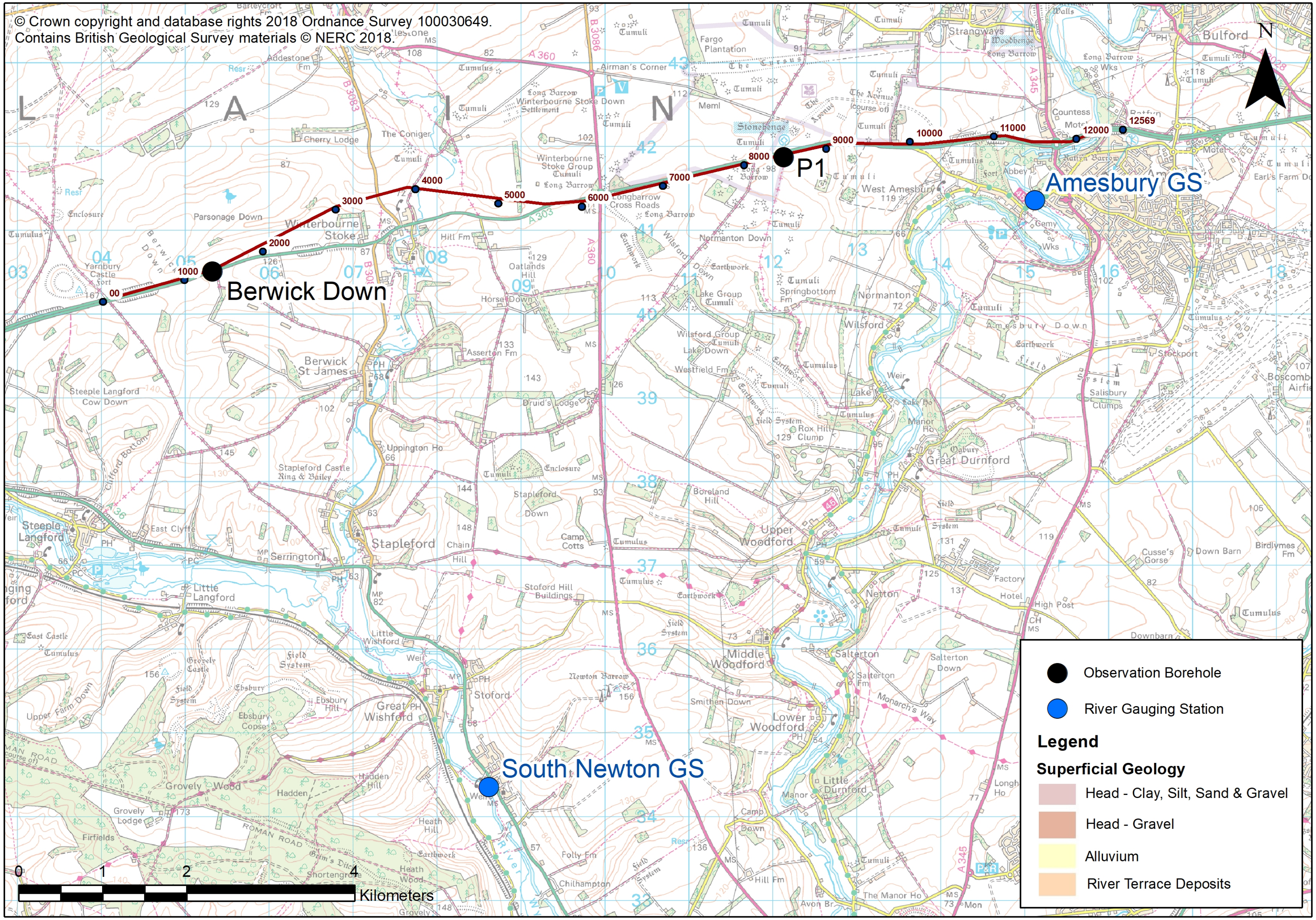
5.1.6 The results of the additional model runs do not affect the findings of the GRA in terms of the impact of the tunnel on flood risk, environment flows and water users. There are no changes to the significance of effects reported in the ES.

6 References

Highways England, October 2018. A303 Amesbury to Berwick Down TR010025. 6.3 Environmental Statement Appendices. Appendix 11.4 Groundwater Risk Assessment

Highways England, January 2019. A303 – Amesbury to Berwick Down Stage 4 – Implications of 2018 Ground Investigations to the Groundwater Risk Assessment

Appendix A – River flow and groundwater level locations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Berwick Down
P1
Amesbury GS
South Newton GS
00
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
12000
12569
N
0
1
2
4
Kilometers
Observation Borehole
River Gauging Station
Legend
Superficial Geology
Head - Clay, Silt, Sand & Gravel
Head - Gravel
Alluvium
River Terrace Deposits

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