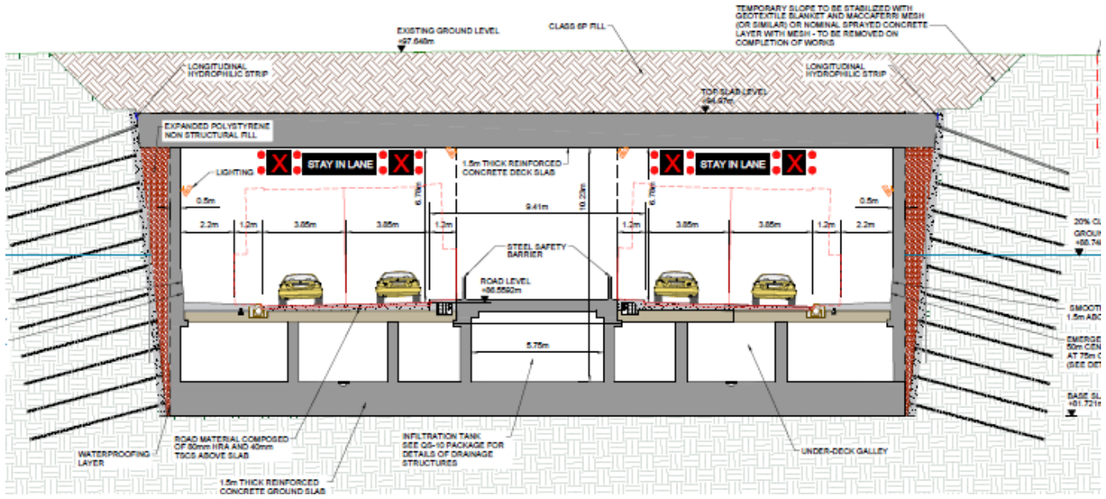
4.1.4. Deck and cover construction

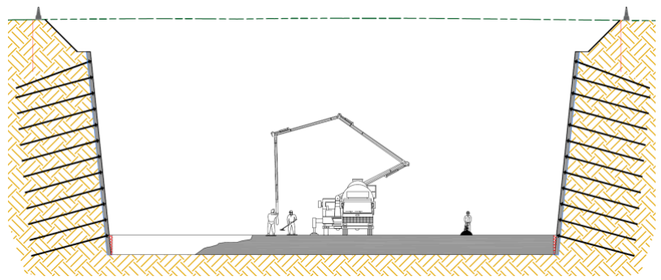
BADGER has included in the design the extension of the tunnel bores westwards from about chainage 7400 to 7300, as a consequence, a reduction in approximately 100m in the length of the west cut and cover section therefore reducing the construction footprint within the WHS (**TQ3A1.1, TQ3A2.1, TQ3A3.1, TQ3A4.1 and, TQ3B2.1, TQ3B3.1, TQ3B4.1**). These TQs will be led and managed by the Design Manager throughout the design stages and then by the Construction/tunneling Manager during the construction phase. Proposed typical cross section through the west cut and cover is shown in the picture below:



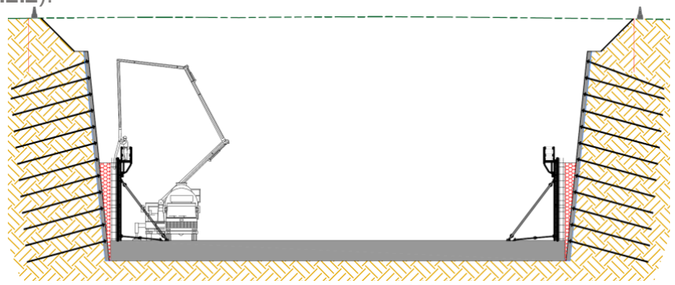
The proposed construction sequence for the cut and cover is detailed below. The base slab and walls will be constructed from in situ reinforced concrete, the intermediate slabs will be pre-cast elements and the roof will consist of precast beams connected to the walls. The roof to side wall joints will be an integral joint connection ensuring the precast beams form an integral structure with the cast in place walls. Particular attention will be paid to waterproofing the joints between adjacent beams and between the beams and the walls, it is anticipated hydrophilic strips and re-injectable tubing will be used to waterproof those joints. It is noted that the future water level (climate change +20%) is still far below these joints, however it is understood that infiltration from rainwater, etc. must still be prevented from entering the structure.

1. Execution of cut and installation soil nailing up to invert level. The construction methodology for the excavation and permanent soil nailing will follow the procedure described in 4.1.1 as well as slope protection, V diches for collecting runoff water and provision for dewatering (ref 4.2.2).

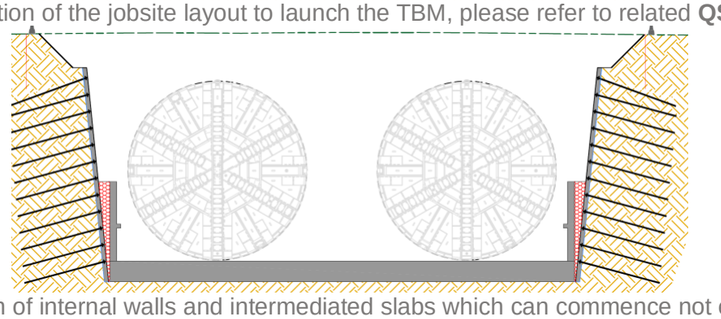
2. Execution of the invert slab, it includes placement of cages and pouring of concrete.



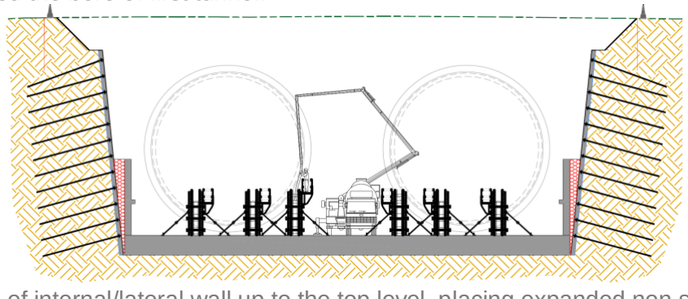
3. Construction of elevated lateral wall sections, placing expanded non structural polystyrene fill **(TQ3A1.5, TQ3A2.5, TQ3A3.5, TQ3A4.5**, led by the Design Manager and Construction Manager**)**, up to groundwater level it includes waterproofing membrane installation, formwork, steel reinforcement and pouring concrete**.**. This allows to prevent groundwater rising issues during subsequent construction phases, then the drawdown dewatering system could be switch off (refer to **4.2.2**).



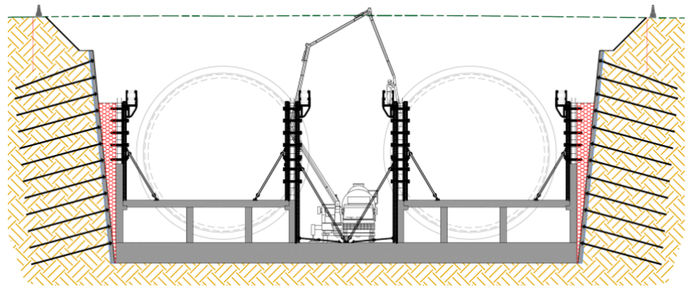
4. Implementation of the jobsite layout to launch the TBM, please refer to related **QS3B**.



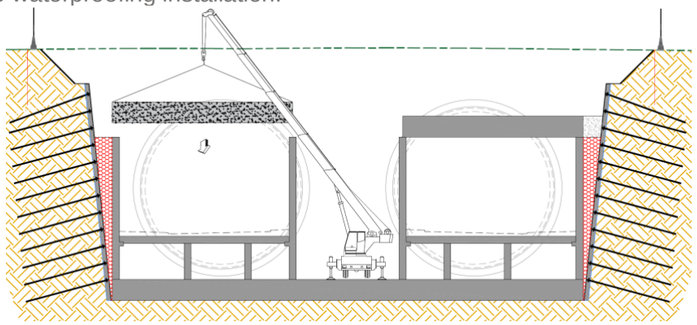
5. Construction of internal walls and intermediated slabs which can commence not earlier that TBM has completed the bore of first tunnel.



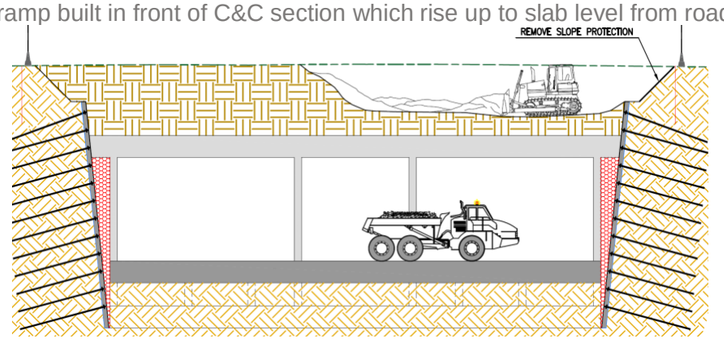
6. Construction of internal/lateral wall up to the top level, placing expanded non structural polystyrene fill **(TQ3A1.5, TQ3A2.5, TQ3A3.5, TQ3A4.5)**, formwork, steel reinforcement and pouring concrete**.** These TQs will be led and managed by the Design Manager throughout all design stages, and by the Construction Manager through the construction stages.



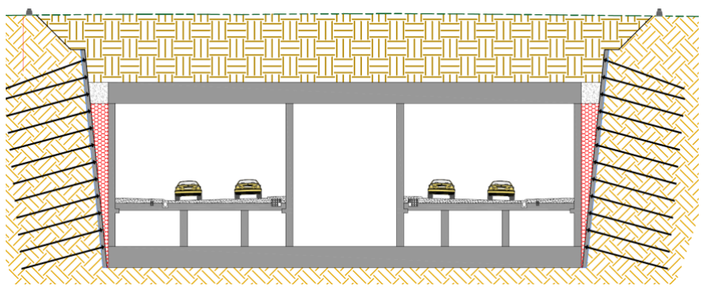
7. Construction of top slab by installation of the precast slab and finalisation of integral joints, including the waterproofing installation.



8. Completion of waterproofing and backfilling with class 6P material the structure up to final design level. Backfilling material comes from stockpiles, and it is hauled along jobsite and supplied by a temporary ramp built in front of C&C section which rise up to slab level from road level.



9. Finishes and electromechanical installation.



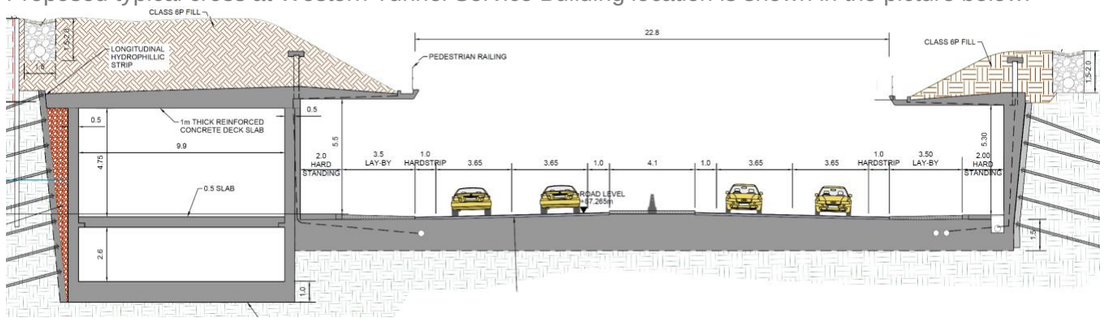
Cut and cover west section is in proximity of existing A303. Predictions of the expected and worst-case settlement that the A303 could experience due to the works will be produced before the start of construction.
It is proposed to monitor the A303 during execution of the work at cut section by using a series of automated total stations whose will be linked to the site control room to allow real time monitoring and alerts. RAG (Red-Amber-Green) trigger levels would be agreed with Highways England and the asset owner, along with associated actions that the construction works would implement. In addition, the movements would be reviewed at regular shift/day meetings and compared against predictions for that phase to identify trends and, if necessary, pre-emptively implement mitigations before trigger levels are reached.
Potential measures during construction to control settlements on A303 close to the retaining wall:

- Increase the number excavation stages to lower height
- Close up the soil nails
- Reduce the length of each excavation level to minimize exposed ground
- Increase thickness of the SCL element of the soil nail wall

Please refer to **4.2.2** for groundwater management during construction.
Please refer to **4.3** for Heritage Monitoring approach.

4.1.5. Construction of the tunnel services building

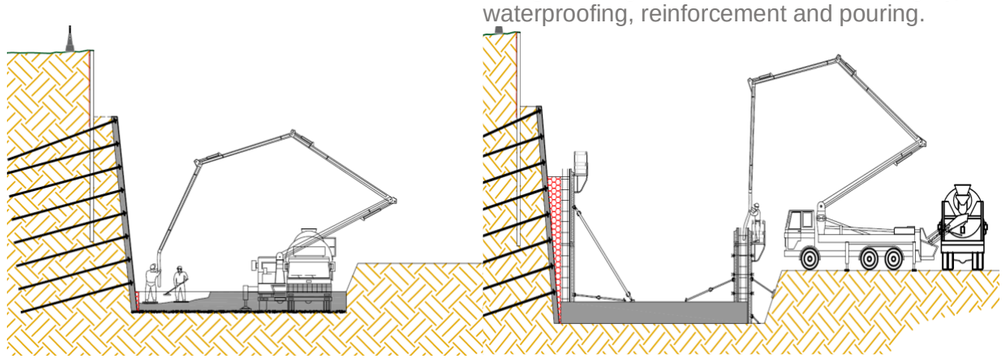
Proposed typical cross at Western Tunnel Service Building location is shown in the picture below:



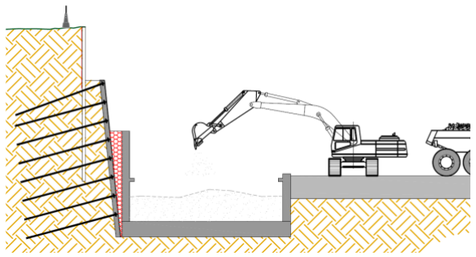
The construction of the tunnel service building will start once the cut and the permanent soil nailing are finished (refer to section **4.1.1**) including V ditches to collect runoff water. The Construction sequence after the excavation is presented below:

1) Execution of foundation slab. Reinforcement placement and concrete pouring

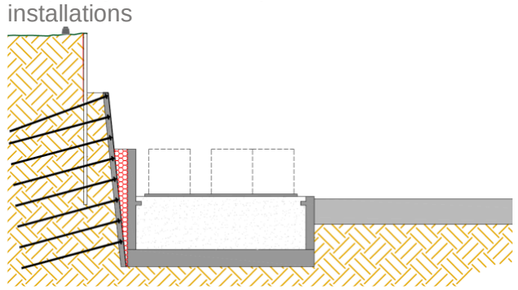
2) Construction of first elevation of wall up to groundwater level. It includes expanded non-structural polystyrene fill **(TQ3A1.5, TQ3A2.5, TQ3A3.5,TQ3A4.5**, led by the Design Manager and Construction Manager**),** formwork, waterproofing, reinforcement and pouring.



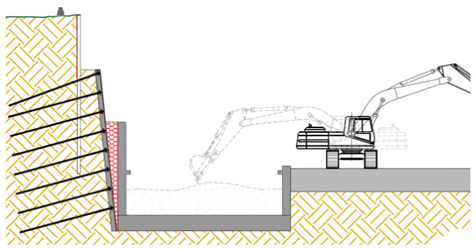
3) Temporary backfilling up to intermediate slab level



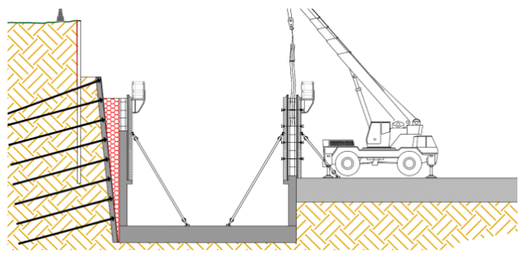
4) Lay down of temporary precast slabs to support temporary facilities and placement of TBM site installations



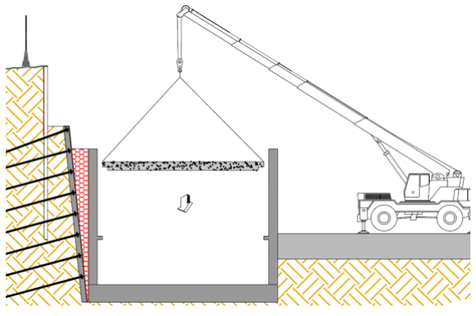
5) Removal of TBM site installations, slabs and backfilling



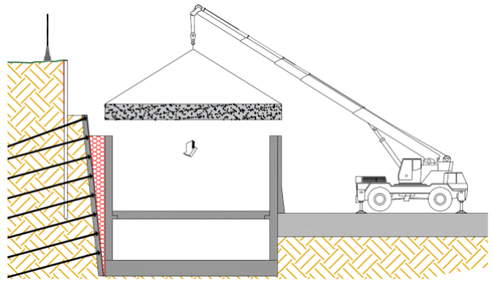
6) Construction of elevated wall sections, installation of expanded non-structural polystyrene fill **(TQ3A1.5, TQ3A2.5, TQ3A3.5,TQ3A4.5**, led by the Design Manager and Construction Manager**)**. Waterproofing, formwork, reinforcement and pouring



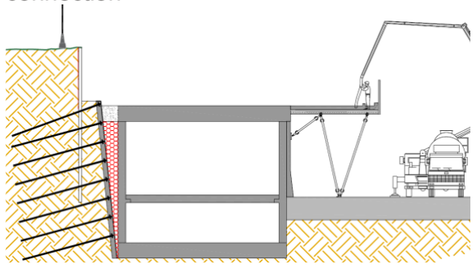
7) Installation of intermediate precast slabs



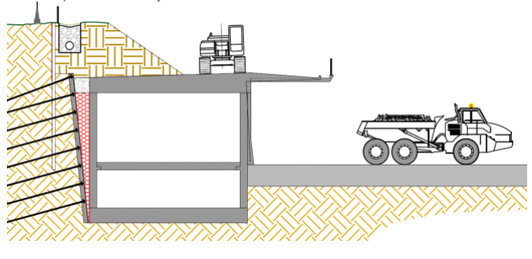
8) Installation of the precast concrete slab (roof)



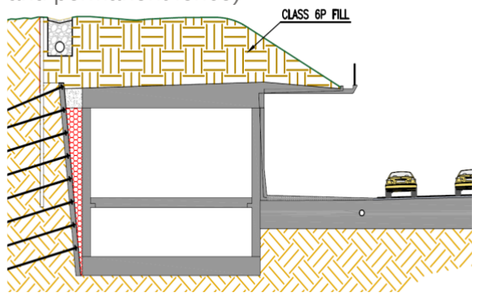
9) Execution of cast in place cantilever: formwork, reinforcement,integral connection



10) completition of waterproofing, 6P class backfilling supplied from roadway, installation of permanent crest drain, landscape.



11) Finishing works (handrail, landscape and permanent fence)



TSB basement includes the construction of a dedicated under carriageways access to the under-deck gallery of the tunnels**.**

4.2. Temporary works and temporary structures required for each stage of construction

4.2.1. The significant items of temporary works, such as the launch slab and the temporary portal structure

The TBM will be assembled on a steel cradle and pushed in the sealing system.
Base slab will take the loads of jacking system, steel cradle and TBM.

Soil at front will be grouted to improve behaviour, VTR soil nail installed, vertical inclination of the excavation will be adjusted by lean concrete.

Please refer **QS-3B** for further details related to TBM launching.

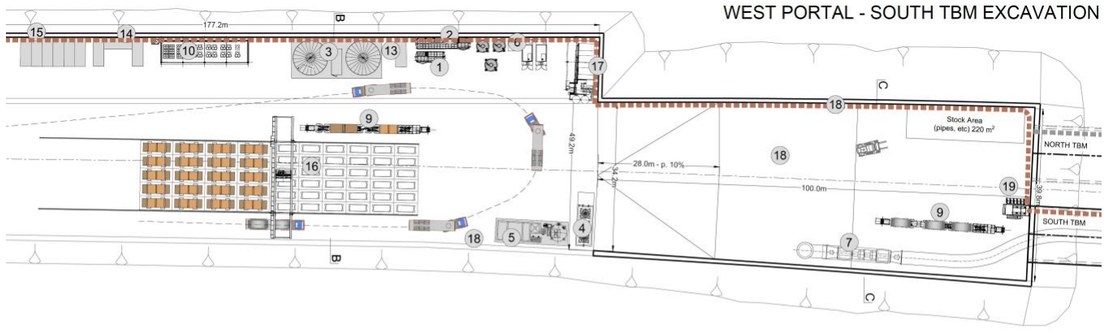


Figure 2: portal layout and sections to launch TBM

4.2.2. Temporary works for the management of ground water

BADGER will utilise sustainable methods for construction wastewater discharges, including site drainage, surface runoff, and dewatering discharges. This includes discharge to watercourses subject to water quality and rate of discharges and scour assessments in accordance with the DCO provisions.

Adequate temporary drainage will be provided during the construction of earthworks. In cuttings sections it is anticipated we will install temporary v-ditch at the base of the wall and at the top edge of the soil nail wall; these diches will intercept surface water liable to flow towards the cutting and along the excavation platform. The water discharged by the ditches into dedicated pits will pumped out from the WHS... The v shaped will be lined with lean concrete and demolished once the backfilling works will begin and replaced by permanent crest drain.

Along the haul road the water runoff will be directed to both sides by adequate slopes of the surface, collected by ditches in dedicated pits. A system will pump out all the water collected during the works staging up to the defined point of discharge outside the WHS, a sedimentation pond placed in the same location of the permanent infiltration pond, west side of Longbarrow junction (refer to **QS10**).

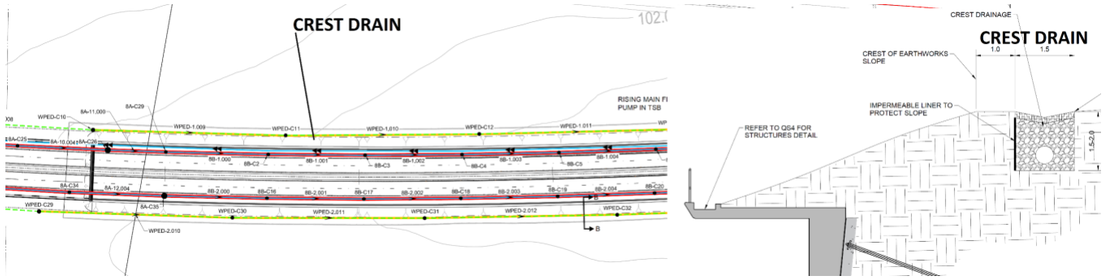


Figure 3: Crest drain at toe on final layout

Our method of groundwater control during construction in the western tunnel approach area is to prevent all excavation below the natural water table from flooding, providing a dry and safe workplace that will allow the right execution of the works. Groundwater control will also have an important role in controlling pore water pressures around the excavation to ensure stability of the excavation base and side slopes, minimizing the risk of landslides.

As per provided wells logs and pumping tests, it is expected that the excavation of west cut section might be affected by high groundwater levels. Groundwater has seasonal variation; most of the times it is expected being below the invert elevation (80m) but some years for short periods the elevation has been exceeded.

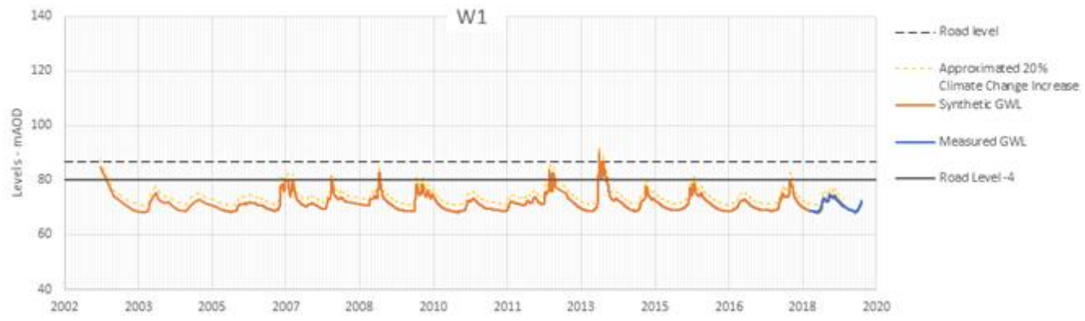


Figure 4: recorded groundwater levels in W1 from 2002 to 2020 and minimum invert level at west (80m)

BADGER intend to install a drawdown groundwater system made by submergible pumps installed from elevation 88m capable to lower the GWL on cut section during the excavation from elevation 88,5 to 80.

Expected pumping rate is subject to execution of further pumping test to evaluate the permeability of the soil within catchment elevations.

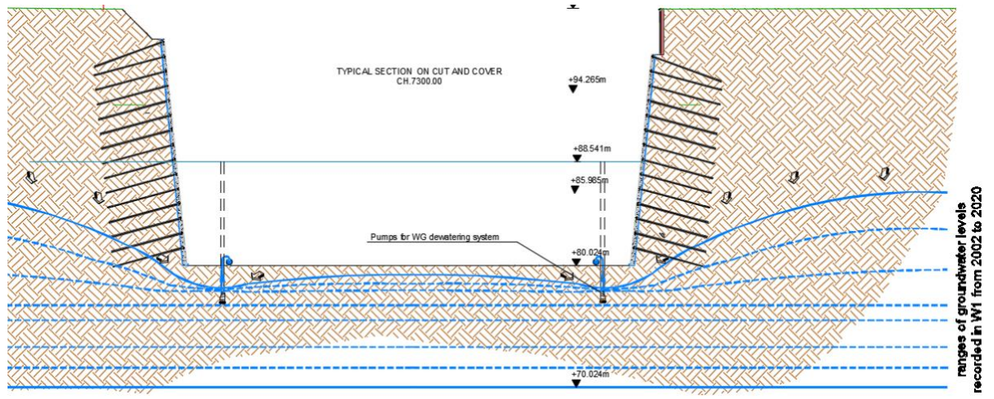


Figure 5: Dewatering system and groundwater elevations from W1

Lowering of excessive groundwater level, it shouldn't impact pre-existences because the wells lower the groundwater to elevations already in place probably 2 months earlier how it happens every year, in any case piezometers will be installed as part of the monitoring system.

BADGER intend to cast the invert slab and vertical wall up to climate change elevation 88m just after the excavation, this might allow to proceed the works without any groundwater issues thus it might allow to switch off the dewatering systems.

The timeframe during which the dewatering system might be potentially needed is composed by the time to excavate from elevation 85 down to 80 and the time to cast the slab and lateral walls.

Dewatering timeframe is on the range of 4-6 months. It depends on seasonal variation and construction time, please refer to programme of work.

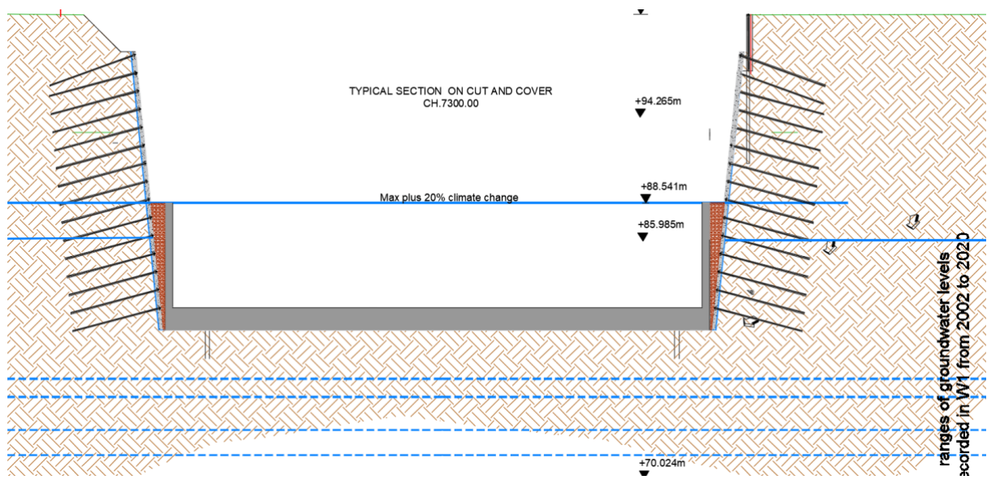


Figure 6: Execution of Invert slab and vertical wall

Groundwater Management Plan will outline the following themes:

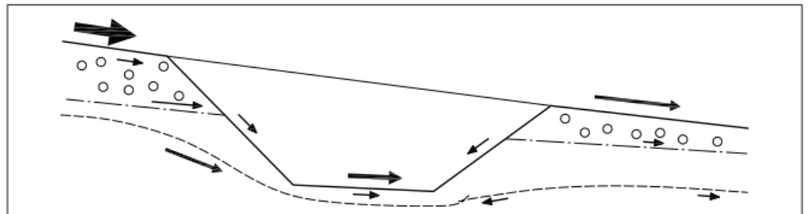
Water collected from dewatering system will be not mixed with water coming from rainwater catchment system. The separation of the systems will allow to treat and discharge by different processes. Discharge to watercourses will only be permitted where permits or other relevant approval has been obtained. We will ensure that site drainage meets the standards required with the relevant permit, and will provide and maintain holding or settling tanks, separators and other measures as may be required to meet those standards.

Access will be provided to the undertaker and Environment Agency, so that, discharge samples can be obtained and analysed, and the flow verified as required.

The following measures will be incorporated during the construction works:

- All temporary Land-take will include adequate areas of land set aside for robust control measures, for example sustainable drainage control.
- Any discharge will be required to be in accordance with the DCO provisions, having regard to the relevant licensing body's requirements
- Water flows from sites will be limited during construction to existing runoff rates, unless otherwise agreed with Wiltshire Council and the Environmental Agency in accordance with relevant legislation.
- The relevant sections of BS 6031: Code of Practice for Earthworks for the general control of site drainage will be followed.

Figure 8 **Design of earthworks drainage to capture significant flows**



NOTE There are many potential sources of water. Drainage requirements commonly include:

- *crest drain – surface water (land drains);*
- *toe drain – surface water/groundwater (installation disturbance);*
- *pavement drain;*
- *slope face drains – seepage points/groundwater profile.*

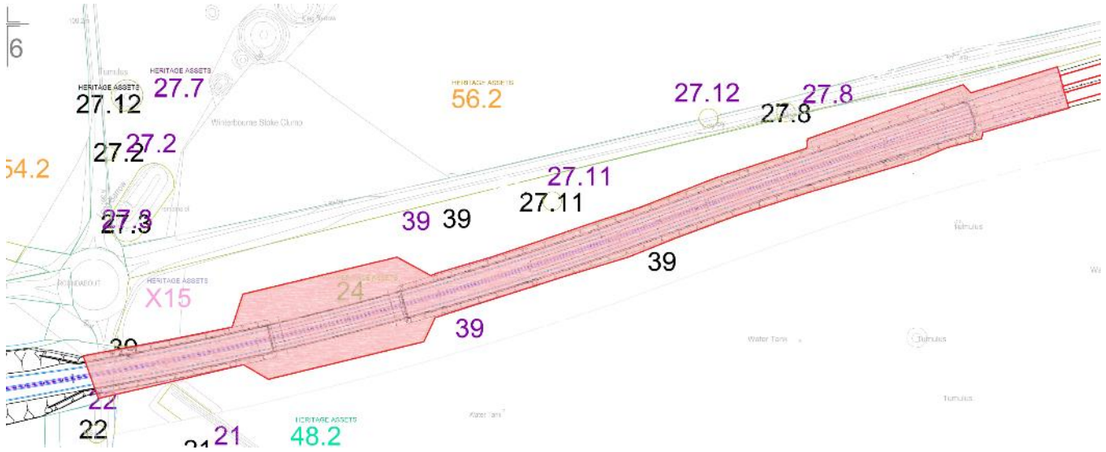
We will ensure the temporary drainage provided is adequate to ensure the success of the earthworks by maximizing the suitability of excavated material and minimizing the potential for deterioration of materials or instability of the works.

4.2.3. The locations and outline details of hoarding and temporary fencing

As stated in QS-13A, temporary fencing and Hoardings to be installed in the Western Tunnel Approach Working area will comply the following requirements:

- Colour to aid integration into the landscape
- Will be kept free from graffiti and posters
- Will be kept well maintained
- Will not contain advertising or promotional information
- Fencing and hoardings in areas at risk of flooding will be permeable to floodwater, unless otherwise agreed with the Environment Agency, to ensure that the fluvial floodplain and areas liable to other sources of flooding continue to function effectively for storage and conveyance of floodwater. Fencing will protect existing water features from degradation and physical damage during construction.

The proposed location for temporary fencing and hoarding is shown in the picture (red line):



All temporary fences and hoardings within the Western Tunnel Approach area will be no more than 4m in height and its purpose of use will be:

- safety and security
- livestock control
- protection of heritage and environmental features.

Temporary fencing and hoardings will be installed in the boundaries of the site of the area affecting to this western tunnel approach. This temporary fencing will be located in the same place as the permanent fencing, which will be replaced at the final stage of the construction programme. This way we will avoid any possible damage in the permanent fencing during the construction stage, the intrusion of any unexpected visitor in the site works, and we will protect the users of the existing A303 and A360 from any possible risk coming from the worksite.

4.3. Protective measures which will be implemented for environment and heritage assets and the wider historic landscape of the WHS;

BADGER will prepare for the delivery stage a Heritage Management Plan (HMP) and a Construction Environmental Management Plan (CEMP) ; this will include the procedure for dealing properly with any unexpected finds during the construction process and with the sites of archaeological interest that are to be protected in compliance with the DAMS Detailed Archaeological Mitigation Strategy in accordance with the DCO.

Specific Method Statements will be released at the start of the construction works to describe specific construction measures to be develop to the siteworks and area of interest in compliance with OEMP and HMP.

The Method Statements will describe in detail how to protect the specific areas where archaeology or heritage assets (PAR Preservation Archaeological remains) need to be preserved in situ by temporary fencing any other strategy.

The Method Statements will also cover the temporary haul roads and temporary traffic management diversions where archaeological remains will be retained in situ.

They will address:

- How we intend to preserve in situ sensitive archaeological remains and prevent deformation of topsoil/subsoil horizons (this will include no-dig solutions).
- Measures for monitoring continued protection of in situ archaeological remains.
- Where appropriate, i.e., for temporary measures, how these will be reversed following the end of construction, e.g., at compound locations, the ground and surface returned to its original shape and condition.

From the start of the mobilisation works we will undertake an appropriate level of monitoring of all heritage assets (both designated and non-designated) within and close to the Scheme boundary Thus identifying archaeological features potentially affected or disturbed by the works all along the corridor. Identifying so all the areas.

All the risk associated to these works will be identified and any mitigation measures will be implemented during the works to avoid any damages (vibration, noise, dust, ground movement visual impact, contamination etc).

The measures of protection will be built by BADGER and managed during the delivery stage.

The assets on the sitework will be clearly indicated with specific signage and protected by fence.

All the operators and drivers will receive a specific training and induction to identify and preserve the archaeological assets.

BADGER will have the responsibility to manage, monitor and maintain all the protective measures installed along the site works throughout the main works construction period.

BADGER will comply with responsibilities set out in OEMP table 2.1 Chapter 2 for protecting environment and heritage assets.

Inspections will be undertaken alongside the EM in order to:

- ensure the environmental controls as set out within the CEMP are in place and working effectively
- monitor compliance with the environmental licences/consents for the works and the measures within the CEMP.

BADGER will have a close coordination with the Archaeological Clerk of Works (ACoW) (The Authority), ACoW will Monitor BADGER/s' compliance with our obligations to ensure that protection measures are in place, maintained and monitored appropriately throughout the construction period in compliance with approved HMPs, DAMS and relevant SSWSIs.

BADGER will ensure that all employees and subcontractors will receive Induction Training (including environmental) and Toolbox Talks to inform about the archaeological and historic environment constraints on site, the protection measures that are required and their obligations under this OEMP and generally to ensure that these are put in place and complied with.

Please refer to **QS-3C, Appendix D** to assess BADGER's monitoring strategies.

4.4. The key construction risks that are uniquely associated with the construction of this Scheme area and the proposed mitigation

BADGER will apply a strategy to proactively manage risk from the outset, which will enable us to safeguard the integrity of HE´s goals and objectives for the project.

KEY RISK	PROPOSED MITIGATION MEASURE
Settlements on existing A303 proximity sections to cut and cover section	- Geotech campaign to detail Geotech parameters - Proper design of retaining structures, evaluation of alternative retaining structures or adjustments - Construction strategies to reduce settlements - Install settlement monitor system and alarms
High groundwater level during excavation/construction along the lower section of the west portal	- To conduct further pumping tests to assess proper permeability coefficients - To install dewatering system - To cast the invert slab and lateral wall up to climate change level in a way to switch off the dewatering system as soon as practicable - Discharge in a proper location outside WHS
Failures of retaining/shoring systems	- Geotechnical campaign to have detailed design inputs - Robust design systems
	- Inspections during execution - Monitoring systems
Work at height	- Planning of the activities - Design of the working area and provide suitable systems such as: Collective fall protection systems, Lanyard, Lifeline, personal fall arrest system, Personal fall protection system - Conduct Job safety Analysis - Identification of simultaneous operations and interferences - Method statement with mitigation/control measures - Competence, Training, and information
Activities near excavation	- Excavation area properly fenced, limited, signaled and provided with appropriate access/egress ways - Verify excavation conditions - Always verify presence of unexpected water, contaminants, non-foreseen soil/rock - In case of any dangerous situation, stop activity, follow contingency plans - Provide adequate pedestrian path
Compliance with DAMS Requirements and related mitigation measures during the construction works	- We will ensure that key objectives and procedures outlined in the DAMS are communicated to all site personnel initially via the Site Induction and then by regular toolbox talks. Only trained personnel will manage tasks in terms of preservation of archeological remains. Our trained people will ensure that all site personnel are aware of the importance to respect these measures before commencing any type of activity and earthworks
Noise and Vibration impact to the WHS receptors	- Noise and Vibration Management Plan and the Noise and Vibration Monitoring report will be developed once we get access to the site within the WHS and during the works. Noise barrier and best practical means will be implemented from the beginning to be compliant with the requirements