Eastern Tunnel Approach | QS-5B | Delivery Methodology | Construction Methodology for the Eastern Tunnel Approach

4. Your construction methodology for the eastern cut and cover tunnel section, the eastern cut retaining structures and the eastern tunnel services building shall provide the following information as a minimum:

4.1. a detailed breakdown and description of the stages of construction including:
- 4.1.1 the excavation of the eastern cut;
- 4.1.2 the substructure construction methodology, including piling methods;
- 4.1.3 construction of the retaining structures;
- 4.1.4 the deck and cover construction;
- 4.1.5 construction of the tunnel services building;

4.2. temporary works and temporary structures including:
- 4.2.1 for ground water management;
- 4.2.2 the locations and outline details of hoarding and temporary fencing;

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

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

4.1. Detailed breakdown and description of the stages of construction

This document details the BADGER construction methodology for the Eastern Tunnel Approach section, which includes the Eastern Cut and Cover Tunnel Section, the Eastern Cut Retaining Structures (both the reinforced concrete structure and the soil nail work) and the Eastern Tunnel Services Building.

The proposed Eastern Tunnel Approach will span over the new A303. The site is within the World Heritage Site (WHS) therefore we will work in compliance with the DCO, which will include all the mitigations in accordance with the Detailed Archaeological Mitigation Strategy (DAMS).

The main works will be preceded by the installation of security fences and hoardings around the perimeter of the works and in accordance with the DAMS. These will be outside the preserved areas such as the retained Nile Clumps Trees and the Avenue.

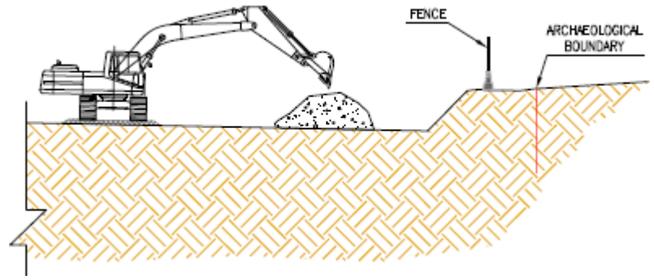
The document has been developed in compliance with:

- The DCO Documents
- Volume 2 Part 2 (Design and Technical Requirements)
- Outline Environmental Management Plan
- Detailed Archaeological Mitigation Strategy
- Contract drawings
- Data Room documents
- Tender Documents in general including Public and Confidential responses to the Competitive Queries and Tender Amendments.

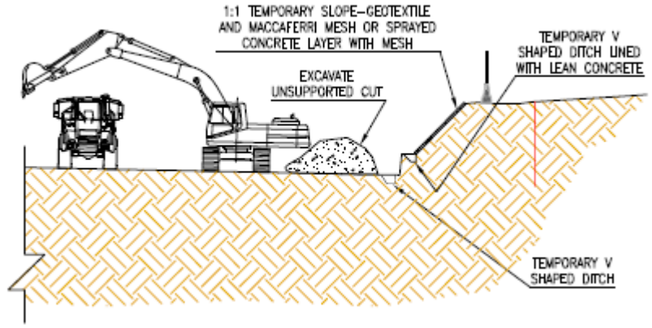
4.1.1. Excavation of the eastern cut

The eastern cut retaining structures will extend for approximately 300m on either side of the carriageway, from Chainage 10425 to Chainage 10700. After the execution of preparatory works including general clearing, erection of fences and hoardings, the execution of geotechnical, archaeological, and environmental surveys can be completed.

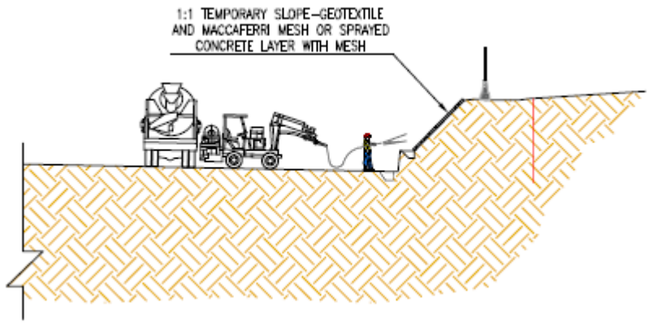
The excavation of the eastern cut section will be executed using the following methodology:



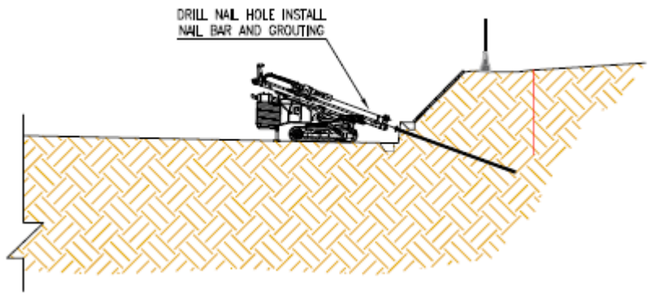
1. Temporary fencing installation and access to work site. The temporary construction haul routes within the WHS will be within the footprint of the permanent works as per requirement **10.3.1 of Vol 2 Part 2.** Clearing and grubbing activities will be completed, and execution of the permanent trench drain just beyond the archeological boundary, if necessary, based on the DAMS limits.



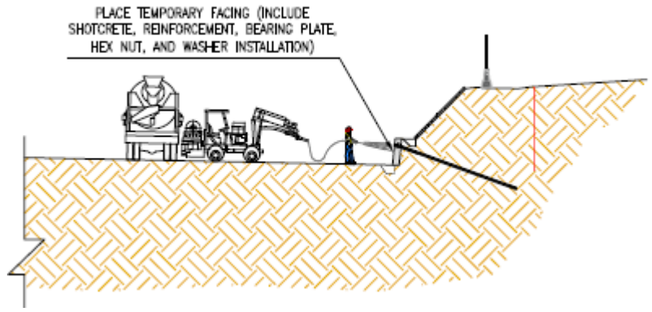
2. Excavation of unsupported cut (1-2 m high). Loading and transport of the excavated material to final area by temporary haul road along the road scheme on the footprint of the foreseen road within the WHS. A temporary V shaped foot drain will be included along the side to collect the water run-off from the excavated platform during the different steps of excavation activity.



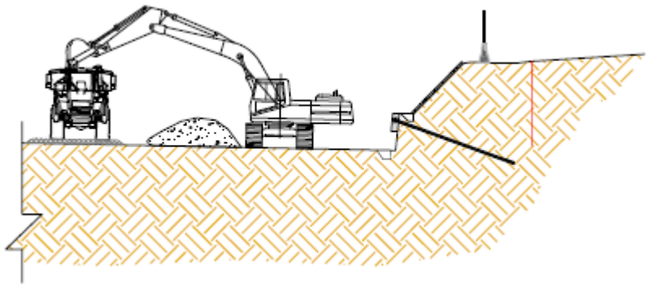
3. If the unsupported cut results in a 1:1 slope based on the DAMS boundary restriction, the surface will be stabilized by geotextile Maccaferri (or similar) mesh or sprayed concrete layer with mesh (to be removed before the final backfilling). A temporary “V” shaped temporary dich will be executed at the base of the slope thus at the top of retaining wall, the diches will collect run off water.



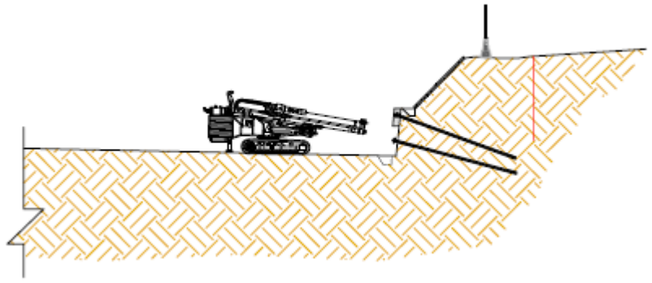
4. Permanent soil nailing installation: we will drill the nail hole, using specialised drilling equipment operated from the excavated platform then install and grout the nail. The soil nails are permanent and load carrying for 120 years design life; they are galvanised steel with a sacrificial thickness to allow for corrosion over 120 years and contribute to final stability of the retaining structure.



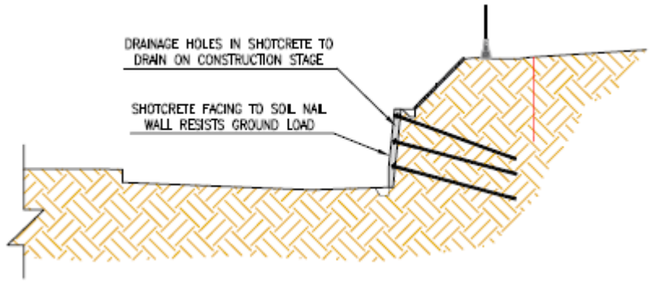
5. Shotcrete installation. Place shotcrete, reinforcement, bearing plate, washer and hex nut installation placing of formers for drain holes and finally spraying of shotcrete to required thickness.



6. Construction of subsequent levels. Excavation of unsupported cut (1-2 m high), loading and transport of the excavated material to final area by temporary haul road along the road scheme on the footprint of the foreseen road within the WHS.



7. Construction of subsequent levels: Permanent soil nailing installation. Drill the nail hole, install and grout the nail.



8. Construction of subsequent levels up to the bottom of the excavation: Shotcrete application, place facing including Shotcrete, reinforcement, bearing plate, washer and hex nut installation, formers for drain holes and finally spraying of shotcrete to required thickness. Design invert elevation is achieved, retaining wall includes permanent soil nails, shotcrete layer, temporary V diches on top and on bottom of wall, drainage holes through shotcrete layer.

When the area is close to the DAMS zone it is envisaged that the soil nail will be >4m below ground level. The intention is that the uppermost nail will be installed 0.5m below the bottom of the 1:2 cut slope and will be angled at ~20° from the horizontal. In this way, the soil nails will be >4m below ground level when the DAMS zone is reached.

Settlement Monitoring

The excavation activities will be implemented in a manner that any ground movement and vibration that the works could cause shall be minimised and an assessment of any potential risk of damages shall be carried out. BADGER Team will prepare a Ground Movement Monitoring Strategy (GMMS) in order to comply with the Scope of Works, and the requirements of the Outline Environmental Management Plan (OEMP). The main aim of the GMMS is to minimise the settlement and assess the risk of damage on any existing structures associated with the ground movements caused by the execution of the works. The GMMS will:

- Describe the methodology and approach to assessing damage
- Show the predicted ground movement on settlement contour plans
- Establish the extent of the zone of Influence and inform the horizontal extent of the instrumentation and monitoring plan to be set up. The zone of influence will not be extended outside the site, and it will cover 1mm settlement contour as a best practice
- Assess the risk of damage to existing infrastructure, archaeology and cultural heritage
- Classify damage using an objective system
- Identifying where ground movement predictions result in an unacceptable level of damage occurring (including cosmetic)

- Describe the mitigation and protective measures to be implemented when an unacceptable level of damage is predicted.

Instrumentation and Monitoring (I&M)

A specific plan for monitoring and mitigating settlement and vibration effects due to excavation will be produced in order to control any potential risk of damage to adjacent structures and the Works themselves. The I&M plans will define the following:

- Instrumentation types and locations
- Acceptable limits (trigger level of each instrument reading) and reading frequencies
- Contingency plan is case limit criteria are exceeded, and pertinent actions to carry out (mitigation, protective or remedial measures)
- I&M report and review meetings to address the progress of the excavation activities and to present and assess the data obtained.

The effects of ground movement and vibrations arising from the cut activities will be assessed to avoid:

- Any impact to heritage assets
- Disturbances to building occupants or damage to buildings and infrastructures.

Statutory Undertakers will be consulted to establish and define the damage acceptance criteria (including trigger levels), any potential mitigation and protective measures when required and also to identify measures and responsibility for remedial actions arising from the monitoring to ensure the protection of the assets. The trigger levels will be defined in detailed design and be revised following the installation of the monitoring instrumentation and the conditions surveys. However, at least two levels shall be considered:

- **Alert level:** ground behaviour is still within the design expectations, but is approaching the envelope (maximum allowed value)
- **Alarm level:** ground behaviour has reached the anticipated envelope and any further movement will be beyond the design limits. Note that asset damage may not be expected at this level; however, the contingency plan shall be activated with the implementation of mitigation and protective measures.

The I&M activities will be conducted at the following stages of the project:

- **Pre-Construction:** monitoring will be undertaken to provide a baseline reading, in which this data will be compared during the Works. To develop this baseline monitoring, a radar interferometry technology (INSAR) will be proposed. This s a remote sensing modality that permits the monitoring of large project areas as it uses radar images obtained by satellites to estimate ground movements and variations on surface.
- **During Construction:** monitoring will take place according to the I&M plan and the data will be recorded, compiled, and compared with the relevant baseline readings from the pre-construction phase. Detailed instrumentation sections will be implemented on relevant project areas (Stonehenge Bottom, Custodian Cottage and Barrows, A303 and Utilities) within the zone of influence defined.
- **Post-Construction:** After completion of construction, the monitoring frequency will reduce, but continue until stable measurements are reached by the long-term monitoring or until movement rate is 2mm per annum or less over a minimum of 6 months. Use of INSAR technology is also recommended for this I&M stage. Automatic electronic systems will be used for this purpose in order to collect, process and make available the data on a web based I&M system in real-time using AGS format.

The measures, after prediction of unacceptable movement, but before excavation will be to:

- Undertake more detailed structural analysis of affected buildings / assets
- Undertake pre-construction examination (of the cottages)
- Set agreed triggers and include in a monitoring plan to understand what will be done at each level of ground movement and what the responsibilities are
- Baseline monitoring
- Additional SI to understand where the poorer ground might be (soil nail walls)
- Increase thickness of the SCL element of the soil nail wall.

If any alert level or alarm level occurs, the mitigation measures during construction of the retaining walls will be to:

- Increase the number excavation stages to more of a lower height
- Close up the soil nails
- Reduce the length of each excavation level to minimise exposed ground.

Interface with existing structure

The existing A303 is within relatively close proximity to the proposed eastern portal structures. Predictions of the expected and worst case movements that the A303 could experience due to the works will be produced before the start of construction. We proposed to monitor the A303 using a series of automated total stations, all 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/daily meetings and compared against predictions for that phase to identify trends and, if necessary, pre-emptively implement mitigations before trigger levels are reached.

4.1.2. The substructure construction methodology, including piling methods

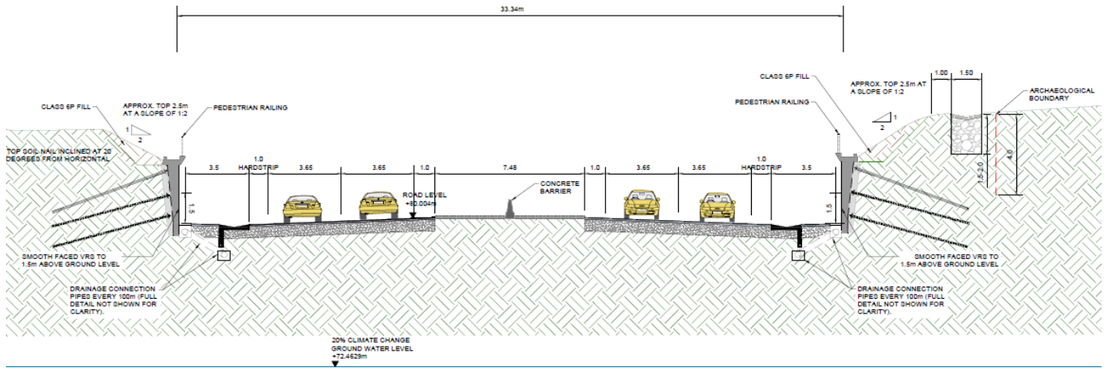
For the eastern tunnel approach, substructure elements will only be executed for the construction of the cut and cover and tunnel services building. These substructure elements will be detailed in the subsequent points:

- 4.1.4 Deck and cover construction, and
- 4.1.5 Construction of tunnel services Building

With our design approach, no piling is expected in this Eastern Tunnel Approach.

4.1.3. Construction of the retaining structures

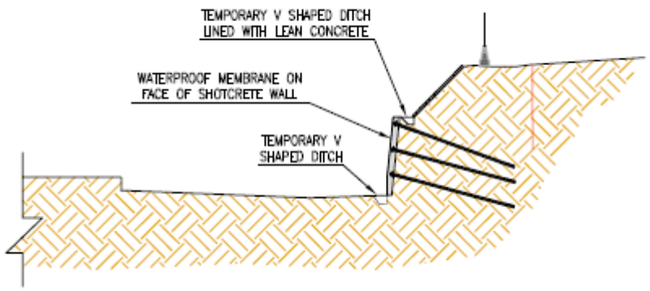
The construction of the retaining structures will include the construction of the retaining walls at both sides of the Eastern cut section and the construction of a small cantilever top edge as shown in the section below and in the Technical Solution **QS-5A**:



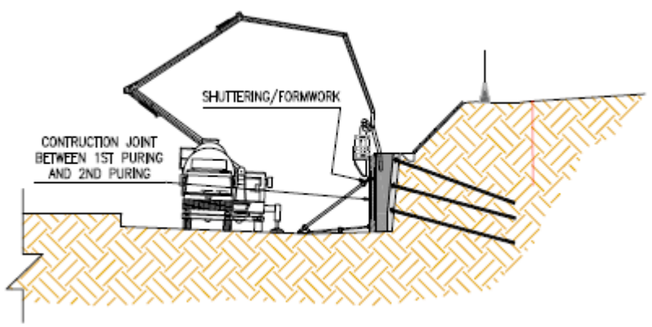
The retaining walls at both sides are made by permanent soil nails installed during excavation, a concrete casted in place final lining and a concreted cast in place small cantilever edge on the top of the wall. The soil nails are permanent and load carrying for 120 years design life. They are galvanised steel and have a sacrificial thickness to allow for corrosion over 120 years and contribute to final stability of the retaining structure.

The final finish of the casted in situ wall will be determined during detailed design to suit the agreed design vision and noise reduction requirements. This will be executed by special formwork to reproduce the intent of the external architectural finishing (Rough textured finished concrete).

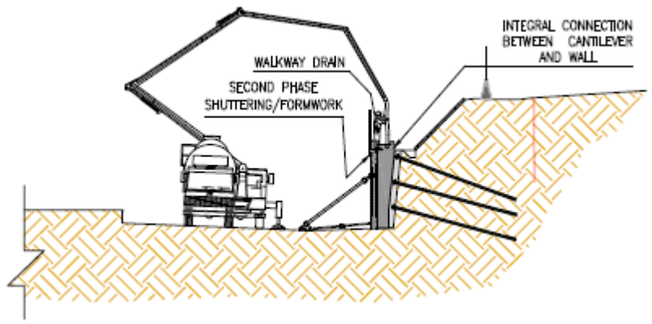
Before the cast in situ concrete a permanent waterproofing membrane will be installed on the face of the shotcrete Following the excavation procedures described in section **4.1.1**, the subsequent phases to execute the retaining structures are the following:



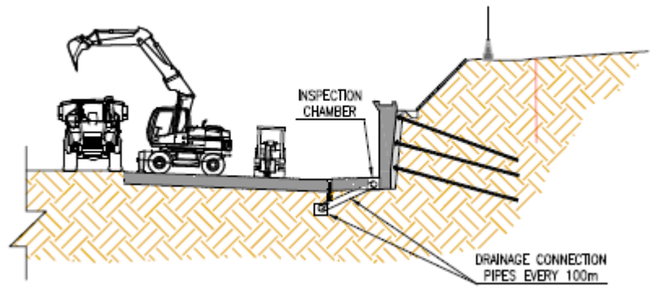
1. Installation of the waterproofing membrane on the shotcrete surface and removal of the temporary foot drain.



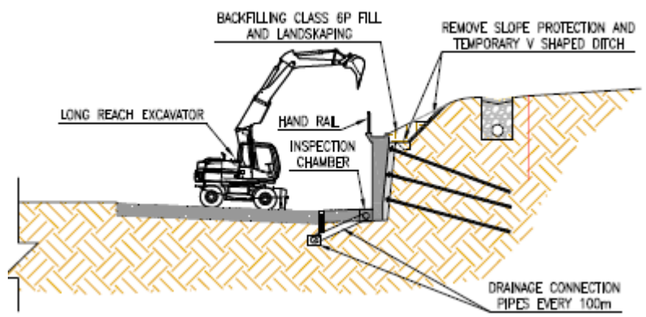
2. Cast in place wall: installation of the reinforcement bars and shuttering / formwork. Before to pouring the concrete, a dedicated drainage pipe will be installed trough the wall to connect the drainage system at the bottom level of the section. A construction joint will be placed between the first pouring and the second.



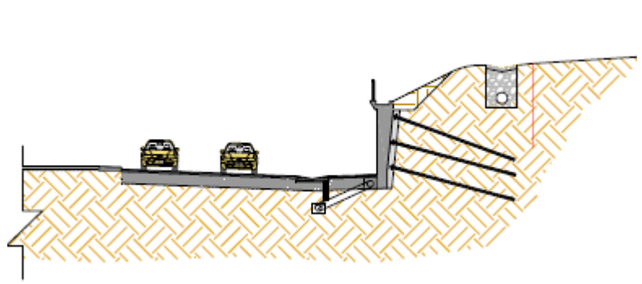
3. Cast in place cantilever edge: installation of the reinforcement bars and shuttering / formwork. Before to pouring the concrete, a dedicated drainage pipe will be installed trough the top of the wall to connect the vertical drainage system within the wall. A construction joint will be placed between the first pouring and the second. An integral connection is foreseen between the top of the wall and the cantilever edge.



4. Installation of the permanent drainage system elements at the toe of the foreseen retaining structure and execution of subbase road layers.

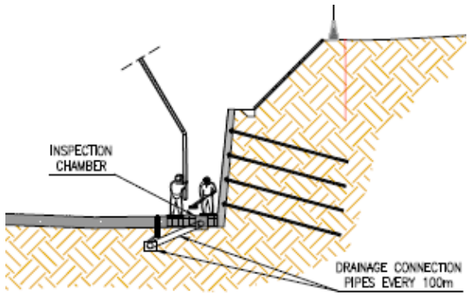


5. Backfilling with 6P material and landscape: Once the concrete structure is finalised on the top of the retaining structure the temporary protection of the slope done by shotcrete will be removed and the final backfilling will be laid to model the final configuration as per requirements and design vision. The backfilling material will be placed from the road level as per requirement and the handrail will be installed on the top of the roof slab. On the top of the section between the crest of the backfilling and the archaeological boundary a crest drain, and a permanent fence will be installed.

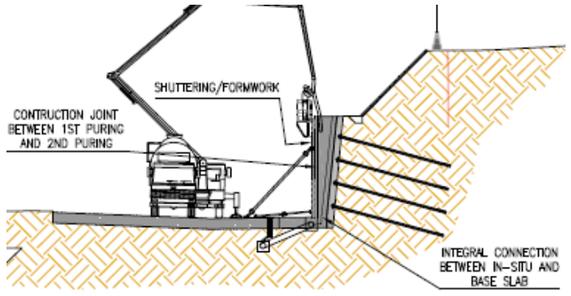


6. Retaining structure: final configuration

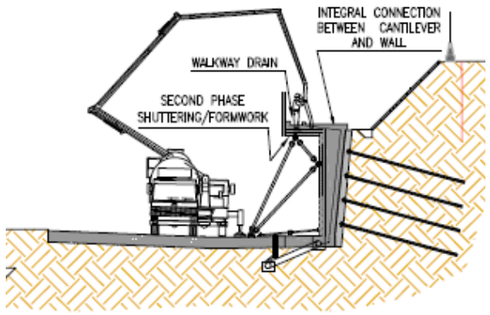
In front of the Tunnel Service Building the retaining structure includes an extended cantilever section as per **Design Vision** requirement and the final construction sequences are shown below (slightly similar to the sequence described above):



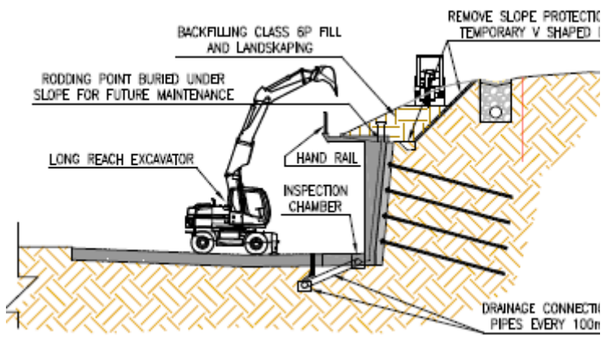
Installation of permanent drainage system and execution of concrete base slab



Cast in place wall (an integral connection is foreseen between the base slab and the wall



Cast in place cantilever roof (an integral connection is foreseen between the top of the wall and the cantilever slab)

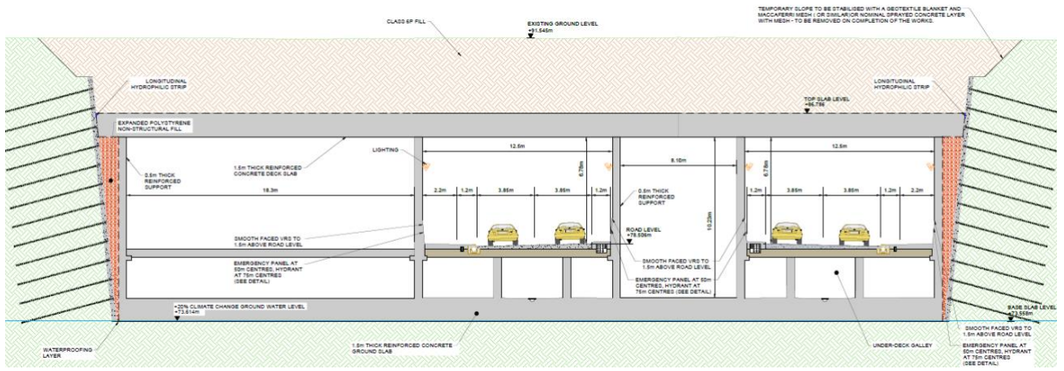


Backfilling with 6P material, landscape and final finishing

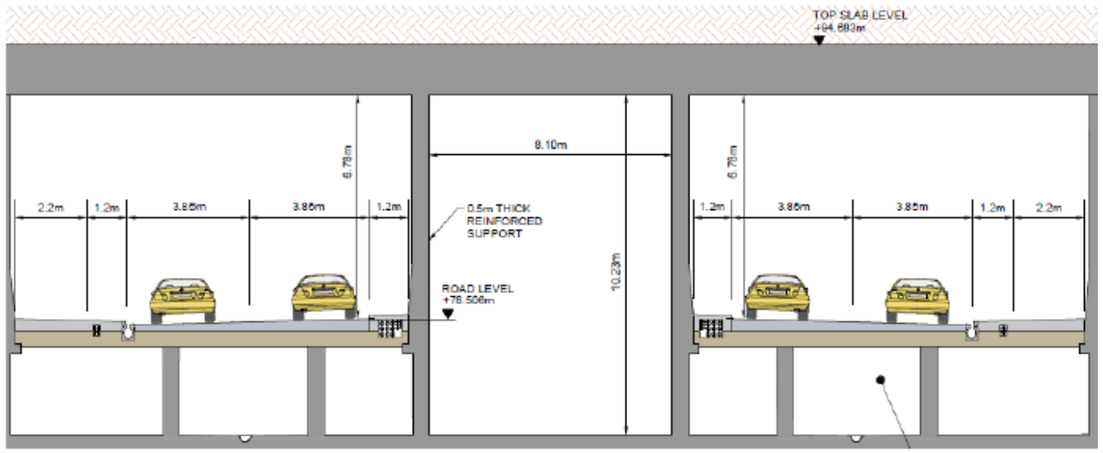
4.1.4. Deck and cover construction

The eastern cut and cover tunnel will run from the end of the retained cut at CH 10475 to the start of the bored tunnel at CH 10425 and is composed of upper, intermediate and base slabs with supporting walls. The intermediate slab supports the carriageway, beneath which is an under-deck access gallery support by the base slab. 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 detailed as moment connections to ensure the precast beams form an integral structure with the walls.

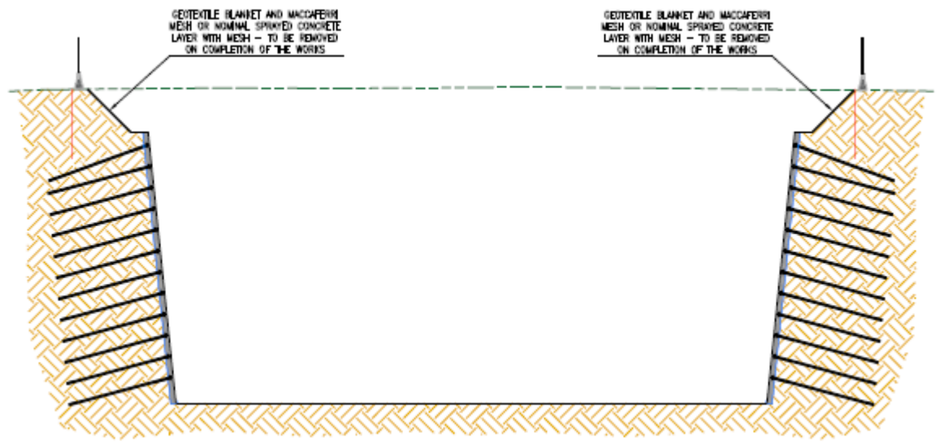
Particular attention will be paid to waterproofing the joints between adjacent beams and between the beams and the walls; it is anticipated hydrophilic strips and re-injectable tubing will be used to waterproof those joints. It is noted that the future water level (climate change +20%) is still far below these joints, however it is understood that infiltration from rainwater, etc must still be prevented from entering the structure. Proposed typical cross section through the cut and cover is shown in the pictures below. In the first picture the tunnel service building is also shown on the left part of the section.



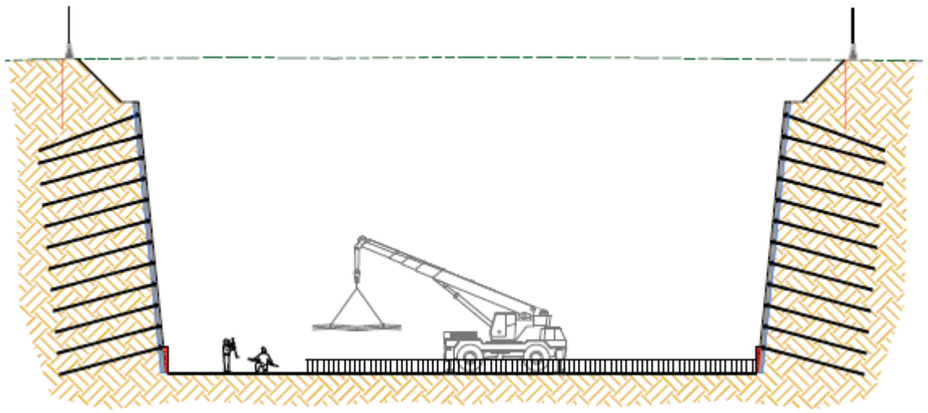
Below the typical Cross-section through cut and cover tunnel:

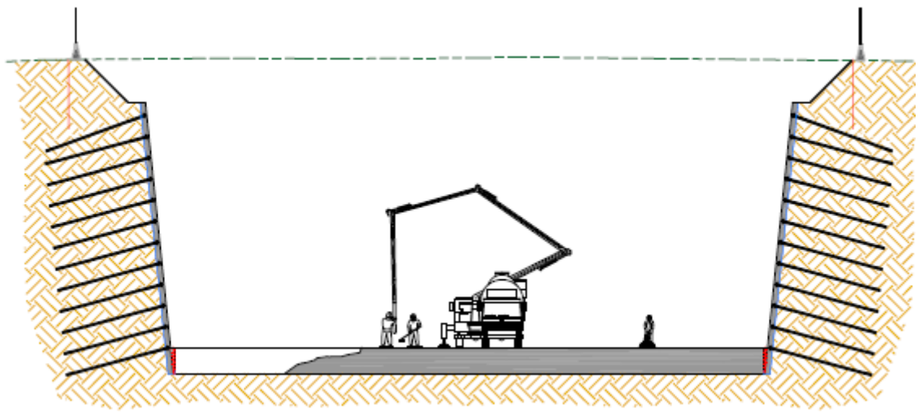


The proposed construction sequence for the cut and cover is detailed below:

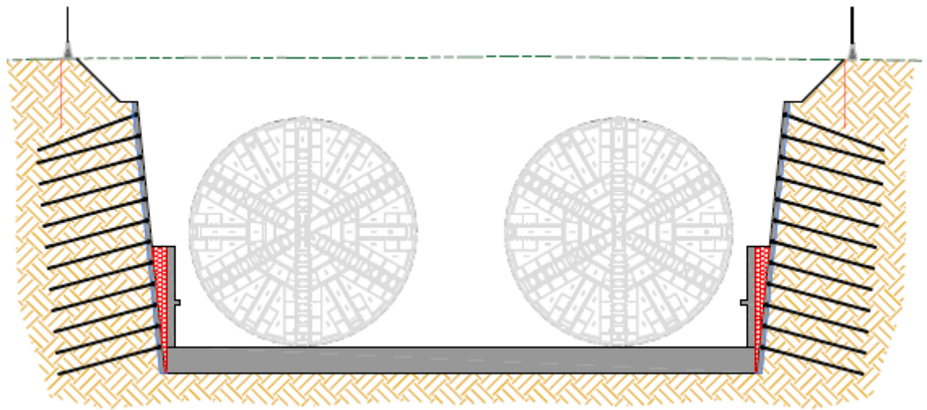


1. Execution of cut and installation of soil nailing up to invert level. The construction methodology for the excavation and permanent soil nailing will follow the procedure described in **4.1.1**., as well as slope protection, V diches for collecting runoff water.

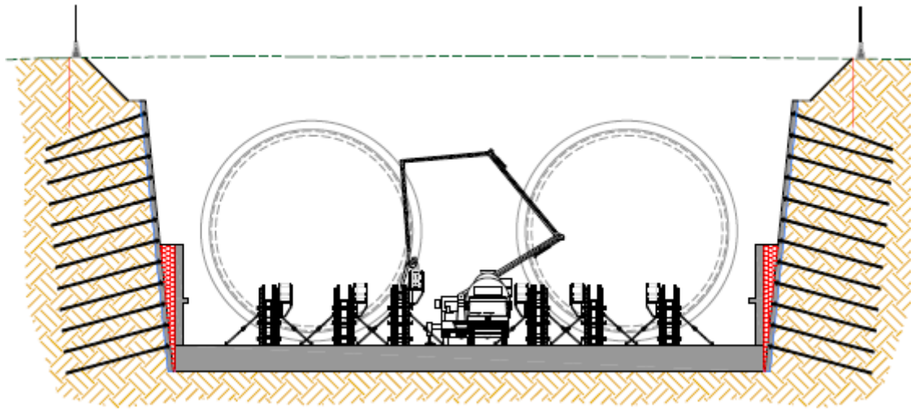


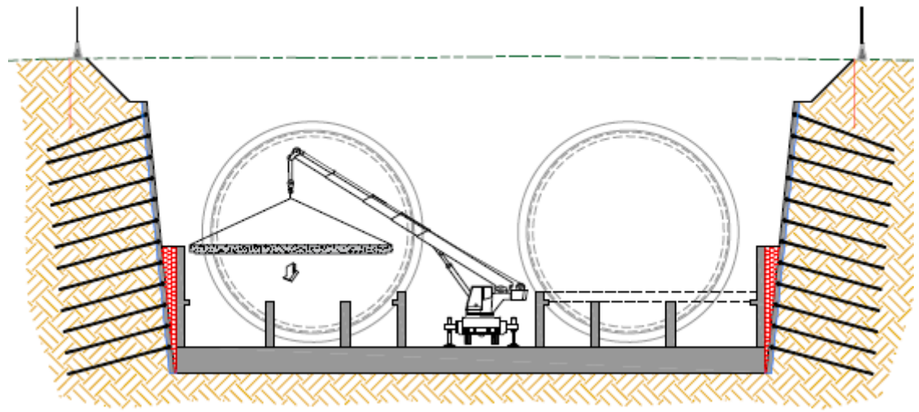


2. Execution of the invert slab including placement of cages and pouring of concrete.

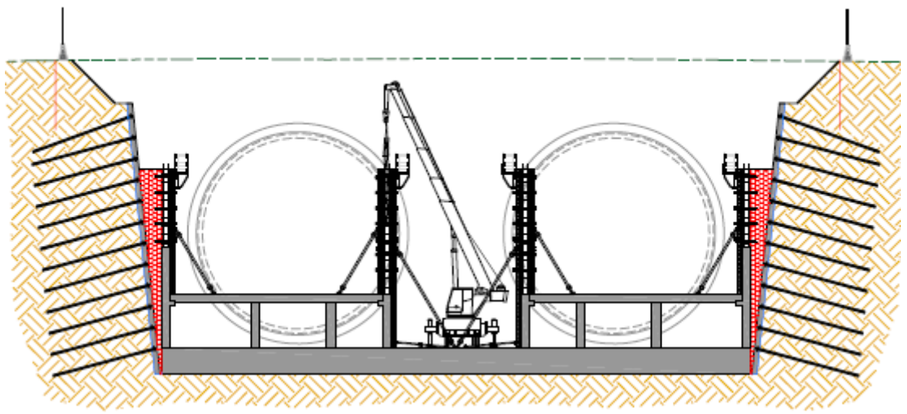


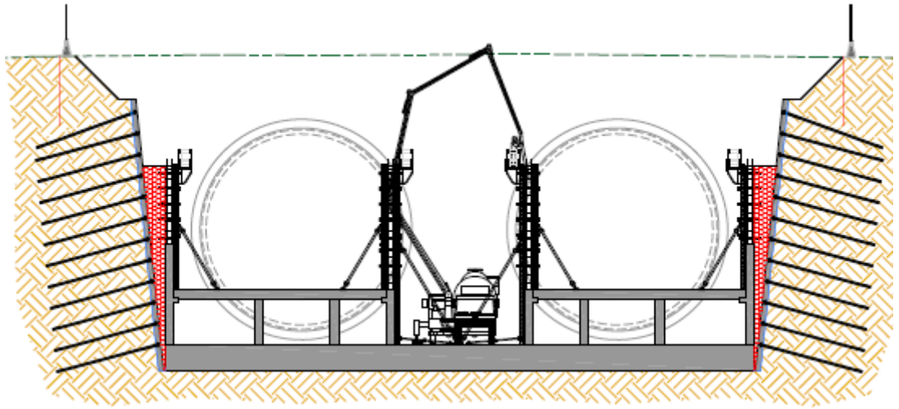
3. Construction of lateral walls sections including waterproofing membrane installation. Arrival of the machine and disassembly. For the Implementation of the temporary works and sequences for the arrival of the TBM, please refer to related **QS3B**. The space between the sprayed concrete and the outer walls will be filled with a light-weight non-structural void filling material.



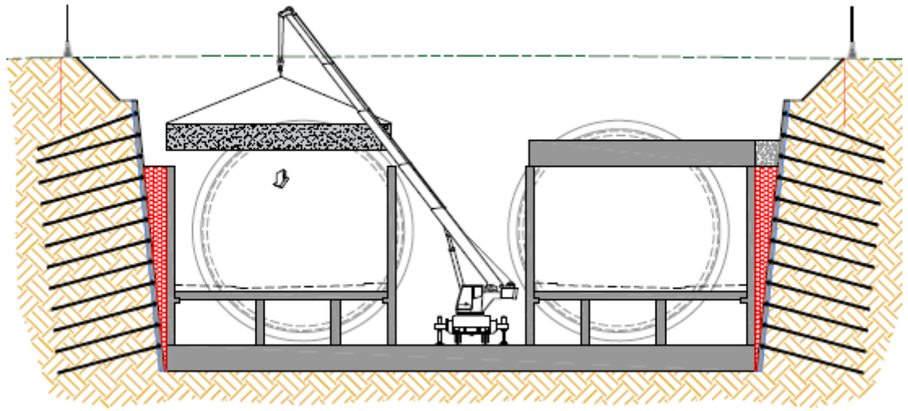


4. Construction of internal walls and intermediated slabs which can commence not earlier than the TBM has completed the bore of first tunnel.

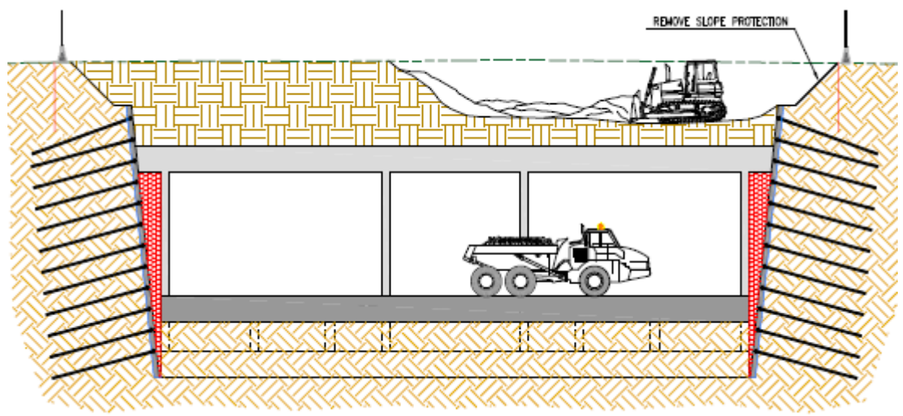




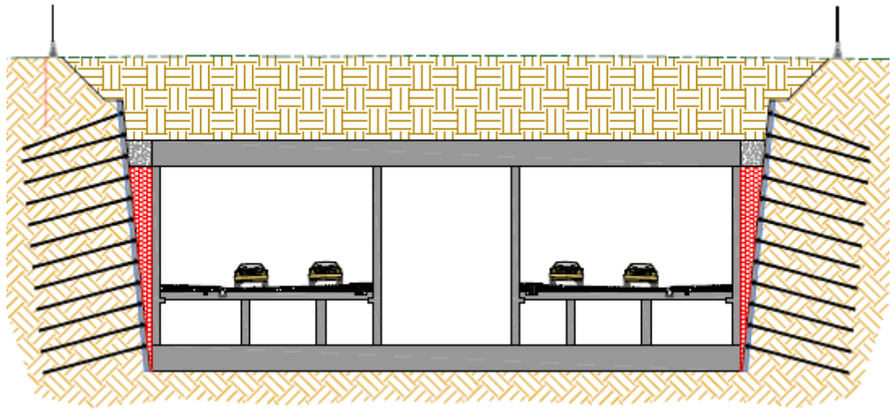
5. Construction of internal and external walls up to the top level, placing of scaffolding, steel reinforcement and pouring concrete. The space between the sprayed concrete and the outer walls will be filled with a light-weight non-structural void filling material.



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



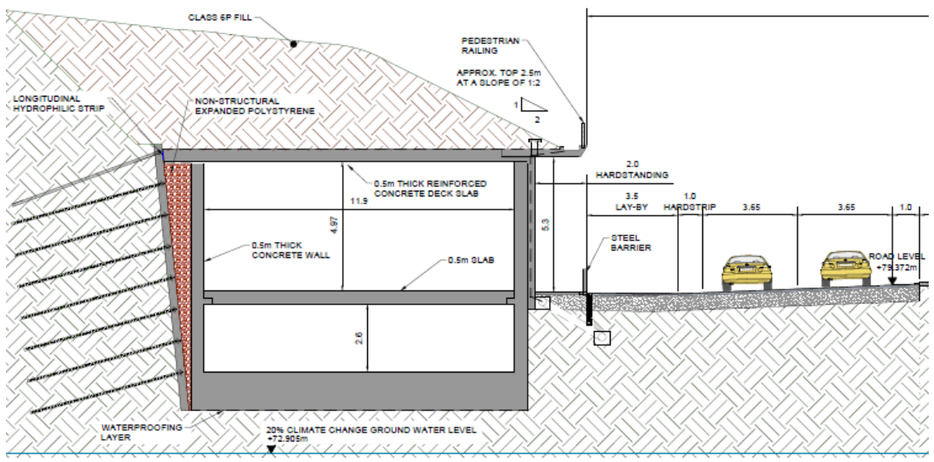
7. Backfilling with class 6P material the structure up to final design level. Backfilling material comes from stockpiles and it is hauled along jobsite and supplied by a temporary ramp built in front of C&C section which rises up to slab level from road level.



8. Finishes and electromechanical installation.

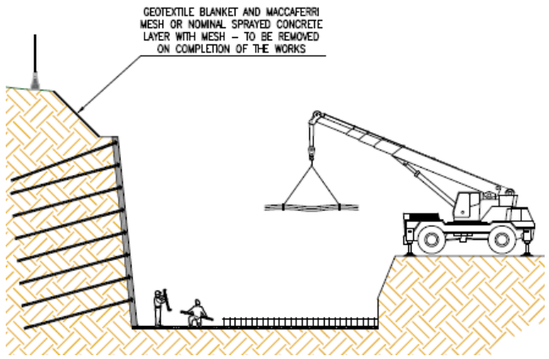
4.1.5. Construction of the tunnel services building

The eastern Tunnel Service Building (TSB) will be composed of upper, intermediate and lower reinforced concrete slabs with internal walls to separate rooms and external structural walls. The eastern TSB tapers in as it approaches the portal to reduce the overall footprint of the area whilst still providing efficient use of space. The structure will run from CH 10452 to CH 10616.The proposed typical cross at tunnel service building location is shown in the picture below:

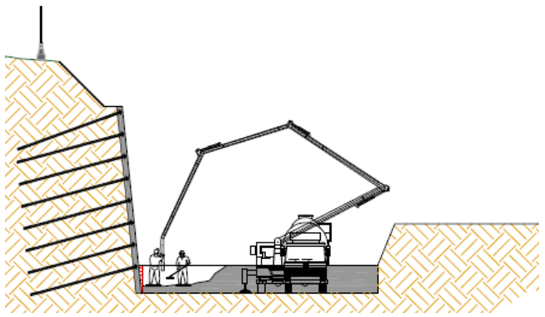


The construction of the TSB will start once the cut and the permanent soil nailing are in place (refer to section **4.1.1**). The construction sequence is detailed below:

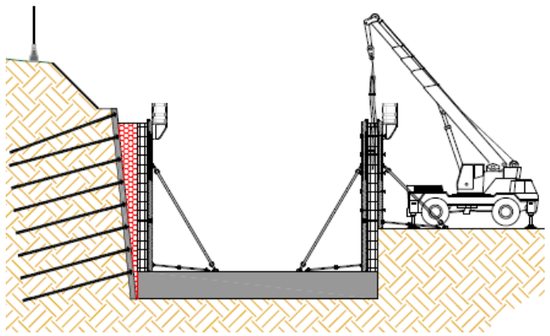
1) Execution of foundation slab. Reinforcement placement.



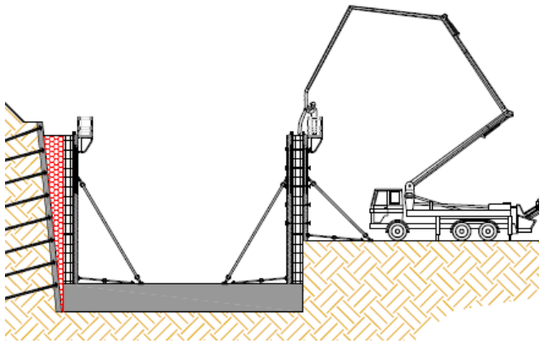
2) Execution of foundation slab. Concrete pouring.



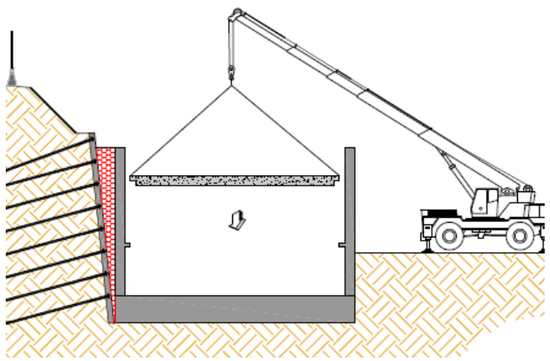
3) Construction of elevated walls. Formwork and reinforcement. The space between the sprayed concrete and the outer walls will be filled with a light-weight non-structural void filling material.



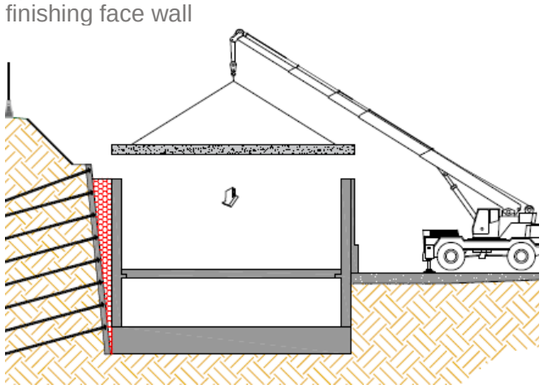
4) Construction of elevated walls. Concrete pouring.



5) Installation of intermediate precast slabs.

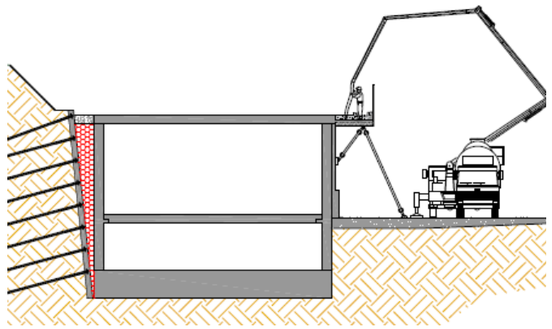


6) Installation of precast final slab and cast in situ finishing face wall

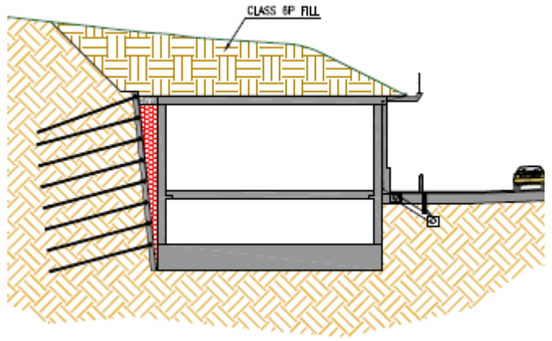


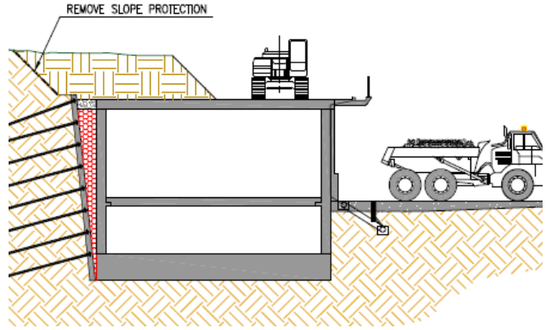
7) Execution cantilever edge section and integral joint between the precast slab and vertical wall.

8) Backfilling with class 6P material up to final design level, soil supplied from roadway.



9) Finishing works (handrail, landscape and permanent fence).





Tunnel Service Building – Final Configuration

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

4.2.1. Temporary works for the ground water management

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, discharge rate and scour assessments in accordance with the provisions of the DCO.

Adequate management of drainage will be provided during the construction stages. In cutting sections, it is anticipated we will install a v-ditch (or where insufficient space is available, a permanent crest drain) along the crest of the cutting to intercept runoff water preventing overtopping. The V shaped will be lined with lean concrete and demolished once the backfilling works begin.

Along the haul road, the run-off water will be directed to the sides, collected by temporary foot drain ditch along the route and discharged to dedicated pits. A system will pump out the collected water up to defined discharge point.

Our purpose of groundwater control in this eastern 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, minimising the risk of landslides.

No dewatering system is foreseen for the excavation of the eastern tunnel approach due to the fact that the maximum level achieved for seasonal reason is under the deeper level of the C&C's bottom slab.

The maximum anticipated groundwater level in this location, (using 20% allowance for climate change) is 73.9m, which is substantially below the level of the structures, so water management is primarily concerned with managing run off water.

During the construction phases of the Eastern Tunnel approach, our approach includes collecting the rainfall water and water runoff in a temporary pit and pump out the water from the area to the site of the permanent linear pond closed to Countess, using a dedicated temporary sedimentation pond.

Badger will follow the requirements of MW-WAT 3 of the OEMP and the need to limit water flows from site to the existing rate unless otherwise agreed with the Environment Agency and the requirements for treatment prior to discharge.

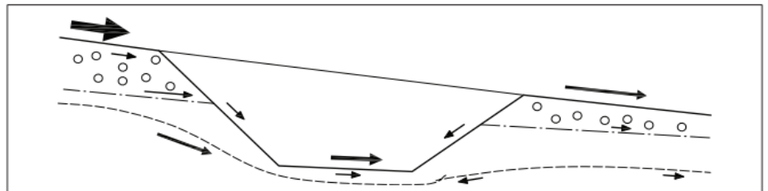
We will ensure that site drainage meets the effluent and flood risk standards required, in accordance with the relevant permit. We will provide and maintain the sedimentation pond, separators and other measures as may be required to meet those standards.

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 maximising the suitability of excavated material and minimising the potential for deterioration of materials or instability of the works.

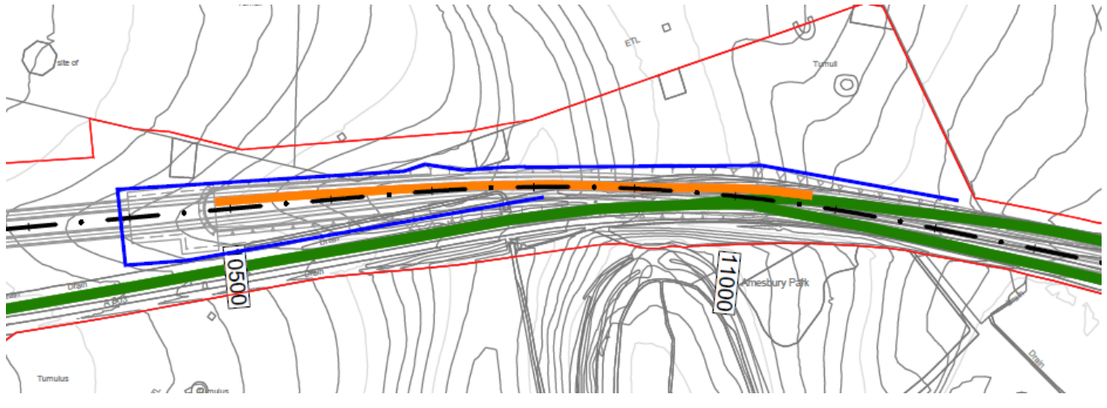
4.2.2. The locations and outline details of hoarding and temporary fencing

As stated in **QS13A**, temporary fencing and hoardings will be installed in the Eastern Tunnel Approach Working area which 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.

Temporary fencing and hoardings will be installed on the boundaries of the site of the area affecting by this eastern 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 to the site works, and we will protect the users of the existing A303 and A360 from any possible risk coming from the worksite.

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



All temporary fences and hoardings within the Eastern Tunnel Approach area will be as per standard requirement and in compliance with the OEMP and its purpose of use will be:

- Safety and security
- Livestock control
- Protection of heritage and environmental features.

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.) These will include the procedures and management strategies for dealing 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.

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 the OEMP and HMP.

The method statement 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 or any other particular 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, identifying archaeological features potentially affected or disturbed by the works all along the corridor.

All the risk associated to these works will be identified and any mitigation measures will be implemented during the works to avoid any damage (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 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. We 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 close coordination with the Archaeological Clerk of Works (ACoW) (The Authority). ACow will monitor BADGER 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 receive Induction Training (including environmental) and Toolbox Talks to inform them 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.

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 Highways England´s goals and objectives for the project.

A key Risk Matrix related to the construction of the Eastern Tunnel approach and the related mitigations are summarised in the table:

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 adjustment. ▪ Construction strategies to reduce settlement ▪ Install settlement monitor system and alarms
Failures of retaining/shoring systems	▪ Geotechnical campaign to have a proper design ▪ Robust design systems ▪ Inspections during execution ▪ Monitoring systems
Work at height	▪ Planning of the activities ▪ Design of the working area and provision of 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, signalled 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 particular tasks in terms of preservation of archaeological remains. Our trained people will ensure that all site personnel are aware of the importance of respecting these measures before starting any type of activity and earthworks.
Occupation of the DAMS areas	▪ Segregation of the site works will be guarantee from the beginning once we get access to the site and during the preliminary activities, including installation of the fences in the right position in compliance with DAMS Figure 12.
Noise and Vibration impact to the WHS receptors	▪ Noise and vibration management plan and noise and vibration monitoring reporting systems will be ready 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.