



Havant Thicket Reservoir – Main Pipeline Works

Construction Method Statement – Main Pipeline

HTR-WAB-PI-ZZ-MS-W-0001

22nd May 2024

Rev: S4-P03

Suitable for construction approval

Ward & Burke Construction Limited,
Unit N, Bourne End Business Park,
Cores End Road, Bourne End,
Bucks SL8 5AS

PH: +44 1494 775954

Email: info@wardandburke.com

Issue and Revision Record

Havant Thicket Reservoir – Main Pipeline Works

Construction Method Statement – Main Pipeline

Document Title: Construction Method Statement – Main Pipeline

Project Number: C725

Client Project Number: HTR

Client: Portsmouth Water Limited

Project Location: Meyrick Road, Havant, PO9 1NR

Rev	Date	Originator	Checker	Approver	Description
P01	23/01/2024	AON	BC	JD	Internal review and comment
P02	01/05/2024	AON	BC	JD	Updated in line with DG comments
P03	22/05/2024	AON	BC	JD	Updated in line with DG comments

Document Status: S4

Document Reference: HTR-WAB-PI-ZZ-MS-W-0001

Information Class: Standard

This document is issued for the party which commissioned it and for specific purposes connected with the above-captioned project only. It should not be relied upon by any other party or used for any other purpose.

Ward and Burke Construction Limited accept no responsibility for the consequences of this document being relied upon by any other party, or being used for any other purpose, or containing any error or omission which is due to an error or omission in data supplied to us by other parties.

This document contains confidential information and proprietary intellectual property. It should not be shown to other parties without consent from us and from the party which commissioned it.

Contents

Issue and Revision Record	2
1 Abbreviations and Definitions	5
2 Introduction	6
2.1 Works Background	6
3 Site Details	7
4 Access Arrangements.....	8
5 Programme and Sequence of Works	9
6 Responsible Person in Charge.....	10
7 Sections P1 and P3 – P8.....	11
7.1 Working area setup	11
7.2 Shaft Setup	11
7.3 Cutting Shoe and Internal Shutter	13
7.4 Steel Fixing and External Shutter	14
7.5 Pouring of Concrete	14
7.6 Striking External Shutter	15
7.7 Striking Internal Shutter	15
7.8 Excavation Works	15
7.9 Shaft Access and Egress	16
7.10 Reinforced Concrete Microtunnelling Pipe	16
7.11 Microtunnelling - Overview	16
7.12 Site Preparation	18
7.13 Delivery of Microtunnelling Equipment	19
7.14 Installation of Separation	19
7.15 Launch Seal and Jacking Frame Installation	19
7.16 Launch Seal and Jacking Frame Installation	20
7.17 Launch of TBM and Tunnelling Operations	20
7.18 Maintaining Face Pressure	20
8 Opencut Section P2 and P9.....	23
8.1 Pipe Installation.....	23
9 Culvert Upgrades	25
9.1 Pipe Ramming	25
10 Appendix	27

1 Abbreviations and Definitions

Client	=	Portsmouth Water Limited
Contractor	=	Ward and Burke Construction Limited
COSHH	=	Control of Substances Hazardous to Health Regulations
CPCS	=	Construction Plant Competence Scheme
CSCS	=	Construction Skills Certification Scheme
EA	=	Environment Agency
ED	=	Emergency Discharge
EUSR	=	Energy and Utility Skills Register
HTR MPW	=	Havant Thicket Reservoir Main Pipeline Works
HTR MRW	=	Havant Thicket Reservoir Main Reservoir Works
PPE	=	Personal Protective Equipment
PUWER	=	Provision and Use of Work Equipment Regulations
PW	=	Portsmouth Water Limited
RAMS	=	Risk Assessment / Method Statement
SDS	=	Safety Data Sheet
SHEQ	=	Safety, Health, Environment and Quality
SMSTS	=	Site Management Safety Training Scheme
SSSTS	=	Site Supervision Safety Training Scheme
SWMP	=	Site Waste Management Plan
SWS	=	Southern Water Services
TBM	=	Tunnel Boring Machine
WBCL	=	Ward and Burke Construction Limited

2 Introduction

The objective of the Havant Thicket Reservoir Project is to provide a new resource to supply drinking water in the water-stressed Southeast of England, while maximising the community and environmental benefits of a new raw water reservoir.

Ward and Burke Construction Limited (WBCL) have been appointed by Portsmouth Water Limited (PW) to design, construct, and commission a new pipeline connecting Bedhampton Pumping Station to Havant Thicket Reservoir, including an emergency discharge structure at the Hermitage Stream, culvert upgrades and an Under Track Crossing.

This Construction Method Statement forms part of a planning application for a revised pipeline scheme between the Havant Thicket Reservoir and Bedhampton springs and pumping station. Following outline approval of a pipeline scheme in October 2021 (Havant Borough Council ref. APP/20/00991), a new pipeline route and design have been identified, which needs a new planning approval. There has also been a change in approach to deliver additional resilience to the water network, with an additional pipe now being proposed. The new water pipes would be installed inside two adjacent tunnels which would be constructed concurrently to ensure maximum efficiency is achieved, with construction programme durations, and subsequent disruption to local residents minimised.

2.1 Works Background

Portsmouth Water have outlined seven strategic drivers for this project to ensure continued focus on meeting the Project's objectives.

These project drivers are:

- **Quality:** Quality in procurement, design, and delivery to deliver an exemplar project to serve Customers in the short, medium, and long term,
- **Timeliness:** In service and operating by 2029 to support a major bulk transfer to Southern Water,
- **Innovation:** Develop best practice in the largest new reservoir project in the southeast for decades. Capture learning from companies working in partnership to deliver better value for Customers,
- **Flexibility:** Create a project that offers multiple uses and enables Portsmouth Water to be a strategic water supplier for the South over the medium and long term,
- **Responsibility:** Realise and build upon our health, safety, and well-being goals,
- **Connectivity:** Positive connection for all stakeholders – Customers, the local community, regulators, staff, contractors, shareholders, commercial partners, environmental groups, and individuals with a passion for the environment, and
- **Environment:** A positive contribution to local and internationally important habitats. Direct support for Government's objective to reduce the damaging abstraction of water from rivers.

3 Site Details

This document will outline works that will be carried out at the below site locations:

- Shaft W1 – Havant, PO9 1NR
- Shaft W2 – Havant, PO9 3DR
- Shaft W3 – Hooks Farm Way, Havant, PO9 3DR
- Shaft W4 – Havant, PO9 3AD
- Emergency Discharge Shaft – Corhampton Crescent, Havant, PO9 4AA
- Shaft W5 – Purbrook Way, Havant, PO9 5AY
- Shaft W6 – Dunsbury Way, Havant, PO9 5BB
- Shaft W7 – High Lawn Way, Havant, PO9 5BS
- Shaft W8 – Middle Park Way, Havant, PO9 5DT

This document will, also, outline the works carried out to construct the tunnelled pipeline section listed below:

- Sections P1 and P3-P8
- Dunsbury Way, Purbrook Way and Middle Park Way culverts
- Shafts W2-W8 and Emergency Discharge shaft

This document will also take into consideration the open cut method at locations W1, P2 and P9.

These works are part of the Havant Thicket Reservoir, Main Pipeline Works, as shown in Appendix 1.

4 Access Arrangements

At each shaft location, access will be available as per the Construction Traffic Management Plan. The What3Words location to quote for each site entrance is as follows:

Shaft W1 - **///shirt.game.stars**

Shaft W2 - **///shaped.fried.dull**

Shaft W3 - **///shaped.fried.dull**

Shaft W4 - **///twigs.mute.view**

ED Shaft - **///remedy.splice.forget**

Shaft W5 - **///wings.they.point**

Shaft W6 - **///many.former.wide**

Shaft W7 - **///shelf.latter.twins**

Shaft W8 - **///holly.lanes.loudly**

Middle Park Way Culvert - **///odds.unwanted.wonderfully**

Purbrook Way Culvert - **///noises.shops.record**

Dunsbury Way Culvert - **///learns.broker.spill**

5 Programme and Sequence of Works

Works are planned to begin in March 2025, and will take approximately 3 years to construct. At each shaft location, the shaft will be constructed, microtunnelling carried out, dual pipeline installed, and commissioning completed.

Upon completion of these works, each shaft will be fitted out, covered/backfilled, and landscaping will be complete.

Please refer to the Phasing Plan submitted with planning submission for a breakdown of works sequence and timeline.

6 Responsible Person in Charge

Table 1: List of Responsible Person in Charge

Name	Organisation	Job Title
Joe Dobey	Ward & Burke	Project Director
Brien Curran	Ward & Burke	Project Manager
Bryn Phillips	Ward & Burke	Design Manager
Jack Templeton	Ward & Burke	Site Engineer
Aaron O'Neill	Ward & Burke	Ast. Project Manager
Martin Walsh	Ward & Burke	Site Supervisor / Foreman
Chris Bolton	Ward & Burke	SHEQ Advisor

The **Contracts Manager** shall be responsible for ensuring that all the necessary resources are made available to execute the work to programme, specification, and safety.

The **Project Manager** shall be responsible for planning the works and ensuring the resources are correctly allocated on site.

The **Site Agent** shall ensure that the works proceed according to this approved Method Statement without any deviation. Any deviation shall be recorded and re-assessed.

The **Site Supervisor / Foreman** will deliver a daily briefing to all personnel prior to works commencing. This will be delivered in the site canteen before going out to work area.

7 Sections P1 and P3 – P8

The following sections outline the sequence of works for sections P1 and P2 – P8. This methodology describes the compound set up, excavation works, installation of cutting shoe, concrete pours to form caisson, sinking of caisson, concrete works, and the proposed trenchless crossing of 1500mm ID & 1650mm internal diameter tunnel carrier pipe via microtunnelling. The microtunnel boring machine (MTBM) will be launched from various launch shafts into various reception shafts. Table 1, below, outlines the durations of the works associated with the microtunnelling sections.

Pipeline Section	Duration	Construction Period
P1	41 days	15 th Sept – 10 th Dec 2025
P3	27 days	11 th Jun – 17 th Jul 2025
P4	27 days	5 th Aug – 11 th Sept 2025
P5	27 days	3 rd Feb – 11 th Mar 2026
P6	36 days	30 th Mar – 21 st May 2026
P7	31 days	24 th Jun – 5 th Aug 2026
P8	37 days	25 th Aug – 15 th Oct 2026

Table 1 – Microtunnelling Sections Construction Durations

7.1 Working area setup

Compound Set Up

1. The location for the welfare facility and the general site compound will be marked out as per site location.
2. Heras Fence Panels, hoarding, equipment, and plant (as required) i.e. Excavators, dumper, diesel bowser etc. will arrive to site on an articulated truck.
3. All delivery drivers will be informed of the access route and entrance procedures to the site.
4. Heras panels/hoarding will be erected along the boundary of the agreed area. This area will have space for the site welfare including changing rooms, toilet facilities, site offices, canteen, skip laydown area & refuelling area.
5. Pedestrian barriers will also be erected to form pedestrian access routes between welfare facility & work zones if required. All proposed layouts and plans will be discussed between Ward & Burke and site management. These routes will be agreed once the site welfare has been installed.

HOLD POINT - All mechanical lifts to be carried out during these enabling works will be done so in accordance with the non-crane lift plans for the excavator, crane and the HIABs.

6. Suitable set of chains/slugs will be used which all will have in date certification.
7. All plant/machinery brought to site will be inspected before use and pre-authorized user forms/check sheets completed. All plant/equipment will also have in date certification and/or inspection checklists.
8. Any changes to site access or layout will be documented and confirmed between both parties.

Stoning up of the area

1. A permit to break ground is to be in place prior to any excavations being carried out. This will be obtained with the aid of service drawings and eCAT4 & Genny (with trained operator).
2. An excavator will strip off the top layer of soil in the compound area. All excavated topsoil is to be stockpiled locally for later use.

3. A single layer of non-woven geotextile membrane is to then be laid down at formation level within the excavated area. A minimum of 300mm overlap is to be maintained throughout.
4. Once the membrane is fully laid out, a layer of primary type 1 is to be laid and compacted using a ride on roller. Ducting is to be installed to allow for future installation of services including water, broadband and power supply.
5. Once the welfare cabins have been installed, the remainder of the stoned-up areas will be fully fenced off via Heras fencing. This same methodology is to be followed for the stoning up of car park area and all other areas required.
6. Crowd barriers are to be utilised to create walkways between the compound and the carpark area.

Welfare Cabin Foundations

1. Once the welfare area has been stoned up and service ducting has been installed, foundations for the welfare cabins are to be installed.
2. The level of the ground beneath the foundations is to be checked prior to installation of formwork to ensure correct level is achieved and consistent throughout. Once the level is deemed adequate by the site engineer, the outline of the footings can then be marked out.
3. Once the footings have been marked out and checked, the roadforms can then be installed to the external perimeter. Each road form is fixed to the compacted type 1 beneath via 3 no. 400mm long pins once plumb and on line. The top of shutter level is also to be checked throughout installation.
4. Following installation of external roadforms, the internal forms are then to be erected. Any voids where the road forms cannot be installed are to be made up with plywood & 4x2 timber.
5. Once the formwork has been fully erected and checked for line, level & plumbness, sheets of A393 mesh are to be cut to size with a petrol cut off saw and placed within the forms whilst maintaining the specified 40mm cover to all faces. A hot works permit is to be issued prior to cutting of any mesh.
6. Prior to pouring the foundations, a pre-pour inspection is to be carried out by the site engineer. Once deemed acceptable the pre-pour inspection is to be signed off and the pour can take place.
7. Mould oil is to be sprayed onto the road forms prior to concrete placement to act as a release agent when dismantling the shutter at a later date. The concrete delivery wagon is to be reversed as close as possible to the area being poured & placed within the shutters via 8t excavator & bucket.
8. The concrete is to be poured in even layers and compacted using a 2" electric concrete poker throughout. Task specific PPE is to be worn by all concrete finishers which includes wellington boots, disposable concrete coveralls, full seal goggles and PVC coated gloves.

Footpaths & Plinths

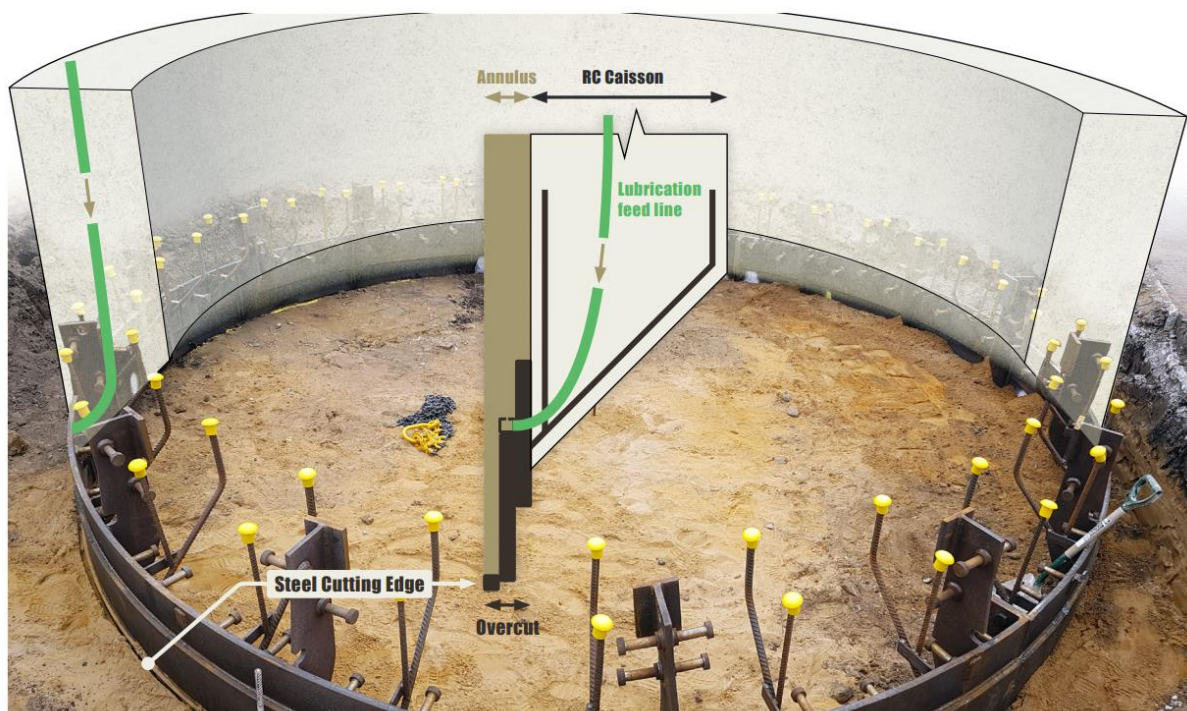
1. Following the delivery & installation of the welfare cabins, footpaths & plinths for staircases are to be cast around the perimeter of the cabins.
2. The formwork for these items is to be made up from 4x2 timber & plywood. A single layer of A393 mesh is to be installed within the formwork.
3. The above steps 7, 8 & 9 are to be followed in regard to concrete placement.

7.2 Shaft Setup

1. A permit to dig is to be issued by the Site Engineer

2. Cat & Genny scans will be carried out by trained and competent Ward and Burke operatives.
3. An initial excavation will be excavated around the centre of the shaft.
4. The excavation will be stepped and battered. Access will be via ramp/steps formed in the bank by the excavator.
5. A 50mm thick blinding will be poured providing a level surface for the cutting shoe to be installed.
6. The cutting shoe will be delivered to site on an articulated trailer.
7. Cutting shoe will be lifted into position by crane or excavator using SWL chains. The shoe will be bolted together using bolts and spanners.
8. The shoe will be supported using timbers or props until sections are bolted together and it is stable, in line with issued Temporary Works drawing.
9. The level of the cutting shoe will also be monitored regularly by the engineer to ensure it is level.

Lubrication in the form of a steel hose will be built into the cutting shoe and additional hoses will be connected to the built-in hose, at the bottom of the cutting shoe. This will assist with the sinking of the shaft once this stage has been reached, if needed. 5 hoses will be fixed to the cutting shoe and will run vertically up the shaft to the bentonite pumping machine, as shown in *Fig. 2*. Lubrication will then be pumped into the over-cut annulus to reduce skin friction. Interceptor tray to be used to protect from spillages. Bentonite and/or TK60 lubricant will be used (liquid and produces no dust) or similar. Pumped volumes will be monitored and managed to match the volume of the overcut created by the cutting shoe and pressure maintained such as to avoid loss of bentonite to the ground.



Copyright © 2020 Ward & Burke. All rights reserved.

WARD & BURKE

NOT FOR CONSTRUCTION - Visuals are indicative

Fig. 2 Cutting shoe detail

7.3 Cutting Shoe and Internal Shutter

1. The internal and external shutters will be delivered to the site on the flatbed trailer and off-loaded using previous methods and in accordance with the non-crane lift plan.

2. Crane or excavator to lift/lower the shutter sections as required using suitable SWL chains, guided by a slinger signaller.
3. Retarder is to be sprayed onto the Pour 1 shutter. This will be jet washed to remove the laitance and expose the aggregate to create a bond when the plug is poured.
4. Wavy Tail Lifting Anchors will be fixed through holes in the shutter to allow Peri Brackets to be fixed once the shutter is struck.
5. When the internal shutter and the cutting shoe are in place, Type 1 stone or sand will be placed underneath the sloping angle of the cutting shoe by crane or excavator. Polythene will be placed on top of the stone to prevent a bond between the concrete and the stone, as well as making excavation easier at a later stage.
6. This material will be excavated during the sinking of the shaft. The concrete skip will be used to transfer the material into this area or if access is not restricted the 4t excavator will carry out this work.
7. At this stage, the cutting shoe and internal shutter are now in place.

7.4 Steel Fixing and External Shutter

1. Steel will be lowered in small manageable bundles – verts to be fixed first to starter bars on the cutting shoe.
2. Steel to be lifted/lowered using crane or excavator with suitable SWL chains/slings. Slinger signaller to control the operation, with appropriate lift plan in place. Adequate access/egress to be established prior to entering shaft, with man basket and ladder access available.
3. All hot works permits will again be issued for these works. Any mobile plant i.e., cut off saws will be placed on plant nappies within the working area.
4. All steel cut-offs will be placed in a steel skip which will be removed off site for recycling.
5. Once the first section is fixed, the oiled external shutter will be lowered into place with the excavator/crane and chains of suitable SWL and secured into position.
6. The shutter will be assembled as per the shutter drawing/TW design.
7. Steel will continue to be fixed in sections as to allow to be closed behind as each section of reinforcement is completed.
8. The platform erected on the external shutter will provide access for pouring concrete.
9. Once all is in place and checked, permit to load shutter will be issued.

7.5 Pouring of Concrete

1. On closing of the external shutter, the complete shutter will be rechecked for plumb and verticality. For the first pour, it may be necessary to employ Acro props to adjust verticality.
2. The concrete quantity will be measured and confirmed for delivery to site. The concrete will be delivered in a concrete wagon. The wagon will enter the site access gates and will be directed to the point of discharge.
3. The concrete will be poured using a skip with a tremie pipe and will be lifted to the point of discharge by the excavator/crane or the concrete will be pumped with a mobile pump.
4. A high frequency electric poker will then be used to vibrate the concrete. This poker will be powered by a 110v supply from the welfare setup.
5. On completion of the concrete pour, the concrete wagon is to proceed to the concrete washout skip to wash chute etc. prior to departing site. Banksman will be in place for site movements.
6. Pressure washer uses minimal water at high pressure. Any run-off is to be directed to a sump area and pumped to a concrete washout bund or skip.
7. Concrete Testing: Cubes will be taken on site by the site Engineer and sent away to be tested, with the results forming part of the quality documentation. Cubes will be tested for 7 and 28 day compressive strength.

7.6 Striking External Shutter

1. The shutter will be struck by unbolting the sections and lifting them off the drilled in brackets, and then cleaned using the pressure washer, and removed using a crane or excavator.
2. The shutter will be stacked vertically and propped using a fixed Acrow prop.
3. The shutter will be cleaned and oiled again prior to reinstallation.

7.7 Striking Internal Shutter

1. Two Ward and Burke operatives will be lowered into the shaft using the man basket.
2. The internal shutter pieces will be struck from the inside.
3. Man-basket is removed from shaft.
4. Internal Shutter is removed using crane and placed onto Ground Level.
5. The shutter will then be cleaned using a pressure washer to remove the laitance of the shutter.
6. Steel fixing will begin from ground level. Aluminium podium hop-ups will be used as more height is required to fix steel.
7. Internal Shutter is lifted onto Peri Brackets.
8. When all pours are complete the internal shutter will need to be completely struck from the caisson, the shutter should then be placed in a lay down area and power washed, ready to leave site via flatbed trailer.

7.8 Excavation Works

1. First section of excavated works is as detailed above. The initial sinking process can be done with a large excavator digging out from the external of the shaft, alternatively if dry the 4t excavator can be lifted into the shaft using a crane which will dig and load the muck skip.
2. An excavator with a clamshell bucket can also be used to continue excavation works inside the launch shaft.
3. Gas monitors to be bump tested daily as per manufacturers recommendations.
4. When diesel plant is operating in the shaft forced air ventilation will be utilised.
5. An operative will be present in the basket of a boom lift to oversee the workings inside the shaft. This operative is known as a "Top Man," and it is their job to record the confined space and bank the crane.
6. If a mini excavator inside the shaft is used for excavation, a muck skip will be lowered into the shaft by a crane on the outside of the shaft, for the mini excavator to fill. The skip will be guided by the "Top Man" viewing from the top of the shaft. This excavated material will be stored in a laydown area until taken away by the waste contractor. All lifts of material/plant will be done with an excavator in accordance with the non-crane lift plan.
7. If water is encountered in the shaft, a sump will be dug in the bottom of the shaft. Water will then be pumped from here out of the shaft. A permit to pump must be in place prior to any pumping of water taking place. Should the water be unmanageable the shaft can be sunk underwater. The water from the pumps will be sent through a Siltbuster to remove any silt within the water through a settlement process, and then pumped into the nearest watercourse or sewer under consent from the relevant source.
8. Referring to emergency and access plans, the primary means of access/egress will be the man-basket for the operative to enter the shaft during excavation. Ladders or davit arm may also be available as alternative access/egress in line with confined space procedure.
9. When the shaft has sank to a level where the rebar can be tied, and it is still sinking to desired level steel fixing may commence. An exclusion zone must be set up in the slew radius of the muck skip to keep operatives safe.
10. If wet material is encountered, it will be removed and stored in a stockpile area to dry. A bunded area will be created using concrete kelly blocks and polythene to ensure that any water that is soaked from the material is correctly stored.

7.9 Shaft Access and Egress

1. Access will be via the man-basket lifted into the shaft by the crane, this method may be used until the shaft has reached formation, Davit arm and winch may be used as a secondary means of escape when sinking.
2. A shaft ladder will also be installed when the shaft has reached formation level, with access via gated access platform and steel ladder bolted to the shaft wall.
3. Maximum length of ladder is not to exceed 6m without a landing platform.
4. Any issues with shaft access/egress must be reported to the site management.

7.10 Reinforced Concrete Microtunnelling Pipe

Ward & Burke will use reinforced concrete microtunnelling jacking pipe.

To ensure uniform distribution of jacking forces across the pipe joints and to avert damage to the ends of the concrete pipes, each pipe will be fitted with a packer made of 15mm thick medium density fibreboard (MDF). These packers come in equal sized arcs and are adhered to the microtunnelling pipe using clear silicon.

Ward & Burke propose to install lubrication ports at every third pipe. Using a grout port diameter of 37.5mm is standard practice for Ward & Burke for all pipe sizes and ground conditions. The adequacy of this port diameter has been confirmed by the successful completion of long curved tunnels with both horizontal and vertical curves with low jacking forces.

7.11 Microtunnelling - Overview

The tunnelling equipment essentially comprises of the tunnel boring machine (TBM), the control container, the jacking frame, the separation and water circuit equipment, and the various ancillary equipment such as hydraulics and bentonite lubrication system.

The AVN TBM has the advantage of being a closed face method of construction which significantly reduces the risk of losing the face stability. The TBM uses slurry pressure in conjunction with the jacking force to maintain tunnel face stability and prevent over-excavation. The slurry pressures will be constantly monitored during the drive by both the tunnel operator and the engineering staff to ensure that the slurry pressure is meeting the in-situ stresses acting on the face of the tunnel boring machine and therefore preventing the possibility of over-excavation or frac-out. This method also has the advantage of the operator being above ground at the launch pit. A simple schematic diagram can be seen in *Figure 1* and a description of the various tunnelling plant can be found in the following.

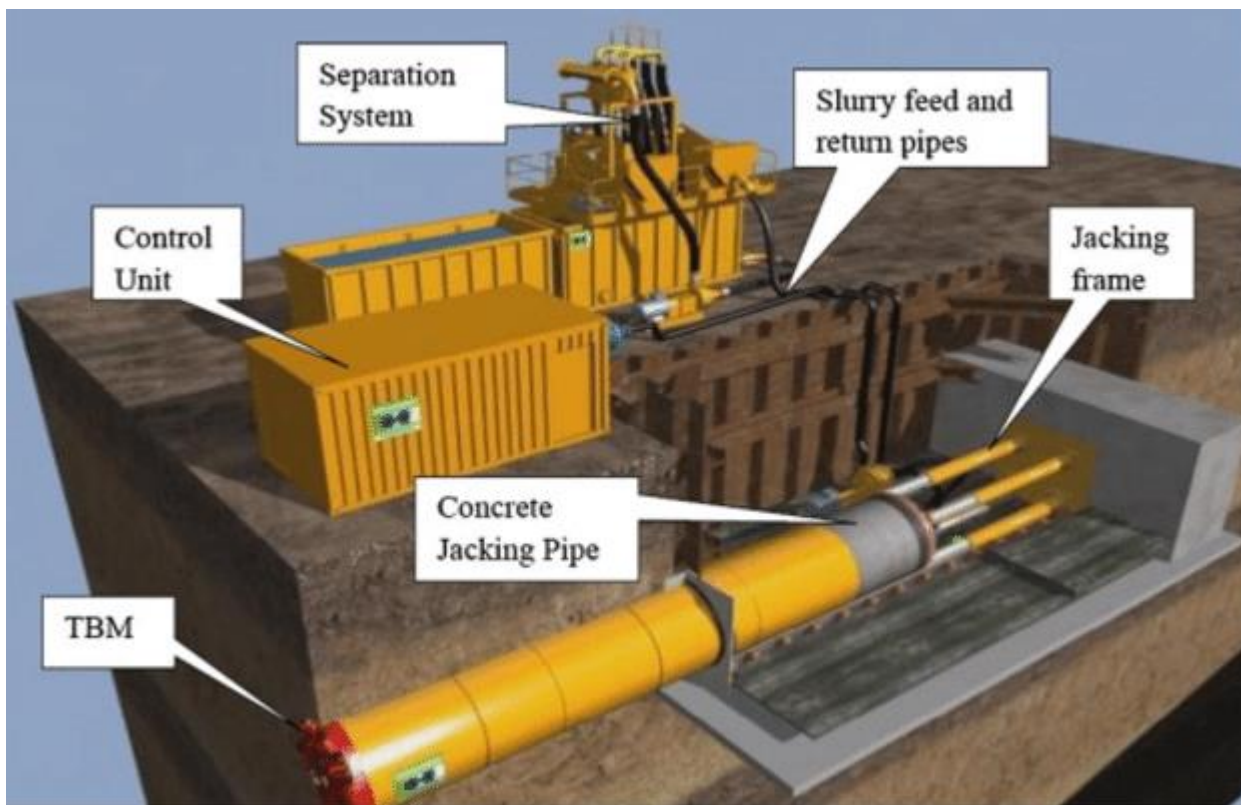


Figure 1: Schematic Diagram

The Herrenknecht – AVN – standard range covers all the components for unmanned pipe jacking. These components are optimally designed for use together and enable safe and efficient tunnelling above and beneath the groundwater level, without the need for accompanying action such as groundwater level lowering, provision of compressed air, grouting, or freezing. The compact construction of these systems makes them ideally suited for use in urban areas. The Herrenknecht microtunnelling consists of four main components:

- AVN Microtunnel boring machine
- Control container including guidance system
- Jacking frame and slurry pumps
- Settlement tank including water circuit
- Additionally, bentonite pumps and high-pressure water jet pumps can become part of the system depending on requirements.

The Control Container

The control container is the heart and brain of the entire system. In its back section it houses the hydraulic power pack and electric distribution panels for powering all the equipment supplied with the system. The power pack consists of powerful and separate pumps for the cutting wheel, jacking frame, steering cylinders, and slurry bypass system. The pumps are mounted on top and around a generous hydraulic oil tank and ample oil cooler. The main and sub-distribution panels supply not only the power pack but also the entire control station and operator panel, laser and VMT guidance system, bentonite pump and mixer, thyristor controlled variable speed slurry pumps, and mono-rail crane. In its front section, separated by a sound insulated wall, sits the operator's control station for remote operation of the Microtunnelling machine. The controls include all functions such as operation of equipment and colour monitor for VMT guidance system, including route guidance. The noise rating for the generator assembly is 70 dB at 15m. In the event of noise being a concern, we can place an insulating barrier along the site perimeter.

Jacking Frame

The Jacking frame is of a unique space saving design. Due to its three-stage ratchet system it builds competitively short A total stroke of 3m requires only a cylinder stroke of 1m. The operation starts with the push block being pulled back almost to the very end of the jacking frame. Here the first set of ratchets catch the push block. Once the cylinders are fully extended, the rams are pulled back while the push block stays in place. Now the second set of ratchets catch the push block, and a new stroke can commence. This process is repeated one more time until the entire length of pipe is installed in the ground and a new section of pipe is lowered into the jacking frame by an excavator/crane.

Cutting Head

The AVN microtunnelling machine or cutting head is the workhorse of the system. Pushed by the jacking frame and the installed pipes respectively, it excavates the ground with one of its various cutting wheels driven by powerful hydraulic motors, which are frequency controlled. One of the key features of Herrenknecht Micro tunnelling machines are its fast adaptation to different ground conditions. Different cutting wheels that fit the same cutting head are available for sand, clay, gravel, solid rock, and mixed face conditions. For the purpose of the PWDR Hodder Road crossing a mixed ground head has been selected.

The excavated material enters the face of the cutting wheel into the crusher chamber lying behind. There, all particles including boulders are crushed down into smaller pieces between the powerful crusher bars. During this process, slurry is pumped into the crusher chamber through various selectable nozzles inside the cutting head. The slurry helps create and maintain a stabilized face pressure to ensure no over excavation and also washes excavated material into the crusher cone where the tunnel pump sucks and pumps to the separation plant.

The cutting head itself is articulated by hydraulic steering cylinders inside, allowing the machine to be controlled in line and grade. An ELS target or VMT target is mounted inside the machine. A laser with adjustable focus, mounted at the back wall of the jacking shaft, shoots a beam onto the back of the target which in combination with the VMT guidance system or ELS guidance system inside the control container determines the exact location and orientation of the cutting head. The information is transmitted back into the control container via a control cable that runs through the installed tunnel. This cable also functions as the control line between container and machine: all sensor signals, and solenoids for actuation of cylinders and valves inside the cutting head are receiving and transmit their feedback through this one cable.

Slurry System or Water Circuit

The slurry system or water circuit basically starts inside the crusher chamber of the cutting head. After the slurry is formed, it is pumped out by a frequency-controlled slurry pump located at the bottom of the shaft. During long drives an additional tunnel pump directly behind the cutting head can be added. The slurry is then pumped to the launch shaft location where an additional slurry pump at the base of the launch pit pumps the slurry to the separation plant on the surface. In the control container, the slurry passes through a flow meter allowing the operator to monitor the amount of slurry taken out of the ground to avoid loss of ground, ground water or over excavation. After passing the flow meter, the slurry enters the separation system. A series of screens, hydro cyclones, and a centrifuge separates all solids in suspension and deposit them into a truck for disposal. The solid-free water that remains in the tanks overflows into the next compartment and from where it is re-used and pumped down the shaft by the feed pump, through the tunnel, to the cutting head and into the crusher chamber once again. The quantity of feed water is also monitored by a flow meter giving the operator all the information needed for successful slurry removal while avoiding over excavation.

To control the flow of feed and slurry water, the pumps are not only driven by frequency drives, but the cutting head itself is equipped with a bypass system. The system consists of a set of hydraulically operated ball valves allowing to direct or simply circulate the flow of water, appropriate to the current situation underground.

7.12 Site Preparation

HOLD POINT: Ensure all operatives have been briefed on the following works

In preparation for the tunnelling equipment the following works will need to be carried out:

1. Launch and reception shafts will be constructed in line with the approved permanent works design and construction drawings.
2. Safe method of access and egress is to be installed to the shaft bottom in the form of a hooped ladder with landing platforms (if exceeding 6m deep), bolted to the shaft wall.
3. Construction of suitable crane platforms on both the launch and reception shaft compounds in line with a temporary works design.
4. Launch and reception shaft seals to be installed as detailed below.
5. Set-up of control unit and all related equipment as detailed below.
6. Delivery and storage of jacking pipes and consumables (Bentonite etc.)

7.13 Delivery of Microtunnelling Equipment

1. The first stage of tunnelling works will be to mobilise all the equipment to site.
2. Deliveries will be planned and managed with site logistics manager and the relevant traffic management company to avoid unnecessary congestion/blockages.
3. Each truck will be directed to the unloading locations by a designated banksman.
4. Unloading procedure will be according to the Unloading/Loading RAMS and relevant lift plans.
5. The separation plant, control unit, generator, TBM will be unloaded and laid down in the pre-determined positions using a mobile crane (size TBC).
6. All operatives will be briefed on Loading and Unloading RAMS.

7.14 Installation of Separation

1. The plant will be located as close as possible to the Launch shaft. This confines pipework and cables to a minimum area reducing the chances of slips, trips, and falls. The area between the shaft and separation plant will be cordoned off and access will be restricted to trained personnel only.
2. The plant will be lifted into place with a mobile crane.
3. A proprietary platform provided with the separation plant is also installed as a means of access to the top of the tank. Handrails are installed, and access will be by means of secured ladder. Operatives will wear a harness with fall restraint lanyard fixed to the crane via an inertia reel while erecting the platform and until it is fully erected.
4. All pumps are positioned, and pipework plumbed up.
5. Every effort will be made to lay hoses and pipes in an organised manner to minimise slips, trips, and falls, where required temporary ramps will be used at crossing points.
6. Pedestrian walkways will be constructed to ensure ease of access over pipework and hoses.
7. Slurry lines feeding down the shaft will be fixed and secured to the wall with purpose made brackets.

7.15 Launch Seal and Jacking Frame Installation

1. All the equipment will be run from the generator.
2. A 1600 amp feed will be run to the site MDU adjacent to the container.
3. The following outgoing feeds will be distributed to the MCCB's around site:
 - a. 1250 amp to the control cabin used to operate all hydraulic power packs and systems within the control container itself and further distributes power to the machine and tunnel and shaft pumps.
 - b. 250 amp to the centrifuge
 - c. 160 amp the separation plant distribution board.
 - d. Several smaller feeds for site transformers, lights, etc.
4. All cables will be run along pallets and in such a way to avoid being a trip hazard or over head as required.

5. Once the install is complete and prior to initiating power to the plant a qualified electrician will check the install and issue a certificate of installation.

7.16 Launch Seal and Jacking Frame Installation

1. Once the shaft and plug are completed, the line of the tunnel is set out. The launch seal is then bolted to the wall in front of the soft-eye/box-out. The purpose of the seal is to eliminate ground water flow into the shaft during tunnelling and hence, prevent ground movement outside the shaft.
2. Once the seal is in place the jacking frame is then positioned, as per the lift plan, to the required grade and alignment that the tunnel dictates.
3. The gap between the back of the jacking frame and the shaft wall is then filled with concrete, ensuring a complete transfer of load to the shaft from the jacked pipes. There is a small pocket in this back wall which houses the tunnel laser that is essential for alignment of the drive.
4. Once the jacking frame is in position, a platform is installed on each side to support the shaft pump, slurry hoses, and workforce. A temporary works design will be provided for the working platforms.
5. A control room will be positioned at the top of the shaft so the TBM driver has eye contact with shaft activities at all times. The separation plant will be placed adjacent to the control container.
6. The lowering/raising of the tunnel machine will be via a crane of suitable lifting capacity. A lift plan will be in place prior to the commencement of the lifting works.

7.17 Launch of TBM and Tunnelling Operations

1. Prior to launching the TBM the pre-drive checklist will be completed, and all ITP hold points will be signed off.
2. The AVN TBM will be lifted into the shaft with a mobile crane and offered up to the face of the excavation through the launch eye. The relevant slurry and hydraulic hoses will be connected to the control unit and separation plant located on top of the shaft.
3. The mixed cutter head of the TBM is rotated and the main jacks extended to push forward and start the excavation.
4. The concrete jacking pipes will be lowered into the caisson by crane. A banksman will direct lifting operations. All lifting will be carried out as per the approved lift plan. All operatives will be out of the shaft while the pipe is being lowered.
5. When slinging/unslinging pipes - The chains and lifters will be guided into place over the pipe, a competent slinger signaller will connect to the inertia reel (connected to the crane) and access the lifters via a footed ladder.

7.18 Maintaining Face Pressure

Face pressure will be monitored with a sensor located at the face of the TBM. A real time value will be displayed in the control container for the driver to see. The face pressure is ultimately required to hold or stabilise the face of ground in front of the machine to ensure no over excavation occurs while TBM advances and to equalise ground water pressure to ensure there no dewatering or frac out occurs. A stable overcut can then be created and filled with bentonite to ensure no ground movement and reduced skin friction.

In addition to this, jacking forces and cutter head working pressure (torque) is also monitored to give the driver a better understanding/feel for the stability of ground at the face. The slurry pressure is controlled by the variable frequency pumps and will be adjusted to match the earth pressure by the TBM operator. The operator will continue to compare the actual real times pressures with the theoretical values throughout the drive to ensure the conditions being realised are in line with the theoretical values.

Face Pressure During Pipe Changes

The TBM has slurry isolation valves at the front of the machine which allow face pressure to be maintained while a pipe is being changed to prevent any loss of face pressure ground water infiltration.

During a pipe change the valves are closed and the by-pass system is then opened which connects the feed line directly to the return line behind the machine. This by-pass allows the driver to flush the return line of all material before the pipe is changed. Once lines are flushed, all power and pumps feeding the TBM are switched off and disconnected before installing a new jacking pipe.

Once installed, all lines and power to the TBM are reconnected. The TBM driver then uses by-pass system to generate desired flows and pressures in feed and return line.

Once happy with flows and pressures, by-pass system is closed, and tunnelling recommences.

This ensures no pressure drop while changing jacking pipes.

Indicators of a loss of/insufficient Face Pressure

- **Constant increases in Jacking forces**
 - Insufficient face pressure to ensure a clean overcut is achieved resulting in the overcut closing on to pipe increasing the skin friction and ultimately the jacking force.
 - Mitigation: Stable Jacking Forces. TBM driver will monitor Jacking force and record start of pipe jacking force and end of pipe jacking force in a Microtunnel Record Sheet. Increasing bentonite pressure to TBM and pipes to ensure stable overcut is maintained throughout drive.
- **Cutter Head working pressure or Torque is high**
 - Mitigation: The TBM driver will have the experience to monitor this and adjust his face pressure to suit. TBM will be advanced with careful monitoring of slurry flows and control of slurry pressures at the face.
 - The advance rate of the TBM will be adjusted to this optimal working pressure. Too high can indicate machine is advancing too fast and too low can indicate machine cutter head is not engaging with the face. Driver experience determines advance rate.
 - Viscosity of slurry fluid adjusted to match ground conditions to ensure filter cake is formed at the tunnel face to prevent loss of face pressure.
- **Settlement above crown of the TBM**
 - Mitigation: Increase flow of slurry to the face increasing face pressure.
 - Continuous monitoring of settlement monitoring points in advance of and during microtunnelling will give earlier warning of any potential for face loss.
- **Loss of Slurry**
 - Level of tanks in the separation plant continuously dropping can indicate a loss of slurry through the porosity of the ground.
 - Bentonite can be added to the slurry to increase overall viscosity which will help form a sufficient layer cake on tunnel face.
- **Over-excavation**
 - Flows monitored and controlled from the control container using Variable Frequency Pumps.
 - Recording of muck away volumes.
 - Comparison of actual vs. theoretical excavation records.
- **Possibility of spills and water infiltration**
 - All generators on site have double bunding to prevent diesel spills. The slurry fluid is stored in 6mm thick steel plate containers, making damage or spill unlikely.
 - Microtunnelling is a closed system and groundwater infiltration is not possible. Therefore, no ground water control is required along the tunnel alignment. The pipe joints contain a rubber gasket, which is protected by a circumferential steel band collar. The gasket is compressed when each pipe is installed.
 - One of the primary advantages of the system is the need not to dewater. Dewatering systems take the water out of the voids in the soil matrix causing surface disturbance and settlement. Therefore, this system can tunnel underneath a high water head.

- Any slurry or bentonite created for the tunnel construction will be stored in a bunded area, avoiding contact with any local watercourse and ground contamination.

8 Opencut Section P2 and P9

The following sections outline the sequence of works for P2 and P9.

1. Fencing will be erected along the wayleave in advance of the works and any footpath and/or PRow diversion put in place.
2. Trench location and depth is to be marked out by site engineer using GPS and marked on the ground.
3. Area to be scanned using CAT/Genny by appropriately trained person in accordance with HSG47 – Avoiding danger from underground services. If any live services are detected, good practises are to be followed – I.e. hand digging only with insulated tools adjacent as opposed to on top of the service, scanning every 200mm until the service is uncovered. This is then to be traced and isolated, if possible, if not work is to be stopped and reassessed.
4. The main sections of the trench in Havant Playing Fields (P2) and Staunton Country Park (P9) will be excavated using a 35-ton excavator with a 1650mm wide bucket.
5. Topsoil will be stripped and stored adjacent to the works areas. In Staton Country Park (P9) the turf will be lifted and placed to one side on the adjacent grassed area and stored for reinstatement upon completion.
6. There are 2 layers of subsoil to be excavated, these will be segregated as the trench is being excavated.
7. The material excavated to be re-used as backfill will be stored in the same area as the trench, to be used as backfill once the pipes are installed and tested. It will be stored a suitable distance away from the trench so that it does not impose overburden pressure on the sides of the excavation.
8. Extra attention must be taken when crossing the PROW (Public right of way). During this section banksmen will escort any pedestrians around the works area.
9. Sides of the excavations are to be battered/stepped with the 350 excavators where necessary or trench support installed
10. Shingle will be transported to the required area via the tractor and tipper trailer.

8.1 Pipe Installation

1. Engineer to mark position and check level of first pipe, then install pipe laser with correct grade for remainder of pipes.
2. Once first pipe is in position, 2nd pipe will be lowered into position and lined in. Straps will then be wrapped around the first pipe and the spigot end of the pipe will be “pulled or pushed home” into the socket using either lever hoists / turfers or an excavator.
3. When using turfers to pull home pipes, slings will be wrapped around previous pipe and the pipe being pulled home and then winched into position. Ensure all lifting accessories to be used are certified and the SWL of each item is not exceeded.
4. When using the excavator, a heavy timber will be placed on the front face of the pipe, and the quick hitch will be used to slowly push the pipe into the socket. Do not push quick hitch directly onto pipe as this will cause damage to the socket and spigot.
5. There are 4 different joint types along the pipeline route from ASP1 – Pump Station – ASP2 area:
6. Ve Joint (Restrained Socket/Spigot): Installation to follow the manufacturers installation instructions (copy attached). Trial run to be carried out on first joint.
7. Socket/Spigot: Socketed pipes to have gaskets installed in sockets, be cleaned, and be lubricated with pipe grease prior to pulling home. Ensure pipe is fully inserted into socket prior to installation of next pipe.
8. Flanged Joints:
 - a. Any flanged pipework to be bolted together as per specifications and bolts torqued to correct limits.
 - b. Engineer to complete bolt torque checklist and pipe laying ITR's prior to backfill. P1 protection to be applied to all buried flanges.
9. Tied Couplers/Flange Adaptors: All flange adaptors and couplers to be tightened and torqued to the correct limit. P1 protection to be applied to all buried flange adaptors and couplers.

10. Occasionally pipes will have to be cut to suit on site to ensure the correct position of bends etc. When cutting pipes, measure the pipe from a fixed point and mark the pipe the full circumference to ensure the pipe is cut square. Pipes then to be chamfered to ensure the spigots will fit into the socket effectively.
11. Operatives must wear hearing and eye protection during any cutting activities and have a hot work permit in place.
12. Weld beads will need to be applied to the spigot ends of cut pipes used on restrained Ve joints. Welding to be carried out in on site welding container at the welfare area. Pipe to be transported from area to welding container and back using tractor and trailer. See welding RAMS for full details of cutting and welding large diameter pipework.

9 Culvert Upgrades

Culvert upgrade works are being undertaken along Riders Lane stream at Purbrook Way, Middle Park Way and Dunsbury Way. The culverts at Middle Park Way and Dunsbury Way will be installed using a trenchless method of pipe ramming. Purbrook Way culvert will be installed using the opencut method.

9.1 Pipe Ramming

1. Pipe ramming location and launch pit will be marked out by the site engineer, to the side of the existing headwalls. Launch pit will be located downstream of the bridge and the pipe will be rammed up hill. A reception pit will be dug after the pipe is rammed upstream of the bridge.
2. The support frame will be set in position. Suitable sheet piles will be driven around the frame the required depth as per the temporary works design.
3. When sheet piles have been installed, a suitably sized excavator will be used to excavate out the pipe ramming works area to formation level. A layer of clean stone will be placed at the base of the excavation as a filter layer. Confined space procedures will be followed in the launch pit.
4. The excavation will be fenced off with suitable barriers and suitable ladder access into the excavation will be provided.
5. A sump will be sunk in one corner of the excavation and a suitably sized pump will be used to control ground water. Water will be pumped through the silt busters/settlement tanks currently set up adjacent to the bridge.
6. An I-beam will be lowered into the excavation using a suitably sized excavator and set to the required line and level on steel shims. A concrete base will be poured in the excavation using a concrete skip and excavator and the I beam will be set into this to fix it in place and form a rail for the pipe ram.
13. The line will be checked by the site engineer before any pipe ramming works commence.
14. A hole will be burned through the sheet piles at the end of the cofferdam using gas to enable the pipes to penetrate into the ground.
15. The steel pipe will be lifted into position using a suitably sized excavator and lifting gear and set on the rail. Sandbags will be placed inside the pipe at the face to minimise water flow back into the pipe in the initial few metres of the ram.
16. The Gundoram pipe rammer will be lifted into position and set up behind the steel pipe. The pipe rammer and steel pipe will be set up.
17. The steel pipe to be marked at 1m intervals to allow progress to be monitored.
18. The Gundoram (pipe rammer) will be held tightly to the pipe through tensioning of suitably rated straps and ratchets. The straps will be fastened to the pipe using two pre-welded eyelets.
19. The Gundoram unit can then be connected to the compressor and the ramming works can commence. The compressor hoses will be restrained with suitably rated whip checks.
20. The first pipe will be rammed with reduced airflow from the compressors to control the line of the pipe until the first pipe length is rammed into position.
21. When the first pipe ram is complete, the second pipe will be lifted into position onto the guide rail. A full penetration weld (external) will be carried out to connect the two pipes.
22. The ramming procedure will be repeated to the required distance and until the end of the sleeve protrudes approx. 500mm into the reception shaft.
23. The Gundoram unit will be stopped, disconnected, and removed from the excavation.
24. The reception pit will be dug to expose the end of the steel pipe on the upstream end. The reception pit will be constructed and supported using trench sheets similar to the launch pit.
25. When the pipe ram has passed underneath the bridge, the contents of the steel pipe can be cleaned out by a combination of auger boring, jetting from a jetter lorry and removal of debris using hand tools (shovel, brush, etc.).
26. For auger boring the ground will be levelled inside the excavation and using granular fill. The rails will be lifted into the excavation and bolted together as required. The auger bore machine will be lifted into place

on the rails using a suitably sized excavator. The first auger & cutting head will be lifted into the excavation and connected to the front of the machine. Barriers will be set up at the back of machine to create an exclusion zone around the augers. The auger machine will drive the auger inside the steel pipe and the spoil will be returned to the excavation. Additional auger section will be connected as required to penetrate further into the steel pipe. The auger machine will be retracted as required to enable the spoil to be cleared out the launch pit. This will be down from ground level using a suitably sized excavator or alternatively, a smaller machine will load a muck skip inside the excavation, and this will be lifted out using a suitably sized excavator. If the auger is unable to remove all spoil from the pipe, then jetting may also be used.

27. Use of a jetter will liquefy the soil and make excavation by hand easier. The jet vac lorry will be set up at ground level on the causeway. The material will be flushed back into the launch pit by the jetter head which is pushed into the pipe on a reel.
28. A muck skip and excavator will be used to move muck out of the launch pit for storage at a suitable location on site.
29. When the steel pipe is clear and exposed both sides, the pipe will be surveyed, and ductile iron spigot socket pipes can then be installed.
30. If required to achieve the correct grade, equal angle sections will be spot welded to the inside of the steel pipe. This will be spaced to ensure that the ductile pipes are suitably supported at all times. These will act as a rail for the ductile pipes and ensure pipes are pushed at correct line and level.
31. Each ductile iron pipe will be pushed home until the pipeline is completed through the steel sleeved pipe. This will be achieved with the use of a steel frame to choke the pipe at the entrance of the steel pipe. An excavator will then be used to push the pipe home.
32. The pipelayer will then check the joint before removing the steel choke. Once removed the pipe will be pushed through the steel pipe.
33. This process is to be repeated until this section of pipe is completed.
34. Pre-cast concrete headwalls will subsequently be installed with in-situ concrete pours to stitch the new headwall structure to the exiting.

10 Appendix

Appendix 1 - Project overview.

