Appendix 9

Stuarts Point Sewerage Scheme HDD Underbore Feasibility Review

Underbore Solutions (2024)

April 2024

STUARTS POINT SEWERAGE SCHEME

HDD UNDERBORE FEASIBILITY REVIEW

KEMPSEY SHIRE COUNCIL

Trenchless Option Review

ABN: 47 656 763 469

ACN: 656 763 469

Web: https://underbore-solutions.com.au/

Email: dgunnell@underbore-solutions.com.au

Phone: 0434 317 767

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CONTENTS

1. EXECUTIVE SUMMARY

Underbore Solutions has been engaged by Kempsey Shire Council (KSC) to review the feasibility of using Trenchless Technologies to underbore sections of the proposed Stuarts Point Sewer Scheme Pressure Main along Grassy Head Rd, Fishermans Reach Rd, and the effluent main crossing the Macleay Arm to the Dunal Discharge location.

The report has assessed the viability of using Horizontal Directional Drilling (HDD) along with the potential impact areas to assist in the environmental review which will be used to inform the EIS.

The underbore installation of the pressure main along Grassy Head Rd and Fisherman's Reach Rd has been reviewed onsite with areas identified for the HDD Equipment Setups, Links & Connections and Value Locations in line with the PS Solutions drawings and to limit the potential for impacting existing sensitive vegetation.

The pipeline alignment is within the current road verge and overhead electrical easement within previously disturbed lands. The provided geotech report along the route indicates that the conditions at the pipe depth are generally within sandy soils with potential to be below the water table making trenching challenging and likely to cause ground disturbance. The HDD Methodology is to drill below the ground and have limited impacts on the route by linking approximately every 100m or at required vales, changes in direction and connections.

The effluent transfer infrastructure and Dunal discharge require a pipeline crossing of the Macleay Arm to a disposal area located on the vegetated dunes adjacent to Stuarts Point Beach. The pipeline is to be installed using HDD trenchless technology due to the length, depth, and site conditions.

The profile above indicates an underbore of 450m length whilst reaching a depth of around 12m below the riverbed zone with tolerance to go slightly shallower or slightly deeper to limit the risk of fracout or avoid unfavourable ground condition.

The HDD Rig and equipment set up for the underbore of Macleay Arm at Kimpton St as this best suited using the access to Stuarts Point for the Heavier Vehicles and using the flatter area to the northern side of the Kimpton Road Surface. For the entry location, the space on the side of the road is suitable to house the HDD Rig and the ancillary equipment removing the impact on the traffic at this location, though some vehicles may make use of the road surface in this area. The exit location in the dunes would need to have some ground modifications to allow access and house the excavator and vacuum truck along with the pipe string for installation. An area approx. 40x20 is required at the entry whilst 20x20 plus the pipe string area is required at the release location. The HDD Rig required for this installation is a medium to large rig of 50,000lbs - 100,000lbs.

The installation of the pressure main along Grassy Head Rd and Fishermans Reach Rd is small diameter of pipe (range between 50m and 200mm) and has a nominal distance of 100m for the drill shot lengths, this shows the underbores will be undertaken by small HDD Rig (20,000lbs - 36,000lbs) which will also see a reduction in the amount of equipment and size of ancillary equipment required at the site.

A site visit identified locations for the setup of HDD equipment for the entry locations, exit locations where valves are required and exit locations where the bores can be linked in temporary pits to limit the length of underbores. These sites where Identified as three categories, Type A for Rig Setup approx. 300m2 (30x10) Type B for connection to values, approx. 200m2 (20x10) and a Type C which is just to link the underbores at the 100m lengths and or change of direction, approx. 50m2 (5x10).

The site setup area required for the small HDD (Type A) would generally be an approximate 30x10m area which is suitable to house the HDD Rig, Fluid Delivery System, Drill Rods, Vacuum Truck, Excavator and

Support Vehicles. This area can be adjusted to suit the site and reconfigured to limit the impact on tree clearing and use previously disturbed and cleared areas along the side of the road and within the Overhead Electrical Easement. Works on the alignment require room for the HDD Rig to sit and an Excavator to dig holes and install pipes. Vacuum Trucks need access to get vacuum hoses to the entry or exit pits and support vehicle need intermittent access to provide tooling.

The Underbore profiles along the pressure main routes are required to Link the pipeline at depths of 1-2m to allow for the pipe grade and limit the need for any Air Values at High points. This requires the HDD Rig to be setup back from the proposed link area by around 5-10m to allow for the rods to enter the surface and bend down to the pipe alignment using a sharp bend radius and bore to exit in pits. A transition area of 3-5m between bore entry and exit area is required to link the pipes and will require excavation of the pipes to the correct depths to join the pipes. This will likely be undertaken in dense sandy soils and may be below the water table which will require shoring and dewatering for the construction.

The HDD methodology will lower site construction risks of trenching below the water table and is designed at suitable depth and length to limited potential for Fracout. However, during the drilling of the underbores the drill fluid cuttings and downhole pressure will need to be monitored to ensure that no localise blockage or loss of flow develops into a fracout. Swabbing of drill rods, use of drilling fluids suitable for the sandy soils, reducing downhole fluid pressure and maintaining the steady production rates whilst drilling will limit the risk. Equipment and personnel are required onsite to deal with any fracout as part of the monitoring and fracout management plan. A control, contain and clean up procedure using sediment controls and vacuum truck are used as a minimum.

The HDD Underbore options to drill and install pipeline along Grassy Head Rd and Fishermans Reach Rd are suitable and feasible with limited environmental impacts. This underbore of Macleay Arm is considered suitable with limited risks but only to be undertaken by a contractor with previous experience drilling below water ways in sandy soils.

Next steps to further develop the HDD Designs would be to engage a suitable contractor with experience in drilling HDD in these ground conditions. Based on the final pipeline design and ESI, set out location for the HDD and review Topographic and Utilities Survey, Geotechnical Investigation, Profile design/assurance, and provide a Detailed Methodology and Fracout Management Plan.

For further information please contact Underbore Solutions.

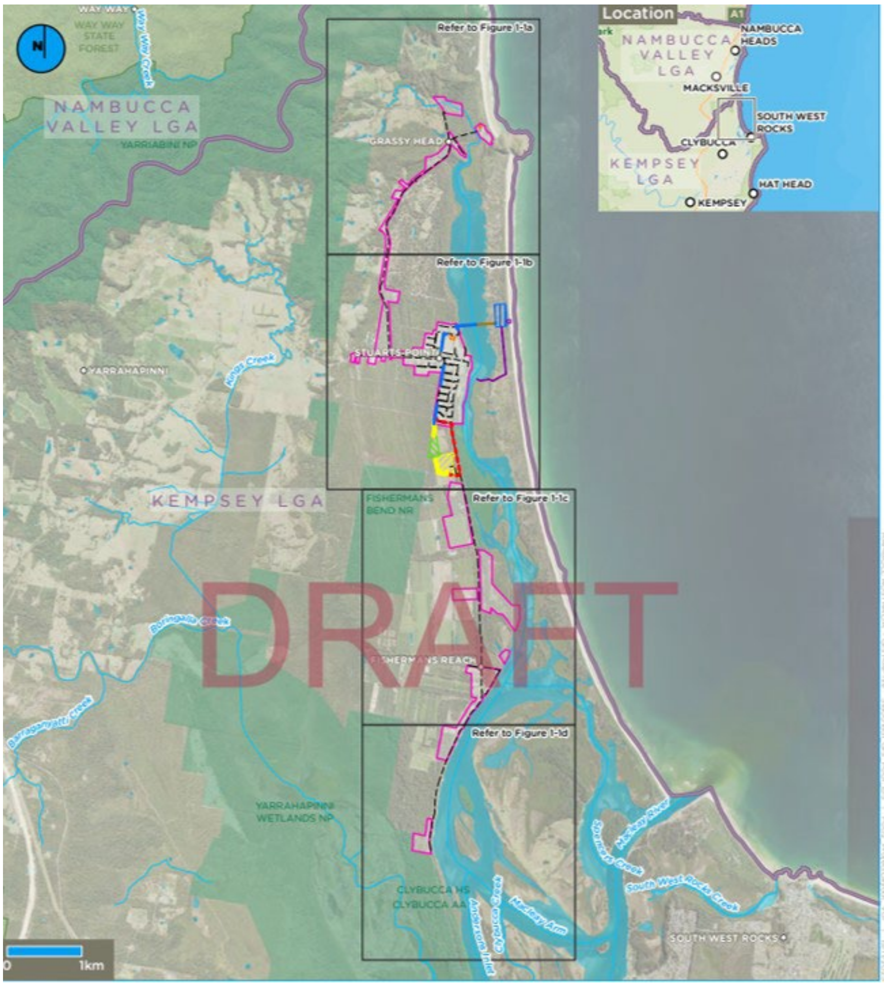
2. INTRODUCTION

It is understood that the Kempsey Shire Council (KSC) is currently in design and EIS phase for the Stuarts Point Sewer Scheme which includes the pressure mains between Grassy Head and the Sewerage Treatment Plant (STP), Fishermans Reach and the STP, and the Effluent Transfer Main to the Dunal Release.

KSC has identified Horizontal Directional Drilling (HDD) as the proposed method of construction to install the Sewer Schemes Pipelines. The use of HDD will limit the excavation in the sandy soils, below water table further limiting the ground disturbance in challenging ground conditions. The EIS assessment will look at the environmental impact of the construction footprint which may have an impact on design and construction based on outcomes within the report and risk to the scheme. This report is to inform on the constructability and construction of the Stuarts Point pressure sewer network using HDD as the preferred methodology for the emerging sewerage scheme and identify impact areas and risks during construction that describe the likely overall environmental impact.

Underbore Solutions conducted a site visit on the 14th and 15th of March 2024 to review the scheme alignment and potential location for the HDD setup and exit points. A further site visit was undertaken on the 15th of April 2024 to review areas marked onsite as locations of potential Impact from the HDD Underbore and excavation for pipe linking and valves with areas identified for detailed biodiversity review.

This report will inform on the HDD Technique and Methodology, provide concept on site layouts, identify risks and contingencies, and provide comments on the installation of the Sewerage Scheme from Grassy Head along Grassy Head Rd to Stuarts Point Rd, from the STP along Fisherman's Reach Rd to Fisherman's Reach and the transfer main underbore below the Macleay Arm to Dunal Release Point.



Macleay Arm Crossing for Dunal Release

Pressure Mains Grassy Head to Stuarts Point and Fishermans Reach To STP.

3. TRENCHLESS TECHNOLOGY

Trenchless techniques are often considered as the preferred method for installing underground assets especially under surfaces such as major roadways, under rivers and railway where conventional trenching is not a suitable option. Due to the reduced costs in restoration and minimal impacts on the ground surface, Trenchless techniques have also become popular in heavy residential and commercial areas.

When designing infrastructure, a variety of construction techniques should be considered to ensure that the correct and most efficient method is chosen. An array of information should be assessed including benefits, constraints, risks, and cost when considering the appropriate construction technique in each area. All sites are different and should be assessed as such as in most cases not one method is suitable for all installations and often a combination of Trenching and Horizontal Directional Drilling (HDD) and/or Thrust Boring is required to meet the installation needs of the project.

Trenchless Benefits

Deciding when it is appropriate to engage a Trenchless technique to install part or all an underground asset can usually come down to several major factors. All these factors should be seen as a benefit to the client and construction of the project. These being:

a) Requirement to minimise disruption and disturbance any surface structures.
b) Ability to install under existing surfaces and structures (road, rail, water)
c) Minimal disturbance to sensitive areas
d) Avoid existing underground utilities.
e) Ability to install under areas of limit accessibility.
f) Installation in or below difficult ground conditions
g) Lower reinstatement costs
h) Lower overall project cost
i) Possible shortening of proposed routes.
j) Minimising risks and impacts
k) More effective design and/or operation

Trenchless Constraints

Along with every other construction method being used, Trenchless techniques also have certain constraints restricting its practicality. When deciding on using a Trenchless technique you must ensure you investigate all parameters relating to this method. To ensure correct and practical design the project should cater for the Trenchless technique. In each individual Trenchless project, there can often be an array of issues that need to be resolved. Through careful planning and consideration in design many issues can be surmised and minimised prior to construction.

These must include:

a) Likely and achievable ground conditions to be drilled (method dependant)
b) Above and below existing structures and assets
c) Practical set up and set back distances.
d) Achievable bend radius and/or Grade
e) Available area for storage or stringing out of product.
f) Required depths and achievable depths at required connection points or alignment changes.
g) Achievable overall underbore distances (method dependant)
h) Product specifications to be installed.
i) Active and Passive Interference which could impact on the location equipment.

j) Underbore Guidance – Laser guided or Pilot Tube or unguided for Thrust bores or if The HDD drill head can be located with a walk over or a wire line or gyro system.

Other areas of concern

- Entry and exist depths (dewatering, shoring, zone of impact)
- Entry and exist angles (Method and equipment dependant)
- Clearances to existing utilities
- Required depths to reduce risks like the possibility of frac-outs, subsidence, or damage to existing utilities.

Safe Drilling Clearances

To assign a safe drilling distance from the existing utilities, first the existing utilities must be located and potholed to confirm their depth. During design it may be beneficial to undertake a preliminary utility review that would include a DBYD inquiry, electronic location of conflicting utilities and possible potholing of those utilities thought to have a major impact on the design. These findings should be overlayed on a single plan to allow for easy assessment.

It is also worth noting that the Trenchless techniques, which rely on electronic locating of the drill head for construction, may find it difficult to maintain these required separations effectively if the locating equipment is picking up interference to the signal. One of the largest sources of active interference comes from the existing electrical cables. It may be that the underbore is required to be at greater depths for safety, outside of the standard alignment to reduce interference or it may be more practical to design the underbore away from the existing cabling where possible.

Designing a safe drilling clearance below structures and waterways requires an in-depth investigation into the geology. A geotechnical investigation including boreholes down to below the proposed depth of installation must be conducted to gather factual data for the HDD Designer and/or HDD operator to assess the potential risks of frac-out, required downhole tooling and likely pulling forces. The geotechnical investigation may also require a Geophysics Survey in between boreholes to fill in the gaps in the geotechnical data along the alignment with the interpretive model.

Set Up Requirements

HDD rigs being surface launch machines require a setback distance before they are at the required entry depth and angle. This incorporates the length of the machine, entry angle and required depth in the entry pit. In most cases it could be assumed that 10-12m would be required for the machine to reach an entry depth of 700mm. Additional lengths will be required for larger rigs or for greater entry depth. This and all other relevant requirements should be taken on a site-specific basis only.

The alignment of the pipeline and proximity of boundary fences, trees or other surface features must also be considered when looking at an available entry point for HDD. Most HDD rigs have a centreline of the rod as 1.2m to 2.5m. This means that a rig will need to encroach on the property to be able to fit within an easement close to the boundary line or if there are structures in the way that will not allow this, the bore will be required to begin outside of the alignment and be steered back on to alignment along the path. Ancillary equipment (pumps, mixing systems, vacuum truck, support vehicle, etc.) must also be considered as these will need to be stationed near the rig site to assist in the drilling process. Thrust Boring (Microtunnel/Augerbore) requires a large deep pit to be excavated which will incorporate the length of the pipe to be installed, Stroke/thrust length of the machine and working space. These vary from contractor to contractor but could be up to 11m in length and 3m wide.

Types of Trenchless Methods

Horizontal Directional Drilling (HDD)

- Surface launched.
- Shallow entry and exit pits required.
- Produces a shallow arc.
- Steer-able.
- Suitable in most ground conditions.
- Requires area for laying out product pipe.
- Uses positive downhole pressure to support the borehole.
- Not always suitable when incorporating a casing.

Microtunnelling

- Pit launched.
- Straight bore (very accurate, Laser Guided).
- Requires pits down below Installation depth. (6mx3m)
- Can be limited, depending on ground conditions.
- Installs casing/pipe directly behind drilling unit.
- Excellent, for maintaining borehole stability.
- Larger the bore, the longer its achievability.
- May be limited contractor base.

Auger Boring

- Pit launched.
- Straight bore (may not be as accurate as Microtunnel).
- May incorporate Pilot Tube for greater accuracy.
- May be limited in drive length.
- Requires large pits down below installation depth. (11mx3m)
- Can be limited depending on ground conditions.
- Can install steel casing directly behind drilling unit.
- Limited contractors.
- Due to auger cutting action can cause ground destabilisation in unsuitable ground conditions.

Pipe Ramming

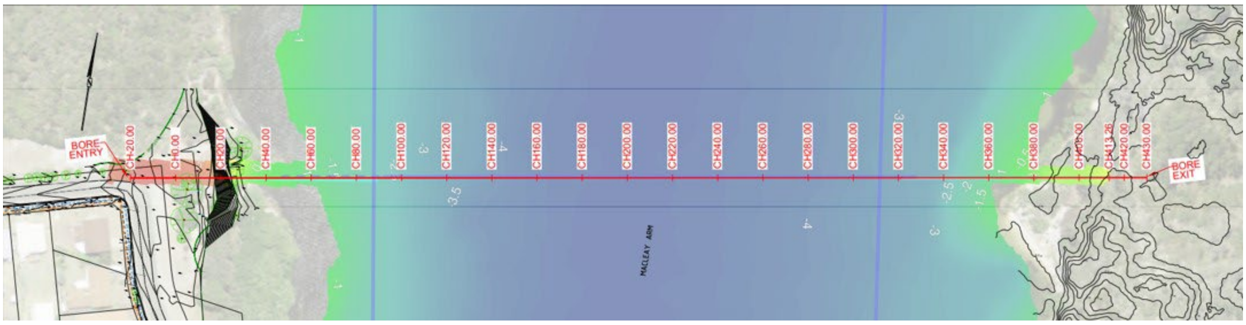
- Pit launched, Straight bore.
- Requires pits down below installation depth. (10mx3m)
- Suitable in soft/poor ground conditions
- Limited contractors, relatively short distances. (20m-30m)
- Installs open pipe (casing) directly into the ground by a ramming technique.

4. MACLEAY ARM CROSSING

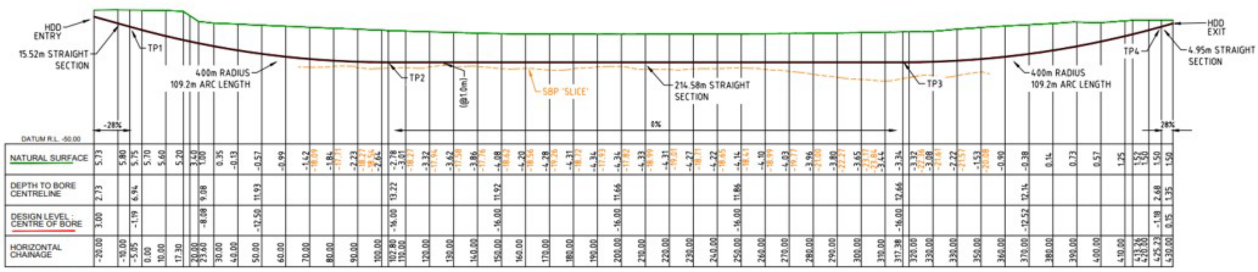
Kempsey Shire Council contracted GHD to undertake a conceptual design, environmental assessment, and geotechnical/geophysical investigation for the proposed effluent transfer infrastructure and Dunal discharge at Stuarts Point, NSW. The proposed transfer infrastructure is to comprise a pipeline crossing of the Macleay Arm to a disposal area located on the vegetated dunes adjacent to Stuarts Point Beach. The pipeline is to be installed using HDD trenchless technology.

Underbore Solutions previously assessed the underbore across Macleay Arm for HDD feasibility in October 2022. The review assessed the setup of the underbore in Kimpton St to the western side of the river with the exit point within the dunes on the eastern side of the river.

Underbore Profile: The depth of the underbore is dependent on the ground conditions at the site and the depth required to pass safely below the riverbed. The geometry is limited due to the sandy ground conditions at the site reducing the ability to steer the drill head more quickly. An HDD design assessed the use a large radius in design to allow for a tolerance when drilling the underbore and enable the contractor to install the pipe more effectively. A 400m radius was factored into the preliminary design to allow for the steering capabilities in the loose sands at the site. Shallower entry and exit pits are required to limit the excavation in the non-cohesive soils. An indicative profile below shows an underbore which could be achievable below Macleay Arm.

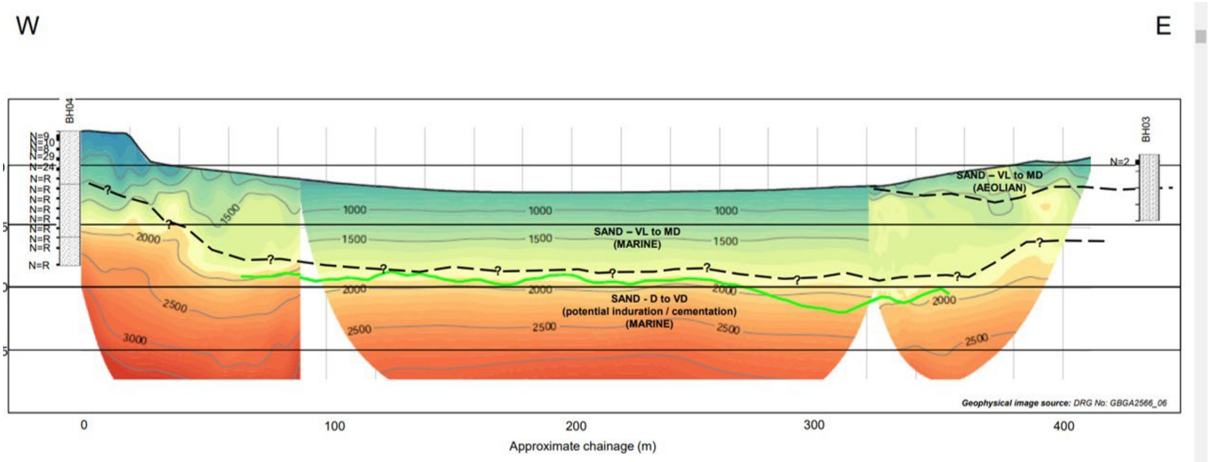


Approximate Length and Location of Underbore

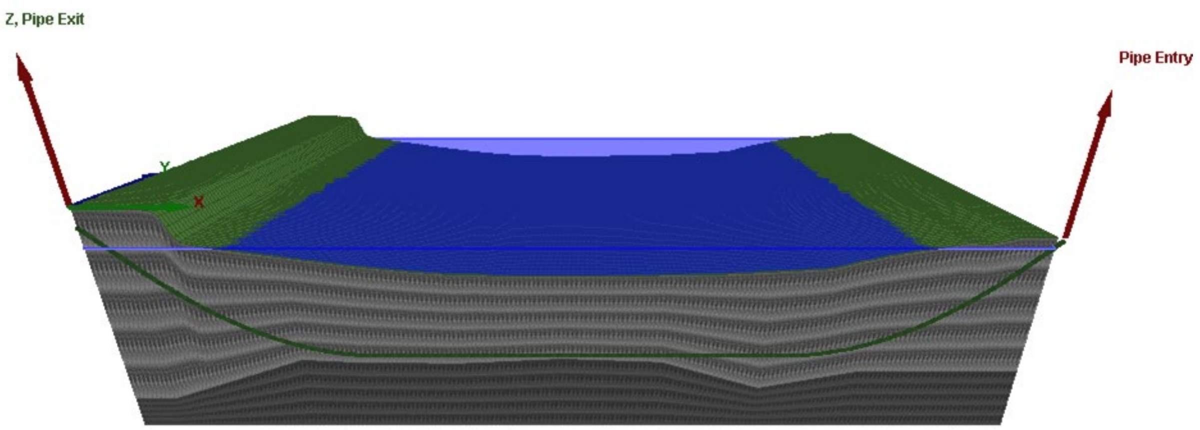


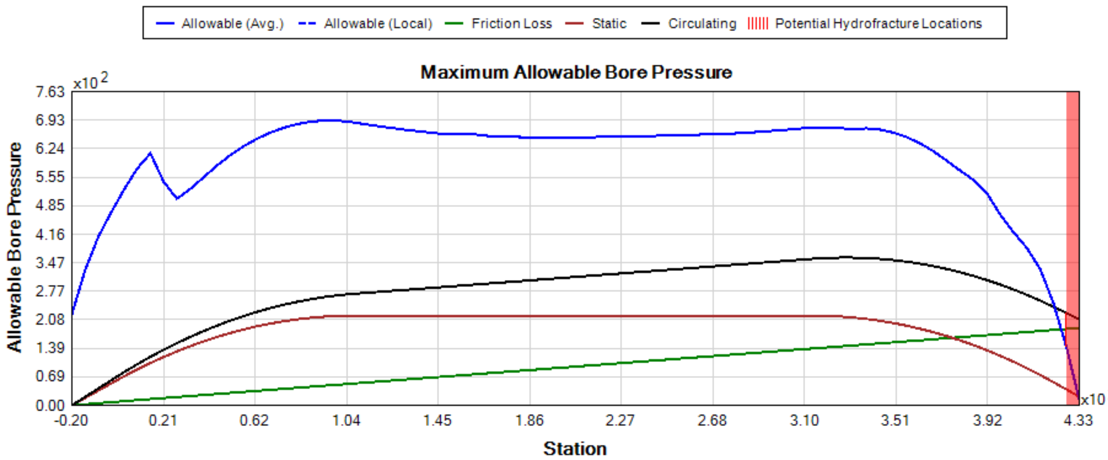
Approximate HDD Profile and Depth of Underbore

The site specific geotech information provided for the underbore shows that the HDD will be within the dense to very dense sandy soils and below the water table. This can be difficult soil medium for drilling through especially with very low N values shown, though it is still suitable for HDD and can be managed with suitable drilling fluids and experienced contractors. The risk of settlement or fracout is higher if the underbore is shallower so greater depth may be required to limit the risks. In addition, harder ground may also be encounter in the area which increases issues when drilling between the soft and hard ground conditions. Underboring below the Macleay Arm should be drilled at 10m+ plus cover to limit potential settlement or fracout.



Below is a preliminary soil profile with underbore profile through the sands and further below a preliminary hydrofracture analysis which indicates that an underbore within the sands at 10m+m below the riverbed is possible at this location though an experienced contractor with previous history drilling below waterways within these soil conditions is a must to limit the risk and be confident in achieving the underbore.





Site Setup: The HDD Rig and equipment set up for the underbore of Macleay Arm at Kimpton St as this best suited using the access to Stuarts Point for the Heavier Vehicles and using the flatter area to the northern side of the Kimpton Road Surface. For the entry location the space on the side of the road is suitable to house the HDD Rig and the ancillary equipment removing the impact on the traffic at this location, though some vehicles may make use of the road surface in this area. The exit location in the dunes would need to have some ground modifications to allow access and house the excavator and vacuum truck along with the pipe string for installation. An area approx. 40x20 is required at the entry whilst 20x20 plus the pipe string area is required at the release location.

Kimpton St

Dune Side

Indicative Setup and Exit Area

Trenchless Method: A medium to large HDD rig (50,000lbs - 100,000lbs) would be suitable for the pipe weight and allow for the geometry to suit the HDD profile on a 400m minimum bend radius along with standard entry and exit angles though the HDD rig may be required to be setback from the entry point to allow for the drill to enter the ground at the required depth and angle whilst avoiding existing utilities. The profile above indicates an underbore of 450m length whilst reaching a depth of around 12m below the riverbed zone with tolerance to go slightly shallower or slightly deeper to limit the risk of fracout or avoid unfavourable ground condition.

This HDD Rig will require approximately 10m to 15m for the drill rig to sit and to enter the pit at the required angle. The ancillary equipment for the site including a fluid delivery system and support vehicles would need to be setup near the rig. The site appears to have a few limitations on room on the Stuart Point side due to residential traffic and parking which will see access limited to Kimpton St during the works.

For HDD the pipe will be installed from the exit location back to the HDD Rig entry location. This site requires the same length as the underbore of lay down area for the pipeline to be welded and strung out prior to installation. This is feasible if the area is cleared with some access required along the beach to string pipes.

Drilling in the expected sandy soils anticipated at the site is suitable for the HDD. Steering the drill head on a 400m minimum bend in sandy soils is suitable for HDD though tolerance can be built in the overall design of the underbore to allow for any under-steer, harder ground condition and to limit the pressure on the pipe.

A mud return line will be required to be placed between the release location and the entry site to maintain fluid circulation when drilling if a larger pipe and back reaming is required. This may be strung out and laid on the bottom of the river or may require a second small drill across the river to allow for the return of fluids. If a smaller diameter pipe is chosen (200mm or less) then this may not be required.

Steering the underbore across the Macleay Arm would most likely be undertaken using a wireline or gyro steering tool to maintain accurate line, level, and depth below the river however advancements in standard handheld devices may also make this achievable.

5. GRASSY HEAD TO FISHERMANS REACH UNDERBORE REVIEW

The proposed Pressure Mains for Stuarts Point Sewer Scheme between Grassy Head and Fisherman's Reach are to be installed via Horizontal Directional Drilling (HDD). The underbore installation of the sewer pipeline along Grassy Head Rd and Fisherman's Reach Rd has been reviewed onsite with areas identified for the HDD Equipment Setups, Links & Connections and Value Locations in line with the PS Solutions drawings and to limit the potential for impacting existing sensitive vegetation.

The pipeline alignment is shown within the current road verge and overhead wire easement within previously disturbed lands. The provided geotech report along the route indicates that the conditions at the pipe depth are generally within sandy soils with potential to be below the water table making trenching challenging and likely to cause ground disturbance. The HDD Methodology is to drill below the ground and have limited impacts on the route by linking approximately every 100m or at required vales, changes in direction and connections.

Sub Surface: Douglas Partners previously undertook geotechnical assessment for the new sewer main as part of the Stuarts Point Sewerage Scheme extending approximately 8.5 km. The aim of the investigation was to assess the subsurface soil and groundwater conditions at the test locations in order to provide information on the following:

- Subsurface conditions.
- Depth to groundwater and potential dewatering requirements (if encountered).
- Excavation conditions and depth to rock (if encountered).
- Likelihood of acid sulphate soils (actual or potential).
- Comments on aggressiveness of the soil to buried concrete structures.
- Recommendations for temporary and permanent batter slopes and trench support requirements.
- Horizontal and vertical allowable bearing capacities for thrust block design.

The investigation included the excavation of sixteen test pits as requested by the client and acid sulphate screening tests of selected samples. The details of the field work and laboratory testing are presented in this report, together with comments and recommendations on the geotechnical aspects of design and construction. Below is the pic of the geotech investigation area and a table indication on the material likely to be encountered in the depth range for the underbores proposed.

Table 2: Summary of Geotechnical Units at Test Locations

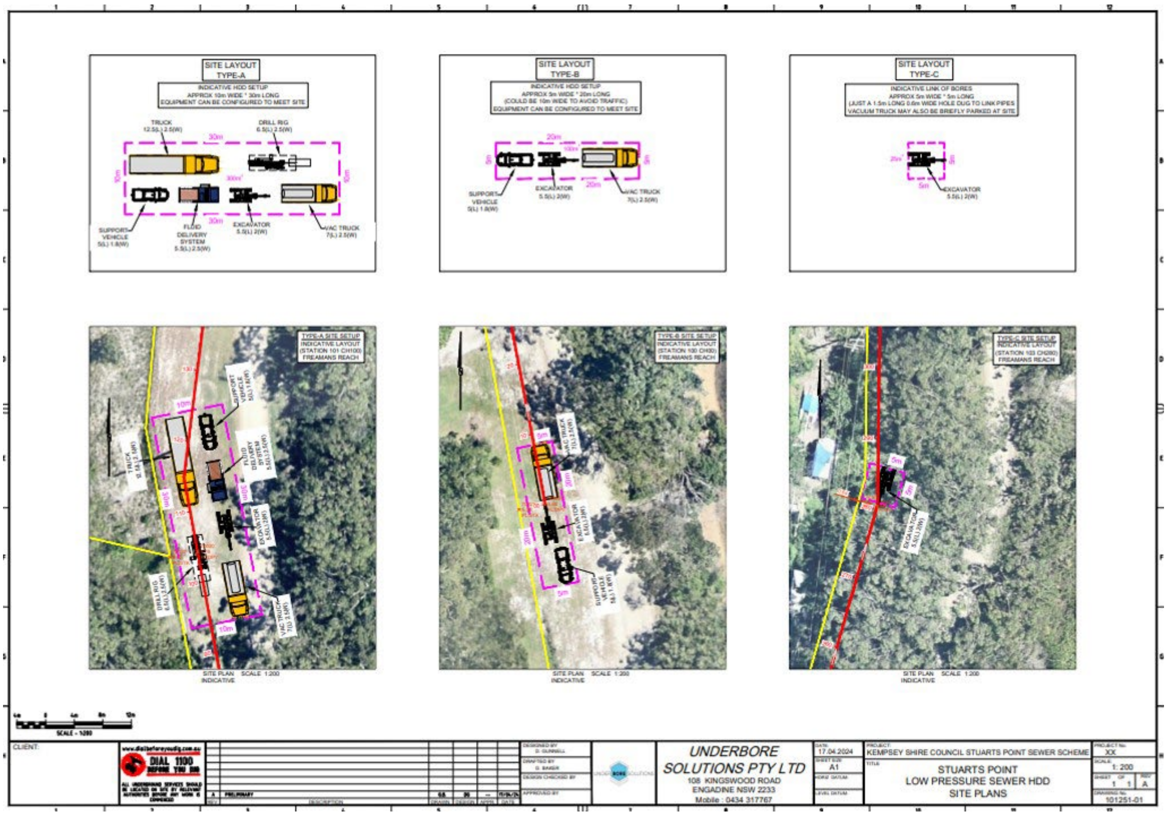
Pit	Depth Encountered Below Existing Ground Level (m)				
	Unit 1A (Topsoil)	Unit 1B (Filling)	Unit 2 (Sand / Silty Sand)	Unit 2A (Indurated)	Groundwater Observation
1	–	0 – 0.45	0.45 – 1.6 2.0 - LOI	1.6 – 2.0	1.8
2	0 – 0.15	–	0.15 – LOI	–	-
3	0 – 0.2	–	0.2 - LOI	–	1.9
4	–	0 – 0.2	0.2 – LOI	–	1.8
5	0 – 0.2	–	0.2 – LOI	–	0.9
6	–	0 – 0.15	0.15 – 1.3 1.9 - LOI	1.3 – 1.9	1.8
7	–	0 – 0.2	0.2 – LOI	–	0.9
8	0 – 0.2	–	0.2 – LOI	–	0.9
9	0 – 0.25	–	0.2 – 1.5 1.8 – LOI	1.5 – 1.8	–
10	0 – 0.2	–	0.2 – 1.5 1.8 - LOI	1.5 – 1.8	–
11	–	0 – 0.1	0.1 – 1.4 1.8 – LOI	1.4 – 1.8	–
12	0 – 0.2	–	0.2 – LOI	–	–
13	0 – 0.25	–	0.25 – LOI	–	–
14	0 – 0.2	–	0.2 – LOI	–	–
15	–	0 – 0.2	0.2 – LOI	–	–
16	0 – 0.2	–	0.2 – LOI	–	–

Note: LOI = limit of investigation

Site Setup: The previous site visit identified locations for the setup of HDD equipment for the entry locations, exit locations where valves are required and exit locations where the bores can be linked in temporary pits to limit the length of underbores. These sites where Identified as three categories as below:

Set up Type		Approx Size	Approx m2
Type A	HDD rig set up and valve location	30x10	300
Type B	Exit location and valves	20x10	200
Type C	Exit location temporary pit	10x5	50

Areas at which each setup type are suitable are pegged and surveyed onsite for environmental assessment and review. Below is an indication of what the site areas and equipment layout are likely to be onsite showing limited potential for impact in the road reserve and overhead easement.

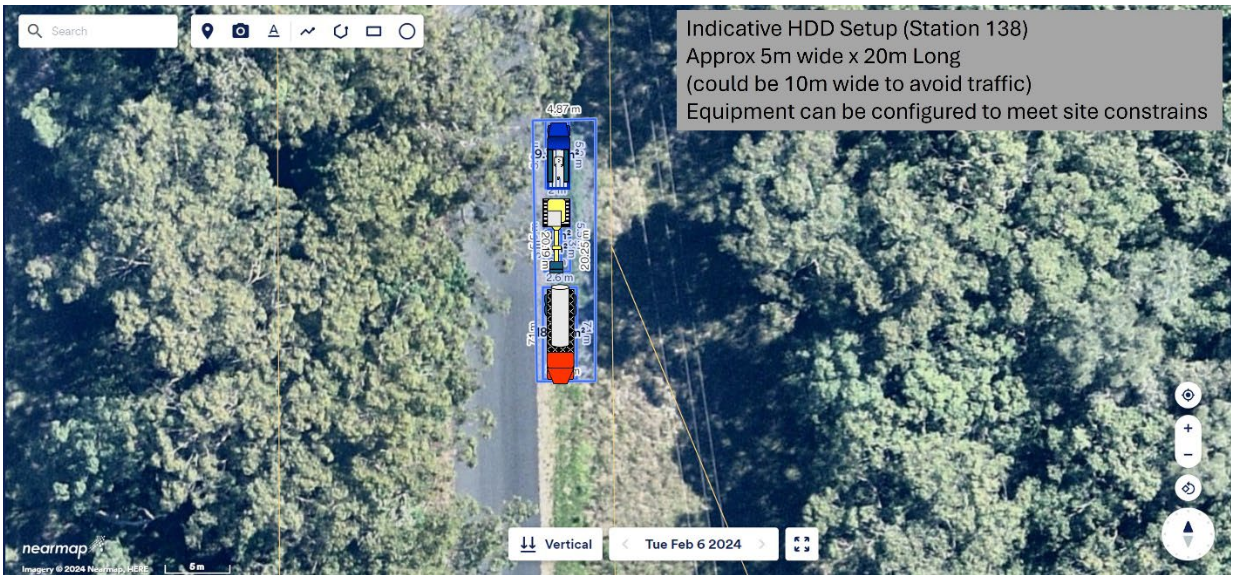


Site Type A – HDD Entry Location (Site is at Peg 164 near the proposed STP on Fisherman's Reach Rd)

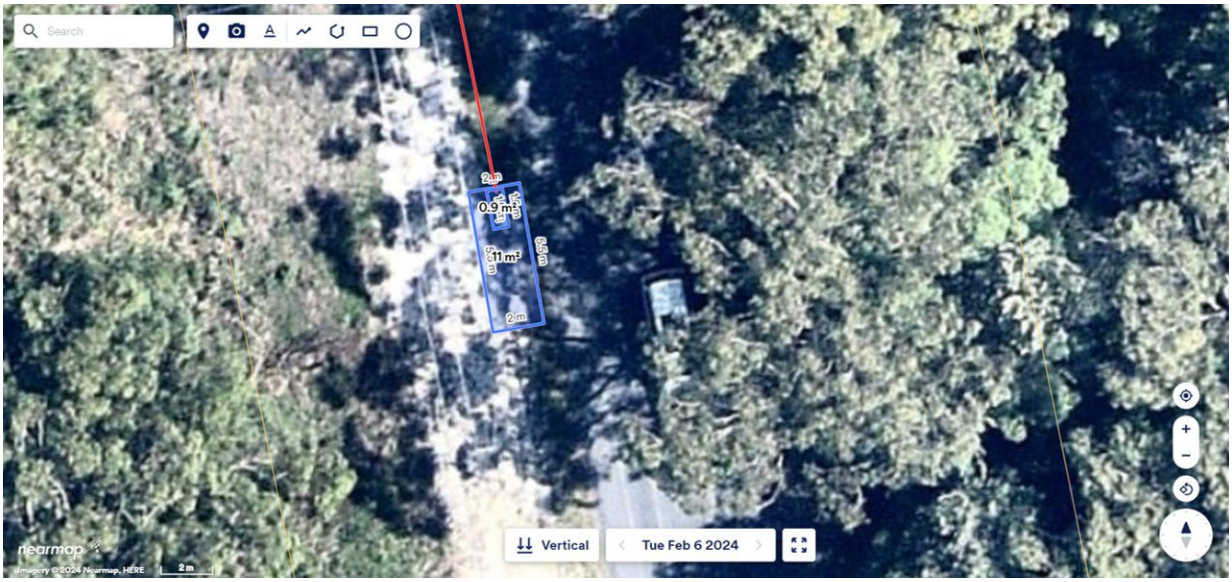
Site Type A – Indicative Equipment Layout

Site Type B – HDD Exit Location for valves (Site is at Peg 138 on Fisherman's Reach Rd)

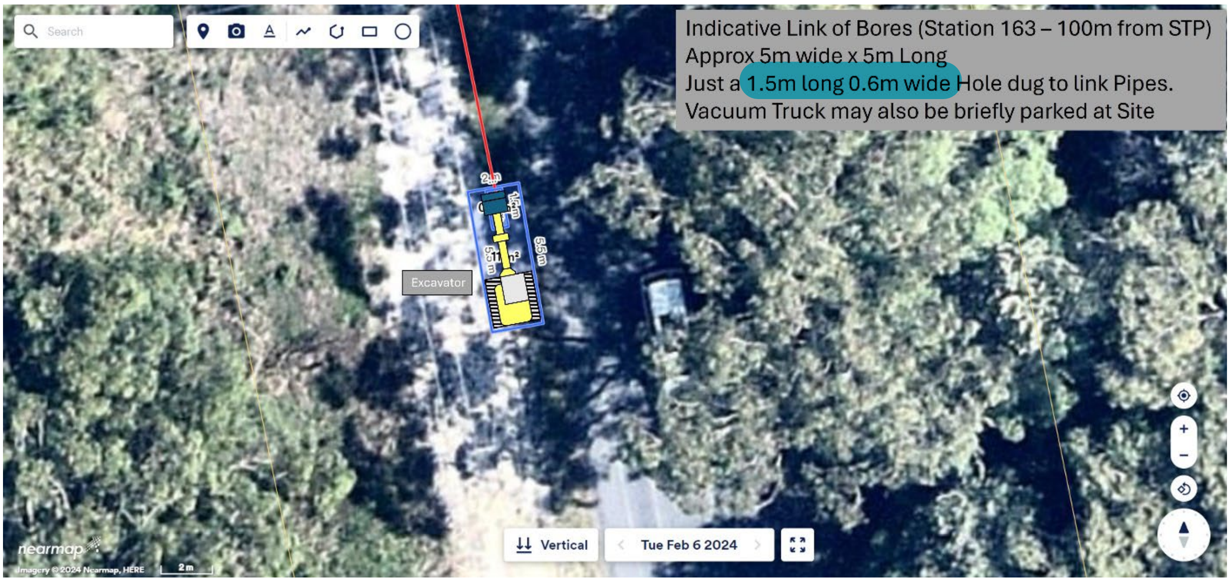




Site Type B – Equipment Layout



Site Type C – HDD Exit Location (Site is at Peg 163 near the proposed STP on Fisherman’s Reach Rd)



Site Type C Equipment Layout

These setup areas limit any impact on the vegetation and environmental areas with all works contained with the Road, Verge and under the existing easement for Over Head Electrical Wire which is cleared and or previously disturbed. Short term access to the sites is all that is required and small excavations of approx. 3m x 1m x 2m required to link the pipeline at depth.

Traffic Controls will need to be in place to allow for the HDD underboring and excavation to be undertaken, however due to the short drill shots and small diameter pipeline each site will only be used for 1 to 2 days before moving down to the next site. Sites for Type A have been chosen so that the HDD rig may drill north and install 100m of pipe then be turned to drill south for 100m. This limits the HDD Rig and equipment movements and makes use of the most available space.

The list below is the Setout locations and estimated Setup Type for each location. The Chainage is as per the long sections of the pipeline provided. (Some Peg Numbers and locations may vary onsite). Indicative drawings are also provided separately to indicate these locations along with site photos of the pegged locations. However, based on the overall EIS assessment any locations deemed to be in proximity to environmentally sensitive areas can be adjusted to suit the requirements and along the areas where there is no environmental impact is likely due the cleared road verge, adjustments to setup type and location can be assessed onsite to benefit the construction and pipeline installation.

Station	CH	Set up Type	
START OF GRASSY HEAD			
001	20	A	
002	110	B	
003	205	A	
004	300	A	
005	385	B	
006	432	B	
007	503	A	
008	620	B	
009	740	A	
010	820	C	
011	920	A	
012	1020	B	
013	1120	A	
014	1200	C	
015	1280	A	
016	1380	B	
017	1460	A	
018	1600	C	
019	1700	A	
020	1800	C	
021	1900	A	
022	2000	B	
023	2080	A	
024	2160	C	
025	2240	A	
026	2340	C	
027	2440	A	
028	2540	C	
029	2620	A	
030	2720	B	
031	2788	B	
032	2940	C	
033	3000	A	
034	3080	B	
035	3180	A	
036	3280	C	
037	3399	A	
038	3480	C	
039	3600	A	
040A	2880	A	Alternative
040B	2970	A	Alternative
040C	3035	C	Alternative
040D	3110	A	Alternative
040E	3210	C	Alternative
041	3310	A	Alternative
042	3400	C	Alternative
043	3500	A	Alternative
044	3620	A	Alternative
501	68	A	
502	232	A	
503	322	C	
504	454	A	
505	90	A	
506	261	B	
507	148	A	
508	216	A	
509	353	A	
510	568	B	

Station	CH	Set up Type
START OF FISHERMANS REACH		
100	0	B
101	100	A
102	185	A
103	280	C
104	340	A
105	360	A
106	460	C
107	583	A
108	620	B
109	667	A
110	768	C
111	880	A
112	942	C
113	1000	A
114	1060	A
115	1160	C
116	1260	A
117	1360	C
118	1449	A
119	1512	B
120	1562	C
121	1640	A
122	1740	C
123	1836	A
124	1876	A
125	1986	A
126	2080	C
127	2160	A
128	2226	C
129	2240	C
130	2340	A
131	2440	B
132	2520	A
133	2610	B
134	2625	A
135	2660	B
136	2760	C
137	2860	A
138	2980	B
139	3025	A
140	3094	C
141	3094	A
142	3180	C
143	3280	A
144	3380	C
145	3492	A
146	3580	C
147	3680	A
148	3760	C
149	3860	A
150	3960	C
151	4060	A
152	4120	C
153	4220	A
154	4300	C
155	4400	A
156	4500	C
157	4600	C
158	4687	A
159	4800	C
160	4875	A
161	4980	C
162	5080	A
163	5160	C
164	5255	A

Set up Type		Approx Size
Type A	HDD rig set up and valve location	30x10
Type B	Exit location and valves	20x10
Type C	Exit location temporary pit	10x5

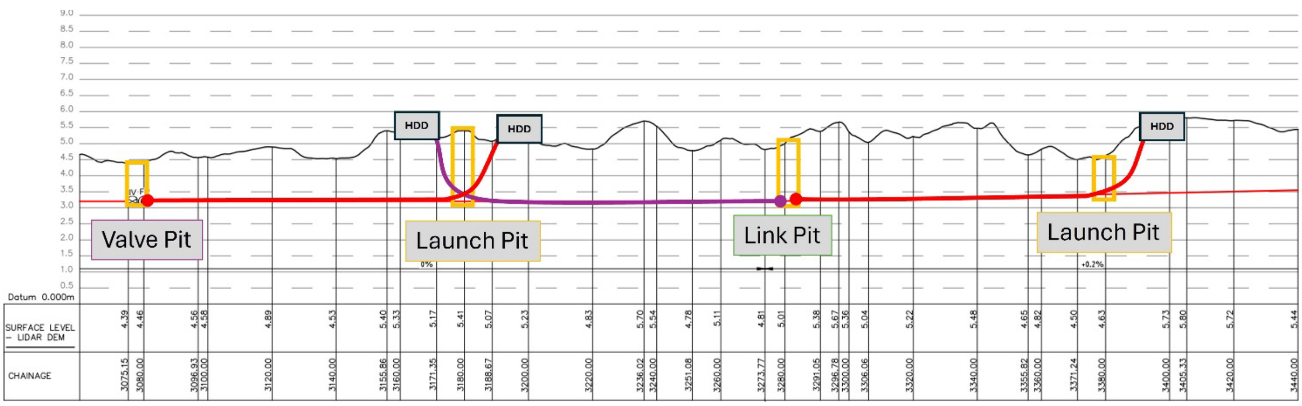
Trenchless Depth and Geometry: The underbores will be required to link the pipeline on the approximate grade and at the depths consistent with the pipeline design due to the distance and hydraulic requirements of the pipeline. This requires Underbores that start at the surface through an excavated pit and onto the depth and grade steering a tight bend radius. However, the geometry will be limited due to the expected ground conditions (sandy silty ground) reducing the ability to steer the drill head. The HDD will only pull and install the pipe back to the pits where they pipe can be linked at the required pipeline depth, after detaching the pipe the drill rods be removed to the surface.

The design for the pipeline has taken into account the ground conditions at the site and the depth required to pass safely below the ground surface, utilities and vegetation to limit fracout. Most of the pipeline is designed at between 1m – 2m deep. By limiting the underbores to approximately 100m in length limits the risk of fracout at the depth of the design in the ground conditions.

The pipeline design has indicated that the sections of pipe shall be linked at the depths of approx. 2m to allow for the grades to be maintained to reduce any high points and the need for air valves in the line and impact areas. To allow this, the HDD Rig will need to be set back 5-10m on a step entry angle to allow for the shortest distance between surface and the pipeline level. As the pipe does not need to be installed back to surface the drill pipe can bend to a 60m radius from the surface to get to the grade and level required for the linking of the pipes. It is likely that a shoring box and excavation to the link level will need to be dewatered to allow for the connection which is most likely below water table. Excavation will be required over approximately 3-5m to dig pipes to level and link.

Bore exit locations for the pipe at greater depth than 1.5m should also use shoring boxes excavated to the pipeline level and remove the drilling tooling. This will limit the impact length and allow the PE pipe installation from the surface to the borehole. If the drill rods traverse back to surface it would be over approx. 10m on an 60m radius whilst the PE pipe can traverse through the pit back to surface from 2m deep on a 5m radius over 5m as it has a much better bend radius and can therefore limit the length of excavation and clearing area.

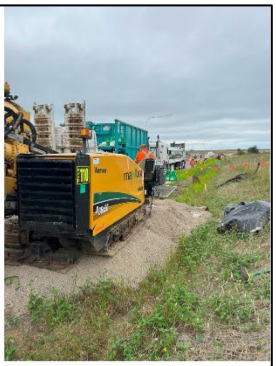
Below is the indicative of HDD Profile for bores linking every 100m starting at CH3180 drilling to CH 3080 for the Valve Pit then turning to Drill to CH3280 to a Link Pit. The bore down with a negative entry angle and 60m radius to bend to the appropriate pipe level by the pit requiring a small trench to link the pipes that cross over in the launch pit. The exit is in line with the pipeline depths for connections to the other bores.



Trenchless Method:

HDD Rig and Equipment

Based on the small diameter of pipe (range between 50mm and 200mm) and the nominal distance of 100m for the drill shot lengths, the underbores will be undertaken by small HDD Rig (20,000 -36,000lbs) which will also see a reduction in the amount of equipment and size of ancillary equipment required at the site. Below are some site photos of HDD Rigs and equipment laid out along the side of roads for pipeline installation.



Approx Equipment Sizes for this site

HDD Rig – 6x2.5 (+ 2m for Rod Entry to ground)

Vac Unit – 7 to 9 x2.5

Excavator – 5.5x2

Fluid System – 5.5x2.5

Standard sizes for ancillary vehicles

Ute – 5x1.8 and Truck – 12.5x2.5

6. HDD METHODOLOGY

HDD Overview

HDD is a method of installing underground pipes and conduits along a prescribed bore path from the surface, with minimal impact to the surrounding area.

The process is generally conducted in four main stages.

- Design of the bore path
- Drilling of a pilot bore which involves the location and steering of a drill bit along the pre-determined bore path from the entry pit to the exit pit.
- Reaming to open the borehole to the required size.
- Installing the product pipe by pulling through the pre reamed borehole.

The key to the great success with any underbore comes with Pre-Planning, Preparation and Good Drilling Practices.

- Pre-Planning – Geotech Investigation, Feasibility Investigation and Design.
- Preparation – Comprehensive Tender Specification based on the preplanning, Risk minimisation and Contingency planning.
- Good Drilling Practices – Use of the appropriate machinery and drilling equipment for the design and ground conditions, appropriate use of drilling additives and rates of penetration and monitoring of Roads, Ground Conditions and Drilling Fluids.

Major components for Horizontal Directional Drilling include the following:

- HDD machine appropriate for the expected subsurface conditions and the pipe diameter to be installed.
- Mixing system to mix additives and reclaim returned slurry used during drilling, reaming and installation.
- Drill Head and Reamers appropriate for the expected subsurface conditions and the pipe diameter to be installed,
- Tracking System to locate drill head during the pilot bore,
- Excavator to excavate entry and exit pits and string out pipes.
- Vacuum Truck to remove drill slurry form containment pits and as a precautionary measure to remove any spillages or frac-out.
- Support Vehicle to carry tools and tooling.
- Butt Fusion Welder to join PE conduits to a continuous length for installation.

A basic HDD procedure for the underbores involves the following:

1. Mobilise machinery and Equipment.
2. Establish site compound.
3. Excavate entry pit at the proposed locations.
4. Manoeuvre drill rig into correct position.
5. Set up all safety and environmental requirements include strike alert system.
6. Mix appropriate drill additives in a mix system.
7. Select appropriate drill head.
8. Install guidance equipment into drill rod / head and calibrate.
9. Proceed with pilot hole. (see Pilot Bore for more information)
10. The location of the drill head will be constantly checked as a new rod is added to the drill string.
11. Data from the locations is collected and recorded on Borelogs and assessed against pre planned profile. Adjustments are made to correct the path if required.
12. Excavate exit pit at the appropriate location and drill into pit.
13. Remove drill head and connect appropriate size reamer.
14. Several passes of different size reamers may be required to achieve the desired borehole diameter for correct product installation. (see Reaming for more information)
15. Butt fusion weld and de-bead conduits (if required). This is a process joining the lengths of PE pipe into a continuous length and laid out ready to be installed.
16. A pulling head or collar will be attached to each conduit and then attached to the reamer via a swivel.
17. Install product pipe by pulling through the completed borehole from the exit point to the entry point. (see Installation for more information)
18. Remove all excess drilling slurry via Vacuum Tankers
19. Demobilization of the machinery equipment
20. Site restoration

Drilling Additives

During the pilot, reaming and product installation process a drilling fluid will be used. The drill fluid is composed of a carrier fluid (water) and drill additives comprising of Bentonite/Polymers. Bentonite is a natural clay mineral that forms into a mud when mixed with water. Polymers are used in minimal quantities to help provide cuttings encapsulation, stabilisation, minimise fluid loss and increase viscosity.

The basis of using drilling fluids, and not just water when drilling/reaming, is to help suspend the cutting, seal the hole to prevent flow into the surrounding native ground formation, stop frac-outs occurring by maintaining fluid circulation and carrying solids from the hole, stabilise the hole by providing positive hydrostatic pressure, cool the drill head and transmitter and help in lubrication of the product during installation.

When drilling or reaming is preformed, the drilling fluid mixes with the natural ground formation and produces drill slurry. The types and quantities of drilling additives required on each bore project can vary considerably due to differing ground conditions that can be encountered.

The geology in this case is Clay and Bedrock of varying strength. The purpose of the drilling additives in the borehole will be:

- A good filter cakes.
  - A containment barrier to hold the fluids inside the hole formed with the use of drilling additives.
- Positive hydrostatic pressure inside the hole
  - The weight of drilling slurry down the hole leaving no cavity for the soils to fall into.
- Fluid circulation
  - To transport the solids/cutting from the hole to the surface

During the drilling of the cohesive clay requires a mixed ground drill head and drilling in bedrock requires a low flow rock head which will require drilling fluids of specific properties. Below are basic products for use in boring. MSDS are available onsite for each product.

Soda Ash – To raise the PH of the water to allow a better yield of the drilling products.
Bentonite – Increases the Viscosity of the water and encapsulates the soils.
Polymers – Increases the carrying capacity of the drilling fluids.
Detergents – lubricates the tooling and seals the borehole.
Dispersants – breaks down clay particles for better encapsulation and limit bit balling.

Slurry that has been circulated downhole and collected in the containment pit is then passed through machinery that separates the cuttings from the slurry. This process involves a series of shaking sieves and various size hydro clones. The cleaned fluid is then recycled back into the mixing tanks to be adjusted to the correct properties and returned back down the borehole.

Spoil Handling

The spoil created by an HDD operation can be viewed as solid and liquid.

The solid spoil comes from excavation of pits and from the removal of solids from the drill slurry during the recycling process. This solid waste should be tested and treated if required before it is transported to a clean fill site.

The liquid spoil is in the form of drill slurry. The view of this operation would be to recycle and reuse as much of the slurry as possible. The remainder will be required to be sucked up with the use of a vacuum tanker and transported to an approved site.

Drilling Fluid Disposal

Drilling fluid and cuttings can be disposed of by:

- Hauling to an approved site or disposal facility.

Monitoring

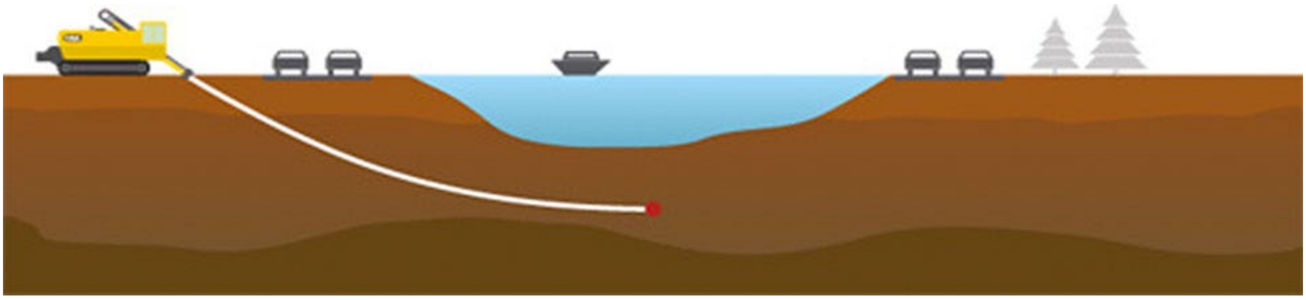
Monitoring of the drill rig, drill fluid and alignment will be undertaken during the HDD process to:

- provide early identification of issues.
- make appropriate changes.
- provide a basis for mitigation; and
- provide a record of decisions and actions to demonstrate due diligence.

Pilot Bore

Pilot Bore Procedure

This process involves guiding a steerable drillhead through the sub ground formation whilst constantly checking for its location using a transmitter and receiver. This allows the drillhead to be accurately steered while following its predetermined bore path as it is drilled from the entry to the exit point.



Drilling fluids are used and recycled during this process to aid in carrying out the cuttings along with stabilising of the bore hole. A standard process can be seen below:

- Mix appropriate drill additives in a mix system.
- Select appropriate drill head.
- Install guidance equipment into drill rod head and calibrate.
- Proceed with pilot hole.
- The location of the drill head is to be constantly checked as every new rod is added to the drill string.
- Data from the locations is collected and recorded on Borelogs and assessed against pre planned profile. Adjustments are made to correct the path if required.
- Prior to reaching the exit point of the bore, an exit pit is to be excavated to ensure containment of the drill slurry once the drill head breaks through the surface.

When the pilot drill is about to break ground, pumping of slurry shall be stopped. Once the pilot hole has been completed the drill head will be removed and an appropriate back reamer connected to the end of the drill string.

The accuracy of the drill profile is largely dependent on variations in the geology and frequency interference. A reasonable drill target tolerance at the pilot borehole exit location is within a metre with a small variance in depth.

During the pilot borehole operation, the drill string may be required to be removed due to:

- Guidance equipment malfunctions.
- Borehole alignment deviation.
- Worn drill bit that requires replacement.

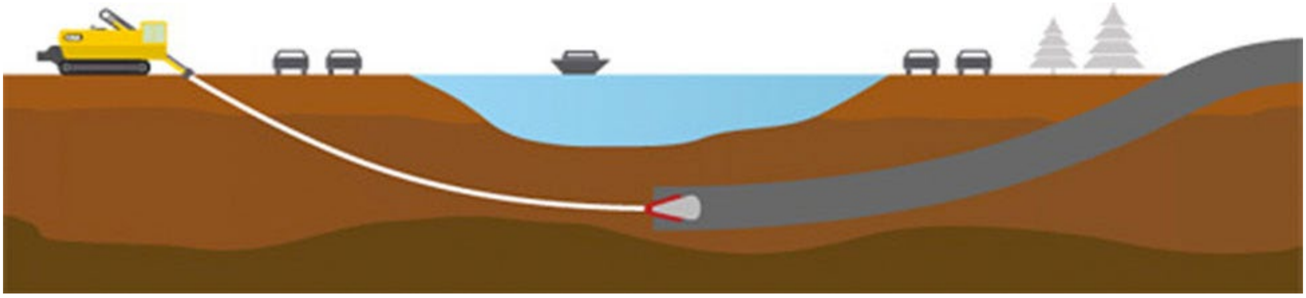
Guidance Systems

To maintain correct depth and lateral position, the drill head will be constantly monitored via a special guidance transmitter placed in the drill string behind the drill head. The periodic reading of the inclination and azimuth information is then relayed to a receiver on the surface detailing the drill heads exact position. This information will be recorded and compared with that required by the pre-determined drill path. Based on the comparison between the information received and that of the design, the driller can determine where next to steer the drillhead.

Reaming/Hole Opening

Reaming

Reaming is a process by which the pilot hole is enlarged through a series of reamers to the appropriate size so as to accept the product pipe. This may be required in several stages to reach the desired diameter and maintain the borehole integrity. Drilling fluids are used and recycled if possible, during this process to aid in carrying out the cuttings along with stabilising of the bore hole.



A bore hole maybe forward reamed if the ground conditions are stable and consistent allowing the borehole to be up sized prior to exiting. This will aid the drill slurry returns and recycle operation by minimising the need for an additional return line or time-consuming transportation of the slurry from the exit back to the rig.

In some ground conditions it can prove too difficult to maintain the bore hole by forward reaming and all the reaming passes maybe be required by the conventional method pulling the reamer from the exit point to the entry pit.

During the reaming phase a volume of slurry will be produced. The gravity may see a lot of this returned to the exit point though a portion may return to the entry side pit. Dependent on the consistency of the drill fluid it will either be pumped straight to the entry or cleaned on the exit side utilising an additional cleaning system before being pumped back via a temporary mud return line or delivered by tanker.

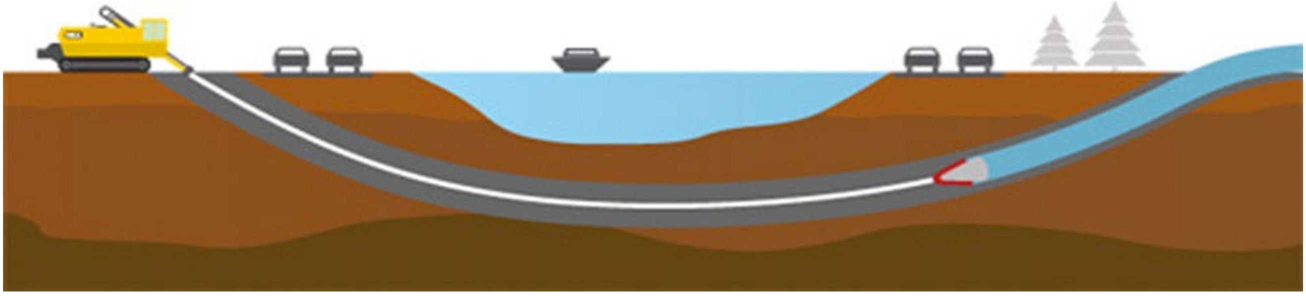
The final ream diameter will be approximately 1.3 to 1.5 times larger than the external diameter of the pipeline depending on the actual ground conditions encountered and the behaviour of the formation. The process is as follows.

- Remove drill head and connect the reamer to the drill string.
- The drill rods and reamer are rotated and pulled back through the ground whilst pumping the drill fluids to assist in removal of the cuttings.
- Several passes of different size reamers may be required to achieve the desired borehole diameter for correct product installation.
- After completion of the reaming operation a swabbing pass will be completed to ensure all drill cuttings are removed from the borehole.

Pipe Installation

Pipe Installation

Prior to installation, the pipes are butt fusion welded and de-beaded if required for PE pipes. This is a process joining the lengths of PE pipe into a continuous length and laid out ready to be installed.



A pulling head or collar will be attached to the conduits and then attached to the reamer via a swivel. The swivel prevents any translation of the reamer's rotation into the pipeline string allowing for a smooth pull into the drilled hole.

Installation of the product pipes is then undertaken by pulling the conduits/pipeline through the completed borehole from the exit point to the entry point. The drilling rig begins the pullback operation, rotating and pulling on the drill string and once again circulating the drilling slurry for the displacement of solids around the outside of the product pipes. The pullback continues until the reamer and conduits enter the pit at the drilling rig. Once the conduit has been pulled through to the entry pit, the pulling collar, swivel, and reamer are removed.

Drilling fluids are used during in this process to aid in carrying out the cuttings, stabilise the hole and lubricate the product pipe. Mud flow is created by pumping the combination of water and drilling fluid through the drill rod and back reamer. The drilling fluid then mixes with soil in the drill hole and creates flowing slurry back along the bore hole as the product pipe is pulled into place. These fluids will be contained and recycled; any excess drilling fluid shall be removed from site on completion of the pipeline installation operation.

Pipe Stringing

As the pipes are being welded together, they will form continuous string. This string will be laid out behind the exit pit in a straight line where possible to allow for reduced friction and easy installation. This may require some temporary road closures and or the use of council and private properties. Slings and rollers are used to protect the pipeline from dragging and damaging the pipe. In areas where full pipe strings cannot be connected and laid out behind the exit location, staged installation will be required with stopping at intervals to weld on new pipes. This will be keep to a minimum to avoid time delays and limit risk of the issues in the borehole.

Demobilisation

At the completion of the Pipe Installation process the machinery and equipment will be cleaned up, packed up and removed from site. Additional works required to the pipeline can then be undertaken along with any site restoration works.

Contingencies

Loss of Fluid Circulation (Frac-out)

Loss of drilling fluid whilst drilling can occur due to fractures in the ground, over pressurising the borehole and borehole collapse. The designed depth of the underbore and the natural formation strength will reduce the risk of frac-out. For the Stuarts Point area, reports and visual inspection of the Geology indicates the ground formation for the most part to be sandy soils.

Should drilling fluids returns reduce or stop during the operation, then drilling activities shall be halted to review the cause of the loss and any impacts assessed prior to continuing. A visual inspection of the bore path and surrounding area will be undertaken to determine if the fluid loss is down hole or a loss to the surface.

If the inadvertent release is on land, determined not to be causing an adverse effect and the surface migration of the drilling mud can be adequately contained and controlled, then drilling can continue.

Should an inadvertent release of drilling fluid occur in accessible areas, containment and subsequent clean-up will begin immediately upon detection. Field measures to contain inadvertent releases of drilling fluid will vary according to site-specific conditions (e.g. volume of fluid, topography, and environmental setting). The most commonly utilised system for containment of surface releases of drill fluids would involve a containment barrier of soil, hay bales, or silt fence. Where this system of containment cannot be employed, containment procedures will be directed by the Site Foreman to minimize environmental impact.

After containment, clean-up and restoration will generally be accomplished utilising one of the following:

- Hand labour, hand tools and buckets
- Portable pumps and hand tools
- Excavation equipment and hand tools
- Vacuum trucks and hand tools.

Continual monitoring of the fluid levels and returns will see early detection of any fluid loss and containment. A drilling continuance plan would be employed based on the severity of the fluid circulation loss as set out in the Drill Fluid and Slurry Plan. This may include additional drilling additives to seal the borehole as well as contain and control measure.

Images of Site Containment for Fracout and Vacuum Truck Clean Up

Borehole Collapse

Underboring in loose no cohesive ground formations can see borehole collapse occur. The contingency to avoid Borehole collapse is to use the correct drilling fluids designed for the specific ground formation and correct drilling practises.

- Should a collapse occur during the underbore operation the Site Foreman must assess the status of the borehole and see what measures are applicable. This could include:
- If the downhole equipment can be pulled or pushed through the collapse, then operation may continue to clean the borehole.
- The drill fluid properties may be adjusted to stabilise the borehole and cleaning of the collapse can take place.
- If the downhole equipment becomes stuck or lost equipment retrieval maybe required.
- Ground stabilisation techniques maybe considered, i.e. grouting of borehole and re-drilling.
- Abandonment of the borehole and re-drilling from a different location maybe required.

Slurry Spills and Overflow

During the HDD operation a drill slurry spillage or overflow might occur from the following source.

- Burst or leaking hose
- Containment pit or mixing system overflow.

The containment and clean up method for spills is:

1. Stop drilling operation.
2. Stop the main drilling fluid pump.
3. Assess the source of the spill.
4. Reduce the volume of mud or make repair.
5. Clean up access spilled slurry with vacuum truck, brooms, and squeegees.

Hazardous Substances Spill

Due to the operation, maintenance and refuelling of vehicles, machinery and equipment on the drill site, spills of Hazardous Substances such as Petrol, Diesel and Oils may occur.

This may come from the following source.

- Overflow during refuelling of Machinery or Equipment – resulting in petrol or diesel spill.
- Storage container leaks – resulting in petrol, diesel, oil, or hydraulic oil spill.
- Broken or leaking hydraulic hose – resulting in hydraulic oil spill.

The containment and clean up method for spills is:

1. Stop refuelling or operation of machinery or equipment.
2. Assess the cause of the spill.
3. Contain the spill to prevent spread and contamination.
4. Remove spilt material using products from spill kit.

5. A fully stocked Spill Kit will be available onsite at all times and hazardous substances will be appropriately contained. The drilling process does not usually have large quantities of chemicals on site.

Down Hole Equipment Retrieval

Should a drill rod break or should there be a loss of downhole equipment during the underbore crossing an attempt will be made to recover or clear the bore path of the drill string or lost equipment. The retrieval method called fishing, where an attempt is made to connect to and push or pull the lost equipment or drill rods out of the borehole at either end to be recovered and replaced.

A variety of fishing tools are available for use depending on the required equipment recovery:

- Overshot's
- Carrot Taps
- Mills
- Washover Rods

Borehole Deviation

If the borehole is to deviate from the pre-determined bore alignment beyond a recoverable limit, then the drill rods maybe pulled back to a point where an attempt can be made to recover the bore back to the desired alignment. This may include additional depth or lateral movement to avoid the abandoned path. Depending on the location of the deviation, bridging of the borehole by grout may be required.

Bore Exit Alternative

Should the underbore be at risk of missing the target exit point or if the target exit point is proven to increase the risk of frac-out or borehole collapse, then an alternative exit point can be assessed.

7. COMMENTS AND RECOMMENDATIONS.

Based on the information provided and several assumptions, including existing underground services and geology, the proposed underbore crossing of Macleay Arm is considered achievable using a Horizontal Directional Drilling (HDD) methodology over approximately 450m with a 10m+ cover below the riverbed.

It is expected that the underbore of Macleay Arm will be in dense to very dense wet sands above the rock /indurated sands though may also encounter loose sands at shallower depths on the way in and out of the river. These are challenging soil mediums for drilling through, though it is still suitable for HDD and can be managed with suitable drilling fluids and experienced contractors. The soft wet sands limit the ability to steer the HDD drill head so this will limit the geometry for the design and may affect the depth and length achievable for the underbore. The risk of settlement or fracout is higher if the underbore is shallower so greater depth is required to limit the risks.

Based on the proposed connection and release points the 450m length underbore is achievable from a setup on the western side of the river in Kimpton St Stuarts Point. For the entry location the space on the side of the road is suitable to house the HDD Rig and the ancillary equipment removing the impact on the traffic at this location. The exit location in the dunes only has access for equipment from Grassy Head along the beach to the receive location. Access would need to be made for the excavator and vacuum truck / Fluid Recycling Unit along with the pipe string for installation. Track Mounted or four-by-four equipment and vehicles are likely to be used due to beach sand conditions. Conducting most works form Stuarts Points and limiting the amount of equipment required at the exit will be essential.

This underbore of Macleay Arm is considered suitable but only to be undertaken by a contractor with previous experience drilling below water ways in sandy soils.

Based on site review, geotech provided and experience the proposed underbores along Grassy Head Rd and Fishermans Reach Rd to the STP considered achievable using a Horizontal Directional Drilling (HDD) methodology and are shown to have reduce the environmental and construction impacts.

It is expected that the underbores will be drilled mostly through the wet sandy soils though may encounter some indurated sands. These are challenging soil mediums for drilling through, though it is still suitable for HDD and can be managed with suitable drilling fluids and experienced contractors. The soft wet soil limits the ability to steer the HDD drill head so this will limit the geometry for the design and may affect the depth and length achievable for the underbore. The risk of settlement or fracout is higher if the underbore is shallower so linking at greater depth and short drill lengths are used to limit the risks.

To limit the risk of fracout, limit settlement potential, and limit the impact from softer loose sands an underbore with steeper entry angle and exit at the required pipe a depth of approx. 1-2m. Maintaining simple line and level is likely to be suitable over the bore distances of approx. 100m.

Based on the proposed connection and receive points the underbore is achievable from a setup types and area as indicated within the report. For the entry location the spaces indicated are suitable to house the HDD Rig and the ancillary equipment through minor clearing maybe required to access the pipeline alignment through the overhead electrical easements. The exit locations are smaller only access for limited equipment including vacuum trucks, excavators, and pipe for installation along with any valves and other connection. The access to sites would need to be managed by the contractor to limit the amount of clearing and to reduce impact on the small roadway. Conducting most works from the road verge and easement whilst limiting the amount of equipment required at the exit will lower the environmental impact. Welding, string and storing of pipes for installation will be in the road verge and will require access to the exit pit.

The HDD methodology will lower site construction risks of trenching below the water table and is designed at suitable depth and length to limited potential for Fracout. However, during the drilling of the underbores the drill fluid cuttings and downhole pressure will need to be monitored to ensure that no localise blockage or loss of flow develops into a fracout. Swabbing of drill rods, use of drilling fluids suitable for the sandy soils, reducing downhole fluid pressure and maintaining the steady production rates whilst drilling will limit the risk. Equipment and personnel are required onsite to deal with any fracout as part of the monitoring and fracout management plan. A control, contain and clean up procedure using sediment controls and vacuum truck are used as a minimum.

Next steps to further develop the HDD Designs would be to engage a suitable contractor with experience in drilling HDD in these ground conditions. Based on the final pipeline design and ESI, set out location for the HDD and review Topographic and Utilities Survey, Geotechnical Investigation, Profile design/assurance, and provide a Detailed Methodology and Fracout Management Plan

For further information please contact Underbore Solutions.

8. LIMITATIONS

This report has been prepared by Underbore Solutions, in conjunction with information supplied by Kempsey Shire Council, Pressure System Solutions, Nearmaps and Google. In preparing this report, Underbore Solutions has relied on this information to achieve appropriate solutions and recommendations relating to this project. Underbore Solutions has not verified the accuracy or completeness of information supplied. Therefore, the information supplied by Underbore Solutions in this report is based on part or all the data supplied.

As the construction methods used with Trenchless Technology occur under the grounds surface, all suggestions and recommendations are based extensively on judgment, experience, and knowledge as well as opinion. Underbore Solutions will not be liable in relation to any incorrect conclusions or recommendations noted should any data and supplied information be incorrect, concealed, withheld, or misrepresented in any way, shape, or form.

The information supplied should been seen as a concept design only as a wide variation of equipment is available within the Trenchless industry which could alter the limitations and achievability of bore. These limitations could also be influenced by the experience and professionalism of the chosen contractor.

This report should be seen as obsolete if the bore is repositioned or altered in any way.

Due to the minimal availability of geotechnical information of the area, there is a possibility that a variation in ground conditions could occur during the process. This may produce additional unknown risks and issues which should be observed and managed by the chosen contractor during the construction period.

Additional construction activities at or adjacent to the work site, as well as natural events such as weather, floods, ground water variations, may also alter the information supplied.

Underbore Solutions will not be liable for the updating of this report to account for any events, circumstances or other relating incidences that may occur after the date of this report.

The costing estimates covers all work and processes required to be undertaken by the Trenchless contractor to complete the bores and installation of products unless otherwise mentioned. As all these contractors operate different size, make and types of Trenchless machines, actual pricing can vary. The following is to be used as a guide only and caution should be undertaken when choosing an appropriate contractor.

The estimates may not include allowances for removal of contaminates, relocation of utilities, supply of product pipe, additional trenching requirements, excavation of pits, grouting of the borehole, purchase of easements, permits, monitoring and project management.