DOCUMENT REVIEW ASSESSING THE SUITABILITY OF USING HDD THROUGH QUEEN ELIZABETH PARK AS PART OF THE SLP PROJECT

Project Reference: GDS1952

Client: Rushmoor Borough Council

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NOMENCLATURE

BGL – Below Ground Level

BH – Borehole

EGL – Existing Ground Level

GDR – Geotechnical Design Report

GDS – Geo Drilling Solutions

GI – Geotechnical Investigations

GIR – Ground Investigation Report

GWL – Ground Water Level

PSSR – Preliminary Sources Study Report

HDD – Horizontal Directional Drilling

ID – Internal Diameter

OD – Outside Diameter

QEP – Queen Elizabeth Park

RC – Rotary Core

ROW – Right of Way

SLP – Southampton to London Pipeline.

SPT – Standard Penetration Test

WS – window or windless sampling

1 INTRODUCTION

Geo Drilling Solutions have been requested by Rushmoor Borough Council to perform a high level review of proposals for pipeline installation at Queen Elizabeth Park (QEP), Farnborough, UK, on the Southampton to London Pipeline (SLP) project.

The purpose of the review is to perform as preliminary assessment into the feasibility of using the Horizontal Directional Drilling (HDD) method for pipeline installation, as an alternative to the conventional open cut pipeline installation method, to cross the QEP area. The open cut method is expected to require the removal of trees in the park, in addition to potentially causing prolonged disruption and visual impact to the area for QEP users. Alternative trenchless pipeline construction methods such as microtunnelling, tunnelling, augerboring, etc have not been considered as part of this review. It has been assumed that references to trenchless methods in the reference documents provided refer to the HDD method for the purpose of this review.

The review is based on the information supplied to Geo Drilling Solutions by Rushmoor Borough Council (RBC).

2 SUMMARY

The SLP project is proposing to install a new fuel pipeline through Queen Elizabeth Park, Farnborough, using the conventional open cut method for pipeline construction. The project has expressed doubts regarding the feasibility of trenchless crossing techniques for this section of the pipeline route, and has cited engineering and logistical difficulties in response to queries from interested parties. The Neighbours and Users of QEP have submitted evidence (Ref [4]) detailing alternative proposals to the open cut method, using the HDD method for trenchless installation of the pipeline through the QEP section. Other methods for trenchless installation of pipelines have not been considered within the examination by RBC due to lack of specialist pipeline industry knowledge. The feasibility of alternative trenchless pipeline installation methods, such as microtunnelling, should be explored.

Queen Elizabeth Park is described in reference documents provided as:

‘Surrounded by the urban extent of Farnborough, Queen Elizabeth Park is set within a broadleaved woodland to the north of Farnborough Train Station. Dense trees and shrubs enclose views within the park.’

Current proposals will involve the removal of existing trees within the park to facilitate pipeline construction. The SLP project has identified a number of mature trees in the area and their proposals have been adapted in order to retain as many mature trees as possible. However there is no detail as to how many of the 33 trees to be lost are mature. Alternative proposals outlined in Ref [4] may still involve the removal of trees in the QEP area but the number is expected to be lower than the number anticipated by the project for their open cut solution. All of the trees to be removed are young trees, more like scrub than trees.

Geo Drilling Solutions have been requested by Rushmoor Borough Council to provide an expert opinion on the feasibility of using a trenchless (HDD) method for pipeline installation below ground level through QEP, as an alternative to the currently proposed open cut method.

Geo Drilling Solutions have reviewed the documents and drawings provided by Rushmoor Borough Council and the main findings are summarised below. Further discussion is included in Section 4.

- Borehole logs from existing SLP project geotechnical borehole investigations in the general area appear to show ground conditions that are suitable for HDD based on the soil descriptions provided. No additional information has been provided relating to laboratory testing of samples, photographs of soil samples taken, particle size distribution analysis, groundwater, etc. This type of information is required for any detailed assessment into the feasibility of using the HDD method for pipeline installation. The

boreholes are outside the area under consideration and cannot be relied upon for an assessment into the feasibility of using the HDD method for pipeline installation in the QEP section of the pipeline route. In order to be able confirm or rule out the feasibility of using the HDD method, site-specific information relating to subsurface conditions in the QEP section of the pipeline route, such as geotechnical or geophysical survey data, is required.

- HDD profile and pipeline string geometries suggested by the SLP project as part of alternative proposals to the open cut method are not considered to be optimised solutions, and it is believed that there is scope to optimise the HDD profile and pipeline string geometries further. Pipeline string lengths can potentially be split to reduce Right of Way (ROW) length requirements, depending on the ground conditions present, the stability of the HDD borehole, pipeline welding times, etc. The radius of curvature of the pipeline string above ground in pipeline stringing areas could potentially be reduced below the 400m radius figure used by the SLP project. The figure used appears to be high based on the temporary status of the pipeline string in this condition. The use of shorter pipeline strings can also reduce the requirement to curve the pipeline string to remain within the limits of the ROW.

3 REFERENCES

Geo Drilling Solutions have been supplied with multiple reference documents relating to the SLP project for review. Each document has been examined for information pertinent to pipeline installation at the QEP area and documents considered relevant to the high level review, including HDD industry guidelines and publications, are listed below.

[1]	Southampton to London Pipeline Project Deadline 3 Response to Action Points from the Issue Specific Hearing on Environmental Matters on December 3 2019 (ISH2) Application Document: 8.20 Planning Inspectorate Reference Number: EN070005 Revision No. 1.0 December 2019
[2]	Southampton to London Pipeline Project Deadline 3 Response to Action Points from the Issue Specific Hearing on Environmental Matters on 4 December 2019 (ISH3) Application Document: 8.22 Planning Inspectorate Reference Number: EN070005 Revision No. 1.0 December 2019
[3]	Southampton to London Pipeline Project Deadline 4 Response to ExA's Further Written Questions – Queen Elizabeth Country Park (QE) Application Document: 8.42 Planning Inspectorate Reference Number: EN070005 Revision No. 1.0 January 2020
[4]	Response to ISH5 Action Point 36 on behalf of the Neighbours and Users of Queen Elizabeth Park Interested Party Reference No. 20022545 (Nick Jarman)
[5]	Various correspondence between Rushmoor Borough Council and Geo Drilling Solutions
[6]	DCA Technical Guidelines – Information and Recommendations for the Planning, Construction and Documentation of HDD Projects (DCA) (4th Ed) (2015)
[7]	Trenchless Technology – Planning, Equipment and Methods (Najafi) (2013)
[8]	Horizontal Directional Drilling – Utility and Pipeline Applications (Willoughby) (2005)

4 DISCUSSION

4.1 SLP CURRENT PROPOSALS FOR PIPELINE INSTALLATION AT QEP

Currently, the SLP project plans to use the conventional open cut method for pipeline installation to cross the park area at QEP. The project is proposing a narrow working corridor through the QEP area to limit the impact on the park and existing precious trees, and to minimise disturbance of the park during pipeline construction activities, although access for park users may be reduced significantly. It is also proposed to use the QEP park area for pipeline stringing on the adjacent TC018 HDD crossing.

Figure 1 below is based on Figure 1.1 from Reference [1] and shows what are believed to be the current proposals for pipeline installation through QEP, and current proposals for pipeline stringing operations at the adjacent TC018 HDD crossing. The HDD exit point site compound for TC018 is shown on the western end of the proposed pipeline route through QEP. A site compound for the TC019 crossing (augerbore crossing of the A325 road) is shown on the eastern end of the proposed route through QEP.

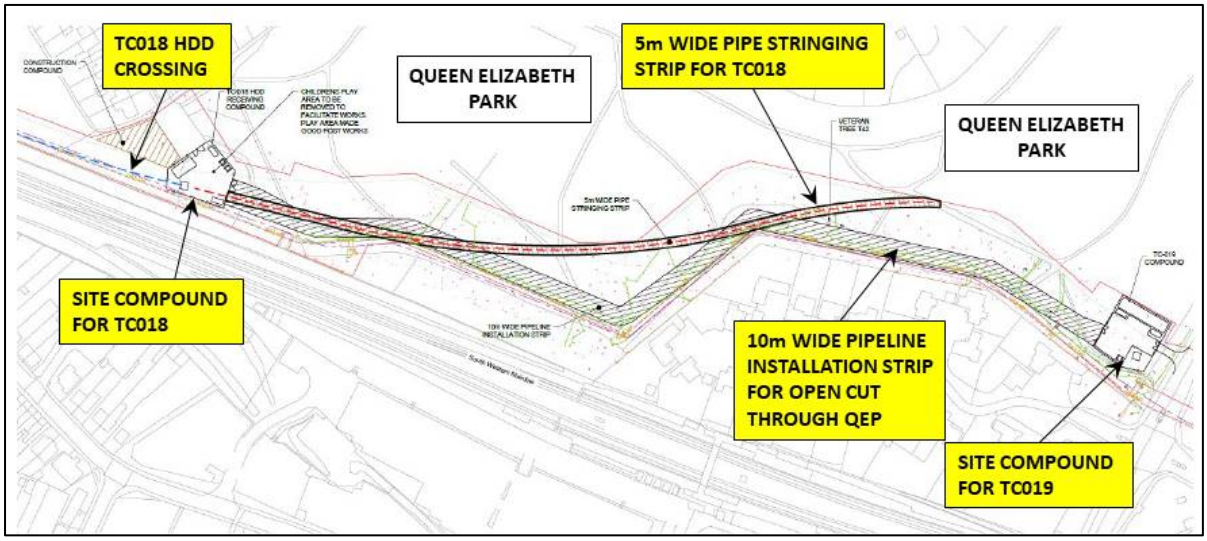

Figure 1 – Current proposals for pipeline installation through QEP section of the SLP pipeline route

4.2 SLP ALTERNATIVE PROPOSALS FOR PIPELINE INSTALLATION BY OPEN CUT AT QEP

The SLP project (referred to as 'Applicant' in project reference documents [1], [2] and [3]) has provided responses to queries from interested parties, and preliminary details of alternative proposals to pipeline installation by open cut. Some of the more pertinent responses relating to the potential use of the HDD method for pipeline installation at QEP are discussed below.

Relevant Actions/Queries	Applicant Response	Geo Drilling Solutions Comment
Action #15 (Reference [1])	"The Applicant has undertaken studies of the potential to undertake a trenchless section of the route from the play area in QEP through to Farnborough Hill School"	These studies should be reviewed if they have been made available. It is understood that these studies have been requested from the Applicant by RBC, to assist with the preparation of this report, but have so far not been released by the Applicant.
	"The use of trenchless techniques requires working at much greater depths and regardless of ground investigation surveys there is always the risk of encountering difficult unknown geology which can cause delays and even failure of the HDD and the need to open trench."	Total failure of a HDD crossing (Requiring an open cut trench as an eventual alternative) is an extremely rare event. The first alternative to a failed HDD crossing is normally to re-drill the crossing. Several re-drills can sometimes be accommodated depending on working area restrictions, ground conditions, pipeline diameter, etc.
	"The particular issues that relate to the alternative of an HDD from QEP to Farnborough Hill school are as follows: The HDD from Stake's Lane would still need to be strung out through QEP and this would involve some tree removal and disturbance to park users."	The potential to reverse the direction of the HDD at Stake's Lane should be investigated in order to assess the feasibility of utilising land parallel to the railway as a pipeline stringing site.
	"To locate the HDD drive pit in this area of the park would require greater mobilisation of plant to the location, a larger drive compound and the potentially greater loss of trees in the south west corner. See Figure 1.3. It also changes the nature of the work from an HDD receiving pit to a drive pit which will result in more noise, larger plant and greater disturbance."	Tree loss can potentially be limited. Items of equipment / offices / storage / welfare facilities can be double-stacked in restricted working areas. Noise barriers can be erected to minimise the impact to adjacent residences. Equipment can be soundproofed.
	"The HDD would require stringing out approximately 600m of pipe in the school grounds."	The pipeline string can be split into shorter lengths depending on borehole stability and pipeline welding times. The geometry of the pipeline string above ground is more flexible than the geometry of the HDD profile. There may be opportunity to optimise the geometry of the pipeline string, or strings, such that the pipeline stringing operation remains within the limits of the current ROW boundary.

	"HDD Option 1- Referring to the sketch (Figure 1.4) above. In order to provide sufficient stringing out distance within Farnborough Hill School (approximately 600m) the receiving compound needs to be in a location within the school ground which would likely necessitate removal of a number of trees in the southern corner of the grounds - including two Veteran Trees. Even when utilising the maximum radius bend for stringing, the string layout is shown to be approximately 30m short of the required length. This shortfall could be accommodated by moving the start point in QEP further back, out of the play area and nearer to the south east corner of the park, which would result in further tree loss. This stringing alignment would also require encroachment on the school grounds."	The HDD profile shown in Figure 1.4 (Ref [1]) contains compound curves which would have to be assessed in terms of suitability for HDD profile drilling, the effect on pipeline installation, and SLP pipeline stress limits. In order to stay within the current ROW boundary lines, the pipeline string could potentially be split into shorter lengths depending on borehole stability and pipeline welding times. The radius of curvature (this should be minimum, not maximum as stated) of the pipeline string in Figure 1.4 (Reference [1]) appears to be larger than necessary. There may be opportunity to reduce the minimum radius of curvature further. The HDD exit point site ('receiving compound') can potentially be moved further West, and the length of the HDD crossing increased, if the use of shorter pipeline strings is feasible.
	"HDD Option 2 - Referring to sketch (Figure 1.5) below. In order to reduce the potential loss of Veteran Trees in the school, this refined layout positions the receiving compound in a location that does not result in the removal of Veteran Trees, however due to the change in alignment there is insufficient stringing length, approximately 150m short. The string could potentially be broken into two sections, however welding, testing, & coating does take a number of days and whilst it is possible to restart a HDD string pull (it is standard practice to pull a string back in one continuous operation), it is has a higher risk of failure which could extend the installation period significantly and could require work to extend into the school term time."	The statement that welding, testing & coating of the pipeline takes a number of days is incorrect. If the pipeline string was split into 2 strings, for example, the pipeline installation operation should only need to be paused for up to 6 hours maximum in order to perform the tie-in weld between the 2 strings. This scenario could be planned for accordingly. The feasibility of this scenario is dependent on the ground conditions present, the stability of the borehole after final HDD borehole cleaning operations, and HDD contractor competence. Contingency measures can be planned in advance for this crossing where a non-standard approach to pipeline installation may be required.
	"This alignment would also require the stringing area to pass through an area of notable trees on the school's southern boundary."	It may be possible to tighten the radius of curvature on the pipeline string alignment shown in Figure 1.5 (Reference [1]) so that the pipeline string remains within the current ROW boundary lines shown in Figure 1.5.

QE 2.1 (Reference [3])	"When using a horizontal directional drilling (HDD) technique, the HDD pipe string needs to be welded to its correct length (the full length of the proposed HDD) and laid out on rollers in as straight a line as possible matching the alignment of the below ground section of the HDD. This is to allow it to be pulled back into the HDD bore. There can be some bending incorporated in the pipe string – the Applicant has calculated that a bending radius of approximately 400m can be achieved given the diameter and thickness of the steel pipe."	It is definitely preferable to fabricate the pipeline string in a single length and for the alignment of the pipeline string to be in line with the HDD borehole. However, this does not preclude splitting the pipeline string into shorter lengths, or having multiple changes of direction in the pipeline string. The risks associated with pipeline installation into the HDD borehole can increase, but the risks can also be mitigated against. The radius of curvature quoted appears to be an arbitrary figure. It may be possible to reduce this figure.
	"It would not be possible for the stringing area to lie adjacent to the Open Cut alignment as the acute bends could not be achieved."	The pipeline string could potentially be split into shorter lengths. A tighter radius of curvature for the pipeline string may also be achievable.
QE 2.2 (Reference [3])	"The Applicant can confirm that it is technically feasible to HDD beneath QEP, but doing so would, in the Applicant's view, transfer effects versus the Open Cut in QEP"	Feasibility of the HDD option cannot be confirmed until adequate data has been obtained relating to subsurface conditions.
	"While a trenchless crossing of Queen Elizabeth Park is physically possible, the Applicant maintains that its adverse impacts would be greater than the current proposal for Open Cut."	It is assumed here that 'trenchless' refers to HDD. In pipeline construction, 'trenchless' applies to several crossing construction methods such as HDD, microtunnelling, tunnelling, augerboring, etc. Alternative trenchless methods to HDD should be considered. Variations on each method may be feasible depending on ground conditions and available space.

It is evident in the comments above that the HDD profile and pipeline string geometries suggested by the SLP project as part of alternative proposals to the open cut method are not considered to be optimised solutions, and it is believed that there is scope to optimise the HDD profile and pipeline string geometries further. Pipeline string lengths can potentially be split to reduce Right of Way (ROW) length requirements, depending on the ground conditions present, the stability of the HDD borehole, pipeline welding times, etc. The radius of curvature of the pipeline string above ground in pipeline stringing areas could potentially be reduced below the 400m radius figure used by the SLP project. The figure used appears to be high based on the temporary status of the pipeline string in this condition. The use of shorter pipeline strings can also reduce the requirement to curve the pipeline string to remain within the limits of the ROW.

4.3 EXISTING GEOTECHNICAL DATA

Good quality subsurface geotechnical information is important when assessing the feasibility of HDD crossings. The greater the quantity of subsurface information available, the further that ground risk associated with the HDD method can be minimised.

No site-specific geotechnical data is available for the section of the SLP pipeline route through QEP. It was noted in correspondence relating to QEP that the SLP project believe that subsurface conditions to be 'very sandy' and 'therefore pose a significant risk to HDD'. The assertion that sandy ground poses a significant risk to HDD operations is an incorrect statement. Ref [7] states that HDD as a trenchless construction method is 'generally

suitable by an experienced contractor with suitable equipment' in 'medium to dense sands above and below the water table'. Ref [8] states that HDD feasibility is 'Good to Excellent' in 'very loose to very dense sand with or without gravel traces' (i.e. Gravel % by weight = 0 – 30%).

A HDD crossing is being proposed for trenchless crossing TC018 on the SLP pipeline route immediately adjacent to QEP, which indicates that ground conditions along the route of TC018 are considered to be suitable for the HDD method.

Whilst several geotechnical investigation boreholes have been drilled for the SLP project in the general area of QEP, no site-specific boreholes have been drilled along the route of the proposed pipeline section through QEP. The closest SLP project borehole to the western end of the proposed route through QEP is BH219, which has been drilled on the western side of the existing play area. The closest SLP project borehole to the eastern end of the proposed route through QEP is BH55.

A number of SLP project geotechnical borehole logs have been made available for review. None of the boreholes have been drilled in the area under consideration for HDD. It should be noted that only the borehole logs have been provided. No laboratory testing results, sample photographs, ground permeability information, particle size distribution information, etc. for the boreholes has been provided. This information would be required to fully assess the feasibility of HDD, as well as alternative trenchless methods to HDD. A list of the borehole logs reviewed, the borehole depth, and the predominant soils recorded in each borehole, is provided below.

SLP Borehole No.	Borehole Depth	Predominant Soils Present
BH55	10.45m	Medium Dense Silty Fine to Medium SAND.
BH56A	10.55m	Medium Dense to Dense Silty Fine to Medium SAND.
BH152	20.0m	Dense Clayey Silty Fine to Medium SAND below layers of Stiff Sandy Gravelly CLAY, and Dense SAND and GRAVEL.
BH155	15.45m	Medium Dense to Dense Silty Fine to Medium SAND below layer of Loose to Medium Dense Silty SAND and GRAVEL.
BH219	10.45m	Medium Dense to Dense Fine to Medium SAND.
WS260	3.8m	Silty Clayey Fine to Medium SAND
WS261	9.0m	Medium Dense to Dense Silty Clayey Fine SAND.

The predominant ground conditions present according to the boreholes provided is Medium Dense to Dense Silty Fine to Medium SAND (assumed as Camberley Sands). No competent bedrock level was recorded in the borehole logs provided. This type of ground is considered to be suitable for HDD. However, it is not known if these are the soils that would be present along any QEP HDD route option and, therefore, the feasibility of HDD in this area cannot be confirmed.

5 RECOMMENDATIONS

If there are feasibility studies/constructability reviews for the adjacent trenchless crossings at TC018 and TC019 then these documents should be made available for review as they may include information which may help with any further investigation into the feasibility of a trenchless crossing at QEP.

HDD appears to be the only trenchless pipeline construction method under consideration as an alternative to the conventional open cut method. Microtunnelling could also be considered as the method is commonly used for long distance trenchless installation of pipelines.

Further consideration should be given to optimising pipeline string lengths and geometry for any HDD option. It is recommended that a tighter radius of curvature for the pipeline string is considered. Splitting of the pipeline string into shorter lengths should also be considered. Routing the underground section of the HDD profile outside of the current ROW boundary, if necessary, should be considered.

In order to be able to determine the feasibility of the HDD method at QEP, it is vital that site-specific geotechnical surveys are performed. Currently it is not possible to properly assess the feasibility of the HDD method at QEP without site-specific geotechnical and topographical survey data. The minimum requirements for geotechnical investigations at a HDD crossing (Reference [6] are that investigative boreholes must be carried out over the drilling route and should not be closer than 5m to the drilling line / drill path at a distance of 50-100m relative to the drill length. Therefore, for a 500m long HDD section, it is recommended by HDD industry guidelines that a minimum of 4 geotechnical investigations are performed. The depths of the boreholes should be extended to an appropriate depth below the proposed HDD profile.

In order to be able to perform intrusive geotechnical investigations in QEP, then temporary access for appropriate geotechnical borehole drilling equipment would be required. This should be taken into consideration. Geophysical surveys could also be considered but would have to be appropriate for the ground conditions present and the likely depth of the HDD profile below ground level.

The schedule and cost impact to the SLP project of a ‘new’ HDD crossing at QEP could be minimised by utilising the HDD contractor and equipment already mobilised for the proposed HDD crossing at TC018. Synergy between HDD operations at TC018 and a HDD crossing at QEP should be considered further.