Managing Underground Services in a Trenchless Installation Project

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ABSTRACT

Minimising the disruption to the public is one of the key fundamental benefits of trenchless Utility installation. However, if an underground service is struck then the consequences of this can far outweigh & overcome any potential "lack of disruption" benefits. Therefore successful management of underground utility services is paramount to achieving a successful trenchless installation project, from both the Contractor's & Client's perspectives.

This paper will discuss the best practices to be followed, as well as a risk management strategy, for both the Contractor & Principal with regard to the issue of locating & managing underground services. It will consider how both parties' legal & contractual obligations can be met, investigate the latest technology available to assist in locating services and also discuss the unseen risks associated with drainage laterals.

Finally, it will "close the loop" by discussing the latest technology to as-built services installed by trenchless methods; as today's new installation becomes tomorrow's existing service that needs to be located & protected and therefore any methods that can be utilized today to make tomorrow easier should be considered.

KEYWORDS

Underground Utility service, ground penetrating radar, drainage lateral, Smart probe, Risk

1 INTRODUCTION

As more Utility owners realize the benefits & advantages of trenchless service installation and Contractor's experience & equipment improves to install such like over greater distances & of larger sizes, so does the probability of striking an underground service increase. The consequence of a service strike can range from a minor inconvenience to a catastrophic explosion and even fatalities. Therefore Risk management strategies to lower the risk must be employed whenever & wherever trenchless utility installations occur. The level of risk mitigation & subsequent associated cost benefit of such shall change depending on the various circumstances; however the general principles & practices to be followed remain the same.

With regard to underground services, the very same benefits of trenchless installation are its pitfalls, compared to the traditional open cut installation. Trenchless installation is effectively "blind" to what is happening underground, both with respect to what is there and also the effect of the installation. Open cut excavation allows you to find & see the underground services as you trench. It also ensures that the installation works do not damage any existing service. In a trenchless installation however, without prior investigation, the location of underground services is an educated guess, similarly any damage caused to a service may not be known at that time & not realized until it becomes a major incident.

A Risk assessment consideration of " *Out of Position Underground Service* " and / or " *Damage to an Existing Service* " will identify that locating underground services is a jointly shared risk for both the Principal & Contractor alike and as such, is best managed in a co-operative, open manner between both parties & not viewed as only being the contractor's problem. The Principal has an equal responsibility towards managing underground services, as the contractor.

2 PRINCIPAL & CONTRACTOR RESPONSIBILITIES – LEGALLY & CONTRACTUALLY

2.1 LEGAL RESPONSIBILITIES UNDER HEALTH & SAFETY IN EMPLOYMENT LEGISLATION

There are numerous NZ statute laws that apply to all Contract Construction works, however with regard to managing underground services, the key legislation is the HASE Act 1992 & 2003 amendments. This Act covers both equally Principal / Client responsibilities and Contractor's. The particular relevant clauses are as follows (please note this is abridged and for reference only & should not be used for any legal requirements) :

2.1.1 SECTION 5 – OBJECT OF ACT

The object of this Act is to promote the prevention of harm to all persons at work and other persons in, or in the vicinity of a place of work ;

2.1.2 SECTION 6 – EMPLOYERS TO ENSURE SAFETY OF EMPLOYEES

Every employer shall take all practicable steps to ensure the safety of employees while at work ; and in particular shall take all practicable steps to –

a) Provide & maintain for employees a safe working environment;

2.1.3 SECTION 18 – DUTIES OF PRINCIPALS

Every principal shall take all practicable steps to ensure that –

a) No employee of a contractor or subcontractor; and

b) If an individual no contractor or subcontractor, - is harmed while doing any work

2.1.4 HEALTH & SAFETY REGULATIONS 1995 ; SECTION 25 – EXCAVATIONS OF HAZARDOUS DEPTH

Every employer shall take all practicable steps to ensure where any excavation is –

a) Readily accessible to any person; and

b) Likely to collect or retain water of such a depth as to constitute a danger to any person, that –

c) Any such excavation is covered or fenced, when no employee is in the immediate vicinity to prevent access to it by any person; and

d) Any such excavation created in the course of the work is covered, fenced or filled at the completion of the work

Summarily this places legal obligations on both the Client / Principal and also the Contractor, as an employer, to have a process(es) in place to manage underground services, such that they do not cause or create a harm to anyone, either employee's or the public. Furthermore these obligations cannot be "contracted out of " they apply to and are enforced to both parties equally.

2.2 CONTRACT RESPONSIBILITIES UNDER NZS 3910:2003

The vast majority of all construction contracts awarded in New Zealand use NZS 3910: 2003 Conditions of Contract for Building & Civil Engineering Construction. This document contains One (1) particular relevant clause, as follows, with regard to the issue of underground services, that outlines the roles & responsibilities of the Principal & Contractor. As noted above, although some Principal's amend this clause to shift more of the risk onto the Contractor, the Principal still has legal requirements to meet under NZ statute law, which override

any Contract condition.(please note this is abridged and for reference only & should not be used for any legal requirements) :

2.2.1 SECTION 5.13.1 – UNDERGROUND & ABOVE GROUND UTILITIES

The Principal shall arrange for the searching of records to determine the existence & position of pipes, cables & other utilities on or about the site, and the position of such utilities shall be indicated on the Contract documents as accurately as the information permits.

2.2.2 SECTION 5.13.2 – UNDERGROUND & ABOVE GROUND UTILITIES

The Contractor shall be responsible for physically locating the position of all such utilities and shall arrange with the controlling authorities for any necessary exploratory work, location, protection, isolation, offsetting, re-instatement or alterations required. –

2.2.3 SECTION 5.13.3 – UNDERGROUND & ABOVE GROUND UTILITIES

The contractor shall be responsible for protecting all utilities whether indicated or not and for arranging their re-instatement or the repair of any damage resulting from its operation.

2.3 GUIDE FOR SAFETY WITH UNDERGROUND SERVICES - 2002

The Department of Labour & OSH have also published a book of guidelines for safe working practices in & around underground services. Although this book is guidelines only & not a legal requirement, the information contained in it is considered "Best Practice" and should be used and followed as a minimum.

The booklet is not detailed but contains some very useful information and should be constantly used & referred to by both Contractor's & Principal's alike, but conversely should not be considered to the "Be All & End All" with regard to locating, protecting & working around underground services. www.osh.dol.got.nz

2.4 RISK MANAGEMENT ASSOCIATED WITH LOCATING SERVICES

The decision as to by whom & when the underground services should be located is project specific and should be determined by the Principal / Client during their project Risk Assessment. The risk of the underground services not being in the position as shown on the Utility owner's plans should be part of the project risk assessment matrix, and assessed in the same manner as ground conditions are assessed as being practical for a trenchless installation.

If the risk of underground services being out of position is assessed as high, due to the need for the new asset to be installed to specific line & level, as is sometimes the case with gravity drainage works, or the fact that there is a tight congestion of existing services in a narrow installation corridor then it is prudent for the Client to undertake a level of service location works during the design stage. Conversely, if there are a number of possible alignment scenarios and / or only a few minor services in a relatively open area then the contractor should be left to locate the services within their overall scope of works.

The nature of the existing underground assets should also be considered in the risk assessment, with respect to the possible consequence of the service being damaged eg a trunk watermain / sewer / gas pipe or high voltage power. Here again, if the risk is assessed as high, then it is prudent for the Principal to get the service located during the design phase.

In assessing this Project Risk, the Principal should evaluate as to whether they and / or their designer has the necessary skills, experience & personnel to carry out this work or whether a specific specialized contractor should be engaged. It should be noted that, as the need & relevance of locating services in a trenchless installation project is now being more fully appreciated by all parties, contractors who specialize solely in this field are becoming more prevalent. There has also been an NZQA Unit standard developed for this specific issue, which again shows its importance & relevance.

2.5 SUMMARY

It can be concluded, that legally & contractually the responsibility for the determination, locating & protecting of underground services in a Trenchless Installation project is shared equally between the Principal & Contractor. Neither party can " Contract Out " their obligations. From a Risk Management Strategy, the responsibility should be jointly shared between both parties, as both have as much to gain & lose, with regard to public image / perception, safety, timeliness & cost, as each other.

3 LOCATING AND MANAGING UNDERGROUND SERVICES

3.1 GENERIC PROCEDURE

Whilst it is accepted that every Project & site is unique and therefore has its own site specific challenges to be met and similarly, every Client has their own specific requirements & procedures that must be followed there are however, with respect to locating underground services, some generic processes that can be applied, as detailed below :

1. Obtain all information from all relevant Utility owners. This can be done by either contacting each utility owner separately, or, where available, using the "Before U Dig " utility location service. This is a simple Internet based " One - Stop – Shop " that contacts all of the relevant utilities for you. This information will consist of the Utility owner's GIS records in hard copy paper map format. Ref www.beforeUdig.co.nz.

2. Mark out all utility service positions within the work site. Once contacted, the utility provider will generally undertake this work.

3. Locate & expose, by hand digging, all services to confirm their exact position and depths. This is critical, as unfortunately, services are not always either where they are shown on GIS maps and / or where there are marked as being. This aspect of the process will be described in more depth further within this paper.

4. All works must be completed by hand digging methods, the use of excavators and / or spearing is strictly prohibited

5. All services located must be treated as "Live" until proven or confirmed otherwise, by the Utility owner.

6. Confirm the condition of the Utility service. Depending on the current state or condition of the asset, it may either necessitate the Utility owner to carry out some remedial works prior to the trenchless installation or place proximity constraints on the trenchless installation ie determine how close to the existing service the new installation can be. The specific trenchless installation procedure needs to be

taken into account, with regard to this aspect, as different methodologies exert different forces & pressures on the surrounding ground & asset types.

7. In conjunction with Items 3 - 6 above, the depth to the underside of the asset also needs to be determined. It is not uncommon for ducts to be laid in banks of rows ie 3 ducts wide by 4 ducts deep. This is most common with Telecommunications & Power assets and although sometimes these are shown on their GIS maps, they are not always. This should be considered when determining the position of the new service, particularly with respect to the size of the back cut & any ground pressures that may be exerted as a result of the installation methodology. In most cases Utility owners will stipulate how close a new service can be installed to their asset but if nothing is stated, 500mm separation should be used as benchmark minimum.

8. Where at all possible, the pilot excavations should be left open until the new asset installation has passed, requiring proper protection through the use of fences, barricades, plates etc. This allows, not only, confirmation that the asset is installed in its planned / proposed alignment & depth but also that no damage occurred to the existing service during installation. If, due to site constraints, it is not practicable to leave the exploratory pilot excavations open then accurate information with regard to depth & alignment of the existing service must be provided to the trenchless installer.

3.2 TRADITIONAL LOCATING METHODS

The traditional method for locating underground services has been to request the Utility owner to mark out the position of their services and then hand dig to locate them. This method works satisfactorily, but very much relies on the accuracy of the mark out position. If the utility is not where it is shown on the plans or marked on site then locating it becomes a "hit or miss " situation.

3.2.1 ISSUES TO BE AWARE OF USING THE TRADITIONAL LOCATING METHOD

The traditional method of hand digging to locate services, although satisfactory, does have a number of issues and / or limitations that need to be appreciated by both Principal & Contractor so that they can be managed, if this methodology is to be employed. The key issues are as detailed below;

a) What to do if the service is not where it is shown on the plan or marked to be? Who is responsible to locate it, where do you start to look for it and who pays; the Contractor, Principal or Utility owner?

b) The locations and number of the excavations may be disruptive to the community ie in driveways, roads etc and negate some of the benefits of a trenchless installation

c) Only shows known services, it does not have any allowance for a utility service that exists in the ground but is not shown on the plans. Nor will this service have been marked out.

d) The depth of the utility is not known. Any depths given on plans should be considered "indicative only" and not relied upon. Therefore, if you have not found the service at a reasonable depth ie < 1.2m then it is unknown as to whether or not it is still deeper or in a different location.

3.3 LATEST TECHNOLOGY & INNOVATIVE TOOLS

As trenchless installation methods have developed & improved, so to have the tools associated with trenchless installations, including service locators

3.3.1 BASIC PIPE LOCATORS

The first basic development was the use of " Cat & Genny " locators that use a combination of magnetic field, radio wave frequency & induced signal detection to locate the position of the service. The Genny signal locator transmitter supplies either a "direct connection" or "induced" signal mode to the utility service. The Cat locates, above ground, the signal either naturally radiating from a metallic services or generated by the Genny.

These are still commonly used today by most utility operators and also more contractors are starting to use these themselves.

Photograph 1: Cat & Genny Locator

3.3.1.1 ISSUES TO BE AWARE OF USING BASIC LOCATORS

Although the " Cat & Genny " has improved greatly over the past 20 years, with improvements in technology, and eliminates some of the issues noted in item 3.2.1, they still have limitations. The key issues to be aware are as detailed below;

a) Will not detect non metallic pipes ie AC / PVC / PE pipes, or plastic ducts with Fibre optic cable, unless other "detection" devices have been installed as well ie magnetic strip, trace wire

b) Reliant on the skill & experience of the operator using the equipment to know what is being identified

c) Other existing services in the near vicinity can affect the signal definition & accuracy and / or appear as 1 signal not multiple

3.3.2 GROUND PENETRATING RADAR

A more recent development in underground utility location is Ground Penetrating Radar (GPR). This non-destructive method uses radar pulses in the UHF / VHF frequencies and detects the reflected signals from subsurface structures. GPR can be used in a variety of media, including rock, soil, ice, fresh water, pavements and structures. It can detect all range of underground objects,including not only pipes & ducts but also other structures & chambers as well as changes in ground material, voids and cracks.

GPR uses a combination of transmitting and receiving antennas wherein the transmitting antenna radiates short pulses of the high-frequency radio waves into the ground. When the wave hits a buried object or a boundary with different density, the receiving antenna records the variations in the reflected return signal.

GPR units come in a range of sizes & shapes from a small simple cart that can be pushed down a footpath by one person, to a series of units (4 or more) that are linked together and are towed behind or infront of a vehicle to give a full picture definition of a whole carriageway.

Photograph 2: Various forms of Ground Penetrating Radar Units

3.3.2.1 ISSUES TO BE AWARE OF USING GROUND PENETRATING RADAR

As with the basic " Cat & Genny " technology, even this latest technologically advanced equipment has limitations. The key issues to be aware are as detailed below;

a) Reliant on the skill & experience of the operator using the equipment to know what is being identified

b) Ground conditions can alter the accuracy and depth of the results. Best results are achieved in dry materials with low electrical conductivity, in these cases up to 15m depth is possible. However in wet soils with high electrical conductivity the accuracy can be as little as only a few centimetres.

3.3.3 " SMART PROBE " 3 - DIMENSIONAL MAPPING

Another of the latest technology tools available for underground locating is Geospatial's Smart Probe™. This technology provides accurate 3 dimensional centerline mapping of pipeline infrastructure, with the option of converting this open format data into a GIS or CAD database. Refer www.geospatialcorporation.com for full details.

This mapping technique uses multiple gyroscopic inertial measurement units (IMUs) within the Smart Probe™ to measure angular and linear velocity changes per second in the X, Y and Z axes as the unit is pulled through the pipeline, thus producing the 3 D map. By establishing reference points with known GPS coordinates at the start and end of the run, and on very long runs at known intervals between the two, a full complete plan can be drawn, with no depth limitations.

Geospatial's Smart Probe™ technologies allow the digital mapping of pipelines as small as 40mm (ID) to as large as 2500mm. In addition, the Smart Probes™ are designed in numerous body styles, allowing the negotiation of extremely tight (90 degree) bends. With these and other unique features, Geospatial's Smart Probe™ technologies are suitable for the location and digital mapping of most all urban utility assets.

Photograph 3: Geospatial SmartProbe

3.3.3.1 ISSUES TO BE AWARE OF USING " SMART PROBE " TECHNOLOGY

The key issues to be aware are as detailed below;

a) Requires to be pulled through a clean pipe / duct. Therefore some preparation work & installation of a pulling rope is required. This may preclude it's use on some "in service" pipes / ducts.

b) May not be cost effective for small projects, in New Zealand.

c) Access is required at both ends of the service duct

3.4 GENERAL ISSUES TO BE AWARE OF WHEN LOCATING SERVICES

Notwithstanding whichever methodology, technology & equipment described above is used, and their own specific limitations, there are still a number of generic issues & risks, associated with locating underground services, that need to be recognized and allowed to be managed. These can be summarized as follows :

a) All utilities in the installation window, both longitudinally & laterally need to be exposed, to confirm their exact location with respect to the installation alignment.. GPR & Smart Probe can assist in confirming if a service is within the window.

b) All excavations must be hand dug and properly protected by use of fences / barricades & plates.

c) All services located must be treated as live, until proven / confirmed otherwise. Never assume anything. The type of pipe or duct is not sufficient to assume the utility type, as various different utilities all use the same pipe types.

d) Care must be given to checking for other services installed underneath a located service.

4 DRAINAGE LATERALS – THE FORGOTTEN / OVERLOOKED SERVICE

Mainline drainage assets, sewer & stormwater, are shown on local authority GIS plans and can generally be located from manholes & by the use of CCTV camera / sonde, to confirm their exact position & depths. However, unfortunately, what is often overlooked, as they are not generally shown on GIS plans, are the branch

laterals connecting to the mainlines, from private properties. Throughout New Zealand, different local authorities treat these lateral pipes, in the road reserve, differently. Some treat them as a public asset (because they are in the public road reserve) whilst other Council's stipulate that they are still a private service until they connect onto the Council's mainline. Whichever definition is applied, the fact remains, that the pipe is there in the ground & needs to be located & protected accordingly. In this regard, generally, sewer laterals are a higher risk than stormwater laterals, but the issues & methodologies for dealing with & working around them are the same for either asset.

4.1 DETERMINING LATERAL POSITIONS

The first step in determining a drainage lateral position is to determine the existence of the lateral in the public road reserve. Although this may appear as obvious, it is generally overlooked by a lot of designers. The determination of the existence of a lateral can be simply done by drawing a line from the dwelling to the sewer mainline, taking recognition of the ground contours, so that the direction of flow is with the ground contour.

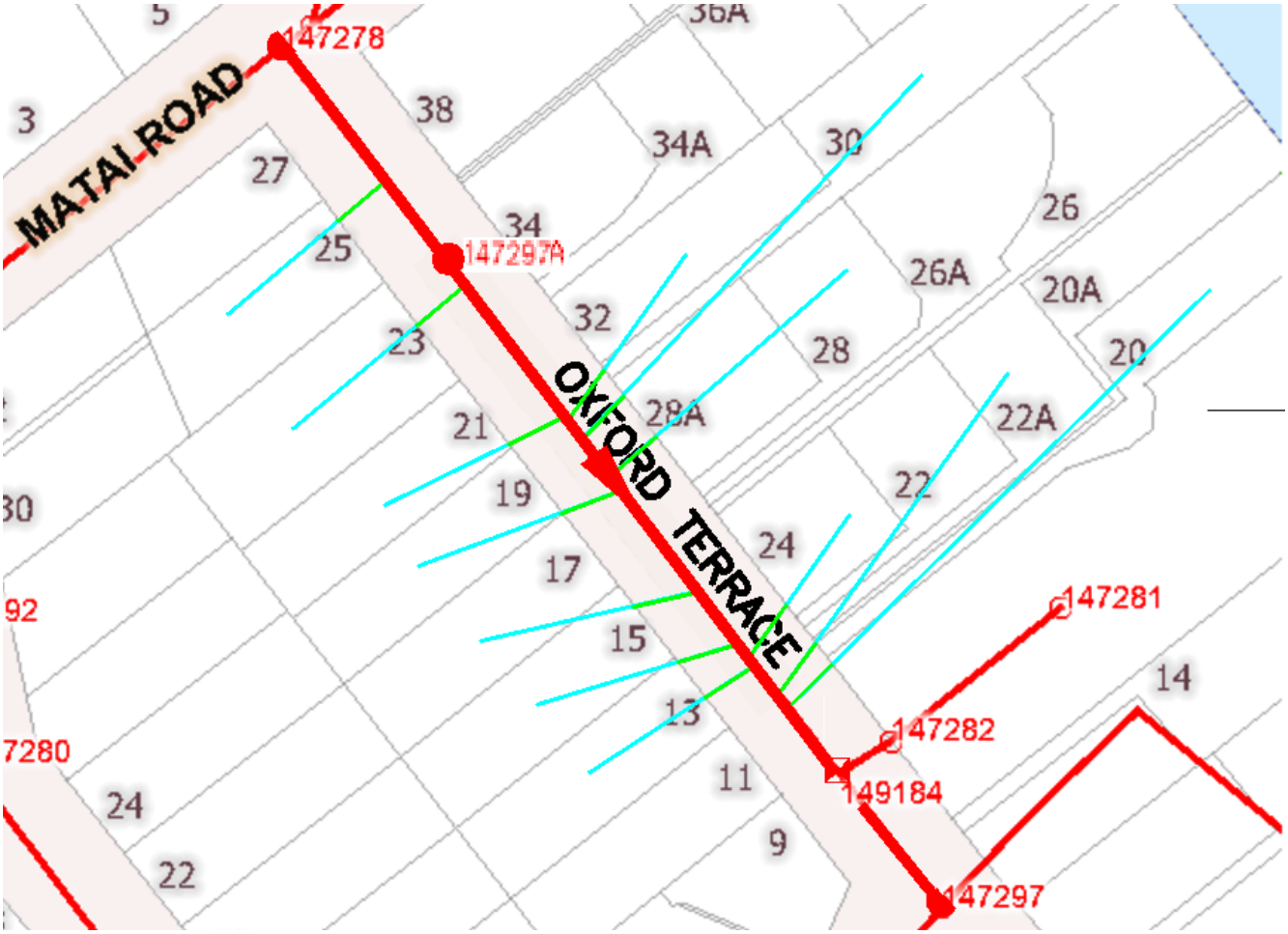

Figure 1: Sketch showing Public Laterals in Road reserve, from Private drainage to mainline connection

4.1.1 IDENTIFYING PUBLIC LATERAL POSITION BY USE OF SONDE

The location of a drainage lateral can only be accurately determined by inserting a sonde from the dwelling and tracking it where it exits from the private property up to the mainline pipe. Not only will the sonde give a longitudinal position but it can also give an approximation of the depth. It should be noted that the depth is only an approximation as the sonde's accuracy, with regard to depth, is affected by a number of on site variables, including concrete driveways, power & telecom cables.

A public lateral position and / or depth cannot be determined from a mainline CCTV. The reason for this, is that laterals do not run perpendicular from their connection on the mainline back to the property. In most

cases they intersect the mainline at an oblique angle & therefore interpolating a position from a mainline connection could run to anywhere along the property boundary. Similarly, the depth of the lateral cannot be assumed to be an even grade from mainline to building. Typically drainage laterals are laid from the building at a minimum flat, shallow grade, so as to minimize the depth of trench, and then ramped down prior to the mainline connection. Therefore, irrespective of the depth of the mainline, the lateral could be intersected at any depth.

Given that, as per above, the lateral depth cannot be determine or assumed from the sonde, once the lateral position is marked, it still needs to be located by methods, as described in section 4 above, to confirm it's exact position & depth.

4.1.2 IDENTIFYING PUBLIC LATERAL CONDITION BY USE OF CCTV CAMERA

An improvement to the above methodology, Item 5.1.1, is to push a CCTV camera down the lateral, with a sonde attached. The sonde still performs the same locating function, as above, with the camera providing a condition assessment at the same time. This methodology provides added value condition assessment, at little to no extra cost.

The value in obtaining a pre-installation condition status of the existing lateral is to;

a) confirm that the lateral is in a satisfactory state for the trenchless installation to proceed in proximity to it and / or any existing defects

b) for a post installation quality assurance, as a baseline reference point to check a post CCTV condition survey against.

Both of these issues are risk mitigation measures, irrespective of whether the lateral is considered public or under private ownership.

Furthermore, depending on the local authority's asset management strategy, this information can be used to update the asset condition register and therefore be available for use for any other projects & programmes that the local authority may be undertaking.

Photograph 4: Public Lateral Location & CCTV Camera

4.2 RISKS / ISSUES ASSOCIATED WITH TRENCHLESS INSTALLATIONS THROUGH DRAINAGE LATERALS

There are Two main risks / issues associated with the trenchless installation of a new asset through an existing drainage lateral. The first being the obvious damage to the lateral, and in the case of a sewer lateral, the

potential discharge of sewerage into the environment. These are not always identified at the time and can continue for long periods of time, until they are found.

The second risk ofthe trenchlessly installed asset causing a blockage & a subsequent overflow has two aspects to it that need to be recognized. Firstly, any sewerage overflow has public health & safety concerns that need to be carefully managed & contained. The second concern is due to the unblocking methodology. The common practice for the unblocking of a pipe is to use mechanical cutting tools & equipment, inserted down the pipe. Often the exact cause of the blockage is not known or able to be identified, even with CCTV equipment, as the cause of the blockage is hidden or shrouded in debris. If the obstruction is a gas pipe or power cable, the consequence of cutting into the service is potentially catastrophic & lethal. This risk is considered to be significant enough that it in some American States, it is compulsory, that after a trenchless gas or power installation is complete, a full CCTV of all laterals must be undertaken, as per 4.1.2 above.

5 LATEST TECHNOLOGY IN TRENCHLESS INSTALLATION AS-BUILTING

The latest asset installed today becomes tomorrow‘s existing asset to be located. Accurate as-builting of all underground utility services is therefore crucial to any utility owner for both their own asset management and to provide accurate information to other parties to minimize the risk of damage to the service. As such, the as built is one of the final stages in an installation project and “ Closes the Loop “ with regard to the management of underground services.

Traditional as-built information determines pipeline X & Y positions by above ground surveying of fixed or known points and interpolates the Z depth co-ordinate from the Contractor’s field notes.

For open trench installation this method can be reliable & accurate but depends greatly on how often the surveyor is called to site & how much of the conduit is open for surveying as opposed to already buried in the ground & not visible. Changes in grade & direction are not always identified or picked up in this manner, unless they are dramatic. Often the as-built interpolates a straight line between the fixed known points, which also is not always accurate or true.

In the case of directional drilling, the level of accuracy can vary even more greatly & the Client is almost totally reliant on the drilling contractor’s field notes & marks and a couple of surface boxes. Here again, in these cases, the as-built often interpolates straight lines between known points & generally shows the Client what the Contractor thinks the Clients wants to see, especially with regard to depth.

As described in Section 3.3.3, equipment such as the Smart Probe is the latest technology available for as-builting, including the third Z or depth co-ordinate & can eliminates all of the above issues in a single pass. One site setup is all that is required to complete a wholly accurate as-built survey of the whole conduit including depths & positions of all bends, without the need for any excavations to confirm compliance. In the case of the SmartProbe, the field data can be imported directly into the Client’s GIS system, negating any possible data transfer contamination or human error and ensuring that the most accurate, up to date information is available to all parties.

Notwithstanding these latest innovations, accurate as built drawings do not negate the need for piloting & locating the underground services, either prior to or during a trenchless installation project. Accurate as built information streamlines the location process and minimizes any potential risk of damage to the utility service.

Photograph 5: Various versions of SmartProbe As built Tool

6 CONCLUSIONS

The management of underground utility services, in a trenchless installation project, by both the Client / Principal & the Contractor are critical items that requires attention, consideration & planning, both at the inception of the project, in the risk assessment, as well as ongoing throughout the installation phase.

Management of underground services is a jointly shared risk between the Principal & the Contractor, with each party having legal & contractual obligations to meet, that cannot be contracted out. Although the balance of Risk shifts between the parties through the various stages of inception, design & construction, , the management of underground utility services and their associated consequences & risks must be jointly shared, if a successful project outcome is to be achieved.

The question of who, when & how should the underground services be located is best determined through the Principal's Risk assessment. Irrespective of who or when the locating works are carried out, consideration should be given to the use of the new technology & the associated tools available, including ground penetrating radar and SmartProbe, with respect to assisting in the locating of underground services. The selection of the appropriate tools should be governed & balanced to the complexity & criticality of the services to be located.

Unknown or unmarked Utility services are a risk and an issue for the Utility owners & contractors alike. Drainage laterals, extending from a private property into the public road reserve, are generally not shown on Local Authority GIS plans and should be considered unknown. A common sense review of the drainage GIS plans, considering the connection from building to mainline, will quickly identify whether drainage laterals are likely to be encountered within the trenchless installation window. Once their possible existence is determined,

location using either a sonde and / or a CCTV camera is the only appropriate method of locating their position. Consideration of "added value" benefits, at minimal extra cost, through the use of a CCTV camera should also be made by the Principal. These benefits include asset management data and post completion quality assurance.

The final stage, at the completion of any trenchless installation project, is the preparation of accurate as built information, as today's new asset becomes tomorrow's existing service. Accurate service as-builts reduce the risks of strikes & simplifies the locating of underground assets. In this regard, the advances in technology & the latest tools available should be utilized to achieve the most cost effective process, for the collecting and on going use of asset data and not just the short term preparation of a plan.

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Dept. of Labour – Guide for Safety with Underground Services (2002)