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Implementing the Australian Standard for Subsurface Utility Information – AS5488

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ABSTRACT

The Australian Standard AS5488-2013 provides a framework for the classification of subsurface utilities and their location via a set of four easy to understand quality levels. The intended audience are those agencies and organisations that own, operate or regulate utility infrastructure, and those that collect, depict and map such infrastructure. The standard facilitates good risk management strategies to be applied when working with or close to subsurface utilities. Subsurface utilities present a high risk for a range of civil construction activities. The risk is often realised via cost overruns in design and construction, work health and safety incidents, and service interruptions to affected utilities. The Australian Standard AS5488 aims to provide a consistent format and definition for information relating to subsurface utilities and help minimise these risks. Use of 'information brokers' such as Dial Before You Dig has become standard practice (and a legislative requirement in New South Wales prior to excavation in the vicinity of electricity and gas). However, the information provided by various asset owners via this pathway is of varying quality in terms of spatial accuracy, and sometimes information is withheld for reasons of security. Existing workflows tend to be focused on short-term outcomes related to project work. The typical workflow outlined in this paper is derived from Roads and Maritime Services guides. Analysis of the workflow highlights the additional steps that are required to capture information to meet the standard. The AS5488 standard provides a 'simple common language' for information captured relating to a subsurface utility. This can be disseminated for people who need to work with and around an asset in the future. This paper will explore strategies to incorporate this standard into existing workflows across a variety of disciplines.

KEYWORDS: *Subsurface, utility, Australian standard.*

1 INTRODUCTION

The recently published Australian Standard AS5488-2013 Classification of Subsurface Utility Information (SUI) provides a national framework to enable the collection and management of subsurface information (Standards Australia, 2013). However, the standard does not indicate how various organisations can implement AS5488-2013. This paper examines existing systems within Roads and Maritime Services (RMS) New South Wales (NSW) and identifies some of the challenges and changes required to adopt the standard.

AS5488-2013 (referred to in this paper as SUI – subsurface utility information) provides a simple common language to enable all involved with the asset lifecycle a clear understanding of what information has been collected and when. At the heart of the standard are four quality levels that quickly convey the level of certainty about a subsurface asset. An executive

summary of the standard is provided in section 2.1. Collecting information for SUI at quality level A or B is not significantly different to performing a typical works as executed survey that is routinely performed as part of engineering projects. The main differences with the SUI standard are (1) the format of the information and (2) collecting some additional attributes associated with each surveyed point. This second point means that more people may need to be consulted in the collation of the information.

RMS (the road authority for the state of NSW) has the overall responsibility for the provision and maintenance of approximately 18,000 km of road network. Within this network there is a significant amount of subsurface infrastructure. This includes over 4,500 traffic signals, intelligent transport systems (variable message signs and traffic monitoring), regulatory systems (detection cameras for speed and oversize vehicles), street lighting, storm water, rock anchors and other structural elements. The vast majority of these assets are located in the more heavily populated areas along the east coast. Not surprisingly, other subsurface asset owners also congregate in proportion to population density.

Collecting and recording Subsurface Utility Information (SUI) is relatively straightforward. However, applying SUI to a vast set of existing assets is not a trivial task. This is further complicated by the distributed nature of the infrastructure lifecycle and awareness of SUI processes. This paper examines typical workflows relating to the installation and upgrade of traffic signals within the RMS environment. It is hoped that by highlighting the critical points within these workflows, other subsurface asset owners can identify similar points in their workflows and take advantage of information presented in this paper.

2 INVESTIGATION OF EXISTING TECHNICAL DOCUMENTS

2.1 SUI – Executive Summary

The Australian Standard AS5488-2013, published by Standards Australia (2013), provides a set of four easy to understand quality levels. The intended audience are those agencies and organisations that own, operate or regulate utility infrastructure, and those that collect, depict and map such infrastructure. The standard facilitates good risk management strategies to be applied when working with or close to subsurface utilities. The scope of the standard is limited to subsurface utility infrastructure and associated surface features that facilitate the location and identification of the infrastructure. Some of these features include access chambers, stop valves, hydrants and terminal pads. It does not extend to above surface infrastructure such as overhead wires.

The quality levels provide a simple common language, indicating the type of information known about a subsurface utility. Quality level A is the highest level, while quality level D is the lowest. The higher the quality level, the more is known about that subsurface utility, and the more accurate and more complete that information is.

Quality Level D (QL-D) is the lowest quality level and default level if any of the other quality levels cannot be satisfied. This information may be compiled from existing records, cursory site inspection or anecdotal evidence. There is no requirement for a spatial tolerance, only a general indication of location.

Quality Level C (QL-C) uses any available information from QL-D and correlates it with surface features. These features may be access points on the surface such as hydrants, stop valves, access chamber lids, or points where utilities enter the subsurface domain (e.g. an electricity cable travels down a power pole and then becomes a subsurface electrical cable). Subsurface utilities may be offset from the alignment of surface features, thus QL-C does not provide a spatial tolerance on location, as for QL-D, only a general indication of location is implied.

Quality Level B (QL-B) provides relative subsurface feature location in three dimensions. Relative location refers to a distance or depth from another feature, e.g. a water pipe may be 2.4 metres from the edge of a footpath and 1 metre below the surface level. QL-B information requires specialist equipment and locaters skilled in tracing utilities (detection via an induced signal along a subsurface utility). The relative spatial positioning for QL-B is ±300 mm horizontal and ±500 mm vertical.

Quality Level A (QL-A) is the only quality level that defines a subsurface utility as 'validated'. The location of points surveyed on the surface and subsurface features are measured in terms of absolute spatial positioning with a maximum horizontal and vertical tolerance of ±50 mm. Other attributes that are relevant to QL-A are utility owner, type (e.g. communications or gas), status (e.g. in service, redundant or abandoned), material, size and configuration, date of installation, date and details of person(s) capturing the information, surveying methods used, and survey control used to determine absolute spatial position.

The standard has informative sections in appendix A and B that recommend several implementation practices including limitation of each quality level, standard paint and line colours, standard feature codes, and standard attributes for each of the quality levels.

The implementation of AS5488-2013 requires a multi-discipline approach. The work crews that work around and install subsurface utilities are not all equipped with all of the skills to collect all of the required information. To implement the standard and gain the maximum benefit, asset owners, installation crews, the wider construction industry, locaters, surveyors, engineers and project managers all need to be aware and work together. Development of efficient methods to 'harvest' this vital information, and supply of this information to those that need to know it, is possible. All of the services we use in the 21st century are increasingly more and more important. The benefits of collecting this information and thus protecting this vital infrastructure are realised across all of society.

2.2 RMS Specifications and Guides relating to Traffic Control Signals

Traffic Control Signals (TCS) have existed on the road network in NSW since 1933, when the first signals were installed at the intersection of Kent and Margaret Streets, Sydney. These signals were turned on at 11:00 am on Friday, 13 October 1933 (RMS, 2013a). Since then, over 3,700 traffic signals have been installed across NSW. Traffic signals provide a means of organising and controlling traffic for safe and efficient travel by users of the road network. The Sydney Co-ordinated Adaptive Traffic System (SCATS) was developed in the 1970s to enable real-time control of traffic signals across the network. Thus traffic signals typically require two types of services, i.e. electricity and communications.

RMS has developed a set of guides and specifications that cover every technical aspect of traffic signals. This ranges from the overall geometry of the roads and speed zones to the

standards for electrical wire used in the cables between the various elements of the signals. The following documents were reviewed for their relevance for the proposed capture of works as executed information:

- RMS QA Specification R155 Design and Construction of Underground Cableways (2013).
- Manage WAE Drawings Technical Procedure Version 1.3, ILC-GEN-TP0-104 RMS (2008).
- RMS Specification D&C R155 Design and Construction of Underground Cableways (2013).
- RMS Revised Traffic Signal Cable Installation and Connection Technical Direction (2013).

One of the daunting prospects in a large organisation such as RMS is the sheer volume of documentation. These documents are not referenced elsewhere in this paper, they are provided here for information purposes. The main documents relating to the design and installation of traffic signals in NSW are:

- RTA Specification SI/TCS/8 Revision 1 (2003).
- RTA Traffic Signal Design (2008).

Section 4 of the Traffic Signal Design document deals with plan requirements (RTA, 2012). As far as Dial Before You Dig (DBYD) is concerned, the information required to complete a traffic signal project is a cable installation plan. This is the plan that ultimately is delivered with a DBYD request. In practice, the cable installation plan is an updated version of the design plan and generally does not include surveyed 'as built' information.

The most relevant (and up-to-date) document detailing the associated workflows is the Installation of Traffic Control Signals Technical Procedure RMS (RMS, 2013b). This procedure lays out the whole process of TCS installation from a road network 'needs' perspective, design, construction, commissioning and handover to the asset manager. A subset of this document is used to analyse how to best identify the critical points in the process where SUI can be adopted.

3 EXAMINATION AND ANALYSIS

3.1 Reasons to Implement SUI

This section examines the reasons why organisations should adopt SUI. Risk management is central to this discussion. An argument for SUI to be adopted as part of a toolkit of risk management tools is developed below.

As urban spaces grow and develop, competition for space in the road reserve increases. This is further compounded by polices such as the deregulation of communications. Where there was once one government asset owner for communications, there are now often three or more communication asset owners sitting side by side and competing for space in the road reserve. Ongoing growth and development compounds these issues.

Many of the issues relating to the coordination of works around subsurface are addressed in the United States of America (USA) by the Common Ground Alliance (CGA). This organisation has representatives by way of stakeholder seats for electric, engineering/design,

equipment manufacturing, excavator, gas transmission, gas distribution, insurance, locator, one call centre, oil, public works, railroad, road builder, state regulator, emergency services and telecommunications. This organisation was formed in the interest of bringing all parties together. One of the 'shining light' outputs from the CGA is the Best Practices 10.0 guide (CGA, 2013). In this document, two major lessons are highlighted: (1) Communication is the key to ensuring safety and free-flowing communication allows all stakeholders to focus on common goals, and (2) cooperation is essential and it works. The equivalent standard to SUI in the USA is ASCE 38-02 Subsurface Utility Engineering (SUE). SUE is a key element in the Best Practices 10.0 guide in terms of enabling effective communication.

Many asset owners outsource the management of the physical network. This means that the days of consulting a local work crew that often knows the detailed history of an asset are gone. The contractor is now responsible for a defined scope of asset installation or maintenance that often does not extend to long-term stewardship. Nor do these contractors gain access to all the information relating to the asset they are managing. Often the contract to manage the physical network is limited in duration. So the current contractor is judged on whatever performance criteria has been set into the contract. A future maintenance contractor may not gain access to a previous maintenance contractor's records. SUI (i.e. a standard) helps with the consistent formatting of information. Therefore the use of many hands (resulting in loss of information), a symptom of contracting, can be reduced.

On construction projects, Works As Executed (WAE) plans are nearly always produced. But in amongst the competing priorities on a construction project, the WAE plan is often a simple mark-up of the design plan. Holding up a construction project while in progress, for any reason, is not popular. In order to efficiently implement SUI in the WAE domain, the workflow needs to be understood by all those involved. This is an extension of the reasons outlined in CGA (2013). In this paper, the WAE plan that includes SUI, is referred to as WAE SUI.

The incidence of utility strikes and the consequences of such are routinely reported in the media. While published data in Australia on the cost benefit of SUI (or similar processes) is virtually non-existent, several overseas studies point to significant project savings when a system such as SUI is adopted (Table 1).

Table 1: Cost benefits of SUI-like processes.

Name of Study	**Benefits Realised**
Federal Highway Administration-USA (1999): Cost Savings on Highway Projects Utilizing Subsurface Utility Engineering	\$4.62 in avoided costs for every \$1.00 spent on SUE
Ontario (Canada) Sewer and Watermain Contractors Association (2004): Subsurface Utility Engineering in Ontario: Challenges and Opportunities	\$3.41 in avoided costs for every \$1.00 spent on SUE
Pennsylvania DOT (2007): Subsurface Utility Engineering Manual	\$21.00 in avoided costs for every \$1.00 spent on SUE

In emergency conditions, emergency workers (i.e. first responders such as ambulance, fire fighters or police) can make more informed decisions in the heat of the moment if they have access to the best possible information. The current model of risk management concerning subsurface utilities revolves around the national DBYD service. This places the responsibility onto those performing work near existing assets to prevent damage. Those doing the work often complain about the lack of detailed information on DBYD plans provided by asset owners.

SUI can be adopted as part of an investigation process that is examining existing conditions. Currently an investigation will typically involve a detailed desktop review, followed by field investigations that may extend to potholing for subsurface utilities. This sometimes does not result in clear results for the task at hand. This is often a reflection on poor communication, or the complex nature of the problem at hand. The initial adoption of SUI will no doubt focus on investigation as part of specific projects.

This paper argues that Quality Level A (QL-A) information should be obtained at the time of construction or installation wherever possible. There may be occasions where Quality Level B (QL-B) is the only information that can be obtained (e.g. under boring roads and rivers).

As the available SUI dataset is limited by the very fact that this is a new standard, the initial benefits seem very limited. So the natural reaction is to skip the extra work required to produce a detailed WAE plan (including QL-A SUI). The benefits of implementing SUI at the time of installation include reduced cost, more accurate information on the type of materials installed, exact date of installation etc. Where to best store this information remains a key question, however it should not be used as reason not to produce WAE plans with SUI.

Implementing SUI uniformly across all asset owners into all DBYD plans is an ideal that may seem a far stretch from current day practices. The waypoints on the road to realising this ideal are implementing SUI initially at a project-by-project level and then across the subsurface utility industry.

3.2 Examination of RMS Workflows

This section examines an existing workflow within RMS. The workflow selected is the current workflow model used by RMS to install Traffic Control Signals (TCS). This workflow model is similar to many asset owners where the construction of the asset is provided by an external construction company. In the decades since the first TCS was installed in NSW, the process has been refined and is in part captured by the flow chart in Figure 1. The process outlined in this flow chart has been derived from the Installation of Traffic Control Signals Technical Procedure RMS (RMS, 2013b).

Figure 1 shows two phases between the start of construction and the completion of commissioning. As can be seen, the site cable plan being made available to DBYD is part of the final Works As Executed (WAE) drawings. Another point to note is that Figure 1 presents the workflow with steps and interactions that are the direct responsibility of RMS personnel. It does not break the major steps down into smaller steps that detail the installation of new underground services – this is further analysed below in section 3.3.

Examination of the steps in the construction phase shows an initial hold point before the start of construction. After the start of construction, the Construction Manager (an RMS representative) is routinely consulting with those performing civil works, however the WAE drawings are not supplied as an output until construction is complete.

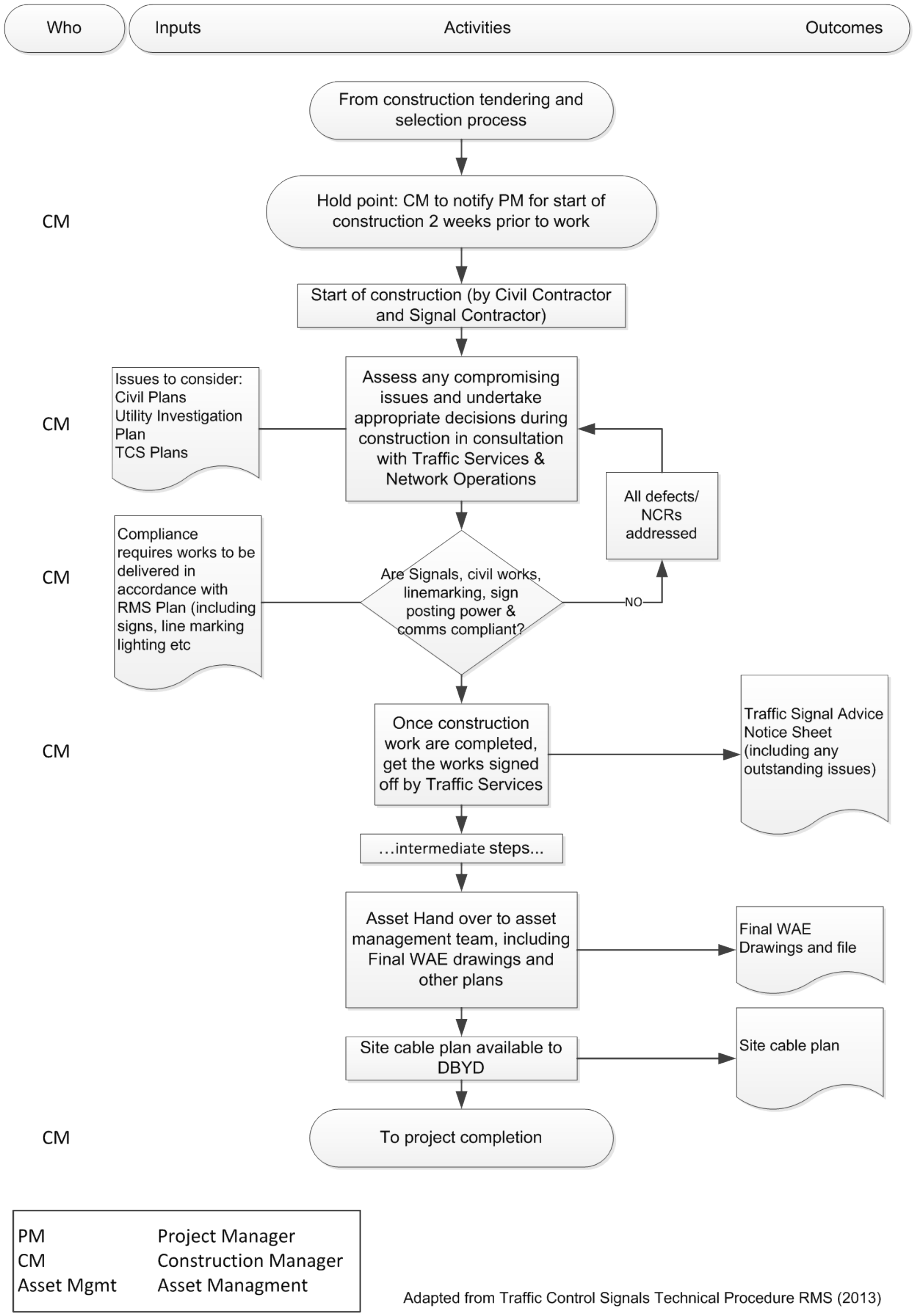

Figure 1: Flow chart of TCS installation – commissioning.

3.3 Adapting SUI into RMS Workflows

This section analyses and suggests an adapted workflow to include the critical points to facilitate the capture of WAE SUI information. At a strategic level, changing an established workflow is not going to happen overnight.

The proposed sequence to implement this change in three steps is detailed below, noting that some flexibility plus support both at a management and technical level will be required:

1) Documenting the workflows (documentation of workflows required to achieve WAE SUI QL-A or QL-B – this goes hand-in-hand with education across the industry).
2) Engaging and educating the various stakeholders
3) Updating RMS contracts to require WAE SUI processes. This may require a financial incentive to comply with new requirements. In practice, this should not differ from any of the other requirements be they technical, environmental or work health and safety.

As can be seen in Figure 2, the additional requirements for WAE information capture have been added to the previous workflow. A sample WAE information capture plan has been provided in Figure 3. This plan is an attempt to provide clear guidance on how the WAE SUI information can be captured at installation time and thus maximise accuracy. The sample illustrates a situation where the work is staged across multiple days. In practice, the format of this document will develop as it is reviewed and trialled.

Several scenarios can be expanded on this method to allow for pick-up after the services are buried. This may include inserting PVC tubes vertically above the conduits as laid. A surveyor can then at a later time capture the spatial data in bulk. Various methods to efficiently capture this information can be developed and expanded.

The WAE information capture plan also needs to include contact details of the relevant people that are going to be on site and very clearly identify each person’s role. Ideally, the WAE information capture plan should be part of the normal project planning and sequencing. If the construction program changes, the WAE information capture plan should be updated and distributed accordingly. An induction process into the WAE information capture plan process for civil contractors, signal contractors and surveyors will establish the ground rules, and what is expected by the other parties. Care needs to be taken in planning and supervision of this process such that it is not used as a variation excuse, although some provision for transitioning to this method is required.

The basic conditions to capture QL-A information need to be well defined and where there are exceptions to these rules, reasons have to be given, e.g. top and centre of conduits to be surveyed at kerb line, crown(s) of road, and exit points from service pits. In addition, conduits are to be surveyed every 10 metres or where there is a change of direction or grade that would lead to a difference of greater than 50 mm between the true top of conduit and a straight line between the sampled points.

A process of performing quality checks at random on the spatial results needs to be developed. This may require additional support, surveillance and/or follow-up investigations. The temptation to ‘manufacture’ results can be tempting, particularly when there is significant effort or re-work required to verify the results.

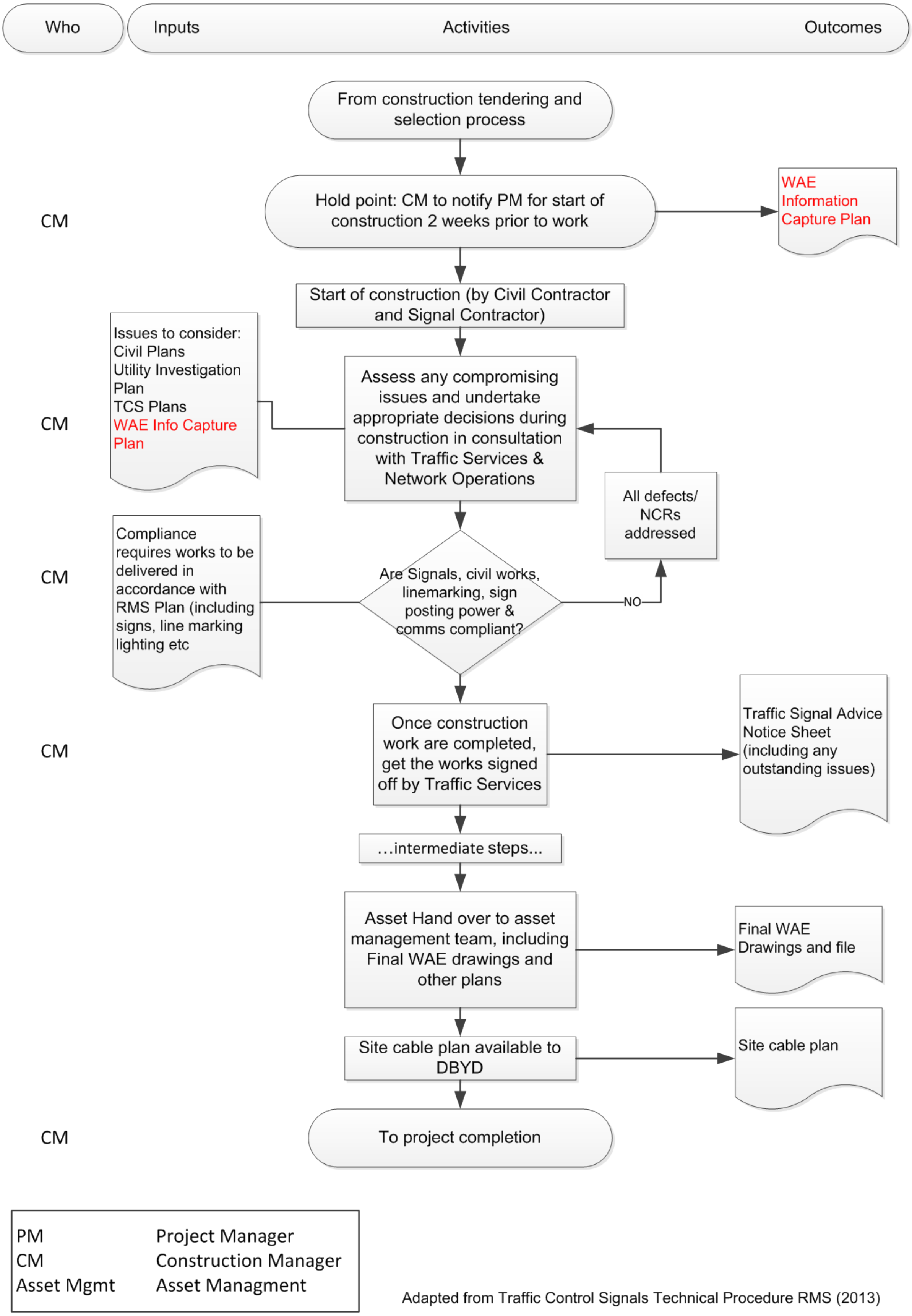

Figure 2: Flow chart of adapted TCS installation – commissioning.

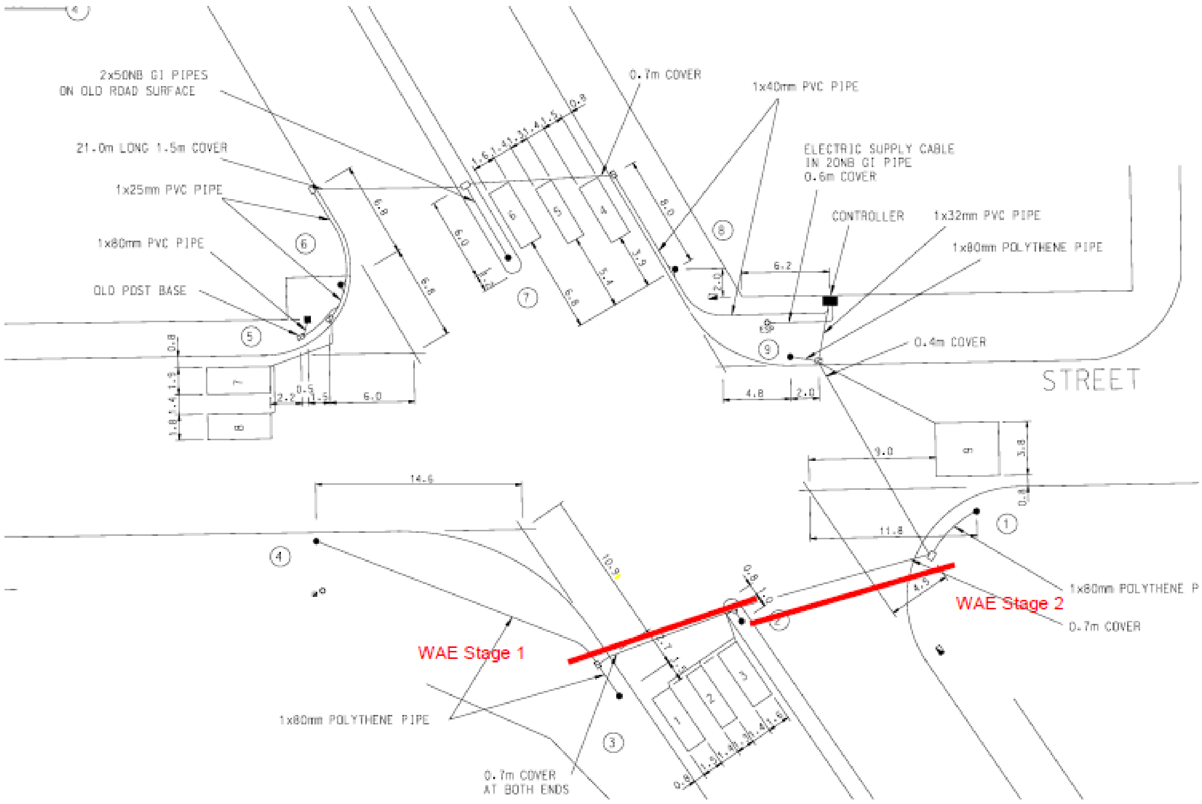

Figure 3: Sample WAE information capture plan.

An example of additional information for WAE capture is given below:

- Contacts:
  Construction Manager: Fred Smith 0415 … …
  Civil Contractor Contact: John D…. 0424 … …
  Signal Contractor Contact: <same as Civil contractor>
  Surveyor: Chris A…. 0438 … …
- Stage 1 proposed works: 24 Feb 2014 from 20:00 to be confirmed.
  Install twin 80 mm electrical conduits across carriageway.
- Stage 2 proposed works: 26 Feb 2014 from 20:00 to be confirmed.
  Install twin 80 mm electrical conduits across carriageway.

A sample list of attributes to be collected for each surveyed SUI point is given in Table 2. At this time, the easiest format to store this information in is CSV (comma separated variable). This allows for simple exchange of information as part of survey metadata. The data can readily be extracted and fed into a Geographic Information System (GIS) for further use. A sample is provided in Figure 4.

Table 2: Suggested SUI attributes to capture for QL-A points.

Attribute Name	**Attribute Description**
PtId	Point Id
Easting	Easting coordinate
Northing	Northing coordinate
RL	Reduced Level
QualityLevel	Quality Level as defined in AS5488-2013
Limitations	Any of the QL limitation, e.g. concrete encased, electricity marker tape, underbore – inaccessible point
RelativeVerticalPosition	Vertical distance from ground surface

Attribute Name	Attribute Description
DateOfCapture	Date that information was captured
SourceOfInformation	Particulars on who was on site, e.g. RMS Survey – Nathan B.
Material	Material as documented on WAE Info Capture Plan and confirmed with site foreman
Size	External dimensions – if one number is specified it is assumed to be a cylinder; if rectangular configuration specify W x H, e.g. 450 mm W x 150 mm H
Configuration	How the utility is configured, e.g. 2 W x 3 H 100 mm PVC conduits laid in trench
LocatingMethods	Potholing / surveyed at time of installation / electronic detection
SurveyControlInformation	A reference to the survey control datum and any permanent marks adopted
SurveyedPoint	Top centreline / invert / obvert / edge of bank – ### Not specified in AS5488, however required for complex configurations ###
PhotoRef	Filename link to jpg file
Notes	Any other notes
Owner	Entity that owns the asset
Status	In service / in construction / redundant / abandoned / unknown – contact asset owner
UtilityType	Code as per AS5488 Table B2
FeatureCode	Code as per AS5488 Table B3

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SUI Data Block:
===============
Source Of Information: RMS Survey Parramatta
Date Information Obtained: 18-Jan-2014
Survey Control Information: RMS Survey Control Diagram ABC
LocatingMethods: Surveyed at service installation

SUI point data Schedule:
========================
PtId,Easting,Northing,RL,QualityLevel,Limitations,RelativeVerticalPosition,DateOf
123,294076.153,6234526.027,110.424,A,,870mm deep,2014-01-18,RMS - Nathan B,White
124,294074.784,6234526.042,110.77,A,,570mm deep,2014-01-18,RMS - Nathan B,AC 150m
125,294066.707,6234531.904,110.836,A,,,2014-01-18,RMS - Nathan B,200mm DICL,Syd W
126,294058.496,6234522.506,110.694,A,,,2014-01-18,RMS - Nathan B,150mm DICL,Syd W
127,294057.367,6234521.05,111.058,A,,,2014-01-18,RMS - Nathan B,White PVC 50mm Di
128,293966.16,6234377.353,105.242,A,,,2014-01-18,RMS - Nathan B,450mm Diameter Co
129,293967.421,6234376.176,104.044,A,,,2014-01-18,RMS - Nathan B,100mm DICL,Syd W
130,295081.404,6235692.005,104.533,A,,,2014-01-18,RMS - Nathan B,200mm DICL,Syd W
131,295080.327,6235692.732,104.657,A,,,2014-01-18,RMS - Nathan B,375mm CICL,Sydne
132,295079.171,6235695.227,104.721,A,,,2014-01-18,RMS - Nathan B,AC 150mm Diamete
133,295086.493,6235704.61,104.112,A,,,2014-01-18,RMS - Nathan B,AC 150mm Diameter
134,295088.453,6235702.29,103.874,A,,,2014-01-18,RMS - Nathan B,375mm CICL,Sydney
135,295090.001,6235700.982,104.11,A,,,2014-01-18,RMS - Nathan B,200mm DICL,Sydney
136,295097.246,6235697.651,103.52,A,,,2014-01-18,RMS - Nathan B,AC 150mm Diameter
SUI Schedule version 1.01 5-Dec-2013 11:00,,,,,,,,,,,,,,,,,,,,
[AS5488-Schedule-SAMPLE.xls]AS5488 Schedule_UT2862,,,,,,,,,,,,,,,,,,,,
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Figure 4: Sample SUI point schedule.

4 CONCLUDING REMARKS

4.1 Benefits of Implementing SUI

This paper presents a considered approach to integrate the SUI standard into existing documentation and construction workflows. The benefits of implementing SUI at the time of installation include reduced cost, more accurate information on the type of materials installed, and exact date of installation. If access to this information is relatively straight forward, it can be used for the many future projects that will enviably eventuate.

Experience of overseas models, referring to CGA (2013), highlights successful collaboration across different disciplines is achieved when the overlap between the disciplines is well defined. Having a standard that all parties can adhere to provides the common language to enable this collaboration.

SUI can be integrated into other engineering and asset systems such as Building Information Modelling (BIM). Clash detection and simulation can be applied to each stage of constructing and operating an asset. Performing investigations on some subsurface assets after construction is very complex and thus costly. Some assets are inaccessible after installation, e.g. concrete encasements. This is further compounded by the need to keep some of these assets running 24 hours a day, seven days a week.

4.2 Barriers to Implementing SUI

Inertia is probably the biggest barrier to SUI becoming widely adopted. Existing processes already produce a result in terms of some record ending up in DBYD. The status quo is often the default position.

To fully maximise the benefits of SUI, education across industry is required. This may require different education packages depending on the different groups that interact with SUI. This may involve a general awareness education with additional modules for specific disciplines that are more heavily involved in the processes, e.g. designers, surveyors and GIS practitioners. There are benefits in having collaborative sessions with the more involved disciplines as often different issues can be raised and answered on the spot.

How to provide incentives for existing civil and traffic signals contractors to participate in this change? This requires that those that are engaging these contractors are convinced that this is a deliverable that adds value. After all, in their eyes the process is established, so why change?

Managing security issues associated with high risk, vulnerable and sensitive assets is another barrier. Currently details for most assets are available via DBYD. Some high-risk assets such as high pressure oil require the work area to be defined in DBYD. A representative of the asset owner can then assist with asset location and supervision of the proposed works. There may be a solution where asset owners can indicate that SUI information exists via the DBYD channel.

It is recognised that increasing pressures exist to recover all costs incurred by the asset owner. The potential consumers of SUI need to be identified, i.e. mainly existing users of DBYD information (e.g. design and construction and associated disciplines).

4.3 Expectations

For some, the expectation is that SUI will start appearing on DBYD plans. In some cases, this may well happen. However, there are many limitations to this happening:

- Asset owners have existing systems to provide DBYD information, and changing these systems represents an additional cost. The case to change these systems to be SUI compliant needs to be demonstrated.
- Asset owners will want to maintain the status quo where the user of DBYD information bears all of the risk and responsibility.
- Asset owners may have security concerns.

The take-up rate of the SUI standard is likely to be relatively slow as many organisations believe they are already providing SUI. To some extent these organisations are investigating using some of the SUI techniques (e.g. potholing, surveying, consultation with utility owners). Case studies that clearly demonstrate the steps to apply to produce SUI to a defined level are required.

4.4 Conclusion

The ability to modify the existing workflow and implement the proposed changes requires consultation with all parties involved. This proposed modification to the workflow and the underlying contract process will only naturally receive some resistance. It may require escalation to gain acceptance at a higher level within an organisation such as RMS.

Areas concerning WAE SUI that require further exploration include:

- Validation and acceptance of the suggested process, i.e. is this approach to capturing WAE SUI acceptable to RMS at a wider organisational level?
- What is the best format to store and present WAE SUI?
- Where in the organisation is the best place to store and maintain WAE SUI?
- Identification and targeting of projects lending themselves to early adoption of WAE SUI.
- What type of education resources should be prepared?
- How to update the relevant contracts to include WAE SUI as a requirement?
- Does the information in this paper relate to other assets, owned by RMS or others?

The benefits accrued from implementing WAE with SUI have been identified. The ideal points in a construction project to plan for and capture WAE SUI have been identified. The steps required to capture WAE SUI are not technically difficult, nor should they add significant costs to a project. The main challenge is one of inertia and changing accepted practices.

Future projects and research could investigate the implementation of some of these steps in a pilot project. However, without clear support from higher levels of management within an organisation such as RMS, any success of such trials will go unnoticed.

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