SEWER MANHOLES – IT'S TIME FOR A RE-THINK!

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ABSTRACT

The construction of gravity sewer networks using large concrete Manholes (MHs) between short lengths of sewer pipes is unnecessary, costly, dangerous to install and inspect, and encroaches on our narrow and scares service corridors. Besides, they often leak through the entry cover, riser joints and pipe connections, significantly contributing to inflow and infiltration. Concrete manholes also have a tendency to corrode over time and repair or replacement is expensive.

The introduction and acceptance of Maintenance Shafts (MSs) as a modern day replacement for large diameter (minimum DN1050) MHs is happening in Australia and elsewhere overseas. So why not New Zealand?

MSs comprise a DN225 or 300 PVC pipe shaft down to a PVC, PE or PP base that either has pre-ordered inlet outlet stubs for each individual location, or are manufactured to accommodate multiple entries at 45, 90 degrees on both sides of the base in addition to the straight through position.

The latest technologies for cleaning, condition checking and repairing sewer pipes no longer require maintenance staff clambering down manholes to carry out such tasks. It's like medical operations using micro-surgery techniques which are quicker, safer, cleaner and less expensive than using the knife. All can be done remotely from the surface. This paper discusses the advantages of MSs in terms of price, installation cost, health and safety, I/I, maintenance and longevity. It also identifies changes to installation and maintenance practices needed for success.

KEYWORDS

Maintenance Shaft, manhole, cost, health and safety, inflow and infiltration, installation, maintenance, corrosion.

PRESENTER PROFILE

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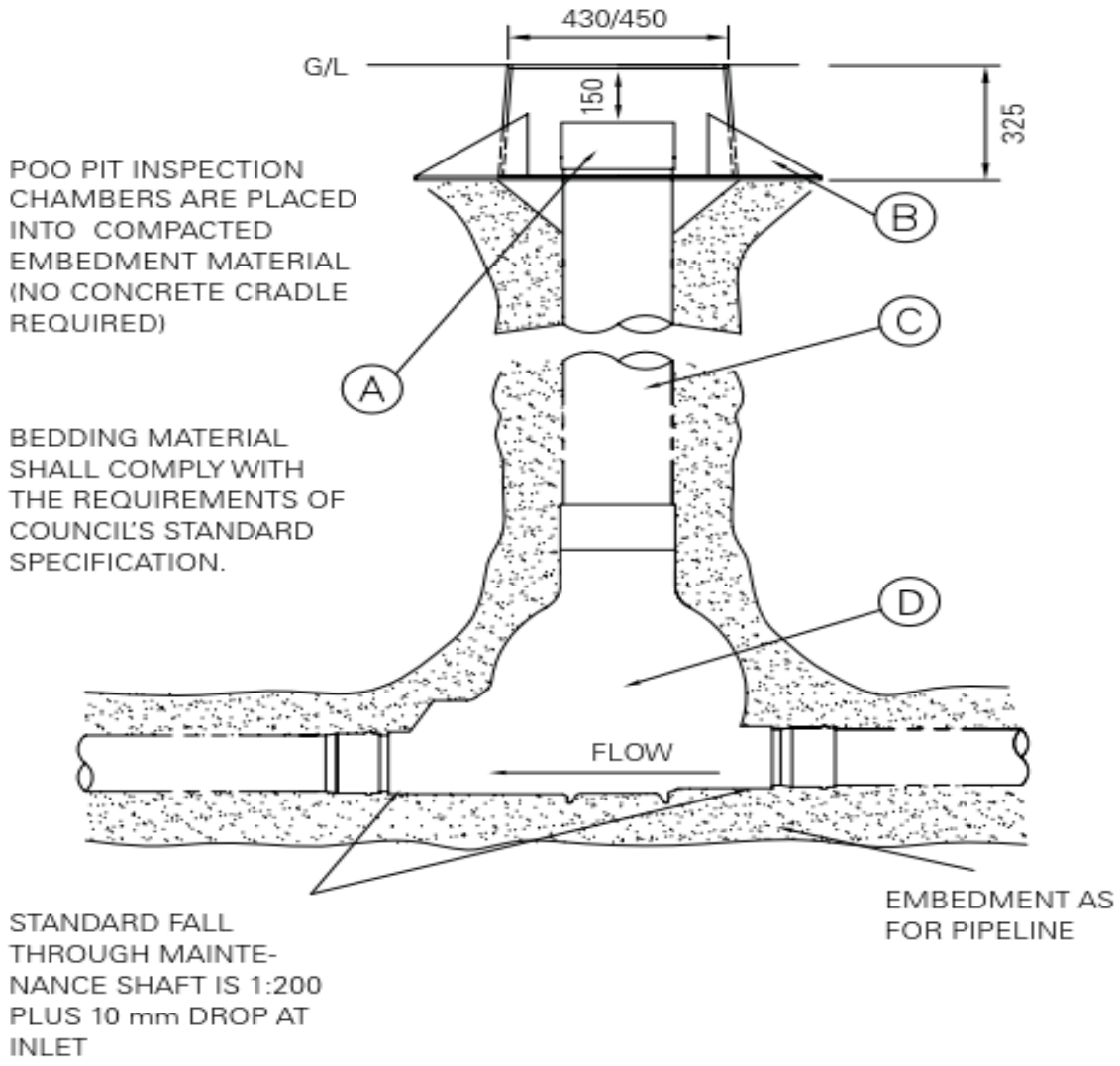
1 WHAT IS A MAINTENANCE SHAFT?

Maintenance shafts comprise a moulded vessel base with a vertical DN225 or 300 inspection shaft to the surface. Sewer pipe inlets and outlet stubs are moulded to the base either in a standard configuration or according to the purchaser's specific requirements. MSs are normally only acceptable for use with DN100, 150 or 225 sewer

pipes. Property laterals can be connected directly to the base as well as into the vertical shaft by way of a tee or saddle fitting. This vertical shaft allows the entry of various forms of equipment into the sewer network, but prevents man entry.

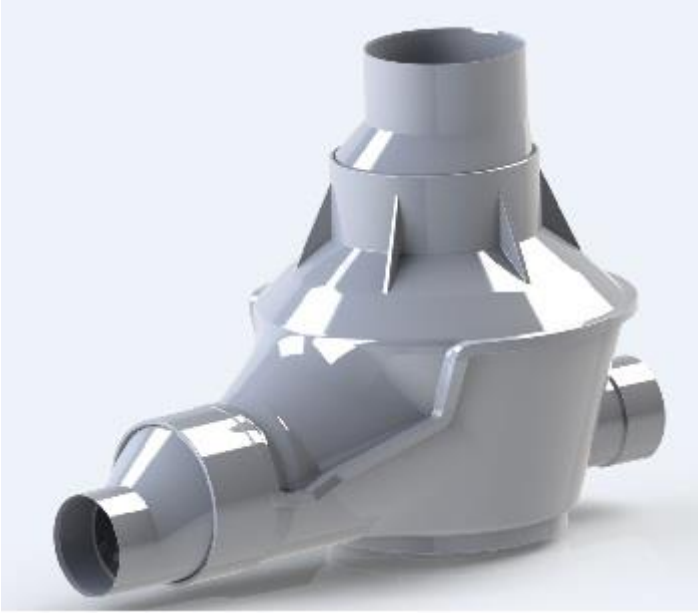
There are an increasing number of proprietary MSs becoming available on the Australasian Market. The Water Services Association of Australia (WSAA) has an approval process, product specifications and AS/NZS Standards relating to the various plastic compounds, (mainly PVC, PE and PP) used in their fabrication.

Figure 1 Main Components of a Maintenance Shaft. (From Smartsteam Poo Pit Maintenance Shaft Technical guide D4.10)



A PVC Threaded Cap
B Steel "Top Hat" Surface Cover and Frame
C DN225/300 Vertical Shaft
D Maintenance Shaft Base

Photos 1-3 Some Proprietry Maintenance Shafts

	**Poo Pit (Hynds)** MDPE sphere of 600 diameter. Downstream outlet is an integral part of the moulding Upstream inlets can be welded to the body in the direction, position and grade to suit the connecting sewers. Vertical shaft is DN225
	**SMS (Australia)** Injection moulded Polypropylene Available as multiple inlet (shown) or straight through 300 diameter bases for DN150 sewer pipes or 350 diameter base for 225 sewer pipes. Directions into and out of base can be adjusted using long radius bends. Vertical shaft may be DN225 or 300.
	**Aymroo (Australia)** Injection moulded uPVC Downstream outlet is an integral part of the moulding Upstream inlets can be moulded to the body in the direction, position and grade to suit the connecting sewers. Vertical shaft may be DN225 or 300.

2 PROS AND CONS

2.1 COST AVANTAGES OF A MS

The following Tables provide both the relative material costs and comparative installation costs for a MS and a MH.

Table 1: Comparison of Manhole and Maintenance Shaft Costs

MANHOLE		**MAINTENANCE SHAFT**	
1.8m 1080 Base	1215	Maintenance shaft base	1165
0.6m Riser	263	2m 225 pipe	134
Rungs 6 Nos	340	2 Nos Slip couplers	82
Extension ring	129	225 Threaded cap	82
1080 concrete lid	305	Frame and cover	658
600 Frame and cover	524		
BM100 / Epoxy	294		
Reinforcing ring	10		
2 Nos MH connectors	228		
2 Nos pipe shorts	208		
Stainless security grill	642		
MH Materials	**4158**	**MS Materials**	**2121**
Excavator and Equipment	1085	Excavator and Equipment	880
Labour	1455	Labour	1200
Materials and Soil removal	409	Materials and Soil removal	230
MH Installation	**2949**	**MS Installation**	**2310**
TOTALS	**7107**		**4431**

2.2 INSTALLATION ADVANTAGES OF A MS

The small size and weight (450 to 700mm diameter and around 20 kg) of a MS allows one person to handle each unit without the assistance of any lifting equipment. The MS can be installed into the pipe trench without further excavation as is required for a MH. The height adjustment is a simple matter of the vertical shaft length. Because the shaft ends below ground level, this measurement is not critical. The surface frame and cover is not directly connected to the MS, therefore no traffic loads are applied to the MS, and the surface level can be adjusted without affecting the MS in any way. There is no concrete required to haunch the connections and bench the channel as with a MH. There is no

waiting for the concrete to set and the MH can be used immediately it has been connected to the sewer pipes. Nor is there any need for step irons, lowering equipment or gas detection units and procedures.

MSs can be tested by pressure or water loss methods as an integral part of the pipeline. MS installation is a one or two man job that is unlikely to take more than a couple of hours to complete. Whereas installation of a manhole will take 2-3 men all day.

2.3 OPERATIONAL ADVANTAGES OF A MS

MHs are injection moulded from a variety of inert plastics, and are therefore resistant to corrosion by wastewater chemicals. Due to the sealed rubber ring joints (rather than the structural grouted epoxy mortar of MHs), infiltration and exfiltration from the sewer is eliminated. The sealed cap on the top of the vertical riser shaft prevents surface water inflow and the escape of odours.

Both minor and major level adjustments are easily completed by extending or cutting the shaft. MSs reduce the corridor width requirement and allow greater separation from other services.

2.4 HEALTH AND SAFETY

Perhaps some of the main advantages of incorporating MS in place of MHs are the safety aspects. Man entry is eliminated (both authorised and unauthorised). Confined Space procedures are unnecessary. Risk of injury to the workers is significantly reduced as there is no heavy lifting, or possibility of the heavy MH components falling on or crushing staff, or staff falling into the MH.

2.5 SOME DISADVANTAGES (REAL AND PERCEIVED) OF MAINTENANCE SHAFTS

There is without doubt a strong mindset amongst civil engineers that man entry to the level of the sewer pipe facilitated by a MH, is basic to servicing the network. It is difficult to think up common scenarios where this may be the case. However in Australia, MSs must only be incorporated as intermediate maintenance structures between MHs spaced no greater than 300 metres apart. Restrictions relating to the use of MSs have become more lenient as time passes and with subsequent revisions of the Gravity Sewerage Code of Australia (WSA 02-2014). This trend may well continue to the point where MHs are deemed an unnecessary and unwanted component of a sewer network.

I have listed below a number of common arguments against the use of MSs and have added my own opinions as to their relevance. I leave you to make up your own minds as to whether these concerns are real or perceived.

- ***It is no longer possible for a pipeline to be checked by 'eye'.*** CCTV (and pole cameras) are now universally used for checking new installations and condition checking of existing sewers.

- ***Solid objects will be more difficult to remove from the sewer.*** Solid objects may still be removed via a MS using a long reach "catch net" or scoop as is often currently used by maintenance staff to save the time and PPE issues required for a man entry retrieval.

- ***Operating CCTV, rodding and jetting equipment will be more difficult.*** Insertion of the above equipment down through the vertical shaft poses no difficulties whatsoever, even via the narrower DN225 shafts and into DN150 sewers especially for downstream runs. If there is significant wastewater flow and

the operator wants to investigate upstream, a long reach 'spoon' can be used to steer the equipment into a MS inlet pipe or a property connection tee'd off the vertical shaft. Once inside the pipe, the equipment will move by its own propulsion (wheels or crawler types) or push cable system.

- ***The use of laser leveling equipment may be more problematic.*** This concern has merit and requires additional effort as retrieval of the laser, or readjustment during its use requires access to the MS. Options include:
    - Temporary placement of a shield or MH riser over the MS during this period.
    - Offsetting the laser above ground and using a vertical alignment meter to positon each new pipe.
    - Where a long radius bend is used to adjust the pipeline angle from the MS stub, a small section of pipe can be removed for placement of the laser, and then replaced and re-connected using a slip coupler.
- ***Is MS buoyancy a problem?*** As with MHs, buoyancy may be a problem if groundwater level is above the bowl of the MS and the soil not cohesive. Generally the weight of soil bearing down on the bowl ensures stability, however in situations where additional ballast is needed, a concrete anchor can be poured or placed under the MS and bracketed to the inlet and outlet stubs. Conversely concrete can be placed over the bowl and around the shaft.
- ***'Breaking' new pipes and connections into a MS.*** Constructing new sewer pipes or connections to an existing MS may require replacement of the MS. However this is likely to take less time than the concrete works required to install a new connection to a concrete MH. In many cases a property connection can be made directly into the vertical shaft using a Tee or Saddle, without interrupting the main flow. Where future connections are anticipated, base units with multiple inlets can be ordered or incorporated during fabrication of the MS, and caped off until required.

2 DESIGN PARAMETERS

2.6 MS/MH LOCATIONS

As a general rule a MS can be used as an alternative to a MH. However, there are some situations where the use of a MS is restricted.

The following Table derived from the Gravity Sewerage Code of Australia WSA 02-2014 Version 3.1, indicates where MSs may or not be used:

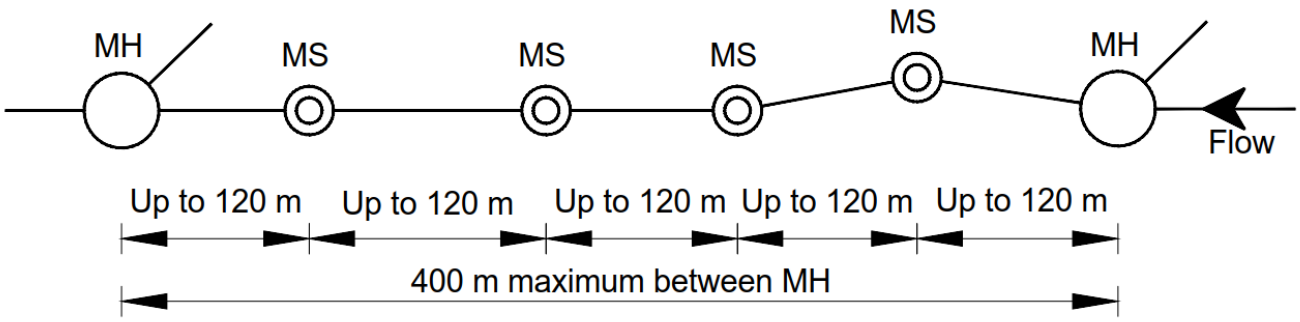
Table 2: Design Parameters for Manhole and Maintenances Shafts

Location	**MH**	**MS**
Sewer main diameter	Unlimited	DN100, 150, 225
Maximum spacing between structures	120m	120m
Sewer main junctions	Yes	Yes
Change of pipeline material	Yes	Yes
Change of pipeline diameter	Yes	Yes

Upstream end of sewer main	Yes	Yes
Maximum depth	Unlimited	3m
Discharge from a sewer rising main	Yes	No
Either side of a railway or major road	Yes	No
Under a road carriageway	Yes	Yes
Property connection into base	Yes	Yes
Property connection into riser/shaft	Only with internal pipe dropper	Yes
Sewer main into riser/shaft	Only with internal pipe dropper	No
Change of direction outside structure	No	<33°

WASA 02-2014 also recommends that MHs be constructed at a maximum distance of 300m with MSs being installed at intermediate positions no further than 120m apart. Some Australian local authorities allow up to 400m between MHs.

The following Figure from NZS 4404:2010 Land Development and Subdivision infrastructure, provides maximum recommended spacings between the various structures.



2.7 MAINTENANCE CHAMBERS

WSA 02-2014 also provides for an intermediate sized "Maintenance Chamber" (MC) based on characteristics similar to a MS but approved for sewer pipelines up to DN375. These are required to have a DN600 vertical shaft and only allow equipment access to the sewer system. Generally over 90% of sewer pipelines are DN150 or 225, therefore I have concentrated this discussion on MSs rather than MCs.

3 CONCLUSIONS

The concept of maintaining our smaller sewer networks (<DN300 using MSs; and up to DN450 using MCs) by surface means is a paradigm shift from the orthodox MH entry

practice. However the huge advantages outlined above overwhelm the risks and changes in procedure that accompany the introduction of any new technology.

MSs are currently not manufactured in New Zealand although some are stocked in standard configurations. North Shore City Council did incorporate MSs into a small area of their sewer network for the purpose of reducing infiltration, but it is difficult to get information regarding results. Their practice of using PE pipes and welding them to the MSs would have been costly and time consuming.

Tauranga City Council have over the last 10 years installed around a dozen MSs of various type. No difficulties have been experienced over that time. Although their use is not currently supported by Council's Infrastructure Development Code (IDC), a process of evaluation is currently underway that will include researching current practices in Australia and consultation with our own development consultants, developers, contractors and suppliers.

The incorporation of large diameter manholes for connecting short lengths of sewer mains dates back to Roman times. Technology needed to inspect and maintain sewer mains has now developed to a stage where it can be inserted into the sewer mains from the surface, thus MH entry is unnecessary.

Besides being a considerably less expensive option to purchase and install, the use of MSs have even more important advantages in terms of health and safety, inflow and infiltration, corrosion resistance and operation and maintenance issues.

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Hynds Pipe Systems Ltd	Provision of the MH and MS component costs forming the basis of the values used in Table 1.

REFERENCES

Gravity Sewer Code of Australia WSA 02-2014 Version 3.1 (Water Services Association of Australia).

NZS 4404:2010 Land Development and Subdivision infrastructure. (Note that the maintenance structure guidelines presented in this document were generally taken from the earlier WSA 02-2004 which have subsequently been revised in WSA 02-2014).