PRESSURE PIPE CONDITION – RIGHT PIPE, RIGHT TEST

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ABSTRACT

Inspecting the condition of pressure pipes is difficult and not a lot has been undertaken in New Zealand, yet. The most critical pressure pipes are invariably difficult to access or isolate. While there are several different inspection technologies in the market there is no single method that can be used for all materials and situations, and many technologies are relatively unproven.

It's very tempting to utilise a single available technology or just choose pipes that are suitable for testing with that technology. It's even more tempting to choose the pipe on Quiet Street instead of the pipe crossing State Highway 1 because it's easier. As a result, Asset Managers are left uncertain of how to proceed to understand the remaining life of their pressure pipes and what repairs may be required before the assets fail.

One of most important tasks when planning a pressure pipe inspection is to understand what information is needed to understand the health of the pipe. The presence of air pockets? Remaining wall thickness? In sewer rising mains there may be reduced capacity so identifying sediment build up in the pipe may be required. In many cases more than one technology or method is required. For example, it may not be much use to only measure the remaining wall thickness of a pipe, because that does not tell you if the pipe is about to fail. But if you combine remaining wall thickness with monitored pressure transients and the as-built wall thickness, you can confidently understand the rate of deterioration and remaining useful life.

Once the desired information is established, the most suitable available technologies can be identified for each pipe in question. Failing to understand what information is needed, or what the limitations are, could be expensive and end up not providing useful results.

Assetlife Alliance have undertaken 60 km of successful pressure pipe condition investigations around New Zealand in the last twelve months. As a result of the recent stimulus funding, we've been engaged to use technologies that are new to New Zealand. Some new technologies have experienced glitches getting up and running and we are persevering with those. Others now have a strong track record such as ePulse (non-invasive acoustic technology that assesses a pipe's average remaining wall thickness) and p-CAT (non-invasive acoustic technology that assesses a pipe's remaining wall thickness in ten-meter increments).

This paper aims to share what has been learned from our experience of successfully completing a range of different pressure pipe projects by giving some specific project examples- from large scale highly critical asbestos cement, steel, ductile iron and plastic water mains to concrete rising mains. This paper will discuss the successes and limitations and importantly the necessary approach required to planning and scoping a pressure pipe inspection project or larger programme in New Zealand.

KEYWORDS

pressure pipe, testing, condition assessment, critical assets

PRESENTER PROFILE

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1 INTRODUCTION

There is an increasing backlog of 3-waters asset renewals required in New Zealand (NZ) to maintain and improve service outcomes. Renewals cannot all be carried out at once so there is a need to prioritise. This prioritisation needs to be evidence based, where possible confirming the condition of the asset. This allows renewals to be targeted and appropriate.

Water utilities have recognised this importance of gaining a better understanding of the condition of their assets so that they can understand the quantum of spend which will be required to renew.

Inspection of gravity pipes using CCTV and Sonar technologies are well understood and are well specified using the Water New Zealand Gravity pipe inspection manual. However, technology and approaches for understanding the condition of pressure pipes is largely unknown. Short of taking coupon samples the inspection methods available have been very limited.

Recently several councils have undertaken full scale testing projects and pilot trials using emerging and established technologies. Most of the projects carried out in 2021 and 2022 have been made possible with assistance of the Department of Internal Affairs three waters stimulus programme.

This paper seeks to provide a number of observations from these projects which have been carried out nationwide, specifically on pressure pipes.

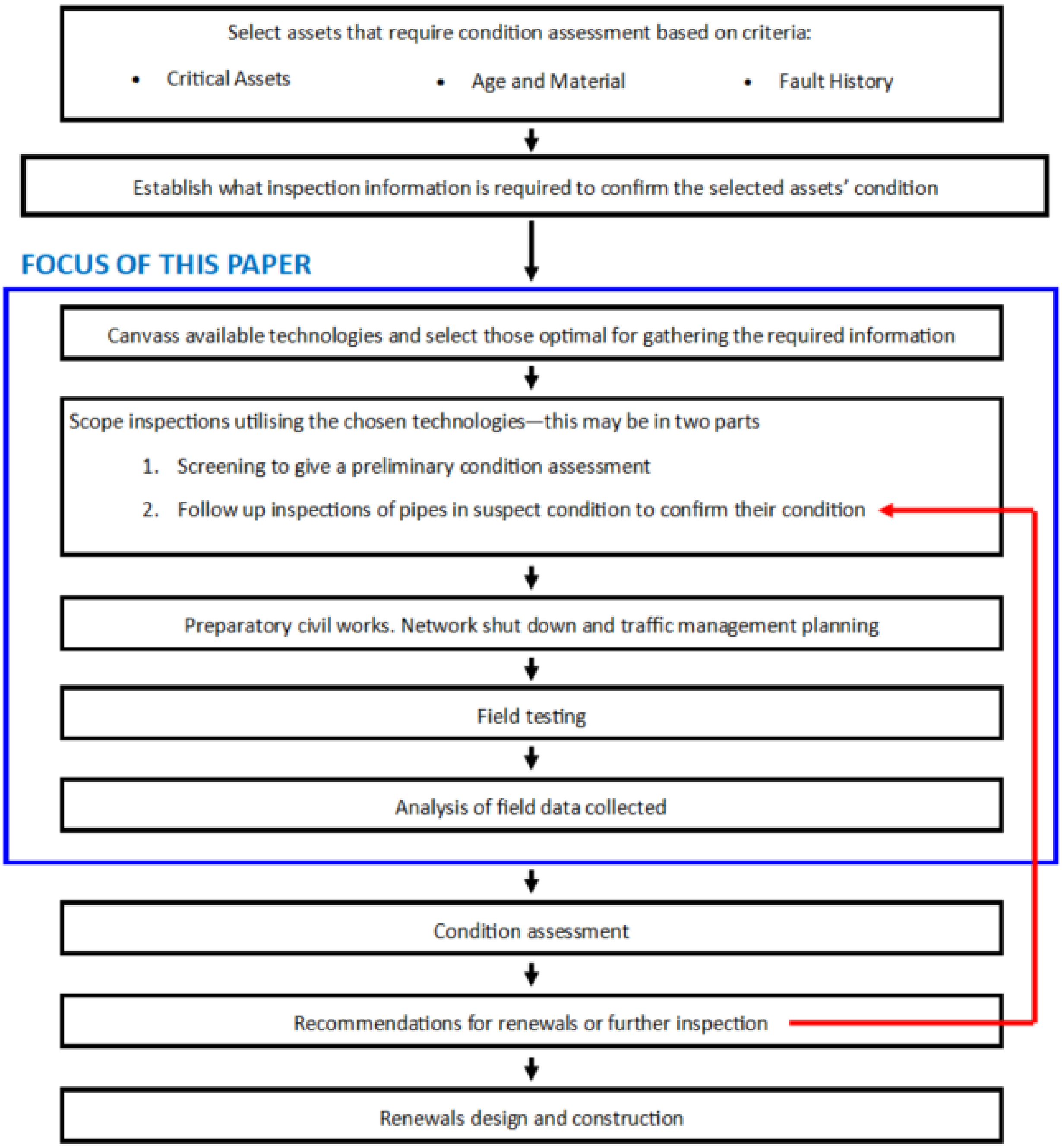
The paper first describes an inspection programme process and highlights the key steps in this process, summarises some of the technology which has been successfully deployed recently and then in the conclusions provides some lessons learned and advice for future projects.

2 INSPECTION PROGRAMME PROCESS

The flow chart below shows the full process from selecting relevant assets, having them inspected appropriately, then using the information for decision making. The decision may be to carry out urgent renewal for an asset in poor condition or to re-inspect after a decade or more for an asset in good condition.

The red loop shows the scenario where the level of confidence in the asset's condition is not high enough to justify an expensive renewal decision, so further inspection methods are used to provide further pieces of evidence and increased confidence in that asset's condition assessment. The sections in this paper broadly follow the steps in the flow chart.

Figure 1: Process for an inspection program



2.1 SELECTION OF ASSETS FOR TESTING

Selecting which assets the utility needs to know about, and what information is required to make an accurate assessment of their condition is crucial. Assets for testing should not be selected because they are suitable for a particular test method, and in a convenient location. The outcome of a thorough selection process will often mean that the assets selected will be in awkward locations such as busy roads, are highly critical and tricky to shut down for testing.

In the testing programme carried out for Wellington Water in 2021-2022 a systematic approach was applied to identify the Very High Critical Assets (VCHA) (Crimp & Blakemore, 2022). Only assets in the VHCA category were added to the programme, with the intention of moving down to High Critical Assets in future inspection programmes.

To identify VHCA assets scores were linked to four factors should the asset fail in its worst conceivable failure mode. These factors are:

- Exposure of the loss of service,
- Time to restore service,
- Whether there is a contingency for the loss of service, and
- Severity of impact.

2.2 INFORMATION REQUIRED TO CONFIRM THE ASSETS' CONDITION

Once assets have been selected for inspection, the information required to assess their condition needs to be determined so the most suitable methods or technologies to gather that information can be chosen.

The test methods prescribed for the pressure pipes in the Wellington VHCA program were

- Pressure Transient (PT) Monitoring on all pipes to establish what pressure loads the pipes are subjected to,
- complemented with p-CAT or ePulse with primary purpose of measuring the remaining wall thickness.

Of the 134 km of VHCA pipes in the original scope 15% were fully inspected by ePulse or p-CAT complemented with PT Monitoring by the end of June 2022. A further 49% were inspected by PT Monitoring only.

Table 1: Pressure Pipe fully tested in Wellington Water VHCA inspections

Prescribed inspection method	Scope	Amount Tested	Comment
ePulse	18 km	7 km	Key reasons pipes not tested: plastic pipes in the scope, poor access to fittings in highways and railways
p-CAT	116 km	13 km	Key reasons pipes not tested: plastic pipes in the original scope, unable to carry out network shutdowns, poor access to fittings, low pressure rising mains
Pressure Transient Monitoring Potable Water	50 sites (60 km)	50 sites (60 km)	
Pressure Transient Monitoring Wastewater	66 sites (74 km)	23 sites (26km approx.)	Additional testing will require access to confined spaces and construction of tapping points in pumpstation valve chambers

During the Wellington pre-inspections and detailed test planning it quickly became apparent that the prescribed ePulse and p-CAT were not suitable technologies to carry out inspections on all of the VHCA pressure pipes. A scoping exercise (Norman & Prince, 2021) identified alternative inspection methods most suitable for each pipe section, as summarized in table 2.

Table 2: Alternative inspections totalling 33.5 km proposed to Wellington Water where ePulse and p-CAT were not suitable

Alternative inspection method	Length (m)	Description
Pipers	15,090	Detect leaks, sediment, gas pockets and significant loss of wall thickness
SmartCAT (or handheld Ultrasonic) + Pipers	6,647	Remaining pipe wall thickness at specific locations + complemented with Pipers
Investigator (JD7)	230	Pressure pipe insertion camera with multisensors to detect leaks and other anomalies
Echowave leak detection	2,902	Advanced leak detection suitable for plastic pipes
Coupons	8,333	Cutting out a section of pipe for inspection and/or lab analysis
CCTV	157	Empty the pipe and CCTV film

Utilising ePulse and p-CAT were considered “gold standard” inspections and to be carried out as far as possible. The alternatives tabled provide limited information but in the case of plastic pipes, which was a large proportion of the original scope, these are notoriously difficult to test and any information is better than none when making renewal decisions.

If budget allows over 60% of the VHCA pressure pipes in the original scope can be feasibly inspected by PT Monitoring plus at least one other additional method.

This would provide sufficient evidence to carry out a condition assessment to a reasonable level of confidence for these pipes.

Table 3: Additional length of Wellington Water VHCA pipe that has been scoped and can be feasibly inspected

VHCA Pipes	km	%	Status June 2022
Original scope	134 km	100%	Original scope
Fully inspected	20 km	15%	Complete
Alternative methods	34 km	25%	Scoping complete for SmartCAT, Coupons, Pipers, CCTV, Investigator
p-CAT	28 km	21%	Detailed test planning complete for 8 pipelines. Requires branch line shutdowns and traffic management.

It will be increasingly costly and disruptive to inspect these remaining assets, but often that is the very reason Wellington Water needs to gather condition information about them- because they are in awkward locations and disruptive to shut down.

The consequence of not testing assets and having them fail unexpectedly is much greater. The key to having a full picture of their VHCA pipes so that renewals can be efficiently targeted and budgeted long into the future will be persistence, eating the elephant one chunk at a time.

One caveat to inspecting all chosen assets is if there is a particular group of assets with similar age, material and environment, a representative sample can be inspected. It makes economic sense to choose a sample of pipe which is easier to test, with the results extrapolated out for the rest of the similar assets. In this case further investigations on the remaining assets would be carried out if the results from the representative sample show alarmingly high levels of deterioration.

2.3 CANVASSING AVAILABLE TECHNOLOGIES

It is important to select technologies that are appropriate to gather the required pieces of information for the type of asset in question. This will normally lead to several technologies used in the same project, not just a single technology that a savvy marketer is trying to sell.

Several technologies are normally required on the same asset to collect different pieces of evidence that are put together to establish a confident assessment of the condition of the asset. The technologies that are appropriate for each different pipe asset will vary, due to factors such as pressure, material or media carried.

There is a broad selection of available technologies internationally. Some are untried in NZ but proven overseas, and emerging technologies are regularly appearing.

We have canvassed a broad selection of the available technologies, so that the focus can lie on establishing what information is desired for a particular asset, then an appropriate technology can be chosen from all options available.

Experience shows that the promised information, described on the back of the packet, can be challenging to gather. This highlights the need to have a local track record before being confident that an available technology will provide the required information.

Review of Condition Assessment Techniques for Pressure Pipes for Water (Pancholy et al. 2020) is an output from the Quake Centre's Building Innovation Partnership program, which is jointly funded by industry and the Ministry of Business Innovation and Employment. This report provides an overview of the technologies that are available for in-situ pressure water pipe condition assessment, and looks to the future to provide insight into the technologies that are yet to be commercially available or are in an early stage of development.

Since that paper was written in 2020 several of the technologies identified in the paper, including ePulse, p-CAT, and further extensive use of high speed PT Monitoring have been successfully deployed.

3 TECHNOLOGIES SUCCESSFULLY PROVEN IN NEW ZEALAND IN THE LAST TWELVE MONTHS

3.1 PROVEN INSPECTION METHODS

3.1.1 ePULSE

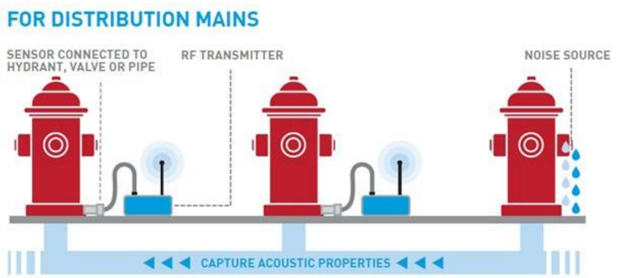
Description

The main area this has been used to date is on drinking water distribution mains. It is most successfully used where pipes have many fittings, such as a network of fire hydrants. It only works on clean water. ePulse is also suitable on large diameter pipes up to 800mm however the field testing and analysis becomes trickier as the diameter increases above 400mm.

ePulse® is applicable to cast iron, asbestos cement, and concrete water pipes. As a pipe degrades (through corrosion for example) the velocity at which sound waves travel through the pipe decreases linearly, forming the basis for the ePulse® technology. ePulse measures the average remaining pipe wall thickness over a length of pipe between two sensors. Pipe wall thickness measurements are accurate to within 10% of the actual pipe wall thickness.

The ePulse® condition assessment is performed by bracketing a section of pipe between two sensors by attaching to appurtenances on the pipe. An out of bracket noise source is then created by tapping on a hydrant or valve, or by flowing a hydrant.

Figure 2: ePulse sensors and noise generation



ePulse testing detects the location of leaks to within about 10m accuracy. To take advantage of this the technicians should carry acoustic leak detection equipment so that the precise location of any leaks found can be pinpointed and spray marked on the ground for repair by the utility.

Ideally a batch of testing will be at least 2 km length to make the establishment and analysis effort economical.

Case Study

The most successful use of this technology was in a project in the Wairarapa for the Tararua Alliance during December 2021 -January 2022. 28 km of Asbestos Cement and Steel distribution pipes were field tested in four weeks.

The key reasons this project was successful was because the client provided one dedicated water maintenance staff member and one traffic management team during the period of the field trials. This enabled the team to become familiar with the test method. The traffic management team and water staff could go ahead and set up the test sites before the test team arrived, then pack up the traffic management as the tests were completed in a rolling operation.

As the testing was in small towns with quiet roads, for the majority generic traffic management plans could be used with the testing carried out during daytime.

6km of pipes were not able to be tested in the first pass, and these may be tested at later date. Recurring reasons these were not tested on this project and other projects are:

- Leaks creating too much background noise for good quality sounds files to be collected. These previously unknown leaks can be repaired and then testing can be carried out.
- Undocumented historic repairs with short lengths of plastic pipe. If the exact location and length of these repairs is confirmed the sound files collected can normally be analysed.
- Chamber or valve lids buried, not found or unable to be opened.
- Fittings such as air valves in very poor condition and needing replacement before test equipment can be attached.
- Pressure reducing valves, pumps or traffic creating too much background noise for sound files to be collected.

A verification test was not carried out in Tararua, however Echologics has an extensive library of verification testing carried out overseas to provide assurance of the accuracy of the results. A verification is normally done by carrying out a test on a new section of pipe where the degradation is negligible and comparing or calibrating this actual remaining wall thickness with the result of the analysis. Shah and Laven (2017) and Mueller Water (2022) give detailed guidance on how validation should be carried out on metallic respective AC pipes.

3.1.2 p-CAT

Description

Main area of use is water trunk mains and long sewer rising mains. It’s key advantage over ePulse is that is gives remaining wall thickness on short increments down to 10m length so that the location of high areas of degradation within a pipe segment can be identified. This allows spot repairs to be targeted, whereas ePulse will give the average degradation between two test points. It does not require clean water so can be used on both water and sewer pipes, provided a minimum pressure of 200 kPa in the pipe.

p-CAT will also detect loss of internal cement lining, blockages, restrictions, closed or restricted valves and air pockets.

Figure 3: Flushing a hydrant in New Plymouth before connecting p-CAT test kit to the riser

Access points can be spaced reasonably far apart, typical access points are air valves, hydrants, flush valves, permanent pressure monitoring tappings, blanked off tees or as a last resort specially constructed tapping points.

Case Study

A total of 13 km of testing was carried out on trunk mains in Wellington with detailed planning complete for a further 28 km.

The key reason more pipe was not tested was because the field test team is based in Australia and the NZ borders were effectively shut during most of the project programme due to Covid-19.

The secondary reason was that Wellington Water did not have capacity to implement shutoff of branch pipes off the VHCA pipe to be tested. Some of these were major feeds to reservoirs or large parts of town, up to 700mm diameter. The planning required and risk to service meant these tests were put on hold. The test plans can be picked up and implemented, likely during winter when water demand is lower. Recent new analysis techniques mean that some of the branch lines could be left open, removing further barriers to carrying out the tests.

A suitable pipe for a verification test was not found in Wellington. Verification would be carried out in a similar fashion to ePulse, by conducting a test on a new section of pipe where the degradation is negligible and comparing or calibrating this actual remaining wall thickness with the result of the analysis.

3.1.3 HIGH SPEED PRESSURE TRANSIENT MONITORING

Description

There are several providers of high speed PT Monitors and using this technology is already well established in NZ. We mention it here as it complements other tests that measure the structural integrity of the pipe. On plastic pipes it will normally be the piece of the condition assessment puzzle that can be most readily obtained.

Figure 4: PT Monitor is the yellow unit, installed in a wastewater pumpstation in Seatoun Wellington.

PT Monitoring measures the internal stresses induced on pipes, which combined with information on the pipe wall condition allows calculation of the factor of safety of the pipe. They can be placed on both fresh and wastewater pipes.

Monitors gauge the pressures induced on pipes typically 1-2km length from where the monitor is placed. The relevance of the readings reduces as distance from the monitor increases, and other factors such as material, diameter, valves and branch pipes.

Measuring pressure transients is relevant when there are pumps, automatic valves, and large users in a system. Typically if a pipe is fed from a reservoir the transient pressure and drops will be minimal, and readings of the static pressure will be sufficient indicators of the stresses induced on the pipe.

The monitors should be left in place for minimum one week in order to pick up readings of the diurnal and weekend pressure changes.

Pressure transients surge rapid accelerations into a water distribution system. A significant proportion of pressure pipeline failures are caused by transient activity. By understanding where and when transient activity takes place, the asset owner can make changes to a network or its operation to extend asset life.

Case Study

In the Wellington Water VHCA pipe health inspections PT Monitoring was combined with pipe condition information to calculate factor of safety for the pipes. 73 PT Monitors were placed for minimum one week each and covered approximately 86 km of pressure pipe.

Figure 5: Screenshot from a typical PT Monitoring report in Wellington with recommendations to reduce the transients.

Coast Road, with 7 days of data recorded from the 6th to the 13th of July. During this period, 1,063 transient events were recorded by the logger, with the majority of these not considered to be potentially damaging. The largest transient event occurred on the 7th July at 09:03 with a severity of 28.0m, as can be seen below this is a potentially damaging event.

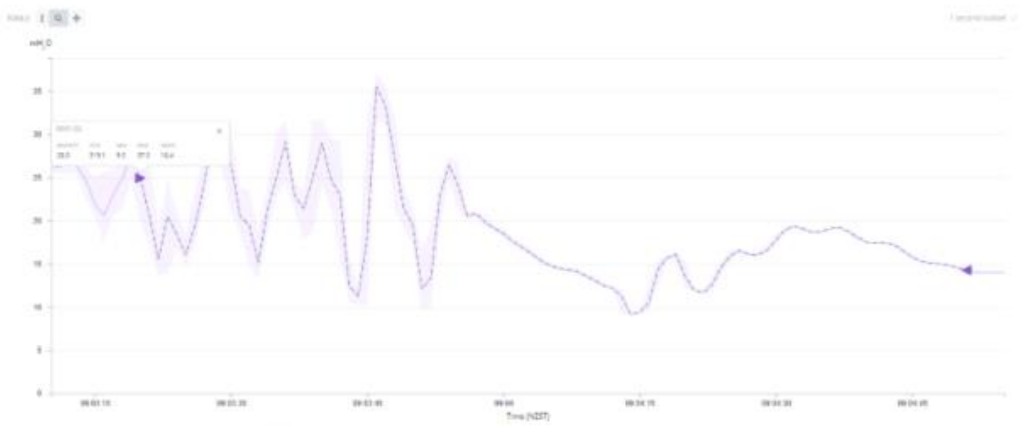


Figure 2: Transient Event on the 7th July

It is likely that events like these are caused by the pump starting and stopping. When a pump receives a command to start or stop, if there is no control device, then it will complete the command suddenly and this causes pressure transients to occur. It is recommended to review pump start/stop data and correlate these events with the transient events. If the pumps are the cause of the transients, then it is recommended to investigate installing soft starters, surge tanks or variable speed drives on the pumps to reduce the shock to the network caused by the pump start/stop.

In addition to the 86km of VHCA pipe that was the target of the monitoring, an analysis was carried out to identify other pipes where the monitoring results were relevant. These were non-VHCA pipes that branched off the VHCA pipes. This bonus information about these out of scope pipes has been added to Wellington Water's database.

3.2 COMMON REQUIREMENTS FOR SUCESSFUL TESTING

3.2.1 TECHNICIAN SKILLS

One of the keys to successful testing is experienced technicians. Like anything, the first few times we carry out testing there is a steep learning curve. But once the technicians have used the same technology on several projects the pitfalls and shortcuts are learned, and the testing quickly becomes more efficient and accurate.

3.2.2 SCOPING AND TEST PLANNING

It is crucial to seek assistance from the analysis teams when carrying out detailed scoping and planning of field testing. There are many factors that will need to be considered to ensure good data is gathered. The analysts will be specialised in that particular niche of testing and best placed to advise

- if existing assets are suitable to tap to test rig onto,
- if potholing or new tapping points need to be constructed
- if testing should be done at night to avoid noise disturbance from traffic,
- which branch lines need to be shut so the acoustic waves don't bounce around and affect the results,
- if known repair sections, normally short sections of replacement plastic pipe, can be allowed for in the analysis

Knowing the above points will inform the planning of minor civil works, traffic management and network shutdown. For successful testing it is crucial to plan these peripheral aspects in detail. As these are often carried out by different parties there is a large amount of coordination to be carried out for everything to come together smoothly.

3.2.3 CIVIL WORKS AND ACCESS TO VALVES AND FITTINGS TO ENABLE TESTING

The amount of preparatory work to enable testing is not to be underestimated and is often more time consuming and expensive than the actual testing.

In the last round of ePulse testing carried out for Wellington Water 80% of the cost of carrying out the testing was peripheral civil works and traffic management, with 20% of the cost in field testing and analysis (Newton, 2022). This demonstrates the tenacity of Wellington Water, determined that once the assets to be tested had been chosen they would see the tests through. These tests with significant peripheral costs were often short test lengths, such as under a railway embankment, or requiring clearance of bush in steep terrain.

Our experience from projects in New Plymouth and Wairarapa where the test points were easier to access is that the cost split can be 20% - 80% the other way.

Carefully planning and pre-inspecting test sites will lead to overall efficiency gains. Pre inspection normally involves:

- locating hydrants and valves (metal detector and hand tools should be carried),
- checking that chambers can be opened and are located as shown on GIS,
- taking photos and measurements so flanges and other special fittings can be sourced as required.

Most testing will require minor civil works such as potholing, asset location and opening buried or seized chambers that could not be accessed during the pre-inspection. There will invariably be traffic management planning and access to private land may need to be arranged.

Figure 6: A local restricting access to a VHCA pipe across private farmland in Wellington. Photo courtesy Chris Newton

The utility's maintenance staff may need to plan shutdown of parts of the network. They will need to be present during the testing to isolate parts of the network, observe while test rig is attached to the water column, and return valves to normal operating position once testing is complete.

3.2.4 PERMANENT INSPECTION SHAFTS

During the work for Wellington it was established that test shafts for ePulse testing were best made permanent. The main reasons for this were

- they could then be used for future re-testing of assets to establish rate of deterioration, and
- a civil contractor could prepare the potholes in advance of the test team being on site. This reduced the number of parties that needed to be present at the site at the same time. It also reduced stand down time if there were difficulties GPR locating assets or excavating the potholes.

A suitable shaft for ePulse testing can be constructed by potholing to the top of the pipe, then creating a chamber with a vertical section of plastic pipe capped with a toby of valve cover. The design shown below was developed in Wellington by collaboration between the test technicians, utility engineers and the civil contractor (courtesy Intergroup and Wellington Water).

Figure 7: Inspection shaft design iterations based on hydrant valve box. Designed in collaboration between the field test technicians, utility engineers and head civil contractor (courtesy Intergroup and Wellington Water).

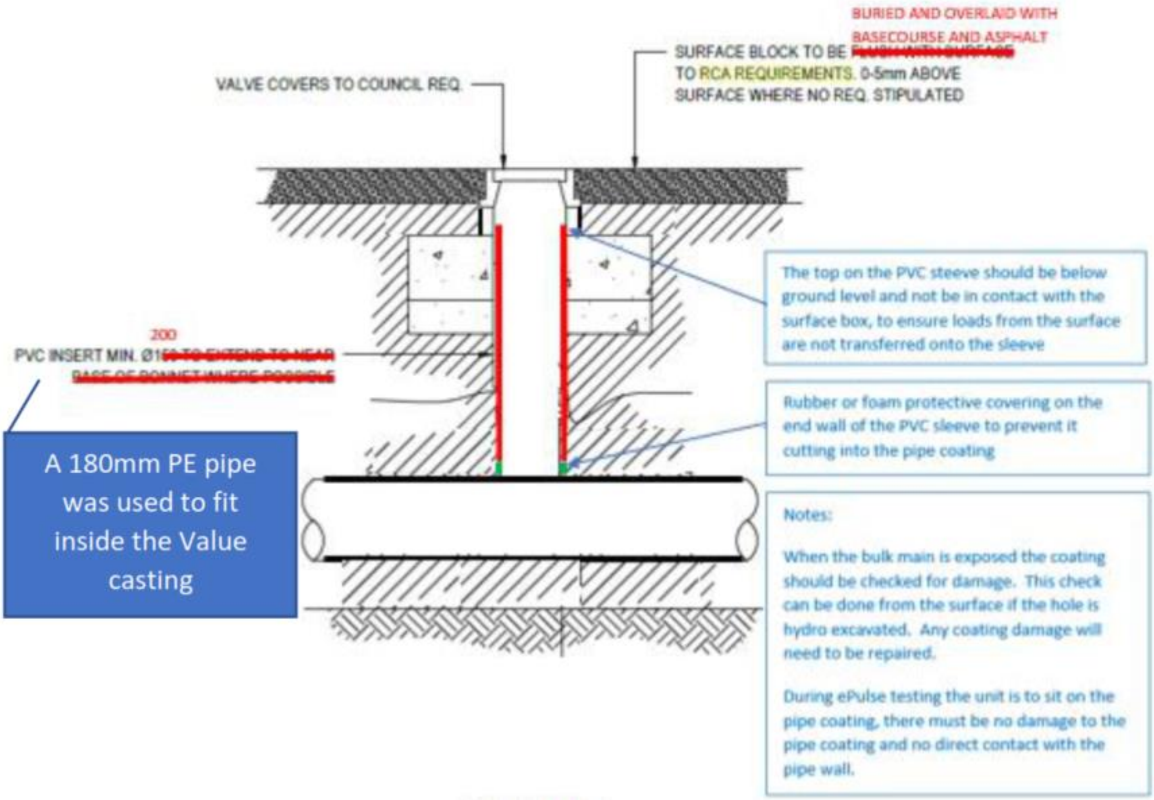


Figure 8: Typical inspection shaft being hydro excavated and finished with cover (courtesy Intergroup and Wellington Water)

3.2.5 FIELD TESTING

For field testing the most efficient way to operate is to coordinate a crew consisting of

- test technicians
- 3-waters maintenance crew and
- traffic management crew.

These operate as a unit moving along the pipelines to be tested.

The units will leapfrog along the road. The 3 waters and traffic management crews will set up traffic management and valve opening/closing ahead of the test technicians. One the test technicians have passed through and carried out the tests, the 3-waters and traffic management will pack up and return valves to normal operational position behind them.

Preparation of inspection shafts/ potholes and opening seized chamber lids will ideally be carried out prior to the test day to avoid delays for the entire team.

3.2.6 ANALYSIS OF DATA

Most of the data collected in the field will be sent overseas for analysis, either in Australia, Canada or Europe. It is essential to have close contact with the analysts during test planning and during the field trials to ensure that good data that can be analysed is gathered, before leaving the site.

One of the key challenges is confirming for the analysts the as-built specifications of the pipes. This is crucial for the analysis and small inaccuracies can have a large effect on the result. Normally incorrect as-built data is identified when the analysis gives unfeasible results- such as the remaining pipe wall being thicker now than when installed 50 years ago.

This often leads to further investigation of actual as-built specification, by searching thoroughly through archives, interviewing seasoned maintenance staff or measuring pipes on site. Once the as-built data is re-confirmed the field test data can be re-analysed to give correct results.

3.2.7 CONDITION ASSESSMENT

Combining pipe condition information with the stresses induced on the pipe will enable a condition assessment to be carried out. This will typically involve calculating the remaining strength of the pipe and testing what factor of safety the pipe has when real life loads are imposed. These loads will ideally be from PT Monitoring and calculation of earth and live loads on the pipe.

3.2.8 RECOMMENDATIONS FOR RENEWALS OR FURTHER INSPECTION

Often a recommendation from the condition assessment will be to gather further information about the pipes condition to increase confidence that the assessed condition of the pipe is accurate.

In Wellington many of the pipes could not be tested adequately or at all on the first pass, so alternative inspections have been recommended. Some of these are disruptive and costly, but the alternative of pipes failing or renewing pipes that have long remaining is a much worse use of resources.

4 DISCUSSION

4.1 WHAT CAN THE INDUSTRY LEARN FROM RECENT TESTING CARRIED OUT

One of the keys to successful collection of data for the test methods described has been the experience of field technicians. The first tests using a new technology have been a steep learning curve for all parties involved. As field staff have become more experienced the pre-planning they carry out has reduced many of the risks, the quality of the data gathered has been better and the percentage of scheduled pipelines successfully tested has increased significantly.

Providing tapping and inspection points so that acoustic inspections can be easily carried out should be considered on new pipelines. The bulk of the work in the tests carried out has often been preparation for the tests- Civil works, partial network closures and traffic management. Well thought out locations for inspection setup would allow for regular acoustic testing to be carried out relatively cheaply, allowing pipeline degradation to be monitored over time.

As technologies for testing are advancing all the time it is difficult to future proof the spacing and size of the tapping points. However, a useful addition to standard drawings for trunk mains and sewer rising mains would be 50mm diameter tapping points with a threaded ball valve, at maximum 1000m spacings along a pipeline. The first tapping point would be on the common main near the pump station or reservoir, located in an accessible valve chamber.

Where potholing needs to be carried out to expose a pipe for testing, the most efficient way to do this is to create a permanent inspection shaft. This allows the shaft to be constructed prior to the day of field testing meaning less parties need to be coordinated on site at the same time. This has the added benefit that if unexpected hold-ups occur such as difficulty locating the correct pipe or delays making the excavation, there is less stand by time for the entire testing team. For further detail about suitable test shafts refer to section 3.2.3

4.2 SECONDAY INFORMATION GATHERED

Aside from condition information, which is the primary purpose of the test, much other valuable information about the network assets will be collected while testing. It would be wasteful not use this information to update the utility’s database. This includes:

- Actual position of assets.
- Correction of incorrectly documented assets, such as make and model of air valves.

- Assets found that aren’t on the GIS, or vice versa.
- Incorrect connections.
- Permanently closed, open or half open valves contrary to the correct operational close/open position.
- Prescence, size, and location of leaks.

Although not the primary purpose of the testing, the testing will typically identify leaks larger than 1 litre/minute to a location accuracy of +/- 10m. The technicians will normally be experienced in leak detection, so it is advantageous if they carry acoustic leak detection equipment with them and a provisional sum is allowed in the contract for them to find and mark the precise location of any leaks found.

4.3 FUTURE TECHNOLOGIES

Test methods are improving, and new technologies are becoming available all the time.

One of the main reasons more testing was not achieved in Wellington was the difficulty of shutting branch lines in the network. Often these were the only supply to large areas or reservoirs, and there wasn’t back up capacity in the system to shut these for the 4-6 hours required for a scheduled night of testing. New analysis methods developed in 2022 after the conclusion of that project promise to remove this barrier by allowing most branch lines to be left open during a test.

Technology advances are occurring rapidly, and investing in trialling and perfecting new technologies in NZ will allow more pipes to be cost effectively tested, while giving better condition information.

5 CONCLUSIONS

Half of the New Zealand councils have indicated they have low confidence in their pipe condition information (Water New Zealand 2018). Extensive testing of pressure pipe condition rarely occurs due to the high cost and intrusive nature of traditional inspection techniques.

The method normally used is coupon sampling, which involves cutting out a section of pipe and measuring its properties or sending it to a lab for analysis. This method only gives information at that point on the pipe and is rarely repeated to provide a picture of degradation over time.

Testing of pressure pipes using the methods described in this paper provides additional evidence about the remaining wall thickness and stresses induced on an asset. It can be repeated to show the deterioration rate over time and gives information about the entire length of the pipe segment, as opposed to a spot sample.

It is suggested that asset managers should not embark on renewals unless they have reasonable confidence particular assets are known to be in poor enough condition so correct and justifiable decisions can be made. If the condition of an asset is suspected to be poor, but this suspicion is purely based on age and material, then it will be a candidate for further inspection. If an asset is critical, and the utility cannot afford for it to fail, then it will also be a prime candidate for regular testing to ensure it is replaced strategically before operating to the end of its life.

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New Plymouth District Council for allowing us to carry out pilot trials of both ePulse and p-CAT technologies, especially Nainchao Pan.

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