WATER PIPELINE TEST FACILITIES RESEARCH

FINDINGS REPORT - FINAL REPORT

For:	Scottish Enterprise
Date:	1 February 2019
Authors:	Thomas McNally Matt Connolly Richard Hayward
Reviewer:	Karyn Georges

Isle Utilities Camelford House, 89 Albert Embankment, SE1 7TP
Company No: 7140964
isleutilities.com

Table of Contents

EXECUTIVE SUMMARY

Isle Utilities has carried out a review of the requirements and demand for additional pipeline test facilities in Scotland, as a project funded by Scottish Enterprise and Scottish Water Horizons. The review consisted of research and interviews with Scottish Water, their suppliers, existing facility providers, research institutes and universities to assess the current situation and identify gaps between what currently exists and is planned for, and whether this meets the needs of the Scottish water industry.

The review identified that:

- Facilities for the training of Scottish Water staff and contractor's personnel on network operations and maintenance meet most needs of the industry. However, there is some scope for provision of secondary facilities (e.g. by a mobile pipe rig and/or redundant Scottish Water assets) for training at more remote locations away from Scotland's central belt.
- Multiple facilities exist in Scotland and further afield for development and testing of new products and services, but these do not always meet suppliers' needs from an availability and capability perspective.
- Suitable facilities for demonstration of new technologies and techniques are limited and not always accessible in Scotland, and there are currently no suitable facilities in Scotland or the UK which accurately replicate the conditions encountered in the real world that are required for validation of certain types of technologies (e.g. condition assessment tools, mains cleaning tools).
- The limited availability of facilities at Scottish Universities and research institutes for fundamental research is likely to be off-set by the availability of collaborative research facilities that are being developed at several universities in England.

The key recommendations that should address the gaps between what currently exists and is planned for are:

- Develop, or improve existing, databases of existing test facilities in Scotland, with details of capabilities and disseminate this information via a suitable platform, such as UK Water Partnership's or CREW's interactive websites.
- Assess the feedback from Water UK's Water Distribution Network group on the need for water industry performance standards for condition assessment tools and then determine the demand for a facility for the testing and validation of these tools.
- Facilitate further discussions between Heriot Watt, Sacro Stopper and McCrae Training to develop the opportunity, with the potential for the James Hutton Institute to be also involved in some capacity.

1. INTRODUCTION

1.1 Background

A dedicated pipe test facility is potentially a valuable resource for the Scottish water industry. New methods, materials, fittings and technologies for water distribution networks are being introduced into the UK at a rapid rate thanks to advances in computerised design, materials technology and the spread of information via the internet. Drivers for implementation of these new materials, technologies, etc. include:

- The significant impacts that the water supply network can have on the quality of water supplied to customers' taps has only recently been realised and the body of research in this area is still in its infancy;
- A greater appreciation of the value of water and the need to reduce leakage;
- A focus on asset management of ageing infrastructure by water companies, including condition assessment tools which can give water companies insight into rehabilitation requirements;
- The requirement to minimise cost and maximise value when asset replacement is necessary.

Testing of new materials, techniques and technologies under local conditions is often required by water utilities before they can be considered for use in the utility's water supply network, so that risk to supply is minimised. The ability to carry out testing of new techniques, and training and assessment of operational staff in the use of new and existing techniques on a realistic system that is not connected to the public supply also provides great value.

There are several test facilities in England and Wales, some linked with research institutes and others owned by water utilities. Access to these for testing of new technologies can be limited and travel time and costs can be restrictive for operational staff based in Scotland. Therefore, a review of what is currently required by the water industry and an assessment of availability and capability of 'live' pipe testing facilities (especially those located in Scotland) was required to determine whether there is opportunity to provide additional resources to fill the gaps that exist.

In order to bring a new product or idea to the water or other pipeline-based industries, technology providers require a facility in which they can innovate, test and prove the efficacy of their offering. Thanks to the development of smart networks, more effective mains cleaning, leak detection and repair, technology plays an increasingly large role in management of distribution networks in the water industry and the number of technology providers is only likely to increase because of this. In order to support innovation in pipeline technology for the water industry, technology companies will require appropriate facilities to be enable them to service the industry.

1.2 Aims and Objectives

The overarching aim of this project was to undertake an independent and technical assessment of the current pipe testing landscape. This will provide Scottish Enterprise (SE) and Scottish Water Horizons (SWH) with:

- A detailed understanding of the demand from industry, technology developers, and academia in Scotland for a dedicated pipeline test and training facility.
- Knowledge of existing pipeline test facilities across Scotland and the rest of the UK and the services they provide.
- Intelligence on the gap between the demand and supply of pipeline test facilities within Scotland and to determine the need for new facilities.

The specific project objectives for this research project were to:

- Assess the demand for pipeline test facilities and specific requirements of companies (pressure, flow rates, pipe material etc.);
- Assess the demand for companies to train their staff on 'live' pipelines and their specific requirements;
- Review and assess the existing pipeline test and training facilities (including those owned by private companies), focused on Scotland, but with an overview of those in rest of UK;
- Review existing SWH pipeline test facilities and make recommendations for potential upgrade and identify any SWH redundant assets suitable for upgrade to test facilities; and
- Consider the demands and test facilities outside water, wastewater and hydro pipelines and include other sectors where there is a potential to combine and share facilities such as oil and gas, district heating and chemicals.

The expected outcomes following this project are for SE and SWH to get a better understanding, based on direct intelligence, of the Scottish and UK landscape in regard to the need for dedicated pipeline test facilities in Scotland. Where the project identifies a gap that could be filled by SWH, the research findings should feed into future business plans for a new or upgraded test facility.

1.3 Scope

The scope of the final project outputs was:

- To gain a full understanding of the range of services that are currently required by the water industry (utilities, contractors, research institutions and technology providers) that could be fulfilled by a pipeline test facility and also any services that are not currently required but may be required in the future;
- To determine the size of the market for those services that are required by the water industry;
- To collect and collate data and information on all of the pipeline test facilities that are currently available in the UK, including the range of services offered, availability

of service (to determine if they are already operating at or near full capacity) and ability to easily increase their offering;

- To analyse all of the information gathered and identify where there is insufficient capacity or there are challenges to uptake of capacity (e.g. cost, distance of facility from demand); and
- To identify the opportunities for investment in pipe testing facilities in Scotland.

2. METHODOLOGY

2.1 Start-up meeting

A start-up meeting between SE, SWH and Isle was held at Balmore WTW training facility (near Glasgow) to confirm the project scope, milestones, project meetings, lines of communication and deliverables. The meeting provided an opportunity to discuss the details of specific aspects of the project, and the requirements of all parties. The location also provided an opportunity for Isle and Scottish Enterprise to view the two pipe rigs that are located at the site.

2.2 Research into demand for pipeline testing facilities

Isle approached a number of organisations within the water and pipeline industries, through existing contacts and additional contacts provided by Scottish Enterprise to determine:

- Details of pipeline testing requirements they have had in the past, e.g.:
    - New materials testing, including for water quality, pressure;
    - New fittings testing including for ease of installation, operability, water quality, pressure;
    - Training of new staff on existing techniques including: installation and operation of fittings; cleaning; repair, disinfection, taking cut-outs, etc.;
    - Training on new techniques, including: installation/ operation of fittings; new repair and cleaning techniques, etc.
- Information about the facilities they have used;
- The barriers to use of test facilities, where they have previously had a requirement;
- Their future requirements for pipe test facilities; and
- Their budget for testing or how much they willing to pay for the use of a test facility.

A list of those organisations contacted is provided in **Appendix A**.

2.2.1 Research into existing pipeline test facilities

Isle, with input from SE, SWH and organisations contacted in Section 3, identified several organisations that have pipe test facilities in the UK. Isle contacted the test facilities to determine the different types of testing they have carried out and/or are capable of carrying out, including ancillary capabilities including access to microbiological, chemical and physical analysis laboratories. In addition to determining their current capabilities, Isle also asked what new services could be provided at their site with minimal investment. Isle then spoke with UK water utilities to determine which test facilities they are aware of. The information provided informed our technical researchers on keywords to be used for additional web-based searches to identify other UK test facilities that are available and their capabilities.

2.2.2 Assessment of information gathered and gaps in supply

All of the information gathered was analysed to determine where the gaps were, between what is currently available, where the facility is located and what the demand is for their services. A matrix approach was used to determine the gaps and to identify opportunities.

3. UNDERSTANDING DEMAND FOR PIPE TEST FACIILITIES

Different organisations and departments within organisations have a diverse range of needs for pipeline test facilities, including:

Training:

- Training of new staff on established techniques; and
- Training existing staff on new techniques and technologies.

Research and testing

- Testing and demonstration of new techniques, technologies, materials and equipment; and
- Fundamental research into how pipe networks function (taking into account internal and external influences).

The following subsections summarise the key findings from the interviews, covering the types of demand for pipeline test facilities by different organisations.

3.1 Scottish Water

Scottish Water have required pipeline test facilities across a wide range of areas in the past, from basic training to fundamental research. These requirements are usually met by in-house facilities, commercial facilities, universities and research institutions.

Training needs

Basic hands-on water network training requirements are met by on-the-job training and by attendance at the facilities at Balmore WTW. The need for training at Balmore is limited as there is a low turnover of staff within network operations, and once staff are trained on operating valves, without causing pressure transients etc., there is no requirement for them to repeat the training. The only challenge to the use of Balmore as a training facility is from those who have to travel a long way; to manage this challenge, training for long-distance attendees is arranged to start later in the morning to take travel time into account.

Research and testing needs

At the other end of the spectrum, Scottish Water contracts pipeline research to universities and research institutions according to specific needs, either through direct commission (e.g. with University of Sheffield on Flow Conditioning) or in collaboration with other water companies.

The areas in which Scottish Water staff identified a need for pipe test facilities were:

- Third party testing, validation and operational requirements of condition assessment technologies (a requirement for third party testing/validation of technologies may need additional support from other water companies to provide a driver for technology companies to accept such testing).
- Simulation of existing systems to minimise risk from construction/ engineering/ rehabilitation activities. (e.g. if Scottish Water suspect there is a leak on a specific

section of pipe in Edinburgh, but the location of the pipe and the inter-connectivity of the pipe mean that repair is potentially very challenging. The ability to simulate an intervention on a non-live section of pipework (which duplicates the real-world conditions) at a test facility would allow risks to be identified and minimised or eliminated).

Both of these types of activities require facilities with assets that provide a realistic setting and are analogous to those used by Scottish Water in the field. Facilities which are currently provided by universities and research organisations, although the UKCRIC facilities which are under development (and which are described in Section 4) may meet at least some of these needs.

Scottish Water made a comment that they also face a specific challenge in finding suitable trial sites for new mains cleaning technologies. Cleaning technologies need to be trialled on pipes which have been operational, so that a layer of biofilm etc. has been allowed to develop. Although testing of cleaning techniques on sections of operational mains offers realistic conditions, testing on a section of mains that is non-operational, but which has had water flowing through it to allow biofilm to develop would be acceptable. Modification of such a set-up to allow sections to be removed for analysis would also provide additional benefit that may not be achievable with operational mains. A challenge of this type of set up would be the time required for biofilm to redevelop following a clean. However, it is unlikely that several cleaning techniques would need to be trialled in short succession. If this is envisaged, parallel duplicate mains could be installed, which would also allow direct comparison.

3.2 Equipment and Service Suppliers

3.2.1 Introduction

To understand the size of the market and requirements of potential technology provider clients, interviews were undertaken. A significant number of companies were approached for interview and detailed conversations were held with 19 technology providers and contractors. **Figure 1** below shows the breakdown of these companies by sub-sector.

The companies interviewed formed a broad range of having used, not used or developed their own pipeline test facility. The companies who had not used facilities previously had used redundant sections of water company network or have had no requirement as the technologies they provide can be proven at laboratory scale or in the field. Other companies who provide very specialised equipment or are from operations contractors have developed their own facilities. These facilities are used for testing of technologies, developing new devices, training staff or proof of concept.

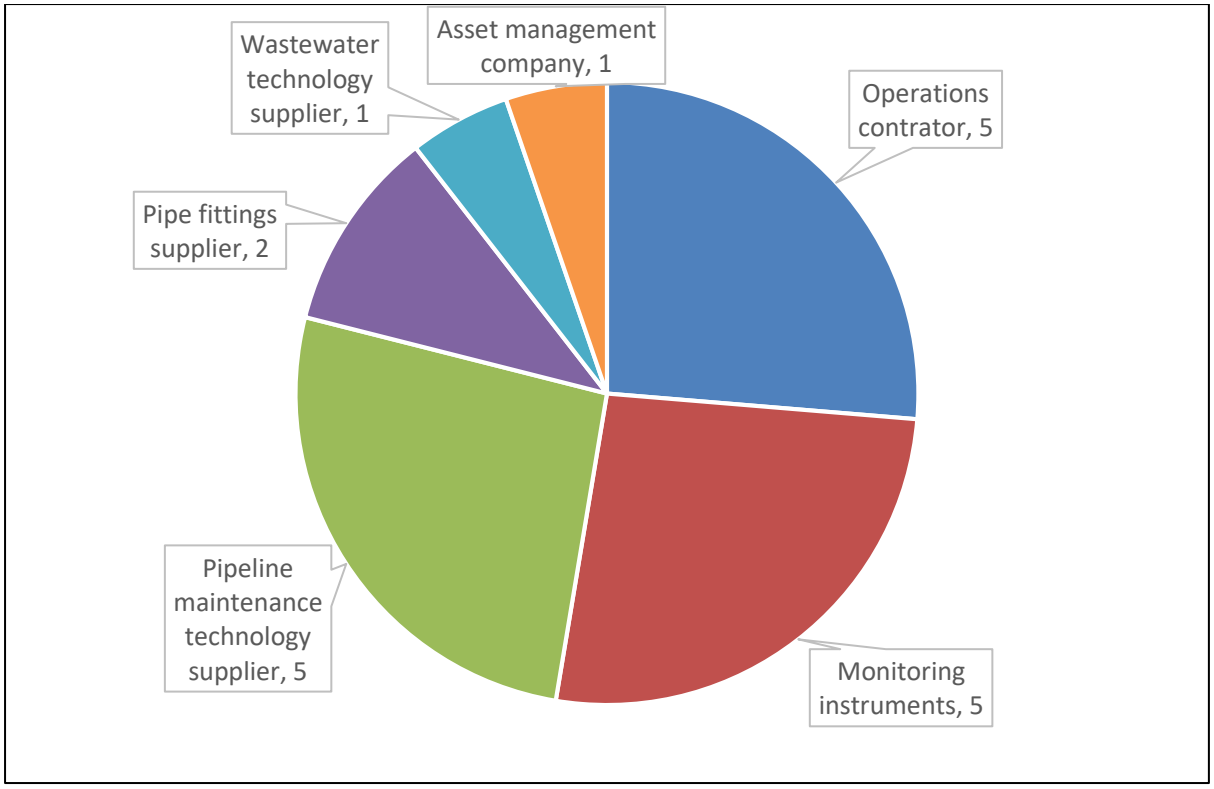

Figure 1: Breakdown of organisations interviewed regarding pipeline test facilities

3.2.2 Use of Existing Pipeline Test Facilities

Pipeline test facilities have been used in the past by 15 of the 19 interviewed companies for testing of materials and technology, developing new technologies and training of staff and clients. As shown by **Figure 2**, technology testing and development was the most common use of pipeline test facilities.

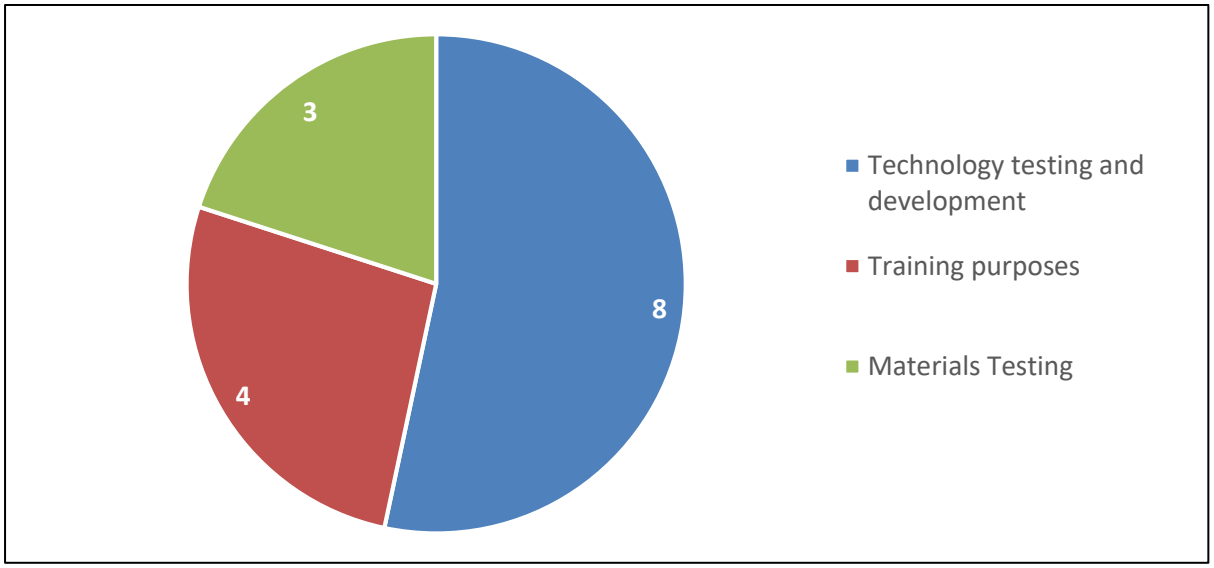

Figure 2: Uses of pipeline test facilities by the companies interviewed

Some of the test facilities have been used for specific trials of technologies. An example of this is a pipe cleaning technology company who inserted sand into a facility to examine how effectively their product removed loose sediment. This required the test facility to be open to the technology company introducing sand into the pipeline, giving full control of the facility to the user.

Training of staff and clients is also a use for pipeline test facilities. Companies reported using facilities for training in:

- Locating underground assets
- Confined space training – water industry specific
- Hygiene / Distribution Operations Maintenance Strategy (DOMS) practical training

3.2.3 Future Requirements

The majority of interviewed companies suggested they would require a test facility in the future. As shown by **Figure 3**, nearly 50% of the companies interviewed stated there was a 9 out of 10 chance they would need to use a facility in the future.

Those companies that anticipated a future requirement for test facilities stated that the requirements would be similar to those required for previous projects: for training, and testing of materials and technology. For technology providers proving their products to water companies and other clients is a key driver for using a test facility. Technology companies would look to build a case study from the tests at the facility, so water utilities would be confident in using their devices. Contractors seem to be more focused on using a facility for training of staff.

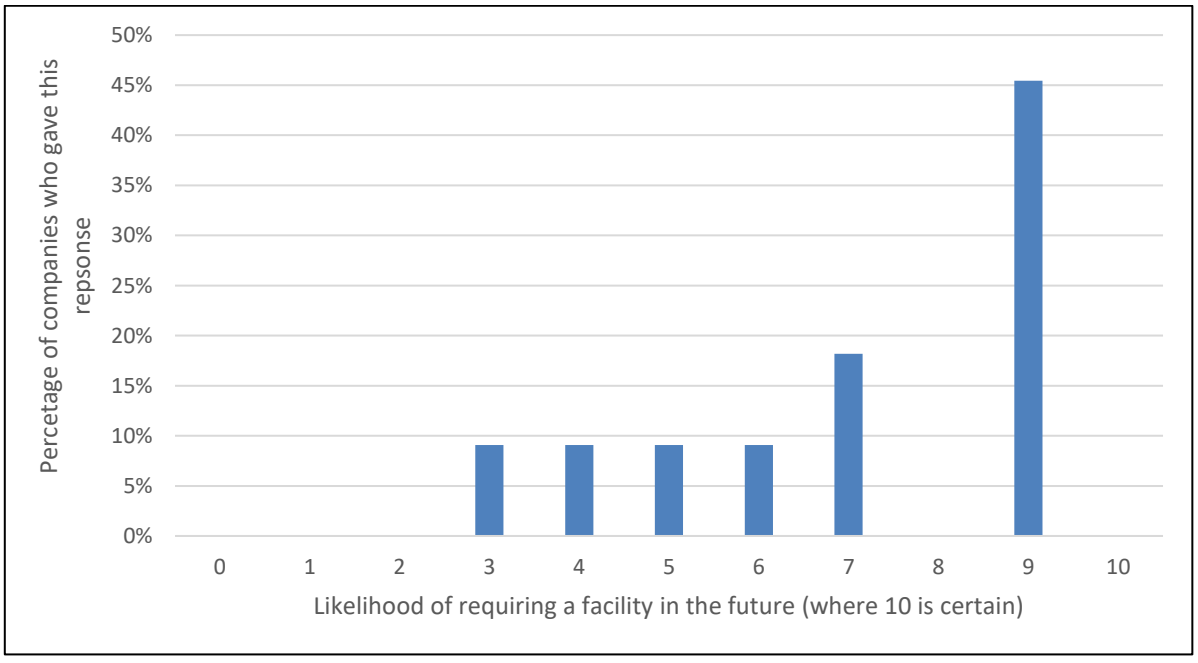

Figure 3: Likelihood of the interviewed companies requiring a facility in the future

3.2.4 Facility Location

Figure 4 shows the importance the interviewed companies place on the location of a test facility. Location polarised the companies interviewed with some feeling strongly that proximity is important when choosing a facility, whereas other companies were more willing to travel if the facility was right for them.

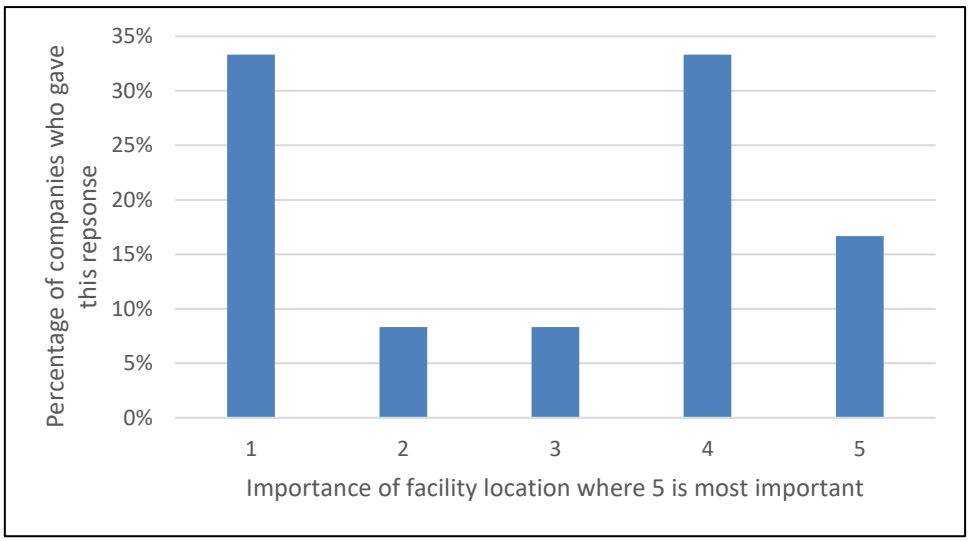

Figure 4: Importance of facility location to the interviewed companies

A key factor here is whether the cost of travel would make a facility prohibitively expensive and if this could be overcome by lower day rates to use the facility. Some technology providers discussed using such a facility to exhibit products to clients who may have travelled from abroad. Where this is the case location in the UK is less important, but a facility's transport links is very important.

A technology company who provide monitoring devices discussed how, in order to overcome issues relating to location, a well-equipped facility could offer testing without the providers on site. (i.e. the technology company could send their devices to the facility who would test under predetermined conditions and supply the results back to the technology company).

3.2.5 Barriers

Various reasons have been given by the interviewed companies not to use a pipeline test facility. The most regularly raised issue was the capabilities of current facilities, as shown by **Figure 5**. In order for technology companies to prove the effectiveness of their products to clients the facilities must be as close to real network scenarios as possible. Some examples of this is are the ability to build up sufficient pressure and flow in worn mains.

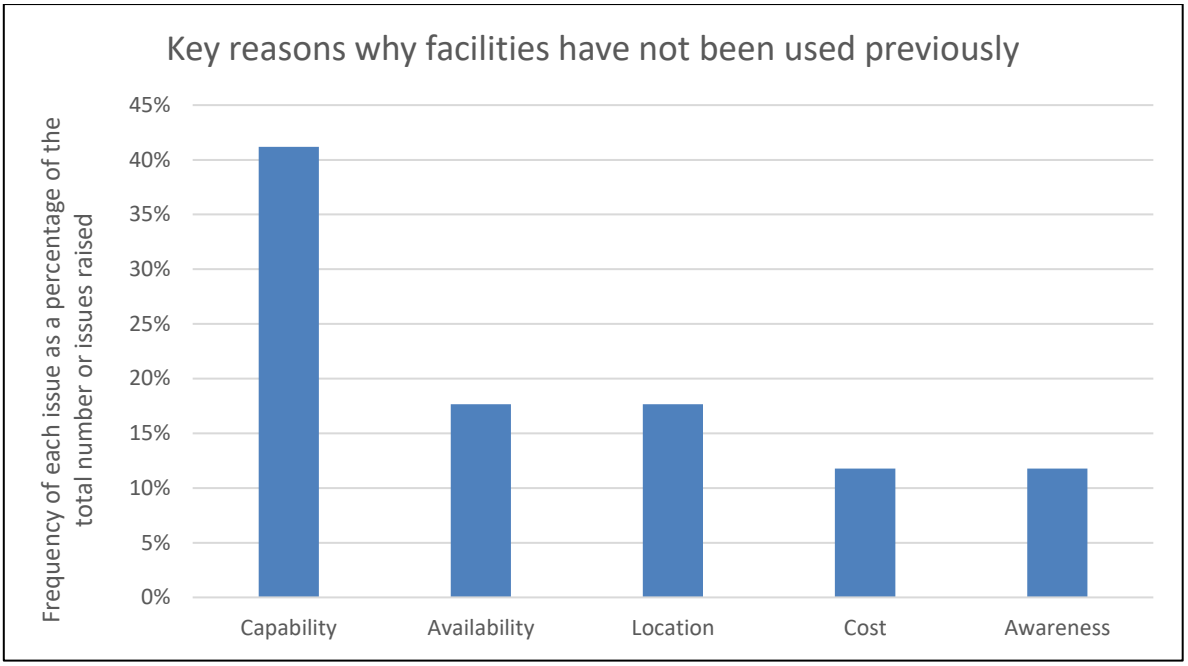

Figure 5: Barriers to previous use of pipeline test facilities

Other key reasons are availability and awareness of facilities, which arise because either the facilities simply do not exist, or companies are not fully aware of them. This shows there is a gap in the market which could be filled by a new, well marketed test facility. As is to be expected cost is also an issue, especially for small technology providers, however, generally the interviewed companies agreed that the investment may be worthwhile for a well-run facility which links back to the capabilities challenge. It was expected that cost would be a larger issue for the potential facility users, however, other issues were more pressing.

3.2.6 Laboratory Facilities

Laboratory requirements were raised during the interviews and generally a laboratory was not deemed necessary. Over 50% of interviewed companies stated that a laboratory was not important for them at a facility and of those who found it necessary only one company required anything particularly advanced; most companies only required a room for analysis with some computing facilities. The company which said they would require a laboratory would like for it to be of sufficient quality to be able to give regulatory approvals.

3.2.7 An ideal facility

Throughout the interviews a number of suggestions were made as to what an ideal facility would look like for each specific company.

Firstly, the length of rig was important with companies suggesting different requirements from 120 m to 300 m. Another company would look for a looped system in order to test very long runs of pipe cleaning technologies. The pipes used should be in similar conditions to those in real mains and predominantly cast iron to match the real network scenarios. For condition assessment technologies the pipe wall should vary in thickness and have weaknesses to allow the technology to locate high burst risk areas. For leak detection and

repair technology providers, a facility with leaks would be ideal especially if any repairs could then be analysed post testing.

The flow and pressure through the facility are also of importance. The interviewed companies would like to see pressures reaching 16 to 20 bar with a flowrate similar to real network conditions for the pipe diameter. Furthermore, the facility should be able to effectively monitor and control the flow rate and pressure in order for technology companies to vary these parameters. One company who provide acoustic monitoring devices would prefer a facility where pressure and flow are high but without proximity to large pumps in order to allow the devices to listen effectively for leaks without mechanical background noise.

Leak repair and location technology providers require a facility that is able to simulate leaks or allow users to add new leaks. One of the companies interviewed raised an issue with a previously used facility where electrical equipment surrounded the pipeline meaning leaks could not be made in the pipe to keep the equipment dry.

In addition, the facility should be run and managed effectively by experienced operators to prevent errors. This includes effective scheduling allowing sufficient time for users including restoring the facility to a normal state after conditions have been changed or materials have been removed from the pipelines.

A crucial issue for technology providers is that they are usually required to trial and prove their technologies at each water company's site. To overcome this challenge, a facility which offers real network conditions and was approved by all water companies is required. If a test facility could provide a technology company with case studies around which they could build a business case to take to water companies, that would be a significant benefit. In order to achieve this aim, the facility would need to be offer sufficient pressure, length and flow using mains that were previously part of a network and to be at least partly underground or even be partly a section of an actual network.

To summarise, for technology providers the following key capabilities of a facility are:

- Long pipeline runs (up to 300 m in length)
- Previously used pipelines
- Real network scenarios
- Ability to produce effective case studies approved by water companies for marketing purposes
- Effective scheduling and operation

3.2.8 Cost

The price range companies would be willing to pay for a facility was difficult to really understand as it was variable on the capabilities of the test facility. The main feedback was that the cost should be worthwhile, so a high cost could be appropriate if the facility provided sufficient capabilities. One technology provider discussed that they were quoted £350 for a morning on a facility; in comparison to this, it was suggested that a new facility could charge £500 - £1000 per day. Also, it was raised by one interviewed company that a

pipeline test facility could offer a cost model where use of the facility was paid for retrospectively once the case studies developed at the facility generated sufficient revenue. The ownership model was generally less important for the interviewed companies who favoured a cost effective and well operated facility, regardless of public or private ownership.

3.2.9 Further Insight

Additional suggestions made during the interviews were that there is a real demand for a high-quality facility in Scotland and such a facility could become a template for further facilities, that could be copied for other locations, if proven successful. Another suggestion was that equipment for the facility could be obtained from providers in return for time on the facility once complete. Finally, there was clear desire to see how a facility like this could improve the uptake and level of innovation in the water industry. The facility could help through two methods. Firstly, it would help a technology provider to undertake research and development on a new product before, secondly, undertaking robust testing to demonstrate to the end user the value of the developed product.

3.3 Summary

The key information from the interviews with relevant companies is summarised below:

- Scottish Water have a requirement for a pipeline test facility for research and testing, with validation of condition assessment tools being of significant interest.
- The most common use for a pipeline test facility identified by the interviewed companies which is for technology testing and development.
- The most common reason interviewees have previously avoided using pipeline test facilities is that current facilities do not have sufficient capabilities, as raised by seven companies.
- An ideal facility for technology providers was suggested to have close to real network scenarios as possible. This is to enable technology providers to build case studies from trials at the facility, to minimise the need for each water company to undertake further trials on their own sites.
- The Sarco Stopper case example in the text box below demonstrates the demand for a pipeline test facility with sufficient capabilities and training services in Scotland, which has led to some technology providers investigating the potential for developing their own facility to meet this demand.

Case example - Sarco Stopper

Sarco Stopper make line-stopping and bypass solutions for oil, gas and water pipelines. Based in Broxburn, near Edinburgh, they have been manufacturing pipe-line isolation equipment since 1877 and producing under-pressure stopper bags for over 40 years.

They traditionally produced equipment for low-pressure systems, but more recently started to develop various high tenacity engineered technical fabrics stoppers for high pressure systems. This has led to the need for higher pressure test facilities than the company has on its own site, so the company has commissioned testing at external organisations such as TUV-NEL, WRc and Esholt Hall (which is no longer available, since being sold by Yorkshire Water).

The company has required very high pressure testing in the past (ca. 80Bar) and looked at testing at DNV-GL's facility at Spadeadam (an ex-MOD facility used for explosion testing, which proved to be prohibitively expensive) and more recently had the need for a fire-fighting water ring main test, for pressures up to 17Bar. Lack of availability of facilities to test at these pressures has led to a stalling of these projects.

TUV-NEL now have a 140Bar test facility that could meet Sarco Stopper's requirements for very high pressure testing. However, Sarco Stopper still see the need for medium pressure testing and are considering setting up their own facility, which they also plan to use for training and testing of third-party equipment. It has been suggested that a facility between 7 to 10bar would meet their requirements.

Sarco Stopper are interested in working with other organisations to develop further pipeline test facilities.

4. Existing Facilities

The following subsections describe the range of facilities currently available in the Scotland, as well as relevant facilities in the rest of the UK and Europe.

4.1 Water Companies and Contractors

4.1.1 Morrison Utilities pipe rigs (various locations)

Morrison Utilities have supplied pipe rigs to several UK water utilities (Thames Water, Severn Trent, Dwr Cymru Welsh Water (DCWW) Northumbrian Water, South Staffs Water, Essex and Suffolk Water, and Yorkshire Water).

The rigs are predominantly for training of field technicians in the operation of valves (for calm networks best practice), including fire brigade and water tanker operators at Yorkshire Water, and key contractors at Thames Water and BAe Systems staff at DCWW (BAe Systems have their own water supply system in Warrington). The rigs are also used for training and evaluation of equipment e.g. for under pressure cameras, line stop equipment etc.

4.1.2 Scottish Water (Gorthleck and Bo'ness)

Scottish Water have two Development Centres at Gorthleck (water) and Bo'ness (wastewater) to enable testing of pre-commercialised equipment on an operational scale. Users can test new processes, technologies and equipment under live conditions to enhance the marketability of their products without risk to Scottish Water operations. The sites, which are operated by Scottish Water Horizons, can provide skilled operators and UKAS accredited sampling and analysis services.

Figure 6: Gorthleck Development Centre
(Courtesy Scottish Water)

Scottish Water also operate a training centre at Balmore Water Treatment Works (WTW) that has two pipe rigs:

- A general training rig used for training on pressure testing, chlorination, de-chlorination, etc. (**Figure 7**);

- A rig similar to those provided by Morrison Utilities (described in Section 4.1.1) to train network staff in the correct operation of valves in order to reduce the chance of a pressure transient (**Figure 8**).

Figure 7: Balmore WTW Training Centre General Training Rig (photo by Isle Utilities)

Figure 8: Balmore WTW Training Centre Pressure Transient Training Rig (photo by Isle Utilities)

The two training rigs at Balmore WTW have also been used to test various technologies and methodologies such as an EZ Valve™ (a way to install a valve without cutting the pipe), and mains cleaning technologies such as Ice Pigging and Intelligent Gels.

There is space on the site for additional test facilities, should there be sufficient demand.

4.1.3 Thames Water (Kempton Park)

Thames Water have identified that existing pipe test facilities (including their pipe rig supplied by Morrison Utilities) do not meet all their requirements and are in the process of developing a pipe test facility at Kempton Park Innovation Centre. Thames Water currently have challenges with their cast iron mains in London, many of which are coming towards the end of their life. These are very specific challenges due to their aging assets, leakage challenges and risk of life due to bursts flooding basement properties, of which there are many in London.

All of these challenges are leading to Thames Water investing in a significant mains replacement programme. In order to keep the cost of the replacement programme down Thames Water are working to find condition assessment tools that would help to identify which sections of main do and do not require replacement, reducing both cost, speed and disruption of the programme. To date Thames Water have found that the condition assessment tools currently available to the market do not give sufficient and reliable data. In addition, Thames Water have not found pipeline test facilities with sufficient resources and capabilities for them to effectively test condition assessment tools.

For these reasons, Thames Water are constructing another facility at their Kempton Park site. The facility will use cast iron mains that were previously part of the network in an above ground facility. The aim of the new facility will be to work collaboratively with technology providers, contractors and other water companies to both prove the size of the market to providers and develop technologies for their application.

Thames Water also have one of the four Smart Water 4 Europe demonstration sites in Reading, known as the Thames Water Innovation and Smart Technology Centre (TWIST). The site provides an environment where new and existing smart sensor technologies can be tested in real situations on two district metered areas. The facility is available to external users, subject to terms and conditions, for the installation of sensors and the implementation of technologies and software applications.

4.1.4 Anglian Water (Newmarket)

Anglian Water's (AW) Shop Window uses existing infrastructure in Newmarket to test-drive innovation through collaboration across AW's business and their supply chain. It provides a real-world test bed to suppliers to trial products, services and initiatives, and develop viable commercial applications. However, access to the test bed is limited to those products and services that are of interest to Anglian Water.

4.1.5 Northumbrian Water (Durham)

Like many UK water companies Northumbrian Water have a pipeline tests facility supplied by Morrison Utilities. The facility is the same as the standard Morrison facilities and is almost exclusively used for training, specifically on valve operations. More recently, however, Northumbrian Water have begun using a long straight length of main at the facility to test some new technologies, particularly meters or other monitoring devices.

4.2 Water industry pipe, technology, and equipment suppliers

4.2.1 Aqualiner (Loughborough)

Aqualiner have only previously used their own test rigs and redundant sections of the network (provided by Anglian Water and Yorkshire Water) and do not anticipate a future need for a pipeline test facility.

4.2.2 Hydro International (Cambridgeshire)

Hydro International use their own hydraulic lab facility for product testing. They also have a drop shaft structure (flow control for CSOs) and for this purpose they have also carried out some testing with Scottish Water at Bo'ness WWTW. Hydro International have approached WRc in the past to get product approval, but the facility didn't have the capabilities to carry out all of the testing they required. The have had products approved by the British Board of Agrément (http://www.bbacerts.co.uk/), though these products are more related to the construction industry. It should be noted that most of Hydro International's products are related to open channel flow rather than piped flow.

4.2.3 Impact Solutions (Grangemouth)

Impact solutions are a Scottish Water framework contractor who carry out materials analysis, failure analysis and accelerated weathering, and quality control for installation and electrofusion for plastic pipes and fittings. They are able to outsource to other organisations for similar work for metal pipes. However, they do not have test facilities for in-situ condition testing of older pipework and do not intend to develop this area of work.

4.2.4 Radius Group (Derby)

Radius Group have their own facility to test their own products and have used other accredited third-party facilities in England, including a facility in Derby which has now been sold to Develop Training.

4.2.5 Qinov8 (Durham)

Qinov8 have had a need in the past for product testing. They have been to look at Northumbrian Water's test facility but found it to be ineffective for their requirements. They are now in the process of building their own facility, however, it will be for small diameter pipes (service connections).

4.3 Training organisations

4.3.1 McCrae Training (East Kilbride)

McCrae Training is a multi-sector training organisation with a strong focus in water and gas utilities training. Training includes valve operations, network construction including jointing, and asbestos pipe handling and has an outdoor network which can be operated up to 10Bar and set at 2.5 Bar to simulate calm networks. Development of a mobile training rig has been considered by the organisation in the past, and although there was not deemed to be sufficient demand at the time, if there was a renewed drive from Scottish Water (e.g. due to an increase in water quality events associated with firefighting) McCrae Training could look at it this potential opportunity again.

The organisation have also carried out R&D testing for Scottish Water for new technologies in the past and have also carried out third-part testing for pipe jointing technology. They are also open to the possibility of providing third-party validation of products, if there was sufficient demand from the water industry.

McCrae Training are interested in working with other organisations to develop further pipeline test facilities.

4.3.2 Develop Training (Falkirk)

Develop Training Ltd. (DTL) have seven dedicated multi-sector training facilities in the UK, including one in Linlithgow, near Falkirk. Training includes network construction, CCTV inspection, jetting and pipe fusion, including practical training on pipe rigs. DTL can also deliver training courses on customer's premises if there are suitable practical facilities.

4.4 Universities

A targeted review of existing university facilities was carried out, initially focussing on relevant universities that are part The Engineering and Physical Sciences Research Council's (EPSRC) STREAM and UKCRIC programs.

STREAM: The Industrial Doctoral Centre (IDC) for the Water Sector, which is delivered by five UK academic centres of excellence in water science and engineering in the UK. STREAM is coordinated by Cranfield University and includes Imperial College London and the universities of Sheffield, Newcastle, and Exeter.

UKCRIC: The UK Collaboratorium for Research on Infrastructure and Cities (UKCRIC) with an investment of £216 million by EPSRC and partner organisations. UKCRIC provides leadership for the development and growth of a UK-based national infrastructure research community. Universities that were considered to be relevant to this study are Cranfield, Sheffield, Newcastle and Birmingham.

Other universities that were known to carry out water and pipeline related research were also contacted to determine their capabilities and facilities.

4.4.1 Cranfield University

Cranfield University are currently undertaking a major investment, as part of the UKCRIC Programme, to build a new "clean" water pilot hall at their existing wastewater treatment facility. The site will give access to existing onsite infrastructure and tankered supplies, allowing treatment of multiple water sources. The site will also have a sensor development capability. Construction of the building is due for completion by February 2019, with test facilities to be completed by summer 2019.

Although most of the investment is focussed on water treatment processes, there is a significant reserve of funding that is currently unallocated, and this may be used to investigate interactions between water treatment and distribution systems. Cranfield still need to firm up their ideas for what this aspect of the development will cover but have stated that it will not replicate the UKCRIC facilities hosted by the universities of Sheffield and Birmingham.

4.4.2 University of Sheffield

The University of Sheffield have been at the forefront of water distribution network research for several years, with a focus on the interaction of pipe materials and water chemistry and biology.
The university has several clean water pipe rigs, including:

- Physical aspects - for research into ingress, leak detection, noise correlation, pressure transients, short period testing and robotic devices
- Quality aspects - a 600m rig for measuring impacts of water chemistry on biofilm, cleaning methods, biofilm control, etc.

The university have also completed construction of the Integrated Civil and Infrastructure Research (ICAIR) Centre that has been funded as part of the UKCRIC programme. The main feature of the centre is a distributed water infrastructure facility, consisting of a 40m x 6m x 5m pool, which can be filled with different materials, including sand, soil and water to simulate hydraulics, surface loading and ground conditions. Full control of groundwater movement is possible, and temperature can be lowered to provide freezing conditions. The facility can be used to test both clean and wastewater pipework.

UKCRIC has also funded the Urban Flows Observatory in Sheffield, which provides methodologies and tools to design urban sensing architectures, including those for water and wastewater networks.

The facilities will be open to others to use, for short- and long-term testing and development of technologies across all levels of readiness for the market.

4.4.3 University of Birmingham

The university is in the process of constructing the National Buried Infrastructure Facility (NBIF), funded by the UKCRIC programme, due for completion in mid-2019.

The facility will be used for research, education and training in buried infrastructure-ground interaction, pipeline detection and condition assessment, tunnelling and trenchless technologies, soil stabilisation and improvement, and geophysical sensing.

The key feature of NBIF is its large pit (25m x 10m x 5m deep), which can be subdivided into smaller bays, with a 10 m x 5 m moveable floor section to simulate subsurface ground displacements. This enables research to be carried out at full-scale or near full-scale under fully-controlled conditions. In addition, the facility comprises:

- Material storage and test assembly areas
- Pipeline and small-structure testing rigs
- Material characterisation facilities
- Visualisation suite and knowledge transfer rooms
- Study space

As with the other UKCRIC facilities, the NBIF will be available for use by external organisations.

4.4.4 Heriot Watt University

Heriot Watt have several research resources that are on the periphery of those considered relevant to this project. The most significant of these is a large laboratory /workshop (funded by several EPSRC projects over past 30 years), which is 4 storeys high and has a footprint of 28m x 30m. The building has an extensive suite of instrumentation and water storage and pumping assets. However, many of these assets are likely to be removed in the near future to make way for a major project with Aliaxis Group SA to research water management in ultra-high-rise buildings (>100 storeys)

The university is very keen to participate in collaborative research and has experience in water and wastewater networks. The university owns land next to the university campus which could potentially be made available for a buried asset research facility.

Heriot Watt are interested in working with other organisations to develop further pipeline test facilities.

4.4.5 Newcastle University

Newcastle University are developing the National Urban Water Infrastructure Laboratory, as part of the UKCRIC programme. It will be a dedicated facility to undertake research into urban flood management to develop and test new approaches to managing the impact of extreme weather events. By linking these approaches with new ‘smart’ technologies they

can then be integrated with other urban infrastructure to improve the resilience of road, rail and water networks. As such it is of minor relevance to this project.

4.4.6 University of Bath

The university is able to carry out modelling work, but do not have any pipeline facilities and have no intention to develop such facilities in the short term.

4.4.7 James Hutton Institute

The James Hutton Institute have been developing a research presence in the water sector, with the CREW partnership being an example of the collaborative work they carry out (see Section 4.9). Although they have assisted Scottish Water with research information on soil conditions, which can be used for estimating pipe condition, they do not have any pipe test facilities. The Institute has recently embarked on a European Union Interreg funded collaborative project, The Water Test Network. The project will establish a transnational network of testing facilities which can be used by SMEs in North-West Europe. The objective is to establish a European network of testing facilities with different water types which can be used by SMEs to test, demonstrate and develop new products for the water sector. However, none of the 14 demonstration sites are dedicated to water pipeline testing.

James Hutton Institute were approached to further discuss potential collaboration with Sarco Stopper, McCrae Training and Heriot Watt to develop a pipeline test facility, however a response was not received in time for submission with this report.

4.4.8 Other Universities

Facilities offered by Imperial College London, University of Exeter, University of Strathclyde were also reviewed, but no significant facilities that were of relevance to this project were identified.

4.5 Commercial and industrial testing and research organisations

4.5.1 TUV-NEL (East Kilbride)

The National Engineering Laboratory (NEL) in East Kilbride was originally one of several large government-funded public research laboratories in the UK. It was privatised and became part of the German-owned TÜV SÜD group in 1995. The facility's main focus is as a flow test laboratory and it is the custodian of the UK National Standards for Flow Measurement. As such, one of its roles is to disseminate best practice to industry in flow measurement.

The majority of the facility's work is with the oil and gas (O&G) sector, but it also has capabilities in the water sector. Examples of tests that it carries out include:

- Performance of materials under flow, including with sand in fluid;
- Impact on materials of accelerated flow conditions (referenced against known materials, with Computational Fluid Dynamics used for validation; and
- High-flow and high-pressure tests - up to 90 Bar

A new facility, partly funded by Scottish Enterprise is under construction that will allow testing up to 140 Bar primarily for deep-sea oil and gas testing.

As a commercially minded organisation, TUV-NEL may be interested in any future developments of pipeline test facilities in Scotland

4.5.2 WRc (Swindon)

WRc have a strong track record of water research and have several pipe test rigs available for testing of materials, fittings, inspection technologies and mains cleaning techniques, including:

- A flow loop, with a variety of pipe sizes up to 300mm diameter and buried and above ground sections (above ground straight runs up to 40m length), capable of flows up to 120L/s. The loop can be modified to suit testing requirements and is fitted with traceable sensing and logging for pressure, temperature and flow.
- A small flowmeter (15mm-30mm) test rig, with traceable sensing and logging for pressure, temperature and flow.
- A 10m x 0.3m x 0.3m flume with flow rates of up to 30L/s
- A 10m x 4m x 4m reinforced concrete test pit that can be backfilled with different material; hydraulic jacks to apply point pressure; in-situ power, water and heating; and pressure, strain, temperature and other sensing options. The pit can be used to test the impact of external factors on pipelines and also be used for assessment of structural liners where the host pipe has failed.

The rigs are available for hire with initial training and induction or with technical support by WRc technicians or with full testing by WRc staff.

4.6 Overseas Facilities

4.6.1 European Pipeline Centre (Austria)

The European Pipeline Centre (EPC) is a test facility which has 2,500 m of laid pipes of all common material and diameter types. The pipes contains leaks, breaks and other features that a wide variety of operating situations can be simulated. The correction of pipe damage is realistically represented to allow testing of inspection equipment and staff training. The facility can also be used for research and development of new technologies for network asset management. These facilities have been used by Panton McLeod for testing of some of their technologies.

4.7 Oil and gas sector (Aberdeen)

A discussion with the Oil and Gas Technology Centre (Aberdeen) identified several training and test facilities that, in addition to the TUV-NEL facility, fully cater the needs of the oil and gas sector in Scotland, with regards to pipeline test facilities. Facilities that may be relevant to some of the pipeline products and services companies in the water sector are described below.

4.7.1 CIRCOR Pipeline Engineering (Aberdeen)

CIRCOR Pipeline Engineering are based in Aberdeen. They design, test and manufacture pipeline pigging and flow assurance products, and offer engineering design, pipeline cleaning services and project management.

4.7.2 Petrofac (Montrose)

Petrofac's training facility is used to train both on and offshore personnel and consists of a 1km, 10" diameter pipeline which has been constructed in a loop formation. Designed for research and testing in addition to training, the pipeline also features state of the art supervisory control and data acquisition (SCADA) technology, a central system that monitors and controls the pipeline and which enables multiple scenario simulations to be programmed during training.

Figure 9: Petrofac's 1km 10" pipe test rig at Montrose
(Image: Euler Acoustics, https://www.euleracoustics.co.uk/case-studies/validation-test/)

4.7.3 Propipe (Hartlepool)

Propipe has had a dedicated test facility in Hartlepool, UK for several years. The facility is focused on pigging for the O&G industry and allows full proof-testing prior to offshore pipeline operations and is also used to accurately predict pig performance. The test rig replicates the pipeline geometry and features as close as is practicable to ensure accurate and meaningful test results. Additionally, pipe spools can be internally coated with polyurethane, wax of varying hardness, oil, etc. to closely simulate the pipeline conditions.

4.7.4 Doosan Babcock (Renfrew)

Doosan Babcock provide bespoke component testing at their Technology & Engineering facility in Renfrew. The site provides a service for advanced analytical equipment testing procedures and techniques, related to performance testing of subsea pipework technologies at full scale.

4.8 UK Water Partnership facilities register

The UK Water Partnership (https://www.theukwaterpartnership.org/) was formed in 2015 to bring together UK business, research and policy stakeholders with an interest in water. The organisation has produced a register and interactive map (as per the map in **Figure 10**) of facilities in the UK that are available for water research and collaboration (https://supplychaindatabase.shinyapps.io/Facility_Register/).

All those facilities within the UK Water Partnership register that are of sufficient relevance to this project have been included in Sections 4.1-4.4 above. Some additional facilities of minor relevance to this project have been included in **Appendix B**.

Figure 10: UK Water Partnership Interactive Map of Water and Wastewater Test Facilities (Courtesy of UK Water Partnership)

4.9 CREW Scottish Water Sector Map

CREW is a Scottish Government funded partnership between the James Hutton Institute and Scottish Universities, supported by the Marine Alliance for Science and Technology for Scotland (MASTS). CREW, in conjunction with Abertay University have produced a register of companies operating in Scotland's water sector as well as water-related services and facilities available to support R&D and innovation across the sector. Their website which provides similar functionality to the UK Water Partnership facilities register is located at https://www.crew.ac.uk/watermap/watermap2017/.

A review of the facilities described on CREW's website did not reveal any facilities of relevance in addition to those already described.

4.10 Existing Facilities – Summary

Although this project has identified multiple facilities available to the Scottish water industry for training, product development and testing, it should be noted that the range of services they offer is often limited to specific areas of testing and for specific pipe diameters, pressures and flow-rates. Their location, their availability and the cost of the service they provide can also be limiting factors that restrict their use. The services that the different organisations provides is summarised in **Table 1**. The existing facilities identified are given on the maps in **Figures 11** and **12**.

Table 1: Summary - Facilities identified and their current capabilities

Function: / Provided by:	Training - Basic O&M	Training - Advanced O&M	Training - Asset Management	Products/service development & testing	Products/service demonstration	Product/Service Validation	Condition Assessment Tool Validation	Fundamental Research
Water companies								
Scottish Water	x							
Anglian Water	x			x				x
Dwr Cymru Welsh Water	x							
Essex and Suffolk Water	x							
Northumbrian Water	x							
Severn Trent	x							
South Staffs Water	x							
Thames Water	x				x			
Yorkshire Water	x							
Equipment/service providers								
Hydro International				x				
Impact solutions				x				
Radius Group				x				
Qinov8				x				
McCrae Training	x	x		x				
Develop Training	x							
European Pipeline Centre	x			x	x	x		
Circor (O&G Sector)				x				
Petrofac (O&G Sector)		x	x	x				
Propipe (O&G Sector)				x	x	x		
Doosan Babcock (O&G Sector)				x	x	x		
Universities/Research Institutes								
Bath				x				x
Birmingham				x				x
Cranfield				x				x
Heriot Watt				x				x
Newcastle				x				x
Sheffield				x				x
James Hutton								x
Commercial testing/research								
TUV-NEL				x		x		x
WRc			x	x	x	x		x

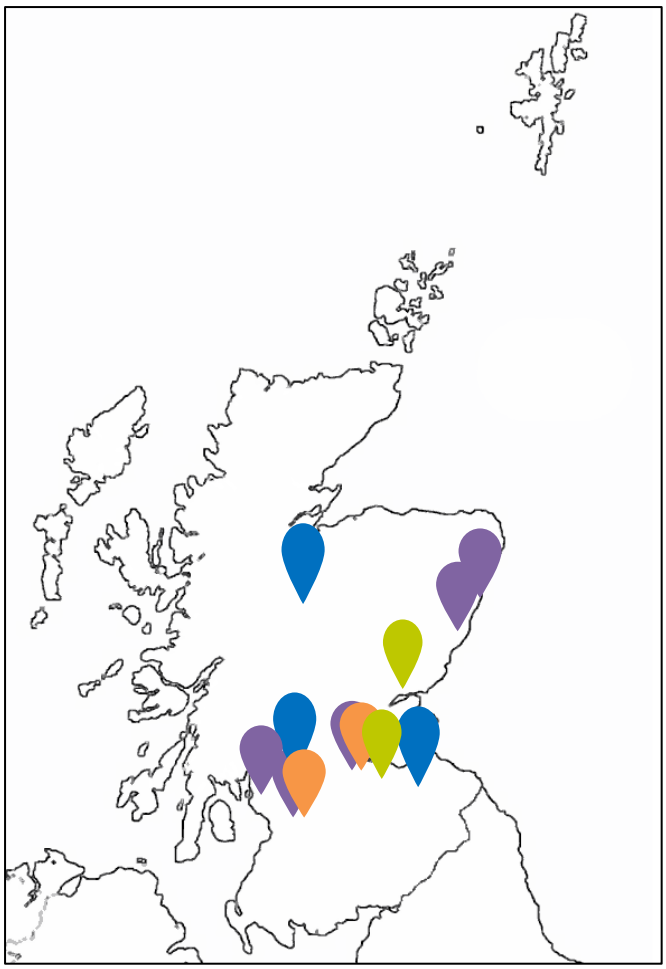

Figure 11 - Pipeline test facilities in Scotland

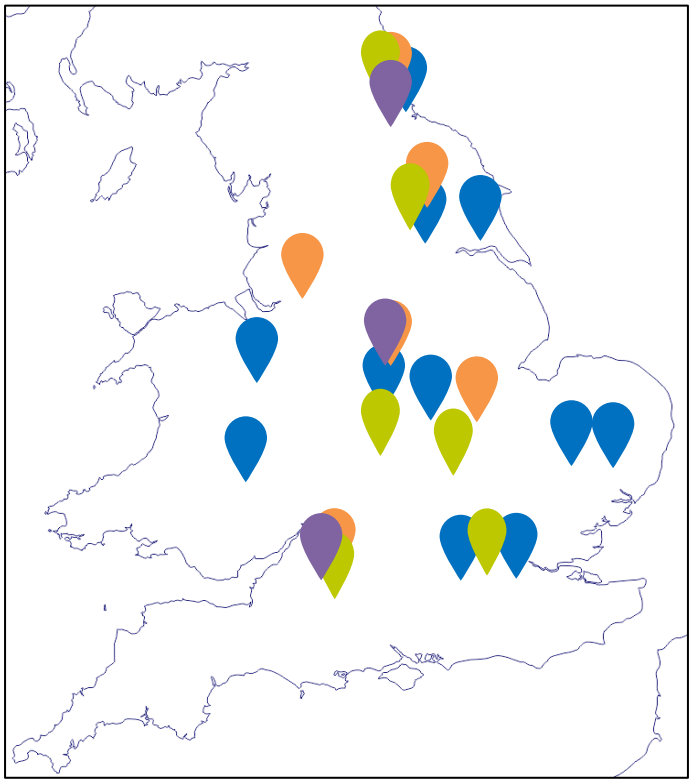

Figure 12 – Pipeline test facilities in England and Wales

5. Gap Analysis

Through sections 3 and 4 an understanding of both the demands from external companies and the current capabilities of existing facilities has been developed. In this section, the gaps in the market, where the requirements are not currently being met by existing facilities, will be explored.

5.1 Training

Training requirements range from general operation of network assets and basic routine maintenance (e.g. flushing, replacement of service connections etc.) by Scottish Water and their operational contractors to the use of more complex operational techniques (e.g. pipe repairs) and the use of intrusive technologies for condition assessment and asset management (e.g. CCTV, advanced cleaning technologies, pipe relining) by specialist contractors. The training requirements for most of these are sufficiently met by existing training facilities and 'on the job' training. However, only one company (based in Moray) stated that the distances required to travel for some training purposes were restrictive.

Areas identified where there is a potential gap between what is available and what is required lies in the following areas:

1. Training on more advanced techniques at non-central locations (i.e. other than Edinburgh/Glasgow).
2. Training for fire services and non-centrally located contracting staff.

However, it is acknowledged that the gap for these areas is relatively small.

5.2 Development and testing of new materials, techniques and technologies

As described in section 3.2.3, nearly half of the equipment and services companies interviewed said there was a strong probability that they would require a test facility in the future and
that the requirements would be similar to those required for previous projects: for training, and testing of materials and technology. Location of test facilities was important to more than half of respondents; however, this was more from an accessibility perspective (proximity to good transport links, including airports) rather than from a 'closeness' perspective.

It is important to note that the capability (or lack thereof) of test facilities was considered to be a barrier to testing by seven of the nineteen companies interviewed. Although in some cases, this may be due to perception, or a lack of awareness, of test facility capabilities, the conversations highlighted a generally good understanding of where facilities existed for water pipe testing. Some of the facilities that have been identified that carry out oil and gas research may also be willing and able to meet these requirements though there was less of an awareness of the capabilities of these facilities. It is worth noting though, that due to the demanding testing requirements of the oil and gas industry, use of these facilities may come at a premium.

5.3 Demonstration and/or validation of new materials, techniques and technologies

Evaluation of performance of new materials and technologies (e.g. cleaning equipment, sensors, condition assessment tools) is a key use of pipeline test facilities. In order for a water company to invest in a new technology the water company must be satisfied in its capabilities. Evaluation is often achieved through demonstration, where end users observe how equipment or services are implemented and a subjective assessment of their performance is carried out. Validation is usually more rigorous, where the service or equipment has to meet pre-determined measurable and repeatable acceptance criteria.

Demonstration is often carried out on a water company's own network or a test facility. Validation will typically require a dedicated test facility to allow for scientific rigour and comparison between different technologies; this may be carried out in house or by an independent third-party.

To allow for a test facility to effectively evaluate a technology it must have capabilities to recreate real network conditions. Not only does this allow for effective evaluation but this allows technology companies to understand how their products function in real scenarios. Therefore, real networks conditions at a pipeline test facility can give water companies sufficient confidence in the technology for significant further trialling not to be required and gives technology providers case studies useful for building a business case.

To gain this real network experience, technology companies have previously had to work with water companies to use their live networks, which are not always suitable nor available. This also means technology companies typically are required to share any findings with the water company, reducing their ability to innovate. No existing non-live facility can offer real network conditions, however the facility that is currently under construction at Thames Water's Kempton Park site should be able to. This site will use old sections of cast iron mains and will be specifically designed for testing of condition assessment tools. This is a significant investment from Thames Water in order to solve an important challenge they face, although it is expected that other technologies will be trialled at the site once the condition assessment tool testing has been completed.

In order to supply a real network scenario at a pipeline test facility the following conditions are required for the development, testing and validation of many types of products and services:

- Previously used mains
- Real network pressure and flow
- Below ground sections of pipe
- Distance from pumps (to reduce mechanical noise for acoustic leak detection)
- Long runs of pipe
- Means of measuring the performance and repeatability of the product or service

A new facility could be constructed with these capabilities which may require a significant cost. An alternative solution would be to use an operating part of Scottish Water's network

as part of the new facility. Challenges would have to be overcome when testing technologies that do not have regulatory approval, but these could be overcome with additional water treatment after the test facility when unapproved technologies are under testing.

A specific gap identified by Scottish Water in the area of evaluation is the need to validate condition assessment tools. These tools are typically electronic sensors that are inserted into pipes that are approaching the end of their predicted asset life to determine how much actual life they have before requiring replacement. To do this they may be required to identify several different characteristics of a pipe (e.g. wall thickness, degree of pitting, hairline cracks, number of minor leaks at joins, etc.). Conversations with water network managers has identified that the accuracy and repeatability of results from these technologies is highly variable. Because the assets that the technologies are tested on are underground, it is difficult to prove whether a new technology performs as it should, and this results in a low degree of confidence in the technologies. To address this, validation using repeatable tests on a pipe facility fitted with aging pipes and where performance is critically assessed has been suggested by some water companies. A facility with appropriate capabilities could be operated by a third party to allow for unbiased evaluation. This would allow for collaboration between water companies to encourage innovation and reduce the cost of evaluation. Furthermore, sharing of third-party testing results would be beneficial to technology companies who could share results with multiple water companies from one test facility. Feedback is being sought from Water UK's Water Distribution Network group to determine the demand for water industry standards for performance of condition assessment tools.

Although some condition assessment tool companies may resist testing if they think that it may not show their technology in a favourable light, those that are confident of their technology's capabilities may see it as an opportunity to gain a competitive edge. A suitable test that is fair and representative and could be modified over time to prevent the system being 'gamed' would need to be agreed by water companies.

Currently, there exist, or are plans to construct, facilities which are able to test under real conditions or offer third party testing such as the Thames Water Kempton Park site and WRc's facilities. However, these facilities are, or will be, based in the southern half of England. Furthermore, it was raised by a contractor who was interviewed that the training facilities they use are located around Scotland, so one facility with enough capabilities to meet different training requirements could centralise their training programmes.

5.4 Fundamental research

Research to determine the causes of changes to the condition of water supply networks and the water transported in them (e.g. impact of chemical dosing and biofilm growth on pipe condition and water quality) often requires specially designed facilities and access to hi-tech analytical services and specialist staff. This results in demand being met by universities and research institutes. The modern research environment is dependent on funding that demonstrates a return on investment and collaborative research. The future investment required to maintain the UK's buried infrastructure and the need to carry out research into

water supply systems that is focussed on benefits to water companies, their suppliers and their customers has recently resulted in significant funding at several universities (e.g. for the development of UKCRIC facilities).

The amount of research funding from central government for water supply network research in Scotland has been limited, although Heriot Watt University has been successful in securing public and private funding for research into water infrastructure for buildings and has some facilities and experience to also carry out water supply network research. However, the fact that the UKCRIC facilities are located in England should not be a barrier to research for the Scottish water industry, as the facilities are funded on the basis of being collaborative. Therefore, Scottish universities could work with the UKCRIC universities to carry out research that is demand-driven from the Scottish water industry.

5.5 Gap analysis summary

The findings of the gap analysis are summarised in **Table 2**.

Table 2: Summary - Analysis of gaps between current facilities and demand for facilities

Facilities required for: \ Demand from:	Network operators	Operational contractors	Technology suppliers	Water company R&D/ Innovation/ Science & Engineering	Academia
Practical training: General operational and maintenance techniques	A				
Practical training: Advanced operation and maintenance techniques		A/B			
Practical training: Asset management techniques and technologies		B	B		
Development and testing of new materials, techniques and technologies		A/B	A/B		
Demonstration of new materials, techniques and technologies		B	B		
Validation of new materials, techniques and technologies			B	B	
Validation of Condition Assessment Tools			D	D	
Fundamental research			B	B/C	B/C

Key:

Strong demand

Limited demand

No demand

A Adequate facilities available in Scotland

B Limited number of facilities available in Scotland

C No facilities currently available in Scotland

D No facilities currently identified in the UK

(Where two letters are shown, this indicates that facilities are available, but they might not fully meet users' requirements due to location and/or range of capabilities)

6. Conclusions

The following conclusions were drawn from this project:

Facilities for training on water supply networks:

The training facilities that currently exist and the use of 'on the job' training meet most of the needs of the Scottish water industry. The gap analysis identified that provision of training facilities away from Scotland's central belt area was more limited, especially for training on more advanced techniques such as CCTV survey.

Facilities for development and testing of new materials, techniques and technologies:

Multiple facilities exist in Scotland and further afield for development and testing of new materials, techniques and technologies, yet many companies interviewed said that the existing facilities did not always meet their needs from an availability and capability perspective. Accessible information and greater awareness of all of the facilities available may address this issue.

Facilities for demonstration and/or validation of new materials, techniques and technologies:

Suitable facilities for demonstration are limited in Scotland. Also, there are currently no entirely suitable facilities in Scotland or the UK for validation of some technologies (e.g. condition assessment tools, mains cleaning tools) that require systems to accurately replicate the conditions encountered in the real world. Although one such facility is being developed by Thames Water, it remains to be seen whether the future work at the facility will be collaborative and benefit the UK water industry, including Scottish Water.

The demonstration of most new techniques and technologies can be carried out using existing assets, both abandoned and operational and therefore a register of assets for contractor use should also be of benefit to technology developers, provided the locations are geographically accessible and have good transport links. Feedback from Water UK's Water Distribution Network group on the potential to develop water industry performance standards for condition assessment tools should be used to determine whether there is sufficient demand within the wider industry for a facility for the testing and validation of these tools.

Fundamental research:

Facilities at Scottish universities and research institutes for fundamental research into water supply networks is limited. However, several research facilities in England are being developed which should allow for collaborative research that can meet the Scottish water industry's needs.

This report has found that there is insufficient demand for Scottish Water to build a dedicated pipeline testing facility without support from other organisations.

7. Recommendations

To address the need for additional training in rural areas, both of the following should be considered:

- Develop a register of assets, especially abandoned assets and assets in more remote locations, that could be used for training of Scottish Water contractors. This would also require a framework to be developed for their safe use, with respect to security of supply of the water network, surrounding environment and health and safety of trainers and trainees.
- Assess in more detail the demand for a mobile training facility to demonstrate the impact of valve operation on pressure transients and water quality, similar to that operated by Yorkshire Water.

To address the issue of test facilities not meeting all suppliers needs for development and testing of new products and services, the following is recommended:

- Develop or improve existing databases of test facilities, with details of capabilities. To disseminate this information, an update of the UK Water Partnership's or CREW's interactive websites, to include the relevant information, or the provision of a new portal, should be considered. An initial action is for Scottish Enterprise to forward this to UK Water and CREW to update their databases.
- There is currently insufficient demand for Scottish Water to build a dedicated pipeline test facility, however, further investigation should be given to developing a new test facility that meets the industry's needs. With the interest from McCrae Training, Sarco Stopper and Heriot Watt there is a good opportunity for all parties to develop a facility to the benefit of all, at a reduced initial cost to each party. The James Hutton Institute should be approached further regarding this opportunity.
- Subject to favourable feedback from the Water UK's Water Distribution Network Group, the requirements for a national water industry standard for performance of condition assessment tools should be developed. This is likely to involve technical committees and several stakeholders, including technology providers. The initial recommendation is to ensure this is discussed at the next Water Distribution Network Group.

APPENDIX A - Organisations contacted to provide feedback on demand for pipeline test facilities

Main function: / Organisation:	Operations Contractor	Monitoring Instruments	Pipeline maintenance	Pipe fittings supplier	Wastewater technology	Asset management
Aqualiner			X			
Ashridge Engineering		X				
Aubin Group	X					
Cetco Energy Services	X					
Clearwater controls		X				
Dustacco	X					
HASL				X		
Hydro International					X	
Intelligent Gels			X			
Minerva						X
Panton McLeod	X					
Primayer		X				
Radius Subterra	X					
Radius Systems				X		
Sarco Stopper			X			
Strathkelvin		X				
UMS		X				
Quinov8			X			
PIPA			X			

APPENDIX B - Test facilities with minor relevance

Facility Name	Operator	Location	Description
SGS United Kingdom Ltd	SGS	Aberdeen	Offer a range of on-site sampling and analysis services for water quality assurance and to ensure that waste water discharge is not contributing to environmental contamination.
Aberdeen Scientific Services	Aberdeen City Council	Aberdeen	Facility is used to analyse a range of environmental samples (e.g. water, food, landfill leachate, consumer products, agriculture feed) and to provide technical and scientific advice where appropriate.
Water Sciences Laboratory	Suez	Grangemouth	Water Sciences Laboratory - focuses on power generation, environmental monitoring, cooling water, soil analysis, refinery process control and sludge characterisation. The lab also ensures compliance of instrumentation, analysis, quality systems and laboratory team to ISO 17025:2005 accreditation framework regulated by UKAS (United Kingdom Accreditation Service).
Water Quality Laboratory	Scottish Water	Edinburgh	Carries out chemical and microbiological tests at their United Kingdom Accreditation Services (UKAS) accredited laboratories. Their Laboratory in Edinburgh is one of only two UKAS accredited laboratories in the UK which can provide Cryptosporidium Analysis and Genotyping.
Exova (UK) Ltd	Exova	Glasgow	Exova examine water that circulates through buildings such as cooling towers, air conditioning systems and hot and cold water testing services. They cover many various types of commercial water testing, including potable, contaminated, heat exchange, domestic showers, swimming pools, jacuzzi and spas. Testing services also include chemical and microbiological analysis.
ALS Life Sciences Ltd Bellshill	ALS Life Sciences	Glasgow	The Bellshill facility at ALS offers a range of accredited water testing services.. They carry out tests on all types of water - including raw, potable, recreational, process and waste.
SEPA Eurocentral	SEPA	Glasgow, Galashiels, Dumfries	Laboratory Services, Testing and Demonstration Facility

ICL Analytical Laboratories	Imperial College London-Environmental and Water Resource Engineering Section	London, England	Analytical laboratories provide facilities and instruments for testing and research concerned with environmental substances and processes and treatment/management technologies.
HR Wallingford General Purpose (GP) Flume	The UK Water Partnership	Wallingford, England	The GP Flume is a flume with certified volumetric measurement capability. Using the volume-time approach to measure flow rates, generally acknowledged to be the most accurate means available, it enables high accuracy data for the development of Standards. The 25 m long x 2.4 m wide, flume with operating depth of 0.3-0.7m is capable of generating flows up to 0.28 m3/s and flow measurement accuracy of ±0.2%