acquaint
In-line Inspection Technologies

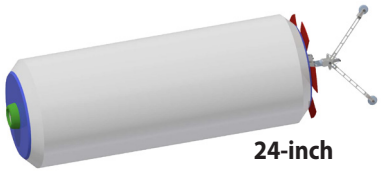
Inspection Technologies

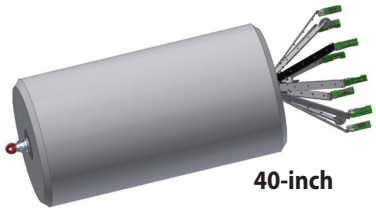
ACQUARIUS
In-line Inspection Tool

With on-board ultrasonic testing (UT) circumferential scanning sensors and internal mapping unit (IMU), the Acquarius is a diverse in-line inspection in-line inspection tool designed to use in different types of pipes and materials. Acquarius' sensors record the condition of many miles worth of transport, pressure or sewer pipelines in a single run without shut down, recording and sending measurement data to the cloud platform. The tool is designed to provide high-quality, accurate data in a wide range of applications, service conditions and pipeline environments. Collected data offers insight into the condition, risks and lifetime of the inspected pipeline. This ultraflexible, pipe friendly and reliable tool provides wall thickness measurements, ID changes, precise pipe geometry, joint gap width and AC leaching (degradation of asbestos cement). The approach can be best summarized as redict, prioritize and act. Set maintenance and management priorities based on the latest data. Predict and repair damage before it occurs.

> "The results were impressive. In less than four hours, the tool had charted over a mile of pipeline."


8-inch

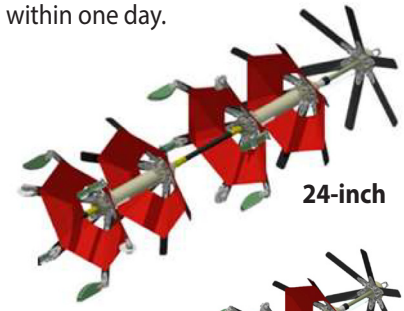

24-inch

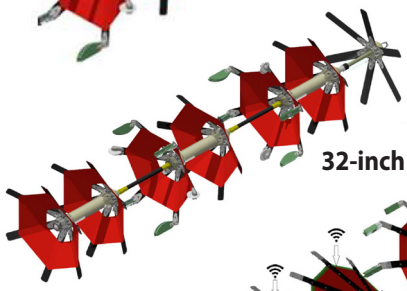

40-inch

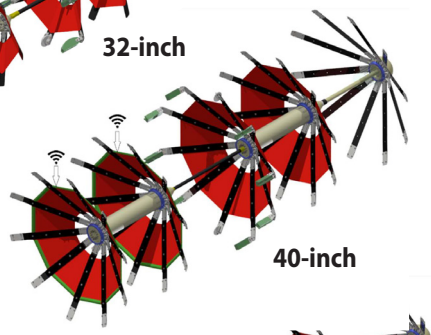
AQUABRELLA
In-line Inspection Tool

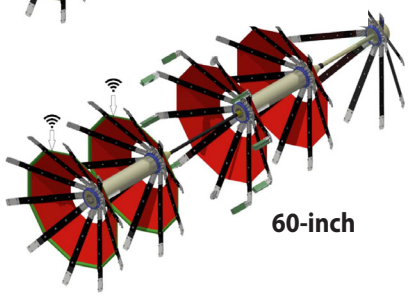
Free swimming, intelligent robot for use on potable water pipelines made of concrete, asbestos cement, cast iron, stainless steel and HPDE/PVC/GRP with a diameter ≥16-inches. Due to the flexible design, Aquabrella easily passes through obstacles such as butterfly valves and alignment changes while its sensors monitor the condition of pressure and transport pipes over many miles in one single run, recording and sending measurement data to the cloud platform. It provides a complete condition assessment measuring wall thickness degradation, location, corrosion, leaching, and sulphate attack. Final data analysis provides current condition and remaining life span of the inspected pipe within one day.

> "The Aquabrella inspected 25 miles of pressurized pipe in three runs."


24-inch


32-inch


40-inch


60-inch

CPM PIPELINES

ACQUARIUS AND AQUABRELLA INSPECTION SEQUENCE

The sequencing of the inspection is broken into pre-inspection, inspection, and post-inspection phases. The tasks involved in each of these phases is summarized below.

Inspection Sequence

PRE-INSPECTION PHASE	▮ Scope Definition ▮ Project Planning ▮ Roles and Responsibilities ▮ Pig Configuration
INSPECTION PHASE	▮ Mobilization ▮ Last-Minute Risk Assessment ▮ Pipeline Cleaning ▮ Plotting Marker Points ▮ Perform "dry" ILI run (if needed) ▮ Perform True Run ▮ Data Verification
POST INSPECTION PHASE	▮ Remover Markers/ Equipment ▮ Demobilization

By understanding the current state of the pipeline, a basis for remaining useful life determination (RUL) can be formed. Structural calculations, finite element analysis, and risk curves provide the foundation for determining remaining useful life. Capital improvement decisions can be reached based on the data including pipeline rehabilitation or replacement and which area(s) of the pipe to prioritize. The data gathered during the inspection is compiled in a straightforward report and deliverables include a geographic shape file (Shape/ GIS/RD) with the results of the inspection. A summary of information obtained as part of the inspection is included in the table on the right.

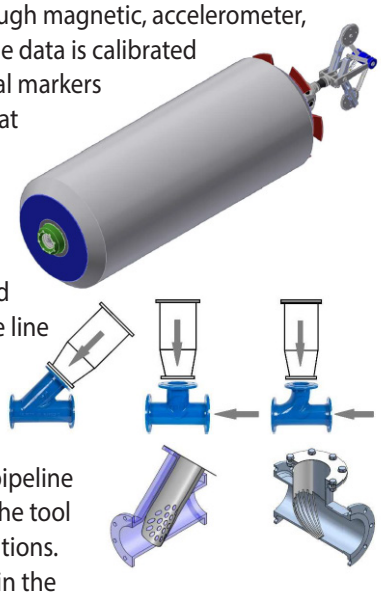
Inspection Data

Information Collected	Data Format	Included
Deviating location	GIS / XLS	Yes
Location (XYZ)	GIS / XLS	Yes
Leaks	GIS / XLS	Yes
Wall thickness	GIS / XLS / C-scan	Yes
Degradation within separate BWP layers	GIS / XLS	Yes
Angular rotation at joint	GIS / XLS per joint	Yes
Joint gap width	GIS / XLS per joint	Yes
Roundness / Ovality	GIS / XLS	Yes
Strength and remaining lifetime calculations	GIS / XLS	Optional

Detailed Data Points

LOCATION DATA

Location data is obtained through magnetic, accelerometer, and gyroscopic technology. The data is calibrated and corrected by using physical markers placed along the alignment that connect with the sensor in the Acquarius tool. The markers are placed roughly 500-feet apart prior to the deployment of the tool and are not required to be placed directly above the line (within 60-feet).

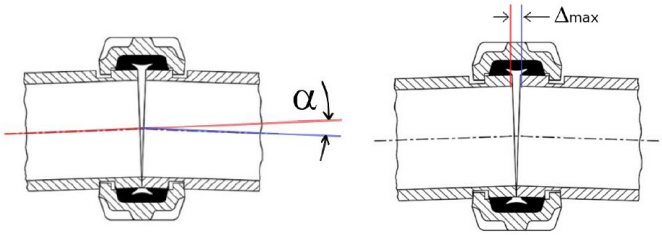


If a deviation is observed, it will be indicated in the final analysis data. Changes in the pipeline material are also detected by the tool including the location of transitions. XYZ coordinates are provided in the National Triangle Coordinate system with the 'Z' coordinate being the deviation from the connection, causing the value

to vary around the zero position. Location data is included in GIS format for the final deliverable. This information serves as a valuable addition to refine existing GIS databases with accurate geographical pipe alignment data.

JOINTS AND CONNECTIONS

The state of pipe segment connections is reported in three values: angular rotation (horizontal and vertical) and joint width. Angular rotation corresponds to the angular displacement reported per joint over 20-centimeters from the center of the joint in both directions.



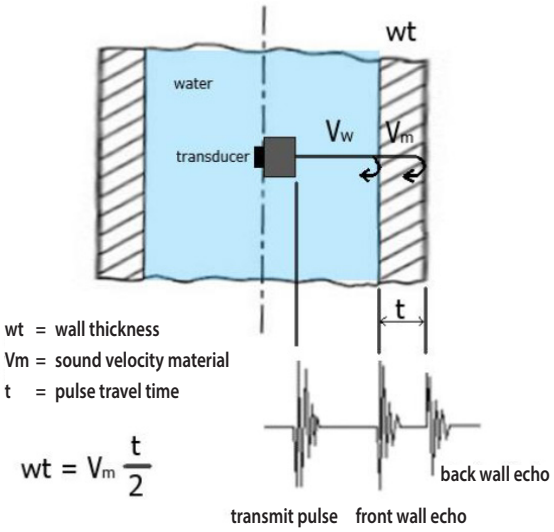
Joint Deflection Analysis

Angular joint displacement output carries a resolution of approximately 0.125 degrees with an inspection speed of about 0.2 meters per second. The angular displacement is reported in two values: horizontal (rotated left or right) and vertical (rotated up or down). Joint width is based on the distance and time traveled and the detected internal diameter change at the joint (via ultrasonic measurements). There are cases where joint width is not detected, for example, when joints are obscured by sediment or other debris. In such cases, it can be possible to determine joint width based on the amplitude of the ultrasonic signal. The detectability of joints can also be beneficial in circumstances where joints were (or were intended to be) grouted during installation and have deteriorated or failed to be grouted initially.

When joints are detectable, they are reported in the feature list of the deliverable. The accuracy of the measurement depends on the inspection speed and measurement speed.

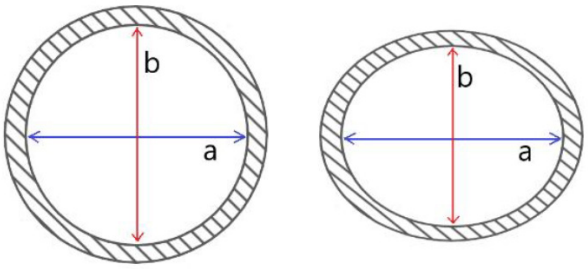
WALL THICKNESS MEASUREMENT

Ultrasonic sensors within the Acquarius tool provide data surrounding the pipeline wall thickness. The sensor measures the detection of sound reflections based on variations of the host material. The time difference between sending and receiving the signal is measured and interpreted to produce pipe wall thickness (t in the figure below) data. The speed of sound through the materials and liquids encountered is known and therefore wall thickness can be calculated. Our team of engineers and experienced operators allow for the necessary QA/QC processing of the data.



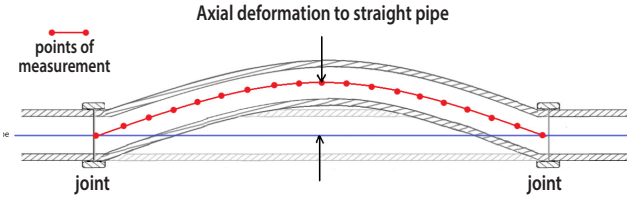
PIPELINE DEFORMATION

The internal diameter of the pipeline is determined based on the ultrasonic measurements. The first reflection of the sensor corresponds to the inner radius of the pipeline and therefore ovality/roundness can be detected.



Ovality/Roundness Detection

Axial deformation is also detected during the inspection based on deviations from a straight pipe. The deformation is determined per pipe section (joint to joint) as shown in the figure below.



Axel Deformation Detection

LEAK DETECTION

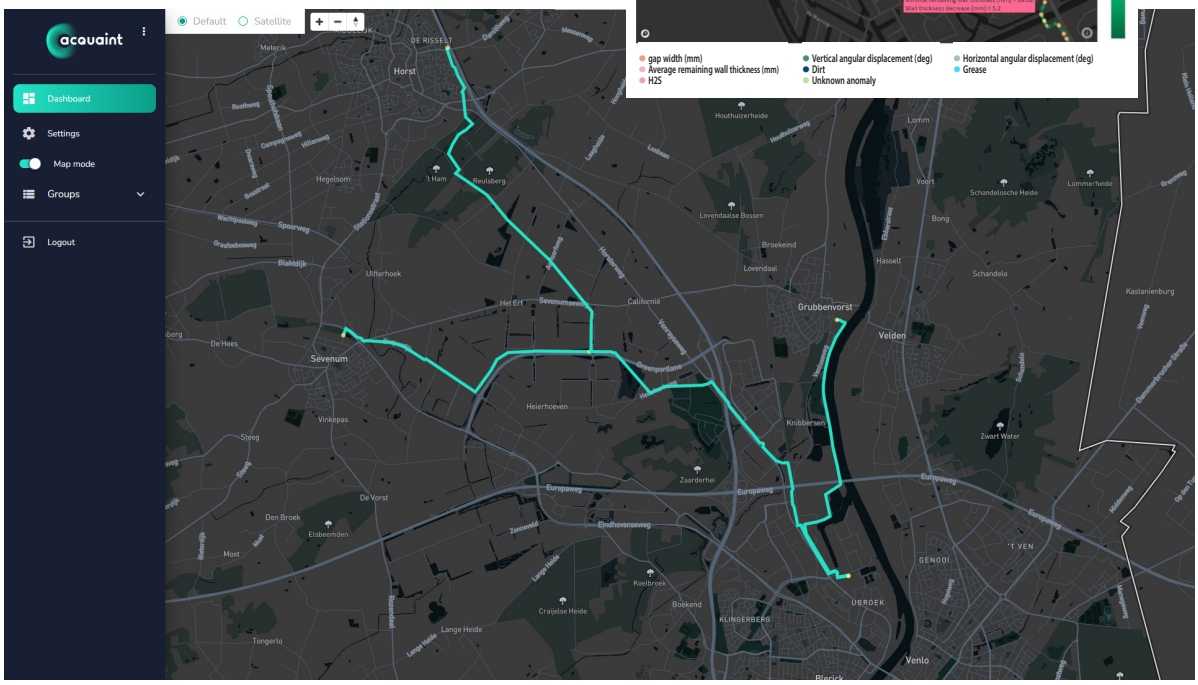
A hydrophone onboard the Acquarius tool continuously records sound during the inspection. When local deviations of the sound spectrum are detected, its location is recorded as an area of a potential leak. When a potential leak is detected, further investigation can be utilized to determine the true nature of the anomaly.

DELIVERABLE

The deliverable includes a summary report including executive summary and spreadsheet of anomalies detected. As stated, it shall also include a summary of findings in GIS format. A sample output of an inspection is shown below, illustrating the various data points gathered and the geographical representation of the locations of points of interest. The data can also be reviewed through a 3D html dashboard containing a comprehensive overview of the pipeline anomalies.

Acquarius and Aquabrella example deliverable

https://cpmpipelines.com/wp-content/uploads/2022/09/Report-Example-Acquarius-Topo-EN.html



Acquarius and Aquabrella dashboard screenshot

Technical Information

ACQUARIUS

	Max Flow @1.6 f/s gpm	Max DP pig	Max ID** reduction	Weight*** (pounds)	Length (feet)
8-inch	510	18 PSI	25%	55	3.2
10-inch	790	14.5 PSI	25%	99	3.4
12-inch	1,150	11.6 PSI	25%	176	3.6
14-inch	1,540	9.4 PSI	25%	264	4
16-inch	2,025	7.25 PSI	25%	330	4.4
20-inch	3,170	5.8 PSI	30%	661	4.9
24-inch	4,540	4.35 PSI	30%	1047	6
28-inch	6,160	3.6 PSI	30%	1543	7.5
32-inch	8,140	2.9 PSI	30%	2314	7.8
36-inch	10,350	2.2 PSI	30%	2976	7.8
40-inch	12,770	1.5 PSI	30%	3527	7.8

*More ranges are available. **Higher reduction possible on request. ***Weight saturated wtih water.

Acquarius's sensors assess the condition of transport, pressure and sewer pipes in a single run: https://www.youtube.com/watch?v=pG45U2mGvbg

AQUABRELLA

Specifications	Wall thickness	Steel, AC, PCCP, PVC, Cast Iron, HDPE
	Mapping XYZ	Accuracy < 1 meter
	Leaching AC	Detectibility >1% from std wall devation
	Max. Inspection Speed	Various 0.2 – 1 m/s
	Max. Inspection Length	24 hours / 25 miles
	Max. operating pressure	10 bars = 150 PSI
Pipeline Requirements	Min. radius bends	>1.5D
	Max. bore reduction	24-inch: 50% of Nominal ID 32-inch: 60% of Nominal ID 40-inch: 70% of Nominal ID 60-inch: 75% of Nominal ID
	Max. flow needed	0.5 m/s + 10%
	Launching and receiving	Possible via T- or Y-piece
Mechanical Specifications	Length	24-inch: ~13.5 feet (unfolded 13 feet) 32-inch: 12 feet 40-inch: ~13.5 feet (unfolded 13 feet) 60-inch ~13.5 feet (unfolded 13 feet)
	Tool Diameter	24-inch: 2 feet 32-inch: 2.6 feet 40-inch: 1 foot 60-inch: 1 foot

CPM PIPELINES