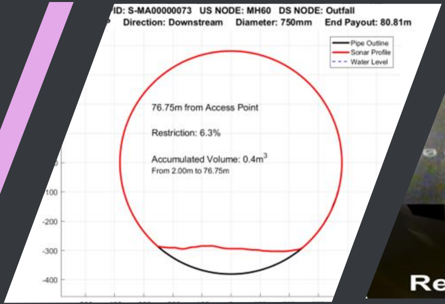
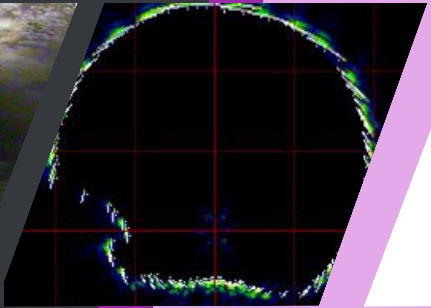
Understanding Profiling Sonar Data

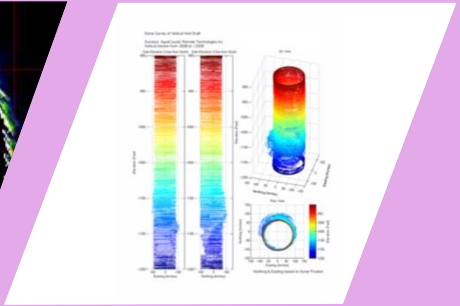


Pipe Sonar Data

Processed Sonar



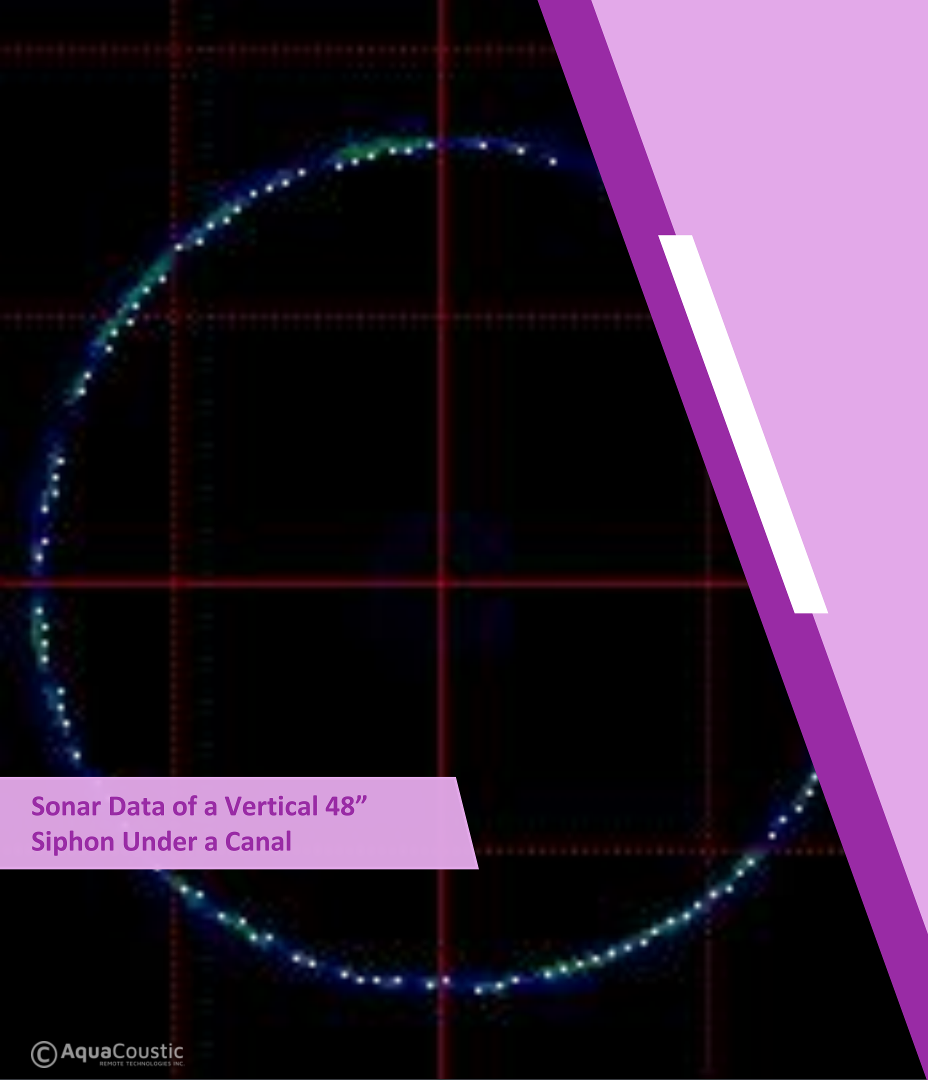
Raw Sonar Data



Shafts/Boreholes

COMPREHENSIVE INFRASTRUCTURE SURVEYS

Specific Information for Pipe Sonar Surveys



Sonar Data of a Vertical 48" Siphon Under a Canal

GOOD DATA STARTS IN THE FIELD

Sonar data is interpretive in nature and good results depend upon the following:

- The skill and knowledge of the operator
- The type of pipe material
- Understanding environmental conditions such as low water flow, aeration or biota in the water column and the effects on sonar data
- Understanding the effect of lateral movement in a pipe
- Understanding the effect of the sonar head not being aligned with the axis of the pipe
- The skill and knowledge of the post processing personnel
- Available field notes and pertinent information from the field personnel

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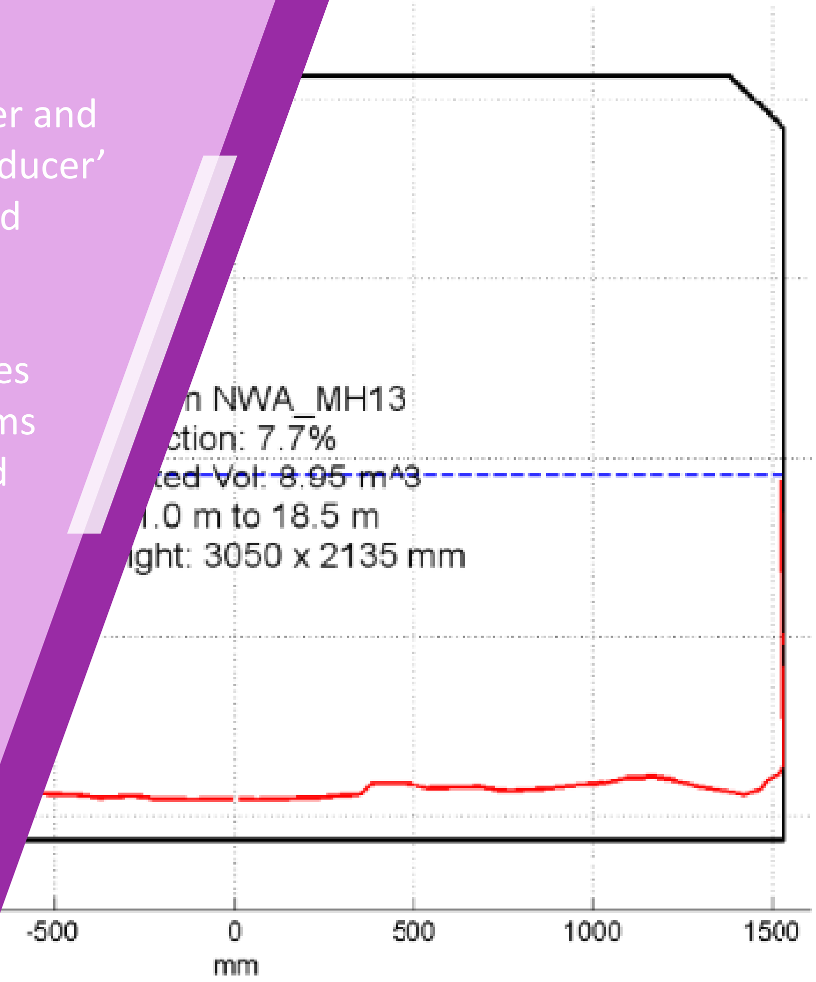
SONAR BASICS

The sonar pulse is produced by a focused sound transmitter and receiver. This unit is called a ‘transducer’. Essentially ‘transducer’ means that the sonar turns electrical signals into sound and sound back into electrical signals.

When the acoustic pulse hits a target, some energy bounces back and the echo appears as a data point recorded in terms of travel time. The range is then calculated using the speed of sound in water and the travel time.

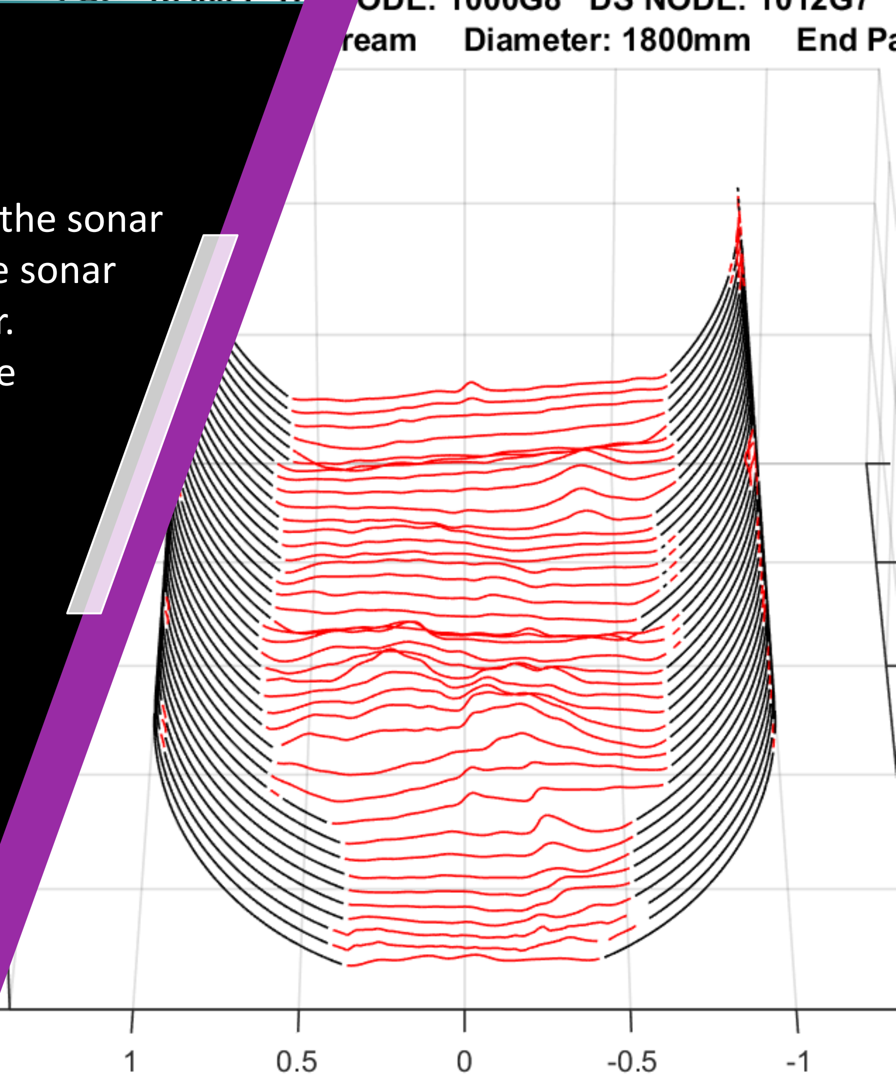


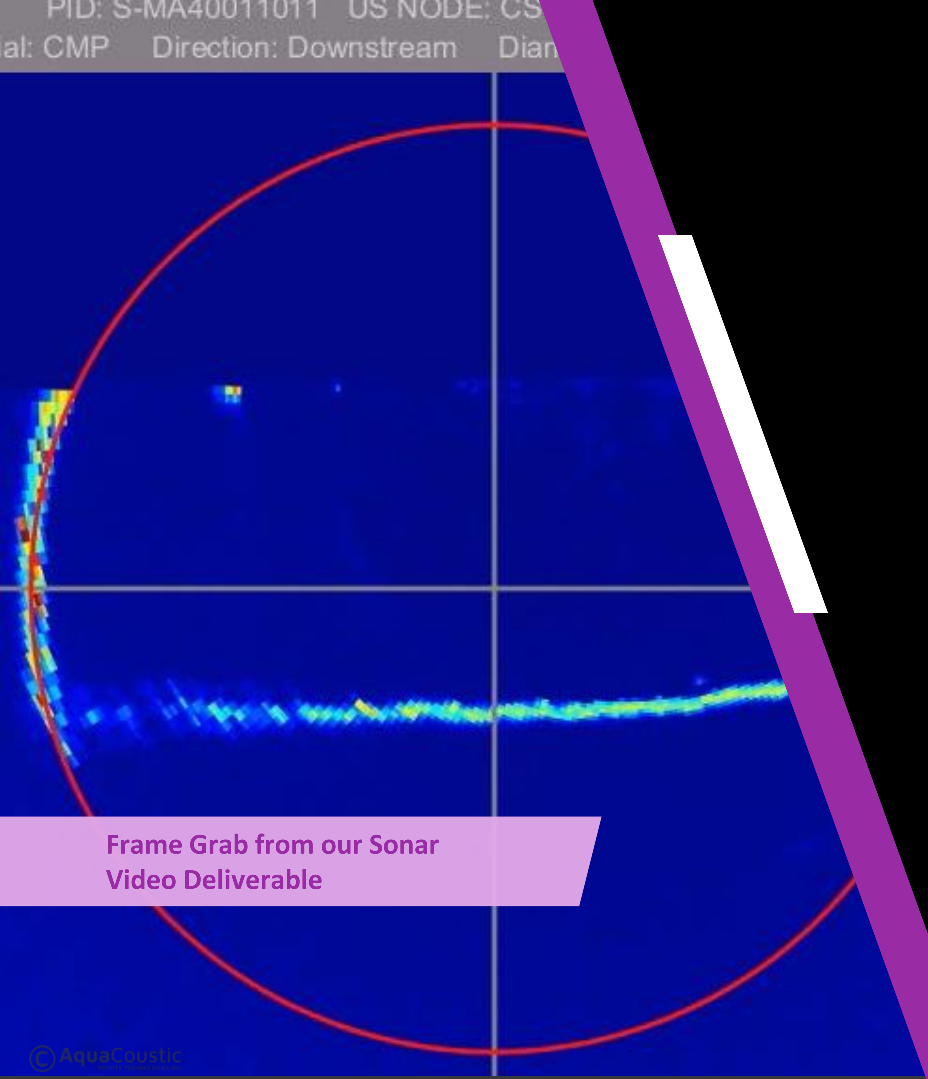
PIPE SONAR BASICS

A profile of the underwater portion of the pipe is built as the sonar head mechanically steps about the longitudinal axis of the sonar enclosure, generating a profile line on the display monitor. This line, consisting of a few hundred points, describes the cross-section of the pipe.

A key to the profiling process is the selection of the echo returns for plotting. The information gathered from the selection criteria forms a data set containing the range and bearing figures.

The primary purpose of the profiling sonar is as a quantitative measuring tool.





Frame Grab from our Sonar Video Deliverable

SONAR THEORY

Sonar is an acronym which stands for "Sound Navigation and Ranging." We determine the distance between transducer and target via timing the pulse's transmit and echo travel time. If it takes a second between the transmit pulse & the return echo to reach the transducer, then the target is half a second away. If we then know the speed of sound in water, we can calculate the distance.

Hydro-acoustics:
Sonars works in air and water, our sonar heads are designed for water only. The transducer vibrates at a set frequency and the resultant pressure wave propagates through the water. If the wave encounters a change in density some of the energy will be reflected back.

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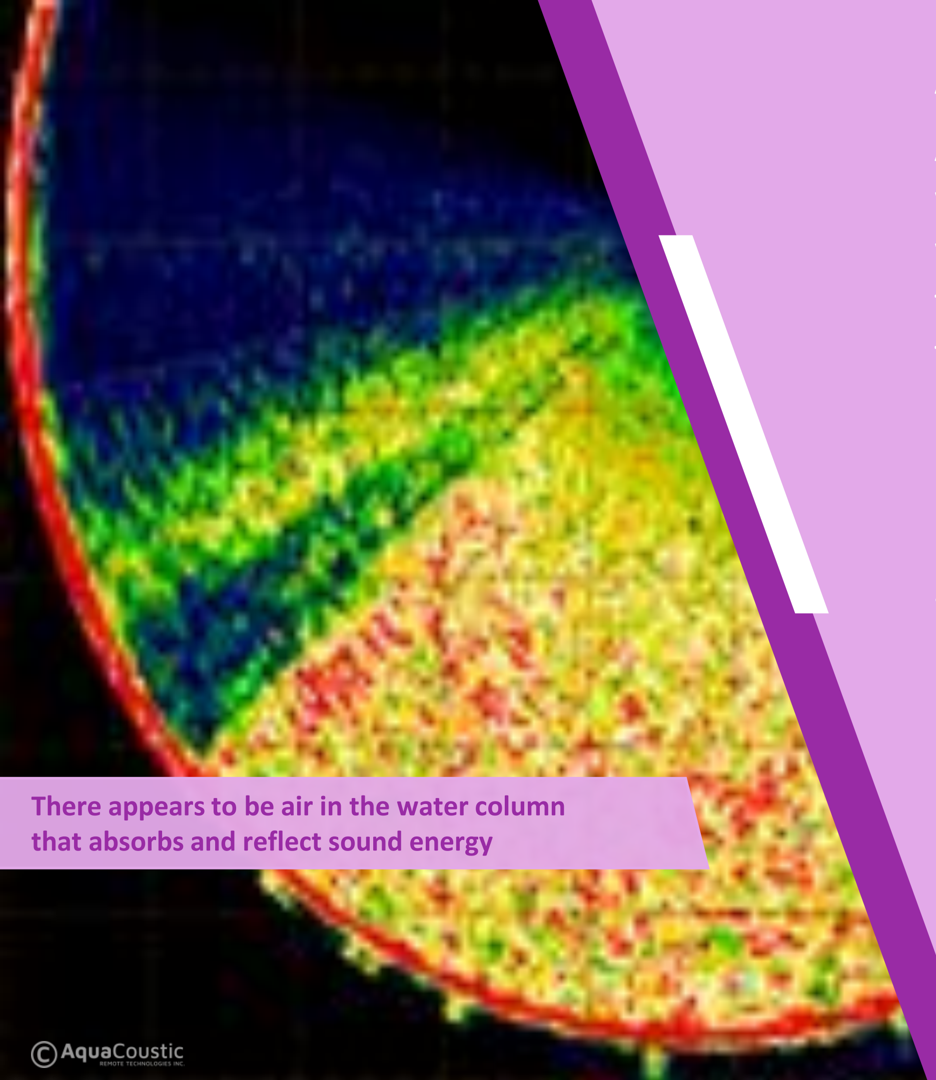


There appears to be air in the water column that absorbs and reflect sound energy

Absorption (Attenuation):

As sound energy moves through water, the pulse gets weaker because of time, sediment or bubbles in the water column. This is called ‘absorption’, we combat this effect by amplifying the return echo by increasing the *gain*. Care has to be taken so as not to saturate the return echoes.

Pulse Length:

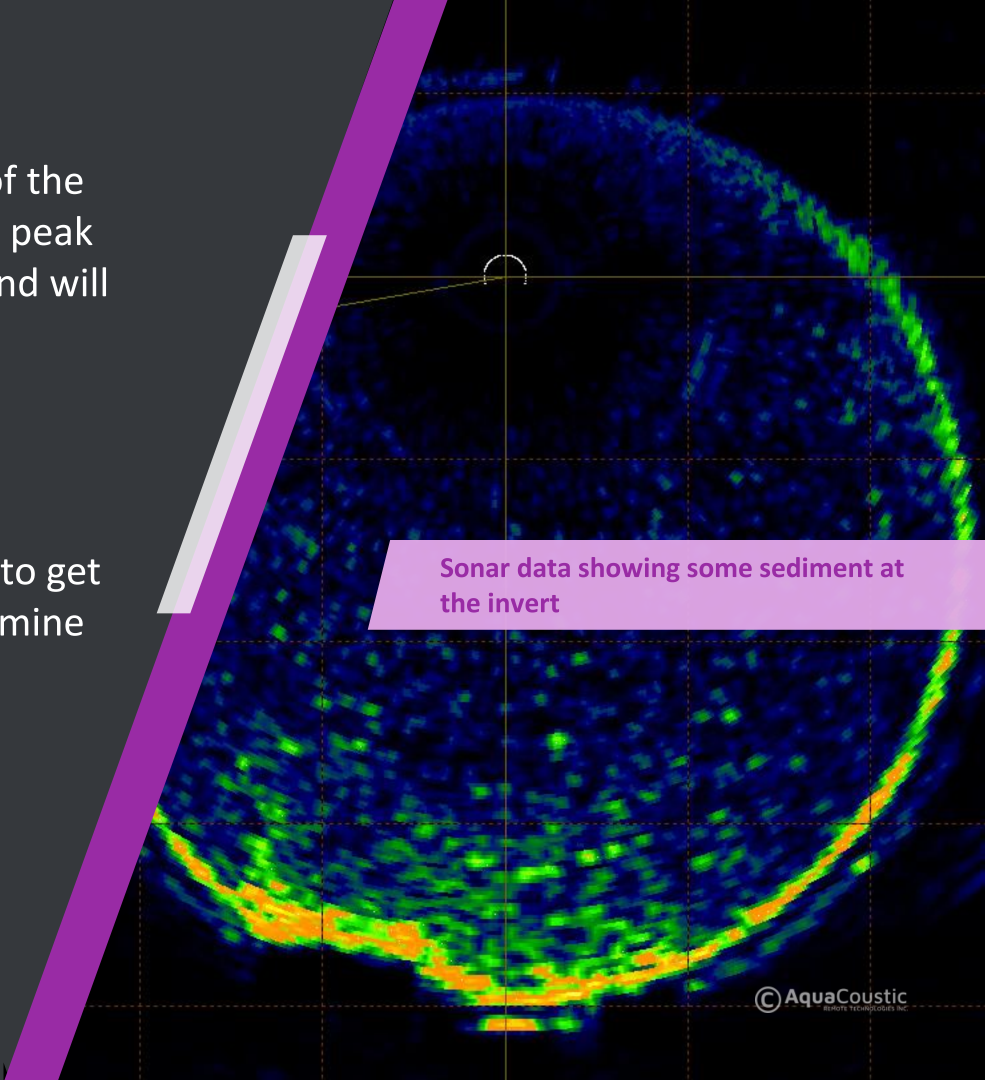
Pulse length is the distance from the beginning of the sound to the end of the sound, measured in microseconds. The transmit time can be as little as 10 microseconds to 100 microseconds or longer. A long pulse length is more robust and will travel through difficult water condition but a short pulse length will provide better detail.

Frequency:

Frequency is the speed of the repetitive oscillation of the transducer and is the measurement from one sound peak to the next. A low sound frequency is more robust and will travel through difficult water condition but a high frequency will provide better detail.

Speed of Sound:

Since we are timing how long the sound pulse takes to get from the transducer to the target and back, to determine range. We use 1,470 m per second as an average for sewage water, as the ranges in pipe is minimal.



Sonar data showing some sediment at the invert

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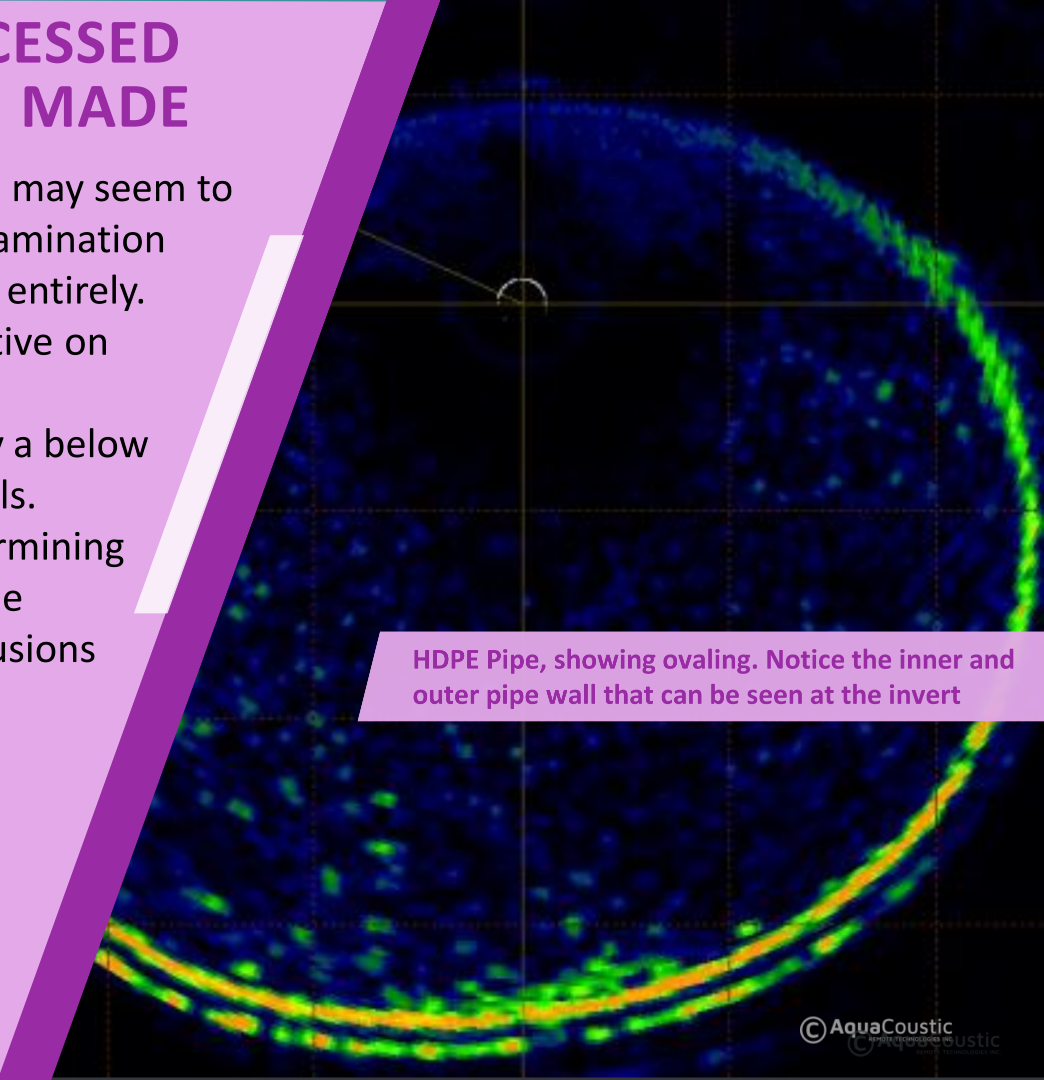
SONAR DATA SHOULD BE PROCESSED BEFORE CONCLUSIONS CAN BE MADE

From time to time the sonar image on the screen may seem to indicate an anomaly in the pipe; but on closer examination it is found not to be a problem or something else entirely. Keep in mind that sonar data is often very deceptive on first glance.

It takes years of experience to definitively classify a below water defect without additional data analysis tools.

There are so many confounding variables in determining a below water defect; that we need to process the data in the office to come to any definitive conclusions about major and minor defects.

e.g. ***If the pipe looks ovaled the sonar axis may not be aligned with the pipe axis. Care should be taken not to jump to any conclusions until all evidence is considered.***



HDPE Pipe, showing ovaling. Notice the inner and outer pipe wall that can be seen at the invert

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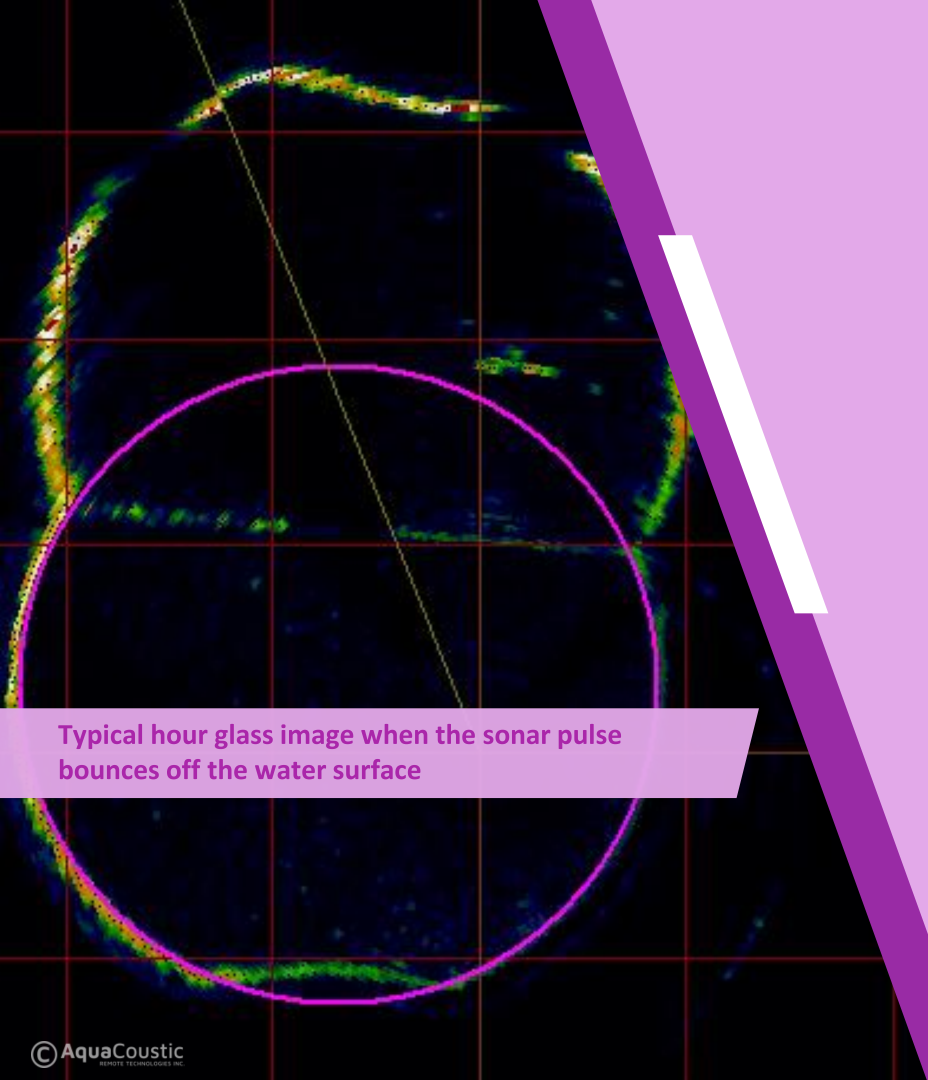

Typical hour glass image when the sonar pulse bounces off the water surface

The sonar pulse moves through the water as a sequence of pressure waves that propagates in the direction of travel.

When the sonar pulse hits a target, such as the inside of a pipe, the change in density reflects some of the energy and it returns as an echo.

Aeration or soft particulates such as wood pulp in the water column will absorb this energy very quickly so no return echo would be seen.

If our sonar pulse intersects the surface of the water it reflects the sound like a mirror, this can be seen in the on screen data and shows a perfect mirror image above the waterline.

We can only see objects by their returns. Any return means there must be a physical interface; thus if we see a return, we can ‘backtrack’ and see where that physical interface is.

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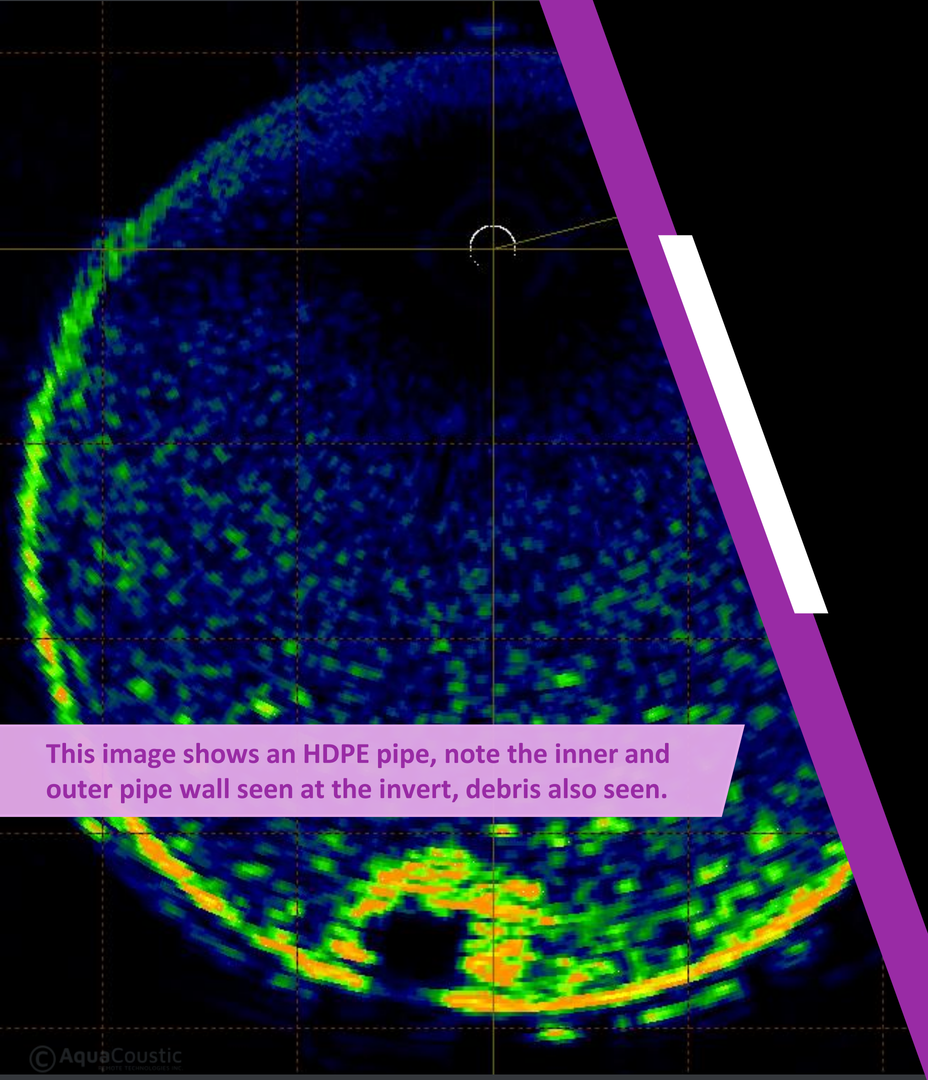

This image shows an HDPE pipe, note the inner and outer pipe wall seen at the invert, debris also seen.

SONAR THEORY

Examples of physical interfaces:

- Water to Air Bubble
- Water to Concrete
- Water to Fiberglass Pipe
- Water to Air

Fiberglass or High Density Polyethylene pipe returns less energy than a denser material such as concrete or steel.

Also HDPE allows some sound pulse energy to continue through the pipe wall. Occasionally flooded voids behind the pipe wall can be seen. The river bed has also been seen through the pipe wall, when the pipe is not buried.

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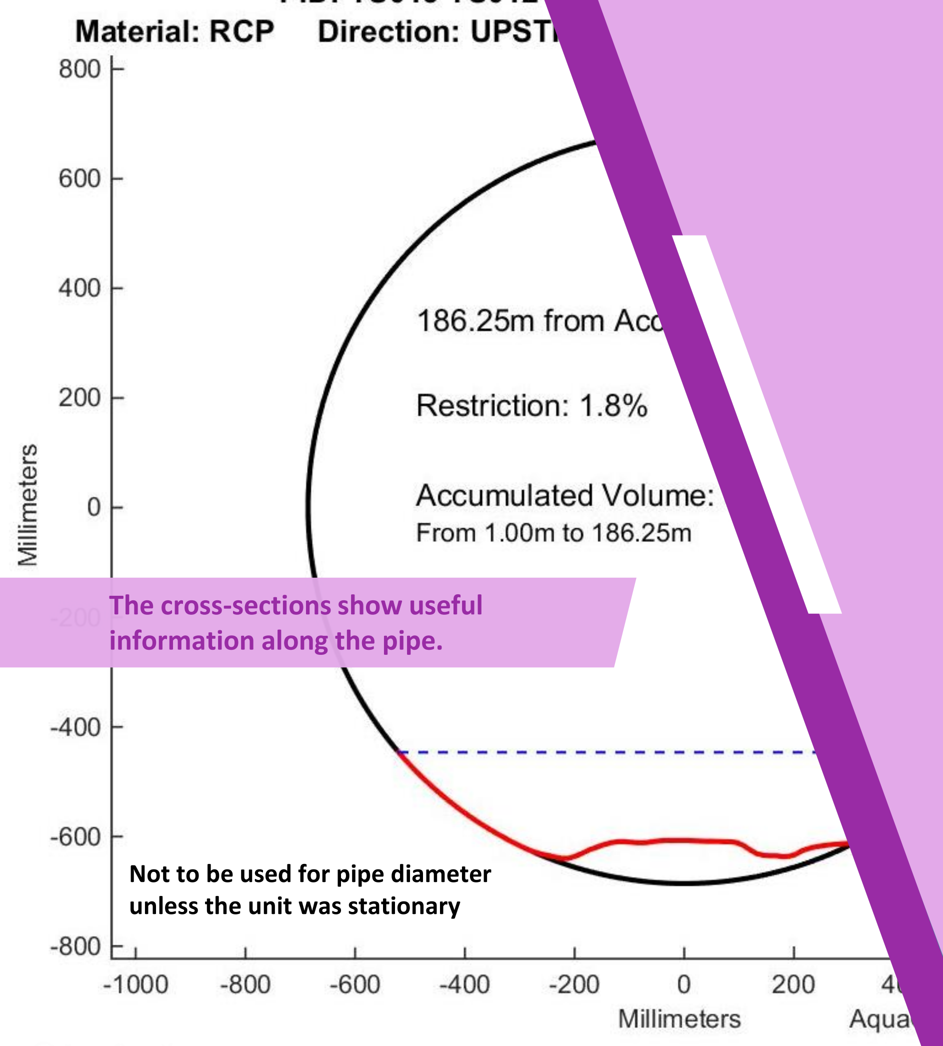

The cross-sections show useful information along the pipe.

Not to be used for pipe diameter unless the unit was stationary

SONAR THEORY

Sonar track:

A sonar profile is built as the sonar transducer steps around the sonar axis. A full sonar profile may take a few seconds, in this time the sonar may move from one side of the pipe to the other.

An important consideration when viewing sonar cross-sections is the relatively slow speed of sound in water. This requires the sonar head to complete a profile rotation in 6 or more seconds for a full 360°.

In this time the work platform may move slightly across the pipe diameter, this movement may change the sonar measured dimensions.

If an underwater measured pipe diameter is required, the system would have to be stationary for a complete profile.

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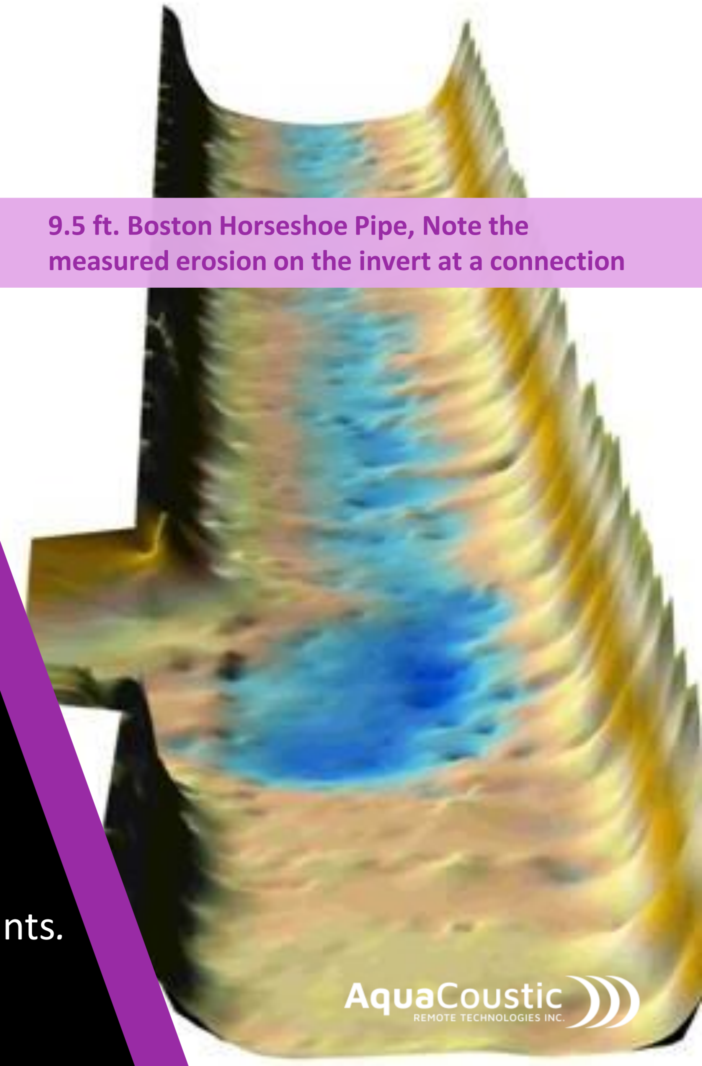
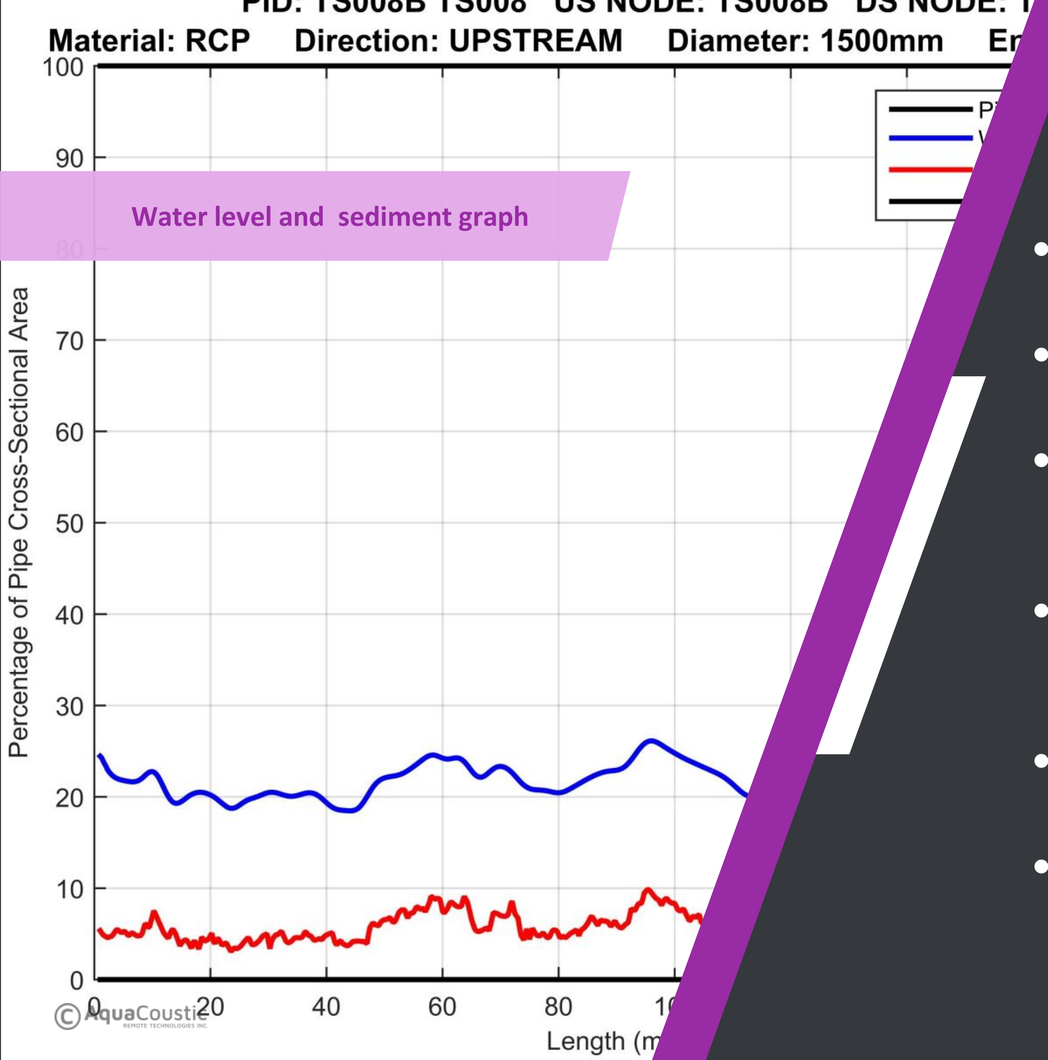
SONAR DATA MAY BE USED TO CALCULATE:

- Siphons volume or damage.
- Indication of structural failures.
- Monitoring progress of projects.
- Collection of information for refurbishment.
- Water levels. (May provide evidence of pipe sag.)
- Accurate (±0.5”) pipe diameters when stationary.
- Below water restrictions due to debris or other factors.
- Used for lining calculations when combined with laser.
- Our data contributes to Hydraulic Capacity, calculations.
- “As-is” storage capacity verses “as-built” storage capacity.
- Monitoring changes which can indicate problems or deformation.
- Accumulated volume of debris including distances from access points. Valuable information for cleaning bids.



9.5 ft. Boston Horseshoe Pipe, Note the measured erosion on the invert at a connection



Water level and sediment graph

AQC KEY POINTS

- We are an infrastructure pre-engineering firm that develops unique data gathering solutions
- Our data helps you prioritize areas of concern and can be instrumental in reducing costs of repairs
- We design and build robotic systems capable of meeting challenges and develop software that transforms data into useful information
- We control the data from collection to deliverables without outsourcing; therefore, we respond to client's input directly and completely
- Our technological solutions generate actionable information that reduces costs
- If you have any technical questions please phone or email us & we'd be happy to provide an answer

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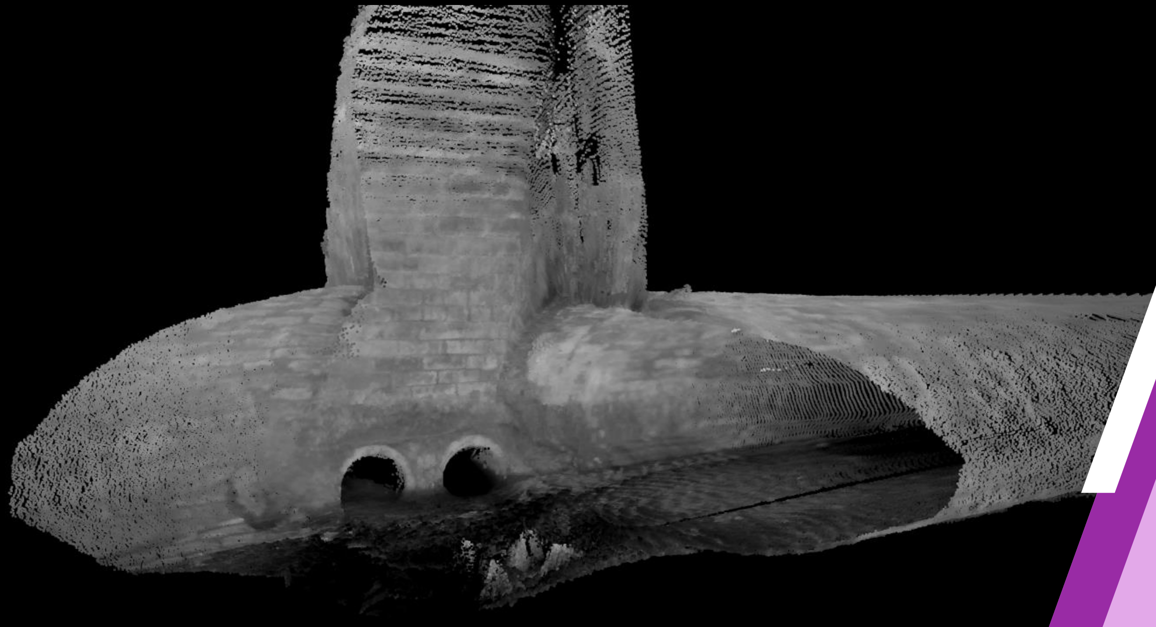
AREAS OF INFRASTUCTURE INSPECTIONS

IF YOU HAVE A PARTICULAR INTEREST OR CHALLENGE, WE CAN DISCUSS SOLUTIONS ON THE PHONE OR WE CAN SEND ADDITIONAL INFORMATION ON THE FOLLOWING:

- ✓ Dams
- ✓ Bridges
- ✓ Tunnels
- ✓ Culverts
- ✓ Manholes
- ✓ Mine Stopes
- ✓ Mine Tailing Ponds
- ✓ Shafts and Boreholes
- ✓ Pipe and Cable River Crossing Surveys
- ✓ Historical Video Re-coding to New Standards
- ✓ Processing Client Collected Sonar & Laser Data
- ✓ Specialty Sonar/Laser Surveys
- ✓ Traffic Management Plans
- ✓ Ports & Marinas
- ✓ Large Diameter Pipes
- ✓ Video Coding Services

AQUACOUSTIC CAN PLAY A SIGNIFICANT ROLE IN YOUR RISK MANAGEMENT STRATEGY



Processed, measureable, CAD ready, 3D Laser Point Cloud of a Brick Manhole

WHAT CAN WE DO FOR YOU

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