



# FIG Working Week 2024

19-24 May

Accra, Ghana

Your World, Our World:  
Resilient Environment  
and Sustainable  
Resource Management  
for All

Presented at the FIG Working Week 2024,  
19-24 May 2024 in Accra, Ghana

## A Smartphone-based Reality Capture Solution for Digital Mapping of Subsurface Utilities – why settle for less ?

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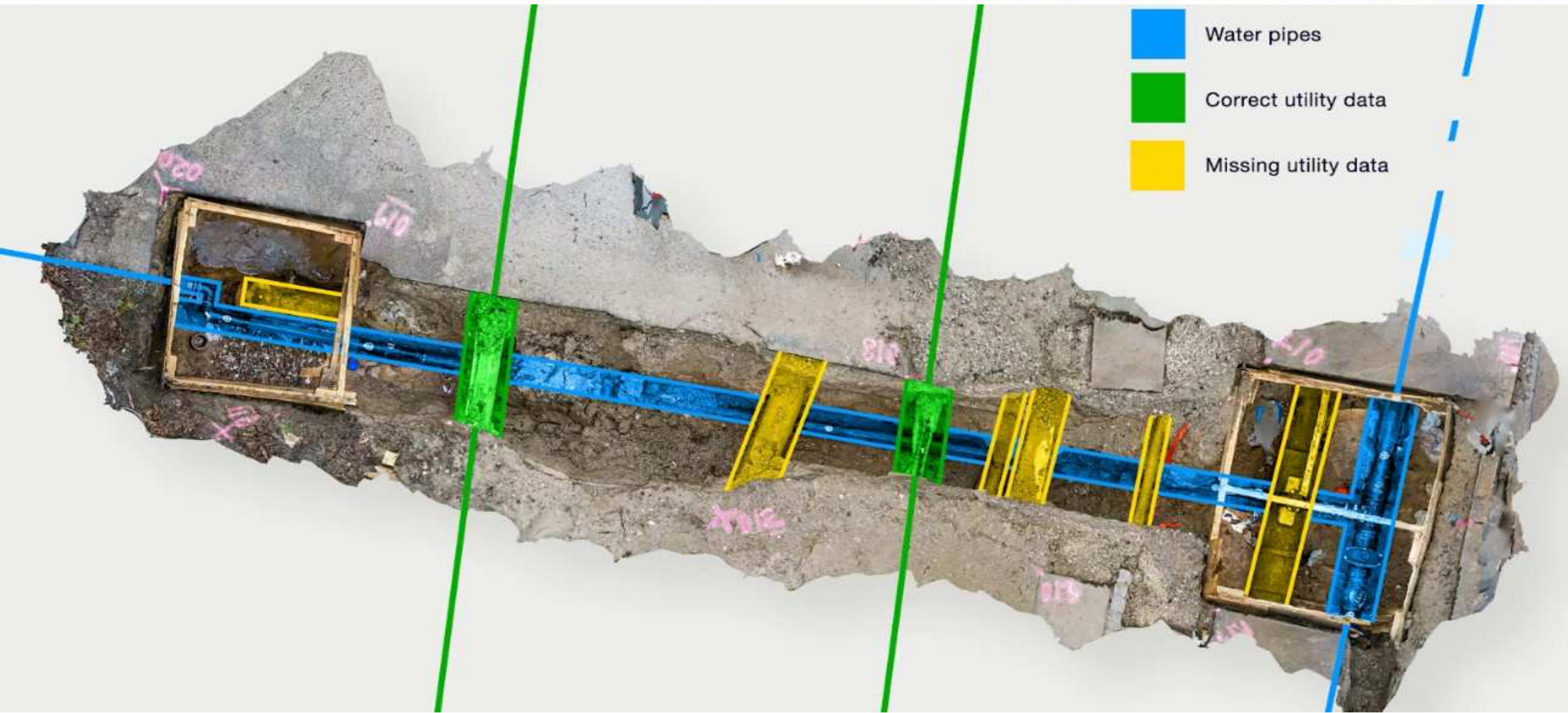


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## Surveying of Subsurface Utilities

### Conventional Surveying Methods:

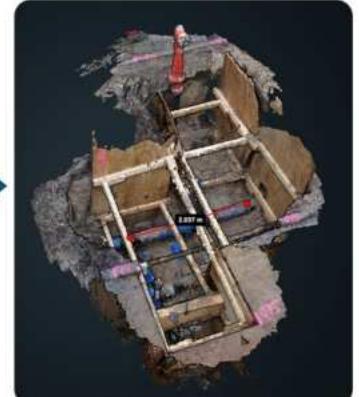
- Utilizes GNSS RTK systems and total stations.
- Produces sparsely located geographically coordinated points.



### Smartphone-Based Reality Capture:

- Utilizes close-range photogrammetry via smartphone cameras.
- Scale bar for internal accuracy – true to scale (< 1 cm)
- Ground Control Points (GCPs) anchor point clouds geospatially or RTK GPS connected to phone.
- Semi-automated and user-friendly workflow.

### FROM VIDEO TO 3D POINT CLOUD



Very High Relative accuracy  
High Absolute accuracy



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## Methodology

### Reality Capture of Pipelines

- Use a marker spray to create GCPs or use RTK connected to phone
- place a scale bar within the site to ensure the model is true to scale.
- Record the excavation site using a smartphone
- Upload the video for processing.

### •Data Processing of Videos

- RC-generated point clouds are then accessible through a 3D web platform called PointView
- PointView uses Potree framework for rendering.

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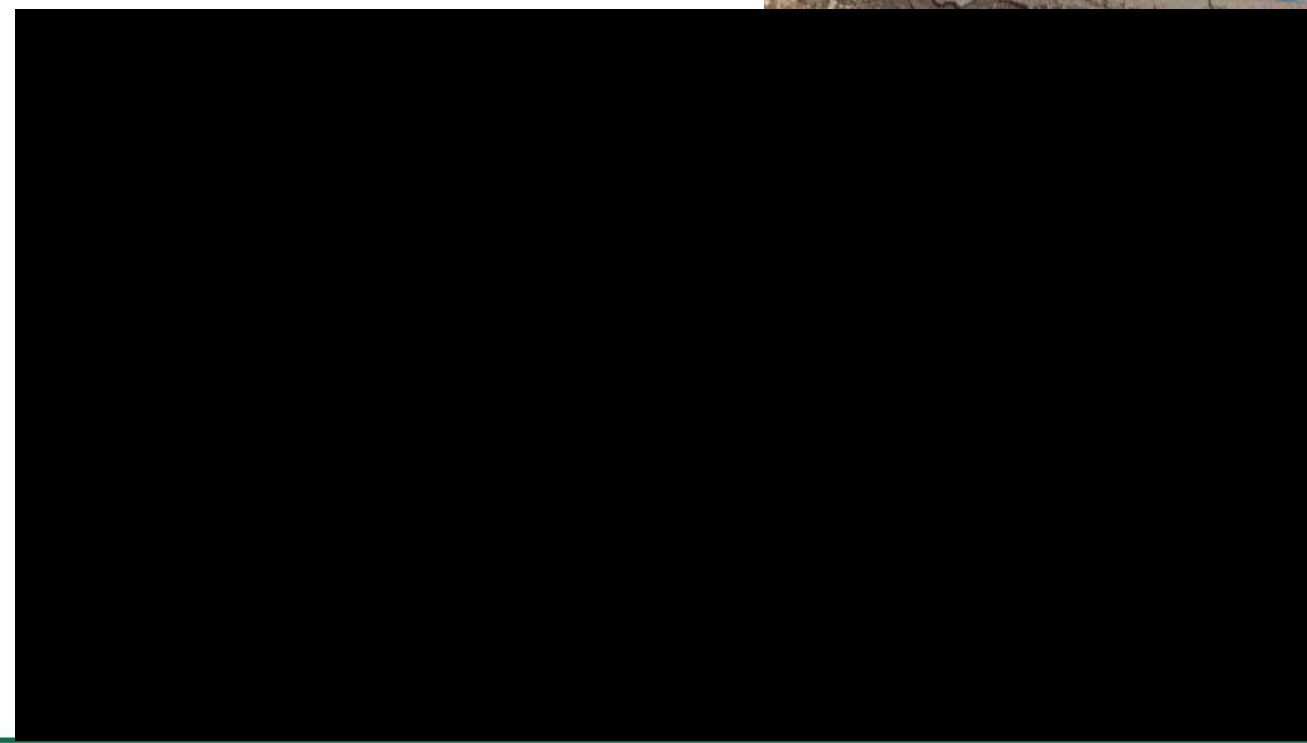
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## Methodology

### Empirical Assessment of Geospatial Accuracy of Point Cloud Data

- Use a scale bar to scale the coordinates of the point clouds data
- Compare true distances on the ground with their corresponding distances on the point clouds data
- Employ Root Mean Square Error (RMSE) calculations to assess quality of the approach.





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- **Accuracy studies** (Based on RTK)

- SmartSurvey displays an average planar deviation of less than 15mm.
- Elevation deviations are approximately twice as large as planar deviations.
- Using the Scalebar improves internal distance accuracy significantly, with an average deviation of only 3mm.



- **Relative Accuracy:**

- The internal distances measured within the point clouds showed higher precision, especially notable when the Scalebar was used.
- Root Mean Square Errors (RMSE) for planar and elevation accuracies were calculated and compared to GNSS measurements, showing good conformity with expected geodetic accuracy levels.

- **Key Insights:**

- SmartSurvey provides sufficient accuracy for applications where elevation accuracy is less critical, making it a viable tool for quick field surveys.
- The addition of Scalebar enhances measurement precision, recommended for projects requiring

PointView S&T	X (m)	Y (m)	Z (m)
RMSE	0,0045	0,0114	0,0357





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### Status in Denmark

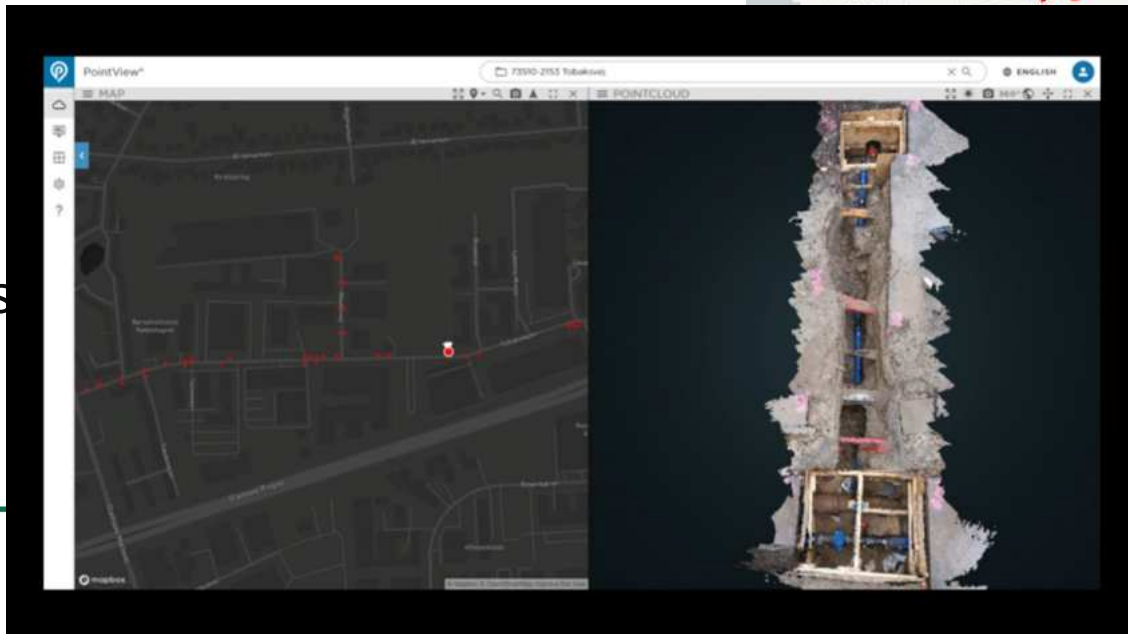
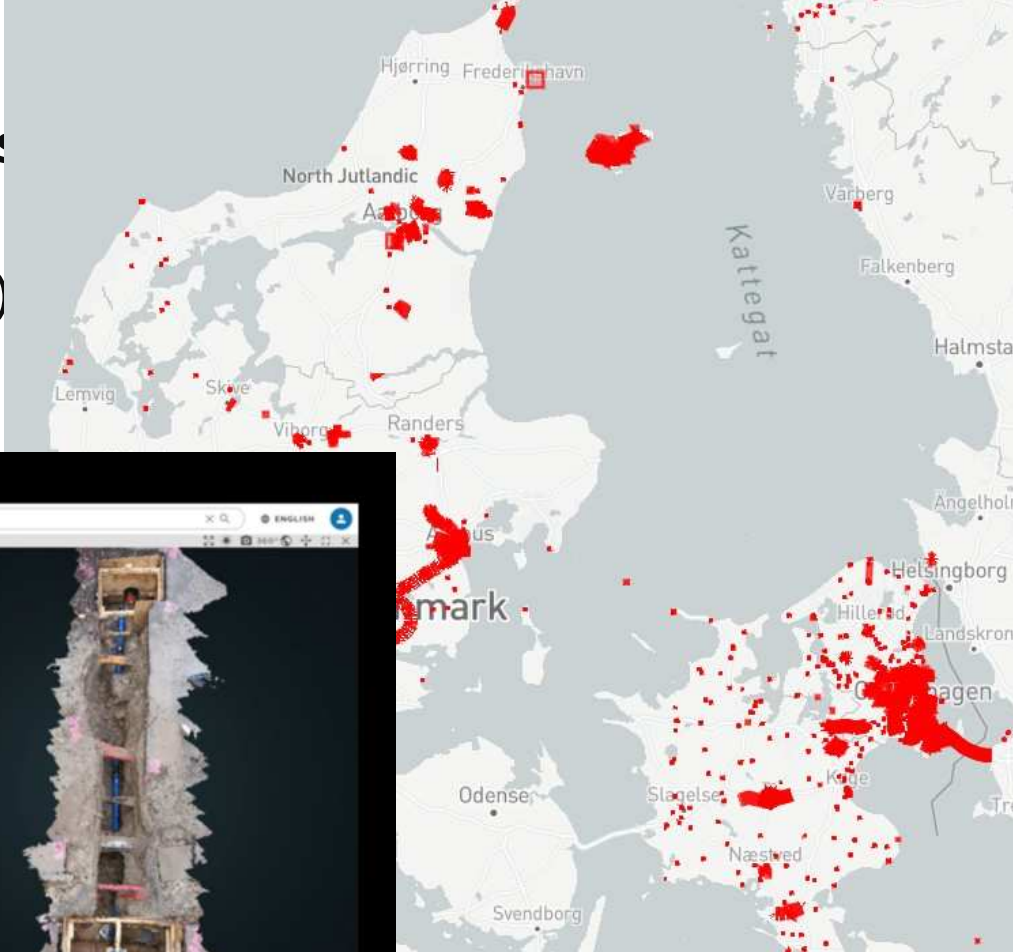
**Reality capture used by more than 30 utility companies**

- +15.000 pointclouds captured with reality capture
- 75% captured with use of Ground Control Points (GCPs)
- 25% captured with RTK connected to Phone

### Usage

- For updating database
- As QA documentation
- For understanding details

<https://pointview.it34.com/pointcloud?settingsLink=3589f354-0570-4108-b130-bfdfe2ff9d8c>



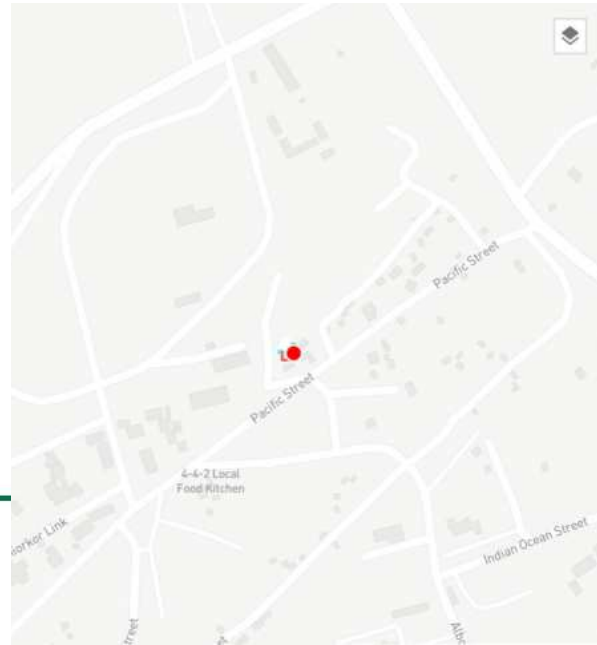
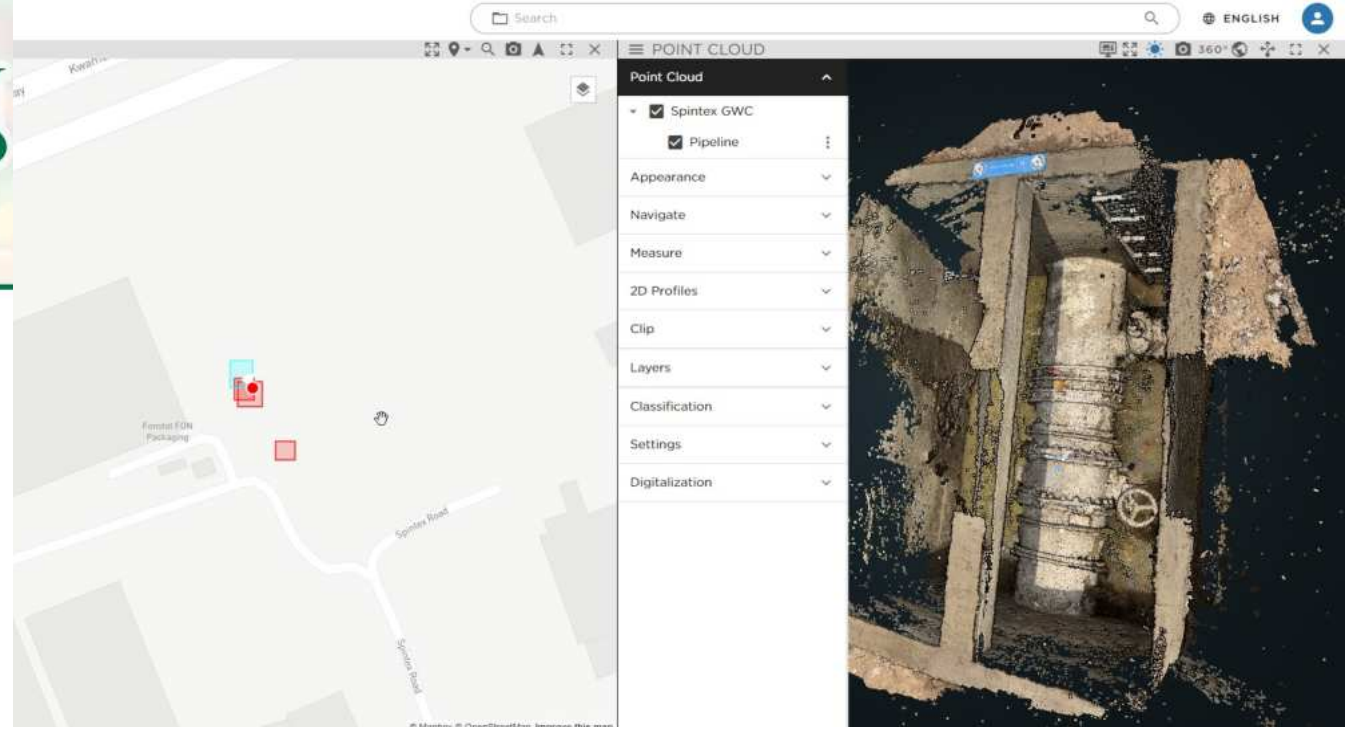
## Status in Ghana

**Reality capture used by more than 1 utility and 1 survey company**

- 23 pointclouds captured with reality capture
- 100 % captured with use of GCPs.

## Usage

- Techniques used when detailed maps are unavailable.
- Local improvisations to employ the technology effectively.







# Classification with AI



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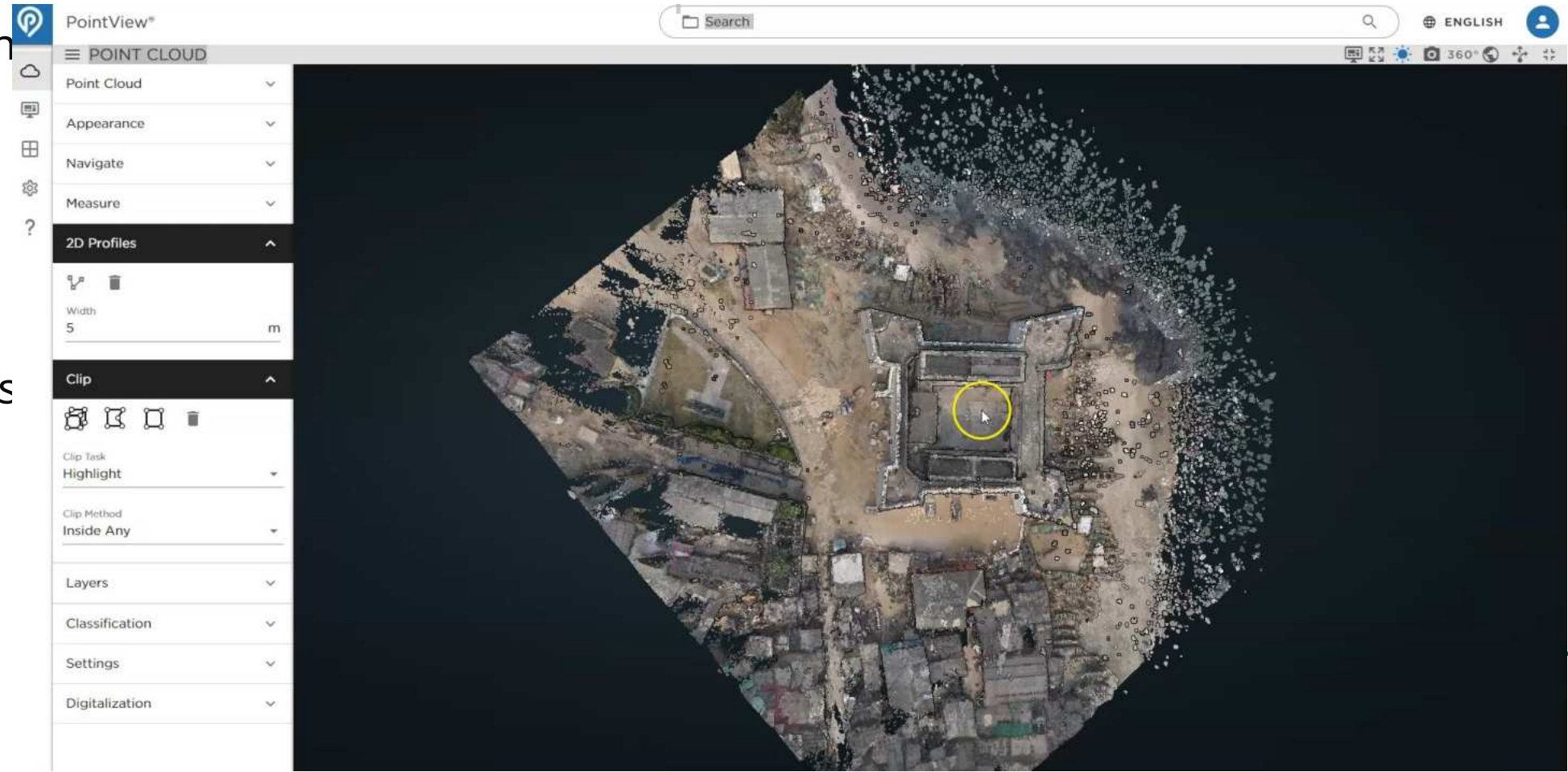
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## Status in Ghana

### Other Usages

- Land administration
- **Digital Twin for Heritage Documentation**
- Engineering surveys
- All other 3D modelling needs







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






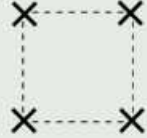
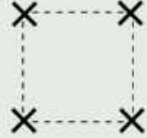


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## Challenges and Limitations

- Documenting extensive or complex excavation sites.
- Quality of point clouds generated by non-specialist users - Noise.
- Technological adoption barriers.
- Accuracy (GPS on Smartphone)

SmartSurvey™	SmartSurvey™ Scale	SmartSurvey™ GCP	SmartSurvey™ RTK
 Smartphone	 Smartphone	 Smartphone	 Smartphone
 Scale bar	 Scale bar	 Scale bar	 Scale bar
 Ground Control Points		 Ground Control Points	
 RTK receiver			 RTK receiver
Absolute accuracy <b>3-5 meters</b>	Absolute accuracy <b>3-5 meters</b>	Absolute accuracy <b>2-4 cm</b>	Absolute accuracy <b>2-4 cm</b>
Relative accuracy <b>30-50 cm</b>	Relative accuracy <b>1 cm</b>	Relative accuracy <b>1 cm</b>	Relative accuracy <b>1 cm</b>
Production time less than 1 hour	Production time less than 1 hour	Production time 24-48 hours	Production time less than 1 hour



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## Conclusion, Practical Applications and perspectives

- Smartphone-based Reality Capture (RC) solution offers considerable potential for utility mapping, with high accuracy and user-friendly operation.
  - Reality Captures in the field of pipework in the ground is fast, reliable and delivers full documentation
  - Future research points to more AI/ML producing automatic or semi-automatic digitization
- We aim to create a crowdsourcing platform to collect and share the vast amount of data that can be documented through reality capture of open construction pits
  - We call it HeyPipe. The perspective is to reduce damage to existing pipes, greater efficiency in planning and execution of the excavation work, and increased safety.

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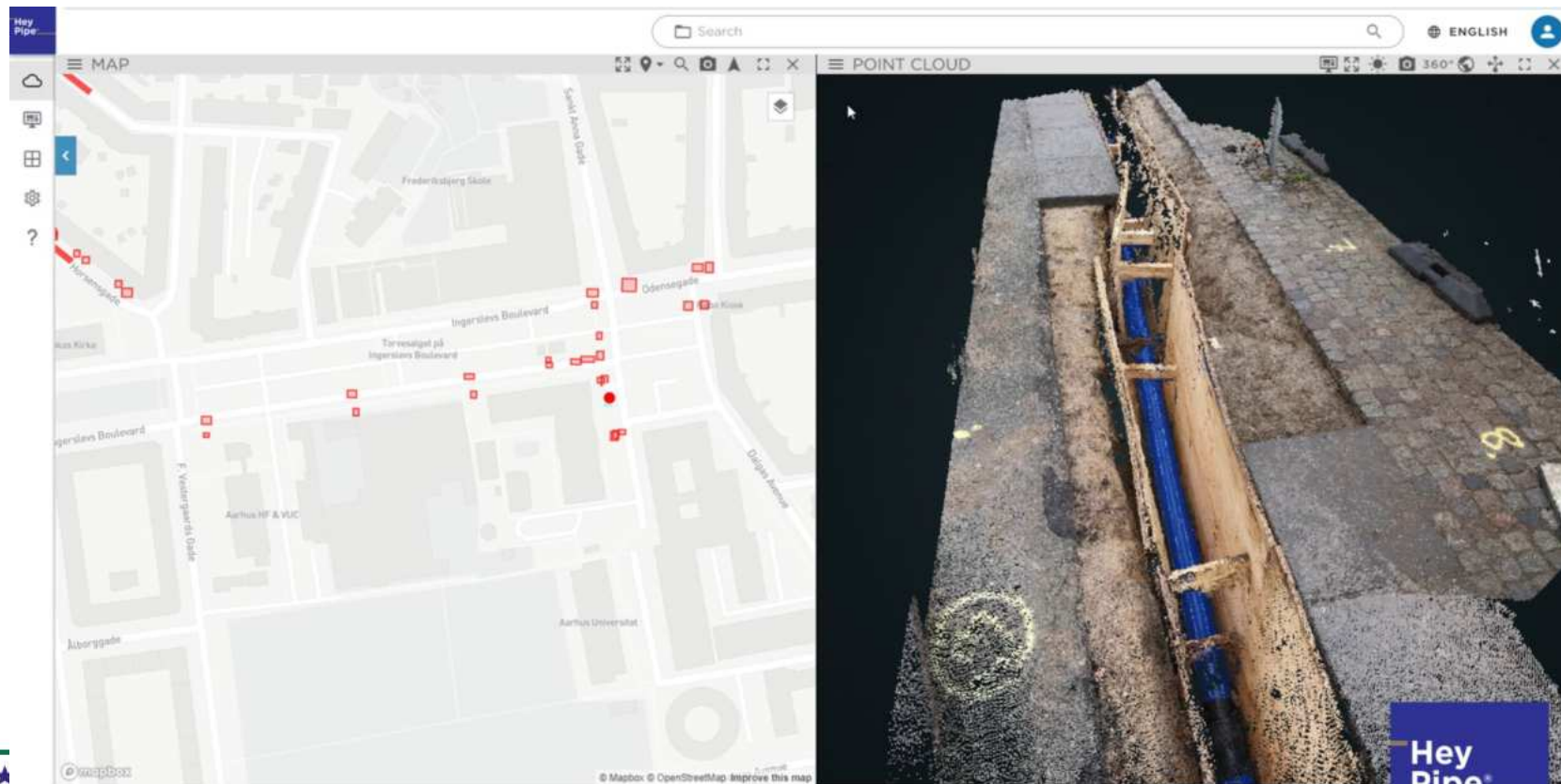
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# A Revolutionary Approach to Underground Data

- At the heart of our mission, the HeyPipe platform bridges today's challenges with tomorrow's solutions in infrastructure and construction work. By embracing the latest technology, we have created a platform that exceeds expectations for data management and sharing.
- HeyPipe™ will become an advanced digital platform where data sharing serves everyone's interests and is part of a broader societal perspective as a one-point-of-entry for underground data. The platform features unique 3D documentation of pipeline installations, images of open pipeline pits, elevation information for all pipelines etc.





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## Sustainable Development Goals

### **Sustainable Development Goal 6 – Clean Water and Sanitation:**

By improving the accuracy and efficiency of infrastructure management, the project directly contributes to optimizing water resource management and reducing the risk of pollution.

### **Sustainable Development Goal 9 – Industry, Innovation, and Infrastructure:**

The project supports the development of robust infrastructure through innovative technology, which improves the quality and lifespan of the supply network.

### **Sustainable Development Goal 11 – Sustainable Cities and Communities:**

Improved data management contributes to safer and more sustainable urban environments by minimizing the risk of infrastructure damage that can affect the quality of life and the environment for citizens.

### **Sustainable Development Goal 13 – Climate Action:**

Better planned and executed infrastructure reduces costs and resource consumption, which supports efforts to reduce climate impact and promote green transition.

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SUSTAINABLE DEVELOPMENT GOALS

International Federation of Surveyors supports the Sustainable Development Goals

## Commission 3

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