Digital Pipeline Integrity Management

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PIGGING CHALLENGES

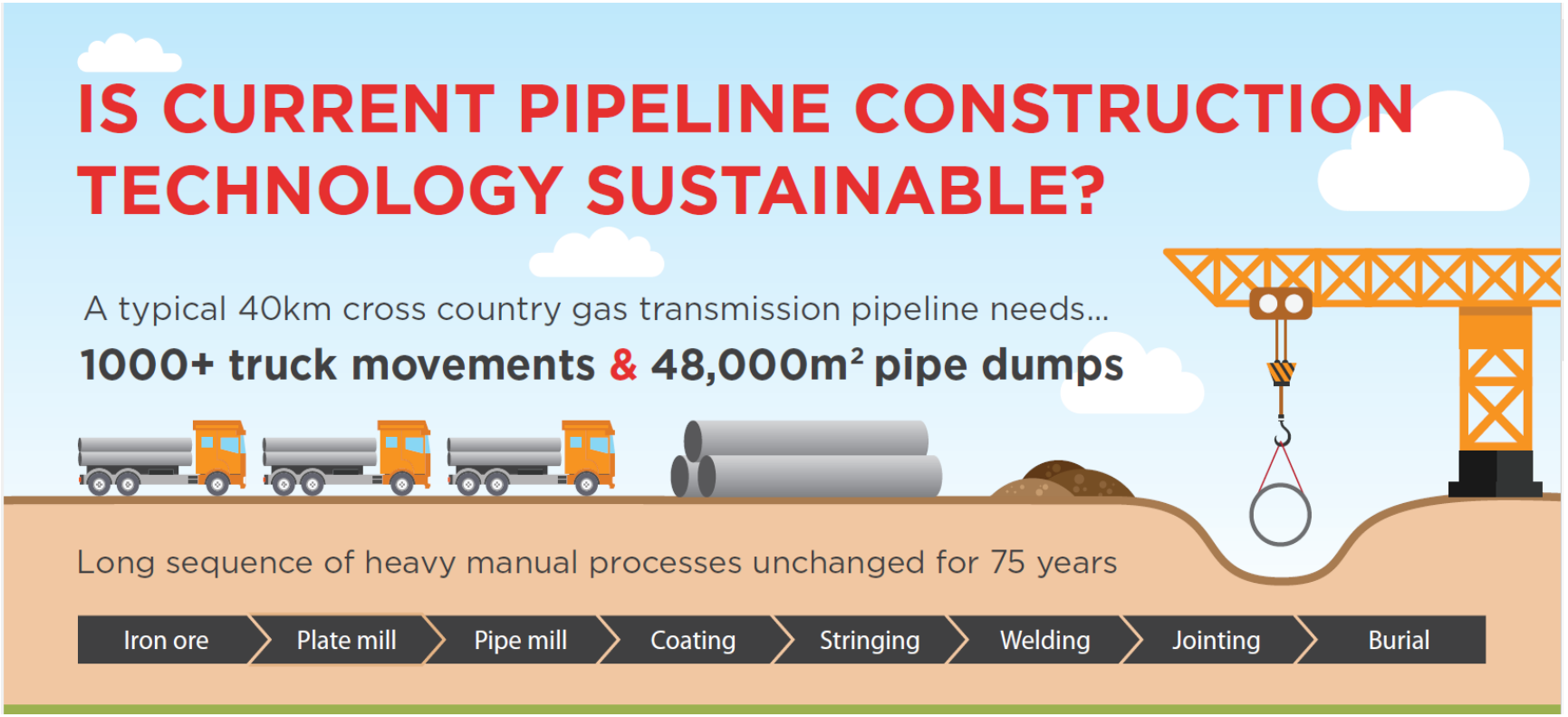
SUSTAINABLE PIPELINE SYSTEMS

- ***INTELLIGENT PIGGING***
  - *Managing schedules and risks*
  - *Larger footprint*
  - *Data processing time*
- ***PROGRESSIVE CLEANING***
  - *Decisions based on lack of data*
- ***PIG TRACKING***
  - *Technology limitations*
- ***STUCK PIG CONTINGENCY***
  - *Limited provision to test contingency plans*

GENERAL MARKET PAIN

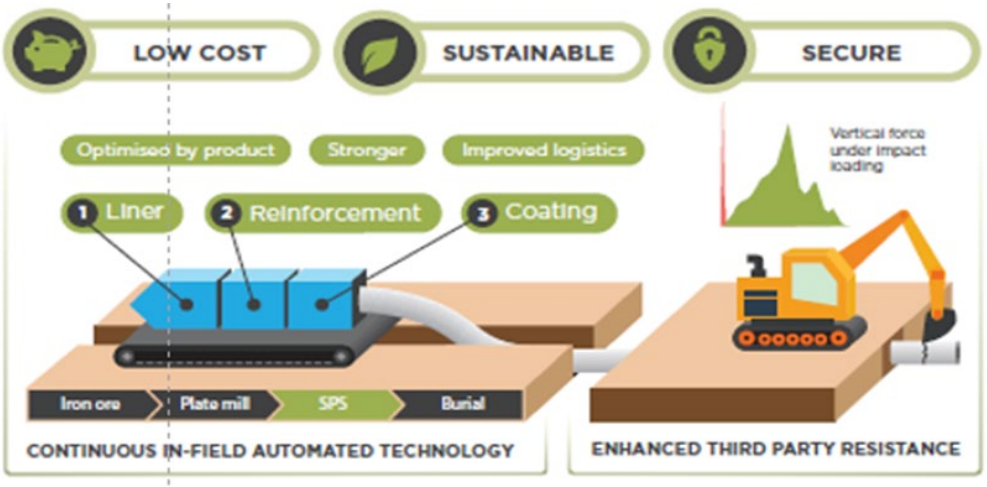
SUSTAINABLE PIPELINE SYSTEMS

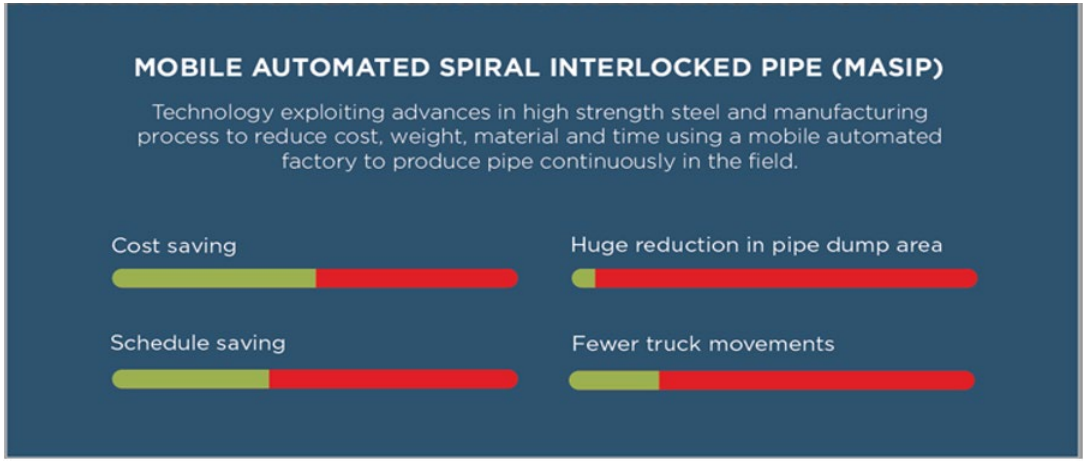
- ***High cost, high impact; reliance on skilled manual processes and transporting short pipe sections***



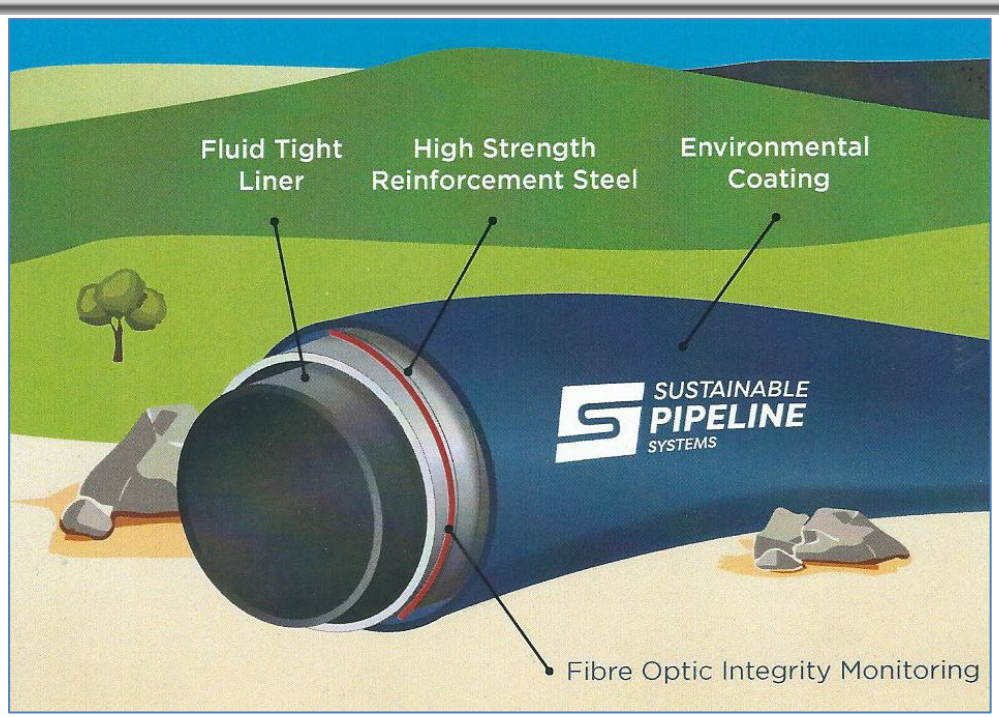
A mobile factory moves across the terrain laying pipe

- **Automated Construction**
  - Manufactured by mobile factory
  - Digital Quality Control
  - Directly laid in trench
  - Hydrotested
- **Digital Operation**
  - Real time data
  - All along pipeline

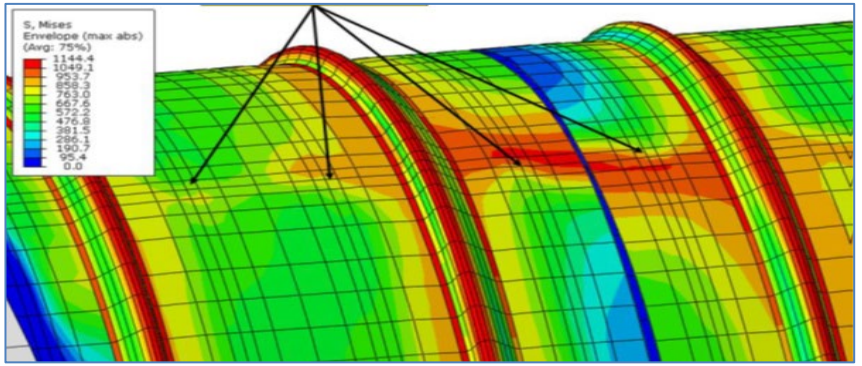


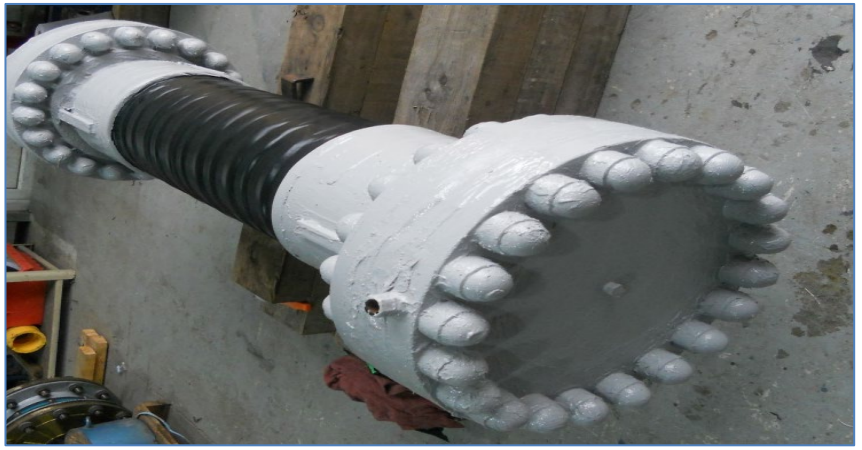


MASIP– Flexible Pipe Structure



ENGINEERING ANALYSIS:
Full 3D local analysis - to 1mm elements
Global 2D analysis – 1m elements



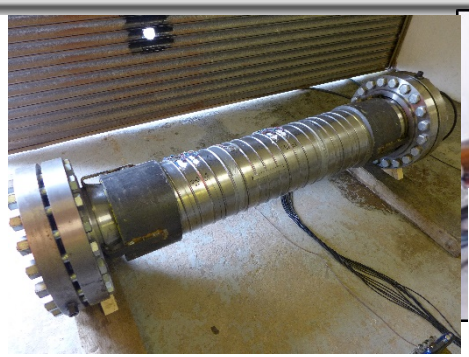


PIPE STRUCTURE :

- **HDPE liner**
- **High strength steel reinforcement**
- **Optical fibre cable**
- **2 layers of environmental coating**

Technology Qualified by DNVGL

SUSTAINABLE PIPELINE SYSTEMS



Pipe burst tests to 1700psi

Bend tests

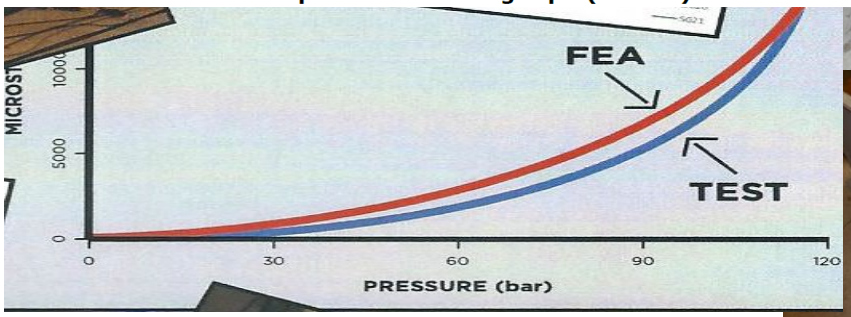
DNV·GL

ENDORSEMENT OF QUALIFICATION PLAN

No. 2019-10159047

This is to endorse in accordance with the provisions of DNVGL-SE-0160 /1/ that the qualification plan /2/ for

Mobile Automated Spiral Interlocking Pipe (MASIP)

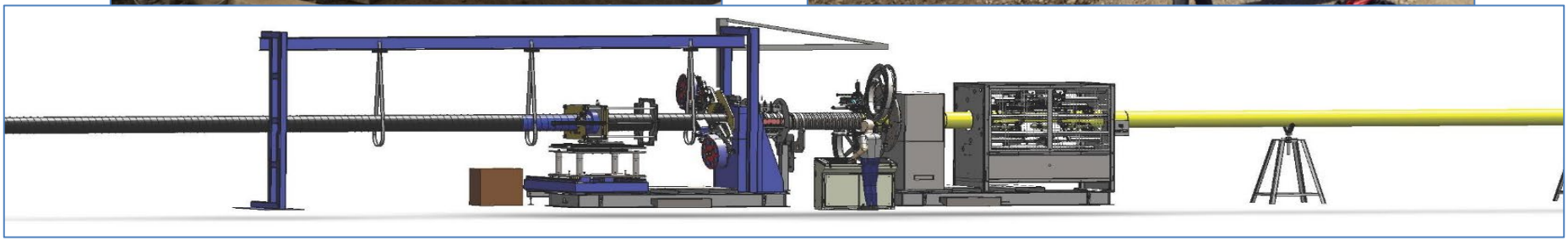


Permeation

Excellent correlation between FEA and pipe tests

Pressure cycling – simulating 50 years life with hydrogen rich gas

Mobile Pipe Factory – Field Trials



Factory modules are shipped to site in containers, assembled in a tent and pipe made in the field

MASiP – Intelligent Pipe with Optical Fibre

SUSTAINABLE PIPELINE SYSTEMS

Spirally wound optical fibre enables sensitive real time integrity monitoring- leak detection, 3rd party interference, pipe displacement

MASiP – Pipe trials

SUSTAINABLE PIPELINE SYSTEMS

Fibre Schematic (2020 Testing) – Data Type 24 Channel Positions

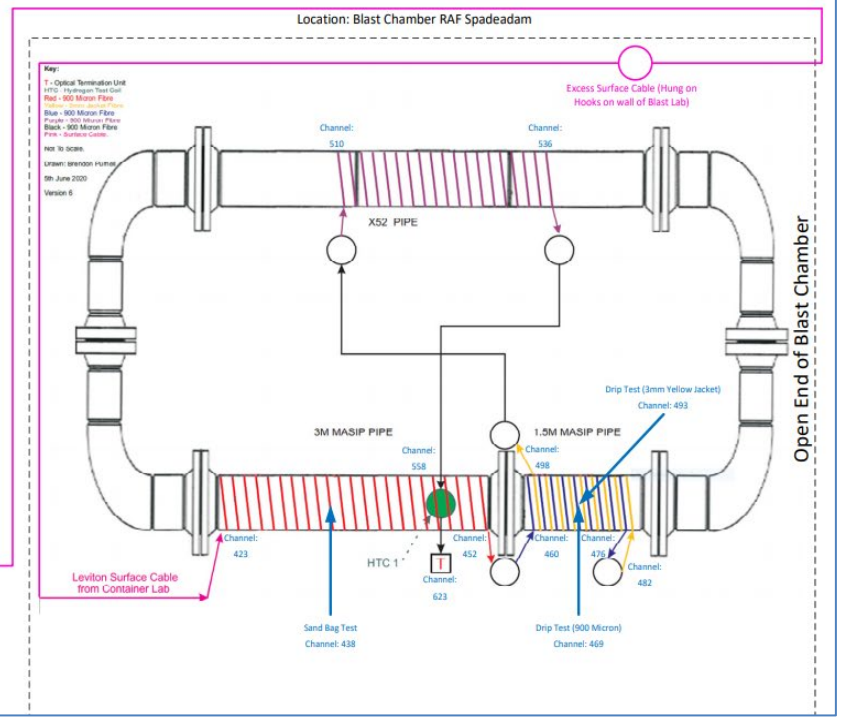
Pic Taken from Open End of Blast Chamber

Label	Opt Di...
Start	0.0
3M Pipe - 900 Micron	423.0
3M Pipe - 900 Micron	452.0
1.5M Pipe - 900 Micron	460.0
1.5M Pipe - 900 Micron	476.0
1.5M Pipe - Yellow 3m...	482.0
1.5M Pipe - Yellow 3m...	500.0
X52 Pipe	510.0
X52 Pipe	536.0
HTC Coil 1	558.0
End - End of HTC Coil 1	623.0

Channel Numbers Extracted from Software

Fibreoptic Surface Cable from ISO Container Lab 98.65M
Cable to be protected from impact (particularly Walking and Vehicles)

ISO Container Lab
(Equipment Location)



Pipe trials included different types of pipe section and a range of pressure cycles with hydrogen rich gas

Integrity Monitoring Dashboard

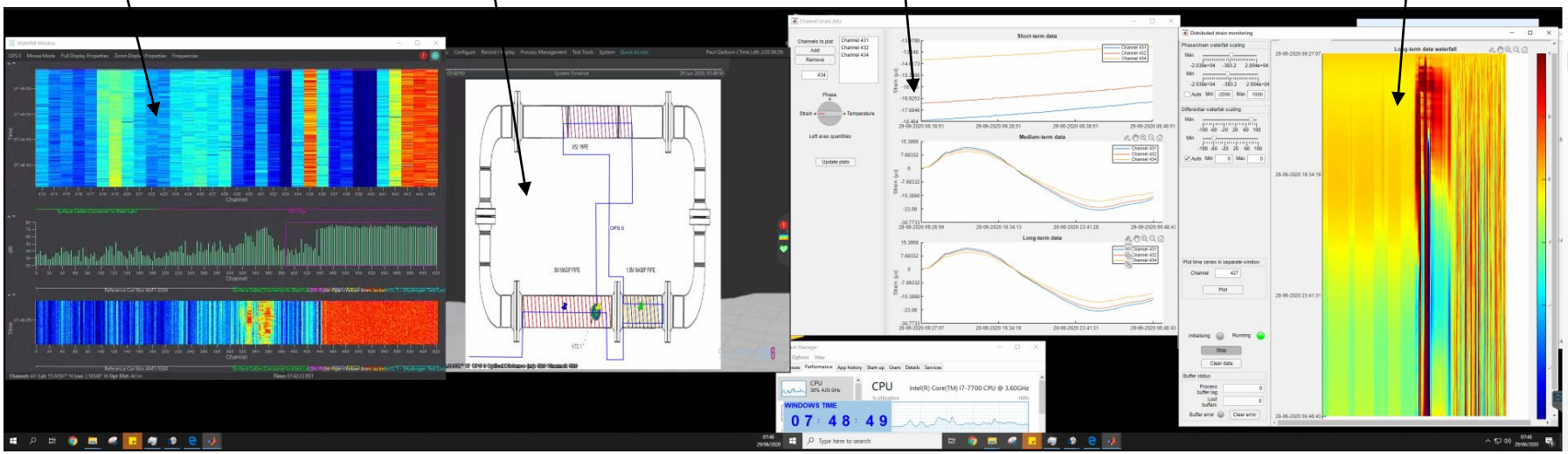
SUSTAINABLE PIPELINE SYSTEMS

ACOUSTIC WATERFALL

PIPELINE SCHEMATIC

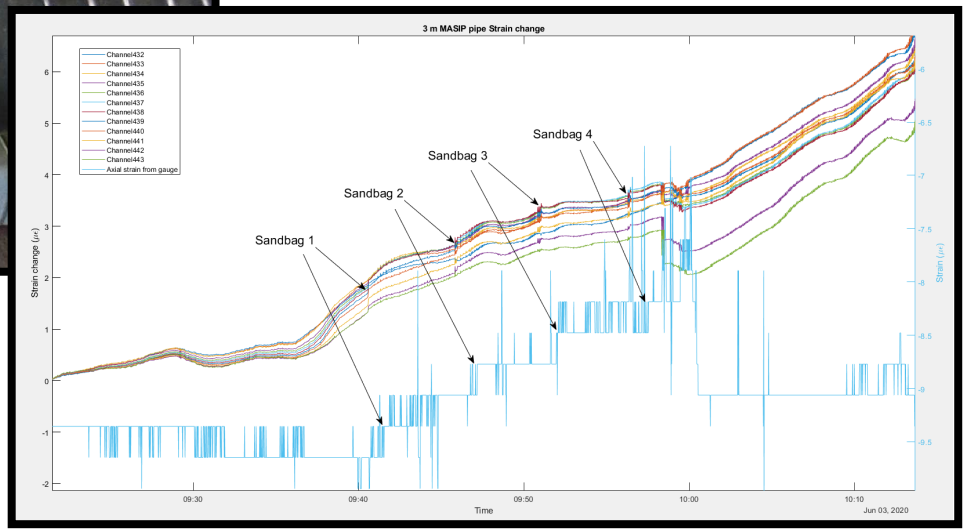
CHANNEL HISTORY

STRAIN WATERFALL



The pipeline is divided into channels of information with spatial resolution of 0.1m

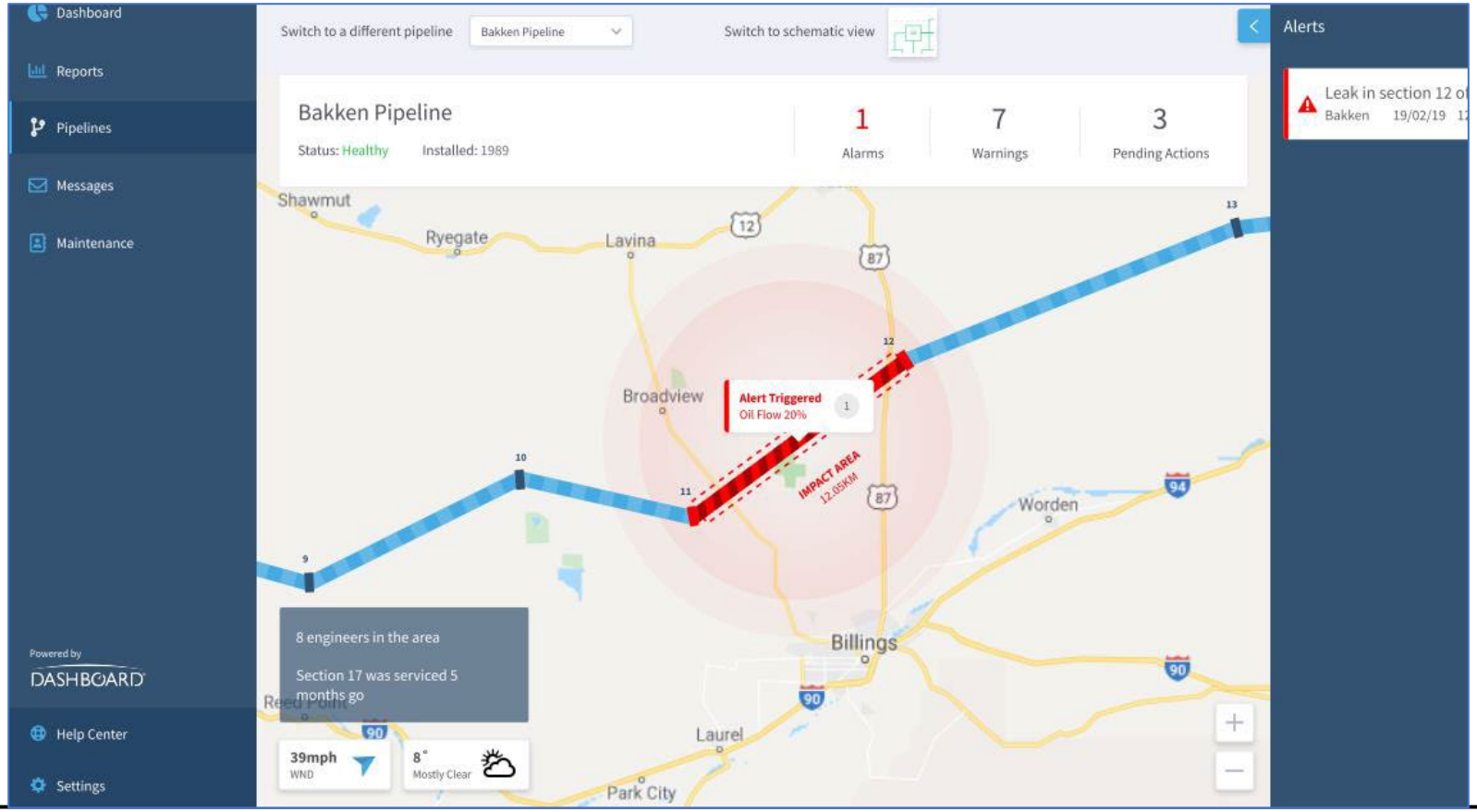
MASiP – Pipe sensitivity trials



Sandbags applied to pipe under gas pressure to test optical fibre sensitivity to local change in pipe wall strain

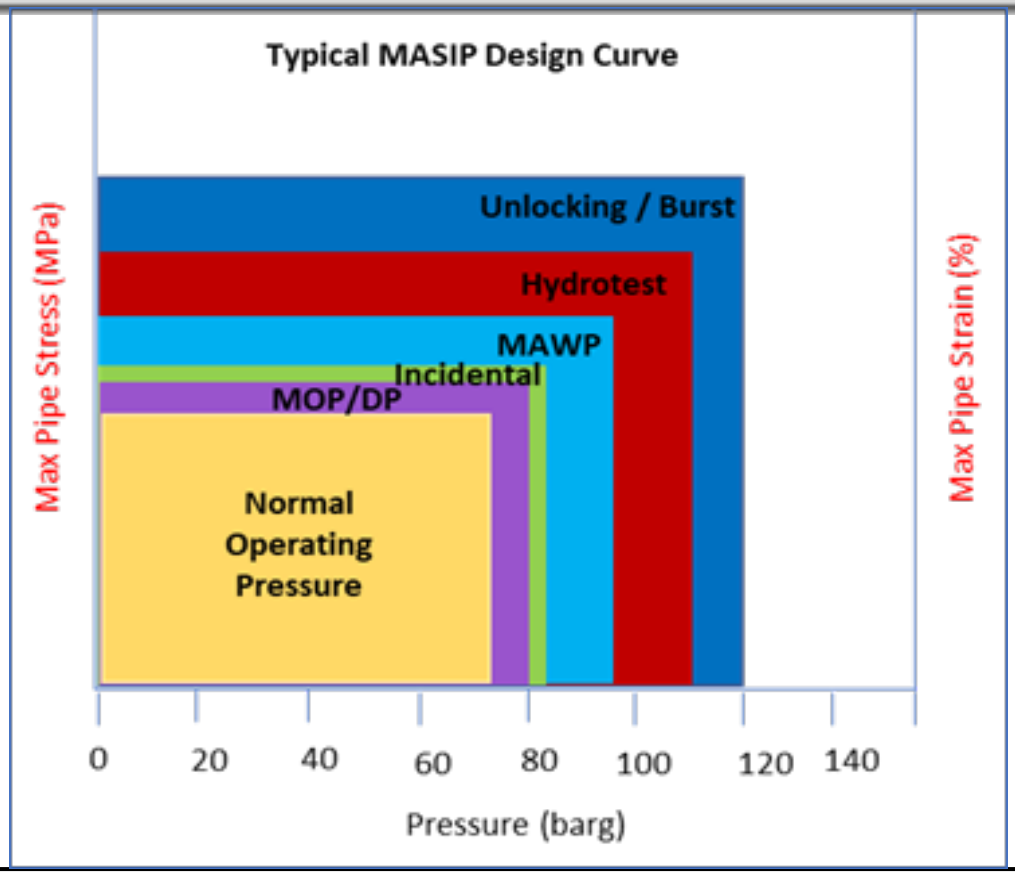
Pipeline Map

SUSTAINABLE PIPELINE SYSTEMS



An alerting system will ‘red flag’ threats in real time linked into GIS system

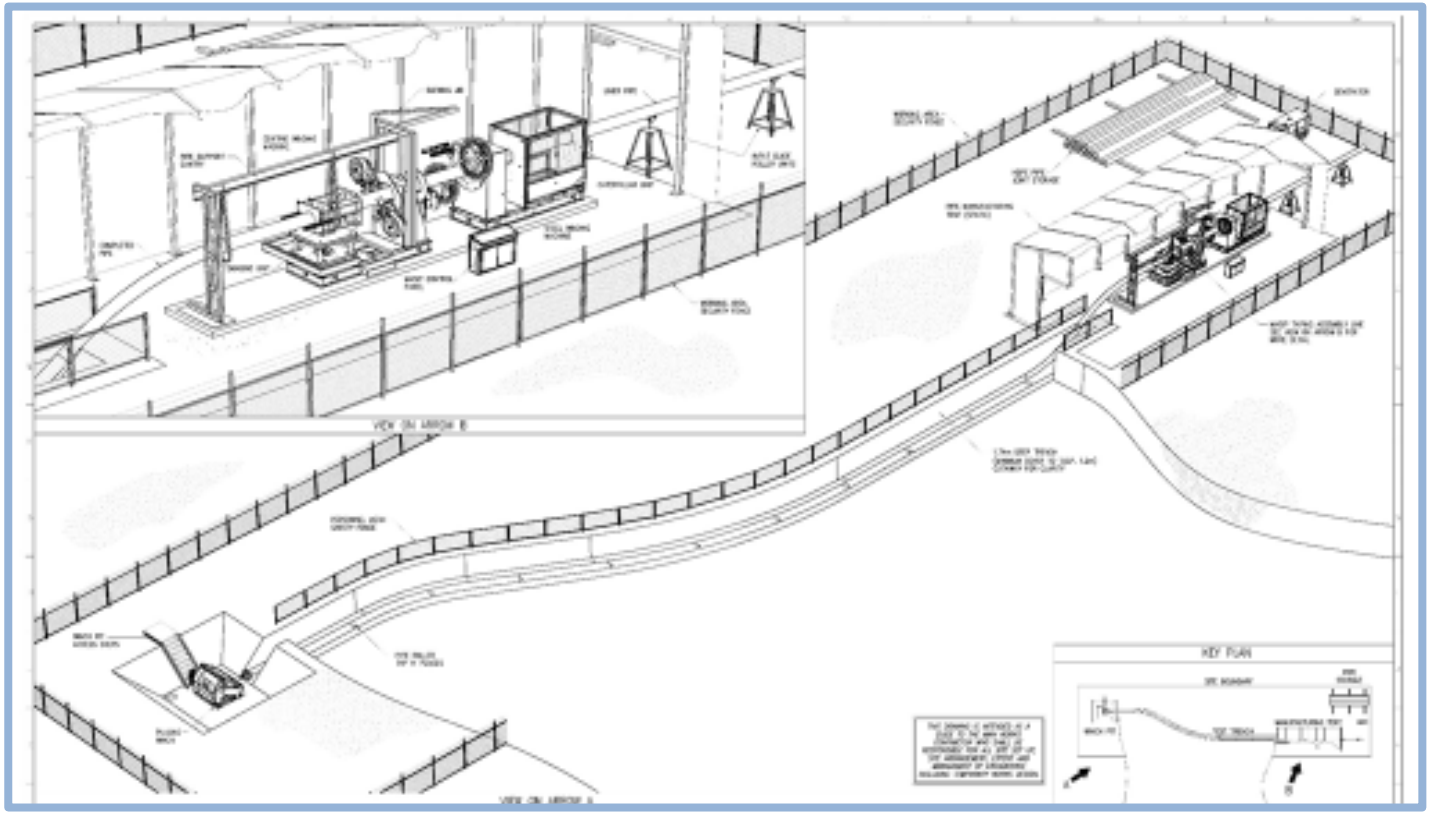
Design Chart



Finite Element Analysis and Physical tests lead to a simplified design chart to determine Maximum Allowable Working Pressure (MAWP)

Full Scale Field Trials

SUSTAINABLE PIPELINE SYSTEMS



Full scale trials are planned for 2021 with Pipeline Operator participation – contact us for details

CONCLUSIONS

- ***SPIRAL OPTICAL FIBRE – NEW APPROACH***
  - *1000x More sensitivity*
  - *Real time data*
  - *Good spatial resolution*
- ***PIGGING AS REQUIRED***
  - *Decisions based on clear and detailed data*
- ***PIG TRACKING***
  - *Accurate digital tracking with optical fibre*
- ***FIELD TRIALS OPEN TO PARTICIPATION IN 2021***
  - *Opportunity to try specific solutions*

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Thank you and Questions

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