Management of Firstgas Transmission Pipeline Waterway Crossing

-- Risk Management and Operational Strategies

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Overview

Firstgas

- **2,500 kms** of high pressure gas transmission pipelines
- **4,800 kms** of smaller gas distribution networks
- More than **1,000** waterway crossings across whole transmission network
- Main Challenges:

  Erosion (banks & beds)

  Geohazards (landslides)

Types of Waterway Crossings and Typical Hazards in NZ

Farm drains and channels

Wetlands and floodplains

Gravel-bed streams and rivers

- Scour and bed degradation
- Bank erosion
- Flood scouring and vibration
- Loss of cover / exposure
- Third-party interference
- Corrosion (external coating damage + CP issues

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Types of Waterway Crossings and Typical Hazards in NZ

Sandy streams and rivers

Other normal streams and rivers

Tide related waterways

- Scour and bed degradation
- Bank erosion
- Flood scouring and vibration
- Loss of cover / exposure
- Third-party interference
- Corrosion (external coating damage + CP issues

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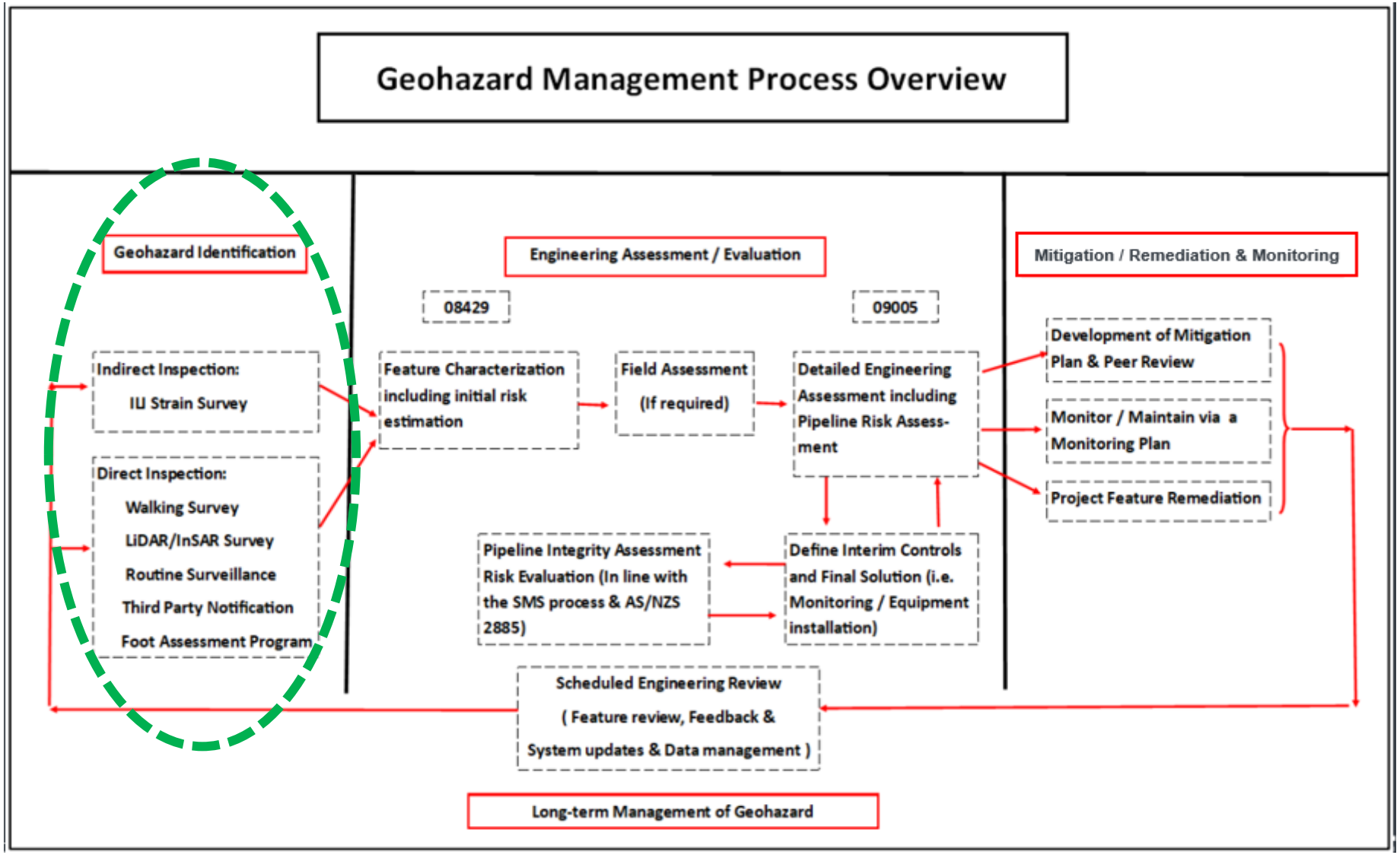
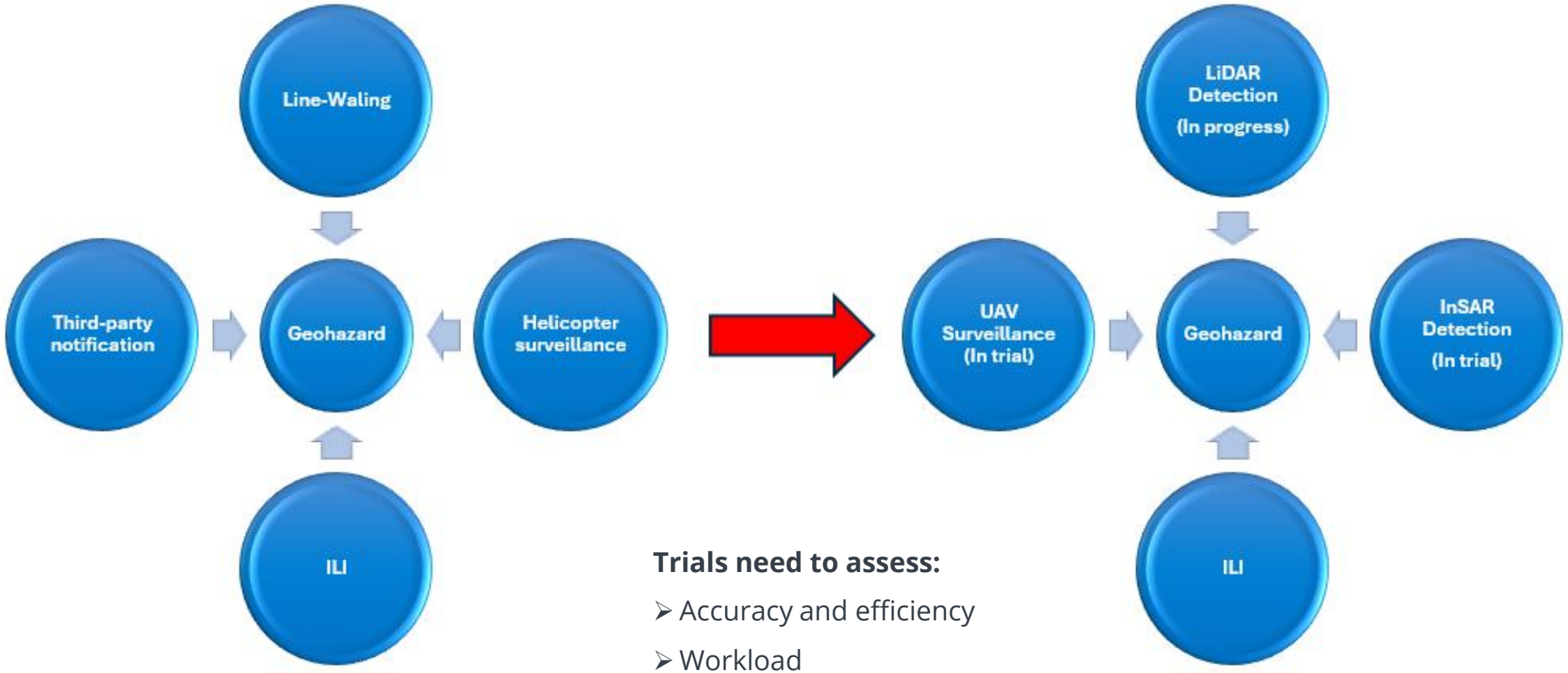
Firstgas Risk-Based Management Approach



- Through Geohazard identification, Engineering assessment, Remediation / Monitoring and set up PM (Preventive Maintenance) to achieve geohazard Long-term management
- Risk identification is the most involved phase of waterway crossing management, requiring diverse monitoring and control methods from multiple teams.
- Clear ownership is essential for long-term geohazard management.

Controls Methodology



Current Methodology

Trials need to assess:

- Accuracy and efficiency
- Workload
- Cost efficiency
- Public awareness

New Methodology in Trial

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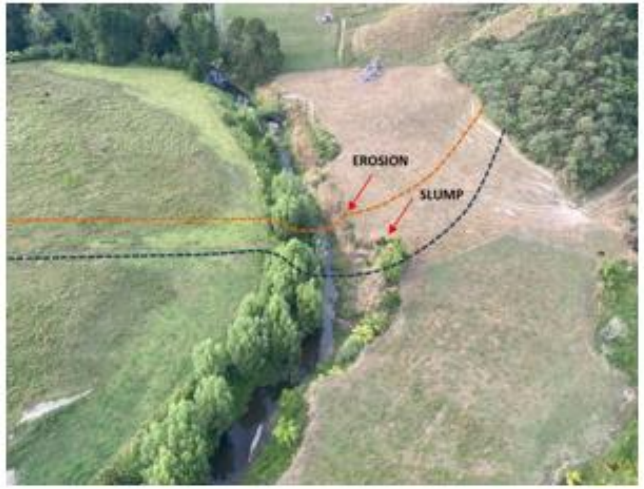

Routine monitoring

- Routine patrol inspections
- Post-flood event inspections
- Targeted monitoring at high-risk crossings
- Survey where required

- Weekly
- Monthly
- Two monthly
- Ad-hoc for Post Extreme Weather Events

- 10 yearly for un-piggable lines
- 2 yearly - 3 yearly - 5 yearly for geohazards line flights in different regions
- Ad-hoc for Post Extreme Weather Events
- Require Engineering geologists or geotechnical engineers

Geohazard Line walking and Line flights

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UAV

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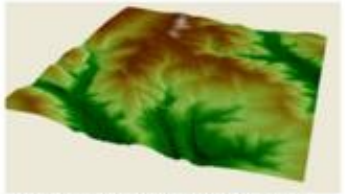
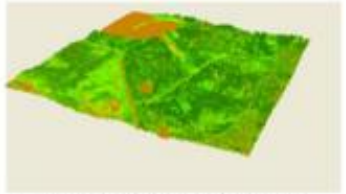


- Digital Elevation Model (DEM) Ground elevations

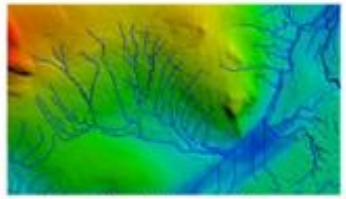


- Canopy Height Model (CHM) – Tree heights (Vegetation subtract DEM)

- Digital Surface Model (DSM) (Lidar first returns)

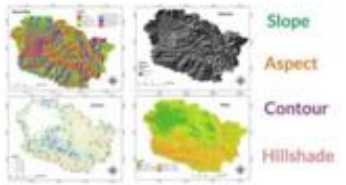
- Intensity Image – This used to map permeable and impermeable surfaces

- Building Height Model (BHM) – (Structure Height subtract DEM)

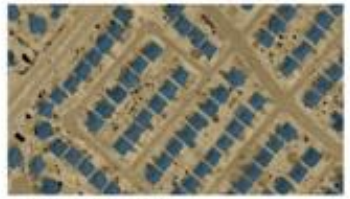


- Watershed model Automated drainage model

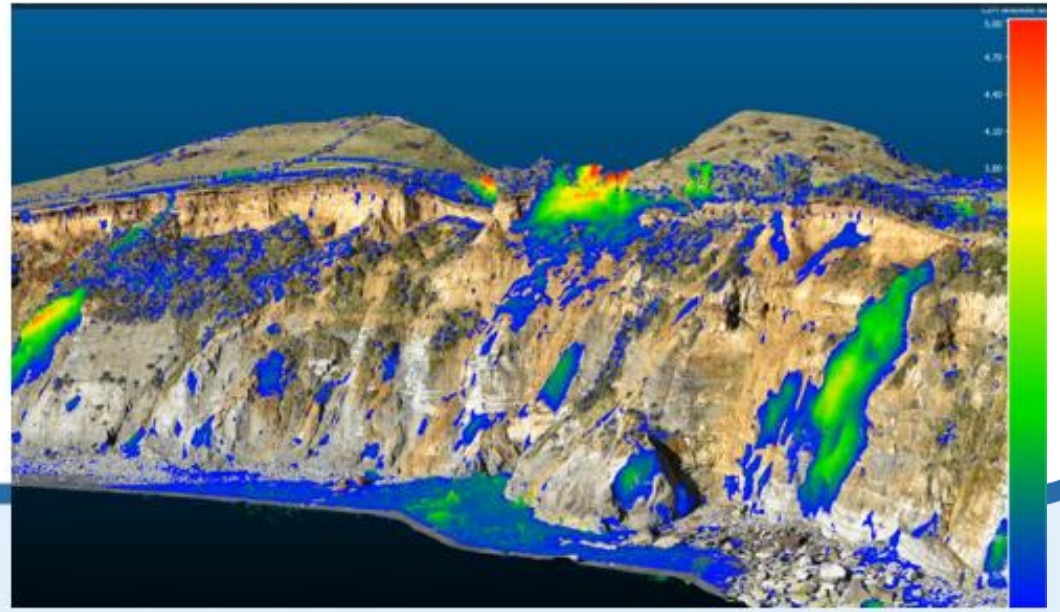
- Hillshade Model – enhanced terrain visualisation.



- Slope Shade Model – highlights aspect and slope characteristics, slip risk analysis

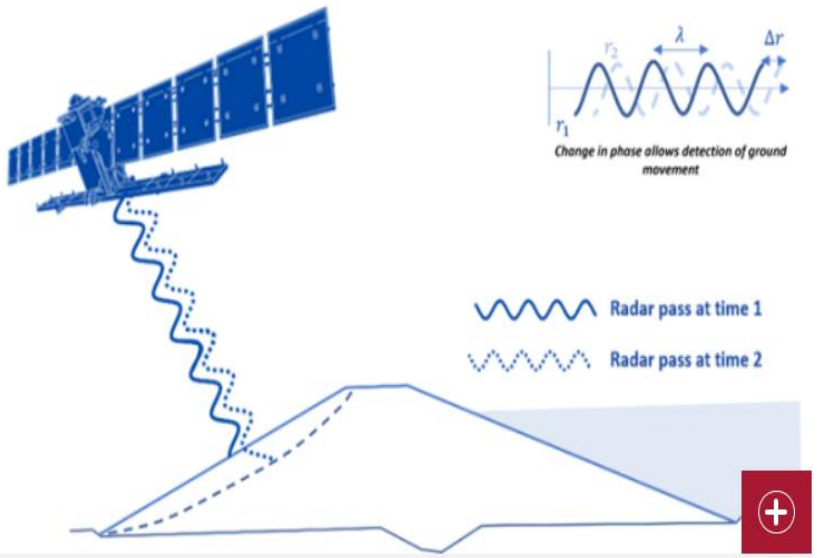


- Building footprints

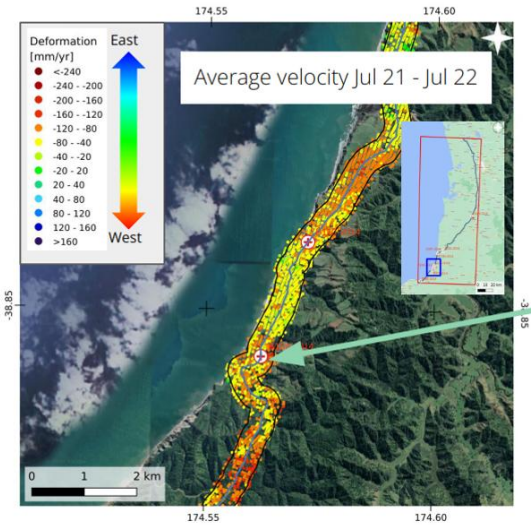


Change Detection by using DEM

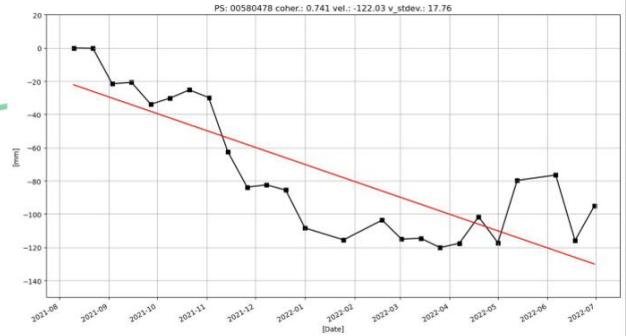
LiDAR



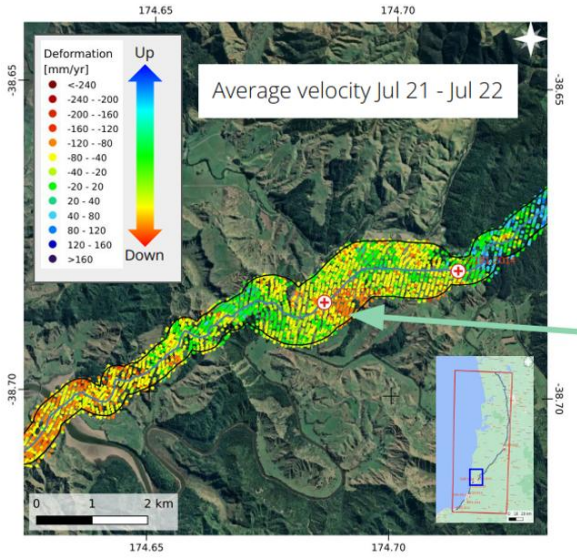
Results: detection of known motion (horizontal)



- LiveEO's InSAR analysis has correctly identified strong ground deformation threat (>10 cm/year) over a large area that is known to the client as a risk.



Results: detection of known motion (vertical)



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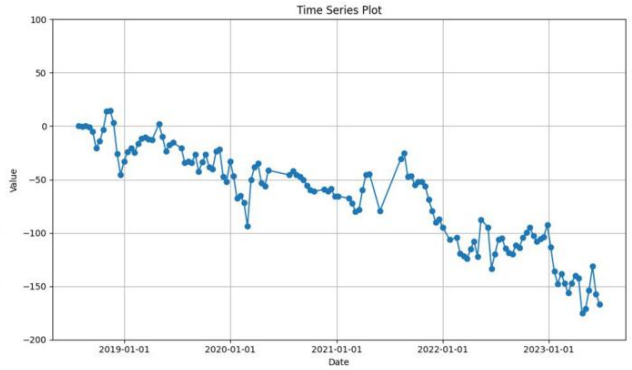
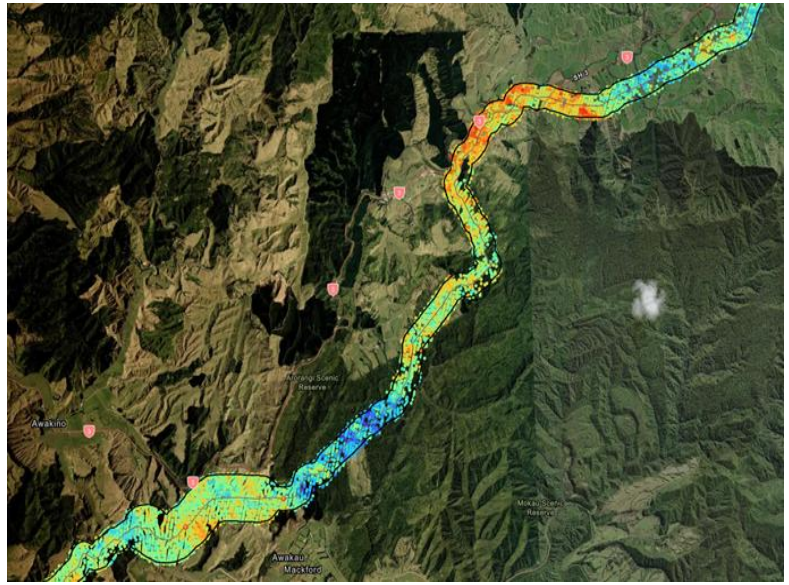
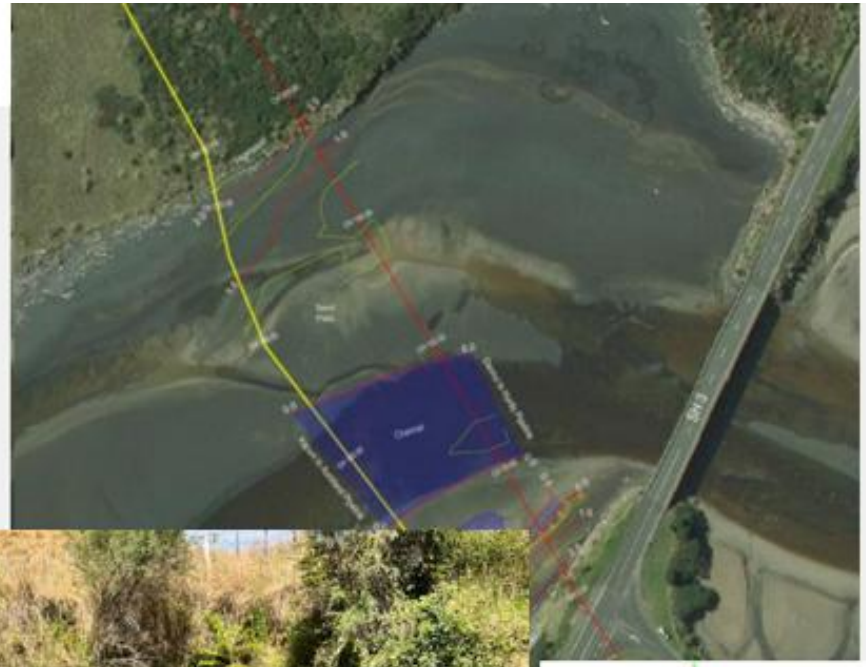
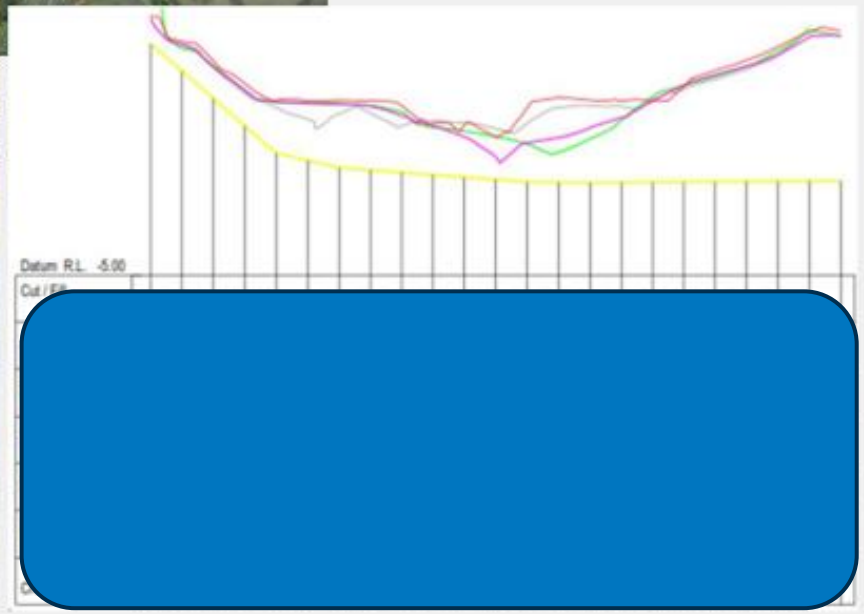




InSAR

What about underwater?





- ✓ **Pipeline depth**
- ✓ **Waterway bed profile**
- ✓ **Water levels**

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RESCUE PLAN – WORKING NEAR OR IN WATERWAY

Activity PIPELINE PTW 1(

Location MANGAKAKAHI RIVER GPS E11

Nearest Medical Centre BARRANO ST HEALTH CENTRE

Address 24 BARRANO STREET, RANGIVIARE Phone:...

Specific Roles

First Aider(s):...

Safety Watch(s

Person(s): DD

Safety or Specific Equipment

- Life Jacket
- Personal Locator Beacon (PLB)
- First Aid Kit
- Safety Line
- Safety Throw Rope
- Communications Equipment

SPECIFIC EQUIPMENT TO BE DETERMINED POST A VISUAL ONSITE ASSESSMENT ROVIEW OF THE CROSSING

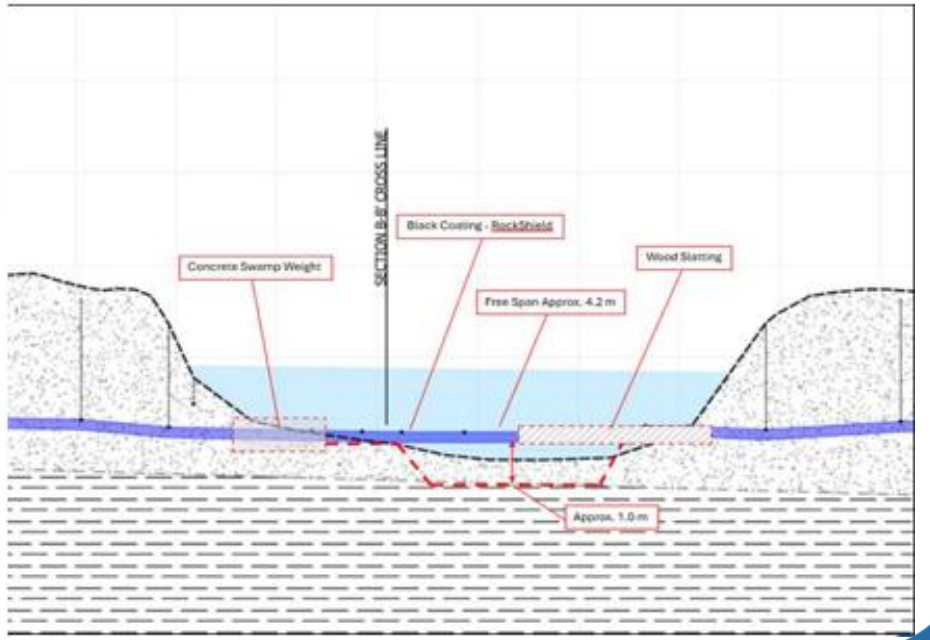
It is important for the individual to develop wading and capability awareness and ensure they work within those capabilities. To operate safely in a moving watercourse there are two key criteria to consider:

- water depth
- water velocity

Table 4 is an extract from NEMS Safe Collection of Environmental Data (Version 2.0.0 November 2024) which provides guidance for controls to minimise risk. These controls are based on ideal under-foot bed conditions and other environmental conditions.

Table 4 - Default guidance for controls for water depth and velocity

Surface velocity (m/s)	Depth				
	Slow	Knee	Mid-thigh	Full thigh	Over groin
>1.0	Single staffing	Single staffing with personal flotation device	Double staffing with personal flotation device	Double staffing with personal flotation device and throw bag	Double staffing with personal flotation device and throw bag
0.5 to 1.0	Single staffing	Single staffing Personal flotation device is discretionary	Double staffing with personal flotation device	Double staffing with personal flotation device and throw bag	Double staffing with personal flotation device and throw bag
<0.5	Single staffing	Single staffing	Single staffing with personal flotation device	Single staffing with personal flotation device	Single staffing with personal flotation device



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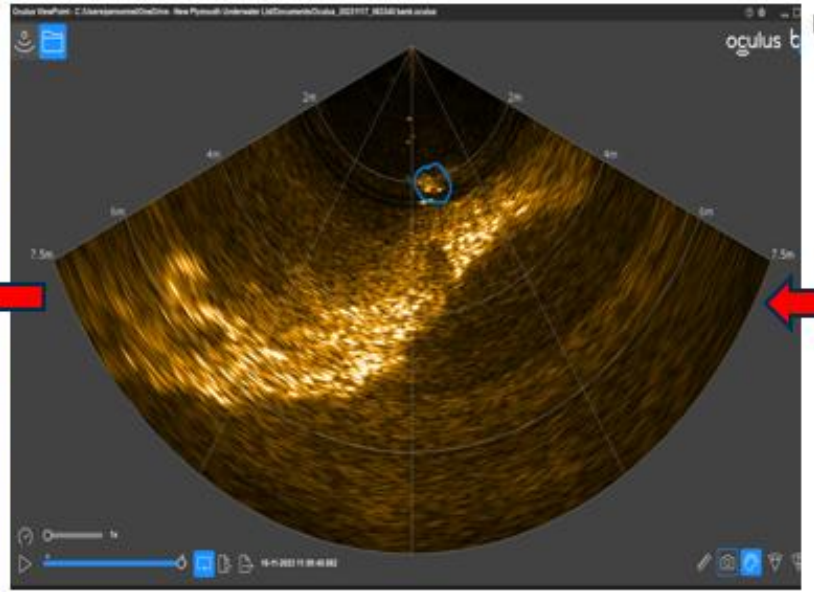
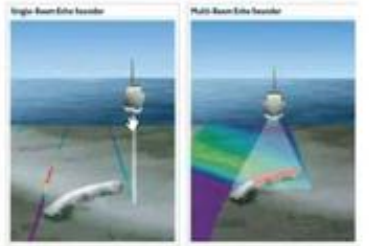
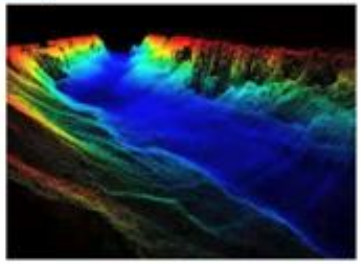
Unmanned Survey Vessel (USV)

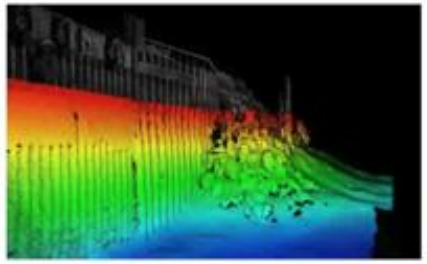
- ✓ **Sonar survey**
- ✓ **GPS survey**
- ✓ **Remote control**

Moving to USV with multibeam echosounder, side-scan sonar and water quality probes.









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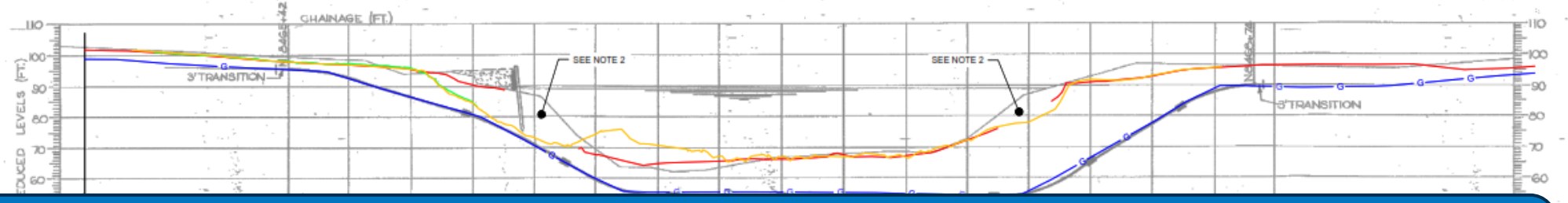

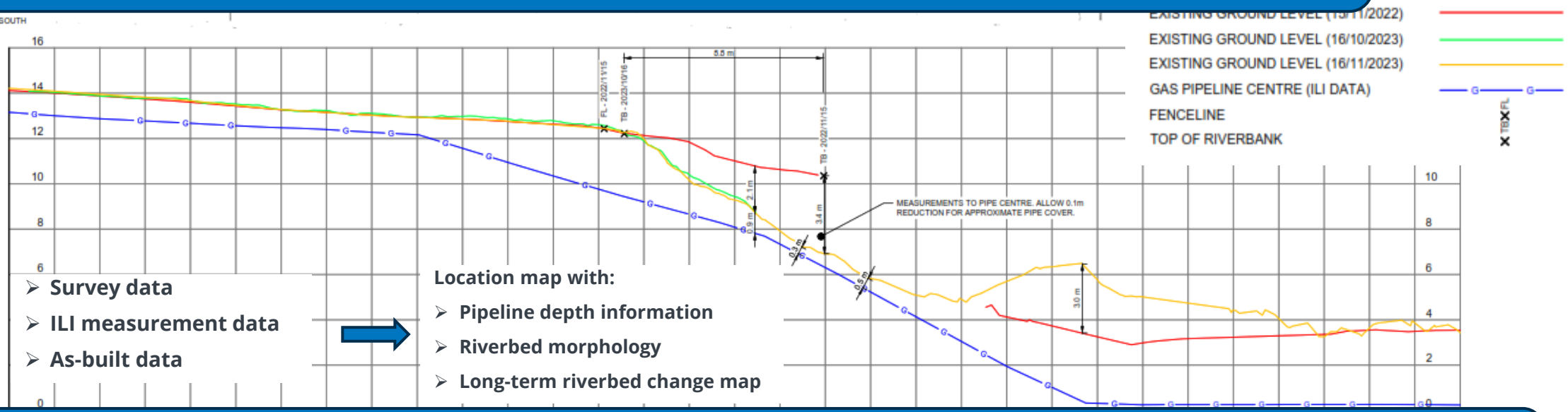

- Survey data
- ILI measurement data
- As-built data

Location map with:

- Pipeline depth information
- Riverbed morphology
- Long-term riverbed change map

What if erosion occurs?

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Controls / Mitigations are Risk-Driven Based

- Risk managed via FGL PIMP and PGMP
- Risk ranking to define the risk level (severity &frequency)
- Apply frequent monitoring depending on risk level
- Apply temporary or permanent remediation depending on different risk assessment and requirements

Remediation options are vary and case by case

Considerations and assessment factors

- Local Councils, Iwi and landowner's plan and requirements.
- Hydrogeological parameters and Ecological impact
- Access conditions
- Balance between geohazard risk and pipeline risk
- Pipeline remaining life, products design life and cost

Options

- ✓ **Sandbags**
- ✓ **HDPE (High-Density Polyethylene)**
- ✓ **Culvert**
- ✓ **Ripraps**
- ✓ **Materials and channel shifting**
- ✓ **Geofabric Sand Containers**
- ✓ **Concrete Slabs**
- ✓ **Concrete Mattress**
- ✓ **Realignment**
- ✓ **HDD**

- ✓ Farm drains / channels
- ✓ Low flow waterways
- ✓ Temporary protection

Hessian Sandbags

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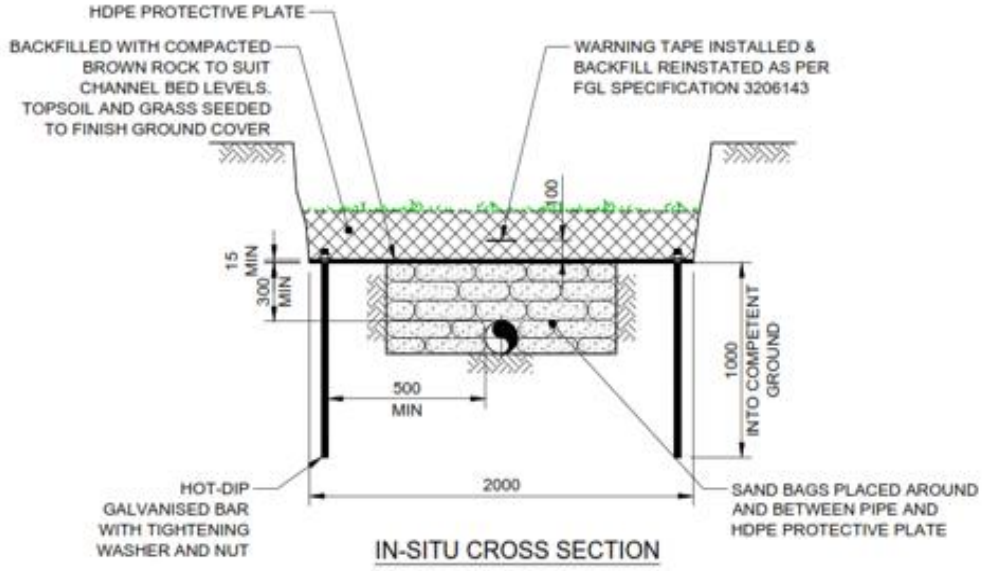
HDPE Protective Plate
(High-Density Polyethylene)

- ✓ Farm drains / channels when pipeline shallow
- ✓ Decomposition of partial farm activity loads
- ✓ Low cost and fast installation
- ✓ Low access condition requirement



IN-SITU CROSS SECTION

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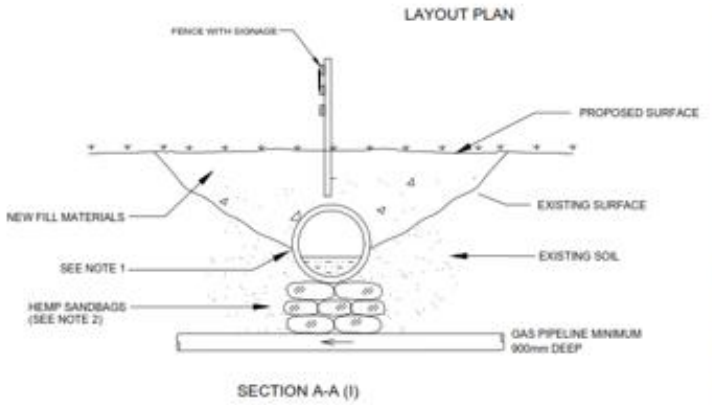

- **Ideal for shallowed pipeline in low flow and narrow waterways**
- **Ideal for farms drains or surface drains**
- **Big culverts at bigger waterways always require maintenance activity and inspection**

Culvert

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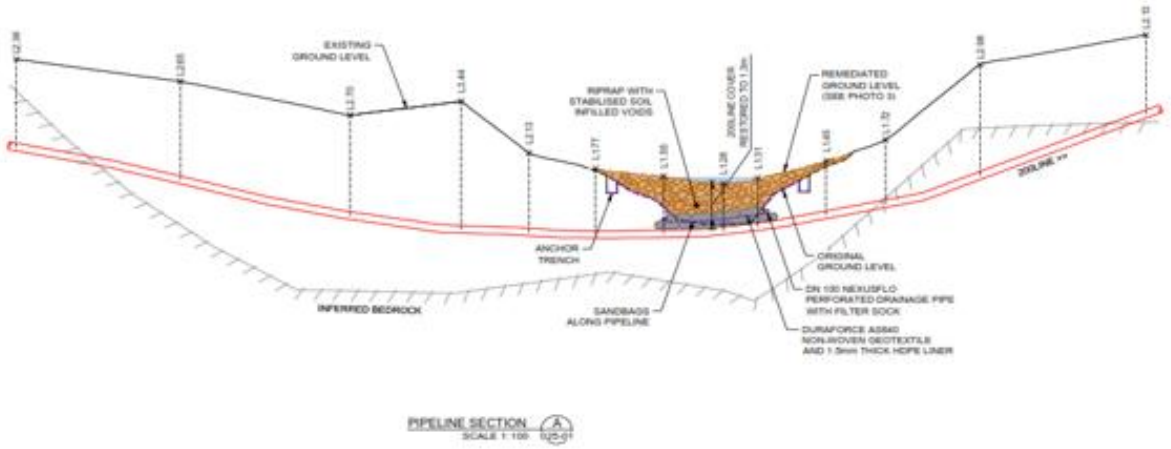
- Ideal for shallowed pipeline in NZ most waterways
- Often used together with concrete slabs / mattress
- Cost-effective and eco-friendly and low access condition requirement



PIPELINE SECTION A
SCALE 1:100

Ripraps

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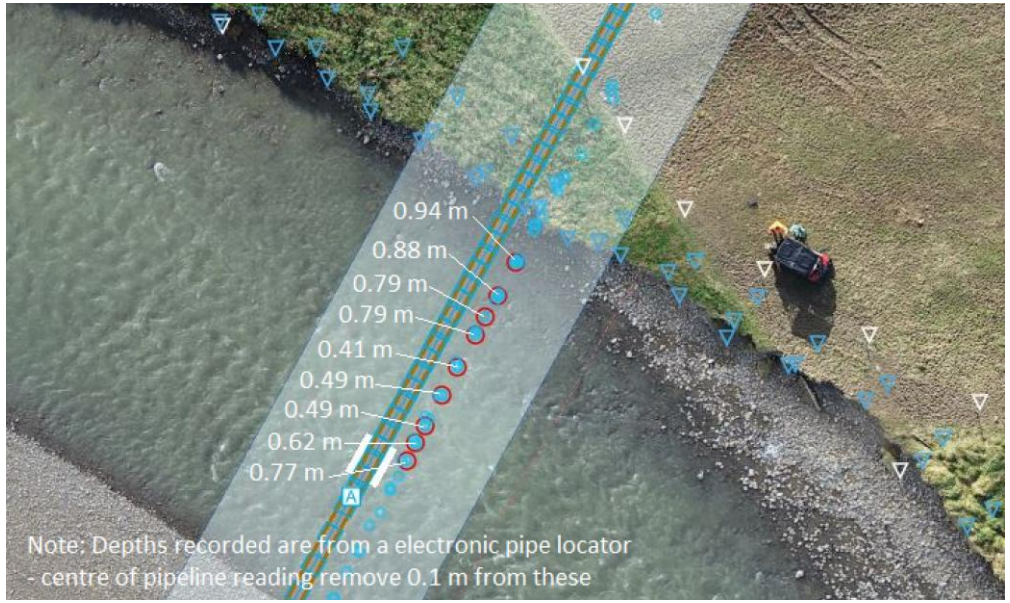
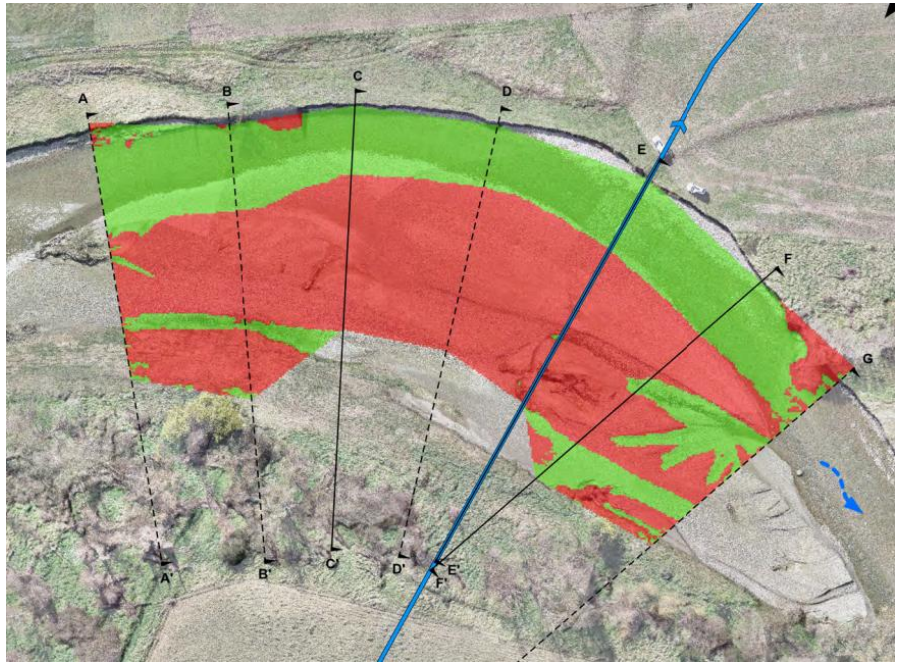
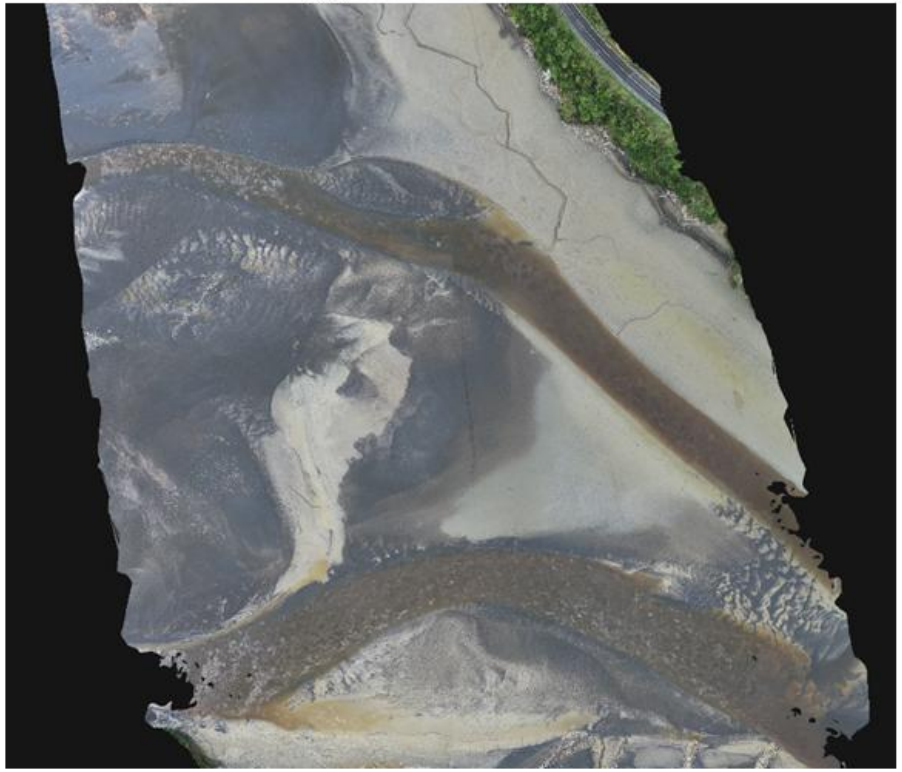
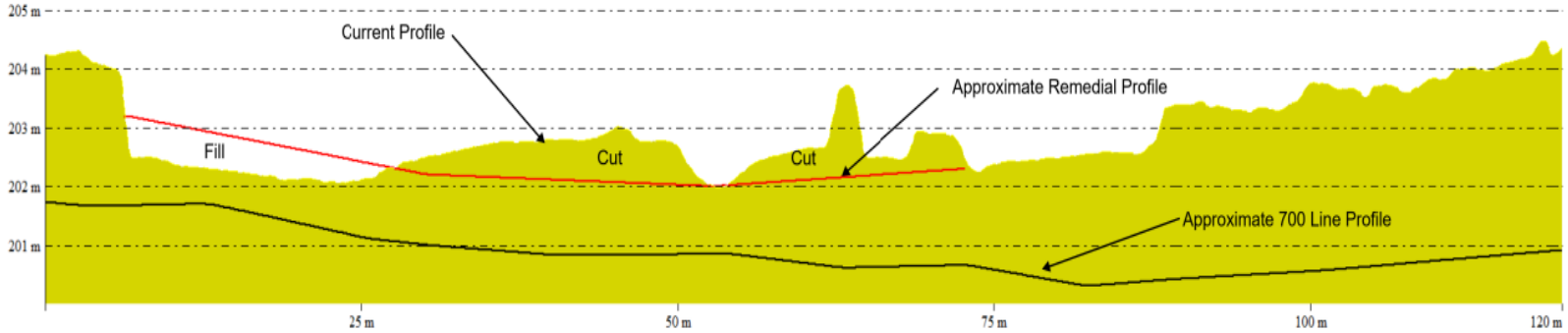




2024



2025



- Require waterway survey and river engineering assessment
- The degradation not severe and pipeline still have some DOC
- Cost-effective

Materials and channel shifting

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Geofabric Sand Containers

- **Ideal for non-gravel bed waterways**
- **Local material sources**
- **Cost-effective**
- **Design life over 20 years and UV proofing**

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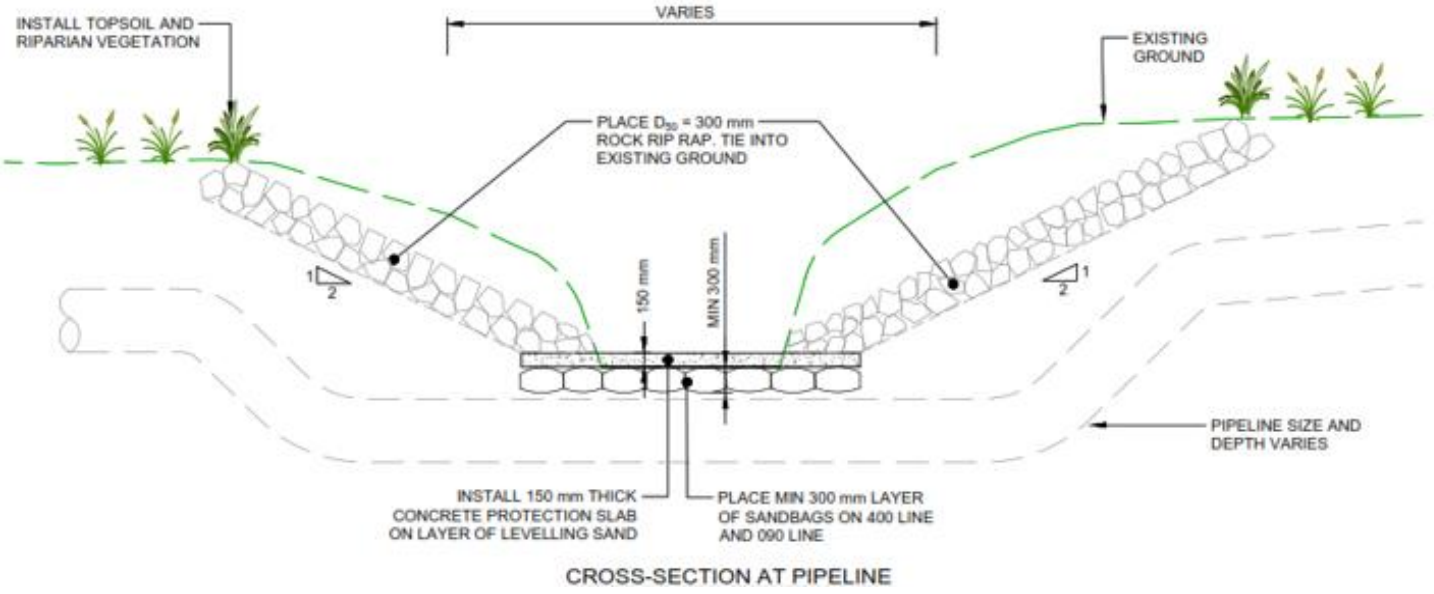
PHOTO 6: CONCRETE SLAB No.3 WITH ANGLE

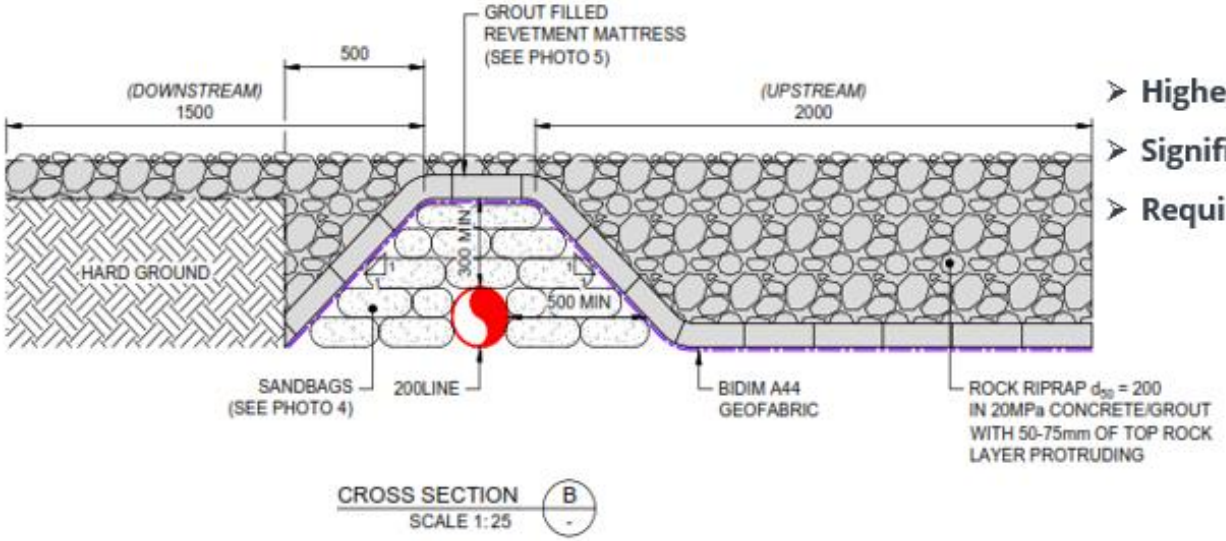


CROSS-SECTION AT PIPELINE

- Can provide solid physical protection
- Acceptable DOC below the standard

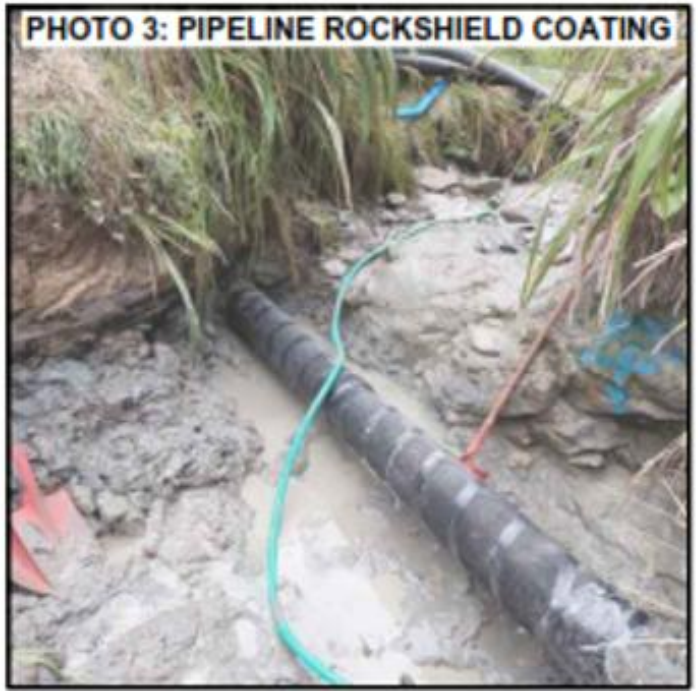
  Total DOC 450mm=300mm + 150mm
- Ideal for exposed pipeline protection
- Ideal for gravel bed waterways
- Ideal for significantly degraded waterways
- Require good access conditions

Concrete Slabs



CROSS SECTION B
SCALE 1:25

- Higher cost
- Significant earthworks
- Require good access conditions



Concrete Mattress

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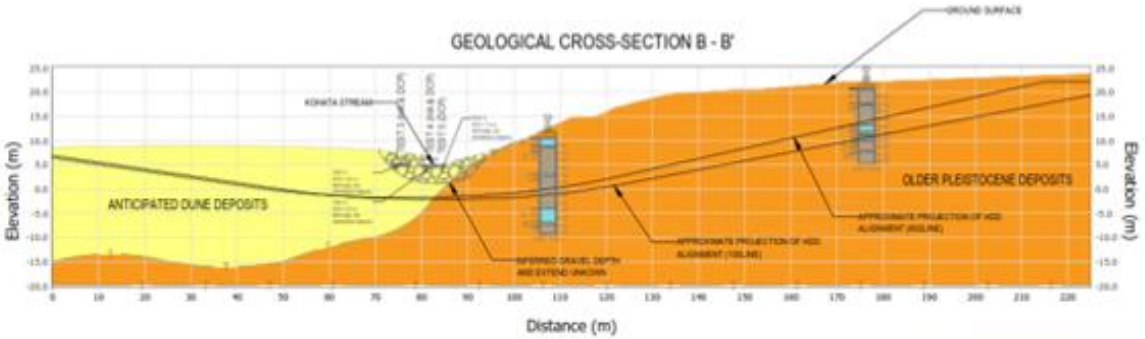
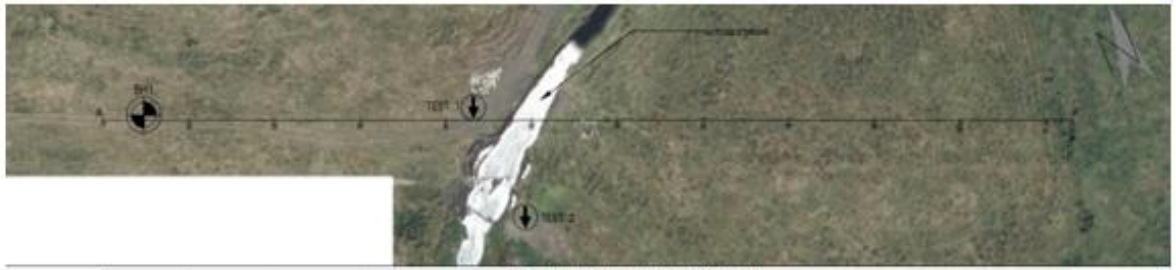
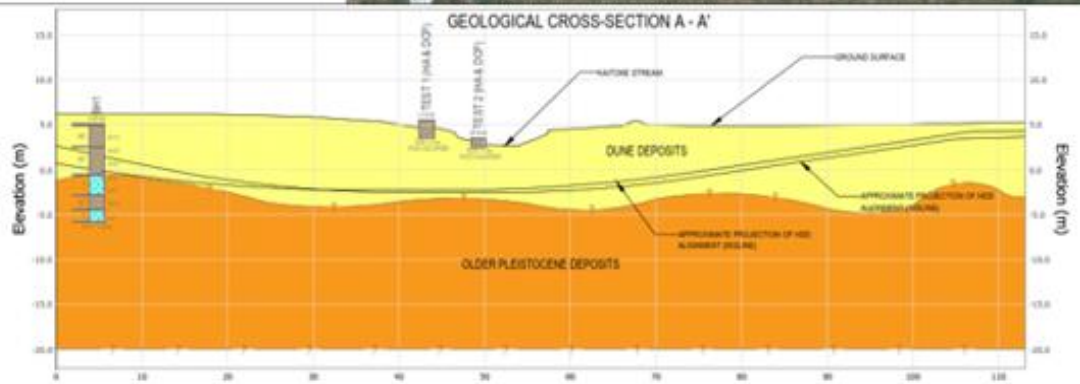
- Banks stability
- Cost efficiency
- Geohazard risk

Realignment







- **Long distance stream/riverbed degradation and composed of soft materials.**
- **Waterway channel always changeable due to erosion.**
- **Common geotechnical remediation solution cannot prevent the recurrence.**
- **Geohazard risk level still high and unacceptable (Score 19 = Major + Unlikely).**

Thank you

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