

Modeling Pipelines Risk from Ground Movement - Case Studies

Operations Technology Development (OTD)

PHMSA R&D Forum - Preventing & Mitigating Geo-Forces on Pipelines & Facilities Working Group

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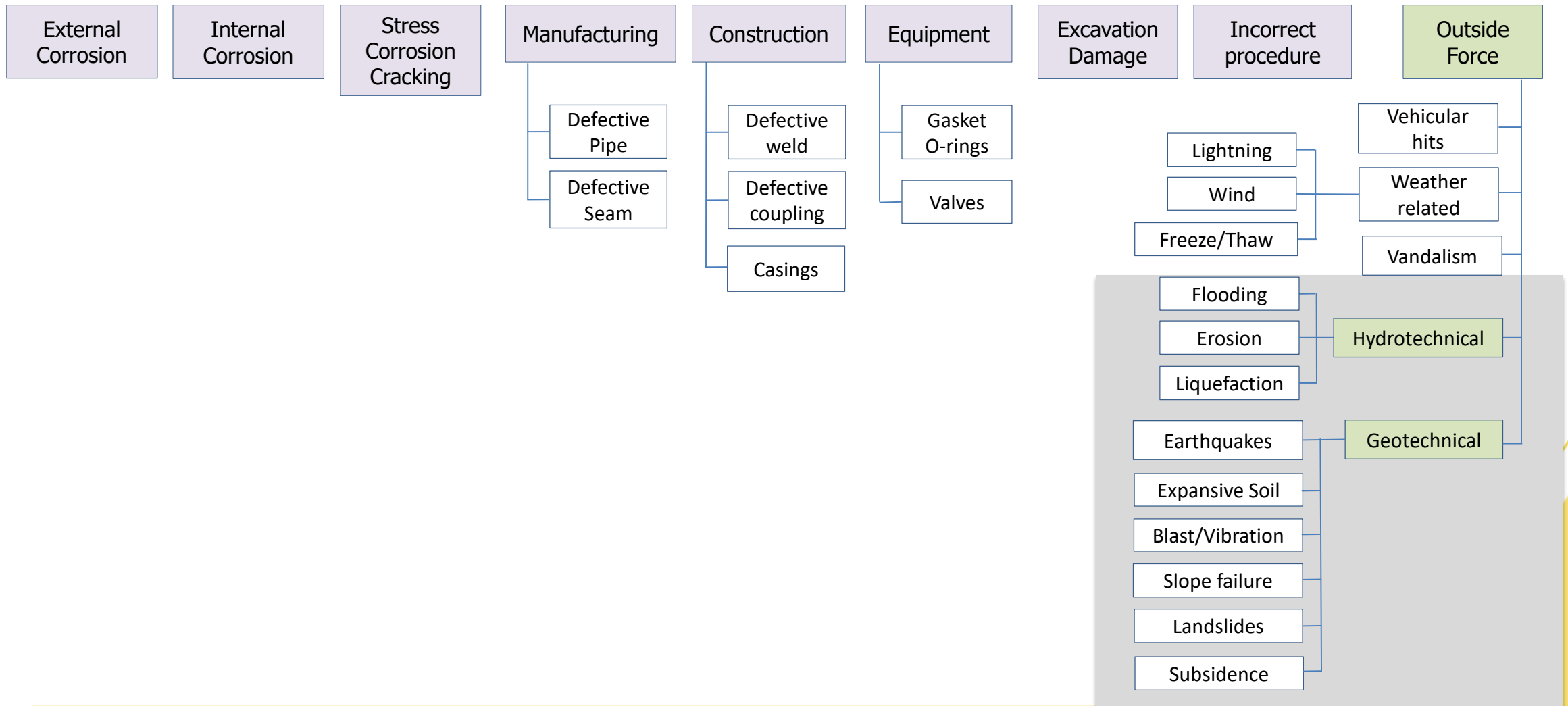
February 19, 2020

Operations Technology Development - Overview

- Established 2003
- Not-for-profit, member-controlled company where gas utilities work together to develop technology solutions to common issues
- New projects selected by members based on needs
- Each member votes their own dollars to specific projects
- All members have access to all project information.



Primary Threat Events



Scope of Presentation

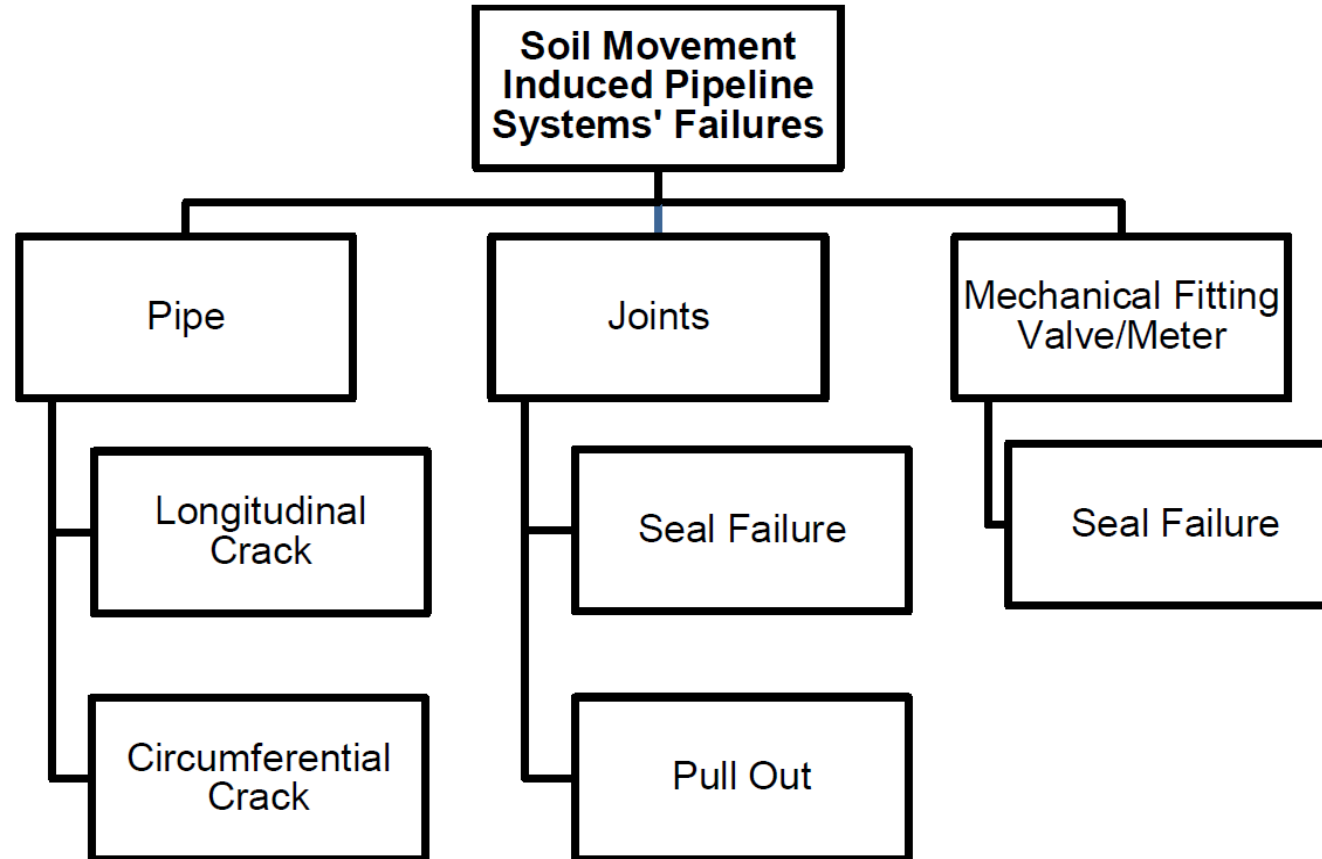
A risk ontology approach for assessment of 'Geo-Forces' on pipelines

Case studies of the application to the risk ontology approach for:

- Assessment of pipeline risk resulting from hurricane force (flooding, erosion, soil movement)
- Pipeline risk resulting from expansive soils potential.

The case studies demonstrate the risk ontology and is not meant to cover all the parameters associated with these threats and consequent damage potential.

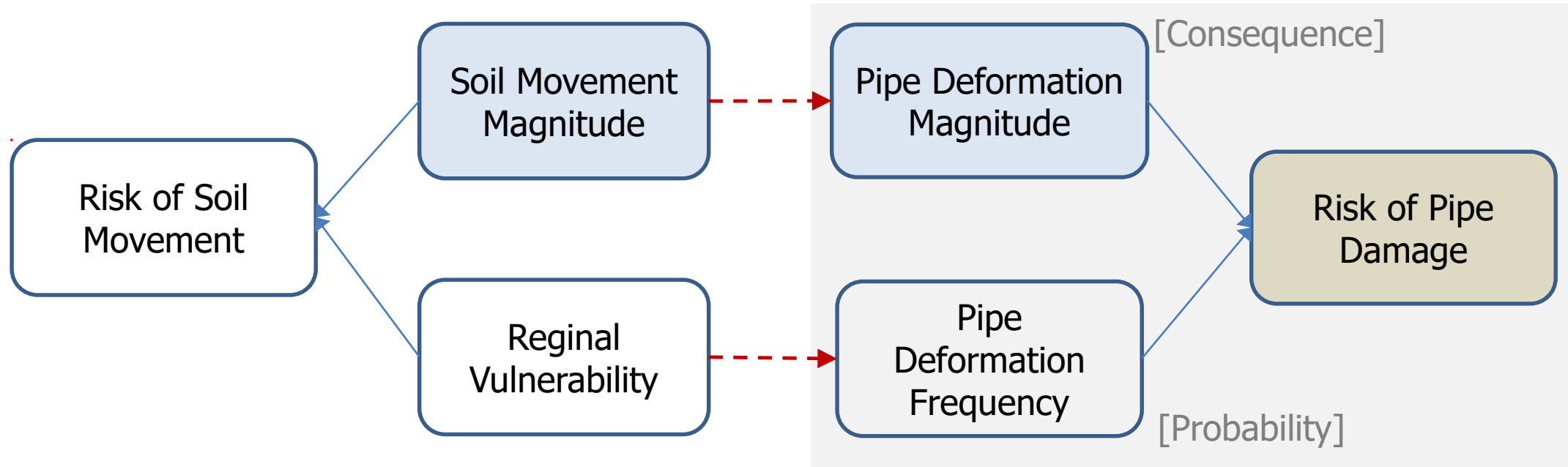
Pipeline Failure Modes from Soil Movement



Pipeline Risk to Ground Movement

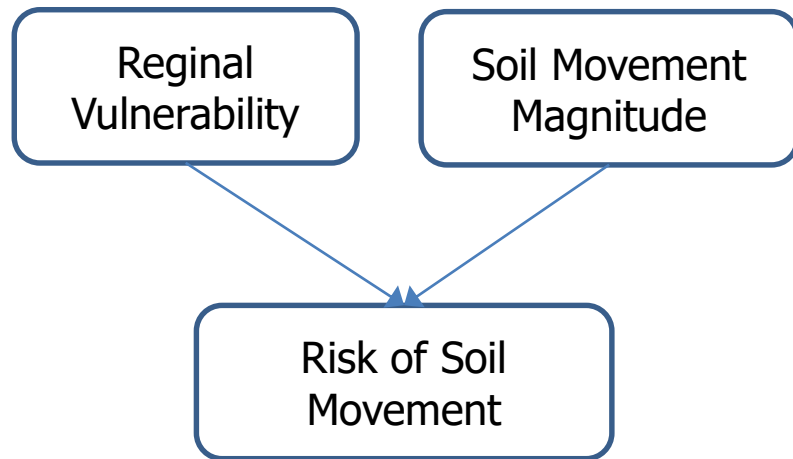
Primary Threat Event [Soil Movement]

Damage to Pipelines

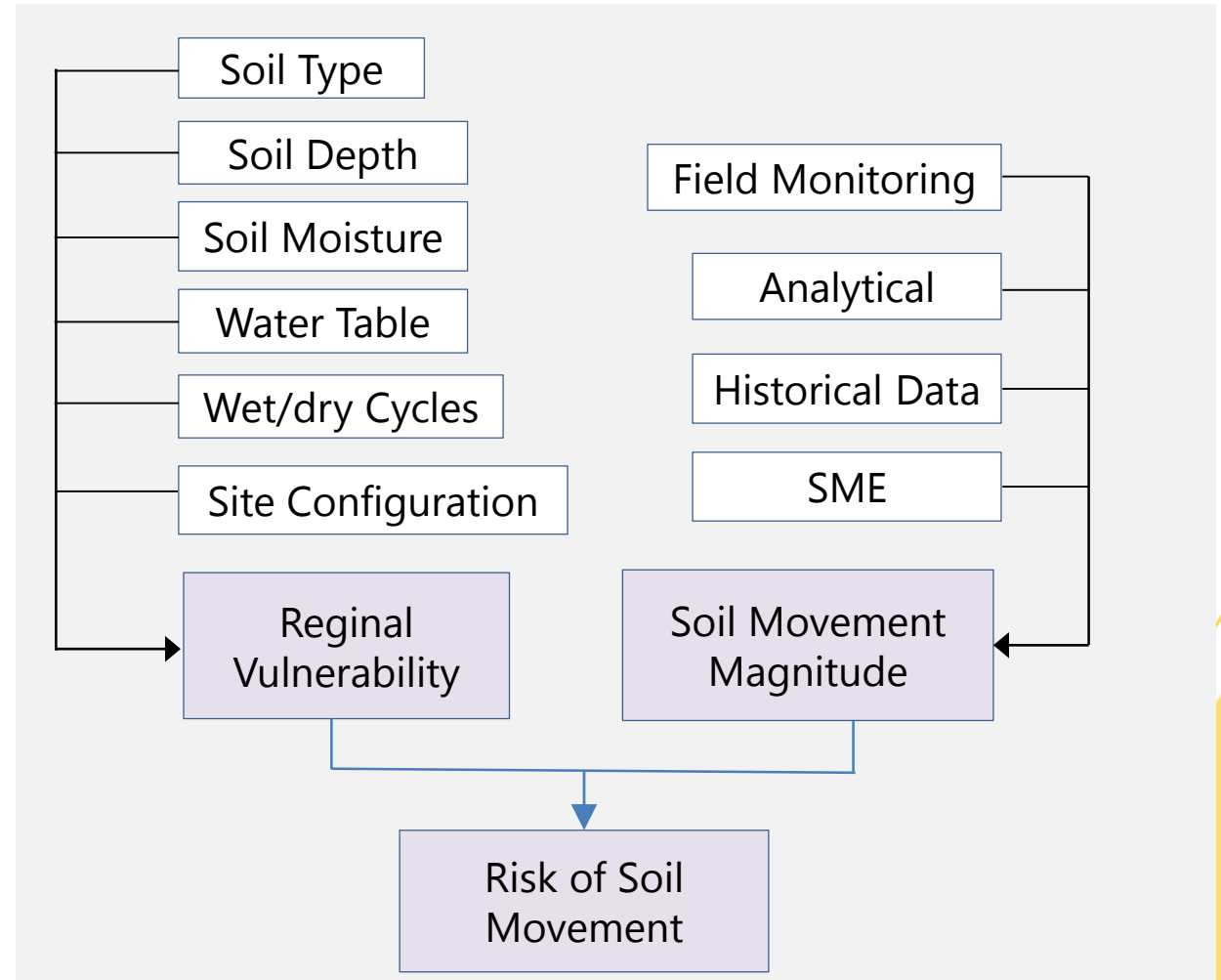


Layout of Soil Risk Ontology

Primary Threat Event [Soil Movement]

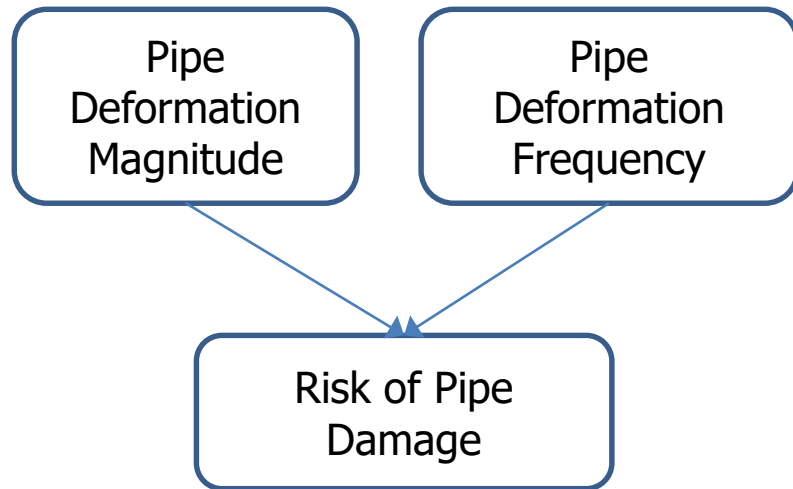


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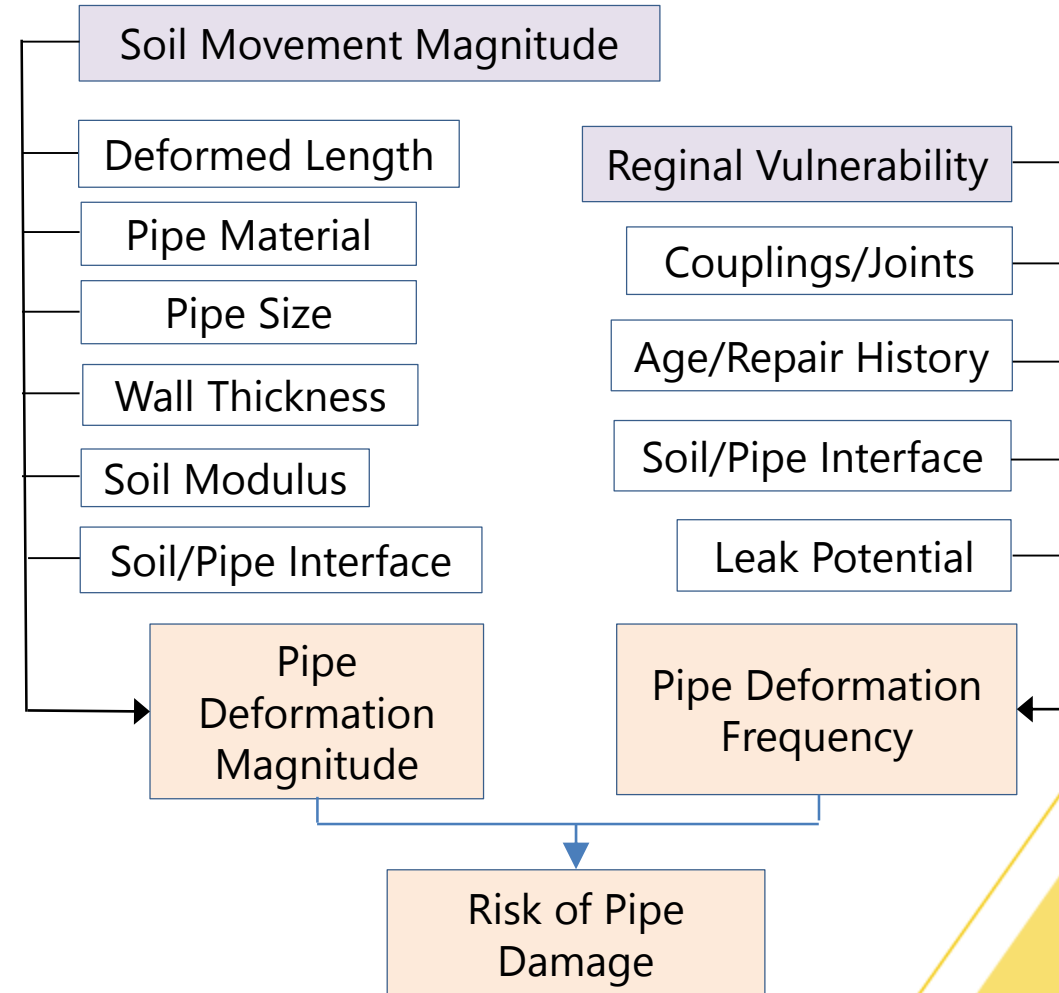


Layout of Pipe Risk Ontology

Damage to Pipeline



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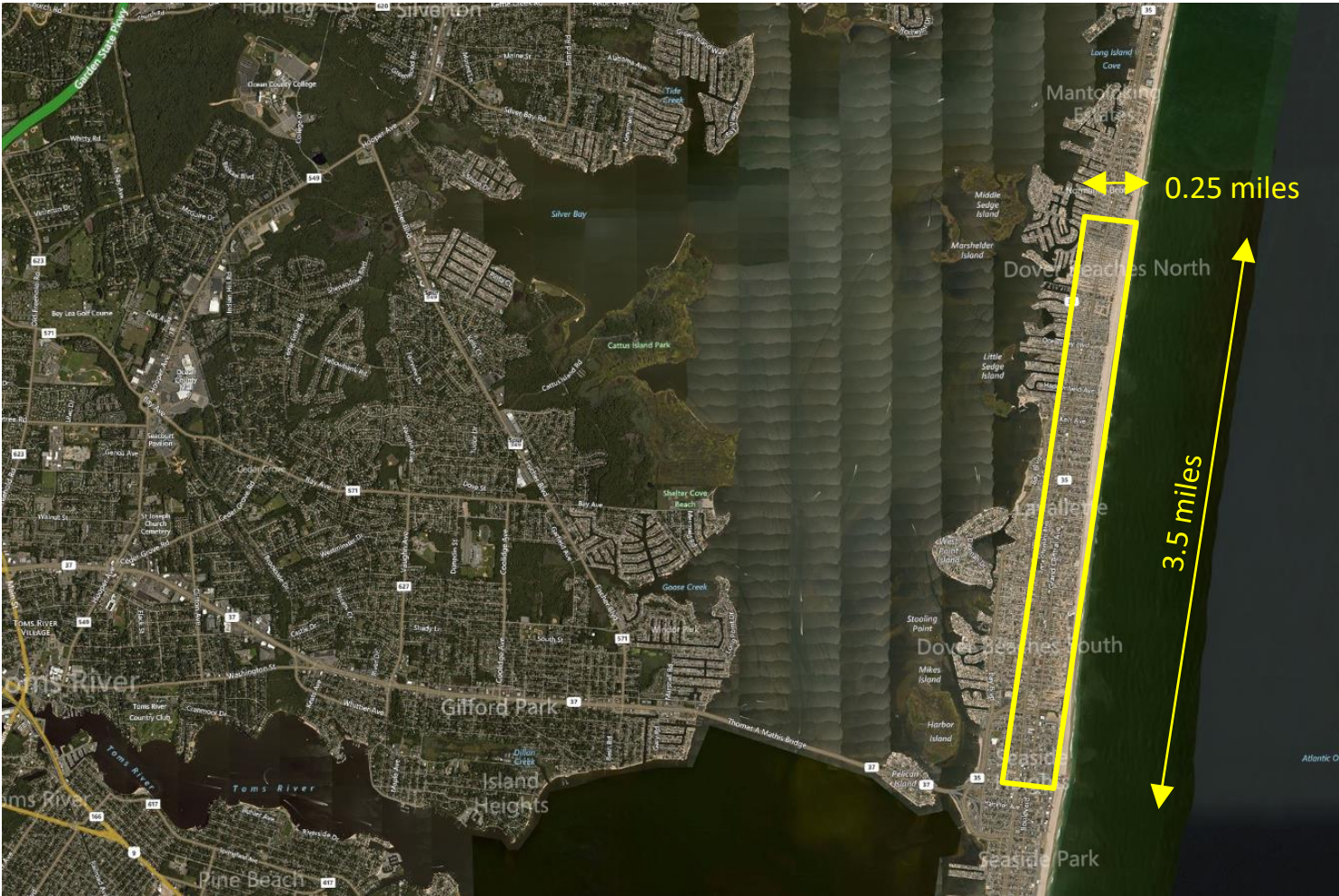
a) Pipeline Risk After Hurricane Sandy



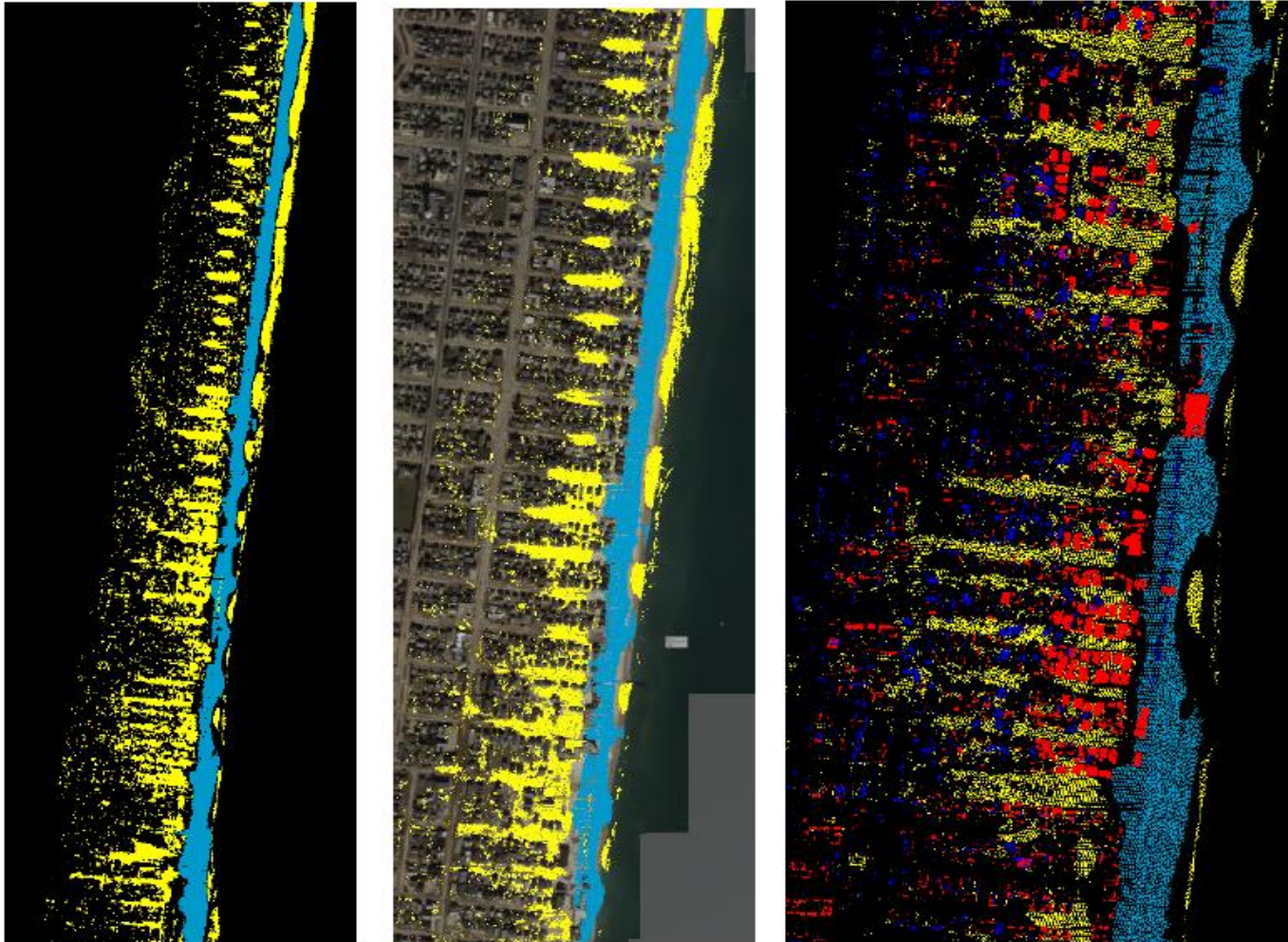
Application to Post-Hurricane Sandy



Buried Pipes Assessment – Ortley Beach



Debris Field and Flow at Ortley Beach



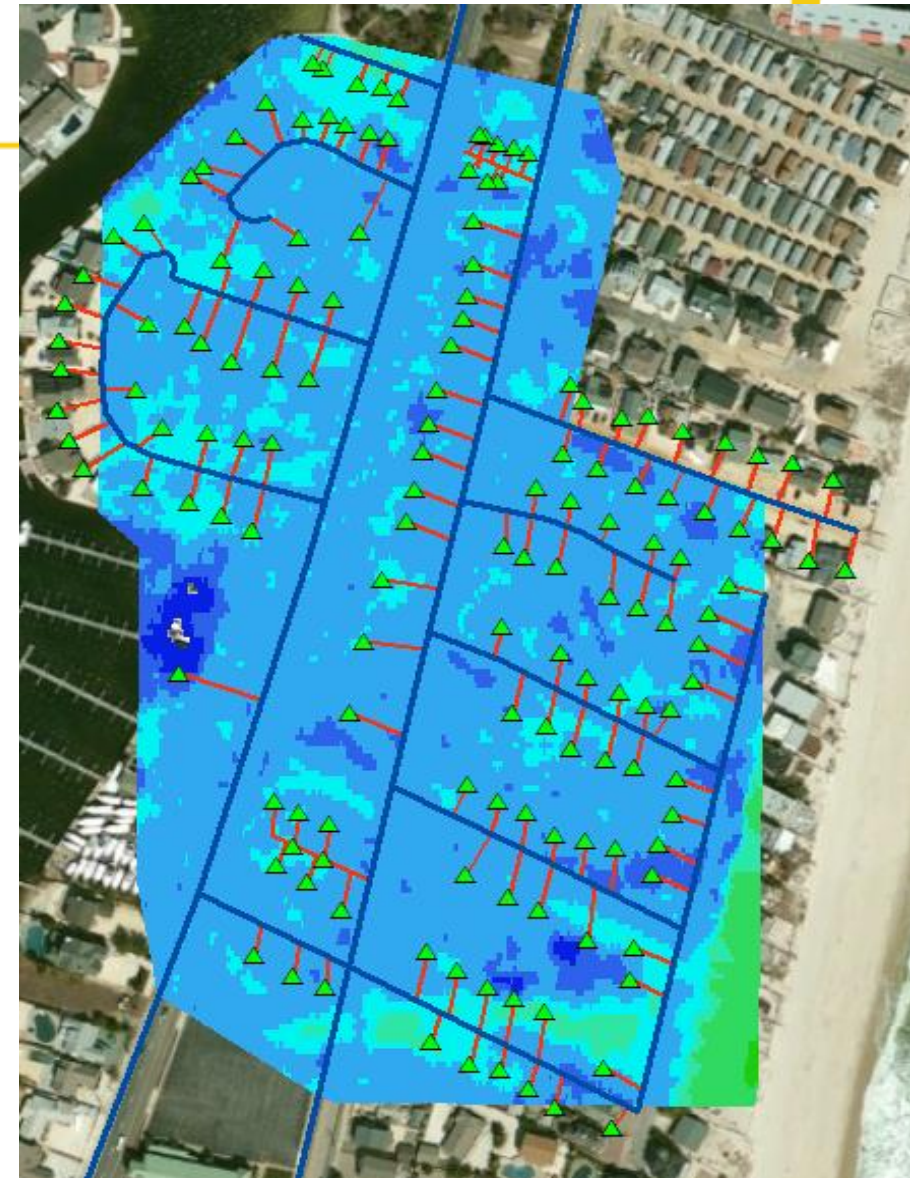
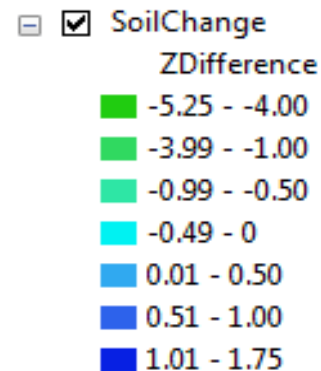
- **Yellow:** Sand Debris
- **Cyan:** Erode Dunes
- **Red:** Destroyed Buildings
- **Blue:** Building Debris or Changes

Soil Movement Magnitude

[LIDAR Data]

Spatial Changes in soil elevation before and after Sandy.

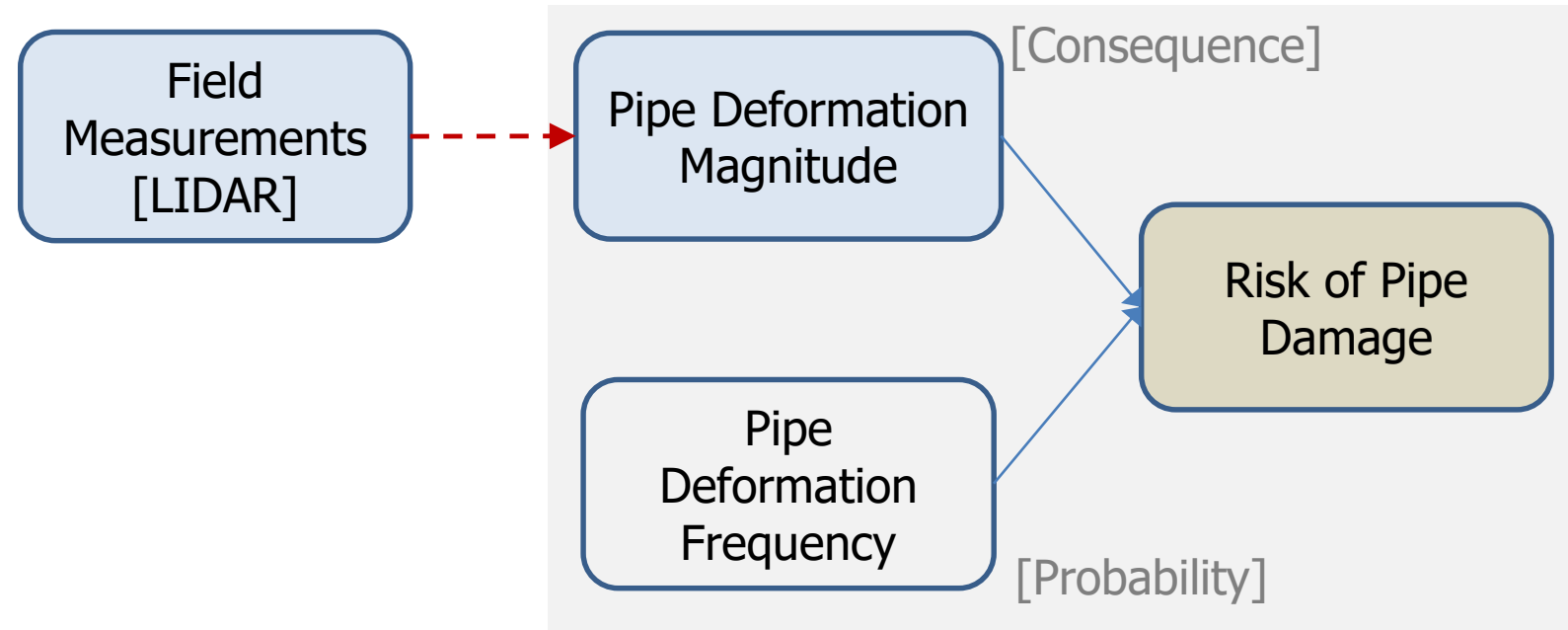
[Note: Z in the figure is in meters]



Pipeline Risk to Ground Movement

Primary Threat Event
[Soil Movement]

Damage to Pipelines



Modeling Pipe-Soil Bayesian Analysis

File Edit View Favorites Tools Help

gti Pipeline Assessment After Large Soil Movement

Gas Technology Institute

Version 1.1

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Enter user name and password

User Name:

Password:

For New users:
Contact gasoperationsinfo@gastechnology.org
to request a User ID and a Password.

gti Pipeline Assessment After Large Soil Movement

Gas Technology Institute

Version 1.1



Data Entry Page

Pipe Material

- Plastic Pipe
- Steel Pipe
- Cast Iron Pipe

Line Type

- Service Lines
- Mains

Pipe Size

- <= 1 inch
- < 4 inch
- 4 to 6 inch
- >= 6 inch

Mechanical Coupling

- Yes
- No
- Unknown

Soil Type

- Sand
- Silt & Clay
- Unknown

Depth of Cover

Leak History

- Low Rate
- Medium Rate
- High Rate

Soil Movement

Horizontal Displacement:

Vertical Displacement:

Length of displaced soil:

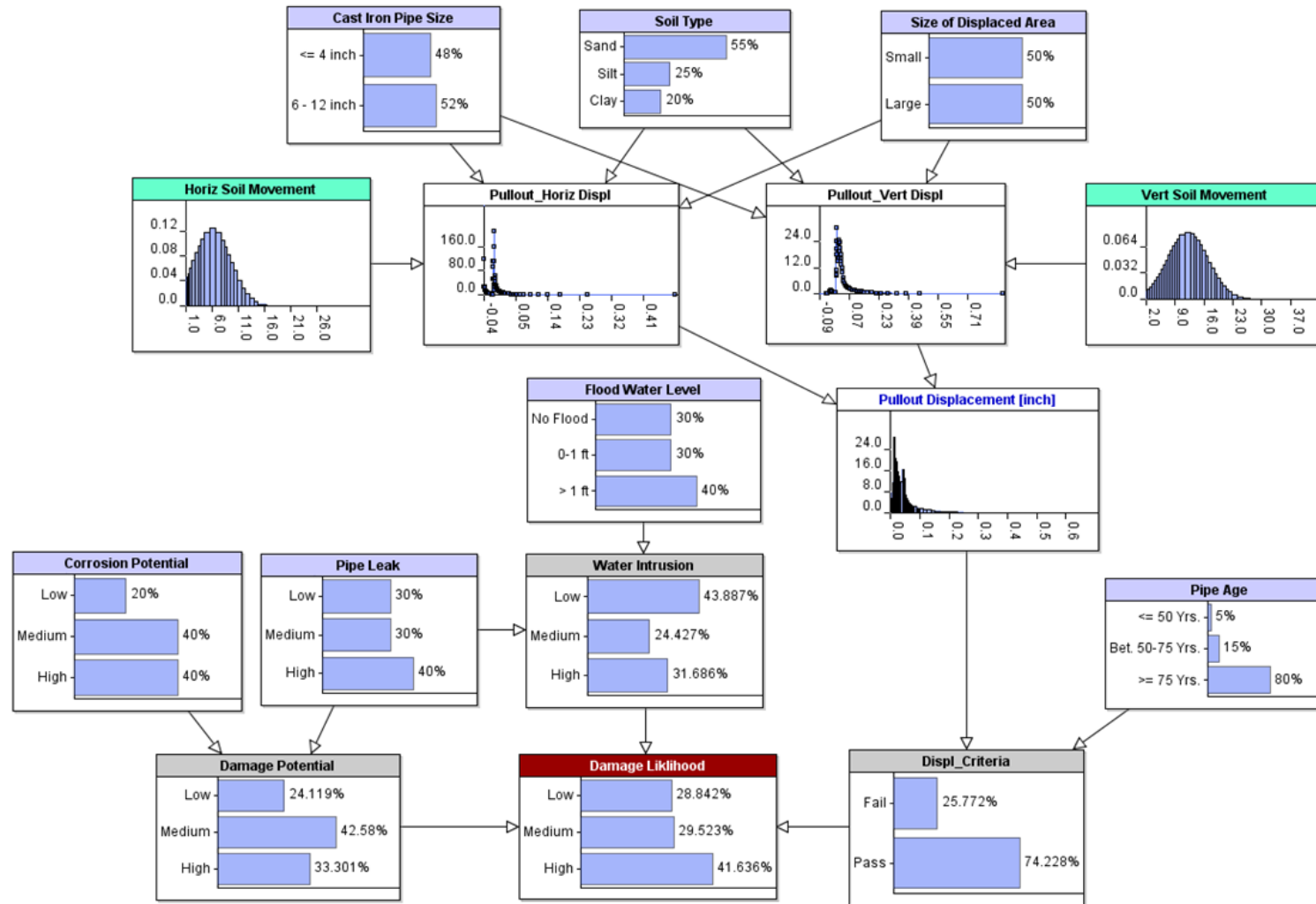
Flood Water Level

- No Flood
- 0-6 ft
- > 6 ft

Run

Please click on 'Run' Button to run program - Allow 15-20 sec. for the results

Modeling Pipe-Soil Bayesian Analysis

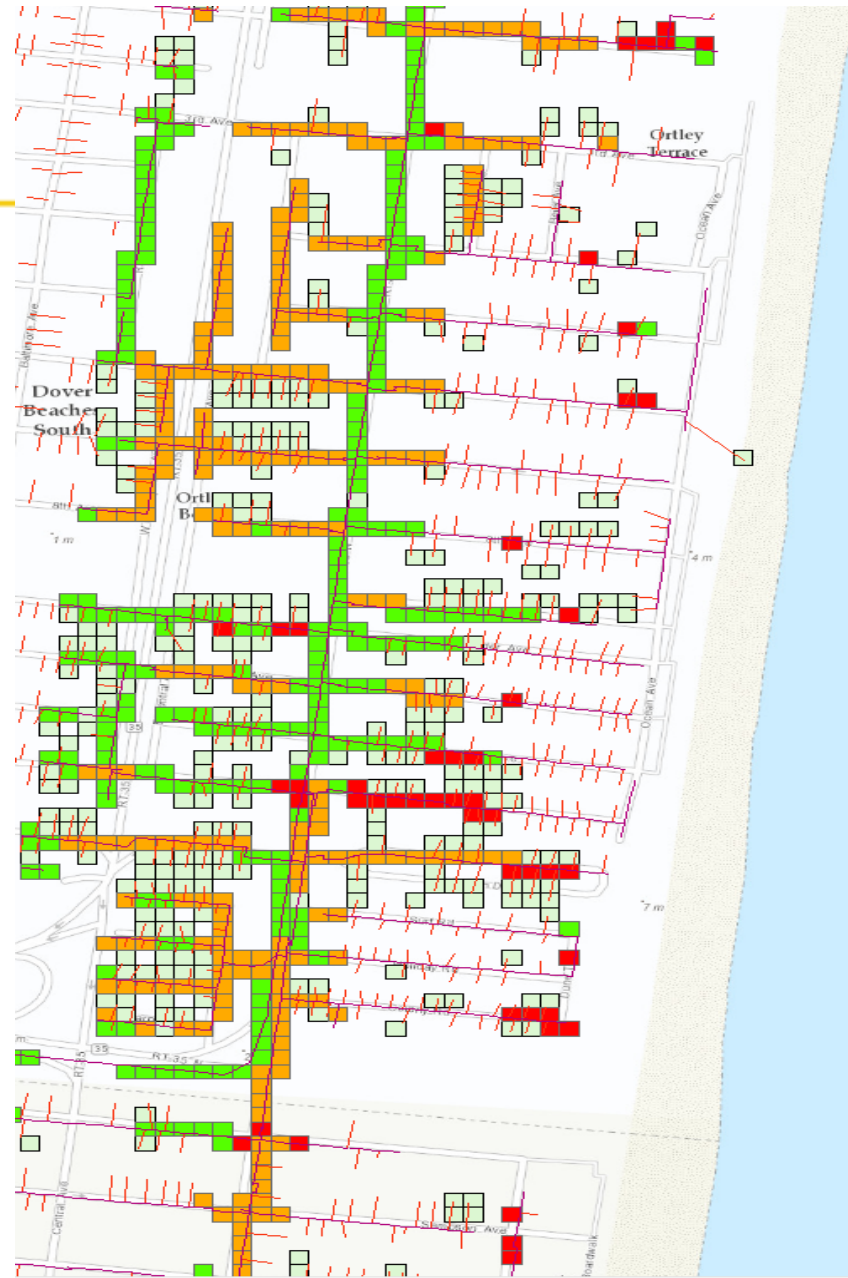


Risk of Pipe Damage

Risk model output in a GIS grid:

Damage Likelihood:

- High
- Medium
- Low



Development Needs

- Systems/sensors to monitor soils movement magnitude
- Establish risk ontology of soil and pipe parameters
- Analytical procedures to estimate pipe response to soil movement
- Integrated approach of field measurement, historical data, and analytics to estimate pipe deformation (or strains) frequency and magnitude
- Risk verification.