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Reinventing tomorrow.

Seismic Piping 101

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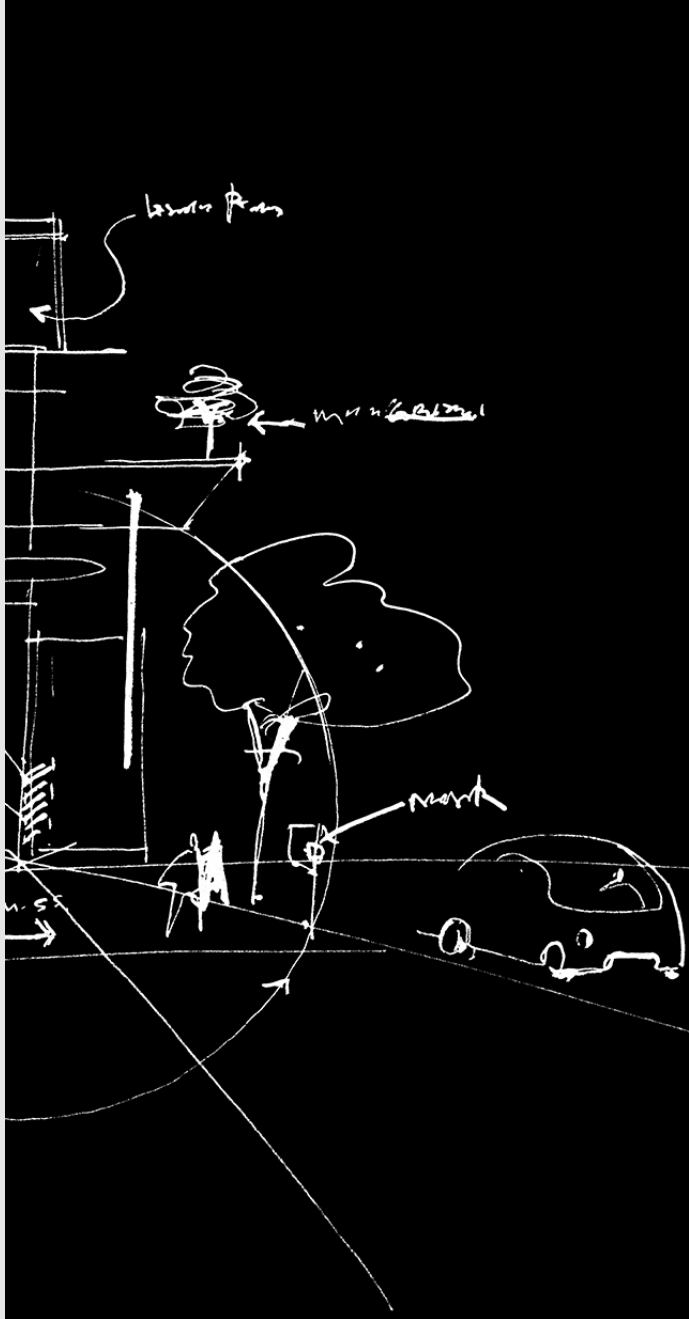
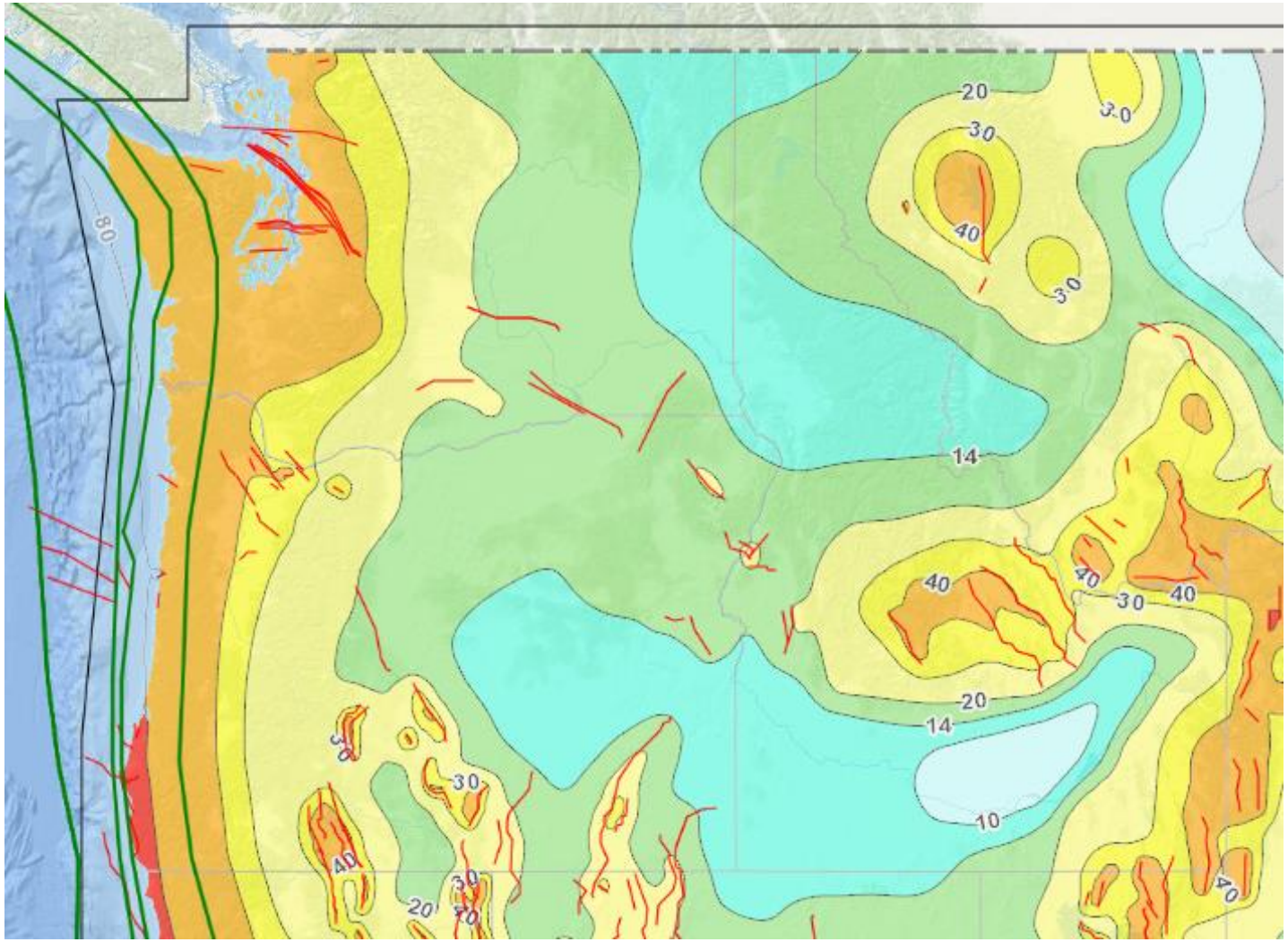
Seismic Risks Overview

Why Seismic Piping

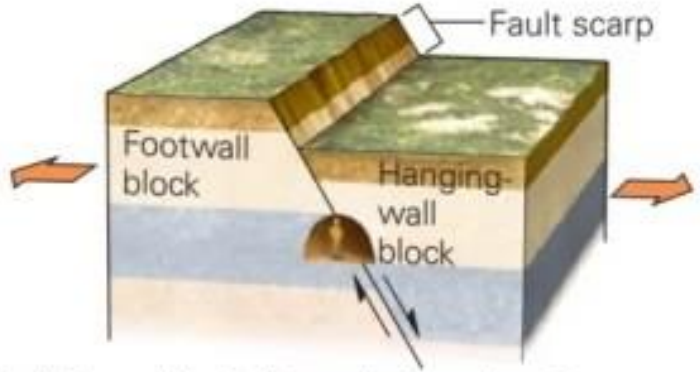


Seismic Risk Overview

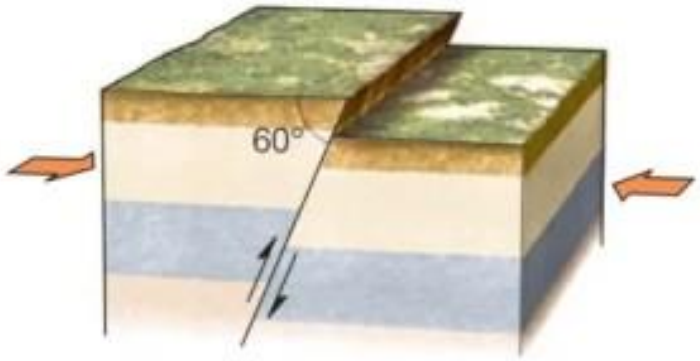
USGS 2014 Seismic Hazard Map



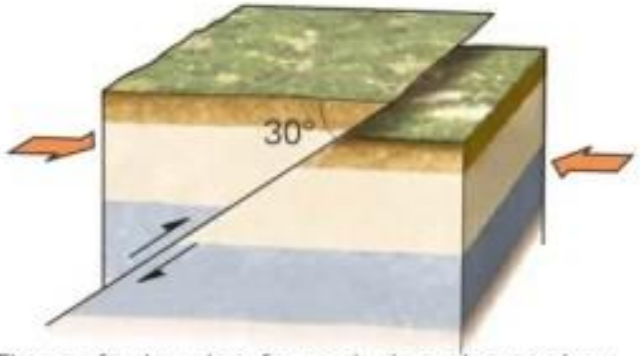
Types of Faults



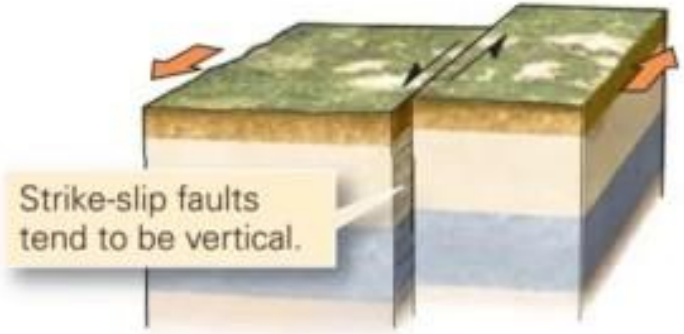
(a) Normal faults form during extension of the crust. The hanging wall moves down.



(b) Reverse faults form during shortening of the crust. The hanging wall moves up and the fault is steep.



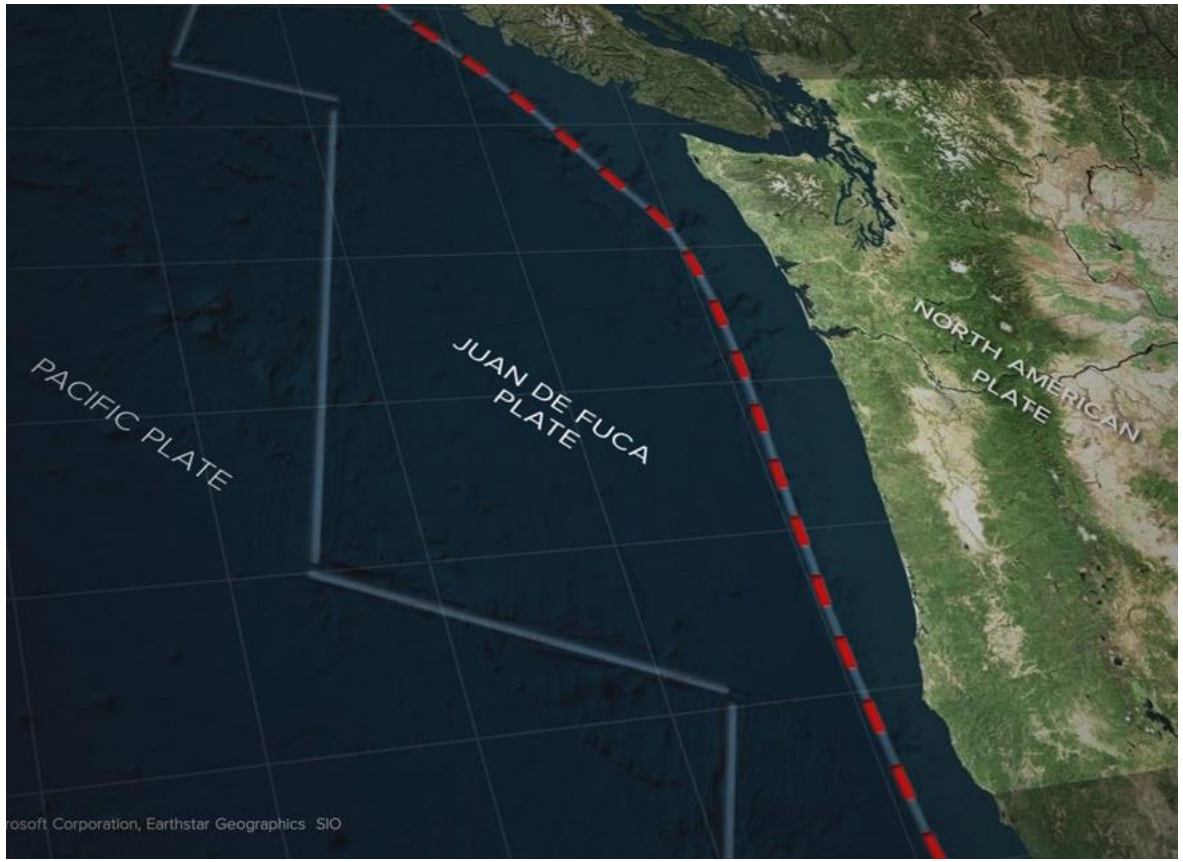
(c) Thrust faults also form during shortening. The fault's slope is gentle (less than 30°).



(d) On a strike-slip fault, one block slides laterally past another, so no vertical displacement takes place.

Name the Famous Faults

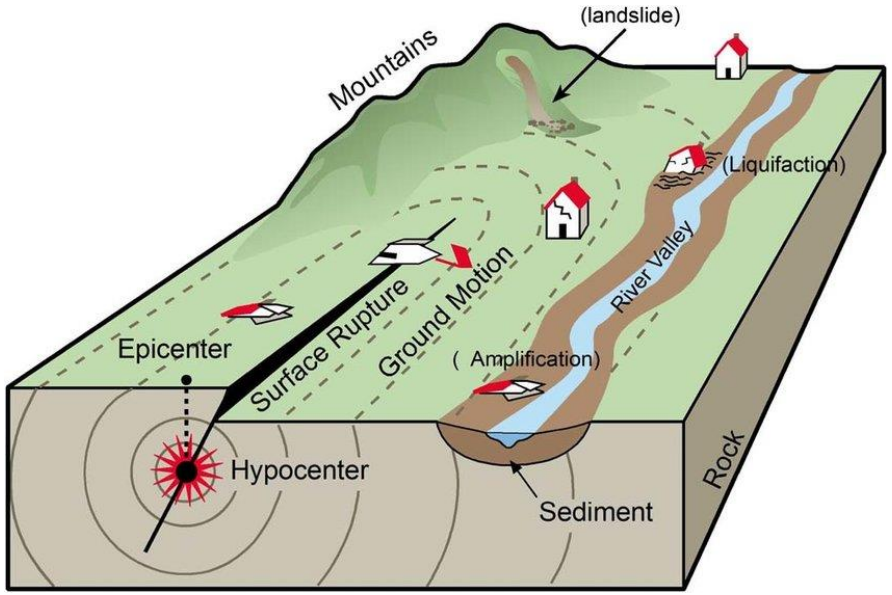
San Andreas Fault, California

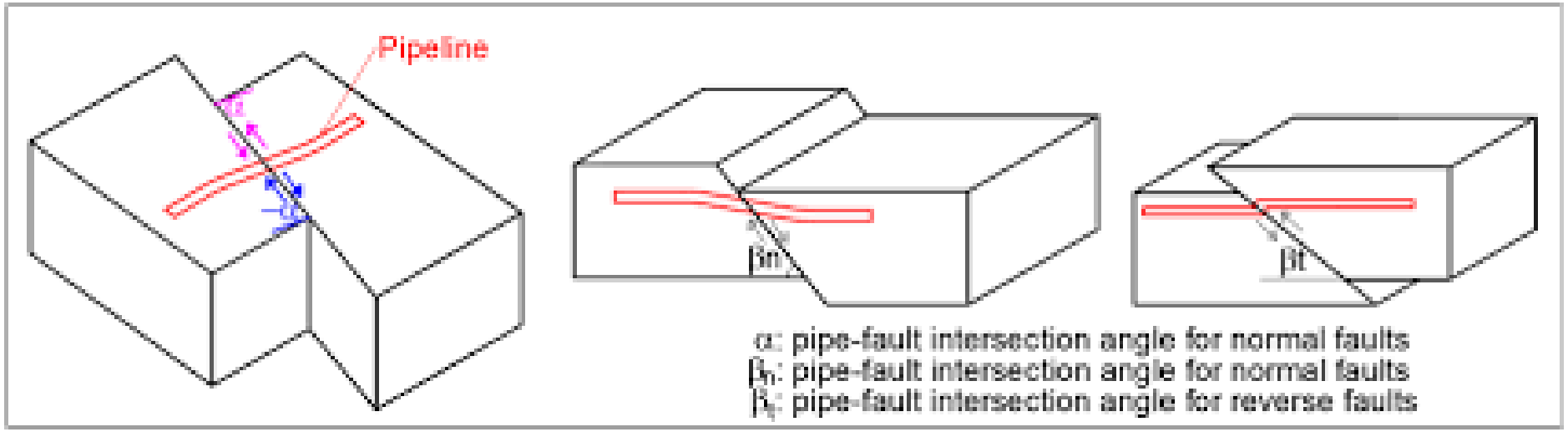


Cascadia Subduction Zone

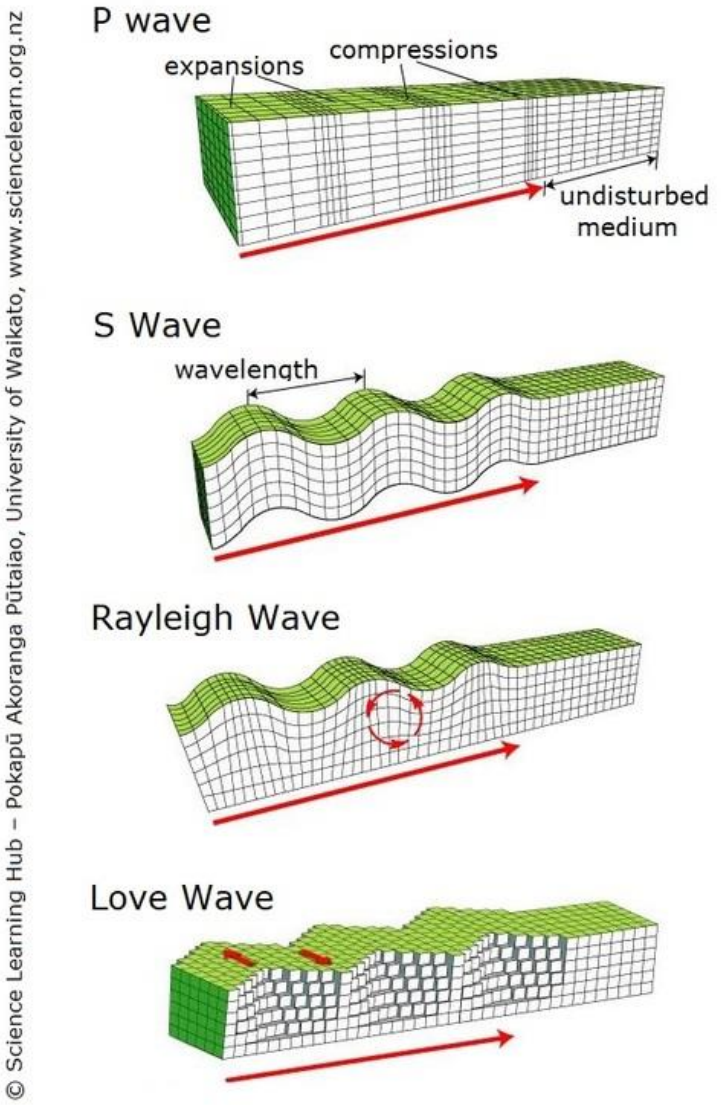
Ground Movement

- Surface Rupture
- Faulting
- Ground movement
- Permanent Ground Deformation
- Liquifaction

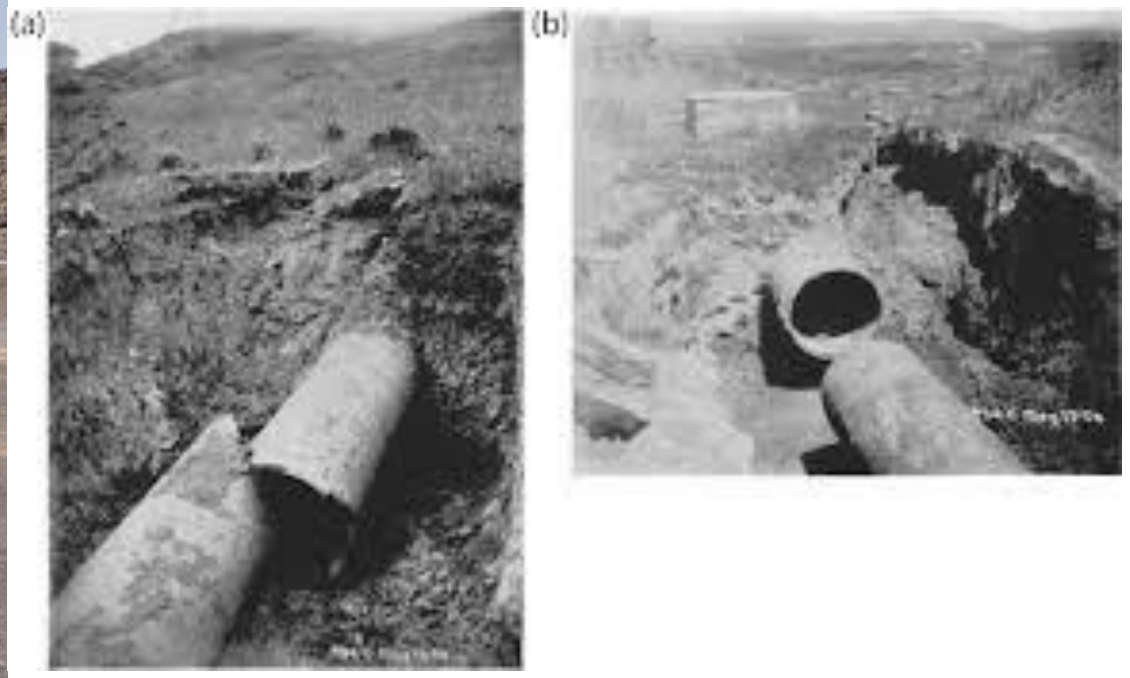




Ground Shaking



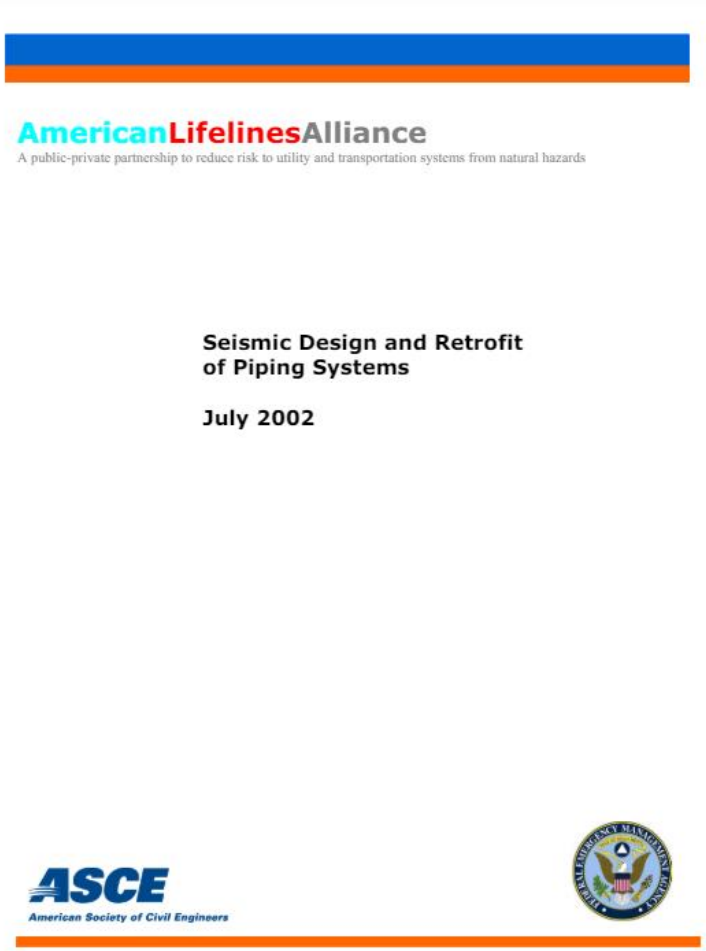
Faulting & Permanent Ground Displacement

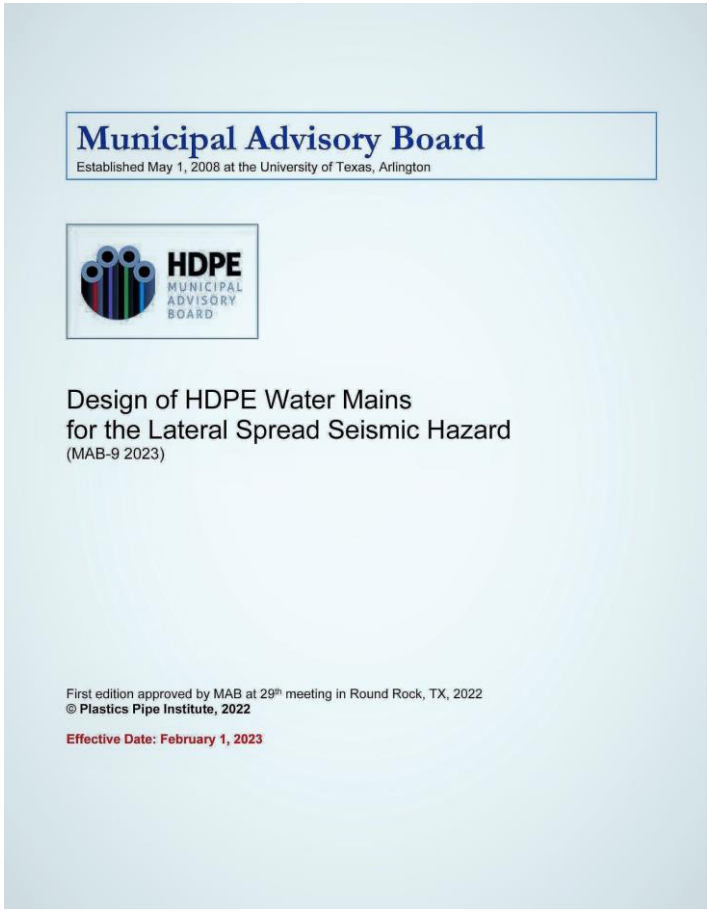


Liquefaction

Guidance on Seismic Design

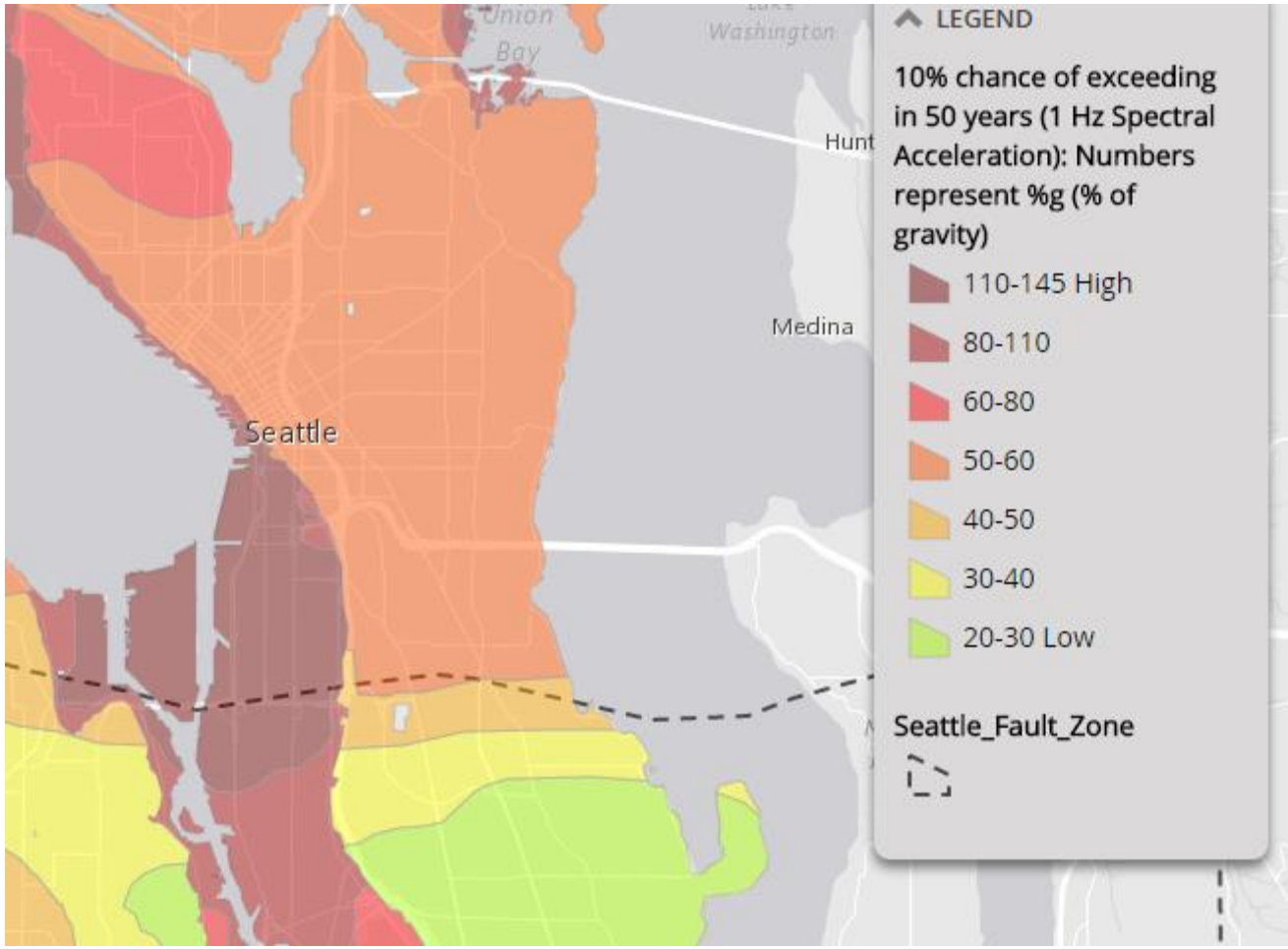
Guidance on Seismic Design





Guidance on Seismic Design

- Understand soils and anticipated ground movements
  - Likelihood and return interval of seismic events
  - Peak ground acceleration
  - Amount of permanent ground deformation
  - Direction and type of faulting
  - Direction and amount of lateral spreading
  - Depth of soil liquefaction



Develop Design Criteria

- How much movement
- Direction of movement
- Ground water table & depth
- Depth constraints (shallow utility crossings)
- Contaminated media
- Criticality

Survivability

- Survivable: Pipeline survives seismic event and continues to function.

Survivability vs. Serviceability

- Serviceability: Pipeline is immediately serviceable and able to be modified as needed by operations crews.

Practical Seismic Design

Ground Shaking

- Restrained joints (not wedge restraint glands)
  - TR-FLEX
  - Flex-Ring

- Welded joints
  - Steel (lap and full butt welded)
  - HDPE
  - PVC

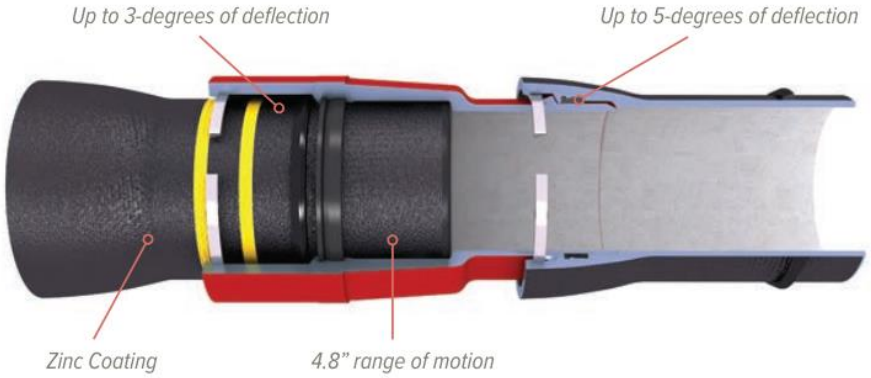
- Fittings
  - Manufacturer Restrained Joint Fittings
  - Flanged?

Deformation causing extension or compression of system

- Ex-tend

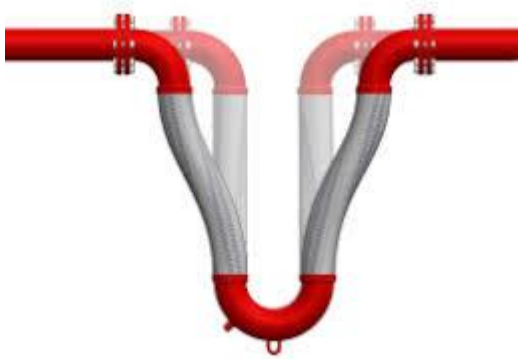
- Geometry

- Joint movement

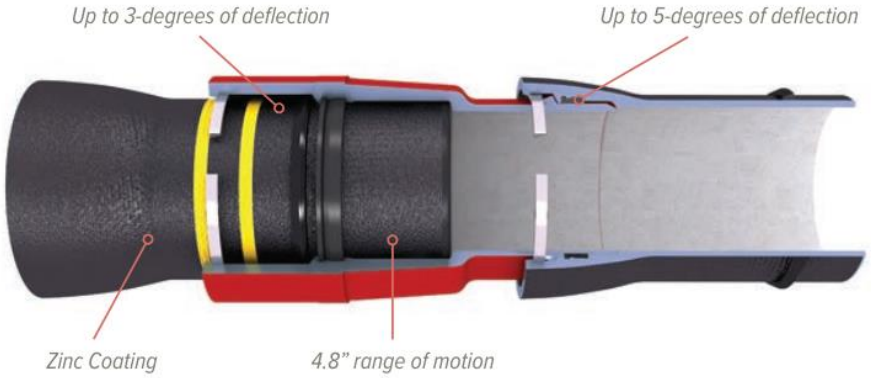


Deformation causing multi-access movement

- Flex-tend



- Geometry
- Joint movement



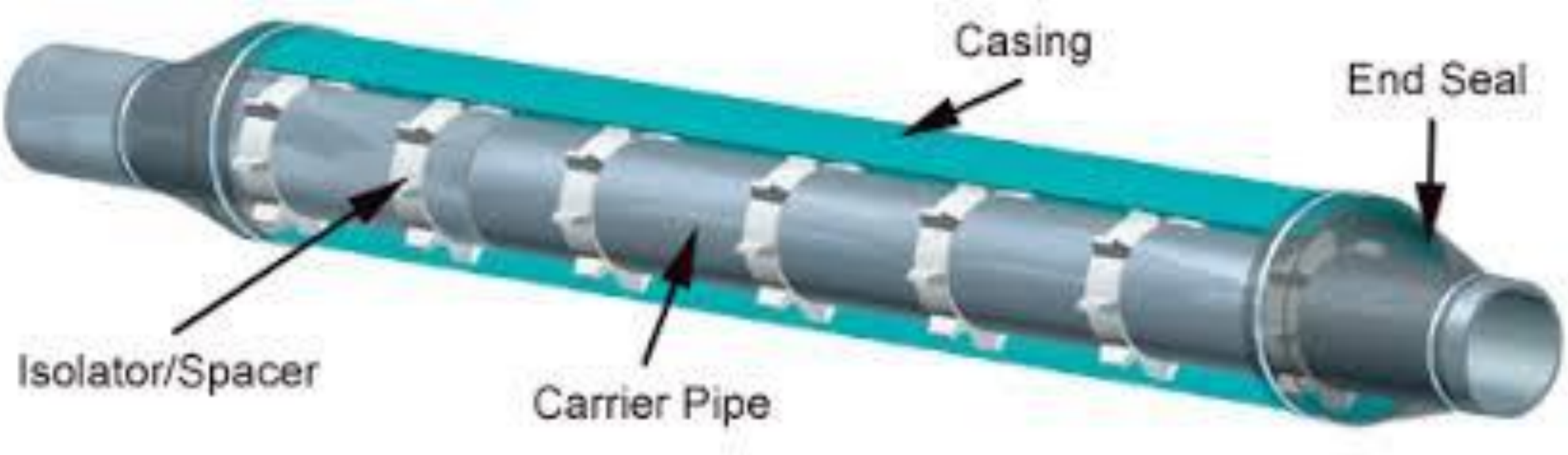
Deformation causing multi-access movement

- HDPE

- ERDIP Ductile

Casings

- HDPE
- PVC
- Steel



Pipe Protection

- Consider corrosive soils
  - Anodes (passive more resilient)
  - Polyethylene Bags

- Contaminated Materials
  - Gasket materials
    - SPR
    - EPDM
    - NBR
    - CR
    - FKM
  - Chemical reaction with pipe materials

Thrust Blocking

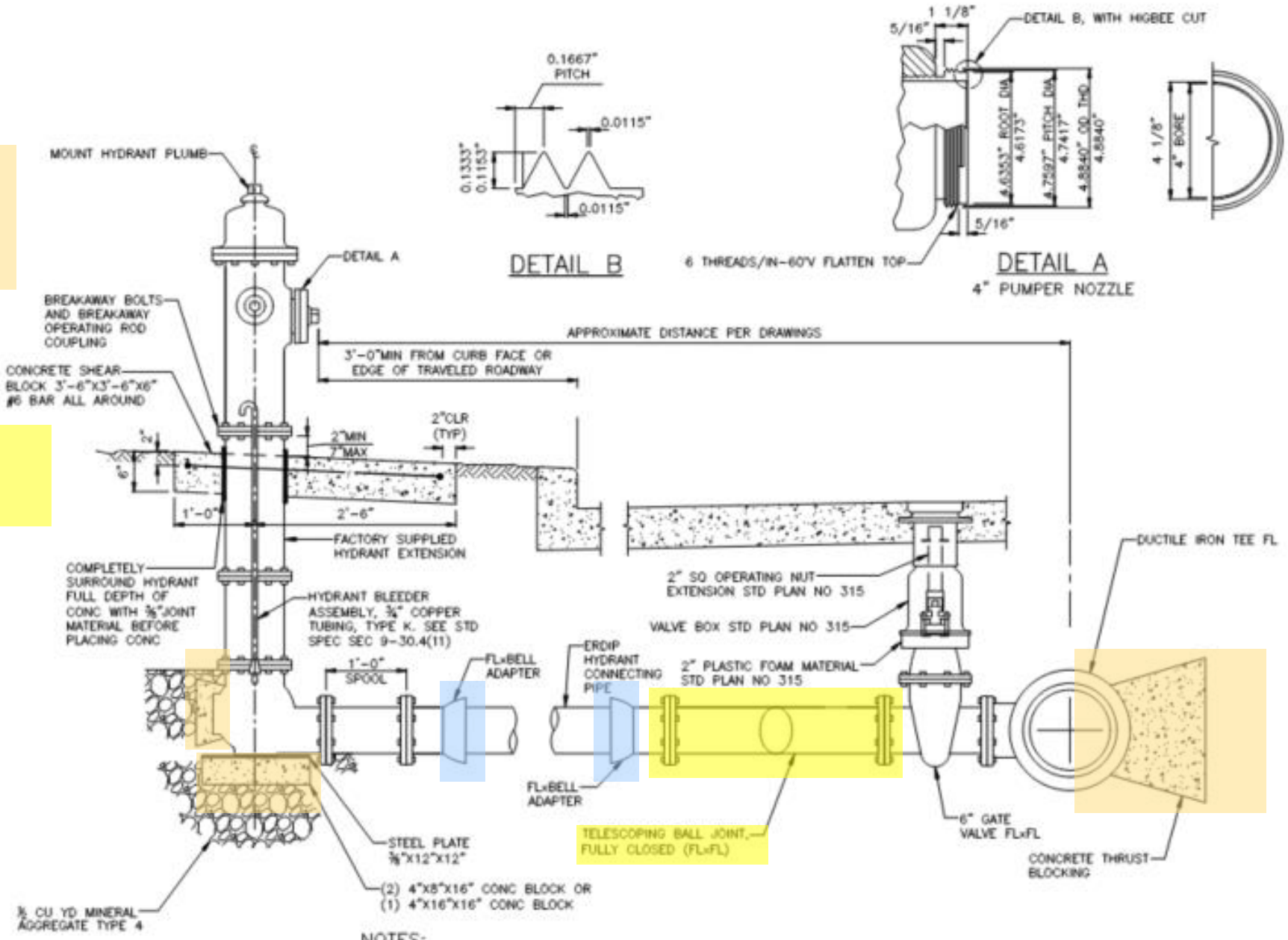
- Must hold system in correction location for pressure testing & normal operations
- If rigidly attached sink in liquefied soils, while pipeline buoyant causing added stress
- Larger surface area pulled by flowing soils
- Solution:
  - Only pour thrust blocks when needed and in direction of thrust not around fitting/pipeline
  - Pour thrust blocks just above spring line to allow thrust blocks to separate during seismic shaking

Hydrants

Thrust block in direction of thrust only

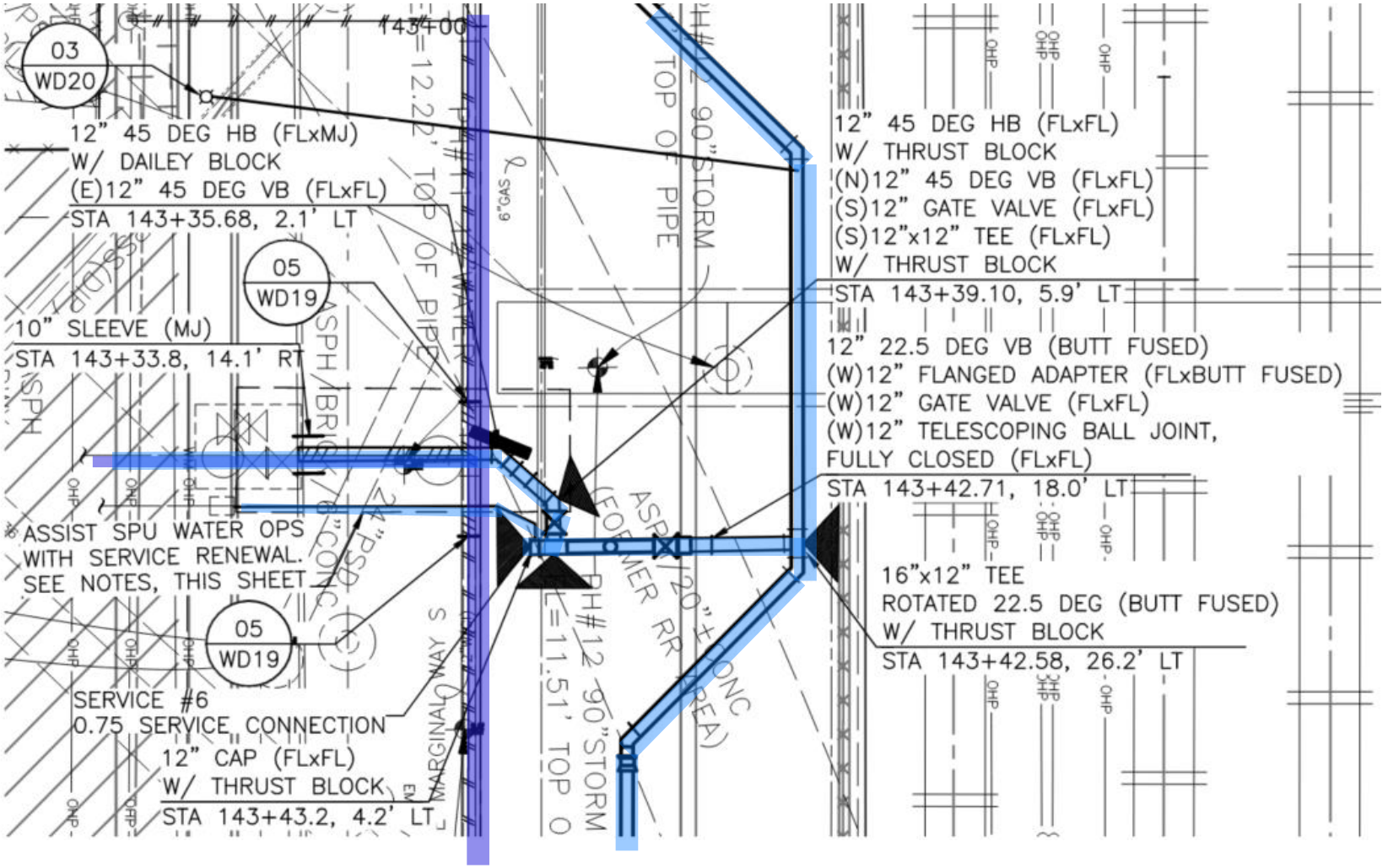
Rotational Flexibility

Extension & Compression



Services

- Flexible Piping
- Offset for flexibility
- Offset to reduce shutdow
- Offset for crossover
- Locate wire



Summary

- Seismic threats are real and “seismic piping” can help in multiple scenarios.
- Growing number of resources for seismic piping design.
- Resilient piping requires additional analysis and understanding.
- Connect with manufacturer representatives honestly and early. Consult multiple opinions.
- Assess diligently to fully understand the constraints.

Questions?

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