

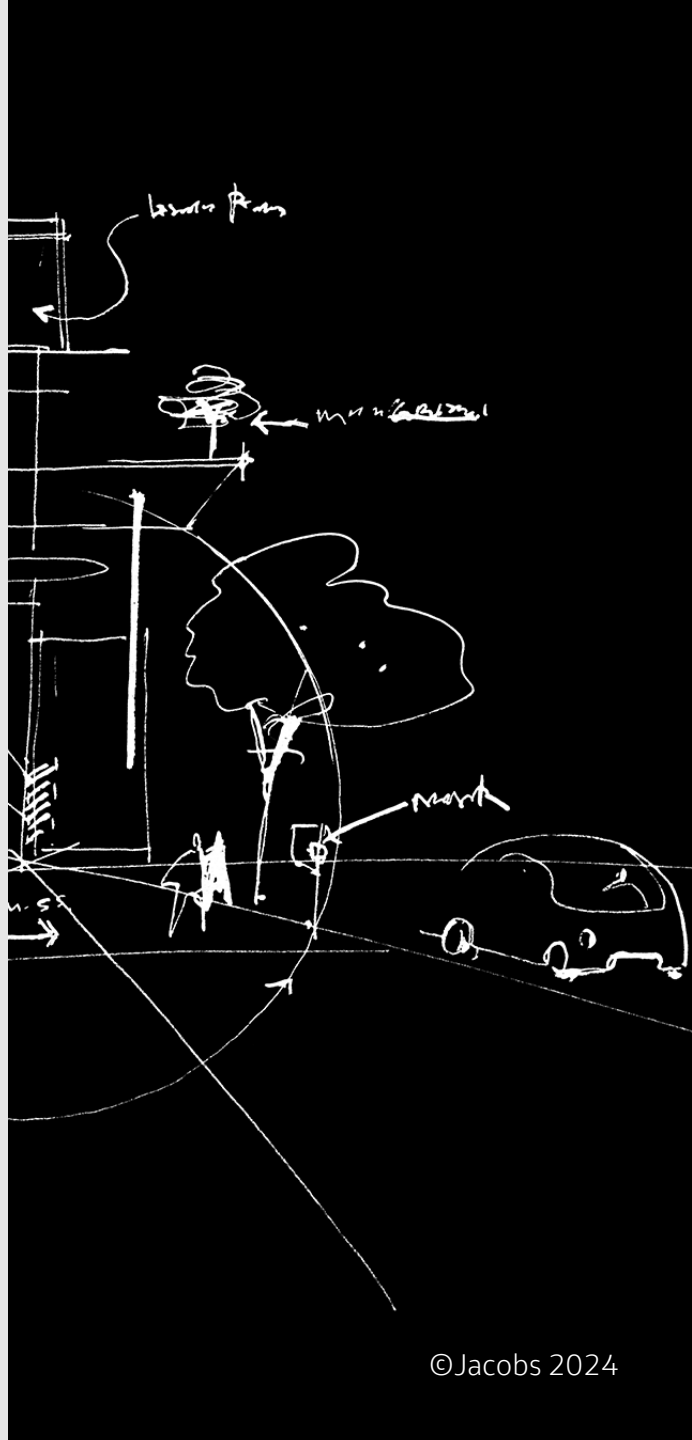
# Seismic Piping 101

Dan Shafar, Sr. Project Manager

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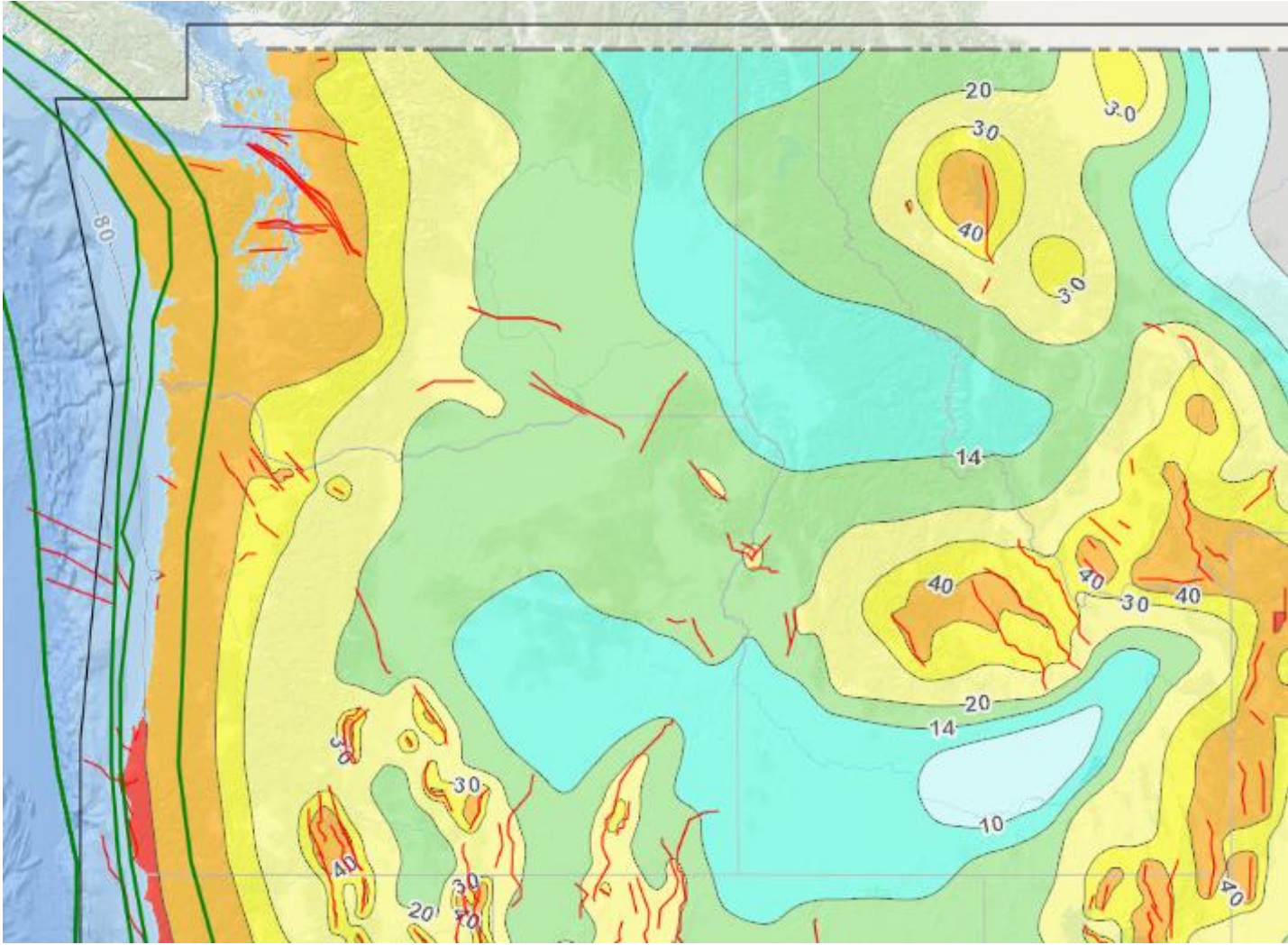
# Seismic Risks Overview

## Why Seismic Piping

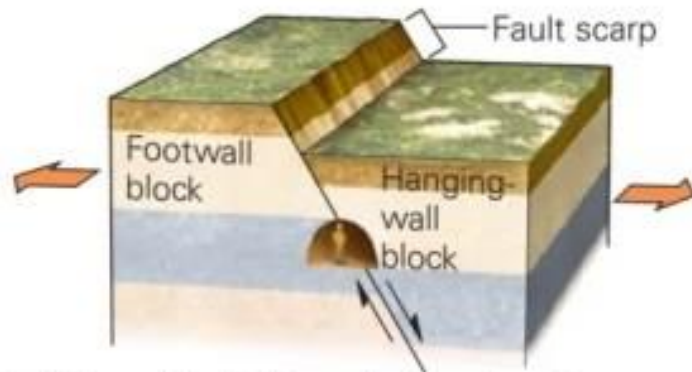


# Seismic Risk Overview

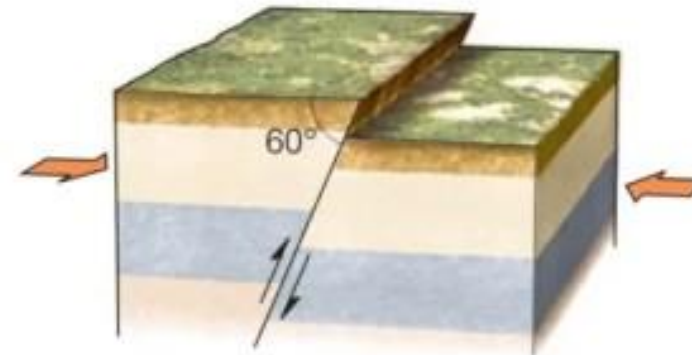
# USGS 2014 Seismic Hazard Map



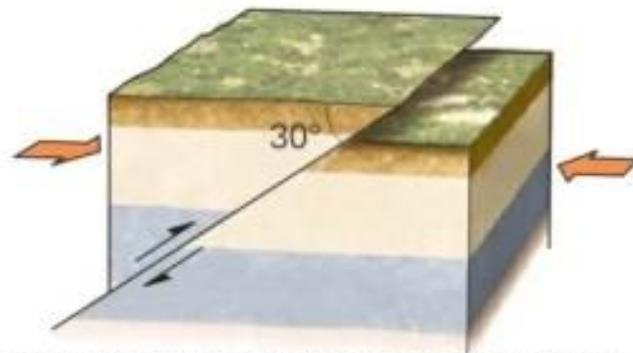
# Types of Faults



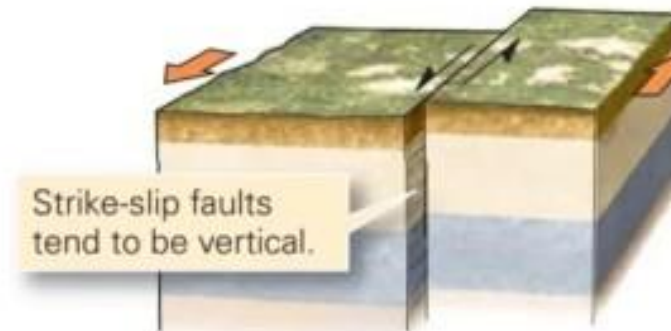
**(a)** Normal faults form during extension of the crust. The hanging wall moves down.



**(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  $30^\circ$ ).

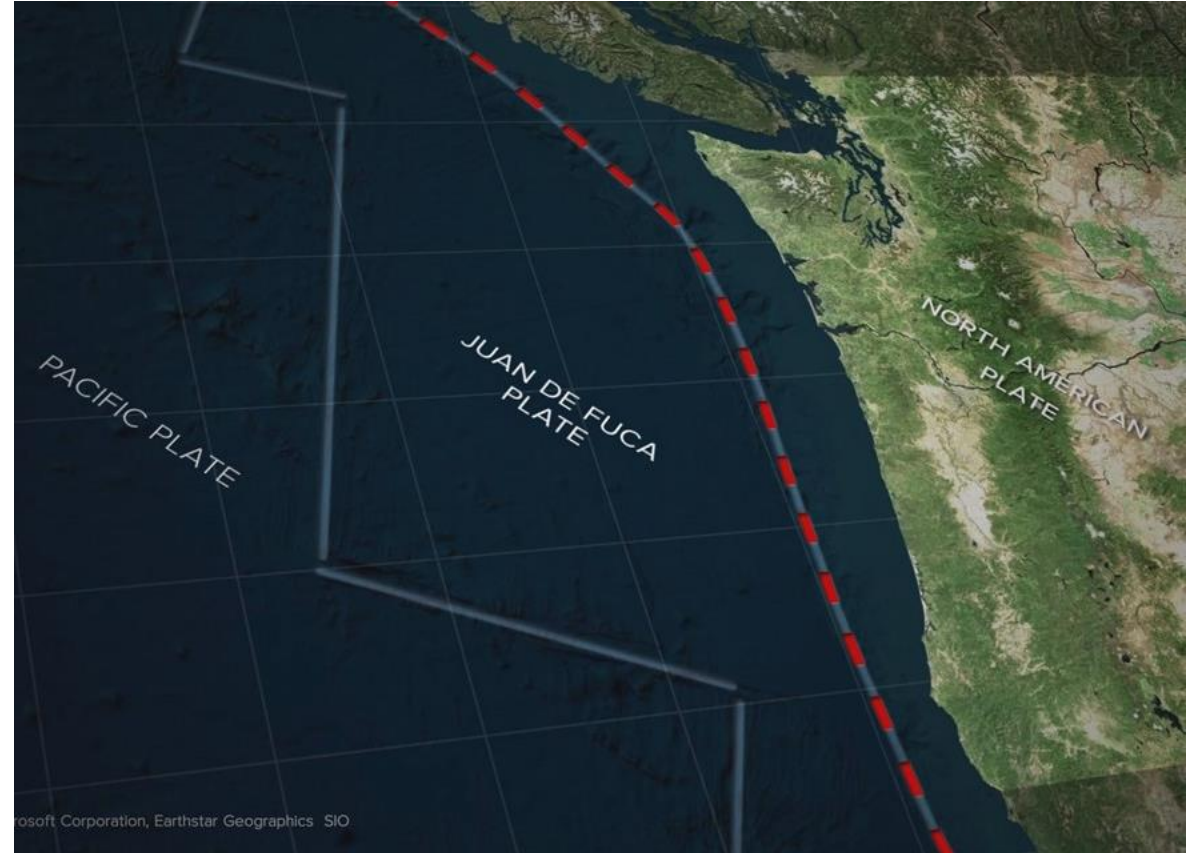


**(d)** On a strike-slip fault, one block slides laterally past another, so no vertical displacement takes place.

# Name the Famous Faults



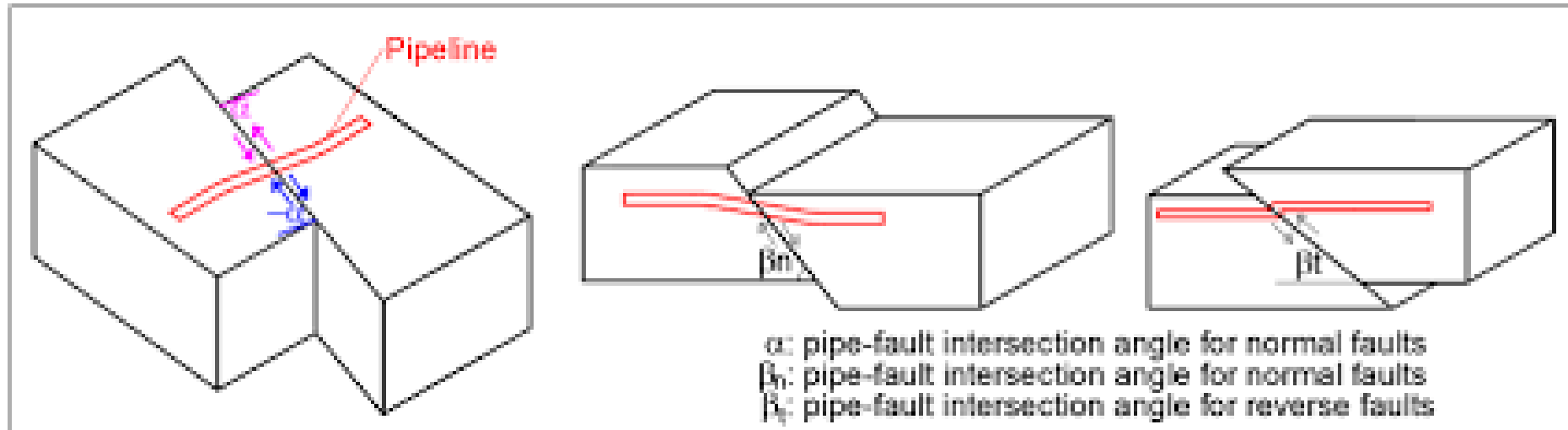
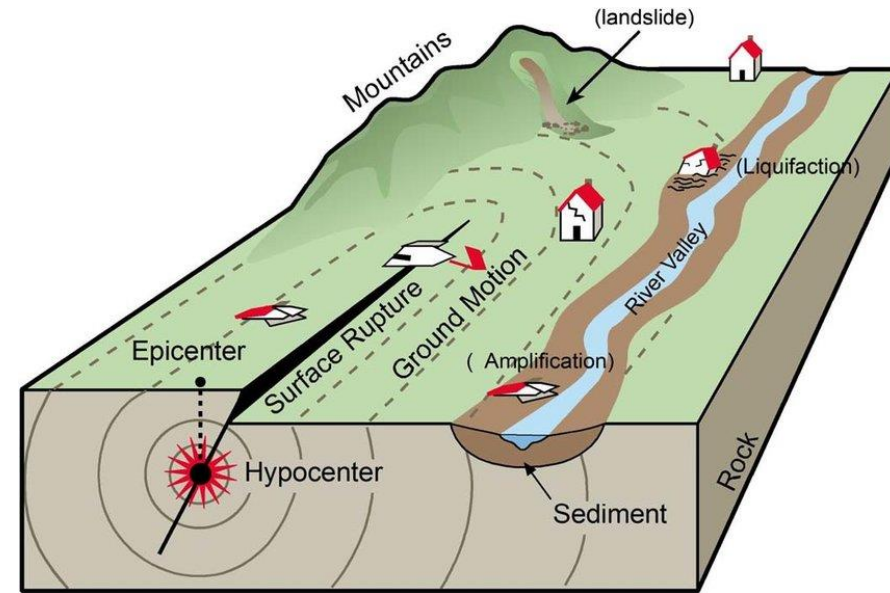
San Andreas Fault, California



Cascadia Subduction Zone

# Ground Movement

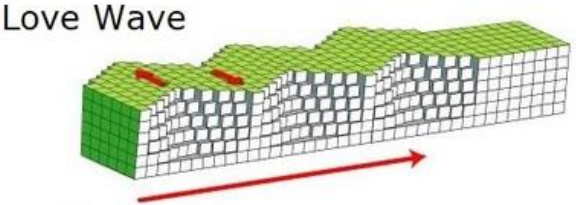
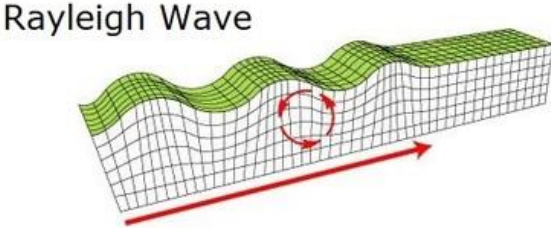
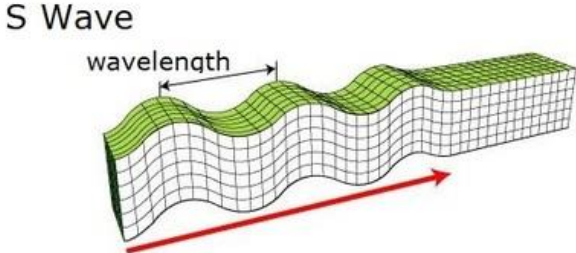
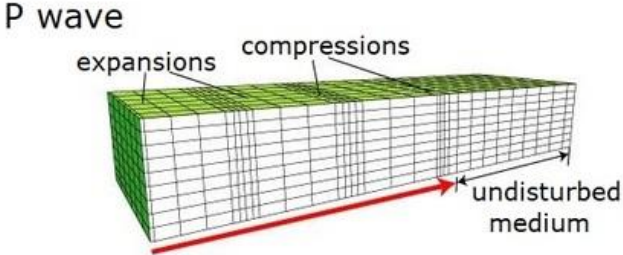
- Surface Rupture
- Faulting
- Ground movement
- Permanent Ground Deformation
- Liquefaction



# Ground Shaking



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# Faulting & Permanent Ground Displacement



# Liquefaction



# Guidance on Seismic Design

# Guidance on Seismic Design



## American Lifelines Alliance

A public-private partnership to reduce risk to utility and transportation systems from natural hazards

### Seismic Design and Retrofit of Piping Systems

July 2002



## INTERNATIONAL STANDARD

### ISO 16134

Second edition  
2020-05

### Earthquake-resistant and subsidence-resistant design of ductile iron pipelines

*Conception de canalisations en fonte ductile résistant aux tremblements de terre et aux phénomènes de subsidence*



Reference number  
ISO 16134:2020(E)

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## Municipal Advisory Board

Established May 1, 2008 at the University of Texas, Arlington



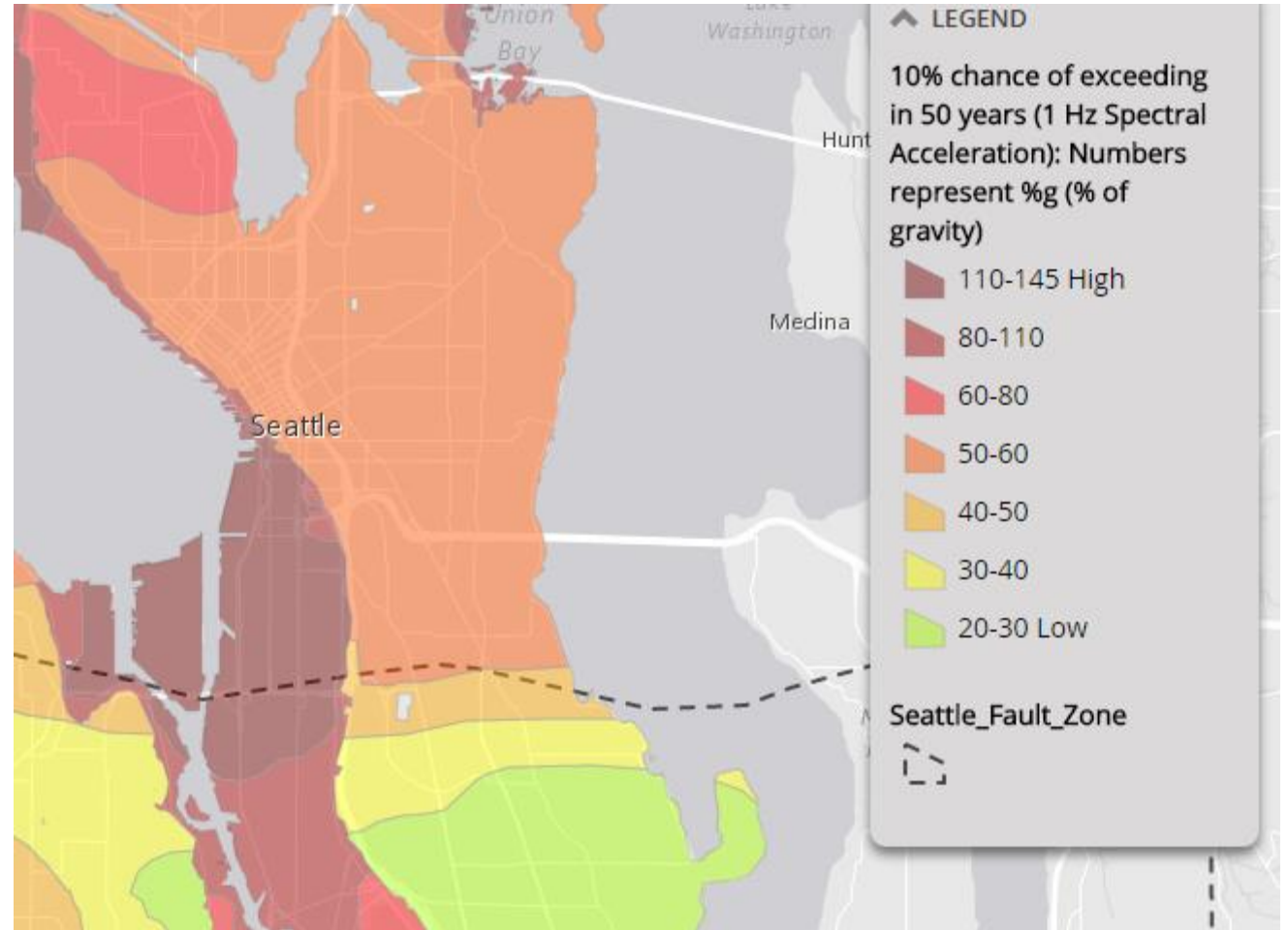
### Design of HDPE Water Mains for the Lateral Spread Seismic Hazard (MAB-9 2023)

First edition approved by MAB at 29<sup>th</sup> meeting in Round Rock, TX, 2022  
© Plastics Pipe Institute, 2022

Effective Date: February 1, 2023

# 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

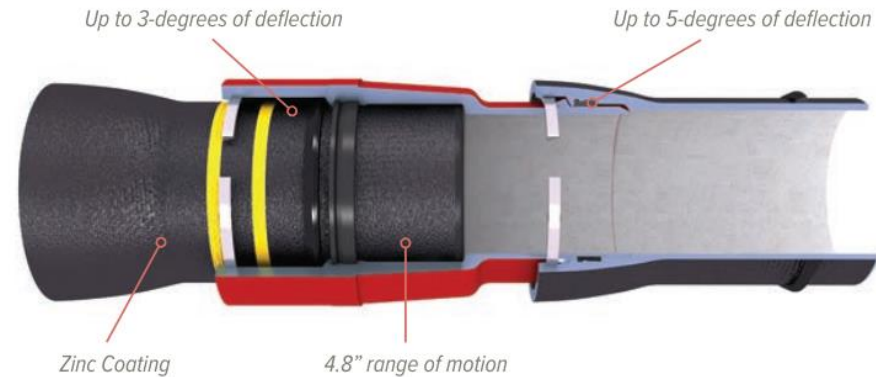
- Ex-tend



- Geometry



- Joint movement



# Deformation causing multi-access movement

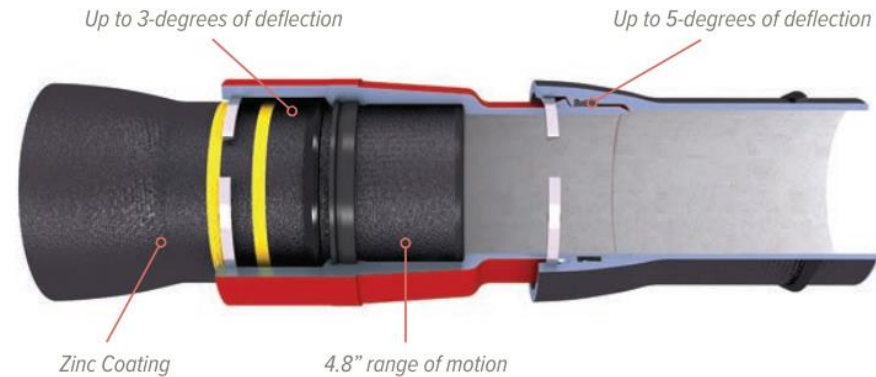
- Flex-tend



- Geometry



- Joint movement



# Deformation causing multi-access movement

- HDPE

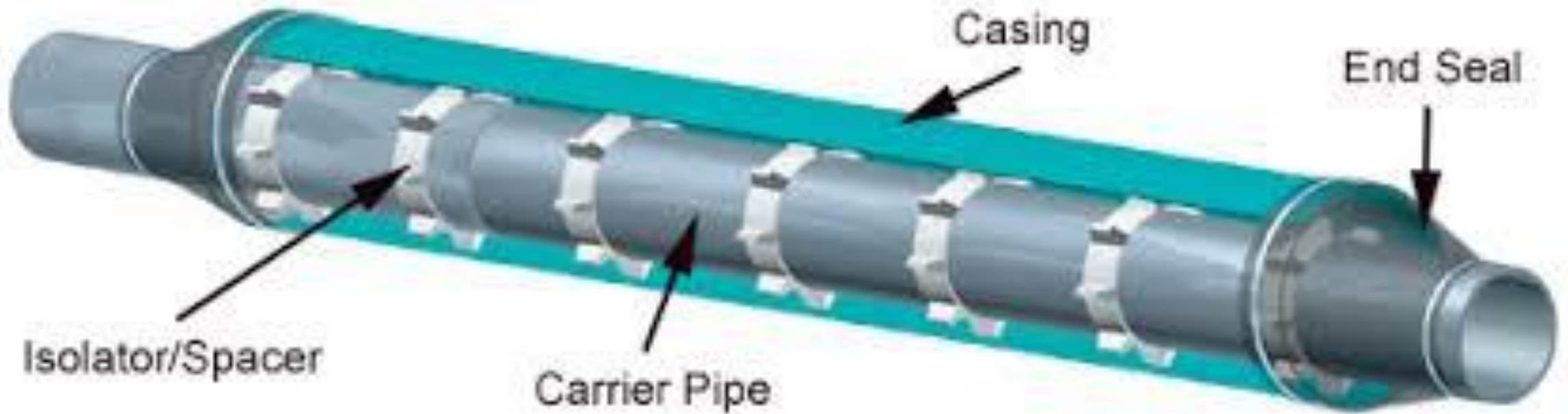


- ERDIP Ductile



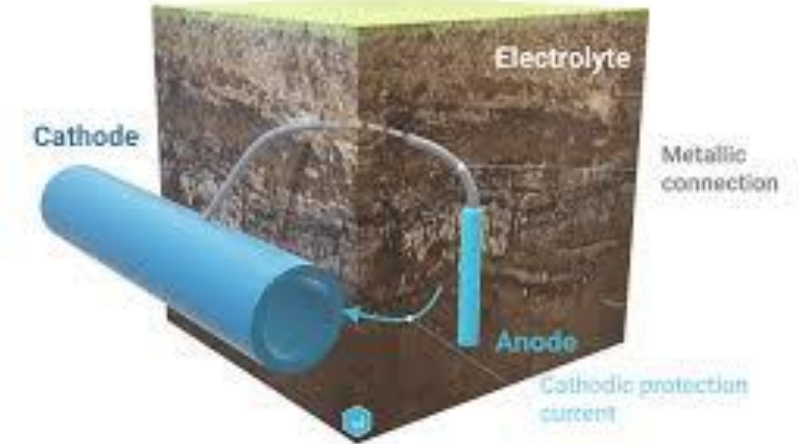
## Casings

- 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



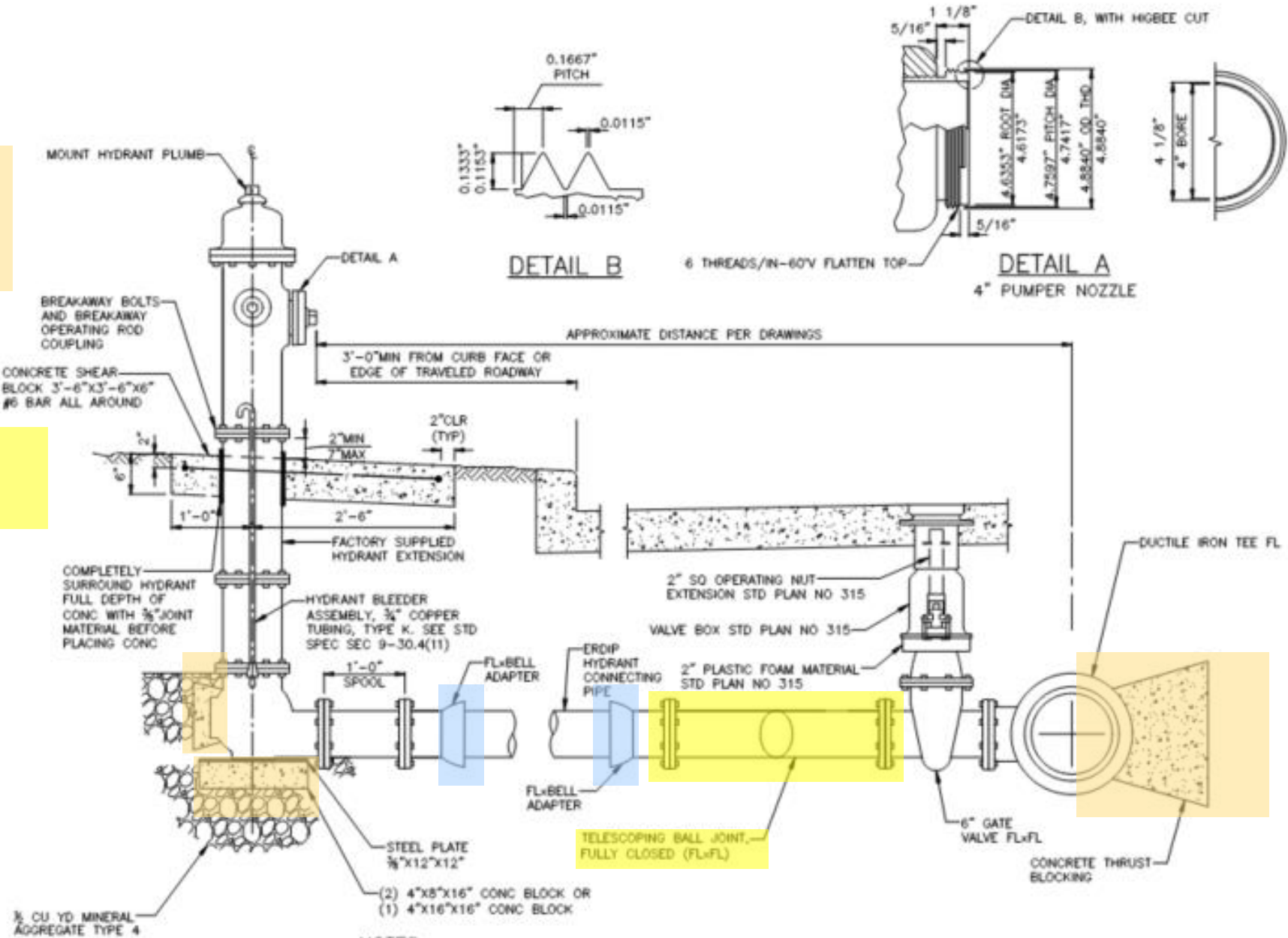


# Hydrants

Thrust block in direction of thrust only

Rotational Flexibility

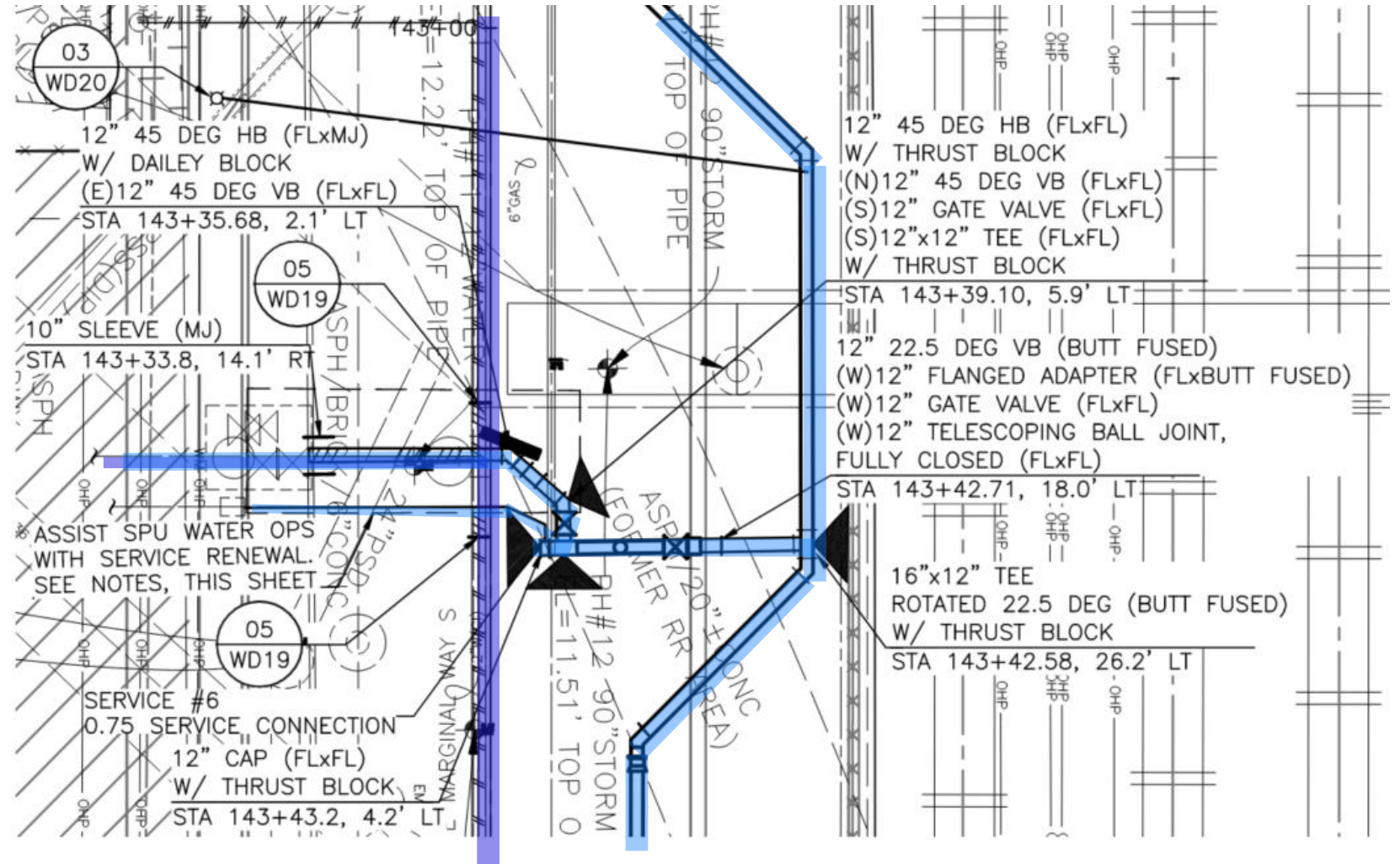
Extension & Compression



**NOTES:**  
1. DOMESTIC ERDIP ADAPTER IS PROPOSED TO USE IN HYDRANT LATERALS.

# 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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Challenging today.  
Reinventing tomorrow.

