Mitigation of Potential Impacts of Seismic Events on a Regional Water Distribution System

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Outline

- Evolution of approach to seismic resilience
- Expanded strategy
- Example projects for risk mitigation
  - Second Lower Feeder fault crossing
  - Casa Loma Siphon fault crossing

Southern California Seismic Setting

Initial Steps Toward Seismic Resilience

1930's
Construction of Colorado River Aqueduct

1971
San Fernando Earthquake

1994
Northridge Earthquake

Seismic Resilience Strategy

Planning

Goal: Provide system flexibility, diversified supply portfolio, & emergency storage

Engineering

Goal: Mitigate seismic risks of infrastructure & water system as a whole

Operations

Goal: Maintain effective emer-gency planning & response capabilities

Reporting

Goal: Provide accountability & transparency

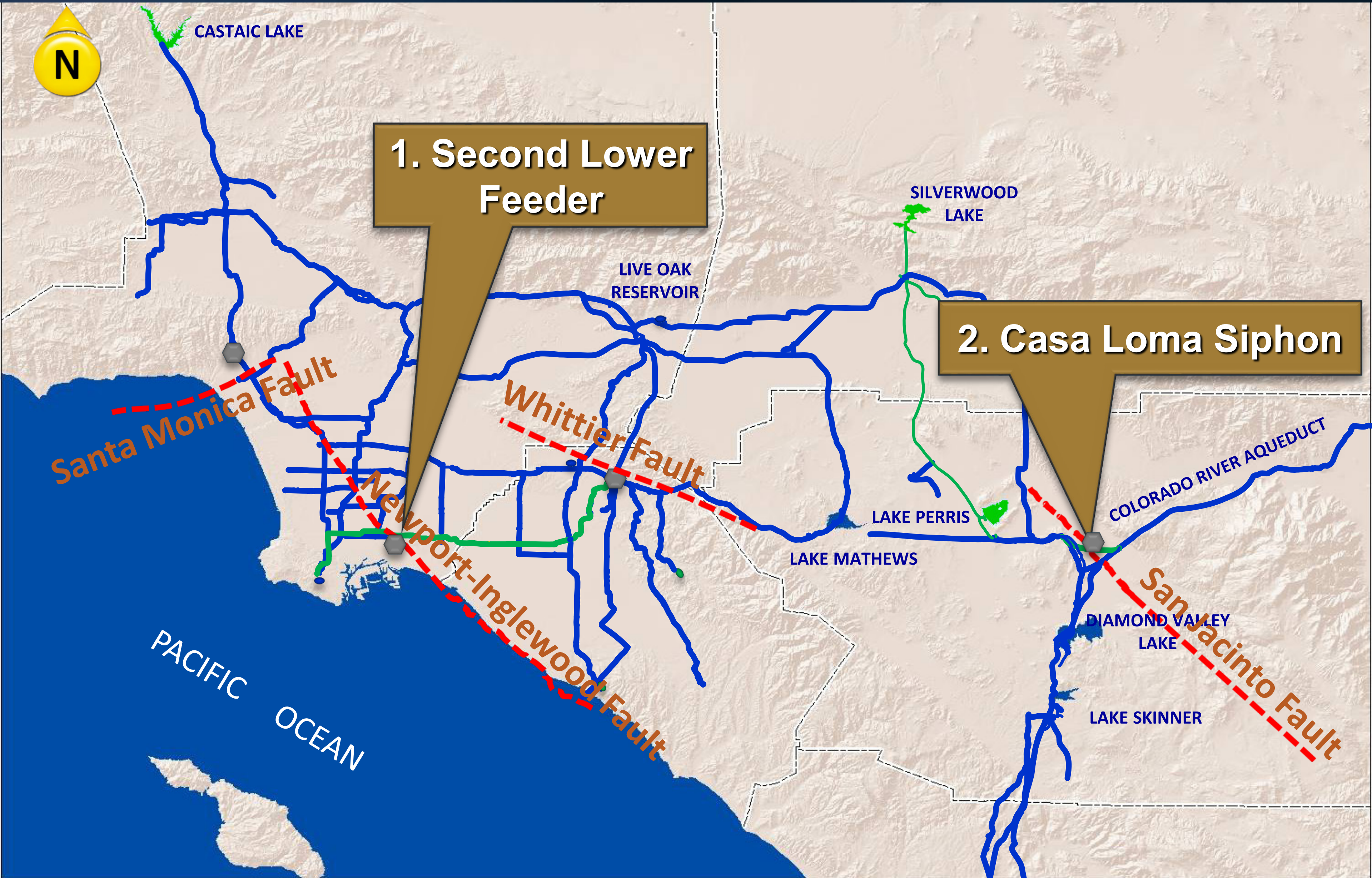
Seismic Resilience Water Supply Task Force

Goal: Enhance the seismic resilience of imported water supplies through multi-agency collaboration

Refined Approach for Seismic Resilience

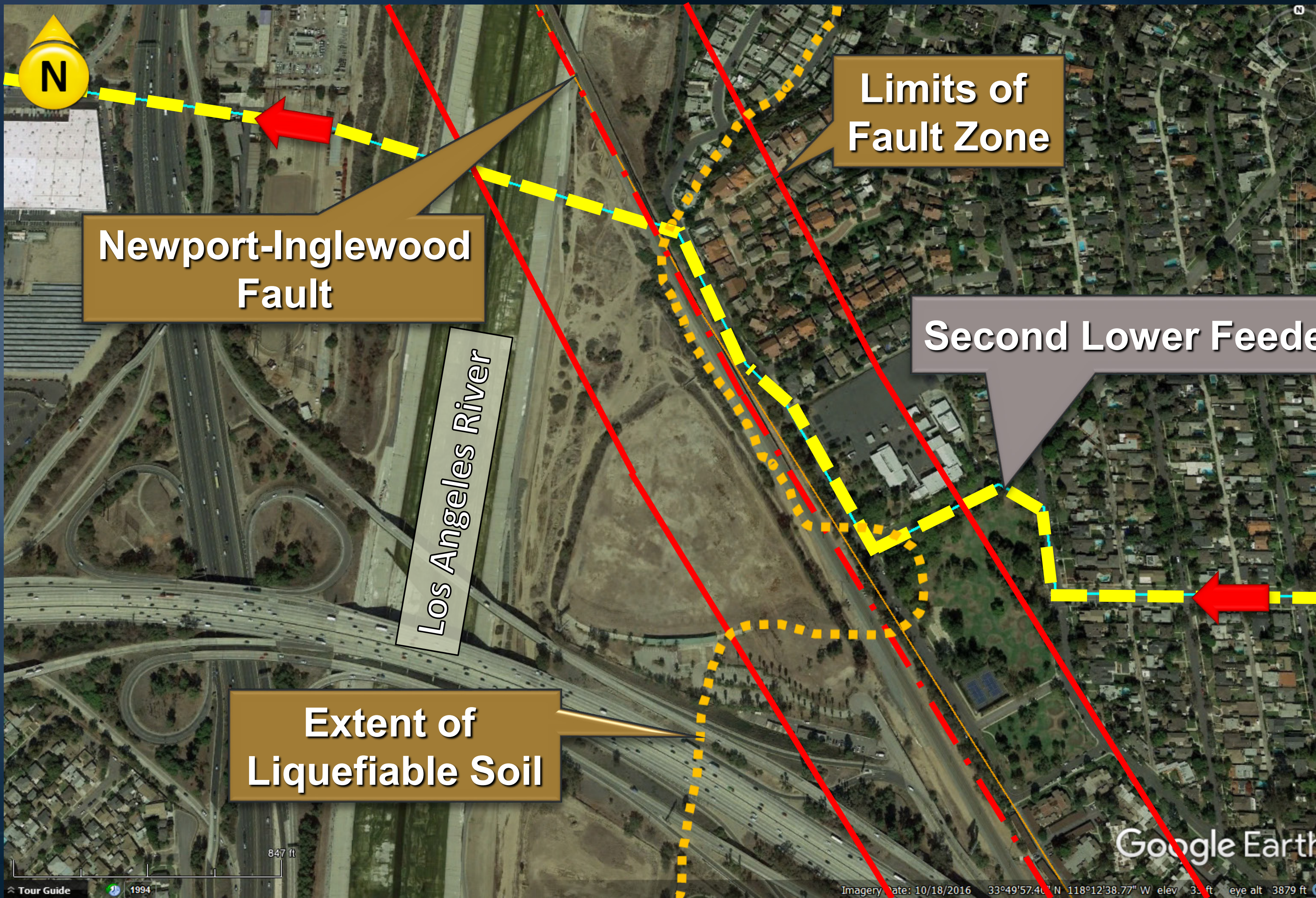
- Conduct assessments & strengthen structures & facilities that are critical to the delivery of water
- Maintain emergency repair capabilities
  - Stockpile key supplies & equipment
  - Maintain in-house construction forces
  - Execute contracts in advance for contractor support
- Conduct vulnerability assessments of distribution system (pipelines, tunnels, canals)
  - Identify mitigation measures & prioritize
  - Execute high-priority projects
  - Mitigate most seismic hazards via long-term rehab programs
    - *Every project is an opportunity to make significant improvements over time*

Examples of Mitigation Projects



1. Second Lower Feeder

Fault Crossing – Newport-Inglewood Fault

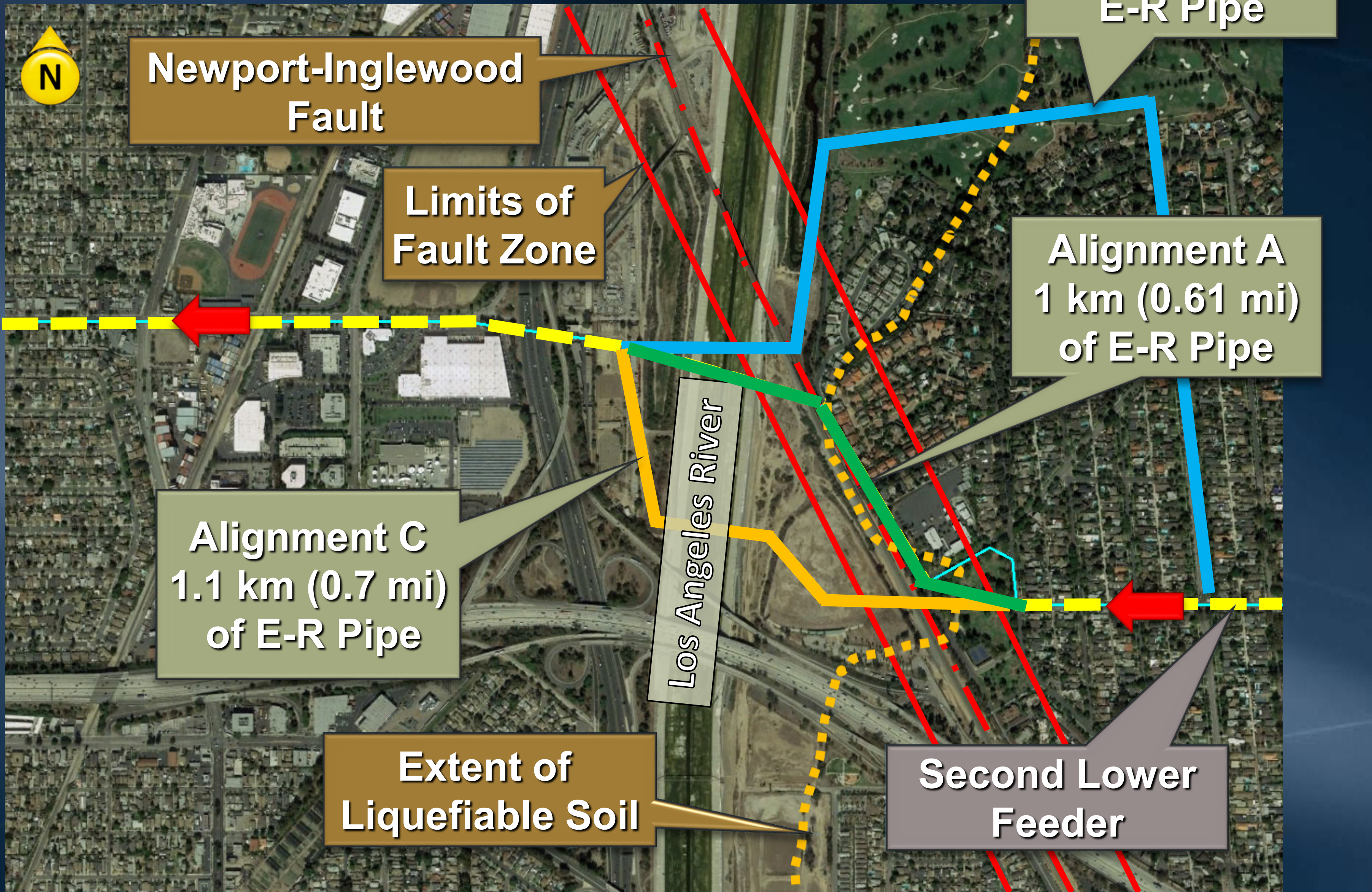


1. Second Lower Feeder

Background - Prestressed Concrete Cylinder Pipe (PCCP)

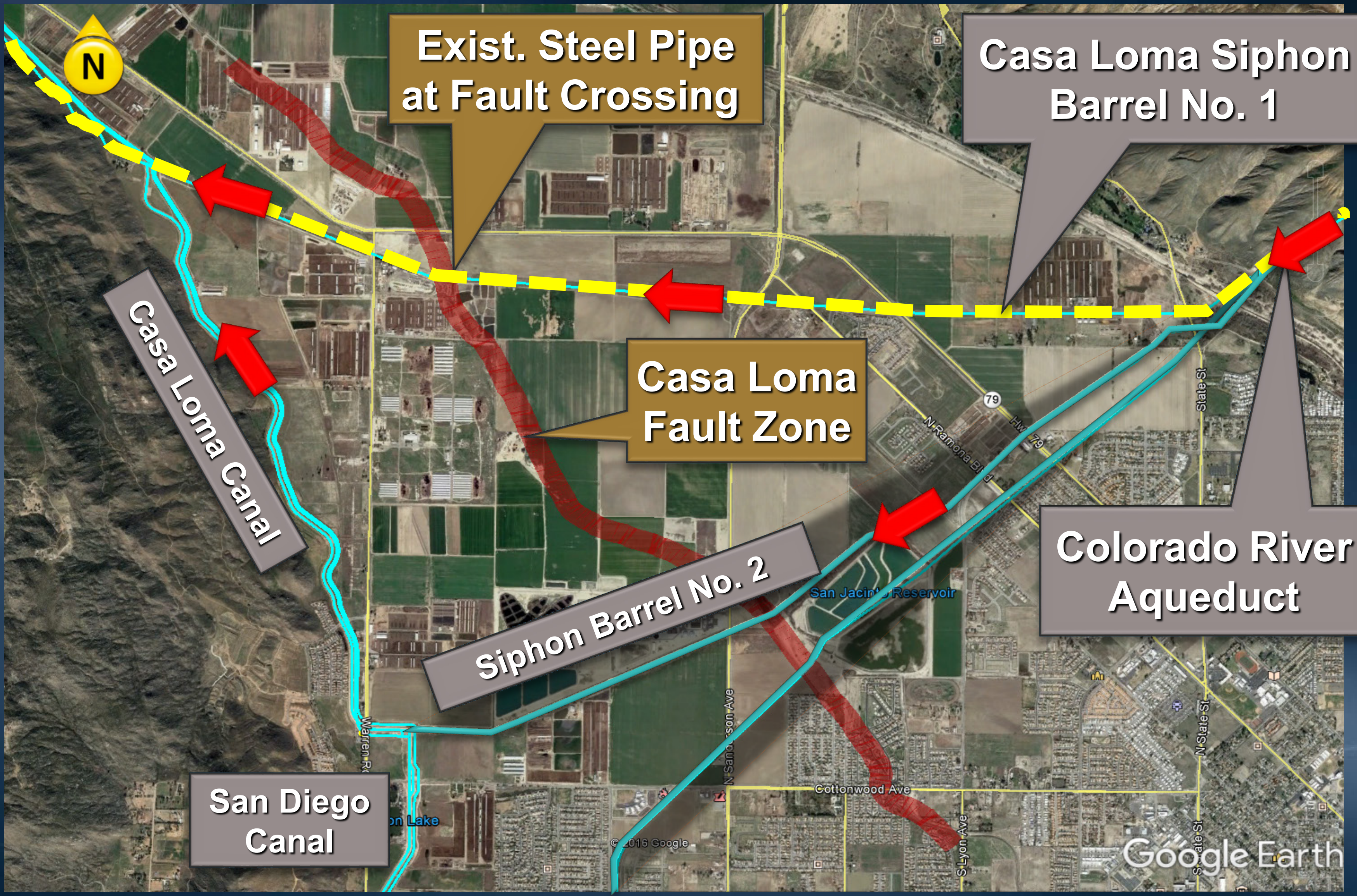
- 10-year project to line 45 km (28 miles) of 2 m (78 inch) dia. PCCP with steel liner
  - Internal pressure is 2 MPa (300 psi)
- Newport-Inglewood Fault
  - Capable of producing M7.5 earthquake
  - Potential horiz. rupture up to 4.9 m (16 ft) at fault crossing, along with liquefaction
- Planned solution
  - Replace exist. line with 2 m (78 inch) E-R pipe
  - Follow new alignment within fault zone
  - Install new pipe in casing under river
- Design is underway – Const. planned for 2020

1. Second Lower Feeder
Relocation Options



2. Casa Loma Siphon

Fault Crossing – Casa Loma Fault (San Jacinto Fault System)



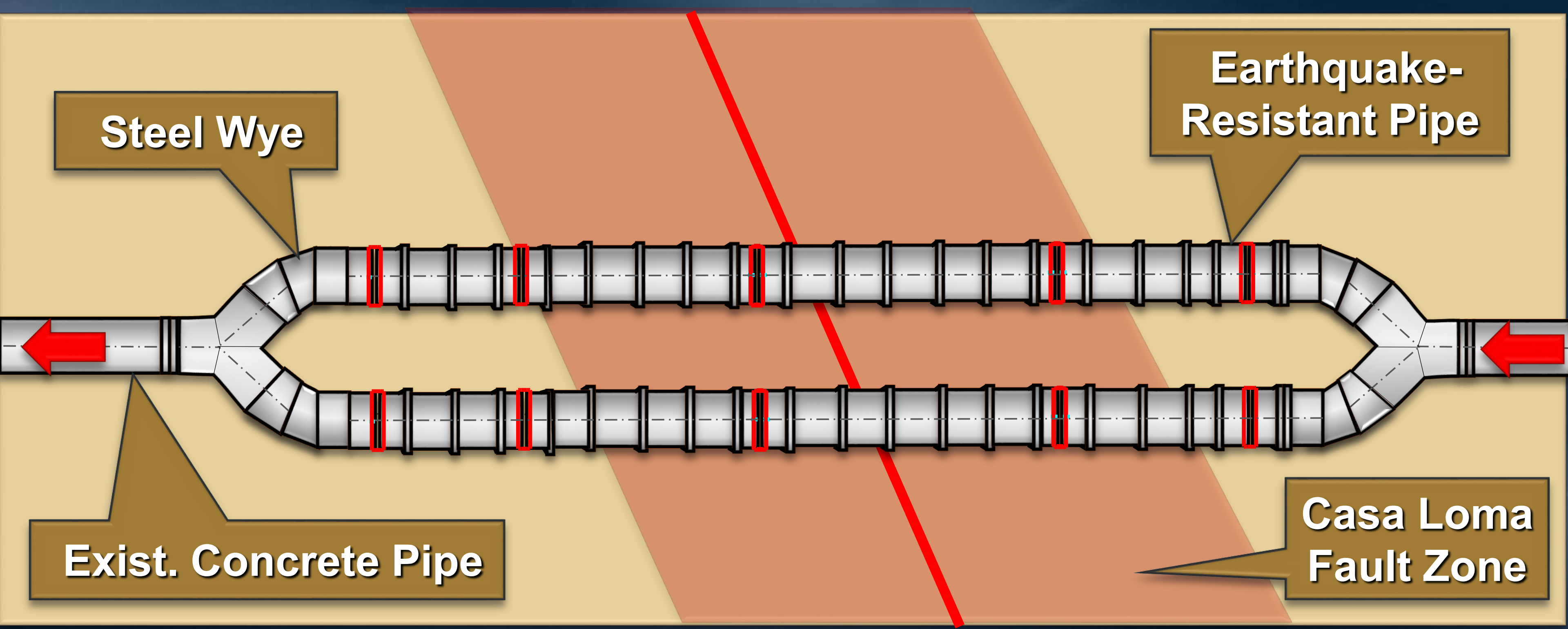
2. Casa Loma Siphon

Background – Permanent Repair of Leaks

- CRA crosses Casa Loma Fault in 2 locations
  - Barrel No. 1 was originally concrete pipe, now 3.8 m (150 inch) dia. steel pipe with sleeve-type couplings
    - Internal pressure is 0.14 MPa (21 psi)
  - Regional subsidence has caused leaks for decades
  - External couplings are corroded – Internal seals installed as interim measure
- Casa Loma Fault (San Jacinto Fault System)
  - Capable of producing M6.7 earthquake
  - Potential rupture of 0.3 m (1 ft) if fault ruptures on its own, or 3 m (10 feet) if multiple reaches rupture

2. Casa Loma Siphon

- Planned solution
  - Replace Barrel No. 1 with at least 90 m (300 ft) of E-R pipe
  - Two parallel 2.6 m (104 inch) dia. lines
- Prelim. design is underway – Const. planned for 2020



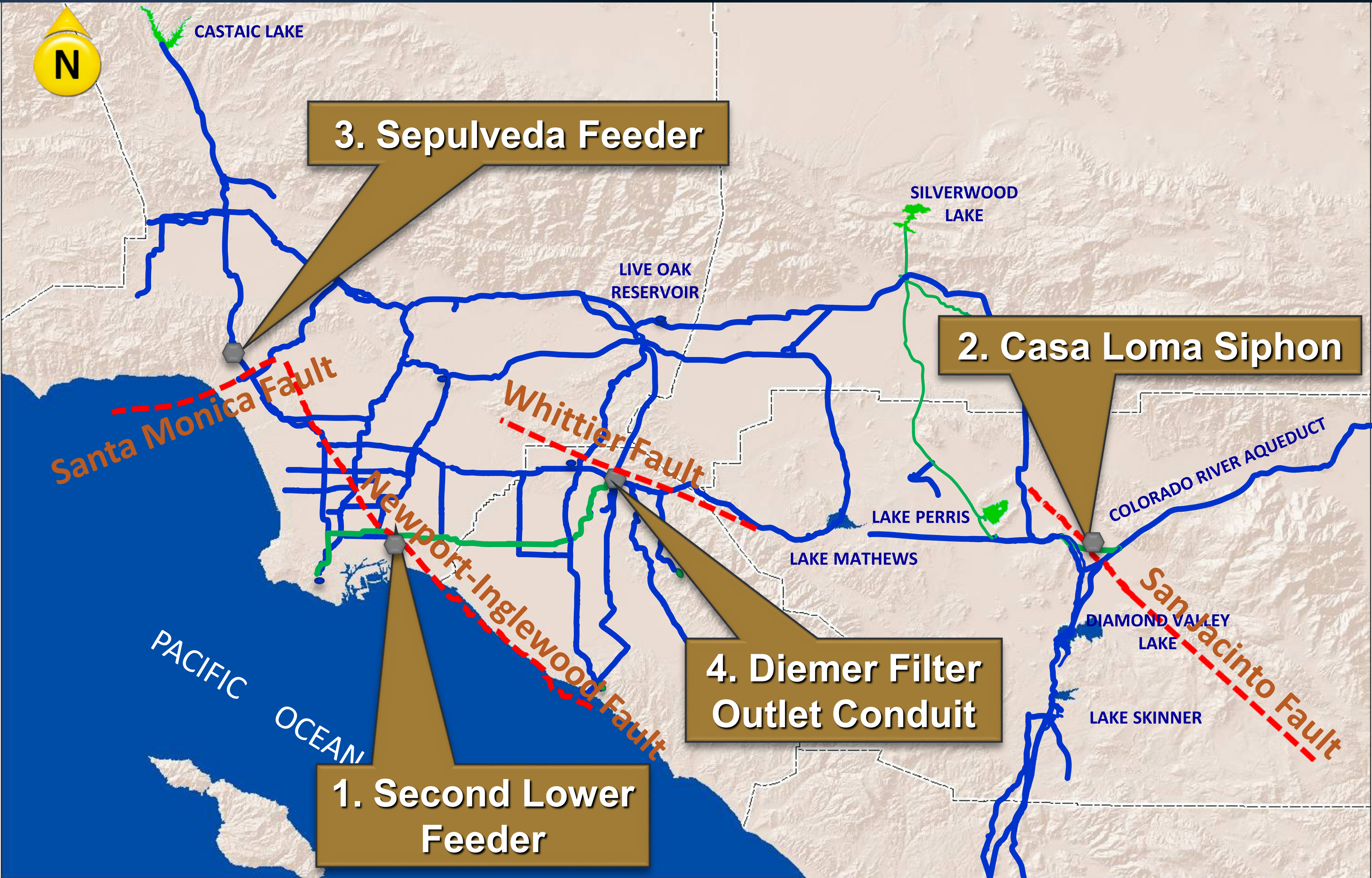
Planned Actions

- Define generalized performance objectives for all pipelines & tunnels
- Finalize resilience approach for new pipelines at
  - Fault crossings
  - Liquefaction zones
  - Connections to structures
- Proceed with 5 initial resilience projects on vulnerable pipelines & tunnels
- Conduct vulnerability assessments of in-system tunnels
- Estimate outage durations for scenario earthquakes

THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

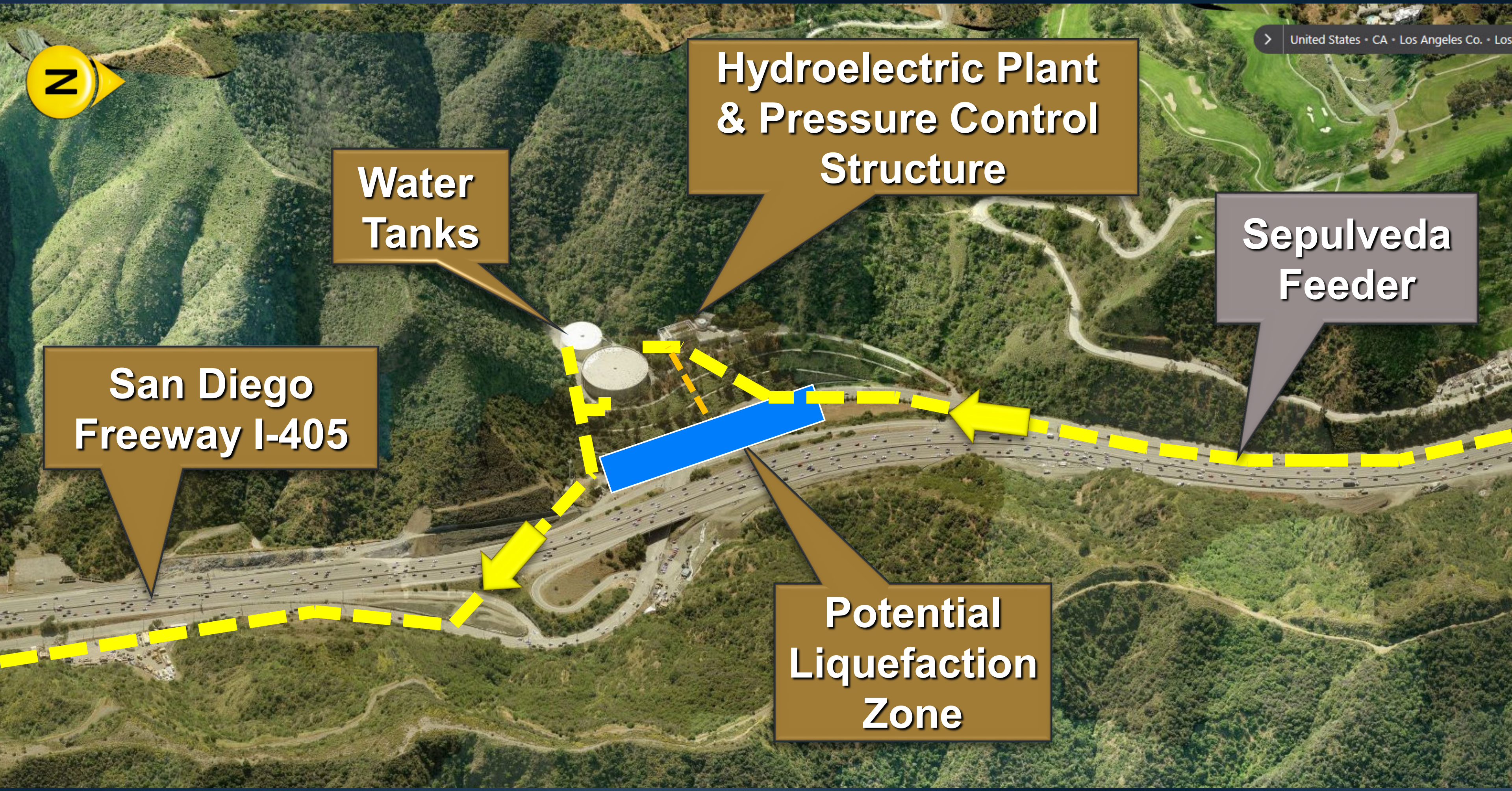
1928

Examples of Mitigation Projects



3. Sepulveda Feeder

Slope Stability/Liquefaction Zone in Sepulveda Canyon



3. Sepulveda Feeder

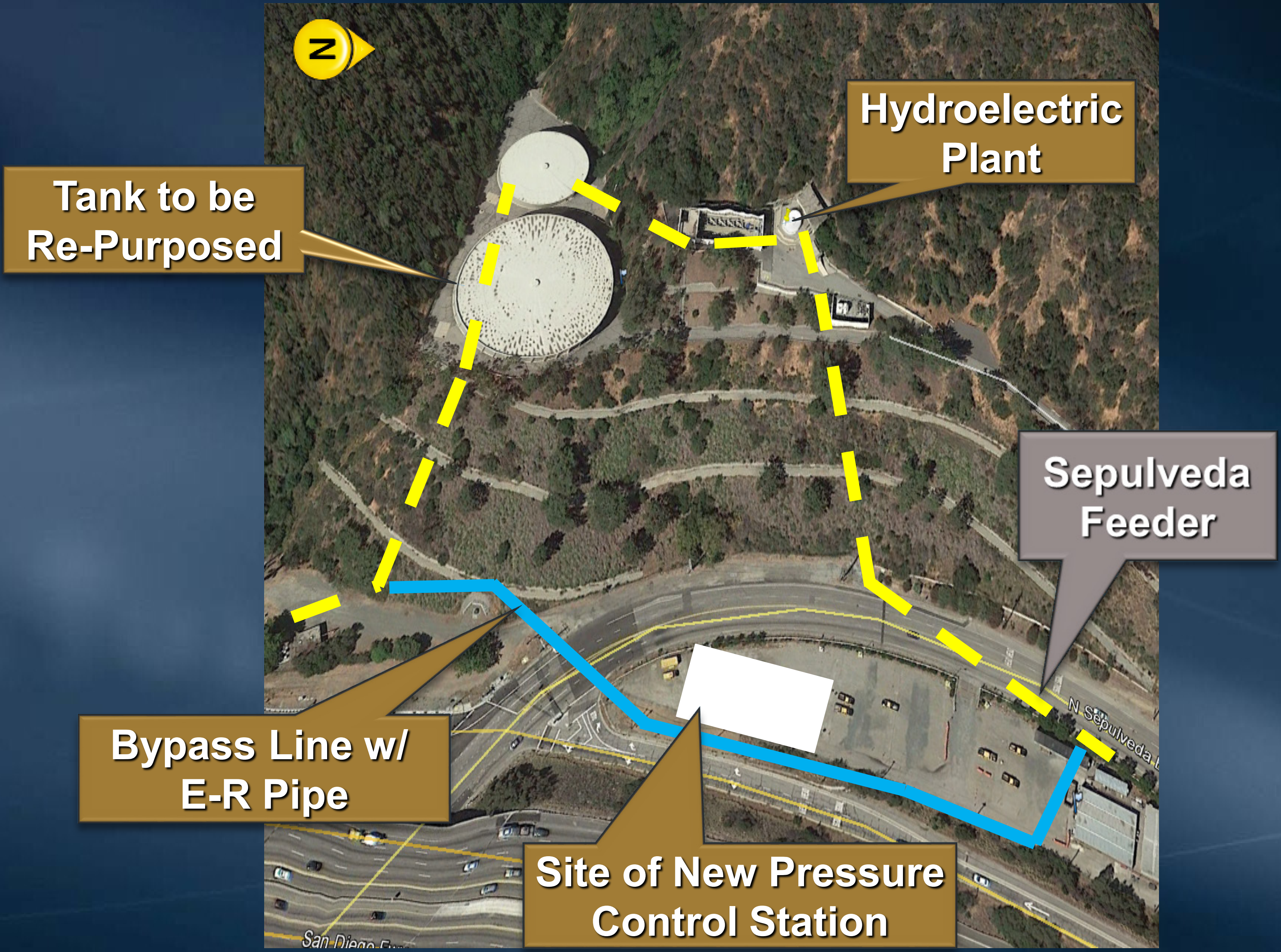
Background – PCCP Rehabilitation

- 12-year project to line 68 km (42 miles) of 2.4 m (96 inch) dia. PCCP with steel liner
  - Internal pressure is 2.5 MPa (360 psi)
- At Sepulveda Canyon, 2 barrels of feeder, 2 tanks, & pressure control structure are vulnerable to slope movement & liquefaction at toe of slope
  - Potential shift of up to 0.5 m (1.7 ft) downslope
  - No bypass line or nearby isolation valves
- Santa Monica Fault & Newport-Inglewood Fault
  - Capable of producing M6.5 to M7.5 earthquake

3. Sepulveda Feeder

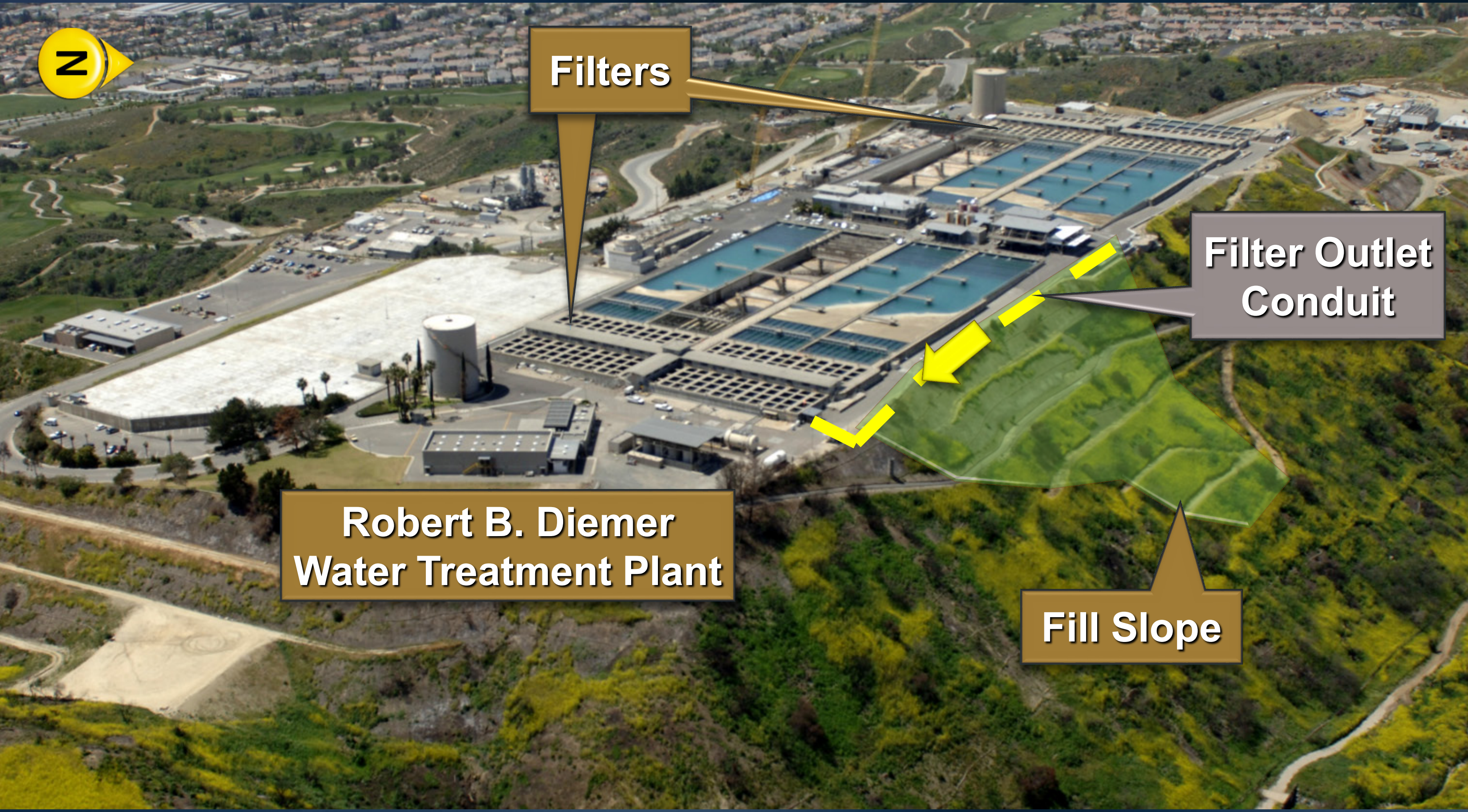
- Planned solution
  - Over-excavate & re-compact soil at toe of slope
  - Relocate pressure control structure to toe of slope
  - Install bypass line with E-R pipe
  - Re-purpose or abandon tank closest to slope
- Design is underway – Construction planned in stages from 2021 to 2023

3. Sepulveda Feeder



4. Diemer Filter Outlet Conduit

Slope Stability



4. Diemer Filter Outlet Conduit

Background – Treatment Plant Reliability Project

- Over 12 structures & conduits at Diemer plant strengthened or relocated to meet seismic goals
- Conduit has 137 m (450 feet) of 3.1 m (121 inch) dia. steel pipe that is vulnerable to slope movement
  - Internal pressure is 0.07 MPa (10 psi)
- Whittier Fault
  - Capable of producing M 6.8 earthquake
  - Potential shift of up to 1.4 m (4.5 ft) downslope
- Planned Solution
  - Install deep caissons to protect pipe in place
  - Replace line with E-R pipe (future phase)
- Design completed – Const. in 2018

4. Diemer Filter Outlet Conduit