A TRANSFORMATIVE INVESTMENT IN CALIFORNIA'S FUTURE

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HIGH-SPEED RAIL: More Than A Transportation Program

- California is 7th Largest Economy in the World
- Comparable to Northeast Corridor in Terms of Distance, Population and Complexity
- Transformative Investment
- Connecting all California Population Centers

HIGH-SPEED RAIL OFFERS MORE CHOICES IN CALIFORNIA

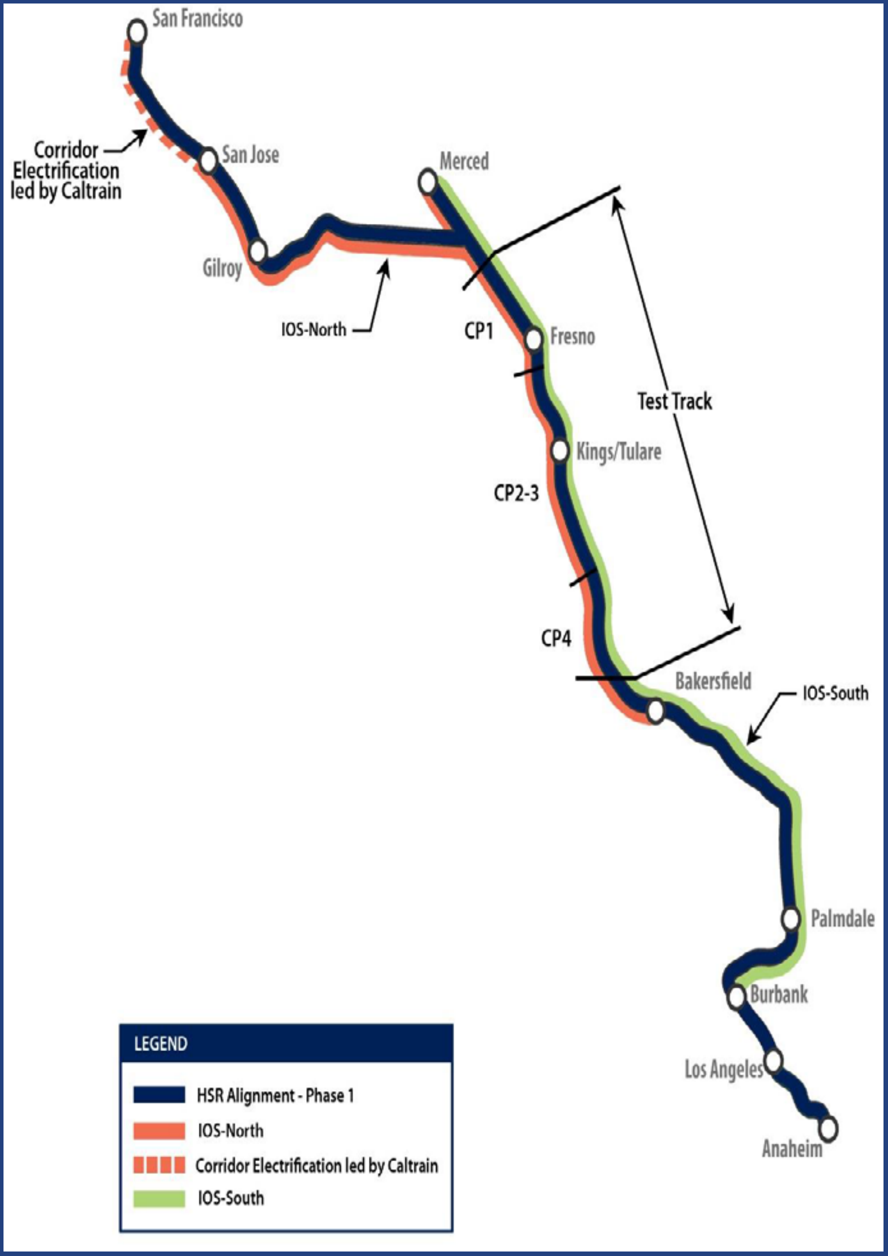
- The State's Population is Growing
  - » 50 million by 2050
- Congestion Diminishes Our Competitiveness
  - » Highway: Six of top 30 congested urban areas in US are in California
  - » Airways: LAX to SFO is the busiest short-haul market in United States
  - » Railways: Freight and passenger service share tracks
- Poor Air Quality Impacts Our Communities
  - » South Coast and Central Valley Air Basins Don't Meet Current Clean Air Objectives
- An Efficient and Less Expensive Alternative
  - » Alternatives are 2-3 times more expensive

CONNECTING CALIFORNIA: PROJECT SCOPE

- Phase I:
  - 520 Miles
  - San Francisco to Los Angeles/Anaheim
- Phase II:
  - Extends 300 Miles
  - Connections to Sacramento & San Diego
- Proposition 1A
  - At least 200 mph
  - San Francisco-Los Angeles Union Station: two hours, 40 minutes
  - 24 total stations

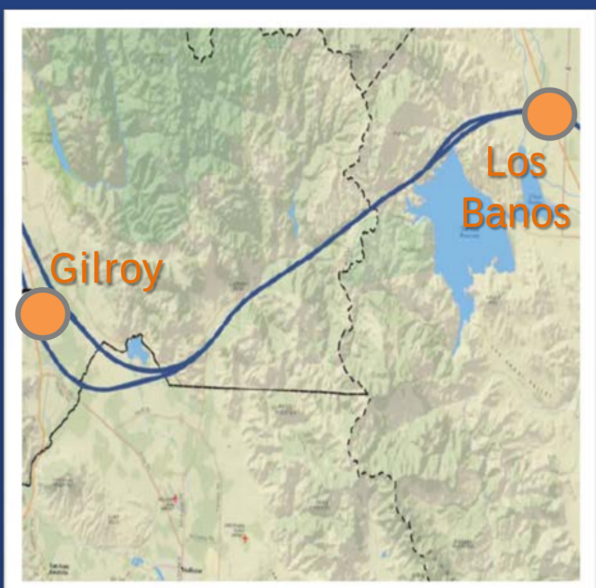
PROGRAM DELIVERY STATUS

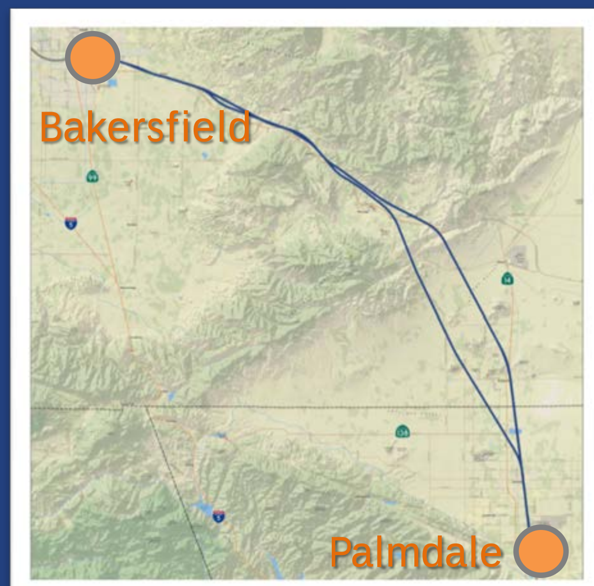
- Environmental Clearances
  - » 10 sections, 2 completed
  - » Complete Phase I by end of 2017
- Construction Underway (Design-Build)
  - » Civil infrastructure in the Central Valley (Construction Package 1, 2-3 and 4)
- Requests for Expressions of Interest
  - » Initial Operating Section (North and/or South)
  - » Design-Build-Finance-Maintain

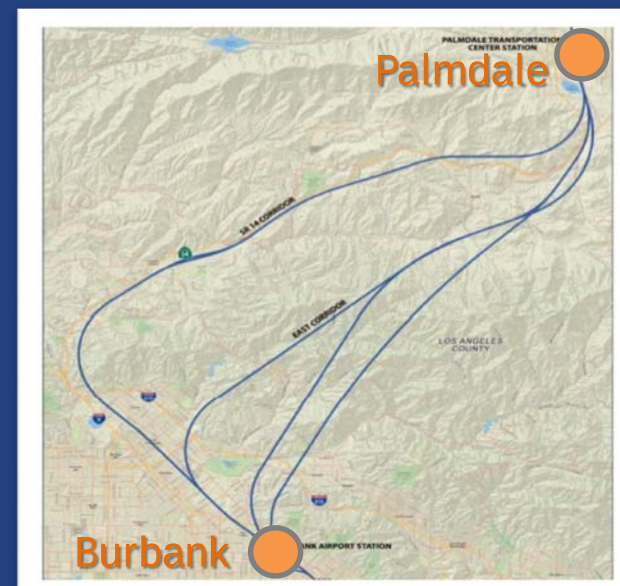


ENGINEERING CHALLENGES: MAJOR INVESTIGATION SEGMENTS

- Three segments for investigation.
  - » Gilroy to Los Banos (Pacheco Pass)
  - » Bakersfield to Palmdale
  - » Palmdale to Burbank

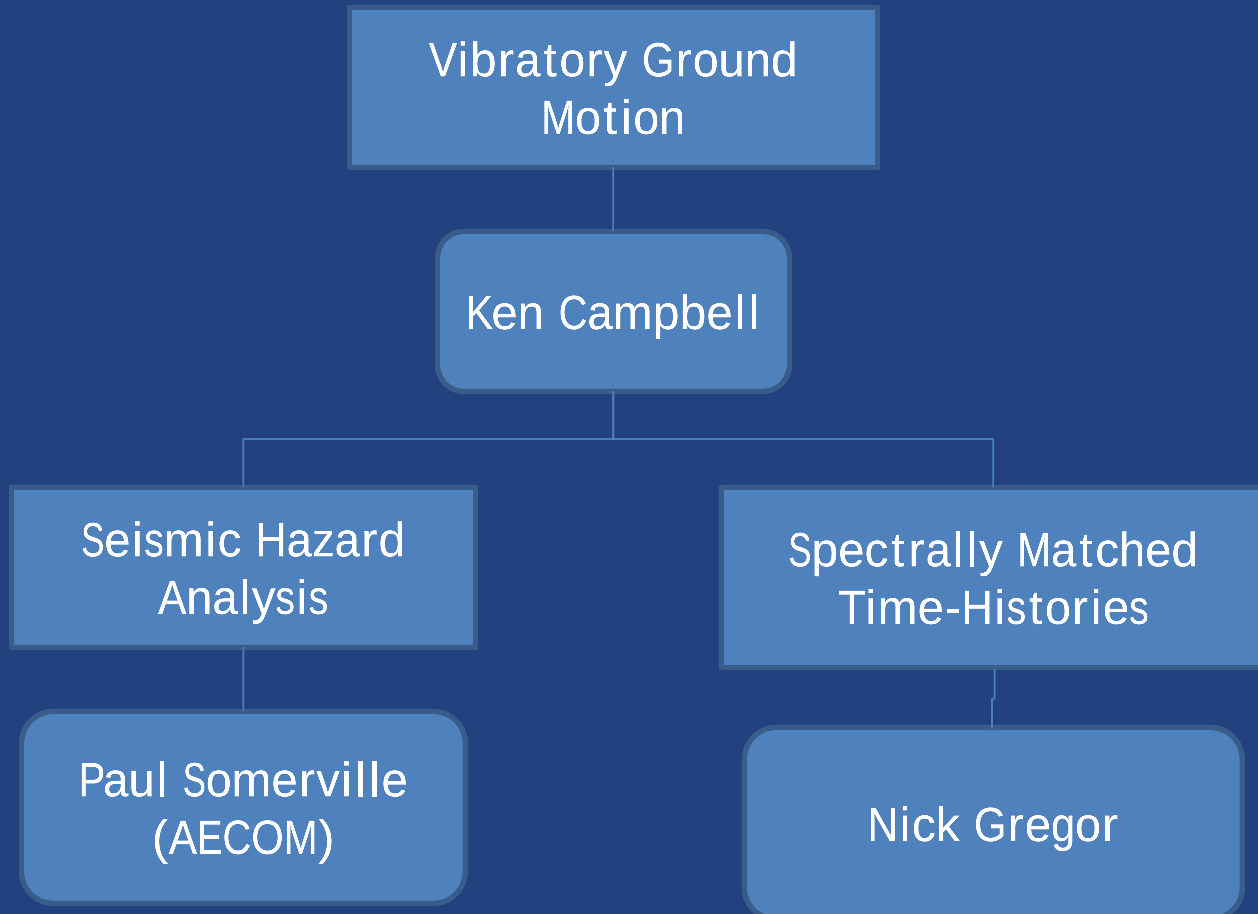






SEISMIC SPECIALISTS TEAM

- Responsible for ground motion development for CP 1 and CP 2-3



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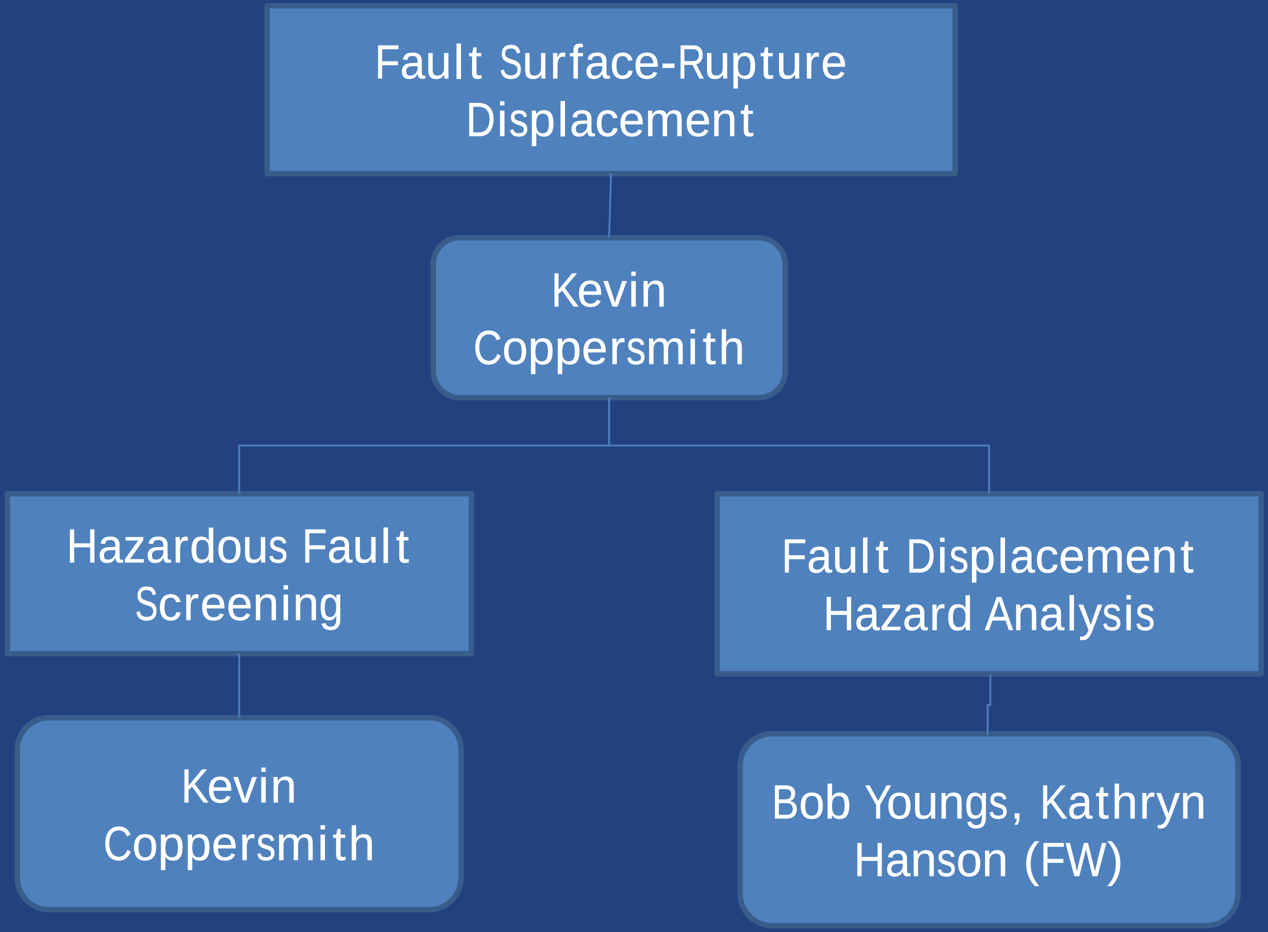

PRELIMINARY GROUND MOTIONS

- Process for developing Preliminary Ground Motions
  - » Purpose: Develop ground motions at ground surface to be used during procurement process by CP bidders to develop bid proposal
  - » Process:
    - Develop ground motions for MCE and OBE according to established procedures
    - Develop horizontal design spectra for V_{S30} zones from PSHA using available site data and alignment data
    - Define controlling events using hazard deaggregation
    - Develop vertical design spectra from horizontal spectra
    - Produce time-histories matched to design spectra
    - Special sites such as those with structures over water crossings require site-specific exploration and are not included

FINAL GROUND MOTIONS

- Process for developing Final Ground Motions – Non-Special Sites
  - » Purpose: Develop ground motions at ground surface to be used during final design of elements such as aerial structures, bridges, tunnels, etc. for non-Special Sites (i.e., locations without highly nonlinear soils)
  - » Process:
    - Develop ground motions for MCE and OBE according to established procedures
    - Revise horizontal design spectra for V_{S30} zones from PSHA using site data and alignment data acquired by CP Contractor
    - Define controlling events using hazard deaggregation
    - Develop vertical design spectra from horizontal spectra
    - Produce time-histories matched to design spectra

FINAL GROUND MOTIONS

- Special Sites
  - » Locations where GMPEs cannot be confidently applied to develop vibratory ground motions at the ground surface
  - » Such sites may include:
    - Locations subject to liquefaction
    - Locations subject to highly nonlinear soil response
    - River crossings
    - NEHRP Site Classes E and F
    - Locations with complex structures (long span bridges, tunnels, underground structures, trench boxes, etc.)

FINAL GROUND MOTIONS

- Process for developing Final Ground Motions – Special Sites
  - » Purpose: Develop ground motions at depth to be used during final design of elements located at Special Sites
  - » Process:
    - Develop ground motions for MCE and OBE according to established procedures
    - Develop spectra and spectrally matched ground motions for V_{S30} of 520 m/s, 760 m/s and 1220 m/s from PSHA and deaggregation in advance of Special Site exploration
    - CP Contractor to obtain V_S measurements in 500 ft boring
    - Develop horizontal design spectra at specified depth in profile
    - Produce time-histories matched to design spectra
    - CP contractor to perform site-response analysis to produce horizontal design ground motions and spectra at ground surface
    - Develop vertical design spectra from horizontal spectra

FAULT SCREENING AND DISPLACEMENT HAZARD

- **Process for Fault Screening/Hazard Analysis**
  - » Purpose: Determine whether faults that cross or are in close proximity to the alignment are hazardous and if so conduct a hazard analysis
  - » Process for Fault Screening:
    - Holocene displacement (i.e., movement within last 10,000 yr)
    - Slip-rate greater than 1 mm/year
    - Recurrence interval less than 1,000 yr
  - » Process for Hazard Analysis:
    - Conduct probabilisitc displacement hazard analysis (PDHA) for MCE and OBE at fault crossings for hazardous faults passing fault screening
    - Determine displacement, fault orientation relative to alignment, width of fault zone and locations of displacement

USER NEEDS

- Required hazard data
  - » Vibratory Ground Motion:
    - Validated probabilistic seismic hazard analysis (PSHA) code
    - Seismic source model (faults and distributed seismicity)
    - Ground motion prediction equations in terms of V_{S30}
    - Full logic tree to capture uncertainty
    - Deaggregated hazard to define controlling events
    - Used OpenSHA, UCERF2 source model and NGA-West1 GMPEs
    - Will update with UCERF3 and NGA-West2 GMPES going forward
  - » Fault Surface-Rupture Displacement:
    - Validated Probabilistic Displacement Hazard Analysis (PDHA) code
    - Seismic source model (faults)
    - Fault displacement scaling relationships in terms of magnitude, type of fault, etc.
    - Full logic tree to capture uncertainty
    - Will use UCERF3 and currently available fault displacement scaling relations

SEISMIC DESIGN CRITERIA

- Discussion

THANK YOU

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