Discussion of Potential Trench Issues

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9/23/2020

These are my personal opinions,
not necessarily those of XCAP or the City of Palo Alto

Potential Trench Issues

- These slides discuss the potential issues for the Charleston/Meadow Trench
  - While the AECOM trench analysis highlights these issues, it does little to determine their solvability
- Potential Issues:
  - Cost
  - Construction duration
  - Creek interference
  - Groundwater leaking/pumping
  - Interference with groundwater flow
  - Tiebacks

Trench Cost

- AECOM's cost estimate for the South Palo Alto trench is $800-950 million
  - However, this cost estimate is inconsistent with other trench projects
  - Also note that these trenches are all much wider than the Palo Alto trench

Rail Trench Project	Total Price (millions $)	Completion Date	Length (ft)	Road Overpasses	Creeks	Trench in Water Table?	Cost/linear foot (thousands $)
South Palo Alto	800-950	2025 (est)	6,000	2	2	Yes	133-158
Reno ReTRAC	282	COMPLETED Dec 2005	10,560	11	0	Yes	27
San Gabriel CA (Alameda Corridor East)	293.7	COMPLETED Sept 2018	7,920	4	2	Yes	37
Carlsbad CA (Short Design)	224	2030 (est)	6,000	6	??	Yes	37
Carlsbad CA (Long Design)	335	2030 (est)	8,400	7	??	Yes	40
Phoenix Sky Harbor	441	2025 (est)	12,000	1	0	??	37

Note that costs are not necessarily in same-year dollars

A $300 million trench estimate would change the Palo Alto trench conversation

Trench Cost (cont'd)

- The Carlsbad Feasibility Study includes a cost analysis which adjusts the trench construction costs into 2016 dollars
  - These costs only include the actual construction, not design/etc

Table 10.2: Comparison of CVDT Proposed Cost with Recently Completed Similar Trench Structures in 2016

Project	Total Construction Cost ($ millions)	Max. Trench Height (ft)[4]	Trench Width (ft)	Trench Length (ft)	Adjusted 2016 Cost / LF of Trench[3]
Reno Transportation Rail Access Corridor[1]	$171 (2002)	33	54	10560	$39,803
San Gabriel Trench Grade Separation[2]	$173 (2012)	30	51	7920	$33,681
CVDT Long Trench (With 30% Contingency)	$226 (2016)	32	55	8100	$27,852
CVDT Short Trench (With 30% Contingency)	$155 (2016)	32	55	5700	$27,263

From Carlsbad Village Double Track – Railroad Trench Alternative Economic Analysis and Feasibility Study (January 2017)

Construction Duration

- AECOM estimates that the Charleston/Meadow trench will require 6 years of construction
- Comparisons:
  - The Reno trench was constructed in 3 years
    - The Reno trench is 75% longer and about twice as wide as Palo Alto's
    - Reno has 11 overpasses compared to Palo Alto's 2 overpasses
    - Reno has similar ground-water constraints
    - Reno's trench was constructed in the middle of an urban environment
    - Reno's excavation was complicated by the removal of large boulders
  - The Alameda trench was completed in less than 4 years

A 6-year construction estimate for Charleston/Meadow trench seems generous

Creek Interference

- Adobe Creek is located ~1200 feet from Charleston Road
  - This makes it difficult for the trench to rise above the creek
  - Some interference with the creek likely is unavoidable
- The current AECOM design dams the creek, pumping the water over the trench
  - It is possible that Valley Water may choose to disallow this design
- Other option is bring creek under the trench using either passive or powered siphons
  - Passive siphons are simpler, but can accumulate sediment
  - Active siphons require backup power, but are less prone to sediment
- Siphons likely would solve creek interference, however they add complexity
  - Siphons would require approval of Valley Water

Mitigations for Creek Interference

- To the first order, creek interference is acceptable provided sufficient the cross-sectional area is maintained
  - While not ideal, sometimes a reduced cross-sectional area is still acceptable if creek geometry allows enough backup to increase pressure
- Cross-sectional area can be increased by widening the creek and/or deepening the creek under the rail
  - The creek flow is currently limited by its culvert under Alma
- The amount of creek interference can also be somewhat reduced by varying the trench's vertical curves
  - Designing the vertical curve to increase the slope at Charleston, results in a more-rapid rise from Charleston to Adobe Creek
  - Raising the track south of Adobe Creek can also reduce creek interference by decreasing the amount of levelling-out that occurs between Charleston and Adobe Creek
  - Reducing the bridge-deck thickness at Charleston reduces creek interference
- The creek interference can also be greatly reduced by increasing the allowable curvature of the rail's vertical curve
  - XCAP should request Caltrain Grade Separation Study to evaluate this topic

Groundwater Leakage

- The current Charleston/Meadow trench design allows groundwater to leak into the trench, requiring continual pumping
  - Pumping permanently lowers the local water table
  - Groundwater pumping must be treated for pollutants
- Conversely, the Reno, Alameda, and Carlsbad trenches all seal the trench from the surrounding groundwater
  - The Carlsbad Feasibility Study compared construction techniques and found that four met their groundwater control criteria
- The trench still requires pumps to eliminate rainwater
  - Stormwater pumping operation/maintenance is approx. $4000-$8000 per year

Table 6.1: Wall System Evaluation Summary

Wall Type	Applicability to Soil Conditions	Groundwater Control	Bridge Abutment Loading	Construction Duration and Impact	Utility/ROW Conflicts
Secant Pile Wall	✓	✓	✓	✓	✓
Slurry-Diaphragm Wall	✓	✓	✓	✓	✓
Deep Soil Mixing (DSM) Wall	✓	✓	✓	✓	✓
Cantilever Wall without Shoring	✓	×	✓	✓	×
Cantilever Wall with Sheetpile Shoring	×	✓	✓	×	✓
Soil Nail Wall	✓	×	×	✓	×
Soldier Piles and Lagging	✓	×	✓	×	✓
MSE Walls	×	×	✓	✓	×

Legend: × Criteria not satisfied
✓ Criteria satisfied

From Carlsbad Village Double Track – Railroad Trench Alternative Economic Analysis and Feasibility Study (January 2017)

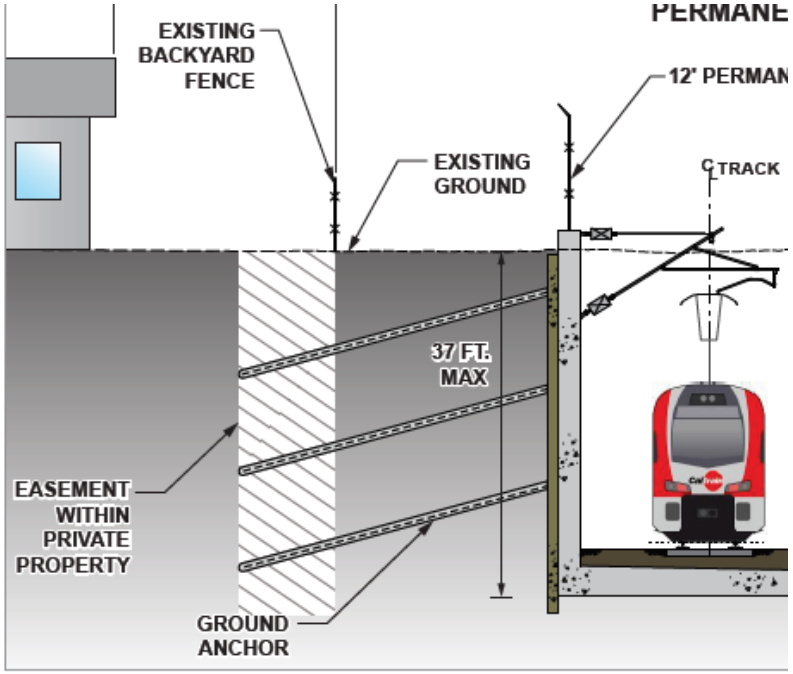
Groundwater Flow

- One concern is that the 30-foot trench will interrupt the flow of groundwater
  - The groundwater depth in Charleston/Meadow is 15-20 feet
- However, consider the number of development at San Antonio and along El Camino
  - The parking/foundations of these developments are much deeper than 30 feet
  - My lay opinion: most groundwater flow is already being constrained to deeper than 30 feet
- However, the trench's impact on groundwater flow should be determined by a groundwater analysis

Trench Tiebacks

- Tiebacks prevent the trench walls from caving inward
  - Tiebacks would likely require easement for the homes on the west side of the tracks
  - Tiebacks also prevent trees from being planted near the trench
- Some construction techniques (such as slurry walls) produce a much stiffer wall, which reduce (but not necessarily eliminate) the need for tiebacks
- The Alameda and Carlsbad trenches could <u>not</u> use tiebacks due to the close proximity of utilities and right-of-way boundaries
  - Those trench projects instead support the wall using struts at the top of the walls
  - The struts are installed in compression to counteract the lateral soil pressure
- The choice of struts/tiebacks depend on a geotechnical soil analysis

Struts <u>may</u> reduce/eliminate the need for trench tiebacks



Alameda Trench Struts

Trench Tiebacks (cont'd)

Picture of Alameda Corridor East (ACE) Trench showing:

- Overhead struts
- Three sets of tracks
- Double-stack rail cars

Summary

- The Charleston/Meadow trench has many engineering challenges
  - My lay opinion: these engineering challenges won't be easy but (from the current data) they don't appear to be show stoppers
- The cost estimates for the Charleston/Meadow trench are not consistent with other rail trench projects
  - The community would be well-served if the City consults with the companies that successfully completed the Reno/Alameda rail trench projects and/or are planning the Carlsbad trench

The potential benefits of the trench alternative warrants refined analysis