City of Palo Alto (ID # 5175)

City Council Staff Report

Report Type: Study Session **Meeting Date: 10/20/2014**

Summary Title: Palo Alto Grade Separation and Trenching Study

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From: City Manager

Lead Department: Planning and Community Environment

Recommendation

This study session provides the City Council an opportunity to discuss findings in the attached report by Hatch Mott McDonald (HMM) and provide direction on next steps. No action is recommended at this time.

Executive Summary

HMM, a consulting firm specializing in construction engineering, was hired at the direction of the Palo Alto City Council to study conceptual grade separation alternatives for a portion of the Caltrain right of way encompassing three existing at-grade crossings (Charleston, Meadow, and Churchill). This study provides preliminary information on the potential impacts and cost of construction (by order of magnitude) for various roadway submersion and trenching alternatives.

This information is intended to facilitate community dialogue on the issue and ultimately to help form a policy position on grade separations. The study is not definitive in determining an ultimate configuration, but does provide a starting point for dialogue on the issue. Specifically, the study indicates that the roadway submersion alternatives would require significant property acquisitions, while the trenching alternatives would not. Also, the trenching alternatives would maintain turning movements along Alma Street, while not all of the roadway submersion alternatives would do so.

For example, the two percent (2%) grade trenching alternative would grade separate Charleston and Meadow for around $488 million and require zero property acquisitions versus the alternative that submerges the roadway beneath the railroad tracks at Charleston and Meadow and maintains turning movements on and off of Alma which would cost approximately $320 million and require acquisition of 32 full parcels and seven partial parcels.

Background

At the November 4, 2013 City Council meeting, HMM was authorized, at a cost of $59,790, to move forward with Phase I of an analysis that delivered a conceptual cost estimate for a number of preliminary grade separation alternatives south of the California Avenue Caltrain Station. The most important information obtained from this analysis was intended to be a clearer understanding of the differences in cost and construction impacts between submerging the roadway and trenching the railroad at certain intersections in Palo Alto. The reason trenching was only studied south of Oregon Expressway is that because if it was determined that trenching was cost prohibitive south of Oregon Expressway it certainly would be north of Oregon Expressway where trenching the corridor would require the complete reconstruction of the City's three existing grade separated crossings (Oregon Expressway, Embarcadero, and University) and submerging the City's two Caltrain stations (California Avenue and Palo Alto), in addition to complications posed by San Francisquito Creek.

Phase I of the analysis, as presented in this report, evaluates the preliminary alternatives by evaluating construction feasibility, right of way impacts (i.e. property acquisitions), and concept level cost estimates for comparison purposes.

Phase II of the analysis would develop the City's selected preliminary alternatives to a final concept level, produce concept design exhibits, and provide refined order of magnitude project costs and assessments of feasibility. The cost of Phase II would be an additional $67,760 and staff is interested in hearing from the Council whether this additional work is needed to provide sufficient information for community dialog and policy decisions regarding which of the preliminary alternatives, if any, should be pursued from a funding and logistical standpoint with outside agencies such as Caltrain, the Santa Clara Valley Transportation Authority, and the Metropolitan Transportation Commission.

Listed below are the specific grade separation alternatives evaluated by HMM. Alternatives that were studded by HMM are:

1. Trenching the corridor from approximately San Antonio to approximately Oregon Expressway, which would grade separate both Meadow and Charleston by keeping the existing roadways at-grade and running rail traffic beneath it in an open trench.
    - ❖ Please note that this alternative does not impact whether or not the roadway is submerged below the railroad tracks at Churchill.
2. Submerging the roadway beneath the railroad tracks at Churchill
3. Submerging the roadway beneath the railroad tracks at Meadow
4. Submerging the roadway beneath the railroad tracks at Charleston

It should be noted, as the report from HMM indicates, that if Council chooses to pursue the roadway submersion alternatives at both Charleston and Meadow that maintain turning movements on and off of Alma they must be done as a single project due to their proximity; however, submerging the roadway at Churchill can occur regardless of what happens at the Meadow and Charleston intersections.

Attached for your review is HMM's Palo Alto Grade Separation Study (Attachment A), including an attachment that outlines the costs associated with each alternative. The primary difference between the trenching estimate that was generated by HMM in 2011 and the one generated in this study is that the previous estimate was based on California High Speed Rail Authority (CHSRA) cost of construction per foot figures and did not take local, existing conditions into consideration at the level of detail this study does.

The updated study uses current and local construction cost information. HMM generated their estimates in part by using information they've obtained from current transportation construction projects in the area with similar traits such as the Bay Area Rapid Transit (BART) to San Jose extension project. Furthermore, HMM used figures that are more applicable to the existing conditions at the intersections they studied as it relates to utility relocation costs, right of way impacts, staging, and traffic signal impacts rather than wholesale allowance numbers.

The use of recent and local construction data provides more realistic order of magnitude cost estimates for work on the Peninsula compared to the 2011 study.

Results of the Analysis

As displayed in the Alternative Cost Estimates attachment to the HMM report, the most expensive alternative is the one percent (1%) grade trench alternative at a cost of approximately $1.05 billion. This alternative would not require a design exemption as it relates to the slope of the grade but it's more than double the cost of the two percent (2%) grade trench alternative mainly due to the impacts it would have on Oregon Expressway (already grade separated) and the San Antonio Avenue and California Avenue Caltrain stations based on its expanded footprint. Additionally, this alternative becomes significantly more complex than the two percent (2%) grade trench alternative when existing creeks are considered because instead of the trench being able to go above them the creeks would have to be rerouted, likely requiring additional infrastructure such as pump stations.

Although both the one percent (1%) grade trench alternative and the two percent (2%) grade trench alternative are more expensive than the roadway submersion alternatives they require zero parcel acquisitions, have fewer visual impacts by having a reduced footprint at each intersection, and result in a grade separated roadway that is level with the existing roadways, significantly benefiting bicycle and pedestrian movements.

Table 1 below summarizes the trench alternatives:

Table 1: Summary of Trench Alternatives

Trench Grade	One Percent (1%)	Two Percent (2%)
Cost	$1,050,728,700	$488,187,283
Full Property Acquisitions	0	0

Partial Property Acquisitions	0	0
Turn Movements Maintained	Yes	Yes

Source: Hatch Mott McDonald, 2014

As for the roadway submersion alternatives displayed in the Alternative Cost Estimates attachment to the HMM report, they are significantly less expensive than the trenching alternatives (ranging in price from approximately $85 million to $184 million per roadway submersion) but have far greater impacts in the form of property acquisitions, lost turning movements, and have far more visual impacts at each intersection due to their larger footprints.

Below are two tables that summarize the roadway submersion alternatives. Table 2 below shows the roadway submersion alternatives where Alma Street is left at-grade and therefore turning movements on and off of Alma Street are lost. Table 3 below shows the roadway submersion alternatives where Alma Street is lowered in order to maintain turning movements.

Table 2: Summary of Roadway Submersion Alternatives that Abolish Alma Street Turning Movements

Roadway Submersion Intersection	Churchill	Meadow	Charleston
Cost	$90,334,561	$84,578,797	$101,783,449
Full Property Acquisitions	16	11	18
Partial Property Acquisitions	4	5	3
Turn Movements Maintained	No	No	No

Source: Hatch Mott McDonald, 2014

Table 3: Summary of Roadway Submersion Alternatives that Lower Alma Street to Maintain Turning Movements

Roadway Submersion Intersection	Churchill	Meadow	Charleston
Cost	$183,513,669	$143,385,047	$152,903,454
Full Property Acquisitions	33	14	18
Partial Property Acquisitions	3	4	3
Turn Movements Maintained	Yes	Yes	Yes

Source: Hatch Mott McDonald, 2014

As previously noted, if the roadway submersion alternatives that maintain turning movements on and off of Alma Street at the Meadow and Charleston intersections are selected they must be constructed congruently, as a single project, and that will cost an additional $23,177,765 for a total project cost of $319,466,266 ($143,385,047 + $152,903,454 + $23,177,765).

Next Steps

Based on Council comments, staff will come back to Council in the near future with a staff

recommendation for Council review and approval on a preferred alternative to pursue. By identifying a preferred alternative staff will be more effective in both discussing the issue with transportation and funding agencies in addition to facilitating our public outreach efforts.

The property acquisitions associated with some of the alternatives presented in the HMM report are significant and therefore staff feels strongly that any decision that is made on this topic should not be rushed. Therefore, staff felt that first discussing the HMM report in a study session before bringing it before Council for action was most appropriate.

Finally, as noted above, staff is interested in learning whether Council believes further study, such as Phase II of the HMM scope of work, should be done or if at this time the information HMM has already provided is sufficient.

Attachments:

- Palo Alto Grade Separation Study 10-7-2014 (PDF)

Hatch Mott MacDonald

MEMO

To Richard Hackmann, City of Palo Alto
From Michael Canepa, PE, HMM
Date 10/7/14
Project # 324006
Page 1 of 7
CC Chris Metzger, Brian Hughes, Derek Penrice
Subject Palo Alto Grade Separation Study

This memo discusses alternatives for grade separating the Caltrain tracks at existing at-grade crossings in the City of Palo Alto. The two alternatives evaluated in this study were: construction of an undercrossing at Churchill Ave, Meadow Dr, and Charleston Rd, and the construction of a rail trench under Meadow Dr and Charleston Rd. The following information was evaluated in support of the findings of this study:

- Typical cross sections for each alternative
- Plan/profile for each alternative
- ROW impacts
- Traffic impacts
- Utility impacts
- Cost estimate

Undercrossing at Churchill Ave, Meadow Dr, and Charleston Rd

The first alternative is to build an undercrossing at Churchill Ave, Meadow Dr, and Charleston Rd to separate the existing Caltrain tracks from the roadways. Due to the proximity of Alma St to the rail corridor, two scenarios were evaluated – keeping Alma St at existing grade and lowering Alma St to match the elevation of the undercrossing.

Design Criteria and Assumptions

- Design speed is assumed to be 5 mph above the posted speed limit or a minimum of 30 mph
- Maximum roadway grade used is 8%
- Maximum sidewalk grade is 5% (per ADA)
- Roadway vertical clearance is 15.5’ (per JPB Standards for Design and Maintenance of Structures 2.4.2)
- Sidewalk vertical clearance is 10’ (per HDM 208.6)
- Minimum vertical curve length is 200’ (per HDM 204.4)
- 1:10 depth to span ratio for rail bridges
- Roadway bridge depths:

- Reinforced concrete bridge (continuous span over Caltrain trench) – AASHTO Bridge Design Table 2.5.2.6.3-1
- Prestressed girder bridge (simple span over roadway undercrossing) – based on manufacturer's recommend depth for prestressed girders

Typical Roadway & Bridge Sections

- Churchill Ave undercrossing width is 60' when Alma St remains at existing grade
  - 2x 12' thru lanes
  - 2x 2' buffer
  - 2x 6' bike lane
  - 2x 2' barrier
  - 2x 8' sidewalk
- Churchill Ave undercrossing width is 70' when Alma St is lowered
  - 2x 12' thru lanes
  - 12' right turn lane
  - 2' buffer
  - 2x 6' bike lane
  - 2x 2' barrier
  - 2x 8' sidewalk
- Meadow Dr undercrossing width is 80' when Alma St is at existing grade or lowered
  - 4x 11' thru lanes
  - 2x 2' buffer
  - 2x 6' bike lane
  - 2x 2' barrier
  - 2x 8' sidewalk
- Charleston Rd undercrossing width is 80' when Alma St is at existing grade or lowered
  - 4x 11' thru lanes
  - 2x 2' buffer
  - 2x 6' bike lane
  - 2x 2' barrier
  - 2x 8' sidewalk
- Rail bridge width at undercrossing is 40'
  - 15' track center (per Caltrain Design Criteria 3.1)

- 2x 9.5' from centerline of track to OCS pole (per Caltrain Standard Drawing ETF-0001-0010)
- 2x 1.5' OCS pole (per Caltrain Standard Drawing ETF-0001-0010)
- 2x 1.5' from OCS pole to edge of bridge deck

Two scenarios were evaluated at each undercrossing. In the first scenario, Alma St would remain at existing grade and each undercrossing would pass below both the Caltrain tracks and Alma St. This would disconnect Alma St from the crossing streets and would require traffic to be routed to the next crossing to the north or south. In the second scenario, to maintain connectivity between the streets, Alma St. would be lowered to match the elevation of the crossing street.

At each crossing, several streets will be closed to avoid property impacts at the intersections with the undercrossing. Closures at these intersections will force traffic to adjacent intersections which may require signalization to compensate for the increase in traffic.

In the first scenario, with Alma St at existing grade, the following impacts will occur:

- ROW impacts along Churchill from Castilleja Ave to Emerson St with intersection closures at Mariposa Ave and the eastern side of Castilleja Ave
- ROW impacts along Meadow Dr from 2nd St to Emerson St with intersection closures at Park Blvd and 2nd St
- ROW impacts along Charleston Rd from Ruthelma Ave to Wright Pl with intersection closure at Park Blvd
- Traffic impacts at Madrono Ave/Churchill Ave intersection
- Traffic impacts at Wilkie Way/Meadow Dr intersection
- Traffic impacts at Ruthelma Ave/Charleston Rd intersection and Wilkie Way/Charleston Rd intersection

For this scenario, there will be 16 full parcel takes and 4 partial takes for Churchill Ave undercrossing, 11 full parcel takes and 5 partial takes for Meadow Dr undercrossing, and 17 full parcel takes and 3 partial takes for Charleston Rd undercrossing.

In the second scenario, with Alma St lowered to the new elevation of the undercrossing, the following impacts will occur ***in addition*** to those listed above:

- ROW impacts along Alma St from Melville Ave to Lowell Ave with intersection closures at Kellogg Ave and Coleridge Ave
- ROW impacts along Alma St from Alma Village Cir to Meadow Dr
- Intersection closure at Lindero Dr if undercrossings are constructed at both Meadow Dr and Charleston Rd
- Traffic impacts at Melville Ave/Alma St intersection and Lowell Ave/Alma St intersection

The total number of parcel takes required for this scenario ***in addition*** to those listed above is 17 additional full parcel takes and 1 less partial take for Churchill Ave undercrossing, 14 additional full parcel takes and 1 less partial take for Meadow Dr undercrossing, and no change in parcel takes for Charleston Rd undercrossing.

This study also evaluated the potential of combining roadway undercrossings with a slight elevation of the rail tracks to minimize the extent of the ROW/traffic impacts along the crossing streets. For every 3' the tracks are raised, the length of the impacted area along the cross street decreases by 40'-50' at each end.

In the first scenario, with Alma St at existing grade, the following benefits will occur when the tracks are raised 3 feet:

- 3 parcel impacts will no longer be required at Churchill Ave
- Castilleja Ave closure will no longer be required at Churchill Ave
- 2 parcel impacts will no longer be required at Meadow Dr
- 2nd St closure will no longer be required at Meadow Dr
- 3 parcel impacts will no longer be required at Charleston Rd

In the second scenario, with Alma St lowered to the new elevation of the undercrossing, the following benefits will occur ***in addition*** to those listed above when the tracks are raised 3 feet:

- 2 additional parcel impacts will no longer be required at Churchill Ave
- Alma Village Cir closure will no longer be required at Meadow Dr

Rail Trench Under Meadow Dr and Charleston Rd

The second alternative is to build a trench under Meadow Dr and Charleston Rd to separate the existing Caltrain tracks from the roadways. Due to the constraints of Matadero Creek, Barron Creek, and Adobe Creek crossing the corridor, two scenarios were studied to avoid impacts to the creeks – maximum grade of 1% (preferred maximum) and maximum grade of 2% (design exception required).

Design Criteria and Assumptions

- Design speed is assumed to be 90 mph (per Caltrain Design Criteria 1.0)
- Preferred maximum grade is 1%; maximum grade with design exception is 2% (per Caltrain Design Criteria 7.1)
- Minimum rail vertical clearance is 24.5’ (per Caltrain Standard Drawing SD-2002)
- Minimum distance from TOR to creek invert at creek crossing is 32.5’ (24.5’ rail vertical clearance + 3’ trench lid + 5’ cover)

Typical Roadway & Trench Sections

- Trench width is 47’
  - 15’ track center (per Caltrain Design Criteria 3.1)
  - 2x 10’ from track centerline to trench wall (per Caltrain Standards for Design and Maintenance of Structures 2.4.3)
  - 2x 3’ trench wall
  - 2x 3’ excavation support wall
- Churchill Ave bridge width is 66’
  - 2x 12’ thru lanes
  - 12’ right turn lane
  - 2’ buffer
  - 2x 6’ bike lane
  - 2x 8’ sidewalk
- Meadow Dr bridge width is 76’
  - 4x 11’ thru lanes
  - 2x 2’ buffer
  - 2x 6’ bike lane

  - 2x 8’ sidewalk
- Charleston Rd bridge width is 76’
  - 4x 11’ thru lanes
  - 2x 2’ buffer
  - 2x 6’ bike lane
  - 2x 8’ sidewalk

Two scenarios were studied for the rail trench alternative. In the first scenario, a maximum grade of 2% is used to minimize the length of the trench while avoiding impacts to the creeks. Using this alternative, the trench will begin just south of the Matadero Creek. It will pass under Baron Creek, Meadow Dr, Charleston Rd, and Adobe Creek, and will return to grade just north of San Antonio Rd. The depth and grade of the trench is controlled by the 32.5’ clearance required under the two creeks (Baron Creek and Adobe Creek) and the constraints at either end (Matadero Creek and San Antonio Rd). Both the 1.75% grade into the trench and the 2.00% grade coming out of the trench will require design exceptions.

In the second scenario, a maximum grade of 1% is used, which will also avoid impacts to creeks but will require approximately 10,500’ additional feet of trench and will require the reconstruction of Oregon Expressway and San Antonio Rd. The trench will begin just south of Churchill Ave. It will pass under Oregon Expressway, which will need to be reconstructed to remove the existing undercrossing and return the roadway to surrounding grade level. The trench will continue under Matadero Creek, Baron Creek, Meadow Dr, Charleston Rd, and Adobe Creek, with the depth of the trench being controlled by the 32.5’ clearance require under Matadero Creek and Adobe Creek. As the trench returns to grade at Rengstorff Ave, it will pass under San Antonio Rd, which will need to be raised several feet to accommodate 24.5’ of clearance over the rail. This alternative will not require any design exceptions.

This study also evaluated the potential relocation of the three existing creeks to mitigate design exceptions and minimize trench length. However, relocation of any of the creeks would require resizing of the culverts to accommodate slower flow through a flatter channel. In addition, at Adobe Creek and Matadero Creek, the 100 year flood water surface elevation is at the top of the culvert, and at Baron Creek there is only 1.8’ of freeboard. Any modifications would require upsizing all the culverts to provide 3’ of freeboard. While maintaining a minimum slope of 0.25%, the creek crossing could be relocated several hundred feet north or south, however, this would not provide enough space to avoid a maximum grade design exception for the 2% grade scenario and would only provide a few hundred feet of savings in trench length for the 1% grade scenario.

There will be no permanent ROW impacts with this alternative, as the trench will be built within the existing JPB ROW. Traffic impacts will be temporary, and will be related to construction of the roadway bridges.

Cost Estimate

A preliminary cost estimate for each alternative for comparative purposes is provided as Attachment A to this memo. The major civil components used to produce the preliminary cost estimates include earthwork, trench and bridge structures, pump stations, railroad shooflies, traffic detours, railroad and roadway signaling, utility relocations, and right-of-way costs. Soft costs for professional services and contingency costs have been included as percentages of estimated construction and project costs.

Attachments

Attachment A – Alternative Cost Estimates

Palo Alto Caltrain - Grade Separation Projects
Attachment A - Alternative Cost Estimates

line no.	Description	Unit	Unit Cost	Rail Trench 1% Max Grade (Caltrain Preferred)		Rail Trench 2% Max. Grade (w/Design Exception)		Churchill Alma At-grade		Churchill Alma Lowered		Meadow Alma At-grade		Meadow Alma Lowered		Charleston Alma At-grade		Charleston Alma Lowered		Meadow&Charleston Alma Lowered	
				Qnty	Total Cost	Qnty	Total Cost	Qnty	Total Cost	Qnty	Total Cost	Qnty	Total Cost	Qnty	Total Cost	Qnty	Total Cost	Qnty	Total Cost	Qnty	Total Cost
001	***Estimate Summary***																				
002	**Construction**				622,440,744		289,191,768		25,200,625		52,677,350		27,370,319		55,705,363		29,076,479		57,591,565		128,158,000
003	**Utility Relocation and Protection**				213,300		104,400		1,664,300		4,960,380		2,750,450		5,559,850		2,350,750		4,129,000		8,562,750
004	**Subtotal A**				622,654,044		289,296,168		26,864,925		57,637,730		30,120,769		61,265,213		31,427,229		61,720,565		136,720,750
005	**Professional Services (% of Subtotal A)**		**35%**		217,928,915		101,253,659		9,402,724		20,173,206		10,542,269		21,442,825		10,999,530		21,602,198		47,852,263
006	**Right of Way (incl. ROW Services)**				-		-		36,000,000		69,000,000		27,000,000		32,000,000		39,000,000		39,000,000		71,000,000
007	**Subtotal B**				840,582,960		390,549,826		72,267,649		146,810,936		67,663,038		114,708,038		81,426,759		122,322,763		255,573,013
008	**Contingency (% of Subtotal B)**		**25%**		210,145,740		97,637,457		18,066,912		36,702,734		16,915,759		28,677,009		20,356,690		30,580,691		63,893,253
009	**Total Project Cost (2014 dollars)**				1,050,728,700		488,187,283		90,334,561		183,513,669		84,578,797		143,385,047		101,783,449		152,903,454		319,466,266
010																					
011	**note 1) Professional Services includes Design Engineering, Project Mgmt, and Construction Mgmt.**																				
012																					
013																					

PRELIMINARY-- worksheet for discussion only

Palo Alto Caltrain - Grade Separation Projects
Attachment A - Alternative Cost Estimates

line no.	Description	Unit	Unit Cost	Rail Trench 1% Max Grade (Caltrain Preferred)		Rail Trench 2% Max. Grade (w/Design Exception)		Churchill Alma At-grade		Churchill Alma Lowered		Meadow Alma At-grade		Meadow Alma Lowered		Charleston Alma At-grade		Charleston Alma Lowered		Meadow&Charleston Alma Lowered	
				Qnty	Total Cost	Qnty	Total Cost	Qnty	Total Cost	Qnty	Total Cost	Qnty	Total Cost	Qnty	Total Cost	Qnty	Total Cost	Qnty	Total Cost	Qnty	Total Cost
014	***Construction***																				
015	**Support of Excavation (SOE)**		-		-		-		-		-		-		-		-		-		-
016	SOE Area	SF	80	2,428,595	194,287,616	1,239,904	99,192,320	59,200	4,736,000	155,040	12,403,200	56,320	4,505,600	155,776	12,462,080	60,000	4,800,000	160,320	12,825,600	381,600	30,528,000
017	**Excavation**		-		-		-		-		-		-		-		-		-		-
018	Mass Excavation	CY	15	1,232,246	18,483,684	588,380	8,825,706	45,222	678,333	123,748	1,856,222	56,059	840,889	137,788	2,066,822	59,722	895,833	142,161	2,132,417	333,778	5,006,667
019	Offhaul/Disposal - Subcontract Trucking	HR	110	236,180	25,979,845	112,773	12,405,019	8,668	953,435	23,718	2,609,023	10,745	1,181,916	26,409	2,905,033	11,447	1,259,144	27,248	2,997,230	63,974	7,037,148
020	Offhaul/Disposal - Dump Fee (Average)	Load	50	118,090	5,904,510	56,386	2,819,323	4,334	216,690	11,859	592,960	5,372	268,617	13,205	660,235	5,723	286,169	13,624	681,189	31,987	1,599,352
021	**Invert Slab**		-		-		-		-		-		-		-		-		-		-
022	Invert Slab Concrete	CY	600	130,163	78,097,778	54,667	32,800,000	8,800	5,280,000	22,489	13,493,333	10,193	6,115,556	24,919	14,951,111	11,467	6,880,000	26,193	15,715,556	54,267	32,560,000
023	Invert Slab Rebar	TON	2,500	6,508	16,270,370	2,733	6,833,333	440	1,100,000	1,124	2,811,111	510	1,274,074	1,246	3,114,815	573	1,433,333	1,310	3,274,074	2,713	6,783,333
024	**Trench Walls**		-		-		-		-		-		-		-		-		-		-
025	Wall Concrete	CY	900	149,556	134,600,400	77,104	69,394,000	3,211	2,890,000	8,567	7,710,000	3,111	2,800,000	8,618	7,756,000	3,267	2,940,000	8,833	7,950,000	21,700	19,530,000
026	Wall Rebar	TON	2,500	22,433	56,083,500	11,566	28,914,167	482	1,204,167	1,285	3,212,500	467	1,166,667	1,293	3,231,667	490	1,225,000	1,325	3,312,500	3,255	8,137,500
027	**Waterproofing**		-		-		-		-		-		-		-		-		-		-
028	Waterproofing Membrane	SF	10	2,224,604	22,246,040	1,062,940	10,629,400	88,300	883,000	228,900	2,289,000	96,800	968,000	245,760	2,457,600	106,800	1,068,000	256,300	2,563,000	561,600	5,616,000
029	**Fences**		-		-		-		-		-		-		-		-		-		-
030	Fence/Railing	LF	200	38,800	7,760,000	18,000	3,600,000	1,800	360,000	4,400	880,000	1,600	320,000	4,400	880,000	1,800	360,000	4,600	920,000	9,600	1,920,000
031	**Bridges**		-		-		-		-		-		-		-		-		-		-
032	Bridge Deck Concrete	SF	500	13,667	6,833,500	6,478	3,239,000	6,798	3,399,000	2,640	1,320,000	8,858	4,429,000	3,440	1,720,000	8,858	4,429,000	3,440	1,720,000	6,880	3,440,000
033	**Creek Crossings**		-		-		-		-		-		-		-		-		-		-
034	Creek Crossing Concrete	SF	500	2,419	1,209,500	1,599	799,500	-	-	-	-	-	-	-	-	-	-	-	-	-	-
035	**Underdrains**		-		-		-		-		-		-		-		-		-		-
036	Underdrain	Rt-Ft	60	19,400	1,164,000	9,000	540,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-
037	**Pump Stations**		-		-		-		-		-		-		-		-		-		-
038	Pump Station - Location 1	LS	1,000,000	1	1,000,000	1	1,000,000	1	1,000,000	1	1,000,000	1	1,000,000	1	1,000,000	1	1,000,000	1	1,000,000	1	1,000,000
039	Pump Station - Location 2	LS	1,000,000	1	1,000,000	1	1,000,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-
040	**Other Work**		-		-		-		-		-		-		-		-		-		-
041	UPRR Shoofly with Temp. Signal System (Corridor)	Rt-Ft	800	19,400	15,520,000	9,000	7,200,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-
042	UPRR Shoofly with Temp. Signal System (Local)	EA	2,500,000	-	-	-	-	1	2,500,000	1	2,500,000	1	2,500,000	1	2,500,000	1	2,500,000	1	2,500,000	2	5,000,000
043	Rebuild Oregon Expwy	LS	15,000,000	1	15,000,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
044	Rebuild San Antonio Road	LS	5,000,000	1	5,000,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
045	Rebuild California Av Caltrain Statn (N.of Oregon Expwy)	LS	8,000,000	1	8,000,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
046	Rebuild San Antonio Caltrain Statn (S.of San Antonio Rd)	LS	8,000,000	1	8,000,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
047	**Total Construction**				622,440,744		289,191,768		25,200,625		52,677,350		27,370,319		55,705,363		29,076,479		57,591,565		128,158,000

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Palo Alto Caltrain - Grade Separation Projects
Attachment A - Alternative Cost Estimates

line no.	Description	Unit	Unit Cost	Rail Trench 1% Max Grade (Caltrain Preferred)		Rail Trench 2% Max. Grade (w/Design Exception)		Churchill Alma At-grade		Churchill Alma Lowered		Meadow Alma At-grade		Meadow Alma Lowered		Charleston Alma At-grade		Charleston Alma Lowered		Meadow&Charleston Alma Lowered	
				Qnty	Total Cost	Qnty	Total Cost	Qnty	Total Cost	Qnty	Total Cost	Qnty	Total Cost	Qnty	Total Cost	Qnty	Total Cost	Qnty	Total Cost	Qnty	Total Cost
048	***Utility Relocation and Protection***																				
049	Protect-in-Place - Electric (Overhead)	LF	200	340	68,000	160	32,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-
050	Protect-in-Place - Gas - 04"	LF	160	-	-	-	-	150	24,000	-	-	-	-	-	-	685	109,600	-	-	-	-
051	Protect-in-Place - Gas - 06"	LF	200	40	8,000	40	8,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-
052	Protect-in-Place - Gas - 08"	LF	250	130	32,500	40	10,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-
053	Protect-in-Place - Sanitary Sewer - 08"	LF	120	40	4,800	40	4,800	-	-	-	-	-	-	-	-	540	64,800	-	-	-	-
054	Protect-in-Place - Sanitary Sewer - 10"	LF	140	40	5,600	40	5,600	-	-	-	-	-	-	-	-	-	-	-	-	-	-
055	Protect-in-Place - Sanitary Sewer - 30"	LF	300	130	39,000	40	12,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-
056	Protect-in-Place - Storm Drain - 12"	LF	140	-	-	-	-	70	9,800	-	-	50	7,000	-	-	65	9,100	-	-	-	-
057	Protect-in-Place - Water - 06"	LF	200	-	-	-	-	75	15,000	-	-	-	-	-	-	-	-	-	-	-	-
058	Protect-in-Place - Water - 08"	LF	220	40	8,800	40	8,800	-	-	-	-	-	-	-	-	-	-	-	-	-	-
059	Protect-in-Place - Water - 10"	LF	240	-	-	-	-	75	18,000	-	-	-	-	-	-	-	-	-	-	-	-
060	Protect-in-Place - Water - 12"	LF	260	130	33,800	40	10,400	75	19,500	-	-	300	78,000	-	-	-	-	-	-	-	-
061	Protect-in-Place - Water - 16"	LF	300	-	-	-	-	-	-	-	-	300	90,000	-	-	655	196,500	-	-	-	-
062	Protect-in-Place - Water - 18"	LF	320	40	12,800	40	12,800	-	-	-	-	-	-	-	-	-	-	-	-	-	-
063	Relocate - Electric (Overhead)	LF	300	-	-	-	-	650	195,000	5,121	1,536,300	4,181	1,254,300	10,661	3,198,300	2,635	790,500	6,450	1,935,000	13,516	4,054,800
064	Relocate - Electric (Underground)	LF	300	-	-	-	-	400	120,000	362	108,600	-	-	-	-	190	57,000	190	57,000	-	-
065	Relocate - Gas - 02"	LF	160	-	-	-	-	650	104,000	425	68,000	100	16,000	100	16,000	-	-	65	10,400	165	26,400
066	Relocate - Gas - 03"	LF	180	-	-	-	-	500	90,000	510	91,800	-	-	-	-	475	85,500	470	84,600	-	-
067	Relocate - Gas - 04"	LF	200	-	-	-	-	-	-	2,185	437,000	-	-	900	180,000	-	-	1,800	360,000	3,170	634,000
068	Relocate - Gas - 06"	LF	250	-	-	-	-	-	-	-	-	240	60,000	970	242,500	775	193,750	765	191,250	1,735	433,750
069	Relocate - Gas - 08"	LF	300	-	-	-	-	-	-	-	-	1,150	345,000	1,150	345,000	-	-	-	-	1,150	345,000
070	Relocate - Joint Trench (PRI,TEL,CATV,W,G,S/L,SEC)	LF	300	-	-	-	-	500	150,000	455	136,500	-	-	-	-	-	-	-	-	-	-
071	Relocate - Sanitary Sewer - 06"	LF	140	-	-	-	-	500	70,000	466	65,240	-	-	-	-	-	-	-	-	-	-
072	Relocate - Sanitary Sewer - 08"	LF	160	-	-	-	-	-	-	795	127,200	1,400	224,000	1,800	288,000	525	84,000	900	144,000	2,700	432,000
073	Relocate - Sanitary Sewer - 10"	LF	180	-	-	-	-	-	-	-	-	-	-	-	-	700	126,000	-	-	-	-
074	Relocate - Sanitary Sewer - 12"	LF	200	-	-	-	-	-	-	-	-	70	14,000	70	14,000	-	-	-	-	70	14,000
075	Relocate - Sanitary Sewer - 30"	LF	350	-	-	-	-	-	-	-	-	-	-	1,145	400,750	-	-	-	-	1,145	400,750
076	Relocate - Storm Drain - 08"	LF	160	-	-	-	-	100	16,000	149	23,840	-	-	-	-	-	-	-	-	-	-
077	Relocate - Storm Drain - 10"	LF	180	-	-	-	-	-	-	25	4,500	-	-	-	-	-	-	-	-	-	-
078	Relocate - Storm Drain - 12"	LF	200	-	-	-	-	300	60,000	516	103,200	430	86,000	430	86,000	300	60,000	900	180,000	1,330	266,000
079	Relocate - Storm Drain - 15"	LF	220	-	-	-	-	-	-	645	141,900	-	-	-	-	-	-	-	-	-	-
080	Relocate - Storm Drain - 27"	LF	300	-	-	-	-	-	-	-	-	15	4,500	15	4,500	-	-	-	-	15	4,500
081	Relocate - Storm Drain - 36"	LF	400	-	-	-	-	-	-	-	-	50	20,000	50	20,000	-	-	-	-	50	20,000
082	Relocate - Water - 06"	LF	240	-	-	-	-	1,200	288,000	2,550	612,000	120	28,800	120	28,800	-	-	-	-	120	28,800
083	Relocate - Water - 08"	LF	260	-	-	-	-	-	-	-	-	650	169,000	650	169,000	1,225	318,500	1,200	312,000	1,850	481,000
084	Relocate - Water - 10"	LF	280	-	-	-	-	-	-	1,835	513,800	-	-	-	-	-	-	-	-	-	-
085	Relocate - Water - 12"	LF	300	-	-	-	-	-	-	1,835	550,500	800	240,000	900	270,000	-	-	-	-	900	270,000
086	Relocate - Water - 16"	LF	330	-	-	-	-	-	-	-	-	345	113,850	900	297,000	-	-	1,800	594,000	2,700	891,000
087	Relocate - Water - 18"	LF	350	-	-	-	-	-	-	-	-	-	-	-	-	730	255,500	745	260,750	745	260,750
088	Relocate - Water - 24"	LF	400	-	-	-	-	650	260,000	605	242,000	-	-	-	-	-	-	-	-	-	-
089	Relocate - Water - 27"	LF	450	-	-	-	-	500	225,000	440	198,000	-	-	-	-	-	-	-	-	-	-
090	**Total Utility Relocation and Protection**				213,300		104,400		1,664,300		4,960,380		2,750,450		5,559,850		2,350,750		4,129,000		8,562,750

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line no.	Description	Unit	Unit Cost	Rail Trench 1% Max Grade (Caltrain Preferred)		Rail Trench 2% Max. Grade (w/Design Exception)		Churchill Alma At-grade		Churchill Alma Lowered		Meadow Alma At-grade		Meadow Alma Lowered		Charleston Alma At-grade		Charleston Alma Lowered		Meadow&Charleston Alma Lowered	
				Qnty	Total Cost	Qnty	Total Cost	Qnty	Total Cost	Qnty	Total Cost	Qnty	Total Cost	Qnty	Total Cost	Qnty	Total Cost	Qnty	Total Cost	Qnty	Total Cost
091	***Right of Way (incl. ROW Services)***																				
092	Property Take - Partial	LS	1,000,000	-	-	-	-	4	4,000,000	3	3,000,000	5	5,000,000	4	4,000,000	3	3,000,000	3	3,000,000	7	7,000,000
093	Property Take - Full	LS	2,000,000	-	-	-	-	16	32,000,000	33	66,000,000	11	22,000,000	14	28,000,000	18	36,000,000	18	36,000,000	32	64,000,000
094	**Total Right of Way (incl. ROW Services)**				-		-		36,000,000		69,000,000		27,000,000		32,000,000		39,000,000		39,000,000		71,000,000

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