SEATTLE DEPARTMENT OF TRANSPORTATION
FAIRVIEW AVE. NORTH BRIDGE REPLACEMENT
VALUE ENGINEERING
17 OCTOBER 2014

Value Engineering Team:

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SDOT
Seattle Department of Transportation

MENG ANALYSIS

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EXECUTIVE SUMMARY

Purpose and Goals of the Study

This Value Engineering (VE) report is presented to Seattle Department of Transportation and the Perteet / HNTB team to assist in decision making and completion of design at the 60% design stage. The purpose of the study was to review the current documents and offer constructability and VE refinements that can assist in the advancement of the project and reduce risk.

The design team requested that the VE team focus on the following items:

- Construction staging
- Construction cost and risks
- Constructability
- Options for SCL relocation
- Vibration mitigation
- Bridge Seismic resisting system

Value Engineering Team

The multi-disciplined study team included the following disciplines: Geotechnical, Structural, Constructability/Construction, Schedule/Traffic, Cost Estimating, and the Value Engineering team leader.

At the initial kick-off meeting the study goals, objectives and criteria were presented by Seattle's Department of Transportation and consultant design teams. The study team worked together, using the formal Value Methodology and job plan. The essential and secondary functions from the project components were identified with their associated costs; refinement and constructability mitigation ideas were generated. The most viable alternatives were developed. Recommended proposals were presented in an oral presentation at the conclusion of the study and documented herein.

Risk Assessment

The workshop team completed a qualitative risk assessment in which probability and impact were identified for potential project cost and schedule risks. Noise, vibration, maintenance of traffic, and staging were identified as the highest project risks.

Value Engineering Proposals

Key proposals include:

- Refine seismic resistance design in column balanced stiffness and in bearing lengths
- Revise drilled shaft configuration to reduce number of shafts
- Construct the bridge with full traffic shut down on the bridge section
- Adjust localizedchannelization to provide full local access adjacent to bridge.
- Reduce bridge length with abutment ground improvements.

Substantiate Current Design

The study team noted a number of design components that merit continued support:

- The basic lane configuration on the new bridge
- Use of concrete prestressed girder bridge
- Temporary relocation of power lines in order to facilitate construction staging and operations

Summary

The proposed project addresses a small, but vital section of roadway along the east side of Lake Union, long overdue for rehabilitation. The proposed bridge is conservatively designed for long life span and to withstand major seismic events. It provides generous additional pedestrian, bike, and overlook lanes, with similar traffic lanes as the current bridge(s).

The TS&L (Type, Size, and Location) phase of this design considered several alternatives that would have considerably reduced the cost of this project. Those solutions were ultimately rejected based on seismic modeling that predicts liquefaction at deep subsoil levels; with complex measures required to mitigate that risk. The proposed structural design is also in many ways shaped by the City's request to maintain two-way traffic across the bridge during construction.

This study revisited both of these criteria; and while acknowledging them, it also looked at some ways to relax and mitigate the impact on construction cost. VE proposals look at some refinements in the basic foundation and structural design – still maintaining the current basic seismic concepts. It also challenges the need to maintain full traffic during construction, offering ways to mitigate local access concerns. This one issue opens up a number of opportunities in both design approach; and even more importantly very large construction means and methods that can considerably shorten the length of this project, with resultant cost savings, and overall reduced impacts on the community.

This study also addressed the constructability and cost estimate risks, prioritizing them based on probability and impact. The study team identified noise, vibration, maintenance of traffic, and staging as highest risk issues, and accordingly, offered a number of suggestions for reducing those risks.

PROJECT DESCRIPTION AND PLANS

Construction Cost and Size:

Construction cost: $34,062,996.76

Project length: 540 foot long, 67 foot wide, multi-span bridge.

Project location: Along Fairview Ave N between Yale Ave N and Fairview Ave E, on the SE shoreline of Lake Union.

Project schedule: Construction: July 2016 to May 2018 (22 Months)

Project Description (Excerpt from Design Team 60% submittal report):

The City of Seattle Department of Transportation (SDOT) proposes to replace two existing bridges on Fairview Avenue North on the southeast shoreline of Lake Union, in Seattle, Washington. The existing bridges consist of an East and a West Bridge that were built in 1948 and1963. Based on a December 2012 inspection report, both bridges are structurally deficient.

A Type, Size, and Location (TS&L) study analyzed various project construction options and recommended the complete replacement of the East Bridge and West Bridge with a single new multi-span bridge. SDOT's proposed bridge replacement is to construct a 540-foot long, 67-foot wide structure comprised of four 135-foot long spans constructed between new abutments located either end of the new bridge. The new four - span bridge will be supported on bents of four foot diameter reinforced concrete bridge columns, constructed on a foundation of eight foot diameter drilled shafts that will be installed to an approximate depth of 140 feet.

The 67-foot wide structure will accommodate the new roadway section, including two northbound travel lanes, one southbound travel lane, a two-way cycle track, and sidewalks along the east and west side of the bridge. The number of travel lanes for the proposed structure is the same as the existing condition. The plan also includes the addition of a mixed use trail/sidewalk and cycle track along the western side of the bridge. The new mixed use trail/sidewalk and cycle track will provide connectivity for the Cheshiahud Lake Union Loop trail within the project corridor

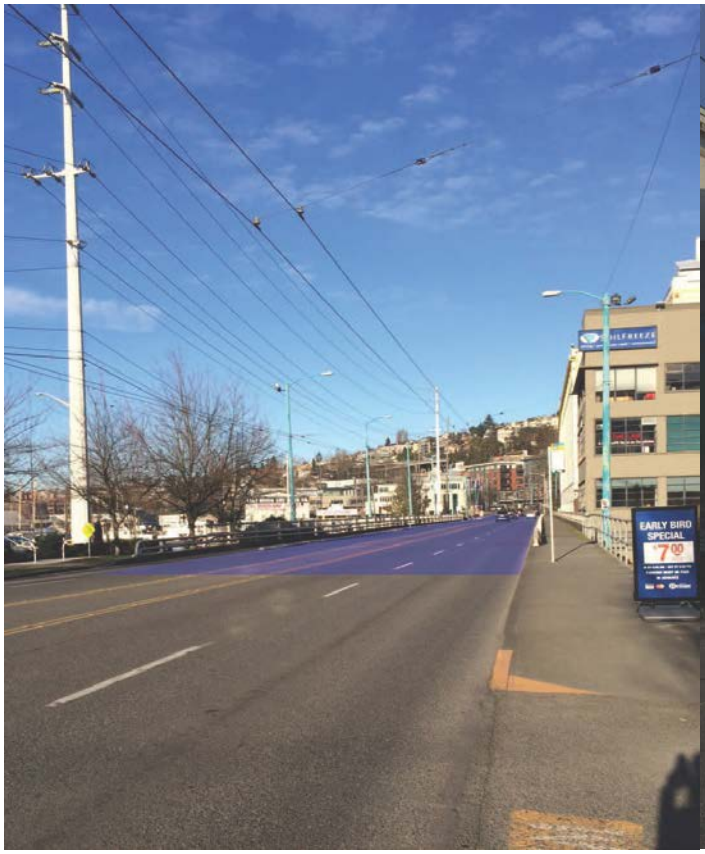
The project will include bridge and roadway reconstruction, relocation of underground and underwater utilities, and the installation of storm water treatment and conveyance. The roadway approaches on the north and south side of the bridge will be reconfigured to provide improved flow and access for traffic as well as pedestrians and users of the Cheshiahud Lake Union Loop Trail. Construction will be staged from the existing structures and adjoining roadway and shoreline areas. Construction access may occur from barges or vessels. Two temporary work trestles will be constructed to support construction equipment and provide access to construct the new structures. Drilled shaft construction will be used to install supports for the temporary trestles.

Demolition of the existing bridges will include the removal of numerous creosote-treated wood piles and concrete piles from the existing City right of way, including those supporting the existing West and East

Bridges. Work also includes the removal of existing concrete rubble along the Lake Union shoreline within the project area.

Existing View

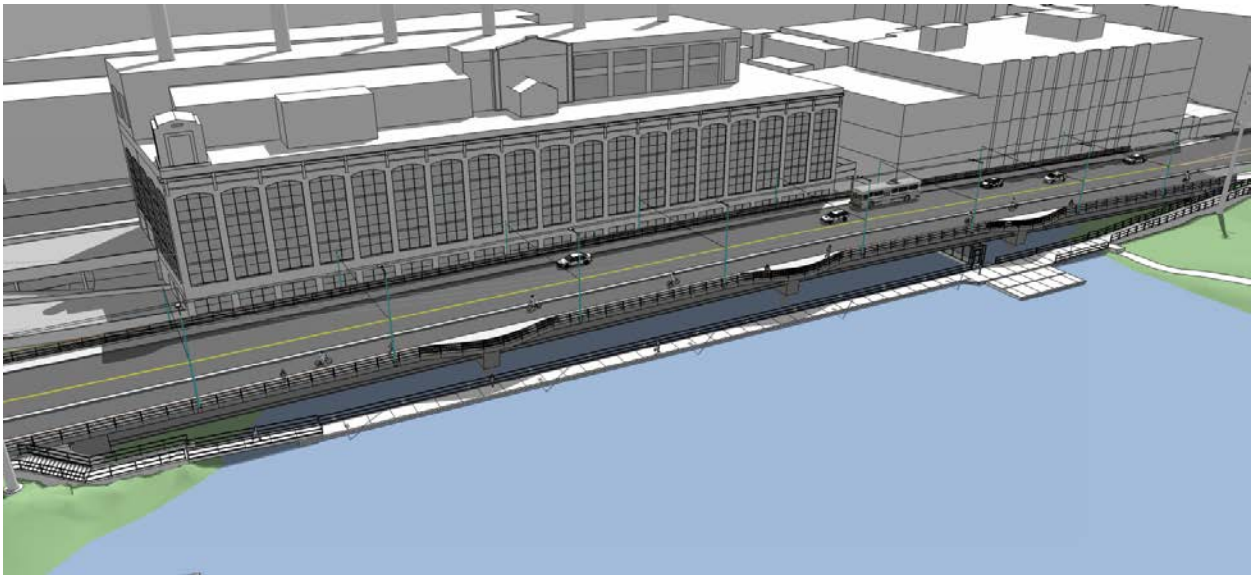
Fairview Ave Bridge North Facing



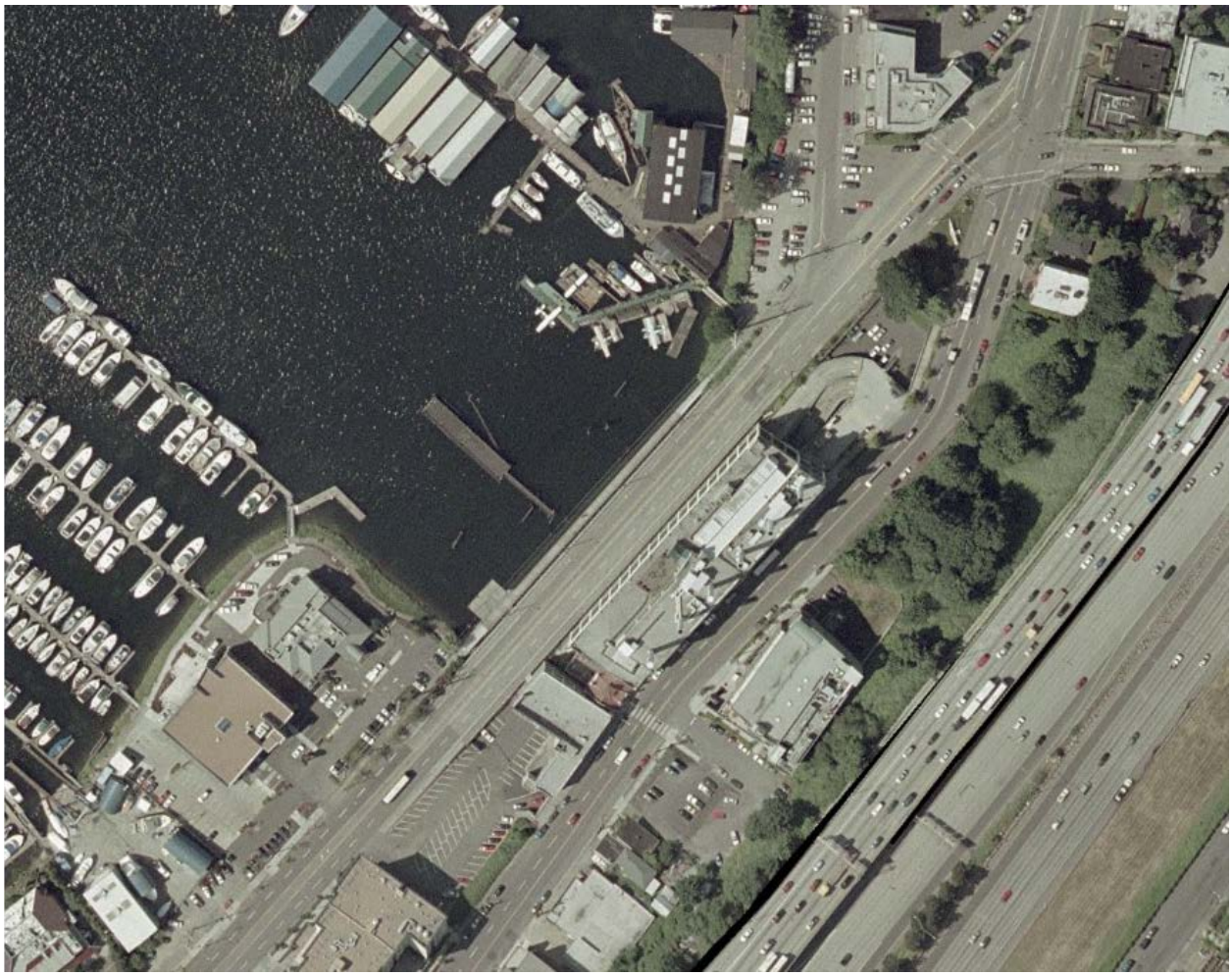
Fairview Ave Bridge South Facing

View from Floating Walkway

Aerial



Project Vicinity Map



Alternatives Summary

Prop. #	Value Engineering Proposal	Current Design	VE Proposal	VE Difference
P1	Segregate Contaminated Materials: No Full Height Removal	1,020,000	206,000	814,000
P2	Permanent Casing - Balancing Stiffness	476,000	263,000	213,000
P3	Shaft Lengths In Bearing Strata	11,084,000	7,917,000	3,167,000
P4	Drilled Shaft Quantity	11,615,000	9,154,000	2,461,000
P5	Bridge Length - Soil improvements	14,919,000	12,716,000	2,203,000
P6a	Maintenance of Traffic - Full Shutdown	16,632,000	7,567,000	9,065,000
P6b	Maintenance of Traffic - 1 Lane Northbound	1,318,000	1,071,000	247,000
P7	Stay-in-Place Forms - Precast Deck Panels	1,339,000	1,030,000	309,000
B1	Reconstruct the East Bridge	21,776,000	13,171,000	8,605,000
	TECHNICAL REPORTS			
T1	Constructability			
T2	SCL (Seattle City Light) Transmission lines			
T3	Vibration criteria			
T4	Construction Schedule and Phasing			

VE IMPLEMENTATION

Prop. #	VE PROPOSAL	PROPOSED COST AVOIDANCE	ACCEPT	REJECT	MODIFY	ACCEPTED VALUE OF PROPOSAL	COMMENTS / DISCUSSION
P1	Segregate Contaminated Materials: No Full Height Removal	814,000					
P2	Permanent Casing - Balancing Stiffness	213,000					
P3	Shaft Lengths In Bearing Strata	3,167,000					
P4	Drilled Shaft Quantity	2,461,000					
P5	Bridge Length - Soil improvements	2,203,000					
P6a	Maintenance of Traffic - Full Shutdown	9,065,000					
P6b	Maintenance of Traffic - 1 Lane Northbound	247,000					
P7	Stay-in-Place Forms - Precast Deck Panels	309,000					
Technical Reports							
T1	Constructability						
T2	SCL (Seattle City Light) Transmission lines						
T3	Vibration criteria						
T4	Construction Schedule and Phasing						

The owner has reviewed each of the Value Engineering proposals and recommends the responses contained herein.	GENERAL COMMENTS REGARDING THIS VALUE ANALYSIS STUDY:
by	
title	
date	

	PROPOSAL	P1
COMPONENT: Contaminated Soil	**AUTHOR**	DA

CURRENT CONCEPT: Soil excavated from drilled shafts and other project excavations treated as contaminated and disposed offsite at permitted disposal facility.

VA CONCEPT: Segregate contaminated material from "clean" soil and dispose of only contaminated portion at offsite disposal facility. Clean soil re-used or sent to a disposal site at lower cost.

FUNCTIONS		
Remove Contaminants	Remove Soil	Protect Lake

CURRENT CONCEPT	**PROPOSED CHANGE**	**DIFFERENCE**
$ 1,020,000	**$** 206,000	**$** 814,000

ADVANTAGES:

- Reduces cost of contaminated soil disposal at landfill.
- Allows reuse of some excavated material
- Separates clean and dirty soil
- Limits contamination of clean soil.

DISADVANTAGES:

- Requires quick turn-around on environmental testing of soil
- Requires separate areas for stockpiling clean and dirty soil
- More handling of material required
- Slows rate of construction

DISCUSSION: The HWA geotechnical report has identified contaminated soils at the site. These contaminated soils are generally located within fill materials found in the upper 15 to 20 feet of soil profile. Native soils below these contaminated soils are understood to be "clean" in the sense that they do not require special handling or disposal.

Construction of the drilled shaft foundations will involve excavating through the contaminated soil and into the underlying "clean" soil. The depth of shaft excavation will

	PROPOSAL	P1
COMPONENT: Contaminated Soil	**AUTHOR**	DA

be approximately 140 feet below the ground surface. Rather than trying to separate the upper 20 feet of contaminated soil from the deeper “clean” soil, all excavated material is being treated as contaminated. This results in disposal of 9,000 tons of excavated soil at a permitted landfill facility. The estimated cost of disposal is $110/ton.

This proposal recommends separating the contaminated soil located in the upper 15 to 20 feet of soil profile from the underlying clean material. By segregating the materials, the cost of contaminated soil disposal is reduced.

Although the idea of segregating soils is conceptually simple, implementation of this approach requires

- The ability to determine in the field whether soils are suitable for clean disposal
- The ability to keep dirty material separated from clean material as it is stockpiled before transport.
- The ability to seal the shaft excavation from infiltration of contaminated groundwater as the shaft is being excavated.

While these constraints on the contractor’s means and methods are significant, they have been used on other major projects, such as the Gerald Desmond Bridge in Long Beach California.

Successful segregation will require sufficient area in proximity of the existing bridge to create separate disposal areas. In view of the limited space within the project limits, the only practical approach for implementation of this proposal will be if there is full closure of Fairview Avenue.

	PROPOSAL	P1
COMPONENT: Contaminated Soil	**AUTHOR**	DA

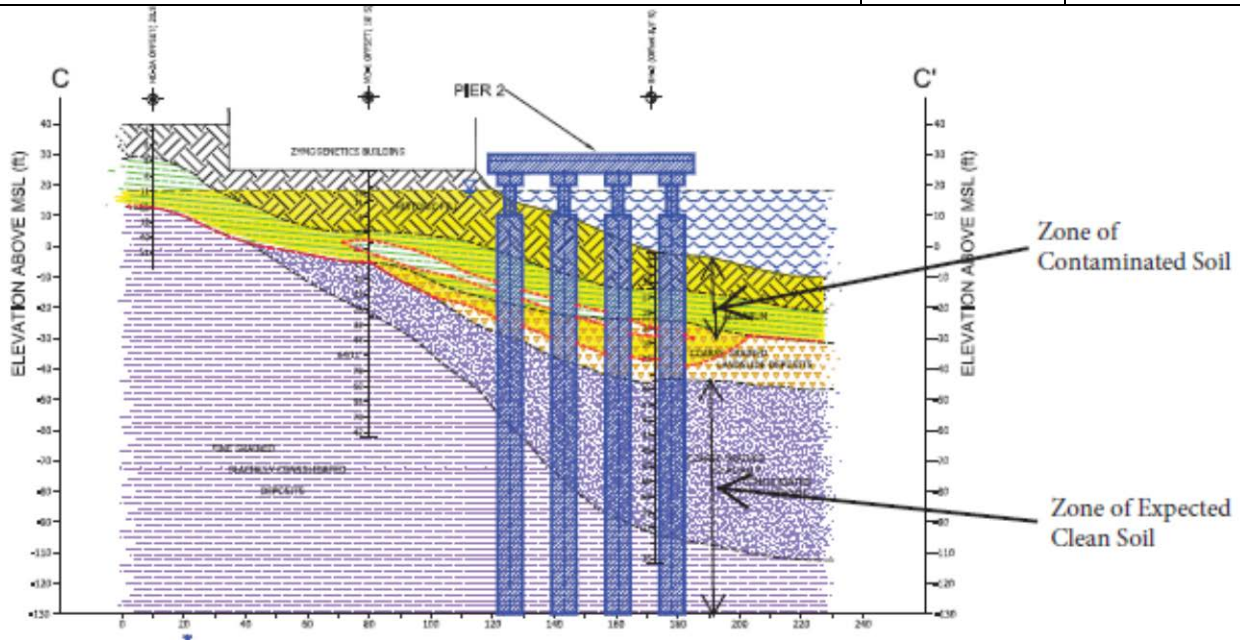


Figure 1. Zone of contaminated soil versus excavation depth.

Figure 1 shows that clean material makes up most of the shaft excavation. Shaft construction will involve use of casing and drilling mud. As long as the head of mud is above the groundwater table, inflow of contaminated groundwater is not expected. To segregate the upper material from the lower, excavation below the base of the historic fill will be required. For costing purposes, it is assumed that the 25% of the shaft excavation is contaminated either directly or indirectly from the excavation process. By cleaning the slurry and checking on conditions at the base of the excavation, material below a certain depth would be treated as clean.

Separate stockpiles will be required for the upper and lower part of each excavation. Water collected from each stockpile will have to be handled separately to avoid cross-contamination of materials and water from the excavation. Environmental testing of the two stockpiles will also be required to confirm the level of contamination in the “dirty” stockpile and that the “clean” stockpile is clean. By taking these methods, the cost of disposal can be reduced by over $800,000.

COST ESTIMATE FORM

COMPONENT: Segregate Contaminated Materials: No Full Height Removal

P1

CURRENT DESIGN					VE PROPOSAL				
ITEM	**QUAN**	**UNIT**	**UNIT COST**	**TOTAL COST**	**ITEM**	**QUAN**	**UNIT**	**UNIT COST**	**TOTAL COST**
Offsite Disposal of Contaminated Mate	9,000	tn	110.00	990,000	Offsite Disposal of Contaminated Mate	1,400	tn	110.00	154,000
					Material Sort Area	4	mo	10000.00	40,000
					Tests	5	ea	1200.00	6,000
Subtotal				990,000	Subtotal				200,000
Inflation	3.00	%		29700	Inflation	3.00	%		6000
Total to nearest $1000				1,020,000	Total				206,000
					Difference				814,000

MENG ANALYSIS

Proposal # **P1**

	PROPOSAL	P2
COMPONENT: Drilled Shafts	**AUTHOR**	DWK
CURRENT CONCEPT: The length of permanent casings has been lengthened to create a balanced stiffness condition for the bridge. Several casings are quite long.		
VA CONCEPT: Forego balanced stiffness and shorten permanent casings as practical.		

FUNCTIONS		
Support bridge	Resist seismic loadings	

CURRENT CONCEPT	**PROPOSED CHANGE**	**DIFFERENCE**
$ 476,000	**$** 263,000	**$** 213,000

ADVANTAGES:	**DISADVANTAGES:**
• Less cost.	• None apparent.

DISCUSSION:

Provisions within the AASHTO code advocating balanced stiffness are advisory, but considered general practice. The bridge structure with its tangent alignment and small slopes is not out of the ordinary. The west dip slope and bowl effect provide a variable response for the foundations. Liquefaction potential is also variable due to lateral spreading over slope.

Much of the foundation's governing loads are applied underground coming from the lateral sliding load. This is in addition to weakened soil properties due to liquefaction. A

	PROPOSAL	P2
COMPONENT: Drilled Shafts	**AUTHOR**	DWK

good effort has been made to evaluate how all these effects combine with the inertial loads from the structure above, but in reality the design loadings and combinations are just educated guesses. In this situation, trying to achieve balanced stiffness for structural response seems overkill. It would also seem impossible to tune it so that the responses are optimum under all the possible scenarios of liquefaction, lateral spreading, and stiffness.

Using casing stiffness to tune the structure response is expensive. Would be more reasonable to limit length of permanent casing to that required to facilitate construction operations. Recommend that length of permanent casing required to facilitate construction operations be limited for cost optimization.

COST ESTIMATE FORM
COMPONENT: Balancing Stiffness

P2

CURRENT DESIGN					VE PROPOSAL				
ITEM	QUAN	UNIT	UNIT COST	TOTAL COST	ITEM	QUAN	UNIT	UNIT COST	TOTAL COST
Furnishing Permanent Casing 8'0" Dia. St	960	lf	450	432,000	Furnishing Permanent Casing 8'0" Dia. St	500	lf	450.00	225,000
Placing Permanent Casing for 8'0" Shaft	12	ea	2500	30,000	Placing Permanent Casing for 8'0" Shaft	12	ea	2500.00	30,000
						-			
						-			
						-			
						-			
						-			
						-			
Subtotal				462,000	Subtotal				255,000
Inflation	3.00	%		13860	Inflation	3.00	%		7650
Total to nearest $1000				476,000	Total				263,000
					Difference				213,000

MENG ANALYSIS

Proposal # **P2**

	PROPOSAL	P3
COMPONENT: Drilled Shafts	**AUTHOR**	DA

CURRENT CONCEPT: Extend drilled shafts to an average depth of 140 feet below the top of the lake mudline or ground surface.

VA CONCEPT: Reduce the length of drilled shaft to approximately 50 feet below the top of coarse-grained glacially consolidated or competent landslide deposit.

FUNCTIONS		
Supports bridge	Resists gravity loads	Resists seismic loads

CURRENT CONCEPT	**PROPOSED CHANGE**	**DIFFERENCE**
$ 11,084,000	**$** 7,917,000	**$** 3,167,000

ADVANTAGES:

- Saves costs.
- Saves construction schedule.
- Less material to dispose.
- Might allow smaller equipment.

DISADVANTAGES:

- Potential for increased lateral movement during seismic loading.
- More settlement under gravity loads.
- More field decisions on when to stop shaft excavations.

DISCUSSION:

Current cost estimates are based on 20 drilled shafts with a shaft diameter of approximately 8 feet and a shaft length of approximately 140 feet. This shaft length results in the toe of the shaft being located in a fine-grained, glaciated consolidated deposits at approximate elevation -130 feet MSL. The estimated cost of the shafts is $9.3 million dollars based on the designer's 60% cost estimate. This proposal recommends shortening the drilled shafts by approximately 40 feet each to reduce project costs.

	PROPOSAL	P3
COMPONENT: Drilled Shafts	**AUTHOR**	DA

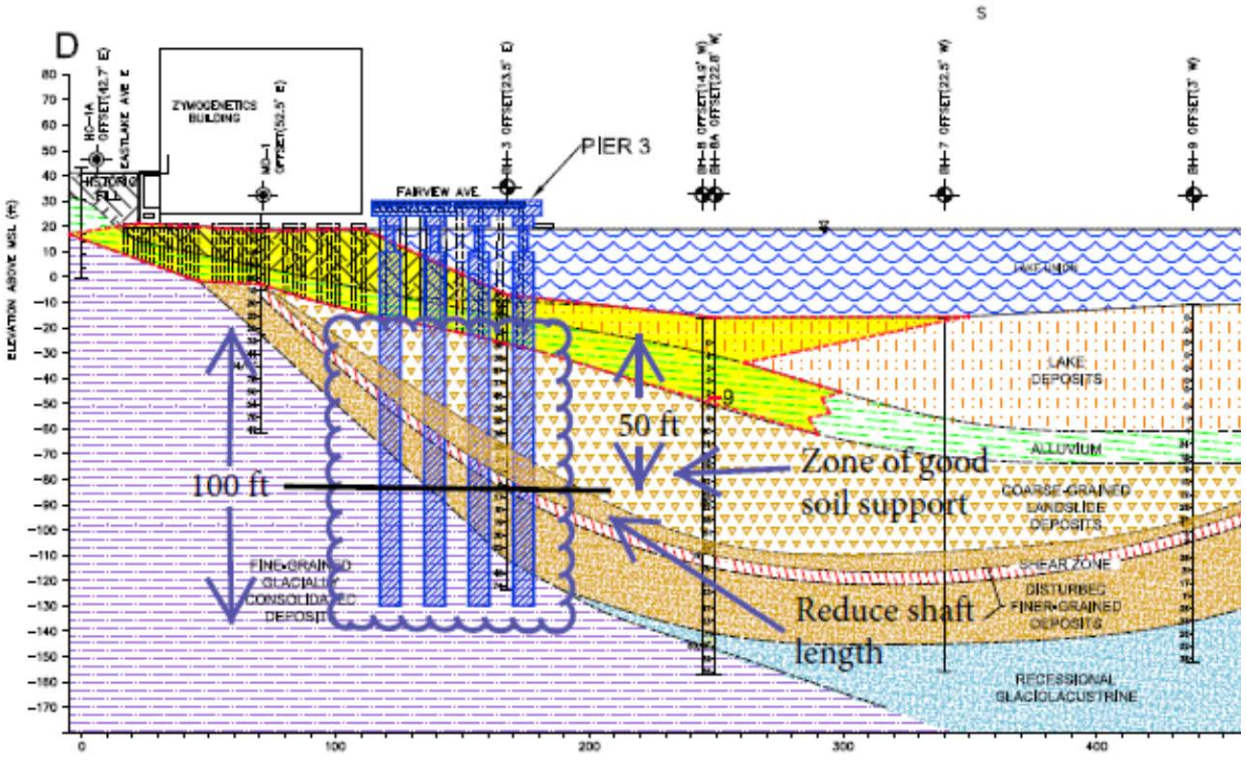
Based on discussions with the designers, it is understood that the length of the drilled shaft is based on the depth to achieve fixity under lateral seismic loading. By going to the designer's planned depth, the lower half of the shaft extends through soil units that have relatively high Standard Penetration Test (SPT) blowcounts – typically ranging from 20 to 30 blows per foot. These soils are not expected to liquefy during the design seismic event and therefore should provide good lateral support during seismic loading.

Although demands from inertial forces and lateral spreading loads are high, the VE team is surprised that the shafts must extend to the depths identified in the geotechnical report and being used as a basis for cost estimating. For these shaft diameters a length of 3 to 5 diameters below the top of competent material would normally be expected to achieve sufficient fixity for seismic design. This rule-of-thumb suggests that rather than extending to 140 feet below the ground surface, the shafts could be shortened to extend 50 feet below the top of the coarse-grained, glacially consolidated deposits.

At one point during design, there was concern about a large, ancient landslide that was identified at the site and that the shafts had to extend below the slip plane associated with the landslide deposit. However, additional site response studies have shown that the design earthquake is not expected to result in landslide movement, and therefore, it is not critical to have the shafts extending below the landslide deposit. This means that if fixity could be achieved above the landslide deposit, the seismic performance would be acceptable.

If fixity at a higher elevation than approximately -130 feet MSL could be demonstrated through further analyses, the potential savings to the project from shortening the shafts could be substantial. For example, if 40 feet of drilled shaft could be saved, the cost savings would be roughly $3,167,000. This estimated savings is based on rolled-up unit costs from the designer's 60% cost estimate. A reduction in construction schedule and risk of construction would also be realized by reduction in shaft length from 140 feet to 100 feet.

	PROPOSAL	P3
COMPONENT: Drilled Shafts	**AUTHOR**	DA



Additional analyses will be required by the design team to determine whether shortening of the shafts is possible. Lateral pile analyses using L-Pile and FB-Multi-pier were used by the design team for their original analyses. These software packages are appropriate. The only suggestion is to revisit the development of P-Y curves and the use of base shear in the drilled shaft model. Consideration might also be given to allowing a few inches of toe displacement during maximum loading from the design (1,000 yr) earthquake. Since design is for life-safety and the likelihood of the design earthquake is low, a best-estimate approach should be taken when estimating soil properties and lateral response, consistent with AASHTO LRFD Bridge Design Specifications and Guide Specifications. Consideration might also be given to base grouting of the shafts. Lateral load tests on drilled shafts have shown that additional base shear can be developed using this method.

COST ESTIMATE FORM
COMPONENT: Shaft Lengths In Bearing Strata

P3

CURRENT DESIGN					VE PROPOSAL				
ITEM	**QUAN**	**UNIT**	**UNIT COST**	**TOTAL COST**	**ITEM**	**QUAN**	**UNIT**	**UNIT COST**	**TOTAL COST**
Soil Excavation for Shaft Including Haul	5,200	cy	650.00	3,380,000	Soil Excavation for Shaft Including Haul	3,714	cy	650.00	2,414,286
Furnishing and Place Temp. Casing	1,900	lf	250	475,000	Furnishing and Place Temp. Casing	1,357	lf	250.00	339,286
Furnishing Permanent Casing 8'0" Dia. Sl	960	lf	450	432,000	Furnishing Permanent Casing 8'0" Dia. Sl	686	lf	450.00	308,571
Placing Permanent Casing for 8'0" Shaft	12	ea	2500	30,000	Placing Permanent Casing for 8'0" Shaft	9	ea	2500.00	21,429
Conc. Class 4000P for Shaft	5300	cy	350	1,855,000	Conc. Class 4000P for Shaft	3,786	cy	350.00	1,325,000
St. Reinf. Bar for Shaft	1900000	lb	2	3,800,000	St. Reinf. Bar for Shaft	#####	lb	2.00	2,714,286
CSL Access Tube	21600	lf	7	151,200	CSL Access Tube	15,429	lf	7.00	108,000
CSL Testing	20	ea	1900	38,000	CSL Testing	14	ea	1900.00	27,143
Removing Shaft Obstructions	1	las	600000	600,000	Removing Shaft Obstructions	0.71	las	600000.00	428,571
Subtotal				10,761,200	Subtotal				7,686,571
Inflation	3.00	%		322836	Inflation	3.00	%		230597
Total to nearest $1000				11,084,000	Total				7,917,000
					Difference				3,167,000

MENG ANALYSIS

Proposal # **P3**

	PROPOSAL	P4
COMPONENT: Structure	**AUTHOR**	DWK
CURRENT CONCEPT: A two-stage construction process with both stages or bridge halves, having two columns and drilled shafts per pier.		
VA CONCEPT: Maintain the two-stage construction concept, but reduce the shaft and column number to three per pier.		

FUNCTIONS		
Span Lake	Carry traffic	

CURRENT CONCEPT	**PROPOSED CHANGE**	**DIFFERENCE**
$ 11,615,000	**$** 9,154,000	**$** 2,461,000

ADVANTAGES:	**DISADVANTAGES:**
• Less cost.	• More complicated shoring.

DISCUSSION:

In order to facilitate stage construction, two column bents are being placed under each stage. This is normal and good practice. This shaft reduction method applies to two phase construction only.

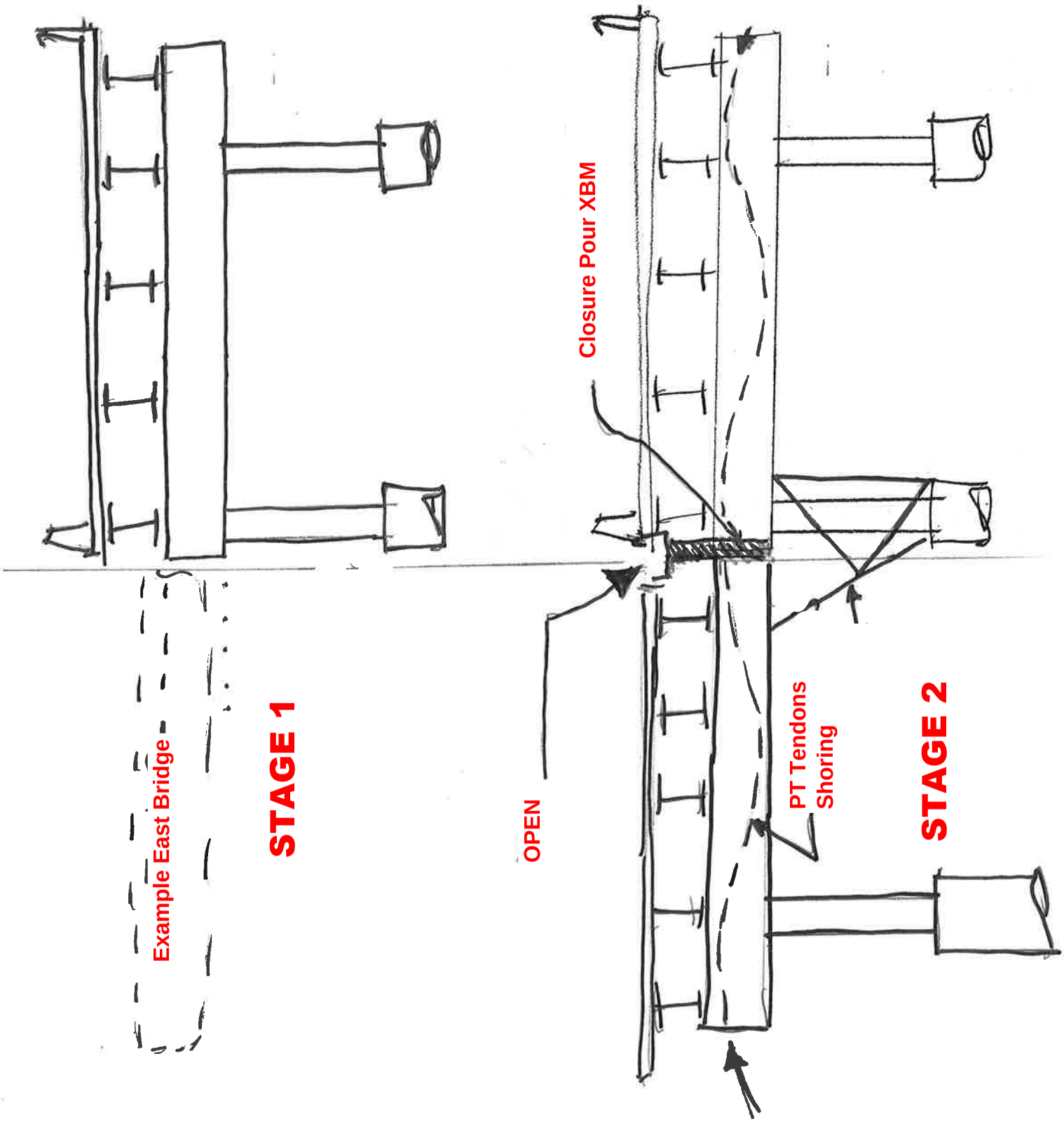
Since the drilled shaft costs are so high, reducing the number of shafts is advisable. Changing the piers to a three column bent, and post-tensioning the crossbeam is proposed. This will involve a more complicated falsework and shoring system under the

	PROPOSAL	P4
COMPONENT: Structure	**AUTHOR**	DWK

crossbeam at the 2nd stage to make the closure joint, but should be worth the effort.

IDEA SHEET

P4



COST ESTIMATE FORM
COMPONENT: Drill Shaft Quantity

P4

CURRENT DESIGN					VE PROPOSAL				
ITEM	**QUAN**	**UNIT**	**UNIT COST**	**TOTAL COST**	**ITEM**	**QUAN**	**UNIT**	**UNIT COST**	**TOTAL COST**
Soil Excavation for Shaft Including Haul	5,200	cy	650.00	3,380,000	Soil Excavation for Shaft Including Haul	3,900	cy	650.00	2,535,000
Furnishing and Place Temp. Casing	1,900	lf	250	475,000	Furnishing and Place Temp. Casing	1,425	lf	250.00	356,250
Furnishing Permanent Casing 8'0" Dia. Sh	960	lf	450	432,000	Furnishing Permanent Casing 8'0" Dia. Sh	720	lf	450.00	324,000
Placing Permanent Casing for 8'0" Shaft	12	ea	2500	30,000	Placing Permanent Casing for 8'0" Shaft	9	ea	2500.00	22,500
Conc. Class 4000P for Shaft	5300	cy	350	1,855,000	Conc. Class 4000P for Shaft	3,975	cy	350.00	1,391,250
St. Reinf. Bar for Shaft	1900000	lb	2	3,800,000	St. Reinf. Bar for Shaft	1,425,000	lb	2.00	2,850,000
CSL Access Tube	21600	lf	7	151,200	CSL Access Tube	16,200	lf	7.00	113,400
CSL Testing	20	ea	1900	38,000	CSL Testing	15	ea	1900.00	28,500
Removing Shaft Obstructions	1	ls	600000	600,000	Removing Shaft Obstructions	0.75	ls	600000.00	450,000
Conc. Class 400 for Bridge	501	cy	550	275,550	Conc. Class 400 for Bridge	551	cy	550	303,105
St. reinf. Bar for Bridge	120000	lb	2	240,000	St. reinf. Bar for Bridge	144000	lb	2	288,000
					Post Tensioning	20000	lb	5	100,000
					Middle shoring per pier	5	ea	25000	125,000
Subtotal				11,276,750	Subtotal				8,887,005
Inflation	3.00	%		338303	Inflation	3.00	%		266610
Total to nearest $1000				11,615,000	Total				9,154,000
					Difference				2,461,000

MENG ANALYSIS

Proposal # **P4**

	PROPOSAL	P5
COMPONENT: Ground Improvement	**AUTHOR**	RC

CURRENT CONCEPT: Bridge length is approximately 530-ft (4 spans, 5 piers with 4 shafts each). Approximately 120-ft of this structure has been added in order to extend the abutments into ground conditions that are not as susceptible to liquefaction.

VE CONCEPT: Shorten the length of the bridge to the minimum required length of approximately 405-ft (3 spans, 4 piers with 4 shafts each). Add ground improvement (i.e. stone columns) to eliminate the risk of liquefaction at the abutment locations.

FUNCTIONS		
Support Bridge Structure	Seismic Stability	

CURRENT CONCEPT	**PROPOSED CHANGE**	**DIFFERENCE**
$ 14,919,000	**$** 12,716,000	**$** 2,203,000

ADVANTAGES:

- Reduced Bridge Structure.
- Reduced Cost & Schedule.
- Reduced risk of liquefaction at the abutment locations & better structure performance in a seismic event.

DISADVANTAGES:

- Increased risk of differing site conditions.
- Added risk of poor ground improvement results.
- Increased risk of environmental impacts from ground improvement.

DISCUSSION: The design team originally considered a shorter bridge concept (approximately 405-ft) combined with a ground improvement program at both abutments in order to reduce the risk of impacts to the bridge from liquefiable soils during a seismic event. This option was determined to not be feasible for several reasons, including: environmental concerns from ground improvement operations so close to the water; potential for vibrations from ground improvement operations that would impact Zymogenetics; lack of adequate working area to perform ground improvement due to the requirement to stage construction and keep traffic moving across the bridge throughout

	PROPOSAL	P5
COMPONENT: Ground Improvement	**AUTHOR**	RC

the duration of the project.

If a full closure of the bridge is feasible (see P6), and the vibration limitations for the project ultimately allow, the use of ground improvement to mitigate the risk of liquefiable soils will likely provide a substantial cost and schedule savings to the project. It will also provide the City with an end product that is less susceptible to damage from a seismic event. One method of ground improvement that was previously investigated by the geotechnical engineer for the project was vibration free stone columns. This method, which consists of the installation of aggregate through drilling rather than vibration, appears to be particularly advantageous for urban projects that require minimal disruption to adjacent structures. A full closure of the bridge would appear to provide sufficient room for full equipment access and would allow one mobilization at each abutment.

From an environmental standpoint, stone columns pose less of a risk than other ground improvement techniques (i.e. jet grouting, compaction grouting) due to the material used and the method of placement. To help further mitigate the risk of environmental impacts, the team should consider the use of a sheet pile barrier wall to help segregate the work from the water. Sheet pile installation methods such as the “hard ground press-in method” are proven to create minimal vibration or noise and are particularly useful in ground conditions that may include wood debris and other obstructions.

Please note the cost savings associated with this proposal do not take into account the additional savings that would be associated with a full closure of the bridge (P6).

COST ESTIMATE FORM
COMPONENT: Bridge Length

P5

CURRENT DESIGN					VE PROPOSAL				
ITEM	QUAN	UNIT	UNIT COST	TOTAL COST	ITEM	QUAN	UNIT	UNIT COST	TOTAL COST
Soil Excavation for Shaft Including Haul	5,200	cy	650.00	3,380,000	Soil Excavation for Shaft Including Haul	4,160	cy	650.00	2,704,000
Furnishing and Place Temp. Casing	1,900	lf	250	475,000	Furnishing and Place Temp. Casing	1,520	lf	250.00	380,000
Furnishing Permanent Casing 8'0" Dia. Sh	960	lf	450	432,000	Furnishing Permanent Casing 8'0" Dia. Sh	768	lf	450.00	345,600
Placing Permanent Casing for 8'0" Shaft	12	ea	2500	30,000	Placing Permanent Casing for 8'0" Shaft	10	ea	2500.00	24,000
Conc. Class 4000P for Shaft	5300	cy	350	1,855,000	Conc. Class 4000P for Shaft	4,240	cy	350.00	1,484,000
St. Reinf. Bar for Shaft	1900000	lb	2	3,800,000	St. Reinf. Bar for Shaft	1,520,000	lb	2.00	3,040,000
CSL Access Tube	21600	lf	7	151,200	CSL Access Tube	17,280	lf	7.00	120,960
CSL Testing	20	ea	1900	38,000	CSL Testing	16	ea	1900.00	30,400
Removing Shaft Obstructions	1	ls	600000	600,000	Removing Shaft Obstructions	0.80	ls	600000.00	480,000
					Schedule Reduction	-2	mo	325000	-650,000
Prestressed Conc. Girder	4730	lf	300	1,419,000	Prestressed Conc. Girder	3,614	lf	300.00	1,084,330
Elastomeric Bearing Pad	18	ea	200	3,600	Elastomeric Bearing Pad	14	ea	200.00	2,751
Girder Stop Pad	32	ea	150	4,800	Girder Stop Pad	24	ea	150.00	3,668
Concrete Class 4000D	1253	cy	800	1,002,400	Concrete Class 4000D	957	cy	800.00	765,985
Concrete Class 4000	360	cy	450	162,000	Concrete Class 4000	275	cy	450.00	123,792
Epoxy Coated St. Reinf. Bar	300000	lb	2.5	750,000	Epoxy Coated St. Reinf. Bar	229,245	lb	2.50	573,113
St. Reinf. Bar for Bridge	29900	lb	2	59,800	St. Reinf. Bar for Bridge	22,848	lb	2.00	45,696
Pedestrian Barrier	1076	lf	160	172,160	Pedestrian Barrier	822	lf	160.00	131,556
Bridge Railing Type BP	1076	lf	95	102,220	Bridge Railing Type BP	822	lf	95.00	78,112
Strip Seal	134	lf	350	46,900	Strip Seal	102	lf	350.00	35,839
					Ground Improvement (stone columns)	304	ea	3000.00	912,000
					Sheet Pile Barrier Wall (Press-in method)	18000	sf	35	630,000
Subtotal				14,484,080	Subtotal				12,345,802
Inflation	3.00	%		434522	Inflation	3.00	%		370374
Total to nearest $1000				14,919,000	Total				12,716,000
					Difference				2,203,000

MENG ANALYSIS

Proposal # **P5**

	PROPOSAL	P6A
COMPONENT: MOT	**AUTHOR**	BK
CURRENT CONCEPT: Phase construction with two lanes of traffic and pedestrian access through construction.		
VA CONCEPT: Full closure of Fairview Avenue.		

FUNCTIONS		
Access businesses	Traffic flow	

CURRENT CONCEPT	**PROPOSED CHANGE**	**DIFFERENCE**
$ 16,632,000	**$** 7,567,000	**$** 9,065,000

ADVANTAGES:

- Reduce construction duration.
- Reduce costs.
- Reduce risk.

DISADVANTAGES:

- Detours.

DISCUSSION: The current design restricts vehicle traffic into one lane in each direction on Fairview Ave N during Stages 1A, 1B, 2A, & 2B. VE Team has explored a full closure of Fairview Ave N and the constructability issues arising out of this option. With a full closure of Fairview Ave N, it can be estimated that the overall duration of the project would be decreased by 8 to 12 months. Providing local access is one of the key issues that will need to be assessed.

Proposal P4 shows a structural method to reduce drilled shafts while still maintaining the

	PROPOSAL	P6A
COMPONENT: MOT	**AUTHOR**	BK

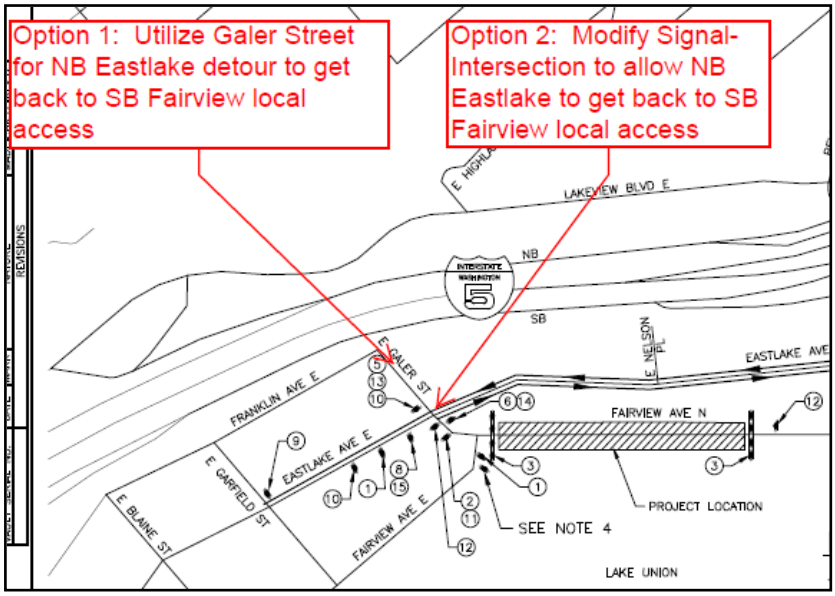
two stage construction. This proposal, with one stage construction, also eliminates drilled shafts since the bridge is no longer two parallel structures as required for two phases.

Key advantages to the full closure of Fairview include:

- Reduction in costs associated with the elimination of five shafts
- Reduction in risk and cost associated with “shaft obstructions”
- Reduction in traffic control costs
- Reduction in night work and periodic weekend closures
- Reduction in noise complaints
- Reduction in overall contract schedule
- Reduction in temporary work bridges
- Increased worker and public safety by segregating construction and the traveling public
- Reduction in cost to demolish the bridge in halves
- Reduction in cost of the bridge through increased productivity in bridge construction and elimination of closure pours
- Reduction in Construction Management Costs
- Increased Staging Area in ROW of Fairview
- Decrease in the amount of Contaminated Material
- Option to classify and sort Contaminated Material for disposal, in the ROW, thus reducing cost
- Facilitates reconsideration of the use of ground improvement and the reduction of the overall bridge length (see P5 for details)

	PROPOSAL	P6A
COMPONENT: MOT	**AUTHOR**	BK

In order to fully close Fairview Ave N, the detour plan will need to address the access to the local businesses on the north end of the bridge that want access from the south. Two options to accommodate this are shown below. Option 1 is to utilize Galer Street to Franklin Ave E to E Garfield to gain access to SB Fairview. Option 2 is to modify the signal and intersection at Eastlake and Fairview to accommodate this turning movement.



COST ESTIMATE FORM
COMPONENT: Full Shutdown

P6a

CURRENT DESIGN					VE PROPOSAL				
ITEM	QUAN	UNIT	UNIT COST	TOTAL COST	ITEM	QUAN	UNIT	UNIT COST	TOTAL COST
Soil Excavation for Shaft Including Haul	5,200	cy	650.00	3,380,000	Soil Excavation for Shaft Including Haul	3,900	cy	600.00	2,340,000
Furnishing and Place Temp. Casing	1,900	lf	250	475,000	Furnishing and Place Temp. Casing	1,425	lf	240.00	342,000
Furnishing Permanent Casing 8'0" Dia. Shaft	960	lf	450	432,000	Furnishing Permanent Casing 8'0" Dia. Shaft	720	lf	450.00	324,000
Placing Permanent Casing for 8'0" Shaft	12	ea	2500	30,000	Placing Permanent Casing for 8'0" Shaft	9	ea	2500.00	22,500
Conc. Class 4000P for Shaft	5300	cy	350	1,855,000	Conc. Class 4000P for Shaft	3,975	cy	325.00	1,291,875
St. Reinf. Bar for Shaft	1900000	lb	2	3,800,000	St. Reinf. Bar for Shaft	1,425,000	lb	1.95	2,778,750
CSL Access Tube	21600	lf	7	151,200	CSL Access Tube	16,200	lf	7.00	113,400
CSL Testing	20	ea	1900	38,000	CSL Testing	15	ea	1900.00	28,500
Removing Shaft Obstructions	1	ls	600000	600,000	Removing Shaft Obstructions	0.75	ls	600000.00	450,000
Bridge Demolition	1	ls	1200000	1,200,000	Bridge Demolition	1	ls	960000	960,000
Maintenance and Protection of Traffic	1	ls	1100000	1,100,000	Maintenance and Protection of Traffic	1	ls	570000.00	570,000
Work Access	1	ls	1700000	1,700,000	Work Access	0.60	ls	1700000.00	1,020,000
					Contractorj's Monthly Overhead Reduction	(10)	mo	175000.00	-1,750,000
					Owner's CM Monthly Overhead Reduction	(10)	mo	150000.00	-1,500,000
Construction Stormwater & Erosion Control Plan	1	ls	576000	576,000	Construction Stormwater & Erosion Control Plan	0.60	ls	576000.00	345,600
Site Rental for Laydown, Workers, Treatment	18	mo	45000	810,000	Site Rental for Laydown, Workers, Treatment	10	mo	45000.00	450,000
					Superstructure Increased Productivity	1	ls	-500000.00	-500,000
					Lost Parking Revenue on Aloha	10	mo	6000.00	60,000
Subtotal				16,147,200	Subtotal				7,346,625
Inflation	3.00	%		484416	Inflation	3.00	%		220399
Total to nearest $1000				16,632,000	Total				7,567,000
					Difference				9,065,000

MENG ANALYSIS

Proposal # **P6a**

	PROPOSAL	P6B
COMPONENT: MOT	**AUTHOR**	BK
CURRENT CONCEPT: Phase construction with two lanes of traffic and pedestrian access through construction.		
VA CONCEPT: One lane Northbound on Fairview Ave N.		

FUNCTIONS		
Access business	Traffic flow	Facilitate construction

CURRENT CONCEPT	**PROPOSED CHANGE**	**DIFFERENCE**
$ 1,318,000	**$** 1,071,000	**$** 247,000

ADVANTAGES:

- Reduce costs.
- Reduce construction duration.
- Reduce nighttime construction.

DISADVANTAGES:

- Detours.

DISCUSSION: The current design restricts vehicle traffic into one lane in each direction on Fairview Ave N during Stages 1A, 1B, 2A, & 2B. The VE Team has explored the option of allowing Northbound (NB) traffic only on Fairview Ave N and the constructability issues arising out of this option.

Key advantages to the single NB lane on Fairview include:

- Allow material delivery and spoils removal during the day on a single lane

	PROPOSAL	P6B
COMPONENT: MOT	**AUTHOR**	BK

dedicated to construction vehicles only.

- Reduction in traffic control costs.
- Reduction in night work and periodic weekend closures.
- Reduction in noise complaints due to less night work.
- Increased Staging Area in ROW of Fairview.
- Option to classify and sort Contaminated Material for disposal, in the ROW, thus reducing cost.

Note: this proposal could also be used as an intermittent stage in conjunction with either the current two-way traffic approach or the full closure approach.

COST ESTIMATE FORM
COMPONENT: 1 Lane Northbound

P6b

CURRENT DESIGN					VE PROPOSAL				
ITEM	**QUAN**	**UNIT**	**UNIT COST**	**TOTAL COST**	**ITEM**	**QUAN**	**UNIT**	**UNIT COST**	**TOTAL COST**
Maintenance and Protection of Traffic	1	ls	1100000	1,100,000	Maintenance and Protection of Traffic	1	ls	950000.00	950,000
Site offices	18	mo	10000.00	180,000	Site offices	18	mo	5000.00	90,000
Subtotal				1,280,000	Subtotal				1,040,000
Inflation	3.00	%		38400	Inflation	3.00	%		31200
Total to nearest $1000				1,318,000	Total				1,071,000
					Difference				247,000

MENG ANALYSIS

Proposal # **P6b**

	PROPOSAL	P7
COMPONENT: Structure	**AUTHOR**	DWK
CURRENT CONCEPT: A cast-in-place concrete deck.		
VA CONCEPT: Utilize stay in place precast concrete deck panels with a cast-in-place concrete deck on top.		

FUNCTIONS		
Span Lake	Carry Traffic	

CURRENT CONCEPT	**PROPOSED CHANGE**	**DIFFERENCE**
$ 1,339,000	**$** 1,030,000	**$** 309,000

ADVANTAGES:

- Decrease schedule.

DISADVANTAGES:

- Increased potential for deck cracking.

DISCUSSION:

The bridge deck is cast-in-place concrete. The construction method for building this deck usually requires a false work deck installed between girders, and formwork for diaphragms and the bridge deck soffit. After construction, both the work deck and formwork have to be stripped.

Stay in place precast deck forms are proposed to be used, along with bolt-in steel

	PROPOSAL	P7
COMPONENT: Structure	**AUTHOR**	DWK

diaphragms. This will speed up construction, and should save cost.

This proposal would not apply to the overhangs as they will still be formed off girder brackets.

COST ESTIMATE FORM

COMPONENT: Stay in Place Forms-Precast Deck Panels

P7

CURRENT DESIGN					VE PROPOSAL				
ITEM	**QUAN**	**UNIT**	**UNIT COST**	**TOTAL COST**	**ITEM**	**QUAN**	**UNIT**	**UNIT COST**	**TOTAL COST**
Conc. Class 4000D for Bridge	1000	cy	800	800,000	Conc. Class 4000D for Bridge	500	cy	500	250,000
Epoxy Coated St. Reinf. Bar	200000	lb	2.5	500,000	Epoxy Coated St. Reinf. Bar	100000	lb	2.5	250,000
					Deck Panels	26,156	sf	15.00	392,340
					Steel Diaphragms	24,000	lb	4.50	108,000
Subtotal				1,300,000	Subtotal				1,000,340
Inflation	3.00	%		39000	Inflation	3.00	%		30010
Total to nearest $1000				1,339,000	Total				1,030,000
					Difference				309,000

MENG ANALYSIS

Proposal # **P7**

	PROPOSAL	B1
COMPONENT: Structure	**AUTHOR**	DWK
CURRENT CONCEPT: Both the east and west existing structures are being replaced.		
VA CONCEPT: Replace the existing west structure as planned, but retrofit the east structure and postpone strengthening for the future streetcar as required in the future.		

FUNCTIONS		
Span Lake	Carry traffic	

CURRENT CONCEPT	**PROPOSED CHANGE**	**DIFFERENCE**
$ 21,776,000	**$** 13,171,000	**$** 8,605,000

ADVANTAGES:

- Reduce cost.
- Reduces schedule and saves on MOT.

DISADVANTAGES:

- Design change cost and schedule.

DISCUSSION:

The existing east bridge is approximately 50-years old. It is a prestressed girder bridge with concrete deck supported on prestressed concrete piles. The piles are driven to bearing at a layer that is about 4-feet below the identified liquefaction-prone layer.

The condition of the bridge is good in general. The prestressed girders have developed cracks at the ends adjacent to the bearings. The bridge is seismically vulnerable and poses a life-safety threat because of brittle connections at the tops of piles. The bridge

	PROPOSAL	B1
COMPONENT: Structure	**AUTHOR**	DWK

has other seismic vulnerabilities, but they do not necessarily constitute a life-safety threat.

The bridge does not have the capacity to carry the future streetcar loading without strengthening. It is proposed to limit the strengthening to the zone that needs it, and to complete the work only when it needs to be done.

The bridge's condition may not warrant replacement. It is in much better load-carrying and seismic condition than many of the City's bridge structures. This proposal would change the scope of the project, but open up opportunities for alternate use of funding.

The bridge's piles should be retrofitted with fiber wrapping or steel jackets to improve seismic ductile performance. This should be all that is necessary to prevent collapse. The vulnerability of the piles to lateral sliding, liquefaction, and below ground hazards could mean that after a design event, the piles would be damaged. If it were a replaced structure, a more robust foundation would be wanted. But if retrofitted, the foundation condition should be okay.

The girder ends should be repaired by epoxy injection and fiber wrapping. This would extend the girder life.

A seismic strategy to design the new west bridge to help laterally support the east bridge could be employed. This should also improve the seismic resistivity of the east bridge by reducing the demand displacements.

Another big advantage of foregoing the east bridge replacement is to minimize impacts to the ZymoGenetics Building.

COST ESTIMATE FORM
COMPONENT: Reconstruct the East Structural

B1

CURRENT DESIGN					VE PROPOSAL				
ITEM	QUAN	UNIT	UNIT COST	TOTAL COST	ITEM	QUAN	UNIT	UNIT COST	TOTAL COST
Soil Excavation for Shaft Including Haul	5,200	cy	650.00	3,380,000	Soil Excavation for Shaft Including Haul	2,600	cy	650.00	1,690,000
Furnishing and Place Temp. Casing	1,900	lf	250	475,000	Furnishing and Place Temp. Casing	950	lf	250.00	237,500
Furnishing Permanent Casing 8'0" Dia. Sl	960	lf	450	432,000	Furnishing Permanent Casing 8'0" Dia. Sl	480	lf	450.00	216,000
Placing Permanent Casing for 8'0" Shaft	12	ea	2500	30,000	Placing Permanent Casing for 8'0" Shaft	6	ea	2500.00	15,000
Conc. Class 4000P for Shaft	5300	cy	350	1,855,000	Conc. Class 4000P for Shaft	2,650	cy	350.00	927,500
St. Reinf. Bar for Shaft	1900000	lb	2	3,800,000	St. Reinf. Bar for Shaft	950,000	lb	2.00	1,900,000
CSL Access Tube	21600	lf	7	151,200	CSL Access Tube	10,800	lf	7.00	75,600
CSL Testing	20	ea	1900	38,000	CSL Testing	10	ea	1900.00	19,000
Removing Shaft Obstructions	1	ls	600000	600,000	Removing Shaft Obstructions	0.50	ls	600000.00	300,000
Prestressed Conc. Girder	4730	lf	300	1,419,000	Prestressed Conc. Girder	2,365	lf	300.00	709,500
Elastomeric Bearing Pad	18	ea	200	3,600	Elastomeric Bearing Pad	9	ea	200.00	1,800
Girder Stop Pad	32	ea	150	4,800	Girder Stop Pad	16	ea	150.00	2,400
Concrete Class 4000D	1253	cy	800	1,002,400	Concrete Class 4000D	627	cy	800.00	501,200
Concrete Class 4000	360	cy	450	162,000	Concrete Class 4000	180	cy	450.00	81,000
Epoxy Coated St. Reinf. Bar	300000	lb	2.5	750,000	Epoxy Coated St. Reinf. Bar	150,000	lb	2.50	375,000
St. Reinf. Bar for Bridge	29900	lb	2	59,800	St. Reinf. Bar for Bridge	14,950	lb	2.00	29,900
Pedestrina Barrier	1076	lf	160	172,160	Pedestrina Barrier	503	lf	160.00	80,480
Bridge Railing Type BP	1076	lf	95	102,220	Bridge Railing Type BP	2,012	lf	95.00	191,140
Strip Seal	134	lf	350	46,900	Strip Seal	67	lf	350.00	23,450
Items from page 2				6,658,100	Items from page 2				5,410,550
Subtotal				21,142,180	Subtotal				12,787,020
Inflation	3.00	%		634265	Inflation	3.00	%		383611
Total to nearest $1000				21,776,000	Total				13,171,000
					Difference				8,605,000

MENG ANALYSIS

Proposal # **B1**

TECHNICAL COMMENTS

In the value engineering process, the team explores issues that could be useful to the design team and the owner as the project progresses. These are typically not alternative design systems resulting in cost adjustments to the project, but they may improve constructability and avoid potential change orders. They are mentioned here as a courtesy to the design team.

TECHNICAL REPORT	**PROPOSAL**	**T1**
COMPONENT: Constructability	**AUTHOR**	BK

CURRENT CONCEPT: Construction Staging, Material Handling, Noise Mitigation, Shaft Construction, and Contaminated Water.

CONSIDERATIONS:

CONSTRUCTION STAGING: Currently, construction staging is the contractor's responsibility. The City of Seattle owns the block bordered by Mercer, Roy, 9th Ave and Dexter that is currently being used for the Mercer West Project – which is scheduled for completion in the fall of 2015. If the City would allow the Fairview Ave N Contractor to use this property as a staging area, the contaminated material generated from the project could be stockpiled and treated (remove water if present) for proper testing-classification of the material. Based on the geotechnical report, only the top portion of the material is contaminated and the lower material is clean. By having a large staging area, only the contaminated material will be hauled off and disposed of at a higher cost; the remaining material can be disposed of at a greatly reduced rate. Having an owner provide the staging area will reduce the contractor's costs to acquire a staging area.

MATERIAL HANDLING: A gantry crane that spans the width of the bridge could be used as a mitigation measure to provide for the hoisting of materials during construction. This would enable nearly all of the demolition tasks to be done under the overhead lines. It would also reduce traffic interruption since a load could be serviced from any part of the bridge deck. Since the gantry would span above the traffic lanes, traffic would be able to continue to drive over the bridge. Extending the gantry rails past the abutments would also allow for unloading and loading of materials from either end of the bridge. A crawler crane is limited to where it can walk and a large crane move is a safety issue and time consuming process. Whereas a gantry crane can pick a load from any location within the rails and leap frog it to any other location where the rails are set. This will result in more efficient handling of materials since the entire bridge site can be accessed without the interference of a boom crane. There is also a potential for additional area to be made available since the gantry can travel from end to end of the bridge site.

TECHNICAL REPORT	**PROPOSAL**	**T1**
COMPONENT: Constructability	**AUTHOR**	BK

Material Handling: The use of a barge will be necessary if the existing dock is removed and could be used on a portion of the west side.

Noise Mitigation: A significant risk on the project is the assumption that night work can take place with nighttime closures of Fairview. With the close proximity to sensitive receivers, potential mitigation measures may not be feasible. Proposals 6a (full closure of Fairview) and 6b (one lane NB on Fairview) would reduce – if not eliminate – the need to work nights.

Shaft Construction: Contact provisions require either a rotating or oscillating shaft installation. There is a potential risk (with the limited availability of equipment necessary to perform the work) of one or two subcontractors bidding on the shaft construction. The current two phased construction only exacerbates this risk. Proposal 6a (full closure of Fairview) eliminates the two phases and allows the shafts to be installed in one mobilization.

Contaminated Water: During the shaft excavation, contaminated material will be removed. Water that has the potential to become contaminated will also be removed. The contract specifications need to address how the contaminated water will be handled, disposed of, and paid for.

TECHNICAL REPORT	**PROPOSAL**	**T2**
COMPONENT: Aerial Power & Communication	**AUTHOR**	BK

CURRENT CONCEPT: Existing overhead high voltage transmission lines, distribution power lines and communication lines are to be relocated temporarily.

CONSIDERATIONS: Have SCL install temporary poles west of existing poles with temporary guy systems to move the 115Kv and 26Kv – followed by the two franchised utilities. Also consider having the franchised utilities install their lines higher in the temporary configuration to help with clearance issues.

The VE Team highly suggests that the temporary relocation (estimated duration of 2-4 months) be completed ahead of NTP.

Finally, the VE Team investigated if the 26Kv could be dead headed at the two transmission poles and the existing wires removed until the completion of the project (to reduce any potential clearance issues with the 26Kv lines); however, SCL confirmed that the 26Kv will have to be relocated with the transmission.

TECHNICAL REPORT	PROPOSAL	T3
COMPONENT: Vibration	**AUTHOR**	DA

CURRENT CONCEPT: Construction methods that limit the potential for construction vibrations are identified by the design team. These constraints are placed on construction because of the sensitivity of the ZymoGenetics' operations to vibrations. Affected construction methods include shaft construction, installation of sheet-pile walls, and ground improvement methods – amongst others.

CONSIDERATIONS: The ZymoGenetics Building is located within 10 feet of the east side of the Fairview Bridge. The proximity of the building makes it susceptible to construction vibrations. The VE team understands that the designers have been in discussions with ZymoGenetics and have learned that ZymoGenetic operations have no tolerance for vibrations. Furthermore, the design team reports that the nature of ZymoGenetics operations is such that their facility must be vibration free at all times – 24 hours a day – and that there are no periods during planned bridge construction when the ZymoGenetics facility can relax their vibration requirements.

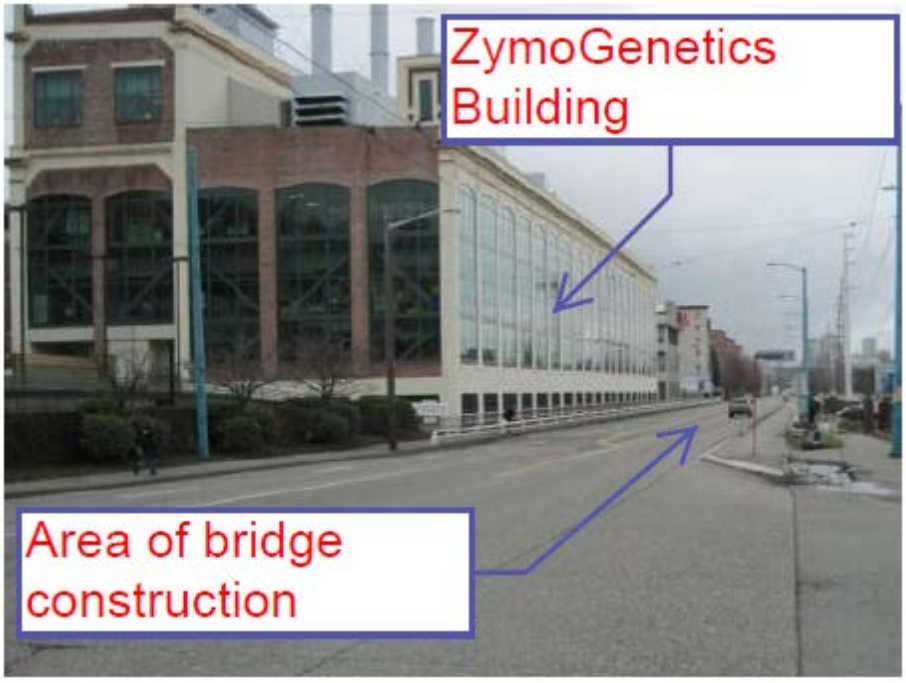


Figure 1. Location of ZymoGenetics Building relative to bridge reconstruction.

TECHNICAL REPORT	**PROPOSAL**	**T3**
COMPONENT: Vibration	**AUTHOR**	DA

The sensitivity of the ZymoGenetics operations has resulted in a number of construction constraints. For example:

- Vibratory methods for installing shaft casing are not allowed according to the 60% special provisions. Wording within the special provisions implies that an oscillator should be used to excavate the shaft.
- Piles to support a work bridge will be drilled piles, rather than a more conventional approach of installing piles by vibratory methods.
- The most likely method of ground improvement – stone columns – was abandoned because of the vibrations normally associated with compaction of the stone in the column. In its place, a non-vibratory stone column method was initially considered. However, the costs and space requirements associated with a non-vibratory stone column method led to dropping this idea.

Specific limits on vibration levels within the ZymoGenetics Building or during construction of the Fairview Avenue Bridge have not been identified, as far as the VE team is aware. Normally these limits include peak particle velocity (PPV) and its variation for predominant frequency of vibration. Various general criteria have been developed to give general limits. These criteria show that the levels of PPV to cause structural damage can be in excess of 1 inch/second. On the other extreme, historic structures may be damaged at levels of vibration of less than 0.1 inches/second. Actual limits will vary according to soil support, frequency, and construction method.

The VE team believes that a detailed review of vibration requirements could be beneficial to the project. This review needs to establish the manner in which vibrations created along the alignment of the bridge during construction propagate through the soil and piles supporting the ZymoGenetic Building into the various levels of the building. The combination of soil and timber piles would normally be expected to attenuate the level of ground shaking and therefore levels of vibration will be lower than at the source of vibration.

TECHNICAL REPORT	PROPOSAL	T3
COMPONENT: Vibration	AUTHOR	DA

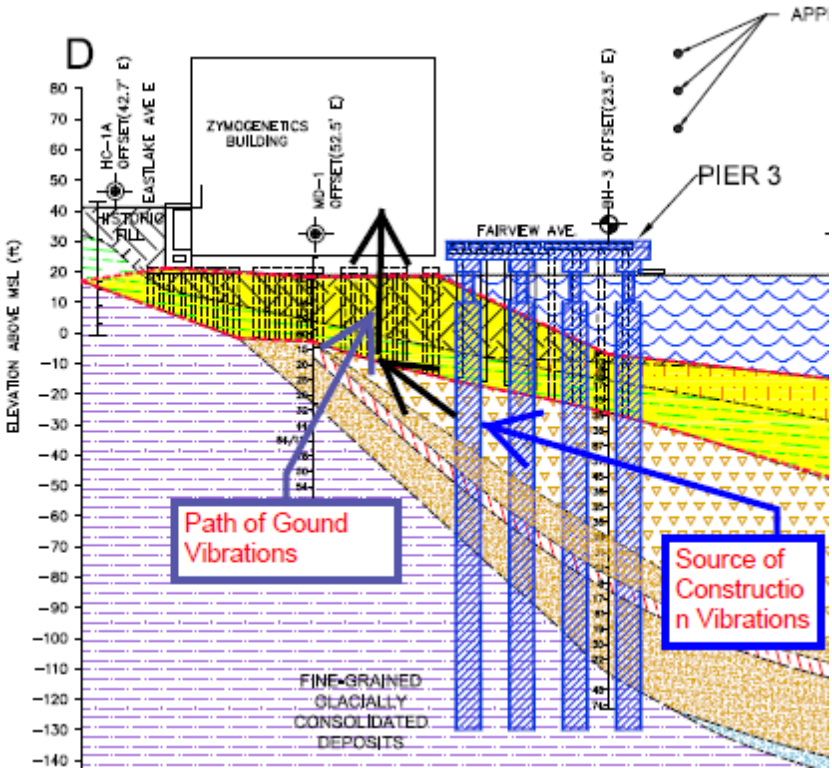


Figure 2. Path of vibrations from construction into ZymoGenetics Building.

The quantification of vibration levels will require a systematic evaluation of the sources of vibration, attenuation of vibration levels through the soil, and propagation into the building. This evaluation is best made through a monitoring program where levels of vibration near and within the building are recorded for a number of different vibration sources along Fairview Avenue. The sources should include heavy trucks and Metro Bus traffic and controlled source generation. Vibrations should also be monitored throughout demolition of the Gunn Building. Data collection and interpretation should include peak levels of ground velocity and frequency, as well as Fourier analyses of the data to understand frequency distributions. Correlations between the source, distance, and levels of vibration should be developed.

As part of this monitoring program, representative vibration levels should also be established for construction methods such as: oscillator versus casing/auger methods of drilled shaft construction, for ground improvement using standard stone column methods,

TECHNICAL REPORT	PROPOSAL	T3
COMPONENT: Vibration	**AUTHOR**	DA

and for installation of pipe piles using vibratory methods. Either published data or monitoring local construction activities could be conducted to collect this data. This information would serve as typical source information when evaluating levels of likely vibration within the ZymoGenetics Building. Comparisons can also be made with published criteria – such as those established by Dowding (Caltrans, 2004) and various other sources.

Structure and Condition	Limiting PPV (in/sec)
Historic and some old buildings	0.5
Residential structures	0.5
New residential structures	1.0
Industrial buildings	2.0
Bridges	2.0

The monitoring program should be conducted as soon as possible to establish vibration baseline information for use in the special provisions of the contract documents. This would allow the contractor to judge possible constraints in construction means and methods. The results of the monitoring may also allow a relaxation of requirements for drilled shaft construction, sheet pile installation, or ground improvement methods in the special conditions. By relaxing current constraints on means and methods, lower construction bids will be obtained and the possibility of more creative construction methods may result.

TECHNICAL REPORT	**PROPOSAL**	**T4**
COMPONENT: Construction Schedule	**AUTHOR**	RC

CURRENT CONCEPT: The preliminary construction schedule provided to the VE team for review identifies a total construction duration of approximately 20 months. This duration is based on the construction staging sequence outlined in the current 60% plans that initially places single lane two-way traffic on the east bridge to allow for demolition and reconstruction of the west bridge, followed by shifting of single lane two-way traffic over the new west bridge to allow for demolition and reconstruction of the east bridge.

CONSIDERATIONS:

In summary, the construction schedule provided for review includes major project activities that will drive the critical path under the current construction staging sequence. These major activities also include some detail regarding estimated means and methods, quantities and productivity rate assumptions. Based on a general review of these activities, along with their estimated means and methods and productivity rates, the overall schedule duration of approximately 20 months appears to be reasonable. Additional schedule detail is warranted at this point in the design to further validate this duration and to identify all of the relationships and interdependencies between the various activities. Consider the following to support the further development of the construction schedule:

- Recommend developing the construction schedule in Microsoft Project (or other scheduling software). This will facilitate the development of a more detailed construction schedule as the design advances and will allow for activity relationships and interdependencies to be more clearly established. This format will also coincide with current design schedule format and will enable the team to have one comprehensive master schedule that defines the entire project from current state to completion. (A sample construction schedule in Microsoft Project based on the excel schedule is provided for the team's use, if desired.)
- Confirm that sufficient time is identified up front after construction contract award to allow for critical construction submittal development/review/approval and permit approval. 45 days appears to be the current window of time in the schedule, which may not be sufficient time depending on the number of upfront submittal and permit approvals the contractor is required to obtain prior to starting work.

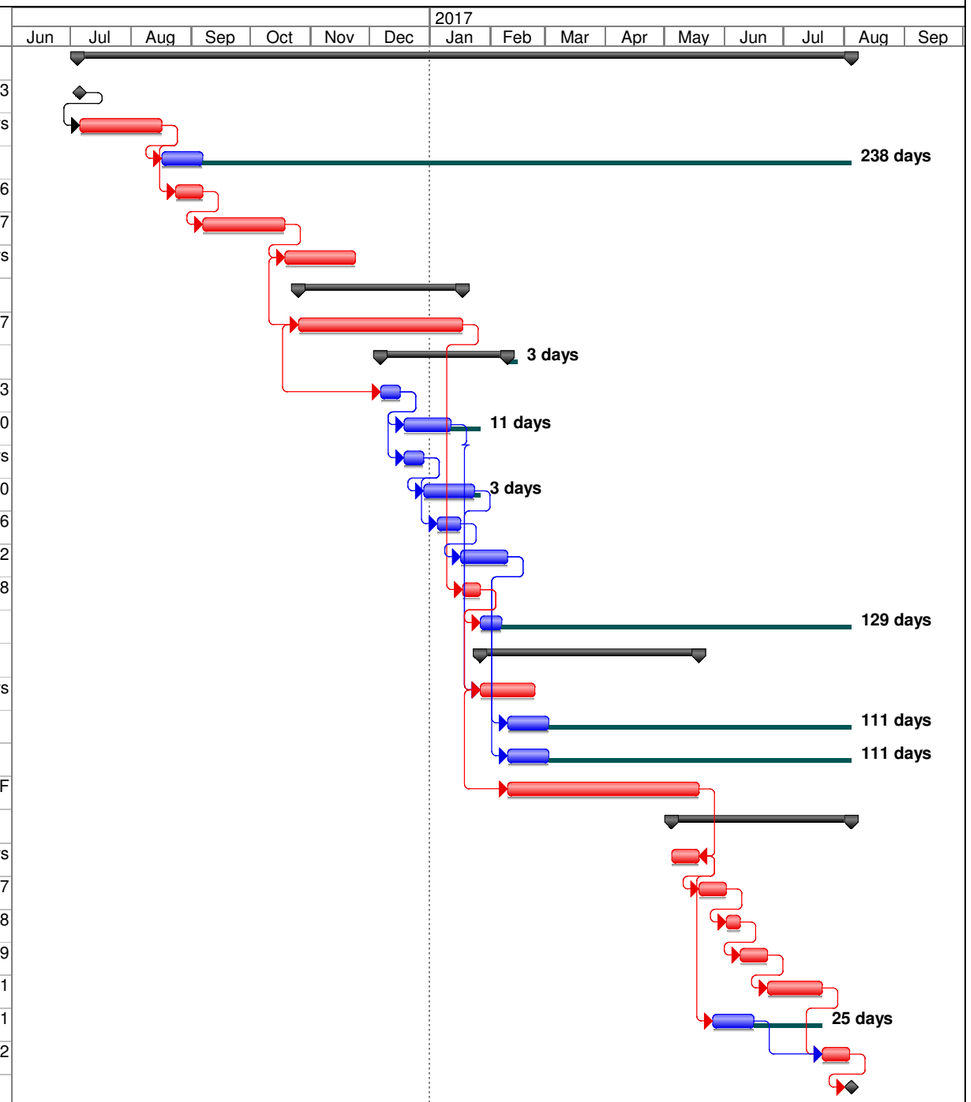
TECHNICAL REPORT	**PROPOSAL**	**T4**
COMPONENT: Construction Schedule	**AUTHOR**	RC

- The design team has a detailed design schedule that identifies the various environmental permits and approval required for the project. Recommend reconfirming the timelines for these various permits and approvals given the current status of the project.
- Recommend confirming that in-water work will be allowed to take place outside of the In-Water Work Window. The current construction schedule identifies bridge demolition and shaft construction activities taking place outside of the In-Water Work Window.
- For drilled shaft construction, consider adding at least one more work day per shaft to account for the various constraints associated with these shafts (depth of 140-ft, construction from work deck, reaction pile installation, mob/demob, permanent casing, likelihood of obstructions, night work and site constraint limitations). This would result in an additional month of construction duration, assuming all drilled shafts fall on the critical path.
- Recommend adding third party utility relocations into the overall program schedule. Assuming these relocations will be coordinated by the City and executed by the third party, this work should be scheduled to take place prior to award of the construction contract in order to sufficiently mitigate the City's risk.
- Recommend including additional detail to the construction schedule to coincide with the current state of the design. Activity productivity assumptions should coincide with the cost estimate. Consider further the development of a cost loaded schedule that will provide the City with anticipated expenditures throughout the duration of the project.
- Consider adding critical path schedule contingency to cover unforeseen delays associated with subsurface obstructions. This time contingency would coincide with the contingency in the estimate set aside to cover the cost (Removing Shaft Obstructions [619908]). Recommend 30 days.
- The primary opportunity for improving the construction schedule appears to be the full closure of Fairview Ave N to allow access to both bridges at the same time. Please see proposal P6a for more detail on this benefits of this concept. By implementing this concept, the project schedule could be reduced in schedule by up to 12 months. See the attached schedule outlining a conceptual approach to completing the work with a full closure of Fairview Ave N.

MENG Analysis

Seattle Department of Transportation
Fairview Avenue Bridge VE Construction Schedule - Fairview Ave N Closure

ID	Task Name	Duration (Work Days)	Start	Finish	Predecessors	Successors
1	**CONSTRUCTION**	**284 days**	**Tue 7/5/16**	**Fri 8/4/17**		
2	Notice to Proceed	1 day	Tue 7/5/16	Tue 7/5/16		3
3	Preliminary Construction Submittals & Permit Approvals	30 days	Wed 7/6/16	Tue 8/16/16	2	4,5FS+5 days
4	Install TESC	15 days	Wed 8/17/16	Tue 9/6/16	3	
5	Install Traffic Control & Close Fairview Ave N.	10 days	Wed 8/24/16	Tue 9/6/16	3FS+5 days	6
6	Demolish Existing Bridges	30 days	Wed 9/7/16	Tue 10/18/16	5	7
7	Install Work Bridge (13 spans, 1 every 2 days)	26 days	Wed 10/19/16	Wed 11/23/16	6	9SS+5 days
8	**Drilled Shafts**	**60 days**	**Wed 10/26/16**	**Tue 1/17/17**		
9	Drilled Shafts (15 each including reaction piles)	60 days	Wed 10/26/16	Tue 1/17/17	7SS+5 days	11SS+30 days,17
10	**Substructure**	**47 days**	**Wed 12/7/16**	**Thu 2/9/17**		
11	Columns Bent 4 (3 ea)	8 days	Wed 12/7/16	Fri 12/16/16	9SS+30 days	12,13
12	X-Beam P-4 (incl cure/strip)	18 days	Mon 12/19/16	Wed 1/11/17	11	20
13	Columns Bent 3 (3 ea)	8 days	Mon 12/19/16	Wed 12/28/16	11	14,15FS+5 days
14	X-Beam P-3 (incl cure/strip)	18 days	Thu 12/29/16	Mon 1/23/17	13	20
15	Columns Bent 2 (3 ea)	8 days	Thu 1/5/17	Mon 1/16/17	13FS+5 days	16
16	X-Beam P-2 (incl cure/strip)	18 days	Tue 1/17/17	Thu 2/9/17	15	21,22
17	Abutment 5	7 days	Wed 1/18/17	Thu 1/26/17	9	20,18
18	Abutment 1	7 days	Fri 1/27/17	Mon 2/6/17	17	
19	**Superstructure**	**80 days**	**Fri 1/27/17**	**Thu 5/18/17**		
20	Set Girders - 1 span/night stage per week w/ trestle rmv	20 days	Fri 1/27/17	Thu 2/23/17	12,17,14	23SS+10 days
21	Remove Work Trestle Superstructure	15 days	Fri 2/10/17	Thu 3/2/17	16	
22	Remove Work Trestle Shafts	15 days	Fri 2/10/17	Thu 3/2/17	16	
23	Pour Diaphrams & Deck (14 weeks)	70 days	Fri 2/10/17	Thu 5/18/17	20SS+10 days	25FF
24	**Roadway & Finishes**	**66 days**	**Fri 5/5/17**	**Fri 8/4/17**		
25	Complete Roadway Fills	10 days	Fri 5/5/17	Thu 5/18/17	23FF	26,30FS+5 days
26	Roadway Paving	10 days	Fri 5/19/17	Thu 6/1/17	25	27
27	Striping	5 days	Fri 6/2/17	Thu 6/8/17	26	28
28	Permanent Signing	10 days	Fri 6/9/17	Thu 6/22/17	27	29
29	Illumination	20 days	Fri 6/23/17	Thu 7/20/17	28	31
30	Pour Sidewalks (on new structure)	15 days	Fri 5/26/17	Thu 6/15/17	25FS+5 days	31
31	Put Traffic into Final Configuration	10 days	Fri 7/21/17	Thu 8/3/17	30,29	32
32	Substantial Completion	1 day	Fri 8/4/17	Fri 8/4/17	31	



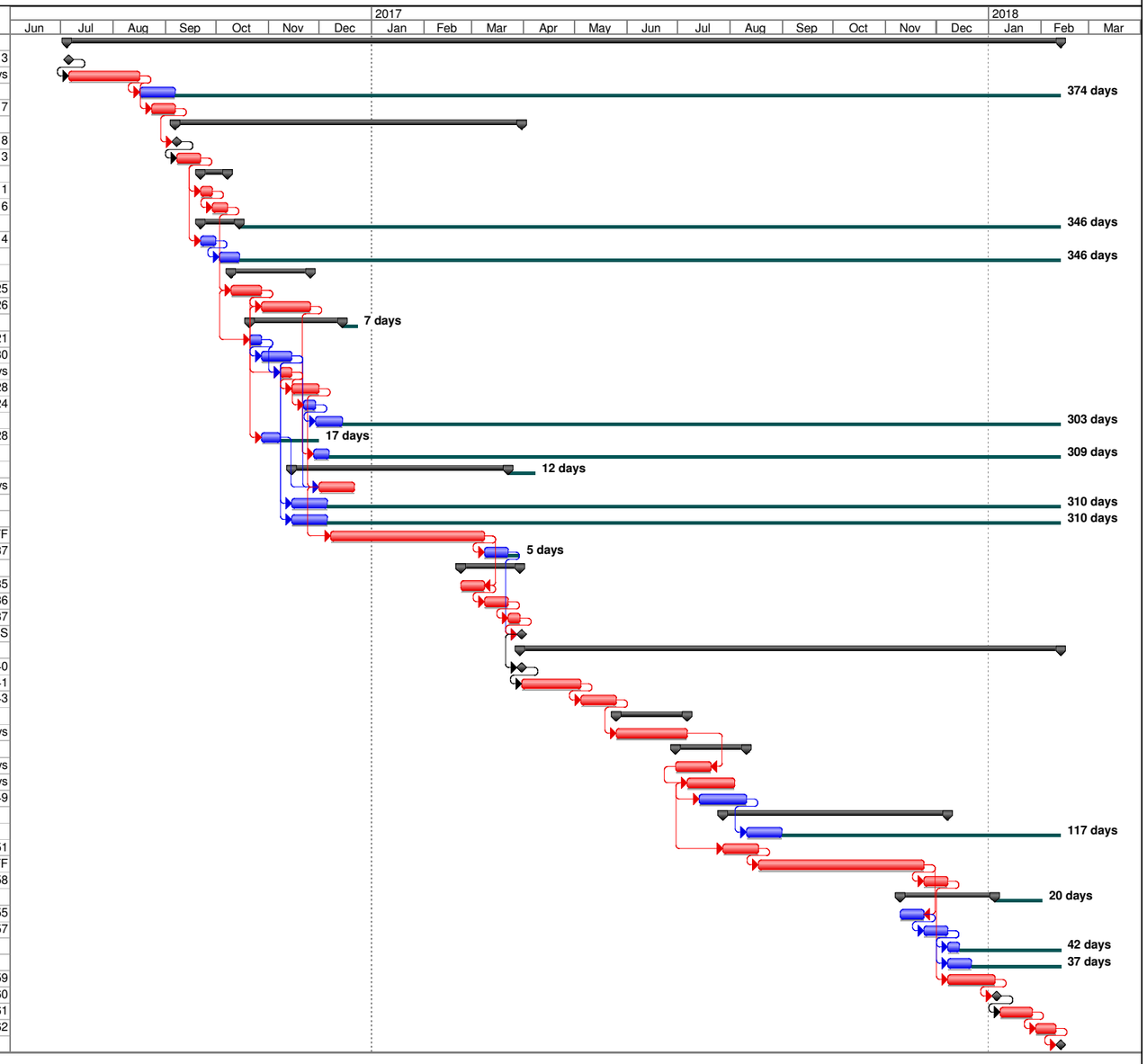
Project: Issaquah Roadway VE Prelim
Date: Thu 10/16/14

Critical
Critical Split
Task
Split
Progress
Milestone
Slack
Slippage
Summary
Project Summary
Rolled Up Critical
Rolled Up Critical
External Tasks
External Milestone
Deadline

Preliminary Construction Schedule

Seattle Department of Transportation
Fairview Avenue Bridge VE Construction Schedule - Baseline

ID	Task Name	Duration (Work Days)	Start	Finish	Predecessors	Successors
1	**CONSTRUCTION**	**420 days**	**Tue 7/5/16**	**Mon 2/12/18**		
2	Notice to Proceed	1 day	Tue 7/5/16	Tue 7/5/16		3
3	Preliminary Construction Submittals & Permit Approvals	30 days	Wed 7/6/16	Tue 8/16/16	2	4,5FS+5 days
4	Install TESC	15 days	Wed 8/17/16	Tue 9/6/16	3	
5	Install Traffic Control	10 days	Wed 8/24/16	Tue 9/6/16	3FS+5 days	7
6	**West Bridge**	**147 days**	**Wed 9/7/16**	**Thu 3/30/17**		
7	Close West Bridge	1 day	Wed 9/7/16	Wed 9/7/16	5	8
8	Cut Holes in Deck for Trestle Pile	10 days	Thu 9/8/16	Wed 9/21/16	7	10,13
9	**South Trestle (concurrent construction)**	**12 days**	**Thu 9/22/16**	**Fri 10/7/16**		
10	Drill Trestle Pile thru Deck (12 ea)	5 days	Thu 9/22/16	Wed 9/28/16	8	11
11	Remove Existing Deck Build Trestle (24/7) (5 spans)	7 days	Thu 9/29/16	Fri 10/7/16	10	16
12	**North Trestle (concurrent construction**	**17 days**	**Thu 9/22/16**	**Fri 10/14/16**		
13	Drill Trestle Pile thru Deck (18 ea)	7 days	Thu 9/22/16	Fri 9/30/16	8	14
14	Remove Existing Deck Build Trestle (24/7) (8 Spans)	10 days	Mon 10/3/16	Fri 10/14/16	13	
15	**Drilled Shafts**	**35 days**	**Mon 10/10/16**	**Fri 11/25/16**		
16	Drilled Shafts P-4, 5 (4ea) 8-Reaction Pile	14 days	Mon 10/10/16	Thu 10/27/16	11	17,19SS+9 days,25
17	Drilled Shafts P-3,2,1 (6ea) 24-Reaction Pile	21 days	Fri 10/28/16	Fri 11/25/16	16	21SS+7 days,26
18	**Substructure**	**39 days**	**Fri 10/21/16**	**Wed 12/14/16**		
19	Columns Bent 4 (2 ea)	5 days	Fri 10/21/16	Thu 10/27/16	16SS+9 days	20,21
20	X-Beam P-4 (incl cure/strip)	12 days	Fri 10/28/16	Mon 11/14/16	19	28,29,30
21	Columns Bent 3 (2 ea)	5 days	Tue 11/8/16	Mon 11/14/16	19,17SS+7 days	22,23FS+5 days
22	X-Beam P-3 (incl cure/strip)	12 days	Tue 11/15/16	Wed 11/30/16	21	28
23	Columns Bent 2 (2 ea)	5 days	Tue 11/22/16	Mon 11/28/16	21FS+5 days	24
24	X-Beam P-2 (incl cure/strip)	12 days	Tue 11/29/16	Wed 12/14/16	23	
25	Abutment 5	7 days	Fri 10/28/16	Mon 11/7/16	16	28
26	Abutment 1	7 days	Mon 11/28/16	Tue 12/6/16	17	
27	**Superstructure**	**92 days**	**Tue 11/15/16**	**Wed 3/22/17**		
28	Set Girders - 1 span/night stage w/ trestle rmv	15 days	Thu 12/1/16	Wed 12/21/16	20,25,22	31SS+5 days
29	Remove Work Trestle Superstructure	15 days	Tue 11/15/16	Mon 12/5/16	20	
30	Remove Work Trestle Shafts	15 days	Tue 11/15/16	Mon 12/5/16	20	
31	Pour Diaphrams & Deck (13 weeks)	65 days	Thu 12/8/16	Wed 3/8/17	28SS+5 days	32,34FF
32	Bridge Rail	10 days	Thu 3/9/17	Wed 3/22/17	31	37
33	**Roadway**	**25 days**	**Thu 2/23/17**	**Wed 3/29/17**		
34	Complete Roadway Fills	10 days	Thu 2/23/17	Wed 3/8/17	31FF	35
35	Roadway Paving	10 days	Thu 3/9/17	Wed 3/22/17	34	36
36	Striping	5 days	Thu 3/23/17	Wed 3/29/17	35	37
37	Switch Traffic to new West Bridge	1 day	Thu 3/30/17	Thu 3/30/17	36,32	39SS
38	**East Bridge**	**228 days**	**Thu 3/30/17**	**Mon 2/12/18**		
39	Close Existing East Bridge	1 day	Thu 3/30/17	Thu 3/30/17	37SS	40
40	Remove Existing East Bridge (15 spans 3/week)	25 days	Fri 3/31/17	Thu 5/4/17	39	41
41	Build Work Trestle (East Br) 13 spans 1/day	15 days	Fri 5/5/17	Thu 5/25/17	40	43
42	**Drilled Shafts**	**30 days**	**Fri 5/26/17**	**Thu 7/6/17**		
43	Drilled Shafts (10 ea 3d/shaft incl react-pile)	30 days	Fri 5/26/17	Thu 7/6/17	41	45FF+10 days
44	**Substructure**	**30 days**	**Fri 6/30/17**	**Thu 8/10/17**		
45	Columns P-2,3,4 (6 ea)	15 days	Fri 6/30/17	Thu 7/20/17	43FF+10 days	46SS+5 days
46	X-Beams P-2,3,4 (3 ea)	20 days	Fri 7/7/17	Thu 8/3/17	45SS+5 days	days,50SS+15 days
47	Abutments P-1 & 5	20 days	Fri 7/14/17	Thu 8/10/17	46SS+5 days	49
48	**Superstructure**	**95 days**	**Fri 7/28/17**	**Thu 12/7/17**		
49	Set Girders (coordinate with Trestle removal)	15 days	Fri 8/11/17	Thu 8/31/17	47	
50	Remove Work Trestle	15 days	Fri 7/28/17	Thu 8/17/17	46SS+15 days	51
51	Pour Deck & Deck Closure	70 days	Fri 8/18/17	Thu 11/23/17	50	52,54FF
52	Bridge Rail	10 days	Fri 11/24/17	Thu 12/7/17	51	58
53	**Roadway & Finishes**	**40 days**	**Fri 11/10/17**	**Thu 1/4/18**		
54	Complete Roadway Fills	10 days	Fri 11/10/17	Thu 11/23/17	51FF	55
55	Roadway Paving	10 days	Fri 11/24/17	Thu 12/7/17	54	56,57
56	Striping	5 days	Fri 12/8/17	Thu 12/14/17	55	
57	Permanent Signing	10 days	Fri 12/8/17	Thu 12/21/17	55	
58	Illumination	20 days	Fri 12/8/17	Thu 1/4/18	52	59
59	Switch Traffic to New East Bridge	1 day	Fri 1/5/18	Fri 1/5/18	58	60
60	Pour Sidewalks (on new structure)	15 days	Mon 1/8/18	Fri 1/26/18	59	61
61	Put Traffic into Final Configuration	10 days	Mon 1/29/18	Fri 2/9/18	60	62
62	Substantial Completion	1 day	Mon 2/12/18	Mon 2/12/18	61	



Project: Issaquah Roadway VE Prelim
Date: Thu 10/16/14

Critical · Critical Split · Task · Split · Progress · Milestone · Slack · Slippage · Summary · Project Summary · Rolled Up Critical · Rolled Up Critical · External Tasks · External Milestone · Deadline

Developed by R. Capka
MENG Analysis VE Study

COST ANALYSIS

In preparation for the VE study, the team modeled the project costs for primary and secondary systems. These models below illustrate the large cost impact of the bridge foundations relative to all other components. These models also highlight the large proportion of the estimate that is still based on "percentage" estimates. As the estimate is refined, these elements (contingency, mobilization, inflation) should be broken down and estimated relatives to actual work items and schedule, rather than just raw percentages.

VALUE ENGINEERING

CURRENT PROJECT ESTIMATE SUMMARY:

Fairview Ave N - Bridge Replacement 60% 10-2-2014

By: Salima Hamlin
Reviewed By: xxxx

HNTB Corporation

Schedule / Bid Item [Bid Item#]	Total Quantity	Units	Unit Price	Unit Price Extension	Schedule Total
SCHEDULE: BASE BID					
CONSTRUCTION SURVEYING [105005]	1	LS	120,000.00	$ 120,000.00	
HEALTH AND SAFETY PLAN [107901]	1	LS	2,000.00	$ 2,000.00	
SITE CLEANUP OF BIOLOGICAL AND PHYSICAL HAZARDS [107902]	1	FA	20,000.00	$ 20,000.00	
MAINTENANCE AND PROTECTION OF TRAFFIC CONTROL INCLUDING FLAGGING [110005]	1	LS	355,800.00	$ 355,800.00	
CLEARING & GRUBBING [201010]	1	LS	2,000.00	$ 2,000.00	
REMOVE ASPHALT PAVEMENT [202030]	239	SY	20.00	$ 4,780.00	
REMOVE CEM CONC SIDEWALK [202035]	774	SY	12.00	$ 9,288.00	
REMOVE PAVEMENT [202045]	2281	SY	50.00	$ 114,050.00	
REMOVE CURB [202145]	44	LF	11.00	$ 484.00	
REMOVE FENCE, CHAIN LINK [202170]	662	LF	4.00	$ 2,648.00	
REMOVE PIPE [202190]	66	LF	17.00	$ 1,122.00	
REMOVE BOLLARD [202250]	4	EA	100.00	$ 400.00	
REMOVE CATCH BASIN OR SAND BOX [202270]	5	EA	250.00	$ 1,250.00	
REMOVE FOUNDATION, STREET LIGHT POLE [202310]	8	EA	650.00	$ 5,200.00	
REMOVE LUMINAIRE AND BRACKET ARM [202350]	10	EA	200.00	$ 2,000.00	
REMOVE PAINT LEGEND/SYMBOL [202365]	16	EA	50.00	$ 800.00	
REMOVE POLE, STREET LIGHT [202390]	7	EA	300.00	$ 2,100.00	
REMOVE POLE, WOOD [202395]	1	EA	450.00	$ 450.00	
REMOVE POST, STREET NAME [202415]	1	EA	100.00	$ 100.00	
REMOVE POST, TRAFFIC SIGN [202420]	16	EA	100.00	$ 1,600.00	
REMOVE SIGN [202430]	2	EA	100.00	$ 200.00	
REMOVE SIGN, TRAFFIC [202450]	12	EA	100.00	$ 1,200.00	
REMOVE TREE [202480]	16	EA	500.00	$ 8,000.00	
SAWCUT ASPHALT CONCRETE, FULL DEPTH [202750]	363	LF	2.50	$ 907.50	
SAWCUT RIGID PAVEMENT, FULL DEPTH [202770]	352	LF	5.00	$ 1,760.00	
REMOVE IRRIGATION [202901]	1	LS	1,000.00	$ 1,000.00	
REMOVE TRAFFIC SIGNAL HEAD [202902]	1	EA	250.00	$ 250.00	
RELOCATE TRAFFIC SIGNAL HEAD [202903]	1	EA	250.00	$ 250.00	
DEMOLISH BRIDGE NO. 69 [202904]	1	LS	972,000.00	$ 972,000.00	
DEMOLISH BRIDGE NO. 70 [202905]	1	LS	796,800.00	$ 796,800.00	
REMOVAL OF STRUCTURE AND OBSTRUCTION [202906]	1	LS	10,000.00	$ 10,000.00	
RELOCATE PEDESTRIAN PUSH BUTTON ASSEMBLY [202907]	2	EA	200.00	$ 400.00	
OFFSITE DISPOSAL OF CONTAMINATED MATERIALS [202908]	5208	TN	65.00	$ 338,520.00	
REMOVAL AND DISPOSAL OF ASBESTOS MATERIAL [202909]	1	LS	10,000.00	$ 10,000.00	
DEMOLITION STAIRS [203903]	1	LS	1,650.00	$ 1,650.00	
DEMOLITION WOOD DECK [203904]	1	LS	1,300.00	$ 1,300.00	
DEMOLITION EXISTING WOOD WALKWAY [203905]	1	LS	4,200.00	$ 4,200.00	
COMMON EXCAVATION [204005]	2130	CY	40.00	$ 85,200.00	
STRUCTURE EXCAVATION [204020]	670	CY	42.00	$ 28,140.00	
SAFETY SYSTEMS IN STRUCTURAL EXCAVATION [207030]	1	LS	14,000.00	$ 14,000.00	
CONSTRUCTION GEOTEXTILE FOR UNDERGROUND DRAINAGE [215010]	260	SY	2.00	$ 520.00	

VALUE ENGINEERING

Fairview Ave N - Bridge Replacement 60% 10-2-2014

By: Salima Hamlin
Reviewed By: xxxx

HNTB Corporation

Schedule / Bid Item [Bid Item#]	Total Quantity	Units	Unit Price	Unit Price Extension	Schedule Total
MINERAL AGGREGATE, TYPE 2 [401002]	520	TN	26.00	$ 13,520.00	
MINERAL AGGREGATE, TYPE 17 [401017]	490	TN	32.00	$ 15,680.00	
PAVEMENT, HMA (CL 1/2 IN) [504045]	5	TN	120.00	$ 600.00	
ROADWAY CEM CONC, 10 IN [505124]	1660	SY	100.00	$ 166,000.00	
WORK ACCESS - STAGE 1 [601901]	1	LS	1,300,000.00	$ 1,300,000.00	
WORK ACCESS - STAGE 2 [601902]	1	LS	740,000.00	$ 740,000.00	
RELOCATE FLOATING WALKWAY [601903]	1	LS	80,000.00	$ 80,000.00	
STEEL REINFORCING BAR [602350]	120000	LB	1.25	$ 150,000.00	
SUPERSTRUCTURE [602360]	1	LS	3,400,000.00	$ 3,400,000.00	
BRIDGE APPROACH SLAB [602364]	455	SY	250.00	$ 113,750.00	
GRAVEL BACKFILL FOR WALL [602420]	160	CY	40.00	$ 6,400.00	
DEFICIENT STRENGTH CONC PRICE ADJUSTMENT [602450]	1	CALC	-	$ -	
CONCRETE CLASS 4000 FOR BRIDGE [602901]	505	CY	885.00	$ 446,925.00	
SUPERSTRUCTURE INSTALLATION OF 4" CONDUIT [602902]	2	LS	65,000.00	$ 130,000.00	
DRIVING STEEL PILE [605901]	15	EA	2,000.00	$ 30,000.00	
FURNISHING STEEL PILE [605902]	900	LF	100.00	$ 90,000.00	
BRIDGE RAILING TYPE BP [606901]	126	LF	95.00	$ 11,970.00	
BRIDGE RAILING TYPE PEDESTRIAN [606902]	70	LF	110.00	$ 7,700.00	
CAST-IN-PLACE CONCRETE BARRIER [610010]	126	LF	60.00	$ 7,560.00	
STRUCTURAL EARTH WALLS [613901]	800	SF	50.00	$ 40,000.00	
SOIL EXCAVATION FOR SHAFT [619901]	5200	CY	650.00	$ 3,380,000.00	
FURNISH AND PLACE TEMP. CASING FOR 8' DIA. SHAFT [619902]	1900	LF	250.00	$ 475,000.00	
FURNISH PERMANENT CASING FOR 8' DIA. SHAFT [619903]	960	LF	450.00	$ 432,000.00	
PLACE PERMANENT CASING FOR 8' DIA. SHAFT [619904]	12	EA	2,500.00	$ 30,000.00	
CONCRETE CLASS 4000P FOR SHAFT [619905]	5300	CY	350.00	$ 1,855,000.00	
STEEL REINF. BAR FOR SHAFT [619906]	1900000	LB	1.25	$ 2,375,000.00	
CSL ACCESS TUBE [619907]	21600	LF	8.76	$ 189,216.00	
REMOVING SHAFT OBSTRUCTIONS [619908]	1	EST	600,000.00	$ 600,000.00	
UNDERDRAIN PIPE 6 IN. DIA. [701901]	330	LF	15.00	$ 4,950.00	
DRAIN PIPE 6 IN. DIA [701902]	290	LF	15.00	$ 4,350.00	
MAINTENANCE HOLE, TYPE 204B [705058]	7	EA	3,600.00	$ 25,200.00	
EXTRA DEPTH, TYPE 204B MAINTENANCE HOLE [705158]	3	VF	325.00	$ 975.00	
CATCH BASIN, TYPE 242B [705356]	6	EA	2,500.00	$ 15,000.00	
CATCH BASIN, TYPE 240C [705357]	9	EA	2,300.00	$ 20,700.00	
INLET, TYPE 250B [705451]	3	EA	1,500.00	$ 4,500.00	
WATER QUALITY VAULT A [705901]	1	EA	75,000.00	$ 75,000.00	
WATER QUALITY VAULT B [705902]	1	EA	75,000.00	$ 75,000.00	
PIPE, CB CONN, D.I., CL 50, 8 IN [708058]	334	LF	80.00	$ 26,720.00	
PIPE, INLET CONN, D.I., CL 50, 8 IN [708258]	46	LF	75.00	$ 3,450.00	
BEDDING, CL B, 8 IN PIPE [717008]	379	LF	10.00	$ 3,790.00	
TELEVISION INSPECTION [717100]	925	LF	4.00	$ 3,700.00	

By: Salima Hamlin

Fairview Ave N - Bridge Replacement 60% 10-2-2014 Reviewed By: xxxx

HNTB Corporation

Schedule / Bid Item [Bid Item#]	Total Quantity	Units	Unit Price	Unit Price Extension	Schedule Total
PIPE, PS, D.I., CL 50, 12 IN [717312]	501	LF	90.00	$ 45,090.00	
TEE, D.I., 8 IN [717848]	13	EA	750.00	$ 9,750.00	
ADJUST EXISTING MH, CB, OR VC [720005]	4	EA	350.00	$ 1,400.00	
ADJUST EXISTING VALVE BOX [720020]	3	EA	340.00	$ 1,020.00	
ADJUST EXISTING HANDHOLE [720045]	2	EA	400.00	$ 800.00	
CONSTRUCTION STORMWATER & EROSION CONTROL PLAN (CSECP) [801001]	1	LS	576,000.00	$ 576,000.00	
TREE, VEGETATION & SOIL PROTECTION PLAN (TVSPP) [801002]	1	LS	5,000.00	$ 5,000.00	
SPILL PLAN (SP) [801003]	1	LS	20,000.00	$ 20,000.00	
TEMPORARY DISCHARGE PLAN (TDP) [801004]	1	LS	30,000.00	$ 30,000.00	
TREE, BROADLEAF EVERGREEN, 5 FT TO 6 FT [802006]	5	EA	100.00	$ 500.00	
TOPSOIL, TYPE A [802160]	26	CY	50.00	$ 1,300.00	
MULCH, BARK [802220]	11	CY	43.00	$ 473.00	
BOLLARD, REMOVABLE [802315]	4	EA	750.00	$ 3,000.00	
RELOCATE TREE [802400]	9	EA	300.00	$ 2,700.00	
RELOCATE SHRUB [802475]	240	EA	40.00	$ 9,600.00	
RELOCATE GROUND COVER [802480]	415	EA	10.00	$ 4,150.00	
SEEDED LAWN INSTALLATION [802610]	375	SF	0.25	$ 93.75	
IRRIGATION SYSTEM, AUTOMATIC [803005]	1	LS	10,000.00	$ 10,000.00	
CURB, CEM CONC [804005]	1190	LF	21.00	$ 24,990.00	
CURB AND GUTTER, CEM CONC [804015]	50	LF	33.00	$ 1,650.00	
EXTRUDED CURB, CEMENT CONCRETE [806010]	150	LF	14.00	$ 2,100.00	
RELOCATE OR RESET MONUMENT FRAME AND COVER [813030]	2	EA	500.00	$ 1,000.00	
SIDEWALK, CEM CONC [814005]	920	SY	40.00	$ 36,800.00	
SIDEWALK, THICKENED EDGE [814010]	1050	LF	8.00	$ 8,400.00	
CURB RAMP 422A [814020]	3	EA	1,450.00	$ 4,350.00	
CURB RAMP, NON-STANDARD [814024]	15	SY	350.00	$ 5,250.00	
DETECTABLE WARNING PLATE [814030]	35	SF	70.00	$ 2,450.00	
STAIRWAY, CEM CONC, SPECIAL [818020]	130	SF	80.00	$ 10,400.00	
HANDRAIL, TYPE 442 [818142]	270	LF	100.00	$ 27,000.00	
DRIVEWAY, CEM CONC, 8 IN [819008]	50	SY	80.00	$ 4,000.00	
INSTALL SIGN, TRAFFIC, OWNER FURNISHED [821006]	21	EA	100.00	$ 2,100.00	
INSTALL SIGN, STREET NAME, OWNER FURNISHED, POST MT. [821015]	4	EA	150.00	$ 600.00	
POST, TRAFFIC SIGN [821030]	12	EA	170.00	$ 2,040.00	
POST, STREET NAME [821040]	1	EA	150.00	$ 150.00	
POST, BUS ZONE [821045]	1	EA	140.00	$ 140.00	
RELOCATE SIGN, TRAFFIC [821050]	10	EA	150.00	$ 1,500.00	
RELOCATE SIGN, STREET NAME [821055]	2	EA	150.00	$ 300.00	
RELOCATE SIGN, BUS ZONE [821060]	1	EA	150.00	$ 150.00	
PAVEMENT MARKING, PAINT, 4 IN STRIPE [822004]	3200	LF	0.20	$ 640.00	
PAVEMENT MARKING, PAINT, 6 IN STRIPE [822006]	60	LF	2.00	$ 120.00	
PAVEMENT MARKING, PAINT, 8 IN STRIPE [822008]	50	LF	2.50	$ 125.00	

Fairview Ave N - Bridge Replacement 60% 10-2-2014

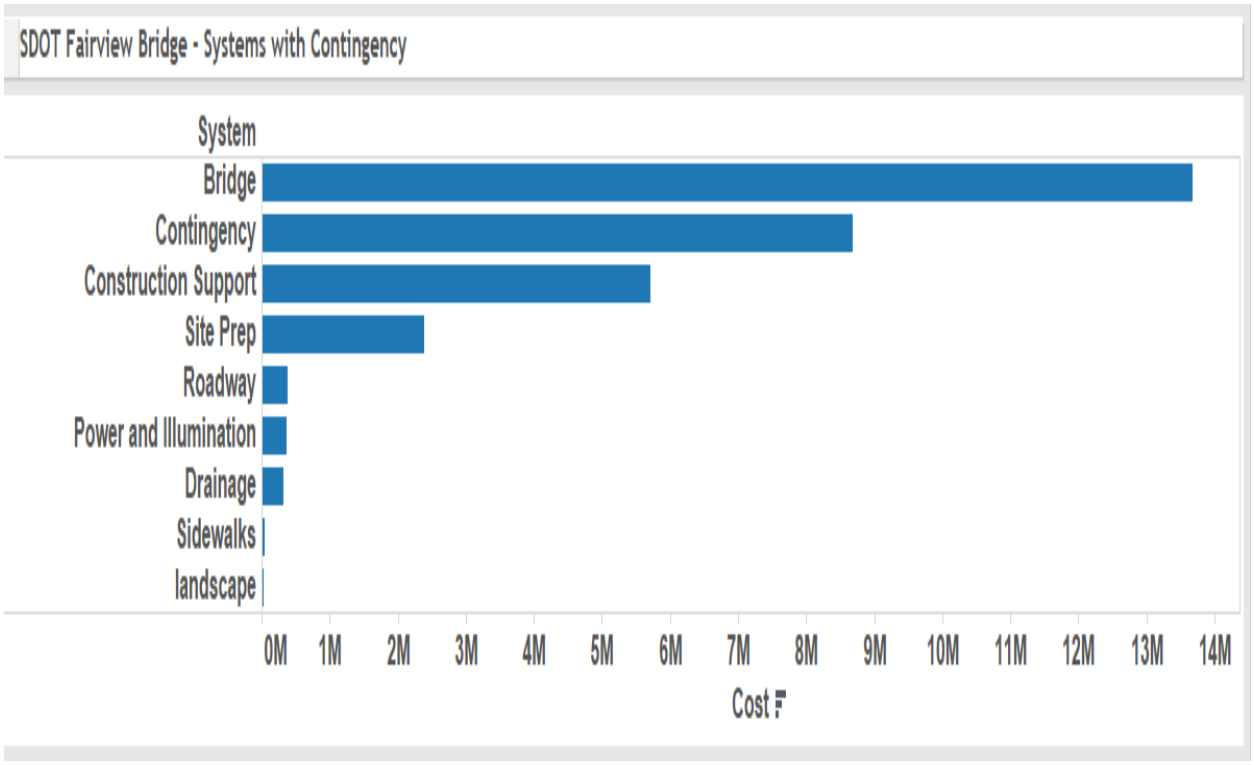
By: Salima Hamlin
Reviewed By: xxxx

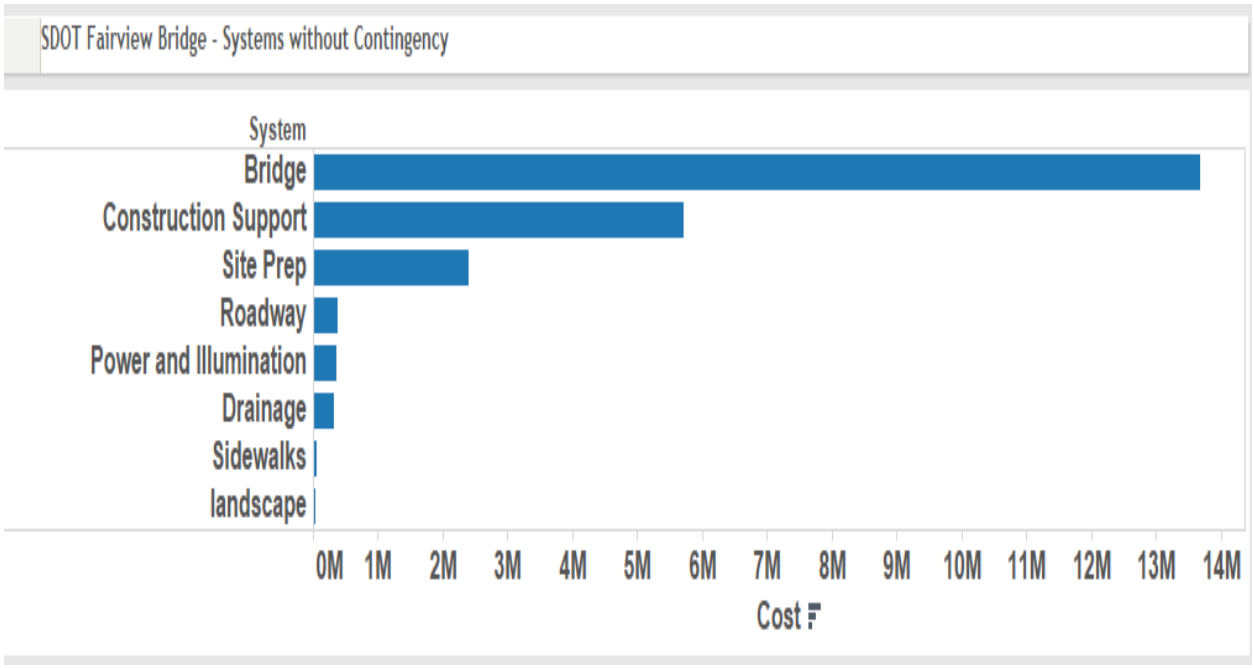
HNTB Corporation

Schedule / Bid Item [Bid Item#]	Total Quantity	Units	Unit Price	Unit Price Extension	Schedule Total
PAVEMENT MARKING, THERMOPLASTIC, 8 IN STRIPE [822018]	230	LF	5.00	$ 1,150.00	
PAVEMENT MARKING, THERMOPLASTIC, LEGEND/SYMBOL [822020]	10	EA	85.00	$ 850.00	
PAVEMENT MARKING, GREEN BIKE BOX [822901]	920	SF	10.00	$ 9,200.00	
LUMINAIRE, INDUCTION OR LIGHT EMITTING DIODE (LED) [830310]	14	EA	500	$ 7,000.00	
WIRING, STREET LIGHTING [830600]	1	LS	1300	$ 1,300.00	
POLE, STEEL STRAIN, TYPE Z [832020]	11	EA	12600	$ 138,600.00	
POLE, ALUMINUM LIGHTING, 25 FT TO 35 FT [832285]	1	EA	2000	$ 2,000.00	
FOUNDATION, POLE TYPE Z [832540]	11	EA	3500	$ 38,500.00	
FOUNDATION, STREET LIGHT POLE [832545]	1	EA	1900	$ 1,900.00	
BRACKET ARM, 12 FT [832812]	14	EA	1100	$ 15,400.00	
CONDUIT, PVC, 2 IN [833020]	2440	LF	8	$ 19,520.00	
TRENCHING, CONDUIT [833200]	50	LF	14	$ 700.00	
FLOOD LIGHT, (LIGHT SOURCE TYPE) (SIZE)	2	EA	200	$ 400.00	
TEMPORARY STREET LIGHTING	1	LS	150000	$ 150,000.00	
STRUCTURE MOUNTNED JUNCTION BOX (TYPE)	13	EA	965	$ 12,545.00	
HANDHOLE, TYPE 2 [833302]	10	EA	700	$ 7,000.00	**$ 20,535,222.25**
Subtotal				$ 20,535,222.25	
PROJECT CONTINGENCY [108902] - 15% of subtotal	1	LS	3,080,283.34	$ 3,080,283.34	**$ 23,615,505.59**
INFLATION - 3% (mid point of CN) [108903] (2015 - 2017)	1	LS	$ 2,189,794.99	$ 2,189,794.99	**$ 25,805,300.57**
MOBILIZATION [109005] - 10% of subtotal	1	LS	2,580,530.06	$ 2,580,530.06	
Total					**$ 28,385,830.63**
CONSTRUCTION CONTINGENCY					
CONSTRUCTION CONTINGENCY [108901] - 20% of total	1	LS	$ 5,677,166.13	$ 5,677,166.13	**$ 34,062,996.76**
GRAND TOTAL					**$ 34,062,996.76**

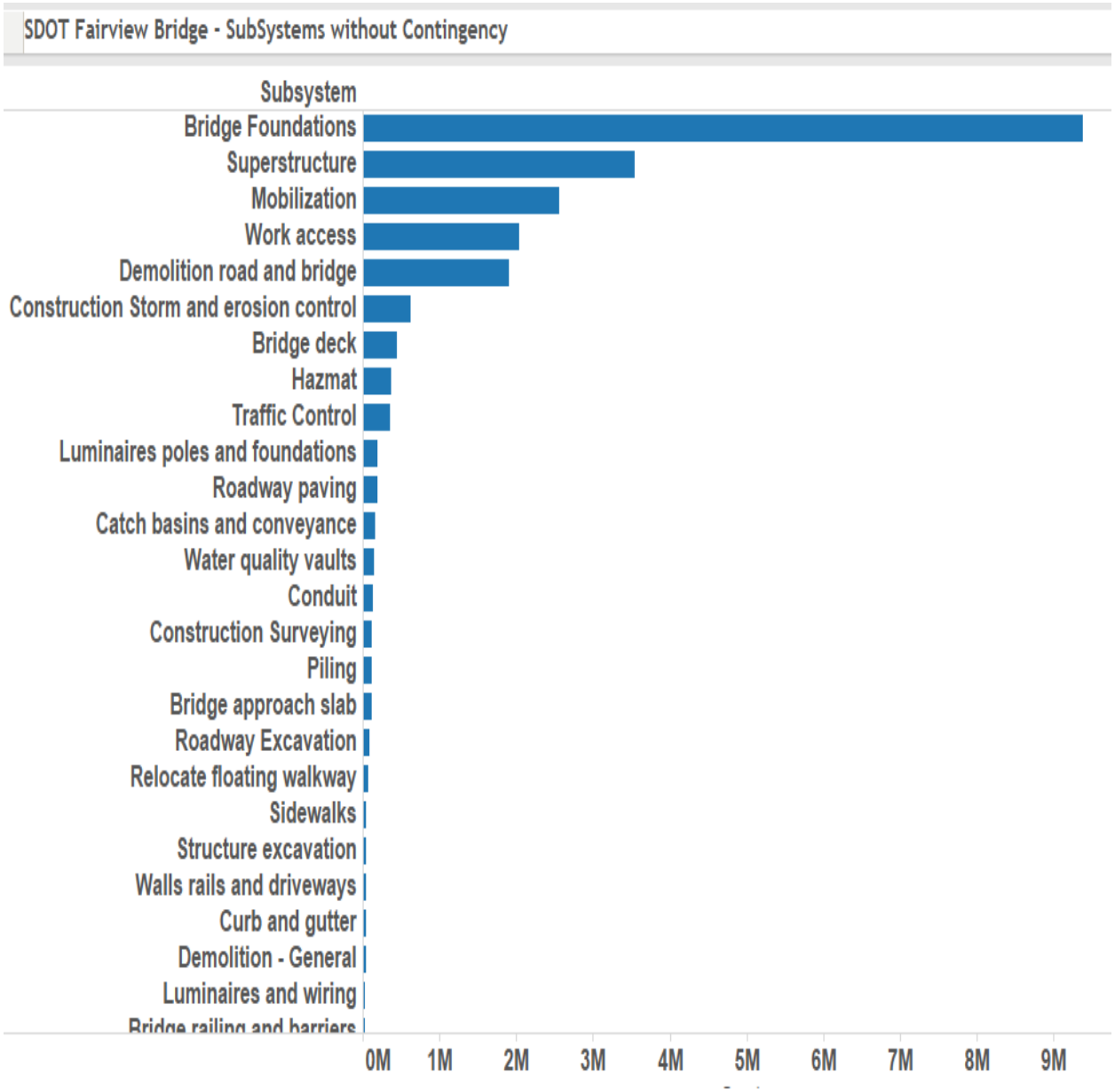
0.16985856

Primary Cost Components

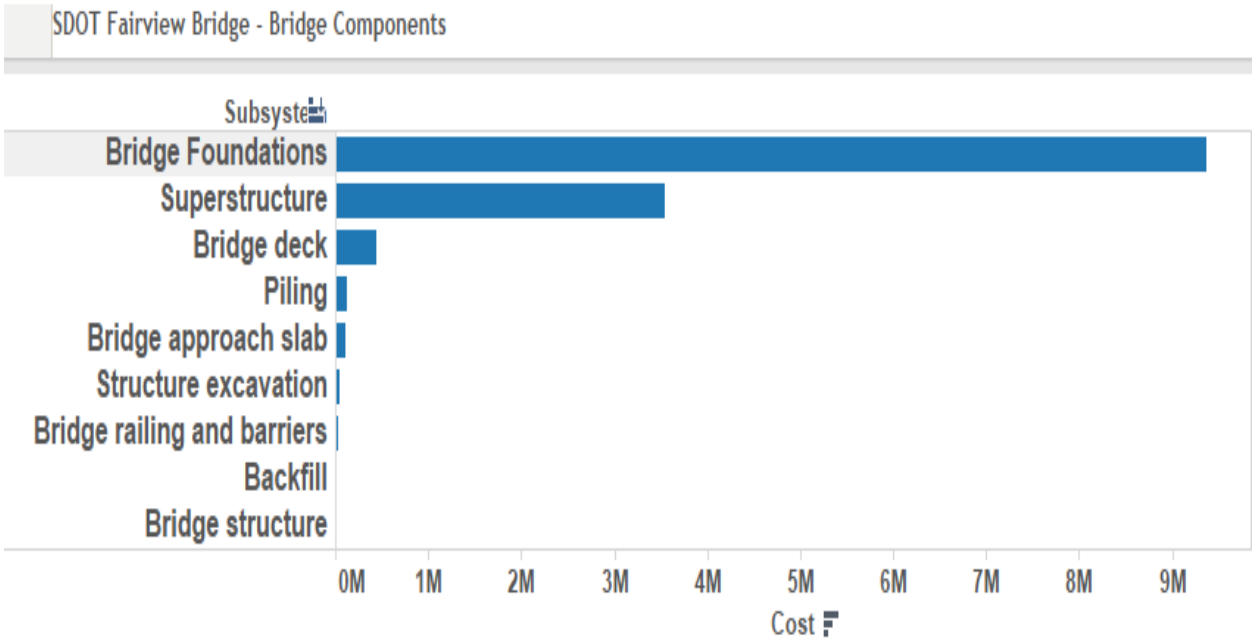




Secondary Systems without Contingency



Bridge Component Costs



COST ESTIMATE COMMENTS

The review team was not tasked to complete a detailed cost estimate review for the entire project, but did review some of the major elements. A few items warranting further review include: Rebar unit prices, Contingencies, Contractors site rental, Maintenance of traffic, Floating walkway relocation, and Hazardous material disposal.

Most of the current estimate is based on unit costs for installed materials. This estimate would benefit from a schedule / labor driven analysis. Although there are currently very large contingencies in the estimate that may cover these labor unknowns, the best way to reduce cost estimate risk and to better validate the budget would be to complete a schedule driven estimate.

CE#	BUILDING COMPONENT	CURRENT TOTAL	VA TOTAL	DIFF TOTAL	COMMENT
1	Estimate Adjustments - Construction Support	$413,000	$2,195,000	($1,782,000)	Prices of plans, contractor's site rental, bussing, traffic control
2	Estimate Adjustments - Hazardous and Contaminated Materials	$615,000	$1,425,000	($810,000)	Unit price adjustments and additional treatment
3	Estimate Adjustments - Site Prep	$95,000	$491,000	($396,000)	Unit price adjustments, floating bridge replacement
4	Estimate Adjustments - Bridge	$3,064,000	$4,975,000	($1,911,000)	Primarily steel reinforcing in-place, augered steel piles
5	Estimate Adjustments - Roadway	$172,000	$300,000	($128,000)	Unit price adjustments
6	Estimate Adjustments - Landscape	$17,000	$162,000	($145,000)	Unit price adjustments

COST ESTIMATE FORM
COMPONENT: Estimate Adjustments - Construction Support

CE1

CURRENT DESIGN					VA PROPOSAL				
ITEM	**QUAN**	**UNIT**	**UNIT COST**	**TOTAL COST**	**ITEM**	**QUAN**	**UNIT**	**UNIT COST**	**TOTAL COST**
Health and Safety Plan	1	ls	2000.00	2,000	Health and Safety Plan	1	ls	10000.00	10,000
Tree, Vegetation & Soil Protection Plan	1	ls	5000.00	5,000	Tree, Vegetation & Soil Protection Plan	1	ls	15000.00	15,000
Spill Plan	1	ls	20000.00	20,000	Spill Plan	1	ls	50000.00	50,000
Temporary Discharge Plan	1	ls	30000.00	30,000	Temporary Discharge Plan	1	ls	50000.00	50,000
					Contractor's Laydown Area	18	mo	20000.00	360,000
					Site offices, Labor Force Parking	18	mo	10000.00	180,000
					Work Force Bussing to and from the Site	18	mo	15000.00	270,000
Maintenance and Protection of Traffic	1	ls	355800.00	355,800	Maintenance and Protection of Traffic	1	ls	1100000.00	1,100,000
					Sand Blanket	5333	tn	30.00	160,000
Subtotal				412,800	Subtotal				2,195,000
General Contractor Markup		%			General Contractor Markup		%		
Total to nearest $1000				413,000	Total				2,195,000
					Difference				(1,782,000)

MENG ANALYSIS

Proposal # **CE1**

COST ESTIMATE FORM
COMPONENT: Estimate Adjustments - Hazardous and Contaminated Materials

CE2

CURRENT DESIGN					VA PROPOSAL				
ITEM	**QUAN**	**UNIT**	**UNIT COST**	**TOTAL COST**	**ITEM**	**QUAN**	**UNIT**	**UNIT COST**	**TOTAL COST**
Site Cleanup of Biological and Physical Hazards	1	ls	20000	20,000	Site Cleanup of Biological and Physical Hazards	1	ls	80000	80,000
Materials	9000	tn	65	585,000	Materials	9000	tn	110	990,000
Removal and Disposal of Asbestos Material	1	ls	10000.00	10,000	Treatment and Disposal of Contaminated Water	15000	gal	10.00	150,000
					Material	1	ls	25000.00	25,000
					Contractor's Contaminated Water and Material Treatment Area	18	mo	10000.00	180,000
Subtotal				615,000	Subtotal				1,425,000
General Contractor Markup		%			General Contractor Markup		%		
Total to nearest $1000				615,000	Total				1,425,000
					Difference				(810,000)

MENG ANALYSIS

Proposal # **CE2**

COST ESTIMATE FORM
COMPONENT: Estimate Adjustments - Site Prep

CE3

CURRENT DESIGN					VA PROPOSAL				
ITEM	QUAN	UNIT	UNIT COST	TOTAL COST	ITEM	QUAN	UNIT	UNIT COST	TOTAL COST
Clearing & Gubbing	1	ls	2000	2,000	Clearing & Gubbing	1	ls	15000	15,000
Remove Bollard	4	ea	100.00	400	Remove Bollard	4	ea	500.00	2,000
Remove Catch Basin or Sand Box	5	ea	250.00	1,250	Remove Catch Basin or Sand Box	5	ea	1200.00	6,000
Remove Pole, Street Light	7	ea	300.00	2,100	Remove Pole, Street Light	7	ea	1500.00	10,500
Remove Pole, Wood	1	ea	450.00	450	Remove Pole, Wood	1	ea	750.00	750
Remove Tree	16	ea	500.00	8,000	Remove Tree	16	ea	1500.00	24,000
Remove Traffic Signal Head	1	ea	250.00	250	Remove Traffic Signal Head	1	ea	2500.00	2,500
Relocate Traffic Signal Head	1	ea	250.00	250	Relocate Traffic Signal Head	1	ea	2500.00	2,500
Assembly	2	ea	200.00	400	Assembly	2	ea	800.00	1,600
Relocate Floating Walkway	1	ls	80000.00	80,000	Demo and Replace Floating Walkway	1	ea	164000.00	164,000
					Remove Coal Dock				
					Crane Barge	80	hr	2000.00	160,000
					Disposal Barge	80	hr	1000.00	80,000
					Disposal of materials	200	tn	110.00	22,000
Subtotal				95,100	Subtotal				490,850
General Contractor Markup		%			General Contractor Markup		%		
Total to nearest $1000				95,000	Total				491,000
					Difference				(396,000)

MENG ANALYSIS

Proposal # **CE3**

COST ESTIMATE FORM
COMPONENT: Estimate Adjustments - Bridge

CE4

CURRENT DESIGN					VA PROPOSAL				
ITEM	**QUAN**	**UNIT**	**UNIT COST**	**TOTAL COST**	**ITEM**	**QUAN**	**UNIT**	**UNIT COST**	**TOTAL COST**
Safety Systems in Structural Excavation	1	ls	14000.00	14,000	Safety Systems in Structural Excavation	1	ls	50000.00	50,000
Driving Steel Pile	15	ea	2000.00	30,000	mix	15	ea	5000.00	75,000
Steel Reinforcing Bar	120000	lb	1.25	150,000	Steel Reinforcing Bar	120000	lb	2.00	240,000
Steel reif. Bar for Shaft	1900000	lb	1.25	2,375,000	Steel reif. Bar for Shaft	1900000	lb	2.00	3,800,000
Super Structure					Super Structure				
Epoxy Coated St. reinf. Bar	300000	lb	1.50	450,000	Epoxy Coated St. reinf. Bar	300000	lb	2.50	750,000
St. Reinf. Bar for Bridge	29900	lb	1.50	44,850	St. Reinf. Bar for Bridge	29900	lb	2.00	59,800
Subtotal				3,063,850	Subtotal				4,974,800
General Contractor Markup		%			General Contractor Markup		%		
Total to nearest $1000				3,064,000	Total				4,975,000
					Difference				(1,911,000)

MENG ANALYSIS

Proposal # **CE4**

COST ESTIMATE FORM
COMPONENT: Estimate Adjustments - Roadway

CE5

CURRENT DESIGN					VA PROPOSAL				
ITEM	QUAN	UNIT	UNIT COST	TOTAL COST	ITEM	QUAN	UNIT	UNIT COST	TOTAL COST
Roadway Cem Conc, 10 in	1660.00	sy	100	166,000	Roadway Cem Conc, 10 in	1660.00	ls	150	249,000
Install Sign, Traffic, Owner Furnished	21.00	ea	100.00	2,100	Install Sign, Traffic, Owner Furnished	21.00	ea	800.00	16,800
Furnished	4.00	ea	150.00	600	Furnished	4.00	ea	1000.00	4,000
Relocate Sign, Traffic	10.00	ea	150.00	1,500	Relocate Sign, Traffic	10.00	ea	750.00	7,500
Relocate Sign, Street Name	2.00	ea	150.00	300	Relocate Sign, Street Name	2.00	ea	800.00	1,600
Relocate Sign, Bus Zone	1.00	ea	150.00	150	Relocate Sign, Bus Zone	1.00	ea	750.00	750
Wiring Street Lighting	1.00	ls	1300.00	1,300	Wiring Street Lighting	1.00	ea	20000.00	20,000
Subtotal				171,950	Subtotal				299,650
General Contractor Markup		%			General Contractor Markup		%		
Total to nearest $1000				172,000	Total				300,000
					Difference				(128,000)

MENG ANALYSIS

Proposal # **CE5**

COST ESTIMATE FORM
COMPONENT: Estimate Adjustments - Landscape

CE6

CURRENT DESIGN					VA PROPOSAL				
ITEM	QUAN	UNIT	UNIT COST	TOTAL COST	ITEM	QUAN	UNIT	UNIT COST	TOTAL COST
Tree, Broadleaf Evergreen	5	ea	100	500	Tree, Broadleaf Evergreen	5	ea	1500	7,500
Relocate Tree	9	ea	300	2,700	Relocate Tree	9	ea	1500	13,500
Relocate Shrub	240	ea	40.00	9,600	Relocate Shrub	240	ea	500.00	120,000
Relocate Groundcover	415	ea	10.00	4,150	Relocate Groundcover	415	ea	50.00	20,750
Subtotal				16,950	Subtotal				161,750
General Contractor Markup		%			General Contractor Markup		%		
Total to nearest $1000				17,000	Total				162,000
					Difference				(145,000)

MENG ANALYSIS

Proposal # **CE6**

COST RISK ANALYSIS

The following cost risk analysis used the October 2014 Updated 60% estimate, sorted and subtotaled by secondary cost elements as the base cost for the analysis. The VE team developed a rudimentary triangular simulation model with worst case, best case, and most likely case numbers offered for each secondary system level cost element. A basic @Risk Latin Hypercube simulation was run in order to present a risk model that highlights mean probable total cost.

This output, shown below, excludes current project contingencies, engineering and escalation, and shows a simulated most likely cost of $27.4 million, approximately 19% more than the current $23.9 million estimate. Based on this simulation, there is less than a 10% probability that the estimate will exceed that amount.

Although higher than the current estimate, those above numbers do not include contingencies. It also doesn't include the current 25% construction contingency (38% total contingencies) included in the current estimate that cover the basic estimate increases.

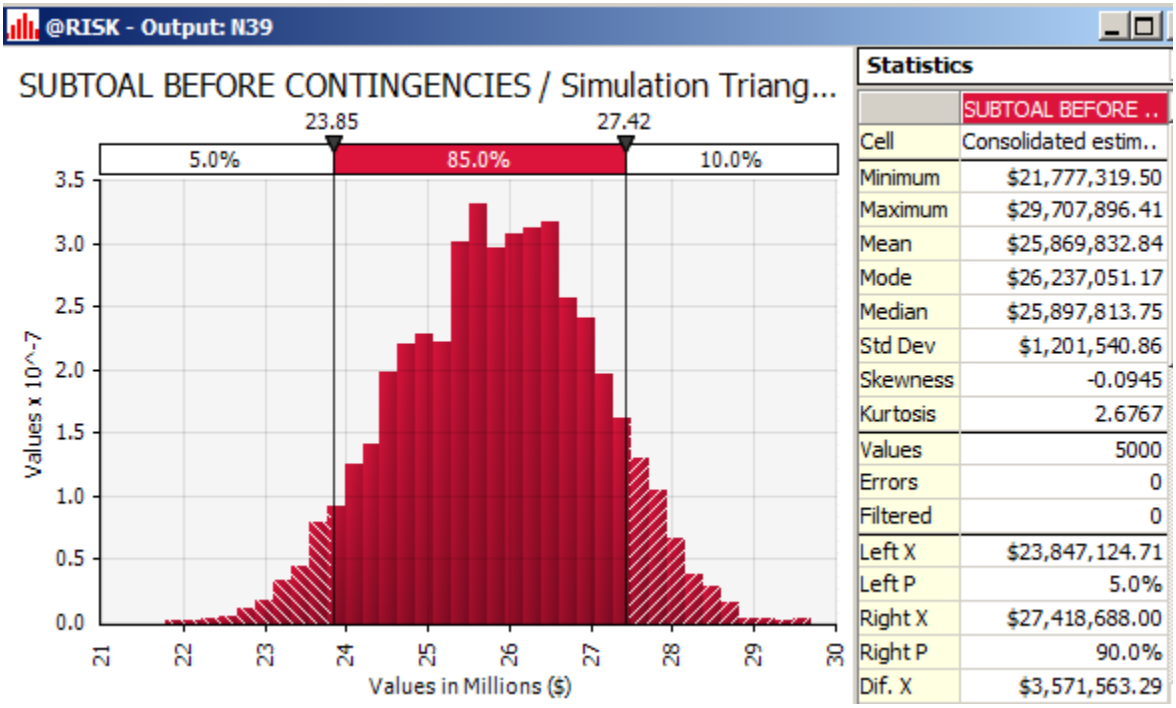
Please note that this is a rudimentary estimate review. Many of the larger deviations used in the potential ranges are based on lack of estimating detail at this stage of the project. We expect most of those to be reduced as the design and estimates are further defined. The rest of this Risk and VE report offers specific ways to make up the gaps between the current estimate and these simulated numbers.

Cost Risk Summary

These simulations indicate a potential 14 - 16% increase in cost over the current basic construction estimate. This is most likely not a serious problem for this project for several reasons. First, that figure does not include contingencies that are still in the current budget estimate at 20% of construction costs.

Secondly, this study points out that most of the identified cost estimate risks are due to elements that are not quite worked out in the project design. This study should aid in making some of those key decisions and remove much of the risk with an updated cost estimate. The recommendations for structural approach alone, should reduce basic construction cost and remove much of the subsoil and environmental risks identified in this study.

From this independent study team's perspective, it appears that the City and the design team are already on the path of reducing environmental risks, are open to the less risky structural approaches, and should be ready to move forward and update the project estimate to reflect the next level of detail. This next estimate should be able to reduce the contingency from about 25% construction (38% total) to the more typical 10 to 15% range.

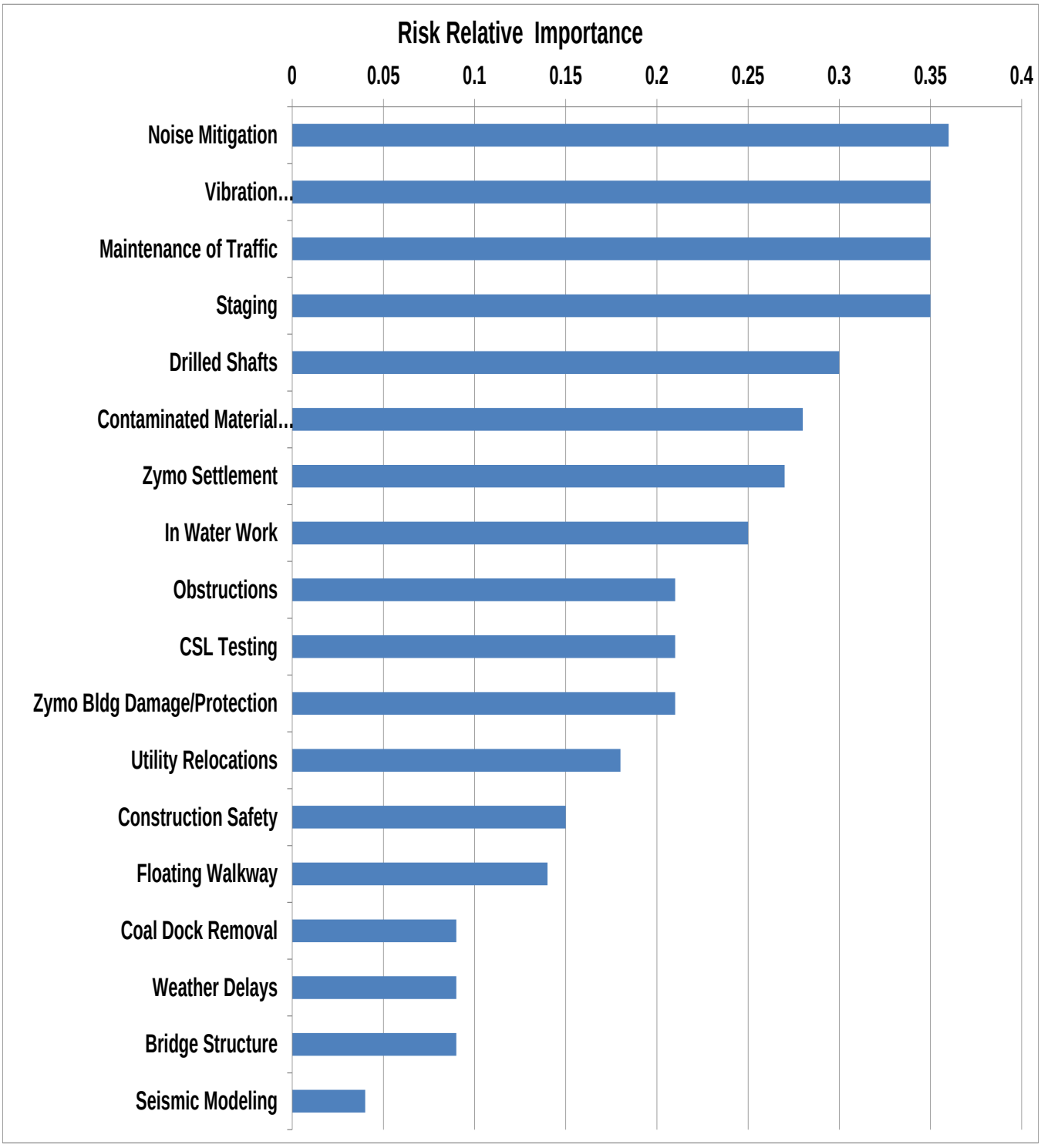


RISK ANALYSIS

The VE team discussed the potential project risks, assessing probability and potential impacts. Risks, Costs and Schedule Impacts were identified as: *very low, low, medium, high, or very high*. Combined (order of importance) scores are calculated as the product of probability and impact.

This analysis was used to identify focus areas for the study, as well as to look for ways to balance the relationship between cost and risk with specific VE proposals. It is often possible to reduce risk with additional expenditures; but it is important to keep a good value ratio between those costs and the value of the reduced risk.

Prioritized Project Risk Assessment



METHODOLOGY

Value Engineering Purpose

Value Engineering provides an independent, impartial project review by a team assembled specifically for this study. Value engineering is an organized creative process, which examines the proposed project and identifies alternatives to optimize cost and performance, while assuring compliance with project requirements. For this project, the VE process was used to focus on both design and constructability issues.

Through a structured system of investigation, idea generation, and analysis, the independent multi-disciplined team is able to consider and identify alternatives for design, budget, schedule, construction methods, concurrently in a concentrated study.

Process

After the initial presentation by the design teams and the Seattle Department of Transportation representative, the study team analyzed the budget and cost estimate, and defined the basic functions of each project component.

All major project components were reviewed for constructability issues; and value engineering refinements were generated in response to these constructability risks.

Specific proposals and reports were prepared and analyzed by the group for conformance to the project goals and study goals, prior to final prioritization. The design team, materials suppliers, and specialty contractors were contacted regarding design questions, material options and pricing.

Prioritization and brainstorming were conducted in group sessions alternating with additional small group and individual study sessions. All members supported an "open minded" attitude to new suggestions, and all alternatives were considered valid until rejected by the entire team.

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Transmittal

Perteet

Date: October 8, 2014

Project No.: 20100169.001
Project Name: Fairview Ave N Bridge

To:	Jaime Souza	From:	Kurt Ahrensfeld, PE
	MENG Analysis		Perteet Inc.
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	Suite 200		Suite 300
	Seattle, WA 98121-3300		Seattle, WA 98104
	Phone: 206-587-3797		Phone: 425-252-7700

☐ Urgent ☐ For Review ☐ Please Comment ☐ Please Reply

Comments:

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SIGN-UP SHEET

DATE: 10/14/2014

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DATE: 10/14/14

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APPENDIX: COST RISK SIMULATION SPREADSHEET

Description	AMOUNT Current Estimate	Best Case - %	Worst Case + %	Most likely + or - %
Bridge Foundations	9,376,216	20%	30%	10%
Superstructure	3,550,000	5%	20%	0%
Mobilization	2,560,054	50%	20%	-5%
Work access	2,040,000	25%	20%	-5%
Demolition road and bridge	1,908,310	10%	60%	5%
Construction Storm and erosion control	626,000	10%	20%	0%
Bridge deck	446,925	10%	20%	0%
Hazmat	368,520	0%	300%	200%
Traffic Control	355,800	0%	500%	340%
Luminaires poles and foundations	196,400	0%	50%	10%
Roadway paving	195,800	10%	20%	0%
Catch basins and conveyance	166,445	0%	60%	15%
Water quality vaults	150,000	0%	20%	0%
Conduit	130,000	0%	20%	0%
Construction Surveying	120,000	10%	20%	0%
Piling	120,000	10%	60%	10%
Bridge approach slab	113,750	10%	20%	0%
Roadway Excavation	85,200	5%	30%	0%
Relocate floating walkway	80,000	0%	400%	130%
Sidewalks	47,650	5%	10%	0%
Structure excavation	42,660	10%	30%	0%
Walls rails and driveways	41,400	5%	10%	0%
Curb and gutter	38,340	5%	10%	0%
Demolition - General	37,880	10%	60%	15%
Luminaires and wiring	35,520	10%	20%	0%
Bridge railing and barriers	27,230	10%	20%	0%
Planting	21,817	0%	200%	50%
Pavement markings	12,085	5%	10%	0%
Irrigation	10,000	5%	10%	0%
Signage	6,980	5%	40%	10%
Backfill	6,400	5%	10%	0%
Construction Landscape protection	5,000	5%	10%	0%
Underdrain	4,950	5%	10%	0%
Clear and grub	2,000	5%	10%	0%
Construction support	2,000	5%	10%	0%
Coal Dock	1,000	100%	30000%	25000%
Monument Frame and Cover	1,000	5%	10%	0%
SUBTOTAL CONSTRUCTION	**$ 22,933,331**			
				median
Construction Contingency	$ 5,632,118	25%		
Project Contingency	$ 3,055,842	38%		
TOTAL PROJECT, with Contingency, not escalated	**$ 31,621,291**			

APPENDIX: CREATIVITY ALTERNATIVES SHEETS

The following creativity worksheets are used by the VA team to record options discussed during the workshop. They are included herein to illustrate the range of options considered during the study for key project elements.

PROJECT: SDOT Fairview Ave Bridge VE **DATE:**

COMPONENT: Site Prep

FUNCTIONS:

1
2
3 Reduce Turbidity
4 Protect Water Quality
5. Lift Out Structure
6. Cut into Pieces
7 Move Float. Sidewalk
8

#	CURRENT CONCEPT	
2	. Erosion Sed Control / Curtains / Sand Blanket	600 K
	" Pavement / Sidewalk / Luminaires	200 K
	: Floating Bridge Sidewalk	80K
	/ Bridge Demo	1.8 M
	/ Remove Coal Dock	?
	. Sand blanket	

#	ALTERNATE PROPOSALS	
	. Low Vibration Sheet for turbidity Control	
	. Bubble Curtain ILO turbidity Curtain	
	: Barge out demo. Sections (Raise wires for clearance)	
	:	
	: Underground lines	2-3 million
Bryan ~~Justin~~ T-1	: Gantry over road	
	"	
	: Eliminate Work Bridge	
	→ a) Partial Closure	
	→ b) Full Closure	
w/ MOT.	Limited Work Structure	
	. Work Structure to West of Bridge	

PROJECT: SDOT Fairview Ave. Bridge VE **DATE:**

COMPONENT: Geotech | Fdns.

FUNCTIONS:

1 Support Bridge
2 Balance Stiffness
3 Resist Lateral Spreading
4 Bear Loads
5 AASHTO 100 Yr / Site Specific
6
7
8

#	CURRENT CONCEPT	
	• Drilled Shafts - (20) @ 140 x 8 dia • - Permanent Casing • Excavate Contam Soils	$450 K

#	ALTERNATE PROPOSALS	
	• CMS Criteria	
Don PB Dave	• Segregate, Contaminated Materials - → Not full height removal	R W J
PB Dave	• Reduce permanent casing • Relax balanced Stiffness Criteria → - Only upper 20 ft.	R K VE
	• Refine lateral Spreading Calcs, - Reduce Shaft diameter	
Don PB Dave	• Reduce Shaft length (in bearing strata)	R K J
PB	• Reduce drilled Shaft Qty. to 15 vs. 20	R J
PS Rick	• Shorten Bridge length • Stone Columns - 40 ft. • Jet grout / Compaction Grout • Sheet Pile - Press. in to provide barrier	R J
	• Filled Structure W/ Stone Column behind Sea Wall	

PROJECT: SDOT Fairview Ave. Bridge VE DATE:

COMPONENT: Geotech / Fdns. Cont

FUNCTIONS:

1		5	
2		6	
3		7	
4		8	

#	CURRENT CONCEPT
•	Smaller - More Shafts - Smaller equipment : Secant : Augar Cast : Vertical Pile

#	ALTERNATE PROPOSALS
•	Optimize abutments
•	Lightweight fills @ abutments
•	Lightweight Steel Structure . Prefab
•	Suspension Bridge
•	Voided Slab Bridge
•	Reduce Criteria to Life Safety - last Safety Response
•	Continue Column (Shafts) up to Structure 1CO Smaller Column

PROJECT: SDOT Fairview Ave Bridge VE DATE:

COMPONENT: Bridge Structure

FUNCTIONS:
1
2 Span lake
3 Carry traffic
4 Replace exist Bridges
5
6 Support Structures
7 Upgrade Seismic
8- Extend life

#	CURRENT CONCEPT		
	Columns / Cap	?	400 k
	2 Column		
	4 Span @ 130		$ 3.4 mil
	Prestressed Girders		
	Concrete Deck		

#	ALTERNATE PROPOSALS
Pg Dave	• Rebuild East Struct. Replace West Structure • retrofit fdn. - • micropiles • new west bridge support east. • don't retrofit fdns - life safety ok
	• Longer precast girders
Dave P?	• precast deck panels Stay in place forms

Road	Bridge Configs
Pg Bridge width	
ERIC	• Elim. overlooks • Elim float walkway - provide small dock for • Cycle track on walkway • Narrow ped. sidewalk to 5 Ft. • One side only Ped walkway

PROJECT: SDOT Fairview Ave Bridge VE DATE:

COMPONENT: Utilities

FUNCTIONS:

1		5	
2		6	
3		7	
4. Relocate / demolished	Place	8. Collect, Convey, treat Storm	

#	CURRENT CONCEPT	
	• Storm drainage : Conveyance : Vaults	350K
	• Relocate Franchise utilities	By Franchiso
	• Power / Conduits	
	• Overhead Power - S.L.	
	• Illumination, bus trolley	2000 K.

#	ALTERNATE PROPOSALS
	S.L. Power towers
Bryan T2	* Relocate all lines to temp poles - ~~30~~ Ft West — 3-4 months (B J)
	* Horiz drill - underground (R J B)
	* Relocate / Remove lower level lines → 60 Ft. High → 55 Ft. Max * 26 KV. relocate or shut off (B J A) * neutral - move up (neutral for what?) * Comm liner - move up
	* Don't replace west Bridge

ROJECT: SDOT Fairview Ave Bridge VE

DATE:

OMPONENT: Maintenance of Traffic MOT

NCTIONS:

1		5	
2		6	
3		7	
4		8	

#	CURRENT CONCEPT
●	Phase 1a traffic to east 1 lane eq. $355K 1b ~~night ops~~ - 1 way northbound for intersections 2a traffic West - 1 lane eq. 2b temp back to east - 1 lane eq.

#	ALTERNATE PROPOSALS
*	Elim. metro trolley buses during construction
*	Construct/demo 1) east first, 2) then west
6a ●	Full Shut down down - modify local access as necessary
*	Build/Close center first - 1 lane E, W each - then Build out
6b •	Just 1 ~~lane~~ lane North throughout

PROJECT: SDOT Fairview Ave. Bridge VE

DATE:

COMPONENT: Constructibility

FUNCTIONS:

1		5	
2		6	
3		7	
4	Support Equipment	8	

#	CURRENT CONCEPT	
	• Working Platform • Staging • Vibration • Contaminated Soil	$2.5 mil

#	ALTERNATE PROPOSALS
T1 Cost	* Stage all on barge(s)
	* Dexter / 7th Mercer laydown site for laydown
	* Full closure (Fairview R.O.W) for Staging
Don T3	[* Vibration] : Pretest & monitor @ Gun & 2yrs →: Vibrate wall Piers →: Vibrate vs oscillated shafts
Risk T4	→ More breaking demo vs. all saw cut. Schedule / Risk