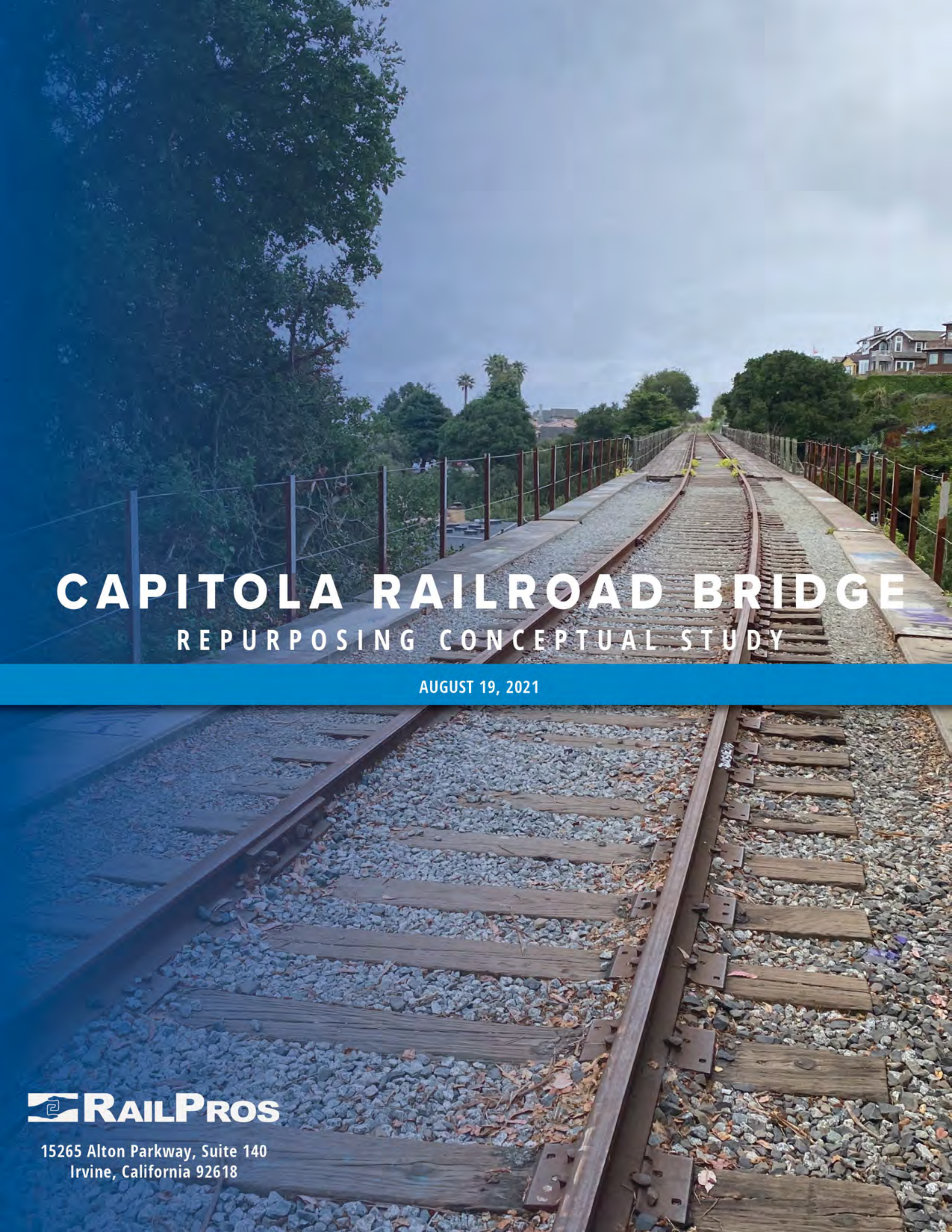

CAPITOLA RAILROAD BRIDGE

REPURPOSING CONCEPTUAL STUDY

AUGUST 19, 2021

RAILPROS

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1. EXECUTIVE SUMMARY

The purpose of this conceptual study is to analyze potential conversion of the Capitola Railroad Bridge at MP15.89 to a pedestrian and bicycle trail bridge. Currently the bridge is not in service due to structural deficiencies and other factors related to the rail line. However, conversion of the deck system and structural retrofit would allow pedestrian and bicycle usage.

The existing bridge consists of five segments differing in superstructure and substructure type. Superstructures include prestressed concrete, timber, and an iron truss. Portions of the bridge are over 100 years old—particularly the wrought iron deck truss. RailPros' performed loadratings on the concrete spans and found them adequate for freight rail loadings. Preliminary analysis of the truss resulted in an E29 rating, which is adequate for pedestrian and bicycle loading.

Overall, the condition of the bridge is unknown because a complete inspection has not been done for many years. A complete inspection will be necessary to know the extent of repairs needed before returning the bridge to service for any purpose. However, it is known at this time that the timber trestles will require significant renovation.

In addition, it will be necessary to determine the seismic resistance capacity of the bridge. Geotechnical investigation and foundation data will be required for seismic evaluation. Retrofit work may be required as a result of the evaluation.

Three decking systems were evaluated for conversion and include: 1) precast concrete deck panels; 2) corrugated steel bridge deck panels; and 3) FRP deck panels. The following criteria were considered for selection of the optimal deck system:

1. No or low added dead load because aged bridges may have seismic deficiencies with respect to current AREMA and AASHTO seismic codes. Geotechnical investigation and foundation data will be required to determine the seismic adequacy of the bridge
2. Cost-effective system
3. Easy, rapid, and affordable installation
4. Low or no maintenance required system
5. Long-lasting system
6. High corrosion-resistant system

Results of our cost analysis show that the FRP deck panels, combined with hot-dip galvanized steel framing, result in the best decking system to convert the Capitola Railroad Bridge to a pedestrian and bicycle bridge. This is mainly due to having the lowest added dead load compared to other systems, as well as meeting the weight limit, based on the demolished railroad components. Also, compared to other proposed deck systems, it has a reasonable cost estimate of $348/SF. It is not the lowest cost system, as compared to the corrugated steel planks on a steel frame at $293/SF. However, the FRP deck panels are half the weight of the corrugated steel planks and there would likely be savings over time, due to lower maintenance costs. Further additional substructure retrofit may be needed to accommodate the additional loads from the corrugated steel planks.

Overall, conversion of the Capitola Railroad Bridge for pedestrian and bicycle use is feasible. Entire removal of the existing deck system for each span will be required. Any of the evaluated deck systems can be applied to the bridge. We recommend the FRP concrete deck supported by a galvanized steel frame as the new deck system end to end.

2. INTRODUCTION

The Santa Cruz County Regional Transportation Commission (SCCRTC) owns and maintains a 32-mile rail coastal corridor which at one time supported freight rail service. Roaring Camp operates a tourist train which uses the branch line between MP20.2 and MP19.43. The short line railroad operator, St. Paul & Pacific Railroad, operates freight in Watsonville between MP 0 and MP 3.0. Otherwise, there is no indication that freight or other rail service will return in the near future north of MP 3.0.

The County of Santa Cruz is developing a project to construct Segments 10 and 11 of the Coastal Rail Trail, along the Santa Cruz Branch Line right of way, between 17th Avenue in Live Oak and State Park Drive in Aptos. The SCCRTC has a desire to evaluate the structural feasibility of repurposing the existing railroad bridge to a pedestrian and bicycle bridge either as part of the County project or as a separate stand-alone project.

This new use of the bridge will require conversion of the deck and railing for that purpose. As shown in figure below, the bridge consists of different types of spans, concrete, timber, and an iron truss. This study will evaluate deck and railing options available and requirements for constructing the conversions for each span type.

Based on limited information in hand and missing as-built plans, it is prudent that the existing bridge components will need to be evaluated for the proposed pedestrian loads in accordance with AASHTO LRFD Specifications for Pedestrian Bridges, as well as seismic performance requirements. A concept-level cost estimate for conversion of the bridge for pedestrian and bicycle use is shown at the end of the study. The cost is based on current pricing.

3. EXISTING CONDITION ASSESSMENT

3.1. Superstructure (Deck and girders including truss)

3.1.1. Concrete Spans

The bridge has two concrete approach segments (Segments "A" and "E") built in 1970. The easterly span (Segment "A") is a precast prestressed concrete box with 60 ft span, and the westerly span (Segment "E") is a cast-in-place post-tensioned concrete thru girder (trough) with 70 ft span. Generally, these spans are in good condition. There are some cable railing post deck connections that are damaged. RailPros has recently load rated these spans and found that Segments "A" and "E" are only adequate for E71 and E64 Cooper Vehicles, respectively.

Segments "A" & "E" open concrete decks

3.1.2. Timber Spans

The bridge has two timber segments (Segment "B and "D"). There are no complete as-built drawings available to find the exact span lengths. Previous inspection measurements for Segments "B" and "D" were 215 ft and 40 ft respectively. The decks are open systems, where the stringers are bundled under the rails. The condition of the stringers cross beams and posts are difficult to determine without a "close up" inspection which should be completed prior to placing a new deck system. The bracing across the posts is in fair to poor condition and needs replacement. SCCRTC estimates 30-40% of the post need to be replaced.

Segment "B" open timber deck

Similarly, the wood ties appear to be in fair to poor condition and should not be considered for future use as part of a new deck system. Many ties are substantially split in both Segments "B and D".

3.1.3. Wrought Iron Deck Truss

The truss was built between 1890 and 1903, and spans 149 feet over Soquel Creek. From recent observations and a 2012 inspection report, the truss is in fair to good condition. Minor corrosion was found at the pin connections. The truss roller bearings were found to be in a poor or nonworking condition. Replacement of the bearings would be needed prior to the truss returning to service. It is very likely that in the past nine years, these issues have increased in magnitude. Inspection should be performed to accurately determine the present condition of the truss before it is returned to service. RailPros performed a review of a 2012 loadrating of the truss in the as-built condition and found it to rate at Cooper E29 for a floor beam connection. The rating would decrease if the actual condition was factored in. Although this rating is low for freight train usage, it is more than sufficient for pedestrian and bicycle use.

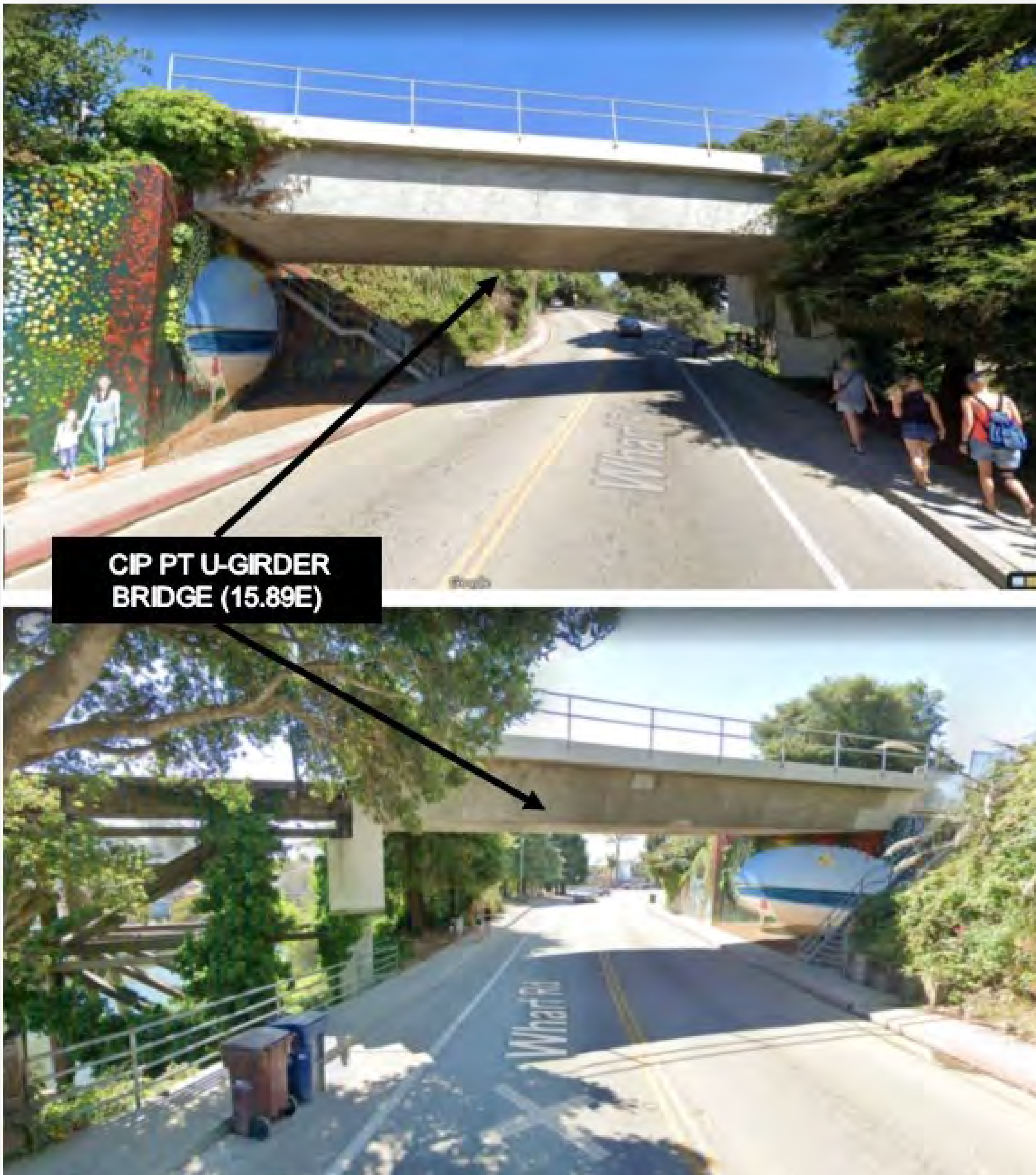
Segment "C" open timber deck for truss

3.2. Substructure

3.2.1. Concrete Spans

Segments "A" and "E" are supported on a concrete pile bents and abutments. The substructure for these spans appears to be in good condition, although the condition of the piles below surface is unknown. Segment "A" rating results show that the substructure is adequate for E80 vertical loads and lateral wind loads. However, the longitudinal force effects were not studied due to lack of geotechnical information for the piles and pile information for Segment "B". Segment "E" rating results show that the column and abutment wall are adequate for E72 and E76 Cooper vehicles, respectively.

Span is supported by concrete piers



Span is supported by short concrete column bent and abutment

3.2.2. Timber Spans

Based on recent assessments, the substructure for both Segments "B" and "D" requires significant restoration. In both segments, excessive splitting of bracing and posts were observed. There were signs of rot and rutting at the mud sills. Also, numerous splice repairs were observed. It is estimated that between 30-40% of the post will need replacement.

Split bracing at post on mud

Timber substructure for Segments "B" and "D" require total replacement

3.2.3. Wrought Iron Deck Truss

The truss is placed on top of two concrete piers located at top of the banks of Soquel Creek. The piers appear to be in good condition, as they do not show stress cracking. Although there are no indications of scour near the footings, inspection has not been conducted to confirm that condition.

Concrete piers for truss are located within ordinary high water of stream channel

4. EXISTING BRIDGE STRUCTURAL CAPACITY ASSESSMENT

Vertical Freight Loading: The Capitola Railroad Bridge was designed to carry freight loads. However, the timber trestles in their current condition, based on past inspections, and our preliminary condition assessments, should not be in service for train use until major repairs and/or replacements are completed. Also, the truss rated low because of the floor beams in the as-built condition. An inspection will be needed to determine if there is corrosion in the joints or section loss in the members, which may further affect the rating. The following table shows a summary of the bridge segment ratings.

BRIDGE SEGMENT RATINGS	
SEGMENT	**RATING**
Segment A concrete box beam spans	E71 (Cooper E80) E108 (286K Locomotive)
Segment B timber trestle	No rating extensive repairs needed
Segment C iron deck truss	E29 (Cooper E80)
Segment D timber trestle	No rating extensive repairs needed
Segment E concrete thru beam span	E64 (Cooper E80) E100 (286K Locomotive)

Vertical Pedestrian Loading: Pedestrian loading per AASHTO is 90 PSF. Also, pedestrian bridges are required to be designed for truck H-10 load (10K axle). Although the design loads are much lighter than freight loads, we recommend that the timber trestles be properly inspected prior to pedestrian service. Sound connections between stringers, bent caps, and pile posts should be verified.

Lateral Loading: There is not sufficient data to analyze the entire bridge for lateral forces including seismic. Only Segment "E" had sufficient data to assess longitudinal forces. For this span traction force controlled. Analysis found that both the bent and abutment were adequate for E72 and E76 equipment, which exceeds current restrictions. Segment "A" will require geotechnical investigation to determine lateral resistance capacity of the piles.

The roller bearings for the truss in Segment "C" require replacement, otherwise the truss will not respond well to lateral forces. A seismic analysis should be first completed prior to replacement of the bearings, so that the bearings and connections to them can be adequately sized.

Since not all as-built information is available and all necessary repairs have not been made, design criteria for conversion of the bridge should include not adding deadload. Otherwise, additional lateral loads would be applied to the bridge substructure to resist. This would increase the risk of any assumptions made to compensate for missing bridge data. The following is a recommended procedure for seismic analysis of the entire bridge.

Recommended Seismic Assessment Stepwise Procedures

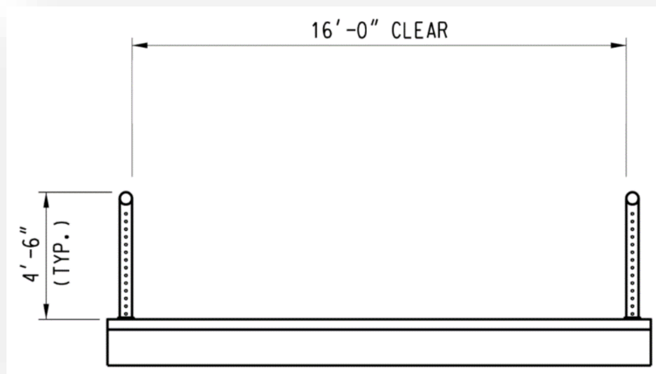
1. Detail field inspection and measurement.
2. Comprehensive Geotechnical study to evaluate the foundation capacities and assign seismic loading parameters for structural analysis.
3. Seismic analysis of the bridges to calculate the demand loads and capacity ratio for different components.

4. Based on the demand and capacity ratio data, a detailed seismic strategy report with a retrofit scheme should be prepared. In addition, preliminary plans showing retrofit to coincide with the retrofit report.
5. Based on the plans, a construction cost estimate for the retrofit can be prepared.

5. EVALUATION OF DECK AND RAILING CONVERSION

5.1. Bridge Deck Layout

The converted bridge will require sufficient width for two-way pedestrian and bicycle traffic. In consideration of the entire bridge end to end, the deck width is proposed as 16 ft A 4'-6". Combination metal bike-pedestrian railing would be installed on the deck as shown on the section to the right. Over roads the railing height would increase to a minimum of eight feet or as otherwise directed by the City of Capitola. The proposed railing is similar to the railing that was installed on the walkway for the through San Lorenzo River truss at MP 19.43 as shown below.



Proposed new deck section

5.2. Pedestrian and Bicycle Bridge Loading

Since the bridge will be repurposed for pedestrian and bicycle use, loadings should be per the latest version of AASHTO LRFD Guide Specifications for the Design of Pedestrian Bridges. Pedestrian bridges should be designed for a uniform pedestrian loading of 90 psf and a H10 vehicle. This loading shall be distributed to produce maximum load effects. Note that both these loadings are substantially lighter than freight loads (the H10 axle is seven times lighter than that of a 286,000 LB engine). Consideration of dynamic load allowance is not required with the pedestrian loading.

Open metal railing for pedestrian and bicycle used on San Lorenzo River truss

Also, pedestrian bridges should be designed for a maintenance vehicle load specified in AASHTO Table 3.2.1 unless vehicular access is prevented by permanent physical methods. Since the proposed width is more than 10 ft, a H10 vehicle is recommended.

5.3. New Deck Alternatives

Options are available for retrofit of the bridge decks for pedestrian and bicycle use. One key selection criterion is the weight of the new deck system. Other key selection criterion includes constructability for this tall bridge, cost, and low maintenance requirements.

5.3.1. Demolition

The existing rail and ties would be removed similarly for each bridge segment. Typically, the Contractor would cut the tie and rail at locations to create panels of a certain length. The panels would be lifted in whole. For the open decks the ties would need to first be unbolted from the stringers.

Deck Alternatives: The following systems meet the above criterion and are evaluated with explained pros/cons.

5.3.2. Precast Concrete Deck Panels

Pros:

- Precast concrete decking is a cost efficient and quick construction option for accelerated bridge construction.
- They are easily and quickly placed on any level surface as shown in the below photos.
- No forming is required, except for leveling and a topping slab if desired.
- Most concrete panel decks require no maintenance, while some stained concrete decks require minimal maintenance to re-seal the concrete.

Cons:

- Over time panel joints may require maintenance.
- This option is acceptable for both concrete bridges (Segments "A" and "E"). However, for the timber and truss bridges, it will impose more dead load compared to the existing condition.
- Time consuming to remove for inspection of steel supports.

Installation of precast concrete deck panels

5.3.3. Corrugated Steel Bridge Deck Panels

Permanent corrugated steel bridge deck is a heavy-duty system for forming bridge deck slabs quickly and permanently. A description of this system along with pros and cons are listed below.

Pros:

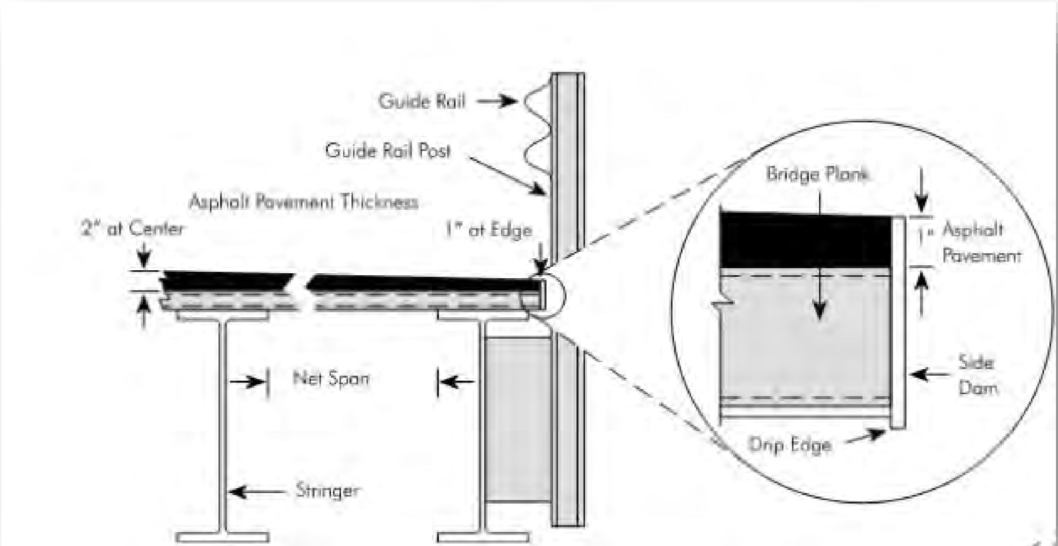
- This bridge decking system is versatile and can be used on existing steel, wood, or concrete girders.
- The planks are hot dip galvanized after fabrication for long-lasting corrosion protection.
- These planks are typically filled with asphalt paving or concrete and provide a smooth wearing surface for traffic. This is a very economical and long-lasting bridge decking option.
- Rigid panel construction restores strength to old structures. Positive welded connections help stiffen the entire structure and the deck becomes an integral part of the bridge.
- This system offers an acceptable strength-to-weight ratio. Total weight is only slightly higher than most timber floors, and in some cases, (especially replacement of ballasted decks) the load is reduced.

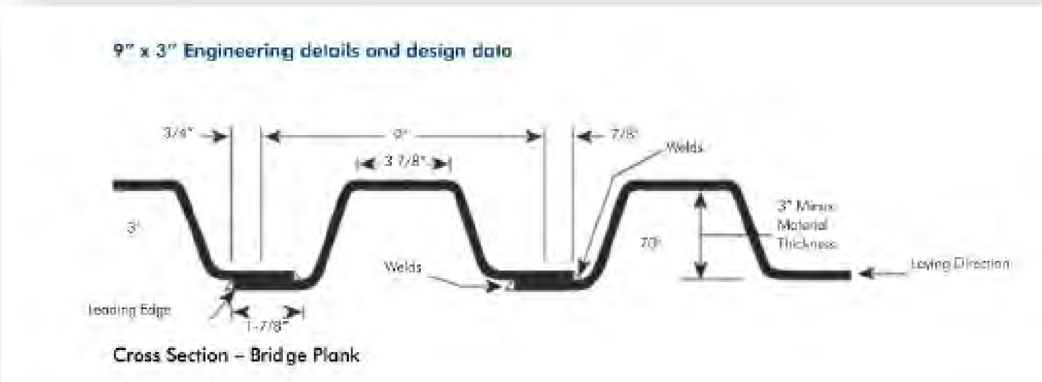
Cons:

- Time to install is longer due to placement of wearing surface.
- Long term maintenance of wearing surface may be required.
- Time consuming to remove for inspection of steel supports.

The following pictures briefly show installation of the corrugated steel deck panels on pedestrian bridges.

Corrugated steel plank installed over steel girder





5.3.4. FRP Deck Panels

Fiber Reinforced Polymer (FRP) concrete is a composite material that contains high strength continuous fibers, such as glass, carbon, or steel wires embedded in a polymer matrix. The fibers provide the main reinforcing elements, while the polymer matrix (epoxy resins) acts as a binder, protects the fibers, and transfers loads to and between the fibers. Unlike conventional unreinforced concrete, FRP has good tensile strength properties. The material has many structural applications including bridge decks. Description of this system, along with its advantages are listed below. The only disadvantage found is the cost may be higher than corrugated steel planks.

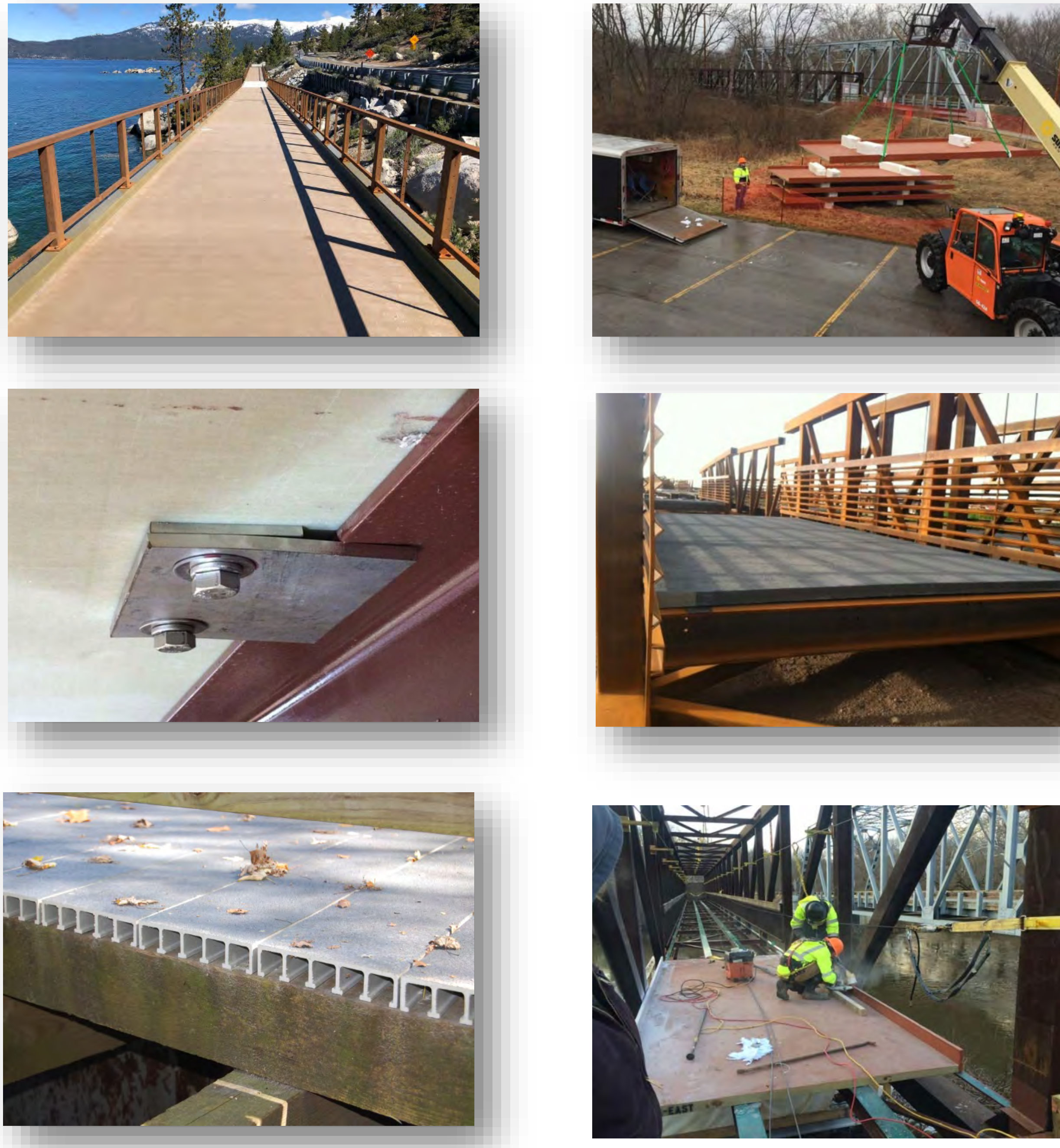
Pros:

- An FRP deck only weighs 10 to 20 percent of a comparable reinforced concrete with maximum weight of 30 pcf. This weight reduction is a substantial advantage in the construction process, allowing for easy, rapid, and affordable installation.
- Reinforcement is not required due to its tensile strength.
- FRP surfaces are corrosion-resistant by resisting degradation from common corrosive and abrasive influences.
- FRP has a long working life compared with other materials; a FRP deck is expected to last more than 50 years with no maintenance, even when installed in difficult environmental conditions.

Cons:

- Higher cost than corrugated steel planks.
- Repair of wearing surface may be expensive.
- Time consuming to remove for inspection of steel supports.

Installation of FRP Panels



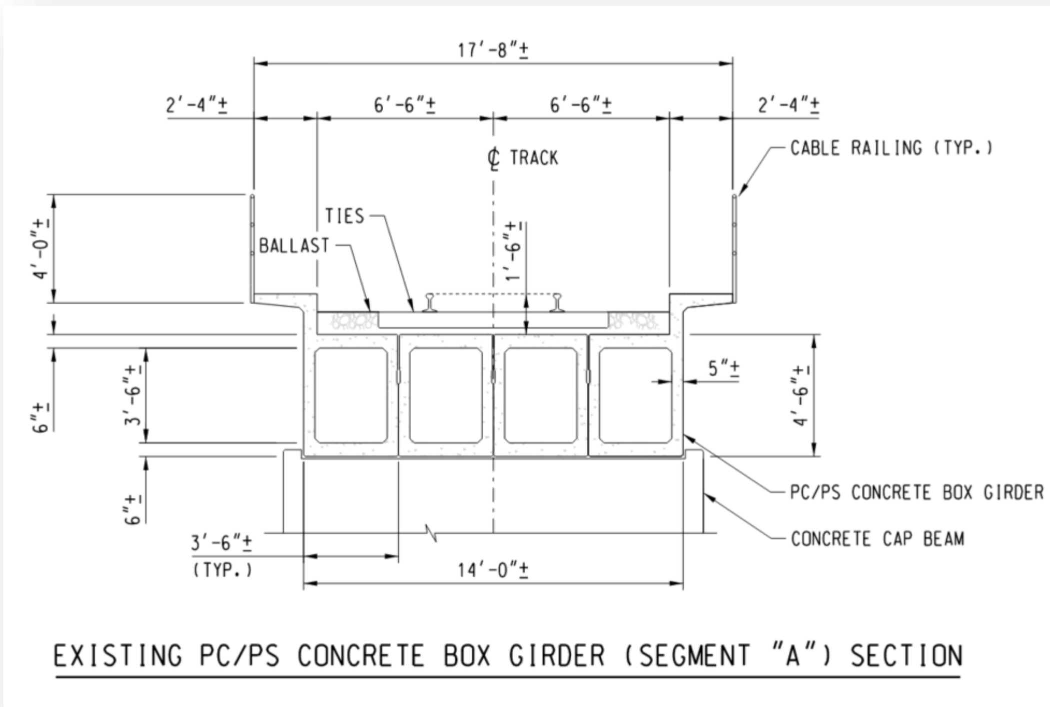
FRP panels installed on truss and timber bridges

6. DECK CONVERSION METHODOLOGY

6.1. PC/PS Concrete Box Girder Segment "A" (15.89a)

6.1.1. Existing Deck Section

The existing section of the PC/PS concrete box girder is shown below. To convert this bridge deck, removal of ties, and rails will be required. The proposed deck should keep the new deadloads lower than the removed deadloads. Also, to keep the top of the proposed deck at the same level as the top of the existing walkway, a 1'-6" height of the new decking system will need to be constructed.

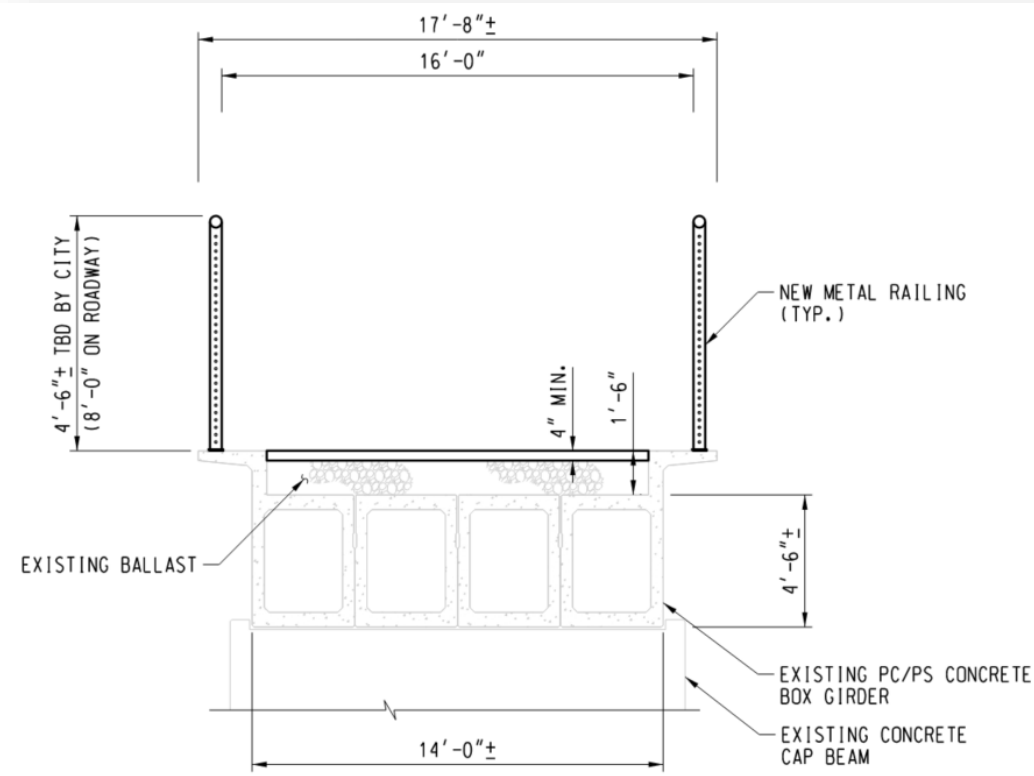


6.1.2. New Deck System for PC/PS Concrete Box Girder Spans – Segment A"

There are two options considered to replace the removed ties, and rails for Segment "A". **Option 1** is a new deck system (4" minimum) on top of the existing ballast fill. **Option 2** is to place the new deck on top of a new steel frame consisting of W-shape stringers framed with C-Channel diaphragms. This option requires removing the existing ballast. Removed and added dead load from each option is calculated in the table that follows. Details of both options are also shown. As can be seen, FRP deck imposes the lowest amount of dead load.

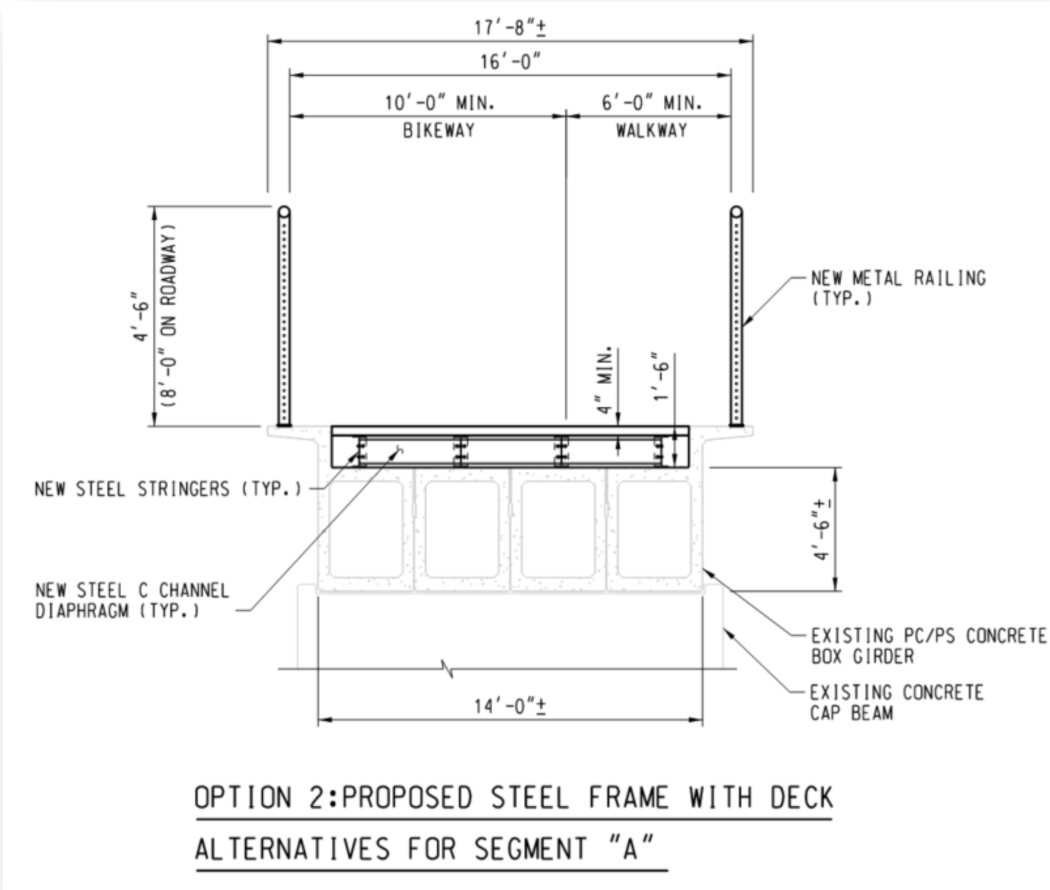
Deadload comparison of new deck system for Segment "A"

DECK SYSTEM	OPTION 1: EXISTING BALLAST FILL + NEW DECK		OPTION 2: NEW STEEL FRAME + NEW DECK	
	Added Dead Load (LB/FT)	Dead Load Limit (Per Removals) (LB/FT)	Added Dead Load (LB/FT)	Dead Load Limit (Per Removals (LB/FT)
4" Precast Concrete Panel (150 pcf)	900		1,156	
9"x3" Corrugated Steel Panel (34 psf)	644	400	900	2,400
5" FRP Panel (10 psf)	260		516	



OPTION 1:PROPOSED BALLAST FILL WITH DECK

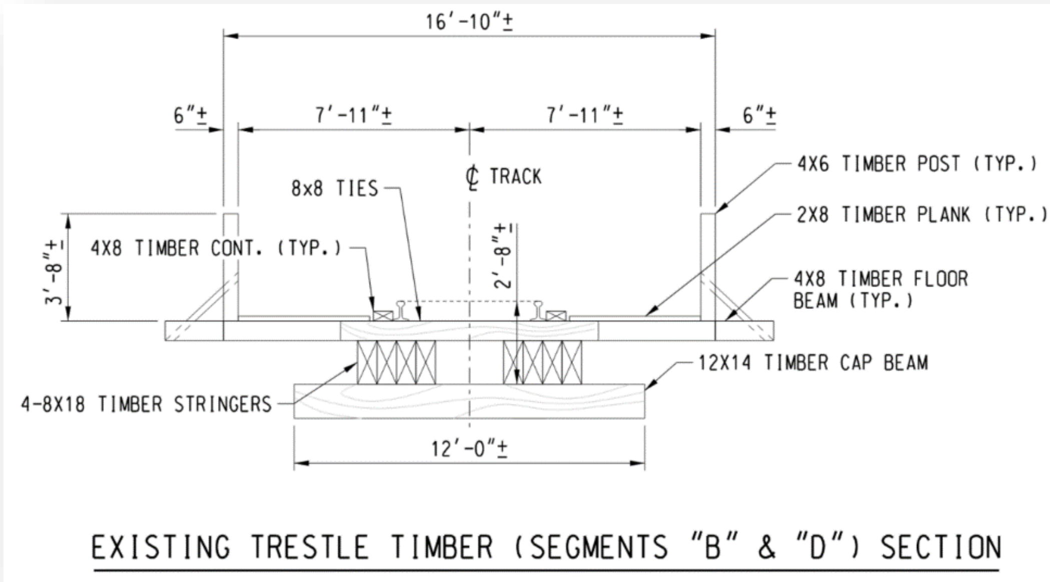
ALTERNATIVES FOR SEGMENT "A"



6.2. Trestle Timber Bridge (15.89b & 15.89b)

6.2.1. Existing Deck System

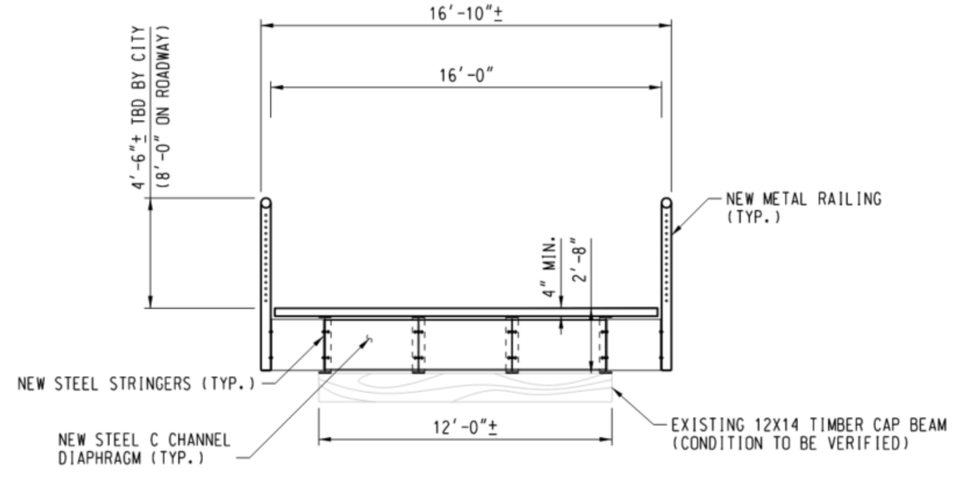
As previously stated, the timber spans are in fair to poor condition. To convert this bridge deck as shown in the diagram that follows, it will be necessary to remove all members above the timber cap beam. Removing these components will reduce 650 lb/ft of dead load from the bridge deck. For the new deck to be at the same level as top of walkway, 2' of a new decking system should be constructed.



6.2.2. New Deck System

There is only one suitable option to replace the removed ties and rails on this section, as well as the underlying bundled timber stringers under the rails. This option is to rest the new deck on top of steel frame with W-shape stringers framed with C-Channel diaphragms. Metal railings can be connected to the steel C Channel outriggers. Added dead load from each deck system is calculated in the table shown below. Details of proposed section is also shown below. FRP deck results in the lowest amount of added dead load and is the only deck meeting the weight limit.

DECK SYSTEM	ADDED DEAD LOAD (LB/FT)	DEAD LOAD LIMIT (PER REMOVALS) (LB/FT)
4" Precast Concrete Panel (150 pcf)	1,244	650
9"x3" Corrugated Steel Panel (34 psf)	988	
5" FRP Panel (10 psf)	604	

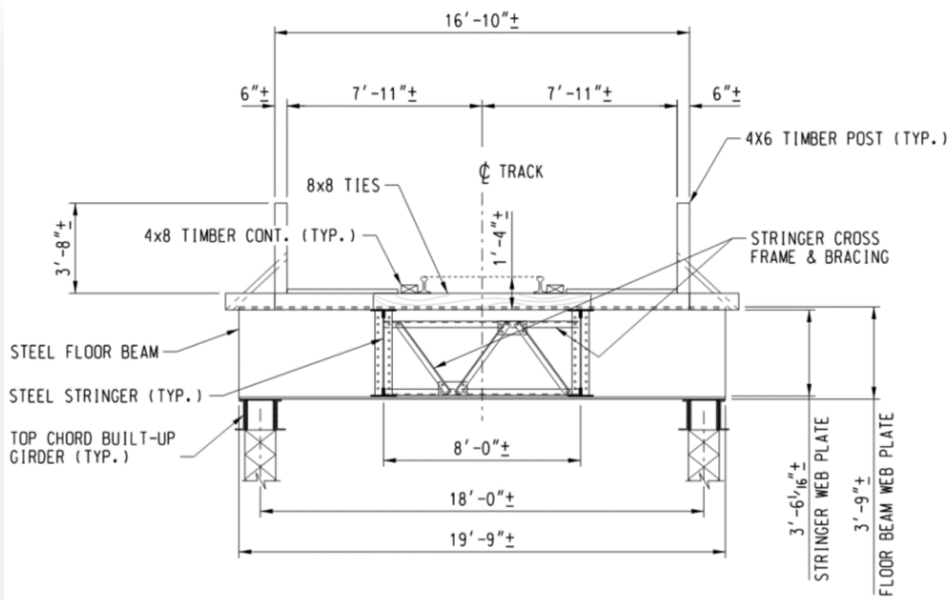


PROPOSED STEEL FRAME WITH DECK ALTERNATIVES FOR SEGMENT "B" & "D"

6.3. Wrought Iron Truss Bridge (15.89c)

6.3.1. Existing Deck Section

The existing timber deck for the truss is set on a steel frame which is mounted on top of the truss as shown in the diagram that follows. To convert this bridge deck, it will be necessary to remove all of the timber decking. Removing this material above the steel frame will reduce 410 lb/ft of dead load from the bridge deck. To keep the top of the new deck at the same level as top of the existing walkway, 12" of new decking system should be constructed.

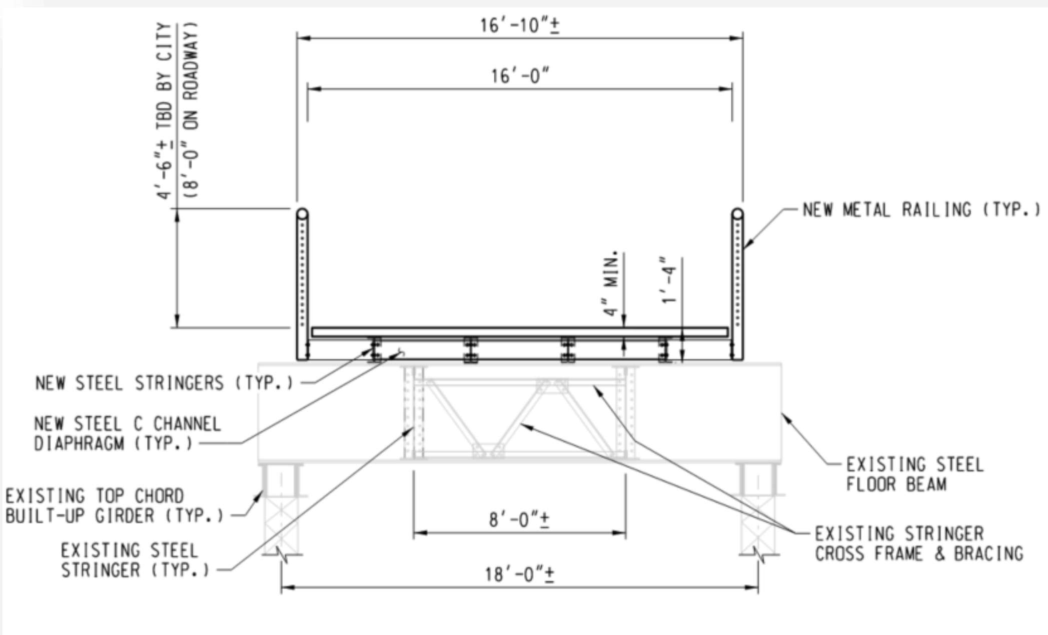


EXISTING WROUGHT IRON TRUSS (SEGMENT "C") SECTION

6.3.2. New Deck System for Truss

Similar to the trestle timber span, the new deck would be placed on top of a steel frame which would be superimposed on the existing frame on top of the truss. Metal railings would be connected to the steel C-Channel outriggers of the new frame. Added dead load from each deck system alternative is shown in the table below. Details of proposed section are also shown below. The FRP deck again results in the lowest amount of added dead load and is the only deck meeting the weight limit.

DECK SYSTEM	ADDED DEAD LOAD (LB/FT)	DEAD LOAD LIMIT (PER REMOVALS) (LB/FT)
4" Precast Concrete Panel (150 pcf)	1,024	410
9"x3" Corrugated Steel Panel (34 psf)	768	
5" FRP Panel (10 psf)	384	

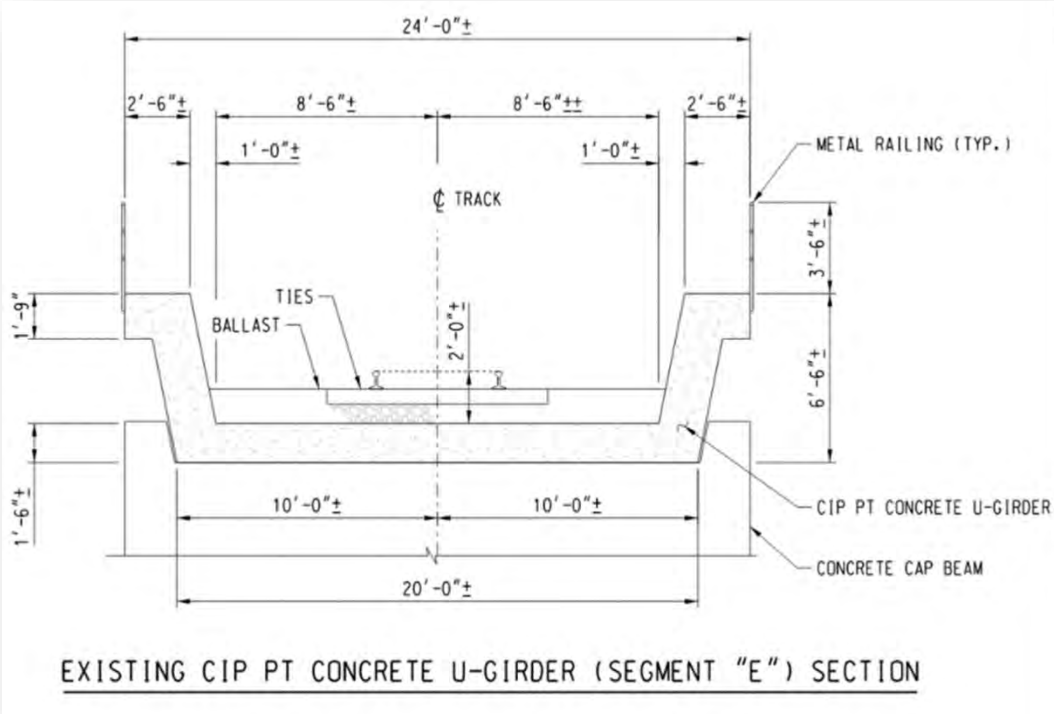


PROPOSED STEEL FRAME WITH DECK ALTERNATIVES FOR SEGMENT "C"

6.4. CIP PT U-Girder Wharf Bridge (15.89e)

6.4.1. Existing Section

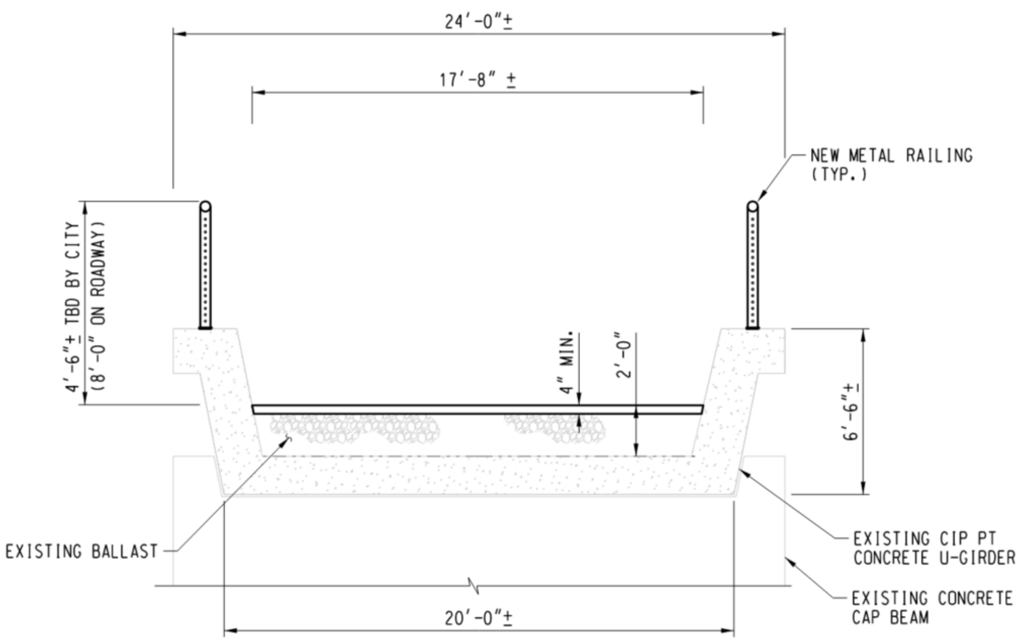
The existing section of the superstructure is shown below. To convert this bridge deck, it is required to remove ballast, ties, and rails. Removing these items will reduce 3,200 kip/ft of dead load from the bridge deck. To keep the top of the proposed deck at the same level as the top of the existing walkway, 2'-0" of new decking system should be constructed.



6.4.2. Proposed Sections

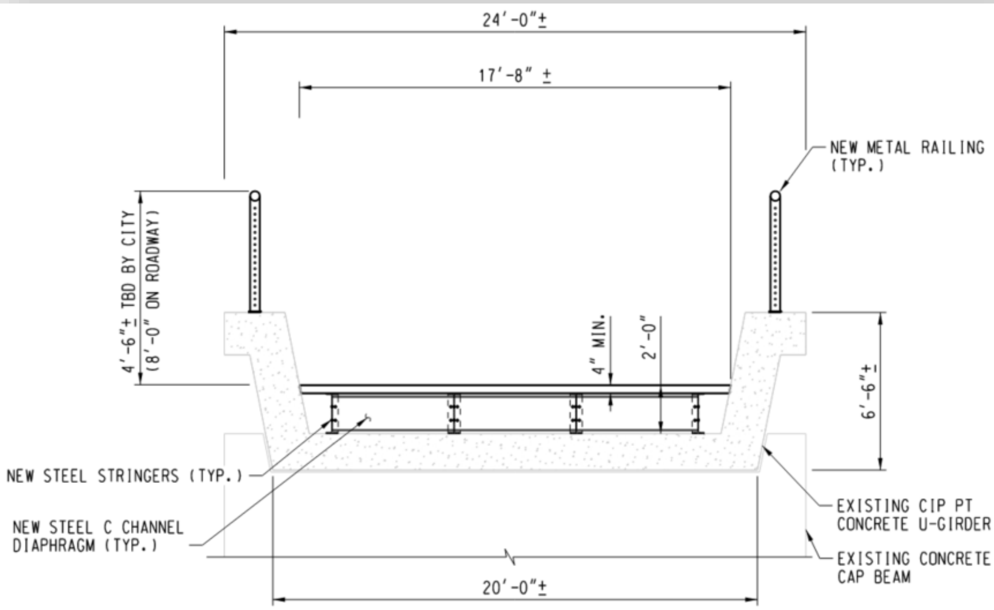
Similar to concrete box girder, there are two options considered to replace the removed ballast, ties, and rails on this section. **Option 1** is to place a new deck system (4" min) on top of the existing ballast. **Option 2** is to place the new deck on top of new steel W-shape stringers framed with C-Channel diaphragm. This option requires removing the existing ballast. Removed and added dead load from each deck system is shown in the table below. Details of both options are also shown below. Results indicate that FRP deck will impose the lowest amount of dead load.

DECK SYSTEM	OPTION 1: EXISTING BALLAST FILL + NEW DECK		OPTION 2: NEW STEEL FRAME + NEW DECK	
	Added Dead Load (LB/FT)	Dead Load Limit (Per Removals) (LB/FT)	Added Dead Load (LB/FT)	Dead Load Limit (Per Removals (LB/FT)
4" Precast Concrete Panel (150 pcf)	983	400	1,211	3,200
9"x3" Corrugated Steel Panel (34 psf)	700		929	
5" FRP Panel (10 psf)	277		505	



OPTION 1:PROPOSED BALLAST FILL WITH DECK

ALTERNATIVES FOR SEGMENT "E"



OPTION 2:PROPOSED STEEL FRAME WITH DECK

ALTERNATIVES FOR SEGMENT "E"

7. CONCEPTUAL COST ESTIMATE

The tables below show a cost estimate for each of new proposed deck system. For each system, two different estimates were calculated. Left and right columns calculate cost of concrete spans (Segments "A" & "E") with light-weight concert and steel stringers, respectively.

NEW PRECAST CONCRETE DECK								
Description	Segments A&E: Option1 Segments B&C&D: Steel Stringers				Segments A&E: Option2 Segments B&C&D: Steel Stringers			
	Quantity	Unit	Unit Price	Cost	Quantity	Unit	Unit Price	Cost
Demolition								
Remove Rail & Ties	550	LF	$35.0	$19,250	550	LF	$35.0	$19,250
Timber Bidge Deck and Railing Demolition	1	LS	$24,000.0	$24,000	1	LS	$24,000.0	$24,000
Ballast Removal	0	CY	$50.0	$0	95	CY	$50.0	$4,750
Metal Railing Removal Span A & E	130	LF	$30.0	$3,900	130	LF	$30.0	$3,900
Installation								
Steel Structure	154,472	LB	$7.5	$1,158,540	185,795	LB	$7.5	$1,393,463
PC Concrete Panel	8,737	SF	$120.0	$1,048,440	8,737	SF	$120.0	$1,048,440
Ped/Bike Railing	1,100	LF	$100.0	$110,000	1,100	LF	$100.0	$110,000
Drainage	1	LS	$20,000.0	$20,000	1	LS	$20,000.0	$20,000
	Sub Total Contract Items			**$ 2,384,130**	**Sub Total Contract Items**			**$ 2,623,803**
	Contingencies 20%			**$ 476,826**	**Contingencies 20%**			**$ 524,761**
	Grand Total			**$ 2,860,956**	**Grand Total**			**$ 3,148,563**

NEW CORROGATED STEEL DECK								
Description	Segments A&E: Option1 Segments B&C&D: Steel Stringers				Segments A&E: Option2 Segments B&C&D: Steel Stringers			
	Quantity	Unit	Unit Price	Cost	Quantity	Unit	Unit Price	Cost
Demolition								
Remove Rail & Ties	550	LF	$35.0	$19,250	550	LF	$35.0	$19,250
Timber Bidge Deck and Railing Demolition	1	LS	$24,000.0	$24,000	1	LS	$24,000.0	$24,000
Ballast Removal	95	CY	$50.0	$4,750	95	CY	$50.0	$4,750
Metal Railing Removal Span A & E	130	LF	$30.0	$3,900	130	LF	$30.0	$3,900
Installation								
Steel Structure	154,472	LB	$7.5	$1,158,540	185,795	LB	$7.5	$1,393,463
Corrogated Steel Panel	8,737	SF	$64.0	$559,168	8,737	SF	$64.0	$559,168
Ped/Bike Railing	1,100	LF	$100.0	$110,000	1,100	LF	$100.0	$110,000
Drainage	1	LS	$20,000.0	$20,000	1	LS	$20,000.0	$20,000
	Sub Total Contract Items			**$ 1,899,608**	**Sub Total Contract Items**			**$ 2,134,531**
	Contingencies 20%			**$ 379,922**	**Contingencies 20%**			**$ 426,906**
	Grand Total			**$ 2,279,530**	**Grand Total**			**$ 2,561,437**

NEW FRP DECK								
Description	Segments A&E: Option1 Segments B&C&D: Steel Stringers				Segments A&E: Option2 Segments B&C&D: Steel Stringers			
	Quantity	Unit	Unit Price	Cost	Quantity	Unit	Unit Price	Cost
Demolition								
Remove Rail & Ties	550	LF	$35.0	$19,250	550	LF	$35.0	$19,250
Timber Bidge Deck and Railing Demolition	1	LS	$24,000.0	$24,000	1	LS	$24,000.0	$24,000
Ballast Removal	95	CY	$50.0	$4,750	95	CY	$50.0	$4,750
Metal Railing Removal Span A & E	130	LF	$30.0	$3,900	130	LF	$30.0	$3,900
Installation								
Steel Structure	154,472	LB	$7.5	$1,158,540	185,795	LB	$7.5	$1,393,463
FRP Molded Panel	8,737	SF	$110.0	$961,070	8,737	SF	$110.0	$961,070
Ped/Bike Railing	1,100	LF	$100.0	$110,000	1,100	LF	$100.0	$110,000
Drainage	1	LS	$20,000.0	$20,000	1	LS	$20,000.0	$20,000
	Sub Total Contract Items			**$ 2,301,510**	**Sub Total Contract Items**			**$ 2,536,433**
	Contingencies 20%			**$ 460,302**	**Contingencies 20%**			**$ 507,287**
	Grand Total			**$ 2,761,812**	**Grand Total**			**$ 3,043,719**

The following table summarizes the costs of the different systems. It shows that corrugated steel deck costs less than the other two alternatives. Also using steel stringers for all spans are more cost-effective.

	Concrete Spans (Segments "A" & "E")	Grand Total Cost	Cost/Area ($/sqft)
NEW PRECAST CONCRETE DECK	**Existing Ballast**	**$ 2,860,956**	**327**
	Steel Frame	**$ 3,148,563**	**360**
NEW CORROGATED STEEL DECK	**Existing Ballast**	**$ 2,279,530**	**261**
	Steel Frame	**$ 2,561,437**	**293**
NEW FRP DECK	**Existing Ballast**	**$ 2,761,812**	**316**
	Steel Frame	**$ 3,043,719**	**348**

Deck Area = 8737 SF

CONCLUSION AND RECOMMENDATIONS

Deck Conversion for Pedestrian and Bicycle Use: The results of the cost analysis show that the FRP deck panels combined with hot-dip galvanized steel framing for timber and iron truss spans and existing ballast for concrete spans, result in the best decking system to convert the Capitola Railroad Bridge to a pedestrian and bicycle bridge. This is mainly due to having the lowest added dead load compared to other systems, as well as meeting the weight limit based on the demolished railroad components. Also, compared to other proposed deck systems, it has a reasonable cost estimate of $316/SF. It is not the lowest cost system, which is the corrugated steel planks at $261/SF. However, the FRP deck panels are half the weight of the corrugated steel planks, and there would likely be savings in additional substructure retrofit that would be needed to accommodate the additional loads from the corrugated steel planks.

Related Additional Work Recommended: Prior to pedestrian and bicycle use or returning the bridge to freight service, inspections, site investigations, and analysis and will be needed. Major repairs and renovations will be needed for the timber trestles and the truss. Also, seismic retrofit may be needed as a result of analysis.

The table below provides a conceptual estimate of costs for converting the Capitola Bridge for pedestrian and bicycle use.

CAPITOLA BRIDGE REPURPOSING COST ESTIMATE | TOTAL PROJECT COST			
Work Item	**Description**	**Segment**	**Est Cost**
Engineering			
Geotechnical Investigation	Min 5 borings + report	All	$150,000
Seismic analysis	Model entire bridge, analyze per AREMA and AASHTO	All	$100,000
Deck conversion PS&E	Construction docs for bridge conversion	All	$250,000
Inspection	Inspect bridge and prepare complete report	All	$35,000
Renovation Work			
Timber Trestle Substructure repair	Replace all bracing and select post and caps	B, D	$2,500,000
Removal of stringers for timber trestles	Unbolt ties from stringers	B, D	$50,000
Truss Bearing Replacement	Jack up truss & Replace roller bearings	C	$100,000
Railing, Rail & Tie Removal	Remove all track and railing	All	$100,000
New Ped/Bike Deck			
New Ped/Bike Deck System	Install new decking and railing	All	$3,000,000
		Total Estimated Cost	**$6,285,000**
		20% Contingency	$1,257,000
		ESTIMATED GRAND TOTAL	**$7,542,000**

8. REFERENCES

1. https://www.conteches.com/Portals/0/Documents/Brochures/Contech%20Bridge%20Plank%20Bro-web.pdf?ver=2018-05-16-090424-373

2. www.creativecompositesgroup.com

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