

# Santa Ana-Garden Grove Fixed Guideway Corridor

## Appendix N

### Bridge Design Option



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## **TECHNICAL MEMORANDUM: EVALUATION OF SANTA ANA RIVER CROSSING DESIGN OPTIONS**

The purpose of this memorandum is to document the design options considered for the Santa Ana – Garden Grove Fixed Guideway crossing of the Santa Ana River and the disposition of the historic Pacific Electric Santa Ana River Bridge that currently resides within the Pacific Electric Right-of-Way (PE ROW), where the fixed guideway would cross the river.

### **BACKGROUND**

In 2008, the cities of Santa Ana and Garden Grove completed a study that identified the benefits of developing a fixed guideway corridor to link key activity and employment centers in their communities to the Santa Ana Regional Transportation Center (SARTC). In 2009, the cities initiated the Alternatives Analysis and Environmental Review for the Santa Ana-Garden Grove Fixed Guideway Corridor in coordination with the Orange County Transportation Authority (OCTA).

Through a multi-step alternatives analysis process that included considerable community involvement, a reduced set of alternatives (or alternatives carried forward for detailed evaluation) has been identified. The alternatives that are the subject of the detailed evaluation including the environmental review for the project consist of a No Build Alternative, which is used as a basis for comparing the costs and benefits of the build alternatives, a TSM Alternative, and two Build Alternatives. Following completion of the detailed evaluation and the environmental review process, which includes public review and comment on a draft environmental impact report/environmental assessment for the project, a Locally Preferred Alternative will be selected and adopted by the cities of Santa Ana and Garden Grove. The alternatives which are the subject of the detailed evaluation and environmental review are described below:

**No Build Alternative** - The No Build Alternative assumes no further transportation improvements within the Study Area beyond what has already been funded and committed through the year 2035.

**TSM Alternative** - The TSM Alternative represents the best that can be done for mobility without construction of major new transportation facilities or physical capacity improvements to the existing transportation infrastructure. As such, the TSM Alternative consists of relatively inexpensive projects, operational improvements, or policy actions such as increases in existing bus service, improved signal timing, and incentives to carpooling. Figure 1 is a map of the proposed routes for the TSM bus network enhancements.

Figure 1: Transportation Systems Management (TSM) Alternative - Selected Elements



 **LEGEND**

-  TSM 1st Street Alignment (OCTA Route 64)
-  Skip Stop Overlay to/from SARTC
-  TSM Civic Center Alignment
-  TSM Station Link Enhancement (OCTA BRT Route 462)
-  Proposed Stop
-  Study Area

**Streetcar Alternative 1 (Santa Ana Boulevard and 4th Street Couplet)** - Table 1 provides a summary description of the key physical and operational attributes of Streetcar Alternative 1 (Santa Ana Boulevard and 4th-Street Couplet). Figure 2 illustrates the alignment for Streetcar Alternative 1 relative to the existing street network within the Study Area.

**Streetcar Alternative 2 (Santa Ana Boulevard and 5th Street/Civic Center Drive Couplet)** - Table 2 provides a summary description of the key physical and operational attributes of Streetcar Alternative 2. Figure 3 provides a conceptual illustration of the alignment for Streetcar Alternative 2 relative to the existing street network within the Study Area.

**Table 1: Key Physical and Operational Attributes of Streetcar Alternative 1**

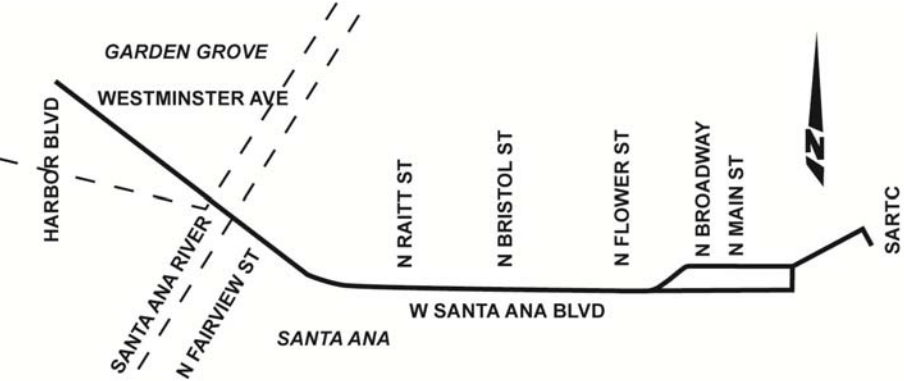
KEY ATTRIBUTES	DESCRIPTIONS
Transit Mode	Streetcar
Termini	Western Terminus: Harbor Blvd. Eastern Terminus: SARTC
Alignment Description	<p><u>Routing by Segment:</u></p> <ul style="list-style-type: none"> <li>• <i>PE ROW</i>, from Harbor Blvd. to Raitt St.: streetcars operate at-grade, bi-directionally, in exclusive ROW.</li> <li>• <i>Santa Ana Blvd.</i>, from Raitt St. to Ross St: streetcars operate in the street, at grade, bi-directionally, along with mixed-flow traffic.</li> <li>• <i>4th St./Santa Ana Blvd. Couplet</i>, from Ross St. to Mortimer St.: streetcars operate in the street, at grade, one-way, along with mixed-flow traffic.</li> <li>• <i>Santa Ana Blvd.</i>, from Mortimer St. to SARTC: streetcars operate in the street, at grade, bi-directionally, along with mixed-flow traffic.</li> </ul>  <p>The map shows the streetcar alignment starting at Harbor Blvd in the Garden Grove area, heading southeast through Westminster Ave, Santa Ana River, and Fairview St. It then turns east along Santa Ana Blvd, crossing Raitt St, Bristol St, Flower St, Broadway, and Main St, before ending at SARTC. A north arrow is also present.</p>
Length of Alignment.	4.1 miles (Harbor Blvd. to SARTC)

Table 1 - continued

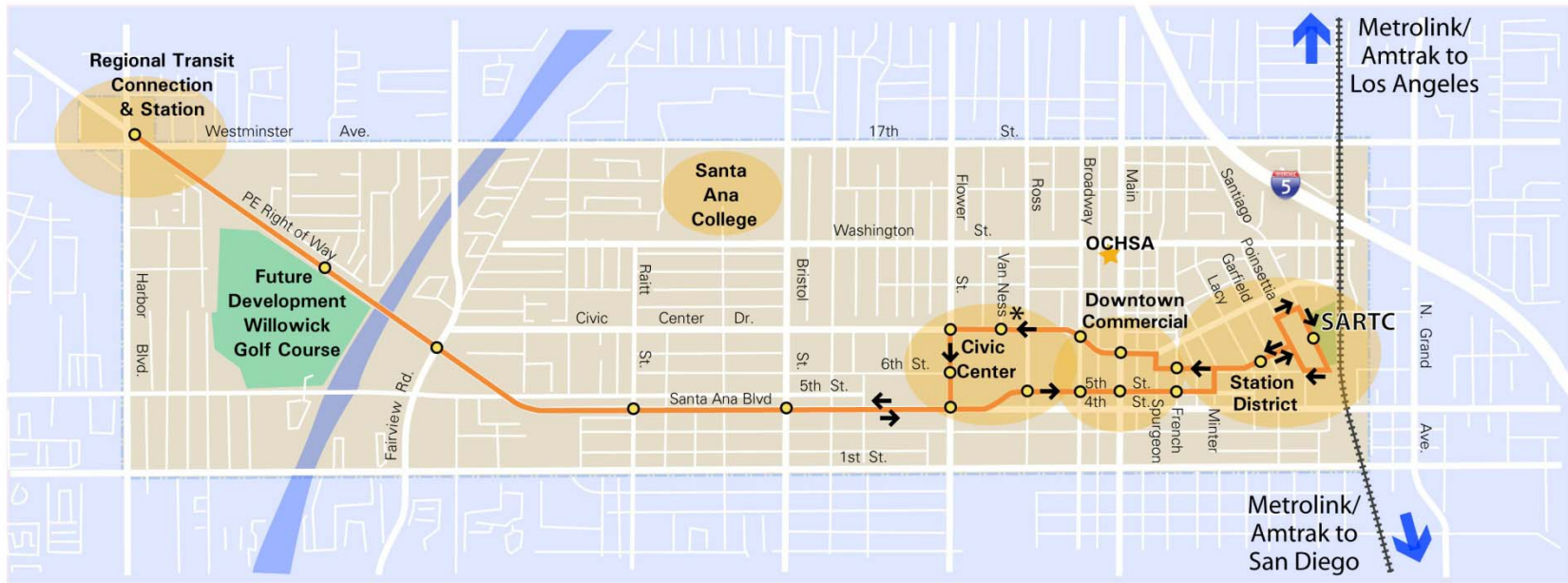
KEY ATTRIBUTES	DESCRIPTIONS											
Stations (12 Stations)	1. Harbor Blvd. and Westminster Ave. 2. Willowick 3. Fairview St. and PE ROW 4. Raitt St. and Santa Ana Blvd. 5. Bristol St. and Santa Ana Blvd. 6. Flower St. and Santa Ana Blvd. <hr/> <table border="0" data-bbox="505 495 1427 674"> <tr> <td data-bbox="505 495 943 674"><i>Couplet Section (Eastbound)</i></td> <td data-bbox="943 495 1427 674"><i>Couplet Section (Westbound)</i></td> </tr> <tr> <td>7. Sasscer Park</td> <td>7. Ross St. and Santa Ana Blvd.</td> </tr> <tr> <td>8. Broadway and 4th St.</td> <td>8. Broadway and Santa Ana Blvd.</td> </tr> <tr> <td>9. Main St. and 4th St.</td> <td>9. Main St. and Santa Ana Blvd.</td> </tr> <tr> <td>10. French St. and 4th St.</td> <td>10. French St. and Santa Ana Blvd.</td> </tr> </table> <hr/> 11. Lacy St. and Santa Ana Blvd. 12. SARTC		<i>Couplet Section (Eastbound)</i>	<i>Couplet Section (Westbound)</i>	7. Sasscer Park	7. Ross St. and Santa Ana Blvd.	8. Broadway and 4th St.	8. Broadway and Santa Ana Blvd.	9. Main St. and 4th St.	9. Main St. and Santa Ana Blvd.	10. French St. and 4th St.	10. French St. and Santa Ana Blvd.
<i>Couplet Section (Eastbound)</i>	<i>Couplet Section (Westbound)</i>											
7. Sasscer Park	7. Ross St. and Santa Ana Blvd.											
8. Broadway and 4th St.	8. Broadway and Santa Ana Blvd.											
9. Main St. and 4th St.	9. Main St. and Santa Ana Blvd.											
10. French St. and 4th St.	10. French St. and Santa Ana Blvd.											
Alignment Design Options	Western Terminus (Harbor Blvd. and Westminster Ave.): <ul style="list-style-type: none"> <li>• Elevated Option</li> </ul> <hr/> Santa Ana River Crossing: <ul style="list-style-type: none"> <li>• Bridge Avoidance Option B</li> </ul> <hr/> Sasscer Park: <ul style="list-style-type: none"> <li>• Option 1A (Direct Route)</li> </ul> <hr/> 4th Street Parking Scenarios: <ul style="list-style-type: none"> <li>• Scenario A: South Side Parallel</li> <li>• Scenario B: South Side Removal</li> <li>• Scenario C: South Side and North Side Removal</li> </ul>											
Headways	Peak: 10 minutes (6:00 a.m. to 6:00 p.m.) Off-Peak: 15 minutes (after 6:00 p.m.)											
Hours of Operation (in revenue service)	Monday – Thursday: 6:00 a.m. to 11:00 p.m. (17 hours) Friday and Saturday: 6:00 a.m. to 1:00 a.m. (19 hours) Sunday: 7:00 a.m. to 10:00 p.m. (15 hours)											
Transit Vehicle	Streetcar – Vehicle type selection has yet to be determined. The two classifications under consideration include: <ul style="list-style-type: none"> <li>• Classic Modern Streetcar (e.g., United Streetcar Portland vehicle)</li> <li>• CPUC Compliant Streetcar (e.g., Siemens S70)</li> </ul>											
Power Source	Electric, Overhead Contact System, Traction Power Substations											
Operations and Maintenance Facility Sites	Two Candidate Sites: <ul style="list-style-type: none"> <li>• Site A: South of SARTC, bordered by 4th St., 6th St., Poinsettia St. and Metrolink tracks.</li> <li>• Site B: West of Raitt St., between the PE ROW and 5th St.</li> </ul>											

Table 1 - continued

KEY ATTRIBUTES	DESCRIPTIONS
Major Bicycle and Pedestrian Features	<ul style="list-style-type: none"> <li>• Sidewalk and pedestrian improvements in the vicinity of proposed station platforms.</li> <li>• 4th St.: In conjunction with on-street parking modifications, widen sidewalks on 4th St. between Ross St. and French St.:               <ul style="list-style-type: none"> <li>– Scenario A: On south side by 8 ft. for a total width of 20 ft.</li> <li>– Scenario B: On south side by 16 ft. for a total width of 28 ft.</li> <li>– Scenario C: On both sides by 16 ft. for a total width of 28 ft.</li> </ul> </li> </ul>

Source: Cordoba Corporation, Conceptual Design Plan Set, August 2011

Figure 2: Streetcar Alternative 1 Alignment



LEGEND

- Streetcar 2
- Proposed Stop
- Future Extension to Metro East Mixed-Use Development
- Study Area
- \* Civic Center station/stop on Civic Center Drive is located at Van Ness in Design Option 1 and at Ross Street in Design Option 2



**Table 2: Key Physical and Operational Attributes of Streetcar Alternative 2**

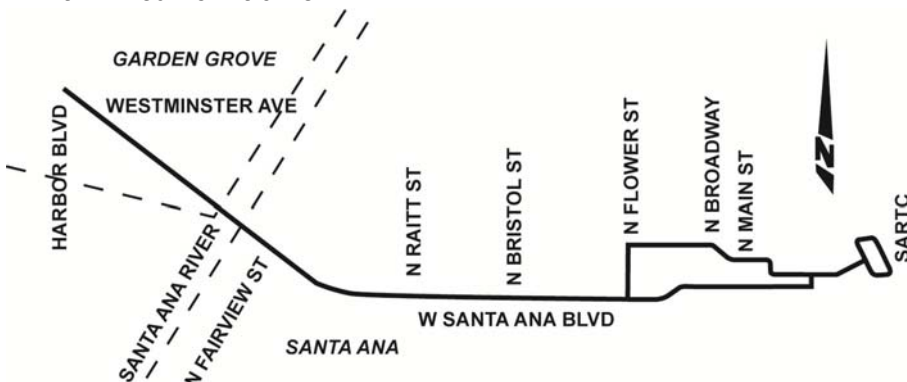
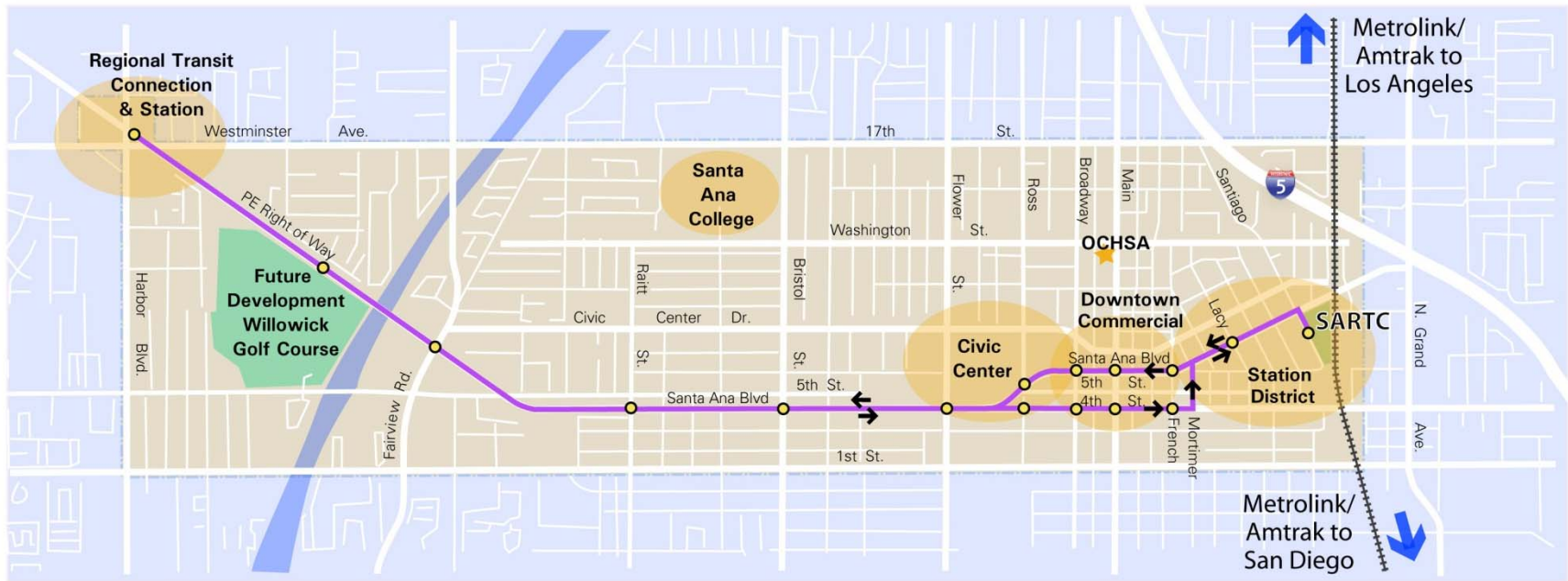
KEY ATTRIBUTES	DESCRIPTIONS					
Transit Mode	Streetcar					
Termini	<ul style="list-style-type: none"> <li>• Western Terminus: Harbor Blvd.</li> <li>• Eastern Terminus: SARTC</li> </ul>					
Alignment Description	<ul style="list-style-type: none"> <li>• <i>PE ROW</i>, from Harbor Blvd. to Raitt St.: streetcars operate at-grade, bi-directionally, in exclusive ROW.</li> <li>• <i>Santa Ana Blvd.</i>, from Raitt St. to Flower St.: streetcars operate in the street, at-grade, bi-directionally, along with mixed-flow traffic.</li> <li>• <i>Santa Ana Blvd./5th St. and Civic Center Dr. Couplet</i>, from Flower St. to Minter St.: streetcars operate in the street, at-grade, one-way, along with mixed-flow traffic.</li> <li>• <i>6th St./Brown St.</i>, from Minter St. to Poinsettia St.: streetcars operate in the street, at grade, bi-directionally, along with mixed-flow traffic.</li> <li>• <i>Poinsettia St./Santa Ana Blvd. /Santiago St./6th St. (SARTC Loop)</i>: streetcars operate in a one-way loop, in the street, at-grade, along with mixed-flow traffic.</li> </ul> <div style="text-align: center; margin-top: 10px;">  <p>The map shows the streetcar route starting at Harbor Blvd in Garden Grove, heading southeast through Westminister Ave and Fairview St. It then turns east along Santa Ana Blvd, passing Raitt St, Bristol St, Flower St, Broadway, and Main St. The route ends at SARTC in Santa Ana. A north arrow is also present.</p> </div>					
Length of Alignment	4.5 miles (Harbor Blvd. to SARTC)					
Stations (13 Stations)	<table border="0" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; vertical-align: top; border-right: 1px solid black; padding-right: 5px;"> <ol style="list-style-type: none"> <li>1. Harbor Blvd. and Westminister Ave.</li> <li>2. Willowick</li> <li>3. Fairview St. and PE ROW</li> <li>4. Raitt St. and Santa Ana Blvd.</li> <li>5. Bristol St. and Santa Ana Blvd.</li> </ol> <p><i>Couplet Section (Eastbound)</i></p> <ol style="list-style-type: none"> <li>6. Flower St. and Santa Ana Blvd.</li> <li>7. -----</li> <li>8. Ross St. and Santa Ana Blvd.</li> <li>9. Broadway and 5th St.</li> <li>10. Main St. and 5th St.</li> <li>11. French St. and 5th St.</li> </ol> </td> <td style="width: 50%; vertical-align: top; padding-left: 5px;"> <p><i>Couplet Section (Westbound)</i></p> <ol style="list-style-type: none"> <li>6. Flower St. and 6th St.</li> <li>7. Flower St. and Civic Center Dr.</li> <li>8. Van Ness Ave. and Civic Center Dr.</li> <li>9. Broadway and Civic Center Dr.</li> <li>10. Main St. and Civic Center Dr.</li> <li>11. French St. and Santa Ana Blvd.</li> </ol> </td> </tr> <tr> <td colspan="2" style="border-top: 1px solid black; padding-top: 5px;"> <ol style="list-style-type: none"> <li>12. Brown Street and Porter Street</li> <li>13. SARTC</li> </ol> </td> </tr> </table>		<ol style="list-style-type: none"> <li>1. Harbor Blvd. and Westminister Ave.</li> <li>2. Willowick</li> <li>3. Fairview St. and PE ROW</li> <li>4. Raitt St. and Santa Ana Blvd.</li> <li>5. Bristol St. and Santa Ana Blvd.</li> </ol> <p><i>Couplet Section (Eastbound)</i></p> <ol style="list-style-type: none"> <li>6. Flower St. and Santa Ana Blvd.</li> <li>7. -----</li> <li>8. Ross St. and Santa Ana Blvd.</li> <li>9. Broadway and 5th St.</li> <li>10. Main St. and 5th St.</li> <li>11. French St. and 5th St.</li> </ol>	<p><i>Couplet Section (Westbound)</i></p> <ol style="list-style-type: none"> <li>6. Flower St. and 6th St.</li> <li>7. Flower St. and Civic Center Dr.</li> <li>8. Van Ness Ave. and Civic Center Dr.</li> <li>9. Broadway and Civic Center Dr.</li> <li>10. Main St. and Civic Center Dr.</li> <li>11. French St. and Santa Ana Blvd.</li> </ol>	<ol style="list-style-type: none"> <li>12. Brown Street and Porter Street</li> <li>13. SARTC</li> </ol>	
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<ol style="list-style-type: none"> <li>12. Brown Street and Porter Street</li> <li>13. SARTC</li> </ol>						

Table 2 - continued

Alignment Design Options	Western Terminus (Harbor Blvd. and Westminster Ave.)
	<ul style="list-style-type: none"> <li>• At-Grade Option</li> </ul>
	Santa Ana River Crossing: <ul style="list-style-type: none"> <li>• Bridge Avoidance Option B</li> </ul>
Headways	Civic Center Drive
	<ul style="list-style-type: none"> <li>• Option 2A (Parking Removal and Additional Right-of-Way)</li> </ul>
Hours of Operation (in revenue service)	Peak: 10 minutes (6:00 a.m. to 6:00 p.m.) Off-Peak: 15 minutes (after 6:00 p.m.)
Hours of Operation (in revenue service)	Monday – Thursday: 6:00 a.m. to 11:00 p.m. (17 hours) Friday and Saturday: 6:00 a.m. to 1:00 a.m. (19 hours) Sunday: 7:00 a.m. to 10:00 p.m. (15 hours)
Transit Vehicle	Streetcar – Vehicle type selection has yet to be determined. The two classifications under consideration include: <ul style="list-style-type: none"> <li>• Classic Modern Streetcar (e.g., United Streetcar Portland vehicle)</li> <li>• CPUC Compliant Streetcar (e.g., Siemens S70)</li> </ul>
Power Source	Electric, Overhead Contact System, Traction Power Substations
Operations and Maintenance Facility Sites	Two Candidate Sites: <ul style="list-style-type: none"> <li>• <b>Site A:</b> South of SARTC, bordered by 4th St., 6th St., Poinsettia St., and the Metrolink tracks.</li> <li>• <b>Site B:</b> West of Raitt St., between the PE ROW and 5th St.</li> </ul>
Major Bicycle and Pedestrian Features	<ul style="list-style-type: none"> <li>• Sidewalk and pedestrian improvements in the vicinity of proposed station platforms.</li> <li>• Civic Center Drive: Provide sufficient street width on Civic Center Drive between Flower Street and Spurgeon Street to support the City’s planned development of a striped bike lane on each side of the street.</li> </ul>

Source: Cordoba Corporation, Conceptual Design Plan Set, August 2011

Figure 3: Streetcar Alternative 2 Alignment



LEGEND

- Streetcar 1
- Proposed Stop
- Future Extension to Metro East Mixed-Use Development
- Study Area



Alternative 1 Design Option 1  
Sasscer Park mitigation

## **SANTA ANA RIVER BRIDGE**

While the Streetcar Alternatives vary in their alignments between the SARTC and Flower Street, through Downtown Santa Ana, both alternatives continue on Santa Ana Boulevard to Raitt Street where they enter the PE ROW and continue to a western terminus at Harbor Boulevard. West of Fairview Street, the PE ROW crosses the Santa Ana River. Approximately centered within the PE ROW alignment, crossing the river, is the historic Pacific Electric (PE) Santa Ana River Bridge. The historic bridge is inadequate to accommodate the proposed fixed guideway due to its age, size (it was constructed as a single-track bridge), disrepair, undetermined structural integrity (both superstructure and foundation) and non-compliance with current building and safety requirements.

The bridge is a Pegram Truss, built in 1907 as part of the Pacific Electric Railway route that operated between Long Beach and Santa Ana until 1950, when service was discontinued. In the early 1970's, when the PE ROW was acquired by OCTA and the tracks were removed, the bridge was fenced at each end to prevent access. The bridge has therefore been out of operations and unmaintained since 1950. Previous studies including the SR-22/West Orange County Connection FEIR/FEIS have identified the PE Santa Ana River Bridge as eligible for inclusion in the National Register of Historic Places (NRHP).

As part of the alternatives analysis, design options have been defined and evaluated to address the fixed guideway crossing of the Santa Ana River while minimizing impacts to the historic bridge. The following describes the design options and the evaluation process used to identify the most promising options that were carried forward for evaluation through the environmental review process.

### **DESIGN OPTIONS**

Four design options were identified to address the fixed guideway river crossing and the historic Pacific Electric Santa Ana River Bridge:

1. Replace the historic bridge with a new bridge that includes decorative treatment to resemble the historic bridge: In Option 1, the historic PE Santa Ana River Bridge would be demolished. A new bridge would be constructed in its place. The new bridge would accommodate double tracks and would include a decorative treatment to resemble the original historic bridge. Figure 4 shows the Option 1 concept.
2. Leave the historic bridge in place and construct new single-track bridges on each side: In Option 2, the historic PE Santa Ana River Bridge would remain in its current location and condition. New single-track bridges would be constructed immediately north and south of the historic bridge to carry the fixed guideway. Although the historic bridge would remain, the view of the bridge would be obstructed by the new bridges. Figure 5 shows the Option 2 concept.
3. Relocate and repurpose the historic bridge: In Option 3, the historic PE Santa Ana River Bridge would be detached from its existing foundation and moved approximately 650 feet south of its current location. It would be positioned on a new foundation and piers

providing the potential for future repurposing of the bridge for bicyclists and pedestrians. A new double-track bridge would be constructed within the PE ROW to accommodate the fixed guideway. Figures 6 and 7 show the Option 3 concept.

4. Leave the historic bridge in place and construct a new single-track bridge immediately south: In Option 4, the historic PE Santa Ana River Bridge would remain in its current location and condition. A new single-track bridge would be constructed immediately south of the historic bridge to carry the fixed guideway. Through the use of gates and signaling, the single-track bridge would accommodate bi-directional fixed guideway operations. Although adequate for the proposed fixed guideway project, this will pose some capacity constraints for future expansion of fixed guideway operations. Although the, the view of the historic bridge would be somewhat obstructed by the new bridge when viewed from the south, the view from the north would remain unchanged. Figure 8 shows the Option 4 concept.

## **EVALUATION CRITERIA**

The design options were evaluated against seven criteria to determine which were appropriate for further evaluation through the environmental review process. The criteria included:

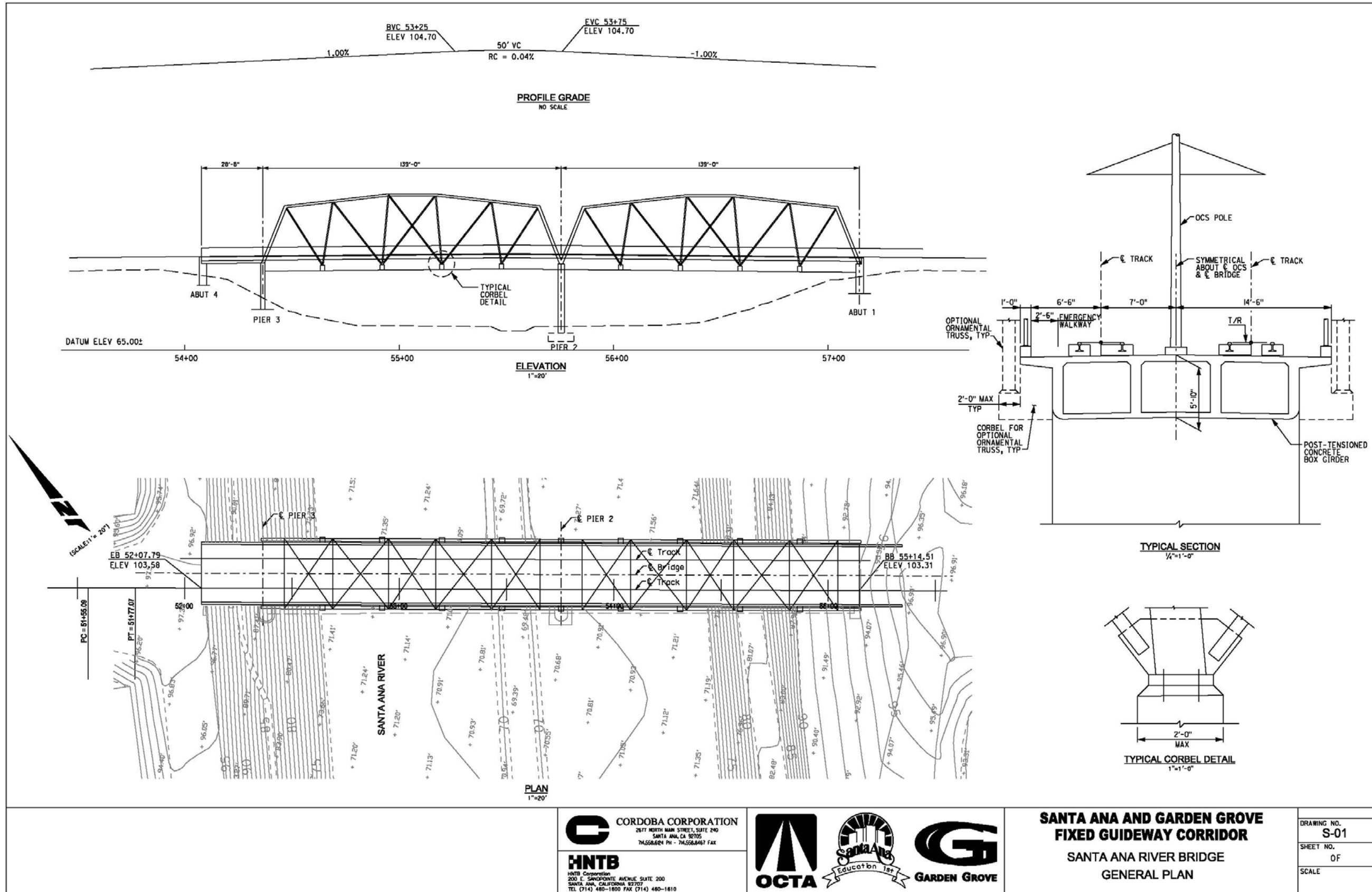
1. Capital Cost
2. Feasibility
3. Hydrologic impacts to the Santa Ana River
4. Constructability
5. Compatibility with future plans and improvements
6. Impact to a historical resource.

The design options were evaluated and ranked based on each of these criteria; the overall results of the evaluations were used to identify which design options would be carried forward into the environmental review process, and which would be eliminated from further study.

## **EVALUATION OF OPTIONS**

The following describes the evaluation of each of the design options against the evaluation criteria. Table 3 presents the results of the evaluation.

Figure 4: Option 1: Replace the Historic Bridge with a New Bridge That Includes Decorative Treatment to Resemble the Historic Bridge



**C** CORDOBA CORPORATION  
 2677 NORTH MAIN STREET, SUITE 240  
 SANTA ANA, CA 92705  
 714.568.0464 PH - 714.568.0467 FAX

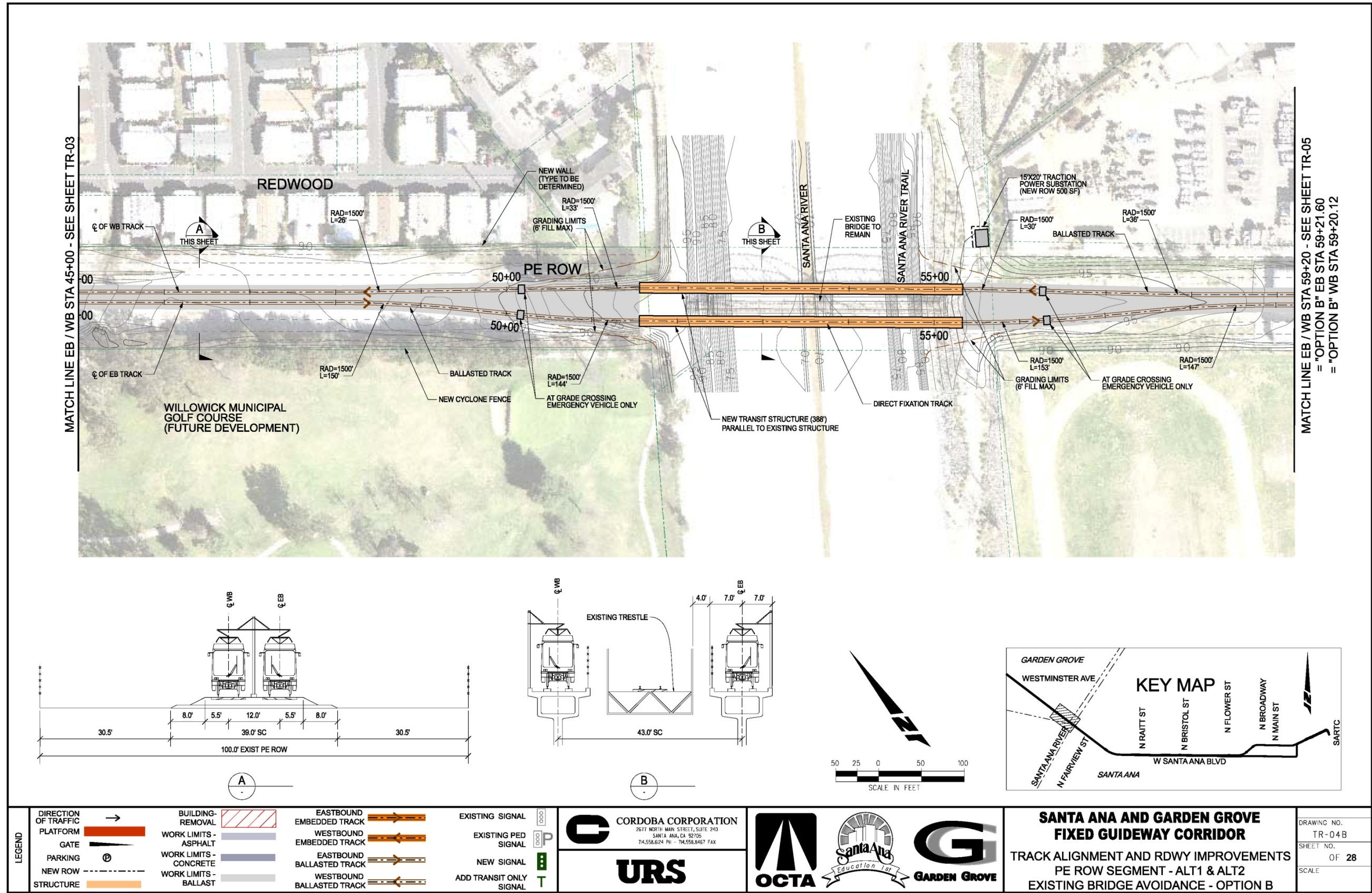
**HNTB**  
 HNTB Corporation  
 200 E. SANFORD AVENUE, SUITE 200  
 SANTA ANA, CALIFORNIA 92707  
 TEL: (714) 480-1800 FAX: (714) 480-1810

**OCTA** **SANTA ANA** **GARDEN GROVE**  
 Education 1st

**SANTA ANA AND GARDEN GROVE  
 FIXED GUIDEWAY CORRIDOR**  
 SANTA ANA RIVER BRIDGE  
 GENERAL PLAN

DRAWING NO.  
**S-01**  
 SHEET NO.  
 OF  
 SCALE

Figure 5: Option 2: Leave the Historic Bridge in Place and Construct New Single-Track Bridges on Each Side



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Figure 6: Option 3: Relocate and Repurpose the Historic Bridge

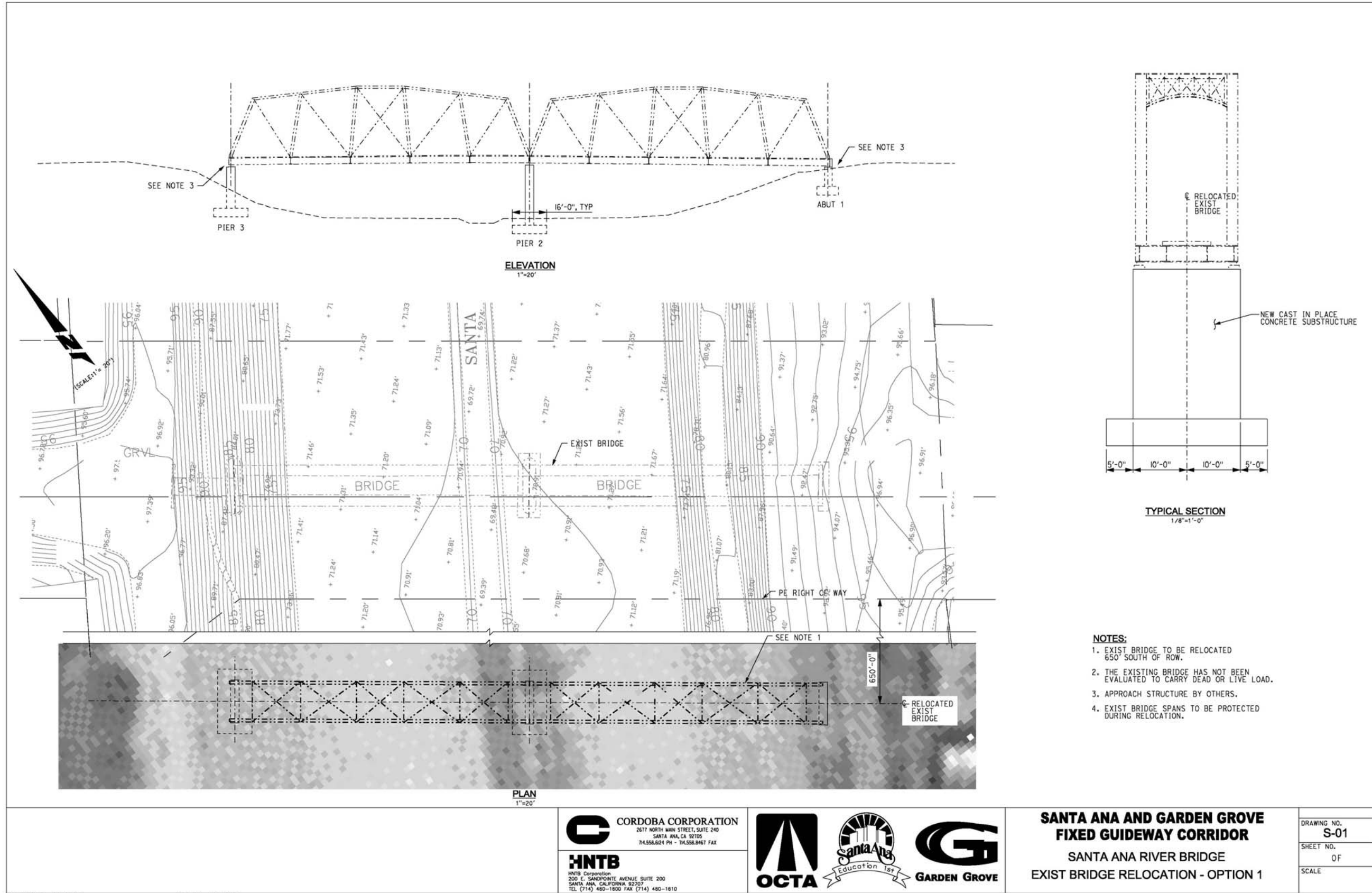




Figure 7: Option 3: Relocate and Repurpose the Historic Bridge – Replacement Bridge

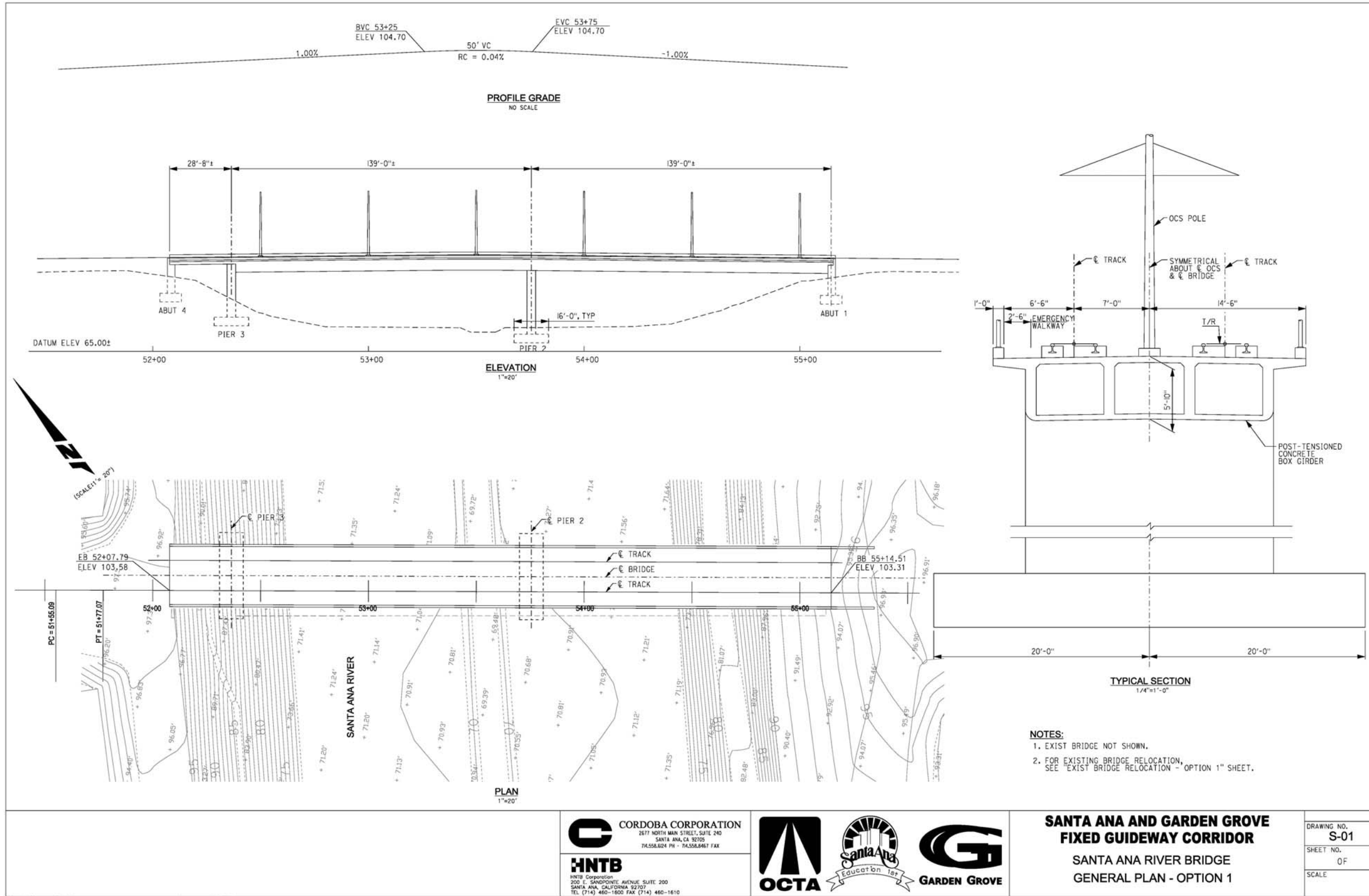
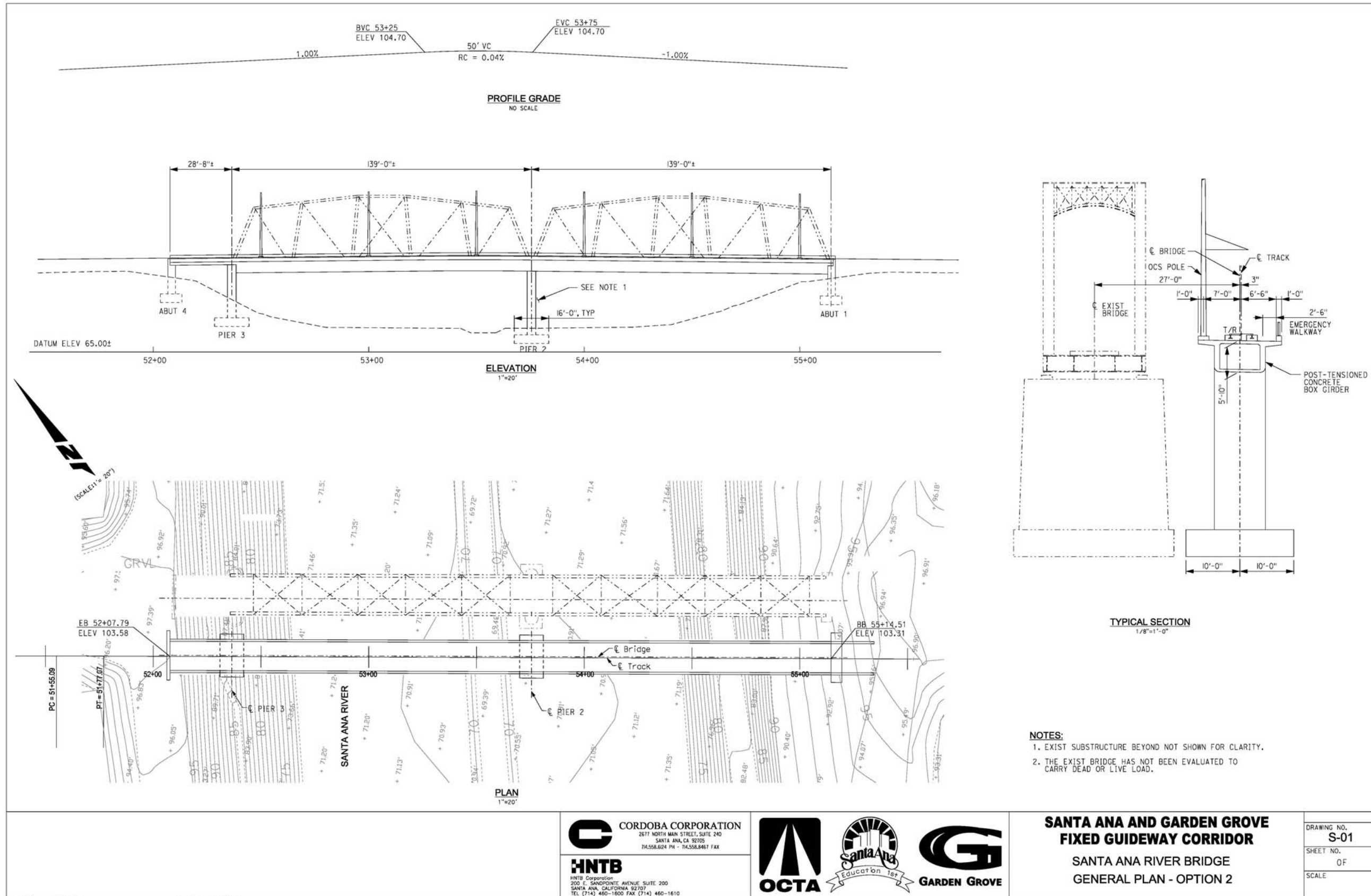


Figure 8: Option 4: Leave the Historic Bridge in Place and Construct a New Single-Track Bridge Immediately South



**C** CORDOBA CORPORATION  
2677 NORTH MAIN STREET, SUITE 240  
SANTA ANA, CA 92705  
714.558.6224 PH - 714.558.8461 FAX

**HNTB**  
HNTB Corporation  
200 F. SHADWORTH AVENUE SUITE 200  
SANTA ANA, CALIFORNIA 92707  
TEL (714) 460-1800 FAX (714) 460-1610

**OCTA**

**Santa Ana**  
Education 1st

**G** GARDEN GROVE

**SANTA ANA AND GARDEN GROVE  
FIXED GUIDEWAY CORRIDOR**

SANTA ANA RIVER BRIDGE  
GENERAL PLAN - OPTION 2

DRAWING NO.	S-01
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SCALE	

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**Table 3: Evaluation of Design Options**

		EVALUATION MEASURES					IMPACT TO HISTORICAL RESOURCE
		RATING SCALE: 1=BEST; 5=WORST					
BRIDGE TREATMENT OPTIONS		FEASIBILITY	HYDROLOGIC IMPACTS	CONSTRUCTABILITY	COMPATIBILITY	TRAIL IMPACTS	
1.	Demolish existing bridge; replace with new bridge including decorative treatment	1	1	2	1	1	5
2.	Existing bridge remains; construct new single-track bridges on each side of existing bridge	1	5	3	5	5	4
3.	Relocate existing bridge 650 feet south of current location; construct new two-track bridge	5	3	5	1	1	4
4.	Existing bridge remains; construct new single-track bridge south of existing bridge	1	2	1	4	5	1
WEIGHTING		2	4	4	3	5	1

## Cost

The costs of the various design options ranged from \$2,079,000 for Option 4 to \$5,791,500 for Option 3. Table 4 shows the estimated cost for each design option. Although there were significant variations between some of the design options, overall the cost for any of the design options represents less than 3 percent of the total cost of the project. Cost was therefore not considered a sufficient reason to eliminate any of the design options.

**Table 4: Estimate Capital Cost of Design Options**

	DESIGN OPTION	COST (2012 \$s)
1.	Replace the historic bridge with a new bridge that includes decorative treatment to resemble the historic bridge	\$4,603,500
2.	Leave the historic bridge in place and construct new single-track bridges on each side	\$3,564,000
3.	Relocate and repurpose the historic bridge	\$5,791,500
4.	Leave the historic bridge in place and construct a new single-track bridge immediately south:	\$2,079,000

## Feasibility

This measure considers the degree of risk associated with each of the design options. Due to age and unmaintained condition of the bridge, and its location within the Santa Ana River channel, there are a number of issues which could substantially affect project implementation which cannot be fully evaluated due to lack of or inadequacy of available information. An example of this is whether the strength and integrity of the historic bridge's superstructure is adequate to allow it to be relocated. The design options were rated on a scale of 1 to 5 with 1 being the most feasible, lowest risk, and 5 being the least feasible, highest risk option. Options 1, 2 and 4 all received a rating of 1. In the case of Option 1, the historic bridge would be demolished and a new bridge constructed in its place, eliminating any need to verify the integrity of the historic bridge. In Options 2 and 4, the historic bridge remains undisturbed and new bridges are constructed adjacent to it. Again, there is not need to consider the integrity of the historic bridge since it will remain unused. Option 3 received a rating of 5 because it is uncertain that the historic bridge superstructure can be detached from its existing piers and moved down the river channel without damaging the bridge. If this design option is selected as

the preferred, there will also need to be confirmation of the structural capability of the concrete river channel floor to support the load associated with moving the bridge.

### **Hydrologic Impacts**

The hydrologic impacts relate to the effect of the bridge piers on channel capacity and flow. The design options were again rated on a 1 to 5 scale with 1 being the least impactful and 5 being the most impactful.

The existing bridge has a single pier in the channel bottom that is approximately 28 feet by 9 feet. Option 1 would replace the existing pier with one that is approximately 23 feet by 4 feet. Option 1 would have the least hydrologic impact and received a rating of 1. Option 3 would also have a 23-feet by 4-foot pier in the channel bottom, replacing the existing bridge pier. It would introduce a second pier to the channel bottom, approximately 650 feet south to support the relocated historic bridge. The overall hydrologic impact to the channel of the two piers is estimated to be less than the existing pier. Option 3 was rated 3. Under Option 4, the existing bridge would remain and a second bridge would be constructed, supported on a 20-foot by 4-foot pier in the river channel. The new pier is smaller than and located sufficiently close to the existing pier that the hydrologic impacts to the channel would be nominally greater than existing conditions. Option 4 was rated 2. Option 2 has the greatest hydrologic impacts. In Option 2, the existing pier remains and two new 20-foot by 4-foot piers would be added adjacent to and on each side of the existing pier. Although still marginally greater, Option 2 would have greater impacts on channel capacity and flow than the other options. Option 2 was rated 5.

### **Constructability**

Constructability considers the complexity of project construction, rating the design options from 1 to 5, with 1 being the least difficult and 5 being the most difficult to construct. Option 4, in which the existing bridge remains and a new single-track bridge is constructed immediately to the south is rated the least complex (rating of 1). Option 1 in which the historic bridge is demolished and a new bridge is constructed is rated 2. Option 2 is rated 3, with the historic bridge again remaining in place and new bridges constructed adjacent to the north and south.

Option 3 is the most complex (rating of 5). It requires that new foundations be constructed approximately 650 feet south of the bridge's current location and then the historic bridge superstructure will be detached from its existing foundation, relocated 650 feet south and reattached to the new foundation. Once the historic bridge superstructure is relocated, the old foundations will be demolished and a new double track bridge will be constructed in its place. The historic bridge's superstructure will need to undergo materials testing to determine its adequacy to withstand relocation and reuse.

### **Compatibility with Future Plans and Improvements**

The Orange County Master Plan of Arterial Highways identifies a four-lane arterial within the 100-foot wide PE ROW. The City of Santa Ana and the Orange County Transportation Authority have defined the facility as a multi-modal corridor which will include a four-lane

roadway with bike lanes, and high-capacity transit in the middle. Future opportunities to provide direction connections to/from SR-22 have also been identified.

The historic PE Santa Ana River Bridge is approximately 15 feet wide and located in the center of the PEROW alignment. In the design options in which the historic bridge remains in place (Options 2 and 4), there is inadequate room remaining within the PE ROW to accommodate the future multi-modal arterial. Option 2 is rated 5 and Option 4 is rated 4 because they are not compatible with these future plans and would therefore necessitate acquisition of additional right-of-way to accommodate the multi-modal corridor.

In Options 1 and 3, the multi-modal corridor could be accommodated in the future with additional bridges or bridge widening within the PE ROW alignment. Options 1 and 3 are rated 1 because they are compatible with future plans.

### **Trail Impacts**

A multi-purpose regional recreational trail and a maintenance road are currently maintained along the top of the bank on the west side of the Santa Ana River. At various locations along the river where bridge improvements have been implemented (i.e., 5<sup>th</sup> Street, Fairview Road, Memory Lane) the trail and the maintenance road have been depressed beneath the bridges, and access to the arterials from the maintenance road has been reestablished. The trail and the maintenance road currently cross the PE ROW at grade. With the modifications to Santa Ana River crossing at the PE ROW as part of the fixed guideway project,, these improvements would be required to be included..

In Options 1 and 3, where the historic bridge is either demolished or relocated, the trail and maintenance road could be accommodated beneath the new bridge, consistent with the standards required by the County of Orange. Options 1 and 3 received a rating of 1.

In Options 2 and 4, where the historic bridge remains in place, a bridge abutment on the west bank of the river would make depressing the trail and maintenance road impossible without major modifications to the abutment bridge support and the river channel embankment. Options 2 and 4 received a rating of 5.

### **Historic Resource Impacts**

The purpose of considering design options for the Santa Ana River crossing is to minimize impacts to the existing historic PE Santa Ana River Bridge. In this measure each design option is rated from 1 to 5 with 1 being the best and 5 being the worst, on how well the option addresses this objective.

Option 1 is rated 5 and is the least effective in addressing this objective since it results in the demolition and replacement of the historic bridge with a new bridge.

Option 2 maintains the historic bridge, but it is rated 4 and is the second least effective design option. This is because the placement of a new bridge on each side of the historic bridge will substantially alter the view of the historic bridge.

Option 3 is also rated 4 and is the second least effective in addressing the objective. By relocating and repurposing the bridge, there is risk of damaging the bridge. In addition the setting and the view of the bridge is altered.

Option 4 is rated 1 because the bridge would remain untouched in its existing location. While the additional of the new bridge on the south side would somewhat obstruct the view of the bridge from the south, the view from the north would remain unchanged.

### **SUMMARY OF FINDINGS AND CONCLUSIONS**

Table 4 shows the ratings for each design option against each measure. Table 5 tallies the ratings for each design option and ranks the options from lowest (best) to highest (worst).

Some of the evaluation criteria were considered more important in determining which design options would be carried forward for further study than others. For example, since the primary objective in considering the design options was to minimize impacts to the historic PE Santa Ana River Bridge, Impact to Historical Resource was considered the number 1 criteria in evaluating the options. Feasibility was considered next most important in selecting an implementable design option, as well as the ability to comply with the Orange County Public Works standards for the multi-purpose trail/maintenance road. Compatibility with adopted plans and future improvements was ranked 3<sup>rd</sup>. Hydrologic impacts and constructability were considered technical issues which could add complexity and cost to an option, but that could be addressed through design; they were ranked 4<sup>th</sup>. Each design option's ranking on a measure was multiplied by the importance ranking of the measure to yield a weighted total.

Review of Table 5 shows that although the totals change with the application of the weightings, the overall ranking of the design options did not.

### **Options to Be Carried Forward**

Based on the evaluation and ranking of the design options, the top three options will be carried forward for further study in the environmental review. The top three design options in ranking order include:

1. Option 4: Existing bridge remains; construct new single-track bridge south of existing bridge;

### **Options to Be Eliminated**

Although Option 1 is ranked first among the options, it will be eliminated from further consideration because, based on the requirements of NEPA and Section 4(f), the impacts to

the historic bridge represent a “fatal flaw” when there is an available option that does not significantly impact the bridge as an historic resource.

Option 2 will be eliminated from further consideration. With the exception of Feasibility, this design option performed at the bottom on all other measures. Most importantly, it failed to perform well in terms of Impact to Historic Resource because the construction of two new bridges immediately adjacent and on each side of the historic bridge would obstruct the view of the historic bridge and alter the visual setting. It was also incompatible with future plans and improvements within the PE ROW, and would necessitate acquisition of considerable additional right-of-way with potential community impacts if future improvements were to be accommodated.

Option 3 will be eliminated for the same reason as Option 1. The impacts of relocating and repurposing the bridge would create a potentially significant impact to an historic resource under Section 4(f).



**Table 5: Design Options Evaluation Results and Rankings**

	BRIDGE TREATMENT OPTIONS	NOTES	RAW		WEIGHTED	
			TOTAL	RANKING	TOTAL	RANKING
1.	Demolish existing bridge; replace with new bridge including decorative treatment	Eliminates existing bridge; accommodates new 2-track bridge and trail improvements	11	1	27	1
2.	Existing bridge remains; construct new single-track bridges on each side of existing bridge	Obstructs view of existing bridge; accommodates 2 single-track bridges; does not allow compliance with trail standards	23	4	78	4
3.	Relocate existing bridge 650 feet south of current location; construct new two-track bridge	Relocates/repurposes existing bridge; assumes adequate structural integrity of existing bridge to survive relocation; risk to channel shell; accommodates new 2-track bridge and trail improvements	19	3	54	3
4.	Existing bridge remains; construct new single-track bridge south of existing bridge	Maintains existing bridge; limited capacity; operational constraints; accommodates 1 single track bridge; does not allow compliance with trail standards	14	2	52	2

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