FINAL DRAFT PROJECT ASSESSMENT

FOR

DESERT PEAK PARKWAY & CAVE BUTTES WASH BRIDGE

City of Phoenix Project Number: ST85110180-1

January 2024

Prepared for and Approved By:

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1.0 INTRODUCTION

1.1 Overview

The primary purpose of this Project Assessment (PA) is to establish a preferred alternative for an all-weather crossing over Cave Buttes Wash along the East Desert Peak Parkway.

1.2 Alternatives

The project alternatives reviewed as part of this PA include all-weather crossings over Cave Buttes Wash. Alternative 1 is a bridge structure completely spanning the Cave Buttes floodplain. Alternative 2 is a bridge structure crossing the Cave Buttes Wash Floodway with additional culverts proposed along the embankments approaching the bridge structure.

1.3 Location

The project is located along the East Desert Peak Parkway approximately 1/2-mile west of the Cave Creek Road, crossing the Cave Buttes Wash. Figure 1 provides an aerial depiction of the project location.

Figure 1 – Project Location – Short Bridge Option Shown

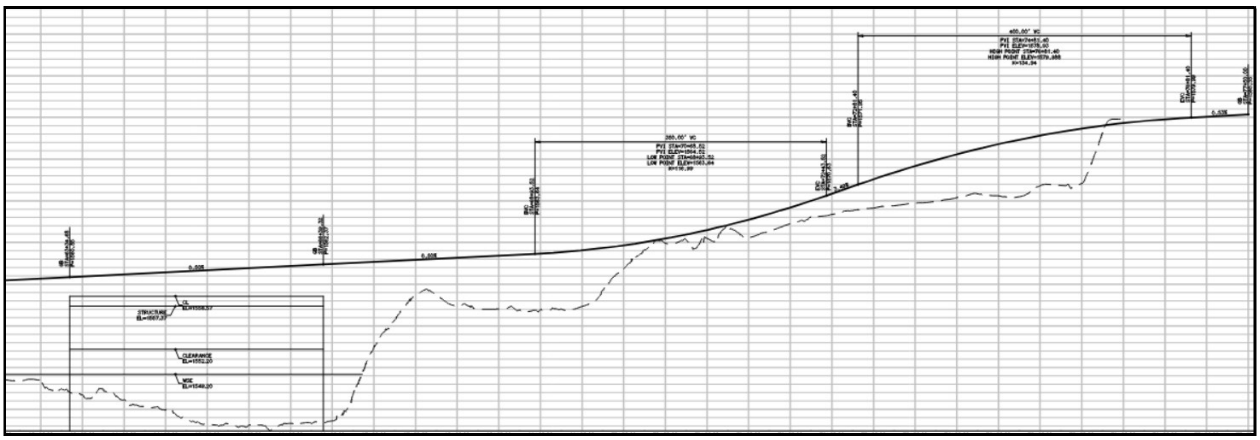
2.0 ROADWAY GEOMETRIC

2.1 Horizontal Geometric

The horizonal geometry of the proposed roadway alignment along the East Desert Peak Parkway is provided by the City of Phoenix.

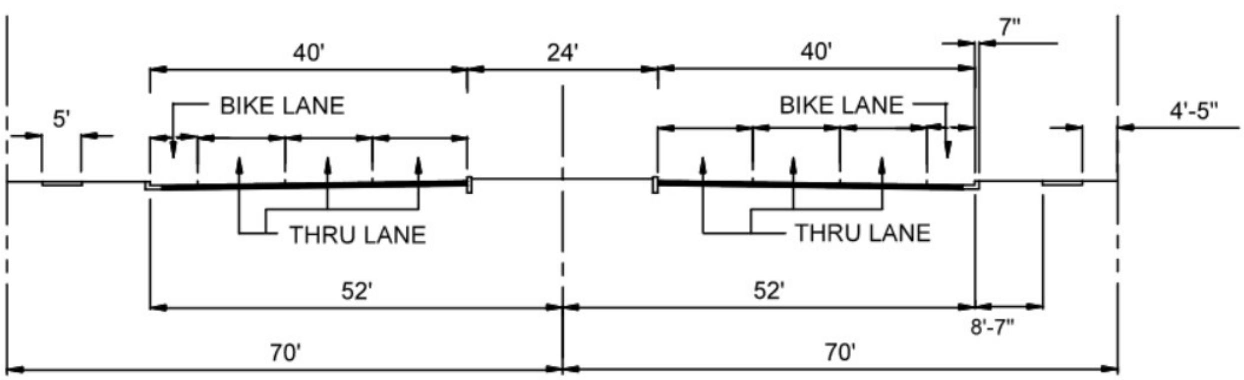
2.2 Profile Geometric

The preliminary proposed profile along the East Desert Peak Parkway starts on the eastern end tying into the recently constructed roadway improvements. Based on existing topography (GIS), the proposed profile drops approximately 15’ to the west as it crosses the Cave Buttes Wash. The proposed profile grade provides sufficient clearance to the 100-year water surface elevation (3’ to the bottom of the structure).



2.3 Lane Configuration

The proposed roadway alignment along the East Desert Peak Parkway would consist of a 40’ wide pavement section in each direction providing for 3 lanes and a bicycle lane. Throughout the alignment, a 24’ wide curbed median would be provided. The typical section will include a detached 5’ sidewalk separated by a 10’ landscape buffer per the City’s Standard Cross Section A shown below.



CROSS SECTION A

The proposed horizontal geometry for the East Desert Peak Parkway was provided by the City's Consultant Entellus, Inc. The roadway geometry across the proposed bridge structure is composed of a straight section followed by a reversing curve to shift the roadway further south. The reversing curve geometry will not impact the proposed bridge structure layout.

3.0 HYDRAULIC ANALYSIS

Cave Creek generally flows north to south. The proposed project consists of extending the existing East Desert Peak Parkway from Cave Creek Dam Road west to 7th Street. The proposed alignment crosses Cave Creek Wash approximately 2,300-feet (0.4-miles) south of Cave Buttes Dam and approximately 1.2-miles north of the Central Arizona Project (CAP) Canal.

The hydrology and hydraulics of Cave Creek Wash has previously been studied by the Flood Control District of Maricopa County (FCDMC) and designated with a Federal Emergency Management Agency (FEMA) regulatory Zone AE floodplain and floodway. The effective Flood Insurance Study (FIS) identifies the 100-year discharge rate at Cave Buttes Dam (1,000 cfs) and at the CAP Canal (4,900 cfs). The 100-year discharge at the East Desert Peak Parkway crossing of Cave Creek Wash is 1,100 cfs. The effective floodplain and floodway are graphically presented on the Flood Insurance Rate Map (FIRM) panel number 04013C1285M.

To determine the impact of the proposed bridge crossing of Cave Creek Wash, the effective floodplain/floodway hydraulics model was obtained from the FCDMC and modified to two alternative bridge configurations: Case I) a five-span, 500-ft long bridge crossing the floodway with the bridge abutments located outside of the floodplain, and; Case II) a three-span, 300-ft long bridge crossing the floodway with the eastern bridge abutment located outside of the floodplain and the western abutment located within the floodplain on an elevated roadway embankment. Each model includes the bridge deck, abutments and piers. The results of the proposed conditions models are compared with the effective model in the following table.

X-Section ID	River Mile	Corrected Effective (NGVD'29)		Corrected Effective (NAVD'88)[1]		Proposed Conditions		**Change in WSEL**	
		Floodplain	Floodway	Floodplain	Floodway	Floodplain	Floodway	Floodplain	Floodway
		[WSEL]	[WSEL]	[WSEL]	[WSEL]	[WSEL]	[WSEL]	[WSEL]	[WSEL]
125	27.294	1562.54	1562.54	1564.30	1564.30	1564.30	1564.30	0.00	0.00
124	27.166	1562.17	1562.17	1564.05	1564.05	1564.05	1564.05	0.00	0.00
123	27.060	1559.5	1559.49	1561.38	1561.37	1561.38	1561.37	0.00	0.00
122	26.984	1547.32	1548.07	1549.21	1549.62	1549.21	1549.62	0.00	0.00
121	26.883	1547.31	1547.93	1549.21	1549.45	1549.21	1549.45	0.00	0.00
120.6	26.851	-	-	1549.20	1549.52	1549.20	1549.52	0.00	0.00
Bridge	-	-	-	-	-	-	-	-	-
120.4	26.827	-	-	1549.20	1549.51	1549.20	1549.51	0.00	0.00
120	26.784	1546.18	1546.25	1548.06	1548.13	1548.06	1548.13	0.00	0.00
119	26.673	1533.99	1534.96	1535.87	1536.84	1535.87	1536.84	0.00	0.00
118	26.582	1532.24	1532.43	1534.12	1534.31	1534.12	1534.31	0.00	0.00

Notes: Vertcon adjustment between NGVD'29 and NAVD'88 is: NGVD'29 + 1.88 ft = NAVD'88

Table 1 – Effective VS. Proposed Conditions Model Results

The results of the two bridge models are identical in that the calculated water surface elevation is the same for each configuration. The physical characteristics of the existing wash, specifically, that there is an embankment crossing the wash approximately 200-feet downstream of the proposed bridge crossing alignment which is approximately 2.5-feet higher than the upstream wash bottom. This grade control creates a shallow pond upstream, through the bridge alignment, and a constant tailwater condition independent upon selected bridge option.

Therefore, there is no change in the calculated water surface elevation (WSEL) between the Corrected Effective (NAVD'88) and the Proposed Conditions models. For the same reason, the bridges and piers (with debris flow) are not showing any impact to the effective floodplain or floodway.

Additional, due to the nature of the ponding condition, the model results in very low flow velocity through this reach of Cave Creek Wash with flow channel velocities averaging about 0.8 feet per second through the bridge. In Case I, the proposed bridge abutments do not encroach into the effective floodplain, therefore only the bridge piers provide obstructions to flow. Whereas, in Case II, the western roadway embankment and bridge abutment are located within the floodplain. For both Cases, the Froude number through the bridge are also low indicating laminar flow consistent with that of a shallow pond. The proposed bridge soffit is at elevation 1552.0 and the high-water surface elevation is 1549.20 provide almost 3-feet of freeboard.
Scour at the bridge is estimated using the simplified Arizona Department of Water Resources (ADWR) State Standard SSA 5-96 (State Standard for Watercourse System Sediment Balance). Using the Level 1 analysis which is based solely on the peak discharge (1,100 cfs) passing through the proposed bridge, the range of scour is estimated at between 3.92 ft (for a straight reach) and 4.94 feet (for a curved reach). Thus between 4.0 and 5.0 feet. Since the reach has some curvature, use 5.0 feet.

4.0 BRIDGE ANALYSIS

The bridge type selection process is an assessment of the functional, project, and site-specific parameters with respect to the economical and practical constraints for various bridge types at any given location. These economical and practical constraints typically are imposed by items such as constructability, construction sequencing, traffic control, structural capacity/performance, roadway geometrics and bridge site constraints. Generally, the bridge types and configurations that are thought to be economical, practical, serviceable, and aesthetically pleasing for that site are evaluated with these constraints taken into consideration. Economics and constructability are typically the governing constraints but on occasion another parameter may have a significant influence on the evaluation. The final recommended bridge type and configuration is that which best meets all the applicable constraints.

Recent bridge construction history for Arizona has predominately consisted of both reinforced and prestressed concrete with some steel construction for unique structures.
The precast prestressed concrete I- girder is typically used where rapid construction is desired or

where falsework is not ideal. These girders are manufactured locally and can be erected rapidly using one or two cranes. The main advantage of the precast girder system is the lack of falsework and minimal formwork for superstructure construction. This can greatly reduce construction restrictions in difficult access areas. The most efficient spans for individual girders are less than 150 feet. However, precast girders can be spliced together for longer spans.

Cast-in-place post-tensioned concrete box girder bridges are very efficient bridge types that are constructed on either soffit fill or falsework. This bridge type has minimal long-term deflections. It generally has good, reserved future capacity and has minimal maintenance cost. This structure type can accommodate varying bridge geometry and can span maximum openings of 300 feet. This alternative will require falsework spanning over the Cave Buttes Wash which will significantly drive up the construction cost and result in additional coordination with the City.

Composite steel girder bridges generally offer similar functional characteristics as precast girders and have been successfully utilized in the City. However, due to the location of fabrication plants and the general cost of structural steel, they have not been found to be as economical as concrete construction in this area. Furthermore, this type of structure requires higher maintenance and inspection costs compared to the concrete structure. As a result, this structure type has not been evaluated in detail for this project except where spans exceed the limits for precast prestressed concrete girders.

Abutment type and placement for typical bridge structures on this project consists of both full height abutment supported on spread footing and stub abutments supported on drilled shafts. In this preliminary study, a stub abutment supported on drilled shaft is considered a better candidate for both abutments due to scour. The full height abutment can be considered further in final design with the recommendation from geotechnical engineer.

For girder bridges, piers are typically multi-column bents with caps consisting of a non-integral supporting beam. Each column, typically circular to minimize blockage to the water flow, is supported on a single drilled shaft.

The technical design specifications and guidelines followed in the development of this bridge study are:

- AASHTO LRFD Bridge Design Specifications, 9th Edition
- Bridge Design Guidelines, ADOT, current version

All roadway bridges on this project will be designed for the HL93 live loading.

4.1 Roadway and Bridge Geometry

The roadway section of East Desert Peak Parkway at the bridge crossing is symmetrical about the East Desert Peak Parkway construction centerline and profile grade line. The 104’-0” roadway consists of a 6’-0” bike lane, two 11’-0” eastbound lanes, a 12’-0” thru lane (EB), a 24’-0” raised median, a 12’-0” thru lane (WB), two 11’-0” westbound lanes and a 6’-0” bike lane. A 6’-0” sidewalk with 1’-2” wide curb and pedestrian railing is located on each side of the roadway. Both the sidewalks are separated from the roadway by 1’-0” ADOT SD 1.12 barriers. The resulting out-to-out width of the bridge deck is 120'-4". The East Desert Peak Parkway horizontal alignment at the bridge is on a tangent. The entire bridge is on 0.50% vertical tangent. The cross slope is a standard 2% crowned cross slope.

4.2 Alternative Considerations

Our first approach is using ADOT Standard Box Culvert to span over entire floodplain of Cave Buttes Wash. The total distance of the floodplain and floodway is approximately 400ft. The span of the culvert is limited to 12' based on ADOT Standard Details. Using the ADOT standard box culverts as a crossing solution over entire floodplain will require 33 barrels of box culverts. The ADOT Standard box culverts will generate higher drainage blockage over the floodplain and provide a higher impact on the water surface elevation. In addition, using box culvert as crossing method will require constructing concrete aprons at both the upstream and downstream of the box culvert. Per the recommendation of our drainage engineer, the concrete apron will have limited protection against certain flood events. This solution is not considered further in our study.

Our second approach is using a full bridge to span over the floodway and combine with using box culvert to span over the remaining floodplain of Cave Buttes Wash. However, this approach was quickly eliminated as we find out that the transition between the bridge structure and the concrete box would generate similar amount of drainage blockage to the flow.

Our final approach is using a prestressed I-girder bridge supported on drilled shaft foundation to span over the Cave Buttes Wash. The benefits of this alternative include minimum hydraulic blockage, no falsework in the wash bed, widely used in the valley and ease of construction. Two alternatives are analyzed: a). Five span bridge with the abutments placed outside the floodplain; b). Three span bridge with the abutments placed inside the floodplains.

4.2 Alternative 1 Bridge Configuration

This alternative will fully span over the entire floodplain of the Cave Buttes Wash. The structure consists of 5 unequal spans with an overall bridge length of 504'-7¾". The span configuration consists of 98'-9" for span 1, 100'-0" for span 2 to span 4, and 98'-9" for span 5. The structure depth is 5'-2" at the supports. Since the expansion joint movement rating is 4 inches, a strip seal joint is selected for this alternative at Abutment 1, Pier 2, and Abutment 2. This bridge has sub abutments supported on drilled shafts at both the Abutment 1 and Abutment 2. Five 4'-0" diameter circular columns spaced at 26'-0" along the pier centerline are used to support the bridge. Each column will be supported by a single 72-inch diameter drilled shaft.

All the abutments are placed outside the floodplain. This option will generate the minimum hydraulic impact on the flow and provide the lowest high-water elevation which will directly reduce the required profile height along the alignment. This alternative will provide the most savings in roadway cost including the retaining walls along the embankment. See Appendix A for the plan and elevation.

4.3 Alternative 2 Bridge Configuration

This alternative will span over the floodway of the Cave Buttes Wash only. The structure consists of 3 unequal spans with an overall bridge length of 304'-7¾". The span configuration consists of spans of 98’-9”, 100’-0” and 98’-9”. Similar to Alternative 1, since the expansion joint movement rating is 4 inches, a strip seal joint is selected for this alternative at Abutment 1 and Abutment 2. This bridge has sub abutment supported on drilled shaft at both the Abutment 1 and Abutment 2. Five 4’-0” diameter circular columns spaced at 26’-0” along the pier centerline are used to support the bridge. Each column will be supported by a single 72-inch diameter drilled shaft.

Since all the abutments are placed inside the floodplains, bank protections including retaining walls are required along both side of the roadway inside the floodplain. This alternative has narrowed the steam flow at the bridge causing higher high-water elevation in the wash. This will require raising the roadway profile to meet free board requirement at the bridge and to prevent any overflow for the roadway sections that are located inside the floodplains. This alternative will generate higher roadway and retaining wall cost for this project. See Appendix B for the plan and elevation.

4.4 Bridge Typical Section

The proposed typical section is the same for all the options. The typical section is symmetric about the construction centerline. The typical section at the bridge consists of a 1’-2” outside pedestrian rail, a 6’-0” sidewalk, a 1’-0” separated vehicular barrier, a 8’-0” bike lane, two 11’-0” lanes, one 12’-0” lane and 20’-0” raised median centered about the construction centerline. The resulting overall bridge width is 120’-4”. The deck slab thickness is 8 inches except at the edges where 9 inches is required. For the required spans and geometry, 14 UBT50 precast prestressed I-girders are equally spaced. The overhang is 3’-3½” on both sides. See Appendix C for the typical section.

4.5 Substructure

The proposed typical section is similar for all the options. Since the Geotech data is not available in this assessment, the substructure discussed below is proposed using engineering experience and judgement. The 500-year scour event does not control the design of this bridge. The dam breaks event is not considered in this assessment. The bridge study is conducted using the 100-year flow drainage data. All the substructures proposed herein are for cost estimate only. All the substructures shall be designed and finalized in the final design based on the provide geotechnical data and hydraulic data.

Each of the piers consists of a 5’-0” wide by 5’-0” deep cap supported by five (5) 4’-0” diameter columns each on an individual 6’-0” diameter drilled shaft. The shaft tip is assumed to be 5 times the diameter below the 100-year scour elevation.

Each abutment consists of a 1’-0” back wall with an approach slab seat and a 5’-6” wide stem supported by a single row of five (5) 5’-0” diameter drilled shafts. The shaft length is assumed to be five times the diameter below the 100-year scour elevation.

4.5 Alternative Comparison

The table below provides a side-by-side comparison of the Alternatives.

ALTERNATIVE COMPARISON		
	Alternative 1	Alternative 2
Bridge Spanning Feature	Entire Flood Plain	Flood Way only
Bridge Length/# Spans	504.65ft / 5	304.65ft / 3
Bridge Width	120.33ft	120.33ft
Cross Slope	0.02'/ft	0.02'/ft
Construction Cost	$12.6M / $209 per sq ft	$9.7M / $267 per sq ft
Maintenance Cost	Comparable with Alt 2	Comparable with Alt 1
Advantages	• Less Cave Buttes Wash Reconstruction Required • Less Maintenance and Construction Costs associated with Bank Protection	• Lower Construction Costs • Lower Maintenance Costs associated with Concrete Bridge Deck
Disadvantages	• Additional Strip Seal Joint Required • Higher Construction Costs • Higher Bridge Maintenance Cost	• More Extensive Cave Buttes Wash Bank Protection Required • Higher roadway and retaining wall cost

4.6 Preferred Alternative

The precast prestressed I-girder bridge will have a low maintenance cost for its life span. Majority of the maintenance costs are associated with bridge inspection, joint replacement and repainting the structure itself. The Alternative 1 which has a larger footprints of maintenance area either on the bridge or underneath the bridge, therefore, our preliminary assessment indicates Alternative 1 will have a higher bridge maintenance cost compared the Alternative 2. Our preliminary assessment shows no difference on the environmental impacts for each alternative. Based on drainage effect analysis, preliminary maintenance cost analysis and the construction cost comparison, Alternative 2 is the recommended alternative for this project.

The layout and the recommendation do not consider the cost impact and consequences of the Cave Buttes Dam failure. The model prepared by the Maricopa County Flood Control District does not consider the dam breach scenario.

4.7 Aesthetic Considerations

Per the City request, a preliminary aesthetic consideration was performed to generate a preliminary aesthetic estimate for the study. We used the Happy Valley Bridge in the City of Peoria as an example for our estimate. The following pictures show aesthetic treatment being implemented for the Happy Valley Bridge. A similar theme will be applied for the New Cave Buttes Bridge. Our estimated cost to achieve this similar aesthetic outcome is approximately 700K for Alternative 1 and 500k for Alternative 2 in addition to the construction cost.

APPENDIX A – ALTERNATIVE 1

STREET NAME

PHOENIX STREET – MARICOPA CO.

LIMITS

F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	AS BUILT
9	ARIZ.				

DATE — CONSULTING ENGINEER

DESIGN: DRAWN: CHECKED:

NO.	DESCRIPTION	REV BY	CKD BY	DATE

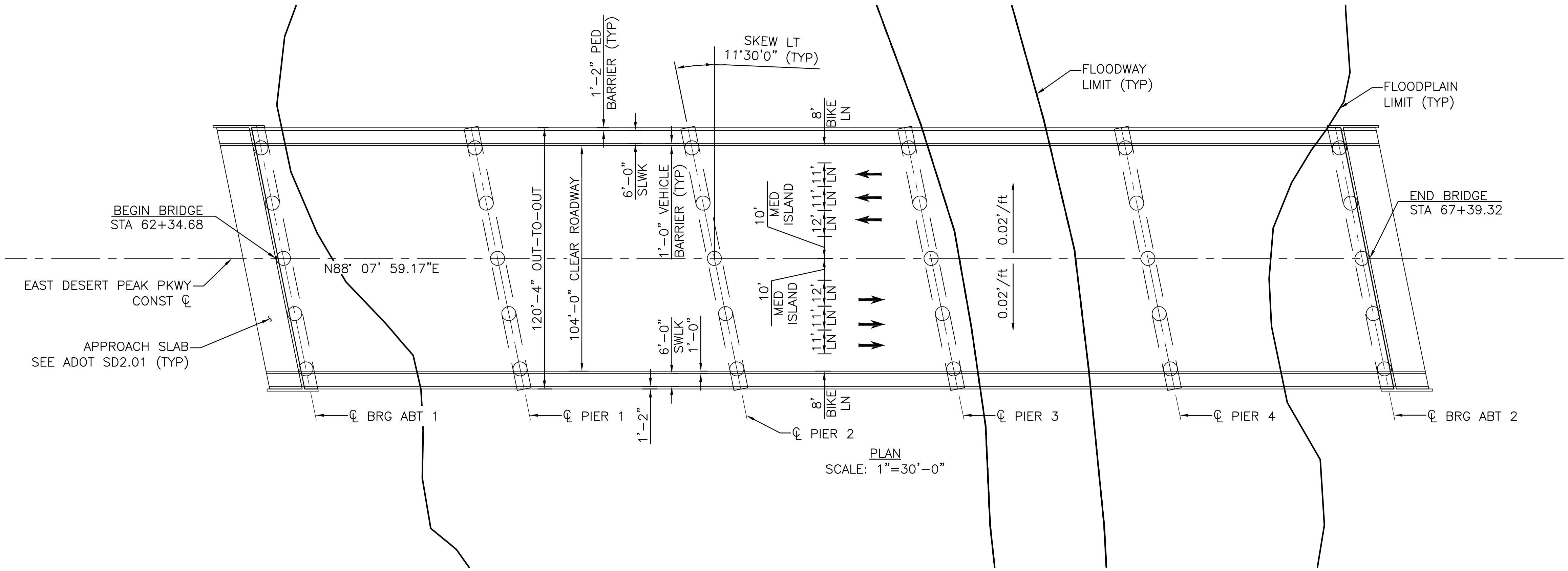
REVISION BY CITY OF PHOENIX

NO.	DESCRIPTION	REV BY	CKD BY	DATE

REVISION BY CITY OF PHOENIX

NO.	DESCRIPTION	REV BY	CKD BY	DATE

REVISION BY CITY OF PHOENIX



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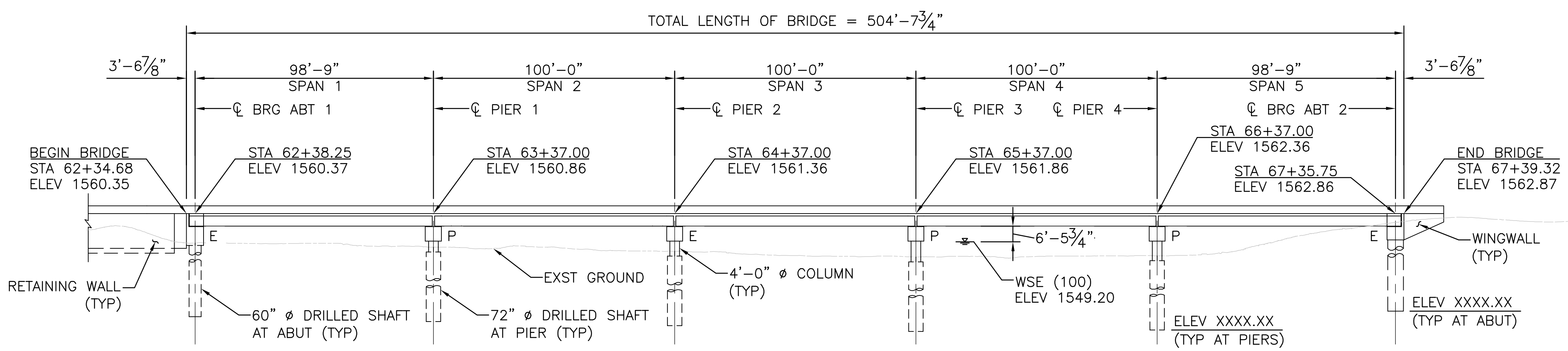

ELEVATION
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PLAN & ELEVATION

CITY OF PHOENIX, ARIZONA
STREET TRANSPORTATION DEPARTMENT

CAVE BUTTES WASH BRIDGE

ALTERNATIVE - 1

DR: DWNBY DATE:MM/YY	DES: DESBY DATE: MM/YY	CK: CHKBY DATE: MM/YY	SHEET NO:	TOTAL SHEETS	AS BUILT
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APPENDIX B – ALTERNATIVE 2

STREET NAME

PHOENIX STREET – MARICOPA CO. LIMITS

NO.	DESCRIPTION	REV BY	CKD BY	DATE

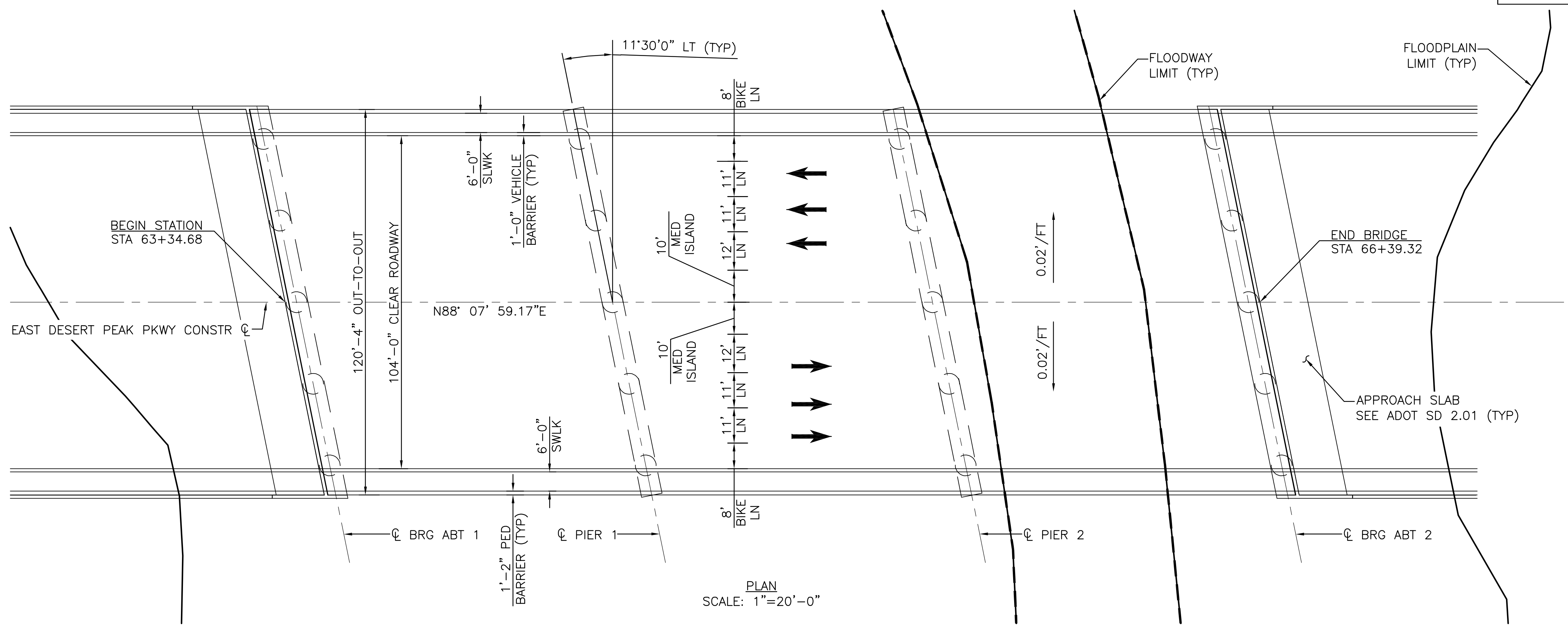
REVISION BY CITY OF PHOENIX

NO.	DESCRIPTION	REV BY	CKD BY	DATE

REVISION BY CITY OF PHOENIX

NO.	DESCRIPTION	REV BY	CKD BY	DATE

REVISION BY CITY OF PHOENIX



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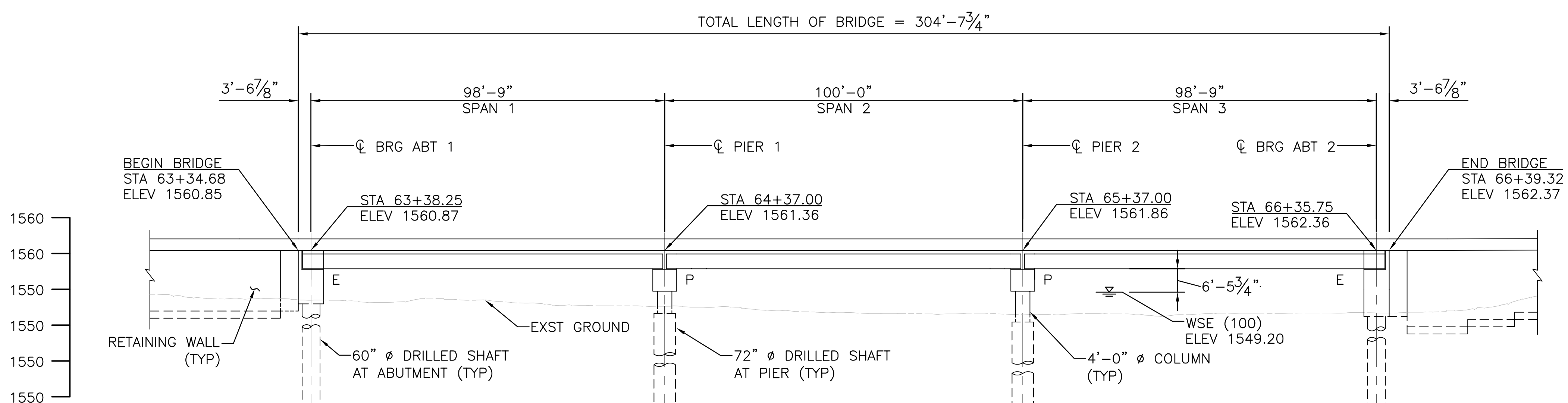

ELEVATION
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DATE — CONSULTING ENGINEER

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PLAN & ELEVATION

CITY OF PHOENIX, ARIZONA
STREET TRANSPORTATION DEPARTMENT

CAVE BUTTES WASH BRIDGE

ALTERNATIVE - 2

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APPENDIX C – TYPICAL SECTION

STREET NAME

PHOENIX STREET – MARICOPA CO. LIMITS

F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	AS BUILT
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DATE — CONSULTING ENGINEER

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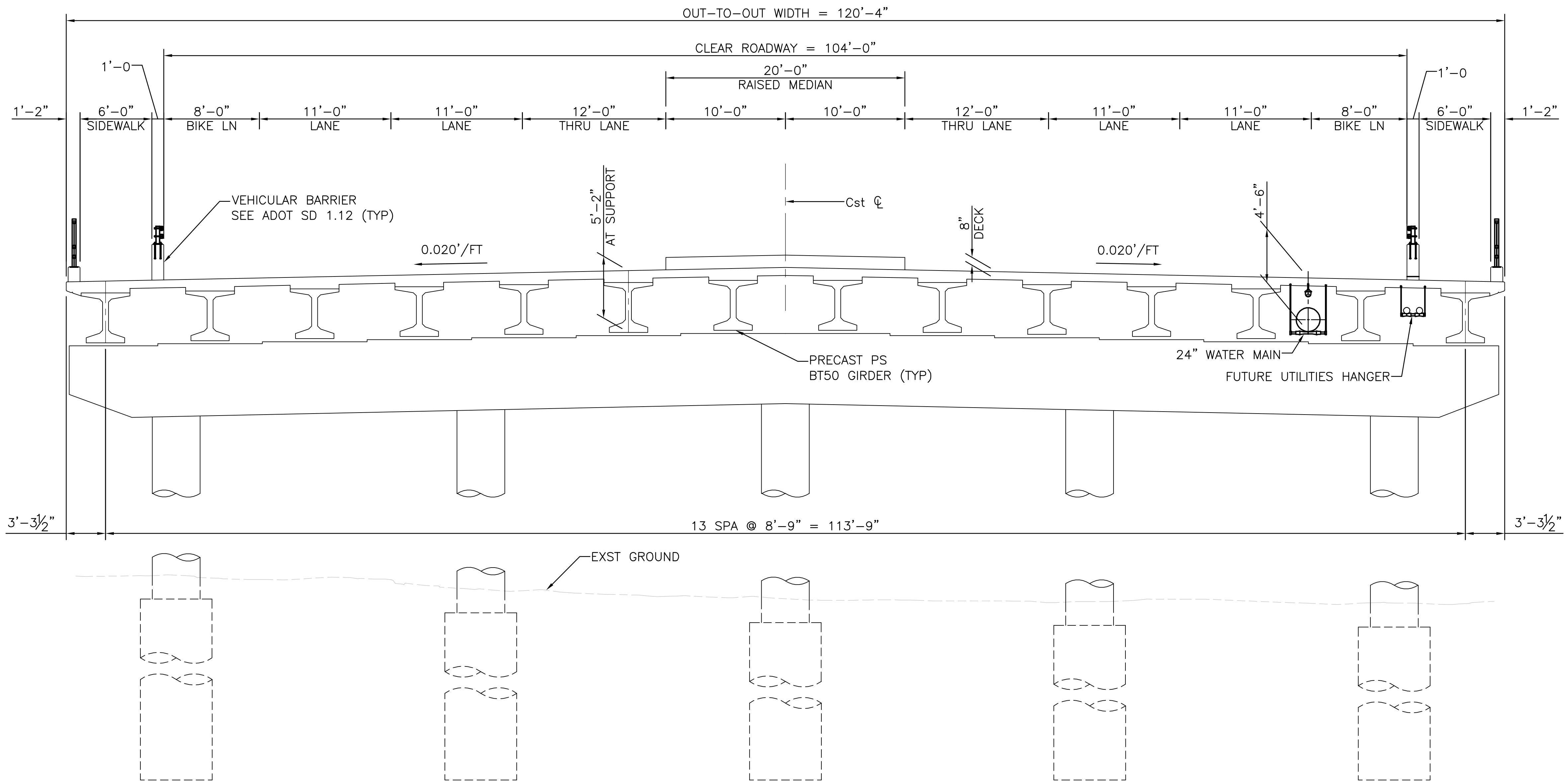

TYPICAL SECTION
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TYPICAL SECTION

CITY OF PHOENIX, ARIZONA

STREET TRANSPORTATION DEPARTMENT

CAVE BUTTES WASH BRIDGE

ALTERNATIVE - 1/2

DR: DWNBY DATE:MM/YY	DES: DESBY DATE: MM/YY	CK: CHKBY DATE: MM/YY	SHEET NO:	TOTAL SHEETS	AS BUILT
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