Appendix A: Bridge Rehabilitation and Reconstruction Alternatives

HARRINGTON & CORTELYOU, INC.
Consulting Engineers

June 13, 2003

Re : Bridge Rehabilitation - H&C Response to Comments
Job No. : J9P0436, J9P0437 and J9P0438
Route : 19
County : Shannon
HCI No. : 10180-00

Mr. Shyam Gupta, P.E.
State Bridge Engineer
Missouri Department of Transportation
105 West Capitol Ave.
P.O. Box 270
Jefferson City, Missouri 65102

Attn: Joyce Foster

Dear Mr. Gupta:

We offer the following response to the questions and observations related to the draft Bridge Rehabilitation or Reconstruction Alternatives for the Environmental Impact Study submittal for Route 19, Shannon County.

Bridge H-79 over Sinking Creek:

- The existing piers will be used to support a new cap and superstructure for the P/S Type IV replacement option at Sinking Creek. The parallel flange widening at the Current River (Br. G-804) will reuse the existing piers in conjunction with new piers adjacent to the existing.

- Our preliminary analysis utilized 3'-9" MoDOT Type IV prestressed girders with 0.6" diameter strands and an f'c = 8 ksi. The standard section dimensions would not need to modified for these span lengths. This depth was preferable to minimize grade raise.

- The use of high performance weathering steel is a possible alternative for this site. A steel structure on new alignment and profile could be used to improve hydraulics and reduce the number of bents. The arch and associated aesthetic value would subsequently be removed from this site. The steel alternative was not further developed at this location due to the significant difference in appearance when compared to the existing structure.

- The estimated cost for Alternate 2 new P/S Girder Main and Approach Spans is higher than typical Bridge Unit costs. The intent of the somewhat conservative estimate was to reflect relative construction costs associated with difficulties in girder transportation along with complexities associated with the geometry of the site, maintaining one lane of traffic and environmentally sensitive construction practices.

- Complete replacement alternative at Sinking Creek was assumed 1 ft. above extreme high water shown on existing bridge plans. Rehabilitation alternate will have extreme high water approximately one foot up on the girder. Elevation of girder for the rehabilitation is controlled by the arch geometrics.

Bridge G-804A over the Current River:

- A MoDOT Type 7 Girder for complete replacement was considered. Use of 130 ft. long, 60 ton girders was not further developed due to girder transportation concerns for the long girders on Rte 19 and large crane requirements to set the heavy girders. An alternative with type 6 girders (75-75-90-90-90-90-65-65) added three additional piers in the channel and was not further developed.

- The estimated costs to partially or completely remove the existing bridge are conservative and sensitive to anticipated complications associated with the site, structure and environment. Partial removal will also include removal of fill material within existing arches.

- Haunches at the segmental bridge have been reduced from 15' to 12' at the piers to minimize channel obstruction. A design exception will eventually be required. The new layout significantly reduces the channel obstruction compared to the existing bridge. A design exception may also be required for the 500 ft. radius curves that will be used at each end of the bridge.

Bridge J-420 over Spring Valley:

- In order to evaluate the full hydraulic effects from the Current River, a thorough hydraulic study would be needed. Recent information provided by District 9 indicates water elevations approximately 12 ft. lower than the extreme high water elevation shown on the existing plans. It appears the 155 ft. span length could be reduced without an increase in channel obstruction. A cost estimate for a conventional prestressed girder structure was added to the report. The new prestressed girder bridge described in the text and cost estimates utilized special prestressed concrete girders to match the appearance of the existing bridge. The spliced 155 ft. girder allows for shipping the long girder in shorter pieces.

- Estimated construction costs are included in the report as Item B. on page 26.

- Design exception may be required for the 500 ft. radius curves at each end of the bridge.

Sincerely,

HARRINGTON & CORTELYOU, INC.

Kevin R Eisenbeis

Kevin R. Eisenbeis, P.E.

KRE:prc

Revised pg 26, 27, 28, 29, Current River Drawings

HARRINGTON & CORTELYOU, INC.
Consulting Engineers

March 31, 2003

Re : Bridge Rehabilitation or Reconstruction Alternatives
Environmental Impact Study, Bridges G-804A, J-420, H-79
Rte 19, Shannon County

Ms. Joyce Foster
Missouri Department of Transportation
Capitol and Jefferson
Jefferson City, Missouri

Dear Ms. Foster

We are pleased to summarize the results of our bridge evaluations, design studies and cost estimates for the Rte. 19 arch bridges in Shannon County. These studies were performed for the Missouri Department of Transportation (MoDOT) as part of the Rte. 19 Environmental Impact Study.

The three concrete arch bridges under consideration are located within the Ozark National Scenic Riverways. The structures span the Current River, Spring Valley and Sinking Creek. A significant interest prevails for maintaining the appearance and character of the existing structures in the parkland setting. Construction alternatives have been developed to minimize impact to the pristine environment and accommodate the variety of park users. Our efforts have focused on incorporating the existing arch structures and visual aesthetics where feasible.

Study alternatives have been developed to maintain a minimum of one lane of traffic at all times. Preservation, rehabilitation, reconstruction and replacement schemes are discussed. This study included a coordinated on-site investigation with MoDOT personnel for inspection, material sampling and evaluation of the existing structures.

We appreciate this opportunity to develop alternatives for the Rte. 19 arch bridges.

Sincerely,

HARRINGTON & CORTELYOU, INC.

Kevin R. Eisenbeis

Kevin R. Eisenbeis, P.E., S.E.

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Bridge Rehabilitation or Reconstruction Alternatives

Environmental Impact Study, Bridges G-804A, J-420, H-79
Rte. 19, Shannon County

Table of Contents

1. Executive Summary

This report summarizes the results of our bridge evaluations, design studies and cost estimates for the Rte. 19 arch bridges in Shannon County. These studies were performed for the Missouri Department of Transportation (MoDOT) as part of the Rte. 19 Environmental Impact Study.

The three concrete arch bridges under consideration are located within the Ozark National Scenic Riverways. The structures span the Current River, Spring Valley and Sinking Creek. There is a significant interest in maintaining the appearance and character of the existing structures in the parkland setting. Construction alternatives have been developed to minimize impact to the pristine environment and accommodate the variety of park users. Our efforts have focused on incorporating the existing arch structures and visual aesthetics where feasible.

Study alternatives have been developed to maintain a minimum of one lane of traffic at all times. Preservation, rehabilitation, reconstruction and replacement schemes are discussed. This study included a coordinated on-site investigation with MoDOT personnel for inspection, material sampling and evaluation of the existing structures.

Bridge H-79 over Sinking Creek is not suitable for carrying HS20 live loads. A construction alternative is presented where the arch can be preserved for aesthetic purposes. Bridge G-804 over the Current River and Bridge J-420 will require additional structural widening, and replacement of portions of the existing floor systems to carry two lanes of HS20 loading.

Methods of arch bridge widening and reconstruction are also presented. Replacement of the Current River arch bridge with a haunched segmental concrete box girder structure presents an attractive replacement possibility. The graceful shape of the segmental box approximates the shape and appearance of the existing filled arch. Balanced cantilever construction allows the entire superstructure to be constructed from above with minimal impact to the river valley. Slender piers, constructed on drilled shaft foundations, minimize excavation within the river. Depth of haunches at the piers can be exaggerated to emphasize the arch shape of this alternative.

2. Existing Structures

General

The structures carrying Rte. 19 through the Ozark National Scenic Riverways are of 1920's vintage reinforced concrete construction. Attractive arch spans command a visitor's attention when the bridges come into view. Upon closer observation, the intricate detail attention provided in the original construction becomes apparent. Skewed arches, open structural framing, haunched girders and distinctive cantilever brackets supporting the deck slab contribute to the character of the structures. Although similar in concrete construction, all three structures exhibit unique differences in detail and appearance.

An inspection of the existing structures was performed in conjunction with the development of this report. MoDOT maintenance and inspection personnel assisted Harrington & Cortelyou with the inspection and provided materials testing and chloride sampling at several locations on the arch spans. A snooper truck was used to reach inaccessible areas. A summary of MoDOT's chloride and compressive strength results are included at the end of this section.

Bridge H-79 over Sinking Creek

The existing bridge over Sinking Creek was constructed around 1925, according to the original construction plans. Comprised of five spans, the overall bridge length is 339 ft. from fill face to fill face of abutments. The three center spans are 84 ft. open spandrel concrete arches, with two arch ribs per span. The 41.5 ft. approach spans at each end consist of concrete T-girder construction with the concrete deck cast monolithically with four rectangular girder stems. The 21 ft. wide bridge carries an 18 ft. clear roadway.

All reinforced concrete piers and abutments are founded on rock, utilizing spread footings embedded at least 6 inches into solid rock. Abutments are spill-thru type with deep counterforts, supported on two spread footings.

Several deficiencies were observed during the field inspection. The underside of the roadway slab is in poor condition. Large delaminations and areas of exposed reinforcing steel are present. Several delaminations are 4 ft. by 5 ft. in size. Moderate tapping with a hammer caused pieces of concrete to fall to the ground below. Significant cracking and spalling occurs on the second and fifth floorbeam in each arch span, at locations where transverse construction joints occurred in the original deck construction. Re-use of the deck and these floorbeams is not recommended based on visual observation.

Elevation View - Looking East

Roadway - Looking South

Delaminated concrete was observed at the crown of all three east arches and the one west arch sounded. Areas up to 2.5 ft. wide and 7 ft. long were detected. Exposed reinforcing occurs at spalled corners of the arches. Chloride content at the east crown of the south arch span was measured at a high level of 5.1-5.8 lbs./cu.yd. Loose and crumbling concrete was also observed at decorative cornices near the pier tops.

According to the inventory appraisal form, the current operating (capacity) rating is 47 tons (MO-5 truck on two lanes) and the inventory (service) rating is H24 (1 lane). An HS20 inventory rating with two lanes on the structure is desired.

Ratings of the various structural components were made as part of this study. Reductions in reinforcing steel of 15% at the crown and 5% at the springing were made to account for the observed condition of the arches. The existing arches rate at HS15. The floorbeams and spandrel columns on the arches are adequate for HS20 loading, based on load factor rating of the original design.

The 18 ft. roadway width is also a limiting component of the structure. Currently, wider vehicles such as trucks, busses, recreational vehicles and those pulling trailers have difficulty crossing the bridge against opposing traffic.

Bridge G-804A over Current River

Bridge G-804A spans the Current River and was constructed in 1924 as noted on a plaque near the north abutment. The original construction plans indicate the bridge has five spans with an overall bridge length of 602 ft. from fill face to fill face of abutments. The three center spans are 136 ft. filled concrete arches, with one 14 ft. wide arch rib per span. The two 63 ft. end spans are also filled concrete arch spans. The 21'-4" wide bridge carries an 18 ft. clear roadway. Roadway paving is supported on the earth and gravel fill contained within the arch spans.

All reinforced concrete piers and abutments are founded on spread footings keyed into rock. Deep abutments are 34 ft. long, hollow cell, filled type with internal cross beams supporting side walls.

Staining on the spandrel walls occurs below the first, third, eighth and tenth cantilever brackets in each 130 ft. arch span. Vertical expansion joints in the walls occur at these locations. Similar staining occurs at expansion joint locations in the 60 ft. arch spans. Cantilever brackets at these locations exhibit significant concrete spalling and staining. Most of these support brackets would not be suitable for re-use in a rehabilitated structure based on visual observation. Water staining also occurs over many large areas on the underside of the arches. Chloride content in the arch samples was very low.

Elevation View - Looking Southeast

Roadway - Looking South
(Note utility/pedestrian bridge at left)

According to the inventory appraisal form, the current operating (capacity) rating is 34 tons and the inventory (service) rating is H11. An HS20 inventory rating with two lanes on the structure is desired.

The 18 ft. roadway width is also a limiting component of the structure. Currently, wider vehicles such as trucks, busses, recreational vehicles and those pulling trailers have difficulty crossing the bridge against opposing traffic.

Bridge J-420 over Spring Valley

Original construction plans for the existing bridge over Spring Valley are dated 1930. The bridge is skewed at 45 degrees, right advance. Consisting of eight spans, the overall bridge length is 522.75 ft. from fill face to fill face of abutments. The center span is a 155 ft. open spandrel concrete arch, with the two arch ribs staggered to accommodate the large skew. The three approach spans from the north and four approach spans from the south are of cast-in-place concrete girder construction. The deck slab is cast monolithically with the floorbeams in the arch span and the two girder system in the approach spans. The 23 ft. wide bridge carries a 20 ft. clear roadway.

Both reinforced concrete piers supporting the arch span are founded on rock, utilizing spread footings embedded at least 18 inches into solid rock. Framed bents on spread footings are embedded at least 6 inches into rock. Abutments are spill-thru type with deep counterforts. The north abutment is supported on two spread footings. South abutment support is provided by a spread footing on the east side, and a timber pile supported footing on the west. The 25 ft. long timber piles extend below the adjacent rock elevation of the eastern footing, most likely due to a sink hole, cavern or drastic change in bedrock elevation.

A few minor concrete spalls were observed on the arch spans. One 7 ft. length of exposed reinforcing occurs at the top outside corner near the crown of the east arch. Water staining, approximately 4 ft. along the length of the arches, occurs on the sides of the arches at the fifth and eighth floorbeams. The location near the exposed reinforcing and staining was chosen for the chloride sampling. Chloride content was found to be well within acceptable levels. Floorbeams supporting the deck slab at these locations are not acceptable for re-use based on visual observation. Water staining was also observed on one quarter of the width of the underside of the arches.

According to the inventory appraisal form, the current operating (capacity) rating is 34 tons and the inventory (service) rating is H15, controlled by the deck slab. Inventory rating for the 50 ft. approach span is H18 and the 150 ft. arch span is H32. An HS20 inventory rating is desired for the structure. The existing

Elevation View - Looking Northeast

Span Over Park Road - Looking East

arches will carry HS20. Floorbeams and spandrel columns on the arches are adequate for HS20 loading, based on load factor rating of the original design.

The 20 ft. roadway width is also a limiting component of the structure. Currently, wider vehicles such as trucks, busses, recreational vehicles and those pulling trailers have difficulty crossing the bridge against opposing traffic.

Missouri
Department
of Transportation

MoDOT

Henry Hungerbeeler, Director

105 West Capitol Avenue
P.O. Box 270
Jefferson City, MO 65102
(573) 751-2551
Fax (573) 751-6555
www.modot.org

January 7, 2003

Mr. Kevin Eisenbeis,
Harrington & Cortelyou, Inc.
911 Main, Suite 1900
Kansas City, MO. 64105
(816) 421-8386

Dear Mr. Eisenbeis:

Enclosed is chloride and compressive strength results for the arch concrete of the following bridges as requested in you're letter dated 12/03/2002. The bridges, numbers J-420, G-804A, and H-79, are located in Shannon County, Rte. 19.

The concrete is in amazingly good shape with the exception of chloride content on the top of the arch on the south span of the Sinking Creek bridge. The high chlorides, 5.1 – 5.8 Lbs./Cu.Yd., at the level of the rebar will continue to cause spalling of this concrete in the future. It would be very costly and impossible to replace all of the salt contaminated concrete in this area. Only the East arch was tested, so the West arch may be as badly contaminated in this span. Some kind of corrosion control treatment is needed if this arch is left in place, even if only for aesthetic reasons. Some of the options would be coating with a moisture proof sealer, chloride removal or a passive (galvanic) cathodic protection system. The cost of a sprayed on anode would be $11-$12/sf. Depending on the type, research funds could be secured at either the 100% or 80% federal level for this work. I would be happy to discuss these options with you, if in the design process you come to this same conclusion.

1018-00
KRE ✓
MJT ✓

Please call me or Eric Burks, who did the field work and reporting on this project, or send an email at the addresses below if we can answer any questions.

Sincerely,

John D. Wenzlick, P.E.
Research & Development Engineer
wenzlj@mail.modot.state.mo.us
(573) 751-1039

Eric Burks,
Research & Development Assistant
burkse@mail.modot.state.mo.us
(573) 526-4323

Attachments:

Copy: br-Attn: Boyd Denson

jdw

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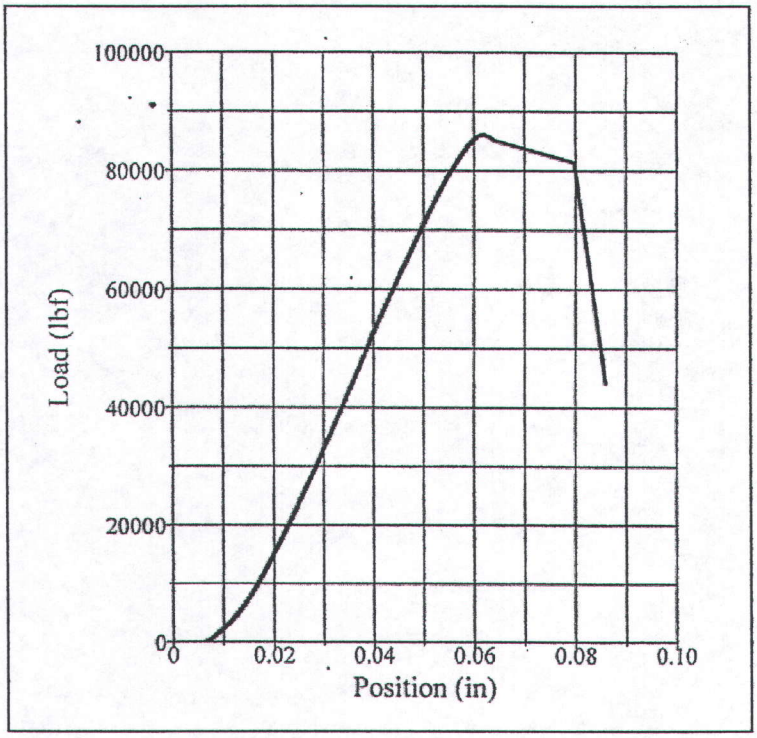
MISSOURI DEPARTMENT OF TRANSPORTATION

Research, Development and Technology Division

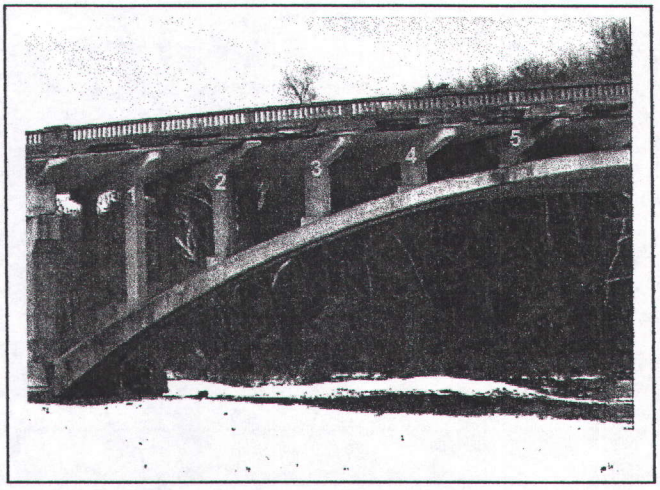


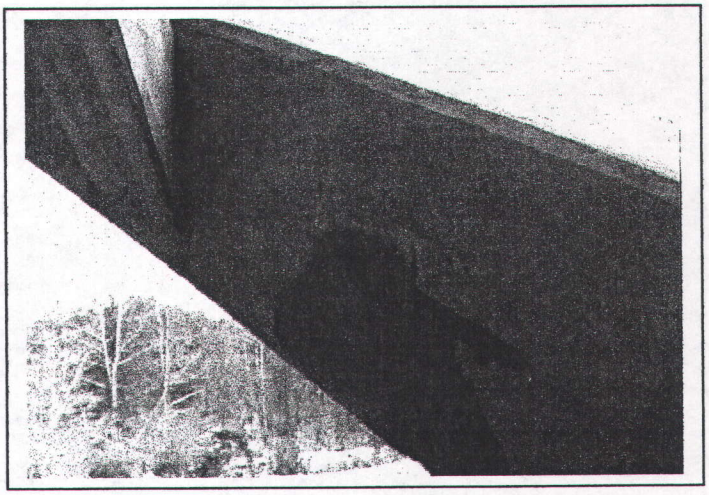
Bridge #:	**J-420**
Route:	**19**
County:	**Shannon**
Sample Date:	**12/17/02**
Location:	**Round Spring**
	Test Results
Diameter:	**3.7850** in
Area:	**11.2518** in 2
Compressive Strength:	**7640** psi
Peak Load:	**85991** lbf
	Test Summary
Counter:	**18641**
Elapsed Time:	**00:02:52**
Specimen Identification:	**2RJ5B336**
Operator:	**TECH**
Specimen #:	**1**
Type of Fracture:	**CONE**
Procedure Name:	**Concrete Cores**
Start Date:	**12/26/2002**
Start Time:	**7:31:28 AM**
End Date:	**12/26/2002**
End Time:	**7:34:20 AM**
Workstation:	**MoDOT**
Tested By:	**TECH**

Chloride Content, (lbs. / yd.3) of concrete (assumed weight 3900 lbs. / yd.3) (.001 X 3900 = 0.4 #/cy) from areas of presumed good concrete, individual samples at depths of:

	¼" to ¾"	¾" to 1 ¼"	1 ¼" to 1 ¾"	1 ¾" to 2 ¼"	2 ¼" to 2 ¾"	2 ¾" to 3 ¼"	3 ¼" to 3 ¾"	3 ¾" to 4 ¼"	4 ¼" to 4 ¾"	4 ¾" to 5 ¼"
Sample #1	1.2	1.2	0.7	0.6	0.5	0.6	0.6	0.5	0.8	0.6
Sample #2	0.8	0.12	0.12	0.12	0.2	0.12	0.12	0.12	0.12	0.8

Note: Chloride Samples were taken between the 4th & 5th Spandrels on Eastern most arch (#1-east edge / #2-west edge). Core Sample was taken from the inside of the Eastern most arch approximately 4' from the Skewback.





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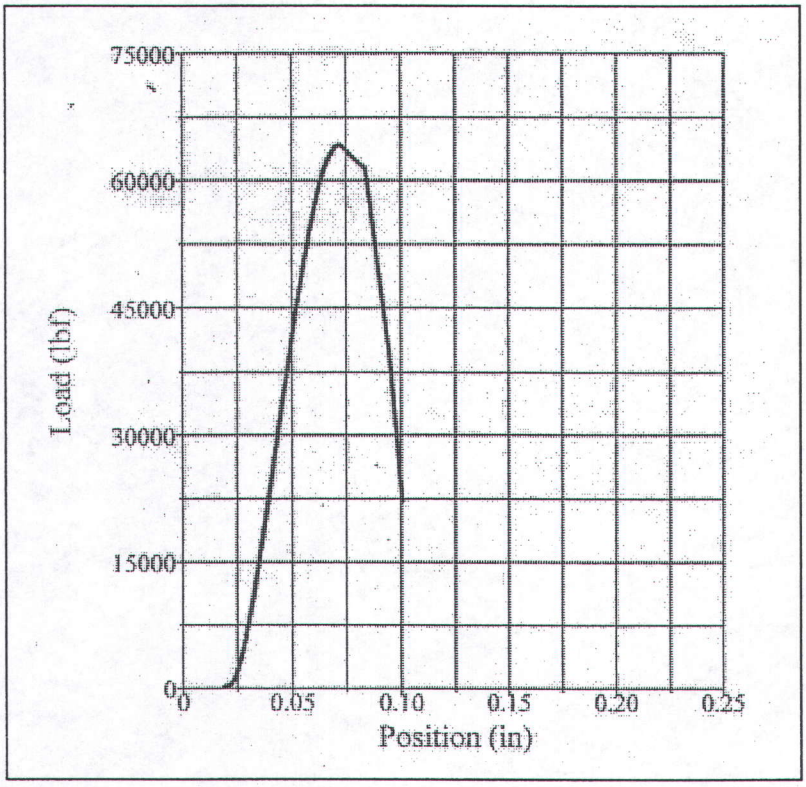
Research, Development and Technology Division



Bridge #:	**G-804A**
Route:	**19**
County:	**Shannon**
Location:	**Current River**
	Test Results
Diameter:	**3.7900** in
Area:	**11.2815** in 2
Compressive Strength:	**5690** psi
Peak Load:	**64193** lbf
	Test Summary
Counter:	**18642**
Elapsed Time:	**00:02:13**
Specimen Identification:	**2RJ5B337**
Operator:	**TECH**
Specimen #:	**2**
Type of Fracture:	**CONE & SHEAR**
Procedure Name:	**Concrete Cores**
Start Date:	**12/26/2002**
Start Time:	**7:39:19 AM**
End Date:	**12/26/2002**
End Time:	**7:41:32 AM**
Workstation:	**MoDOT**
Tested By:	**TECH**

Chloride Content, (lbs. / yd.3) of concrete (assumed weight 3900 lbs. / yd.3) (.001 X 3900 = 0.4 #/cy) from areas of presumed good concrete, individual samples at depths of:

	¼" to ¾"	¾" to 1 ¼"	1 ¼" to 1 ¾"	1 ¾" to 2 ¼"	2 ¼" to 2 ¾"	2 ¾" to 3 ¼"	3 ¼" to 3 ¾"	3 ¾" to 4 ¼"	4 ¼" to 4 ¾"	4 ¾" to 5 ¼"
Sample #1	1.2	0.5	0.2	0.04	0.04	0.04	0.04	0.04	0.04	0.2
Sample #2	0.2	0.08	0.12	0.12	0.08	0.08	0.04	0.04	0.08	0.04
Sample #3	0.2	0.08	0.08	0.04	0.04	0.08	0.08	0.04	0.04	0.08

Note: Chloride Samples were drilled horizontally in the East Side of the bridge (#1-Top of second arch from the South / #2-Top of second arch from the North, #3-was sampled halfway between top of arch & the Skewback).
Core Sample was taken from the East Side of second arch from the North, approximately 4' from the Skewback.

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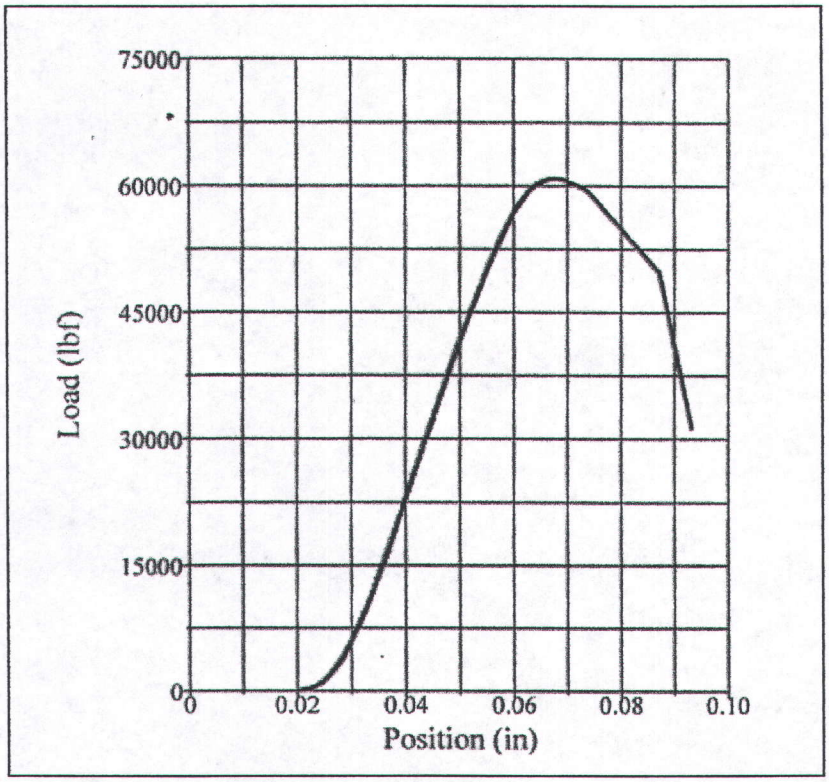
Research, Development and Technology Division

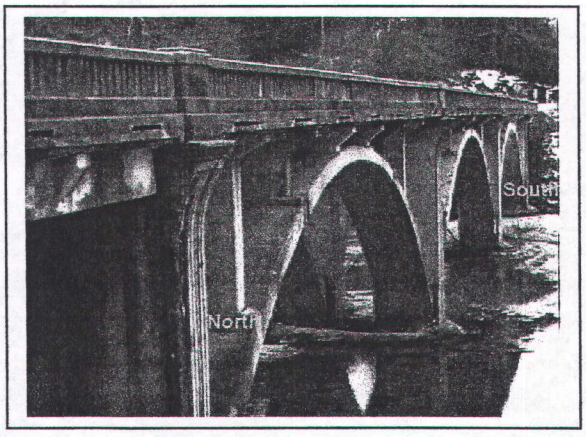


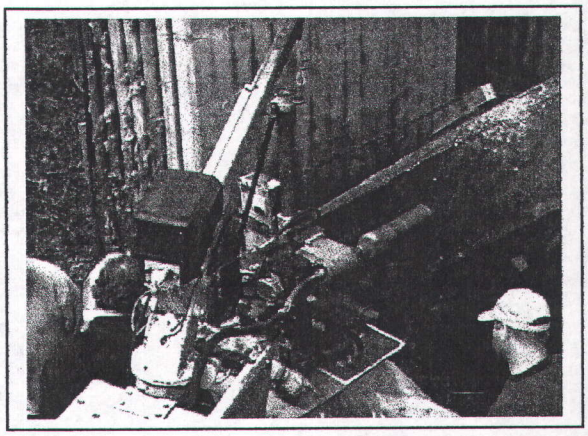
Bridge #:	**H-79**
Route:	**19**
County:	**Shannon**
Location:	**Sinking Creek**
	Test Results
Diameter:	**3.7850** in
Area:	**11.2518** in 2
Compressive Strength:	**5410** psi
Peak Load:	**60854** lbf
	Test Summary
Counter:	**18643**
Elapsed Time:	**00:02:06**
Specimen Identification:	**2RJ5B338**
Operator:	**TECH**
Specimen #:	**3**
Type of Fracture:	**CONE & SPLIT**
Procedure Name:	**Concrete Cores**
Start Date:	**12/26/2002**
Start Time:	**7:46:02 AM**
End Date:	**12/26/2002**
End Time:	**7:48:08 AM**
Workstation:	**MoDOT**
Tested By:	**TECH**

Chloride Content, (lbs. / yd.3) of concrete (assumed weight 3900 lbs. / yd.3) (.001 X 3900 = 0.4 #/cy) from areas of presumed good concrete, individual samples at depths of:

	¼" to ¾"	¾" to 1 ¼"	1 ¼" to 1 ¾"	1 ¾" to 2 ¼"	2 ¼" to 2 ¾"	2 ¾" to 3 ¼"	3 ¼" to 3 ¾"	3 ¾" to 4 ¼"	4 ¼" to 4 ¾"	4 ¾" to 5 ¼"
Sample #1	3.5	2.0	0.8	0.12	0.08	0.08	0.08	0.08	0.04	0.12
Sample #2	2.0	1.6	0.8	0.6	0.12	0.08	0.08	0.2	0.08	0.04
Sample #3	6.6	3.1	1.6	5.1	5.8	5.1	3.1	1.6	0.5	0.3
				Approximate Steel Depth						

Note: Chloride sample #1 was taken from the north arch, south west side of the second spandrel column; 6" from edge of arch.
Sample #2 was between fifth & sixth spandrels of center arch; 2' from west edge of arch.
Sample #3 was between fourth & fifth spandrels of the south arch; 4' from west edge of arch.
Core sample was sampled on the west side of north arch approximately 4' from the Skewback.





3. Local Conditions and Corridor Screening

Ozark National Scenic Riverways

Ozark National Scenic Riverways (ONSR) was established in 1964. An act of Congress created ONSR to protect 134 miles of the Current and Jacks Fork Rivers. It was the first National Scenic Riverways, preceding the National Wild and Scenic Rivers act by two years. Previous to the authorization, much of the area including Alley Spring, Big Spring, and Round Spring, had been state parks administered by the State of Missouri. The argument for the creation of the Riverways can be traced to the 1930s, and controversial proposals for dams on the Current and Jacks Fork Rivers. The National Park Service administers ONSR.

Subsurface Information

The southeast Missouri Ozark Mountains are typified by narrow steep-sided hollows, numerous streams, and bluffs. This area is geologically complex. It is classified as a karst terrain, characterized by sinkholes, caves, and underground drainage. There are over 300 reported caves within the boundaries of ONSR. Much of the area is underlain by soluble limestone and dolomite with lesser amounts of sandstone and chert. Occasionally, the terrain is interrupted locally by knobs of volcanic rhyolite. Springs abound in the area. An estimated sixty per cent of the Current and Jacks Fork Rivers' flow comes from springs.

Evidence of variable subsurface rock conditions occurs at Abutment 9 (south abutment) at Bridge J-420 over Spring Valley. This deep spill-through type abutment is founded on two footings. The east spread footing is supported on solid rock approximately 40 ft. below the roadway surface. The west footing, located 24 ft. away is supported on timber piling extending an estimated 25 ft. below the adjacent footing elevation. This is the only significant variation noted in the existing plans for the three bridges under consideration.

Recreation

The natural beauty, rugged terrain and clear streams draw many visitors to the park. Float trips on the rivers are a common occurrence. Many canoe and inner tube rental locations are available in the area. Overnight camping is allowed in designated campgrounds and public gravel bars along the rivers. Fishing and hunting are allowed within the ONSR, although most visitors choose to observe the birds and wildlife. Horseback riding, hiking and swimming is also common.

All three bridges are located near public campgrounds. The Current River and Sinking Creek are floatable streams.

Construction Issues

Several construction issues will affect all three bridges. All bridges fall within the Ozark National Scenic Riverways, an environmentally sensitive and protected area. Many park visitors will be near the construction sites. Float trips on the rivers will occur during construction of the bridges. Special accommodations will be required to get floaters safely through the construction areas. Floating diversion booms may be required upstream of the construction to control floating traffic. Overhead deflectors/collectors may be required to prevent removal materials from falling into the streams and on people below.

Access to the construction areas should be limited to minimal access paths adjacent to the bridges. Paths will be removed and all disturbed areas will be restored after completion. Excavation methods will be required to prevent excess turbidity in the streams. Hauling of earth and concrete removal items to approved upland locations will likely be required.

Some protected areas require scheduled quiet time for nesting of eagles and other birds.

Construction of foundations in the karst formations is a potential issue at all bridge sites.

Aerial photographs of the corridor are included at the end of this section.

<u>Bridge H-79 over Sinking Creek</u>
River and campground access roads are located approximately 290 ft. north of the bridge. A large camping and picnic area is located west of the bridge, on the north side of Sinking Creek. A high voltage electric line is located east of Rte. 19 in the vicinity of the bridge. An intersection with a county road occurs approximately 430 ft. south of the bridge.

<u>Bridge G-804A over the Current River</u>
A pedestrian/utility bridge parallels the existing bridge approximately 50 ft. east of Bridge G-804A. A convenience store is located on the west side of Rte. 19, approximately 180 ft. north of the north end of the bridge. A large camping and picnic area is located west of the bridge, on the north side of the Current River and east of the bridge, south of the Current River. An intersection with a small road is located approximately 200 ft. south of the bridge.

Bridge J-420 over Spring Valley

A most prominent feature near Bridge J-420 is Round Spring. The spring is approximately 380 ft. north and 140 ft. east of the north end of the bridge (along Rte 19). Park ranger headquarters, including several buildings, is located southwest of the existing bridge. Access to the headquarters and Round Spring Cave is via a roadway under the existing Rte. 19 bridge. The closest park building is approximately 230 ft. south of the bridge and 100 ft. west of Rte. 19. A low water crossing, carrying vehicular traffic to the Round Spring parking area is located 140 ft. downstream of the Rte. 19 bridge. The intersection of the campground and Spring access roadway is located approximately 200 ft. south of the bridge.

A significant variation in rock elevation occurs at the south abutment of bridge J-420.

Hydraulics

The bridges can be rehabilitated and widened utilizing companion concrete arches without appreciably affecting backwater elevations.

Extreme high water at the Sinking Creek bridge, due to backwater from the Current River, will be approximately one foot above the bottom of the bottom flange if prestressed girders are used at this location. Storm flows from the Sinking Creek watershed are well below the bottom of the girders and do not create backwater conditions.

Extreme high water at the Current River bridge would be approximately one foot below the bottom of the bottom flange, if steel girders are used as a replacement structure.

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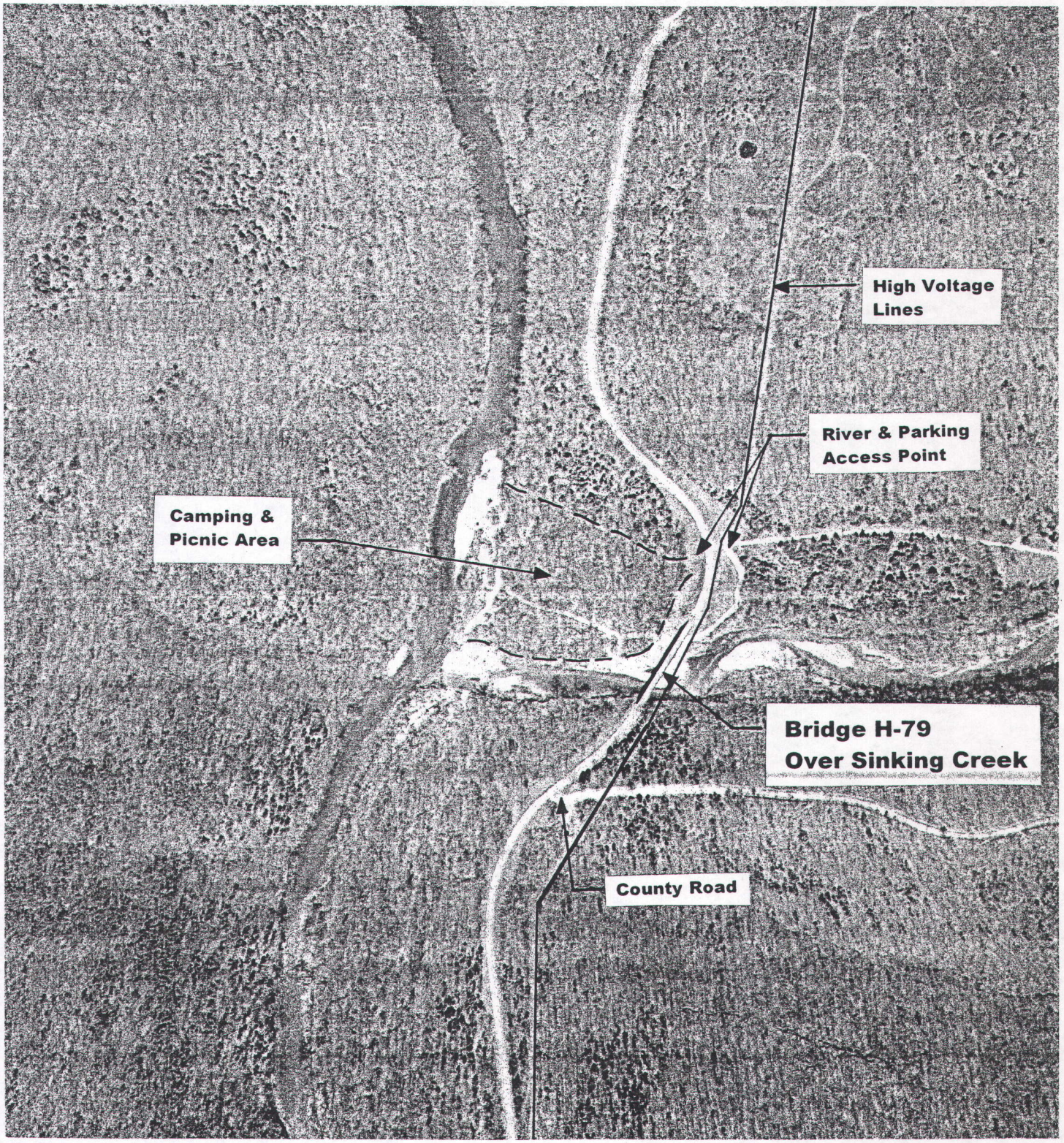

Corridor Screening
Bridge H-79
Over Sinking Creek

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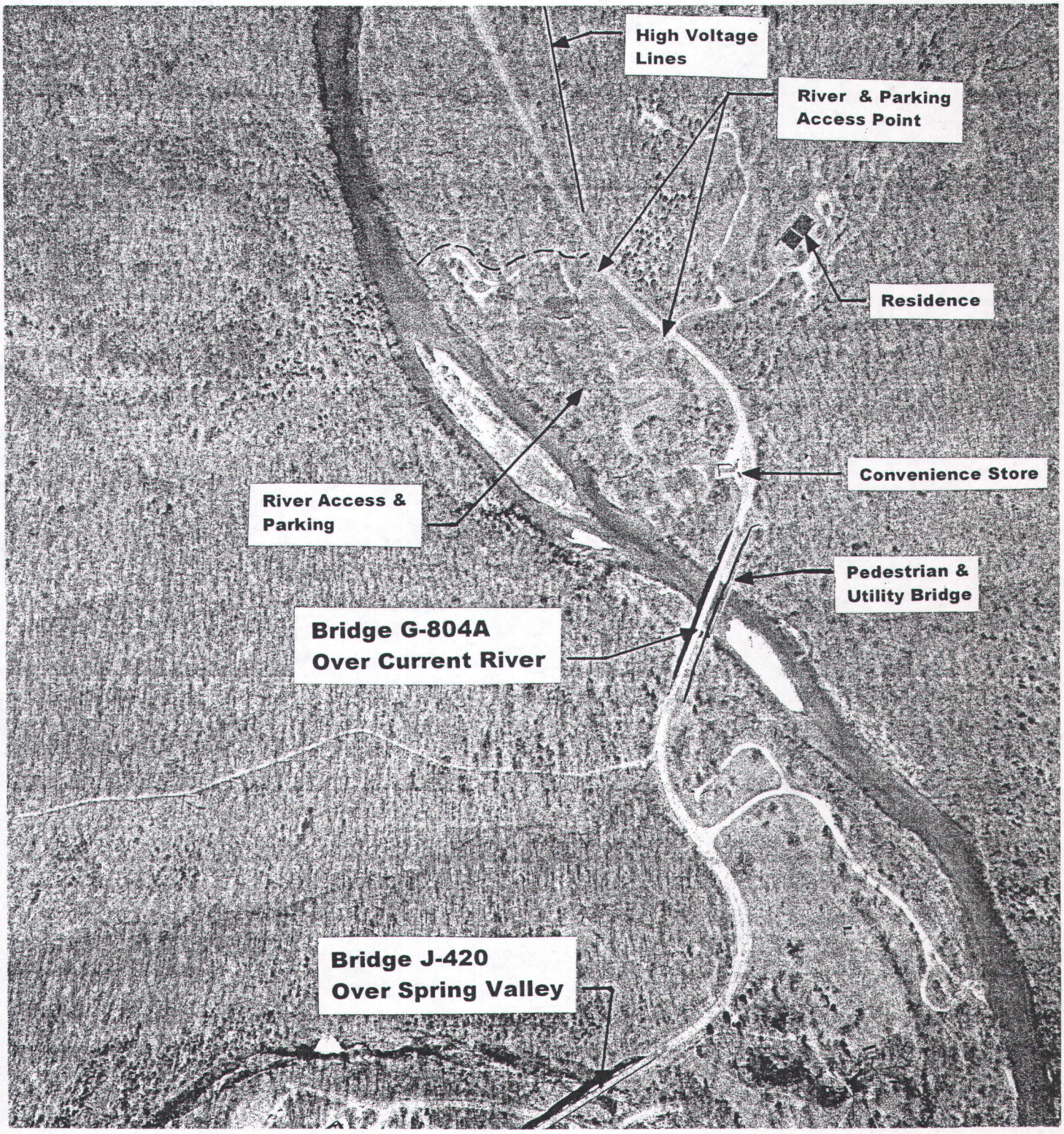

Corridor Screening
Bridge G-804A
Over Current River

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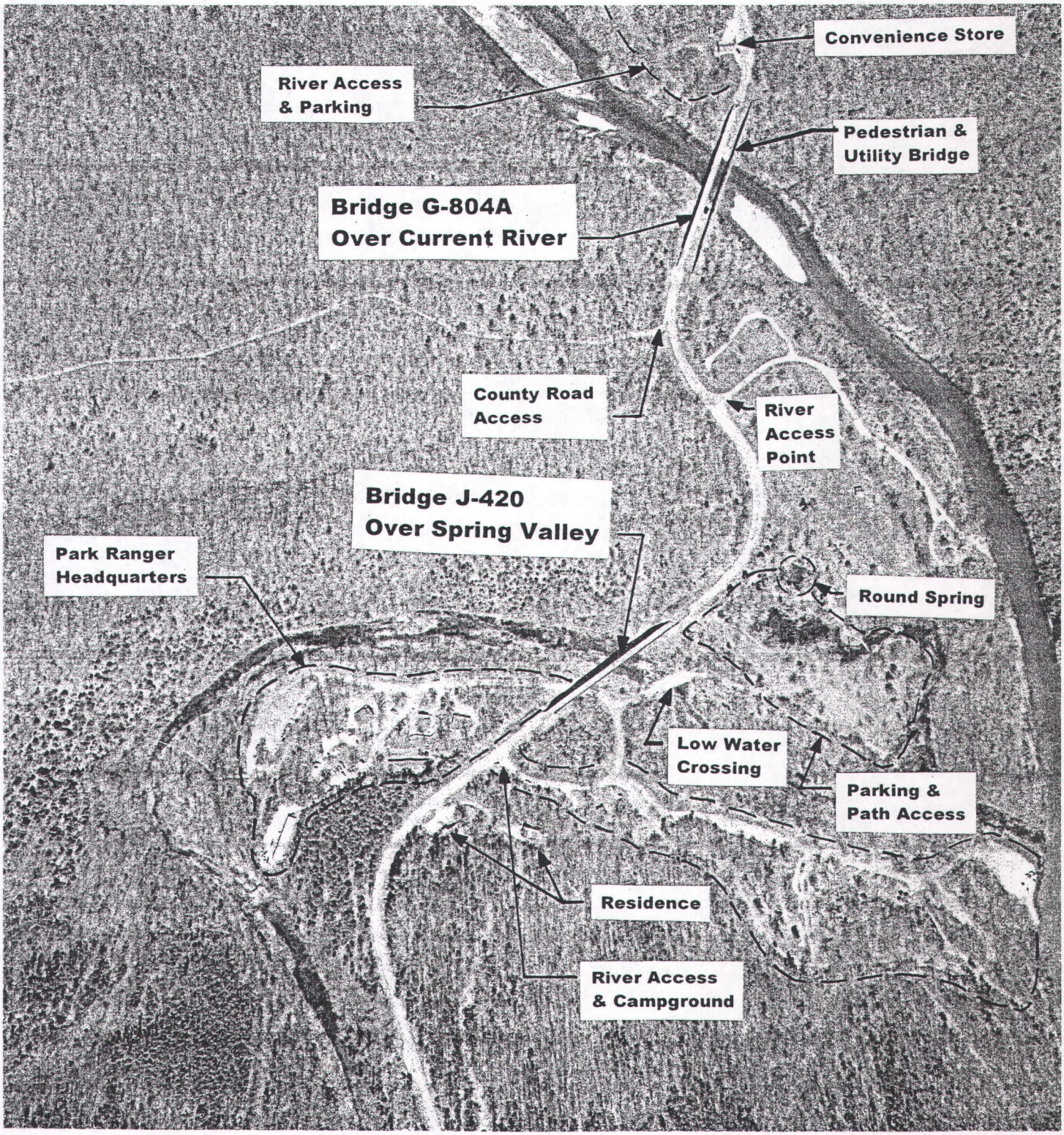


Corridor Screening
Bridge J-420
Over Spring Valley

4. Evaluation of Alternative Structures

General

This section summarizes our bridge evaluations and design studies for the Rte. 19 arch bridges over Sinking Creek, Current River, and Spring Valley in Shannon County. These studies were performed for the Missouri Department of Transportation (MoDOT) as part of the Rte. 19 Environmental Impact Study.

The three concrete arch bridges under consideration are located within the Ozark National Scenic Riverways. There is a significant interest in maintaining the appearance and character of the existing structures in the parkland setting. Structure alternatives have been developed to minimize construction impact to the environment and accommodate a wide variety of ONSR patrons. Our efforts focus on incorporating the existing arch structures and visual aesthetics where feasible.

Study alternatives have been developed to maintain a minimum of one lane of traffic at all times. A minimum roadway width of 40 ft. (two 12 ft. lanes with 8 ft. shoulders) is targeted to meet the safety needs of the motoring public. Additional bridge width for sidewalks and bikeways is also discussed. Preservation, rehabilitation, reconstruction and replacement schemes are discussed. Structural conditions, rating capacities, environmental issues and economic factors are considered in the development of alternatives.

Bridge H-79 over Sinking Creek

Re-Use of Existing Structure

Structural condition of the Sinking Creek bridge superstructure is poor. Re-use of the bridge deck and many of the deteriorated floorbeams is not feasible. Structural condition, chloride content and rating of the 80 ft. arch spans is undesirable for re-use in a traffic carrying capacity. As stated in MoDOT's chloride and compressive strength results, "The high chlorides, 5.1-5.8 Lbs./Cu.Yd., at the level of the rebar will continue to cause spalling of this concrete in the future. It would be very costly and impossible to replace all of the salt contaminated concrete in this area….Some kind of corrosion control is needed if this arch is left in place, even if only for aesthetic reasons." The HS15 inventory capacity of the existing arch is low. Strengthening the arches to HS20 capacity with the application of carbon fiber reinforced polymers (CFRP) is possible but not desirable with the low existing capacity and surface condition of the arches.

Although strengthening of the existing arches is not recommended for the desired loading on the bridge, repairing

the arches to retain their aesthetic value has merit. A rehabilitation concept with preservation of the arches is described below.

Rehabilitation with Preservation of Arches

The 84 ft. pier spacings supporting the arches are ideal span lengths for prestressed concrete I-girders carrying HS20 loading. A staged construction concept can be utilized to widen the existing bridge while maintaining traffic on the existing structure. When viewed from stream level, the bridge will maintain the existing open spandrel columns while the existing arches appear to support the new superstructure. Cantilever brackets added outside of the exterior girders replicate the appearance of the existing slab overhangs.

A new pier cap will be stage constructed on the existing pier shaft. Two MoDOT Type IV (3'-9") girders are placed outside of one existing arch while one lane of traffic is maintained on a portion of the existing bridge. These girders, with a new deck slab, can then carry one lane of traffic while the existing deck slab and floorbeams are removed. Arch preservation may occur after the new structure is complete. Options for preserving the arches include removing deteriorated concrete, chloride removal, moisture proof sealer or a passive (galvanic) cathode protection system.

Exhibit drawings and a three-dimensional rendering illustrating this concept are included in the report.

Reconstruction

Reconstruction of the arch spans can be accomplished utilizing precast concrete arch segments and the existing foundations. Two arch ribs can be constructed adjacent to the existing bridge while traffic is maintained on the existing structure. Traffic is then switched to the newly constructed bridge while the existing bridge superstructure, arches and pier tops are removed. Precast arch segments are then set to replace the existing arches. Additional reinforcement, doweled into the existing piers, is required prior to closure pours. Use of staged construction and the existing bridge alignment minimizes right-of-way issues and impact to the surroundings related to roadway realignment. This alternative is not further developed in this report as another less costly option, incorporating the existing arches, is available.

Replacement

Complete replacement of the structure can be accomplished on an adjacent alignment. A prestressed concrete I-girder superstructure using MoDOT Type IV girders can be built on conventional concrete piers to match the existing span layout. Drilled shaft foundations will minimize the amount

of excavation in the riverbed and be adaptable to variations in the karst topography. No change in profile is necessary for this alternative.

Bridge G-804A over the Current River

Re-use of the Existing Structure

The existing Current River bridge is in fair condition and generally suitable for re-use. Portions of the structure, including the railings, deck slab and some cantilever overhang brackets are not usable and would require replacement. Chloride content in the concrete arches is relatively low. Test results also indicate a compressive strength of 5690 psi in the arch concrete.

Widening the roadway on the existing arch is not feasible. Very little structure depth is available near the arch crowns for extension of cantilever brackets supporting the roadway. Live load ratings for the arch are further reduced by the additional dead loads involved in raising the profile grade and widening the roadway. A new roadway on the existing arch would be similar in width to the existing roadway, undesirable for traffic safety.

Re-use of the existing arch in conjunction with a new companion arch bridge presents a feasible alternative for widening.

Rehabilitation with Preservation of Existing Arch

A 40 ft. wide clear roadway can be achieved by constructing a companion arch adjacent to the existing. Companion arch spans can be built utilizing precast concrete arch segments. Use of precast segments minimizes the amount of temporary support falsework required in the river. The 14 ft. wide arch would consist of two separate arches connected with a closure slab. The individual arches would be constructed with three segments, sized for casting, handling and transportation requirements. Two-way traffic will be maintained on the existing bridge while the new half is constructed. Traffic would then be shifted to the new portion, to allow for rehabilitation and strengthening of the existing bridge.

Existing arch spans can be rehabilitated to support HS20 loading. Removal of the earth and gravel fill within the arches and conversion to an internal framing system also improves the load rating and continuity with the new widening.

New piers would be required immediately adjacent to the existing. Base shafts can be tied to the existing or remain separate. Large excavations will be required if similar spread footings are constructed. Drilled shaft foundations

can be designed to support the loads and reduce the excavation requirements.

Exhibit drawings and a three-dimensional rendering illustrating this concept are included in the report.

Reconstruction

Reconstruction of the arch spans can be accomplished utilizing precast concrete arch segments and the existing foundations. A new arch rib can be constructed to replace the existing arch, similar to the precast concept described in the rehabilitation section above. Replacement of the arch and superstructure would occur after construction of the new widening. Traffic handling would be similar to the rehabilitation scheme. Additional reinforcement, doweled into the existing piers, would be required prior to closure pours.

Replacement

Complete replacement can be accomplished on an adjacent alignment. A minimum centerline offset of approximately 40 ft. would be required to construct a 40 ft. clear roadway. An offset to the west would require removal of an existing pedestrian/utility bridge, however a new bridge could be designed with a sidewalk and to carry the utilities. An offset to the east will require taking of the local general store and is not recommended.

Replacement of the arch bridge with a haunched segmental concrete box girder structure presents an attractive replacement possibility. The graceful shape of the segmental box approximates the shape and appearance of the existing filled arch. Balanced cantilever construction allows the entire superstructure to be constructed from above with minimal impact to the river valley. Slender piers can be constructed on drilled shaft foundations to minimize excavation within the river. Depth of haunches at the piers can be exaggerated to emphasize the arch shape of the new bridge.

Replacement of the existing arches with a steel girder bridge was also investigated. A new steel structure, utilizing haunched welded plate girders, can be built with the span arrangement and alignment described above for the segmental concrete alternate. The segmental concrete alternative provides a more attractive match to the existing bridge and is further developed in the exhibit drawings.

Another possibility, shown in the exhibit drawings, utilizes parallel flange girders and re-use of the existing piers. This widening concept involves constructing a steel bridge immediately adjacent to the existing bridge, removing the arch bridge, constructing new pier caps on the existing piers, and using new steel girders to replace the arch

spans. Steel girder segments can be offloaded from the adjacent roadways. This option was considered to reduce foundation costs, however, the appearance of the existing bridge is not maintained.

Bridge J-420 over Spring Valley

Re-use of the Existing Structure

The existing arch span over Spring Valley Creek is in surprisingly good condition for a 73 year old bridge. The arch span, skewed at 45 degrees, is generally suitable for re-use. Portions of the structure, including the railings, deck slab and two floorbeams are not suitable for re-use based on visual observation. Chloride content in the concrete arches is relatively low. Core samples indicate a high compressive strength of 7640 psi in the arch concrete.

The approach spans, also skewed at 45 degrees, consist of cast-in-place girders on framed concrete bents. Repairs have been made at the beam seat level to brace the girder webs against lateral translation.

Widening the roadway on the existing arch main span and the concrete girder approach spans is not feasible. Live load ratings for the arch and approach girders are reduced by the additional dead loads involved in raising the profile grade and widening the roadway. A new roadway on the existing bridge would be similar in width to the existing roadway, undesirable for traffic safety.

Re-use of the existing bridge in conjunction with new companion arches and approach girdgers provides a feasible alternative for widening.

Rehabilitation with Preservation of Existing Arch

A 44'-8" wide clear roadway can be achieved by constructing two companion arches adjacent to the existing arch span. The roadway width is controlled by the location of the new arches and pier footings relative to the existing. Individual companion arch ribs can be built utilizing precast concrete arch segments as described above for the Current River. A 34 ft. clear roadway can be constructed with the addition of one arch rib, however, the two-girder system at the approach spans are not conducive to the narrower widening when maintenance of traffic is considered.

Use of precast segments minimizes the amount of temporary support falsework required in the river. The new arch ribs and columns would match the existing architecture. The individual arches would be constructed with three segments, sized for casting, handling and transportation requirements. Two-way traffic will be maintained on the existing bridge while the new half is constructed. Traffic would then be

shifted to the new portion, to allow for rehabilitation and strengthening of the existing bridge.

Existing arch spans can be rehabilitated to support HS20 loading. New floorbeams would be constructed as necessary to replace existing. New piers, similar to the existing, would be required immediately adjacent to the bridge along the skew.

New prestressed concrete girders would be used in the approach spans. Girders can be precast to the same geometric configuration as the existing, including the haunched soffit. The new prestressed girders will carry HS20 design loads.

A three-dimensional rendering illustrating this concept is included in the report.

Reconstruction

Reconstruction of the arch spans can be accomplished utilizing precast concrete arch segments and the existing foundations. Two new arch ribs can be constructed to replace the existing arches, similar to the precast concept described in the rehabilitation section above. Replacement of the arch and superstructure would occur after construction of the new widening. Traffic handling would be similar to the rehabilitation method, with two lanes of traffic in each direction at each phase of construction. Additional reinforcement, doweled into the existing piers, would be required prior to closure pours.

Replacement

The 155 ft. arch span can be replaced with a post-tensioned, prestressed bulb-tee girder span. Bulb-tee girders can be shipped to the site in three pieces, post-tensioned together on the ground, then lifted into place.

Approach spans can utilize special prestressed concrete girders to match the existing bridge or conventional prestressed I-girders.

5. ESTIMATED CONSTRUCTION COSTS

A. Sinking Creek - Bridge H-79

Alternate 1 - Construct New P/S Girder Spans & Rehabilitate Existing Arches

			Unit	Unit Price	
New P/S Girder Main Spans	240	42.33	Sq. Ft.	$ 85.00	$ 864,000
New P/S Girder Approach Spans	84	42.33	Sq. Ft.	$ 80.00	$ 285,000
Rehabilitate Existing Arches & Substructure	240	22	Sq. Ft.	$ 56.00	$ 296,000
Associated Roadwork	2	800	Lin. Ft.	$ 200.00	$ 320,000
Subtotal Estimated Current Construction Cost =					$ 1,765,000
Ongoing Maint. & Repair of Exist. Bridge (15 yr. intervals)					$ 140,000
Present Value of Future Deck Overlays (25 yrs.)		1440	Sq. Yd.	$ 20.00	$ 87,000
Total Estimated Life Cycle Cost =					$ 1,992,000

Alternate 2 - Construct New P/S Girder Bridge on New Alignment

			Unit	Unit Price	
Remove Existing Bridge	339	21.33	Sq. Ft.	$ 34.00	$ 246,000
New P/S Girder Main Spans	240	42.33	Sq. Ft.	$ 100.00	$ 1,016,000
New P/S Girder Approach Spans	100	42.33	Sq. Ft.	$ 90.00	$ 381,000
Associated Roadwork	2	1,200	Lin. Ft.	$ 250.00	$ 600,000
Subtotal Estimated Current Construction Cost =					$ 2,243,000
Present Value of Future Deck Overlays (25 yrs.)		1511	Sq. Yd.	$ 20.00	$ 91,000
Present Value of Major Rehabilitations (37.5 yrs.)					$ 100,000
Total Estimated Life Cycle Cost =					$ 2,434,000

B. Spring Valley - Bridge J-420

Alternate 1 - Construct New Arch Spans & Rehabilitate Existing Arches

			Unit	Unit Price	
New Arch Widening	155	24.00	Sq. Ft.	$ 230.00	$ 856,000
New P/S Girder Approach Spans	368	24.00	Sq. Ft.	$ 120.00	$ 1,060,000
Rehabilitate Existing Arches & Substructure	155	23.00	Sq. Ft.	$ 150.00	$ 535,000
Rehabilitate Existing Approach Spans	368	23.00	Sq. Ft.	$ 130.00	$ 1,101,000
Associated Roadwork	2	600	Lin. Ft.	$ 200.00	$ 240,000
Subtotal Estimated Current Construction Cost =					$ 3,792,000
Ongoing Maint. & Repair of Exist. Bridge (15 yr. Intervals)					$ 100,000
Present Value of Future Deck Overlays (25 yrs.)		44.67	Sq. Yd.	$ 60.00	$ 156,000
Total Estimated Life Cycle Cost =					$ 4,048,000

Alternate 2 - Construct New P/S Girder Bridge on New Alignment

			Unit	Unit Price	
Remove Existing Bridge	523	23.00	Sq. Ft.	$ 16.50	$ 199,000
New P/S Girder Main Spans	155	42.33	Sq. Ft.	$ 140.00	$ 919,000
New P/S Girder Approach Spans (Match Exist.)	390	42.33	Sq. Ft.	$ 120.00	$ 1,982,000
Associated Roadwork	2	1,200	Lin. Ft.	$ 250.00	$ 600,000
Subtotal Estimated Current Construction Cost =					$ 3,501,000
Present Value of Future Deck Overlays (25 yrs.)		2422	Sq. Yd.	$ 20.00	$ 146,000
Present Value of Major Rehabilitations (37.5 yrs.)					$ 100,000
Total Estimated Life Cycle Cost =					$ 3,747,000

Alternate 2A - Construct New Conventional P/S Girder Bridge on New Alignment

			Unit	Unit Price	
Remove Existing Bridge	523	23.00	Sq. Ft.	$ 16.50	$ 199,000
New P/S Girder Main & Approach Spans	545	42.33	Sq. Ft.	$ 110.00	$ 2,538,000
Associated Roadwork	2	1,200	Lin. Ft.	$ 250.00	$ 600,000
Subtotal Estimated Current Construction Cost =					$ 3,138,000
Present Value of Future Deck Overlays (25 yrs.)		2422	Sq. Yd.	$ 20.00	$ 146,000
Present Value of Major Rehabilitations (37.5 yrs.)					$ 100,000
Total Estimated Life Cycle Cost =					$ 3,384,000

ESTIMATED CONSTRUCTION COSTS cont.

C. Current River - Bridge G-804A

Alternate 1 - Construct New Concrete Arches & Rehabilitate Existing Arch

			Unit	Unit Price	
New Arch Bridge	602	21	Sq. Ft.	$ 200.00	$ 2,529,000
Rehabilitated Existing Arch	602	22	Sq. Ft.	$ 140.00	$ 1,860,000
Associated Roadwork	2	500	Lin. Ft.	$ 200.00	$ 200,000
Subtotal Estimated Current Construction Cost =					$ 4,589,000
Ongoing Maint. & Repair of Exist. Bridge (15 yr. intervals)					$ 200,000
Present Value of Future Bridge Resurface (15 yrs.)	2,676		Sq. Yd.	$ 21.50	$ 288,000
Replace Rehabilitated Arch (37.5 yrs.)					$ 2,600,000
Total Estimated Life Cycle Cost =					$ 7,677,000

Alternate 2 - Construct New Segmental Concrete Bridge on New Alignment

			Unit	Unit Price	
Remove Existing Bridge	602	21.33	Sq. Ft.	$ 34.00	$ 437,000
Segmental Bridge (w/o Sidewalk)	640	42.33	Sq. Ft.	$ 150.00	$ 4,070,000
Associated Roadwork	2	1,000	Lin. Ft.	$ 250.00	$ 500,000
Subtotal Estimated Current Construction Cost =					$ 5,007,000
Present Value of Future Deck Overlays (25 yrs.)		2844	Sq. Yd.	$ 26.00	$ 222,000
Present Value of Major Rehabilitations (37.5 yrs.)					$ 350,000
Total Estimated Life Cycle Cost =					$ 5,579,000

Alternate 2S - Construct New Segmental Concrete Bridge w/Sdwk. on New Alignment

			Unit	Unit Price	
Remove Existing Bridge	602	21.33	Sq. Ft.	$ 34.00	$ 437,000
Segmental Bridge (w/ Sidewalk)	640	51.33	Sq. Ft.	$ 150.00	$ 4,930,000
Associated Roadwork	2	1,000	Lin. Ft.	$ 255.00	$ 510,000
Subtotal Estimated Current Construction Cost =					$ 5,877,000
Present Value of Future Deck Overlays (25 yrs.)		2844	Sq. Yd.	$ 26.00	$ 222,000
Present Value of Major Rehabilitations (37.5 yrs.)					$ 250,000
Total Estimated Life Cycle Cost =					$ 6,349,000

Alternate 3 - Construct New Parallel Flange Steel Girder Bridge Incorporating Existing Piers

			Unit	Unit Price	
Partial Bridge Removal	602	12.00	Sq. Ft.	$ 34.00	$ 246,000
Steel Plate Girder Bridge (On Exist. Piers)	602	22.00	Sq. Ft.	$ 90.00	$ 1,200,000
Steel Plate Girder Bridge (On New Piers)	602	20.33	Sq. Ft.	$ 110.00	$ 1,350,000
Associated Roadwork	2	500	Lin. Ft.	$ 200.00	$ 200,000
Subtotal Estimated Current Construction Cost =					$ 2,996,000
Ongoing Maint. & Repair of Exist. Bridge (15 yr. intervals)					$ 75,000
Present Value of Future Deck Overlays (25 yrs.)		2676	Sq. Yd.	$ 20.00	$ 161,000
Present Value of Major Rehabilitations (37.5 yrs.)					$ 300,000
Total Estimated Life Cycle Cost =					$ 3,532,000

ESTIMATED CONSTRUCTION COSTS cont.

Alternate 4 - Construct New Haunched Steel Girder Bridge on New Alignment

			Unit	Unit Price	
Remove Existing Bridge	602	21.33	Sq. Ft.	$ 34.00	$ 437,000
Steel Plate Girder Bridge (w/o Sidewalk)	640	42.33	Sq. Ft.	$ 130.00	$ 3,530,000
Associated Roadwork	2	1,000	Lin. Ft.	$ 250.00	$ 500,000
Subtotal Estimated Current Construction Cost =					$ 4,467,000
Present Value of Future Deck Overlays (25 yrs.)		2844	Sq. Yd.	$ 20.00	$ 171,000
Present Value of Major Rehabilitations (37.5 yrs.)					$ 300,000
Total Estimated Life Cycle Cost =					$ 4,938,000

Alternate 4S - Construct New Haunched Steel Girder Bridge w/Sdwk. on New Alignment

			Unit	Unit Price	
Remove Existing Bridge	602	21.33	Sq. Ft.	$ 34.00	$ 437,000
Steel Plate Girder Bridge (w/ Sidewalk)	640	51.33	Sq. Ft.	$ 130.00	$ 4,280,000
Associated Roadwork	2	1,000	Lin. Ft.	$ 255.00	$ 510,000
Subtotal Estimated Current Construction Cost =					$ 5,227,000
Present Value of Future Deck Overlays (25 yrs.)		2844	Sq. Yd.	$ 20.00	$ 171,000
Present Value of Major Rehabilitations (37.5 yrs.)					$ 350,000
Total Estimated Life Cycle Cost =					$ 5,748,000

Alternate 5 - Construct New Parallel Flange Steel Girder Bridge on New Alignment

			Unit	Unit Price	
Remove Existing Bridge	602	21.33	Sq. Ft.	$ 34.00	$ 437,000
Steel Plate Girder Bridge (w/o Sidewalk)	640	42.33	Sq. Ft.	$ 110.00	$ 2,990,000
Associated Roadwork	2	1,000	Lin. Ft.	$ 250.00	$ 500,000
Subtotal Estimated Current Construction Cost =					$ 3,927,000
Present Value of Future Deck Overlays (25 yrs.)		2844	Sq. Yd.	$ 20.00	$ 171,000
Present Value of Major Rehabilitations (37.5 yrs.)					$ 300,000
Total Estimated Life Cycle Cost =					$ 4,398,000

Alternate 5S - Construct New Parallel Flange Steel Girder Bridge w/Sdwk. on New Alignment

			Unit	Unit Price	
Remove Existing Bridge	602	21.33	Sq. Ft.	$ 34.00	$ 437,000
Steel Plate Girder Bridge (w/ Sidewalk)	640	51.33	Sq. Ft.	$ 110.00	$ 3,620,000
Associated Roadwork	2	1,000	Lin. Ft.	$ 255.00	$ 510,000
Subtotal Estimated Current Construction Cost =					$ 4,567,000
Present Value of Future Deck Overlays (25 yrs.)		2844	Sq. Yd.	$ 20.00	$ 171,000
Present Value of Major Rehabilitations (37.5 yrs.)					$ 350,000
Total Estimated Life Cycle Cost =					$ 5,088,000

CURRENT RIVER BRIDGE - AESTHETIC ENHANCEMENT COST COMPARISIONS

REHABILITATION, PRESERVATION AND RECONSTRUCTION ALTERNATIVES

Alternative Description	Estimated Current Construction Cost	Estimated Aesthetic Enhancement Cost	Estimated Total Life Cycle Cost	Aesthetic Enhancement Features
Parallel Flange Plate Girder On Exist. Piers	$ 2,996,000	$ 36,000	$ 3,532,000	Corral Rail
Rehabilitate Exist. Arch & Construct New Arch	$ 4,589,000	$ 1,593,000	$ 7,677,000	Corral Rail, New & Rehab. Arches

NEW ALIGNMENT ALTERNATIVES

Alternative Description	Estimated Current Construction Cost	Estimated Aesthetic Enhancement Cost	Estimated Total Life Cycle Cost	Aesthetic Enhancement Features
Parallel Flange Plate Girder	$ 3,927,000	$ 38,000	$ 4,398,000	Corral Rail
Segmental Concrete	$ 5,007,000	$ 1,080,000	$ 5,579,000	Corral Rail, Segmental Concrete
Haunched Steel Plate Girder	$ 4,467,000	$ 540,000	$ 4,938,000	Corral Rail, Haunched Web

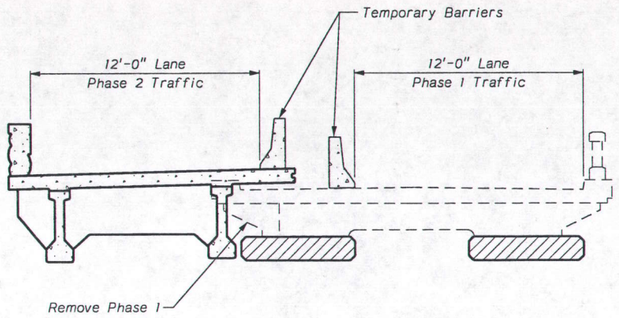
NEW ALIGNMENT ALTERNATIVES (w/Sidewalk)

Alternative Description	Estimated Current Construction Cost	Estimated Aesthetic Enhancement Cost	Estimated Total Life Cycle Cost	Aesthetic Enhancement Features
Parallel Flange Plate Girder	$ 4,567,000	$ 141,000	$ 5,088,000	Corral Rail, Orn. Fence & Rail
Segmental Concrete	$ 5,877,000	$ 1,310,000	$ 6,349,000	Corral Rail, Orn. Fence & Rail, Seg. Concrete
Haunched Steel Plate Girder	$ 5,227,000	$ 660,000	$ 5,748,000	Corral Rail, Orn. Fence & Rail, Haunched Web

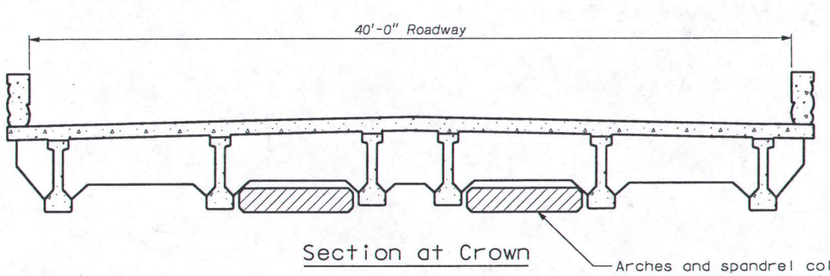
Assume the following costs for aesthetic features:

Decorative Rail $90/lf; Ornamental Fence $160/lf; Ornamental Rail $60/lf

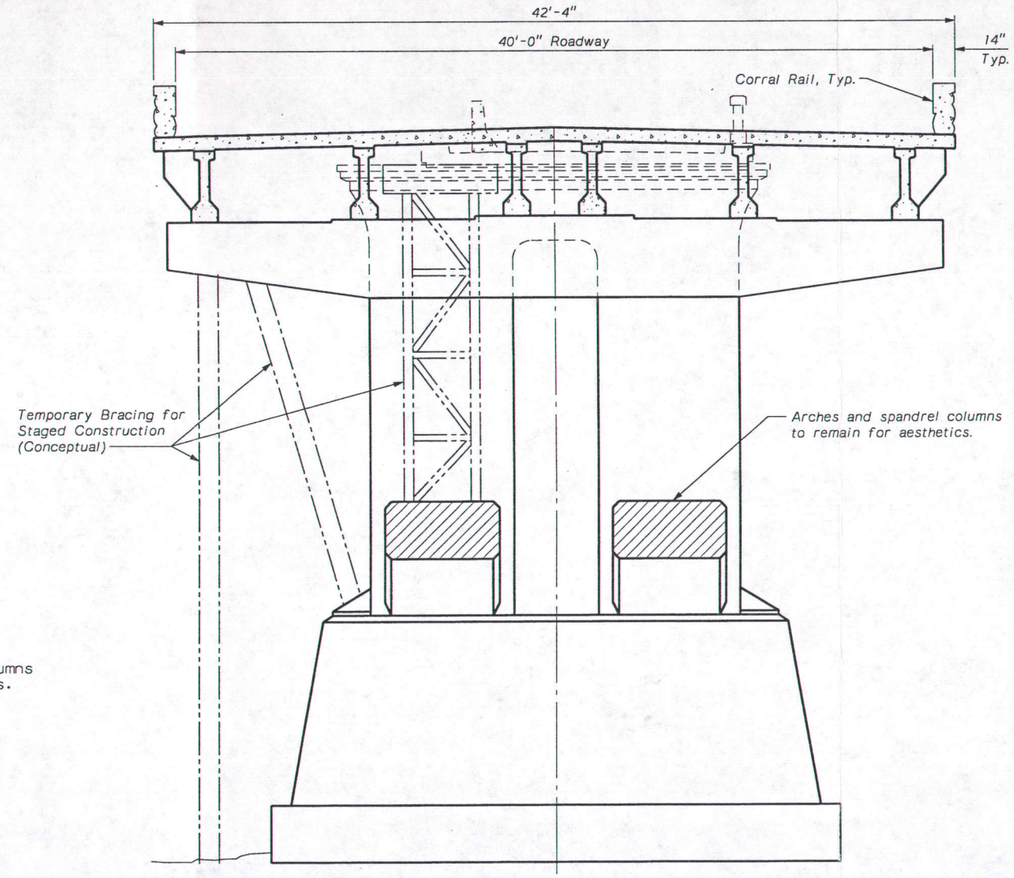
Jersey Barrier $60/lf; Chain Fence $50/lf; Std. Rail on Curb $20/lf



Construction Staging



Section at Crown



Section Near Pier

REHAB. WITH P/S GIRDER - SECTIONS
ROUTE 19 SINKING CREEK BRIDGE
Shannon County

HARRINGTON & CORTELYOU, INC.
Consulting Engineers

NOTE: DO NOT SCALE THIS DRAWING. FOLLOW DIMENSIONS.

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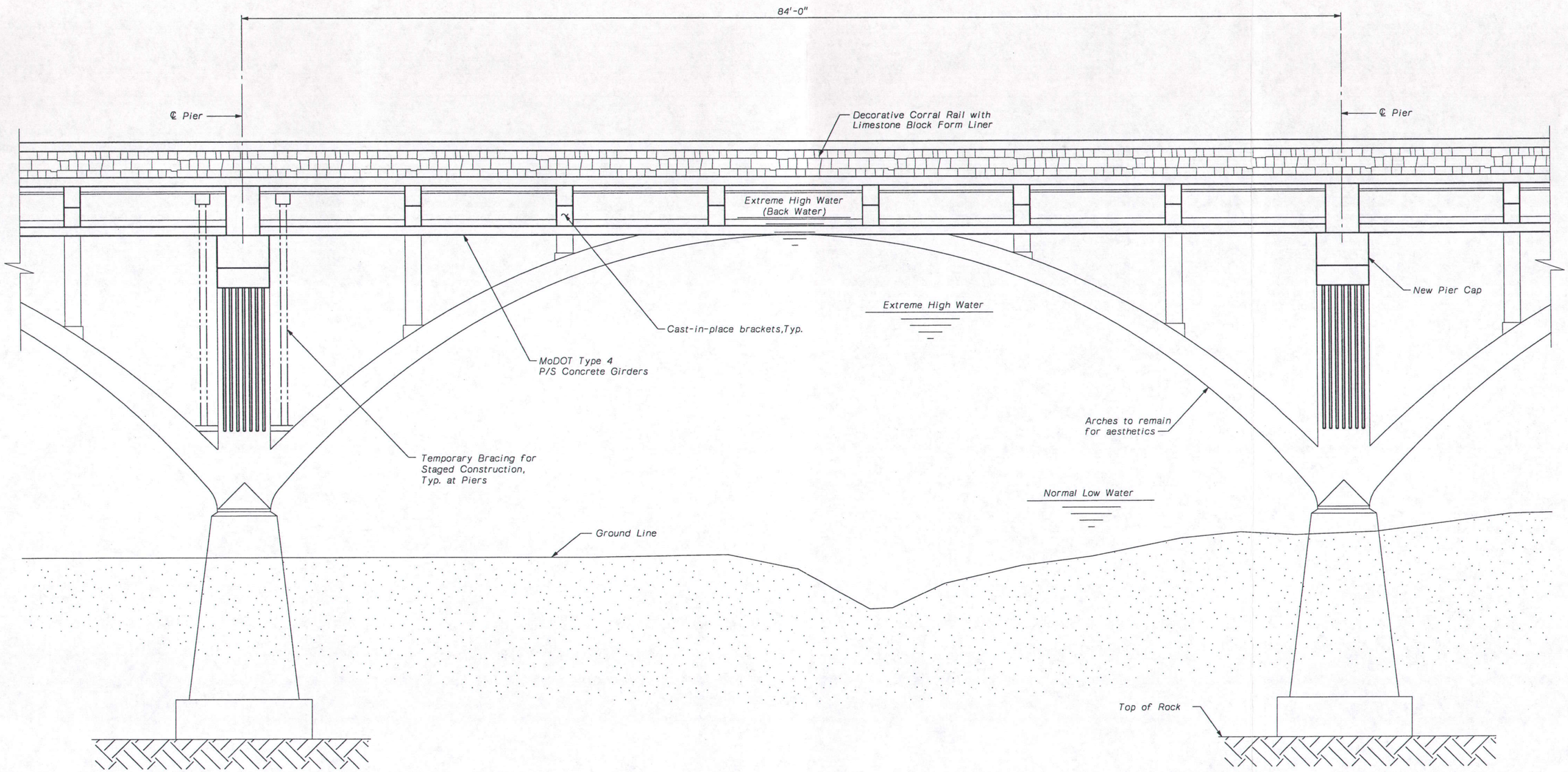


ELEVATION

REHAB. WITH P/S GIRDER - ELEVATION

ROUTE 19 SINKING CREEK BRIDGE

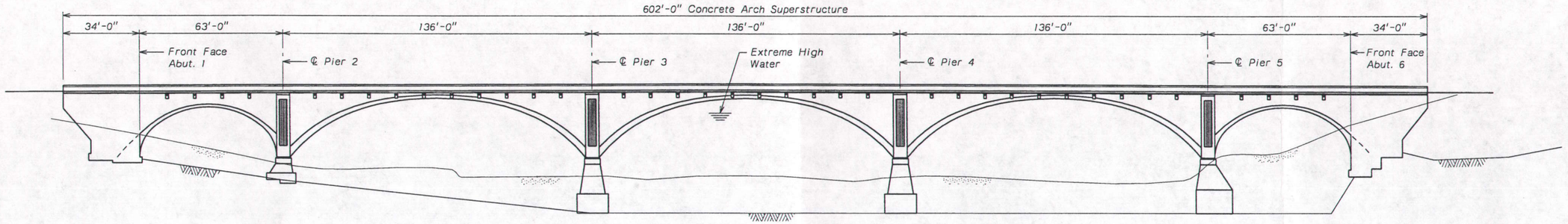
Shannon County

HARRINGTON & CORTELYOU, INC.
Consulting Engineers

NOTE: DO NOT SCALE THIS DRAWING. FOLLOW DIMENSIONS.

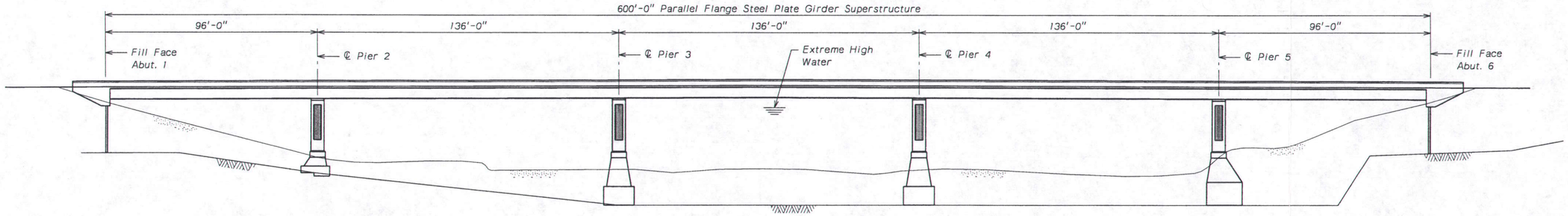
H-79

4:11:02 PM 4/9/2003 s:\Route 19\Sinking Creek\Elev-Diagram.dgn



Concrete Arch Alternate

Note: Rehabilitate, Reconstruct and Preserve Existing Arch.



Steel Plate Girder Superstructure Alternate

Note: Utilizes Existing Piers 2 - 5

REHABILATION SPAN LAYOUTS

ROUTE 19 CURRRENT RIVER BRIDGE

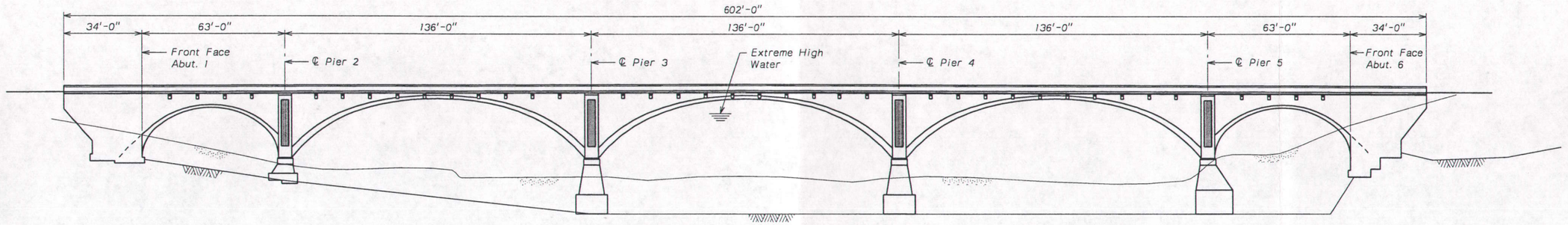
Shannon County

HARRINGTON & CORTELYOU, INC.
Consulting Engineers

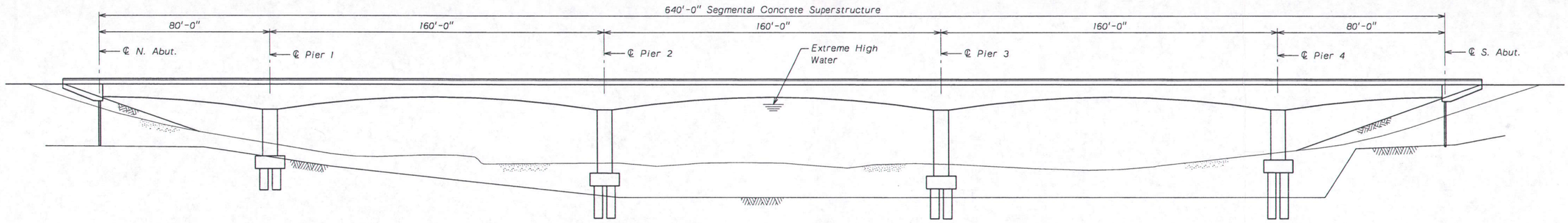
NOTE: DO NOT SCALE THIS DRAWING. FOLLOW DIMENSIONS.

G-804A

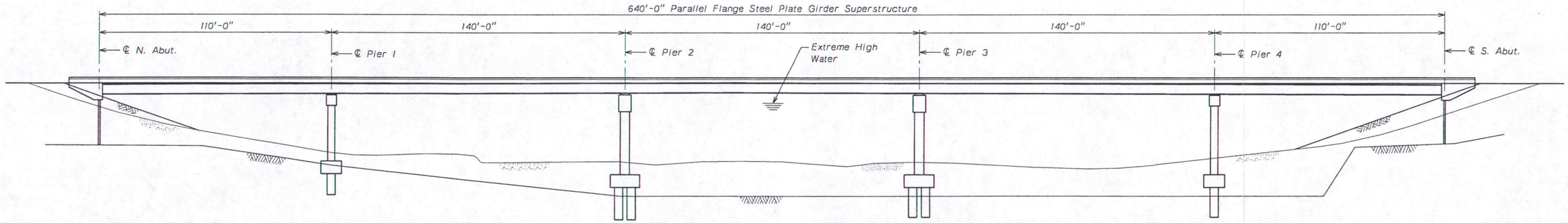
2:38:32 PM 6/13/2003 s:\Route 19\Current River\Alt_Elev_Current.dgn



Existing Concrete Arch



Segmental Concrete Superstructure Alternate



Steel Plate Girder Superstructure Alternate

(Haunched Steel Plate Girder Similar)

REALIGNMENT SPAN LAYOUTS

ROUTE 19 CURRRENT RIVER BRIDGE

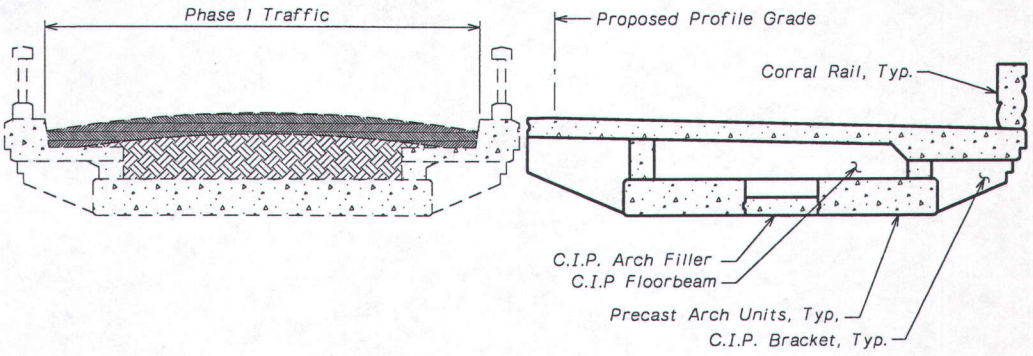
Shannon County

HARRINGTON & CORTELYOU, INC.
Consulting Engineers

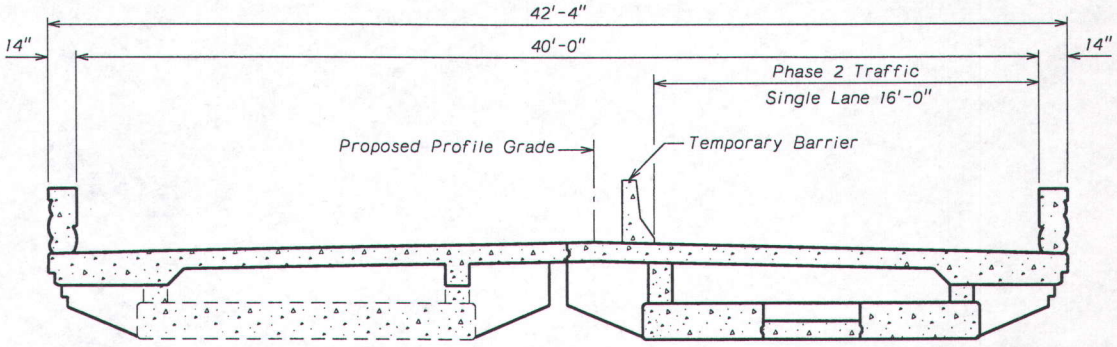
NOTE: DO NOT SCALE THIS DRAWING. FOLLOW DIMENSIONS.

G-804A

2:37:29 PM 6/13/2003 s:\Route 19\Current River\Alt-Elev_Current_Pltgdr.dgn



Phase 1



Phase 2

- - - - Existing
——— New Construction

SECTIONS NEAR CENTER OF ARCH

ROUTE 19 CURRENT RIVER BRIDGE

Shannon County

HARRINGTON & CORTELYOU, INC.
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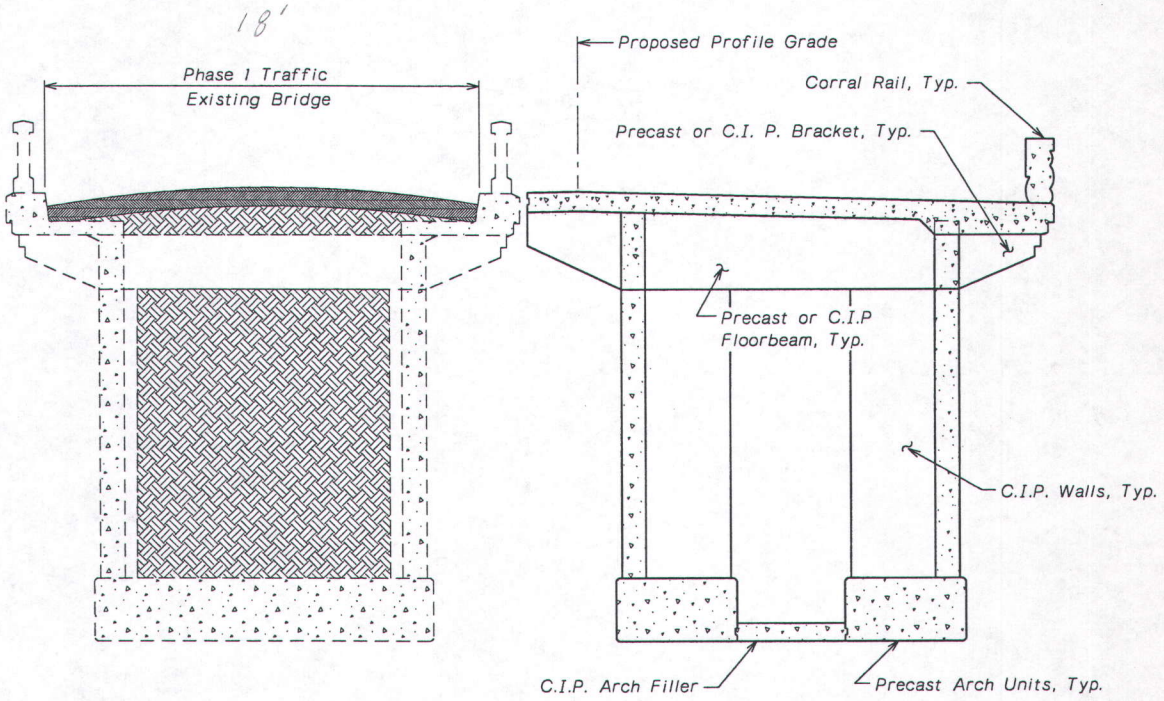
G-804A

6:55:10 PM 4/9/2003 s:\Route 19\Current River\Phase1&2-Center Arch.dgn



Phase 1

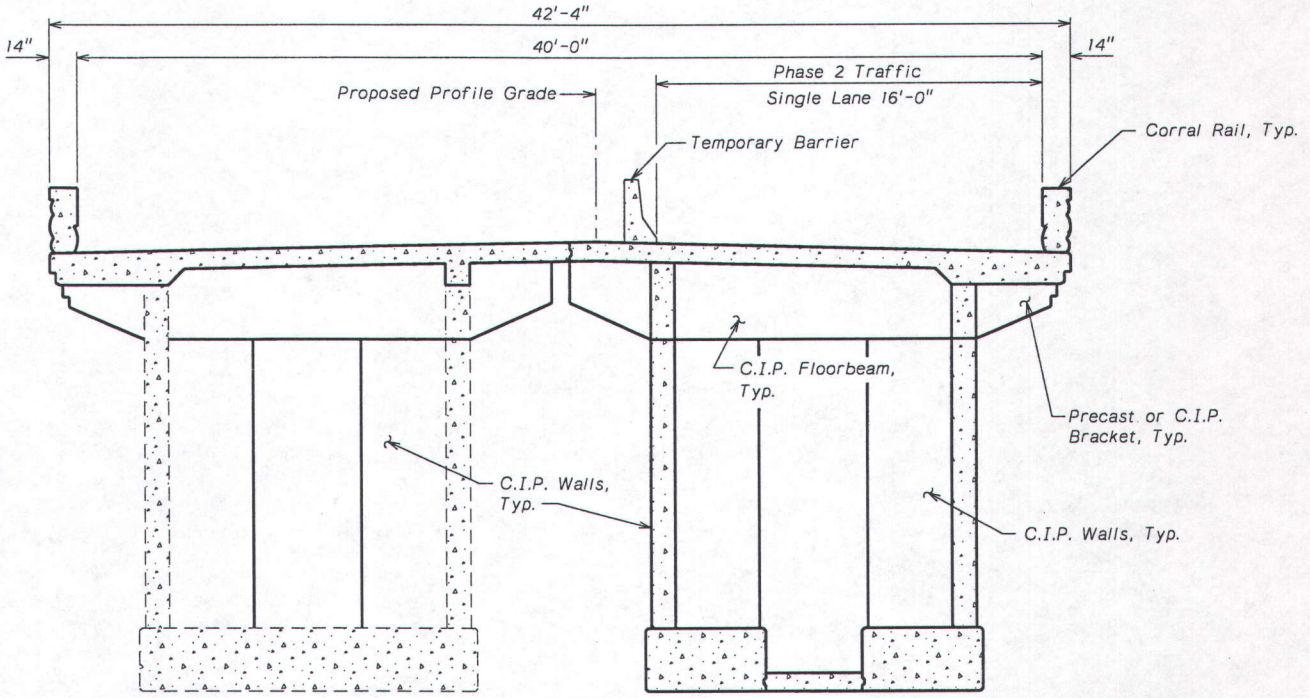
- - - - Existing
——— New Construction

SECTION NEAR SPRINGING LINE
ROUTE 19 CURRENT RIVER BRIDGE
Shannon County

HARRINGTON & CORTELYOU, INC.
Consulting Engineers

G-804A

1:43:24 PM 4/9/2003 s:\Route 19\Current River\Phase1-Spring Lane.dgn



Phase 2

SECTION NEAR SPRINGING LINE

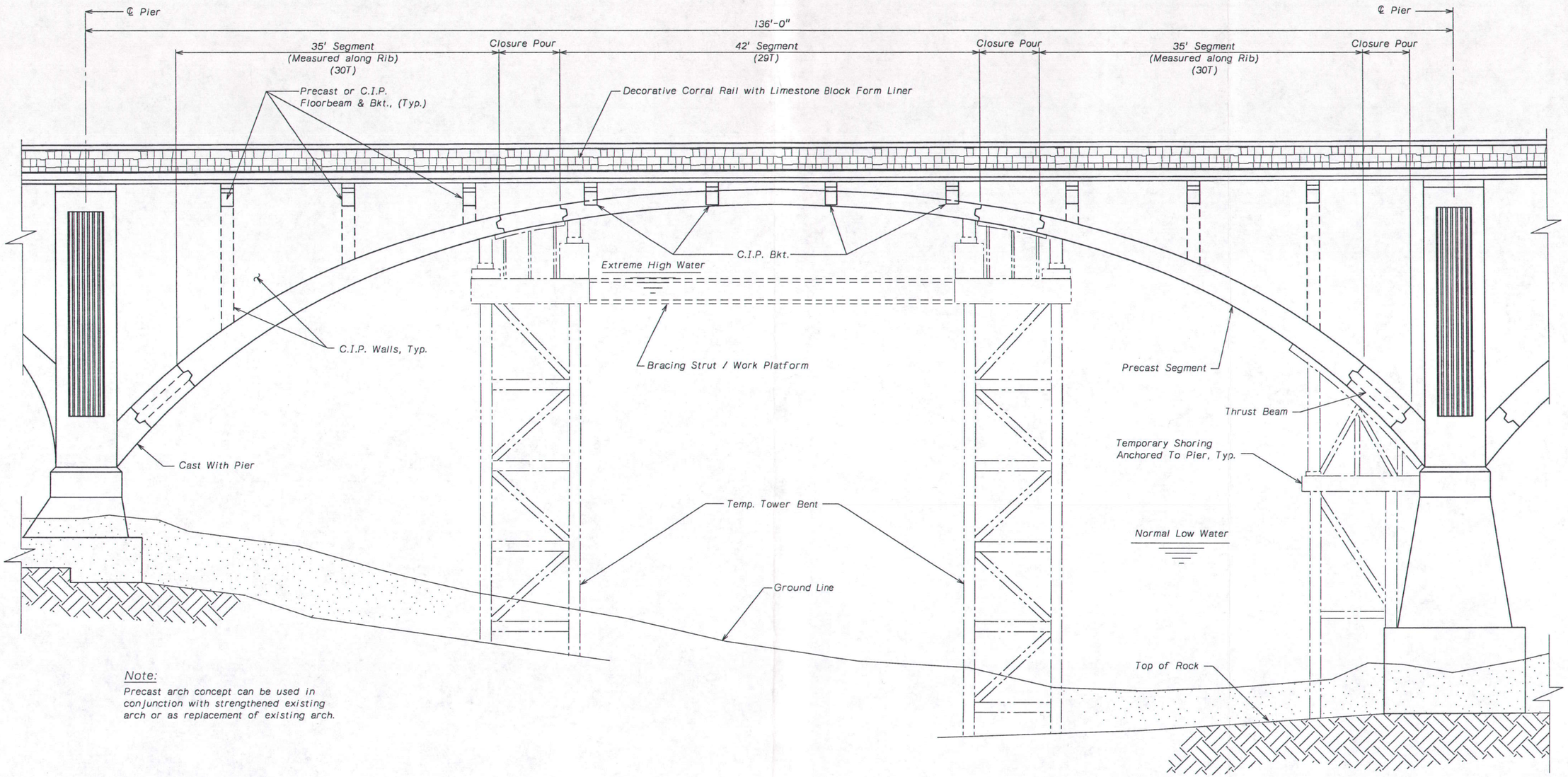
ROUTE 19 CURRENT RIVER BRIDGE

Shannon County

HARRINGTON & CORTELYOU, INC.
Consulting Engineers

G-804A

4:40:33 PM 4/9/2003 s:\Route 19\Current River\Phase2-Spring Lane.dgn



Note:
Precast arch concept can be used in conjunction with strengthened existing arch or as replacement of existing arch.

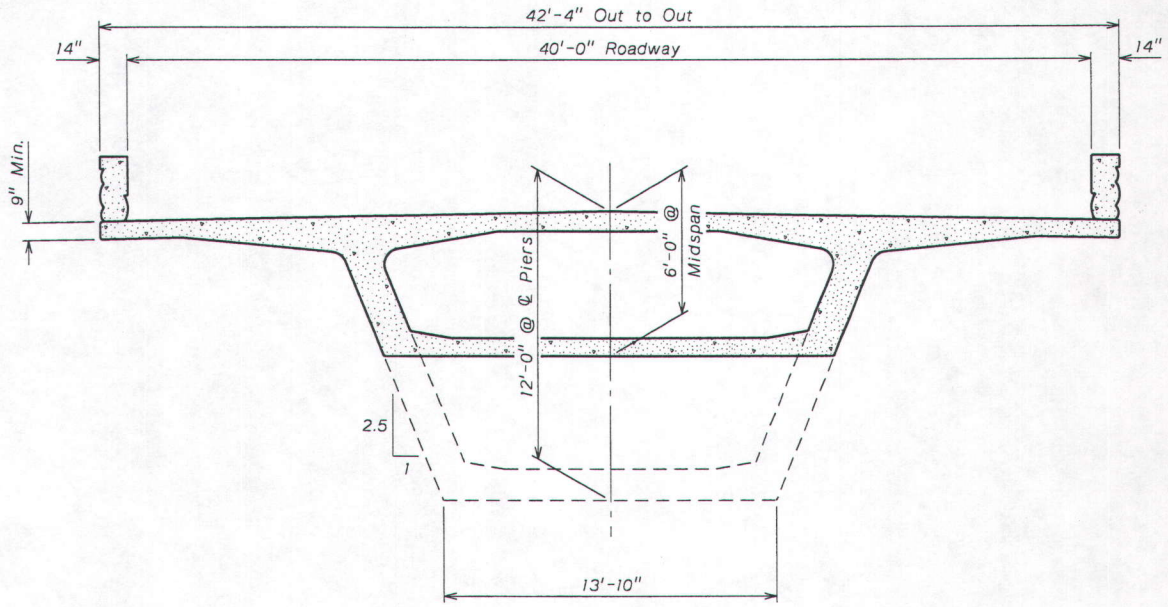
TYPICAL ELEVATION
ROUTE 19 CURRRENT RIVER BRIDGE
Shannon County

HARRINGTON & CORTELYOU, INC.
Consulting Engineers

NOTE: DO NOT SCALE THIS DRAWING. FOLLOW DIMENSIONS.

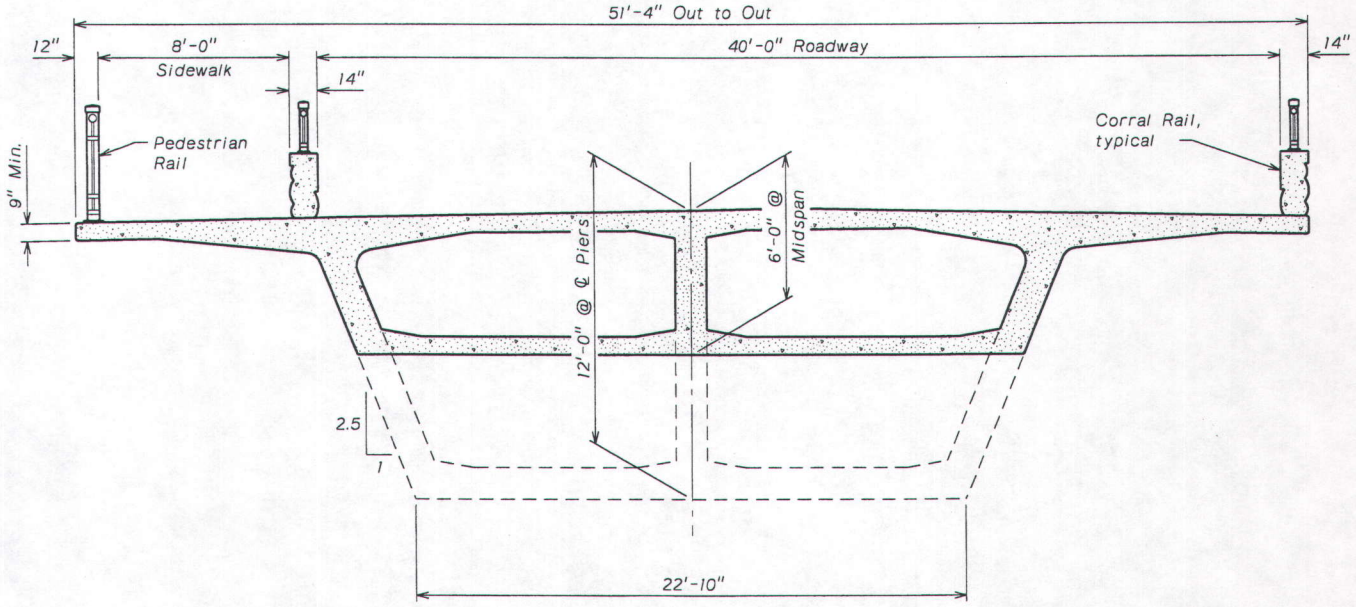
G-804A

4:23:02 PM 4/9/2003 s:\Route 19\Current River\Typical Elevation.dgn



TYPICAL SECTION

(without sidewalk)



TYPICAL SECTION

(with sidewalk)

Note:
Design box for additional effects of eccentricity, or consider two 6' sidewalks.

SEGMENTAL CONCRETE SECTIONS

ROUTE 19 CURRENT RIVER BRIDGE

Shannon County

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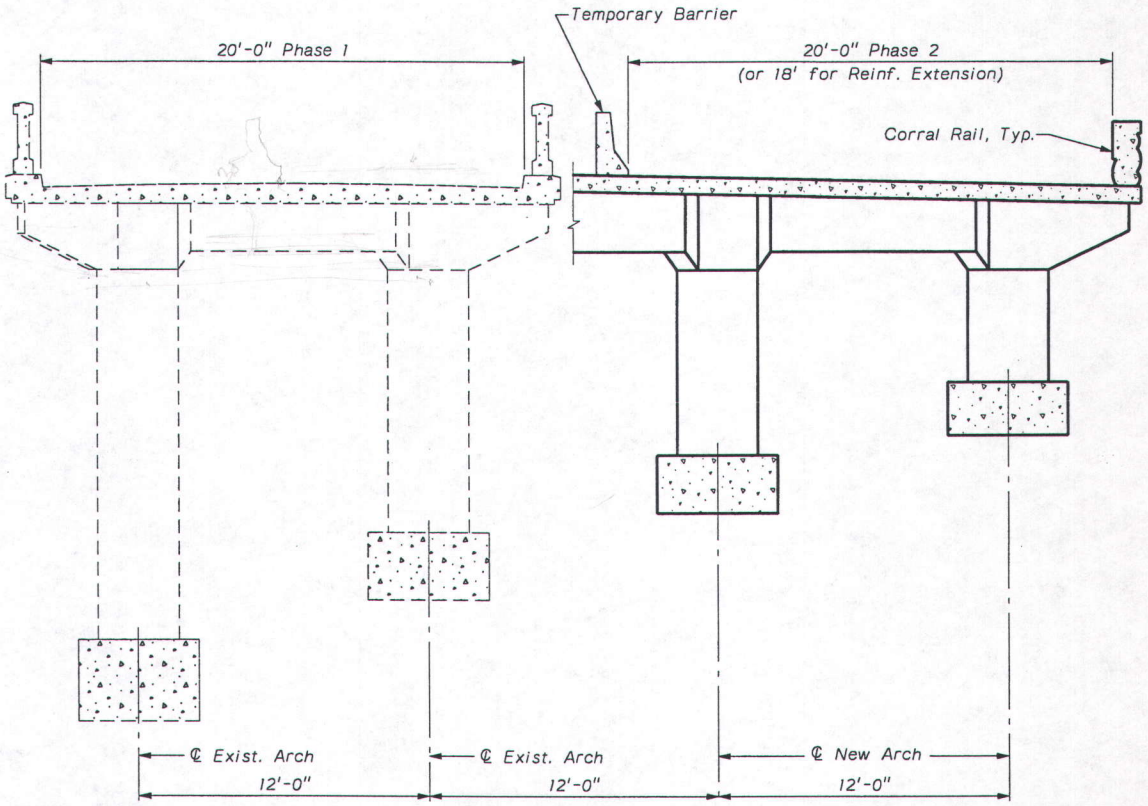
Consulting Engineers

G-804A

3:22:06 PM 6/13/2003 s:\Route 19\Current River\seg-box-gdr.dgn



Phase 1 & 2

--- Existing
——— New Construction

SECTION THRU ARCH SPAN

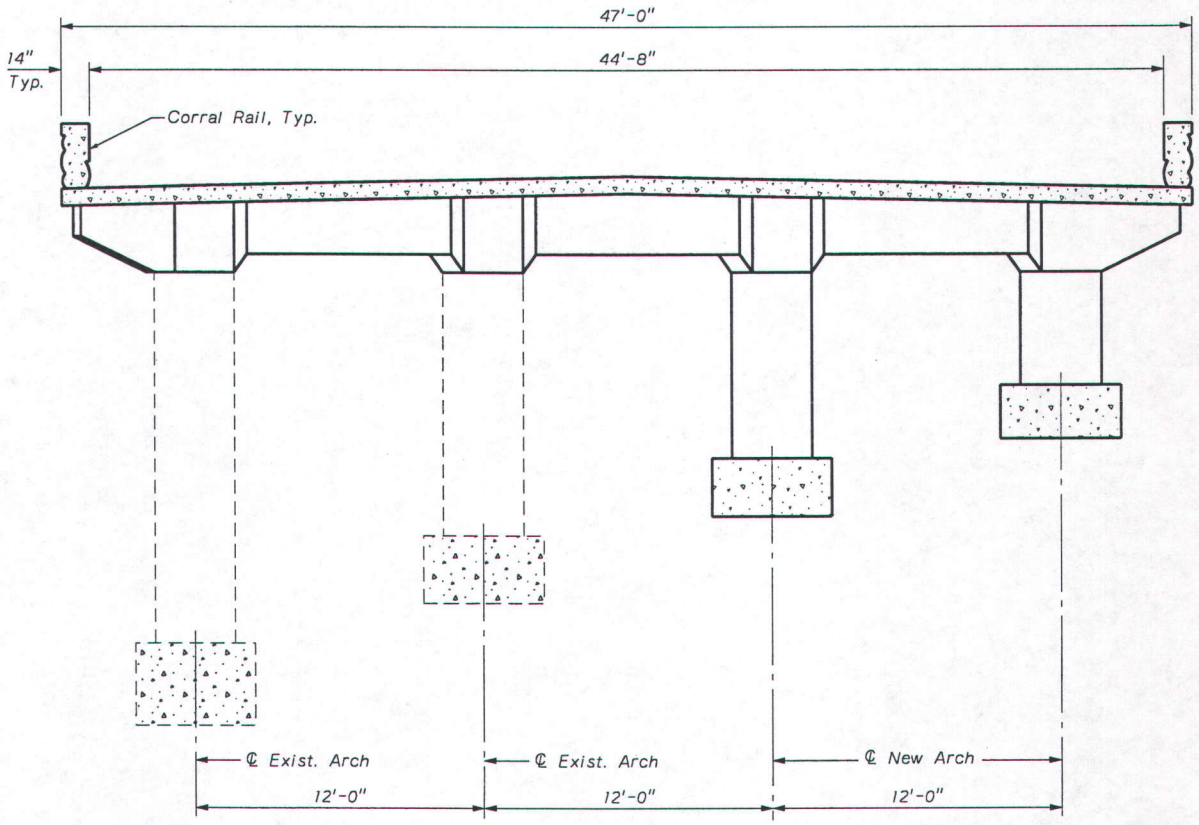
ROUTE 19 SPRING VALLEY BRIDGE

Shannon County

HARRINGTON & CORTELYOU, INC.
Consulting Engineers

J-420

4:04:35 PM 4/9/2003 s:\Route 19\Spring Valley\SecThru Arch1.dgn



Final Roadway Section

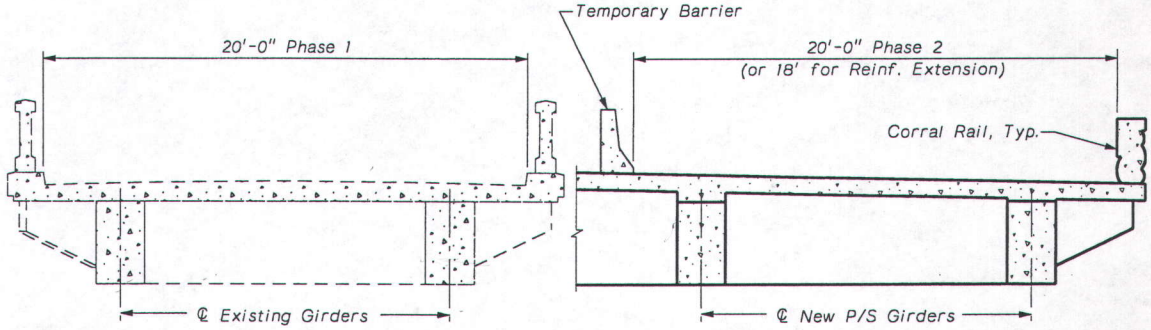
--- Existing
——— New Construction

SECTION THRU ARCH SPAN
ROUTE 19 SPRING VALLEY BRIDGE
Shannon County

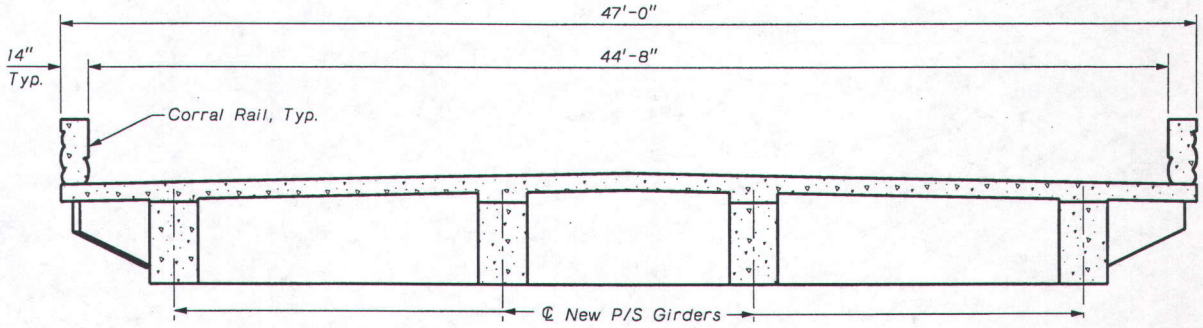
HARRINGTON & CORTELYOU, INC.
Consulting Engineers

J-420

1:42:55 PM 4/9/2003 s:\Route 19\Spring Valley\SecThru Arch2.dgn



Phase 1 & 2



Final Roadway Section

--- Existing
——— New Construction

SECTIONS THRU APPROACH ROADWAY
ROUTE 19 SPRING VALLEY BRIDGE
Shannon County

HARRINGTON & CORTELYOU, INC.
Consulting Engineers

J-420

4:04:16 PM 4/9/2003 s:\Route 19\Spring Valley\SecThruApproach.dgn

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Bridge G-804A Over Current River

HARRINGTON & CORTELYOU, INC.
Consulting Engineers

Bridge H-79 Over Sinking Creek

HARRINGTON & CORTELYOU, INC.
Consulting Engineers

Bridge J-420 Over Spring Valley Creek