RIVERFRONT PARK BRIDGES

INSPECTION AND ANALYSIS

HOWARD STREET SOUTH CHANNEL BRIDGE

NOVEMBER 14, 2014 | Final Report

kpff Consulting Engineers

HOWARD STREET SOUTH CHANNEL BRIDGE

November 14, 2014

Prepared for

City of Spokane
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1. BRIDGE DESCRIPTION

The Howard Street South Channel Bridge was built in 1931 as a vehicle bridge. The bridge currently carries only pedestrian traffic over the south channel of the Spokane River. The center of the bridge is fenced off to reduce the live load on the bridge. The four span cast in place reinforced concrete bridge has span lengths of 48 feet, 48 feet, 48 feet, and 41 feet.

This bridge is programmed for replacement. Accordingly our task as inspectors was to determine if we concur with the established sentiment regarding this bridge's current state of deterioration, remaining life, and to develop concepts and costs for replacement.

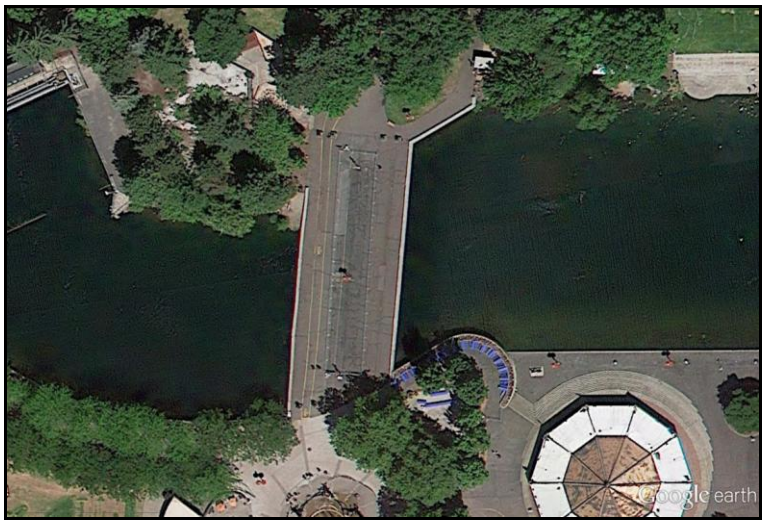


Figure 1: Aerial view of the Howard Street South Channel Bridge

2. DOCUMENT REVIEW

In preparation for this evaluation, Kpff reviewed the following documents related to the Howard Street South Channel Bridge:

- Bridge Plans (general plan and elevation and structural details)
- Downtown Spokane Streetcar Alternative Analysis – Howard Street Corridor Bridge Analysis
- Previous routine inspection reports
- 2012 Interim underwater inspection report

3. EVALUATION PROCEDURES

Kpff was tasked to inspect the primary structural components. However, the bridge is already known to contain severely defective structural girders and the City has already determined they wish to replace this bridge. Accordingly our evaluation was intended to provide a second opinion in regards to the degree and severity of the

deterioration of the structural support system based only on a visual inspection and a review of previous load rating analysis preformed by others.

ROUTINE BRIDGE INSPECTION

A visual inspection of the asphalt overlay and railings was performed. These components were accessed by foot. A visual inspection of the girders, soffit, crossbeams, and abutments was also performed. These components were accessed by float tube.

The inspection also served to assist in determining feasible replacement options.

STRUCTURAL ANALYSIS

A load rating analysis was not performed by Kpff as part of this evaluation.

4. EVALUATION FINDINGS

BRIDGE INSPECTION

The bridge is in poor condition structurally. Most of the primary load carrying components as seen from the underside of the bridge exhibit severe concrete deterioration such as cracks, spalls, and exposed corroded reinforcement with measurable section loss. The exterior girders (A, B, E, and F) are in worse condition than the interior girders. The cap beams, which the longitudinal girders frame into, and the deck underside, which the longitudinal girders support, also exhibit evidence of advance deterioration to both the concrete and reinforcing steel.

At the east corner of the south abutment (Pier 1), material has spilled out from under the retaining wall but does not appear to be impacting the abutment. At the north abutment (Pier 5), the embankment has sloughed and material has accumulated next to Span 4 Girder B.

The bridge inspection report, component labeling system, and photographs and are included in Appendix A.

STRUCTURAL ANALYSIS

The 2009 “Downtown Spokane Streetcar Alternative Analysis” report by CH2MHill found that the crossbeams do not have enough capacity to support the bridge dead load using conservative assumptions for material strengths. The longitudinal girders were deficient in shear and bending under pedestrian live load using conservative assumptions for material strengths.

5. CONCLUSIONS AND RECOMMENDATIONS

Kpff concurs that this 83 year old bridge has completed its useful service life and should be programmed for replacement. This is due to the condition of the concrete girders, caps, deck, and the undermining of Pier 2 which was temporarily repaired about 14 years ago.

Currently, a portion of the middle deck area is blocked from pedestrian use forcing the pedestrians toward the exterior concrete railing. However, we determined that the exterior girders are in worse condition than the interior

girders. Accordingly we recommend that consideration be given to restricting access to the outside area of the bridge and the interior area re-opened to pedestrian traffic.

BRIDGE REPLACEMENT OPTIONS

The bridge replacement options address visual and hydraulic clearance constraints as summarized below:

1) *The City Engineering Department requires the new bridge superstructure to be below deck (girder style) and not above deck (truss or arch style)*

   This requires using a multiple span bridge (two or three in water piers) in order to achieve a shallow structural system.

2) *The City Engineering Department requires the new bridge superstructure to have a 3-foot minimum clearance above mean high water*.

   On the existing bridge the bottoms of the crossbeams are below the high water mark. The new bridge must be more slender. In addition room must be made for inspection access below the bridge. This means that any new bridge superstructure depth must be minimized to provide sufficient clearance for routine bridge inspections. It also further challenges the first constraint.

3) *Because permitting for bridge replacements over water involve shadow effects in the river*, *the new bridge footprint (total area) should not be greater than the existing bridge footprint.*

   Two replacement options that meet these constraints are being considered for the new Howard Street South Bridge.

The first option consists of a three-span pre-stressed voided slab superstructure. This configuration requires two in-water bents, with three columns at each bent (six total in-water columns). The footprint of the bridge matches the existing bridge layout.

The second option also uses pre-stressed voided slabs for the superstructure. This layout has three main spans in the middle of the bridge, but the ends of the bridge “flair out”. The two triangular pieces of the bridge at the south end of the bridge would be cast in place. The substructure would require at least eight in-water piers and the south abutment would be about twice as long as the abutment in option 1. This geometry was proposed by the City Parks Department to ease congestion around the fountain at the south end of the bridge.

Details and a cost estimate of the bridge replacement options are included in Appendix B. The total estimated cost for the first replacement option is $4.4 million. The total estimated cost for the second replacement option is $5.8 million.

Due to the age, poor construction quality, and previous scour issues, a bridge replacement option using the existing in-water piers is not recommended.

A single span structure with no interior piers is a feasible replacement option. However, our understanding is that the City Parks Department prefers that the bridge blends in with the surrounding park pedestrian paths and views a bridge with an above deck structure, such as a truss, arch, or pylon-cable system to not meet this criterion. The advantage of the above deck structural system is that it removes all piers from the water, creates an improved hydraulic cross-section, reduces scour as a design consideration, and allows for much greater access for inspection. In addition, the above deck system could promote an opportunity for creative and iconic designs that

become a visual attribute for the park. However, the costs would likely be greater than the options considered herein.

6. PERMITS AND CULTURAL RESOURCE REQUIREMENTS

PERMITS

An environmental permit matrix was prepared by SWCA Environmental Consultants for the Riverfront Park Bridges. The proposed bridge improvement work may require the following permits or approvals:

- Section 404 Nationwide Permit 14 (NWP 14) – Linear transportation projects from US Army Corps of Engineers
- Section 7 Endangered Species Act consultation from US Fish and Wildlife Service
- National Historic Preservation Act – Section 106 consultation from Washington Department of Archaeology and Historic Preservation and potentially affected tribes
- Executive Order 05-05 from Washington Department of Archaeology and Historic Preservation
- Hydraulic Project Approval permit from the Washington Department of Fish and Wildlife.
- State Environmental Policy Act Threshold Determination from the City of Spokane
- Critical Areas Review from the City of Spokane
- Shoreline Substantial Development Permit from the City of Spokane

CULTURAL RESOURCE STUDY

This bridge is not currently listed on the National Register of Historic Places (NRHP), but is eligible for NRHP status. The Howard Street Bridge replacement will require a Washington State Historic Property Inventory Form. An archeological survey will be required due to the excavation at the abutments.

For more detailed information on the permits and cultural resource requirements please see the full report prepared by SWCA Environmental Consultants.

APPENDIX A

LIST OF PHOTOGRAPHS

CITY OF SPOKANE

PEDESTRIAN BRIDGE INSPECTION FORM

				Bridge No.	811
Bridge Name	Howard St. South Channel Bridge		**Bridge Location**	Howard St. and South Channel of Spokane River	
Inspection Date	8/13/14	**Inspector(s)**	P. Georgieff / M. Frymoyer	**Agency**	KPFF
Access Method	Float tube for in water access (contact Avista before performing in-water work)			**Weather**	Sunny/Hot
Load Rating Date	none	**Live Load**	**Pedestrian**	**Vehicle**	
Load Rating Factor(s)	**Ped.** / **Veh.**	**Controlling Component**	**Pedestrian**	**Vehicle**	

Description of Bridge

Built in 1931 as a vehicle bridge. Currently closed to vehicle traffic and used by pedestrians for park access. Primary support is provided by concrete girders. Span lengths: 48', 48', 48', 41' (bridge length is 185 feet). Middle of the bridge is fenced off - apparently to reduce the likelihood of over-stressing the bridge from too many pedestrians.

Summary of Condition and Critical Findings

Nearly all the primary structure components on the underside of the bridge (concrete girders, cap beam, deck, pier columns) exhibit moderate to critical levels of deterioration which includes: large cracks, delaminations, spalls, and exposed and heavily corroded reinforcement with measurable section loss. The exterior girders are in worse condition than the interior girders.

Summary of Recommendations

Given the extensive deterioration of the concrete components, and load rating factors of less than 1.0 (performed by CH2MHill), replacement of the bridge is recommended. Rehabilitation is costly and difficult from a construction perspective due (first) to the river and (second) the low water clearance. The bridge is 83 years old. By the time concept, preliminary design, permitting, securing funding, and building the bridge has all been performed the bridge will be 88 years old.

Summary of Bridge Condition

	Bridge Component	No. of Compon.	% of **	Condition Rating* 8 – 7 Good	6 – 5 Fair	4 – 3 Poor	Comments
1	Asphalt Concrete Overlay	1	area	40%	50%	10%	Cracks and potholes
2	Concrete Soffit	1	area	50%	50%	0%	See notes next page.
3	Concrete Railing	2	length	90%	10%	0%	Hairline cracks, spalls, exposed rebar.
4	Concrete Girder	6	length	25%	25%	50%	Exposed rebar, cracks, spalls, and efflourescence
5	Concrete Pile Column	6	area	100%	0%	0%	
6	Concrete Pier Capbeam	3	area	67%	33%	0%	Cracking and efflourescence
7	Concrete Abutments	2	area	25%	75%	0%	Cracks and spalls.
8	Expansion Joints	2	length	100%	0%	0%	
9	Scour	8	each	80%	20%	0%	South retaining wall footing is exposed downstream of the bridge
10	Erosion	2	length	0%	100%	0%	See notes next page.
11							
12							
13							

*See Page 2 for detailed descriptions **Condition rating percentages are based on the % of area, length, or each of the bridge components inspected.

GENERAL NOTES

Scour components are 1 for each in-water column plus each abutment. Erosion components are 1 for each bank.
If the bridge is to remain in service for an extended period we recommend core samples of the concrete be taken for strength testing and the load rating repeated every 5 years to account for additional loss of capacity.

DESCRIPTION OF CONDITION OF BRIDGE COMPONENT		
Condition Value	**Material**	**Description**
8 – 7 Very good → Good 2 yr. insp. Cycle No repairs.	Steel	Like new, surface rust, minor pitting, no material loss. Connections are good. No damage.
	Concrete	No to minor/ insignificant defects includes: cracks, spalls, chips, consolidation, efflorescence.
	Timber	Beams: Minor splits, checks, or defects (one side), no decay or insects – sounds solid. Posts: Splits or cracks less than ⅜" (one side), no decay or insects – sounds solid.
	Paint	No defects, no sign of rust including no freckled rust, no peeling, no exposed steel.
	Scour / Erosion	None or minor.
6 – 5 Satisfactory → Fair 1 – 2 yr insp. cycle Monitor for repairs Paint: Max 10 year life estimate	Steel	Moderate corrosion, pitting, flaking, pack rust. Material loss is evident but barely measurable. Connections have up to moderate corrosion but remain fully functional. No cracks.
	Concrete	Some spalling but exposed rebar (if any) is insignificant or exhibits some surface rust; delamination is evident with or without evidence of rebar corrosion. Shear zone cracks are tight, barely measureable, and low density. Flexure zone cracks are measurable but less than .035 inch and low density. Concrete may exhibit: efflorescence (moderate to heavy), surface rust, heavy map cracking, very poor consolidation. Settlement cracks in foundations and wall are stable and less than ¼" wide.
	Timber	Beams: Less than ⅜" splits – two sides or greater than ⅜" on one side. Some decay (max 10% by volume), some softness but sounds solid – no insects. Posts: More than ½ "splits – two sides or greater than ¾" on one side. Decay is evident (greater than 20% by volume), timber may have extensive wetness and softness.
	Paint	Freckled rust, small areas of exposed steel, some peeling, oxidized.
	Scour / Erosion	Evidence of scour, exposed footing, no undermining. Banks are sloughing, protection, if any, needs repair.
4 – 3 Poor → Critical 3 mo – 1 yr. insp. cycle (as needed) Repairs needed. (ASAP or one year) Re - paint	Steel	Heavy to severe: corrosion, pitting, pack rust. Measurable material loss. Connections are heavily corroded, missing, and questionable functionality. Fatigue cracks.
	Concrete	Large spalls, deep w/ exposed and corroded rebar w/ material loss evident. Cracks are wider, closely spaced, clearly structural in nature both in shear and flexure zone. Concrete quality appears poor w/ heavy scaling, stagilites, efflorescence, map cracking, extensive surface rust and delamination, and very poor consolidation of concrete. Settlement cracks are significant.
	Timber	Beams: Greater than ⅜" on two sides. Moderate decay up to 20%, surface softness, do not sound solid – may have insects. Posts: Less than ½ "splits – two sides or greater than ½" on one side. Decay is evident (20%), wetness and soft.
	Paint	Extensive freckled rust, larger areas of exposed steel, heavily oxidized, extensive peeling.
	Scour / Erosion	Undermining or threatens undermining in a manner that could impact structure stability. Banks are heavily eroded, protection if any is non-functional.

Additional Comments by Component Number

Bridge Comp. No.	**Comments**
2	Map cracking and efflorescence/stalactites. There are locations that are slowly dripping water that is held within the deck.
10	At the east corner of Pier 1, soil and concrete debris has washed out from under retaining wall, but does not appear to affect abutment. North embankment has sloughed soil and has accumulated around Span 4 Girder B.

Photo 1 –Howard Street South Bridge Deck (Looking North)

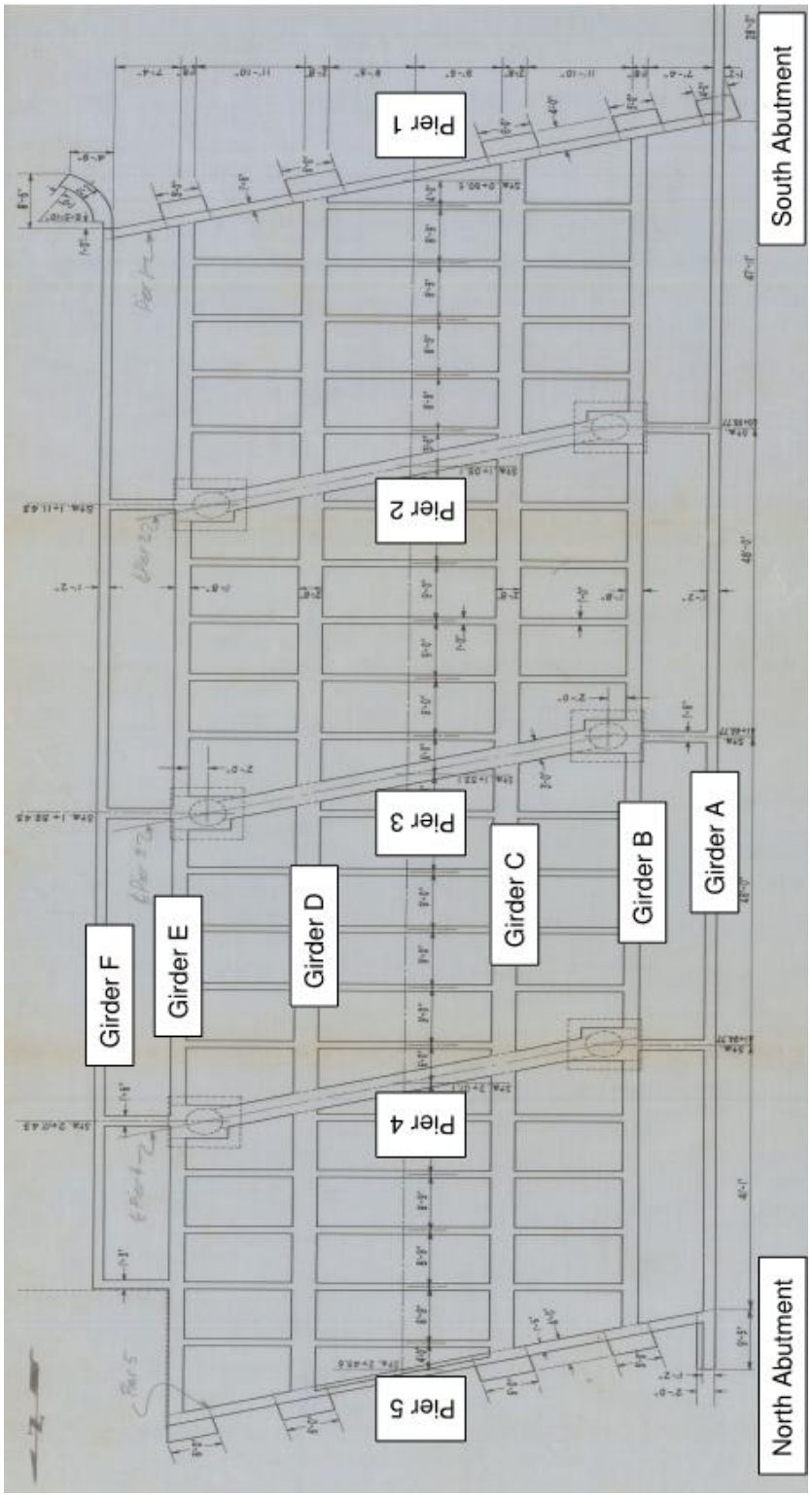
Photo 2 – Howard Street South Bridge Elevation (Looking West)

Photo 3 – Typical Soffit Condition - Map Cracking with Effloresence/Stalactites

Photo 4 – Typical Condition of Exterior Girders – Exposed/Corroded Reinforcement

Photo 5 – Typical Condition of Girders – Horizontal Leaching Cracks

Photo 6 – Material Spilling Through at South Abutment

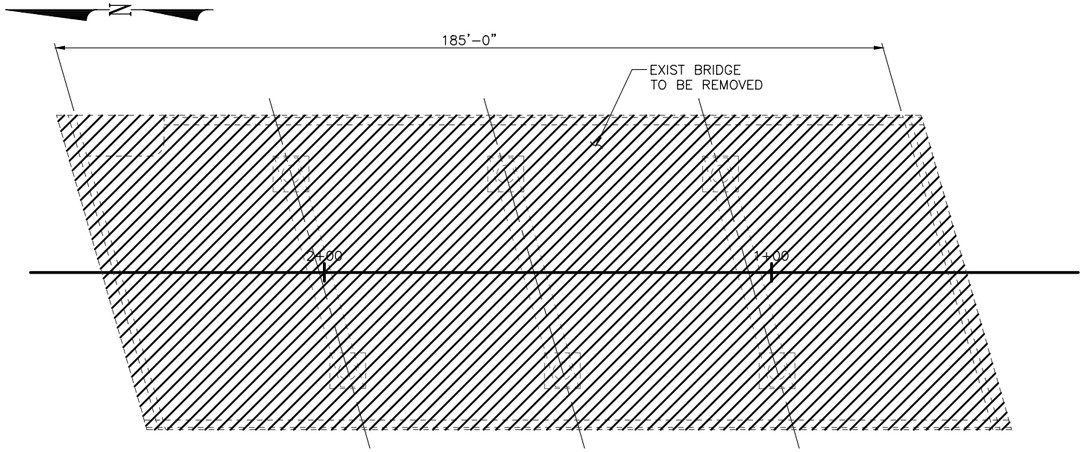


Bridge Component Labeling System

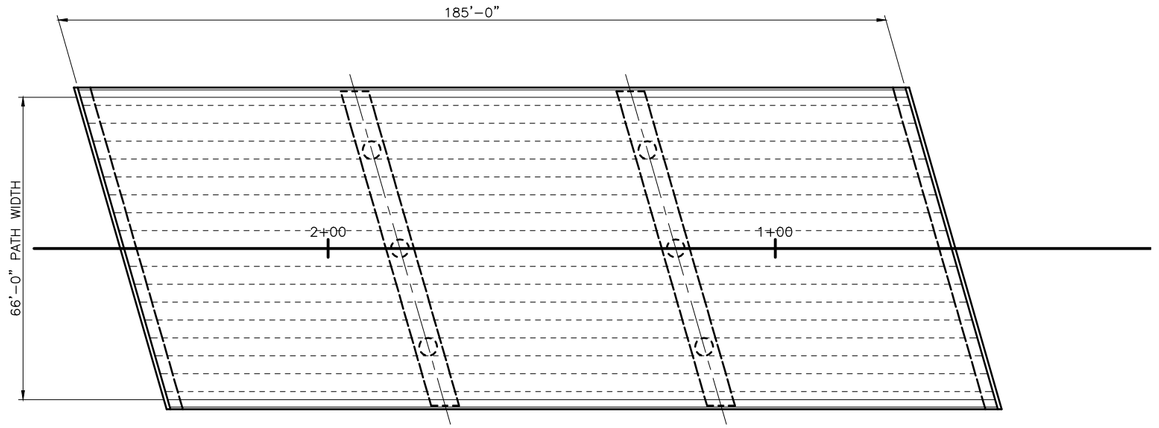
APPENDIX B

IMPROVEMENT DETAILS
COST ESTIMATES

REGION NO.	STATE	FEDERAL AID PROJECT NO.	SHEET NO.
EASTERN	WASH.	---	

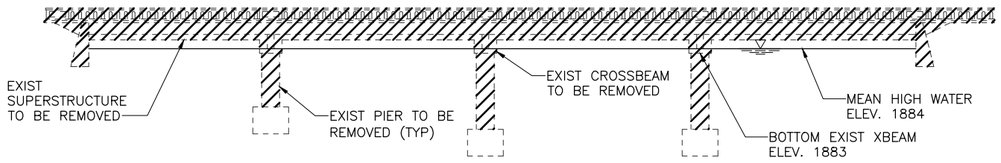


PLAN – REMOVAL

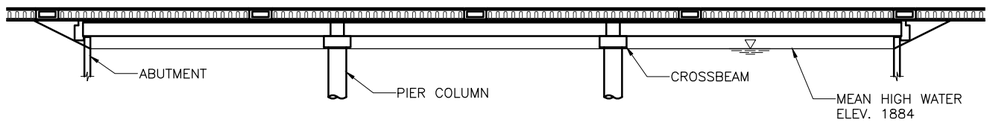


PLAN REPLACEMENT – OPTION #1

PRESTRESSED VOIDED SLABS



ELEVATION – REMOVAL



ELEVATION REPLACEMENT – OPTION #1

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DATE	BY	PROJ.	DESCRIPTION
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REVISIONS

DATE	BY	PROJ.	E.F.N. - U.S.N.	FROM	TO	COUNCIL ACCEPT DATE

AS BUILT

FROM	TO	ORD. NO.	DATE	FILE NO.

GRADE ORDINANCE LIST

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AS OF JANUARY, 2000 USE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)

BENCH MARK LOCATION: -
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NAVD88 ELEV: -

CBM NO: -

NAVD88 DATUM

BAR IS ONE INCH ON ORIGINAL DRAWING

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HORIZONTAL PLAN/PROFILE AS SHOWN

VERTICAL PROFILE ONLY

SCALE

CURRENT C.O.S. DRAFTING STANDARDS ADOPTED FEB.2007

	BY:	DATES
DRAWN:	HT	11/14
REVISED:	MLF	11/14
CHECKED:	TW	11/14
APPROVED:	MLF	11/14

CITY OF SPOKANE, WASHINGTON
DEPARTMENT OF ENGINEERING SERVICES
808 WEST SPOKANE FALLS BLVD.
SPOKANE, WASHINGTON 99201-3343
(509) 625-6700

PROJECT NAME: RIVERFRONT PARK BRIDGES

BRIDGE NAME: HOWARD STREET SOUTH
BRIDGE REPLACEMENT

PLAN AND ELEVATION

TYPE OF IMPROVEMENT: BRIDGE

CITY PROJECT NUMBER: 2013186

PLAN NUMBER: 1 of 3

DFN: --

CALL BEFORE YOU DIG 1-800-424-5555

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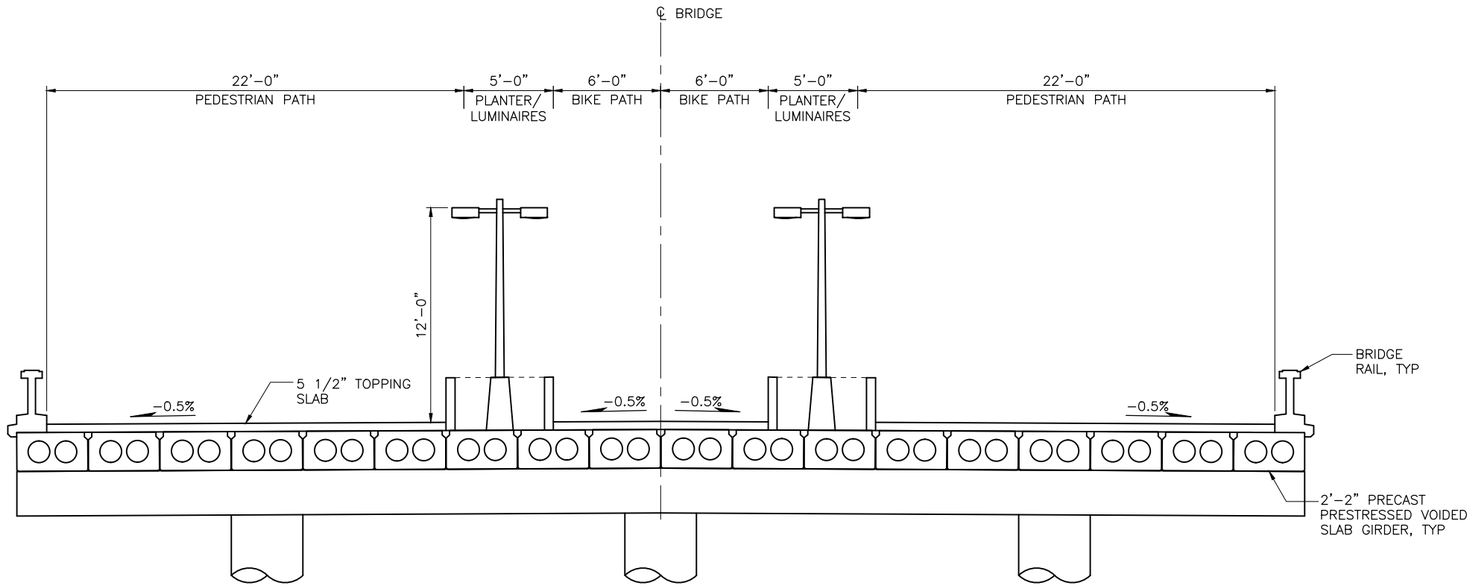
EASTERN	WASH.	---	



TYPICAL SECTION REPLACEMENT – OPTION #1

TYPICAL SECTION EXISTING BRIDGE

REVISIONS							
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DATE	BY	PROJ.	E.F.N. U.S.N.	FROM	TO	COUNCIL ACCEPT DATE

GRADE ORDINANCE LIST					
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SCALE

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CITY OF SPOKANE, WASHINGTON
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808 WEST SPOKANE FALLS BLVD.
SPOKANE, WASHINGTON 99201-3343
(509) 625-6700

PROJECT NAME: RIVERFRONT PARK BRIDGES
BRIDGE NAME: HOWARD STREET SOUTH
BRIDGE REPLACEMENT
TYPICAL SECTION

TYPE OF IMPROVEMENT: BRIDGE
CITY PROJECT NUMBER: 2013186
PLAN NUMBER: 2 of 3
DPW: --

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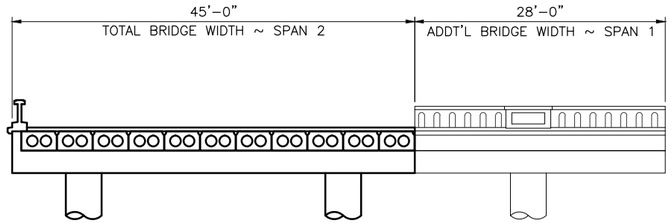
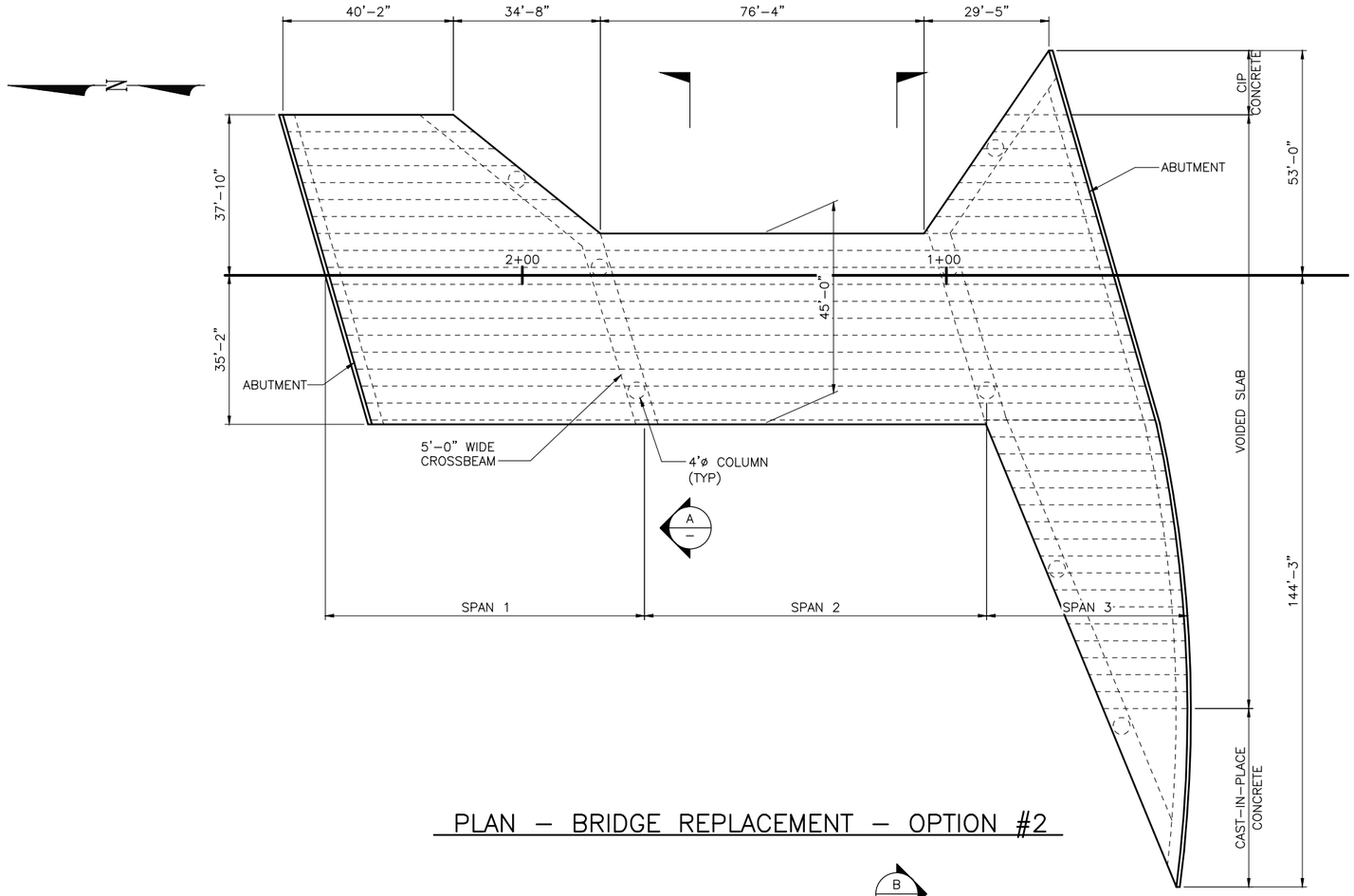
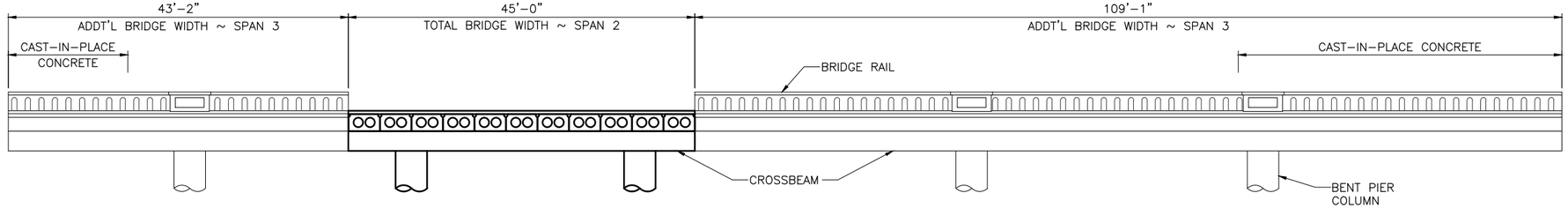


SECTION A
LOOKING NORTH



PLAN – BRIDGE REPLACEMENT – OPTION #2

B



SECTION B
LOOKING SOUTH

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REVISIONS

DATE	BY	PROJ.	E.F.N.	U.S.N.	FROM	TO	COUNCIL ACCEPT DATE

AS BUILT

FROM	TO	ORD. NO.	DATE	FILE NO.

GRADE ORDINANCE LIST

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CRM NO.: -

NAVD88 DATUM

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SCALE

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SPOKANE, WASHINGTON 99201-3343
(509) 625-6700

PROJECT NAME: RIVERFRONT PARK BRIDGES

BRIDGE NAME: HOWARD STREET SOUTH BRIDGE REPLACEMENT

PLAN AND SECTIONS

TYPE OF IMPROVEMENT: BRIDGE
CITY PROJECT NUMBER: 2013186
PLAN NUMBER: 3 of 3
EFN: --

CALL BEFORE YOU DIG 1-800-424-5555

City of Spokane Pedestrian Bridges Nov-14

Cost Estimates for Bridge Improvements Based on the 2014 KPFF Inspection and Analysis Recommendations

Bridge Name: Howard Street South Bridge Option 1
Bridge Length and Width (feet) 205 71

Recommendations for Improvements - Include: Replace existing bridge with a 3-span structure on similar footprint

Item no	Item Description	Cost Unit	Quantity	Unit Cost		Item Cost
1	Remove existing structure(s)	SQ FT	13135	30	$	394,050
2	Precast Conc Girders	LF	3639	300	$	1,091,625
3	5 " concrete deck overlay	CUYD	225	750	$	168,461
4	Concrete Piers	CUYD	150	1000	$	150,000
5	Pile Foundations (Abut & Piers)	EA	44	5000	$	220,000
6	Concrete Abutments & Wingwalls (2)	CUYD	200	1000	$	200,000
7	Bridge Railing (aesthetic)	LF	410	200	$	82,000
8	Bearings -Exp Joints - Drainage	LS	1	150000	$	150,000
9	Landscaping and Bank Enhancements	LS	1	50000	$	50,000
	Total				$	2,506,136
10	Mobilization	10%			$	250,614
11	Design, Permits, Hydraulic, Geotech, Survey	15%			$	375,920
12	Construction Management	13%			$	313,267
13	Taxes	8%			$	200,491
14	Contingency	30%			$	751,841
15	Excalation (1 year)	3%			$	75,184
16	Agency Project Development & Mngmt.	5%			$	125,307
	Total				$	2,092,623
	Total Project Cost (2015)				**$**	**4,598,759**
	Square Foot Cost ($/SF)				$	316

City of Spokane Pedestrian Bridges Nov-14

Cost Estimates for Bridge Improvements Based on the 2014 KPFF Inspection and Analysis Recommendations

Bridge Name: Howard Street South Bridge Option 2
Bridge Length and Width (feet) 205 varies

Recommendations for Improvements - Include: Replace existing bridge with a 3-span structure with "flaired" approach spans

Item no	Item Description	Cost Unit	Quantity	Unit Cost		Item Cost
1	Remove existing structure(s)	SQ FT	13135	30	$	394,050
2	Precast Conc Girders	LF	3639	375	$	1,364,531
3	5 " concrete deck overlay	CUYD	225	750	$	168,461
4	Concrete Piers	CUYD	225	1000	$	225,000
5	Pile Foundations (Abut & Piers)	EA	66	5000	$	330,000
6	Concrete Abutments & Wingwalls (2)	CUYD	300	1000	$	300,000
7	Bridge Railing (aesthetic)	LF	480	260	$	124,800
8	Bearings -Exp Joints - Drainage	LS	1	225000	$	225,000
9	Landscaping and Bank Enhancements	LS	1	75000	$	75,000
	Total				$	3,206,842
10	Mobilization	10%			$	320,684
11	Design, Permits, Hydraulic, Geotech, Survey	15%			$	481,026
12	Construction Management	13%			$	400,855
13	Taxes	8%			$	256,547
14	Contingency	30%			$	962,053
15	Excalation (1 year)	3%			$	96,205
16	Agency Project Development & Mngmt.	5%			$	160,342
	Total				$	2,677,713
	Total Project Cost (2015)				**$**	**5,884,555**
	Square Foot Cost ($/SF)				$	404

APPENDIX C

PHOTOGRAPH LOG
PHOTOGRAPH CONTACT SHEET

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Project	Riverfront Park Bridges Inspection	By	MLF	Sheet No.
Location	Spokane	Date	8/14/2014	1 OF 1
Client	City of Spokane			Job No.
Inspection Photo Log				114176.12

Bridge Name: Howard St South Channel Bridge

Date of Inspection: 8/13/2014

Photo No.	Location	Notes	By
920	Pier 1, West corner	Concrete spalls at pavement seat	PG
921	Pier 1, West corner	Concrete spalls at pavement seat / Cracks in Retaining Wall	PG
922	General	Exterior girders	PG
923	Pier 1, East corner	Material sloughing in from retaining wall	PG
924	Pier 1, East corner	Material sloughing in from retaining wall	PG
925	Pier 1, East corner	Material sloughing in from retaining wall	PG
926	Girder E	Efflorescense under girder	PG
927	Girder D	Rust stained efflorescense under Girder D	PG
928	Girder D	Rust stained efflorescense under Girder D	PG
929	Span 1, Girder B	Exposed reinforcement, cracks, spalls efflorescence	PG
930	Span 1, Girder B	Exposed reinforcement, cracks, spalls efflorescence	PG
931	Pier 2	Cap submereged in low water	PG
932	Span 1, Btw. Gir B/C	Exposed reinforcement	PG
933	Btw. Gir D/E	Heavy efflorescence in soffit	PG
934		Water dripping from soffit (rain night before)	PG
939	Span 1, Gir F	3 ft. long spalll	PG
940	Pier 3, Girder E	Crack in pile cap above Pile B	PG
941	Span 3, Girder E	Spalling, exposed rebar	PG
942	Span 3, Girder E	Spalling, exposed rebar	PG
944	Span 3, Girder E	Spalling, exposed rebar	PG
945	Span 3, Btw. Gir A/B	Exposed rebar in soffit	MF
946	Span 3, Btw. Gir E/F	Heavy leaching, cracks in soffit	MF
947	Span 3, Btw. Gir E/F	Leaching, spalls, delaminations in soffit	MF
948	Pier 6	Leaching cracks and spalls	MF
949	Span 5, Girder E	Spall, exposed corroded rebar	MF
950	Span 5, Girder E	Spall, exposed corroded rebar	MF
1989	Elevation	Elevation, looking west	MF
1990	Elevation	Elevation, looking west	MF
1991	Deck	Deck, looking north	MF

Howard Street Bridge South Channel Photographs


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