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Scour Evaluation Model Implementation Phase

(Volume 2 of 2)

FINAL REPORT
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Submitted by

John R. Schuring, PE, PhD
Professor of Civil & Environmental Engineering
New Jersey Institute of Technology

Robert Dresnack, PE, PhD
Professor of Civil & Environmental Engineering
New Jersey Institute of Technology

Eugene Golub, PE, PhD
Professor of Civil & Environmental Engineering
New Jersey Institute of Technology

NJDOT Research Project Manager
Ms. Pragna Shah

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16. Abstract

The overall goal of this project was to launch New Jersey's new Scour Evaluation Model (SEM) and to begin applying it to the State's inventory of scour critical bridges. SEM is designed to evaluate the scour risk of non-tidal bridges. The model offers new scour assessment methods and protocols, while still retaining the applicable parts of HEC-18. The study commenced with a prescreening phase that identified 17 high risk bridges requiring repair or replacement. The next project task evaluated 12 bridges using SEM to fully demonstrate the method. These evaluations yielded a number of low risk bridges, which were recommended for removal from the scour critical list. Three New Jersey consulting firms participated in the project for the purposes of technology transfer. The study also investigated the use of envelope curves to assess scour, finding that envelope curves can be an effective tool within select geologic regions within the State. The project concluded with seven supplemental SEM bridge evaluations to further validate the model.

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APPENDICES

APPENDIX A

SUPPLEMENTAL SEM EVALUATIONS

Towards the end of the research study, seven supplemental SEM evaluations were done to further validate the model. The evaluations were performed by the project Consultants in coordination with the Research Team. At the request of the Research Customer, the effort was directed towards high risk bridges.

The supplemental bridges are listed in **Table A.1** along with each respective location, physiographic province, erosion class, and maximum flow seen. The SEM results for each bridge are also summarized in the table. Included are the Scour Priority Level (1 thru 4) based on the risk analyses and the FHWA Item 113 coding. In summary, the risk level findings for the supplemental study group were:

- 4 more bridges were found to be Priority 1 (high risk)
- 1 more bridge was found to be Priority 2 (high to medium risk)
- 1 more bridge was found to be Priority 3 (medium to low risk)
- 1 more bridge was found to be Priority 4 (low risk)

These recommendations were presented to NJDOT for appropriate administrative action. In addition, SEM reports were generated for each bridge and have been submitted separately. See **Appendix C**.

Table A.1 – Summary of Key Findings and Data for "Supplemental" SEM Study Bridges

	Bridge No.	SEM Priority	Consultant	Location	County	Province	Erosion Class	Substantial Scour	Q100 seen	NBIS 113 Coding
1	0216-150	1	AECOM	Route 17 over Sprout Brook	Bergen	Piedmont	G2	Yes	90.2%	3
2	0218-162	1*	Mott MacDonald	Route 17 Southbound over Route 202 and Ramapo River	Bergen	Highlands	G3	Yes	114.7%	3
3	1303-155	1	Mott MacDonald	U.S. 9 over Milford Brook	Monmouth	Coastal Plain	G3	Yes	78.5%	3
4	1320-152	1*	Mott MacDonald	Route 71 over Wreck Pond	Monmouth	Coastal Plain	G3	Yes	69.9%	3
5	2113-160	2	AECOM	I-78 Westbound over Musconetcong River and Asbury Road	Warren/ Hunterdon	Highlands	G2/G3	No	94.4%	3
6	1005-153	3** DM&R	AECOM	Route 22 over Rockaway Brook	Hunterdon	Piedmont	G2/G3	No	86.8%	4
7	0218-161	4	Mott MacDonald	Route 17 Northbound over Route 202 and Ramapo River	Bergen	Highlands	G2/G3	No	114.7%	5

* Indicates the bridge has a SEM matrix priority of 1. The bridge was also found to be important using the Bridge Importance Analysis.

** Indicates the bridge requires "Directed Maintenance and Repair" to protect a specific element or section from the effects of scour.

APPENDIX B

SEM SUMMARY FORMS

Examples from "Task 2: Evaluation of Scour Critical Bridges Using SEM," including the following 3 bridges:

1102-150
1810-155
2107-156

Examples from "Task 1: Prescreening of High Risk Bridges," including the following 2 bridges:

0606-150
1912-160

Examples from "Supplemental SEM Evaluations," including the following 3 bridges:

0218-161
1005-153
2113-160

SEM Summary Form

Struct. No: **1102-150** Route/Stream: **Route US 1B over Shabakunk Creek** County: **Mercer**
Length: **67.3 ft** No. Spans: **2** Year Built/Reconstr.: **1928/1938** Foundation: **Unreinf./Reinf. Concrete footings**

Geo Data	Field Scour Observations	Hydro/Hydraulic Data
Province: **Coastal Plain near boundary with Non-Glaciated Piedmont** Bed: **Predominantly sand and gravel with some silt** Borings? **No**	Source: **Stage II & SEM Visit** Findings: **Up to 4 ft local/contraction scour north span; up to 3 ft aggradation south span; vertical crack in center pier (at widening joint).** Substantial Scour? **Yes**	% Q100 Seen: **276%.1% (1975)** Envelope Curve OK? **Checked; Not OK** Channel: **Minimal skew; minor constriction; laterally stable.** V_{100}= **6.9 fps**

Geo Risk	Comments	Hydro/Hydraulic Risk
Erosion Class: **G3** Age: **> 50 years** Substantial Scour? **Yes**	General: **Currently NJDOT Scour Critical.** Assessed or Calculated Scour Conditions: **Scour from historic 1975 storm apparently caused upstream end of center pier to settle ~5 inches; remain NJDOT Scour Critical; repair or replace.**	Erosion Class: **G3** 100 yr storm seen? **Yes (276.1%)** Substantial Scour: **Yes** Envelope Curve OK? **Checked; Not OK**
Risk Level: High		**Risk Level: High**

Hydrologic/Hydraulic Risk \ Geotechnical Risk	High	Medium	Low
High	Scour Priority 1 ●	Scour Priority 2	Scour Priority 3
Medium	Scour Priority 2	Scour Priority 3	Scour Priority 4
Low	Scour Priority 4	Scour Priority 4	Scour Priority 4

Matrix Priority = **1**

Bridge Importance Analysis

Special Importance? **No**

ADT = **35,400** veh/day
Bridge Length = **67.9** ft
Detour Length (Detour Risk) = **0.55** mi
ARF = $\frac{(ADT)\ (Length)}{1000}$ = **2,404**

Change Scour Priority? **No Change**

Item 113 Coding = **3**

Final Scour Priority = 1



Photo SEM-1: Looking north along girder at upstream fascia; note ~5 inch sag at center pier due to settlement.



Photo SEM-2: Looking downstream at bridge; joint between girder ends open at bottom and crushing together at top due to pier settlement.

SEM Summary Form

Struct. No: **1810-155** Route/Stream: **Route 206 over Cruzers Brook** County: **Somerset**
Length: **71 ft** No. Spans: **3** Year Built/Reconstr.: **1925** Foundation: **Plain Concrete spread footings**

Geo Data	Field Scour Observations	Hydro/Hydraulic Data
Province: **Piedmont** Bed: **Predominantly sand, silt and clay with cobbles and gravel and few boulders on surface. Located on fractured shale.** Borings? **Yes, 8 (1969)**	Source: **Stage II & SEM** Findings: **No exposed footings; minor aggradation and degradation** Substantial Scour? **No**	% Q100 Seen: **176% (1999)** Envelope Curve OK? **N/A** Channel: **Some sedimentation; low skew; Laterally Stable; V_{100}= 4.6 ft/s**

Geo Risk	Comments	Hydro/Hydraulic Risk
Erosion Class: **R1** Age: **> 50 years** Substantial Scour? **No**	General: **Currently, NJDOT Scour Critical; confirmed shale under stream bed; footings embedded in shale.** Assessed or Calculated Scour Conditions: **Stable. Remove from Critical List.**	Erosion Class: **R1** 100 yr storm seen? **Yes (176%)** Substantial Scour: **No** Envelope Curve OK? **N/A**
Risk Level: Medium or Low		**Risk Level: Low**

Hydrologic/Hydraulic Risk \ Geotechnical Risk	High	Medium	Low
High	Scour Priority 1	Scour Priority 2	Scour Priority 3
Medium	Scour Priority 2	Scour Priority 3	Scour Priority 4
Low	Scour Priority 4	Scour Priority 4	Scour Priority 4

Matrix Priority = 4

Bridge Importance Analysis – Not Required

Special Importance?

ADT = veh/day
Bridge Length =
Detour Length (Detour Risk) = ___mi
ARF = $\frac{(ADT)\ (Length)}{1000}$ =

Change Scour Priority?
ARF < 2500
No Change

Item 113 Coding = **Currently 3, update to 8**

Final Scour Priority = 4



SEM Summary Form

Struct. No: **2107-156** Route/Stream: **Route 46 over Paulins Kill** County: **Warren**
Length: **91.4 ft** No. Spans: **3** Year Built/Reconstr.: **1933** Foundation: **Reinf. Concrete spread footings**

Geo Data	Field Scour Observations	Hydro/Hydraulic Data
Province: **Valley and Ridge** Bed: **Silt, sand, and gravel, with cobbles and boulders** Borings? **Yes, original**	Source: **Stage II & SEM Visit** Findings: **Spread footing at west abutment exposed at some locations (overflow channel); pier footings and east abutment not exposed.** Substantial Scour? **No**	% Q100 Seen: **136.4% (1955)** Envelope Curve OK? **N/A** Channel: **Low upstream skew; laterally Stable; V_{100}= 6.1 ft/s; no restriction**

Geo Risk	Comments	Hydro/Hydraulic Risk
Erosion Class: **G1** Age: **> 50 years** Substantial Scour? **No**	General: **Currently, NJDOT Scour Critical; definite extremely coarse particle (ECP) bed; tributary to Delaware River ~ 200 yards downstream.** Assessed or Calculated Scour Conditions: **Above top of footings, stable. Remove from Critical List.**	Erosion Class: **G1** 100 yr storm seen? **Yes (136.4%)** Substantial Scour: **No** Envelope Curve OK? **N/A**
Risk Level: Low		**Risk Level: Low**

Hydrologic/Hydraulic Risk \ Geotechnical Risk	High	Medium	Low
High	Scour Priority 1	Scour Priority 2	Scour Priority 3
Medium	Scour Priority 2	Scour Priority 3	Scour Priority 4
Low	Scour Priority 4	Scour Priority 4	Scour Priority 4

Matrix Priority = 4

Bridge Importance Analysis – Not Required	
Special Importance? **No**	
ADT = **17,400** veh/day Bridge Length = **91.4** ft Detour Length (Detour Risk) = _*_mi ARF = (ADT) (Length) / 1000 = **1,590**	Change Scour Priority? **No Change**
Item 113 Coding = **Currently 3, update to 8**	
Final Scour Priority = 4	



Photo SEM-1: Looking downstream towards the bridge fascia (Main Channel – Eastern Abutment and Pier 1 visible)



Photo SEM-2: Looking upstream at bridge (Main Channel – Eastern Abutment and Pier 1 visible)

SEM Analysis Summary

Version 1.0

Basic Data				Date: 8/3/2015
Structure No: 0606-150	Route No/Stream: Rt. 49 over Menantico River			
County: Cumberland	Length: 23 ft	No. Spans: 1	Year Built: 1929	Reconstr:
Bridge/Foundation Description: Reinforced concrete slab with fill; concrete gravity type with vertical face abutments; spread footings				

Geotechnical Analysis	Hydrologic/Hydraulic Analysis
Reconnaissance Study	*Reconnaissance Study*
Physiographic Province: Coastal Plain	Physiographic Province: Coastal Plain
Geo Sources Reviewed: USGS Surficial X Rutgers X USDA __ NJDOT Logs __ Other _____	USGS Gage: ___ Distance = ___mi Record Flow: ___ cfs Year: _____ USGS Q_{100} = ___ cfs StreamStats Q_{100} = ___ cfs
Stage II Summary	
No. Borings Drilled: Orig. Construct.: 0 Stage II Deep: 1 Stage II Shallow: 2	Lab Tests: Sample Depth: 1 ft Grain Size Range 0.07 to 25 mm D_{50} used scour calcs: 0.29 mm
Comments:	Channel Findings: Flow restriction; high velocity, V=11.4fps
	Proportion of Q_{100} Seen: <100%

Field Scour Investigation	
SEM Findings	*Stage II Findings/USGS Erosion Data/ NBIS Fascia*
Level: Full __ Abbrev. X Summary: Similar to Stage II	Summary: Stg II: Substantial scour; east and west abutment footings exposed with undermining at upstream end.

Geotechnical Risk		Hydrologic/Hydraulic Risk	
Erosion Class: G3, Fine to Medium Granular Soil		Erosion Class: G3, Fine to Medium Granular Soil	
Bridge Age >50 yrs? Yes	Substantial Field Scour? Yes	100 Yr Storm Seen? No	Substantial Field Scour? Yes
Calculation Results (if applic.):		Envelope Curve Results (if applic.): Checked: Not OK	
Risk Level: High		Risk Level: High	

Risk Decision Matrix

Hydrologic/Hydraulic Risk \ Geotechnical Risk	High	Medium	Low
High	Scour Priority 1 ●	Scour Priority 2	Scour Priority 3
Medium	Scour Priority 2	Scour Priority 3	Scour Priority 4
Low	Scour Priority 4	Scour Priority 4	Scour Priority 4

Matrix Priority = 1

Bridge Importance Analysis	
Special Importance Category (if any): (e.g. Interstate, SHARAHNET)	
ADT = 4900 veh/day Bridge Length = 23 ft Detour Length (Detour Risk) = 1 mi ARF = (ADT) (Length) / 1000 = 113	Change Scour Priority? No Change
Item 113 Coding =	
Final Scour Priority = 1	

SEM Analysis Summary

Version 1.0

Basic Data				Date: 8/3/2015
Structure No: 1912-160	Route No/Stream: Rt. 206 over Big Flat Brook			
County: Sussex	Length: 93 ft	No. Spans: 2	Year Built: 1929	Reconstr:
Bridge/Foundation Description: Simply supported, concrete encased stringers; plain concrete full height vertical abutments; plain concrete solid wall piers; spread footings for piers and abutments				

Geotechnical Analysis	Hydrologic/Hydraulic Analysis
Reconnaissance Study	Reconnaissance Study
Physiographic Province: Ridge and Valley	Physiographic Province: Ridge and Valley
Geo Sources Reviewed: USGS Surficial _X_ Rutgers _X_ USDA__ NJDOT Logs__ Other_____	USGS Gage: ___ Distance = ___mi Record Flow: ___ cfs Year: _____ USGS Q_{100} = ___ cfs StreamStats Q_{100} = ___ cfs
Stage II Summary	
No. Borings Drilled: Orig. Construct.: 0 Stage II Deep: 0 Stage II Shallow: 2 Lab Tests: Sample Depth: 1 ft Grain Size Range 0.075 to 50 mm D_{50} used scour calcs: 8.97 mm	Channel Findings: Moderate flow restriction; channel gradient steepens significantly downstream of bridge, V=7.2 fps
Comments:	Proportion of Q_{100} Seen: >100%

Field Scour Investigation	
SEM Findings	Stage II Findings/USGS Erosion Data/ NBIS Fascia
Level: Full__ Abbrev. _X_ Summary: Similar to USGS	Summary: USGS: Substantial scour; up to 3.8 ft bed erosion during Irene; center pier footing exposed upstream face

Geotechnical Risk		Hydrologic/Hydraulic Risk	
Erosion Class: G1, Extremely Coarse Granular Soil		Erosion Class: G1, Extremely Coarse Granular Soil	
Bridge Age >50 yrs? Yes	Substantial Field Scour? Yes	100 Yr Storm Seen? Yes	Substantial Field Scour? Yes
Calculation Results (if applic.):		Envelope Curve Results (if applic.): Not Applicable	
Risk Level: High		Risk Level: Medium	

Risk Decision Matrix

Hydrologic/Hydraulic Risk \ Geotechnical Risk	High	Medium	Low
High	Scour Priority 1	Scour Priority 2	Scour Priority 3
Medium	● Scour Priority 2	Scour Priority 3	Scour Priority 4
Low	Scour Priority 4	Scour Priority 4	Scour Priority 4

Matrix Priority = 2

Bridge Importance Analysis	
Special Importance Category (if any): (e.g. Interstate, SHARAHNET)	
ADT = 11000 veh/day Bridge Length = 93 ft Detour Length (Detour Risk) = 1 mi ARF = (ADT) (Length) / 1000 = 1023	Change Scour Priority? No Change
Item 113 Coding =	
Final Scour Priority = 2	

SEM Quick Form Bridge No. 0218-161 (7/11/17)

Struct. No: **0218-161** Route/Stream: **Route 17N over Rt 202 & Ramapo River** County: **Bergen**

Length: **268.6 ft** No. Spans: 3 Year Built/Reconstr.**1956** Foundation: **Concr. footings, N abut / pier 1 on piles**

Geo Data	Field Scour Observations	Hydro/Hydraulic Data
Province: **Highlands near boundary with Piedmont** Bed: **Predominantly sand and gravel with some silt, clay, & organics** Borings? **No**	Source: **Stage II & SEM Visit** Findings: **Up to 2 ft local/contraction scour; erosion at upstream north bank; aggradation upstream south bank; minor contraction scour in channel** Substantial Scour? **No**	% Q100 Seen: 114.6% **(2011)** Envelope Curve OK? **N/A** Channel: **Minimal skew; minor constriction; laterally stable.** V_{100}= **8.53 fps (main channel)** **Velocities are less in overbank flows (pier 2 & 3)**

Geo Risk	Comments	Hydro/Hydraulic Risk
Erosion Class: **G3** Age: **> 50 years** Substantial Scour? **No**	General: Currently NJDOT Scour Critical Assessed or Calculated Scour Conditions: Stable **Scour not determined to be substantial.** Bridge is candidate for removal from the scour critical list	Erosion Class: **G3** 100 yr storm seen? **Yes (114.6%)** Substantial Scour: **No** Envelope Curve OK? **N/A**
Risk Level: Med		**Risk Level: Low**

Hydrologic/Hydraulic Risk	Geotechnical Risk: High	Geotechnical Risk: Medium	Geotechnical Risk: Low
High	Scour Priority 1	Scour Priority 2	Scour Priority 3
Medium	Scour Priority 2	Scour Priority 3	Scour Priority 4
Low	Scour Priority 4	Scour Priority 4 ●	Scour Priority 4

Bridge Importance Analysis – Not Required	
Special Importance?	
ADT = **38,050** veh/day	Change Scour Priority? **N/A, No Change**
Item 113 Coding = **5**	
Final Scour Priority = 4	



Photo SEM-1: Looking Downstream at Bridge
(Pier 1 and Pier 2 Visible)

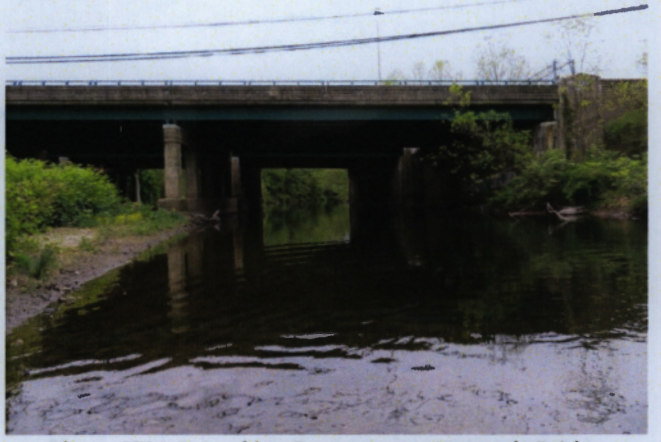


Photo SEM-2: Looking Downstream Towards Bridge
(Pier 1 and North Abutment Visible)

SEM Analysis Summary

Version 1.0

Basic Data				Date: 7/21/2017
Structure No: 1005-153	Route No/Stream: U.S. Rt. 22 over Branch Rockaway Creek			
County: Hunterdon	Length: 26 ft	No. Spans: 1	Year Built: 1942	Reconstr: N/A
Bridge/Foundation Description: Single span, reinforced concrete rigid frame without fill; abutments reinforced concrete vertical walls and spread footings.				

Geotechnical Analysis		Hydrologic/Hydraulic Analysis
Reconnaissance Study		Reconnaissance Study
Physiographic Province: Non-Glaciated Highlands		Physiographic Province: Non-Glaciated Highlands
Geo Sources Reviewed: USGS Surficial _X_ Rutgers _X_ USDA __ NJDOT Logs __ Other _____		USGS Gage: 01399670 Distance = 3.6 mi U/S Record Flow: 2,620 cfs Year: 1999 USGS Q_{100} = 3,019 cfs StreamStats Q_{100} = 2,160 cfs
Stage II Summary		
No. Borings Drilled: Orig. Construct.: 0 Stage II Deep: 0 Stage II Shallow: 2	Lab Tests: Sample Depth: 1 ft Grain Size Range 0.07 to 50 mm D_{50} used scour calcs: 0.40 mm	Channel Findings: Severe bend U/S of about 75 deg, smaller bend D/S; minor constriction
Comments:		Proportion of Q_{100} Seen: 87%

Field Scour Investigation	
SEM Findings	Stage II Findings/USGS Erosion Data/ NBIS Fascia
Level: Full __ Abbrev. _X_ Summary: Based on visual inspection from top of the bridge, channel bed is covered with coarse granular materials with occasional cobbles. Aggradation on both sides on inside of bends.	Summary: Stg II: (1997) undermining of NE WW and abut. footings at NE corner; E. Abut. footing exposed about 30 ft. Bridge on severe bend; constriction; heavy sediment deposits. NJIT (2017) soundings: U/S E. Abut. 1 ft riprap cover & W. Abut. 4 ft (like 1997).

Geotechnical Risk		Hydrologic/Hydraulic Risk	
Erosion Class: G2/G3, Coarse/Fine to Medium Granular Soil		Erosion Class: G2/G3, Coarse/Fine to Medium Granular Soil	
Bridge Age >50 yrs? Yes	Substantial Field Scour? No	100 Yr Storm Seen? No	Substantial Field Scour? No (historic scour; now riprap)
Calculation Results (if applic.):		Envelope Curve Results (if applic.): N/A	
Risk Level: Medium		Risk Level: Medium	

Risk Decision Matrix

Hydrologic/Hydraulic Risk \ Geotechnical Risk	High	Medium	Low
High	Scour Priority 1	Scour Priority 2	Scour Priority 3
Medium	Scour Priority 2	Scour Priority 3 ●	Scour Priority 4
Low	Scour Priority 4	Scour Priority 4	Scour Priority 4

Matrix Priority = 3 with Directed Maintenance & Repair

Bridge Importance Analysis	
Special Importance Category (if any): None (e.g. Interstate, SHARAHNET)	
ADT = 27,520 veh/day (2014) Bridge Length = 26 ft Detour Length (Detour Risk) = 2 mi ARF = (ADT) (Bridge Length) / 1000 = 716	Change Scour Priority? No Change; Detour & ARF Low Risk
Item 113 Coding = 4	
Final Scour Priority = 3	

SEM Analysis Summary

Version 1.0 **FIGURE 3**

Basic Data				Date: 7/24/2017
Structure No: 2113-160	Route No/Stream: U.S. Rt. I-78 WB over Musconetcong River & CR 632 (Asbury Rd)			
County: Warren	Length: 296 ft	No. Spans: 4	Year Built: 1959	Reconstr: 2005
Bridge/Foundation Description: Four span, simple supported, reinf. concrete stub abutment and multi-column piers. Piers 1 and 2 on spread footings, abutments and Pier 3 on steel bearing piles.				

Geotechnical Analysis		Hydrologic/Hydraulic Analysis
Reconnaissance Study		*Reconnaissance Study*
Physiographic Province: Non-Glaciated Highlands		Physiographic Province: Non-Glaciated Highlands
Geo Sources Reviewed: USGS Surficial _X_ Rutgers _X_ USDA __ NJDOT Logs __ Other _____		USGS Gage: 01457000 Distance = 1 mi downstream Record Flow: 7,200 cfs Year: 1979 USGS Q_{100} = 7,630 cfs StreamStats Q_{100} = 8,250 cfs
Stage II Summary		
No. Borings Drilled: Orig. Construct.: 0 Stage II Deep: 0 Stage II Shallow: 2	Lab Tests: Sample Depth: 0.5 ft Grain Size Range 0.07 to 10 mm D_{50} used scour calcs: 2.5 mm	Channel Findings: Straight channel; parallel EB bridge downstream; fast water flow.
Comments:		Proportion of Q_{100} Seen: 94.4%

Field Scour Investigation	
SEM Findings	*Stage II Findings/USGS Erosion Data/ NBIS Fascia*
Level: Full __ Abbrev. _X_ Summary: Between Piers 1 and 2, overburden is fill material comprising silty sand with hard bed density. In the main channel bed (between Piers 2 and 3) near Pier 2 is protected with occasional riprap.	Summary: Stg II: Piers 2 and 3 on river banks; both had riprap protection, but not present during 1992 Stage II inspection. NJIT soundings (2017) indicate riverbed about same elevation as Stage II and original construction. Land side of pier about 4 ft higher.

Geotechnical Risk		Hydrologic/Hydraulic Risk	
Erosion Class: G2/G3, Coarse/Fine to Medium Granular Soil		Erosion Class: G2/G3, Coarse/Fine to Medium Granular Soil	
Bridge Age >50 yrs? Yes	Substantial Field Scour? No	100 Yr Storm Seen? No	Substantial Field Scour? No
Calculation Results (if applic.):		Envelope Curve Results (if applic.): Potential scour below bottom of Pier 2 spread footing.	
Risk Level: Medium		Risk Level: Medium	

Risk Decision Matrix

Hydrologic/Hydraulic Risk \ Geotechnical Risk	High	Medium	Low
High	Scour Priority 1	Scour Priority 2	Scour Priority 3
Medium	Scour Priority 2	Scour Priority 3 ●	Scour Priority 4
Low	Scour Priority 4	Scour Priority 4	Scour Priority 4

Matrix Priority = 3

Bridge Importance Analysis	
Special Importance Category (if any): Interstate (e.g. Interstate, SHARAHNET)	
ADT = 48,600 veh/day (2014) Bridge Length = 296 ft Detour Length (Detour Risk) = 2 mi ARF = (ADT) (Bridge Length) / 1000 = 14,385	Change Scour Priority? Change 3 to 2; Interstate & ARF High Risk
Item 113 Coding = 3	
Final Scour Priority = 2	

APPENDIX C

SEM REPORTS GENERATED DURING THE STUDY

Table C.1 – Listing of Consultant SEM Reports*

	Bridge No.	Consultant	Title	Date	Project Phase	No. of Pages
1	**0119-151**	AECOM	SEM Analysis and Stage III Evaluation Report, Structure No. 0119-151, Route 322 Over Hospitality Brook	December 2016	Initial	73
2	**0216-150**	AECOM	Abbreviated SEM Analysis Report, Structure No. 0216-150, Route 17 Over Sprout Brook	July 2017	Supple-mental	16
3	**0218-161**	Mott MacDonald	Bridge Scour Analysis Using the Scour Evaluation Model of NJDOT Bridge No. 0218-161	July 7, 2017	Supple-mental	69
4	**0218-162**	Mott MacDonald	Bridge Scour Analysis Using the Scour Evaluation Model of NJDOT Bridge No. 0218-162	July 10, 2017	Supple-mental	66
5	**0324-155**	McCormick Taylor	Bridge Scour Evaluation and Geotechnical Reconnaissance Study, Route 206 Over South Branch Rancocas Creek, Structure No. 0324-155	July 2017	Initial	20
6	**0324-156**	AECOM	SEM Analysis and Stage III Evaluation Report, Structure No. 0324-156, Route 206 Over Jade Run	December 2016	Initial	63
7	**0324-160**	McCormick Taylor	Bridge Scour Evaluation and Geotechnical Reconnaissance Study, Route 206 Over Barkers Brook, Structure No. 0324-160	July 2017	Initial	18
8	**0709-150**	McCormick Taylor	Bridge Scour Evaluation and Geotechnical Reconnaissance Study Route 10 Over Willow Meadow Brook, Structure No. 0709-150	July 2017	Initial	18
9	**1005-153**	AECOM	Abbreviated SEM Analysis Report, Structure No. 1005-153, U.S. Route 202 Over Branch of Rockaway Creek	July 2017	Supple-mental	16
10	**1102-150**	Mott MacDonald	Bridge Scour Analysis Using the Scour Evaluation Model of NJDOT Bridge No. 1102-150, Route 1B Over Shabakuk Creek	January 15, 2017	Initial	100
11	**1303-155**	Mott MacDonald	Bridge Scour Analysis Using the Scour Evaluation Model of NJDOT Bridge No. 1303-155	July 25, 2017	Supple-mental	41
12	**1320-152**	Mott MacDonald	Bridge Scour Analysis Using the Scour Evaluation Model of NJDOT Bridge No. 1320-152	July 25, 2017	Supple-mental	39
13	**1405-156**	Mott MacDonald	Bridge Scour Analysis Using the Scour Evaluation Model of NJDOT Bridge No. 1405-156, Route 23 Pequannock River, Hamburg Turnpike SB, and NYS & WRR	January 15, 2017	Initial	111
14	**1417-156**	Mott MacDonald	Bridge Scour Analysis Using the Scour Evaluation Model of NJDOT Bridge No. 1417-156, Route 206 Over South Branch of Raritan River – Conlon Pond Brook	January 15, 2017	Initial	77

* All reports were submitted to NJDOT and placed on file.

Table C.1 – Listing of Consultant SEM Reports* (Continued)

15	**1809-150**	AECOM	SEM Analysis and Stage III Evaluation Report, Structure No. 1809-150, US Route 22 Over North Branch Raritan River	December 2016	Initial	86
16	**1810-155**	McCormick Taylor	Bridge Scour Evaluation and Geotechnical Reconnaissance Study Route 206 Over Cruzer Brook, Structure No. 1810-155	July 2017	Initial	18
17	**1810-158**	Mott MacDonald	Bridge Scour Analysis Using the Scour Evaluation Model of NJDOT Bridge No. 1810-158, Route 206 over Branch Crusers Brook	January 15, 2017	Initial	87
18	**2107-156**	Mott MacDonald	Bridge Scour Analysis Using the Scour Evaluation Model of NJDOT Bridge No. 2107-156, Route 46 over Paulins Kill	January 15, 2017	Initial	70
19	**2113-160**	AECOM	Abbreviated SEM Analysis Report, Structure No. 2113-160, I-78 WB Over Musconetcong River and CR 632 (Asbury Road)	July 2017	Supple-mental	16

* All reports were submitted to NJDOT and placed on file.

APPENDIX D

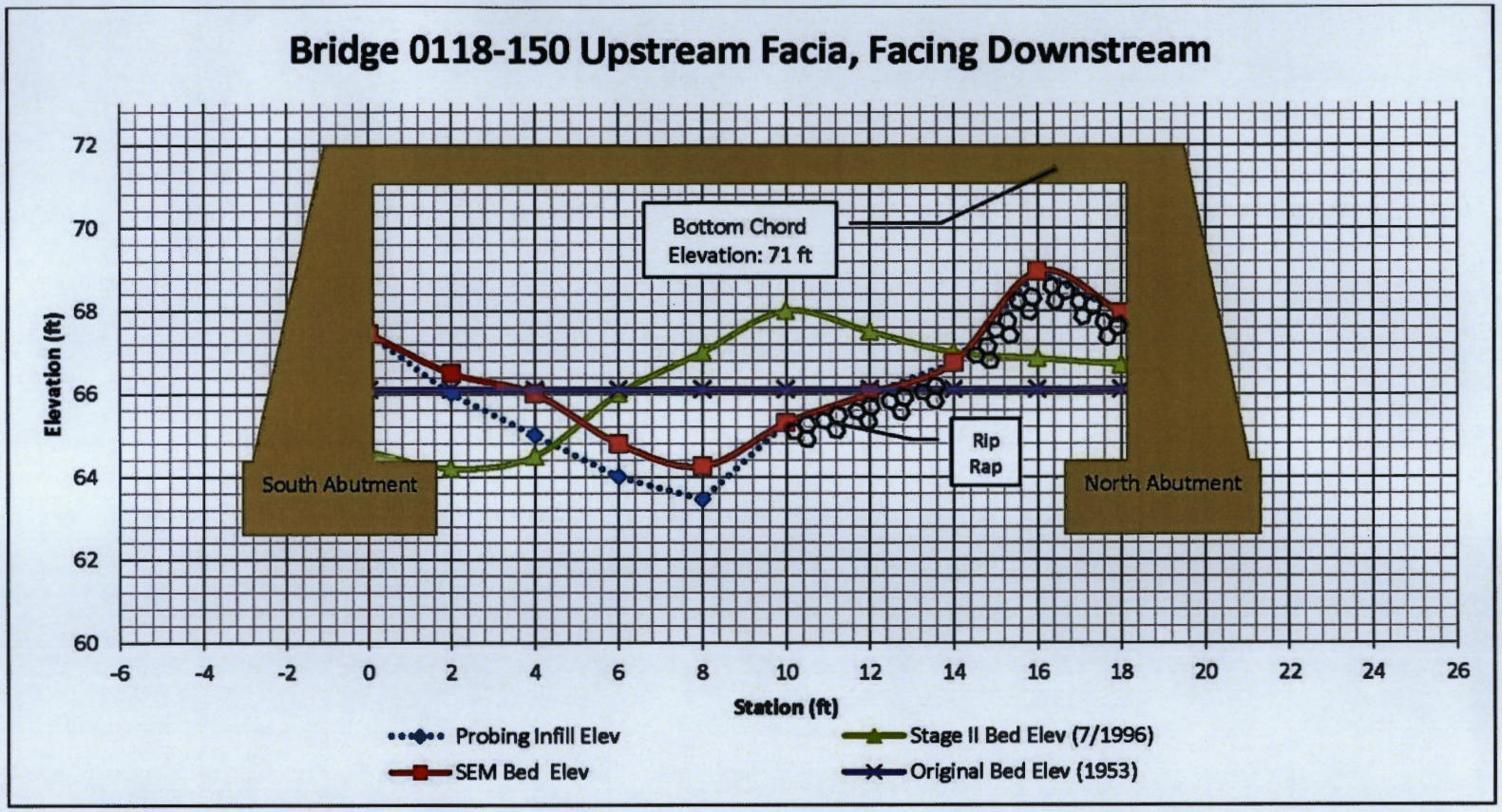
FASCIA SOUNDINGS

Including the following 15 bridges:

0118-150	1227-159
0118-152	1304-151
0119-151	1304-156
0324-156	2003-162
0606-150	2103-152
0807-152	2103-153
1102-150	2105-164
1105-152	

Subsurface Fascia Sounding

Bridge 0118-150 (Route 206 over Cedar Branch)

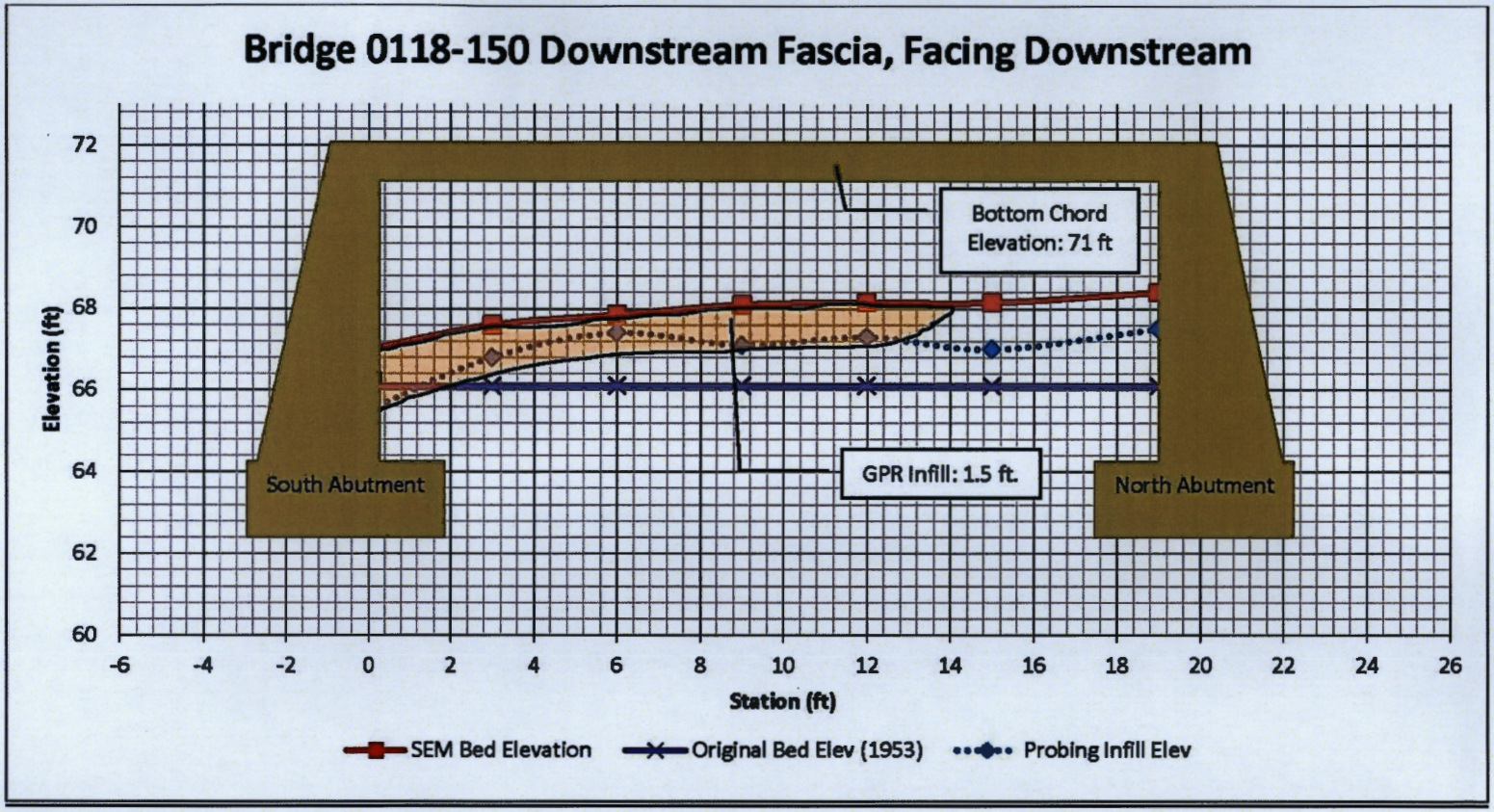


Notes:

- Vertical scale is exaggerated.
- All soundings are measured from the elevation of the chord as shown above, and assuming that the deck was level.
- SEM visit date 8/31/16.
- Reference elevation at bridge is based on Stage 2 data and NVGD 1929.

Subsurface Fascia Sounding

Bridge 0118-150 (Route 206 over Cedar Branch)

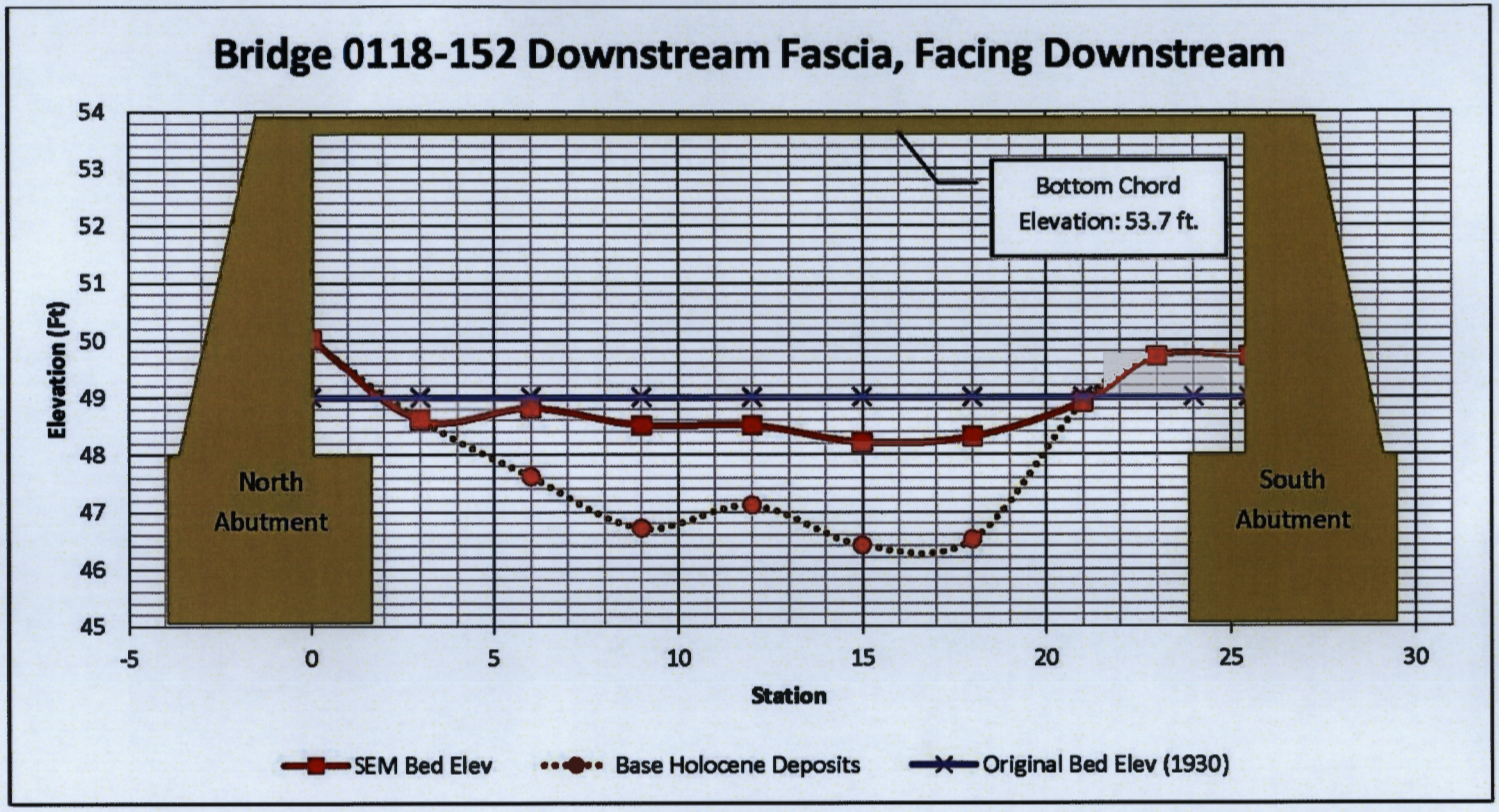


Notes:

- Vertical scale is exaggerated.
- All soundings are measured from the elevation of the chord as shown above, and assuming that the deck was level.
- SEM visit date 8/31/16.
- Reference elevation at bridge is based on Stage 2 data and NVGD 1929.

Subsurface Fascia Sounding

Bridge 0118-152 (Route 206 over Great Swamp Brook)

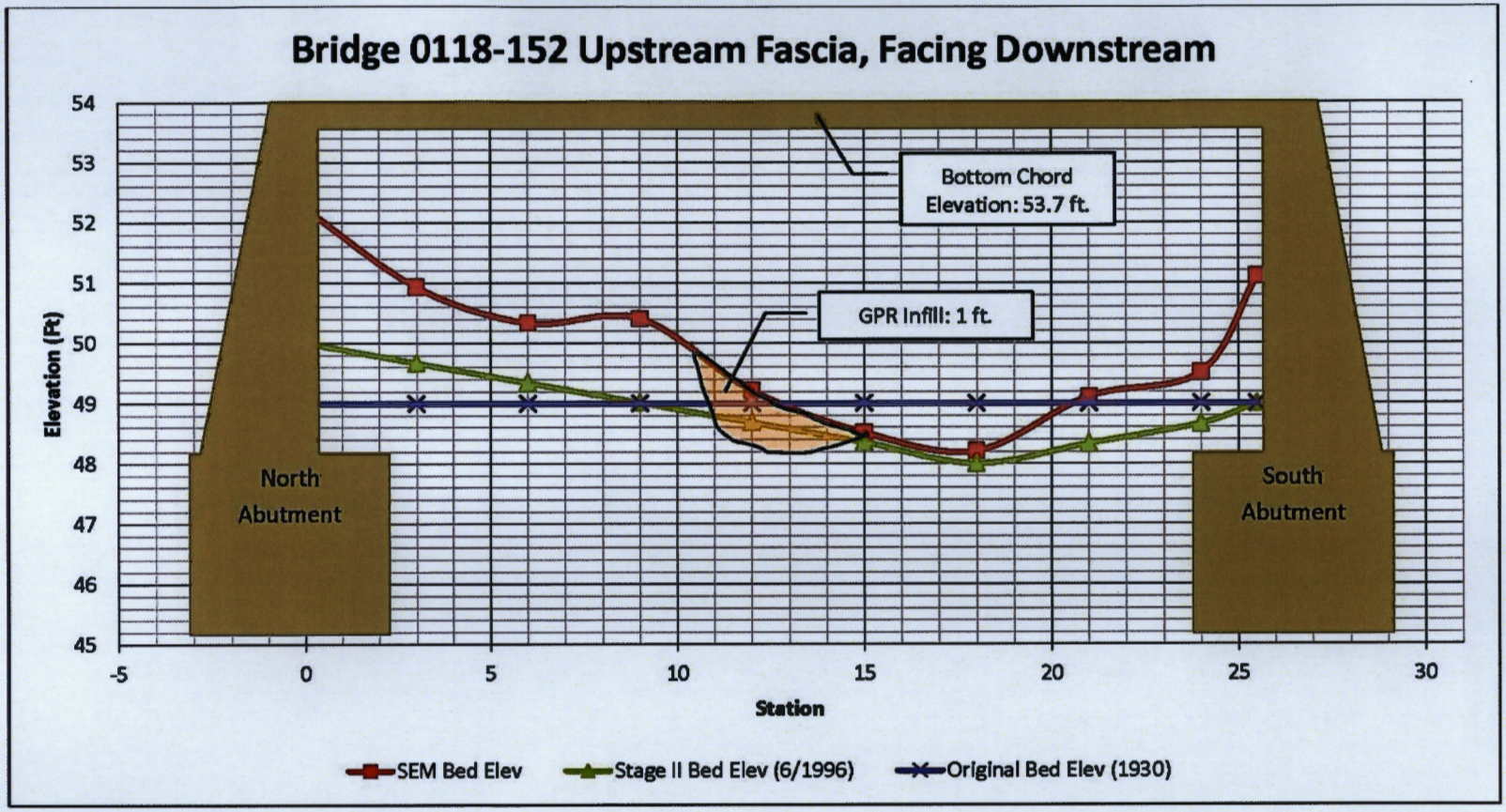


Notes:

- Vertical scale is exaggerated.
- All soundings are measured from the elevation of the chord as shown above, and assuming that the deck was level.
- SEM visit date 8/2/16.
- Reference elevation at bridge is based on Stage 2 data and NVGD 1929.
- Base of Holocene Deposits was determined by field probing.

Subsurface Fascia Sounding

Bridge 0118-152 (Route 206 over Great Swamp Brook)

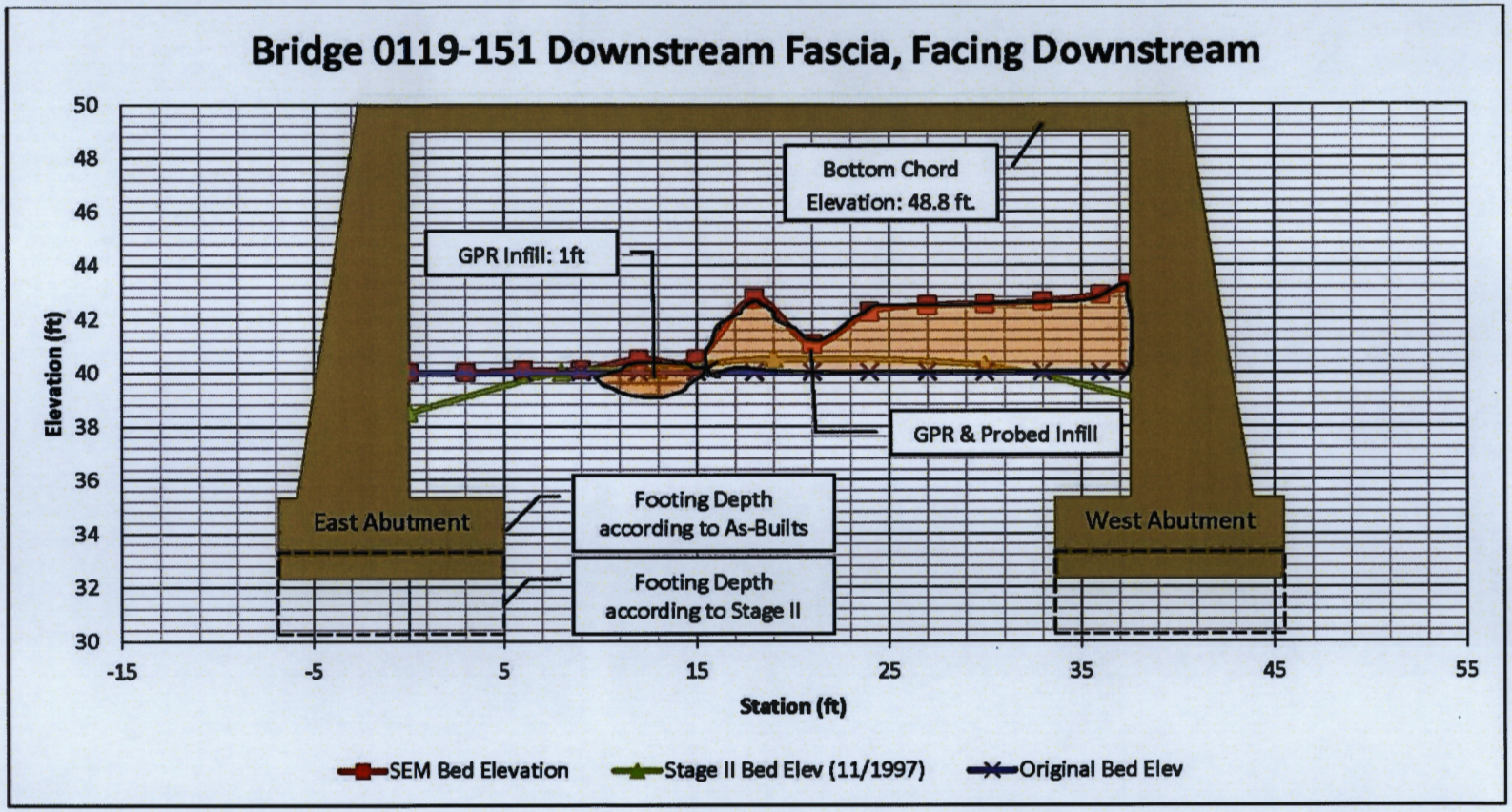


Notes:

- Vertical scale is exaggerated.
- All soundings are measured from the elevation of the chord as shown above, and assuming that the deck was level.
- SEM visit date 8/2/16.
- Reference elevation at bridge is based on Stage 2 data and NVGD 1929.

Subsurface Fascia Sounding

Bridge 0119-151 (Route 322 over Hospitality Brook)

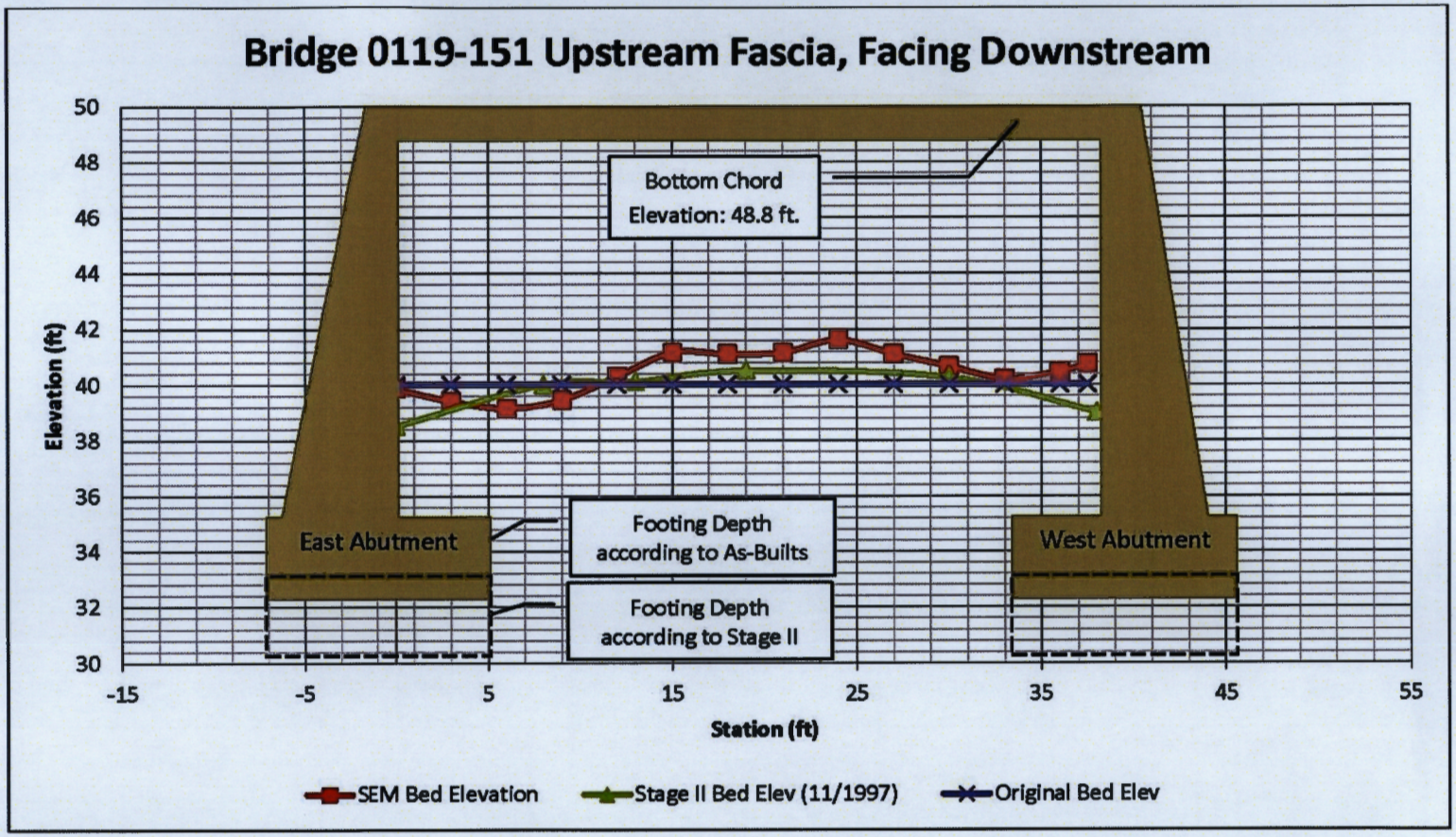


Notes:

- Vertical scale is exaggerated.
- All soundings are measured from the elevation of the chord as shown above, and assuming that the deck was level.
- SEM visit date 7/26/16; Stage II Bed elevation is shown on the downstream section for reference purposes only.
- Reference elevation at bridge is based on Stage 2 data and NVGD 1929.

Subsurface Fascia Sounding

Bridge 0119-151 (Route 322 over Hospitality Brook)

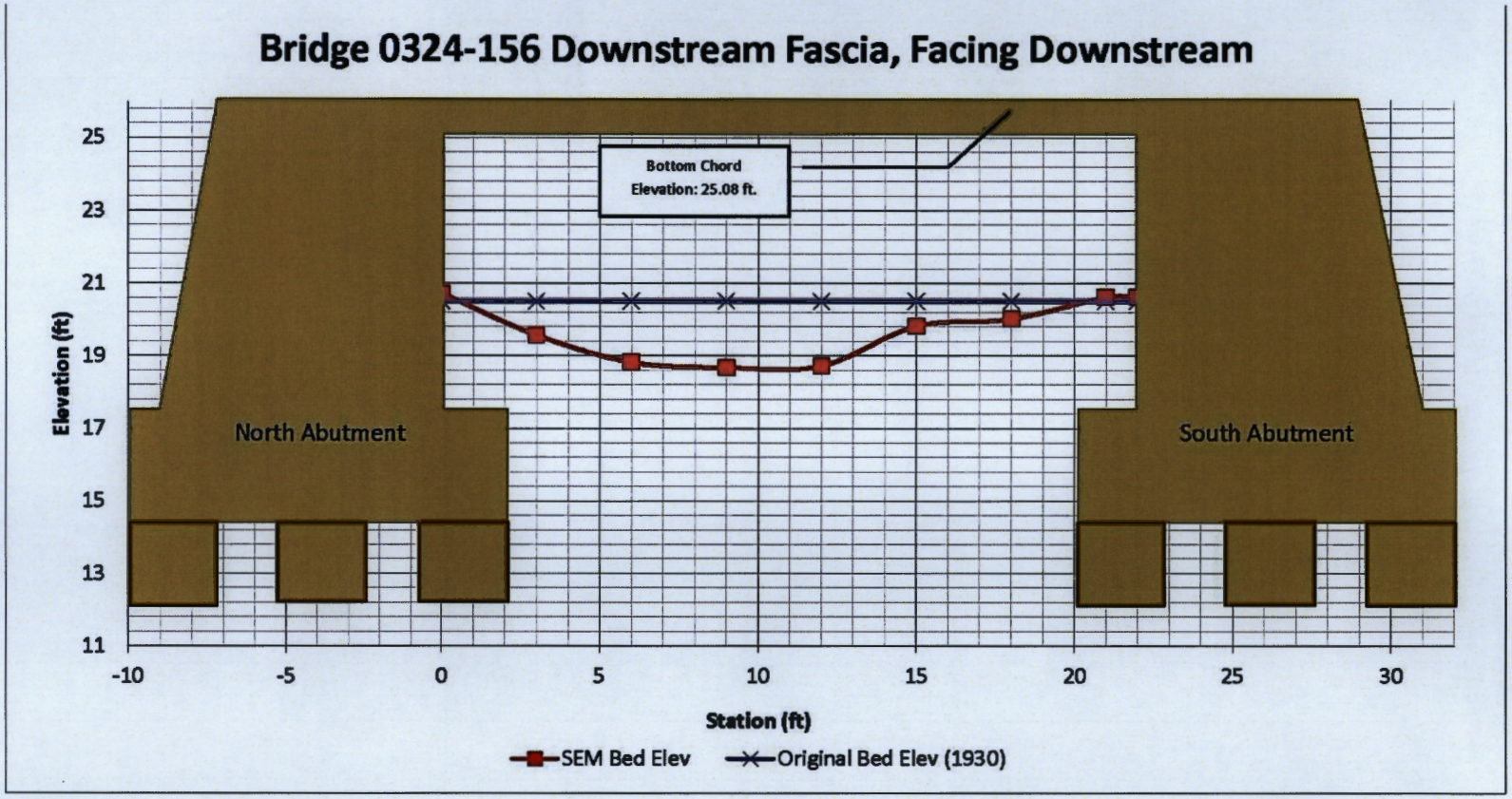


Notes:

- Vertical scale is exaggerated.
- All soundings are measured from the elevation of the chord as shown above, and assuming that the deck was level.
- SEM visit date 7/26/16.
- Reference elevation at bridge is based on Stage 2 data and NVGD 1929.

Subsurface Fascia Soundings

Bridge 0324-156 (Route 206 over Jade Run)

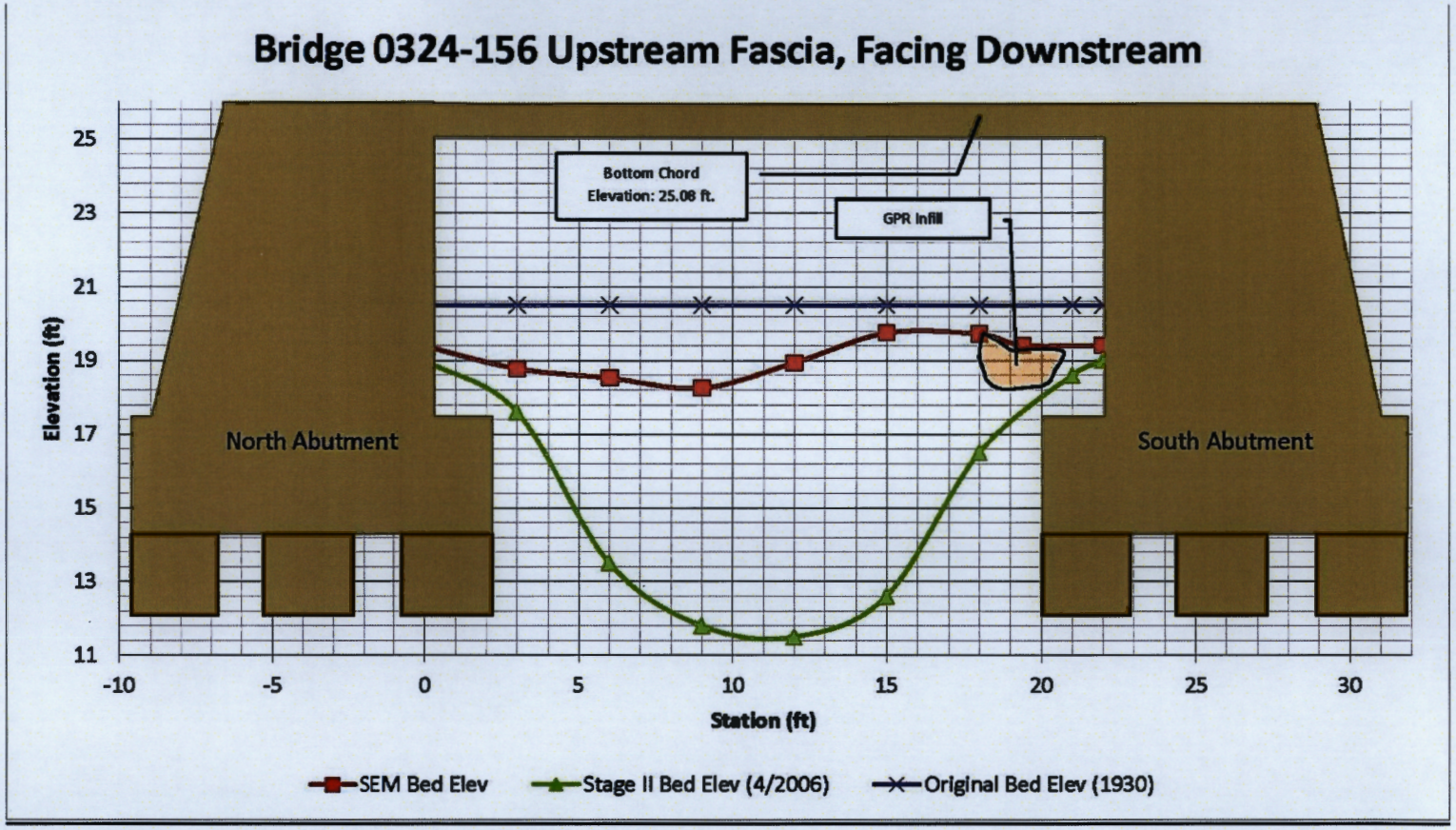


Notes:

- Vertical scale is exaggerated.
- All soundings are measured from the elevation of the chord as shown above, and assuming that the deck was level.
- SEM visit date 3/2/16.
- Reference elevation at bridge is based on Stage 2 data and NVGD 1929.

Subsurface Fascia Soundings

Bridge 0324-156 (Route 206 over Jade Run)

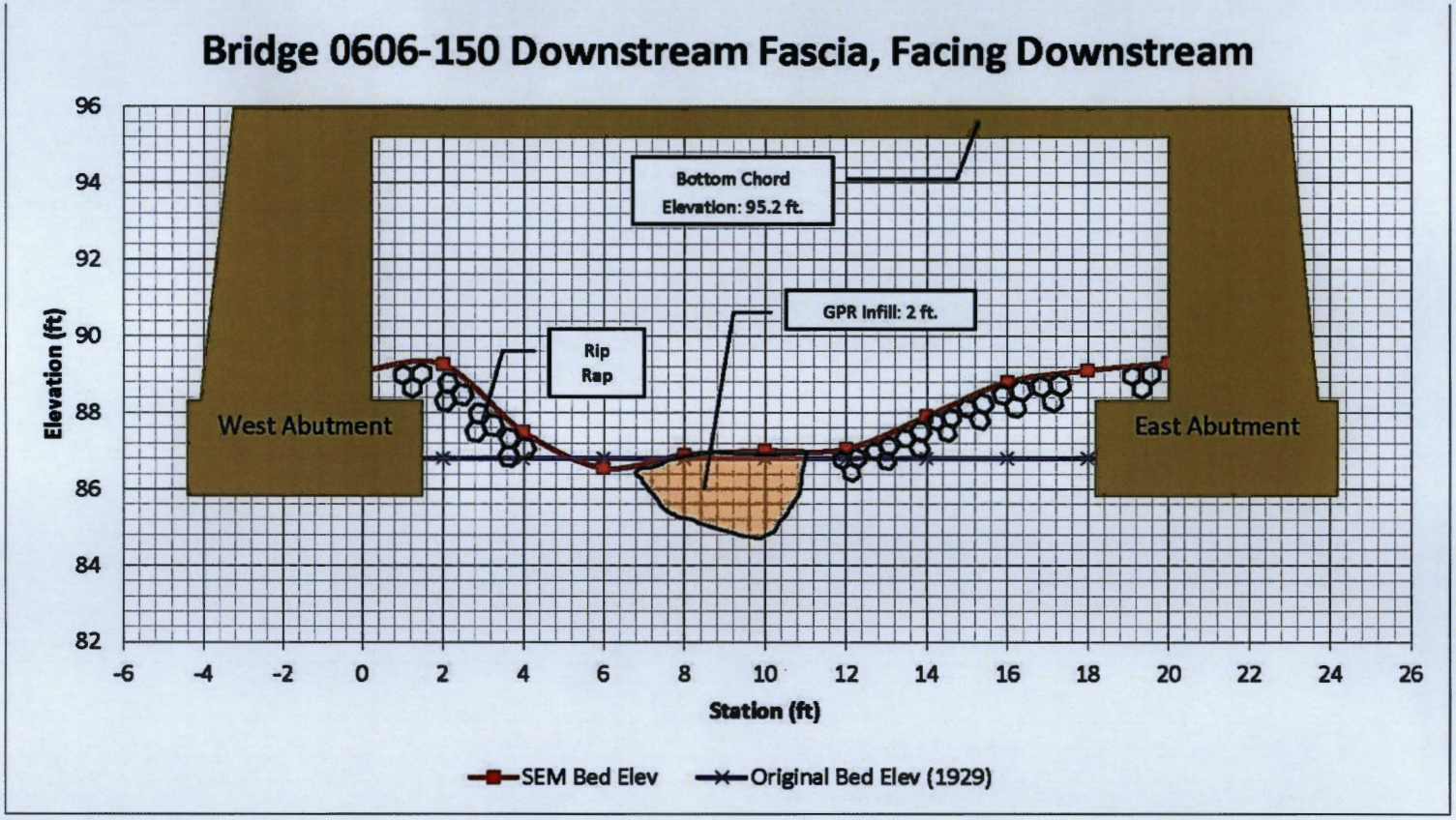


Notes:

- Vertical scale is exaggerated.
- All soundings are measured from the elevation of the chord as shown above, and assuming that the deck was level.
- SEM visit date 3/2/16.
- Reference elevation at bridge is based on Stage 2 data and NVGD 1929.

Subsurface Fascia Soundings

Bridge 0606-150 (Route 49 over Menantico Creek)

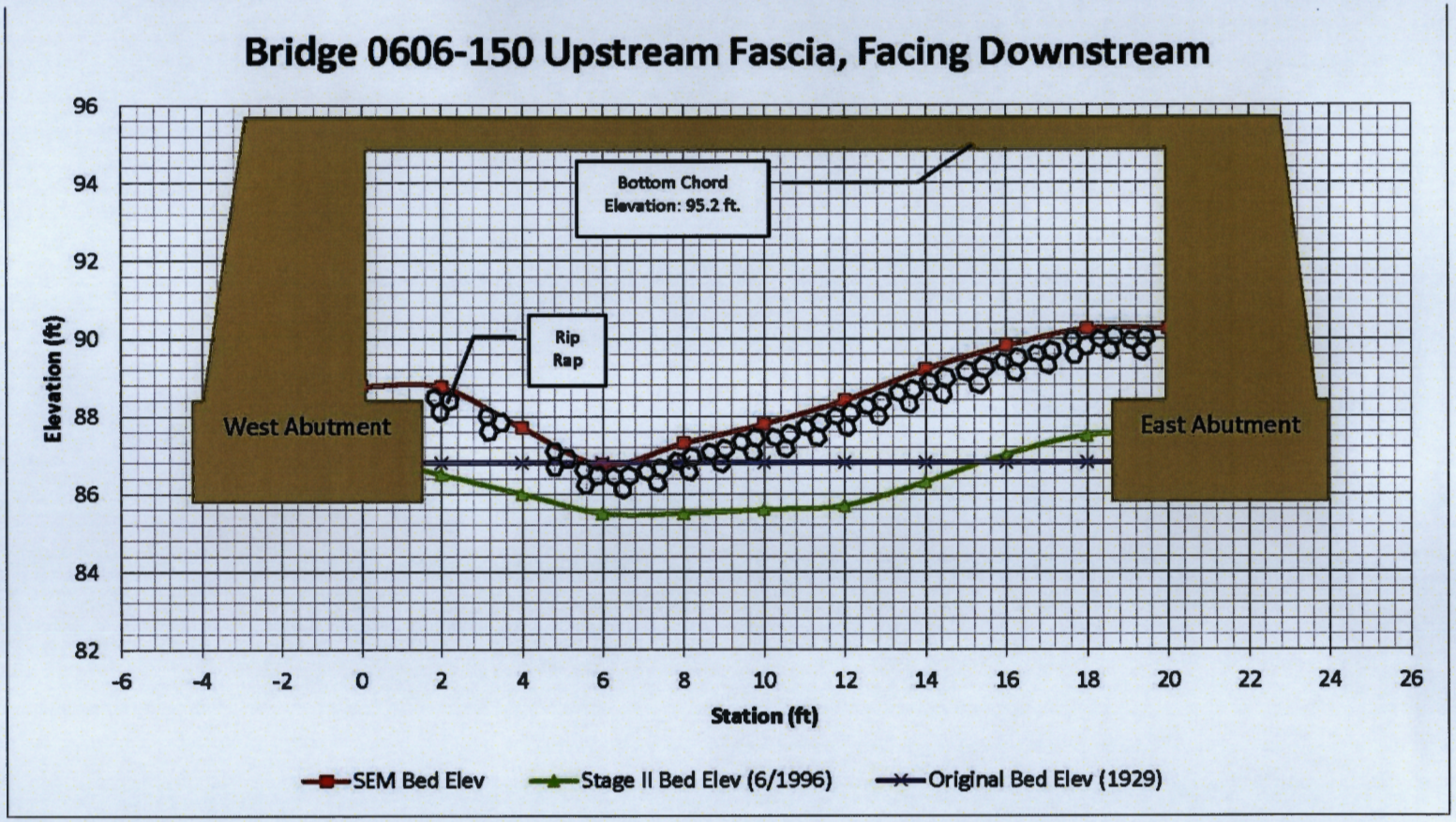


Notes:

- Vertical scale is exaggerated.
- All soundings are measured from the elevation of the chord as shown above, and assuming that the deck was level.
- SEM visit date 8/29/16.
- Reference elevation at bridge is based on Stage 2 data and NVGD 1929.

Subsurface Fascia Soundings

Bridge 0606-150 (Route 49 over Menantico Creek)

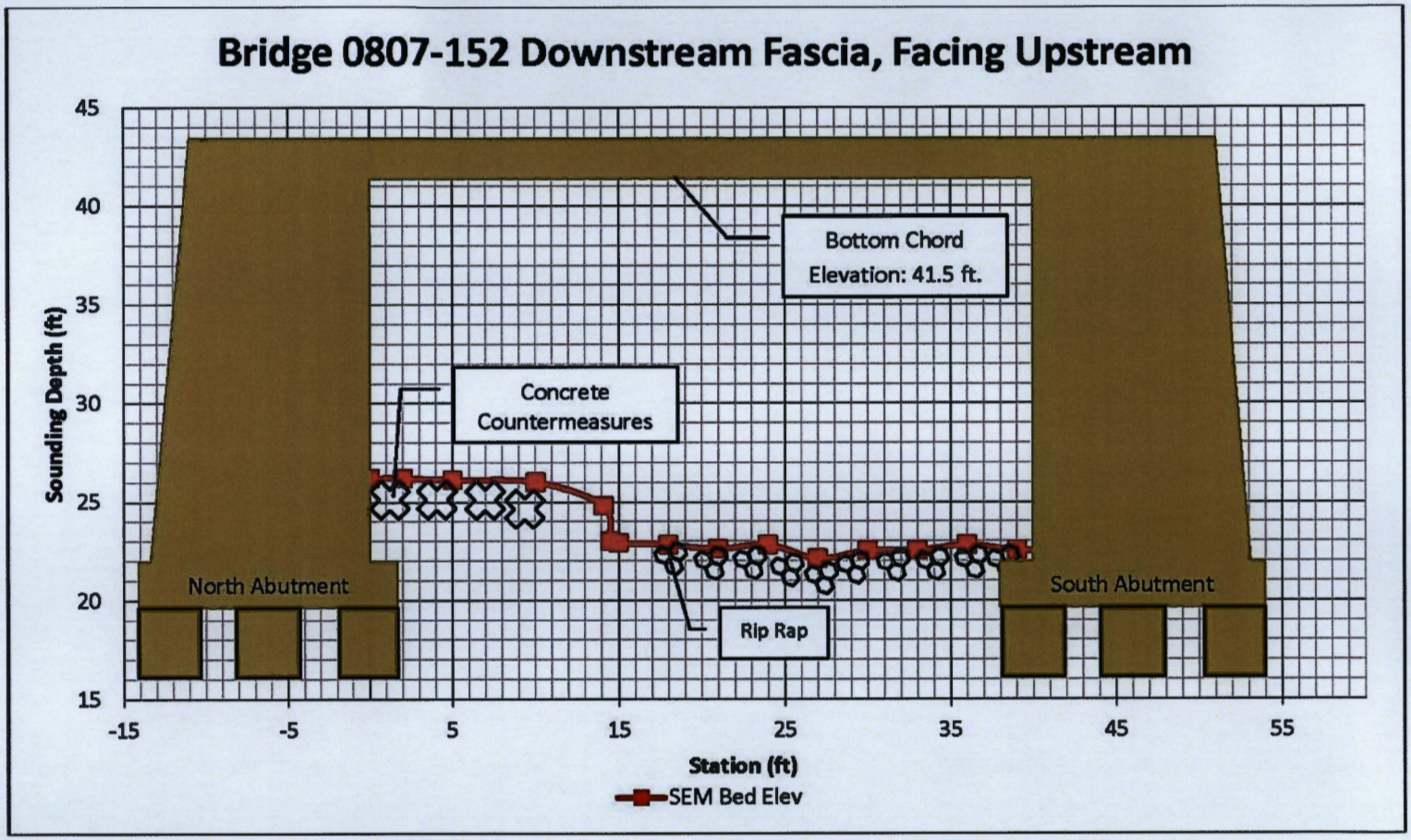


Notes:

- Vertical scale is exaggerated.
- All soundings are measured from the elevation of the chord as shown above, and assuming that the deck was level.
- SEM visit date 8/29/16.
- Reference elevation at bridge is based on Stage 2 data and NVGD 1929.

Subsurface Fascia Sounding

Bridge 0807-152 (Route 45 over Raccoon Creek)

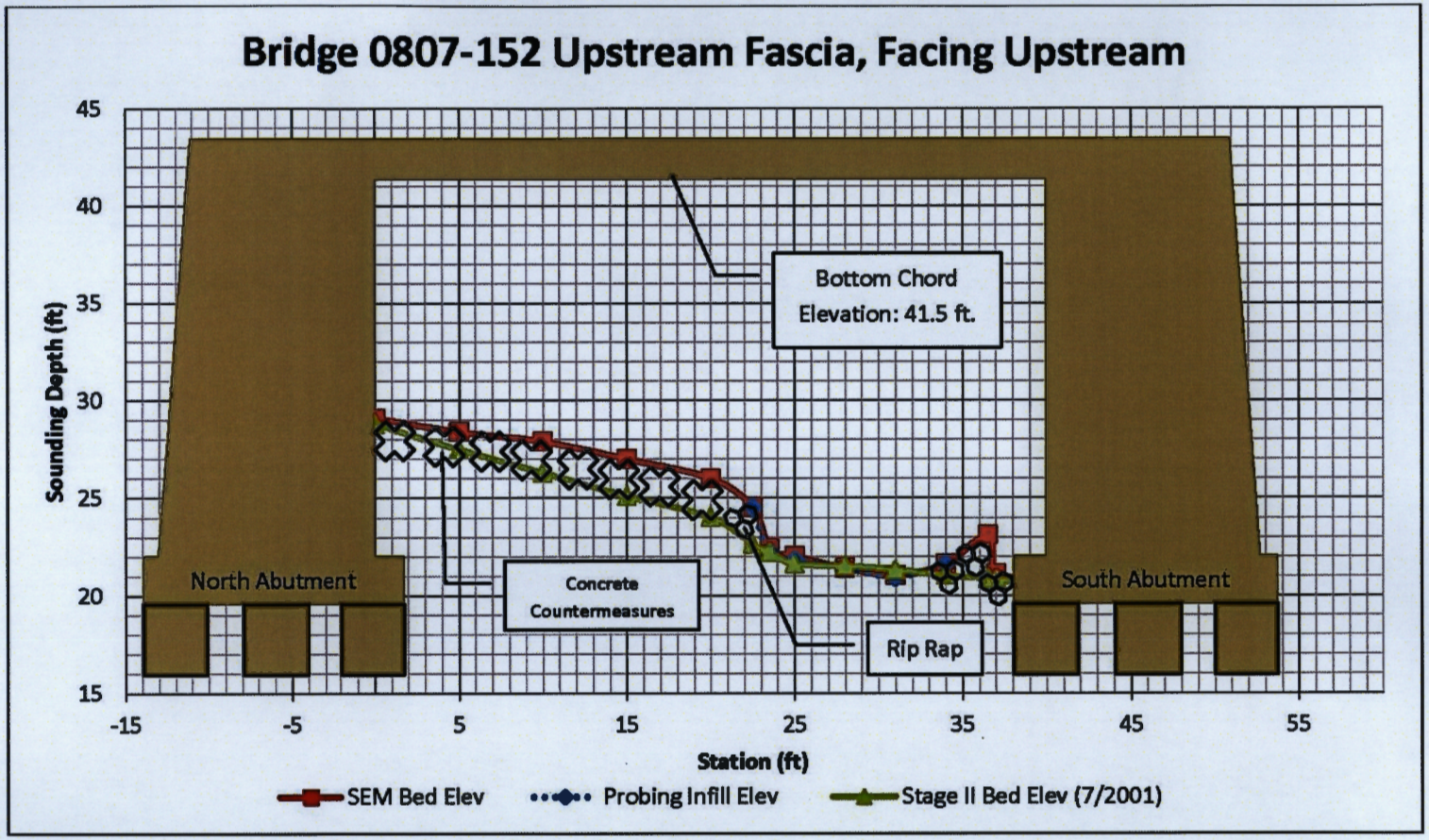


Notes:

- Vertical scale is exaggerated.
- All soundings are measured from the elevation of the chord as shown above, and assuming that the deck was level.
- SEM visit date 11/5/16.
- Reference elevation at bridge is based on Stage 2 data and NVGD 1929.
- Infill was determined by combination of GPR measurement and field probing.

Subsurface Fascia Sounding

Bridge 0807-152 (Route 45 over Raccoon Creek)

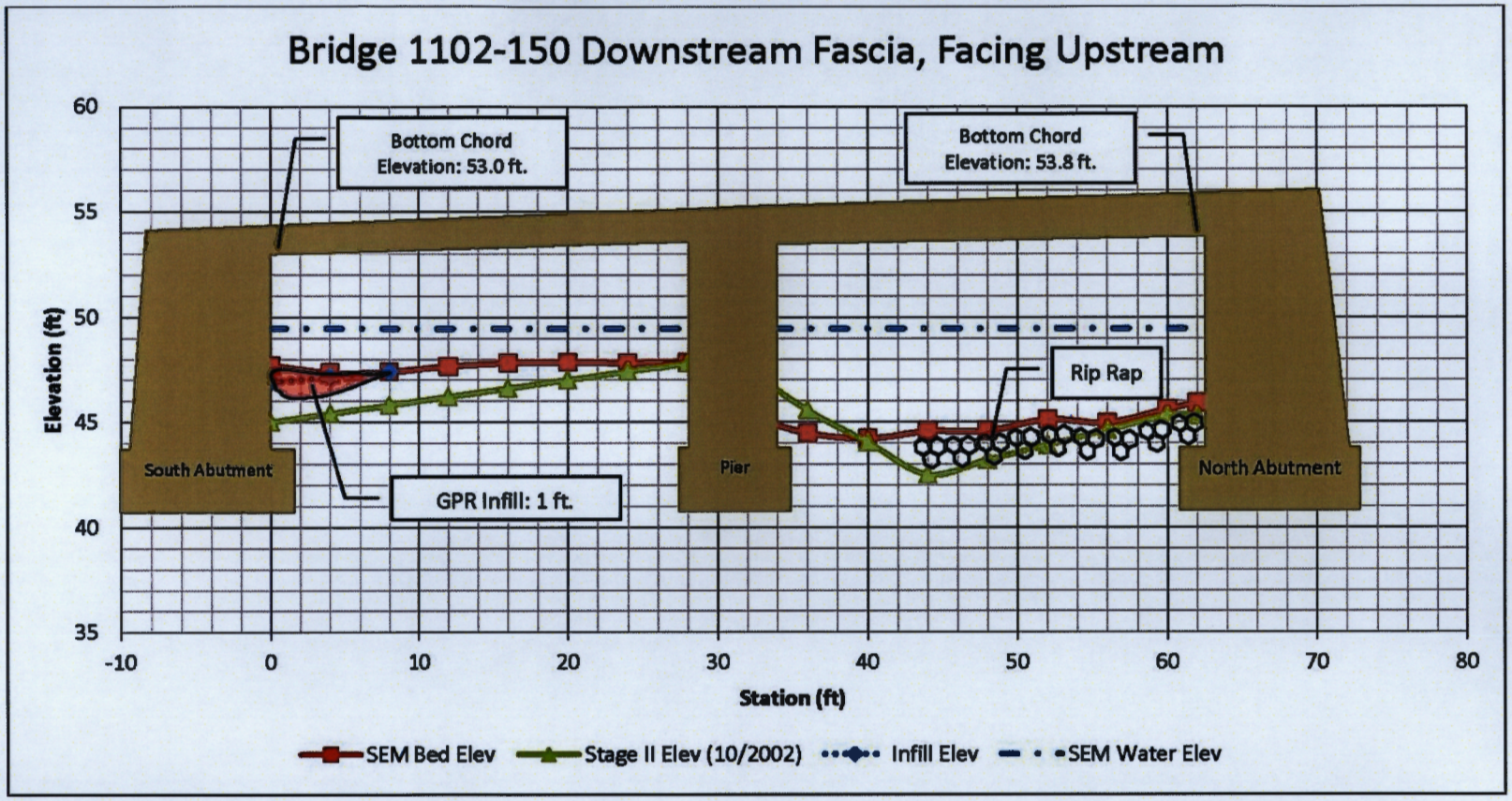


Notes:

- Vertical scale is exaggerated.
- All soundings are measured from the elevation of the chord as shown above, and assuming that the deck was level.
- SEM visit date 11/5/16.
- Reference elevation at bridge is based on Stage 2 data and NVGD 1929.
- Infill was determined by combination of GPR measurement and field probing.

Subsurface Fascia Sounding

Bridge 1102-150 (Route 1B over Shabakunk Creek)

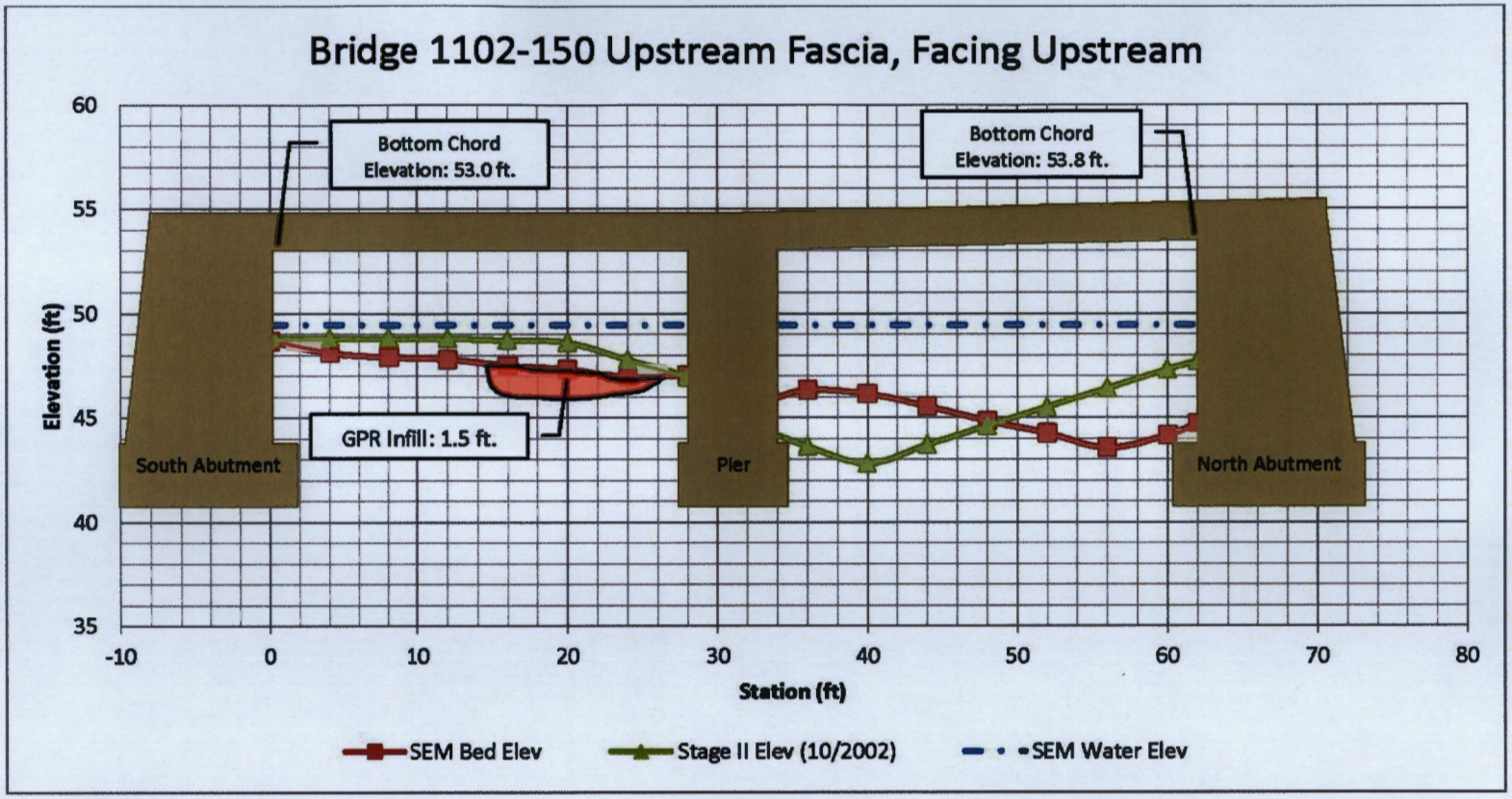


Notes:

- Vertical scale is exaggerated.
- SEM visit date 10/21/16.
- All soundings are measured from the elevation of the chord as shown above.
- Reference elevation at bridge is based on Stage 2 data and NVGD 1929.

Subsurface Fascia Sounding

Bridge 1102-150 (Route 1B over Shabakunk Creek)

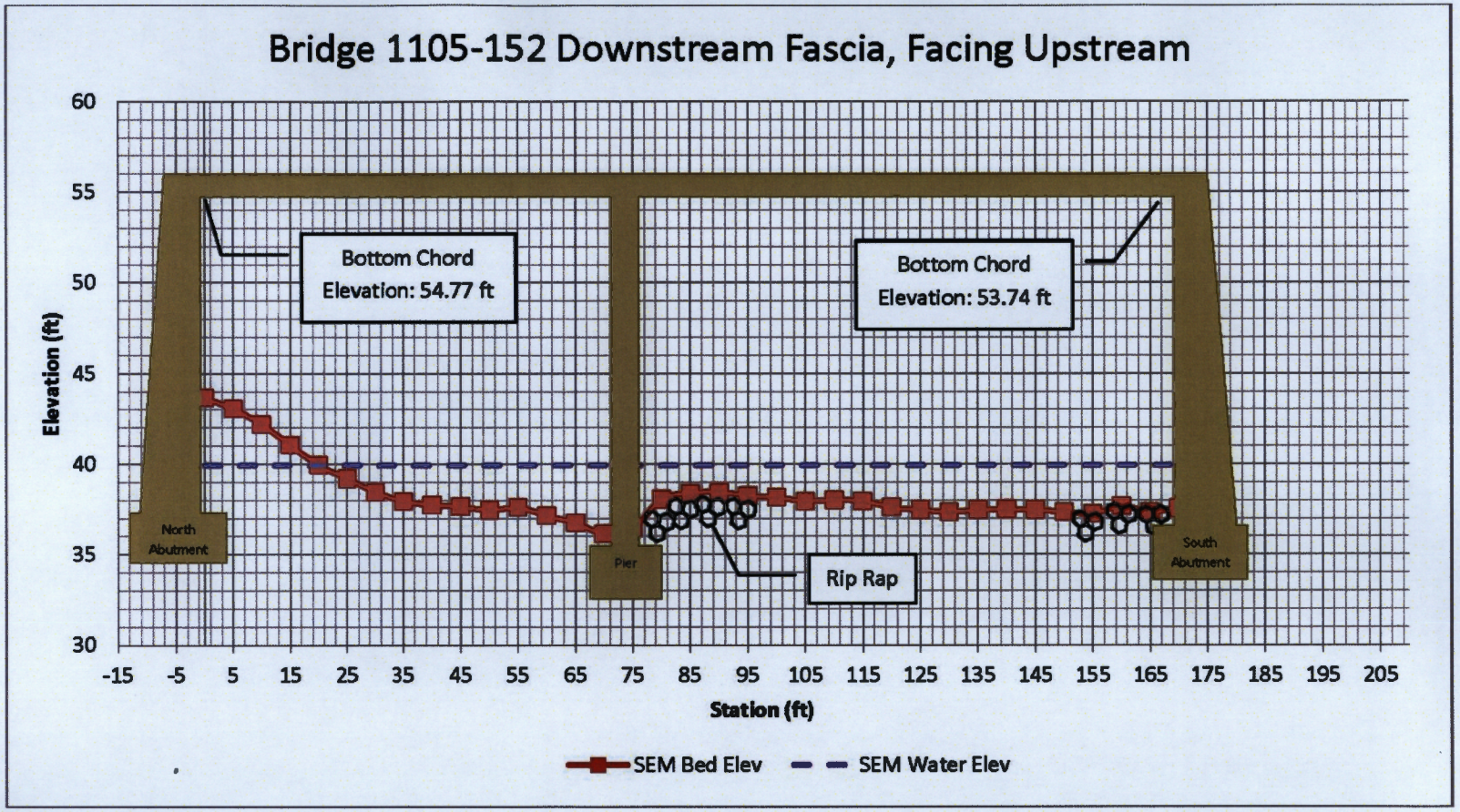


Notes:

- Vertical scale is exaggerated.
- SEM visit date 10/21/16.
- All soundings are measured from the elevation of the chord as shown above.
- Bridge chord is not level; settlement of the pier was observed and elevation adjustments were made.
- Reference elevation at bridge is based on Stage 2 data and NVGD 1929.

Subsurface Fascia Sounding

Bridge 1105-152 (Route 27 over Millstone River)

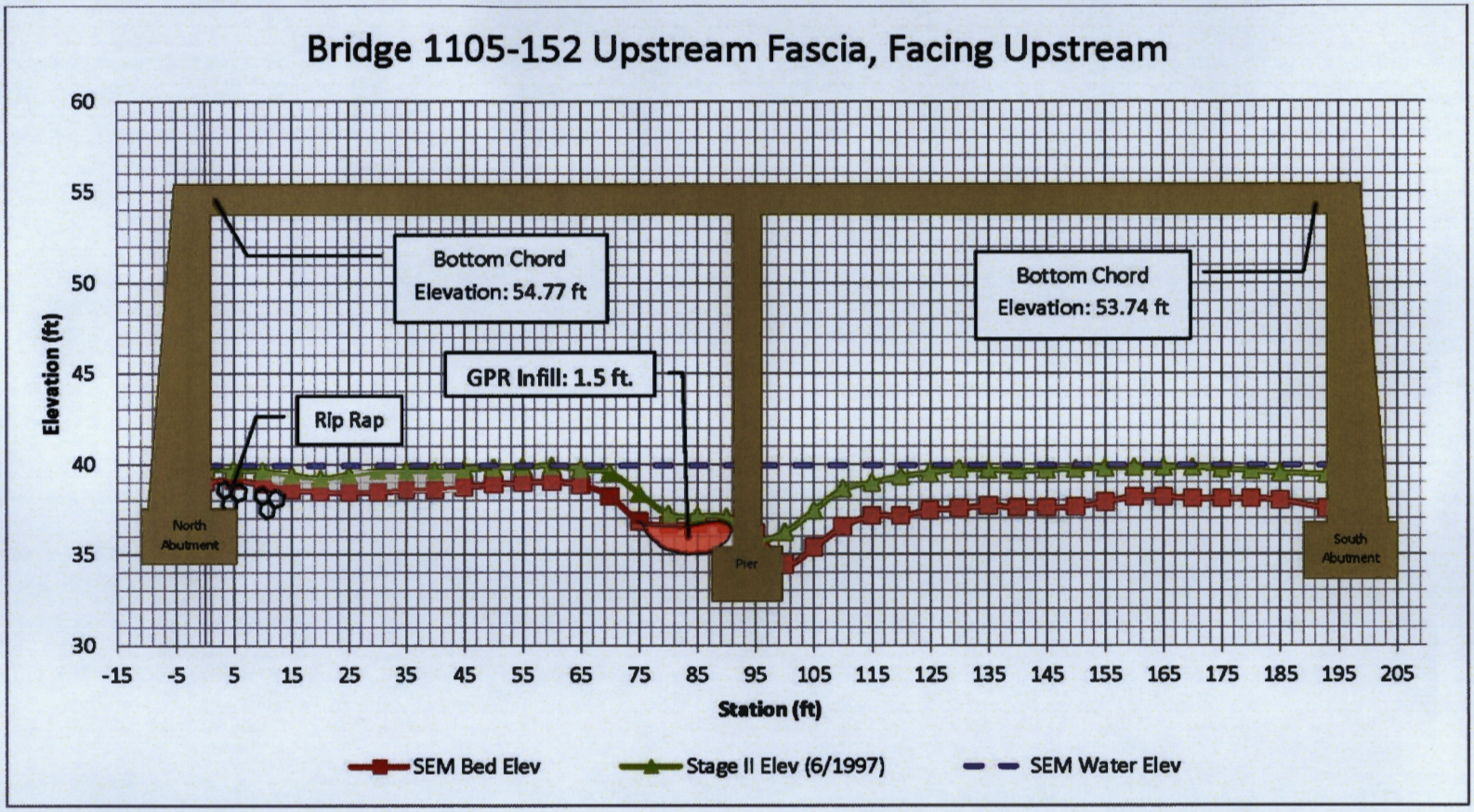


Notes:

- Vertical scale is exaggerated.
- All soundings are measured from the elevation of the chord, and the elevation difference at each end is 1 ft.
- SEM visit date 9/24/16.
- Reference elevation at bridge is based on Stage 2 data and NVGD 1929.

Subsurface Fascia Sounding

Bridge 1105-152 (Route 27 over Millstone River)

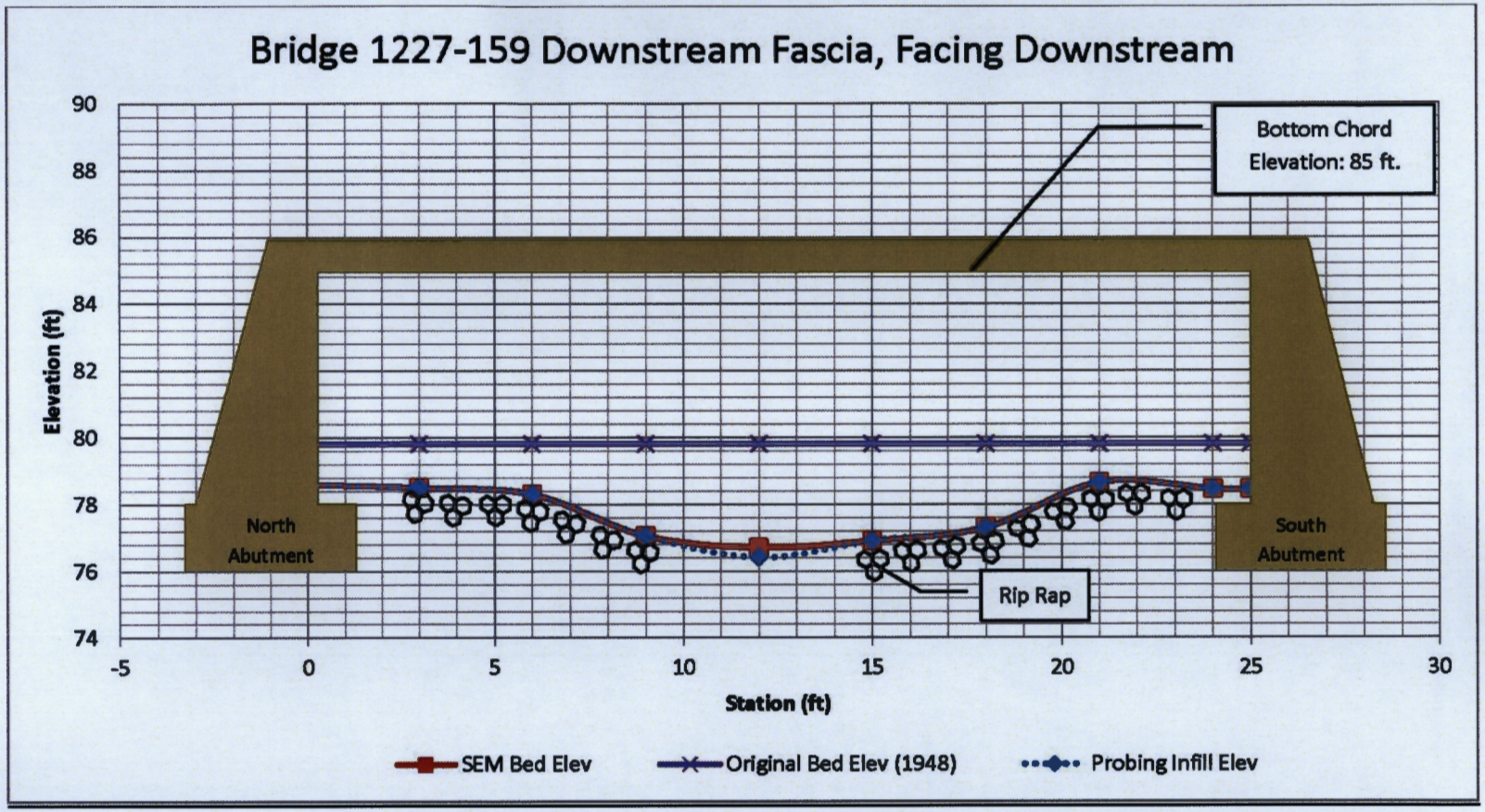


Notes:

- Vertical scale is exaggerated.
- All soundings are measured from the elevation of the chord, and the elevation difference at each end is 1 ft.
- SEM visit date 9/24/16.
- Reference elevation at bridge is based on Stage 2 data and NVGD 1929.

Subsurface Fascia Sounding

Bridge 1227-159 (Route 130 over Oakey's Brook)

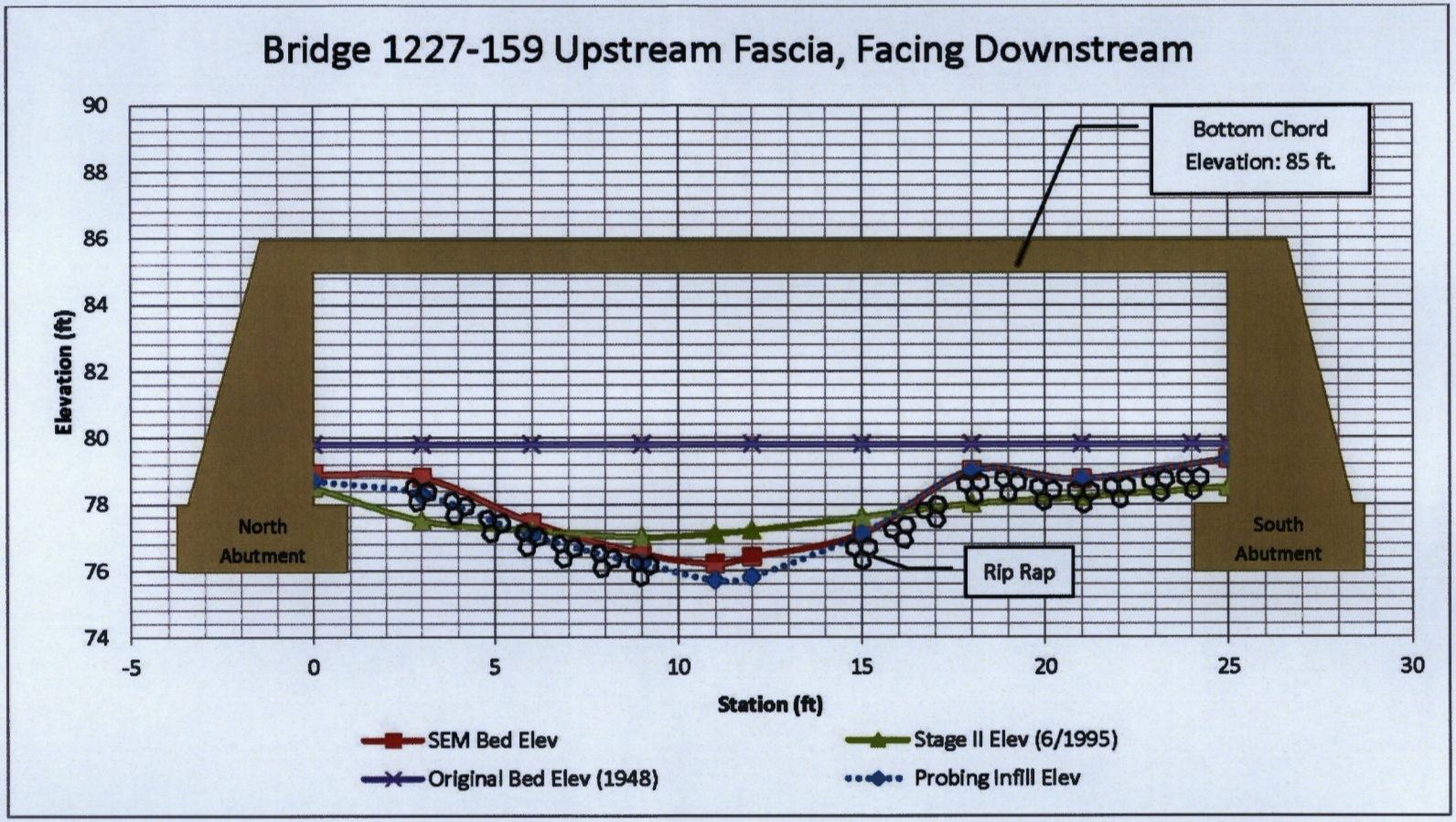


Notes:

- Vertical scale is exaggerated.
- All soundings are measured from the elevation of the chord as shown above, and assuming that the deck was level.
- SEM visit date 9/16/16.
- Infill was determined by a combination of GPR and field probing.
- Reference elevation at bridge is based on Stage 2 data and NVGD 1929.

Subsurface Fascia Sounding

idge 1227-159 (Route 130 over Oakey's Brook)

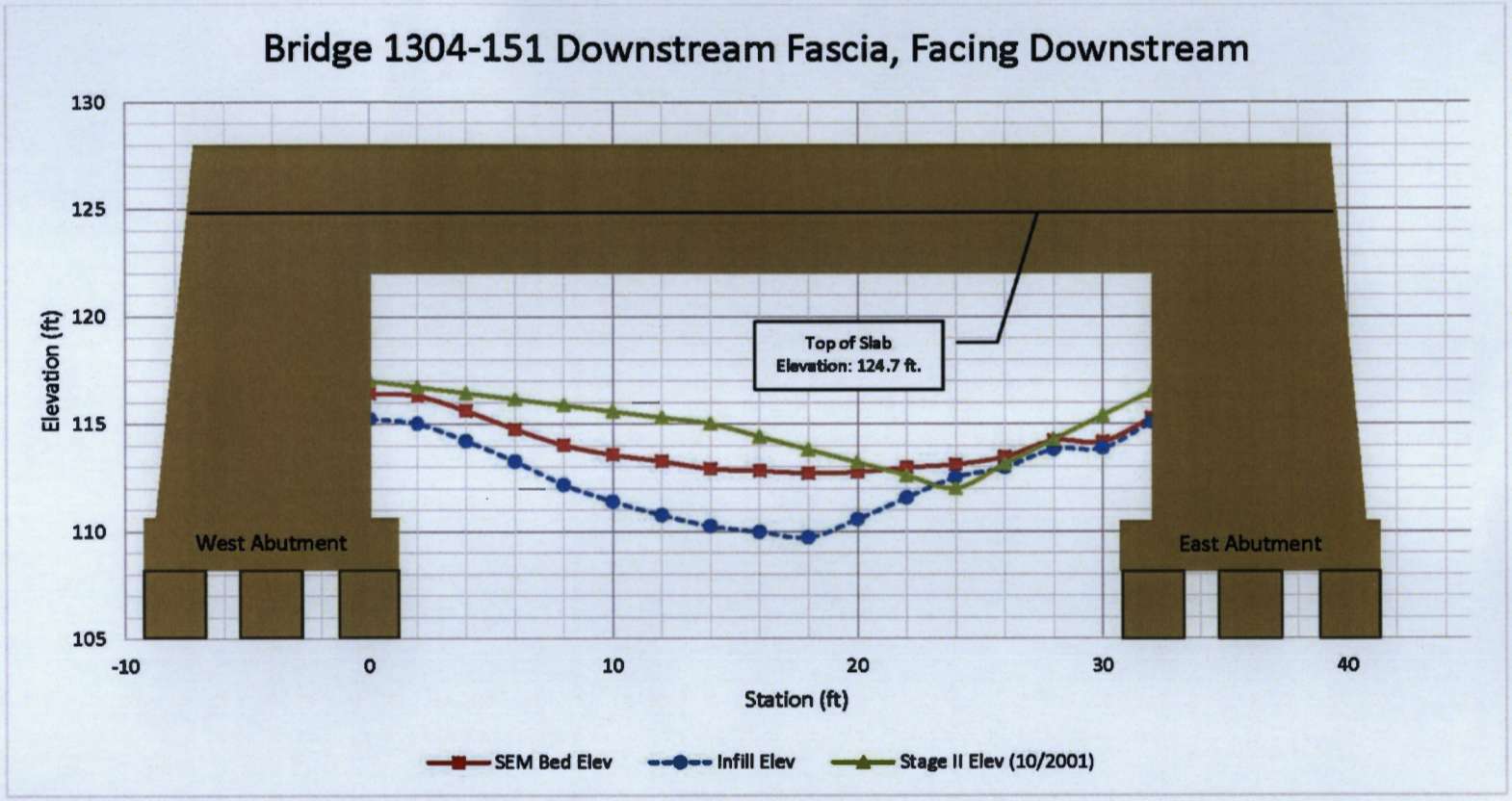


Notes:

- Vertical scale is exaggerated.
- All soundings are measured from the elevation of the chord as shown above, and assuming that the deck was level.
- SEM visit date 9/16/16.
- Infill was determined by a combination of GPR and field probing.
- Reference elevation at bridge is based on Stage 2 data and NVGD 1929.

Subsurface Fascia Sounding

Bridge 1304-151 (Route 33 over Millstone River)

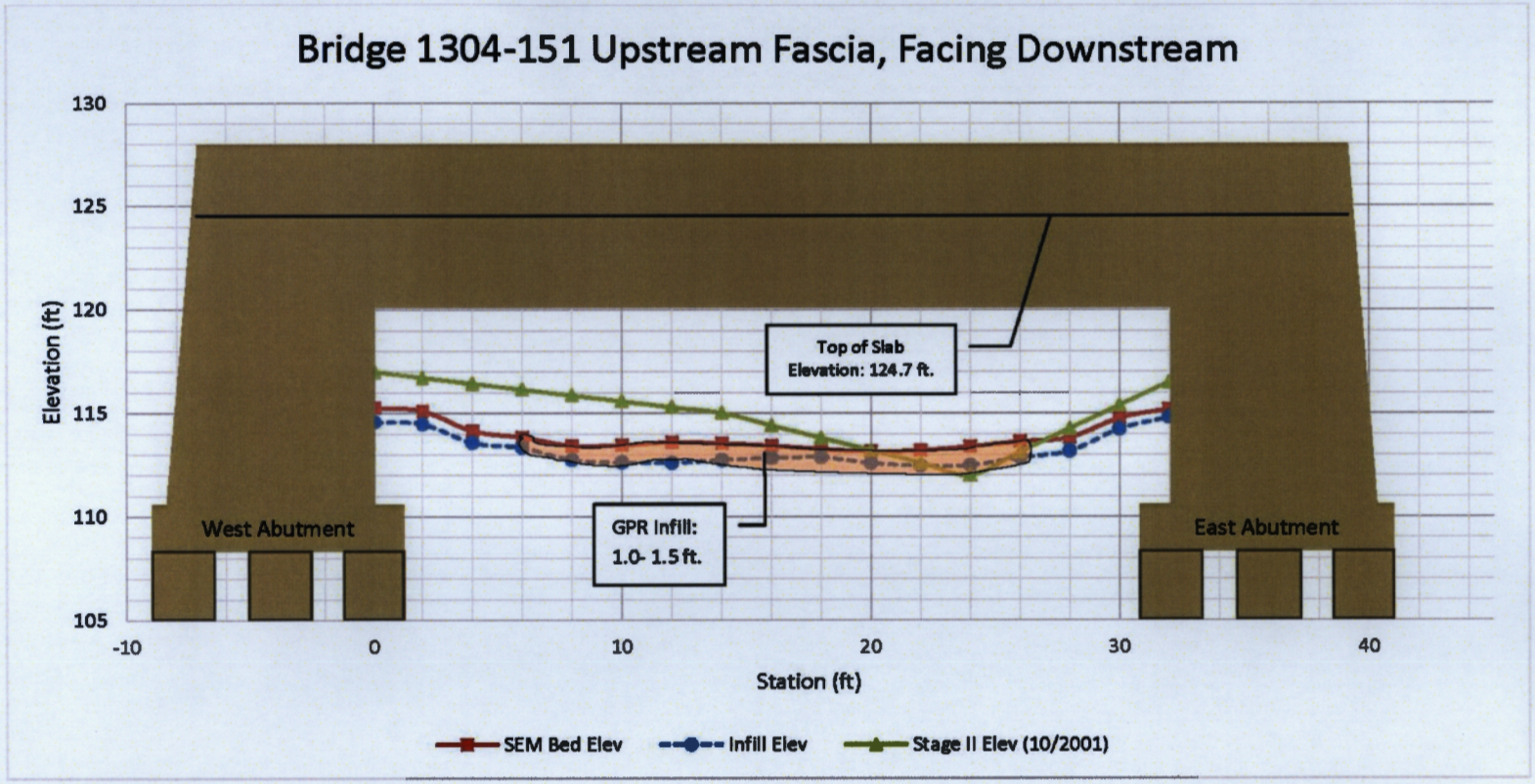


Notes:

- Vertical scale is exaggerated.
- All soundings are measured from the elevation of the top of slab as shown above.
- SEM visit date 10/7/16.
- Reference elevation at bridge is based on SEM survey data and NVGD 1929.

Subsurface Fascia Sounding

Bridge 1304-151 (Route 33 over Millstone River)

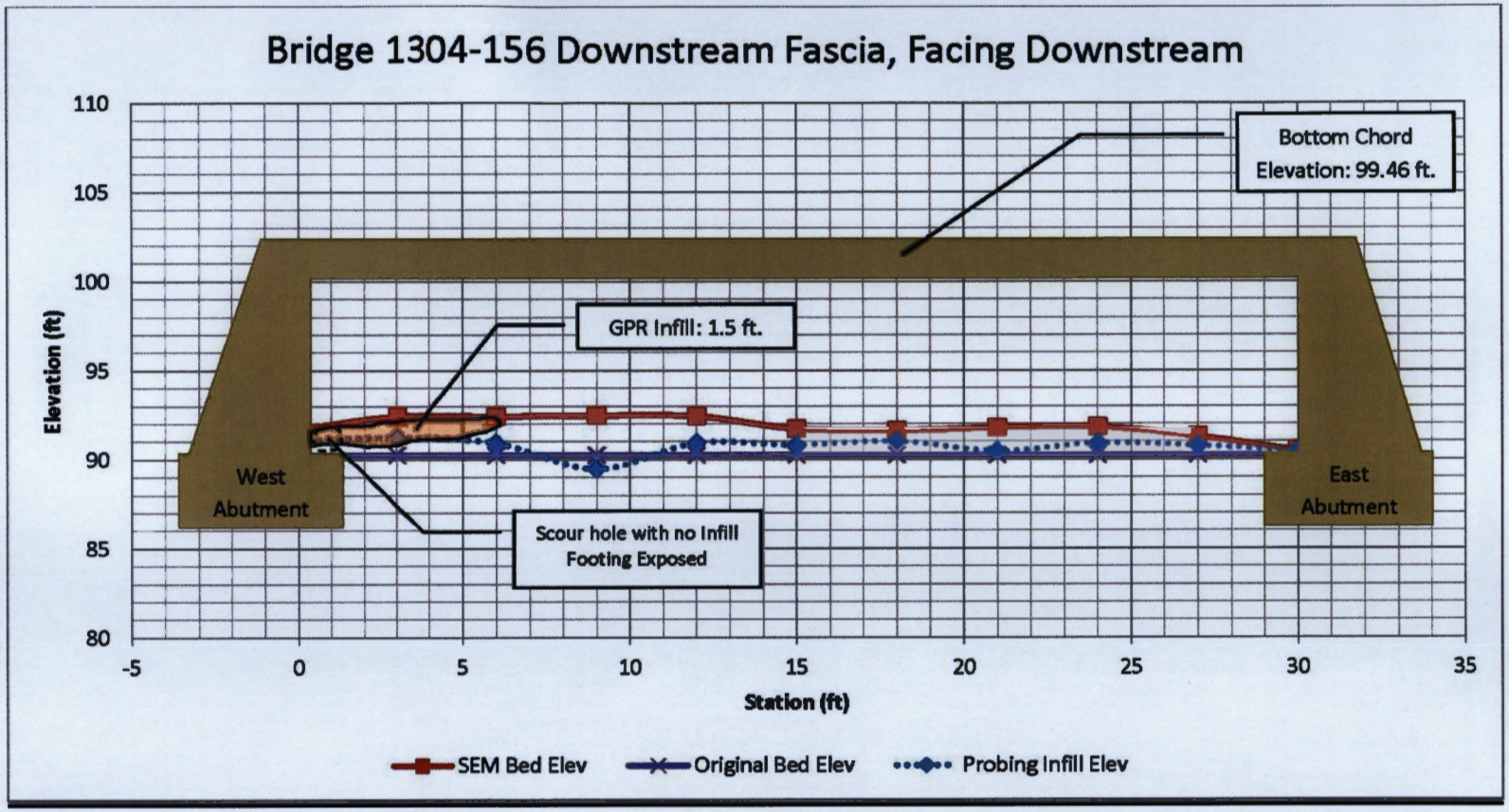


Notes:

- Vertical scale is exaggerated.
- All soundings are measured from the elevation of the top of slab as shown above.
- SEM visit date 10/7/16.
- Reference elevation at bridge is based on SEM survey data and NVGD 1929.

Subsurface Fascia Sounding

Bridge 1304-156 (Route 33 over Manalapan Brook)

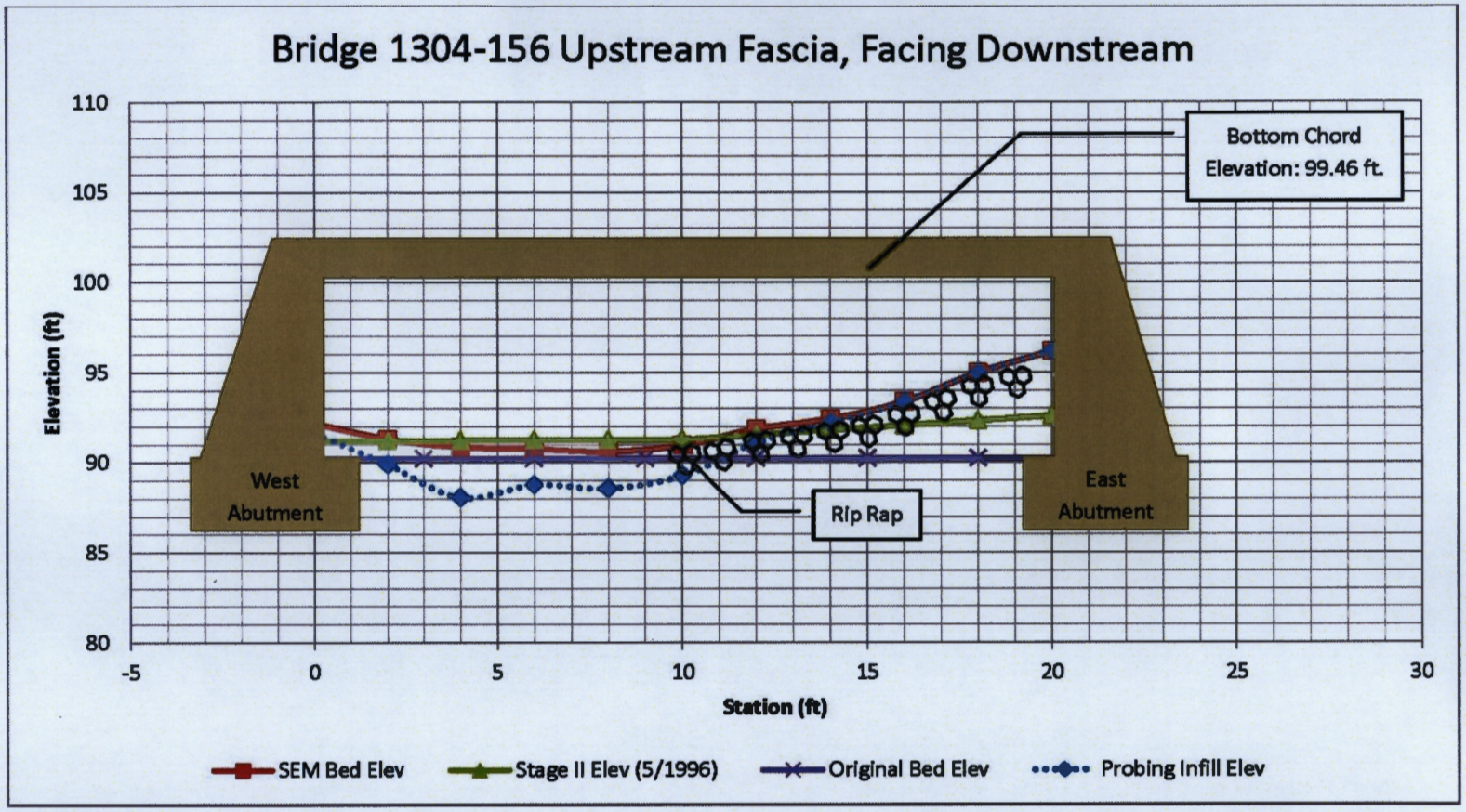


Notes:

- Vertical scale is exaggerated.
- All soundings are measured from the elevation of the chord as shown above, and assuming that the deck was level.
- SEM visit date 9/9/16.
- Reference elevation at bridge is based on Stage 2 data and NVGD 1929.

Subsurface Fascia Sounding

Bridge 1304-156 (Route 33 over Manalapan Brook)

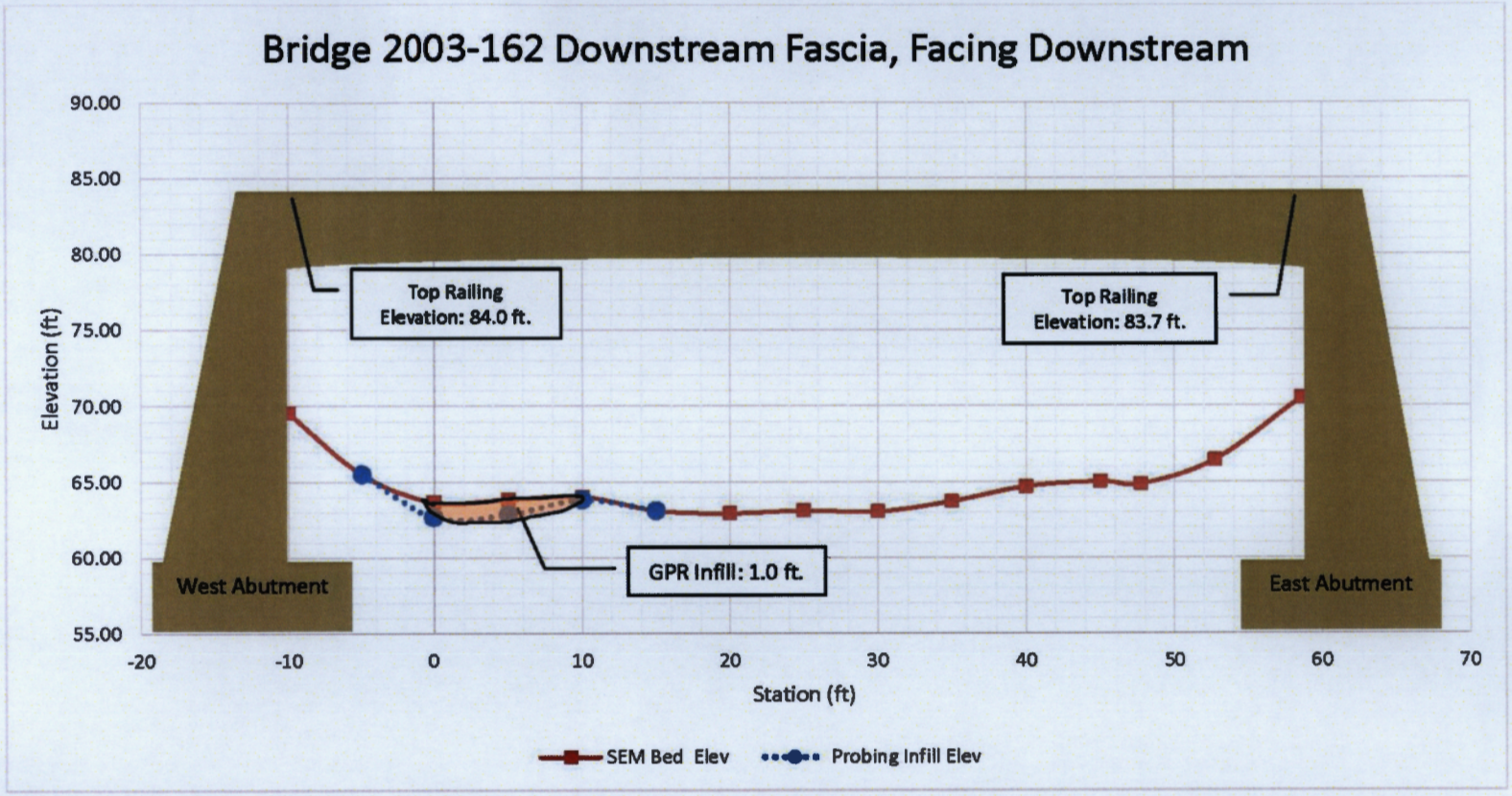


Notes:

- Vertical scale is exaggerated.
- All soundings are measured from the elevation of the chord as shown above, and assuming that the deck was level.
- SEM visit date 9/9/16.
- Reference elevation at bridge is based on Stage 2 data and NVGD 1929.

Subsurface Fascia Sounding

Bridge 2003-162 (Route 22 WB over Rahway River)

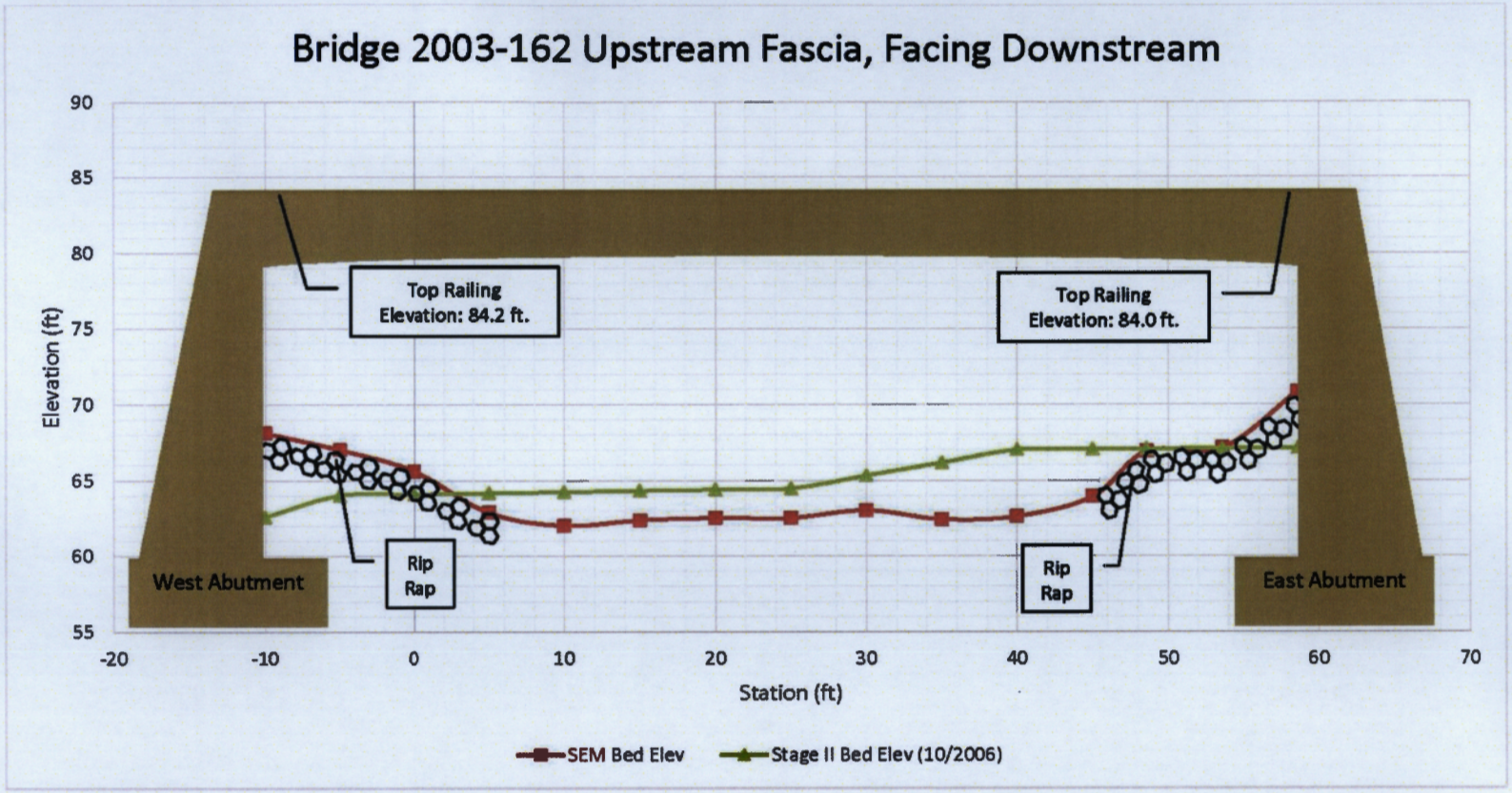


Notes:

- Vertical scale is exaggerated.
- SEM visit date 11/18/16.
- All soundings are measured from the elevation of the top railing as shown above.
- Reference elevation at bridge is based on Stage 2 data and NVGD 1929.

Subsurface Fascia Sounding

Bridge 2003-162 (Route 22 WB over Rahway River)

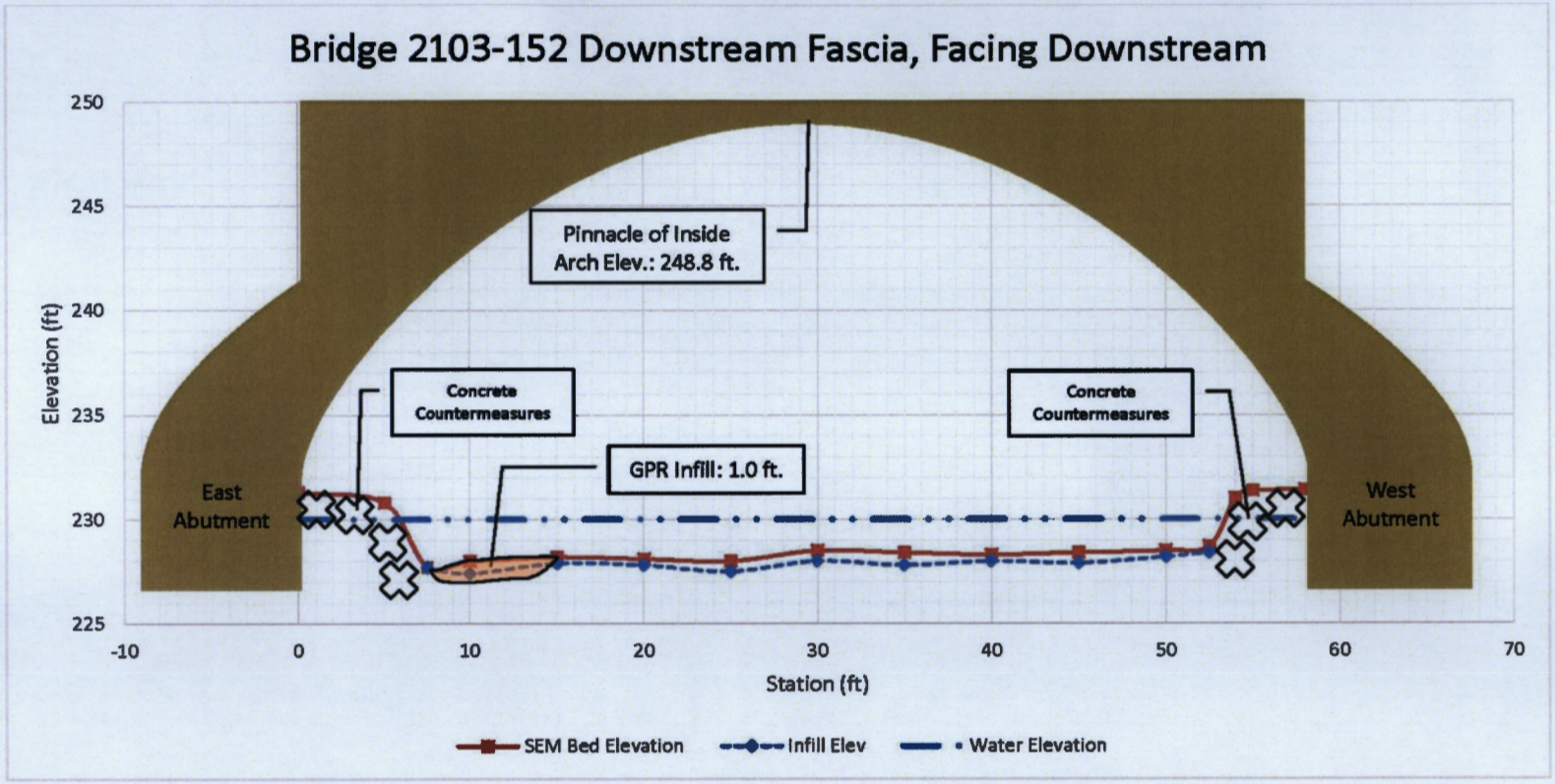


Notes:

- Vertical scale is exaggerated.
- SEM visit date 11/18/16.
- All soundings are measured from the elevation of the top railing as shown above.
- Reference elevation at bridge is based on Stage 2 data and NVGD 1929.

Subsurface Fascia Sounding

Bridge 2103-152 (Route 173 over Pohatcong Creek)

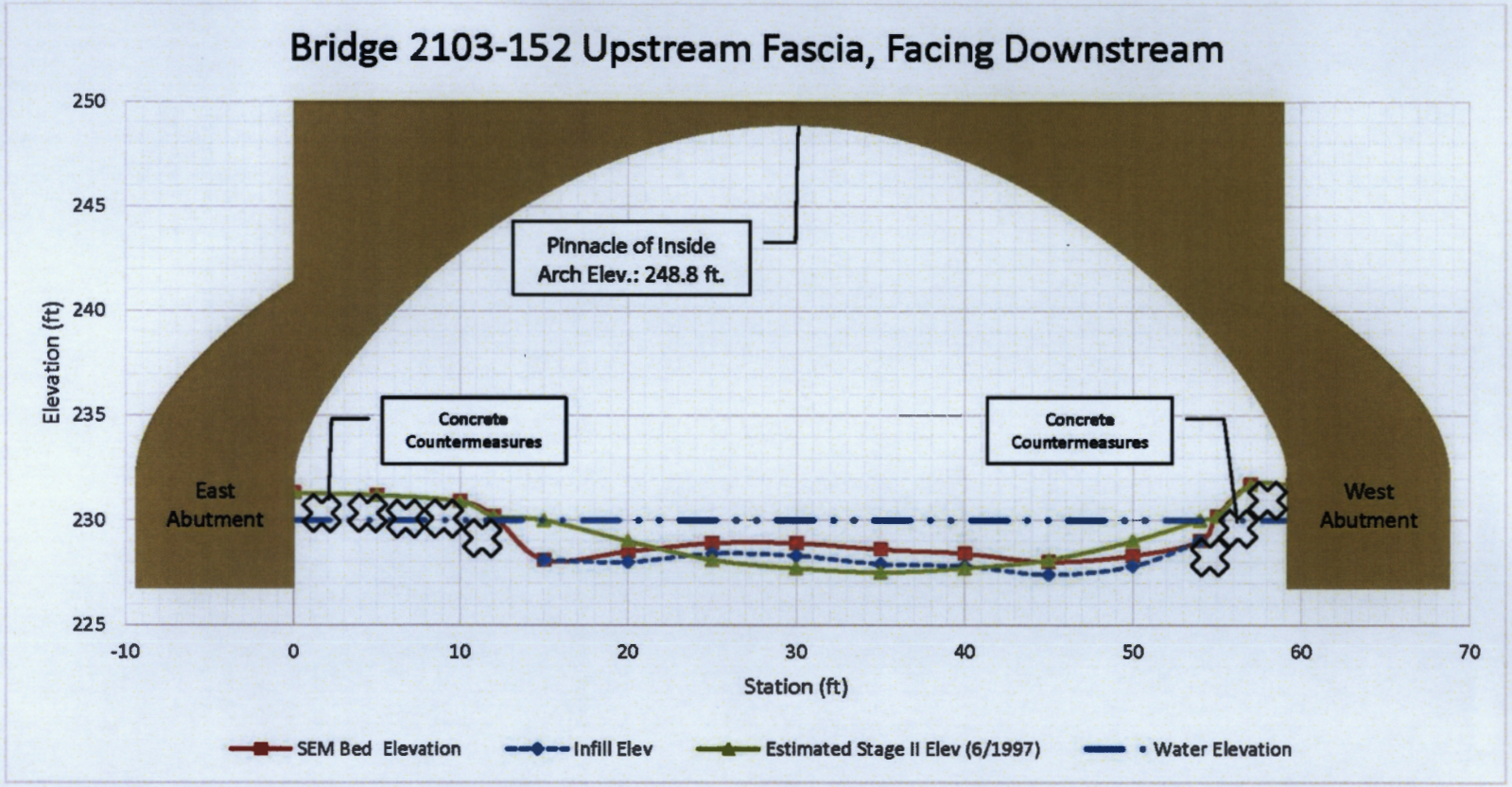


Notes:

- Vertical scale is exaggerated.
- All soundings are referenced from the arch as shown above.
- SEM visit date 12/27/16.
- Reference elevation at bridge is based on Stage 2 data and NVGD 1929.

Subsurface Fascia Sounding

Bridge 2103-152 (Route 173 over Pohatcong Creek)

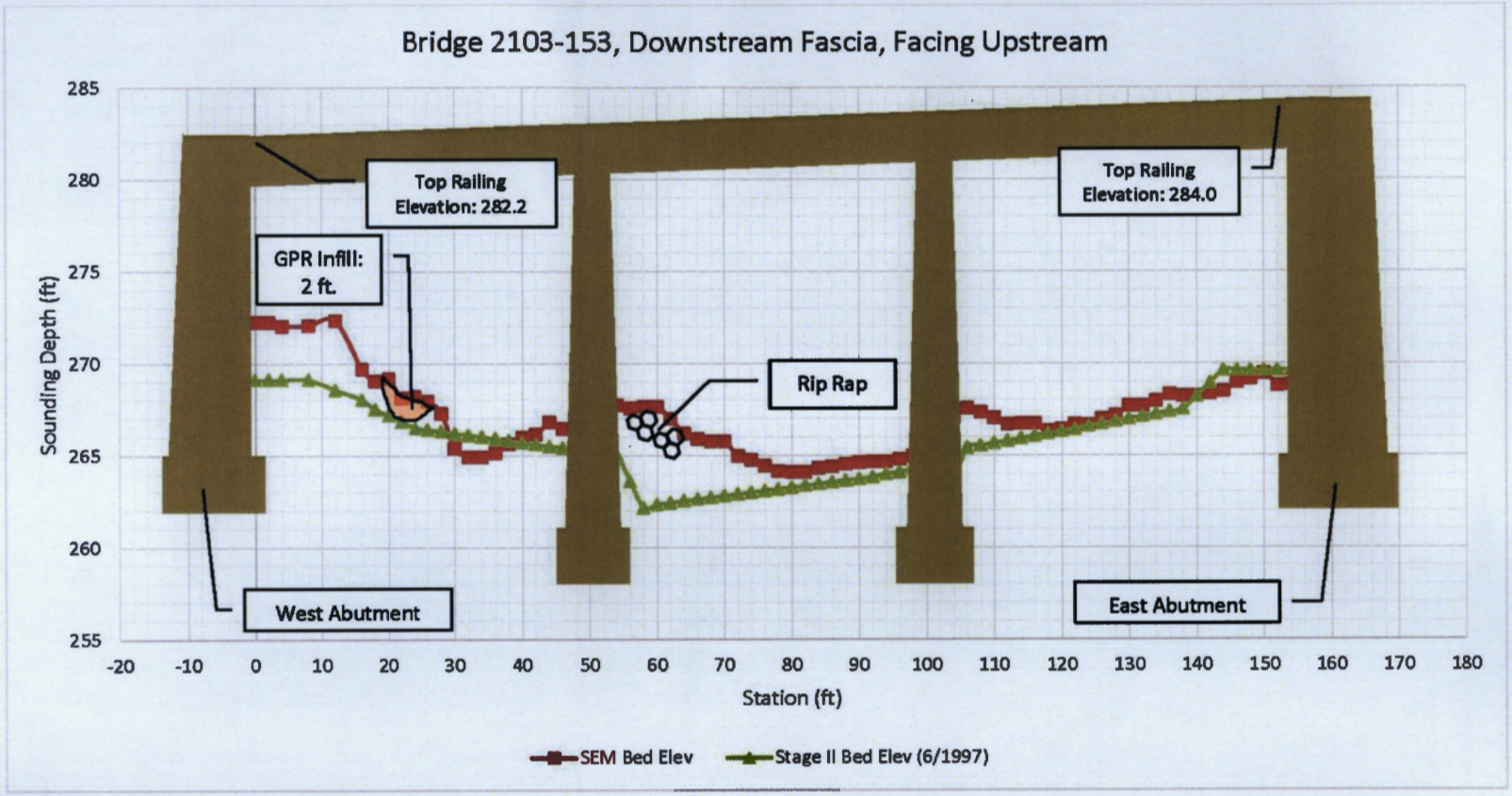


Notes:

- Vertical scale is exaggerated.
- All soundings are referenced from the arch as shown above.
- SEM visit date 12/27/16.
- Reference elevation at bridge is based on Stage 2 data and NVGD 1929.

Subsurface Fascia Sounding

Bridge 2103-153 (Route 173 over Musconetcong River)

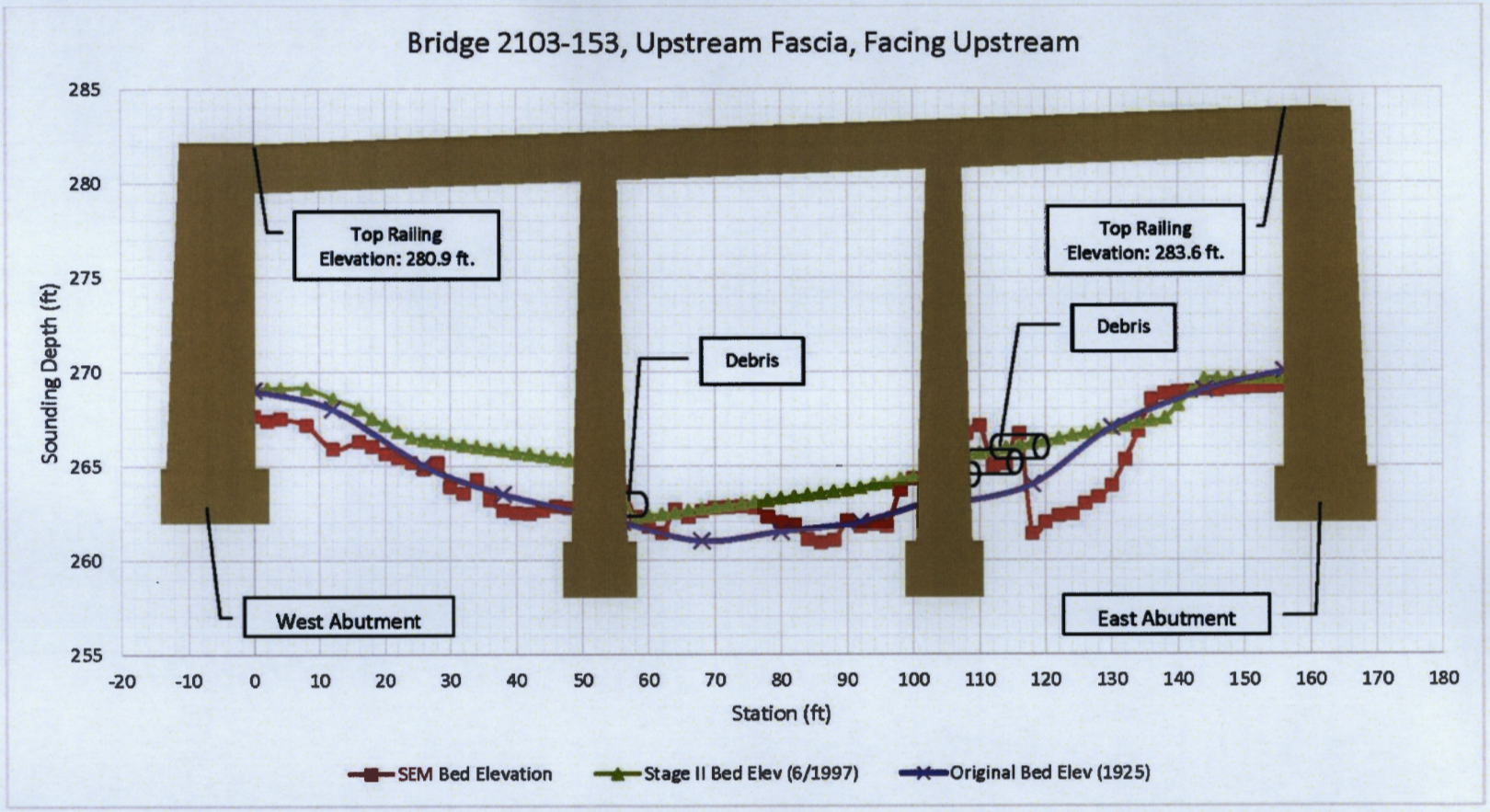


Notes:

- Vertical scale is exaggerated.
- SEM visit date 7/21/16.
- All soundings are measured from the elevation of the top railing as shown above.
- Reference elevation at bridge is based on Stage 2 data and NVGD 1929.

Subsurface Fascia Sounding

Bridge 2103-153 (Route 173 over Musconetcong River)

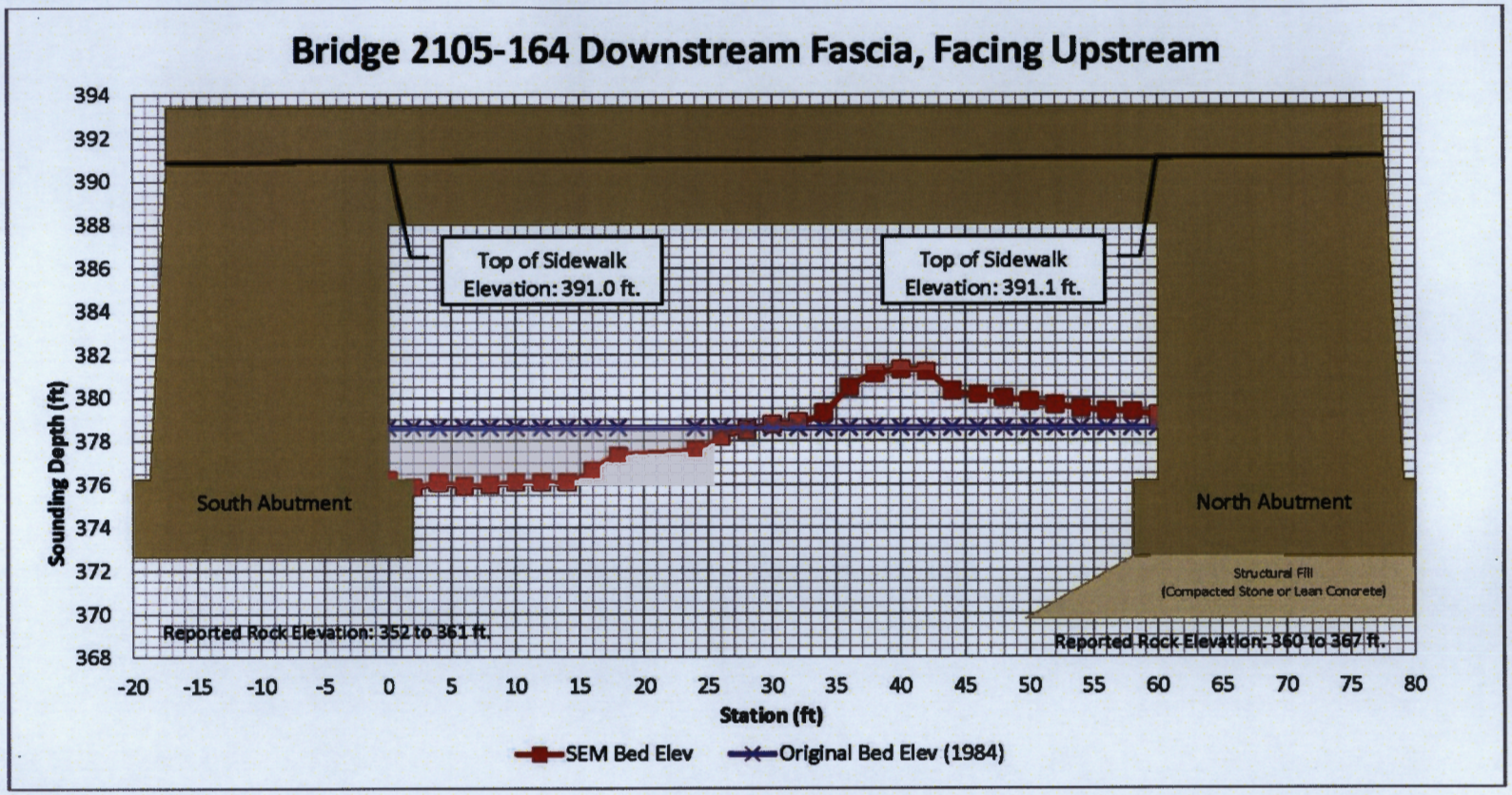


Notes:

- Vertical scale is exaggerated.
- SEM visit date 7/21/16.
- All soundings are measured from the elevation of the top railing as shown above.
- Reference elevation at bridge is based on Stage 2 data and NVGD 1929.

Subsurface Fascia Sounding

Bridge 2105-164 (Route 57 over Pohatcong Creek)

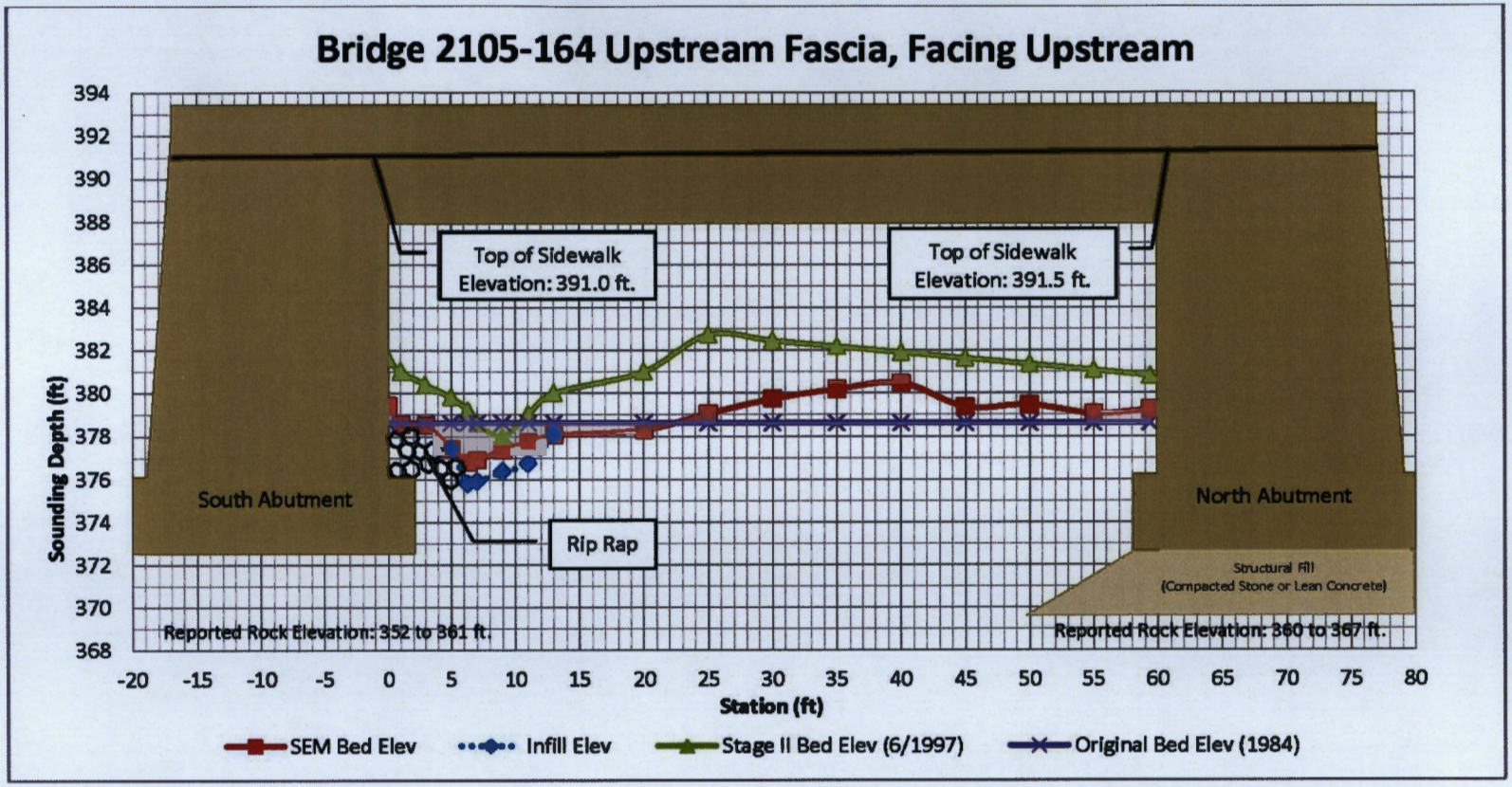


Notes:

- Vertical scale is exaggerated.
- All soundings are measured from the elevation of the top of sidewalk as shown above.
- SEM visit date 7/20/16.
- Reference elevation at bridge is based on SEM survey data and NVGD 1929.

Subsurface Fascia Sounding

Bridge 2105-164 (Route 57 over Pohatcong Creek)



Notes:

- Vertical scale is exaggerated.
- All soundings are measured from the elevation of the top of sidewalk as shown above.
- SEM visit date 7/20/16.
- Reference elevation at bridge is based on SEM survey data and NVGD 1929.
- Infill was determined by combination of GPR measurement and field probing.

APPENDIX E

HYDROLOGIC ANALYSIS CALCULATIONS

for BRIDGE SCOUR INVESTIGATION

Including the following 24 bridges:

0118-150	1304-151
0118-152	1304-156
0119-151	1405-156
0324-155	1417-156
0324-156	1809-150
0324-160	1810-155
0606-150	1810-158
0709-150	2003-162
0807-152	2103-152
1102-150	2103-153
1105-152	2105-164
1227-159	2107-156

Hydrologic Analysis Calculations
for Bridge Scour Investigation

Structure: **0118-150** Route/Stream: **Route 206 over Cedar Branch** County/Town: **Atlantic**

Stage 2 Study:	
Date Published: July-96	Cooridinates: 39.656952,-74.782906
Year Built: 1953	Q100 (CFS): 567
Method: FEMA/HEC-RAS	
StreamStats/USGS Gage Data:	
Gage Used: 01409500	Bridge Location Relative to Gage: 8 mi Upstream
Drainage Area At the Bridge: 2.66 mi^2	Drainage Area at the Gage: 67.8 mi^2
Hydrologic Province of Drainage Area: Outer Coastal Plain	Regression - Q100 (CFS): N/A (Sufficient Gage Data)
Observed Peak Flow after Year Built (CFS): 1240	Record Date: 7/30/1969
Regression (StreamStats) - Q100 at the Bridge (CFS): 360	
USGS Reports (SIR 2009-5167/SIR 2013-5234):	
Transfer Coefficient (from Hydro Province): 0.73	O [Log-Pearson Type III] - Q100 (CFS): 1650

Calculated:

Q100 at Bridge Transference (CFS):

$$Q_{100(u)g} = \left(\frac{DA_u}{DA_g}\right)^b Q_{100(o)g}$$ = [(2.66/67.8)^0.73]*1650 = **155**

%Q100 Seen at Gage:

$$\%Q100 = \frac{Peak\ Flow}{Q100}(100\%)$$ = (1240/1650)*100% = **75.2%**

Conclusion: **No, Q100 Not Seen**

Notes: Case 2 (Gage on nearby and similar stream, where transfer equations are also applicable)

O calculated by USGS from 2009 Study not 2011, Peak flow is an estimate, Gage is downstream of major confluence

Hydrologic Analysis Calculations
for Bridge Scour Investigation

Structure: **0118-152** Route/Stream: **Route 206 over Great Swamp Branch** County/Town: **Atlantic/ Hammonton**

Stage 2 Study:	
Date Published: June-96	Cooridinates: 39.684361,-74.763342
Year Built: 1930	Q100 (CFS): 480
Method: SR-38	
StreamStats/USGS Gage Data:	
Gage Used: 01411000	Bridge Location Relative to Gage: 7.81 mi NE
Drainage Area At the Bridge: 8.06 mi^2	Drainage Area at the Gage: 57 mi^2
Hydrologic Province of Drainage Area: Outer Coastal Plain	Regression - Q100 (CFS): N/A (Sufficient Gage Data)
Observed Peak Flow after Year Built (CFS): 1370	Record Date: 8/29/2011
Regression (StreamStats) - Q100 at the Bridge (CFS): 492	
USGS Reports (SIR 2009-5167/SIR 2013-5234):	
Transfer Coefficient (from Hydro Province): 0.73	O [Log-Pearson Type III] - Q100 (CFS): 1289

Calculated:

Q100 at Bridge Transference (CFS):

$$Q_{100(u)g} = \left(\frac{DA_u}{DA_g}\right)^b Q_{100(o)g}$$ = [(8.06/57)^0.73]*1289 = **309**

%Q100 Seen at Gage:

$$\%Q100 = \frac{Peak\ Flow}{Q100}(100\%)$$ = (1370/1289)*100% = **106.3%**

Conclusion: **Yes, Q100 Seen**

Notes: Case 2 (Gage on nearby and similar stream, where transfer equations are also applicable)

Hydrologic Analysis Calculations
for Bridge Scour Investigation

Structure: **0119-151** Route/Stream: **US 322 over Hospitality Brook** County/Town: **Atlantic/ Folsom**

Stage 2 Study:	
Date Published: November-97	Cooridinates: 39.569790, -74.821149
Year Built: 1961	Q100 (CFS): 2670
Method: USGS Special Report	
StreamStats/USGS Gage Data:	
Gage Used: 01411000	Bridge Location Relative to Gage: 2.37 mi SE
Drainage Area At the Bridge: 54.2 mi^2	Drainage Area at the Gage: 57.1 mi^2
Hydrologic Province of Drainage Area: Outer Coastal Plain	Regression - Q100 (CFS): N/A (Sufficient Gage Data)
Observed Peak Flow after Year Built (CFS): 1370	Record Date: 8/29/2011
Regression (StreamStats) - Q100 at the Bridge (CFS): 1710	
USGS Reports (SIR 2009-5167/SIR 2013-5234):	
Transfer Coefficient (from Hydro Province): 0.73	O [Log-Pearson Type III] - Q100 (CFS): 1289

Calculated:

Q100 at Bridge Transference (CFS):

$$Q_{100(u)g} = \left(\frac{DA_u}{DA_g}\right)^b Q_{100(o)g}$$ = [(54.2/57.1)^0.73]*1289 = **1241**

%Q100 Seen at Gage:

$$\%Q100 = \frac{Peak\ Flow}{Q100}(100\%)$$ = (1370/1289)*100% = **106.3%**

Conclusion: **Yes, Q100 Seen**

Notes: Case 2 (Gage on nearby and similar stream, where transfer equations are also applicable)

Bridge near confluence of Hospitality Brook and Great Egg Harbor River

Hydrologic Analysis Calculations
for Bridge Scour Investigation

Structure: **0324-155** Route/Stream: **Route 206 over S BR Rancocas Creek** County/Town: **Burlington/ Shamong**

Stage 2 Study:	
Date Published: September-01	Cooridinates: 39.92946,-74.742393
Year Built: 1930	Q100 (CFS): 1300
Method: HEC-RAS	
StreamStats/USGS Gage Data:	
Gage Used: 01465850	Bridge Location Relative to Gage: 1.33 mi Upstream
Drainage Area At the Bridge: 47.7 mi^2	Drainage Area at the Gage: 64.9 mi^2
Hydrologic Province of Drainage Area: Inner / Outer Coastal	Regression - Q100 (CFS): N/A (Sufficient Gage Data)
Observed Peak Flow after Year Built (CFS): 2550	Record Date: 8/28/2011
Regression (StreamStats) - Q100 at the Bridge (CFS): 1320	
USGS Reports (SIR 2009-5167/SIR 2013-5234):	
Transfer Coefficient (from Hydro Province): 0.7295	O [Log-Pearson Type III] - Q100 (CFS): 2204

Calculated:

Q100 at Bridge Transference (CFS):

$$Q_{100(u)g} = \left(\frac{DA_u}{DA_g}\right)^b Q_{100(o)g}$$ = [(47.7/64.9)^0.7295]*2204 = **1761**

%Q100 Seen at Gage:

$$\%Q100 = \frac{Peak\ Flow}{Q100}(100\%)$$ = (2550/2204)*100% = **115.7%**

Conclusion: **Yes, Q100 Seen**

Notes: Case 1 (Gage upstream/downstream of bridge, where transfer equations are applicable)

Dam failure in 2004 produced peak discharge of 4160 cfs on stream

Hydrologic Analysis Calculations
for Bridge Scour Investigation

Structure: **0324-156** Route/Stream: **Route US 206 over Jade Run** County/Town: **Burlington/ Southampton**

Stage 2 Study:	
Date Published: April-06	Cooridinates: 39.936360, -74.743032
Year Built: 1930	Q100 (CFS): 700
Method: HEC-RAS	
StreamStats/USGS Gage Data:	
Gage Used: 01465850	Bridge Location Relative to Gage: 1.1 mi E
Drainage Area At the Bridge: 11.2 mi^2	Drainage Area at the Gage: 64.9 mi^2
Hydrologic Province of Drainage Area: Inner / Outer Coastal	Regression - Q100 (CFS): N/A (Sufficient Gage Data)
Observed Peak Flow after Year Built (CFS): 2550	Record Date: 8/28/2011
Regression (StreamStats) - Q100 at the Bridge (CFS): 643	
USGS Reports (SIR 2009-5167/SIR 2013-5234):	
Transfer Coefficient (from Hydro Province): 0.7102	O [Log-Pearson Type III] - Q100 (CFS): 2204

Calculated:

Q100 at Bridge Transference (CFS):

$$Q_{100(u)g} = \left(\frac{DA_u}{DA_g}\right)^b Q_{100(o)g}$$ = [(11.2/64.9)^0.7102]*2204 = **633**

%Q100 Seen at Gage:

$$\%Q100 = \frac{Peak\ Flow}{Q100}(100\%)$$ = (2550/2204)*100% = **115.7%**

Conclusion: **Yes, Q100 Seen**

Notes: Case 1 (Gage upstream/downstream of bridge, where transfer equations are applicable)

Gage is Downstream of major confluence; Dam failure in 2005 produced peak discharge of 4,160 cfs (on different branch)

Hydrologic Analysis Calculations
for Bridge Scour Investigation

Structure: **0324-160** Route/Stream: **Route 206 over Barkers Brook** County/Town: **Burlington/ Springton**

Stage 2 Study:	
Date Published: September-96	Cooridinates: 40.025265,-74.731214
Year Built: Rec. 1929 and 1957	Q100 (CFS): 1040
Method: SR-38	
StreamStats/USGS Gage Data:	
Gage Used: 01464375	Bridge Location Relative to Gage: 7.64 mi West
Drainage Area At the Bridge: 8.53 mi^2	Drainage Area at the Gage: 4.66 mi^2
Hydrologic Province of Drainage Area: Inner / Outer Coastal	Regression - Q100 (CFS): 499
Observed Peak Flow after Year Built (CFS): 1860	Record Date: 8/31/1978
Regression (StreamStats) - Q100 at the Bridge (CFS): 982	
USGS Reports (SIR 2009-5167/SIR 2013-5234):	
Transfer Coefficient (from Hydro Province): 0.6629	O [Log-Pearson Type III] - Q100 (CFS): 1 Year of Data

Calculated:

Q100 at Bridge Transference (CFS):

$$Q_{100(u)g} = \left(\frac{DA_u}{DA_g}\right)^b Q_{100(o)g}$$ = Transference Equation Invalid

%Q100 Seen at Gage:

$$\%Q100 = \frac{Peak\ Flow}{Q100}(100\%)$$ = (1860/499)*100% **372.7%**

Conclusion: **Yes, Q100 Seen**

Notes: Case 3 (Partial record gage near bridge, Streamstats estimates used)

Irene Not Included, Only 1 Year of Data, R Value Deliniated

Hydrologic Analysis Calculations
for Bridge Scour Investigation

Structure: **0606-150** Route/Stream: **Route 49 over Mamtico Creek** County/Town: **Cumberland**

Stage 2 Study:	
Date Published: June-96	Cooridinates: 39.386435, -74.989299
Year Built: 1929	Q100 (CFS): 1190
Method: SR-38	
StreamStats/USGS Gage Data:	
Gage Used: 01412000	Bridge Location Relative to Gage: 2 mi Downstream
Drainage Area At the Bridge: 26.4 mi^2	Drainage Area at the Gage: 23.2 mi^2
Hydrologic Province of Drainage Area: Outer Coastal Plain	Regression - Q100 (CFS): N/A (Sufficient Gage Data)
Observed Peak Flow after Year Built (CFS): 1050	Record Date: 8/20/1939
Regression (StreamStats) - Q100 at the Bridge (CFS): 1160	
USGS Reports (SIR 2009-5167/SIR 2013-5234):	
Transfer Coefficient (from Hydro Province): 0.73	O [Log-Pearson Type III] - Q100 (CFS): 988

Calculated:

Q100 at Bridge Transference (CFS):

$$Q_{100(u)g} = \left(\frac{DA_u}{DA_g}\right)^b Q_{100(o)g}$$ = [(26.4/23.2)^0.73]*988 = **1086**

%Q100 Seen at Gage:

$$\%Q100 = \frac{Peak\ Flow}{Q100}(100\%)$$ = (1050/988)*100% = **106.3%**

Conclusion: **Yes, Q100 Seen**

Notes: Case 1 (Gage upstream/downstream of bridge, where transfer equations are applicable)

O calculated by USGS from 2009 Study not 2011, Peak flow is an estimate. Discharge affected to unknown degree by Regulation or Diversion

Hydrologic Analysis Calculations
for Bridge Scour Investigation

Structure: **0709-150** Route/Stream: **Rt. 10 over Willow Meadow Brook** County/Town: **Essex/ Livingston**

Stage 2 Study:	
Date Published: September-97	Cooridinates: 40.796294,-74.343294
Year Built: 1959	Q100 (CFS): 720
Method: FEMA	
StreamStats/USGS Gage Data:	
Gage Used: 01379520	Bridge Location Relative to Gage: 2.44 mi NW
Drainage Area At the Bridge: N/A mi^2	Drainage Area at the Gage: 0.47 mi^2
Hydrologic Province of Drainage Area: Valley and Ridge	Regression - Q100 (CFS): 398
Observed Peak Flow after Year Built (CFS): 610	Record Date: 9/16/1999
Regression (StreamStats) - Q100 at the Bridge (CFS): N/A (DA too small)	
USGS Reports (SIR 2009-5167/SIR 2013-5234):	
Transfer Coefficient (from Hydro Province): 0.59	O [Log-Pearson Type III] - Q100 (CFS): < 20 years of data

Calculated:

Q100 at Bridge Transference (CFS):

$$Q_{100(u)g} = \left(\frac{DA_u}{DA_g}\right)^b Q_{100(o)g}$$ = Transference Equation Invalid

%Q100 Seen at Gage:

$$\%Q100 = \frac{Peak\ Flow}{Q100}(100\%)$$ = (610/398)*100% **153.3%**

Conclusion: **Yes, Q100 Seen**

Notes: Case 3 (Partial record gage near bridge, Streamstats estimates used)

StreamStats: One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors; Irene Not Included, Gage Data Only to 2010

Hydrologic Analysis Calculations
for Bridge Scour Investigation

Structure: **0807-152** Route/Stream: **Route 45 over Raccoon Creek** County/Town: **Gloucester/ Harrison**

Stage 2 Study:	
Date Published: September-01	Cooridinates: 39.736164, -75.224636
Year Built: 1940	Q100 (CFS): 2660
Method: HEC-RAS	
StreamStats/USGS Gage Data:	
Gage Used: 01477120	Bridge Location Relative to Gage: 1.86 mi Upstream
Drainage Area At the Bridge: 14.6 mi^2	Drainage Area at the Gage: 25.9 mi^2
Hydrologic Province of Drainage Area: Inner / Outer Coastal	Regression - Q100 (CFS): N/A (Sufficient Gage Data)
Observed Peak Flow after Year Built (CFS): 5510	Record Date: 8/28/2011
Regression (StreamStats) - Q100 at the Bridge (CFS): 1580	
USGS Reports (SIR 2009-5167/SIR 2013-5234):	
Transfer Coefficient (from Hydro Province): 0.689	O [Log-Pearson Type III] - Q100 (CFS): 4187

Calculated:

Q100 at Bridge Transference (CFS):

$$Q_{100(u)g} = \left(\frac{DA_u}{DA_g}\right)^b Q_{100(o)g}$$ = [(14.6/25.9)^0.689]*4187 = **2821**

%Q100 Seen at Gage:

$$\%Q100 = \frac{Peak\ Flow}{Q100}(100\%)$$ = (5510/4187)*100% = **131.6%**

Conclusion: **Yes, Q100 Seen**

Notes: Case 1 (Gage upstream/downstream of bridge, where transfer equations are applicable)

Hydrologic Analysis Calculations
for Bridge Scour Investigation

Structure: **1102-150** Route/Stream: **US Route 1B over Shabakunk Creek** County/Town: **Mercer**

Stage 2 Study:	
Date Published: October-02	Cooridinates: 40.256755, -74.728282
Year Built: 1928	Q100 (CFS): 3401
Method: FEMA	
StreamStats/USGS Gage Data:	
Gage Used: 01463740	Bridge Location Relative to Gage: 2.59 Downstream
Drainage Area At the Bridge: 12.6 mi^2	Drainage Area at the Gage: 3.99 mi^2
Hydrologic Province of Drainage Area: Unglaciated Piedmont	Regression - Q100 (CFS): 2010
Observed Peak Flow after Year Built (CFS): 5550	Record Date: 7/21/1975
Regression (StreamStats) - Q100 at the Bridge (CFS): 4020	
USGS Reports (SIR 2009-5167/SIR 2013-5234):	
Transfer Coefficient (from Hydro Province): 0.58	O [Log-Pearson Type III] - Q100 (CFS): < 20 years of data

Calculated:

Q100 at Bridge Transference (CFS):

$$Q_{100(u)g} = \left(\frac{DA_u}{DA_g}\right)^b Q_{100(o)g}$$ = Transference Equation Invalid

%Q100 Seen at Gage:

$$\%Q100 = \frac{Peak\ Flow}{Q100}(100\%)$$ = (5550/2010)*100% **276.1%**

Conclusion: **Yes, Q100 Seen**

Notes: Case 3 (Partial record gage near bridge, Streamstats estimates used)

Irene was 1920

Hydrologic Analysis Calculations
for Bridge Scour Investigation

Structure: **1105-152** Route/Stream: **Rt. 27 over Millstone R.** County/Town: **Mercer/ Princeton**

Stage 2 Study:	
Date Published: September-97	Cooridinates: 40.374344, -74.619897
Year Built: 1970	Q100 (CFS): 12672
Method: FEMA	
StreamStats/USGS Gage Data:	
Gage Used: 01401301	Bridge Location Relative to Gage: 0.05 mi Upstream
Drainage Area At the Bridge: 154 mi^2	Drainage Area at the Gage: 162 mi^2
Hydrologic Province of Drainage Area: U.P. / Inner Coastal Plain	Regression - Q100 (CFS): N/A (Sufficient Gage Data)
Observed Peak Flow after Year Built (CFS): 17700	Record Date: 8/28/2011
Regression (StreamStats) - Q100 at the Bridge (CFS): 13700	
USGS Reports (SIR 2009-5167/SIR 2013-5234):	
Transfer Coefficient (from Hydro Province): 0.6259	O [Log-Pearson Type III] - Q100 (CFS): 14000

Calculated:

Q100 at Bridge Transference (CFS):

$$Q_{100(u)g} = \left(\frac{DA_u}{DA_g}\right)^b Q_{100(o)g}$$ = [(154/162)^0.6259]*14000 = **13563**

%Q100 Seen at Gage:

$$\%Q100 = \frac{Peak\ Flow}{Q100}(100\%)$$ = (17700/14000)*100% = **126.4%**

Conclusion: **Yes, Q100 Seen**

Notes: Case 1 (Gage upstream/downstream of bridge, where transfer equations are applicable)

O calculated by USGS from 2009 Study not 2011

Hydrologic Analysis Calculations
for Bridge Scour Investigation

Structure: **1227-159** Route/Stream: **Route 130 over Oakeys Brook** County/Town: **Middlesex**

Stage 2 Study:	
Date Published: August-96	Cooridinates: 40.416355, -74.502041
Year Built: 1934	Q100 (CFS): 1490
Method: FEMA	
StreamStats/USGS Gage Data:	
Gage Used: 01405000	Bridge Location Relative to Gage: 3.5 Upstream
Drainage Area At the Bridge: 4.48 mi^2	Drainage Area at the Gage: 34.4 mi^2
Hydrologic Province of Drainage Area: Glaciated Piedmont	Regression - Q100 (CFS): N/A (Sufficient Gage Data)
Observed Peak Flow after Year Built (CFS): 4920	Record Date: 7/21/1975
Regression (StreamStats) - Q100 at the Bridge (CFS): 1460	
USGS Reports (SIR 2009-5167/SIR 2013-5234):	
Transfer Coefficient (from Hydro Province): 0.58	O [Log-Pearson Type III] - Q100 (CFS): 4790

Calculated:

Q100 at Bridge Transference (CFS):

$$Q_{100(u)g} = \left(\frac{DA_u}{DA_g}\right)^b Q_{100(o)g}$$ = [(4.48/34.4)^0.58]*4790 = **1468**

%Q100 Seen at Gage:

$$\%Q100 = \frac{Peak\ Flow}{Q100}(100\%)$$ = (4920/4790)*100% = **102.7%**

Conclusion: **Yes, Q100 Seen**

Notes: Case 1 (Gage upstream/downstream of bridge, where transfer equations are applicable)

O calculated by USGS from 2009 Study not 2011, Discharge affected to unknown degree by Regulation or Diversion, Gage is Downstream of major confluence

Hydrologic Analysis Calculations
for Bridge Scour Investigation

Structure: **1304-151** Route/Stream: **Route 33 over Millstone River** County/Town: **Monmouth**

Stage 2 Study:	
Date Published: May-02	Cooridinates: 40.262098, -74.420056
Year Built: 1915	Q100 (CFS): 1155
Method: FEMA	
StreamStats/USGS Gage Data:	
Gage Used: 01400630	Bridge Location Relative to Gage: 8.6 mi Upstream
Drainage Area At the Bridge: 7.37 mi^2	Drainage Area at the Gage: 40.9 mi^2
Hydrologic Province of Drainage Area: Inner/Outer Coastal	Regression - Q100 (CFS): N/A (Sufficient Gage Data)
Observed Peak Flow after Year Built (CFS): 2110	Record Date: 8/28/1971
Regression (StreamStats) - Q100 at the Bridge (CFS): 1080	
USGS Reports (SIR 2009-5167/SIR 2013-5234):	
Transfer Coefficient (from Hydro Province): 0.6638	O [Log-Pearson Type III] - Q100 (CFS): 2020

Calculated:

Q100 at Bridge Transference (CFS):

$$Q_{100(u)g} = \left(\frac{DA_u}{DA_g}\right)^b Q_{100(o)g}$$ = [(7.37/40.9)^0.6638]*2020 = **648**

%Q100 Seen at Gage:

$$\%Q100 = \frac{Peak\ Flow}{Q100}(100\%)$$ = (2110/2020)*100% = **104.5%**

Conclusion: **Yes, Q100 Seen**

Notes: Case 1 (Regulated stream, Streamstats estimates invalid)

Discharge is an Estimate; O calculated by USGS from 2009 Study not 2011, Irene not Included, Gage Data only to 2000

Hydrologic Analysis Calculations
for Bridge Scour Investigation

Structure: **1304-156** Route/Stream: **Route 33 over BR Manalapan Brook** County/Town: **Monmouth/ Manalapan**

Stage 2 Study:	
Date Published: November-96	Cooridinates: 40.253263, -74.349962
Year Built: 1927; Widened 1966	Q100 (CFS): 950
Method: FEMA	
StreamStats/USGS Gage Data:	
Gage Used: 01405400	Bridge Location Relative to Gage: 12.2 mi Downstream
Drainage Area At the Bridge: 7.85 mi^2	Drainage Area at the Gage: 40.7 mi^2
Hydrologic Province of Drainage Area: Inner/Outer Coastal	Regression - Q100 (CFS): N/A (Sufficient Gage Data)
Observed Peak Flow after Year Built (CFS): 6650	Record Date: 8/28/2011
Regression (StreamStats) - Q100 at the Bridge (CFS): 806	
USGS Reports (SIR 2009-5167/SIR 2013-5234):	
Transfer Coefficient (from Hydro Province): 0.6978	O [Log-Pearson Type III] - Q100 (CFS): 4160

Calculated:

Q100 at Bridge Transference (CFS):

$$Q_{100(u)g} = \left(\frac{DA_u}{DA_g}\right)^b Q_{100(o)g}$$ = [(7.85/40.7)^0.6978]*4160 = **1319**

%Q100 Seen at Gage:

$$\%Q100 = \frac{Peak\ Flow}{Q100}(100\%)$$ = (6650/4160)*100% = **159.9%**

Conclusion: **Yes, Q100 Seen**

Notes: Case 1 (Gage upstream/downstream of bridge, where transfer equations are applicable)

Peak Discharge affected by unknown degree of regulation/diversion.

Hydrologic Analysis Calculations for Bridge Scour Investigation

Structure: **1405-156** Route/Stream: **Rt. 23 over Pequannock R./Hamburg Turnpike** County/Town: **Passaic/ West Milford**

Stage 2 Study:	
Date Published: August-01	Cooridinates: 41.011508,-74.370514
Year Built: 1934	Q100 (CFS): 4265
Method: FEMA	
StreamStats/USGS Gage Data:	
Gage Used: 01382500	Bridge Location Relative to Gage: 1.7 mi Downstream
Drainage Area At the Bridge: 67.3 mi^2	Drainage Area at the Gage: 63.7 mi^2
Hydrologic Province of Drainage Area: Valley & Ridge	Regression - Q100 (CFS): N/A
Observed Peak Flow after Year Built (CFS): 4880	Record Date: 4/5/1984
Regression (StreamStats) - Q100 at the Bridge (CFS): N/A	
USGS Reports (SIR 2009-5167/SIR 2013-5234):	
Transfer Coefficient (from Hydro Province): 0.59	O - FEMA Transference Q100 (CFS): 5394

Calculated:

Q100 at Bridge Transference (CFS):

$$Q_{100(u)g} = \left(\frac{DA_u}{DA_g}\right)^b Q_{100(o)g}$$ = [(67.3/63.7)^0.59]*5394 = **5572**

%Q100 Seen at Gage:

$$\%Q100 = \frac{Peak\ Flow}{Q100}(100\%)$$ = (4880/5394)*100% = **90.5%**

Conclusion: **No, Q100 Not Seen**

Notes: Case 4 / 1 (Regulated stream, Streamstats estimates invalid; Gage upstream/downstream of bridge, where transfer equations are applicable)
Over Regulated River, Discharge affected to unknown degree by Regulation or Diversion, O-Q100 Estimated by Transference from FEMA Study; See Regulated Bridges Table for Details

Hydrologic Analysis Calculations
for Bridge Scour Investigation

Structure: **1417-156** Route/Stream: **Route 206 over SB Raritan River** County/Town: **Morris/ Mount Olive**

Stage 2 Study:	
Date Published: May-95	Cooridinates: 40.850072, -74.70078
Year Built: 1928	Q100 (CFS): 1215
Method: FEMA	
StreamStats/USGS Gage Data:	
Gage Used: 01396152	Bridge Location Relative to Gage: 0.3 mi Downstream
Drainage Area At the Bridge: 2.21 mi^2	Drainage Area at the Gage: 1.97 mi^2
Hydrologic Province of Drainage Area: Valley & Ridge	Regression - Q100 (CFS): 664
Observed Peak Flow after Year Built (CFS): 1360	Record Date: 8/28/2011
Regression (StreamStats) - Q100 at the Bridge (CFS): 747	
USGS Reports (SIR 2009-5167/SIR 2013-5234):	
Transfer Coefficient (from Hydro Province): 0.59	O [Log-Pearson Type III] - Q100 (CFS): No O (Inactive Gage)

Calculated:

Q100 at Bridge Transference (CFS):

$$Q_{100(u)g} = \left(\frac{DA_u}{DA_g}\right)^b Q_{100(o)g}$$ = Transference Equation Invalid

%Q100 Seen at Gage:

$$\%Q100 = \frac{Peak\ Flow}{Q100}(100\%)$$ = (1360/664)*100% **204.8%**

Conclusion: **Yes, Q100 Seen**

Notes: Case 3 (Partial record gage near bridge, Streamstats estimates used)

Limited gage data including Irene, R Q100 Delineated

Hydrologic Analysis Calculations
for Bridge Scour Investigation

Structure: **1809-150** Route/Stream: **Rt. 202 over NB Raritan River** County/Town: **Somerset/ Bedminster**

Stage 2 Study:	
Date Published: August-05	Cooridinates: 40.68285, -74.63833
Year Built: 1922	Q100 (CFS): 9430
Method: HEC-RAS	
StreamStats/USGS Gage Data:	
Gage Used: 01398500	Bridge Location Relative to Gage: 1.8 mi Downstream
Drainage Area At the Bridge: 40.8 mi^2	Drainage Area at the Gage: 26.2 mi^2
Hydrologic Province of Drainage Area: Unglaciated Piedmont/ V&R	Regression - Q100 (CFS): N/A (Sufficient Gage Data)
Observed Peak Flow after Year Built (CFS): 6390	Record Date: 8/28/1971
Regression (StreamStats) - Q100 at the Bridge (CFS): 5090.66	
USGS Reports (SIR 2009-5167/SIR 2013-5234):	
Transfer Coefficient (from Hydro Province): 0.5899	O [Log-Pearson Type III] - Q100 (CFS): 6903

Calculated:

Q100 at Bridge Transference (CFS):

$$Q_{100(u)g} = \left(\frac{DA_u}{DA_g}\right)^b Q_{100(o)g}$$ = [(40.8/26.2)^0.5899]*6903 = **8964**

%Q100 Seen at Gage:

$$\%Q100 = \frac{Peak\ Flow}{Q100}(100\%)$$ = (6390/6903)*100% = **92.6%**

Conclusion: **No, Q100 Not Seen**

Notes: Case 1 (Gage upstream/downstream of bridge, where transfer equations are applicable)

Hydrologic Analysis Calculations
for Bridge Scour Investigation

Structure: **1810-155** Route/Stream: **Rt. 206 over Cruisers Brook** County/Town: **Somerset/ Montgomery**

Stage 2 Study:	
Date Published: August-01	Cooridinates: 40.454439,-74.660067
Year Built: 1925	Q100 (CFS): 3176
Method: HEC-RAS	
StreamStats/USGS Gage Data:	
Gage Used: 01401650	Bridge Location Relative to Gage: 1.11 mi North
Drainage Area At the Bridge: 4.8 mi^2	Drainage Area at the Gage: 5.36 mi^2
Hydrologic Province of Drainage Area: Unglaciated Piedmont	Regression - Q100 (CFS): N/A (Sufficient Gage Data)
Observed Peak Flow after Year Built (CFS): 8200	Record Date: 9/16/1999
Regression (StreamStats) - Q100 at the Bridge (CFS): 2580	
USGS Reports (SIR 2009-5167/SIR 2013-5234):	
Transfer Coefficient (from Hydro Province): 0.58	O [Log-Pearson Type III] - Q100 (CFS): 4660

Calculated:

Q100 at Bridge Transference (CFS):

$$Q_{100(u)_g} = \left(\frac{DA_u}{DA_g}\right)^b Q_{100(o)_g}$$ = [(4.8/5.36)^0.58]*4660 = **4371**

%Q100 Seen at Gage:

$$\%Q100 = \frac{Peak\ Flow}{Q100}(100\%)$$ = (8200/4660)*100% = **176.0%**

Conclusion: **Yes, Q100 Seen**

Notes: Case 2 (Gage on nearby and similar stream, where transfer equations are also applicable)

Hydrologic Analysis Calculations
for Bridge Scour Investigation

Structure: **1810-158** Route/Stream: **Rt. 206 over Crusers Brook** County/Town: **Somerset/ Hillsborough**

Stage 2 Study:	
Date Published: September-97	Cooridinates: 40.474097, -74.656981
Year Built: 1927	Q100 (CFS): 3530
Method: FEMA	
StreamStats/USGS Gage Data:	
Gage Used: 01401650	Bridge Location Relative to Gage: 1 mi Upstream
Drainage Area At the Bridge: 4.34 mi^2	Drainage Area at the Gage: 5.29 mi^2
Hydrologic Province of Drainage Area: Unglaciated Piedmont	Regression - Q100 (CFS): N/A (Sufficient Gage Data)
Observed Peak Flow after Year Built (CFS): 8200	Record Date: 9/16/1999
Regression (StreamStats) - Q100 at the Bridge (CFS): 2570	
USGS Reports (SIR 2009-5167/SIR 2013-5234):	
Transfer Coefficient (from Hydro Province): 0.58	O [Log-Pearson Type III] - Q100 (CFS): 4660

Calculated:

Q100 at Bridge Transference (CFS):

$$Q_{100(u)g} = \left(\frac{DA_u}{DA_g}\right)^b Q_{100(o)g}$$ = [(4.34/5.29)^0.58]*4660 = **4155**

%Q100 Seen at Gage:

$$\%Q100 = \frac{Peak\ Flow}{Q100}(100\%)$$ = (8200/4660)*100% = **176.0%**

Conclusion: **Yes, Q100 Seen**

Notes: Case 1 (Gage upstream/downstream of bridge, where transfer equations are applicable)

Irene was 3,280 cfs

Hydrologic Analysis Calculations
for Bridge Scour Investigation

Structure: **2003-162** Route/Stream: **US 22 WB over Rahway River** County/Town: **Union/ Springfield**

Stage 2 Study:	
Date Published: October-05	Cooridinates: 40.688558, -74.311835
Year Built: 1941	Q100 (CFS): 6000
Method: HEC-RAS	
StreamStats/USGS Gage Data:	
Gage Used: 01394500	Bridge Location Relative to Gage: 0.05 mi Upstream
Drainage Area At the Bridge: 25 mi^2	Drainage Area at the Gage: 24.9 mi^2
Hydrologic Province of Drainage Area: Glaciated Piedmont	Regression - Q100 (CFS): N/A (Sufficient Gage Data)
Observed Peak Flow after Year Built (CFS): 8620	Record Date: 8/28/2011
Regression (StreamStats) - Q100 at the Bridge (CFS): 4780	
USGS Reports (SIR 2009-5167/SIR 2013-5234):	
Transfer Coefficient (from Hydro Province): 0.68	Q [Log-Pearson Type III] - Q100 (CFS): 7532

Calculated:

Q100 at Bridge Transference (CFS):

$$Q_{100(u)g} = \left(\frac{DA_u}{DA_g}\right)^b Q_{100(o)g}$$ = [(25/24.9)^0.68]*7532 = **7553**

%Q100 Seen at Gage:

$$\%Q100 = \frac{Peak\ Flow}{Q100}(100\%)$$ = (8620/7532)*100% = **114.4%**

Conclusion: **Yes, Q100 Seen**

Notes: Case 1 (Gage upstream/downstream of bridge, where transfer equations are applicable)

Hydrologic Analysis Calculations
for Bridge Scour Investigation

Structure: **2103-152** Route/Stream: **Route 173 over Pohatcong Creek** County/Town: **Warren/ Greenwich**

Stage 2 Study:	
Date Published: February-98	Cooridinates: 40.660915, -75.113547
Year Built: 1914	Q100 (CFS): 4840
Method: FEMA	
StreamStats/USGS Gage Data:	
Gage Used: 01455200	Bridge Location Relative to Gage: 4.39 mi Downstream
Drainage Area At the Bridge: 51.6 mi^2	Drainage Area at the Gage: 33.3 mi^2
Hydrologic Province of Drainage Area: Valley and Ridge	Regression - Q100 (CFS): N/A (Sufficient Gage Data)
Observed Peak Flow after Year Built (CFS): 3570	Record Date: 1/25/1979
Regression (StreamStats) - Q100 at the Bridge (CFS): 4290	
USGS Reports (SIR 2009-5167/SIR 2013-5234):	
Transfer Coefficient (from Hydro Province): 0.59	O [Log-Pearson Type III] - Q100 (CFS): 3180

Calculated:

Q100 at Bridge Transference (CFS):

$$Q_{100(u)g} = \left(\frac{DA_u}{DA_g}\right)^b Q_{100(o)g}$$ = [(51.6/33.3)^0.59]*3180 = **4118**

%Q100 Seen at Gage:

$$\%Q100 = \frac{Peak\ Flow}{Q100}(100\%)$$ = (3570/3180)*100% = **112.3%**

Conclusion: **Yes, Q100 Seen**

Notes: Case 1 (Gage upstream/downstream of bridge, where transfer equations are applicable)

O calculated by USGS from 2009 Study not 2011, Irene not Included, Gage Data only to 2000

Hydrologic Analysis Calculations
for Bridge Scour Investigation

Structure: **2103-153** Route/Stream: **Rt. 173 over Musconetcong River** County/Town: **Warren/ Greenich**

Stage 2 Study:	
Date Published: February-98	Cooridinates: 40.658860, -75.080169
Year Built: 1925	Q100 (CFS): 8690
Method: FEMA	
StreamStats/USGS Gage Data:	
Gage Used: 01457000	Bridge Location Relative to Gage: 1.37 mi Downstream
Drainage Area At the Bridge: 142 mi^2	Drainage Area at the Gage: 141 mi^2
Hydrologic Province of Drainage Area: Valley & Ridge	Regression - Q100 (CFS): N/A (Sufficient Gage Data)
Observed Peak Flow after Year Built (CFS): 7200	Record Date: 1/25/1979
Regression (StreamStats) - Q100 at the Bridge (CFS): 8240	
USGS Reports (SIR 2009-5167/SIR 2013-5234):	
Transfer Coefficient (from Hydro Province): 0.59	O [Log-Pearson Type III] - Q100 (CFS): 7630

Calculated:

Q100 at Bridge Transference (CFS):

$$Q_{100(u)g} = \left(\frac{DA_u}{DA_g}\right)^b Q_{100(o)g}$$ = [(142/141)^0.59]*7630 = **7662**

%Q100 Seen at Gage:

$$\%Q100 = \frac{Peak\ Flow}{Q100}(100\%)$$ = (7200/7630)*100% = **94.4%**

Conclusion: **No, Q100 Not Seen**

Notes: Case 1 (Gage upstream/downstream of bridge, where transfer equations are applicable)

Discharge affected to unknown degree by Regulation or Diversion

Hydrologic Analysis Calculations
for Bridge Scour Investigation

Structure: **2105-164** Route/Stream: **Route 57 over Pahatcong Creek** County/Town: **Warren/ Washington**

Stage 2 Study:	
Date Published: February-98	Cooridinates: 40.752591,-75.001382
Year Built: 1984	Q100 (CFS): Missing Page
Method: Missing Page	
StreamStats/USGS Gage Data:	
Gage Used: 01455200	Bridge Location Relative to Gage: 4.5 mi Upstream
Drainage Area At the Bridge: 14.6 mi^2	Drainage Area at the Gage: 33.3 mi^2
Hydrologic Province of Drainage Area: Valley and Ridge	Regression - Q100 (CFS): N/A (Sufficient Gage Data)
Observed Peak Flow after Year Built (CFS): 2450	Record Date: 9/21/1989
Regression (StreamStats) - Q100 at the Bridge (CFS): 1940	
USGS Reports (SIR 2009-5167/SIR 2013-5234):	
Transfer Coefficient (from Hydro Province): 0.59	O [Log-Pearson Type III] - Q100 (CFS): 3180

Calculated:

Q100 at Bridge Transference (CFS):

$$Q_{100(u)g} = \left(\frac{DA_u}{DA_g}\right)^b Q_{100(o)g}$$ = [(14.6/33.3)^0.59]*3180 = **1955**

%Q100 Seen at Gage:

$$\%Q100 = \frac{Peak\ Flow}{Q100}(100\%)$$ = (2450/3180)*100% = **77.0%**

Conclusion: **No, Q100 Not Seen**

Notes: Case 1 (Gage upstream/downstream of bridge, where transfer equations are applicable)

O calculated by USGS from 2009 Study not 2011, Irene not Included, Gage Data only to 2000

Hydrologic Analysis Calculations
for Bridge Scour Investigation

Structure: **2107-156** Route/Stream: **Route 46 Over Paulins Kill** County/Town: **Warren/ Knowlton**

Stage 2 Study:	
Date Published: May-95	Cooridinates: 40.920743,-75.088085
Year Built: 1933	Q100 (CFS): 8117
Method: FEMA	
StreamStats/USGS Gage Data:	
Gage Used: 01443500	Bridge Location Relative to Gage: 9.15 mi Downstream
Drainage Area At the Bridge: 177 mi^2	Drainage Area at the Gage: 126 mi^2
Hydrologic Province of Drainage Area: Valley & Ridge	Regression - Q100 (CFS): N/A (Sufficient Gage Data)
Observed Peak Flow after Year Built (CFS): 6520	Record Date: 9/8/2011
Regression (StreamStats) - Q100 at the Bridge (CFS): 7100	
USGS Reports (SIR 2009-5167/SIR 2013-5234):	
Transfer Coefficient (from Hydro Province): 0.59	O [Log-Pearson Type III] - Q100 (CFS): 6413

Calculated:

Q100 at Bridge Transference (CFS):

$$Q_{100(u)g} = \left(\frac{DA_u}{DA_g}\right)^b Q_{100(o)g}$$ = [(177/126)^0.59]*6413 = **7837**

%Q100 Seen at Gage:

$$\%Q100 = \frac{Peak\ Flow}{Q100}(100\%)$$ = (6520/6413)*100% = **101.7%**

Conclusion: **Yes, Q100 Seen**

Notes: Case 1 (Gage upstream/downstream of bridge, where transfer equations are applicable)

November 2017 **FHWA-NJ-2017-015**

New Jersey Department of Transportation
Bureau of Research

Technical Brief

Scour Evaluation Model Implementation Phase

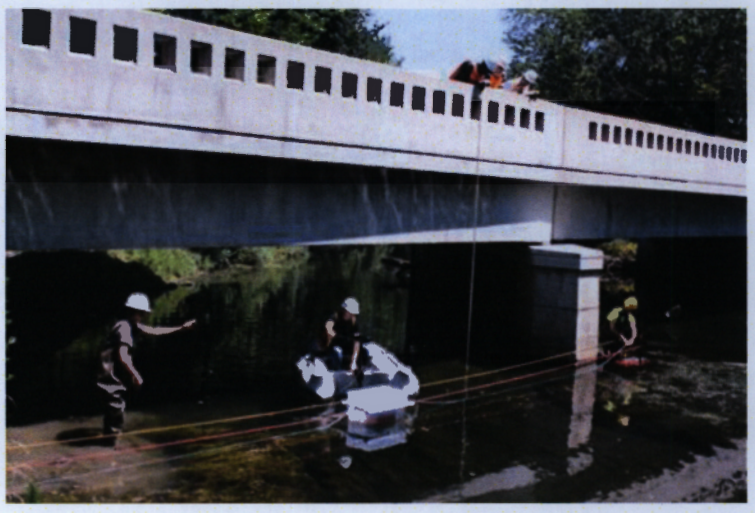
This project launched the new Scour Evaluation Model (SEM) and began applying it to New Jersey bridges. The model was used to evaluate three dozen bridges across the State to help discern those that require repair from others that have low scour risk. The overall goal was to provide the State with a rational tool to manage bridges on the Scour Critical List.

Background

Beginning in the 1990s, the New Jersey Department of Transportation (NJDOT) launched a robust Plan of Action to identify scour critical bridges and to perform corrective work. In carrying out the plan, the Department decided to develop New Jersey's own modified method of scour analysis known as the Scour Evaluation Model (SEM). The model is risk-based and reflects the State's unique geology and hydrology. More information about SEM and its development is available in the report, "Design and Evaluation of Scour for Bridges Using HEC-18," FHWA-NJ-2017-011.

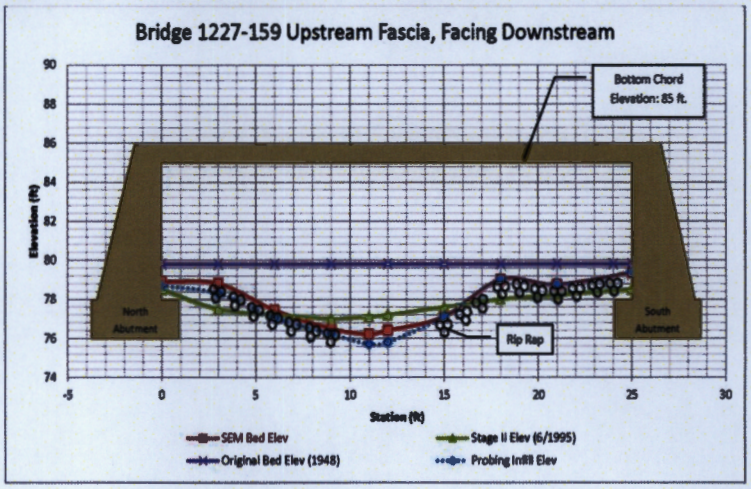
Research Objectives and Approach

This project was the "Implementation Phase" for SEM aimed at transferring the model into state-wide practice. Bridges were evaluated in all four of New Jersey's physiographic provinces, including the Coastal Plain, Piedmont, Highlands, and Valley and Ridge. The chosen bridges had a wide variety of characteristics, including age, structure type, number of spans, drainage basin size, and flooding history. Bridges were subjected to thorough geotechnical and hydrological investigations. Field measurements were also conducted using soundings and ground penetrating radar (GPR). The key findings for each bridge were the Scour Priority Level (1 thru 4) based on a risk analysis, as well as specific recommended actions. Three New Jersey consulting firms participated in the project for the purposes of technology transfer.



Findings

- The study commenced with a prescreening phase to search for high risk bridges. This allowed the Department to begin repairing scour critical bridges even while the rest of the project was underway. The prescreening phase identified 17 bridges for repair or replacement.
- During the next project task, 19 bridges were evaluated using SEM to fully demonstrate the model. The evaluations yielded a range of results, including:
  - Low risk bridges that are recommended for removal from the Scour Critical List;
  - Medium risk bridges that are recommended for minor repair or continued monitoring; and
  - High risk bridges that are recommended for priority repair or replacement.
- A new hydrologic calculation procedure was established to analyze the historic flow events at any State bridge. The procedure estimates the100-year storm flow (Q_{100}), which is a key input parameter for SEM.
- The study investigated the use of envelope curves to assess scour at bridges founded in fine textured sediments. It was concluded that envelope curves can be an effective tool within select geologic regions of the State, when coupled with the other SEM evaluative procedures.



For More Information Contact:

NJDOT Project Manager:	Pragna Shah
	609-530-8025
	Pragna.Shah@dot.nj.gov
Principal Investigator:	John R. Schuring, PE, PhD
	Dept. of Civil and Environmental Engineering New Jersey Institute of Technology
	973-596-5849
	schuring@njit.edu

A final report is available online at: http://www.state.nj.us/transportation/refdata/research/. If you would like a copy of the full report, send an e-mail to: Research.Bureau@dot.state.nj.us.

Scour Evaluation Model Implementation Phase
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