Bridge Number 2955, Route 4 over Sandy River in Phillips
Final Design Hydrology and Hydraulics Report

NORTHSTAR HYDRO

For Stantec

Maine DOT WIN 022616.00

December 11, 2018

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STATE OF MAINE
ELLEN KNIGHT O'BRIEN
No. 7945
LICENSED
PROFESSIONAL ENGINEER

12/11/18

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1.0 Introduction

The Wing Bridge in Phillips carries Route 4 over the Sandy River about 0.5 mile southeast of the Madrid Town Line. Figure 1 shows the site location.

Figure 1. Project Location, Wing Bridge No. 2955 in Phillips over Sandy River.

The 62' single span bridge crosses a segment of river with rapid flows and steep gradient. The bridge crosses the river at approximately a 35 degree angle and is just upstream of a bend in the river. Figure 2 is an air photo that shows rapids above the bridge and a bend downstream of the bridge.

Figure 2. Air photo of bridge crossing showing rapids upstream and bend downstream. Note skew of bridge structure to direction of roadway.

The river segment contains large boulders and some pools and rapids. Figure 3 is taken from downstream looking up at the southeasterly abutment towards the upstream river section.

Figure 3. Looking upstream. Note steep drop just upstream of bridge.

2.0 Existing Data Review

Existing data related to this bridge was reviewed, including but not limited to:

- MDOT file information including
  - No specific reports related to scour were furnished
  - Structure Inventory and Appraisal Sheets from 1999 mention that the channel is narrower at the bridge than in the river and that the old downstream abutments are narrower than the current bridge. The report also notes some settlement of upstream southeasterly abutment with "potholes". It also notes that the streambed is composed of "ledge" along with erodible sand, gravel, and glacial stones.
- FEMA Flood Maps and FIS report
  - FEMA prepared a Flood Insurance Study report which was published in 1978 and updated in 1995. The study was prepared by the USDA SCS. This study lists the 100-year flood elevation at this bridge as elevation 792 NGVD on the upstream side. The FIS study 100-year flow is 12,300 cfs for 36.1 square mile drainage area. This flow was computed using an SCS TR20 model. This model typically calculates flows considerably higher than the newer USGS method used by Maine DOT for this bridge study. Hydraulic analyses were done using model WSP2. Minimum channel elevations at the bridge are listed as elevations 770 and 775. Note that project survey identifies minimum channel elevation as 768-770 through the bridge. Because the flows are too high, the survey does not match well with new survey and the hydraulic model was different from HECRAS, the FEMA FIS data was not used for this bridge study. Copies of relevant FIS pages are included in the appendix.
- Air photos
- Topographic Maps
- Historical Flood Information – No site specific flood information was found for this location. However, the 1987 flood in this area is estimated to be approximately a 150-year event. The 1936 hurricane is the next largest flood on the Sandy River. Information on Hurricane Irene in 2011 was recorded at Madrid (see below), and is likely the flood of record at this site.
- Soil borings – material, depth, size and distribution of bottom materials: Schonewald Engineering Associates prepared Geotechnical Design Criteria for the Wing Bridge Replacement on August 30, 2015. Data includes a boring at each corner of abutments and seismic lines at each bridge face.
- USGS gaging station records- the nearest long term USGS Gage on the Sandy River is near Mercer, Maine, about 40 miles downstream with a drainage area of 516 square miles. This gage record runs from 1928 to 2015.
  http://waterdata.usgs.gov/nwis/inventory/?site_no=01048000&agency_cd=USGS
  A second gage, located at Madrid, drains 25.3 square miles and has records from 2008 to present. Flood of record at this gage was 5200 cfs during Hurricane Irene on August 28, 2011. Other annual peaks have ranged from 1500 to 2800 cfs.
  http://waterdata.usgs.gov/nwis/inventory/?site_no=01047200&agency_cd=USGS
- Channel cross sections and project survey were utilized for hydraulic modeling.

Hydrologic Analysis:

Maine DOT furnished peak discharges for floods of selected design intervals, including the 1.1-year, 10-, 25-, 50-, 100-, and 500-year flood based on the USGS Regression Equations. At the Wing Bridge, drainage area is 36.0 square miles and percent wetlands is 2.67. Table 1 below summarizes peak flood flows as computed by Maine DOT and as used for this bridge analysis. In addition to flow data calculated by Maine DOT, the record for the USGS gage at Madrid was used to identify a range of typical annual peak flows and the flow for Hurricane Irene. Flow data for the upstream gage is also included in Table 1. The flow data for specific frequencies were calculated by the Regression formula and the Irene and Peak flows are as recorded by the gage.

No specific historic data was found for the 1987 for 1936 floods. However, recent Hurricane Irene (August 28, 2011) dropped 8.5" of rain on the Carrabassett Valley area, washing out two bridges on Route 27 near the Sugarloaf Access Road. This storm was recorded by the gage on the Sandy River at Madrid. For the 25 sq mi. mile drainage basin, the 5200 cfs recorded flow is about a 500-year event. Estimated flow at the Phillips Bridge during this storm is 7000 cfs based on the upstream gage record. Annual peak events as recorded by the gage over the last seven years and transposed to the Phillips Bridge range from 2000-3800 cfs, corresponding to 5-25 year recurrence intervals.

Other hydrologic data for this site include peak flows computed for the FEMA FIS first prepared in December of 1979 and updated in April, 1995. These flows were computed using the SCS TR20 hydrologic model. Experience with this model indicates that flows are typically substantially higher than those predicted by Regression Equations or gage records specific to Maine. Flows calculated for the FEMA FIS are listed below in Table 1. Table 2 highlights the hydrology data used in the final design bridge analysis.

Summary of Available Hydrologic Data, Wing Bridge, Phillips

Location, Drainage Area	Gage on Sandy River at 25 sq mi.	Wing Bridge, 36.0 square miles	FEMA FIS
Calculation Method	USGS Regression Formula or recorded, 2.7% wetlands	USGS Regression Formula, 2.7% wetlands	SCS TR20 Model
Recurrence Interval	Flow, cfs	Flow, cfs	Flow, cfs
1.1	525.7	728.1	
2	1106.5	1508.4	
5	1763.6	2379.9	
10	2262.1	3037.2	5300
25	2937.9	3921.6	
50	3476.5	4623.7	10000
100	4049.7	5368.6	12300
500	5503.5	7251.0	17800
Hurricane Irene	5200.0	7040 (est.)	
Gage Annual Peak Low	1500.0	2030 (est.)	
Gage Annual Peak High	2800.0	3790 (est.)	
September Mean Low		8.5	
October Mean Low		14.4	

Table 1. Flow frequency data for, calculated by Maine DOT.

Drainage Area	36.0 sq mi
Design Discharge (Q50)	4624 cfs
Check Discharge (Q100)	5369 cfs
Scour Check Discharge (Q500)	7251 cfs
Ordinary High Water (Q1.1)	728 cfs
Flood of Record (Hurricane Irene)	7040 cfs

Table 2. Summary of Hydrologic Data for Bridge Analysis

Hydraulic Analysis*:*

The goal of the hydraulic and scour analysis was to provide information on flood elevations and flow velocities under existing and proposed conditions. Model data was used by the design team to assist in establishing required alternative road profiles, structure depths, and substructure layout for a replacement bridge. The hydraulic model was also used to assess channel conditions related to fish passage.

Figure 4 shows project survey and layout of model cross sections used for the hydraulic analysis. These sections and modified sections were used to simulate channel conditions as the bridge exists now and under expected conditions for a replacement bridge.

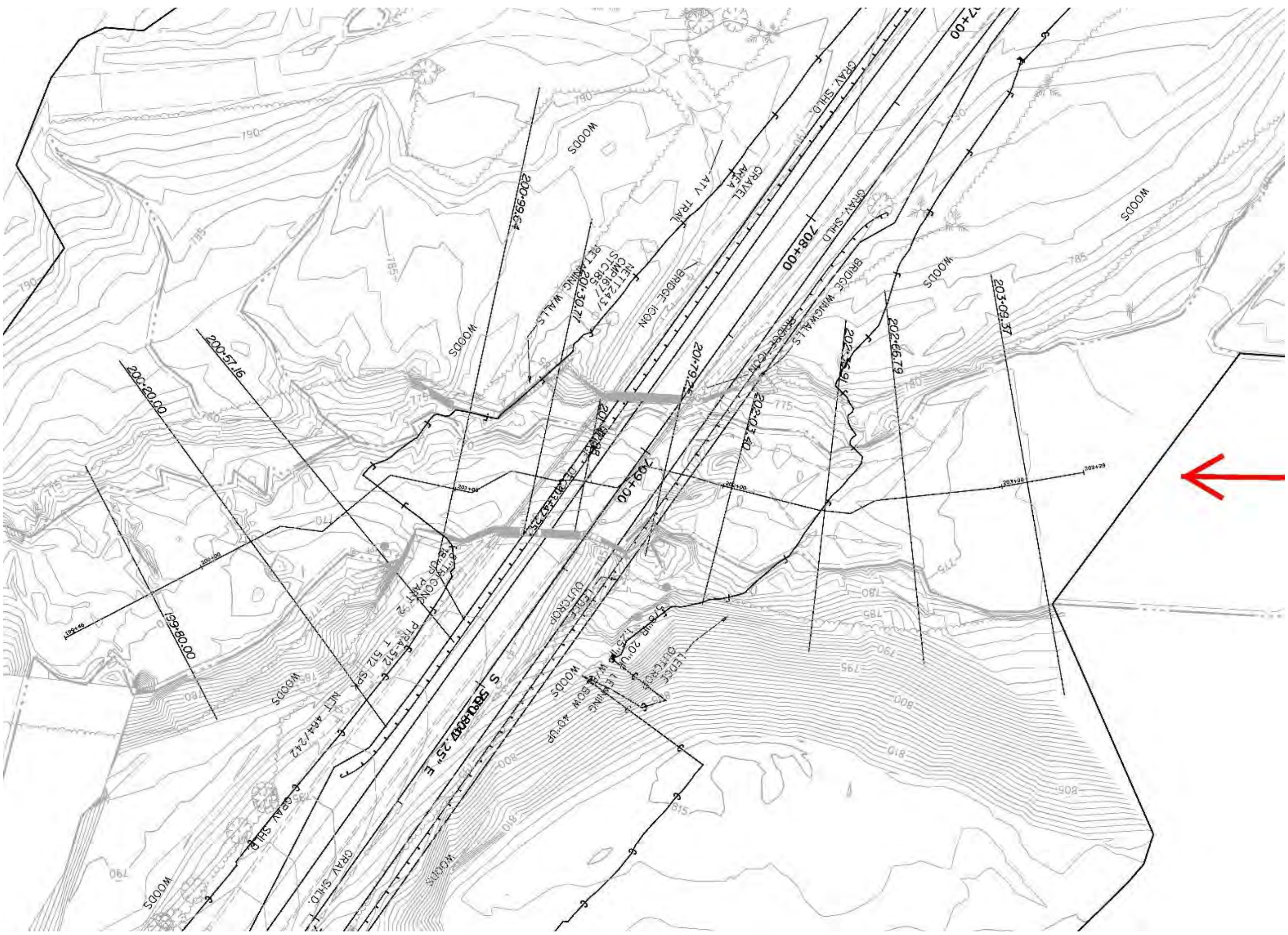

Figure 4. Channel Cross sections

The existing bridge crosses the river at approximately a 35 degree angle. While the bridge span is 62' with a clearspan of 59', the channel width at base of abutments, from face to face perpendicular to flow and considering battering of abutment faces, is approximately 45'. Downstream of the bridge, abutments remain that carried an old bridge across the river. Channel width perpendicular to flow at these old abutments is approximately 42'. The channel has rapidly varying flow conditions, with sharp drops, boulders and pools. Figures 5-15 show channel conditions near the bridge.

Figure 5. - Looking at Upstream Right Abutment. Note that left and right refers to perspective facing downstream.

Figure 6. Phillips - Looking at Right Abutment center), note old stone abutment (left in image). Upstream is on right of photo

Figure 7. - Looking at Bridge from upstream. Looking at Left Abutment. Note projecting rocks into Left Channel.

Figure 8. - Looking at bridge from upstream. Left Abutment is at left of photo. Note flow against Left Abutment. Right abutment is on bedrock.

Figure 9. Upstream of Bridge. Note Bedrock, and rocks projecting into Stream.

Figure 10. Looking Upstream from Bridge, standing on Right Bank.

Figure 11. Looking at Left Abutment. Note old rock abutment downstream of existing bridge.

Figure 12. Looking Downstream from Bridge. Note old abutment on right. Old abutment set on rock.

Figure 13. Left Abutment. Note deep flow against Abutment, and rock projecting just upstream of the bridge.

Figure 14. Abutment for former bridge on Right bank, downstream of existing Bridge

Goals of the hydraulic analysis included providing information so that adequate clearance for passage of peak flood flows may be designed (typically 2’ for minor structures such as this bridge, 4’ for major bridges). In addition, pre- and post- condition flood elevations were determined and compared to assure that flood levels will not be raised by the new bridge. The hydraulic analysis also assisted with determining average Bank Full Width channel section for design related to fish passage.

The proposed bridge span is also skewed approximately 35 degrees to flow, but 88 feet long along the centerline or 72 feet perpendicular to flow. Plans include removal of the concrete abutments for the existing bridge, as well as reconstruction of the streambed and banks. The plans also call for removal of the old stone abutment downstream on the left side (facing downstream). Figure 15 shows the proposed bridge in plan view. Figure 16 shows a section of the bridge.

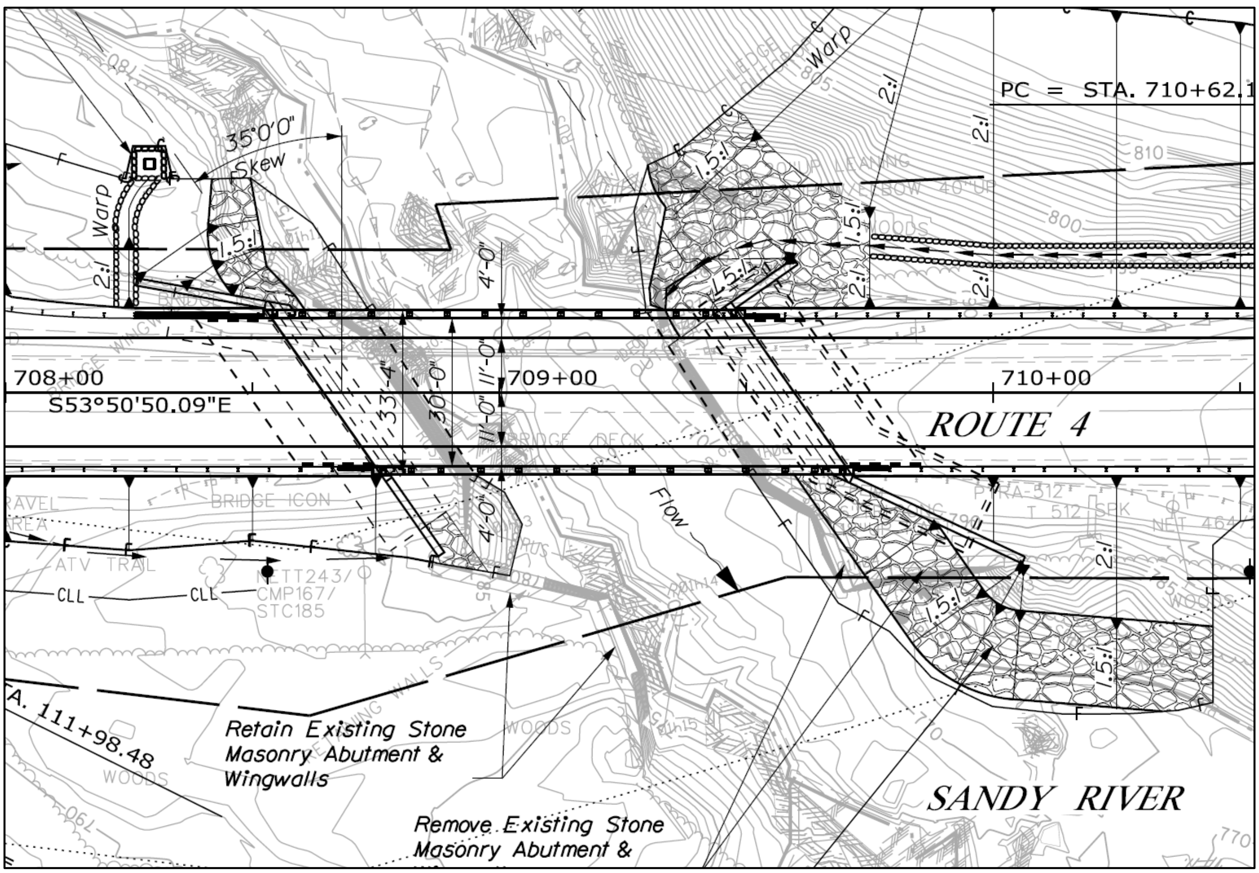

Figure 15. Proposed Bridge Design: Note: Easterly Old Stone abutments to be removed, westerly stone abutments to remain.

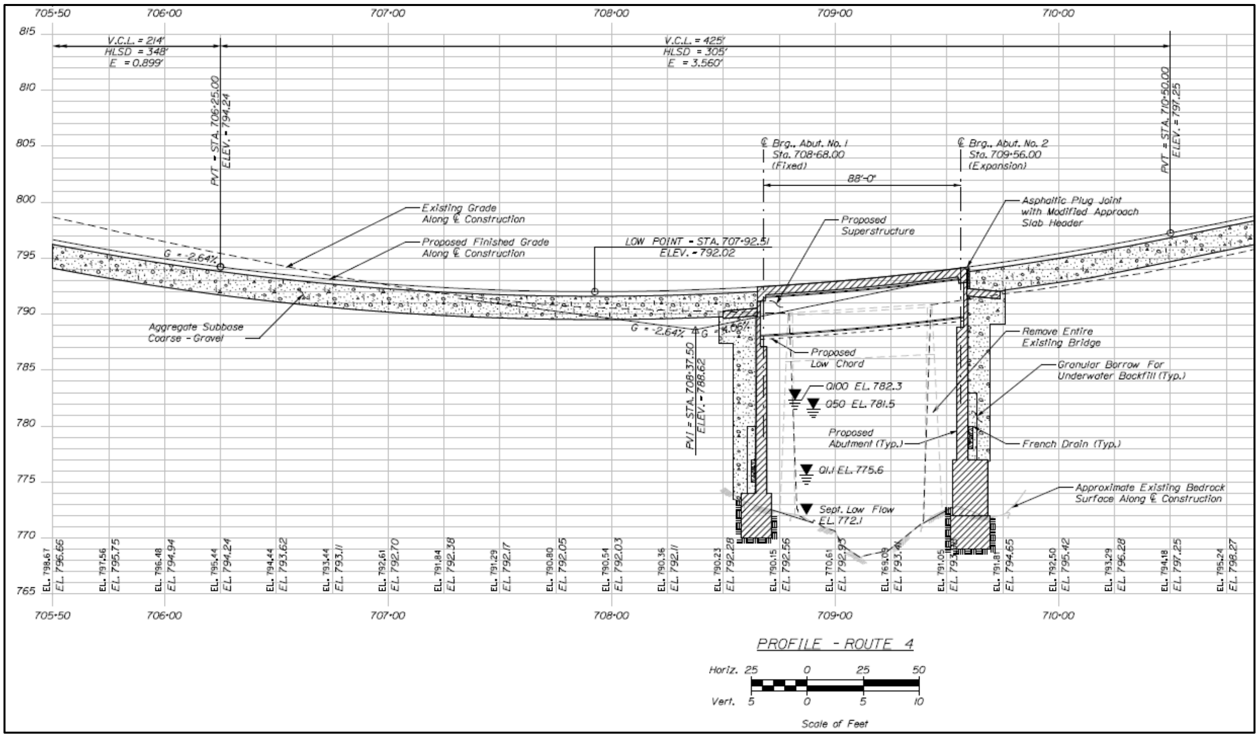

Figure 16. Proposed Bridge Profile: Note water surface elevations are estimates from the preliminary design H&H analysis.

Hydraulic analysis was performed in accordance with the procedures outlined in the Maine DOT Bridge Design Guide. Hydraulic analysis was prepared using HECRAS, version 5.03, River Analysis System by the U.S. Army Corps of Engineers.

Locations of modeled cross sections are shown in Figure 4 above. In addition to sections shown on this plan, two sections at the bridge faces for each design option were included in the model, and skewed 35 degrees to plot perpendicular to flow.

Figure 17 shows the HECRAS model plot of the river profile showing minimum channel elevations (thalweg) with distance through the bridge.

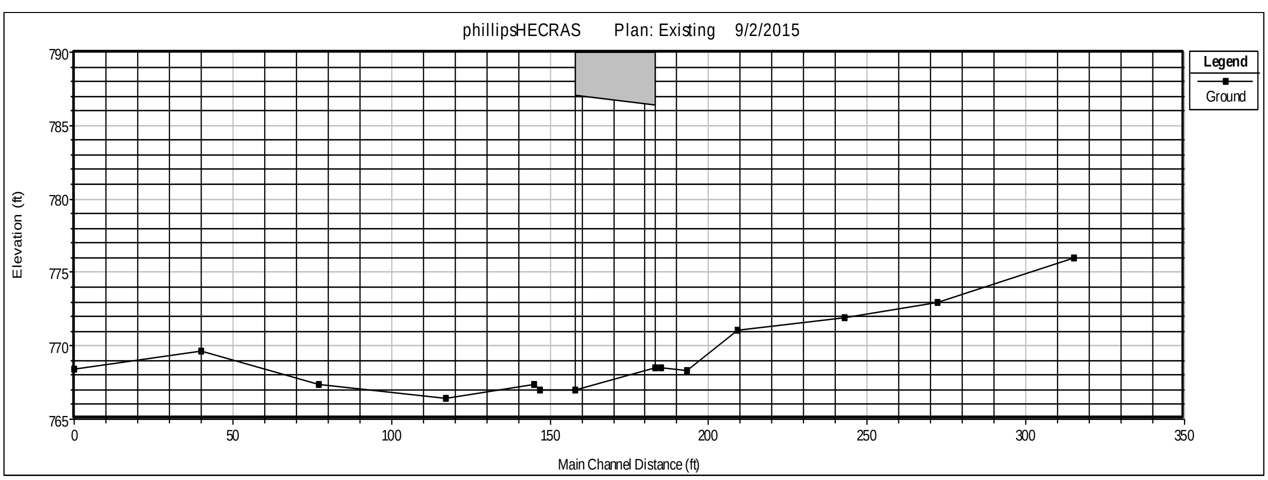

Figure 17. HECRAS Profile Plot of existing bridge.

Table 3 below summarizes hydraulic data for existing and proposed conditions.

Table 3: Summary of Hydraulic Data	Existing Bridge	Proposed Bridge
Low Chord	786.2-787.1	787.5-789.00
Width at Q100	45.1	69.5
Width at Banks (base of footing/abutment to abutment) – perpendicular to flow	44.0	66.4/69.5
Headwater at Q25, ft, (at bridge face)	780.3	779.8
Energy Grade Line for Q25 at US face.	781.5	780.4
Headwater at Q50, ft, (at bridge face)	781.2	780.6
Energy Grade Line for Q50 at US face	782.6	781.3
Headwater at Q100, ft, (at bridge face)	782.2	781.3
Energy Grade Line for Q100 at US face	783.8	782.1
Discharge Velocity at Q25, fps	9.1	6.9
Discharge Velocity at Q50, fps	9.9	7.5
Discharge Velocity at Q100, fps	10.5	8.1
Ordinary High Water Elevation (Q1.1) (US face), ft	775.6	775.3
Discharge Velocity at Q1.1, fps	3.3	2.8
Clearance at lowest point @ Q25, ft	5.9	7.7
Clearance at lowest point @ Q50, ft	3.6	6.9
Clearance at lowest point @ Q100, ft	2.4	6.2
Bridge Opening Area, ft^2	712.6	1211.6
Flow Area at Q100, ft^2	524.5	690.5

Scour Computations:

For this bridge, a scour POA has not been developed by Maine DOT. The bridge is rated "8 Stable above Footing" in the Maine DOT Structure Inventory and Appraisal Sheet (2013). According to the geotechnical report and boring data, new abutments will be founded on competent bedrock. Because footings are to be located on competent rock surface, a rock scour analysis to check for potential scour was completed. Scour computations using rock scour equations typically predict maximum potential scour occurring within portions of rock that is not deemed "competent" and predict rock scour only for piers in flow, not at abutments. However, the equations were modified to estimate Local Stream Power at faces of abutments and compare to that to Critical Stream Power based on recorded rock properties as listed in site borings. For the lowest potential Critical Stream Power, the local Stream Power is not predicted to scour this rock.

Fish Passage:

The Sandy River flows into the Kennebec River and is thus part of the Atlantic Salmon Restoration Initiative. Improved fish passage allowance is required for the new bridge. The existing bridge constricts the natural channel as do the old abutments downstream. Several methods were used to estimate natural bank width including

- Noting bank to bank width for each surveyed cross section as selected by survey team
- Estimation of natural geomorphic characteristics of channel prior to existing bridge based on aerial photographs and project survey
- Selection of channel widths at each cross section based on plotted data
- Calculation of 1.1-year channel flow with HECRAS model.

Note that each method is somewhat subjective, but collectively these estimates provide strong evidence of natural channel width. Calculations and diagrams are included in the appendix. Bank Full Width (BFW) was calculated to be 68.6' perpendicular to flow for both the up- and down-stream channel segments. PIC plans show a clear span of 91', abutment to abutment width of 85' and footing to footing width of 81' with an irregular natural stream bottom. For a bridge channel width of 68.6', a span of 84' is required due to a channel skew of 35 degrees in relation to flow direction. At base of footings, channel width is 66.4' perpendicular to flow, and is 69.5' above footings.

6.0 Summary of Findings

- The existing bridge with a span of 62' crosses the channel at an angle.
- The existing bridge and downstream old stone abutments constrict the channel to narrower than natural bank full width.
- The Flood Insurance Study 100-year elevation at this location is 792' NGVD. However discrepancies in minimum channel elevation and high peak flow calculations indicate that this elevation is not correct for this location.
- No records of overtopping were found and adequate clearance (2.4') is provided at low chord for existing bridge.
- The drainage area is 36.0 square miles, with a short term stream gage located upstream in Madrid with a 25 square mile drainage area.
- The hydraulic characteristics of the bridge site indicate rapid flow through and downstream of the bridge. The stream continues in a rapid gradient below the bridge.
- Starting water levels for the hydraulic model were based on calculated stream gradient and normal depth.
- The existing bridge clearance above the 50-year storm is 3.6', and above the 100-year storm is 2.4'.
- The proposed bridge also crosses the channel at an angle but has an 88' span which increases the available channel width through the bridge to 70'.
- For the proposed bridge, 50-year clearance is 6.9', and 100-year clearance is 6.2' according to the hydraulic model.
- Both abutments are to be founded on competent rock. Rock qualities, stream power and available scour analytical methods for abutments indicate that rock scour is not an issue at the proposed bridge abutments.
- Improvements in fish passage will be provided by widening the bridge opening to bank full width.

References

Federal Emergency Management Agency. Flood Insurance Study, Town of Phillips, Maine. April 17, 1995

U. S. Dept. of the Interior, Geological Survey, with Maine Dept. of Transportation. Estimating the Magnitude and Frequency of Peak Flows for Streams in Maine for Selected Recurrence Intervals. Water Resources Investigations Report 99-4008.

U.S. Army Corps of Engineers, Hydrologic Engineering Center. HEC-RAS River Analysis System. Version 5.0 Beta. January, 2010. Davis, CA

U.S. Department of Transportation. Federal Highway Administration. Evaluating Scour at Bridges, 5th edition. HEC-18. April 2012 , Publication No. FHWA-HIF-12-003

U.S. Department of Transportation. Federal Highway Administration. Bridge Scour and Stream Instability Countermeasures. HEC-23. Volume 2. September, 2009. FHWA-NHI-09-112 . DG 14, Rock Riprap at Bridge Abutments and DG 4, Riprap Revetment

Maine Dept. of Transportation. Bridge Design Manual. August 2003

ESRI ArcMap, ArcGIS Desktop, Version 10.5. Arcview license. Data added from MEGIS website, project plans and ESRI

http://www.theirregular.com/news/2011-08-31/Front_Page/Irenes_comings_and_goings.html

Schonewald Engineering Associates, Inc. Geotechnical Design Criteria, Wing Bridge Replacement, Route 4 over Sandy River, Phillips, Maine. Maine DOT WIN 22616.00

Stantec, Wing Bridge, Bridge #2955, Design Plans dated September 2017.

Maine Dept. of Transportation. Structure Inventory and Appraisal Sheet, Bridge # 2955. 3/18/2014 and 8/4/1999

Wing Bridge #2955, Sandy River, Phillips, Maine

Final Design Hydrologic and Hydraulics Report

Appendix

Project Name:	Phillips - Wing Bridge	**PIN:**	22616
Stream Name:	Sandy River	**Town:**	Phillips
Bridge Name:	Wing Bridge	**Bridge No.**	2955
Route No.	ME 4	**USGS Quad:**	
Analysis by:	CSH	**Date:**	3/19/2014

Peak Flow Calculations by USGS Regression Equations (Hodgkins, 1999)

Enter data in blue cells only!

	km^2	mi^2	ac	
				Enter data in [mi^2]
A	93.24	36.00	23040.0	Watershed Area
W	2.49	0.96	615.1	Wetlands area (by NWI)
P_c	379306	4968926		watershed centroid (E, N; UTM 19N; meters)
County	Franklin			*choose county from drop-down menu*
pptA	45.6			mean annual precipitation (inches; by look-up)
SG	0.00			sand & gravel aquifer as decimal fraction of watershed A

A (km^2)	93.24	**Conf Lvl**	0.67
W (%)	2.67		

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Maine Dept. Transportation
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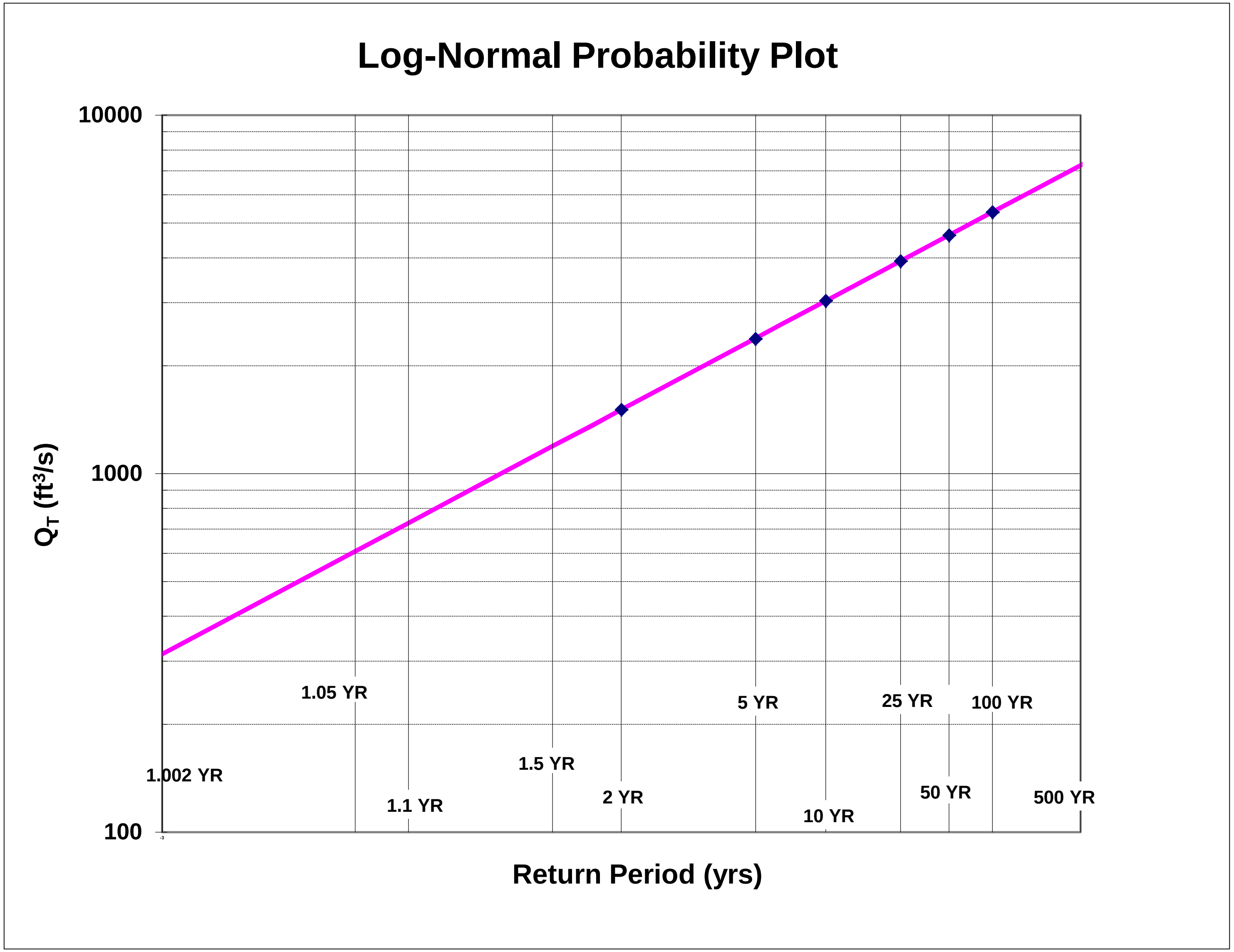
Ret Pd	**Peak Flow Estimate**			
T (yr)	**Lower**	**Q_T (m^3/s)**	**Upper**	**Q_T (ft^3/s)**
1.1		20.62		728.1
2	30.48	42.72	59.87	1508.4
5	47.86	67.40	94.92	2379.9
10	60.54	86.01	122.21	3037.2
25	77.06	111.06	160.05	3921.6
50	89.80	130.95	190.95	4623.7
100	103.00	152.04	224.43	5368.6
500	134.71	205.35	313.04	7251.0

Reference:

Hodgkins, G., 1999.
Estimating the magnitude of peak flows for streams
in Maine for selected recurrence intervals
Water-Resources Investigations Report 99-4008
US Geological Survey, Augusta, Maine

$Q_T = b \times A^a \times 10^{-wW}$



Log-Normal Probability Plot
10000
1000
100
QT (ft3/s)
1.002 YR
1.05 YR
1.1 YR
1.5 YR
2 YR
5 YR
10 YR
25 YR
50 YR
100 YR
500 YR
Return Period (yrs)

Project Name:	Phillips - Wing Bridge		**PIN:**	22616
Stream Name:	Sandy River		**Town:**	Phillips
Bridge Name:	Wing Bridge		**Bridge No.**	2955
Route No.	ME 4		**USGS Quad:**	
Analysis by:	CSH		**Date:**	3/19/2014

DO NOT ENTER ANY DATA ON THIS PAGE; EVERYTHING IS CALCULATED

MAINE MONTHLY MEDIAN FLOWS BY USGS REGRESSION EQUATIONS (2004)

Worksheet prepared by:
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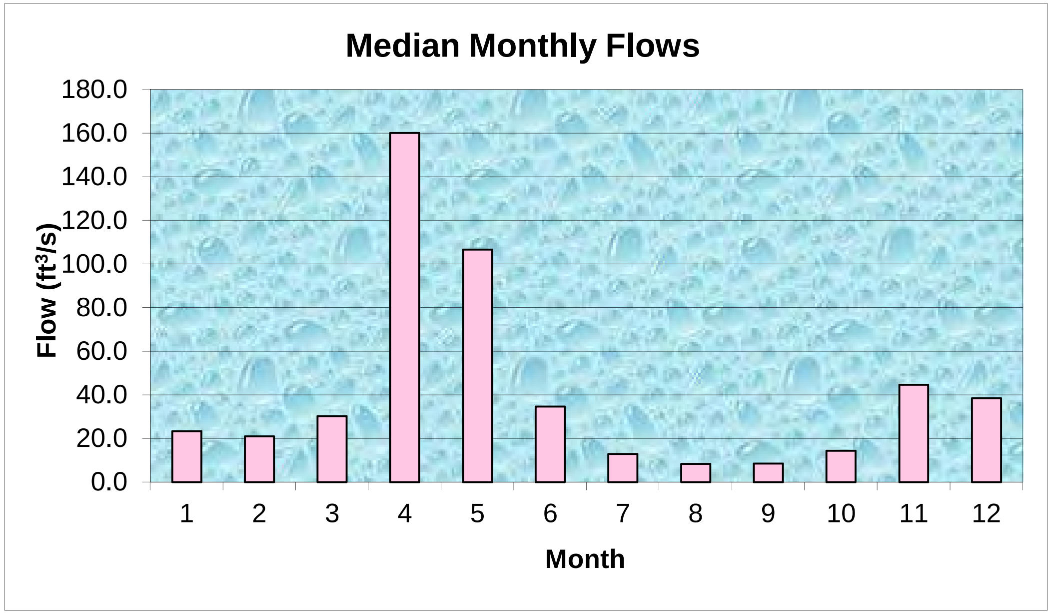
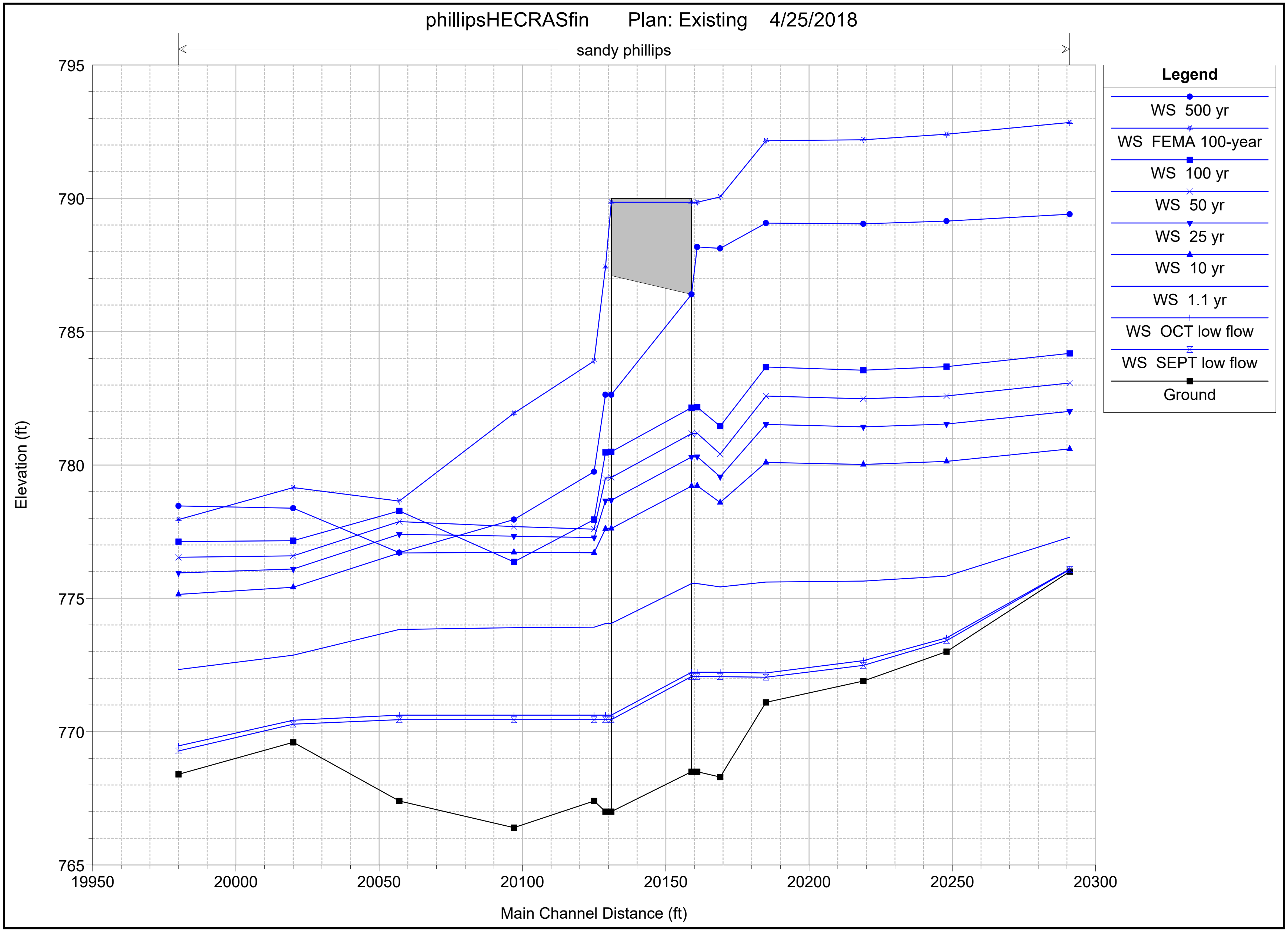
Charles.Hebson@maine.gov

	Value	**Variable**	**Explanation**
	36.000	*A*	Area (mi^2)
379306	4968926	P_c	Watershed centroid (E,N; UTM; Zone 19; meters)
	111.76	*DIST*	Distance from Coastal reference line (mi)
	45.6	*pptA*	Mean Annual Precipitation (inches)
	0.00	*SG*	Sand & Gravel Aquifer (decimal fraction of watershed area)

Month	**Q_{median}** (ft3/s)	(m^3/s)
Jan	**23.32**	0.6608
Feb	**21.02**	0.5955
Mar	**30.18**	0.8552
Apr	**160.21**	4.5401
May	**106.61**	3.0213
Jun	**34.70**	0.9832
Jul	**12.89**	0.3654
Aug	**8.41**	0.2384
Sep	**8.49**	0.2406
Oct	**14.41**	0.4083
Nov	**44.63**	1.2647
Dec	**38.43**	1.0891

Q_{bf}	**223.5**	
ann avg	**73.4**	
ann med	**39.2**	
$Q_{1.002}$	**313.5**	
$Q_{1.01}$	422.8	
$Q_{1.05}$	606.7	
W_{bf}	49.1	
d_{bf}	3.8	
Q_{bf}	752.2	assume v = 4ft/s




phillipsHECRASfin Plan: Existing 4/25/2018
sandy phillips
Legend
WS 500 yr
WS FEMA 100-year
WS 100 yr
WS 50 yr
WS 25 yr
WS 10 yr
WS 1.1 yr
WS OCT low flow
WS SEPT low flow
Ground
Elevation (ft)
Main Channel Distance (ft)
795
790
785
780
775
770
765
19950
20000
20050
20100
20150
20200
20250
20300

HEC-RAS Plan: EX River: sandy Reach: phillips

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
phillips	20309	1.1 yr	728.00	776.00	777.29	777.29	777.94	0.028069	6.44	113.09	89.10	1.01
phillips	20309	10 yr	3037.00	776.00	780.60	779.32	781.41	0.007058	7.21	421.32	97.05	0.61
phillips	20309	25 yr	3922.00	776.00	782.01	779.93	782.77	0.004656	7.01	563.45	106.91	0.52
phillips	20309	50 yr	4624.00	776.00	783.08	780.37	783.82	0.003630	6.94	682.44	116.31	0.47
phillips	20309	100 yr	5369.00	776.00	784.19	780.82	784.91	0.002913	6.88	817.02	126.11	0.43
phillips	20309	500 yr	7251.00	776.00	789.40	781.87	789.80	0.000854	5.23	1709.39	210.74	0.25
phillips	20309	SEPT low flow	8.50	776.00	776.08	776.08	776.10	0.049131	1.31	6.51	86.18	0.84
phillips	20309	OCT low flow	14.40	776.00	776.10	776.10	776.14	0.063740	1.74	8.26	86.23	0.99
phillips	20309	FEMA 100-year	12300.00	776.00	792.84	784.29	793.44	0.000997	6.60	2450.55	218.54	0.29
phillips	20267	1.1 yr	728.00	773.00	775.83	775.68	776.59	0.019956	7.00	103.97	54.35	0.89
phillips	20267	10 yr	3037.00	773.00	780.14		781.10	0.006512	7.90	387.83	75.90	0.60
phillips	20267	25 yr	3922.00	773.00	781.54		782.54	0.004963	8.06	496.63	80.28	0.55
phillips	20267	50 yr	4624.00	773.00	782.59		783.62	0.004223	8.19	584.05	86.02	0.52
phillips	20267	100 yr	5369.00	773.00	783.69		784.74	0.003629	8.29	683.64	98.04	0.49
phillips	20267	500 yr	7251.00	773.00	789.14		789.74	0.001155	6.43	1432.29	164.01	0.30
phillips	20267	SEPT low flow	8.50	773.00	773.41	773.43	773.54	0.073404	2.90	2.93	15.67	1.19
phillips	20267	OCT low flow	14.40	773.00	773.52	773.53	773.65	0.052784	2.99	4.82	19.25	1.05
phillips	20267	FEMA 100-year	12300.00	773.00	792.40		793.35	0.001487	8.37	1989.58	174.81	0.35
phillips	20237	1.1 yr	728.00	771.90	775.65		776.14	0.008941	5.64	129.18	51.97	0.63
phillips	20237	10 yr	3037.00	771.90	780.02		780.92	0.004877	7.62	410.80	73.75	0.54
phillips	20237	25 yr	3922.00	771.90	781.43		782.40	0.004061	7.97	517.26	77.59	0.51
phillips	20237	50 yr	4624.00	771.90	782.48		783.51	0.003625	8.21	600.46	80.46	0.49
phillips	20237	100 yr	5369.00	771.90	783.55		784.64	0.003291	8.45	692.25	103.25	0.48
phillips	20237	500 yr	7251.00	771.90	789.04		789.70	0.001169	6.79	1374.18	147.80	0.31
phillips	20237	SEPT low flow	8.50	771.90	772.49	772.43	772.59	0.027721	2.55	3.33	10.47	0.80
phillips	20237	OCT low flow	14.40	771.90	772.66	772.57	772.77	0.021004	2.65	5.43	13.08	0.72
phillips	20237	FEMA 100-year	12300.00	771.90	792.19		793.29	0.001609	9.02	1897.09	170.00	0.37
phillips	20203	1.1 yr	728.00	771.10	775.61		775.87	0.004195	4.09	178.34	64.68	0.43
phillips	20203	10 yr	3037.00	771.10	780.10		780.71	0.002830	6.35	517.82	86.25	0.42
phillips	20203	25 yr	3922.00	771.10	781.52		782.21	0.002527	6.76	643.28	89.89	0.40
phillips	20203	50 yr	4624.00	771.10	782.59		783.32	0.002346	7.04	740.52	92.93	0.40
phillips	20203	100 yr	5369.00	771.10	783.67		784.46	0.002184	7.28	843.45	96.29	0.39
phillips	20203	500 yr	7251.00	771.10	789.07		789.63	0.000957	6.31	1407.82	113.56	0.28
phillips	20203	SEPT low flow	8.50	771.10	772.04		772.08	0.008974	1.60	5.32	14.17	0.46
phillips	20203	OCT low flow	14.40	771.10	772.20		772.25	0.011381	1.72	8.37	23.93	0.51
phillips	20203	FEMA 100-year	12300.00	771.10	792.16		793.23	0.001474	8.79	1790.65	127.63	0.35
phillips	20179	1.1 yr	728.00	768.30	775.43		775.79	0.004234	4.84	150.72	37.68	0.42
phillips	20179	10 yr	3037.00	768.30	778.59		780.50	0.011744	11.17	290.08	49.66	0.73
phillips	20179	25 yr	3922.00	768.30	779.56	778.49	781.95	0.012955	12.59	340.27	54.27	0.78
phillips	20179	50 yr	4624.00	768.30	780.41	779.35	783.05	0.012932	13.29	388.31	58.35	0.78
phillips	20179	100 yr	5369.00	768.30	781.46	780.19	784.19	0.012033	13.61	451.90	63.34	0.76
phillips	20179	500 yr	7251.00	768.30	788.12		789.52	0.003911	10.08	893.95	77.55	0.44
phillips	20179	SEPT low flow	8.50	768.30	772.07		772.07	0.000040	0.23	37.07	29.85	0.04
phillips	20179	OCT low flow	14.40	768.30	772.23		772.23	0.000078	0.34	41.90	30.03	0.05
phillips	20179	FEMA 100-year	12300.00	768.30	790.05		793.00	0.007592	14.80	1045.12	122.07	0.61
phillips	20171	1.1 yr	728.00	768.50	775.55	772.25	775.71	0.001293	3.18	228.89	44.52	0.25
phillips	20171	10 yr	3037.00	768.50	779.22	775.66	780.15	0.004434	7.73	392.72	44.86	0.46
phillips	20171	25 yr	3922.00	768.50	780.32	776.64	781.54	0.005236	8.88	441.91	44.96	0.50
phillips	20171	50 yr	4624.00	768.50	781.19	777.36	782.63	0.005684	9.61	481.30	45.03	0.52
phillips	20171	100 yr	5369.00	768.50	782.17	778.09	783.79	0.005961	10.22	525.31	45.12	0.53
phillips	20171	500 yr	7251.00	768.50	788.17	779.78	789.46	0.003378	9.09	798.03	45.67	0.38
phillips	20171	SEPT low flow	8.50	768.50	772.07	769.26	772.07	0.000004	0.11	79.46	39.50	0.01
phillips	20171	OCT low flow	14.40	768.50	772.23	769.43	772.23	0.000010	0.17	85.86	39.77	0.02
phillips	20171	FEMA 100-year	12300.00	768.50	789.85	783.74	792.93	0.007573	14.06	874.81	45.82	0.57
phillips	20152		Bridge									
phillips	20133	1.1 yr	728.00	767.00	774.06		774.22	0.001440	3.28	221.72	44.52	0.26
phillips	20133	10 yr	3037.00	767.00	777.61		778.60	0.004916	7.98	380.37	44.81	0.48
phillips	20133	25 yr	3922.00	767.00	778.66		779.97	0.005814	9.17	427.62	44.90	0.52
phillips	20133	50 yr	4624.00	767.00	779.51		781.04	0.006301	9.93	465.83	44.97	0.54
phillips	20133	100 yr	5369.00	767.00	780.48		782.20	0.006570	10.54	509.23	45.05	0.55
phillips	20133	500 yr	7251.00	767.00	782.63		784.85	0.007287	11.95	606.57	45.23	0.58
phillips	20133	SEPT low flow	8.50	767.00	770.45		770.45	0.000004	0.11	74.81	33.92	0.01
phillips	20133	OCT low flow	14.40	767.00	770.62		770.62	0.000010	0.18	80.65	34.35	0.02
phillips	20133	FEMA 100-year	12300.00	767.00	787.42		790.88	0.008969	14.93	824.12	45.62	0.62
phillips	20131	1.1 yr	728.00	767.40	773.92		774.20	0.002846	4.28	170.25	40.16	0.37
phillips	20131	10 yr	3037.00	767.40	776.71		778.49	0.009897	10.73	286.65	43.39	0.72
phillips	20131	25 yr	3922.00	767.40	777.28		779.81	0.012878	12.80	311.63	44.24	0.82
phillips	20131	50 yr	4624.00	767.40	777.59	777.13	780.83	0.015742	14.47	325.59	44.81	0.91
phillips	20131	100 yr	5369.00	767.40	777.95	777.95	781.94	0.018418	16.05	341.88	45.46	0.99
phillips	20131	500 yr	7251.00	767.40	779.75	779.75	784.55	0.017978	17.67	425.25	47.13	0.99
phillips	20131	SEPT low flow	8.50	767.40	770.45		770.45	0.000012	0.16	51.83	28.30	0.02
phillips	20131	OCT low flow	14.40	767.40	770.62		770.62	0.000026	0.25	56.70	28.80	0.03
phillips	20131	FEMA 100-year	12300.00	767.40	783.90	783.90	790.52	0.017408	20.85	626.59	49.78	0.98

HEC-RAS Plan: EX River: sandy Reach: phillips (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
phillips	20100	1.1 yr	728.00	766.40	773.90		774.11	0.002140	3.69	197.16	42.80	0.30
phillips	20100	10 yr	3037.00	766.40	776.73		778.13	0.007787	9.51	319.64	43.57	0.62
phillips	20100	25 yr	3922.00	766.40	777.33		779.33	0.009978	11.35	346.09	43.65	0.71
phillips	20100	50 yr	4624.00	766.40	777.69		780.24	0.011980	12.80	361.75	43.70	0.78
phillips	20100	100 yr	5369.00	766.40	776.37	777.15	781.22	0.028726	17.67	304.06	43.53	1.18
phillips	20100	500 yr	7251.00	766.40	777.95	778.88	783.84	0.026584	19.47	373.16	43.73	1.17
phillips	20100	SEPT low flow	8.50	766.40	770.45		770.45	0.000006	0.12	69.28	31.09	0.01
phillips	20100	OCT low flow	14.40	766.40	770.62		770.62	0.000013	0.19	74.61	31.33	0.02
phillips	20100	FEMA 100-year	12300.00	766.40	781.94	782.94	789.84	0.021471	22.56	548.65	44.25	1.12
phillips	20057	1.1 yr	728.00	767.40	773.83		774.02	0.002081	3.48	208.99	54.63	0.31
phillips	20057	10 yr	3037.00	767.40	776.70		777.74	0.006478	8.19	377.11	63.00	0.57
phillips	20057	25 yr	3922.00	767.40	777.40		778.80	0.007815	9.51	422.03	64.87	0.63
phillips	20057	50 yr	4624.00	767.40	777.88		779.57	0.008801	10.49	453.19	66.02	0.67
phillips	20057	100 yr	5369.00	767.40	778.28	776.76	780.33	0.009991	11.55	479.74	66.93	0.72
phillips	20057	500 yr	7251.00	767.40	776.71	778.20	782.60	0.036707	19.51	377.93	63.03	1.35
phillips	20057	SEPT low flow	8.50	767.40	770.45		770.45	0.000014	0.17	48.86	27.73	0.02
phillips	20057	OCT low flow	14.40	767.40	770.62		770.62	0.000032	0.27	53.74	29.86	0.04
phillips	20057	FEMA 100-year	12300.00	767.40	778.65	781.83	788.45	0.044900	25.25	504.90	68.18	1.54
phillips	20020	1.1 yr	728.00	769.60	772.87	772.87	773.76	0.027292	7.58	96.08	54.60	1.01
phillips	20020	10 yr	3037.00	769.60	775.41	775.41	777.26	0.020146	10.94	282.91	80.05	0.99
phillips	20020	25 yr	3922.00	769.60	776.10	776.10	778.29	0.019126	11.92	338.79	82.65	0.99
phillips	20020	50 yr	4624.00	769.60	776.59	776.59	779.04	0.018662	12.62	379.99	84.88	1.00
phillips	20020	100 yr	5369.00	769.60	777.16	777.16	779.80	0.017395	13.11	429.74	89.31	0.98
phillips	20020	500 yr	7251.00	769.60	778.38	778.38	781.52	0.016040	14.37	544.16	98.75	0.98
phillips	20020	SEPT low flow	8.50	769.60	770.28	770.28	770.43	0.048605	3.14	2.71	9.04	1.01
phillips	20020	OCT low flow	14.40	769.60	770.43	770.43	770.60	0.046422	3.31	4.35	13.00	1.01
phillips	20020	FEMA 100-year	12300.00	769.60	779.15	781.20	786.26	0.031660	21.70	622.85	104.74	1.39
phillips	19980	1.1 yr	728.00	768.40	772.33	771.68	772.68	0.008003	4.76	153.33	74.79	0.58
phillips	19980	10 yr	3037.00	768.40	775.15	774.00	776.24	0.008002	8.41	370.19	79.32	0.67
phillips	19980	25 yr	3922.00	768.40	775.95	774.71	777.29	0.008003	9.31	434.63	80.62	0.69
phillips	19980	50 yr	4624.00	768.40	776.54	775.20	778.06	0.008001	9.94	482.26	81.56	0.70
phillips	19980	100 yr	5369.00	768.40	777.12	775.74	778.83	0.008001	10.54	530.35	83.11	0.71
phillips	19980	500 yr	7251.00	768.40	778.47	776.93	780.63	0.008008	11.88	645.82	90.20	0.73
phillips	19980	SEPT low flow	8.50	768.40	769.27	769.03	769.32	0.008005	1.67	5.09	11.64	0.45
phillips	19980	OCT low flow	14.40	768.40	769.47	769.18	769.52	0.008010	1.91	7.56	14.18	0.46
phillips	19980	FEMA 100-year	12300.00	768.40	777.95	779.87	785.05	0.028609	21.51	600.63	86.29	1.37

HEC-RAS Plan: EX River: sandy Reach: phillips

Reach	River Sta	Profile	E.G. Elev	W.S. Elev	Crit W.S.	Frctn Loss	C & E Loss	Top Width	Q Left	Q Channel	Q Right	Vel Chnl
			(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(cfs)	(ft/s)
phillips	20179	1.1 yr	775.79	775.43		0.02	0.06	37.68	0.11	727.89		4.84
phillips	20179	10 yr	780.50	778.59		0.05	0.29	49.66	57.89	2979.11		11.17
phillips	20179	25 yr	781.95	779.56	778.49	0.06	0.35	54.27	114.09	3807.91		12.59
phillips	20179	50 yr	783.05	780.41	779.35	0.07	0.36	58.35	183.67	4440.33		13.29
phillips	20179	100 yr	784.19	781.46	780.19	0.07	0.33	63.34	292.34	5076.66		13.61
phillips	20179	500 yr	789.52	788.12		0.03	0.03	77.55	951.13	6299.87		10.08
phillips	20179	SEPT low flow	772.07	772.07		0.00	0.00	29.85		8.50		0.23
phillips	20179	OCT low flow	772.23	772.23		0.00	0.00	30.03		14.40		0.34
phillips	20179	FEMA 100-year	793.00	790.05		0.06	0.01	122.07	1951.43	10348.41	0.16	14.80
phillips	20171	1.1 yr	775.71	775.55	772.25			44.52		728.00		3.18
phillips	20171	10 yr	780.15	779.22	775.66			44.86		3037.00		7.73
phillips	20171	25 yr	781.54	780.32	776.64			44.96		3922.00		8.88
phillips	20171	50 yr	782.63	781.19	777.36			45.03		4624.00		9.61
phillips	20171	100 yr	783.79	782.17	778.09			45.12		5369.00		10.22
phillips	20171	500 yr	789.46	788.17	779.78			45.67		7251.00		9.09
phillips	20171	SEPT low flow	772.07	772.07	769.26			39.50		8.50		0.11
phillips	20171	OCT low flow	772.23	772.23	769.43			39.77		14.40		0.17
phillips	20171	FEMA 100-year	792.93	789.85	783.74			45.82		12300.00		14.06
phillips	20152 BR U	1.1 yr	775.71	775.55	772.25			44.52		728.00		3.18
phillips	20152 BR U	10 yr	780.14	779.21	775.66			44.86		3037.00		7.74
phillips	20152 BR U	25 yr	781.53	780.30	776.65			44.95		3922.00		8.89
phillips	20152 BR U	50 yr	782.61	781.17	777.36			45.03		4624.00		9.62
phillips	20152 BR U	100 yr	783.78	782.15	778.10			45.12		5369.00		10.24
phillips	20152 BR U	500 yr	789.46	786.40	779.81					7251.00		10.18
phillips	20152 BR U	SEPT low flow	772.07	772.07	769.26			39.50		8.50		0.11
phillips	20152 BR U	OCT low flow	772.23	772.23	769.44			39.77		14.40		0.17
phillips	20152 BR U	FEMA 100-year	792.93	789.85	783.77				149.07	10934.18	1206.64	13.54
phillips	20152 BR D	1.1 yr	774.23	774.06	770.69			44.52		728.00		3.28
phillips	20152 BR D	10 yr	778.61	777.62	774.33			44.81		3037.00		7.97
phillips	20152 BR D	25 yr	779.98	778.68	775.31			44.90		3922.00		9.16
phillips	20152 BR D	50 yr	781.06	779.53	776.03			44.97		4624.00		9.91
phillips	20152 BR D	100 yr	782.22	780.50	776.77			45.05		5369.00		10.52
phillips	20152 BR D	500 yr	784.85	782.63	778.47			45.23		7251.00		11.95
phillips	20152 BR D	SEPT low flow	770.45	770.45	767.64			33.92		8.50		0.11
phillips	20152 BR D	OCT low flow	770.62	770.62	767.79			34.35		14.40		0.18
phillips	20152 BR D	FEMA 100-year	792.77	789.85	782.43				149.07	10934.18	1206.64	12.56
phillips	20133	1.1 yr	774.22	774.06		0.01	0.01	44.52		728.00		3.28
phillips	20133	10 yr	778.60	777.61		0.03	0.08	44.81		3037.00		7.98
phillips	20133	25 yr	779.97	778.66		0.03	0.12	44.90		3922.00		9.17
phillips	20133	50 yr	781.04	779.51		0.04	0.17	44.97		4624.00		9.93
phillips	20133	100 yr	782.20	780.48		0.04	0.23	45.05		5369.00		10.54
phillips	20133	500 yr	784.85	782.63		0.04	0.26	45.23		7251.00		11.95
phillips	20133	SEPT low flow	770.45	770.45		0.00	0.00	33.92		8.50		0.11
phillips	20133	OCT low flow	770.62	770.62		0.00	0.00	34.35		14.40		0.18
phillips	20133	FEMA 100-year	790.88	787.42		0.05	0.32	45.62		12300.00		14.93
phillips	20131	1.1 yr	774.20	773.92		0.07	0.02	40.16		728.00	0.00	4.28
phillips	20131	10 yr	778.49	776.71		0.25	0.11	43.39		3029.28	7.72	10.73
phillips	20131	25 yr	779.81	777.28		0.32	0.16	44.24		3907.96	14.04	12.80
phillips	20131	50 yr	780.83	777.59	777.13	0.38	0.21	44.81		4604.44	19.56	14.47
phillips	20131	100 yr	781.94	777.95	777.95	0.64	0.08	45.46		5341.71	27.29	16.05
phillips	20131	500 yr	784.55	779.75	779.75	0.61	0.11	47.13		7174.30	76.70	17.67
phillips	20131	SEPT low flow	770.45	770.45		0.00	0.00	28.30		8.50		0.16
phillips	20131	OCT low flow	770.62	770.62		0.00	0.00	28.80		14.40		0.25
phillips	20131	FEMA 100-year	790.52	783.90	783.90	0.54	0.13	49.78		12024.50	275.50	20.85

Plan: EX sandy phillips RS: 20152 Profile: 1.1 yr

E.G. US. (ft)	775.71	Element	Inside BR US	Inside BR DS
W.S. US. (ft)	775.55	E.G. Elev (ft)	775.71	774.23
Q Total (cfs)	728.00	W.S. Elev (ft)	775.55	774.06
Q Bridge (cfs)	728.00	Crit W.S. (ft)	772.25	770.69
Q Weir (cfs)		Max Chl Dpth (ft)	7.05	7.06
Weir Sta Lft (ft)		Vel Total (ft/s)	3.18	3.28
Weir Sta Rgt (ft)		Flow Area (sq ft)	228.89	221.86
Weir Submerg		Froude # Chl	0.25	0.26
Weir Max Depth (ft)		Specif Force (cu ft)	696.02	687.29
Min El Weir Flow (ft)	790.01	Hydr Depth (ft)	5.14	4.98
Min El Prs (ft)	786.40	W.P. Total (ft)	52.20	52.29
Delta EG (ft)	1.49	Conv. Total (cfs)	20248.0	19200.7
Delta WS (ft)	1.50	Top Width (ft)	44.52	44.52
BR Open Area (sq ft)	712.58	Frctn Loss (ft)		
BR Open Vel (ft/s)	3.28	C & E Loss (ft)		
BR Sluice Coef		Shear Total (lb/sq ft)	0.35	0.38
BR Sel Method	Momentum	Power Total (lb/ft s)	1.13	1.25

Plan: EX sandy phillips RS: 20152 Profile: 50 yr

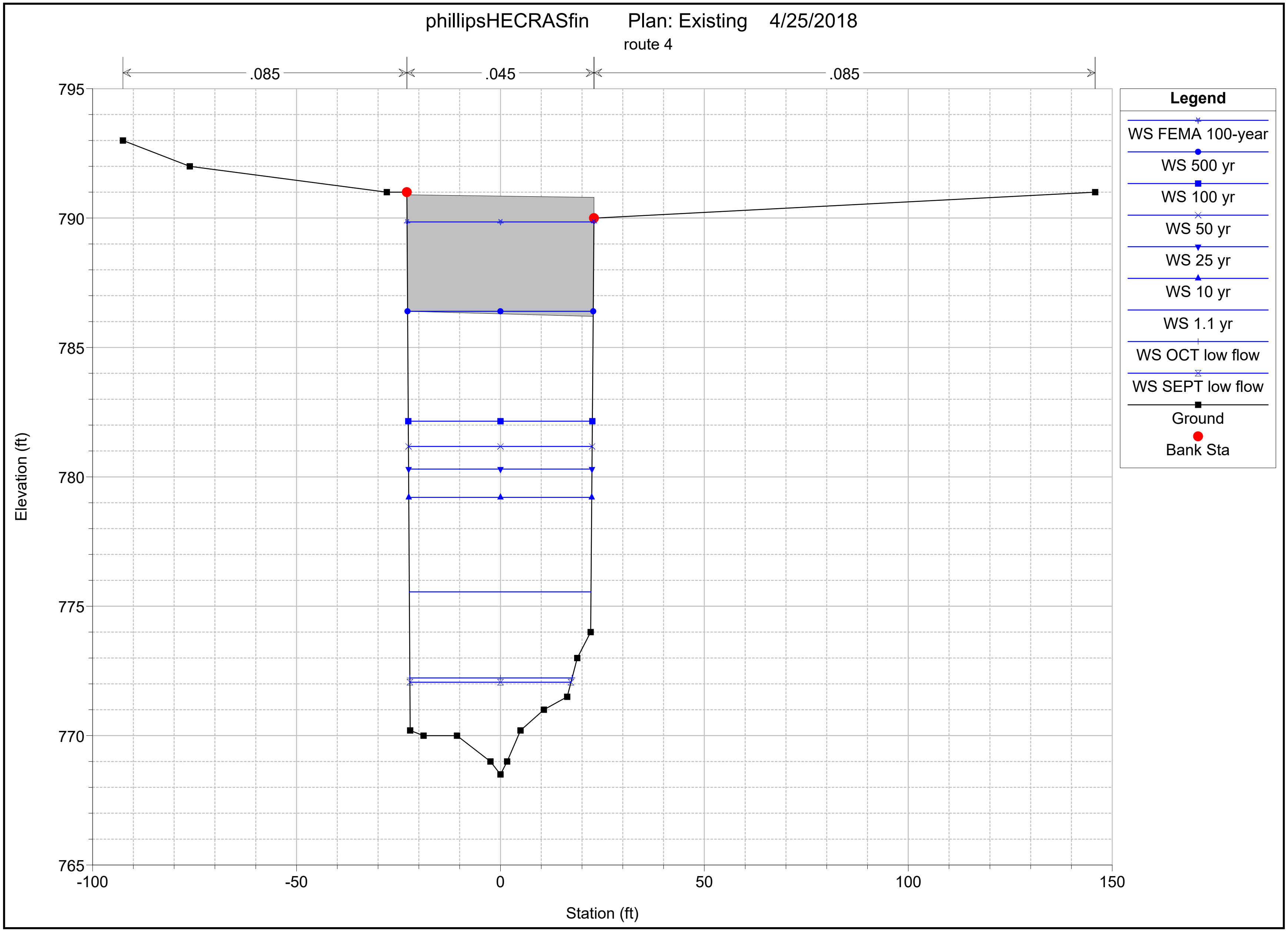
E.G. US. (ft)	782.63	Element	Inside BR US	Inside BR DS
W.S. US. (ft)	781.19	E.G. Elev (ft)	782.61	781.06
Q Total (cfs)	4624.00	W.S. Elev (ft)	781.17	779.53
Q Bridge (cfs)	4624.00	Crit W.S. (ft)	777.36	776.03
Q Weir (cfs)		Max Chl Dpth (ft)	12.67	12.53
Weir Sta Lft (ft)		Vel Total (ft/s)	9.62	9.91
Weir Sta Rgt (ft)		Flow Area (sq ft)	480.54	466.67
Weir Submerg		Froude # Chl	0.52	0.54
Weir Max Depth (ft)		Specif Force (cu ft)	3999.11	3919.56
Min El Weir Flow (ft)	790.01	Hydr Depth (ft)	10.67	10.38
Min El Prs (ft)	786.40	W.P. Total (ft)	63.45	63.24
Delta EG (ft)	1.58	Conv. Total (cfs)	61193.4	58405.8
Delta WS (ft)	1.68	Top Width (ft)	45.03	44.97
BR Open Area (sq ft)	712.58	Frctn Loss (ft)		
BR Open Vel (ft/s)	9.91	C & E Loss (ft)		
BR Sluice Coef		Shear Total (lb/sq ft)	2.70	2.89
BR Sel Method	Momentum	Power Total (lb/ft s)	25.98	28.61

Plan: EX sandy phillips RS: 20152 Profile: 100 yr

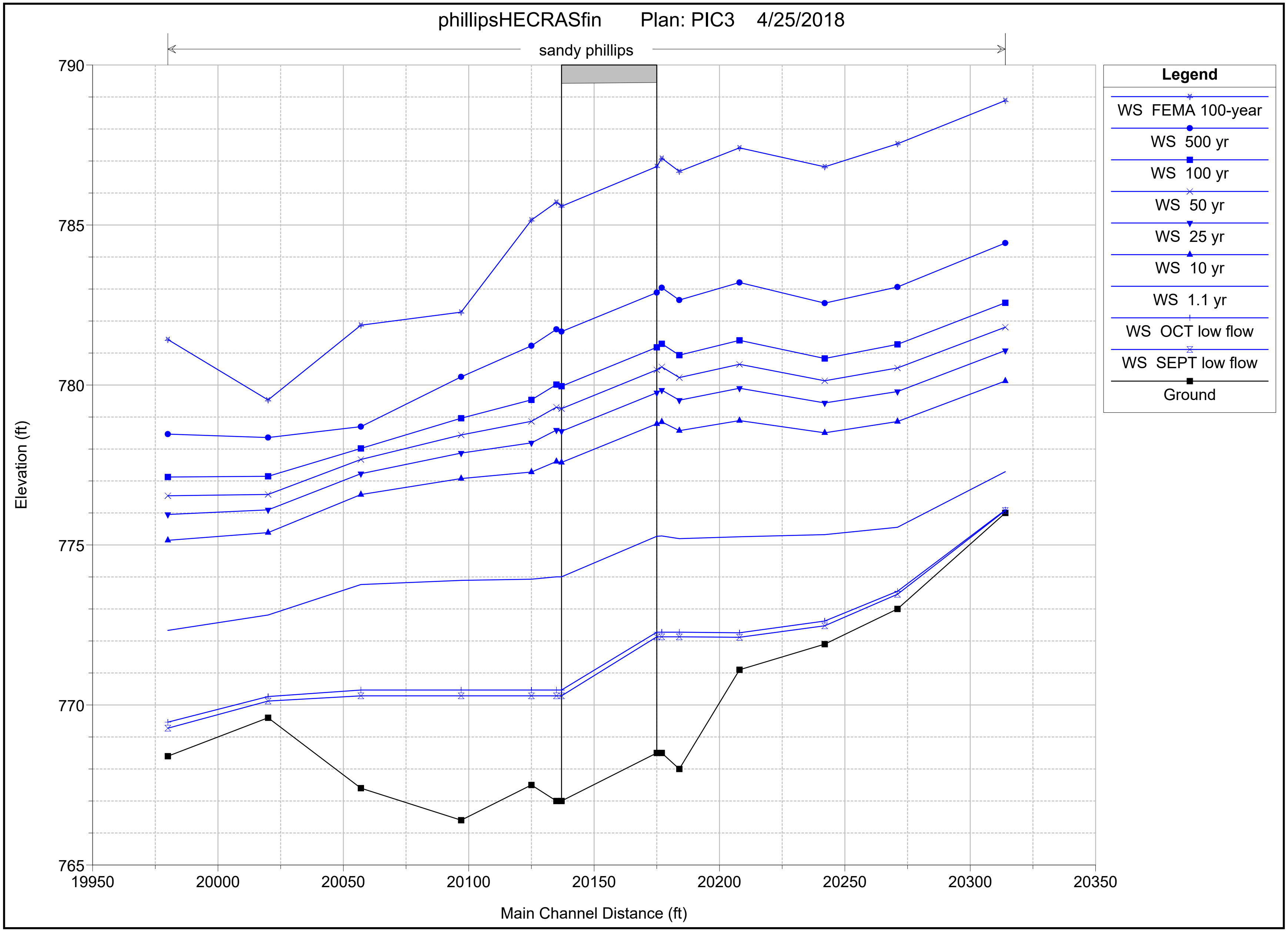
E.G. US. (ft)	783.79	Element	Inside BR US	Inside BR DS
W.S. US. (ft)	782.17	E.G. Elev (ft)	783.78	782.22
Q Total (cfs)	5369.00	W.S. Elev (ft)	782.15	780.50
Q Bridge (cfs)	5369.00	Crit W.S. (ft)	778.10	776.77
Q Weir (cfs)		Max Chl Dpth (ft)	13.65	13.50
Weir Sta Lft (ft)		Vel Total (ft/s)	10.24	10.52
Weir Sta Rgt (ft)		Flow Area (sq ft)	524.49	510.13
Weir Submerg		Froude # Chl	0.53	0.55
Weir Max Depth (ft)		Specif Force (cu ft)	4814.34	4723.46
Min El Weir Flow (ft)	790.01	Hydr Depth (ft)	11.62	11.32
Min El Prs (ft)	786.40	W.P. Total (ft)	65.40	65.18
Delta EG (ft)	1.59	Conv. Total (cfs)	69386.8	66404.5
Delta WS (ft)	1.69	Top Width (ft)	45.12	45.05
BR Open Area (sq ft)	712.58	Frctn Loss (ft)		
BR Open Vel (ft/s)	10.52	C & E Loss (ft)		

Plan: EX sandy phillips RS: 20152 Profile: 100 yr (Continued)

BR Sluice Coef		Shear Total (lb/sq ft)	3.00	3.19
BR Sel Method	Momentum	Power Total (lb/ft s)	30.68	33.62



phillipsHECRASfin Plan: Existing 4/25/2018
route 4
.085
.045
.085
795
790
785
780
775
770
765
-100
-50
0
50
100
150
Elevation (ft)
Station (ft)
Legend
WS FEMA 100-year
WS 500 yr
WS 100 yr
WS 50 yr
WS 25 yr
WS 10 yr
WS 1.1 yr
WS OCT low flow
WS SEPT low flow
Ground
Bank Sta



phillipsHECRASfin Plan: PIC3 4/25/2018
sandy phillips
Legend
WS FEMA 100-year
WS 500 yr
WS 100 yr
WS 50 yr
WS 25 yr
WS 10 yr
WS 1.1 yr
WS OCT low flow
WS SEPT low flow
Ground
Elevation (ft)
790
785
780
775
770
765
19950
20000
20050
20100
20150
20200
20250
20300
20350
Main Channel Distance (ft)

HEC-RAS Plan: PIC3-2 River: sandy Reach: phillips

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
phillips	20309	1.1 yr	728.00	776.00	777.29	777.29	777.94	0.028069	6.44	113.09	89.10	1.01
phillips	20309	10 yr	3037.00	776.00	780.13	779.32	781.14	0.010172	8.09	375.28	95.90	0.72
phillips	20309	25 yr	3922.00	776.00	781.08	779.93	782.17	0.008461	8.39	467.52	98.67	0.68
phillips	20309	50 yr	4624.00	776.00	781.81	780.37	782.95	0.007312	8.57	541.84	105.11	0.64
phillips	20309	100 yr	5369.00	776.00	782.57	780.82	783.75	0.006372	8.73	624.51	111.83	0.61
phillips	20309	500 yr	7251.00	776.00	784.44	781.87	785.68	0.004769	8.99	849.05	128.33	0.56
phillips	20309	SEPT low flow	8.50	776.00	776.08	776.08	776.10	0.049131	1.31	6.51	86.18	0.84
phillips	20309	OCT low flow	14.40	776.00	776.10	776.10	776.14	0.063740	1.74	8.26	86.23	0.99
phillips	20309	FEMA 100-year	12300.00	776.00	788.89	784.28	790.16	0.002863	9.32	1602.05	207.76	0.46
phillips	20267	1.1 yr	728.00	773.00	775.55	775.68	776.59	0.032823	8.18	89.02	53.73	1.12
phillips	20267	10 yr	3037.00	773.00	778.86	778.56	780.54	0.015828	10.39	292.83	71.98	0.90
phillips	20267	25 yr	3922.00	773.00	779.79	779.32	781.64	0.013551	10.90	362.07	75.13	0.86
phillips	20267	50 yr	4624.00	773.00	780.53		782.47	0.011875	11.19	418.05	76.78	0.82
phillips	20267	100 yr	5369.00	773.00	781.27		783.31	0.010670	11.49	475.20	78.91	0.80
phillips	20267	500 yr	7251.00	773.00	783.06		785.31	0.008498	12.08	625.47	89.03	0.74
phillips	20267	SEPT low flow	8.50	773.00	773.46	773.43	773.54	0.035461	2.23	3.81	17.55	0.84
phillips	20267	OCT low flow	14.40	773.00	773.55	773.53	773.66	0.035392	2.61	5.52	19.99	0.88
phillips	20267	FEMA 100-year	12300.00	773.00	787.54		789.88	0.005229	12.64	1177.92	151.23	0.62
phillips	20237	1.1 yr	728.00	771.90	775.32	774.93	775.97	0.013708	6.47	112.57	50.91	0.77
phillips	20237	10 yr	3037.00	771.90	778.51	777.95	780.10	0.012541	10.15	302.20	69.63	0.83
phillips	20237	25 yr	3922.00	771.90	779.44		781.27	0.011364	10.90	368.20	72.16	0.81
phillips	20237	50 yr	4624.00	771.90	780.13		782.14	0.010643	11.40	419.06	74.06	0.80
phillips	20237	100 yr	5369.00	771.90	780.83		783.00	0.010066	11.88	471.20	75.95	0.79
phillips	20237	500 yr	7251.00	771.90	782.56		785.04	0.008650	12.76	606.61	80.66	0.76
phillips	20237	SEPT low flow	8.50	771.90	772.47	772.43	772.58	0.030578	2.64	3.22	10.30	0.83
phillips	20237	OCT low flow	14.40	771.90	772.62		772.76	0.027427	2.92	4.93	12.50	0.82
phillips	20237	FEMA 100-year	12300.00	771.90	786.82		789.67	0.006097	13.95	1068.25	135.04	0.68
phillips	20203	1.1 yr	728.00	771.10	775.26		775.56	0.006586	4.38	166.09	76.13	0.52
phillips	20203	10 yr	3037.00	771.10	778.89		779.60	0.004320	6.82	456.65	83.80	0.50
phillips	20203	25 yr	3922.00	771.10	779.90		780.76	0.004192	7.47	542.41	85.83	0.50
phillips	20203	50 yr	4624.00	771.10	780.65		781.61	0.004095	7.92	607.04	86.69	0.51
phillips	20203	100 yr	5369.00	771.10	781.39		782.46	0.004015	8.35	671.98	87.44	0.51
phillips	20203	500 yr	7251.00	771.10	783.20		784.49	0.003756	9.20	831.89	89.39	0.51
phillips	20203	SEPT low flow	8.50	771.10	772.11		772.14	0.006520	1.30	6.54	18.69	0.39
phillips	20203	OCT low flow	14.40	771.10	772.26		772.29	0.007453	1.48	9.71	25.22	0.42
phillips	20203	FEMA 100-year	12300.00	771.10	787.41		789.20	0.003321	10.91	1217.76	94.09	0.51
phillips	20179	1.1 yr	728.00	768.00	775.20		775.43	0.003154	3.86	188.63	57.19	0.37
phillips	20179	10 yr	3037.00	768.00	778.57		779.46	0.006068	7.59	407.11	73.43	0.55
phillips	20179	25 yr	3922.00	768.00	779.53		780.61	0.006130	8.39	478.15	75.34	0.57
phillips	20179	50 yr	4624.00	768.00	780.23		781.46	0.006088	8.94	531.62	76.33	0.58
phillips	20179	100 yr	5369.00	768.00	780.93		782.31	0.006056	9.47	585.40	77.32	0.59
phillips	20179	500 yr	7251.00	768.00	782.65		784.34	0.005765	10.50	720.61	79.75	0.59
phillips	20179	SEPT low flow	8.50	768.00	772.13		772.13	0.000019	0.17	50.54	37.09	0.03
phillips	20179	OCT low flow	14.40	768.00	772.27		772.28	0.000039	0.26	55.90	37.40	0.04
phillips	20179	FEMA 100-year	12300.00	768.00	786.67		789.04	0.005184	12.51	1054.27	87.42	0.59
phillips	20172	1.1 yr	728.00	768.50	775.28	772.56	775.38	0.000928	2.48	293.34	73.54	0.22
phillips	20172	10 yr	3037.00	768.50	778.85	775.03	779.31	0.001928	5.47	557.20	74.45	0.35
phillips	20172	25 yr	3922.00	768.50	779.84	775.74	780.44	0.002133	6.25	631.02	74.70	0.38
phillips	20172	50 yr	4624.00	768.50	780.57	776.26	781.28	0.002258	6.79	685.51	74.88	0.39
phillips	20172	100 yr	5369.00	768.50	781.29	776.75	782.12	0.002371	7.31	739.64	75.07	0.41
phillips	20172	500 yr	7251.00	768.50	783.04	777.99	784.14	0.002524	8.40	871.53	75.51	0.43
phillips	20172	SEPT low flow	8.50	768.50	772.13	769.25	772.13	0.000008	0.11	75.45	56.40	0.02
phillips	20172	OCT low flow	14.40	768.50	772.28	769.44	772.28	0.000018	0.17	83.79	59.39	0.03
phillips	20172	FEMA 100-year	12300.00	768.50	787.09	780.83	788.83	0.002707	10.60	1179.13	76.54	0.47
phillips	20152		Bridge									
phillips	20132	1.1 yr	728.00	767.00	774.01		774.13	0.001283	2.79	261.08	70.64	0.26
phillips	20132	10 yr	3037.00	767.00	777.61		778.15	0.002318	5.90	517.52	71.70	0.38
phillips	20132	25 yr	3922.00	767.00	778.59		779.29	0.002540	6.71	587.95	71.99	0.41
phillips	20132	50 yr	4624.00	767.00	779.31		780.13	0.002676	7.28	639.67	72.20	0.43
phillips	20132	100 yr	5369.00	767.00	780.01		780.97	0.002803	7.84	690.88	72.41	0.44
phillips	20132	500 yr	7251.00	767.00	781.74		782.99	0.002964	8.99	816.15	72.91	0.47
phillips	20132	SEPT low flow	8.50	767.00	770.29		770.29	0.000008	0.14	59.76	31.35	0.02
phillips	20132	OCT low flow	14.40	767.00	770.47		770.47	0.000018	0.22	65.63	32.93	0.03
phillips	20132	FEMA 100-year	12300.00	767.00	785.71		787.69	0.003154	11.31	1107.98	74.08	0.51
phillips	20131	1.1 yr	728.00	767.50	773.93	771.19	774.10	0.001760	3.33	218.87	56.51	0.30
phillips	20131	10 yr	3037.00	767.50	777.28	774.59	778.07	0.004273	7.12	426.46	67.02	0.50
phillips	20131	25 yr	3922.00	767.50	778.19	775.46	779.19	0.004700	8.03	488.33	68.69	0.53
phillips	20131	50 yr	4624.00	767.50	778.87	776.09	780.03	0.004941	8.64	535.06	69.93	0.55
phillips	20131	100 yr	5369.00	767.50	779.54	776.72	780.86	0.005149	9.22	582.40	71.17	0.57
phillips	20131	500 yr	7251.00	767.50	781.23	778.11	782.88	0.005082	10.30	703.92	72.28	0.58
phillips	20131	SEPT low flow	8.50	767.50	770.29	767.85	770.29	0.000013	0.16	53.37	32.86	0.02
phillips	20131	OCT low flow	14.40	767.50	770.47	767.99	770.47	0.000026	0.24	59.47	34.04	0.03
phillips	20131	FEMA 100-year	12300.00	767.50	785.15	781.13	787.57	0.004739	12.46	989.54	79.72	0.59

HEC-RAS Plan: PIC3-2 River: sandy Reach: phillips (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
phillips	20100	1.1 yr	728.00	766.40	773.90		774.05	0.001438	3.15	231.43	52.90	0.27
phillips	20100	10 yr	3037.00	766.40	777.08		777.93	0.004307	7.43	409.02	58.29	0.49
phillips	20100	25 yr	3922.00	766.40	777.87		779.03	0.005021	8.62	455.54	58.35	0.54
phillips	20100	50 yr	4624.00	766.40	778.44		779.83	0.005538	9.48	488.42	58.39	0.58
phillips	20100	100 yr	5369.00	766.40	778.96		780.63	0.006099	10.36	519.08	58.43	0.61
phillips	20100	500 yr	7251.00	766.40	780.25		782.57	0.007088	12.22	594.61	58.53	0.67
phillips	20100	SEPT low flow	8.50	766.40	770.29		770.29	0.000006	0.12	71.87	35.63	0.01
phillips	20100	OCT low flow	14.40	766.40	770.47		770.47	0.000012	0.18	78.42	36.15	0.02
phillips	20100	FEMA 100-year	12300.00	766.40	782.28	781.16	786.93	0.011162	17.30	713.25	58.68	0.87
phillips	20057	1.1 yr	728.00	767.40	773.77		773.97	0.002289	3.65	199.24	52.76	0.33
phillips	20057	10 yr	3037.00	767.40	776.58		777.70	0.006604	8.51	362.86	63.90	0.61
phillips	20057	25 yr	3922.00	767.40	777.23		778.74	0.008019	9.89	405.45	66.56	0.68
phillips	20057	50 yr	4624.00	767.40	777.67		779.51	0.009113	10.91	435.38	68.37	0.73
phillips	20057	100 yr	5369.00	767.40	778.02		780.25	0.010583	12.05	459.14	69.77	0.79
phillips	20057	500 yr	7251.00	767.40	778.70	778.44	782.07	0.014602	14.82	507.69	73.09	0.94
phillips	20057	SEPT low flow	8.50	767.40	770.28		770.29	0.000018	0.19	44.44	26.23	0.03
phillips	20057	OCT low flow	14.40	767.40	770.47		770.47	0.000039	0.29	49.35	27.89	0.04
phillips	20057	FEMA 100-year	12300.00	767.40	781.87	781.87	786.40	0.013201	17.34	784.61	99.93	0.94
phillips	20020	1.1 yr	728.00	769.60	772.81	772.81	773.70	0.026799	7.57	96.21	53.99	1.00
phillips	20020	10 yr	3037.00	769.60	775.39	775.39	777.23	0.020571	10.90	282.46	79.17	1.00
phillips	20020	25 yr	3922.00	769.60	776.10	776.10	778.24	0.019412	11.77	339.87	81.94	0.99
phillips	20020	50 yr	4624.00	769.60	776.58	776.58	778.98	0.019288	12.48	379.54	84.11	1.00
phillips	20020	100 yr	5369.00	769.60	777.15	777.15	779.72	0.018141	12.93	428.56	88.57	0.99
phillips	20020	500 yr	7251.00	769.60	778.36	778.36	781.39	0.016931	14.08	541.74	98.10	0.98
phillips	20020	SEPT low flow	8.50	769.60	770.12	770.12	770.27	0.046676	3.06	2.77	9.46	1.00
phillips	20020	OCT low flow	14.40	769.60	770.26	770.26	770.44	0.044015	3.42	4.21	11.59	1.00
phillips	20020	FEMA 100-year	12300.00	769.60	779.53	781.13	785.56	0.028041	19.94	662.10	107.31	1.30
phillips	19980	1.1 yr	728.00	768.40	772.33	771.68	772.68	0.008003	4.76	153.33	74.79	0.58
phillips	19980	10 yr	3037.00	768.40	775.15	774.00	776.24	0.008002	8.41	370.19	79.32	0.67
phillips	19980	25 yr	3922.00	768.40	775.95	774.71	777.29	0.008003	9.31	434.63	80.62	0.69
phillips	19980	50 yr	4624.00	768.40	776.54	775.20	778.06	0.008001	9.94	482.26	81.56	0.70
phillips	19980	100 yr	5369.00	768.40	777.12	775.74	778.83	0.008001	10.54	530.35	83.11	0.71
phillips	19980	500 yr	7251.00	768.40	778.47	776.93	780.63	0.008008	11.88	645.82	90.20	0.73
phillips	19980	SEPT low flow	8.50	768.40	769.27	769.03	769.32	0.008005	1.67	5.09	11.64	0.45
phillips	19980	OCT low flow	14.40	768.40	769.47	769.18	769.52	0.008010	1.91	7.56	14.18	0.46
phillips	19980	FEMA 100-year	12300.00	768.40	781.42	779.87	784.62	0.008004	14.57	947.30	114.39	0.77

HEC-RAS Plan: PIC3-2 River: sandy Reach: phillips

Reach	River Sta	Profile	E.G. Elev	W.S. Elev	Crit W.S.	Frctn Loss	C & E Loss	Top Width	Q Left	Q Channel	Q Right	Vel Chnl
			(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(cfs)	(ft/s)
phillips	20179	1.1 yr	775.43	775.20		0.01	0.04	57.19	0.01	728.00		3.86
phillips	20179	10 yr	779.46	778.57		0.02	0.13	73.43	15.62	3021.38		7.59
phillips	20179	25 yr	780.61	779.53		0.02	0.14	75.34	29.49	3892.51	0.00	8.39
phillips	20179	50 yr	781.46	780.23		0.02	0.15	76.33	43.23	4580.77	0.00	8.94
phillips	20179	100 yr	782.31	780.93		0.03	0.16	77.32	60.27	5308.73	0.00	9.47
phillips	20179	500 yr	784.34	782.65		0.03	0.18	79.75	116.04	7134.96	0.01	10.50
phillips	20179	SEPT low flow	772.13	772.13		0.00	0.00	37.09		8.50		0.17
phillips	20179	OCT low flow	772.28	772.27		0.00	0.00	37.40		14.40		0.26
phillips	20179	FEMA 100-year	789.04	786.67		0.03	0.19	87.42	329.98	11969.98	0.04	12.51
phillips	20172	1.1 yr	775.38	775.28	772.56			73.54	0.00	727.99	0.01	2.48
phillips	20172	10 yr	779.31	778.85	775.03			74.45	0.19	3036.19	0.63	5.47
phillips	20172	25 yr	780.44	779.84	775.74			74.70	0.36	3920.53	1.11	6.25
phillips	20172	50 yr	781.28	780.57	776.26			74.88	0.54	4621.87	1.59	6.79
phillips	20172	100 yr	782.12	781.29	776.75			75.07	0.76	5366.06	2.17	7.31
phillips	20172	500 yr	784.14	783.04	777.99			75.51	1.51	7245.43	4.06	8.40
phillips	20172	SEPT low flow	772.13	772.13	769.25			56.40		8.50		0.11
phillips	20172	OCT low flow	772.28	772.28	769.44			59.39		14.40		0.17
phillips	20172	FEMA 100-year	788.83	787.09	780.83			76.54	4.64	12283.80	11.56	10.60
phillips	20152 BR U	1.1 yr	775.38	775.27	772.58			67.84		728.00		2.57
phillips	20152 BR U	10 yr	779.31	778.79	775.07			69.47		3037.00		5.79
phillips	20152 BR U	25 yr	780.44	779.76	775.81			69.47		3922.00		6.62
phillips	20152 BR U	50 yr	781.28	780.47	776.34			69.47		4624.00		7.21
phillips	20152 BR U	100 yr	782.12	781.18	776.91			69.47		5369.00		7.78
phillips	20152 BR U	500 yr	784.14	782.89	778.20			69.48		7251.00		8.96
phillips	20152 BR U	SEPT low flow	772.13	772.13	769.25			56.40		8.50		0.11
phillips	20152 BR U	OCT low flow	772.28	772.28	769.43			59.39		14.40		0.17
phillips	20152 BR U	FEMA 100-year	788.83	786.83	781.16			69.49		12300.00		11.36
phillips	20152 BR D	1.1 yr	774.13	774.00	771.03			67.70		728.00	0.00	2.83
phillips	20152 BR D	10 yr	778.15	777.58	774.18			69.47		3036.62	0.38	6.07
phillips	20152 BR D	25 yr	779.30	778.55	774.92			69.47		3921.48	0.52	6.91
phillips	20152 BR D	50 yr	780.14	779.26	775.45			69.47		4623.37	0.63	7.50
phillips	20152 BR D	100 yr	780.98	779.96	776.02			69.47		5368.26	0.74	8.07
phillips	20152 BR D	500 yr	783.00	781.67	777.34			69.48		7249.99	1.01	9.26
phillips	20152 BR D	SEPT low flow	770.29	770.29	767.37			31.35		8.50		0.14
phillips	20152 BR D	OCT low flow	770.47	770.47	767.52			32.93		14.40		0.22
phillips	20152 BR D	FEMA 100-year	787.70	785.59	780.31			69.48		12298.31	1.69	11.67
phillips	20132	1.1 yr	774.13	774.01		0.01	0.01	70.64		727.99	0.01	2.79
phillips	20132	10 yr	778.15	777.61		0.03	0.05	71.70	0.16	3035.80	1.03	5.90
phillips	20132	25 yr	779.29	778.59		0.03	0.06	71.99	0.33	3919.87	1.81	6.71
phillips	20132	50 yr	780.13	779.31		0.04	0.07	72.20	0.49	4620.95	2.56	7.28
phillips	20132	100 yr	780.97	780.01		0.04	0.07	72.41	0.71	5364.81	3.48	7.84
phillips	20132	500 yr	782.99	781.74		0.04	0.08	72.91	1.42	7243.15	6.43	8.99
phillips	20132	SEPT low flow	770.29	770.29		0.00	0.00	31.35		8.50		0.14
phillips	20132	OCT low flow	770.47	770.47		0.00	0.00	32.93		14.40		0.22
phillips	20132	FEMA 100-year	787.69	785.71		0.04	0.09	74.08	4.42	12277.57	18.01	11.31
phillips	20131	1.1 yr	774.10	773.93	771.19	0.04	0.01	56.51		728.00		3.33
phillips	20131	10 yr	778.07	777.28	774.59	0.12	0.01	67.02		3037.00		7.12
phillips	20131	25 yr	779.19	778.19	775.46	0.14	0.03	68.69	0.00	3922.00		8.03
phillips	20131	50 yr	780.03	778.87	776.09	0.15	0.05	69.93	0.00	4624.00		8.64
phillips	20131	100 yr	780.86	779.54	776.72	0.16	0.07	71.17	0.00	5369.00		9.22
phillips	20131	500 yr	782.88	781.23	778.11	0.17	0.13	72.28	0.00	7250.95	0.05	10.30
phillips	20131	SEPT low flow	770.29	770.29	767.85	0.00	0.00	32.86		8.50		0.16
phillips	20131	OCT low flow	770.47	770.47	767.99	0.00	0.00	34.04		14.40		0.24
phillips	20131	FEMA 100-year	787.57	785.15	781.13	0.19	0.45	79.72	0.03	12297.91	2.07	12.46

Plan: PIC3-2 sandy phillips RS: 20152 Profile: 1.1 yr

E.G. US. (ft)	775.38	Element	Inside BR US	Inside BR DS
W.S. US. (ft)	775.28	E.G. Elev (ft)	775.38	774.13
Q Total (cfs)	728.00	W.S. Elev (ft)	775.27	774.00
Q Bridge (cfs)	728.00	Crit W.S. (ft)	772.58	771.03
Q Weir (cfs)		Max Chl Dpth (ft)	6.77	7.00
Weir Sta Lft (ft)		Vel Total (ft/s)	2.57	2.83
Weir Sta Rgt (ft)		Flow Area (sq ft)	283.09	257.44
Weir Submerg		Froude # Chl	0.22	0.26
Weir Max Depth (ft)		Specif Force (cu ft)	691.24	679.18
Min El Weir Flow (ft)	790.01	Hydr Depth (ft)	4.17	3.80
Min El Prs (ft)	789.45	W.P. Total (ft)	74.25	71.64
Delta EG (ft)	1.25	Conv. Total (cfs)	22812.8	19981.1
Delta WS (ft)	1.28	Top Width (ft)	67.84	67.70
BR Open Area (sq ft)	1211.57	Frctn Loss (ft)		
BR Open Vel (ft/s)	2.83	C & E Loss (ft)		
BR Sluice Coef		Shear Total (lb/sq ft)	0.24	0.30
BR Sel Method	Momentum	Power Total (lb/ft s)	0.62	0.84

Plan: PIC3-2 sandy phillips RS: 20152 Profile: 50 yr

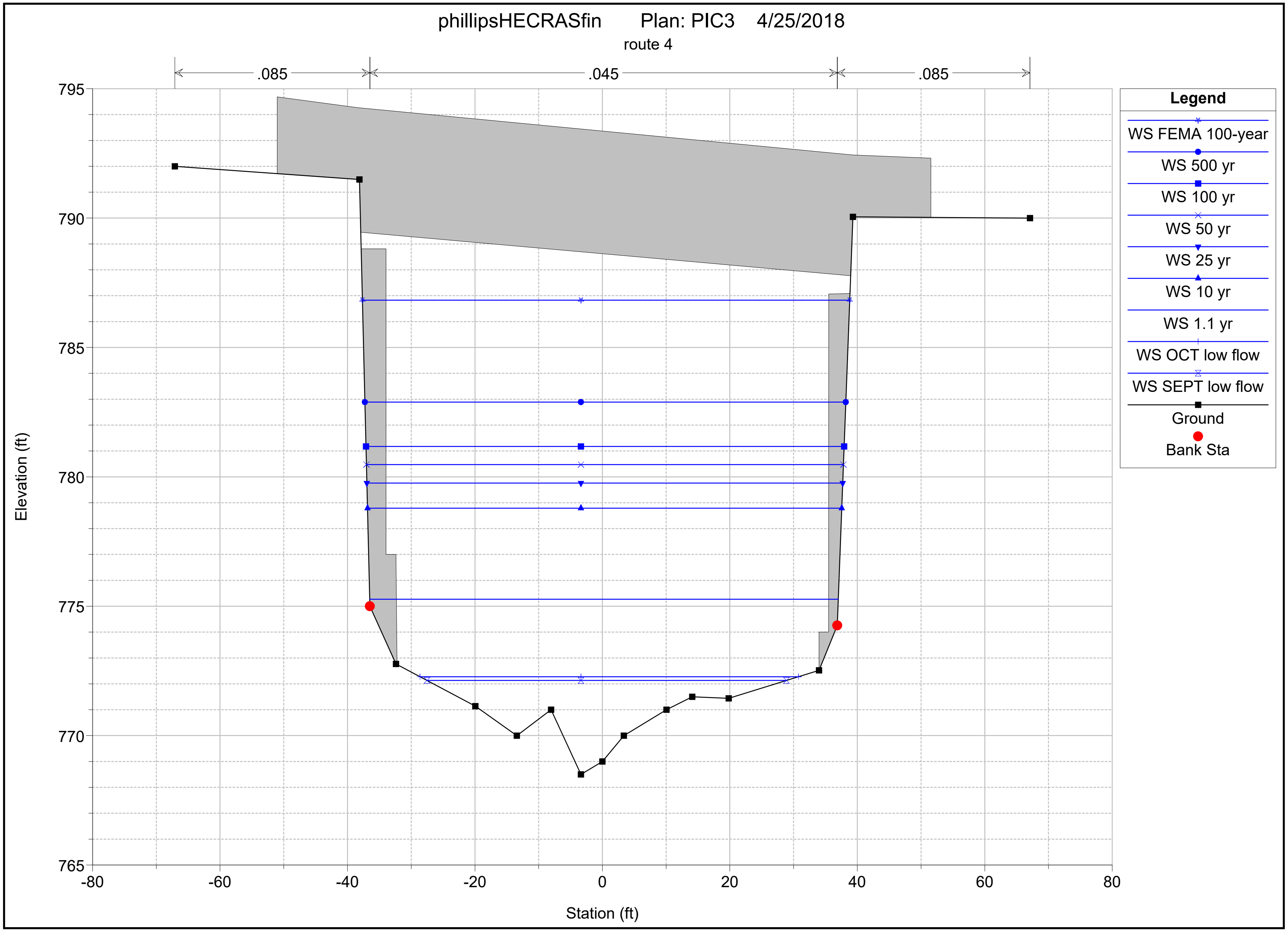
E.G. US. (ft)	781.28	Element	Inside BR US	Inside BR DS
W.S. US. (ft)	780.57	E.G. Elev (ft)	781.28	780.14
Q Total (cfs)	4624.00	W.S. Elev (ft)	780.47	779.26
Q Bridge (cfs)	4624.00	Crit W.S. (ft)	776.34	775.45
Q Weir (cfs)		Max Chl Dpth (ft)	11.97	12.26
Weir Sta Lft (ft)		Vel Total (ft/s)	7.21	7.48
Weir Sta Rgt (ft)		Flow Area (sq ft)	641.55	617.86
Weir Submerg		Froude # Chl	0.42	0.44
Weir Max Depth (ft)		Specif Force (cu ft)	4068.01	3988.79
Min El Weir Flow (ft)	790.01	Hydr Depth (ft)	9.23	8.89
Min El Prs (ft)	789.45	W.P. Total (ft)	86.21	83.72
Delta EG (ft)	1.15	Conv. Total (cfs)	80749.1	80580.2
Delta WS (ft)	1.26	Top Width (ft)	69.47	69.47
BR Open Area (sq ft)	1211.57	Frctn Loss (ft)		
BR Open Vel (ft/s)	7.48	C & E Loss (ft)		
BR Sluice Coef		Shear Total (lb/sq ft)	1.52	1.52
BR Sel Method	Momentum	Power Total (lb/ft s)	10.98	11.35

Plan: PIC3-2 sandy phillips RS: 20152 Profile: 100 yr

E.G. US. (ft)	782.12	Element	Inside BR US	Inside BR DS
W.S. US. (ft)	781.29	E.G. Elev (ft)	782.12	780.98
Q Total (cfs)	5369.00	W.S. Elev (ft)	781.18	779.96
Q Bridge (cfs)	5369.00	Crit W.S. (ft)	776.91	776.02
Q Weir (cfs)		Max Chl Dpth (ft)	12.68	12.96
Weir Sta Lft (ft)		Vel Total (ft/s)	7.78	8.06
Weir Sta Rgt (ft)		Flow Area (sq ft)	690.53	666.51
Weir Submerg		Froude # Chl	0.43	0.46
Weir Max Depth (ft)		Specif Force (cu ft)	4799.16	4707.93
Min El Weir Flow (ft)	790.01	Hydr Depth (ft)	9.94	9.59
Min El Prs (ft)	789.45	W.P. Total (ft)	87.62	85.13
Delta EG (ft)	1.15	Conv. Total (cfs)	90297.2	90868.2
Delta WS (ft)	1.27	Top Width (ft)	69.47	69.47
BR Open Area (sq ft)	1211.57	Frctn Loss (ft)		
BR Open Vel (ft/s)	8.06	C & E Loss (ft)		

Plan: PIC3-2 sandy phillips RS: 20152 Profile: 100 yr (Continued)

BR Sluice Coef		Shear Total (lb/sq ft)	1.74	1.71
BR Sel Method	Momentum	Power Total (lb/ft s)	13.52	13.75


phillipsHECRASfin Plan: PIC3 4/25/2018
route 4
.085
.045
.085
Legend
WS FEMA 100-year
WS 500 yr
WS 100 yr
WS 50 yr
WS 25 yr
WS 10 yr
WS 1.1 yr
WS OCT low flow
WS SEPT low flow
Ground
Bank Sta
Elevation (ft)
Station (ft)
795
790
785
780
775
770
765
-80
-60
-40
-20
0
20
40
60
80

Phillips: Wing Bridge

Span of Current Bridge:	62 FT
Year of Construction:	1933
Type of Bridge:	Steel Beam

Phillips:			<u>Channel Type:</u>
September-October Low Flows:	8.6 cfs (Sept)	14.6 cfs (Oct)	Stable
Existing Flow Depth for Low Flows:	1.5-1.6 FT		Rock Base
Drop in water surface through bridge:	1.5 FT		Swift flow
Maximum Velocity (low flow) :	0.18 FPS		Mountain Torrents

Bank Full Width				
Stream Cross Section Number	1. Width of Channel at time of Survey (FT)	2. Natural Channel Geomorphic Estimate (FT)	3. Cross Section Survey Plots (FT)	4. Hydraulic Model HECRAS 1.1-year flow width (FT)
199+80	70	70	82	74
200+20	52	60	90	55
200+57	43	57	75	55
Average each method	55.0	62.3	82.3	61.3
AVERAGE WIDTH (FT): Downstream River Segment (Using Methods 2, 3, 4):				68.7
200+99	37	55	49	43
Old Bridge 201+30	39	57	61	49
Bridge 201+48	39	57	47	44
Bridge 201+79	35	57	57	44
Average each method	37.5	56.5	53.5	45.0
202+03	45	60	76	64
202+37	41	70	84	52
202+67	45	85	72	54
Average each method	43.7	71.7	77.3	56.7
AVERAGE WIDTH (FT): Upstream River Segment (Using Methods 2, 3, 4):				68.6
203+09	87	87	95	95

Recommended Bank Full Width (Perpendicular to the channel edge): **68.6** **FT**

Bridge Length required for Bank Width Recommended (Skew = 35°): **84.0** **FT**

METHODS;

<u>1. Width of Channel at Time of Survey:</u> Data provided for rough check of channel width and is subject to water levels at the time the survey was taken. The data is <u>*not*</u> used in the average calculation used to derive bank full width as it can be subjective.

<u>2. Natural Geomorphic Channel:</u> Assessment of channel width based on important channel features such as slope, bedrock outcrops and the channel alignment without constrictions (bridge in this case). Data <u>*is*</u> considered in the average.

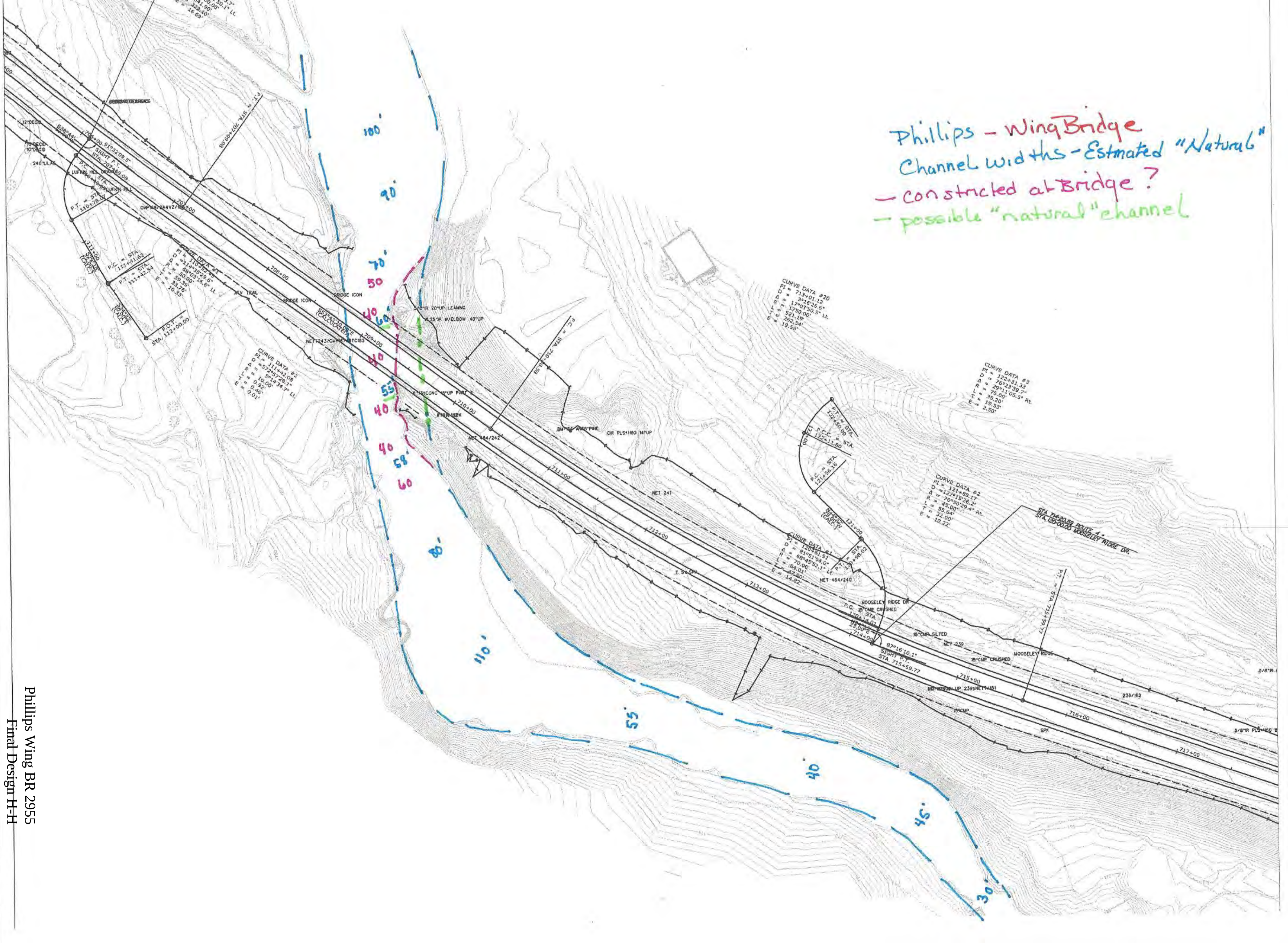
<u>3. Cross Section Survey Plot Data:</u> Width of channel is estimated from channel survey information. The bank edge of the channel is the change in slope in the topography; no specific water level is considered. Data <u>*is*</u> considered in the average.

<u>4. Hydraulic Model HECRAS 1.1-year flow width:</u> Most reliable data for bank full width assessment. Using model HECRAS and the 1.1-year streamflow, channel width is calculated from the 1.1 year flow data output, intersection of water level and channel bank. Data <u>*is*</u> considered in the average.

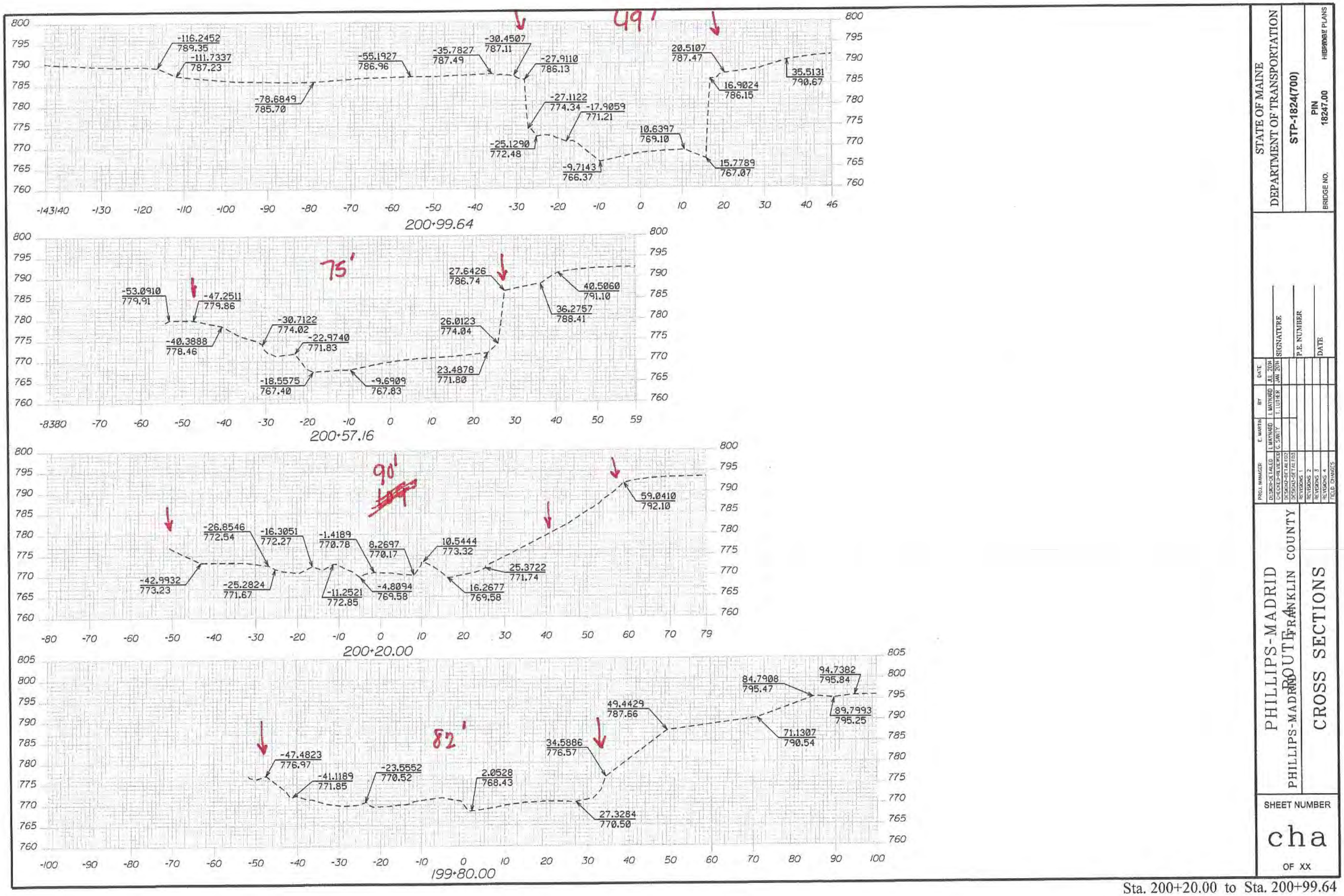
METHOD 1: Width of Channel at time of survey

WING BRIDGE
PHILLIPS

METHOD 2 : Natural Channel Geopmorphic Estimate

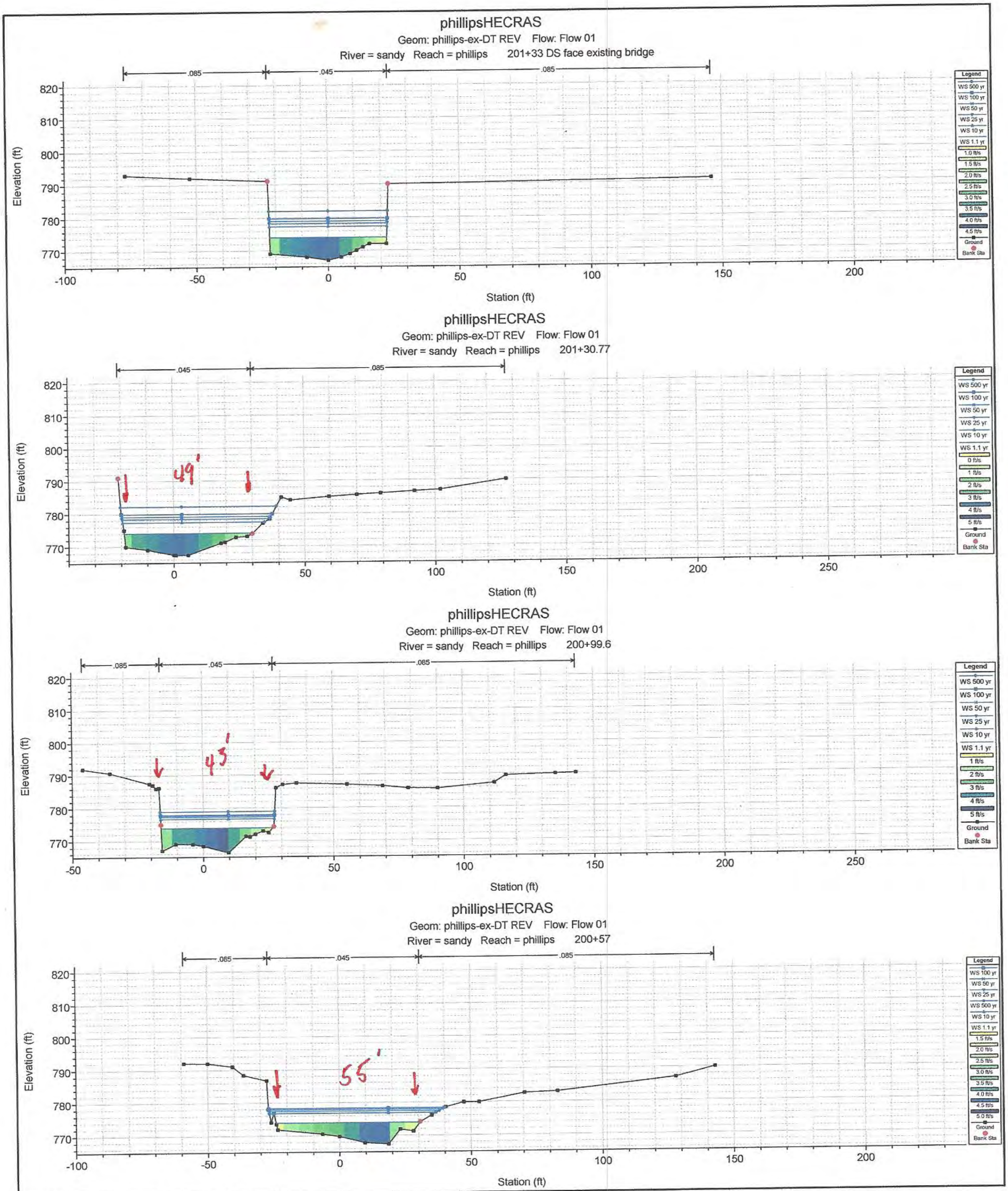


METHOD 3: Channel Cross Section Survey Plots

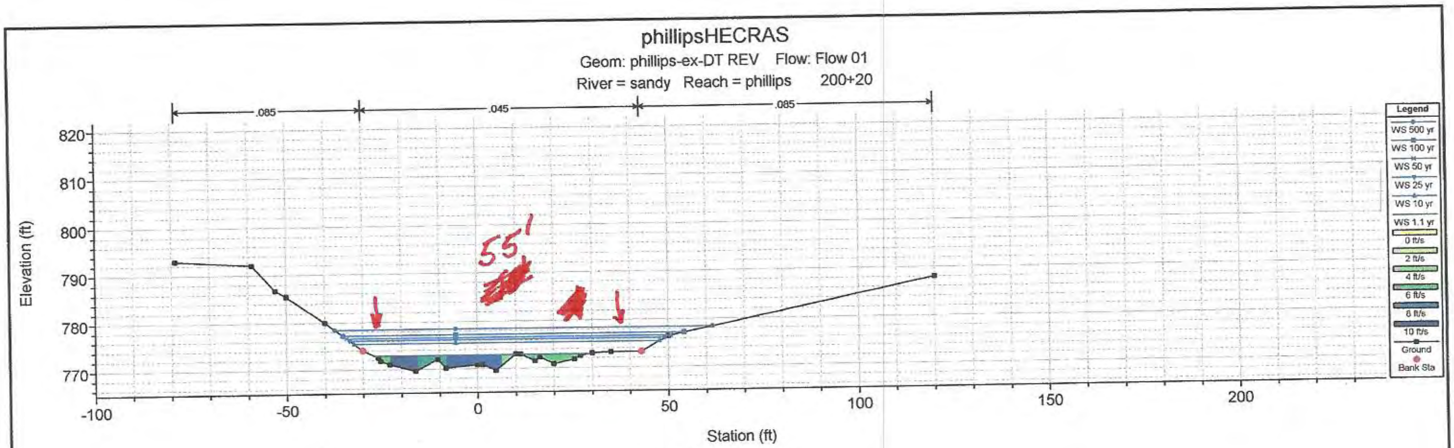


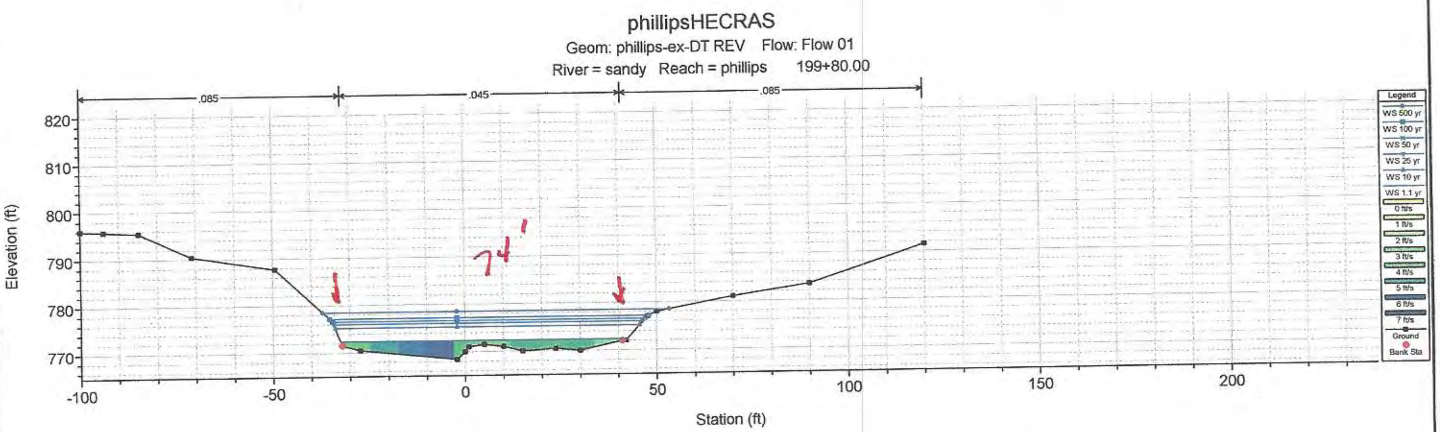
Sta. 200+20.00 to Sta. 200+99.64

METHOD 4: Hydraulic Model HECRAS 1.1-year flow width

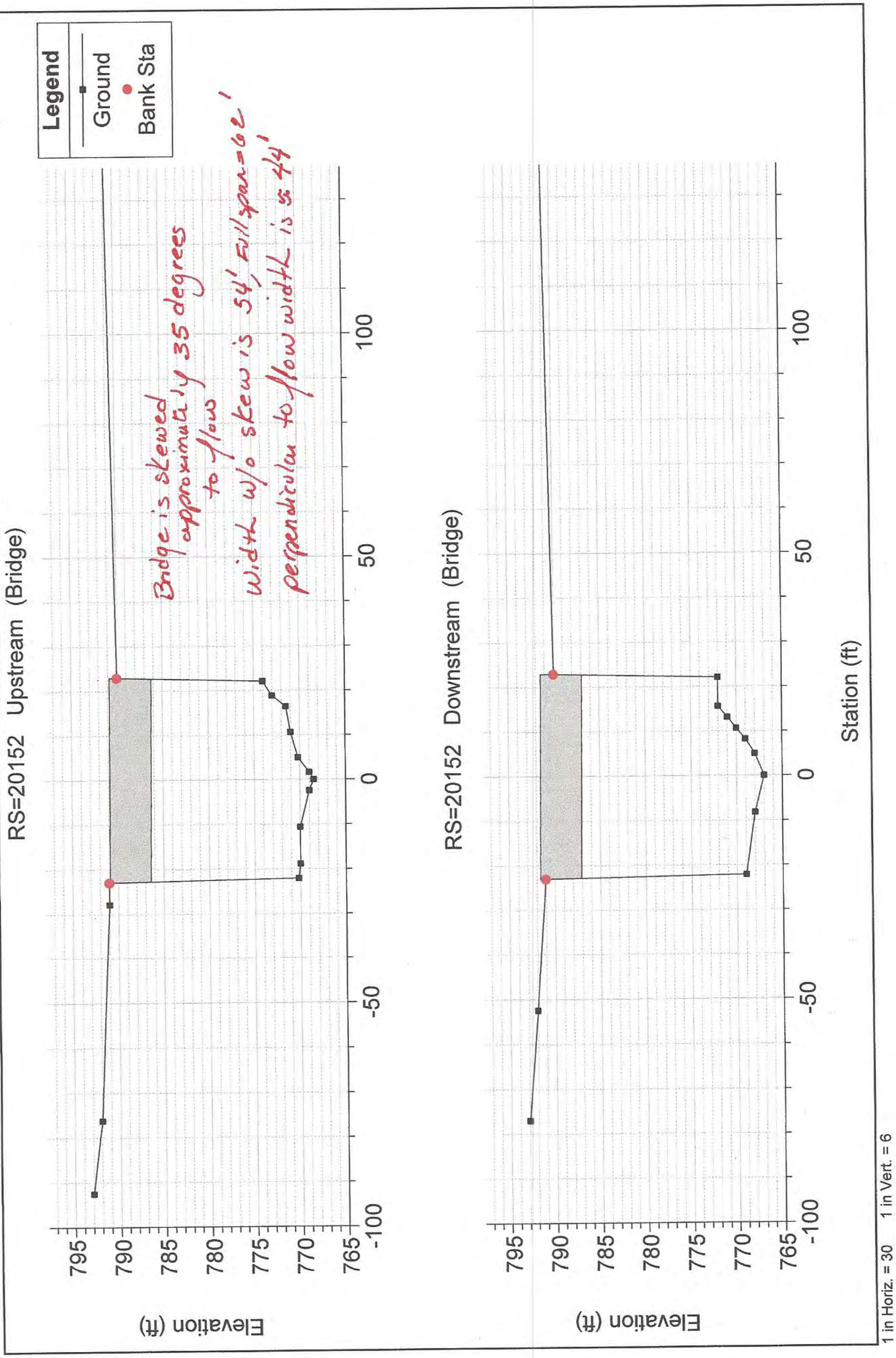


1 in Horiz. = 50 ft 1 in Vert. = 40 ft





1 in Horiz. = 50 ft 1 in Vert. = 40 ft


RS=20152 Upstream (Bridge)
Legend
Ground
Bank Sta
Elevation (ft)
795
790
785
780
775
770
765
-100
-50
0
50
100
Bridge is skewed approximately 35 degrees to flow
Width w/o skew is 54', Full span = 62'
perpendicular to flow width is ≈ 44'
RS=20152 Downstream (Bridge)
Station (ft)
1 in Horiz. = 30 1 in Vert. = 6

Phillips

HEC-RAS Plan: Plan 02 River: sandy Reach: phillips

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
phillips	20309	1.1 yr	734.00	776.00	777.30	777.30	777.95	0.027984	6.45	113.76	89.12	1.01
phillips	20309	10 yr	3059.00	776.00	780.29	779.34	781.24	0.009084	7.83	390.72	96.29	0.68
phillips	20309	25 yr	3949.00	776.00	781.48	779.94	782.42	0.006558	7.79	507.67	102.20	0.60
phillips	20309	50 yr	4655.00	776.00	782.40	780.39	783.34	0.005256	7.78	605.63	110.33	0.56
phillips	20309	100 yr	5405.00	776.00	783.38	780.84	784.31	0.004265	7.75	718.60	119.02	0.51
phillips	20309	500 yr	7298.00	776.00	786.03	781.89	786.88	0.002601	7.48	1071.69	158.72	0.42
phillips	20309	SEPT low flow	8.60	776.00	776.07	776.07	776.10	0.082032	1.53	5.62	86.16	1.06
phillips	20309	OCT low flow	14.60	776.00	776.10	776.10	776.14	0.066082	1.77	8.24	86.23	1.01
phillips	20267	1.1 yr	734.00	773.00	775.57	775.69	776.61	0.032718	8.20	89.56	53.76	1.12
phillips	20267	10 yr	3059.00	773.00	779.60		780.81	0.009428	8.85	347.36	74.69	0.71
phillips	20267	25 yr	3949.00	773.00	780.79		782.08	0.007490	9.14	437.59	77.35	0.66
phillips	20267	50 yr	4655.00	773.00	781.70		783.04	0.006452	9.33	509.74	81.11	0.63
phillips	20267	100 yr	5405.00	773.00	782.68		784.06	0.005557	9.46	591.55	86.57	0.59
phillips	20267	500 yr	7298.00	773.00	785.38		786.70	0.003645	9.33	877.04	128.00	0.51
phillips	20267	SEPT low flow	8.60	773.00	773.45	773.43	773.54	0.039642	2.33	3.69	17.30	0.89
phillips	20267	OCT low flow	14.60	773.00	773.52	773.53	773.66	0.050695	2.96	4.93	19.37	1.04
phillips	20237	1.1 yr	734.00	771.90	775.59	774.94	776.12	0.009720	5.81	126.41	51.79	0.65
phillips	20237	10 yr	3059.00	771.90	779.43		780.55	0.006928	8.50	367.95	72.15	0.63
phillips	20237	25 yr	3949.00	771.90	780.62		781.87	0.006019	9.01	455.79	75.40	0.61
phillips	20237	50 yr	4655.00	771.90	781.54		782.87	0.005441	9.32	526.02	77.90	0.59
phillips	20237	100 yr	5405.00	771.90	782.51		783.90	0.004896	9.56	602.81	80.54	0.57
phillips	20237	500 yr	7298.00	771.90	785.21		786.59	0.003459	9.62	874.34	115.26	0.50
phillips	20237	SEPT low flow	8.60	771.90	772.49	772.43	772.59	0.027301	2.54	3.38	10.53	0.79
phillips	20237	OCT low flow	14.60	771.90	772.67	772.57	772.78	0.021133	2.67	5.48	13.13	0.73
phillips	20203	1.1 yr	734.00	771.10	775.55		775.82	0.004581	4.21	174.35	64.40	0.45
phillips	20203	10 yr	3059.00	771.10	779.53		780.27	0.003809	6.98	469.29	83.74	0.47
phillips	20203	25 yr	3949.00	771.10	780.75		781.60	0.003552	7.53	574.28	87.91	0.47
phillips	20203	50 yr	4655.00	771.10	781.68		782.61	0.003342	7.87	657.56	90.30	0.47
phillips	20203	100 yr	5405.00	771.10	782.66		783.65	0.003118	8.15	747.72	93.17	0.46
phillips	20203	500 yr	7298.00	771.10	785.35		786.39	0.002437	8.47	1008.81	101.47	0.42
phillips	20203	SEPT low flow	8.60	771.10	772.04		772.08	0.009094	1.60	5.37	14.36	0.46
phillips	20203	OCT low flow	14.60	771.10	772.20		772.25	0.011305	1.72	8.47	24.03	0.51
phillips	20179	1.1 yr	734.00	768.30	775.49		775.73	0.002579	3.93	187.00	46.31	0.34
phillips	20179	10 yr	3059.00	768.30	778.94		780.11	0.006326	8.76	375.63	62.66	0.56
phillips	20179	25 yr	3949.00	768.30	779.96		781.42	0.006906	9.85	442.83	68.63	0.59
phillips	20179	50 yr	4655.00	768.30	780.79		782.42	0.007038	10.47	501.45	73.44	0.60
phillips	20179	100 yr	5405.00	768.30	781.73		783.47	0.006844	10.89	572.61	77.69	0.60
phillips	20179	500 yr	7298.00	768.30	784.54		786.24	0.005361	10.98	792.68	78.95	0.54
phillips	20179	SEPT low flow	8.60	768.30	772.07		772.07	0.000026	0.19	45.37	36.44	0.03
phillips	20179	OCT low flow	14.60	768.30	772.23		772.23	0.000051	0.28	51.31	36.66	0.04
phillips	20171	1.1 yr	734.00	768.50	775.53	772.26	775.69	0.001331	3.22	227.95	44.52	0.25
phillips	20171	10 yr	3059.00	768.50	779.02	775.69	780.01	0.004810	7.97	383.89	44.84	0.48
phillips	20171	25 yr	3949.00	768.50	780.01	776.67	781.33	0.005822	9.22	428.12	44.93	0.53
phillips	20171	50 yr	4655.00	768.50	780.78	777.39	782.35	0.006459	10.06	462.61	45.00	0.55
phillips	20171	100 yr	5405.00	768.50	781.58	778.09	783.40	0.007004	10.83	498.89	45.07	0.57
phillips	20171	500 yr	7298.00	768.50	783.83	779.83	786.13	0.007530	12.15	600.60	45.27	0.59
phillips	20171	SEPT low flow	8.60	768.50	772.07	769.27	772.07	0.000005	0.11	79.58	39.51	0.01
phillips	20171	OCT low flow	14.60	768.50	772.23	769.44	772.23	0.000010	0.17	86.03	39.78	0.02
phillips	20152		Bridge		slope = .04							
phillips	20133	1.1 yr	734.00	767.00	774.02		774.19	0.001495	3.33	220.25	44.51	0.26
phillips	20133	10 yr	3059.00	767.00	777.34		778.41	0.005485	8.31	368.32	44.79	0.51
phillips	20133	25 yr	3949.00	767.00	778.26		779.70	0.006691	9.64	409.47	44.86	0.56
phillips	20133	50 yr	4655.00	767.00	778.96		780.69	0.007481	10.55	441.10	44.92	0.59
phillips	20133	100 yr	5405.00	767.00	779.72		781.73	0.008123	11.37	475.28	44.98	0.62
phillips	20133	500 yr	7298.00	767.00	781.94		784.44	0.008565	12.68	575.49	45.17	0.63
phillips	20133	SEPT low flow	8.60	767.00	770.45		770.45	0.000005	0.11	74.92	33.93	0.01
phillips	20133	OCT low flow	14.60	767.00	770.62		770.63	0.000010	0.18	80.80	34.36	0.02
phillips	20131	1.1 yr	734.00	767.40	774.00		774.19	0.001766	3.47	211.75	49.13	0.29

HEC-RAS Plan: Plan 02 River: sandy Reach: phillips (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
phillips	20131	10 yr	3059.00	767.40	777.35		778.37	0.004847	8.09	384.52	54.18	0.52
phillips	20131	25 yr	3949.00	767.40	778.31		779.63	0.005536	9.25	437.44	56.27	0.56
phillips	20131	50 yr	4655.00	767.40	779.06		780.60	0.005886	10.00	479.75	56.93	0.58
phillips	20131	100 yr	5405.00	767.40	779.87		781.61	0.006072	10.65	526.32	57.65	0.59
phillips	20131	500 yr	7298.00	767.40	782.23		784.27	0.005680	11.55	664.46	59.48	0.58
phillips	20131	SEPT low flow	8.60	767.40	770.45		770.45	0.000008	0.14	63.39	34.56	0.02
phillips	20131	OCT low flow	14.60	767.40	770.62		770.63	0.000017	0.21	69.39	35.18	0.03
phillips	20100	1.1 yr	734.00	766.40	773.92		774.13	0.002154	3.71	197.80	42.82	0.30
phillips	20100	10 yr	3059.00	766.40	776.74		778.16	0.007840	9.56	320.38	43.57	0.62
phillips	20100	25 yr	3949.00	766.40	777.35		779.37	0.010052	11.40	346.76	43.65	0.71
phillips	20100	50 yr	4655.00	766.40	777.70		780.28	0.012076	12.87	362.34	43.70	0.78
phillips	20100	100 yr	5405.00	766.40	777.93	777.19	781.22	0.014901	14.55	372.17	43.73	0.88
phillips	20100	500 yr	7298.00	766.40	778.92	778.92	783.74	0.018844	17.60	415.73	43.86	1.00
phillips	20100	SEPT low flow	8.60	766.40	770.45		770.45	0.000006	0.12	69.39	31.10	0.01
phillips	20100	OCT low flow	14.60	766.40	770.62		770.62	0.000014	0.20	74.76	31.34	0.02
phillips	20057	1.1 yr	734.00	767.40	773.85		774.04	0.002090	3.50	209.81	54.65	0.31
phillips	20057	10 yr	3059.00	767.40	776.72		777.76	0.006517	8.23	378.27	63.05	0.57
phillips	20057	25 yr	3949.00	767.40	777.42		778.83	0.007857	9.55	423.20	64.92	0.63
phillips	20057	50 yr	4655.00	767.40	777.89		779.60	0.008850	10.54	454.41	66.07	0.67
phillips	20057	100 yr	5405.00	767.40	778.29		780.36	0.010052	11.61	480.88	66.97	0.72
phillips	20057	500 yr	7298.00	767.40	776.78	778.23	782.61	0.035992	19.42	382.42	63.25	1.34
phillips	20057	SEPT low flow	8.60	767.40	770.45		770.45	0.000014	0.18	48.95	27.76	0.02
phillips	20057	OCT low flow	14.60	767.40	770.62		770.62	0.000033	0.27	53.87	29.93	0.04
phillips	20020	1.1 yr	734.00	769.60	772.87	772.87	773.78	0.027709	7.64	96.12	54.61	1.01
phillips	20020	10 yr	3059.00	769.60	775.43	775.43	777.29	0.020120	10.97	284.33	80.11	0.99
phillips	20020	25 yr	3949.00	769.60	776.12	776.12	778.32	0.019095	11.95	340.47	82.73	0.99
phillips	20020	50 yr	4655.00	769.60	776.61	776.61	779.07	0.018634	12.65	381.86	85.05	1.00
phillips	20020	100 yr	5405.00	769.60	777.19	777.19	779.83	0.017372	13.13	431.87	89.50	0.98
phillips	20020	500 yr	7298.00	769.60	778.42	778.42	781.55	0.015907	14.37	548.27	99.07	0.97
phillips	20020	SEPT low flow	8.60	769.60	770.28	770.28	770.43	0.048600	3.14	2.74	9.12	1.01
phillips	20020	OCT low flow	14.60	769.60	770.43	770.43	770.60	0.046204	3.31	4.41	13.12	1.01
phillips	19980	1.1 yr	734.00	768.40	772.34	771.69	772.70	0.008003	4.78	154.10	74.81	0.58
phillips	19980	10 yr	3059.00	768.40	775.17	774.02	776.26	0.008002	8.44	371.87	79.35	0.67
phillips	19980	25 yr	3949.00	768.40	775.98	774.73	777.32	0.008003	9.34	436.51	80.65	0.69
phillips	19980	50 yr	4655.00	768.40	776.56	775.22	778.09	0.008002	9.96	484.30	81.60	0.70
phillips	19980	100 yr	5405.00	768.40	777.15	775.76	778.87	0.008001	10.57	532.63	83.21	0.71
phillips	19980	500 yr	7298.00	768.40	778.50	776.95	780.67	0.008008	11.91	648.67	90.45	0.73
phillips	19980	SEPT low flow	8.60	768.40	769.28	769.03	769.32	0.008005	1.68	5.13	11.69	0.45
phillips	19980	OCT low flow	14.60	768.40	769.47	769.18	769.53	0.008012	1.91	7.63	14.26	0.46

Phillips - Bridge Sections.

HEC-RAS Plan: Plan 02 River: sandy Reach: phillips

Reach	River Sta	Profile	E.G. Elev	W.S. Elev	Crit W.S.	Frctn Loss	C & E Loss	Top Width	Q Left	Q Channel	Q Right	Vel Chnl
			(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(cfs)	(ft/s)
phillips	20179	1.1 yr	775.73	775.49		0.01	0.02	46.31	0.16	733.84		3.93
phillips	20179	10 yr	780.11	778.94		0.04	0.05	62.66	68.19	2990.81		8.76
phillips	20179	25 yr	781.42	779.96		0.05	0.04	68.63	132.45	3816.55		9.85
phillips	20179	50 yr	782.42	780.79		0.06	0.02	73.44	205.25	4449.76		10.47
phillips	20179	100 yr	783.47	781.73		0.06	0.01	77.69	314.64	5090.36		10.89
phillips	20179	500 yr	786.24	784.54		0.05	0.06	78.95	748.87	6549.13		10.98
phillips	20179	SEPT low flow	772.07	772.07		0.00	0.00	36.44		8.60		0.19
phillips	20179	OCT low flow	772.23	772.23		0.00	0.00	36.66		14.60		0.28
phillips	20171	1.1 yr	775.69	775.53	772.26			44.52		734.00		3.22
phillips	20171	10 yr	780.01	779.02	775.69			44.84		3059.00		7.97
phillips	20171	25 yr	781.33	780.01	776.67			44.93		3949.00		9.22
phillips	20171	50 yr	782.35	780.78	777.39			45.00		4655.00		10.06
phillips	20171	100 yr	783.40	781.58	778.09			45.07		5405.00		10.83
phillips	20171	500 yr	786.13	783.83	779.83			45.27		7298.00		12.15
phillips	20171	SEPT low flow	772.07	772.07	769.27			39.51		8.60		0.11
phillips	20171	OCT low flow	772.23	772.23	769.44			39.78		14.60		0.17
phillips	20152 BR U	1.1 yr	775.69	775.53	772.27			44.52		734.00		3.22
phillips	20152 BR U	10 yr	780.00	779.01	775.68			44.84		3059.00		7.98
phillips	20152 BR U	25 yr	781.32	779.99	776.68			44.93		3949.00		9.24
phillips	20152 BR U	50 yr	782.34	780.76	777.40			45.00		4655.00		10.08
phillips	20152 BR U	100 yr	783.39	781.56	778.13			45.07		5405.00		10.85
phillips	20152 BR U	500 yr	786.11	783.81	779.85			45.27		7298.00		12.17
phillips	20152 BR U	SEPT low flow	772.07	772.07	769.27			39.51		8.60		0.11
phillips	20152 BR U	OCT low flow	772.23	772.23	769.44			39.78		14.60		0.17
				1.5-1.6' drop								
phillips	20152 BR D	1.1 yr	774.21	774.04	770.70			44.51		734.00		3.32
phillips	20152 BR D	10 yr	778.47	777.42	774.36			44.79		3059.00		8.23
phillips	20152 BR D	25 yr	779.77	778.36	775.34			44.87		3949.00		9.54
phillips	20152 BR D	50 yr	780.77	779.09	776.05			44.93		4655.00		10.42
phillips	20152 BR D	100 yr	781.82	779.86	776.80			45.00		5405.00		11.22
phillips	20152 BR D	500 yr	784.53	782.09	778.51			45.18		7298.00		12.53
phillips	20152 BR D	SEPT low flow	770.45	770.45	767.64			33.93		8.60		0.11
phillips	20152 BR D	OCT low flow	770.63	770.62	767.79			34.36		14.60		0.18
phillips	20133	1.1 yr	774.19	774.02		0.01	0.00	44.51		734.00		3.33
phillips	20133	10 yr	778.41	777.34		0.03	0.02	44.79		3059.00		8.31
phillips	20133	25 yr	779.70	778.26		0.03	0.04	44.86		3949.00		9.64
phillips	20133	50 yr	780.69	778.96		0.03	0.06	44.92		4655.00		10.55
phillips	20133	100 yr	781.73	779.72		0.04	0.08	44.98		5405.00		11.37
phillips	20133	500 yr	784.44	781.94		0.04	0.14	45.17		7298.00		12.68
phillips	20133	SEPT low flow	770.45	770.45		0.00	0.00	33.93		8.60		0.11
phillips	20133	OCT low flow	770.63	770.62		0.00	0.00	34.36		14.60		0.18
phillips	20131	1.1 yr	774.19	774.00		0.05	0.00	49.13		734.00	0.00	3.47
phillips	20131	10 yr	778.37	777.35		0.16	0.04	54.18		3047.24	11.76	8.09
phillips	20131	25 yr	779.63	778.31		0.20	0.07	56.27		3924.62	24.39	9.25
phillips	20131	50 yr	780.60	779.06		0.22	0.10	56.93		4614.75	40.25	10.00
phillips	20131	100 yr	781.61	779.87		0.24	0.15	57.65		5344.05	60.95	10.65
phillips	20131	500 yr	784.27	782.23		0.26	0.28	59.48		7163.38	134.62	11.55
phillips	20131	SEPT low flow	770.45	770.45		0.00	0.00	34.56		8.60		0.14
phillips	20131	OCT low flow	770.63	770.62		0.00	0.00	35.18		14.60		0.21

Project Name:	Phillips - Wing Bridge	**PIN:**	22616
Stream Name:	Sandy River	**Town:**	Phillips
Bridge Name:	Wing Bridge	**Bridge No.**	2955
Route No.	ME 4	**USGS Quad:**	
Analysis by:	CSH	**Date:**	3/19/2014

Peak Flow Calculations by USGS Regression Equations (Hodgkins, 1999)

Enter data in blue cells only!

	km^2	mi^2	ac	*Enter data in [mi^2]*
A	94.28	36.40	23296.0	Watershed Area
W	2.54	0.98	627.6	Wetlands area (by NWI)
P_c	379385	4968913		watershed centroid (E, N; UTM 19N; meters)
County	Franklin			*choose county from drop-down menu*
pptA	45.6			mean annual precipitation (inches; by look-up)
SG	0.00			sand & gravel aquifer as decimal fraction of watershed A
A (km^2)	94.28			
W (%)	2.69			

Conf Lvl 0.67

Worksheet prepared by:
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Environmental Office
Maine Dept. Transportation
Augusta, ME 04333-0016
207-557-1052
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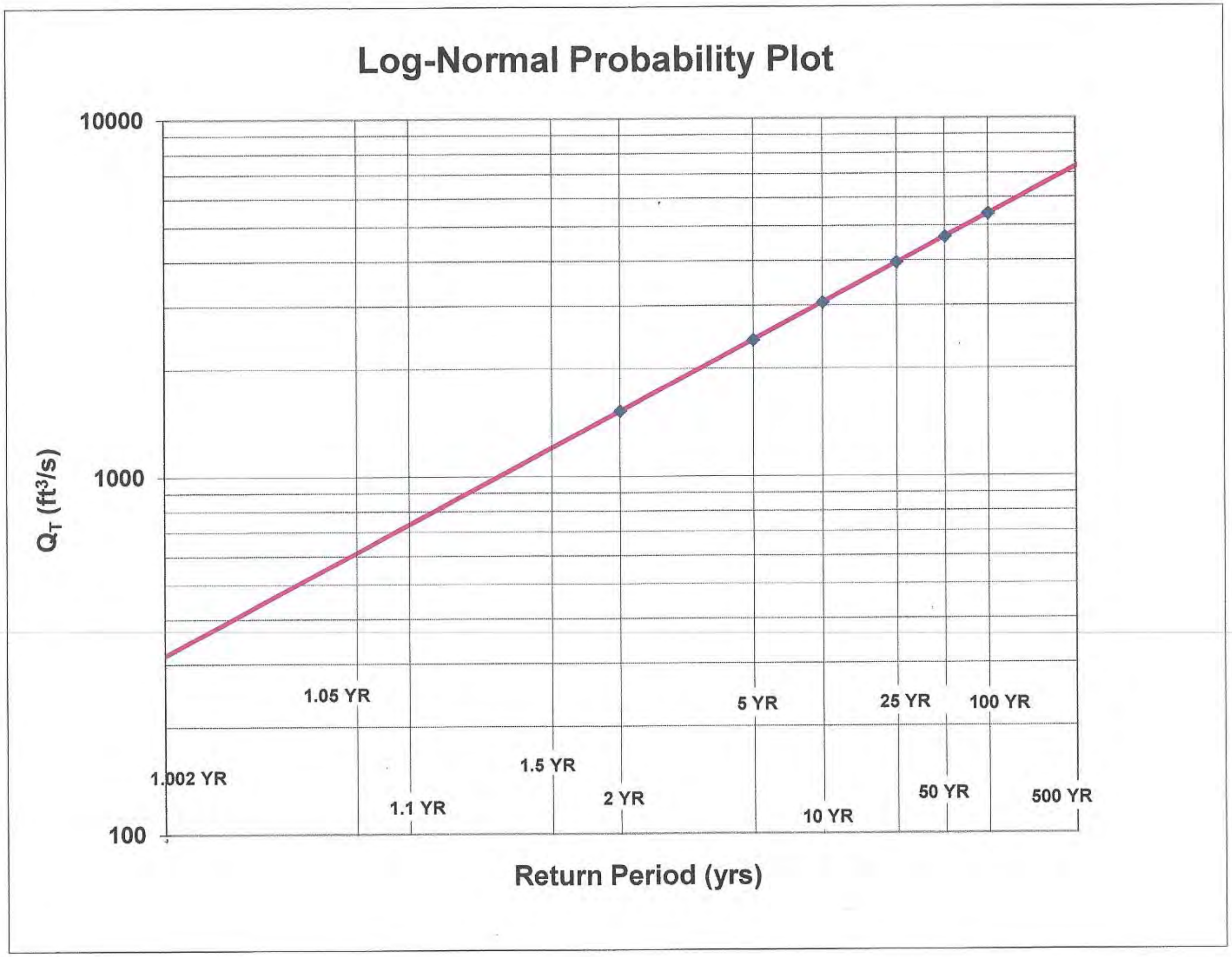
Ret Pd T (yr)	Peak Flow Estimate Lower	Q_T (m^3/s)	Upper	Q_T (ft^3/s)
1.1		20.80		734.3
2	30.73	43.06	60.34	1520.3
5	48.22	67.90	95.62	2397.7
10	60.98	86.64	123.09	3059.1
25	77.61	111.84	161.16	3949.0
50	90.42	131.84	192.24	4655.4
100	103.70	153.06	225.91	5404.6
500	135.59	206.67	315.02	7297.6

Reference:

Hodgkins, G., 1999.
Estimating the magnitude of peak flows for streams in Maine for selected recurrence intervals
Water-Resources Investigations Report 99-4008
US Geological Survey, Augusta, Maine

$Q_T = b \times A^a \times 10^{-wW}$


Log-Normal Probability Plot
10000
1000
100
Q_T (ft³/s)
1.002 YR
1.05 YR
1.1 YR
1.5 YR
2 YR
5 YR
10 YR
25 YR
50 YR
100 YR
500 YR
Return Period (yrs)

Project Name:	Phillips - Wing Bridge	**PIN:**	22616
Stream Name:	Sandy River	**Town:**	Phillips
Bridge Name:	Wing Bridge	**Bridge No.**	2955
Route No.	ME 4	**USGS Quad:**	
Analysis by:	CSH	**Date:**	3/19/2014

DO NOT ENTER ANY DATA ON THIS PAGE; EVERYTHING IS CALCULATED

MAINE MONTHLY MEDIAN FLOWS BY USGS REGRESSION EQUATIONS (2004)

	Value	Variable	Explanation
	36.400	*A*	Area (mi^2)
379385	4968913	P_c	Watershed centroid (E,N; UTM; Zone 19; meters)
	111.73	*DIST*	Distance from Coastal reference line (mi)
	45.6	*pptA*	Mean Annual Precipitation (inches)
	0.00	*SG*	Sand & Gravel Aquifer (decimal fraction of watershed area)

Worksheet prepared by:
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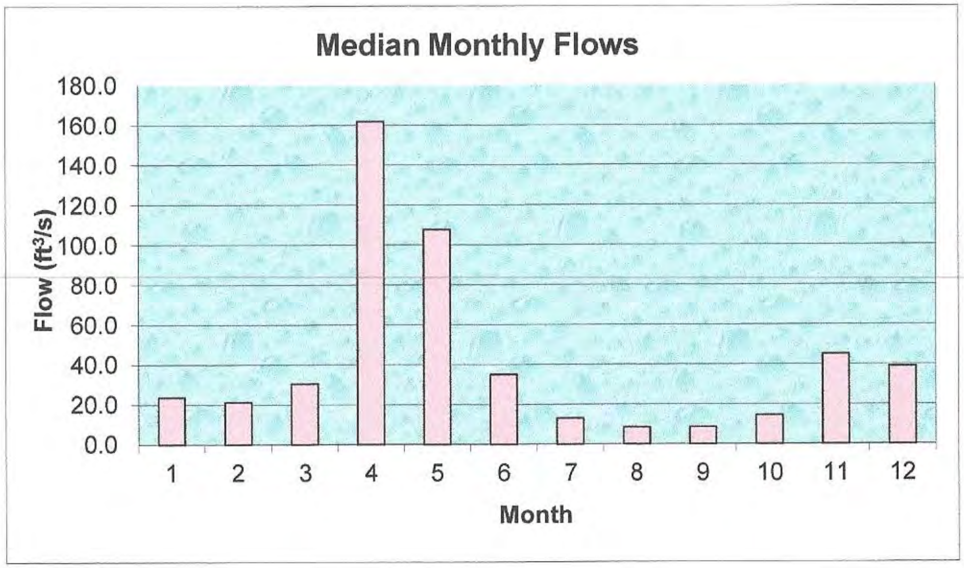
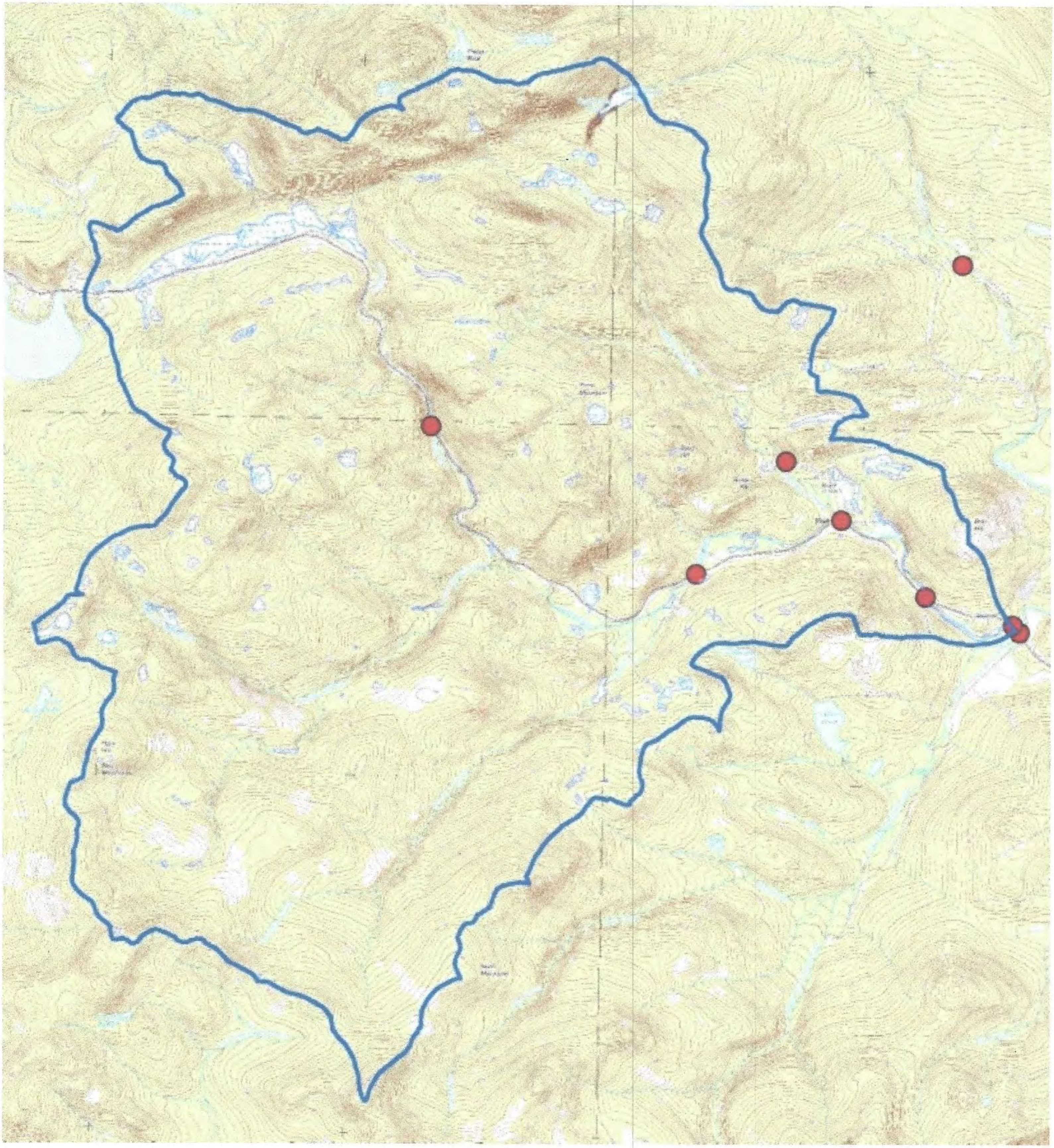
Chief Hydrologist
Maine Dept. Transportation
Augusta, ME 04333-0016
207-624-3073
Charles.Hebson@maine.gov

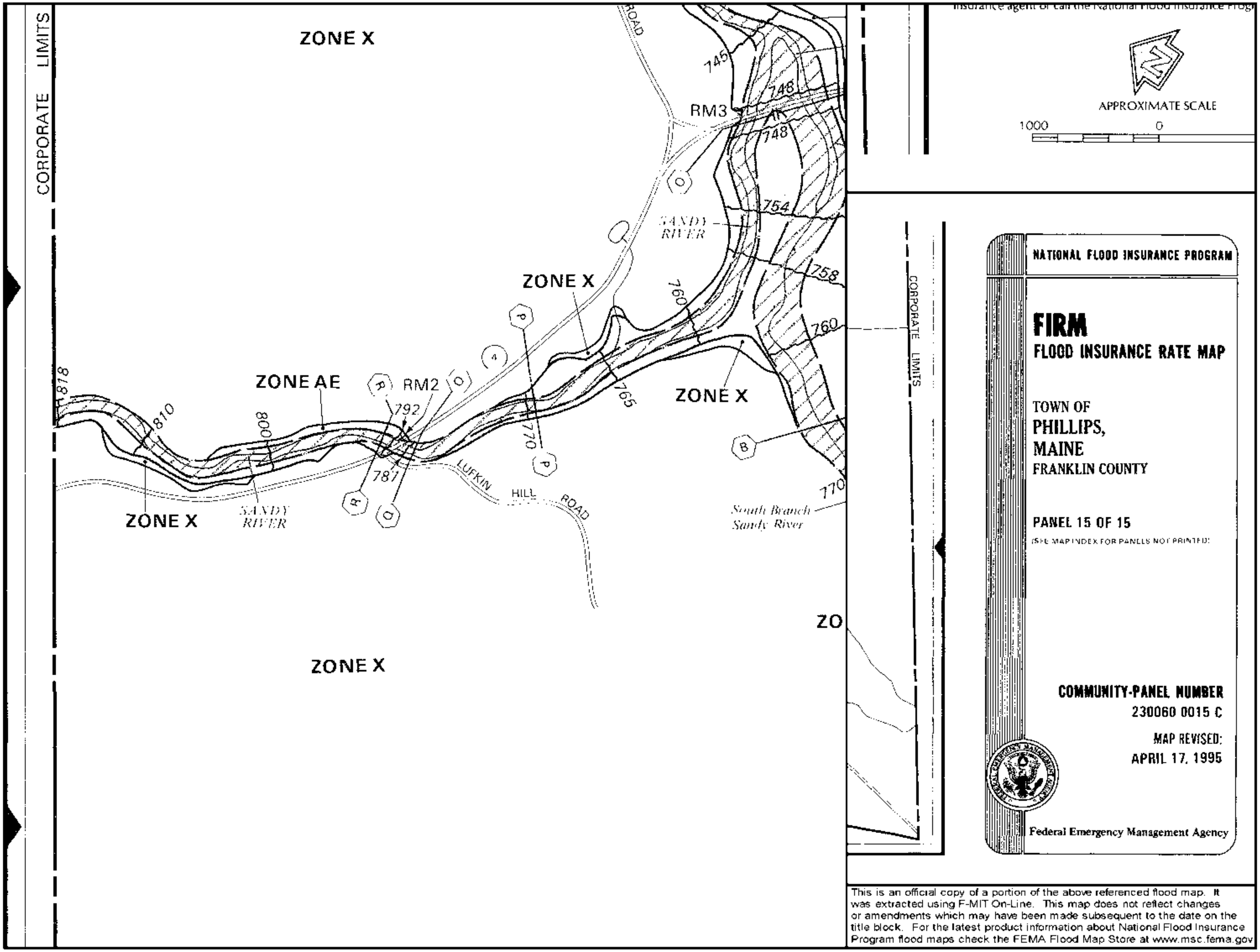
Month	Q_{median} (ft3/s)	(m^3/s)
Jan	23.59	0.6686
Feb	21.26	0.6024
Mar	30.52	0.8650
Apr	162.01	4.5911
May	107.87	3.0568
Jun	35.11	0.9950
Jul	13.06	0.3701
Aug	8.52	0.2414
Sep	8.59	0.2435
Oct	14.58	0.4132
Nov	45.12	1.2788
Dec	38.87	1.1014

Q_{bf}	226.1
ann avg	74.2
ann med	39.7
$Q_{1.002}$	316.4
$Q_{1.01}$	426.7
$Q_{1.05}$	612.0

W_{bf}	49.4	
d_{bf}	3.9	
Q_{bf}	760.9	assume v = 4ft/s



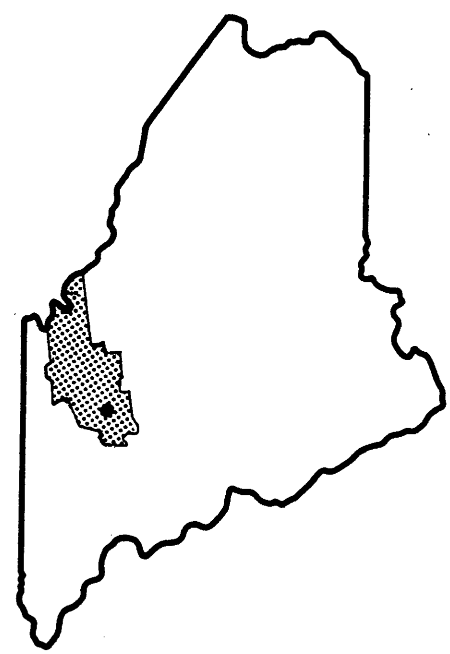



CORPORATE LIMITS
ZONE X
ZONE X
ZONE AE
ZONE X
ZONE X
ZONE X
ZO
RM3
RM2
SANDY RIVER
SANDY RIVER
South Branch Sandy River
LUFKIN HILL ROAD
ROAD
745
748
748
754
758
760
760
765
770
770
787
792
808
810
818
APPROXIMATE SCALE
1000
0
CORPORATE LIMITS
NATIONAL FLOOD INSURANCE PROGRAM
FIRM
FLOOD INSURANCE RATE MAP
TOWN OF
PHILLIPS,
MAINE
FRANKLIN COUNTY
PANEL 15 OF 15
(SEE MAP INDEX FOR PANELS NOT PRINTED)
COMMUNITY-PANEL NUMBER
230060 0015 C
MAP REVISED:
APRIL 17, 1995
Federal Emergency Management Agency
This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

FLOOD INSURANCE STUDY

TOWN OF PHILLIPS, MAINE

FRANKLIN COUNTY



REVISED:

APRIL 17, 1995

Federal Emergency Management Agency

COMMUNITY NUMBER - 230060

to 1,148 in 1990 giving it a population density of 22 persons per square mile in 1990 (References 1 and 2).

Approximately 90 percent of the land area of the town is forested, 5 percent is agricultural or open, and 5 percent is urban. Within the floodplains studied, development consists of single family residences, farms, recreational properties, parks, roads, bridges, and utilities. Development in the town is heaviest in and around the village center of Phillips.

The Sandy River, which flows southeasterly through Phillips, is one of the principal tributaries of the Kennebec River. The Sandy River has a length of 66 miles and a drainage area of 596 square miles at its confluence with the Kennebec River in Norridgewock.

Orbeton Stream, a tributary flowing southerly to the Sandy River, has a length of 12 miles and a drainage area of 59.1 square miles at its confluence with the Sandy River in Phillips.

South Branch Sandy River, a tributary flowing northeasterly to the Sandy River, has a length of 4 miles and a drainage area of 21.1 square miles at its confluence with the Sandy River in Phillips.

Toothaker Pond is located in north-central Phillips and has a surface area of 30 acres and a drainage area of 0.1 square miles at its outlet in Phillips.

The area around the town receives a mean annual precipitation of 45.6 inches, which includes the water equivalent of 100 inches of snow. The precipitation is rather evenly distributed throughout the year; however, snowmelt accounts for a large part of the runoff. The mean annual temperature of the town is approximately 41.0 degrees Fahrenheit (°F), ranging from means of 13.2°F in January to 66.2°F in July (Reference 3).

2.3 Principal Flood Problems

Flooding problems in Phillips occur primarily along the Sandy River, Orbeton Stream, and South Branch Sandy River. Flooding generally occurs in the winter and early spring months as a result of heavy rainfall on snow-covered or frozen ground. Ice jams occasionally compound flood problems.

In April 1987, the Sandy River watershed experienced an unprecedented flood which devastated many homes, businesses, roads, bridges, and utilities. Although no lives were lost, there were many instances where local citizens were in extreme danger due either to excessively deep water or swift currents. This flood has an estimated recurrence interval of 150 years for the Sandy River in Phillips.

The second largest flood occurred in March 1936 and had a frequency estimated at 100 years. This flood resulted in a peak discharge of

38,600 cubic feet per second (cfs) at a USGS stream gage (No. 01048000) near Mercer, Maine, approximately 40 miles downstream from Phillips. The next highest discharge of 36,900 cfs was recorded in March 1953 and is assigned a frequency of 95 years. Stream gage records date back to October 1928. Other notable floods have occurred during the following years: 1950, 1951, 1954, 1959, 1960, 1963, 1964, 1966, 1969, 1970, 1973, 1978, 1979, 1983, and 1984. Journals show that other floods also occurred in 1785, 1820, 1855, and 1869.

The major flood damages along the Sandy River are to homes, farms, parks, utilities, roads, and bridges. The Park Street area occasionally floods, causing damage to homes and rendering the road impassable. Flooding caused by the Sandy River also causes serious erosion of rich interval farmlands.

2.4 Flood Protection Measures

There are no known existing or planned flood protection structures within the Town of Phillips.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude which are expected to be equaled or exceeded once on the average during any 10, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1, and 0.2 percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (1 percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for each flooding source studied in detail affecting the community.

Flood discharges on the Sandy River, Orbeton Stream, South Branch Sandy River, and Toothaker Pond were generated from the SCS TR-20 hydrologic evaluation model (Reference 4). The Sandy River watershed model was calibrated to a log-Pearson Type III analysis of a USGS stream gage (No. 01048000) near Mercer with 54 years of record (References 5 and 6).

A summary of the drainage area-peak discharge relationships for the streams studied by detailed methods is shown in Table 1, "Summary of Discharges."

TABLE 1 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs)			
		10-YEAR	50-YEAR	100-YEAR	500-YEAR
SANDY RIVER					
At State Route 149	139.9	12,700	24,800	31,100	46,300
At State Route 142	135.5	12,900	25,300	31,700	47,100
At State Route 4 (upper crossing)	36.1	5,300	10,000	12,300	17,800
ORBETON STREAM					
At Toothaker Pond Road	57.4	5,250	10,800	14,100	21,450
SOUTH BRANCH SANDY RIVER					
At State Route 4	21.1	2,850	5,240	6,230	9,380
At Boise Cascade Road	16.8	2,530	4,650	5,630	8,260
TOOTHAKER POND					
At outlet	0.1	2	6	6	8

The stillwater elevations for the 10-, 50-, 100-, 500-year floods have been determined for Toothaker Pond and are summarized in Table 2, "Summary of Stillwater Elevations."

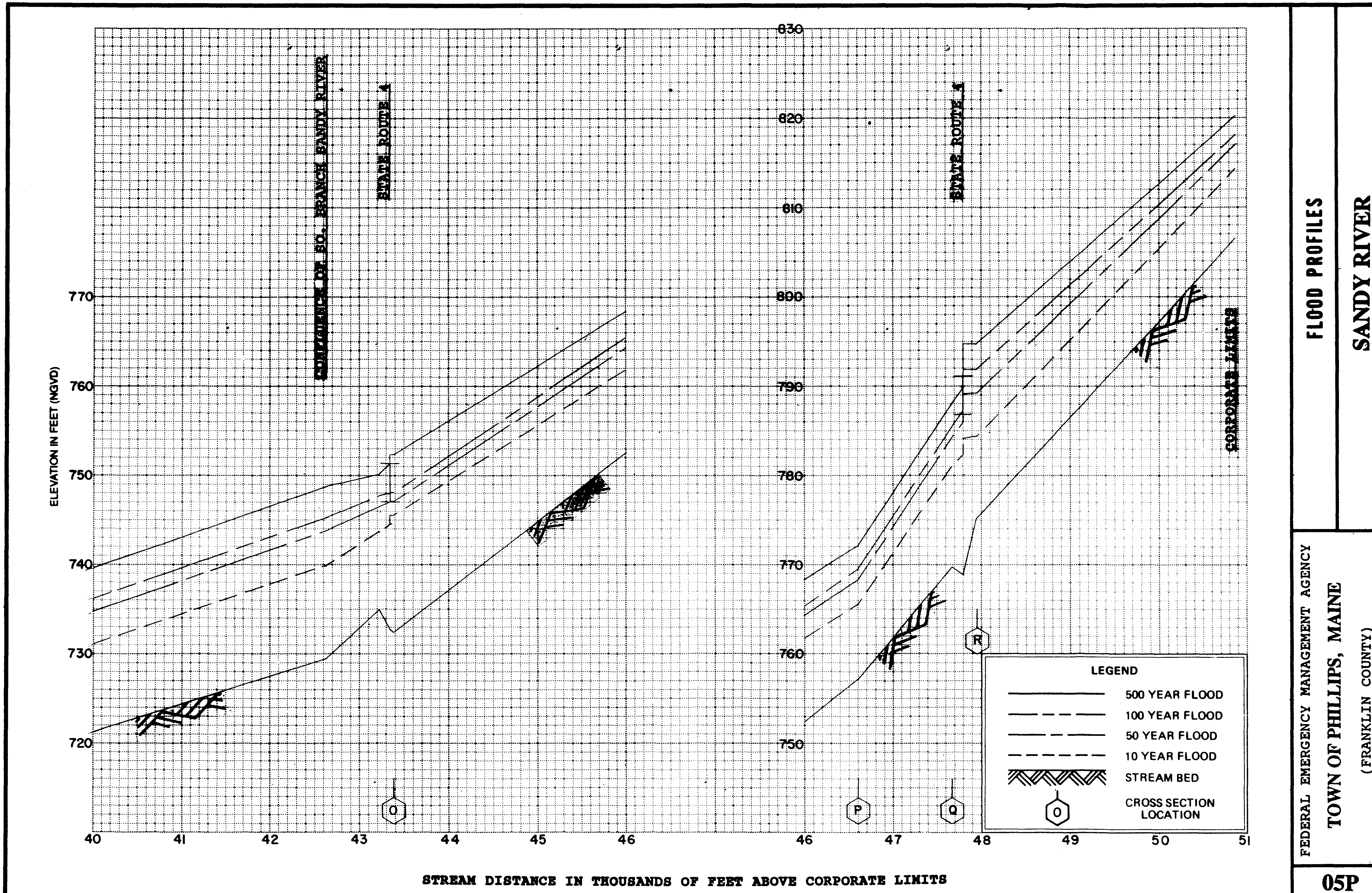
TABLE 2 - SUMMARY OF STILLWATER ELEVATIONS

FLOODING SOURCE AND LOCATION	ELEVATION (feet*)			
	10-YEAR	50-YEAR	100-YEAR	500-YEAR
TOOTHAKER POND				
Entire shoreline within community	794.9	795.0	795.1	795.2

* National Geodetic Vertical Datum of 1929 (NGVD)

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals.


ELEVATION IN FEET (NGVD)
CONFLUENCE OF SO. BRANCH SANDY RIVER
STATE ROUTE 4
STATE ROUTE 4
CORPORATE LIMITS
LEGEND
500 YEAR FLOOD
100 YEAR FLOOD
50 YEAR FLOOD
10 YEAR FLOOD
STREAM BED
CROSS SECTION LOCATION
STREAM DISTANCE IN THOUSANDS OF FEET ABOVE CORPORATE LIMITS
FLOOD PROFILES
SANDY RIVER
FEDERAL EMERGENCY MANAGEMENT AGENCY
TOWN OF PHILLIPS, MAINE
(FRANKLIN COUNTY)
05P

K = Ms Kb Kd Js

Abutment	Boring	Rock depth	rock elev	ground	RQD %		Kb, if Jn=2	Ms	Js	Kd	K	Critical Stream Power Pc= K^.75
							top layer					Pc
							2					
East	101	22.5-23.9	768.5-767.1	791	29%	0.3	0.145	8.4	1	3	3.7	2.6
					67%	0.67	0.335	17.7	1	3	17.8	8.7
	103	17		791	53%	0.53	0.265	8.4	1	3	6.7	4.2
					72%	0.72	0.36	17.7	1	3	19.1	9.1
West	102	16.4-18.8	773.6-771.2	790	85%	0.85	0.425	8.4	1	3	10.7	5.9
					70%	0.7	0.35	17.7	1	3	18.6	9.0
	104			760	77%	0.7	0.385	8.4	1	3	9.7	5.5
					80%	0.8	0.4	17.7	1	3	21.2	9.9

Critical Stream Power : Power of Approach Flow

Pa = 7.853 p(t/p)1.5

only applies to piers

HEC-18 page 7.42. Erodibility Index Method for Rock Scour

Step 1. Calculate Erodibility Index K.

K = Ms Kb Kd Js

Step 2 Calculate critical stream power, Pc.

Abutment	Boring	Rock depth	rock elev	ground	RQD %	RQD	Kb, if Jn=2	Ms	Js	Kd	Erodibility Index K	Critical Stream Power Pc= K^.75
						decimal	top layer					Pc
							2					KW/m^2
East	101	22.5-23.9	768.5-767.1	791	29%	0.3	0.145	8.4	1	3	3.7	2.6
					67%	0.67	0.335	17.7	1	3	17.8	8.7
	103	17		791	53%	0.53	0.265	8.4	1	3	6.7	4.2
					72%	0.72	0.36	17.7	1	3	19.1	9.1
West	102	16.4-18.8	773.6-771.2	790	85%	0.85	0.425	8.4	1	3	10.7	5.9
					70%	0.7	0.35	17.7	1	3	18.6	9.0
	104			760	77%	0.7	0.385	8.4	1	3	9.7	5.5
					80%	0.8	0.4	17.7	1	3	21.2	9.9
												6.9 Average

Compare Critical Stream Power : Power of Approach Flow

Pa = 7.853 p(t/p)1.5

only applies to piers

Trial for abutments, using footing width of 3'.

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Step 3- calculate the approach shear stress t in SI units, using the local approach depth upstream of the abutment (pier).

t= v y Sf= 9800 (y/3.28) (sf)) — S @ section 20203 per profile - 500-year

approach depth y, 500 year = 10' — 10

t 113.2378049 N/m^2 — 0.00379

Step 4- Calculate the approach stream power in W/m^2 and convert to KW/m^2

Pa = 7.853 p (t/p)^3/2

Pa = 7.853 (1000) (t/1000)^1.5

Pa 299.2421458 W/m2

Pa = 0.299242146 KW/m^2

Step 5

Calculate local stream power at the pier (abutment) as a function of pier (abutment) width and scour hole depth to find the maximum depth of scour at the pier using a critical stream power of 2.6 to 9.9.

P/Pa = 8.42 e ^(-.712(ys/b))

	feet	m
b=	3	0.914634146

ys/b	-.712*ys/b	e^(-.712(ys/	P/Pa	P	P>Pc?	P/Pc?	ys
assumed				P=(P/Pa)*Pa	Pc =2.5	Pc= 9.9	m
0.1	-0.0712	0.9312825	7.8413986	2.346476942	no	no	
0.5	-0.356	0.7004985	5.8981972	1.764989178	no	no	
1	-0.712	0.4906981	4.1316781	1.23637223	no	no	
1.5	-1.068	0.3437333	2.8942342	0.866076863	no	no	
2	-1.424	0.2407846	2.0274067	0.606685523	no	no	