THIS PLAN WAS PREPARED BY:
JENNIFER BIRD
KCI TECHNOLOGIES
MDNR QUALIFIED PROFESSIONAL STATUS
(SEPTEMBER 2011)

SIGNATURE

FEBRUARY 2018
DATE

HORIZONTAL DATUM NAD 83/91
VERTICAL DATUM NAVD 88

WWW.JMT.COM 410-329-3100

KCI TECHNOLOGIES
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PLANNERS
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P.E. STAMP HERE

Maryland Transportation Authority
Engineering Division

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE

JOHN F. KENNEDY MEMORIAL HIGHWAY
I-95 ETL NORTHBOUND EXTENSION
CARSINS RUN STREAM MITIGATION PLANS
APPENDIX A: NATURAL RESOURCES INVENTORY - FOREST STAND DELINEATION MAP

DESIGNED BY ____ DRAWN BY ____ CHECKED BY ____
CONST. REVIEW BY ____ DATE FEBRUARY 2018 SCALE 1" = 20'

CONTRACT NO. AE 2796-000-001/6
DRAWING NO. NRI-01
SHEET NO. 2 OF 5

FILE: M:\2014\22145228.36\Drawings\pNRI-P001_Carsins_NRI.dgn DATE: Friday, February 23, 2018 AT 02:55 PM

LEGEND

····· 430 ·····	EX. CONTOUR
—×—×—	EX. FENCE
	EX. WOODS LINE
	EX. TREE
SS SD	EX. MANHOLE
	EX. UTILITY POLE
	PROPERTY LINE
	STUDY AREA BOUNDARY
— WUS —	WATERS OF THE U.S.
— WUSE —	WATERS OF THE U.S. EPHEMERAL
• • • • •	EX. NON-TIDAL WETLAND
— B —	25' WETLAND BUFFER
— SB —	75' STREAM BUFFER
	SLOPES 15-25%
	SLOPES 25% OR GREATER
GhB / GuB	SOILS LINE
x UPL-1	WETLAND/UPLAND SAMPLE PLOT
x A-2	FOREST STAND SAMPLE PLOT
CRZ SP-1	SPECIMEN TREE
	EX. FEMA 100 YEAR FLOODPLAIN

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DATE

SCALE: 1" = 20'

HORIZONTAL DATUM NAD 83/91
VERTICAL DATUM NAVD 88

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ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE

JOHN F. KENNEDY MEMORIAL HIGHWAY
I-95 ETL NORTHBOUND EXTENSION
CARSINS RUN STREAM MITIGATION PLANS
APPENDIX A: NATURAL RESOURCES INVENTORY - FOREST STAND DELINEATION MAP

DESIGNED BY	DRAWN BY	CHECKED BY
CONST. REVIEW BY	DATE FEBRUARY 2018	SCALE 1" = 20'

CONTRACT NO. AE 2796-000-001/6
DRAWING NO. NRI-02
SHEET NO. 3 OF 5

FILE: M:\2014\22145228.36\Drawings\pNRI-P002_Carsins_NRI.dgn
DATE: Friday, February 23, 2018 AT 02:56 PM

LEGEND

430	EX. CONTOUR
	EX. FENCE
	EX. WOODS LINE
	EX. TREE
SS SD	EX. MANHOLE
	EX. UTILITY POLE
	PROPERTY LINE
	STUDY AREA BOUNDARY
WUS	WATERS OF THE U.S.
WUSE	WATERS OF THE U.S. EPHEMERAL
	EX. NON-TIDAL WETLAND
B	25' WETLAND BUFFER
SB	75' STREAM BUFFER
	SLOPES 15-25%
	SLOPES 25% OR GREATER
GhB / GuB	SOILS LINE
x UPL-1	WETLAND/UPLAND SAMPLE PLOT
x A-2	FOREST STAND SAMPLE PLOT
CRZ SP-1	SPECIMEN TREE
	EX. FEMA 100 YEAR FLOODPLAIN

20' 0 20' 40'

SCALE: 1" = 20'

THIS PLAN WAS PREPARED BY:
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SIGNATURE

FEBRUARY 2018

DATE

HORIZONTAL DATUM NAD 83/91

VERTICAL DATUM NAVD 88

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ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE

JOHN F. KENNEDY MEMORIAL HIGHWAY
I-95 ETL NORTHBOUND EXTENSION
CARSINS RUN STREAM MITIGATION PLANS
APPENDIX A: NATURAL RESOURCES INVENTORY
- FOREST STAND DELINEATION MAP

DESIGNED BY ____	DRAWN BY ____	CHECKED BY ____
CONST. REVIEW BY ____	DATE FEBRUARY 2018	SCALE 1" = 20'

CONTRACT NO. AE 2796-000-001/6

DRAWING NO. **NRI-03**

SHEET NO. 4 OF 5

FILE: M:\2014\22145228.36\Drawings\pNRI-P003_Carsins_NRI.dgn

DATE: Friday, February 23, 2018 AT 02:57 PM

HORIZONTAL DATUM NAD 83/91

VERTICAL DATUM NAVD 88

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Maryland Transportation Authority
Engineering Division

ADDENDUMS & REVISIONS			
NO.	DESCRIPTION	BY	DATE

JOHN F. KENNEDY MEMORIAL HIGHWAY
I-95 ETL NORTHBOUND EXTENSION
CARSINS RUN STREAM MITIGATION PLANS
APPENDIX A: NATURAL RESOURCES INVENTORY - FOREST STAND DELINEATION MAP

DESIGNED BY ______	DRAWN BY ______	CHECKED BY ______
CONST. REVIEW BY ______	DATE FEBRUARY 2018	SCALE 1" = 20'

CONTRACT NO. AE 2796-000-001/6

DRAWING NO. **NRI-04**

SHEET NO. 5 OF 5

FILE: M:\2014\22145228.36\Drawings\pNRI-P004_Carsins_NRI.dgn

DATE: Friday, February 23, 2018 AT 02:58 PM

APPENDIX B

Data Point Forms: Wetland Determination and Stream Features

Stream Features
Field Sheet

Date: 2/5/18 **Project Site:** Carsins Run Stream Restoration **Stream #** WL001
Observers: KM, AW

Stream Flow: X Perennial ___ Intermittent ___ Ephemeral
Gradient: 2%

Morphology:

Average Bankful Width 12' Average Bankfull Depth 1' Average Water Depth: 6"

Has stream morphometry been altered? Describe type and degree: The channel is culverted under I-95, and is concrete lined directly upstream of the I-95 culvert.

Habitat and Pollutants:

Substrate:

___ Bedrock X Gravel/Sand X Silt

X Sand X Cobble/Gravel ___ Clay

Habitat Complexity:

X Riffle/Pools ___ Undercut banks

X Tree Roots X Woody Debris

Bank Erosion: ___ Severe X Moderate ___ Minor

Describe: Some banks are sheer with close to a 90 degree drop in some areas

Silt Deposition: ___ Severe ___ Moderate X Minor

Riparian Zone:

Right Bank: X Forested ___ Vegetated ___ Developed ___ Maintained

Notes: Adjacent to upland riparian forest.

Slope: 2%

Left Bank. X Forested ___ Vegetated ___ Developed ___ Maintained

Notes: Adjacent to upland riparian forest.

Slope: 5%

Cowardin (1979) Stream Classification: R2UB1/2

Stream Features
Field Sheet

Date: 2/5/18 **Project Site:** Carsins Run Stream Restoration **Stream #** WL002
Observers: AW, KM

Stream Flow: ____ Perennial ____ Intermittent __X__ Ephemeral
Gradient: __1%__

Morphology:

Average Bankful Width __4'__ Average Bankfull Depth __4"__ Average Water Depth: __1"__

Has stream morphometry been altered? Describe type and degree: A stormwater outfall outlets into the channel.

Habitat and Pollutants:

Substrate:

____ Bedrock __X__ Gravel/Sand __X__ Silt

__X__ Sand ____ Cobble/Gravel ____ Clay

Habitat Complexity:

__X__ Riffle/Pools ____ Undercut banks

__X__ Tree Roots ____ Woody Debris

Bank Erosion: ____ Severe ____ Moderate __X__ Minor

Describe: A low gradient channel, with minimal erosion, that is fed by an upstream outfall.

Silt Deposition: ____ Severe ____ Moderate __X__ Minor

Riparian Zone:

Right Bank: __X__ Forested ____ Vegetated ____ Developed ____ Maintained

Notes: Adjacent to upland riparian forest.

Slope: __2%__

Left Bank. __X__ Forested ____ Vegetated ____ Developed ____ Maintained

Notes: Adjacent to upland riparian forest.

Slope: __2%__

Cowardin (1979) Stream Classification: N/A

Stream Features
Field Sheet

Date: 2/5/18 **Project Site:** Carsins Run Stream Restoration **Stream #** WL003
Observers: AW, KM

Stream Flow: ____ Perennial __X__ Intermittent ____ Ephemeral
Gradient: __4%__

Morphology:

Average Bankful Width __2'__ Average Bankfull Depth __1'__ Average Water Depth: __2"__

Has stream morphometry been altered? Describe type and degree: Not within project area. WUS WL003 originates at Wetland WL007.

Habitat and Pollutants:

Substrate:

____ Bedrock __X__ Gravel/Sand __X__ Silt

__X__ Sand __X__ Cobble/Gravel ____ Clay

Habitat Complexity:

__X__ Riffle/Pools ____ Undercut banks

____ Tree Roots __X__ Woody Debris

Bank Erosion: ____ Severe __X__ Moderate ____ Minor

Describe: Some sheer banks and areas of incision.

Silt Deposition: ____ Severe ____ Moderate __X__ Minor

Riparian Zone:

Right Bank: __X__ Forested ____ Vegetated ____ Developed ____ Maintained

Notes: Adjacent to upland riparian forest.

Slope: __3%__

Left Bank. __X__ Forested ____ Vegetated ____ Developed ____ Maintained

Notes: Adjacent to upland riparian forest.

Slope: __3%__

Cowardin (1979) Stream Classification: R4SB3/4

Stream Features
Field Sheet

Date: 2/5/18 **Project Site:** Carsins Run Stream Restoration **Stream #** WL004
Observers: AW, KM

Stream Flow: ____ Perennial ____ Intermittent __X__ Ephemeral
Gradient: __1%__

Morphology:

Average Bankful Width __1.5'__ Average Bankfull Depth __4"__ Average Water Depth: __<0.5"__

Has stream morphometry been altered? Describe type and degree: Not within project area. The channel originates as overflow from WUS WL003, and outlets into WUS WL001.

Habitat and Pollutants:

Substrate:

____ Bedrock __X__ Gravel/Sand __X__ Silt

__X__ Sand ____ Cobble/Gravel ____ Clay

Habitat Complexity:

__X__ Riffle/Pools ____ Undercut banks

____ Tree Roots __X__ Woody Debris

Bank Erosion: ____ Severe ____ Moderate __X__ Minor

Describe: This is a low gradient overflow channel from WUS WL003.

Silt Deposition: ____ Severe ____ Moderate __X__ Minor

Riparian Zone:

Right Bank: __X__ Forested ____ Vegetated ____ Developed ____ Maintained

Notes: Adjacent to upland riparian forest.

Slope: __2%__

Left Bank. __X__ Forested ____ Vegetated ____ Developed ____ Maintained

Notes: Adjacent to upland riparian forest and WUS WL003.

Slope: __1%__

Cowardin (1979) Stream Classification: N/A

Stream Features
Field Sheet

Date: 2/5/18 **Project Site:** Carsins Run Stream Restoration **Stream #** WL005
Observers: AW, KM

Stream Flow: ____ Perennial __X__ Intermittent ____ Ephemeral
Gradient: 2%

Morphology:

Average Bankful Width 15' Average Bankfull Depth 10" Average Water Depth: 8"

Has stream morphometry been altered? Describe type and degree: Not within the project area.
The originates at its confluence with WUS WL001 and flows outside of the project area.

Habitat and Pollutants:

Substrate:

____ Bedrock __X__ Gravel/Sand ____ Silt

__X__ Sand __X__ Cobble/Gravel ____ Clay

Habitat Complexity:

__X__ Riffle/Pools __X__ Undercut banks

__X__ Tree Roots __X__ Woody Debris

Bank Erosion: ____ Severe __X__ Moderate ____ Minor

Describe: Some banks are undercut and beginning to erode.

Silt Deposition: ____ Severe ____ Moderate __X__ Minor

Riparian Zone:

Right Bank: __X__ Forested ____ Vegetated ____ Developed ____ Maintained

Notes: Adjacent to upland riparian forest

Slope: 3%

Left Bank. __X__ Forested ____ Vegetated ____ Developed ____ Maintained

Notes: Adjacent to upland riparian forest

Slope: 1%

Cowardin (1979) Stream Classification: R4SB3/4

Stream Features
Field Sheet

Date: 2/5/18 **Project Site:** Carsins Run **Stream #** WL006
Observers: AW, KM

Stream Flow: ____ Perennial ____ Intermittent X Ephemeral
Gradient: 1%

Morphology:

Average Bankful Width 2' Average Bankfull Depth 4" Average Water Depth: <1"

Has stream morphometry been altered? Describe type and degree: Not within the project area.
WUS WL006 originates at Wetland WL008, and outlets into WUS WL005.

Habitat and Pollutants:

Substrate:

____ Bedrock X Gravel/Sand ____ Silt

X Sand ____ Cobble/Gravel ____ Clay

Habitat Complexity:

____ Riffle/Pools ____ Undercut banks

____ Tree Roots ____ Woody Debris

Bank Erosion: ____ Severe ____ Moderate X Minor

Describe: This is a natural channel that has formed in Wetland WL008.

Silt Deposition: ____ Severe ____ Moderate X Minor

Riparian Zone:

Right Bank: X Forested ____ Vegetated ____ Developed ____ Maintained

Notes: Adjacent to upland riparian forest.

Slope: 1%

Left Bank. X Forested X Vegetated ____ Developed ____ Maintained

Notes: Adjacent to Wetland WL008

Slope: 1%

Cowardin (1979) Stream Classification: N/A

WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont Region

Project/Site: Carsins Run Stream Restoration City/County: Harford Sampling Date: 2/6/18

Applicant/Owner: Maryland Transportation Authority State: MD Sampling Point: WL007-W

Investigator(s): AW, BD Section, Township, Range: Aberdeen

Landform (hillslope, terrace, etc.): terrace Local relief (concave, convex, none): none Slope (%): 1

Subregion (LRR or MLRA): MLRA 148 Lat: 39.531739 Long: -76.183367 Datum: NAD 83

Soil Map Unit Name: Delanco silt loam, 3-8% slopes (DcB) NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ☐ (If no, explain in Remarks.)

Are Vegetation ☐, Soil ☐, or Hydrology ☐ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ☐

Are Vegetation ☐, Soil ☐, or Hydrology ☐ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No ☐	Is the Sampled Area within a Wetland? Yes ✓ No ☐
Hydric Soil Present?	Yes ✓ No ☐	
Wetland Hydrology Present?	Yes ✓ No ☐	

Remarks:

The sample plot satisfies the three mandatory wetland criteria; therefore, this area is classified as a palustrine, forested, broad-leaved deciduous, temporarily flooded (PFO1A) wetland. The wetland is located adjacent to the Ripken Stadium complex and outlets into WUS WL003. A stormwater management (SWM) pond is located above the wetland. Standing water is present throughout the wetland. Rain has occurred within the past 48 hours.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ✓ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ✓ Water-Stained Leaves (B9)
- ☐ Aquatic Fauna (B13)
- ☐ True Aquatic Plants (B14)
- ☐ Hydrogen Sulfide Odor (C1)
- ✓ Oxidized Rhizospheres on Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ✓ Drainage Patterns (B10)
- ☐ Moss Trim Lines (B16)
- ☐ Dry-Season Water Table (C2)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Stunted or Stressed Plants (D1)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☐ Microtopographic Relief (D4)
- ☐ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes ☐	No ✓	Depth (inches): N/A
Water Table Present?	Yes ✓	No ☐	Depth (inches): 1"
Saturation Present? (includes capillary fringe)	Yes ✓	No ☐	Depth (inches): surfa

Wetland Hydrology Present? Yes ✓ No ☐

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

The sample plot satisfies the wetland hydrology criterion. Surface water is present throughout the wetland; however, no surface water was present near the wetland sample plot.

VEGETATION (Five Strata) – Use scientific names of plants.

Sampling Point: WL007-WET

Tree Stratum (Plot size: 30ft radius)	Absolute % Cover	Dominant Species?	Indicator Status
1. Acer rubrum	50	Y	FAC
2. Fraxinus pennsylvanica	20	Y	FAC+
3. Liquidambar styraciflua	10	N	FAC
4.			
5.			
6.			
	80 = Total Cover		
50% of total cover: 40	20% of total cover: 16		
Sapling Stratum (Plot size: 15ft radius)			
1.			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover: 0	20% of total cover: 0		
Shrub Stratum (Plot size: 15ft radius)			
1. Rosa multiflora	15	Y	FACU
2.			
3.			
4.			
5.			
6.			
	15 = Total Cover		
50% of total cover: 7.5	20% of total cover: 3		
Herb Stratum (Plot size: 5ft radius)			
1. Microstegium vimineum	40	Y	FAC
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	40 = Total Cover		
50% of total cover: 20	20% of total cover: 8		
Woody Vine Stratum (Plot size: 30ft radius)			
1. Toxicodendron radicans	2	Y	FAC
2.			
3.			
4.			
5.			
	2 = Total Cover		
50% of total cover: 1	20% of total cover: 0.4		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 4 (A)

Total Number of Dominant Species Across All Strata: 5 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 80 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

- ☐ 1 - Rapid Test for Hydrophytic Vegetation
- ☑ 2 - Dominance Test is >50%
- ☐ 3 - Prevalence Index is ≤3.0[1]
- ☐ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Five Vegetation Strata:

Tree – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

Sapling – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

Shrub – Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

Herb – All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

Woody vine – All woody vines, regardless of height.

Hydrophytic Vegetation Present? Yes ☑ No ☐

Remarks: (Include photo numbers here or on a separate sheet.)

The sample plot satisfies the hydrophytic vegetation criterion.

SOIL

Sampling Point: WL007

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-8	10YR 4/2	70	10YR 2/1	10	D	M	sicl	organic matter
			7.5YR 4/4	20	C	M/PL		
8-20	2.5Y 6/1	40	10YR 5/2	25	C	M	sicl	
			10YR 5/8	15	C	M		
			10YR 3/2	5	C	M		
			7.5YR 4/4	15	C	M/PL		
20-24	2.5Y 6/1	50	10YR 6/8	25	C	M	cl	
			10YR 3/2	10	C	M		
			10YR 4/4	15	C	M		

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5)
- ☐ 2 cm Muck (A10) **(LRR N)**
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1) **(LRR N, MLRA 147, 148)**
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Dark Surface (S7)
- ☐ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
- ☐ Thin Dark Surface (S9) **(MLRA 147, 148)**
- ☐ Loamy Gleyed Matrix (F2)
- ☑ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
- ☐ Umbric Surface (F13) **(MLRA 136, 122)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 148)**
- ☐ Red Parent Material (F21) **(MLRA 127, 147)**

Indicators for Problematic Hydric Soils[3]:

- ☐ 2 cm Muck (A10) **(MLRA 147)**
- ☐ Coast Prairie Redox (A16) **(MLRA 147, 148)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: N/A

Depth (inches):

Hydric Soil Present? Yes ☑ No ☐

Remarks: The sample plot satisfies the hydric soils criterion.

WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont Region

Project/Site: Carsins Run Stream Restoration City/County: Harford Sampling Date: 2/6/18
Applicant/Owner: Maryland Transportation Authority State: MD Sampling Point: WL008-W
Investigator(s): AW/BD Section, Township, Range: Aberdeen
Landform (hillslope, terrace, etc.): terrace Local relief (concave, convex, none): none Slope (%): 1
Subregion (LRR or MLRA): MLRA 148 Lat: 39.531255 Long: -76.178877 Datum: NAD 83
Soil Map Unit Name: Aldino very stony silt loam, 0-8% slopes (AsB) NWI classification: PFO1A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ☐ (If no, explain in Remarks.)
Are Vegetation ☐, Soil ✓, or Hydrology ☐ significantly disturbed? Are "Normal Circumstances" present? Yes ☐ No ✓
Are Vegetation ☐, Soil ☐, or Hydrology ☐ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No ☐	Is the Sampled Area within a Wetland? Yes ✓ No ☐
Hydric Soil Present?	Yes ✓ No ☐	
Wetland Hydrology Present?	Yes ✓ No ☐	

Remarks:
The sample plot satisfies all three mandatory wetland criteria; therefore, this areas is classified as a palustrine, forested, broad-leaved deciduous, temporarily flooded (PFO1A) wetland. The sample plot is located downstream of Interstate 95 on the left bank of WUS WL001. Rock and cobble are present throughout the wetland.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ✓ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Aquatic Fauna (B13)
- ☐ True Aquatic Plants (B14)
- ☐ Hydrogen Sulfide Odor (C1)
- ✓ Oxidized Rhizospheres on Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Moss Trim Lines (B16)
- ☐ Dry-Season Water Table (C2)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Stunted or Stressed Plants (D1)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☐ Microtopographic Relief (D4)
- ☐ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes ☐	No ✓	Depth (inches):
Water Table Present?	Yes ✓	No ☐	Depth (inches): 10"
Saturation Present? (includes capillary fringe)	Yes ✓	No ☐	Depth (inches): Surfa

Wetland Hydrology Present? Yes ✓ No ☐

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:
The sample plot satisfies the wetland hydrology criterion.

VEGETATION (Five Strata) – Use scientific names of plants.

Sampling Point: WL008-WET

Tree Stratum (Plot size: 30ft radius)	Absolute % Cover	Dominant Species?	Indicator Status
1. Liquidambar styraciflua	10	N	FAC
2. Carpinus caroliniana	5	N	FAC
3. Fagus grandifolia	10	N	FACU
4. Acer rubrum	35	Y	FAC
5. Nyssa sylvatica	20	Y	FAC
6. Quercus alba	15	N	FACU
	95 = Total Cover		
50% of total cover: 47.5	20% of total cover: 19		
Sapling Stratum (Plot size: 15ft radius)			
1. Fagus grandifolia	10	Y	FACU
2.			
3.			
4.			
5.			
6.			
	10 = Total Cover		
50% of total cover: 5	20% of total cover: 2		
Shrub Stratum (Plot size: 15ft radius)			
1.			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		
50% of total cover: 0	20% of total cover: 0		
Herb Stratum (Plot size: 5ft radius)			
1. Carex species	10	Y	NI
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	10 = Total Cover		
50% of total cover: 5	20% of total cover: 2		
Woody Vine Stratum (Plot size: 30ft radius)			
1.			
2.			
3.			
4.			
5.			
	0 = Total Cover		
50% of total cover: 0	20% of total cover: 0		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 67 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

- ☐ 1 - Rapid Test for Hydrophytic Vegetation
- ☑ 2 - Dominance Test is >50%
- ☐ 3 - Prevalence Index is ≤3.0[1]
- ☐ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Five Vegetation Strata:

Tree – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

Sapling – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

Shrub – Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

Herb – All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

Woody vine – All woody vines, regardless of height.

Hydrophytic Vegetation Present? Yes ☑ No ☐

Remarks: (Include photo numbers here or on a separate sheet.)

The sample plot satisfies the hydrophytic vegetation.

SOIL Sampling Point: WL008

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-8	10YR 4/1	85	10YR 4/4	10	C	M/PL	sicl	
			10YR 6/1	5	C	M		
8-12	10YR 5/1	55	10YR 4/1	10	D	M	sicl	
			10YR 5/6	15	C	M/PL		
			10YR 6/6	20	C	M		
12+	---	--	---	--	--	--	--	Refusal

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5)
- ☐ 2 cm Muck (A10) **(LRR N)**
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1) **(LRR N, MLRA 147, 148)**
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Dark Surface (S7)
- ☐ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
- ☐ Thin Dark Surface (S9) **(MLRA 147, 148)**
- ☐ Loamy Gleyed Matrix (F2)
- ☑ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
- ☐ Umbric Surface (F13) **(MLRA 136, 122)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 148)**
- ☐ Red Parent Material (F21) **(MLRA 127, 147)**

Indicators for Problematic Hydric Soils[3]:

- ☐ 2 cm Muck (A10) **(MLRA 147)**
- ☐ Coast Prairie Redox (A16) **(MLRA 147, 148)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: Rock

Depth (inches): 12+

Hydric Soil Present? Yes ☑ No ☐

Remarks: The sample plot satisfies the hyrdric soils criterion. Refusal occurred at 12 inches due to the presence of rock and cobble throughout the wetland.

WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont Region

Project/Site: Carsins Run Stream Restoration City/County: Harford Sampling Date: 2/6/18
Applicant/Owner: Maryland Transportation Authority State: MD Sampling Point: UPL-1
Investigator(s): AW, BD Section, Township, Range: Aberdeen
Landform (hillslope, terrace, etc.): hillslope Local relief (concave, convex, none): none Slope (%): 1
Subregion (LRR or MLRA): MLRA 148 Lat: 39.531805 Long: -76.181951 Datum: NAD 83
Soil Map Unit Name: Aldino silt loam, 3-8% slopes (AdB) NWI classification: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ☐ (If no, explain in Remarks.)
Are Vegetation ☐, Soil ☐, or Hydrology ☐ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ☐
Are Vegetation ☐, Soil ☐, or Hydrology ☐ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ☐	No ✓
Hydric Soil Present?	Yes ☐	No ✓
Wetland Hydrology Present?	Yes ☐	No ✓

Is the Sampled Area within a Wetland? Yes ☐ No ✓

Remarks:

The sample plot does not satisfy the three mandatory wetland criteria; therefore, this area is classified as upland. The sample plot is located on a hillslope within Forest Stand Delineation Sample Plot FSD A-3. Rain has occurred within the past 48 hours.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Aquatic Fauna (B13)
- ☐ True Aquatic Plants (B14)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres on Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Moss Trim Lines (B16)
- ☐ Dry-Season Water Table (C2)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Stunted or Stressed Plants (D1)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☐ Microtopographic Relief (D4)
- ☐ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes ☐	No ✓	Depth (inches):
Water Table Present?	Yes ☐	No ✓	Depth (inches):
Saturation Present? (includes capillary fringe)	Yes ☐	No ✓	Depth (inches):

Wetland Hydrology Present? Yes ☐ No ✓

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

The sample plot does not satisfy the hydrology criterion.

VEGETATION (Five Strata) – Use scientific names of plants.

Sampling Point: UPL-1

Tree Stratum (Plot size: 30ft radius)

Tree Stratum	Absolute % Cover	Dominant Species?	Indicator Status
1. Liquidambar styraciflua	15	N	FAC
2. Quercus alba	40	Y	FACU
3. Fagus grandifolia	20	Y	FACU
4. Juniperus virginiana	5	N	FACU
5. Nyssa sylvatica	5	N	FAC
6. Liriodendron tulipifera	10	N	FACU
	95 = Total Cover		

50% of total cover: 47.5 20% of total cover: 19

Sapling Stratum (Plot size: 15ft radius)

Sapling Stratum	Absolute % Cover	Dominant Species?	Indicator Status
1. Carpinus caroliniana	5	Y	FAC
2.			
3.			
4.			
5.			
6.			
	5 = Total Cover		

50% of total cover: 2.5 20% of total cover: 1

Shrub Stratum (Plot size: 15ft radius)

Shrub Stratum	Absolute % Cover	Dominant Species?	Indicator Status
1. Lindera benzoin	15	Y	FAC
2.			
3.			
4.			
5.			
6.			
	15 = Total Cover		

50% of total cover: 7.5 20% of total cover: 3

Herb Stratum (Plot size: 5ft radius)

Herb Stratum	Absolute % Cover	Dominant Species?	Indicator Status
1. Lonicera japonica	10	Y	FACU
2. Allium canadense	2	N	FACU
3. Microstegium vimineum	5	N	FAC
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	17 = Total Cover		

50% of total cover: 8.5 20% of total cover: 3.4

Woody Vine Stratum (Plot size: 30ft radius)

Woody Vine Stratum	Absolute % Cover	Dominant Species?	Indicator Status
1. Toxicodendron radicans	5	Y	FAC
2. Vitis labrusca	5	Y	FACU
3.			
4.			
5.			
	10 = Total Cover		

50% of total cover: 5 20% of total cover: 2

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)

Total Number of Dominant Species Across All Strata: 7 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 43 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	0	x 1 = 0
FACW species	0	x 2 = 0
FAC species	50	x 3 = 150
FACU species	92	x 4 = 368
UPL species	0	x 5 = 0
Column Totals:	142 (A)	518 (B)

Prevalence Index = B/A = 3.65

Hydrophytic Vegetation Indicators:

- ☐ 1 - Rapid Test for Hydrophytic Vegetation
- ☐ 2 - Dominance Test is >50%
- ☐ 3 - Prevalence Index is ≤3.0[1]
- ☐ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Five Vegetation Strata:

Tree – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

Sapling – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

Shrub – Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

Herb – All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

Woody vine – All woody vines, regardless of height.

Hydrophytic Vegetation Present? Yes ☐ No ☑

Remarks: (Include photo numbers here or on a separate sheet.)

The sample plot does not satisfy the hydrophytic vegetation criterion.

SOIL

Sampling Point: UPL-1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-10	10YR 4/4	70	7.5YR 4/4	30	C	M	sil	
10-24	7.5YR 4/6	70	10YR 3/3	30	C	M	sil	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5)
- ☐ 2 cm Muck (A10) **(LRR N)**
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1) **(LRR N, MLRA 147, 148)**
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Dark Surface (S7)
- ☐ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
- ☐ Thin Dark Surface (S9) **(MLRA 147, 148)**
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
- ☐ Umbric Surface (F13) **(MLRA 136, 122)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 148)**
- ☐ Red Parent Material (F21) **(MLRA 127, 147)**

Indicators for Problematic Hydric Soils[3]:

- ☐ 2 cm Muck (A10) **(MLRA 147)**
- ☐ Coast Prairie Redox (A16) **(MLRA 147, 148)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: N/A

Depth (inches):

Hydric Soil Present? Yes ☐ No ☑

Remarks:
The sample plot does not satisfy the hydric soils criterion.

WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont Region

Project/Site: Carsins Run Stream Restoration City/County: Harford Sampling Date: 2/6/18
Applicant/Owner: Maryland Transportation Authority State: MD Sampling Point: UPL-2
Investigator(s): AW, BD Section, Township, Range: Aberdeen
Landform (hillslope, terrace, etc.): terrace Local relief (concave, convex, none): none Slope (%): 1
Subregion (LRR or MLRA): MLRA 148 Lat: 39.531114 Long: -76.179001 Datum: NAD 83
Soil Map Unit Name: Aldino very stony silt loam, 0-8% slopes (AsB) NWI classification: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ☐ (If no, explain in Remarks.)
Are Vegetation ☐ Soil ☐, or Hydrology ☐ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ☐
Are Vegetation ☐, Soil ☐, or Hydrology ☐ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

	Yes	No
Hydrophytic Vegetation Present?	✓	
Hydric Soil Present?		✓
Wetland Hydrology Present?	✓	
Is the Sampled Area within a Wetland?		✓

Remarks:
The sample plot satisfies only two of the three mandatory wetland criteria; therefore, the area is classified as upland. The sample plot is located on the floodplain adjacent to WUS WL001, Wetland WL008, and a fence line. Rain has occurred within the past 48 hours.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ✓ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Aquatic Fauna (B13)
- ☐ True Aquatic Plants (B14)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres on Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Moss Trim Lines (B16)
- ☐ Dry-Season Water Table (C2)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Stunted or Stressed Plants (D1)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☐ Microtopographic Relief (D4)
- ☐ FAC-Neutral Test (D5)

Field Observations:

	Yes	No	Depth (inches)
Surface Water Present?		✓	
Water Table Present?		✓	
Saturation Present? (includes capillary fringe)	✓		8"

Wetland Hydrology Present? Yes ✓ No ☐

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:
The sample plot satisfies the hydrology criterion. No water table is associated with the zone of saturation.

VEGETATION (Five Strata) – Use scientific names of plants.

Sampling Point: UPL-2

Tree Stratum (Plot size: 30ft radius)

	Absolute % Cover	Dominant Species?	Indicator Status
1. Acer rubrum	40	Y	FAC
2. Juniperus virginiana	5	N	FACU
3. Nyssa sylvatica	5	N	FAC
4. Liquidambar styraciflua	35	N	FAC
5. Fagus grandifolia	10	N	FACU
6.			
	95 = Total Cover		

50% of total cover: 47.5 20% of total cover: 19

Sapling Stratum (Plot size: 15ft radius)

	Absolute % Cover	Dominant Species?	Indicator Status
1. Fagus grandifolia	10	Y	FACU
2.			
3.			
4.			
5.			
6.			
	10 = Total Cover		

50% of total cover: 5 20% of total cover: 2

Shrub Stratum (Plot size: 15ft radius)

	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		

50% of total cover: 0 20% of total cover: 0

Herb Stratum (Plot size: 5ft radius)

	Absolute % Cover	Dominant Species?	Indicator Status
1. Carex species	15	Y	NI
2. Microstegium vimineum	5	Y	FAC
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	20 = Total Cover		

50% of total cover: 10 20% of total cover: 4

Woody Vine Stratum (Plot size: 30ft radius)

	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
	0 = Total Cover		

50% of total cover: 0 20% of total cover: 0

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 67 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

- ☐ 1 - Rapid Test for Hydrophytic Vegetation
- ☑ 2 - Dominance Test is >50%
- ☐ 3 - Prevalence Index is ≤3.0[1]
- ☐ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Five Vegetation Strata:

Tree – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

Sapling – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

Shrub – Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

Herb – All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

Woody vine – All woody vines, regardless of height.

Hydrophytic Vegetation Present? Yes ☑ No ☐

Remarks: (Include photo numbers here or on a separate sheet.)

The sample plot satisfies the hydrophytic vegetation criterion.

SOIL

Sampling Point: UPL-2

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-6	10YR 3/3	80	10YR 4/4	20	C	M	ms	
6-12	10YR 4/3	100	---	--	C	M	sil	with fine sand
12-20	2.5Y 5/4	45	2.5Y 5/3	20	C	M	sicl	
			10YR 5/6	15	C	M		
			10YR 6/6	15	C	M		
			10YR 3/2	5	D	M		

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5)
- ☐ 2 cm Muck (A10) **(LRR N)**
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1) **(LRR N, MLRA 147, 148)**
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Dark Surface (S7)
- ☐ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
- ☐ Thin Dark Surface (S9) **(MLRA 147, 148)**
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
- ☐ Umbric Surface (F13) **(MLRA 136, 122)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 148)**
- ☐ Red Parent Material (F21) **(MLRA 127, 147)**

Indicators for Problematic Hydric Soils[3]:

- ☐ 2 cm Muck (A10) **(MLRA 147)**
- ☐ Coast Prairie Redox (A16) **(MLRA 147, 148)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: N/A

Depth (inches):

Hydric Soil Present? Yes ☐ No ☑

Remarks:
The sample plot does not satisfy the hydric soils criterion.

APPENDIX C

Forest Sampling Data Sheets and Forest Summary Datasheets

Property: Carsins Run Stream Restoration **Prepared By:** AW, BD

Stand #: A **Plot #:** 1 **Plot Size:** 1/10 Acre **Date:** 2/6/2018

Basal Area in sf/acre: 120	Size Class of trees >20' height within sample plot															
Tree Species	# of Trees 2-5.9" dbh			# of Trees 6-11.9" dbh			# of Trees 12-19.9" dbh			# of Trees 20-29.9" dbh			# of Trees > 30" dbh			
Crown Position	Dom	CoD	Other	Dom	CoD	Other	Dom	CoD	Other	Dom	CoD	Other	Dom	CoD	Other	Total
Fagus grandifolia										1						1
Liriodendron tulipifera							1			2						3
Acer rubrum							1			1						2
																0
																0
																0
																0
																0
																0
																0
																0
																0
Total Number of Trees per Size Class	0			0			2			4			0			6
Number & Size of Standing Dead Trees	1						1									2

List of Common Understory Species 3' - 20':
Berberis thunbergii, Fagus grandifolia, Lindera benzoin

% of Canopy Closure

C	*N*	*E*	*S*	*W*	*Total*
95	90	90	95	85	91

% Understory Cover 3' - 20'

C	*N*	*E*	*S*	*W*	*Total*
5	15	10	15	15	12

Percent of Invasive Cover per Plot (All Layers): 10%

Plot Successional Stage: Early-Mid

List of Herbaceous Species 0' - 3':
Lonicera japonica

% of Herbaceous Cover 0' - 3'

C	*N*	*E*	*S*	*W*	*Total*
2	0	0	0	2	0.8

Comments
The sample plot is located at the upstream end of the project area on the right bank, and is located generally northwest of I-95. A moderate amount of downed woody debris is present. There is a minimal amount of understory and herbaceous coverage within the sample plot. Approximately 1/2" of leaf litter is present within the forest stand sample plot.

Property: Carsins Run Stream Restoration **Prepared By:** AW, BD

Stand #: A **Plot #:** 2 **Plot Size:** 1/10 Acre **Date:** 2/6/2018

Basal Area in sf/acre: 105	**Size Class of trees >20' height within sample plot**															
Tree Species	# of Trees 2-5.9" dbh			# of Trees 6-11.9" dbh			# of Trees 12-19.9" dbh			# of Trees 20-29.9" dbh			# of Trees > 30" dbh			
Crown Position	**Dom**	**CoD**	**Other**	**Dom**	**CoD**	**Other**	**Dom**	**CoD**	**Other**	**Dom**	**CoD**	**Other**	**Dom**	**CoD**	**Other**	**Total**
Carpinus caroliniana			2													2
Prunus serotina			1													1
Liriodendron tulipifera										1						1
Liquidambar styraciflua							2									2
Celtis occidentalis			1													1
Carya glabra							1									1
Quercus alba						1				1						2
																0
																0
																0
																0
																0
Total Number of Trees per Size Class	4			1			3			2			0			10
Number & Size of Standing Dead Trees																0

List of Common Understory Species 3' - 20':
Crataegus species, *Fagus grandifolia, Lindera benzoin*

% of Canopy Closure

C	*N*	*E*	*S*	*W*	*Total*
80	90	85	90	95	88

% Understory Cover 3' - 20'

C	*N*	*E*	*S*	*W*	*Total*
20	5	25	30	10	18

Percent of Invasive Cover per Plot (All Layers): 5%

Plot Successional Stage: Early-Mid

List of Herbaceous Species 0' - 3':
Allium canadensis, Lonicera japonica

% of Herbaceous Cover 0' - 3'

C	*N*	*E*	*S*	*W*	*Total*
2	2	5	2	0	2.2

Comments
The sample plot is located generally northwest of I-95 and is located on the left bank of WUS WL003. Rock is present within the sample plot, and there is a minimal amount of downed woody debris present. Approximately 1/2" of leaf litter is present within the forest stand sample plot.

Property: Carsins Run Stream Restoration **Prepared By:** AW, BD

Stand #: A **Plot #:** 3 **Plot Size:** 1/10 Acre **Date:** 2/6/2018

Basal Area in sf/acre: 120

Size Class of trees >20' height within sample plot

Tree Species	# of Trees 2-5.9" dbh			# of Trees 6-11.9" dbh			# of Trees 12-19.9" dbh			# of Trees 20-29.9" dbh			# of Trees > 30" dbh			
Crown Position	**Dom**	**CoD**	**Other**	**Dom**	**CoD**	**Other**	**Dom**	**CoD**	**Other**	**Dom**	**CoD**	**Other**	**Dom**	**CoD**	**Other**	**Total**
Liriodendron tulipifera			1			1	2									4
Fagus grandifolia			3													3
Liquidambar styraciflua							3									3
Prunus serotina			1													1
Quercus alba							2									2
Juniperus virginiana			1													1
Carya glabra										1						1
Nyssa sylvatica			2													2
Carpinus caroliniana			2													2
																0
																0
																0
Total Number of Trees per Size Class	10			1			7			1			0			19
Number & Size of Standing Dead Trees	1			1												2

List of Common Understory Species 3' - 20':
Carpinus caroliniana, Lindera benzoin, Smilax rotundifolia, Vitis labrusca

% of Canopy Closure

C	*N*	*E*	*S*	*W*	*Total*
80	60	60	60	80	68

% Understory Cover 3' - 20'

C	*N*	*E*	*S*	*W*	*Total*
0	10	15	15	10	10

Percent of Invasive Cover per Plot (All Layers): 15%

Plot Successional Stage: Early

List of Herbaceous Species 0' - 3':
Allium canadense, Lonicera japonica, Microstegium vimineum, Rosa multiflora

% of Herbaceous Cover 0' - 3'

C	*N*	*E*	*S*	*W*	*Total*
2	5	2	10	10	5.8

Comments
The forest stand sample plot is located generally northwest of I-95, and is on the right bank of WUS WL003. The forest stand plot is surrounded by upland riparian forest. There is approximately 1/2" of leaf litter, and a moderate amount of downed woody debris present within the plot. There is a minimal amount of understory and herbaceous coverage within the sample plot.

Property: Carsins Run Stream Restoration **Prepared By:** AW, BD

Stand #: B **Plot #:** 1 **Plot Size:** 1/10 Acre **Date:** 2/6/2018

Basal Area in sf/acre: 130	**Size Class of trees >20' height within sample plot**															
Tree Species	# of Trees 2-5.9" dbh			# of Trees 6-11.9" dbh			# of Trees 12-19.9" dbh			# of Trees 20-29.9" dbh			# of Trees > 30" dbh			
Crown Position	**Dom**	**CoD**	**Other**	**Dom**	**CoD**	**Other**	**Dom**	**CoD**	**Other**	**Dom**	**CoD**	**Other**	**Dom**	**CoD**	**Other**	**Total**
Liriodendron tulipifera			1		1		6			1						9
Liquidambar styraciflua			1	2	3											6
Fagus grandifolia			9													9
Acer rubrum					2											2
Nyssa sylvatica			5													5
Carpinus caroliniana			5													5
Ulmus rubra			1													1
																0
																0
																0
																0
																0
Total Number of Trees per Size Class	22			8			6			1			0			37
Number & Size of Standing Dead Trees	1			1												2

List of Common Understory Species 3' - 20':
Carpinus caroliniana, Fagus grandifolia, Vitis labrusca

% of Canopy Closure

C	*N*	*E*	*S*	*W*	*Total*
85	90	0	90	95	72

% Understory Cover 3' - 20'

C	*N*	*E*	*S*	*W*	*Total*
2	0	5	0	0	1.4

Percent of Invasive Cover per Plot (All Layers): 20%

Plot Successional Stage: Early

List of Herbaceous Species 0' - 3':
Allium canadense, Carex species, *Lonicera japonica, Polystichum acrostichoides, Rosa multiflora, Smilax rotundifolia*

% of Herbaceous Cover 0' - 3'

C	*N*	*E*	*S*	*W*	*Total*
10	2	45	5	30	18.4

Comments
The sample plot is located generally southeast of I-95, and is located on the right bank of WUS WL001 and WUS WL005. Rock and a moderate amount of downed woody debris and herbaceous cover is present within the sample plot. There is an approximately 1/2" of leaf litter present within the sample plot.

Property: Carsins Run Stream Restoration **Prepared By:** AW, BD

Stand #: B **Plot #:** 2 **Plot Size:** 1/10 Acre **Date:** 2/6/2018

Basal Area in sf/acre: 70

Size Class of trees >20' height within sample plot

Tree Species	# of Trees 2-5.9" dbh			# of Trees 6-11.9" dbh			# of Trees 12-19.9" dbh			# of Trees 20-29.9" dbh			# of Trees > 30" dbh			
Crown Position	**Dom**	**CoD**	**Other**	**Dom**	**CoD**	**Other**	**Dom**	**CoD**	**Other**	**Dom**	**CoD**	**Other**	**Dom**	**CoD**	**Other**	**Total**
Fagus grandifolia		1	4													5
Liquidambar styraciflua				3												3
Acer rubrum			3	2	2		1									8
Quercus alba			1													1
Nyssa sylvatica			3	1												4
Carpinus caroliniana			5													5
																0
																0
																0
																0
																0
																0
Total Number of Trees per Size Class	17			8			1			0			0			26
Number & Size of Standing Dead Trees																0

List of Common Understory Species 3' - 20':
Acer rubrum, Carpinus caroliniana, Fagus grandifolia, Smilax rotundifolia

% of Canopy Closure

C	*N*	*E*	*S*	*W*	*Total*
95	90	90	95	95	93

% Understory Cover 3' - 20'

C	*N*	*E*	*S*	*W*	*Total*
0	5	2	0	0	1.4

Percent of Invasive Cover per Plot (All Layers): 10%

Plot Successional Stage: Early

List of Herbaceous Species 0' - 3':
Carex species, *Microstegium vimineum, Smilax rotundifolia*

% of Herbaceous Cover 0' - 3'

C	*N*	*E*	*S*	*W*	*Total*
20	2	2	20	10	10.8

Comments
The sample plot is located southeast of I-95, on the left bank of WUS WL001, and within Wetland WL008. The sample plot is located within the existing fence line. A moderate amount of downed woody debris is present. There is a minimal amount of understory and herbaceous cover present within the sample plot. Approximatly 1/2" of leaf litter is present within the sample plot.

Property Name: Carsins Run Stream Restoration	
Location: Aberdeen, Harford County, MD	
Prepared By: AW, BD	**Date: 2/6/18**

Stand Variable	**Stand A**
1. Dominant/Codominant species	**Dominant:** *Acer rubrum, Carya glabra, Fagus grandifolia, Liriodendron tulipifera, Liquidambar styraciflua, Quercus alba*
2. Successional stage	Early-Mid
3. Basal area in square feet per acre	115
4. Size class of dominant species	12-19.9", 20-29.9"
5. Percent of canopy closure	82.3%
6. Number of tree species per acre	11
7. Common understory species per acre	*Berberis thumbergii, Carpinus caroliniana, Crataegus* species, *Fagus grandifolia, Lindera benzoin, Smilax rotundifolia, Vitis labrusca*
8. Percent of understory cover 3' to 10' tall	13.3%
9. Number of woody plants species 3' to 20' tall	7
10. Common herbaceous species 0' to 3' tall	*Allium canadense, Lonicera japonica, Microstegium viminuem, Rosa multiflora*
11. Percent of herbaceous and woody plant cover 0' to 3' tall	2.9%
12. List of major invasive plant species and percent cover	*Berberis thunbergii, Lonicera japonica, Microstegium vimineum, Rosa multiflora* - 10%
13. Number of standing dead trees 6" dbh or greater	2
14. Comments	The forest stand is located generally northwest of I-95. There is a moderate amount of downed woody debris present. A majority of the specimen trees are located within this forest stand. There is a moderate amount of understory and invasive species coverage. Additionally, there is a minimal amount of herbaceous coverage.

Property Name: Carsins Run Stream Restoration	
Location: Aberdeen, Harford County, MD	
Prepared By: AW, BD	**Date: 2/6/18**

Stand Variable	**Stand B**
1. Dominant/Codominant species	**Dominant:** *Acer rubrum, Liquidambar styraciflua, Liriodendron tulipifera, Nyssa sylvatica* **CoDomiant:** *Fagus grandifolia*
2. Successional stage	Early
3. Basal area in square feet per acre	100
4. Size class of dominant species	6-11.9”, 12-19.9”, 20-29.9”
5. Percent of canopy closure	82.5%
6. Number of tree species per acre	8
7. Common understory species per acre	*Acer rubrum, Carpinus caroliniana, Fagus grandifolia, Smilax rotundifolia, Vitis labrusca*
8. Percent of understory cover 3’ to 10’ tall	1.4%
9. Number of woody plants species 3’ to 20’ tall	5
10. Common herbaceous species 0’ to 3’ tall	*Allium canadense, Carex* species, *Carpinus caroliniana, Lonicera japonica, Microstegium vimineum, Polystichum acrostichoides, Rosa multiflora, Smilax rotundifolia*
11. Percent of herbaceous and woody plant cover 0’ to 3’ tall	14.6%
12. List of major invasive plant species and percent cover	*Lonicera japonica, Microstegium vimineum, Rosa multiflora,*– 15%
13. Number of standing dead trees 6” dbh or greater	1
14. Comments	Forest Stand B is located southeast of I-95. This early successional stand has a moderate amount of herbaceous and invasive species coverage. There is a minimal amount of understory coverage present. There is a moderate amount of downed woody debris present.

APPENDIX D

Representative Site Photographs

Photographic Record

KCI Technologies, Inc.
Agency: Maryland Transportation Authority
Project: Carsins Run Stream Restoration
Project No. – 22145228.36

Photographer: K. Myers
Date: 2/5/18
Frame No. 1
Direction: North
Comments: View of WUS WL001 facing upstream from flag WL001-002

Photographer: K. Myers
Date: 2/5/18
Frame No. 2
Direction: North
Comments: View of WUS WL001 facing upstream between flags WL001-008 and WL001-009.

Photographic Record

KCI Technologies, Inc.

Agency: Maryland Transportation Authority
Project: Carsins Run Stream Restoration
Project No. – 22145228.36

Photographer: K. Myers
Date: 2/5/18
Frame No. 3
Direction: North
Comments: View of WUS WL001 facing upstream from flag WL001-011.

Photographer: K. Myers
Date: 2/5/18
Frame No. 4
Direction: Southeast
Comments: View of WUS WL001 facing downstream from flag WL001-011.

Photographic Record

KCI Technologies, Inc.
Agency: Maryland Transportation Authority
Project: Carsins Run Stream Restoration
Project No. – 22145228.36

Photographer: K. Myers
Date: 2/5/18
Frame No. 5
Direction: Northeast
Comments: View of Waterway WL002 facing upstream from flag WL002-002.

Photographer: K. Myers
Date: 2/5/18
Frame No. 6
Direction: West
Comments: View of WUS WL003 facing upstream from flag WL003-003.

Photographic Record

KCI Technologies, Inc.
Agency: Maryland Transportation Authority
Project: Carsins Run Stream Restoration
Project No. – 22145228.36

Photographer: K. Myers
Date: 2/5/18
Frame No. 7
Direction: West
Comments: View of Waterway WL003 facing upstream from flag WL003-007.

Photographer: K. Myers
Date: 2/5/18
Frame No. 8
Direction: East
Comments: View of WUS WL003 facing downstream from flag WL003-032.

Photographic Record

KCI Technologies, Inc.
Agency: Maryland Transportation Authority
Project: Carsins Run Stream Restoration
Project No. – 22145228.36

Photographer: K. Myers
Date: 2/5/18
Frame No. 9
Direction: East
Comments: View of Waterway WL003 facing downstream from flag WL003-037.

Photographer: K. Myers
Date: 2/5/18
Frame No. 10
Direction: West
Comments: View of WUS WL003 facing upstream from flag WL003-038.

Photographic Record

KCI Technologies, Inc.
Agency: Maryland Transportation Authority
Project: Carsins Run Stream Restoration
Project No. – 22145228.36

Photographer: K. Myers
Date: 2/5/18
Frame No. 11
Direction: Northwest
Comments: View of Waterway WL004 facing upstream from flag WL004-002.

Photographer: K. Myers
Date: 2/5/18
Frame No. 12
Direction: Southeast
Comments: View of Waterway WL004 facing downstream from flag WL004-002.

Photographic Record

KCI Technologies, Inc.
Agency: Maryland Transportation Authority
Project: Carsins Run Stream Restoration
Project No. – 22145228.36

Photographer: K. Myers
Date: 2/5/18
Frame No. 13
Direction: South
Comments: View of WUS WL001 facing upstream from flag WL001-017.

Photographer: K. Myers
Date: 2/5/18
Frame No. 14
Direction: North
Comments: View of WUS WL005 facing downstream from flag WL005-004.

Photographic Record

KCI Technologies, Inc.
Agency: Maryland Transportation Authority
Project: Carsins Run Stream Restoration
Project No. – 22145228.36

Photographer: K. Myers
Date: 2/5/18
Frame No. 15
Direction: South
Comments: View of WUS WL001 facing upstream from flag WL001-017.

Photographer: K. Myers
Date: 2/5/18
Frame No. 16
Direction: North
Comments: View of Waterway WL006 facing upstream from flag WL006-003.

Photographic Record

KCI Technologies, Inc.
Agency: Maryland Transportation Authority
Project: Carsins Run Stream Restoration
Project No. – 22145228.36

Photographer: K. Myers
Date: 2/5/18
Frame No. 17
Direction: South
Comments: View of Waterway WL006 facing downstream from flag WL006-006.

Photographer: A. Wagoner
Date: 2/6/18
Frame No. 18
Direction: Northwest
Comments: View of Wetland Sample Plot WL007-WET towards Ripken Stadium complex

Photographic Record

KCI Technologies, Inc.
Agency: Maryland Transportation Authority
Project: Carsins Run Stream Restoration
Project No. – 22145228.36

Photographer: A. Wagoner
Date: 2/6/18
Frame No. 19
Direction: N/A
Comments: View of Wetland Sample Plot WL007-WET soils.

Photographer: A. Wagoner
Date: 2/6/18
Frame No. 20
Direction: South
Comments: View of Wetland Sample Plot WL008-WET.

Photographic Record

KCI Technologies, Inc.
Agency: Maryland Transportation Authority
Project: Carsins Run Stream Restoration
Project No. – 22145228.36

Photographer: A. Wagoner
Date: 2/6/18
Frame No. 21
Direction: N/A
Comments: View of Wetland Sample Plot WL008-WET soils.

Photographer: A. Wagoner
Date: 2/6/18
Frame No. 22
Direction: North
Comments: View of Upland Sample Plot UPL-1.

Photographic Record

KCI Technologies, Inc.
Agency: Maryland Transportation Authority
Project: Carsins Run Stream Restoration
Project No. – 22145228.36

Photographer: A. Wagoner
Date: 2/6/18
Frame No. 23
Direction: N/A
Comments: View of Upland Sample Plot UPL-1 soils.

Photographer: A. Wagoner
Date: 2/6/18
Frame No. 24
Direction: Southwest
Comments: View of Upland Sample Plot UPL-2.

Photographic Record

KCI Technologies, Inc.
Agency: Maryland Transportation Authority
Project: Carsins Run Stream Restoration
Project No. – 22145228.36

Photographer: A. Wagoner
Date: 2/6/18
Frame No. 25
Direction: N/A
Comments: View of Upland Sample Plot UPL-2 soils.

Photographer: A. Wagoner
Date: 2/6/18
Frame No. 26
Direction: West
Comments: View of Forest Stand Delineation Sample Plot FSD A-1 from center.

Photographic Record

KCI Technologies, Inc.
Agency: Maryland Transportation Authority
Project: Carsins Run Stream Restoration
Project No. – 22145228.36

Photographer: A. Wagoner
Date: 2/6/18
Frame No. 27
Direction: East
Comments: View of Forest Stand Delineation Sample Plot FSD A-2 from center.

Photographer: A. Wagoner
Date: 2/6/18
Frame No. 28
Direction: East
Comments: View of Forest Stand Delineation Sample Plot FSD A-3 from center.

Photographic Record

KCI Technologies, Inc.

Agency: Maryland Transportation Authority
Project: Carsins Run Stream Restoration
Project No. – 22145228.36

Photographer: A. Wagoner
Date: 2/6/18
Frame No. 29
Direction: North
Comments: View of Forest Stand Delineation Sample Plot FSD B-1 from center.

Photographer: A. Wagoner
Date: 2/6/18
Frame No. 30
Direction: North
Comments: View of Forest Stand Delineation Sample Plot FSD B-2 from center.

APPENDIX E

Natural Resource, Historic and Cultural Review Correspondence

United States Department of the Interior
U.S. Fish & Wildlife Service
Chesapeake Bay Field Office
177 Admiral Cochrane Drive
Annapolis, MD 21401
410/573 4575

Online Certification Letter

Today's date: 2/7/2018

Project: Carsins Run Stream Restoration

Dear Applicant for online certification:

Thank you for using the U.S. Fish and Wildlife Service (Service) Chesapeake Bay Field Office online project review process. By printing this letter in conjunction with your project review package, you are certifying that you have completed the online project review process for the referenced project in accordance with all instructions provided, using the best available information to reach your conclusions. This letter, and the enclosed project review package, completes the review of your project in accordance with the Endangered Species Act of 1973 (16 U.S.C. 1531-1544, 87 Stat. 884), as amended (ESA).This letter also provides information for your project review under the National Environmental Policy Act of 1969 (P.L. 91-190, 42 U.S.C. 4321-4347, 83 Stat. 852), as amended. A copy of this letter and the project review package must be submitted to this office for this certification to be valid. This letter and the project review package will be maintained in our records.

Based on this information and in accordance with section 7 of the Endangered Species Act (87 Stat. 884, as amended; 16 U.S.C. 1531 et seq.), we certify that except for occasional transient individuals, no federally proposed or listed endangered or threatened species are known to exist within the project area. Therefore, no Biological Assessment or further section 7 consultation with the U.S. Fish and Wildlife Service is required. Should project plans change, or if additional information on the distribution of listed or proposed species becomes available, this determination may be reconsidered.

This response relates only to federally protected threatened or endangered species under our jurisdiction. For additional information on threatened or endangered species in Maryland, you should contact the Maryland Wildlife and Heritage Division at (410) 260-8573. For information in Delaware you should contact the Delaware Division of Fish and Wildlife, Wildlife Species Conservation and Research Program at (302) 735-8658. For information in the District of Columbia, you should contact the National Park Service at (202) 339-8309.

The U.S. Fish and Wildlife Service also works with other Federal agencies and states to minimize loss of wetlands, reduce impacts to fish and migratory birds, including bald eagles, and restore habitat for wildlife. Information on these conservation issues and how development projects can avoid affecting these resources can be found on our website (www.fws.gov/chesapeakebay)

We appreciate the opportunity to provide information relative to fish and wildlife issues, and thank you for your interest in these resources. If you have any questions or need further assistance, please contact Chesapeake Bay Field Office Threatened and Endangered Species program at (410) 573-4527.

Sincerely,

Genevieve LaRouche
Field Supervisor

300 Authority Drive
Baltimore MD 21222-2200
410-537-7500
410-537-7803 (fax)
711 (MD Relay)
1-888-754-0098

e-mail: mdta@
mdta.maryland.gov

www.mdta.maryland.gov

February 8, 2018

Mr. Tony Redman
Maryland Department of Natural Resources
Environmental Review Program, ERP
Tawes State Office Building C-3
580 Taylor Avenue
Annapolis, Maryland 21401

RE: Maryland Transportation Authority (MDTA)
I-95 Express Toll Lanes Northbound Extension
Carsins Run Stream Restoration
MDTA Tracking # KH-3009
Aberdeen, Harford County, Maryland
Fisheries Information Request

Dear Mr. Redman:

The Maryland Transportation Authority is considering stream restoration along an approximately 500 linear foot segment of Carsins Run (upstream and downstream of I-95) and an intermittent tributary to Carsins Run that originates at a wetland, upstream of I-95 and northeast of Ripken Stadium. Stream restoration efforts would serve as compensatory mitigation for unavoidable impacts incurred during construction of the I-95 Express Toll Lanes Northbound Extension project. A map of the project location has been included for your reference.

We request any information concerning resident fish and anadromous fish or additional water quality considerations within the study area. Please include the MDTA tracking information listed in the subject line above in all future correspondence. If you have questions regarding this request or require additional information to complete your review, please contact me at wpines@mdta.state.md.us or (410) 931-0808.

Sincerely,

William N. Pines, P.E.
Director of Project Development

Enclosure

Cc:
JMT: Leyla Lange, Michael Rothenheber
KCI: Jennifer Bird
CDM Smith: David Greenwood

MDTA
Maryland Transportation Authority

300 Authority Drive
Baltimore MD 21222-2200
410-537-7500
410-537-7803 (fax)
711 (MD Relay)
1-888-754-0098

e-mail: mdta@mdta.maryland.gov

www.mdta.maryland.gov

February 8, 2018

Ms. Lori Byrne, Environmental Review Division
Maryland Department of Natural Resources
Wildlife and Heritage Service
Tawes State Office Building E-1
580 Taylor Avenue
Annapolis, Maryland 21401

RE: Maryland Transportation Authority (MDTA)
I-95 Express Toll Lanes Northbound Extension
Carsins Run Stream Restoration
MDTA Tracking # KH-3009
Aberdeen, Harford County, Maryland
Threatened and Endangered Species and Unique Habitat Information Request

Dear Ms. Byrne:

The Maryland Transportation Authority is considering stream restoration along an approximately 500 linear foot segment of Carsins Run (upstream and downstream of I-95) and an intermittent tributary to Carsins Run that originates at a wetland, upstream of I-95 and northeast of Ripken Stadium. Stream restoration efforts would serve as compensatory mitigation for unavoidable impacts incurred during construction of the I-95 Express Toll Lanes Northbound Extension project. A map of the project location has been included for your reference.

We request any information concerning federally or state-listed rare, threatened or endangered species and unique habitat that may occur in the study area. Please include the MDTA tracking information listed in the subject line above in all future correspondence. If you have questions regarding this request or require additional information to complete your review, please contact me at wpines@mdta.state.md.us or (410) 931-0808.

Sincerely,

William N. Pines, P.E.
Director of Project Development

Enclosure

Cc:
JMT: Leyla Lange, Michael Rothenheber
KCI: Jennifer Bird
CDM Smith: David Greenwood

February 8, 2018

300 Authority Drive
Baltimore MD 21222-2200
410-537-7500
410-537-7803 (fax)
711 (MD Relay)
1-888-754-0098

e-mail: mdta@
mdta.maryland.gov

www.mdta.maryland.gov

Ms. Elizabeth Hughes
State Historic Preservation Officer
Maryland Historic Trust
100 Community Place, 3rd floor
Crownsville, MD 21032-2023

Attention: Ms. Beth Cole

RE: Maryland Transportation Authority (MDTA)
I-95 Express Toll Lanes Northbound Extension
Carsins Run Stream Restoration
MDTA Tracking # KH-3009
Aberdeen, Harford County, Maryland
Historic Properties and Archeological Resources Information Request

Dear Ms. Hughes:

The Maryland Transportation Authority is considering stream restoration along an approximately 500 linear foot segment of Carsins Run (upstream and downstream of I-95) and an intermittent tributary to Carsins Run that originates at a wetland, upstream of I-95 and northeast of Ripken Stadium. Stream restoration efforts would serve as compensatory mitigation for unavoidable impacts incurred during construction of the I-95 Express Toll Lanes Northbound Extension project. A map of the project location has been included for your reference.

We request any information concerning historic or archeological resources within the vicinity of the study area. Please include the MDTA tracking information listed in the subject line above in all future correspondence. If you have questions regarding this request or require additional information to complete your review, please contact me at wpines@mdta.state.md.us or (410) 931-0808.

Sincerely,

William N. Pines, P.E.
Director of Project Development

Enclosure

Cc:
JMT: Leyla Lange, Michael Rothenheber
KCI: Jennifer Bird
CDM Smith: David Greenwood

APPENDIX F

Qualification of Preparer

MARYLAND
DEPARTMENT OF NATURAL RESOURCES

Martin O'Malley, Governor
Anthony G. Brown, Lt. Governor
John R. Griffin, Secretary
Joseph P. Gill, Deputy Secretary

September 6, 2011

Jennifer Bird
1717 Dogwood Dr.
Frederick, MD 21701

Dear Ms. Bird:

The Maryland Department of Natural Resources has reviewed your application for qualified professional status for the purpose of developing Forest Stand Delineations and Forest Conservation Plans. We are happy to inform you that you meet the requirements of COMAR 08.19.06.01 for qualified professional status.

Your name will be included on a list of qualified professionals to be sent to the jurisdictions with authority to review Forest Stand Delineations and Forest Conservation Plans.

Participation by professionals like you is key to successful implementation of the Forest Conservation Act. Thank you for submitting your application.

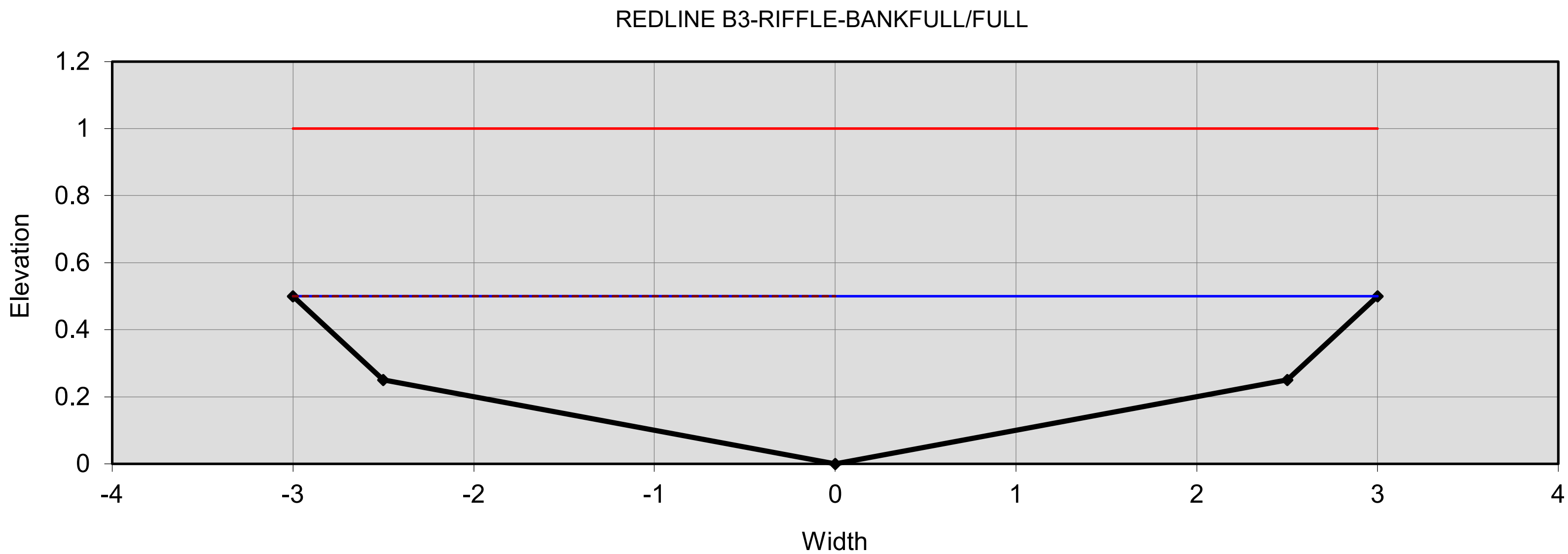
Sincerely,

Steven W. Koehn

Steven W. Koehn
Director/State Forester

APPENDIX F
PROPOSED SECTIONS

Cross Section



Bankfull Dimensions	
2.0	x-section area (ft.sq.)
6.0	width (ft)
0.3	mean depth (ft)
0.5	max depth (ft)
6.1	wetted parimeter (ft)
0.3	hyd radi (ft)
18.0	width-depth ratio

Flood Dimensions	
9.0	W flood prone area (ft)
1.5	entrenchment ratio
0.5	low bank height (ft)
1.0	low bank height ratio

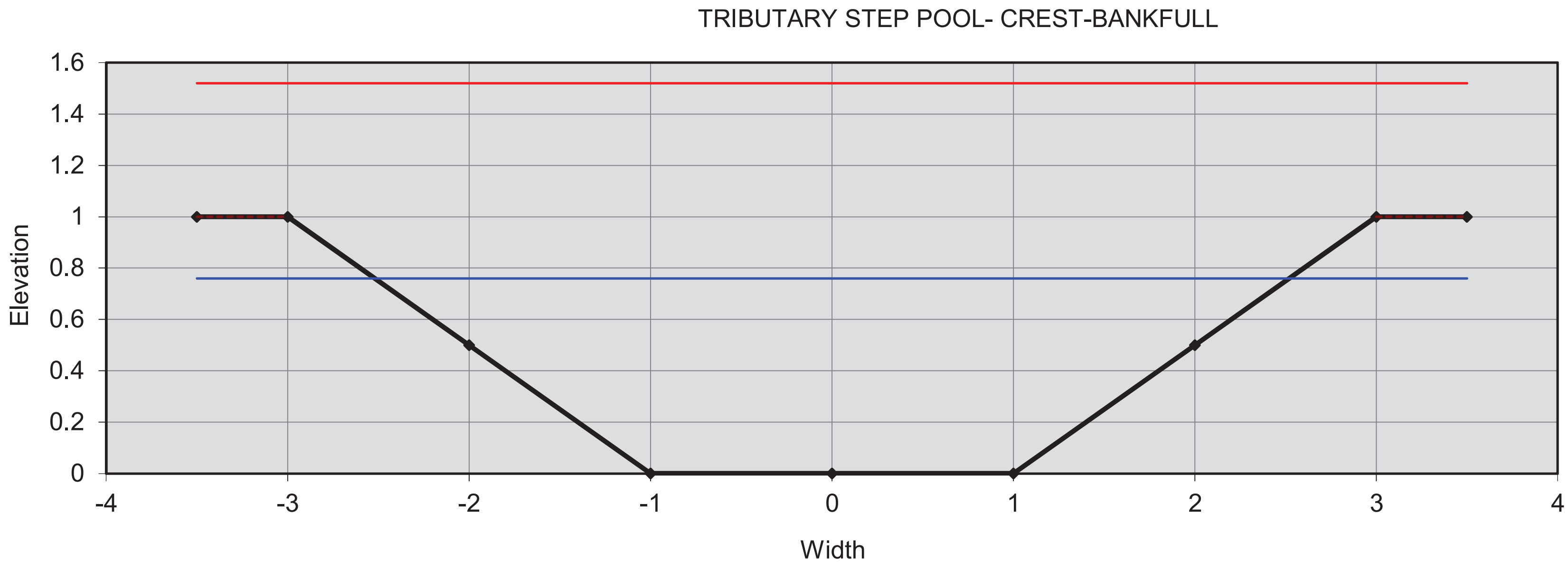
Materials	
---	D50 (mm)
---	D84 (mm)
31	threshold grain size (mm):

Bankfull Flow	
3.1	velocity (ft/s)
6.2	discharge rate (cfs)
0.96	Froude number

Flow Resistance	
0.040	Manning's roughness
0.27	D'Arcy-Weisbach fric.
---	resistance factor u/u*
---	relative roughness

Forces & Power	
3.1	channel slope (%)
0.63	shear stress (lb/sq.ft.)
0.57	shear velocity (ft/s)
2	unit strm power (lb/ft/s)

Cross Section Crest



Bankfull Dimensions

2.7	x-section area (ft.sq.)
5.0	width (ft)
0.5	mean depth (ft)
0.8	max depth (ft)
5.4	wetted parimeter (ft)
0.5	hyd radi (ft)
9.5	width-depth ratio

Flood Dimensions

10.2	W flood prone area (ft)
2.0	entrenchment ratio
1.0	low bank height (ft)
1.2	low bank height ratio*

Materials

---	D50 (mm)
---	D84 (mm)
99	threshold grain size (mm):

Bankfull Flow

2.4	velocity (ft/s)
6.4	discharge rate (cfs)
0.60	Froude number

Flow Resistance

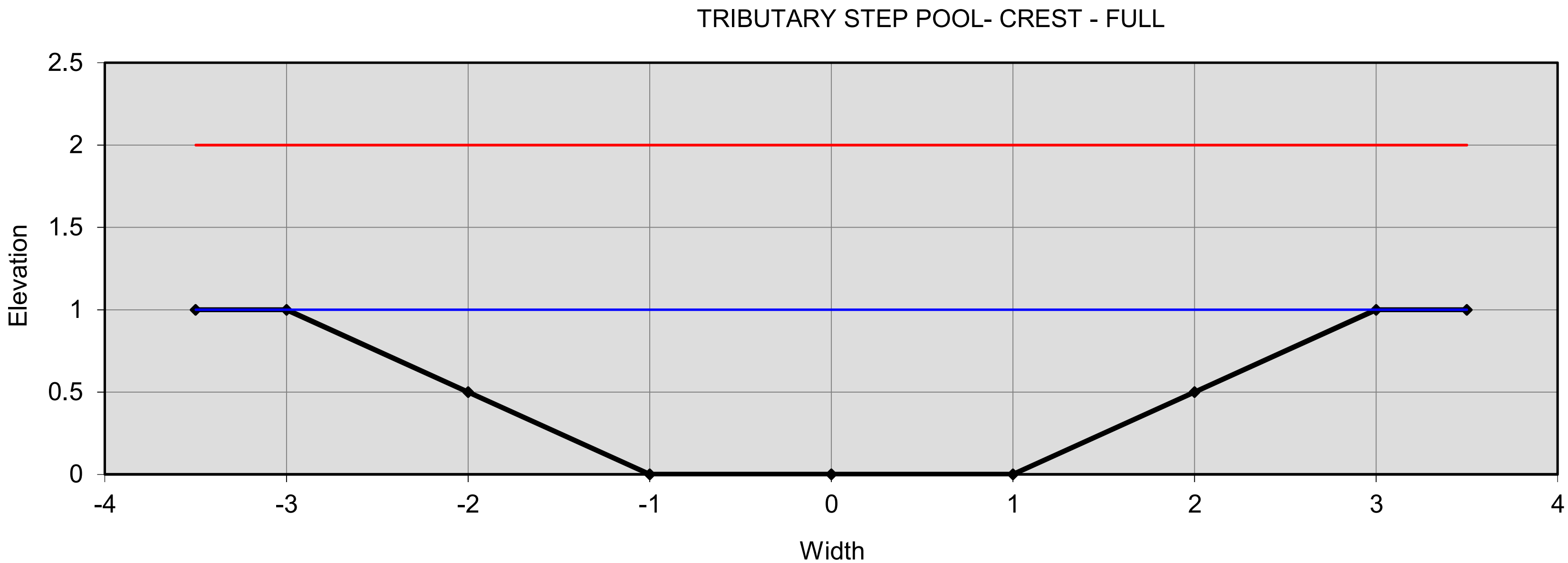
0.100	Manning's roughness
1.47	D'Arcy-Weisbach fric.
---	resistance factor u/u*
---	relative roughness

Forces & Power

6.5	channel slope (%)
2.01	shear stress (lb/sq.ft.)
1.02	shear velocity (ft/s)
5.1	unit strm power (lb/ft/s)

*Constructed section geometry and resulting BHR will vary due to irregularity of boulders and riprap.

Cross Section Crest



Bankfull Dimensions

4.0	x-section area (ft.sq.)
6.0	width (ft)
0.7	mean depth (ft)
1.0	max depth (ft)
6.5	wetted parimeter (ft)
0.6	hyd radi (ft)
9.0	width-depth ratio

Flood Dimensions

---	W flood prone area (ft)
---	entrenchment ratio
---	low bank height (ft)
---	low bank height ratio

Materials

---	D50 (mm)
---	D84 (mm)
123	threshold grain size (mm):

Bankfull Flow

2.8	velocity (ft/s)
11.0	discharge rate (cfs)
0.62	Froude number

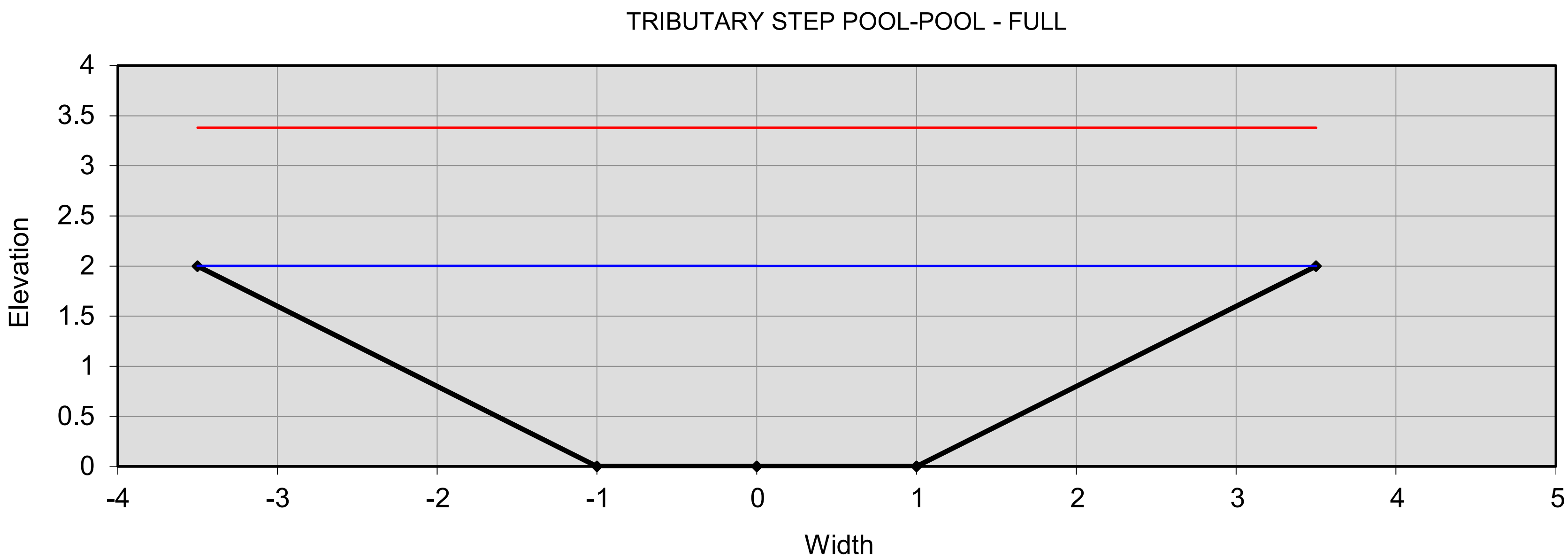
Flow Resistance

0.100	Manning's roughness
1.36	D'Arcy-Weisbach fric.
---	resistance factor u/u*
---	relative roughness

Forces & Power

6.5	channel slope (%)
2.51	shear stress (lb/sq.ft.)
1.14	shear velocity (ft/s)
7.5	unit strm power (lb/ft/s)

Cross Section



Bankfull Dimensions	
9.0	x-section area (ft.sq.)
7.0	width (ft)
1.3	mean depth (ft)
2.0	max depth (ft)
8.4	wetted parimeter (ft)
1.1	hyd radi (ft)
5.4	width-depth ratio

Flood Dimensions	
---	W flood prone area (ft)
---	entrenchment ratio
---	low bank height (ft)
---	low bank height ratio

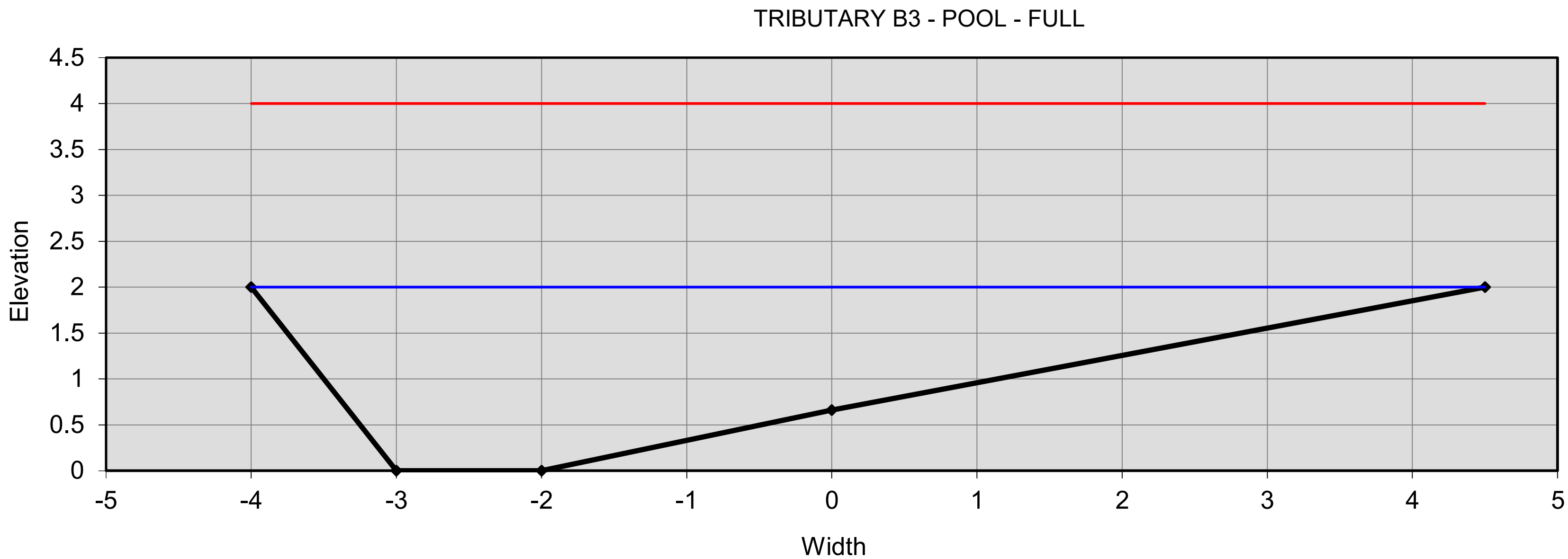
Materials	
---	D50 (mm)
---	D84 (mm)
72	threshold grain size (mm):

Bankfull Flow	
---	velocity (ft/s)
---	discharge rate (cfs)
---	Froude number

Flow Resistance	
---	Manning's roughness
---	D'Arcy-Weisbach fric.
---	resistance factor u/u*
---	relative roughness

Forces & Power	
2.2	channel slope (%)
1.47	shear stress (lb/sq.ft.)
0.87	shear velocity (ft/s)
---	unit strm power (lb/ft/s)

Cross Section



Bankfull Dimensions	
9.4	x-section area (ft.sq.)
8.5	width (ft)
1.1	mean depth (ft)
2.00	max depth (ft)
10.0	wetted parimeter (ft)
0.9	hyd radi (ft)
7.7	width-depth ratio

Flood Dimensions	
---	W flood prone area (ft)
---	entrenchment ratio
---	low bank height (ft)
---	low bank height ratio

Materials	
---	D50 (mm)
---	D84 (mm)
63	threshold grain size (mm):

Bankfull Flow	
---	velocity (ft/s)
---	discharge rate (cfs)
---	Froude number

Flow Resistance	
---	Manning's roughness
---	D'Arcy-Weisbach fric.
---	resistance factor u/u*
---	relative roughness

Forces & Power	
2.2	channel slope (%)
1.28	shear stress (lb/sq.ft.)
0.81	shear velocity (ft/s)
---	unit strm power (lb/ft/s)

Contract documents allow for the top of bank to be lowered up to 0.5' to provide additional floodplain access at the direction of the Engineer.

Cross Section

Bankfull Dimensions

44.0	x-section area (ft.sq.)
32.0	width (ft)
1.4	mean depth (ft)
2.0	max depth (ft)
32.5	wetted parimeter (ft)
1.4	hyd radi (ft)
23.3	width-depth ratio

Flood Dimensions

40.0	W flood prone area (ft)
1.3	entrenchment ratio
---	low bank height (ft)
---	low bank height ratio

Materials

---	D50 (mm)
---	D84 (mm)
36	threshold grain size (mm):

Bankfull Flow

4.2	velocity (ft/s)
186.9	discharge rate (cfs)
0.64	Froude number

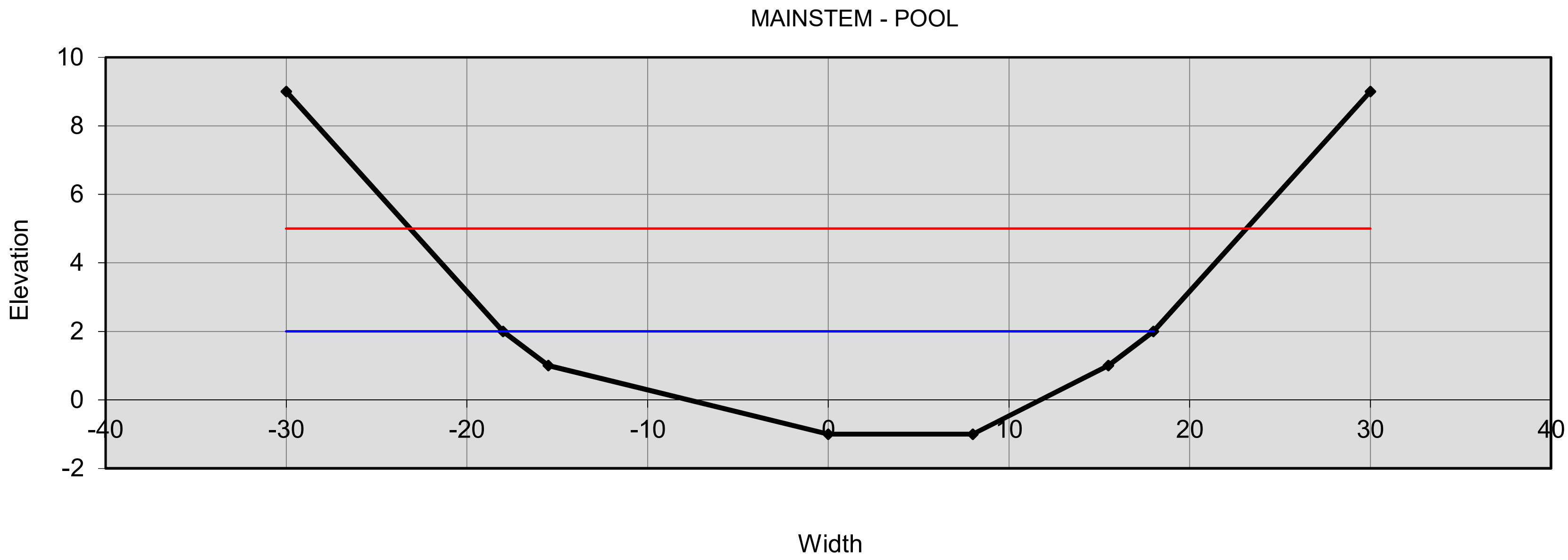
Flow Resistance

0.040	Manning's roughness
0.17	D'Arcy-Weisbach fric.
---	resistance factor u/u*
---	relative roughness

Forces & Power

0.87	channel slope (%)
0.73	shear stress (lb/sq.ft.)
0.62	shear velocity (ft/s)
3.2	unit strm power (lb/ft/s)

Cross Section



Bankfull Dimensions

72.5	x-section area (ft.sq.)
36.0	width (ft)
2.0	mean depth (ft)
3.0	max depth (ft)
36.8	wetted parimeter (ft)
2.0	hyd radi (ft)
17.9	width-depth ratio

Flood Dimensions

46.3	W flood prone area (ft)
1.3	entrenchment ratio
---	low bank height (ft)
---	low bank height ratio

Materials

---	D50 (mm)
---	D84 (mm)
133	threshold grain size (mm):

Bankfull Flow

---	velocity (ft/s)
---	discharge rate (cfs)
---	Froude number

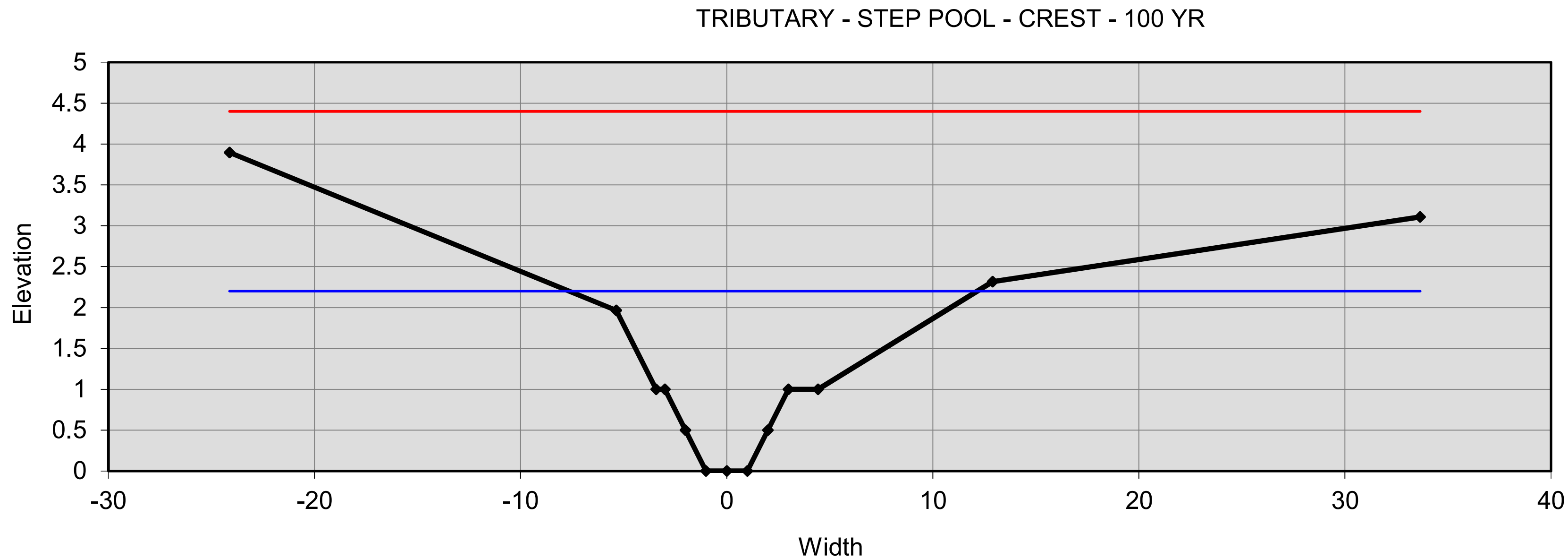
Flow Resistance

---	Manning's roughness
---	D'Arcy-Weisbach fric.
---	resistance factor u/u*
---	relative roughness

Forces & Power

2.2	channel slope (%)
2.71	shear stress (lb/sq.ft.)
1.18	shear velocity (ft/s)
---	unit strm power (lb/ft/s)

Cross Section Crest



Bankfull Dimensions	
19.7	x-section area (ft.sq.)
19.8	width (ft)
1.0	mean depth (ft)
2.2	max depth (ft)
20.6	wetted parimeter (ft)
1.0	hyd radi (ft)
19.9	width-depth ratio

Flood Dimensions	
---	W flood prone area (ft)
---	entrenchment ratio
---	low bank height (ft)
---	low bank height ratio

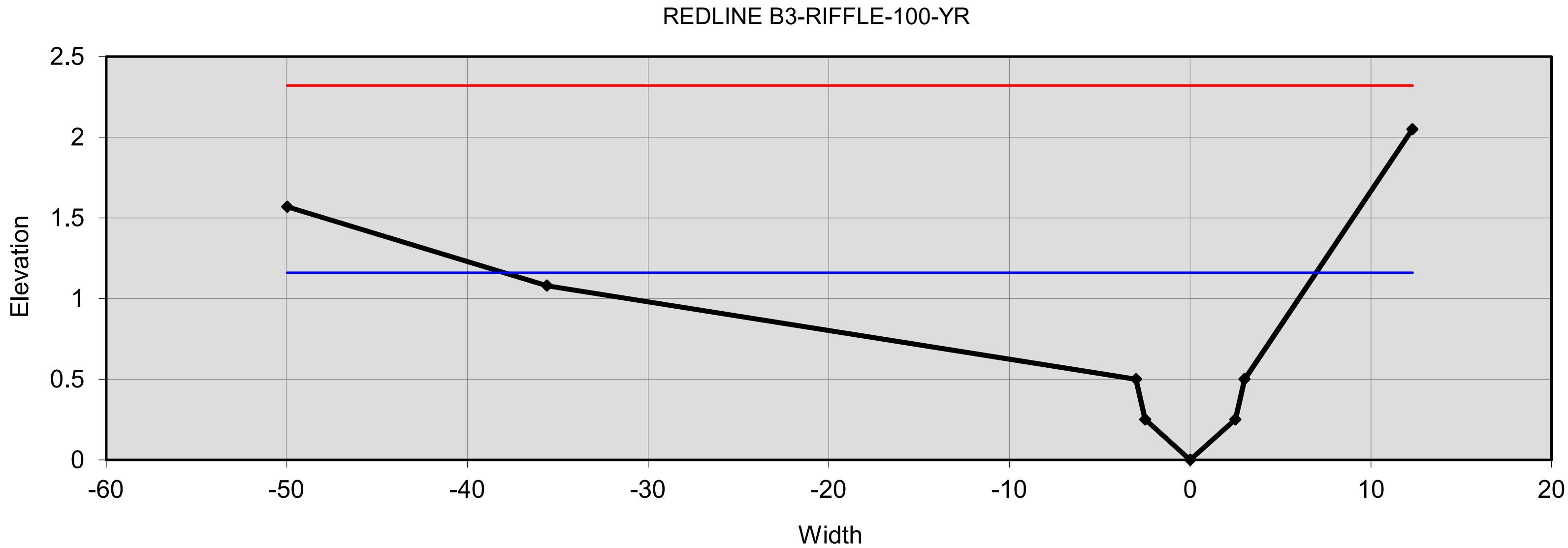
Materials	
---	D50 (mm)
---	D84 (mm)
191	threshold grain size (mm):

Bankfull Flow	
3.7	velocity (ft/s)
72.7	discharge rate (cfs)
0.66	Froude number

Flow Resistance	
0.100	Manning's roughness
1.18	D'Arcy-Weisbach fric.
---	resistance factor u/u*
---	relative roughness

Forces & Power	
6.5	channel slope (%)
3.88	shear stress (lb/sq.ft.)
1.42	shear velocity (ft/s)
14.9	unit strm power (lb/ft/s)

Cross Section



Bankfull Dimensions	
19.4	x-section area (ft.sq.)
44.9	width (ft)
0.4	mean depth (ft)
1.2	max depth (ft)
45.1	wetted parimeter (ft)
0.4	hyd radi (ft)
103.8	width-depth ratio

Flood Dimensions	
20.0	W flood prone area (ft)
0.4	entrenchment ratio
0.5	low bank height (ft)
0.4	low bank height ratio

Materials	
---	D50 (mm)
---	D84 (mm)
41	threshold grain size (mm):

Bankfull Flow	
3.7	velocity (ft/s)
72.7	discharge rate (cfs)
1.00	Froude number

Flow Resistance	
0.040	Manning's roughness
0.25	D'Arcy-Weisbach fric.
---	resistance factor u/u*
---	relative roughness

Forces & Power	
3.1	channel slope (%)
0.83	shear stress (lb/sq.ft.)
0.66	shear velocity (ft/s)
3.1	unit strm power (lb/ft/s)

APPENDIX G
PROPOSED STONE SIZING COMPUTATIONS

Bank Material Sizing by Velocity

Project Name: Carsin's Run **Reflects Redline Revision 2020**
Project Number: 22145228.47
Designed: HS **Checked:** SL
River: Tributary to Carsin's Run

Maximum Channel Velocity:

Sta.	Reach	Feature Type	HEC-RAS Station	Channel Velocity (ft/s)	Storm Event
27+53	Reach 4	Pool Pavement	193.16	4.80	10 yr existing
27+53	Reach 4	Pool Pavement	64.76	5.98	100 yr existing
25+53	Reach 3	Toe Boulder	393.08	5.54	10 yr existing
25+53	Reach 3	Toe Boulder	393.08	8.37	100 yr existing
23+94	Reach 2b	Pool Pavement	552.49	4.44	10 yr existing
23+94	Reach 2b	Pool Pavement	552.49	5.84	100 yr existing
22+33	Reach 2a/No Restoration	Pool Pavement	713.14	3.69	10 yr existing
22+33	Reach 2a/No Restoration	Pool Pavement	713.14	5.74	100 yr existing
20+50	Reach 1	Toe Boulder	896.36	8.23	10 yr existing
20+50	Reach 1	Toe Boulder	896.36	9.99	100 yr existing
13+41	Mainstem	RGCM	922	7.77	1 yr existing
13+41	Mainstem	RGCM	922	9.37	2 yr existing

Requires Input

(1) Enter identifying data of each design feature and max velocity at each feature HEC-RAS station based on storm event

Isbash Equation:

$$v = c * \sqrt{2g * \frac{\rho_s - \rho_w}{\rho_w}} * D^{1/2}$$

Therefore,

$$D = \left(\frac{v}{c * \sqrt{2g * \frac{\rho_s - \rho_w}{\rho_w}}} \right)^2$$

Where,

D = threshold grain size (ft), spherical diameter of stone
v = Velocity (ft/s)
c = Isbash constant (0.86 for high turbulence level flow)
g = Acceleration of gravity, 32.2 ft/s^2
ρ_s = Specific stone weight, 160 lbs/ft^3
ρ_w = Specific weight of water, 62.4 lbs/ft^3

References: Isbash 1936, USACE 1970, USACE 1991, USDA 2007 TS14C
https://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17812.wba

Minimum Stone Size:

Sta.	Channel Location	Feature Type	Threshold Grain Size (ft)	Equivalent Stone Weight (assume 160 lbs/ft³)	Safety Factor	Minimum Stone Weight (lbs)	Minimum Stone Size (ft)
27+53	Reach 4	Pool Pavement	0.31	2	1.2	3	0.33 ft
27+53	Reach 4	Pool Pavement	0.48	9	1.2	11	0.51 ft
25+53	Reach 3	Toe Boulder	0.41	6	1.2	7	0.44 ft
25+53	Reach 3	Toe Boulder	0.94	70	1.2	84	1.00 ft
23+94	Reach 2b	Pool Pavement	0.26	2	1.2	2	0.28 ft
23+94	Reach 2b	Pool Pavement	0.46	8	1.2	10	0.49 ft
22+33	Reach 2a/No Restoration	Pool Pavement	0.18	1	1.2	1	0.19 ft
22+33	Reach 2a/No Restoration	Pool Pavement	0.44	7	1.2	9	0.47 ft
20+50	Reach 1	Toe Boulder	0.91	63	1.2	76	0.97 ft
20+50	Reach 1	Toe Boulder	1.34	201	1.2	242	1.42 ft
13+41	Mainstem	RGCM	0.81	45	1.2	53	0.86 ft
13+41	Mainstem	RGCM	1.18	137	1.2	164	1.25 ft

Bed Boulder Material Sizing by Critical Shear Stress

Project Name: Carsin's Run Stream Mitigation **Reflects Redline Revision 2020**
Project Number: 22145228.47
Designed: HS **Checked: SL**
River: Tributary to Carsin's Run

KCI TECHNOLOGIES

Maximum Channel Shear:

Sta.	Sub-Reach	Feature Type	HEC-RAS Station	Channel Shear	Storm Event
27+53	Reach 4	Step Pool Crests	193.16	6.86	10yr Existing
27+53	Reach 4	Step Pool Crests	193.16	8.95	100yr Existing
25+53	Reach 3	RGC Sill	393.08	1.55	10yr Existing
25+53	Reach 3	RGC Sill	393.08	3.09	100yr Existing
23+94	Reach 2b	Step Pool Crests	552.49	6.07	2yr Existing**
23+94	Reach 2b	Step Pool Crests	552.49	8.77	100yr Existing
22+33	No Restoration	N/A	713.14	3.81	10yr Existing
22+33	No Restoration	N/A	713.14	8.21	100yr Existing
22+27	Reach 2a/No Restoration	Tie in	719.16	2.34	10yr Existing
22+27	Reach 2a/No Restoration	Tie in	719.16	4.80	100yr Existing
20+50	Reach 1	RGC Sill	896.36	3.86	10yr Existing
20+50	Reach 1	RGC Sill	896.36	4.72	100yr Existing
10+90	Mainstem	Outfall Confluence	1180	3.11	10yr Existing
10+90	Mainstem	Outfall Confluence	1180	3.12	100yr Existing

Requires Input

(1) Enter identifying data of each design feature and max shear at each feature HEC-RAS station based on storm event

*- This section is the transistion between 2b and 3

**- Note that they 2 year shear is greater than the 10 year shear

Critical Shear Stress (t_c) Equation:

$$\tau_c = \tau_{ci}^*(\rho_s - \rho_w) g I$$

Therefore,

$$D = \frac{\tau_c}{\tau_{ci}^*(\rho_s - \rho_w) g}$$

Where,

ρ_s = 5.15 slugs/ft^3 (quartz sediment)
ρ_w = 1.94 slugs/ft^3
g = 32.2 ft/sec^2
D = threshold grain size (ft)
t^*_{ci} = dimensionless critical shear stress. For steeper step-pool streams with little sediment supply, studies find that a critical shear stress of 0.17 to 0.67 better relates to measured bed material mobilized at bankfull (Bunte, 2010). Therefore we applied 0.03 for Reaches 1 & 3 & Mainstem; and 0.05 for Reaches 2 & 4 that are steep.

Reference: Shields 1936

Minimum Stone Size:

Sta.	Sub-Reach	Feature Type	Dimensionless Critical Shear Stress	Threshold Grain Size (ft)	Equivalent Stone Weight (assume 160 lbs/ft³)	Safety Factor	Minimum Stone Weight (lbs)	Minimum Stone Size (ft)
27+53	Reach 4	Step Pool Crests	0.05	1.33	196	1.2	235	**1.4 ft**
27+53	Reach 4	Step Pool Crests	0.05	1.73	435	1.2	522	**1.8 ft**
25+53	Reach 3	RGC Sill	0.03	0.50	10	1.2	13	**0.5 ft**
25+53	Reach 3	RGC Sill	0.03	1.00	83	1.2	99	**1.1 ft**
23+94	Reach 2b	Step Pool Crests	0.05	1.17	136	1.2	163	**1.2 ft**
23+94	Reach 2b	Step Pool Crests	0.05	1.70	409	1.2	491	**1.8 ft**
22+33	No Restoration	N/A	0.05	0.74	34	1.2	40	**0.8 ft**
22+33	No Restoration	N/A	0.05	1.59	336	1.2	403	**1.7 ft**
22+27	Reach 2a/No Restoration	Tie in	0.05	0.45	8	1.2	9	**0.5 ft**
22+27	Reach 2a/No Restoration	Tie in	0.05	0.93	67	1.2	81	**1.0 ft**
20+50	Reach 1	RGC Sill	0.03	1.24	162	1.2	194	**1.3 ft**
20+50	Reach 1	RGC Sill	0.03	1.52	295	1.2	354	**1.6 ft**
9+22	Mainstem	RGCM	0.03	1.00	84	1.2	101	**1.1 ft**
9+22	Mainstem	RGCM	0.03	1.01	85	1.2	102	**1.1 ft**

Bed Material Mix Based on Colorado Curve

Project Name: **Carsins Run**
Project Number: **22145228.47**
Designed: **Checked: SL**
River: Carsins Run & Tributary to Carsins Run
Reflects Redline Revision 2020
***Maximum 10-year shear in Reaches 1/3**

Where:

Rosgen Colorado Curve data (tau in lbs/ft2)

dmax (mm) = 152.02tau^(0.7355)

	RGC		RGC	
Channel	**Mainstem**		**Trib***	Requires Input
tau (lb/ft^2)	4.58		3.86	(1) Enter max shear at channel location
dmax (mm)	465.6		410.5	(2) dmax (mm) computed by Rosgen Curve
dmax (in)	18.3		16.2	(3) dmax (mm) converted to dmax (in)

Mix Gradations:

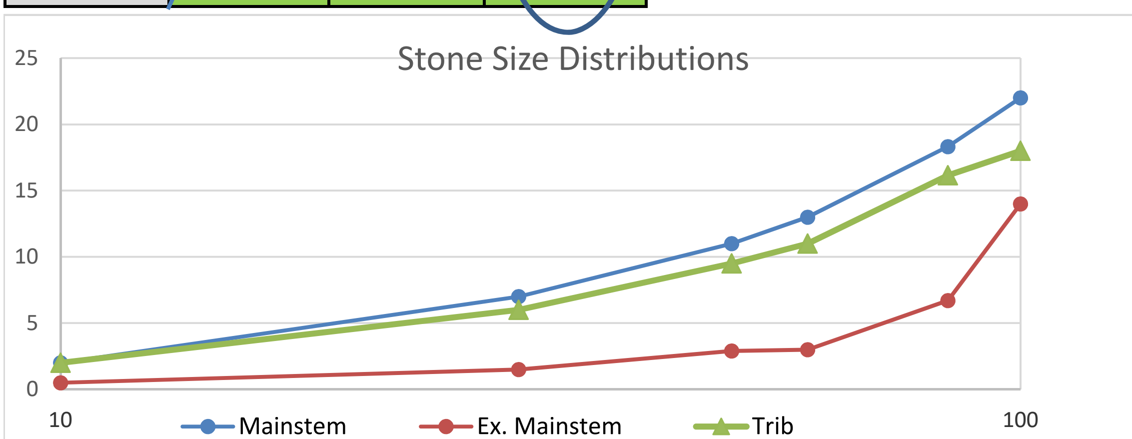
Where:

Coefficient of Curvature: $Cz = d30^2 / (d60*d10)$ (Craig 1993)

The Cz of a well mixed bed ranges between 1 and 3

% less than	Mainstem	Ex. Mainstem	Trib	
10	2.0	0.5	2.0	
30	7.0	1.5	6.0	
50	11.0	2.9	9.5	
60	13.0	3.0	11.0	
84	18.3	6.7	16.2	(4) dmax (in) set to equal D84
100	22.0	14.0	18.0	(5) manually
Cz	1.9	1.5	1.6	

The specified RGC Mix will be sufficient to withstand predicted shear stress in the Trib, and is larger than the existing Mainstem riffle material, which appears stable.



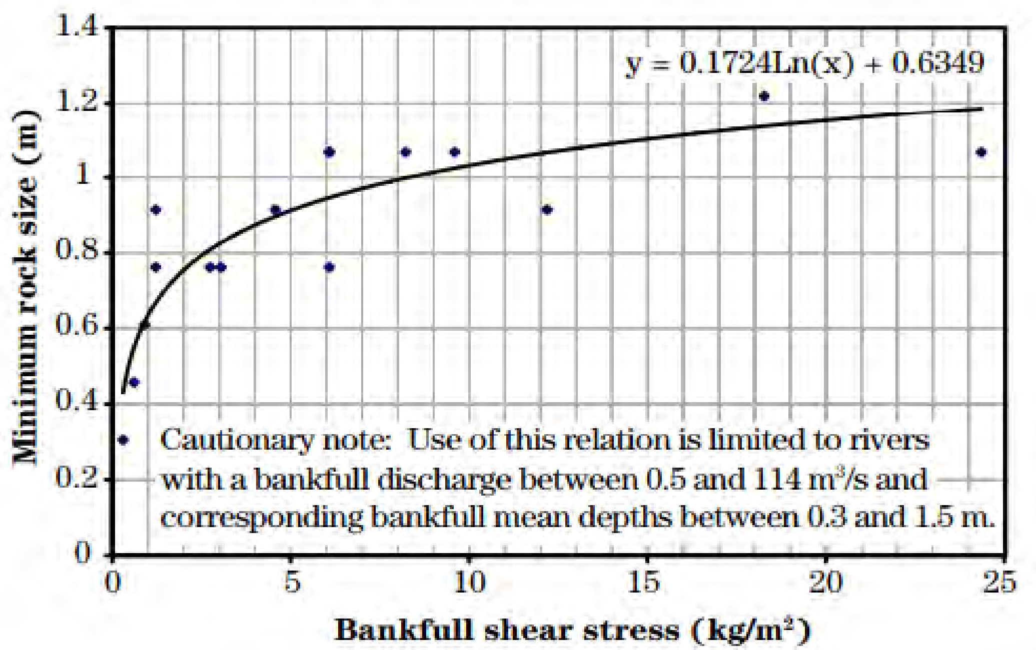
W-Weir Stone Sizing by Shear Stress

Project Name: **CARSINS**
Project Number: **22145228.470**
Designed: HS **Checked: SL**
River: Tributary to Carsin's Run

Where:

Based on Part 654 Chapter 11 Figure 11-43 Rock Size
https://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17771.wba

Figure 11–43 Rock size



Sub-Reach	Feature Type	Maximum Channel 2-year Shear (lb/sf)	Maximum Channel Shear (kg/sm)	Minimum Rock Size (m)	Minimum Rock Size (ft):
MAINSTEM	WWEIR	4.58	22.36	1.17	**3.54**

APPENDIX H
PROPOSED SCOUR COMPUTATIONS

Footer Scour Analysis by Maximum Velocity

Project Name: Carsin's Run

Project Number: 22145228.47

Designed: HS **Checked: SL**

River: **Tributary to Carsin's Run/Carsin's Run**

Summary of Estimated Scour Depths

Location	Baseline Station	HECRAS Station	Riprap Class	Applicable Stationing	Storm Event	Velocity (ft/s)	Blench/ Lacey Scour (Largest Value) (ft)	Bend Scour Meynard (ft)	Proposed Footer Depth (ft)
Tributary Reach 1	20+50	896.36	I Boulders	Reach 1	100	6.6	0.71	0.37	Riffle Sill: 3.0 Toe Boulder: 1.3
Tributary Reach 2b	23+94	552.49	II/III Boulders	Reach 2a, 2b, 4	100	5.84	0.88	NA	Step Pool Crest: 3.0
Tributary Reach end 2b	24+28	518.16	II/III Boulders	Reach 2a, 2b, 4	100	8.29	1.48	0.61	Step Pool Crest: 3.0
Tributary Reach 3	25+53	393.08	I Boulders	Reach 3	100	8.89	0.71	0.45	Riffle Sill: 3.0 Toe Boulder: 1.3
Mainstem	13+41	922	Imbricated III	14+02 to 14+33	1-yr	7.77	1.41	NA	W-Weir: 3.0
Mainstem	13+41	922	Imbricated III	14+02 to 14+33	10-yr	5.27	2.46	NA	

Input Assumptions for PBSJ spreadhseet:

1. D50/D90 are existing bed material
2. Bend radius conservatively estimated as 3 times the width of the channel
3. Manning's 'n' is the designed 'n' value for the given reach
4. Minor adjustment to HEC-RAS subsequent to scour analysis.

Tributary Reach 1, HEC-RAS Section 896.36, 100-YR

GENERAL SCOUR

Zeller General Scour	Value	Description
Reference: Simons Li & Associates, 1985		
y_{max}	1.39	feet. Maximum depth of flow
V_m	9.08	ft/s. Average velocity of flow
Y_h	0.35	feet. Hydraulic or mean depth of flow
S_e	0.058	Energy slope (or bed slope or uniform slope)
$y_{gs, calculated}$	0.598467214	feet. $=y_{max}$ [(0.0685 $V_m^{0.8}$) / ($y_h^{0.4}$ $S_e^{0.3}$) -1]. Zeller equation general scour depth.
$y_{gs,}$ (minimum 0)	**0.598467214**	feet. Zeller General Scour (greater of 0 or Zeller equation).

Neill Incised	**Value**	**Description**
Reference: Neill, 1973		
y_i	0.49	feet. average depth at bankfull discharge in incised reach
q_f	2.218844985	(ft3/s/ft). Design flood discharge per unit width
$Q_{bankfull}$	6.4	cfs. Bankfull or channel forming discharge
$W_{bankfull}$	5.5	feet. Bankfull width.
q_i	1.163636364	(ft^3/s/ft). Bankfull discharge in incised reach per unit width
m	0.85	exponent varying from 0.67 for sand to 0.85 for coarse gravel
y_f	0.848123908	feet. Scoured depth (general scour) below design floodwater level
Z	0.7	Neill Incised Z
		$=Z * y_f$
y_s	**0.593686736**	Neill general scour below streambed.

Blench Zero Bed Factor	Value	Description
Reference: Pemberton & Lara, 1984		
q_f	2.218844985	cfs/ft. Design discharge per unit width.
D_{50}	25	mm.
F_{b0}	4.11116356	$ft^{2/}s$. Blench's "zero bed factor," (interpolated)
		feet. Water depth for zero bed sediment transport
y_{f0}	1.061931222	$= q_f^{2/3} / F_{b0}^{1/3}$
Degree of bend	severe	
Z	0.6	Blench Z
		feet. $=Z * y_{f0}$
y_s	**0.637158733**	Blench general scour below streambed.

Lacey	Value	Description
Reference: ASCE, Predicting Bed Scour, 2005		
Q	73	design discharge, (ft^3/s)
d_m	25	mean grain size of bed material (mm)
f	8.8	Lacey's silt factor = 1.76 $(D_m)^{1/2}$
Use Laceys regime equation for mean depth?	yes	
Mean depth using Lacey's regime eq.	0.951432365	feet.
Mean depth from inputs	0.35	feet.
y_m	0.951432365	feet. Mean water depth for Lacey scour equation.
Z	0.75	Lacey Z
y_s	**0.713574273**	feet. $=Z * y_m$. Scour depth below streambed

Neill Competent Velocity	**Value**	Description
Reference: Pemberton & Lara, 1984		
D_{50}	25	mm
y_m	0.35	mean depth, (ft)
V_c	#N/A	ft/sec. Competent mean velocity (interpolated)
V_m	9.08	mean velocity, (ft/s)
		$=y_m (V_m / V_c - 1)$
y_s	**#N/A**	scour depth below streambed, (ft)

USBR Envelope Curve	Value	Description
Reference: Pemberton & Lara, 1984		
q	2.218844985	Unit discharge, cfs per foot width
ds	**2.966446739**	Scour depth, feet below streambed, from curve.
Within valid slope range	FALSE	
Within valid D_{50} range	FALSE	

USBR Mean Velocity Method	Value	Description
Reference: Pemberton & Lara, 1984		
Z	0.75	Lacey Z from Lacey's method
d_m	0.35	feet. Mean depth
d_s	**0.2625**	feet. Scour depth below streambed. $d_s = Z d_m$

Tributary Reach 1, HEC-RAS Section 896.36, 100-YR

BEND SCOUR

Zeller Bend Scour	Value	
Reference: Simons Li & Associates, 1985 (page 5.105-5.106)		
y_{max}	1.54	feet. Maximum Depth of upstream flow
V	6.6	fps. Mean velocity of upstream flow
y_h	0.38	feet. Hydraulic Depth of upstream flow
S_e	0.031	Upstream energy slope
W	90.5	feet. Channel topwidth of upstream flow
r_c	18	feet. Radius of curvature to centerline of channel
$\sin^2(\alpha/2)/\cos(\alpha)$	1.256944	Used in Zeller Bend Scour Equation
$y_{bs,}$ prelimiinary	2.388262	feet. Zeller Bend Scour, initial calculation
y_{bs}	**2.388262**	feet. Zeller Bend Scour, final (disallowing negative values)
Manning n-value	0.04	to calculate Chezy coefficient
Hydraulic Radius	0.35	feet.
Chezy coefficient	31.18675	
b	32.9	feet. Design discharge top width in the bend.
Superelevation	6.807896	feet. $= V_z^2\ b\ / (g\ r_c)$ (Equation 16-11, Chow) (based on top width, velocity, and radius of curvature, where b=W=topwidth)
Maximum depth of flow	1.39	feet.
y	8.197896	feet. Max depth of flow including superelevation on outside of bend
X	***103.6752***	feet. $= 2.3\ (C\ g^{1/2})\ y$. Distance downstream of end of curvature to where downstream currents have dissipated

Maynord Bend Scour	Value	Note: Not recommended where overbank depth exceeds 20% channel depth
Reference: Maynord, 1996 via ASCE, 2005		Comment
y_u	0.38	feet. Average water depth in crossing upstream of bend.
r_c	18	feet. Centerline radius of bend.
W_u	11.7	feet. Water surface width at upstream end of bend (active or bankfull width)
nominal r_c / W_u	1.538462	Equation limited to $r_c / W_u < 10$, ratio in equation set to 1.5 if less
r_c / W_u for equation	1.538462	dimensionless.
r_c / W_u within range	TRUE	
nominal W_u / y_u	30.78947	Equation limited to $W_u / y_u < 125$, ratio in equation set to 20 if less
nominal W_u / y_u for equation	30.78947	dimensionless.
W_u / y_u within range	TRUE	
y_{mxb}	0.752465	feet. $= y_u * (1.8 - 0.051\ (r_c / W_u) + 0.0084\ (W_u / y_u))$. Maximum water depth in bend.
y_{bs}	**0.372465**	feet. $= y_{mxb} - y_u$ = Below thalweg.

Thorne Bend Scour	Value	
Reference: Thorne et. al, 1995 via ASCE, 2005		
y_u	0.38	feet. Average water depth in crossing upstream of bend.
r_c	18	feet. Centerline radius of bend.
W_u	90.5	feet. Water surface width at upstream end of bend.
y_{max} / y_u	#NUM!	$=2.07-0.19*\log_{10}(r_c / W_u-2)$. Thorne bend scour equation
y_{max}	#NUM!	$= (y_{max} / y_{u)})\ * y_{u.}$ Thorne bend scour below water surface.
r_c / W_u	0.198895	dimensionless.
r_c / W_u within range	FALSE	Equation limited to $r_c / W_u > 2$
y_{bs} (below thalweg)	**#NUM!**	feet. $= y_{max} - y_u$. Scour below thalweg

Bend Scour Design Curves, Corps of Engineers	Value	
Reference: Corps of Engrs. EM 1110-2-1601 Plate B41		
r_b	18	feet. Centerline radius of bend
W	32.9	feet. Water surface width
r_b / W	0.547112	x-axis of design curve
Mean depth in the approach section	0.38	feet.
Maximum depth in the bend	1.39	feet
Max depth bend / mean depth approach (Sand Bed Channels)	3.765504	y-axis of design curve, sand-bed channels
Max depth bend / mean depth approach (Gravel Bed Channels)	3.801157	y-axis of design curve, gravel-bed channels
Bend Scour Depth, sand-bed channels	**0.040892**	feet. Below minimum channel elevation (no bend scour if negative).
Bend Scour Depth, gravel-bed channels	**0.05444**	feet. Below minimum channel elevation (no bend scour if negative).

Tributary Reach 2/3, HEC-RAS Section 518.16, 100-YR

GENERAL SCOUR

Zeller General Scour	Value	Description
Reference: Simons Li & Associates, 1985		
y_{max}	1.54	feet. Maximum depth of flow
V_m	8.29	ft/s. Average velocity of flow
Y_h	1	feet. Hydraulic or mean depth of flow
S_e	0.04	Energy slope (or bed slope or uniform slope)
$y_{gs,\ calculated}$	-0.035345046	feet. $=y_{max}\ [(0.0685\ V_m^{0.8}) / (y_h^{0.4}\ S_e^{0.3}) - 1]$. Zeller equation general scour depth.
$y_{gs,}$ (minimum 0)	**0**	feet. Zeller General Scour (greater of 0 or Zeller equation).

Neill Incised	**Value**	**Description**
Reference: Neill, 1973		
y_i	0.51	feet. average depth at bankfull discharge in incised reach
q_f	7.832618026	(ft3/s/ft). Design flood discharge per unit width
$Q_{bankfull}$	6.4	cfs. Bankfull or channel forming discharge
$W_{bankfull}$	5.59	feet. Bankfull width.
q_i	1.14490161	(ft^3/s/ft). Bankfull discharge in incised reach per unit width
m	0.85	exponent varying from 0.67 for sand to 0.85 for coarse gravel
y_f	2.614797978	feet. Scoured depth (general scour) below design floodwater level
Z	0.7	Neill Incised Z
		$=Z * y_f$
y_s	**1.830358585**	Neill general scour below streambed.

Blench Zero Bed Factor	Value	Description
Reference: Pemberton & Lara, 1984		
q_f	7.832618026	cfs/ft. Design discharge per unit width.
D_{50}	25	mm.
F_{b0}	4.11116356	$ft^{2/}s$. Blench's "zero bed factor," (interpolated)
		feet. Water depth for zero bed sediment transport
y_{f0}	2.461971645	$= q_f^{2/3} / F_{b0}^{1/3}$
Degree of bend	severe	
Z	0.6	Blench Z
		feet. $=Z * y_{f0}$
y_s	**1.477182987**	Blench general scour below streambed.

Lacey	Value	Description
Reference: ASCE, Predicting Bed Scour, 2005		
Q	73	design discharge, (ft^3/s)
d_m	25	mean grain size of bed material (mm)
f	8.8	Lacey's silt factor = $1.76\ (D_m)^{1/2}$
Use Laceys regime equation for mean depth?	yes	
Mean depth using Lacey's regime eq.	0.951432365	feet.
Mean depth from inputs	1	feet.
y_m	0.951432365	feet. Mean water depth for Lacey scour equation.
Z	0.75	Lacey Z
y_s	**0.713574273**	feet. $=Z * y_m$. Scour depth below streambed

Neill Competent Velocity	**Value**	Description
Reference: Pemberton & Lara, 1984		
D_{50}	25	mm
y_m	1	mean depth, (ft)
V_c	#N/A	ft/sec. Competent mean velocity (interpolated)
V_m	8.29	mean velocity, (ft/s)
		$=y_m\ (V_m / V_c - 1)$
y_s	**#N/A**	scour depth below streambed, (ft)

USBR Envelope Curve	Value	Description
Reference: Pemberton & Lara, 1984		
q	7.832618026	Unit discharge, cfs per foot width
ds	**4.015168281**	Scour depth, feet below streambed, from curve.
Within valid slope range	FALSE	
Within valid D_{50} range	FALSE	

USBR Mean Velocity Method	Value	Description
Reference: Pemberton & Lara, 1984		
Z	0.75	Lacey Z from Lacey's method
d_m	1	feet. Mean depth
d_s	**0.75**	feet. Scour depth below streambed. $d_s = Z\ d_m$

Tributary Reach 2/3, HEC-RAS Section 518.16, 100-YR

BEND SCOUR

Zeller Bend Scour	Value	
Reference: Simons Li & Associates, 1985 (page 5.105-5.106)		
y_{max}	1.76	feet. Maximum Depth of upstream flow
V	5.84	fps. Mean velocity of upstream flow
y_h	0.81	feet. Hydraulic Depth of upstream flow
S_e	0.106	Upstream energy slope
W	19.64	feet. Channel topwidth of upstream flow
r_c	18	feet. Radius of curvature to centerline of channel
$\sin^2(\alpha/2)/\cos(\alpha)$	0.272778	Used in Zeller Bend Scour Equation
$y_{bs,}$ prelimiinary	0.653716	feet. Zeller Bend Scour, initial calculation
$\mathbf{y_{bs}}$	**0.653716**	feet. Zeller Bend Scour, final (disallowing negative values)
Manning n-value	0.04	to calculate Chezy coefficient
Hydraulic Radius	0.93	feet.
Chezy coefficient	36.70337	
b	9.32	feet. Design discharge top width in the bend.
Superelevation	1.156761	feet. = V_z^2 b / (g r_c) (Equation 16-11, Chow) (based on top width, velocity, and radius of curvature, where b=W=topwidth)
Maximum depth of flow	1.54	feet.
y	2.696761	feet. Max depth of flow including superelevation on outside of bend
X	***40.13754***	feet. = 2.3 (C $g^{1/2}$) y. Distance downstream of end of curvature to where downstream currents have dissipated

Maynord Bend Scour	Value	Note: Not recommended where overbank depth exceeds 20% channel depth
Reference: Maynord, 1996 via ASCE, 2005		Comment
y_u	0.81	feet. Average water depth in crossing upstream of bend.
r_c	18	feet. Centerline radius of bend.
W_u	4.24	feet. Water surface width at upstream end of bend (active or bankfull width)
nominal r_c / W_u	4.245283	Equation limited to r_c / W_u < 10, ratio in equation set to 1.5 if less
r_c / W_u for equation	4.245283	dimensionless.
r_c / W_u within range	TRUE	
nominal W_u / y_u	5.234568	Equation limited to W_u / y_u < 125, ratio in equation set to 20 if less
nominal W_u / y_u for equation	20	dimensionless.
W_u / y_u within range	TRUE	
y_{mxb}	1.418707	feet. = y_u * (1.8 - 0.051 (r_c / W_u) + 0.0084 (W_u / y_u). Maximum water depth in bend.
$\mathbf{y_{bs}}$	**0.608707**	feet. = y_{mxb} - y_u = Below thalweg.

Thorne Bend Scour	Value	
Reference: Thorne et. al, 1995 via ASCE, 2005		
y_u	0.81	feet. Average water depth in crossing upstream of bend.
r_c	18	feet. Centerline radius of bend.
W_u	19.64	feet. Water surface width at upstream end of bend.
y_{max} / y_u	#NUM!	=2.07-0.19*$\log_{10}$(r_c / W_u-2). Thorne bend scour equation
y_{max}	#NUM!	= (y_{max} / $y_{u)}$ * $y_{u.}$ Thorne bend scour below water surface.
r_c / W_u	0.916497	dimensionless.
r_c / W_u within range	FALSE	Equation limited to r_c / W_u>2
y_{bs} (below thalweg)	**#NUM!**	feet. = y_{max} - y_u. Scour below thalweg

Bend Scour Design Curves, Corps of Engineers	Value	
Reference: Corps of Engrs. EM 1110-2-1601 Plate B41		
r_b	18	feet. Centerline radius of bend
W	9.32	feet. Water surface width
r_b / W	1.93133	x-axis of design curve
Mean depth in the approach section	0.81	feet.
Maximum depth in the bend	1.54	feet
Max depth bend / mean depth approach (Sand Bed Channels)	2.938357	y-axis of design curve, sand-bed channels
Max depth bend / mean depth approach (Gravel Bed Channels)	2.909903	y-axis of design curve, gravel-bed channels
Bend Scour Depth, sand-bed channels	**0.840069**	feet. Below minimum channel elevation (no bend scour if negative).
Bend Scour Depth, gravel-bed channels	**0.817021**	feet. Below minimum channel elevation (no bend scour if negative).

Tributary Reach 2, HEC-RAS Section 552.49, 100-YR

GENERAL SCOUR

Zeller General Scour	Value	Description
Reference: Simons Li & Associates, 1985		
y_{max}	1.76	feet. Maximum depth of flow
V_m	5.84	ft/s. Average velocity of flow
Y_h	0.81	feet. Hydraulic or mean depth of flow
S_e	0.106	Energy slope (or bed slope or uniform slope)
$y_{gs,\ calculated}$	-0.704768493	feet. $=y_{max}\ [(0.0685\ V_m^{0.8}) / (y_h^{0.4}\ S_e^{0.3}) - 1]$. Zeller equation general scour depth.
$y_{gs,}$ (minimum 0)	**0**	feet. Zeller General Scour (greater of 0 or Zeller equation).

Neill Incised	**Value**	**Description**
Reference: Neill, 1973		
y_i	0.56	feet. average depth at bankfull discharge in incised reach
q_f	3.716904277	(ft3/s/ft). Design flood discharge per unit width
$Q_{bankfull}$	6.4	cfs. Bankfull or channel forming discharge
$W_{bankfull}$	4.24	feet. Bankfull width.
q_i	1.509433962	(ft^3/s/ft). Bankfull discharge in incised reach per unit width
m	0.85	exponent varying from 0.67 for sand to 0.85 for coarse gravel
y_f	1.204620355	feet. Scoured depth (general scour) below design floodwater level
Z	0.5	Neill Incised Z
		$=Z * y_f$
y_s	**0.602310178**	Neill general scour below streambed.

Blench Zero Bed Factor	Value	Description
Reference: Pemberton & Lara, 1984		
q_f	3.716904277	cfs/ft. Design discharge per unit width.
D_{50}	34	mm.
F_{b0}	4.431909207	ft^2/s. Blench's "zero bed factor," (interpolated)
		feet. Water depth for zero bed sediment transport
y_{f0}	1.460799572	$= q_f^{2/3} / F_{b0}^{1/3}$
Degree of bend	straight	
Z	0.6	Blench Z
		feet. $=Z * y_{f0}$
y_s	**0.876479743**	Blench general scour below streambed.

Lacey	Value	Description
Reference: ASCE, Predicting Bed Scour, 2005		
Q	73	design discharge, (ft^3/s)
d_m	34	mean grain size of bed material (mm)
f	10.26247533	Lacey's silt factor = $1.76\ (D_m)^{1/2}$
Use Laceys regime equation for mean depth?	yes	
Mean depth using Lacey's regime eq.	0.903902184	feet.
Mean depth from inputs	0.81	feet.
y_m	0.903902184	feet. Mean water depth for Lacey scour equation.
Z	0.25	Lacey Z
y_s	**0.225975546**	feet. $=Z * y_m$. Scour depth below streambed

Neill Competent Velocity	**Value**	Description
Reference: Pemberton & Lara, 1984		
D_{50}	34	mm
y_m	0.81	mean depth, (ft)
V_c	#N/A	ft/sec. Competent mean velocity (interpolated)
V_m	5.84	mean velocity, (ft/s)
		$=y_m\ (V_m / V_c - 1)$
y_s	**#N/A**	scour depth below streambed, (ft)

USBR Envelope Curve	Value	Description
Reference: Pemberton & Lara, 1984		
q	3.716904277	Unit discharge, cfs per foot width
ds	**3.357450472**	Scour depth, feet below streambed, from curve.
Within valid slope range	FALSE	
Within valid D_{50} range	FALSE	

USBR Mean Velocity Method	Value	Description
Reference: Pemberton & Lara, 1984		
Z	0.25	Lacey Z from Lacey's method
d_m	0.81	feet. Mean depth
d_s	**0.2025**	feet. Scour depth below streambed. $d_s = Z\ d_m$

Tributary Reach 3, HEC-RAS Section 393.08, 100-YR

GENERAL SCOUR

Zeller General Scour	Value	Description
Reference: Simons Li & Associates, 1985		
y_{max}	1.38	feet. Maximum depth of flow
V_m	8.89	ft/s. Average velocity of flow
Y_h	0.38	feet. Hydraulic or mean depth of flow
S_e	0.056	Energy slope (or bed slope or uniform slope)
$y_{gs, calculated}$	0.518109313	feet. $=y_{max}$ [(0.0685 $V_m^{0.8}$) / ($y_h^{0.4}$ $S_e^{0.3}$) -1]. Zeller equation general scour depth.
y_{gs}, (minimum 0)	**0.518109313**	feet. Zeller General Scour (greater of 0 or Zeller equation).

Neill Incised	**Value**	**Description**
Reference: Neill, 1973		
y_i	0.51	feet. average depth at bankfull discharge in incised reach
q_f	2.183014354	(ft3/s/ft). Design flood discharge per unit width
$Q_{bankfull}$	6.4	cfs. Bankfull or channel forming discharge
$W_{bankfull}$	5.59	feet. Bankfull width.
q_i	1.14490161	(ft^3/s/ft). Bankfull discharge in incised reach per unit width
m	0.85	exponent varying from 0.67 for sand to 0.85 for coarse gravel
y_f	0.882704494	feet. Scoured depth (general scour) below design floodwater level
Z	0.7	Neill Incised Z
		$=Z * y_f$
y_s	**0.617893146**	Neill general scour below streambed.

Blench Zero Bed Factor	Value	Description
Reference: Pemberton & Lara, 1984		
q_f	2.183014354	cfs/ft. Design discharge per unit width.
D_{50}	25	mm.
F_{b0}	4.11116356	$ft^{2/}$s. Blench's "zero bed factor," (interpolated)
		feet. Water depth for zero bed sediment transport
y_{f0}	1.050467956	$= q_f^{2/3} / F_{b0}^{1/3}$
Degree of bend	severe	
Z	0.6	Blench Z
		feet. $=Z * y_{f0}$
y_s	**0.630280774**	Blench general scour below streambed.

Lacey	Value	Description
Reference: ASCE, Predicting Bed Scour, 2005		
Q	73	design discharge, (ft^3/s)
d_m	25	mean grain size of bed material (mm)
f	8.8	Lacey's silt factor = 1.76 $(D_m)^{1/2}$
Use Laceys regime equation for mean depth?	yes	
Mean depth using Lacey's regime eq.	0.951432365	feet.
Mean depth from inputs	0.38	feet.
y_m	0.951432365	feet. Mean water depth for Lacey scour equation.
Z	0.75	Lacey Z
y_s	**0.713574273**	feet. $=Z * y_m$. Scour depth below streambed

Neill Competent Velocity	**Value**	Description
Reference: Pemberton & Lara, 1984		
D_{50}	25	mm
y_m	0.38	mean depth, (ft)
V_c	#N/A	ft/sec. Competent mean velocity (interpolated)
V_m	8.89	mean velocity, (ft/s)
		$=y_m (V_m / V_c - 1)$
y_s	**#N/A**	scour depth below streambed, (ft)

USBR Envelope Curve	Value	Description
Reference: Pemberton & Lara, 1984		
q	2.183014354	Unit discharge, cfs per foot width
ds	**2.95487876**	Scour depth, feet below streambed, from curve.
Within valid slope range	FALSE	
Within valid D_{50} range	FALSE	

USBR Mean Velocity Method	Value	Description
Reference: Pemberton & Lara, 1984		
Z	0.75	Lacey Z from Lacey's method
d_m	0.38	feet. Mean depth
d_s	**0.285**	feet. Scour depth below streambed. $d_s = Z d_m$

Tributary Reach 3, HEC-RAS Section 393.08, 100-YR

BEND SCOUR

Zeller Bend Scour	Value	
Reference: Simons Li & Associates, 1985 (page 5.105-5.106)		
y_{max}	1.84	feet. Maximum Depth of upstream flow
V	5.2	fps. Mean velocity of upstream flow
y_h	0.56	feet. Hydraulic Depth of upstream flow
S_e	0.012	Upstream energy slope
W	52.89	feet. Channel topwidth of upstream flow
r_c	18	feet. Radius of curvature to centerline of channel
$\sin^2(\alpha/2)/\cos(\alpha)$	0.734583	Used in Zeller Bend Scour Equation
$y_{bs,}$ prelimiinary	2.182746	feet. Zeller Bend Scour, initial calculation
$\mathbf{y_{bs}}$	**2.182746**	feet. Zeller Bend Scour, final (disallowing negative values)
Manning n-value	0.04	to calculate Chezy coefficient
Hydraulic Radius	0.37	feet.
Chezy coefficient	31.47694	
b	33.44	feet. Design discharge top width in the bend.
Superelevation	2.469771	feet. $= V_z^2\ b\ /\ (g\ r_c)$ (Equation 16-11, Chow) (based on top width, velocity, and radius of curvature, where b=W=topwidth)
Maximum depth of flow	1.38	feet.
y	3.849771	feet. Max depth of flow including superelevation on outside of bend
X	***49.13938***	feet. $= 2.3\ (C\ g^{1/2})\ y$. Distance downstream of end of curvature to where downstream currents have dissipated

Maynord Bend Scour	Value	Note: Not recommended where overbank depth exceeds 20% channel depth
Reference: Maynord, 1996 via ASCE, 2005		Comment
y_u	0.56	feet. Average water depth in crossing upstream of bend.
r_c	18	feet. Centerline radius of bend.
W_u	5.63	feet. Water surface width at upstream end of bend (active or bankfull width)
nominal r_c / W_u	3.197158	Equation limited to $r_c / W_u < 10$, ratio in equation set to 1.5 if less
r_c / W_u for equation	3.197158	dimensionless.
r_c / W_u within range	TRUE	
nominal W_u / y_u	10.05357	Equation limited to $W_u / y_u < 125$, ratio in equation set to 20 if less
nominal W_u / y_u for equation	20	dimensionless.
W_u / y_u within range	TRUE	
y_{mxb}	1.010769	feet. $= y_u * (1.8 - 0.051\ (r_c / W_u) + 0.0084\ (W_u / y_u))$. Maximum water depth in bend.
$\mathbf{y_{bs}}$	**0.450769**	feet. $= y_{mxb} - y_u$ = Below thalweg.

Thorne Bend Scour	Value	
Reference: Thorne et. al, 1995 via ASCE, 2005		
y_u	0.56	feet. Average water depth in crossing upstream of bend.
r_c	18	feet. Centerline radius of bend.
W_u	52.89	feet. Water surface width at upstream end of bend.
y_{max} / y_u	#NUM!	$=2.07-0.19*\log_{10}(r_c / W_u-2)$. Thorne bend scour equation
y_{max}	#NUM!	$= (y_{max} / y_{u)})\ * y_{u.}$ Thorne bend scour below water surface.
r_c / W_u	0.340329	dimensionless.
r_c / W_u within range	FALSE	Equation limited to $r_c / W_u>2$
y_{bs} (below thalweg)	**#NUM!**	feet. $= y_{max} - y_u$. Scour below thalweg

Bend Scour Design Curves, Corps of Engineers	Value	
Reference: Corps of Engrs. EM 1110-2-1601 Plate B41		
r_b	18	feet. Centerline radius of bend
W	33.44	feet. Water surface width
r_b / W	0.538278	x-axis of design curve
Mean depth in the approach section	0.56	feet.
Maximum depth in the bend	1.38	feet
Max depth bend / mean depth approach (Sand Bed Channels)	3.776181	y-axis of design curve, sand-bed channels
Max depth bend / mean depth approach (Gravel Bed Channels)	3.812661	y-axis of design curve, gravel-bed channels
Bend Scour Depth, sand-bed channels	**0.734661**	feet. Below minimum channel elevation (no bend scour if negative).
Bend Scour Depth, gravel-bed channels	**0.75509**	feet. Below minimum channel elevation (no bend scour if negative).

Mainstem, HEC-RAS Section 922, 1-YR

GENERAL SCOUR

Zeller General Scour	Value	Description
Reference: Simons Li & Associates, 1985		
y_{max}	1.54	feet. Maximum depth of flow
V_m	7.77	ft/s. Average velocity of flow
Y_h	1.05	feet. Hydraulic or mean depth of flow
S_e	0.0531	Energy slope (or bed slope or uniform slope)
$y_{gs, calculated}$	-0.25310228	feet. $=y_{max}$ [(0.0685 $V_m^{0.8}$) / ($y_h^{0.4}$ $S_e^{0.3}$) -1]. Zeller equation general scour depth.
$y_{gs,}$ (minimum 0)	**0**	feet. Zeller General Scour (greater of 0 or Zeller equation).

Neill Incised	**Value**	**Description**
Reference: Neill, 1973		
y_i	1.54	feet. average depth at bankfull discharge in incised reach
q_f	8.164556962	(ft3/s/ft). Design flood discharge per unit width
$Q_{bankfull}$	387	cfs. Bankfull or channel forming discharge
$W_{bankfull}$	47.4	feet. Bankfull width.
q_i	8.164556962	(ft^3/s/ft). Bankfull discharge in incised reach per unit width
m	0.85	exponent varying from 0.67 for sand to 0.85 for coarse gravel
y_f	1.54	feet. Scoured depth (general scour) below design floodwater level
Z	0.5	Neill Incised Z
		$=Z * y_f$
y_s	**0.77**	Neill general scour below streambed.

Blench Zero Bed Factor	Value	Description
Reference: Pemberton & Lara, 1984		
q_f	8.164556962	cfs/ft. Design discharge per unit width.
D_{50}	60	mm.
F_{b0}	5.091639011	ft^2/s. Blench's "zero bed factor," (interpolated)
		feet. Water depth for zero bed sediment transport
y_{f0}	2.356871368	$= q_f^{2/3} / F_{b0}^{1/3}$
Degree of bend	straight	
Z	0.6	Blench Z
		feet. $=Z * y_{f0}$
y_s	**1.414122821**	Blench general scour below streambed.

Lacey	Value	Description
Reference: ASCE, Predicting Bed Scour, 2005		
Q	387	design discharge, (ft^3/s)
d_m	60	mean grain size of bed material (mm)
f	13.63290138	Lacey's silt factor = 1.76 $(D_m)^{1/2}$
Use Laceys regime equation for mean depth?	no	
Mean depth using Lacey's regime eq.	1.433745547	feet.
Mean depth from inputs	1.05	feet.
y_m	1.05	feet. Mean water depth for Lacey scour equation.
Z	0.25	Lacey Z
y_s	**0.2625**	feet. $=Z * y_m$. Scour depth below streambed

Neill Competent Velocity	**Value**	Description
Reference: Pemberton & Lara, 1984		
D_{50}	60	mm
y_m	1.05	mean depth, (ft)
V_c	#N/A	ft/sec. Competent mean velocity (interpolated)
V_m	7.77	mean velocity, (ft/s)
		$=y_m (V_m / V_c - 1)$
y_s	**#N/A**	scour depth below streambed, (ft)

USBR Envelope Curve	Value	Description
Reference: Pemberton & Lara, 1984		
q	8.164556962	Unit discharge, cfs per foot width
ds	**4.055364676**	Scour depth, feet below streambed, from curve.
Within valid slope range	FALSE	
Within valid D_{50} range	FALSE	

USBR Mean Velocity Method	Value	Description
Reference: Pemberton & Lara, 1984		
Z	0.25	Lacey Z from Lacey's method
d_m	1.05	feet. Mean depth
d_s	**0.2625**	feet. Scour depth below streambed. $d_s = Z\ d_m$

Mainstem, HEC-RAS Section 922, 10-YR

GENERAL SCOUR

Zeller General Scour	Value	Description
Reference: Simons Li & Associates, 1985		
y_{max}	5.3	feet. Maximum depth of flow
V_m	5.27	ft/s. Average velocity of flow
Y_h	3.61	feet. Hydraulic or mean depth of flow
S_e	0.0042	Energy slope (or bed slope or uniform slope)
$y_{gs, calculated}$	-1.059302781	feet. $=y_{max}$ [(0.0685 $V_m^{0.8}$) / ($y_h^{0.4}$ $S_e^{0.3}$) -1]. Zeller equation general scour depth.
$y_{gs,}$ (minimum 0)	**0**	feet. Zeller General Scour (greater of 0 or Zeller equation).

Neill Incised	**Value**	**Description**
Reference: Neill, 1973		
y_i	1.52	feet. average depth at bankfull discharge in incised reach
q_f	18.76889255	(ft3/s/ft). Design flood discharge per unit width
$Q_{bankfull}$	387	cfs. Bankfull or channel forming discharge
$W_{bankfull}$	47.7	feet. Bankfull width.
q_i	8.113207547	(ft^3/s/ft). Bankfull discharge in incised reach per unit width
m	0.85	exponent varying from 0.67 for sand to 0.85 for coarse gravel
y_f	3.100649962	feet. Scoured depth (general scour) below design floodwater level
Z	0.5	Neill Incised Z
		$=Z * y_f$
y_s	**1.550324981**	Neill general scour below streambed.

Blench Zero Bed Factor	Value	Description
Reference: Pemberton & Lara, 1984		
q_f	18.76889255	cfs/ft. Design discharge per unit width.
D_{50}	60	mm.
F_{b0}	5.091639011	ft^2/s. Blench's "zero bed factor," (interpolated)
		feet. Water depth for zero bed sediment transport
y_{f0}	4.105252715	$= q_f^{2/3} / F_{b0}^{1/3}$
Degree of bend	straight	
Z	0.6	Blench Z
		feet. $=Z * y_{f0}$
y_s	**2.463151629**	Blench general scour below streambed.

Lacey	Value	Description
Reference: ASCE, Predicting Bed Scour, 2005		
Q	1366	design discharge, (ft^3/s)
d_m	60	mean grain size of bed material (mm)
f	13.63290138	Lacey's silt factor = 1.76 $(D_m)^{1/2}$
Use Laceys regime equation for mean depth?	no	
Mean depth using Lacey's regime eq.	2.182991242	feet.
Mean depth from inputs	3.61	feet.
y_m	3.61	feet. Mean water depth for Lacey scour equation.
Z	0.25	Lacey Z
y_s	**0.9025**	feet. $=Z * y_m$. Scour depth below streambed

Neill Competent Velocity	**Value**	Description
Reference: Pemberton & Lara, 1984		
D_{50}	60	mm
y_m	3.61	mean depth, (ft)
V_c	8.476584245	ft/sec. Competent mean velocity (interpolated)
V_m	5.27	mean velocity, (ft/s)
		$=y_m (V_m / V_c - 1)$
y_s	**-1.365617186**	scour depth below streambed, (ft)

USBR Envelope Curve	Value	Description
Reference: Pemberton & Lara, 1984		
q	18.76889255	Unit discharge, cfs per foot width
ds	**4.95212228**	Scour depth, feet below streambed, from curve.
Within valid slope range	TRUE	
Within valid D_{50} range	FALSE	

USBR Mean Velocity Method	Value	Description
Reference: Pemberton & Lara, 1984		
Z	0.25	Lacey Z from Lacey's method
d_m	3.61	feet. Mean depth
d_s	**0.9025**	feet. Scour depth below streambed. $d_s = Z\ d_m$

APPENDIX I
HYDROLOGIC AND HYDRAULIC REPORT

APPENDIX I.1

EXISTING CONDITIONS
HYDROLOGIC AND HYDRAULIC REPORT

APPENDIX I.1 – EXISTING CONDITIONS HYDROLOGIC AND HYDRAULICS REPORT

TO: William Pines
Maryland Transportation Authority
8019 Corporate Drive, Suite F
White Marsh, MD 21236

FROM: James Tomlinson, PE
KCI Technologies, Inc.
Water Resources Practice

DATE: June 27, 2019

SUBJECT: H&H Technical Memo
Carsins Run Mitigation Project
KCI Job Number: No. 22145228.47

INTRODUCTION

The Maryland Transportation Authority (MdTA or "The Authority") is currently developing plans for the extension of Express Toll Lanes (ETL) along Section 200 of Interstate 95 (I-95). KCI Technologies, Inc. (KCI) is providing services to provide field assessment, design services, and regulatory coordination to assist in the mitigation of impacts assocated with the project. For this project, KCI investigated a portion of Carsins Run near the I-95 culvert, and a tributary entering the channel just upstream from the culvert, from the right bank (facing downstream). The purpose of the investigation was to determine feasibility of restoration for the channels.

This memorandum documents the hydrologic modeling of the watershed and the hydraulic modeling of the stream, culvert crossing, and tributary.

HYDROLOGY

The hydrologic analysis was based on the Natural Resources Conservation Service (NRCS) methodology and computer program TR20 version 2.0 (NRCS 1992). The three primary hydrologic input parameters required to generate discharges were the drainage area (A), runoff curve number (RCN) and the time of concentration (Tc) computed by GIS Hydro 2000 (Moglen 2007).

APPENDIX I.1 – EXISTING CONDITIONS HYDROLOGIC AND HYDRAULICS REPORT

DRAINAGE AREA

The drainage area limits were determined for the main stem to the culvert under I-95 from GIS Hydro using 30 meter DEM by several subroutines developed by the Center for Research and Water Resources (CRWR) and the University of Maryland (UMD). This drainage area is inclusive of the tributary. The drainage area and patterns to the study point, delineated by GIS Hydro, were 3.88 square miles for both existing and ultimate conditions. The drainage area to the tributary was delineated manually, and calculated to be 11.60 acres.

A site visit was conducted in February 2018 to verify the drainage boundary to the study point. The drainage area derived from GIS Hydro was then modified digitally in GIS according to field reconnaissance notes in order to have a more accurate representation of the project drainage area. The revised drainage area was then imported back into GIS Hydro to compute the basin characteristics and peak discharges. The resultant field-verified drainage area was computed in GIS Hydro and determined to be 4.27 square miles.

RUNOFF CURVE NUMBER

The runoff curve number (RCN) reflects the runoff potential for a drainage area. Runoff potential is primarily dependent on soil type and land cover (i.e., land use) characteristics, and is computed for the drainage area using TR-55. Hydrologic soil groups (HSG) or runoff potential were determined from the United States Department of Agriculture (USDA) NRCS Web Soil Survey. Existing land use was determined from GIS Hydro 2000 embedded data derived from Maryland Department of Planning land use data for year 2010 and from zoning layers for the ultimate land use conditions. These conditions were field-verified. The RCN for the total drainage area to the outlet was estimated to be 75.7 for existing land use and 75.8 for ultimate zoning; therefore, the drainage area should be considered fully developed.

The runnoff curve number calculated for the tributary was 69.3 for existing land use conditions and 88.8 for ultimate zoning conditions.

TIME OF CONCENTRATION

The time of concentration (Tc) for both drainage areas were computed using the overland flow method as presented in TR-55. The Tc was determined by dividing the total flow path into segments (sheet, shallow concentrated, and channel flow) and computing the travel time through each segment. A maximum overland sheet flow length of 100 feet was used in this study. Shallow concentrated flow was assumed to extend to the point at which the flow path enters a closed storm drain system. Multiple channel segments, identified based on field inspection, provide the channel flow portion for the time of concentration. The total time of concentration for the watershed is 3.03 hours. The tributary time of concentration is 0.17 hours. Details of these computations are included in Appendix A of this report.

SUMMARY OF DISCHARGES

TR-20 uses the hydrologic characteristics to generate a hydrograph for defined rainfall depths and distributions that are based on NOAA Atlas 14.

The 4.27 square mile watershed is fully developed such that existing and ultimate RCN's are nearly equivalent and the times of concentration were considered to be identical. The TR-20 model was run for the 1-, 2-, 10-, and 100-year storm events.

The overall watershed analysis is inclusive of the tributary, so no subareas were defined. The analysis of the tributary is therefore independent of the overall watershed analysis.

The Tables 1 and 2 below provide a summary of the ultimate development discharges in the tributary and at the study point.

Table 1 : Summary of TR-55 Discharges to Tributary

Storm	Discharge (cfs) (12-hour for 1, 2 and 10-year and 24-hour for 100-yr)	
	Existing	Ultimate Land Use
1-year	6.42 cfs	24.85 cfs
2-year	10.92 cfs	32.66 cfs
10-year	27.99 cfs	57.83 cfs
100-year	73.21 cfs	111.47 cfs

APPENDIX I.1 – EXISTING CONDITIONS HYDROLOGIC AND HYDRAULICS REPORT

Table 2 : Summary of TR-20 Discharges to Study Point

Storm	Discharge (cfs) (12-hour for 1, 2 and 10-year and 24-hour for 100-yr)	
	Existing	Ultimate Land Use
1-year	387 cfs	391 cfs
2-year	612 cfs	617 cfs
10-year	1,366 cfs	1,374 cfs
100-year	3,207 cfs	3,215 cfs

HYDRAULICS

EXISTING HEC-RAS CROSS SECTIONS

Cross sections were developed from the existing channel geometry, using field-run survey data. Sections were located at key points along the study reaches, typically at riffles. Cross section geometry data and elevations were generated from the field survey.

MANNING'S ROUGHNESS

The Manning's coefficient represents the roughness characteristics of a natural or artificial channel based on the type of material, sinuosity, changes in cross section geometry, and vegetation among other factors. It is intended to estimate the resistance to flow. The values for Manning's Roughness Coefficient was selected by field observation. For the existing conditions model, a value of 0.045 was used for the natural channel within the main stem. Values of 0.035, 0.015, and 0.050 were used for the section entering the concrete flume, the flume, and the riprap culvert outfall respectively. A value of 0.035 was used to represent the tributary channel. An overbank value of 0.100 was selected throughout the project area to represent the wooded areas with moderately dense vegetation for the overbanks. All the manning's n values for the stream channel and floodplain are using the Table 3-1 in the HECRAS Reference Manual as a reference.

Existing 2-yr and 10-yr shear stresses and velocities in the channel are presented in the tables below.

Table 3: Existing 2-yr Shear Stress and Velocity

River	Reach	River Station	Profile	Shear Channel (lb/sq ft)	Velocity Channel (ft/s)
Tributary	Main	867.2198	2-yr ex	0.88	4.40
Tributary	Main	718.7947	2-yr ex	0.77	4.18
Tributary	Main	602.422	2-yr ex	3.67	8.34
Tributary	Main	520.8726	2-yr ex	0.92	4.35
Tributary	Main	410.9627	2-yr ex	1.19	5.05
Tributary	Main	266.3346	2-yr ex	0.71	3.98
Tributary	Main	186.1341	2-yr ex	1.41	5.23
Tributary	Main	90.83922	2-yr ex	0.36	2.37
Carsins_Run	Main_Stem	1896	2-yr ex	1.08	4.97
Carsins_Run	Main_Stem	1598	2-yr ex	3.53	9.11
Carsins_Run	Main_Stem	1423	2-yr ex	3.49	8.66
Carsins_Run	Main_Stem	1233	2-yr ex	1.21	5.47
Carsins_Run	Main_Stem	1180	2-yr ex	1.94	6.78
Carsins_Run	Main_Stem	1134	2-yr ex	1.02	5.04
Carsins_Run	Main_Stem	1085	2-yr ex	1.30	5.43
Carsins_Run	Main_Stem	1049	2-yr ex	1.72	6.14

River	Reach	River Station	Profile	Shear Channel (lb/sq ft)	Velocity Channel (ft/s)
Carsins_Run	DS_Stem	922	2-yr ex	5.99	13.48
Carsins_Run	DS_Stem	868	2-yr ex	0.64	10.65
Carsins_Run	DS_Stem	721.4		Culvert	Culvert
Carsins_Run	DS_Stem	574	2-yr ex	3.82	8.26
Carsins_Run	DS_Stem	473	2-yr ex	2.1	6.80
Carsins_Run	DS_Stem	375	2-yr ex	1.11	4.80
Carsins_Run	DS_Stem	269	2-yr ex	1.05	4.52

Table 4: Existing 10-yr Shear Stress and Velocity

River	Reach	River Station	Profile	Shear Channel (lb/sq ft)	Velocity Channel (ft/s)
Tributary	Main	867.2198	10-yr ex	1.36	5.92
Tributary	Main	718.7947	10-yr ex	1.08	5.35
Tributary	Main	602.422	10-yr ex	5.64	11.19
Tributary	Main	520.8726	10-yr ex	1.58	6.14
Tributary	Main	410.9627	10-yr ex	1.58	6.23
Tributary	Main	266.3346	10-yr ex	0.99	5.17
Tributary	Main	186.1341	10-yr ex	2.83	7.94
Tributary	Main	90.83922	10-yr ex	0.52	3.17
Carsins_Run	Main_Stem	1896	10-yr ex	1.42	5.67
Carsins_Run	Main_Stem	1598	10-yr ex	1.58	6.20
Carsins_Run	Main_Stem	1423	10-yr ex	7.89	13.65
Carsins_Run	Main_Stem	1233	10-yr ex	1.92	7.34

River	Reach	River Station	Profile	Shear Channel (lb/sq ft)	Velocity Channel (ft/s)
Carsins_Run	Main_Stem	1180	10-yr ex	3.59	9.71
Carsins_Run	Main_Stem	1134	10-yr ex	2.14	7.58
Carsins_Run	Main_Stem	1085	10-yr ex	2.17	7.49
Carsins_Run	Main_Stem	1049	10-yr ex	2.71	8.18
Carsins_Run	DS_Stem	922	10-yr ex	7.28	16.26
Carsins_Run	DS_Stem	868	10-yr ex	1.01	14.32
Carsins_Run	DS_Stem	721.4			Culvert
Carsins_Run	DS_Stem	574	10-yr ex	4.72	9.68
Carsins_Run	DS_Stem	473	10-yr ex	3.18	8.99
Carsins_Run	DS_Stem	375	10-yr ex	1.99	6.81
Carsins_Run	DS_Stem	269	10-yr ex	1.53	5.83

INEFFECTIVE FLOW AREAS

Ineffective flow areas were set upstream and downstream of the culvert to represent transition in flow from the broader floodplain to the culvert. A transition slope of 1:1 was set for the upstream approach, and 2:1 set for the downstream expansion. Inneffective areas were allowed to be active once the roadway elevation was met, and the road overtops (this does not occur for modeled profiles).

BOUNDARY CONDITIONS

Boundary conditions are necessary to establish the starting water surface at the limits of the modeled reach (upstream and downstream). The upstream and downstream boundary conditions for both the main stem and tributary were set to normal depth, with a channel slope based on surveyed data.

MODEL RESULTS

APPENDIX I.1 – EXISTING CONDITIONS HYDROLOGIC AND HYDRAULICS REPORT

The following discusses the existing conditions results of the model. The water surface elevations for the main stem 100-year ultimate conditions flows are contained within the stream valley for all reaches, all sections. The culvert passes all modeled storm events. The 100-year ultimate condition profile passes through the culvert with 10.88 feet of freeboard.

Shear stresses range in the main stem from 1.01 lb/sqft to 7.89 lb/sqft, for the 10-year existing conditions profile. The shear stresses at the dowstrean end of the upstream meandering channel and near the culvert are high. Downstream of the culvert, shear stresses remain moderately high for the first few cross sections.

Shear stresses in the tributary are relatively low.

References

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APPENDIX A

<u>Existing Landuse</u>

Basin Stats and Composition
TR-20
Small Tributary TR-55
Drainage Area Map

<u>Ultimate Landuse</u>

Basin Stats and Composition
TR-20
Small Tributary TR-55
Drainage Area Map

```
Watershed Statistics for:
GISHydro Release Version Date: January 8, 2011
Hydro Extension Version Date:  January 8, 2011
Analysis Date:                 November 26, 2018

Data Selected:
     Quadrangles Used: aberdeen, bel_air, conowingo_dam, delta
     DEM Coverage: NED DEMs
     Land Use Coverage: 2010 MOP Landuse
     Soil Coverage: SSURGO Soils
     Hydrologic Condition: (see Lookup Table)
     Impose NHD stream Locations: Yes
     Outlet Easting:        470532 m. (MD Stateplane, NAD 1983)
     Outlet Northing:       207356 m. (MD Stateplane, NAD 1983)

Findings:
     Outlet Location:       Piedmont
     Outlet State:          Maryland
     Drainage Area          4.3 square miles
       -Piedmont (100.0% of area)
     Channel Slope:         51.2 feet/mile
     Land Slope:            0.051 ft/ft
     Urban Area:            17.4%
     Impervious Area:       8.3%
 ******************************************************
     URBAN DEVELOPMENT IN WATERSHED EXCEEDS 15%.
     Calculated discharges from USGS Regression
     Equations may not be appropriate.
 ******************************************************
 ******************************************************
     Watershed is within 5km of physiographic
     province boundary.  You should consider
     sensitivity of discharges to region location.
 ******************************************************
     Time of Concentration: 3.7 hours  [W.O. Thomas, Jr. Equation]
     Time of Concentration: 3.5 hours  [From SCS Lag Equation * 1.67]
     Longest Flow Path:     4.80 miles
     Basin Relief:          354.0 feet
     Average CN:            76
     % Forest Cover:        44.4
     % Storage:             0.0
     % Limestone:           0.0
     Selected Soils Data Statistics:
        % A Soils:          0.6
        % B Soils:          26.7
        % C Soils:          46.6
        % D Soils:          26.2
     SSURGO Soils Data Statistics (used in Regression Equations):
```

```
   % A Soils:           0.6
   % B Soils:           26.7
   % C Soils:           46.6
   % D Soils:           26.2
2-Year,24-hour Prec.:  3.27 inches
Mean Annual Prec.:     46.23 inches
```

GISHydro Release Version Date: January 8, 2011
Hydro Extension Version Date: January 8, 2011
Analysis Date: November 26, 2018

Landuse and Soil Distributions for:

Distribution of Landuse by Soil Group

Land Use	Acres on Indicated Soil Group A-Soil	B-Soil	C-Soil	D-Soil
Low Density Residential	2.89	146.11	147.45	51.82
Medium Density Residential	1.33	60.05	20.68	3.56
High Density Residential	0	0	1.56	0.22
Commercial	0	15.57	23.35	2
Institutional	0	15.57	8.67	0.44
Open Urban Land	0	18.68	22.68	0.67
Cropland	3.11	188.59	304.46	103.19
Pasture	0	82.29	67.61	27.8
Deciduous Forest	0	112.53	531.74	444.79
Brush	7.34	0.44	0	0.22
Transportation	0	5.34	4.23	1.78
Large Lot Agricultural	1.33	39.81	94.74	36.47
Large Lot Forest	0	34.25	46.26	38.25
Agricultural Buildings	0	10.45	0.44	4.89
Total Area:	16.01	729.67	1273.87	716.11

Distribution of Land Use and Curve Numbers Used

Land Use	Acres	Percent	A	B	C	D
Low Density Residential	348.71	12.74	54	70	80	85
Medium Density Residential	85.62	3.13	61	75	83	87
High Density Residential	1.78	0.07	77	85	90	92
Commercial	40.92	1.5	89	92	94	95
Institutional	24.69	0.9	69	80	86	89
Open Urban Land	42.03	1.54	39	61	74	80
Cropland	599.35	21.9	67	78	85	89
Pasture	177.69	6.49	39	61	74	80
Deciduous Forest	1089.29	39.8	30	55	70	77
Brush	8.01	0.29	30	48	65	73
Transportation	11.34	0.41	83	89	92	94
Large Lot Agricultural	172.36	6.3	67	78	85	89
Large Lot Forest	118.98	4.35	30	55	70	77
Agricultural Buildings	15.79	0.58	59	74	82	86

```
*****************80-80 LIST OF INPUT DATA FOR TR-20 HYDROLOGY******************

JOB TR-20                                                   NOPLOTS
TITLE     Carsins Run
TITLE     MD 2010 - SSURGO
 6 RUNOFF 1   3      1      4.2740      75.69       3.0363        1
 5 RAINFL 1             .1
 8          0.0000      0.0064      0.0129      0.0193      0.0257
 8          0.0321      0.0386      0.0450      0.0514      0.0578
 8          0.0643      0.0707      0.0771      0.0835      0.0900
 8          0.0964      0.1023      0.1082      0.1141      0.1200
 8          0.1260      0.1391      0.1522      0.1653      0.1784
 8          0.1915      0.2160      0.2404      0.2794      0.3412
 8          0.5000      0.6588      0.7206      0.7596      0.7840
 8          0.8085      0.8216      0.8347      0.8478      0.8609
 8          0.8740      0.8800      0.8859      0.8918      0.8977
 8          0.9036      0.9100      0.9165      0.9229      0.9293
 8          0.9357      0.9422      0.9486      0.9550      0.9614
 8          0.9679      0.9743      0.9807      0.9871      0.9936
 8          1.0000      1.0000      1.0000      1.0000      1.0000
 9 ENDTBL
 5 RAINFL 2             .1
 8          0.0000      0.0031      0.0062      0.0093      0.0124
 8          0.0155      0.0186      0.0216      0.0247      0.0278
 8          0.0309      0.0340      0.0371      0.0402      0.0433
 8          0.0464      0.0495      0.0526      0.0557      0.0588
 8          0.0619      0.0649      0.0680      0.0711      0.0742
 8          0.0773      0.0804      0.0835      0.0866      0.0897
 8          0.0928      0.0980      0.1032      0.1085      0.1137
 8          0.1189      0.1242      0.1294      0.1346      0.1399
 8          0.1451      0.1503      0.1556      0.1608      0.1660
 8          0.1713      0.1761      0.1809      0.1857      0.1905
 8          0.1954      0.2060      0.2167      0.2274      0.2381
 8          0.2488      0.2687      0.2885      0.3203      0.3706
 8          0.5000      0.6294      0.6797      0.7115      0.7313
 8          0.7512      0.7619      0.7726      0.7833      0.7940
 8          0.8046      0.8095      0.8143      0.8191      0.8239
 8          0.8287      0.8340      0.8392      0.8444      0.8497
 8          0.8549      0.8601      0.8654      0.8706      0.8758
 8          0.8811      0.8863      0.8915      0.8968      0.9020
 8          0.9072      0.9103      0.9134      0.9165      0.9196
 8          0.9227      0.9258      0.9289      0.9320      0.9351
 8          0.9381      0.9412      0.9443      0.9474      0.9505
 8          0.9536      0.9567      0.9598      0.9629      0.9660
```

```
  8          0.9691      0.9722      0.9753      0.9784      0.9814
  8          0.9845      0.9876      0.9907      0.9938      0.9969
  8          1.0000      1.0000      1.0000      1.0000      1.0000
  9 ENDTBL
  5 RAINFL 3              .1
  8          0.0000      0.0011      0.0022      0.0033      0.0044
  8          0.0055      0.0066      0.0077      0.0088      0.0099
  8          0.0110      0.0121      0.0132      0.0143      0.0154
1
```

```
 ********************80-80 LIST OF INPUT DATA (CONTINUED)*********************

  8          0.0165      0.0176      0.0187      0.0198      0.0209
  8          0.0220      0.0231      0.0242      0.0253      0.0264
  8          0.0275      0.0286      0.0297      0.0308      0.0319
  8          0.0330      0.0341      0.0352      0.0363      0.0374
  8          0.0385      0.0396      0.0407      0.0418      0.0429
  8          0.0440      0.0451      0.0462      0.0473      0.0484
  8          0.0495      0.0506      0.0518      0.0529      0.0540
  8          0.0551      0.0562      0.0573      0.0584      0.0595
  8          0.0606      0.0617      0.0628      0.0639      0.0650
  8          0.0661      0.0687      0.0714      0.0741      0.0768
  8          0.0795      0.0822      0.0849      0.0875      0.0902
  8          0.0929      0.0956      0.0983      0.1010      0.1036
  8          0.1063      0.1090      0.1117      0.1144      0.1171
  8          0.1197      0.1224      0.1251      0.1278      0.1305
  8          0.1332      0.1358      0.1385      0.1412      0.1439
  8          0.1466      0.1511      0.1557      0.1602      0.1647
  8          0.1693      0.1738      0.1784      0.1829      0.1875
  8          0.1920      0.1965      0.2011      0.2056      0.2102
  8          0.2147      0.2189      0.2231      0.2273      0.2314
  8          0.2356      0.2449      0.2542      0.2634      0.2727
  8          0.2820      0.2992      0.3165      0.3440      0.3877
  8          0.5000      0.6123      0.6560      0.6835      0.7008
  8          0.7180      0.7273      0.7366      0.7458      0.7551
  8          0.7644      0.7686      0.7727      0.7769      0.7811
  8          0.7853      0.7898      0.7944      0.7989      0.8035
  8          0.8080      0.8125      0.8171      0.8216      0.8262
  8          0.8307      0.8353      0.8398      0.8443      0.8489
  8          0.8534      0.8561      0.8588      0.8615      0.8642
  8          0.8668      0.8695      0.8722      0.8749      0.8776
  8          0.8803      0.8829      0.8856      0.8883      0.8910
  8          0.8937      0.8964      0.8990      0.9017      0.9044
  8          0.9071      0.9098      0.9125      0.9151      0.9178
  8          0.9205      0.9232      0.9259      0.9286      0.9313
  8          0.9339      0.9350      0.9361      0.9372      0.9383
```

```
  8          0.9394     0.9405     0.9416     0.9427     0.9438
  8          0.9449     0.9460     0.9471     0.9482     0.9494
  8          0.9505     0.9516     0.9527     0.9538     0.9549
  8          0.9560     0.9571     0.9582     0.9593     0.9604
  8          0.9615     0.9626     0.9637     0.9648     0.9659
  8          0.9670     0.9681     0.9692     0.9703     0.9714
  8          0.9725     0.9736     0.9747     0.9758     0.9769
  8          0.9780     0.9791     0.9802     0.9813     0.9824
  8          0.9835     0.9846     0.9857     0.9868     0.9879
  8          0.9890     0.9901     0.9912     0.9923     0.9934
  8          0.9945     0.9956     0.9967     0.9978     0.9989
  8          1.0000     1.0000     1.0000     1.0000     1.0000
  9 ENDTBL
  5 RAINFL 4           .1
  8          0.0000     0.0063     0.0125     0.0188     0.0251
  8          0.0313     0.0376     0.0439     0.0501     0.0564
1


 ********************80-80 LIST OF INPUT DATA (CONTINUED)*********************

  8          0.0627     0.0689     0.0752     0.0815     0.0877
  8          0.0940     0.1001     0.1062     0.1122     0.1183
  8          0.1244     0.1374     0.1505     0.1635     0.1765
  8          0.1895     0.2147     0.2400     0.2799     0.3428
  8          0.5000     0.6572     0.7201     0.7600     0.7853
  8          0.8105     0.8235     0.8365     0.8495     0.8626
  8          0.8756     0.8817     0.8878     0.8938     0.8999
  8          0.9060     0.9123     0.9185     0.9248     0.9311
  8          0.9373     0.9436     0.9499     0.9561     0.9624
  8          0.9687     0.9749     0.9812     0.9875     0.9937
  8          1.0000     1.0000     1.0000     1.0000     1.0000
  9 ENDTBL
  5 RAINFL 5           .1
  8          0.0000     0.0031     0.0061     0.0092     0.0123
  8          0.0154     0.0184     0.0215     0.0246     0.0277
  8          0.0307     0.0338     0.0369     0.0400     0.0430
  8          0.0461     0.0492     0.0522     0.0553     0.0584
  8          0.0615     0.0645     0.0676     0.0707     0.0738
  8          0.0768     0.0799     0.0830     0.0861     0.0891
  8          0.0922     0.0973     0.1024     0.1075     0.1127
  8          0.1178     0.1229     0.1280     0.1331     0.1382
  8          0.1433     0.1484     0.1535     0.1587     0.1638
  8          0.1689     0.1738     0.1788     0.1838     0.1887
  8          0.1937     0.2043     0.2149     0.2255     0.2362
  8          0.2468     0.2673     0.2879     0.3205     0.3718
  8          0.5000     0.6282     0.6795     0.7121     0.7327
```

```
  8          0.7532      0.7638      0.7745      0.7851      0.7957
  8          0.8063      0.8113      0.8162      0.8212      0.8262
  8          0.8311      0.8362      0.8413      0.8465      0.8516
  8          0.8567      0.8618      0.8669      0.8720      0.8771
  8          0.8822      0.8873      0.8925      0.8976      0.9027
  8          0.9078      0.9109      0.9139      0.9170      0.9201
  8          0.9232      0.9262      0.9293      0.9324      0.9355
  8          0.9385      0.9416      0.9447      0.9478      0.9508
  8          0.9539      0.9570      0.9600      0.9631      0.9662
  8          0.9693      0.9723      0.9754      0.9785      0.9816
  8          0.9846      0.9877      0.9908      0.9939      0.9969
  8          1.0000      1.0000      1.0000      1.0000      1.0000
  9 ENDTBL
  5 RAINFL 6            .1
  8          0.0000      0.0011      0.0022      0.0033      0.0044
  8          0.0055      0.0066      0.0077      0.0088      0.0099
  8          0.0109      0.0120      0.0131      0.0142      0.0153
  8          0.0164      0.0175      0.0186      0.0197      0.0208
  8          0.0219      0.0230      0.0241      0.0252      0.0263
  8          0.0274      0.0285      0.0296      0.0307      0.0317
  8          0.0328      0.0339      0.0350      0.0361      0.0372
  8          0.0383      0.0394      0.0405      0.0416      0.0427
  8          0.0438      0.0449      0.0460      0.0471      0.0482
  8          0.0493      0.0504      0.0515      0.0525      0.0536
1


 ********************80-80 LIST OF INPUT DATA (CONTINUED)*********************

  8          0.0547      0.0558      0.0569      0.0580      0.0591
  8          0.0602      0.0613      0.0624      0.0635      0.0646
  8          0.0657      0.0684      0.0710      0.0737      0.0764
  8          0.0790      0.0817      0.0844      0.0870      0.0897
  8          0.0924      0.0950      0.0977      0.1004      0.1031
  8          0.1057      0.1084      0.1111      0.1137      0.1164
  8          0.1191      0.1217      0.1244      0.1271      0.1298
  8          0.1324      0.1351      0.1378      0.1404      0.1431
  8          0.1458      0.1502      0.1547      0.1591      0.1635
  8          0.1680      0.1724      0.1769      0.1813      0.1857
  8          0.1902      0.1946      0.1991      0.2035      0.2079
  8          0.2124      0.2167      0.2210      0.2253      0.2296
  8          0.2339      0.2431      0.2524      0.2616      0.2708
  8          0.2800      0.2979      0.3158      0.3441      0.3886
  8          0.5000      0.6114      0.6559      0.6842      0.7021
  8          0.7200      0.7292      0.7384      0.7476      0.7569
  8          0.7661      0.7704      0.7747      0.7790      0.7833
  8          0.7876      0.7921      0.7965      0.8009      0.8054
```

```
  8          0.8098      0.8143      0.8187      0.8231      0.8276
  8          0.8320      0.8365      0.8409      0.8453      0.8498
  8          0.8542      0.8569      0.8596      0.8622      0.8649
  8          0.8676      0.8702      0.8729      0.8756      0.8783
  8          0.8809      0.8836      0.8863      0.8889      0.8916
  8          0.8943      0.8969      0.8996      0.9023      0.9050
  8          0.9076      0.9103      0.9130      0.9156      0.9183
  8          0.9210      0.9236      0.9263      0.9290      0.9316
  8          0.9343      0.9354      0.9365      0.9376      0.9387
  8          0.9398      0.9409      0.9420      0.9431      0.9442
  8          0.9453      0.9464      0.9475      0.9485      0.9496
  8          0.9507      0.9518      0.9529      0.9540      0.9551
  8          0.9562      0.9573      0.9584      0.9595      0.9606
  8          0.9617      0.9628      0.9639      0.9650      0.9661
  8          0.9672      0.9683      0.9693      0.9704      0.9715
  8          0.9726      0.9737      0.9748      0.9759      0.9770
  8          0.9781      0.9792      0.9803      0.9814      0.9825
  8          0.9836      0.9847      0.9858      0.9869      0.9880
  8          0.9891      0.9901      0.9912      0.9923      0.9934
  8          0.9945      0.9956      0.9967      0.9978      0.9989
  8          1.0000      1.0000      1.0000      1.0000      1.0000
  9 ENDTBL
  5 RAINFL 7               .1
  8          0.0000      0.0033      0.0066      0.0099      0.0132
  8          0.0165      0.0198      0.0232      0.0265      0.0298
  8          0.0331      0.0364      0.0397      0.0430      0.0463
  8          0.0496      0.0529      0.0562      0.0595      0.0629
  8          0.0662      0.0695      0.0728      0.0761      0.0794
  8          0.0827      0.0860      0.0893      0.0926      0.0959
  8          0.0992      0.1044      0.1095      0.1146      0.1197
  8          0.1249      0.1300      0.1351      0.1402      0.1454
  8          0.1505      0.1556      0.1607      0.1659      0.1710
1



 ********************80-80 LIST OF INPUT DATA (CONTINUED)*********************

  8          0.1761      0.1812      0.1863      0.1914      0.1966
  8          0.2017      0.2127      0.2238      0.2348      0.2459
  8          0.2570      0.2795      0.3021      0.3365      0.3874
  8          0.5000      0.6126      0.6635      0.6979      0.7205
  8          0.7430      0.7541      0.7652      0.7762      0.7873
  8          0.7983      0.8034      0.8086      0.8137      0.8188
  8          0.8239      0.8290      0.8341      0.8393      0.8444
  8          0.8495      0.8546      0.8598      0.8649      0.8700
  8          0.8751      0.8803      0.8854      0.8905      0.8956
  8          0.9008      0.9041      0.9074      0.9107      0.9140
```

```
  8          0.9173      0.9206      0.9239      0.9272      0.9305
  8          0.9338      0.9371      0.9405      0.9438      0.9471
  8          0.9504      0.9537      0.9570      0.9603      0.9636
  8          0.9669      0.9702      0.9735      0.9768      0.9802
  8          0.9835      0.9868      0.9901      0.9934      0.9967
  8          1.0000      1.0000      1.0000      1.0000      1.0000
  9 ENDTBL
  5 RAINFL 8            .1
  8          0.0000      0.0012      0.0025      0.0037      0.0050
  8          0.0062      0.0075      0.0087      0.0100      0.0112
  8          0.0125      0.0137      0.0150      0.0162      0.0175
  8          0.0187      0.0200      0.0212      0.0225      0.0237
  8          0.0249      0.0262      0.0274      0.0287      0.0299
  8          0.0312      0.0324      0.0337      0.0349      0.0362
  8          0.0374      0.0387      0.0399      0.0412      0.0424
  8          0.0437      0.0449      0.0462      0.0474      0.0487
  8          0.0499      0.0511      0.0524      0.0536      0.0549
  8          0.0561      0.0574      0.0586      0.0599      0.0611
  8          0.0624      0.0636      0.0649      0.0661      0.0674
  8          0.0686      0.0699      0.0711      0.0724      0.0736
  8          0.0748      0.0777      0.0805      0.0833      0.0861
  8          0.0889      0.0917      0.0945      0.0974      0.1002
  8          0.1030      0.1058      0.1086      0.1114      0.1142
  8          0.1170      0.1199      0.1227      0.1255      0.1283
  8          0.1311      0.1339      0.1367      0.1395      0.1424
  8          0.1452      0.1480      0.1508      0.1536      0.1564
  8          0.1592      0.1636      0.1680      0.1723      0.1767
  8          0.1810      0.1854      0.1897      0.1941      0.1985
  8          0.2028      0.2072      0.2115      0.2159      0.2202
  8          0.2246      0.2289      0.2333      0.2376      0.2420
  8          0.2463      0.2557      0.2651      0.2745      0.2839
  8          0.2934      0.3125      0.3317      0.3610      0.4042
  8          0.5000      0.5958      0.6390      0.6683      0.6875
  8          0.7066      0.7161      0.7255      0.7349      0.7443
  8          0.7537      0.7580      0.7624      0.7667      0.7711
  8          0.7754      0.7798      0.7841      0.7885      0.7928
  8          0.7972      0.8015      0.8059      0.8103      0.8146
  8          0.8190      0.8233      0.8277      0.8320      0.8364
  8          0.8408      0.8436      0.8464      0.8492      0.8520
  8          0.8548      0.8576      0.8605      0.8633      0.8661
1


 ********************80-80 LIST OF INPUT DATA (CONTINUED)*********************

  8          0.8689      0.8717      0.8745      0.8773      0.8801
  8          0.8830      0.8858      0.8886      0.8914      0.8942
```

```
8           0.8970      0.8998      0.9026      0.9055      0.9083
8           0.9111      0.9139      0.9167      0.9195      0.9223
8           0.9252      0.9264      0.9276      0.9289      0.9301
8           0.9314      0.9326      0.9339      0.9351      0.9364
8           0.9376      0.9389      0.9401      0.9414      0.9426
8           0.9439      0.9451      0.9464      0.9476      0.9489
8           0.9501      0.9513      0.9526      0.9538      0.9551
8           0.9563      0.9576      0.9588      0.9601      0.9613
8           0.9626      0.9638      0.9651      0.9663      0.9676
8           0.9688      0.9701      0.9713      0.9726      0.9738
8           0.9751      0.9763      0.9775      0.9788      0.9800
8           0.9813      0.9825      0.9838      0.9850      0.9863
8           0.9875      0.9888      0.9900      0.9913      0.9925
8           0.9938      0.9950      0.9963      0.9975      0.9988
8           1.0000      1.0000      1.0000      1.0000      1.0000
9 ENDTBL
5 RAINFL 9               .1
8           0.0000      0.0015      0.0029      0.0044      0.0059
8           0.0073      0.0088      0.0103      0.0117      0.0132
8           0.0147      0.0161      0.0176      0.0191      0.0205
8           0.0220      0.0234      0.0249      0.0264      0.0278
8           0.0293      0.0308      0.0322      0.0337      0.0352
8           0.0366      0.0381      0.0396      0.0410      0.0425
8           0.0440      0.0454      0.0469      0.0484      0.0498
8           0.0513      0.0528      0.0542      0.0557      0.0572
8           0.0586      0.0601      0.0615      0.0630      0.0645
8           0.0659      0.0674      0.0689      0.0703      0.0718
8           0.0733      0.0747      0.0762      0.0777      0.0791
8           0.0806      0.0821      0.0835      0.0850      0.0865
8           0.0879      0.0912      0.0944      0.0976      0.1008
8           0.1041      0.1073      0.1105      0.1138      0.1170
8           0.1202      0.1234      0.1267      0.1299      0.1331
8           0.1364      0.1396      0.1428      0.1460      0.1493
8           0.1525      0.1557      0.1589      0.1622      0.1654
8           0.1686      0.1719      0.1751      0.1783      0.1815
8           0.1848      0.1895      0.1941      0.1988      0.2035
8           0.2082      0.2128      0.2175      0.2222      0.2269
8           0.2315      0.2362      0.2409      0.2456      0.2502
8           0.2549      0.2593      0.2637      0.2681      0.2725
8           0.2769      0.2867      0.2966      0.3064      0.3163
8           0.3261      0.3452      0.3642      0.3913      0.4279
8           0.5000      0.5721      0.6087      0.6358      0.6548
8           0.6739      0.6837      0.6936      0.7034      0.7133
8           0.7231      0.7275      0.7319      0.7363      0.7407
8           0.7451      0.7498      0.7544      0.7591      0.7638
8           0.7685      0.7731      0.7778      0.7825      0.7872
8           0.7918      0.7965      0.8012      0.8059      0.8105
8           0.8152      0.8185      0.8217      0.8249      0.8281
```

```
 ********************80-80 LIST OF INPUT DATA (CONTINUED)*********************

  8          0.8314      0.8346      0.8378      0.8411      0.8443
  8          0.8475      0.8507      0.8540      0.8572      0.8604
  8          0.8636      0.8669      0.8701      0.8733      0.8766
  8          0.8798      0.8830      0.8862      0.8895      0.8927
  8          0.8959      0.8992      0.9024      0.9056      0.9088
  8          0.9121      0.9135      0.9150      0.9165      0.9179
  8          0.9194      0.9209      0.9223      0.9238      0.9253
  8          0.9267      0.9282      0.9297      0.9311      0.9326
  8          0.9341      0.9355      0.9370      0.9385      0.9399
  8          0.9414      0.9428      0.9443      0.9458      0.9472
  8          0.9487      0.9502      0.9516      0.9531      0.9546
  8          0.9560      0.9575      0.9590      0.9604      0.9619
  8          0.9634      0.9648      0.9663      0.9678      0.9692
  8          0.9707      0.9722      0.9736      0.9751      0.9766
  8          0.9780      0.9795      0.9809      0.9824      0.9839
  8          0.9853      0.9868      0.9883      0.9897      0.9912
  8          0.9927      0.9941      0.9956      0.9971      0.9985
  8          1.0000      1.0000      1.0000      1.0000      1.0000
  9 ENDTBL
    ENDATA
  7 INCREM 6                    0.1
  7 COMPUT 7   3     3          0.0        1.91        1.01 2  1   1
    ENDCMP 1
  7 COMPUT 7   3     3          0.0        2.35        1.02 2  1   2
    ENDCMP 1
  7 COMPUT 7   3     3          0.0        2.70        1.03 2  1   3
    ENDCMP 1
  7 COMPUT 7   3     3          0.0        2.32        1.04 2  1   4
    ENDCMP 1
  7 COMPUT 7   3     3          0.0        2.84        1.05 2  1   5
    ENDCMP 1
  7 COMPUT 7   3     3          0.0        3.27        1.06 2  1   6
    ENDCMP 1
  7 COMPUT 7   3     3          0.0        4.28        1.07 2  1   7
    ENDCMP 1
  7 COMPUT 7   3     3          0.0        5.03        1.08 2  1   8
    ENDCMP 1
  7 COMPUT 7   3     3          0.0        8.67        1.09 2  1   9
    ENDCMP 1
    ENDJOB 2

 ******************************END OF 80-80 LIST******************************
```

```
1
 TR20 -------------------------------------------------------------------- SCS -
                                Carsins Run                             VERSION
 11/28/**                     MD 2010 - SSURGO                         2.04TEST
 09:43:39                  PASS   1   JOB NO.   1                      PAGE   1



 EXECUTIVE CONTROL INCREM    MAIN TIME INCREMENT =   .100 HOURS


 EXECUTIVE CONTROL COMPUT    FROM XSECTION   3  TO XSECTION   3
    STARTING TIME =   .00       RAIN DEPTH =  1.91       RAIN DURATION =  1.00
    ANT. RUNOFF COND. = 2       MAIN TIME INCREMENT =   .100 HOURS
    ALTERNATE NO. = 1           STORM NO. = 1            RAIN TABLE NO. = 1


 OPERATION RUNOFF   XSECTION   3

    PEAK TIME(HRS)             PEAK DISCHARGE(CFS)         PEAK ELEVATION(FEET)
        5.32                         282.3                        (RUNOFF)

    RUNOFF ABOVE BASEFLOW  (BASEFLOW =    .00 CFS)
                    .36 WATERSHED INCHES;     989 CFS-HRS;      81.8 ACRE-FEET.


 EXECUTIVE CONTROL ENDCMP    COMPUTATIONS COMPLETED FOR PASS   1


 EXECUTIVE CONTROL COMPUT    FROM XSECTION   3  TO XSECTION   3
    STARTING TIME =   .00       RAIN DEPTH =  2.35       RAIN DURATION =  1.00
    ANT. RUNOFF COND. = 2       MAIN TIME INCREMENT =   .100 HOURS
    ALTERNATE NO. = 1           STORM NO. = 2            RAIN TABLE NO. = 2


 OPERATION RUNOFF   XSECTION   3

    PEAK TIME(HRS)             PEAK DISCHARGE(CFS)         PEAK ELEVATION(FEET)
        8.19                         386.7                        (RUNOFF)

    RUNOFF ABOVE BASEFLOW  (BASEFLOW =    .00 CFS)
                    .59 WATERSHED INCHES;    1635 CFS-HRS;     135.1 ACRE-FEET.


 EXECUTIVE CONTROL ENDCMP    COMPUTATIONS COMPLETED FOR PASS   2


 EXECUTIVE CONTROL COMPUT    FROM XSECTION   3  TO XSECTION   3
```

```
   STARTING TIME =   .00       RAIN DEPTH =  2.70       RAIN DURATION =  1.00
   ANT. RUNOFF COND. = 2       MAIN TIME INCREMENT =   .100 HOURS
   ALTERNATE NO. = 1           STORM NO. = 3            RAIN TABLE NO. = 3
1
 TR20 -------------------------------------------------------------------- SCS -
                                Carsins Run                                VERSION
 11/28/**                     MD 2010 - SSURGO                            2.04TEST
 09:43:39                  PASS   3   JOB NO.   1                         PAGE   2



 OPERATION RUNOFF   XSECTION   3

    PEAK TIME(HRS)             PEAK DISCHARGE(CFS)         PEAK ELEVATION(FEET)
       14.12                          474.6                        (RUNOFF)

    RUNOFF ABOVE BASEFLOW  (BASEFLOW =    .00 CFS)
                    .80 WATERSHED INCHES;    2216 CFS-HRS;     183.1 ACRE-FEET.


 EXECUTIVE CONTROL ENDCMP    COMPUTATIONS COMPLETED FOR PASS   3


 EXECUTIVE CONTROL COMPUT    FROM XSECTION   3  TO XSECTION   3
    STARTING TIME =   .00       RAIN DEPTH =  2.32       RAIN DURATION =  1.00
    ANT. RUNOFF COND. = 2       MAIN TIME INCREMENT =   .100 HOURS
    ALTERNATE NO. = 1           STORM NO. = 4            RAIN TABLE NO. = 4


 OPERATION RUNOFF   XSECTION   3

    PEAK TIME(HRS)             PEAK DISCHARGE(CFS)         PEAK ELEVATION(FEET)
        5.23                          468.4                        (RUNOFF)

    RUNOFF ABOVE BASEFLOW  (BASEFLOW =    .00 CFS)
                    .58 WATERSHED INCHES;    1587 CFS-HRS;     131.2 ACRE-FEET.


 EXECUTIVE CONTROL ENDCMP    COMPUTATIONS COMPLETED FOR PASS   4


 EXECUTIVE CONTROL COMPUT    FROM XSECTION   3  TO XSECTION   3
    STARTING TIME =   .00       RAIN DEPTH =  2.84       RAIN DURATION =  1.00
    ANT. RUNOFF COND. = 2       MAIN TIME INCREMENT =   .100 HOURS
    ALTERNATE NO. = 1           STORM NO. = 5            RAIN TABLE NO. = 5


 OPERATION RUNOFF   XSECTION   3
```

```
   PEAK TIME(HRS)            PEAK DISCHARGE(CFS)         PEAK ELEVATION(FEET)
       8.13                        611.7                         (RUNOFF)

   RUNOFF ABOVE BASEFLOW  (BASEFLOW =    .00 CFS)
                   .89 WATERSHED INCHES;    2462 CFS-HRS;     203.5 ACRE-FEET.
1
 TR20 -------------------------------------------------------------------- SCS -
                                Carsins Run                              VERSION
 11/28/**                     MD 2010 - SSURGO                          2.04TEST
 09:43:39                  PASS   6   JOB NO.   1                       PAGE   3



 EXECUTIVE CONTROL ENDCMP    COMPUTATIONS COMPLETED FOR PASS   5


 EXECUTIVE CONTROL COMPUT    FROM XSECTION   3  TO XSECTION   3
    STARTING TIME =   .00       RAIN DEPTH =  3.27       RAIN DURATION =  1.00
    ANT. RUNOFF COND. = 2       MAIN TIME INCREMENT =   .100 HOURS
    ALTERNATE NO. = 1           STORM NO. = 6            RAIN TABLE NO. = 6


 OPERATION RUNOFF   XSECTION   3

    PEAK TIME(HRS)            PEAK DISCHARGE(CFS)         PEAK ELEVATION(FEET)
      14.07                        733.0                         (RUNOFF)

    RUNOFF ABOVE BASEFLOW  (BASEFLOW =    .00 CFS)
                  1.18 WATERSHED INCHES;    3261 CFS-HRS;     269.5 ACRE-FEET.


 EXECUTIVE CONTROL ENDCMP    COMPUTATIONS COMPLETED FOR PASS   6


 EXECUTIVE CONTROL COMPUT    FROM XSECTION   3  TO XSECTION   3
    STARTING TIME =   .00       RAIN DEPTH =  4.28       RAIN DURATION =  1.00
    ANT. RUNOFF COND. = 2       MAIN TIME INCREMENT =   .100 HOURS
    ALTERNATE NO. = 1           STORM NO. = 7            RAIN TABLE NO. = 7


 OPERATION RUNOFF   XSECTION   3

    PEAK TIME(HRS)            PEAK DISCHARGE(CFS)         PEAK ELEVATION(FEET)
       8.06                       1365.8                         (RUNOFF)

    RUNOFF ABOVE BASEFLOW  (BASEFLOW =    .00 CFS)
                  1.93 WATERSHED INCHES;    5328 CFS-HRS;     440.3 ACRE-FEET.
```

```
 EXECUTIVE CONTROL ENDCMP    COMPUTATIONS COMPLETED FOR PASS   7
1
 TR20 -------------------------------------------------------------------- SCS -
                                 Carsins Run                              VERSION
 11/28/**                      MD 2010 - SSURGO                          2.04TEST
 09:43:39                   PASS   8   JOB NO.   1                       PAGE   4



 EXECUTIVE CONTROL COMPUT    FROM XSECTION   3  TO XSECTION   3
    STARTING TIME =   .00       RAIN DEPTH =  5.03       RAIN DURATION =  1.00
    ANT. RUNOFF COND. = 2       MAIN TIME INCREMENT =   .100 HOURS
    ALTERNATE NO. = 1           STORM NO. = 8            RAIN TABLE NO. = 8


 OPERATION RUNOFF   XSECTION   3

    PEAK TIME(HRS)             PEAK DISCHARGE(CFS)          PEAK ELEVATION(FEET)
       14.00                        1578.6                          (RUNOFF)

    RUNOFF ABOVE BASEFLOW  (BASEFLOW =    .00 CFS)
                  2.53 WATERSHED INCHES;    6988 CFS-HRS;     577.5 ACRE-FEET.


 EXECUTIVE CONTROL ENDCMP    COMPUTATIONS COMPLETED FOR PASS   8


 EXECUTIVE CONTROL COMPUT    FROM XSECTION   3  TO XSECTION   3
    STARTING TIME =   .00       RAIN DEPTH =  8.67       RAIN DURATION =  1.00
    ANT. RUNOFF COND. = 2       MAIN TIME INCREMENT =   .100 HOURS
    ALTERNATE NO. = 1           STORM NO. = 9            RAIN TABLE NO. = 9


 OPERATION RUNOFF   XSECTION   3

    PEAK TIME(HRS)             PEAK DISCHARGE(CFS)          PEAK ELEVATION(FEET)
       13.95                        3206.6                          (RUNOFF)

    RUNOFF ABOVE BASEFLOW  (BASEFLOW =    .00 CFS)
                  5.73 WATERSHED INCHES;   15813 CFS-HRS;    1306.8 ACRE-FEET.


 EXECUTIVE CONTROL ENDCMP    COMPUTATIONS COMPLETED FOR PASS   9
1
 TR20 -------------------------------------------------------------------- SCS -
                                 Carsins Run                              VERSION
```

```
                            SUMMARY TABLE 1
                            ---------------
   SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL IN ORDER PERFORMED.
   A CHARACTER FOLLOWING THE PEAK DISCHARGE TIME AND RATE (CFS) INDICATES:
F-FLAT TOP HYDROGRAPH   T-TRUNCATED HYDROGRAPH   R-RISING TRUNCATED HYDROGRAPH

XSECTION/  STANDARD                                    PEAK DISCHARGE
STRUCTURE   CONTROL    DRAINAGE   RUNOFF   ------------------------------------
   ID      OPERATION     AREA     AMOUNT   ELEVATION   TIME      RATE    RATE
                        (SQ MI)    (IN)      (FT)      (HR)     (CFS)   (CSM)

RAINFALL OF   1.91 inches AND   6.00 hr DURATION, BEGINS AT    .0 hrs.
RAINTABLE NUMBER  1,    ARC 2
MAIN TIME INCREMENT   .100 HOURS

   ALTERNATE    1   STORM    1
   ---------------------------
XSECTION   3  RUNOFF     4.27      .36        ---      5.32      282     66.0

RAINFALL OF   2.35 inches AND  12.00 hr DURATION, BEGINS AT    .0 hrs.
RAINTABLE NUMBER  2,    ARC 2

   ALTERNATE    1   STORM    2
   ---------------------------
XSECTION   3  RUNOFF     4.27      .59        ---      8.19      387     90.6

RAINFALL OF   2.70 inches AND  24.00 hr DURATION, BEGINS AT    .0 hrs.
RAINTABLE NUMBER  3,    ARC 2

   ALTERNATE    1   STORM    3
   ---------------------------
XSECTION   3  RUNOFF     4.27      .80        ---     14.12      475    111.2

RAINFALL OF   2.32 inches AND   6.00 hr DURATION, BEGINS AT    .0 hrs.
RAINTABLE NUMBER  4,    ARC 2

   ALTERNATE    1   STORM    4
   ---------------------------
XSECTION   3  RUNOFF     4.27      .58        ---      5.23      468    109.6

RAINFALL OF   2.84 inches AND  12.00 hr DURATION, BEGINS AT    .0 hrs.
RAINTABLE NUMBER  5,    ARC 2

   ALTERNATE    1   STORM    5
```

```
   ---------------------------
XSECTION   3  RUNOFF     4.27      .89        ---      8.13      612    143.3
1
TR20 -------------------------------------------------------------------- SCS -
                             Carsins Run                                VERSION
11/28/**                   MD 2010 - SSURGO                            2.04TEST
09:43:39                 SUMMARY, JOB NO.   1                          PAGE   6


                         SUMMARY TABLE 1
                         ---------------
   SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL IN ORDER PERFORMED.
   A CHARACTER FOLLOWING THE PEAK DISCHARGE TIME AND RATE (CFS) INDICATES:
F-FLAT TOP HYDROGRAPH   T-TRUNCATED HYDROGRAPH   R-RISING TRUNCATED HYDROGRAPH

XSECTION/  STANDARD                                  PEAK DISCHARGE
STRUCTURE   CONTROL    DRAINAGE   RUNOFF   ------------------------------------
   ID      OPERATION     AREA     AMOUNT   ELEVATION   TIME     RATE    RATE
                       (SQ MI)    (IN)      (FT)      (HR)     (CFS)   (CSM)


RAINFALL OF   3.27 inches AND  24.00 hr DURATION, BEGINS AT    .0 hrs.
RAINTABLE NUMBER  6,    ARC 2

   ALTERNATE    1   STORM    6
   ---------------------------
XSECTION   3  RUNOFF     4.27     1.18        ---     14.07      733    171.7

RAINFALL OF   4.28 inches AND  12.00 hr DURATION, BEGINS AT    .0 hrs.
RAINTABLE NUMBER  7,    ARC 2

   ALTERNATE    1   STORM    7
   ---------------------------
XSECTION   3  RUNOFF     4.27     1.93        ---      8.06     1366    319.9

RAINFALL OF   5.03 inches AND  24.00 hr DURATION, BEGINS AT    .0 hrs.
RAINTABLE NUMBER  8,    ARC 2

   ALTERNATE    1   STORM    8
   ---------------------------
XSECTION   3  RUNOFF     4.27     2.53        ---     14.00     1579    369.8

RAINFALL OF   8.67 inches AND  24.00 hr DURATION, BEGINS AT    .0 hrs.
RAINTABLE NUMBER  9,    ARC 2

   ALTERNATE    1   STORM    9
   ---------------------------
XSECTION   3  RUNOFF     4.27     5.73        ---     13.95     3207    751.1
```

```
1
 TR20 ------------------------------------------------------------------- SCS -
                                  Carsins Run                          VERSION
 11/28/**                       MD 2010 - SSURGO                        2.04TEST
 09:43:39                     SUMMARY, JOB NO.   1                      PAGE   7


                            SUMMARY TABLE 3
                            ---------------
      STORM DISCHARGES (CFS) AT XSECTIONS AND STRUCTURES FOR ALL ALTERNATES
      QUESTION MARK (?) AFTER: OUTFLOW PEAK - RISING TRUNCATED HYDROGRAPH.

 XSECTION/          DRAINAGE
 STRUCTURE            AREA      STORM NUMBERS..........
   ID               (SQ MI)         1         2         3         4         5


 XSECTION    3         4.27
 ---------------------------
    ALTERNATE    1                 282       387       475       468       612

                            SUMMARY TABLE 3
                            ---------------
      STORM DISCHARGES (CFS) AT XSECTIONS AND STRUCTURES FOR ALL ALTERNATES
      QUESTION MARK (?) AFTER: OUTFLOW PEAK - RISING TRUNCATED HYDROGRAPH.

 XSECTION/          DRAINAGE
 STRUCTURE            AREA      STORM NUMBERS..........
   ID               (SQ MI)         6         7         8         9


 XSECTION    3         4.27
 ---------------------------
    ALTERNATE    1                 733      1366      1579      3207
1
 TR20 ------------------------------------------------------------------- SCS -
                                  Carsins Run                          VERSION
 11/28/**                       MD 2010 - SSURGO                        2.04TEST



 END OF  1 JOBS IN THIS RUN
```

```
                 SCS  TR-20,  VERSION 2.04TEST
                                  FILES

 INPUT  = tr20in.dat                              , GIVEN DATA FILE
 OUTPUT = tr20in.OUT                              , DATED 11/28/**,09:43:39

          FILES GENERATED - DATED 11/28/**,09:43:39

                           NONE!



       TOTAL NUMBER OF WARNINGS =   0,  MESSAGES =   0

                 *** TR-20 RUN COMPLETED ***
```

KCI Technologies, Inc.

TR-55 DESIGN COMPUTATIONS

By:	KTC	Project Name:	I-95 Carsins Run	Project Number:	22145228.36
Date:	1/8/2019	County:	Harford County		
		Drainage Area:	Small Tributary	Existing:	[shaded]
				Proposed:	
				Ultimate:	

WEIGHTED RUNOFF CURVE NUMBER

Soil Group	Land Use or Zoning No.	Description	% Imperv.	RCN Table 2-2	RCN Figure 2-3	RCN Figure 2-4	Area (Acre)	RCN x Area
B	65	Woods - (good)		55			0.632	34.74
C	65	Woods - (good)		70			4.698	328.89
D	65	Woods - (good)		77			0.143	11.01
B	3	Open Space (good) - grass >75%		61			2.758	168.23
C	3	Open Space (good) - grass >75%		74			2.881	213.19
B	4	Imperv. - paved parking lots,roofs,drives	100	98			0.077	7.51
C	4	Imperv. - paved parking lots,roofs,drives	100	98			0.413	40.45
			Total Square Miles:	0.01813		Total Acres:	11.60	804.03
			Weighted RCN:	69.30		Use:	69	

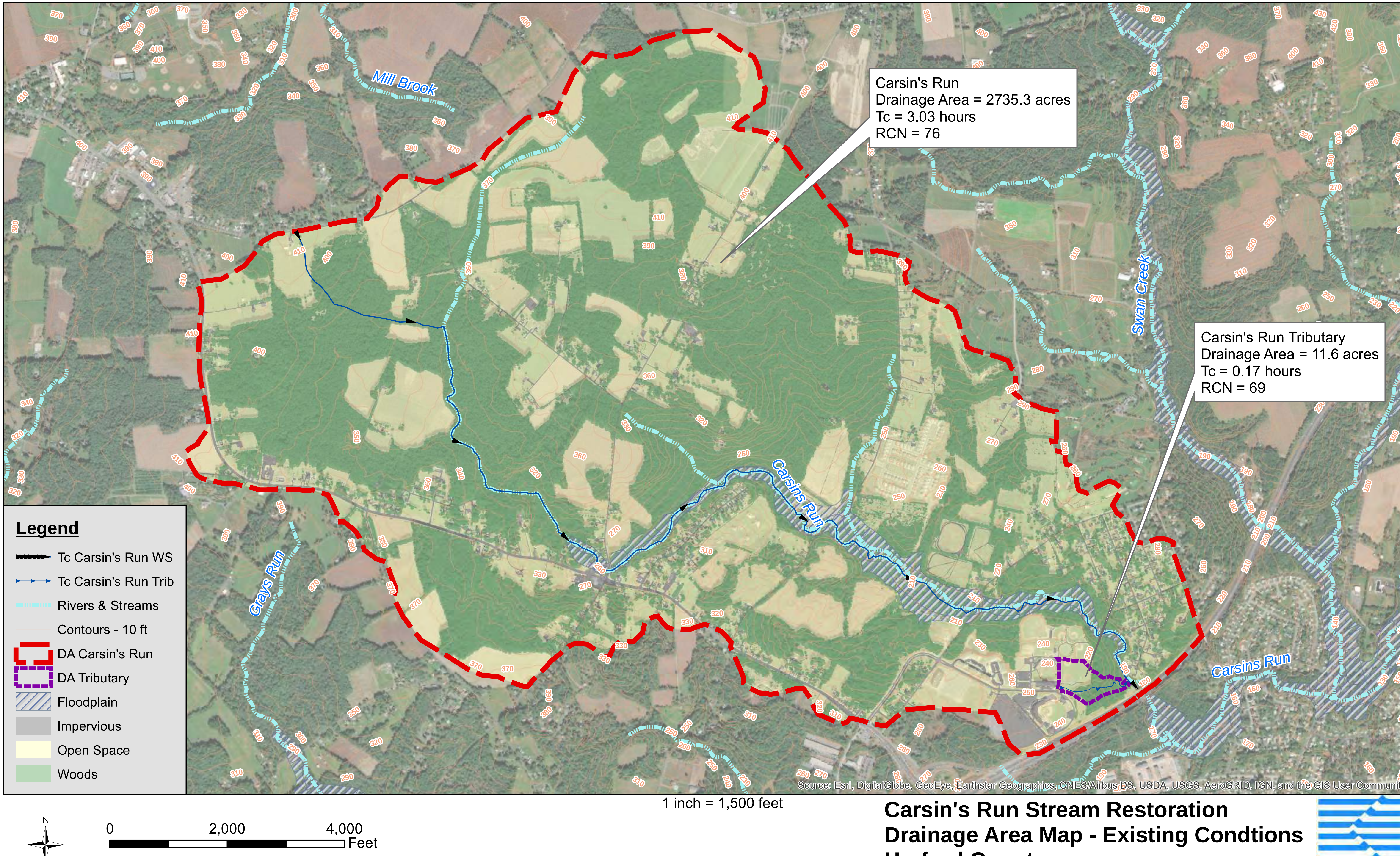
TIME OF CONCENTRATION

ID		Type of Flow			L(ft.)	n	A	WP	Slope (Percent)	Vel. (fps)	Time (Hours)
	Sheet Flow										
A-B	5	Grass - short			100	0.150			7.0		0.098
	Shallow Concentrated Flow										
B-C		paved	x	unpaved	452.36				4.2	3.31	0.038
		paved		unpaved							
		paved		unpaved							
		paved		unpaved							
		paved		unpaved							
	Concentrated Flow*										
C-D	1	Channel Flow, d (ft) =	0.7		855.26	0.035	4.48	8.13	4.8	6.27	0.038
										Total	**0.174**

GRAPHICAL PEAK DISCHARGE METHOD

Initial Abstraction Ia = 0.899 in. (Table 5-1) Use Tc= 0.17 Tt=

Rainfall Freq. =	1 Year	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
Rainfall, P (in) =	2.7	3.2	4.2	5.0	6.2	7.3	8.5
Ia/P =	0.337	0.278	0.217	0.181	0.145	0.123	0.105
Peak csm/in. =	707	756	786	801	821	832	842
Runoff Q (in) =	0.50	0.80	1.37	1.93	2.87	3.75	4.79
Peak Dischg. (CFS)=	6.42	10.92	19.44	27.99	42.72	56.58	73.21



Carsin's Run Stream Restoration
Drainage Area Map - Existing Condtions
Harford County
KCI Job No. 22145228.47

KCI TECHNOLOGIES

```
Watershed Statistics for:
GISHydro Release Version Date: January 8, 2011
Hydro Extension Version Date:  January 8, 2011
Analysis Date:                 November 26, 2018

Data Selected:
     Quadrangles Used: aberdeen, bel_air
     DEM Coverage: NED DEMs
     Land Use Coverage: Ultimate Landuse
     Soil Coverage: SSURGO Soils
     Hydrologic Condition: (see Lookup Table)
     Impose NHD stream Locations: Yes
     Outlet Easting:        470531 m. (MD Stateplane, NAD 1983)
     Outlet Northing:       207357 m. (MD Stateplane, NAD 1983)

Findings:
     Outlet Location:       Piedmont
     Outlet State:          Maryland
     Drainage Area          4.3 square miles
       -Piedmont (100.0% of area)
     Channel Slope:         51.1 feet/mile
     Land Slope:            0.051 ft/ft
     Urban Area:            7.8%
     Impervious Area:       4.0%
 ******************************************************
     Watershed is within 5km of physiographic
     province boundary.  You should consider
     sensitivity of discharges to region location.
 ******************************************************
     Time of Concentration: 3.9 hours  [W.O. Thomas, Jr. Equation]
     Time of Concentration: 3.5 hours  [From SCS Lag Equation * 1.67]
     Longest Flow Path:     4.81 miles
     Basin Relief:          354.1 feet
     Average CN:            76
     % Forest Cover:        44.3
     % Storage:             0.0
     % Limestone:           0.0
     Selected Soils Data Statistics:
        % A Soils:          0.6
        % B Soils:          26.6
        % C Soils:          46.6
        % D Soils:          26.2
     SSURGO Soils Data Statistics (used in Regression Equations):
        % A Soils:          0.6
        % B Soils:          26.6
        % C Soils:          46.6
        % D Soils:          26.2
     2-Year,24-hour Prec.:  3.27 inches
```

Mean Annual Prec.:   46.24 inches

basincomposition.txt

GISHydro Release Version Date: January 8, 2011
Hydro Extension Version Date: January 8, 2011
Analysis Date: November 26, 2018

Landuse and Soil Distributions for:

Distribution of Landuse by Soil Group

Land Use	Acres on Indicated Soil Group			
	A-Soil	B-Soil	C-Soil	D-Soil
Low Density Residential	0.22	57.82	74.72	30.02
Medium Density Residential	3.56	16.23	3.78	2.67
Commercial	1.78	10.01	10.01	3.56
Open Urban Land	0	18.68	15.35	0.44
Cropland	4.23	339.6	471.7	138.11
Pasture	0	20.46	18.01	11.34
Orchards	0	0	0.89	0
Deciduous Forest	1.11	146.78	569.33	477.92
Brush	5.12	0.22	7.56	4.45
Res.: 2.00 ac <=x	0	108.31	101.19	44.92
Agricultural Buildings	0	10.9	1.33	3.11
Total Area:	16.01	729.01	1273.87	716.55

Distribution of Land Use and Curve Numbers Used

Land Use	Acres	Percent	A	B	C	D
Low Density Residential	162.79	5.95	54	70	80	85
Medium Density Residential	26.24	0.96	61	75	83	87
Commercial	25.58	0.93	89	92	94	95
Open Urban Land	34.47	1.26	39	61	74	80
Cropland	954.07	34.87	67	78	85	89
Pasture	49.82	1.82	39	61	74	80
Orchards	0.89	0.03	32	58	72	79
Deciduous Forest	1195.37	43.68	30	55	70	77
Brush	17.35	0.63	30	48	65	73
Res.: 2.00 ac <=x	254.42	9.3	46	65	77	82
Agricultural Buildings	15.35	0.56	59	74	82	86

```
 ****************80-80 LIST OF INPUT DATA FOR TR-20 HYDROLOGY*****************

 JOB TR-20                                                  NOPLOTS
 TITLE     Carsins Run
 TITLE     Ultimate Land Use - SSURGO
  6 RUNOFF 1   3       1       4.2740      75.82        3.0363         1
  5 RAINFL 1              .1
  8          0.0000      0.0064      0.0129      0.0193      0.0257
  8          0.0321      0.0386      0.0450      0.0514      0.0578
  8          0.0643      0.0707      0.0771      0.0835      0.0900
  8          0.0964      0.1023      0.1082      0.1141      0.1200
  8          0.1260      0.1391      0.1522      0.1653      0.1784
  8          0.1915      0.2160      0.2404      0.2794      0.3412
  8          0.5000      0.6588      0.7206      0.7596      0.7840
  8          0.8085      0.8216      0.8347      0.8478      0.8609
  8          0.8740      0.8800      0.8859      0.8918      0.8977
  8          0.9036      0.9100      0.9165      0.9229      0.9293
  8          0.9357      0.9422      0.9486      0.9550      0.9614
  8          0.9679      0.9743      0.9807      0.9871      0.9936
  8          1.0000      1.0000      1.0000      1.0000      1.0000
  9 ENDTBL
  5 RAINFL 2              .1
  8          0.0000      0.0031      0.0062      0.0093      0.0124
  8          0.0155      0.0186      0.0216      0.0247      0.0278
  8          0.0309      0.0340      0.0371      0.0402      0.0433
  8          0.0464      0.0495      0.0526      0.0557      0.0588
  8          0.0619      0.0649      0.0680      0.0711      0.0742
  8          0.0773      0.0804      0.0835      0.0866      0.0897
  8          0.0928      0.0980      0.1032      0.1085      0.1137
  8          0.1189      0.1242      0.1294      0.1346      0.1399
  8          0.1451      0.1503      0.1556      0.1608      0.1660
  8          0.1713      0.1761      0.1809      0.1857      0.1905
  8          0.1954      0.2060      0.2167      0.2274      0.2381
  8          0.2488      0.2687      0.2885      0.3203      0.3706
  8          0.5000      0.6294      0.6797      0.7115      0.7313
  8          0.7512      0.7619      0.7726      0.7833      0.7940
  8          0.8046      0.8095      0.8143      0.8191      0.8239
  8          0.8287      0.8340      0.8392      0.8444      0.8497
  8          0.8549      0.8601      0.8654      0.8706      0.8758
  8          0.8811      0.8863      0.8915      0.8968      0.9020
  8          0.9072      0.9103      0.9134      0.9165      0.9196
  8          0.9227      0.9258      0.9289      0.9320      0.9351
  8          0.9381      0.9412      0.9443      0.9474      0.9505
  8          0.9536      0.9567      0.9598      0.9629      0.9660
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  8          0.9691      0.9722      0.9753      0.9784      0.9814
  8          0.9845      0.9876      0.9907      0.9938      0.9969
  8          1.0000      1.0000      1.0000      1.0000      1.0000
  9 ENDTBL
  5 RAINFL 3               .1
  8          0.0000      0.0011      0.0022      0.0033      0.0044
  8          0.0055      0.0066      0.0077      0.0088      0.0099
  8          0.0110      0.0121      0.0132      0.0143      0.0154
1
```

********************80-80 LIST OF INPUT DATA (CONTINUED)*********************

```
  8          0.0165      0.0176      0.0187      0.0198      0.0209
  8          0.0220      0.0231      0.0242      0.0253      0.0264
  8          0.0275      0.0286      0.0297      0.0308      0.0319
  8          0.0330      0.0341      0.0352      0.0363      0.0374
  8          0.0385      0.0396      0.0407      0.0418      0.0429
  8          0.0440      0.0451      0.0462      0.0473      0.0484
  8          0.0495      0.0506      0.0518      0.0529      0.0540
  8          0.0551      0.0562      0.0573      0.0584      0.0595
  8          0.0606      0.0617      0.0628      0.0639      0.0650
  8          0.0661      0.0687      0.0714      0.0741      0.0768
  8          0.0795      0.0822      0.0849      0.0875      0.0902
  8          0.0929      0.0956      0.0983      0.1010      0.1036
  8          0.1063      0.1090      0.1117      0.1144      0.1171
  8          0.1197      0.1224      0.1251      0.1278      0.1305
  8          0.1332      0.1358      0.1385      0.1412      0.1439
  8          0.1466      0.1511      0.1557      0.1602      0.1647
  8          0.1693      0.1738      0.1784      0.1829      0.1875
  8          0.1920      0.1965      0.2011      0.2056      0.2102
  8          0.2147      0.2189      0.2231      0.2273      0.2314
  8          0.2356      0.2449      0.2542      0.2634      0.2727
  8          0.2820      0.2992      0.3165      0.3440      0.3877
  8          0.5000      0.6123      0.6560      0.6835      0.7008
  8          0.7180      0.7273      0.7366      0.7458      0.7551
  8          0.7644      0.7686      0.7727      0.7769      0.7811
  8          0.7853      0.7898      0.7944      0.7989      0.8035
  8          0.8080      0.8125      0.8171      0.8216      0.8262
  8          0.8307      0.8353      0.8398      0.8443      0.8489
  8          0.8534      0.8561      0.8588      0.8615      0.8642
  8          0.8668      0.8695      0.8722      0.8749      0.8776
  8          0.8803      0.8829      0.8856      0.8883      0.8910
  8          0.8937      0.8964      0.8990      0.9017      0.9044
  8          0.9071      0.9098      0.9125      0.9151      0.9178
  8          0.9205      0.9232      0.9259      0.9286      0.9313
  8          0.9339      0.9350      0.9361      0.9372      0.9383
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  8          0.9394      0.9405      0.9416      0.9427      0.9438
  8          0.9449      0.9460      0.9471      0.9482      0.9494
  8          0.9505      0.9516      0.9527      0.9538      0.9549
  8          0.9560      0.9571      0.9582      0.9593      0.9604
  8          0.9615      0.9626      0.9637      0.9648      0.9659
  8          0.9670      0.9681      0.9692      0.9703      0.9714
  8          0.9725      0.9736      0.9747      0.9758      0.9769
  8          0.9780      0.9791      0.9802      0.9813      0.9824
  8          0.9835      0.9846      0.9857      0.9868      0.9879
  8          0.9890      0.9901      0.9912      0.9923      0.9934
  8          0.9945      0.9956      0.9967      0.9978      0.9989
  8          1.0000      1.0000      1.0000      1.0000      1.0000
  9 ENDTBL
  5 RAINFL 4            .1
  8          0.0000      0.0063      0.0125      0.0188      0.0251
  8          0.0313      0.0376      0.0439      0.0501      0.0564
1


 ********************80-80 LIST OF INPUT DATA (CONTINUED)**********************

  8          0.0627      0.0689      0.0752      0.0815      0.0877
  8          0.0940      0.1001      0.1062      0.1122      0.1183
  8          0.1244      0.1374      0.1505      0.1635      0.1765
  8          0.1895      0.2147      0.2400      0.2799      0.3428
  8          0.5000      0.6572      0.7201      0.7600      0.7853
  8          0.8105      0.8235      0.8365      0.8495      0.8626
  8          0.8756      0.8817      0.8878      0.8938      0.8999
  8          0.9060      0.9123      0.9185      0.9248      0.9311
  8          0.9373      0.9436      0.9499      0.9561      0.9624
  8          0.9687      0.9749      0.9812      0.9875      0.9937
  8          1.0000      1.0000      1.0000      1.0000      1.0000
  9 ENDTBL
  5 RAINFL 5            .1
  8          0.0000      0.0031      0.0061      0.0092      0.0123
  8          0.0154      0.0184      0.0215      0.0246      0.0277
  8          0.0307      0.0338      0.0369      0.0400      0.0430
  8          0.0461      0.0492      0.0522      0.0553      0.0584
  8          0.0615      0.0645      0.0676      0.0707      0.0738
  8          0.0768      0.0799      0.0830      0.0861      0.0891
  8          0.0922      0.0973      0.1024      0.1075      0.1127
  8          0.1178      0.1229      0.1280      0.1331      0.1382
  8          0.1433      0.1484      0.1535      0.1587      0.1638
  8          0.1689      0.1738      0.1788      0.1838      0.1887
  8          0.1937      0.2043      0.2149      0.2255      0.2362
  8          0.2468      0.2673      0.2879      0.3205      0.3718
  8          0.5000      0.6282      0.6795      0.7121      0.7327
```

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  8          0.7532      0.7638      0.7745      0.7851      0.7957
  8          0.8063      0.8113      0.8162      0.8212      0.8262
  8          0.8311      0.8362      0.8413      0.8465      0.8516
  8          0.8567      0.8618      0.8669      0.8720      0.8771
  8          0.8822      0.8873      0.8925      0.8976      0.9027
  8          0.9078      0.9109      0.9139      0.9170      0.9201
  8          0.9232      0.9262      0.9293      0.9324      0.9355
  8          0.9385      0.9416      0.9447      0.9478      0.9508
  8          0.9539      0.9570      0.9600      0.9631      0.9662
  8          0.9693      0.9723      0.9754      0.9785      0.9816
  8          0.9846      0.9877      0.9908      0.9939      0.9969
  8          1.0000      1.0000      1.0000      1.0000      1.0000
  9 ENDTBL
  5 RAINFL 6             .1
  8          0.0000      0.0011      0.0022      0.0033      0.0044
  8          0.0055      0.0066      0.0077      0.0088      0.0099
  8          0.0109      0.0120      0.0131      0.0142      0.0153
  8          0.0164      0.0175      0.0186      0.0197      0.0208
  8          0.0219      0.0230      0.0241      0.0252      0.0263
  8          0.0274      0.0285      0.0296      0.0307      0.0317
  8          0.0328      0.0339      0.0350      0.0361      0.0372
  8          0.0383      0.0394      0.0405      0.0416      0.0427
  8          0.0438      0.0449      0.0460      0.0471      0.0482
  8          0.0493      0.0504      0.0515      0.0525      0.0536
1


 ********************80-80 LIST OF INPUT DATA (CONTINUED)*********************

  8          0.0547      0.0558      0.0569      0.0580      0.0591
  8          0.0602      0.0613      0.0624      0.0635      0.0646
  8          0.0657      0.0684      0.0710      0.0737      0.0764
  8          0.0790      0.0817      0.0844      0.0870      0.0897
  8          0.0924      0.0950      0.0977      0.1004      0.1031
  8          0.1057      0.1084      0.1111      0.1137      0.1164
  8          0.1191      0.1217      0.1244      0.1271      0.1298
  8          0.1324      0.1351      0.1378      0.1404      0.1431
  8          0.1458      0.1502      0.1547      0.1591      0.1635
  8          0.1680      0.1724      0.1769      0.1813      0.1857
  8          0.1902      0.1946      0.1991      0.2035      0.2079
  8          0.2124      0.2167      0.2210      0.2253      0.2296
  8          0.2339      0.2431      0.2524      0.2616      0.2708
  8          0.2800      0.2979      0.3158      0.3441      0.3886
  8          0.5000      0.6114      0.6559      0.6842      0.7021
  8          0.7200      0.7292      0.7384      0.7476      0.7569
  8          0.7661      0.7704      0.7747      0.7790      0.7833
  8          0.7876      0.7921      0.7965      0.8009      0.8054
```

```
  8          0.8098     0.8143     0.8187     0.8231     0.8276
  8          0.8320     0.8365     0.8409     0.8453     0.8498
  8          0.8542     0.8569     0.8596     0.8622     0.8649
  8          0.8676     0.8702     0.8729     0.8756     0.8783
  8          0.8809     0.8836     0.8863     0.8889     0.8916
  8          0.8943     0.8969     0.8996     0.9023     0.9050
  8          0.9076     0.9103     0.9130     0.9156     0.9183
  8          0.9210     0.9236     0.9263     0.9290     0.9316
  8          0.9343     0.9354     0.9365     0.9376     0.9387
  8          0.9398     0.9409     0.9420     0.9431     0.9442
  8          0.9453     0.9464     0.9475     0.9485     0.9496
  8          0.9507     0.9518     0.9529     0.9540     0.9551
  8          0.9562     0.9573     0.9584     0.9595     0.9606
  8          0.9617     0.9628     0.9639     0.9650     0.9661
  8          0.9672     0.9683     0.9693     0.9704     0.9715
  8          0.9726     0.9737     0.9748     0.9759     0.9770
  8          0.9781     0.9792     0.9803     0.9814     0.9825
  8          0.9836     0.9847     0.9858     0.9869     0.9880
  8          0.9891     0.9901     0.9912     0.9923     0.9934
  8          0.9945     0.9956     0.9967     0.9978     0.9989
  8          1.0000     1.0000     1.0000     1.0000     1.0000
  9 ENDTBL
  5 RAINFL 7            .1
  8          0.0000     0.0033     0.0066     0.0099     0.0132
  8          0.0165     0.0198     0.0232     0.0265     0.0298
  8          0.0331     0.0364     0.0397     0.0430     0.0463
  8          0.0496     0.0529     0.0562     0.0595     0.0629
  8          0.0662     0.0695     0.0728     0.0761     0.0794
  8          0.0827     0.0860     0.0893     0.0926     0.0959
  8          0.0992     0.1044     0.1095     0.1146     0.1197
  8          0.1249     0.1300     0.1351     0.1402     0.1454
  8          0.1505     0.1556     0.1607     0.1659     0.1710
1



 ********************80-80 LIST OF INPUT DATA (CONTINUED)*********************

  8          0.1761     0.1812     0.1863     0.1914     0.1966
  8          0.2017     0.2127     0.2238     0.2348     0.2459
  8          0.2570     0.2795     0.3021     0.3365     0.3874
  8          0.5000     0.6126     0.6635     0.6979     0.7205
  8          0.7430     0.7541     0.7652     0.7762     0.7873
  8          0.7983     0.8034     0.8086     0.8137     0.8188
  8          0.8239     0.8290     0.8341     0.8393     0.8444
  8          0.8495     0.8546     0.8598     0.8649     0.8700
  8          0.8751     0.8803     0.8854     0.8905     0.8956
  8          0.9008     0.9041     0.9074     0.9107     0.9140
```

```
  8          0.9173      0.9206      0.9239      0.9272      0.9305
  8          0.9338      0.9371      0.9405      0.9438      0.9471
  8          0.9504      0.9537      0.9570      0.9603      0.9636
  8          0.9669      0.9702      0.9735      0.9768      0.9802
  8          0.9835      0.9868      0.9901      0.9934      0.9967
  8          1.0000      1.0000      1.0000      1.0000      1.0000
  9 ENDTBL
  5 RAINFL 8            .1
  8          0.0000      0.0012      0.0025      0.0037      0.0050
  8          0.0062      0.0075      0.0087      0.0100      0.0112
  8          0.0125      0.0137      0.0150      0.0162      0.0175
  8          0.0187      0.0200      0.0212      0.0225      0.0237
  8          0.0249      0.0262      0.0274      0.0287      0.0299
  8          0.0312      0.0324      0.0337      0.0349      0.0362
  8          0.0374      0.0387      0.0399      0.0412      0.0424
  8          0.0437      0.0449      0.0462      0.0474      0.0487
  8          0.0499      0.0511      0.0524      0.0536      0.0549
  8          0.0561      0.0574      0.0586      0.0599      0.0611
  8          0.0624      0.0636      0.0649      0.0661      0.0674
  8          0.0686      0.0699      0.0711      0.0724      0.0736
  8          0.0748      0.0777      0.0805      0.0833      0.0861
  8          0.0889      0.0917      0.0945      0.0974      0.1002
  8          0.1030      0.1058      0.1086      0.1114      0.1142
  8          0.1170      0.1199      0.1227      0.1255      0.1283
  8          0.1311      0.1339      0.1367      0.1395      0.1424
  8          0.1452      0.1480      0.1508      0.1536      0.1564
  8          0.1592      0.1636      0.1680      0.1723      0.1767
  8          0.1810      0.1854      0.1897      0.1941      0.1985
  8          0.2028      0.2072      0.2115      0.2159      0.2202
  8          0.2246      0.2289      0.2333      0.2376      0.2420
  8          0.2463      0.2557      0.2651      0.2745      0.2839
  8          0.2934      0.3125      0.3317      0.3610      0.4042
  8          0.5000      0.5958      0.6390      0.6683      0.6875
  8          0.7066      0.7161      0.7255      0.7349      0.7443
  8          0.7537      0.7580      0.7624      0.7667      0.7711
  8          0.7754      0.7798      0.7841      0.7885      0.7928
  8          0.7972      0.8015      0.8059      0.8103      0.8146
  8          0.8190      0.8233      0.8277      0.8320      0.8364
  8          0.8408      0.8436      0.8464      0.8492      0.8520
  8          0.8548      0.8576      0.8605      0.8633      0.8661
1


 ********************80-80 LIST OF INPUT DATA (CONTINUED)*********************

  8          0.8689      0.8717      0.8745      0.8773      0.8801
  8          0.8830      0.8858      0.8886      0.8914      0.8942
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8          0.8970     0.8998     0.9026     0.9055     0.9083
8          0.9111     0.9139     0.9167     0.9195     0.9223
8          0.9252     0.9264     0.9276     0.9289     0.9301
8          0.9314     0.9326     0.9339     0.9351     0.9364
8          0.9376     0.9389     0.9401     0.9414     0.9426
8          0.9439     0.9451     0.9464     0.9476     0.9489
8          0.9501     0.9513     0.9526     0.9538     0.9551
8          0.9563     0.9576     0.9588     0.9601     0.9613
8          0.9626     0.9638     0.9651     0.9663     0.9676
8          0.9688     0.9701     0.9713     0.9726     0.9738
8          0.9751     0.9763     0.9775     0.9788     0.9800
8          0.9813     0.9825     0.9838     0.9850     0.9863
8          0.9875     0.9888     0.9900     0.9913     0.9925
8          0.9938     0.9950     0.9963     0.9975     0.9988
8          1.0000     1.0000     1.0000     1.0000     1.0000
9 ENDTBL
5 RAINFL 9            .1
8          0.0000     0.0015     0.0029     0.0044     0.0059
8          0.0073     0.0088     0.0103     0.0117     0.0132
8          0.0147     0.0161     0.0176     0.0191     0.0205
8          0.0220     0.0234     0.0249     0.0264     0.0278
8          0.0293     0.0308     0.0322     0.0337     0.0352
8          0.0366     0.0381     0.0396     0.0410     0.0425
8          0.0440     0.0454     0.0469     0.0484     0.0498
8          0.0513     0.0528     0.0542     0.0557     0.0572
8          0.0586     0.0601     0.0615     0.0630     0.0645
8          0.0659     0.0674     0.0689     0.0703     0.0718
8          0.0733     0.0747     0.0762     0.0777     0.0791
8          0.0806     0.0821     0.0835     0.0850     0.0865
8          0.0879     0.0912     0.0944     0.0976     0.1008
8          0.1041     0.1073     0.1105     0.1138     0.1170
8          0.1202     0.1234     0.1267     0.1299     0.1331
8          0.1364     0.1396     0.1428     0.1460     0.1493
8          0.1525     0.1557     0.1589     0.1622     0.1654
8          0.1686     0.1719     0.1751     0.1783     0.1815
8          0.1848     0.1895     0.1941     0.1988     0.2035
8          0.2082     0.2128     0.2175     0.2222     0.2269
8          0.2315     0.2362     0.2409     0.2456     0.2502
8          0.2549     0.2593     0.2637     0.2681     0.2725
8          0.2769     0.2867     0.2966     0.3064     0.3163
8          0.3261     0.3452     0.3642     0.3913     0.4279
8          0.5000     0.5721     0.6087     0.6358     0.6548
8          0.6739     0.6837     0.6936     0.7034     0.7133
8          0.7231     0.7275     0.7319     0.7363     0.7407
8          0.7451     0.7498     0.7544     0.7591     0.7638
8          0.7685     0.7731     0.7778     0.7825     0.7872
8          0.7918     0.7965     0.8012     0.8059     0.8105
8          0.8152     0.8185     0.8217     0.8249     0.8281
```

```
 ********************80-80 LIST OF INPUT DATA (CONTINUED)*********************

  8          0.8314      0.8346      0.8378      0.8411      0.8443
  8          0.8475      0.8507      0.8540      0.8572      0.8604
  8          0.8636      0.8669      0.8701      0.8733      0.8766
  8          0.8798      0.8830      0.8862      0.8895      0.8927
  8          0.8959      0.8992      0.9024      0.9056      0.9088
  8          0.9121      0.9135      0.9150      0.9165      0.9179
  8          0.9194      0.9209      0.9223      0.9238      0.9253
  8          0.9267      0.9282      0.9297      0.9311      0.9326
  8          0.9341      0.9355      0.9370      0.9385      0.9399
  8          0.9414      0.9428      0.9443      0.9458      0.9472
  8          0.9487      0.9502      0.9516      0.9531      0.9546
  8          0.9560      0.9575      0.9590      0.9604      0.9619
  8          0.9634      0.9648      0.9663      0.9678      0.9692
  8          0.9707      0.9722      0.9736      0.9751      0.9766
  8          0.9780      0.9795      0.9809      0.9824      0.9839
  8          0.9853      0.9868      0.9883      0.9897      0.9912
  8          0.9927      0.9941      0.9956      0.9971      0.9985
  8          1.0000      1.0000      1.0000      1.0000      1.0000
  9 ENDTBL
    ENDATA
  7 INCREM 6                    0.1
  7 COMPUT 7   3     3          0.0        1.91        1.01 2  1   1
    ENDCMP 1
  7 COMPUT 7   3     3          0.0        2.35        1.02 2  1   2
    ENDCMP 1
  7 COMPUT 7   3     3          0.0        2.70        1.03 2  1   3
    ENDCMP 1
  7 COMPUT 7   3     3          0.0        2.32        1.04 2  1   4
    ENDCMP 1
  7 COMPUT 7   3     3          0.0        2.84        1.05 2  1   5
    ENDCMP 1
  7 COMPUT 7   3     3          0.0        3.27        1.06 2  1   6
    ENDCMP 1
  7 COMPUT 7   3     3          0.0        4.28        1.07 2  1   7
    ENDCMP 1
  7 COMPUT 7   3     3          0.0        5.03        1.08 2  1   8
    ENDCMP 1
  7 COMPUT 7   3     3          0.0        8.67        1.09 2  1   9
    ENDCMP 1
    ENDJOB 2

 ******************************END OF 80-80 LIST******************************
```

```
1
 TR20 -------------------------------------------------------------------- SCS -
                               Carsins Run                                VERSION
 11/28/**                Ultimate Land Use - SSURGO                      2.04TEST
 09:45:54                  PASS   1   JOB NO.   1                        PAGE   1



 EXECUTIVE CONTROL INCREM    MAIN TIME INCREMENT =   .100 HOURS


 EXECUTIVE CONTROL COMPUT    FROM XSECTION   3  TO XSECTION   3
    STARTING TIME =   .00       RAIN DEPTH =  1.91       RAIN DURATION =  1.00
    ANT. RUNOFF COND. = 2       MAIN TIME INCREMENT =   .100 HOURS
    ALTERNATE NO. = 1           STORM NO. = 1            RAIN TABLE NO. = 1


 OPERATION RUNOFF   XSECTION   3

    PEAK TIME(HRS)             PEAK DISCHARGE(CFS)         PEAK ELEVATION(FEET)
        5.31                         285.8                       (RUNOFF)

    RUNOFF ABOVE BASEFLOW  (BASEFLOW =    .00 CFS)
                    .36 WATERSHED INCHES;    1000 CFS-HRS;      82.7 ACRE-FEET.


 EXECUTIVE CONTROL ENDCMP    COMPUTATIONS COMPLETED FOR PASS   1


 EXECUTIVE CONTROL COMPUT    FROM XSECTION   3  TO XSECTION   3
    STARTING TIME =   .00       RAIN DEPTH =  2.35       RAIN DURATION =  1.00
    ANT. RUNOFF COND. = 2       MAIN TIME INCREMENT =   .100 HOURS
    ALTERNATE NO. = 1           STORM NO. = 2            RAIN TABLE NO. = 2


 OPERATION RUNOFF   XSECTION   3

    PEAK TIME(HRS)             PEAK DISCHARGE(CFS)         PEAK ELEVATION(FEET)
        8.18                         390.9                       (RUNOFF)

    RUNOFF ABOVE BASEFLOW  (BASEFLOW =    .00 CFS)
                    .60 WATERSHED INCHES;    1650 CFS-HRS;     136.3 ACRE-FEET.


 EXECUTIVE CONTROL ENDCMP    COMPUTATIONS COMPLETED FOR PASS   2


 EXECUTIVE CONTROL COMPUT    FROM XSECTION   3  TO XSECTION   3
```

```
   STARTING TIME =   .00       RAIN DEPTH =  2.70       RAIN DURATION =  1.00
   ANT. RUNOFF COND. = 2       MAIN TIME INCREMENT =   .100 HOURS
   ALTERNATE NO. = 1           STORM NO. = 3            RAIN TABLE NO. = 3
1
 TR20 -------------------------------------------------------------------- SCS -
                              Carsins Run                               VERSION
 11/28/**                Ultimate Land Use - SSURGO                    2.04TEST
 09:45:54                  PASS   3   JOB NO.   1                      PAGE   2



 OPERATION RUNOFF   XSECTION   3

   PEAK TIME(HRS)             PEAK DISCHARGE(CFS)         PEAK ELEVATION(FEET)
      14.11                         479.2                          (RUNOFF)

   RUNOFF ABOVE BASEFLOW  (BASEFLOW =    .00 CFS)
                   .81 WATERSHED INCHES;    2233 CFS-HRS;     184.6 ACRE-FEET.


 EXECUTIVE CONTROL ENDCMP    COMPUTATIONS COMPLETED FOR PASS   3


 EXECUTIVE CONTROL COMPUT    FROM XSECTION   3  TO XSECTION   3
   STARTING TIME =   .00       RAIN DEPTH =  2.32       RAIN DURATION =  1.00
   ANT. RUNOFF COND. = 2       MAIN TIME INCREMENT =   .100 HOURS
   ALTERNATE NO. = 1           STORM NO. = 4            RAIN TABLE NO. = 4


 OPERATION RUNOFF   XSECTION   3

   PEAK TIME(HRS)             PEAK DISCHARGE(CFS)         PEAK ELEVATION(FEET)
       5.23                         473.1                          (RUNOFF)

   RUNOFF ABOVE BASEFLOW  (BASEFLOW =    .00 CFS)
                   .58 WATERSHED INCHES;    1602 CFS-HRS;     132.4 ACRE-FEET.


 EXECUTIVE CONTROL ENDCMP    COMPUTATIONS COMPLETED FOR PASS   4


 EXECUTIVE CONTROL COMPUT    FROM XSECTION   3  TO XSECTION   3
   STARTING TIME =   .00       RAIN DEPTH =  2.84       RAIN DURATION =  1.00
   ANT. RUNOFF COND. = 2       MAIN TIME INCREMENT =   .100 HOURS
   ALTERNATE NO. = 1           STORM NO. = 5            RAIN TABLE NO. = 5


 OPERATION RUNOFF   XSECTION   3
```

```
   PEAK TIME(HRS)            PEAK DISCHARGE(CFS)         PEAK ELEVATION(FEET)
       8.13                        617.1                      (RUNOFF)

   RUNOFF ABOVE BASEFLOW  (BASEFLOW =    .00 CFS)
                   .90 WATERSHED INCHES;    2481 CFS-HRS;     205.0 ACRE-FEET.
1
 TR20 -------------------------------------------------------------------- SCS -
                             Carsins Run                                VERSION
 11/28/**             Ultimate Land Use - SSURGO                      2.04TEST
 09:45:54               PASS   6   JOB NO.   1                        PAGE   3



 EXECUTIVE CONTROL ENDCMP    COMPUTATIONS COMPLETED FOR PASS   5


 EXECUTIVE CONTROL COMPUT    FROM XSECTION   3  TO XSECTION   3
    STARTING TIME =   .00       RAIN DEPTH =  3.27       RAIN DURATION =  1.00
    ANT. RUNOFF COND. = 2       MAIN TIME INCREMENT =   .100 HOURS
    ALTERNATE NO. = 1           STORM NO. = 6            RAIN TABLE NO. = 6


 OPERATION RUNOFF   XSECTION   3

   PEAK TIME(HRS)            PEAK DISCHARGE(CFS)         PEAK ELEVATION(FEET)
      14.07                        738.8                      (RUNOFF)

   RUNOFF ABOVE BASEFLOW  (BASEFLOW =    .00 CFS)
                  1.19 WATERSHED INCHES;    3283 CFS-HRS;     271.3 ACRE-FEET.


 EXECUTIVE CONTROL ENDCMP    COMPUTATIONS COMPLETED FOR PASS   6


 EXECUTIVE CONTROL COMPUT    FROM XSECTION   3  TO XSECTION   3
    STARTING TIME =   .00       RAIN DEPTH =  4.28       RAIN DURATION =  1.00
    ANT. RUNOFF COND. = 2       MAIN TIME INCREMENT =   .100 HOURS
    ALTERNATE NO. = 1           STORM NO. = 7            RAIN TABLE NO. = 7


 OPERATION RUNOFF   XSECTION   3

   PEAK TIME(HRS)            PEAK DISCHARGE(CFS)         PEAK ELEVATION(FEET)
       8.06                       1373.7                      (RUNOFF)

   RUNOFF ABOVE BASEFLOW  (BASEFLOW =    .00 CFS)
                  1.94 WATERSHED INCHES;    5356 CFS-HRS;     442.6 ACRE-FEET.
```

```
 EXECUTIVE CONTROL ENDCMP    COMPUTATIONS COMPLETED FOR PASS   7
1
 TR20 ------------------------------------------------------------------- SCS -
                                 Carsins Run                            VERSION
 11/28/**                  Ultimate Land Use - SSURGO                  2.04TEST
 09:45:54                    PASS   8   JOB NO.   1                    PAGE   4



 EXECUTIVE CONTROL COMPUT    FROM XSECTION   3  TO XSECTION   3
    STARTING TIME =   .00       RAIN DEPTH =  5.03       RAIN DURATION =  1.00
    ANT. RUNOFF COND. = 2       MAIN TIME INCREMENT =   .100 HOURS
    ALTERNATE NO. = 1           STORM NO. = 8            RAIN TABLE NO. = 8


 OPERATION RUNOFF   XSECTION   3

    PEAK TIME(HRS)             PEAK DISCHARGE(CFS)         PEAK ELEVATION(FEET)
       14.00                        1586.3                        (RUNOFF)

    RUNOFF ABOVE BASEFLOW  (BASEFLOW =    .00 CFS)
                  2.54 WATERSHED INCHES;    7020 CFS-HRS;     580.1 ACRE-FEET.


 EXECUTIVE CONTROL ENDCMP    COMPUTATIONS COMPLETED FOR PASS   8


 EXECUTIVE CONTROL COMPUT    FROM XSECTION   3  TO XSECTION   3
    STARTING TIME =   .00       RAIN DEPTH =  8.67       RAIN DURATION =  1.00
    ANT. RUNOFF COND. = 2       MAIN TIME INCREMENT =   .100 HOURS
    ALTERNATE NO. = 1           STORM NO. = 9            RAIN TABLE NO. = 9


 OPERATION RUNOFF   XSECTION   3

    PEAK TIME(HRS)             PEAK DISCHARGE(CFS)         PEAK ELEVATION(FEET)
       13.95                        3215.1                        (RUNOFF)

    RUNOFF ABOVE BASEFLOW  (BASEFLOW =    .00 CFS)
                  5.75 WATERSHED INCHES;   15857 CFS-HRS;    1310.4 ACRE-FEET.


 EXECUTIVE CONTROL ENDCMP    COMPUTATIONS COMPLETED FOR PASS   9
1
 TR20 ------------------------------------------------------------------- SCS -
                                 Carsins Run                            VERSION
```

```
                              SUMMARY TABLE 1
                              ---------------
   SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL IN ORDER PERFORMED.
   A CHARACTER FOLLOWING THE PEAK DISCHARGE TIME AND RATE (CFS) INDICATES:
F-FLAT TOP HYDROGRAPH   T-TRUNCATED HYDROGRAPH   R-RISING TRUNCATED HYDROGRAPH

XSECTION/  STANDARD                                    PEAK DISCHARGE
STRUCTURE   CONTROL    DRAINAGE   RUNOFF   ------------------------------------
   ID      OPERATION     AREA     AMOUNT   ELEVATION   TIME      RATE    RATE
                        (SQ MI)    (IN)      (FT)      (HR)      (CFS)   (CSM)

RAINFALL OF   1.91 inches AND   6.00 hr DURATION, BEGINS AT    .0 hrs.
RAINTABLE NUMBER  1,    ARC 2
MAIN TIME INCREMENT   .100 HOURS

   ALTERNATE    1   STORM    1
   ---------------------------
XSECTION   3  RUNOFF     4.27      .36        ---      5.31      286     67.0

RAINFALL OF   2.35 inches AND  12.00 hr DURATION, BEGINS AT    .0 hrs.
RAINTABLE NUMBER  2,    ARC 2

   ALTERNATE    1   STORM    2
   ---------------------------
XSECTION   3  RUNOFF     4.27      .60        ---      8.18      391     91.6

RAINFALL OF   2.70 inches AND  24.00 hr DURATION, BEGINS AT    .0 hrs.
RAINTABLE NUMBER  3,    ARC 2

   ALTERNATE    1   STORM    3
   ---------------------------
XSECTION   3  RUNOFF     4.27      .81        ---     14.11      479    112.2

RAINFALL OF   2.32 inches AND   6.00 hr DURATION, BEGINS AT    .0 hrs.
RAINTABLE NUMBER  4,    ARC 2

   ALTERNATE    1   STORM    4
   ---------------------------
XSECTION   3  RUNOFF     4.27      .58        ---      5.23      473    110.8

RAINFALL OF   2.84 inches AND  12.00 hr DURATION, BEGINS AT    .0 hrs.
RAINTABLE NUMBER  5,    ARC 2

   ALTERNATE    1   STORM    5
```

```
   ---------------------------
XSECTION   3  RUNOFF     4.27      .90        ---      8.13      617    144.5
1
TR20 -------------------------------------------------------------------- SCS -
                              Carsins Run                               VERSION
11/28/**             Ultimate Land Use - SSURGO                        2.04TEST
09:45:54                SUMMARY, JOB NO.   1                           PAGE   6


                            SUMMARY TABLE 1
                            ---------------
   SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL IN ORDER PERFORMED.
   A CHARACTER FOLLOWING THE PEAK DISCHARGE TIME AND RATE (CFS) INDICATES:
F-FLAT TOP HYDROGRAPH   T-TRUNCATED HYDROGRAPH   R-RISING TRUNCATED HYDROGRAPH

XSECTION/  STANDARD                                    PEAK DISCHARGE
STRUCTURE   CONTROL    DRAINAGE   RUNOFF   ------------------------------------
   ID      OPERATION     AREA     AMOUNT   ELEVATION   TIME      RATE    RATE
                       (SQ MI)    (IN)       (FT)      (HR)      (CFS)   (CSM)


RAINFALL OF   3.27 inches AND  24.00 hr DURATION, BEGINS AT    .0 hrs.
RAINTABLE NUMBER  6,    ARC 2

   ALTERNATE    1   STORM    6
   ---------------------------
XSECTION   3  RUNOFF     4.27     1.19        ---     14.07      739    173.1

RAINFALL OF   4.28 inches AND  12.00 hr DURATION, BEGINS AT    .0 hrs.
RAINTABLE NUMBER  7,    ARC 2

   ALTERNATE    1   STORM    7
   ---------------------------
XSECTION   3  RUNOFF     4.27     1.94        ---      8.06     1374    321.8

RAINFALL OF   5.03 inches AND  24.00 hr DURATION, BEGINS AT    .0 hrs.
RAINTABLE NUMBER  8,    ARC 2

   ALTERNATE    1   STORM    8
   ---------------------------
XSECTION   3  RUNOFF     4.27     2.54        ---     14.00     1586    371.4

RAINFALL OF   8.67 inches AND  24.00 hr DURATION, BEGINS AT    .0 hrs.
RAINTABLE NUMBER  9,    ARC 2

   ALTERNATE    1   STORM    9
   ---------------------------
XSECTION   3  RUNOFF     4.27     5.75        ---     13.95     3215    752.9
```

```
1
 TR20 -------------------------------------------------------------------- SCS -
                              Carsins Run                                VERSION
 11/28/**              Ultimate Land Use - SSURGO                      2.04TEST
 09:45:54                 SUMMARY, JOB NO.   1                         PAGE   7


                                SUMMARY TABLE 3
                                ---------------
      STORM DISCHARGES (CFS) AT XSECTIONS AND STRUCTURES FOR ALL ALTERNATES
      QUESTION MARK (?) AFTER: OUTFLOW PEAK - RISING TRUNCATED HYDROGRAPH.

 XSECTION/           DRAINAGE
 STRUCTURE             AREA      STORM NUMBERS..........
   ID                (SQ MI)          1          2          3          4          5


 XSECTION    3          4.27
 ---------------------------
    ALTERNATE    1                  286        391        479        473        617

                                SUMMARY TABLE 3
                                ---------------
      STORM DISCHARGES (CFS) AT XSECTIONS AND STRUCTURES FOR ALL ALTERNATES
      QUESTION MARK (?) AFTER: OUTFLOW PEAK - RISING TRUNCATED HYDROGRAPH.

 XSECTION/           DRAINAGE
 STRUCTURE             AREA      STORM NUMBERS..........
   ID                (SQ MI)          6          7          8          9


 XSECTION    3          4.27
 ---------------------------
    ALTERNATE    1                  739       1374       1586       3215
1
 TR20 -------------------------------------------------------------------- SCS -
                              Carsins Run                                VERSION
 11/28/**              Ultimate Land Use - SSURGO                      2.04TEST




 END OF  1 JOBS IN THIS RUN
```

```
              SCS  TR-20,  VERSION 2.04TEST
                                FILES

INPUT  = tr20in.dat                              , GIVEN DATA FILE
OUTPUT = tr20in.OUT                              , DATED 11/28/**,09:45:54

         FILES GENERATED - DATED 11/28/**,09:45:54

                   NONE!


      TOTAL NUMBER OF WARNINGS =   0,  MESSAGES =   0

              *** TR-20 RUN COMPLETED ***
```

KCI Technologies, Inc.

TR-55 DESIGN COMPUTATIONS

By: KTC	Project Name:	I-95 Carsins Run	Project Number:	22145228.36
Date: 1/8/2019	County:	Harford County		
	Drainage Area:	Small Tributary	Proposed:	
			Proposed:	
			Ultimate:	

WEIGHTED RUNOFF CURVE NUMBER

Soil Group	Land Use or Zoning No.	Description	% Imperv.	RCN Table 2-2	RCN Figure 2-3	RCN Figure 2-4	Area (Acre)	RCN x Area
B	60	Woods/Grass combination - (poor)		73			0.576	42.06
B	11	Urban district - commercial/business	85	92			2.890	265.88
C	60	Woods/Grass combination - (poor)		82			3.405	279.20
C	11	Urban district - commercial/business	85	94			4.587	431.21
D	60	Woods/Grass combination - (poor)		86			0.143	12.30
				Total Square Miles:	0.01813	Total Acres:	11.60	1030.66
				Weighted RCN:	88.84	Use:	89	

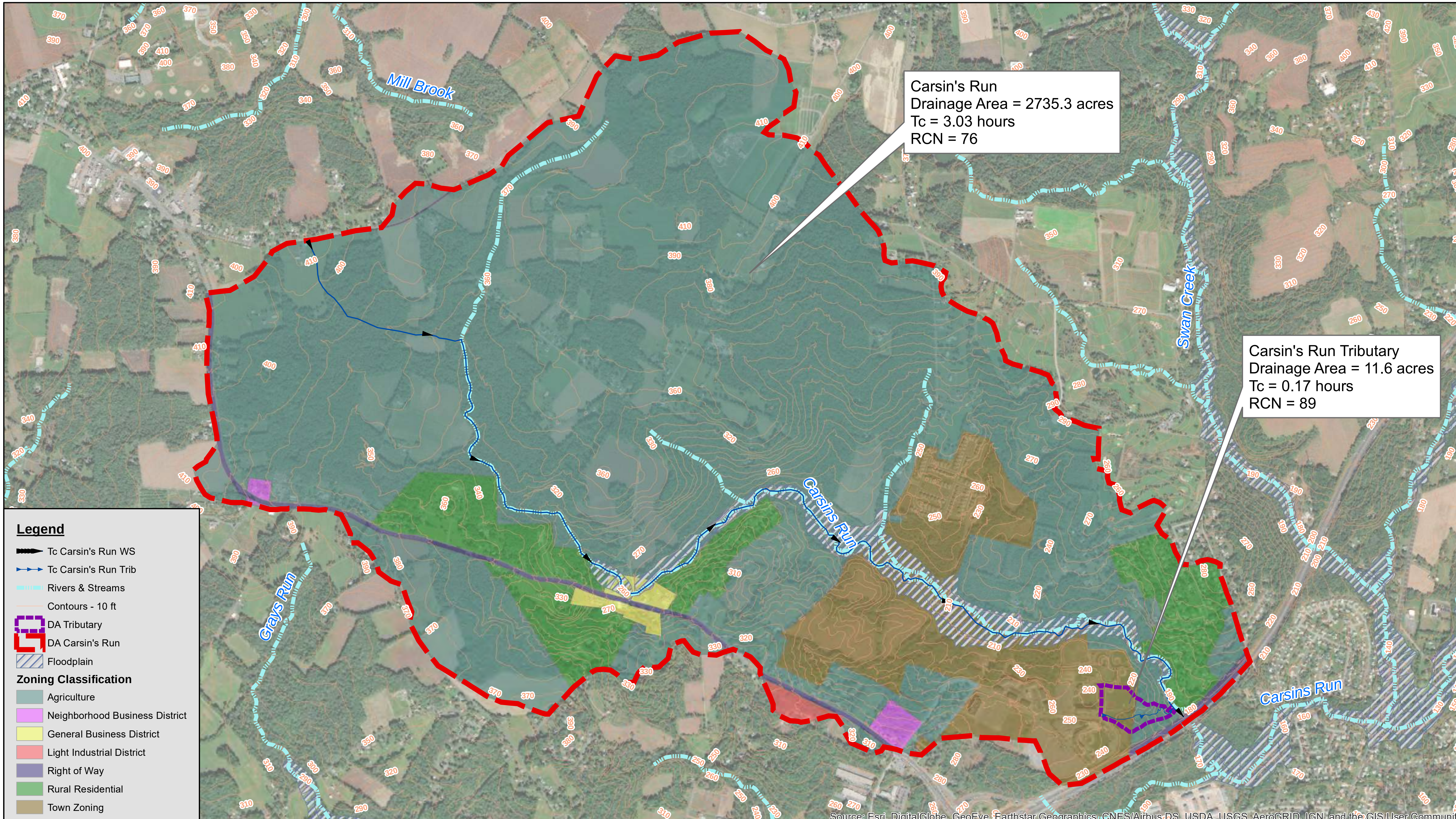
TIME OF CONCENTRATION

ID	Type of Flow			L(ft.)	n	A	WP	Slope (Percent)	Vel. (fps)	Time (Hours)
	Sheet Flow									
A-B	5	Grass - short		100	0.150			7.0		0.098
	Shallow Concentrated Flow									
B-C		paved	x unpaved	452.36				4.2	3.31	0.038
		paved	unpaved							
		paved	unpaved							
		paved	unpaved							
		paved	unpaved							
	Concentrated Flow*									
C-D	1	Channel Flow, d (ft) =	1.0	855.26	0.035	7.00	9.47	4.8	7.62	0.031
									Total	**0.168**

GRAPHICAL PEAK DISCHARGE METHOD

Initial Abstraction Ia = 0.247 in. (Table 5-1) Use Tc= 0.17 Tt=

Rainfall Freq. =	1 Year	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
Rainfall, P (in) =	2.7	3.2	4.2	5.0	6.2	7.3	8.5
Ia/P =	0.093	0.077	0.060	0.050	0.040	0.034	0.029
Peak csm/in. =	854	854	854	854	854	854	854
Runoff Q (in) =	1.60	2.11	2.96	3.73	4.93	5.99	7.20
Peak Dischg. (CFS)=	24.85	32.66	45.91	57.83	76.34	92.79	111.47



1 inch = 1,500 feet

N

0 2,000 4,000 Feet

Carsin's Run Stream Restoration
Drainage Area Map - Ultimate Condtions
Harford County
KCI Job No. 22145228.47

KCI TECHNOLOGIES

APPENDIX B

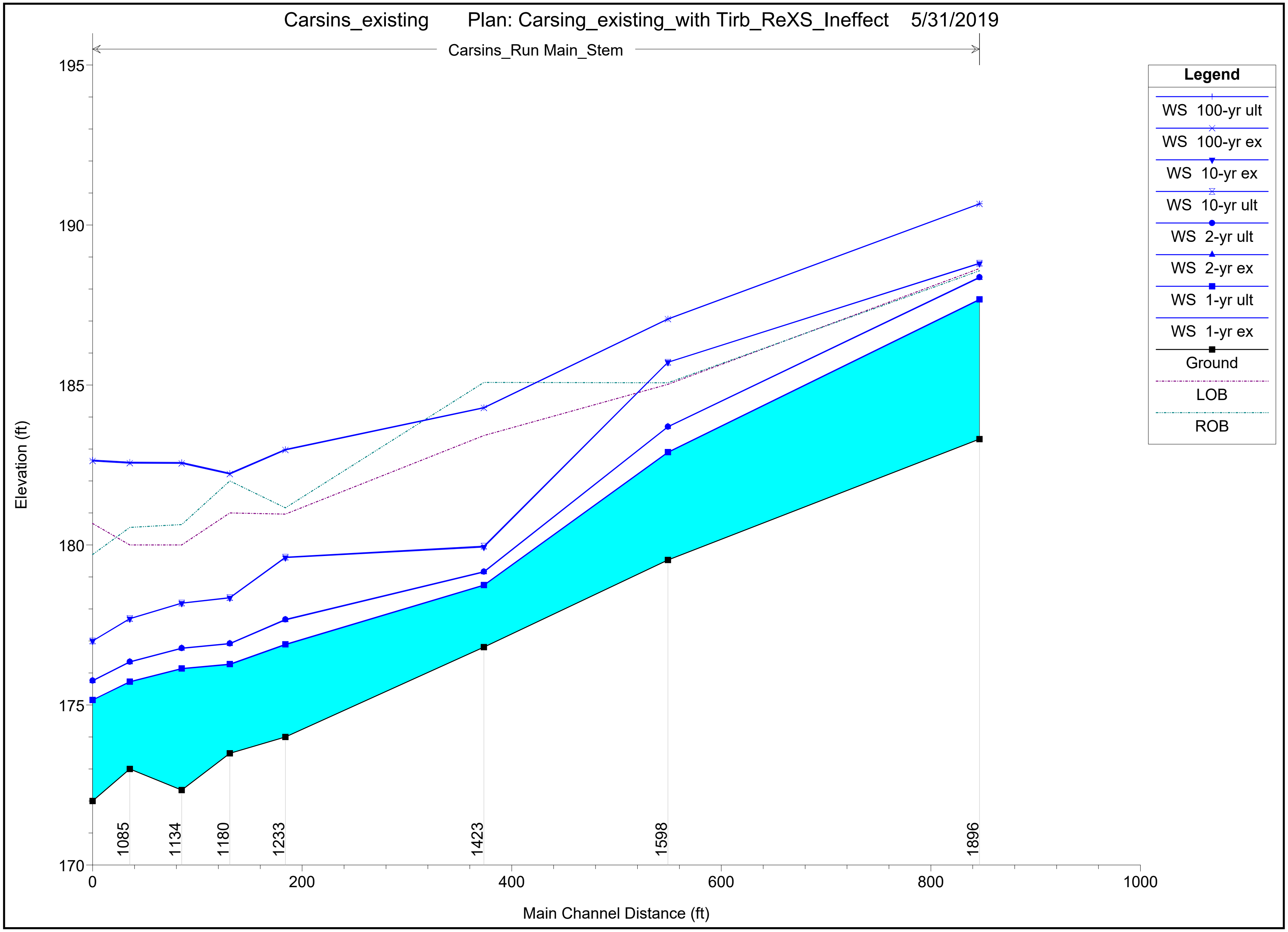
<u>Existing HEC-RAS Results</u>

Profiles

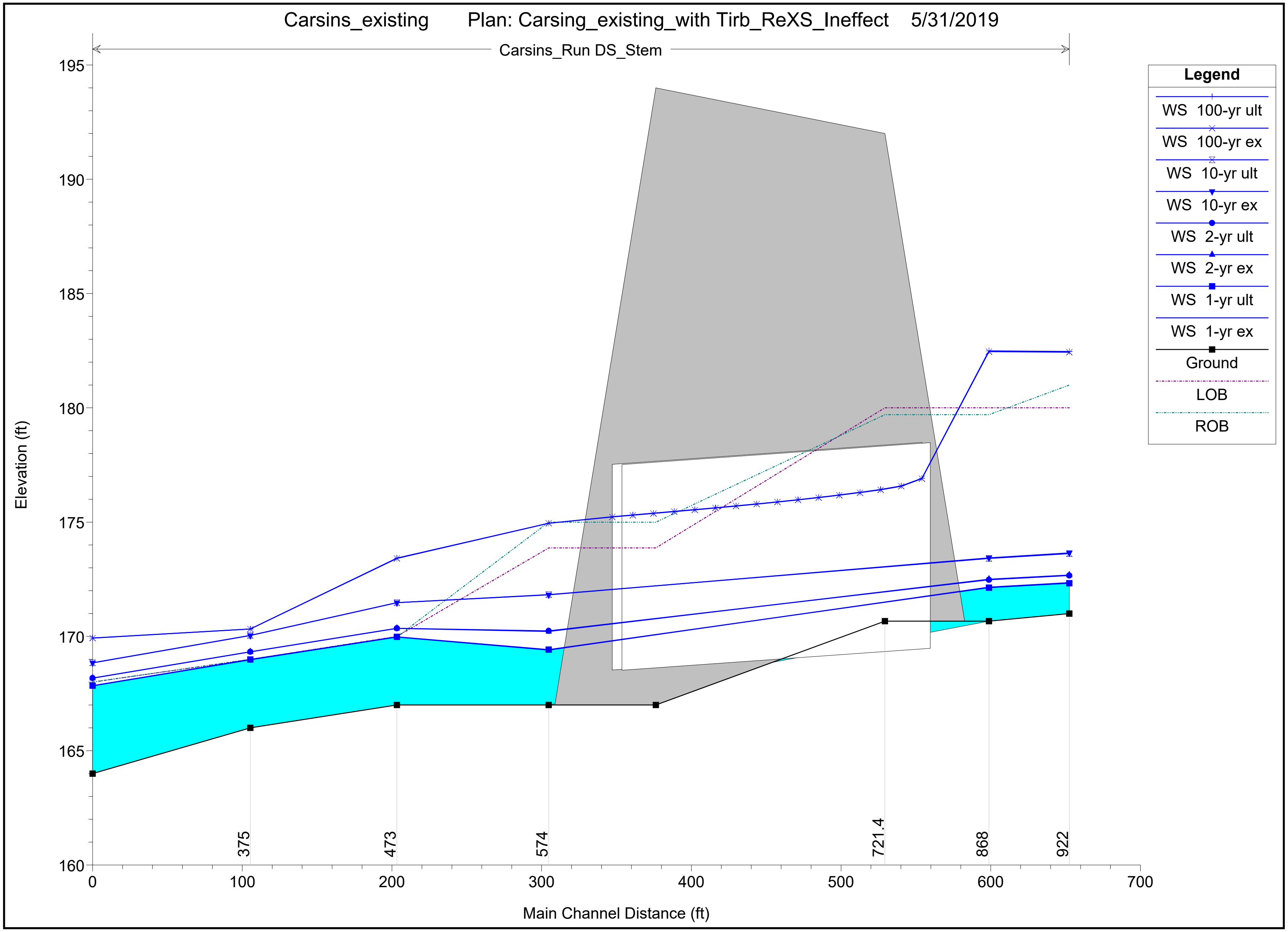
Summary Table

Cross Sections

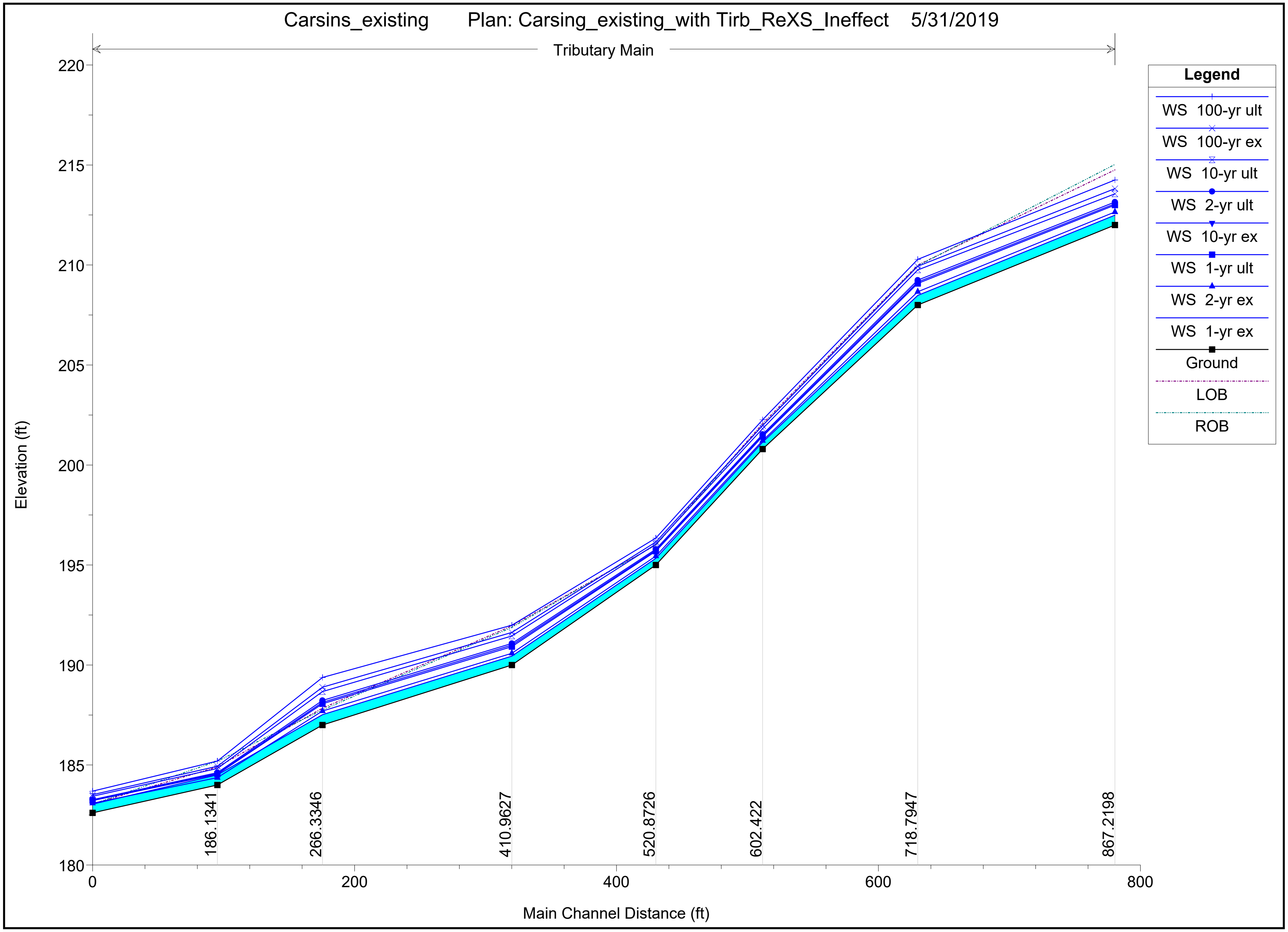
Cross Section Map



Carsins_existing Plan: Carsing_existing_with Tirb_ReXS_Ineffect 5/31/2019
Carsins_Run Main_Stem
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ex
WS 10-yr ult
WS 2-yr ult
WS 2-yr ex
WS 1-yr ult
WS 1-yr ex
Ground
LOB
ROB
Elevation (ft)
195
190
185
180
175
170
1085
1134
1180
1233
1423
1598
1896
0
200
400
600
800
1000
Main Channel Distance (ft)



Carsins_existing Plan: Carsing_existing_with Tirb_ReXS_Ineffect 5/31/2019
Carsins_Run DS_Stem
Elevation (ft)
Main Channel Distance (ft)
195
190
185
180
175
170
165
160
0
100
200
300
400
500
600
700
375
473
574
721.4
868
922
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 10-yr ex
WS 2-yr ult
WS 2-yr ex
WS 1-yr ult
WS 1-yr ex
Ground
LOB
ROB



Carsins_existing Plan: Carsing_existing_with Tirb_ReXS_Ineffect 5/31/2019
Tributary Main
Elevation (ft)
220
215
210
205
200
195
190
185
180
Main Channel Distance (ft)
0
200
400
600
800
186.1341
266.3346
410.9627
520.8726
602.422
718.7947
867.2198
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 2-yr ult
WS 10-yr ex
WS 1-yr ult
WS 2-yr ex
WS 1-yr ex
Ground
LOB
ROB

HEC-RAS Plan: Ex_RE

River	Reach	River Sta	Profile	W.S. Elev	Vel Head	Frctn Loss	C & E Loss	Q Left	Q Channel	Q Right	Top Width	Shear LOB	Shear Chan	Shear ROB	Vel Left	Vel Chnl	Vel Right	Froude # Chl
				(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(cfs)	(ft)	(lb/sq ft)	(lb/sq ft)	(lb/sq ft)	(ft/s)	(ft/s)	(ft/s)	
Tributary	Main	867.2198	1-yr ex	212.49	0.22	4.03	0.00		6.42		4.43		0.69			3.76		1.07
Tributary	Main	867.2198	2-yr ex	212.65	0.30	3.81	0.00		10.92		5.02		0.88			4.40		1.10
Tributary	Main	867.2198	10-yr ex	213.06	0.54	3.98	0.03		27.99		5.86		1.36			5.92		1.16
Tributary	Main	867.2198	100-yr ex	213.82	0.89	4.02	0.06		73.21		7.95		1.96			7.55		1.21
Tributary	Main	867.2198	1-yr ult	213.00	0.50	3.99	0.03		24.85		5.78		1.29			5.70		1.16
Tributary	Main	867.2198	2-yr ult	213.15	0.60	3.98	0.03		32.66		5.99		1.47			6.22		1.17
Tributary	Main	867.2198	10-yr ult	213.56	0.85	3.99	0.08		57.83		6.56		1.91			7.40		1.20
Tributary	Main	867.2198	100-yr ult	214.25	1.08	4.06	0.04		111.47		9.52		2.27			8.32		1.24
Tributary	Main	718.7947	1-yr ex	208.48	0.21	6.80	0.05		6.42		4.32		0.64			3.66		1.01
Tributary	Main	718.7947	2-yr ex	208.66	0.27	6.55	0.08		10.92		4.82		0.77			4.18		1.00
Tributary	Main	718.7947	10-yr ex	209.15	0.44	6.02	0.15		27.99		5.98		1.08			5.35		1.01
Tributary	Main	718.7947	100-yr ex	209.94	0.69	5.67	0.21		73.21		9.08		1.51			6.64		1.06
Tributary	Main	718.7947	1-yr ult	209.08	0.41	6.07	0.14		24.85		5.85		1.03			5.16		1.00
Tributary	Main	718.7947	2-yr ult	209.25	0.49	5.96	0.16		32.66		6.15		1.16			5.60		1.01
Tributary	Main	718.7947	10-yr ult	209.75	0.59	5.72	0.20		57.83		8.65		1.34			6.15		1.04
Tributary	Main	718.7947	100-yr ult	210.28	0.96	5.43	0.24	0.02	111.19	0.25	11.02	0.15	1.95	0.30	0.51	7.85	0.79	1.11
Tributary	Main	602.422	1-yr ex	201.14	0.69	6.16	0.15		6.42		4.26		2.55			6.67		2.47
Tributary	Main	602.422	2-yr ex	201.22	1.08	6.33	0.24		10.92		4.47		3.67			8.34		2.72
Tributary	Main	602.422	10-yr ex	201.47	1.95	6.69	0.41		27.99		5.15		5.64			11.19		2.83
Tributary	Main	602.422	100-yr ex	201.97	2.76	6.90	0.46		73.21		6.95		6.85			13.33		2.64
Tributary	Main	602.422	1-yr ult	201.43	1.85	6.65	0.39		24.85		5.02		5.46			10.90		2.85
Tributary	Main	602.422	2-yr ult	201.53	2.08	6.74	0.43		32.66		5.34		5.87			11.57		2.81
Tributary	Main	602.422	10-yr ult	201.82	2.60	6.89	0.48		57.83		6.25		6.66			12.93		2.70
Tributary	Main	602.422	100-yr ult	202.26	3.31	6.97	0.45	0.06	110.83	0.58	11.31	0.63	7.51	1.00	0.99	14.64	1.34	2.52
Tributary	Main	520.8726	1-yr ex	195.33	0.20	4.80	0.01		6.42		6.29		0.70			3.63		1.21
Tributary	Main	520.8726	2-yr ex	195.45	0.29	4.75	0.01		10.92		6.68		0.92			4.35		1.25
Tributary	Main	520.8726	10-yr ex	195.73	0.59	4.72	0.00		27.99		7.70		1.58			6.14		1.41
Tributary	Main	520.8726	100-yr ex	196.15	1.23	4.74	0.09	0.45	72.76	0.01	14.04	0.38	2.89	0.18	0.81	8.91	0.49	1.65
Tributary	Main	520.8726	1-yr ult	195.69	0.54	4.70	0.01		24.85		7.55		1.47			5.87		1.38
Tributary	Main	520.8726	2-yr ult	195.79	0.65	4.72	0.00		32.66		8.01		1.73			6.49		1.44
Tributary	Main	520.8726	10-yr ult	196.04	1.00	4.72	0.05	0.05	57.78	0.00	12.35	0.12	2.45		0.38	8.02	0.21	1.58
Tributary	Main	520.8726	100-yr ult	196.35	1.81	4.84	0.21	2.53	108.87	0.06	17.35	0.89	4.07	0.49	1.39	10.92	0.94	1.83
Tributary	Main	410.9627	1-yr ex	190.44	0.29	3.00	0.01		6.42		4.42		0.94			4.30		1.31
Tributary	Main	410.9627	2-yr ex	190.58	0.40	3.00	0.00		10.92		4.96		1.19			5.05		1.35
Tributary	Main	410.9627	10-yr ex	190.99	0.60	2.95	0.00		27.99		6.73		1.58			6.23		1.35
Tributary	Main	410.9627	100-yr ex	191.63	0.92	2.42	0.01		73.21		9.16		2.08			7.68		1.33
Tributary	Main	410.9627	1-yr ult	190.91	0.60	3.00	0.00		24.85		6.03		1.59			6.23		1.35
Tributary	Main	410.9627	2-yr ult	191.07	0.65	2.86	0.00		32.66		7.00		1.66			6.47		1.34
Tributary	Main	410.9627	10-yr ult	191.45	0.82	2.53	0.01		57.83		8.55		1.93			7.26		1.33
Tributary	Main	410.9627	100-yr ult	191.99	1.12	1.64	0.04	0.00	111.47	0.00	10.99		2.38	0.09	0.16	8.50	0.32	1.32
Tributary	Main	266.3346	1-yr ex	187.51	0.19	1.07	0.04		6.42		4.69		0.61			3.54		1.00
Tributary	Main	266.3346	2-yr ex	187.70	0.25	3.13	0.02		10.92		5.55		0.71			3.98		1.00
Tributary	Main	266.3346	10-yr ex	188.13	0.41	2.93	0.06	0.15	27.78	0.06	8.30	0.18	0.99	0.18	0.58	5.17	0.58	0.97
Tributary	Main	266.3346	100-yr ex	188.89	0.70	2.52	0.13	3.26	69.03	0.92	12.02	0.52	1.43	0.44	1.23	6.92	1.10	0.95
Tributary	Main	266.3346	1-yr ult	188.06	0.39	2.98	0.05	0.07	24.74	0.03	7.82	0.14	0.95	0.15	0.49	5.01	0.52	0.98
Tributary	Main	266.3346	2-yr ult	188.23	0.45	2.88	0.07	0.30	32.25	0.10	8.85	0.23	1.05	0.22	0.69	5.43	0.66	0.97
Tributary	Main	266.3346	10-yr ult	188.67	0.61	2.62	0.11	1.88	55.41	0.54	10.97	0.44	1.29	0.36	1.09	6.42	0.96	0.95
Tributary	Main	266.3346	100-yr ult	189.38	0.88	2.30	0.17	7.56	101.81	2.10	15.89	0.58	1.69	0.55	1.35	7.85	1.30	0.95
Tributary	Main	186.1341	1-yr ex	184.51	0.07	1.47	0.00		6.42		7.18		0.21			2.10		0.57
Tributary	Main	186.1341	2-yr ex	184.37	0.42	1.57	0.01		10.92		6.73		1.41			5.23		1.65
Tributary	Main	186.1341	10-yr ex	184.57	0.98	1.82	0.03		27.99		7.39		2.83			7.94		2.03
Tributary	Main	186.1341	100-yr ex	184.94	2.00	1.78	0.12	0.00	73.21		8.38		4.95		0.24	11.34		2.27
Tributary	Main	186.1341	1-yr ult	184.54	0.87	1.78	0.03		24.85		7.29		2.55			7.48		1.95
Tributary	Main	186.1341	2-yr ult	184.62	1.11	1.87	0.04		32.66		7.54		3.13			8.45		2.08
Tributary	Main	186.1341	10-yr ult	184.82	1.72	1.87	0.10		57.83		8.14		4.46			10.53		2.26
Tributary	Main	186.1341	100-yr ult	185.20	2.59	1.62	0.15	0.03	111.44		8.79	0.55	5.89		0.93	12.90		2.27

HEC-RAS Plan: Ex_RE (Continued)

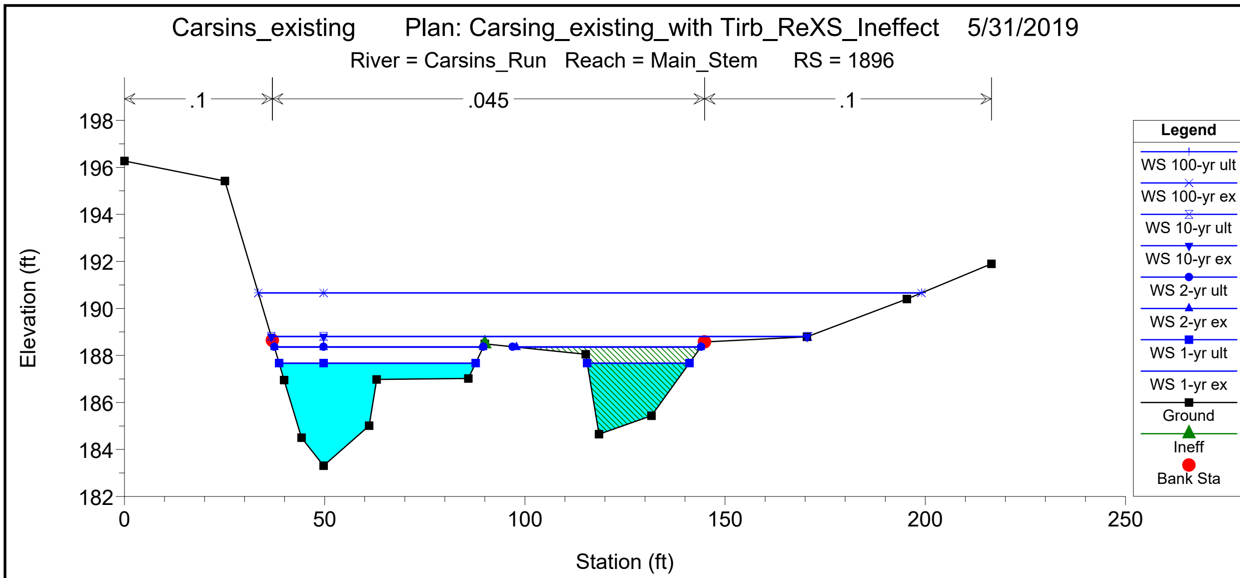
River	Reach	River Sta	Profile	W.S. Elev	Vel Head	Frctn Loss	C & E Loss	Q Left	Q Channel	Q Right	Top Width	Shear LOB	Shear Chan	Shear ROB	Vel Left	Vel Chnl	Vel Right	Froude # Chl
				(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(cfs)	(ft)	(lb/sq ft)	(lb/sq ft)	(lb/sq ft)	(ft/s)	(ft/s)	(ft/s)	
Tributary	Main	90.83922	1-yr ex	183.04	0.06	1.49	0.07		6.42		28.58		0.29			2.00		1.05
Tributary	Main	90.83922	2-yr ex	183.09	0.09	1.39	0.09	0.00	10.92	0.00	29.17		0.36		0.20	2.37	0.24	1.04
Tributary	Main	90.83922	10-yr ex	183.24	0.16	0.93	0.11	0.04	27.89	0.06	31.85	0.10	0.52	0.17	0.36	3.17	0.53	1.01
Tributary	Main	90.83922	100-yr ex	183.52	0.26	0.10	0.02	2.28	70.46	0.47	42.14	0.31	0.73	0.31	0.82	4.19	0.83	0.96
Tributary	Main	90.83922	1-yr ult	183.22	0.14	1.48	0.06	0.03	24.77	0.04	31.20	0.09	0.46	0.15	0.36	2.98	0.49	0.97
Tributary	Main	90.83922	2-yr ult	183.27	0.17	1.40	0.08	0.09	32.49	0.08	36.22	0.07	0.56	0.20	0.33	3.34	0.58	1.01
Tributary	Main	90.83922	10-yr ult	183.44	0.23	0.92	0.10	1.28	56.25	0.30	41.19	0.23	0.65	0.27	0.68	3.88	0.75	0.96
Tributary	Main	90.83922	100-yr ult	183.69	0.34	0.10	0.01	5.31	105.16	1.00	43.39	0.47	0.88	0.39	1.11	4.82	0.98	0.97
Carsins_Run	Main_Stem	1896	1-yr ex	187.66	0.30	3.98	0.07		387.00		74.46		0.92			4.39		0.58
Carsins_Run	Main_Stem	1896	2-yr ex	188.35	0.38	3.66	0.09		612.00		98.17		1.08			4.97		0.57
Carsins_Run	Main_Stem	1896	10-yr ex	188.79	0.50	2.98	0.01	0.01	1364.94	1.06	133.82	0.04	1.42	0.08	0.25	5.67	0.36	0.67
Carsins_Run	Main_Stem	1896	100-yr ex	190.66	0.73	2.85	0.07	4.11	3079.10	123.78	165.61	0.39	1.76	0.64	1.15	6.97	1.60	0.61
Carsins_Run	Main_Stem	1896	1-yr ult	187.68	0.30	3.97	0.07		391.00		74.61		0.92			4.39		0.58
Carsins_Run	Main_Stem	1896	2-yr ult	188.37	0.38	3.66	0.09		617.00		99.29		1.08			4.97		0.57
Carsins_Run	Main_Stem	1896	10-yr ult	188.81	0.50	2.99	0.01	0.01	1372.73	1.26	134.05	0.05	1.42	0.08	0.27	5.66	0.39	0.67
Carsins_Run	Main_Stem	1896	100-yr ult	190.66	0.73	2.85	0.07	4.14	3086.43	124.43	165.69	0.39	1.76	0.64	1.15	6.97	1.60	0.61
Carsins_Run	Main_Stem	1598	1-yr ex	182.89	1.02	4.35	0.08		387.00		41.22		2.99			8.11		0.99
Carsins_Run	Main_Stem	1598	2-yr ex	183.69	1.29	4.62	0.04		612.00		48.71		3.53			9.11		1.00
Carsins_Run	Main_Stem	1598	10-yr ex	185.71	0.60	3.25	0.23	2.18	1363.01	0.81	91.39	0.20	1.58	0.19	0.71	6.20	0.67	0.65
Carsins_Run	Main_Stem	1598	100-yr ex	187.06	1.41	2.21	0.05	49.34	3137.82	19.84	112.32	0.99	3.35	0.83	1.92	9.63	1.70	0.83
Carsins_Run	Main_Stem	1598	1-yr ult	182.90	1.03	4.35	0.08		391.00		41.32		3.02			8.15		0.99
Carsins_Run	Main_Stem	1598	2-yr ult	183.70	1.30	4.62	0.04		617.00		48.80		3.56			9.15		1.00
Carsins_Run	Main_Stem	1598	10-yr ult	185.71	0.60	3.26	0.23	2.19	1370.99	0.81	91.39	0.21	1.60	0.19	0.71	6.24	0.67	0.66
Carsins_Run	Main_Stem	1598	100-yr ult	187.07	1.41	2.20	0.05	49.89	3145.04	20.07	112.41	0.99	3.35	0.83	1.92	9.63	1.71	0.83
Carsins_Run	Main_Stem	1423	1-yr ex	178.74	0.75	2.15	0.13		387.00		35.71		2.41			6.95		0.98
Carsins_Run	Main_Stem	1423	2-yr ex	179.15	1.16	2.06	0.13		612.00		36.64		3.49			8.66		1.10
Carsins_Run	Main_Stem	1423	10-yr ex	179.94	2.90	1.91	0.13		1366.00		38.40		7.89			13.65		1.49
Carsins_Run	Main_Stem	1423	100-yr ex	184.28	1.93	1.66	0.15	0.69	3206.31		49.21	0.29	4.02		0.86	11.14		0.80
Carsins_Run	Main_Stem	1423	1-yr ult	178.75	0.75	2.15	0.13		391.00		35.74		2.41			6.96		0.98
Carsins_Run	Main_Stem	1423	2-yr ult	179.17	1.17	2.06	0.13		617.00		36.67		3.49			8.66		1.10
Carsins_Run	Main_Stem	1423	10-yr ult	179.96	2.87	1.91	0.13		1374.00		38.46		7.80			13.59		1.48
Carsins_Run	Main_Stem	1423	100-yr ult	184.30	1.93	1.65	0.15	0.72	3214.28		49.25	0.29	4.02		0.87	11.14		0.80
Carsins_Run	Main_Stem	1233	1-yr ex	176.88	0.33	0.44	0.02		387.00		34.73		0.92			4.59		0.52
Carsins_Run	Main_Stem	1233	2-yr ex	177.66	0.47	0.47	0.02		612.00		36.28		1.21			5.47		0.55
Carsins_Run	Main_Stem	1233	10-yr ex	179.60	0.84	0.57	0.06		1366.00		40.05		1.92			7.34		0.60
Carsins_Run	Main_Stem	1233	100-yr ex	182.97	1.44	0.43	0.03	15.07	3184.97	6.96	59.85	0.52	2.83	0.35	1.40	9.64	1.07	0.62
Carsins_Run	Main_Stem	1233	1-yr ult	176.90	0.33	0.44	0.02		391.00		34.76		0.92			4.61		0.52
Carsins_Run	Main_Stem	1233	2-yr ult	177.67	0.47	0.47	0.03		617.00		36.30		1.21			5.49		0.55
Carsins_Run	Main_Stem	1233	10-yr ult	179.62	0.84	0.57	0.06		1374.00		40.08		1.92			7.36		0.60
Carsins_Run	Main_Stem	1233	100-yr ult	182.99	1.44	0.42	0.03	15.35	3192.50	7.15	59.99	0.52	2.83	0.35	1.41	9.64	1.07	0.62
Carsins_Run	Main_Stem	1180	1-yr ex	176.27	0.49	0.30	0.07		387.00		32.29		1.42			5.60		0.67
Carsins_Run	Main_Stem	1180	2-yr ex	176.91	0.71	0.37	0.10		612.00		33.10		1.94			6.78		0.72
Carsins_Run	Main_Stem	1180	10-yr ex	178.35	1.47	0.57	0.17		1366.00		37.44		3.59			9.71		0.88
Carsins_Run	Main_Stem	1180	100-yr ex	182.22	1.73	0.28	0.26	2.63	3204.25	0.12	56.41	0.24	3.54	0.07	0.80	10.56	0.33	0.72
Carsins_Run	Main_Stem	1180	1-yr ult	176.28	0.49	0.31	0.07		391.00		32.31		1.43			5.62		0.68
Carsins_Run	Main_Stem	1180	2-yr ult	176.92	0.72	0.37	0.10		617.00		33.14		1.95			6.80		0.73
Carsins_Run	Main_Stem	1180	10-yr ult	178.36	1.48	0.57	0.17		1374.00		37.46		3.61			9.74		0.89
Carsins_Run	Main_Stem	1180	100-yr ult	182.24	1.73	0.27	0.26	2.89	3211.95	0.17	56.95	0.26	3.53	0.07	0.83	10.55	0.35	0.72
Carsins_Run	Main_Stem	1134	1-yr ex	176.13	0.25	0.31	0.01		387.00		36.87		0.67			3.98		0.43
Carsins_Run	Main_Stem	1134	2-yr ex	176.77	0.40	0.36	0.01		612.00		38.87		1.02			5.04		0.50
Carsins_Run	Main_Stem	1134	10-yr ex	178.18	0.89	0.50	0.01		1366.00		45.12		2.14			7.58		0.67
Carsins_Run	Main_Stem	1134	100-yr ex	182.55	0.86	0.17	0.07	25.28	3160.90	20.82	88.71	0.40	1.71	0.28	1.29	7.49	1.01	0.49
Carsins_Run	Main_Stem	1134	1-yr ult	176.14	0.25	0.31	0.01		391.00		36.91		0.68			4.00		0.43
Carsins_Run	Main_Stem	1134	2-yr ult	176.78	0.40	0.36	0.01		617.00		38.90		1.03			5.07		0.50
Carsins_Run	Main_Stem	1134	10-yr ult	178.19	0.90	0.50	0.01		1374.00		45.16		2.15			7.60		0.67
Carsins_Run	Main_Stem	1134	100-yr ult	182.58	0.86	0.17	0.07	25.77	3167.72	21.52	88.89	0.40	1.70	0.28	1.29	7.48	1.02	0.49

HEC-RAS Plan: Ex_RE (Continued)

River	Reach	River Sta	Profile	W.S. Elev	Vel Head	Frctn Loss	C & E Loss	Q Left	Q Channel	Q Right	Top Width	Shear LOB	Shear Chan	Shear ROB	Vel Left	Vel Chnl	Vel Right	Froude # Chl
				(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(cfs)	(ft)	(lb/sq ft)	(lb/sq ft)	(lb/sq ft)	(ft/s)	(ft/s)	(ft/s)	
Carsins_Run	Main_Stem	1085	1-yr ex	175.72	0.34	0.53	0.04		387.00		45.93		1.04			4.69		0.62
Carsins_Run	Main_Stem	1085	2-yr ex	176.34	0.46	0.52	0.04		612.00		49.95		1.30			5.43		0.64
Carsins_Run	Main_Stem	1085	10-yr ex	177.69	0.87	0.53	0.05		1366.00		53.70		2.17			7.49		0.72
Carsins_Run	Main_Stem	1085	100-yr ex	182.56	0.61	0.08	0.06	14.26	3127.71	65.03	107.67	0.26	1.21	0.31	1.04	6.35	1.15	0.41
Carsins_Run	Main_Stem	1085	1-yr ult	175.73	0.34	0.53	0.04		391.00		46.01		1.05			4.71		0.62
Carsins_Run	Main_Stem	1085	2-yr ult	176.35	0.46	0.52	0.04		617.00		49.98		1.30			5.44		0.64
Carsins_Run	Main_Stem	1085	10-yr ult	177.70	0.88	0.53	0.05		1374.00		53.72		2.19			7.52		0.72
Carsins_Run	Main_Stem	1085	100-yr ult	182.59	0.61	0.08	0.06	14.53	3134.15	66.31	107.83	0.26	1.20	0.31	1.04	6.33	1.16	0.41
Carsins_Run	Main_Stem	1049	1-yr ex	175.16	0.44	8.38	0.21		387.00		42.38		1.38			5.33		0.72
Carsins_Run	Main_Stem	1049	2-yr ex	175.75	0.59	7.40	0.27		612.00		48.21		1.72			6.14		0.75
Carsins_Run	Main_Stem	1049	10-yr ex	177.00	1.04	5.23	0.40		1366.00		59.51		2.71			8.18		0.84
Carsins_Run	Main_Stem	1049	100-yr ex	182.63	0.40			3.44	3164.03	39.53	118.28	0.12	0.79	0.19	0.65	5.09	0.89	0.34
Carsins_Run	Main_Stem	1049	1-yr ult	175.16	0.45	8.47	0.22		391.00		42.39		1.41			5.39		0.73
Carsins_Run	Main_Stem	1049	2-yr ult	175.76	0.59	7.51	0.28		617.00		48.30		1.73			6.17		0.76
Carsins_Run	Main_Stem	1049	10-yr ult	177.00	1.05	5.34	0.41		1374.00		59.50		2.75			8.23		0.85
Carsins_Run	Main_Stem	1049	100-yr ult	182.65	0.40			3.54	3171.03	40.44	118.39	0.12	0.78	0.19	0.65	5.09	0.89	0.33
Carsins_Run	DS_Stem	922	1-yr ex	172.35	2.17	0.88	0.29		387.00		37.38		5.06			11.81		2.22
Carsins_Run	DS_Stem	922	2-yr ex	172.69	2.83	0.91	0.32		612.00		38.48		5.99			13.48		2.19
Carsins_Run	DS_Stem	922	10-yr ex	173.66	4.11	0.87	0.28		1366.00		40.77		7.28			16.26		2.00
Carsins_Run	DS_Stem	922	100-yr ex	182.43	0.41	0.02	0.02	14.66	3185.87	6.46	138.99	0.08	0.48	0.03	0.55	5.18	0.30	0.32
Carsins_Run	DS_Stem	922	1-yr ult	172.33	2.34	0.95	0.32		391.00		37.30		5.51			12.27		2.34
Carsins_Run	DS_Stem	922	2-yr ult	172.66	2.99	0.98	0.34		617.00		38.41		6.37			13.87		2.27
Carsins_Run	DS_Stem	922	10-yr ult	173.63	4.29	0.91	0.30		1374.00		40.71		7.62			16.61		2.05
Carsins_Run	DS_Stem	922	100-yr ult	182.46	0.41	0.02	0.02	15.15	3192.82	7.04	139.40	0.08	0.47	0.03	0.56	5.17	0.31	0.32
Carsins_Run	DS_Stem	868	1-yr ex	172.15	1.20				387.00		37.50		0.47			8.79		1.43
Carsins_Run	DS_Stem	868	2-yr ex	172.51	1.76				612.00		38.90		0.64			10.65		1.55
Carsins_Run	DS_Stem	868	10-yr ex	173.44	3.18				1366.00		42.40		1.01			14.32		1.68
Carsins_Run	DS_Stem	868	100-yr ex	182.46	0.35			7.79	3189.06	10.15	182.70	0.01	0.07	0.01	0.19	4.77	0.16	0.28
Carsins_Run	DS_Stem	868	1-yr ult	172.14	1.26				391.00		37.43		0.50			9.02		1.48
Carsins_Run	DS_Stem	868	2-yr ult	172.48	1.86				617.00		38.79		0.68			10.94		1.60
Carsins_Run	DS_Stem	868	10-yr ult	173.41	3.29				1374.00		42.33		1.04			14.55		1.72
Carsins_Run	DS_Stem	868	100-yr ult	182.49	0.35			8.04	3196.33	10.63	183.52	0.01	0.07	0.01	0.19	4.76	0.16	0.28
Carsins_Run	DS_Stem	721.4		Culvert														
Carsins_Run	DS_Stem	574	1-yr ex	169.40	0.93				387.00		26.99		3.50			7.73		1.00
Carsins_Run	DS_Stem	574	2-yr ex	170.22	1.06				612.00		35.04		3.82			8.26		1.00
Carsins_Run	DS_Stem	574	10-yr ex	171.82	1.46				1366.00		48.30		4.72			9.68		1.00
Carsins_Run	DS_Stem	574	100-yr ex	174.95	1.49	1.48	0.01	7.54	3199.47		124.53	1.02	4.18		1.91	9.80		0.81
Carsins_Run	DS_Stem	574	1-yr ult	169.42	0.93				391.00		27.05		3.50			7.74		1.00
Carsins_Run	DS_Stem	574	2-yr ult	170.24	1.05				617.00		35.25		3.78			8.23		0.99
Carsins_Run	DS_Stem	574	10-yr ult	171.83	1.46				1374.00		48.40		4.73			9.70		1.00
Carsins_Run	DS_Stem	574	100-yr ult	174.95	1.50	1.48	0.00	7.53	3207.47		124.50	1.03	4.21		1.92	9.83		0.82
Carsins_Run	DS_Stem	473	1-yr ex	169.97	0.44	1.13	0.06		387.00		43.40		1.38			5.33		0.73
Carsins_Run	DS_Stem	473	2-yr ex	170.35	0.71	1.29	0.11	1.65	604.41	5.95	75.47	0.23	2.10	0.33	0.70	6.80	0.89	0.84
Carsins_Run	DS_Stem	473	10-yr ex	171.48	1.14	1.45	0.16	48.11	1239.00	78.89	107.33	0.90	3.18	1.20	1.74	8.99	2.11	0.89
Carsins_Run	DS_Stem	473	100-yr ex	173.41	1.55	2.23	0.08	340.16	2491.70	375.15	165.74	1.64	4.22	1.89	2.69	11.22	2.96	0.87
Carsins_Run	DS_Stem	473	1-yr ult	169.99	0.45	1.13	0.06		391.00		43.45		1.39			5.35		0.73
Carsins_Run	DS_Stem	473	2-yr ult	170.36	0.71	1.29	0.11	1.72	609.10	6.17	75.75	0.23	2.12	0.34	0.71	6.83	0.91	0.84
Carsins_Run	DS_Stem	473	10-yr ult	171.48	1.15	1.45	0.16	48.57	1245.88	79.55	107.41	0.91	3.20	1.21	1.75	9.03	2.12	0.89
Carsins_Run	DS_Stem	473	100-yr ult	173.43	1.54	2.22	0.08	342.59	2494.98	377.43	165.93	1.64	4.21	1.89	2.69	11.20	2.96	0.87
Carsins_Run	DS_Stem	375	1-yr ex	168.98	0.25	1.14	0.00		387.00		107.73		0.84			4.04		0.60
Carsins_Run	DS_Stem	375	2-yr ex	169.32	0.34	1.18	0.01	4.99	574.30	32.71	177.00	0.18	1.11	0.30	0.63	4.80	0.91	0.64
Carsins_Run	DS_Stem	375	10-yr ex	170.04	0.61	1.33	0.06	42.55	1149.29	174.17	246.06	0.44	1.99	0.85	1.12	6.81	1.73	0.77
Carsins_Run	DS_Stem	375	100-yr ex	170.33	2.33	1.45	0.12	157.50	2561.16	488.34	252.78	2.19	7.61	3.72	2.66	13.58	3.79	1.45
Carsins_Run	DS_Stem	375	1-yr ult	168.99	0.25	1.14	0.00		391.00		108.83		0.84			4.05		0.60
Carsins_Run	DS_Stem	375	2-yr ult	169.33	0.34	1.18	0.01	5.17	578.39	33.44	177.41	0.18	1.12	0.31	0.64	4.82	0.91	0.64
Carsins_Run	DS_Stem	375	10-yr ult	170.04	0.61	1.33	0.06	43.33	1154.68	175.99	246.19	0.45	1.99	0.85	1.13	6.82	1.74	0.77

HEC-RAS Plan: Ex_RE (Continued)

River	Reach	River Sta	Profile	W.S. Elev	Vel Head	Frctn Loss	C & E Loss	Q Left	Q Channel	Q Right	Top Width	Shear LOB	Shear Chan	Shear ROB	Vel Left	Vel Chnl	Vel Right	Froude # Chl
				(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(cfs)	(ft)	(lb/sq ft)	(lb/sq ft)	(lb/sq ft)	(ft/s)	(ft/s)	(ft/s)	
Carsins_Run	DS_Stem	375	100-yr ult	170.33	2.34	1.45	0.12	157.96	2567.40	489.64	252.79	2.20	7.64	3.74	2.67	13.61	3.80	1.45
Carsins_Run	DS_Stem	269	1-yr ex	167.84	0.25				387.00		118.86		0.87			4.00		0.64
Carsins_Run	DS_Stem	269	2-yr ex	168.17	0.29			34.19	566.65	11.16	277.59	0.28	1.05	0.17	0.85	4.52	0.60	0.66
Carsins_Run	DS_Stem	269	10-yr ex	168.84	0.42			182.22	1070.16	113.62	309.97	0.68	1.53	0.63	1.53	5.83	1.46	0.71
Carsins_Run	DS_Stem	269	100-yr ex	169.93	0.64			623.26	2138.84	444.90	377.49	1.14	2.32	1.37	2.15	7.69	2.43	0.76
Carsins_Run	DS_Stem	269	1-yr ult	167.84	0.25				391.00	0.00	121.25		0.87			4.01	0.03	0.64
Carsins_Run	DS_Stem	269	2-yr ult	168.18	0.30			35.00	570.37	11.63	277.87	0.29	1.05	0.17	0.86	4.53	0.61	0.66
Carsins_Run	DS_Stem	269	10-yr ult	168.85	0.42			183.98	1075.14	114.89	310.26	0.68	1.54	0.64	1.53	5.84	1.46	0.71
Carsins_Run	DS_Stem	269	100-yr ult	169.93	0.64			625.35	2143.23	446.42	377.79	1.14	2.32	1.37	2.15	7.69	2.44	0.76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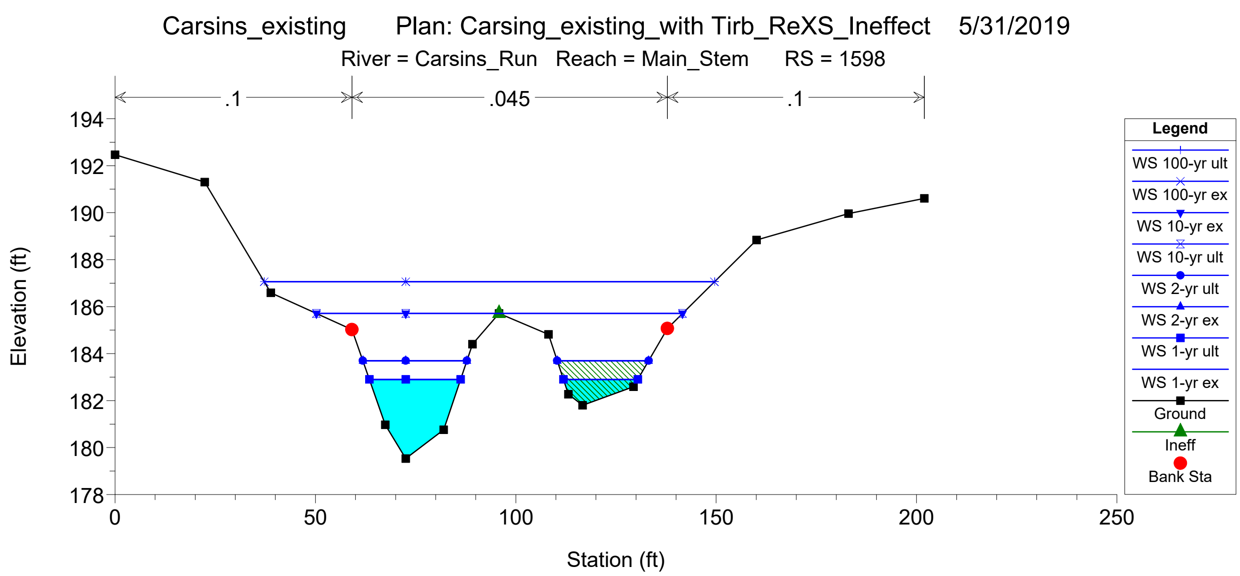
River = Carsins_Run Reach = Main_Stem RS = 1896
.1
.045
.1
Elevation (ft)
198
196
194
192
190
188
186
184
182
0
50
100
150
200
250
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 10-yr ex
WS 2-yr ult
WS 2-yr ex
WS 1-yr ult
WS 1-yr ex
Ground
Ineff
Bank Sta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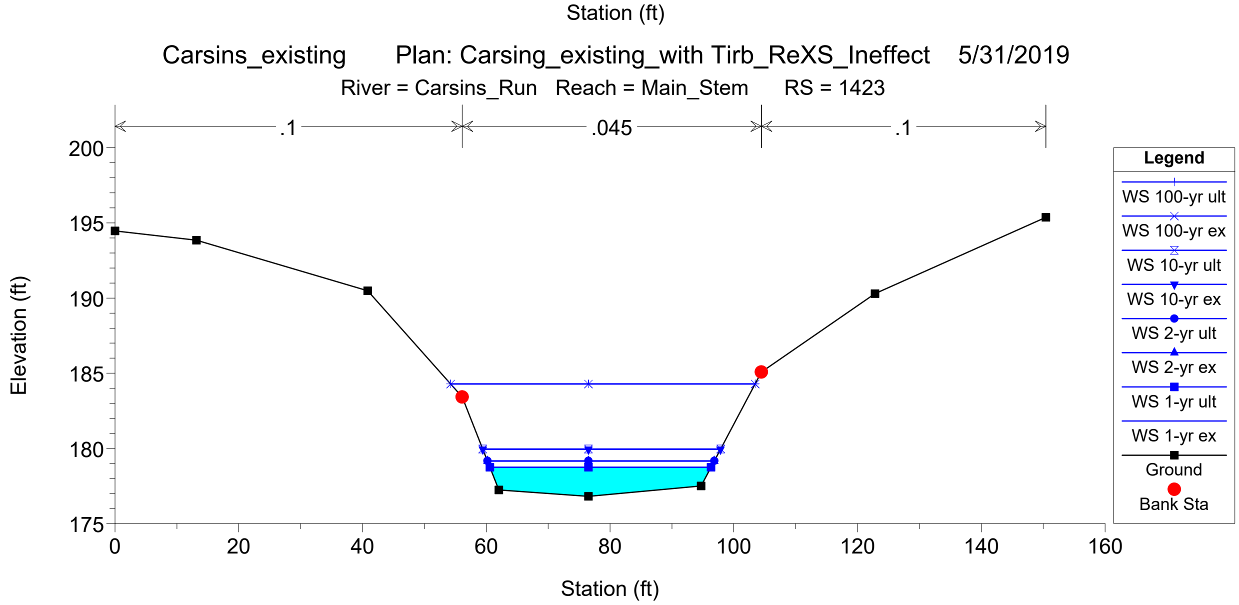
River = Carsins_Run Reach = Main_Stem RS = 1598
.1
.045
.1
Elevation (ft)
194
192
190
188
186
184
182
180
178
0
50
100
150
200
250
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ex
WS 10-yr ult
WS 2-yr ult
WS 2-yr ex
WS 1-yr ult
WS 1-yr ex
Ground
Ineff
Bank Sta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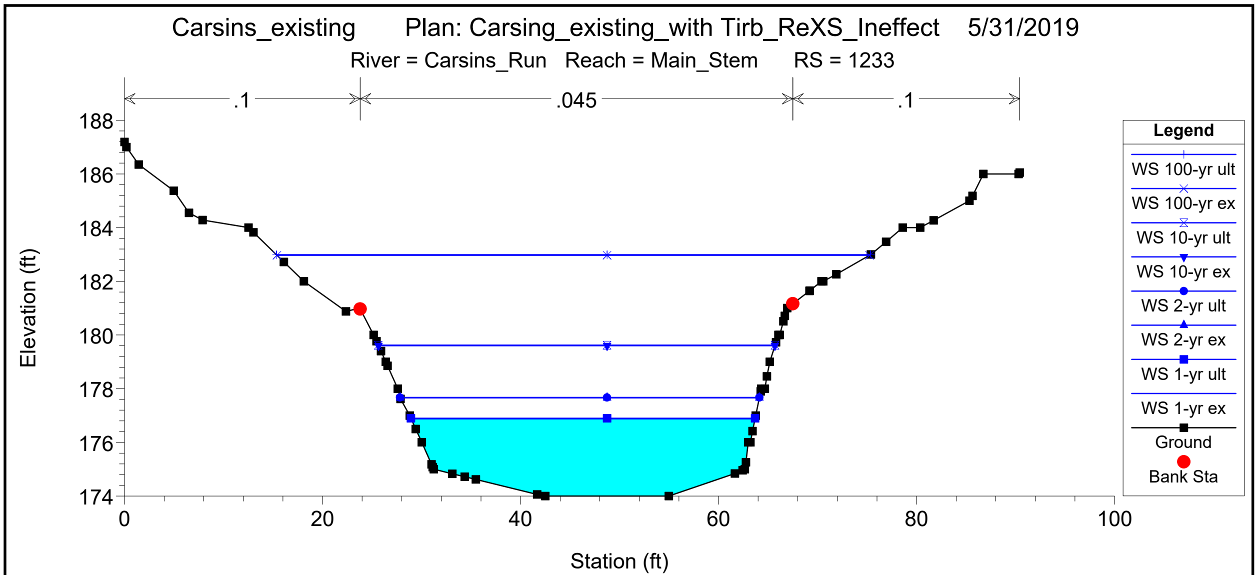
River = Carsins_Run Reach = Main_Stem RS = 1423
.1
.045
.1
Elevation (ft)
200
195
190
185
180
175
0
20
40
60
80
100
120
140
160
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 10-yr ex
WS 2-yr ult
WS 2-yr ex
WS 1-yr ult
WS 1-yr ex
Ground
Bank Sta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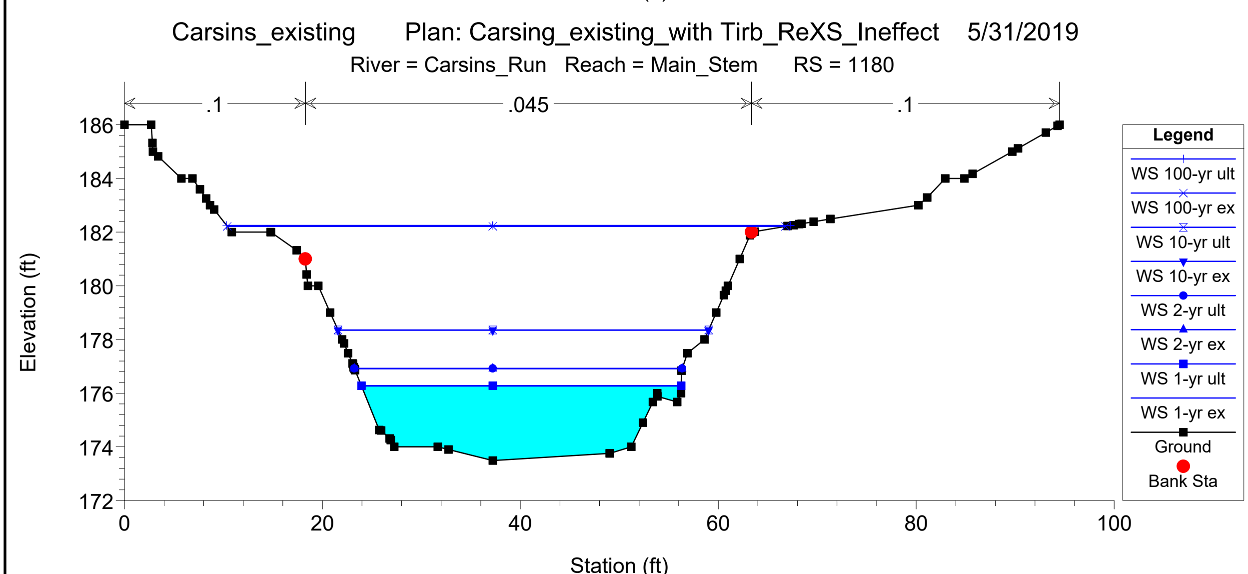
River = Carsins_Run Reach = Main_Stem RS = 1233
.1
.045
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 10-yr ex
WS 2-yr ult
WS 2-yr ex
WS 1-yr ult
WS 1-yr ex
Ground
Bank Sta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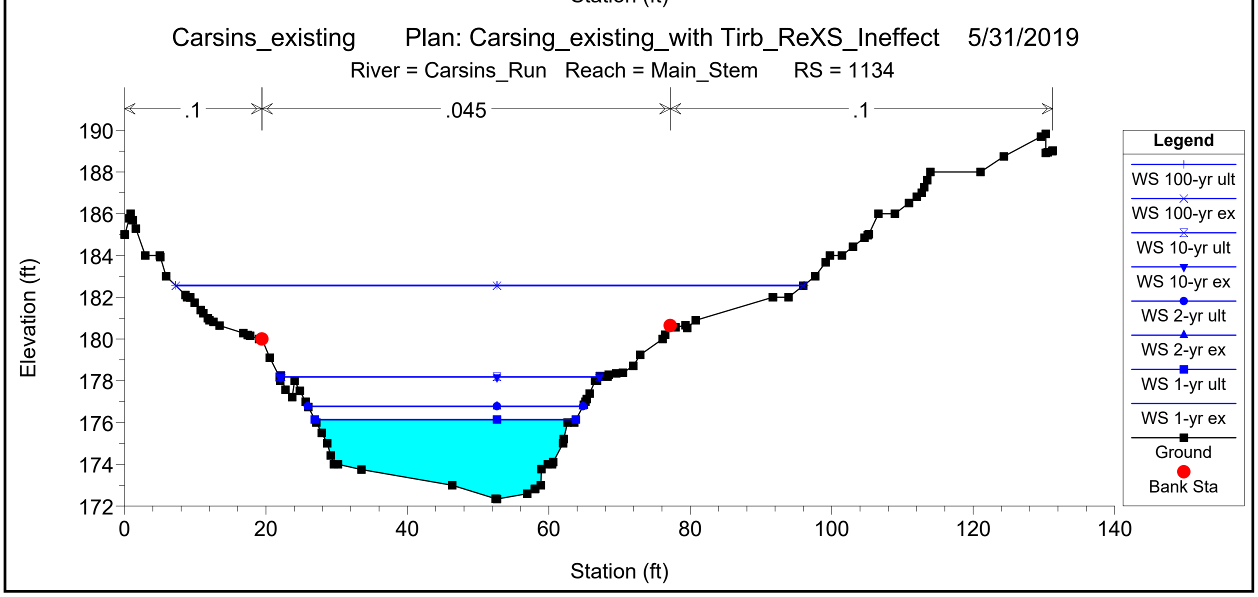
River = Carsins_Run Reach = Main_Stem RS = 1180
.1
.045
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 10-yr ex
WS 2-yr ult
WS 2-yr ex
WS 1-yr ult
WS 1-yr ex
Ground
Bank Sta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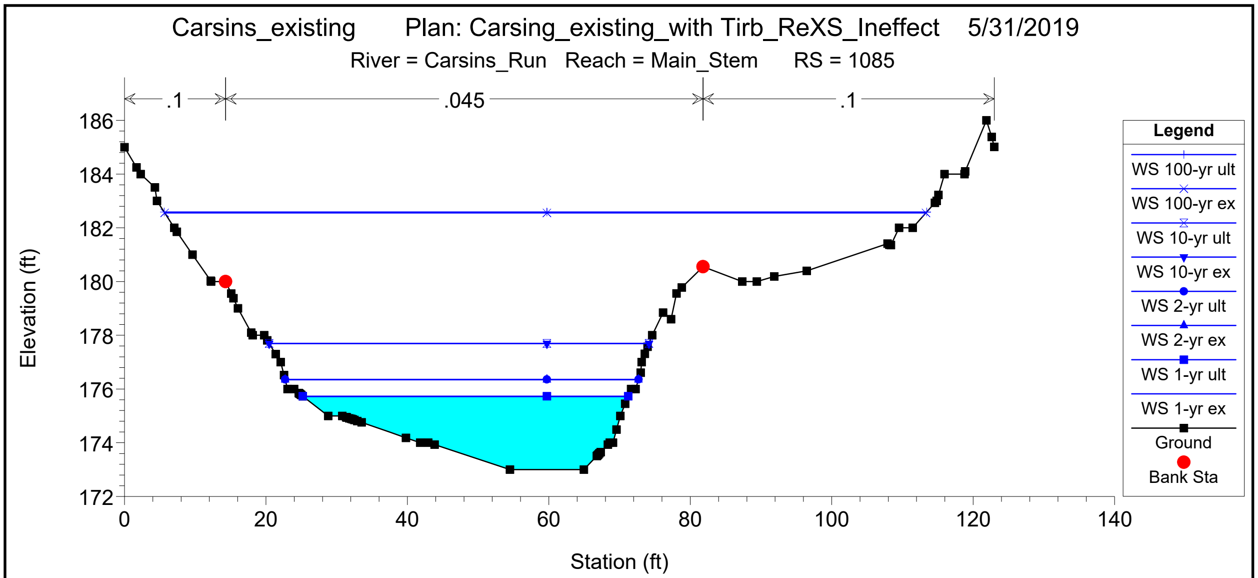
River = Carsins_Run Reach = Main_Stem RS = 1134
.1
.045
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 10-yr ex
WS 2-yr ult
WS 2-yr ex
WS 1-yr ult
WS 1-yr ex
Ground
Bank Sta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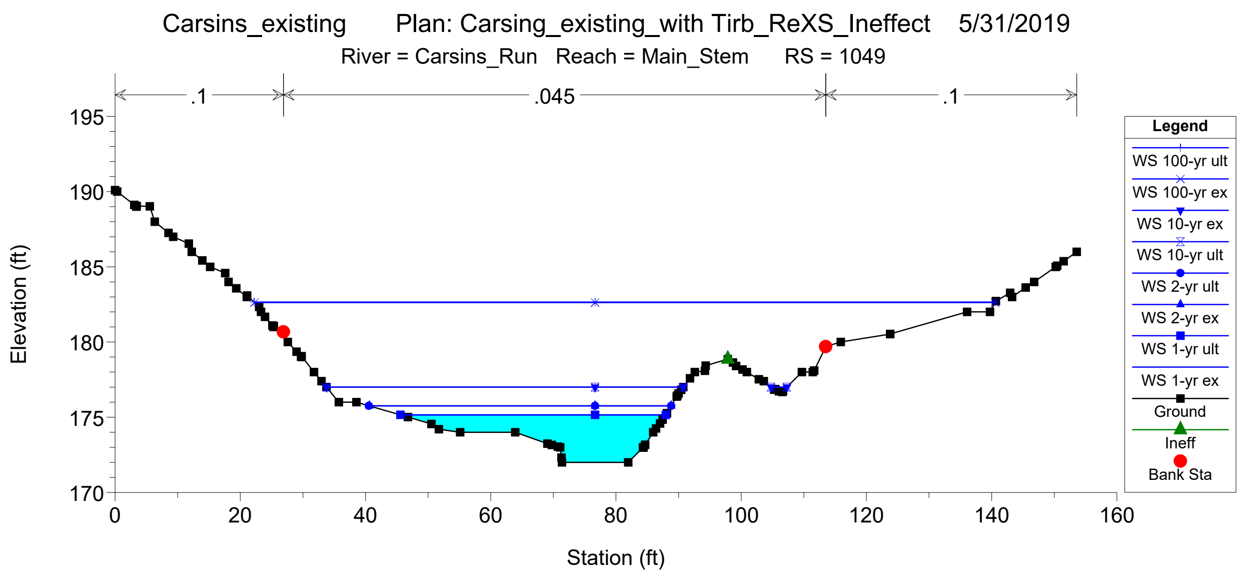
River = Carsins_Run Reach = Main_Stem RS = 1085
.1
.045
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 10-yr ex
WS 2-yr ult
WS 2-yr ex
WS 1-yr ult
WS 1-yr ex
Ground
Bank Sta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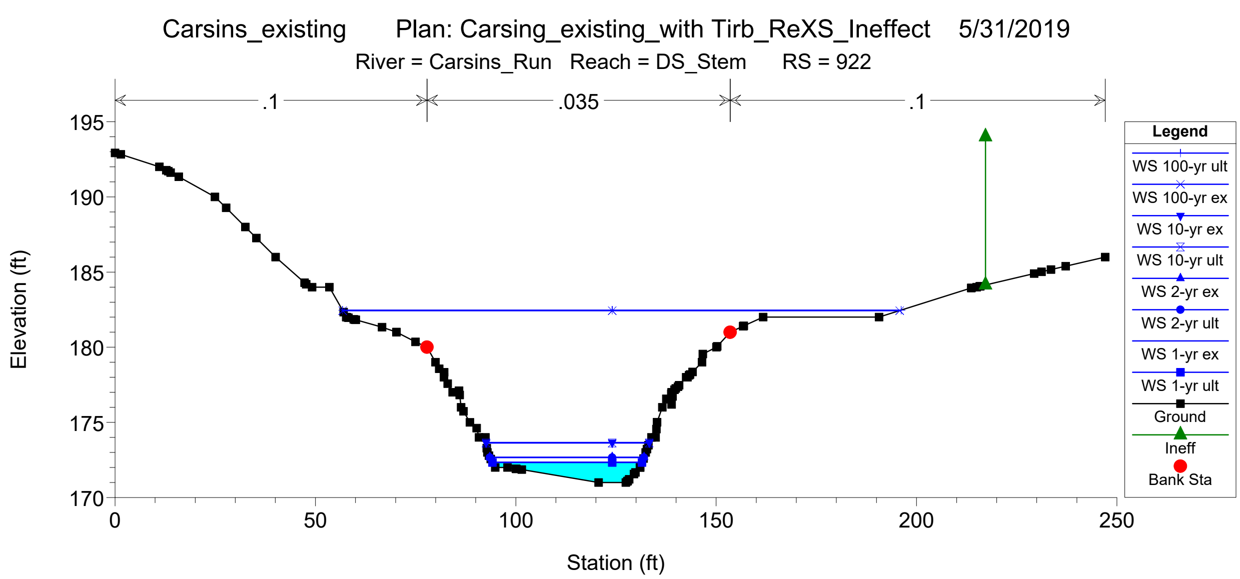
River = Carsins_Run Reach = Main_Stem RS = 1049
.1
.045
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ex
WS 10-yr ult
WS 2-yr ult
WS 2-yr ex
WS 1-yr ult
WS 1-yr ex
Ground
Ineff
Bank Sta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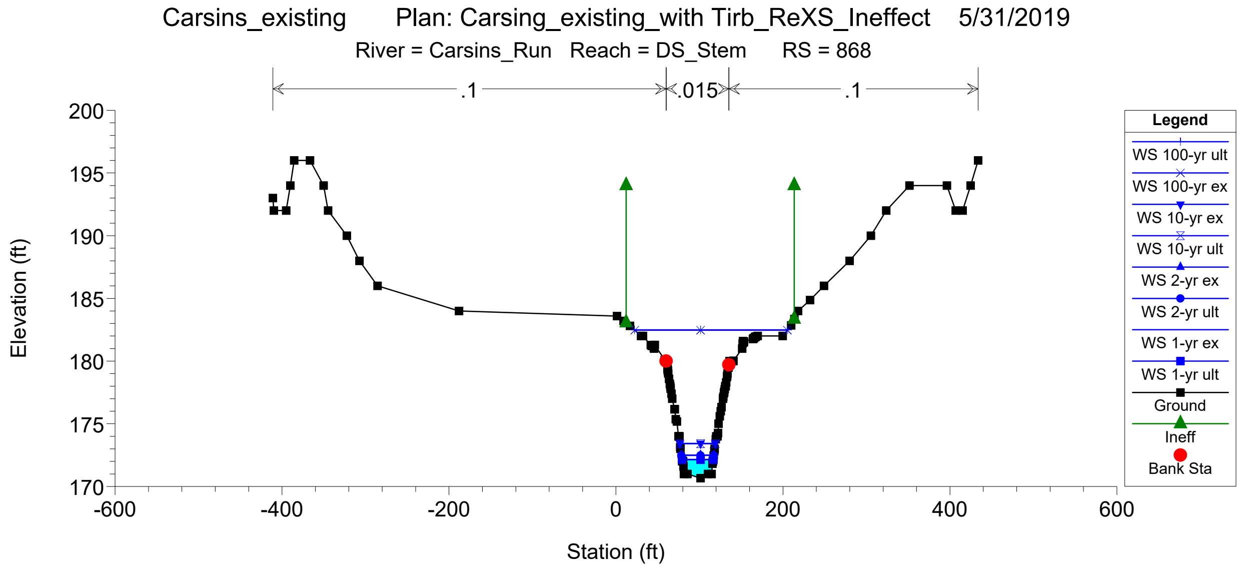
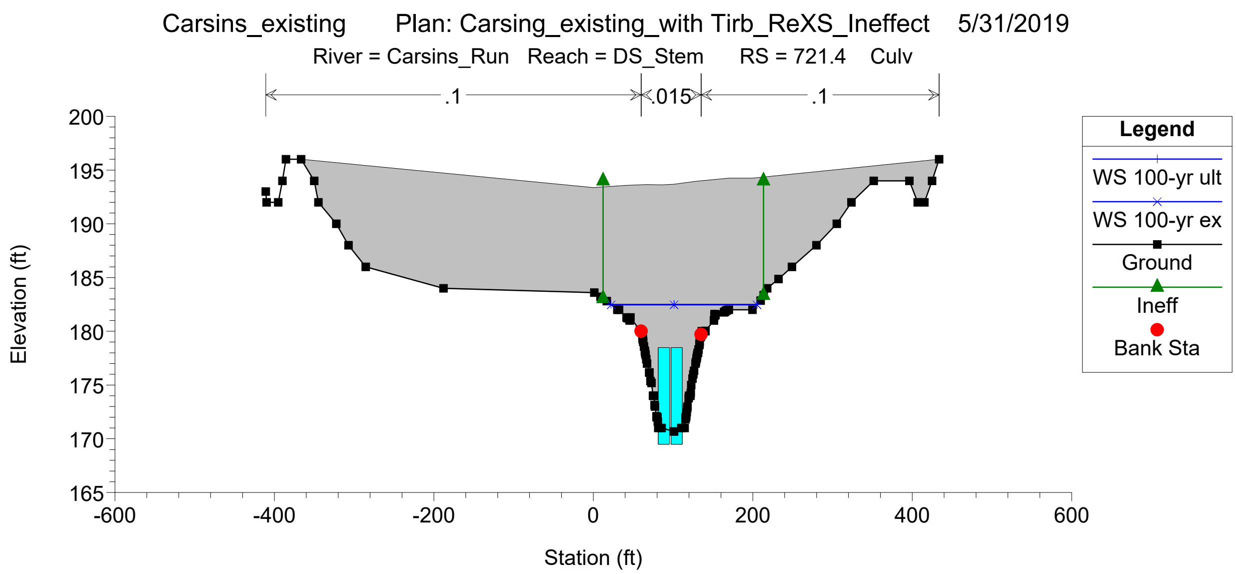
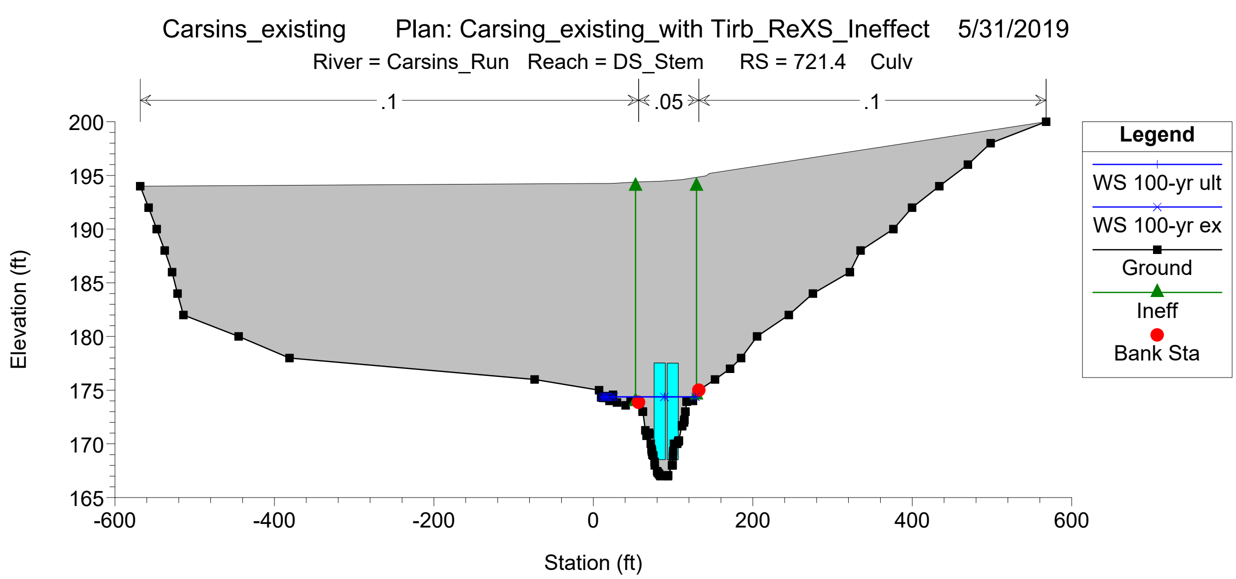
River = Carsins_Run Reach = DS_Stem RS = 922
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ex
WS 10-yr ult
WS 2-yr ex
WS 2-yr ult
WS 1-yr ex
WS 1-yr ult
Ground
Ineff
Bank Sta



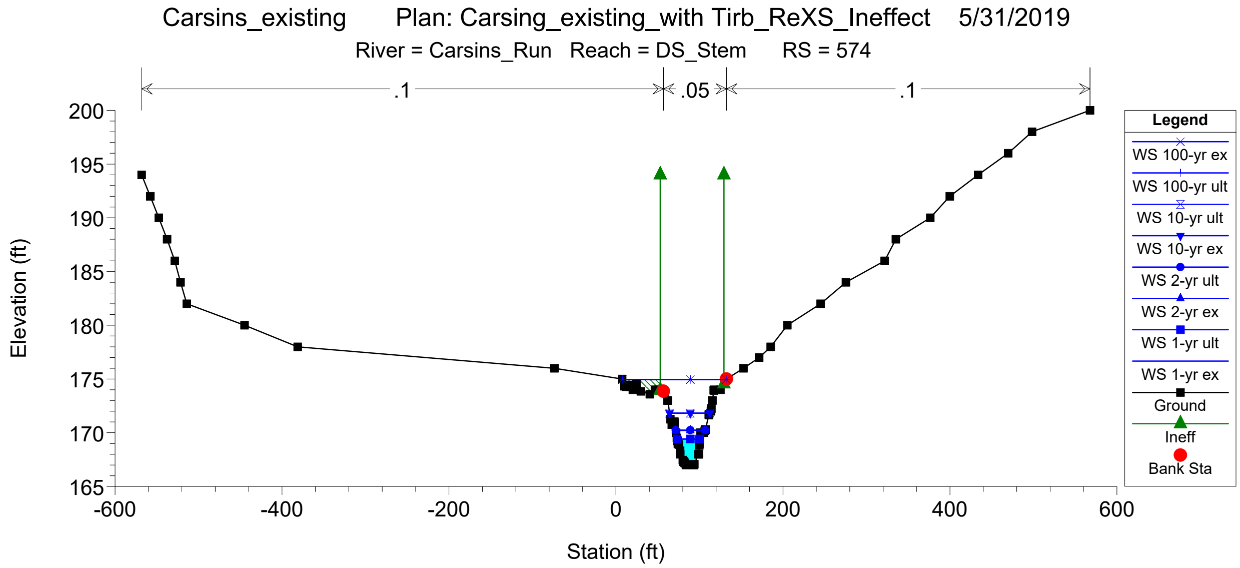
Carsins_existing Plan: Carsing_existing_with Tirb_ReXS_Ineffect 5/31/2019
River = Carsins_Run Reach = DS_Stem RS = 868
.1
.015
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ex
WS 10-yr ult
WS 2-yr ex
WS 2-yr ult
WS 1-yr ex
WS 1-yr ult
Ground
Ineff
Bank Sta

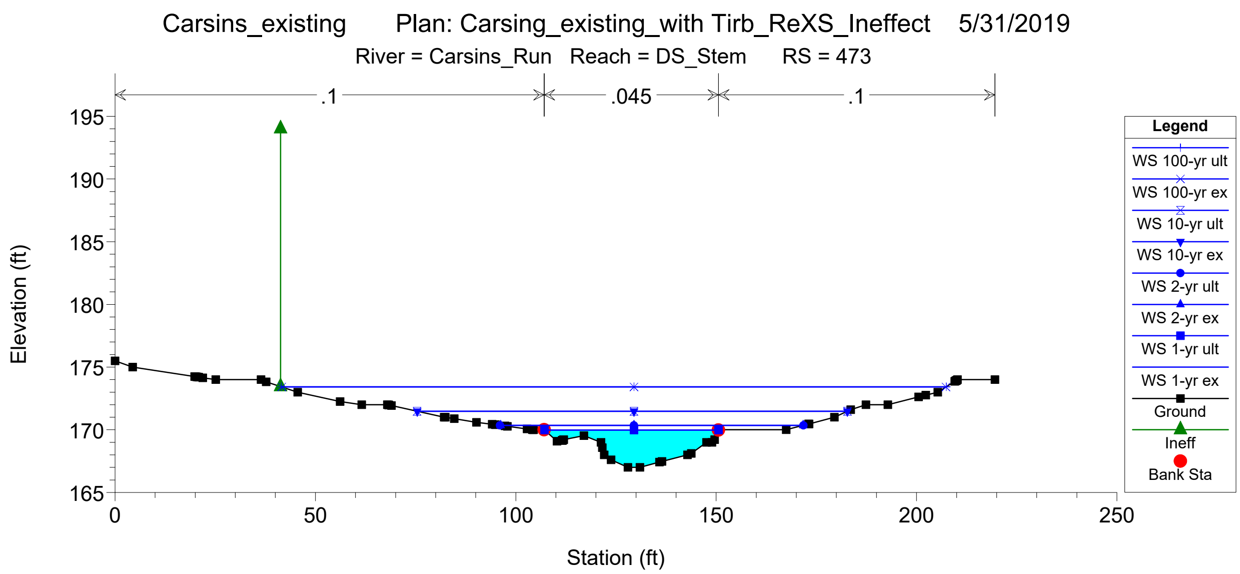


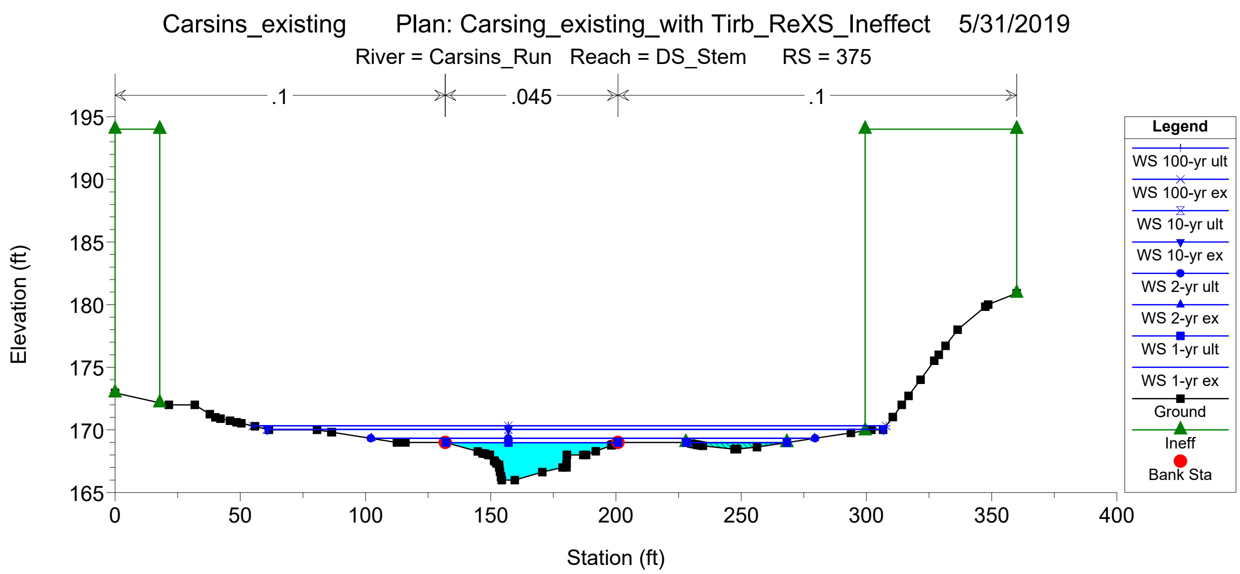
Carsins_existing Plan: Carsing_existing_with Tirb_ReXS_Ineffect 5/31/2019
River = Carsins_Run Reach = DS_Stem RS = 721.4 Culv
.1
.015
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
Ground
Ineff
Bank Sta

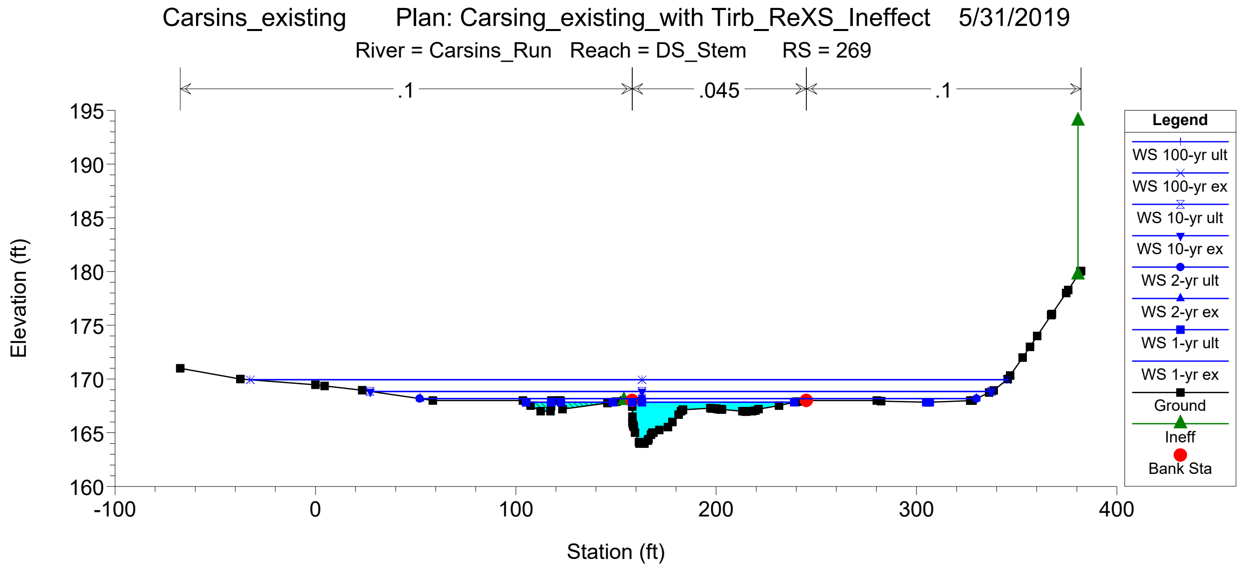


Carsins_existing Plan: Carsing_existing_with Tirb_ReXS_Ineffect 5/31/2019
River = Carsins_Run Reach = DS_Stem RS = 721.4 Culv
.1
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
Ground
Ineff
Bank Sta


Carsins_existing Plan: Carsing_existing_with Tirb_ReXS_Ineffect 5/31/2019
River = Carsins_Run Reach = DS_Stem RS = 574
.1
.05
.1
Elevation (ft)
Station (ft)
200
195
190
185
180
175
170
165
-600
-400
-200
0
200
400
600
Legend
WS 100-yr ex
WS 100-yr ult
WS 10-yr ult
WS 10-yr ex
WS 2-yr ult
WS 2-yr ex
WS 1-yr ult
WS 1-yr ex
Ground
Ineff
Bank Sta


Carsins_existing Plan: Carsing_existing_with Tirb_ReXS_Ineffect 5/31/2019
River = Carsins_Run Reach = DS_Stem RS = 473
.1
.045
.1
Elevation (ft)
Station (ft)
195
190
185
180
175
170
165
0
50
100
150
200
250
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 10-yr ex
WS 2-yr ult
WS 2-yr ex
WS 1-yr ult
WS 1-yr ex
Ground
Ineff
Bank Sta


Carsins_existing Plan: Carsing_existing_with Tirb_ReXS_Ineffect 5/31/2019
River = Carsins_Run Reach = DS_Stem RS = 375
.1
.045
.1
Elevation (ft)
Station (ft)
195
190
185
180
175
170
165
0
50
100
150
200
250
300
350
400
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 10-yr ex
WS 2-yr ult
WS 2-yr ex
WS 1-yr ult
WS 1-yr ex
Ground
Ineff
Bank Sta



Carsins_existing Plan: Carsing_existing_with Tirb_ReXS_Ineffect 5/31/2019
River = Carsins_Run Reach = DS_Stem RS = 269
.1
.045
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 10-yr ex
WS 2-yr ult
WS 2-yr ex
WS 1-yr ult
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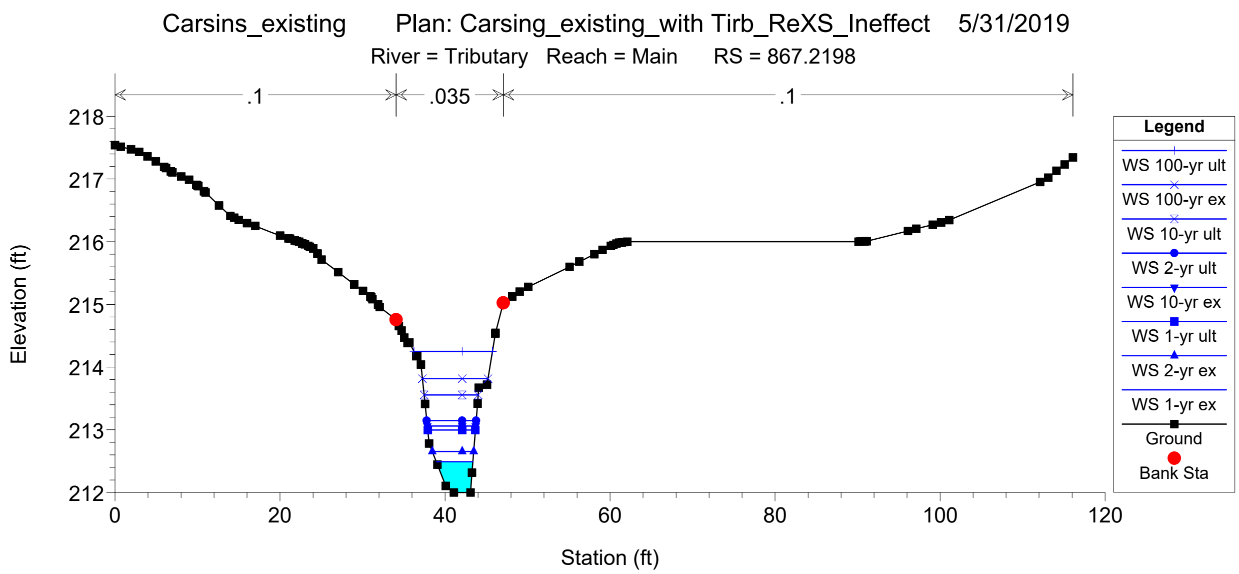
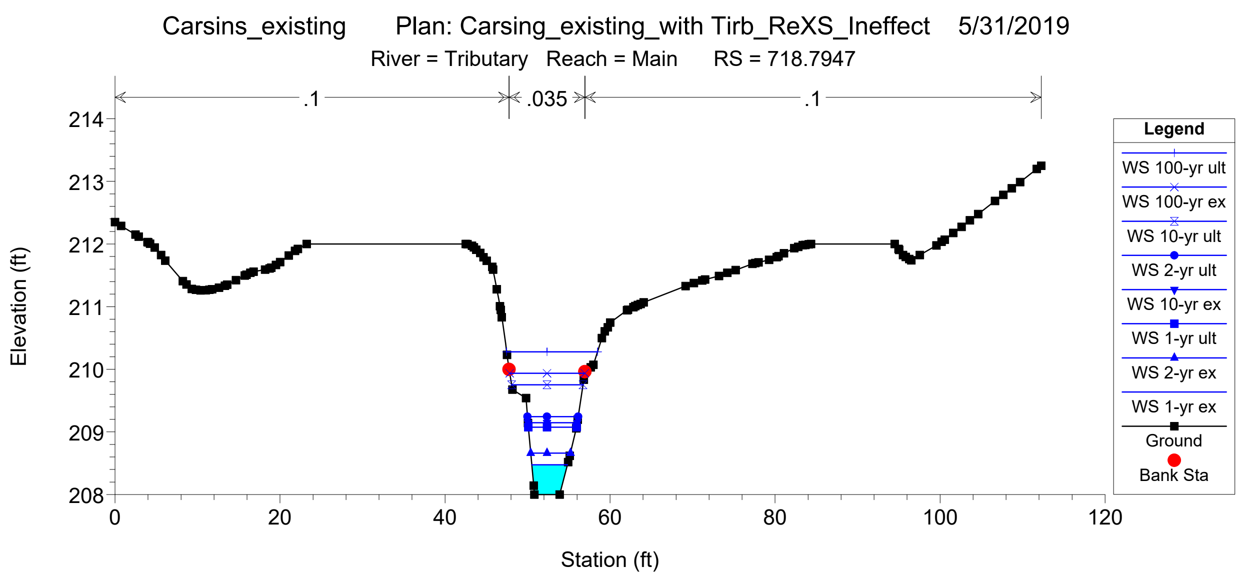
Bank Sta



Carsins_existing Plan: Carsing_existing_with Tirb_ReXS_Ineffect 5/31/2019
River = Tributary Reach = Main RS = 867.2198
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 2-yr ult
WS 10-yr ex
WS 1-yr ult
WS 2-yr ex
WS 1-yr ex
Ground
Bank Sta



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Station (ft)
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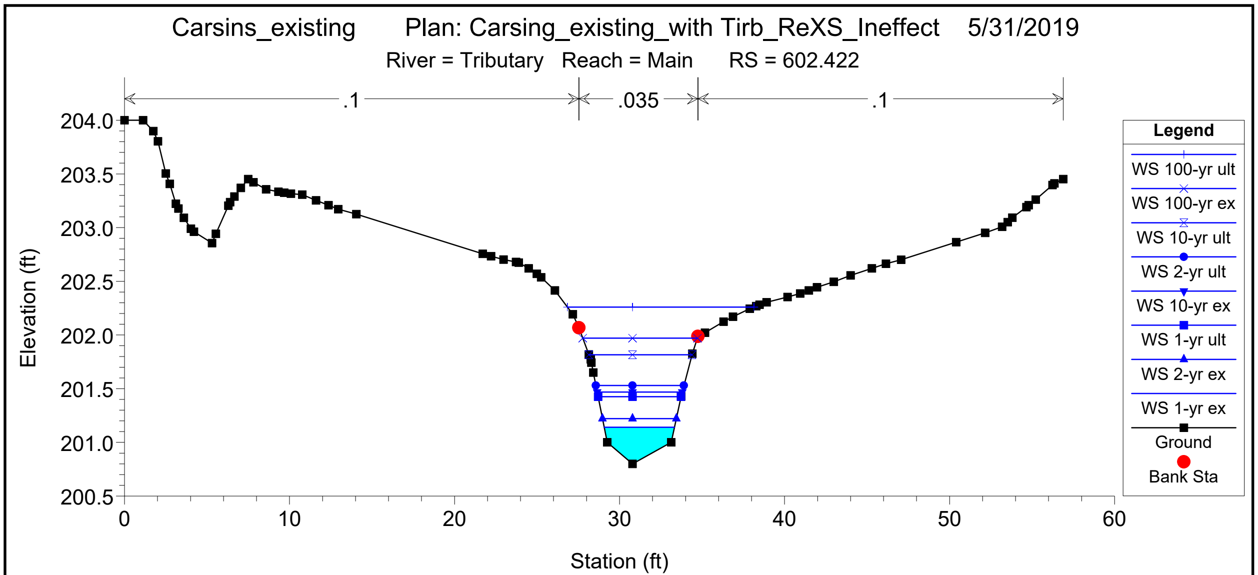
Ground
Bank Sta



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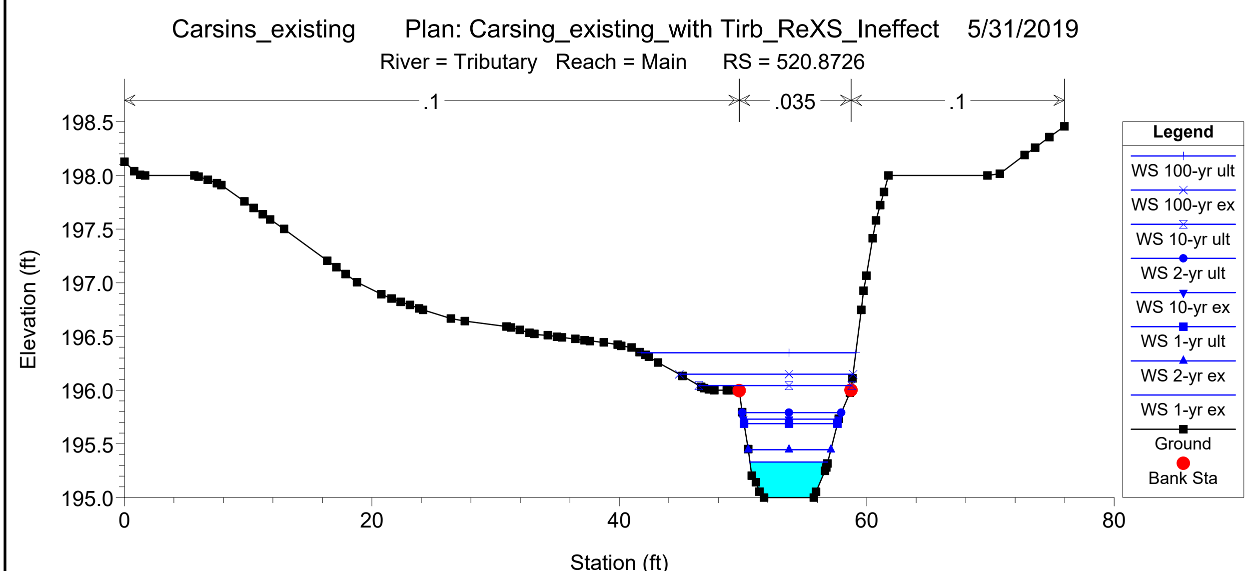
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 2-yr ult
WS 10-yr ex
WS 1-yr ult
WS 2-yr ex
WS 1-yr ex
Ground
Bank Sta



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.035
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
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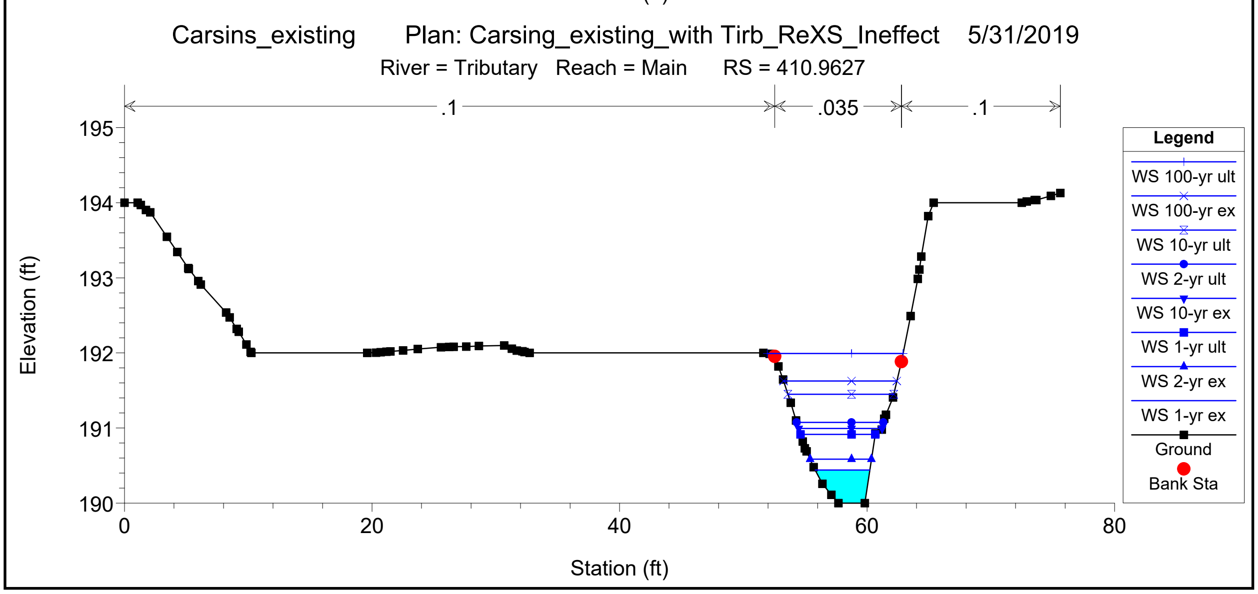
WS 2-yr ult
WS 10-yr ex
WS 1-yr ult
WS 2-yr ex
WS 1-yr ex
Ground
Bank Sta



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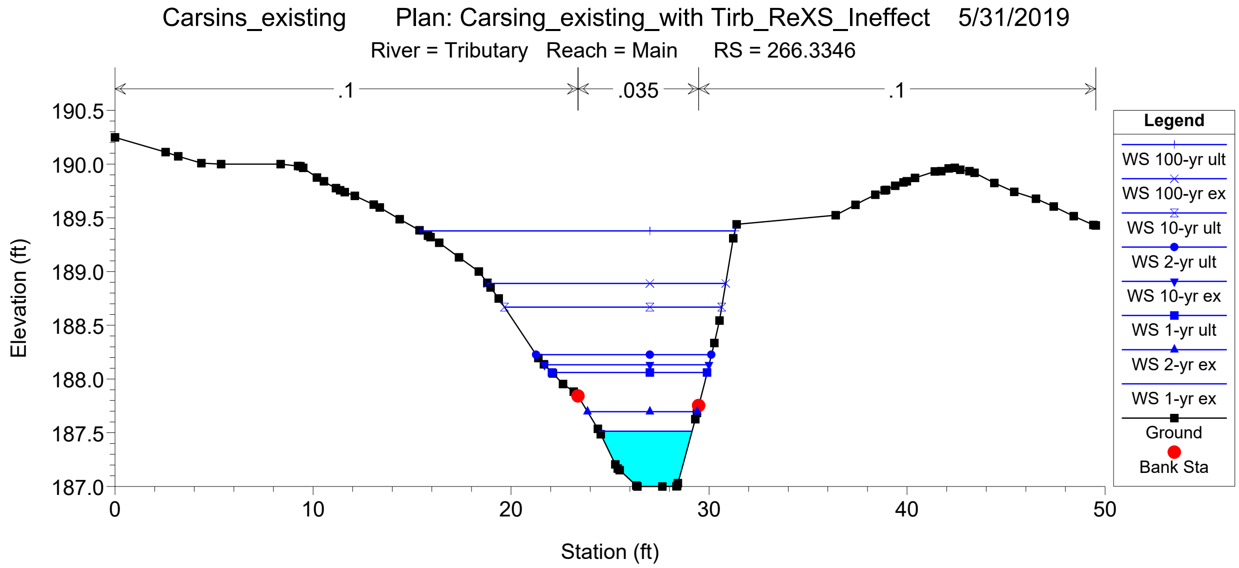
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 2-yr ult
WS 10-yr ex
WS 1-yr ult
WS 2-yr ex
WS 1-yr ex
Ground
Bank Sta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Station (ft)
Legend
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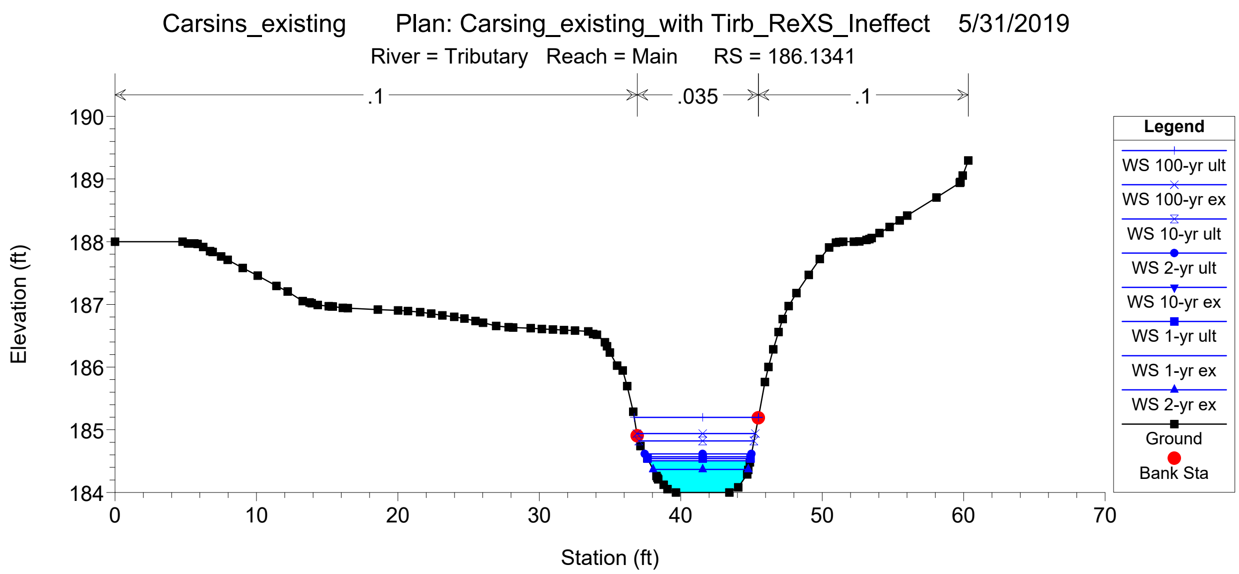
WS 2-yr ult
WS 10-yr ex
WS 1-yr ult
WS 2-yr ex
WS 1-yr ex
Ground
Bank Sta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.1
.035
.1
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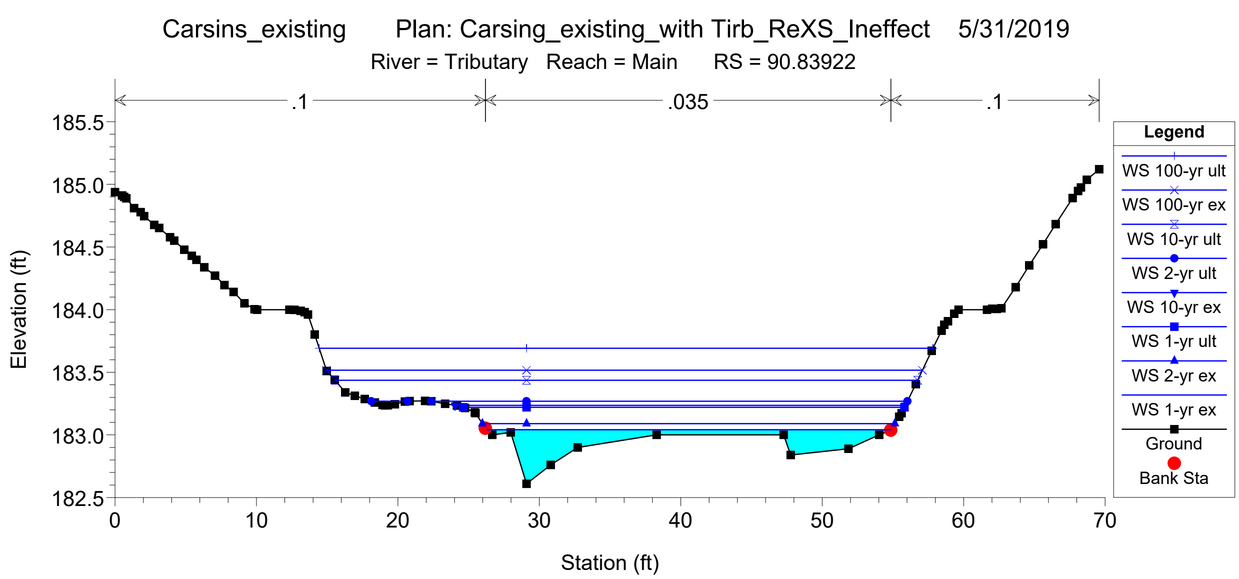
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 2-yr ult
WS 10-yr ex
WS 1-yr ult
WS 1-yr ex
WS 2-yr ex
Ground
Bank Sta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.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 2-yr ult
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WS 1-yr ult
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WS 1-yr ex
Ground
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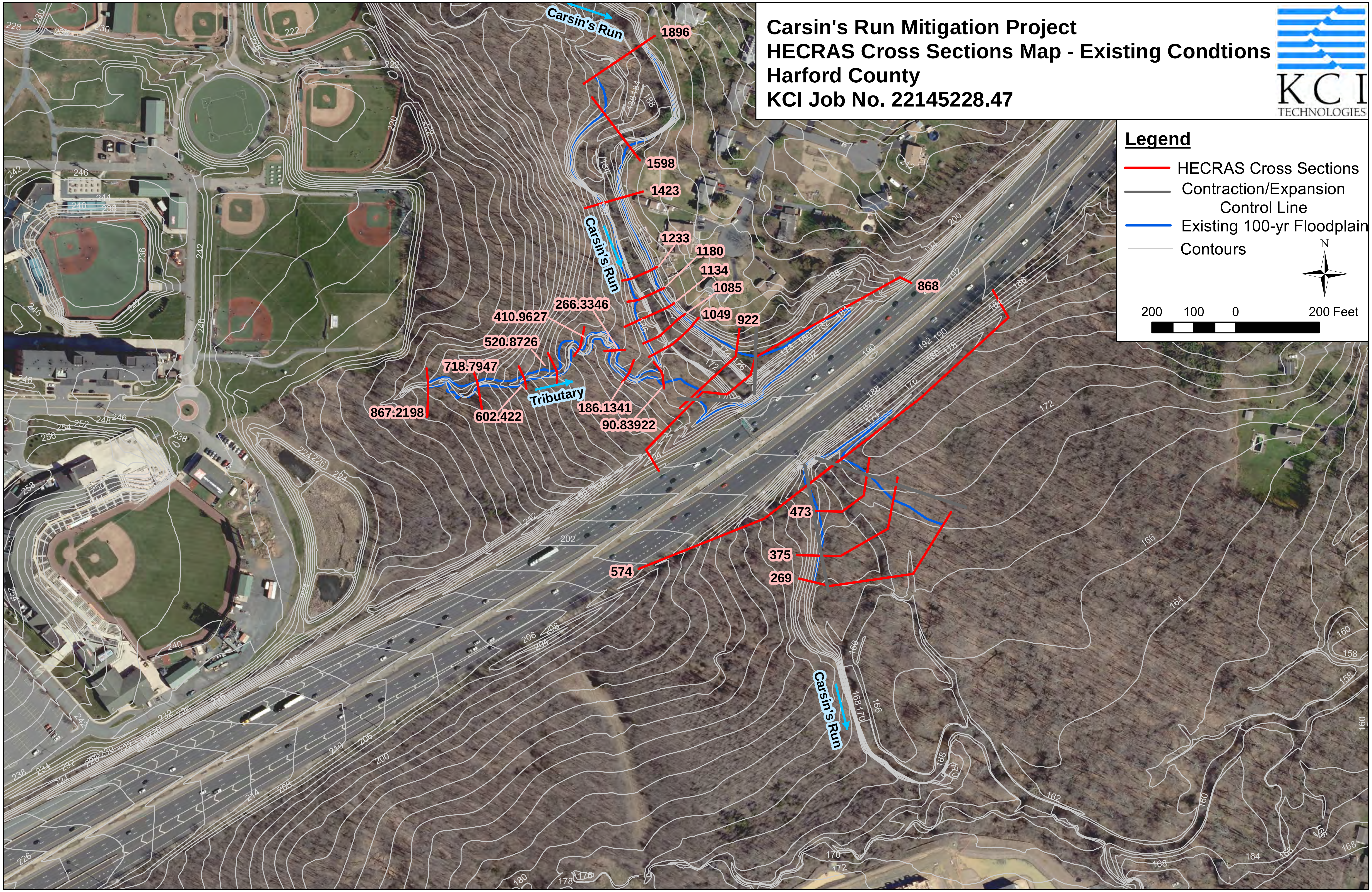
Carsin's Run Mitigation Project
HECRAS Cross Sections Map - Existing Condtions
Harford County
KCI Job No. 22145228.47
KCI TECHNOLOGIES
Legend
HECRAS Cross Sections
Contraction/Expansion Control Line
Existing 100-yr Floodplain
Contours
N
200 100 0 200 Feet
Carsin's Run
Tributary
1896
1598
1423
1233
1180
1134
1085
1049
922
868
266.3346
410.9627
520.8726
718.7947
867.2198
602.422
186.1341
90.83922
473
375
269
574

APPENDIX I.2

PROPOSED CONDITIONS
HYDRAULIC REPORT

HYDRAULICS

PROPOSED CONDITIONS

The Carsins Run Mainstem and Tributary will be improved to provide long term stability and enhanced habitat conditions. Improvements to the Carsins Run Mainstem include removal of the current failing concrete channel section; installation of two riffle grade controls; and installation of one W-Weir at the entrance to the existing I-95 box culvert. Improvements to the Tributary include re-alignment of portions of the channel and installation of rock step pools and riffle pools to protect the channel bed and banks from erosion. The existing conditions HEC-RAS model serves as the base; updated to include the proposed improvements. This effort included adding new cross sections to the main stem model and re-defining Manning's 'n' values along the tributary reach to simulate losses within the step pools. Appendix (I) has been updated to incorporate spring 2020 Redline No. 1 revisions to the proposed designed.

PROPOSED HEC-RAS CROSS SECTIONS

The existing conditions cross section locations have been utilized, where possible, in the proposed HEC-RAS geometry model to serve as a point of comparison (water surface elevation, channel velocity, and shear stress) between the two development conditions. The existing cross section geometry has been revised to incorporate the proposed grading. Additional cross sections have been provided within the study reaches to define key points such as changes in profile grade, changes in channel geometry or locations of grade control structures. Regarding the tributary channel improvements, cross sections were placed at the end of step pools or other critical areas to analyze the maximum velocities and shear stresses within the system, see Appendix I.2.2 for cross section map.

MANNING'S ROUGHNESS

The values for Manning's 'n' coefficient have been selected to simulate the roughness characteristics of the channel bed, banks and floodplain based on the proposed improvements. All values utilized are within the acceptable ranges based on Chow's *Open Channel Hydraulics, 1959*. The 'n' value of 0.045 assigned to the main stem natural channel in the existing conditions model remains unchanged in the proposed condition model, except the portion of the reach containing the proposed 'W' weir. For the 'W' weir cross section, a value of 0.6 has been assigned to simulate the effect of the energy losses imposed by this structure within the contraction zone of the I-95 box culvert. Regarding the tributary reaches 1 & 3, a Manning's 'n' value of 0.04 is used where rock is introduced by the riffles. In reaches 2 & 4, an 'n' value of 0.1 is defined for the proposed step pools. The overbank 'n' value for all reaches remains at 0.1 (the same as the existing conditions model) to represent the wooded nature of the landscape.

MODELING APPROACH AND SUMMARY TABLES

As previously referenced within the report, the ultimate buildout scenario within the watershed is unlikely; therefore, the existing condition hydrology has been utilized within the steady flow data for the two (2) and ten (10) year storm recurrence intervals to evaluate and validate the stream restoration design. A comparison summary of results for the existing vs. proposed conditions modeling (shear stress and channel velocity) is provided in Tables 1 through 4. The complete HEC-RAS results are provided in Appendix I.2.1. See report Section 4.1.4 and Appendix G. for a discussion concerning the channel bed stone sizing and material design methodology.

Table 1. Existing and Proposed 2-yr Shear Stress – Existing Hydrology

River	Reach	Existing River Station	Existing Shear Channel (lb/sq ft)**	Proposed River Station	Proposed Shear Channel (lb/sq ft) ***	% Change
Carsins_Run	Main_Stem	1896	1.08	1896	1.08	0%
Carsins_Run	Main_Stem	1598	3.53	1598	3.53	0%
Carsins_Run	Main_Stem	1423	3.49	1423	2.43	-30%
Carsins_Run	Main_Stem	1233	1.21	1233	1.41	17%
Carsins_Run	Main_Stem	1180	1.94	1180	1.59	-18%
Carsins_Run	Main_Stem	1134	1.02	1134	1.03	1%
Carsins_Run	Main_Stem	1085	1.30	1085	1.33	2%
Carsins_Run	Main_Stem	1049	1.72	1049	1.50	-13%
Carsins_Run	Main_Stem	922	5.99	922	4.58	-24%
Carsins_Run	DS_Stem	868	0.64	868	5.11	698%
Carsins_Run	DS_Stem	574	3.82	574	3.82	0%
Carsins_Run	DS_Stem	473	2.10	473	2.10	0%
Carsins_Run	DS_Stem	375	1.11	375	1.11	0%
Carsins_Run	DS_Stem	269	1.05	269	1.05	0%
Tributary	Reach 1	867.2198	0.88	854.56	0.58	-34%
Tributary	Reach 2A	718.7947	0.77	713.14	2.25	192%
Tributary	Reach 2B	602.422	3.67	597.94	2.92	-20%
Tributary	Reach 2B	520.8726	0.92	518.16	1.12	22%
Tributary	Reach 3	410.9627	1.19	420.35	1.13	-5%

**Results from Existing HEC-RAS model – See Appendix I.1.1

***Results from Proposed HEC-RAS model – See Appendix I.2.1

Table 2. Existing and Proposed 10-yr Shear Stress – Existing Hydrology

River	Reach	Existing River Station	Existing Shear Channel (lb/sq ft)	Proposed River Station	Proposed Shear Channel (lb/sq ft)	% Change
Carsins_Run	Main_Stem	1896	1.42	1896	1.42	0%
Carsins_Run	Main_Stem	1598	1.58	1598	1.58	0%
Carsins_Run	Main_Stem	1423	7.89	1423	7.88	0%
Carsins_Run	Main_Stem	1233	1.92	1233	2.24	17%
Carsins_Run	Main_Stem	1180	3.59	1180	3.11	-13%
Carsins_Run	Main_Stem	1134	2.14	1134	2.18	2%
Carsins_Run	Main_Stem	1085	2.17	1085	2.30	6%
Carsins_Run	Main_Stem	1049	2.71	1049	2.74	1%
Carsins_Run	Main_Stem	922	7.28	922	1.01	-86%

River	Reach	Existing River Station	Existing Shear Channel (lb/sq ft)	Proposed River Station	Proposed Shear Channel (lb/sq ft)	% Change
Carsins_Run	DS_Stem	868	1.01	868	3.65	261%
Carsins_Run	DS_Stem	574	4.72	574	1.92	-59%
Carsins_Run	DS_Stem	473	3.18	473	3.18	0%
Carsins_Run	DS_Stem	375	1.99	375	1.99	0%
Carsins_Run	DS_Stem	269	1.53	269	1.53	0%
Tributary	Reach 1	867.2198	1.36	854.56	0.89	-35%
Tributary	Reach 2A	718.7947	1.08	713.14	3.81	253%
Tributary	Reach 2B	602.422	5.64	597.94	4.35	-23%
Tributary	Reach 2B	520.8726	1.58	518.16	2.29	45%
Tributary	Reach 3	410.9627	1.58	420.35	1.59	1%

Table 3. Existing and Proposed 2-yr Channel Velocity – Existing Hydrology

River	Reach	Existing River Station	Existing Channel Velocity (ft/s)	Proposed River Station	Proposed Channel Velocity (ft/s)	% Change
Carsins_Run	Main_Stem	1896	4.97	1896	4.97	0%
Carsins_Run	Main_Stem	1598	9.11	1598	9.11	0%
Carsins_Run	Main_Stem	1423	8.66	1423	7.38	-15%
Carsins_Run	Main_Stem	1233	5.47	1233	5.87	7%
Carsins_Run	Main_Stem	1180	6.78	1180	6.22	-8%
Carsins_Run	Main_Stem	1134	5.04	1134	5.06	0%
Carsins_Run	Main_Stem	1085	5.43	1085	5.49	1%
Carsins_Run	Main_Stem	1049	6.14	1049	5.77	-6%
Carsins_Run	Main_Stem	922	13.48	922	9.37	-30%
Carsins_Run	DS_Stem	868	10.65	868	7.85	-26%
Carsins_Run	DS_Stem	574	8.26	574	8.26	0%
Carsins_Run	DS_Stem	473	6.8	473	6.80	0%
Carsins_Run	DS_Stem	375	4.8	375	4.81	0%
Carsins_Run	DS_Stem	269	4.52	269	4.52	0%
Tributary	Reach 1	867.2198	4.40	854.56	3.22	-27%
Tributary	Reach 2A	718.7947	4.18	713.14	2.63	-37%
Tributary	Reach 2B	602.422	8.34	597.94	2.95	-65%
Tributary	Reach 2B	520.8726	4.35	518.16	4.29	-1%
Tributary	Reach 3	410.9627	5.05	420.35	4.30	-15%

Table 4. Existing and Proposed 10-yr Channel Velocity – Existing Hydrology

River	Reach	Existing River Station	Existing Channel Velocity (ft/s)	Proposed River Station	Proposed Channel Velocity (ft/s)	% Change
Carsins_Run	Main_Stem	1896	5.67	1896	5.67	0%
Carsins_Run	Main_Stem	1598	6.20	1598	6.20	0%
Carsins_Run	Main_Stem	1423	13.65	1423	13.65	0%
Carsins_Run	Main_Stem	1233	7.34	1233	7.87	7%
Carsins_Run	Main_Stem	1180	9.71	1180	9.12	-6%
Carsins_Run	Main_Stem	1134	7.58	1134	7.64	1%
Carsins_Run	Main_Stem	1085	7.49	1085	7.70	3%
Carsins_Run	Main_Stem	1049	8.18	1049	8.21	0%
Carsins_Run	Main_Stem	922	16.26	922	5.27	-68%
Carsins_Run	DS_Stem	868	14.32	868	7.34	-49%
Carsins_Run	DS_Stem	574	9.68	574	6.46	-33%
Carsins_Run	DS_Stem	473	8.99	473	8.99	0%
Carsins_Run	DS_Stem	375	6.81	375	6.82	0%
Carsins_Run	DS_Stem	269	5.83	269	5.83	0%
Tributary	Reach 1	867.2198	5.92	854.56	4.26	-28%
Tributary	Reach 2A	718.7947	5.35	713.14	3.69	-31%
Tributary	Reach 2B	602.422	11.19	597.94	3.82	-66%
Tributary	Reach 2B	520.8726	6.14	518.16	6.67	9%
Tributary	Reach 3	410.9627	6.23	420.35	5.61	-10%

In order to evaluate the possible changes in the 100-yr floodplain due to the restoration improvements, the ultimate hydrology has been incorporated into the proposed condition steady flow data (provided in Table 5 below). A comparison summary of the water surface elevation results for the existing vs. proposed conditions modeling is provided in Table 5. The complete HEC-RAS results are provided in Appendix I.2.1.

Table 5. Existing and Proposed 100 yr Water Surface Elevation-Ultimate Hydrology

River	Reach	Existing River Station	Existing W.S Elev (ft)*	Proposed River Station	Proposed W.S Elev (ft)**	Change (ft)
Carsins_Run	Main_Stem	1896	191.38	1896	190.67	-0.71
Carsins_Run	Main_Stem	1598	188.47	1598	187.06	-1.41
Carsins_Run	Main_Stem	1423	186.21	1423	184.31	-1.9
Carsins_Run	Main_Stem	1233	184.41	1233	183.05	-1.36
Carsins_Run	Main_Stem	1180	183.95	1180	182.46	-1.49
Carsins_Run	Main_Stem	1134	183.41	1134	182.73	-0.68
Carsins_Run	Main_Stem	1085	183.17	1085	182.74	-0.43
Carsins_Run	Main_Stem	1049	183.02	1049	182.78	-0.24
Carsins_Run	Main_Stem	922	182.43	922	182.63	0.20
Carsins_Run	DS_Stem	868	182.46	868	182.52	0.06

River	Reach	Existing River Station	Existing W.S Elev (ft)*	Proposed River Station	Proposed W.S Elev (ft)**	Change (ft)
Carsins_Run	DS_Stem	574	174.95	574	174.95	0.00
Carsins_Run	DS_Stem	473	173.42	473	173.43	0.01
Carsins_Run	DS_Stem	375	170.32	375	170.33	0.01
Carsins_Run	DS_Stem	269	169.93	269	169.93	0.00
Tributary	Reach 1	867.2198	214.70	854.56	215.99	1.29
Tributary	Reach 2A	718.7947	210.62	713.14	210.22	-0.40
Tributary	Reach 2B	602.422	204.73	597.94	202.79	-1.94
Tributary	Reach 2B	520.8726	197.38	518.16	196.35	-1.03
Tributary	Reach 3	410.9627	192.54	420.35	193.26	0.72

*Results from Existing HEC-RAS model using existing hydrology
**Results from Proposed HEC-RAS model using ultimate hydrology

Table 6 identifies the location of each river reach with respect to the baseline of construction.

Table 6. Reach Summary

Reach Name	River	Upstream Beginning Construction Baseline Station	Ending Construction Baseline Station	Upstream Beginning Reach Station	Ending Reach Station
DS_Stem	Carsins Run DS of I-95 culvert	NA	NA	NA	NA
Main_Stem	Carsins Run US of I-95 culvert	10+00	14+34	1233	868
Reach 1	Tributary	20+00	21+95	946.36	751.37
Reach 2a	Tributary	21+95	22+27	751.37	718.61
Reach 2b	Tributary	23+23	24+28	718.61	518.16
Reach 3	Tributary	24+28	27+37	518.16	209.36
Reach 4	Tributary	27+37	29+37	209.36	0.0

ADDITIONAL MODELING EVALUATION

Two HEC-RAS models were developed for the proposed condition in order to identify the relationship between maximum channel flows vs. maximum shear stress within the tributary channel. Our reasoning for the two models is based on the assumption that the Tributary will convey the peak discharge well ahead of the Carsins Run Mainstem; therefore, no back flooding of the Tributary will occur. The evaluation was conducted to confirm the controlling flood event for evaluation of the maximum shear stress. The two scenarios posited were: 1. The peak discharge occurs within the tributary channel before the Carsins Run main stem floods; thereby creating maximum velocities and shear stresses in the lower downstream portion of the channel; and 2. Flooding from Carsins Run will drown out the lower section of the tributary, thus creating an ineffective flow pool. In the first case, only the tributary channel was considered in the analysis, ignoring any flow or flooding effects from the main stem. The second scenario considered the combined impact while both river systems were operating. Based on the results, the two models did not differ significantly; therefore, we have only provided the results of the combined HEC-RAS model.

LEVEE COMMAND

The levee command was utilized in the main stem analysis to prevent program interpretation of the tributary channel as divided flow. It is assumed that during high flow events in the main channel, the tributary channel will be back flooded, and thus not acting as a flow channel. As discussed in the Additional Modeling Evaluation section above, the peak flow within the tributary channel will occur prior to the main stem flood event.

INEFFECTIVE FLOW AREAS

The ineffective flow area inputs at the approach and exit to the I-95 culvert remain unchanged from existing conditions.

BOUNDARY CONDITIONS

In the proposed condition, the upstream and downstream boundary conditions for both the main stem and tributary channel were assumed to be normal depth of flow.

CONTRACTION AND EXPANSION COEFFICIENTS

In the proposed condition, a 'W' weir will be installed within the contraction zone of the box culvert carrying Carsins Run under I-95. In order to simulate the losses imposed by this structure, the contraction and expansion coefficients have been adjusted to 0.3 and 0.5; respectively. The contraction and expansion coefficients for all other cross sections were set to 0.1 and 0.3, respectively.

MODEL RESULTS

The results show that for the 10-year proposed conditions model, main stem shear stress and velocities range from 1.01 lb/sq-ft to 7.88 lb/sq-ft and from 5.27 ft/s to 13.65 ft/s; respectively. Notable shear stress increases occur at cross section Stations 868 and 1233. As a point of discussion, cross-section 868 is located immediately upstream of the I-95 culvert within the new ‘W’ weir installation section of the channel. It is also located near the junction of the tributary channel which most likely is a contributing factor to the shear stress increase. Cross-section 1233 is located immediately upstream of a pre-formed scour hole (designed to dissipate energy at the storm drain culvert outfall). The shear stress increase at this location is local and associated with the channel improvement.

Ten year (10-yr) proposed shear stresses and velocities in the tributary stem vary from 0.89 lb/sq-ft to 4.35 lb/sq-ft and from 3.69 ft/s to 6.67 ft/s. It should be noted that shear stress changes in the tributary stem occur at cross-sections 518.16 and 713.14; whereby increases of more than 10% are computed. Rock step pools and riffle pools with proper stone sizes have been proposed to protect the channel bed and banks from erosion. A summary of proposed stone sizing is provided in the section 4.1.4 of the main report. Equations, distribution calculations, and stone size computations can be found in Appendix G.
The proposed water surface elevation for the main stem during the 100-year ultimate condition flow event shows an increase at four river stations (375, 473, 868 and 922). The water surface will remain unchanged or be lowered at all other main stem river station locations. The installation of the 'W' weir upstream of the I-95 culvert resulted in minor ultimate 100-yr water surface elevation increases in the 100 linear foot reach upstream of I-95; at Station 868 (0.06' increase) and 922 (0.20' increase). It should be noted that on the north side of the channel in this reach where there are private properties, the 100-year floodplain is completely within the existing drainage easement and there is about 9.3 ft of freeboard during 100-year flows. Therefore, no impacts to the adjacent private properties are anticipated for the ultimate 100-yr flow event.

Regarding the tributary channel, the 100 yr water surface, based on ultimate conditions, increases within Reaches 1 and 3 due to the horizontal and vertical re-alignment improvements. By design, the new channel will be significantly raised to provide flood relief during higher flow events. It should be noted that the tributary water surface increases occur on public State land and there is no infrastructure in the vicinity of the channel that would be impacted by the improvements.

REDLINE SUMMARY

The results of the modeled spring 2020 redline design are insignificant relative to the PSE design and do not require modification to the specified rock materials or treatments beyond what is indicated on the plan set.

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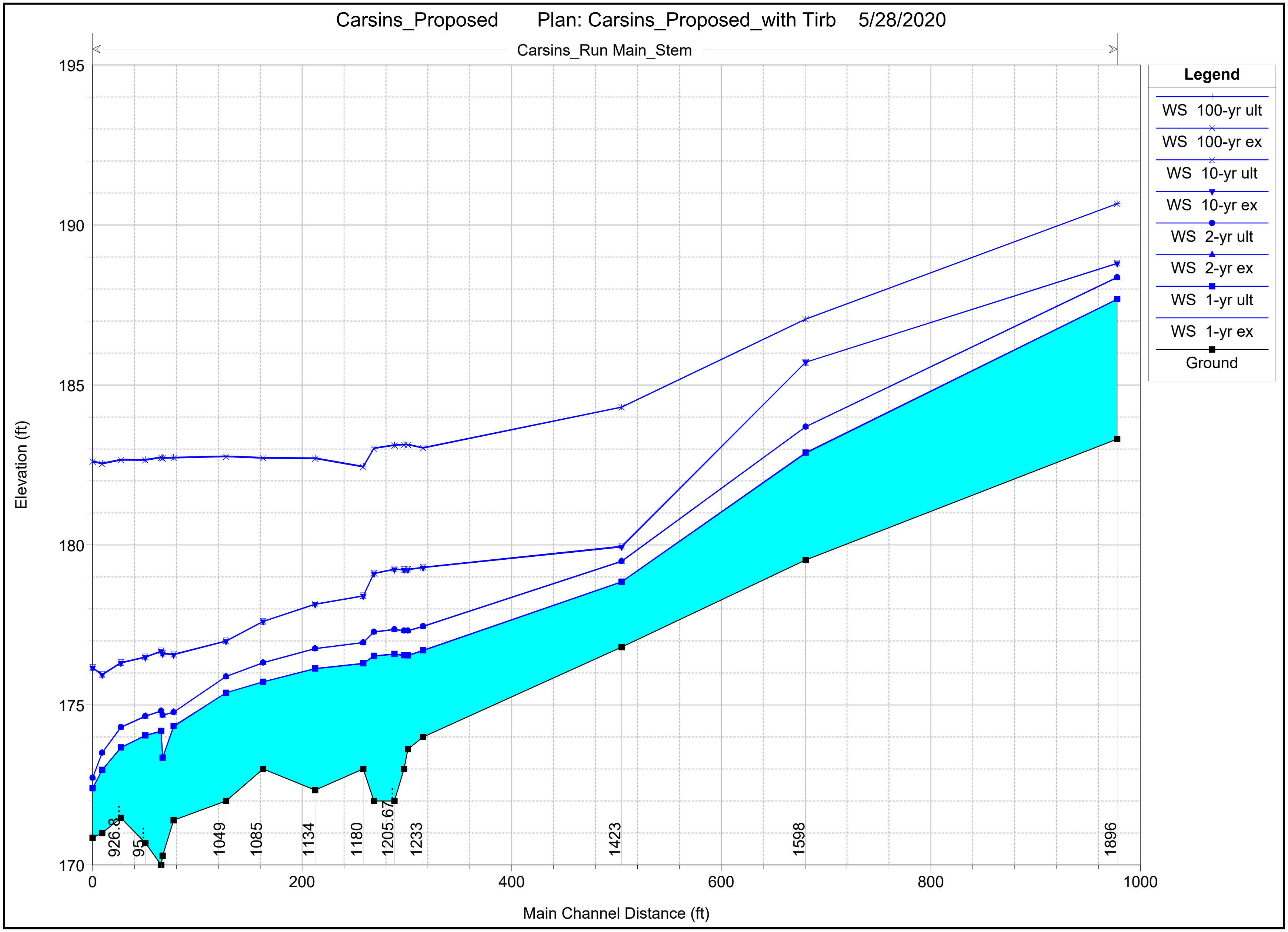
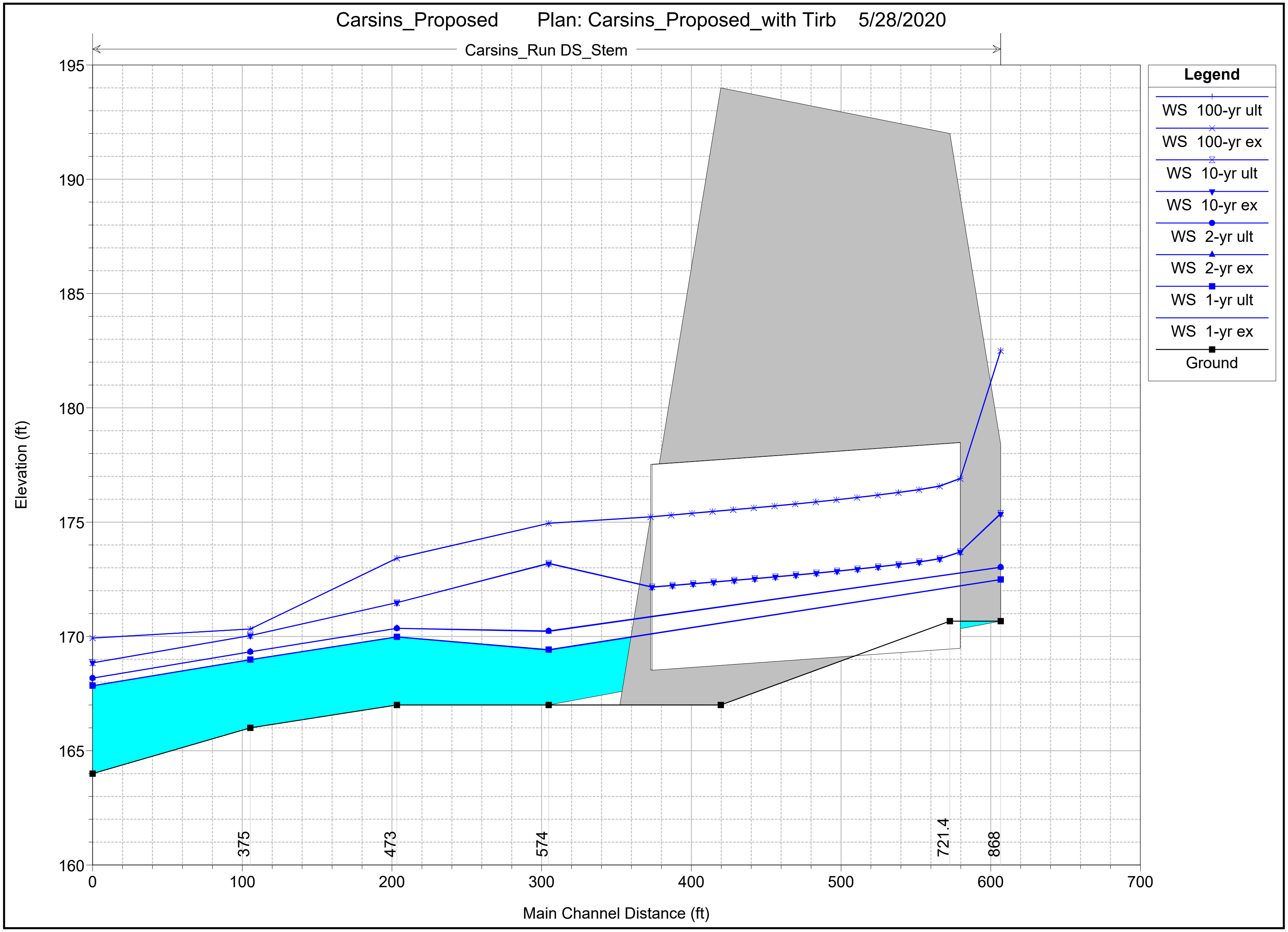
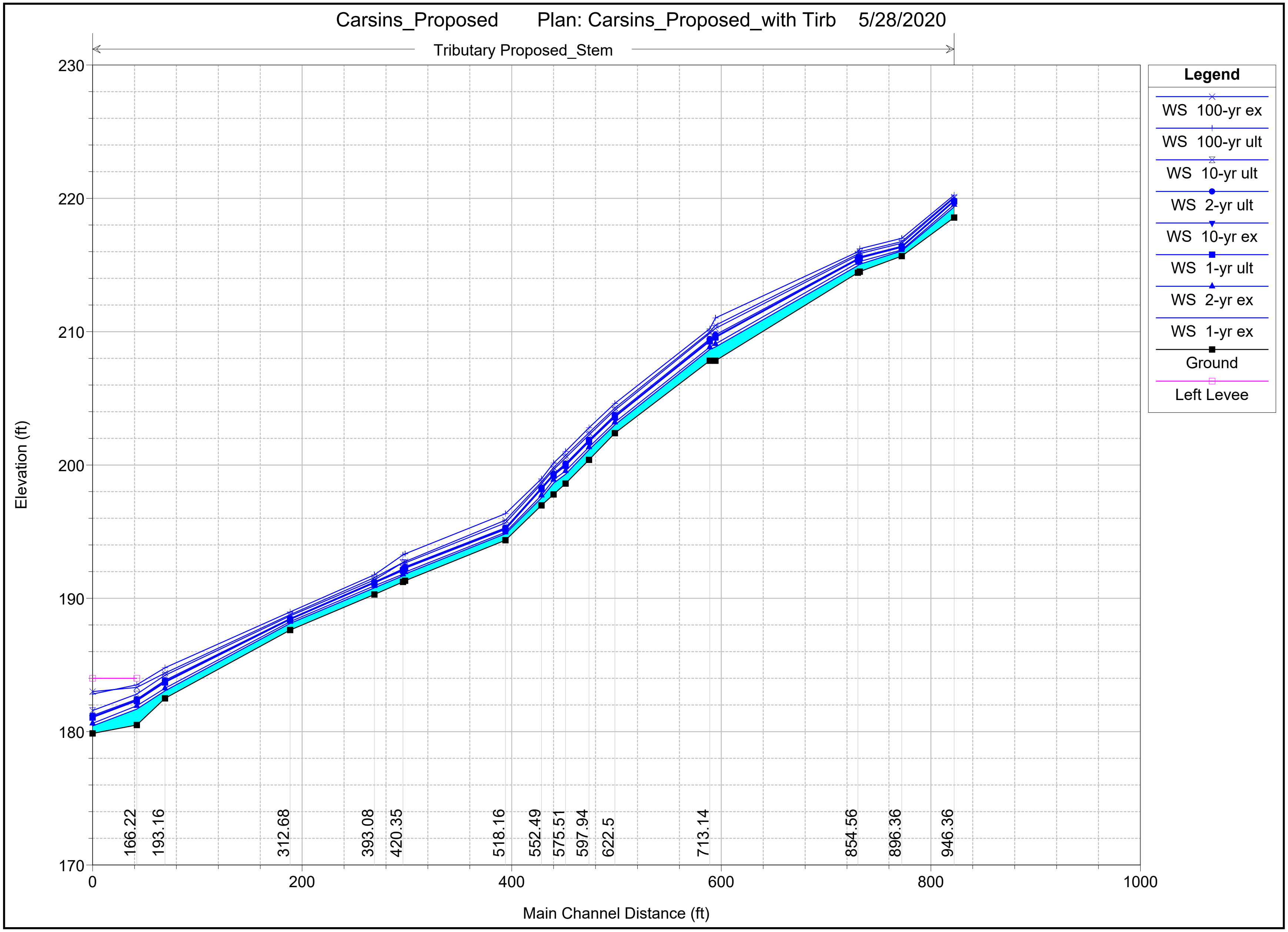
APPENDIX I.2.1

PROPOSED HEC-RAS RESULTS



Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
Carsins_Run Main_Stem
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 10-yr ex
WS 2-yr ult
WS 2-yr ex
WS 1-yr ult
WS 1-yr ex
Ground
Elevation (ft)
Main Channel Distance (ft)
195
190
185
180
175
170
0
200
400
600
800
1000
926.8...
95...
1049
1085
1134
1180
1205.67...
1233
1423
1598
1896


Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
Carsins_Run DS_Stem
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 10-yr ex
WS 2-yr ult
WS 2-yr ex
WS 1-yr ult
WS 1-yr ex
Ground
Elevation (ft)
Main Channel Distance (ft)
195
190
185
180
175
170
165
160
0
100
200
300
400
500
600
700
375
473
574
721.4
868



Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
Tributary Proposed_Stem
Legend
WS 100-yr ex
WS 100-yr ult
WS 10-yr ult
WS 2-yr ult
WS 10-yr ex
WS 1-yr ult
WS 2-yr ex
WS 1-yr ex
Ground
Left Levee
Elevation (ft)
Main Channel Distance (ft)
230
220
210
200
190
180
170
0
200
400
600
800
1000
166.22
193.16
312.68
393.08
420.35
518.16
552.49
575.51
597.94
622.5
713.14
854.56
896.36
946.36

HEC-RAS Plan: Carsing_Prop1

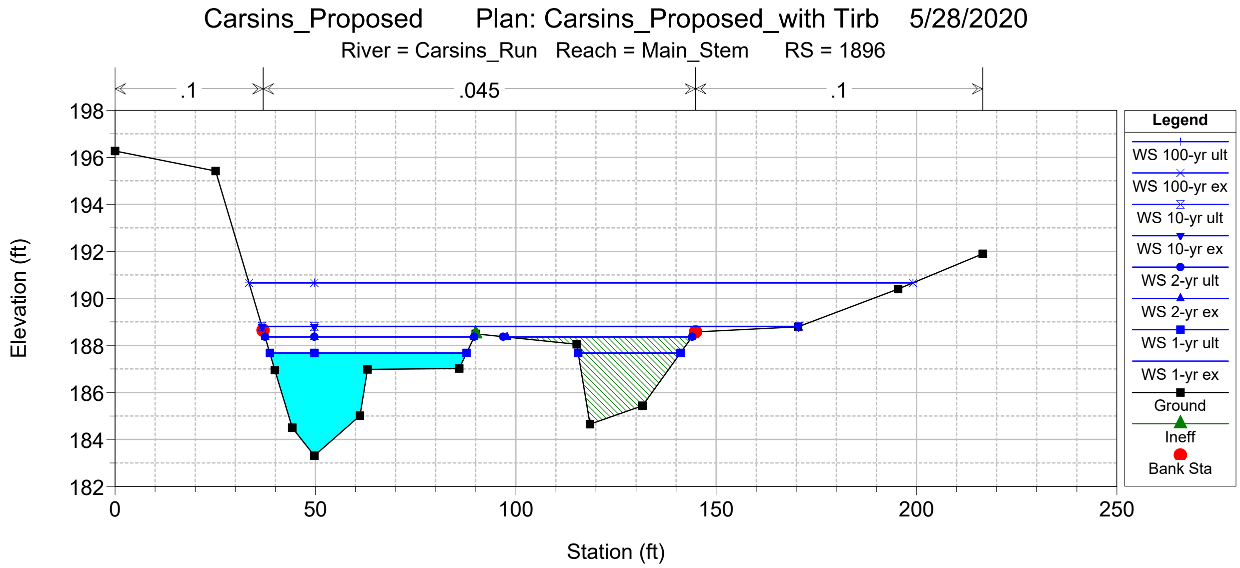
River	Reach	River Sta	Profile	W.S. Elev	Q Left	Q Channel	Q Right	Top Width	Vel Left	Vel Chnl	Vel Right	Shear LOB	Shear Chan	Shear ROB	Froude # XS	Hydr Depth L	Hydr Depth C	Hydr Depth R
				(ft)	(cfs)	(cfs)	(cfs)	(ft)	(ft/s)	(ft/s)	(ft/s)	(lb/sq ft)	(lb/sq ft)	(lb/sq ft)		(ft)	(ft)	(ft)
Tributary	Proposed_Stem	946.36	1-yr ex	219.35		6.42		4.53		3.63			0.83		1.02		0.40	
Tributary	Proposed_Stem	946.36	2-yr ex	219.53	0.31	10.61		11.72	0.52	4.07		0.17	0.95		1.35	0.09	0.52	
Tributary	Proposed_Stem	946.36	10-yr ex	219.80	3.72	21.46	2.81	53.73	0.97	5.38	0.68	0.44	1.44	0.25	1.76	0.23	0.79	0.13
Tributary	Proposed_Stem	946.36	100-yr ex	220.10	14.78	36.43	21.99	90.47	1.43	6.64	1.19	0.78	1.98	0.60	1.37	0.40	1.08	0.31
Tributary	Proposed_Stem	946.36	1-yr ult	219.77	3.01	19.92	1.92	48.24	0.92	5.22	0.61	0.40	1.38	0.22	1.80	0.21	0.75	0.11
Tributary	Proposed_Stem	946.36	2-yr ult	219.85	4.80	23.56	4.30	60.92	1.04	5.58	0.75	0.48	1.53	0.30	1.72	0.25	0.83	0.15
Tributary	Proposed_Stem	946.36	10-yr ult	220.02	10.88	32.37	14.58	86.37	1.28	6.33	1.04	0.67	1.84	0.48	1.49	0.34	1.01	0.25
Tributary	Proposed_Stem	946.36	100-yr ult	220.25	24.49	45.46	41.52	98.93	1.70	7.26	1.48	1.01	2.26	0.82	1.20	0.52	1.24	0.42
Tributary	Proposed_Stem	896.36	1-yr ex	216.05		6.42		5.47		5.06			1.89		1.85		0.23	
Tributary	Proposed_Stem	896.36	2-yr ex	216.13		10.92		5.78		6.41			2.81		2.08		0.29	
Tributary	Proposed_Stem	896.36	10-yr ex	216.36	0.20	25.54	2.25	17.88	0.98	8.23	1.53	0.63	3.86	1.22	2.68	0.08	0.51	0.16
Tributary	Proposed_Stem	896.36	100-yr ex	216.75	4.26	54.38	14.57	25.29	1.84	9.99	2.72	1.48	4.72	2.65	2.13	0.27	0.90	0.50
Tributary	Proposed_Stem	896.36	1-yr ult	216.33	0.11	23.19	1.55	17.23	0.86	8.00	1.34	0.52	3.73	1.01	2.77	0.06	0.48	0.13
Tributary	Proposed_Stem	896.36	2-yr ult	216.41	0.39	28.91	3.37	18.80	1.14	8.52	1.75	0.78	4.02	1.48	2.58	0.11	0.56	0.20
Tributary	Proposed_Stem	896.36	10-yr ult	216.63	2.36	45.31	10.17	23.03	1.65	9.58	2.47	1.29	4.55	2.36	2.26	0.22	0.78	0.40
Tributary	Proposed_Stem	896.36	100-yr ult	217.00	11.38	74.89	25.21	28.45	2.37	10.72	3.06	2.05	5.00	3.01	1.88	0.47	1.15	0.68
Tributary	Proposed_Stem	856.33	1-yr ex	215.06	0.02	6.39	0.00	13.62	0.19	2.73	0.19	0.03	0.46	0.03	1.00	0.03	0.39	0.03
Tributary	Proposed_Stem	856.33	2-yr ex	215.26	1.33	9.43	0.15	29.08	0.44	2.67	0.39	0.10	0.39	0.09	0.89	0.15	0.59	0.13
Tributary	Proposed_Stem	856.33	10-yr ex	215.55	8.01	18.80	1.19	34.23	0.88	3.56	0.66	0.29	0.60	0.19	0.76	0.42	0.88	0.27
Tributary	Proposed_Stem	856.33	100-yr ex	215.99	27.61	39.44	6.16	43.94	1.43	4.97	0.99	0.63	1.03	0.36	0.76	0.80	1.32	0.45
Tributary	Proposed_Stem	856.33	1-yr ult	215.51	6.73	17.17	0.96	33.50	0.82	3.41	0.62	0.26	0.56	0.17	0.76	0.38	0.84	0.25
Tributary	Proposed_Stem	856.33	2-yr ult	215.61	9.98	21.10	1.58	35.31	0.96	3.74	0.71	0.33	0.65	0.21	0.75	0.47	0.94	0.30
Tributary	Proposed_Stem	856.33	10-yr ult	215.86	20.84	32.87	4.11	40.98	1.29	4.59	0.90	0.53	0.91	0.31	0.76	0.69	1.19	0.40
Tributary	Proposed_Stem	856.33	100-yr ult	216.22	42.35	57.87	11.26	63.71	1.65	6.20	1.03	0.82	1.51	0.41	0.95	0.83	1.56	0.41
Tributary	Proposed_Stem	854.56	1-yr ex	214.96		6.42		5.84		3.28			0.70		1.00		0.34	
Tributary	Proposed_Stem	854.56	2-yr ex	215.17	0.46	10.39	0.07	27.57	0.34	3.22	0.38	0.08	0.58	0.09	1.33	0.07	0.54	0.09
Tributary	Proposed_Stem	854.56	10-yr ex	215.44	6.47	20.66	0.86	32.38	0.94	4.26	0.73	0.37	0.89	0.25	1.03	0.33	0.81	0.22
Tributary	Proposed_Stem	854.56	100-yr ex	215.82	25.31	43.07	4.83	40.20	1.65	6.02	1.15	0.89	1.56	0.52	1.02	0.66	1.19	0.38
Tributary	Proposed_Stem	854.56	1-yr ult	215.40	5.21	18.98	0.66	31.64	0.87	4.13	0.68	0.33	0.85	0.23	1.06	0.29	0.77	0.20
Tributary	Proposed_Stem	854.56	2-yr ult	215.49	8.20	23.32	1.14	33.16	1.05	4.56	0.80	0.44	1.00	0.29	1.04	0.37	0.85	0.24
Tributary	Proposed_Stem	854.56	10-yr ult	215.71	18.65	35.97	3.21	37.60	1.47	5.56	1.05	0.74	1.38	0.45	1.03	0.56	1.08	0.34
Tributary	Proposed_Stem	854.56	100-yr ult	215.99	41.09	61.25	9.13	43.85	2.15	7.55	1.48	1.41	2.35	0.81	1.16	0.79	1.35	0.45
Tributary	Proposed_Stem	719.16	1-yr ex	208.85		6.41	0.01	6.12		1.53	0.39		0.76	0.10	0.33		0.71	0.12
Tributary	Proposed_Stem	719.16	2-yr ex	209.08		10.85	0.07	6.59		1.96	0.67		1.16	0.23	0.37		0.90	0.23
Tributary	Proposed_Stem	719.16	10-yr ex	209.64		27.26	0.73	7.77		2.98	1.34		2.34	0.70	0.46		1.37	0.51
Tributary	Proposed_Stem	719.16	100-yr ex	210.48	0.53	68.35	4.33	10.78	1.29	4.59	2.16	0.71	4.80	1.55	0.62	0.32	2.16	0.77
Tributary	Proposed_Stem	719.16	1-yr ult	209.56		24.28	0.57	7.59		2.83	1.24		2.15	0.62	0.45		1.30	0.47
Tributary	Proposed_Stem	719.16	2-yr ult	209.76		31.66	1.00	8.01		3.18	1.47		2.62	0.83	0.48		1.46	0.57
Tributary	Proposed_Stem	719.16	10-yr ult	210.25	0.16	54.87	2.80	9.84	0.93	4.13	1.91	0.43	4.02	1.27	0.58	0.20	1.93	0.69
Tributary	Proposed_Stem	719.16	100-yr ult	211.03	2.77	98.96	9.74	13.03	1.93	5.30	2.61	1.30	5.92	2.04	0.66	0.59	2.71	1.00
Tributary	Proposed_Stem	713.14	1-yr ex	208.67		6.42	0.00	5.84		2.08	0.26		1.52		0.50		0.54	0.02
Tributary	Proposed_Stem	713.14	2-yr ex	208.84		10.85	0.07	6.62		2.63	0.79		2.25	0.37	0.58		0.70	0.11
Tributary	Proposed_Stem	713.14	10-yr ex	209.34		26.50	1.49	8.09		3.69	1.97		3.81	1.49	0.64		1.13	0.44
Tributary	Proposed_Stem	713.14	100-yr ex	209.98	0.00	65.71	7.49	9.69	0.52	5.74	3.58	0.23	8.21	4.04	0.83	0.04	1.64	0.83
Tributary	Proposed_Stem	713.14	1-yr ult	209.27		23.72	1.13	7.91		3.55	1.82		3.60	1.32	0.64		1.06	0.39
Tributary	Proposed_Stem	713.14	2-yr ult	209.45		30.61	2.05	8.34		3.89	2.17		4.15	1.73	0.65		1.21	0.51
Tributary	Proposed_Stem	713.14	10-yr ult	209.87		52.28	5.55	9.34		4.88	3.03		6.07	2.96	0.72		1.54	0.77
Tributary	Proposed_Stem	713.14	100-yr ult	210.22	0.16	98.50	12.81	10.48	1.48	7.51	4.70	1.18	13.44	6.65	1.03	0.16	1.87	0.97
Tributary	Proposed_Stem	622.5	1-yr ex	203.01		6.21	0.21	7.02		2.46	1.15		2.27	0.73	0.69		0.44	0.14
Tributary	Proposed_Stem	622.5	2-yr ex	203.21		10.15	0.77	8.23		2.77	1.50		2.60	1.03	0.67		0.60	0.24
Tributary	Proposed_Stem	622.5	10-yr ex	203.65		23.66	4.33	11.10		3.62	2.24		3.82	1.85	0.69		0.96	0.45
Tributary	Proposed_Stem	622.5	100-yr ex	204.27	12.21	46.38	14.62	45.13	1.53	4.22	2.16	0.97	4.46	1.63	0.83	0.32	1.52	0.53
Tributary	Proposed_Stem	622.5	1-yr ult	203.59		21.26	3.59	10.63		3.49	2.14		3.62	1.74	0.69		0.91	0.43
Tributary	Proposed_Stem	622.5	2-yr ult	203.75		27.25	5.41	12.21		3.78	2.25		4.05	1.87	0.71		1.03	0.46
Tributary	Proposed_Stem	622.5	10-yr ult	204.11	4.39	42.04	11.40	40.81	1.10	4.28	2.29	0.62	4.76	1.87	0.99	0.17	1.36	0.51
Tributary	Proposed_Stem	622.5	100-yr ult	204.62	33.51	53.38	24.58	54.42	1.95	3.96	2.00	1.26	3.65	1.31	0.61	0.61	1.87	0.64
Tributary	Proposed_Stem	597.94	1-yr ex	201.14		6.42		4.98		2.44			2.14		0.59		0.53	
Tributary	Proposed_Stem	597.94	2-yr ex	201.34		10.92		5.78		2.95			2.92		0.65		0.64	
Tributary	Proposed_Stem	597.94	10-yr ex	201.80	0.21	27.57	0.21	9.58	1.34	3.82	1.34	0.91	4.35	0.91	0.75	0.20	0.90	0.20
Tributary	Proposed_Stem	597.94	100-yr ex	202.42	2.68	67.84	2.69	12.07	2.58	5.56	2.59	2.45	7.74	2.46	0.87	0.51	1.53	0.51
Tributary	Proposed_Stem	597.94	1-yr ult	201.74	0.14	24.58	0.14	9.34	1.20	3.65	1.20	0.77	4.08	0.77	0.74	0.17	0.84	0.17
Tributary	Proposed_Stem	597.94	2-yr ult	201.88	0.35	31.97	0.35	9.90	1.53	4.07	1.53	1.11	4.80	1.11	0.78	0.24	0.98	0.24
Tributary	Proposed_Stem	597.94	10-yr ult	202.25	1.62	54.57	1.63	11.41	2.24	5.02	2.24	1.95	6.56	1.96	0.83	0.43	1.36	0.43
Tributary	Proposed_Stem	597.94	100-yr ult	202.79	3.89	102.13	5.46	21.93	1.82	6.72	2.38	1.49	10.53	2.21	1.21	0.26	1.90	0.39
Tributary	Proposed_Stem	575.51	1-yr ex	199.30		6.42		4.78		2.73			2.72		0.69		0.49	
Tributary	Proposed_Stem	575.51	2-yr ex	199.55		10.92		5.77		2.98			2.99		0.66		0.63	
Tributary	Proposed_Stem	575.51	10-yr ex	200.01	0.93	25.97	1.09	9.59	1.79	4.05	1.83	1.36	4.65	1.41	0.78	0.31	1.07	0.32
Tributary	Proposed_Stem	575.51	100-yr ex	200.72	7.53	58.60	7.08	21.26	1.95	5.50	2.73	1.53	7.26	2.54	0.99	0.35	1.77	0.60
Tributary	Proposed_Stem	575.51	1-yr ult	199.94	0.67	23.40	0.79	9.31	1.62	3.90	1.66	1.18	4.40	1.23	0.78	0.26	1.00	0.27
Tributary	Proposed_Stem	575.51	2-yr ult	200.11	1.37	29.70	1.59	9.96	1.99	4.26	2.04	1.59	5.00	1.66	0.79	0.36	1.16	0.38
Tributary	Proposed_Stem	575.51	10-yr ult	200.53	3.84	49.13	4.86	16.34	1.79	5.17	2.61	1.36	6.66	2.38	0.94	0.31	1.58	0.56
Tributary	Proposed_Stem	575.51	100-yr ult	201.01	19.86	78.85	12.76	28.93	2.47	6.34	3.13	2.23	9.16	3.17	1.06	0.47	2.07	0.69
Tributary	Proposed_Stem	564.00	1-yr ex	198.64		6.42		5.39		2.05			1.46		0.47		0.58	
Tributary	Proposed_Stem	564.00	2-yr ex	198.90	0.01	10.91	0.01	8.45	0.44	2.22	0.44	0.15	1.67	0.15	0.51	0.06	0.61	0.06
Tributary	Proposed_Stem	564.00	10-yr ex	199.26	0.30	27.40	0.29	9.88	1.32	3.52	1.32	0.83	3.61	0.83	0.67	0.24	0.97	0.24
Tributary	Proposed_Stem	564.00	100-yr ex	199.80	4.62	66.03	2.56	20.49	1.72	5.46	2.53	1.32	7.48	2.36	1.05	0.26	1.51	0.51
Tributary	Proposed_Stem	564.00	1-yr ult	199.21	0.21	24.43	0.21	9.66	1.20	3.32	1.19	0.71	3.28	0.71	0.65	0.21	0.92	0.21
Tributary	Proposed_Stem	564.00	2-yr ult	199.34	0.45	31.76	0.44	10.19	1.49	3.78	1.49	1.01	4.05	1.00	0.70	0.28	1.05	0.28
Tributary	Proposed_Stem	564.00	10-yr ult	199.65	1.94	54.26	1.63	16.65	1.41	4.98	2.23	0.97	6.45	1.93	0.97	0.20	1.36	0.43
Tributary	Proposed_Stem	564.00	100-yr ult	200.14	17.38	88.78	5.31	28.96	2.28	5.99	2.95	1.98	8.42	2.90	1.05	0.42	1.85	0.68
Tributary	Proposed_Stem	552.49	1-yr ex	197.53		6.42		4.24		3.66			5.20		1.01		0.41	
Tributary	Proposed_Stem	552.49	2-yr ex	197.73		10.92		5.02		4.12			6.07		1.00		0.53	
Tributary	Proposed_Stem	552.49	10-yr ex	198.23	2.84	24.75	0.40	14.36	1.79	4.44	1.65	1.50	5.85	1.32	1.03	0.22	0.93	0.20
Tributary	Proposed_Stem	552.49	100-yr ex	198.73	20.05	50.02	3.14	19.64	3.22	5.84	2.88	3.59	8.77	3.04	1.01	0.54	1.43	0.50
Tributary	Proposed_Stem	552.49	1-yr ult	198.18	1.92	22.66	0.27	13.79	1.58	4.31	1.47	1.25	5.64	1.12	1.05	0.18	0.88	0.17
Tributary	Proposed_Stem	552.49	2-yr ult	198.30	4.25	27.79	0.61	15.07	2.04	4.65	1.86	1.83	6.28	1.59	1.03	0.27	1.00	0.25
Tributary	Proposed_Stem	552.49	10-yr ult	198.59	13.60	42.15	2.08	18.17	2.88	5.45	2.58	3.03	7.90	2.58	1.01	0.46	1.29	0.42
Tributary	Proposed_Stem	552.49	100-yr ult	198.97	36.58	68.95	5.94	22.14	3.99	6.91	3.57	5.13	11.67	4.34	1.08	0.68	1.66	0.62
Tributary	Proposed_Stem	518.16	1-yr ex	194.84		6.42		5.91		3.43			0.79		1.07		0.32	
Tributary	Proposed_Stem	518.16	2-yr ex	194.95	0.00	10.91	0.00	6.36	0.36	4.29	0.36	0.11	1.12	0.11	1.19	0.05	0.42	0.05
Tributary	Proposed_Stem	518.16	10-yr ex	195.22	0.13	27.73	0.13	7.43	1.02	6.67	1.02	0.54	2.29	0.54	1.52	0.18	0.69	0.18
Tributary	Proposed_Stem	518.16	100-yr ex	195.86	1.70	69.81	1.70	9.98	1.71	8.74	1.71	1.09	3.17	1.09	1.51	0.50	1.33	0.50
Tributary	Proposed_Stem	518.16	1-yr ult	195.17	0.09	24.67	0.09	7.23	0.93	6.39	0.93	0.48	2.16	0.48	1.50	0.15	0.64	0.15
Tributary	Proposed_Stem	518.16	2-yr ult	195.29	0.21	32.23	0.21	7.73	1.14	7.01	1.14	0.63	2.45	0.63	1.53	0.22	0.77	0.22
Tributary	Proposed_Stem	518.16	10-yr ult	195.65	0.97	55.88	0.97	9.16	1.55	8.27	1.55	0.97	3.00	0.96	1.53	0.40	1.13	0.40
Tributary	Proposed_Stem	518.16	100-yr ult	196.35	4.31	102.85	4.31	11.93	1.95	9.41	1.95	1.24	3.31	1.24	1.41	0.74	1.82	0.74
Tributary	Proposed_Stem	422.37	1-yr ex	191.82		6.42	0.00	10.66		3.18	0.10		0.67	0.02	1.28		0.34	0.01
Tributary	Proposed_Stem	422.37	2-yr ex	191.96	0.01	10.43	0.48	11.39	0.39	3.64	0.66	0.11	0.77	0.24	1.11	0.07	0.48	0.14
Tributary	Proposed_Stem	422.37	10-yr ex	192.31	0.20	24.35	3.43	13.12	0.84	4.96	1.30	0.33	1.20	0.64	1.06	0.24	0.82	0.43
Tributary	Proposed_Stem	422.37	100-yr ex	192.76	2.30	58.44	12.47	32.17	0.78	7.68	2.19	0.31	2.48	1.50	1.71	0.16	1.27	0.76
Tributary	Proposed_Stem	422.37	1-yr ult	192.25	0.15	21.86	2.84	12.86	0.77	4.74	1.22	0.29	1.12	0.58	1.06	0.22	0.77	0.39
Tributary	Proposed_Stem	422.37	2-yr ult	192.37	0.29	28.07	4.30	13.43	0.92	5.32	1.43	0.39	1.34	0.74	1.09	0.27	0.88	0.48
Tributary	Proposed_Stem	422.37	10-yr ult	192.65	0.86	47.49	9.48	24.62	0.61	6.79	1.92	0.21	2.00	1.19	1.48	0.12	1.17	0.69
Tributary	Proposed_Stem	422.37	100-yr ult	193.34	25.37	67.52	18.57	52.31	1.15	6.07	1.76	0.45	1.37	0.84	0.93	0.59	1.85	1.14
Tributary	Proposed_Stem	420.35	1-yr ex	191.69		6.42		5.82		3.69			0.93		1.19		0.30	
Tributary	Proposed_Stem	420.35	2-yr ex	191.81	0.00	10.69	0.22	11.01	0.34	4.30	0.58	0.10	1.13	0.22	1.47	0.04	0.41	0.08
Tributary	Proposed_Stem	420.35	10-yr ex	192.14	0.15	24.90	2.94	12.42	0.89	5.61	1.42	0.40	1.59	0.80	1.28	0.20	0.74	0.37
Tributary	Proposed_Stem	420.35	100-yr ex	192.68	1.76	59.26	12.20	28.71	0.75	7.67	2.17	0.30	2.46	1.47	1.66	0.15	1.29	0.77
Tributary	Proposed_Stem	420.35	1-yr ult	192.08	0.10	22.38	2.37	12.15	0.83	5.43	1.33	0.36	1.53	0.73	1.30	0.18	0.69	0.33
Tributary	Proposed_Stem	420.35	2-yr ult	192.21	0.22	28.62	3.82	12.79	0.98	5.87	1.53	0.45	1.69	0.89	1.26	0.24	0.81	0.43
Tributary	Proposed_Stem	420.35	10-yr ult	192.69	1.46	46.72	9.66	29.21	0.59	6.01	1.70	0.18	1.51	0.90	1.30	0.16	1.30	0.77
Tributary	Proposed_Stem	420.35	100-yr ult	193.26	22.11	70.66	18.70	51.86	1.12	6.33	1.81	0.44	1.49	0.90	1.01	0.54	1.86	1.13
Tributary	Proposed_Stem	393.08	1-yr ex	190.79		6.42	0.00	8.93		3.23	0.07		0.68		1.20		0.33	0.00
Tributary	Proposed_Stem	393.08	2-yr ex	190.93	0.07	10.48	0.37	12.88	0.42	3.67	0.63	0.12	0.78	0.22	1.20	0.07	0.48	0.13
Tributary	Proposed_Stem	393.08	10-yr ex	191.19	1.23	24.27	2.50	18.90	0.94	5.54	1.27	0.43	1.55	0.67	1.43	0.20	0.73	0.31
Tributary	Proposed_Stem	393.08	100-yr ex	191.55	8.12	55.10	10.00	27.62	1.68	8.37	2.09	1.10	3.09	1.53	1.69	0.38	1.10	0.53

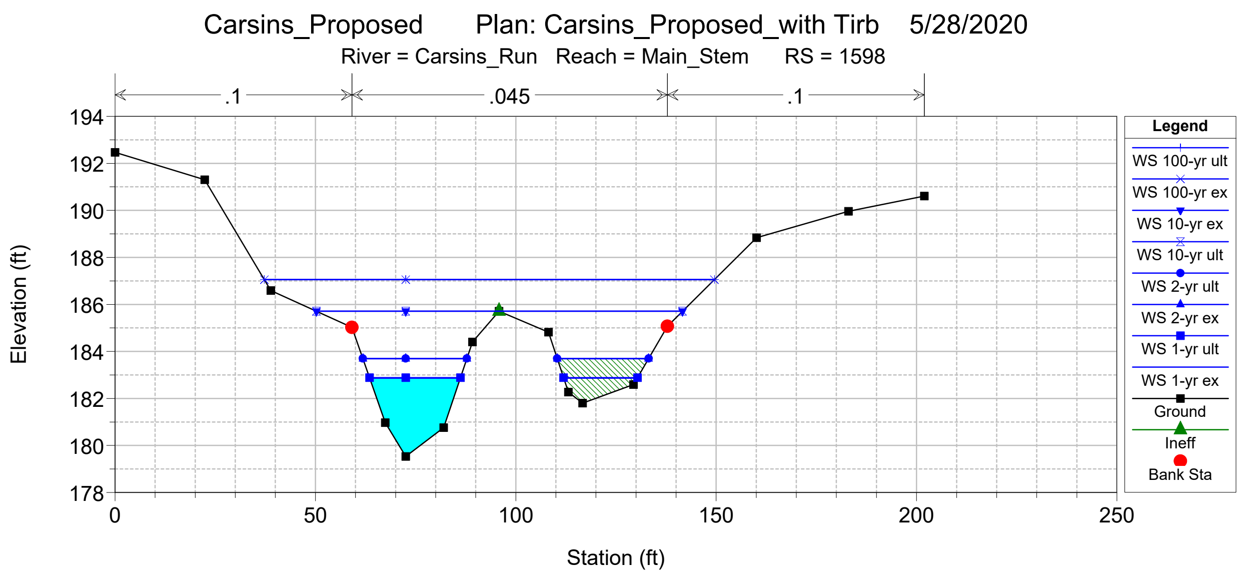
HEC-RAS Plan: Carsing_Prop1 (Continued)

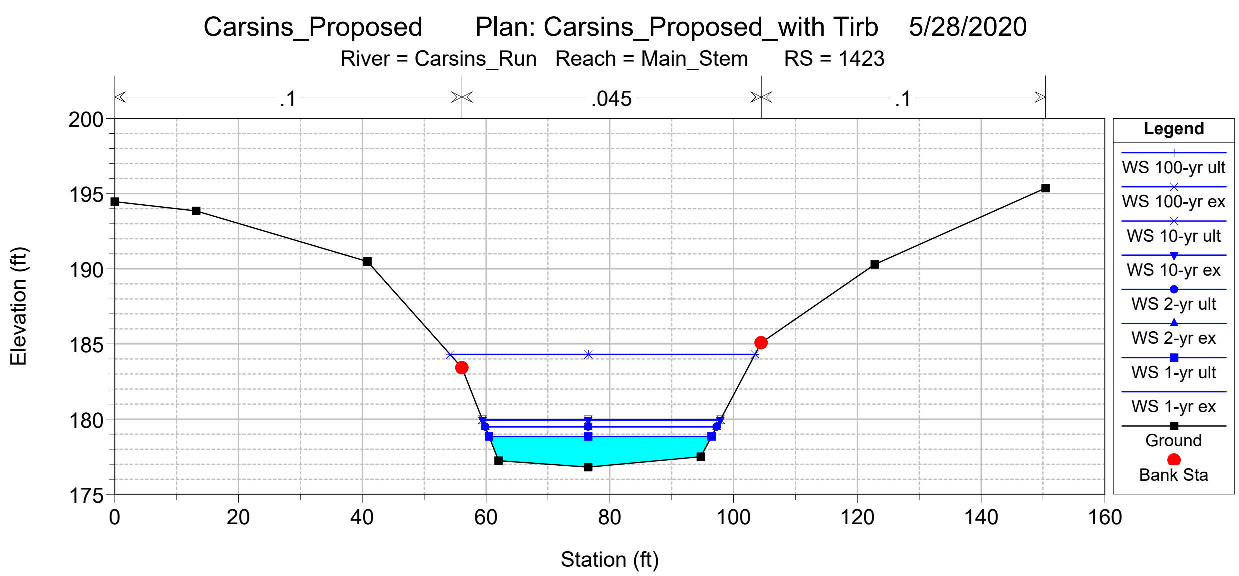
River	Reach	River Sta	Profile	W.S. Elev	Q Left	Q Channel	Q Right	Top Width	Vel Left	Vel Chnl	Vel Right	Shear LOB	Shear Chan	Shear ROB	Froude # XS	Hydr Depth L	Hydr Depth C	Hydr Depth R
				(ft)	(cfs)	(cfs)	(cfs)	(ft)	(ft/s)	(ft/s)	(ft/s)	(lb/sq ft)	(lb/sq ft)	(lb/sq ft)		(ft)	(ft)	(ft)
Tributary	Proposed_Stem	393.08	1-yr ult	191.15	0.93	21.87	2.05	18.01	0.87	5.26	1.18	0.38	1.43	0.60	1.40	0.18	0.69	0.29
Tributary	Proposed_Stem	393.08	2-yr ult	191.23	1.70	27.80	3.16	19.99	1.05	5.97	1.39	0.52	1.77	0.79	1.49	0.22	0.78	0.34
Tributary	Proposed_Stem	393.08	10-yr ult	191.38	4.61	46.41	6.81	23.55	1.59	8.35	2.03	1.07	3.26	1.55	1.87	0.30	0.93	0.43
Tributary	Proposed_Stem	393.08	100-yr ult	191.76	14.48	79.94	17.06	42.22	1.69	10.20	2.50	1.16	4.34	2.08	2.07	0.34	1.31	0.61
Tributary	Proposed_Stem	312.68	1-yr ex	188.12	0.00	6.38	0.04	48.93	0.02	3.18	0.12		0.67	0.02	2.55	0.00	0.33	0.01
Tributary	Proposed_Stem	312.68	2-yr ex	188.25	0.50	7.88	2.55	51.74	0.47	2.83	0.51	0.12	0.47	0.14	1.03	0.12	0.46	0.14
Tributary	Proposed_Stem	312.68	10-yr ex	188.44	2.45	14.35	11.19	55.94	0.82	3.64	0.91	0.29	0.70	0.34	0.80	0.27	0.66	0.32
Tributary	Proposed_Stem	312.68	100-yr ex	188.78	8.88	28.18	36.15	62.53	1.20	4.74	1.40	0.52	1.03	0.65	0.70	0.49	0.99	0.62
Tributary	Proposed_Stem	312.68	1-yr ult	188.41	2.06	13.25	9.53	55.29	0.77	3.52	0.85	0.27	0.66	0.31	0.82	0.25	0.63	0.29
Tributary	Proposed_Stem	312.68	2-yr ult	188.48	3.05	15.93	13.68	56.83	0.88	3.80	0.98	0.33	0.74	0.38	0.78	0.30	0.70	0.36
Tributary	Proposed_Stem	312.68	10-yr ult	188.68	6.55	23.75	27.53	60.59	1.11	4.45	1.27	0.46	0.94	0.57	0.72	0.43	0.89	0.53
Tributary	Proposed_Stem	312.68	100-yr ult	188.98	15.07	38.81	57.59	66.45	1.41	5.41	1.67	0.66	1.26	0.85	0.68	0.62	1.20	0.80
Tributary	Proposed_Stem	193.16	1-yr ex	183.06		6.42		4.24		3.67			5.22		1.01		0.41	
Tributary	Proposed_Stem	193.16	2-yr ex	183.25		10.92		5.01		4.15			6.16		1.01		0.53	
Tributary	Proposed_Stem	193.16	10-yr ex	183.76	0.33	26.63	1.03	10.55	1.71	4.80	1.66	1.46	6.86	1.39	1.07	0.19	0.92	0.17
Tributary	Proposed_Stem	193.16	100-yr ex	184.39	3.54	55.88	13.79	17.38	2.94	5.98	2.97	3.08	8.95	3.12	1.02	0.55	1.56	0.51
Tributary	Proposed_Stem	193.16	1-yr ult	183.69	0.19	24.08	0.58	9.82	1.49	4.68	1.44	1.20	6.69	1.14	1.07	0.15	0.86	0.14
Tributary	Proposed_Stem	193.16	2-yr ult	183.85	0.57	30.21	1.88	11.54	1.95	4.95	1.90	1.75	7.07	1.69	1.06	0.25	1.02	0.23
Tributary	Proposed_Stem	193.16	10-yr ult	184.22	2.30	46.91	8.62	15.57	2.66	5.62	2.66	2.67	8.22	2.67	1.02	0.46	1.39	0.42
Tributary	Proposed_Stem	193.16	100-yr ult	184.79	6.75	74.73	29.99	28.30	2.14	6.36	3.27	1.84	9.39	3.45	1.05	0.36	1.96	0.67
Tributary	Proposed_Stem	166.22	1-yr ex	181.69	0.10	6.19	0.13	10.41	0.40	1.21	0.36	0.09	0.45	0.07	0.28	0.15	0.85	0.13
Tributary	Proposed_Stem	166.22	2-yr ex	181.94	0.48	9.64	0.81	13.62	0.65	1.45	0.58	0.18	0.59	0.15	0.30	0.32	1.11	0.26
Tributary	Proposed_Stem	166.22	10-yr ex	182.36	8.86	15.46	3.67	47.43	0.71	1.68	0.82	0.19	0.71	0.24	0.32	0.39	1.53	0.48
Tributary	Proposed_Stem	166.22	100-yr ex	183.31	39.59	20.16	13.46	55.79	0.92	1.35	0.77	0.22	0.39	0.17	0.16	1.34	2.48	0.99
Tributary	Proposed_Stem	166.22	1-yr ult	182.31	6.92	14.76	3.16	46.89	0.65	1.67	0.80	0.17	0.71	0.23	0.34	0.33	1.47	0.45
Tributary	Proposed_Stem	166.22	2-yr ult	182.44	11.73	16.50	4.43	48.15	0.78	1.71	0.85	0.22	0.73	0.25	0.30	0.47	1.61	0.52
Tributary	Proposed_Stem	166.22	10-yr ult	182.82	27.86	20.95	9.02	51.69	1.03	1.76	0.93	0.32	0.72	0.28	0.24	0.84	1.98	0.71
Tributary	Proposed_Stem	166.22	100-yr ult	183.51	61.43	28.40	21.64	57.28	1.24	1.77	1.03	0.39	0.65	0.29	0.20	1.54	2.68	1.10
Tributary	Proposed_Stem	123.47	1-yr ex	180.43		6.42		4.25		3.66			5.19		1.00		0.41	
Tributary	Proposed_Stem	123.47	2-yr ex	180.62		10.92		5.02		4.13			6.11		1.00		0.53	
Tributary	Proposed_Stem	123.47	10-yr ex	181.12	0.57	26.83	0.59	9.09	1.86	4.89	1.84	1.68	7.15	1.65	1.03	0.21	0.91	0.20
Tributary	Proposed_Stem	123.47	100-yr ex	183.00	12.00	50.49	10.71	22.01	1.81	3.01	1.28	0.87	1.86	0.52	0.39	1.39	2.80	0.74
Tributary	Proposed_Stem	123.47	1-yr ult	181.06	0.35	24.14	0.36	8.82	1.60	4.71	1.58	1.34	6.80	1.32	1.03	0.16	0.85	0.16
Tributary	Proposed_Stem	123.47	2-yr ult	181.21	0.99	30.64	1.03	9.51	2.16	5.07	2.13	2.06	7.42	2.02	1.01	0.27	1.01	0.26
Tributary	Proposed_Stem	123.47	10-yr ult	181.59	3.81	49.94	4.08	11.16	3.09	6.02	3.06	3.48	9.44	3.42	1.02	0.50	1.38	0.49
Tributary	Proposed_Stem	123.47	100-yr ult	182.82	16.85	78.47	16.15	18.39	2.94	5.01	2.44	2.37	5.28	1.80	0.64	1.21	2.61	0.87
Carsins_Run	Main_Stem	1896	1-yr ex	187.67		387.00		74.56		4.36			0.91		0.57		1.81	
Carsins_Run	Main_Stem	1896	2-yr ex	188.35		612.00		98.27		4.97			1.08		0.57		2.36	
Carsins_Run	Main_Stem	1896	10-yr ex	188.79	0.01	1364.94	1.06	133.82	0.25	5.67	0.36	0.04	1.42	0.08	0.74	0.08	2.23	0.11
Carsins_Run	Main_Stem	1896	100-yr ex	190.66	4.12	3078.97	123.91	165.64	1.15	6.96	1.60	0.39	1.76	0.64	0.68	1.01	4.10	1.43
Carsins_Run	Main_Stem	1896	1-yr ult	187.68		391.00		74.68		4.38			0.91		0.57		1.82	
Carsins_Run	Main_Stem	1896	2-yr ult	188.37		617.00		99.38		4.97			1.08		0.57		2.38	
Carsins_Run	Main_Stem	1896	10-yr ult	188.81	0.01	1372.73	1.26	134.05	0.27	5.66	0.39	0.05	1.42	0.08	0.74	0.08	2.25	0.13
Carsins_Run	Main_Stem	1896	100-yr ult	190.67	4.15	3086.28	124.57	165.72	1.15	6.97	1.60	0.39	1.76	0.64	0.68	1.01	4.10	1.44
Carsins_Run	Main_Stem	1598	1-yr ex	182.87		387.00		40.99		8.21			3.07		1.00		2.09	
Carsins_Run	Main_Stem	1598	2-yr ex	183.69		612.00		48.71		9.11			3.53		1.00		2.59	
Carsins_Run	Main_Stem	1598	10-yr ex	185.71	2.18	1363.01	0.81	91.39	0.71	6.20	0.67	0.20	1.58	0.19	0.70	0.35	2.79	0.32
Carsins_Run	Main_Stem	1598	100-yr ex	187.05	49.16	3138.07	19.77	112.28	1.92	9.64	1.70	0.99	3.36	0.83	0.94	1.17	4.14	0.99
Carsins_Run	Main_Stem	1598	1-yr ult	182.89		391.00		41.17		8.21			3.07		1.00		2.10	
Carsins_Run	Main_Stem	1598	2-yr ult	183.70		617.00		48.80		9.15			3.56		1.00		2.60	
Carsins_Run	Main_Stem	1598	10-yr ult	185.71	2.19	1370.99	0.81	91.39	0.71	6.24	0.67	0.21	1.60	0.19	0.70	0.35	2.79	0.32
Carsins_Run	Main_Stem	1598	100-yr ult	187.06	49.69	3145.32	19.99	112.37	1.92	9.64	1.71	0.99	3.36	0.83	0.93	1.18	4.14	1.00
Carsins_Run	Main_Stem	1423	1-yr ex	178.84		387.00		35.94		6.52			2.08		0.89		1.65	
Carsins_Run	Main_Stem	1423	2-yr ex	179.48		612.00		37.38		7.38			2.43		0.87		2.22	
Carsins_Run	Main_Stem	1423	10-yr ex	179.94		1366.00		38.40		13.65			7.88		1.49		2.61	
Carsins_Run	Main_Stem	1423	100-yr ex	184.30	0.73	3206.27		49.27	0.87	11.11		0.29	4.00		0.81	0.44	6.09	
Carsins_Run	Main_Stem	1423	1-yr ult	178.85		391.00		35.96		6.54			2.09		0.89		1.66	
Carsins_Run	Main_Stem	1423	2-yr ult	179.50		617.00		37.41		7.40			2.43		0.87		2.23	
Carsins_Run	Main_Stem	1423	10-yr ult	179.96		1374.00		38.46		13.59			7.80		1.48		2.63	
Carsins_Run	Main_Stem	1423	100-yr ult	184.31	0.76	3214.24		49.32	0.88	11.11		0.29	4.00		0.81	0.45	6.11	
Carsins_Run	Main_Stem	1233	1-yr ex	176.70		387.00		34.41		4.97			1.09		0.58		2.26	
Carsins_Run	Main_Stem	1233	2-yr ex	177.45		612.00		35.87		5.87			1.41		0.61		2.91	
Carsins_Run	Main_Stem	1233	10-yr ex	179.29		1366.00		39.39		7.87			2.24		0.66		4.41	
Carsins_Run	Main_Stem	1233	100-yr ex	183.02	15.77	3183.73	7.50	60.22	1.41	9.57	1.08	0.52	2.78	0.35	0.70	1.31	7.61	0.87
Carsins_Run	Main_Stem	1233	1-yr ult	176.71		391.00		34.44		4.98			1.10		0.58		2.28	
Carsins_Run	Main_Stem	1233	2-yr ult	177.46		617.00		35.90		5.89			1.42		0.61		2.92	
Carsins_Run	Main_Stem	1233	10-yr ult	179.31		1374.00		39.43		7.88			2.25		0.66		4.42	
Carsins_Run	Main_Stem	1233	100-yr ult	183.05	16.09	3191.18	7.74	60.35	1.41	9.57	1.09	0.52	2.77	0.35	0.70	1.32	7.63	0.88
Carsins_Run	Main_Stem	1218.5	1-yr ex	176.54		387.00		35.23		5.15			1.19		0.62		2.13	
Carsins_Run	Main_Stem	1218.5	2-yr ex	177.31		612.00		37.88		5.92			1.45		0.63		2.73	
Carsins_Run	Main_Stem	1218.5	10-yr ex	179.22		1366.00		44.04		7.51			2.06		0.65		4.13	
Carsins_Run	Main_Stem	1218.5	100-yr ex	183.13	6.11	3186.31	14.58	68.47	0.95	8.61	1.13	0.27	2.23	0.35	0.63	0.88	7.48	1.11
Carsins_Run	Main_Stem	1218.5	1-yr ult	176.55		391.00		35.28		5.16			1.20		0.62		2.15	
Carsins_Run	Main_Stem	1218.5	2-yr ult	177.33		617.00		37.93		5.93			1.46		0.63		2.74	
Carsins_Run	Main_Stem	1218.5	10-yr ult	179.24		1374.00		44.09		7.52			2.06		0.65		4.14	
Carsins_Run	Main_Stem	1218.5	100-yr ult	183.15	6.29	3193.78	14.93	68.68	0.95	8.61	1.13	0.27	2.22	0.35	0.63	0.89	7.51	1.12
Carsins_Run	Main_Stem	1214.8	1-yr ex	176.54		387.00		35.23		4.85			1.04		0.57		2.26	
Carsins_Run	Main_Stem	1214.8	2-yr ex	177.31		612.00		37.88		5.67			1.32		0.59		2.85	
Carsins_Run	Main_Stem	1214.8	10-yr ex	179.22		1366.00		44.02		7.34			1.95		0.63		4.23	
Carsins_Run	Main_Stem	1214.8	100-yr ex	183.13	6.00	3186.69	14.31	68.47	0.93	8.51	1.11	0.26	2.17	0.34	0.62	0.88	7.58	1.11
Carsins_Run	Main_Stem	1214.8	1-yr ult	176.56		391.00		35.28		4.87			1.05		0.57		2.27	
Carsins_Run	Main_Stem	1214.8	2-yr ult	177.33		617.00		37.93		5.68			1.32		0.59		2.86	
Carsins_Run	Main_Stem	1214.8	10-yr ult	179.24		1374.00		44.08		7.35			1.95		0.63		4.24	
Carsins_Run	Main_Stem	1214.8	100-yr ult	183.15	6.18	3194.17	14.66	68.68	0.93	8.50	1.11	0.26	2.16	0.34	0.62	0.89	7.60	1.12
Carsins_Run	Main_Stem	1205.67	1-yr ex	176.58		387.00		33.70		3.90			0.62		0.40		2.94	
Carsins_Run	Main_Stem	1205.67	2-yr ex	177.35		612.00		36.09		4.86			0.91		0.46		3.49	
Carsins_Run	Main_Stem	1205.67	10-yr ex	179.23		1366.00		42.23		6.85			1.64		0.56		4.72	
Carsins_Run	Main_Stem	1205.67	100-yr ex	183.11	4.47	3184.62	17.91	68.34	0.85	8.35	1.11	0.22	2.06	0.33	0.60	0.83	7.90	1.18
Carsins_Run	Main_Stem	1205.67	1-yr ult	176.60		391.00		33.74		3.92			0.63		0.40		2.95	
Carsins_Run	Main_Stem	1205.67	2-yr ult	177.37		617.00		36.13		4.88			0.91		0.46		3.50	
Carsins_Run	Main_Stem	1205.67	10-yr ult	179.25		1374.00		42.29		6.87			1.65		0.56		4.73	
Carsins_Run	Main_Stem	1205.67	100-yr ult	183.13	4.59	3192.09	18.32	68.62	0.85	8.35	1.12	0.22	2.06	0.33	0.60	0.83	7.92	1.19
Carsins_Run	Main_Stem	1186.07	1-yr ex	176.52		387.00		33.51		3.82			0.59		0.39		3.02	
Carsins_Run	Main_Stem	1186.07	2-yr ex	177.27		612.00		35.84		4.80			0.89		0.45		3.55	
Carsins_Run	Main_Stem	1186.07	10-yr ex	179.10		1366.00		41.79		6.89			1.66		0.56		4.74	
Carsins_Run	Main_Stem	1186.07	100-yr ex	183.01	4.00	3186.97	16.03	67.09	0.85	8.37	1.08	0.22	2.08	0.32	0.60	0.83	7.89	1.12
Carsins_Run	Main_Stem	1186.07	1-yr ult	176.54		391.00		33.56		3.84			0.59		0.39		3.04	
Carsins_Run	Main_Stem	1186.07	2-yr ult	177.29		617.00		35.88		4.82			0.89		0.45		3.56	
Carsins_Run	Main_Stem	1186.07	10-yr ult	179.12		1374.00		41.85		6.90			1.67		0.56		4.76	
Carsins_Run	Main_Stem	1186.07	100-yr ult	183.04	4.10	3194.48	16.43	67.37	0.85	8.36	1.09	0.22	2.07	0.32	0.60	0.83	7.91	1.14
Carsins_Run	Main_Stem	1180	1-yr ex	176.29		387.00		32.32		5.03			1.11		0.57		2.38	
Carsins_Run	Main_Stem	1180	2-yr ex	176.94		612.00		33.19		6.22			1.59		0.64		2.96	
Carsins_Run	Main_Stem	1180	10-yr ex	178.40		1366.00		37.58		9.12			3.11		0.81		3.98	
Carsins_Run	Main_Stem	1180	100-yr ex	182.43	4.73	3201.54	0.73	60.46	0.94	10.00	0.48	0.30	3.12	0.11	0.76	0.60	7.10	0.22
Carsins_Run	Main_Stem	1180	1-yr ult	176.30		391.00		32.34		5.05			1.12		0.58		2.39	
Carsins_Run	Main_Stem	1180	2-yr ult	176.96		617.00		33.21		6.25			1.60		0.64		2.97	
Carsins_Run	Main_Stem	1180	10-yr ult	178.42		1374.00		37.61		9.14			3.12		0.81		4.00	
Carsins_Run	Main_Stem	1180	100-yr ult	182.46	5.03	3209.13	0.85	60.95	0.96	9.99	0.50	0.30	3.11	0.11	0.76	0.63	7.12	0.23
Carsins_Run	Main_Stem	1134	1-yr ex	176.13		387.00		36.87		3.98			0.67		0.43		2.64	
Carsins_Run	Main_Stem	1134	2-yr ex	176.76		612.00		38.84		5.06			1.03		0.51		3.11	
Carsins_Run	Main_Stem	1134	10-yr ex	178.14		1366.00		44.98		7.64			2.18		0.68		3.97	
Carsins_Run	Main_Stem	1134	100-yr ex	182.70	27.62	3154.98	24.40	89.72	1.29	7.33	1.04	0.40	1.63	0.29	0.56	1.70	7.46	1.21
Carsins_Run	Main_Stem	1134	1-yr ult	176.14		391.00		36.91		4.00			0.68		0.43		2.65	
Carsins_Run	Main_Stem	1134	2-yr ult	176.77		617.00		38.87		5.08			1.04		0.51		3.12	
Carsins_Run	Main_Stem	1134	10-yr ult	178.16		1374.00		45.04		7.66			2.19		0.68		3.98	
Carsins_Run	Main_Stem	1134	100-yr ult	182.73	28.11	3161.78	25.11	89.90	1.29	7.32	1.05	0.40	1.62	0.29	0.55	1.72	7.48	1.23

HEC-RAS Plan: Carsing_Prop1 (Continued)

River	Reach	River Sta	Profile	W.S. Elev	Q Left	Q Channel	Q Right	Top Width	Vel Left	Vel Chnl	Vel Right	Shear LOB	Shear Chan	Shear ROB	Froude # XS	Hydr Depth L	Hydr Depth C	Hydr Depth R
				(ft)	(cfs)	(cfs)	(cfs)	(ft)	(ft/s)	(ft/s)	(ft/s)	(lb/sq ft)	(lb/sq ft)	(lb/sq ft)		(ft)	(ft)	(ft)
Carsins_Run	Main_Stem	1085	1-yr ex	175.72		387.00		45.93		4.69			1.04		0.62		1.80	
Carsins_Run	Main_Stem	1085	2-yr ex	176.32		612.00		49.90		5.49			1.33		0.65		2.23	
Carsins_Run	Main_Stem	1085	10-yr ex	177.60		1366.00		53.35		7.70			2.30		0.74		3.33	
Carsins_Run	Main_Stem	1085	100-yr ex	182.71	15.60	3120.27	71.14	108.56	1.03	6.20	1.16	0.26	1.15	0.31	0.47	1.68	7.45	1.91
Carsins_Run	Main_Stem	1085	1-yr ult	175.73		391.00		45.99		4.71			1.05		0.62		1.80	
Carsins_Run	Main_Stem	1085	2-yr ult	176.33		617.00		49.92		5.51			1.34		0.65		2.24	
Carsins_Run	Main_Stem	1085	10-yr ult	177.62		1374.00		53.40		7.71			2.31		0.74		3.34	
Carsins_Run	Main_Stem	1085	100-yr ult	182.74	15.88	3126.72	72.40	108.72	1.03	6.19	1.16	0.26	1.14	0.31	0.47	1.69	7.48	1.93
Carsins_Run	Main_Stem	1049	1-yr ex	175.38		387.00		44.60		4.70			1.04		0.61		1.85	
Carsins_Run	Main_Stem	1049	2-yr ex	175.88		612.00		49.49		5.77			1.50		0.70		2.14	
Carsins_Run	Main_Stem	1049	10-yr ex	176.99		1366.00		59.40		8.21			2.74		0.85		2.92	
Carsins_Run	Main_Stem	1049	100-yr ex	182.76	4.03	3157.77	45.21	118.89	0.68	5.13	0.94	0.13	0.80	0.21	0.38	1.19	7.11	1.76
Carsins_Run	Main_Stem	1049	1-yr ult	175.38		391.00		44.62		4.74			1.06		0.61		1.85	
Carsins_Run	Main_Stem	1049	2-yr ult	175.89		617.00		49.58		5.79			1.51		0.70		2.15	
Carsins_Run	Main_Stem	1049	10-yr ult	177.00		1374.00		59.53		8.22			2.74		0.85		2.93	
Carsins_Run	Main_Stem	1049	100-yr ult	182.78	4.13	3164.81	46.07	119.08	0.68	5.12	0.94	0.13	0.80	0.21	0.38	1.20	7.13	1.78
Carsins_Run	Main_Stem	996.9	1-yr ex	174.32		387.00		54.42		6.23			2.13		1.03		1.14	
Carsins_Run	Main_Stem	996.9	2-yr ex	174.77		612.00		57.12		7.02			2.47		1.00		1.53	
Carsins_Run	Main_Stem	996.9	10-yr ex	176.57		1366.00		64.73		6.93			1.91		0.70		3.05	
Carsins_Run	Main_Stem	996.9	100-yr ex	182.72	0.18	3203.59	3.23	143.62	0.28	4.69	0.24	0.03	0.66	0.03	0.37	0.36	7.35	0.28
Carsins_Run	Main_Stem	996.9	1-yr ult	174.34		391.00		54.55		6.17			2.09		1.01		1.16	
Carsins_Run	Main_Stem	996.9	2-yr ult	174.78		617.00		57.17		7.04			2.48		1.00		1.53	
Carsins_Run	Main_Stem	996.9	10-yr ult	176.59		1374.00		64.81		6.92			1.91		0.70		3.06	
Carsins_Run	Main_Stem	996.9	100-yr ult	182.74	0.20	3211.05	3.75	144.23	0.28	4.68	0.25	0.03	0.65	0.03	0.37	0.37	7.38	0.30
Carsins_Run	Main_Stem	985.43	1-yr ex	173.34		387.00		32.46		8.59			3.82		1.29		1.39	
Carsins_Run	Main_Stem	985.43	2-yr ex	174.68		612.00		55.35		5.65			1.47		0.71		1.96	
Carsins_Run	Main_Stem	985.43	10-yr ex	176.60		1366.00		63.88		6.11			1.42		0.58		3.50	
Carsins_Run	Main_Stem	985.43	100-yr ex	182.71	8.82	3182.02	16.16	136.37	0.67	4.65	0.44	0.11	0.62	0.06	0.35	1.51	8.42	0.80
Carsins_Run	Main_Stem	985.43	1-yr ult	173.36		391.00		32.81		8.60			3.84		1.29		1.39	
Carsins_Run	Main_Stem	985.43	2-yr ult	174.69		617.00		55.44		5.65			1.47		0.71		1.97	
Carsins_Run	Main_Stem	985.43	10-yr ult	176.62		1374.00		63.96		6.11			1.42		0.57		3.52	
Carsins_Run	Main_Stem	985.43	100-yr ult	182.73	9.02	3189.06	16.92	137.03	0.67	4.65	0.44	0.11	0.62	0.06	0.35	1.53	8.45	0.82
Carsins_Run	Main_Stem	973	1-yr ex	174.18		387.00		52.08		3.60			0.59		0.44		2.06	
Carsins_Run	Main_Stem	973	2-yr ex	174.81		612.00		54.65		4.33			0.79		0.48		2.58	
Carsins_Run	Main_Stem	973	10-yr ex	176.67		1366.00		62.31		5.46			1.09		0.48		4.02	
Carsins_Run	Main_Stem	973	100-yr ex	182.73	2.65	3189.58	14.77	134.31	0.48	4.44	0.44	0.07	0.57	0.06	0.33	0.95	8.06	0.85
Carsins_Run	Main_Stem	973	1-yr ult	174.19		391.00		52.13		3.62			0.59		0.44		2.07	
Carsins_Run	Main_Stem	973	2-yr ult	174.82		617.00		54.70		4.35			0.80		0.48		2.60	
Carsins_Run	Main_Stem	973	10-yr ult	176.69		1374.00		62.39		5.46			1.09		0.48		4.03	
Carsins_Run	Main_Stem	973	100-yr ult	182.75	2.75	3196.87	15.38	135.02	0.49	4.43	0.45	0.07	0.57	0.06	0.33	0.97	8.09	0.86
Carsins_Run	Main_Stem	950.49	1-yr ex	174.04		387.00		48.95		4.01			0.74		0.50		1.97	
Carsins_Run	Main_Stem	950.49	2-yr ex	174.64		612.00		51.03		4.84			1.00		0.54		2.48	
Carsins_Run	Main_Stem	950.49	10-yr ex	176.48		1366.00		62.48		6.02			1.34		0.54		3.91	
Carsins_Run	Main_Stem	950.49	100-yr ex	182.65	34.38	3115.13	57.49	127.08	0.81	4.89	0.78	0.15	0.66	0.14	0.35	2.01	9.25	1.99
Carsins_Run	Main_Stem	950.49	1-yr ult	174.05		391.00		48.99		4.03			0.74		0.50		1.98	
Carsins_Run	Main_Stem	950.49	2-yr ult	174.65		617.00		51.08		4.85			1.00		0.54		2.49	
Carsins_Run	Main_Stem	950.49	10-yr ult	176.50		1374.00		62.65		6.03			1.34		0.54		3.92	
Carsins_Run	Main_Stem	950.49	100-yr ult	182.67	34.99	3122.01	58.00	127.87	0.82	4.88	0.78	0.15	0.66	0.14	0.35	2.03	9.28	1.98
Carsins_Run	Main_Stem	926.8	1-yr ex	173.66		387.00		52.27		5.10			1.31		0.73		1.51	
Carsins_Run	Main_Stem	926.8	2-yr ex	174.30		612.00		56.32		5.65			1.44		0.69		2.07	
Carsins_Run	Main_Stem	926.8	10-yr ex	176.31		1366.00		73.61		6.19			1.43		0.57		3.72	
Carsins_Run	Main_Stem	926.8	100-yr ex	182.65	3.58	3078.19	125.23	137.54	0.49	4.57	0.95	0.07	0.60	0.19	0.33	0.95	8.34	2.68
Carsins_Run	Main_Stem	926.8	1-yr ult	173.68		391.00		52.35		5.11			1.31		0.73		1.52	
Carsins_Run	Main_Stem	926.8	2-yr ult	174.31		617.00		56.40		5.66			1.45		0.69		2.08	
Carsins_Run	Main_Stem	926.8	10-yr ult	176.33		1374.00		73.75		6.19			1.43		0.56		3.74	
Carsins_Run	Main_Stem	926.8	100-yr ult	182.68	3.72	3085.31	125.96	138.27	0.49	4.57	0.95	0.07	0.60	0.19	0.33	0.97	8.37	2.67
Carsins_Run	Main_Stem	926	1-yr ex	172.97		387.00		39.19		6.85			2.39		1.01		1.44	
Carsins_Run	Main_Stem	926	2-yr ex	173.50		612.00		41.09		7.84			2.87		1.00		1.90	
Carsins_Run	Main_Stem	926	10-yr ex	175.94		1366.00		62.24		7.23			1.95		0.66		3.78	
Carsins_Run	Main_Stem	926	100-yr ex	182.53	18.56	2986.68	201.76	132.68	0.66	5.24	1.18	0.11	0.76	0.27	0.37	1.33	9.42	3.35
Carsins_Run	Main_Stem	926	1-yr ult	172.98		391.00		39.23		6.87			2.40		1.01		1.45	
Carsins_Run	Main_Stem	926	2-yr ult	173.51		617.00		41.13		7.86			2.88		1.00		1.91	
Carsins_Run	Main_Stem	926	10-yr ult	175.96		1374.00		62.66		7.23			1.95		0.65		3.80	
Carsins_Run	Main_Stem	926	100-yr ult	182.56	19.11	2993.49	202.40	133.44	0.66	5.24	1.18	0.11	0.76	0.27	0.37	1.35	9.45	3.33
Carsins_Run	Main_Stem	922	1-yr ex	172.39		387.00		47.40		7.77			3.42		1.34		1.05	
Carsins_Run	Main_Stem	922	2-yr ex	172.72		612.00		48.14		9.37			4.58		1.42		1.36	
Carsins_Run	Main_Stem	922	10-yr ex	176.15		1363.81	2.19	72.78		5.27	0.53		1.01	0.11	0.49		4.06	0.46
Carsins_Run	Main_Stem	922	100-yr ex	182.60	16.26	3096.03	94.71	134.85	0.55	4.38	0.84	0.08	0.52	0.14	0.30	1.38	9.83	2.74
Carsins_Run	Main_Stem	922	1-yr ult	172.40		391.00		47.41		7.81			3.45		1.34		1.06	
Carsins_Run	Main_Stem	922	2-yr ult	172.72		617.00		48.15		9.40			4.60		1.42		1.36	
Carsins_Run	Main_Stem	922	10-yr ult	176.17		1371.64	2.36	72.88		5.27	0.54		1.01	0.11	0.49		4.08	0.48
Carsins_Run	Main_Stem	922	100-yr ult	182.63	16.72	3103.12	95.16	135.60	0.55	4.38	0.83	0.08	0.52	0.14	0.30	1.40	9.85	2.73
Carsins_Run	DS_Stem	868	1-yr ex	172.48		387.00		38.81		6.84			4.24		1.00		1.46	
Carsins_Run	DS_Stem	868	2-yr ex	173.02		612.00		40.97		7.85			5.11		1.00		1.90	
Carsins_Run	DS_Stem	868	10-yr ex	175.36		1366.00		51.91		7.34			3.65		0.68		3.58	
Carsins_Run	DS_Stem	868	100-yr ex	182.49	31.55	3133.72	41.73	183.54	0.73	4.67	0.64	0.15	1.09	0.12	0.40	1.13	8.91	0.93
Carsins_Run	DS_Stem	868	1-yr ult	172.50		391.00		38.86		6.85			4.24		1.00		1.47	
Carsins_Run	DS_Stem	868	2-yr ult	173.03		617.00		41.03		7.85			5.11		1.00		1.91	
Carsins_Run	DS_Stem	868	10-yr ult	175.39		1374.00		52.12		7.32			3.62		0.68		3.60	
Carsins_Run	DS_Stem	868	100-yr ult	182.52	32.54	3138.80	43.66	184.37	0.74	4.66	0.65	0.15	1.09	0.12	0.39	1.15	8.94	0.95
Carsins_Run	DS_Stem	721.4		Culvert														
Carsins_Run	DS_Stem	574	1-yr ex	169.40		387.00		26.99		7.73			3.50		1.00		1.85	
Carsins_Run	DS_Stem	574	2-yr ex	170.22		612.00		35.04		8.26			3.82		1.00		2.11	
Carsins_Run	DS_Stem	574	10-yr ex	173.19		1366.00		54.98		6.46			1.92		0.58		3.85	
Carsins_Run	DS_Stem	574	100-yr ex	174.95	7.51	3199.49		124.50	1.91	9.81		1.02	4.19		0.83	1.04	4.50	
Carsins_Run	DS_Stem	574	1-yr ult	169.42		391.00		27.05		7.74			3.50		1.00		1.87	
Carsins_Run	DS_Stem	574	2-yr ult	170.24		617.00		35.25		8.23			3.78		0.99		2.13	
Carsins_Run	DS_Stem	574	10-yr ult	173.20		1374.00		55.08		6.47			1.92		0.58		3.86	
Carsins_Run	DS_Stem	574	100-yr ult	174.95	7.53	3207.47		124.50	1.92	9.83		1.03	4.21		0.83	1.04	4.50	
Carsins_Run	DS_Stem	473	1-yr ex	169.97		387.00		43.40		5.33			1.38		0.73		1.67	
Carsins_Run	DS_Stem	473	2-yr ex	170.35	1.65	604.40	5.95	75.48	0.70	6.80	0.89	0.23	2.10	0.33	1.05	0.22	2.04	0.32
Carsins_Run	DS_Stem	473	10-yr ex	171.48	48.11	1239.00	78.89	107.33	1.74	8.99	2.11	0.90	3.18	1.20	1.10	0.87	3.17	1.16
Carsins_Run	DS_Stem	473	100-yr ex	173.42	340.58	2490.92	375.50	165.79	2.68	11.20	2.95	1.64	4.21	1.89	1.04	1.94	5.11	2.24
Carsins_Run	DS_Stem	473	1-yr ult	169.99		391.00		43.45		5.35			1.39		0.73		1.68	
Carsins_Run	DS_Stem	473	2-yr ult	170.36	1.72	609.10	6.17	75.75	0.71	6.82	0.91	0.23	2.12	0.34	1.05	0.22	2.05	0.32
Carsins_Run	DS_Stem	473	10-yr ult	171.48	48.57	1245.88	79.55	107.41	1.75	9.03	2.12	0.91	3.20	1.21	1.10	0.87	3.17	1.17
Carsins_Run	DS_Stem	473	100-yr ult	173.43	342.59	2494.98	377.43	165.93	2.69	11.20	2.96	1.64	4.21	1.89	1.03	1.94	5.12	2.25
Carsins_Run	DS_Stem	375	1-yr ex	168.98		387.00		107.72		4.04			0.84		0.60		1.40	
Carsins_Run	DS_Stem	375	2-yr ex	169.32	4.99	574.31	32.70	176.99	0.63	4.81	0.91	0.18	1.11	0.30	0.85	0.27	1.73	0.46
Carsins_Run	DS_Stem	375	10-yr ex	170.04	42.40	1149.66	173.94	246.02	1.12	6.82	1.73	0.44	1.99	0.85	0.98	0.53	2.45	1.02
Carsins_Run	DS_Stem	375	100-yr ex	170.32	157.29	2561.65	488.06	252.75	2.67	13.58	3.79	2.19	7.62	3.72	1.74	0.77	2.73	1.30
Carsins_Run	DS_Stem	375	1-yr ult	168.99		391.00		108.61		4.06			0.85		0.60		1.40	
Carsins_Run	DS_Stem	375	2-yr ult	169.33	5.17	578.39	33.43	177.41	0.64	4.82	0.91	0.18	1.12	0.31	0.86	0.27	1.74	0.46
Carsins_Run	DS_Stem	375	10-yr ult	170.04	43.04	1155.41	175.55	246.12	1.13	6.84	1.74	0.45	2.00	0.85	0.98	0.53	2.45	1.02
Carsins_Run	DS_Stem	375	100-yr ult	170.33	157.96	2567.40	489.64	252.79	2.67	13.61	3.80	2.20	7.64	3.74	1.74	0.77	2.74	1.31
Carsins_Run	DS_Stem	269	1-yr ex	167.84		387.00		118.86		4.00			0.87		0.64		1.20	
Carsins_Run	DS_Stem	269	2-yr ex	168.17	34.19	566.65	11.16	277.59	0.85	4.52	0.60	0.28	1.05	0.17	0.94	0.38	1.44	0.22
Carsins_Run	DS_Stem	269	10-yr ex	168.84	182.22	1070.16	113.62	309.97	1.53	5.83	1.46	0.68	1.53	0.63	0.83	0.91	2.11	0.85
Carsins_Run	DS_Stem	269	100-yr ex	169.93	623.26	2138.84	444.90	377.49	2.15	7.69	2.43	1.14	2.32	1.37	0.80	1.52	3.20	1.83
Carsins_Run	DS_Stem	269	1-yr ult	167.84		391.00	0.00	121.25		4.01	0.03		0.87		0.65		1.21	0.00
Carsins_Run	DS_Stem	269	2-yr ult	168.18	35.00	570.37	11.63	277.87	0.86	4.53	0.61	0.29	1.05	0.17	0.94	0.39	1.45	0.23
Carsins_Run	DS_Stem	269	10-yr ult	168.85	183.98	1075.13	114.89	310.26	1.53	5.84	1.46	0.68	1.54	0.64	0.83	0.92	2.12	0.85
Carsins_Run	DS_Stem	269	100-yr ult	169.93	625.35	2143.23	446.42	377.79	2.15	7.69	2.44	1.14	2.32	1.37	0.80	1.53	3.20	1.83


Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
River = Carsins_Run Reach = Main_Stem RS = 1896
.1
.045
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 10-yr ex
WS 2-yr ult
WS 2-yr ex
WS 1-yr ult
WS 1-yr ex
Ground
Ineff
Bank Sta


Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
River = Carsins_Run Reach = Main_Stem RS = 1598
.1
.045
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ex
WS 10-yr ult
WS 2-yr ult
WS 2-yr ex
WS 1-yr ult
WS 1-yr ex
Ground
Ineff
Bank Sta


Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
River = Carsins_Run Reach = Main_Stem RS = 1423
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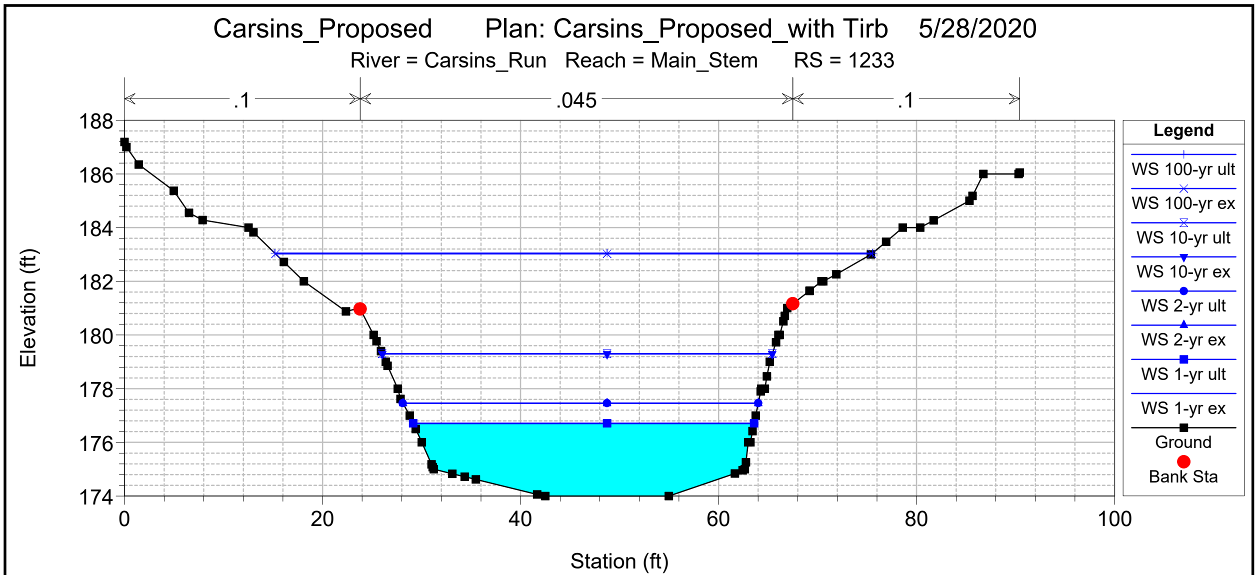
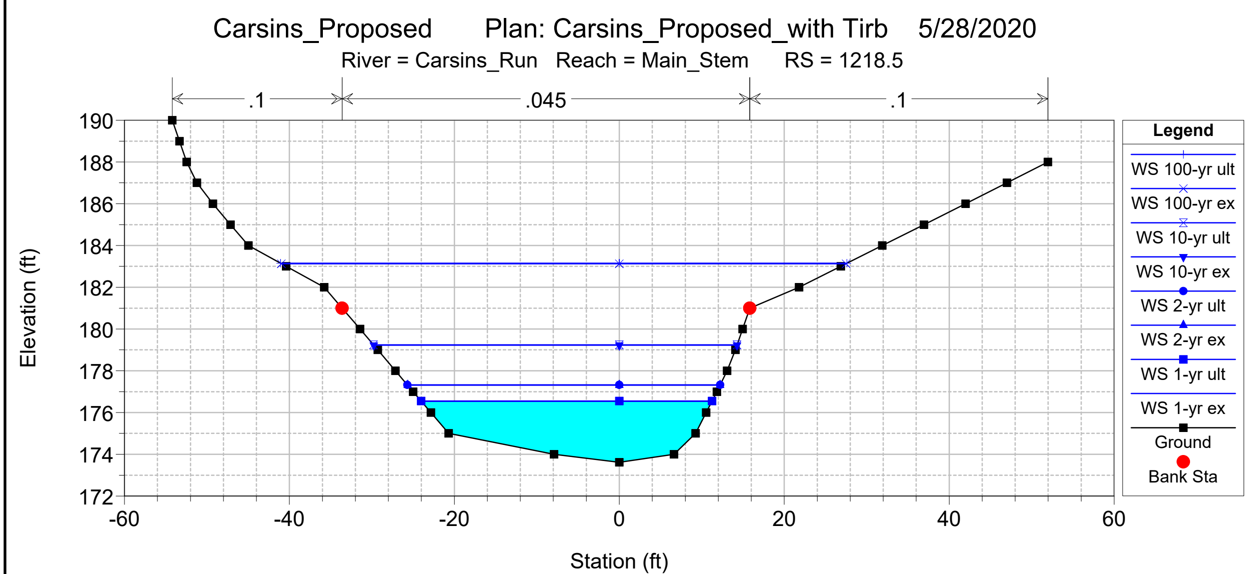
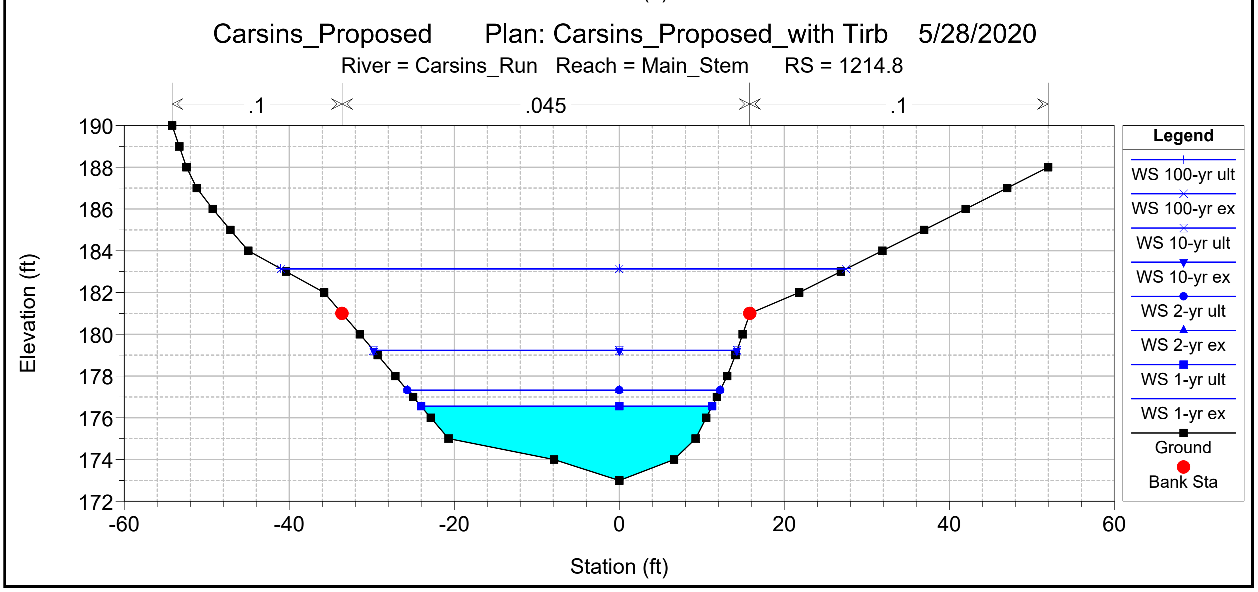
.045
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 10-yr ex
WS 2-yr ult
WS 2-yr ex
WS 1-yr ult
WS 1-yr ex
Ground
Bank Sta



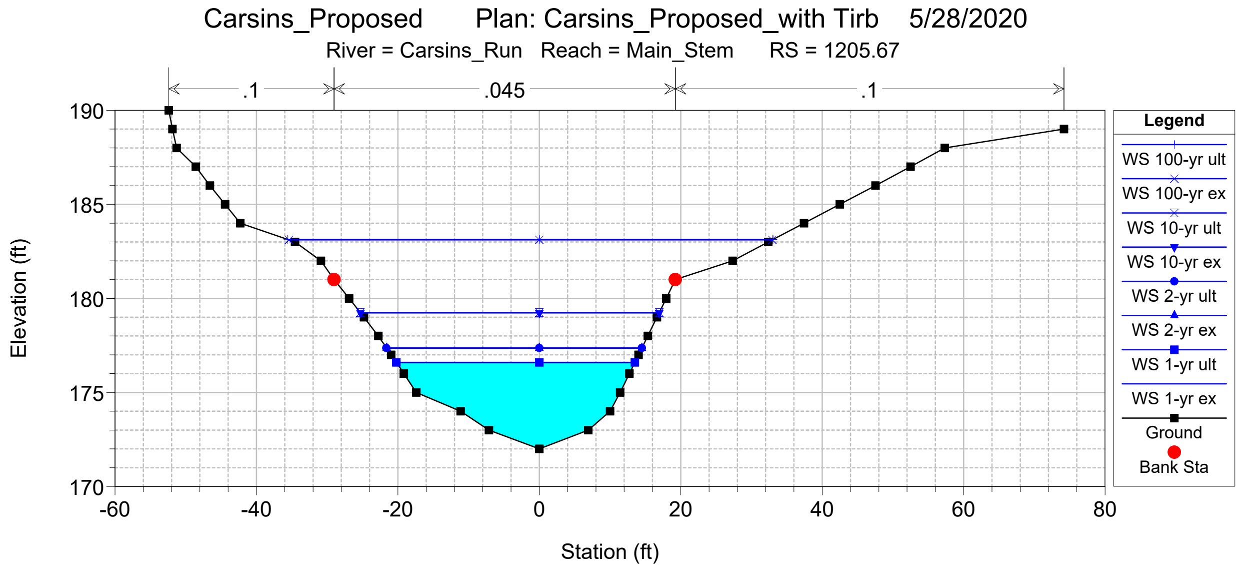
Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
River = Carsins_Run Reach = Main_Stem RS = 1233
.1
.045
.1
Elevation (ft)
Station (ft)
188
186
184
182
180
178
176
174
0
20
40
60
80
100
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 10-yr ex
WS 2-yr ult
WS 2-yr ex
WS 1-yr ult
WS 1-yr ex
Ground
Bank Sta

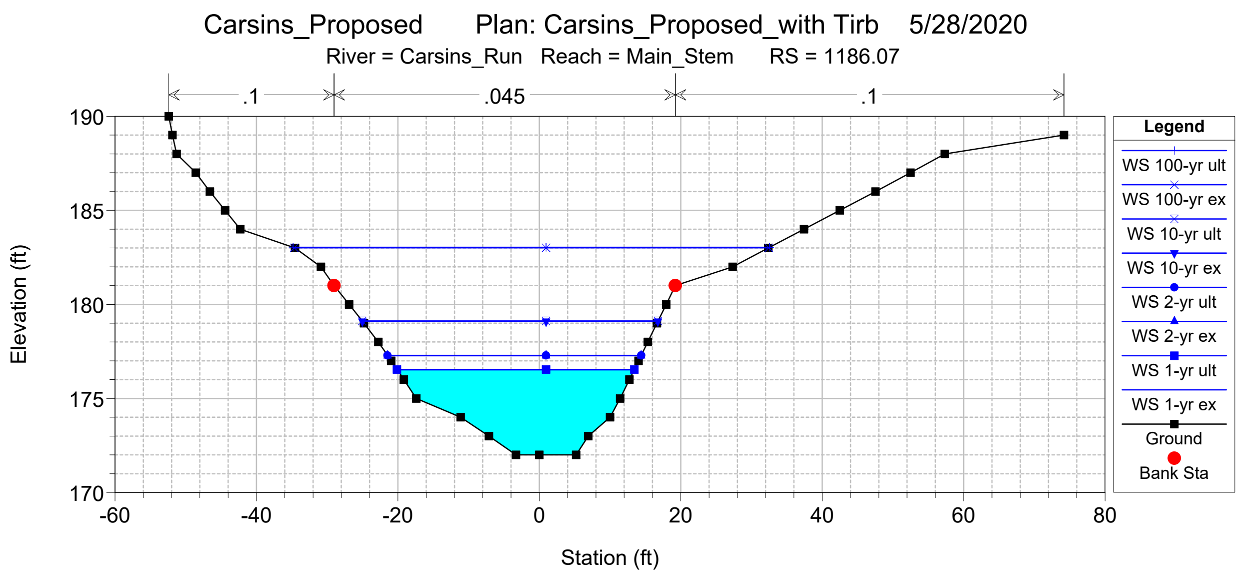


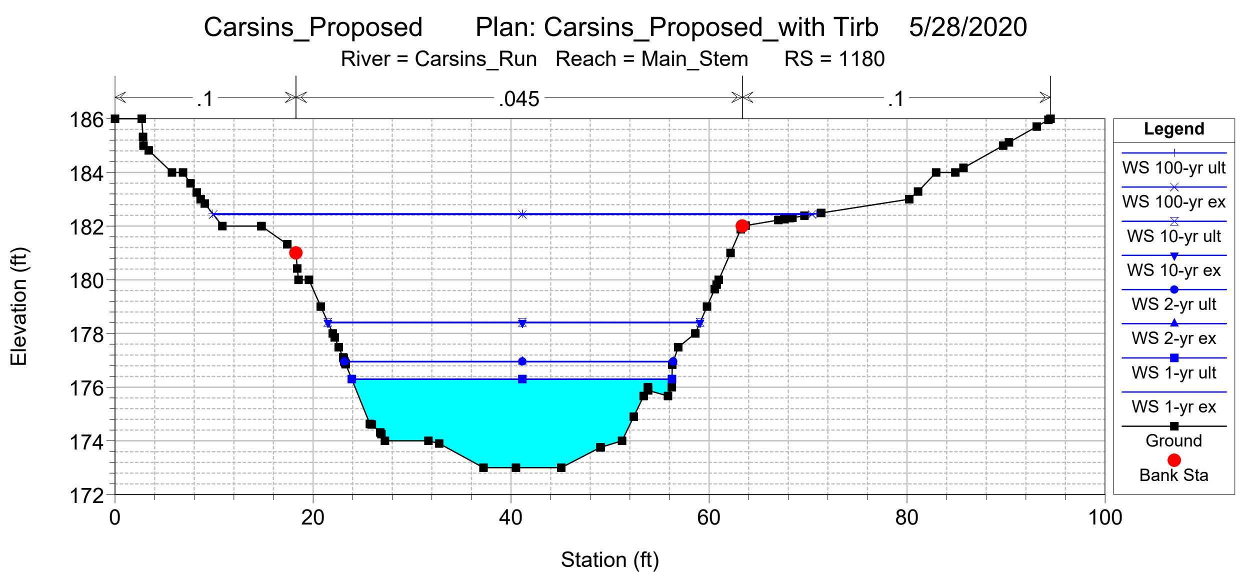
Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
River = Carsins_Run Reach = Main_Stem RS = 1218.5
.1
.045
.1
Elevation (ft)
Station (ft)
190
188
186
184
182
180
178
176
174
172
-60
-40
-20
0
20
40
60
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 10-yr ex
WS 2-yr ult
WS 2-yr ex
WS 1-yr ult
WS 1-yr ex
Ground
Bank Sta

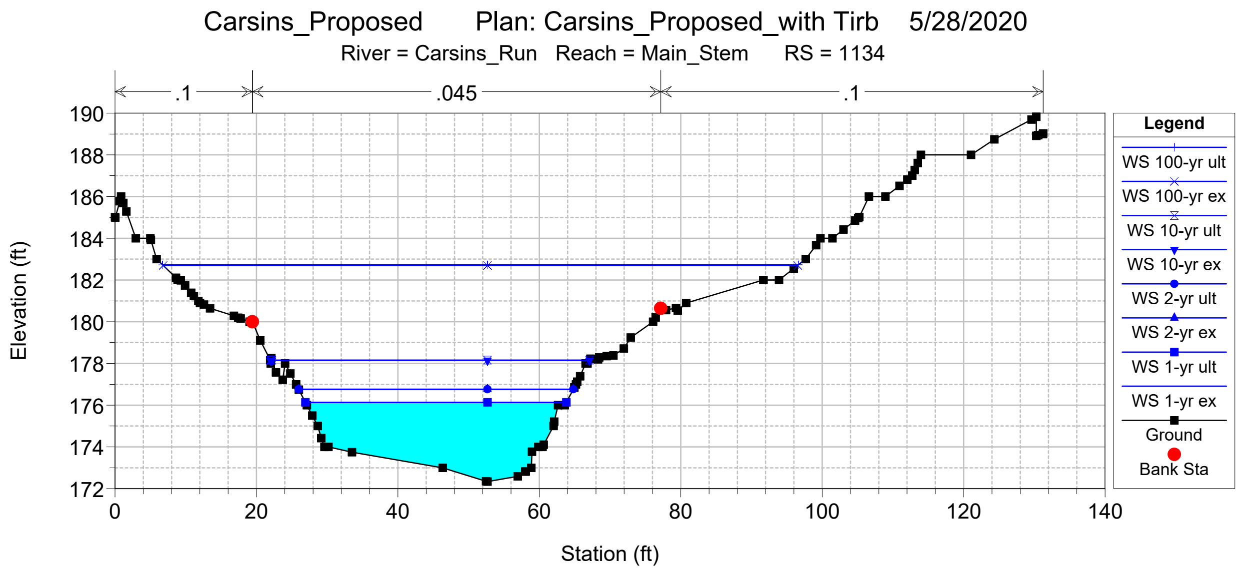


Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
River = Carsins_Run Reach = Main_Stem RS = 1214.8
.1
.045
.1
Elevation (ft)
Station (ft)
190
188
186
184
182
180
178
176
174
172
-60
-40
-20
0
20
40
60
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 10-yr ex
WS 2-yr ult
WS 2-yr ex
WS 1-yr ult
WS 1-yr ex
Ground
Bank Sta

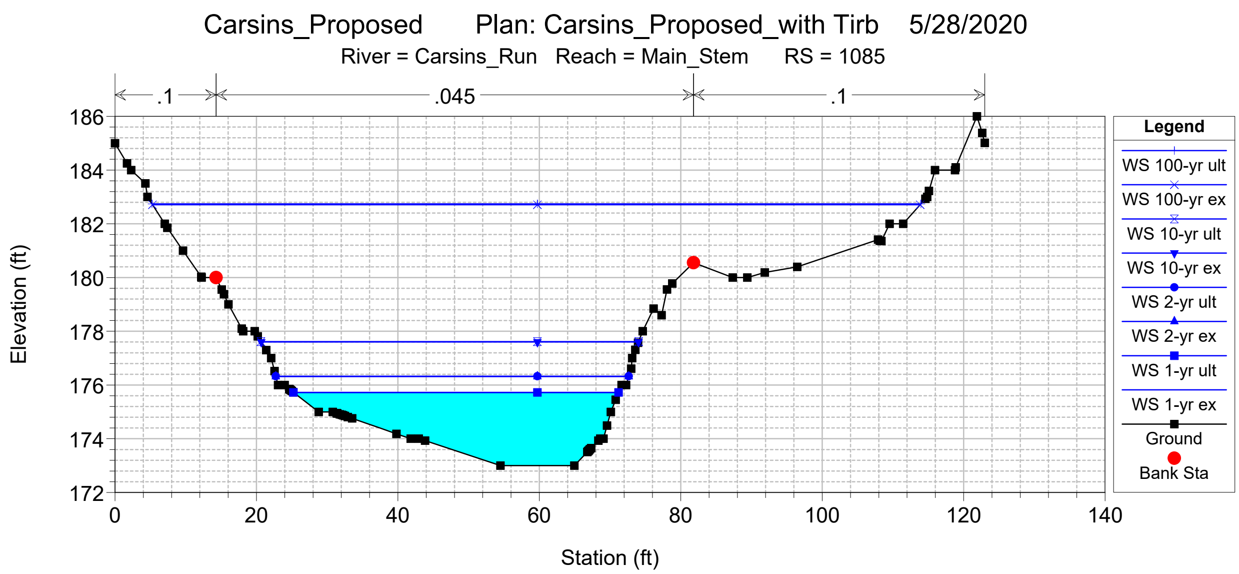

Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
River = Carsins_Run Reach = Main_Stem RS = 1205.67
.1
.045
.1
Elevation (ft)
190
185
180
175
170
-60
-40
-20
0
20
40
60
80
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 10-yr ex
WS 2-yr ult
WS 2-yr ex
WS 1-yr ult
WS 1-yr ex
Ground
Bank Sta


Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
River = Carsins_Run Reach = Main_Stem RS = 1186.07
.1
.045
.1
Elevation (ft)
190
185
180
175
170
-60
-40
-20
0
20
40
60
80
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 10-yr ex
WS 2-yr ult
WS 2-yr ex
WS 1-yr ult
WS 1-yr ex
Ground
Bank Sta

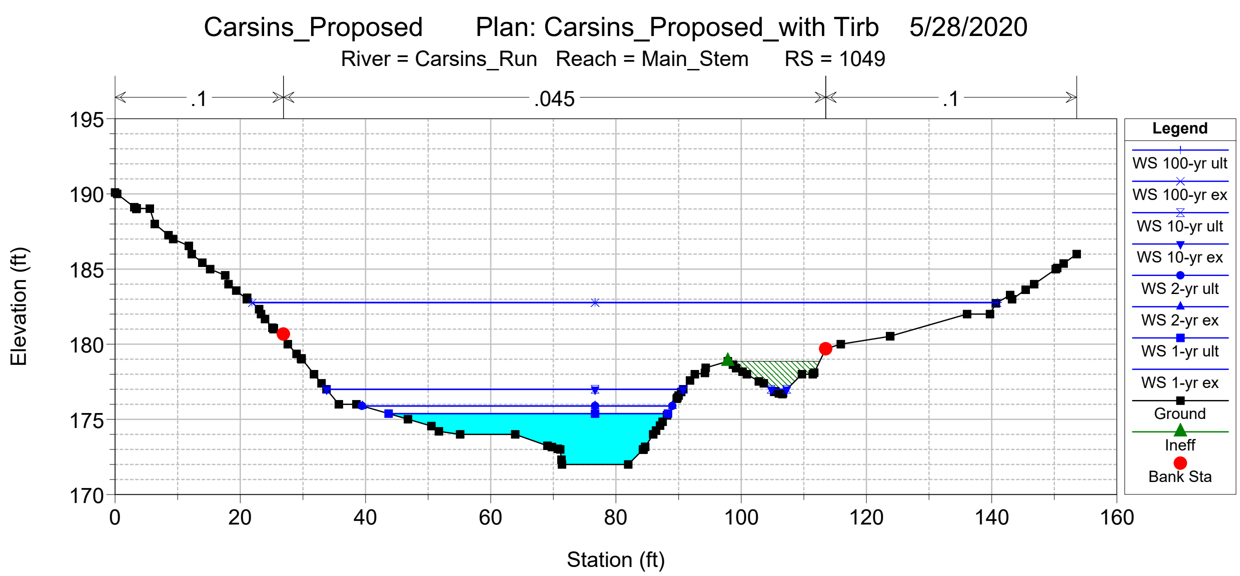

Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
River = Carsins_Run Reach = Main_Stem RS = 1180
.1
.045
.1
Elevation (ft)
186
184
182
180
178
176
174
172
0
20
40
60
80
100
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 10-yr ex
WS 2-yr ult
WS 2-yr ex
WS 1-yr ult
WS 1-yr ex
Ground
Bank Sta



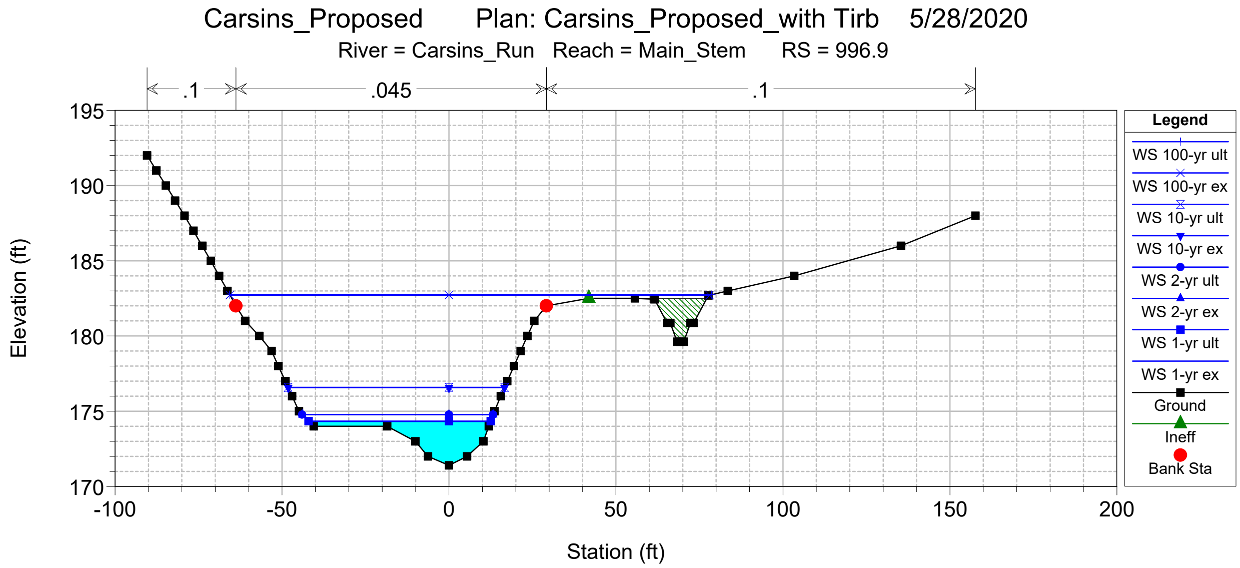
Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
River = Carsins_Run Reach = Main_Stem RS = 1134
.1
.045
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 10-yr ex
WS 2-yr ult
WS 2-yr ex
WS 1-yr ult
WS 1-yr ex
Ground
Bank Sta



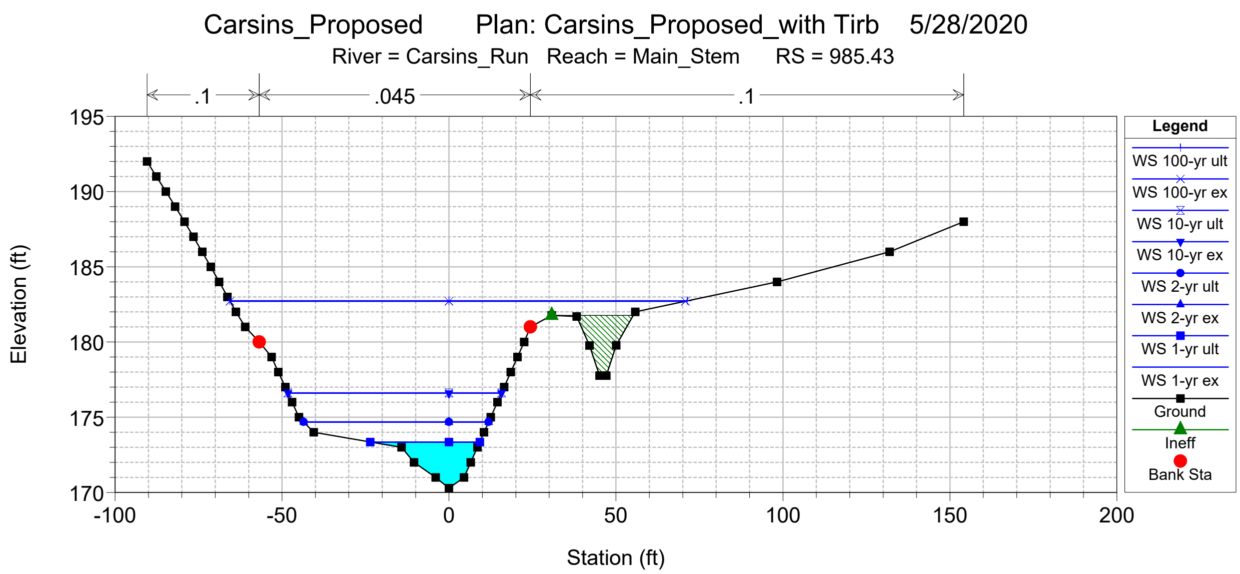
Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
River = Carsins_Run Reach = Main_Stem RS = 1085
.1
.045
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 10-yr ex
WS 2-yr ult
WS 2-yr ex
WS 1-yr ult
WS 1-yr ex
Ground
Bank Sta



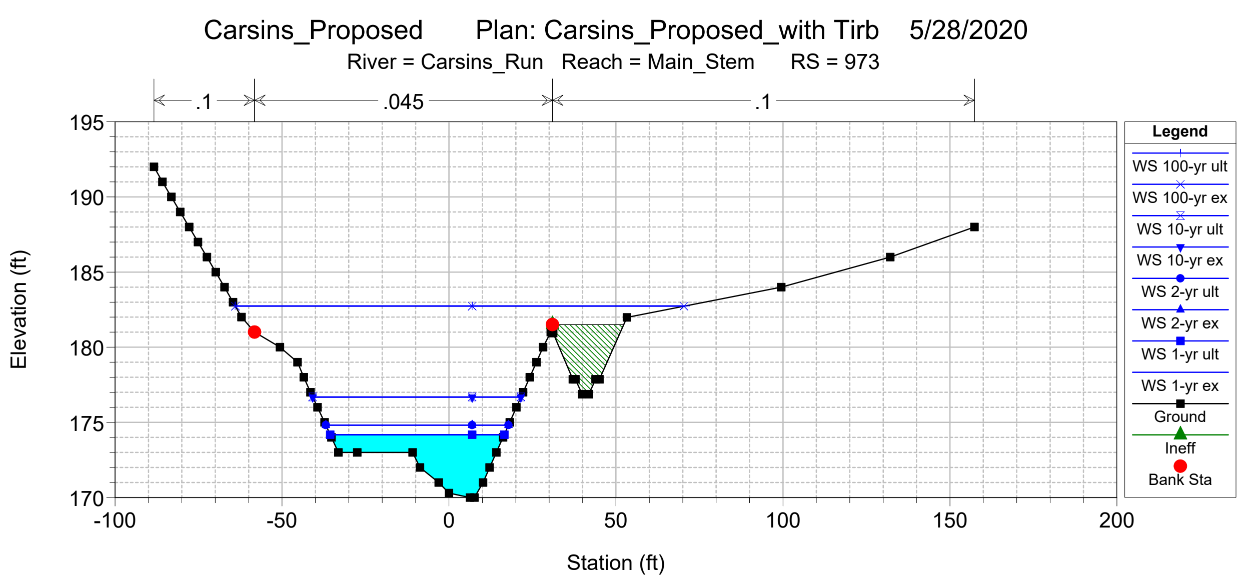
Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
River = Carsins_Run Reach = Main_Stem RS = 1049
.1
.045
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 10-yr ex
WS 2-yr ult
WS 2-yr ex
WS 1-yr ult
WS 1-yr ex
Ground
Ineff
Bank Sta



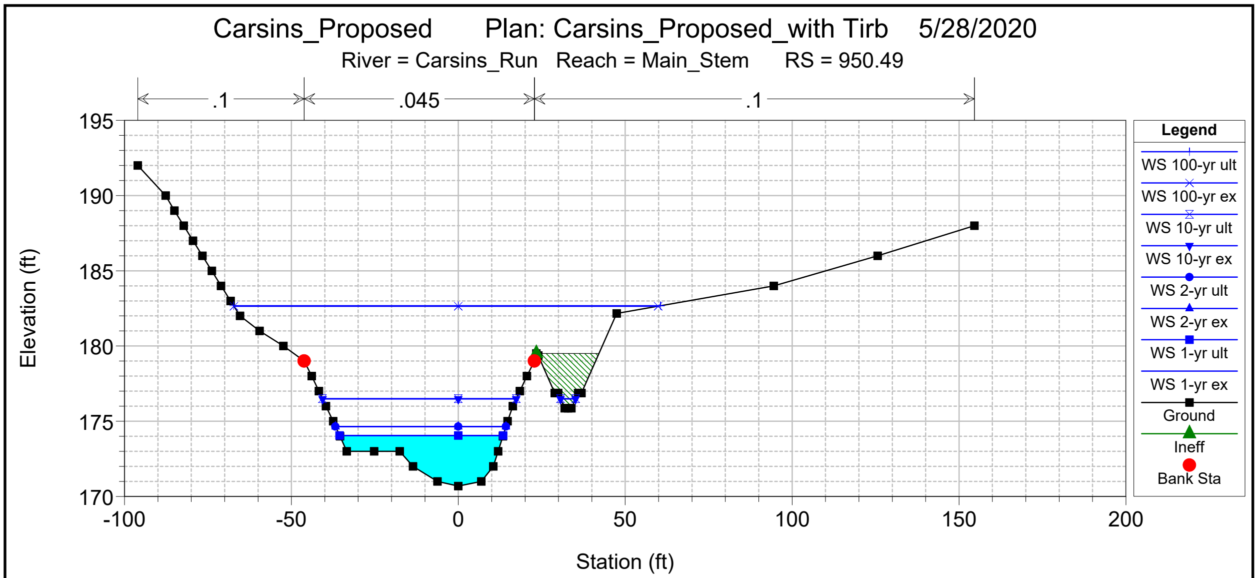
Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
River = Carsins_Run Reach = Main_Stem RS = 996.9
.1
.045
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 10-yr ex
WS 2-yr ult
WS 2-yr ex
WS 1-yr ult
WS 1-yr ex
Ground
Ineff
Bank Sta

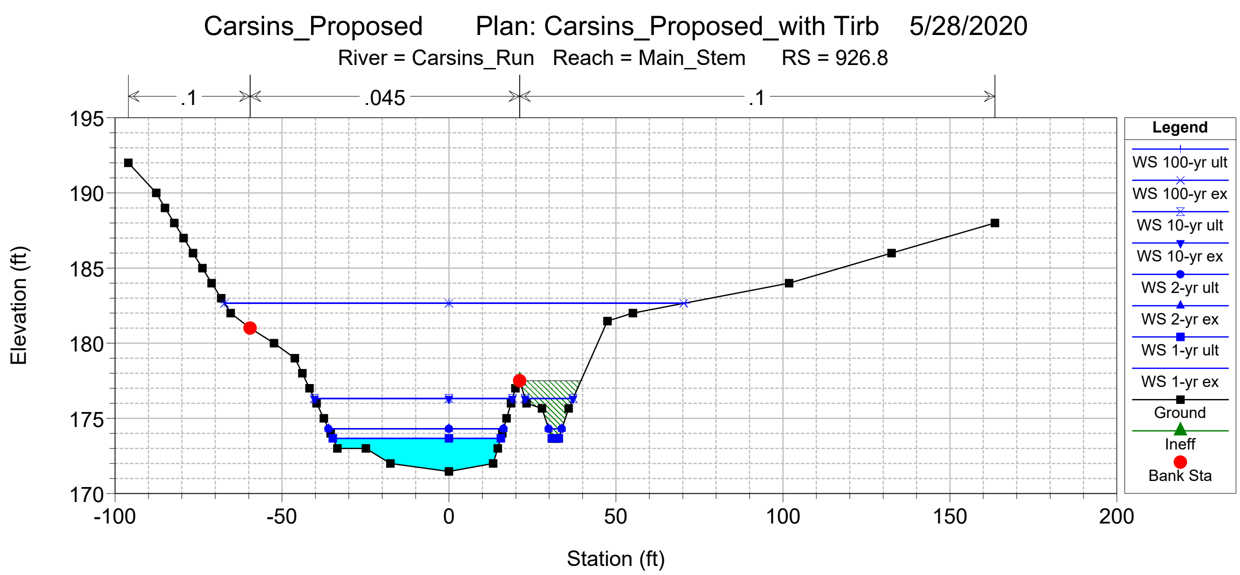


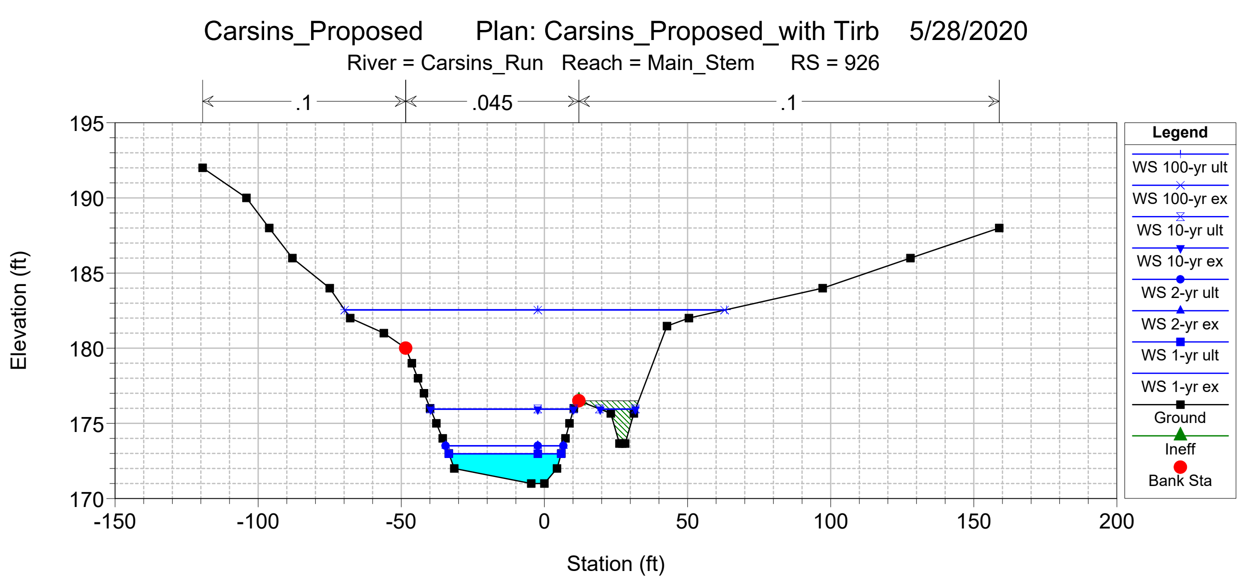
Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
River = Carsins_Run Reach = Main_Stem RS = 985.43
.1
.045
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 10-yr ex
WS 2-yr ult
WS 2-yr ex
WS 1-yr ult
WS 1-yr ex
Ground
Ineff
Bank Sta

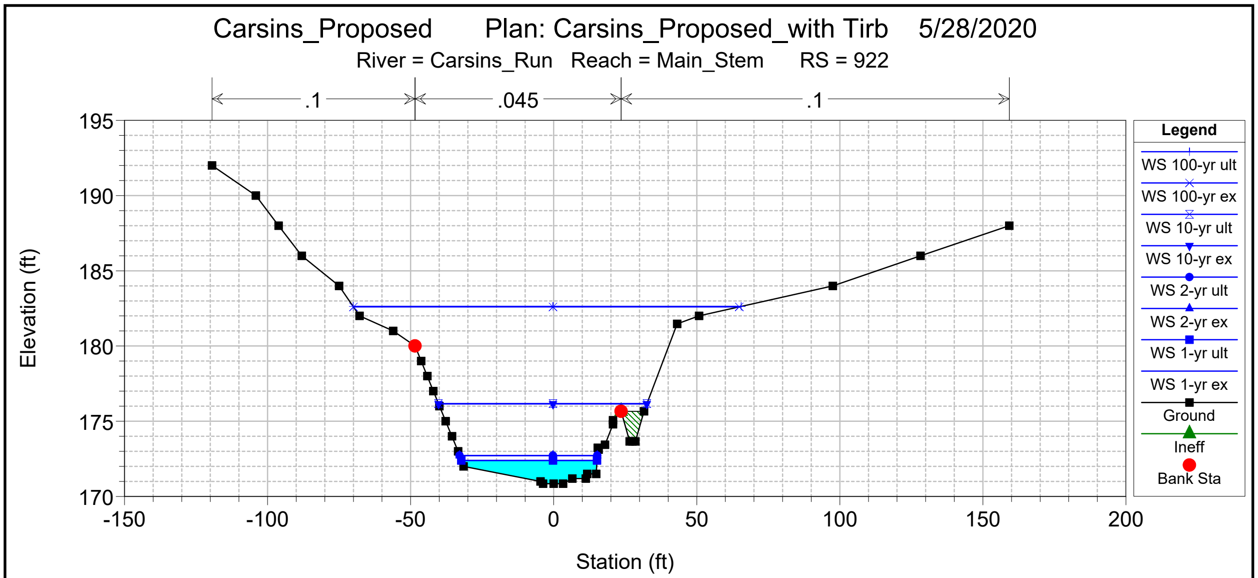


Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
River = Carsins_Run Reach = Main_Stem RS = 973
.1
.045
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 10-yr ex
WS 2-yr ult
WS 2-yr ex
WS 1-yr ult
WS 1-yr ex
Ground
Ineff
Bank Sta

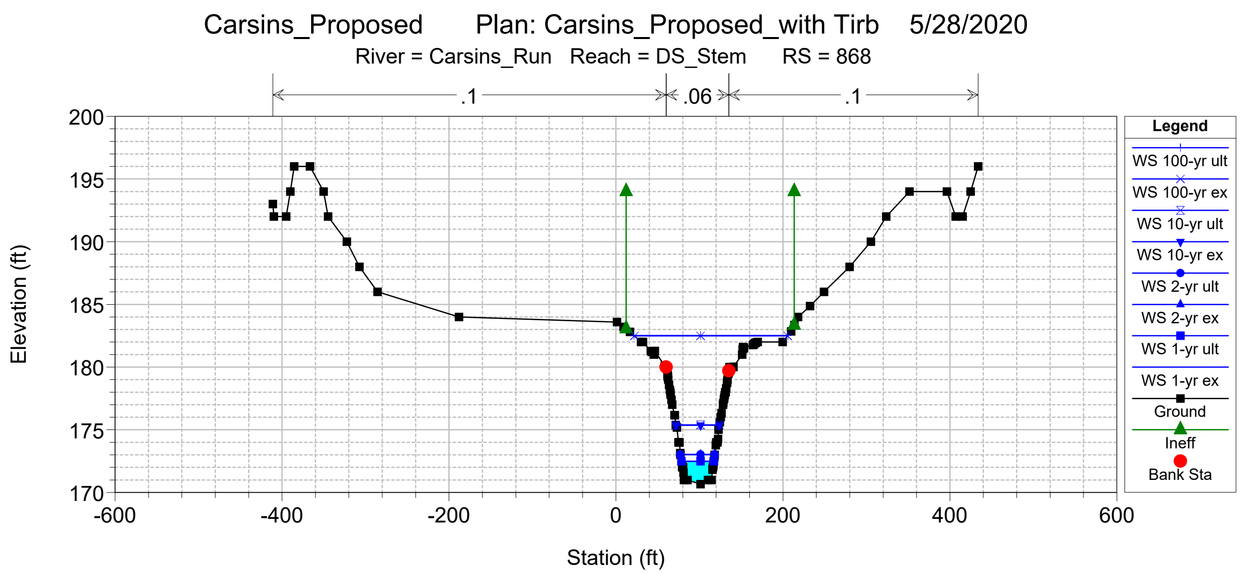

Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
River = Carsins_Run Reach = Main_Stem RS = 950.49
.1
.045
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 10-yr ex
WS 2-yr ult
WS 2-yr ex
WS 1-yr ult
WS 1-yr ex
Ground
Ineff
Bank Sta


Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
River = Carsins_Run Reach = Main_Stem RS = 926.8
.1
.045
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 10-yr ex
WS 2-yr ult
WS 2-yr ex
WS 1-yr ult
WS 1-yr ex
Ground
Ineff
Bank Sta

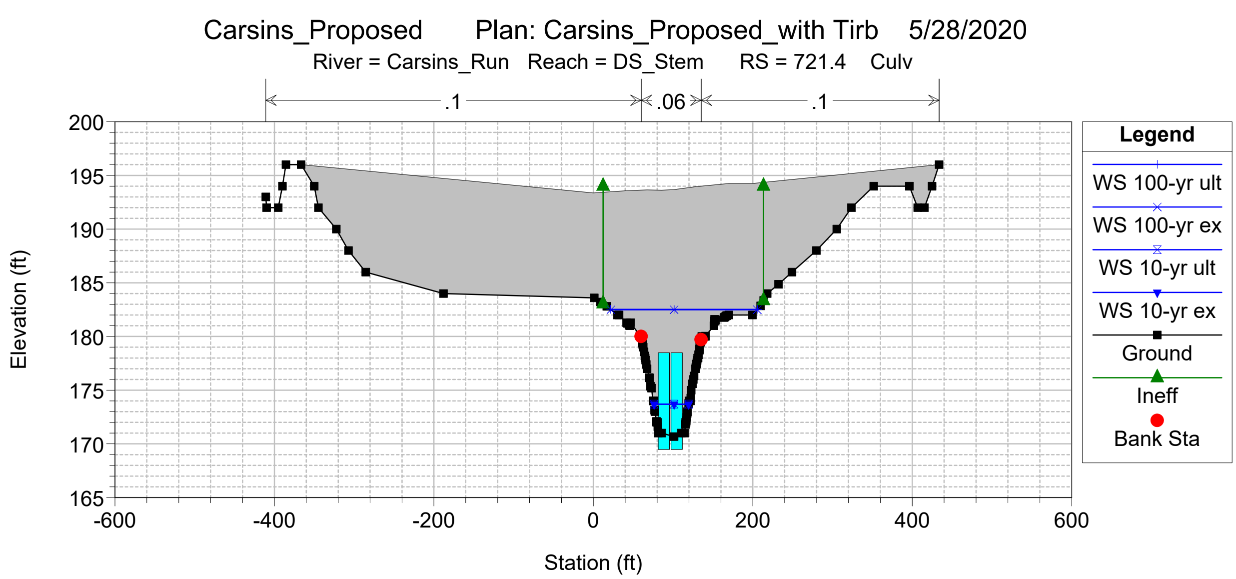

Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
River = Carsins_Run Reach = Main_Stem RS = 926
.1
.045
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 10-yr ex
WS 2-yr ult
WS 2-yr ex
WS 1-yr ult
WS 1-yr ex
Ground
Ineff
Bank Sta



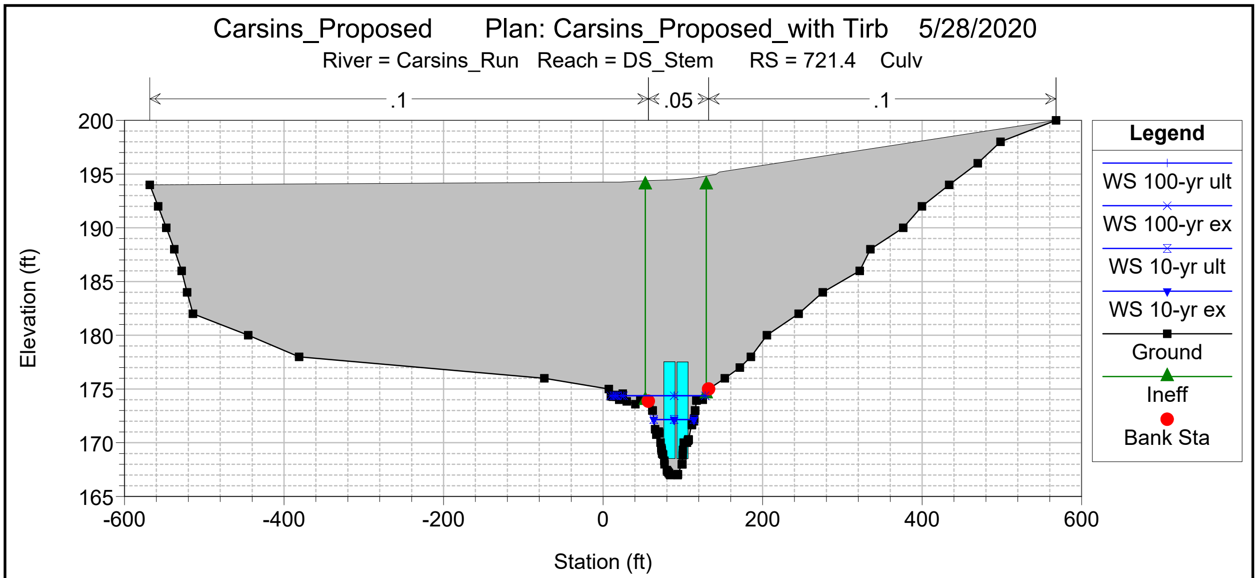
Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
River = Carsins_Run Reach = Main_Stem RS = 922
.1
.045
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 10-yr ex
WS 2-yr ult
WS 2-yr ex
WS 1-yr ult
WS 1-yr ex
Ground
Ineff
Bank Sta

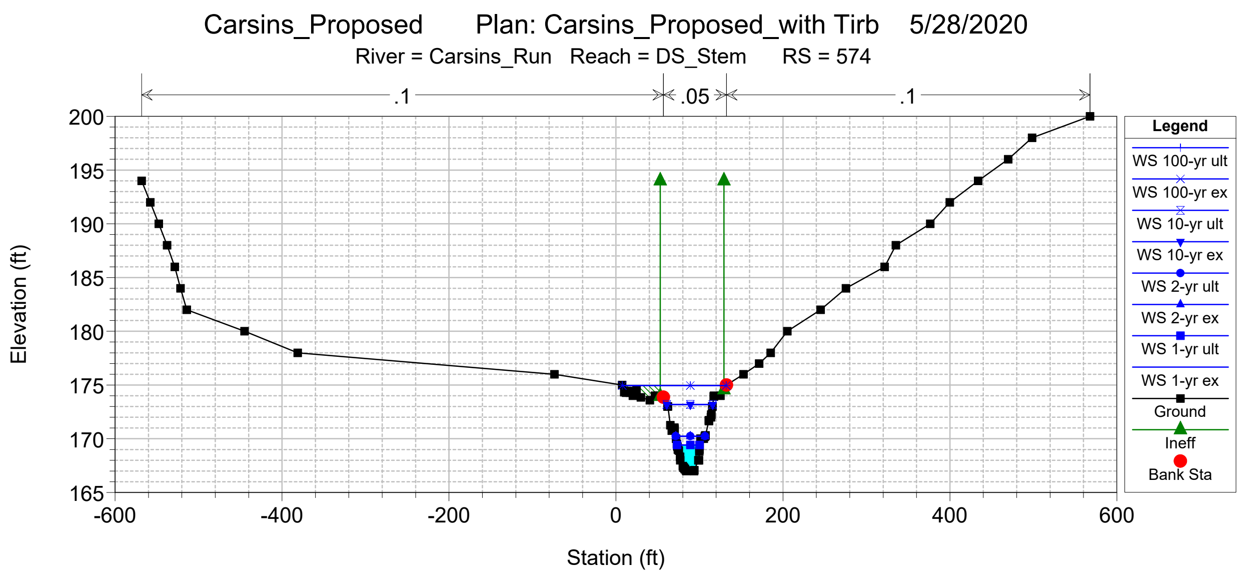


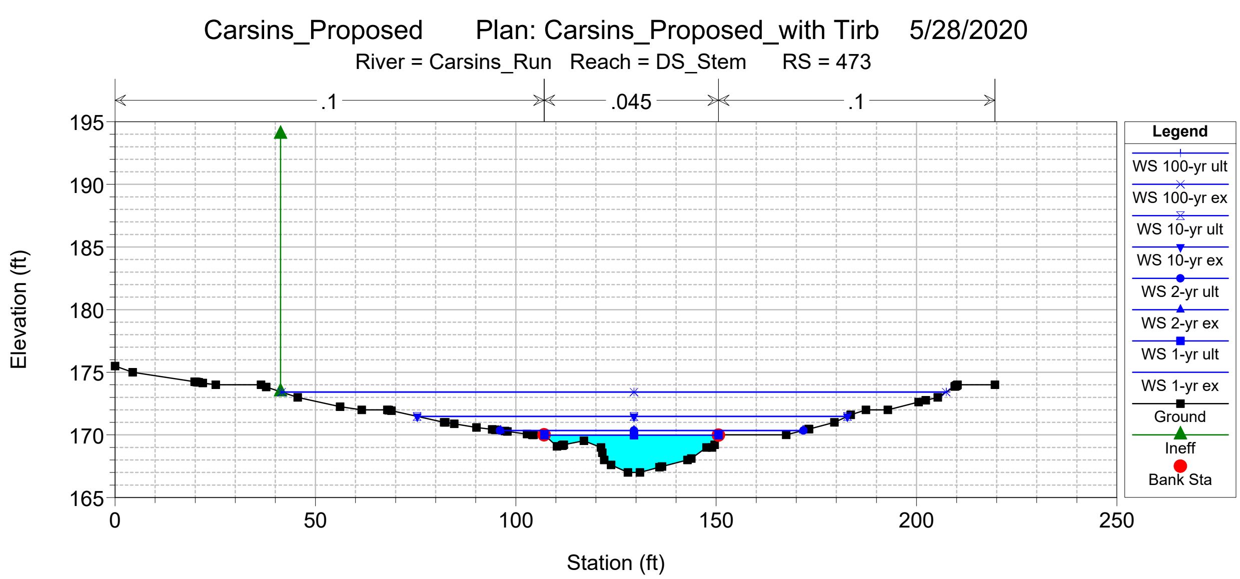
Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
River = Carsins_Run Reach = DS_Stem RS = 868
.1
.06
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 10-yr ex
WS 2-yr ult
WS 2-yr ex
WS 1-yr ult
WS 1-yr ex
Ground
Ineff
Bank Sta

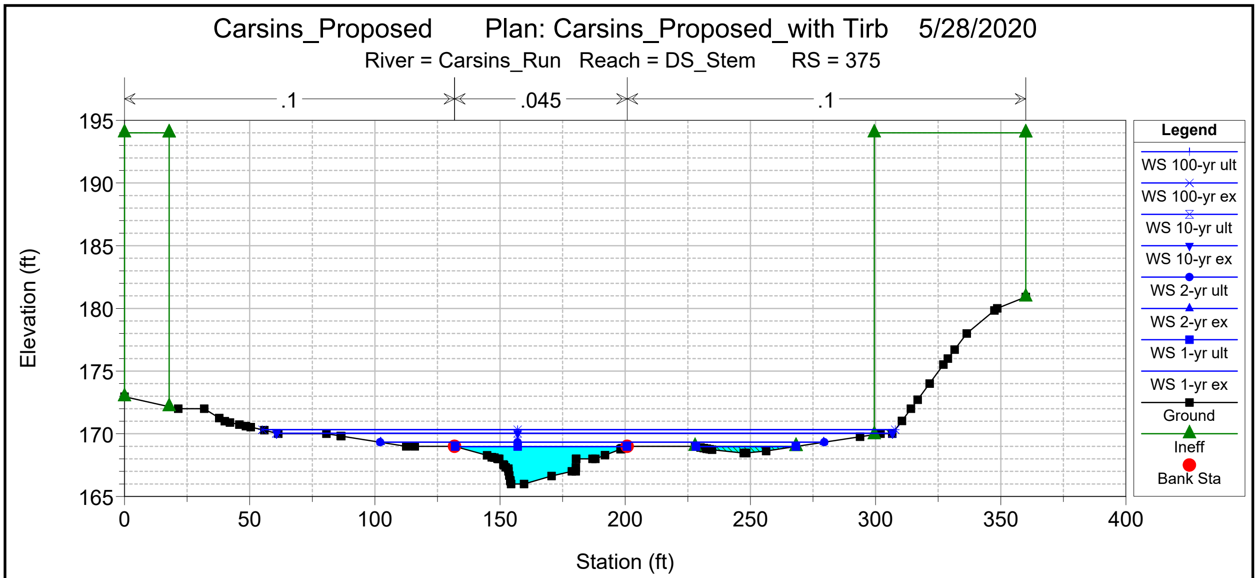


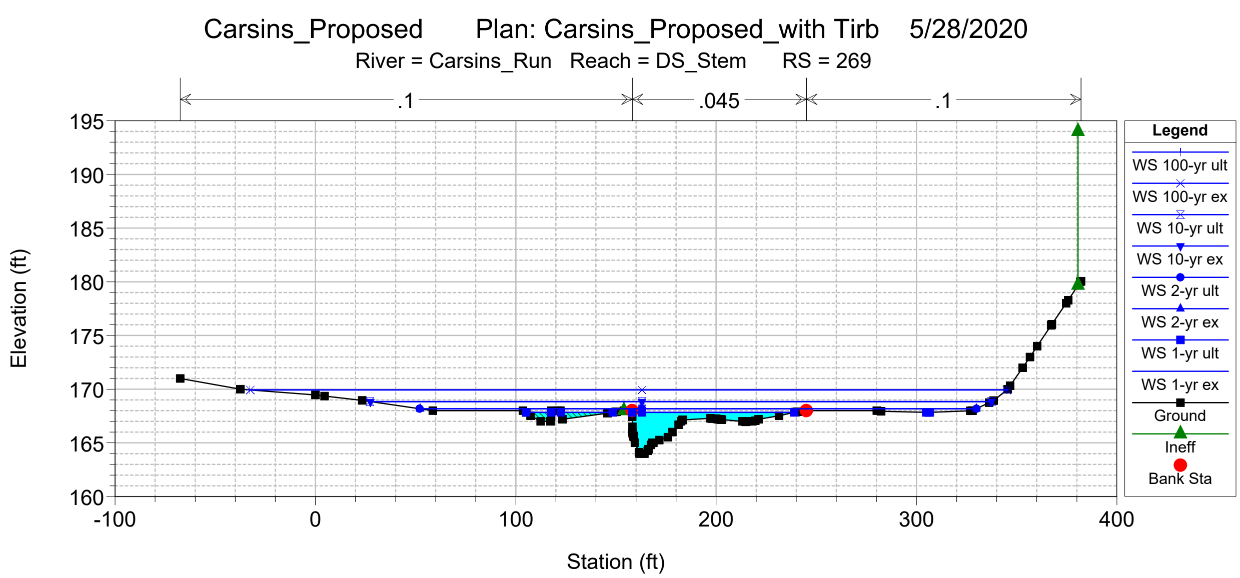
Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
River = Carsins_Run Reach = DS_Stem RS = 721.4 Culv
.1
.06
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 10-yr ex
Ground
Ineff
Bank Sta

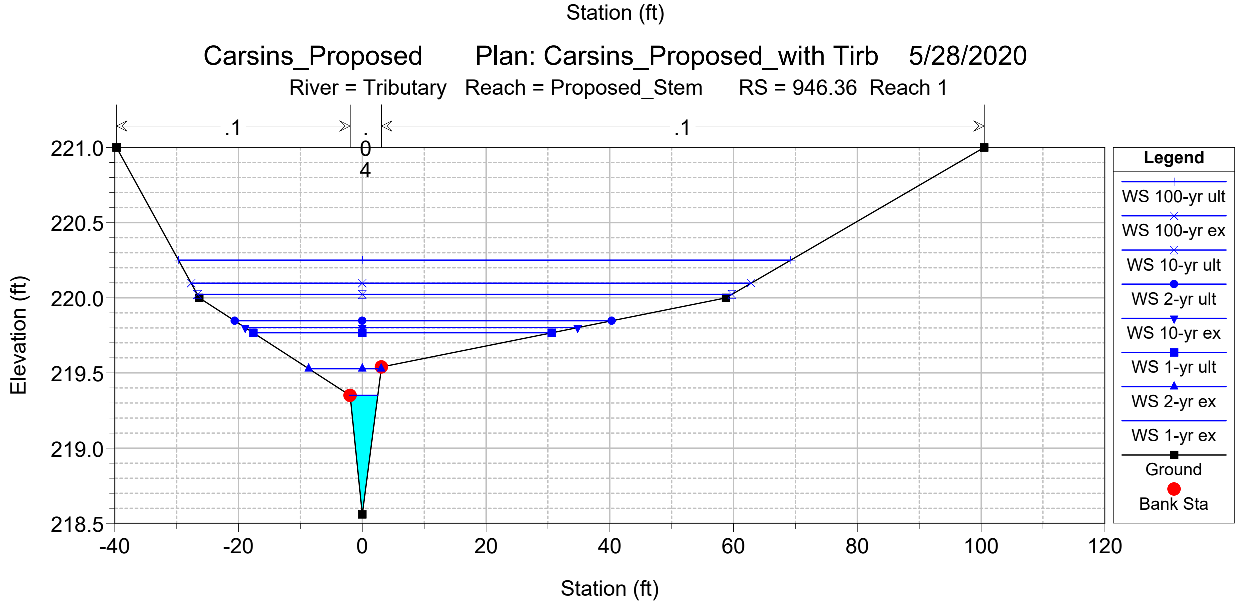

Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
River = Carsins_Run Reach = DS_Stem RS = 721.4 Culv
.1
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 10-yr ex
Ground
Ineff
Bank Sta

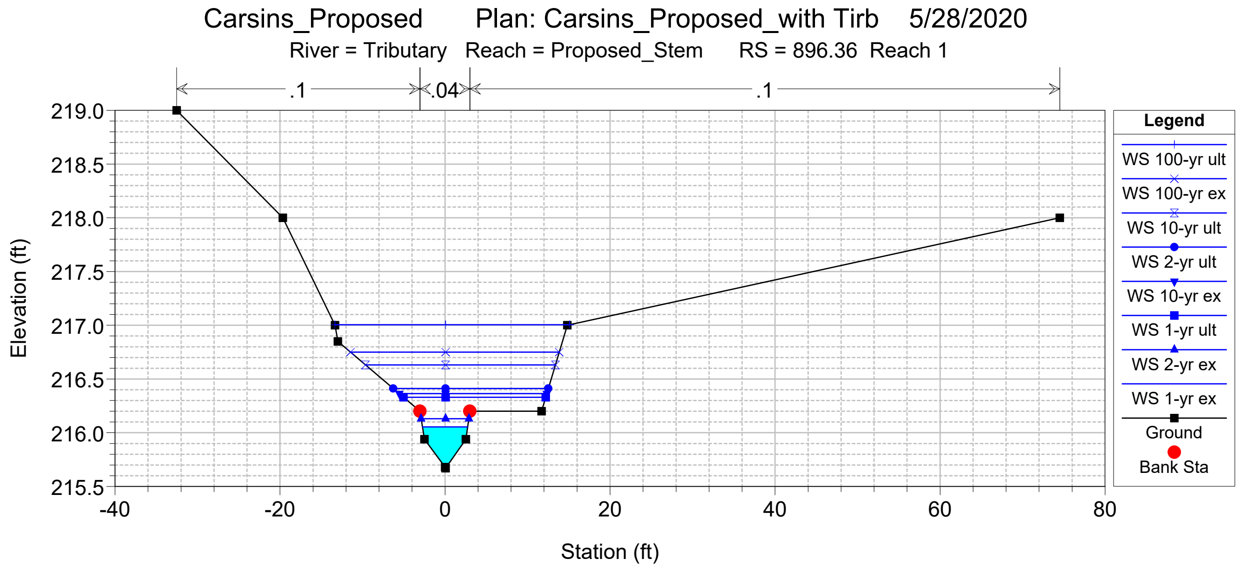

Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
River = Carsins_Run Reach = DS_Stem RS = 574
.1
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 10-yr ex
WS 2-yr ult
WS 2-yr ex
WS 1-yr ult
WS 1-yr ex
Ground
Ineff
Bank Sta


Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
River = Carsins_Run Reach = DS_Stem RS = 473
.1
.045
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 10-yr ex
WS 2-yr ult
WS 2-yr ex
WS 1-yr ult
WS 1-yr ex
Ground
Ineff
Bank Sta

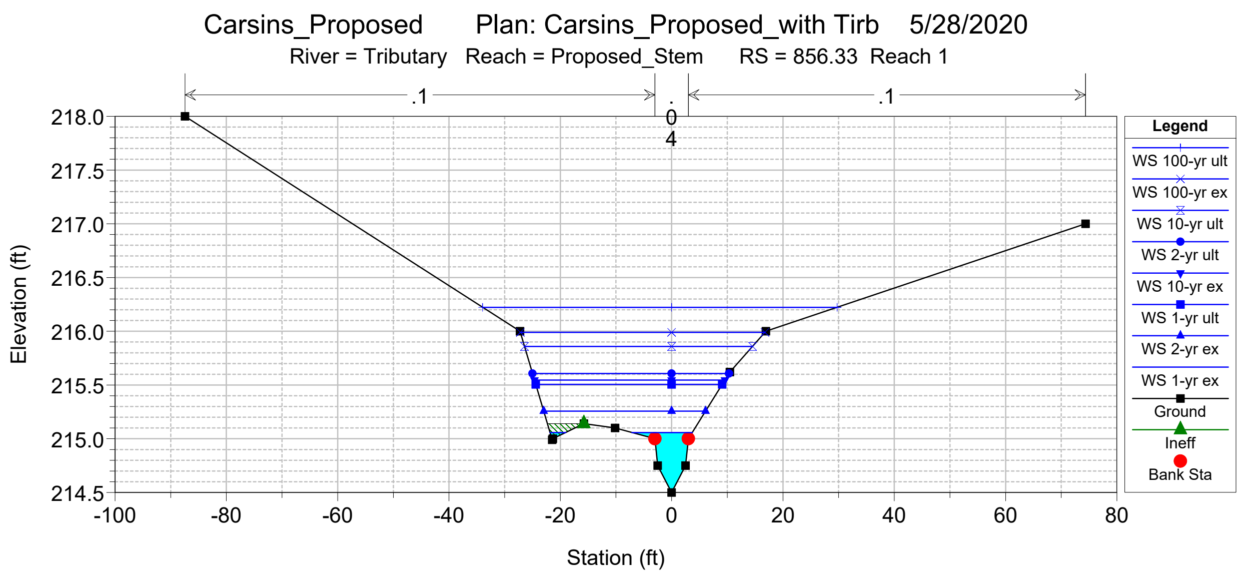

Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
River = Carsins_Run Reach = DS_Stem RS = 375
.1
.045
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 10-yr ex
WS 2-yr ult
WS 2-yr ex
WS 1-yr ult
WS 1-yr ex
Ground
Ineff
Bank Sta


Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
River = Carsins_Run Reach = DS_Stem RS = 269
.1
.045
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 10-yr ex
WS 2-yr ult
WS 2-yr ex
WS 1-yr ult
WS 1-yr ex
Ground
Ineff
Bank Sta

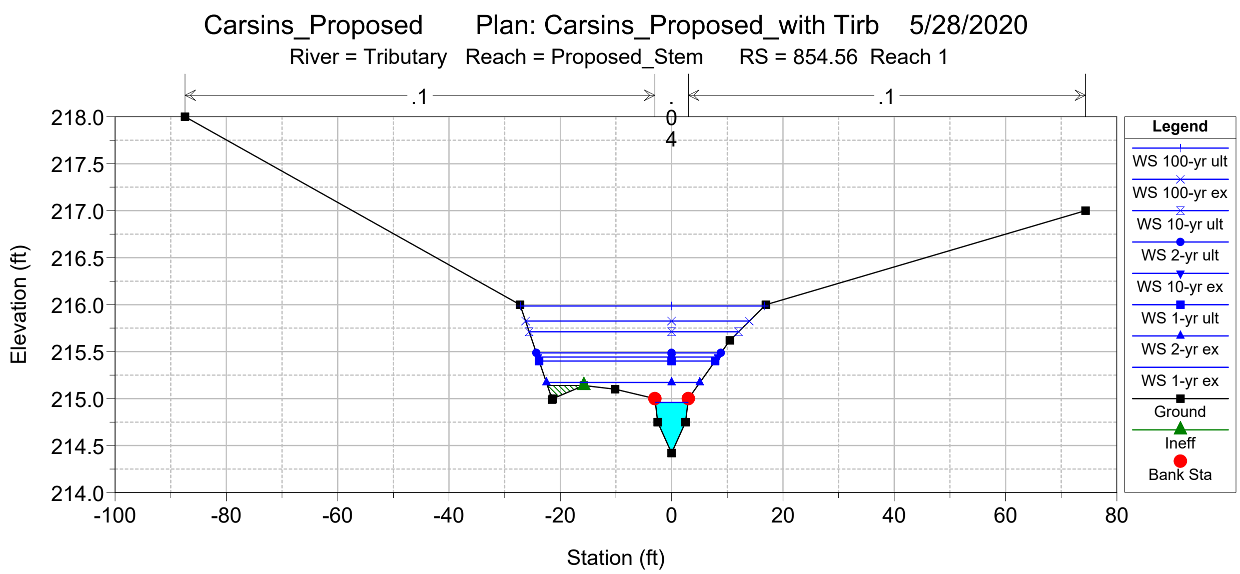

Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
River = Tributary Reach = Proposed_Stem RS = 946.36 Reach 1
.1
.04
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 2-yr ult
WS 10-yr ex
WS 1-yr ult
WS 2-yr ex
WS 1-yr ex
Ground
Bank Sta



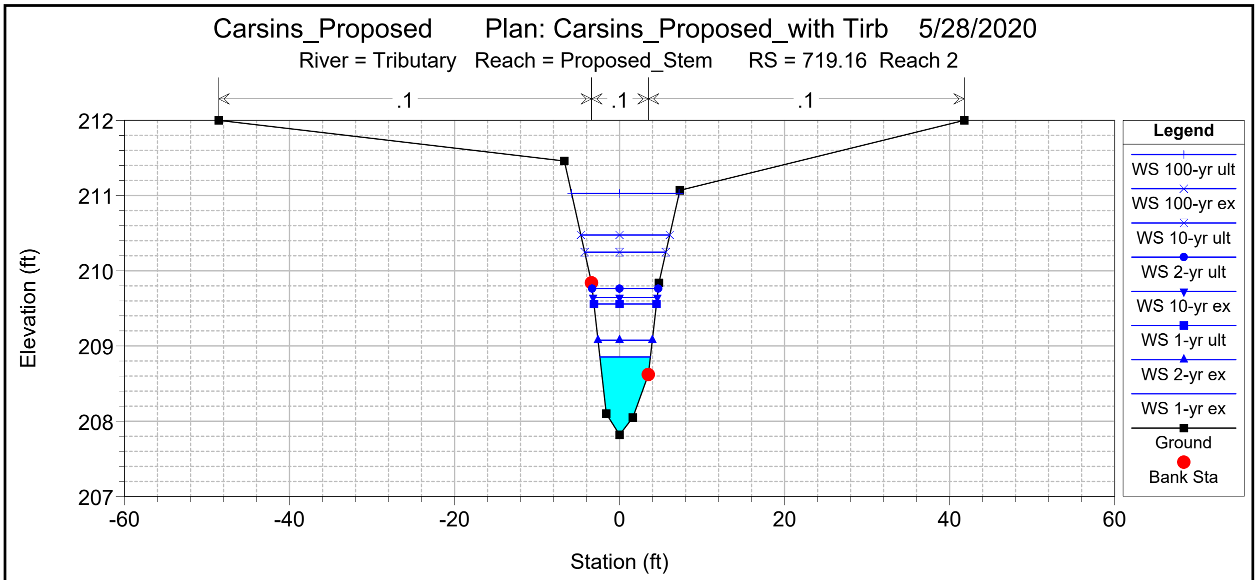
Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
River = Tributary Reach = Proposed_Stem RS = 896.36 Reach 1
.1
.04
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 2-yr ult
WS 10-yr ex
WS 1-yr ult
WS 2-yr ex
WS 1-yr ex
Ground
Bank Sta

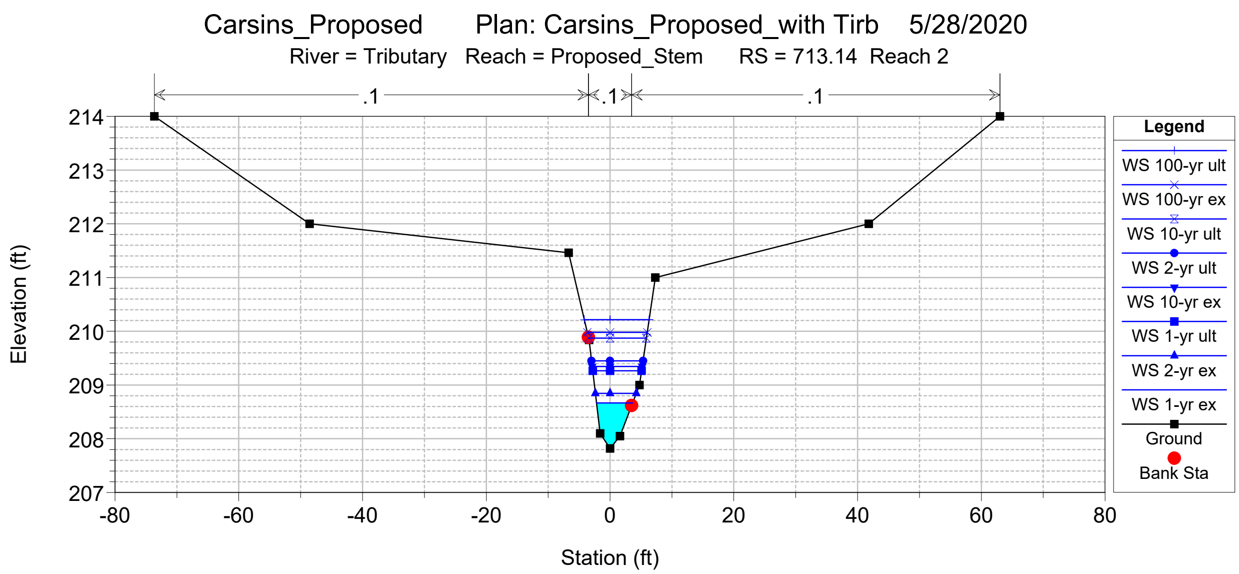


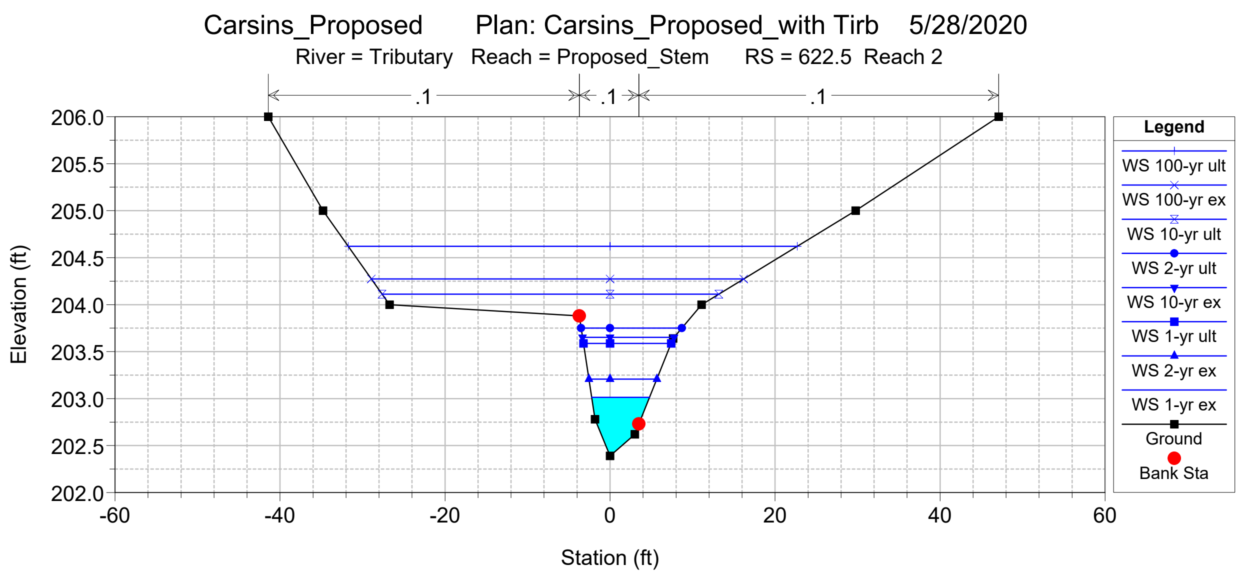
Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
River = Tributary Reach = Proposed_Stem RS = 856.33 Reach 1
.1
.04
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 2-yr ult
WS 10-yr ex
WS 1-yr ult
WS 2-yr ex
WS 1-yr ex
Ground
Ineff
Bank Sta



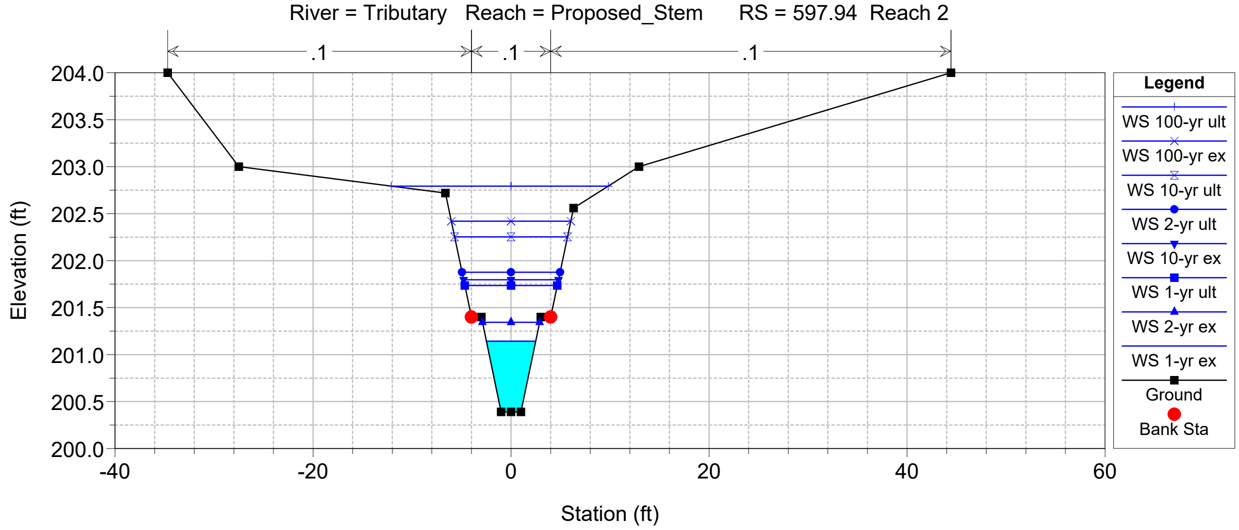
Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
River = Tributary Reach = Proposed_Stem RS = 854.56 Reach 1
.1
.04
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 2-yr ult
WS 10-yr ex
WS 1-yr ult
WS 2-yr ex
WS 1-yr ex
Ground
Ineff
Bank Sta


Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
River = Tributary Reach = Proposed_Stem RS = 719.16 Reach 2
.1
.1
.1
Elevation (ft)
Station (ft)
212
211
210
209
208
207
-60
-40
-20
0
20
40
60
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 2-yr ult
WS 10-yr ex
WS 1-yr ult
WS 2-yr ex
WS 1-yr ex
Ground
Bank Sta

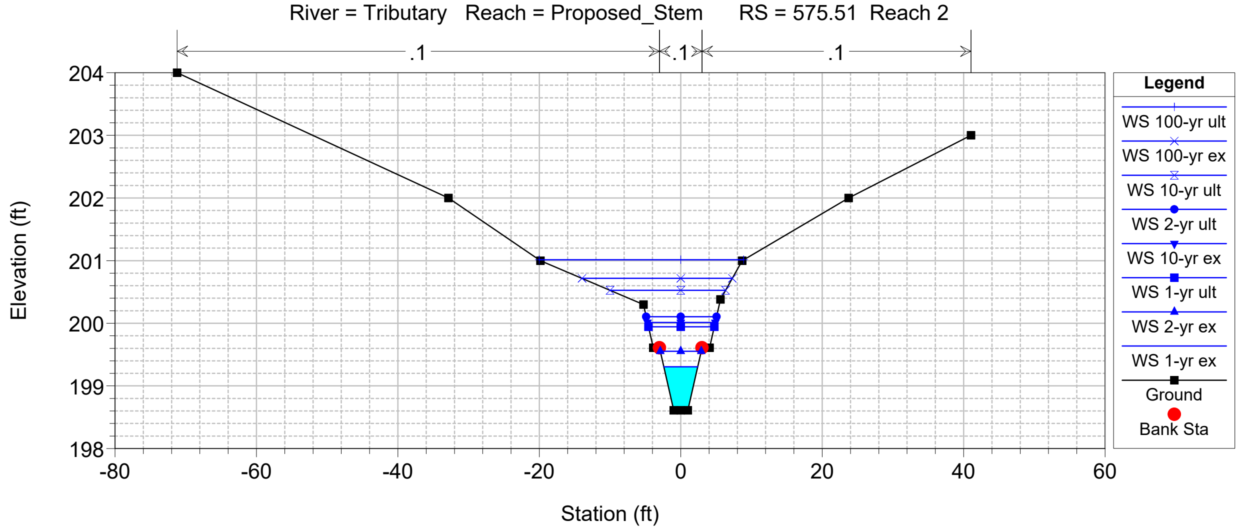

Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
River = Tributary Reach = Proposed_Stem RS = 713.14 Reach 2
.1
.1
.1
Elevation (ft)
Station (ft)
214
213
212
211
210
209
208
207
-80
-60
-40
-20
0
20
40
60
80
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 2-yr ult
WS 10-yr ex
WS 1-yr ult
WS 2-yr ex
WS 1-yr ex
Ground
Bank Sta


Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
River = Tributary Reach = Proposed_Stem RS = 622.5 Reach 2
.1
.1
.1
Elevation (ft)
Station (ft)
206.0
205.5
205.0
204.5
204.0
203.5
203.0
202.5
202.0
-60
-40
-20
0
20
40
60
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 2-yr ult
WS 10-yr ex
WS 1-yr ult
WS 2-yr ex
WS 1-yr ex
Ground
Bank Sta

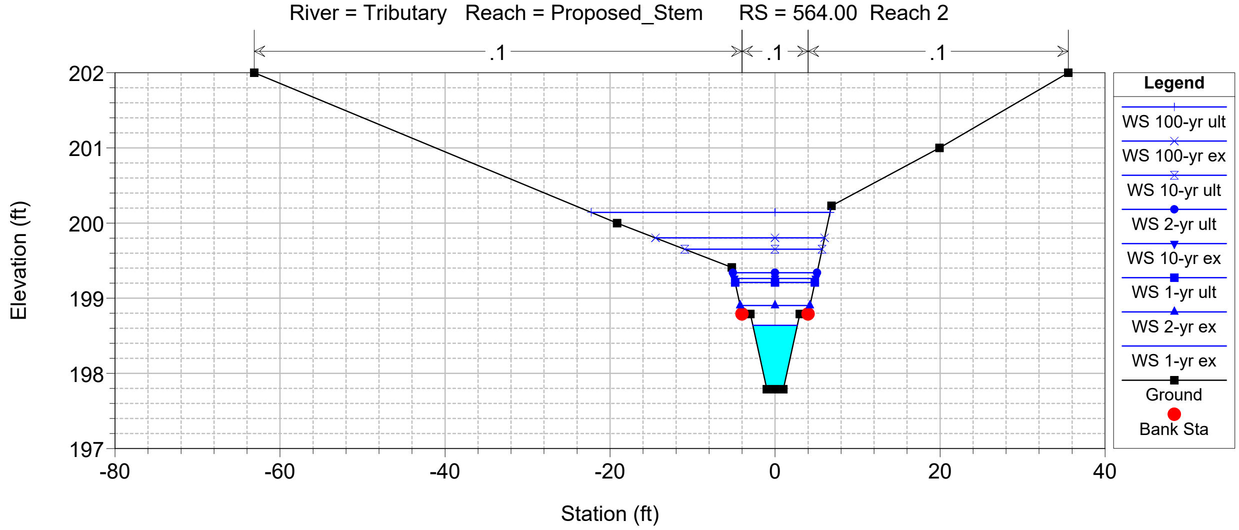
Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
River = Tributary Reach = Proposed_Stem RS = 597.94 Reach 2

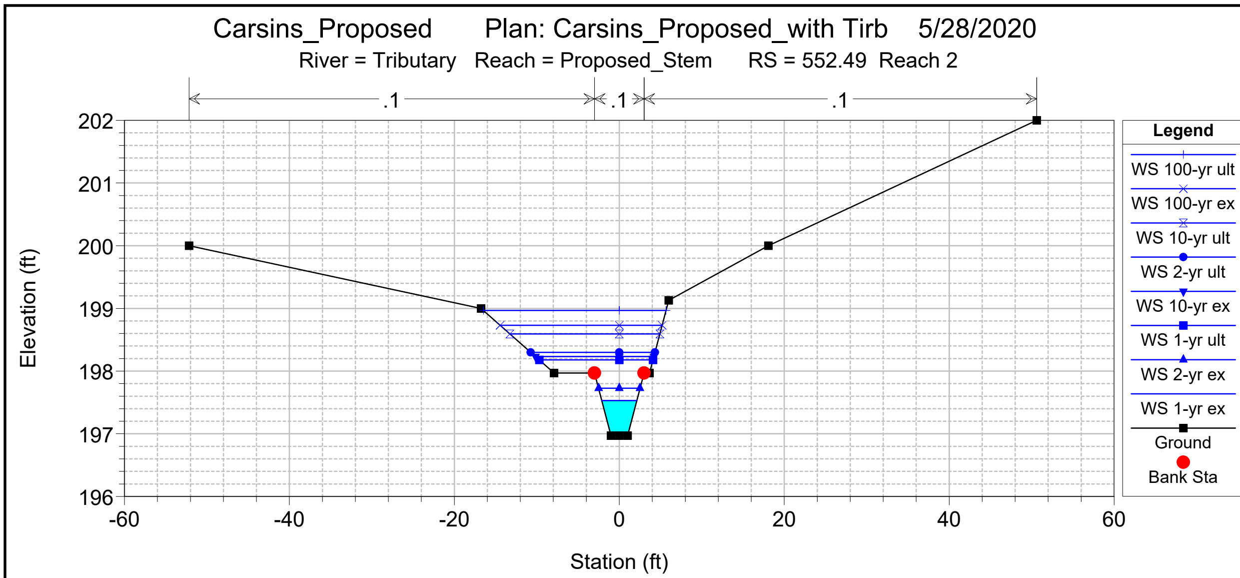


Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
River = Tributary Reach = Proposed_Stem RS = 575.51 Reach 2

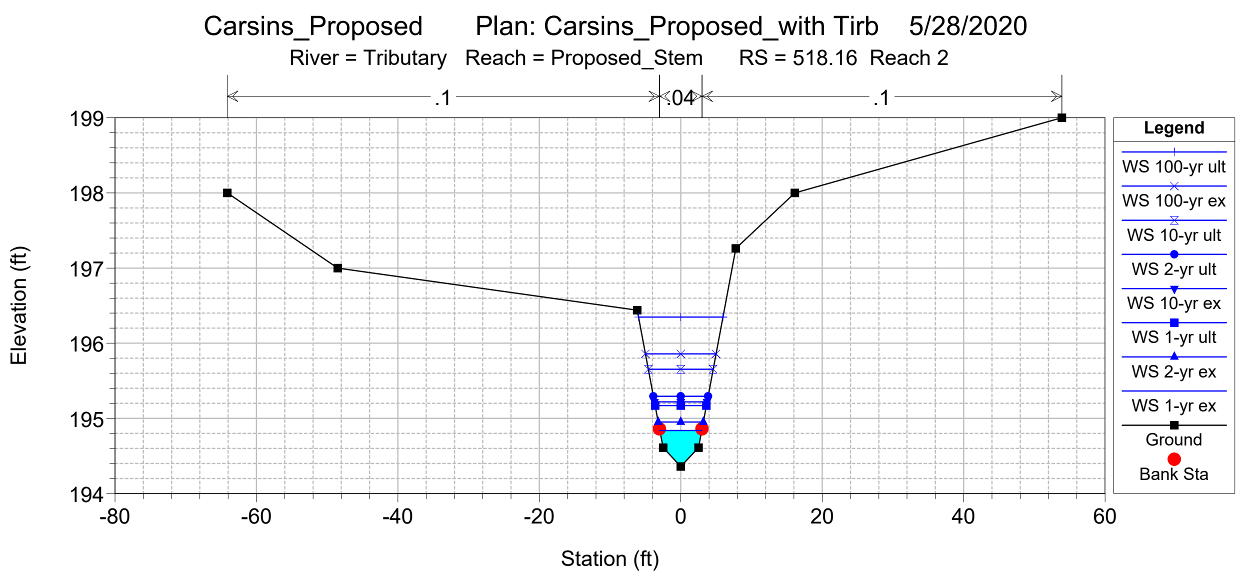


Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
River = Tributary Reach = Proposed_Stem RS = 564.00 Reach 2

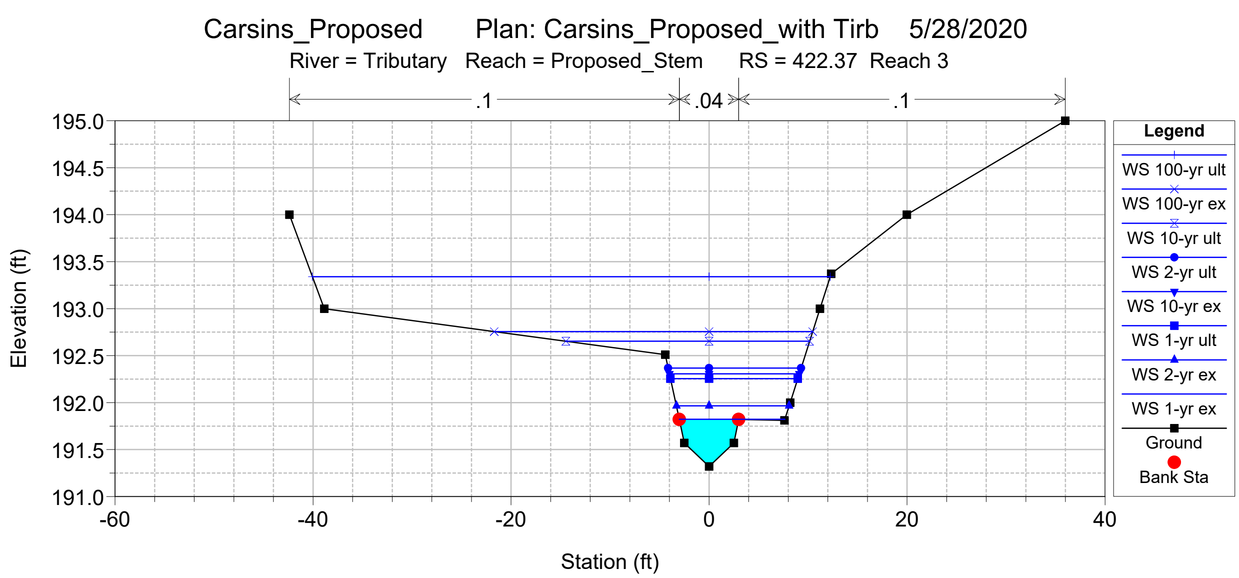




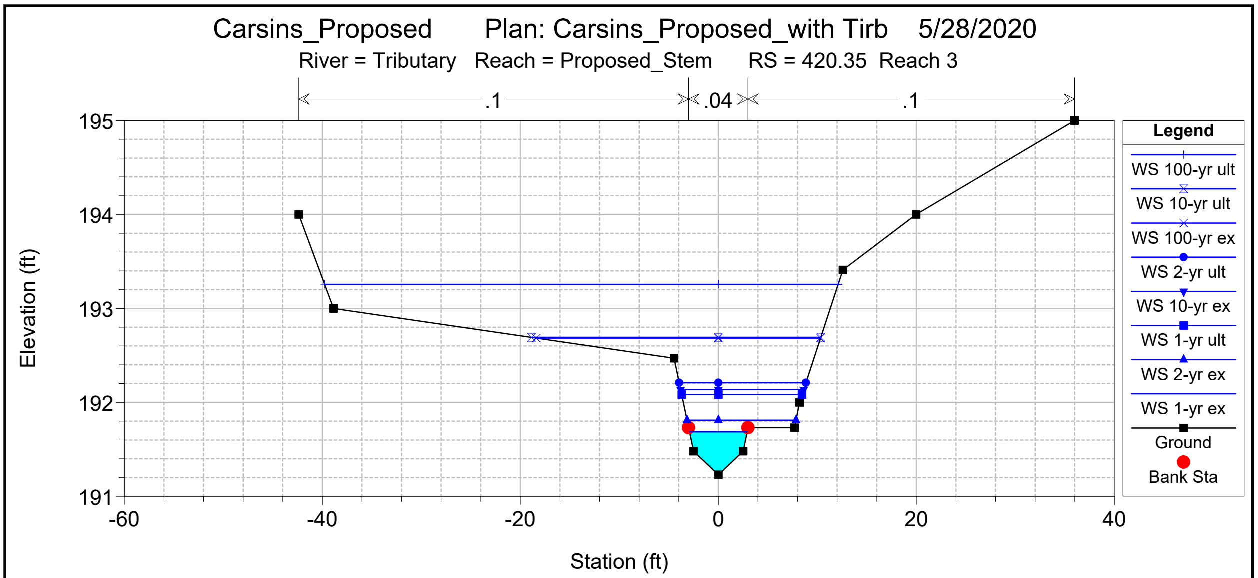
Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
River = Tributary Reach = Proposed_Stem RS = 552.49 Reach 2
.1
.1
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 2-yr ult
WS 10-yr ex
WS 1-yr ult
WS 2-yr ex
WS 1-yr ex
Ground
Bank Sta

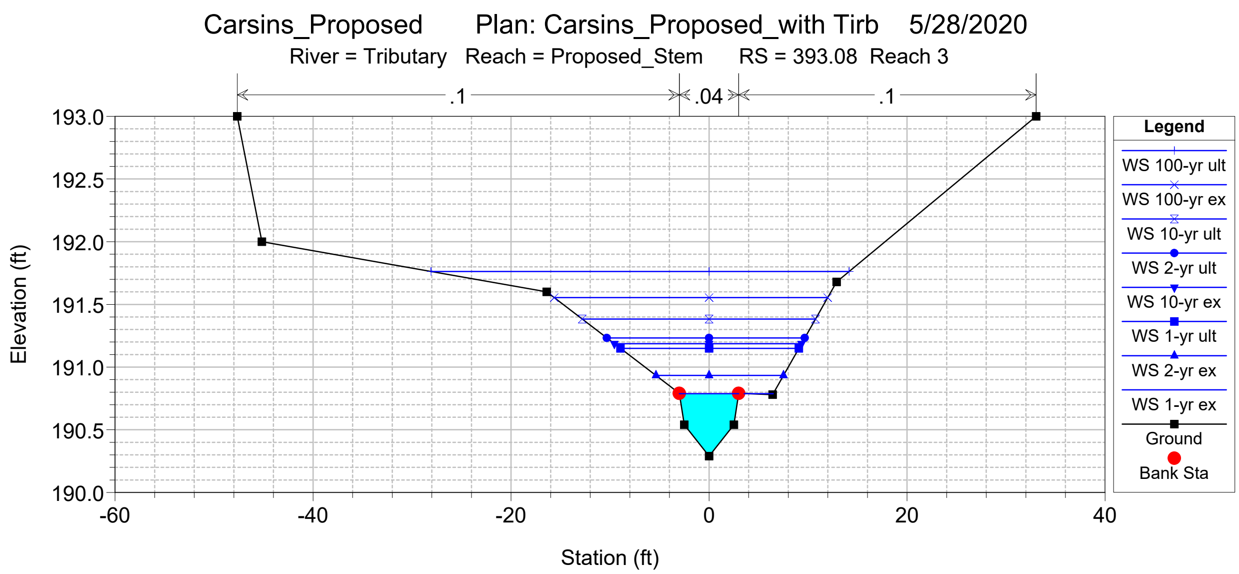


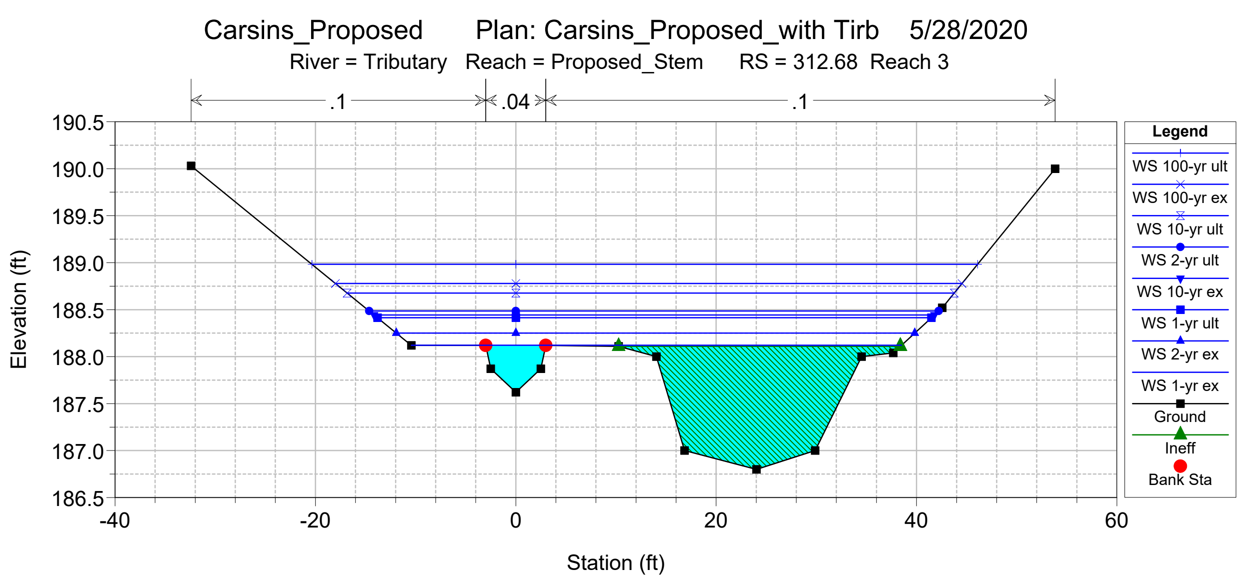
Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
River = Tributary Reach = Proposed_Stem RS = 518.16 Reach 2
.1
.04
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 2-yr ult
WS 10-yr ex
WS 1-yr ult
WS 2-yr ex
WS 1-yr ex
Ground
Bank Sta

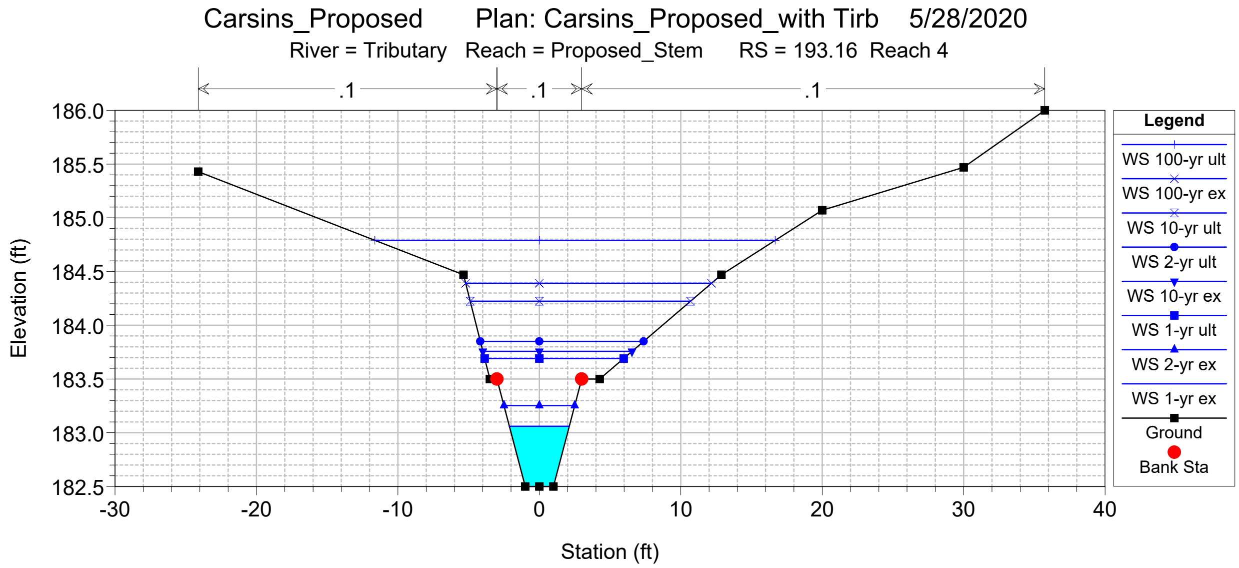


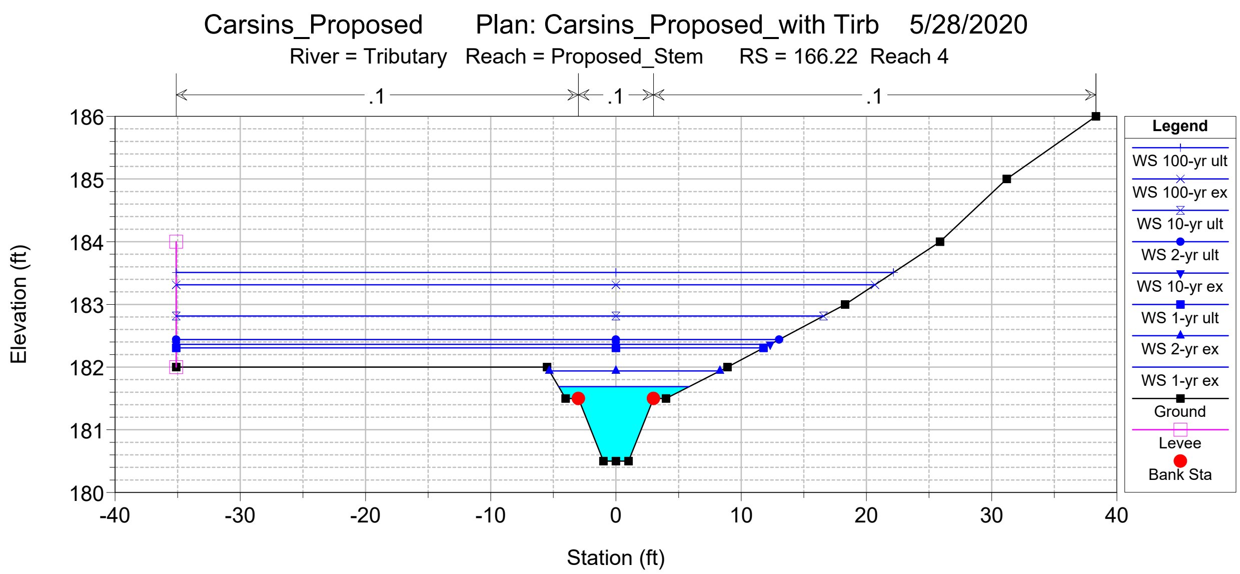
Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
River = Tributary Reach = Proposed_Stem RS = 422.37 Reach 3
.1
.04
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 2-yr ult
WS 10-yr ex
WS 1-yr ult
WS 2-yr ex
WS 1-yr ex
Ground
Bank Sta

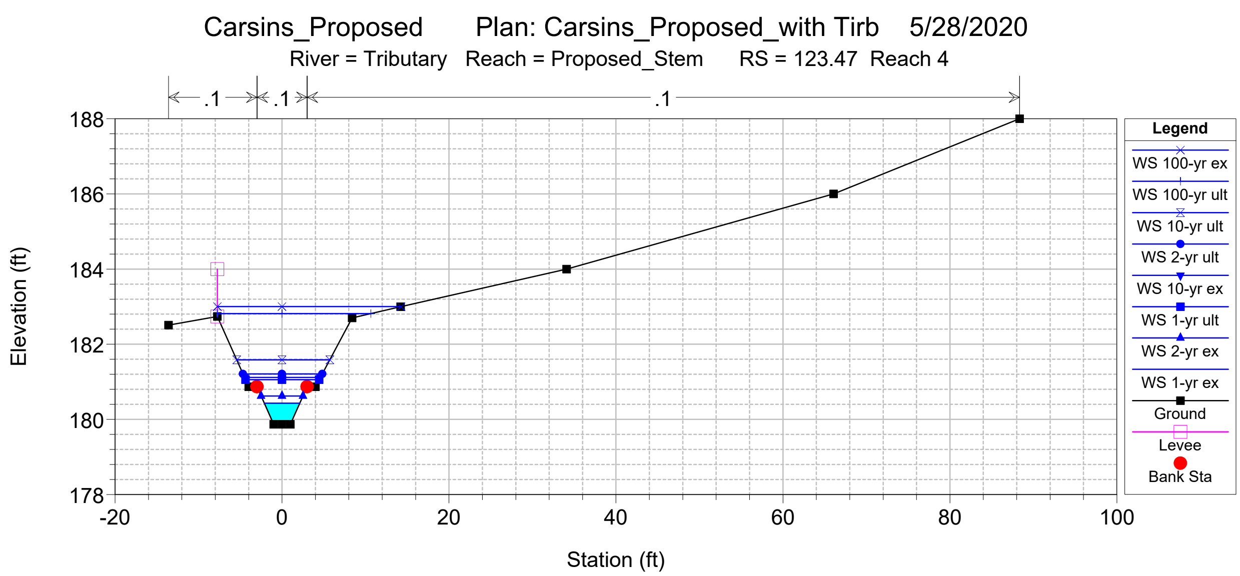

Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
River = Tributary Reach = Proposed_Stem RS = 420.35 Reach 3
.1
.04
.1
Elevation (ft)
195
194
193
192
191
-60
-40
-20
0
20
40
Station (ft)
Legend
WS 100-yr ult
WS 10-yr ult
WS 100-yr ex
WS 2-yr ult
WS 10-yr ex
WS 1-yr ult
WS 2-yr ex
WS 1-yr ex
Ground
Bank Sta


Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
River = Tributary Reach = Proposed_Stem RS = 393.08 Reach 3
.1
.04
.1
Elevation (ft)
193.0
192.5
192.0
191.5
191.0
190.5
190.0
-60
-40
-20
0
20
40
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 2-yr ult
WS 10-yr ex
WS 1-yr ult
WS 2-yr ex
WS 1-yr ex
Ground
Bank Sta


Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
River = Tributary Reach = Proposed_Stem RS = 312.68 Reach 3
.1
.04
.1
Elevation (ft)
190.5
190.0
189.5
189.0
188.5
188.0
187.5
187.0
186.5
-40
-20
0
20
40
60
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 2-yr ult
WS 10-yr ex
WS 1-yr ult
WS 2-yr ex
WS 1-yr ex
Ground
Ineff
Bank Sta

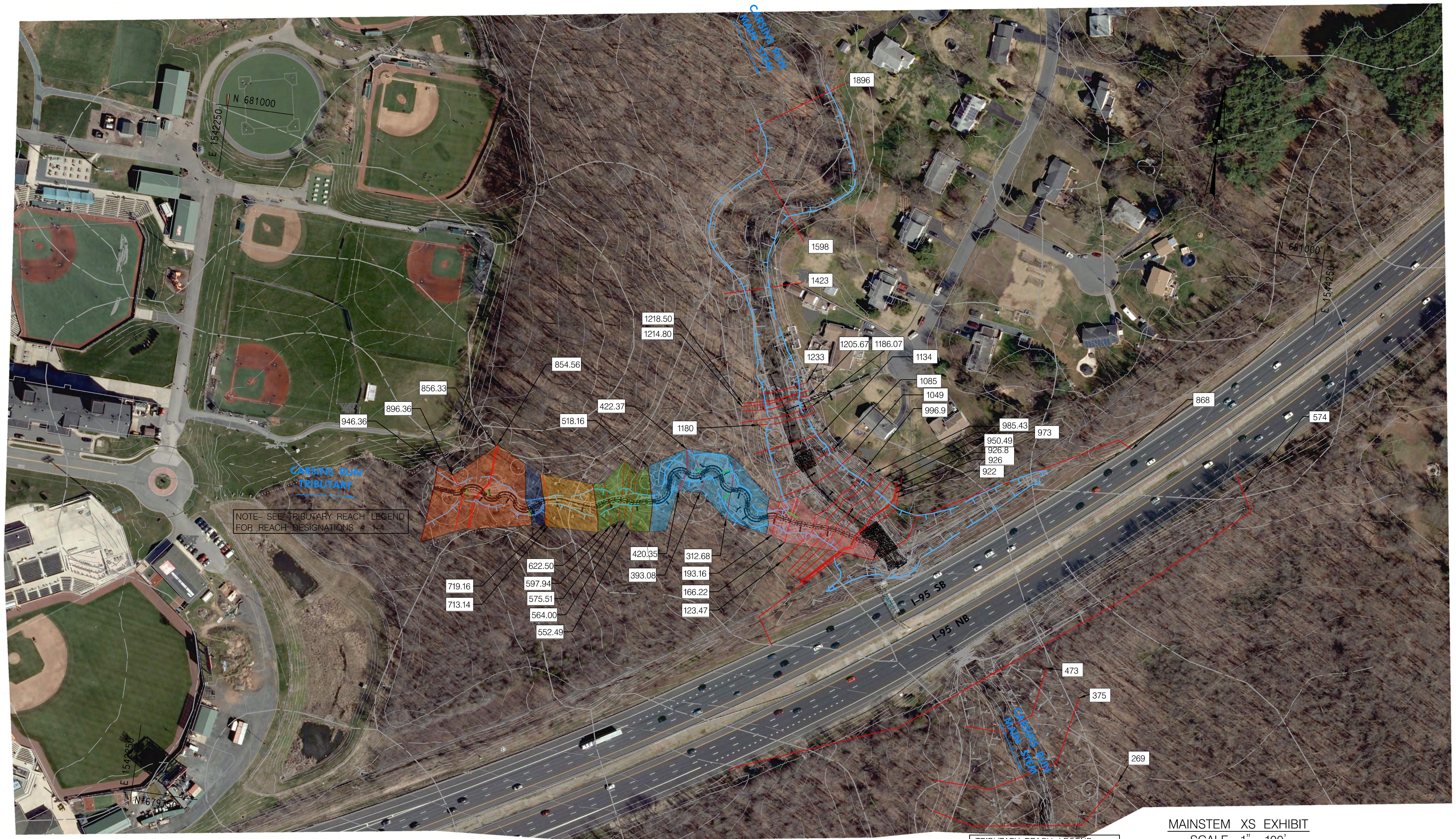

Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
River = Tributary Reach = Proposed_Stem RS = 193.16 Reach 4
.1
.1
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 2-yr ult
WS 10-yr ex
WS 1-yr ult
WS 2-yr ex
WS 1-yr ex
Ground
Bank Sta


Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
River = Tributary Reach = Proposed_Stem RS = 166.22 Reach 4
.1
.1
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr ult
WS 100-yr ex
WS 10-yr ult
WS 2-yr ult
WS 10-yr ex
WS 1-yr ult
WS 2-yr ex
WS 1-yr ex
Ground
Levee
Bank Sta


Carsins_Proposed Plan: Carsins_Proposed_with Tirb 5/28/2020
River = Tributary Reach = Proposed_Stem RS = 123.47 Reach 4
.1
.1
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr ex
WS 100-yr ult
WS 10-yr ult
WS 2-yr ult
WS 10-yr ex
WS 1-yr ult
WS 2-yr ex
WS 1-yr ex
Ground
Levee
Bank Sta

APPENDIX I.2.2

PROPOSED CROSS SECTION MAP



MAINSTEM XS EXHIBIT

SCALE- 1" =100'

TRIBUTARY REACH LEGEND:

- REACH 1
- REACH 2A
- STABLE (N/A)
- REACH 2B
- REACH 3
- REACH 4

LEGEND:

- HEC-RAS PROPOSED CONDITION CROSS SECTIONS
- EXISING CONTOURS
- PROPOSED CONTOURS
- EXISTING 100 YR FLOODPAIN
- PROPOSED 100 YR FLOODPAIN

100' 0 100' 200'

SCALE: 1" =100'

HORIZONTAL DATUM NAD 83/91

VERTICAL DATUM NAVD 88

CONSTELLATION DESIGN GROUP, INC.
CONSULTING ENGINEERS
57 W. TIMONIUM ROAD
SUITE 200
TIMONIUM, MD 21093
410-252-1884

P.E. STAMP HERE

Maryland Transportation Authority

Engineering Division

ADDENDUMS & REVISIONS			
NO.	DESCRIPTION	BY	DATE

JOHN F. KENNEDY MEMORIAL HIGHWAY
I-95 EXPRESS TOLL LANES NORTHBOUND EXTENSION
CARSINS RUN STREAM MITIGATION MAP

HEC-RAS CROSS SECTION MAP-
PROPOSED CONDITIONS

DESIGNED BY FNA | DRAWN BY JCT | CHECKED BY FNA

CONST. REVIEW BY | DATE MARCH 2019 | SCALE AS SHOWN

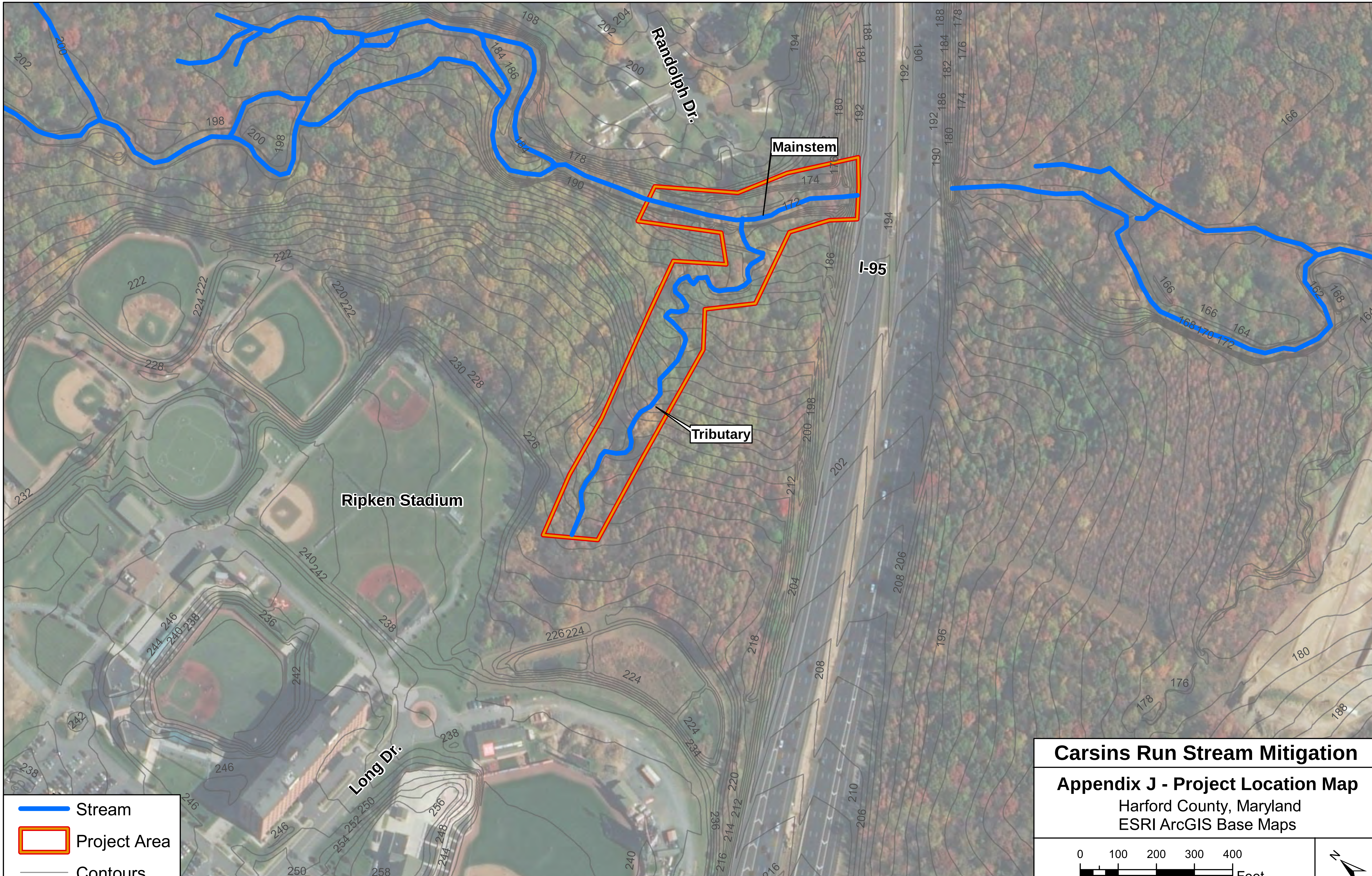
CONTRACT NO. TBD

DRAWING NO. XS-P-1

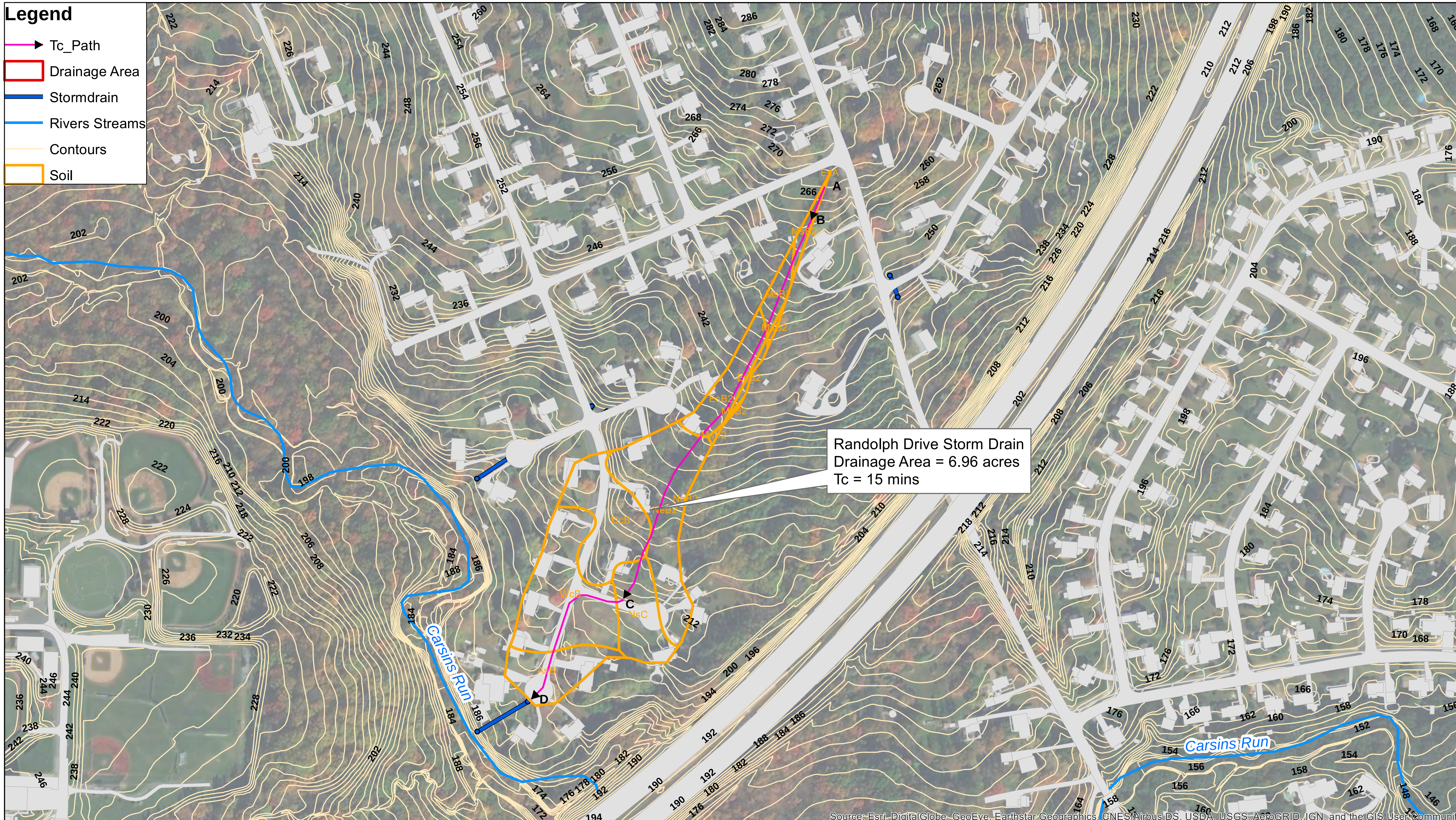
SHEET NO. OF 74

FILE: pw:\\MDTAPWAPP1:MDTA_PW_OEC\Documents\20 - OEC Design Projects\KH (Kennedy Highway)\ETL NB Extension\KH-3025 Carsins Run Stream Mitigation\07 Design Computations\06 Hydraulics & Hydrology\Revised Proposed HEC-RAS\HEC-RAS XS Map\pXS-P001_CarsinsRun_propo DATE: Friday, June 25, 2021 AT 08:15 AM

APPENDIX J
PROJECT LOCATION MAP


Randolph Dr.
Mainstem
Tributary
I-95
Ripken Stadium
Long Dr.
Stream
Project Area
Contours
Carsins Run Stream Mitigation
Appendix J - Project Location Map
Harford County, Maryland
ESRI ArcGIS Base Maps
0
100
200
300
400
Feet
N

APPENDIX K
STORM DRAIN COMPUTATIONS



1 inch = 250 feet

N

0 170 340 680 1,020 1,360 Feet

Carsins Run Stream Restoration
Randolph Drive SD Drainage Area Map
Harford County
KCI Job No.22145228.47

KCI TECHNOLOGIES

"C" FACTOR COMPUTATIONS

JOB NAME: Carsins Run DPZ NO.: ______ DATE: 5/9/2019
QC DATE: ______

Structure ID: EX-Inlet Total Area 303,308 s.f.

Land Use	Soil Type	Slope (%)	Area (s.f.)	< 25 Year Storm "C" Factor	< 25 Year Storm Partical "C"	25+ Year Storm "C" Factor	25+ Year Storm Partical "C"
Impervious	B	6.3	15,115	0.87	0.04	0.97	0.05
Open Space	B	6.3	85,813	0.21	0.06	0.26	0.07
Impervious	C	6.3	36,721	0.87	0.11	0.97	0.12
Open Space	C	6.3	93,828	0.24	0.07	0.32	0.10
Impervious	D	6.3	23,261	0.87	0.07	0.97	0.07
Open Space	D	6.3	48,569	0.28	0.04	0.37	0.06
				Composite "C" =	**0.39**		**0.47**

KCI Technologies, Inc. 936 Ridgebrook Road, Sparks MD. 21152

TIME OF CONCENTRATION COMPUTATIONS

By: YH Project Name: Carsins Run Stream Restoration Ramdolph Dr SD Project Number: 22145228.47
Date: 5/9/2019
Check: County: Harford Existing: [shaded]
Date: Ultimate:
Proposed:

I-A10

ID	Type of Flow				L(ft.)	n	A	WP	Slope (Percent)	Vel. (fps)	Time (Hours)
	Sheet Flow										
A-B	5	Grass - short			96	0.150			4.2		0.118
	Shallow Conc. Flow										
B-C		paved	X	unpaved	1166				4.7	3.50	0.092
C-D	X	paved		unpaved	446				2.5	3.19	0.039
										Total (Hours)	0.25
										Total (Min.)	15

MARYLAND STATE HIGHWAY ADMINISTRATION
STORM DRAIN DESIGN - 10-YEAR PIPE CAPACITY

DESIGNED BY: YH
CHECKED BY: JT

CONTRACT: KH3028
TITLE: Carsins Run Stream Restoration Randolph Dr. SD

RAINFALL FACTOR: 0.998
RET. PERIOD: 10

Structure		Contributing Area			10 Year Runoff					Pipe								Remarks
From	To	C Area (#)	A Area ac.	Δ CA	Σ A	ΣCA	tc Time Conc. Min	iif Rainfall Intens. in./hr.	Q cfs	Size (in)	Type	n Mann-ing's Coef.	So Slope %	Vo Vel. fps	L Leng. Ft.	tt Travel Time Min	Capac. Full cfs	
EX-Inlet	DS-1	0.39	6.96	2.71	6.96	2.71	15.00	5.04	13.68	21	RCP	0.013	6.10%	14.8	156	0.18	39.2	
DS-1	EW-1	--	--	--	6.96	2.71	15.18	5.04	13.68	24	RCP	0.013	0.50%	5.7	24	0.07	16.0	

STATE HIGHWAY ADMINISTRATION
STORM DRAIN DESIGN - 10 YEAR

DESIGNED BY: YH | CONTRACT: KH3028 | RAINFALL FACTOR: 0.998 | RET. PERIOD: 10 YEAR

CHECKED BY: JT | TITLE: Carsins Run Stream Restoration Randolph Dr. SD | Harford County, Maryland

KCI TECHNOLOGIES

Structure		Contributing Area				10 YEAR Runoff				Pipe								Hydraulic Gradient								
From	To	C Area (#)	A Area ac.	Δ CA	Σ A	ΣCA	tc Time Conc. Min	i_i Rainfall Intens. in./hr.	Q cfs	Size (in)	Type	n Mann-ing's Coef.	S_o Slope %	S_f Slope %	V_f Vel. fps	L Leng. Ft.	d_n Normal Depth ft	Angle (0)	Kb	Hb (ft)	Hf (ft)	INV IN	INV OUT	Elev. Out	Elev High	Top Elev
EX-Inlet	DS-1	0.39	6.96	2.714	6.96	2.71	15.00	5.04	13.68	21	RCP	0.013	6.10%	0.74	5.7	156	0.71	180	1.00	0.50	1.16	193.38	183.86	194.09	194.60	196.90
DS-1	EW-1	--	--	--	6.96	2.71	15.18	5.04	13.68	24	RCP	0.013	0.50%	0.36	4.4	24	1.42	180	1.50	0.44	0.09	174.12	174.00	175.54	175.98	186.50

STATE HIGHWAY ADMINISTRATION
STORM DRAIN DESIGN - 25 YEAR

DESIGNED BY: YH | CONTRACT: KH3028 | RAINFALL FACTOR: 0.998 | RET. PERIOD: 25 YEAR

CHECKED BY: JT | TITLE: Carsins Run Stream Restoration Randolph Dr. SD | Harford County, Maryland

KCI TECHNOLOGIES

Structure		Contributing Area				25 YEAR Runoff				Pipe								Hydraulic Gradient								
From	To	C Area (#)	A Area ac.	Δ CA	Σ A	ΣCA	tc Time Conc. Min	i_f Rainfall Intens. in./hr.	Q cfs	Size (in)	Type	n Mann-ing's Coef.	S_o Slope %	S_f Slope %	V_f Vel. fps	L Leng. Ft.	d_n Normal Depth ft	Angle (0)	Kb	Hb (ft)	Hf (ft)	INV IN	INV OUT	Elev. Out	Elev High	Top Elev
EX-Inlet	DS-1	0.47	6.96	3.271	6.96	3.27	15.00	5.04	16.49	21	RCP	0.013	6.10%	1.08	6.9	156	0.79	90	1.50	1.09	1.68	193.38	183.86	194.17	195.27	196.90
DS-1	EW-1	--	--	--	6.96	3.27	15.18	5.04	16.49	24	RCP	0.013	0.50%	0.53	5.2	24	2.00	90	1.50	0.64	0.13	174.12	174.00	176.12	176.76	186.50

Hydraulic Analysis Report

Project Data

Project Title: Carsins Run Stream Restoration Randolph SD Outfall

Designer: YH

Project Date: Friday, May 10, 2019

Project Units: U.S. Customary Units

Notes: The side slopes and channel longitudinal slope are using the steepest section of the outfall channel to be conservative.

Channel Analysis: Channel Analysis

Notes:

Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 2.5500 ft/ft

Side Slope 2 (Z2): 2.5500 ft/ft

Channel Width: 8.0000 ft

Longitudinal Slope: 0.2530 ft/ft

Manning's n: 0.0137

Lining Type: Rock Riprap

Flow: 13.6500 cfs (Q10 from Drainage Design)

Result Parameters

Depth: 0.1247 ft

Area of Flow: 1.0375 ft^2

Wetted Perimeter: 8.6833 ft

Hydraulic Radius: 0.1195 ft

Average Velocity: 13.1563 ft/s

Top Width: 8.6361 ft

Froude Number: 6.6891

Critical Depth: 0.4281 ft

Critical Velocity: 3.5066 ft/s

Critical Slope: 0.0039 ft/ft

Critical Top Width: 10.18 ft

Calculated Max Shear Stress: 1.9692 lb/ft^2

Calculated Avg Shear Stress: 1.8863 lb/ft^2

Channel Lining Analysis: Channel Lining Design Analysis

Notes:

Lining Input Parameters

Channel Lining Type: Riprap, Cobble, or Gravel

D50: 0.79 ft

Riprap Specific Weight: 165 lb/ft^3

Water Specific Weight: 62.4 lb/ft^3

Riprap Shape is Angular

Safety Factor: 1.5

Calculated Safety Factor: 1.09857

Lining Results

Angle of Repose: 41.7 degrees

Relative Flow Depth: 0.180307 ft

Manning's n method: Bathurst

Manning's n: 0.0137334

Channel Bottom Shear Results

V*: 1.10136

Reynold's Number: 71493.5

Shield's Parameter: 0.0672739

shear stress on channel bottom: 2.35065 lb/ft^2

Permissible shear stress for channel bottom: 4.21326 lb/ft^2

channel bottom is stable

Stable D50: 0.661133 ft

Channel Side Shear Results

K1: 0.8383

K2: 1

Kb: 0

shear stress on side of channel: 2.35065 lb/ft^2

Permissible shear stress for side of channel: 4.21326 lb/ft^2

Stable Side D50: 0.554227 lb/ft^2

side of channel is stable

Channel Lining Stability Results

the channel is stable

Channel Summary

Name of Selected Channel: Channel Analysis

KCI