OSBORN CONSULTING INCORPORATED
1800 112th Avenue NE Suite 220-E | Bellevue, WA 98004 | P: 425.451.4009 | F: 425.451.4901

DATE MAY 29, 2020

TO ROBERT CRITTENDEN, PE (CITY OF REDMOND)
EMILY FLANAGAN, PE (CITY OF REDMOND)
ROGER DANE (CITY OF REDMOND)

CC TORREY LUITING (NATURAL SYSTEMS DESIGN)

FROM LAURA RUPPERT, PE, INDULEKSHMI, EIT, OSBORN CONSULTING, INC.

SUBJECT CITY OF REDMOND SMITH WOODS – ALTERNATIVES ANALYSIS H&H MODELING TECHNICAL MEMORANDUM

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INTRODUCTION

This memorandum summarizes the hydrologic and hydraulic modeling carried out to analyze the two alternatives considered to restore fish passage and in-stream habitat for the section of Monticello Creek passing through the Smith Woods Pond. Smith Woods is a City-owned, 10-acre parcel located in a rapidly developing neighborhood in Northeast Redmond. The property is mostly undeveloped and provides a natural area oasis for the residential community as well as valuable habitat at the headwaters of Monticello Creek. Monticello Creek flows from north to south in Smith Woods, through a small pond, and continues south as a small stream through the culvert at NE 122nd St. The main purpose of the project is to develop and design the Monticello Creek and Smith Woods pond to meet Washington Department of Fish and Wildlife (WDFW) fish passage requirements.

MODEL SETUP

Existing Conditions

Hydraulic modeling for the Monticello Creek was completed using the HEC-RAS modeling platform. Cross-sections and stream centerline were drawn in the topographic survey in CADD and were exported to HEC-RAS to develop the model. The reach lengths between the cross sections were adjusted based on the topographic survey. Ordinary high-water mark points identified in the survey were used to mark the right and left overbanks. Manning's roughness values for the cross-sections were selected based on field observations and then following Chow's reference table (Chow, 1959). **Table 1** lists the Manning's roughness values used in the existing and proposed model for different sections of the channel.

Table 1 | Manning's Roughness Values

Location	Description	Roughness Coefficient
Cross-sections upstream of the pond - main channel	Clean, straight, full stage, no rifts or deep pools	0.030
Cross-sections upstream of the pond - river banks	Scattered brush, heavy weeds	0.050
Cross-sections downstream of the pond - main channel	Clean, winding, some pools and shoals, some weeds and stones	0.045
Cross-sections downstream of the pond - river banks	Light brush and trees, in summer	0.060
Pond main channel	Channels not maintained, weeds and brush uncut with dense weeds, high as flow depth	0.080
Pond banks	Channels not maintained, weeds and brush uncut with dense weeds, high as flow depth	0.120

Proposed Conditions

The two alternatives that were considered to restore fish passage at Monticello Creek are:

1. Alternative 1- Rebuilt berm, maintain the pond, and create a roughened channel in same location as the existing stream and
2. Alternative 2- Remove berm and rebuilt roughened channel from pond inlet.

Initially, both the alternatives considered roughened channel to make up grade changes. Figures showing the plan view and profile view of the two alternatives are included in **Appendix A**. Alternative 1 with the pond option and steeper channel was modeled and was found to give flow velocities meeting fish passage requirements. Hence, alternative 1 was selected over the remove pond alternative and was considered during the design phase.

During 30% design phase alternative 1 was modified to include step pools in the roughened channel. It was proposed to lower the pond outlet by 0.5 ft and regrade the channel approximately 120 feet downstream of the pond. The channel was proposed to be cascading type with steps/pools created with wood logs. Steps were created by embedding 18-24-inch logs every 6 ft to 7 ft in the channel. Only a small portion of the logs were exposed to the surface such that it created a jump height of 0.5 ft. The proposed jump height is within the maximum allowed drop of 0.8 ft between successive crests (WDFW Water Crossing Design Guidelines (WCDG), 2013). To aid in the grading of the proposed channel the alignment of the stream was slightly modified to remove sharp turns and bends. Approximately 18 steps were fitted into the channel thereby providing a 28-ft offset from the culvert to act as the transition zone. Plans created at 30% design phase are included in **Appendix B.**

The proposed channel was modeled using a proposed cross section shape (designed based on existing channel geometry). To compare the flow velocity and depth, cross sections were taken at every step and pool section. The existing channel bankfull width of 4 ft and bankfull depth of 0.5 ft was maintained for the proposed channel. The Bankfull Width Memo prepared by Osborn Consulting, Inc. (OCI) summarizing the bankfull width determination methods is provided in **Appendix C**. The channel banks were assumed to be sloped at 2:1, and the channel bottom was considered flat (low flow channel to be incorporated during final design). Downstream of the pond, Manning's roughness was assumed as 0.045 for the main channel and 0.06 for right and left overbanks.

Hydraulics

The HEC-RAS model was run using the steady flow simulation option. Channel flow was modeled using a mixed flow regime to allow for transitions between subcritical and supercritical flow that occur in the area near the pond outlet.

The upstream and downstream boundary condition were set to normal depth, with an energy slope of 3.2% and 2.6% respectively.

Hydrology

Model flows were taken from a previously developed WWHM model documented by Golder in 2016. These flow rates were used to design interim channel stabilization measures constructed at the pond outlet. Design flows are provided in cubic feet per second (CFS) and are listed in **Table 2**. The Hydrology Memo prepared by Osborn Consulting summarizing the suitability assessment of hydrologic models and design flow recommendation for the hydraulic modeling is provided as **Appendix D**. In this study, the HEC-RAS models were run for the 2-year, 25-year and 100-year return periods.

Table 2 | Design Flow Rates					
Return Interval	**2-YR**	**5-YR**	**10-YR**	**25-YR**	**100-YR**
WWHM Flow Rate	5.43 CFS	7.64 CFS	9.37 CFS	11.91 CFS	16.45 CFS

MODEL RESULTS

Table 3 listed below compares the modeled flow depth and velocity for existing and proposed conditions within the project area. According to WCDG (2013), two-year peak flood flow data can be used as the design discharge to calculate maximum velocity in the culvert when stream flow data is not available. Hence, results comparison for only the 2-year are reported here.

Table 3 | 2-Year Flow Velocities and Flow Depth				
Location	**Existing Condition**		**Proposed Condition**	
	Velocity (fps)	Depth (ft)	Velocity (fps)	Depth (ft)
D/S of Pond Outlet Existing Condition RS: 1137.74 Proposed Condition RS: 1144.04	3.34	0.76	2.34	0.7
Middle of the roughened channel Existing Condition RS: 1084.92 Proposed Condition RS: 1086.71	3.45	0.4	1.18	1.16
Transition Zone Existing Condition RS: 1030.06 Proposed Condition RS: 1029.81	2.32	0.63	2.61	0.62

Coastal cut-throat trout is the fish species identified to be present in Monticello Creek where it enters Bear Creek (WDFW Statewide Integrated Fish Distribution (SWIFD), 2018). Fish passage design criteria for different Adult Trout fish species for culvert installation is provided in **Table 4** (WCDG, 2013).The average flow velocity through the proposed channel for 2-year return period was 2.2 fps which meets the fish passage design criteria. Flow velocity calculated for the proposed condition is conservative as it does not account for the additional roughness due to wood logs and root wads that would be added to the channel to create natural stream habitat conditions. Hence, it is expected that actual velocity in the channel would be lower than the calculated flow velocities.

Table 4 | Fish Passage Design Criteria for Culvert Installation	
Criteria	**Adult Trout > 6 in. (150 mm)**
Velocity, Maximum (fps) for Culvert Length 100-200 (ft)	3
Flow Depth Minimum (ft)	0.8
Hydraulic Drop, Maximum (ft)	0.8

According to WCDG minimum flow depth requirement reported in **Table 4** above is only for culverts without sediment inside and is calculated using 2-year seven-day low flows as the design flows. Even though roughened channel design is exempt from this requirement, flow depth in the proposed channel at the pool locations using 2-year flow data was reported to be 1.53 ft. For the proposed step pool channel, hydraulic drop was considered a more important design parameter as WDFW guidelines recommends maintaining a maximum drop of 0.8 ft at both low and high fish flows. **Figure 1** and **Table 5** shows the water surface elevation at a typical step and pool location in the proposed channel. Hydraulic drop was estimated to be 0.3 ft thereby meeting fish passage design requirements.

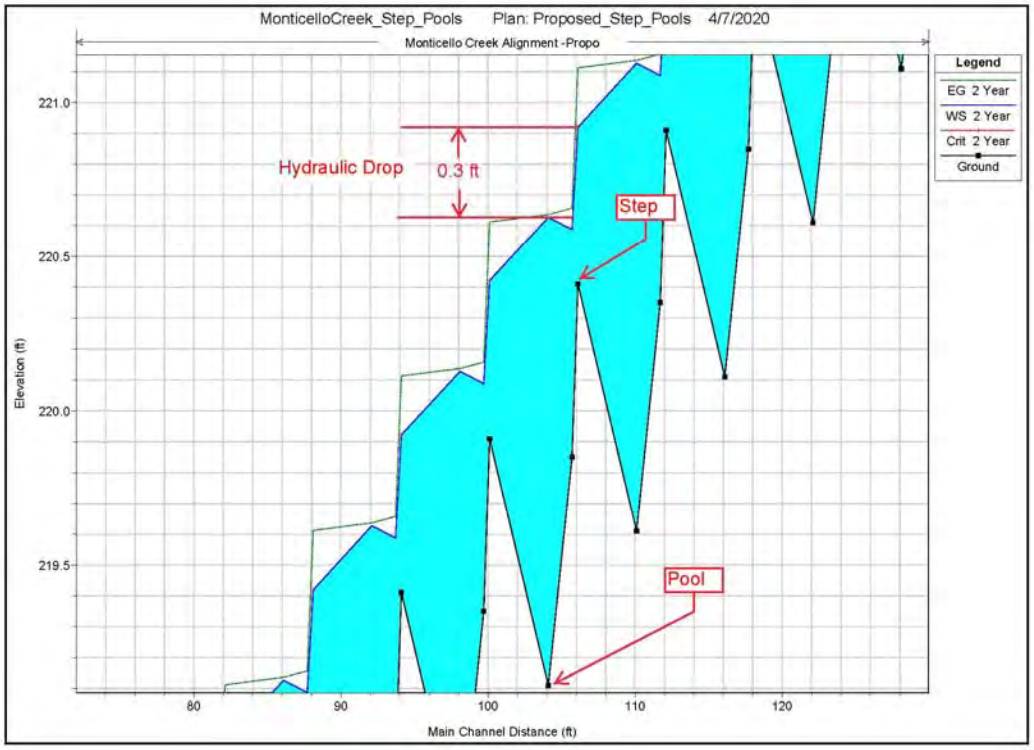

Figure 1: Proposed Conditions Hydraulic Drop

Table 5| Proposed Hydraulic Drop		
Location	**WSE (ft)**	**Hydraulic Drop (ft)**
Step	222.42	0.3
Pool	222.13	

The proposed roughened channel with step pools improve fish passage conditions compared to the existing condition by lowering the pond outlet and eliminating the large hydraulic drop which was considered a fish barrier. Detailed HEC-RAS model results for 2-year, 25-year and 100-year return flows are provided in **Appendix E**.

Design Calculations

The 100-year HEC-RAS model results were used to perform spread sheet-based calculations to size proposed streambed gravel, and to assess shear stress and scour depth. Detailed scour and sediment sizing are included in **Appendix F**.

Pebble counts were conducted downstream of the pond by OCI staff during a field visit on May 16, 2019 and are summarized in **Appendix G**. The proposed channel has a gradient of 7.5% which is much steeper than the adjacent reference reaches where the pebble counts were taken. According to WDFW guidelines, the proposed D_{50} should be within 20% of the measured D_{50}. However, our proposed fish passage channel is steeper than the adjacent channel sections, therefore, larger streambed material is necessary to maintain a stable channel. And, during previous site visits it was noticed that 10-12-inch cobbles had been mobilized in the existing temporary channel. In order to ensure that the proposed stream bed material is not washed out during high flows, D_{50} size of 2.4 inches which is greater than the average measured D_{50} is proposed. Larger proposed D_{50} is warranted in this case as the average measured D_{50} is not a representative of the entire channel. The proposed gradation summarized in **Table 6** was designed using WSDOT Standard Specifications Section 9-03.11 and will consist of 50% streambed sediment and 50% 12-in cobbles.

Table 6| Proposed Streambed Gradation		
	Diameter (in)	
Percentile	**Average Measured**	**Proposed Gradation**
D_{16}	0.2	0.8
D_{50}	1.2	2.4
D_{84}	2.6	6.0
D_{100}	4.0	15
D_{max}	4.0	15

Conclusion

The HEC-RAS model prepared to support alternative analysis of Smith Woods study indicates that the proposed channel with step pools would eliminate the hydraulic drop at the pond outlet and meets the fish passage design criteria velocity through the channel section.

References

Chow, V.T., 1959, Open-channel hydraulics: New York, McGraw-Hill

Washington Department of Fish and Wildlife (WDFW), 2012, Stream Habitat Restoration Guidelines: Washington State Aquatic Habitat Guidelines

Washington Department of Fish and Wildlife (WDFW), 2013, Water Crossing Design Guidelines: Washington State Aquatic Habitat Guidelines

Washington State Department of Ecology, 2016, Determining the Ordinary HighWater Mark for Shoreline Management Act Compliance in Washington State: Publication no. 16-06-029

Washington Department of Fish and Wildlife (WDFW), 2018, Statewide Integrated Fish Distribution (SWIFD)

Washington Department of Fish and Wildlife (WDFW), 2003, Integrated Streambank Protection Guidelines, Appendix E: Hydraulics

Appendices List

Appendix A: Alternative Analysis Figures
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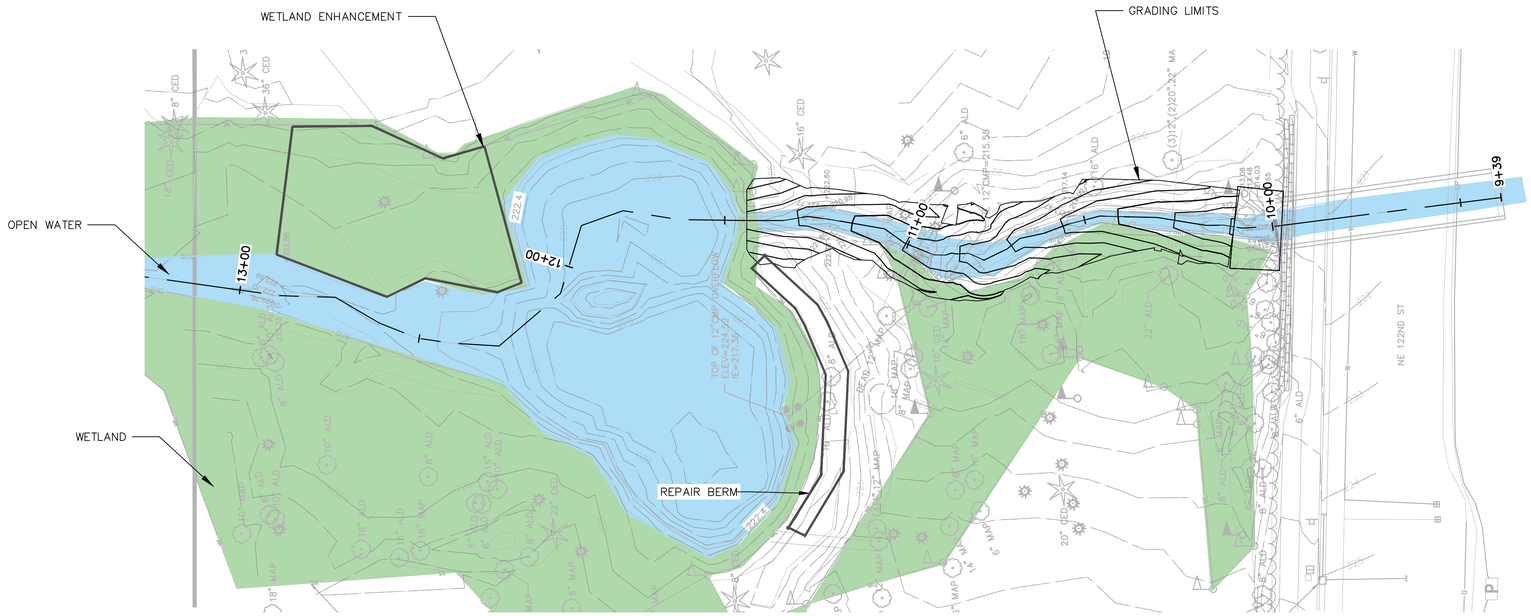
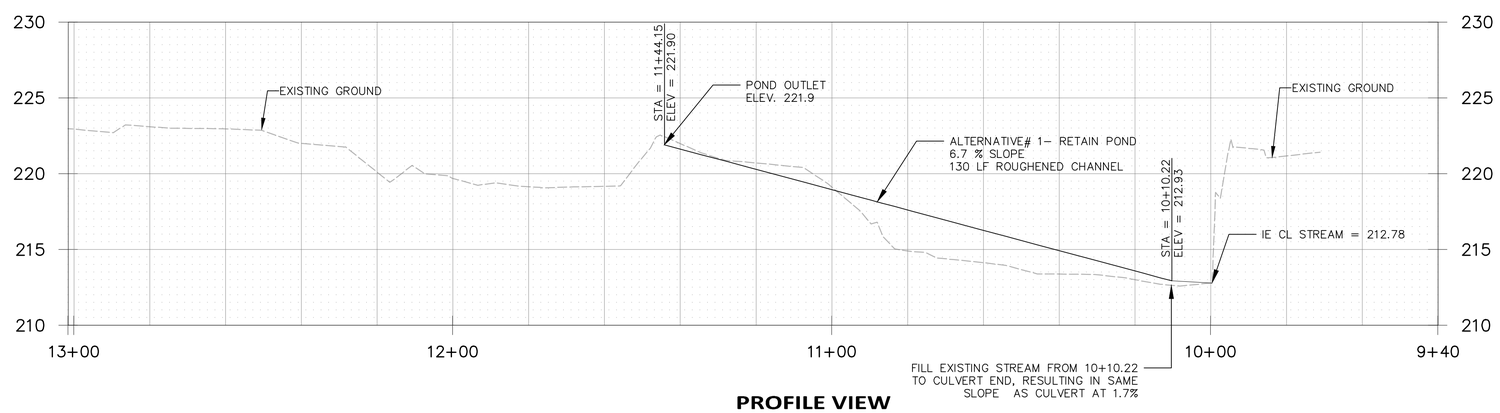
Appendix A: Alternative Analysis Figures



PLAN VIEW



PROFILE VIEW

N

HORIZONTAL SCALE — SCALE: 1" = 20' — 0 20 40 60

VERTICAL SCALE — SCALE: 1" = 5' — 0 5 10 15

FIGURE 1

PRELIMINARY

DESIGNED BY IL	OSBORN CONSULTING INCORPORATED	OSBORN CONSULTING, INC.	NO.	DATE	REVISION	BY	CITY OF REDMOND SMITH WOODS
DRAWN BY AKS		1800 112th Ave. NE, Suite 220E Ph (425) 451–4009 Bellevue, WA. 98004					ALT-1 RETAIN POND
CHECKED BY RCW							

JOB# / DWG: 10–180036 — DATE: 8/30/19

SCALE: H: 1"=20' V: 1"=5' — SHEET: 1 of 2

FILE NAME: P:\10-180036 CITY OF REDMOND SMITH WOODS PARK\3 CADD\FIGURES\OPTIONS ANALYSIS\F_10-180036_ALT-1 RETAIN POND.DWG
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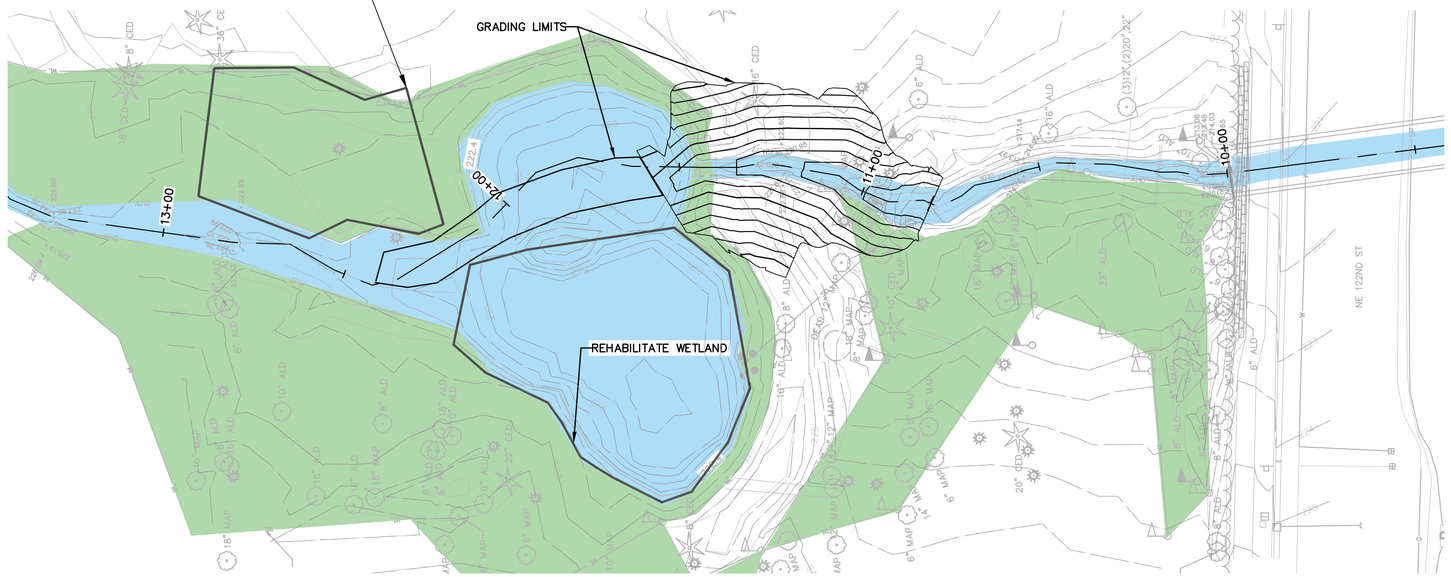
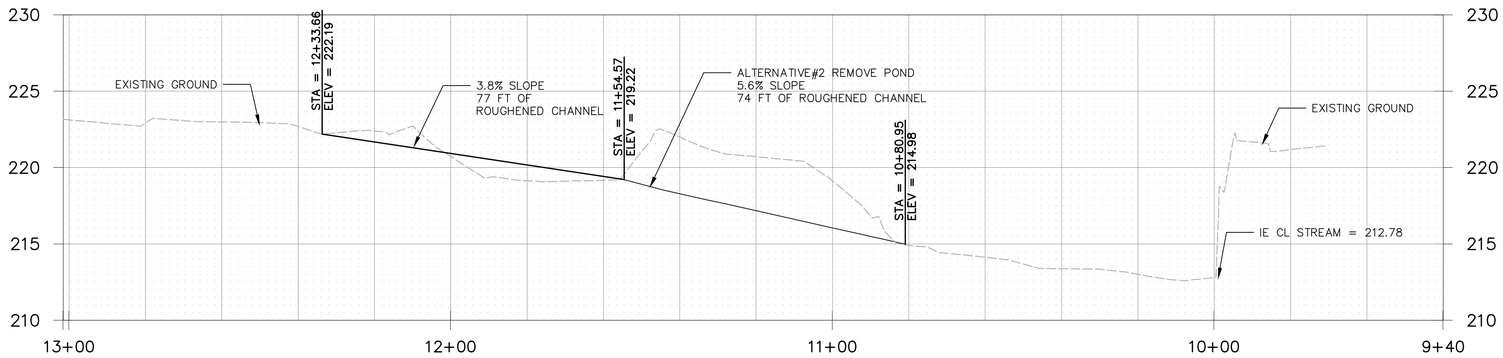
USER NAME:INDULEKSHMI, EIT



PLAN VIEW

HORIZONTAL SCALE — SCALE: 1" = 20' — 0 20 40 60

VERTICAL SCALE — SCALE: 1" = 5' — 0 5 10 15



PROFILE VIEW

FIGURE 2

PRELIMINARY

DESIGNED BY IL DRAWN BY AKS CHECKED BY RCW	OSBORN CONSULTING INCORPORATED	OSBORN CONSULTING, INC. 1800 112th Ave. NE, Suite 220E Ph (425) 451-4009 Bellevue, WA. 98004	NO. / DATE / REVISION / BY	CITY OF REDMOND SMITH WOODS	ALT-2 REMOVE POND	JOB# / DWG 10-180036 SCALE H: 1"=20' V: 1"=5' DATE 8/30/19 SHEET 2 of 2

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PLOT TIME: 8/30/2019 3:52 PM
USER NAME:JACOB ROMERO

APPENDIX B: 30% DESIGN PLANS

CITY OF REDMOND
SMITH WOODS STREAM AND POND REHABILITATION

PROJECT NUMBER 20021811
30% SUBMITTAL NOT FOR CONSTRUCTION

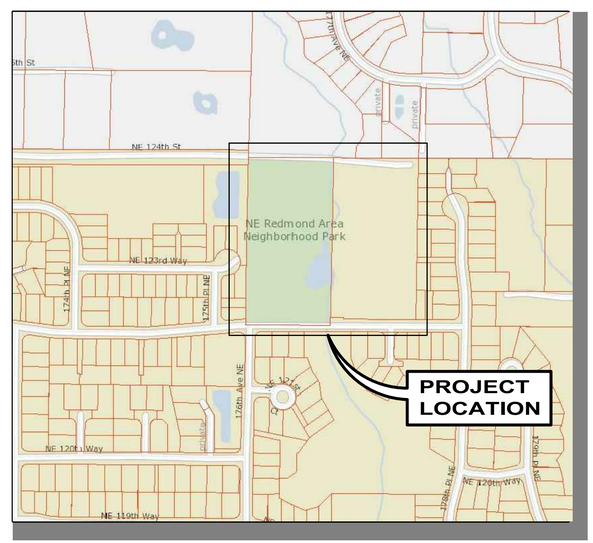
CITY OF REDMOND:

PROJECT MANAGER
ROB CRITTENDEN, PE (425)-556-2838
EMAIL: RCRITTENDEN@REDMOND.GOV

SURVEYOR:
PACE ENGINEERS
JACK SEEDS, PLS
11255 KIRKLAND WAY, SUITE 300
KIRKLAND, WA 98033
(425) 827-2014

ENGINEERING:
OSBORN CONSULTING, INC.
LAURA RUPPERT, PE
1800 112TH AVE. NE, SUITE 220E
BELLEVUE, WA 98004
(425) 451-4009

DATUM:
HORIZONTAL DATUM: PROJECT, BASED ON CITY OF REDMOND CONTROL POINTS GPS 90-5C3 AND GLO-4CS. SCALED TO GROUND BY A CGF OF 1.000040892 ABOUT GPS 90-5C3
VERTICAL DATUM: NAVD 88 PER CITY OF REDMOND BM NO. COR9194
ELEV=192.51
NAVD 88 PER CITY OF REDMOND BM NO. COR9193
ELEV=244.55



VICINITY MAP
N.T.S.

SHEET INDEX

SHEET #	SHEET TITLE
1	COVER SHEET
2	NOTES AND LEGEND
3	EXISTING CONDITIONS, TESC & BYPASS – NORTH
4	EXISTING CONDITIONS TESC & BYPASS – SOUTH
5	PLAN AND PROFILE
6	BERM REPAIR DETAILS
7	PROJECT IMPACTS
8	TYPICAL SECTIONS
9	STREAM RESTORATION AND PLANTING DETAILS

APPROVED FOR CONSTRUCTION

STEVE FLUDE, P.E. DATE
CITY ENGINEER

Know what's below. Call before you dig.

REFERENCE: *(USACE will provide)*	LOCATION: *NE REDMOND AREA NEIGHBORHOOD PARK, 252685-9109*	PROPOSED PROJECT: *SMITH WOODS STREAM AND POND REHABILITATION*	
APPLICANT: *CITY OF REDMOND, WA 15670 NE 85TH ST, REDMOND, WA 98052*			
ADJACENT PROPERTY OWNERS:	LAT/LONG: *47.709561, -122.104020*	IN: *MONTICELLO CREEK*	
1.		NEAR/AT: *REDMOND*	
2.		COUNTY: *KING*	
3.	PAGE *1* OF *9*	DATE: *APRIL 2020*	STATE: *WA*
4.			

DESIGNED BY IL	OSBORN CONSULTING INCORPORATED	**Osborn Consulting, Inc.** Bellevue | Seattle | Spokane www.osbornconsulting.com	NO.	DATE	REVISION	BY
DRAWN BY JAR						
CHECKED BY LCR						

City of Redmond WASHINGTON

SMITH WOODS STREAM AND POND REHABILITATION
COVER SHEET

JOB# / DWG	DATE
20021811	APR 2020
SCALE H: N/A V: N/A	SHEET 1 of 9

FILE NAME: P:\10-180036 CITY OF REDMOND SMITH WOODS PARK\3 CADD\SHEETS\P_10-180036_CVR.DWG
PLOT TIME: 5/22/2020 3:09 PM
USER NAME:LAURA TURNIDGE

GENERAL NOTES:

1. CALL FOR UTILITY LOCATES 1-800-424-5555.
2. SUBMIT A TRAFFIC CONTROL PLAN FOR REVIEW AND APPROVAL PER CITY OF REDMOND STANDARD SPECIFICATIONS.
3. EXISTING UTILITIES WITHIN PROPOSED EXCAVATION LIMITS ARE REQUIRED TO BE "POTHOLED" PRIOR TO CONSTRUCTION. ALL OPEN-CUT STREET SURFACES AND HARD SURFACE AREAS SHALL BE BACKFILLED PER CITY OF REDMOND STANDARD SPECIFICATIONS & STANDARD DETAIL DRAWING. MIXED DESIGNS SHALL BE SUBMITTED FOR REVIEW & APPROVAL.
4. ALL CITY UTILITIES HAVE PRIORITY. REFERENCE PLACEMENT VERTICALLY AND HORIZONTALLY.
5. TRENCH SHORING IS TO MEET MINIMUM SAFETY STANDARDS SET BY THE STATE OF WASHINGTON DEPARTMENT OF LABOR AND INDUSTRIES. [CHAPTER 296-155 WAC.]
6. SEDIMENT AND EROSION CONTROL SHALL MEET THE REQUIREMENTS OF THE REDMOND 2017 STORMWATER TECHNICAL NOTEBOOK. CONTRACTOR IS REQUIRED TO PROVIDE PROTECTION OF THE CITY STORM DRAIN SYSTEM.
7. RESTORATION SHALL MEET THE REQUIREMENT OF CITY OF REDMOND STANDARD SPECIFICATIONS. ROADWAY RESTORATION SHALL INCLUDE STREETS, SIDEWALKS, DRIVEWAYS, CURB & GUTTER, TRAFFIC SIGNS AND MARKINGS, LANDSCAPING, AND IRRIGATION SYSTEMS (FOR PARKS DEPT SYSTEMS CONTACT SCOTT VAN DE VANTER @ 425-556-2354).
8. THE CONTRACTOR SHALL PREPARE AND SUBMIT FOR APPROVAL THE WORK ACCESS PLAN.
9. PROTECT SITE FROM THE EXPOSURE OF INVASIVE NEW ZEALAND MUD SNAILS PER APPENDIX G OF THE SPECIAL PROVISIONS.
10. HOURS OF WORK PER CITY OF REDMOND STANDARD SPECIFICATIONS
11. WORK SHALL FOLLOW THE UNANTICIPATED DISCOVERY PROTOCOL (UDP) TRAINING PROVIDED BY A PROFESSIONAL ARCHAEOLOGIST. A COPY OF THE UDP IN INCLUDED IN THE CONTRACT DOCUMENTS AND SHALL BE ON SITE AT ALL TIMES.

STANDARD CLEARING, GRADING AND TEMPORARY EROSION CONTROL PLAN NOTES:

1. ALL WORK AND MATERIALS TO BE PER CITY OF REDMOND STANDARDS.
2. KEEP OFF-SITE STREETS CLEAN AT ALL TIMES. FLUSHING STREETS SHALL NOT BE ALLOWED. ALL STREETS SHOULD BE SWEPT.
3. ADDITIONAL EROSION/SEDIMENT CONTROL MEASURES MAY BE REQUIRED BY CITY INSPECTOR.
4. WHEN WORK IS STOPPED/COMPLETED IN AN AREA, THE CITY INSPECTOR MAY REQUIRE POST-CONSTRUCTION EROSION CONTROL INCLUDING SEEDING OR OTHER MEASURES.
5. LOCATIONS SHOWN OF EXISTING UTILITIES ARE APPROXIMATE. IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO VERIFY THE CORRECT LOCATIONS TO AVOID DAMAGE OR DISTURBANCE.
6. IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO OBTAIN STREET USE AND OTHER RELATED PERMITS PRIOR TO ANY CONSTRUCTION.
7. ALL GROUND COVER IS TO REMAIN UNDISTURBED OUTSIDE OF CLEARING AREAS.
8. THE TEMPORARY EROSION/SEDIMENT CONTROLS SHALL BE INSTALLED, INSPECTED, AND OPERATING BEFORE ANY GRADING OR EXTENSIVE LAND CLEARING. THESE CONTROLS MUST BE SATISFACTORILY MAINTAINED UNTIL CONSTRUCTION AND LANDSCAPING ARE COMPLETE.
9. A PRE-CONSTRUCTION MEETING WITH THE CONSTRUCTION DIVISION AND ALL PERMITS MUST BE COMPLETED BEFORE START OF CONSTRUCTION.
10. CLEARING LIMITS SHALL BE LOCATED BY A LICENSED CIVIL ENGINEER OR LAND SURVEYOR.
11. TESC SHOWN ON THE PLANS REPRESENT POTENTIAL LOCATIONS AND IS A DRAFT. CONTRACTOR TO VERIFY SITE CONDITIONS AND SUBMIT FINAL TESC PLAN FOR APPROVAL.
12. APPROVAL OF THIS TEMPORARY EROSION/SEDIMENTATION CONTROL (TESC) PLAN DOES NOT CONSTITUTE AN APPROVAL OF PERMANENT ROAD OR DRAINAGE DESIGN.
13. THIS APPROVAL FOR TESC IS VALID FOR CONSTRUCTION BETWEEN MAY 1 AND SEPTEMBER 30. THIS APPROVAL FOR TESC IS NOT VALID FOR THE RAINY SEASON (OCTOBER 1 THROUGH APRIL 30).
14. REMOVE ALL TESC MEASURES ONCE ALL WORK IS COMPLETED AND SITE IS PERMANENTLY STABILIZED.

SURVEY NOTES:

HORIZONTAL DATUM: PROJECT, BASED ON CITY OF REDMOND CONTROL POINTS GPS 90-5C3 AND GLO-4CS. SCALED TO GROUND BY A CGF OF 1.000040892 ABOUT GPS 90-5C3

VERTICAL DATUM: NAVD 88 PER CITY OF REDMOND BM NO. COR9194 ELEV=192.51
NAVD 88 PER CITY OF REDMOND BM NO. COR9193 ELEV=244.55

ALL DISTANCES SHOWN ARE GROUND DISTANCES UNLESS OTHERWISE NOTED.

THE LOCATION AND DESCRIPTION OF ALL SURVEY MARKERS SHOWN HEREON ARE BASED ON FIELD OBSERVATIONS TAKEN IN APRIL 2019, UNLESS OTHERWISE INDICATED.

WORK PERFORMED IN CONJUNCTION WITH THIS SURVEY UTILIZED THE FOLLOWING EQUIPMENT AND PROCEDURES: (A) 1" TRIMBLE S6 SERIES ELECTRONIC TOTAL STATION, MAINTAINED TO THE MANUFACTURER'S SPECIFICATIONS PER W.A.C. 332-130-100. (B) FIELD TRAVERSE, EXCEEDING REQUIREMENTS SET FORTH IN W.A.C. 332-130-090.

THIS SURVEY WAS PERFORMED WITHOUT THE BENEFIT OF A TITLE REPORT AND DOES NOT PURPORT TO SHOW ALL EASEMENTS.

THIS TOPOGRAPHIC SURVEY DRAWING ACCURATELY PRESENTS SURFACE FEATURES LOCATED DURING THE COURSE OF THIS SURVEY. UNDERGROUND UTILITIES SHOWN HEREON ARE BASED SOLELY UPON INFORMATION PROVIDED BY OTHERS AND PACE ENGINEERS, INC. DOES NOT ACCEPT RESPONSIBILITY OR ASSUME LIABILITY FOR THEIR ACCURACY OR COMPLETENESS. CONTRACTOR/ENGINEERS SHALL VERIFY EXACT SIZE AND LOCATION PRIOR TO CONSTRUCTION.
CALL FOR LOCATE: UTILITY LOCATION SERVICE: 811

ABBREVIATIONS:

ADT	AVERAGE DAILY TRAFFIC
APPROX.	APPROXIMATE, APPROXIMATELY
BMP	BEST MANAGEMENT PRACTICE
BW	BOTTOM OF WALL
CFS	CUBIC FEET PER SECOND
CHNL	CHANNEL
CL	CENTERLINE
CONC	CONCRETE
CMP	CORRUGATED METAL PIPE
CTR	CENTER
CY	CUBIC YARDS
DI	DUCTILE IRON
DIA	DIAMETER
E	EAST, EASTING
ELEV	ELEVATION
FLEX	FLEXIBLE
FT	FOOT, FEET
HPA	HYDRAULIC APPROVAL
HVF	HIGH VISIBILITY FENCE
IE	INVERT ELEVATION
LCL	LOCAL LOW POINT
MAX	MAXIMUM
MPH	MILES PER HOUR
MON	MONUMENT
N	NORTH, NORTHING
N.T.S.	NOT TO SCALE
OHWM	ORDINARY HIGH WATER MARK
RJ	RESTRAINED JOINT
ROW	RIGHT OF WAY
RXR	RAILROAD
S	SOUTH
SF	SQUARE FEET
STA.	STATION
SSMH	SANITARY SEWER MANHOLE
TBM	TEMPORARY BENCHMARK
TW	TOP OF WALL
TYP	TYPICAL
UG	UNDERGROUND
W	WEST
XFMR	TRANSFORMER

LEGEND

PROPOSED

- INLET PROTECTION INSERT
- TREE REMOVED
- PUMP
- TURBIDITY MONITORING STATION
- GRAVEL BAG
- REMOVED SALVAGED TREE
- TEMPORARY CHAINLINK FENCE
- HVF — HIGH VISIBILITY FENCE
- FILTER FABRIC FENCE
- FM — FORCE MAIN
- FISH SCREEN
- PROJECT LIMITS
- DISPERSION MAT
- SEDIMENT MAT
- CONSTRUCTION ENTRANCE
- FILTER BAG
- ROOT WAD

EXISTING

- WATER VALVE
- HYDRANT
- WATER METER
- MANHOLES (SS/SD)
- CB
- POWER/UTILITY POLE
- GUY ANCHOR
- POWER TRANSFORMER
- POWER/TELEPHONE VAULT
- POWER METER
- TELEPHONE/TV RISER
- GAS VALVE
- IRRIGATION CONTROL VALVE
- JUNCTION BOX
- GAS METER
- STREET LIGHT LUMINAIRE
- SPOT ELEVATION
- SIGN
- MAILBOX
- ROCKERY
- DATA POINT
- WETLAND FLAG
- SIZE TYPE(CONIFEROUS TREE)
- SIZE TYPE(DECIDUOUS TREE)
- CASED MONUMENT
- MAGNETIC NAIL W/ WASHER
- REBAR AND CAP
- CENTER LINES
- PROPERTY LINES
- RIGHT-OF-WAY LINES
- LOT LINES
- DITCH LINE
- WATER LINE
- SANITARY SEWER LINE
- STORM DRAIN LINE
- GAS LINE
- UNDERGROUND POWER LINES
- UNDERGROUND COMMUNICATION LINES
- OVERHEAD UTILITY LINES
- HIGH WATER LINE
- WETLAND LINE
- CHAIN LINK FENCE
- WIRE FENCE
- WOOD FENCE
- EDGE OF WOODS/HEDGE LINE

REFERENCE: *(USACE will provide)*	**LOCATION:** *NE REDMOND AREA NEIGHBORHOOD PARK, 252605-9109*	**PROPOSED PROJECT:** *SMITH WOODS STREAM AND POND REHABILITATION*	
APPLICANT: *CITY OF REDMOND, WA 15670 NE 85TH ST, REDMOND, WA 98052*			
ADJACENT PROPERTY OWNERS:	**LAT/LONG:** *47.709561, -122.104020*	**IN:** *MONTICELLO CREEK*	
1.		**NEAR/AT:** *REDMOND*	
2.		**COUNTY:** *KING*	
3.	**PAGE** *2* **OF** *9*	**DATE:** *APRIL 2020*	**STATE:** *WA*
4.			

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NO.	DATE	REVISION	BY

City of Redmond WASHINGTON

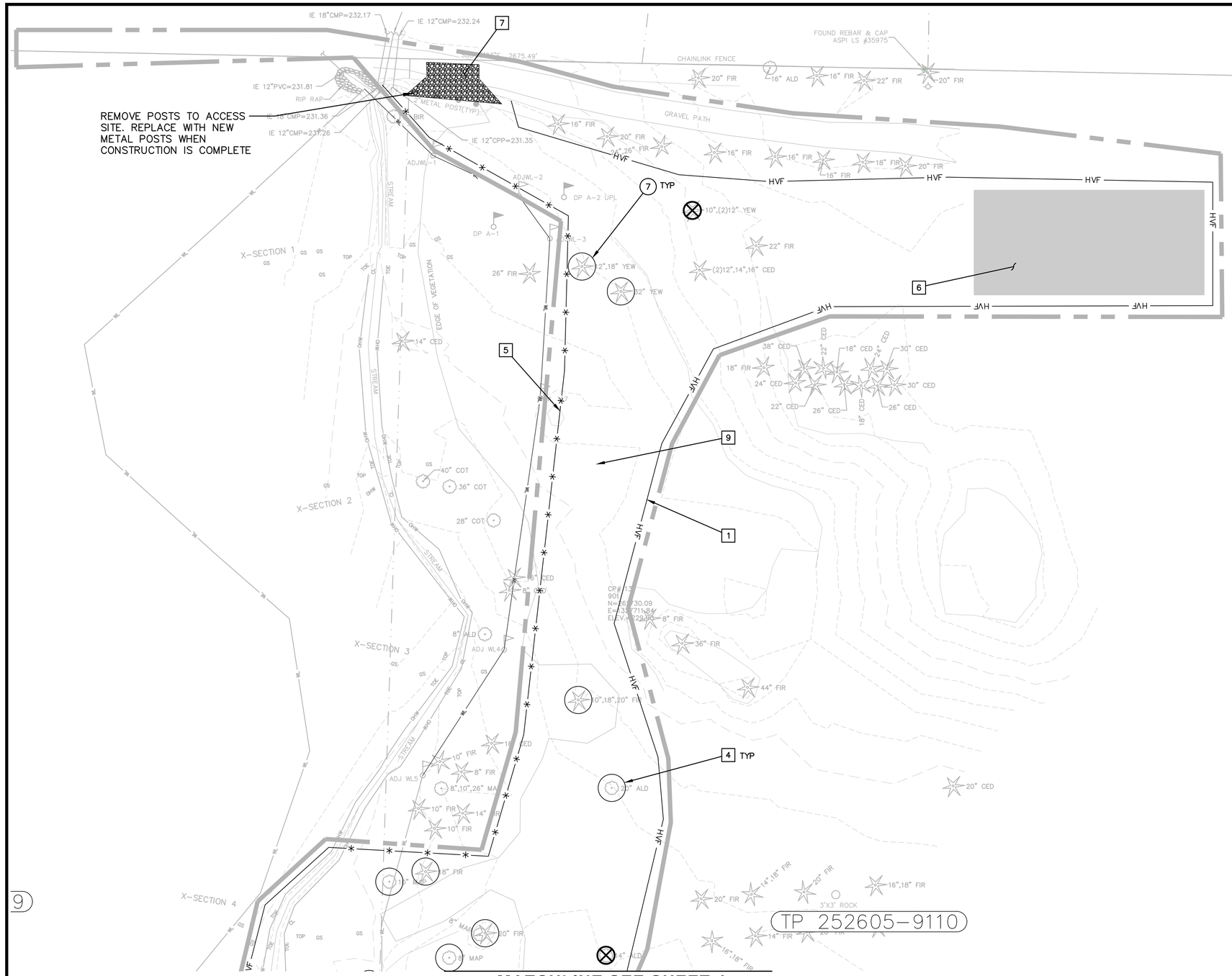
SMITH WOODS STREAM AND POND REHABILITATION

NOTES AND LEGEND

JOB# / DWG 20021811
DATE APR 2020
SCALE H: N/A V: N/A
SHEET 2 of 9

LAURA RUPPERT STATE OF WASHINGTON 43848 REGISTERED PROFESSIONAL ENGINEER

FILE NAME: P:\10-180036 CITY OF REDMOND SMITH WOODS PARK\3 CADD\SHEETS\P_10-180036_CVR.DWG
PLOT TIME: 5/22/2020 3:09 PM
USER NAME:LAURA TURNIDGE



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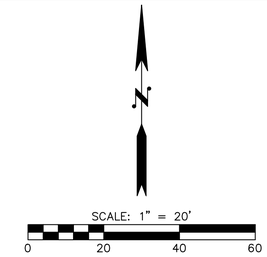

SITE PREPARATION AND TESC NOTES:

1. MARK PROJECT LIMITS IN ACCORDANCE WITH WSDOT STANDARD PLAN 1-10.10-01 HIGH VISIBILITY FENCE.
2. INSTALL INLET PROTECTION PER CITY OF REDMOND STANDARD DETAIL 508 STORM DRAIN INLET PROTECTION.
3. EXISTING TREE/VEGETATION TO REMAIN PER REDMOND ZONING CODE RCZ 21.72.070. TREE LIMBS LESS THAN 1-INCH DIAMETER CAN BE REMOVED WITH APPROVAL FROM THE CITY OF REDMOND. TREE BRANCHES TRIMMED AS NEEDED.
4. INSTALL TREE PROTECTION PER CITY OF REDMOND STANDARD DETAIL 507 TREE PROTECTION FENCE DETAIL.
5. INSTALL FILTER FENCE PER CITY OF REDMOND STANDARD DETAIL 502 FILTER FABRIC FENCE.
6. APPROXIMATE LOCATION FOR MATERIALS STAGING.
7. INSTALL TEMPORARY STABILIZED CONSTRUCTION ENTRANCE PER CITY OF REDMOND STANDARD DETAIL 503.
8. PROTECT EXISTING UTILITY, STRUCTURE, OR WALL. PROTECT CURB, GUTTER, AND SIDEWALK. RESTORE ANY PANELS CRACKED OR DAMAGED PER CITY OF REDMOND STANDARD DETAIL 303. STREET LIGHTS MUST REMAIN IN OPERATION AT ALL TIMES OR A TEMPORARY LIGHTING PLAN PROPOSED.
9. RESTORE DISTURBED AREAS TO EXISTING CONDITION OR BETTER.

TEMPORARY STREAM BYPASS GENERAL NOTES:

1. THE CONTRACTOR SHALL SUBMIT THE TEMPORARY BYPASS AND ISOLATION SYSTEM PLAN TO THE ENGINEER FOR REVIEW AND APPROVAL THE TEMPORARY BYPASS SYSTEM SHOWN ON PLAN IS SUGGESTED ONLY.
2. THE TEMPORARY BYPASS AND ISOLATION SYSTEM AND PLAN SHALL MEET ALL PERMIT REQUIREMENTS. CONTRACTOR SHALL REMOVE ALL TEMPORARY BYPASS MEASURES AFTER COMPLETION OF PROJECT.
3. THE TEMPORARY STREAM BYPASS SHALL BE INSPECTED DAILY BY THE CONTRACTOR AND MAINTAINED TO ENSURE CONTINUED PROPER FUNCTION.
4. THE 2-YEAR AND 10-YEAR STATISTICAL FLOWS FOR THIS SITE ARE 5.43 CFS AND 9.37 CFS RESPECTIVELY. CONTRACTOR SHALL BE PREPARED TO PROTECT WORK SITE DURING HIGHER FLOWS.
5. FISH EXCLUSION AND FISH REMOVAL SHALL BE PERFORMED BEFORE IN-WATER WORK IN ACCORDANCE WITH THE WASHINGTON DEPARTMENT OF FISH AND WILDLIFE HPA.
6. GRAVEL BAG CONTENTS THAT ARE ROUNDED(I.E. PEA GRAVEL) MAY REMAIN IN THE CHANNEL.
7. NO GROUND DISTURBANCE (MECHANICAL EQUIPMENT) SHALL OCCUR OUTSIDE OF THE CLEARING AND GRADING LIMITS.
8. CONTRACTOR SHALL RETAIN ANY LARGE WOODY MATERIAL INSIDE THE CHANNEL REMOVED FOR CONSTRUCTION (DEFINED AS TREES OR TREE PARTS LARGER THAN 4-IN IN DIAMETER AND LONGER THAN 6-FT) AND REPLACE BELOW OHWM PRIOR TO COMPLETION OF THE PROJECT.

TEMPORARY STREAM BYPASS CONSTRUCTION NOTES:

1. INSTALL SEDIMENT MAT
2. INSTALL FISH SCREEN
3. INSTALL GRAVEL BAG BERM
4. INSTALL BYPASS PIPE. CONTRACTOR TO DETERMINE PIPE SIZE BASED ON FLOW RATE IN THE CHANNEL AT THE TIME OF CONSTRUCTION.
5. INSTALL PIPE TO DEWATER THE POND. CONTRACTOR TO DETERMINE PIPE SIZE BASED ON POND VOLUME.
6. INSTALL TEMPORARY DISPERSION MAT TO PREVENT EROSION AT BYPASS OUTFALL. DISPERSION MAT MAY UTILIZE ROUNDED COBBLE, STRAW BALES, PLASTIC, AND/OR A SETTLEMENT BASIN. DISPERSION MAT SHALL BE REMOVED WHEN THE CONSTRUCTION IS COMPLETE.
7. EXISTING TREE/ VEGETATION TO REMAIN. PROTECT DURING CONSTRUCTION PER ECOLOGY BMP 101: PRESERVING NATURAL VEGETATION. TREE LIMBS MAY BE TRIMMED WITH APPROVAL FROM THE CITY'S ENGINEER.
8. INSTALL FILTER BAG FOR DEWATERING AND SEDIMENT REMOVAL.
9. INSTALL TURBIDITY MONITORING STATION.

811 Know what's below. Call before you dig.

LAURA RUPPERT STATE OF WASHINGTON 43848 REGISTERED PROFESSIONAL ENGINEER

30% SUBMITTAL NOT FOR CONSTRUCTION

REFERENCE: *(USACE will provide)*	**LOCATION:** *NE REDMOND AREA NEIGHBORHOOD PARK, 252605-9109*
APPLICANT: *CITY OF REDMOND, WA* *15670 NE 85TH ST, REDMOND, WA 98052*	**LAT/LONG:** *47.709561, -122.104020*
ADJACENT PROPERTY OWNERS: 1. 2. 3. 4.	**PAGE** *3* **OF** *9* **DATE:** *APRIL 2020*
PROPOSED PROJECT: *SMITH WOODS STREAM AND POND REHABILITATION*	
IN: *MONTICELLO CREEK*	
NEAR/AT: *REDMOND*	
COUNTY: *KING*	
STATE: *WA*	

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NO.	DATE	REVISION	BY

City of Redmond WASHINGTON

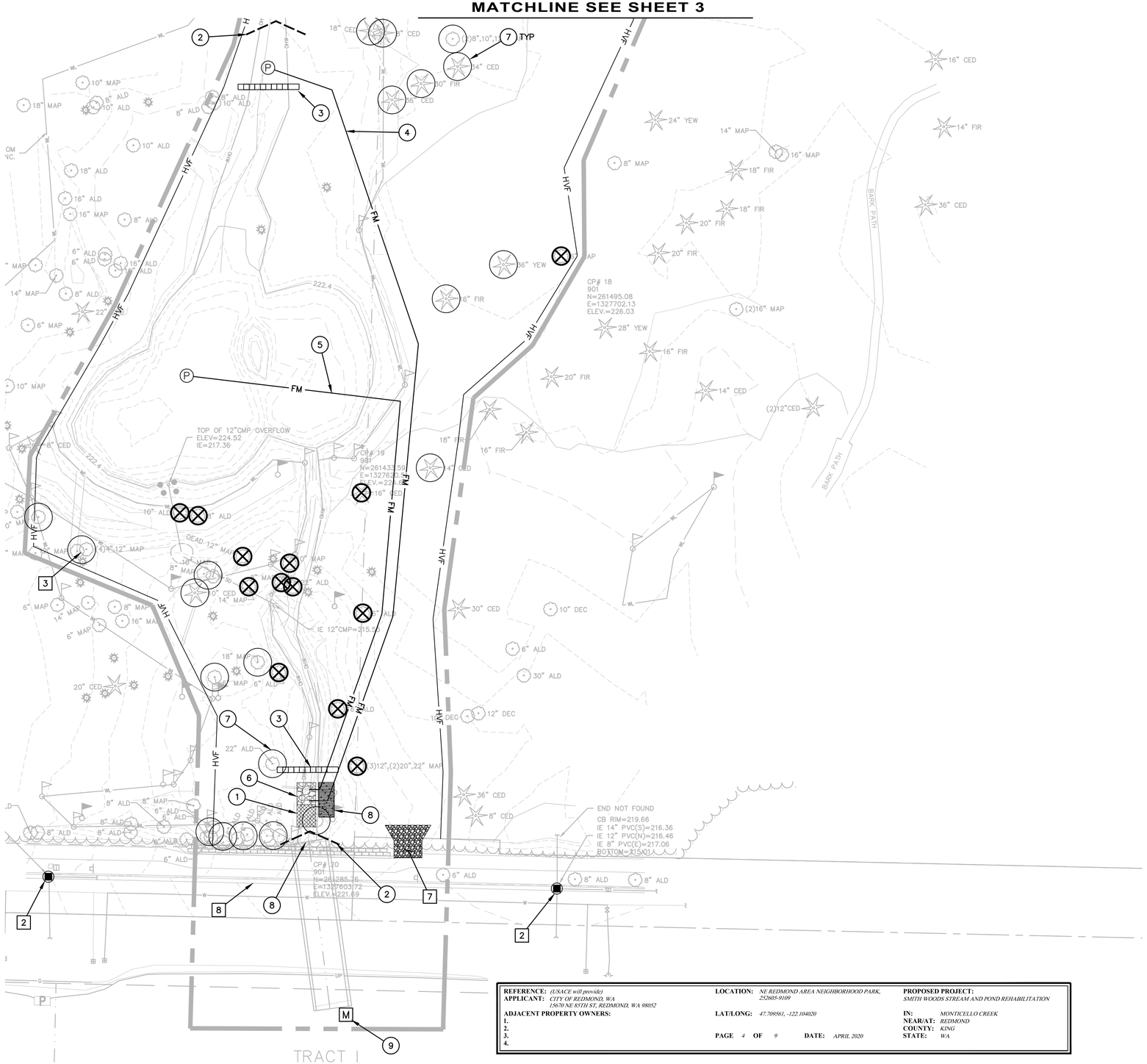
SMITH WOODS STREAM AND POND REHABILITATION

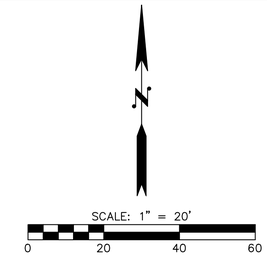
EXISTING CONDITIONS, TESC & BYPASS - NORTH

JOB# / DWG: 20021811
DATE: APR 2020
SCALE: H: 1"=20' V: N/A
SHEET: 3 of 9

FILE NAME: P:\10-180036 CITY OF REDMOND SMITH WOODS PARK\3 CADD\SHEETS\P_10-180036_TESC.DWG
PLOT TIME: 5/22/2020 3:09 PM
USER NAME:LAURA TURNIDGE

9





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LAURA RUPPLEY
STATE OF WASHINGTON
43848
REGISTERED
PROFESSIONAL ENGINEER

30% SUBMITTAL NOT FOR CONSTRUCTION

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APPLICANT: *CITY OF REDMOND, WA* *15670 NE 85TH ST, REDMOND, WA 98052*		**IN:** *MONTICELLO CREEK*	
ADJACENT PROPERTY OWNERS:	**LAT/LONG:** *47.708561, -122.104020*	**NEAR/AT:** *REDMOND*	
1.		**COUNTY:** *KING*	
2.		**STATE:** *WA*	
3.	**PAGE** *4* **OF** *9* **DATE:** *APRIL 2020*		
4.			

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City of Redmond WASHINGTON

SMITH WOODS STREAM AND POND REHABILITATION

EXISTING CONDITIONS TESC & BYPASS - SOUTH

JOB# / DWG	DATE
20021811	APR 2020
SCALE H: 1"=20' V: N/A	SHEET 4 of 9

FILE NAME: P:\10-180036 CITY OF REDMOND SMITH WOODS PARK\3 CADD\SHEETS\P_10-180036_TESC.DWG
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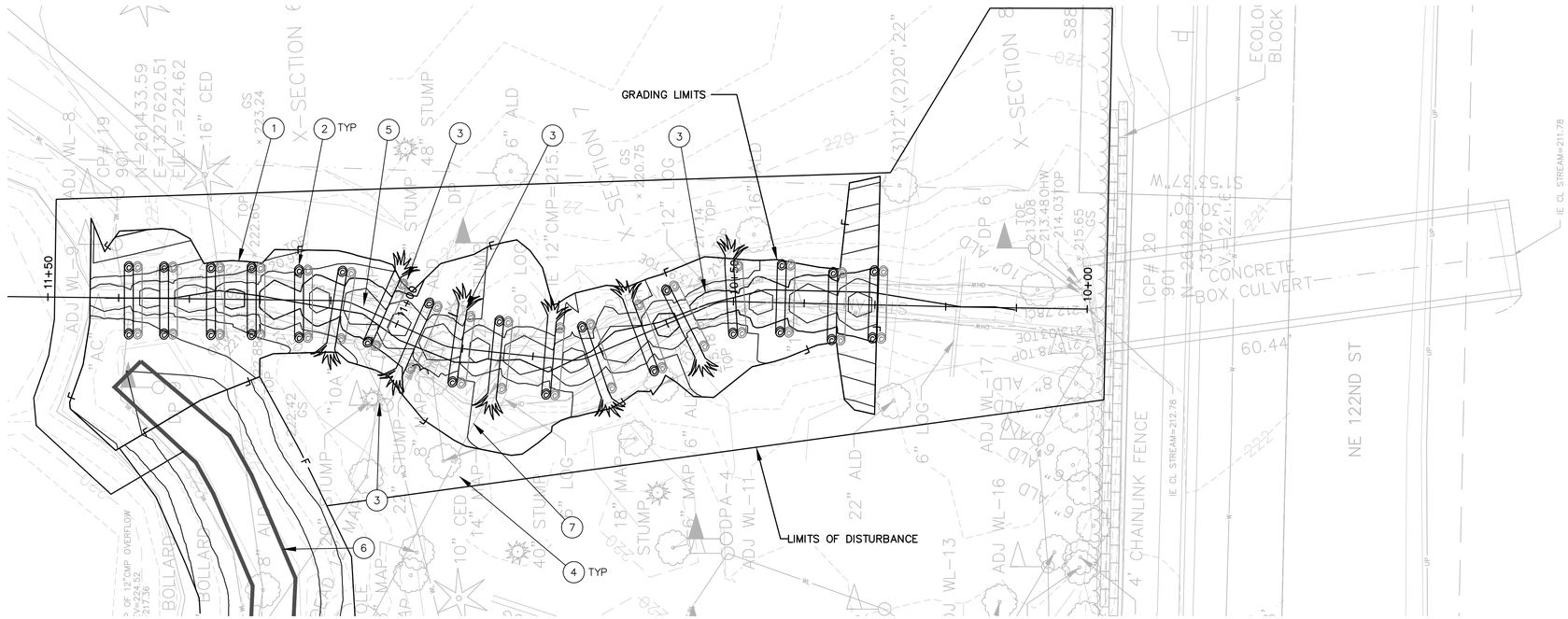
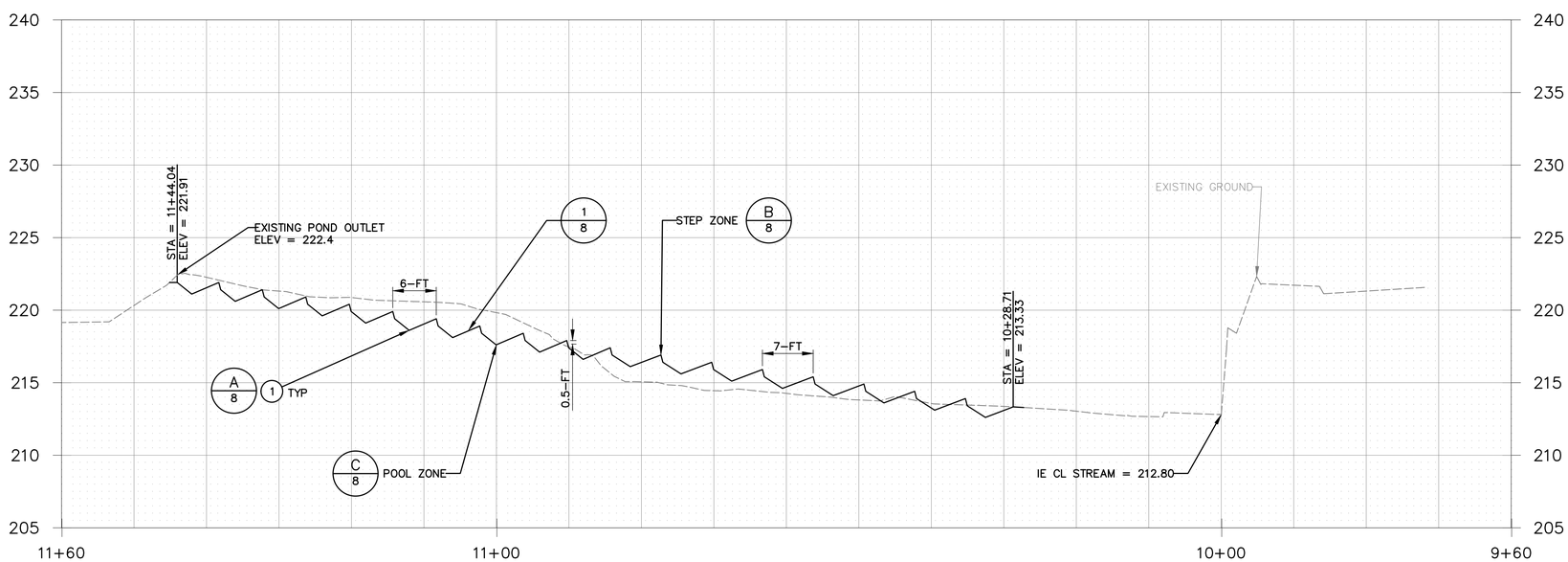
USER NAME:LAURA TURNIDGE



PLAN VIEW



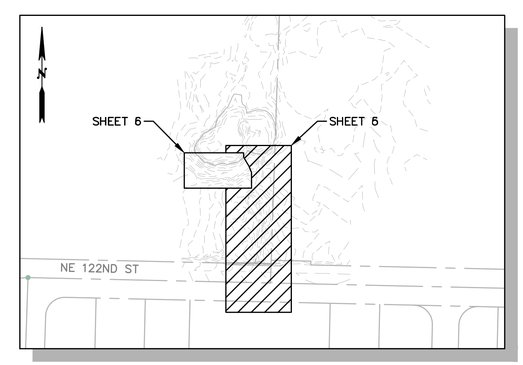
PROFILE VIEW

HORIZONTAL SCALE — SCALE: 1" = 10' (0, 10, 20, 30)

VERTICAL SCALE — SCALE: 1" = 5' (0, 5, 10, 15)

(##) CONSTRUCTION NOTES:

1. INSTALL STEP POOLS PER DETAILS ON SHEET 8.
2. INSTALL DOUBLE LOG PER DETAILS ON SHEET 8.
3. REPOSITION EXISTING STUMP/ROOT WAD/LOG WITHIN THE PROPOSED CHANNEL AS DIRECTED IN THE FIELD. WOOD SHALL BE PLACED TO INTERACT WITH CHANNEL LOW FLOWS.
4. REMOVE EXISTING TREE. REUSE WOOD ON SITE TO THE EXTENT PRACTICAL AND AS DIRECTED BY THE ENGINEER.
5. TREE TOPS AND LIMPS SALVAGED ON SITE TO BE PLACED WITHIN POOLS.
6. REPAIR BERM PER DETAILS ON SHEET 6.
7. REMOVE EXPOSED EXISTING PIPE. PLUG ANY EXISTING BURIED PIPE REMAINING PER WSDOT STANDARD SPECIFICATION 7-08.3(4).



KEY MAP

REFERENCE: *(USACE will provide)*	**LOCATION:** *NE REDMOND AREA NEIGHBORHOOD PARK, 252605-9109*	**PROPOSED PROJECT:** *SMITH WOODS STREAM AND POND REHABILITATION*	
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1.		**NEAR/AT:** *REDMOND*	
2.		**COUNTY:** *KING*	
3.	**PAGE** *5* **OF** *9*	**DATE:** *APRIL 2020*	**STATE:** *WA*
4.			

30% SUBMITTAL NOT FOR CONSTRUCTION

LAURA RUPPERT — STATE OF WASHINGTON — 43848 — REGISTERED PROFESSIONAL ENGINEER

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CityofRedmond WASHINGTON

SMITH WOODS STREAM AND POND REHABILITATION

PLAN AND PROFILE

JOB# / DWG	DATE
20021811	APR 2020
SCALE H: 1"=10' V: 1"=5'	SHEET 5 of 9

FILE NAME: P:\10-180036 CITY OF REDMOND SMITH WOODS PARK\3 CADD\SHEETS\P_10-180036_PP.DWG
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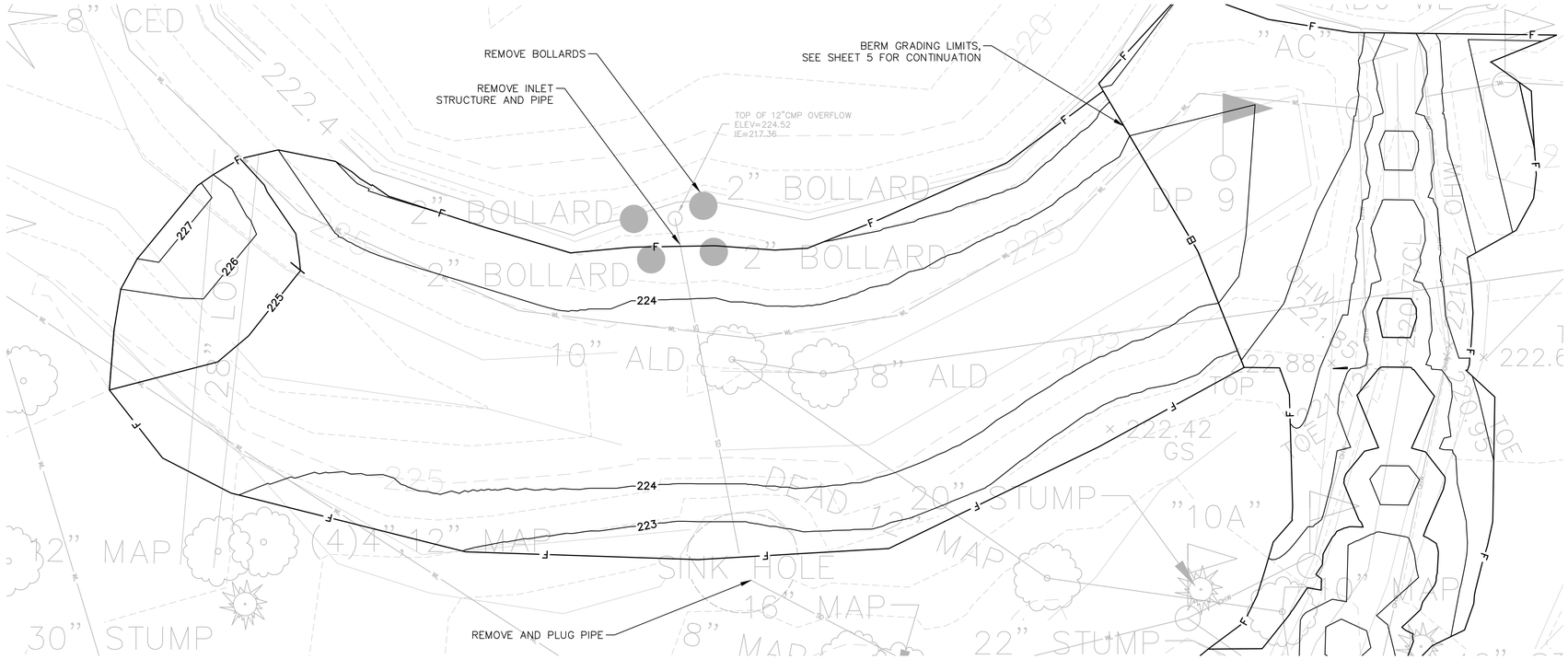
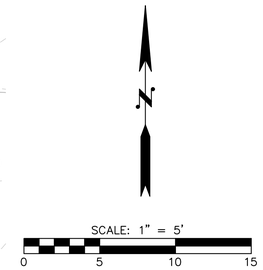
USER NAME:LAURA TURNIDGE

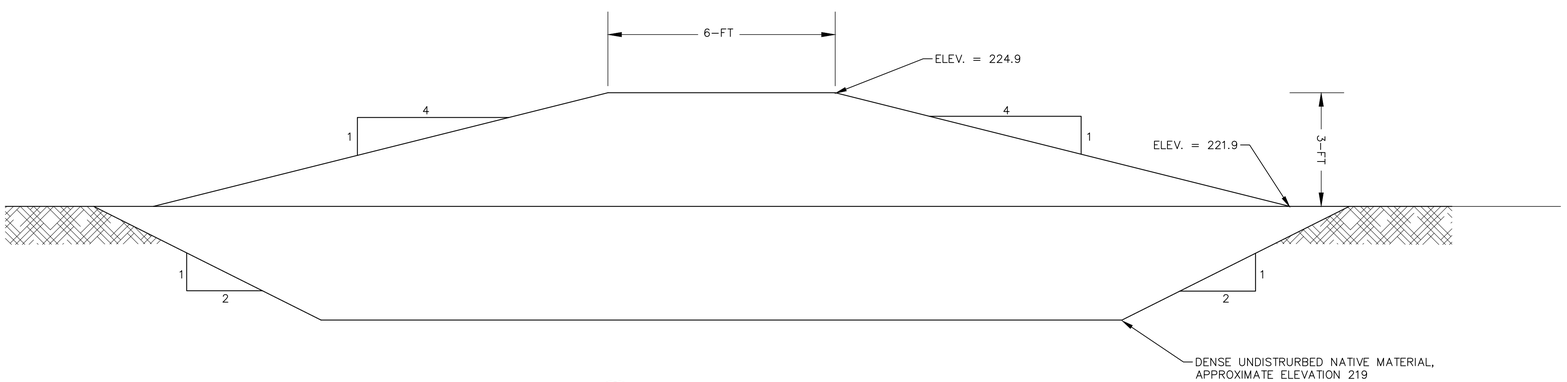


1/5 **BERM PLAN**
SCALE: 1"=5'

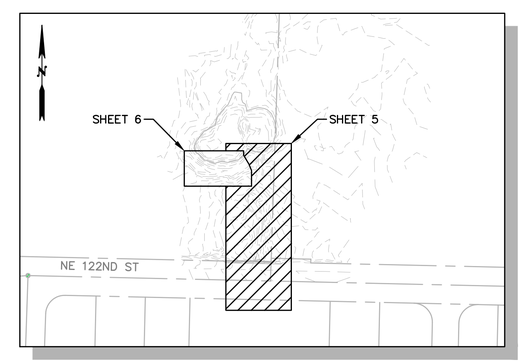


BERM REPAIR NOTES:

1. EXCAVATE AND REPLACE A MINIMUM OF 6-FT WIDE PORTION OF THE BERM.
2. MINIMUM TOP OF BERM ELEVATION TO 224.9-FT.
3. EXCAVATION AND REPLACEMENT OF BERM TO BE DOWN TO 219.0-FT OR UNTIL DENSE NATIVE MATERIAL IS ENCOUNTERED.
4. TOP OF BERM TO BE REBUILT BACK UP TO MINIMUM ELEVATION OR TO SURROUNDING GRADE WHICHEVER IS HIGHER.
5. REMOVE EXPOSED EXISTING PIPE. PLUG ANY EXISTING BURIED PIPE REMAINING PER WSDOT STANDARD SPECIFICATION 7-08.3(4).



./5 **BERM REPAIR DETAIL**
SCALE: 1"=2'



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	PAGE *6* **OF** *9* **DATE:** *APRIL 2020*	

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City of Redmond WASHINGTON

SMITH WOODS STREAM AND POND REHABILITATION
BERM REPAIR DETAILS

JOB# / DWG	DATE
20021811	APR 2020
SCALE H:AS NOTED V: NONE	SHEET 6 of 9

FILE NAME: P:\10-180036 CITY OF REDMOND SMITH WOODS PARK\3 CADD\SHEETS\P_10-180036_BERM_DET.DWG
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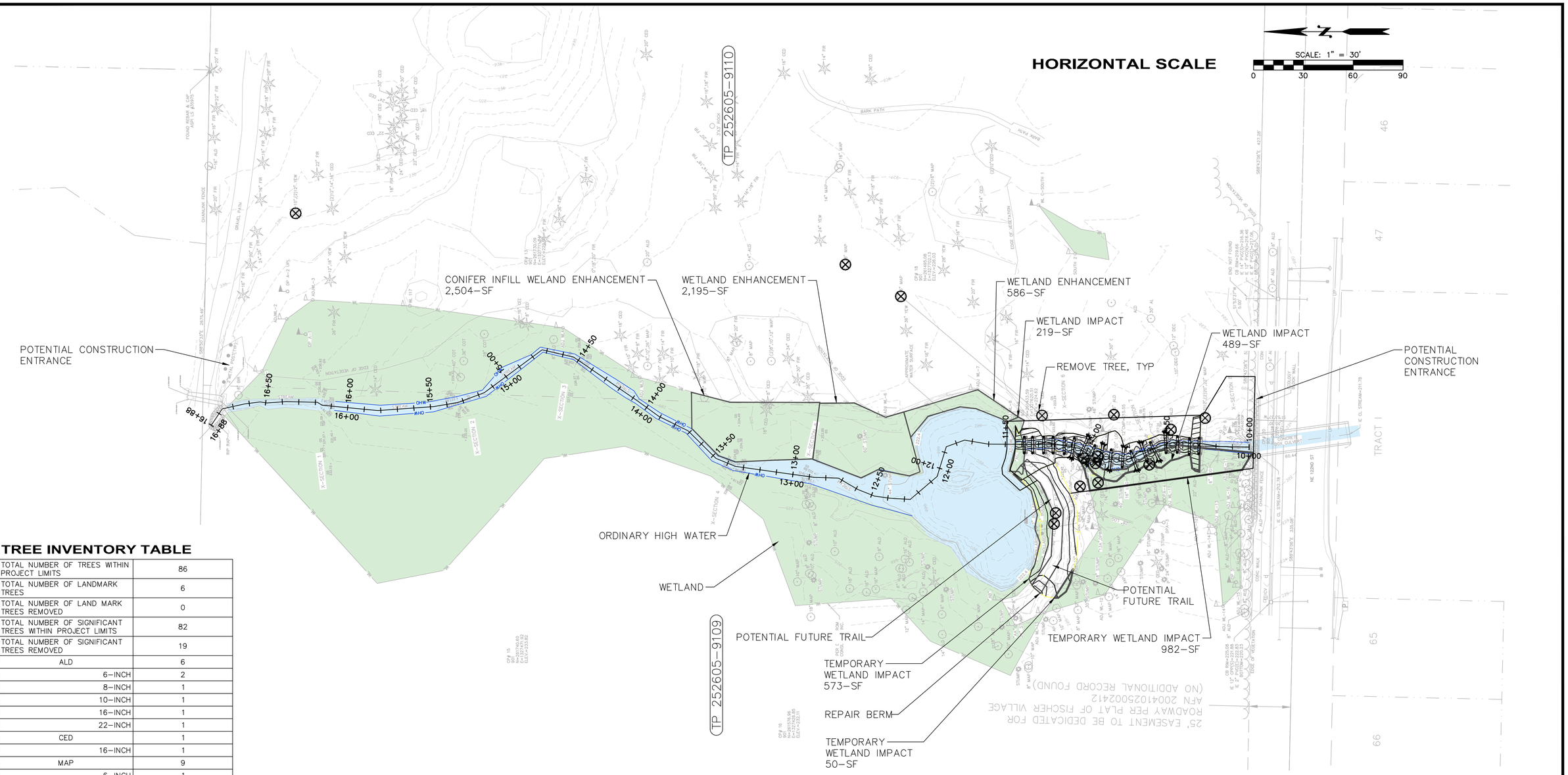

TREE INVENTORY TABLE

TOTAL NUMBER OF TREES WITHIN PROJECT LIMITS	86
TOTAL NUMBER OF LANDMARK TREES	6
TOTAL NUMBER OF LAND MARK TREES REMOVED	0
TOTAL NUMBER OF SIGNIFICANT TREES WITHIN PROJECT LIMITS	82
TOTAL NUMBER OF SIGNIFICANT TREES REMOVED	19
ALD	6
6-INCH	2
8-INCH	1
10-INCH	1
16-INCH	1
22-INCH	1
CED	1
16-INCH	1
MAP	9
6-INCH	1
8-INCH	2
10-INCH	1
12-INCH	4
14-INCH	1
REDWOOD	3
10-INCH	1
12-INCH	2
PROPOSED REPLACEMENT TREES	2 BIG LEAF MAPLE, 57 CONIFERS, 60 WILLOWS

CRITICAL AREA	TOTAL AREA	TEMPORARY IMPACT (SF)	PERMANENT IMPACT (SF)	UNDISTURBED AREA (SF)	ENHANCED AREA (SF)	BUFFER AREA (SF) AND WIDTH	TEMPORARY BUFFER IMPACTS (SF)	STREAM LENGTH (DOWNSTREAM OF POND) (LF)	RESTORED STREAM LENGTH (DOWNSTREAM OF POND) (LF)
WETLAND A, INCL POND	54,740	1,605	708	52,427	5,285	170,624 SF; 110-FT WIDE	45,624	N/A	N/A
WETLAND C	479	–	–	479	–	18,800 SF; 60-FT WIDE	217	N/A	N/A
MONTICELLO CREEK	4,646	1,324	–	3,322	2,222	159,439 SF; 150-FT WIDE	43,580	120	120

REFERENCE: *(USACE will provide)*
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PAGE *7* **OF** *9* **DATE:** *APRIL 2020*

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City of Redmond WASHINGTON

SMITH WOODS STREAM AND POND REHABILITATION
PROJECT IMPACTS

JOB# / DWG 20021811
DATE APR 2020
SCALE H: 1"=20' V: N/A
SHEET 7 of 9

FILE NAME: P:\10-180036 CITY OF REDMOND SMITH WOODS PARK\3 CADD\SHEETS\7 PROJECT IMPACTS.DWG
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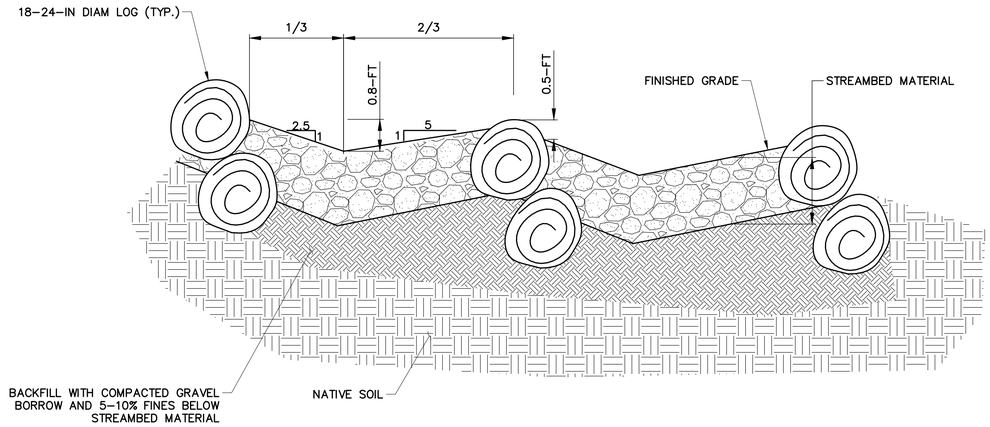
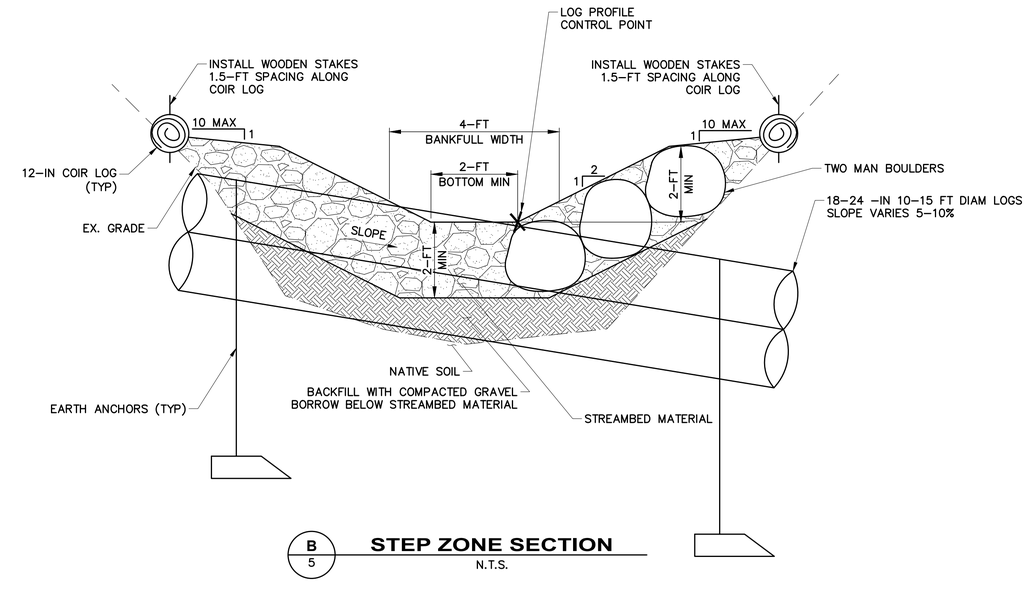
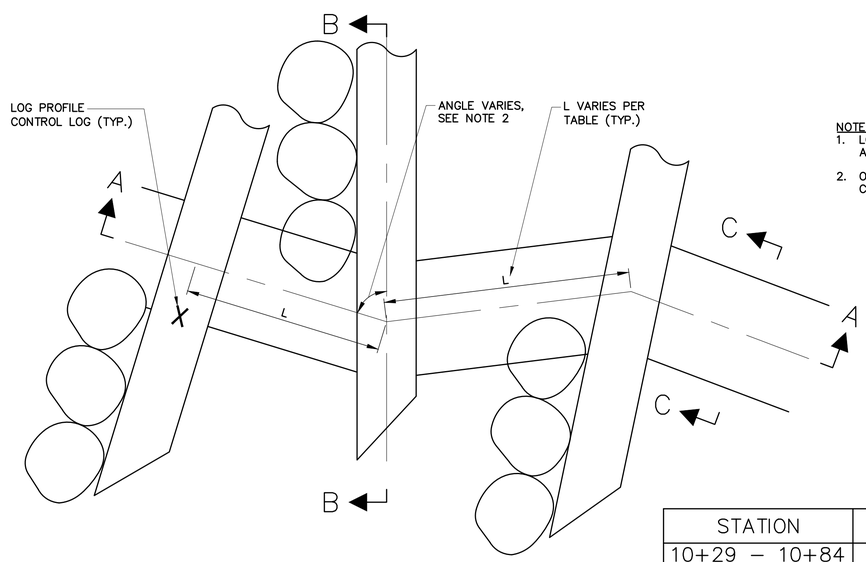


A/5 STEP POOL PROFILE
N.T.S.



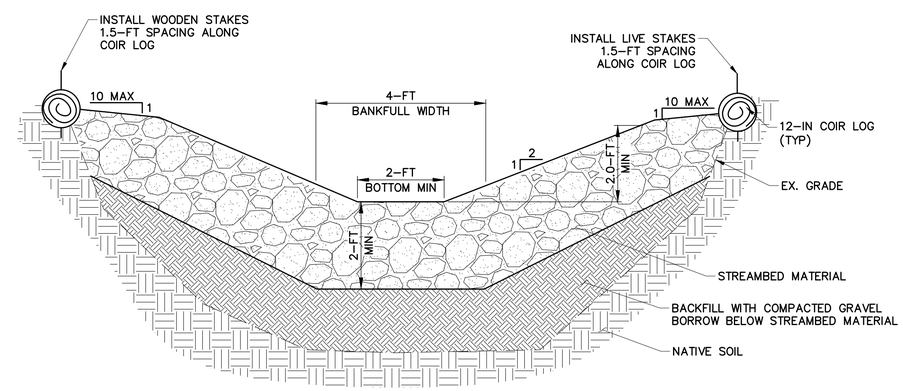
B/5 STEP ZONE SECTION
N.T.S.



NOTE:
1. LOG PROFILE CONTROL POINTS SHALL ALTERNATE SIDES FOR EACH LOG WEIR.
2. ORIENT LOG PERPENDICULAR TO CHANNEL FLOW.

STATION	L (FT)
10+29 – 10+84	7
10+84 – 11+44	6

1/5 STEP POOL DETAIL
N.T.S.



C/5 POOL ZONE SECTION
N.T.S.

Know what's below. Call before you dig.

30% SUBMITTAL NOT FOR CONSTRUCTION

LAURA RUPPERT STATE OF WASHINGTON 43848 REGISTERED PROFESSIONAL ENGINEER

REFERENCE: (USACE will provide)	LOCATION: NE REDMOND AREA NEIGHBORHOOD PARK, 252605-9109	PROPOSED PROJECT: SMITH WOODS STREAM AND POND REHABILITATION
APPLICANT: CITY OF REDMOND, WA 15670 NE 85TH ST, REDMOND, WA 98052		
ADJACENT PROPERTY OWNERS: 1. 2. 3. 4.	LAT/LONG: 47.709561, -122.104020	IN: MONTICELLO CREEK NEAR/AT: REDMOND COUNTY: KING STATE: WA
	PAGE 8 OF 9 DATE: APRIL 2020	

RECORD NO. XXXXXX

DESIGNED BY	DRAWN BY	CHECKED BY
IL	JAR	LCR

OSBORN CONSULTING INCORPORATED

Osborn Consulting, Inc.
Bellevue | Seattle | Spokane
www.osbornconsulting.com

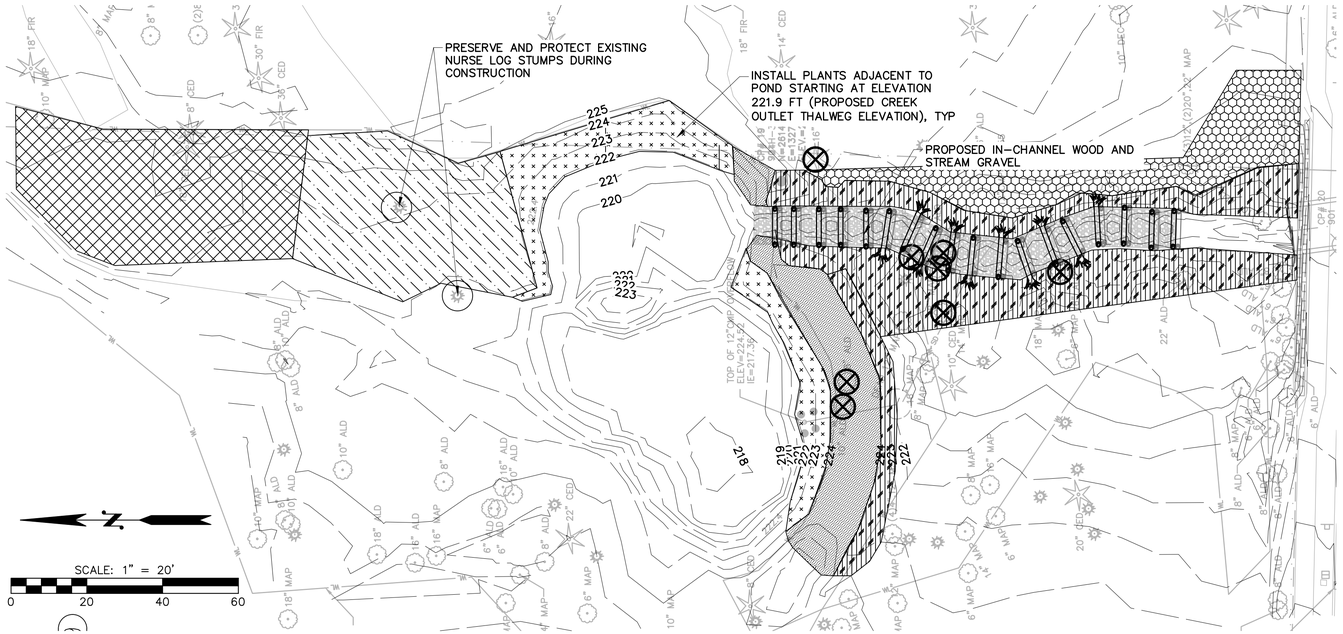
NO.	DATE	REVISION	BY

City of Redmond WASHINGTON

SMITH WOODS STREAM AND POND REHABILITATION
TYPICAL SECTIONS

JOB# / DWG: 20021811
DATE: APR 2020
SCALE: H: N/A V: N/A
SHEET: 8 of 9

FILE NAME: P:\10-180036 CITY OF REDMOND SMITH WOODS PARK\3 CADD\SHEETS\8 TYPICAL SECTIONS.DWG
PLOT TIME: 5/22/2020 3:10 PM
USER NAME:LAURA TURNIDGE



PLAN VIEW

- CONIFER INFILL 2508 SF
- DENSE SHRUBS WITH SOME TREES 2178 SF
- EMERGENT WETLAND FRINGE 859 SF (EAST), 503 SF (SOUTH)
- CREEKBANK AND WETLAND FOREST 422 SF SOUTH BERM SLOPE, 1679 SF RIGHT CREEK BANK, 955 SF LEFT CREEK BANK
- UPLAND FOREST 1533 SF
- NATIVE GRASS SEED MIX 1206 SF TOP OF BERM, 108 SF ON EAST SIDE OF POND

GENERAL NOTES:

1. SOIL PREPARATION AND PLANTING WILL BE OVERSEEN BY AN ECOLOGIST OR LANDSCAPE ARCHITECT.
3. PLANTINGS WILL BE COMPRISED OF NATIVE LOCAL MATERIALS AND WILL INCLUDE CONIFER AND DECIDUOUS TREE SPECIES, SHRUBS AND GROUNDCOVERS WITH THE INTERIM GOAL OF QUICKLY ESTABLISHING ROOT MASS AND VEGETATIVE COVER AND THE MID- TO LONG-RANGE GOAL OF ESTABLISHING A NATIVE CONIFER-DOMINATED RIPARIAN PLANT COMMUNITY.
4. SPECIES SUBSTITUTIONS MUST BE APPROVED BY ENGINEER.
5. REMOVE ENGLISH IVY, HIMALAYAN BLACKBERRY, YELLOW IRIS, HOLLY, AND OTHER NON-NATIVE VEGETATION FROM PLANTING ZONES.
6. PLANT SPECIES PER PLANTING SCHEDULE. OFFSETTING PLANTS FROM EXISTING VEGETATION IS APPROPRIATE PRIORITIZING IN AREAS THAT HAD INVASIVE REMOVED.
7. WITHIN CONIFER INFILL AND DENSE SHRUBS PLANTING AREAS, MULCH PLANTING AREA WITH ARBORIST WOOD CHIP MULCH.
8. WITHIN CREEKBANK AND WETLAND FOREST PLANTING AREA, AND UPLAND FOREST PLANTING AREA, COVER ALL EXPOSED SOILS ABOVE THE OHWM (INCLUDING FILL SOILS OVER BANK-EMBEDDED PORTIONS OF IN-STREAM LOGS) WITH COMPOST AND ADD ARBORIST WOOD CHIP MULCH PER DETAIL, PRIOR TO PLANTING.
9. COVER GRADED AREAS WITH NATIVE GRASS SEED MIX OR EMERGENT WETLAND PLANTS WITH COMPOST PRIOR TO SEEDING OR PLANTING, ENSURING COMPOST IS ABOVE OHWM ELEVATION.

UPLAND FOREST PLANT SCHEDULE (1533 SF)

LAYER	SPECIES	COMMON NAME	CONTAINER SIZE	AVG. SPACING (FT)	QTY.
Tree	Abies grandis	grand fir	1 gal	10	2
	Acer macrophyllum	bigleaf maple	1 gal	10	2
	Thuja plicata	western red cedar	1 gal	10	8
	Tsuga heterophylla	western hemlock	1 gal	10	5
				Subtotals	17
Shrub	Acer circinatum	vine maple	1 gal	10	5
	Corylus cornuta	beaked hazelnut	1 gal	4	10
	Ribes lacustre	prickly currant	1 gal	4	10
	Rubus spectabilis	salmonberry	1 gal	4	43
	Sambucus racemosa	red elderberry	1 gal	4	5
				Subtotals	73
Ground	Athyrium filix-femina	common ladyfern	1 gal	2	57
	Dicentra formosa	Pacific bleeding heart	1 gal	2	77
	Maianthemum dilatatum	false lily-of-the-valley	1 gal	2	38
	Polystichum munitum	western swordfern	1 gal	2	115
	Tolmiea menziesii	youth on age	1 gal	2	96
				Subtotals	383

CREEK BANK AND WETLAND FOREST PLANT SCHEDULE (3056 SF)

LAYER	SPECIES	COMMON NAME	CONTAINER SIZE	AVG. SPACING (FT)	QTY.
Tree	Thuja plicata	western red cedar	1 gal	10	31
				Subtotals	31
Shrub	Acer circinatum	vine maple	1 gal	10	6
	Oemleria cerasiformis	Indian plum	1 gal	4	19
	Rubus spectabilis	salmonberry	1 gal	4	96
	Sambucus racemosa	red elderberry	1 gal	10	6
				Subtotals	127
Ground	Dicentra formosa	Pacific bleeding heart	1 gal	2	115
	Hydrophyllum tenuipes	Pacific waterleaf	1 gal	2	115
	Polystichum munitum	western swordfern	1 gal	3	102
	Tellima grandiflora	fringecup	1 gal	2	153
	Tolmiea menziesii	youth on age	1 gal	2	153
				Subtotals	638

CONIFER INFILL PLANT SCHEDULE (2508 SF)

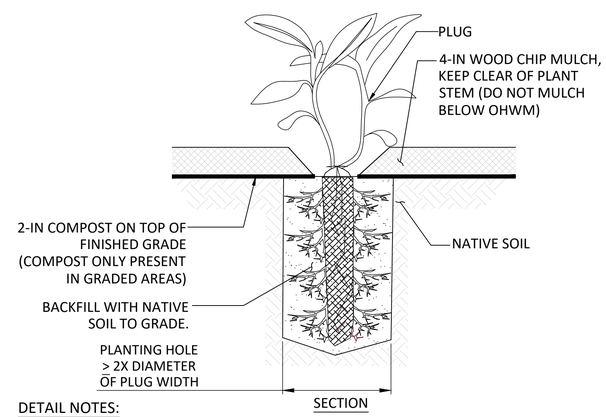
LAYER	SPECIES	COMMON NAME	CONTAINER SIZE	AVG. SPACING (FT)	QTY.
Tree	Picea sitchensis	Sitka spruce	1 gal	15	3
	Thuja plicata	western red cedar	1 gal	15	8
				Subtotals	11

DENSE SHRUBS WITH SOME TREES PLANT SCHEDULE (2178 SF)

LAYER	SPECIES	COMMON NAME	CONTAINER SIZE	AVG. SPACING (FT)	QTY.
Tree	Salix lasiandra	Pacific willow	1 gal	6	36
	Salix sitchensis	Sitka willow	1 gal	6	24
				Subtotals	60
Shrub	Acer circinatum	vine maple	1 gal	4	14
	Cornus sericea	redosier dogwood	1 gal	4	68
	Oemleria cerasiformis	Indian plum	1 gal	4	14
	Rubus spectabilis	salmonberry	1 gal	4	41
				Subtotals	137
Ground	Athyrium filix-femina	common ladyfern	1 gal	4	27
	Polystichum munitum	western swordfern	1 gal	4	27
				Subtotals	54

EMERGENT WETLAND FRINGE PLANT SCHEDULE (1362 SF)

LAYER	SPECIES	COMMON NAME	CONTAINER SIZE	AVG. SPACING (FT)	QTY.
Ground	Carex obnupta	slough sedge	10 cubic in. plug	1	272
	Eleocharis palustris	common spikerush	10 cubic in. plug	1	272
	Juncus acuminatus	tapertip rush	10 cubic in. plug	1	272
	Juncus ensifolius	swordleaf rush	10 cubic in. plug	1	272
	Scirpus microcarpus	small-fruited bulrush	10 cubic in. plug	1	272
				Subtotals	1360

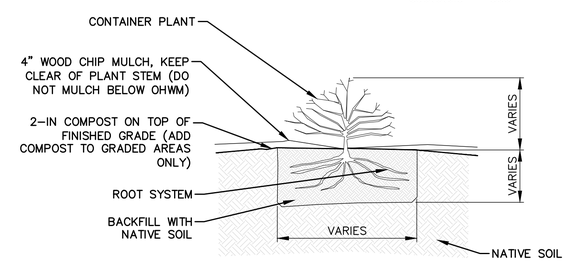


DETAIL NOTES:

1. REMOVE PLUG FROM TRAY OR CONTAINER BY PUSHING UP THROUGH BOTTOM OF LINER. DO NOT PULL THE PLANT BY VEGETATIVE MATERIAL.
2. DO NOT PULL ROOT SYSTEM APART.
3. MATCH TOP OF BACKFILLED NATIVE SOIL WITH SOIL LEVEL AT TOP OF PLUG.
4. TAMP IN BACKFILLED SOIL GENTLY AND WATER PLUG IN TO ENSURE SOIL-ROOT CONTACT.
5. STORE PLANTS ONSITE IN SHADE AND INSTALL AS SOON AS POSSIBLE AFTER DELIVERY, WATERING AS NECESSARY.
6. DO NOT ALLOW ROOTS TO DRY OUT DURING HANDLING.
7. REFER TO SPECIAL PROVISION 8-02.3(8) FOR ADDITIONAL PLANTING SPECIFICATIONS.

EMERGENT PLUG PLANTING DETAIL

N.T.S.



DETAIL NOTES:

1. ALL NOTES FROM EMERGENT PLUG PLANTING DETAIL APPLY TO CONTAINER PLANTING DETAIL.

CONTAINER PLANTING DETAIL

N.T.S.

Know what's below. Call before you dig.

STATE OF WASHINGTON — DANIELLE L. DEVER — NO. 3969 EXP. 7/24/2020 — LANDSCAPE ARCHITECT

30% SUBMITTAL NOT FOR CONSTRUCTION

REFERENCE:	(USACE will provide)
APPLICANT:	CITY OF REDMOND, WA 15670 NE 85TH ST, REDMOND, WA 98052
ADJACENT PROPERTY OWNERS:	1. 2. 3. 4.
LOCATION:	NE REDMOND AREA NEIGHBORHOOD PARK, 252605-9109
LAT/LONG:	47.709561, -122.104020
PAGE 9 OF 9	DATE: MAY 2020
PROPOSED PROJECT:	SMITH WOODS STREAM AND POND REHABILITATION
IN:	MONTICELLO CREEK
NEAR/AT:	REDMOND
COUNTY:	KING
STATE:	WA

DESIGNED BY	DLD		
DRAWN BY	DLD		
CHECKED BY	KP		

NO.	DATE	REVISION	BY

City of Redmond WASHINGTON

SMITH WOODS STREAM AND POND REHABILITATION

STREAM RESTORATION AND PLANTING DETAILS

JOB# / DWG	DATE
20021811	MAY 2020
SCALE H: 1"=XX' V: 1"=XX'	SHEET 9 of 9

FILE NAME: N:\PROJECTS\OSBORN CONSULTING\SMITH WOODS_CITY OF REDMOND\DESIGN\CAD DWGS - CURRENT\P_10-180036_PLNT.DWG
PLOT TIME: 5/14/2020 2:43 PM
USER NAME:DANIELLE DEVER

APPENDIX C: BANKFULL WIDTH MEMO

OSBORN CONSULTING INCORPORATED
1800 112th Avenue NE Suite 220-E | Bellevue, WA 98004 | P: 425.451.4009 | F: 425.451.4901

DATE MAY 29, 2019

TO ROBERT CRITTENDEN, PE (CITY OF REDMOND)
EMILY FLANAGAN, PE (CITY OF REDMOND)
ROGER DANE (CITY OF REDMOND)

CC TORREY LUITING (NATURAL SYSTEMS DESIGN)

FROM INDULEKSHMI, EIT, (OSBORN CONSULTING, INC.)
MATTHEW GRAY, PE (OSBORN CONSULTING, INC.)

SUBJECT CITY OF REDMOND SMITH WOODS – BANKFULL WIDTH DOCUMENTATION MEMORANDUM

INTRODUCTION

This memorandum summarizes the methods and rationale used to determine the bankfull width along Monticello Creek passing through Smith Woods in Redmond, Washington. Bankfull width is the preferred measurement by Washington Department of Fish and Wildlife (WDFW) for designing water crossings. Based on the documentation outlined in this memorandum, the design bankfull width is determined to be 4 feet.

SITE CONDITIONS

Smith Woods is a City-owned, 10-acre parcel located in a rapidly developing neighborhood in Northeast Redmond. The property is mostly undeveloped and provides a great natural area oasis for the residential community as well as valuable habitat at the headwaters of Monticello Creek. Monticello Creek flows from north to south in Smith Woods, through a small pond, and continues south as a small stream through the culvert at NE 122nd St. The Monticello Creek basin is a small urban drainage with predominantly residential land use. One of the main concerns for this section of Monticello Creek passing through Smith Woods is the loss of in-stream habitat at the outlet of the pond forming a barrier to fish passage. This bankfull width determination is necessary to select a preferred alternative for rehabilitating the Monticello Creek and the pond. The bankfull width determination will help to design the channel width and slope for the reconfigured stream in accordance with WDFW stream simulation channel design guidelines.

SITE OBSERVATIONS AND BANKFULL WIDTH ANALYSIS

Osborn Consulting Inc. (OCI) conducted a site visit on May 16, 2019 to determine the bankfull width. The locations of the bankfull width measurements for the length of the project are shown in **Figure 1** and photos of each location are included in the photo log in **Attachment 1**.

The guidance document, **Determining the Ordinary High Water for Shoreline Management Act Compliance in Washington State** by the Department of Ecology (Anderson et. al. 2016) describes the bankfull width as:

> *"the wetted channel width at bankfull discharge. Often the term bankfull width is used to describe the active stream channel. The active stream channel does not typically include nearby*

vegetation except those that can sustain frequent channel scour or grow at or below water's edge for very long durations."

Field efforts included walking the stream and investigation of the stream channel and culvert locations for conditions characteristic of bankfull width. OCI measured the bankfull width in the field according to guidance provided in the Water Crossings Design Guidelines (WCDG), which recommends taking the average of several random width measurements that reflect the natural channel condition outside the influence of factors that could affect the bankfull width.

It was very difficult to find locations representing natural channel conditions downstream of the NE 122nd culvert as the stream was relatively dry with intermittent ponding and flows going subsurface within. The first bankfull width was measured around 150 feet downstream of the culvert and is believed to be influenced by 12-16-inch size logs on the left bank.

The NE 122nd St culvert measured a span of 12 feet with 3 feet of clearance at the outlet. The stream was dry at the culvert. A 6-inch PVC storm drain pipe discharges into the stream at the outlet of the culvert.

Upstream of the NE 122nd St culvert was comparatively less influenced by logs but was dry with a silty bottom. Moving further upstream closer to the pond, stream was a little wider with no flow and a gravel bottom with some smaller cobbles.

About 144 feet upstream of the culvert is the Smith Woods pond with an approximate area of 0.14 acres surrounded by wetlands. Upstream of the pond, the stream has a silty bottom with intermittent pools of water. About 100 feet upstream of the pond, the stream was well defined with predominately gravel bottom and no flow.

At the north boundary of Smith Woods along the unimproved NE 124th Street right-of-way there was a walking trail beneath which three culverts - 18-inch CMP, 12-inch CMP (crushed) and 12-inch culvert with CMP inlet and CPP outlet were observed. At the outlet of the culverts on the west side there was another 12-inch green plastic pipe draining to the stream. The green plastic pipe is assumed to be draining from the stormwater pond located 500 feet west of the culverts next to the walking trail. No measurements were taken upstream from NE 124th as there was a large wetland which was fenced serving as the headwaters of Monticello Creek.

The locations of the bankfull width measurements for the length of the project are shown in **Figure 1**. Bankfull width measurement for the first location is considered an outlier in calculating the average width as it is double the width of the stream in other locations due to the presence of logs. The bankfull width measurement values used in calculating the average bankfull width for the stream are provided in **Table 1**. Sites were selected in locations where natural indicators could be used to identify bankfull elevation. Bankfull indicators included breaks in bank slope, top of bank, vegetation changes, extent of perennial woody vegetation, undercut banks, water lines, debris lodged in overhanging branches, and root scour on the streambanks. The resulting bankfull widths were calculated to average 3.8 feet downstream and 3.9 feet upstream of the culvert at NE 122nd St.

TABLE 1 | SMITH WOODS MONTICELLO CREEK BANKFULL WIDTH FIELD MEASUREMENTS		
Location	**Bankfull width (ft)**	**Notes**
BFW 1	7.0	Downstream of the culvert approximately 150 feet. 12-16-inch logs on the left bank.
BFW 2	3.5	Ponded water with silt bottom.
BFW 3	4.0	Dry stream. Influenced by logs.
BFW 4	5.5	No flow. Pebbles and gravels at the bottom.
BFW 5	3.5	Silty bottom. Probably fish larvae present.
BFW 6	3.5	Silty bottom. Well defined channel.
BFW 7	3.5	No flow. Small pebbles and silty bottom.
BFW 8	3.5	No flow. Some pebbles and silty bottom.
BFW 9	3.5	No flow. Angular rocks and concrete pieces. Fairly defined channel.
Average	**3.9**	
Median	**3.5**	

RECOMMENDED BANKFULL WIDTH

The average bankfull widths measured in the field was 3.9 feet. The recommended design bankfull depth for Monticello Creek is 4 feet.

REFERENCES

Anderson, P.S., Meyer, S., Olson, P., & Stockdale, E. (2016). Determining the Ordinary High Water Mark for Shoreline Management Act Compliance in Washington State. Final Review. Washington State Department of Ecology, Shorelands & Environmental Assistance Program, Olympia WA. Ecology Publication no. 16-06-029.

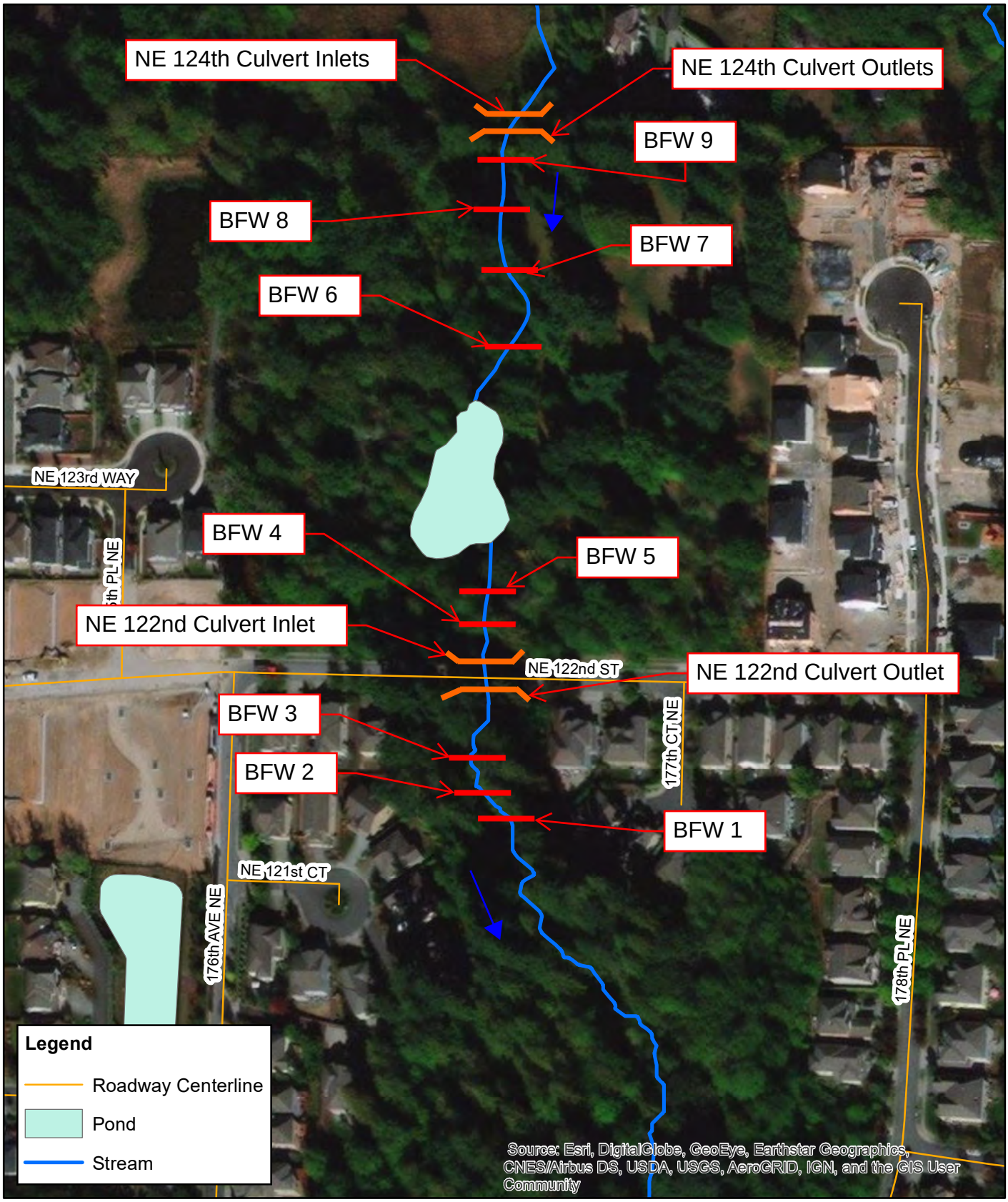
Barnard, R. J., J. Johnson, P. Brooks, K. M. Bates, B. Heiner, J. P. Klavas, D.C. Ponder, P.D. Smith, and P. D. Powers (2013), Water Crossings Design Guidelines, Washington Department of Fish and Wildlife, Olympia, Washington.

FIGURES

Figure 1 Bankfull Width Measurement Locations

ATTACHMENTS

Attachment 1 Photo Log



OSBORN CONSULTING INCORPORATED

N

0 90 180 360 Feet

Figure 1: Bankfull Width Measurement Locations
Monticello Creek, Smith Woods

Redmond, WA

Prepared by IL, 5/17/2019

ATTACHMENT 1: PHOTO LOG

BFW-1 looking downstream

BFW-2 looking downstream

BFW-3 looking downstream

NE 122nd Culvert Outlet looking upstream

NE 122nd Culvert Inlet looking downstream

BFW-4 looking upstream

BFW-5 looking upstream

Smith Woods Pond looking downstream

BFW-6 looking upstream

BFW-7 looking upstream

BFW-8 looking upstream

BFW-9 looking upstream

Two of the three culvert outlets at NE 124th St

Third culvert with CPP outlet at NE 124th St

Green Plastic Pipe draining to the stream from the west at NE 124th St culverts

Three culvert inlets at NE 124th St walking trail

APPENDIX D: HYDROLOGY MEMO

OSBORN CONSULTING INCORPORATED
1800 112th Avenue NE Suite 220-E | Bellevue, WA 98004 | P: 425.451.4009 | F: 425.451.4901

DATE NOVEMBER 4, 2019

TO ROBERT CRITTENDEN, PE (CITY OF REDMOND)
EMILY FLANAGAN, PE (CITY OF REDMOND)
ROGER DANE (CITY OF REDMOND)

FROM LAURA RUPPERT, PE (OSBORN CONSULTING, INC.)

SUBJECT CITY OF REDMOND SMITH WOODS – HYDROLOGY MEMORANDUM

INTRODUCTION

This memorandum summarizes the suitability assessment of two hydrologic models and documents our design flow recommendation for the hydraulic modeling and design of Monticello Creek and pond at Smith Woods in Redmond, WA. Smith Woods is a City-owned, 10-acre parcel located in a rapidly developing neighborhood in Northeast Redmond. The property is mostly undeveloped and provides a great natural area oasis for the residential community as well as valuable habitat at the headwaters of Monticello Creek. Monticello Creek flows from north to south in Smith Woods, through a small pond, and continues south as a small stream through the culvert at NE 122nd St. The Monticello Creek basin is a small urban drainage basin with predominantly residential land use.

EXISTING MODELS

The two existing Monticello Creek hydrology models assessed are the Western Washington Hydrologic Model (WWHM) prepared by Golder as part of the emergency repair work in 2016 and the 2016 Hydrologic Simulation Program Fortran (HSPF) model prepared by King County as part of the Monticello Basin SUSTAIN modeling.

WWHM

A WWHM was developed by Golder in 2016, and the resulting flow rates were used to design interim channel stabilization measures constructed at the pond outlet. The following assumptions went into the WWHM model:

- 100.6 acres of contributing area
- Coverage incorporated land use data provided by the City as part of the Redmond Watershed Management Plan (Herrera, 2003) and with effective impervious percentages assigned that assumed more recent developments would have higher drainage connectivity. The resulting breakdown is 13-percent Impervious, 69-percent lawn/pasture, and 18-percent forest.
- Group B soils, which are gravelly sandy loam with moderate water transmission rates, based on NRCS/USDA 2015 soil data.

See **Table 1** for the resulting flow frequency results.

HSPF

An HSPF model was developed and calibrated by King County in 2016. The resulting flows were used as input into the SUSTAIN model, which was also developed by King County in partnership with the City for the Monticello Creek Watershed Restoration Plan. As the King County design documentation is not yet available, the results summarized here are based on select information provided by King County via email and gathered by reviewing the HSPF model input files.

Two HSPF catchment locations are located within the Smith Woods project area. MON025 is associated with flow at the pond and MON026 is associated with flow in the channel downstream of the pond and upstream of NE 122nd St. Snap shots of the catchment routing and subbasin boundaries are included as **Attachment A**. The following assumptions went into the HSPF model:

- 84.8 acres contributing to MON025 (the pond); 99.2 acres contributing to MON026 (channel downstream of the pond).
- Coverage incorporated King County's GIS data for 2015 impervious cover, soils, and slopes.
    - Area tributary to MON025 is on average 18-percent impervious.
    - Area tributary to MON026 is on average 16-percent impervious.

The HSPF model is calibrated to stream flow gage BC0119 located near the mouth of Monticello Creek (near Avondale Rd. NE and NE 116th St. in Redmond, WA). Calibration plots are available upon request. See **Table 1** for the resulting flow frequency results.

TABLE 1 | FLOW FREQUENCY RESULTS

Return Interval	1.01-YR	2-YR	5-YR	10-YR	20-YR	25-YR	100-YR
WWHM Flow Rate		5.43 CFS	7.64 CFS	9.37 CFS		11.91 CFS	16.45 CFS
HSPF Flow (MON025)	1 CFS	3.5 CFS	5.7 CFS	7.5 CFS	10.1 CFS		15.2 CFS
HSPF Flow (MON026)	1 CFS	3.6 CFS	5.9 CFS	7.7 CFS	10.5 CFS		15.7 CFS

GAGE DATA

In 2016, King County added a Monticello Creek gage closer to the project site than the gage used for the HSPF model calibration. The new gage is identified as RPWS_MONMN. The gage is located approximately 1,100 ft downstream from NE 122nd Street, just upstream from the 178thy Place NE culvert crossing. The drainage basin is roughly 50% larger than the project basin. **Table 2** summarizes the low and high flows recorded at this gage. While a low summer base flow is maintained at the gage site, the project reach between the pond outlet and NE 122nd Street has been observed to be dry for most of the summer. Select gage data summaries are included as **Attachment B**.

TABLE 2 | SUMMARY OF KING COUNTY GAGE RPWS_MONMN RECORDINGS BY WATER YEAR

Water Year	High Flow	Low Flow
2019	1.9 CFS	<0.03~0.2 CFS
2018	4.1 CFS	<0.03~0.5 CFS
2017	7.8 CFS	<0.03~0.6 CFS
2016	3.7 CFS	<0.03~0.3 CFS

COMPARE FLOWS

Both models have similar basin areas, impervious assumptions, and flow frequency results. The HSPF flows may be more defensible, because they are derived from a calibrated model that was built using actual 2015 impervious coverages. However, the calibration location is at the mouth of the creek and our site is closer to a tributary headwater. The WWHM flows are higher, and therefore, more conservative.

The gage data is for a larger basin, and four years of data is not enough to perform statistical analysis, so it is not appropriate for comparison to the model predictions. Gage data is provided for reference only.

FUTURE FLOWS

Neither model accounts for future development, which will increase the amount of impervious area in the basin. King County's future flow model assumes 29-percent impervious area (compared to 18-percent in the 2015 existing condition). Flow control requirements should mitigate increases in impervious area greater than 2,000 SF up through the 50-year design flow.
Potential effects of climate change on stream flows include:

- Higher peak flows in the spring and winter. This is riskier in higher elevation basins where warmer temperatures will affect the amount of snowfall, but this project is not located in a higher elevation basin.
- Warmer and drier summers have the potential to lengthen the period of no flow during the summer.
- Sea level rise is not an issue at this location.

Spending additional time developing design flows with a more sophisticated hydrology model and calibration is not recommended considering the small project size and low risk.

Recommended Design Flow

Design flow recommendations are as follows:

- The WWHM existing condition flows (**Table 1**) are recommended for use during design, because they are more conservative than the HSPF flows.
- The 2-year peak flood flow shall be used for fish passage design in accordance with WAC-220-110, since site specific stream data during fish migration periods is not available.
- Spreadsheet calculations for sizing streambed gravel and assessing shear stress, bank stability, and wood buoyancy shall use a factor of safety in consideration for unknowns associated with future flow rates.
- No model changes or updates are recommended to account for future flows.

References

Stoneman, S., & Thurman, D. (2016). Smith Woods Pond – Interim Channel Stabilization. Golder Associates.

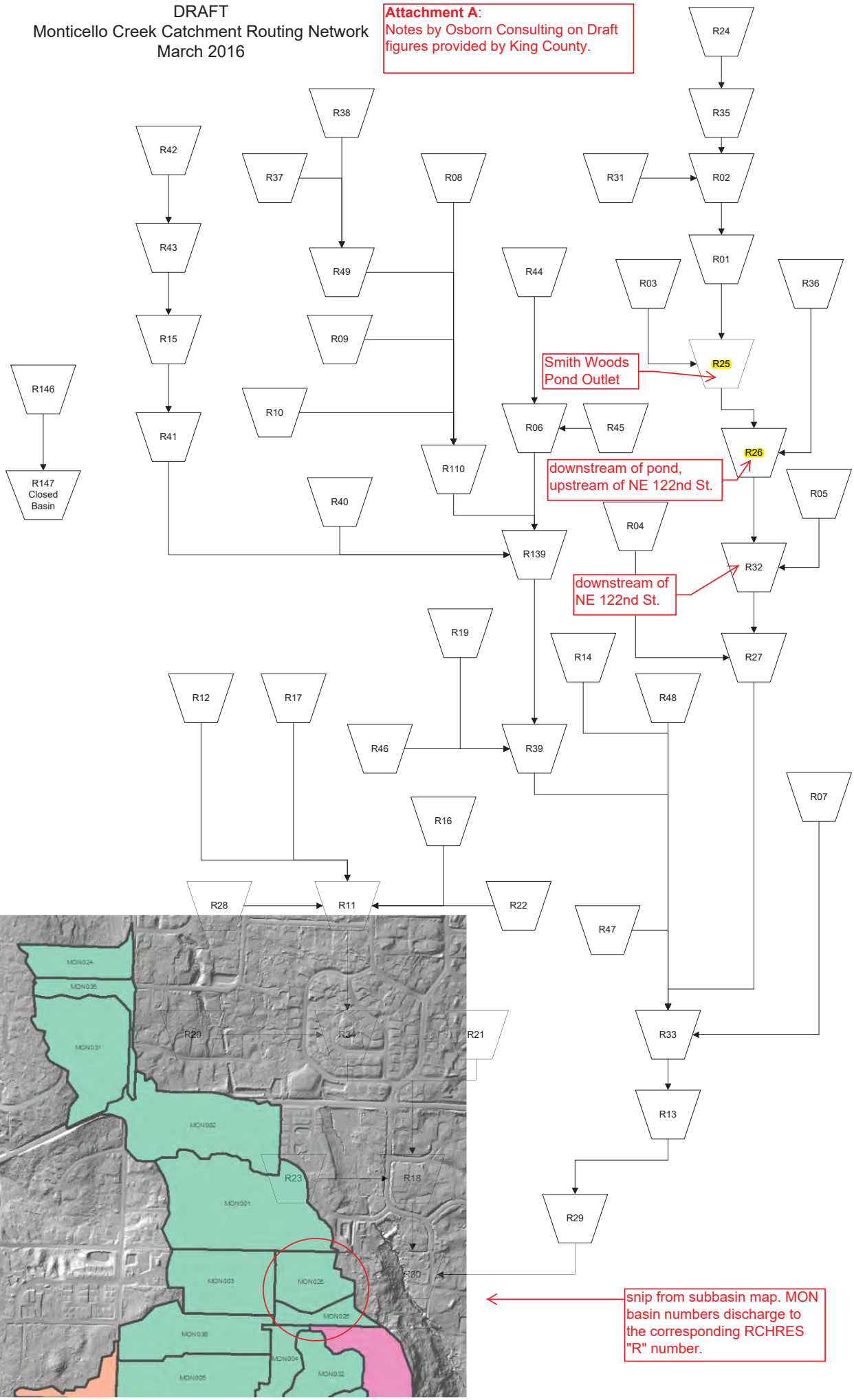
Attachments

Attachment A HSPF Catchment Routing and Subbasin Boundaries

Attachment B Select King County Gage Data Summaries

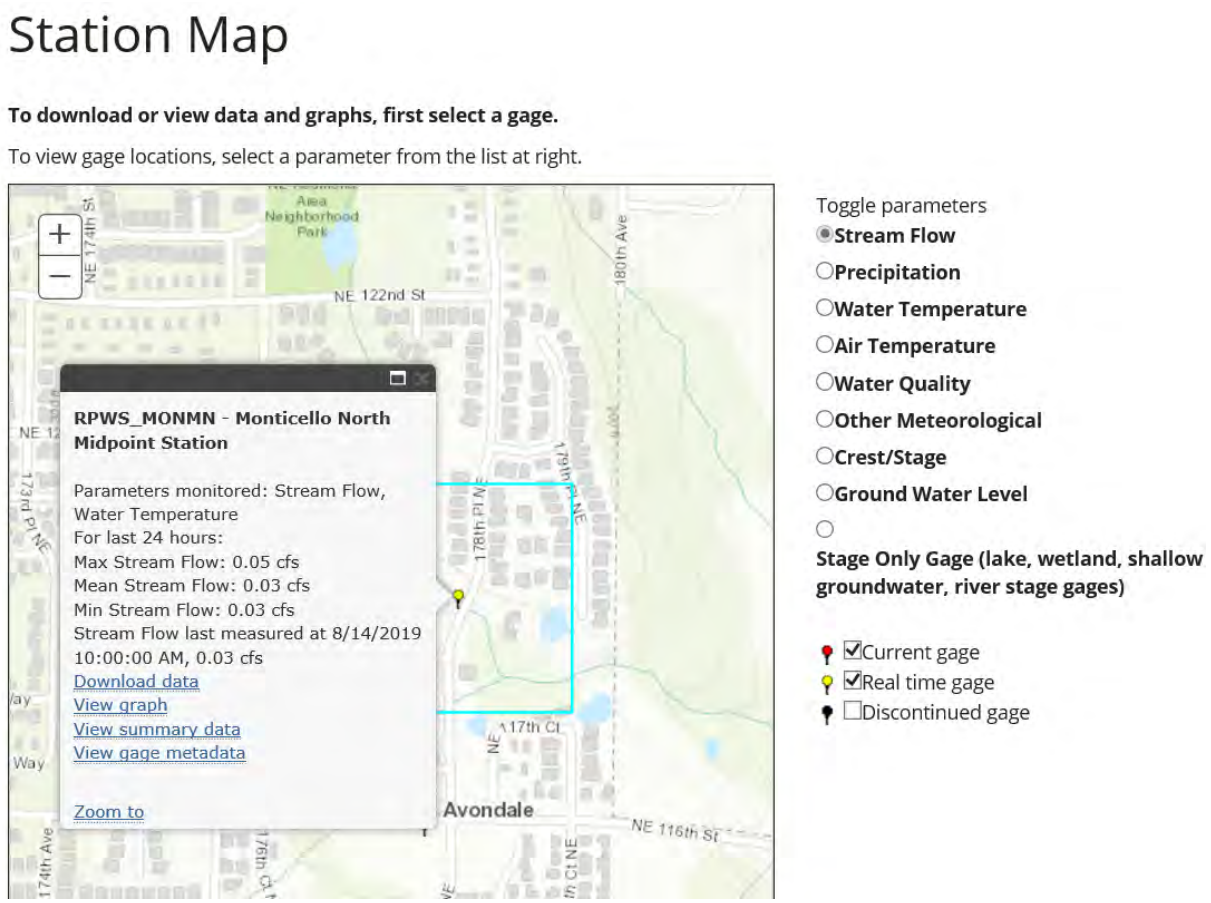
DRAFT
Monticello Creek Catchment Routing Network
March 2016

Attachment A:
Notes by Osborn Consulting on Draft figures provided by King County.



King County gage data available here: https://green2.kingcounty.gov/hydrology/GaugeMap.aspx

Map of gage downstream a of Smith Woods:



Monticello Creek consistently goes dry in summer. Gage reports flows ranging 0.03~0.05 CFS August 13/14, 2019. Table 1 summarizes the high and low flows measured at this gage. The corresponding annual summary graphs by water year are provided below.

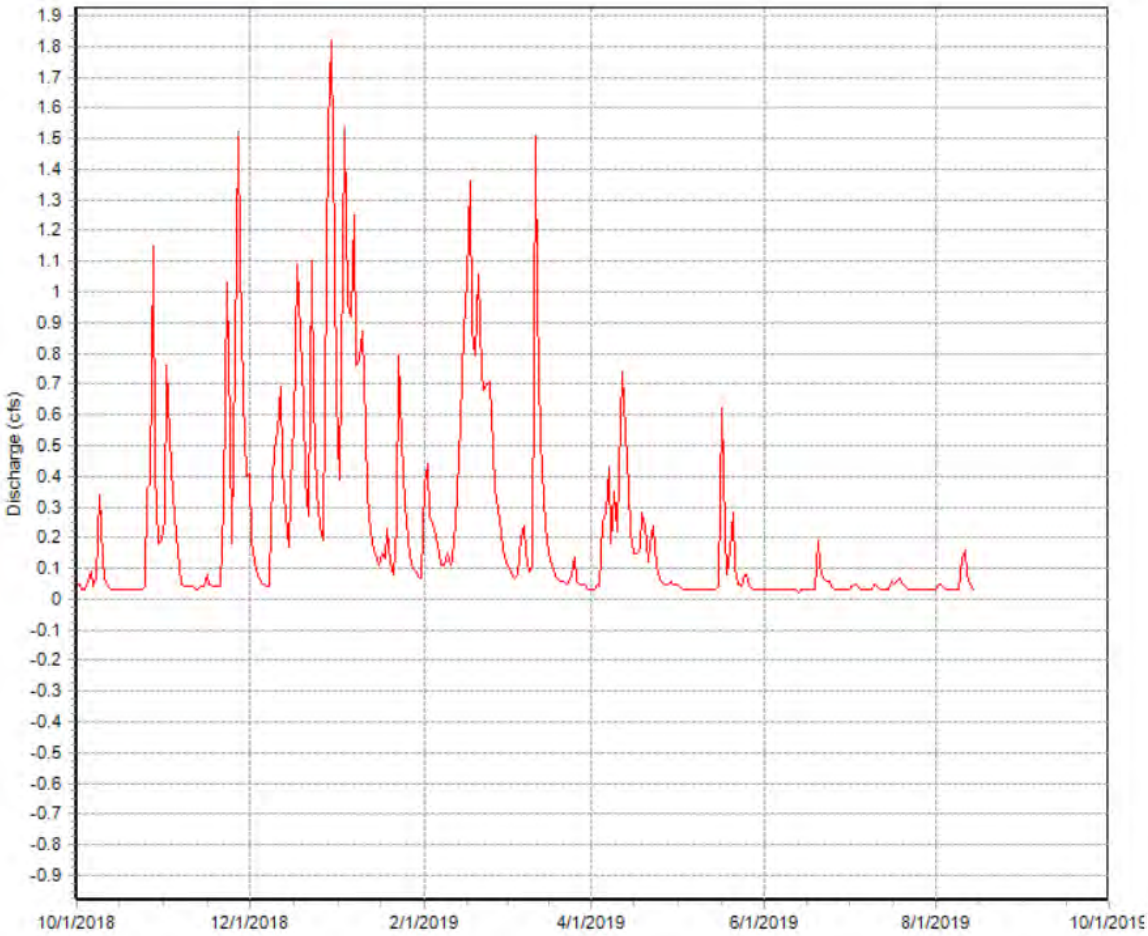
Table 1 – Summary of King County Gage RPWS_MONMN recordings by water year

Water Year	Winter High Flow	Summer Low Flow
2019	1.9 CFS	<0.03~0.2 CFS
2018	4.1 CFS	<0.03~0.5 CFS
2017	7.8 CFS	<0.03~0.6 CFS
2016	3.7 CFS	<0.03~0.3 CFS

RPWS_MONMN - Monticello North Midpoint Station Stream Gauge(Recording)

Select a parameter: Stream Flow

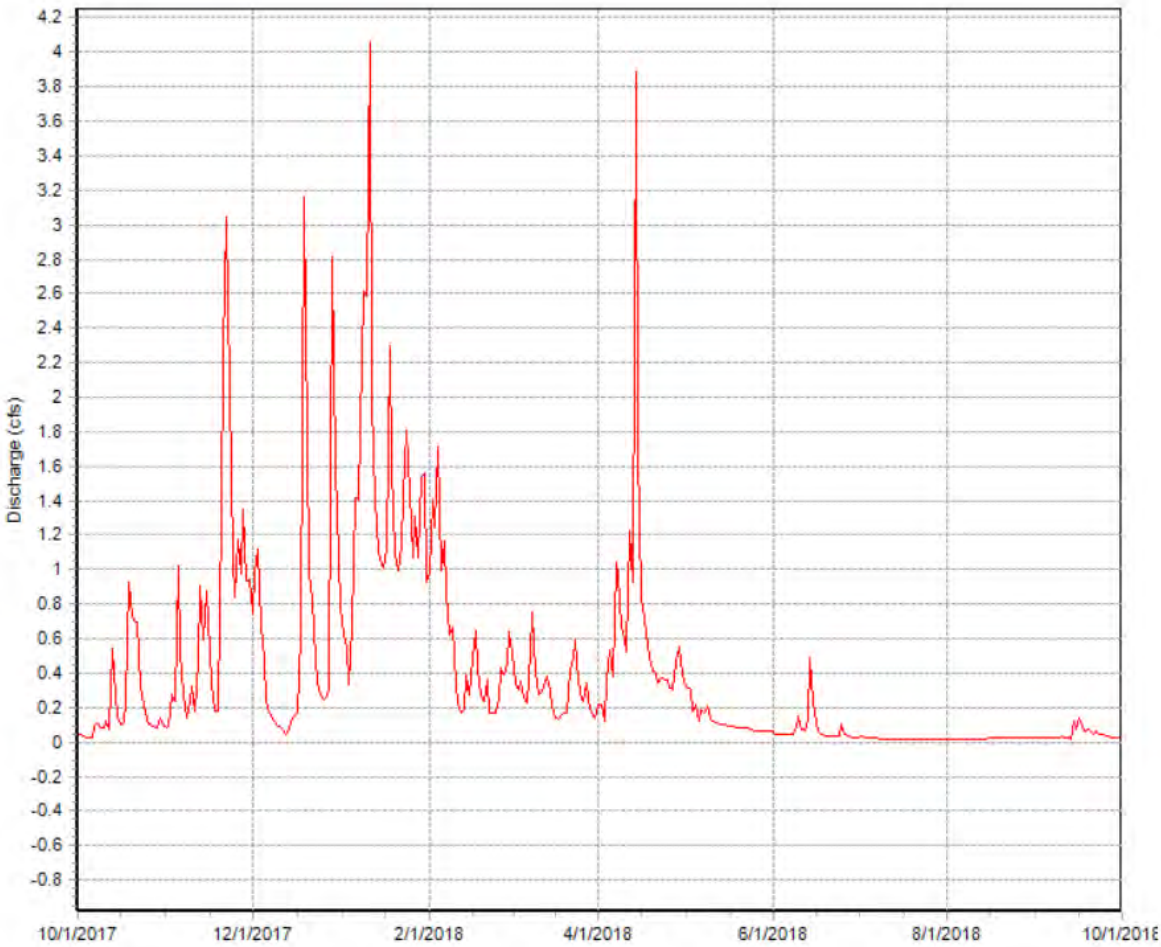
Select a water year: 2019



RPWS_MONMN - Monticello North Midpoint Station Stream Gauge(Recording)

Select a parameter: Stream Flow

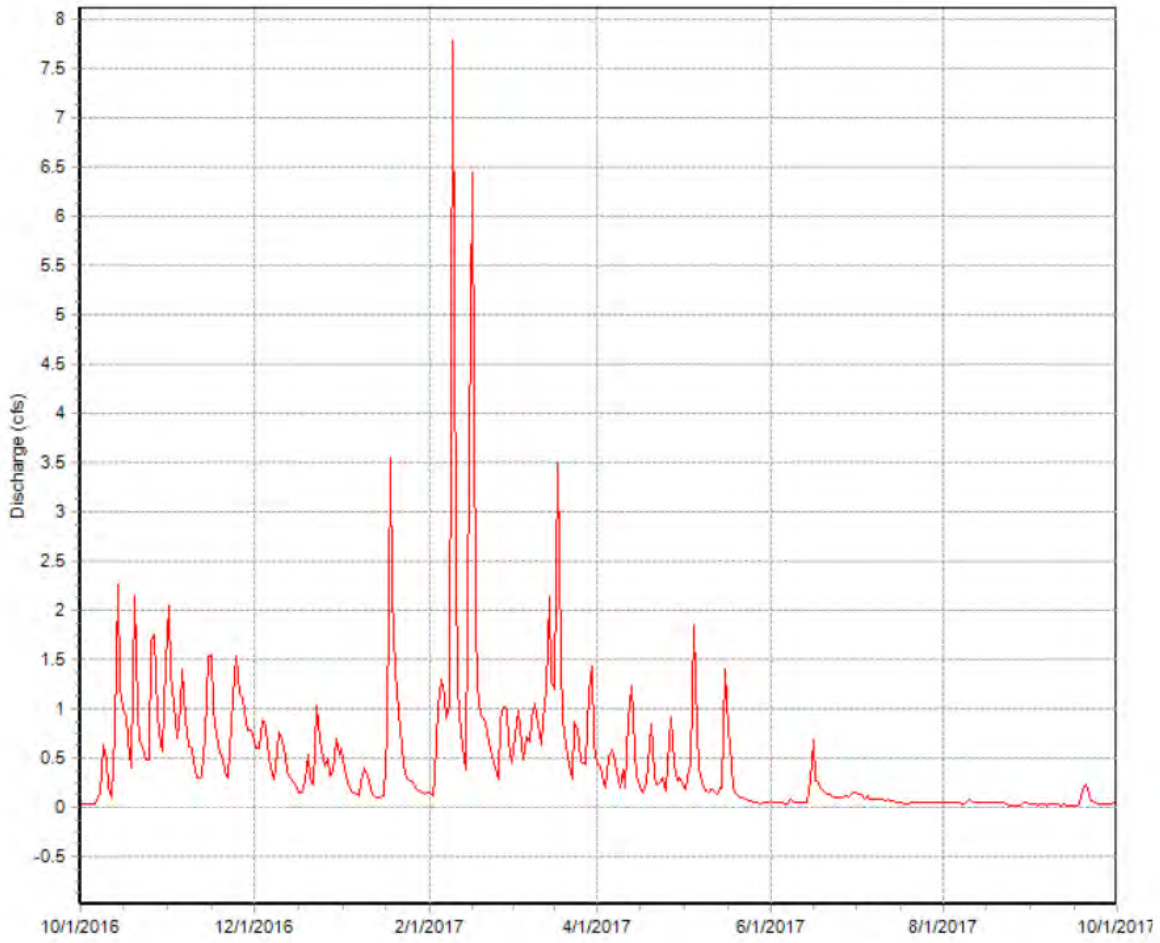
Select a water year: 2018



RPWS_MONMN - Monticello North Midpoint Station Stream Gauge(Recording)

Select a parameter: Stream Flow

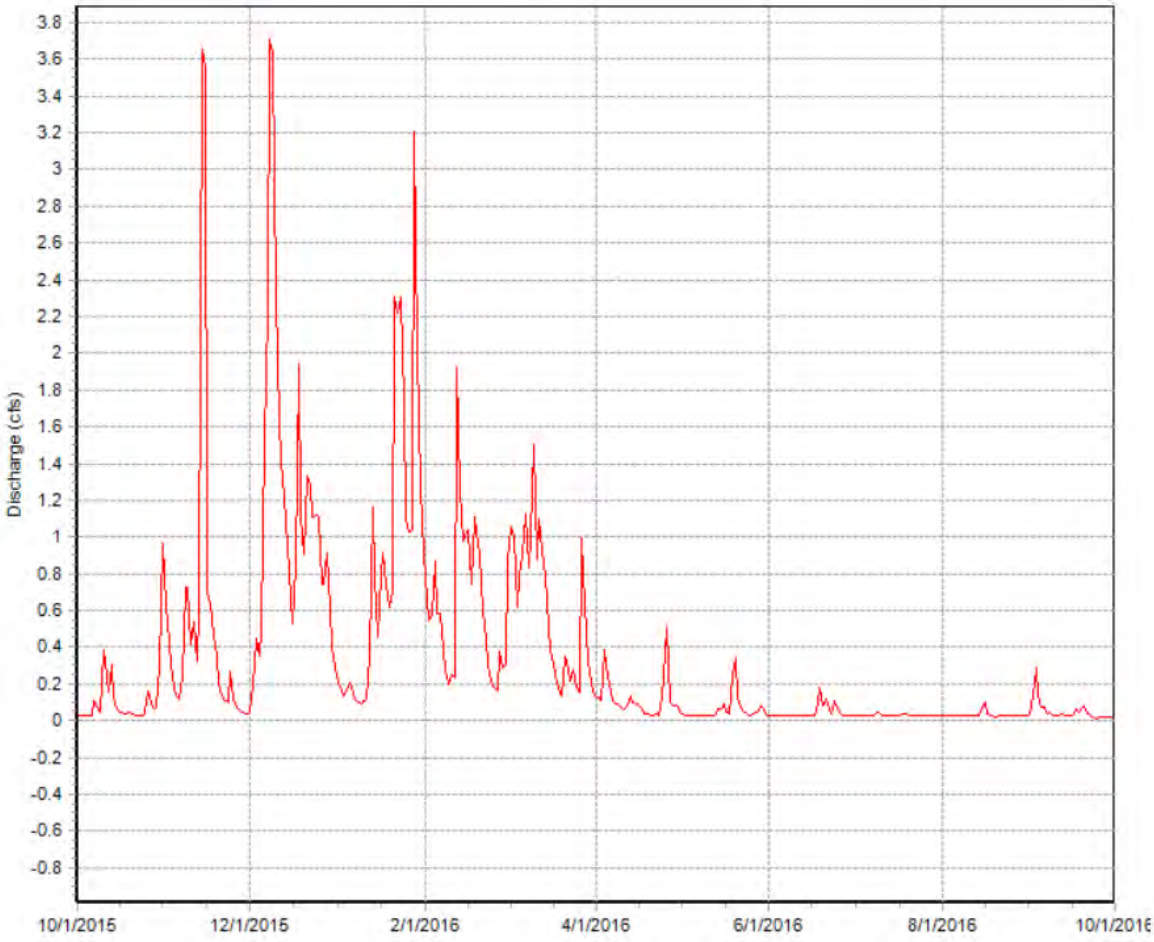
Select a water year: 2017



RPWS_MONMN - Monticello North Midpoint Station Stream Gauge(Recording)

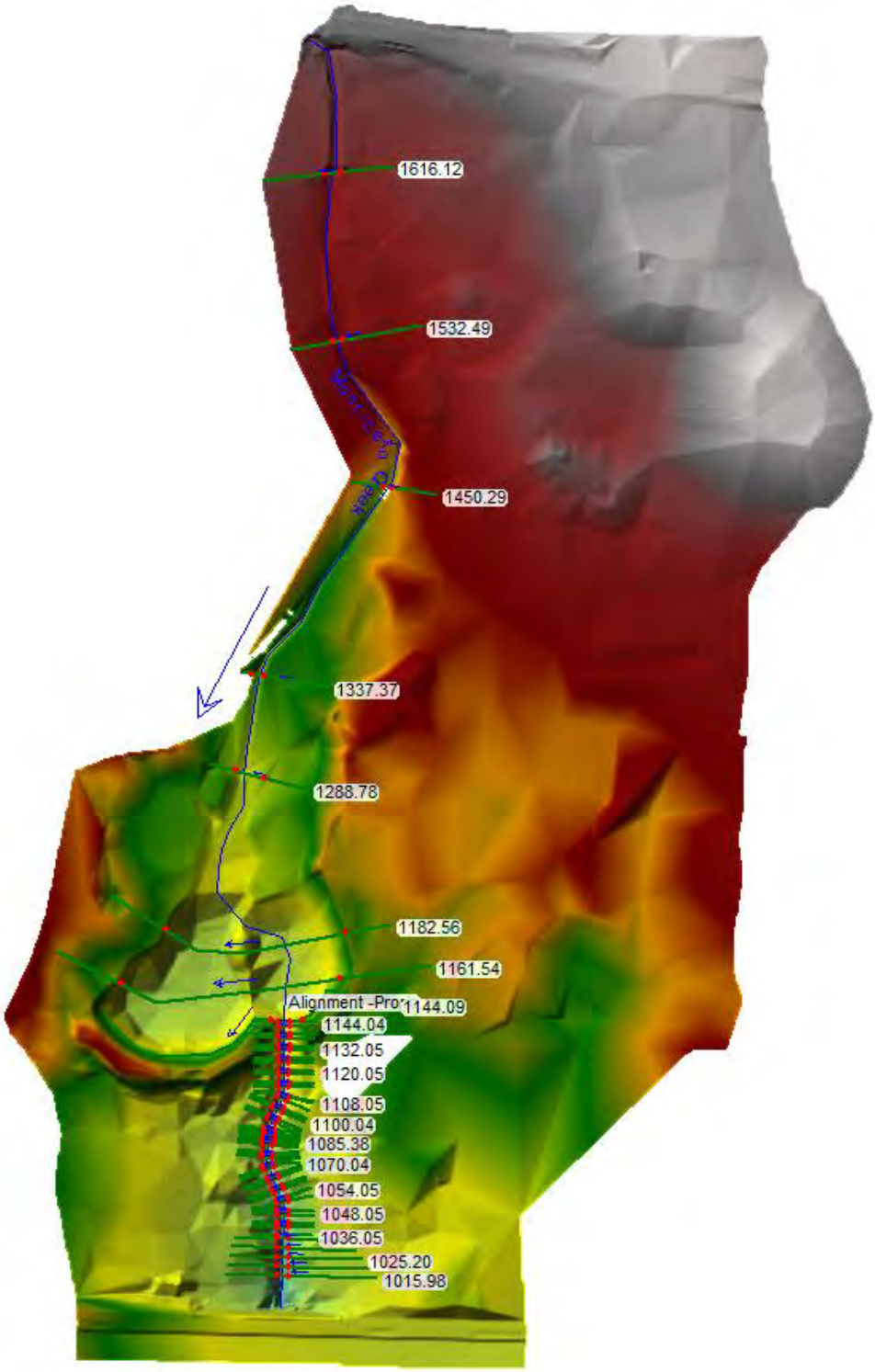
Select a parameter: Stream Flow

Select a water year: 2016

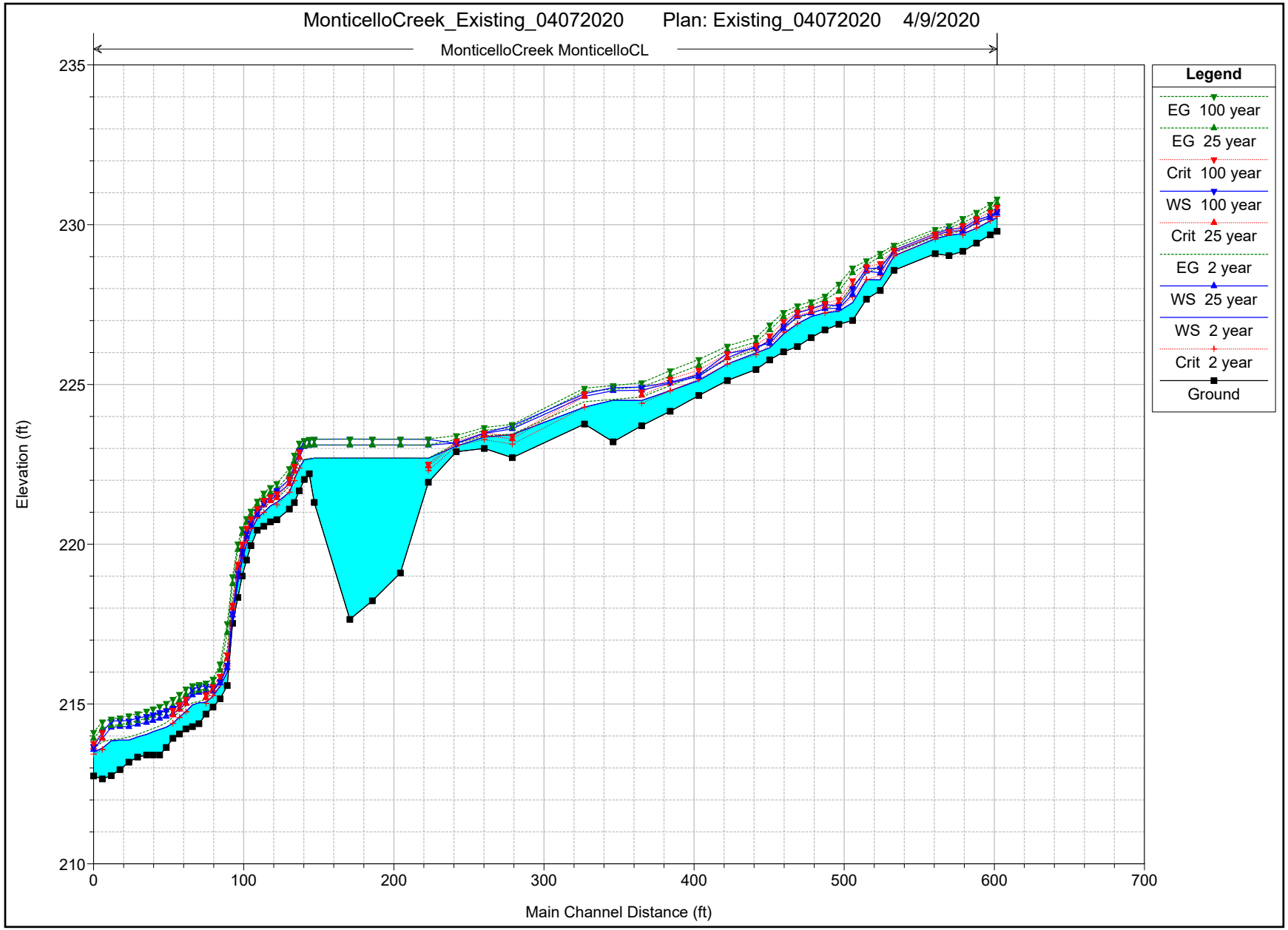


APPENDIX E: HEC-RAS OUTPUT RESULTS

Plan View - Monticello Creek



Existing Conditions Modeled Profile Plot



Existing Conditions Modeled Results

HEC-RAS Plan: 100 River: MonticelloCreek Reach: MonticelloCL

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
MonticelloCL	1602.66	2 year	5.43	229.79	230.22	230.26	230.40	0.032015	3.41	1.61	7.74	1.23
MonticelloCL	1602.66	25 year	11.91	229.79	230.35	230.45	230.67	0.032042	4.60	2.99	12.62	1.32
MonticelloCL	1602.66	100 year	16.45	229.79	230.42	230.55	230.81	0.032050	5.15	3.94	14.79	1.36
MonticelloCL	1598.08	2 year	5.43	229.68	230.11	230.13	230.25	0.025136	2.93	1.88	9.23	1.08
MonticelloCL	1598.08	25 year	11.91	229.68	230.22	230.30	230.50	0.033621	4.33	3.00	12.55	1.33
MonticelloCL	1598.08	100 year	16.45	229.68	230.28	230.39	230.64	0.035397	4.96	3.79	14.18	1.40
MonticelloCL	1588.91	2 year	5.43	229.42	229.89	229.90	230.03	0.023631	3.04	1.82	7.84	1.06
MonticelloCL	1588.91	25 year	11.91	229.42	230.07	230.09	230.27	0.016986	3.64	3.78	13.54	0.98
MonticelloCL	1588.91	100 year	16.45	229.42	230.15	230.19	230.39	0.017526	4.12	4.89	15.70	1.03
MonticelloCL	1579.75	2 year	5.43	229.16	229.72	229.67	229.81	0.012827	2.44	2.23	8.19	0.80
MonticelloCL	1579.75	25 year	11.91	229.16	229.81	229.87	230.06	0.027251	4.09	3.02	10.70	1.21
MonticelloCL	1579.75	100 year	16.45	229.16	229.89	229.97	230.20	0.025335	4.52	4.03	14.62	1.20
MonticelloCL	1570.58	2 year	5.43	229.03	229.67		229.71	0.007168	1.68	3.28	14.87	0.59
MonticelloCL	1570.58	25 year	11.91	229.03	229.80	229.72	229.88	0.007964	2.32	5.64	20.70	0.66
MonticelloCL	1570.58	100 year	16.45	229.03	229.86	229.79	229.97	0.009247	2.74	6.96	26.01	0.73
MonticelloCL	1561.42	2 year	5.43	229.09	229.56	229.55	229.62	0.014734	2.03	3.02	18.68	0.81
MonticelloCL	1561.42	25 year	11.91	229.09	229.65	229.65	229.77	0.019347	2.97	4.87	24.15	0.98
MonticelloCL	1561.42	100 year	16.45	229.09	229.72	229.72	229.85	0.017112	3.21	6.58	27.96	0.96
MonticelloCL	1533.92	2 year	5.43	228.57	229.02	229.02	229.11	0.023172	2.41	2.31	15.34	1.00
MonticelloCL	1533.92	25 year	11.91	228.57	229.15	229.15	229.28	0.016960	2.93	4.83	24.68	0.93
MonticelloCL	1533.92	100 year	16.45	228.57	229.20	229.21	229.36	0.018653	3.39	6.10	28.06	1.00
MonticelloCL	1524.76	2 year	5.43	227.94	228.27	228.42	228.72	0.079576	5.35	1.02	4.32	1.91
MonticelloCL	1524.76	25 year	11.91	227.94	228.49	228.66	229.00	0.043692	5.80	2.27	7.07	1.55
MonticelloCL	1524.76	100 year	16.45	227.94	228.64	228.78	229.10	0.030499	5.68	3.45	9.23	1.34
MonticelloCL	1515.56	2 year	5.43	227.67	228.28	228.28	228.45	0.019885	3.36	1.64	5.26	1.01
MonticelloCL	1515.56	25 year	11.91	227.67	228.54	228.56	228.74	0.011785	3.77	4.26	15.25	0.85
MonticelloCL	1515.56	100 year	16.45	227.67	228.63	228.69	228.87	0.012436	4.24	5.84	20.01	0.89
MonticelloCL	1506.35	2 year	5.43	227.00	227.56	227.74	228.11	0.068699	5.95	0.94	3.15	1.83
MonticelloCL	1506.35	25 year	11.91	227.00	227.82	228.05	228.49	0.049734	6.70	1.93	4.53	1.67

HEC-RAS Plan: 100 River: MonticelloCreek Reach: MonticelloCL (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
MonticelloCL	1506.35	100 year	16.45	227.00	227.99	228.25	228.65	0.038025	6.66	2.84	6.62	1.50
MonticelloCL	1497.15	2 year	5.43	226.88	227.29	227.35	227.52	0.042180	3.81	1.43	6.13	1.39
MonticelloCL	1497.15	25 year	11.91	226.88	227.39	227.56	227.91	0.068998	5.81	2.05	6.74	1.86
MonticelloCL	1497.15	100 year	16.45	226.88	227.45	227.66	228.14	0.080292	6.70	2.46	7.30	2.04
MonticelloCL	1487.95	2 year	5.43	226.71	227.24	227.24	227.38	0.016774	2.97	2.00	8.09	0.92
MonticelloCL	1487.95	25 year	11.91	226.71	227.37	227.44	227.65	0.025373	4.41	3.17	10.26	1.19
MonticelloCL	1487.95	100 year	16.45	226.71	227.50	227.53	227.77	0.018728	4.38	4.64	12.02	1.06
MonticelloCL	1478.74	2 year	5.43	226.47	227.12		227.22	0.014151	2.54	2.14	7.35	0.83
MonticelloCL	1478.74	25 year	11.91	226.47	227.23	227.28	227.48	0.026718	3.95	3.01	9.10	1.18
MonticelloCL	1478.74	100 year	16.45	226.47	227.36	227.39	227.59	0.017937	3.89	4.57	15.44	1.01
MonticelloCL	1469.54	2 year	5.43	226.19	226.90	226.90	227.07	0.019006	3.31	1.66	5.78	0.98
MonticelloCL	1469.54	25 year	11.91	226.19	227.12	227.16	227.35	0.015990	4.01	3.85	14.35	0.96
MonticelloCL	1469.54	100 year	16.45	226.19	227.24	227.26	227.46	0.012750	4.11	5.94	19.63	0.89
MonticelloCL	1460.34	2 year	5.43	226.02	226.58	226.64	226.82	0.042580	3.93	1.38	5.64	1.40
MonticelloCL	1460.34	25 year	11.91	226.02	226.75	226.85	227.11	0.037726	4.90	2.59	8.91	1.41
MonticelloCL	1460.34	100 year	16.45	226.02	226.84	226.97	227.25	0.036467	5.28	3.47	10.91	1.42
MonticelloCL	1451.13	2 year	5.43	225.77	226.15	226.23	226.40	0.048570	4.07	1.37	6.77	1.50
MonticelloCL	1451.13	25 year	11.91	225.77	226.28	226.41	226.71	0.050405	5.31	2.43	8.79	1.62
MonticelloCL	1451.13	100 year	16.45	225.77	226.36	226.53	226.87	0.046275	5.84	3.15	9.84	1.61
MonticelloCL	1441.93	2 year	5.43	225.47	225.99	225.93	226.08	0.011633	2.37	2.29	7.57	0.76
MonticelloCL	1441.93	25 year	11.91	225.47	226.19	226.12	226.33	0.011632	2.92	4.08	9.88	0.80
MonticelloCL	1441.93	100 year	16.45	225.47	226.14	226.23	226.47	0.032081	4.62	3.56	9.27	1.32
MonticelloCL	1422.9	2 year	5.43	225.13	225.64	225.64	225.78	0.019505	3.07	1.81	6.93	0.99
MonticelloCL	1422.9	25 year	11.91	225.13	225.83	225.83	226.06	0.016023	3.89	3.49	10.10	0.98
MonticelloCL	1422.9	100 year	16.45	225.13	225.97	225.97	226.20	0.012629	4.05	5.20	15.38	0.90
MonticelloCL	1403.86	2 year	5.43	224.65	225.13	225.17	225.31	0.031699	3.44	1.64	7.84	1.22
MonticelloCL	1403.86	25 year	11.91	224.65	225.25	225.35	225.60	0.036518	4.85	2.74	9.98	1.41
MonticelloCL	1403.86	100 year	16.45	224.65	225.31	225.46	225.78	0.041625	5.69	3.34	11.12	1.54

HEC-RAS Plan: 100 River: MonticelloCreek Reach: MonticelloCL (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
MonticelloCL	1384.83	2 year	5.43	224.16	224.80	224.80	224.97	0.020071	3.23	1.68	5.22	1.00
MonticelloCL	1384.83	25 year	11.91	224.16	225.04	225.04	225.26	0.014643	3.80	3.48	10.29	0.93
MonticelloCL	1384.83	100 year	16.45	224.16	225.07	225.16	225.43	0.022755	4.92	3.80	10.95	1.17
MonticelloCL	1365.79	2 year	5.43	223.71	224.50	224.41	224.61	0.012052	2.61	2.08	5.95	0.78
MonticelloCL	1365.79	25 year	11.91	223.71	224.82	224.66	224.93	0.006677	2.59	4.76	10.98	0.63
MonticelloCL	1365.79	100 year	16.45	223.71	224.92	224.77	225.05	0.007525	2.99	5.89	13.07	0.68
MonticelloCL	1346.76	2 year	5.43	223.21	224.51		224.53	0.001111	1.28	4.34	6.61	0.26
MonticelloCL	1346.76	25 year	11.91	223.21	224.81		224.85	0.001627	1.80	8.63	23.76	0.33
MonticelloCL	1346.76	100 year	16.45	223.21	224.90		224.96	0.001963	2.11	11.04	25.32	0.37
MonticelloCL	1327.72	2 year	5.43	223.76	224.29	224.29	224.46	0.019879	3.31	1.64	4.86	1.00
MonticelloCL	1327.72	25 year	11.91	223.76	224.63	224.63	224.78	0.009218	3.25	4.81	22.87	0.75
MonticelloCL	1327.72	100 year	16.45	223.76	224.71	224.71	224.88	0.009396	3.58	6.74	23.37	0.77
MonticelloCL	1279.57	2 year	5.43	222.71	223.44	223.13	223.45	0.001344	0.97	5.71	16.07	0.27
MonticelloCL	1279.57	25 year	11.91	222.71	223.61	223.29	223.64	0.001853	1.40	9.42	24.97	0.34
MonticelloCL	1279.57	100 year	16.45	222.71	223.71	223.38	223.75	0.001913	1.59	11.99	27.51	0.35
MonticelloCL	1260.94	2 year	5.43	223.00	223.35	223.27	223.40	0.008207	1.75	3.11	12.74	0.62
MonticelloCL	1260.94	25 year	11.91	223.00	223.46	223.41	223.57	0.011329	2.55	4.75	16.15	0.77
MonticelloCL	1260.94	100 year	16.45	223.00	223.48	223.48	223.65	0.018049	3.32	5.07	16.71	0.98
MonticelloCL	1242.32	2 year	5.43	222.90	223.07	223.07	223.14	0.025604	2.11	2.57	18.73	1.00
MonticelloCL	1242.32	25 year	11.91	222.90	223.17	223.17	223.28	0.021684	2.67	4.46	20.11	1.00
MonticelloCL	1242.32	100 year	16.45	222.90	223.15	223.23	223.40	0.052968	3.99	4.12	19.91	1.54
MonticelloCL	1223.69	2 year	5.43	221.94	222.69	222.30	222.70	0.003238	0.63	9.03	22.56	0.16
MonticelloCL	1223.69	25 year	11.91	221.94	223.10	222.45	223.11	0.001790	0.67	19.18	27.28	0.13
MonticelloCL	1223.69	100 year	16.45	221.94	223.28	222.51	223.29	0.001744	0.75	25.01	34.79	0.14
MonticelloCL	1205.07	2 year	5.43	219.10	222.69		222.69	0.000005	0.06	90.68	54.46	0.01
MonticelloCL	1205.07	25 year	11.91	219.10	223.10		223.10	0.000012	0.11	114.48	61.52	0.01
MonticelloCL	1205.07	100 year	16.45	219.10	223.29		223.29	0.000017	0.14	125.99	63.22	0.02
MonticelloCL	1186.44	2 year	5.43	218.23	222.69		222.69	0.000001	0.03	199.23	72.70	0.00
MonticelloCL	1186.44	25 year	11.91	218.23	223.10		223.10	0.000002	0.05	229.97	77.31	0.01

HEC-RAS Plan: 100 River: MonticelloCreek Reach: MonticelloCL (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
MonticelloCL	1186.44	100 year	16.45	218.23	223.29		223.29	0.000003	0.07	244.52	82.42	0.01
MonticelloCL	1171.42	2 year	5.43	217.65	222.69		222.69	0.000000	0.01	367.14	107.45	0.00
MonticelloCL	1171.42	25 year	11.91	217.65	223.10		223.10	0.000000	0.03	411.89	110.85	0.00
MonticelloCL	1171.42	100 year	16.45	217.65	223.29		223.29	0.000001	0.04	432.48	112.76	0.00
MonticelloCL	1147.71	2 year	5.43	221.31	222.69		222.69	0.000099	0.11	49.09	107.14	0.03
MonticelloCL	1147.71	25 year	11.91	221.31	223.10		223.10	0.000058	0.13	94.05	111.47	0.02
MonticelloCL	1147.71	100 year	16.45	221.31	223.29		223.29	0.000058	0.15	114.73	113.05	0.03
MonticelloCL	1144.15	2 year	5.43	222.21	222.67		222.69	0.027942	0.91	4.45	12.51	0.40
MonticelloCL	1144.15	25 year	11.91	222.21	223.09		223.10	0.008376	0.91	12.59	22.73	0.25
MonticelloCL	1144.15	100 year	16.45	222.21	223.27		223.29	0.007078	0.95	16.98	26.63	0.24
MonticelloCL	1141.07	2 year	5.43	222.03	222.64		222.65	0.000953	0.26	13.37	13.98	0.08
MonticelloCL	1141.07	25 year	11.91	222.03	223.06		223.06	0.001657	0.43	20.26	20.08	0.11
MonticelloCL	1141.07	100 year	16.45	222.03	223.24		223.25	0.002166	0.46	24.34	27.09	0.13
MonticelloCL	1137.74	2 year	5.43	221.67	222.39	222.38	222.60	0.135205	3.65	1.49	3.49	0.99
MonticelloCL	1137.74	25 year	11.91	221.67	222.72	222.72	222.99	0.115196	4.25	2.90	6.44	0.96
MonticelloCL	1137.74	100 year	16.45	221.67	222.93	222.90	223.17	0.084752	4.07	4.65	10.00	0.84
MonticelloCL	1134.42	2 year	5.43	221.31	222.05	221.99	222.20	0.097908	3.19	1.70	3.86	0.85
MonticelloCL	1134.42	25 year	11.91	221.31	222.30	222.28	222.58	0.119105	4.27	2.79	4.67	0.97
MonticelloCL	1134.42	100 year	16.45	221.31	222.44	222.44	222.79	0.123850	4.73	3.48	5.12	1.01
MonticelloCL	1131.1	2 year	5.43	221.10	221.63	221.63	221.82	0.141241	3.49	1.56	4.20	1.01
MonticelloCL	1131.1	25 year	11.91	221.10	221.90	221.90	222.17	0.126728	4.24	2.81	5.12	1.01
MonticelloCL	1131.1	100 year	16.45	221.10	222.02	222.04	222.37	0.130993	4.70	3.50	5.56	1.04
MonticelloCL	1122.79	2 year	5.43	220.77	221.31	221.23	221.41	0.020992	2.55	2.18	5.80	0.71
MonticelloCL	1122.79	25 year	11.91	220.77	221.56	221.46	221.73	0.020896	3.37	3.70	6.70	0.76
MonticelloCL	1122.79	100 year	16.45	220.77	221.69	221.58	221.90	0.020369	3.79	4.61	7.19	0.78
MonticelloCL	1118.46	2 year	5.43	220.70	221.20		221.31	0.026783	2.69	2.02	5.78	0.79
MonticelloCL	1118.46	25 year	11.91	220.70	221.38	221.36	221.61	0.035042	3.87	3.12	6.49	0.96
MonticelloCL	1118.46	100 year	16.45	220.70	221.49	221.49	221.78	0.035871	4.36	3.86	6.90	0.99

HEC-RAS Plan: 100 River: MonticelloCreek Reach: MonticelloCL (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
MonticelloCL	1114.14	2 year	5.43	220.57	221.00	221.00	221.15	0.046697	3.13	1.74	5.84	1.01
MonticelloCL	1114.14	25 year	11.91	220.57	221.24	221.24	221.45	0.035191	3.70	3.34	9.67	0.94
MonticelloCL	1114.14	100 year	16.45	220.57	221.29	221.37	221.60	0.046200	4.48	3.96	11.41	1.09
MonticelloCL	1109.81	2 year	5.43	220.44	220.82	220.83	220.96	0.045227	3.07	1.88	8.49	0.99
MonticelloCL	1109.81	25 year	11.91	220.44	220.93	221.02	221.23	0.069168	4.53	3.00	10.76	1.27
MonticelloCL	1109.81	100 year	16.45	220.44	221.02	221.11	221.35	0.066008	4.89	3.99	12.38	1.27
MonticelloCL	1105.48	2 year	5.43	219.96	220.41	220.50	220.67	0.091598	4.14	1.32	5.48	1.40
MonticelloCL	1105.48	25 year	11.91	219.96	220.60	220.70	220.92	0.071866	4.72	2.96	11.54	1.31
MonticelloCL	1105.48	100 year	16.45	219.96	220.67	220.79	221.04	0.073842	5.18	3.90	13.57	1.35
MonticelloCL	1102.59	2 year	5.43	219.51	220.01	220.12	220.36	0.119030	4.76	1.14	4.07	1.58
MonticelloCL	1102.59	25 year	11.91	219.51	220.24	220.40	220.68	0.087727	5.28	2.29	7.57	1.45
MonticelloCL	1102.59	100 year	16.45	219.51	220.35	220.50	220.81	0.080771	5.53	3.28	10.63	1.42
MonticelloCL	1099.71	2 year	5.43	219.01	219.48	219.64	219.95	0.162260	5.48	0.99	3.60	1.84
MonticelloCL	1099.71	25 year	11.91	219.01	219.68	219.90	220.33	0.145768	6.48	1.89	6.42	1.84
MonticelloCL	1099.71	100 year	16.45	219.01	219.78	220.01	220.49	0.137855	6.85	2.62	8.39	1.82
MonticelloCL	1096.82	2 year	5.43	218.33	218.81	219.01	219.40	0.212667	6.17	0.88	3.25	2.09
MonticelloCL	1096.82	25 year	11.91	218.33	219.00	219.26	219.84	0.189176	7.36	1.69	5.86	2.08
MonticelloCL	1096.82	100 year	16.45	218.33	219.10	219.38	220.01	0.180690	7.83	2.30	7.15	2.07
MonticelloCL	1093.21	2 year	5.43	217.53	217.70	217.84	218.27	0.522059	6.06	0.90	6.99	2.98
MonticelloCL	1093.21	25 year	11.91	217.53	217.78	218.00	218.76	0.555237	7.94	1.50	8.13	3.26
MonticelloCL	1093.21	100 year	16.45	217.53	217.83	218.10	218.99	0.506291	8.62	1.91	8.52	3.21
MonticelloCL	1089.61	2 year	5.43	215.58	216.00	216.19	216.72	0.368430	6.82	0.80	3.90	2.66
MonticelloCL	1089.61	25 year	11.91	215.58	216.14	216.42	217.23	0.342627	8.38	1.42	4.78	2.71
MonticelloCL	1089.61	100 year	16.45	215.58	216.22	216.55	217.52	0.340049	9.16	1.80	5.22	2.75
MonticelloCL	1084.92	2 year	5.43	215.16	215.56	215.61	215.75	0.099214	3.45	1.57	8.00	1.37
MonticelloCL	1084.92	25 year	11.91	215.16	215.66	215.77	216.06	0.135535	5.08	2.34	8.37	1.69
MonticelloCL	1084.92	100 year	16.45	215.16	215.71	215.87	216.25	0.154082	5.95	2.77	8.56	1.85
MonticelloCL	1080.23	2 year	5.43	214.90	215.25	215.26	215.39	0.057290	3.01	1.81	7.63	1.09
MonticelloCL	1080.23	25 year	11.91	214.90	215.41	215.44	215.64	0.051671	3.82	3.11	8.43	1.11

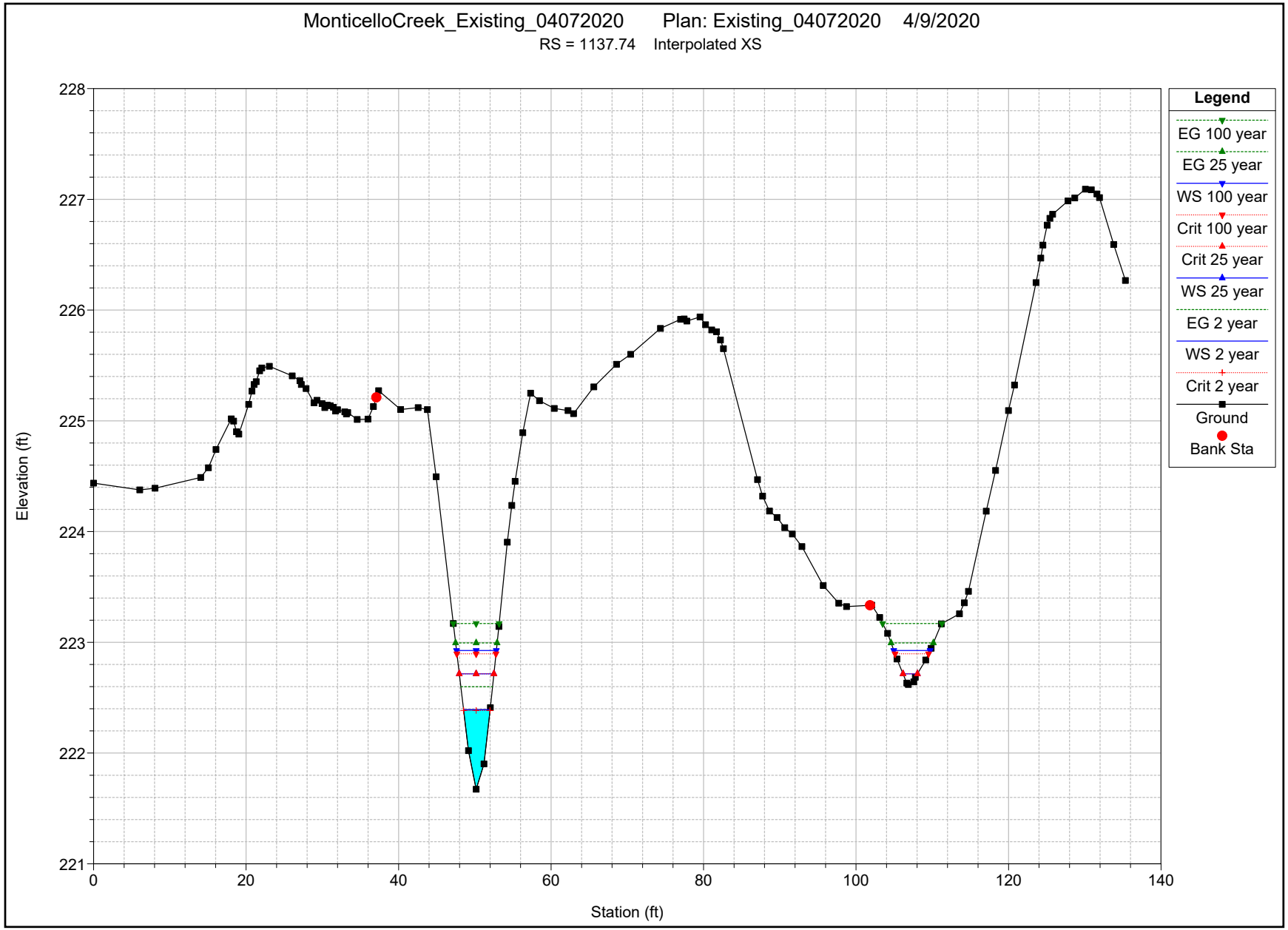
HEC-RAS Plan: 100 River: MonticelloCreek Reach: MonticelloCL (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
MonticelloCL	1080.23	100 year	16.45	214.90	215.50	215.54	215.78	0.052341	4.28	3.84	8.84	1.14
MonticelloCL	1075.54	2 year	5.43	214.69	215.06	215.02	215.15	0.031574	2.50	2.17	7.72	0.83
MonticelloCL	1075.54	25 year	11.91	214.69	215.38	215.20	215.48	0.012673	2.43	4.90	9.04	0.58
MonticelloCL	1075.54	100 year	16.45	214.69	215.56	215.30	215.66	0.009798	2.52	6.55	9.66	0.53
MonticelloCL	1070.85	2 year	5.43	214.38	215.04		215.08	0.006638	1.62	3.36	6.94	0.41
MonticelloCL	1070.85	25 year	11.91	214.38	215.36		215.43	0.006394	2.06	5.78	8.04	0.43
MonticelloCL	1070.85	100 year	16.45	214.38	215.54		215.62	0.006015	2.28	7.26	8.68	0.43
MonticelloCL	1066.52	2 year	5.43	214.29	214.97		215.04	0.011828	2.06	2.63	5.79	0.54
MonticelloCL	1066.52	25 year	11.91	214.29	215.28		215.39	0.011335	2.58	4.62	6.95	0.56
MonticelloCL	1066.52	100 year	16.45	214.29	215.46		215.58	0.010944	2.79	5.89	7.60	0.56
MonticelloCL	1062.19	2 year	5.43	214.22	214.76	214.75	214.94	0.041614	3.35	1.62	4.43	0.98
MonticelloCL	1062.19	25 year	11.91	214.22	215.03	215.02	215.29	0.037232	4.09	2.91	5.33	0.98
MonticelloCL	1062.19	100 year	16.45	214.22	215.16	215.16	215.48	0.038353	4.54	3.63	5.77	1.01
MonticelloCL	1057.86	2 year	5.43	214.06	214.60	214.58	214.76	0.038580	3.27	1.66	4.43	0.94
MonticelloCL	1057.86	25 year	11.91	214.06	214.84	214.84	215.11	0.039528	4.18	2.85	5.24	1.00
MonticelloCL	1057.86	100 year	16.45	214.06	214.95	214.98	215.30	0.043224	4.75	3.46	5.59	1.06
MonticelloCL	1053.53	2 year	5.43	213.93	214.40	214.40	214.58	0.044541	3.45	1.57	4.28	1.00
MonticelloCL	1053.53	25 year	11.91	213.93	214.70	214.66	214.95	0.031257	4.00	3.01	5.22	0.91
MonticelloCL	1053.53	100 year	16.45	213.93	214.87	214.80	215.15	0.027438	4.24	3.96	5.81	0.87
MonticelloCL	1049.13	2 year	5.43	213.64	214.27		214.42	0.027401	3.04	1.79	4.00	0.80
MonticelloCL	1049.13	25 year	11.91	213.64	214.61		214.81	0.023899	3.61	3.29	5.02	0.79
MonticelloCL	1049.13	100 year	16.45	213.64	214.79		215.02	0.022753	3.84	4.29	5.73	0.78
MonticelloCL	1044.73	2 year	5.43	213.41	214.20		214.31	0.017832	2.63	2.06	4.09	0.65
MonticelloCL	1044.73	25 year	11.91	213.41	214.55		214.71	0.017763	3.26	3.65	5.16	0.68
MonticelloCL	1044.73	100 year	16.45	213.41	214.73		214.93	0.017391	3.52	4.67	5.73	0.69
MonticelloCL	1040.33	2 year	5.43	213.41	214.13		214.23	0.016643	2.53	2.15	4.31	0.63
MonticelloCL	1040.33	25 year	11.91	213.41	214.48		214.63	0.016012	3.13	3.81	5.26	0.65
MonticelloCL	1040.33	100 year	16.45	213.41	214.67		214.85	0.015337	3.39	4.87	5.93	0.65

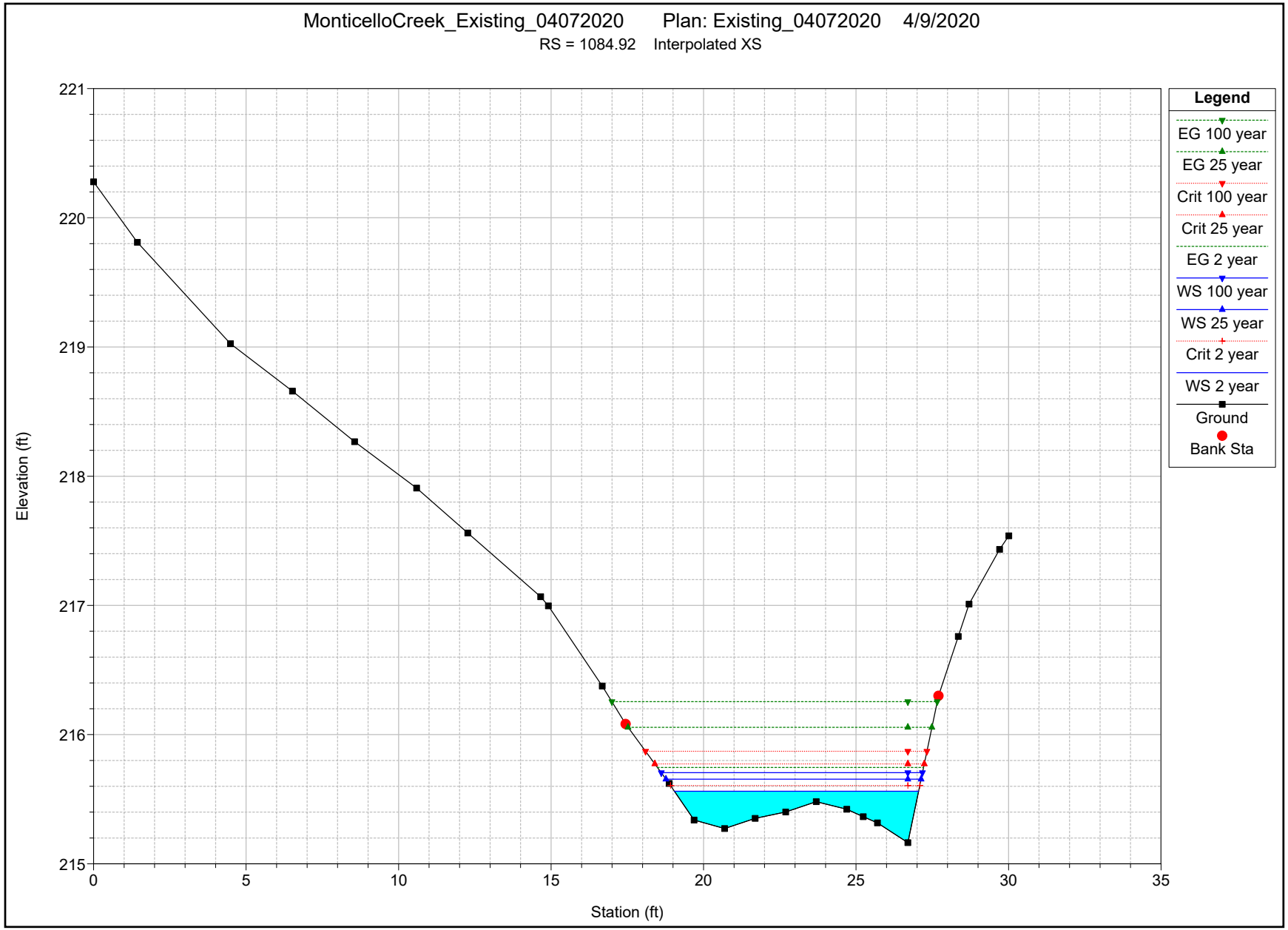
HEC-RAS Plan: 100 River: MonticelloCreek Reach: MonticelloCL (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
MonticelloCL	1035.93	2 year	5.43	213.41	214.05		214.15	0.019212	2.61	2.08	4.52	0.68
MonticelloCL	1035.93	25 year	11.91	213.41	214.42		214.56	0.014749	3.04	3.92	5.35	0.63
MonticelloCL	1035.93	100 year	16.45	213.41	214.61		214.78	0.014210	3.29	5.00	5.78	0.62
MonticelloCL	1030.06	2 year	5.43	213.34	213.97		214.05	0.013634	2.32	2.35	4.65	0.57
MonticelloCL	1030.06	25 year	11.91	213.34	214.37		214.48	0.010950	2.70	4.41	5.71	0.54
MonticelloCL	1030.06	100 year	16.45	213.34	214.56		214.70	0.010818	2.95	5.58	6.24	0.55
MonticelloCL	1024.19	2 year	5.43	213.18	213.87		213.97	0.015124	2.47	2.20	4.38	0.61
MonticelloCL	1024.19	25 year	11.91	213.18	214.29		214.42	0.010810	2.88	4.23	5.40	0.55
MonticelloCL	1024.19	100 year	16.45	213.18	214.47		214.63	0.011146	3.22	5.27	5.85	0.57
MonticelloCL	1018.32	2 year	5.43	212.95	213.87		213.91	0.003914	1.55	3.52	5.17	0.32
MonticelloCL	1018.32	25 year	11.91	212.95	214.29		214.36	0.004530	2.05	5.99	6.69	0.37
MonticelloCL	1018.32	100 year	16.45	212.95	214.48		214.57	0.005103	2.34	7.34	7.50	0.40
MonticelloCL	1012.45	2 year	5.43	212.76	213.85		213.88	0.004003	1.51	3.60	5.35	0.32
MonticelloCL	1012.45	25 year	11.91	212.76	214.27		214.33	0.004536	1.93	6.19	7.07	0.36
MonticelloCL	1012.45	100 year	16.45	212.76	214.46		214.53	0.004866	2.17	7.64	8.22	0.38
MonticelloCL	1006.59	2 year	5.43	212.66	213.62	213.57	213.82	0.037327	3.55	1.53	3.14	0.90
MonticelloCL	1006.59	25 year	11.91	212.66	213.92	213.92	214.24	0.042936	4.51	2.64	4.21	1.01
MonticelloCL	1006.59	100 year	16.45	212.66	214.12	214.12	214.45	0.041013	4.61	3.57	5.47	1.00
MonticelloCL	1000.72	2 year	5.43	212.75	213.50	213.43	213.61	0.026003	2.60	2.09	5.70	0.76
MonticelloCL	1000.72	25 year	11.91	212.75	213.57	213.65	213.93	0.070897	4.75	2.51	5.93	1.28
MonticelloCL	1000.72	100 year	16.45	212.75	213.67	213.77	214.11	0.070147	5.35	3.09	6.24	1.31

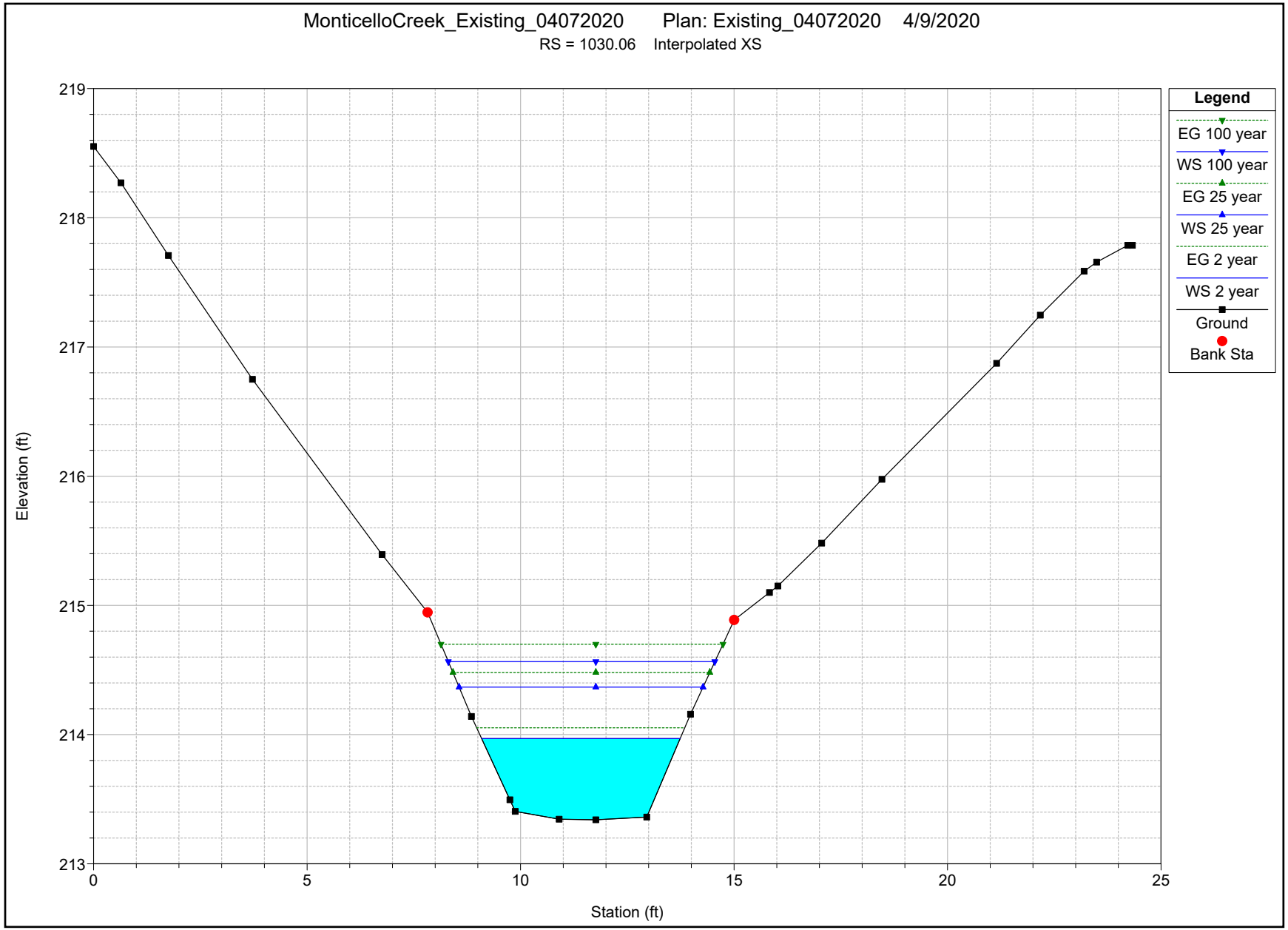
Existing XS Downstream of the Pond



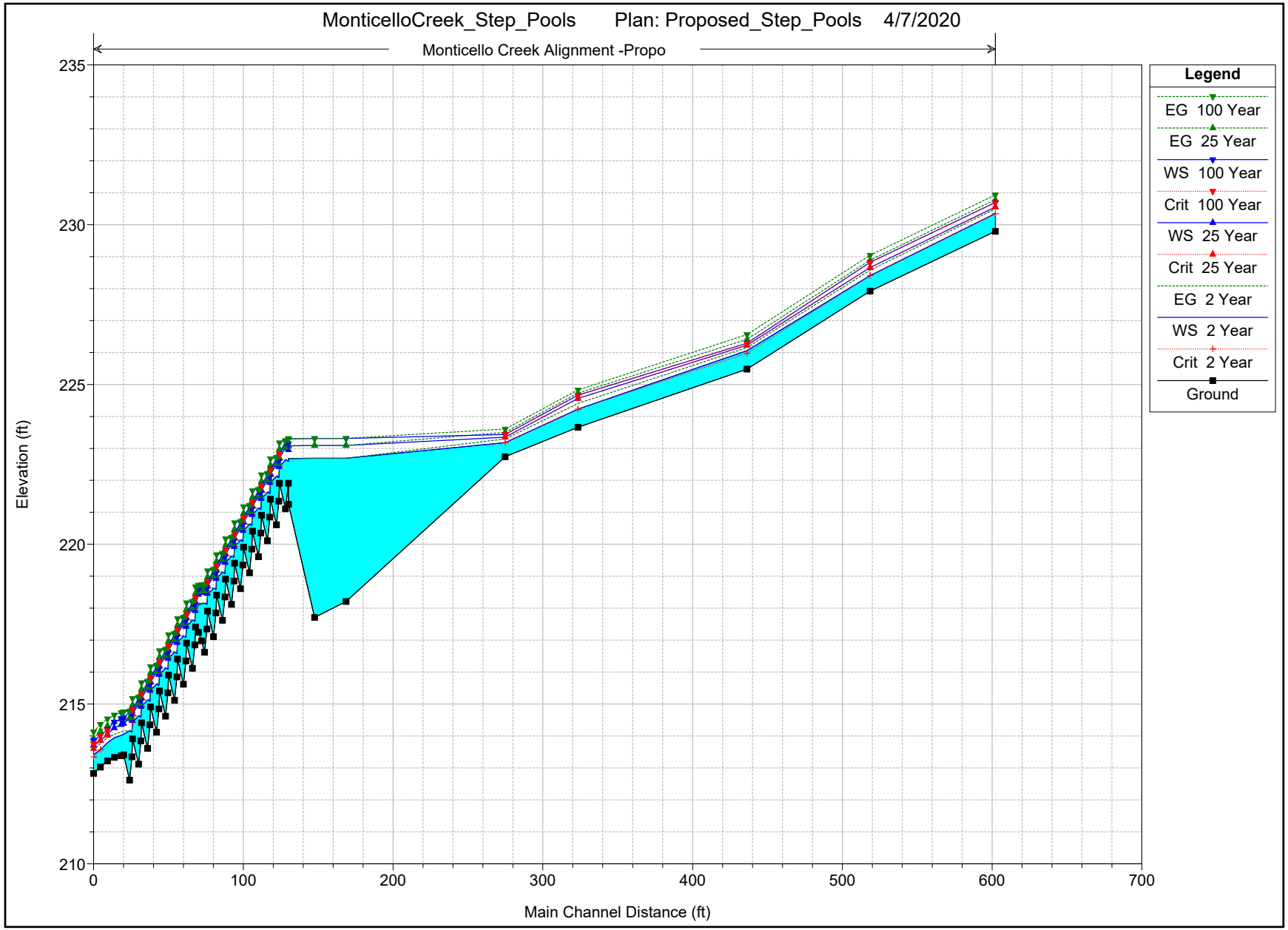
Existing XS Middle of the Roughened Channel



Existing XS in the Transition Zone



Proposed Conditions Modeled Profile Plot



Proposed Conditions Modeled Results

HEC-RAS Plan: 21 River: Monticello Creek Reach: Alignment -Propo

	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
	Alignment -Propo	1616.12	2 Year	5.43	229.79	230.35	230.35	230.49	0.021178	3.09	1.76	6.31	1.02
	Alignment -Propo	1616.12	25 Year	11.91	229.79	230.55	230.55	230.78	0.017681	3.86	3.17	7.44	1.00
	Alignment -Propo	1616.12	100 Year	16.45	229.79	230.70	230.70	230.93	0.014223	3.95	4.68	12.85	0.93
	Alignment -Propo	1532.49	2 Year	5.43	227.92	228.41	228.41	228.58	0.018323	3.33	1.73	6.04	0.98
	Alignment -Propo	1532.49	25 Year	11.91	227.92	228.66	228.66	228.89	0.014124	4.00	3.73	11.15	0.92
	Alignment -Propo	1532.49	100 Year	16.45	227.92	228.82	228.82	229.04	0.010322	4.03	6.37	23.62	0.82
	Alignment -Propo	1450.29	2 Year	5.43	225.48	226.06	225.98	226.15	0.012264	2.94	2.93	8.69	0.81
	Alignment -Propo	1450.29	25 Year	11.91	225.48	226.23	226.23	226.42	0.019484	4.20	4.58	10.89	1.05
	Alignment -Propo	1450.29	100 Year	16.45	225.48	226.29	226.29	226.56	0.025773	5.06	5.33	12.23	1.23
	Alignment -Propo	1337.37	2 Year	5.43	223.66	224.23	224.23	224.41	0.019850	3.38	1.61	4.56	1.00
	Alignment -Propo	1337.37	25 Year	11.91	223.66	224.56	224.56	224.73	0.010382	3.35	4.93	27.46	0.78
	Alignment -Propo	1337.37	100 Year	16.45	223.66	224.66	224.66	224.83	0.009327	3.50	8.12	32.87	0.76
	Alignment -Propo	1288.78	2 Year	5.43	222.74	223.18	223.18	223.29	0.021452	2.70	2.01	8.80	1.00
	Alignment -Propo	1288.78	25 Year	11.91	222.74	223.35	223.35	223.50	0.019348	3.13	3.83	13.95	0.99
	Alignment -Propo	1288.78	100 Year	16.45	222.74	223.44	223.44	223.60	0.017388	3.31	5.27	19.20	0.97
	Alignment -Propo	1182.56	2 Year	5.43	218.21	222.69		222.69	0.000001	0.03	205.33	74.22	0.00
	Alignment -Propo	1182.56	25 Year	11.91	218.21	223.09		223.09	0.000002	0.05	236.06	79.01	0.01
	Alignment -Propo	1182.56	100 Year	16.45	218.21	223.31		223.31	0.000003	0.06	253.84	84.93	0.01
	Alignment -Propo	1161.54	2 Year	5.43	217.71	222.69		222.69	0.000000	0.01	383.03	105.80	0.00
	Alignment -Propo	1161.54	25 Year	11.91	217.71	223.09		223.09	0.000000	0.03	425.98	108.53	0.00
	Alignment -Propo	1161.54	100 Year	16.45	217.71	223.31		223.31	0.000001	0.04	449.89	110.01	0.00
	Alignment -Propo	1144.09	2 Year	5.43	221.25	222.68		222.69	0.003633	0.78	6.93	11.33	0.18
	Alignment -Propo	1144.09	25 Year	11.91	221.25	223.08		223.09	0.004183	0.98	12.68	22.42	0.20
	Alignment -Propo	1144.09	100 Year	16.45	221.25	223.30		223.31	0.003144	1.00	19.77	41.23	0.18
Pond Outlet	Alignment -Propo	1144.04	2 Year	5.43	221.91	222.60		222.68	0.044955	2.34	2.32	4.76	0.59
	Alignment -Propo	1144.04	25 Year	11.91	221.91	222.95		223.08	0.035429	2.84	4.28	6.18	0.56
	Alignment -Propo	1144.04	100 Year	16.45	221.91	223.15		223.30	0.031873	3.12	5.54	6.95	0.56
Pool Location	Alignment -Propo	1142.04	2 Year	5.43	221.11	222.64		222.65	0.001384	0.79	7.75	8.12	0.12
	Alignment -Propo	1142.04	25 Year	11.91	221.11	223.01		223.04	0.002653	1.29	11.04	9.59	0.18
	Alignment -Propo	1142.04	100 Year	16.45	221.11	223.21		223.25	0.003308	1.55	13.04	10.39	0.20

HEC-RAS Plan: 21 River: Monticello Creek Reach: Alignment -Propo (Continued)

	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Step Location	Alignment -Propo	1138.05	2 Year	5.43	221.91	222.42	222.42	222.61	0.139474	3.51	1.55	4.05	1.00
	Alignment -Propo	1138.05	25 Year	11.91	221.91	222.69	222.69	222.98	0.125156	4.27	2.79	5.13	1.01
	Alignment -Propo	1138.05	100 Year	16.45	221.91	222.83	222.83	223.18	0.112994	4.70	3.55	5.69	0.99
	Alignment -Propo	1137.65	2 Year	5.43	221.35	222.09		222.16	0.033461	2.12	2.57	4.95	0.51
	Alignment -Propo	1137.65	25 Year	11.91	221.35	222.43		222.55	0.030087	2.77	4.47	6.31	0.53
	Alignment -Propo	1137.65	100 Year	16.45	221.35	222.61		222.76	0.029128	3.10	5.70	7.08	0.54
Pool Location	Alignment -Propo	1136.04	2 Year	5.43	220.61	222.13		222.14	0.000450	0.79	7.64	8.07	0.12
	Alignment -Propo	1136.04	25 Year	11.91	220.61	222.49		222.51	0.000868	1.30	10.81	9.50	0.18
	Alignment -Propo	1136.04	100 Year	16.45	220.61	222.68		222.72	0.001083	1.56	12.74	10.28	0.20
Step Location	Alignment -Propo	1132.05	2 Year	5.43	221.41	221.92	221.92	222.11	0.044391	3.52	1.54	4.05	1.01
	Alignment -Propo	1132.05	25 Year	11.91	221.41	222.19	222.19	222.48	0.039671	4.26	2.80	5.14	1.01
	Alignment -Propo	1132.05	100 Year	16.45	221.41	222.33	222.33	222.67	0.035690	4.69	3.56	5.70	0.99
	Alignment -Propo	1131.65	2 Year	5.43	220.85	221.59		221.66	0.010631	2.11	2.57	4.96	0.52
	Alignment -Propo	1131.65	25 Year	11.91	220.85	221.93		222.04	0.009486	2.76	4.48	6.31	0.53
	Alignment -Propo	1131.65	100 Year	16.45	220.85	222.11		222.25	0.009134	3.09	5.70	7.08	0.53
Pool Location	Alignment -Propo	1130.04	2 Year	5.43	220.11	221.63		221.64	0.000448	0.79	7.65	8.07	0.12
	Alignment -Propo	1130.04	25 Year	11.91	220.11	221.99		222.01	0.000866	1.30	10.81	9.50	0.18
	Alignment -Propo	1130.04	100 Year	16.45	220.11	222.18		222.22	0.001080	1.56	12.74	10.28	0.20
Step Location	Alignment -Propo	1126.05	2 Year	5.43	220.91	221.42	221.42	221.61	0.044026	3.51	1.55	4.05	1.00
	Alignment -Propo	1126.05	25 Year	11.91	220.91	221.69	221.69	221.98	0.040006	4.27	2.79	5.14	1.01
	Alignment -Propo	1126.05	100 Year	16.45	220.91	221.84	221.84	222.17	0.035377	4.68	3.57	5.71	0.99
	Alignment -Propo	1125.65	2 Year	5.43	220.35	221.09		221.16	0.010751	2.11	2.57	4.96	0.52
	Alignment -Propo	1125.65	25 Year	11.91	220.35	221.43		221.54	0.009506	2.76	4.47	6.31	0.53
	Alignment -Propo	1125.65	100 Year	16.45	220.35	221.61		221.75	0.009122	3.08	5.71	7.08	0.53
Pool Location	Alignment -Propo	1124.04	2 Year	5.43	219.61	221.13		221.14	0.000448	0.79	7.65	8.07	0.12
	Alignment -Propo	1124.04	25 Year	11.91	219.61	221.49		221.51	0.000866	1.30	10.81	9.50	0.18
	Alignment -Propo	1124.04	100 Year	16.45	219.61	221.68		221.72	0.001079	1.56	12.75	10.28	0.20
Step Location	Alignment -Propo	1120.05	2 Year	5.43	220.41	220.92	220.92	221.11	0.044472	3.52	1.54	4.05	1.01
	Alignment -Propo	1120.05	25 Year	11.91	220.41	221.20	221.20	221.48	0.039076	4.24	2.81	5.15	1.00

HEC-RAS Plan: 21 River: Monticello Creek Reach: Alignment -Propo (Continued)

	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
	Alignment -Propo	1120.05	100 Year	16.45	220.41	221.33	221.33	221.67	0.035722	4.69	3.56	5.70	0.99
	Alignment -Propo	1119.65	2 Year	5.43	219.85	220.59		220.66	0.010779	2.12	2.56	4.95	0.52
	Alignment -Propo	1119.65	25 Year	11.91	219.85	220.93		221.04	0.009513	2.77	4.47	6.30	0.53
	Alignment -Propo	1119.65	100 Year	16.45	219.85	221.11		221.25	0.009169	3.10	5.69	7.08	0.54
Pool Location	Alignment -Propo	1118.04	2 Year	5.43	219.11	220.63		220.64	0.000449	0.79	7.64	8.07	0.12
	Alignment -Propo	1118.04	25 Year	11.91	219.11	220.99		221.01	0.000869	1.30	10.80	9.50	0.18
	Alignment -Propo	1118.04	100 Year	16.45	219.11	221.18		221.22	0.001084	1.57	12.73	10.28	0.20
Step Location	Alignment -Propo	1114.05	2 Year	5.43	219.91	220.42	220.42	220.61	0.044087	3.51	1.55	4.05	1.00
	Alignment -Propo	1114.05	25 Year	11.91	219.91	220.69	220.69	220.98	0.039889	4.27	2.79	5.14	1.01
	Alignment -Propo	1114.05	100 Year	16.45	219.91	220.84	220.84	221.17	0.035209	4.67	3.57	5.71	0.98
	Alignment -Propo	1113.65	2 Year	5.43	219.35	220.09		220.16	0.010792	2.11	2.57	4.96	0.52
	Alignment -Propo	1113.65	25 Year	11.91	219.35	220.43		220.54	0.009464	2.76	4.48	6.31	0.53
	Alignment -Propo	1113.65	100 Year	16.45	219.35	220.61		220.76	0.009106	3.08	5.71	7.09	0.53
Pool Location	Alignment -Propo	1112.04	2 Year	5.43	218.61	220.13		220.14	0.000448	0.79	7.65	8.07	0.12
	Alignment -Propo	1112.04	25 Year	11.91	218.61	220.49		220.51	0.000865	1.30	10.81	9.50	0.18
	Alignment -Propo	1112.04	100 Year	16.45	218.61	220.68		220.72	0.001078	1.56	12.75	10.28	0.20
Step Location	Alignment -Propo	1108.05	2 Year	5.43	219.41	219.92	219.92	220.11	0.043692	3.50	1.55	4.06	1.00
	Alignment -Propo	1108.05	25 Year	11.91	219.41	220.19	220.19	220.48	0.039913	4.27	2.79	5.14	1.01
	Alignment -Propo	1108.05	100 Year	16.45	219.41	220.33	220.33	220.67	0.035318	4.68	3.57	5.71	0.99
	Alignment -Propo	1107.65	2 Year	5.43	218.85	219.59		219.66	0.011015	2.13	2.55	5.00	0.52
	Alignment -Propo	1107.65	25 Year	11.91	218.85	219.92		220.04	0.009575	2.77	4.47	6.35	0.53
	Alignment -Propo	1107.65	100 Year	16.45	218.85	220.11		220.25	0.009147	3.09	5.72	7.22	0.54
Pool Location	Alignment -Propo	1106.04	2 Year	5.43	218.12	219.63		219.64	0.000461	0.80	7.57	8.04	0.12
	Alignment -Propo	1106.04	25 Year	11.91	218.12	219.99		220.01	0.000885	1.30	10.72	9.47	0.18
	Alignment -Propo	1106.04	100 Year	16.45	218.12	220.18		220.22	0.001098	1.56	12.66	10.26	0.20
Step Location	Alignment -Propo	1102.05	2 Year	5.43	218.91	219.42	219.42	219.61	0.044539	3.52	1.54	4.05	1.01
	Alignment -Propo	1102.05	25 Year	11.91	218.91	219.69	219.69	219.97	0.038754	4.24	2.81	5.16	1.00
	Alignment -Propo	1102.05	100 Year	16.45	218.91	219.83	219.83	220.17	0.035527	4.70	3.56	5.70	0.99
	Alignment -Propo	1101.65	2 Year	5.43	218.35	219.09		219.16	0.011007	2.13	2.55	4.94	0.52

HEC-RAS Plan: 21 River: Monticello Creek Reach: Alignment -Propo (Continued)

	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
	Alignment -Propo	1101.65	25 Year	11.91	218.35	219.43		219.54	0.009590	2.77	4.46	6.30	0.53
	Alignment -Propo	1101.65	100 Year	16.45	218.35	219.61		219.76	0.009159	3.09	5.70	7.09	0.54
Pool Location	Alignment -Propo	1100.04	2 Year	5.43	217.62	219.13		219.14	0.000461	0.80	7.57	8.03	0.12
	Alignment -Propo	1100.04	25 Year	11.91	217.62	219.49		219.51	0.000884	1.31	10.73	9.47	0.18
	Alignment -Propo	1100.04	100 Year	16.45	217.62	219.69		219.72	0.001098	1.57	12.67	10.26	0.20
Step Location	Alignment -Propo	1096.05	2 Year	5.43	218.41	218.92	218.92	219.11	0.044559	3.52	1.54	4.05	1.01
	Alignment -Propo	1096.05	25 Year	11.91	218.41	219.19	219.19	219.48	0.039387	4.29	2.78	5.13	1.01
	Alignment -Propo	1096.05	100 Year	16.45	218.41	219.34	219.34	219.68	0.034443	4.68	3.58	5.72	0.98
	Alignment -Propo	1095.65	2 Year	5.43	217.85	218.59		218.66	0.010880	2.13	2.55	4.92	0.52
	Alignment -Propo	1095.65	25 Year	11.91	217.85	218.92		219.04	0.009651	2.79	4.44	6.27	0.53
	Alignment -Propo	1095.65	100 Year	16.45	217.85	219.11		219.25	0.009331	3.12	5.65	7.05	0.54
Pool Location	Alignment -Propo	1094.02	2 Year	5.43	217.11	218.63		218.64	0.000452	0.80	7.63	8.11	0.12
	Alignment -Propo	1094.02	25 Year	11.91	217.11	218.99		219.01	0.000871	1.30	10.82	9.62	0.18
	Alignment -Propo	1094.02	100 Year	16.45	217.11	219.18		219.22	0.001085	1.56	12.78	11.28	0.20
Step Location	Alignment -Propo	1090.05	2 Year	5.43	217.91	218.42	218.42	218.61	0.043676	3.50	1.55	4.06	1.00
	Alignment -Propo	1090.05	25 Year	11.91	217.91	218.69	218.69	218.97	0.039954	4.27	2.79	5.14	1.01
	Alignment -Propo	1090.05	100 Year	16.45	217.91	218.83	218.83	219.17	0.035365	4.67	3.57	5.71	0.99
	Alignment -Propo	1089.65	2 Year	5.43	217.35	218.12		218.18	0.009210	2.01	2.71	5.05	0.48
	Alignment -Propo	1089.65	25 Year	11.91	217.35	218.46		218.57	0.008451	2.66	4.66	6.42	0.50
	Alignment -Propo	1089.65	100 Year	16.45	217.35	218.64		218.78	0.008281	2.99	5.92	7.32	0.51
Pool Location	Alignment -Propo	1088.04	2 Year	5.43	216.62	218.15		218.16	0.000428	0.78	7.78	8.14	0.12
	Alignment -Propo	1088.04	25 Year	11.91	216.62	218.51		218.54	0.000832	1.28	10.98	9.58	0.17
	Alignment -Propo	1088.04	100 Year	16.45	216.62	218.71		218.74	0.001044	1.55	12.92	10.35	0.20
	Alignment -Propo	1086.71	2 Year	5.43	216.98	218.14		218.16	0.001609	1.18	4.89	6.70	0.22
	Alignment -Propo	1086.71	25 Year	11.91	216.98	218.49		218.53	0.002387	1.79	7.59	8.94	0.28
	Alignment -Propo	1086.71	100 Year	16.45	216.98	218.67		218.74	0.002674	2.08	9.40	10.30	0.31
	Alignment -Propo	1085.38	2 Year	5.43	217.24	218.10		218.15	0.005855	1.79	3.12	5.42	0.40
	Alignment -Propo	1085.38	25 Year	11.91	217.24	218.43		218.52	0.006900	2.49	5.12	7.20	0.46
	Alignment -Propo	1085.38	100 Year	16.45	217.24	218.60		218.72	0.007067	2.84	6.53	9.09	0.48

HEC-RAS Plan: 21 River: Monticello Creek Reach: Alignment -Propo (Continued)

	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Step Location	Alignment -Propo	1084.05	2 Year	5.43	217.41	217.92	217.92	218.11	0.044524	3.52	1.54	4.05	1.01
	Alignment -Propo	1084.05	25 Year	11.91	217.41	218.19	218.19	218.47	0.039762	4.27	2.79	5.14	1.01
	Alignment -Propo	1084.05	100 Year	16.45	217.41	218.33	218.33	218.67	0.035507	4.69	3.56	5.70	0.99
	Alignment -Propo	1083.65	2 Year	5.43	216.85	217.59		217.66	0.010986	2.13	2.55	4.93	0.52
	Alignment -Propo	1083.65	25 Year	11.91	216.85	217.92		218.04	0.009685	2.78	4.44	6.28	0.53
	Alignment -Propo	1083.65	100 Year	16.45	216.85	218.11		218.25	0.009354	3.11	5.65	7.05	0.54
Pool Location	Alignment -Propo	1082.04	2 Year	5.43	216.12	217.63		217.64	0.000461	0.80	7.57	8.03	0.12
	Alignment -Propo	1082.04	25 Year	11.91	216.12	217.99		218.01	0.000888	1.31	10.71	9.46	0.18
	Alignment -Propo	1082.04	100 Year	16.45	216.12	218.18		218.22	0.001108	1.58	12.63	10.24	0.21
Step Location	Alignment -Propo	1078.05	2 Year	5.43	216.91	217.42	217.42	217.61	0.045379	3.55	1.53	4.04	1.02
	Alignment -Propo	1078.05	25 Year	11.91	216.91	217.69	217.69	217.97	0.039333	4.25	2.81	5.16	1.00
	Alignment -Propo	1078.05	100 Year	16.45	216.91	217.83	217.83	218.17	0.035833	4.68	3.56	5.71	0.99
	Alignment -Propo	1077.65	2 Year	5.43	216.35	217.09		217.16	0.010777	2.13	2.55	4.94	0.52
	Alignment -Propo	1077.65	25 Year	11.91	216.35	217.43		217.54	0.009638	2.77	4.46	6.29	0.53
	Alignment -Propo	1077.65	100 Year	16.45	216.35	217.61		217.75	0.009256	3.09	5.68	7.07	0.54
Pool Location	Alignment -Propo	1076.04	2 Year	5.43	215.62	217.13		217.14	0.000464	0.80	7.56	8.03	0.12
	Alignment -Propo	1076.04	25 Year	11.91	215.62	217.49		217.51	0.000889	1.31	10.71	9.47	0.18
	Alignment -Propo	1076.04	100 Year	16.45	215.62	217.68		217.72	0.001107	1.57	12.63	10.25	0.20
Step Location	Alignment -Propo	1072.05	2 Year	5.43	216.41	216.92	216.92	217.11	0.044349	3.52	1.54	4.05	1.00
	Alignment -Propo	1072.05	25 Year	11.91	216.41	217.19	217.19	217.48	0.039802	4.27	2.80	5.15	1.01
	Alignment -Propo	1072.05	100 Year	16.45	216.41	217.34	217.34	217.67	0.035255	4.68	3.57	5.71	0.98
	Alignment -Propo	1071.65	2 Year	5.43	215.85	216.59		216.66	0.010804	2.13	2.55	4.95	0.52
	Alignment -Propo	1071.65	25 Year	11.91	215.85	216.92		217.04	0.009617	2.77	4.46	6.29	0.53
	Alignment -Propo	1071.65	100 Year	16.45	215.85	217.11		217.25	0.009223	3.10	5.68	7.07	0.54
Pool Location	Alignment -Propo	1070.04	2 Year	5.43	215.12	216.63		216.64	0.000466	0.80	7.55	8.03	0.12
	Alignment -Propo	1070.04	25 Year	11.91	215.12	216.99		217.01	0.000893	1.31	10.70	9.46	0.18
	Alignment -Propo	1070.04	100 Year	16.45	215.12	217.18		217.22	0.001109	1.57	12.63	10.24	0.20
Step Location	Alignment -Propo	1066.05	2 Year	5.43	215.91	216.42	216.42	216.61	0.044329	3.52	1.54	4.05	1.00
	Alignment -Propo	1066.05	25 Year	11.91	215.91	216.69	216.69	216.97	0.039827	4.28	2.79	5.14	1.01
	Alignment -Propo	1066.05	100 Year	16.45	215.91	216.83	216.83	217.17	0.035470	4.69	3.56	5.70	0.99

HEC-RAS Plan: 21 River: Monticello Creek Reach: Alignment -Propo (Continued)

	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
	Alignment -Propo	1065.65	2 Year	5.43	215.35	216.09		216.16	0.010982	2.13	2.55	4.93	0.52
	Alignment -Propo	1065.65	25 Year	11.91	215.35	216.42		216.54	0.009688	2.78	4.44	6.28	0.53
	Alignment -Propo	1065.65	100 Year	16.45	215.35	216.61		216.75	0.009288	3.11	5.67	7.06	0.54
Pool Location	Alignment -Propo	1064.04	2 Year	5.43	214.62	216.13		216.14	0.000461	0.80	7.57	8.03	0.12
	Alignment -Propo	1064.04	25 Year	11.91	214.62	216.49		216.51	0.000888	1.31	10.71	9.46	0.18
	Alignment -Propo	1064.04	100 Year	16.45	214.62	216.68		216.72	0.001105	1.58	12.64	10.24	0.20
Step Location	Alignment -Propo	1060.05	2 Year	5.43	215.41	215.92	215.92	216.11	0.045699	3.55	1.53	4.04	1.02
	Alignment -Propo	1060.05	25 Year	11.91	215.41	216.19	216.19	216.47	0.039495	4.27	2.80	5.14	1.00
	Alignment -Propo	1060.05	100 Year	16.45	215.41	216.33	216.33	216.67	0.035365	4.69	3.56	5.71	0.99
	Alignment -Propo	1059.65	2 Year	5.43	214.85	215.59		215.66	0.011041	2.13	2.54	4.92	0.52
	Alignment -Propo	1059.65	25 Year	11.91	214.85	215.92		216.04	0.009683	2.78	4.44	6.28	0.53
	Alignment -Propo	1059.65	100 Year	16.45	214.85	216.11		216.25	0.009286	3.11	5.67	7.06	0.54
Pool Location	Alignment -Propo	1058.04	2 Year	5.43	214.12	215.63		215.64	0.000462	0.80	7.56	8.03	0.12
	Alignment -Propo	1058.04	25 Year	11.91	214.12	215.99		216.01	0.000888	1.31	10.71	9.46	0.18
	Alignment -Propo	1058.04	100 Year	16.45	214.12	216.18		216.22	0.001104	1.58	12.64	10.24	0.20
Step Location	Alignment -Propo	1054.05	2 Year	5.43	214.91	215.42	215.42	215.61	0.044517	3.52	1.54	4.05	1.01
	Alignment -Propo	1054.05	25 Year	11.91	214.91	215.69	215.69	215.97	0.039922	4.27	2.79	5.13	1.01
	Alignment -Propo	1054.05	100 Year	16.45	214.91	215.83	215.83	216.17	0.035658	4.70	3.55	5.69	0.99
	Alignment -Propo	1053.65	2 Year	5.43	214.35	215.09		215.16	0.010989	2.13	2.54	4.91	0.52
	Alignment -Propo	1053.65	25 Year	11.91	214.35	215.42		215.54	0.009737	2.79	4.43	6.27	0.53
	Alignment -Propo	1053.65	100 Year	16.45	214.35	215.61		215.75	0.009344	3.11	5.65	7.05	0.54
Pool Location	Alignment -Propo	1052.04	2 Year	5.43	213.61	215.13		215.14	0.000467	0.80	7.51	7.96	0.13
	Alignment -Propo	1052.04	25 Year	11.91	213.61	215.49		215.51	0.000898	1.31	10.63	9.40	0.18
	Alignment -Propo	1052.04	100 Year	16.45	213.61	215.68		215.72	0.001118	1.58	12.56	10.30	0.21
Step Location	Alignment -Propo	1048.05	2 Year	5.43	214.41	214.92	214.92	215.11	0.044561	3.52	1.54	4.05	1.01
	Alignment -Propo	1048.05	25 Year	11.91	214.41	215.19	215.19	215.47	0.039944	4.27	2.79	5.14	1.01
	Alignment -Propo	1048.05	100 Year	16.45	214.41	215.33	215.33	215.67	0.035677	4.69	3.55	5.70	0.99
	Alignment -Propo	1047.65	2 Year	5.43	213.85	214.59		214.66	0.010956	2.13	2.55	4.93	0.52
	Alignment -Propo	1047.65	25 Year	11.91	213.85	214.93		215.04	0.009646	2.77	4.45	6.29	0.53

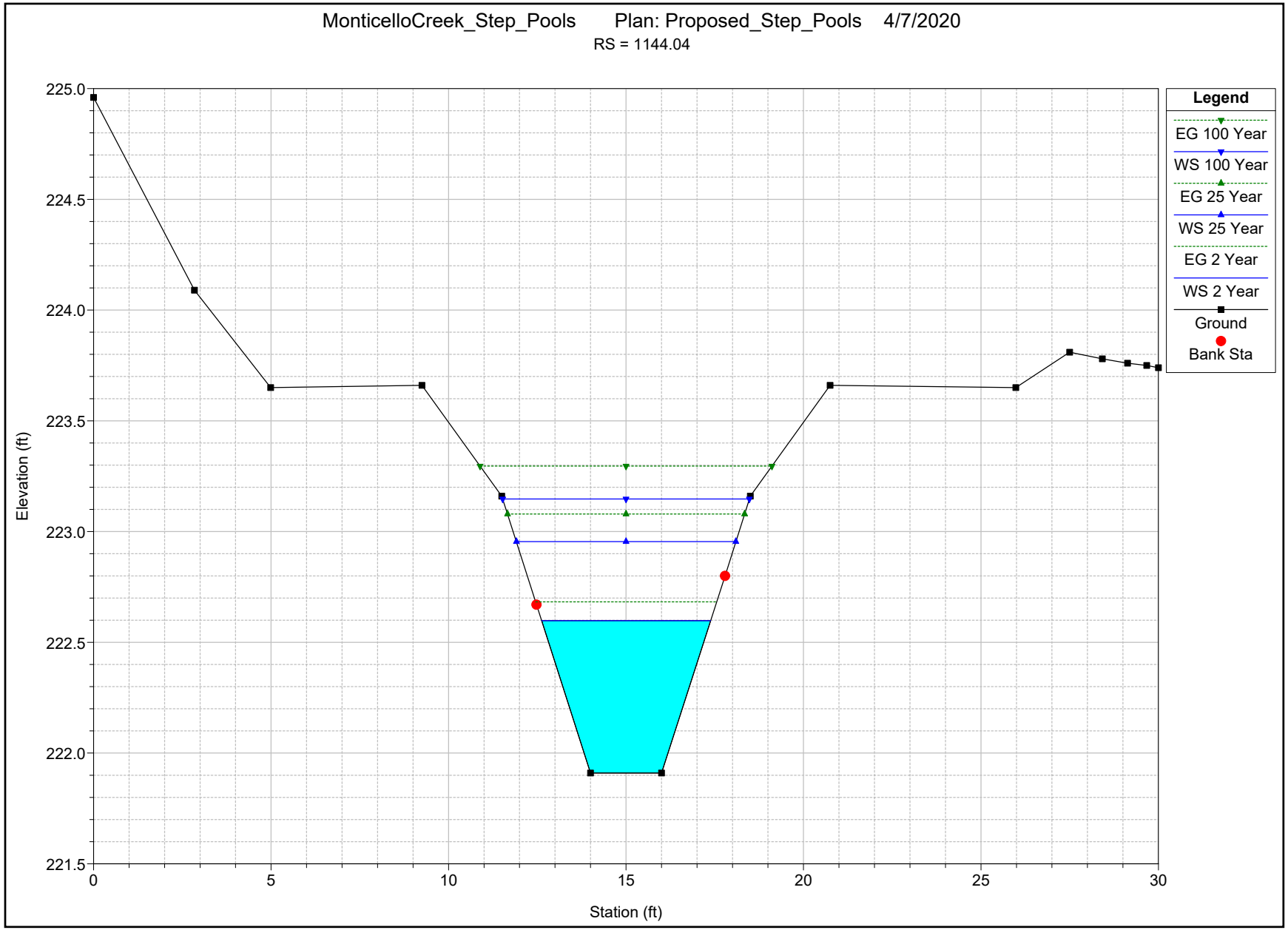
HEC-RAS Plan: 21 River: Monticello Creek Reach: Alignment -Propo (Continued)

	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
	Alignment -Propo	1047.65	100 Year	16.45	213.85	215.11		215.26	0.009226	3.10	5.68	7.08	0.54
Pool Location	Alignment -Propo	1046.04	2 Year	5.43	213.12	214.63		214.64	0.000461	0.80	7.57	8.03	0.12
	Alignment -Propo	1046.04	25 Year	11.91	213.12	214.99		215.01	0.000886	1.31	10.72	9.47	0.18
	Alignment -Propo	1046.04	100 Year	16.45	213.12	215.18		215.22	0.001101	1.57	12.66	10.25	0.20
Step Location	Alignment -Propo	1042.05	2 Year	5.43	213.91	214.42	214.42	214.61	0.044521	3.52	1.54	4.05	1.01
	Alignment -Propo	1042.05	25 Year	11.91	213.91	214.69	214.69	214.98	0.039744	4.28	2.78	5.13	1.01
	Alignment -Propo	1042.05	100 Year	16.45	213.91	214.83	214.83	215.17	0.035392	4.70	3.56	5.70	0.99
	Alignment -Propo	1041.65	2 Year	5.43	213.35	214.13		214.19	0.008412	1.97	2.76	5.11	0.46
	Alignment -Propo	1041.65	25 Year	11.91	213.35	214.49		214.59	0.007351	2.57	4.88	6.56	0.47
	Alignment -Propo	1041.65	100 Year	16.45	213.35	214.69		214.81	0.007080	2.87	6.27	7.67	0.48
Pool Location	Alignment -Propo	1040.04	2 Year	5.43	212.62	214.16		214.17	0.000421	0.78	7.84	8.17	0.12
	Alignment -Propo	1040.04	25 Year	11.91	212.62	214.54		214.57	0.000786	1.26	11.25	9.69	0.17
	Alignment -Propo	1040.04	100 Year	16.45	212.62	214.75		214.78	0.000968	1.51	13.33	10.51	0.19
Step Location	Alignment -Propo	1036.05	2 Year	5.43	213.41	214.06		214.16	0.018044	2.55	2.13	4.59	0.66
	Alignment -Propo	1036.05	25 Year	11.91	213.41	214.39		214.54	0.013917	3.15	3.90	5.94	0.63
	Alignment -Propo	1036.05	100 Year	16.45	213.41	214.57		214.76	0.012711	3.46	5.05	6.67	0.62
	Alignment -Propo	1034.41	2 Year	5.43	213.38	214.02		214.13	0.017718	2.67	2.08	4.53	0.66
	Alignment -Propo	1034.41	25 Year	11.91	213.38	214.36		214.52	0.016286	3.32	3.80	5.67	0.67
	Alignment -Propo	1034.41	100 Year	16.45	213.38	214.54		214.73	0.015558	3.58	4.92	6.30	0.67
Transition Zone Begins	Alignment -Propo	1029.81	2 Year	5.43	213.33	213.95		214.05	0.015942	2.61	2.14	4.34	0.63
	Alignment -Propo	1029.81	25 Year	11.91	213.33	214.26		214.44	0.017265	3.47	3.61	5.10	0.69
	Alignment -Propo	1029.81	100 Year	16.45	213.33	214.44		214.66	0.017351	3.84	4.56	5.57	0.71
	Alignment -Propo	1025.20	2 Year	5.43	213.22	213.79		213.94	0.031570	3.16	1.72	4.05	0.86
	Alignment -Propo	1025.20	25 Year	11.91	213.22	214.06	214.02	214.32	0.032415	4.17	2.87	4.66	0.92
	Alignment -Propo	1025.20	100 Year	16.45	213.22	214.20	214.17	214.54	0.032511	4.65	3.58	4.99	0.94
	Alignment -Propo	1020.59	2 Year	5.43	213.03	213.57	213.57	213.77	0.044489	3.59	1.51	3.82	1.01
	Alignment -Propo	1020.59	25 Year	11.91	213.03	213.85	213.85	214.16	0.040663	4.42	2.70	4.52	1.01
	Alignment -Propo	1020.59	100 Year	16.45	213.03	214.01	214.01	214.37	0.038795	4.77	3.45	4.93	1.00
	Alignment -Propo	1015.98	2 Year	5.43	212.83	213.42	213.35	213.55	0.026014	2.90	1.87	4.32	0.78

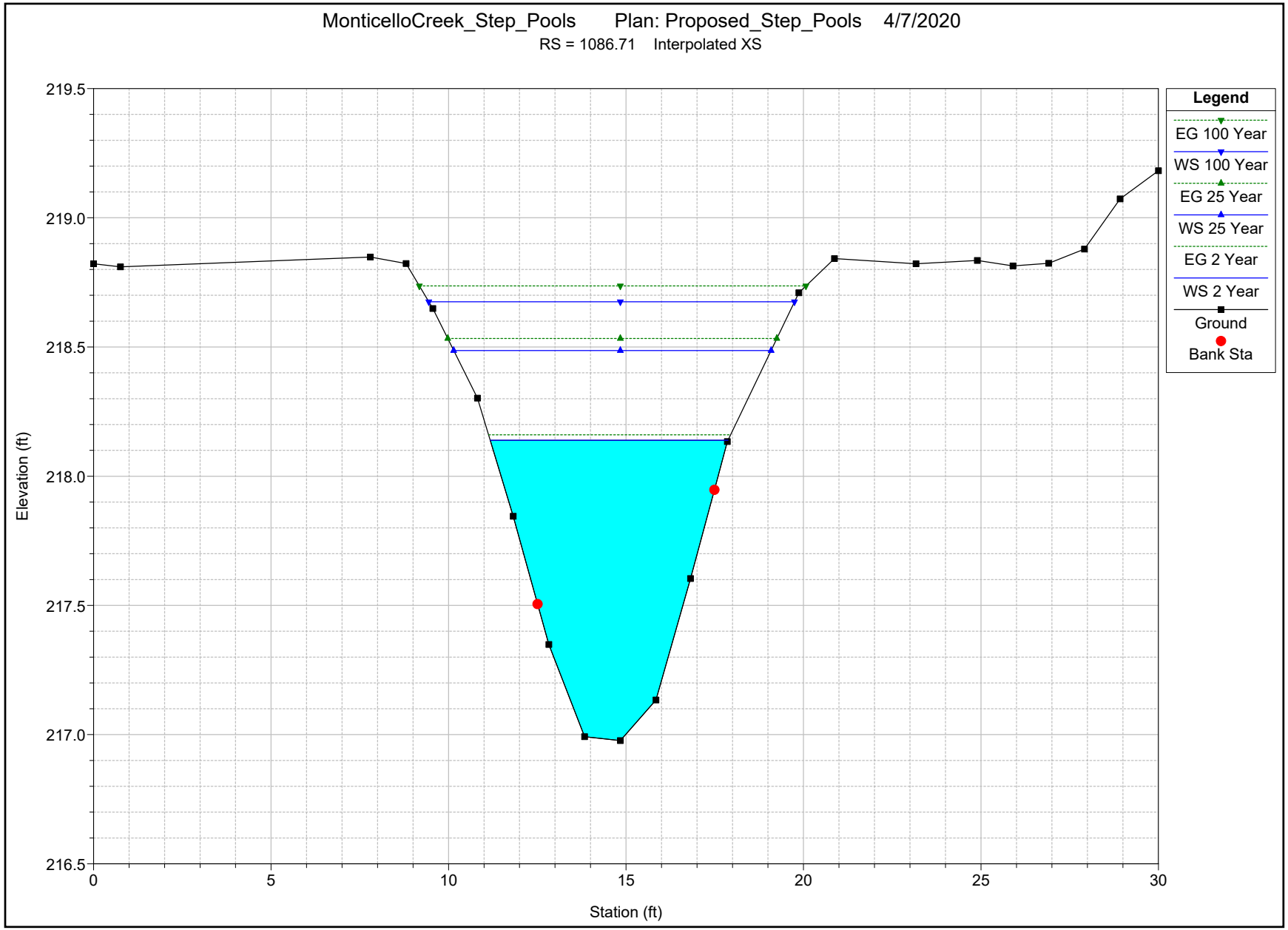
HEC-RAS Plan: 21 River: Monticello Creek Reach: Alignment -Propo (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Alignment -Propo	1015.98	25 Year	11.91	212.83	213.71	213.61	213.92	0.026037	3.73	3.20	4.87	0.81
Alignment -Propo	1015.98	100 Year	16.45	212.83	213.87	213.76	214.13	0.026008	4.11	4.00	5.17	0.82

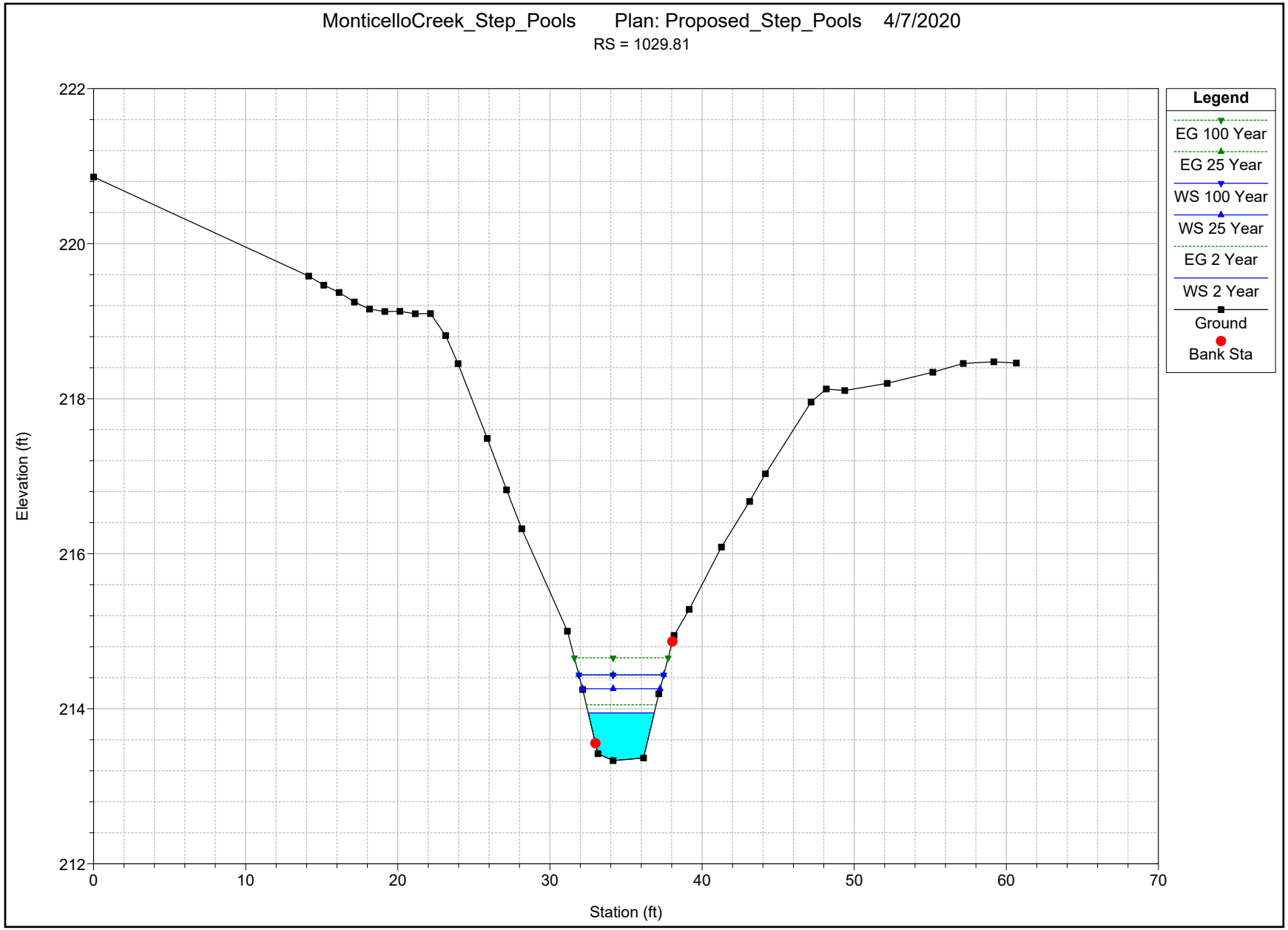
Proposed XS Downstream of the Pond



Proposed XS Middle of the Roughened Channel



Proposed XS in the Transition Zone



APPENDIX F: STREAM BED SIZING AND SCOUR CALCULATIONS

Project Name: Smith Woods
Design Level: 30% Design

Calcs by: IL
Date: 3/21/2020

Checked By: LCR
Date: 4/3/2020

Paleohydraulic Design Calculations

Unit-Discharge Bed Design

J.C. Bathurst equations provided in Water Crossing Design Guidelines, WDFW, 2013

Bathurst equation rearranged to predict the size of D_{84}.

Eqn. 3.3 $D_{84} = 3.54S^{0.747}(1.25q_c)^{2/3}/g^{1/3}$

	D_{84}	84th percentile particle (percent finer); (ft)
	S	energy slope of the proposed channel; (ft/ft)
	q_c	critical unit discharge (Qdesign/Wchannel) at which incipient motion of D_{84} occurs; (cfs) For channels sloped >4%, use the 100-yr storm
32.174	g	acceleration due to gravity; (ft/sec^2) $1/g^{1/3}$ = 0.314775

Site Specific Characteristics: W_{chan} Existing Channel Bankfull Width

Typical Section	$Q_{100\text{-}yr}$ (cfs)	W_{chan} (ft)	q_{c100} (sf/s)	Slope (ft/ft)	D_{84} (ft)	$Depth_{100}$ (ft)	Comment (compare results to Table 3-1)
From Sta 1144.04 to Sta 1103.6	16.45	4	4.11	0.061	0.41	0.92	
From Sta 1103.6 to Sta 1063.3	16.45	4	4.11	0.074	0.47	0.92	
From Sta 1063.3 to Sta 1029.29	16.45	4	4.11	0.088	0.54	0.92	
				Average :	0.48		
				Use	**0.50**	<- recommended (results in Dmax similar to Dmax from Table 3-1)	

Use Table 3-1 to see if flow depth is enough to mobilized the calculated D_{84}

Table 3-1 is derived based on the Costa Equation (Eqn. 3.4). The Costa Equation checks the relationship between an assumed D_{84} and the channel velocity.

Per WDFW guidance, this equation is best suited for streams having a gradient of less than 4%.

At higher slopes, the Costa equation consistently indicates smaller particle sizes than the Bathurst equation, all other conditions being equal

Eqn. 3.4 $V = 9.57(D_{84})^{0.487}$

Location	Depth	V (ft/s)	D84	
From Sta 1144.04 to Sta 1103.6	0.92	4.70	0.23	Depth and velocities taken from HECRAS model
From Sta 1103.6 to Sta 1063.3	0.92	4.70	0.23	
From Sta 1063.3 to Sta 1029.29	0.92	4.70	0.23	
		Average:	0.23	<---- Eqn. 3.4 results not appropriate for Smith Woods higher gradient stream.

Table 3-1. Prediction of water depth for a given maximum particle size that has been moved. Data has been converted to English Units; some values are log-interpolated.

Slope ---->	0.005	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.1
Particle Size (ft)	**Flow Depth (ft)**										
0.2	1.2	0.9	0.6	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.4
0.5	3	2.1	1.5	1.3	1.2	1	1	0.9	0.9	0.9	0.8
1	6	4.1	2.9	2.5	2.2	1.9	1.8	1.8	1.7	1.6	1.5
1.5	8.8	5.9	4.1	3.6	3.1	2.7	2.6	2.5	2.4	2.2	2.1
2	11.3	7.4	5.2	4.5	3.9	3.4	3.2	3.1	2.9	2.8	2.7
2.5	13.6	8.9	6.2	5.4	4.7	4.1	3.9	3.7	3.5	3.3	3.2
3	15.6	10.2	7.1	6.1	5.3	4.6	4.4	4.2	4	3.8	3.6
3.5	17.6	11.4	7.9	6.9	6	5.2	4.9	4.7	4.5	4.3	4.1
4	19.5	12.6	8.7	7.5	6.6	5.7	5.4	5.2	4.9	4.7	4.5
4.5	21.3	13.7	9.4	8.2	7.2	6.2	5.9	5.7	5.4	5.1	4.9
8.1	36.4	23.1	15.6	13.5	11.7	10.1	9.6	9.1	8.6	8.2	7.8
10.5	45.6	28.9	19.4	16.7	14.4	12.5	11.8	11.2	10.6	10	9.5

Recommended D84

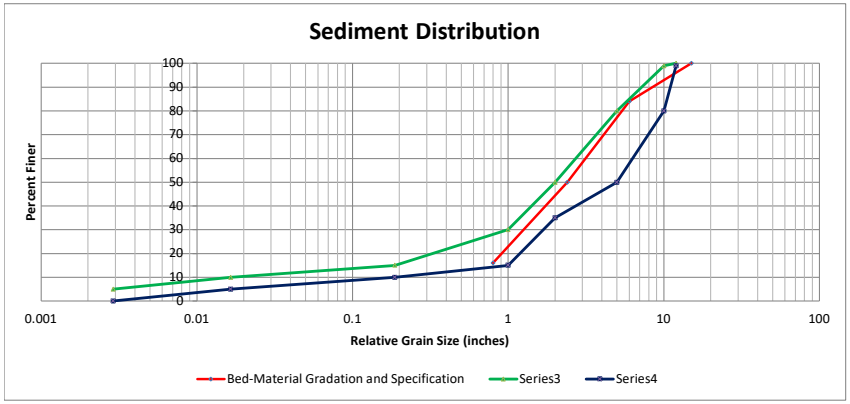
0.50 feet
6 inches

Bed-Material Gradation and Specification

Basic relationships found in natural distributions as a function of D_{84}:

D_{84}/D_{100} =	0.4
D_{84}/D_{50} =	2.5
D_{84}/D_{16} =	8.0

D_{16}	D_{50}	D_{84}	D_{100}	
0.06	0.20	0.50	1.25	(feet)
0.8	2.4	6	15	(inches)
16	50	84	100	(% pass)



RECOMMENDED: MAX Bed-Material Gradation

Gradations expressed as "percent passing" WSDOT sieve sizes for inclusion in the project special provisions.

Sieve Size		Percent Passing by Weight	
12	" Square	99	100
10	" Square	80	99
5	" Square	50	80
2	" Square	35	50
1	" Square	15	30
0.187	No. 4	10	15
0.0165	No. 40	5	10
0.0029	No. 200	0	5

Layer depth = 1.5 * Dmax ; or 2-feet minimum

Layer Depth = 1.875 feet < 2 feet, use 2-feet

Layer Depth = 2 feet

Calculated with equations found in WDFW 2003 Integrated Streambank Protection Guidelines, Appendix E

Bed Shear Stress in a Straight Reach

specific weight of water:	62.4	lb/cf	
energy slope:	0.035	ft/ft	from HEC-RAS
hydraulic radius:	0.65	ft	from HEC-RAS
max. bed shear stress:	1.4196	psf	Eq. 1 from Apx E
Minimum diameter of material required:	4	inch	Interpolation results in 4 inch material

Bank Shear Stress in a Straight Reach

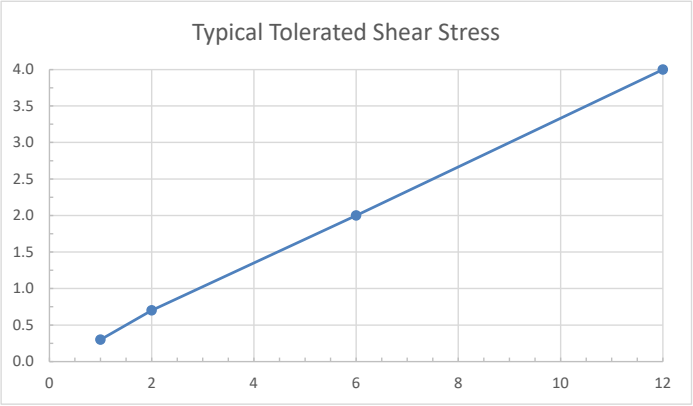
max. bank shear stress:	1.13568	psf	Eq. 2 from Apx E
Minimum diameter of material required:	3	inch	Interpolation results in 3 inch material

Shear Stress in Bends

radius of curvature of bend:	49	ft	
bottom width of channel at bend:	4	ft	
bend coefficient:	0.847232		
max. shear stress on bank/bed in bend:	1.20273	psf	
Minimum diameter of material required:	4	inch	Interpolation results in 4 inch material

Typical Tolerated Shear Stress

1	1" diameter gravel:	0.3	psf
2	2" diameter gravel:	0.7	psf
6	6" rock riprap:	2.0	psf
12	12" rock riprap:	4.0	psf



Calculated with equations found in WDFW 2003 Integrated Streambank Protection Guidelines, Appendix E

Calcs by IL 03/21/2020

Thorne Equation

Developed for mean bed-particle sizes between 0.3 to 63 mm (0.01 to 2.5 in). Applicable to gravel-bed streams.

$d/y_1 = 1.07 - \log(R_C/W - 2)$ for $2 < R_C/W < 22$

average flow depth directly upstream of bend (y_1):	0.92	ft	100-yr Flow
width of flow (W):	10	ft	conservative estimate based on Indu's 4/2/20 email
radius of curvature at channel centerline (R_C):	49	ft	Radius estimated using CAD
max. depth of scour (d):	0.558994	ft	

Maynord Equation

Developed for natural, sand-bed channels. Applicable for sand-bed streams, or conservative estimates for larger material.

Limited to $1.5 > R_C/W > 10$ (Use $R_C/W = 1.5$ when less than 1.5)

Limited to $20 > W/D_U > 125$ (Use $W/D_U = 20$ when less than 20)

Recommended safety factor of 1.08

$D_{MB}/D_U = 1.8 - 0.051(R_C/W) + 0.0084(W/D_U)$

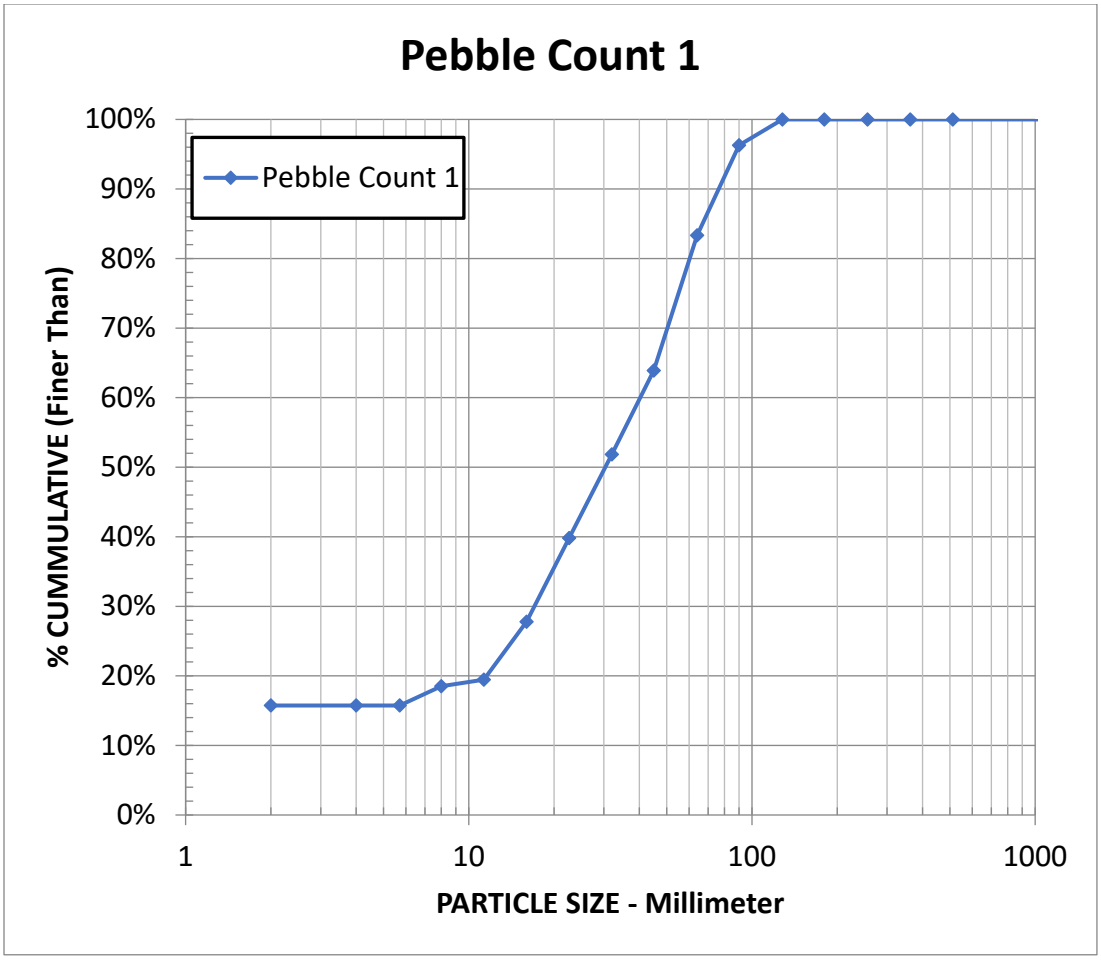
where D_U = cross sectional area/W

check of R_C/W:	8.596491		
check of W/D_U:	6.195652		
width of flow at upstream of bend (W):	5.7	ft	adjusted so W/Du = 20
mean channel depth at upstream crossing (D_U):	0.92	ft	model results used instead of area/W
radius of curvature at channel centerline (R_C):	49	ft	Radius estimated using CAD
max water depth in bend (D_{MB}):	1.516139	ft	

APPENDIX G: PEBBLE COUNT SUMMARY

PEBBLE COUNT SUMMARY

PEBBLE COUNT							Project Reach		
Stream:	Monticello Creek		Site No:				Pebble Count #1		
Reach:	Above NE 122nd and Below Pond		Party:	Indu, Gray			Date:	5/16/2019	
Inches	*Particle*	*Millimeters*		Particle Count			*Tot #*	*Item %*	*% Cum*
				1	2	3			
	Silt Clay	< 0.062	SILT/CLAY	17			17	15.7%	15.7%
	Very Fine	.062 - .125	SAND				0	0.0%	15.7%
	Fine	.125 - .25					0	0.0%	15.7%
	Medium	.25 - .50					0	0.0%	15.7%
	Coarse	.50 - 1.0					0	0.0%	15.7%
.04 - .08	Very Coarse	1.0 - 2					0	0.0%	15.7%
.08 - .16	Very Fine	2 - 4	GRAVEL				0	0.0%	15.7%
.16 -.22	Fine	4 - 5.7					0	0.0%	15.7%
.22 - .31	Fine	5.7 - 8		3			3	2.8%	18.5%
.31 - .44	Medium	8 - 11.3		1			1	0.9%	19.4%
.44 - .63	Medium	11.3 - 16		9			9	8.3%	27.8%
.63 - .89	Coarse	16 - 22.6		13			13	12.0%	39.8%
.89 - 1.26	Coarse	22.6 - 32		13			13	12.0%	51.9%
1.26 - 1.77	Very Coarse	32 - 45		13			13	12.0%	63.9%
1.77 - 2.5	Very Coarse	45 - 64		21			21	19.4%	83.3%
2.5 - 3.5	Small	64 - 90	COBBLE	14			14	13.0%	96.3%
3.5 - 5.0	Small	90 - 128		4			4	3.7%	100.0%
5.0 - 7.1	Large	128 - 180					0	0.0%	100.0%
7.1 - 10.1	Large	180 - 256					0	0.0%	100.0%
10.1 - 14.3	Small	256 - 362	BOULDER				0	0.0%	100.0%
14.3 - 20	Small	362 - 512					0	0.0%	100.0%
20 - 40	Medium	512 -1024					0	0.0%	100.0%
40 - 80	Large-Very Large	1024 - 2048					0	0.0%	100.0%
	Bedrock		BEDROCK				0	0.0%	100.0%
						TOTALS	108	100.0%	100.0%



Count 1 Interpolating					
	D16	D35	D50	D84	D100
Y1	15.7%	27.8%	39.8%	83.3%	100.0%
Y2	15.7%	39.8%	51.9%	96.3%	96.3%
X1	5.7	16	22	64	64
X2	0.125	22.6	32	90	90
(MM)	6	20	30	65	101
(ft)	0.02	0.06	0.10	0.21	0.33