

RELOCATION CHANNEL HABITAT UNITS

- POINT BAR
- POOL
- RIFFLE
- TRANSITION/RUN

MAIN CHANNEL TREATMENTS

- BED AGGRADATION STRUCTURE
- COARSEN RIFFLE
- MAIN CHANNEL PLUG
- MAIN CHANNEL PLUG - LOW PROFILE

RELOCATION 2 GRADING SCHEDULE

Station	Design Thalweg (ft)	Design TOB (ft)	Channel Feature
125	5425.5	5427.9	Riffle Crest
300	5422	5427.4	Max Pool Depth
350	5424.8	5427.2	Riffle Crest
450	5421.6	5427	Max Pool Depth
550	5424.4	5426.8	Riffle Crest
700	5421	5426.4	Max Pool Depth
750	5423.8	5426.2	Riffle Crest
900	5420.5	5425.9	Max Pool Depth
950	5423.4	5425.8	Riffle Crest
1100	5420	5425.3	Max Pool Depth
1200	5422.7	5425.1	Riffle Crest
1450	5419	5424.5	Max Pool Depth
1550	5421.8	5424.2	Riffle Crest
1700	5418.5	5423.9	Max Pool Depth
1850	5421	5423.4	Riffle Crest



DATUM: North American Datum 1983  
PROJECTION: Montana State Plane  
UNIT: US Foot  
DATA SOURCES:  
USDA NAIP Imagery, 2017

MAIN CHANNEL RELOCATION 2  
GRADING and HABITAT UNITS

RUBY RIVER RVHA RESTORATION PROJECT  
MADISON COUNTY, MONTANA

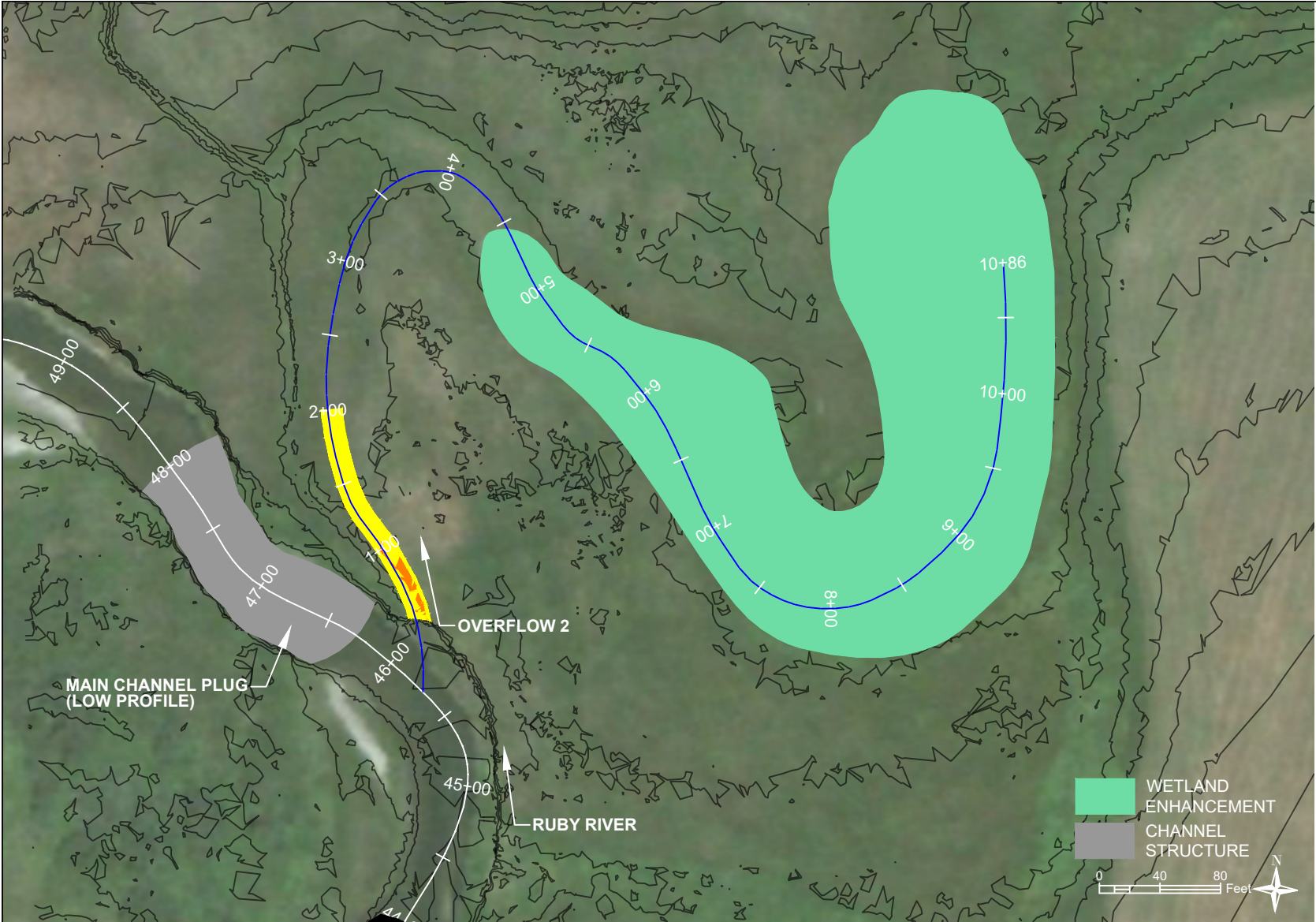
DRAWN BY: J. Wallace  
DESIGNED BY: Geum, AGI, Gillilan  
DATE: April 2021

SHEET

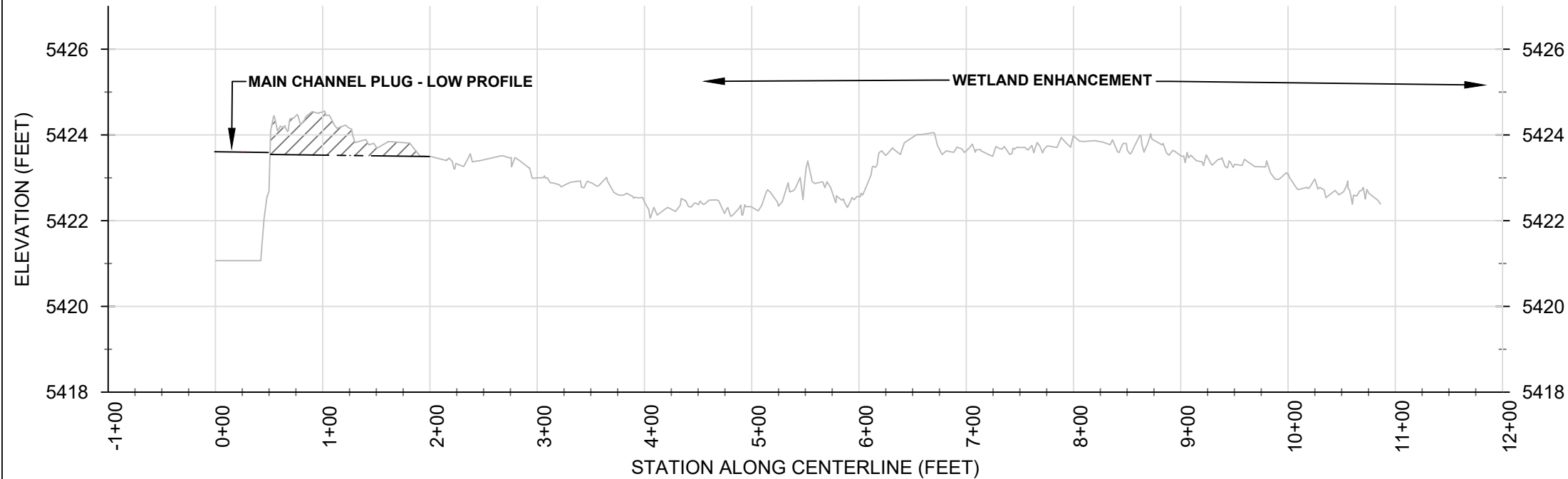
4.51





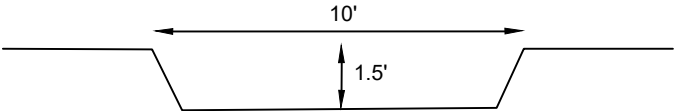


OVERFLOW 2 - PROFILE VIEW



ACTIVATION CHANNEL DETAILS	
MAIN CHANNEL START STATION	45+73
MAIN CHANNEL END STATION	N/A
ACTIVATED CHANNEL LENGTH (FT)	865
CONSTRUCTED CHANNEL (FT)	150
TARGET INLET ELEVATION (FT)	5423.5
TARGET OUTLET ELEVATION (FT)	N/A
ACTIVATION STAGE ABOVE BED (FT)	N/A
ACTIVATION Q (CFS)	N/A
DAYS PER YEAR ACTIVATED	N/A
SLOPE	0.11%
MAIN CHANNEL PLUG LOW PROFILE ELEVATION	5423.6

OVERFLOW 2  
TYPICAL CROSS SECTION



CUT/FILL		
COLOR	MIN. ELEVATION	MAX. ELEVATION
	-5.00	-4.00
	-4.00	-3.00
	-3.00	-2.00
	-2.00	-1.00
	-1.00	0.00
	0.00	1.00

ESTIMATED EARTHWORK VOLUMES FOR CONSTRUCTED CHANNEL	
CUT (CY)	35
FILL (CY)	0

LEGEND

- EXISTING GROUND
- DESIGN THALWEG
- CHANNEL STRUCTURE
- EXCAVATION



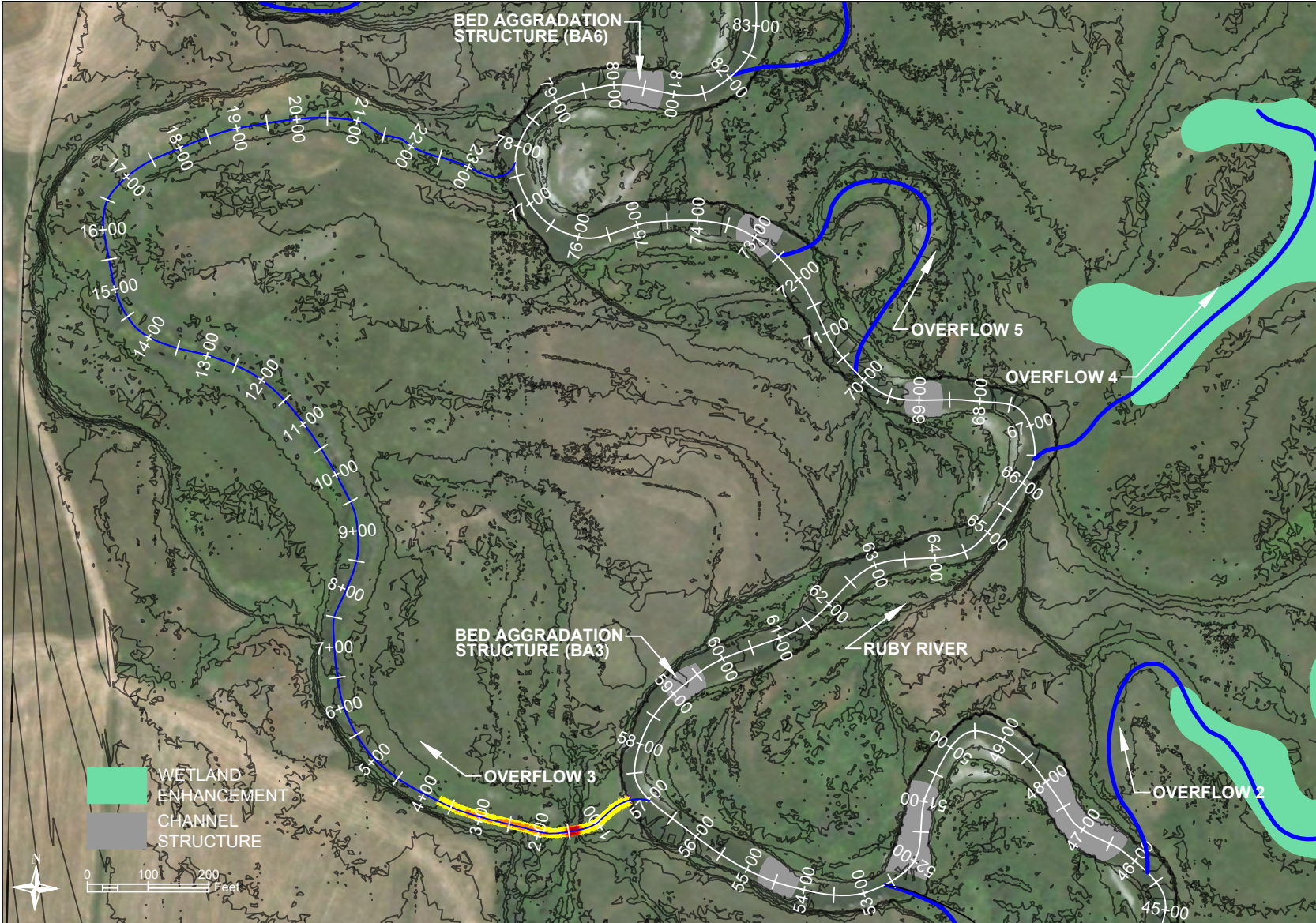
DATUM: North American Datum 1983  
PROJECTION: Montana State Plane  
UNITS: US Foot  
DATA SOURCES: Digital Globe Imagery

ACTIVATION CHANNEL  
OVERFLOW 2 DETAILS

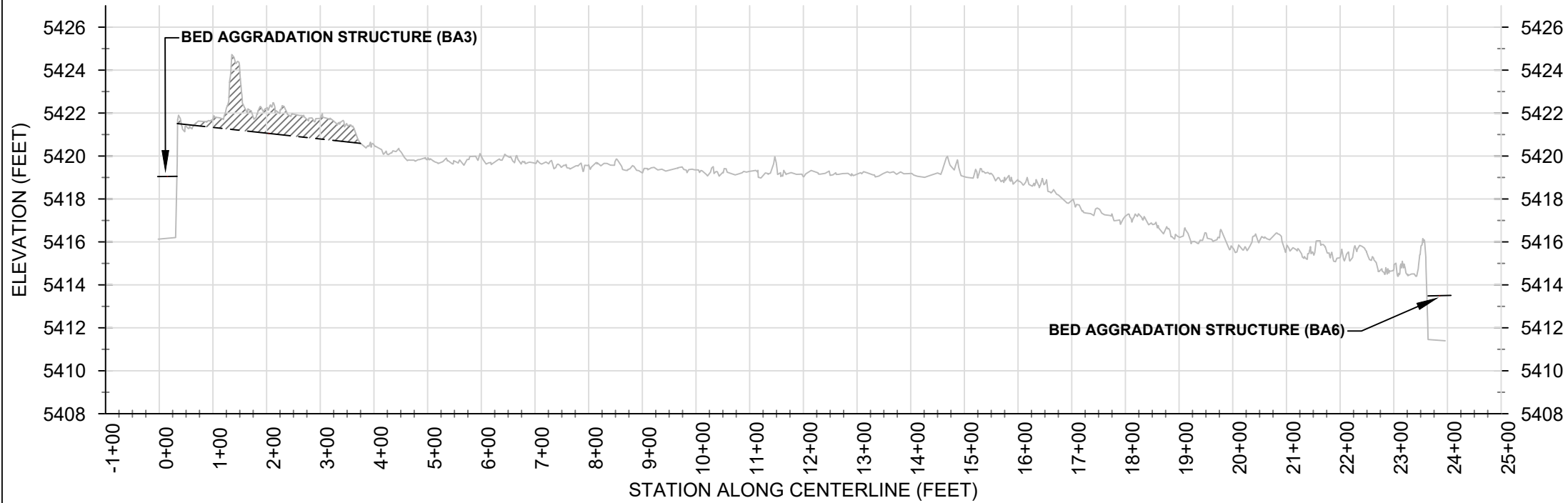
RUBY RIVER RVHA RESTORATION PROJECT  
MADISON COUNTY, MONTANA

DRAWN BY: A.Gulley  
DESIGNED BY: Geum, AGI, Gillian  
DATE: April 2021

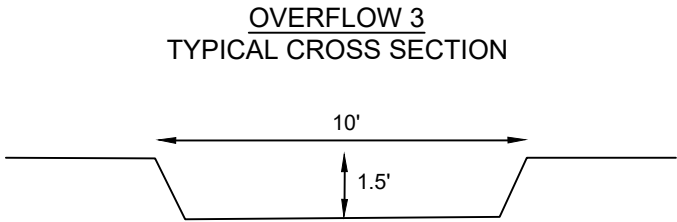




OVERFLOW 3 - PROFILE VIEW



Activation Channel Details	
Main Channel Start Station	56+98
Main Channel End Station	77+75
Activated Channel Length (ft)	1985
Constructed Channel Length (ft)	340
Target Inlet Elevation (ft)	5421.5
Target Outlet Elevation (ft)	N/A
Activation Stage Above Bed (ft)	2.5
Activation Q (cfs)	670
Days per Year Activated	11
Slope	0.31%
Bed Aggradation Structure BA3 Elevation	5419.0
Bed Aggradation Structure BA6 Elevation	5413.5



Cut/Fill		
Color	Min. Elevation	Max. Elevation
	-5.00	-4.00
	-4.00	-3.00
	-3.00	-2.00
	-2.00	-1.00
	-1.00	0.00
	0.00	1.00

Estimated Earthwork Volumes for Constructed Channel	
Cut (CY)	140
Fill (CY)	0

Legend	
	Existing Ground
	Design Thalweg
	Channel Structure
	Excavation



Datum: North American Datum 1983  
Projection: Montana State Plane  
Units: US Foot  
Data Sources: Digital Globe Imagery

Activation Channel  
Overflow 3 Details

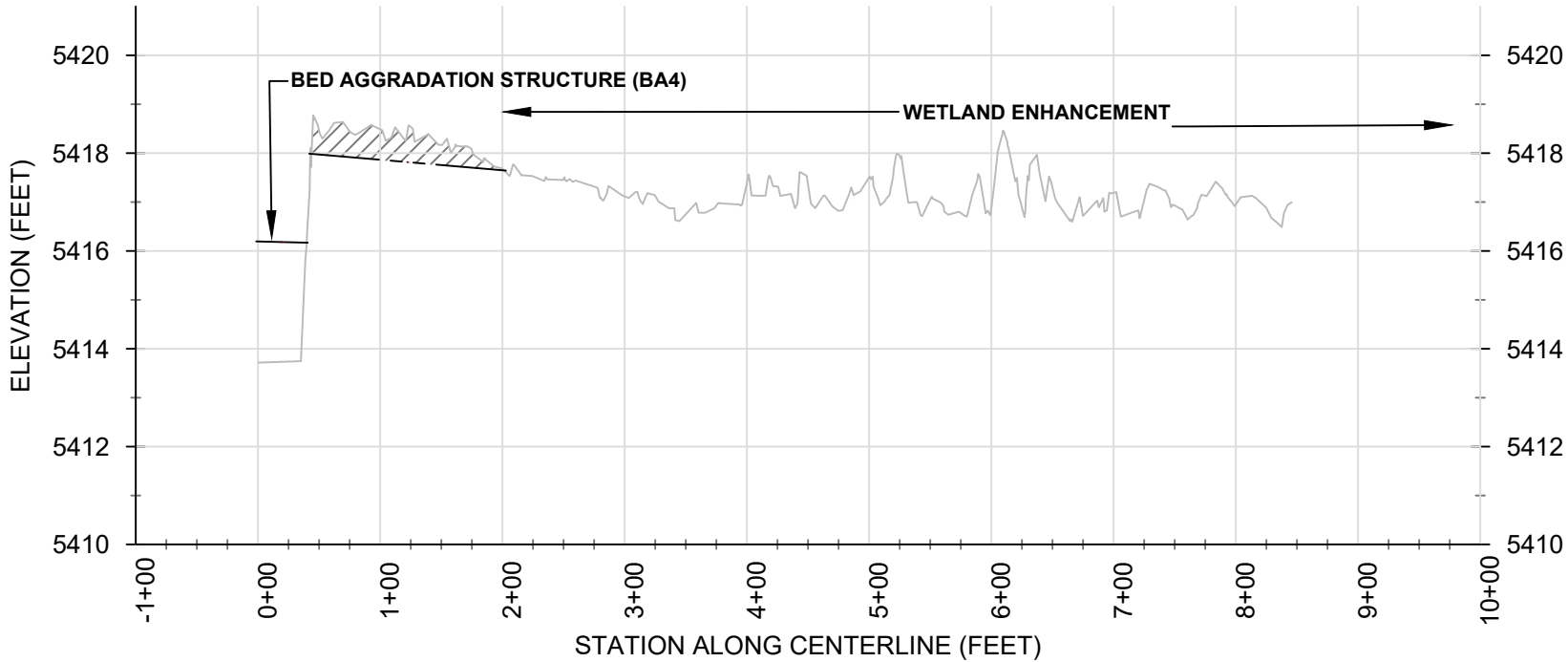
Ruby River RVHA Restoration Project  
Madison County, Montana

Drawn by: A. Gulley  
Designed by: Geum, AGI, Gillilan  
Date: April 2021

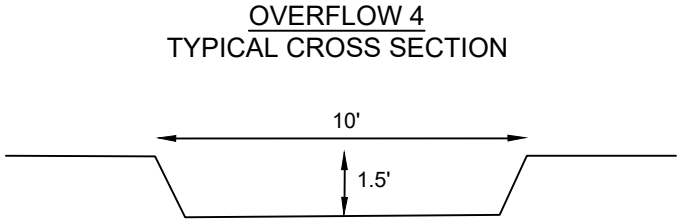




OVERFLOW 4 - PROFILE VIEW



Activation Channel Details	
Main Channel Start Station	66+46
Main Channel End Station	N/A
Activated Channel Length (ft)	645
Constructed Channel Length (ft)	160
Target Inlet Elevation (ft)	5418.0
Target Outlet Elevation (ft)	N/A
Activation Stage Above Bed (ft)	2.0
Activation Q (cfs)	340
Days per Year Activated	37
Slope	0.15%
Bed Aggradation Structure BA4 Elevation	5416.2



Cut/Fill		
Color	Min. Elevation	Max. Elevation
	-5.00	-4.00
	-4.00	-3.00
	-3.00	-2.00
	-2.00	-1.00
	-1.00	0.00
	0.00	1.00

Estimated Earthwork Volumes for Constructed Channel	
Cut (CY)	25
Fill (CY)	0

- Legend**
- EXISTING GROUND
  - DESIGN THALWEG
  - CHANNEL STRUCTURE
  - EXCAVATION



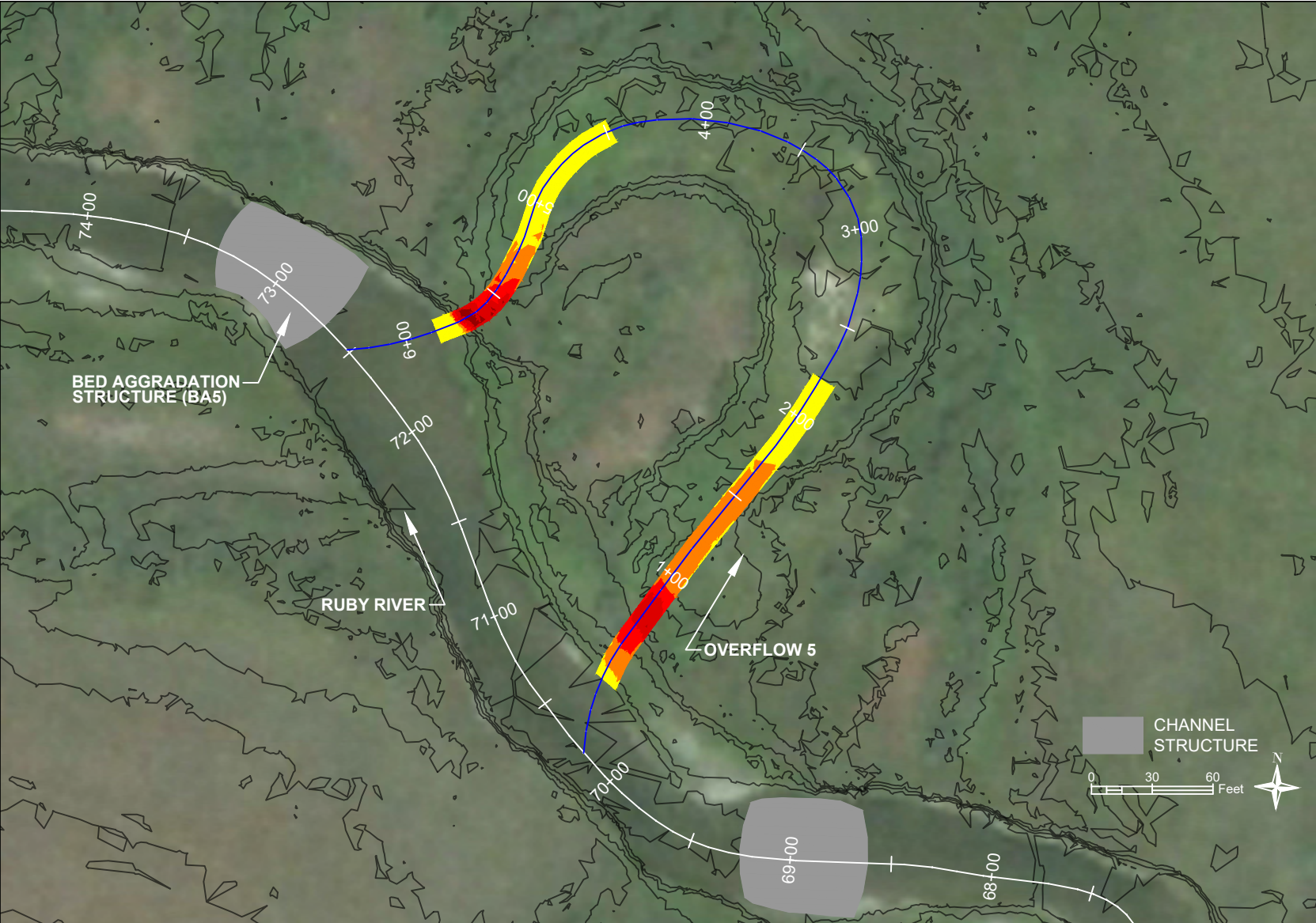
DATUM: North American Datum 1983  
PROJECTION: Montana State Plane  
UNITS: US Foot  
DATA SOURCES: Digital Globe Imagery

ACTIVATION CHANNEL  
OVERFLOW 4 DETAILS

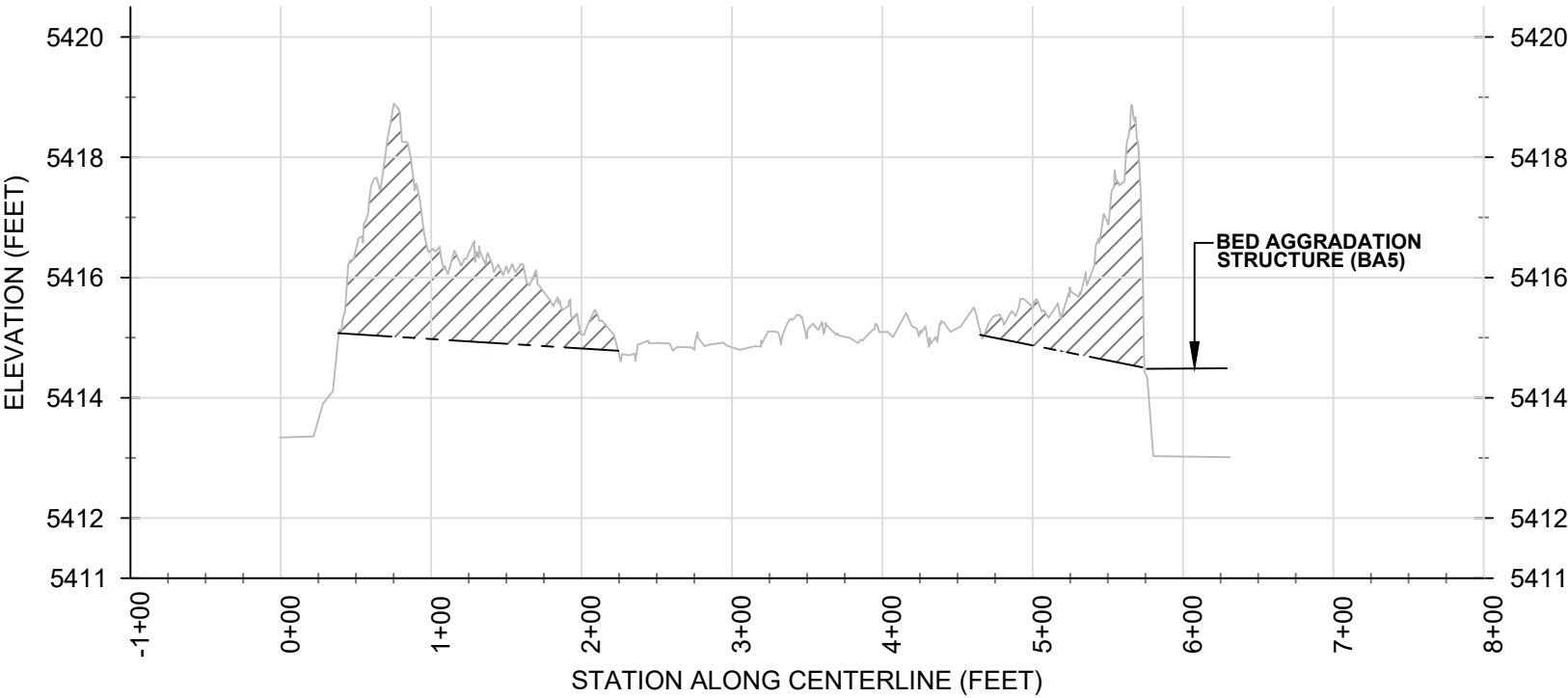
RUBY RIVER RVHA RESTORATION PROJECT  
MADISON COUNTY, MONTANA

DRAWN BY: A.Gulley  
DESIGNED BY: Geum, AGI, Gillian  
DATE: April 2021

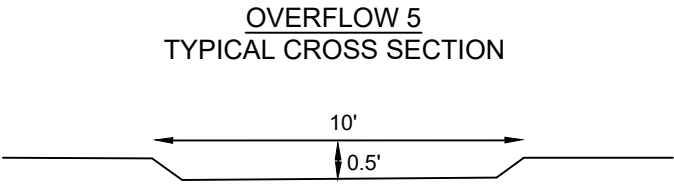




OVERFLOW 5 - PROFILE VIEW



ACTIVATION CHANNEL DETAILS	
MAIN CHANNEL START STATION	70+22
MAIN CHANNEL END STATION	72+54
ACTIVATED CHANNEL LENGTH (FT)	240
CONSTRUCTED CHANNEL LENGTH (FT)	295
TARGET INLET ELEVATION (FT)	5415.0
TARGET OUTLET ELEVATION (FT)	5414.5
ACTIVATION STAGE ABOVE BED (FT)	0.8
ACTIVATION Q (CFS)	80
DAYS PER YEAR ACTIVATED	354
SLOPE	0.08%
BED AGGRADATION STRUCTURE BA5 ELEVATION	5414.6



CUT/FILL		
COLOR	MIN. ELEVATION	MAX. ELEVATION
	-5.00	-4.00
	-4.00	-3.00
	-3.00	-2.00
	-2.00	-1.00
	-1.00	0.00
	0.00	1.00

ESTIMATED EARTHWORK VOLUMES FOR CONSTRUCTED CHANNEL	
CUT (CY)	190
FILL (CY)	0

- LEGEND
- EXISTING GROUND
  - DESIGN THALWEG
  - CHANNEL STRUCTURE
  - EXCAVATION



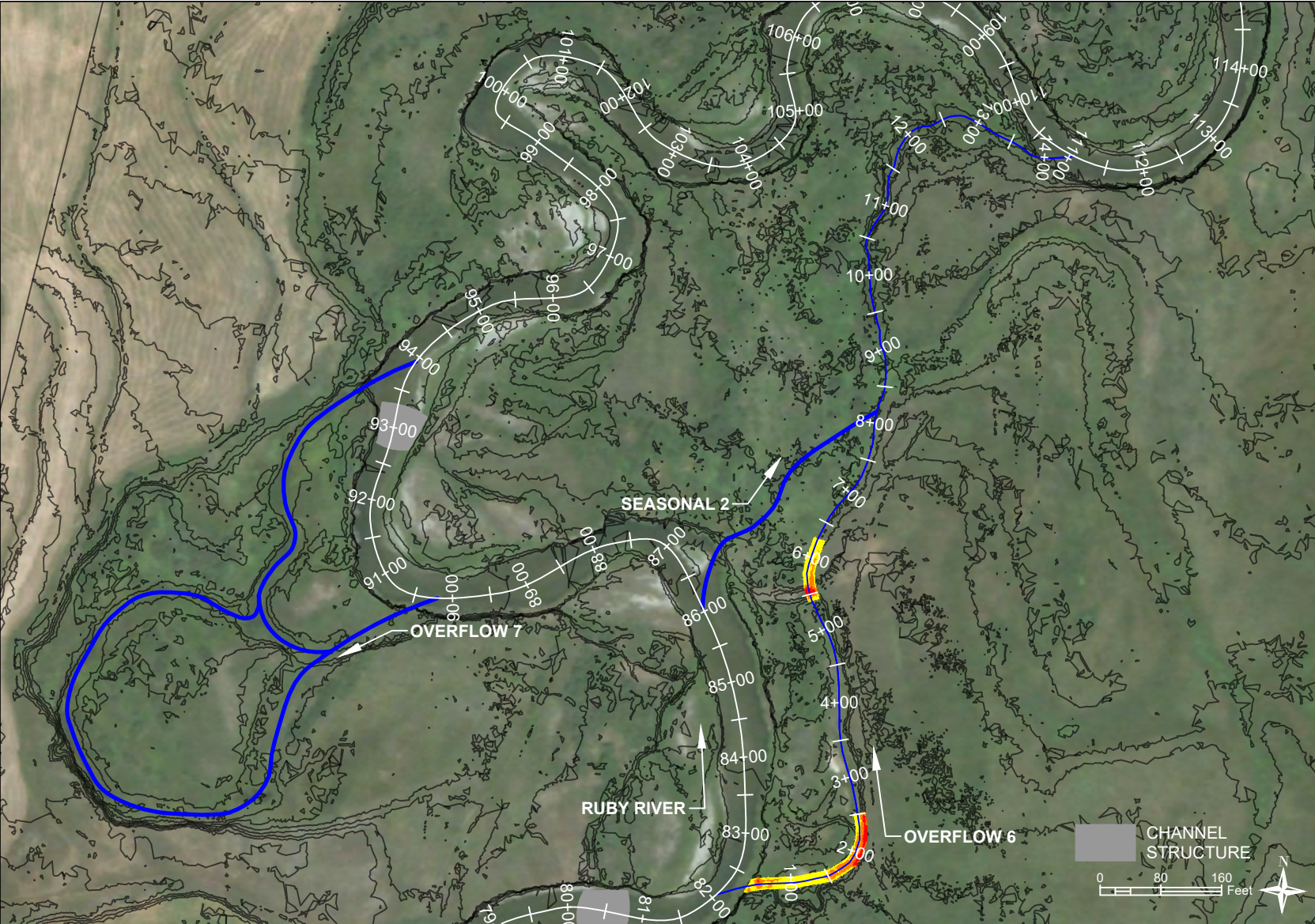
DATUM: North American Datum 1983  
PROJECTION: Montana State Plane  
UNITS: US Foot  
DATA SOURCES: Digital Globe Imagery

ACTIVATION CHANNEL  
OVERFLOW 5 DETAILS

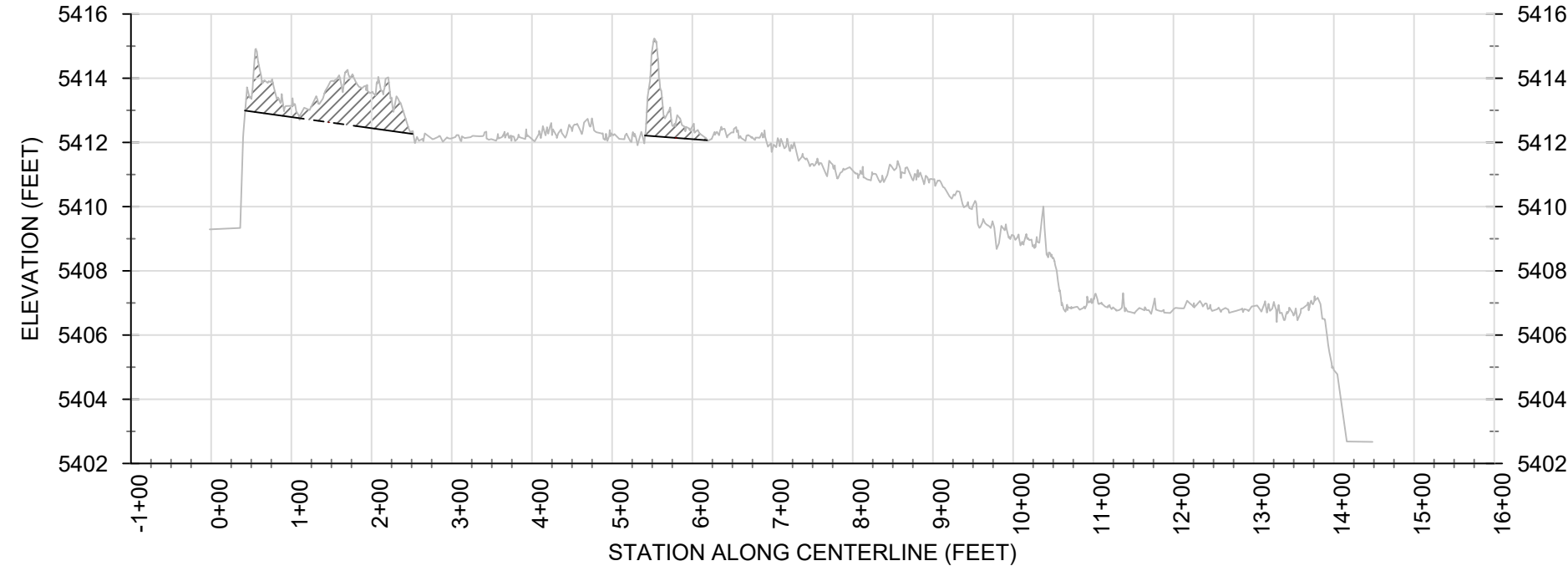
RUBY RIVER RVHA RESTORATION PROJECT  
MADISON COUNTY, MONTANA

DRAWN BY: A.Gulley  
DESIGNED BY: Geum, AGI, Gillian  
DATE: April 2021

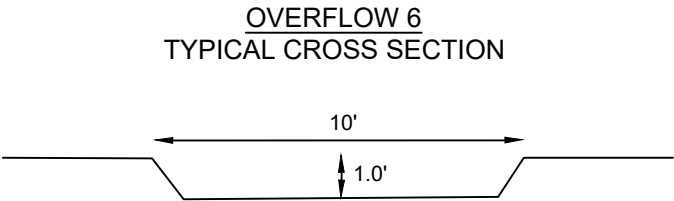




OVERFLOW 6 - PROFILE VIEW



ACTIVATION CHANNEL DETAILS	
MAIN CHANNEL START STATION	82+10
MAIN CHANNEL END STATION	111+08
ACTIVATED CHANNEL LENGTH (FT)	1050
CONSTRUCTED CHANNEL LENGTH (FT)	285
TARGET INLET ELEVATION (FT)	5413.0
TARGET OUTLET ELEVATION (FT)	N/A
ACTIVATION STAGE ABOVE BED (FT)	1.8
ACTIVATION Q (CFS)	390
DAYS PER YEAR ACTIVATED	35
SLOPE	0.42%



CUT/FILL		
COLOR	MIN. ELEVATION	MAX. ELEVATION
	-5.00	-4.00
	-4.00	-3.00
	-3.00	-2.00
	-2.00	-1.00
	-1.00	0.00
	0.00	1.00

ESTIMATED EARTHWORK VOLUMES FOR CONSTRUCTED CHANNEL	
CUT (CY)	140
FILL (CY)	0

- LEGEND**
- EXISTING GROUND
  - DESIGN THALWEG
  - CHANNEL STRUCTURE
  - EXCAVATION



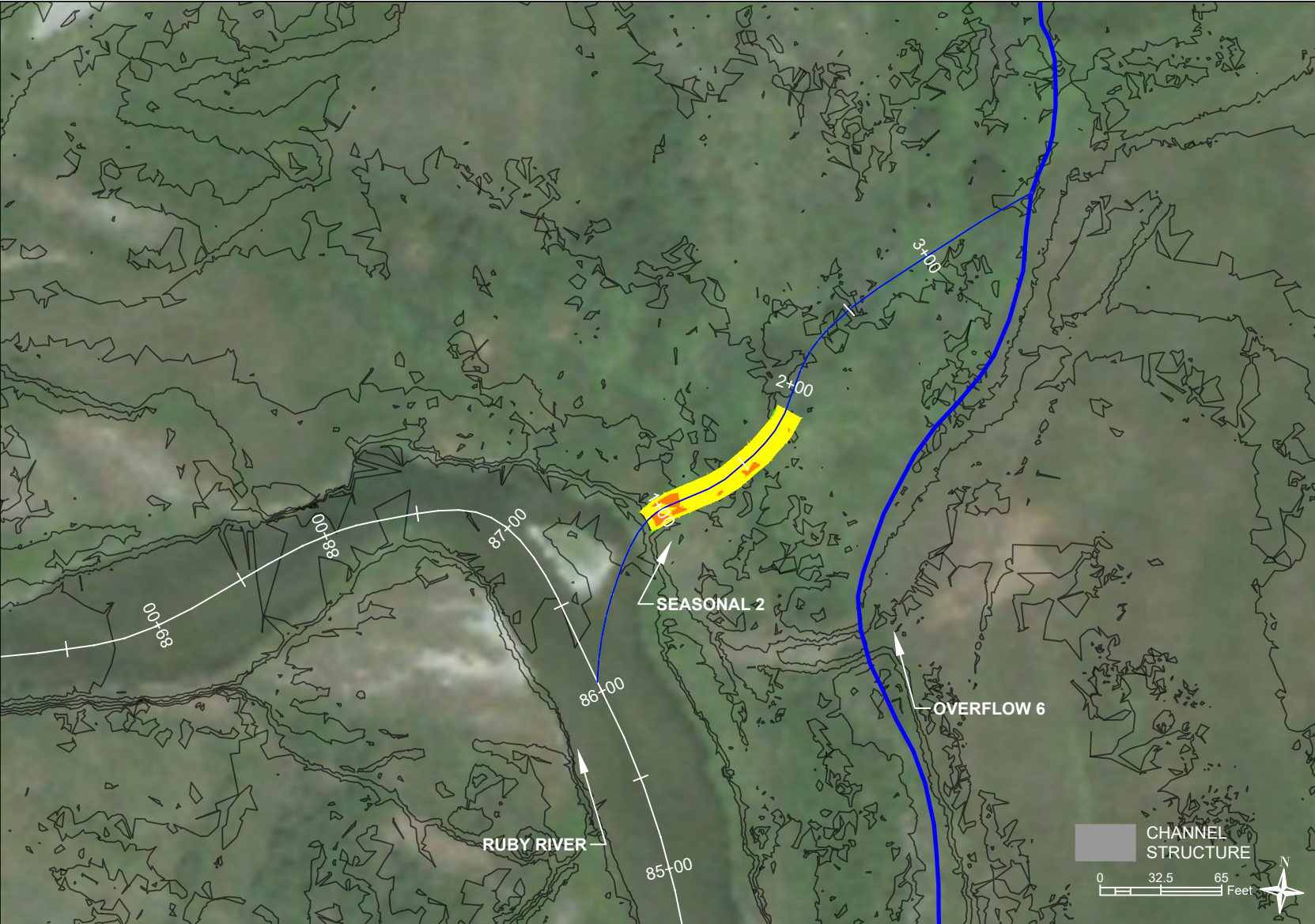
DATUM: North American Datum 1983  
PROJECTION: Montana State Plane  
UNITS: US Foot  
DATA SOURCES: Digital Globe Imagery

ACTIVATION CHANNEL  
OVERFLOW 6 DETAILS

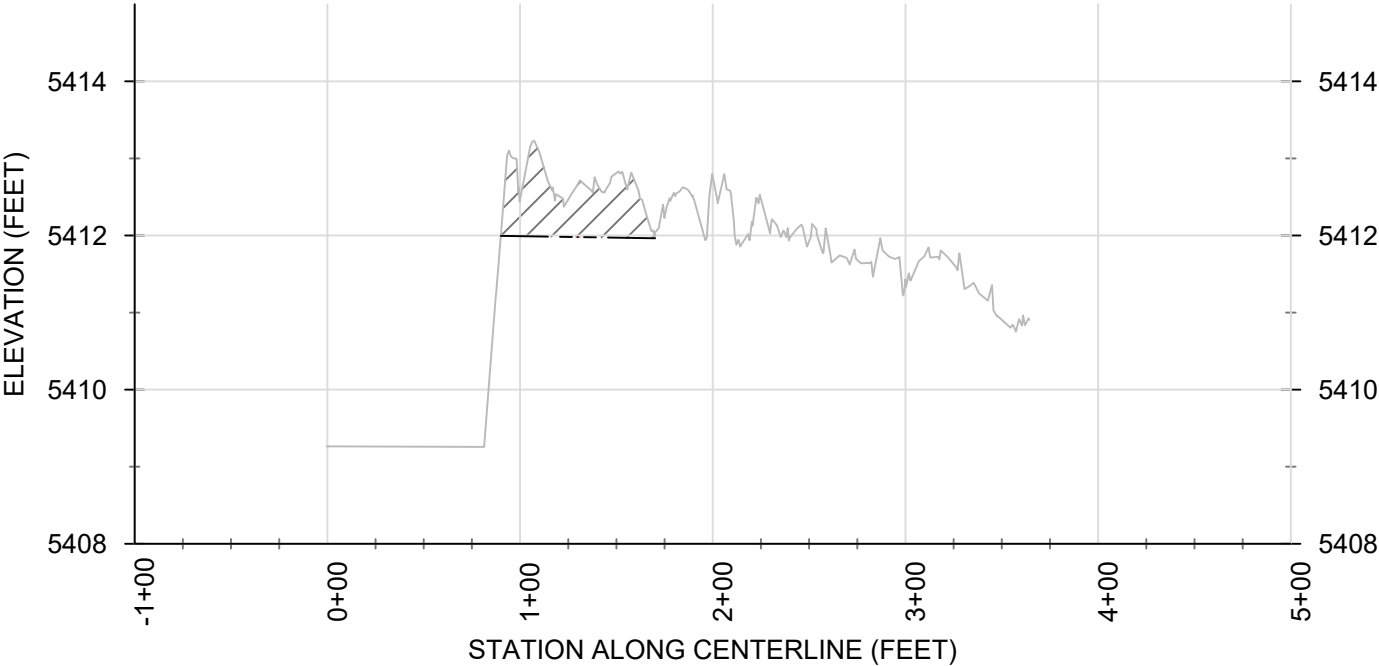
RUBY RIVER RVHA RESTORATION PROJECT  
MADISON COUNTY, MONTANA

DRAWN BY: A.Gulley  
DESIGNED BY: Geum, AGI, Gillilan  
DATE: April 2021



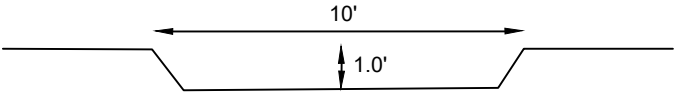


SEASONAL 2 - PROFILE VIEW



ACTIVATION CHANNEL DETAILS	
MAIN CHANNEL START STATION	86+08
MAIN CHANNEL END STATION	N/A
ACTIVATED CHANNEL LENGTH (FT)	105
CONSTRUCTED CHANNEL LENGTH (FT)	75
TARGET INLET ELEVATION (FT)	5412.0
TARGET OUTLET ELEVATION (FT)	N/A
ACTIVATION STAGE ABOVE BED (FT)	2.0
ACTIVATION Q (CFS)	470
DAYS PER YEAR ACTIVATED	26
SLOPE	0.40%

SEASONAL 2  
TYPICAL CROSS SECTION



CUT/FILL		
COLOR	MIN. ELEVATION	MAX. ELEVATION
	-5.00	-4.00
	-4.00	-3.00
	-3.00	-2.00
	-2.00	-1.00
	-1.00	0.00
	0.00	1.00

ESTIMATED EARTHWORK VOLUMES FOR CONSTRUCTED CHANNEL	
CUT (CY)	30
FILL (CY)	0

LEGEND

- EXISTING GROUND
- DESIGN THALWEG
- CHANNEL STRUCTURE
- EXCAVATION



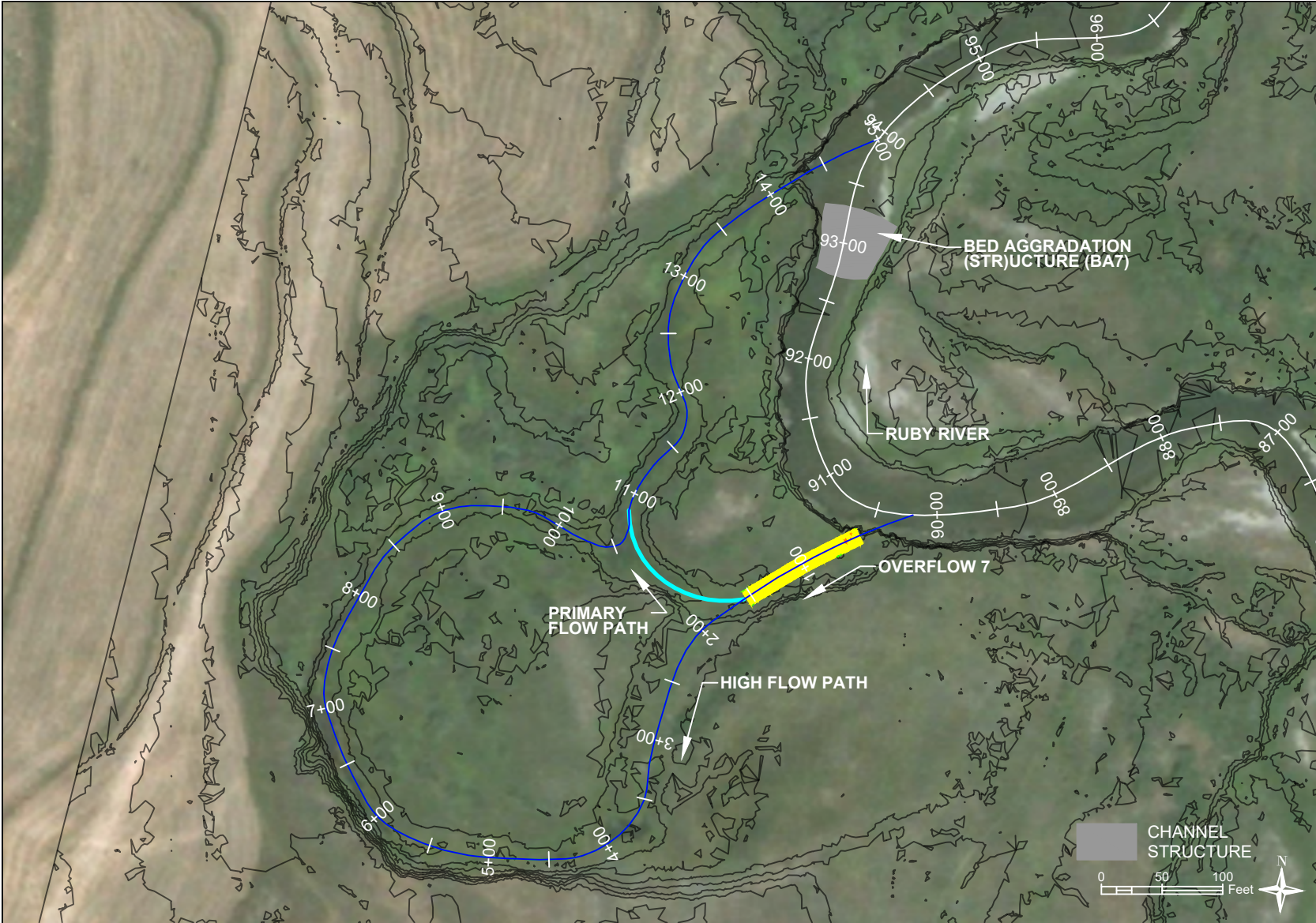
DATUM: North American Datum 1983  
PROJECTION: Montana State Plane  
UNITS: US Foot  
DATA SOURCES: Digital Globe Imagery

ACTIVATION CHANNEL  
SEASONAL 2 DETAILS

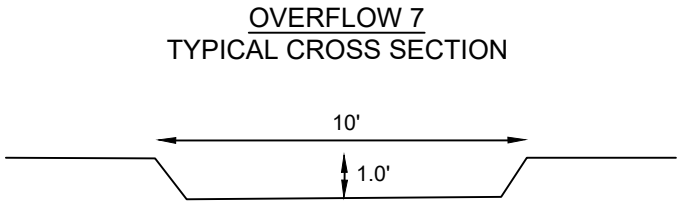
RUBY RIVER RVHA RESTORATION PROJECT  
MADISON COUNTY, MONTANA

DRAWN BY: A.Gulley  
DESIGNED BY: Geum, AGI, Gillian  
DATE: April 2021

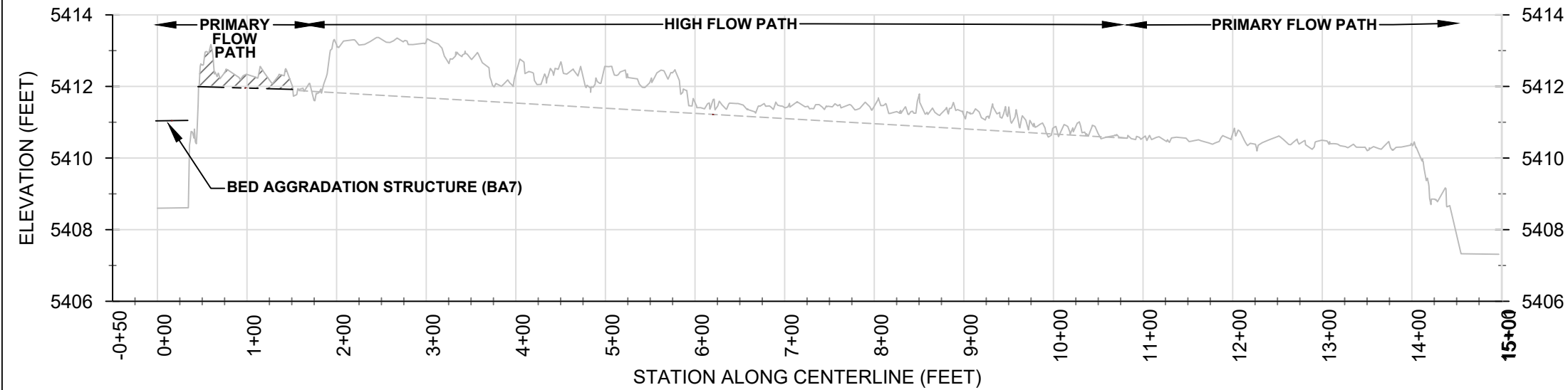




ACTIVATION CHANNEL DETAILS	
MAIN CHANNEL START STATION	90+23
MAIN CHANNEL END STATION	93+95
ACTIVATED CHANNEL LENGTH (FT)	1290
CONSTRUCTED CHANNEL LENGTH (FT)	105
TARGET INLET ELEVATION (FT)	5412.0
TARGET OUTLET ELEVATION (FT)	N/A
ACTIVATION STAGE ABOVE BED (FT)	2.0
ACTIVATION Q (CFS)	330
DAYS PER YEAR ACTIVATED	37
SLOPE	0.13%
BED AGGRADATION STRUCTURE BA7 ELEVATION	5411.0



OVERFLOW 7 - PROFILE VIEW



CUT/FILL		
COLOR	MIN. ELEVATION	MAX. ELEVATION
	-5.00	-4.00
	-4.00	-3.00
	-3.00	-2.00
	-2.00	-1.00
	-1.00	0.00
	0.00	1.00

ESTIMATED EARTHWORK VOLUMES FOR CONSTRUCTED CHANNEL	
CUT (CY)	20
FILL (CY)	0

- LEGEND
- EXISTING GROUND
  - DESIGN THALWEG
  - CHANNEL STRUCTURE
  - EXCAVATION



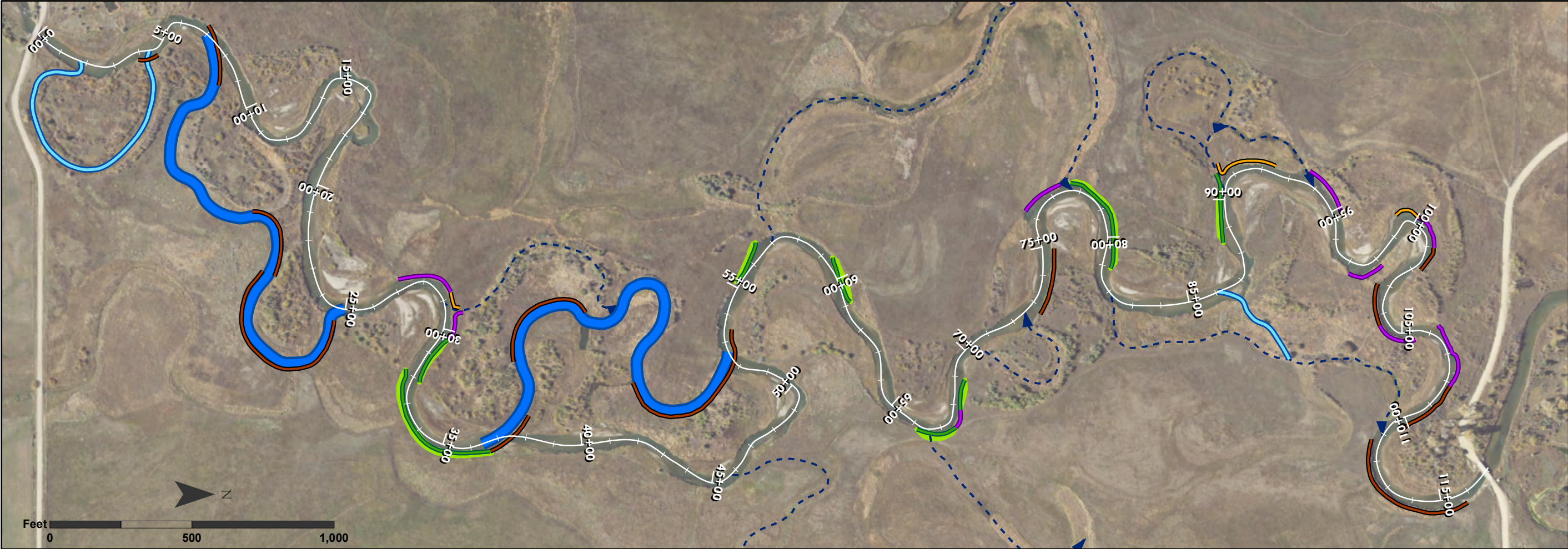
DATUM: North American Datum 1983  
PROJECTION: Montana State Plane  
UNITS: US Foot  
DATA SOURCES: Digital Globe Imagery

ACTIVATION CHANNEL  
OVERFLOW 7 DETAILS

RUBY RIVER RVHA RESTORATION PROJECT  
MADISON COUNTY, MONTANA

DRAWN BY: A.Gulley  
DESIGNED BY: Geum, AGI, Gillilan  
DATE: April 2021





DESIGN BANK TREATMENTS

- BRUSH MATRIX W/ INSET FLOODPLAIN BANK TREATMENT
- BRUSH MATRIX BANK TREATMENT - TYPE 1
- BRUSH MATRIX BANK TREATMENT - TYPE 2
- BRUSH MATRIX BANK TREATMENT - TYPE 3
- INSET FLOODPLAIN

CHANNEL ACTIVATIONS

- MAIN CHANNEL RELOCATION
- SEASONAL CHANNEL
- OVERFLOW CHANNEL

**\*NOTE:**  
TABLE DOES NOT INCLUDE  
STREAMBANK TREATMENTS  
FOR MAIN CHANNEL RELOCATIONS

Structure Type	Type	Bank	Station Start	TOB Design	Station End	TOB Design	Length	Inset FP Area (sq ft)
WBM	3	RB	390	5435.00	463	5435.00	73	
WBM	2	LB	2717	5428.80	2880	5428.20	210	
WBM	1	LB	2880	5428.20	2930	5428.00	70	
WBM	2	LB	2950	5428.00	3020	5427.80	120	
WBM	Inset floodplain	LB	3020	5427.80	3210	5427.60	187	1190
WBM	Inset floodplain	RB	3180	5427.70	3560	5426.80	522	5544
WBM	Inset floodplain	LB	5520	5420.80	5670	5420.50	159	1563
WBM	Inset floodplain	LB	5928	5420.00	6085	5419.60	168	2308
WBM	Inset floodplain	RB	6620	5417.80	6730	5417.40	145	1862
WBM	2	RB	6730	5417.40	6785	5417.30	65	
WBM	Inset floodplain	RB	6785	5417.30	6890	5417.10	109	1053
WBM	3	RB	7270	5416.50	7490	5415.90	240	
WBM	2	LB	7615	5415.00	7750	5414.70	155	
WBM	Inset floodplain	LB	7770	5414.70	8110	5413.90	380	3450
WBM	Inset floodplain	LB	8850	5412.50	9050	5412.00	247	1840
WBM	1	LB	9070	5412.00	9250	5411.50	247	
WBM	2	LB	9360	5411.00	9515	5410.60	185	
WBM	2	RB	9700	5410.00	9800	5409.50	134	
WBM	1	LB	9960	5409.50	10005	5409.30	97	
WBM	2	LB	10005	5409.30	10105	5409.10	92	
WBM	3	LB	10105	5409.10	10185	5408.80	125	
WBM	3	RB	10300	5408.50	10430	5408.20	152	
WBM	2	RB	10430	5408.20	10545	5407.90	147	
WBM	2	LB	10610	5408.50	10815	5408.00	243	
WBM	3	LB	10815	5408.00	11035	5407.50	233	
WBM	3	RB	11135	5407.50	11585	5406.50	530	



DATUM: North American Datum 1983  
PROJECTION: Montana State Plane  
UNIT: US Foot  
DATA SOURCES:  
USDA NAIP Imagery, 2017

STREAMBANK TREATMENT & INSET  
FLOODPLAIN DESIGN ELEVATIONS

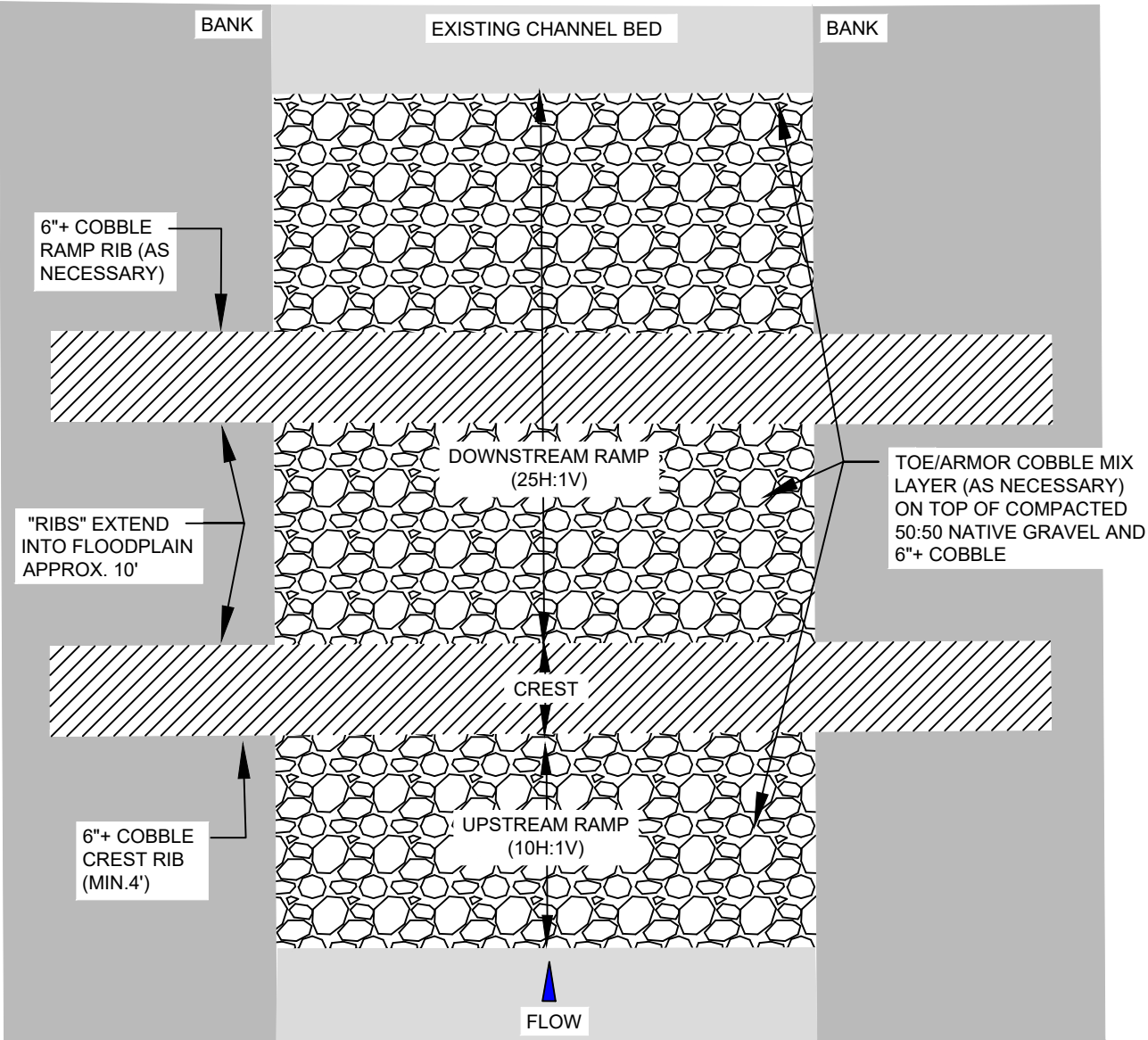
RUBY RIVER RVHA RESTORATION PROJECT  
MADISON COUNTY, MONTANA

DRAWN BY: J. Wallace  
DESIGNED BY: Geum, AGI, Gillian  
DATE: April 2021

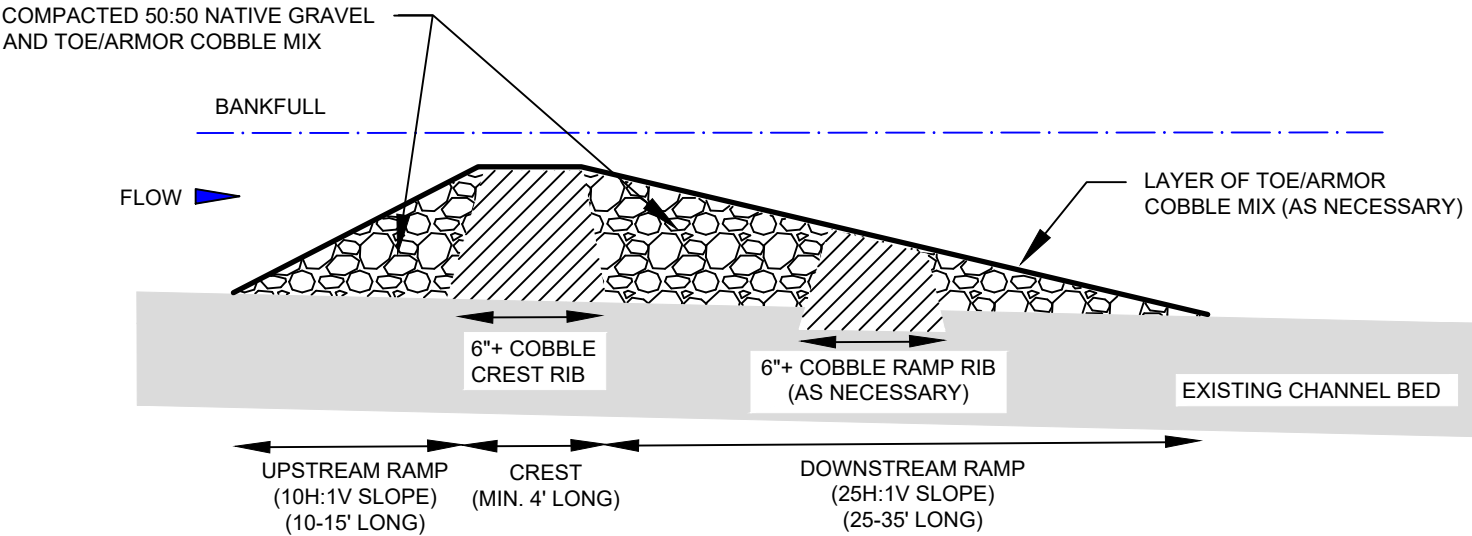
SHEET  
4.13



BED AGGRADATION STRUCTURE  
PLAN VIEW



BED AGGRADATION STRUCTURE  
PROFILE VIEW



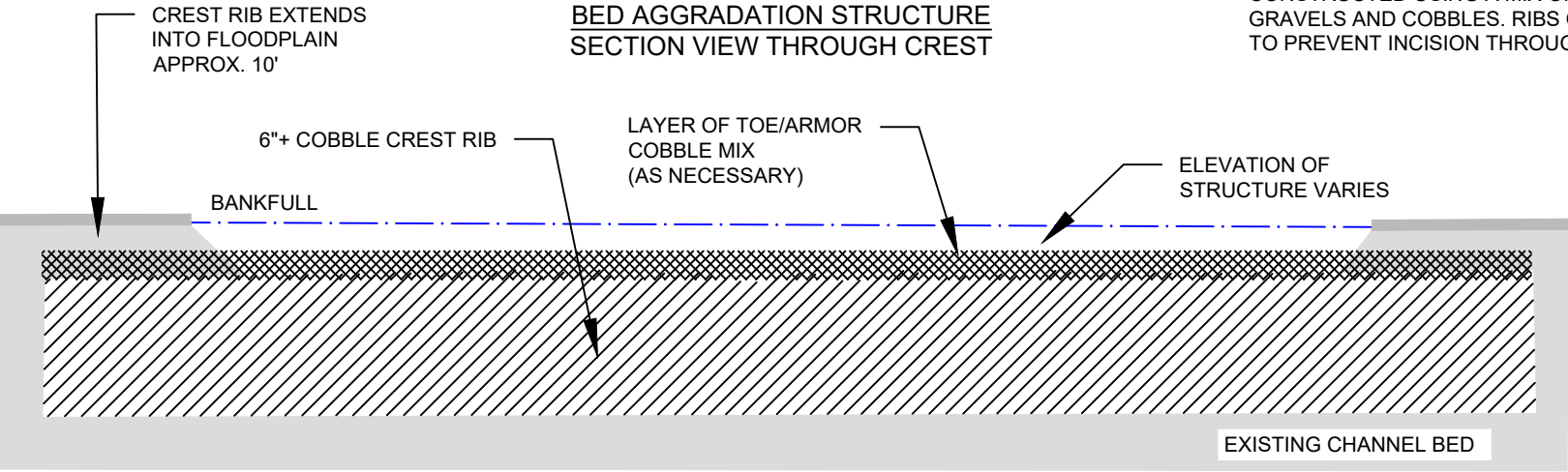
6"+ COBBLE ROCK GRADATION		
SIZE (INCHES)	PERCENT PASSING	SIZE CLASS
9	100	
6	80-100	
3	55-80	D84
2	35-55	D50
1	20-35	
0.5	0-20	D16

MATERIAL SCHEDULE PER STRUCTURE			
ITEM	DIMENSION	UNIT	QUANTITY
6"+ COBBLE	AREA (SF)	CY	VARIABLES BY STRUCTURE
TOE/ARMOR COBBLE MIX	AREA (SF)	CY	VARIABLES BY STRUCTURE
NATIVE GRAVEL	AREA (SF)	CY	VARIABLES BY STRUCTURE

**WORK DESCRIPTION**  
THIS WORK INCLUDES CONSTRUCTION OF BED AGGRADATION STRUCTURES AT THE LOCATIONS SHOWN ON SHEET 3.0. THE INTENT OF THIS STRUCTURE IS TO LOCALLY RAISE THE BED ELEVATION TO CREATE A BACKWATER THAT WILL ACTIVATE SEASONAL AND OVERFLOW CHANNELS DURING VARIOUS FLOW DISCHARGES TO PASSIVELY INCREASE FLOODPLAIN RECONNECTION. THE BACKWATER DEPTH AND EXTENT VARIES FOR EACH STRUCTURE. THE BED UPSTREAM OF EACH STRUCTURE IS EXPECTED TO AGGRADE OVER TIME. STRUCTURES ARE CONSTRUCTED USING A MIX OF COMPACTED NATIVE AND IMPORTED GRAVELS AND COBBLES. RIBS OF 6" OR LARGER COBBLE ARE INSTALLED TO PREVENT INCISION THROUGH THE STRUCTURE.

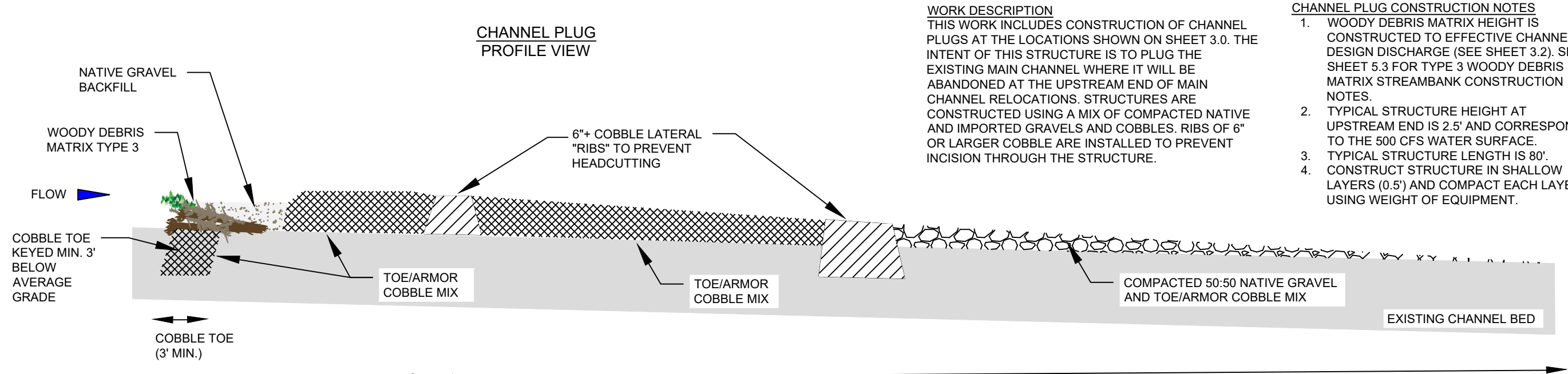
- BED AGGRADATION STRUCTURE CONSTRUCTION NOTES**
1. UPSTREAM RAMP SLOPE WILL VARY DEPENDING ON DESIRED BED MORPHOLOGY.
  2. AS-BUILT THE STRUCTURE WILL APPEAR AS A NATURAL RIFFLE.
  3. TYPICAL STRUCTURE HEIGHT IS 1' TO 1.5'.
  4. TYPICAL STRUCTURE LENGTH IS 40' TO 60'.
  5. CONSTRUCT STRUCTURE ON EXISTING CHANNEL BED.
  6. CONSTRUCT STRUCTURE IN SHALLOW LAYERS (0.5') AND COMPACT EACH LAYER.

BED AGGRADATION STRUCTURE  
SECTION VIEW THROUGH CREST



EXAMPLE OF BED AGGRADATION STRUCTURE





**WORK DESCRIPTION**  
THIS WORK INCLUDES CONSTRUCTION OF CHANNEL PLUGS AT THE LOCATIONS SHOWN ON SHEET 3.0. THE INTENT OF THIS STRUCTURE IS TO PLUG THE EXISTING MAIN CHANNEL WHERE IT WILL BE ABANDONED AT THE UPSTREAM END OF MAIN CHANNEL RELOCATIONS. STRUCTURES ARE CONSTRUCTED USING A MIX OF COMPACTED NATIVE AND IMPORTED GRAVELS AND COBBLES. RIBS OF 6" OR LARGER COBBLE ARE INSTALLED TO PREVENT INCISION THROUGH THE STRUCTURE.

- CHANNEL PLUG CONSTRUCTION NOTES**
1. WOODY DEBRIS MATRIX HEIGHT IS CONSTRUCTED TO EFFECTIVE CHANNEL DESIGN DISCHARGE (SEE SHEET 3.2). SEE SHEET 5.3 FOR TYPE 3 WOODY DEBRIS MATRIX STREAMBANK CONSTRUCTION NOTES.
  2. TYPICAL STRUCTURE HEIGHT AT UPSTREAM END IS 2.5' AND CORRESPONDS TO THE 500 CFS WATER SURFACE.
  3. TYPICAL STRUCTURE LENGTH IS 80'.
  4. CONSTRUCT STRUCTURE IN SHALLOW LAYERS (0.5') AND COMPACT EACH LAYER USING WEIGHT OF EQUIPMENT.



**CHANNEL PLUG SECTION VIEW THROUGH CREST**

6"+ COBBLE ROCK GRADATION		
SIZE (INCHES)	PERCENT PASSING	SIZE CLASS
9	100	
6	80-100	
3	55-80	D84
2	35-55	D50
1	20-35	
0.5	0-20	D16

MATERIAL SCHEDULE PER STRUCTURE			
ITEM	DIMENSION	UNIT	QUANTITY
NATIVE GRAVEL	AREA (SF)	CY	VARIES BY STRUCTURE
6"+ COBBLE	AREA (SF)	CY	VARIES BY STRUCTURE
TOE/ARMOR COBBLE MIX	AREA (SF)	CY	VARIES BY STRUCTURE

\*SEE SHEET 5.3 FOR WOODY DEBRIS MATRIX MATERIAL SCHEDULE



EXAMPLE OF CHANNEL PLUG (PHOTO LOOKING UP PLUG FROM DOWNSTREAM RAMP DURING HIGH FLOWS)



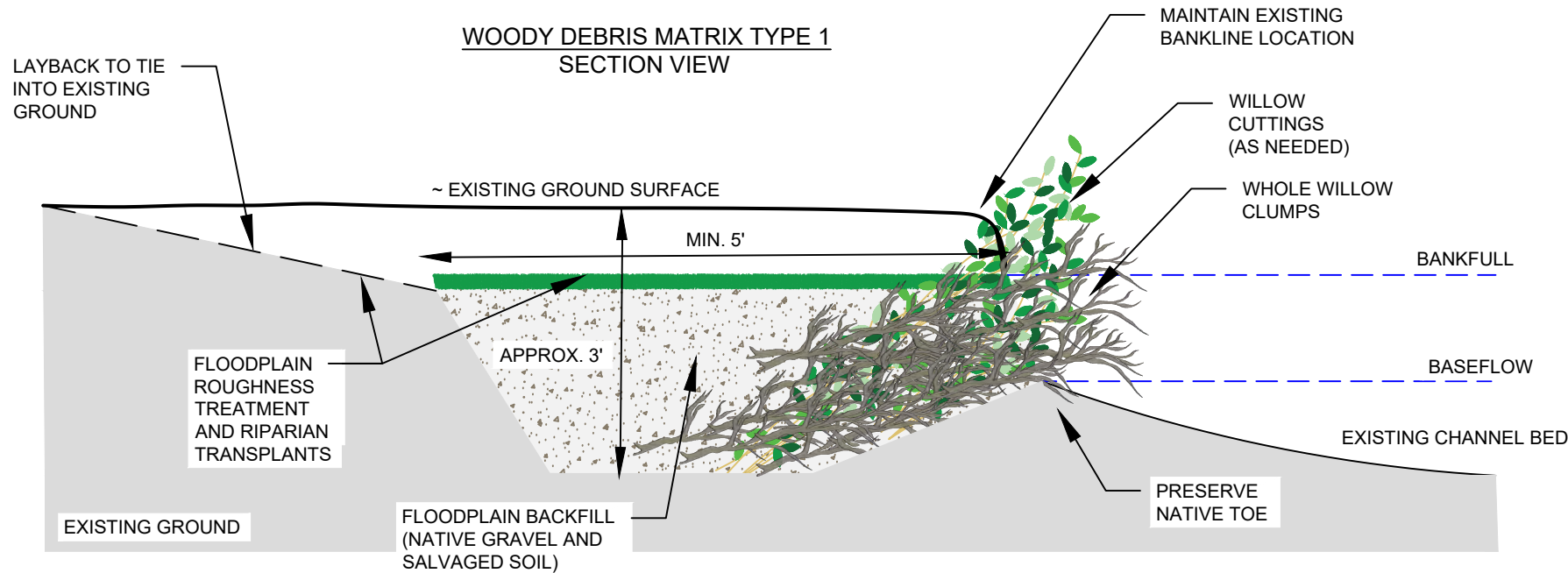
DATUM:  
PROJECTION:  
UNITS: US Feet  
DATA SOURCES:

MAIN CHANNEL PLUG DETAIL

RUBY RIVER RVHA RESTORATION PROJECT  
MADISON COUNTY, MONTANA

DRAWN BY: Alyssa Guley  
DESIGNED BY:  
DATE: April 2021





**MATERIAL SCHEDULE PER LINEAR FOOT**

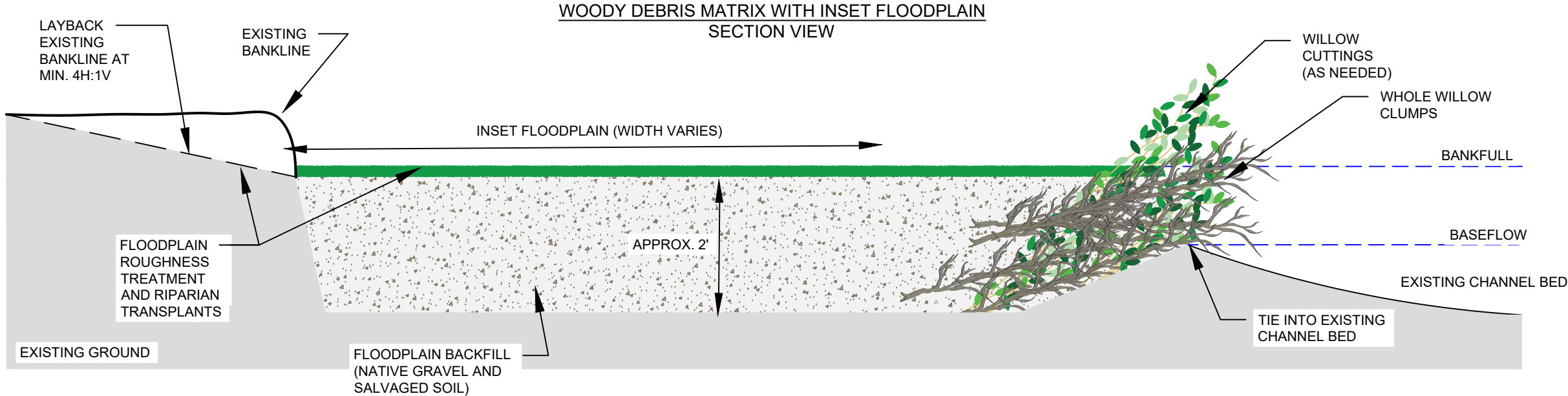
ITEM	DIMENSION	UNIT	QUANTITY
WHOLE WILLOW CLUMPS	10' MIN. HEIGHT W/ ROOTBALL	EA	0.2 (1 PER 8FT)
DORMANT WILLOW CUTTINGS	MIN. 1/2" D, 6-8' L	EA	3
RIPIARIAN SHRUB TRANSPLANTS (AS AVAILABLE)	VARIES	EA	0.2 (1 PER 8FT)
FLOODPLAIN BACKFILL (TYPE 1 WOODY DEBRIS MATRIX)	NATIVE	CY/LF	1.1
FLOODPLAIN BACKFILL (WOODY DEBRIS MATRIX WITH INSET FLOODPLAIN)	NATIVE	CY/LF	VARIES

**WORK DESCRIPTION**  
THIS WORK INCLUDES INSTALLATION OF TYPE 1 WOODY DEBRIS MATRIX STRUCTURES AND WOODY DEBRIS MATRIX WITH INSET FLOODPLAIN STRUCTURES. THESE STRUCTURES PRESERVE THE NATIVE STREAMBANK TOE. THE INTENT OF THESE STRUCTURES IS TO PROVIDE TEMPORARY BANK STABILIZATION AND CREATE A COMPLEX, VEGETATED BANK MARGIN THAT CREATES AQUATIC HABITAT AND SUPPORTS VEGETATION ESTABLISHMENT. IN SELECT LOCATIONS WOODY DEBRIS MATRIX STRUCTURES WILL INCLUDE AN INSET FLOODPLAIN DESIGNED TO NARROW THE CHANNEL DIMENSIONS AND PROVIDE FLOODPLAIN CONNECTIVITY.

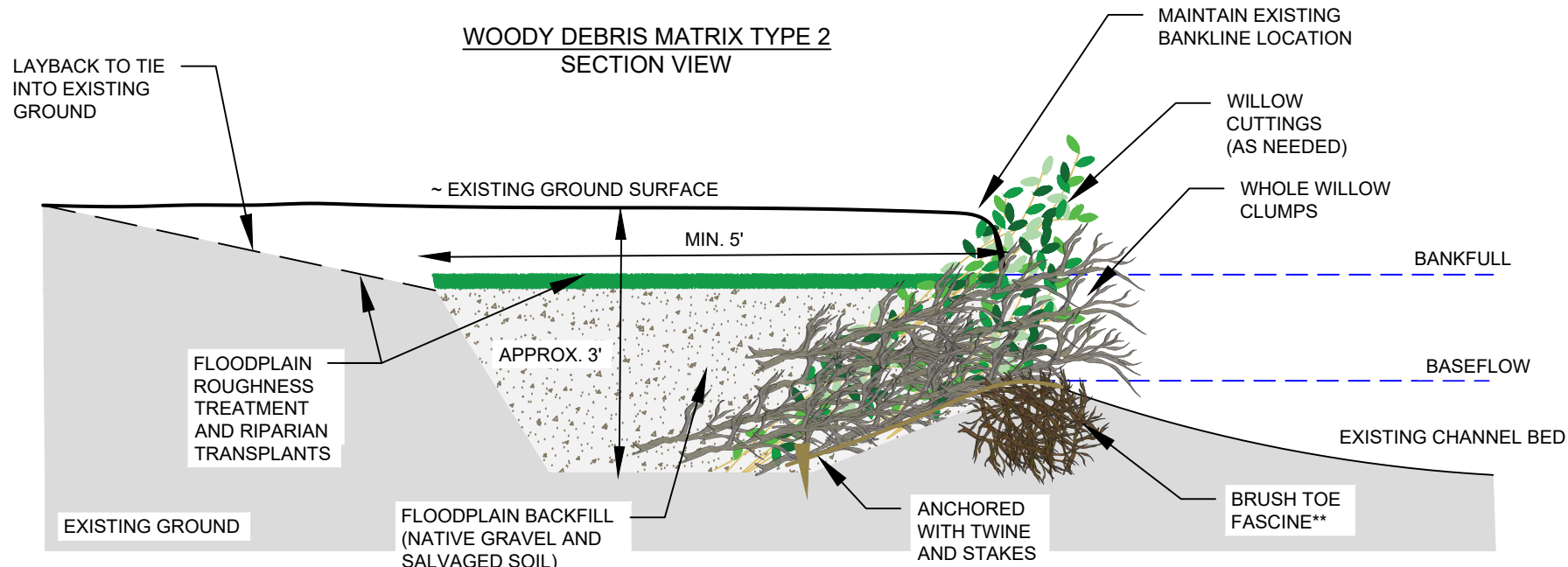
- WOODY DEBRIS MATRIX STREAMBANK CONSTRUCTION NOTES**
1. EXCAVATE STREAMBANK TO SUBGRADE ELEVATIONS.
  2. INSTALL WHOLE WILLOW CLUMPS IN THE STREAMBANK AT A DOWNWARD ANGLE TO THE STREAMBANK. CLUMPS CAN OVERLAP AND CAN BE ORIENTED FACING UPSTREAM OR DOWNSTREAM, BUT SHOULD BE PLACED BELOW THE BANKFULL ELEVATION.
  3. IF OUTSIDE OF DORMANCY PLACE WILLOW CUTTINGS INTO THE MATRIX AS SHOWN IN THE DRAWING WITH THE STEMS IN CONTACT WITH THE BASEFLOW WATER TABLE AND TOPS AT OR ABOVE THE BANKFULL ELEVATION.
  4. BACKFILL STREAMBANK WITH FLOODPLAIN BACKFILL TO DESIGN ELEVATIONS. WASH FINES INTO THE FLOODPLAIN BACKFILL TO SEAL VOIDS. IN LOCATIONS WITH AN INSET FLOODPLAIN, FLOODPLAIN BACKFILL WILL EXTEND BEYOND THE WOODY DEBRIS MATRIX. THE WIDTH OF INSET FLOODPLAINS VARIES AND WILL BE DEFINED FOR EACH FEATURE.
  5. WHERE THE EXISTING BANKLINE ABUTS THE FLOODPLAIN BACKFILL, LAY BACK THE GROUND BY EXCAVATING MATERIAL TO FORM A SLOPE AT A MINIMUM OF 4H:1V TO BLEND THE WOODY DEBRIS MATRIX STREAMBANK AND INSET FLOODPLAIN WITH THE ADJACENT EXISTING GROUND.
  6. THE FLOODPLAIN BENCH SHOULD BE ROUGHENED AND RIPARIAN TRANSPLANTS INSTALLED IF AVAILABLE.



EXAMPLES OF WOODY DEBRIS MATRIX STREAMBANK TREATMENTS



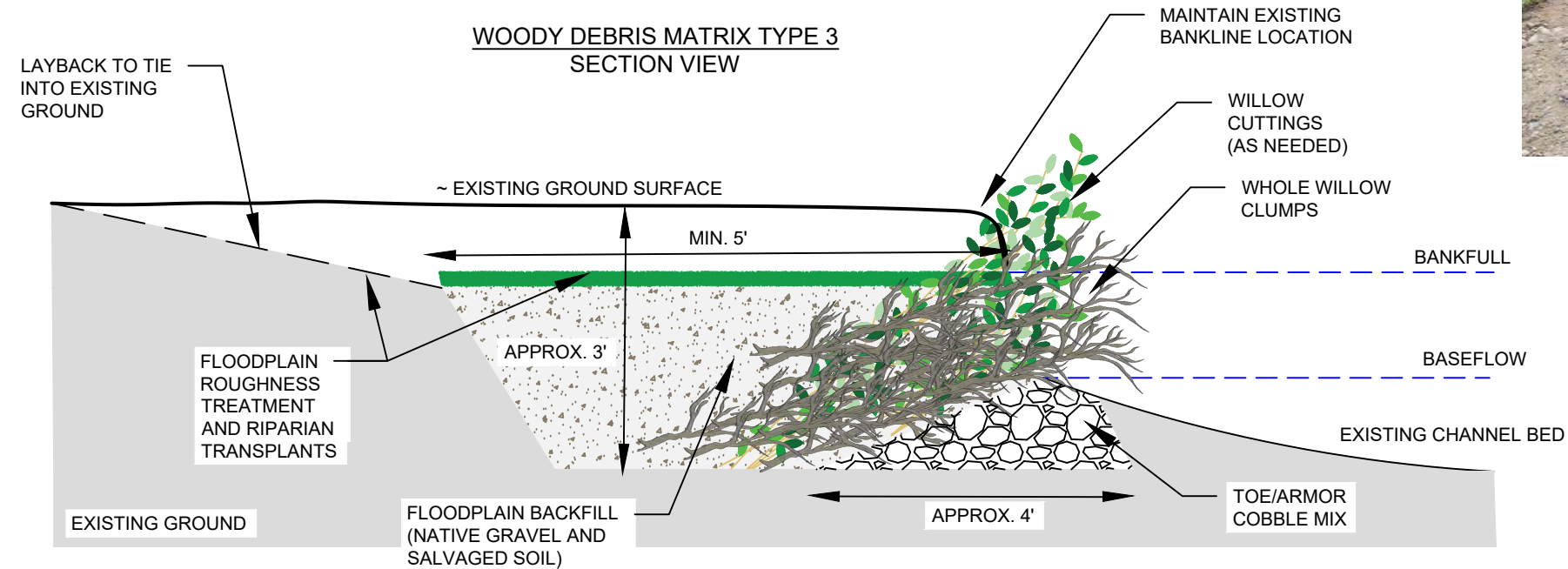




\*\* BRUSH TOE FASCINE CONSTRUCTED WITH BUNDLES OF JUNIPER BRANCHES (OR OTHER) PLACED PARALLEL TO STREAMFLOW AND ANCHORED BENEATH WHOLE WILLOW CLUMPS USING BIODEGRADABLE TWINE AND 2FT WOODEN STAKES

#### MATERIAL SCHEDULE PER LINEAR FOOT

ITEM	DIMENSION	UNIT	QUANTITY
WHOLE WILLOW CLUMPS	10' MIN. HEIGHT W/ ROOTBALL	EA	0.2 (1 PER 8FT)
DORMANT WILLOW CUTTINGS	MIN. 1/2" D, 6-8' L	EA	3
TOE/ARMOR COBBLE MIX	TBD	CY/LF	0.3
RIPARIAN SHRUB TRANSPLANTS (AS AVAILABLE)	VARIES	EA	0.2 (1 PER 8FT)
FLOODPLAIN BACKFILL	NATIVE	CY/LF	1.1
BRUSH TOE FASCINES	1-2' WIDE, 8-10' L	EA	0.2



#### WORK DESCRIPTION

THIS WORK INCLUDES INSTALLATION OF TYPE 2 AND TYPE 3 WOODY DEBRIS MATRIX STRUCTURES AT THE LOCATIONS SHOWN ON SHEET 3.0. THE INTENT OF THESE STRUCTURES IS TO PROVIDE TEMPORARY BANK STABILIZATION AND CREATE A COMPLEX, VEGETATED BANK MARGIN THAT CREATES AQUATIC HABITAT AND SUPPORTS VEGETATION ESTABLISHMENT. TYPE 2 WILL BE USED ALONG POOLS TO INCREASE HABITAT AND TYPE 3 WILL BE USED IN HIGH VELOCITY AREAS WHERE TOE STABILITY IS NEEDED.

#### WOODY DEBRIS MATRIX STREAMBANK CONSTRUCTION NOTES

- EXCAVATE STREAMBANK TO SUBGRADE ELEVATIONS.
- FOR TYPE 2 INSTALL BRUSH TOE FASCINE AND ANCHOR TO BACK OF EXCAVATION. FOR TYPE 3 CONSTRUCT STREAMBANK TOE WHERE NEEDED AND ACCORDING TO SPECIFIED DIMENSIONS.
- INSTALL WHOLE WILLOW CLUMPS IN THE STREAMBANK AT A DOWNWARD ANGLE TO THE STREAMBANK. CLUMPS CAN OVERLAP AND CAN BE ORIENTED FACING UPSTREAM OR DOWNSTREAM, BUT SHOULD BE PLACED BELOW THE BANKFULL ELEVATION.
- IF OUTSIDE OF DORMANCY PLACE WILLOW CUTTINGS INTO THE MATRIX AS SHOWN IN THE DRAWING WITH THE STEMS IN CONTACT WITH THE BASEFLOW WATER TABLE AND TOPS AT OR ABOVE THE BANKFULL ELEVATION.
- BACKFILL STREAMBANK WITH FLOODPLAIN BACKFILL TO DESIGN ELEVATIONS. WASH FINES INTO THE FLOODPLAIN BACKFILL TO SEAL VOIDS. IN LOCATIONS WITH AN INSET FLOODPLAIN, FLOODPLAIN BACKFILL WILL EXTEND BEYOND THE WOODY DEBRIS MATRIX. THE WIDTH OF INSET FLOODPLAINS VARIES AND WILL BE DEFINED FOR EACH FEATURE.
- WHERE THE EXISTING BANKLINE ABUTS THE FLOODPLAIN BACKFILL, LAY BACK THE GROUND BY EXCAVATING MATERIAL TO FORM A SLOPE AT A MINIMUM OF 4H:1V TO BLEND THE WOODY DEBRIS MATRIX STREAMBANK AND INSET FLOODPLAIN WITH THE ADJACENT EXISTING GROUND.
- THE FLOODPLAIN BENCH SHOULD BE ROUGHENED AND RIPARIAN TRANSPLANTS INSTALLED IF AVAILABLE.



EXAMPLES OF WOODY DEBRIS MATRIX STREAMBANK TREATMENTS

DATUM:  
PROJECTION:  
UNITS: US Feet  
DATA SOURCES:

## WOODY DEBRIS MATRIX TYPE 2 AND TYPE 3 DETAIL

RUBY RIVER RVHA RESTORATION PROJECT  
MADISON COUNTY, MONTANA

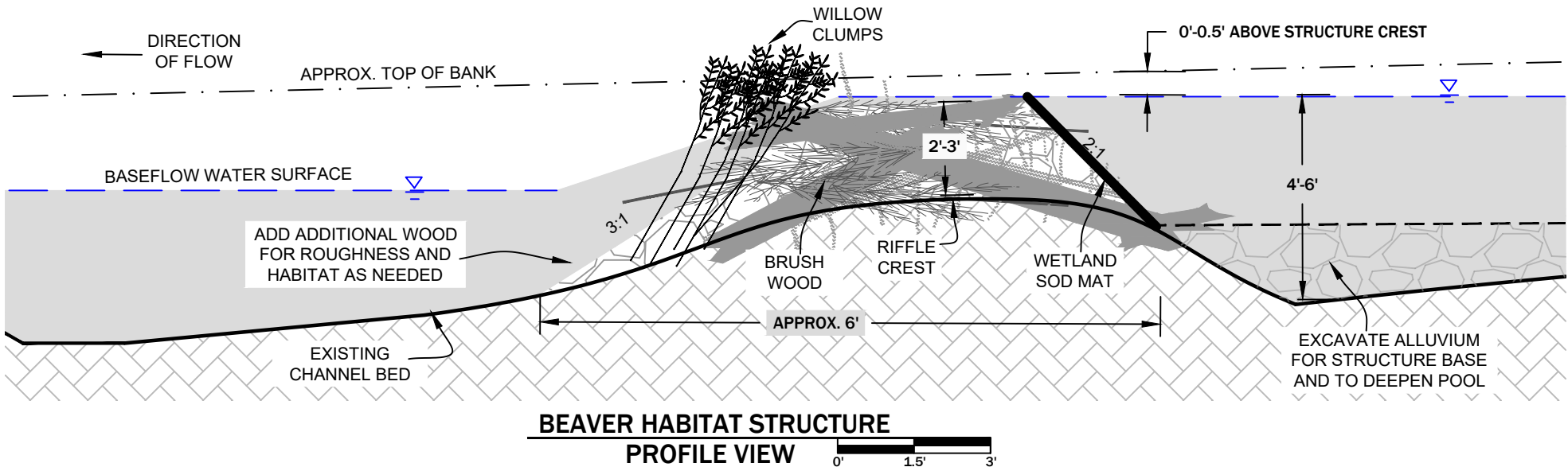
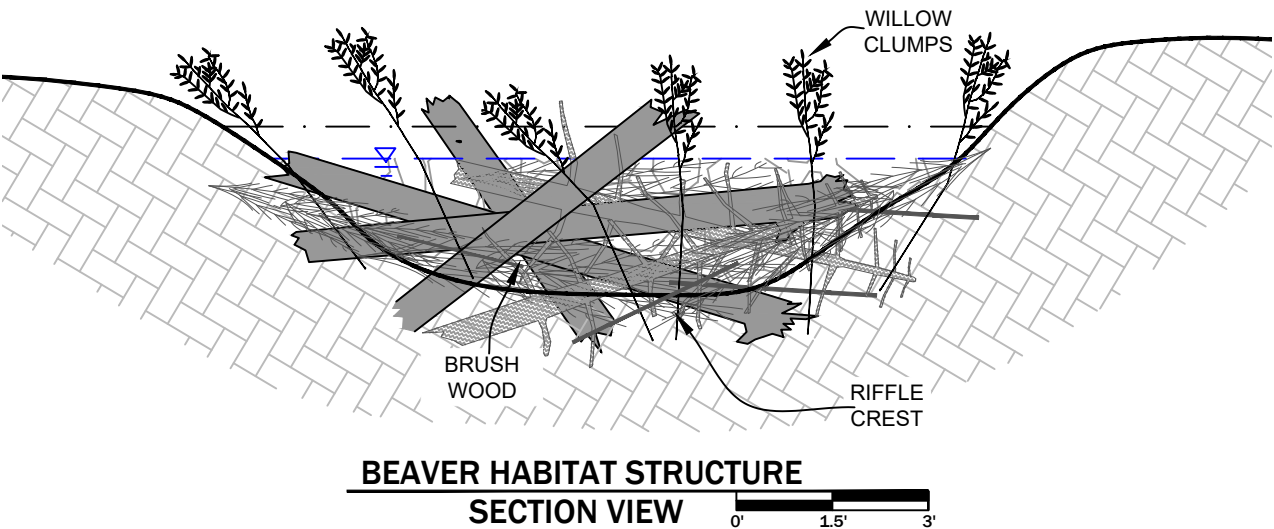
DRAWN BY: Alyssa Guley  
DESIGNED BY:  
DATE: April 2021

SHEET  
**5.3**





EXAMPLES OF CONSTRUCTED BEAVER HABITAT STRUCTURES

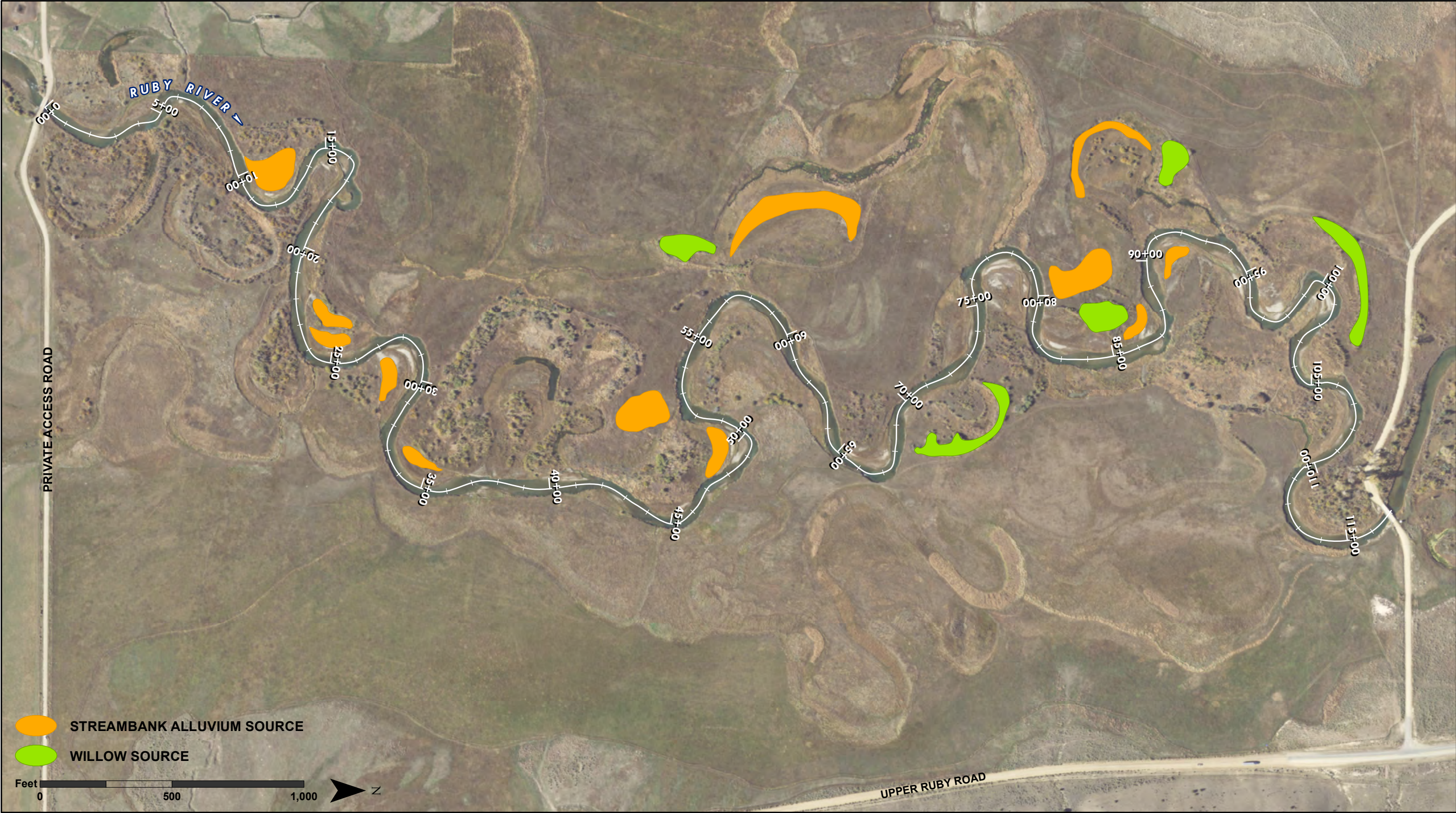


**WORK DESCRIPTION**  
BEAVER HABITAT STRUCTURES ARE CHANNEL-SPANNING STRUCTURES THAT MIMIC OR REINFORCE NATURAL BEAVER DAMS. THE PURPOSE OF THESE STRUCTURES IS TO PROVIDE FUNCTIONS THAT HAVE BEEN LOST AS THE RESULT OF DECREASED BEAVER ACTIVITY AT THE PROJECT SITE. BEAVER HABITAT STRUCTURES MIMIC HYDRAULICS CREATED BY NATURAL BEAVER DAMS BY REDUCING STREAM VELOCITIES AND RAISING THE WATER SURFACE ELEVATION UPSTREAM OF EACH STRUCTURE. THIS ACTION WILL RESULT IN AGGRADATION OF THE CHANNEL BED UPSTREAM OF THE STRUCTURE RESULTING IN ELEVATION OF THE WATER TABLE IN THE FLOODPLAIN. THIS WILL HELP RESTORE FLOODPLAIN CONNECTIVITY, INCREASE RIPARIAN VEGETATION VIGOR AND HELP NATURAL EXPANSION OF RIPARIAN VEGETATION. THESE HABITAT STRUCTURES ARE ALSO EXPECTED TO CREATE POOL HABITAT AND ENCOURAGE EXPANSION OF THE NATURAL BEAVER POPULATION IN THE PROJECT REACH. THE SUCCESS OF THESE STRUCTURES ON RESTORING FLOODPLAIN CONNECTIVITY AND EXPANDING RIPARIAN VEGETATION RELIES ON THE STRUCTURE BEING RE-BUILT IF THEY ARE BREACHED DURING NATURAL FLOOD EVENTS.

- CONSTRUCTION NOTES**
- EXCAVATE NATIVE ALLUVIUM FROM CHANNEL BED UPSTREAM OF RIFFLE CREST. CONSTRUCT STRUCTURE BASE TO DIMENSIONS SHOWN ON DRAWING USING EXCAVATED ALLUVIUM. BUCKET COMPACT ALLUVIUM.
  - SALVAGE WETLAND SOD MATS FROM ADJACENT FLOODPLAIN AND PLACE ON 2:1 SLOPE ON UPSTREAM SIDE OF STRUCTURE. BUCKET COMPACT SOD MATS INTO ALLUVIUM.
  - PLACE SMALL LOGS IN THE STREAMBANK AND CHANNEL BED ORIENTED AS SHOWN IN THE DRAWINGS. LOGS SHALL BE PLACED UP TO 0.5 FEET ABOVE THE TOP OF BANK ELEVATION. LOGS WILL OVERLAP AND SHOULD EXTEND INTO THE STREAMBANK AND STREAMBED.
  - PLACE EXCAVATED CHANNEL MATERIAL ON TOP OF PLACED LOGS. BUCKET COMPACT FILL MATERIAL.
  - PLACE WHOLE WILLOW TRANSPLANTS ON DOWNSTREAM SIDE OF MATRIX. BURY ENDS OF WILLOWS WITH EXCAVATED CHANNEL MATERIAL.
  - PLACE ADDITIONAL SMALL LOGS AND BRUSH WOOD AT DOWNSTREAM TOE OF STRUCTURE FOR ADDITIONAL ROUGHNESS AND HABITAT. BURY ENDS OF LOGS INTO STREAMBED AND BANKS.
  - REPAIR DISTURBED STREAMBANKS WITH SALVAGED SOD OR RIPARIAN SHRUB TRANSPLANTS AS NECESSARY.

MATERIAL SCHEDULE PER STRUCTURE			
ITEM	DIMENSION	UNIT	QUANTITY
EXCAVATED NATIVE ALLUVIUM		CY	4
BRUSH WOOD	1-3" D, 8-10' L	EA	10
WHOLE WILLOW TRANSPLANTS	10' MIN. HEIGHT W/ ROOTBALL	EA	5
WETLAND SOD MATS	2' X 4'	EA	4





**BORROW SOURCES**

**Alluvial Borrow:**  
Rock and alluvial materials needed to construct streambanks and bed aggradation structures will be both imported and acquired on site. This sheet shows potential on site borrow areas for alluvial gravels based on test pit excavations. All borrow areas will be stripped of sod and soil. Sod will be salvaged to the extent possible. Alluvial gravels will be mined from area, topsoil replaced, and salvaged sod placed on surface to reclaim gravel borrow sites. Abandoned channel segments will also be used to acquire cobble and gravel needed for structure and streambank construction.

**Willow Sources:**  
Streambanks will be constructed using a mix of willows and junipers. Willows will be salvaged from on site to the extent feasible and without impacting the function of existing riparian vegetation. Additional willows and junipers will be imported from off site. This sheet shows the location of potential on site willow sources. On site salvage will consist of digging up older, more decadent willows from existing stands on site. No more than 20% of willows in a stand will be harvested. All other willows and woody material needed for streambank construction will be acquired from off site and transported to the site.

**BORROW and MATERIALS SOURCES**

RUBY RIVER RVHA RESTORATION PROJECT  
MADISON COUNTY, MONTANA



Materials List	Dimensions	Unit	Estimated Total Quantity
Toe/Armor Cobble Mix / 6" Cobble	TBD	cubic yard	1,970
Whole Willow Clumps	10' min. height w/ rootball	each	900
Dormant Willow Cuttings	1/2" min. diameter x 6-8' length	each	24,400
Juniper/Conifers	30-40' tree with branches	each	60
Brush	1-3" diameter x 4-9' length	each	114

Total Estimated Excavation by Treatment (cy)	
Channel Activation (Seasonal)	600
Channel Activation (Overflow)	640
Channel Activation (Main)	25,070
Brush Matrix Streambank Treatments	7,320
Total	33,630

Total Estimated Fill by Treatment (cy)	Native Gravel	Native Gravel or Floodplain	Imported Cobble
Bed Aggradation Structures	730	0	180
Main Channel Plugs	1,260	0	540
Riffle Control Structures	430	0	110
Main Channel Plugs - low profile	2,180	0	0
Brush Matrix Streambank Treatments	0	8,500	1,140
Main Channel Relocations	0	1,350	0
Total	4,600	9,850	1,970

Summary of Total Estimated Excavation and Fill Volumes	Unit	Estimated Total Quantity
Estimated Excavation	cubic yards	33,630
Estimated Fill	cubic yards	14,460
Net	cubic yards	+19,170

**Note:** Excavation quantities are approximate and channel locations will be fit in the field to reduce excess material volume.



MATERIAL SUMMARY

RUBY RIVER RVHA RESTORATION PROJECT  
MADISON COUNTY, MONTANA

DRAWN BY: J. Wallace  
DESIGNED BY: Geum, AGI, Gillilan  
DATE: April 2021