

NEVADA CREEK PHASE 4 RESTORATION PROJECT CONCEPTUAL DESIGN

PROJECT PARTNERS



BIG BLACKFOOT CHAPTER OF
TROUT UNLIMITED
P.O. BOX 1
OVANDO, MONTANA 59854



US FISH AND WILDLIFE SERVICE
P.O. BOX 66
196 LOWER LAKE SIDE LANE
OVANDO, MONTANA 59854



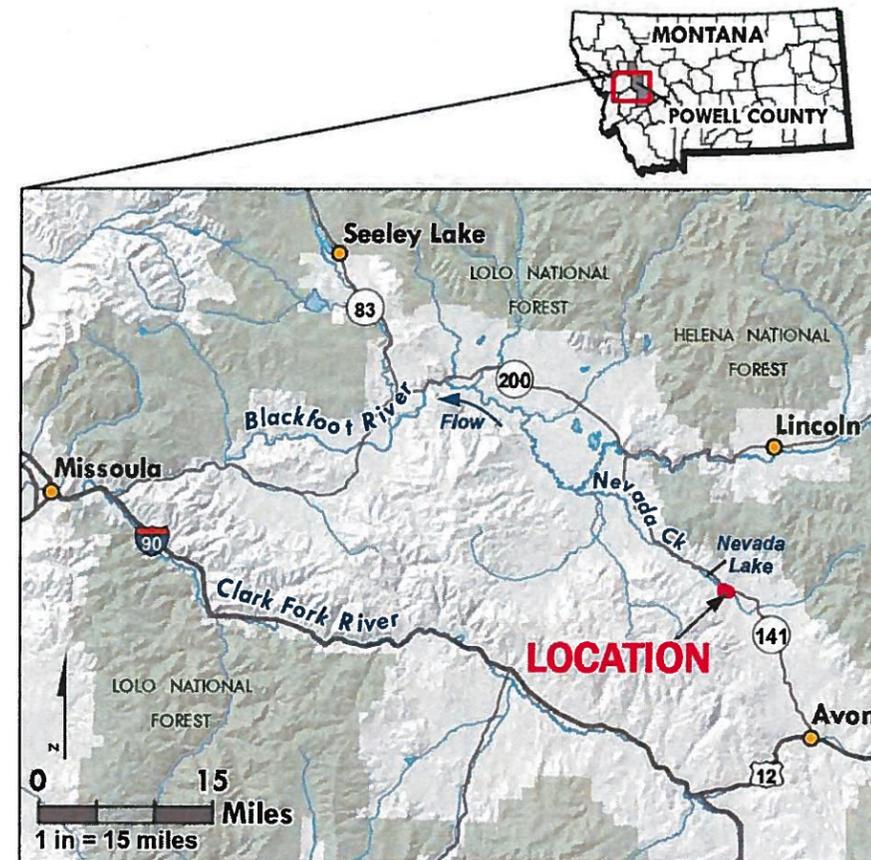
MONTANA FISH, WILDLIFE & PARKS
3201 SPURGIN ROAD
MISSOULA, MONTANA 59804

REM MANNIX AND FAMILY

DRAWING INDEX

- 1.0 COVER PAGE
- 2.0 EXISTING CONDITIONS
- 2.1 EXISTING CONDITIONS: BANK EROSION HAZARD INDEX ASSESSMENT
- 3.0 SITE PLAN AND INDEX
- 4.0 PLAN VIEW AND DATA SHEET
- 4.1 GRADING PLAN AND PROFILE
- 4.2 PLAN VIEW AND DATA SHEET
- 4.3 GRADING PLAN AND PROFILE
- 4.4 PLAN VIEW AND DATA SHEET
- 4.5 GRADING PLAN AND PROFILE
- 5.0 CHANNEL CROSS SECTION DIMENSIONS
- 6.0 SOD AND BRUSH BANK DETAIL
- 6.1 CONSTRUCTED STREAMBED DETAIL
- 6.2 FLOODPLAIN ROUGHNESS DETAIL
- 7.0 BMP DETAILS

NEVADA CREEK PHASE 4 VICINITY MAP



LEGAL DESCRIPTION:
S10, T12N R10W, P.M., M
POWELL COUNTY, MONTANA

PROJECT DESCRIPTION

BIG BLACKFOOT CHAPTER OF TROUT UNLIMITED (BBCTU), IN COOPERATION WITH MONTANA FISH, WILDLIFE & PARKS (MFWP) AND THE U.S. FISH AND WILDLIFE SERVICE (USFWS), RETAINED RIVER DESIGN GROUP, INC. TO DEVELOP CHANNEL, AQUATIC HABITAT, AND FLOODPLAIN RESTORATION PLANS FOR A 6,800 REACH OF NEVADA CREEK, LOCATED APPROXIMATELY 55 MILES EAST OF MISSOULA, MONTANA. NEVADA CREEK IS A THIRD ORDER TRIBUTARY TO THE MIDDLE BLACKFOOT RIVER AND SUPPORTS POPULATIONS OF WESTSLOPE CUTTHROAT TROUT, RAINBOW TROUT, BROWN TROUT AND OTHER FISH SPECIES. NEVADA CREEK HAS BEEN IDENTIFIED AS AN IMPAIRED WATERBODY BY THE MONTANA DEPARTMENT OF ENVIRONMENTAL QUALITY. THE STREAM IS CONSIDERED NONSUPPORTING OF AQUATIC LIFE, COLD WATER FISHERY, AND CONTACT RECREATION DUE TO SEDIMENT AND HABITAT RELATED CAUSES (MDEQ 2008). PROBABLE CAUSES OF WATER QUALITY IMPAIRMENT INCLUDE TOTAL PHOSPHORUS, PHYSICAL SUBSTRATE, HABITAT ALTERATIONS, SEDIMENTATION/SILTATION, AND TOTAL NITROGEN. PROBABLE SOURCES OF IMPAIRMENT INCLUDE AGRICULTURE AND STREAMBANK MODIFICATION/DESTABILIZATION.

THREE PHASES OF RESTORATION WORK HAVE BEEN IMPLEMENTED DOWNSTREAM OF NEVADA CREEK RESERVOIR (2012, 2017 AND 2019). SIMILAR TO PAST PHASES, PHASE 4 WILL ADDRESS THE PRIMARY CAUSES OF WATER QUALITY IMPAIRMENT INCLUDING STREAMBANK MODIFICATIONS AND PHYSICAL HABITAT ALTERATIONS. STREAMBANK STABILITY WILL BE INCREASED WITH THE USE OF VEGETATED WOOD MATRICES AND SOD MATS. TO ADDRESS FLOODPLAIN DISCONNECTION, THE CHANNEL BED WILL BE SLIGHTLY RAISED TO RECONNECT FORMER FLOODPLAIN SURFACES AND FEATURES INCLUDING SIDE CHANNELS, ALCOVES, AND EMERGENT AND SHALLOW OPEN WATER WETLANDS. IN LOCATIONS, EXISTING TERRACES WILL BE LOWERED TO BANKFULL ELEVATION TO INCREASE FLOODPRONE AREA. AQUATIC HABITAT FEATURES INCLUDING RIFFLES, RUNS, POOLS AND GLIDES WILL BE FORMED TO PROVIDE INSTREAM COMPLEXITY FOR NATIVE AND NON-NATIVE FISH SPECIES. APPROXIMATELY 7,000 FEET OF CHANNEL AND 13,600 FEET OF STREAMBANK WILL BE RESTORED. THESE COMBINED ACTIONS ARE PROJECTED TO: 1) REDUCE SEDIMENT LOADING TO NEVADA CREEK BY MORE THAN 545 TONS PER YEAR; 2) INCREASE FLOODPLAIN CONNECTION; AND 3) SET THE STAGE FOR RECOVERY OF THE RIPARIAN ZONE AND AQUATIC HABITAT CONDITIONS BY RESTORING SITE HYDROLOGY AND CHANNEL DIMENSIONS.

GENERAL NOTES

1. CONTOUR INTERVAL IS NOTED ON DRAWINGS.
2. SLOPES DESIGNATED AS 2:1, 1.5:1, ET CETERA, ARE THE RATIOS OF HORIZONTAL DISTANCE TO VERTICAL DISTANCE.
3. DIMENSIONS ARE NOTED IN FEET AND TENTHS OF A FOOT.
4. TOPOGRAPHY AND CROSS SECTION GROUND LINES ARE BASED ON SURVEY WORK PERFORMED FROM JULY TO AUGUST 2016. LIDAR DATA WAS COLLECTED BY TROUT UNLIMITED. ALL LIDAR DATA WAS COORDINATED BY RDG.
5. ALL EXISTING CONDITIONS ARE TO BE VERIFIED IN THE FIELD PRIOR TO CONSTRUCTION AND ANY ADJUSTMENTS TO THE DRAWINGS SHALL BE MADE AS DIRECTED BY THE ENGINEER.
6. EXISTING PRIVATE IMPROVEMENTS, WHICH LIE WITHIN THE CONSTRUCTION LIMITS, UNLESS OTHERWISE NOTED WILL BE REMOVED BY THE OWNER PRIOR TO CONSTRUCTION, OR ABANDONED IN PLACE.
7. PROTECT ALL TREES AND LAND AREAS NOT LOCATED WITHIN THE PROJECT CONSTRUCTION STAGING OR EARTHWORK LIMITS. EXERCISE CARE IN AREAS NOT SO MARKED TO AVOID UNNECESSARY DAMAGE TO NATURAL VEGETATION.
8. THE PROJECT SPONSOR IS RESPONSIBLE FOR COMPLYING WITH ALL PERMITS AND EASEMENTS INCLUDING ALL FEDERAL, STATE, COUNTY, AND LOCAL PERMIT CONDITIONS.
9. EXCAVATION, TRENCHING, SHORING, AND SHIELDING SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR PERFORMING THE WORK, THESE DRAWINGS ARE NOT INTENDED TO PROVIDE MEANS OR METHODS OF CONSTRUCTION.
10. EXCAVATION SHALL MEET THE REQUIREMENTS OF OSHA 29 CFR PART 1926, SUBPART P, EXCAVATIONS. ACTUAL SLOPES SHALL NOT EXCEED THE SLOPES AS INDICATED ON DRAWINGS.
11. ALL EXCAVATORS AND BULLDOZERS SHALL BE EQUIPPED WITH MACHINE GRADE GPS ((L1/L2/GLONASS)). CONSTRUCTION AREAS WILL BE STAKED OUT PRIOR TO CONSTRUCTION USING SURVEY GRADE GPS (L1/L2/GLONASS).
12. ENGINEER WILL PROVIDE SURVEY CONTROL AND GRADING SURFACES FOR EQUIPMENT WITH GPS MACHINE CONTROL CAPABILITY. CONTRACTOR SHALL PROVIDE SURVEY STAKING AND LAYOUT FOR CONSTRUCTION.
13. VERTICAL TOLERANCE FOR CONSTRUCTION COMPLIANCE WILL BE 0.3 FEET. HORIZONTAL TOLERANCE WILL BE 1.0 FEET.
14. CONTRACTOR SHALL CONFIRM QUANTITIES. REPORTED VOLUMES ARE NEATLINE AND DO NOT INCLUDE ADJUSTMENTS FOR COMPACTION OR OTHER FACTORS.

STANDARD OF PRACTICE

RIVER DESIGN GROUP, INC. WORKS EXCLUSIVELY IN THE RIVER ENVIRONMENT AND UTILIZES THE MOST CURRENT AND ACCEPTED PRACTICES AVAILABLE FOR PLANNING AND DESIGN OF RIVER, FLOODPLAIN, AND AQUATIC HABITAT RESTORATION PROJECTS. CURRENT STANDARDS FOR THE DESIGN OF RESTORATION PROJECTS VARY DEPENDING ON PROJECT GOALS. STABILITY CRITERIA INCLUDE DESIGNING STREAMBED AND STREAMBANK STRUCTURES FOR THE 10-YEAR RECURRENCE INTERVAL FLOOD. HEC-RAS, A ONE-DIMENSIONAL RIVER ANALYSIS MODEL WAS USED TO COMPLETE HYDRAULIC MODELING AND EVALUATE WATER SURFACE ELEVATIONS, CHANNEL AND OVERBANK SHEAR STRESSES, AND VELOCITIES FOR A RANGE OF FLOWS, INCLUDING BANKFULL DISCHARGE, THE 10-YEAR DESIGN STABILITY FLOW, AND HIGHER RETURN INTERVAL DISCHARGES INCLUDING THE 100-YEAR FLOW.

REUSE OF DRAWINGS

THESE DRAWINGS, THE IDEAS AND DESIGNS INCORPORATED HEREIN, AS AN INSTRUMENT OF PROFESSIONAL SERVICE, ARE THE PROPERTY OF RIVER DESIGN GROUP, INC. (RDG) AND ARE NOT TO BE USED, IN WHOLE OR IN PART, FOR ANY OTHER PROJECT WITHOUT THE WRITTEN AUTHORIZATION OF RDG. LIKEWISE, THESE DRAWINGS MAY NOT BE ALTERED OR MODIFIED WITHOUT AUTHORIZATION OF RDG. DRAWING DUPLICATION IS ALLOWED IF THE ORIGINAL CONTENT IS NOT MODIFIED.



236 Wisconsin Avenue
Whitefish, MT 59937
Tel: 406.862.4927
Fax: 406.862.4943

311 SW Jefferson Avenue
Covallis, OR 97333
Tel: 541.738.2920
Fax: 541.758.8324

COVER PAGE
NEVADA CREEK PHASE 4
NEAR HELMSVILLE, MONTANA

NO.	DATE	BY	DESCRIPTION	CHK
1	9-27-19	NW	CONCEPTUAL DESIGN	JM

PROJECT NUMBER
RDG-18-002

SHEET NUMBER

1.0



IMAGE: RDG ORTHO PHOTO 2019

RDG
RIVER DESIGN GROUP

236 Wisconsin Avenue
Whitefish, MT 59937
Tel: 406.862.4927
Fax: 406.862-4963

311 SW Jefferson Avenue
Corvallis, OR 97333
Tel: 541.738.2920
Fax: 541.738.8324

EXISTING CONDITIONS
NEVADA CREEK PHASE 4
NEAR HELMVILLE, MONTANA

EXISTING CONDITIONS

THE PHASE 4 RESTORATION PROJECT AREA IS IN THE UPPER NEVADA CREEK WATERSHED UPSTREAM OF NEVADA CREEK RESERVOIR, IN POWELL COUNTY, MONTANA. THE PROJECT AREA IS WITHIN A REACH OF NEVADA CREEK THAT IS CONSIDERED NON-SUPPORTING OF AQUATIC LIFE DUE TO SEDIMENT AND HABITAT RELATED IMPAIRMENT CAUSES. WATER USE CLASS IS B-1, WHICH INCLUDE WATERS CLASSIFIED SUITABLE FOR DRINKING, CULINARY, AND FOOD PROCESSING PURPOSES; BATHING, SWIMMING AND RECREATION; GROWTH AND PROPAGATION OF SALMONID FISHES AND ASSOCIATED AQUATIC LIFE; WATERFOWL AND FURBEARERS; AND AGRICULTURAL AND INDUSTRIAL WATER SUPPLY. PROBABLE CAUSES OF IMPAIRMENT INCLUDE STREAMSIDE ALTERATIONS, TOTAL NITROGEN, TOTAL PHOSPHORUS, PHYSICAL SUBSTRATE HABITAT ALTERATIONS, SEDIMENT, AND TEMPERATURE. PROBABLE SOURCES INCLUDING GRAZING IN RIPARIAN AREAS, AGRICULTURE, AND STREAMBANK MODIFICATIONS/DESTABILIZATION. APPROXIMATELY 54% OF STREAMBANKS IN THE PROJECT AREA (7,830 FEET) DISPLAY MODERATE TO VERY HIGH BANK ERODIBILITY HAZARD RATINGS, CONTRIBUTING OVER 545 TONS PER YEAR OF SEDIMENT TO NEVADA CREEK.

WITHIN THE PROJECT AREA, NEVADA CREEK IS CHARACTERIZED AS A MODERATELY TO HIGHLY ENTRENCHED, GRAVEL DOMINATED, F STREAM TYPE WITH ALTERNATING RIFFLE AND POOL SEQUENCES. REFERENCE CHANNEL WIDTHS FOR RIFFLE AND POOL CROSS-SECTIONS MEASURED IN THE PROJECT AREA RANGE FROM 24.5 FEET TO 37.5, RESPECTIVELY. AVERAGE SLOPE IS 0.29%, AND AQUATIC HABITAT IS GENERALLY CHARACTERIZED BY RIFFLE HABITAT UNITS LACKING COMPLEXITY. HIGH BANK HEIGHT RATIOS, POOR ROOTING STRUCTURE, AND LOSS OF WOODY VEGETATION RESULTS IN ERODIBLE BANK CONDITIONS AND MODERATE TO HIGH FLOODPLAIN DISCONNECTION. BED MATERIALS ARE PREDOMINANTLY GRAVEL AND COBBLE WITH A HIGH PERCENTAGE OF SANDS AND SILTS. BANK EROSION, LACK OF FLOODPLAIN CONNECTION, AND LOSS OF WETLAND AND RIPARIAN VEGETATION ARE PRIMARY LIMITING FACTORS IN THE PROJECT AREA.

SIMILAR TO STREAM REACHES DOWNSTREAM OF NEVADA CREEK RESERVOIR, UPPER NEVADA CREEK HISTORICALLY SUPPORTED A BEAVER/WILLOW COMPLEX THAT HAS BEEN CONVERTED TO HAY/GRAZING PASTURES THROUGH CONTROL AND ERADICATION OF BEAVER. TO DATE, RESTORATION PROJECTS ON LOWER NEVADA CREEK HAVE INCLUDED GRAZING MANAGEMENT, INSTALLATION OF FISH SCREENS AND FISH LADDERS, AND IMPLEMENTATION OF THREE PHASES OF RESTORATION ON THE WADE STITT PROPERTY (PHASES 1 AND 2) AND COOPER CREEK RANCH (PHASE 3).

THE CONSTRAINTS AND LIMITING FACTORS IDENTIFIED DURING THE GEOMORPHIC INVESTIGATION INCLUDE:

- HIGH CHANNEL ENTRENCHMENT AND DISCONNECTED FLOODPLAIN SURFACES.
- HIGH CHANNEL WIDTH-TO-DEPTH RATIOS.
- MODERATE TO VERY HIGH BANK ERODIBILITY CONDITIONS RESULTING IN SEDIMENT LOADING TO THE SYSTEM.
- LACK OF WOODY RIPARIAN SHRUBS AND DEEP BINDING ROOT MASS.
- PAST BANK STABILIZATION PRACTICES, PRIMARILY RIPRAP IN THE LOWER REACH, LIMIT CHANNEL MARGIN COMPLEXITY.
- SIMPLIFIED AQUATIC HABITAT CONDITIONS, INCLUDING LOW POOL FREQUENCY AND LONG RIFFLE HABITAT UNITS WITH A HIGH PERCENTAGE OF FINE SEDIMENT.

NO.	DATE	BY	DESCRIPTION	CHK
1	9-27-19	NW	CONCEPTUAL DESIGN	JM

PROJECT NUMBER
RDG-18-002

SHEET NUMBER
2.0



IMAGE: RDG ORTHO PHOTO 2019

SITE PLAN AND INDEX
NEVADA CREEK PHASE 4
NEAR HELMVILLE, MONTANA

RESTORATION ALTERNATIVES

RESTORATION ALTERNATIVES FOR THE NEVADA CREEK PHASE 4 RESTORATION PROJECT WERE DEVELOPED IN CONSULTATION WITH BIG BLACKFOOT CHAPTER OF TROUT UNLIMITED, MONTANA FISH, WILDLIFE & PARKS, U.S. FISH AND WILDLIFE SERVICE, MONTANA DEPARTMENT OF ENVIRONMENTAL QUALITY, AND THE MANNIX FAMILY (LANDOWNERS). THE SELECTED ALTERNATIVE INCLUDES A COMBINATION OF TWO PRIMARY RESTORATION APPROACHES: 1) EXPANDING THE FLOODPLAIN BY LOWERING HIGH TERRACES TO BANKFULL ELEVATION AND RECONSTRUCTING THE PROPER CHANNEL DIMENSIONS, PATTERN AND PROFILE TYPICAL OF A C4 STREAM TYPE; AND 2) RAISING THE CHANNEL BED ELEVATION AND PROFILE TO RECONNECT FORMER FLOODPLAIN SURFACES THAT ARE DISCONNECTED DUE TO CHANNEL DOWNCUTTING AND WIDENING. LOWERING TERRACES THAT CURRENTLY SUPPORT UPLAND VEGETATION WILL FACILITATE CONVERSION TO EMERGENT WETLAND VEGETATION AND SCRUB-SHRUB COMMUNITIES TO INCREASE STREAMBANK STABILITY, COVER, AND SHADE TO THE CHANNEL. APPROXIMATELY 1,275 FEET OF CHANNEL WILL BE CONSTRUCTED OUTSIDE OF THE CURRENT PATTERN AND MEANDER BELT WIDTH TO ADDRESS FLOODPLAIN DISCONNECTION AND ACCELERATED DOWN VALLEY MEANDER BEND MIGRATION.

THE PREFERRED RESTORATION ALTERNATIVE BALANCES RESOURCE OBJECTIVES WITH LONG-TERM LAND MANAGEMENT NEEDS OF THE LANDOWNER BY MAINTAINING A MINIMUM FLOODPLAIN CORRIDOR THAT WILL BE EXCLUDED FROM GRAZING. GRAZING MANAGEMENT STRATEGIES INCLUDING EXCLOSURE FENCING, HARDENED WATER GAPS, AND OFF-CHANNEL WATER SOURCES, WILL BE IMPLEMENTED IN CLOSE CONSULTATION WITH THE LANDOWNER.

THE FOLLOWING OBJECTIVES WERE DEVELOPED BY BBCTU IN CONJUNCTION WITH USFWS AND MFWP:

- IMPROVE INSTREAM AQUATIC HABITAT CONDITIONS FOR SALMONIDS BY LOWERING CHANNEL WIDTH-TO-DEPTH RATIOS, INCREASING POOL FREQUENCY, OVERHEAD COVER, CHANNEL MARGIN COMPLEXITY, AND THE DISTRIBUTION OF RIFFLE, RUN, POOL AND GLIDE CHANNEL HABITAT UNITS.
- DECREASE SURFACE WATER TEMPERATURE BY REDUCING CHANNEL WIDTH-TO-DEPTH RATIOS, INCREASING VEGETATION COVER AND SHADE, AND ENHANCING HYPORHEIC FLOW EXCHANGE BETWEEN THE FLOODPLAIN, WETLANDS, AND CHANNEL.
- REDUCE SEDIMENT SUPPLY BY RESTORING STREAMBANKS WITH VEGETATION AND WOOD.
- IMPLEMENT FLOODPLAIN RESTORATION TREATMENTS THAT SET THE STAGE FOR NATURAL RECRUITMENT OF RIPARIAN VEGETATION.
- IMPLEMENT A GRAZING MANAGEMENT PLAN TO PROTECT SENSITIVE FLOODPLAIN AND RIPARIAN AREAS.
- UTILIZE NATURAL CHANNEL DESIGN TECHNIQUES AND AVOID THE USE OF HARDENED, NON-DEFORMABLE STRUCTURES SUCH AS ROCK AND LOG VANES, WEIRS, AND OTHER CHANNEL SPANNING STRUCTURES.

RESTORATION TREATMENTS

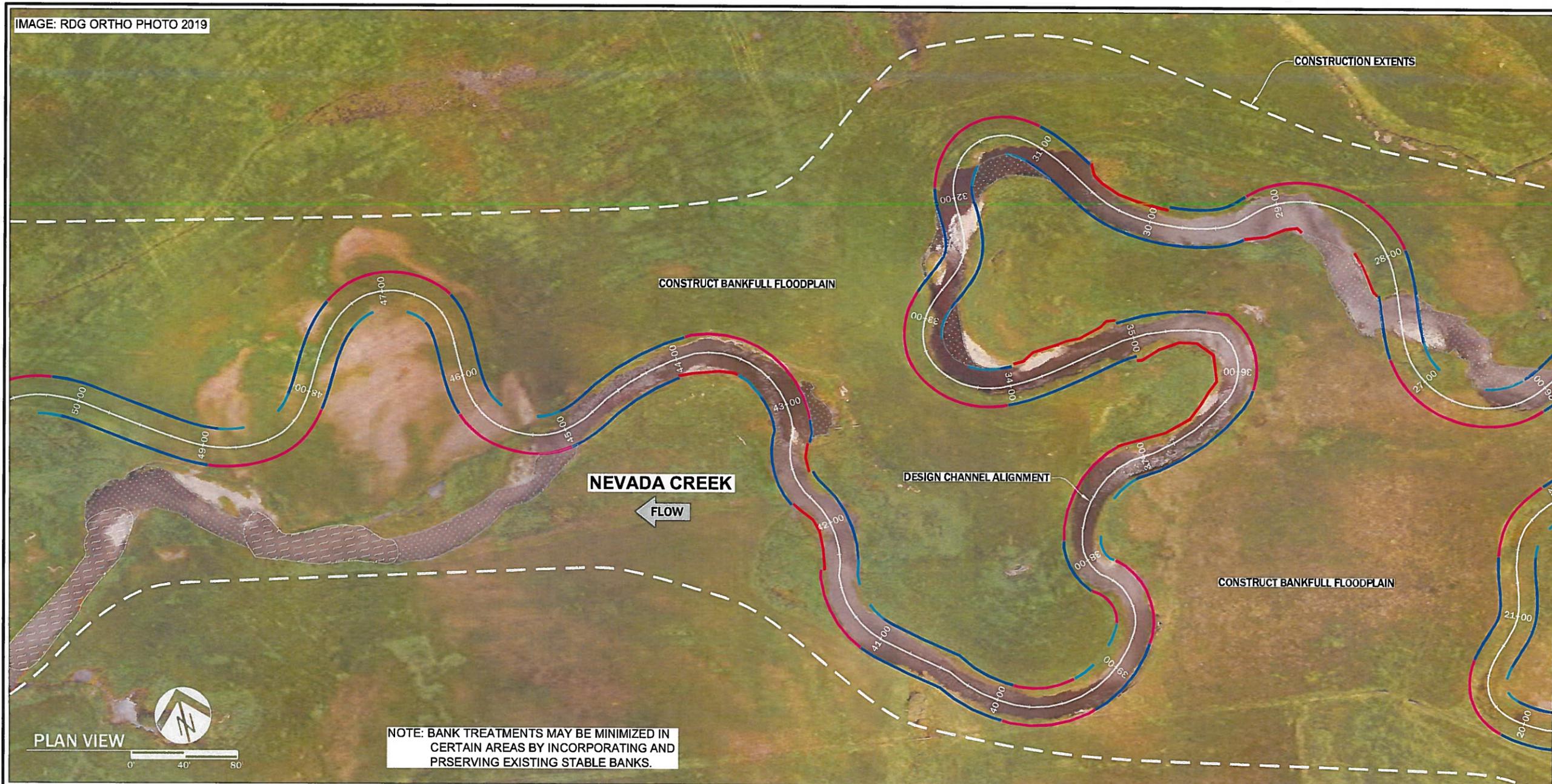
THE RESTORATION PLAN FOCUSES ON RESTORING ERODING STREAMBANKS, RE-ESTABLISHING PROPER CHANNEL CROSS-SECTION, PLAN FORM AND LONGITUDINAL PROFILE DIMENSIONS, AND IDENTIFYING OPPORTUNITIES TO INCREASE FLOODPLAIN CONNECTIVITY. SPECIFICALLY, THE FOLLOWING GUIDELINES WERE USED IN DEVELOPING THE DESIGN:

- MINIMIZE STREAMBED TREATMENTS AND UTILIZE ON-SITE NATIVE MATERIAL FOR CHANNEL SHAPING AND RECONSTRUCTION, TO THE GREATEST EXTENT PRACTICAL.
- INCORPORATE VEGETATED WOOD AND BRUSH FASCINE MATRIX STRUCTURES. LARGE WOOD WILL BE USED ONLY WHERE NECESSARY FOR BANK STABILIZATION AND POOL HABITAT DEVELOPMENT/ENHANCEMENT.
- SHAPE THE CHANNEL TO FORM THE APPROPRIATE CHANNEL DIMENSIONS WITHIN THE OVER-WIDENED STREAM CORRIDOR, INCLUDING RIFFLE, RUN, POOL AND GLIDE CHANNEL HABITAT FEATURES;
- INCREASE SINUOSITY WHILE MAINTAINING OPEN WATER HABITAT THROUGH THE USE OF VEGETATED FLOODPLAIN SURFACES, ALCOVES, AND BACKWATER BAYS.
- EXPAND THE FLOODPLAIN IN ENTRENCHED SECTIONS BY REDUCING BANK HEIGHTS AND CREATING A NARROW FLOODPLAIN CORRIDOR THAT WILL SUPPORT EMERGENT AND SCRUB-SHRUB WETLANDS. CONVERT THE "F" STREAM TYPE SECTIONS TO "C" STREAM TYPES WHERE FEASIBLE.

NO.	DATE	BY	DESCRIPTION	CHK	DATE
1	9-27-19	NW	CONCEPTUAL DESIGN		

PROJECT NUMBER RDG-18-002
SHEET NUMBER 3.0

IMAGE: RDG ORTHO PHOTO 2019



RDG
RIVER DESIGN GROUP
236 Wisconsin Avenue
Whitefish, MT 59937
Tel: 406.862.4927
Fax: 406-862-4963

311 SW Jefferson Avenue
Corvallis, OR 97333
Tel: 541.758.2920
Fax: 541.758.8524

PLAN VIEW AND DATA SHEET
NEVADA CREEK PHASE 4
NEAR HELMVILLE, MONTANA



NOTE: BANK TREATMENTS MAY BE MINIMIZED IN CERTAIN AREAS BY INCORPORATING AND PRESERVING EXISTING STABLE BANKS.

CHANNEL TOP OF BANK ELEVATIONS

STATION	ELEVATION (FT)	STATION	ELEVATION (FT)
27+00	4656.74	39+00	4653.75
28+00	4656.49	40+00	4653.50
29+00	4656.24	41+00	4653.25
30+00	4655.99	42+00	4653.00
31+00	4655.74	43+00	4652.75
32+00	4655.49	44+00	4652.50
33+00	4655.24	45+00	4652.25
34+00	4654.99	46+00	4652.00
35+00	4654.74	47+00	4651.58
36+00	4654.49	48+00	4651.17
37+00	4654.24	49+00	4650.75
38+00	4654.00		

LEGEND

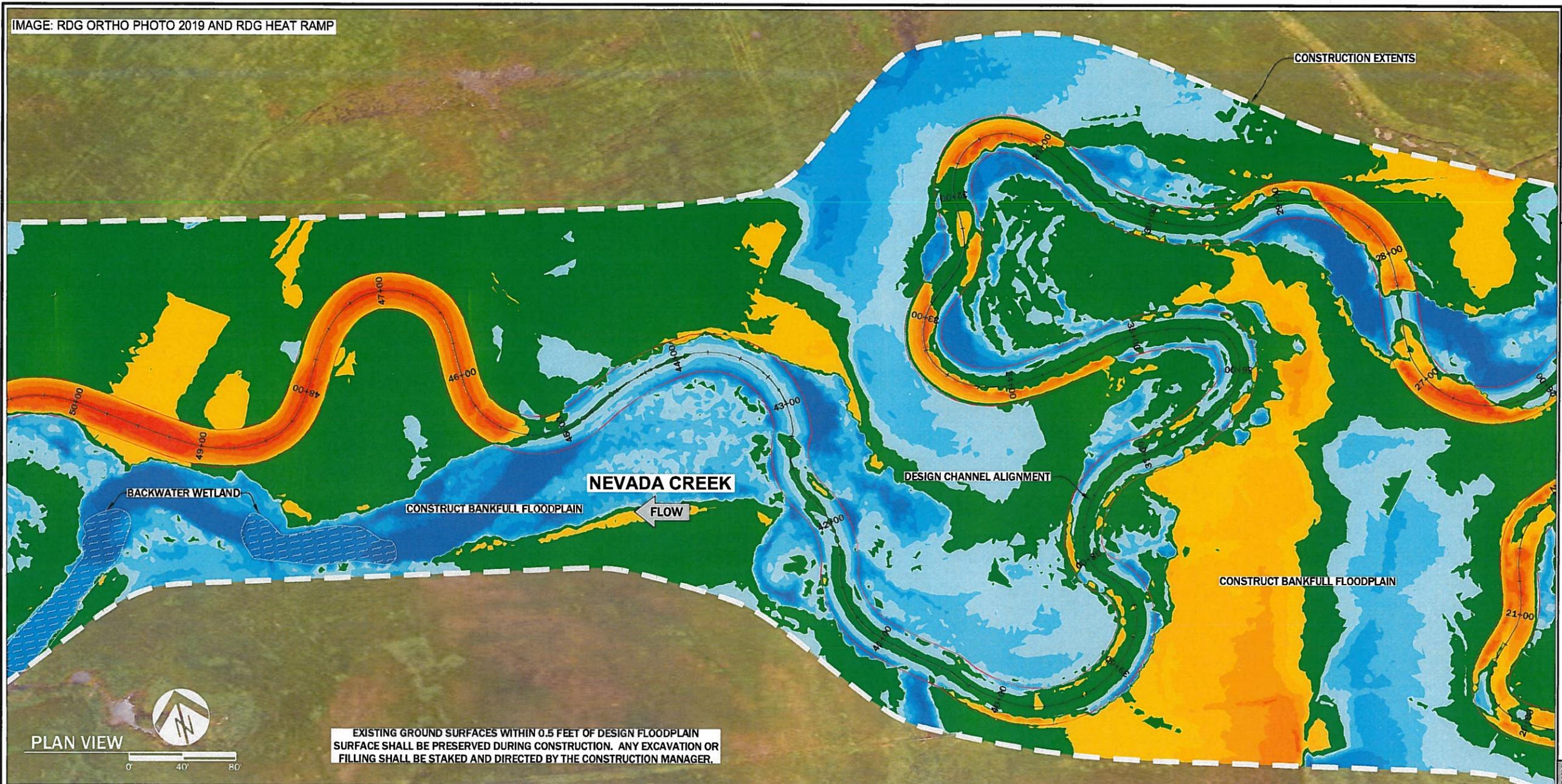
STRUCTURES		DETAIL SHEET #
	SOD AND BRUSH BANK TYPE 1 (SBB 1)	6.0
	SOD AND BRUSH BANK TYPE 2 (SBB 2)	6.0
	SOD AND BRUSH BANK TYPE 3 (SBB 3)	6.0
	PRESERVE EXISTING BANK	
	FILL EXISTING CHANNEL	
	BACKWATER/ALCOVE WETLAND	

NO.	DATE	BY	DESCRIPTION	CHK
				JM
7	9-27-19	NW	CONCEPTUAL DESIGN	

PROJECT NUMBER
RDG-18-002

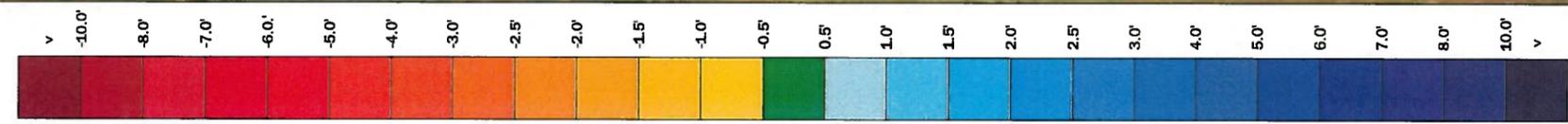
SHEET NUMBER
4.2

IMAGE: RDG ORTHO PHOTO 2019 AND RDG HEAT RAMP

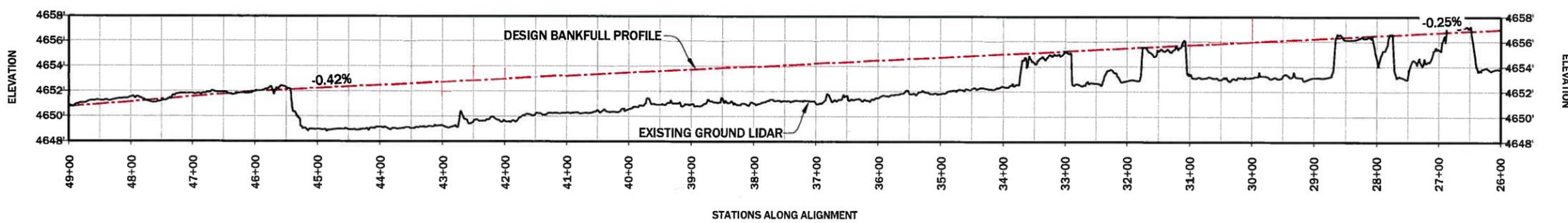


PLAN VIEW
0 40' 80'

EXISTING GROUND SURFACES WITHIN 0.5 FEET OF DESIGN FLOODPLAIN SURFACE SHALL BE PRESERVED DURING CONSTRUCTION. ANY EXCAVATION OR FILLING SHALL BE STAKED AND DIRECTED BY THE CONSTRUCTION MANAGER.



EXISTING GROUND LIDAR SURFACE COMPARED TO DESIGN BANKFULL SURFACE



RDG
RIVER DESIGN GROUP

236 Wisconsin Avenue
Whitefish, MT 59937
tel. 406.862.4927
fax. 406.862.4963

311 SW Jefferson Avenue
Corvallis, OR 97333
tel. 541.758.2920
fax. 541.758.8524

GRADING PLAN AND PROFILE

NEVADA CREEK PHASE 4 NEAR HELMVILLE, MONTANA

NO.	DATE	BY	DESCRIPTION	CHK
1	9-20-19	NW	Conceptual Design	JM

PROJECT NUMBER
RDG-18-002

SHEET NUMBER
4.3

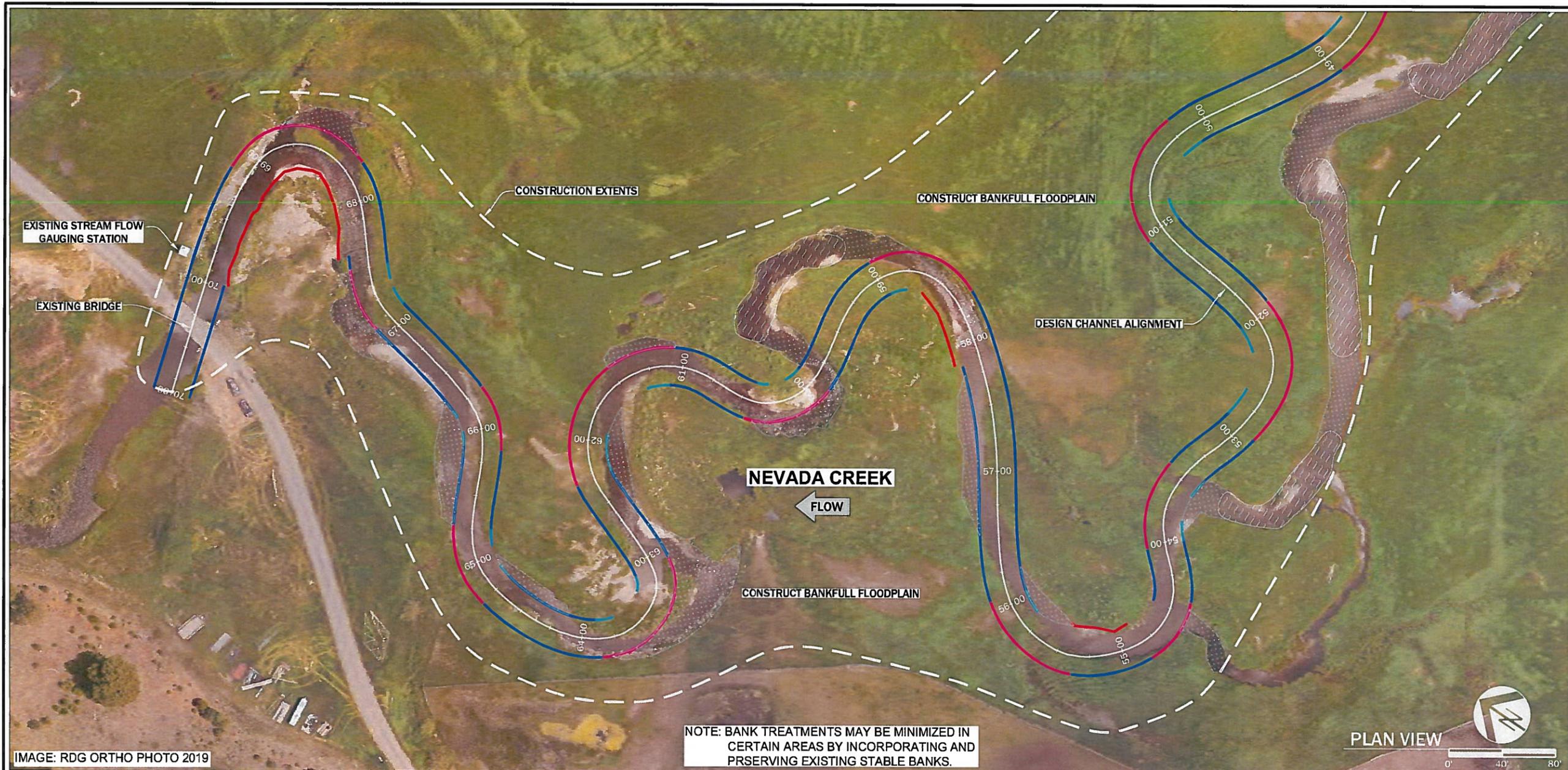


IMAGE: RDG ORTHO PHOTO 2019

CHANNEL TOP OF BANK ELEVATIONS

STATION	ELEVATION (FT)	STATION	ELEVATION (FT)
50+00	4650.34	60+00	4646.00
51+00	4649.92	61+00	4645.52
52+00	4649.51	62+00	4645.05
53+00	4649.09	63+00	4644.57
54+00	4648.68	64+00	4644.10
55+00	4648.26	65+00	4643.63
56+00	4647.85	66+00	4643.15
56+77	4647.53	67+00	4642.68
57+00	4647.42	68+00	4642.20
58+00	4646.95	69+00	4641.73
59+00	4646.47	70+00	4641.26

LEGEND

STRUCTURES		DETAIL SHEET #
	SOD AND BRUSH BANK TYPE 1 (SBB 1)	6.0
	SOD AND BRUSH BANK TYPE 2 (SBB 2)	6.0
	SOD AND BRUSH BANK TYPE 3 (SBB 3)	6.0
	PRESERVE EXISTING BANK	
	FILL EXISTING CHANNEL	
	BACKWATER/ALCOVE WETLAND	



PLAN VIEW AND DATA SHEET
NEVADA CREEK PHASE 4
NEAR HELMVILLE, MONTANA

NO.	DATE	BY	DESCRIPTION	GHK	JM
1	9-27-19	NW	CONCEPTUAL DESIGN		

PROJECT NUMBER
RDG-18-002

SHEET NUMBER

4.4

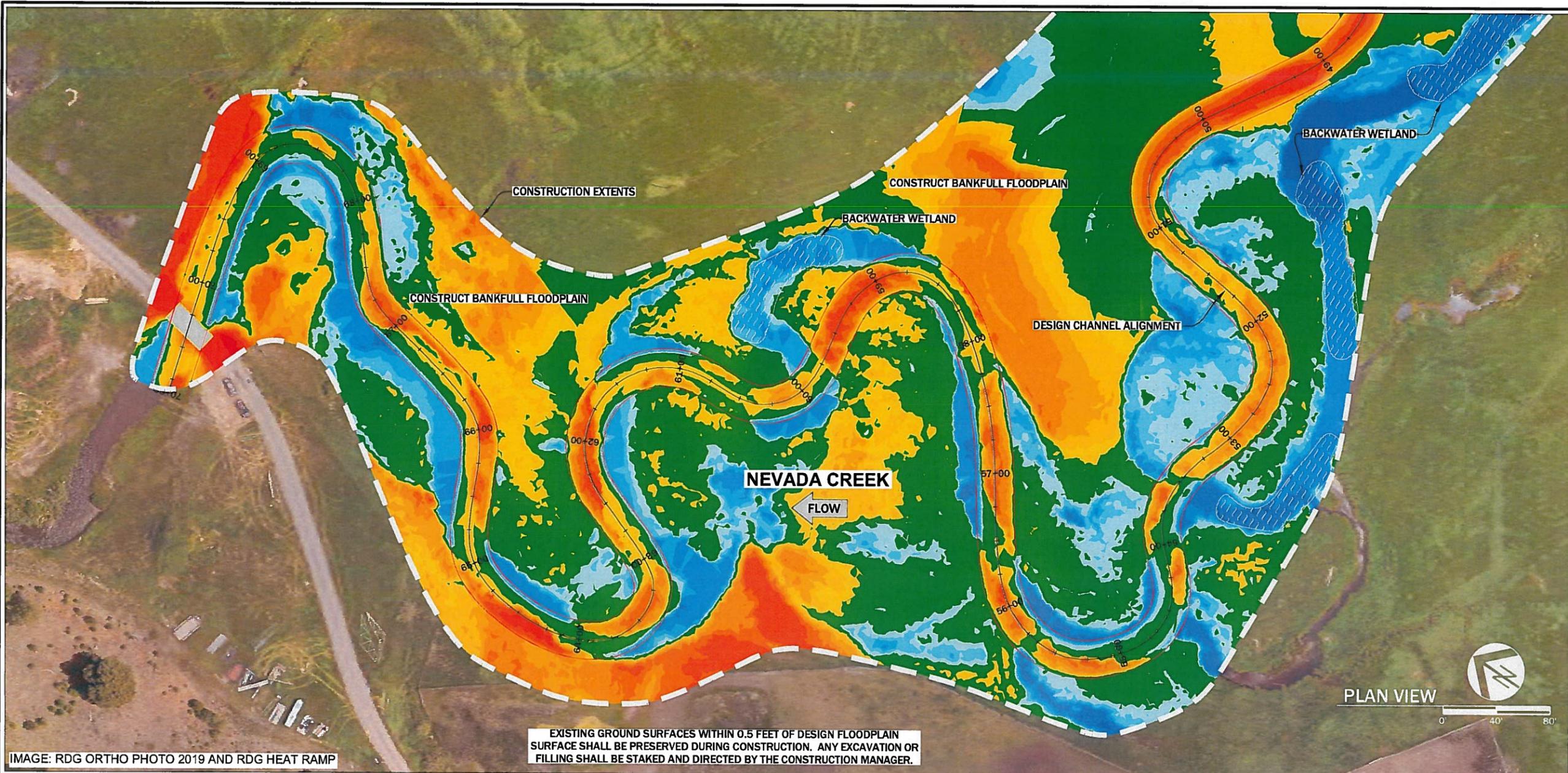
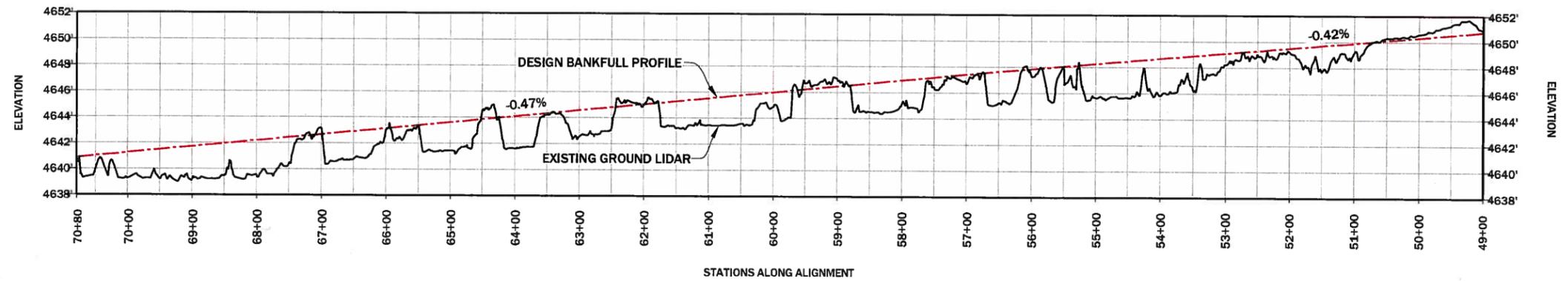
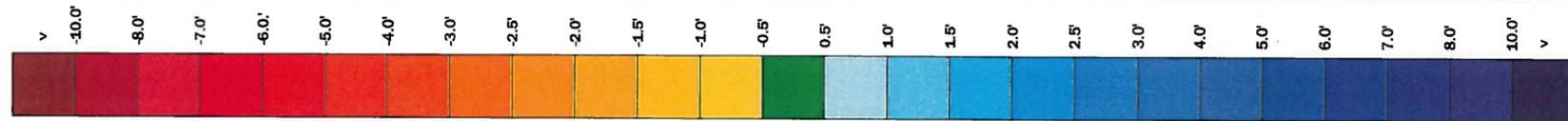


IMAGE: RDG ORTHO PHOTO 2019 AND RDG HEAT RAMP

EXISTING GROUND SURFACES WITHIN 0.5 FEET OF DESIGN FLOODPLAIN SURFACE SHALL BE PRESERVED DURING CONSTRUCTION. ANY EXCAVATION OR FILLING SHALL BE STAKED AND DIRECTED BY THE CONSTRUCTION MANAGER.



GRADING PLAN AND PROFILE

NEVADA CREEK PHASE 4 NEAR HELMVILLE, MONTANA

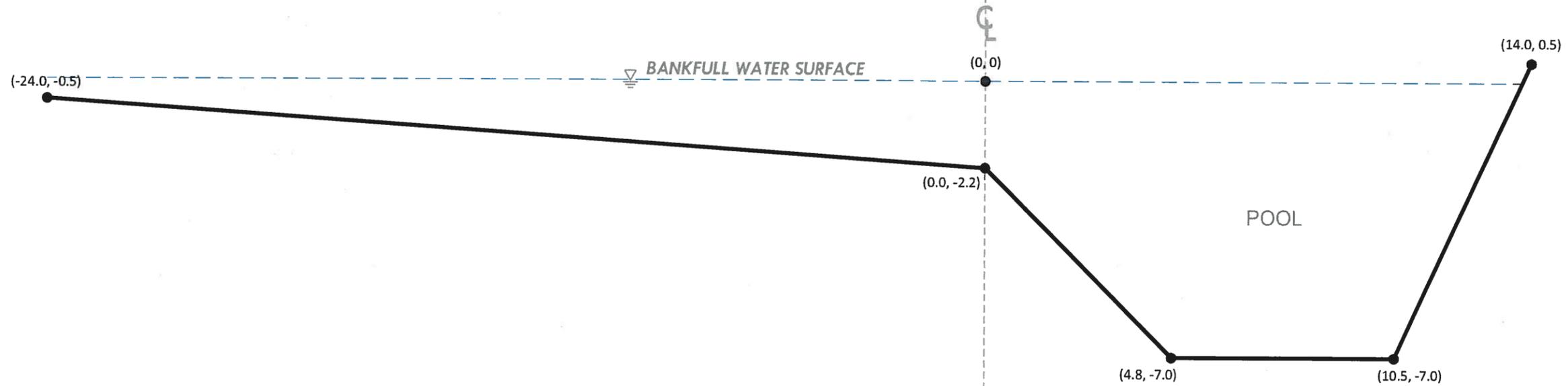
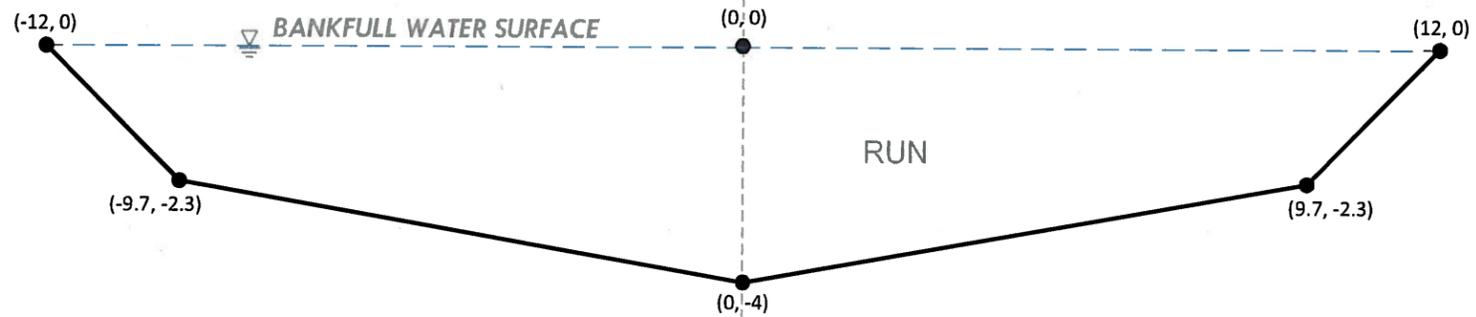
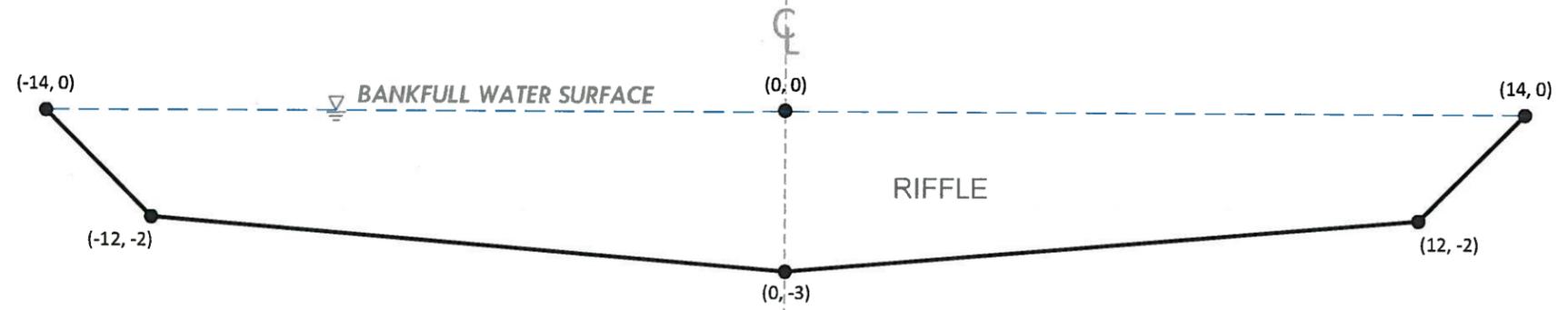
NO.	DATE	BY	DESCRIPTION	CHK	JM
1	9-20-19	NW	Conceptual Design		

PROJECT NUMBER
RDG-18-002

SHEET NUMBER

4.5

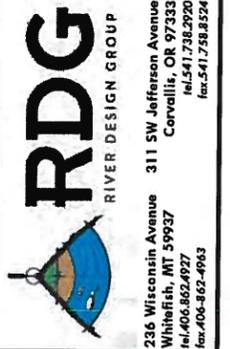
BANKFULL CHANNEL DESIGN CRITERIA			
STREAM TYPE	C4		
DISCHARGE	220 CFS		
VALLEY SLOPE	0.0058 - 0.011 FT/FT		
SINUOSITY	2.3		
CHANNEL SLOPE	0.0025 - 0.0047 FT/FT		
PARAMETER	RIFFLE	RUN	POOL
FEATURE			
WIDTH	27-30 ft	22-28 ft	33-39 ft
MEAN DEPTH	1.9-2.1 ft	2.1-2.6 ft	2.0-2.3 ft
MAX. DEPTH	2.6-3.4 ft	3.4-4.6 ft	5.9-7.9 ft
XS AREA	55 sq ft	58 sq ft	77 sq ft
WIDTH:DEPTH	13-16	N/A	N/A



**CHANNEL CROSS SECTIONS
TYPICAL**



NOTE: COORDINATES ARE REFERENCED FROM TOP OF BANK CENTERLINE



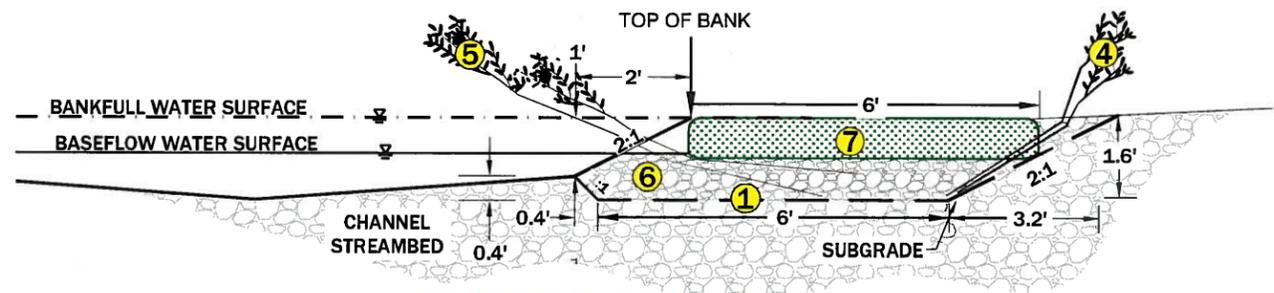
**CHANNEL CROSS
SECTION DIMENSIONS**
NEVADA CREEK PHASE 4
NEAR HELMVILLE, MONTANA

NO.	DATE	BY	DESCRIPTION	CHK
1	9-27-19	NW	CONCEPTUAL DESIGN	JM

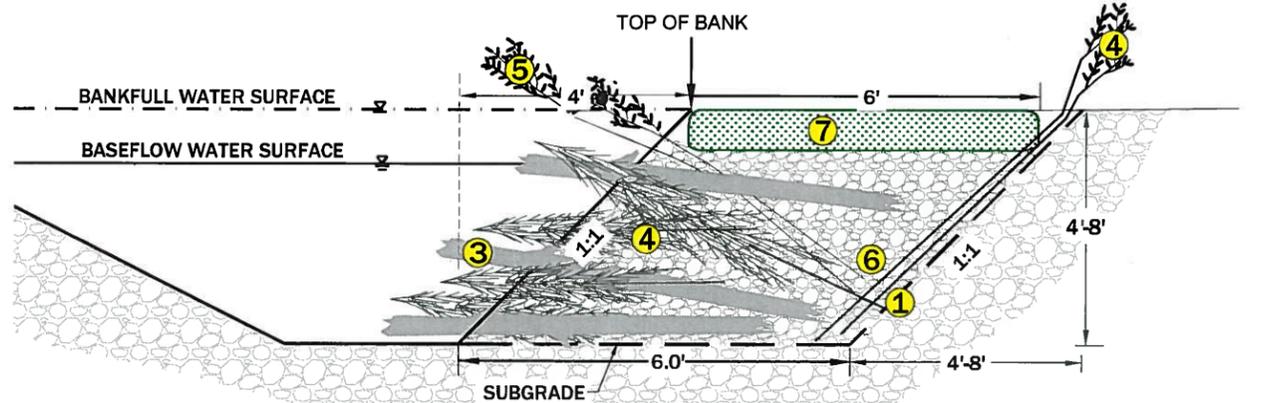
PROJECT NUMBER
RDG-18-002

SHEET NUMBER

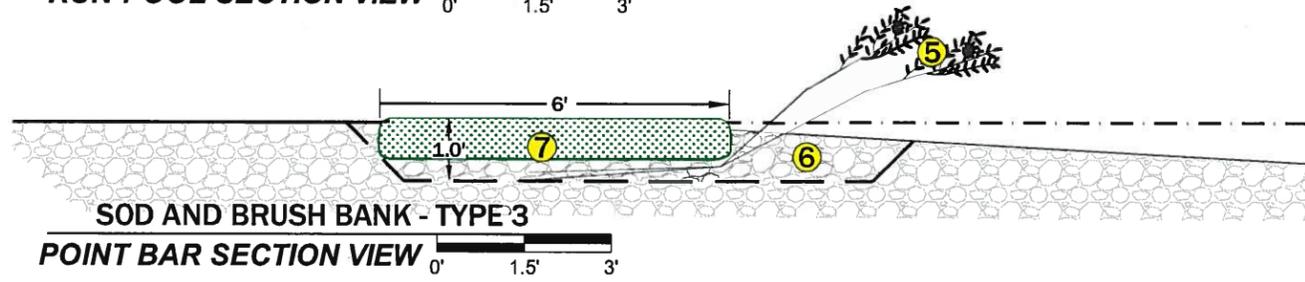
5.0



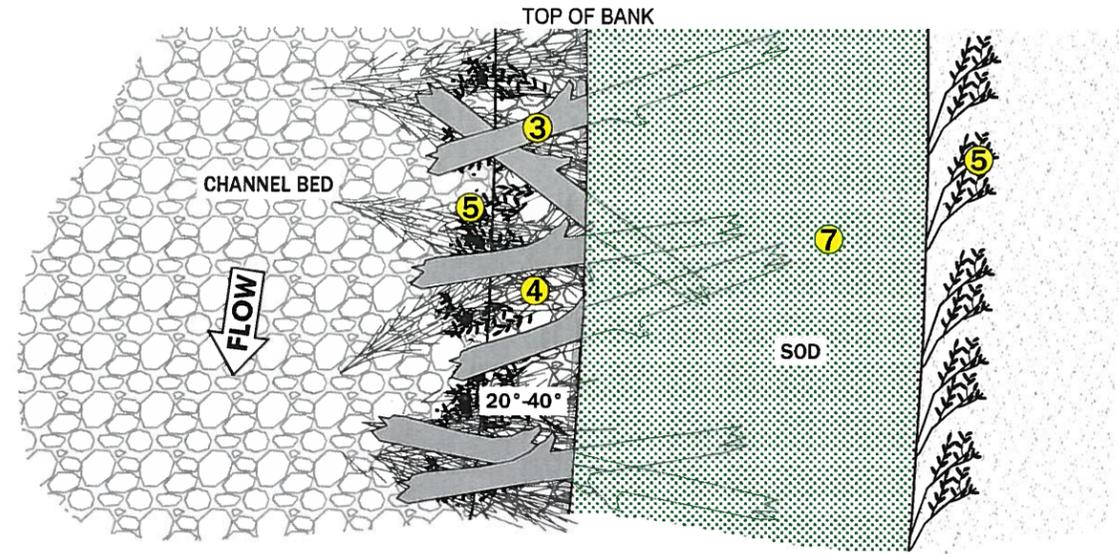
SOD AND BRUSH BANK - TYPE 1
RIFFLE SECTION VIEW
 0' 1.5' 3'



SOD AND BRUSH BANK - TYPE 2
RUN-POOL SECTION VIEW
 0' 1.5' 3'



SOD AND BRUSH BANK - TYPE 3
POINT BAR SECTION VIEW
 0' 1.5' 3'



SOD AND BRUSH BANK
PLAN VIEW
 0' 1.5' 3'

GENERAL NOTES

1. ANY CHANGES TO THE CONSTRUCTION SEQUENCE MUST BE APPROVED THE ENGINEER.
2. FIELD ENGINEER SHALL MARK THE GENERAL CONSTRUCTION LOCATION FOR EACH SOD AND BRUSH BANK STRUCTURE PRIOR TO CONSTRUCTION.

NOTES ON SOD AND BRUSH BANK INSTALLATION

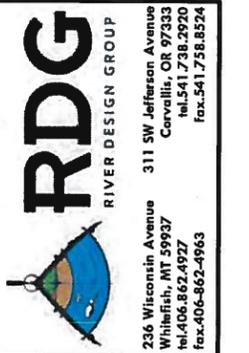
- 1 EXCAVATE STREAMBANK TO SUBGRADE ELEVATIONS.
- 2 PLACE SMALL LOGS IN THE STREAMBANK AT SKEWED ANGLE TO THE STREAMBANK (AS APPLICABLE). LOGS SHALL BE PLACED BELOW THE TOP OF BANK ELEVATION. LOGS MAY OVERLAP.
- 3 PLACE BRUSH WITHIN THE MATRIX OF SMALL LOGS (AS APPLICABLE). BRUSH SHALL PLACED BELOW TOP OF BANK LINE.
- 4 PLACE CUTTINGS INTO THE LOG/BRUSH MATRIX WITH THE STEMS IN CONTACT WITH THE BASEFLOW WATER TABLE AND THE LEAVES AT OR ABOVE THE BANKFULL WATER SURFACE ELEVATION.
- 5 BACKFILL STREAMBANK WITH STREAMBANK FILL PER THE GRADATION SHOWN ON THE DRAWINGS.
- 6 WASH FINES AND WATER FROM ONSITE INTO THE STREAMBANK FILL TO SEAL THE VOIDS IN THE BACKFILL.
- 7 PLACE A 8-12 INCH SOD MAT BEGINNING AT BANKLINE AND EXTENDING BACK 6 FEET IN TO FLOODPLAIN TO MATCH FINISHED GROUND ELEVATIONS. REFER TO VEGETATION SALVAGE PLAN FOR SOD SOURCES.

STREAMBANK FILL GRADATION

SIZE (INCHES)	PERCENT PASSING	REPRESENTATIVE SIZE CLASS
6	95	D100
5	90-95	D95
4	85-90	D84
2.5	65 - 85	D65
2.0	50 - 65	D50
1.5	30 - 50	D35
0.6	10 - 30	D15
FINES	0	

MATERIAL SCHEDULE (PER LINEAR FOOT)

ITEM	TYPE 1 QUANTITY	TYPE 2 QUANTITY	TYPE 3 QUANTITY	DIA. (IN)	LENGTH (FT)
1 CY OF SUBGRADE EXCAVATION	0.34	1	0.1		
6 CY OF STREAMBANK FILL	0.1	0.3	0.05		
3 CATEGORY 3 WOOD	-	4	-	3-6	8-10
4 CATEGORY 4 WOOD	-	4	-	1-3	8-10
7 SEDGE SOD MAT	6 SF	6 SF	6 SF	8-12 (THICK)	
5 WILLOW CUTTINGS	7	7	5	0.75-1.5	6-8

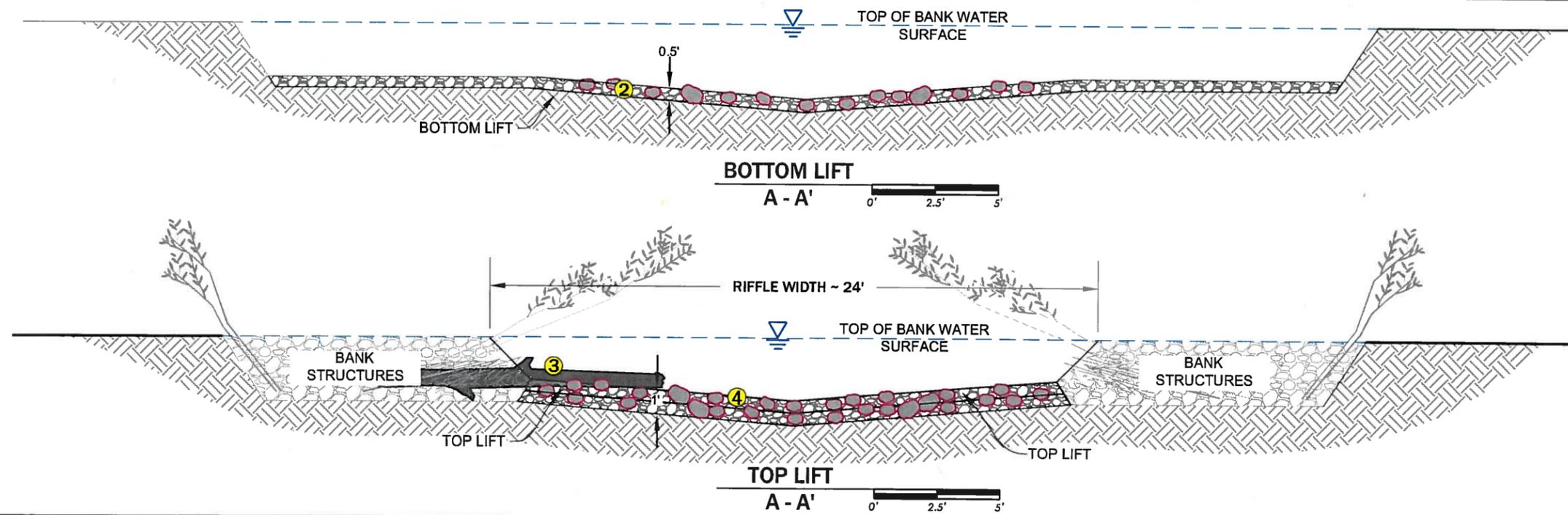
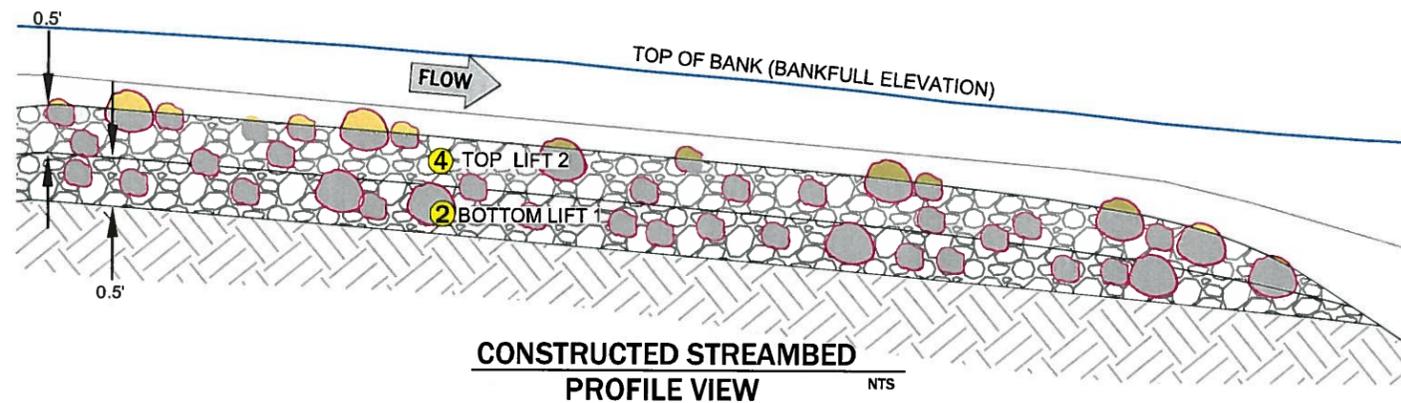
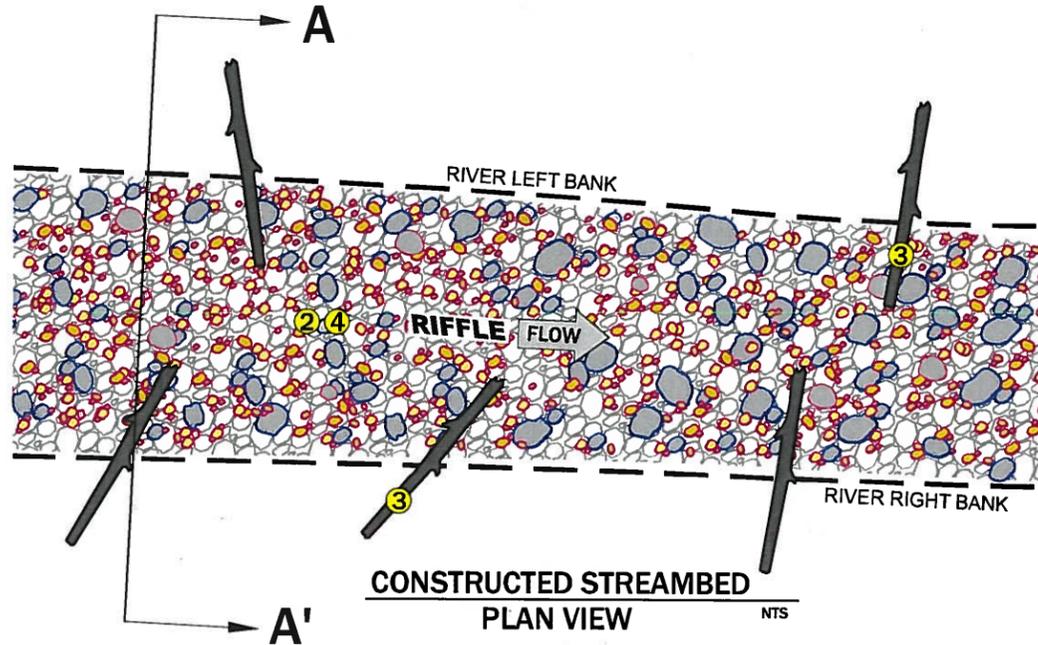


SOD AND BRUSH BANK DETAIL
 NEVADA CREEK PHASE 4
 NEAR HELMVILLE, MONTANA

NO.	DATE	BY	DESCRIPTION	CHK	JM
1	9-27-19	NW	CONCEPTUAL DESIGN		

PROJECT NUMBER
 RDG-18-002

SHEET NUMBER
6.0



GENERAL NOTES

1. ANY CHANGES TO THE CONSTRUCTION SEQUENCE MUST BE APPROVED THE ENGINEER.
2. CONTRACTOR SHALL MARK THE UPSTREAM AND DOWNSTREAM EXTENTS OF THE LOCATIONS OF THE CONSTRUCTED STREAMBED STRUCTURES.

NOTES ON CONSTRUCTED STREAMBED INSTALLATION

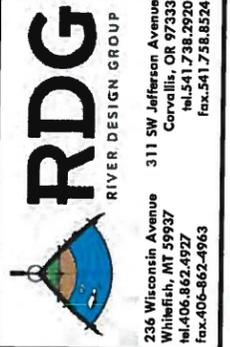
- 1 EXCAVATE STREAMBED TO SUBGRADE ELEVATIONS. THE ENGINEER WILL CONFIRM WHETHER SUBGRADE EXCAVATION AND RIFFLE CONSTRUCTION ARE NECESSARY BASED ON OBSERVED SUBSTRATE CONDITIONS.
- 2 PLACE THE BOTTOM LIFT OF RIFFLE MATERIAL. RIFFLE MATERIAL SHALL CONSIST OF THE DESIGNATED STREAMBED MATERIAL GRADATION.
- 3 COMPACT THE BOTTOM LIFT OF RIFFLE MATERIAL USING WEIGHT OF EQUIPMENT OR BUCKET COMPACTION. WASH WATER AND FINES INTO THE LIFT TO FILL VOIDS.
- 4 PLACE THE TOP LIFT OF RIFFLE MATERIAL LOOSELY ON TOP OF THE FIRST LIFT AND GRADE TO FINISHED ELEVATIONS. DO NOT COMPACT OR TRACK EQUIPMENT OVER THE TOP LIFT OF RIFFLE MATERIAL.
- 5 WASH WATER AND FINES INTO THE TOP LIFT TO FILL VOIDS.

STREAMBED FILL GRADATION

SIZE (INCHES)	PERCENT PASSING	REPRESENTATIVE SIZE CLASS
6	95	D100
5	90-95	D95
4	85-90	D84
2.5	65 - 85	D65
2.0	50 - 65	D50
1.5	30 - 50	D35
0.6	10 - 30	D15
FINES	0-10	

MATERIAL SCHEDULE (PER LINEAR FOOT)

ITEM	DIAMETER	QUANTITY
2 4 STREAMBED MATERIAL	SEE GRADATION	1.0 CY
3 CATEGORY 3 WOOD	3"-6" DIA., 8'-10' L	0.1



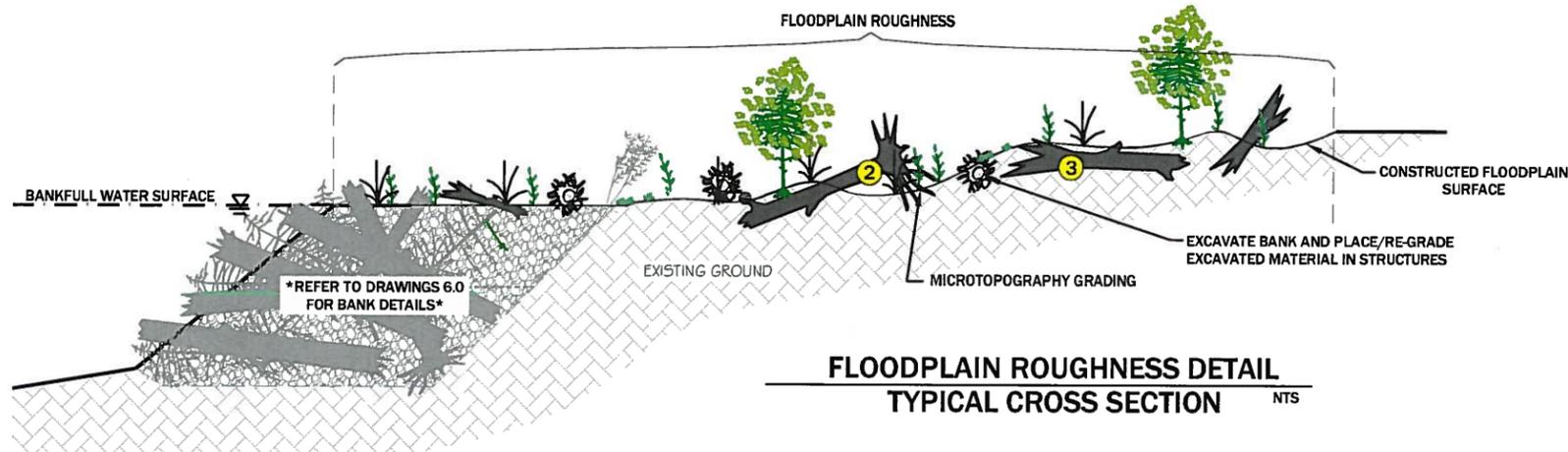
CONSTRUCTED STREAMBED DETAIL
NEVADA CREEK PHASE 4
NEAR HELMVILLE, MONTANA

NO.	DATE	BY	DESCRIPTION	CHK
1	9-27-19	NW	CONCEPTUAL DESIGN	JM

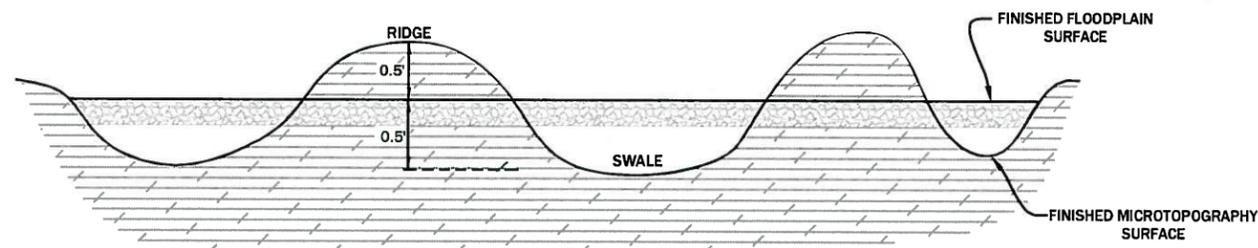
PROJECT NUMBER
RDG-18-002

SHEET NUMBER

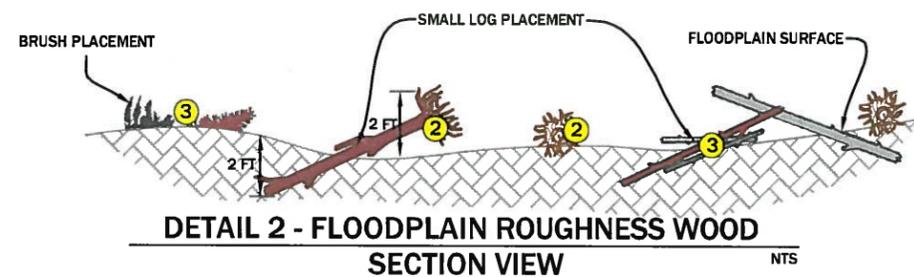
6.1



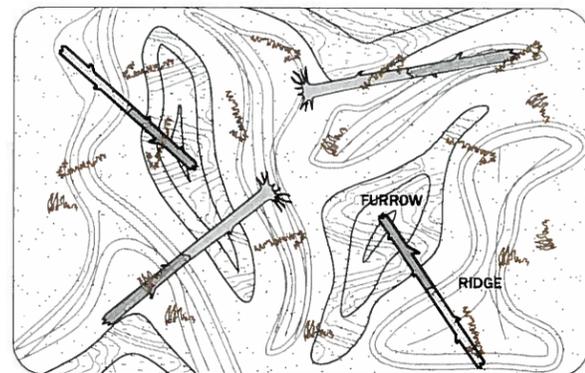
**FLOODPLAIN ROUGHNESS DETAIL
TYPICAL CROSS SECTION** NTS



**DETAIL 1 - MICROTOPOGRAPHY GRADING
SECTION VIEW** NTS



**DETAIL 2 - FLOODPLAIN ROUGHNESS WOOD
SECTION VIEW** NTS



**DETAIL 3 - MICROTOPOGRAPHY AND FLOODPLAIN WOOD PLACEMENT
PLAN VIEW** NTS

GENERAL NOTES

1. ANY CHANGES TO THE CONSTRUCTION SEQUENCE MUST BE APPROVED BY THE ENGINEER.

NOTES ON FLOODPLAIN ROUGHNESS INSTALLATION

1. CONTRACTOR SHALL DEVELOP MICROTOPOGRAPHY AND PLACE WOODY MATERIAL IN THE CONSTRUCTED FLOODPLAIN.
2. TRANSPORT COARSE WOOD AND BRUSH FROM DESIGNATED BORROW SOURCES OR STOCKPILE AREAS AND PLACE IT WITHIN THE MICROTOPOGRAPHY TREATMENT AREA AS SHOWN ON DRAWINGS.
3. PLACE WOOD CATEGORY 2 WOOD AT A RATE OF 50 PIECES PER ACRE, CATEGORY 3 WOOD AT A RATE OF 150 PIECES PER ACRE AND SPACED AT A TYPICAL DISTANCE OF 20 FEET FROM OTHER COARSE WOOD.
4. BURY COARSE WOOD WITHIN THE FLOODPLAIN SURFACE, WITH ONE HALF OF THE LENGTH BURIED TO A DEPTH OF 3-FT. AND ONE HALF EXPOSED AS SHOWN ON DRAWING.
5. CONSTRUCT LOW AND HIGH FEATURES (RIDGES AND FURROWS) AS SHOWN ON DRAWINGS. MAXIMUM HEIGHT OF RIDGES AND DEPTH OF FURROWS SHALL BE NO GREATER THAN 0.5-FT. RELATIVE TO FINISHED FLOODPLAIN SURFACE.

MATERIAL SCHEDULE (PER ACRE)

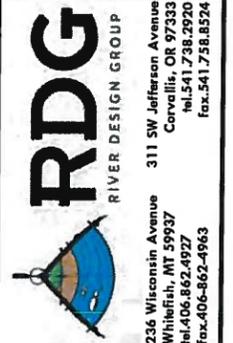
	ITEM	QUANTITY
②	CATEGORY 2 WOOD	50
③	CATEGORY 3 WOOD	150



EXAMPLE OF CONSTRUCTED FLOODPLAIN ROUGHNESS



EXAMPLE OF CONSTRUCTED FLOODPLAIN ROUGHNESS



**FLOODPLAIN ROUGHNESS DETAIL
NEVADA CREEK PHASE 4
NEAR HELMVILLE, MONTANA**

NO.	DATE	BY	DESCRIPTION	CHK
				JM
1	9-27-19	NW	CONCEPTUAL DESIGN	

PROJECT NUMBER
RDG-18-002

SHEET NUMBER

6.2

BMP DETAILS
NEVADA CREEK PHASE 4
NEAR HELMVILLE, MONTANA

NO.	DATE	BY	DESCRIPTION	CHK.
1	9-27-19	NW	CONCEPTUAL DESIGN	JM

PROJECT NUMBER
RDG-18-002

SHEET NUMBER
7.0

BULK BAG NOTES

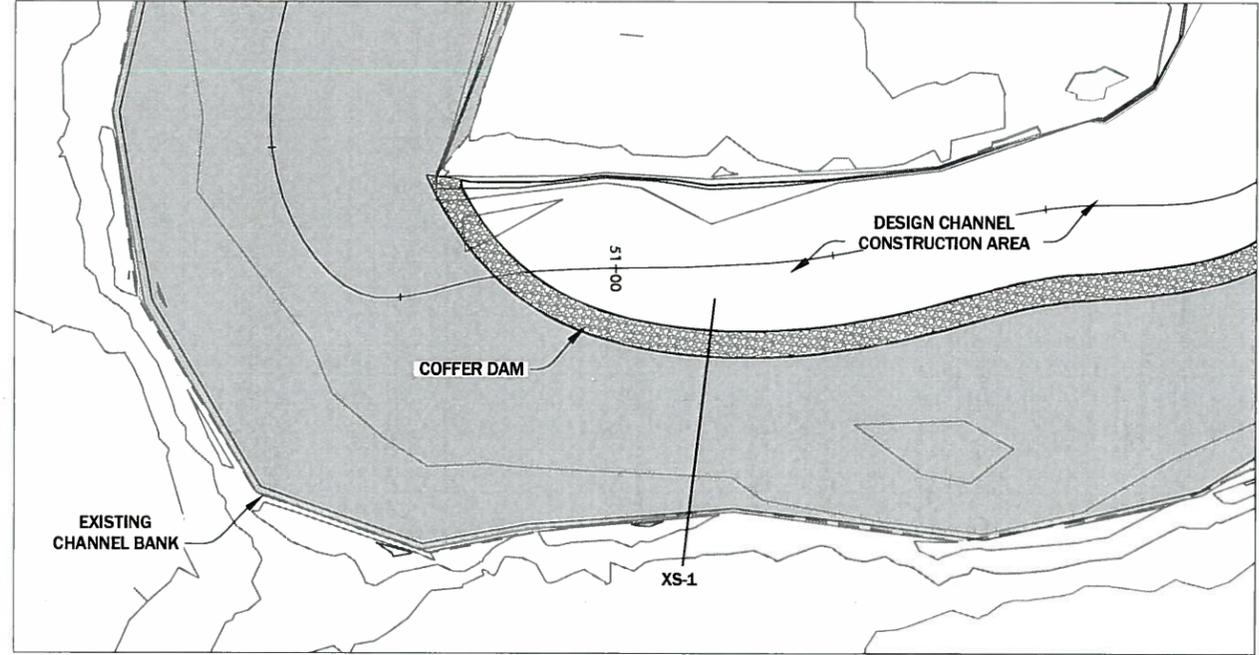
BULK BAGS ARE ALSO CALLED FLEXIBLE INTERMEDIATE BULK CONTAINERS (FIBC) THAT CAN BE CUSTOM MADE FROM VARIOUS FABRIC. THE FOLLOWING REQUIREMENTS ARE NECESSARY FOR THE RIVER ENVIRONMENT:

LARGE BULK BAGS SHALL BE CONSTRUCTED OF 8 oz WOVEN FABRIC, 1200 HOUR UV RESISTANT WITH SEWN LIFTING LOOPS. WHEN FILLED WITH NATIVE RIVER SAND AND GRAVEL, THE BAGS ARE APPROXIMATELY 6' WIDE x 6' LONG x 4' HIGH.

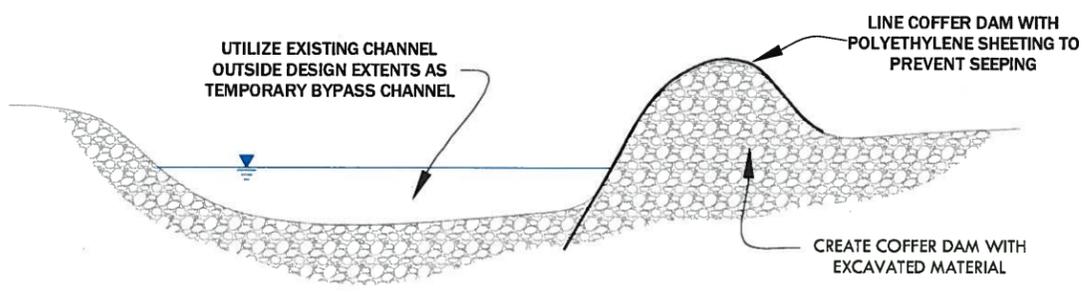
SMALL BULK BAGS SHALL BE CONSTRUCTED OF 8 oz WOVEN FABRIC, 1200 HOUR UV RESISTANT WITH SEWN LIFTING LOOPS. WHEN FILLED WITH NATIVE RIVER SAND AND GRAVEL, THE BAGS ARE APPROXIMATELY 3' WIDE x 3' LONG x 2.5' HIGH.

BULK BAGS SHALL BE CAREFULLY PLACED TO ENSURE NO TEARING OR CUTTING OF THE BAGS OCCURS.

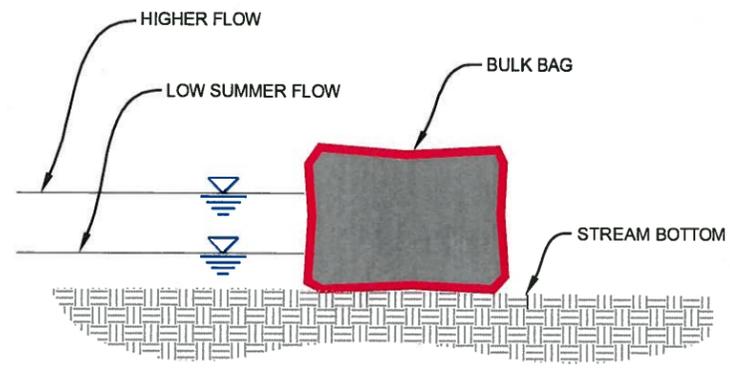
BULK BAGS SHALL BE PLACED USING A HYDRAULIC CRANE OR TRACKHOE USING LIFTING BARS AND STEEL CABLES TO EQUALIZE LOAD ON LIFTING LOOPS.



TEMPORARY COFFER DAM DETAIL
PLAN VIEW



TEMPORARY COFFER DAM DETAIL
XS-1



TYPICAL BULK BAG PLACEMENT