KNIFE RIVER

ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA
APRIL 2020

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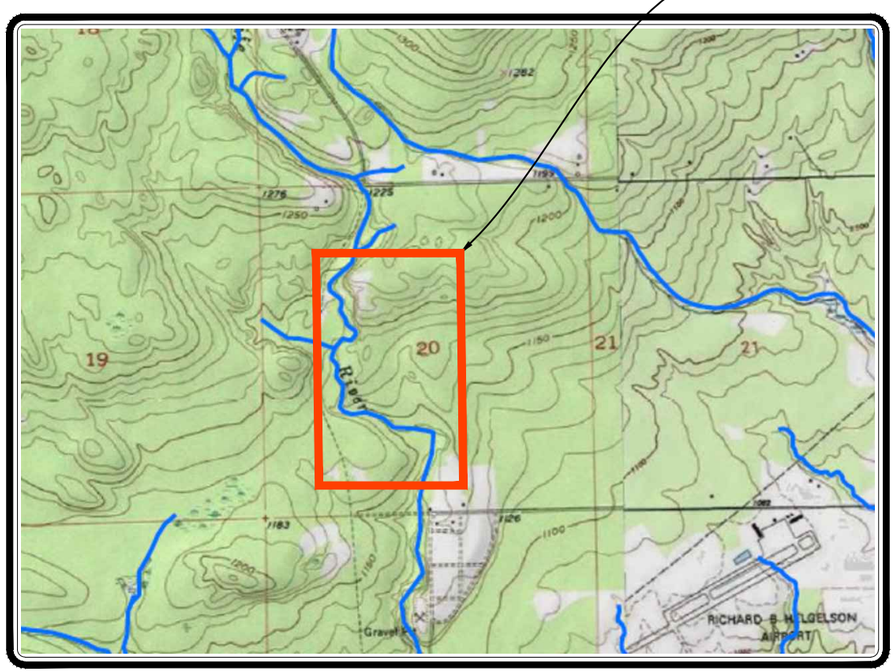
These restoration design plans and specifications were prepared for the Lake Superior Steelhead Associations Reach 4 Knife River Restoration project using Federal funds under award NA18NOS4190081 from the Coastal Zone Management Act of 1972, as amended, administered by the Office for Coastal Management, National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce provided to the Minnesota Department of Natural Resources (MNDNR) for Minnesota's Lake Superior Coastal Program. The statements, findings, conclusions, and recommendations are those of the author(s) and do not necessarily reflect the views of NOAA, the U.S. Department of Commerce, or the MNDNR.

PROJECT LOCATION



GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
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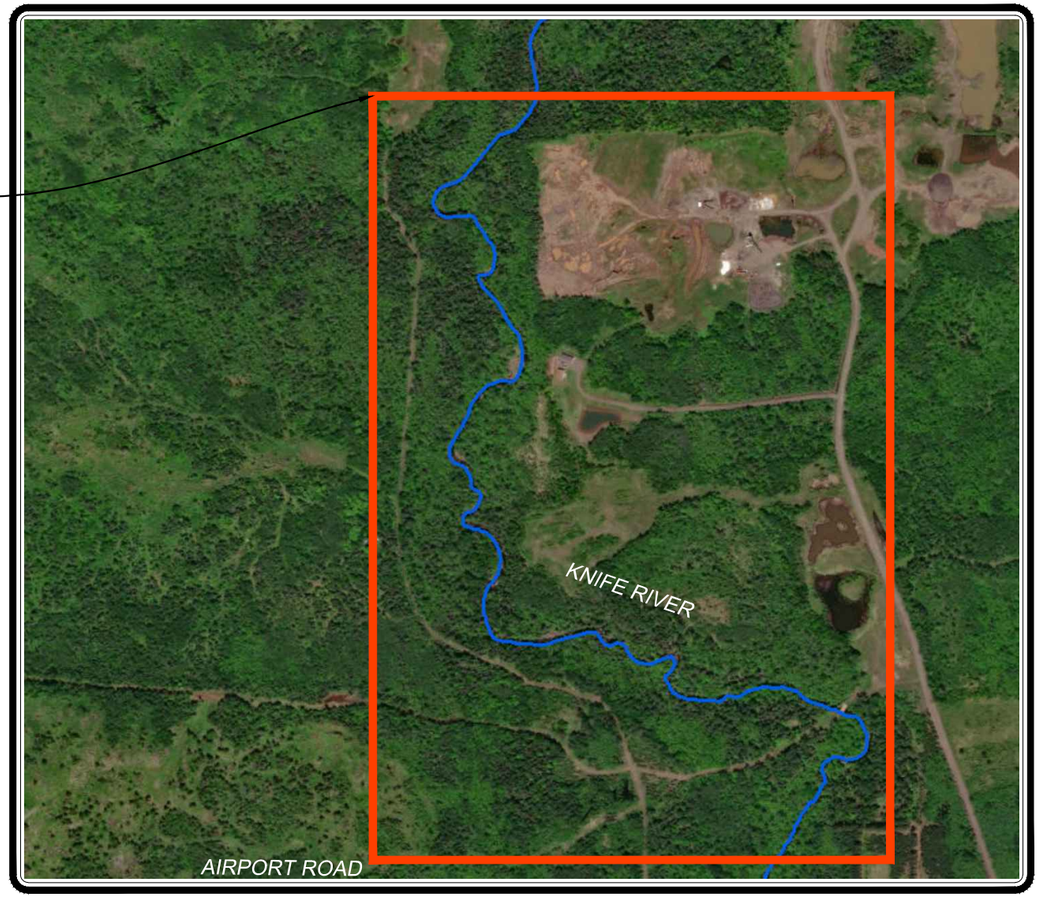
VICINITY MAP
SCALE: 1" = 1000'

0 1000' 2000'
GRAPHIC SCALE IN FEET



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SITE MAP
SCALE: 1" = 80'

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90% DESIGN

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#	DATE	DESCRIPTION	BY

COVER SHEET
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

DATE	APRIL 2020
DRAWN	COD
DESIGNED	ACS
CHECKED	
PROJECT #	J188372100

SHEET TITLE
COVER

SHEET NUMBER
1

LAND USE # —

Existing Project Reach Channel Dimension Summary

Riffle Cross Sections

Station	Facet	Bankfull Area (ft2)	Bankfull Width (ft)	Bankfull Depth (ft)	Maximum Depth (ft)	Entrenchment Ratio	Width Depth Ratio
9+65	Riffle	38.0	28.1	1.4	1.9	1.6	20.8
15+30	Riffle	44.4	24.5	1.8	2.8	3.2	13.5
19+06	Riffle	38.8	27.4	1.4	2.4	5.1	19.3
21+00	Riffle	52.7	27.2	1.9	3.0	2.7	14.0
22+97	Riffle	38.9	23.2	1.7	2.6	1.8	13.8
24+46	Riffle	55.4	31.4	1.8	3.0	5.2	17.9
24+94	Riffle	57.6	29.4	2.0	3.6	3.4	15.0
28+98	Riffle	42.2	24.0	1.8	2.2	3.5	13.7
32+90	Riffle	40.1	30.2	1.3	2.0	1.8	22.7
35+40	Riffle	38.2	25.6	1.5	2.4	4.7	17.2
37+11	Riffle	37.3	22.4	1.7	2.2	3.0	13.5
42+84	Riffle	40.1	35.8	1.1	1.4	1.2	31.9
43+43	Riffle	47.6	24.3	2.0	2.6	2.6	12.4
49+22	Riffle	36.0	38.8	0.9	2.4	3.5	41.7
50+83	Riffle	43.4	40.3	1.1	2.3	3.7	37.3
51+71	Riffle	40.8	26.7	1.5	2.1	2.0	17.4
56+59	Riffle	42.5	42.2	1.0	2.1	2.9	41.7
57+00	Riffle	47.2	37.0	1.3	2.9	2.9	28.9
57+84	Riffle	32.9	21.8	1.5	2.8	4.7	14.4
59+83	Riffle	47.2	27.6	1.7	2.6	3.1	16.2
68+37	Riffle	35.5	24.5	1.5	2.0	6.2	16.9
	Mean	42.7	29.2	1.5	2.4	3.3	21.0
	Min.	32.9	21.8	0.9	1.4	1.2	12.4
	Max.	57.6	42.2	2.0	3.6	6.2	41.7

Pool Cross Sections

Station	Facet	Bankfull Area (ft2)	Bankfull Width (ft)	Bankfull Depth (ft)	Maximum Depth (ft)	Entrenchment Ratio	Width Depth Ratio
11+51	Pool	40.5	24.9	1.6	2.3	2.1	15.4
26+14	Pool	54.6	26.5	2.1	4.3	3.8	12.9
42+42	Pool	50.9	34.4	1.5	3.2	2.1	23.2
48+72	Pool	41.5	21.4	1.9	4.1	5.7	11.0
51+44	Pool	41.1	37.8	1.1	2.3	1.6	34.7
64+57	Pool	35.5	22.1	1.6	2.4	11.3	13.7
67+00	Pool	30.8	20.8	1.5	2.9	5.3	14.0
68+65	Pool	33.3	25.7	1.3	2.8	5.1	19.9
	Mean	41.0	26.7	1.6	3.0	4.6	18.1
	Min.	30.8	20.8	1.1	2.3	1.6	11.0
	Max.	54.6	37.8	2.1	4.3	11.3	34.7

Glide Cross Section

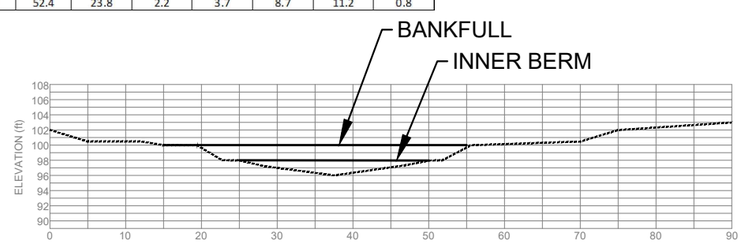
Station	Facet	Bankfull Area (ft2)	Bankfull Width (ft)	Bankfull Depth (ft)	Maximum Depth (ft)	Entrenchment Ratio	Width Depth Ratio
16+17	Glide	48.2	34.4	1.4	3.4	3.7	24.5

Run Cross Section

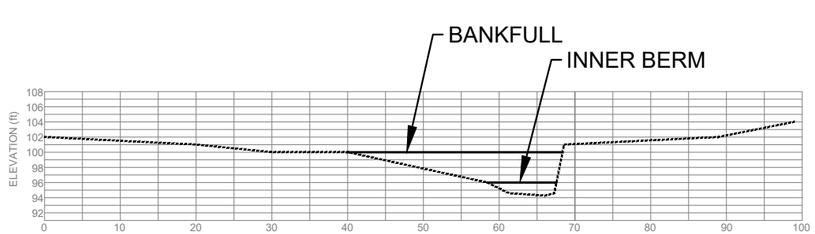
Station	Facet	Bankfull Area (ft2)	Bankfull Width (ft)	Bankfull Depth (ft)	Maximum Depth (ft)	Entrenchment Ratio	Width Depth Ratio
44+56	Run	34.7	25.8	1.4	2.2	2.6	19.1

Proposed Channel - Typical Channel Dimensions

Facet	Bankfull Area (ft2)	Bankfull Width (ft)	Bankfull Depth (ft)	Max Depth (ft)	Inner Berm Area (ft2)	Inner Berm Width (ft)	Inner Berm Depth (ft)
Riffle	46.6	27	1.7	2.3	5.8	17	0.4
Pool	52.4	23.8	2.2	3.7	8.7	11.2	0.8



CROSS SECTION TYPICAL - PROPOSED RIFFLE



CROSS SECTION TYPICAL - PROPOSED POOL

Existing Reference Reach Channel Dimension Summary

Riffle Cross Sections

Station	Facet	Bankfull Area (ft2)	Bankfull Width (ft)	Bankfull Depth (ft)	Maximum Depth (ft)	Entrenchment Ratio	Width Depth Ratio
0+09	Riffle	42.3	28.1	1.5	2.5	2.7	18.6
4+25	Riffle	47.1	26.0	1.8	2.6	5.8	14.3
7+25	Riffle	33.0	20.1	1.6	2.2	2.8	12.3
71+56	Riffle	54.2	31.3	1.7	2.7	2.7	18.1
	Mean	44.2	26.4	1.7	2.5	3.5	15.8
	Min.	33.0	20.1	1.5	2.2	2.7	12.3
	Max.	54.2	31.3	1.8	2.7	5.8	18.6

Pool Cross Sections

Station	Facet	Bankfull Area (ft2)	Bankfull Width (ft)	Bankfull Depth (ft)	Maximum Depth (ft)	Entrenchment Ratio	Width Depth Ratio
2+38	Pool	37.3	21.1	1.8	3.1	4.7	11.9
4+73	Pool	62.6	25.7	2.4	3.5	4.3	10.5
73+29	Pool	53.7	25.1	2.1	3.2	2.7	11.7
75+00	Pool	51.9	32.5	1.6	2.8	1.6	20.3
	Mean	51.4	26.1	2.0	3.1	3.3	13.6
	Min.	37.3	21.1	1.6	2.8	1.6	10.5
	Max.	62.6	32.5	2.4	3.5	4.7	20.3

Proposed Project Reach Channel Dimension Summary

Riffle Cross Sections

Station	Facet	Bankfull Area (ft2)	Bankfull Width (ft)	Bankfull Depth (ft)	Maximum Depth (ft)	Entrenchment Ratio	Width Depth Ratio
15+30	Riffle	46.6	27.0	1.7	2.3	3.3	15.6
21+00	Riffle	46.6	27.0	1.7	2.3	3.4	15.6
22+97	Riffle	47.0	27.0	1.7	2.3	4.7	15.5
26+14	Riffle	46.6	27.0	1.7	2.3	4.4	15.6
28+98	Riffle	42.2	24.0	1.8	2.2	3.5	13.7
37+11	Riffle	46.6	27.0	1.7	2.3	2.9	15.6
	Mean	45.9	26.5	1.7	2.3	3.7	15.3
	Min.	42.2	24.0	1.7	2.2	2.9	13.7
	Max.	47.0	27.0	1.8	2.3	4.7	15.6

Station	Facet	Bankfull Area (ft2)	Bankfull Width (ft)	Bankfull Depth (ft)	Maximum Depth (ft)	Entrenchment Ratio	Width Depth Ratio
11+51	Pool	40.5	24.9	1.7	2.3	2.2	15.4
15+01	Pool	52.4	23.8	2.2	3.7	4.2	10.8
19+06	Pool	52.4	23.8	2.2	3.7	6.6	10.8
24+94	Pool	52.4	23.8	2.2	3.7	5.1	10.8
31+00	Pool	52.4	23.8	2.2	3.7	5.8	10.8
35+08	Pool	52.4	23.8	2.2	3.7	6.0	10.8
42+42	Pool	52.4	23.8	2.2	3.7	3.5	10.8
51+44	Pool	39.6	33.9	1.2	2.3	2.3	28.9
64+57	Pool	45.0	25.1	1.8	2.8	7.6	13.9
	Mean	48.8	25.2	2.0	3.3	4.8	13.7
	Min.	39.6	23.8	1.2	2.3	2.2	10.8
	Max.	52.4	33.9	2.2	3.7	7.6	28.9

Station	Facet	Bankfull Area (ft2)	Bankfull Width (ft)	Bankfull Depth (ft)	Maximum Depth (ft)	Entrenchment Ratio	Width Depth Ratio
16+17	Glide	48.2	34.3	1.4	3.4	3.7	24.3

Station	Facet	Bankfull Area (ft2)	Bankfull Width (ft)	Bankfull Depth (ft)	Maximum Depth (ft)	Entrenchment Ratio	Width Depth Ratio
11+09	Run	46.6	27.0	1.7	2.3	2.2	15.6
44+56	Run	46.6	27.0	1.7	2.3	3.6	15.6
	Mean	46.6	27.0	1.7	2.3	2.9	15.6
	Min.	46.6	27.0	1.7	2.3	2.2	15.6
	Max.	46.6	27.0	1.7	2.3	3.6	15.6

Toewood (TW)

Structure ID	Start	End	Length (ft)	Top of Root Collar Elevation	Bankfull Elevation Start	Bankfull Elevation End	Top of Lift Elevation	Max Lift Height (ft)	Max Lift Setback (ft)	No. of Lifts
TW-1	13+91	15+24	133	1185.8	1188.4	1185.4	1185.9	1.5	1.5	2
TW-2	18+88	19+28	40	1181.8	1183.4	1181.4	1181.9	1.5	1.5	2
TW-3	20+51	20+92	41	1179.7	1181.8	1181.4	1181.9	1.5	1.5	2
TW-4	24+57	25+23	66	1171.6	1174.6	1173.5	1174.0	1.5	1.5	2
TW-5	25+84	26+62	78	1169.7	1172.4	1171.2	1171.7	1.5	1.5	2
TW-6	30+79	31+59	80	1165.0	1167.0	1166.4	1166.9	1.5	1.5	2
TW-7	34+59	35+23	64	1159.9	1162.5	1161.8	1162.3	1.5	1.5	2
TW-8	35+90	36+46	56	1158.7	1161.2	1160.6	1161.1	1.5	1.5	2
TW-9	37+36	38+55	119	1156.6	1159.7	1158.5	1159.0	1.5	1.5	2
TW-10	41+96	42+68	72	1151.4	1154.1	1153.4	1153.9	1.5	1.5	2
TW-11	63+02	65+07	205	1128.9	1132.3	1130.9	1131.4	1.5	1.5	2

J-hook (JH)

Structure ID	Invert Station	Invert Elevation - Footer Stone	Invert Elevation - Surface Stone	Min. Length of Log (ft)	Rootwad Footer Station	Bankfull Elevation at Rootwad Footer	Footer - Vane Intersect	Min. Log Diameter (in)	No. of Logs-Vane
JH-1	13+66	1186.5	1186.8	33	13+91	1188.1	1187.0	20	2
JH-2	18+63	1182.0	1182.3	33	18+88	1183.4	1182.3	20	2
JH-3	20+26	1180.4	1180.7	33	20+51	1181.8	1180.7	20	2
JH-4	24+32	1171.4	1171.7	33	24+57	1174.6	1173.5	20	2
JH-5	25+59	1169.7	1170.0	33	25+84	1172.6	1171.5	20	2
JH-6	27+07	1168.0	1168.3	33	27+32	1169.9	1168.8	20	2
JH-7	30+54	1165.0	1165.3	33	30+79	1167.0	1165.9	20	2
JH-8	34+34	1159.7	1160.0	33	34+59	1162.5	1161.4	20	2
JH-9	35+65	1158.5	1158.8	33	35+90	1161.2	1160.1	20	2
JH-10	37+11	1156.4	1156.7	33	37+36	1159.7	1158.6	20	2
JH-11	41+71	1151.1	1151.4	33	41+96	1154.1	1153.0	20	2
JH-12	50+78	1140.7	1141.0	33	51+03	1143.1	1142.0	20	2
JH-13	55+75	1137.0	1137.3	33	56+00	1138.9	1137.8	20	2
JH-14	62+77	1128.5	1128.8	33	63+02	1132.3	1131.2	20	2

Boulder Cluster (BC)

Structure ID	BC Invert Station	BC End Station	Invert Elevation - Footer Stone	Top of Surface Stone Elevation
BC-1	15+24	15+34	1185.4	1185.7
BC-2	19+28	19+38	1181.4	1181.7
BC-3	20+92	21+02	1179.3	1179.6
BC-4	23+95	24+05	1173.1	1173.4
BC-5	25+23	25+33	1171.4	1171.7
BC-6	26+62	26+72	1169.7	1170.0
BC-7	31+59	31+74	1165.0	1165.3
BC-8	33+87	33+97	1161.4	1161.7
BC-9	35+23	35+33	1159.7	1160.0
BC-10	36+46	36+56	1158.5	1158.8
BC-11	38+55	38+65	1156.4	1156.7
BC-12	42+68	42+78	1151.0	1151.3
BC-13	44+28	44+33	1149.4	1149.7
BC-14	45+90	46+00	1148.3	1148.6
BC-15	51+64	51+74	1140.7	1141.0
BC-16	55+33	55+43	1138.2	1138.5
BC-17	56+23	56+33	1136.9	1137.2
BC-18	56+57	56+67	1136.5	1136.8
BC-19	57+05	57+15	1136.0	1136.3
BC-20	64+20	64+30	1128.3	1128.6
BC-21	65+07	65+17	1128.5	1128.8

Cross Vane (CV)

Structure ID	Invert Station	Invert Elevation - Footer Stone	Invert Elevation - Surface Stone	Bank Intersect Station	Bankfull Elevation at Intersection
CV-1	43+37	1149.6	1149.9	43+62	1152.4
CV-2	57+48	1135.8	1136.1	57+73	1136.3

Log Roller (LR)

Structure ID	Invert Station	Invert Elevation	Min. Dia. Log (In.)
LR-1	44+46	1149.3	10
LR-2	44+64	1149.1	10
LR-3	44+82	1148.9	10
LR-4	45+00	1148.7	10
LR-5	45+19	1148.3	10

Constructed Riffle (CR)

Structure ID	Constructed Riffle Start Station	Bankfull Elevation Start	Riffle Invert Elevation Start	Constructed Riffle End Station	Bankfull Elevation End	Riffle Invert Elevation End	Riffle Length (ft)	Riffle Substrate Depth (ft)	Riffle Substrate Width (ft)
CR-1	19+38	1180.8	1178.5	19+67	1182.6	1180.3	29	2	27
CR-2	24+05	1175.2	1172.9	24+32	1175.0	1171.7	27	2	27
CR-3	25+33	1173.2	1170.9	25+59	1172.8	1169.7	26	2	27
CR-4	26+72	1170.9	1169.5	27+07	1170.3	1168.0	35	2	27
CR-5	30+27	1167.4	1166.0	30+54	1167.2	1165.0	27	2	27
CR-6	33+97	1163.1	1161.3	34+34	1162.7	1159.7	37	2	27
CR-7	35+33	1161.7	1159.4	35+65	1161.4	1158.5	32	2	27
CR-8	36+56	1160.4	1158.1	37+11	1160.0	1156.4	55	2	27
CR-9	38+65	1158.4	1156.1	39+00	1158.1	1155.3	15	2	27
CR-10	41+03	1155.0	1152.7	41+71	1154.3	1151.1	68	2	27
CR-11	42+78	1153.2	1150.9	43+37	1152.6	1149.5	59	2	27
CR-12	51+74	1142.2	1140.1	52+00	1141.9	1139.6	26	2	27
CR-13	55+43	1139.7	1137.4	55+75	1139.3	1137.0	32	2	27
CR-14	56+23	1139.2	1136.9	56+37	1138.8	1136.5	14	2	27
CR-15	56+57	1138.8	1136.5	56+77	1137.7	1136.0	20	2	27
CR-16	57+05	1138.3	1136.0	57+16	1137.2	1135.8	11	2	27
CR-17	62+20	1132.9	1130.6	62+77	1132.8	1128.5	57	2	27
CR-18	65+17	1130.7	1128.4	65+27	1130.5	1128.2	10	2	27

90% DESIGN

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DESIGN NARRATIVE
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

#	DATE	DESCRIPTION	BY

DATE | APRIL 2020
DRAWN | COD
DESIGNED | ACS
CHECKED |
PROJECT # | J188372100
SHEET TITLE
NARRATIVE
SHEET NUMBER
2
LAND USE # ---

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

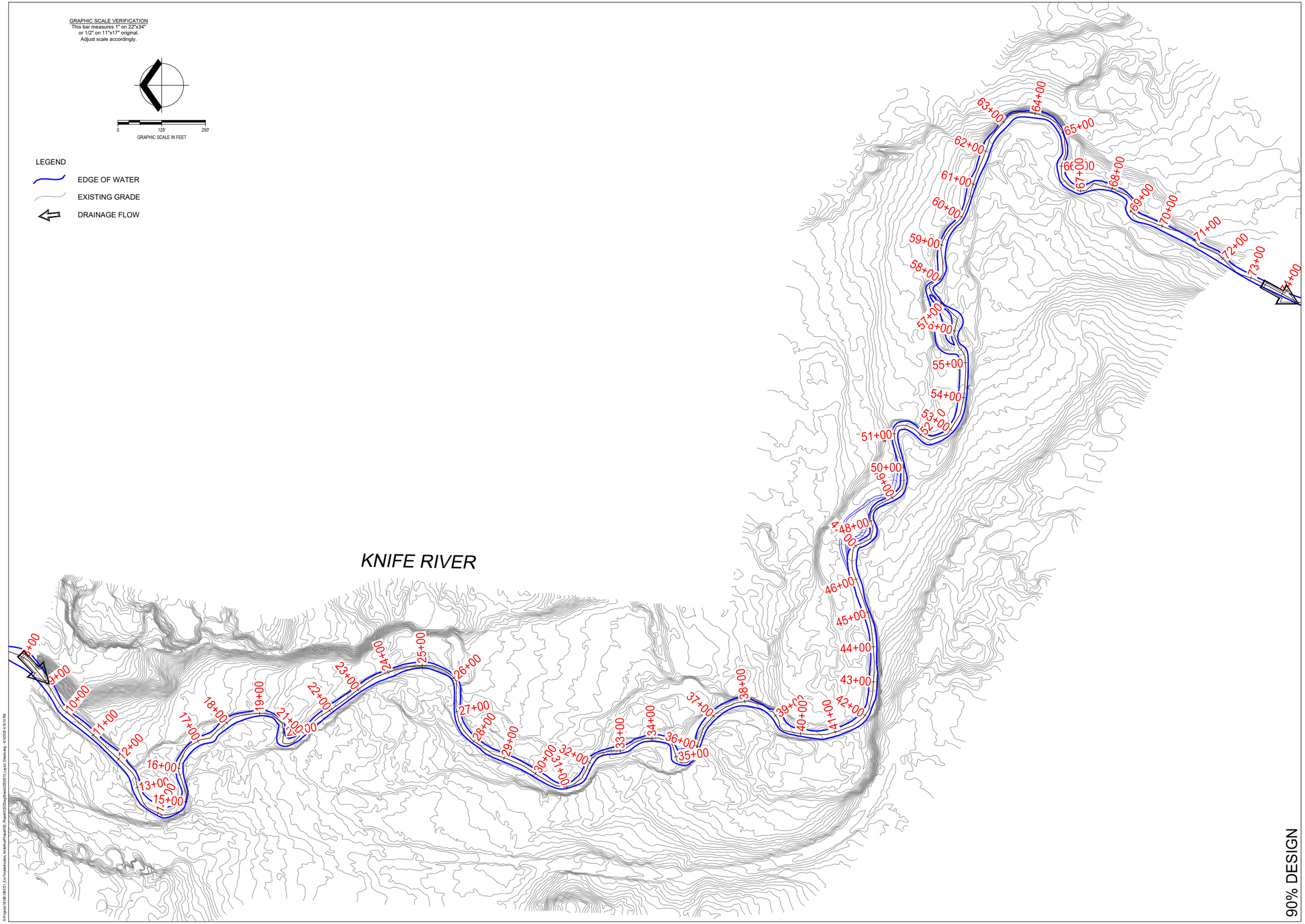
0 125' 250'
GRAPHIC SCALE IN FEET

LEGEND

EDGE OF WATER

EXISTING GRADE

DRAINAGE FLOW



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EXISTING CONDITIONS
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

#	DATE	DESCRIPTION	BY

DATE	APRIL 2020
DRAWN	MGS/COD
DESIGNED	ACS
CHECKED	
PROJECT #	J188372100

SHEET TITLE
EXISTING

SHEET NUMBER
3

LAND USE # ----

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GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

0 300' 600'
GRAPHIC SCALE IN FEET

LEGEND

- EDGE OF WATER
- ACCESS PATH
- STOCKPILE LOCATION

90% DESIGN

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6140 COTTONWOOD DRIVE, SUITE A,
FITCHBURG, WISCONSIN 53719
TEL: (608) 661-2805 FAX: (608) 661-2861
www.cardnoglfew.com

CONSTRUCTION ACCESS
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

#	DATE	DESCRIPTION	BY

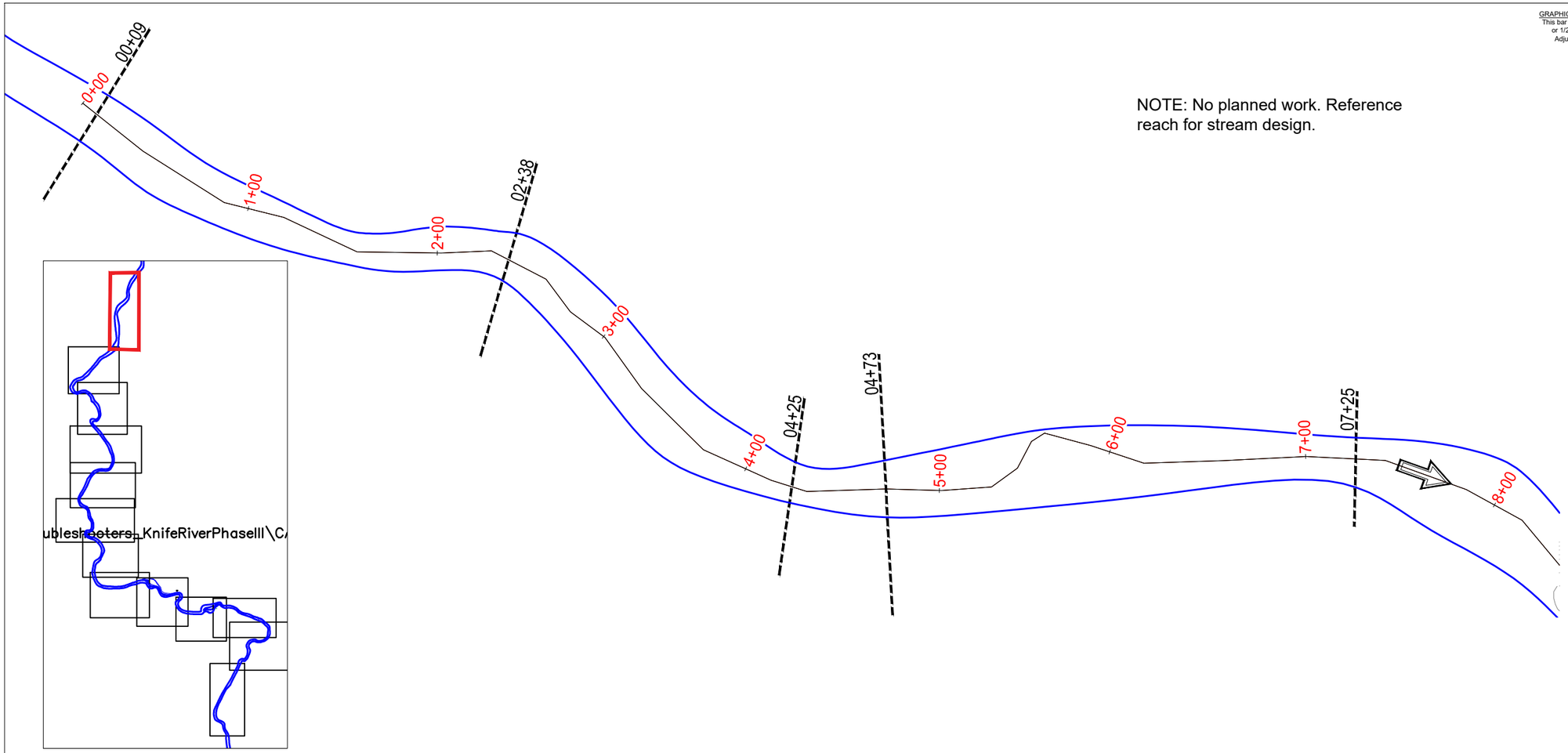
DATE	APRIL 2020
DRAWN	MGS/COD
DESIGNED	ACS
CHECKED	
PROJECT #	J188372100

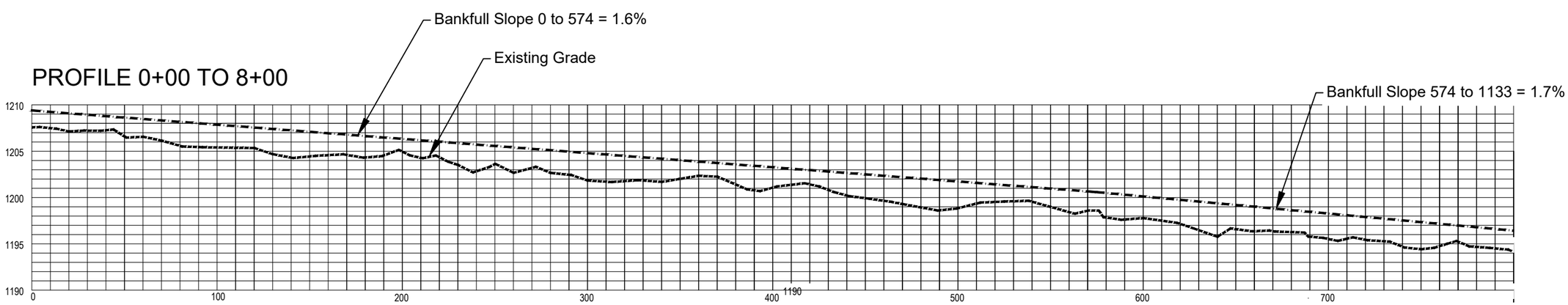
SHEET TITLE
ACCESS

SHEET NUMBER
4

LAND USE # ----

R:\Projects\18\188372\1.Env Troubleshooters_Knife\Phase\90_Phase\CADDwg\Sheet\200203\3_Layout_Sheets.dwg - 4/14/2020 4:31:46 PM





90% DESIGN

Cardno
MADISON
6140 COTTONWOOD DRIVE, SUITE A,
FITCHBURG, WISCONSIN 53719
TEL: (608) 661-2655 FAX: (608) 661-2661
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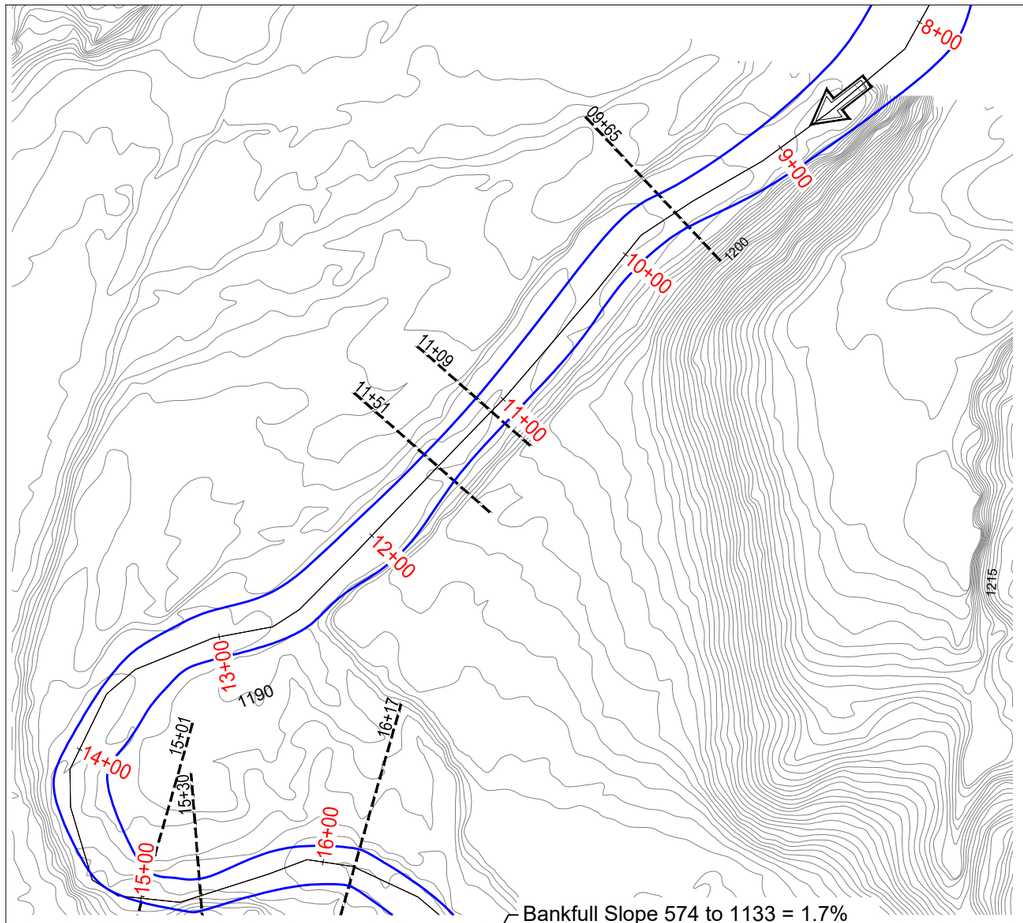
REFERENCE REACH 0+00 TO 0+95
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

#	DATE	DESCRIPTION	BY

DATE	APRIL 2020
DRAWN	MGS/COD
DESIGNED	ACS
CHECKED	
PROJECT #	J188372100
SHEET TITLE	REF 0+00 TO 0+95
SHEET NUMBER	5
LAND USE #	----

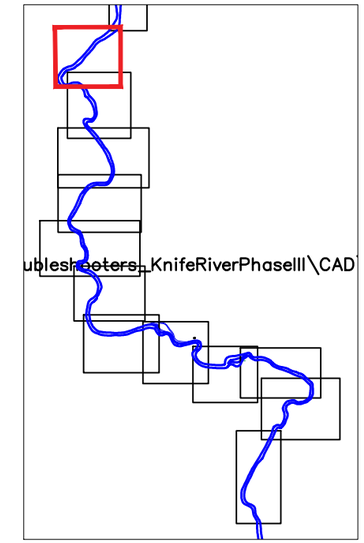


GRAPHIC SCALE IN FEET
0 40' 80'

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

LEGEND

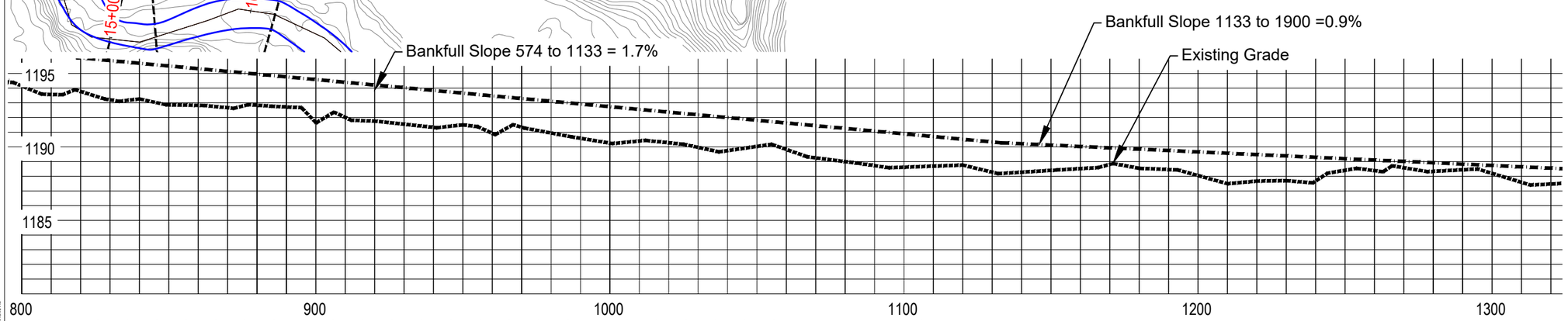
- EDGE OF WATER
- EXISTING GRADE
- DRAINAGE FLOW

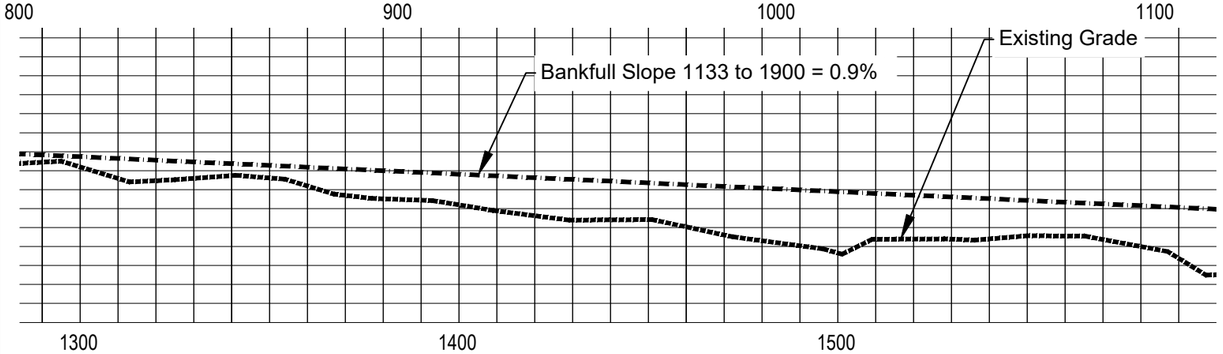


KEY MAP

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

0 600' 1200'
GRAPHIC SCALE IN FEET





GRAPHIC SCALE IN FEET
0 4' 8'

PROFILE 8+00 TO 16+00

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

0 20' 40'
GRAPHIC SCALE IN FEET

90% DESIGN

Cardno
MADISON
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AREA 1 EXISTING CONDITIONS
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

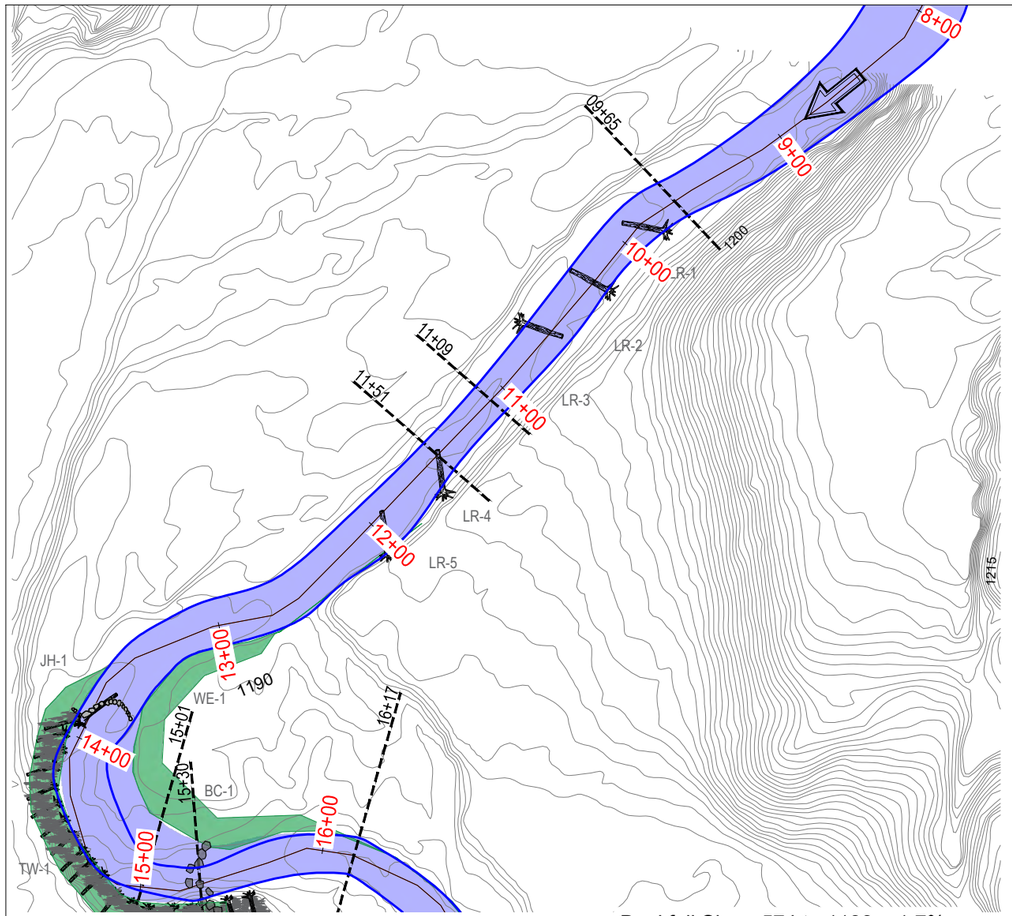
#	DATE	DESCRIPTION	BY

DATE	APRIL 2020
DRAWN	MGS/COD
DESIGNED	ACS
CHECKED	
PROJECT #	J188372100

SHEET TITLE
AREA 1

SHEET NUMBER
6

LAND USE # ----



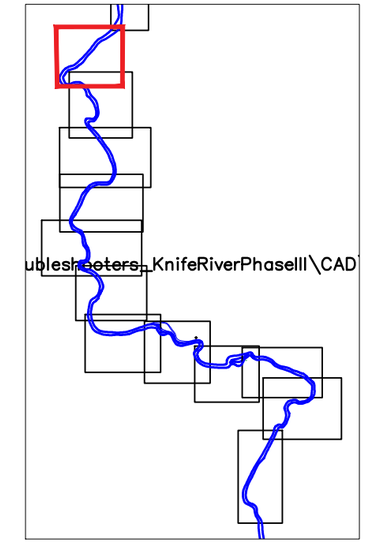
GRAPHIC SCALE IN FEET
0 40' 80'

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

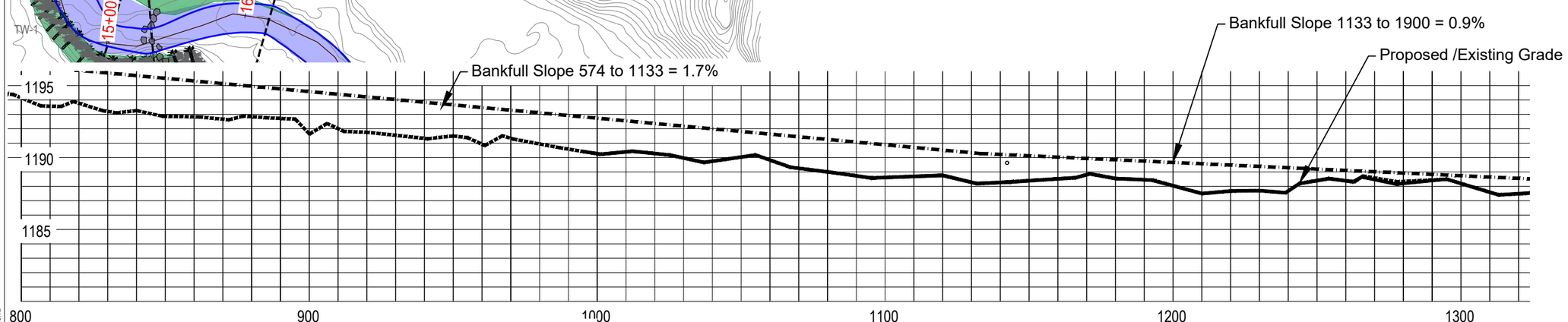
WORK CONSTRUCTED IN SUMMER 2019 FROM STATION 9+00 THROUGH STATION 21+00

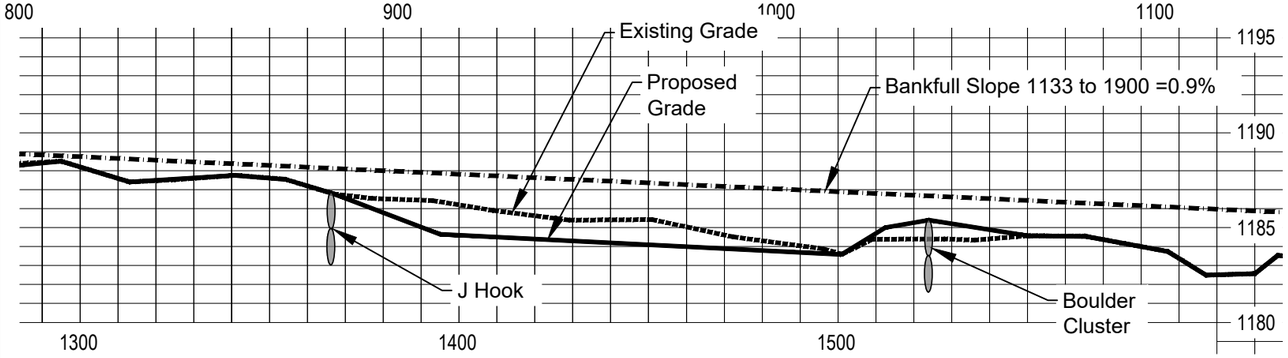
NOTE:
1. Final position, orientation, and elevation of large wood additions to be determined in the field by on-site construction supervisor.

LEGEND
- EDGE OF WATER
- EXISTING GRADE
- DRAINAGE FLOW
- TOEWOOD
- J-HOOK
- BOULDER CLUSTER
- CROSS VANE
- BANK GRADING
- CHANNEL RE-ROUTE
- SUBGRADE LOG VANE
- LOG ROLLER
- CHANNEL TO BE FILLED
- CONSTRUCTED RIFFLE
- LARGE WOOD HABITAT ENHANCEMENT



KEY MAP
GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.
0 600' 1200'
GRAPHIC SCALE IN FEET





GRAPHIC SCALE IN FEET
0 4' 8'

PROFILE 8+00 TO 16+00

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.
0 20' 40'
GRAPHIC SCALE IN FEET

90% DESIGN

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MADISON
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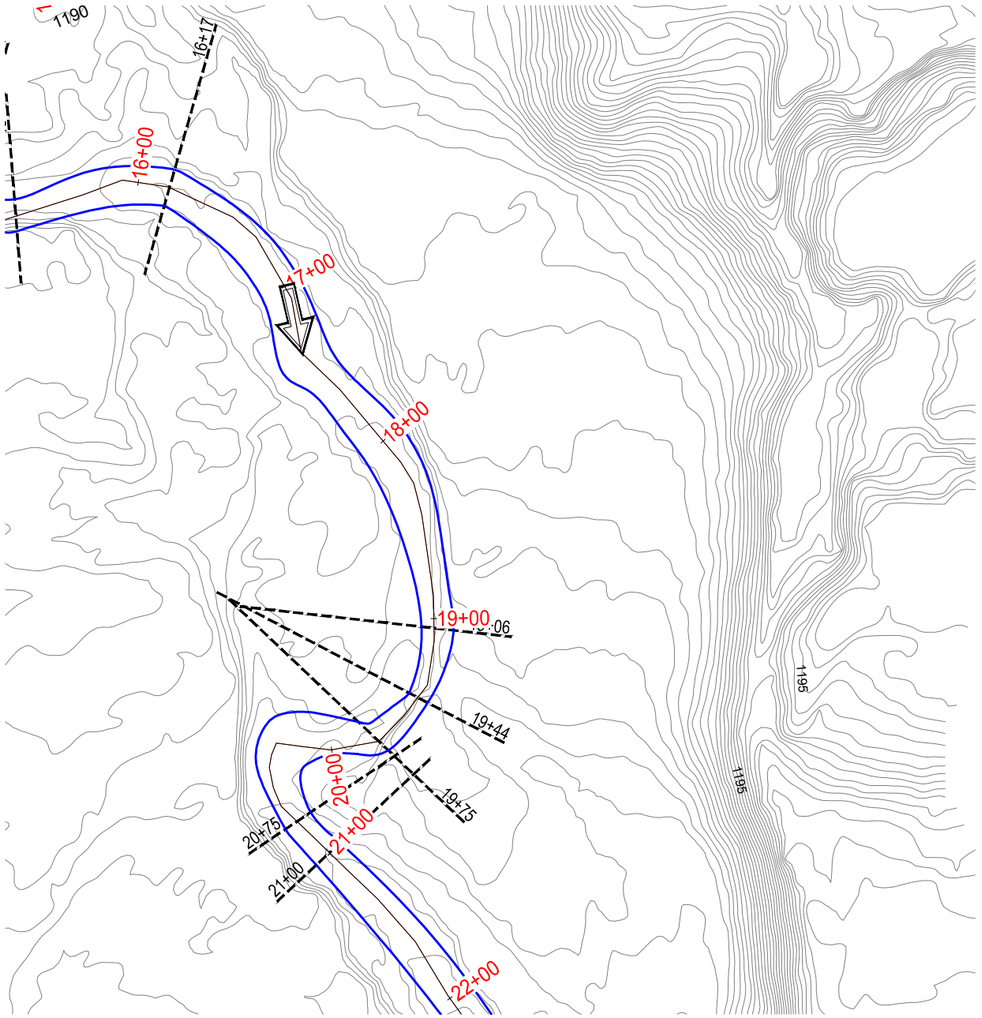
AREA 1 PROPOSED PLAN
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

#	DATE	DESCRIPTION	BY

DATE	APRIL 2020
DRAWN	MGS/COD
DESIGNED	ACS
CHECKED	
PROJECT #	J188372100
SHEET TITLE	AREA 1
SHEET NUMBER	7
LAND USE #	----



GRAPHIC SCALE IN FEET
0 40' 80'

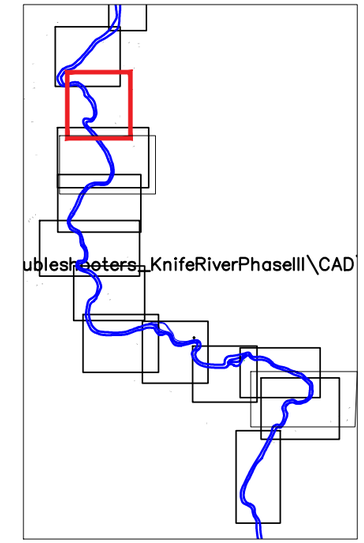
GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

LEGEND

EDGE OF WATER

EXISTING GRADE

DRAINAGE FLOW



GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

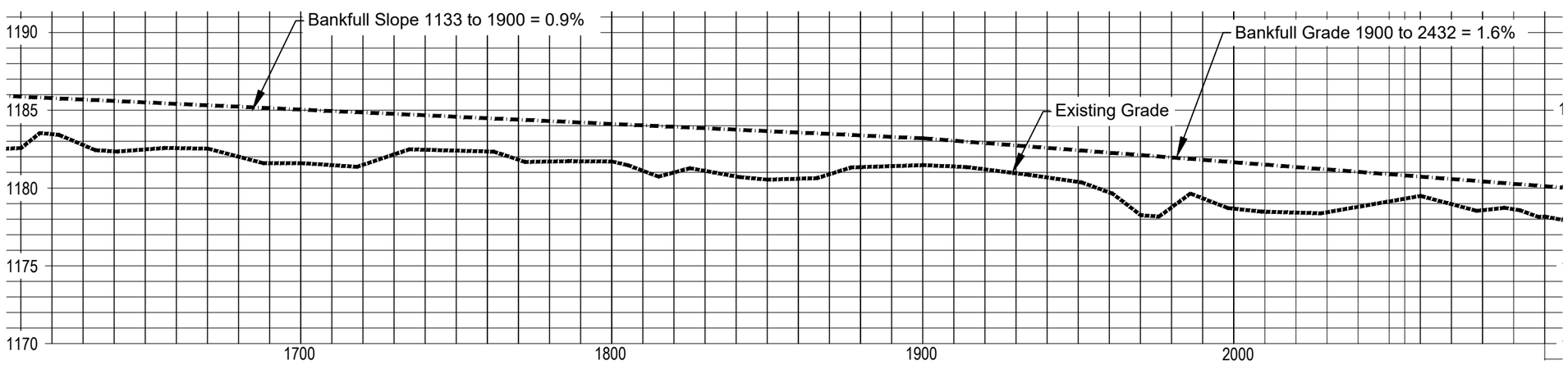
0 600' 1200'
GRAPHIC SCALE IN FEET

PROFILE 16+00 TO 21+00

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

0 20' 40'
GRAPHIC SCALE IN FEET

0 4' 8'
GRAPHIC SCALE IN FEET



90% DESIGN

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AREA 2 EXISTING CONDITIONS
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

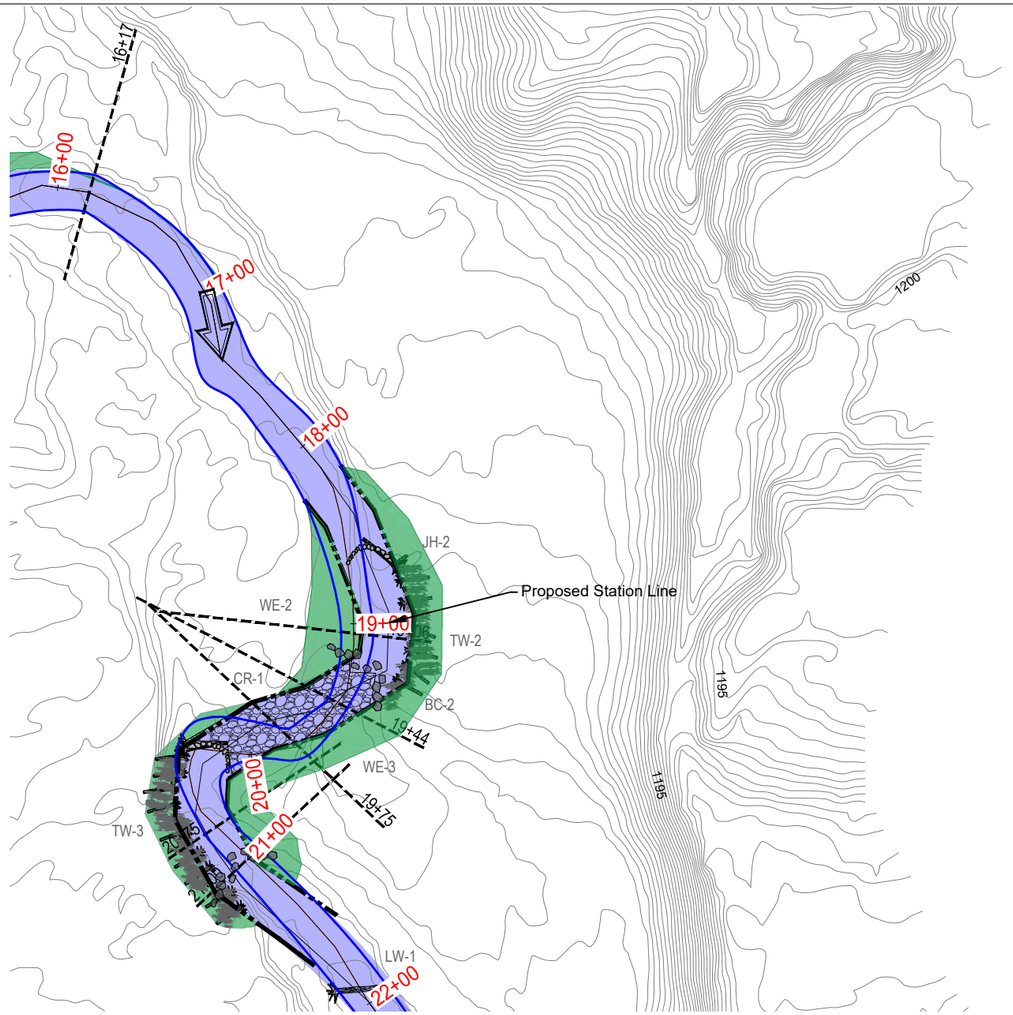
#	DATE	DESCRIPTION	BY

DATE	APRIL 2020
DRAWN	MGS/COD
DESIGNED	ACS
CHECKED	
PROJECT #	J188372100

SHEET TITLE
AREA 2

SHEET NUMBER
8

LAND USE # ----



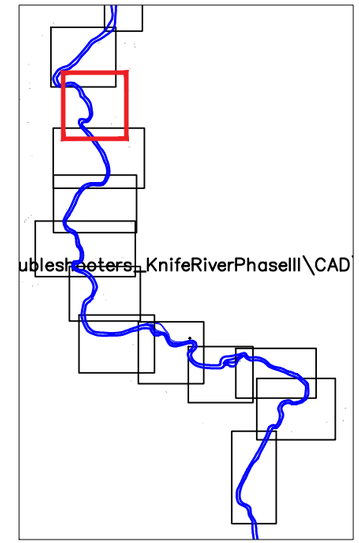
GRAPHIC SCALE IN FEET
0 40' 80'

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

WORK CONSTRUCTED IN SUMMER 2019 FROM STATION 9+00 THROUGH STATION 21+00

NOTE:
1. Final position, orientation, and elevation of large wood additions to be determined in the field by on-site construction supervisor.

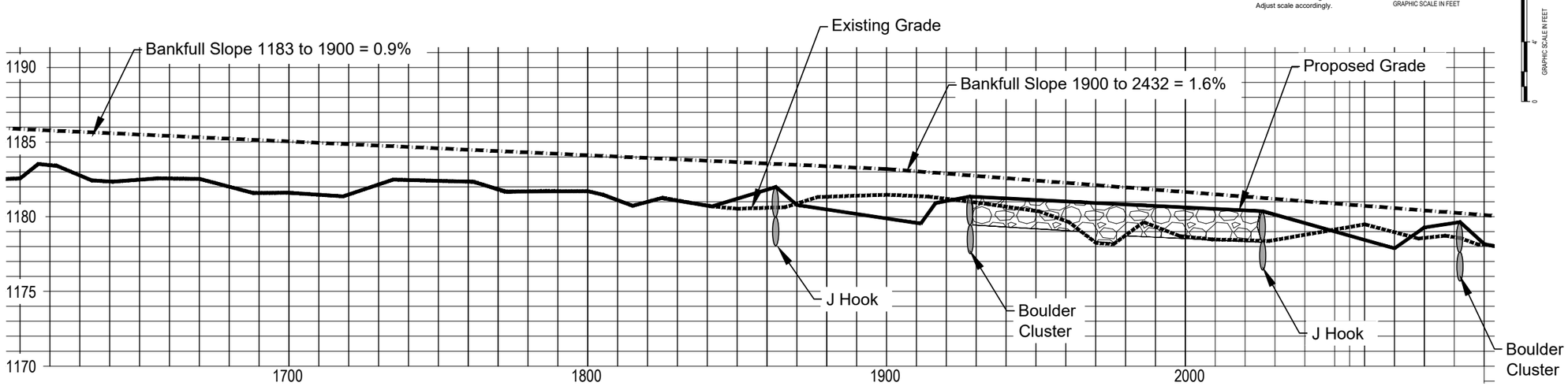
LEGEND
- EDGE OF WATER
- EXISTING GRADE
- DRAINAGE FLOW
- TOEWOOD
- J-HOOK
- BOULDER CLUSTER
- CROSS VANE
- BANK GRADING
- CHANNEL RE-ROUTE
- SUBGRADE LOG VANE
- LOG ROLLER
- CHANNEL TO BE FILLED
- CONSTRUCTED RIFFLE
- LARGE WOOD HABITAT ENHANCEMENT



KEY MAP
GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.
0 600' 1200'
GRAPHIC SCALE IN FEET

PROFILE 16+00 TO 21+00

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.
0 20' 40'
GRAPHIC SCALE IN FEET
0 4' 8'
GRAPHIC SCALE IN FEET



90% DESIGN

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MADISON
6140 COTTONWOOD DRIVE, SUITE A,
FITCHBURG, WISCONSIN 53719
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AREA 2 PROPOSED PLAN
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

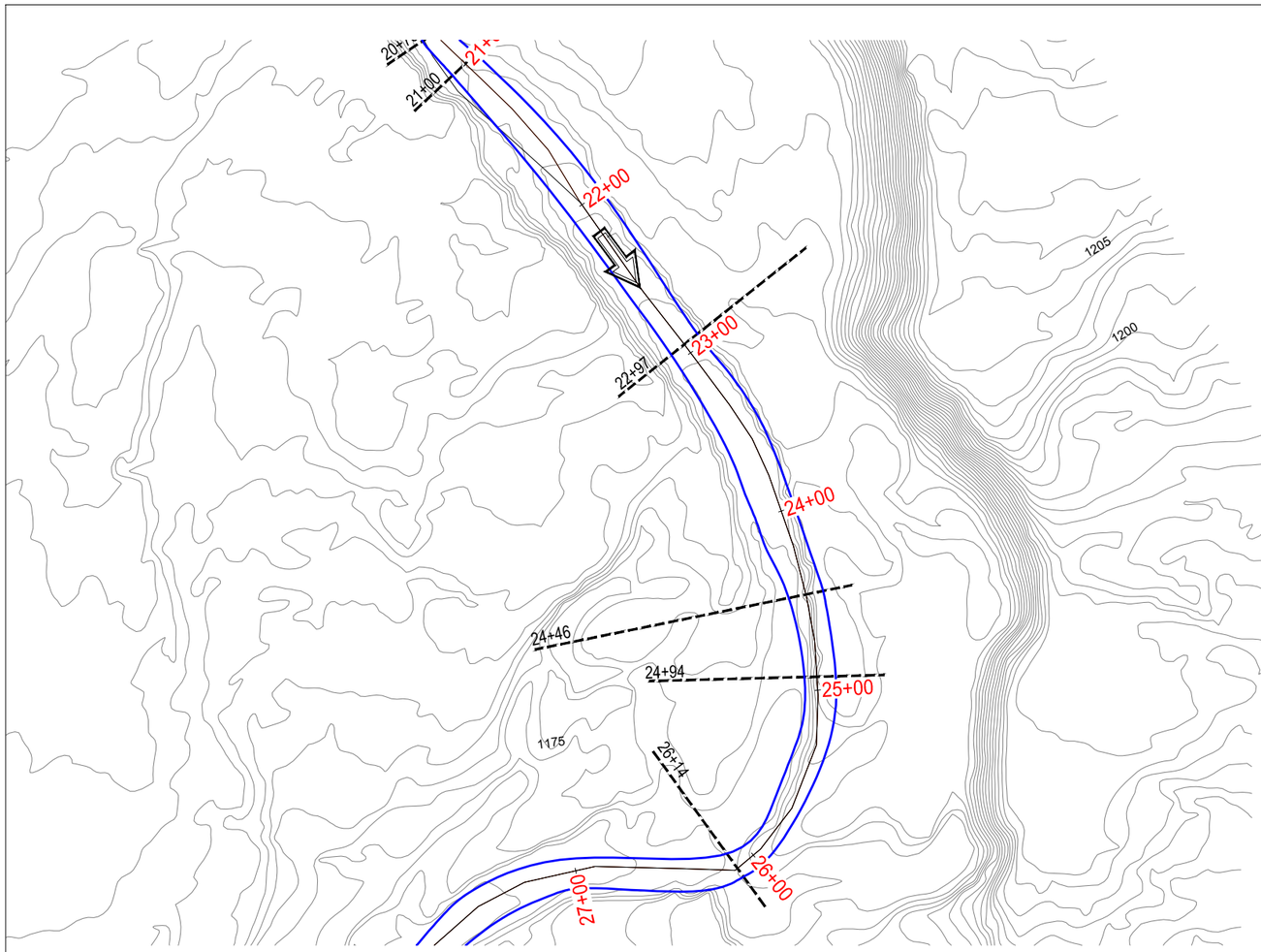
#	DATE	DESCRIPTION	BY

DATE	APRIL 2020
DRAWN	MGS/COD
DESIGNED	ACS
CHECKED	
PROJECT #	J188372100

SHEET TITLE
AREA 2

SHEET NUMBER
9

LAND USE # ----

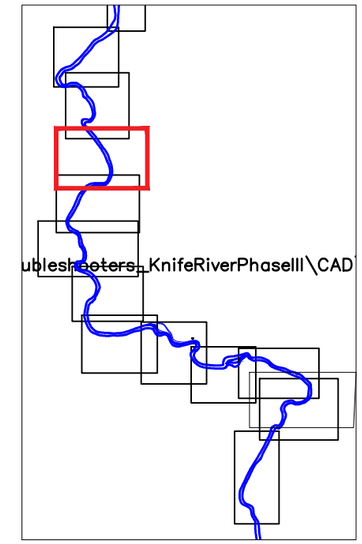


GRAPHIC SCALE IN FEET
0 40' 80'

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

LEGEND

- EDGE OF WATER
- EXISTING GRADE
- DRAINAGE FLOW



KEY MAP

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

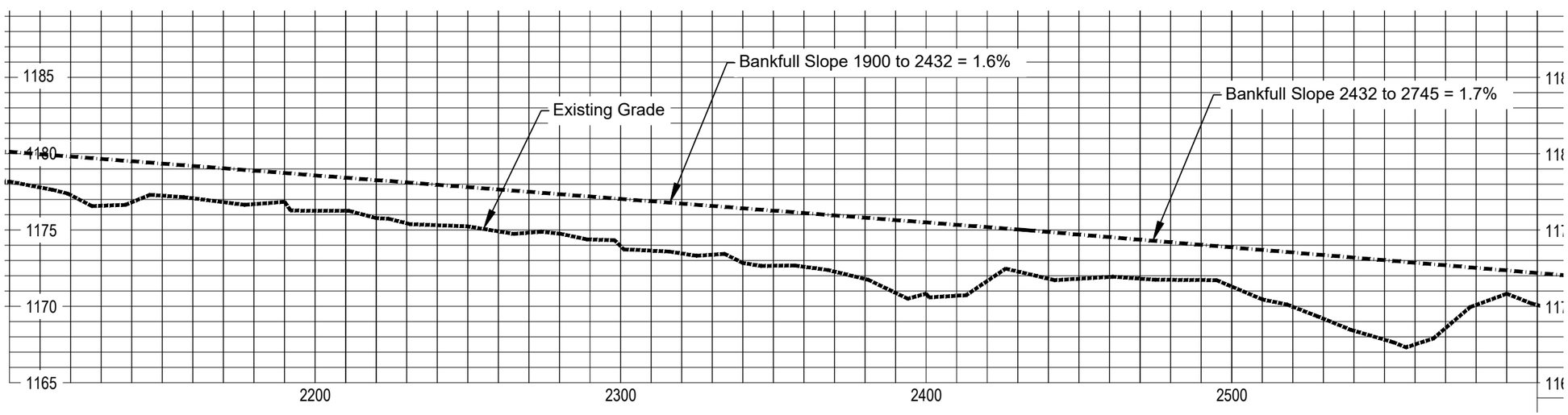
0 600' 1200'
GRAPHIC SCALE IN FEET

PROFILE 21+00 TO 26+00

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

0 20' 40'
GRAPHIC SCALE IN FEET

0 4' 8'
GRAPHIC SCALE IN FEET



90% DESIGN

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6140 COTTONWOOD DRIVE, SUITE A,
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TEL: (608) 661-2805 FAX: (608) 661-2861
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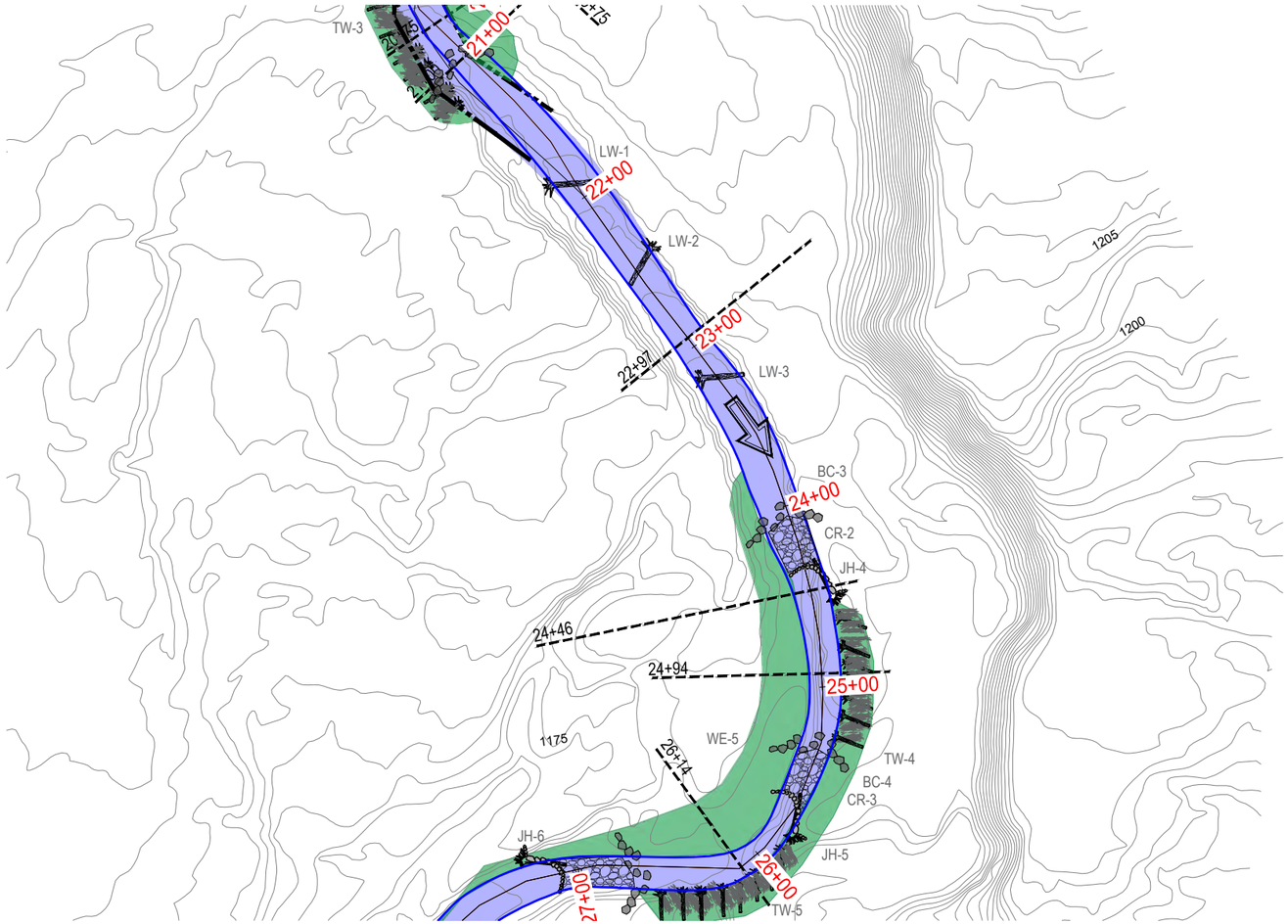
AREA 3 EXISTING CONDITIONS
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

DATE	APRIL 2020
DRAWN	MGS/COD
DESIGNED	ACS
CHECKED	
PROJECT #	J188372100

SHEET TITLE
AREA 3

SHEET NUMBER
10

LAND USE # ----



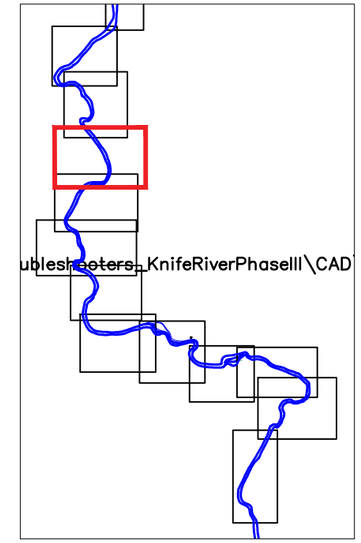
GRAPHIC SCALE IN FEET
0 40' 80'

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

NOTE:
1. Final position, orientation, and elevation of large wood additions to be determined in the field by on-site construction supervisor.

LEGEND

- EDGE OF WATER
- EXISTING GRADE
- DRAINAGE FLOW
- TOEWOOD
- J-HOOK
- BOULDER CLUSTER
- CROSS VANE
- BANK GRADING
- CHANNEL RE-ROUTE
- SUBGRADE LOG VANE
- LOG ROLLER
- CHANNEL TO BE FILLED
- CONSTRUCTED RIFFLE
- LARGE WOOD HABITAT ENHANCEMENT



KEY MAP

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

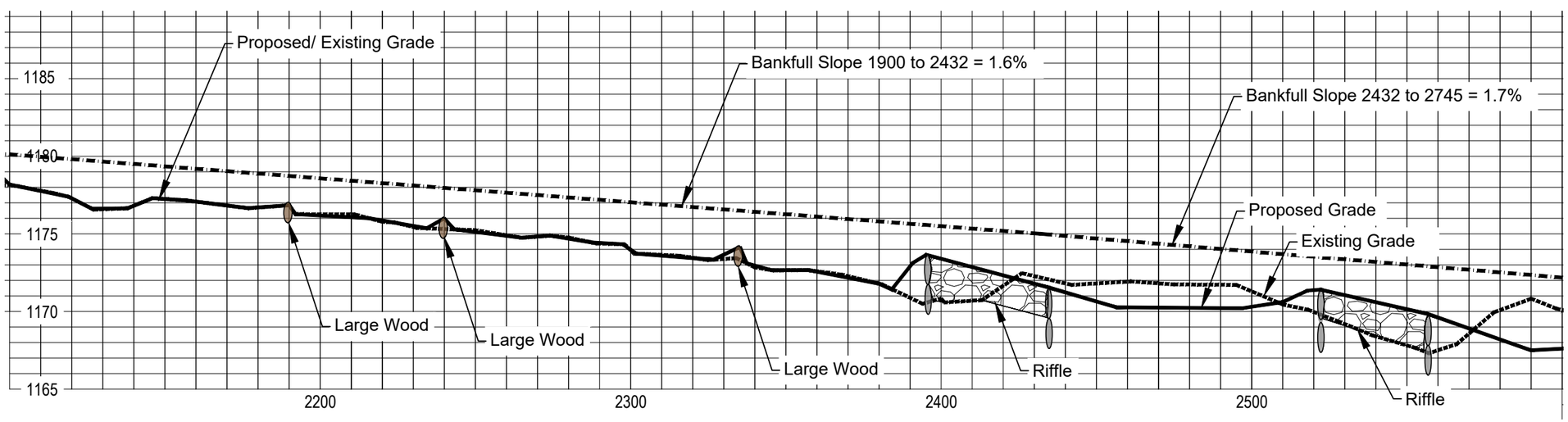
0 600' 1200'
GRAPHIC SCALE IN FEET

PROFILE 21+00 TO 26+00

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

0 20' 40'
GRAPHIC SCALE IN FEET

0 2 4 6 8
GRAPHIC SCALE IN FEET



90% DESIGN

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MADISON
6140 COTTONWOOD DRIVE, SUITE A,
FITCHBURG, WISCONSIN 53719
TEL: (608) 661-2655 FAX: (608) 661-2661
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AREA 3 PROPOSED PLAN
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

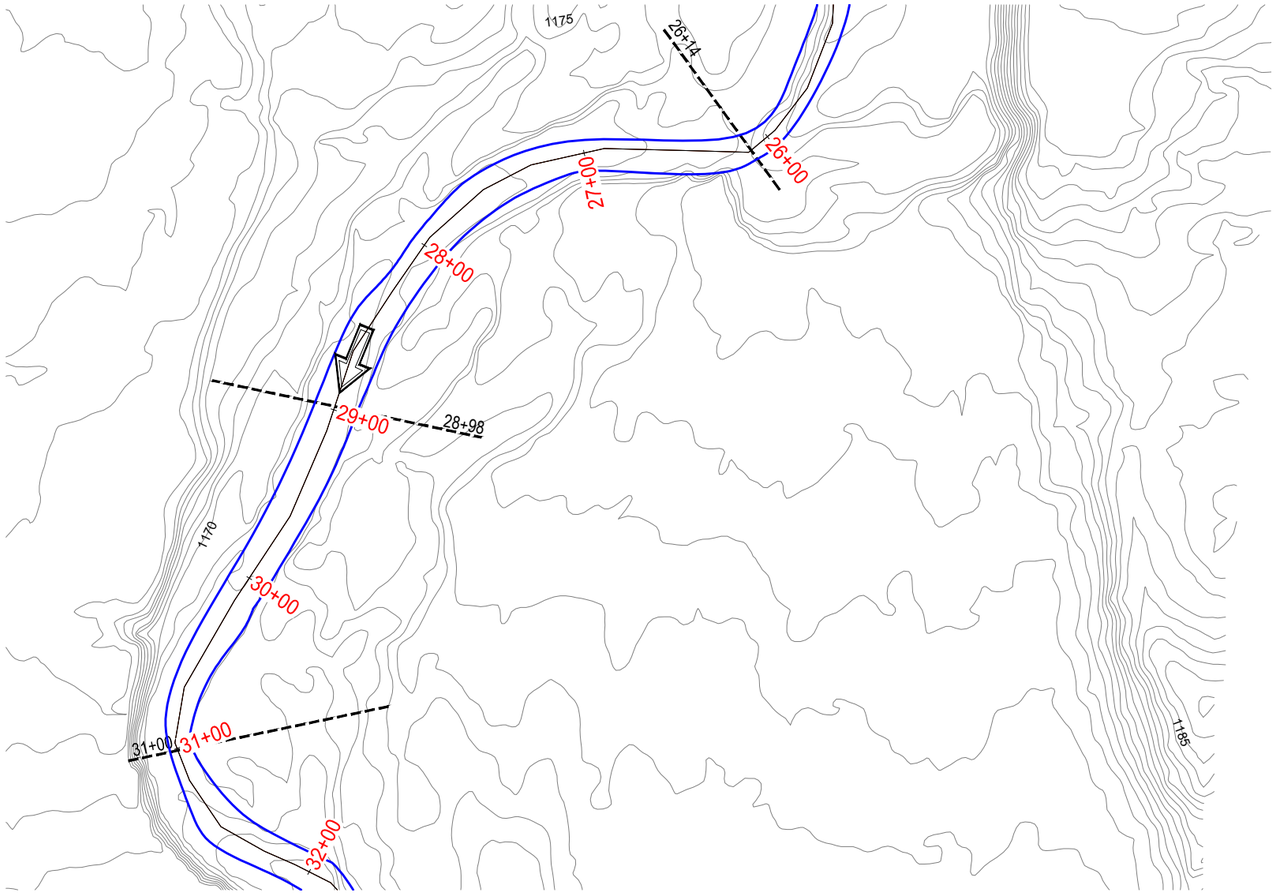
#	DATE	DESCRIPTION	BY

DATE	APRIL 2020
DRAWN	MGS/COD
DESIGNED	ACS
CHECKED	
PROJECT #	J188372100

SHEET TITLE
AREA 3

SHEET NUMBER
11

LAND USE # ----

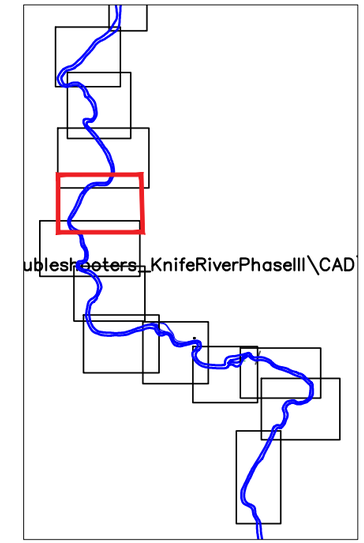


GRAPHIC SCALE IN FEET
0 40' 80'

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

LEGEND

- EDGE OF WATER
- EXISTING GRADE
- DRAINAGE FLOW



KEY MAP

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

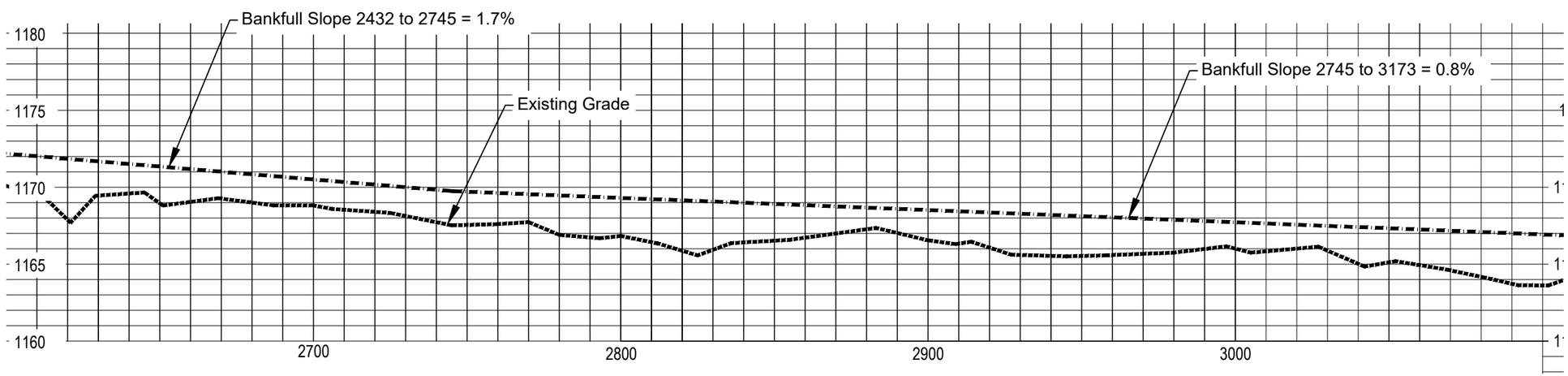
0 600' 1200'
GRAPHIC SCALE IN FEET

PROFILE 26+00 TO 31+00

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

0 20' 40'
GRAPHIC SCALE IN FEET

0 2 4 6 8
GRAPHIC SCALE IN FEET



90% DESIGN

Cardno
MADISON
6140 COTTONWOOD DRIVE, SUITE A,
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TEL: (608) 661-2655 FAX: (608) 661-2661
www.cardnoglaw.com

AREA 4 EXISTING CONDITIONS
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

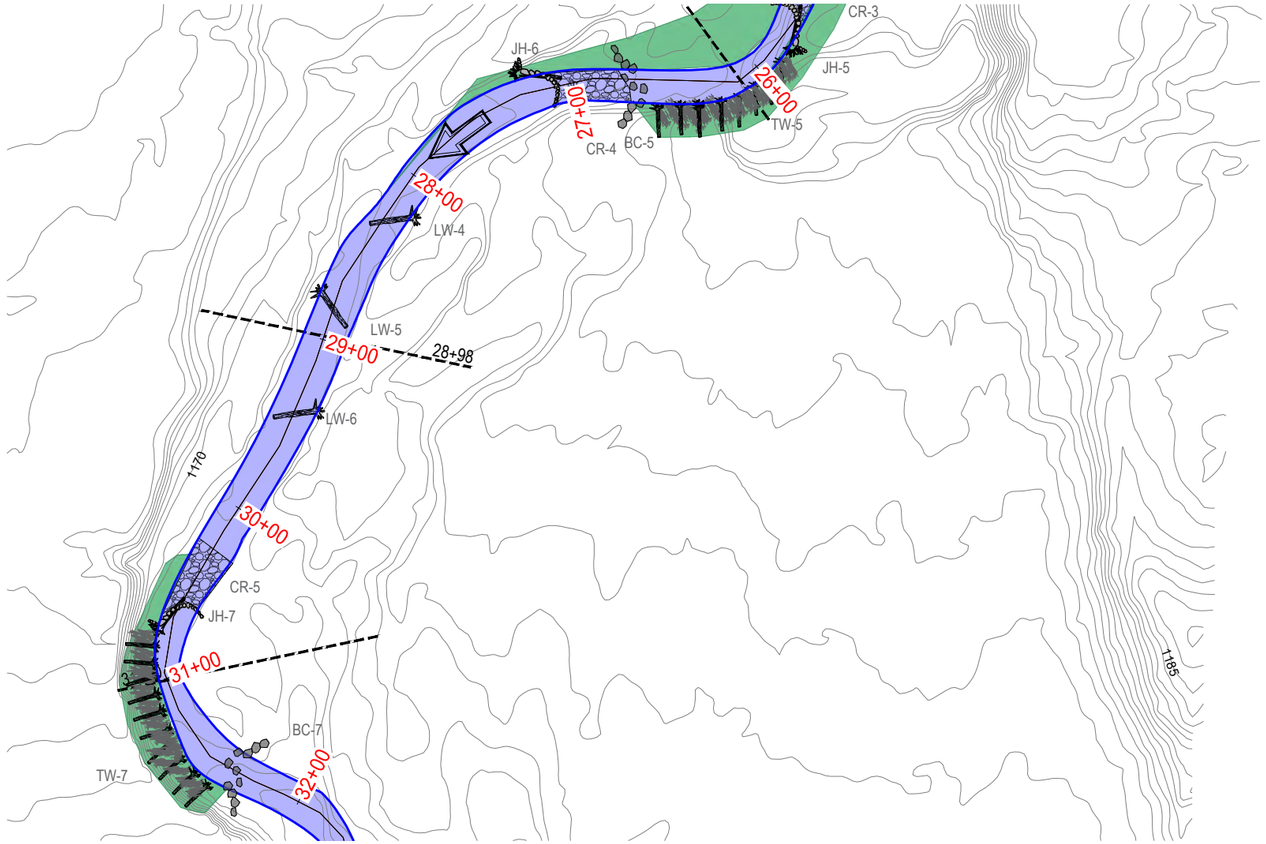
#	DATE	DESCRIPTION	BY
A			

DATE	APRIL 2020
DRAWN	MGS/COD
DESIGNED	ACS
CHECKED	
PROJECT #	J188372100

SHEET TITLE
AREA 4

SHEET NUMBER
12

LAND USE # ----



GRAPHIC SCALE IN FEET
0 40' 80'

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

NOTE:
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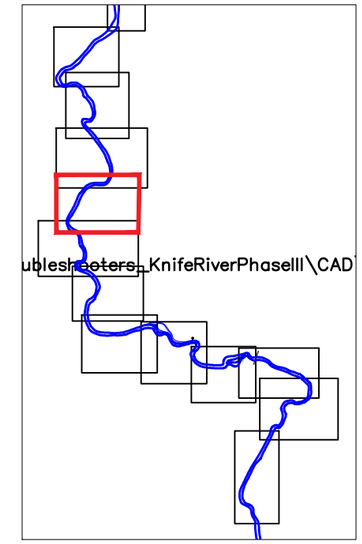
LEGEND

- EDGE OF WATER
- EXISTING GRADE
- DRAINAGE FLOW
- TOEWOOD
- J-HOOK
- BOULDER CLUSTER
- CROSS VANE
- BANK GRADING
- CHANNEL RE-ROUTE
- SUBGRADE LOG VANE
- LOG ROLLER
- CHANNEL TO BE FILLED
- CONSTRUCTED RIFFLE
- LARGE WOOD HABITAT ENHANCEMENT



KEY MAP

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

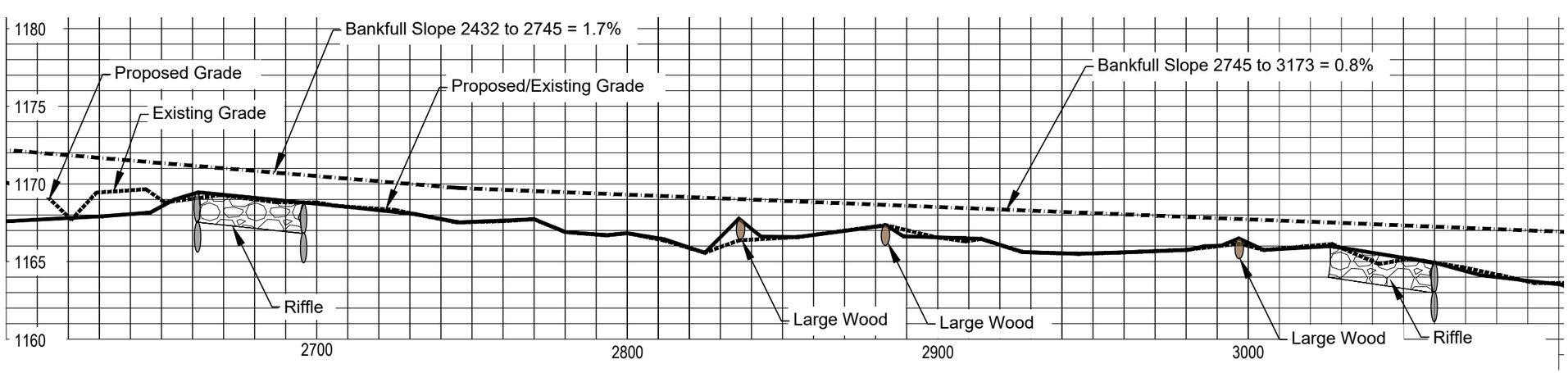
0 600' 1200'
GRAPHIC SCALE IN FEET

PROFILE 26+00 TO 31+00

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

0 20' 40'
GRAPHIC SCALE IN FEET

0 4' 8'
GRAPHIC SCALE IN FEET



90% DESIGN

Cardno
MADISON
6140 COTTONWOOD DRIVE, SUITE A,
FITCHBURG, WISCONSIN 53719
TEL: (608) 661-2805 FAX: (608) 661-2861
www.cardnoflow.com

AREA 4 PROPOSED PLAN
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

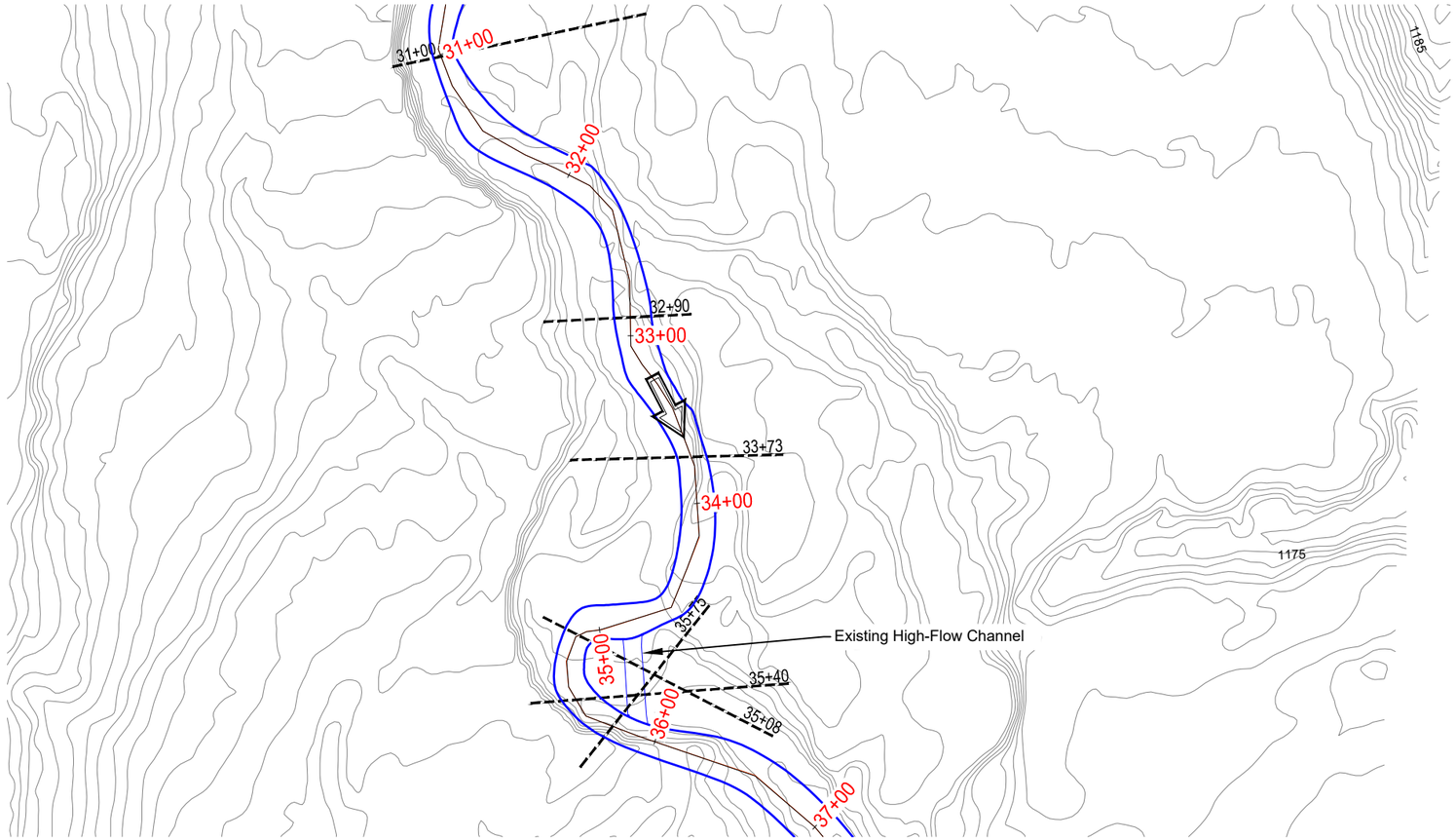
#	DATE	DESCRIPTION	BY

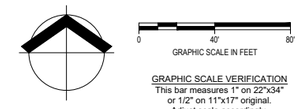
DATE	APRIL 2020
DRAWN	MGS/COD
DESIGNED	ACS
CHECKED	
PROJECT #	J188372100

SHEET TITLE
AREA 4

SHEET NUMBER
13

LAND USE # ----

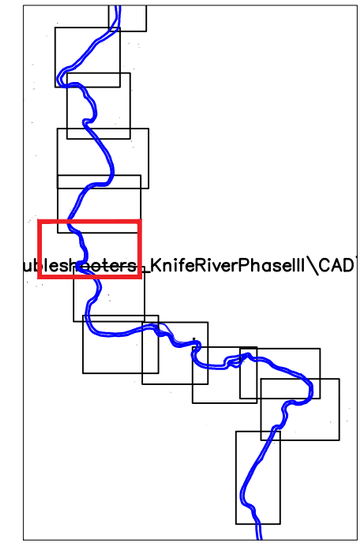




GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

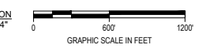
LEGEND

- EDGE OF WATER
- EXISTING GRADE
- DRAINAGE FLOW



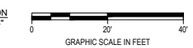
KEY MAP

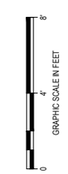
GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

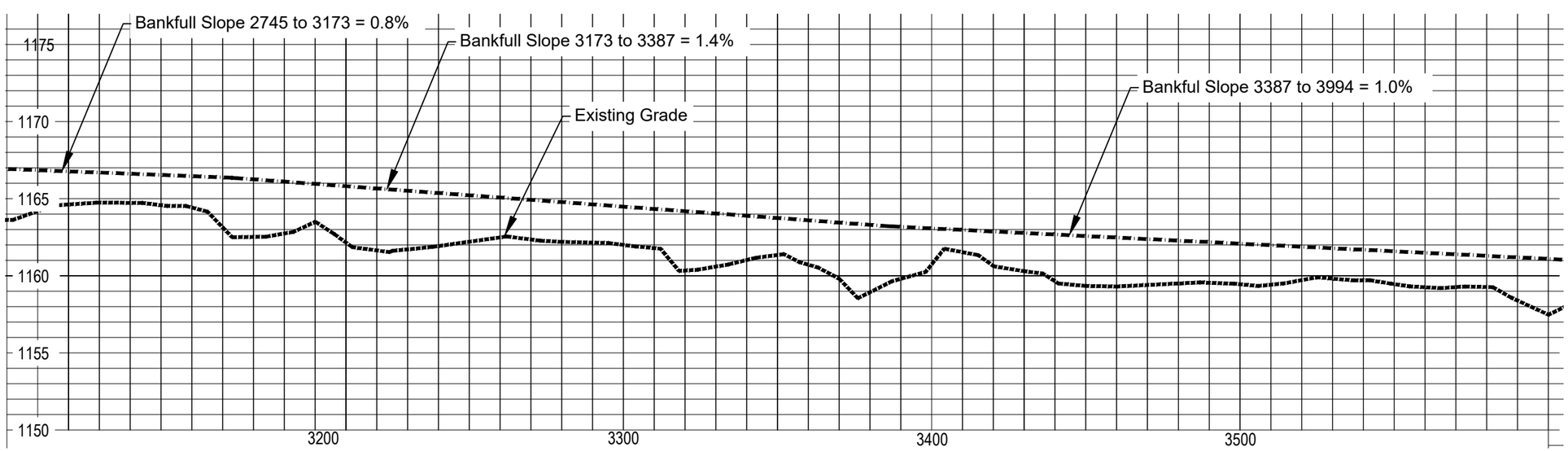


PROFILE 31+00 TO 36+00

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.







90% DESIGN

Cardno
MADISON
6140 COTTONWOOD DRIVE, SUITE A,
FITCHBURG, WISCONSIN 53719
TEL: (608) 661-2805 FAX: (608) 661-2861
www.cardnoglfew.com

AREA 5 EXISTING CONDITIONS
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

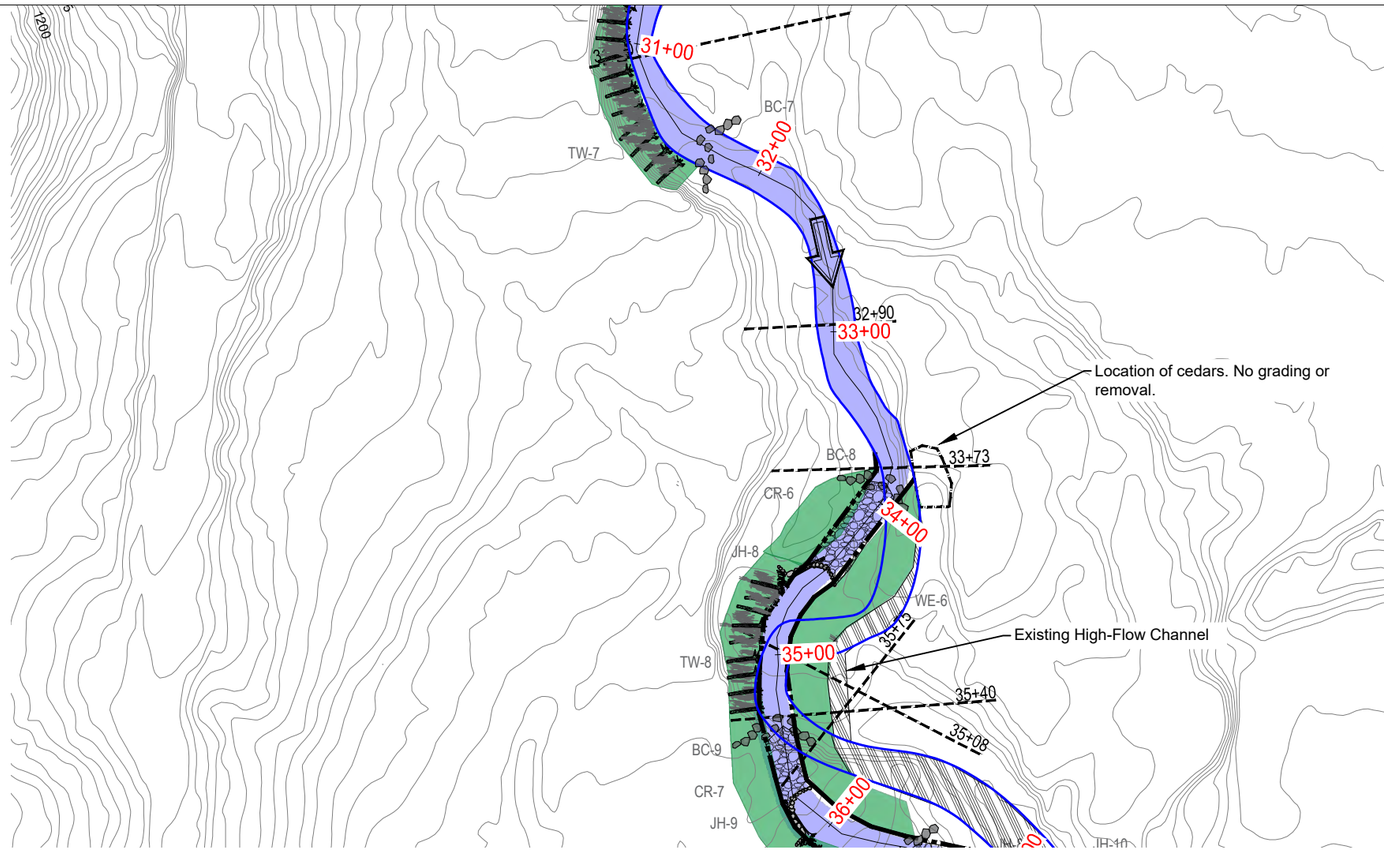
#	DATE	DESCRIPTION	BY
1			

DATE	APRIL 2020
DRAWN	MGS/COD
DESIGNED	ACS
CHECKED	
PROJECT #	J188372100

SHEET TITLE
AREA 5

SHEET NUMBER
14

LAND USE # ----

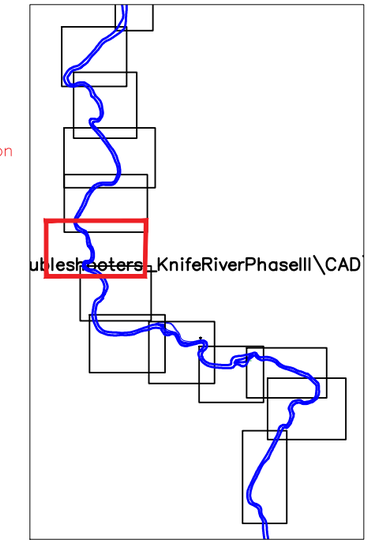


GRAPHIC SCALE IN FEET (0, 40', 80')

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34" or 1/2" on 11"x17" original. Adjust scale accordingly.

NOTE:
1. Final position, orientation, and elevation of large wood additions to be determined in the field by on-site construction supervisor.

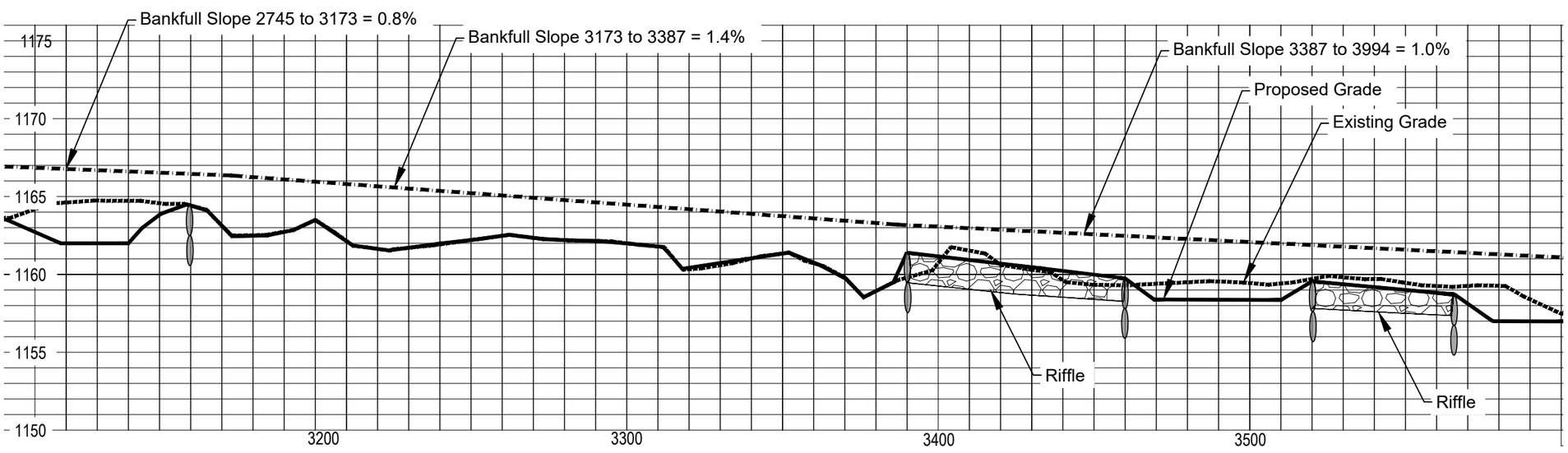
LEGEND
- EDGE OF WATER
- EXISTING GRADE
- DRAINAGE FLOW
- TOEWOOD
- J-HOOK
- BOULDER CLUSTER
- CROSS VANE
- BANK GRADING
- CHANNEL RE-ROUTE
- SUBGRADE LOG VANE
- LOG ROLLER
- CHANNEL TO BE FILLED
- CONSTRUCTED RIFFLE
- LARGE WOOD HABITAT ENHANCEMENT



KEY MAP
GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34" or 1/2" on 11"x17" original. Adjust scale accordingly.
GRAPHIC SCALE IN FEET (0, 600', 1200')

PROFILE 31+00 TO 36+00

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34" or 1/2" on 11"x17" original. Adjust scale accordingly.
GRAPHIC SCALE IN FEET (0, 20', 40')



GRAPHIC SCALE IN FEET (0, 4', 8')

90% DESIGN

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MADISON
6140 COTTONWOOD DRIVE, SUITE A
FITCHBURG, WISCONSIN 53719
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www.cardnoflow.com

#	DATE	DESCRIPTION	BY

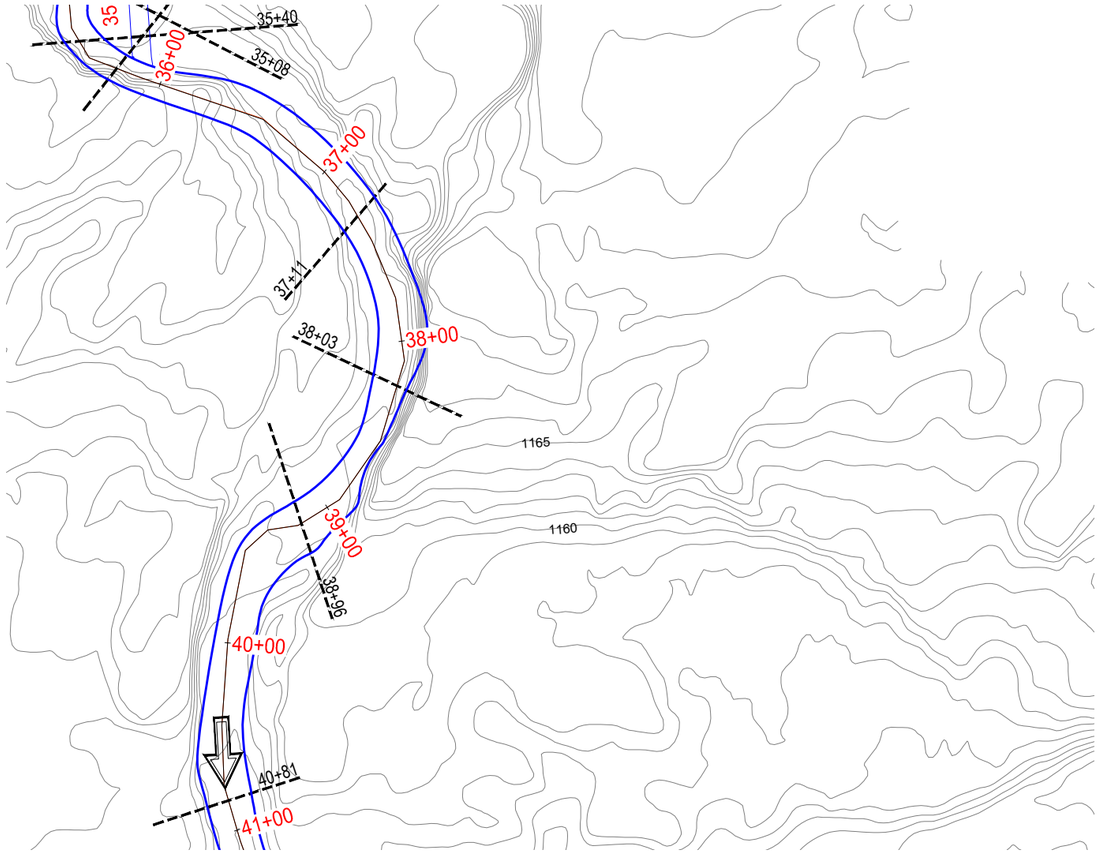
AREA 5 PROPOSED PLAN
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

DATE	APRIL 2020
DRAWN	MGS/COD
DESIGNED	ACS
CHECKED	
PROJECT #	J188372100

SHEET TITLE
AREA 5

SHEET NUMBER
15

LAND USE # ----



GRAPHIC SCALE IN FEET
0 40' 80'

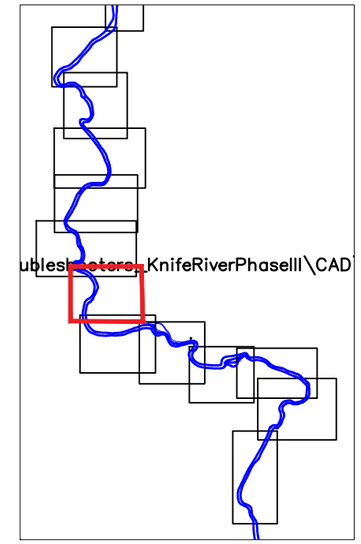
GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

LEGEND

EDGE OF WATER

EXISTING GRADE

DRAINAGE FLOW



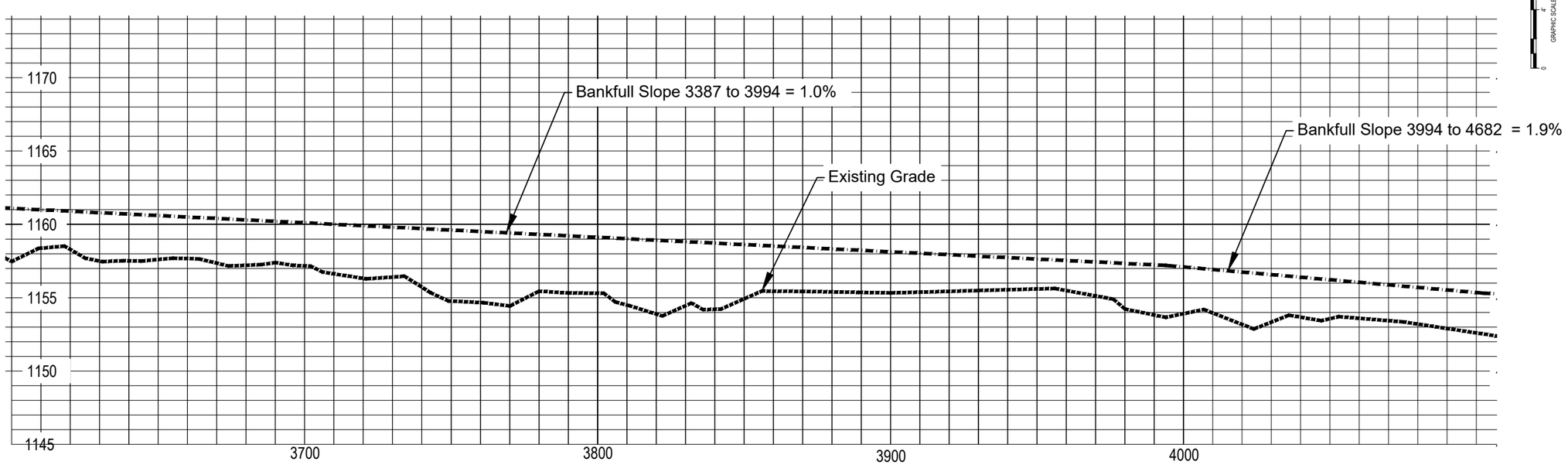
KEY MAP
GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

0 600' 1200'
GRAPHIC SCALE IN FEET

PROFILE 36+00 TO 41+00

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

0 20' 40'
GRAPHIC SCALE IN FEET



90% DESIGN

Cardno
MADISON
6140 COTTONWOOD DRIVE, SUITE A,
FITCHBURG, WISCONSIN 53719
TEL: (608) 661-2655 FAX: (608) 661-2661
www.cardnoglflow.com

AREA 6 EXISTING CONDITIONS
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

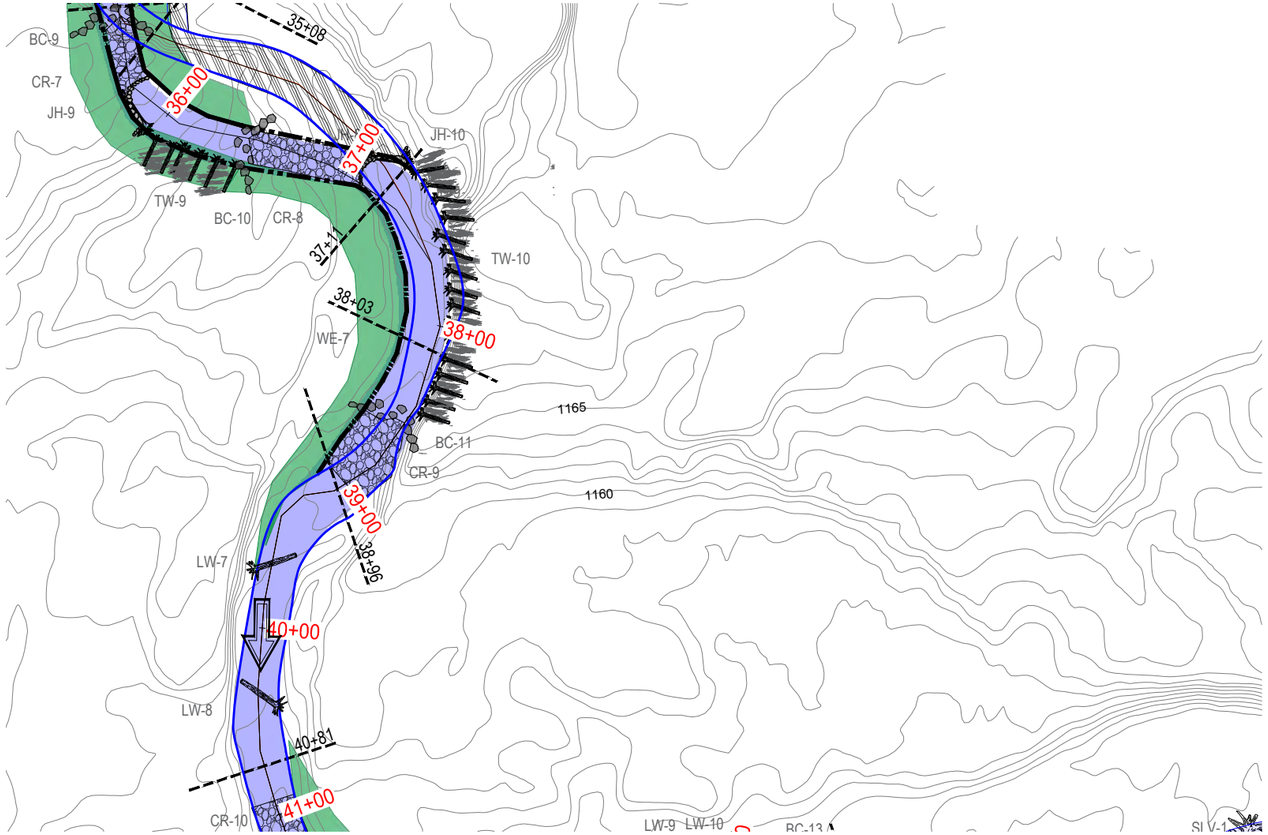
#	DATE	DESCRIPTION	BY

DATE	APRIL 2020
DRAWN	MGS/COD
DESIGNED	ACS
CHECKED	
PROJECT #	J188372100

SHEET TITLE
AREA 6

SHEET NUMBER
16

LAND USE # ----

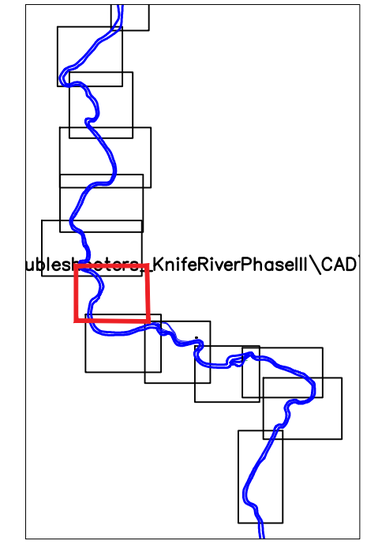


GRAPHIC SCALE IN FEET
0 40' 80'

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

NOTE:
1. Final position, orientation, and elevation of large wood additions to be determined in the field by on-site construction supervisor.

LEGEND
- EDGE OF WATER
- EXISTING GRADE
- DRAINAGE FLOW
- TOEWOOD
- J-HOOK
- BOULDER CLUSTER
- CROSS VANE
- BANK GRADING
- CHANNEL RE-ROUTE
- SUBGRADE LOG VANE
- LOG ROLLER
- CHANNEL TO BE FILLED
- CONSTRUCTED RIFFLE
- LARGE WOOD HABITAT ENHANCEMENT

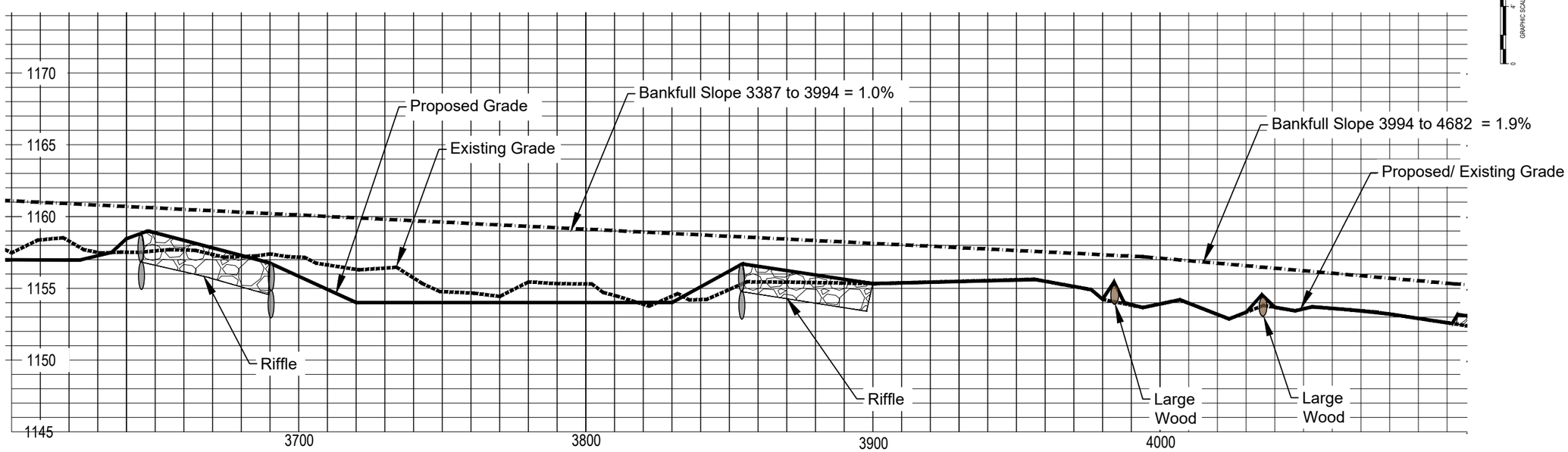


KEY MAP
GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.
0 600' 1200'
GRAPHIC SCALE IN FEET

PROFILE 36+00 TO 41+00

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.
0 20' 40'
GRAPHIC SCALE IN FEET

GRAPHIC SCALE IN FEET
0 2 4 6 8



90% DESIGN

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MADISON
6140 COTTONWOOD DRIVE, SUITE A,
FITCHBURG, WISCONSIN 53719
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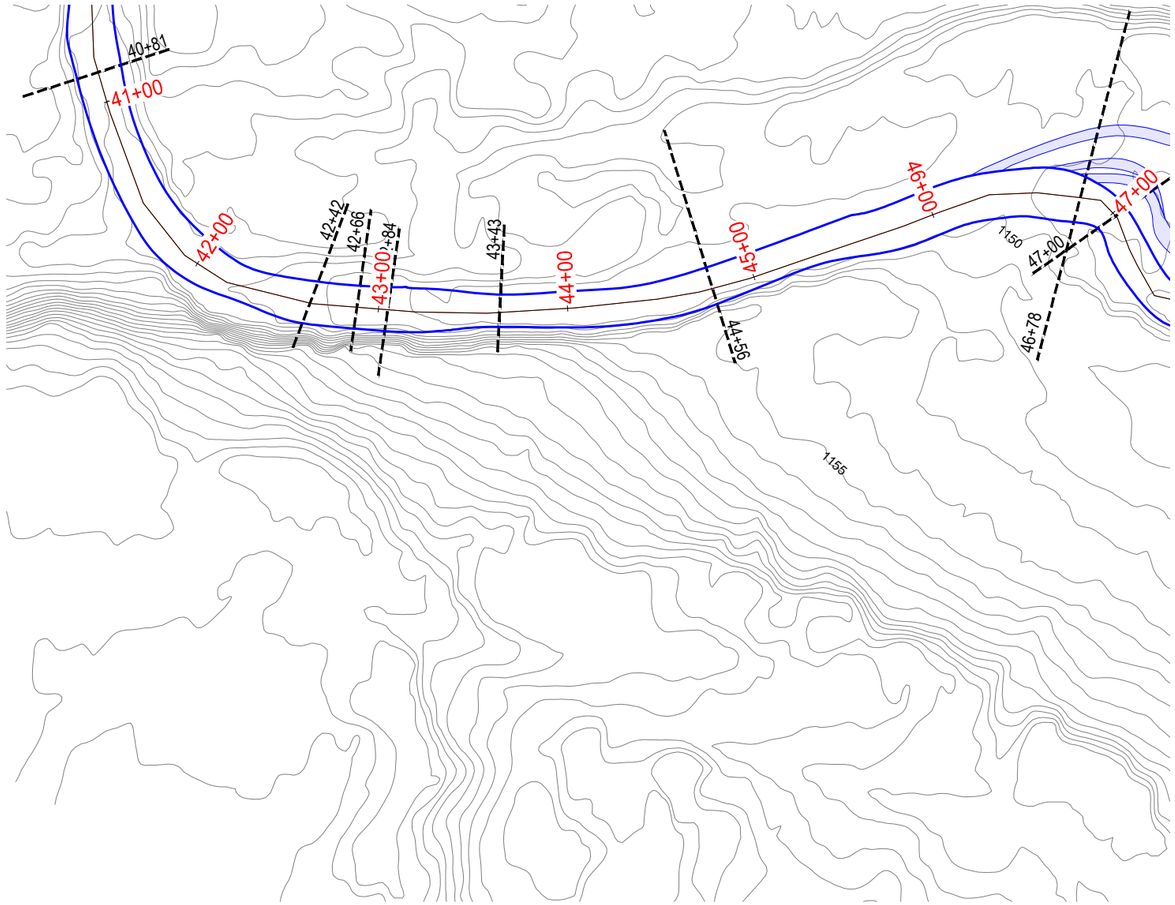
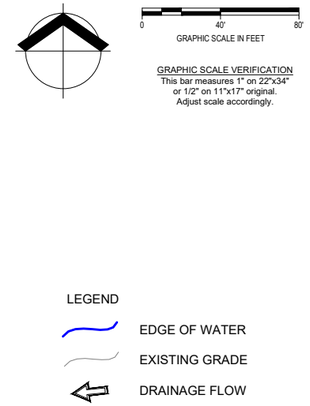
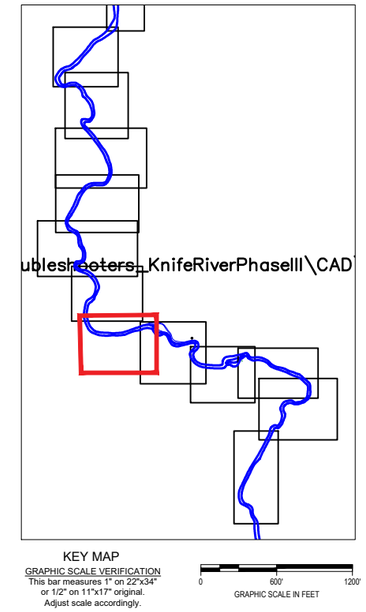
AREA 6 PROPOSED PLAN
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

#	DATE	DESCRIPTION	BY

DATE	APRIL 2020
DRAWN	MGS/COD
DESIGNED	ACS
CHECKED	
PROJECT #	J188372100
SHEET TITLE	AREA 6
SHEET NUMBER	17
LAND USE #	----







KEY MAP

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

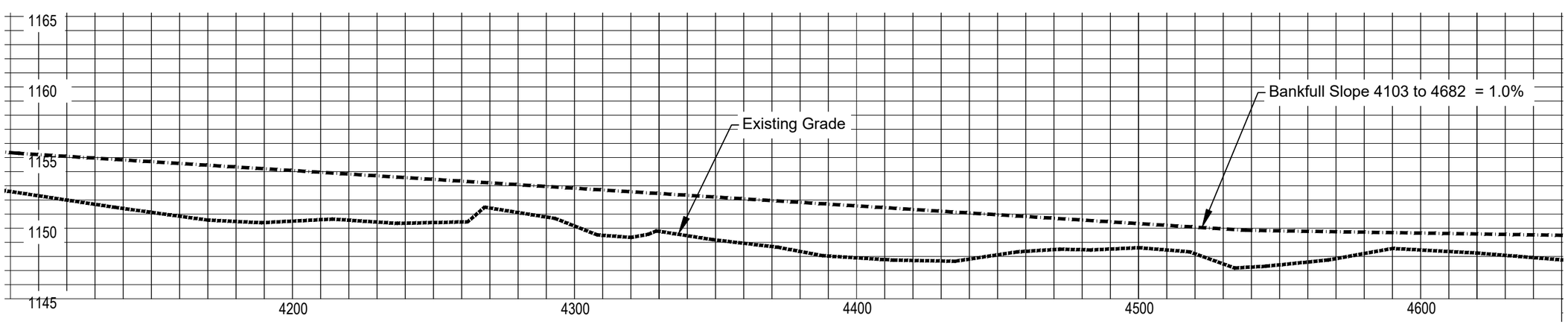
0 600' 1200'
GRAPHIC SCALE IN FEET

PROFILE 41+00 TO 46+50

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

0 20' 40'
GRAPHIC SCALE IN FEET

0 4' 8'
GRAPHIC SCALE IN FEET



90% DESIGN

Cardno
MADISON
6140 COTTONWOOD DRIVE, SUITE A,
FITCHBURG, WISCONSIN 53719
TEL: (608) 661-2655 FAX: (608) 661-2661
www.cardnoglaw.com

AREA 7 EXISTING CONDITIONS
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

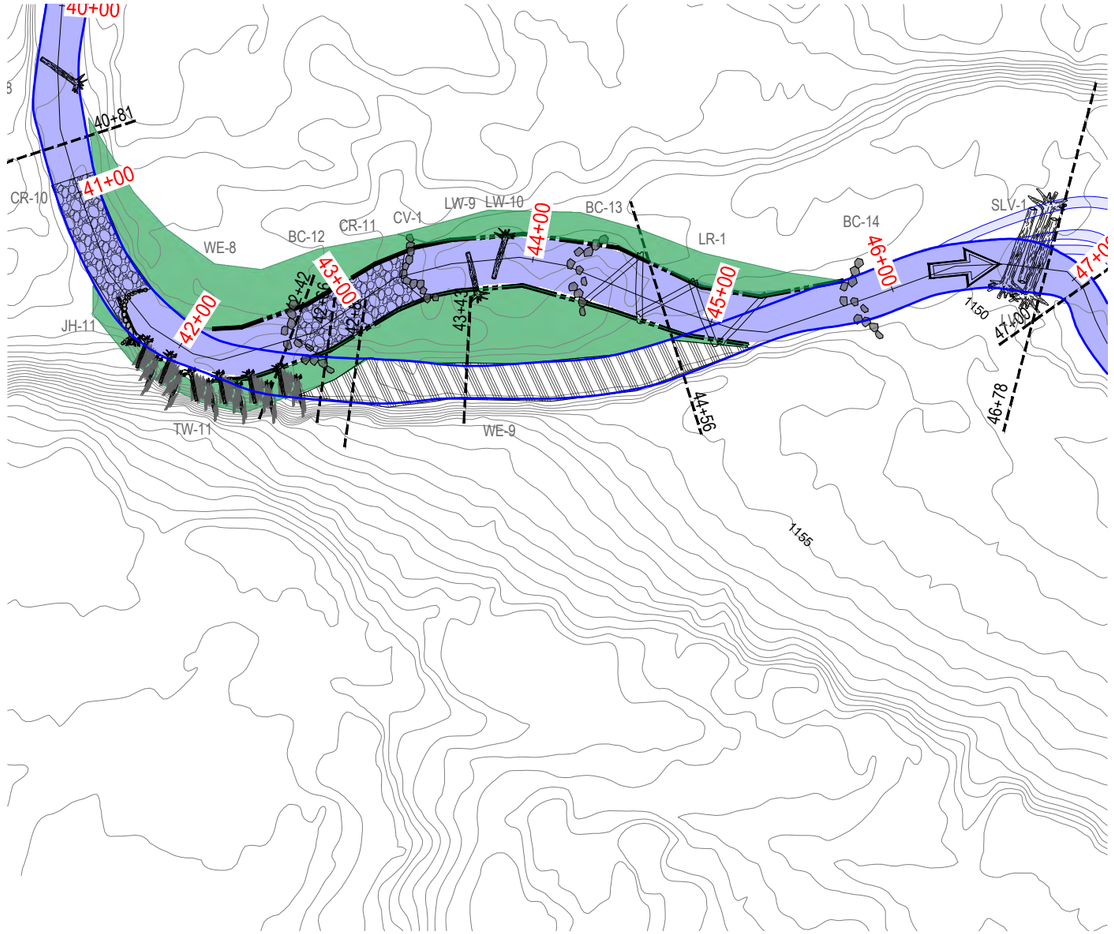
#	DATE	DESCRIPTION	BY

DATE	APRIL 2020
DRAWN	MGS/COD
DESIGNED	ACS
CHECKED	
PROJECT #	J188372100

SHEET TITLE
AREA 7

SHEET NUMBER
18

LAND USE # ----

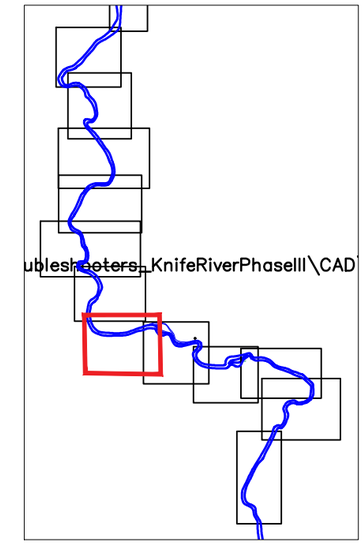


GRAPHIC SCALE IN FEET
0 40' 80'

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

NOTE:
1. Final position, orientation, and elevation of large wood additions to be determined in the field by on-site construction supervisor.

LEGEND
- EDGE OF WATER
- EXISTING GRADE
- DRAINAGE FLOW
- TOEWOOD
- J-HOOK
- BOULDER CLUSTER
- CROSS VANE
- BANK GRADING
- CHANNEL RE-ROUTE
- SUBGRADE LOG VANE
- LOG ROLLER
- CHANNEL TO BE FILLED
- CONSTRUCTED RIFFLE
- LARGE WOOD HABITAT ENHANCEMENT



KEY MAP
GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.
0 600' 1200'
GRAPHIC SCALE IN FEET

PROFILE 41+00 TO 46+50

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.
0 20' 40'
GRAPHIC SCALE IN FEET

0 4' 8'
GRAPHIC SCALE IN FEET

90% DESIGN

Cardno
MADISON
6140 COTTONWOOD DRIVE, SUITE A,
FITCHBURG, WISCONSIN 53719
TEL: (608) 661-2805 FAX: (608) 661-2861
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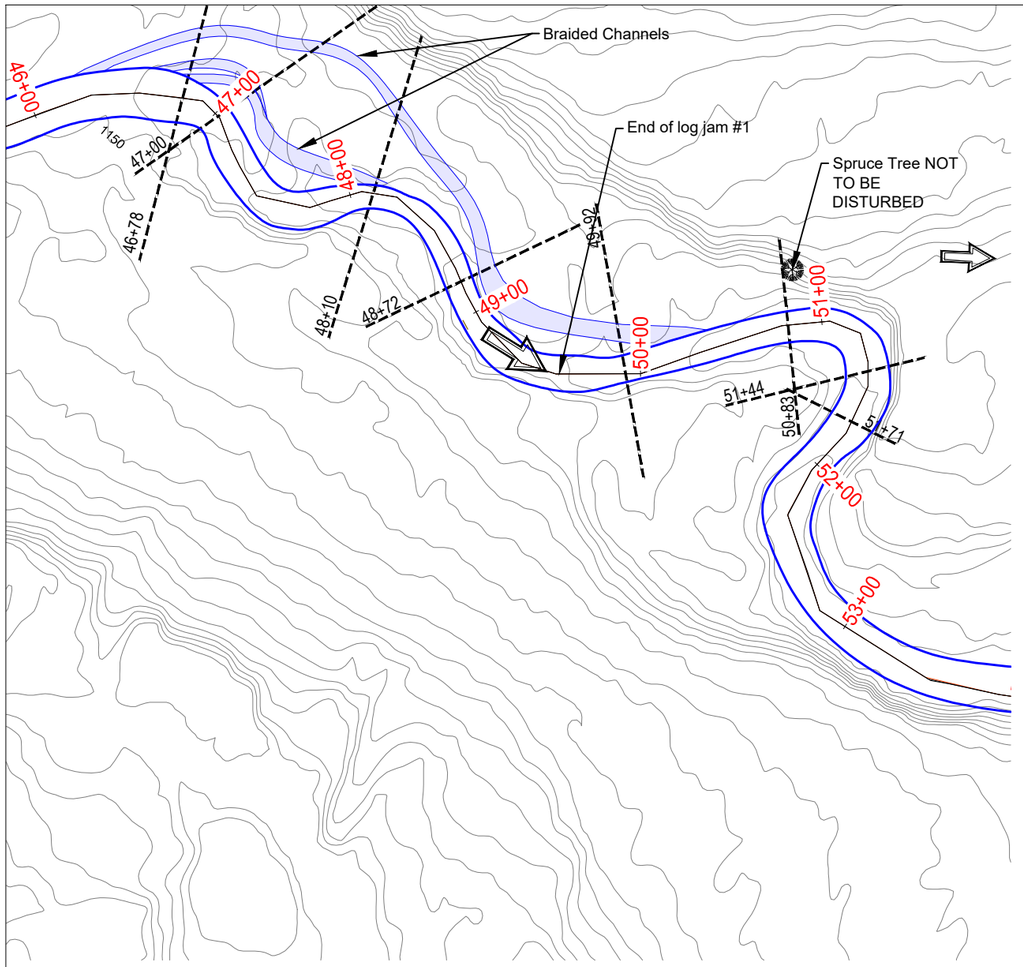
AREA 7 PROPOSED PLAN
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

#	DATE	DESCRIPTION	BY

DATE	APRIL 2020
DRAWN	MGS/COD
DESIGNED	ACS
CHECKED	
PROJECT #	J188372100
SHEET TITLE	AREA 7
SHEET NUMBER	19
LAND USE #	----

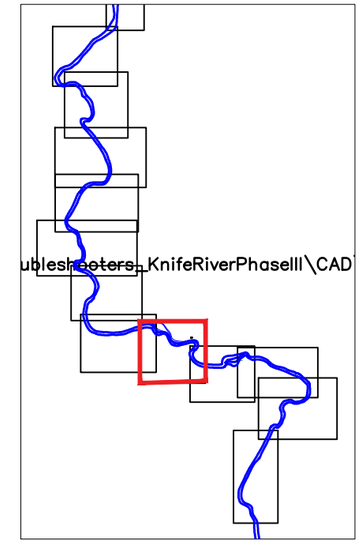


GRAPHIC SCALE IN FEET
0 40' 80'

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34" or 1/2" on 11"x17" original. Adjust scale accordingly.

LEGEND

- EDGE OF WATER
- EXISTING GRADE
- DRAINAGE FLOW



KEY MAP

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34" or 1/2" on 11"x17" original. Adjust scale accordingly.

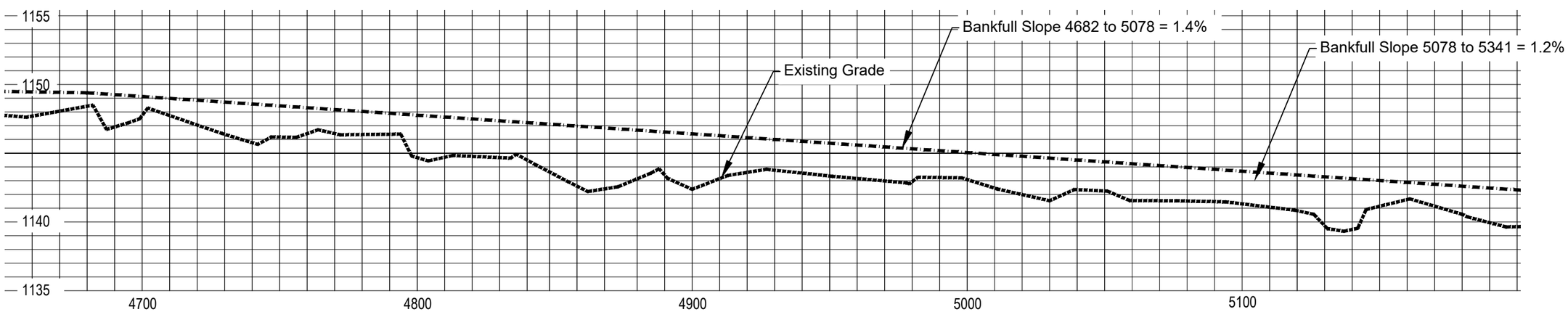
GRAPHIC SCALE IN FEET
0 600' 1200'

PROFILE 46+50 TO 52+00

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34" or 1/2" on 11"x17" original. Adjust scale accordingly.

GRAPHIC SCALE IN FEET
0 20' 40'

GRAPHIC SCALE IN FEET
0 4' 8'



90% DESIGN

Cardno
MADISON
6140 COTTONWOOD DRIVE, SUITE A,
FITCHBURG, WISCONSIN 53719
TEL: (608) 661-2805 FAX: (608) 661-2861
www.cardnoflow.com

AREA 8 EXISTING CONDITIONS
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

#	DATE	DESCRIPTION	BY
A			

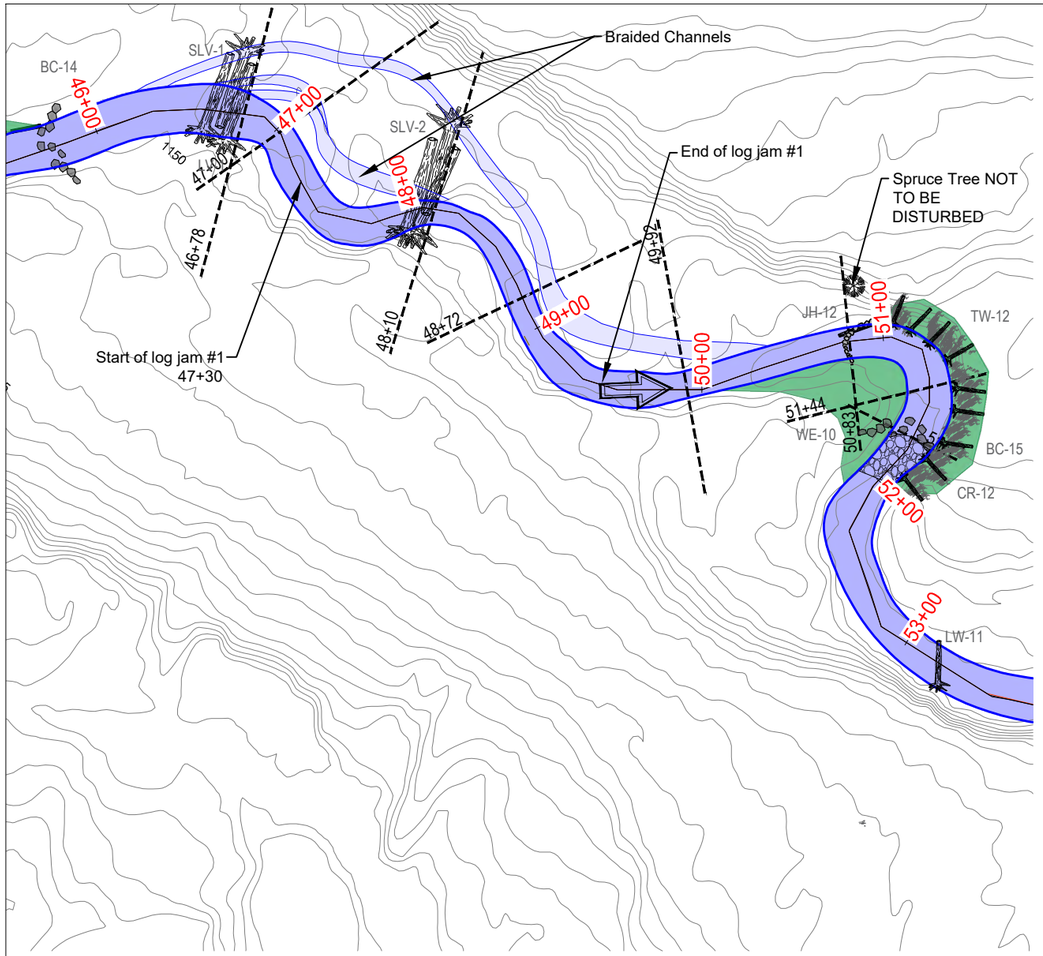
DATE	APRIL 2020
DRAWN	MGS/COD
DESIGNED	ACS
CHECKED	
PROJECT #	J188372100

SHEET TITLE
AREA 8

SHEET NUMBER
20

LAND USE # ----

R:\Projects\18\188\188372_Eno Troubleshooters_Knife\RivPhaseIII\09_Phase III\CAD\Dwg\Sheet\20\20\03.Layout_Sheets.dwg - 4/14/2020 4:25:07 PM



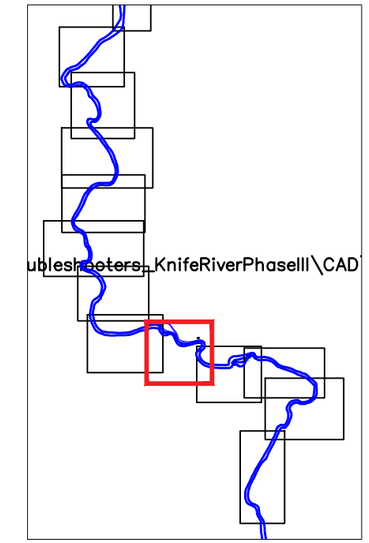
GRAPHIC SCALE IN FEET
0 40 80'

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

NOTE:
1. Final position, orientation, and elevation of large wood additions to be determined in the field by on-site construction supervisor.

LEGEND

- EDGE OF WATER
- EXISTING GRADE
- DRAINAGE FLOW
- TOEWOOD
- J-HOOK
- BOULDER CLUSTER
- CROSS VANE
- BANK GRADING
- CHANNEL RE-ROUTE
- SUBGRADE LOG VANE
- LOG ROLLER
- CHANNEL TO BE FILLED
- CONSTRUCTED RIFFLE
- LARGE WOOD HABITAT ENHANCEMENT



KEY MAP

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

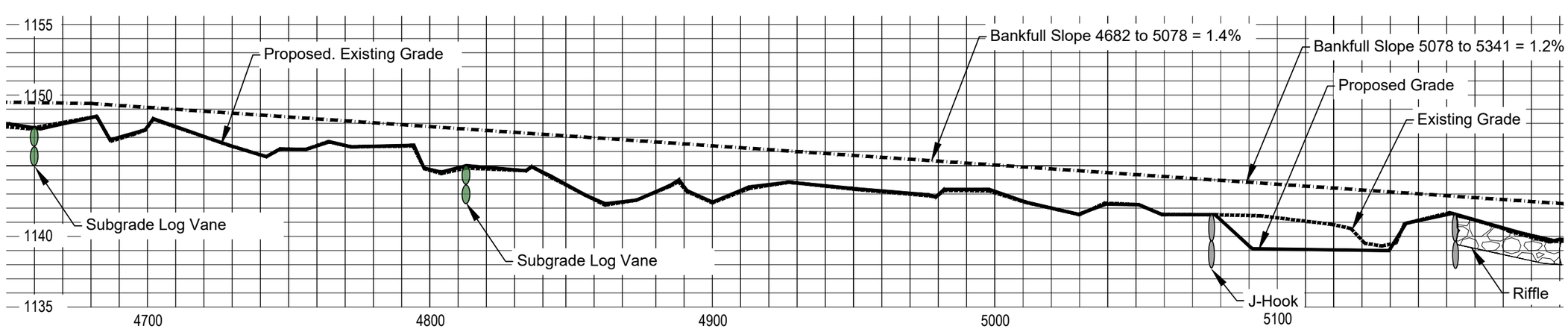
0 600' 1200'
GRAPHIC SCALE IN FEET

PROFILE 46+50 TO 52+00

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

0 20' 40'
GRAPHIC SCALE IN FEET

0 4 8
GRAPHIC SCALE IN FEET



90% DESIGN

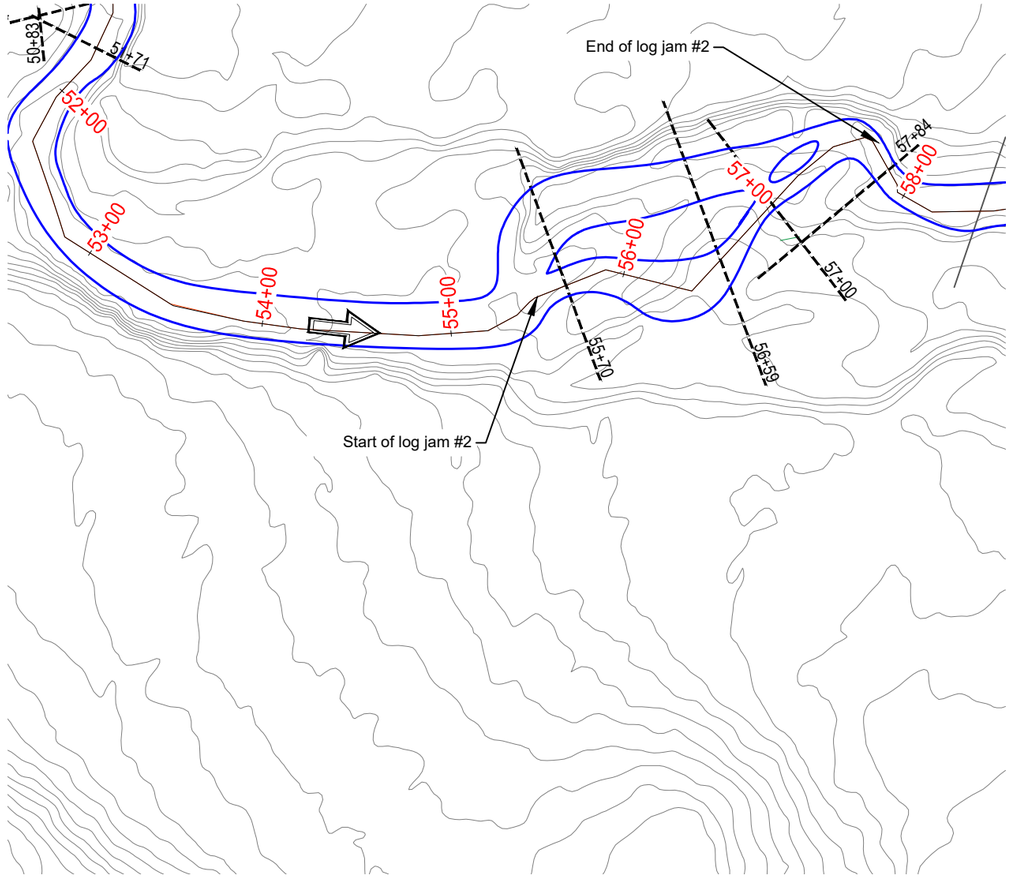
Cardno
MADISON
6140 COTTONWOOD DRIVE, SUITE A,
FITCHBURG, WISCONSIN 53719
TEL: (608) 661-2655 FAX: (608) 661-2661
www.cardnoflow.com

AREA 8 PROPOSED PLAN
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

#	DATE	DESCRIPTION	BY

DATE	APRIL 2020
DRAWN	MGS/COD
DESIGNED	ACS
CHECKED	
PROJECT #	J188372100
SHEET TITLE	AREA 8
SHEET NUMBER	21
LAND USE #	----

P:\Projects\188\188372_Eh-Troubleshooters_KnifeRiverPhaseIII\02_Phase\CADDwg\Design\20200315_Layout_Sheets.dwg - 4/14/2020 4:20:21 PM

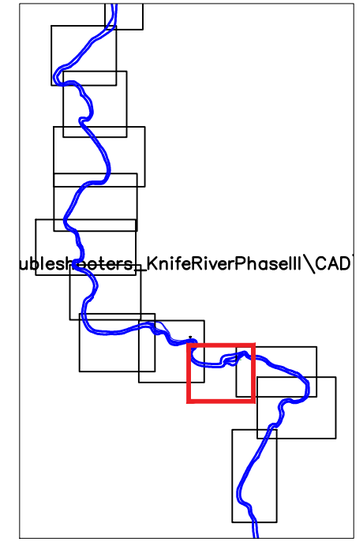


0 40' 80'
GRAPHIC SCALE IN FEET

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

LEGEND

- EDGE OF WATER
- EXISTING GRADE
- DRAINAGE FLOW



KEY MAP

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

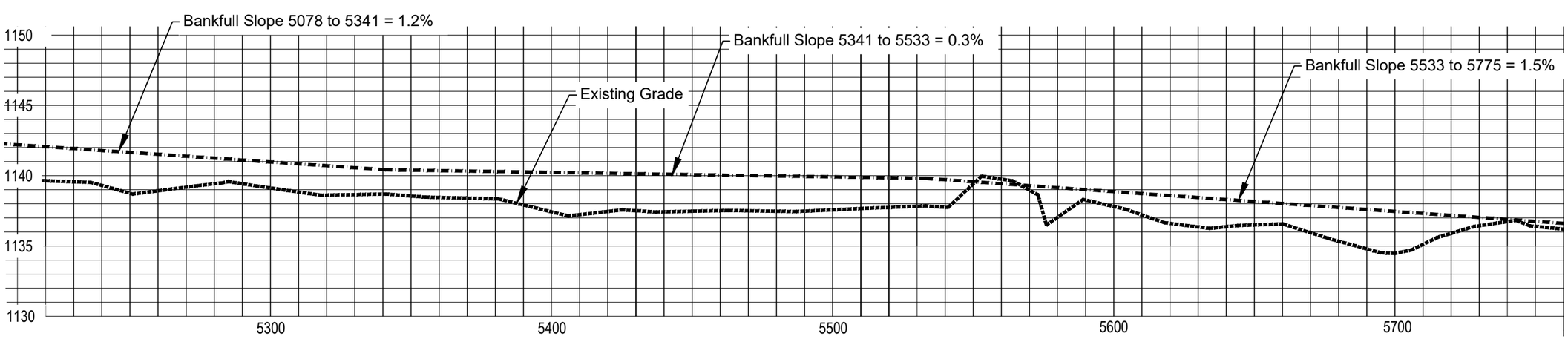
0 600' 1200'
GRAPHIC SCALE IN FEET

PROFILE 52+00 TO 57+50

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

0 20' 40'
GRAPHIC SCALE IN FEET

0 4' 8'
GRAPHIC SCALE IN FEET



90% DESIGN

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MADISON
6140 COTTONWOOD DRIVE, SUITE A,
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AREA 9 EXISTING CONDITIONS
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

#	DATE	DESCRIPTION	BY

DATE	APRIL 2020
DRAWN	MGS/COD
DESIGNED	ACS
CHECKED	
PROJECT #	J188372100

SHEET TITLE
AREA 9

SHEET NUMBER
22

LAND USE # ----

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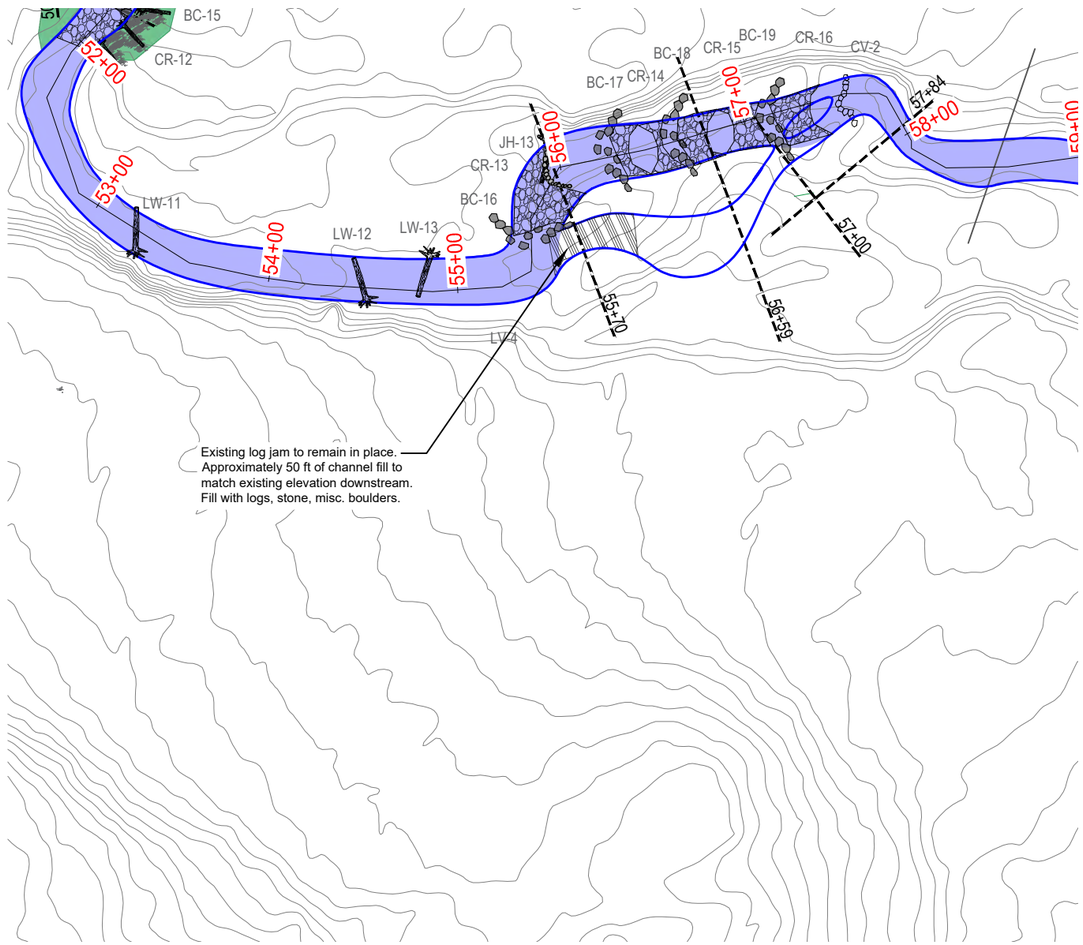


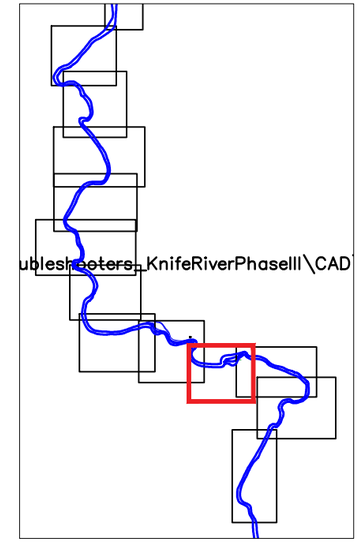
0 40' 80'
GRAPHIC SCALE IN FEET

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

NOTE:
1. Final position, orientation, and elevation of large wood additions to be determined in the field by on-site construction supervisor.

LEGEND

- EDGE OF WATER
- EXISTING GRADE
- DRAINAGE FLOW
- TOEWOOD
- J-HOOK
- BOULDER CLUSTER
- CROSS VANE
- BANK GRADING
- CHANNEL RE-ROUTE
- SUBGRADE LOG VANE
- LOG ROLLER
- CHANNEL TO BE FILLED
- CONSTRUCTED RIFFLE
- LARGE WOOD HABITAT ENHANCEMENT

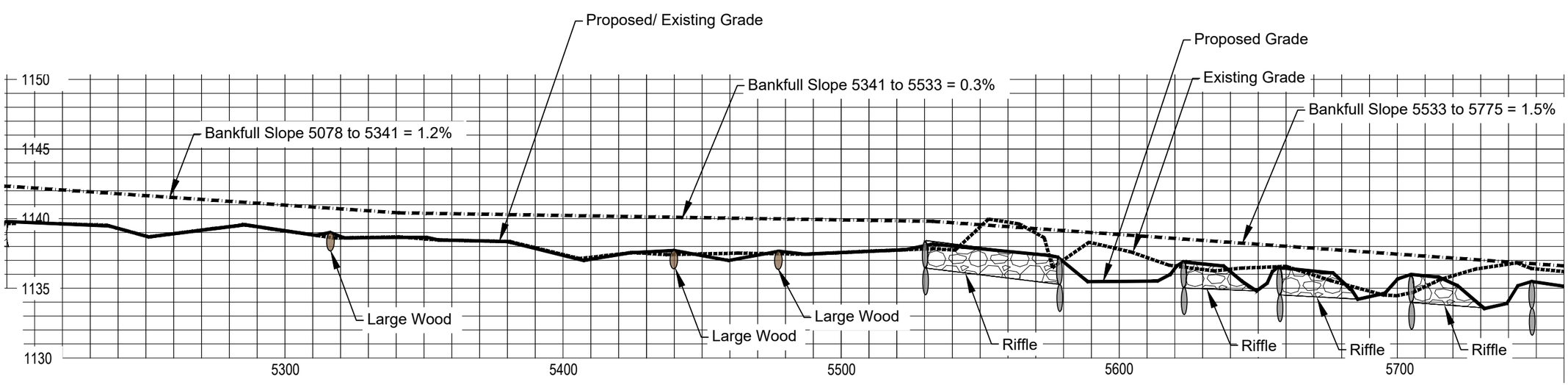


KEY MAP
GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.
0 600' 1200'
GRAPHIC SCALE IN FEET

PROFILE 52+00 TO 57+50

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.
0 20' 40'
GRAPHIC SCALE IN FEET

0 4' 8'
GRAPHIC SCALE IN FEET



90% DESIGN

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AREA 9 PROPOSED PLAN
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

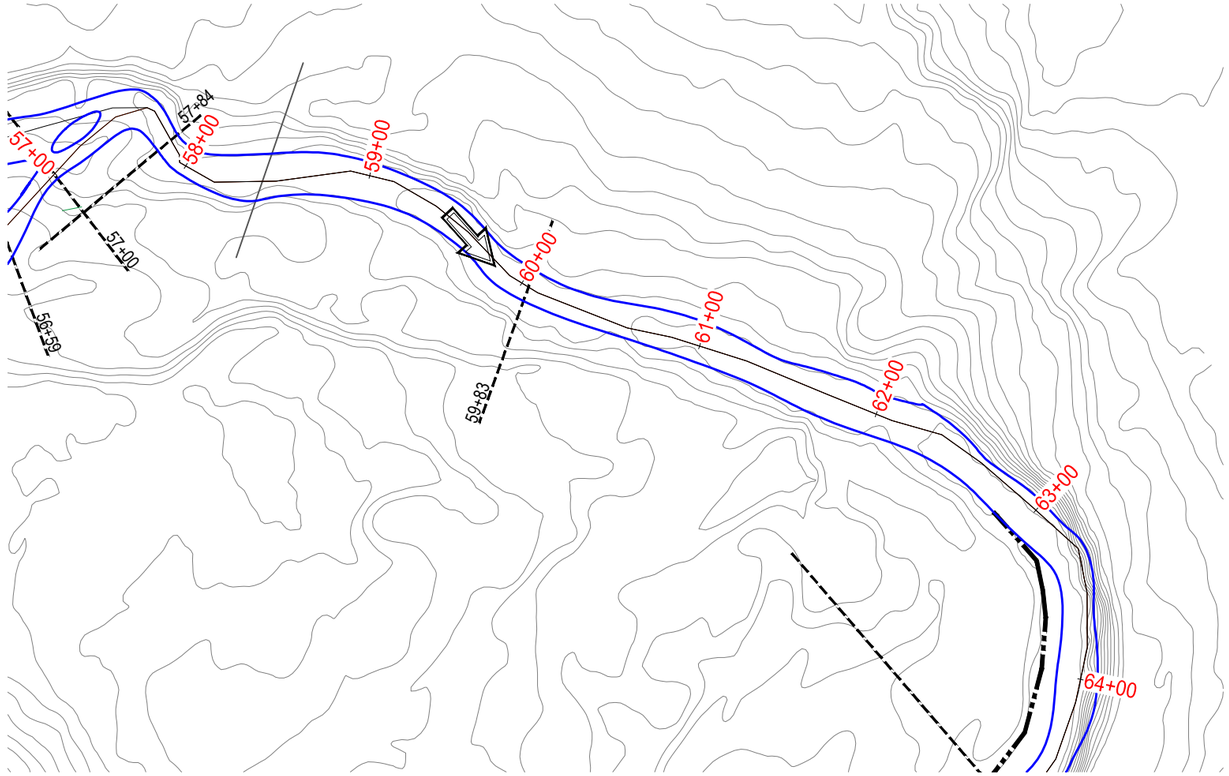
#	DATE	DESCRIPTION	BY

DATE	APRIL 2020
DRAWN	MGS/COD
DESIGNED	ACS
CHECKED	
PROJECT #	J188372100

SHEET TITLE
AREA 9

SHEET NUMBER
23

LAND USE # ----

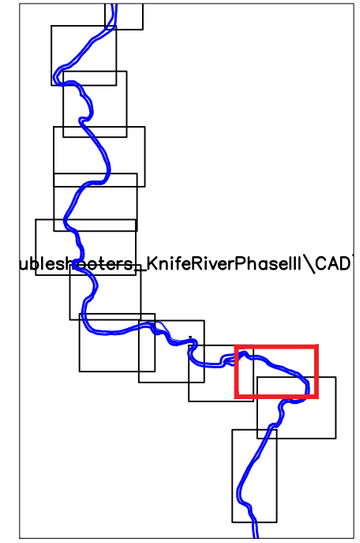


GRAPHIC SCALE IN FEET
0 40' 80'

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

LEGEND

- EDGE OF WATER
- EXISTING GRADE
- DRAINAGE FLOW



KEY MAP

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

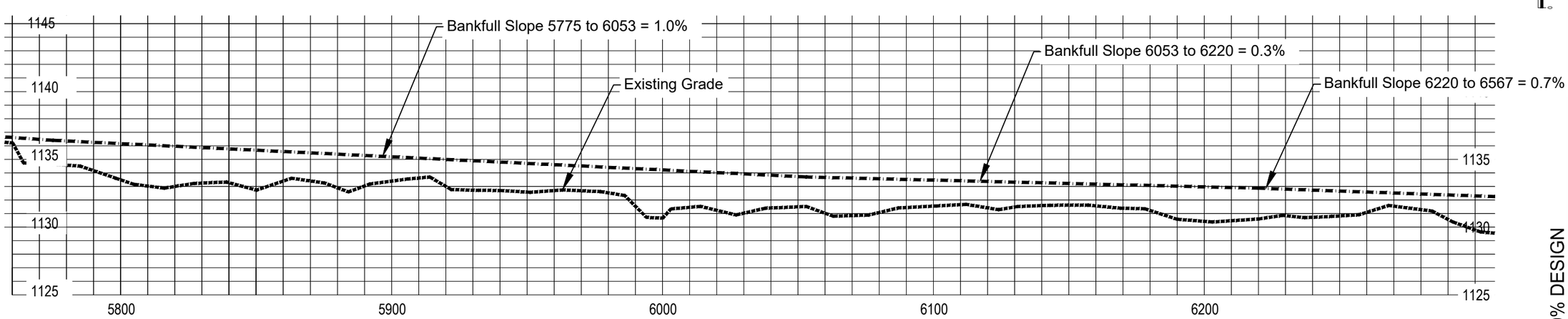
0 600' 1200'
GRAPHIC SCALE IN FEET

PROFILE 57+50 TO 63+00

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

0 20' 40'
GRAPHIC SCALE IN FEET

0 4' 8'
GRAPHIC SCALE IN FEET



90% DESIGN

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AREA 10 EXISTING CONDITIONS
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

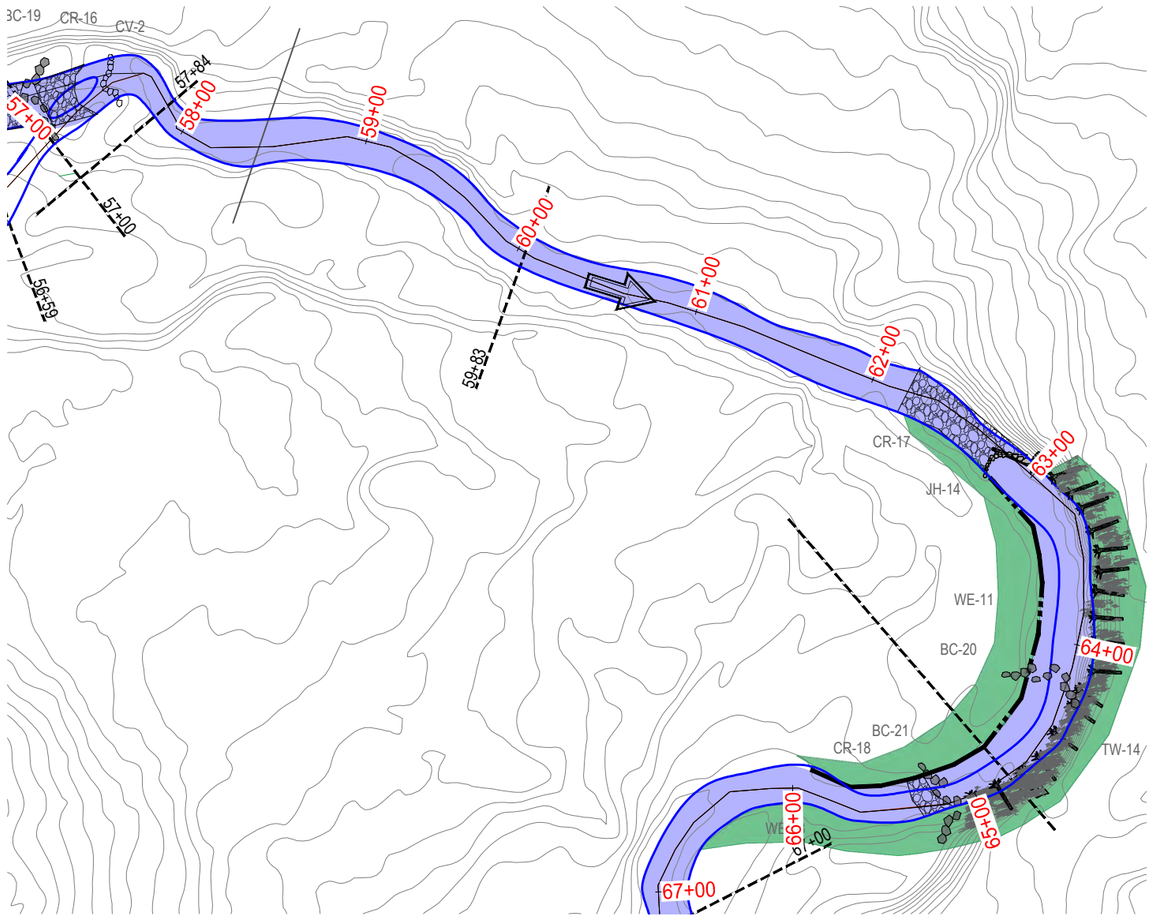
#	DATE	DESCRIPTION	BY

DATE	APRIL 2020
DRAWN	MGS/COD
DESIGNED	ACS
CHECKED	
PROJECT #	J188372100

SHEET TITLE
AREA 10

SHEET NUMBER
24

LAND USE # ----

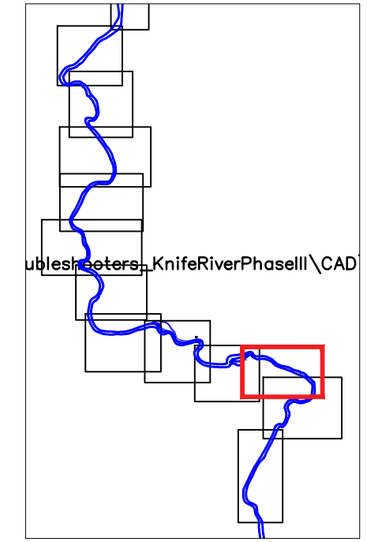


GRAPHIC SCALE IN FEET
0 40' 80'

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

NOTE:
1. Final position, orientation, and elevation of large wood additions to be determined in the field by on-site construction supervisor.

LEGEND
- EDGE OF WATER
- EXISTING GRADE
- DRAINAGE FLOW
- TOEWOOD
- J-HOOK
- BOULDER CLUSTER
- CROSS VANE
- BANK GRADING
- CHANNEL RE-ROUTE
- SUBGRADE LOG VANE
- LOG ROLLER
- CHANNEL TO BE FILLED
- CONSTRUCTED RIFFLE
- LARGE WOOD HABITAT ENHANCEMENT

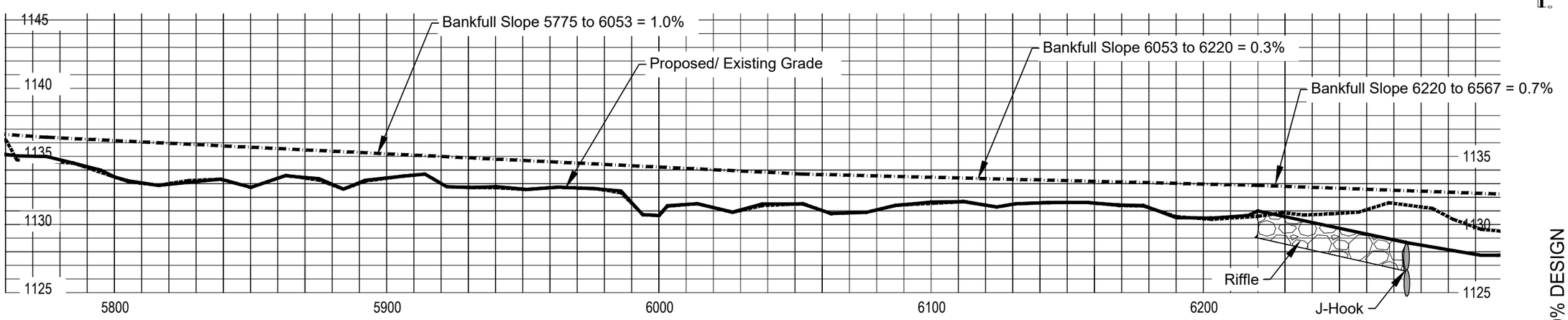


KEY MAP
GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.
0 600' 1200'
GRAPHIC SCALE IN FEET

PROFILE 57+50 TO 63+00

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.
0 20' 40'
GRAPHIC SCALE IN FEET

GRAPHIC SCALE IN FEET
0 4' 8'



90% DESIGN

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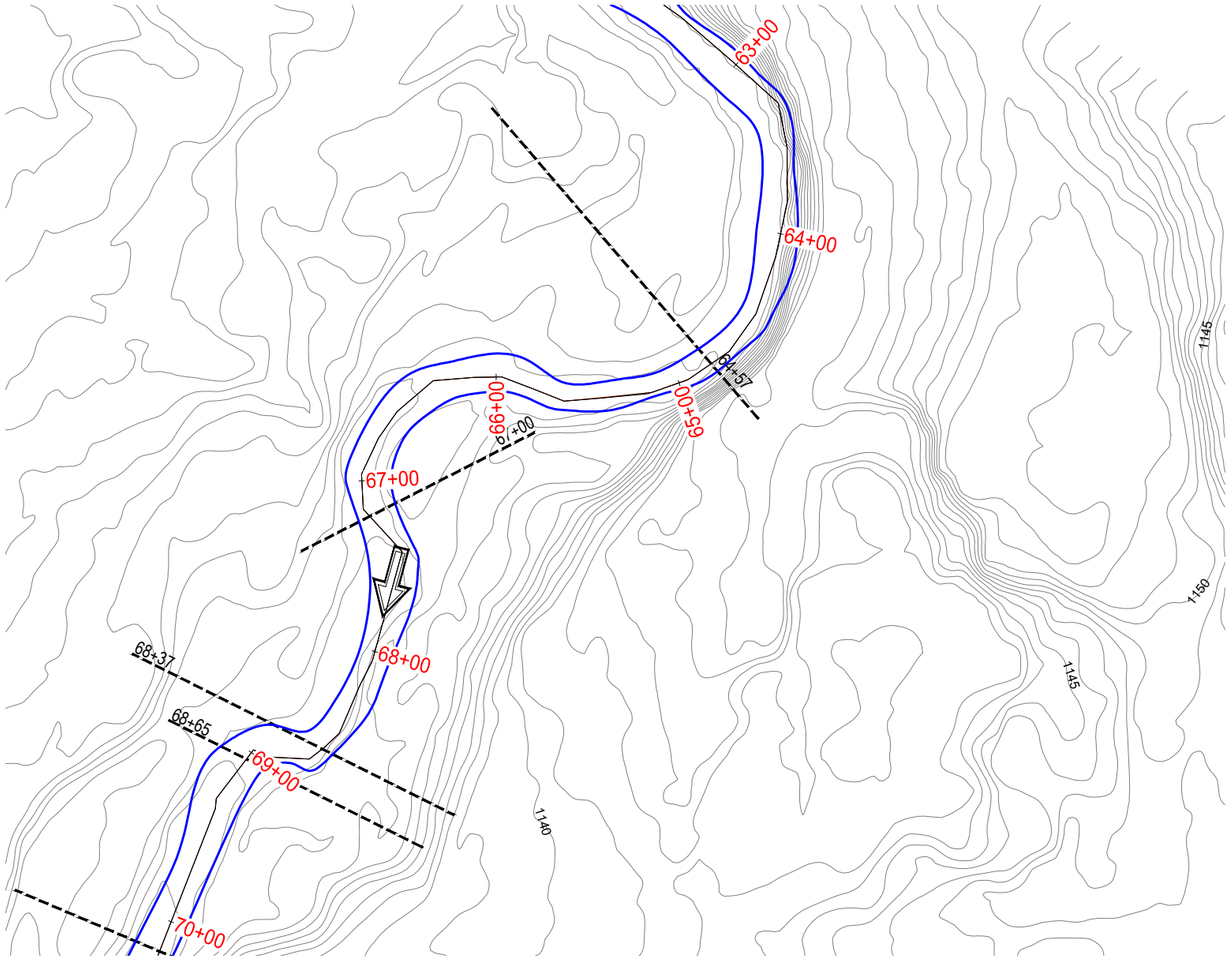
AREA 10 PROPOSED PLAN
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

#	DATE	DESCRIPTION	BY

DATE	APRIL 2020
DRAWN	MGS/COD
DESIGNED	ACS
CHECKED	
PROJECT #	J188372100
SHEET TITLE	AREA 10
SHEET NUMBER	25
LAND USE #	----



GRAPHIC SCALE IN FEET
0 40' 80'

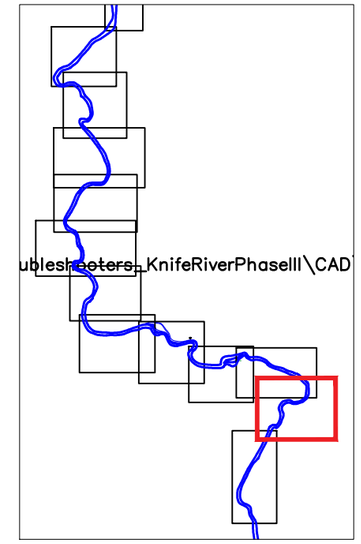
GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

LEGEND

EDGE OF WATER

EXISTING GRADE

DRAINAGE FLOW



KEY MAP

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

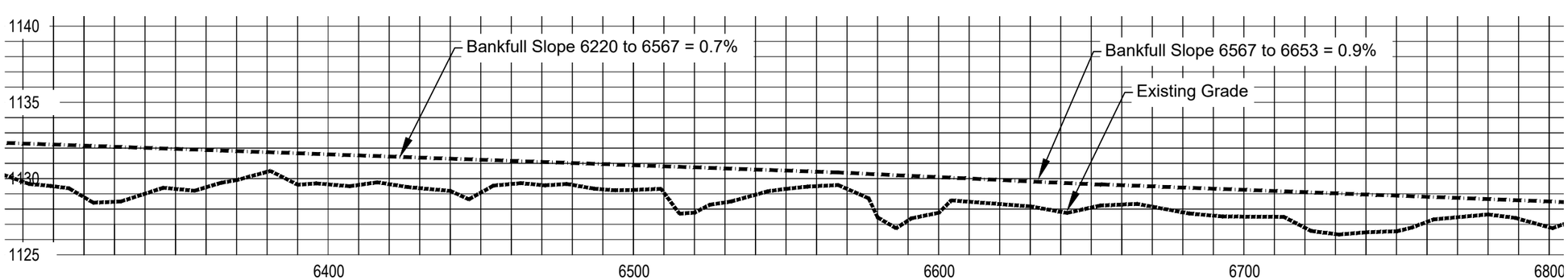
0 600' 1200'
GRAPHIC SCALE IN FEET

PROFILE 63+00 TO 68+00

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

0 20' 40'
GRAPHIC SCALE IN FEET

0 4' 8'
GRAPHIC SCALE IN FEET



90% DESIGN

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AREA 11 EXISTING CONDITIONS
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

#	DATE	DESCRIPTION	BY

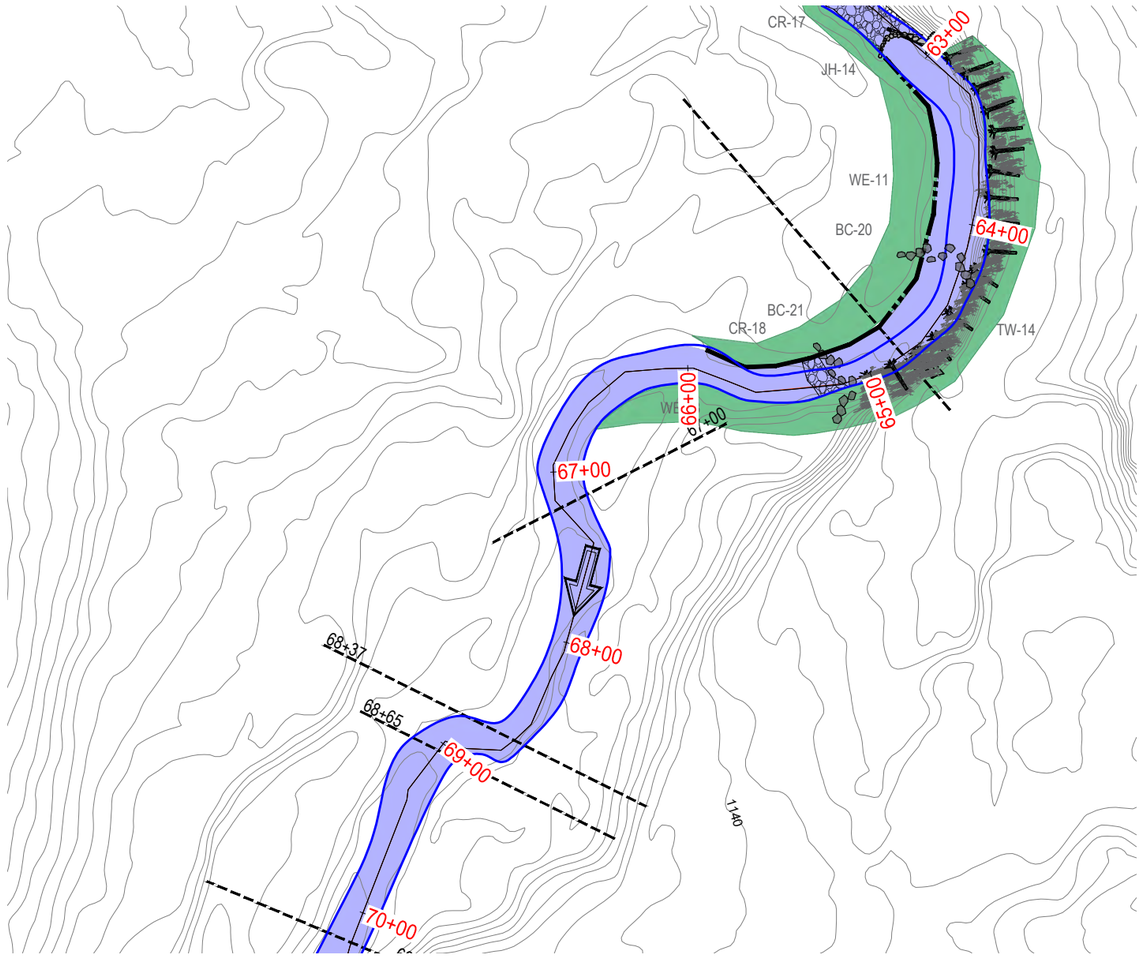
DATE	APRIL 2020
DRAWN	MGS/COD
DESIGNED	ACS
CHECKED	
PROJECT #	J188372100

SHEET TITLE
AREA 11

SHEET NUMBER
26

LAND USE # ----

P:\Projects\18\188372_Eng\troubleshooters_KnifeRiverPhaseIII\0_Phase\CADDwg\Sheets\26\2003170_Layout_Sheets.dwg - 4/14/2020 4:01:22 PM



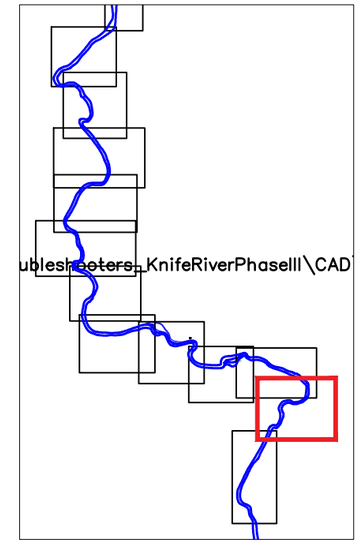
GRAPHIC SCALE IN FEET
0 40' 80'

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

NOTE:
1. Final position, orientation, and elevation of large wood additions to be determined in the field by on-site construction supervisor.

LEGEND

- EDGE OF WATER
- EXISTING GRADE
- DRAINAGE FLOW
- TOEWOOD
- J-HOOK
- BOULDER CLUSTER
- CROSS VANE
- BANK GRADING
- CHANNEL RE-ROUTE
- SUBGRADE LOG VANE
- LOG ROLLER
- CHANNEL TO BE FILLED
- CONSTRUCTED RIFFLE
- LARGE WOOD HABITAT ENHANCEMENT



KEY MAP

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

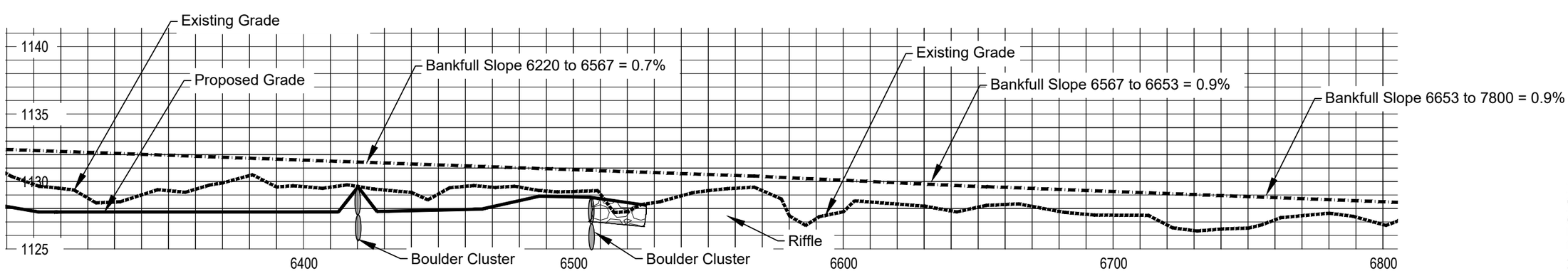
0 600' 1200'
GRAPHIC SCALE IN FEET

PROFILE 63+00 TO 68+00

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

0 20' 40'
GRAPHIC SCALE IN FEET

0 4' 8'
GRAPHIC SCALE IN FEET



90% DESIGN

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MADISON
6140 COTTONWOOD DRIVE, SUITE A,
FITCHBURG, WISCONSIN 53719
TEL: (608) 661-2805 FAX: (608) 661-2861
www.cardnoplfew.com

#	DATE	DESCRIPTION	BY

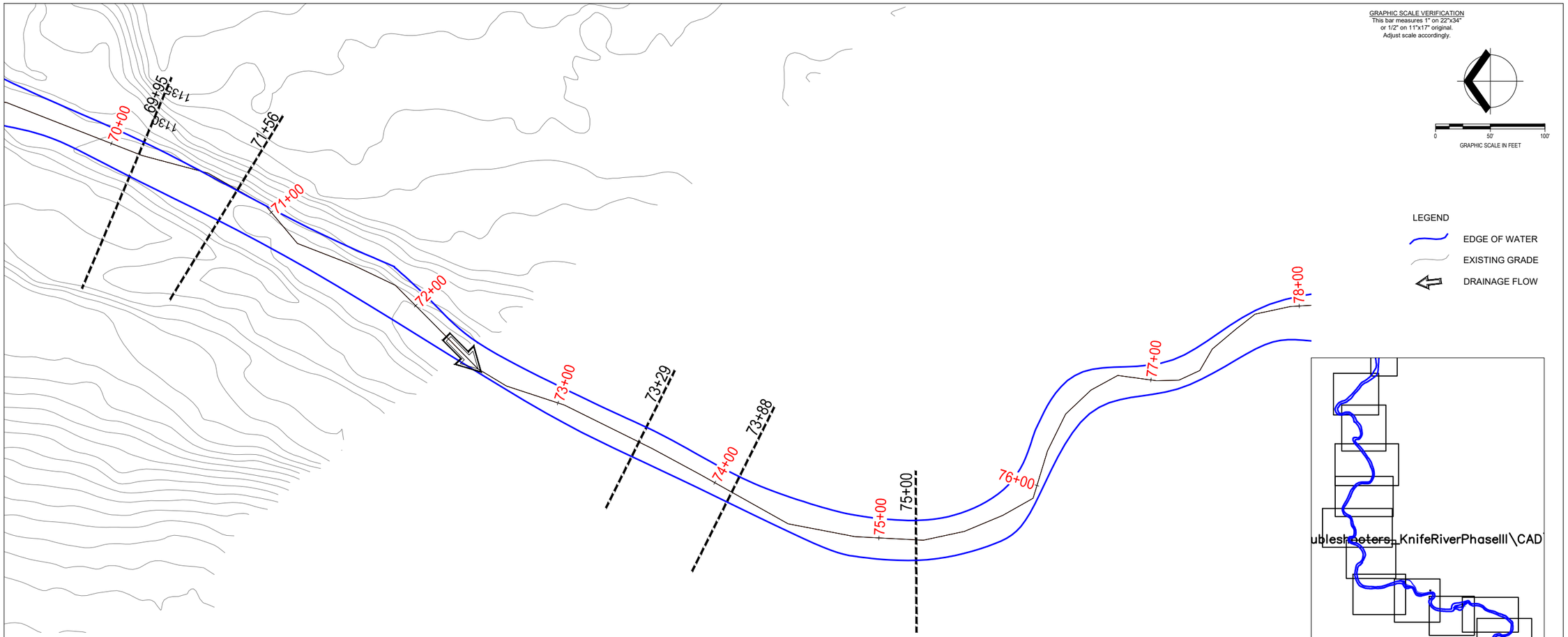
AREA 11 PROPOSED PLAN
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

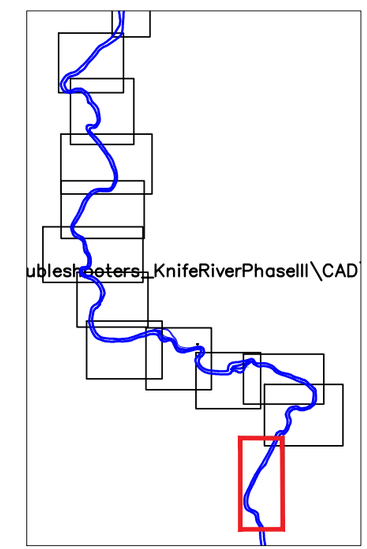
DATE	APRIL 2020
DRAWN	MGS/COD
DESIGNED	ACS
CHECKED	
PROJECT #	J188372100

SHEET TITLE
AREA 11

SHEET NUMBER
27

LAND USE # ----



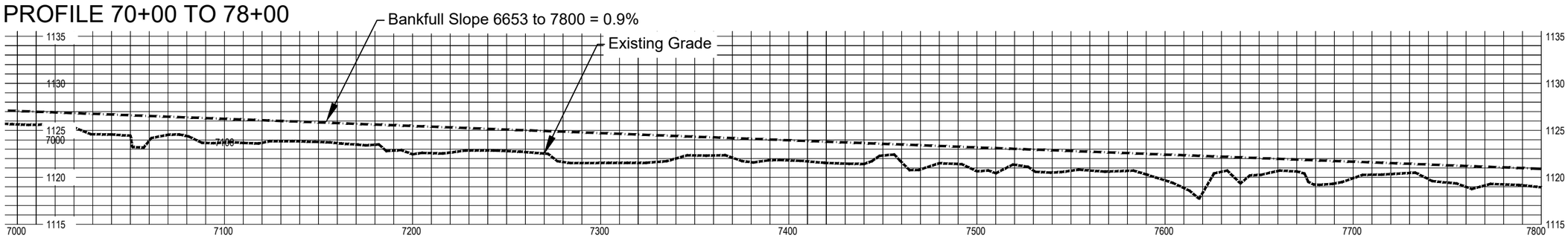


KEY MAP

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

0 600' 1200'
GRAPHIC SCALE IN FEET

PROFILE 70+00 TO 78+00



90% DESIGN

Cardno

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6140 COTTONWOOD DRIVE, SUITE A,
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REFERENCE REACH 70+00 TO 74+00
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

#	DATE	DESCRIPTION	BY

DATE	APRIL 2020
DRAWN	MGS/COD
DESIGNED	ACS
CHECKED	
PROJECT #	J188372100

SHEET TITLE
REF 70+00 TO 74+00

SHEET NUMBER
28

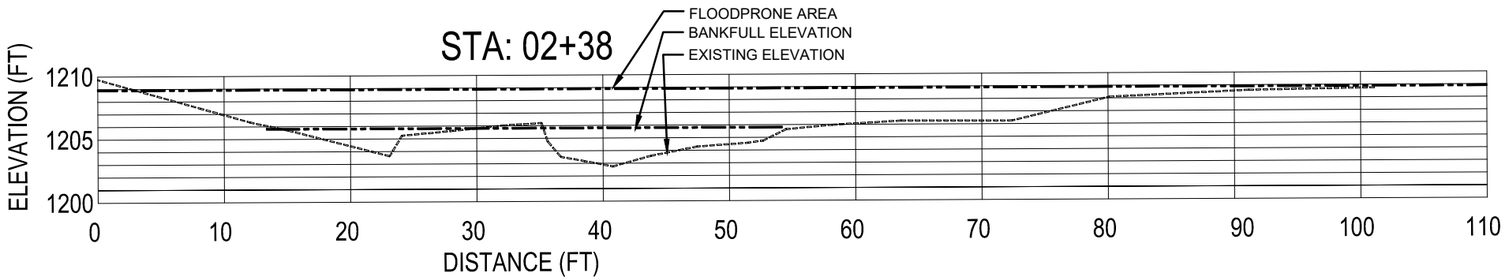
LAND USE # ----

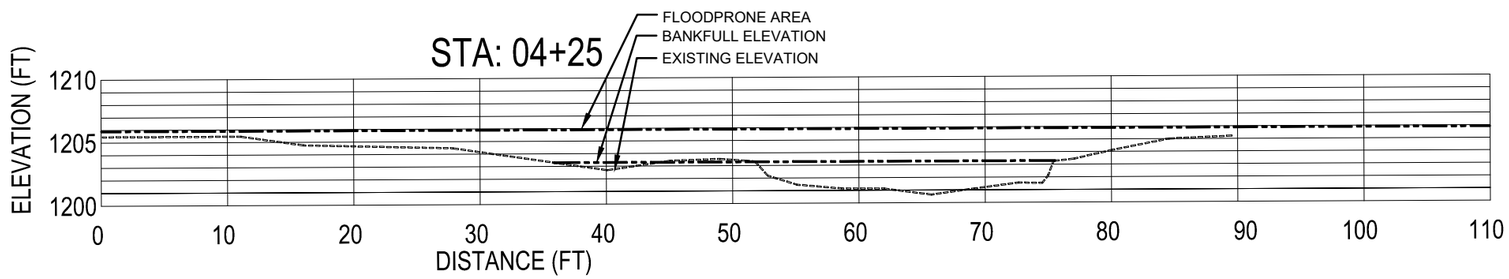
LEGEND

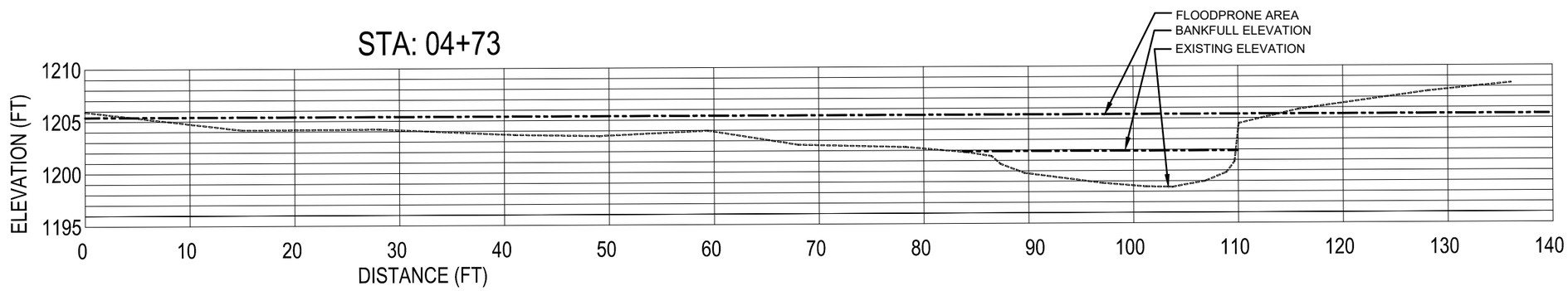
EXISTING GRADE

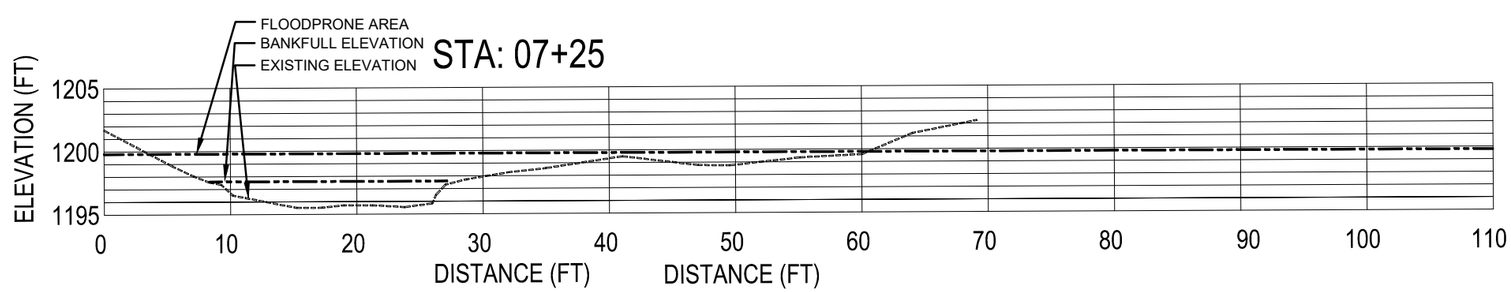
GRAPHIC SCALE IN FEET

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.









90% DESIGN

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FITCHBURG, WISCONSIN, 53719
TEL: (608) 661-2805 FAX: (608) 661-2861
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EXISTING CROSS SECTIONS
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

#	DATE	DESCRIPTION	BY

DATE	APRIL 2020
DRAWN	MGS/COD
DESIGNED	ACS
CHECKED	
PROJECT #	J188372100

SHEET TITLE
CROSS SECTIONS

SHEET NUMBER
29

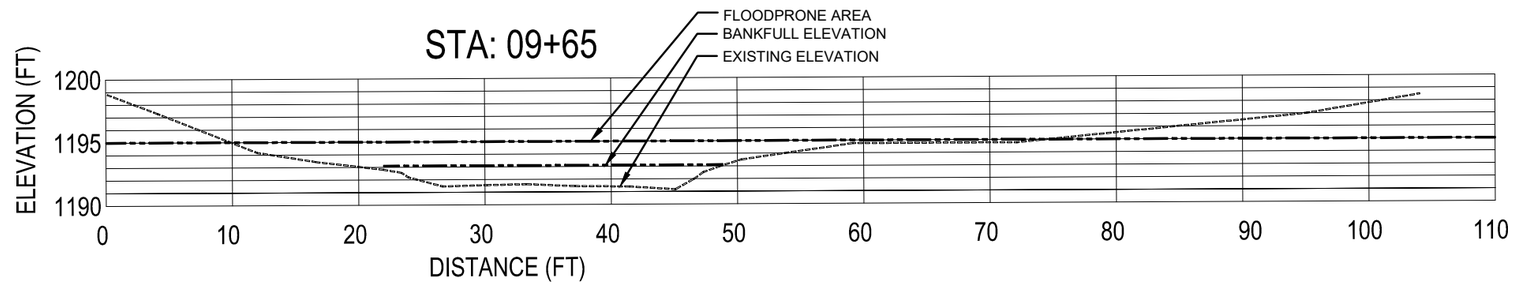
LAND USE # ----

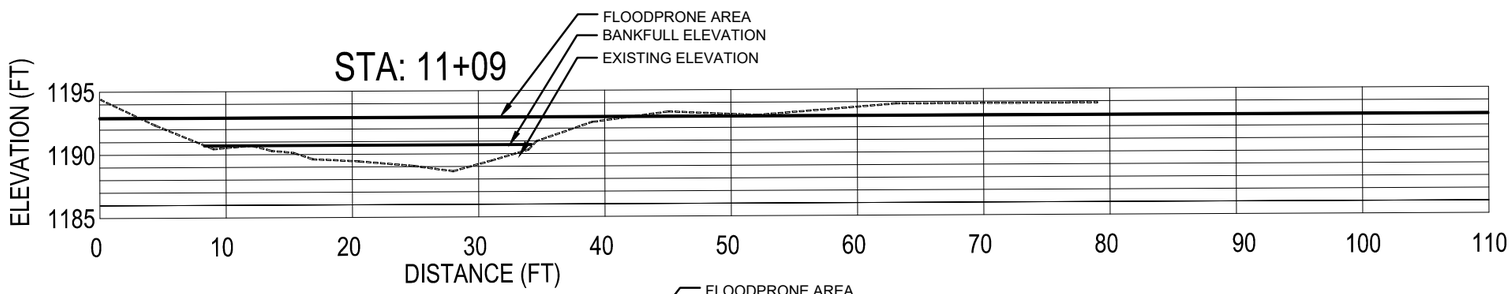
LEGEND

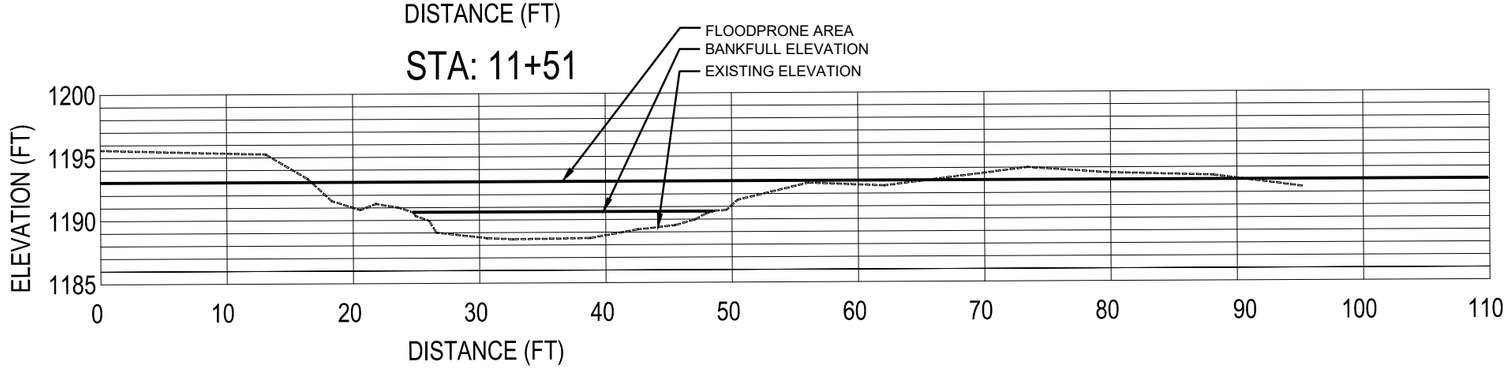
EXISTING GRADE

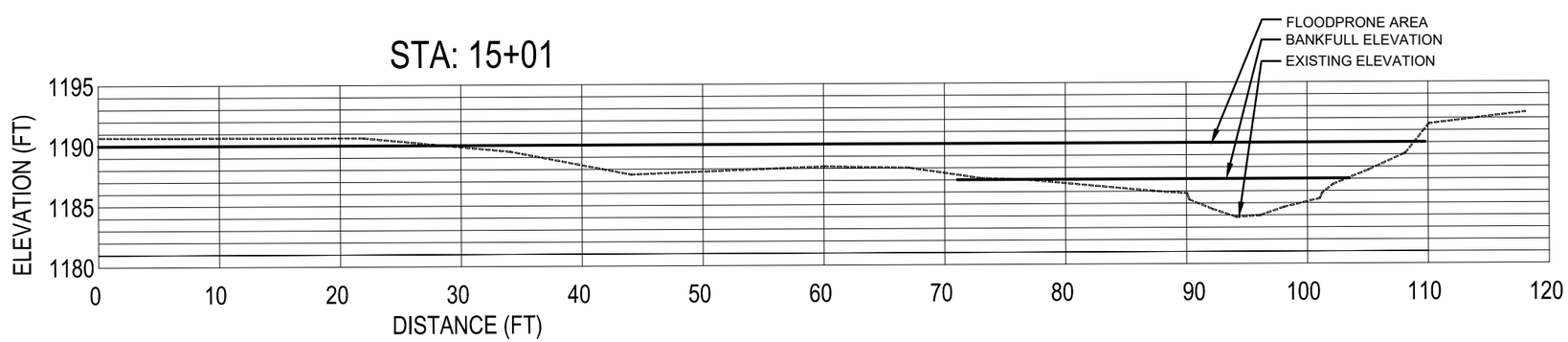
GRAPHIC SCALE IN FEET

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.









90% DESIGN

Cardno
MADISON
6140 COTTONWOOD DRIVE, SUITE A,
FITCHBURG, WISCONSIN 53719
TEL: (608) 661-2655 FAX: (608) 661-2661
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EXISTING CROSS SECTIONS
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

#	DATE	DESCRIPTION	BY

DATE	APRIL 2020
DRAWN	MGS/COD
DESIGNED	ACS
CHECKED	
PROJECT #	J188372100

SHEET TITLE
CROSS SECTIONS

SHEET NUMBER
30

LAND USE # ---

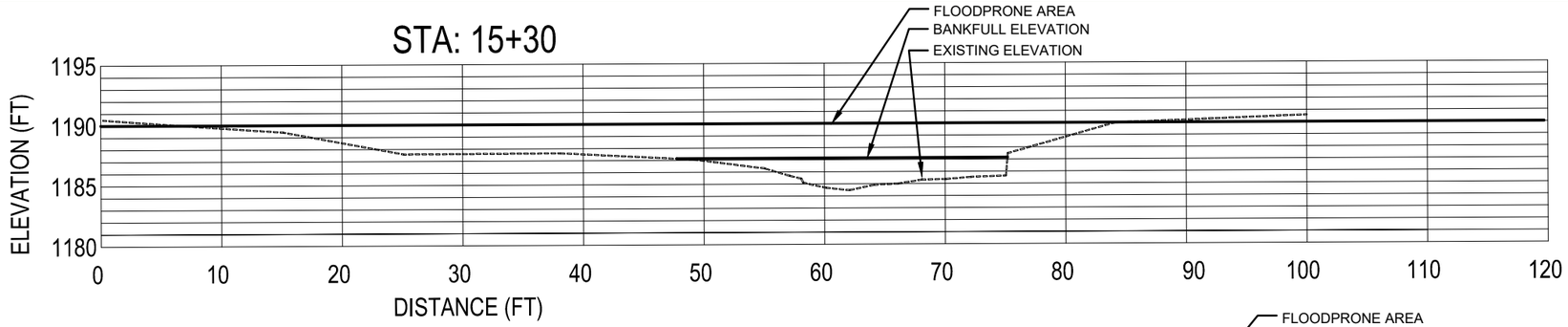
LEGEND

EXISTING GRADE

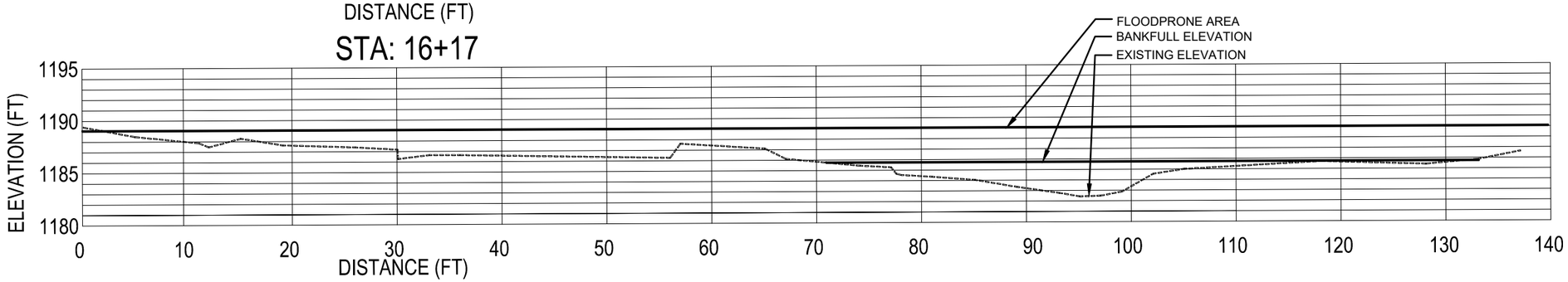
GRAPHIC SCALE IN FEET

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

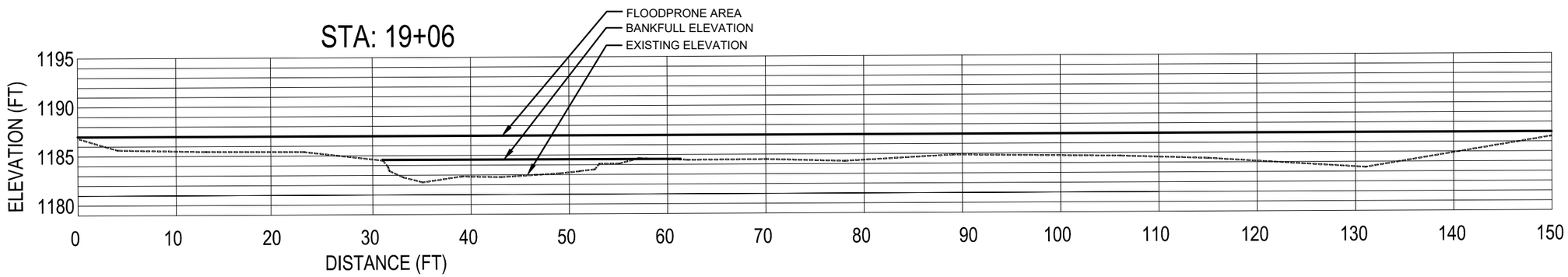
STA: 15+30



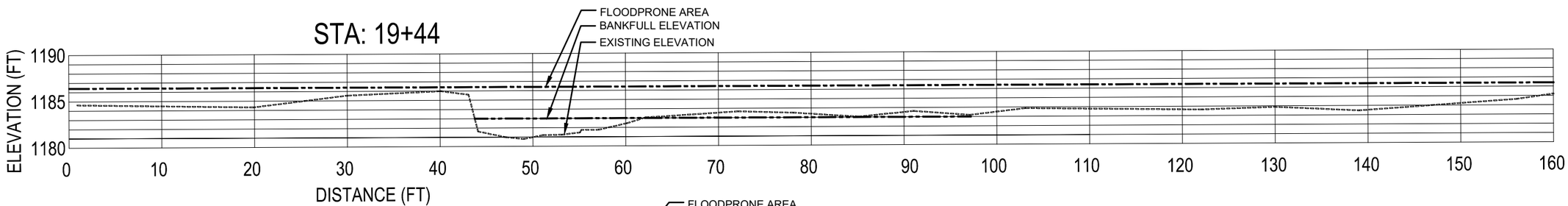
STA: 16+17



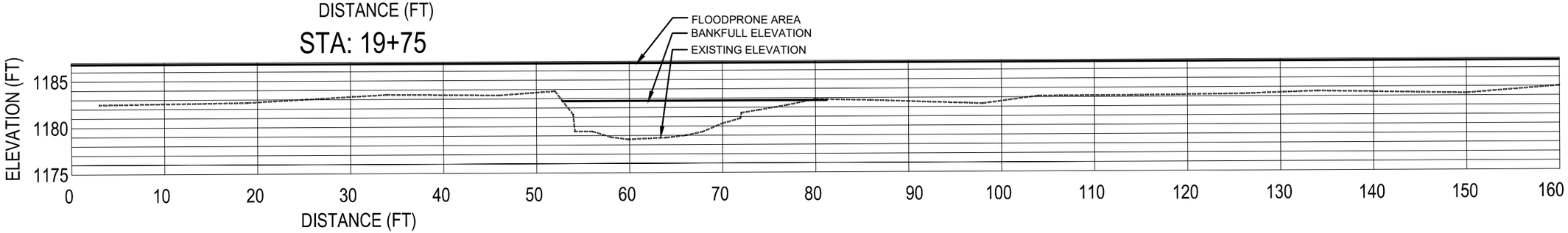
STA: 19+06



STA: 19+44



STA: 19+75



90% DESIGN

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MADISON
6140 COTTONWOOD DRIVE, SUITE A,
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TEL: (608) 661-2805 FAX: (608) 661-2861
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EXISTING CROSS SECTIONS
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

#	DATE	DESCRIPTION	BY

DATE	APRIL 2020
DRAWN	MGS/COD
DESIGNED	ACS
CHECKED	
PROJECT #	J188372100

SHEET TITLE
CROSS SECTIONS

SHEET NUMBER
31

LAND USE # —

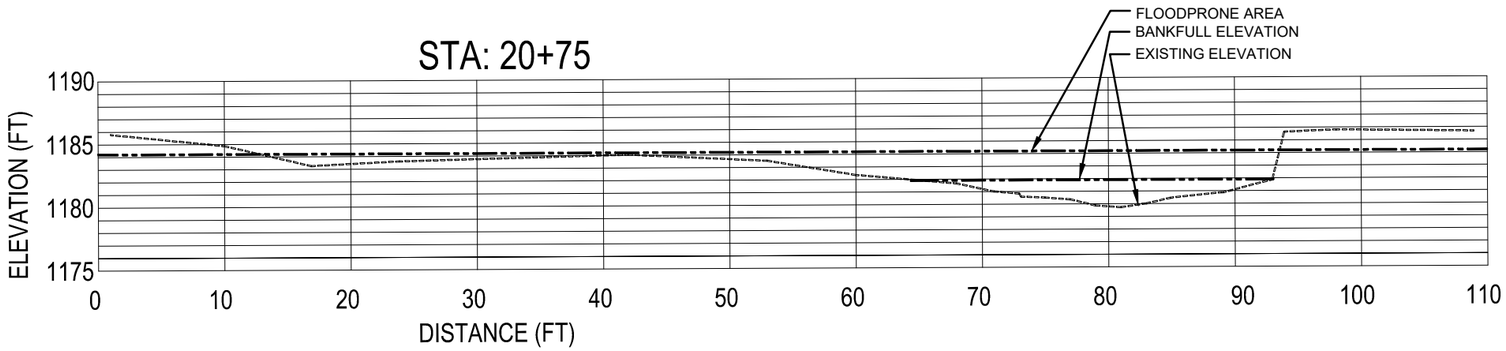
LEGEND

EXISTING GRADE

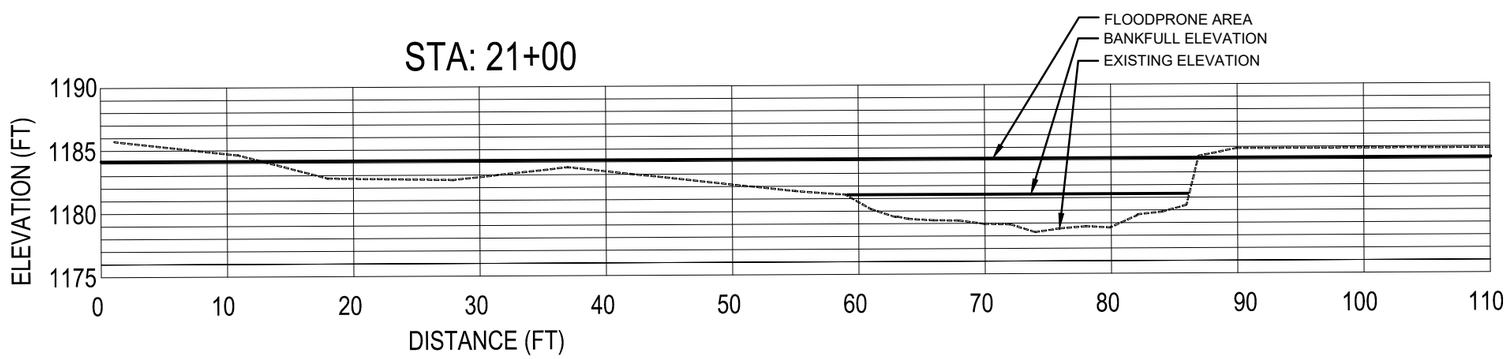
GRAPHIC SCALE IN FEET

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

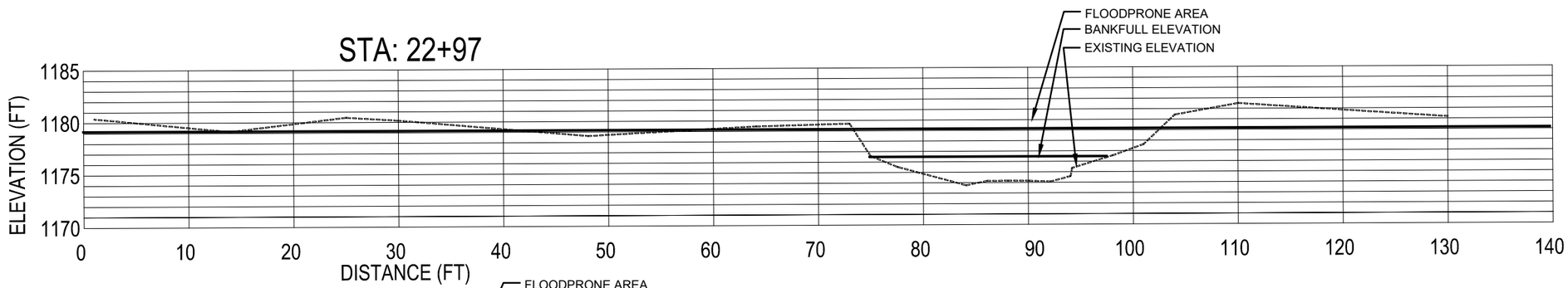
STA: 20+75



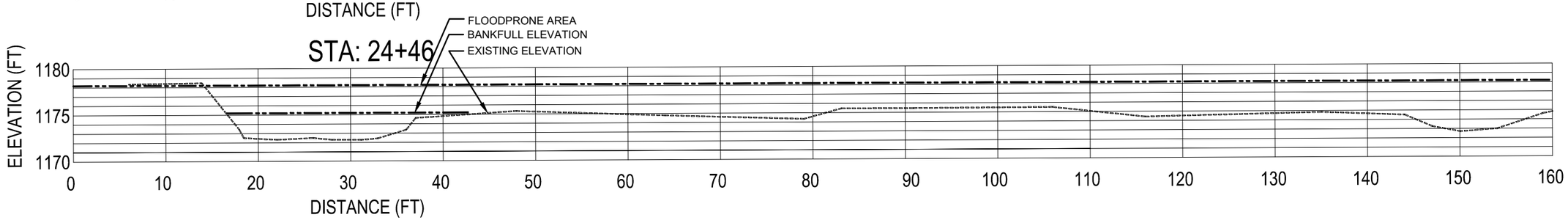
STA: 21+00



STA: 22+97



STA: 24+46



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DRAWN	MGS/COD
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CHECKED	
PROJECT #	J188372100

SHEET TITLE
CROSS SECTIONS

SHEET NUMBER
32

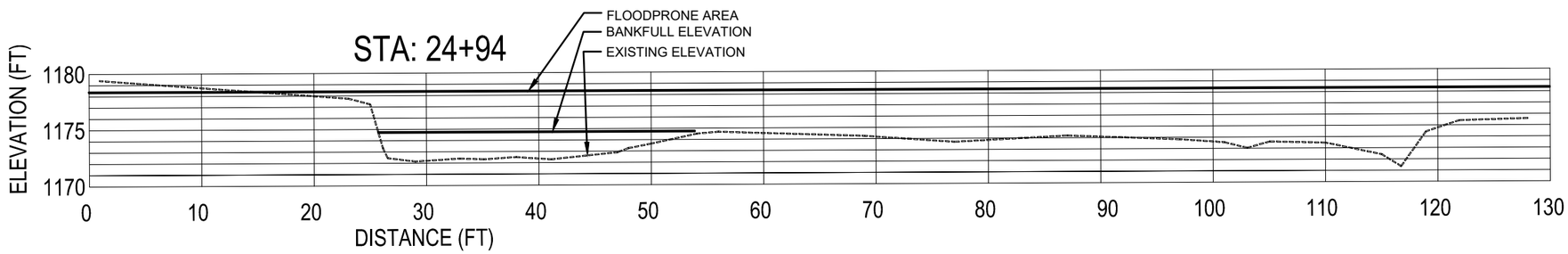
LAND USE # ----

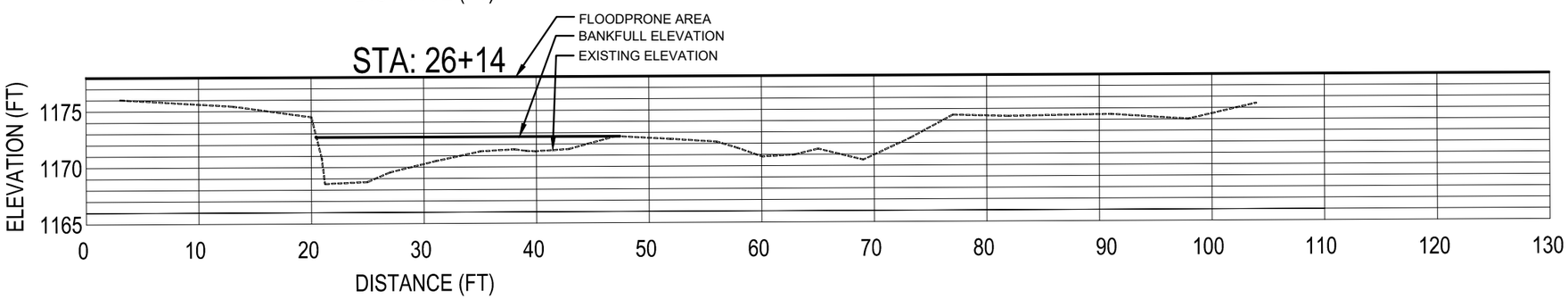
LEGEND

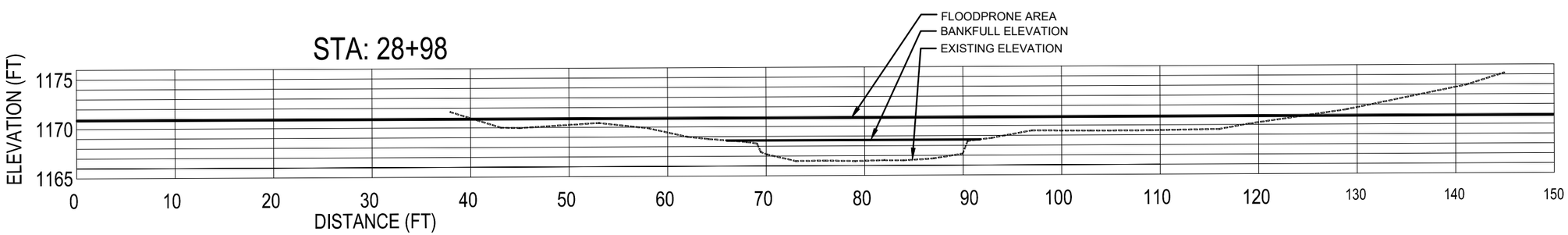
EXISTING GRADE

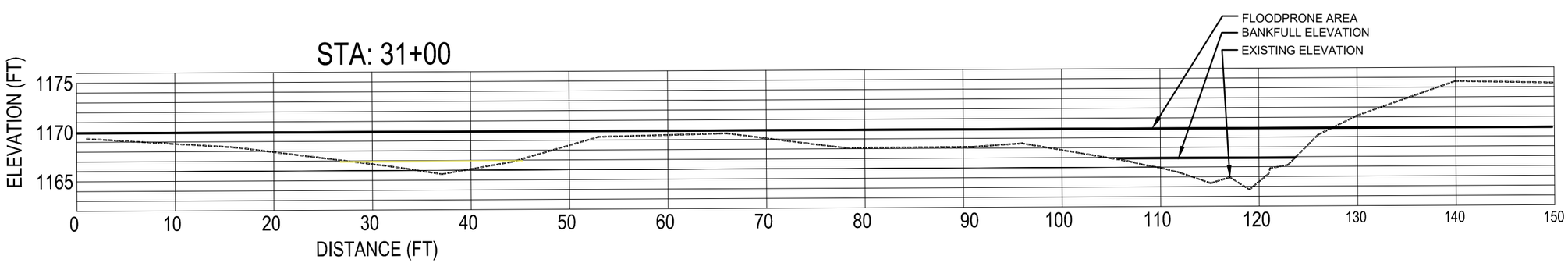
GRAPHIC SCALE IN FEET

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.









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PROJECT #	J188372100

SHEET TITLE
CROSS SECTIONS

SHEET NUMBER
33

LAND USE # ----

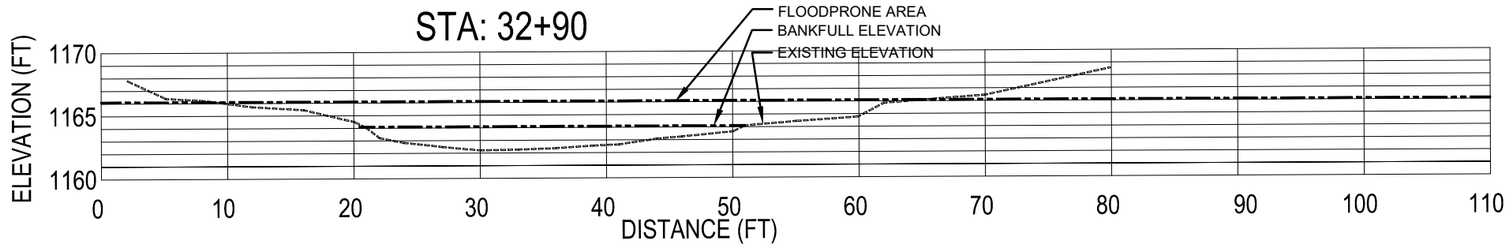
LEGEND

EXISTING GRADE

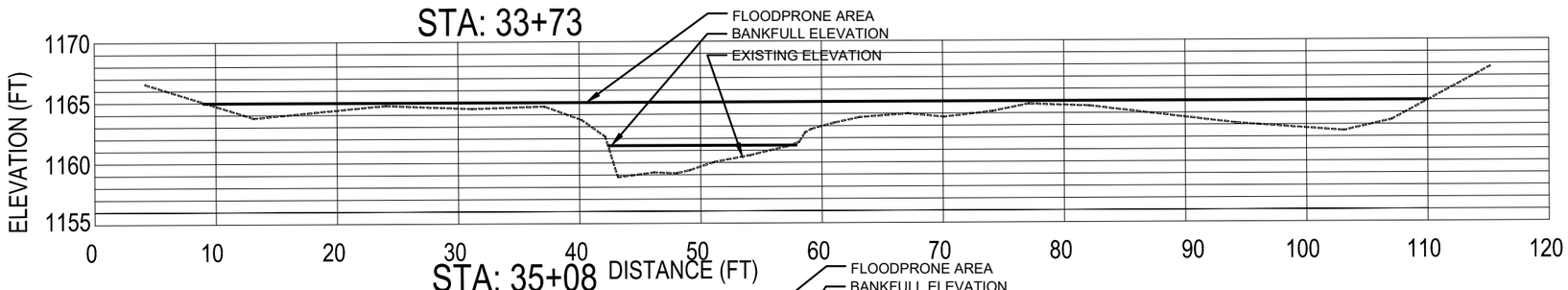
GRAPHIC SCALE IN FEET

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

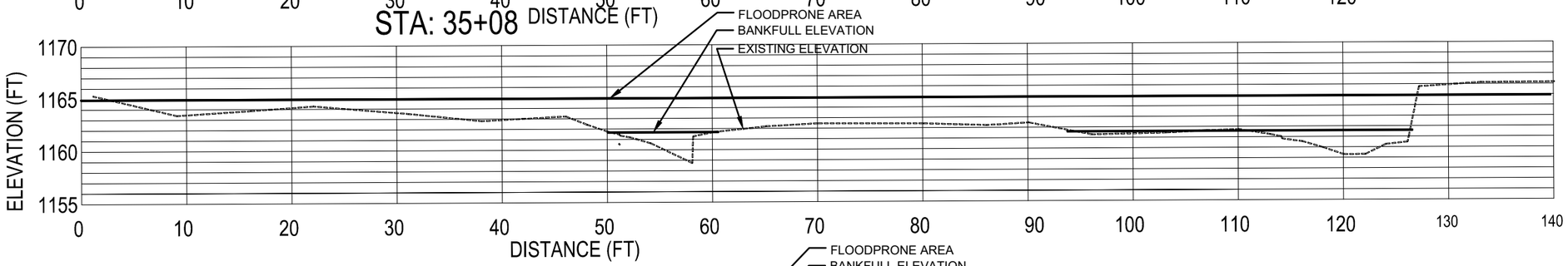
STA: 32+90



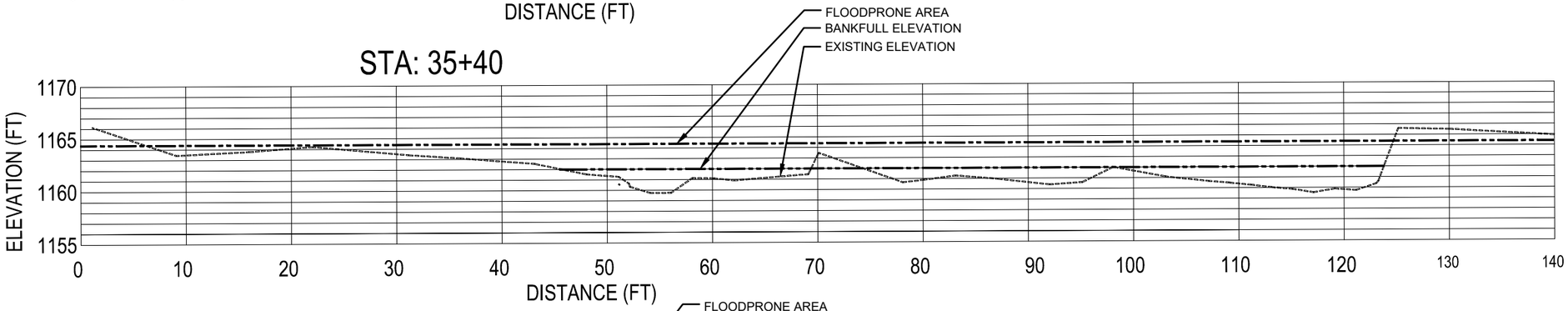
STA: 33+73



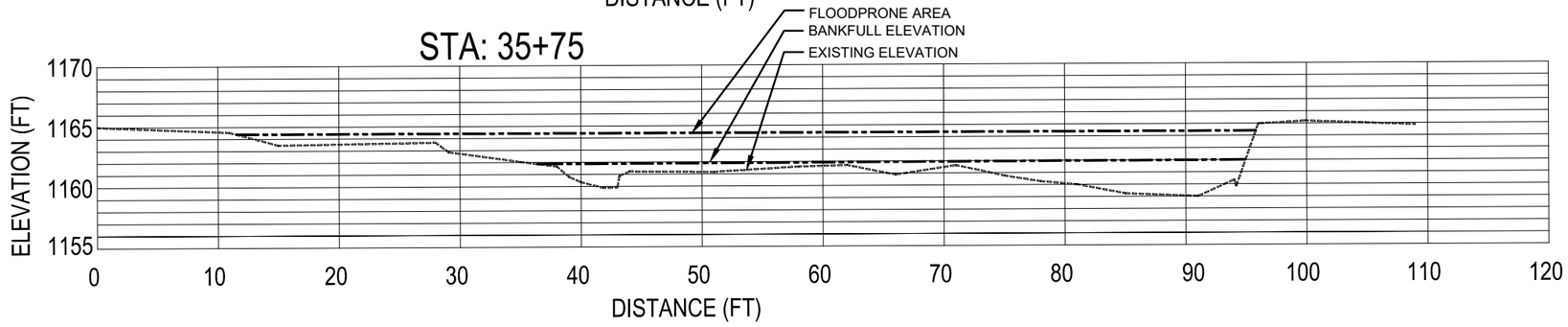
STA: 35+08



STA: 35+40



STA: 35+75



90% DESIGN

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EXISTING CROSS SECTIONS
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

#	DATE	DESCRIPTION	BY

DATE	APRIL 2020
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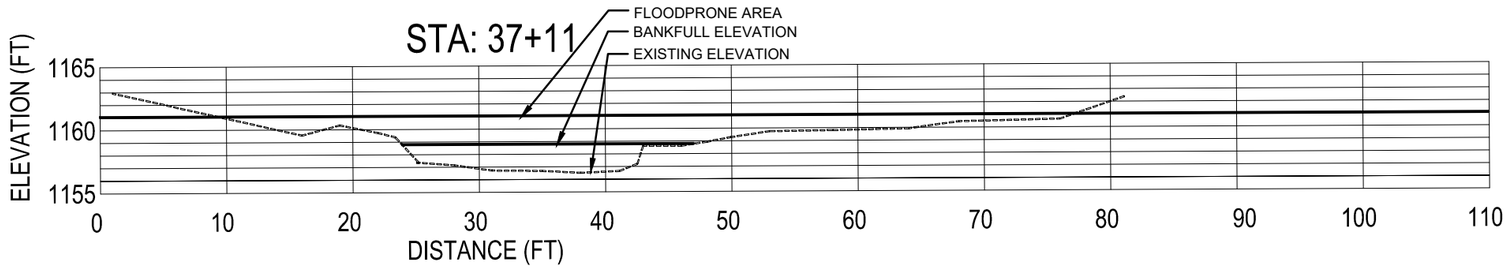
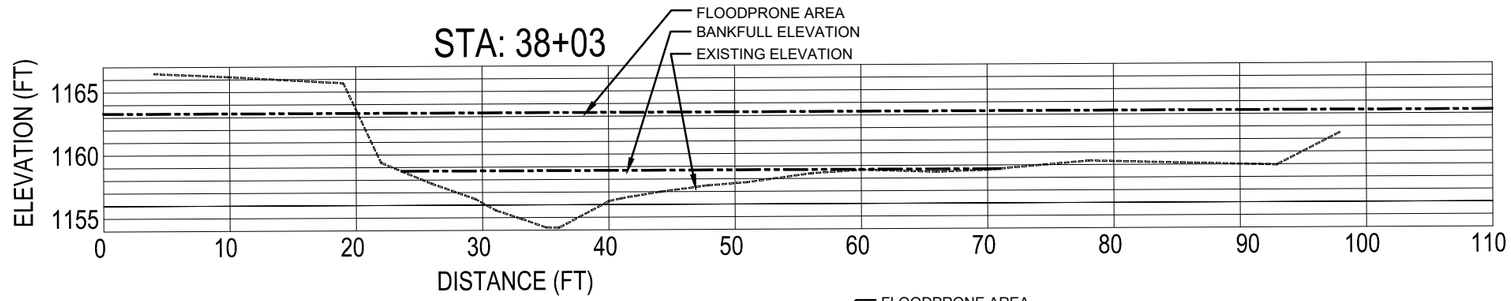
DESIGNED	ACS
CHECKED	
PROJECT #	J188372100

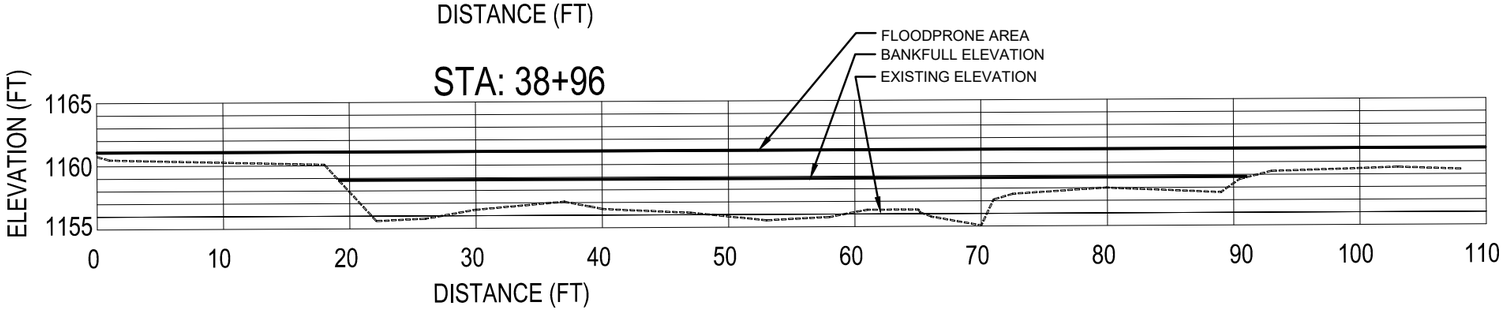
SHEET TITLE
CROSS SECTIONS

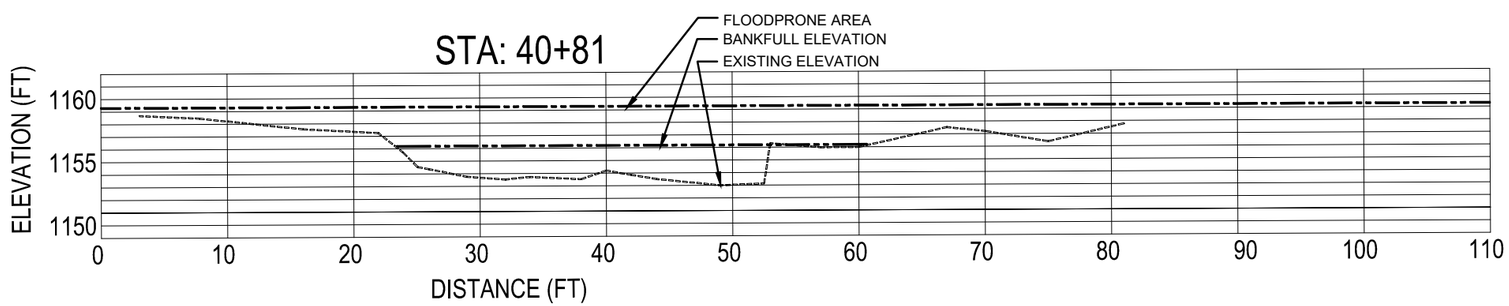
SHEET NUMBER
34

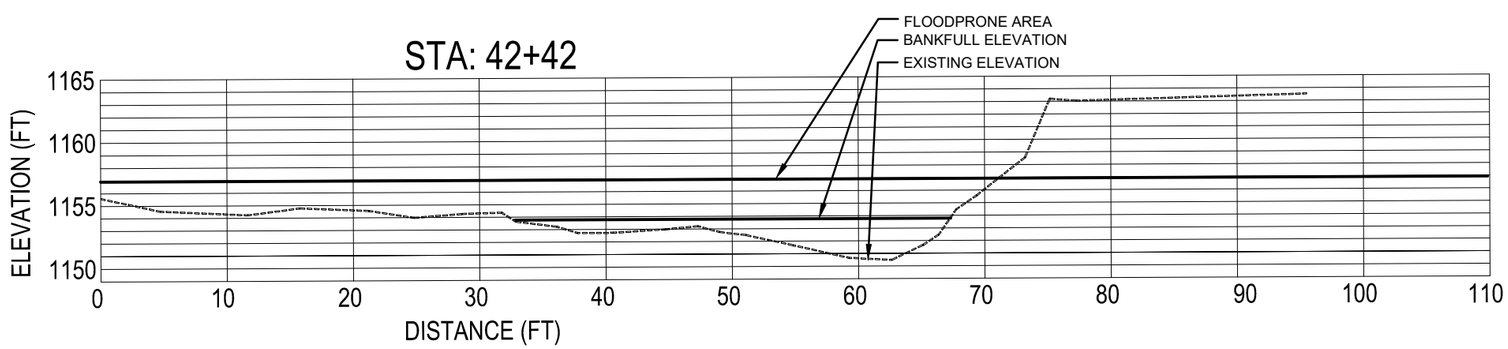
LAND USE # ----











LEGEND

EXISTING GRADE

GRAPHIC SCALE IN FEET

GRAPHIC SCALE VERIFICATION
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Adjust scale accordingly.

90% DESIGN

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TEL: (608) 661-2805 FAX: (608) 661-2861
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EXISTING CROSS SECTIONS
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

#	DATE	DESCRIPTION	BY

DATE	APRIL 2020
DRAWN	MGS/COD
DESIGNED	ACS
CHECKED	
PROJECT #	J188372100

SHEET TITLE
CROSS SECTIONS

SHEET NUMBER
35

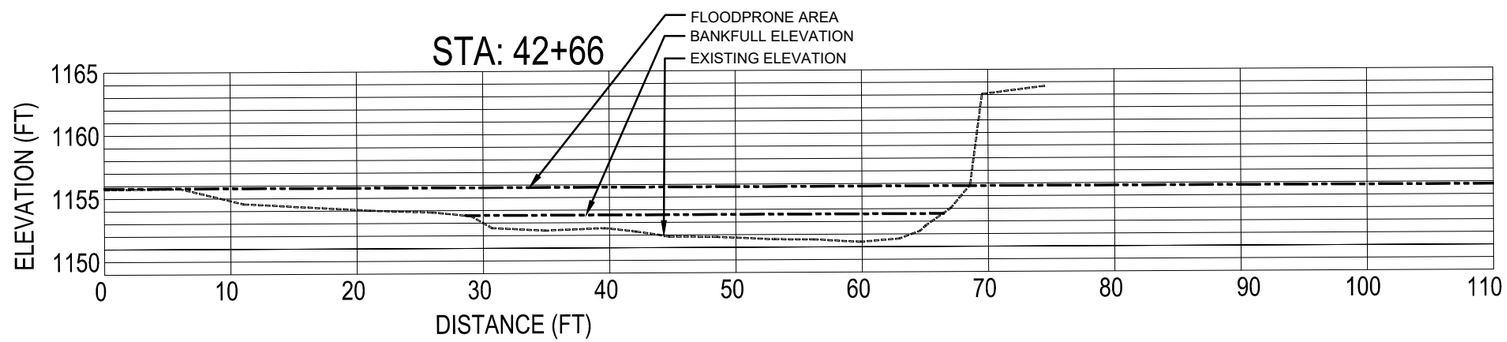
LAND USE # ----

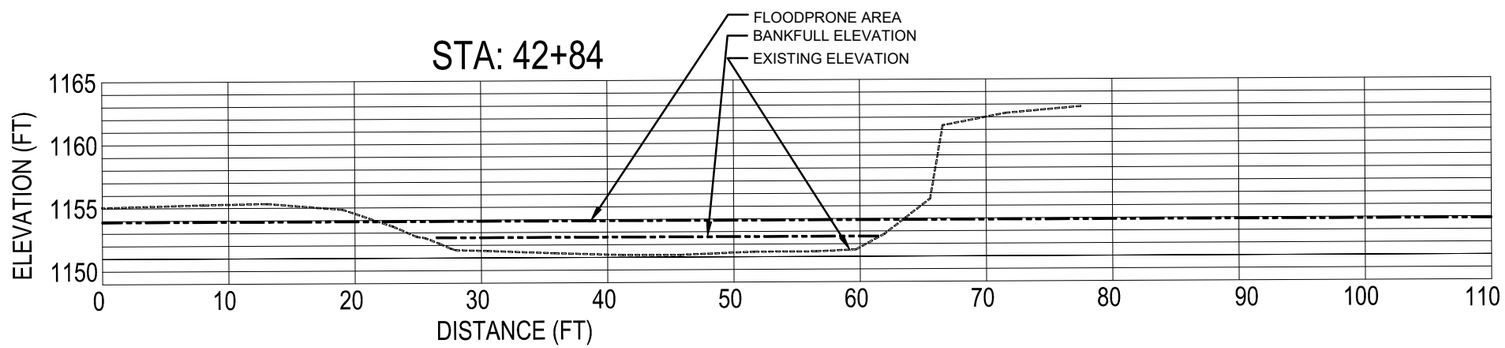
LEGEND

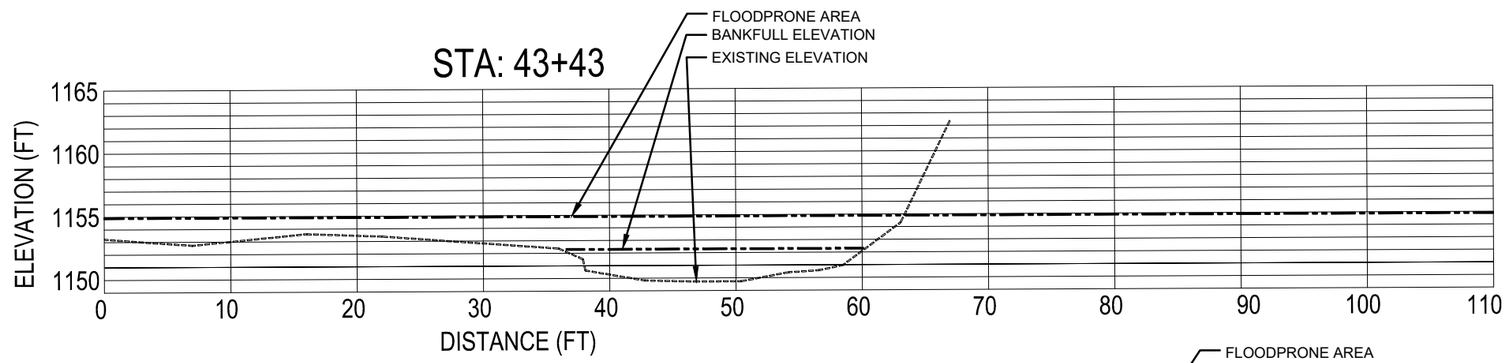
EXISTING GRADE

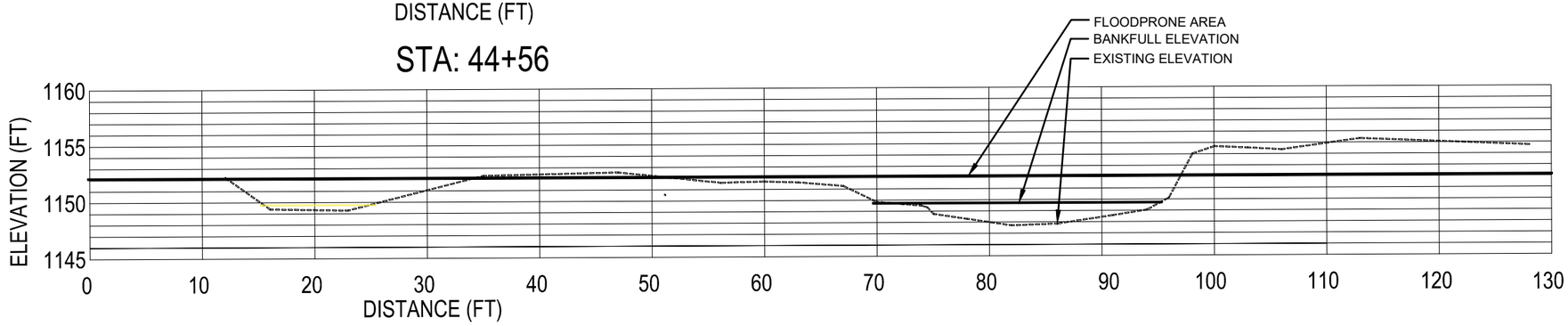
GRAPHIC SCALE IN FEET

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.









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EXISTING CROSS SECTIONS
KNIFE RIVER
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LAKE COUNTY, MINNESOTA

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DATE	APRIL 2020
DRAWN	MGS/COD
DESIGNED	ACS
CHECKED	
PROJECT #	J188372100

SHEET TITLE
CROSS SECTIONS

SHEET NUMBER
36

LAND USE # ----

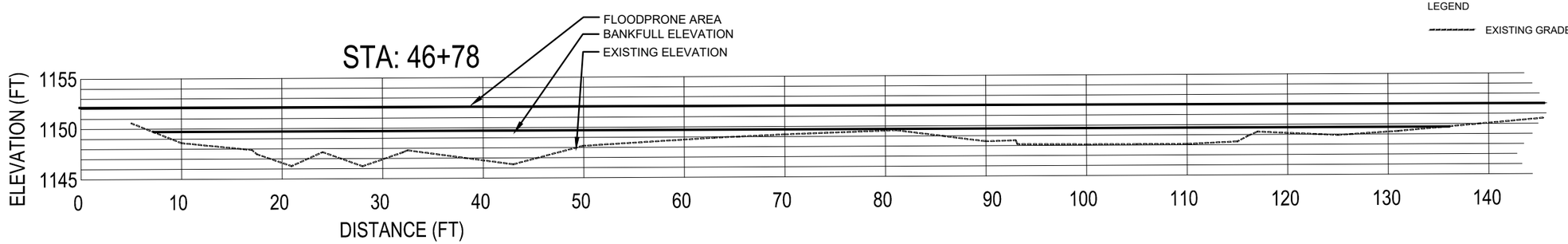
LEGEND

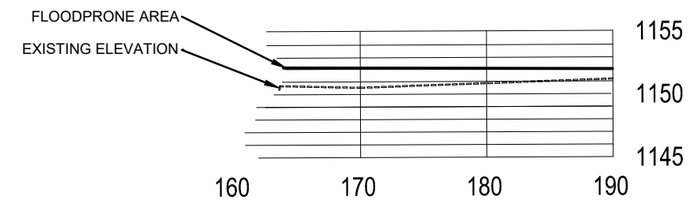
EXISTING GRADE

GRAPHIC SCALE IN FEET

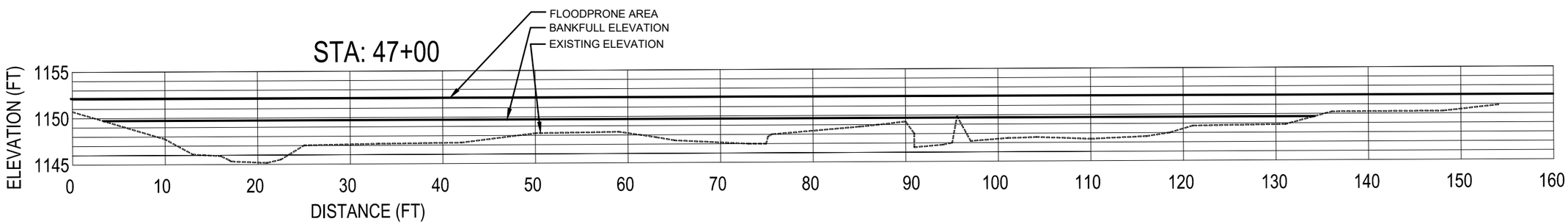
GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

STA: 46+78

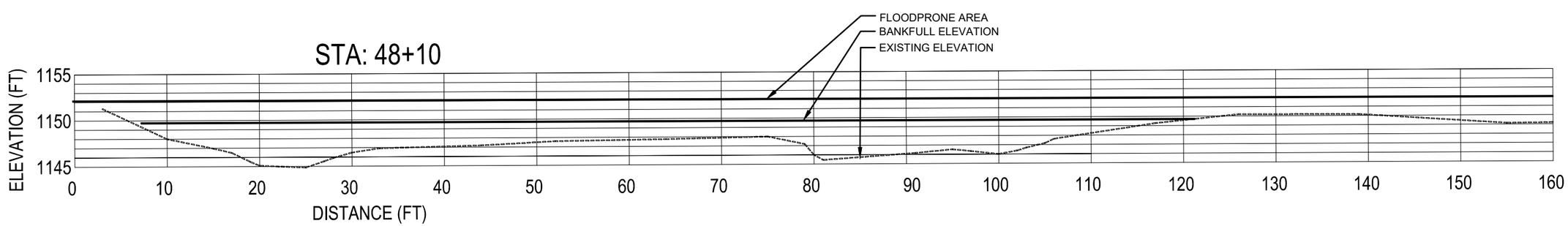




STA: 47+00



STA: 48+10



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DESIGNED	ACS
CHECKED	
PROJECT #	J188372100

SHEET TITLE
CROSS SECTIONS

SHEET NUMBER
37

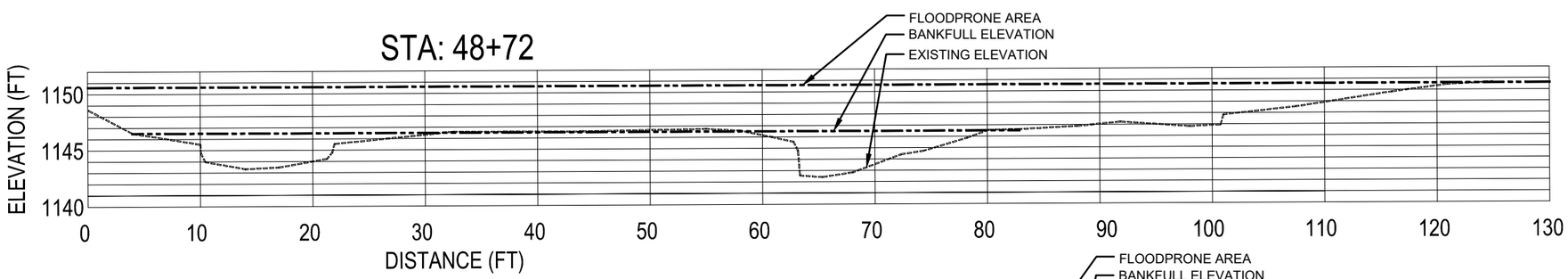
LAND USE # ----

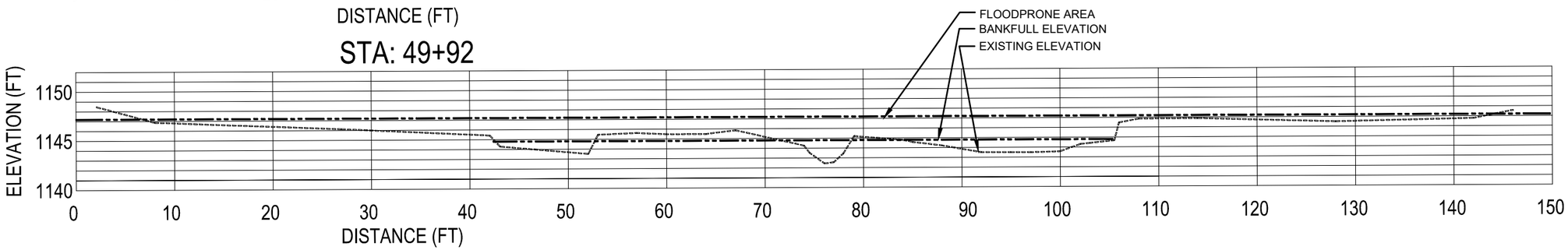
LEGEND

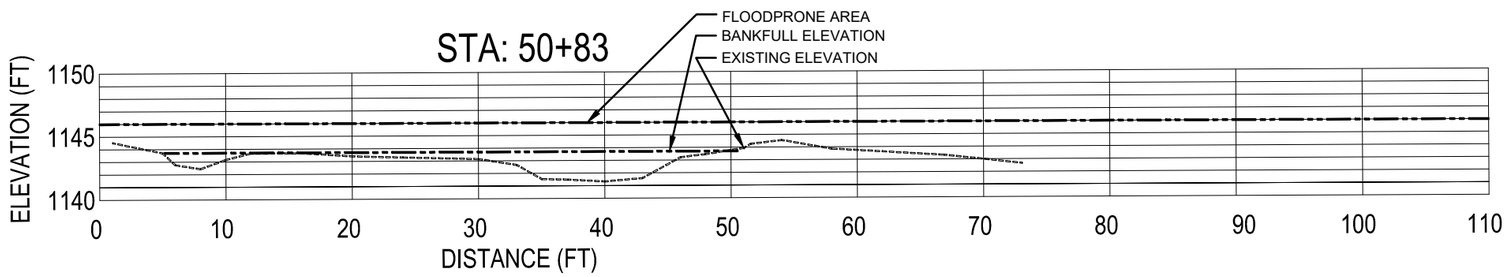
EXISTING GRADE

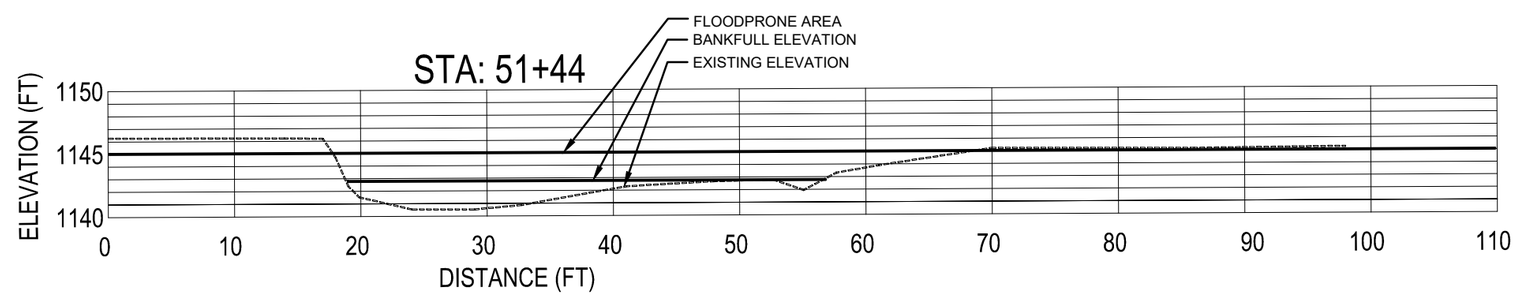
GRAPHIC SCALE IN FEET

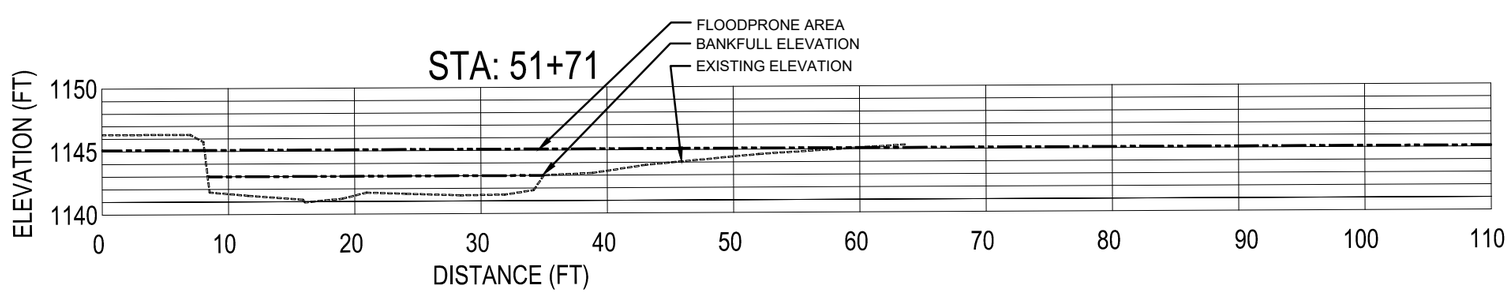
GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.











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EXISTING CROSS SECTIONS
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DRAWN	MGS/COD
DESIGNED	ACS
CHECKED	
PROJECT #	J188372100

SHEET TITLE
CROSS SECTIONS

SHEET NUMBER
38

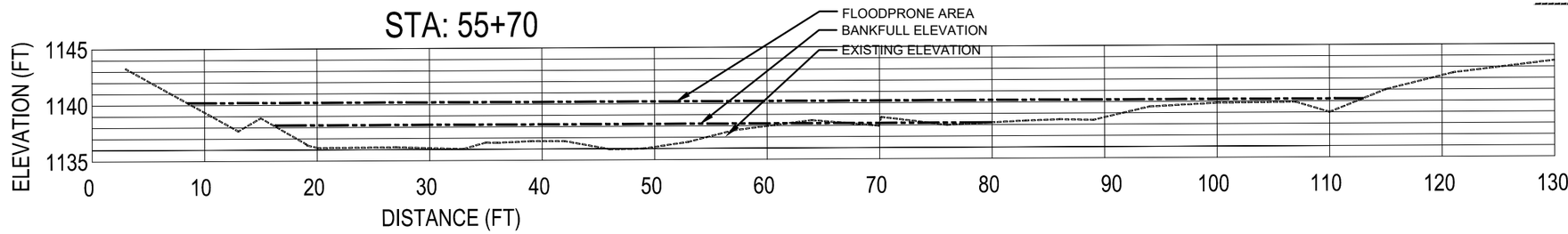
LAND USE # ----

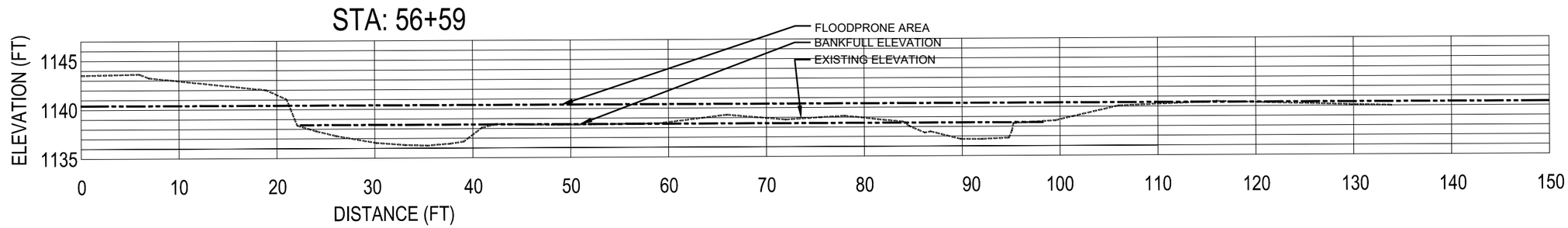
LEGEND

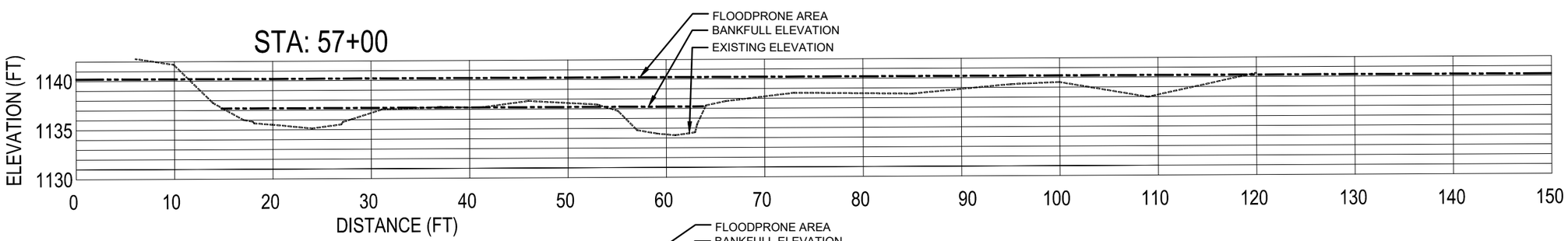
EXISTING GRADE

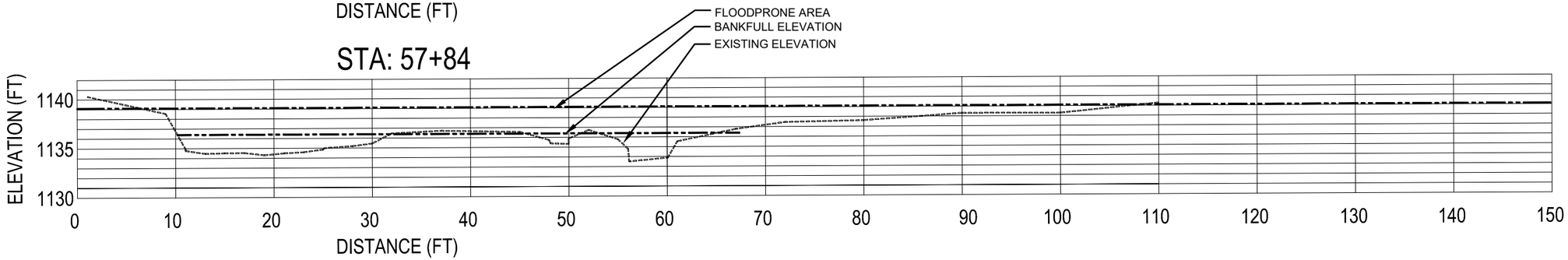
GRAPHIC SCALE IN FEET

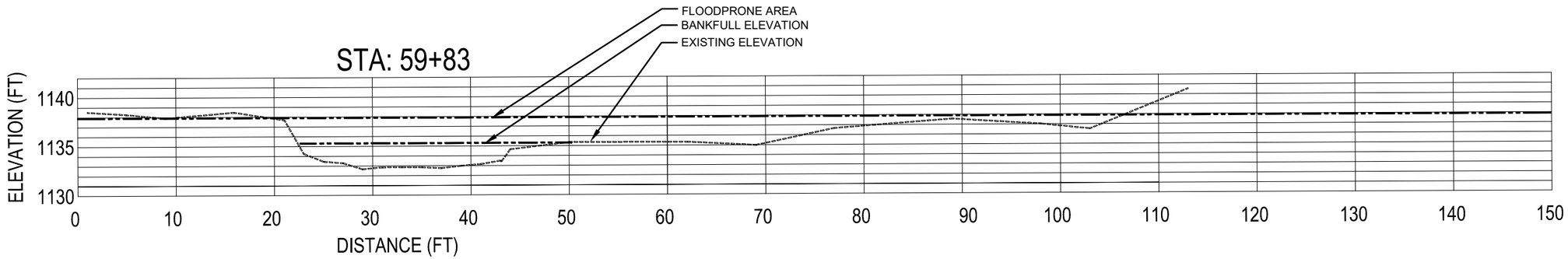
GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.











90% DESIGN

Cardno
MADISON
6140 COTTONWOOD DRIVE, SUITE A,
FITCHBURG, WISCONSIN 53719
TEL: (608) 661-2655 FAX: (608) 661-2661
www.cardnoglfew.com

EXISTING CROSS SECTIONS
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

#	DATE	DESCRIPTION	BY

DATE	APRIL 2020
DRAWN	MGS/COD
DESIGNED	ACS
CHECKED	
PROJECT #	J188372100

SHEET TITLE
CROSS SECTIONS

SHEET NUMBER
39

LAND USE # ----

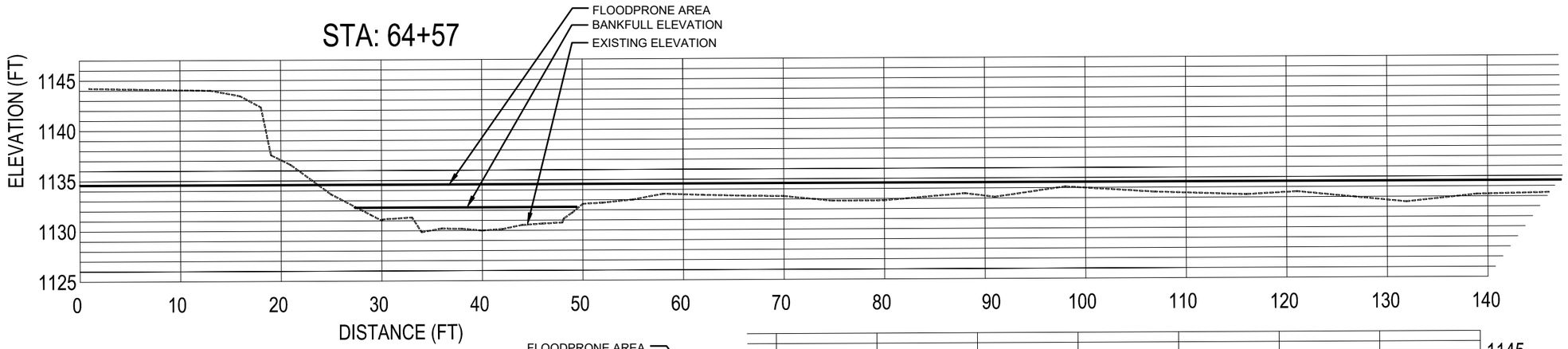
LEGEND

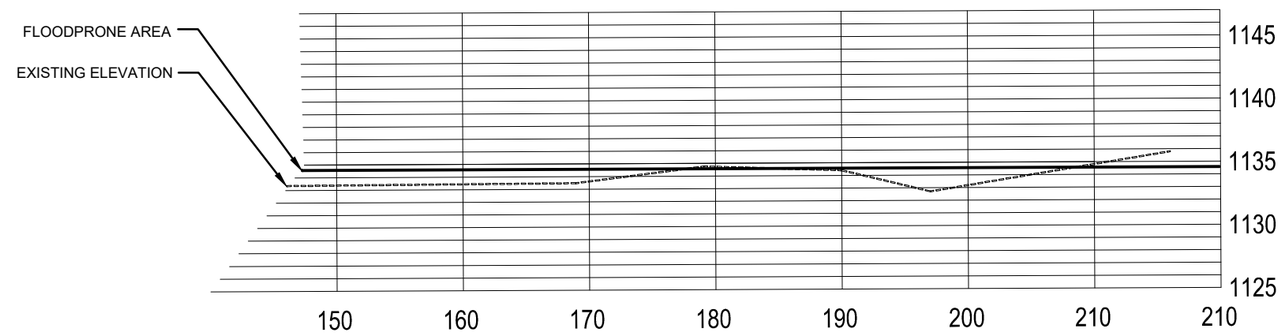
EXISTING GRADE

GRAPHIC SCALE IN FEET

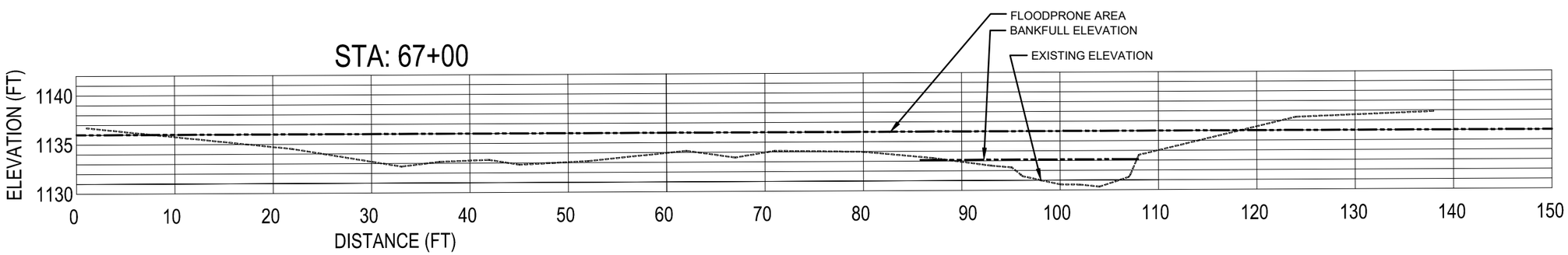
GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

STA: 64+57

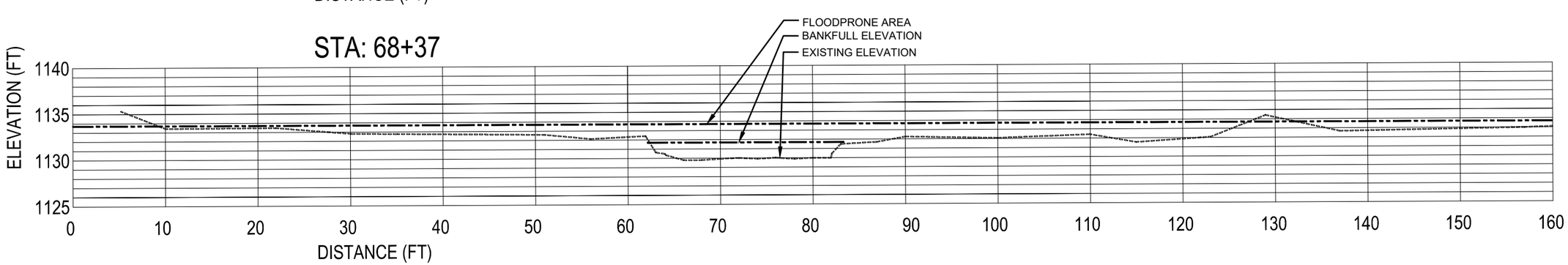




STA: 67+00



STA: 68+37



90% DESIGN

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FITCHBURG, WISCONSIN 53719
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EXISTING CROSS SECTIONS
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

#	DATE	DESCRIPTION	BY

DATE	APRIL 2020
DRAWN	MGS/COD
DESIGNED	ACS
CHECKED	
PROJECT #	J188372100

SHEET TITLE
CROSS SECTIONS

SHEET NUMBER
40

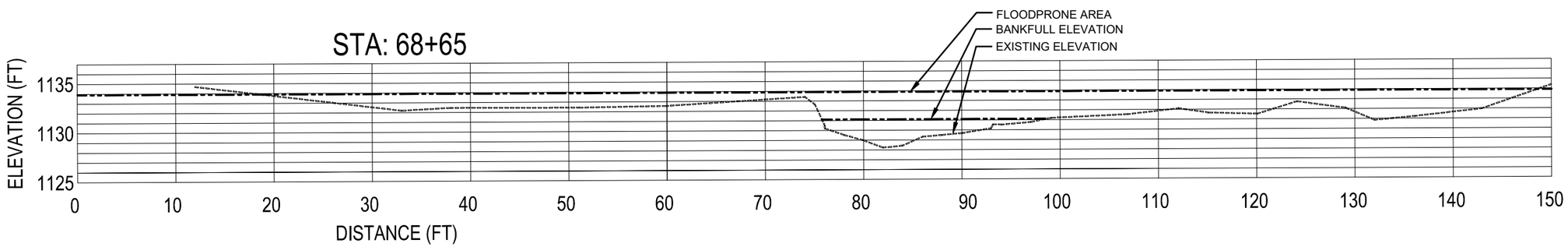
LAND USE # ----

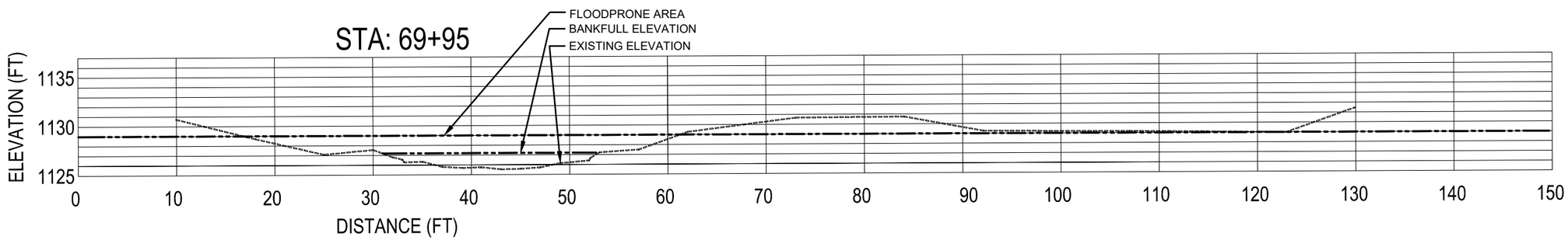
LEGEND

EXISTING GRADE

GRAPHIC SCALE IN FEET

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.





90% DESIGN

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EXISTING CROSS SECTIONS
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

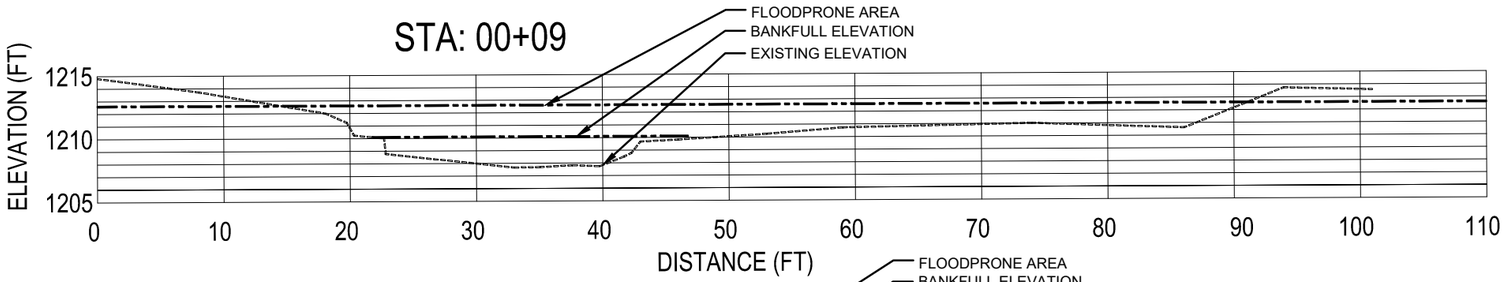
#	DATE	DESCRIPTION	BY

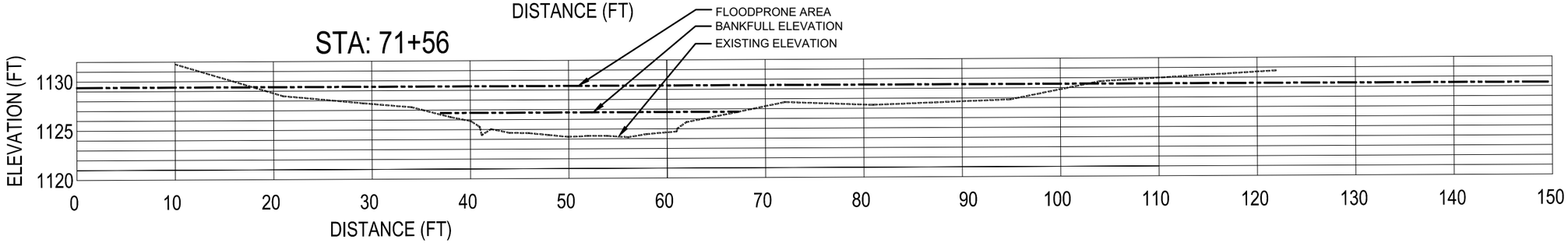
DATE	APRIL 2020
DRAWN	MGS/COD
DESIGNED	ACS
CHECKED	
PROJECT #	J188372100

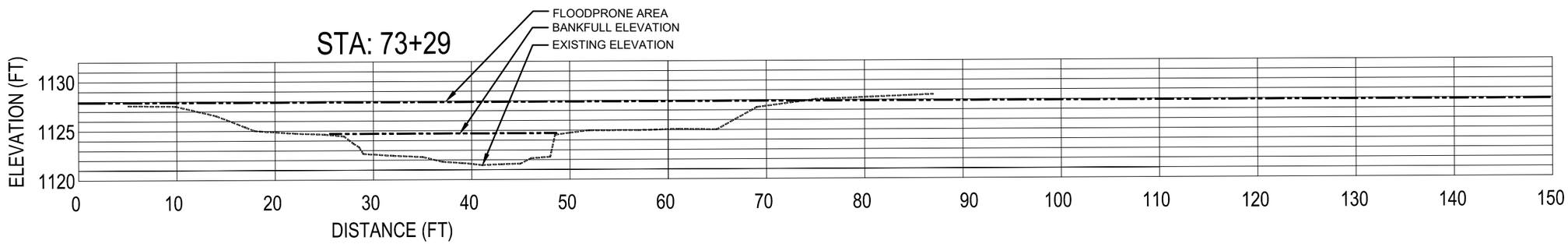
SHEET TITLE
CROSS SECTIONS

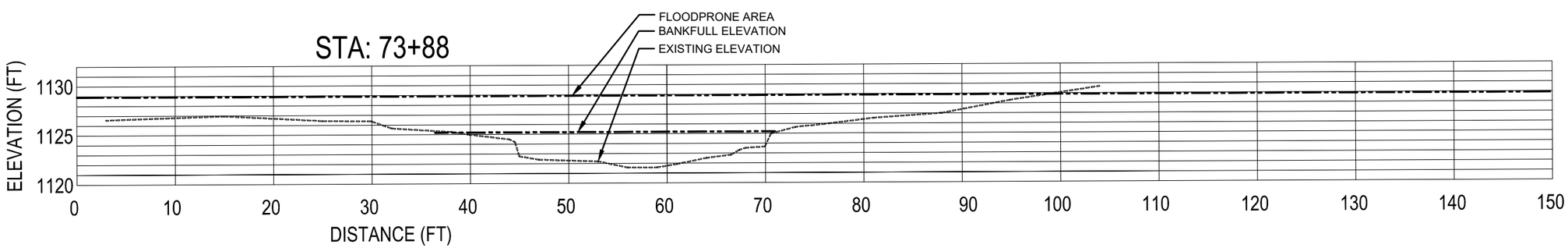
SHEET NUMBER
41

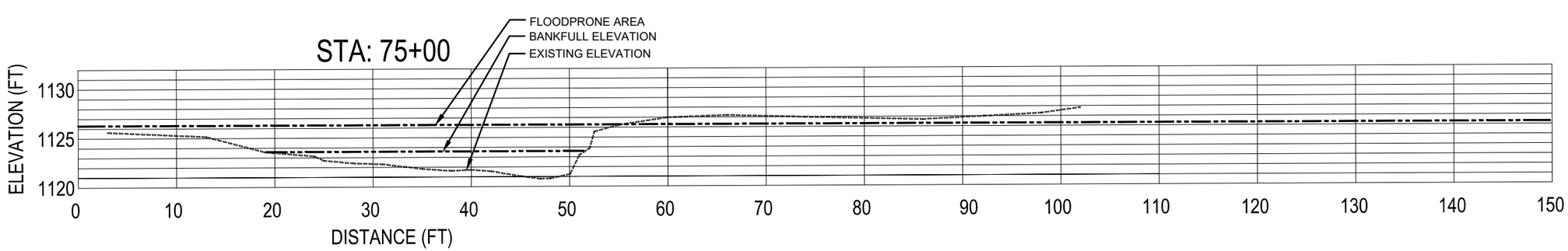
LAND USE # ---











LEGEND

EXISTING GRADE

GRAPHIC SCALE IN FEET

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

90% DESIGN

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	DATE	DESCRIPTION	BY
1			
2			
3			
4			
5			
6			

REFERENCE REACH CROSS SECTIONS
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

DATE	APRIL 2020
DRAWN	MGS/COD
DESIGNED	ACS
CHECKED	
PROJECT #	J188372100

SHEET TITLE
REF. REACH SECTIONS

SHEET NUMBER
42

LAND USE # ----

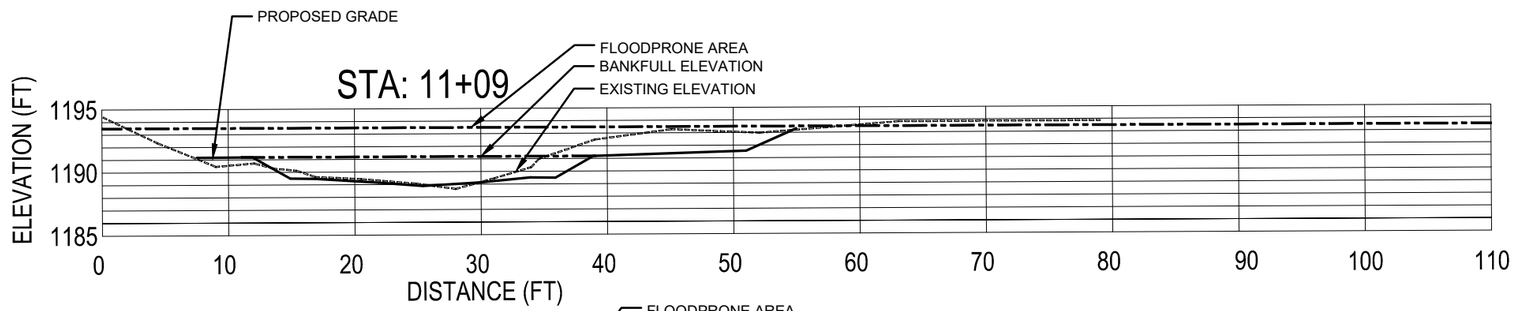
LEGEND

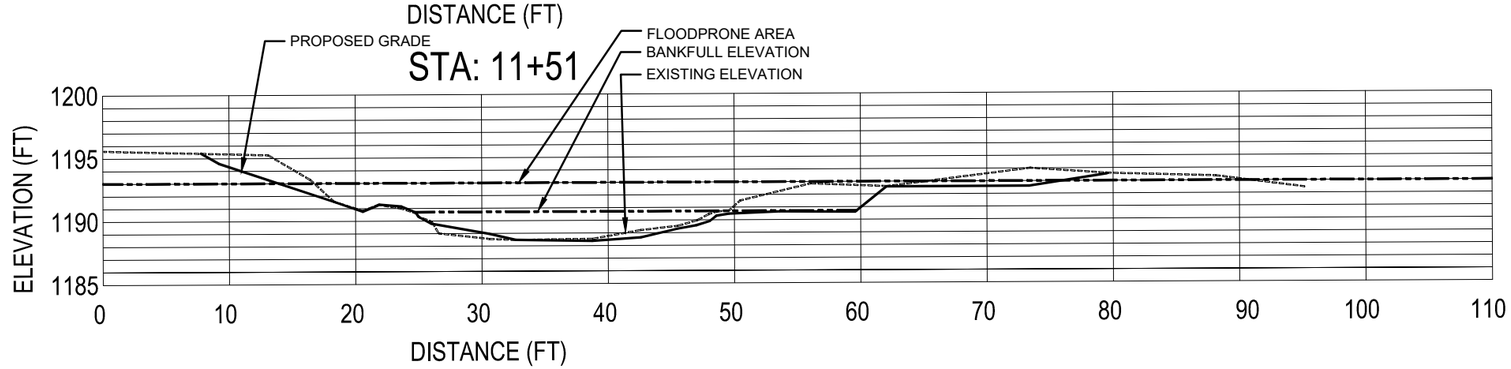
PROPOSED GRADE

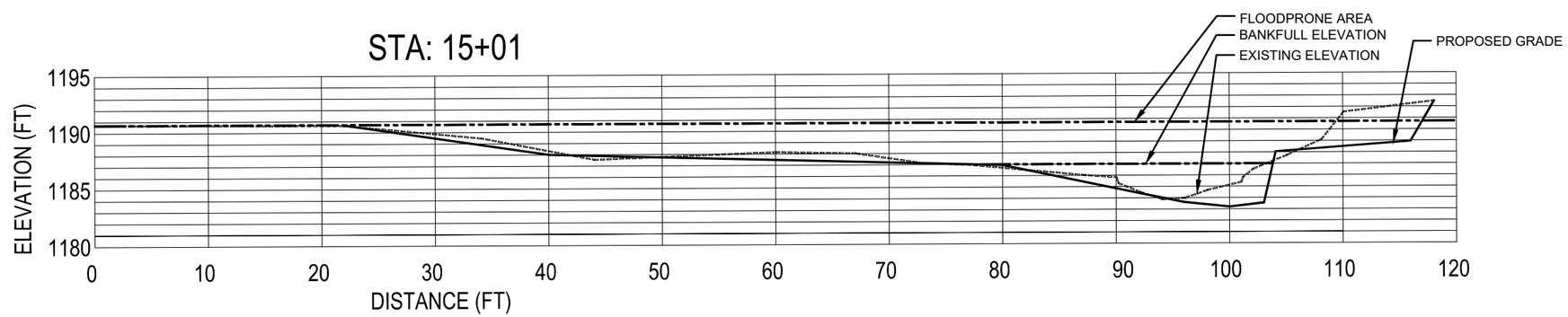
EXISTING GRADE

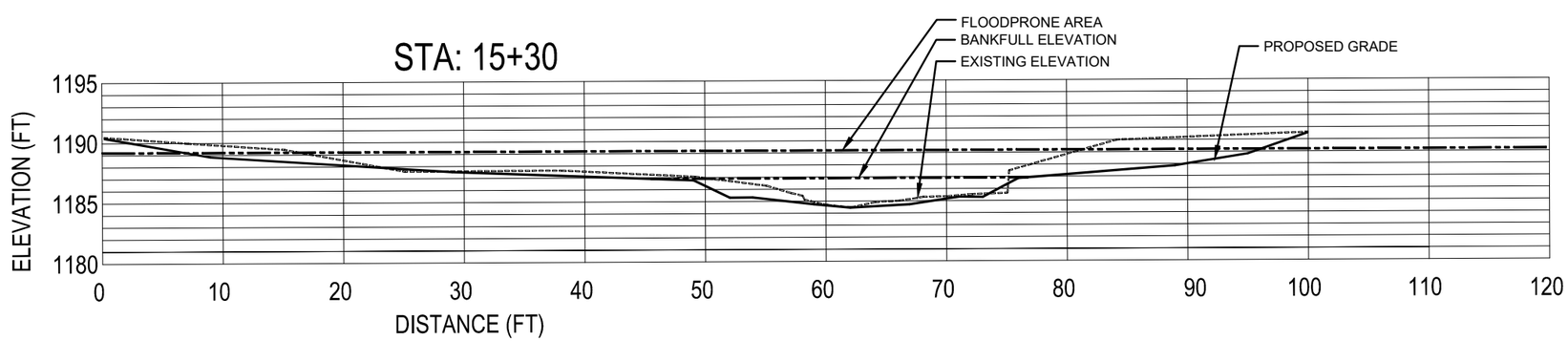
GRAPHIC SCALE IN FEET

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.









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FITCHBURG, WISCONSIN 53719
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PROPOSED CROSS SECTIONS
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

#	DATE	DESCRIPTION	BY

DATE	APRIL 2020
DRAWN	MGS/COD
DESIGNED	ACS
CHECKED	
PROJECT #	J188372100

SHEET TITLE
PROPOSED SECTIONS

SHEET NUMBER
43

LAND USE # ----

LEGEND

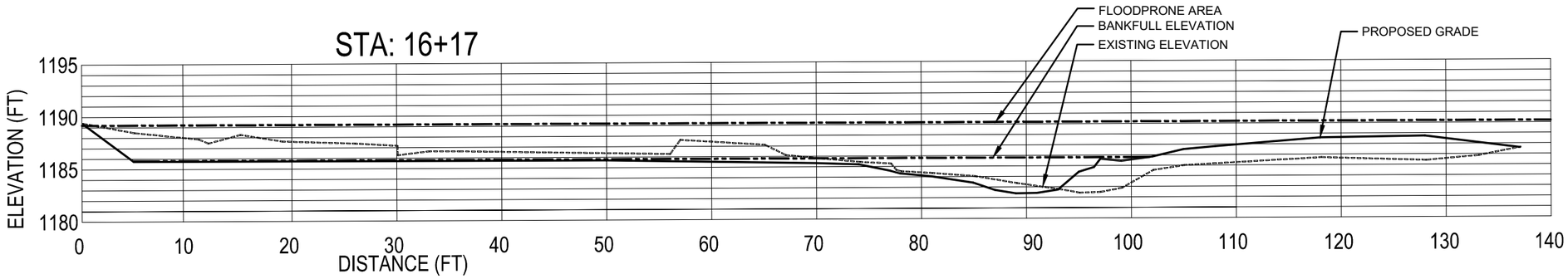
PROPOSED GRADE

EXISTING GRADE

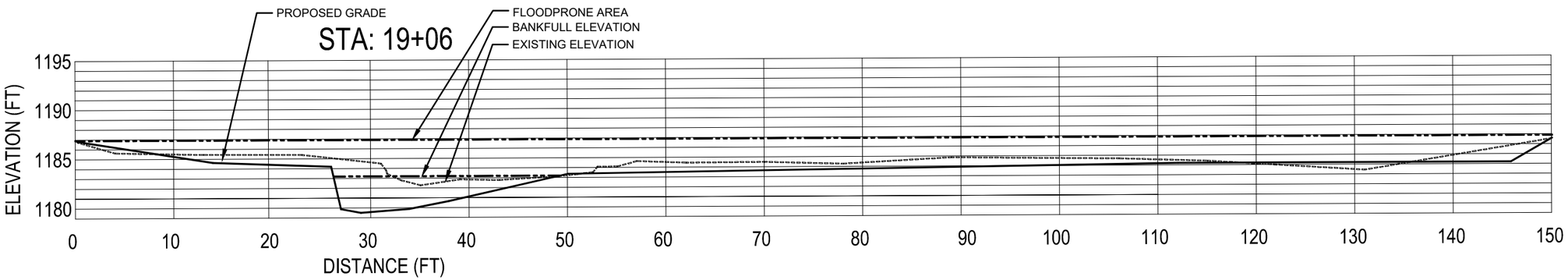
GRAPHIC SCALE IN FEET

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

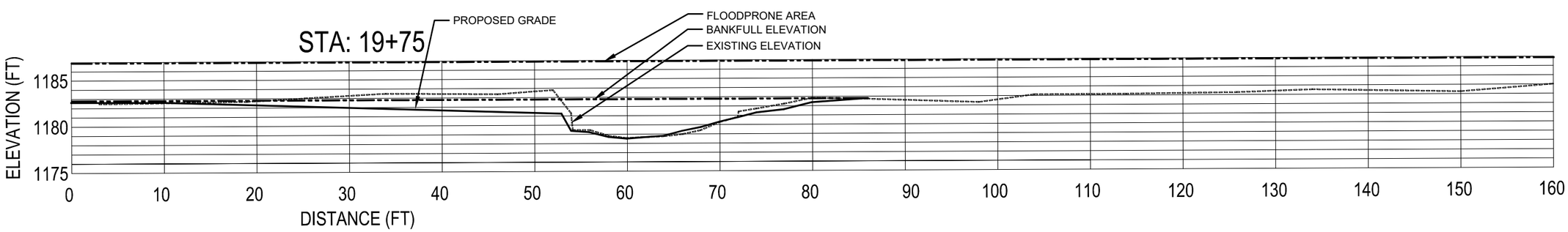
STA: 16+17



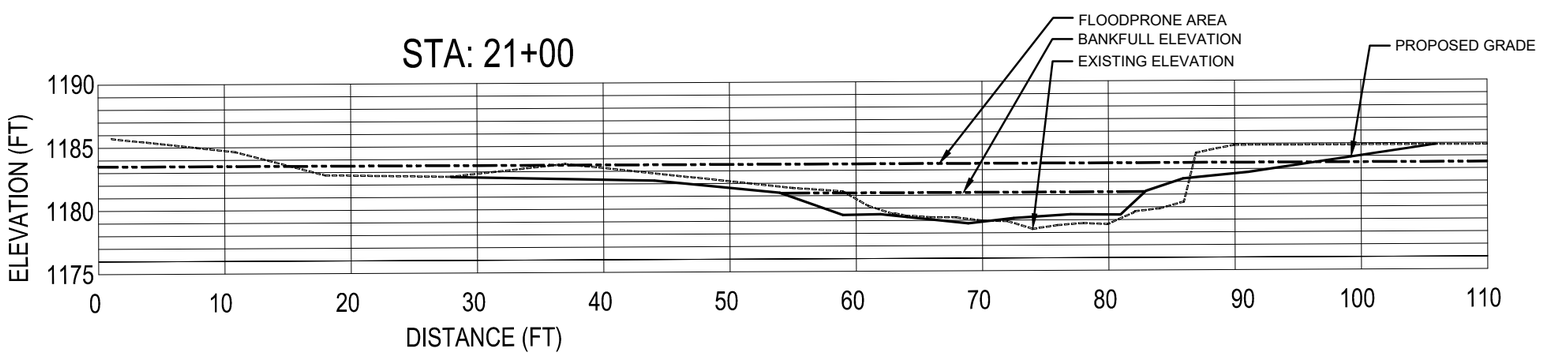
STA: 19+06



STA: 19+75



STA: 21+00



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6140 COTTONWOOD DRIVE, SUITE A,
FITCHBURG, WISCONSIN 53719
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PROPOSED CROSS SECTIONS
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

#	DATE	DESCRIPTION	BY
A			

DATE	APRIL 2020
DRAWN	MGS/COD
DESIGNED	ACS
CHECKED	
PROJECT #	J188372100

SHEET TITLE
PROPOSED SECTIONS

SHEET NUMBER
44

LAND USE # ----

LEGEND

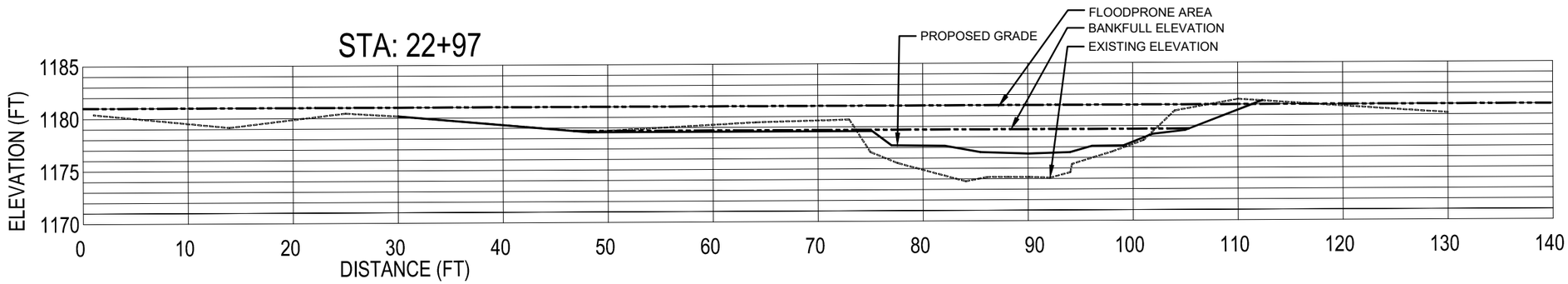
PROPOSED GRADE

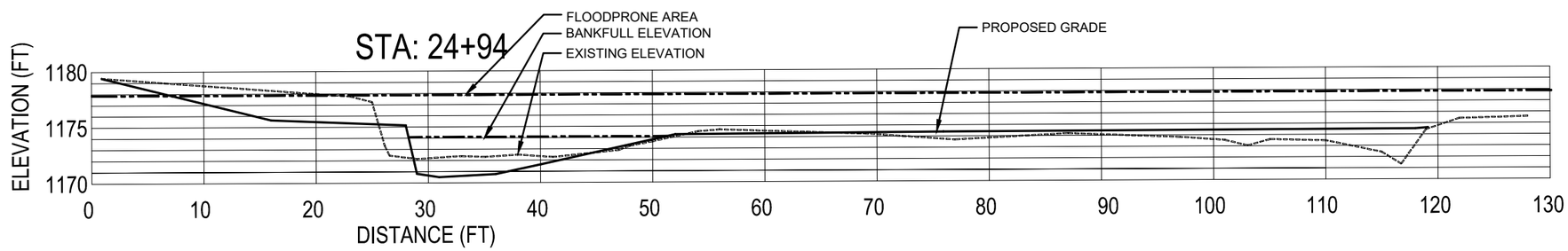
EXISTING GRADE

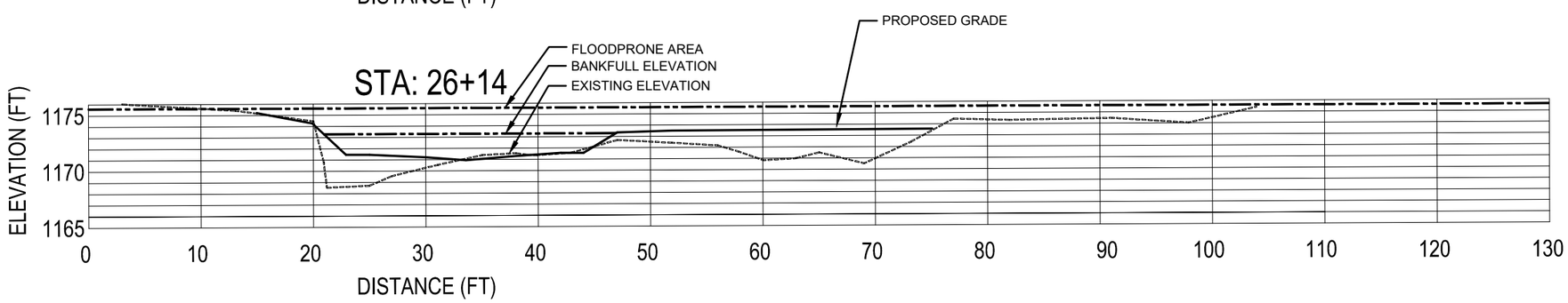
GRAPHIC SCALE IN FEET

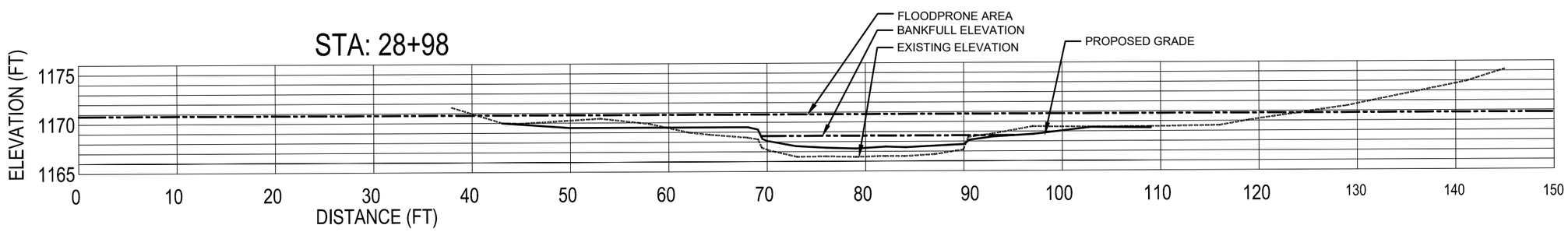
0 6' 12'

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.









90% DESIGN

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MADISON
6140 COTTONWOOD DRIVE, SUITE A
FITCHBURG, WISCONSIN 53719
TEL: (608) 661-2855 FAX: (608) 661-2861
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#	DATE	DESCRIPTION	BY

PROPOSED CROSS SECTIONS
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

DATE	APRIL 2020
DRAWN	MGS/COD
DESIGNED	ACS
CHECKED	
PROJECT #	J188372100

SHEET TITLE
PROPOSED SECTIONS

SHEET NUMBER
45

LAND USE # ----

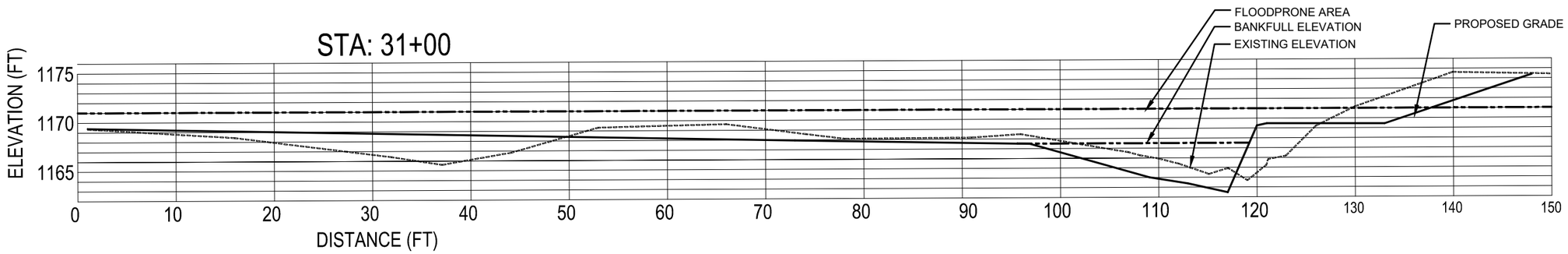
LEGEND

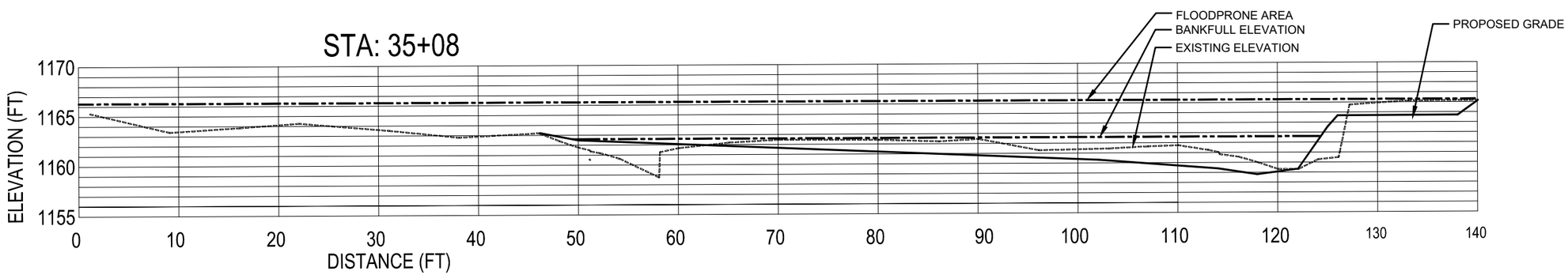
PROPOSED GRADE

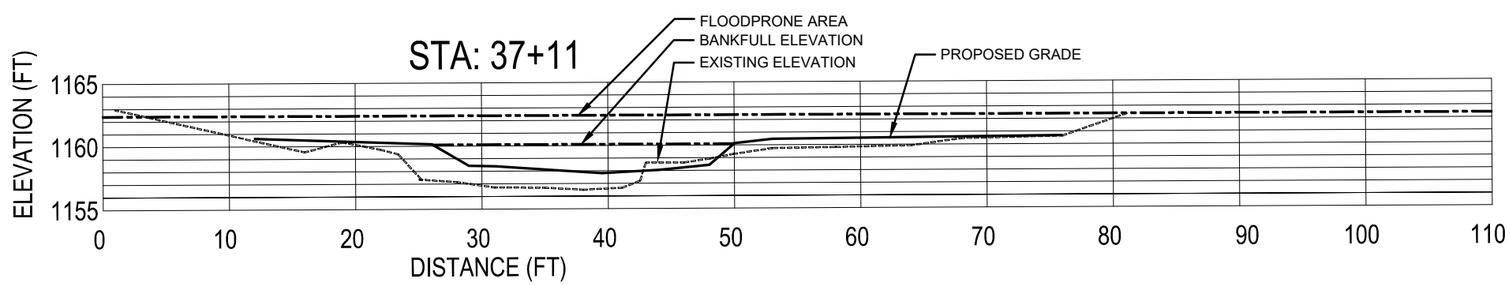
EXISTING GRADE

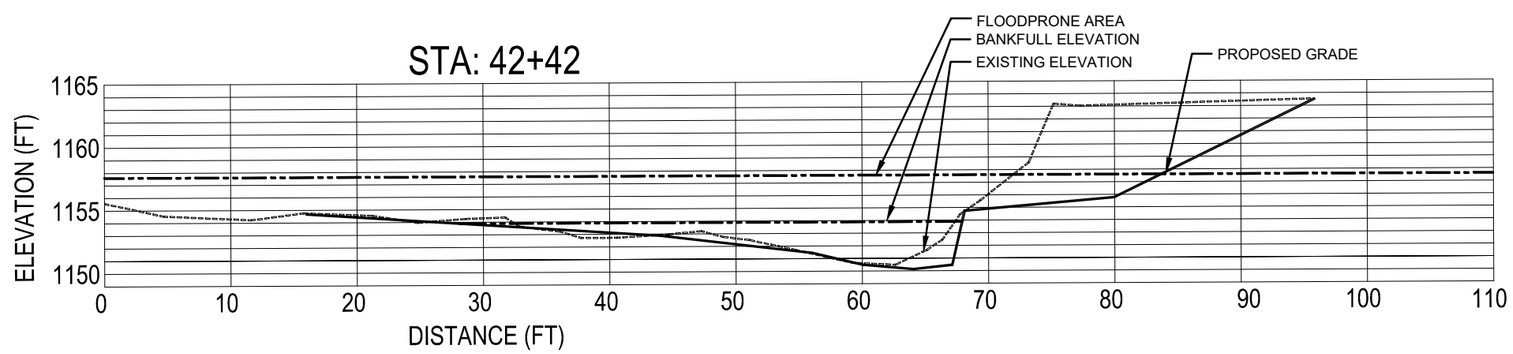
GRAPHIC SCALE IN FEET

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.









90% DESIGN

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PROPOSED CROSS SECTIONS
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

#	DATE	DESCRIPTION	BY

DATE	APRIL 2020
DRAWN	MGS/COD
DESIGNED	ACS
CHECKED	
PROJECT #	J188372100

SHEET TITLE
PROPOSED SECTIONS

SHEET NUMBER
46

LAND USE # ----

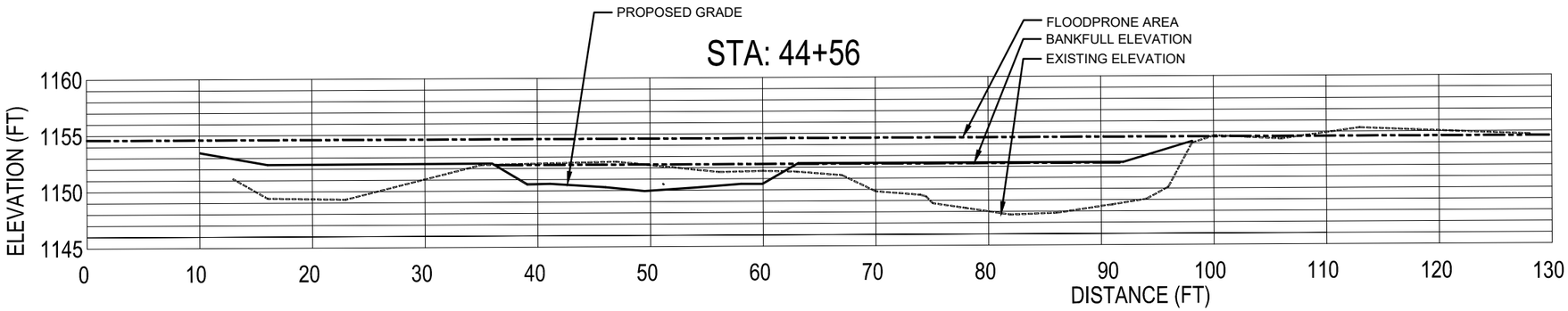
LEGEND

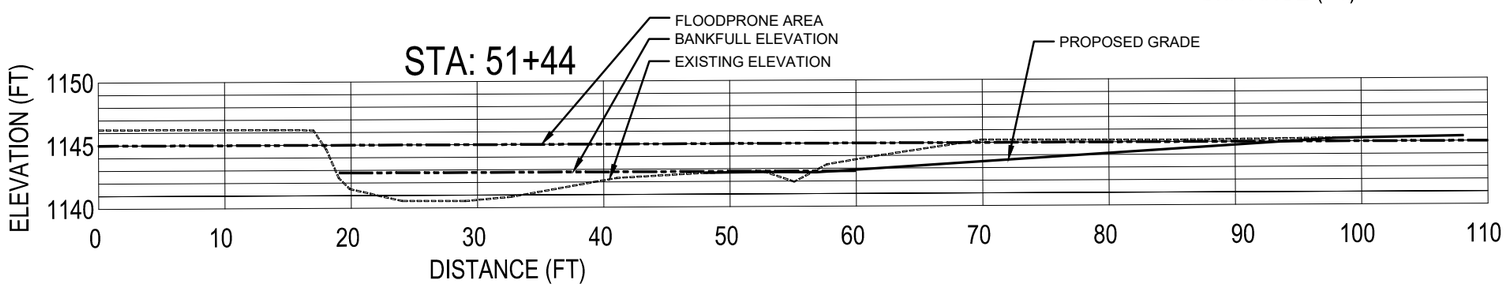
PROPOSED GRADE

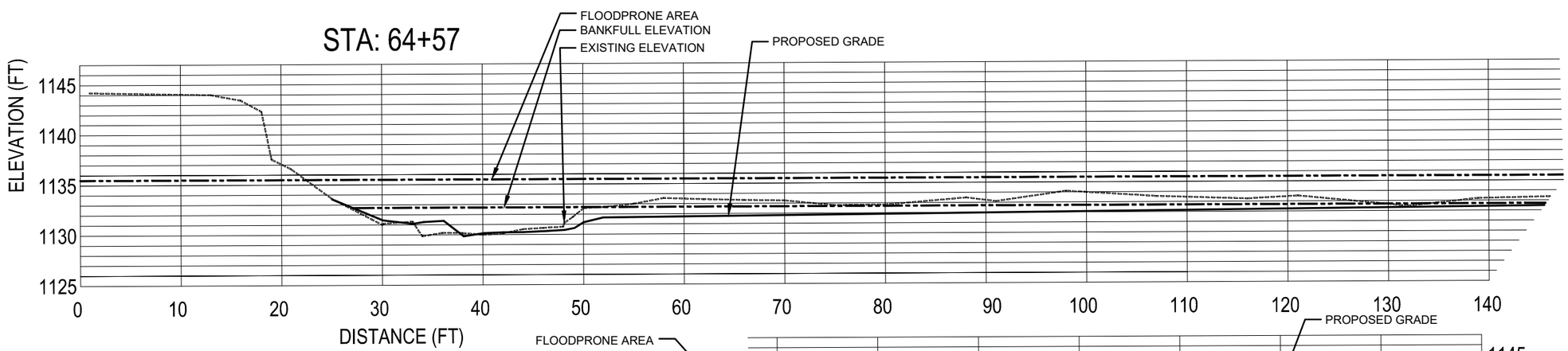
EXISTING GRADE

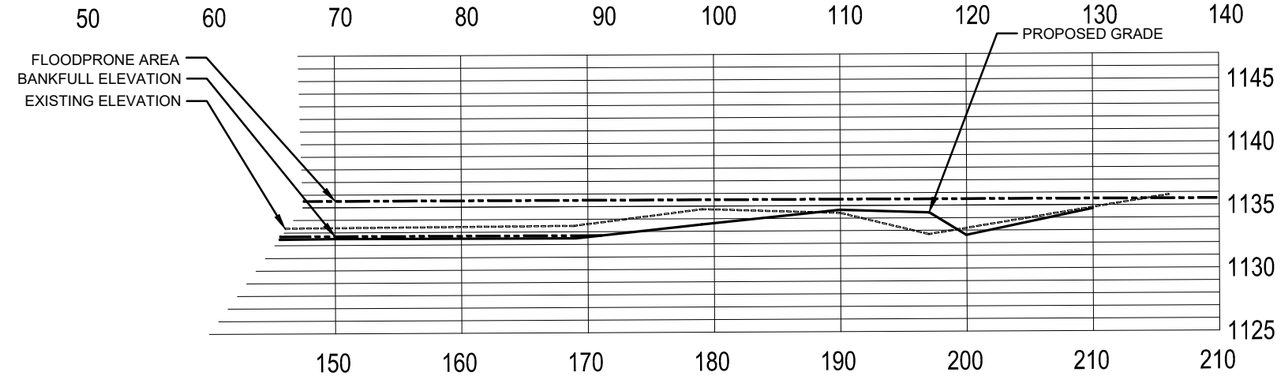
GRAPHIC SCALE IN FEET

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.









90% DESIGN

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PROPOSED CROSS SECTIONS
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

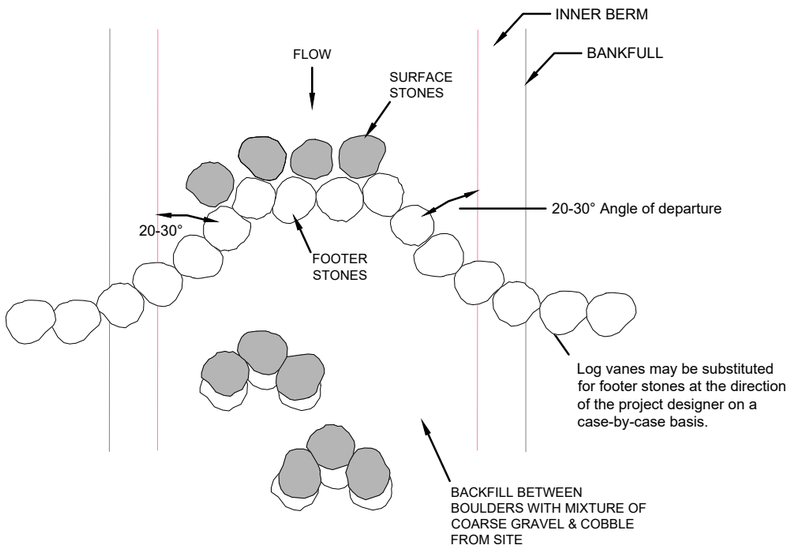
#	DATE	DESCRIPTION	BY

DATE	APRIL 2020
DRAWN	MGS/COD
DESIGNED	ACS
CHECKED	
PROJECT #	J188372100

SHEET TITLE
PROPOSED SECTIONS

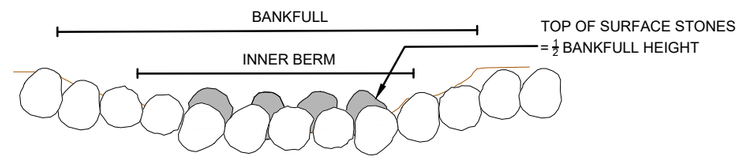
SHEET NUMBER
47

LAND USE # ----

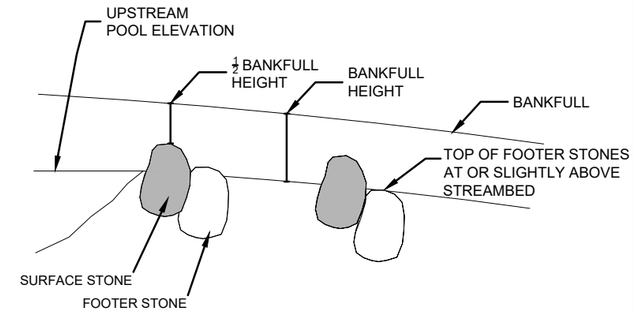


1 CONVERGING BOULDER CLUSTER - PLANVIEW
NOT TO SCALE

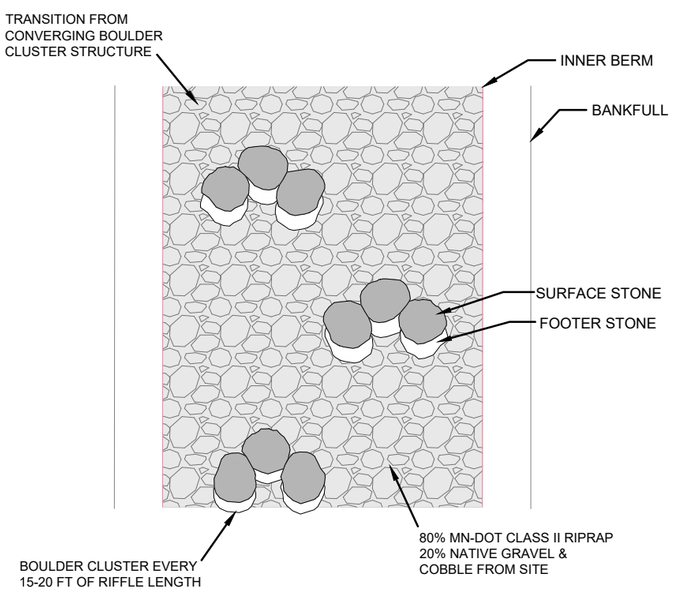
Note:
Boulder shall be at least 36" diameter in 2 of 3 dimensions.



2 CONVERGING BOULDER CLUSTER - CROSS SECTION
NOT TO SCALE

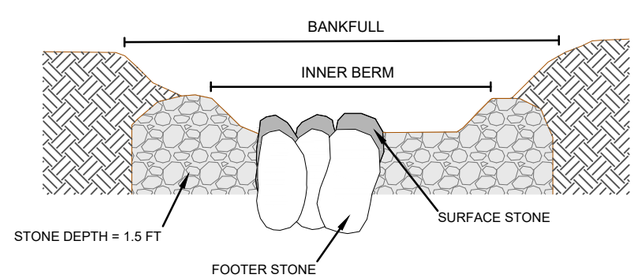


3 CONVERGING BOULDER CLUSTER - PROFILE
NOT TO SCALE



4 CONSTRUCTED RIFFLE - PLANVIEW
NOT TO SCALE

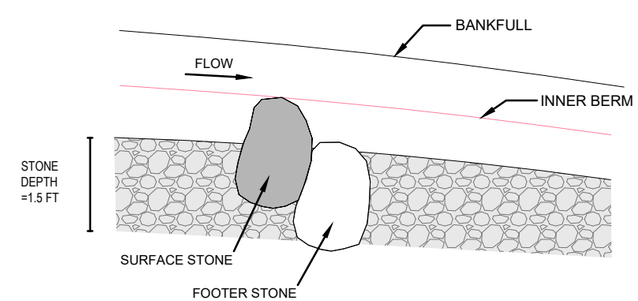
Note:
Boulder shall be at least 36" diameter in 2 of 3 dimensions.



NOTES:

1. EXTEND STONE AT INNER BERM TO BANKFULL WIDTH.

5 CONSTRUCTED RIFFLE - CROSS SECTION
NOT TO SCALE



6 CONSTRUCTED RIFFLE - PROFILE
NOT TO SCALE

90% DESIGN

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DETAILS
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

#	DATE	DESCRIPTION	BY

DATE	APRIL 2020
DRAWN	MGS/COD
DESIGNED	ACS
CHECKED	
PROJECT #	J188372100

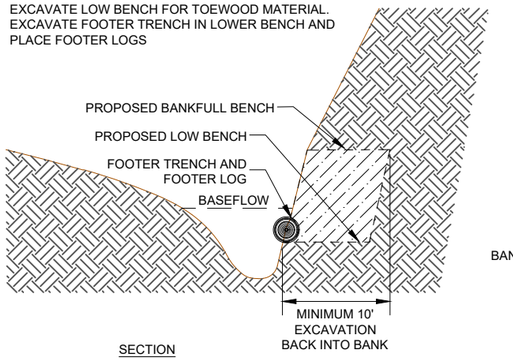
SHEET TITLE
DETAILS

SHEET NUMBER
48

LAND USE # ----

STEP 1:

EXCAVATE LOW BENCH FOR TOEWOOD MATERIAL. EXCAVATE FOOTER TRENCH IN LOWER BENCH AND PLACE FOOTER LOGS



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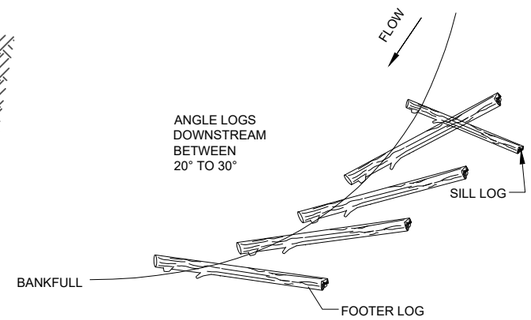
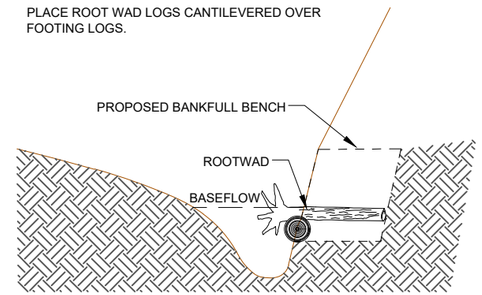


PLAN VIEW

STEP 2:

PLACE ROOT WAD LOGS CANTILEVERED OVER FOOTING LOGS.



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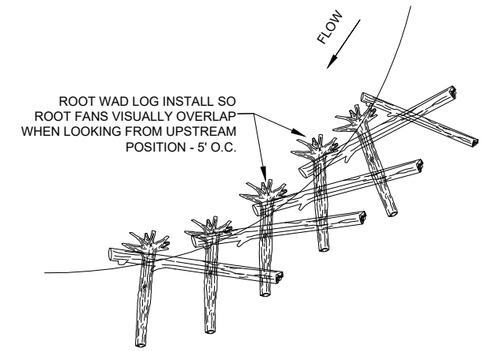
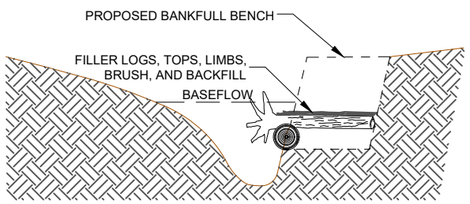


PLAN VIEW

STEP 3:

PLACE FILLER MATERIAL (SMALL LOGS, LIMBS, TREE TOPS AND BRUSH) BETWEEN AND ON TOP OF THE ROOT WADS. THEN PLACE BACKFILL BETWEEN FILLER MATERIAL AND ROOTWADS IN LIFTS



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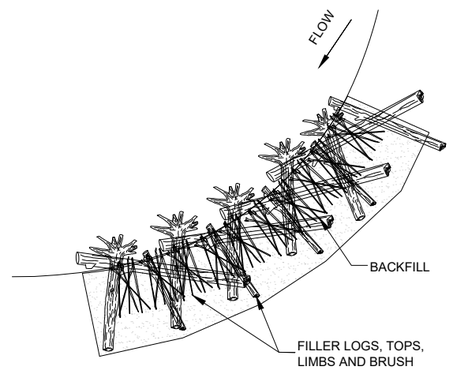
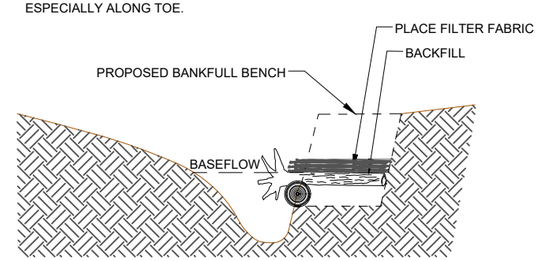


PLAN VIEW

STEP 4:

CONTINUE TO BACKFILL WITH LOGS, LIMBS, TREE TOPS, AND FILLER MATERIAL TO O.5' ABOVE BASEFLOW ELEVATION. COMPACT WITH EXCAVATOR BUCKET, BUT DO NOT REMOVE ALL VOIDS, ESPECIALLY ALONG TOE.



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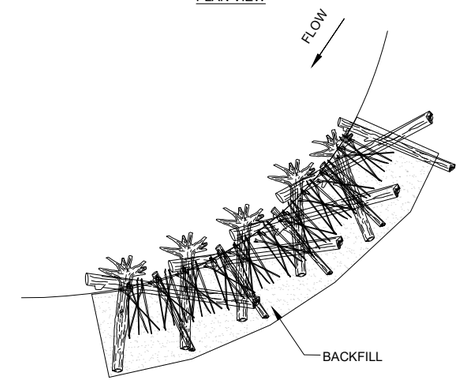
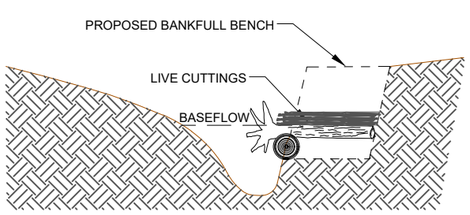


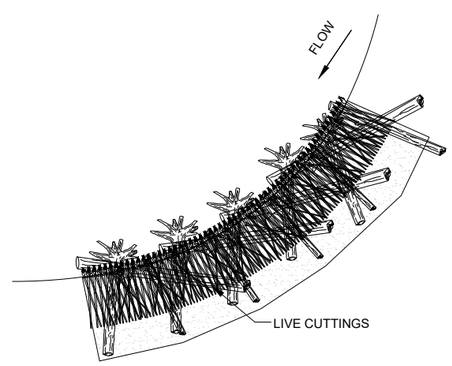
PLAN VIEW

STEP 5:

PLACE LIVE BRUSH CUTTINGS AT LEAST 3' IN LENGTH AND 1/4" DIAMETER, 6 CUTTINGS/FOOT



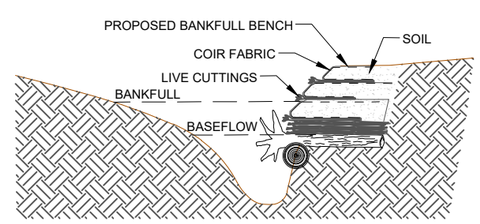
SECTION



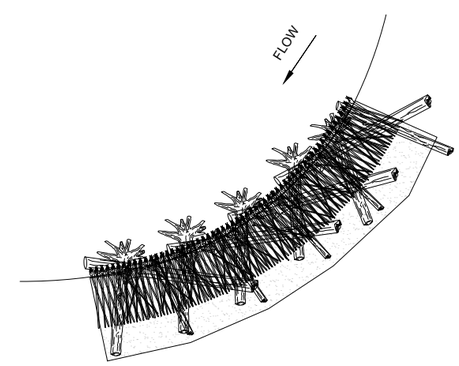
PLAN VIEW

STEP 6:

INSTALL COIR WRAPPED SOIL LIFTS AND LAYERS OF CUTTING BETWEEN SOIL LIFTS UP TO BANKFULL STAGE. WRAP ENDS OF FABRIC AND BURY WITH SILL LOGS AT TOP SOIL LIFT ELEVATION. COVER WITH SOIL. SEE TOEWOOD WITH SOIL LIFT DETAIL.



SECTION



PLAN VIEW

NOTES:

1. THE TOP OF THE ROOTWAD SHOULD BE INSTALLED AT AN ELEVATION SUCH THAT IT REMAINS INUNDATED DURING LOW FLOW EVENTS. THE ELEVATION SHOULD BE APPROXIMATELY 0.5' ABOVE THE DOWNSTREAM RIFFLE INVERT ELEVATION
2.THE WOOD SHOULD BE BURIED A MINIMUM OF 10 FEET INTO THE BANK.
3. LAYERS OF LIVE BRANCH CUTTINGS SHALL BE PLACED BETWEEN SOIL LIFTS.

7 TOEWOOD WITH SOIL LIFT

NOT TO SCALE

90% DESIGN

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DETAILS
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

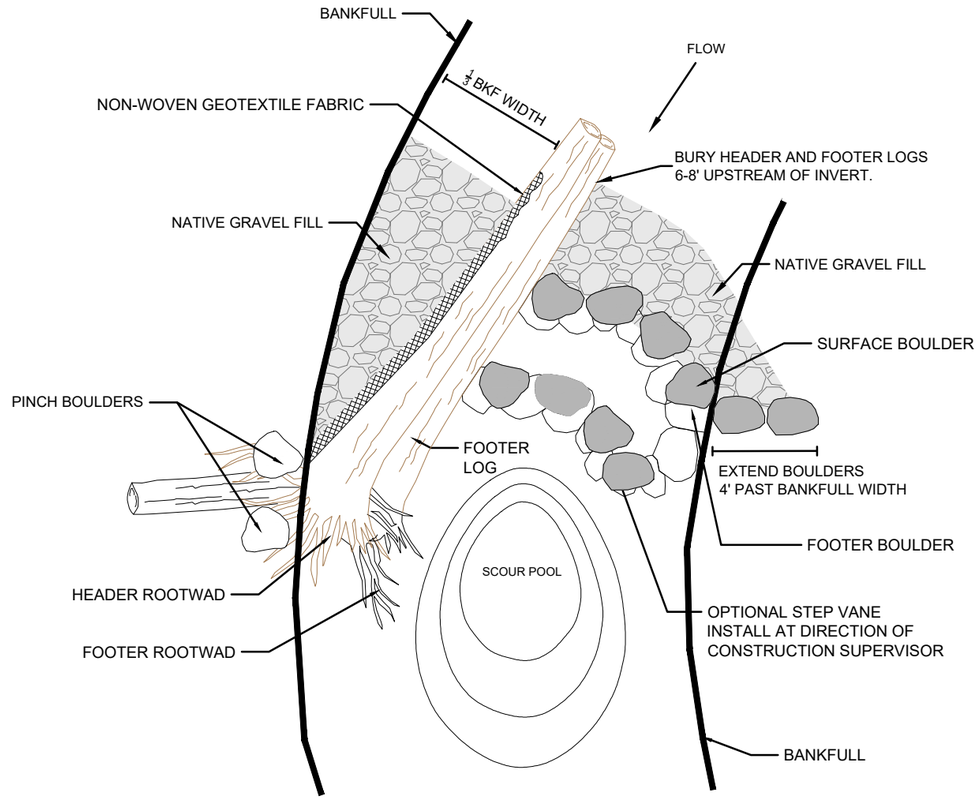
#	DATE	DESCRIPTION	BY

DATE	APRIL 2020
DRAWN	MGS/COD
DESIGNED	ACS
CHECKED	
PROJECT #	J188372100

SHEET TITLE
DETAILS

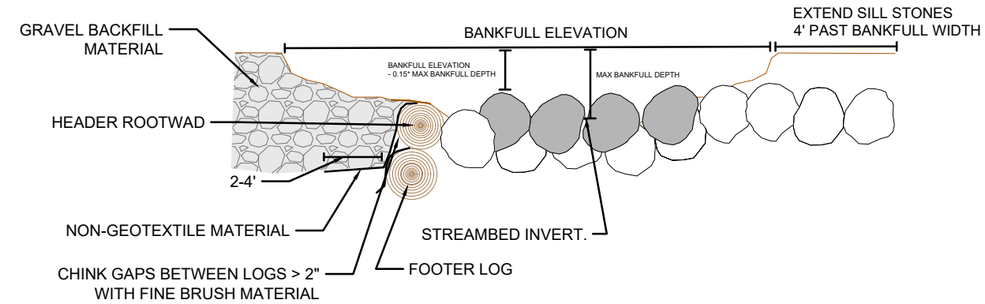
SHEET NUMBER
49

LAND USE # ----

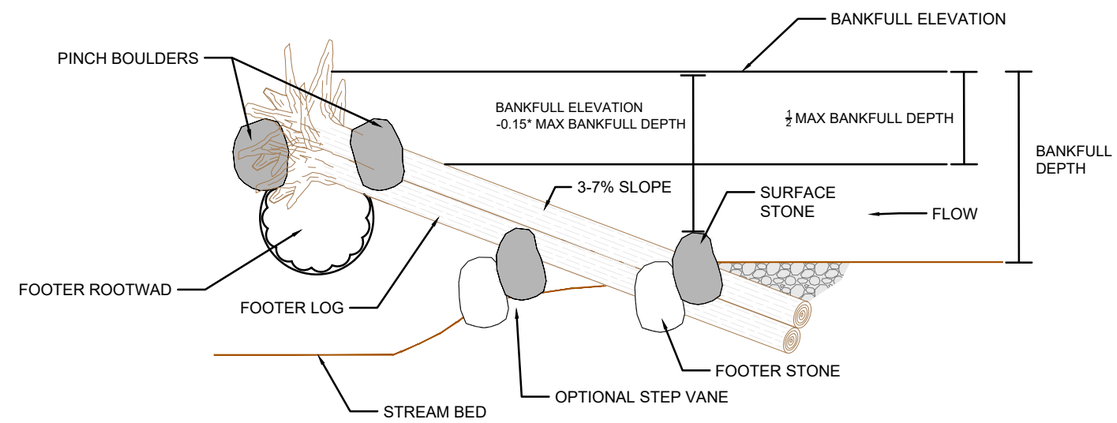


Note:
Boulder shall be at least 36" diameter in 2 of 3 dimensions.

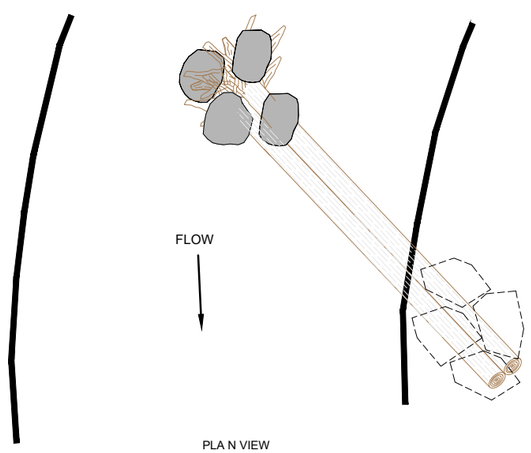
8 J-HOOK LOG VANE - PLAN VIEW
NOT TO SCALE



9 J-HOOK LOG VANE - CROSS SECTION VIEW
NOT TO SCALE



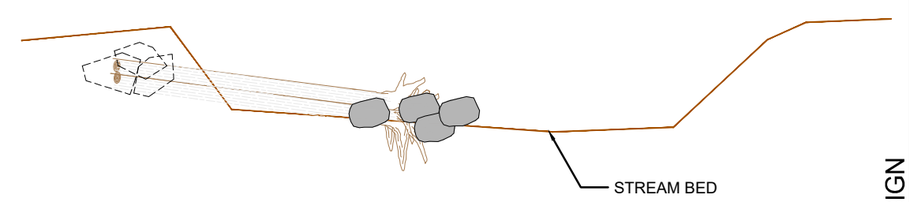
10 J-HOOK LOG VANE - PROFILE VIEW
NOT TO SCALE



PLA N VIEW

LARGE WOOD ENHANCEMENT NOTES

1. Crown should be buried mid stream with the crown below the stream bed.
2. The back third of the log should be buried in the bank with a maximum elevation of the end below the bankfull height.
3. Use boulders to pin the crown and back end of the log into position.
4. Log angle into the streambed can be adjusted based on the length and width of the log.
5. Backfill upstream potion of log to same elevation as the trunk.
6. Flow should be pulled to the center of the channel during low flow stages.



CROSS SECTION

11 LARGE WOOD HABITAT ENHANCEMENT
NOT TO SCALE

90% DESIGN

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DETAILS
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

#	DATE	DESCRIPTION	BY
A			

DATE	APRIL 2020
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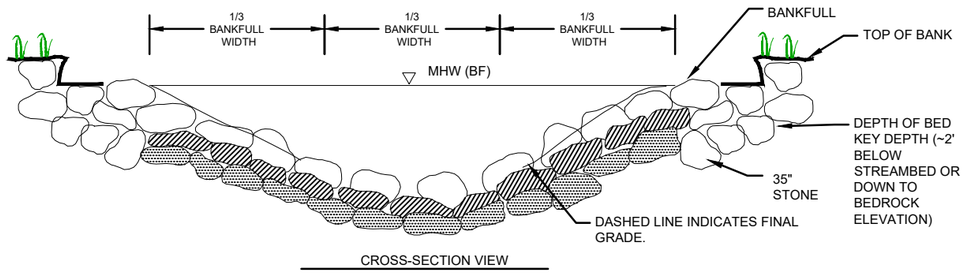
PROJECT #	J188372100

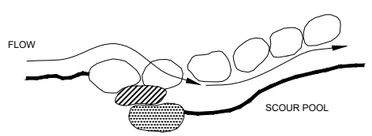
SHEET TITLE
DETAILS

SHEET NUMBER
50

LAND USE # ----



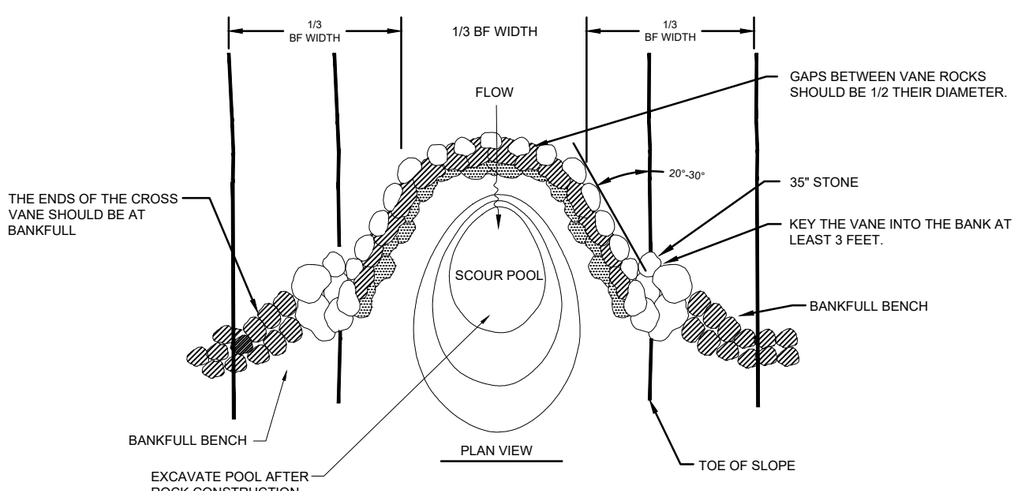
CROSS-SECTION VIEW



PROFILE VIEW

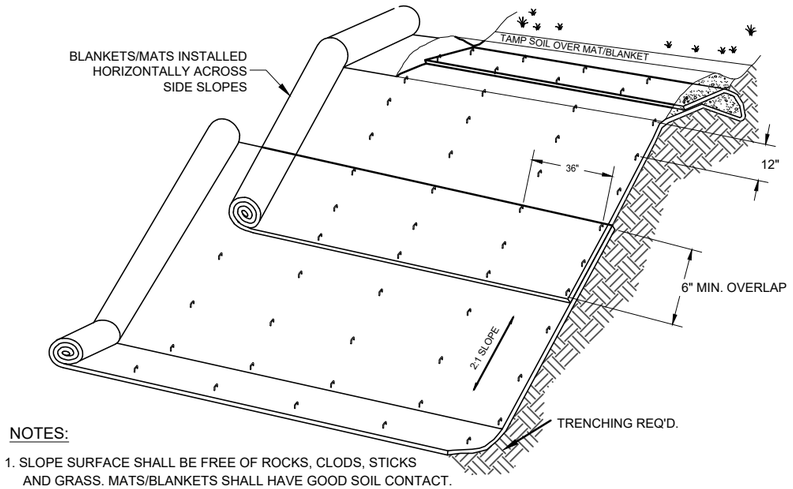
NOTES:

1. FINAL ORIENTATION AND PLACEMENT OF STRUCTURES MAY BE ADJUSTED IN THE FIELD BY PROJECT DESIGNER.



PLAN VIEW

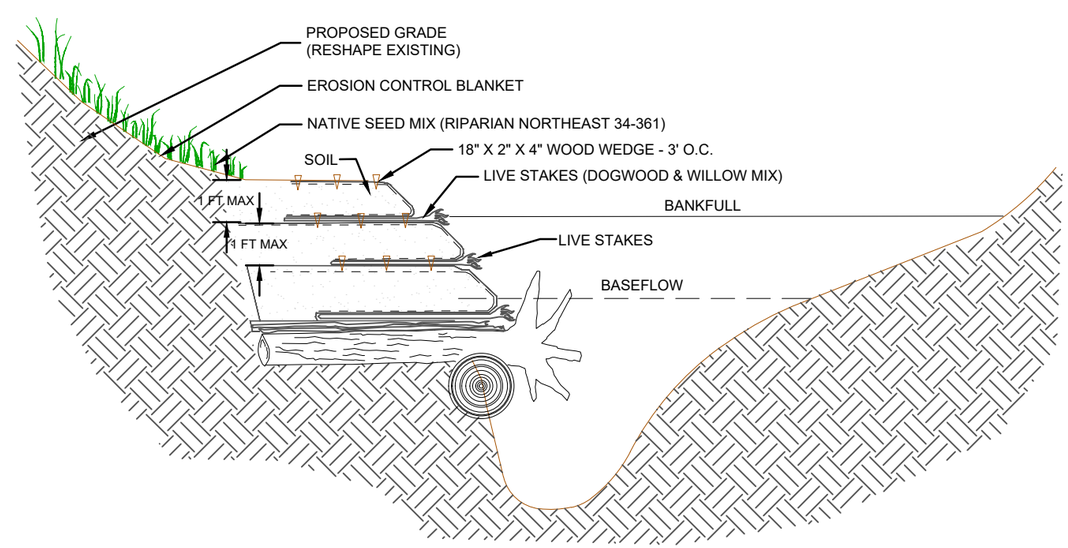
(12) CROSS-VANE
NOT TO SCALE



NOTES:

1. SLOPE SURFACE SHALL BE FREE OF ROCKS, CLODS, STICKS AND GRASS. MATS/BLANKETS SHALL HAVE GOOD SOIL CONTACT.
2. LAY BLANKETS LOOSELY AND STAKE OR STAPLE TO MAINTAIN DIRECT CONTACT WITH THE SOIL. DO NOT STRETCH.
3. NORTH AMERICAN GREEN C125 BN TO BE INSTALLED ON ALL DISTURBED AREAS AS SHOWN ON SHEET 4 & 5

(13) TYPICAL NAG C125 BN BLANKET INSTALLATION
NOT TO SCALE



(14) TOE WOOD - SOIL LIFT APPLICATION DETAIL
NOT TO SCALE

90% DESIGN

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#	DATE	DESCRIPTION	BY

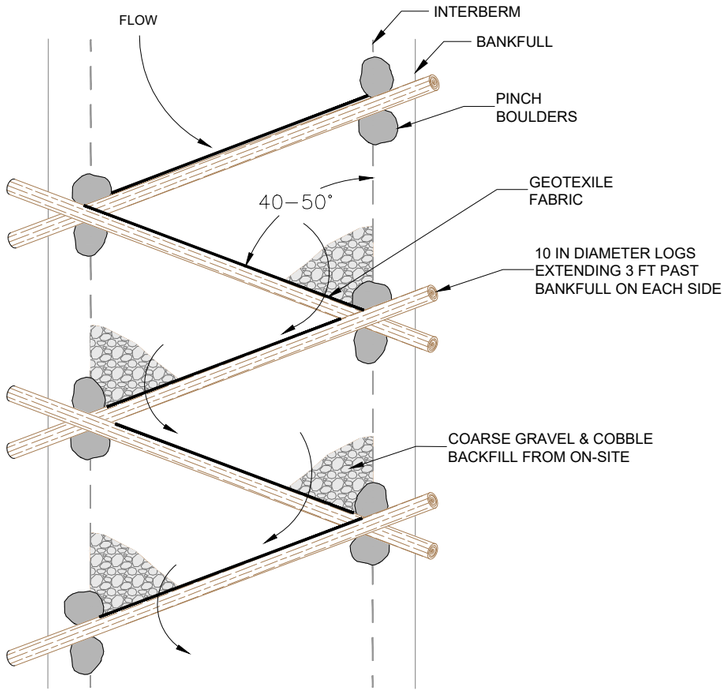
DETAILS
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

DATE	APRIL 2020
DRAWN	MGS/COD
DESIGNED	ACS
CHECKED	
PROJECT #	J188372100

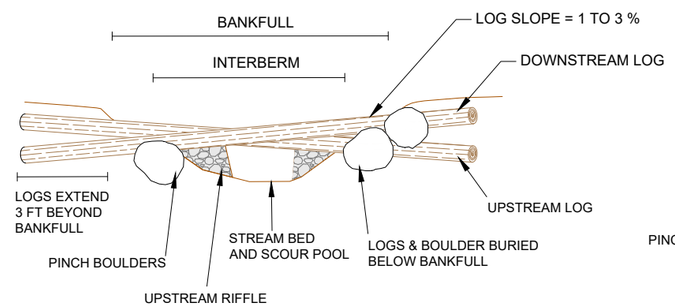
SHEET TITLE
DETAILS

SHEET NUMBER
51

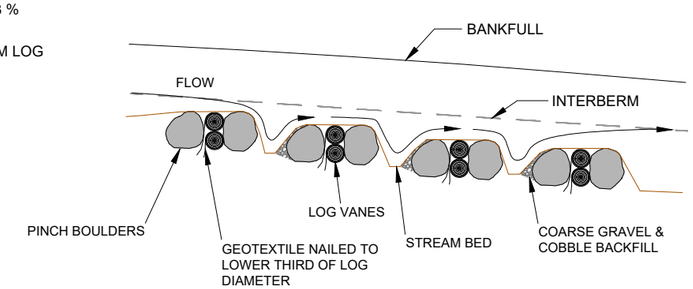
LAND USE # ----



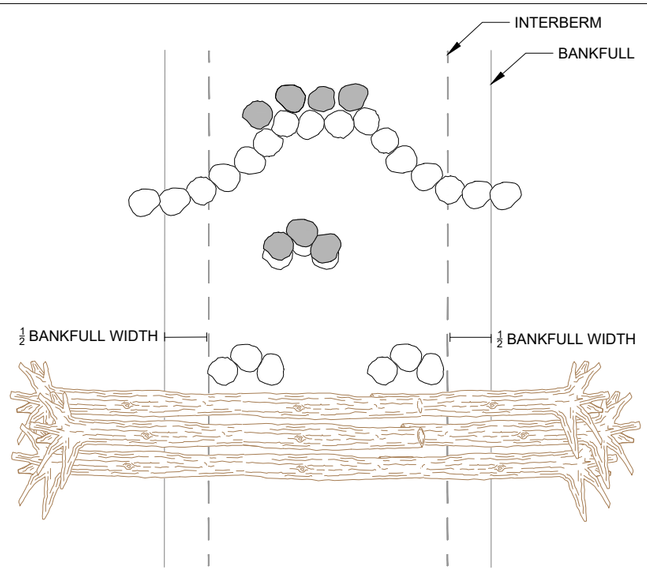
15 LOG ROLLER - PLAN VIEW
NOT TO SCALE



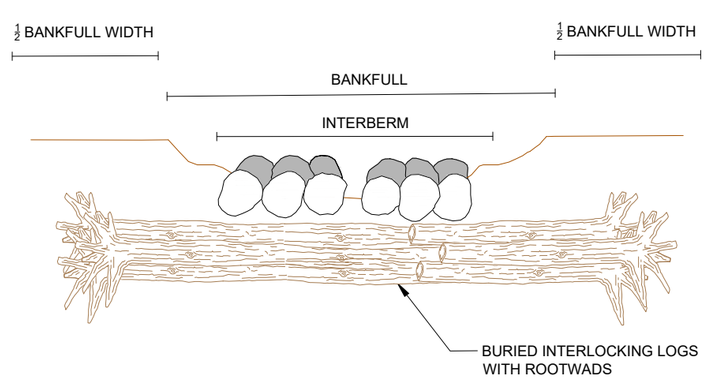
16 LOG ROLLER - CROSS SECTION
NOT TO SCALE



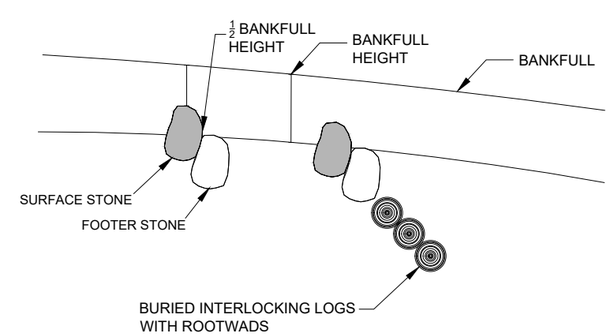
17 LOG ROLLER - PROFILE
NOT TO SCALE



18 SUBGRADE LOG VANE DETAILS - PLAN VIEW
NOT TO SCALE



19 SUBGRADE LOG VANE - CROSS SECTION
NOT TO SCALE



20 SUBGRADE LOG VANE - PROFILE
NOT TO SCALE

90% DESIGN

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DETAILS
KNIFE RIVER
ENVIRONMENTAL TROUBLESHOOTERS
LAKE COUNTY, MINNESOTA

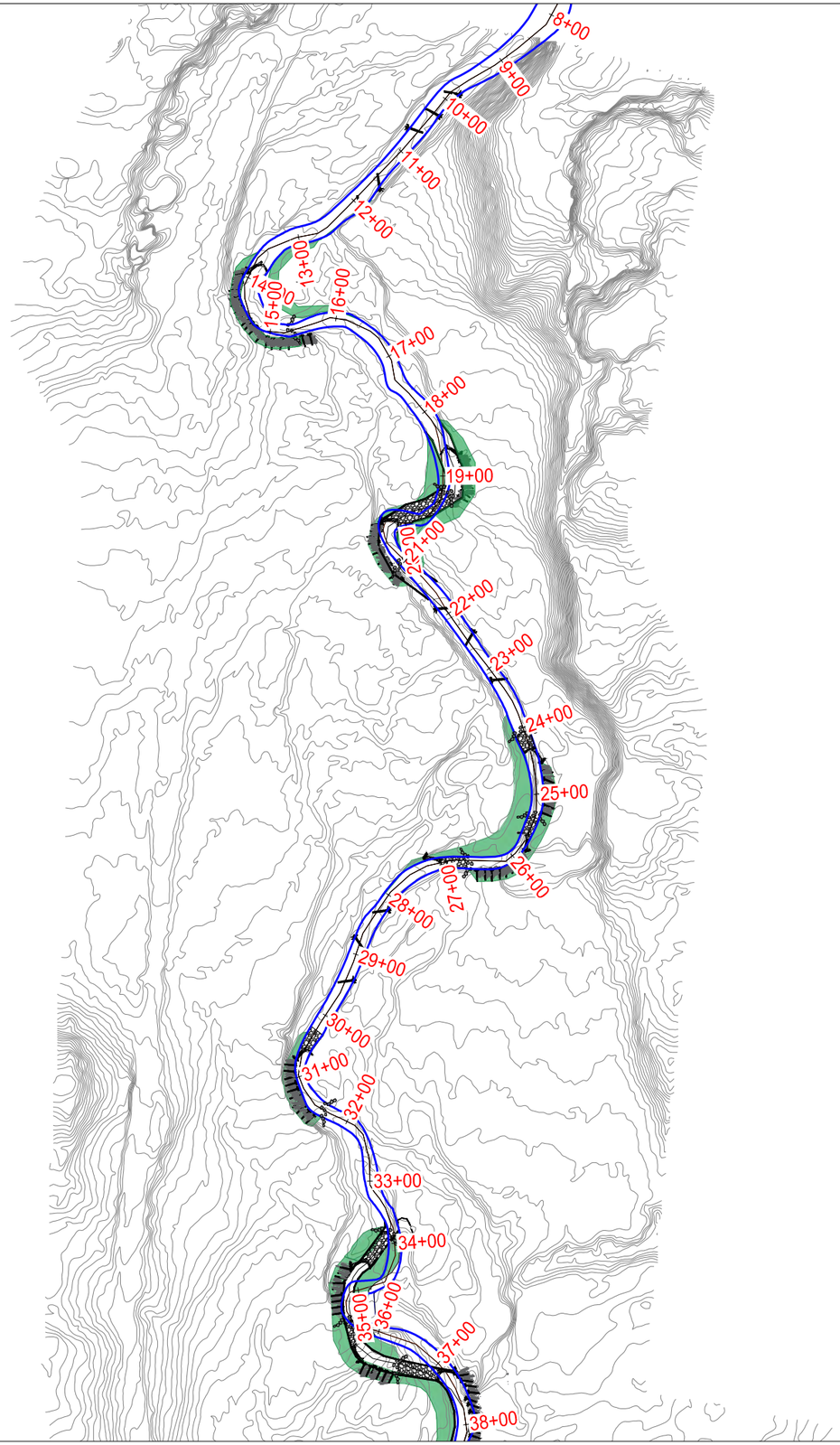
#	DATE	DESCRIPTION	BY

DATE	APRIL 2020
DRAWN	MGS
DESIGNED	MP
CHECKED	
PROJECT #	J188372100

SHEET TITLE
DETAILS

SHEET NUMBER
52

LAND USE # ----



TREE LIST

Inside Point Bar	Spacing	Plant Material
Adjacent to Stream		
Sand bar willow	4 ft o.c.	Live Stakes
Areas periodically flooded		
Tamarack	8-20 ft o.c.	Container
White spruce	8-20 ft o.c.	Container
Silver maple	8-20 ft o.c.	Container
Red maple	8-20 ft o.c.	Container
Bur oak	8-20 ft o.c.	Container
Black willow	8-20 ft o.c.	Container
Red osier dogwood	4 ft o.c.	Container
Areas of higher elevation		
Yellow birch	8-20 ft o.c.	Container
Mountain ash	8-20 ft o.c.	Container
Bur oak	8-20 ft o.c.	Container
White pine	8-20 ft o.c.	Container
Red pine	8-20 ft o.c.	Container
High bush cranberry	8-16 ft o.c.	Container
Outside Bends		
Non-Toewood Banks		
Speckled alder	8-16 ft o.c.	Container
Sandbar willow	4 ft o.c.	Live Stakes
Black willow	4 ft o.c.	Container
Tamarack	8-20 ft o.c.	Container
White spruce	8-20 ft o.c.	Container
Silver maple	8-20 ft o.c.	Container
Red Maple	8-20 ft o.c.	Container
Toewood Bench		
White pine	8-20 ft o.c.	Container
Red pine	8-20 ft o.c.	Container
Basswood	8-20 ft o.c.	Container
Paper birch	8-20 ft o.c.	Container
Yellow birch	8-20 ft o.c.	Container
Red-osier dogwood	8-16 ft o.c.	Container
High bush cranberry	8-16 ft o.c.	Container
Juneberry	8-16 ft o.c.	Container
Chokeberry	8-16 ft o.c.	Container
Smooth sumac	8-16 ft o.c.	Container

SEED MIXES

MN-DOT Seed Mix 34-361 Riparian Northeast				
Common Name	**Scientific Name**	**Rate (lb/acre)**	**Percent of Mix**	**Seeds/Sq ft**
American slough grass	*Beckmannia syzigachne*	1.5	4.78%	27.64
Bluejoint	*Calamagrostis canadensis*	0.06	0.19%	6
Riverbank wild rye	*Elymus riparius*	0.5	1.57%	0.53
Virginia wild rye	*Elymus virginicus*	2	6.33%	3.08
Tall manna grass	*Glyceria grandis*	0.25	0.80%	6.5
Fowl manna grass	*Glyceria striata*	0.09	0.29%	3
Rice cut grass	*Leersia oryzoides*	0.15	0.49%	1.93
Fowl grass	*Poa palustris*	0.7	2.23%	33.5
Total Grasses		**5.25**	**16.68%**	**82.18**
Tussock sedge	*Carex stricta*	0.04	0.13%	0.8
Pointed broom sedge	*Carex scoparia*	0.06	0.21%	2
Fox sedge	*Carex vulpinoidea*	0.2	0.65%	7.5
Path rush	*Juncus tenuis*	0.03	0.09%	10
Dark green bulrush	*Scirpus atrovirens*	0.12	0.38%	20
Woolgrass	*Scirpus cyperinus*	0.05	0.15%	30
Total Sedges and Rushes		**0.5**	**1.61%**	**70.3**
Marsh milkweed	*Asclepias incarnata*	0.12	0.38%	0.21
Flat-topped aster	*Doellingeria umbellata*	0.04	0.13%	1
Common boneset	*Eupatorium perfoliatum*	0.05	0.16%	3
Grass-leaved goldenrod	*Euthamia graminifolia*	0.07	0.22%	9
Spotted joe pye weed	*Eutrochium maculatum*	0.11	0.34%	3.7
Giant sunflower	*Helianthus giganteus*	0.07	0.22%	0.25
Spotted touch-me-not	*Impatiens capensis*	0.03	0.11%	0.05
Blue monkey flower	*Mimulus ringens*	0.02	0.05%	13
Giant goldenrod	*Solidago gigantea*	0.02	0.05%	1.5
Blue vervain	*Verbena hastata*	0.22	0.68%	7.35
Total Forbs		0.75	2.34%	39.06
Oats or winter wheat		25	79.37%	11.14
Total Cover Crop		25	79.37%	11.14
Totals		31.5	100.00%	202.67

MN-DOT Seed Mix 32-241 Native Construction				
Common Name	**Scientific Name**	**Rate (lb/acre)**	**Percent of Mix**	**Seeds/Sq ft**
big bluestem	*Andropogon gerardii*	1.25	3.30%	4.60
side-oats grama	*Bouteloua curtipendula*	1.00	2.64%	2.21
fringed brome	*Bromus ciliatus*	1.40	3.69%	5.67
nodding wild rye	*Elymus canadensis*	2.00	5.26%	3.82
slender wheatgrass	*Elymus trachycaulus*	2.50	6.57%	6.33
Virginia wild rye	*Elymus virginicus*	2.00	5.26%	3.09
switchgrass	*Panicum virgatum*	0.75	1.97%	3.85
fowl bluegrass	*Poa palustris*	0.60	1.57%	28.50
Indian grass	*Sorghastrum nutans*	1.00	2.63%	4.40
Total Grasses		12.50	32.89%	62.47
Canada tick trefoil	*Desmodium canadense*	0.07	0.20%	0.15
partridge pea	*Chamoecrista fasiculata*	0.27	0.72%	0.27
wild bergamot	*Monarda fistulosa*	0.02	0.04%	0.39
black-eyed susan	*Rudbeckia hirta*	0.09	0.23%	3.00
hoary vervain	*Verbena stricta*	0.05	0.13%	0.50
Total Forbs		0.50	1.32%	4.31
Oats or winter wheat		25	65.79%	11.14
Total Cover Crops		25	65.79%	11.14
Totals		38	100.00%	77.91

GRAPHIC SCALE VERIFICATION
This bar measures 1" on 22"x34"
or 1/2" on 11"x17" original.
Adjust scale accordingly.

0 100' 200'
GRAPHIC SCALE IN FEET

90% DESIGN

Cardno
MADISON
6140 COTTONWOOD DRIVE, SUITE A,
FITCHBURG, WISCONSIN 53719
TEL: (608) 661-2805 FAX: (608) 661-2861
www.cardnoglaw.com

PLANTING PLAN
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

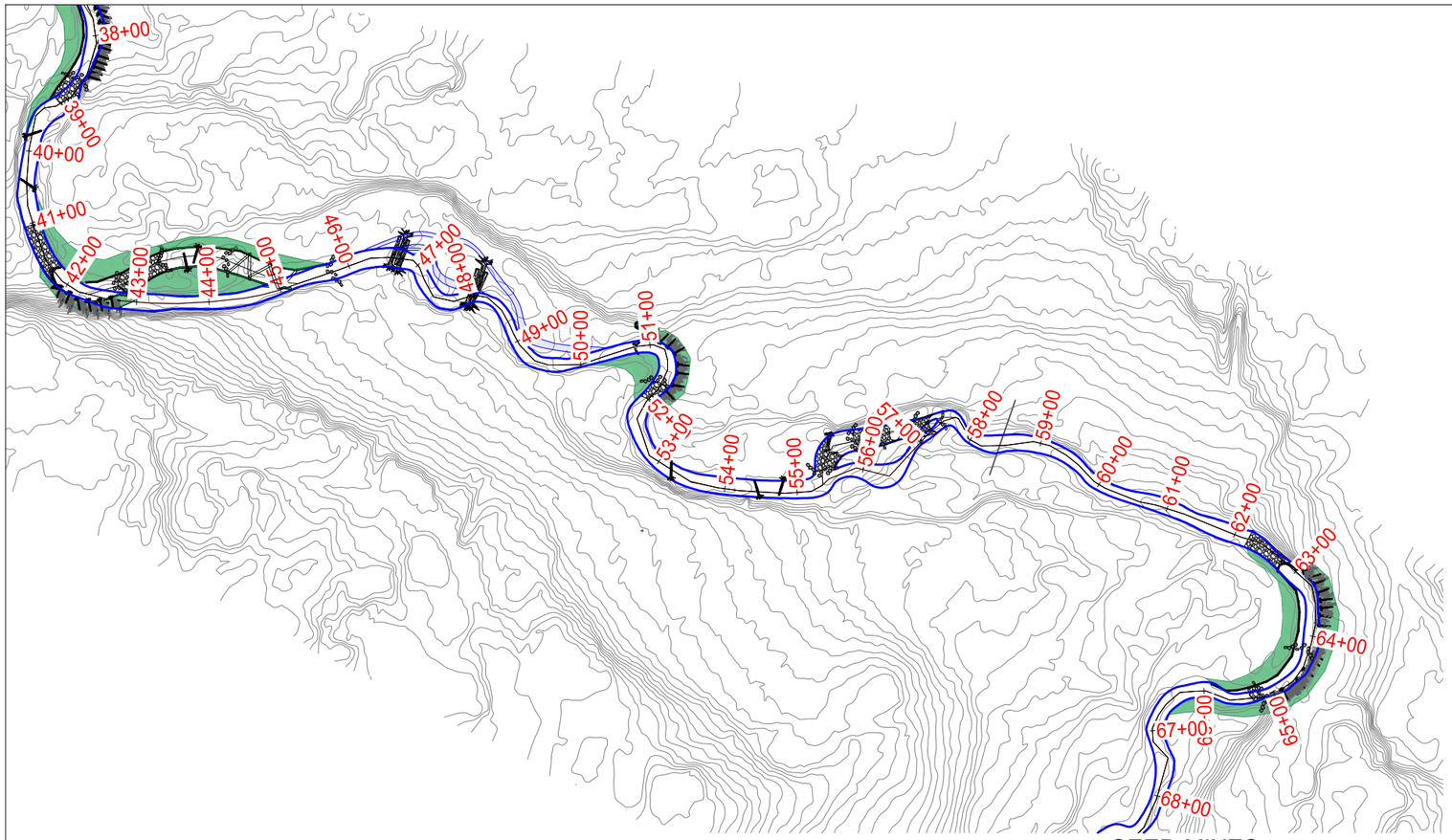
#	DATE	DESCRIPTION	BY

DATE | APRIL 2020
DRAWN | MGS/COD
DESIGNED | ACS
CHECKED |
PROJECT # | J188372100

SHEET TITLE
PLANTING PLAN

SHEET NUMBER
53

LAND USE # ----



TREE LIST

Inside Point Bar	Spacing	Plant Material
Adjacent to Stream		
Sand bar willow	4 ft o.c.	Live Stakes
Areas periodically flooded		
Tamarack	8-20 ft o.c.	Container
White spruce	8-20 ft o.c.	Container
Silver maple	8-20 ft o.c.	Container
Red maple	8-20 ft o.c.	Container
Bur oak	8-20 ft o.c.	Container
Black willow	8-20 ft o.c.	Container
Red osier dogwood	4 ft o.c.	Container
Areas of higher elevation		
Yellow birch	8-20 ft o.c.	Container
Mountain ash	8-20 ft o.c.	Container
Bur oak	8-20 ft o.c.	Container
White pine	8-20 ft o.c.	Container
Red pine	8-20 ft o.c.	Container
High bush cranberry	8-16 ft o.c.	Container
Outside Bends		
Non-Toewood Banks		
Speckled alder	8-16 ft o.c.	Container
Sandbar willow	4 ft o.c.	Live Stakes
Black willow	4 ft o.c.	Container
Tamarack	8-20 ft o.c.	Container
White spruce	8-20 ft o.c.	Container
Silver maple	8-20 ft o.c.	Container
Red Maple	8-20 ft o.c.	Container
Toewood Bench		
White pine	8-20 ft o.c.	Container
Red pine	8-20 ft o.c.	Container
Basswood	8-20 ft o.c.	Container
Paper birch	8-20 ft o.c.	Container
Yellow birch	8-20 ft o.c.	Container
Red-osier dogwood	8-16 ft o.c.	Container
High bush cranberry	8-16 ft o.c.	Container
Juneberry	8-16 ft o.c.	Container
Chokeberry	8-16 ft o.c.	Container
Smooth sumac	8-16 ft o.c.	Container

GRAPHIC SCALE VERIFICATION
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Adjust scale accordingly.

0 100' 200'
GRAPHIC SCALE IN FEET

SEED MIXES

MN-DOT Seed Mix 34-361 Riparian Northeast				
Common Name	**Scientific Name**	**Rate (lb/acre)**	**Percent of Mix**	**Seeds/Sq ft**
American slough grass	*Beckmannia syzigachne*	1.5	4.78%	27.64
Bluejoint	*Calamagrostis canadensis*	0.06	0.19%	6
Riverbank wild rye	*Elymus riparius*	0.5	1.57%	0.53
Virginia wild rye	*Elymus virginicus*	2	6.33%	3.08
Tall manna grass	*Glyceria grandis*	0.25	0.80%	6.5
Fowl manna grass	*Glyceria striata*	0.09	0.29%	3
Rice cut grass	*Leersia oryzoides*	0.15	0.49%	1.93
Fowl grass	*Poa palustris*	0.7	2.23%	33.5
Total Grasses		**5.25**	**16.68%**	**82.18**
Tussock sedge	*Carex stricta*	0.04	0.13%	0.8
Pointed broom sedge	*Carex scoparia*	0.06	0.21%	2
Fox sedge	*Carex vulpinoidea*	0.2	0.65%	7.5
Path rush	*Juncus tenuis*	0.03	0.09%	10
Dark green bulrush	*Scirpus atrovirens*	0.12	0.38%	20
Woolgrass	*Scirpus cyperinus*	0.05	0.15%	30
Total Sedges and Rushes		**0.5**	**1.61%**	**70.3**
Marsh milkweed	*Asclepias incarnata*	0.12	0.38%	0.21
Flat-topped aster	*Doellingeria umbellata*	0.04	0.13%	1
Common boneset	*Eupatorium perfoliatum*	0.05	0.16%	3
Grass-leaved goldenrod	*Euthamia graminifolia*	0.07	0.22%	9
Spotted joe pye weed	*Eutrochium maculatum*	0.11	0.34%	3.7
Giant sunflower	*Helianthus giganteus*	0.07	0.22%	0.25
Spotted touch-me-not	*Impatiens capensis*	0.03	0.11%	0.05
Blue monkey flower	*Mimulus ringens*	0.02	0.05%	13
Giant goldenrod	*Solidago gigantea*	0.02	0.05%	1.5
Blue vervain	*Verbena hastata*	0.22	0.68%	7.35
Total Forbs		0.75	2.34%	39.06
Oats or winter wheat		25	79.37%	11.14
Total Cover Crop		25	79.37%	11.14
Totals		31.5	100.00%	202.67

MN-DOT Seed Mix 32-241 Native Construction				
Common Name	**Scientific Name**	**Rate (lb/acre)**	**Percent of Mix**	**Seeds/Sq ft**
big bluestem	*Andropogon gerardii*	1.25	3.30%	4.60
side-oats grama	*Bouteloua curtipendula*	1.00	2.64%	2.21
fringed brome	*Bromus ciliatus*	1.40	3.69%	5.67
nodding wild rye	*Elymus canadensis*	2.00	5.26%	3.82
slender wheatgrass	*Elymus trachycaulus*	2.50	6.57%	6.33
Virginia wild rye	*Elymus virginicus*	2.00	5.26%	3.09
switchgrass	*Panicum virgatum*	0.75	1.97%	3.85
fowl bluegrass	*Poa palustris*	0.60	1.57%	28.50
Indian grass	*Sorghastrum nutans*	1.00	2.63%	4.40
Total Grasses		12.50	32.89%	62.47
Canada tick trefoil	*Desmodium canadense*	0.07	0.20%	0.15
partridge pea	*Chamoecrista fasiculata*	0.27	0.72%	0.27
wild bergamot	*Monarda fistulosa*	0.02	0.04%	0.39
black-eyed susan	*Rudbeckia hirta*	0.09	0.23%	3.00
hoary vervain	*Verbena stricta*	0.05	0.13%	0.50
Total Forbs		0.50	1.32%	4.31
Oats or winter wheat		25	65.79%	11.14
Total Cover Crops		25	65.79%	11.14
Totals		38	100.00%	77.91

90% DESIGN

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MADISON
6140 COTTONWOOD DRIVE, SUITE A,
FITCHBURG, WISCONSIN 53719
TEL: (608) 661-2655 FAX: (608) 661-2661
www.cardnoplfew.com

PLANTING PLAN
KNIFE RIVER
ENVIRONMENTAL TROUBLE SHOOTERS
LAKE COUNTY, MINNESOTA

DATE	DESCRIPTION	BY

DATE	APRIL 2020
DRAWN	MGS/COD
DESIGNED	ACS
CHECKED	
PROJECT #	J188372100

SHEET TITLE
PLANTING PLAN

SHEET NUMBER
54

LAND USE # ----