French Creek Project Greenline Assessment
2022 Post-restoration Report

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French Creek project area overview. Note dark green wetland vegetation (Baltic rush and wooly sedge) along the activated side-channel following two growing seasons. Photo taken on June 24th, 2022.

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Summary

In the Fall of 2020, the French Creek Streambank Restoration Project was completed on the Mount Haggin Wildlife Management Area. The purpose of this project was to enhance aquatic habitat for Arctic grayling (*Thymallus arcticus*) and Westslope cutthroat trout (*Oncorhynchus clarki lewisi*) and facilitate expansion of wildlife riparian habitat. The project restored 21 streambanks with excessive lateral streambank erosion. In addition to the streambank restoration work, an old side-channel of French Creek was reactivated to increase the riparian/wetland vegetation footprint in the project area.

The purpose of this report is to provide a baseline summary of the vegetation conditions along the 21 streambanks two-years post-restoration. The two-year results are very promising for woody species and riparian vegetation establishment; however, it's still difficult to conclude the project is fully successful, which will be more accurately determined in the next three years of monitoring (2023 – 2025). No grazing occurred in the project area during the summer of 2022. Grazing is not anticipated to occur within the project area until 2024. This monitoring data will be used to track the effectiveness of the restoration techniques developed for the French Creek project to increase riparian vegetation expansion and reduce streambank erosion over the next four years (ending in 2025).

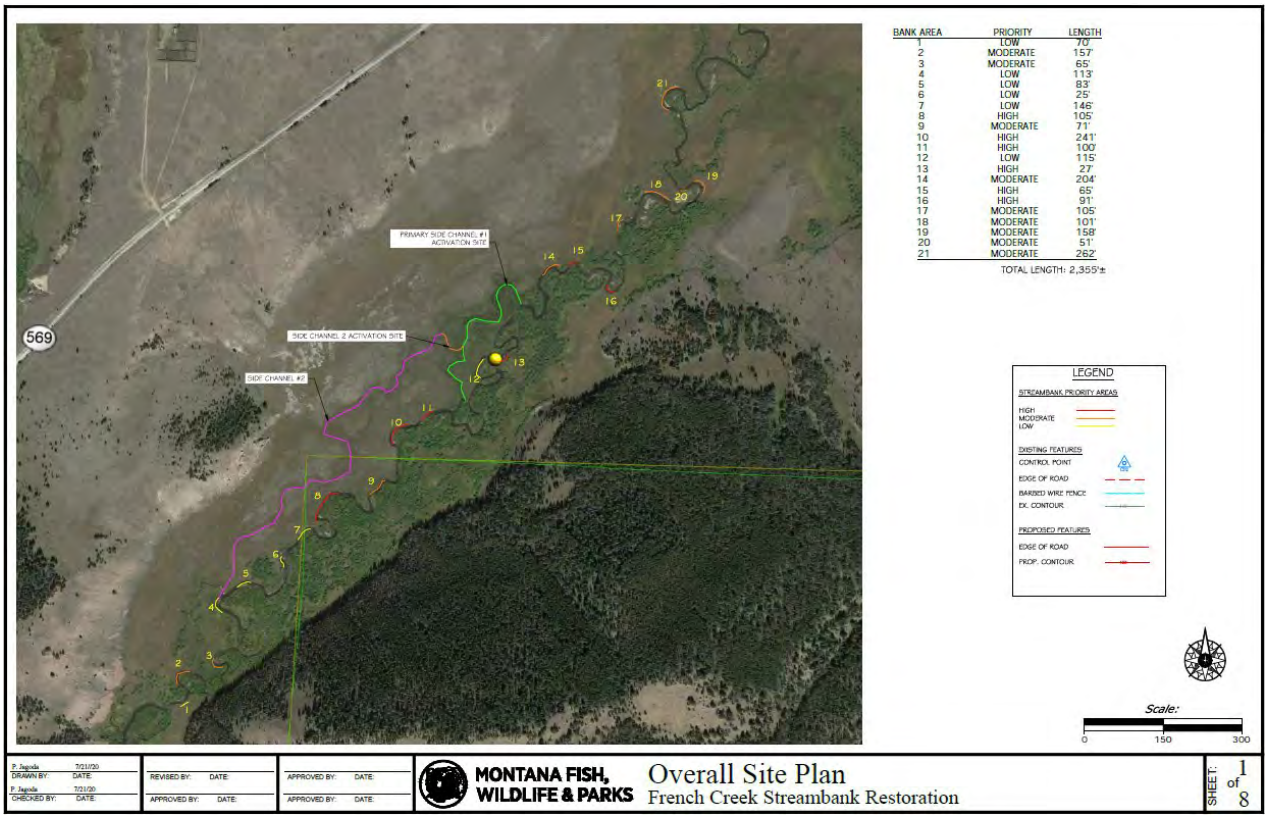

Figure 1. French Creek project plan set area overview.

Methods

On August 22nd and 25th, 2022, Greenline assessments were completed on 21 streambanks for second-year post-construction monitoring. The assessment followed the protocol developed by Winward (2000) for Greenline sampling. Due to the high preponderance of introduced grasses pre-restoration and the interest in evaluating changes specific to those species post-restoration, the Dominance Type (DT) was recorded for each step (Hansen et al., 1995). All Greenline transects were marked with a handheld GPS. Photos were taken at the beginning and end of each Greenline transect. Greenline cross-section transects were not completed because of the timeline anticipated for meaningful riparian expansion beyond the streambanks restored (>5 years).

In addition, to evaluating the DT for each streambank, the following variables were also included in the Greenline assessments: stability, successional status, and woody species regeneration as described by Winward (2000). A rating summary is included in this report for compliance monitoring with the U.S. Army Corp of Engineers (USACE). The wetland rating summary follows the designations for the Western Mountains, Valleys, and Coast Region species list (USACE, 2020).

During the restoration work, Streambank 9 was removed from the project due to a beaver dam and lodge established in the summer of 2020. Streambank 8.5 was substituted in in place of Streambank 9. There is no pre-restoration data for Streambank 8.5. Streambank 9 will be included in future photo monitoring to track vegetative changes. Lastly, Streambanks 1 and 4 did not receive willow clump transplants due to budget limitations but were staked with willow cuttings in spring of 2021. Please see Appendix 1 for photo monitoring of each of the restored streambanks.

Results

Greenline DT Summary

Pre-restoration

The *Poa pratensis* (POPR) DT accounted for 49.2% of the total steps. The *Phleum pretense* (PHPR) DT accounted for 14.7% of the total steps. The *Carex pellita* (CAPEL) DT accounted for 10.4% of the total steps. The remaining DTs each accounted for less than 10% of the total steps.

Post-restoration Two-years

The *Carex pellita* (CAPEL) DT accounted for 25.8% of the total steps. The *Salix geyeriana/Carex utriculata* (SAGE/CAUT) DT accounted for 39.9% of the total steps. The remaining DTs each accounted for less than 10% of the total steps.

Please see Table 1 & 2 for pre-restoration and post-restoration summaries of the overall DT (respectively). Please see Table 3 & 4 for pre-restoration and post-restoration DT steps by

streambank (respectively). All streambank photo monitoring (before and after) is in Appendix One.

Table 1.

Pre-restoration French Creek Greenline DT Total Steps (2020)		
DT	*Total Steps*	*Percent of Total Steps*
Antennaira rosea (ANRO)	7	0.7
Argentina anserine (ARAN)	14	1.4
Carex aquatilis (CAAQ)	106	10.4
Carex praegracilis (CAPR)	1	0.1
Carex utriculata (CAUT)	2	0.2
Dasiphora fruiticosa (DAFR)	2	0.2
Danthonia intermedia (DAIN)	14	1.4
Deschampsia cespitosa (DECE)	22	2.2
Elymus trachycaulus (ELTR)	26	2.6
Festuca idahoensis (FEID)	2	0.2
Juncus balticus (JUBA)	70	6.9
Koeleria macrantha (KOMA)	16	1.6
Phleum pretense (PHPR)	150	14.7
Potentilla gracilis (POGR)	70	6.9
Poa pratensis (POPR)	500	49.2
Salix geyeriana (SAGE)	3	0.3
Symphyotrichum spp. (SY spp)	1	0.1
Taraxacum officinale (TAOF)	11	1.1
Grand Total	**1017**	**100**

Table 2.

Post-construction French Creek Greenline DT Total Steps (2022)		
DT	*Total Steps*	*Percent of Total Steps*
Achillea millefolium (ACMI)	1	0.1
Agrostis scabra (AGSC)	24	2.2
Agrostis stolonifera (AGST)	28	2.6
Alopecurus aequalis (ALAE)	1	0.1
Alopecurus pratensis (ALPR)	1	0.1
Argentina anserina (ARAN)	13	1.2
Carex aquatilis (CAAQ)	21	1.9
Calamagrostis canadensis (CACA)	12	1.1
Carex aquatilis (CAAQ)	3	0.3
Carex pellita (CAPEL)	281	25.8
Carex praegracilis (CAPR)	12	1.1
Calamagrostis stricta (CAST)	19	1.7
Carex utriculata (CAUT)	25	2.3
Dasiphora fruticosa (DAFR)	1	0.1
Deschampsia cespitosa (DECE)	29	2.7
Eleocharis palustris (ELPA)	1	0.1
Epilobium cilliatum (EPCI)	3	0.3
Festuca idahoensis (FEID)	5	0.5
Galium boreale (GABO)	1	0.1
Juncus balticus (JUBA)	14	1.3
Pedicularis groenlandica (PEGR)	1	0.1
Phleum pratense (PHPR)	44	4.0
Potentilla gracilis (POGR)	4	0.4
Poa palustris (POPA)	4	0.4
Poa pratensis (POPR)	35	3.2
Salix brachycarpa (SABR)	5	0.5
Salix geyeriana/Carex utriculata (SAGE/CAUT)	435	39.9
Senecio hydrophiloides (SEHY)	1	0.1
Trifolium repens (TRRE)	65	6.0
Grand Total	**1089**	**100.0**

Table 3.

Pre-restoration French Creek Greenline DT Steps by Streambank (2020)

Streambank	*ANRO*	*ARAN*	*CAAQ*	*CAPR*	*CAUT*	*DAFR*	*DAIN*	*DECE*	*ELTR*	*FEID*	*JUBA*	*KOMA*	*PHPR*	*POGR*	*POPR*	*SAGE*	*SY Spp*	*TAOF*	*Grand Total*
Streambank 1														6	25				**31**
Streambank 2													31	24	7				**62**
Streambank 3			3										18		5				**26**
Streambank 4			9					3					2	2	27				**43**
Streambank 5		14						1						3	14				**32**
Streambank 6							2				2	2			2	3			**11**
Streambank 7									2			2	1	11	38		1		**55**
Streambank 8											7		1		36				**44**
Streambank 9			19										1	3	13				**36**
Streambank 10			7	1		1	12				14		2		57			11	**105**
Streambank 11	7		1										1		34				**43**
Streambank 12			5								13		25	2	2				**47**
Streambank 13											3		9						**12**
Streambank 14			10								10			4	62				**86**
Streambank 15													26		3				**29**
Streambank 16								2	5		1	8		2	24				**42**
Streambank 17			5						3		5		11		17				**41**
Streambank 18			3		2				3		10		15	4	23				**60**
Streambank 19			12			1		9		2	3	4		7	35				**73**
Streambank 20											1		5		17				**23**
Streambank 21			32					7	13		1		2	2	59				**116**
Total Steps	**7**	**14**	**106**	**1**	**2**	**2**	**14**	**22**	**26**	**2**	**70**	**16**	**150**	**70**	**500**	**3**	**1**	**11**	**1017**

Table 4.

Post-restoration French Creek Greenline DT Steps by Streambank (2022)

Streambank	*ACMI*	*AGSC*	*AGST*	*ALAE*	*ALPR*	*ARAN*	*CAAQ*	*CACA*	*CAPACH*	*CAPEL*	*CAPR*	*CAST*	*CAUT*	*DAFR*	*DECE*	*ELPA*	*EPCI*	*FEID*	*GABO*	*JUBA*	*PEGR*	*PHPR*	*POGR*	*POPA*	*POPR*	*SABR*	*SAGE/CAUT*	*SEHY*	*TRRE*	*Grand Total*
Streambank 1	1									4							3	2	1			3	3		4		10			**31**
Streambank 2							7	2		18		3						2				1					21		5	**59**
Streambank 3		2				1	2	1		13			4									2					20		3	**48**
Streambank 4		2		1		5	5			7		4	6							1				1	2		6		7	**47**
Streambank 5		2				4		1		19		2	5					1									7		1	**42**
Streambank 6							2			6		1								3		4					6		3	**25**
Streambank 7		3								12		1	4								1				2		38		2	**63**
Streambank 8		6	1										2		1					1		2			1		31		5	**50**
Streambank 8.5		4						2		5					1							10		1			14		2	**39**
Streambank 10		3	6					1	3	20					5					3		1			1	5	35		8	**91**
Streambank 11			1							6				1		1								1	2		32		1	**45**
Streambank 12			5					2		7		1	1		1							10		1	4		22		3	**57**
Streambank 13										6																	11			**17**
Streambank 14		1	3					1		15					1										1		48			**70**
Streambank 15			1							9					1							1			1		19		7	**39**
Streambank 16			1							35										1					1		10	1		**49**
Streambank 17			6							13		1			1					2		1			2		12		7	**45**
Streambank 18					1	1	5	1		31					4					2		6			3		12		3	**69**
Streambank 19		1								27	11	4			7										2		14			**66**
Streambank 20			3			1		1		2		1								1		1	1		3		15		4	**33**
Streambank 21			1			1				26	1	1	3		7							2			6		52		4	**104**
Total Steps	**1**	**24**	**28**	**1**	**1**	**13**	**21**	**12**	**3**	**281**	**12**	**19**	**25**	**1**	**29**	**1**	**3**	**5**	**1**	**14**	**1**	**44**	**4**	**4**	**35**	**5**	**435**	**1**	**65**	**1089**

Streambank Stability Summary

Pre-restoration
Streambank stability rated poor for all streambanks (average stability weighted by step = 4.1). Individual streambank stability ranged from 3.1 (poor) to 5.8 (moderate).

Post-restoration Two-years
Streambank stability rated high for all streambanks (average stability weighted by step = 7.88). Individual streambank stability ranged from 6.03 (high) to 9.65 (excellent).

For pre-restoration and post-restoration streambank stability by streambank please see Tables 5 and 6 (respectively).

Table 5.

Pre-restoration French Creek Streambank Stability (2020)			
Streambank 1			
DT	*DT Stability Ranking*	*Steps*	*Stability Contribution**
POGR	4	6	0.8
POPR	3	25	2.4
Total Steps/Overall Streambank Stability **		**31**	**3.2**
Streambank 2			
DT	*DT Stability Ranking*	*Steps*	*Stability Contribution**
PHPR	3	31	1.5
POGR	4	24	1.5
POPR	3	7	0.3
Total Steps/Overall Streambank Stability **		**62**	**3.4**
Streambank 3			
DT	*DT Stability Ranking*	*Steps*	*Stability Contribution**
CAAQ	9	3	1.0
PHPR	3	18	2.1
POPR	3	5	0.6
Total Steps/Overall Streambank Stability **		**26**	**3.7**
Streambank 4			
DT	*DT Stability Ranking*	*Steps*	*Stability Contribution**
CAAQ	9	9	1.9
DECE	3	3	0.2
PHPR	3	2	0.1
POGR	4	2	0.2
POPR	3	27	1.9
Total Steps/Overall Streambank Stability **		**43**	**4.3**
Streambank 5			
DT	*DT Stability Ranking*	*Steps*	*Stability Contribution**
ARAR	4	14	1.8
DECE	3	1	0.1
POGR	4	3	0.4
POPR	3	14	1.3
Total Steps/Overall Streambank Stability **		**32**	**3.5**
Streambank 6			
DT	*DT Stability Ranking*	*Steps*	*Stability Contribution**
DAIN	2	2	0.4
JUBA	9	2	1.6
KOMA	3	2	0.5
POPR	3	2	0.5
SAGE	10	3	2.7
Total Steps/Overall Streambank Stability **		**11**	**5.8**
Streambank 7			
DT	*DT Stability Ranking*	*Steps*	*Stability Contribution**
ELTR	3	2	0.1
KOMA	3	2	0.1
PHPR	3	1	0.1
POGR	4	11	0.8
POPR	3	38	2.1
SYAS	3	1	0.1
Total Steps/Overall Streambank Stability **		**55**	**3.2**
Streambank 8			
DT	*DT Stability Ranking*	*Steps*	*Stability Contribution**
JUBA	9	7	1.4
PHPR	3	1	0.1
POPR	3	36	2.5
Total Steps/Overall Streambank Stability **		**44**	**4.0**

Streambank 9			
DT	*DT Stability Ranking*	*Steps*	*Stability Contribution**
CAAQ	9	19	4.8
PHPR	3	1	0.1
POGR	4	3	0.3
POPR	3	13	1.1
Total Steps/Overall Streambank Stability		**36**	**6.3**
Streambank 10			
DT	*DT Stability Ranking*	*Steps*	*Stability Contribution**
CAAQ	9	7	0.6
CAPR	7	1	0.1
DAFR	5	1	0.0
DAIN	2	12	0.2
JUBA	9	14	1.2
PHPR	3	2	0.1
POPR	3	57	1.6
TAOF	3	11	0.3
Total Steps/Overall Streambank Stability		**105**	**4.1**
Streambank 11			
DT	*DT Stability Ranking*	*Steps*	*Stability Contribution**
ANRO	3	7	0.5
CAAQ	9	1	0.2
PHPR	3	1	0.1
POPR	3	34	2.4
Total Steps/Overall Streambank Stability		**43**	**3.1**
Streambank 12			
DT	*DT Stability Ranking*	*Steps*	*Stability Contribution**
CAAQ	9	5	1.0
JUBA	9	13	2.5
PHPR	3	25	1.6
POGR	4	2	0.2
POPR	3	2	0.1
Total Steps/Overall Streambank Stability		**47**	**5.3**
Streambank 13			
DT	*DT Stability Ranking*	*Steps*	*Stability Contribution**
JUBA	9	3	2.3
PHPR	3	9	2.3
Total Steps/Overall Streambank Stability		**12**	**4.5**
Streambank 14			
DT	*DT Stability Ranking*	*Steps*	*Stability Contribution**
CAAQ	9	10	1.0
JUBA	9	10	1.0
POGR	4	4	0.2
POPR	3	62	2.2
Total Steps/Overall Streambank Stability		**86**	**4.4**

Streambank 15			
DT	*DT Stability Ranking*	*Steps*	*Stability Contribution**
PHPR	3	26	2.7
POPR	3	3	0.3
Total Steps/Overall Streambank Stability		**29**	**3.0**

Streambank 16			
DT	*DT Stability Ranking*	*Steps*	*Stability Contribution**
DECE	3	2	0.1
ELTR	3	5	0.4
JUBA	9	1	0.2
KOMA	3	8	0.6
POGR	4	2	0.2
POPR	3	24	1.7
Total Steps/Overall Streambank Stability **		**42**	**3.2**
Streambank 17			
DT	*DT Stability Ranking*	*Steps*	*Stability Contribution**
CAAQ	9	5	1.1
ELTR	3	3	0.2
JUBA	9	5	1.1
PHPR	3	11	0.8
POPR	3	17	1.2
Total Steps/Overall Streambank Stability **		**41**	**4.5**
Streambank 18			
DT	*DT Stability Ranking*	*Steps*	*Stability Contribution**
CAAQ	9	3	0.5
CAUT	9	2	0.3
ELTR	3	3	0.2
JUBA	9	10	1.5
PHPR	3	15	0.8
POGR	4	4	0.3
POPR	3	23	1.2
Total Steps/Overall Streambank Stability **		**60**	**4.6**
Streambank 19			
DT	*DT Stability Ranking*	*Steps*	*Stability Contribution**
CAAQ	9	12	1.5
DAFR	5	1	0.1
DECE	3	9	0.4
FEID	3	2	0.1
JUBA	9	3	0.4
KOMA	3	4	0.2
POGR	4	7	0.4
POPR	3	35	1.4
Total Steps/Overall Streambank Stability **		**73**	**4.4**
Streambank 20			
DT	*DT Stability Ranking*	*Steps*	*Stability Contribution**
JUBA	9	1	0.4
PHPR	3	5	0.7
POPR	3	17	2.2
Total Steps/Overall Streambank Stability **		**23**	**3.3**
Streambank 21			
DT	*DT Stability Ranking*	*Steps*	*Stability Contribution**
CAAQ	9	32	2.5
DECE	3	7	0.2
ELTR	3	13	0.3
JUBA	9	1	0.1
PHPR	3	2	0.1
POGR	4	2	0.1
POPR	3	59	1.5
Total Steps/Overall Streambank Stability **		**116**	**4.7**
Overall Average Streambank Stability†			**4.1**

* calculated as a product of the DT percent of the streambank's total steps and DT stability ranking

**calculated as the sum of all DT stability contributions

†calculated as the sum of the weighted average of each streambank total contribution for overall stability

Table 6.

Post-construction French Creek Streambank Stability (2022)			
Streambank 1			
DT	*DT Stability Rating*	*Steps*	*Stability Contribution**
ACMI	3	1	0.10
CAPEL	9	4	1.16
EPCI	3	3	0.29
FEID	3	2	0.19
GABO	3	1	0.10
PHPR	3	3	0.29
POGR	3	3	0.29
POPR	3	4	0.39
SAGE/CAUT	10	10	3.23
Total Steps/Overall Streambank Stability **		**31**	**6.03**
Streambank 2			
DT	*DT Stability Rating*	*Steps*	*Stability Contribution**
CAAQ	9	7	1.07
CACA	8	2	0.27
CAPEL	9	18	2.75
CAST	8	3	0.41
FEID	3	2	0.10
PHPR	3	1	0.05
SAGE/CAUT	10	21	3.56
TRRE	3	5	0.25
Total Steps/Overall Streambank Stability **		**59**	**8.46**
Streambank 3			
DT	*DT Stability Rating*	*Steps*	*Stability Contribution**
AGSC	2	2	0.08
ARAN	4	1	0.08
CAAQ	9	2	0.38
CACA	8	1	0.17
CAPEL	9	13	2.44
CAUT	9	4	0.75
PHPR	3	2	0.13
SAGE/CAUT	10	20	4.17
TRRE	3	3	0.19
Total Steps/Overall Streambank Stability **		**48**	**8.38**
Streambank 4			
DT	*DT Stability Rating*	*Steps*	*Stability Contribution**
AGSC	2	2	0.09
ALAE	3	1	0.06
ARAN	4	5	0.43
CAAQ	9	5	0.96
CAPEL	9	7	1.34
CAST	8	4	0.68
CAUT	9	6	1.15
JUBA	9	1	0.19
POPA	3	1	0.06
POPR	3	2	0.13
SAGE/CAUT	10	6	1.28
TRRE	3	7	0.45
Total Steps/Overall Streambank Stability **		**47**	**6.81**

Streambank 5			
DT	*DT Stability Rating*	*Steps*	*Stability Contribution**
AGSC	2	2	0.10
ARAN	4	4	0.38
CACA	8	1	0.19
CAPEL	9	19	4.07
CAST	8	2	0.38
CAUT	9	5	1.07
FEID	3	1	0.07
SAGE/CAUT	10	7	1.67
TRRE	3	1	0.07
Total Steps/Overall Streambank Stability **		**42**	**8.00**
Streambank 6			
DT	*DT Stability Rating*	*Steps*	*Stability Contribution**
CAAQ	9	2	0.72
CAPEL	9	6	2.16
CAST	8	1	0.32
JUBA	9	3	1.08
PHPR	3	4	0.48
SAGE/CAUT	10	6	2.4
TRRE	3	3	0.36
Total Steps/Overall Streambank Stability **		**25**	**7.52**
Streambank 7			
DT	*Stability Rating*	*Steps*	*Stability Contribution**
AGSC	2	3	0.10
CAPEL	9	12	1.71
CAST	8	1	0.13
CAUT	9	4	0.57
PEGR	4	1	0.06
POPR	3	2	0.10
SAGE/CAUT	10	38	6.03
TRRE	3	2	0.10
Total Steps/Overall Streambank Stability **		**63**	**8.79**
Streambank 8			
DT	*Stability Rating*	*Steps*	*Stability Contribution**
AGSC	2	6	0.24
AGST	3	1	0.06
CAUT	9	2	0.36
DECE	3	1	0.06
JUBA	9	1	0.18
PHPR	3	2	0.12
POPR	3	1	0.06
SAGE/CAUT	10	31	6.2
TRRE	3	5	0.3
Total Steps/Overall Streambank Stability **		**50**	**7.58**
Streambank 8.5			
DT	*Stability Rating*	*Steps*	*Stability Contribution**
AGSC	2	4	0.21
CACA	8	2	0.41
CAPEL	9	5	1.15
DECE	3	1	0.08
PHPR	3	10	0.77
POPA	3	1	0.08
SAGE/CAUT	10	14	3.59
TRRE	3	2	0.15
Total Steps/Overall Streambank Stability **		**39**	**6.44**

Streambank 10			
DT	*Stability Rating*	*Steps*	*Stability Contribution**
AGSC	2	3	0.07
AGST	3	6	0.20
CACA	8	1	0.09
CAPACH	4	3	0.13
CAPEL	9	20	1.98
DECE	3	5	0.16
JUBA	9	3	0.30
PHPR	3	1	0.03
POPR	3	1	0.03
SABR	7	5	0.38
SAGE/CAUT	10	35	3.85
TRRE	3	8	0.26
Total Steps/Overall Streambank Stability **		**91**	**7.48**
Streambank 11			
DT	*Stability Rating*	*Steps*	*Stability Contribution**
AGST	3	1	0.07
CAPEL	9	6	1.20
DAFR	5	1	0.11
ELPA	6	1	0.13
POPA	3	1	0.07
POPR	3	2	0.13
SAGE/CAUT	10	32	7.11
TRRE	3	1	0.07
Total Steps/Overall Streambank Stability **		**45**	**8.89**
Streambank 12			
DT	*Stability Rating*	*Steps*	*Stability Contribution**
AGST	3	5	0.26
CACA	8	2	0.28
CAPEL	9	7	1.11
CAST	8	1	0.14
CAUT	9	1	0.16
DECE	3	1	0.05
PHPR	3	10	0.53
POPA	3	1	0.05
POPR	3	4	0.21
SAGE/CAUT	10	22	3.86
TRRE	3	3	0.16
Total Steps/Overall Streambank Stability **		**57**	**6.81**
Streambank 13			
DT	*Stability Rating*	*Steps*	*Stability Contribution**
CAPEL	9	6	3.18
SAGE/CAUT	10	11	6.47
Total Steps/Overall Streambank Stability **		**17**	**9.65**
	Streambank 14		
DT	*Stability Rating*	*Steps*	*Stability Contribution**
AGSC	2	1	0.03
AGST	3	3	0.13
CACA	8	1	0.11
CAPEL	9	15	1.93
DECE	3	1	0.04
POPR	3	1	0.04
SAGE/CAUT	10	48	6.86
Total Steps/Overall Streambank Stability **		**70**	**9.14**

Streambank 15			
DT	*Stability Rating*	*Steps*	*Stability Contribution**
AGST	3	1	0.08
CAPEL	9	9	2.08
DECE	3	1	0.08
PHPR	3	1	0.08
POPR	3	1	0.08
SAGE/CAUT	10	19	4.87
TRRE	3	7	0.54
Total Steps/Overall Streambank Stability **		**39**	**7.79**
Streambank 16			
DT	*Stability Rating*	*Steps*	*Stability Contribution**
AGST	3	1	0.06
CAPEL	9	35	6.43
JUBA	9	1	0.18
POPR	3	1	0.06
SAGE/CAUT	10	10	2.04
SEHY	4	1	0.08
Total Steps/Overall Streambank Stability **		**49**	**8.86**
Streambank 17			
DT	*Stability Rating*	*Steps*	*Stability Contribution**
AGST	3	6	0.40
CAPEL	9	13	2.60
CAST	8	1	0.18
DECE	3	1	0.07
JUBA	9	2	0.40
PHPR	3	1	0.07
POPR	3	2	0.13
SAGE/CAUT	10	12	2.67
TRRE	3	7	0.47
Total Steps/Overall Streambank Stability **		**45**	**6.98**
Streambank 18			
DT	*Stability Rating*	*Steps*	*Stability Contribution**
ALPR	6	1	0.09
ARAN	4	1	0.06
CAAQ	9	5	0.65
CACA	8	1	0.12
CAPEL	9	31	4.04
DECE	3	4	0.17
JUBA	9	2	0.26
PHPR	3	6	0.26
POPR	3	3	0.13
SAGE/CAUT	10	12	1.74
TRRE	3	3	0.13
Total Steps/Overall Streambank Stability **		**69**	**7.65**
Streambank 19			
DT	*Stability Rating*	*Steps*	*Stability Contribution**
AGSC	2	1	0.03
CAPEL	9	27	3.68
CAPR	7	11	1.17
CAST	8	4	0.48
DECE	3	7	0.32
POPR	3	2	0.09
SAGE/CAUT	10	14	2.12
Total Steps/Overall Streambank Stability **		**66**	**7.89**

Streambank 20			
DT	*Stability Rating*	*Steps*	*Stability Contribution**
AGST	3	3	0.27
ARAN	4	1	0.12
CACA	8	1	0.24
CAPEL	9	2	0.55
CAST	8	1	0.24
JUBA	9	1	0.27
PHPR	3	1	0.09
POGR	3	1	0.09
POPR	3	3	0.27
SAGE/CAUT	10	15	4.55
TRRE	3	4	0.36
Total Steps/Overall Streambank Stability **		**33**	**7.06**
Streambank 21			
DT	*Stability Rating*	*Steps*	*Stability Contribution**
AGST	3	1	0.03
ARAN	4	1	0.04
CAPEL	9	26	2.25
CAPR	7	1	0.07
CAST	8	1	0.08
CAUT	9	3	0.26
DECE	3	7	0.20
PHPR	3	2	0.06
POPR	3	6	0.17
SAGE/CAUT	10	52	5.00
TRRE	3	4	0.12
Total Steps/Overall Streambank Stability **		**104**	**8.27**
Overall Streambank Stability†			**7.88**

* calculated as a product of the DT percent of the streambank's total steps and DT stability ranking

**calculated as the sum of all DT stability contributions

†calculated as the sum of the weighted average of each streambank total contribution for overall stability

Seral Community Status Summary

Pre-restoration
Early seral community DT made up 73.8% of the streambanks sampled. Late seral community DT made up 26.2% of the total streambanks sampled. Early seral DT varied from 46.9% – 100% of the streambank composition.

Post-restoration Two-years
Early seral community DT made up 8.6% of the streambanks sampled. Late seral community DT made up 91.4% of the total streambanks sampled. Early seral DT varied from 0.0% – 55.6% of the streambank composition.

For the pre-restoration and post-restoration seral community summaries by streambank please see Tables 7 and 8 (respectively).

Table 7.

Pre-restoration French Creek Seral Community Status by Streambank (2020)					
Streambank	*Early Seral DT (steps)*	*Early Seral DT (%)*	*Late Seral DT (steps)*	*Late Seral DT (%)*	*Total (steps)*
Streambank 1	25	80.6	6	19.4	31
Streambank 2	38	61.3	24	38.7	62
Streambank 3	23	88.5	3	11.5	26
Streambank 4	32	74.4	11	25.6	43
Streambank 5	15	46.9	17	53.1	32
Streambank 6	6	54.5	5	45.5	11
Streambank 7	44	80.0	11	20.0	55
Streambank 8	37	84.1	7	15.9	44
Streambank 9	14	38.9	22	61.1	36
Streambank 10	83	79.0	22	21.0	105
Streambank 11	42	97.7	1	2.3	43
Streambank 12	27	57.4	20	42.6	47
Streambank 13	9	75.0	3	25.0	12
Streambank 14	62	72.1	24	27.9	86
Streambank 15	29	100.0	0	0.0	29
Streambank 16	39	92.9	3	7.1	42
Streambank 17	31	75.6	10	24.4	41
Streambank 18	41	68.3	19	31.7	60
Streambank 19	51	69.9	22	30.1	73
Streambank 20	22	95.7	1	4.3	23
Streambank 21	81	69.8	35	30.2	116
Total Steps/Overall Percent	**751**	**73.8***	**266**	**26.2***	**1017**

* calculated by total steps in each seral stage out of the total steps

Table 8.

Post-restoration French Creek Seral Community Status by Streambank (2022)

Streambank	*Early Seral DVT (steps)*	*Early Seral DVT (%)*	*Late Seral DVT (steps)*	*Late Seral DVT (%)*	*Total (steps)*
Streambank 1	17	6.5	14	45.2	31
Streambank 2	8	3.1	51	86.4	59
Streambank 3	7	2.7	41	85.4	48
Streambank 4	13	5.0	34	72.3	47
Streambank 5	4	1.5	38	90.5	42
Streambank 6	7	2.7	18	72.0	25
Streambank 7	7	2.7	56	88.9	63
Streambank 8	16	6.1	34	68.0	50
Streambank 9	18	6.9	21	53.8	39
Streambank 10	27	10.3	64	70.3	91
Streambank 11	7	2.7	38	84.4	45
Streambank 12	24	9.2	33	57.9	57
Streambank 13	0	0.0	17	100.0	17
Streambank 14	6	2.3	64	91.4	70
Streambank 15	11	4.2	28	71.8	39
Streambank 16	2	0.8	47	95.9	49
Streambank 17	17	6.5	28	62.2	45
Streambank 18	17	6.5	52	75.4	69
Streambank 19	21	8.0	45	68.2	66
Streambank 20	12	4.6	21	63.6	33
Streambank 21	21	8.0	83	79.8	104
Total Steps/Overall Percent	**262**	**24.1***	**827**	**75.9***	**1089**

* calculated by total steps in each seral stage out of the total steps

Woody Species Establishment

Pre-restoration
A total of 20 young/saplings were observed on all 21 streambanks. No other seedling/sprout, mature, decadent, or dead age classes were observed along the Greenline transects. Geyer willow (*Salix geyeriana*) was the only woody species observed.

Post-restoration Two-years
During construction, 356 willow clumps were transplanted along all 21 streambanks, and an additional 4,720 willow stakes were planted by volunteers. Of the 356 willow clumps transplanted, 322 or 89% were successful in leafing out and surviving through the subsequent two growing seasons. Of the 4,720 willow stakes planted, 1,430 or 41% were estimated to survive the subsequent growing season. No seedlings or saplings were observed outside of the transplanted willows.

Please see Table 9 for pre-restoration woody species regeneration by streambank. Please see Table 10 for post-restoration of woody species establishment following two growing seasons.

Table 9.

Pre-restoration French Creek Woody Species Establishment Summary (2020)					
Streambank	*Seedling/Sprout*	*Young/Sapling*	*Mature*	*Decadent*	*Dead*
Streambank 1	0	0	0	0	0
Streambank 2	0	0	0	0	0
Streambank 3	0	0	0	0	0
Streambank 4	0	0	0	0	0
Streambank 5	0	0	0	0	0
Streambank 6	0	5	0	0	0
Streambank 7	0	10	0	0	0
Streambank 8	0	1	0	0	0
Streambank 9	0	2	0	0	0
Streambank 10	0	0	0	0	0
Streambank 11	0	0	0	0	0
Streambank 12	0	0	0	0	0
Streambank 13	0	0	0	0	0
Streambank 14	0	0	0	0	0
Streambank 15	0	0	0	0	0
Streambank 16	0	1	0	0	0
Streambank 17	0	0	0	0	0
Streambank 18	0	0	0	0	0
Streambank 19	0	0	0	0	0
Streambank 20	0	0	0	0	0
Streambank 21	0	1	0	0	0
Totals	**0**	**20**	**0**	**0**	**0**

* All woody species observed were Geyer's willow

Table 10.

Post-restoration French Creek Woody Species Establishment Summary (2022)

Streambank	*Live Willow Clumps*	*Dead Willow Clumps*	*Percent Live Clumps*	*Live Willow Cuttings*	*Dead Willow Cuttings*	*Percent Live Cuttings*
Streambank 1	-	-	-	60	90	40%
Streambank 2	11	5	69%	75	125	38%
Streambank 3	13	4	76%	150	150	50%
Streambank 4	-	-	-	150	150	50%
Streambank 5	10	7	59%	100	150	40%
Streambank 6	5	3	63%	60	90	40%
Streambank 7	21	6	78%	125	175	42%
Streambank 8	14	4	78%	100	250	29%
Streambank 9	9	2	82%	80	120	40%
Streambank 10	38	5	88%	125	275	31%
Streambank 11	12	0	100%	100	100	50%
Streambank 12	14	2	88%	25	25	50%
Streambank 13	3	3	50%	10	10	50%
Streambank 14	32	2	94%	100	200	33%
Streambank 15	13	1	93%	40	110	27%
Streambank 16	8	2	80%	75	125	38%
Streambank 17	15	0	100%	75	75	50%
Streambank 18	11	6	65%	75	225	25%
Streambank 19	12	1	92%	75	125	38%
Streambank 20	8	0	100%	125	125	50%
Streambank 21	46	0	100%	150	150	50%
Totals/Percent Average	**322**	**34**	**89%**	**3290**	**1430**	**41%**

Wetland Rating Summary

Pre-restoration
Facultative species DT accounted for 73.5% of the Greenline steps, followed by Facultative Wet species DT at 10.8%, Obligate species DT at 10.6%, Facultative Upland species DT at 2.8% and Upland species DT at 2.3%.

Post-restoration
Facultative Wetland species DT accounted for 48.7% of the Greenline steps, followed by Obligate species DT at 31.5%, Facultative species DT at 19.2%, and Facultative Upland species DT at 0.6%. No Upland species DT were observed.

Please see Table 11 for pre-restoration wetland status by streambank. For post-restoration wetland species status by streambank please see Table 12 below.

Table 11.

Pre-restoration French Creek Wetland Rating Summary (2020)

Streambank	*Facultative*		*Facultative Upland*		*Facultative Wetland*		*Obligate*		*Upland*		*Total Steps*
	Steps	*Percent*	*Steps*	*Percent*	*Steps*	*Percent*	*Steps*	*Percent*	*Steps*	*Percent*	
Streambank 1	31	100.0	0	0.0	0	0.0	0	0.0	0	0.0	31
Streambank 2	62	100.0	0	0.0	0	0.0	0	0.0	0	0.0	62
Streambank 3	23	88.5	0	0.0	0	0.0	3	11.5	0	0.0	26
Streambank 4	31	72.1	0	0.0	3	7.0	9	20.9	0	0.0	43
Streambank 5	17	53.1	0	0.0	15	46.9	0	0.0	0	0.0	32
Streambank 6	2	18.2	2	18.2	5	45.5	0	0.0	2	18.2	11
Streambank 7	52	94.5	1	1.8	0	0.0	0	0.0	2	3.6	55
Streambank 8	37	84.1	0	0.0	7	15.9	0	0.0	0	0.0	44
Streambank 9	17	47.2	0	0.0	0	0.0	19	52.8	0	0.0	36
Streambank 10	60	57.1	23	21.9	15	14.3	7	6.7	0	0.0	105
Streambank 11	35	81.4	0	0.0	0	0.0	1	2.3	7	16.3	43
Streambank 12	29	61.7	0	0.0	13	27.7	5	10.6	0	0.0	47
Streambank 13	9	75.0	0	0.0	3	25.0	0	0.0	0	0.0	12
Streambank 14	66	76.7	0	0.0	10	11.6	10	11.6	0	0.0	86
Streambank 15	29	100.0	0	0.0	0	0.0	0	0.0	0	0.0	29
Streambank 16	31	73.8	0	0.0	3	7.1	0	0.0	8	19.0	42
Streambank 17	31	75.6	0	0.0	5	12.2	5	12.2	0	0.0	41
Streambank 18	45	75.0	0	0.0	10	16.7	5	8.3	0	0.0	60
Streambank 19	43	58.9	2	2.7	12	16.4	12	16.4	4	5.5	73
Streambank 20	22	95.7	0	0.0	1	4.3	0	0.0	0	0.0	23
Streambank 21	76	65.5	0	0.0	8	6.9	32	27.6	0	0.0	116
Total Steps/ Overall Percent	**748**	**73.5***	**28**	**2.8***	**110**	**10.8***	**108**	**10.6***	**23**	**2.3***	**1017**

* percent is calculated from total steps

Table 12.

Post-restoration French Creek Wetland Rating Summary (2022)

Streambank	*Facultative*		*Facultative Upland*		*Facultative Wetland*		*Obligate*		*Total Steps*
	Steps	*Percent*	*Steps*	*Percent*	*Steps*	*Percent*	*Steps*	*Percent*	
Streambank 1	10	32.3	4	12.9	13	41.9	4	12.9	31
Streambank 2	6	10.2	2	3.4	26	44.1	25	42.4	59
Streambank 3	7	14.6		0.0	21	43.8	20	41.7	48
Streambank 4	12	25.5		0.0	11	23.4	24	51.1	47
Streambank 5	3	7.1	1	2.4	10	23.8	28	66.7	42
Streambank 6	7	28.0		0.0	10	40.0	8	32.0	25
Streambank 7	7	11.1		0.0	39	61.9	17	27.0	63
Streambank 8	15	30.0		0.0	33	66.0	2	4.0	50
Streambank 8.5	17	43.6		0.0	17	43.6	5	12.8	39
Streambank 10	22	24.2		0.0	49	53.8	20	22.0	91
Streambank 11	6	13.3		0.0	32	71.1	7	15.6	45
Streambank 12	23	40.4		0.0	26	45.6	8	14.0	57
Streambank 13		0.0		0.0	11	64.7	6	35.3	17
Streambank 14	5	7.1		0.0	50	71.4	15	21.4	70
Streambank 15	10	25.6		0.0	20	51.3	9	23.1	39
Streambank 16	2	4.1		0.0	12	24.5	35	71.4	49
Streambank 17	16	35.6		0.0	16	35.6	13	28.9	45
Streambank 18	13	18.8		0.0	19	27.5	37	53.6	69
Streambank 19	3	4.5		0.0	36	54.5	27	40.9	66
Streambank 20	12	36.4		0.0	18	54.5	3	9.1	33
Streambank 21	13	12.5		0.0	61	58.7	30	28.8	104
Total Steps/ Overall Percent	**209**	**19.2***	**7**	**0.6***	**530**	**48.7***	**343**	**31.5***	**1089**

* percent is calculated from total steps

Discussion

The historical vegetation community of the French Creek restoration project area is best represented by *Salix geyeriana/Carex rostrata* habitat type (HT) as described by Hansen et al. (1995). Currently, the eastern portion of French Creek qualifies as the *Salix geyeriana/Carex rostrata* HT, due to the high abundance of water sedge (*Carex aquatilis*), wooly sedge (*Carex pellita*) and Geyer's willow. However, the pre-restoration conditions on the west portion of French Creek represented the *Salix geyeriana* Community Type (CT; Hansen et al. 1995). The shift in species composition of obligate wetland species (OBL) such as water sedge to facultative (FAC), introduced species such as Kentucky Bluegrass (*Poa pratensis*) and Timothy (*Phleum pretense*) is a strong indication of past disturbances and hydrologic disconnection. Kentucky bluegrass and Timothy are persistent non-native species that limit replacement of preferred native species for the foreseeable future in many regions of Montana (Tyser, 1992; Hansen et al., 1995). In riparian areas, Kentucky bluegrass is considered an invasive species, which facilitates continued destabilization when native species are displaced from disturbance such as overgrazing (Hansen et al. 1995).

Pre-restoration conditions observed the Kentucky bluegrass and Timothy DT accounted for a total of 63.9% of the observations (DTs combined respectively), whereas water sedge, beak sedge (*Carex utriculata*), and Geyer's willow/beak sedge DT accounted for only 10.9% (DTs combined respectively). The abundance of introduced species throughout the streambanks during pre-restoration conditions supports the "poor" streambank rating, dominance of low seral vegetation communities, and dominance of FAC vegetation. These introduced species provide poor rooting for streambank stabilization and early seral habitat conditions (Hansen et al., 1994; Wasser, 1982; Winward, 2000). In addition, these introduced species are classified as FAC as they may occur as either a hydrophyte or non-hydrophyte vegetation (Lichvar et al., 2012), suggesting there is hydrologic disconnection due to the lack of facultative wet (FACW; e.g., Geyer's willow) or OBL wetland species (e.g., water sedge).

Two years post-restoration conditions observed the Kentucky Bluegrass and Timothy DTs accounted for only 7.2% (combined) of the total DT observations, whereas wooly sedge, water sedge, beak sedge, and Geyer's willow/beak sedge DTs accounted for 68.3% (combined) of the total DT observations. This increase in native, riparian vegetation two-years post restoration is attributed to successful transplanting of native sod mats, willow clumps, and staking willow cuttings on the restored streambanks. The riparian vegetation established along the restored streambanks presently supports a "high" streambank stability rating, an increase in late seral community types, and dominance of FACW and OBL vegetation DTs. Although two-year establishment is high for native, riparian vegetation establishment, in general, 3 – 5 years post-restoration is needed to evaluate true efficacy of the restoration treatment. Though introduced species represent a minor proportion of the observations, it is possible these introduced species may increase and revert portions of the restored streambanks to early seral community types and destabilize those streambanks in the future. Thus far, streambank sloping appears

successful in reconnecting with the hydrologic table to support transplanted obligate and facultative wet riparian vegetation.

Pre-restoration willow and woody species recruitment was very low throughout the project area. Anecdotal evidence suggests that clearing and converting of woody riparian habitats to pastures and grasslands are limiting the ability of many woody riparian habitats to recolonize (Poff, et al., 2012). The low observation of willows along the western portion of French Creek may be explained the clearing of willow species for the cultivation non-native grasses that were preventing successful recruitment. Generally, *Salicaceae* (willow family) require fresh mineral deposits (sand, gravels, etc.) and an elevated water table for seedling establishment (Scott, 1996; Woods and Cooper, 2005). Observers noted that recruitment of willows was high on the inside streambanks and protected point bars with fresh mineral deposits; however, the high angle sloughing (~ 75 – 90°) on the 21 streambanks restored where non-native graminoids communities dominated, likely did not provide adequate stable conditions nor fresh lateral sediment deposits for willow recruitment.

Two-year post-restoration willow clump establishment appears successful along the restored streambanks. Willow clump survival rate remained the same from 2021 (89% survival); however, several willow clumps observed as dead in 2021 displayed active growth in 2022 and vice-versa for several willows, which were alive in 2021 and are now dead (no live leaders observed in 2022). A small decline in willow clump survival is likely for willow clumps located higher in elevation on the restored streambanks. This future loss is attributed poor rooting ability into the water table. Approximately 5 – 10% of the transplanted willow clumps are exhibiting the "leaping" stage of willow clump establishment. The "leaping" stage is defined when a transplanted willow has many new leaders that are establishing and growing quickly. Still, most transplanted willow clumps are in the "creeping" stage of willow clump establishment. The "creeping" stage is defined when transplanted willows prioritize root growth over above ground growth (only a few new leaders observed). The "leaping" stage in transplanted willows is expected to increase significantly once adequate rooting is achieved. Overall, future willow clump establishment and growth looks promising in 2023.

Two-year post-restoration willow stake survival remains relatively high with 41% of the cuttings leafing out after two growing seasons. Willow stake survival is expected to decline further due to winter mortality, inter/intraspecies competition, and poor rooting success. However, many of the successful willow stakes surviving in 2023 will likely being increasing above ground growth and continued perseverance into the future. Overall, willow cutting establishment has been successful two-years post restoration.

These restoration sites will continue to be monitored for the next three years (ending in 2025). Photo monitoring will be completed to evaluate riparian expansion beyond the streambanks and this baseline data will be compared with future monitoring of riparian recruitment and establishment to assess project effectiveness.

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APPENDIX 1

Streambank 1 – pre-restoration and post-restoration (two years)

This streambank did not receive willow clump transplants but was staked with cuttings (lower priority streambank).

This streambank did not receive willow clump transplants but was staked with cuttings (lower priority streambank).

Streambank 2 – pre-restoration and post-restoration (two years)


French Creek
Bank #2
West


French
Creek
Streambank 2

Streambank 3 – pre-restoration and post-restoration (two years)


French Creek
Bank #3
West


French
Creek
Streambank 3

Streambank 4 – pre-restoration and post-restoration (two years)

Note: This streambank did not receive willow clump transplants but was staked with cuttings (lower priority streambank).

Note: this streambank did not receive willow clump transplants but was staked with cuttings (lower priority streambank).

Streambank 5 – pre-restoration and post-restoration (two years)


French Creek
Bank #5
North East


French
Creek
Streambank 5

Streambank 6 – pre-restoration and post-restoration (two years)


French Creek
Bank #6
North


French
Creek
Streambank 6

Streambank 7 – pre-restoration and post-restoration (two years)


French Creek
Bank 7
North


French
Creek
Streambank 7

Streambank 8 – pre-restoration and post-restoration (two years)


French Creek
Bank #8
North


French
Creek
Streambank 8

Streambank 8.5 – (two years; no pre-restoration photos as it added later to project after streambank 9 was not restored due to beaver dam)

Streambank 9 – pre-restoration and after with beaver dam (no restoration completed due to dam, but will be monitored into the future)

Note: Streambank 9 beaver dam in June of 2020.

Note: Streambank 9 beaver dam in August of 2022. Fresh willow cuttings present, which suggests dam is still active.

Streambank 10 – pre-restoration and post-restoration (two years)


French Creek
8/12/20
Bank # 10
Northwest


French
Creek
Streambank 10

Streambank 11 – pre-restoration and post-restoration (two years)


French Creek
8/2/20
Bank # 11
North


French
Creek
Streambank 11

Streambank 12 – pre-restoration and post-restoration (two years)


French Creek
8/12/20
Bank # 12
West


French
Creek
Streambank 12

Streambank 13 – pre-restoration and post-restoration (two years)


French Creek
8/12/20
Bank #13
North


French
Creek
Streambank 13

Streambank 14 – pre-restoration and post-restoration (two years)


French Cr
8/12/20
Bank 14
Northwest


French
Creek
Streambank 14

Streambank 15 – pre-restoration and post-restoration (two years)


French
Creek
Streambank 15

Streambank 16 – pre-restoration and post-restoration (two years)

Note: Downstream Photos were lost in 2022. This Photo is from 2021 (one-year post restoration).


French Creek
6/2/16
Bank #16
East


French
Creek
Streambank 16

Streambank 17 – pre-restoration and post-restoration (two years)


French
Creek
Streambank

Streambank 18 – pre-restoration and post-restoration (two years)


French Creek
8/12/20
Bank 18
Southwest


French
Creek
Streambank 18

Streambank 19 – pre-restoration and post-restoration (two years)


French
Creek
Streambank 19

Streambank 20 – pre-restoration and post-restoration (two years)


French Creek
8/12/19
Bank 20
Northeast


French
Creek
Streambank 20

Streambank 21 – pre-restoration and post-restoration (one year)


French Creek
8/2/22
Bank 21
South


French
Creek
Streambank 21