BIGHORN RIVER SIDE CHANNEL RESTORATION PROJECT

ANNUAL MONITORING REPORT - 2023

February 2024

Prepared for:

Prepared by:

TABLE OF CONTENTS

APPENDICES

1.0 INTRODUCTION

In 2020, the Bighorn River Alliance initiated an ambitious plan to improve the long-term health and productivity of the Bighorn River by improving connectivity between the mainstem river and several side channels. The need for side channel restoration stemmed from the progressive loss of connectivity between the main channel and historically active side channels in recent decades; generally due to gravel deposits and vegetation establishment at the side channel entrances (AGI 2020). The Alliance's approach began with an evaluation of 29 side channels along 83.5 miles of the river, with prioritization of 13 side channels exhibiting the greatest opportunity to achieve substantial reconnection with minimal to moderate effort. The "Rattlesnake" and "Juniper" side channels were selected to serve as pilot projects to assess the feasibility, costs, and effectiveness of improving connectivity. In August 2021, the Alliance completed construction on these two channels, which included excavating gravel and cobble deposits and reconfiguring the departure angle to improve sediment transport through their entrances.

The short-term success of these restoration efforts has generated interest by the Alliance in reconnecting additional, high-priority side channels identified during the prioritization planning process. While those efforts are currently underway, it is important to evaluate the longer-term effectiveness of the side channel's ability to remain connected and provide high quality aquatic habitat. Doing so will allow the Alliance to assess whether its resources and funding are being effectively utilized to improve the river's health and productivity; and provide a basis on which to adaptively implement future side channel restoration efforts. The following report provides an initial perspective on the effectiveness of restoration efforts at the Rattlesnake and Juniper side channels two years following their completion.

2.0 SIDE CHANNEL LOCATIONS

The entrance to the Rattlesnake side channel lies 0.75 miles downriver from the 3-Mile Fishing Access site on the Bighorn River. The side channel extends approximately 1,100 feet before its confluence with another short side channel before returning to the Bighorn River mainstem. The entrance to the Juniper side channel lies 3.5 miles downriver from the 3-Mile Fishing Access site and extends 1,500 feet before returning to the mainstem river (Figure 1).

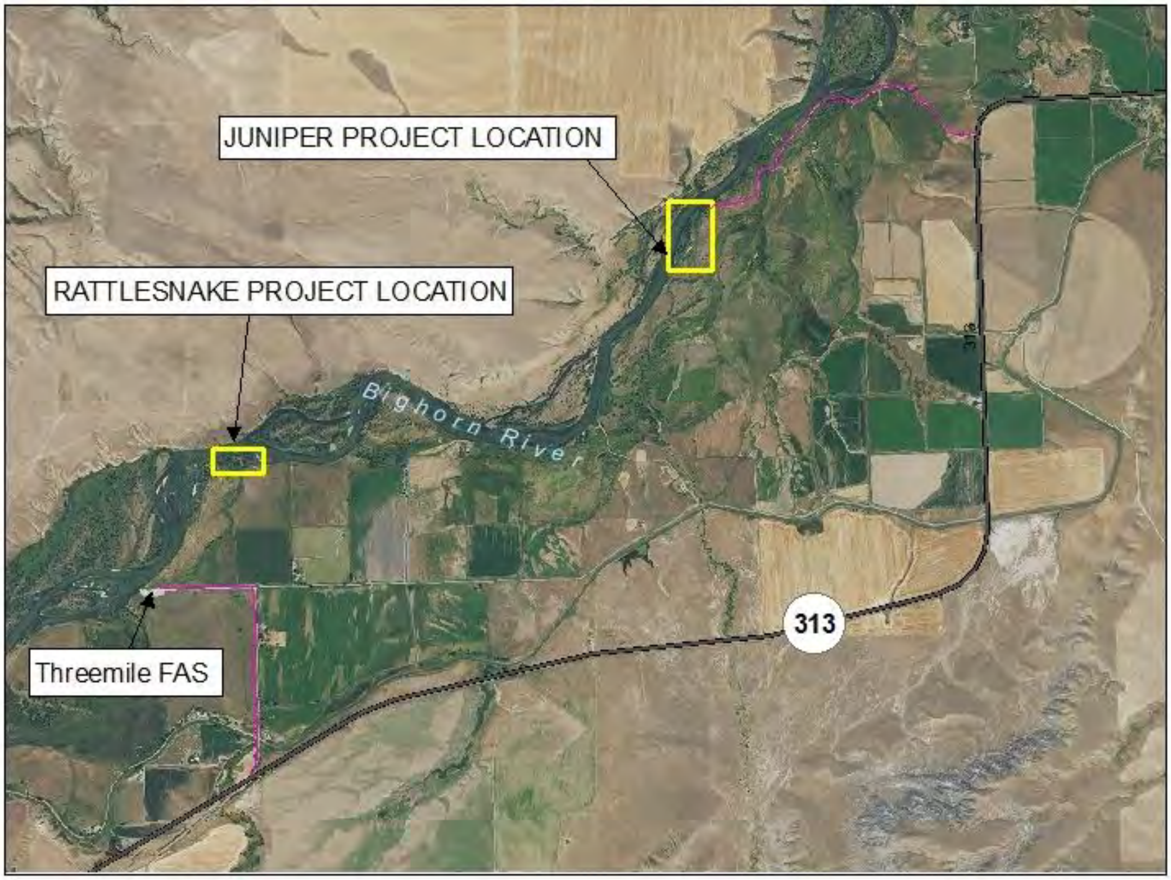


Figure 1. Location of Rattlesnake and Juniper Side Channel Restoration Projects.

3.0 2023 FLOOD

Above average precipitation in southern Montana and northern Wyoming in June of 2023 prompted the Bureau of Reclamation to release excess water through Yellowtail Dam. Discharge records provided by the USGS indicate a peak flow of 16,200 cfs was released on June 25th, as compared to an average annual peak flow of around 7,200 cfs over the period of record (Figure 2). The release of well above-average flows resulted in widespread flooding, erosion, sediment deposition, and both habitat creation and destruction along the lower Bighorn River. The prolonged flood in 2023 provided an excellent opportunity to assess whether the approach of improving connectivity to side channels by excavating deposits and reconfiguring entrance angles is sustainable following very high flow events.

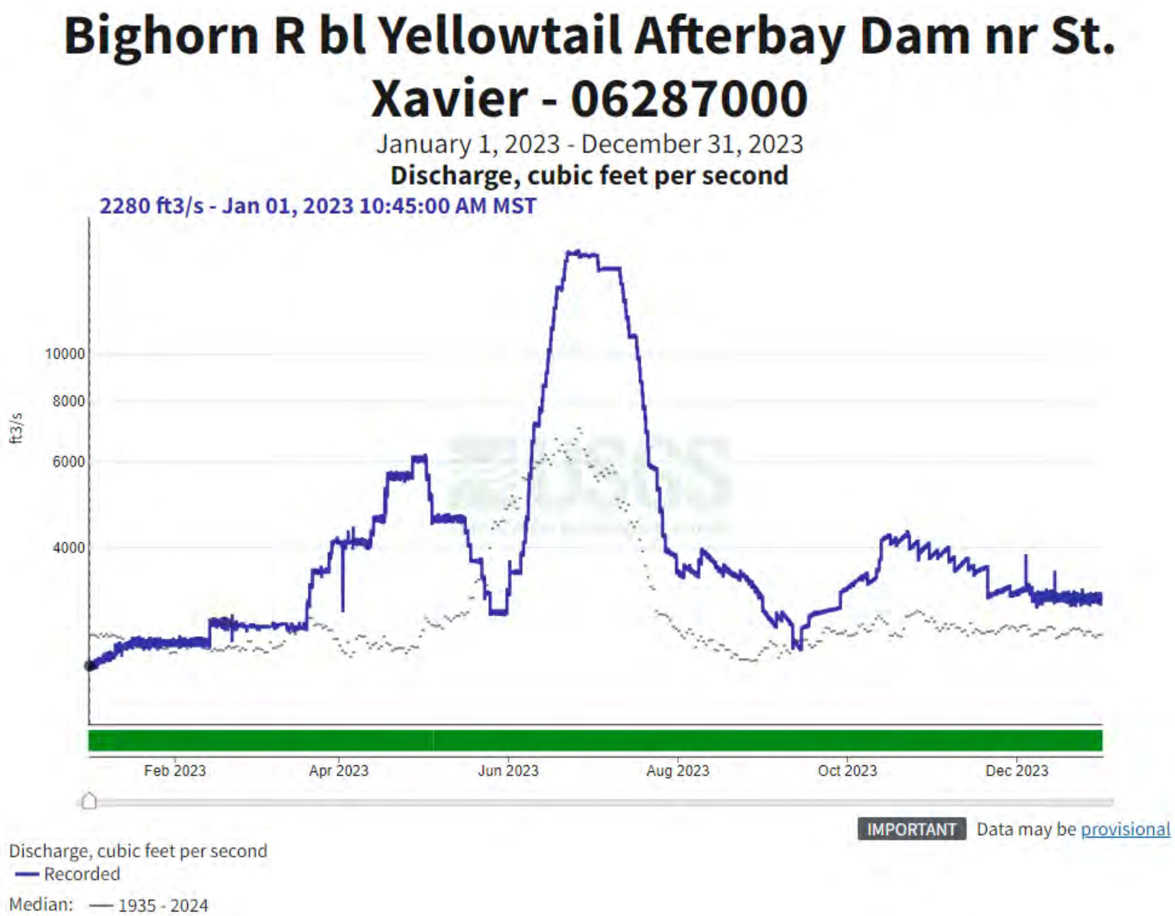


Figure 2. 2023 hydrograph and mean daily flows between 1935 and 2024 for Bighorn River below Afterbay Dam.

4.0 MONITORING METHODS

The following monitoring methods were employed to assess the effectiveness of restoration efforts at Rattlesnake and Juniper side channels:

4.1. Geomorphic Evaluation

The geomorphic evaluation at each side channel entailed:

a. A longitudinal profile survey of the thalweg along the length of the side channel.
b. Survey of one channel-spanning cross section near the side channel entrance.
c. Topographic survey of the side channel entrances (upper 200-250')

Geomorphic survey data were collected in April 2023 (pre-flood) and again in September 2023 (post-flood). All survey data were collected using an RTK survey-grade instrument with base station and rover units. Survey data from multiple years were correlated by tying into control points established during previous surveying events.

4.2. Discharge Monitoring

Staff gages were installed in both side channels in April 2023 (left photo below). Side channel discharges were monitored using a Marsh-McBirney flow meter and top-setting rod (right photo below). Discharges were measured six times in 2023 over a range of flows to create an initial stage-discharge relationship and rating curve for each side channel.

4.3. Fish Sampling

The use of side channel habitats by fish was initially assessed using backpack electroshocking units (left photo below), with the intent of sampling presence/absence and abundance of fish. The first fish sampling event occurred in April, which indicated the use of backpack electroshocking equipment was not effective in sampling due to the size of the side channels and high water velocities in some areas. Subsequent fish sampling events involved 2- and 3-person snorkeling crews cataloging species and lengths of individual fish observed (right photo below).

4.4. Macroinvertebrate Sampling

Three replicate Hess (33 cm diameter, 500-micron mesh) samples were collected within a designated riffle in each side channel to quantitatively sample macroinvertebrates (left photo below). Each Hess sample constituted a benthic area of 0.1 m^2, so a multiplier of 10 was applied to the numbers of total invertebrates in each sample to achieve a per meter squared estimate. At each sampling point, the Hess sampler was pushed into the stream bottom to form an effective seal and all cobbles (>64 mm) within the sampler were scrubbed clean of organisms and removed; then the entire area within the sampler frame was raked for one minute until all organic matter and macroinvertebrates were washed into the collection net of the Hess sampler (right photo below). Samples were collected in mid-April and mid-September.

4.5. Orthophotography

Drone-based ortho-photography was taken to measure the wetted area of each side channel at a specific flow. Aerial photography was imported into an online GIS platform and the wetted area between the entrance of the side channel and its confluence with either the mainstem river or another receiving side channel was digitized.

5.0 MONITORING RESULTS

5.1. Rattlesnake Side Channel

5.1.1. Geomorphology and Entrance Characteristics

Results of the Rattlesnake side channel longitudinal profile and cross section survey are illustrated on Sheet 1 in Appendix A. Sheet 2 provides an illustration of elevation changes between the spring and fall 2023 surveys along the upper 200 feet of the channel. These results indicate the following:

- The elevation of the channel bed at the monitoring cross section rose by ~0.5 to 0.7 feet, indicating gravel deposited in this particular location during the 2023 flood.
- The longitudinal profile indicates gravel has deposited and the thalweg (deepest part) of the channel has become shallower between Stations 0+00 and 0+40 and between Stations 0+60 and 1+20.
- Gravel has not deposited between Station 0+40 and 0+60, which was the original crest of the restored side channel entrance.
- The gravel deposit between Stations 0+60 and 1+00 has adjusted the elevation at the entrance of the channel to approximately 0.1' higher than the design grade. Although this deposit has slightly elevated the entrance elevation, the side channel will remain connected to the mainstem river at lower flows than prior to the reconnection project.
- The longitudinal profile indicates the controlling elevations of the bed slope closely match the proposed grade along the length of Rattlesnake side channel.
- A comparison of pre- and post- 2023 flood elevations at the entrance indicates up to 0.7 feet of gravel has deposited on the inside of the entrance bend and has scoured up to 0.5 feet on the outside of the bend. This pattern of scour and deposition is typical for a meander bend.

5.1.2. Discharge Monitoring

The results of discharge monitoring for the Rattlesnake side channel are provided in Table 1. Measured discharges ranged from a low of 60.5 cfs on July 28th to a high of 152.9 cfs on August 20th. Side channel discharges were measured while flow releases from Yellowtail Dam ranged from 3040-4560 cfs.

Table 1. Discharge monitoring results for Rattlesnake side channel.

Side Channel Summary Data 2023							
Channel	Date	Width (ft)	Xsection Area (sq. ft)	Discharge (cfs)	Gage Reading	River Discharge (cfs)	% Capture by Side Channel
Rattlesnake	4/7/23	22.04	31.38	98.68	1.05	4110	2.4%
Rattlesnake	4/16/23	23.30	36.52	115.13	1.30	4560	2.5%
Rattlesnake	7/28/23	19.95	19.69	60.50	1.00	4200	1.4%
Rattlesnake	8/20/23	22.42	28.20	152.90	1.40	4090	3.7%
Rattlesnake	9/29/23	20.85	28.52	145.96	1.26	3080	4.7%
Rattlesnake	11/4/23	22.80	28.30	148.77	1.28	3040	4.9%

An initial attempt at establishing a stage/discharge relationship using all six discharge measurements produced unreliable results. A relatively tight rating curve for Rattlesnake side channel was generated using the stages and discharges recorded from July through November, and is included in Appendix B. Multiple factors may be contributing to the inability to establish a tight relationship between stage and side channel discharges recorded in 2023, including:

- Extremely high dam releases exceeding 15,000 cfs from late June through early July may have resulted in adjustments to the channel cross section dimensions at the discharge monitoring site, rendering a comparison of stages and discharges measured before the flood incomparable to those measured after the flood.
- A natural shift in stage resulting from the abundance of macrophyte growth in the river is likely occurring during the latter half of the year without a corresponding change in mainstem river discharge.

Interestingly, the three highest discharges recorded in Rattlesnake side channel did not correspond with the highest discharge in the river. Higher discharges recorded in August, September, and November in the Rattlesnake channel occurred during mainstem river discharges that were lower than during the April and July monitoring dates. This indicates the natural shift in mainstem river stage during the latter half of the year due to macrophyte growth affects the discharges observed in the side channel. The percent capture of mainstem flows into the side channel were also higher during the latter half of the year, when macrophyte growth is more prolific.

The stage and discharge data collected to date at the Rattlesnake side channel offers a preliminary understanding of the seasonal relationship between these parameters; however additional discharge monitoring over a wider range of stages is necessary to generate a tighter rating curve that can be relied on to predict discharge from stage readings alone.

5.1.3. Fish Sampling

Table 2 provides the results of the 2023 fish sampling efforts in the Rattlesnake side channel. Six species were observed, including rainbow and brown trout, mountain whitefish, carp, white sucker, and lake chub. Fry were observed but not identified to species. These results indicate use of Rattlesnake side channel by a variety of species. The presence of fry indicates the side channel offers juvenile rearing habitat. Fry were observed during all three snorkeling events and showed particularly high abundance in late July when that age class constituted nearly 74% of all fish observed. Trout were observed in lengths ranging from 3” to 20”, indicating a variety of age classes are utilizing the side channel habitat.

Table 2. Results of fish sampling in Rattlesnake Side Channel, 2023.

Date	Species	Number	Relative Abundance	Effort (min)	Effort (hr)	CPUE (fish/hr)
16-Apr-23	Brown Trout	1	100	89	1.48	0.67
	Total	**1**	**100**			
27-Jun-23	Fry	20	86.96	315	5.25	3.81
	Carp	1	4.35	315	5.25	0.19
	Rainbow	1	4.35	315	5.25	0.19
	White Sucker	1	4.35	315	5.25	0.19
	Total	**23**	**100**			
28-Jul-23	Fry	108	73.97	150	2.50	43.20
	Carp	8	5.48	150	2.50	3.20
	Rainbow	4	2.74	150	2.50	1.60
	White Sucker	1	0.68	150	2.50	0.40
	Brown Trout	23	15.75	150	2.50	9.20
	Mountain Whitefish	2	1.37	150	2.50	0.80
	Total	**146**	**100**			
29-Sep-23	Fry	8	7.21	156	2.60	3.08
	Carp	1	0.90	156	2.60	0.38
	Rainbow	1	0.90	156	2.60	0.38
	Sucker	33	29.73	156	2.60	12.69
	Brown Trout	3	2.70	156	2.60	1.15
	Lake Chub	65	58.56	156	2.60	25.00
	Total	**111**	**100**			

5.1.4. Orthophotography

Results of the drone-based orthophotography are provided in Appendix C and indicate a wetted area for the Rattlesnake side channel of 26,340 square feet (0.60 acres) on April 7th, 2023, during a mainstem river discharge of 4,070 cfs. This area increased to 33,489 square feet (0.77 acres) on June 17th, 2023, during a mainstem river discharge of 11,000 cfs. A third orthophoto taken on February 23, 2024 offers a view of gravel deposits near the entrance of the side channel following the 2023 flood.

5.2. Juniper Side Channel

5.2.1. Geomorphology and Entrance Characteristics

Results of the Juniper side channel longitudinal profile and cross section survey are illustrated on Sheet 3 in Appendix A. Sheet 4 provides an illustration of elevation changes between the spring and fall 2023 surveys along the upper 250 feet of the channel. These results indicate the following:

- The elevation of the channel bed through the monitoring cross section remained consistent following the 2023 flood.
- The longitudinal profile shows little change in elevation at the entrance, indicating efficient sediment transport through the upstream end of the channel.
- The channel has not aggraded above the design grade, indicating it should remain connected with the mainstem river during target flows.
- Deeper pool habitat has developed on the outside bend of the side channel entrance between Stations 1+50 and 2+50.
- The thalweg may have shifted eastward between Station 7+50 and 9+00; however, the longitudinal profile indicates the crest elevation of the controlling riffle has remained consistent in this area.
- A comparison of pre-and post- 2023 flood elevations at the entrance of the channel indicates up to 1 foot of material deposited on the inside of the entrance bend and up to 2.5 feet of material scoured from the outside of the bend. In general, less than 0.3 feet of scour and deposition occurred throughout the entrance of the channel.

5.2.1. Discharge Monitoring

The results of discharge monitoring for the Juniper side channel are provided in Table 3. Measured discharges ranged from a low of 164.1 cfs on September 29th to a high of 303.4 cfs on November 4th. Side channel discharges were measured while flow releases from Yellowtail Dam ranged from 3040-4560 cfs.

Table 3. Discharge monitoring results for Juniper side channel.

Side Channel Summary Data 2023							
Channel	**Date**	**Width (ft)**	**Xsection Area (sq. ft)**	**Discharge (cfs)**	**Gage Reading**	**River Discharge (cfs)**	**% Capture by Side Channel**
Juniper	4/7/23	61.94	84.92	187.43	1.4	4110	4.6%
Juniper	4/16/23	60.80	92.64	203.10	1.5	4560	4.5%
Juniper	7/28/23	60.80	77.77	248.24	1.3	4200	5.9%
Juniper	8/20/23	60.37	71.63	216.47	1.18	4090	5.3%
Juniper	9/29/23	60.23	66.89	164.10	1.06	3080	5.3%
Juniper	11/4/23	60.30	84.86	303.36	1.8	3040	10.0%

Similarly to Rattlesnake side channel, an initial attempt at establishing a stage/discharge relationship for Juniper using all six discharge measurements produced unreliable results. The same factors may be contributing to the inability to establish a tight relationship between stage and side channel discharge, including the extremely high discharges in June and July 2023 and the abundance of macrophyte growth in the channel during the latter half of the year. A tighter rating curve was developed using the last four discharge measurements after the flood, which is included in Appendix B.

Also similar to Rattlesnake, the highest discharges measured in Juniper did not occur during the highest dam releases. A dam release of 4560 on April 16th correlated with a Juniper side channel discharge of 203.1 cfs, which was 4.5% of the total discharge. In November, the dam release was 3,040 cfs, which correlated with a side channel discharge of 303.3 cfs. This inverse relationship may also be the result of increased stage during the latter half of the year from macrophyte growth, which may cause the side channel to capture additional water, as well as a higher percentage of the water in the river during the latter part of the year.

5.2.2. Fish Sampling

Table 4 provides the 2023 fish sampling results from Juniper side channel. Seven species were observed, including rainbow trout, brown trout, mountain whitefish, white sucker, carp, lake chub, and longnose dace. Fry were observed but not identified to species.

Table 4. Results of fish sampling in Juniper Side Channel, 2023.

Date	Species	Number	Relative Abundance	Effort (min)	Effort (hr)	CPUE (fish/hr)
16-Apr-23	Carp	3	75	85	1.42	2.12
	Brown Trout	1	25	85	1.42	0.71
	Total	**4**	**100**			
27-Jun-23	Rainbow Trout	2	66.7	240	4.00	0.50
	White Sucker	1	33.3	240	4.00	0.25
	Total	**3**	**100**			
28-Jul-23	Fry	124	43.97	225	3.75	33.07
	Brown Trout	119	42.20	225	3.75	31.73
	Rainbow	7	2.48	225	3.75	1.87
	White Sucker	7	2.48	225	3.75	1.87
	Longnose Dace	4	1.42	225	3.75	1.07
	Mountain Whitefish	7	2.48	225	3.75	1.87
	Carp	10	3.55	225	3.75	2.67
	Lake Chub	4	1.42	225	3.75	1.07
	Total	**282**	**100**			
29-Sep-23	Fry	138	39.77	180	3.00	46.00
	Longnose Dace	2	0.58	180	3.00	0.67
	Sucker	122	35.16	180	3.00	40.67
	Lake Chub	73	21.04	180	3.00	24.33
	Rainbow Trout	4	1.15	180	3.00	1.33
	Brown Trout	1	0.29	180	3.00	0.33
	Carp	3	0.86	180	3.00	1.00
	Mountain Whitefish	4	1.15	180	3.00	1.33
	Total	**347**	**100**			

These results indicate use of Juniper side channel by a variety of species. The abundance of fry during the 3rd and 4th monitoring events indicates the side channel provides juvenile rearing habitat. Multiple age classes of trout were observed, including young of the year (3”), young adult (5-8”) and mature (15-20”). The variety of species and age classes observed in the side channel indicates a diversity of habitat types are present.

5.2.3. Orthophotography

Results of the drone-based orthophotography are provided in Appendix C and indicate a wetted area for the Juniper side channel of 88,860 square feet (2.04 acres) on April 7th 2023, during a mainstem river discharge of 4,070 cfs and a wetted area of 93,240 square feet (2.14 acres) at a mainstem discharge of 4,500 cfs on April 16th, 2023.

5.3. Macroinvertebrates

A report summarizing results of the macroinvertebrate sampling for both the mainstem Bighorn River and both Rattlesnake and Juniper side channels offers the following conclusions based on the sampling results (Stagliano, 2024):

- Spring and Fall 2023 Benthic Macroinvertebrate (BMI) data across the 10 mainstem Bighorn River sites revealed the record high flushing flows of July-August significantly reduced the densities of macroinvertebrates, especially Chironomidae (Midges) and Aquatic worms, while increasing the richness and percent of EPT taxa (mayfly and caddisflies) across most sites.
- Initial BMI colonizers of Rattlesnake and Juniper side channels were large numbers of Chironomidae (Midges) in Spring 2022, while in the Fall, blackfly larvae (*Simulium spp*.) were the dominant Diptera in the benthic samples. Spring 2023 looked very similar to 2022 with a dominance of midges, but by Fall 2023, a more diverse BMI community has evolved.
- Even though the restored side channels averaged only about 50% species similarity with the mainstem Bighorn River BMI community, 2 years of monitoring is sufficient enough to document the successful BMI colonization and productivity of these habitats.
- BMI densities in the side channels decreased to ~14,000 individuals per m^2 during both sampling events in 2023 and were very comparable to the adjacent Bighorn River mainstem densities (~15,000 per m^2); although, side channel BMI densities were reduced significantly after the 2023 flood, whereas the adjacent mainstem BMI densities increased in the Fall. This indicates that BMI communities in the side channels are likely more affected by scouring flows and higher velocities.

6.0 LITERATURE CITED

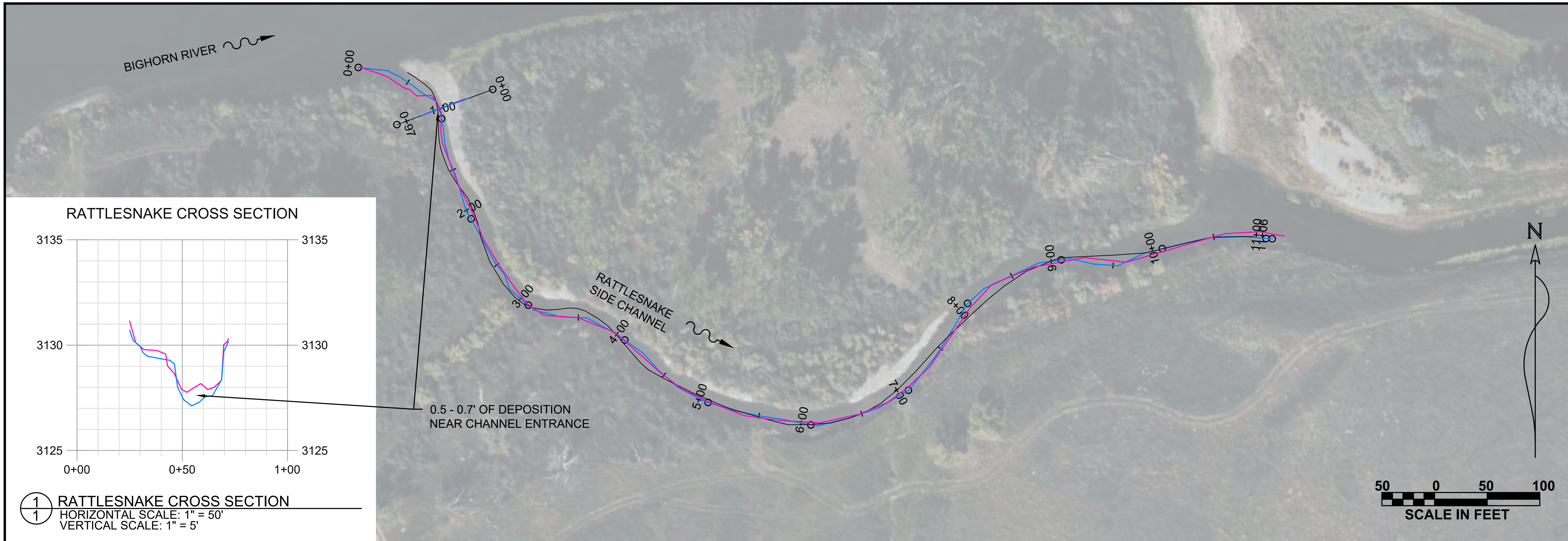
Boyd, K. 2021. Bighorn River Side Channel Restoration Potential. Report prepared for the Bighorn River Alliance.

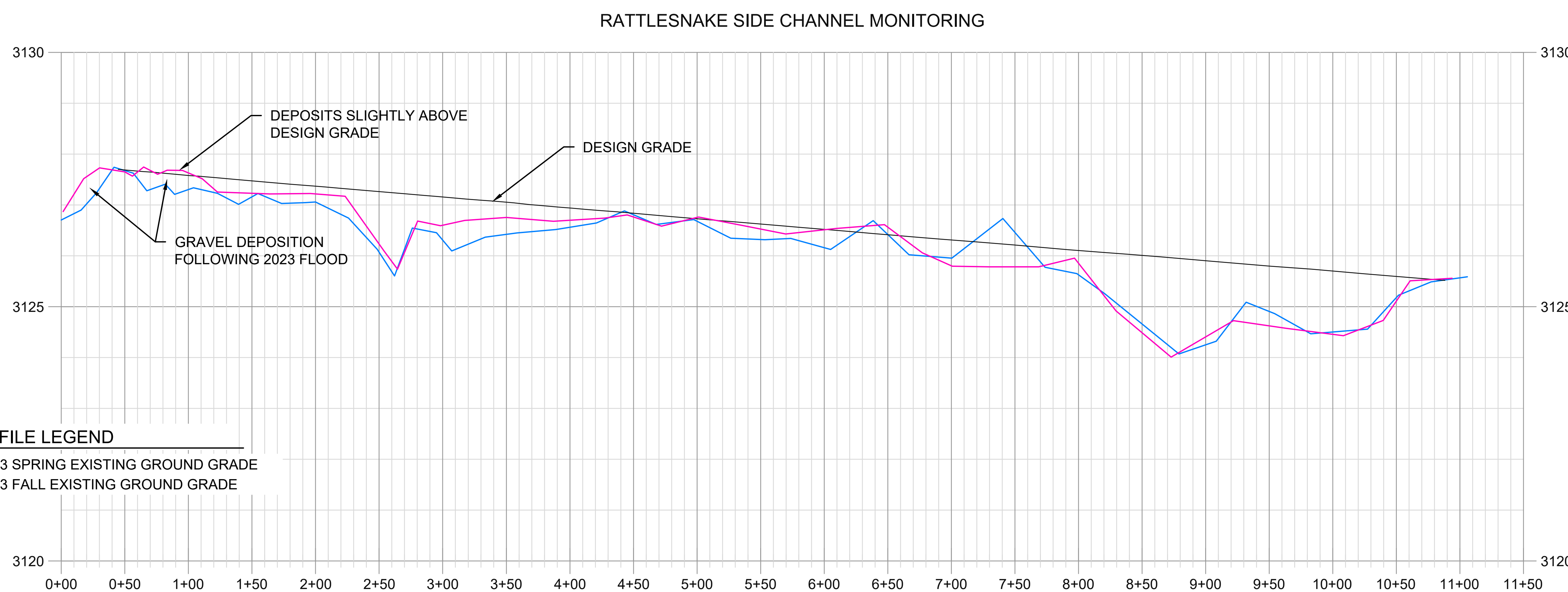
Stagliano, D. 2024. Bighorn River Aquatic Macroinvertebrate Monitoring Summary for 2023: High Flows and Side Channels. Report prepared for the Bighorn River Alliance.

Appendix A

Geomorphic Survey Results

Bighorn River Side Channel Restoration Project
Annual Monitoring Report - 2023





PLAN AND PROFILE LEGEND

2023 SPRING EXISTING GROUND GRADE

2023 FALL EXISTING GROUND GRADE

2 / 1 RATTLESNAKE SIDE CHANNEL PROFILE

HORIZONTAL SCALE: 1" = 100'

VERTICAL SCALE: 1" = 2.5'

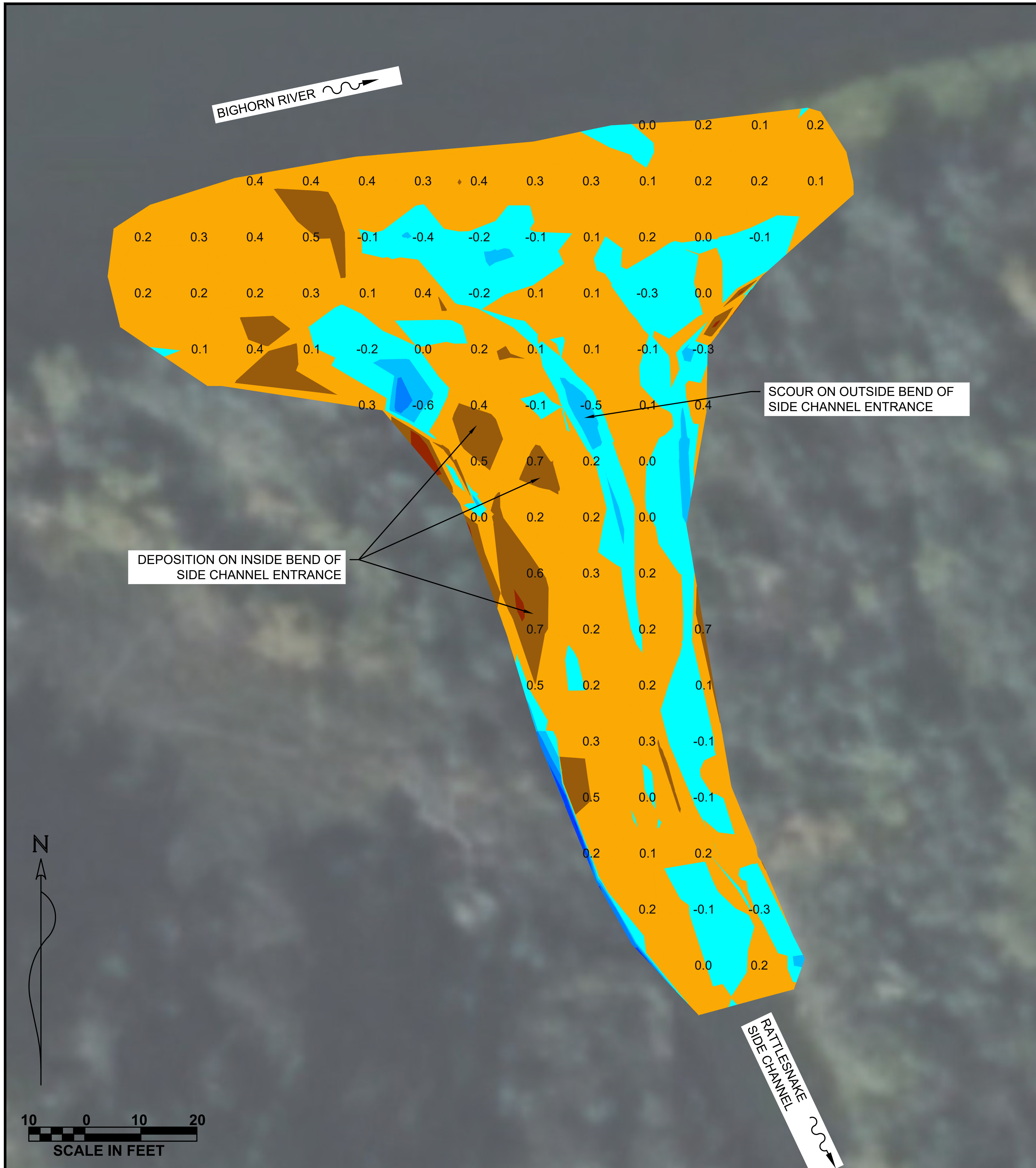
CONFLUENCE CONSULTING

BIGHORN SIDE CHANNEL REACTIVATION MONITORING

FORT SMITH, MT

RATTLESNAKE SIDE CHANNEL MONITORING

SHEET: 1

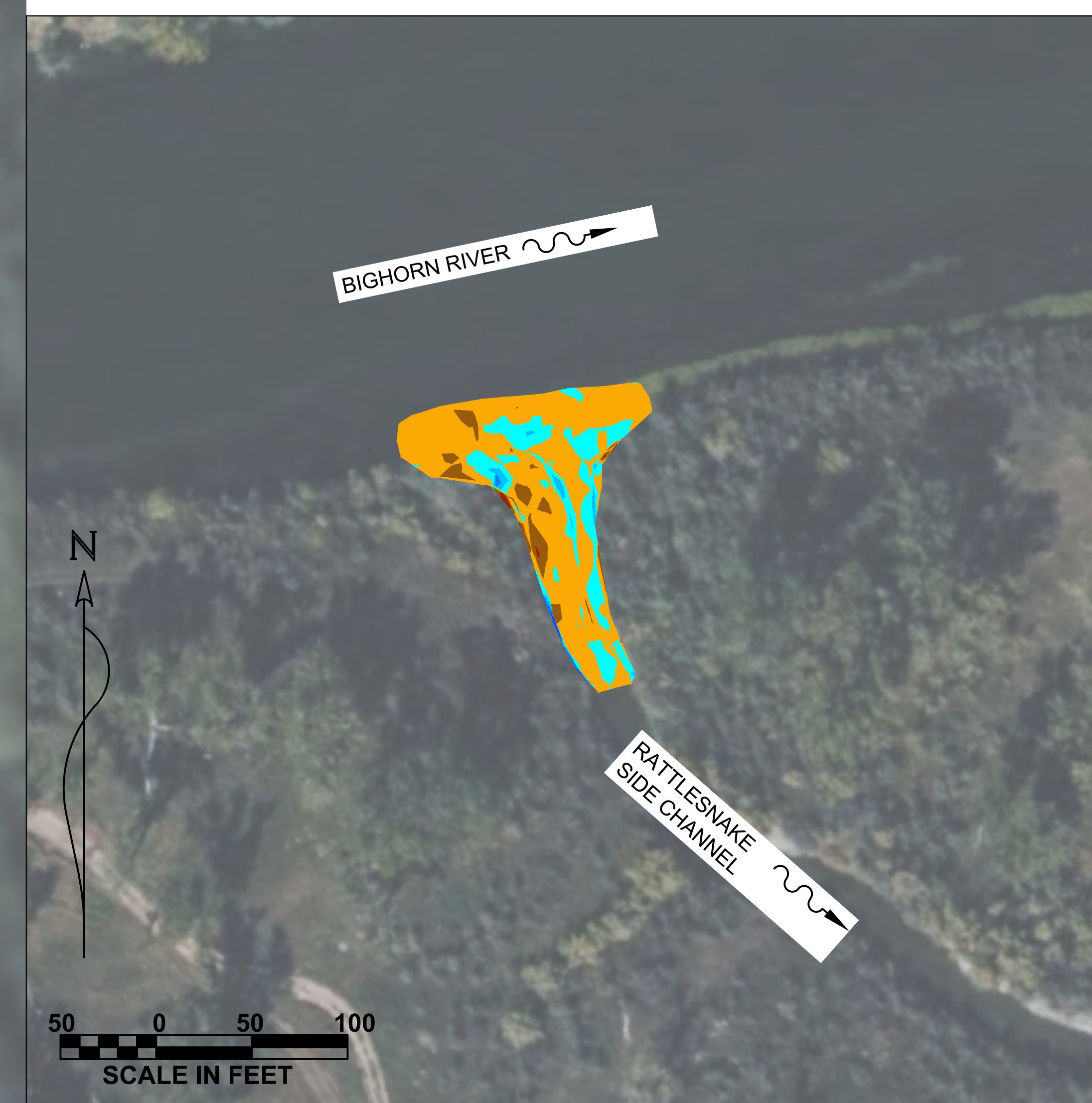


LEGEND

	CUT 2.5' - 2.0
	CUT 2.0' - 1.5'
	CUT 1.5' - 1.0
	CUT 1.0' - 0.5'
	CUT 0.5' - 0.0'
	FILL 0.0 - 0.5'
	FILL 0.5' - 1.0'
	FILL 1.0' - 1.5'
- #.#	CUT VALUE
#.#	FILL VALUE

NOTES:

1. VOLUME COMPARISON IS BETWEEN SPRING 2023 SURVEY AND FALL 2023 SURVEY.
2. A FILL VALUE IS MATERIAL GAIN BETWEEN SPRING 2023 AND FALL 2023.
3. A CUT VALUE IS MATERIAL LOSS BETWEEN SPRING 2023 AND FALL 2023.
4. TOTAL FILL VOLUME = 62 CUBIC YARDS
5. TOTAL CUT VOLUME = 20 CUBIC YARDS
6. NET CUT/FILL = 42 CUBIC YARDS OF FILL



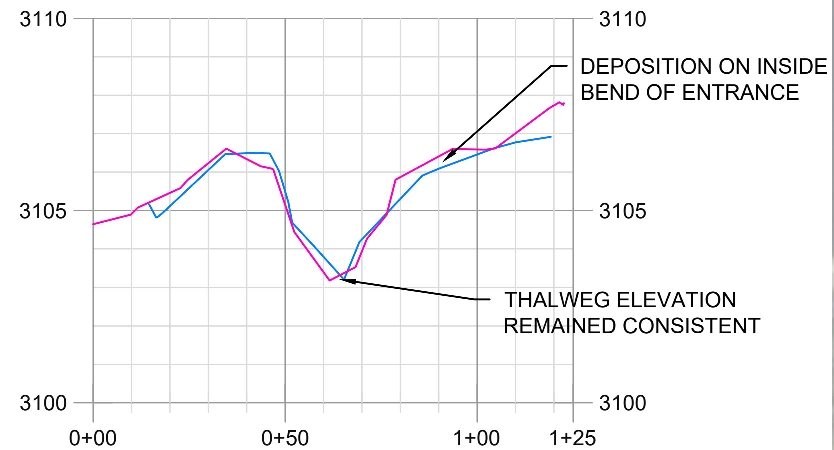
CONFLUENCE CONSULTING

BIGHORN SIDE CHANNEL REACTIVATION MONITORING
FORT SMITH, MT

RATTLESNAKE 2022/2023 VOLUME COMPARISON

SHEET: **2**

JUNIPER CROSS SECTION



1/3 JUNIPER CROSS SECTION
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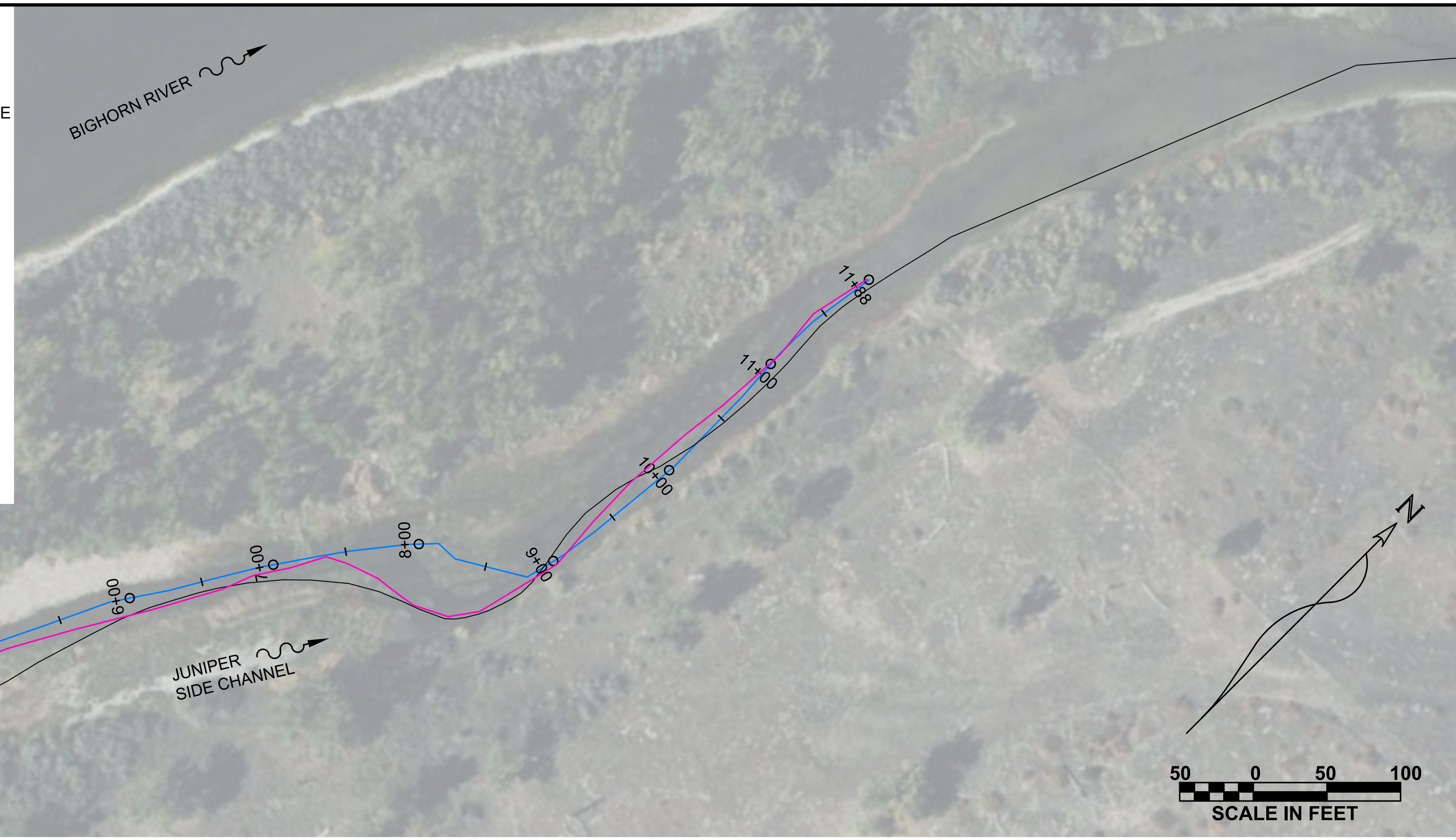
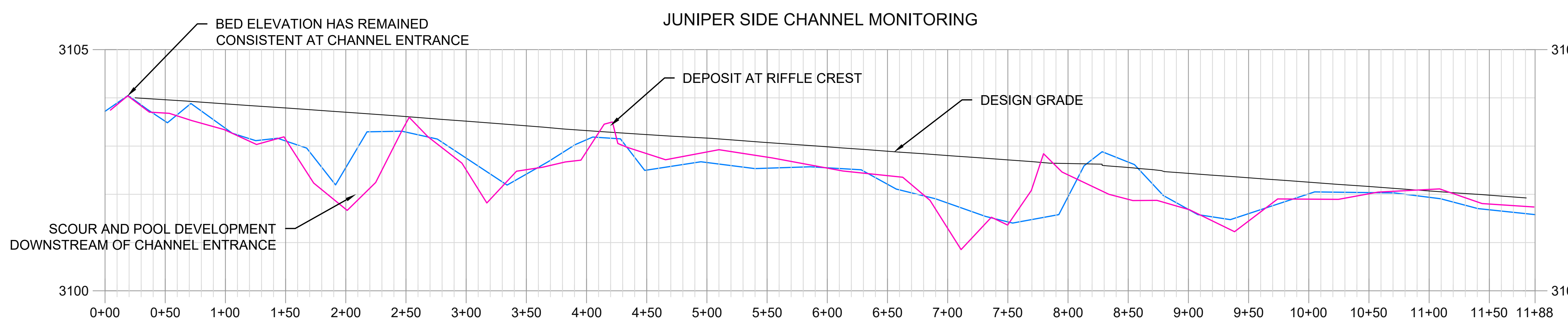
VERTICAL SCALE: 1" = 5'



JUNIPER SIDE CHANNEL MONITORING



2/3 JUNIPER SIDE CHANNEL PROFILE
HORIZONTAL SCALE: 1" = 100'
VERTICAL SCALE: 1" = 2.5'

PLAN AND PROFILE LEGEND

2023 SPRING EXISTING GROUND GRADE
2023 FALL EXISTING GROUND GRADE

DRAWN BY: ---
DESIGNED BY: ---
CHECKED BY: ---
DATE: ---
CCI JOB NO.: ---
FILE NAME: ---

REV.	DATE	DESCRIPTION	BY	APP'D
1	---	---	---	---
2	---	---	---	---

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BIGHORN SIDE CHANNEL REACTIVATION MONITORING
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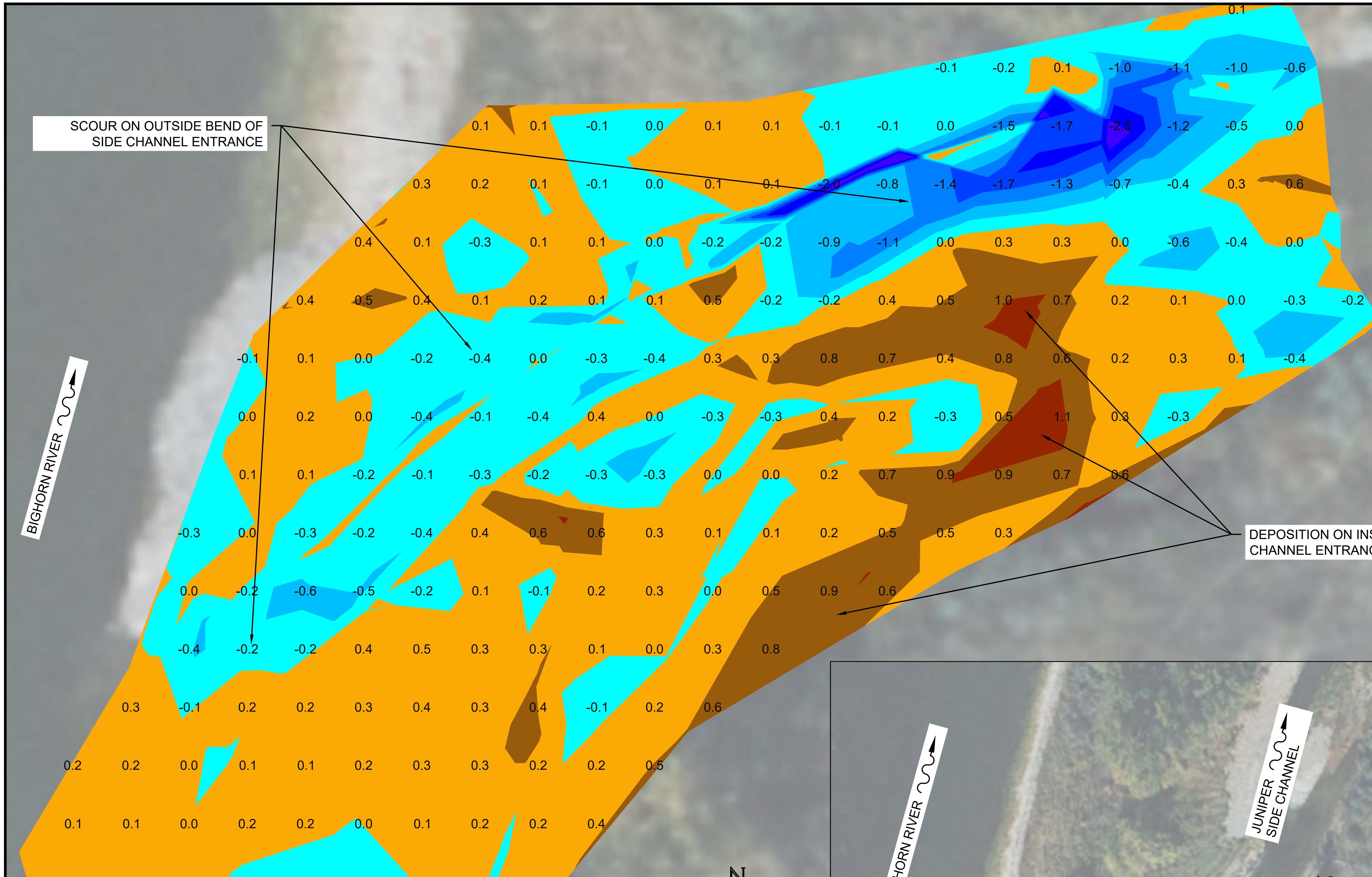
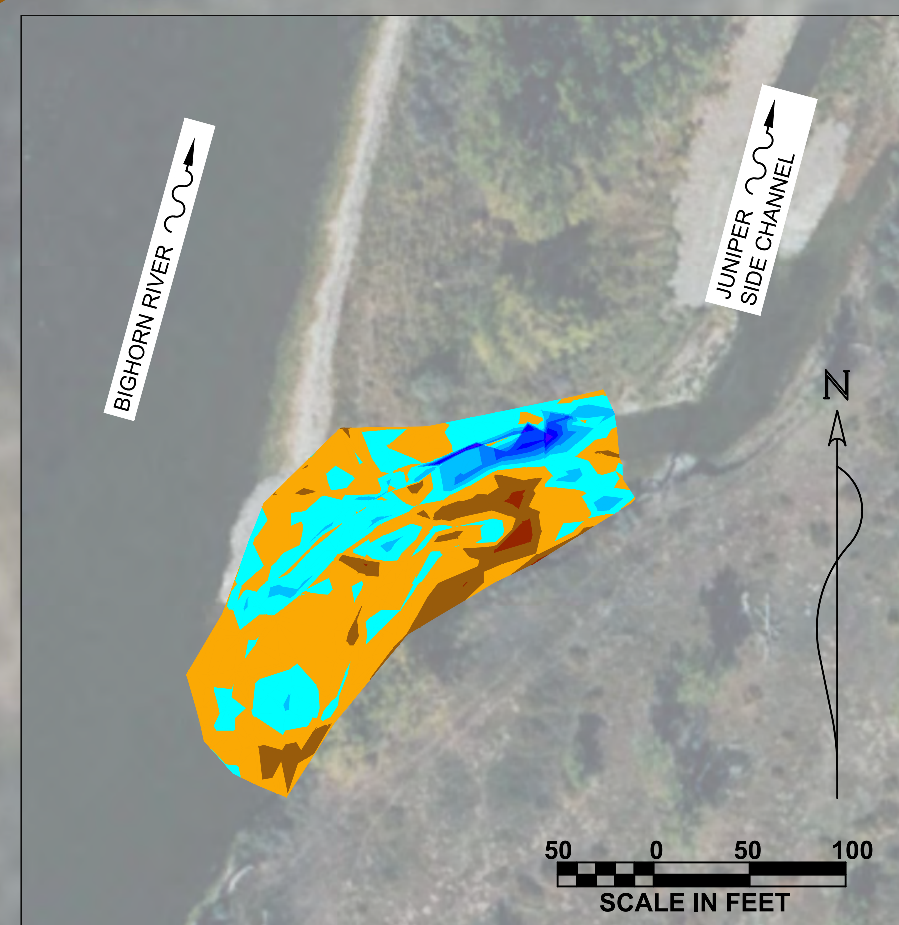
JUNIPER SIDE CHANNEL MONITORING

SHEET: **3**





LEGEND

	CUT 3.0' - 2.5'
	CUT 2.5' - 2.0'
	CUT 2.0' - 1.5'
	CUT 1.5' - 1.0'
	CUT 1.0' - 0.5'
	CUT 0.5 - 0.0'
	FILL 0.0' - 0.5'
	FILL 0.5' - 1.0'
	FILL 1.0' - 1.5'
- #.#	CUT VALUE
#.#	FILL VALUE

NOTES:

1. VOLUME COMPARISON IS BETWEEN SPRING 2023 SURVEY AND FALL 2023 SURVEY.
2. A FILL VALUE IS MATERIAL GAIN BETWEEN SPRING 2023 AND FALL 2023.
3. A CUT VALUE IS MATERIAL LOSS BETWEEN SPRING 2023 AND FALL 2023.
4. TOTAL FILL VOLUME = 154 CUBIC YARDS
5. TOTAL CUT VOLUME = 123 CUBIC YARDS
6. NET CUT/FILL = 31 CUBIC YARDS OF FILL

CONFLUENCE CONSULTING

BIGHORN SIDE CHANNEL REACTIVATION MONITORING
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JUNIPER 2022/2023 VOLUME COMPARISON

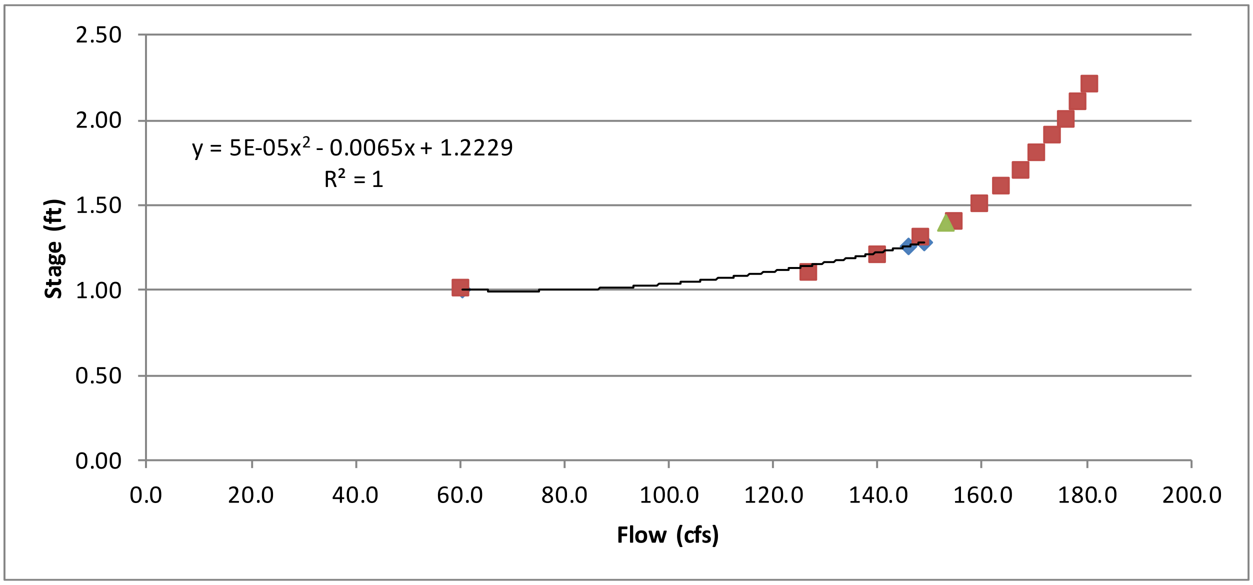
SHEET: 4

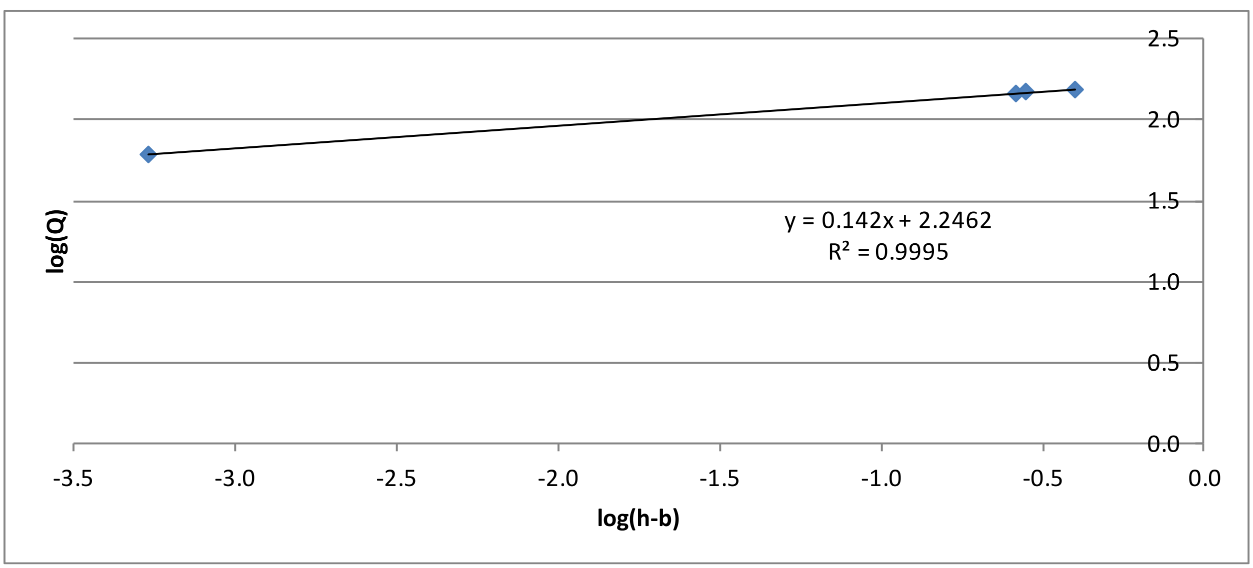
Appendix B

Rating Curves

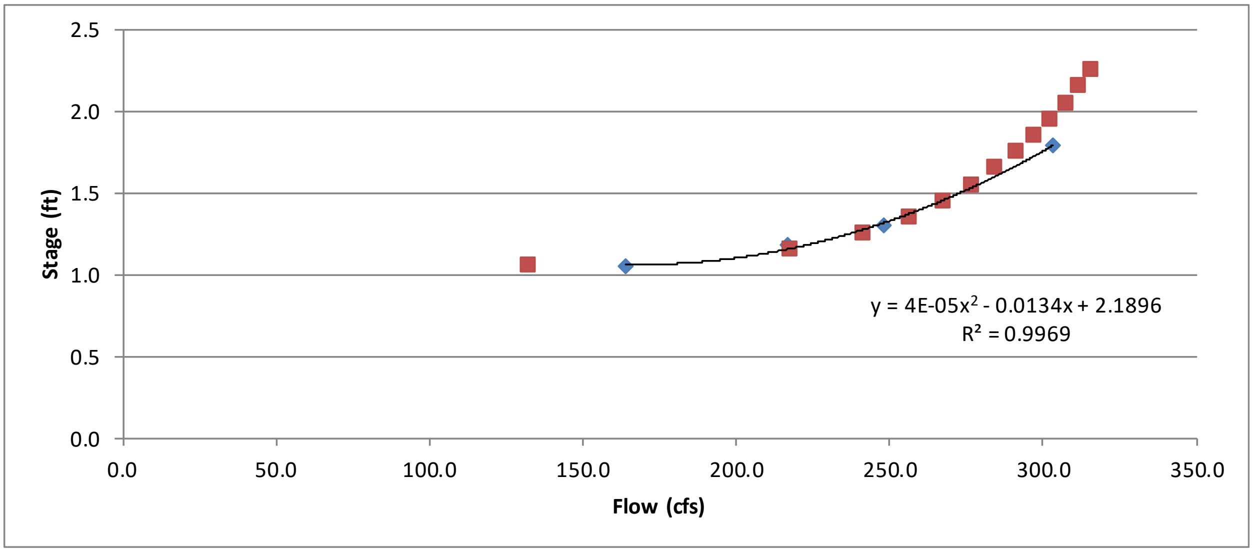
Bighorn River Side Channel Restoration Project
Annual Monitoring Report - 2023

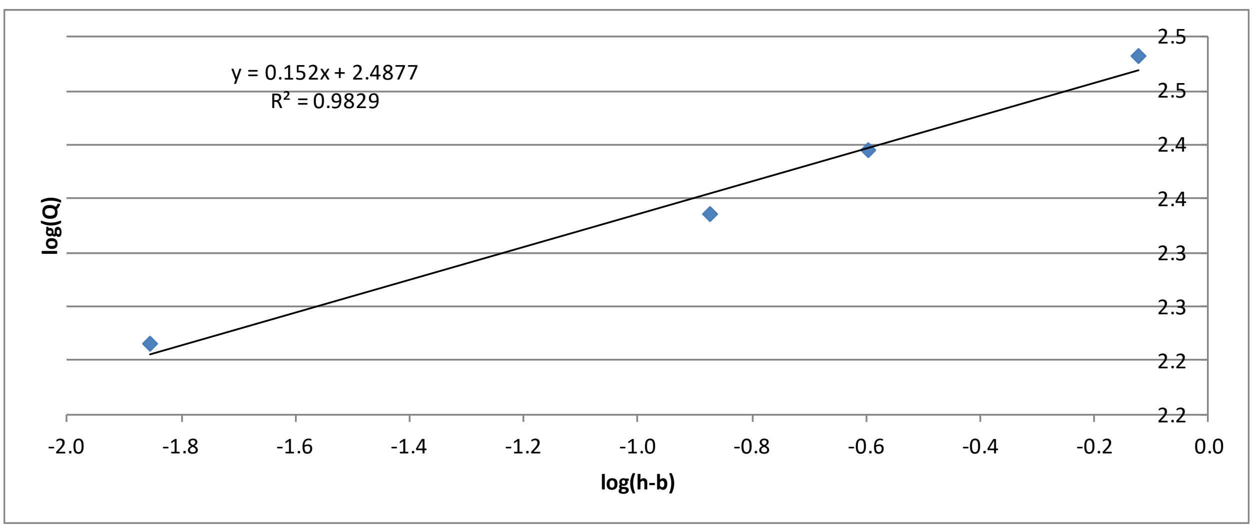
Rattlesnake Side Channel Rating Curve





Juniper Side Channel Rating Curve

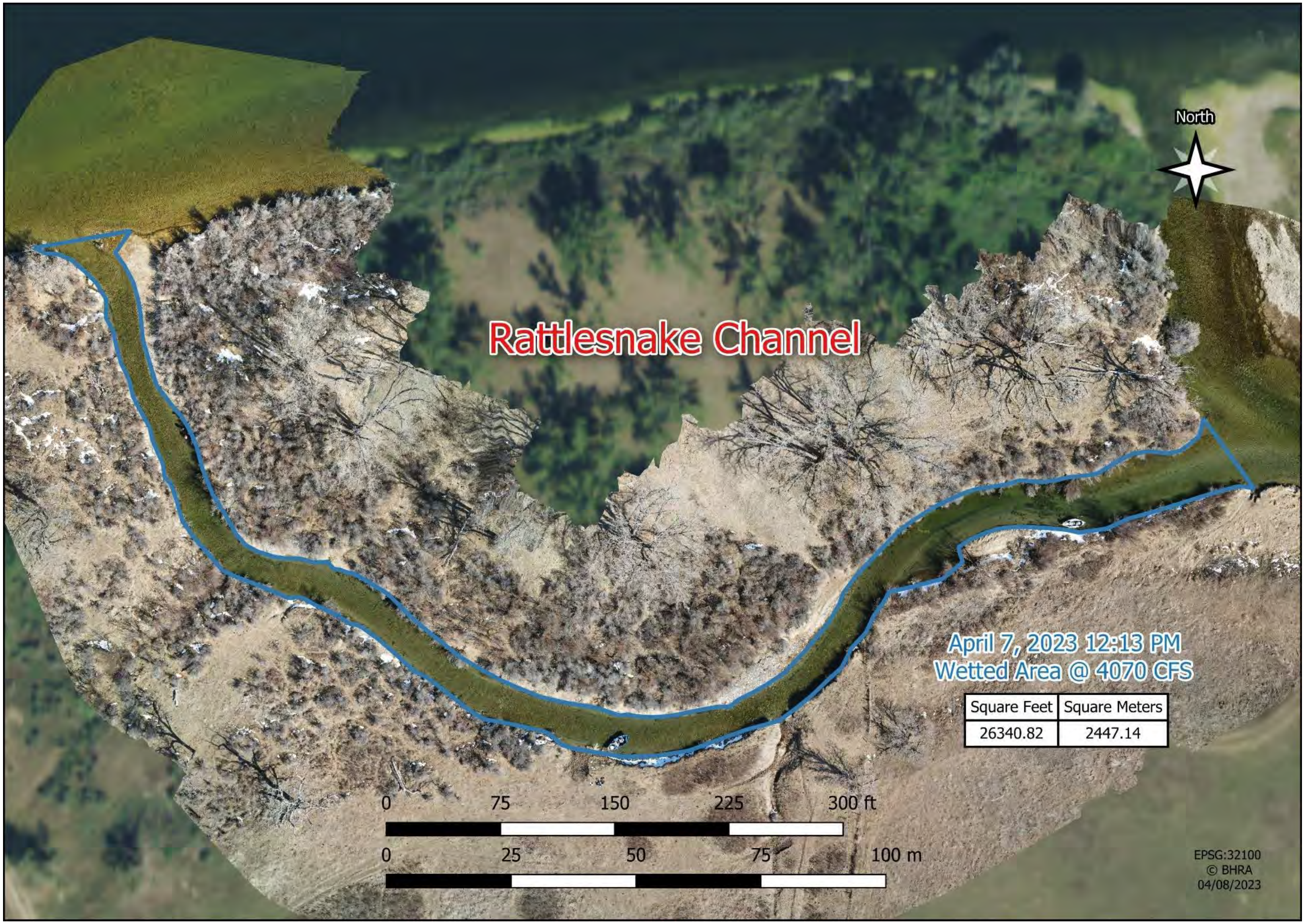


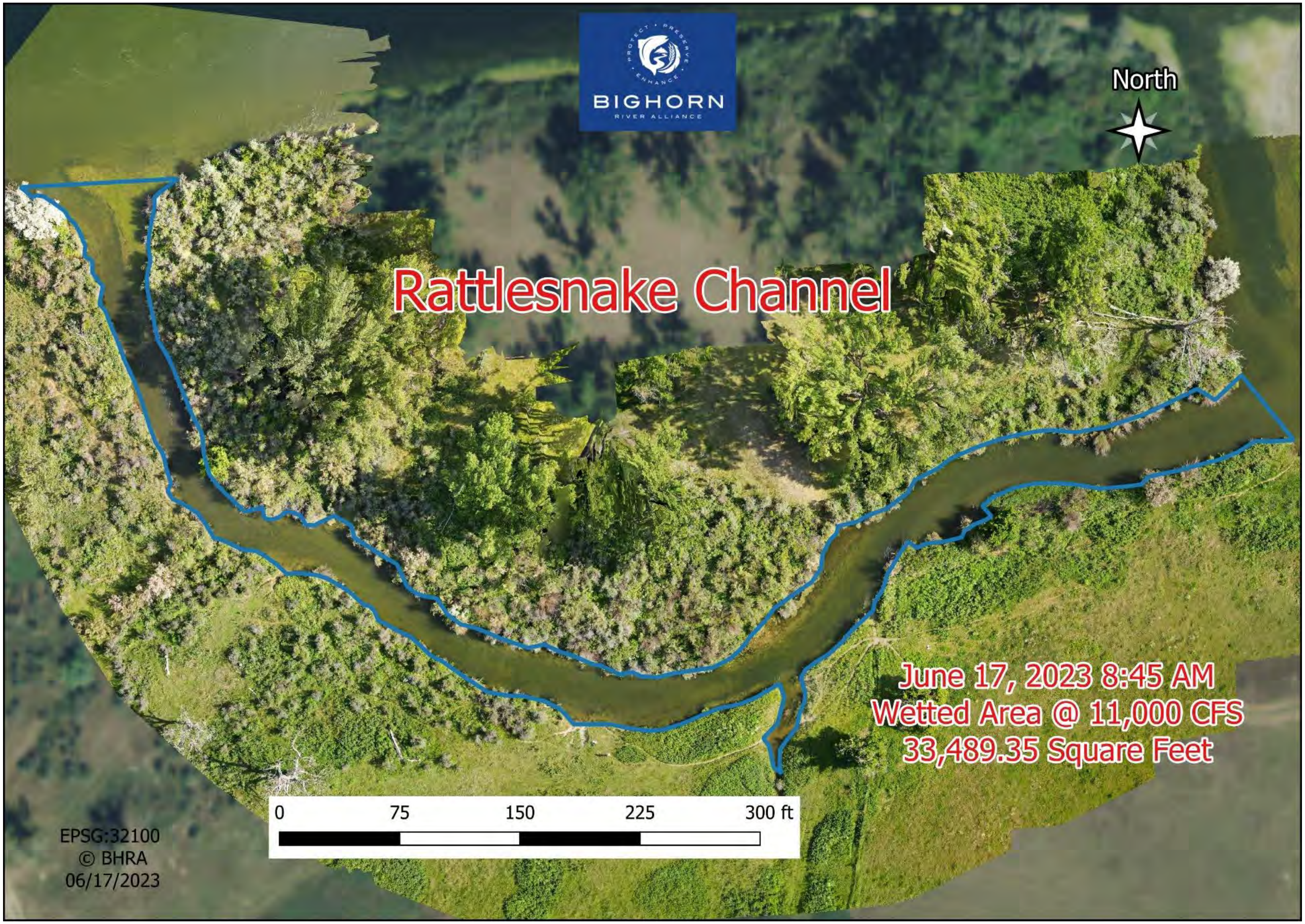


Appendix C

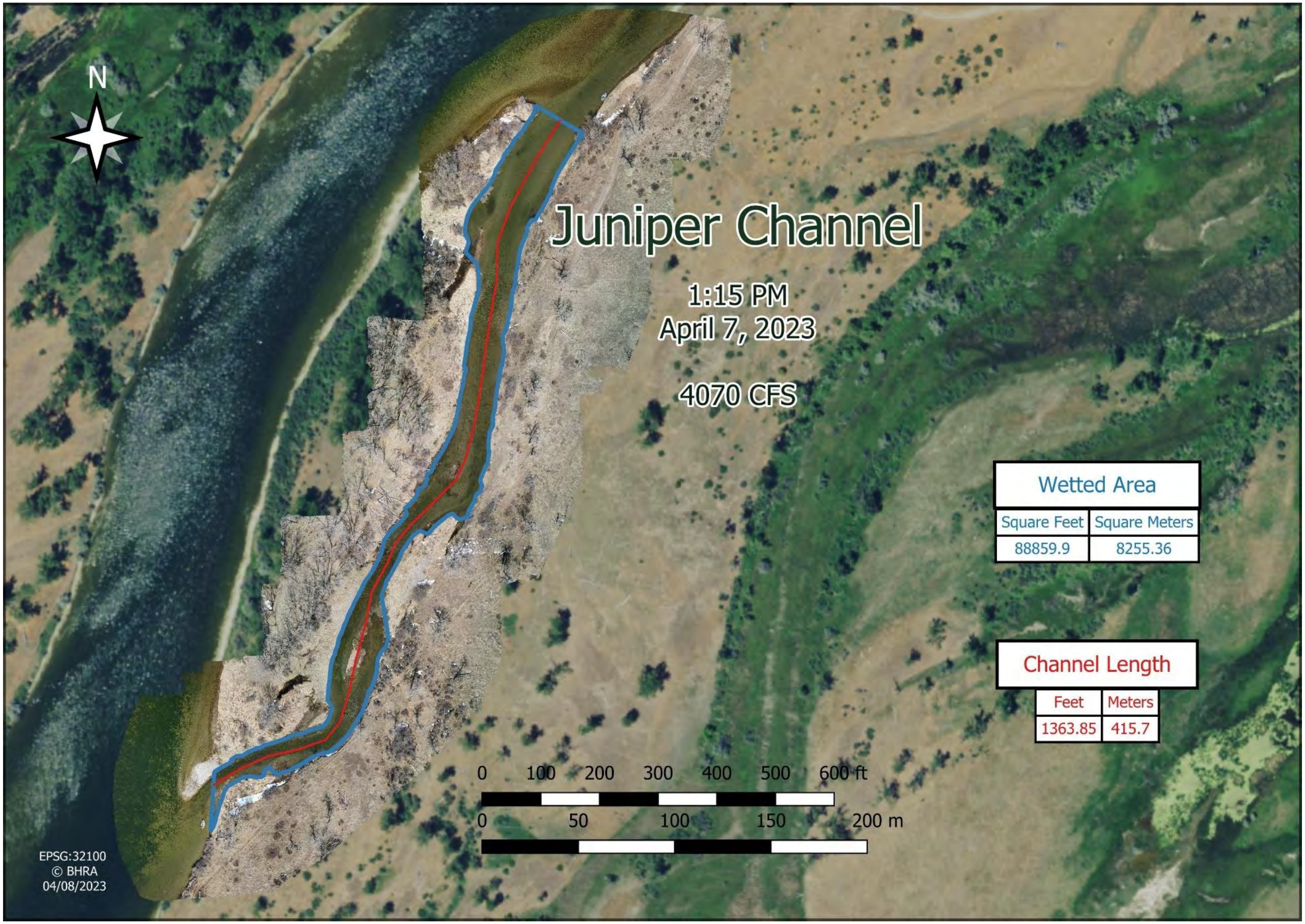
Orthophotography

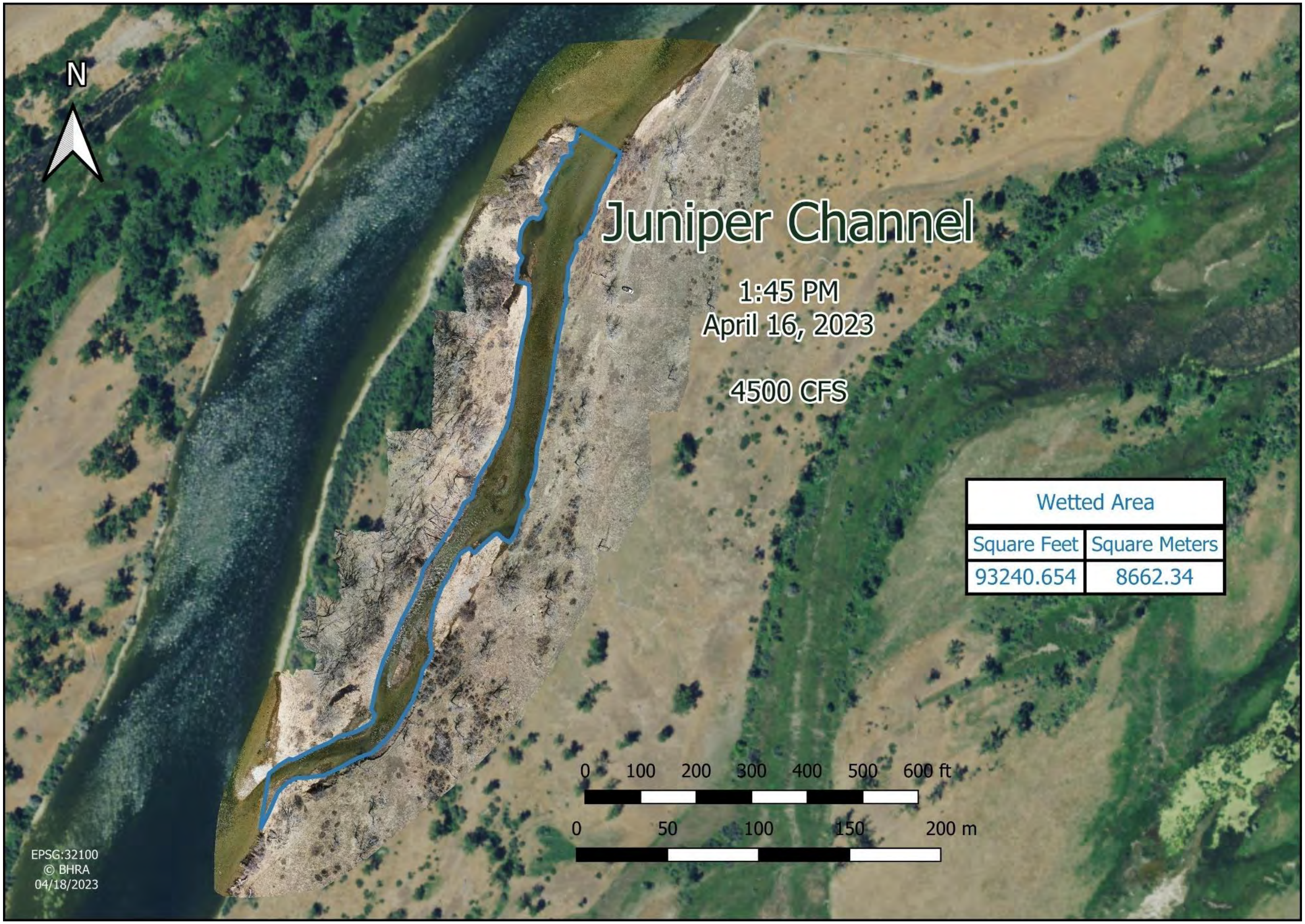
Bighorn River Side Channel Restoration Project
Annual Monitoring Report – 2023


Rattlesnake Channel
North
April 7, 2023 12:13 PM
Wetted Area @ 4070 CFS
Square Feet | Square Meters
26340.82 | 2447.14
0 75 150 225 300 ft
0 25 50 75 100 m
EPSG:32100
© BHRA
04/08/2023


BIGHORN
RIVER ALLIANCE
North
Rattlesnake Channel
June 17, 2023 8:45 AM
Wetted Area @ 11,000 CFS
33,489.35 Square Feet
0
75
150
225
300 ft
EPSG:32100
© BHRA
06/17/2023

February 22, 2024 Orthophoto
of Rattlesnake Side Channel
Entrance


N
Juniper Channel
1:15 PM
April 7, 2023
4070 CFS
Wetted Area
Square Feet | Square Meters
88859.9 | 8255.36
Channel Length
Feet | Meters
1363.85 | 415.7
0 100 200 300 400 500 600 ft
0 50 100 150 200 m
EPSG:32100
© BHRA
04/08/2023



Wetted Area	
Square Feet	Square Meters
93240.654	8662.34