South Platte River
Sportsman's Paradise – Reaches 20 & 21
River Assessment & Restoration Plan
May 2010

Prepared for the Coalition for the Upper South Platte
&
The Sportsman's Paradise Home Owners Association

FIN-UP Habitat Consultants, Inc.

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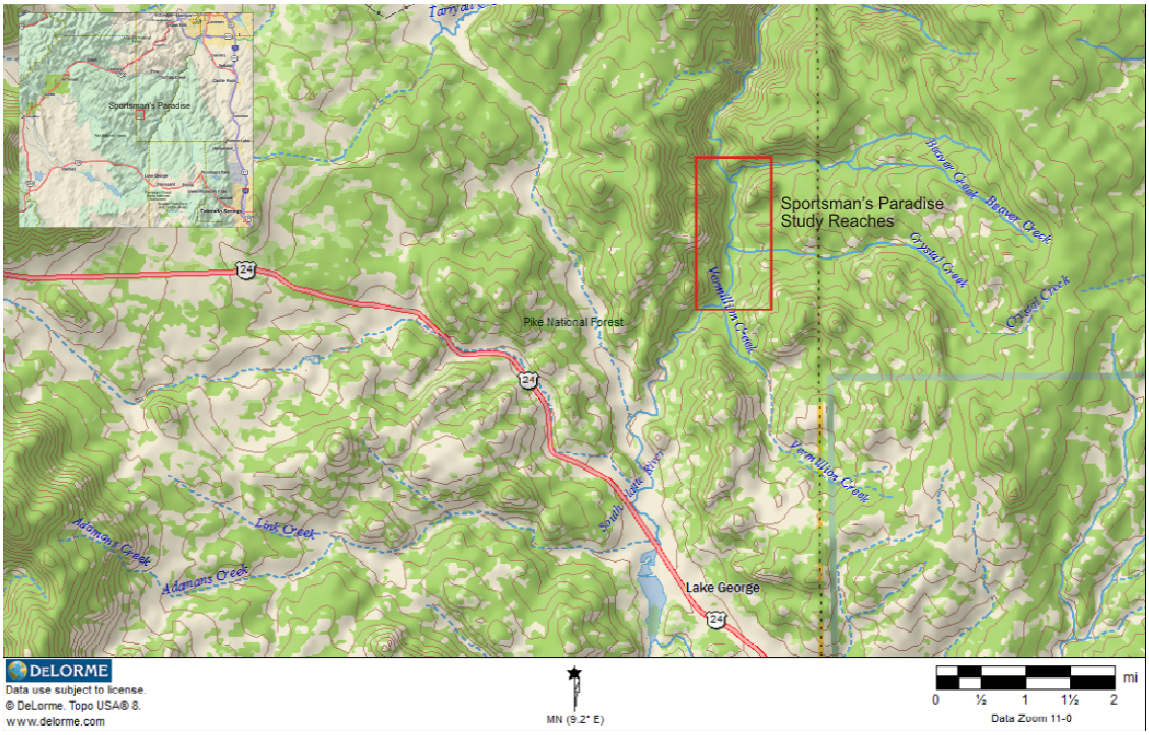
Table of Contents

The following document assesses the current conditions and describes the treatments to be implemented on the South Platte River in the area known as Sportsman's Paradise. This segment of the river, designated Reach 20 and 21, is located on private lands immediately downstream of the USFS Happy Meadows Reach (Reach 22), in Park County, Colorado. The river is managed as a put-and-take fishery by the Sportsman's Paradise Home Owners Association (SPHOA), for the benefit and enjoyment of their members. The project reach is approximately 3.5 miles NNE of the town of Lake George, CO, and is roughly two miles in length. The river within the study segment is accessed by Park County Road #112, which follows the South Platte River throughout the USFS Happy Meadows Reach on the left (west) bank. An electronic gate controls entry into the Sportsman's Paradise property at the top of Reach 21, and public access is not allowed within the property. The project area is bounded by public lands, managed by the South Park District of the Pike National Forest, both the upstream and downstream of the project reaches.

Within the study reaches, roads exist on both sides of the river, with numerous homes and other structures constructed along both sides of the valley. For the most part, the valley bottom, water influence zone, and riparian meadows have remained mostly undeveloped and intact. Soil condition in the riparian zone appears to be relatively poor, however, and is likely due to historic agricultural practices within the property, including extensive potato cultivation in the years before housing development began. Upland regions consist mostly of ponderosa pine and spruce forest, with soils comprised of decomposed granite, with a thin layer of duff and sparse vegetation.

One large off-channel pond has been developed on the left (west) side of the lower region of Reach 21, which is fed by a diversion ditch leading to a large diversion dam at the upstream boundary of Reach 21. The outflow channel of this pond meanders through a meadow dominated by willow and sedge, and re-enters the South Platte River 587ft upstream of the confluence with Crystal Creek and the start of Reach 21. Several smaller ponds exist within the property, but are located along tributaries to the South Platte River. The most extensive pond development has occurred in the Vermillion Creek drainage, near the upstream boundary of the project area.



Map 1: Vicinity Map of the Study Reaches – Sportsman's Paradise Project

Assessment of Current Conditions:

The South Platte River throughout the Sportsman's Paradise reach is limited by excess sediment from sources upstream, and from inputs from the many roads that have been constructed within the property. The property was included in the segment of the South Platte River that was designated by the State of Colorado as impaired by sediment under Section 303(d) of the Federal Clean Water Act of 1972. A total maximum daily load (TMDL) analysis was conducted for the segment of the river between Elevenmile Reservoir and Cheeseman Reservoir between 1996 -2002. In 2002, the Hayman wildfire burned a large portion of the watershed on the eastern side of the project reaches, further increasing sediment input into the river. Compounding these limiting factors, extensive "informal" habitat enhancement efforts, mostly in the form of large boulder structures and channel modifications, have been constructed by the SPHOA over the years. While these efforts likely represented the best of intentions by their sponsors to improve the fishery, they have had an unfortunate and unintended consequence of dramatically reducing the river's natural capacity to transport sediment. The river channel throughout the reach is over-wide in many segments, exhibiting shallow depth, laminar flow, limited habitat complexity, and poor sediment transport. Over-widening is especially apparent near the existing boulder structures. Additionally, the two major tributaries on the right (east) side of the project reaches, Beaver and Crystal Creeks, and several other large gullies, have formed large deposition fans extending into the river, contributing significant quantities of sediment and dramatically effecting habitats downstream.

Photo 1: The diversion structure at the upstream boundary of Reach 21 on the S. Platte River in Sportsman's Paradise.

For the purposes of the current condition assessment, the river through the property was delineated into two distinct reaches, utilizing a continuation of the reach numbering system in use for the river by the US Forest Service. A rapid aquatic habitat and existing structure assessment and a channel morphology survey was conducted along the project reaches in late 2009 by the Coalition for the Upper South Platte (CUSP), Fin-Up Habitat Consultants, Inc., Crane Associates, the US Forest Service, and volunteers from the SPHOA. During the surveys, discharge was measured at Cross-

Section #110 near the downstream boundary, and was calculated to be 154cfs, which is within the expected range of base flow for this segment of the South Platte River. This information has been utilized to develop the current habitat assessment and enhancement proposal. Additionally, a HEC RAS sediment transport model is being developed for the project reaches to verify the sediment transport goals of the design. The model, under final development by Crane Associates, is expected to be complete before construction begins in 2010.

Reach 20 begins at the downstream boundary of the Sportsman's Paradise property, 420 feet downstream of the confluence of the South Platte River and Beaver Creek, and extends 5,834 feet upstream to the confluence with Crystal Creek. The river channel throughout the reach is classified as Rosgen Type C4, with a few segments exhibiting more of a C3 form. Low gradient riffles are the dominant meso-habitat form in the reach, and comprise 46% of the wetted area of the reach. Pool habitats occupy 34% of the reach, with the remaining 20% comprised of poorer quality glides. Glide habitats are typically associated with disturbed areas and segments where previous habitat enhancement attempts have been undertaken. River bank rock composition (BRC) is heavily dominated by gravel or smaller sized particles consisting mostly of decomposed granite. Given the composition of BRC in the reach, the stream banks in Reach 20 are relatively stable and are well vegetated with sedge and willow. 12% of the east (right) river banks and 5% of the left (west) banks exhibit some signs of instability, and 330 feet of bank was found to be actively eroding materials into the river.

Reach 21 begins at the confluence with Crystal Creek, and extends 3,655 feet upstream to the confluence with Vermillion Creek. The river channel throughout the reach is also classified as Rosgen Type C4. Low gradient riffles are once again the dominant meso-habitat form in the reach, and comprise 51% of the wetted area of the reach. Pool habitats are less frequent than in Reach 20, and occupy only 25% of the reach, with the remaining 24% comprised of poorer quality glides. As was the case in Reach 20, glide habitats are closely associated with disturbed areas. BRC is almost entirely dominated by gravel or smaller sized particles consisting decomposed granite. The stream banks in Reach 21 exhibit similar stability and vegetation characteristics to the reach downstream, and are relatively stable and vegetated with sedge and willow. 7% of the east (right) river banks and 15% of the left (west) banks exhibit some signs of instability, and 200 feet of bank was found to be actively eroding materials into the river. Most of the unstable left bank is directly associated with the fill slope forming the diversion ditch that feeds the lake on the west side of the reach.

A channel morphology survey was undertaken as part of the assessment, and the results are included in the Appendix. A longitudinal profile of each reach was surveyed, using the meso-habitat forms to delineate the survey. Channel (thalweg), water surface, and bank-full stage elevations were collected during the survey, as well as maximum pool depth elevations, in order to calculate residual pool depth in the pools. Twenty-one cross-sections were established on the property. These cross-sections represent a representative sample of pool, riffle, and glide habitat forms, and where possible, include the entire riparian zone and flood-prone width of the river.

The map on the following page delineates the project reaches. Each reach has been divided into smaller, more detailed drawings; beginning at the downstream boundary of the property, and progressing upstream. The existing conditions in each drawing and an assessment of the current in-channel structures are described in detail in the text adjacent to each drawing.

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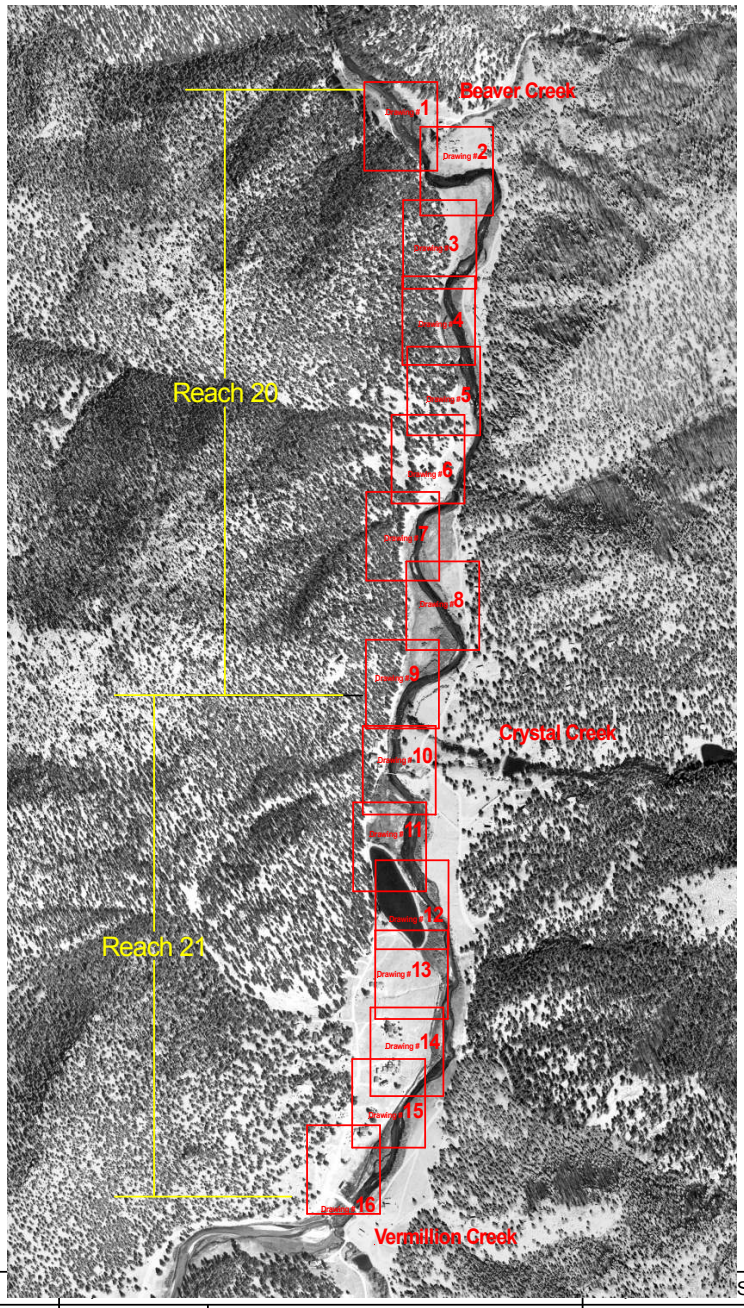

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SP / USFS

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Gallagher		SP_Segment_Key_v1.SKF	April, 2010	

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Sportsmans Paradise - South Platte River
Reaches 20 & 21

Existing Condition & Restoration Drawing Key

Edition Ver. 1.0

Sheet 1

RevNo	Revision note		Date	Signature	Checked

Habitat Map and Restoration Plan Symbol Key

Pool Extent (Natural Scour or Excavated)

Original Stream Bank

Island (Remove)

Island (Leave as is)

Boulder Vane / Groin

Boulder J-Hook Vane

Boulder / Log J-Hook Vane

Full-Channel Boulder Cross Vane

Micro Vortex In-Channel Object Cover

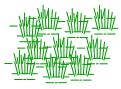
Individual Boulder (existing or placed)

Bank Cover Structure

Large Tree w/ Root Wad

Habitat Tree (w/ branches intact)

Log Toe-Slope Bank-Full Bench



Areas Revegetated w/ Willow, Sedge, Or Sod Mats

	Aquatic Habitat Restoration Plan		Prepared For CUSP / USFS	
Designed by Gallagher	Checked by	Filename SP_Restore_Key.SKF	Date May, 2010	Scale

Fin-Up Habitat Consultants, Inc. 220 Illinois Ave. Manitou Springs, CO 80829 (719) 332-2550	Sportsman's Paradise - South Platte River Reach 20 and 21 - Existing Condition & Restoration Plan		
	Site Plan Symbol Key	Edition Ver. 1.0	Sheet 1

Reach 20 – Habitat Map Drawing #1:

This drawing shows the downstream (northern) most segment of Reach 20, from the USFS/SPHOA property boundary at 0ft upstream to 0+600ft along the longitudinal axis of the river. The segment consists of three riffles, two pools, and one glide habitat. Beaver Creek enters the river on the right (east) side of the channel at 0+420 ft. There are three large mid-channel islands that have formed in the segment. These islands are well established, and covered with bar willow and sedge.

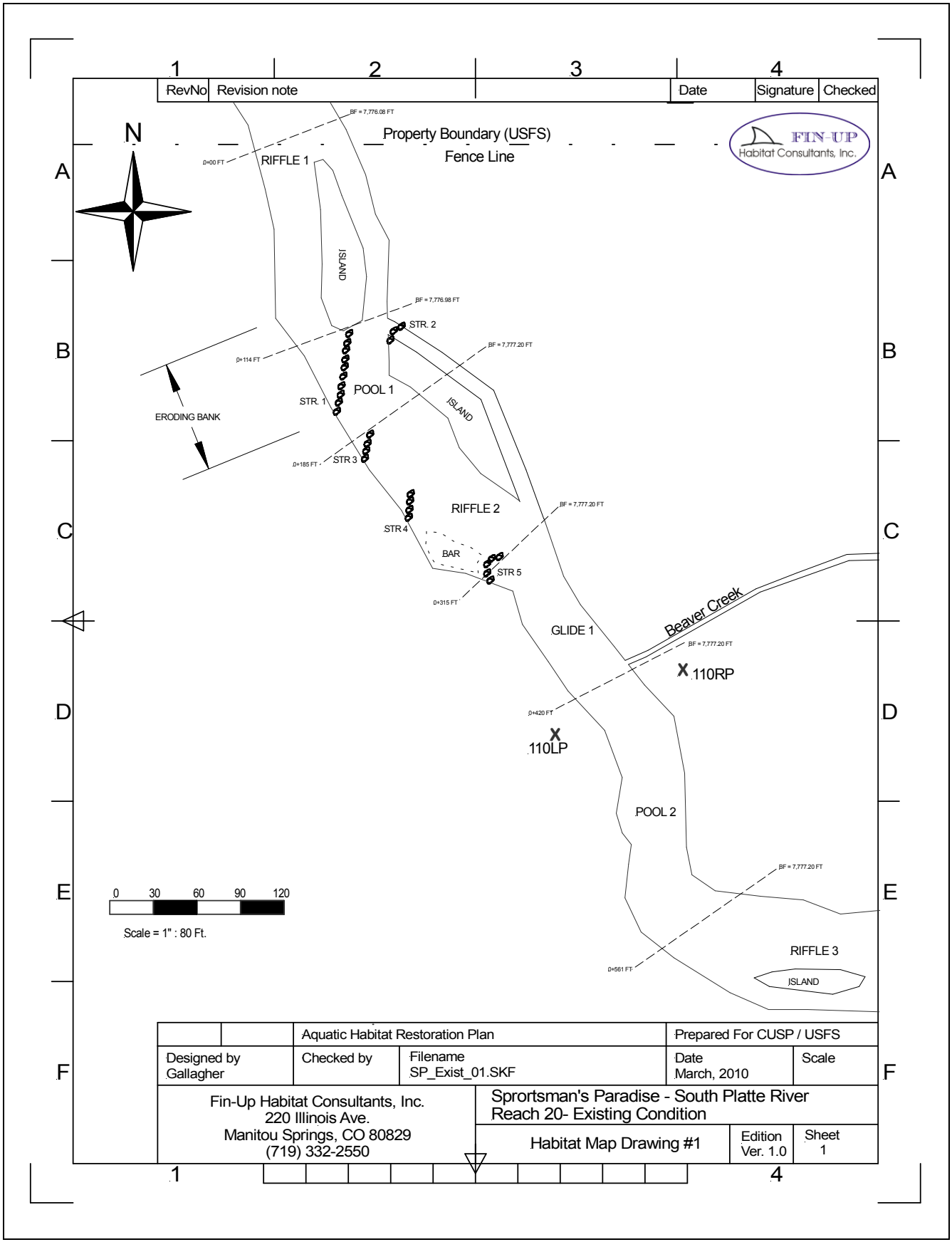
Cross Section 110 is found at 0+439ft, across the tail-out segment of Pool 2. Flow measurements for the study were taken at this cross-section. The wetted width at the time of the survey was 57 feet, and the bank-full width of the channel at this point is 70 ft. The flood prone width of the channel was determined to be 90 ft. Channel entrenchment was 1.29, and the width/depth ratio was calculated to be 32.

Photo 2: View downstream to Cross-Section #110 and the confluence with Beaver Creek on the right.

Five boulder structures exist in this segment, and consist principally of boulder vanes extending from the stream bank downstream into the channel. Boulder elevations tend to be somewhat random, with most of the features ranging from ¾ of the bank-full stage to slightly above BF. A few of the smaller vanes on the left bank have substantial gravel bars forming downstream of the structures.

The large boulder vane at Str.#1 extends all the way to the mid channel island at the bottom of the reach, and is contributing to bank instability along the left side of the channel downstream of the structure. Several of the boulders are high, with corresponding sediment bars forming downstream. Pool 1 is formed by this structure, which effectively dams the water upstream for a brief segment. The maximum depth of this pool is 2.3 ft, and the residual pool depth is less than 1 ft.

The other pool habitat, P2, is a naturally forming pool caused by scour along a meander bend of the channel. The outside of the meander consists of large boulder and bedrock, resulting in a very deep scour along the outside third of the channel. Maximum pool depth was too deep to measure, but was estimated to be greater than 4 ft. RPD was estimated to be approximately 3 ft.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BF = 7,776.98 FT
STR. 2
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0+114 FT
POOL 1
STR. 1
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ERODING BANK
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STR 3
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BAR
STR 5
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GLIDE 1
Beaver Creek
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POOL 2
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Aquatic Habitat Restoration Plan
Prepared For CUSP / USFS
Designed by Gallagher
Checked by
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Date March, 2010
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Fin-Up Habitat Consultants, Inc.
220 Illinois Ave.
Manitou Springs, CO 80829
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Sprortsman's Paradise - South Platte River
Reach 20- Existing Condition
Habitat Map Drawing #1
Edition Ver. 1.0
Sheet 1

Reach 20 – Habitat Map Drawing #2:

This drawing shows the segment of Reach 20 from 0+600ft to 0+1,600 ft along the longitudinal axis of the river. The segment consists of a long meander bend to the west, and includes three riffles, one pool, and one glide habitat. A large gully enters the river on the east at approximately 0+1,020 ft at Pool #3. This gully periodically moves significant quantities of sediment into the river, and a large bar extends into the pool on the outside bend of the meander. There are several mid-channel islands that have formed in the segment. These islands are well established, and covered with bar willow and sedge.

Three cross-sections are found within this segment. Two of the cross-sections are in riffle habitats, and one transects Pool #3. Cross Section 111 and Cross-Section 112 share the same left head pin (111_112LP). Cross-Section 111 is found at 0+898ft, across a representative segment of Riffle #3. The wetted width at the time of the survey was 79 feet, and the bank-full width of the channel at this point is 96 ft. The flood prone width of the channel was determined to be 168 ft. Channel entrenchment was 1.73, and the width/depth ratio was calculated to be 55.

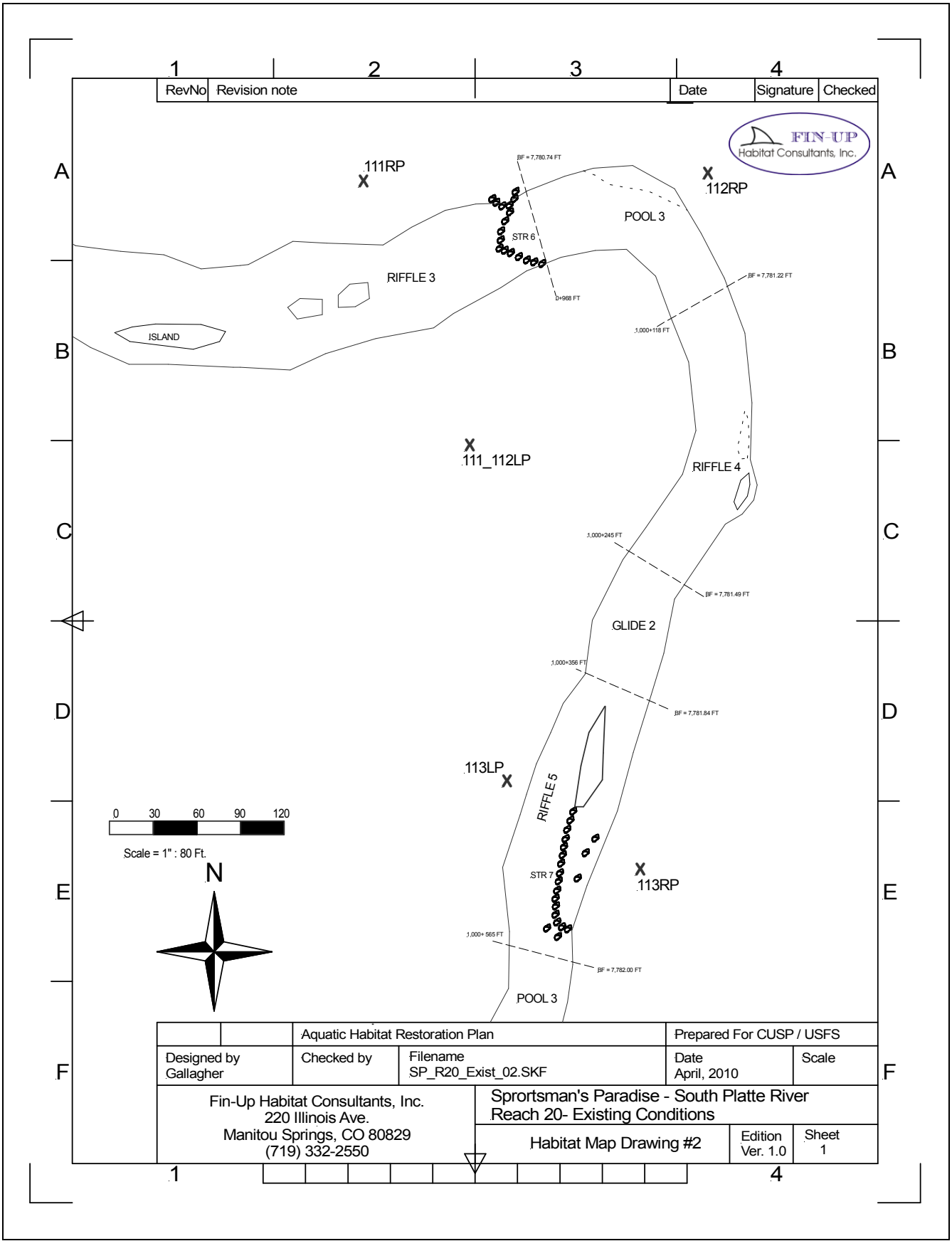
Cross-Section 112 is found at 0+1,048ft, through the center of Pool #3. The wetted width at the time of the survey was 59 feet, and the bank-full width of the channel at this point is 66 ft. Maximum depth of the pool at the time of the survey was 2.6 ft, and bank-full maximum depth was 4.2 ft. Residual pool depth was 0.6 ft.

Cross-Section 113 is found at 0+1,448ft, and transects Structure #7 within Riffle #5. The wetted width at the time of the survey was 63 feet, and the bank-full width of the channel at this point is 86 ft. The flood prone width of the channel was determined to be 144 ft. Channel entrenchment was 1.68, and the width/depth ratio was calculated to be 47.

Two boulder structures exist in this segment, and consist boulder vanes extending into the channel. Boulder elevations tend to be somewhat random, with most of the features ranging from ¾ of the bank-full stage to slightly above bank-full. Structure #6 completely spans the active channel, and is oriented so that the structure extends downstream. While this structure is creating some additional depth in Pool #3, the consequence of the downstream orientation of the feature is significant over-widening of the river channel downstream in Riffle #3.


Photo 3: View from Pool #3 upstream to Riffle #4.

Structure #7 consists of a large boulder vane extending from the right river bank near the top of Riffle #5 almost one hundred feet downstream to the center of the channel. Many of the boulders are at or near the bank-full elevation of the channel at this point, and a large mid-channel island has become established downstream of the structure. Much of the useable habitat that may have initially been formed on the right side of the channel has become inundated with fine sediment. At higher flows, the structure tends to push the thalweg into the left river bank, and the river is gradually becoming wider at this point as segments of the left bank periodically slough off during higher flow events.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Prepared For CUSP / USFS
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Gallagher
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Filename
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Date
April, 2010
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Fin-Up Habitat Consultants, Inc.
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Sprortsman's Paradise - South Platte River
Reach 20- Existing Conditions
Habitat Map Drawing #2
Edition
Ver. 1.0
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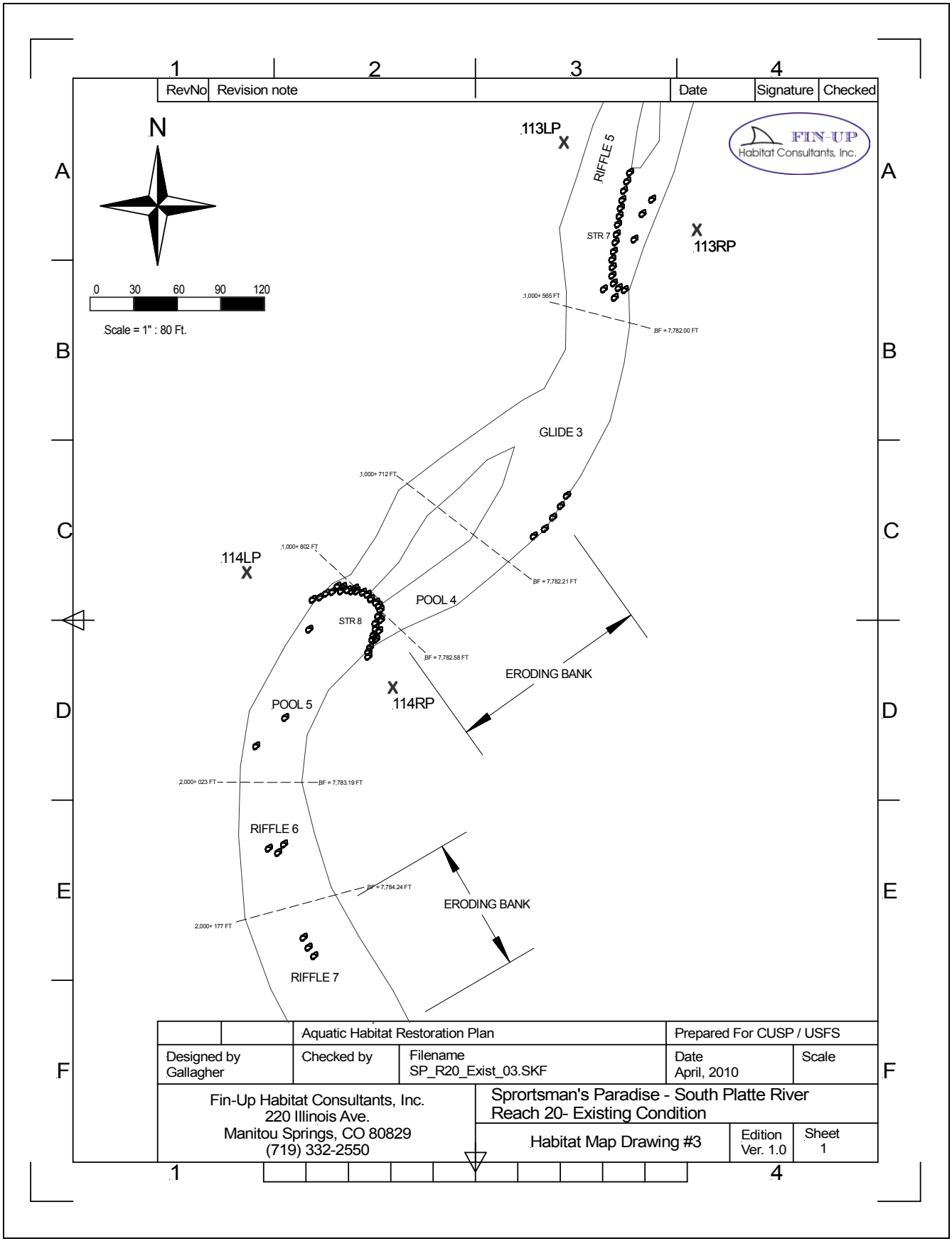
Reach 20 – Habitat Map Drawing #3:

This drawing shows the segment of Reach 20 from 0+1,425ft to 0+2,200 ft along the longitudinal axis of the river. The segment consists of a long meander bend to the east, and includes three riffles, two pools, and one relatively long glide habitat. There is one large mid-channel island that has formed in the segment. This island is well established, and covered with bar willow and sedge.

Two cross-sections are found within this segment. Cross-Section 113 has already been described in the previous section of this document. Cross-Section 114 is found at 0+1,815ft, and transects the upstream side of Structure #8 between Pool #4 and Pool #5. The wetted width at the time of the survey was 71 feet, and the bank-full width of the channel at this point is 91 ft. The flood prone width of the channel was determined to be 126 ft. Channel entrenchment was 1.94, and the width/depth ratio was calculated to be 53.

Photo 4: Structure #8, looking from the right bank to the left bank at Cross-Section #114.

Two boulder structures are found in this segment, consisting of boulder vanes extending into the channel. Boulder elevations are random, with most of the boulder top elevations ranging from ¾ of the bank-full stage to slightly above bank-full. Structure #7 has been previously described. Structure #8 consists of a boulder drop structure that completely spans the active channel, and is oriented so that the vanes forming the feature extend downstream. The structure is much higher than the bank-full stage elevation in the center of the channel, and is likely the cause of the large mid-channel island that has formed downstream. The structure is creating some additional depth in Pool #5, but also functions as a significant sediment trap, holding back a considerable quantity of fine sediment in the pool. The consequence of the downstream orientation of the feature is evident, particularly on the right river bank downstream in Pool #4, where over-widening of the river channel has destabilized the river bank. Rip-rap has been added along a portion of the right bank of Glide #3 to address this problem, but is likely not very effective at this point.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Habitat Consultants, Inc.
Aquatic Habitat Restoration Plan
Prepared For CUSP / USFS
Designed by
Gallagher
Checked by
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Date
April, 2010
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Fin-Up Habitat Consultants, Inc.
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Sprortsman's Paradise - South Platte River
Reach 20- Existing Condition
Habitat Map Drawing #3
Edition
Ver. 1.0
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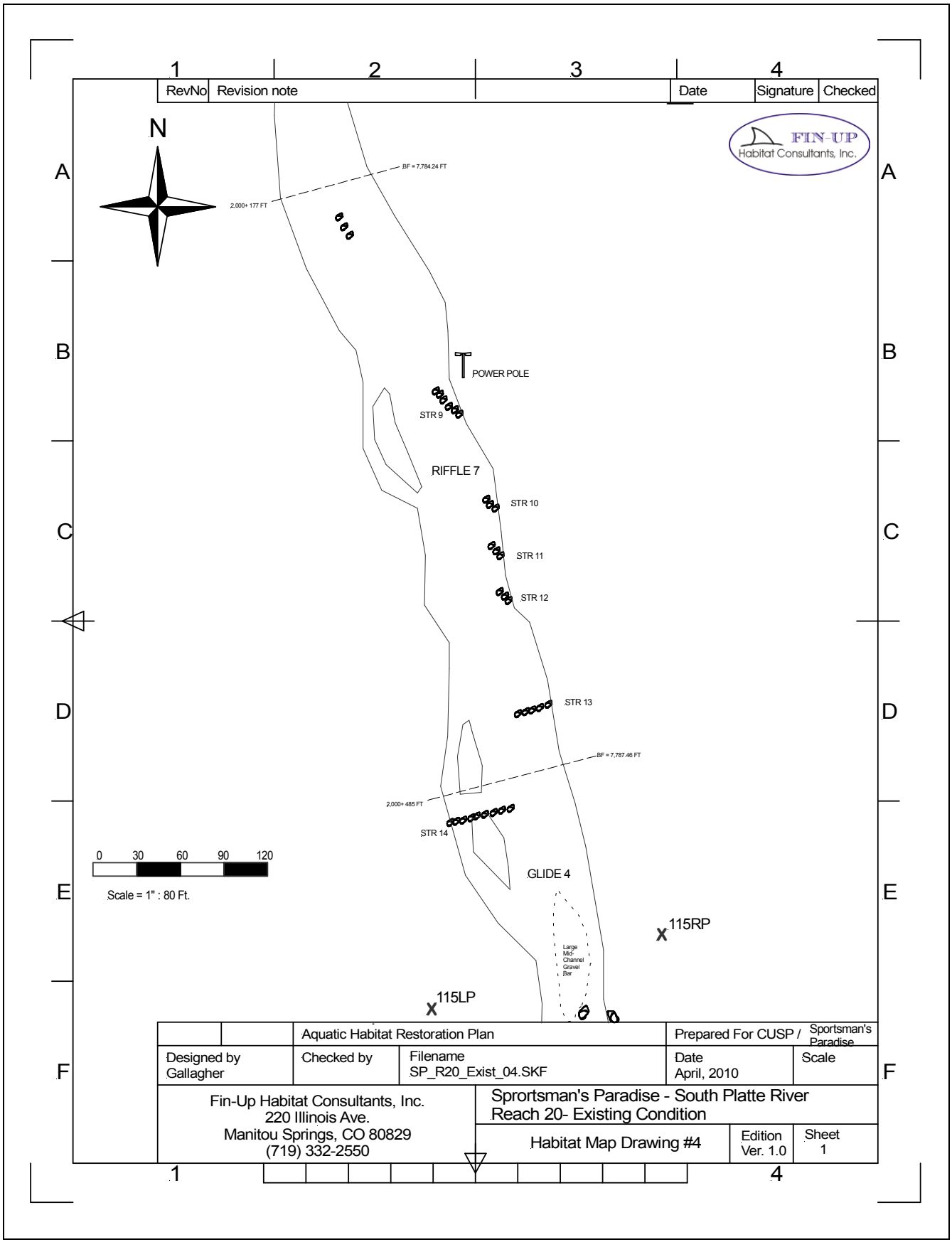
Reach 20 – Habitat Map Drawing #4:

This drawing shows the segment of Reach 20 from 0+2,100 ft to 0+2,650 ft along the longitudinal axis of the river. The segment consists of a long, straight channel that consists of a single low gradient cobble dominated riffle and a large glide. There are several mid-channel islands and one very large mid-channel gravel bar that has formed in the segment. This islands are well established, and covered with bar willow and sedge.

Cross Section 115 is found at 0+2,627ft, and transects the center of Glide habitat #4, through the large gravel bar that has formed downstream of two extremely large boulders in the center of the channel at the top of the habitat unit. The wetted width at the time of the survey was 67 ft, and the bank-full width of the channel at this point is 84.5 ft. The flood prone width of the channel was determined to be 167 ft. Channel entrenchment was 2.07, and the width/depth ratio was calculated to be 43.

Photo 5: Looking downstream from the mid-channel bar at Cross-Section #114.

Six boulder structures exist in this segment, and consist principally of boulder vanes extending from the stream bank downstream into the channel. Boulder elevations are random, with most of the features ranging from ¾ of the bank-full stage to slightly above bank-full elevation. Two of the vanes are perpendicular to the flow in the channel, and Structure #14, in particular, is responsible for an over-widening of the channel at this point. Most of the smaller vanes on the right bank are creating additional shear along the bank downstream of each feature.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STR 10
STR 11
STR 12
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GLIDE 4
115RP
Large Mid-Channel Gravel Bar
115LP
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Aquatic Habitat Restoration Plan
Prepared For CUSP / Sportsman's Paradise
Designed by Gallagher
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Date April, 2010
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Reach 20- Existing Condition
Habitat Map Drawing #4
Edition Ver. 1.0
Sheet 1

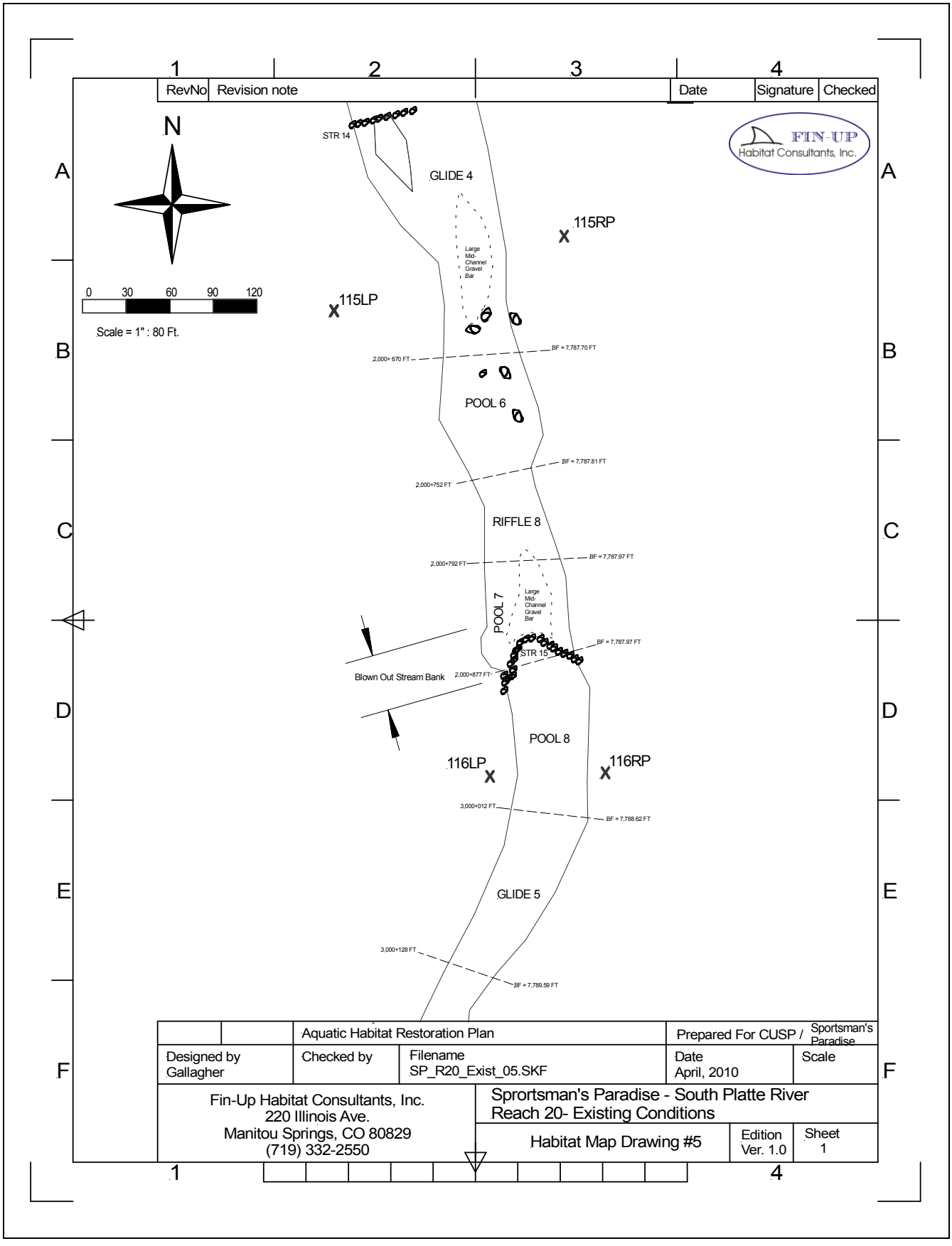
Reach 20 – Habitat Map Drawing #5:

This drawing shows the segment of Reach 20 from 0+2,500 ft to 0+3,150 ft along the longitudinal axis of the river. The segment is a continuation of the long, straight channel in the previous segment, and consists of two pools, two glides, a single low gradient boulder dominated riffle. There are two very large mid-channel gravel bars that have formed in the segment. The downstream bar is associated with large boulders in the center of the channel, and the upstream bar is directly associated with a constructed structure.

Two cross-sections are located in this segment. Cross-Section 115 has been previously described. Cross Section 116 is found at 0+2,943 ft, and transects the upper third of Pool habitat #8. The wetted width at the time of the survey was 56 ft, and the bank-full width of the channel at this point is 58 ft. The flood prone width of the channel was determined to be 83 ft. Channel entrenchment was 1.39, and the width/depth ratio was calculated to be 32.

Photo 6: View downstream from Cross-Section #115 to Structure #15 and the large boulders at Glide 4.

Two structures are found in this segment, consisting of boulder vanes extending into the channel. Boulder elevations are random, with most of the boulder top elevations ranging from ¾ of the bank-full stage to slightly above bank-full. Structure #14 has been previously described. Structure #15 consists of a boulder drop structure that completely spans the active channel, and is oriented so that the vanes forming the feature extend downstream. The structure is constructed at or near the bank-full stage elevation throughout it's legnth, and is likely the cause of the large mid-channel sediment bar that has formed downstream. The structure is creating some additional depth in Pool #8, but also functions as a significant sediment trap, holding back a considerable quantity of fine sediment in the pool. The consequence of the downstream orientation of the feature is evident, particularly on the left river bank downstream in Pool #7, where a significant blow-out of the left bank has occurred. Gradual over-widening of the river channel from this destabilized river bank will likely continue to occur.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115LP
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GLIDE 5
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A
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Aquatic Habitat Restoration Plan
Prepared For CUSP / Sportsman's Paradise
Designed by Gallagher
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Filename SP_R20_Exist_05.SKF
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Reach 20- Existing Conditions
Habitat Map Drawing #5
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Sheet 1

Reach 20 – Habitat Map Drawing #6:

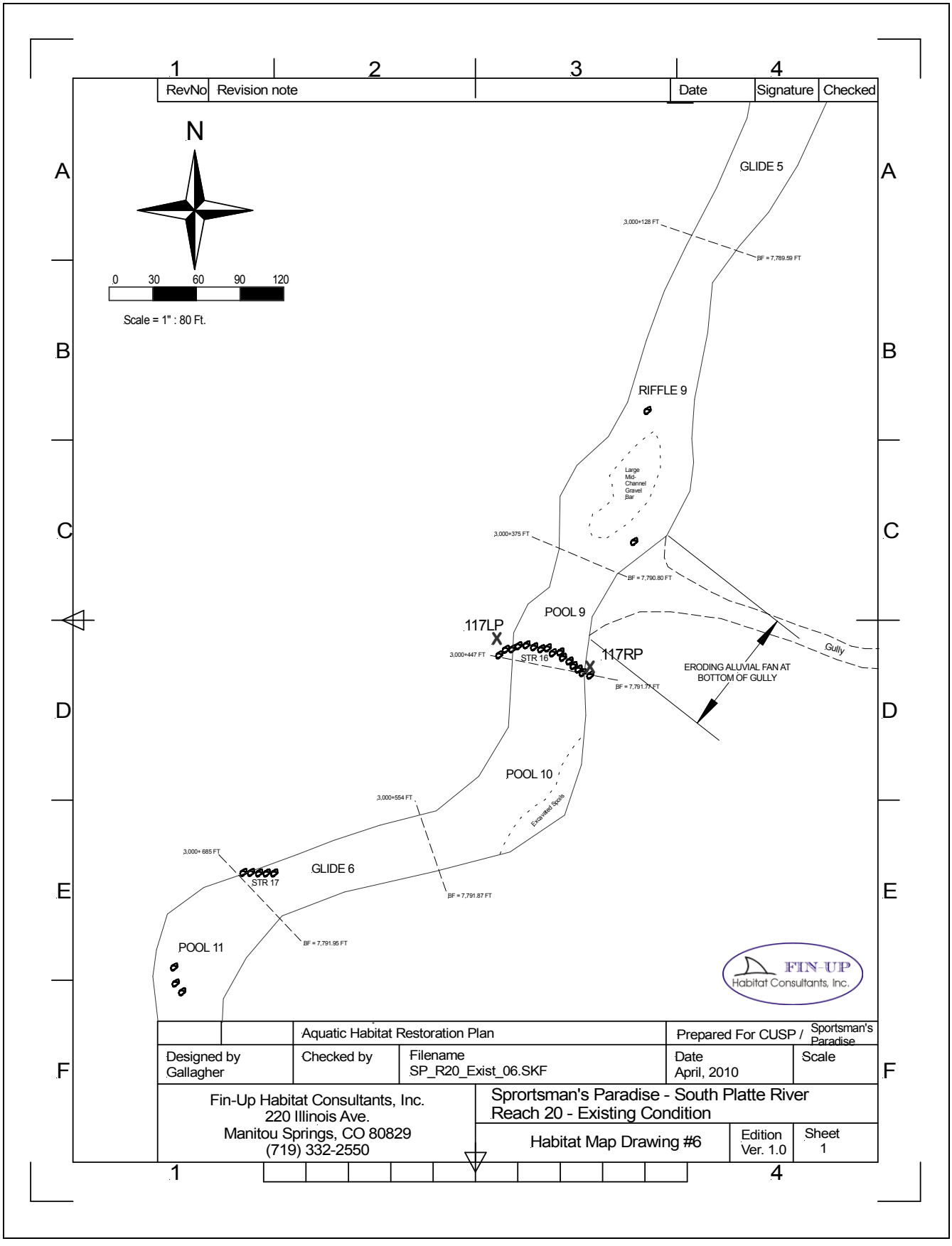
This drawing shows the segment of Reach 20 from 0+3,000 ft to 0+3,800 ft along the longitudinal axis of the river. The segment is a continuation of the long, straight channel in the previous segment, and a large meander in the river to the east. The segment consists of three pools, two glides, a single low gradient boulder dominated riffle. A large gully enters the river on the east at approximately 0+3,375 ft at the riffle crest transition between Riffle #9 and Pool #9. This gully periodically moves significant quantities of sediment into the river, and a large mid-channel gravel bar that has formed in the riffle downstream. The deposition fan of the gully extends into the river channel, and is actively eroding material into the river.

A single cross-section is located in this segment. Cross-Section 117 is found at 0+3,447 ft, and transects the upstream side of Structure #16 between Pool #9 and Pool #10. The wetted width at the time of the survey was 51 feet, and the bank-full width of the channel at this point is 55 ft. The flood prone width of the channel was determined to be 76 ft. Channel entrenchment was 1.38, and the width/depth ratio was calculated to be 21.

Photo 7: View downstream to Cross-Section #117. Note the dredged spoils on the right bank.

Two structures are found in this segment, consisting of boulder vanes extending into the channel. Boulder elevations are generally random and similar to other structures in the survey. Structure #16 consists of a boulder drop structure that completely spans the active channel, and is oriented so that the vanes forming the feature are perpendicular to the direction of flow. The structure is at or near the bank-full stage elevation throughout its length, and has captured a large quantity of sediment behind the feature in Pool 10. There has been at least one attempt to dredge the accumulated sediment. Spoils from this effort were piled along the right river bank, but have, for the most part, sloughed back into the channel. The alignment of the structure has increased shear along both river banks downstream in Pool #9. While large rip-rap has protected the road fill slope on the right bank, there is some evidence of erosion and loss of bank on the left side.

Structure #17 consists of a small rock vane on the left side of the channel near the top of Glide #6. While the alignment of the structure is reversed from what would be the preferred orientation of this type, robust riparian willow immediately downstream appear to be protecting the river bank from additional shear forces created by this feature.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RIFFLE 9
Large Mid-Channel Gravel Bar
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POOL 9
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STR 16
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Gully
ERODING ALUVIAL FAN AT BOTTOM OF GULLY
POOL 10
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Excavated Spoils
3,000+ 685 FT
STR 17
GLIDE 6
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POOL 11
BF = 7,791.95 FT
FIN-UP
Habitat Consultants, Inc.
Aquatic Habitat Restoration Plan
Prepared For CUSP / Sportsman's Paradise
Designed by Gallagher
Checked by
Filename SP_R20_Exist_06.SKF
Date April, 2010
Scale
Fin-Up Habitat Consultants, Inc.
220 Illinois Ave.
Manitou Springs, CO 80829
(719) 332-2550
Sprortsman's Paradise - South Platte River
Reach 20 - Existing Condition
Habitat Map Drawing #6
Edition Ver. 1.0
Sheet 1
A
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Reach 20 – Habitat Map Drawing #7:

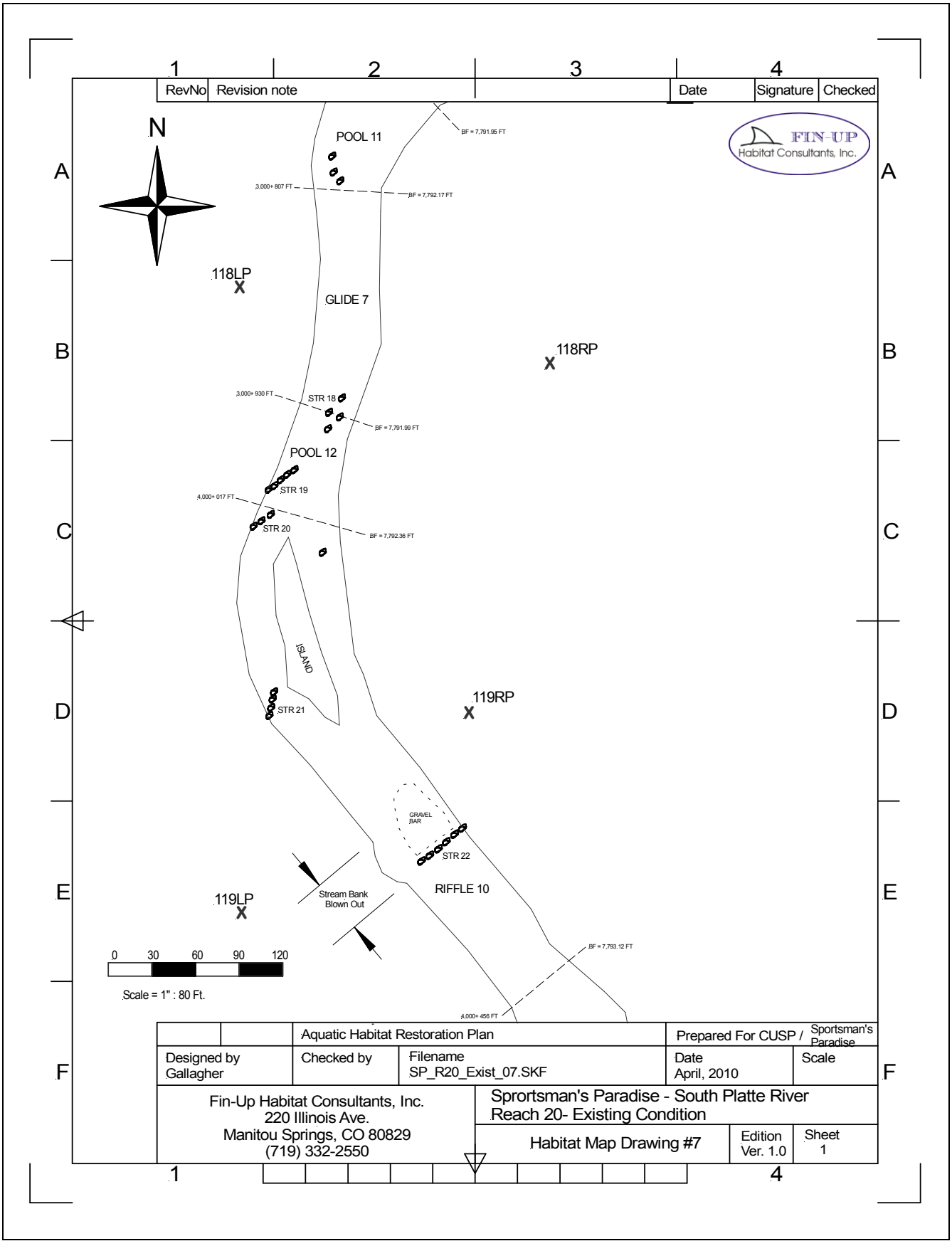
This drawing shows the segment of Reach 20 from 0+3,700 ft to 0+4,500 ft along the longitudinal axis of the river. The segment is a continuation of the large meander in the river to the east. The segment consists of two pools, one glide, and a single long, low gradient, gravel dominated riffle. There is one large mid-channel island that has formed in the segment. This island is well established, and covered with bar willow and sedge. There is also one large mid-channel gravel bar that has formed downstream of a structure within the long low gradient riffle.

Two cross-sections are found within this segment. One of the cross-sections is located within a glide habitat, and one within the long, low gradient gravel riffle. Cross-Section 118 is found at 0+3,891ft, across a representative segment of Glide #7. The wetted width at the time of the survey was 47 feet, and the bank-full width of the channel at this point is 52 ft. The flood prone width of the channel was determined to be 215 ft. Channel entrenchment was 4.02, and the width/depth ratio was calculated to be 29.

Cross-Section 119 is found at 0+4,256 ft, through the center of Riffle #10, and downstream of Structure #22. The wetted width at the time of the survey was 57 feet, and the bank-full width of the channel at this point is 67 ft. The flood prone width of the channel was determined to be 200 ft. Channel entrenchment was 2.97, and the width/depth ratio was calculated to be 45.

Photo 8: View downstream to Cross-Section #119 and Structure #22.

Five structures are found in this segment, and consist of boulder vanes extending from the stream bank both downstream into the channel and perpendicular to the direction of flow. Additionally, there is a boulder cluster structure found near the tail-out of Pool #12. Boulder elevations are random, with most of the features ranging from ¾ of the bank-full stage to slightly above bank-full elevation. Structure #22, is responsible for an over-widening of the channel and a small river bank blow-out on the left side, as well as the formation of a mid-channel sediment bar downstream. The three smaller vanes on the left bank are creating additional shear along the outside of the meander bend, resulting in the river bank downstream of each feature exhibiting signs of erosion and failure.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Date
Signature
Checked
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Habitat Consultants, Inc.
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BF = 7,792.17 FT
118LP
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STR 18
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POOL 12
STR 19
4,000+ 017 FT
STR 20
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STR 21
GRAVEL BAR
STR 22
RIFFLE 10
Stream Bank Blown Out
119LP
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Scale = 1" : 80 Ft.
BF = 7,793.12 FT
4,000+ 456 FT
Aquatic Habitat Restoration Plan
Prepared For CUSP / Sportsman's Paradise
Designed by Gallagher
Checked by
Filename SP_R20_Exist_07.SKF
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220 Illinois Ave.
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Sprortsman's Paradise - South Platte River
Reach 20- Existing Condition
Habitat Map Drawing #7
Edition Ver. 1.0
Sheet 1

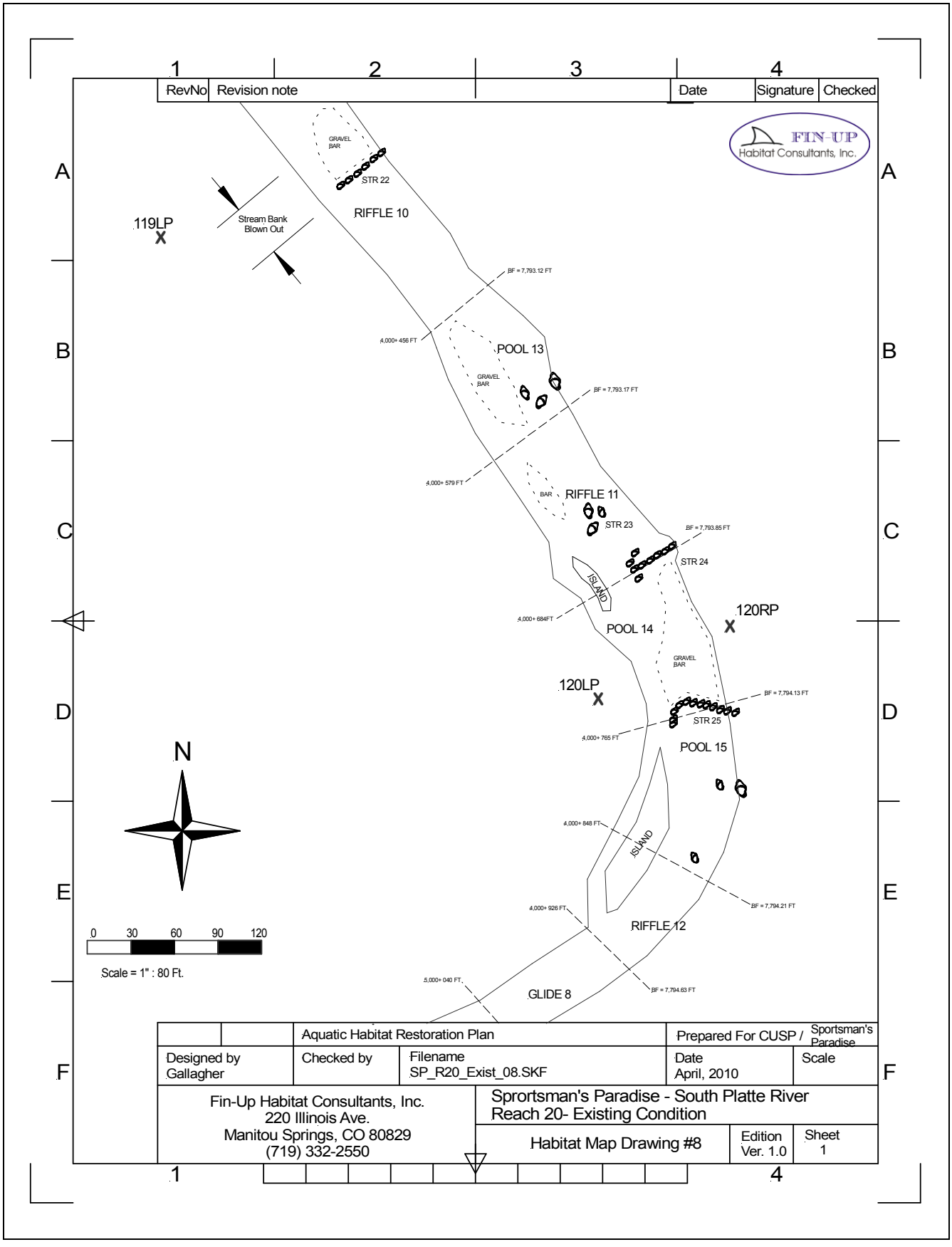
Reach 20 – Habitat Map Drawing #8:

This drawing shows the segment of Reach 20 from 0+4,250 ft to 0+5,050 ft along the longitudinal axis of the river. The segment is dominated for the most part by a large meander in the river to the northwest. The segment consists of three riffles, three pools, and one glide habitat. Each of the riffles exhibit a low gradient, with two dominated by gravel substrate, and one consisting of larger cobble materials. Two of the pools are formed by a structure in the channel, with the remaining pool formed by a natural constriction of the channel by large boulders. One large and one small mid-channel island have formed in the segment. The islands are well established, and covered with bar willow and sedge. There are also several large mid-channel sediment bars in the segment. For the most part, these are directly associated with structure installations.

There is one cross-section found within this segment. Cross-Section 120 is found at 0+4,709 ft, and transects the pool immediately downstream of Structure #25. The wetted width at the time of the survey was 68 feet, and the bank-full width of the channel at this point is 70 ft. The flood prone width of the channel was determined to be 89 ft. Channel entrenchment was 1.36, and the width/depth ratio was calculated to be 42. Maximum depth of the pool at the time of the survey was 3.2 ft, and bank-full maximum depth was 4.1 ft. Residual pool depth was 2.2 ft.

Photo 9: View downstream to Cross-Section #120 and Structure #25.

Four structures are found in this segment, and consist of boulder vanes extending from the stream bank both downstream into the channel and perpendicular to the direction of flow. Additionally, there is a boulder cluster structure found near the middle of Riffle #12. Boulder elevations are random, with most of the features ranging from ¾ of the bank-full stage to slightly above bank-full elevation. Structure #24 is causing over-widening of the channel and a small river bank blow-out on the right side. Structure #23, a boulder cluster, is likely causing the formation of a mid-channel sediment bar downstream on the left third of the channel. Structure #25 consists of a boulder drop structure that has failed on the left side of the channel. The structure is oriented so that the right vane extends downstream, increasing the shear forces on the downstream right bank. The structure is at or near the bank-full stage elevation throughout its length, and has captured a large quantity of sediment behind the feature in Pool 15.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RevNo
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Signature
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FIN-UP
Habitat Consultants, Inc.
GRAVEL BAR
STR 22
RIFFLE 10
119LP
Stream Bank Blown Out
BF = 7,793.12 FT
4,000+ 456 FT
POOL 13
GRAVEL BAR
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4,000+ 579 FT
BAR
RIFFLE 11
STR 23
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STR 24
ISLAND
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GRAVEL BAR
120LP
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STR 25
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POOL 15
4,000+ 848 FT
ISLAND
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4,000+ 926 FT
RIFFLE 12
5,000+ 040 FT
GLIDE 8
BF = 7,794.63 FT
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Aquatic Habitat Restoration Plan
Prepared For CUSP / Sportsman's Paradise
Designed by Gallagher
Checked by
Filename SP_R20_Exist_08.SKF
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Scale
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220 Illinois Ave.
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Sprortsman's Paradise - South Platte River
Reach 20- Existing Condition
Habitat Map Drawing #8
Edition Ver. 1.0
Sheet 1

Reach 20 – Habitat Map Drawing #9:

This drawing shows the segment of Reach 20 from 0+4,250 ft to 0+5,050 ft along the longitudinal axis of the river. The segment is characterized by a meander in the river to the northeast. The segment consists of all or part of three riffles, four pools, and three glide habitats. Each of the riffles exhibits low gradient, with two dominated by gravel substrate, and one consisting of larger cobble materials. All of the pools are associated with structures placed in the channel. One large mid-channel island has formed in the segment. The island is well established, and covered with bar willow and sedge. There are also several large mid-channel sediment bars in the segment. For the most part, these are also associated with structure installations.

There are two cross-sections found within this segment. Cross-Section 121 is found at 0+5,250 ft, at the riffle crest forming the transition from Glide #9 and Riffle #13. The wetted width at the time of the survey was 78 feet, and the bank-full width of the channel at this point is 87 ft. The flood prone width of the channel was determined to be 137 ft. Channel entrenchment was 1.64, and the width/depth ratio was calculated to be 45. Cross-Section 122 is found at 0+5,375 ft, and transects the upstream side of Structure #26 between Pool #16 and Pool #17. The wetted width at the time of the survey was 58 feet, and the bank-full width of the channel at this point is 65 ft. The flood prone width of the channel was determined to be 93 ft. Channel entrenchment was 1.47, and the width/depth ratio was calculated to be 34.

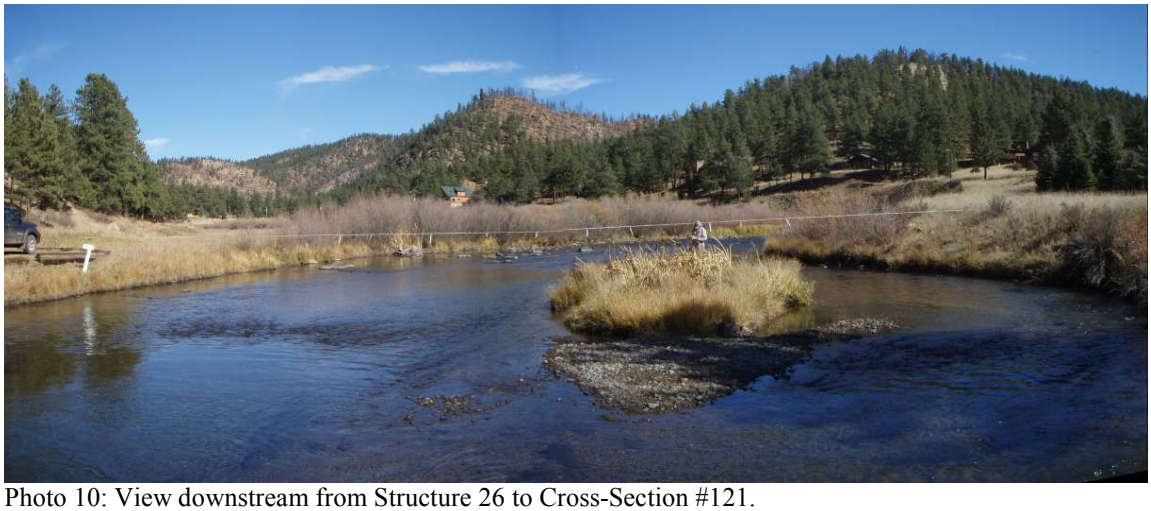
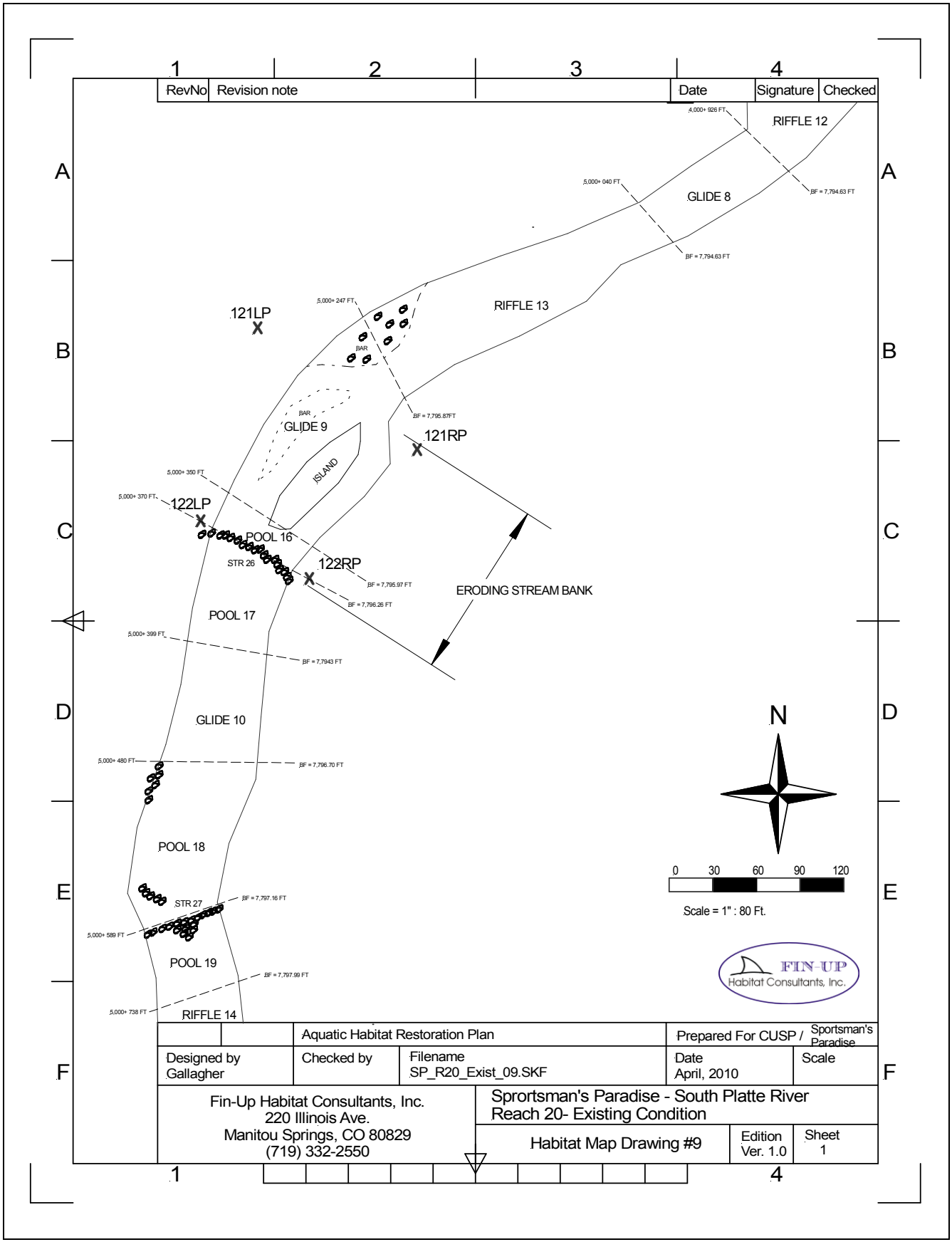


Photo 10: View downstream from Structure 26 to Cross-Section #121.

Two structures are found in this segment, and consist of boulder drop structures extending completely across the active channel, and aligned perpendicular to the direction of flow. Boulder elevations are entirely random, with most of the features ranging from ¾ of the bank-full stage to slightly above bank-full elevation. Structure #26 is quite high in the center of the channel, and has formed a large island immediately downstream. The structure is slightly lower on the right side of the channel, and has directed much of the flow into the smaller right channel downstream. This has, in turn, resulted in much higher shear on the right bank on the inside of the river meander, and this bank has partially failed. The higher elevation of the left side of the structure has resulted in loss of usable pool habitat in Pool #16 and the formation of a gravel bar on the left side of the channel in Glide #9. Structure #27 consists of a boulder drop structure with some additional randomly placed boulders along the center and left side of the structure. The structure may be low enough that a significant downstream bar has not yet formed, but it is causing stress to the downstream left bank and gradual over-widening of the channel.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121RP
GLIDE 9
ISLAND
BAR
122LP
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STR 26
122RP
ERODING STREAM BANK
POOL 17
GLIDE 10
POOL 18
STR 27
POOL 19
RIFFLE 14
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0 30 60 90 120
Scale = 1" : 80 Ft.
FIN-UP
Habitat Consultants, Inc.
Aquatic Habitat Restoration Plan
Prepared For CUSP / Sportsman's Paradise
Designed by Gallagher
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Filename SP_R20_Exist_09.SKF
Date April, 2010
Scale
Fin-Up Habitat Consultants, Inc.
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Sprortsman's Paradise - South Platte River
Reach 20- Existing Condition
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Edition Ver. 1.0
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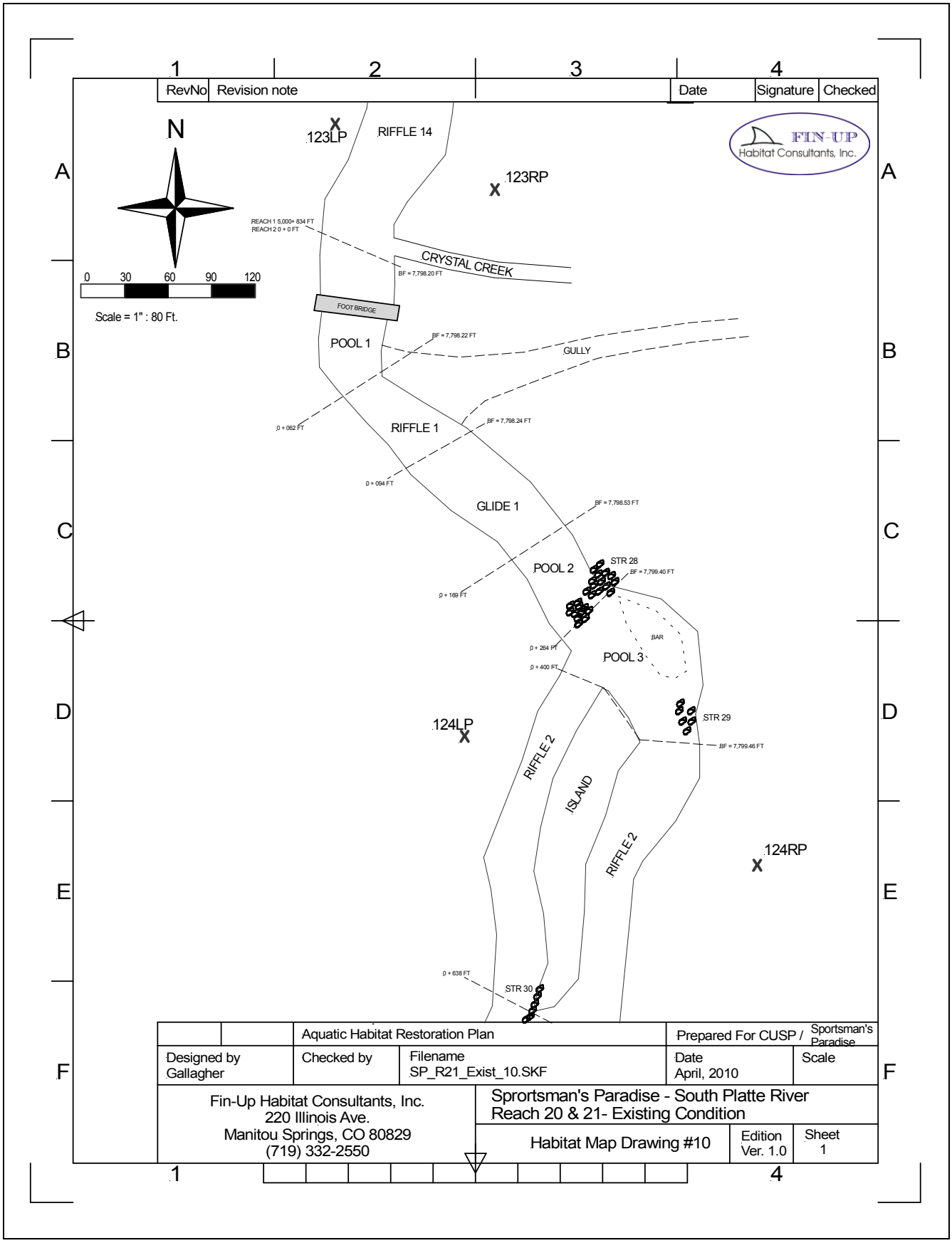
Reach 20 / Reach 21 – Habitat Map Drawing #10:

This drawing shows the segment of Reach 20 from 0+5,050 ft to the end of the reach at the confluence of the South Platte River and Crystal Creek; at 0+5,384 ft. Reach 21 begins upstream of the confluence with Crystal Creek, and the segment described here extends upstream of the reach boundary to 0+638 ft. The segment is characterized by two relatively tight meander bends in the river. The segment consists of the upstream half of Riffle #14 in Reach 20, as well as two riffles, three pools, and one glide habitat in Reach 21. Each of the riffles exhibits low gradient, and are dominated by larger cobble materials. Pool #1 is a naturally forming pool caused by scour along the tight meander bend of the channel. The outside of the meander consists of large boulder and bedrock, resulting in a very deep scour along the outside third of the channel. A footbridge crosses the river above this pool. The other pools are associated with a structure placed in the active channel. A large island has formed upstream of these pools, and is covered with bar willow and sedge. A large gully enters the river on the east at approximately 0+062 ft at the first riffle in the reach. This gully, likely formed by a breach flood event along Crystal Creek following the Hayman Fire, periodically moves significant quantities of sediment into the river, and has formed a deposition fan that extends into the river channel, and is actively eroding material into the river.

Two cross-sections are included within this segment. Cross Section 123 is located within Riffle #14 of Reach 20; at 0+5,325 ft, 59 ft downstream of the confluence with Crystal Creek. The wetted width at the time of the survey was 55 feet, and the bank-full width of the channel at this point is 70 ft. The flood prone width of the channel was determined to be 110 ft. Channel entrenchment was 1.58, and the width/depth ratio was calculated to be 36. Cross Section 124 is located within Riffle #2 of Reach 21; at 0+459 ft along the longitudinal axis of the river. The wetted width at the time of the survey was 77.5 feet, and the bank-full width of the channel at this point is 159 ft. The flood prone width of the channel was determined to be 189 ft. Channel entrenchment was 1.13, and the width/depth ratio was calculated to be 122. This segment of the river was one of the most severely over-wide segments within the property, and may be attributed to the unintended effects of structures placed both upstream and downstream of this riffle.


Photo 11: Reach 21-Riffle #2 and Cross-Section #124.

Three structures are found in this segment, and consist of boulders piled into the active channel. Some are aligned perpendicular to the direction of flow, and elevations appear to be entirely random, with most of the features ranging from ¾ of the bank-full stage to slightly above bank-full elevation. Structure #28 is a failed full-channel drop structure, and is quite high in the center of the channel, and along the right leg of the structure. The structure breach on the left side has resulted in much higher shear on the left bank on the inside of the river meander, and this bank has partially failed. The higher elevation of the right side of the structure, and the random boulder cluster forming Structure #29 near the top of Pool #3, has resulted in loss of usable pool habitat in the pool, and the formation of a gravel bar on the outside of the meander bend. Structure #30 consists of a long boulder vane aligned parallel with the direction of flow, and is described in detail in the next segment.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Habitat Consultants, Inc.
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FOOT BRIDGE
POOL 1
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GULLY
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RIFFLE 1
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0 + 094 FT
GLIDE 1
BF = 7,798.53 FT
0 + 169 FT
POOL 2
STR 28
BF = 7,799.40 FT
BAR
0 + 264 FT
POOL 3
0 + 400 FT
STR 29
124LP
BF = 7,799.46 FT
RIFFLE 2
ISLAND
RIFFLE 2
124RP
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Aquatic Habitat Restoration Plan
Prepared For CUSP / Sportsman's Paradise
Designed by Gallagher
Checked by
Filename SP_R21_Exist_10.SKF
Date April, 2010
Scale
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Sprortsman's Paradise - South Platte River
Reach 20 & 21- Existing Condition
Habitat Map Drawing #10
Edition Ver. 1.0
Sheet 1
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Reach 21 – Habitat Map Drawing #11:

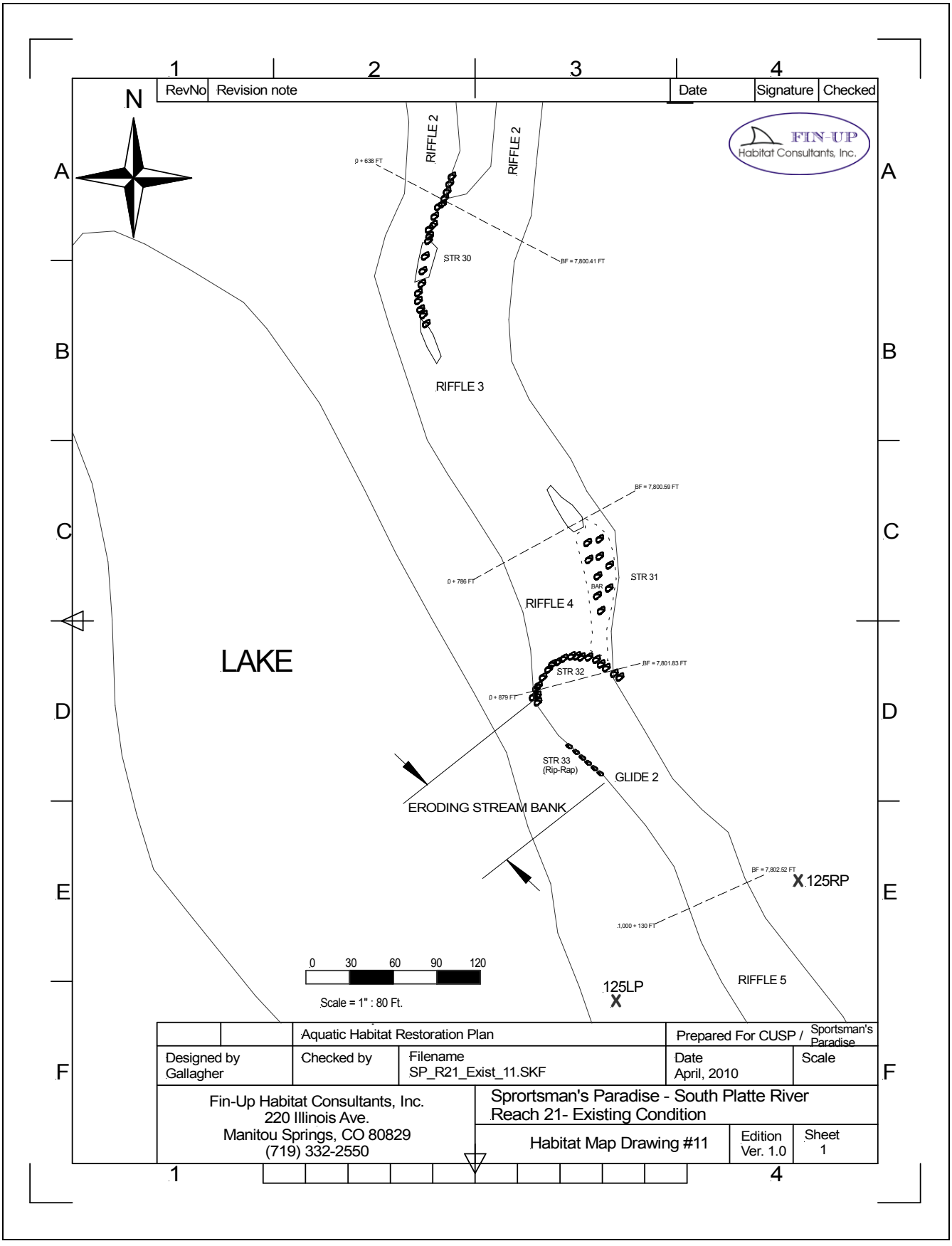
This drawing shows the segment of Reach 21 from 0+600 ft to 0+1,200 ft along the longitudinal axis of the river. The segment is characterized by a long, relatively straight channel and low gradient. The channel along this segment has likely been altered long ago by the construction of the small off-channel lake on the west side of the river. The segment consists of all or part of four riffles and one glide habitat. The riffles are a mix of low gradient and higher gradient pocket water types, and are dominated by cobble and boulder substrates. The glide is associated with a structure placed in the channel. One small mid-channel island and an associated sediment bar have formed in the segment. The island is well established, and covered with bar willow and sedge. For the most part, these are also associated with structure installations.

There is one cross-section found within this segment. Cross-Section 125 is found at 0+1,135 ft, at the the transition from Glide #2 to Riffle #5. . The wetted width at the time of the survey was 52.5 feet, and the bank-full width of the channel is 64 ft. The flood prone width of the channel was determined to be 145 ft. Channel entrenchment was 1.77, and the width/depth ratio was calculated to be 25.

Photo 12: View downstream from Structure 30 to the island in Riffle #2 and Cross-Section #124.

Four structures are found in this segment, consisting of boulders placed at random intervals in the channel. The elevations of most of the boulders appear to be entirely random; and most range from ¾ of the bank-full stage to slightly above bank-full elevation. Structure #30 consists of a boulder vane located in the left third of the channel beginning at the upstream end of the large island at Riffle #2 and extending almost 150 ft upstream to a small vegetated island. Many of the boulders are at bank-full-elevation or slightly higher, and the left bank shows signs of stress from high flows. This structure may have been initially installed as armor and rip-rap to protect the outside bank of a meander bend, but has resulted in the channel splitting, resulting in the severe over-widening of the river channel described in the previous segment.

Structure #32 is a full-channel drop structure, oriented so that the vanes extending from the bank point downstream. The structure elevation is fairly consistent across the entire length, and is somewhat less than the bank-full elevation of the channel. As a consequence, there is less shear on the river banks downstream, but still some noticeable over-widening of the channel. The right side of the structure is slightly higher elevation, and in combination with a random series of high boulder clusters that form Structure #31 immediately downstream, has resulted in the formation of a gravel bar on the right third of the channel. Structure #33 consists of a short segment of rip-rap along the left bank of the river immediately upstream of Structure 32. This rip-rap, which has partially failed, appears to have been placed to try to address the actively eroding river bank on the left side of Glide #2.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BAR
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STR 33
(Rip-Rap)
GLIDE 2
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125RP
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30
60
90
120
Scale = 1" : 80 Ft.
125LP
RIFFLE 5
Aquatic Habitat Restoration Plan
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Designed by
Gallagher
Checked by
Filename
SP_R21_Exist_11.SKF
Date
April, 2010
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Reach 21- Existing Condition
Habitat Map Drawing #11
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Ver. 1.0
Sheet
1

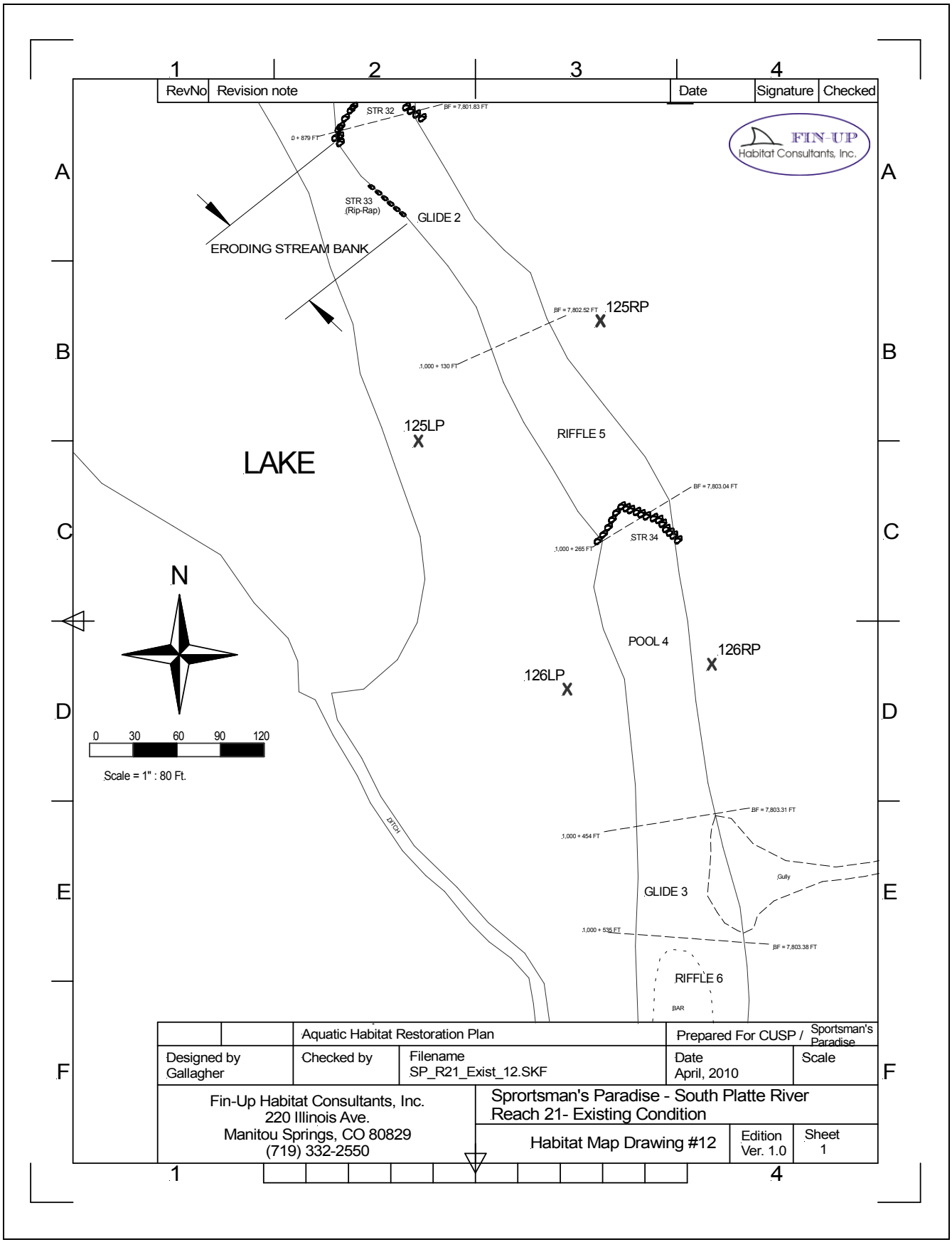
Reach 21 – Habitat Map Drawing #12:

This drawing shows the segment of Reach 21 from 0+880 ft to 0+1,600 ft along the longitudinal axis of the river. The segment is characterized by gradual meander of the channel to the northwest, and is relatively low gradient. As was the case in the previous segment, the channel along this segment likely was altered long ago by the construction of the small off-channel lake on the west side of the river. The segment consists of all or part of two riffles, two glides, and one pool habitat. The riffles are a mix of low gradient and higher gradient pocket water types, and are dominated by cobble and boulder substrates. One glide is associated with a structure placed in the channel, and is characterized by uniform depth and laminar flow velocities due to the accumulation of sediment upstream of the structure. The other glide is immediately adjacent to a large gully, which enters the river on the east at approximately 0+1,455 ft. This gully periodically moves significant quantities of sediment into the river, and has formed a deposition fan that extends into the river channel. The only pool in the segment is formed by the damming effect of a boulder drop structure.

Two cross-sections are located in this segment. Cross-Section #125 has been described in the previous section. Cross Section #126 is located at 0+1,366 ft along the longitudinal axis of the river reach, near the center of Pool 4. The wetted width at the time of the survey was 44.5 feet, and the bank-full width of the channel at this point is 54 ft. The flood prone width of the channel was determined to be 91 ft. Channel entrenchment was 1.69, and the width/depth ratio was calculated to be 19. The maximum depth of the pool at the time of the survey was 3.1 ft, and the bank-full depth was determined to be over 5 ft. The residual pool depth of the habitat was calculated to be 1.06 ft.

Photo 13: Pool #4, Structure #34, and Cross-Section #126.

Three structures are found in this segment. Structure #32 and #33 have been described in the previous section. Structure #34 consists of a channel spanning boulder drop structure. Like most of the full-channel drop structures on the property, this feature is constructed in a downstream orientation, and is impacting the river banks immediately downstream. Most of the boulders are at less than one half of the bank-full-elevation, however, somewhat lessening the shear effects on the banks and reducing the accumulation of material in the center of the channel. The pool shows signs of accumulating sediment, particularly immediately upstream of the structure.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125LP
RIFFLE 5
LAKE
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Gully
GLIDE 3
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RIFFLE 6
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Aquatic Habitat Restoration Plan
Prepared For CUSP / Sportsman's Paradise
Designed by Gallagher
Checked by
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Date April, 2010
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Sprortsman's Paradise - South Platte River
Reach 21- Existing Condition
Habitat Map Drawing #12
Edition Ver. 1.0
Sheet 1

Reach 21 – Habitat Map Drawing #13:

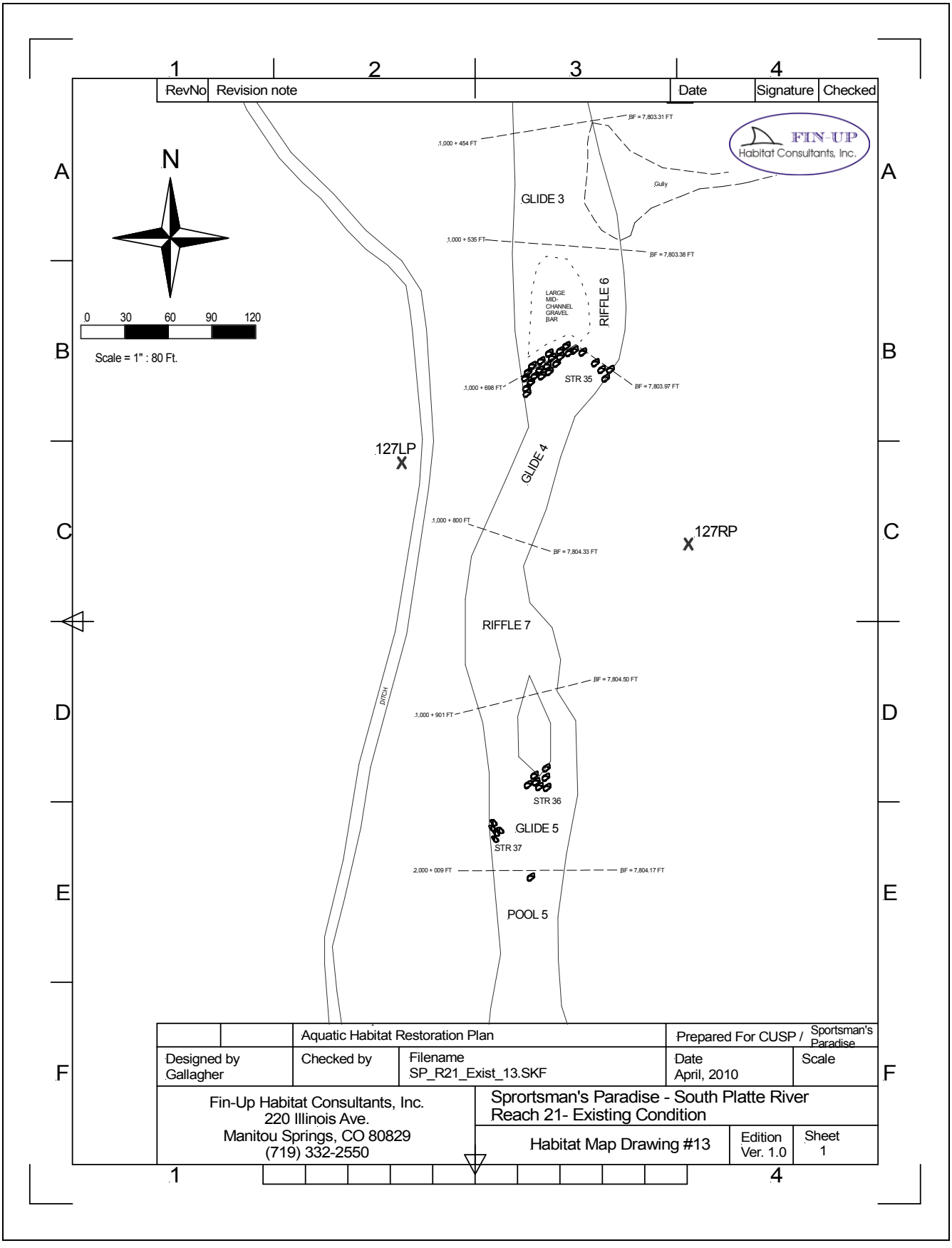
Habitat Map Drawing #13 shows the segment of Reach 21 from 0+1,450 ft to 0+2,100 ft along the longitudinal axis of the river. The segment is relatively straight, and is exhibits a low gradient throughout much of its length. The segment consists of three glides, two riffles, and most of one pool habitat. The riffles are both low gradient, and dominated by cobble sized substrate. Two of the glides are associated with structures placed in the channel, and exhibit uniform depth and laminar flow velocities. The remaining glide is the habitat unit described previously, which is immediately adjacent to a large gully on the east at approximately 0+1,455 ft. The only pool in the segment is formed by a natural narrowing of the channel in the upstream part of the segment. This pool had a maximum depth at the time of the survey of 2.4 ft, and a bank-full depth of 3.5 ft. Residual pool depth was calculated to be 1.1 ft. There is one large mid-channel island and one very large mid-channel gravel bar in the segment. Both of these channel features are the result of structures placed in the channel.

One cross-section exists in this segment. Cross Section #127 is located at 0+1,765 ft along the longitudinal axis of the river reach, in the upstream half of Glide #4. The wetted width at the time of the survey was 45 feet, and the bank-full width of the channel at this point is 51 ft. The flood prone width of the channel was determined to be 189 ft. Channel entrenchment was greater than 3, and the width/depth ratio was calculated to be 21.

Photo 14: Glide #5, Structure #36, and Cross-Section #127.

Three structures are found in this segment. Structure #35 consists of another full-channel boulder drop structure. The structure is constructed in a downstream orientation, and has partially failed on the right side. The result of this failure has been significant over-widening of the channel downstream of the structure, as well as the formation of a significant sediment bar on the left. Most of the boulders are higher than necessary, capturing additional sediment upstream. It is likely that Glide #4 formed due to accumulation of sediments in the dam pool initially created by this structure.

Structure #36 is an accumulation of small boulders and one piece of large wood in the center of the channel in Glide #5. The structure is higher than ½ of the bank-full elevation, and accumulates debris floating downstream during high flows. A large island exists below the structure, and is well established and vegetated. The structure and island effectively split the center of the channel, increasing the shear forces on both banks downstream. Structure #37 consists of a small cluster of boulders on the left bank, and has little hydrological effect on the river or bank.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FIN-UP
Habitat Consultants, Inc.
BF = 7,803.31 FT
1,000 + 454 FT
Gully
GLIDE 3
1,000 + 535 FT
BF = 7,803.38 FT
LARGE MID-CHANNEL GRAVEL BAR
RIFFLE 6
1,000 + 698 FT
STR 35
BF = 7,803.97 FT
127LP
GLIDE 4
1,000 + 800 FT
BF = 7,804.33 FT
127RP
RIFFLE 7
DITCH
BF = 7,804.50 FT
1,000 + 901 FT
STR 36
GLIDE 5
STR 37
2,000 + 009 FT
BF = 7,804.17 FT
POOL 5
Aquatic Habitat Restoration Plan
Prepared For CUSP / Sportsman's Paradise
Designed by Gallagher
Checked by
Filename SP_R21_Exist_13.SKF
Date April, 2010
Scale
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220 Illinois Ave.
Manitou Springs, CO 80829
(719) 332-2550
Sprortsman's Paradise - South Platte River
Reach 21- Existing Condition
Habitat Map Drawing #13
Edition Ver. 1.0
Sheet 1

Reach 20 – Habitat Map Drawing #14:

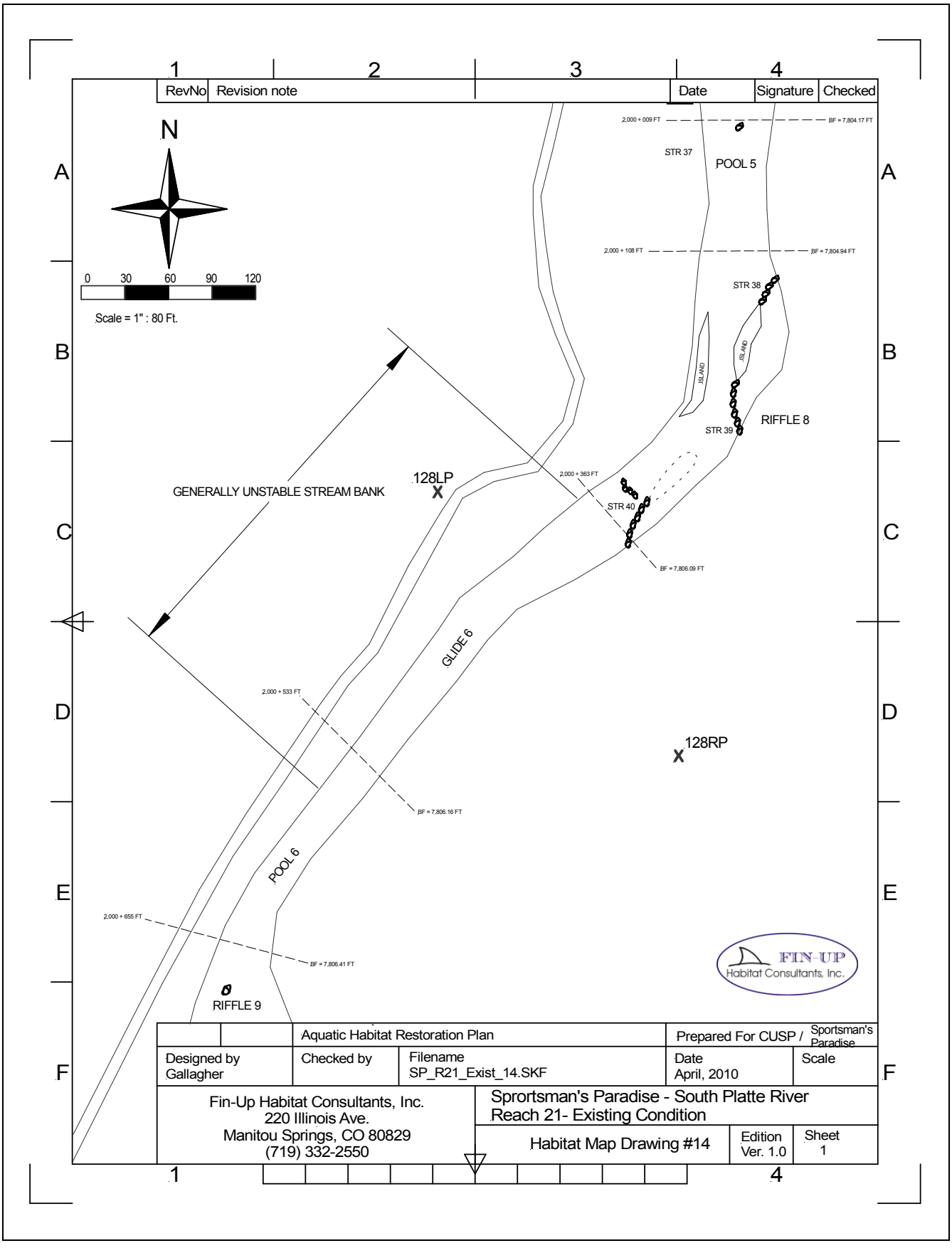
This drawing shows the segment of Reach 21 from 0+2,000 ft to 0+2,700 ft along the longitudinal axis of the river. The segment is characterized by gradual meander of the channel to the northeast, and is low gradient (< 2%) throughout. The segment consists of all or part of two riffles, two pools, and very long glide habitat. The riffles are both low gradient, and dominated by cobble sized substrate. The glide is associated with a structure placed in the channel, and is characterized by uniform depth and laminar flows. One of the pools, Pool #5, was described in the previous segment. The other pool, Pool #6, is formed by a natural constriction and meander bend causing the river scour along outside bend of the channel. Pool #6 had a maximum depth at the time of the survey of 2.4 ft, and a bank-full depth of 4.2 ft. Residual pool depth was calculated to be 1 ft.

There were two mid-channel islands and one very large mid-channel gravel bar in the segment. One of the islands, and the mid-channel bar were likely the result of structures placed in the channel. The entire length of the left bank within Glide #6 was found to be generally unstable, exhibiting sparse vegetation comprised mostly of upland grasses. The left bank throughout this segment forms the fill-slope for the diversion ditch that feeds the small lake, which is perched approximately 6½ feet above the bank-full elevation of the river. The toe of this fill slope is poorly vegetated, and susceptible to shear forces from high flows along the outside of this meander bend

One cross-section exists in this segment. Cross Section #128 is located in Glide #6 at 0+2,401 ft along the longitudinal axis of the river reach, approximately 38 feet upstream of Structure #40. The wetted width at the time of the survey was 48 feet, and the bank-full width of the channel at this point is 58 ft. The flood prone width of the channel was determined to be 209 ft. Channel entrenchment was greater than 3, and the width/depth ratio was calculated to be 30.

Photo 15: The lake diversion ditch, Structure #40, Glide #6, and Cross-Section #128.

Three structures are found in this segment. Structure #35 consists of another full-channel boulder drop structure. The structure is constructed in a downstream orientation, and has partially failed on the right side. The result of this failure has been significant over-widening of the channel downstream of the structure, as well as the formation of a significant sediment bar on the left. Most of the boulders are higher than necessary, capturing additional sediment upstream. It is likely that Glide #4 formed due to accumulation of sediments in the dam pool initially created by this structure.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2,000 + 009 FT
BF = 7,804.17 FT
STR 37
POOL 5
2,000 + 108 FT
BF = 7,804.94 FT
STR 38
ISLAND
ISLAND
STR 39
RIFFLE 8
GENERALLY UNSTABLE STREAM BANK
128LP
2,000 + 363 FT
STR 40
BF = 7,806.09 FT
GLIDE 6
2,000 + 533 FT
128RP
BF = 7,806.16 FT
POOL 6
2,000 + 655 FT
BF = 7,806.41 FT
RIFFLE 9
FIN-UP
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Aquatic Habitat Restoration Plan
Prepared For CUSP / Sportsman's Paradise
Designed by Gallagher
Checked by
Filename SP_R21_Exist_14.SKF
Date April, 2010
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Sprortsman's Paradise - South Platte River
Reach 21- Existing Condition
Habitat Map Drawing #14
Edition Ver. 1.0
Sheet 1

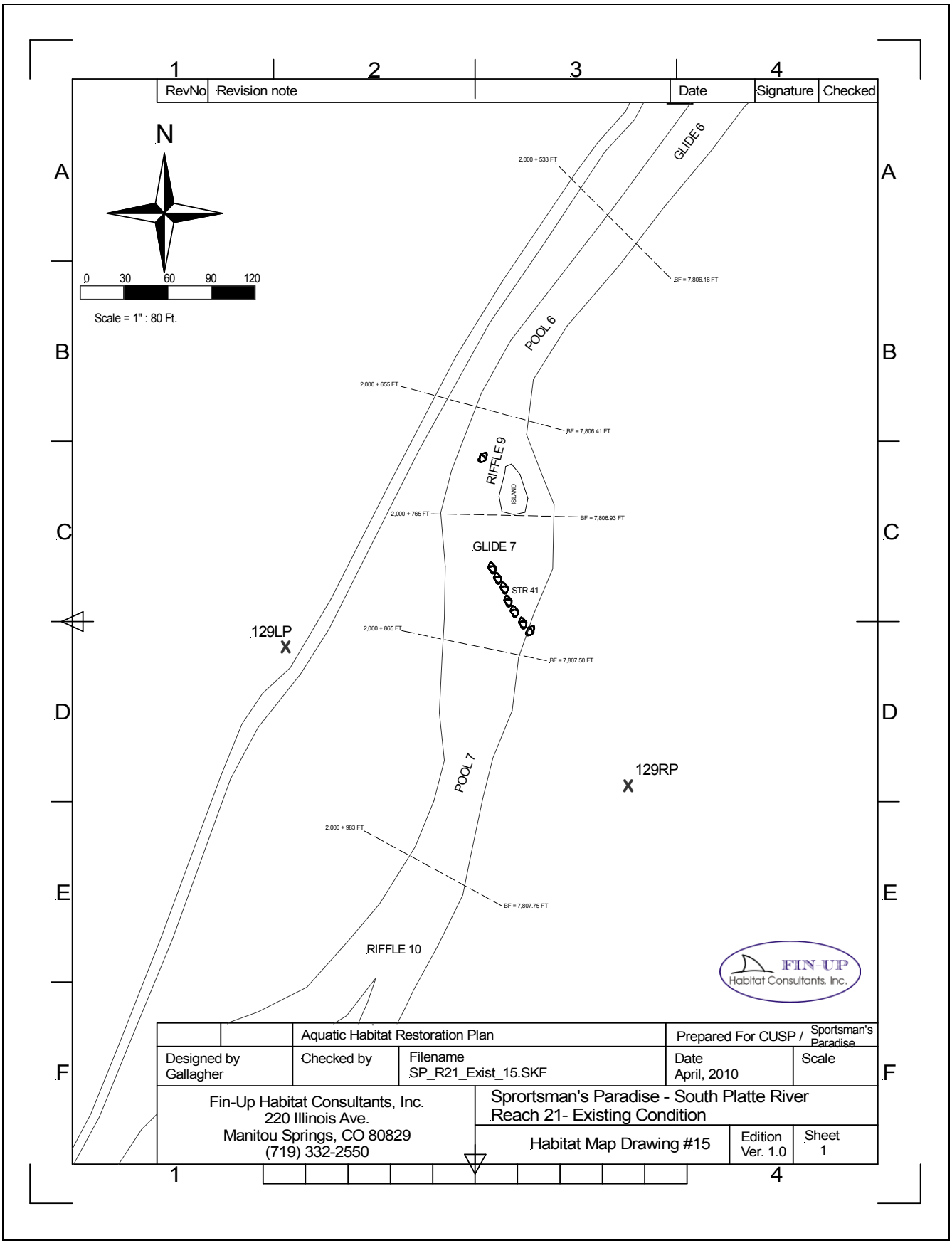
Reach 20 – Habitat Map Drawing #15:

Habitat Map Drawing #15 shows the segment of Reach 21 from 0+2,450 ft to 0+3,100 ft along the longitudinal axis of the river. The segment is relatively straight, and is mostly a low gradient channel throughout much of its length. The segment consists of two glides, two riffles, and two pool habitats. The riffles are a mix of low gradient and higher gradient pocket water types, and are dominated by larger cobble substrates. The two glides are associated with structures placed in the channel. The downstream pool, Pool #6, was described in the previous segment. The other pool, Pool #7, is formed by a natural constriction in the channel, and had a maximum depth at the time of the survey of 1.8 ft, and a bank-full depth of 3.7 ft. Residual pool depth was calculated to be slightly less than 0.8 ft. There is one small mid-channel island in the segment, which was likely formed by a structure upstream in the channel. The island is vegetated with willow and sedge

One cross-section exists in this segment. Cross Section #129 is located at 0+2,919 ft along the longitudinal axis of the river reach, transiting the tail-out of Pool #7. The wetted width at the time of the survey was 54.5 feet, and the bank-full width of the channel at this point is 73 ft. The flood prone width of the channel was determined to be 206 ft. Channel entrenchment was 2.8, and the width/depth ratio was calculated to be 33.

Photo 16: Riffle #10, Pool #7, & Cross-Section #129, from the island in Riffle #10.

Only one structure is located in this segment. Structure #41 consists of a long boulder vane extending from the right bank in Glide #7 downstream to the center of the channel. Most of the boulders are higher ½ of the bank-full elevation, creating a deposition zone downstream of the structure. This has resulted in a small gravel bar and island forming in the center of the channel downstream near the transition from Riffle #9 and Glide #7. The structure increases shear along the right bank downstream, and has resulted in an over-widening of the channel at this point.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GLIDE 6
2,000 + 533 FT
BF = 7,806.16 FT
POOL 6
2,000 + 655 FT
BF = 7,806.41 FT
RIFFLE 9
ISLAND
2,000 + 765 FT
BF = 7,806.93 FT
GLIDE 7
STR 41
129LP
2,000 + 865 FT
BF = 7,807.50 FT
POOL 7
129RP
2,000 + 983 FT
BF = 7,807.75 FT
RIFFLE 10
FIN-UP
Habitat Consultants, Inc.
Aquatic Habitat Restoration Plan
Prepared For CUSP / Sportsman's Paradise
Designed by Gallagher
Checked by
Filename SP_R21_Exist_15.SKF
Date April, 2010
Scale
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220 Illinois Ave.
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Sprortsman's Paradise - South Platte River
Reach 21- Existing Condition
Habitat Map Drawing #15
Edition Ver. 1.0
Sheet 1

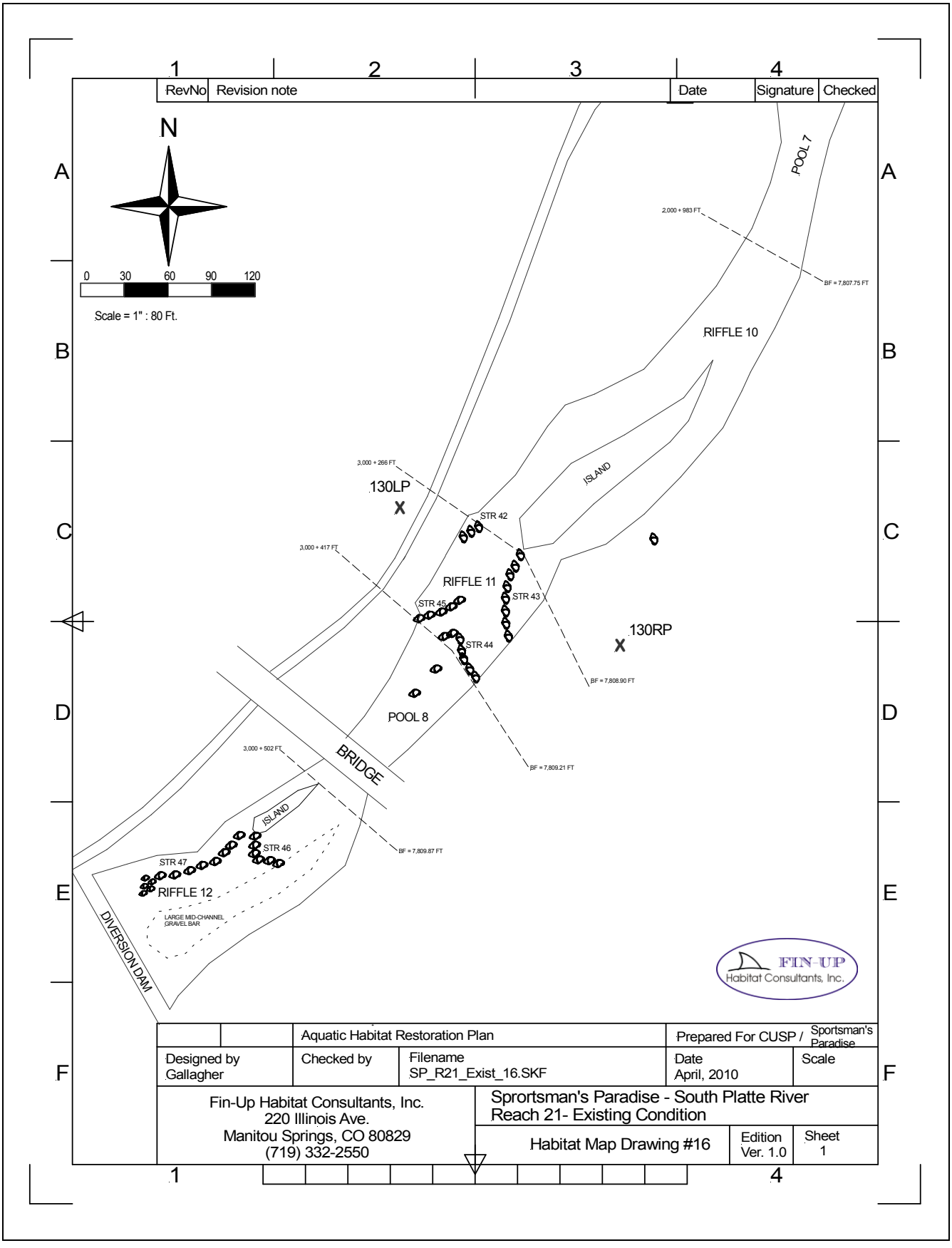
Reach 20 – Habitat Map Drawing #16:

Habitat Map Drawing #16 shows the final segment of Reach 21, from 0+2,900 ft to the end of the reach at the confluence with Vermillion Creek at 0+3,655 ft. The segment consists of three riffles and two pool habitats. The riffles are a mix of low gradient and higher gradient pocket water types, and are dominated by gravel and cobble substrates. The downstream pool, Pool #7, was described in the previous segment. The other pool, Pool #8, is formed by bridge foundation walls which constrict the channel, forcing a vertical scour under the bridge. This pool had a maximum depth at the time of the survey of 2.5 ft, and a bank-full depth of 3.6 ft. Residual pool depth was calculated to be slightly less than 1.2 ft. There is a large mid-channel island in the segment, which was likely formed by structural manipulation in the channel immediately upstream. The island is well established, and vegetated with willow and sedge

One cross-section exists in this segment. Cross Section #130 is located at 0+3,307 ft along the longitudinal axis of the river reach, upstream of the riffle crest between the high gradient pocket water Riffle #10 and the lower gradient Riffle #11. The wetted width at the time of the survey was 74 feet, and the bank-full width of the channel at this point is 79 ft. The flood prone width of the channel was determined to be approximately 188 ft. Channel entrenchment was 2.4, and the width/depth ratio was calculated to be 48. This segment of the river was another of the more severely over-wide segments within the property, and may be attributed to the unintended effects of the numerous structures placed in this riffle.

Photo 17: Riffle #111 & Cross-Section #130 from the bridge. Note the numerous structures in the riffle.

This segment has received more structural work than any other segment within the property. There are six distinct structures within the segment, consisting mostly of boulder vanes and clusters. Structure #43 consists of a long boulder vane extending from the right bank in Riffle #11 downstream to the top of the island in the center of the channel in Riffle#10. Many of the boulders are higher ½ of the bank-full elevation, and deflect low flows into the left channel. Vegetation along the right bank downstream of this structure consists mostly of upland grasses and a few sedges, and this bank shows signs of stress from increased shear from flows defected into the bank by this structure. Structure #44 is located only a few feet upstream, extending from the right bank approximately 2/3 across the width of the channel. This structure resembles a reversed J-hook vane structure, and has significantly increased erosional stress on the right bank immediately downstream.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Revision note
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Signature
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BF = 7,807.75 FT
RIFFLE 10
3,000 + 266 FT
130LP
ISLAND
STR 42
3,000 + 417 FT
RIFFLE 11
STR 43
STR 45
130RP
STR 44
BF = 7,808.90 FT
POOL 8
BRIDGE
3,000 + 502 FT
BF = 7,809.21 FT
ISLAND
STR 46
STR 47
BF = 7,809.87 FT
RIFFLE 12
LARGE MID-CHANNEL GRAVEL BAR
DIVERSION DAM
FIN-UP Habitat Consultants, Inc.
Aquatic Habitat Restoration Plan
Prepared For CUSP / Sportsman's Paradise
Designed by Gallagher
Checked by
Filename SP_R21_Exist_16.SKF
Date April, 2010
Scale
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Sprortsman's Paradise - South Platte River
Reach 21- Existing Condition
Habitat Map Drawing #16
Edition Ver. 1.0
Sheet 1

Structures #42 and 45 consist of boulder vanes extending from the left bank of Riffle #11, extending downstream across one third of the channel width. These structures exhibit similar characteristics to Structure #43, resulting in increased erosion along the downstream bank and causing over-widening of the channel. In addition to these structures, there are several random boulder placements in Riffle #11, as well as three pieces of large wood. The elevations of all of these features are greater than ½ of the bank-full stage, and their effectiveness in creating habitat for resident trout is somewhat limited.

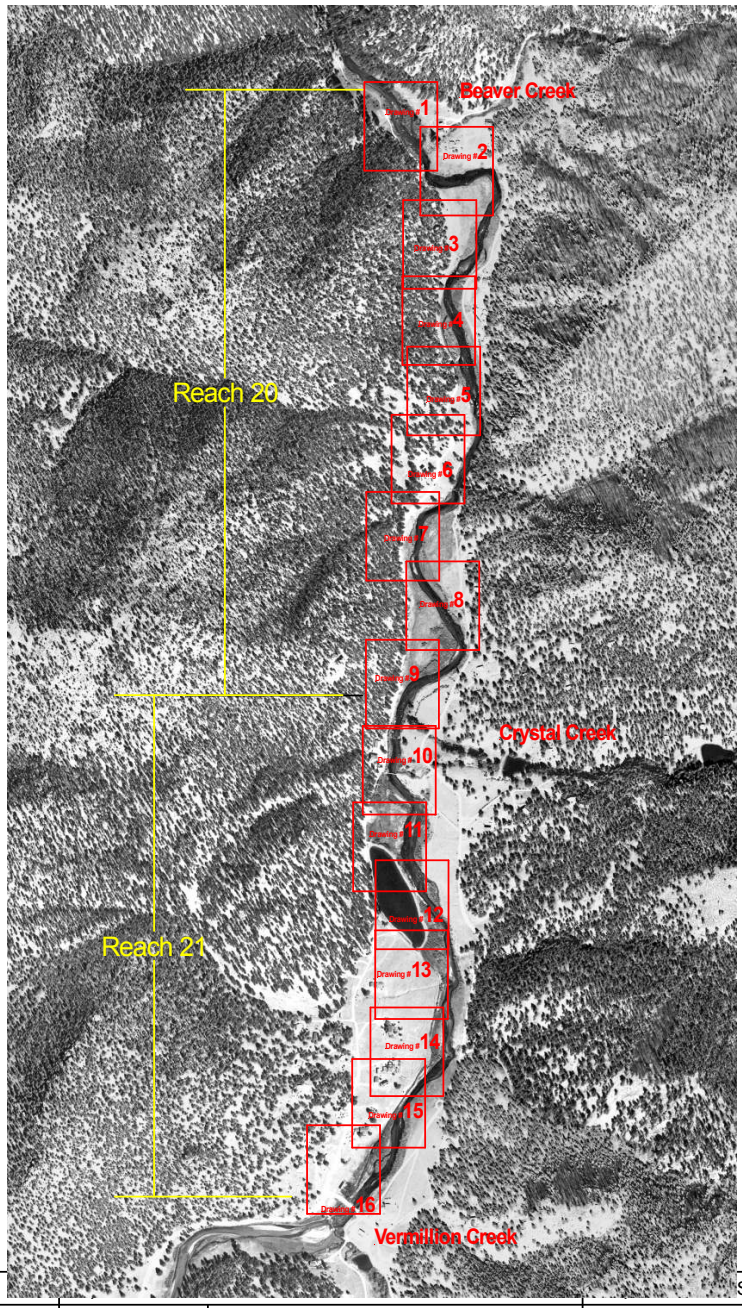
Upstream of the bridge, two more boulder structures are found in Riffle #12. Riffle #12 is also influenced by the large diversion dam at the top of the reach. Three distinct channels are found in the riffle, with the channel on the left being formed by a long boulder vane, Structure #47, which is oriented parallel to the direction of flow. A large gravel bar has formed in right third of the channel, creating the right channel, and is likely the result of the diversion dam being somewhat higher in elevation immediately upstream of this feature. The final structure in the segment, structure #46, consists of a boulder cross-vane in the center channel. The cross-vane is tied into a small island on the right side and the gravel bar on the left. The structure appears to be functioning, but functions more like a boulder cluster at high flows due to the feature not extending to the left and right bank at the bank-full elevation.

Habitat Enhancement Plan:

An aquatic and riparian enhancement plan has been developed for Reach 20 and 21 on the SPHOA property, based on the existing condition assessment and river channel survey. The existing condition assessment indicates that the principal limiting factors to the fishery are poor pool and in-channel pocket-water habitat due to insufficient sediment transport. The channel is over-wide in many areas, particularly those associated with previous in-channel habitat structure efforts. Of the forty-seven structures surveyed in the project reaches, only two were found to not be causing unintended effects to river channel morphology and habitat formation. Many of the structures are configured exactly the opposite of what would be preferable for creating habitat and maintaining channel integrity. The numerous large mid-channel islands and sediment bars found in the South Platte River in Sportsman's Paradise appear to indicate that the river has lost much of it's capacity to move the current sediment load, and most of the features are directly associated with structural improvements immediately upstream. These islands are creating additional shear on the river banks, further exasperating the over-widening issue. If left in the current condition, it is expected that the river will continue laterally migrate and over-widen, with much of the remaining pool and pocket-water habitats eventually filling with fines, further reducing the habitat capacity for trout.

The enhancement project outlined in this document will address the sedimentation and channel morphology issues identified in the assessment. The first priority will be to reconfigure or remove the problematic existing structures that are continuing to degrade channel stability and integrity. Much or the in-channel and river bank enhancement effort will focus on reducing the width/depth ratio of the channel to improve sediment transport. This work will also include many features and techniques that will improve habitat complexity and quality for resident rainbow and brown trout. The gullies on the burned side of the river actively contributing sediment to the river will be stabilized to cut off the sediment supply to the main stem of the channel. The low-head diversion structure at Sportsman's Paradise will be re-configured, allowing for improved sediment transport capacity and restoration of the channel upstream on National Forest lands.

The drawings on the following pages describe the proposed treatments. Each numbered Enhancement Plan Drawing refers to the same segment of river as the similarly numbered Existing Condition Drawing. Treatment locations are described based on grid location on each drawing.



RevNo	Revision note	Date	Signature	Checked

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Designed by	Checked by	Filename	Date	Scale
Gallagher		SP_Segment_Key_v1.SKF	April, 2010	

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Sportsmans Paradise - South Platte River
Reaches 20 & 21

Existing Condition & Restoration Drawing Key

Edition Ver. 1.0

Sheet 1

Reach 20 – Enhancement Plan Drawing #1:

This drawing shows the downstream (northern) most segment of Reach 20, from the USFS/SPHOA property boundary at 0ft upstream to 0+600ft along the longitudinal axis of the river.

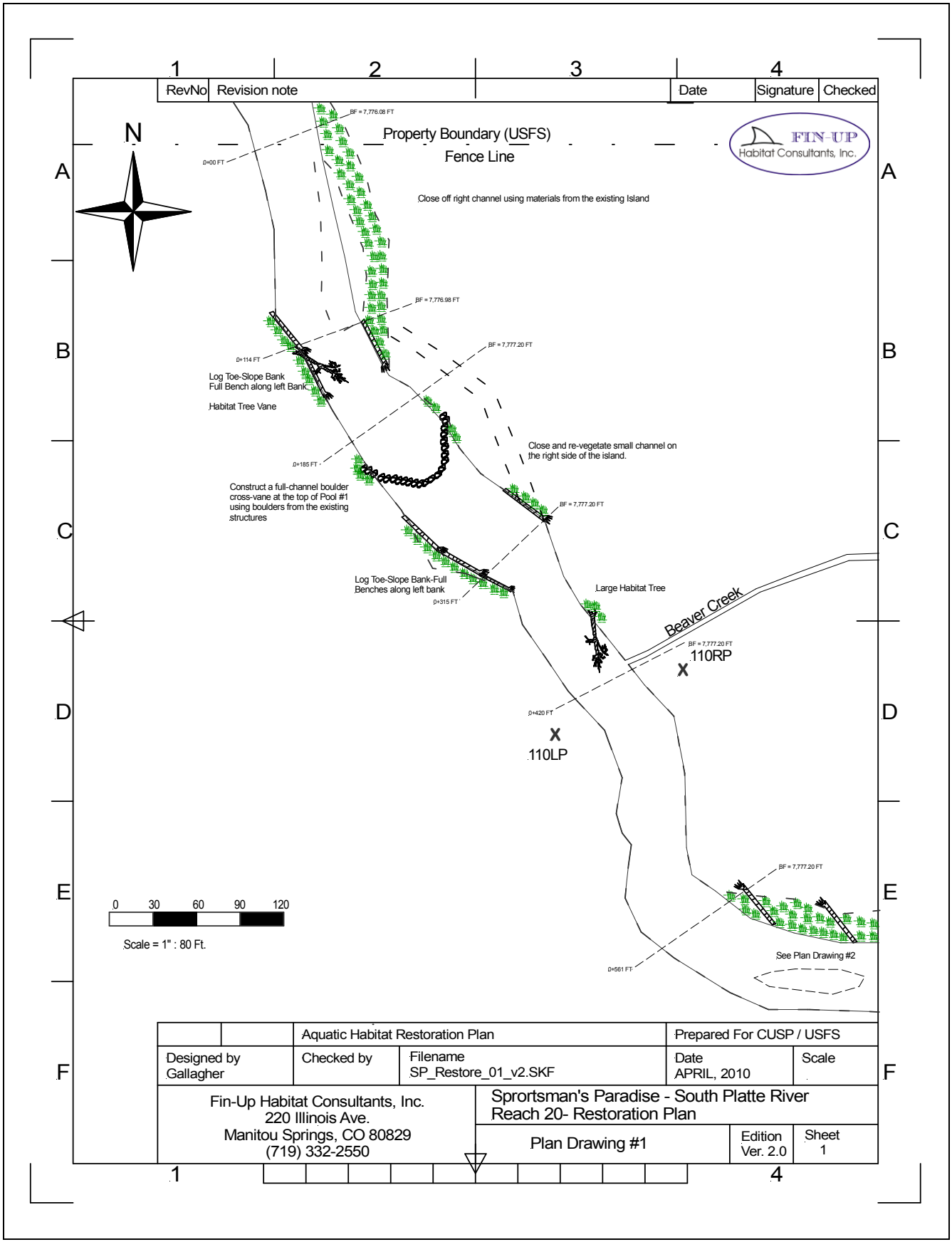
The five structures identified in the condition assessment should be removed, and the boulders utilized to build a full-channel boulder cross-vane at 0+200ft (Grid C-2). This cross-vane will improve scour and depth through the center the existing pool downstream. The vanes forming the structure will be tied into the existing river banks at the bank-full elevation, and the center of the structure will be constructed to an elevation of ½ bank-full or less. The riffle upstream is armored to the point that some small gaps may be left between boulders in the center of the structure to create greater velocity complexity and better feeding stations for trout immediately downstream.

Upon removal of structures #1 and #2, the smaller right channel at 0+114 ft (Grid A\B-2) will be closed off using large wood to create a bank-full riparian bench along the upstream boundary of the channel. The right (island) bank of the left channel will be reconstructed to a bank-full channel width of approximately 70 ft to create a width/depth ratio in the riffle of 30 or less. Vegetation from this river bank will be transplanted to the right channel to re-vegetate this feature.

The small channel on the right side of the large island at 0+315ft will be closed off using large wood and boulder, similar to the side channel downstream. After removal of Structures #4 & #5, the left river bank from 0+ 220ft to 0+330ft will be reconstructed using large wood bank-full benches and willow transplanted from nearby sites upstream.

A large ponderosa pine tree will be installed as a vane along right river bank downstream of the confluence with Beaver Creek. This feature should improve scour and velocity complexity in Glide #1. It is expected that sediment entering the river from Beaver Creek will gradually form a bar upstream of the tree; further reducing the width of the channel at this point and enhancing scour along the left third of the glide habitat. Eventually, this may form a trench pool within this currently habitat limited segment of the river.

The large pool at the meander bend at 0+500 ft (Grid E-3) will be left undisturbed. This feature is currently one of the best pools in the study reaches and does not require any further enhancement. Upstream of this pool, the river becomes significantly over-wide. This segment of the river, from 0+561 ft to 0+968, (see Plan Drawing #2) will be treated using river narrowing techniques developed and demonstrated in Eleven-mile Canyon in 2004 and 2006 (Photo 18). Large wood will be placed low in the channel along the river banks to capture sediment moving through the system and aggrade the bed. Extensive plantings of sedge and sod mats will be utilized. The goal of this work will be to reduce the width/depth ratio of this segment to between 35 – 30. In addition to the channel narrowing work, two log/boulder J-Hook vanes and one large habitat tree will be installed along the outside left bank of the river meander, creating additional complexity and protecting the bank from increased shear.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Property Boundary (USFS)
Fence Line
FIN-UP
Habitat Consultants, Inc.
Close off right channel using materials from the existing Island
BF = 7,776.08 FT
0+00 FT
BF = 7,776.98 FT
BF = 7,777.20 FT
0+114 FT
Log Toe-Slope Bank
Full Bench along left Bank
Habitat Tree Vane
0+185 FT
Close and re-vegetate small channel on
the right side of the island.
Construct a full-channel boulder
cross-vane at the top of Pool #1
using boulders from the existing
structures
BF = 7,777.20 FT
Log Toe-Slope Bank-Full
Benches along left bank
0+315 FT
Large Habitat Tree
Beaver Creek
BF = 7,777.20 FT
110RP
0+420 FT
110LP
BF = 7,777.20 FT
See Plan Drawing #2
0+561 FT
0
30
60
90
120
Scale = 1" : 80 Ft.
A
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Aquatic Habitat Restoration Plan
Prepared For CUSP / USFS
Designed by
Gallagher
Checked by
Filename
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Date
APRIL, 2010
Scale
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Sprortsman's Paradise - South Platte River
Reach 20- Restoration Plan
Plan Drawing #1
Edition
Ver. 2.0
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Reach 20 – Enhancement Plan Drawing #2:

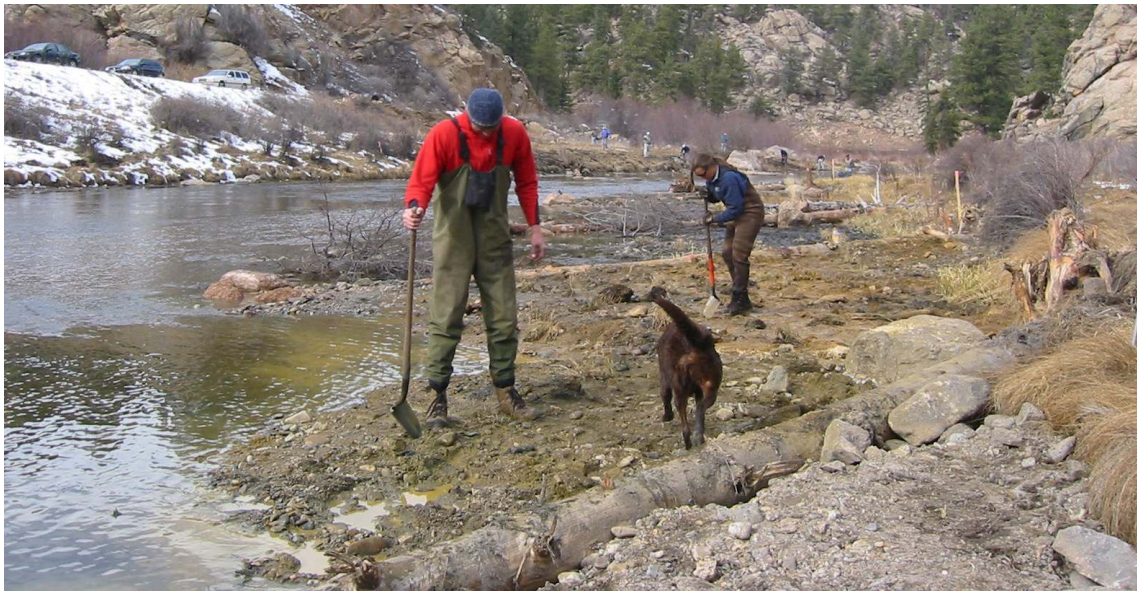


Photo 18: Large wood installed low in the channel to reduce width/depth ratio - South Platte River, Elevenmile Canyon, IFIM Springer Gulch Middle Station. 2004 "*Trees for Trout*" Demonstration Project

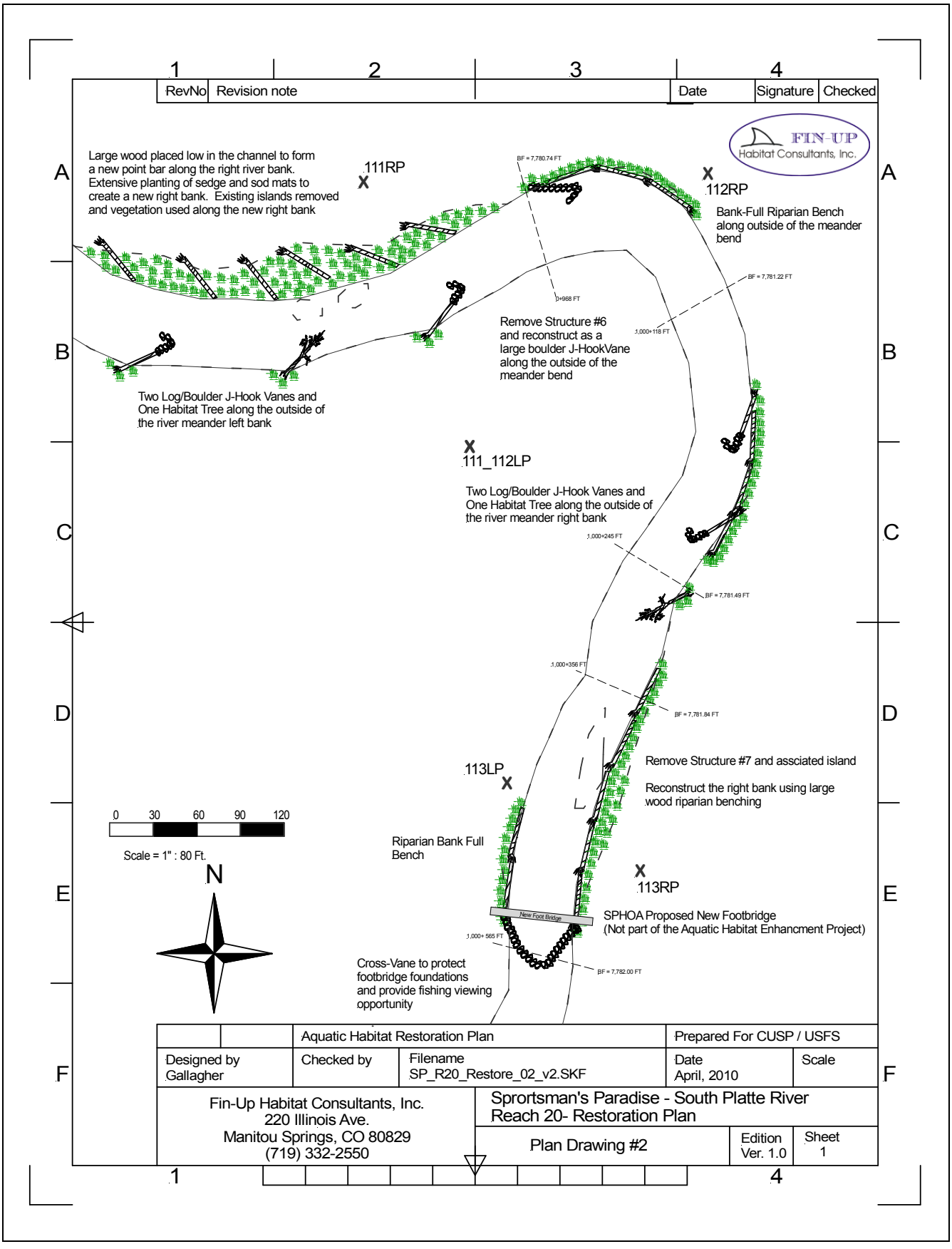
The two structures identified in the condition assessment should be removed, and the boulders utilized to build a large J-Hook vane at 0+968 (Grid A-3), and other features in the segment as described below. The J-Hook vane will anchor the riparian bench work along the right bank of Pool #3, immediately upstream along the outside of this meander bend. Very large wood should be used to form the toe of this feature, in order to effectively capture material and stabilize the deposition fan formed by the gully that enters the stream from the northeast.

The small island and gravel bar at Riffle #4 (Grid C-4) will be removed, and these materials will be incorporated into the new log toe-slope bank-full benches constructed along the right bank of this habitat. Two log/boulder J-Hook vanes will be installed along the right bank to protect the bank from erosion. These features will also provide additional in-channel object cover, and young-of-the-year rearing habitat along the edge of the river.

One large ponderosa pine or spruce tree will be utilized as a habitat tree along the right river bank at Glide #2 (Grid D-3). The tree will provide additional complexity in this otherwise habitat limited segment. Every effort should be utilized to keep all of the tree branches intact, in order to provide as much velocity shelter and cover as possible.

Once Structure #7 is removed, the bank-full width of the river at Cross-Section #113 and Riffle 5 can be reduced to approximately 70 ft utilizing bank-full riparian benching on the right bank along the entire length of the riffle. Vegetation from the island that has formed in the center of the channel downstream of the structure will be transplanted along the riparian benches. A small avulsion on the left bank, near the top of the riffle, may also be treated with bank-full riparian benching.

The SPHOA has proposed building a small footbridge at 0+550ft (Grid E-3). While not a part of the aquatic enhancement project, this structure may require some in-channel work to protect the bridge foundation supports. We recommend that a boulder cross-vane be installed upstream of the structure to address this need, and to provide fish-viewing opportunity as well.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FIN-UP
Habitat Consultants, Inc.
Large wood placed low in the channel to form a new point bar along the right river bank. Extensive planting of sedge and sod mats to create a new right bank. Existing islands removed and vegetation used along the new right bank
111RP
112RP
Bank-Full Riparian Bench along outside of the meander bend
BF = 7,780.74 FT
BF = 7,781.22 FT
0+968 FT
1,000+118 FT
Remove Structure #6 and reconstruct as a large boulder J-HookVane along the outside of the meander bend
Two Log/Boulder J-Hook Vanes and One Habitat Tree along the outside of the river meander left bank
111_112LP
Two Log/Boulder J-Hook Vanes and One Habitat Tree along the outside of the river meander right bank
1,000+245 FT
BF = 7,781.49 FT
1,000+356 FT
BF = 7,781.84 FT
113LP
Remove Structure #7 and assciated island
Reconstruct the right bank using large wood riparian benching
Riparian Bank Full Bench
113RP
New Foot Bridge
SPHOA Proposed New Footbridge
(Not part of the Aquatic Habitat Enhancment Project)
1,000+ 565 FT
BF = 7,782.00 FT
Cross-Vane to protect footbridge foundations and provide fishing viewing opportunity
0
30
60
90
120
Scale = 1" : 80 Ft.
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Aquatic Habitat Restoration Plan
Prepared For CUSP / USFS
Designed by Gallagher
Checked by
Filename SP_R20_Restore_02_v2.SKF
Date April, 2010
Scale
Fin-Up Habitat Consultants, Inc.
220 Illinois Ave.
Manitou Springs, CO 80829
(719) 332-2550
Sprortsman's Paradise - South Platte River Reach 20- Restoration Plan
Plan Drawing #2
Edition Ver. 1.0
Sheet 1

Reach 20 – Enhancement Plan Drawing #3:

This drawing shows the segment of Reach 20 from 0+1,425ft to 0+2,200 ft along the longitudinal axis of the river. The segment up to the new cross-vane at 0+565 has been described in the previous section.

Structure #8 and the large mid-channel island downstream will be removed. The left bank downstream of Structure #8 will be reconstructed using large wood and riparian bank-full benches, utilizing vegetation taken from the mid-channel island. The eroding bank on the right (Grid C/D-2) will also be stabilized using log toe-slope riparian benches. The target bank-full width of the channel through this segment is 80 ft. Boulders from the structure will be utilized to build a full-channel boulder cross-vane at 0+1,765 ft (Grid C-2). This cross-vane will improve scour and depth through the center of the pool downstream. The vanes forming the structure will be tied into the restored river banks at the bank-full elevation, and the center of the structure will be constructed to an elevation of ½ bank-full or less.

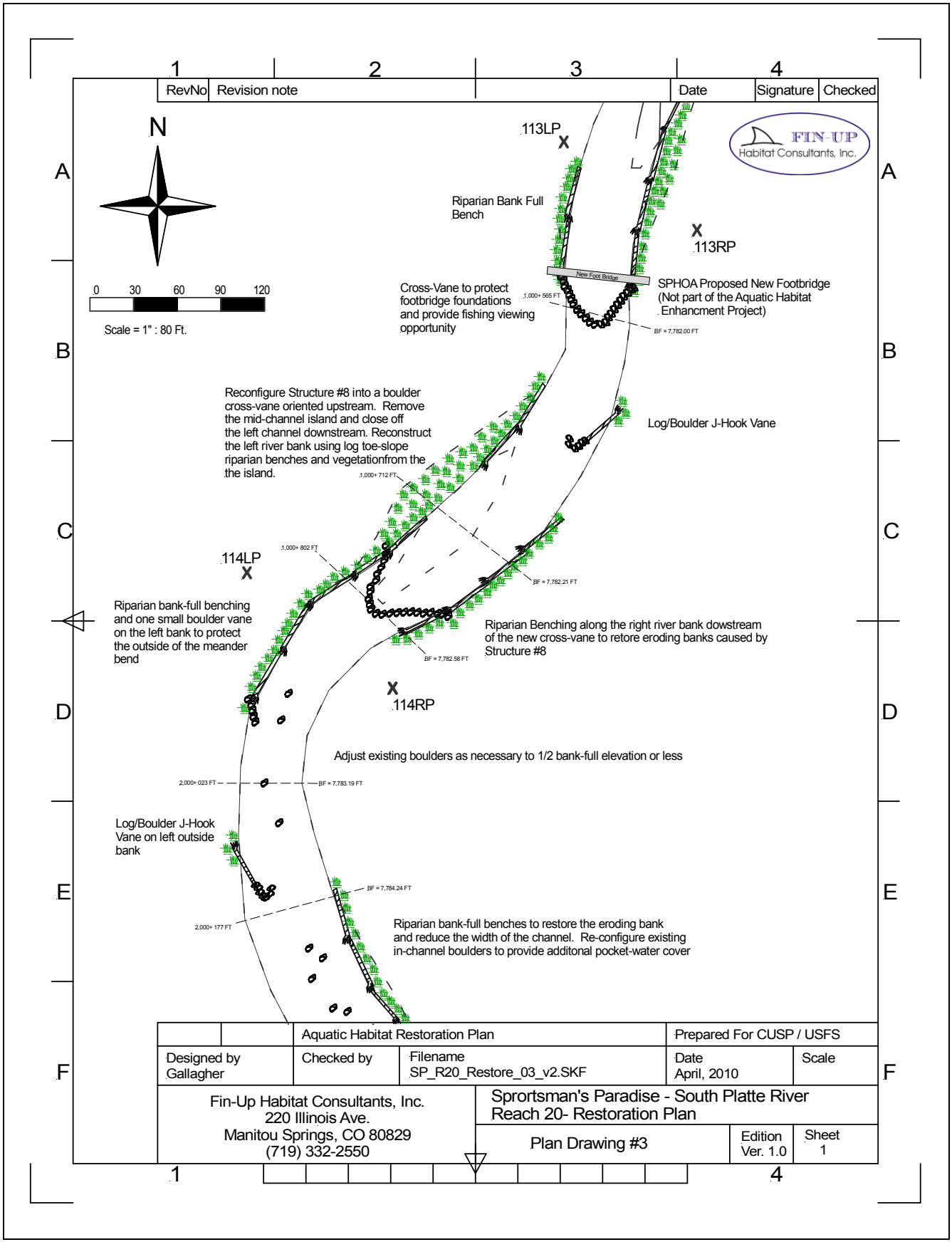
Upstream of the new boulder cross-vane, riparian bench treatments will be continued along the left bank to protect this area from shear along the outside of the meander bend of the river. A small boulder vane will be installed on the upstream side of the riparian benching to protect this feature, and to provide additional velocity shelter in the channel.

Two large log/boulder J-Hook vanes will be installed within this segment. The first will be located along the outside meander bend in Glide #3, at approximately 0+1,740 ft (GridB/C-3). This feature will provide protection to the right river bank along this habitat unit; create additional rearing habitat along the bank for juvenile trout. The second log/boulder J-Hook vane will be installed on the left bank in Riffle #6 at approximately 0+2,070 ft (Grid E-1), to create similar habitat and additional pocket water in this riffle. Several existing boulders in the riffle may be utilized to construct this feature.

The actively eroding right river bank along the downstream half of Riffle #7 will be treated with riparian benching to slightly reduce the width of the channel, creating a more desireable width/depth ratio in the habitat and improving sediment transport through the channel. The target bank-full width of the river through this segment will be 75-80 feet, with a width\depth ratio of 35 or less.

Photo 19: Micro-Vortex Structure – Elevenmile Canyon.

There are numerous existing in-channel boulders in the segment that may be re-aligned or re-positioned to improve object cover and scour along these features. Within Riffle #7, these boulders may be used to create several micro-vortex structures along the thalweg of the river in this habitat.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113LP
113RP
Riparian Bank Full Bench
New Foot Bridge
Cross-Vane to protect footbridge foundations and provide fishing viewing opportunity
1,000+ 565 FT
BF = 7,782.00 FT
SPHOA Proposed New Footbridge (Not part of the Aquatic Habitat Enhancment Project)
Reconfigure Structure #8 into a boulder cross-vane oriented upstream. Remove the mid-channel island and close off the left channel downstream. Reconstruct the left river bank using log toe-slope riparian benches and vegetationfrom the the island.
Log/Boulder J-Hook Vane
1,000+ 712 FT
1,000+ 802 FT
114LP
BF = 7,782.21 FT
Riparian bank-full benching and one small boulder vane on the left bank to protect the outside of the meander bend
Riparian Benching along the right river bank dowstream of the new cross-vane to retore eroding banks caused by Structure #8
BF = 7,782.58 FT
114RP
Adjust existing boulders as necessary to 1/2 bank-full elevation or less
2,000+ 023 FT
BF = 7,783.19 FT
Log/Boulder J-Hook Vane on left outside bank
BF = 7,784.24 FT
2,000+ 177 FT
Riparian bank-full benches to restore the eroding bank and reduce the width of the channel. Re-configure existing in-channel boulders to provide additonal pocket-water cover
Aquatic Habitat Restoration Plan
Prepared For CUSP / USFS
Designed by Gallagher
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Reach 20 – Enhancement Plan Drawing #4:

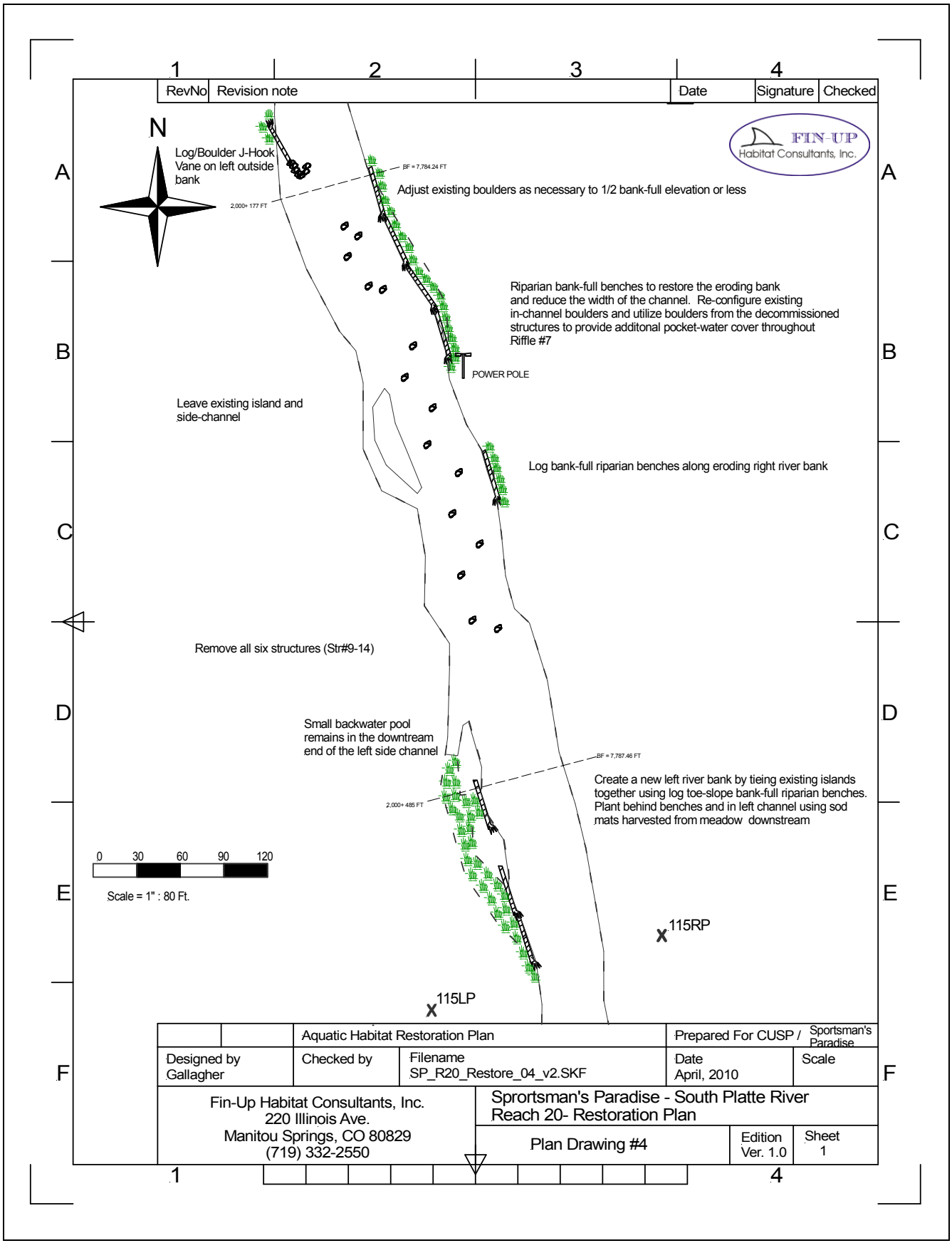
This drawing shows the segment of Reach 20 from 0+2,100 ft to 0+2,650 ft along the longitudinal axis of the river. The log/boulder J-Hook vane on the left bank at 0+2,070 ft has already been described in the previous segment.

The actively eroding right river bank along the downstream half of Riffle #7 will be treated with riparian benching to slightly reduce the width of the channel, creating a more desirable width/depth ratio in the habitat and improving sediment transport through the channel. The target bank-full width of the river through this segment will match the existing channel immediately upstream, with a width\depth ratio of 35 or less. The unstable right river bank at 0+2,300 ft (Grid C-3), adjacent to the location of Structures #10-12, will also be treated with logs along the toe of the bank and bank-full riparian benches.

All six of the existing structures in this segment will be removed from the channel, and the materials utilized to create up to 15 micro-vortex structures and random in-channel boulder object cover structures along the thalweg of the river from 0+2,177 ft to 0+2,400 ft. There are several existing in-channel boulders in the segment that may also be re-aligned or re-positioned to improve object cover and scour along these features.

The left river bank at the top of Riffle #7 and through the lower half of Glide #4 will be reconstructed to eliminate the islands on the left side of the channel, and to reduce the bank-full width in these habitats. This work will be accomplished by closing off the small channels on the left side of the islands, and tying the two islands together using logs and bank-full benches to create the new river bank. The small closed off channels may then be re-vegetated using willow harvested from the left bank and sod-mats harvested from the meadow immediately downstream. Depending on the availability of willow clumps and sod mats, a small backwater pool may be left on the downstream left side of the lowest island (Grid D-2), to provide additional refugia from high flows for juvenile and young-of-the-year trout.

Photo 20: Backwater Pool and Log/Boulder J-Hook Vane. South Platte River at Lake George, CO.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Log/Boulder J-Hook Vane on left outside bank
BF = 7,784.24 FT
2,000+ 177 FT
Adjust existing boulders as necessary to 1/2 bank-full elevation or less
Riparian bank-full benches to restore the eroding bank and reduce the width of the channel. Re-configure existing in-channel boulders and utilize boulders from the decommissioned structures to provide additonal pocket-water cover throughout Riffle #7
POWER POLE
Leave existing island and side-channel
Log bank-full riparian benches along eroding right river bank
Remove all six structures (Str#9-14)
Small backwater pool remains in the downtream end of the left side channel
BF = 7,787.46 FT
2,000+ 485 FT
Create a new left river bank by tieing existing islands together using log toe-slope bank-full riparian benches. Plant behind benches and in left channel using sod mats harvested from meadow downstream
0 30 60 90 120
Scale = 1" : 80 Ft.
115RP
115LP
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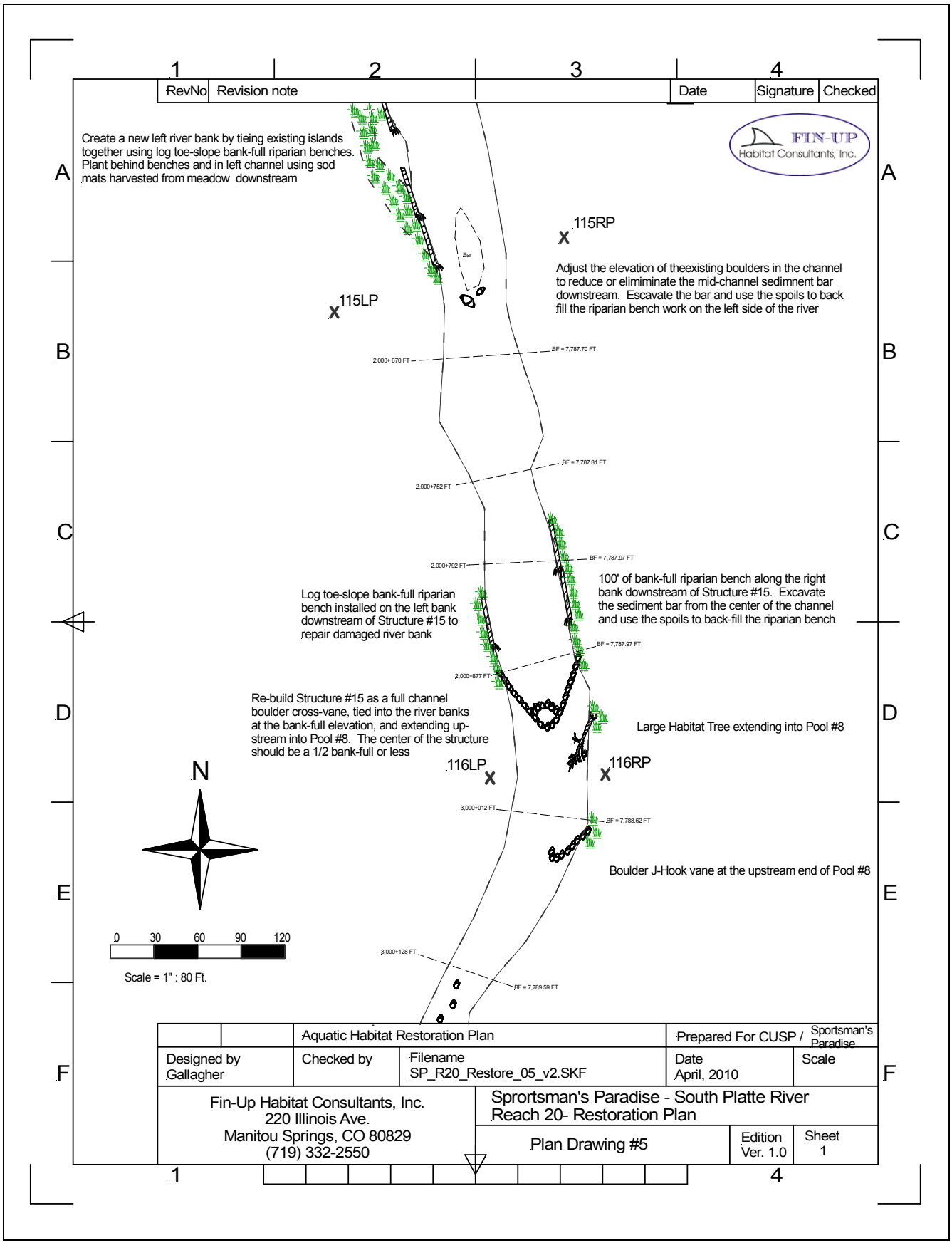
Reach 20 – Enhancement Plan Drawing #5

This drawing shows the segment of Reach 20 from 0+2,500 ft to 0+3,150 ft along the longitudinal axis of the river. The large sediment bar that has formed in the upstream half of Glide #4 (Grid B-2) will be eliminated by re-positioning the existing boulders upstream of the bar so that they do not exceed ½ of the bank-full elevation at this point along the river. The bar will be excavated down to the level of the original cobble bed, and this material will be utilized to back-fill the riparian benching on the left side of the channel downstream.

Structure #15 will be completely removed from the channel, and the boulders will be re-used to construct a full-channel boulder cross-vane at 0+2,877 ft (Grid D-3). This cross-vane will improve scour and depth through the center of the pool downstream, and should be low enough in the center to effectively pass sediment through the feature. The vanes forming the structure will be tied into the river banks at the bank-full elevation, and the center of the structure will be constructed to an elevation of ½ bank-full or less. Downstream of the cross-vane, the bank avulsion on the left side and the unstable banks on the right will be treated using riparian bench techniques. The large mid-channel sediment bar will be excavated down to the level of the original cobble bed, and this material will be utilized to back-fill the riparian benching on either side of the river.

Approximately 30 feet upstream of the new cross-vane, a large habitat tree will be installed along the right river bank to improve habitat complexity and cover in Pool #8. At the top this pool, at 0+3,012 ft, a boulder J-Hook vane will also be installed along the right bank. This structure should protect the right bank both upstream and downstream, and create better initial scour in the top of the pool.

Photo 21: Full Channel Boulder Cross-vane. South Platte River at Lake George, CO.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Create a new left river bank by tieing existing islands together using log toe-slope bank-full riparian benches. Plant behind benches and in left channel using sod mats harvested from meadow downstream
115RP
Adjust the elevation of theexisting boulders in the channel to reduce or eliminate the mid-channel sedimnent bar downstream. Escavate the bar and use the spoils to back fill the riparian bench work on the left side of the river
Bar
115LP
2,000+ 670 FT
BF = 7,787.70 FT
2,000+752 FT
BF = 7,787.81 FT
2,000+792 FT
BF = 7,787.97 FT
100' of bank-full riparian bench along the right bank downstream of Structure #15. Excavate the sediment bar from the center of the channel and use the spoils to back-fill the riparian bench
Log toe-slope bank-full riparian bench installed on the left bank downstream of Structure #15 to repair damaged river bank
BF = 7,787.97 FT
2,000+877 FT
Re-build Structure #15 as a full channel boulder cross-vane, tied into the river banks at the bank-full elevation, and extending up-stream into Pool #8. The center of the structure should be a 1/2 bank-full or less
Large Habitat Tree extending into Pool #8
116LP
116RP
3,000+012 FT
BF = 7,788.62 FT
Boulder J-Hook vane at the upstream end of Pool #8
N
0
30
60
90
120
Scale = 1" : 80 Ft.
3,000+128 FT
BF = 7,789.59 FT
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Reach 20 – Enhancement Plan Drawing #6

This drawing shows the segment of Reach 20 from 0+3,000 ft to 0+3,800 ft along the longitudinal axis of the river. The deposition fan from the large gully entering the river on the right (Grid C-3) will be stabilized using large wood to form the toe of a new right river bank. This wood, and extensive riparian plantings, will re-define the channel along the deposition fan and cut off sediment from the gully. The large mid-channel bar that has formed downstream of this gully will be removed, and the material will be used in combination with riparian bank-full benching to effectively reduce the width of the channel in Riffle #9 to approximately 70 -75 ft. Several of the existing boulders in this riffle will be adjusted to less than ½ bank-full to improve scour and increase pocket water cover in the habitat. Additionally, several micro-vortex structures may be installed along the thalweg of the river, adjacent to the gully deposition fan, to further increase pocket-water habitat in the riffle.

Structure #16 will be removed. The right bank downstream of Structure #16 will be reconstructed using large wood and riparian bank-full benches, tying into the bank work done to stabilize the gully deposition fan. The eroding bank on the right side of the structure will also be stabilized using transplanted willow. Boulders from the structure will be utilized to build a full-channel boulder cross-vane at 0+3,447 ft (Grid D-3). This cross-vane should improve scour, depth, and the overall length through the center of the pool downstream. The vanes forming the structure will be tied into the restored river banks at the bank-full elevation, and the center of the structure will be constructed to an elevation of ½ bank-full or less in order to efficiently pass sediment through the feature.

The right river bank upstream of Structure #16 has been damaged by previous dreding efforts in Pool #10. This unstable bank will be rehabilitated using large wood to redefine the toe of the stream bank along this outside meander bend. Accumulated sediment will be excavated from the right third of the channel in Pool #10, and this material will be used to back-fill the large wood. While riparian plantings will be used extensively along this bank, it will be necessary to provide some hardened access points to the river to provide for the heavy recreation use this pool receives.

Structure #17 currently provides little if any velocity shelter or conver for trout, and will be reconfigured into a boulder J-Hook vane. This reconfigured structure should increase pocket water cover, as well as protecting the river bank on this outside meander bend.

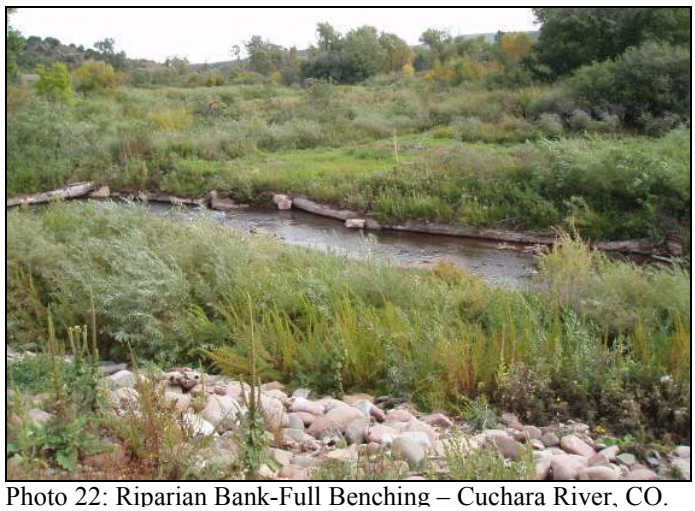
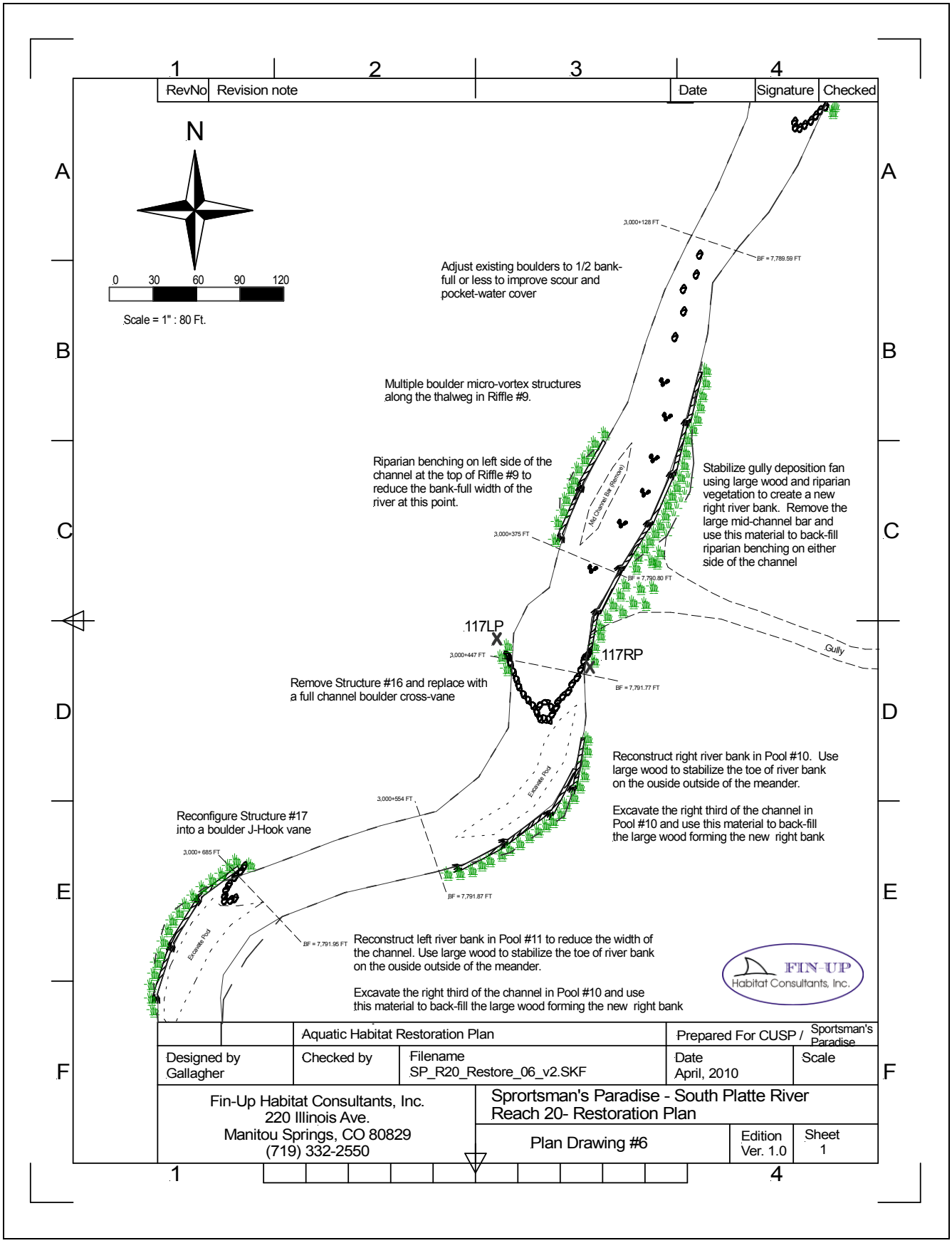


Photo 22: Riparian Bank-Full Benching – Cuchara River, CO.

The left river bank upstream of this structure (Grid E-1) will be redefined using log bank-full benches to reduce the width of the river and create a buffer between the river and the steep slope above. Accumulated sediment will be excavated from the left third of the channel in Pool #11, and this material will be used to back-fill the riparian bank-full benches, and to build the point bar on the right, inside bend of the river meander.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Scale = 1" : 80 Ft.
Adjust existing boulders to 1/2 bank-full or less to improve scour and pocket-water cover
3,000+128 FT
BF = 7,789.59 FT
Multiple boulder micro-vortex structures along the thalweg in Riffle #9.
Riparian benching on left side of the channel at the top of Riffle #9 to reduce the bank-full width of the river at this point.
Mid Channel Bar (Remove)
3,000+375 FT
BF = 7,790.80 FT
Stabilize gully deposition fan using large wood and riparian vegetation to create a new right river bank. Remove the large mid-channel bar and use this material to back-fill riparian benching on either side of the channel
117LP
117RP
3,000+447 FT
BF = 7,791.77 FT
Gully
Remove Structure #16 and replace with a full channel boulder cross-vane
Reconstruct right river bank in Pool #10. Use large wood to stabilize the toe of river bank on the ouside outside of the meander.
Excavate the right third of the channel in Pool #10 and use this material to back-fill the large wood forming the new right bank
Excavate Pool
3,000+554 FT
BF = 7,791.87 FT
Reconfigure Structure #17 into a boulder J-Hook vane
3,000+ 685 FT
BF = 7,791.95 FT
Excavate Pool
Reconstruct left river bank in Pool #11 to reduce the width of the channel. Use large wood to stabilize the toe of river bank on the ouside outside of the meander.
Excavate the right third of the channel in Pool #10 and use this material to back-fill the large wood forming the new right bank
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Reach 20 – Enhancement Plan Drawing #7

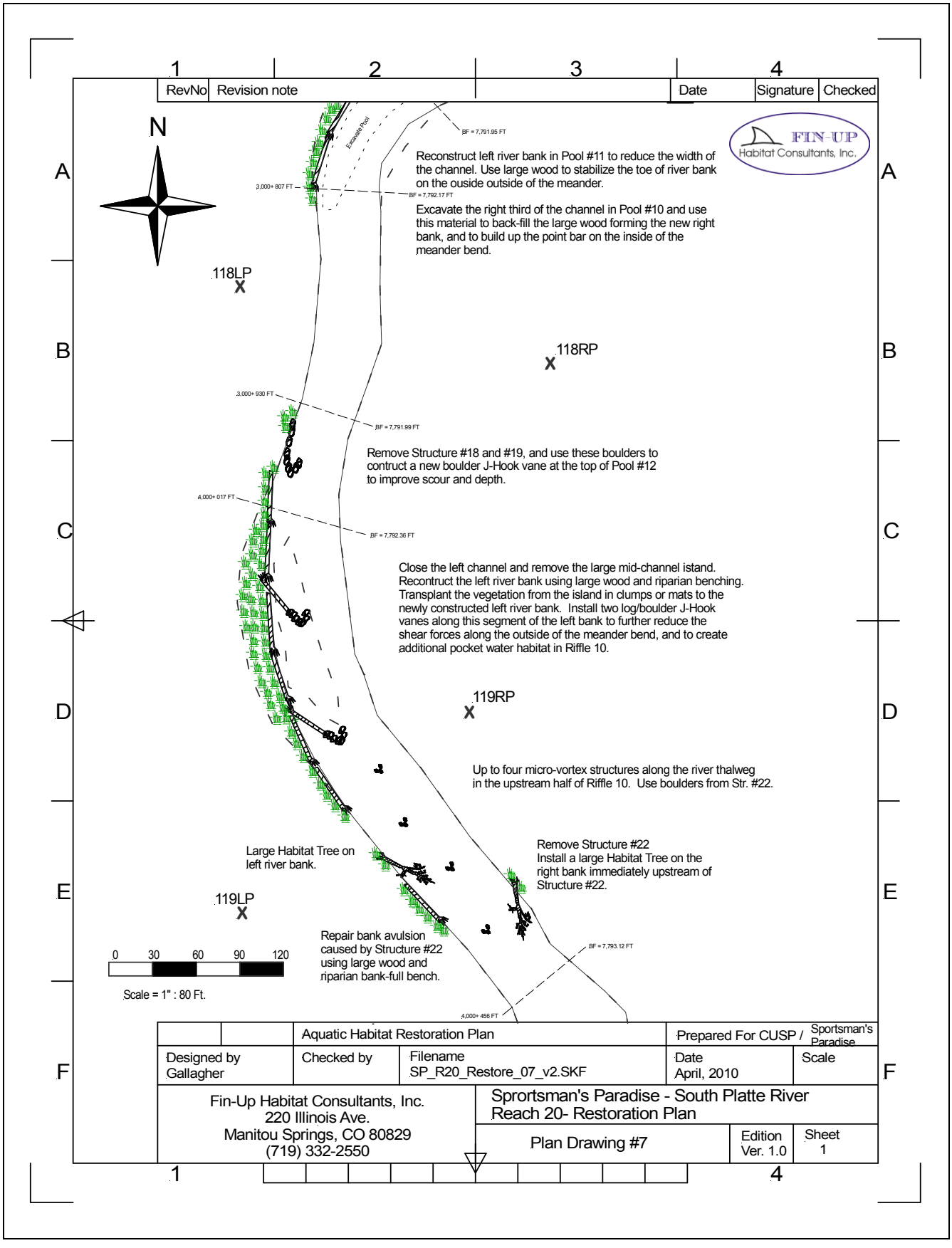
This drawing shows the segment of Reach 20 from 0+3,700 ft to 0+4,500 ft along the longitudinal axis of the river. Structures #18 and #19 will be removed, and the boulders may be used to construct a boulder J-Hook vane on the left bank at the upstream end of Pool #12. This structure will improve scour and depth through the pool, and protect the left river bank from shear.

Structures #20, #21, and the large island upstream of)+4,020 ft will be removed. The river channel will be reconfigured into a single thread, with a target bank-full width of 75 – 80 ft and a width/depth ratio of 35 or less. Vegetation from the island will be used in conjunction with large wood riparian benching to reconstruct the left of bank the river between 0+4,020 and 0+4,300 ft. Two large wood/boulder J-Hook vanes will be installed along the new left bank to direct the thalweg away from the left bank; providing additional protection from high flows, as well as additional holding cover and pocket-water habitat within Riffle 10.

At the current location of Structure #22, near the upstream boundary of Riffle 10, a large habitat tree will be installed along the right river bank. Another large habitat tree will be installed on the left bank, approximately 75 feet downstream, functioning as a vane to redirect the thalweg away from the left bank. Structure #22 will be completely removed, and the gravel bar that has formed immediately downstream will be excavated down to the original cobble bed of the river. The avulsion on the left bank immediately opposite of Structure #22 will be repaired using a log toe-slope riparian bank-full bench. Some material from the bar excavation may be used to back-fill behind this structure.

In addition to the river bank treatments described above, up to four in-channel boulder micro-vortex structures may be installed along the thalweg in Riffle 10 from 0+4275 ft to 0+4,456 ft. These structures may be constructed of boulders left over from the existing structures in this segment.

Photo 23: Large wood / boulder J-Hook Vanes - South Platte River, Elevenmile Canyon, IFIM Springer Gulch Middle Station. 2004 "*Trees for Trout*" Demonstration Project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Excavation Pool
BF = 7,791.95 FT
3,000+ 807 FT
BF = 7,792.17 FT
Reconstruct left river bank in Pool #11 to reduce the width of the channel. Use large wood to stabilize the toe of river bank on the ouside outside of the meander.
Excavate the right third of the channel in Pool #10 and use this material to back-fill the large wood forming the new right bank, and to build up the point bar on the inside of the meander bend.
118LP
118RP
3,000+ 930 FT
BF = 7,791.99 FT
Remove Structure #18 and #19, and use these boulders to contruct a new boulder J-Hook vane at the top of Pool #12 to improve scour and depth.
4,000+ 017 FT
BF = 7,792.36 FT
Close the left channel and remove the large mid-channel istand. Recontruct the left river bank using large wood and riparian benching. Transplant the vegetation from the island in clumps or mats to the newly constructed left river bank. Install two log/boulder J-Hook vanes along this segment of the left bank to further reduce the shear forces along the outside of the meander bend, and to create additional pocket water habitat in Riffle 10.
119RP
Up to four micro-vortex structures along the river thalweg in the upstream half of Riffle 10. Use boulders from Str. #22.
Large Habitat Tree on left river bank.
Remove Structure #22
Install a large Habitat Tree on the right bank immediately upstream of Structure #22.
119LP
Repair bank avulsion caused by Structure #22 using large wood and riparian bank-full bench.
BF = 7,793.12 FT
4,000+ 456 FT
0
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90
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Scale = 1" : 80 Ft.
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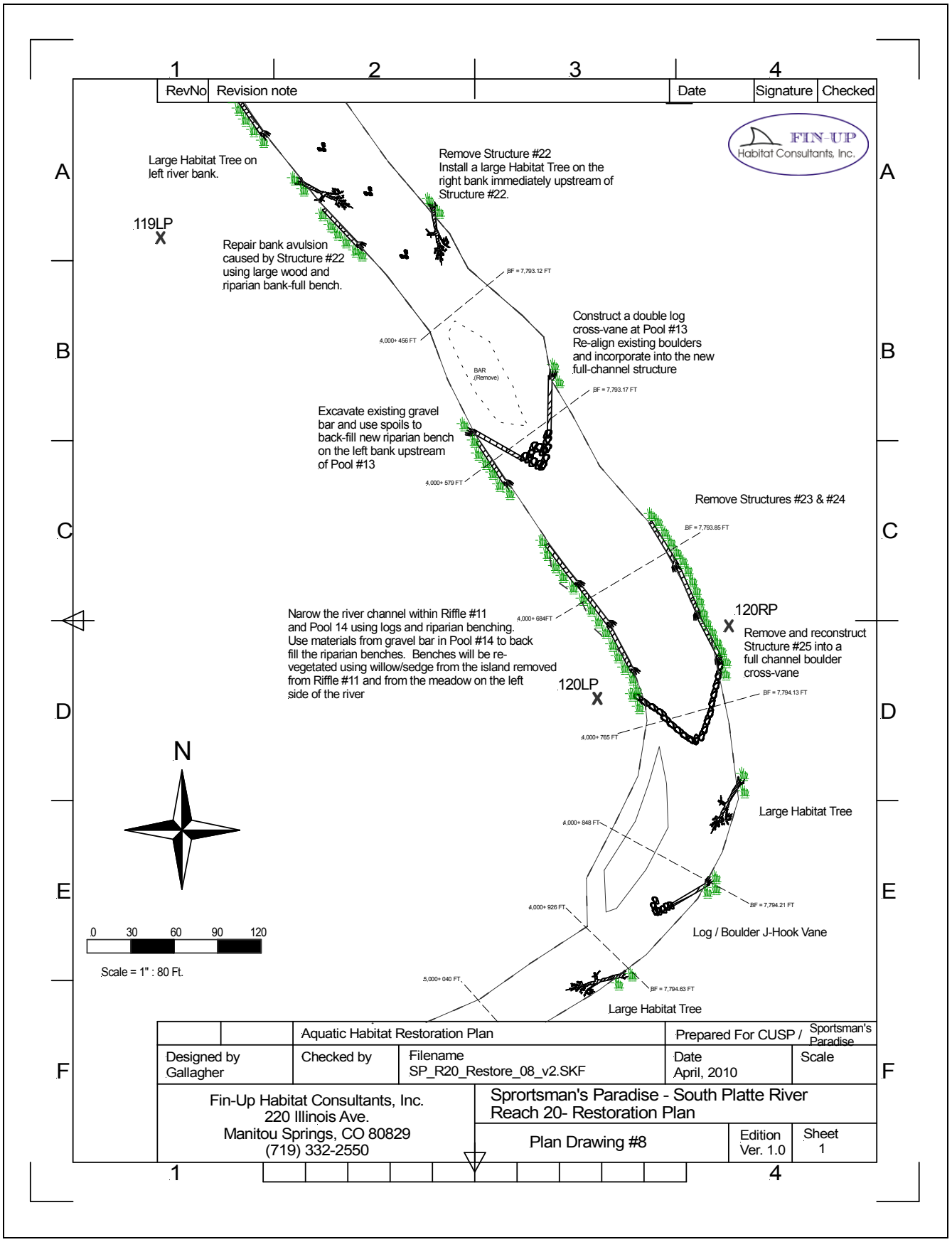
Reach 20 – Enhancement Plan Drawing #8

This drawing shows the segment of Reach 20 from 0+4,250 ft to 0+5,050 ft along the longitudinal axis of the river. The habitat tree and bank work in Riffle #10 (Grid A-2) was described in the previous segment. Upstream, in Pool #13, the existing boulders in the pool will be re-aligned and incorporated into a new double log/boulder cross-vane, spanning the bank-full width of the channel at 0+4,565 ft. This structure will consist of two large ponderosa pines anchored into the river banks at the bank-full elevation (7,793.17ft), extending upstream into the river channel. The center of the structure will consist of large boulders, placed at ½ bank-full or less. Structures #23 and #24 will be removed, and may be used to construct the center of the double log cross-vane structure downstream. Riparian benching will be installed along 40 ft of the left bank immediately upstream of this structure to stabilize this eroding bank. The gravel bar that has formed along the left third of the channel within this pool habitat will be removed down to the original cobble bed elevation, and this material will be utilized to back-fill the riparian bench on the left and the additional benches upstream.

Photo 23: Double Log /Boulder Cross-vane Structure - Eagle Rock Ranch, Tarryall River, Park Co., CO

Structure #25 will be completely removed, and reconstructed as a full channel boulder cross-vane. The cross-vane will not exceed the bank elevation where it ties into the river banks, and will be at ½ bank-full or less in the center. The river channel downstream of this structure, within Riffle #11 and Pool #14, will be effectively narrowed using large wood and riparian benches on both sides of the river. The target bank-full width through this segment should not exceed 80 ft, with a width depth ratio not exceeding 35. The large bar that has formed on the right side of Pool #14 will be removed from the active channel, and these materials will be utilized to back-fill the riparian benches. Sod-mats and willow from the meadow on the left side of the river will be used to re-vegetate these features.

A large habitat tree will be installed along the outside of the meander bend on the right bank of Pool #15, providing additional velocity shelter and cover within this habitat. A log/boulder J-Hook vane will be installed near the top of Pool #15 to provide initial scour and re-align the thalweg into this habitat. Another habitat tree will be installed along the right banks of Glide #8 as well.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Large Habitat Tree on left river bank.
119LP
Repair bank avulsion caused by Structure #22 using large wood and riparian bank-full bench.
Remove Structure #22
Install a large Habitat Tree on the right bank immediately upstream of Structure #22.
BF = 7,793.12 FT
4,000+ 456 FT
Construct a double log cross-vane at Pool #13
Re-align existing boulders and incorporate into the new full-channel structure
BAR (Remove)
BF = 7,793.17 FT
Excavate existing gravel bar and use spoils to back-fill new riparian bench on the left bank upstream of Pool #13
4,000+ 579 FT
Remove Structures #23 & #24
BF = 7,793.85 FT
4,000+ 684FT
120RP
Remove and reconstruct Structure #25 into a full channel boulder cross-vane
Narow the river channel within Riffle #11 and Pool 14 using logs and riparian benching. Use materials from gravel bar in Pool #14 to back fill the riparian benches. Benches will be re-vegetated using willow/sedge from the island removed from Riffle #11 and from the meadow on the left side of the river
120LP
BF = 7,794.13 FT
4,000+ 765 FT
N
Large Habitat Tree
4,000+ 848 FT
BF = 7,794.21 FT
4,000+ 926 FT
Log / Boulder J-Hook Vane
5,000+ 040 FT
BF = 7,794.63 FT
Large Habitat Tree
0 30 60 90 120
Scale = 1" : 80 Ft.
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Reach 20 – Enhancement Plan Drawing #9

This drawing shows the segment of Reach 20 from 0+4,250 ft to 0+5,050 ft along the longitudinal axis of the river. The large habitat tree installed along the right banks of Glide #8 (Grid A-4) will function like a vane on the outside of the meander bend on the right bank of the glide, protecting the bank from high flows, and providing additional cover and velocity shelter in this otherwise limited habitat.

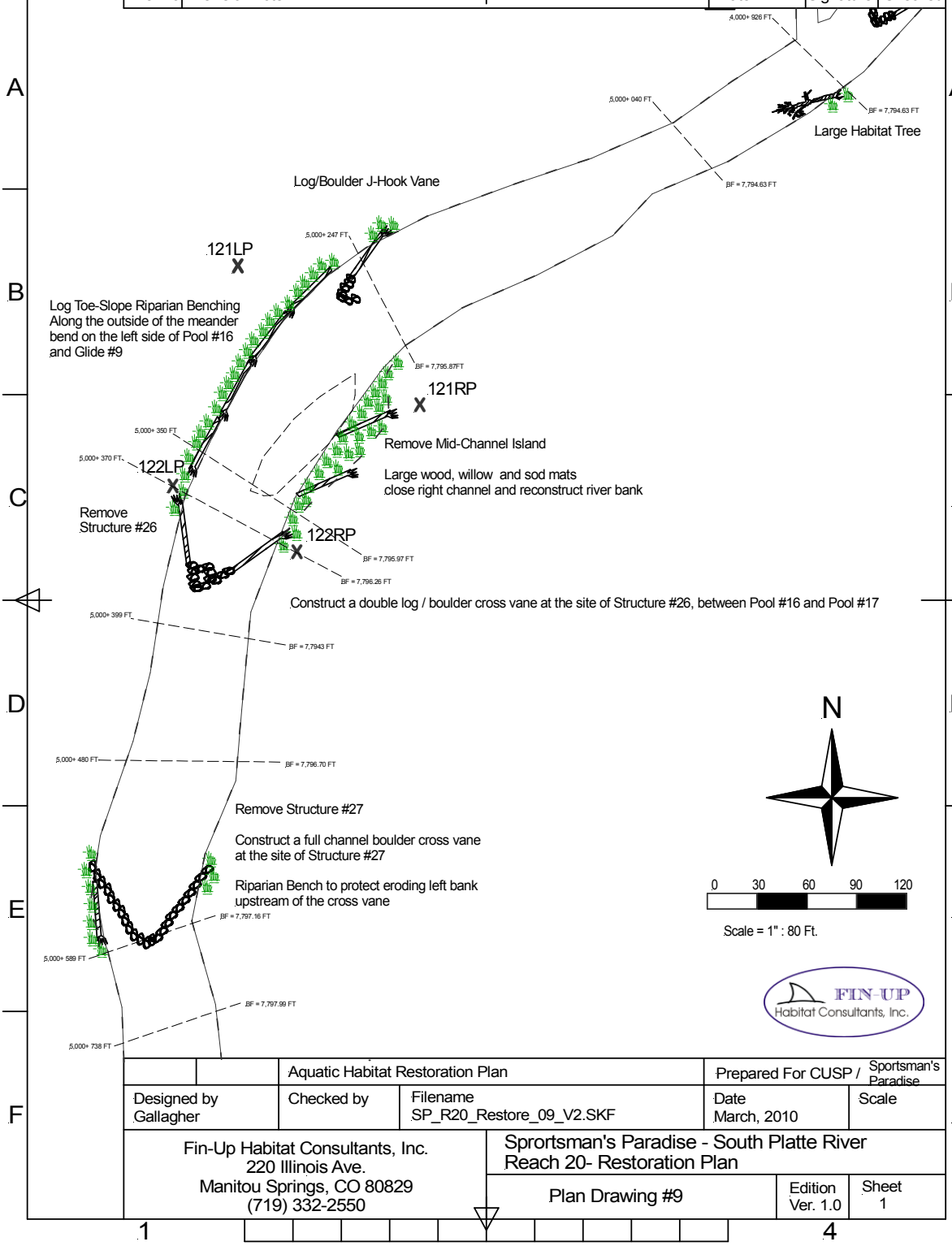
Upstream, near the transition from Riffle #13 to Glide #9, a large log / boulder J-Hook vane will be installed along the outside left bank of the meander bend. The boulders that are forming a gravel bar at this locations may be used to create this structure, which will improve depth of the habitat upstream, protect the left bank from erosion, and provide energy to scour the channel downstream and eliminate the bar.

The boulder drop at Structure #26 that forms the boundary between Pool #16 and Pool #17 should be completely removed, and the boulders used to construct a double log / boulder cross-vane in its place. Once this feature is reconstructed, the large mid-channel island that has formed downstream in Pool #16 and Glide #9 can be removed and a new right river bank and point bar constructed between 0+5,247 ft and 0+5,370 ft. The target bank-full width of the channel through Pool #16 and Glide #9 should be 85 ft or less.

Pool #16 may be restored and enhanced by excavating a scour along the left third of the channel downstream into Glide #9 to create a lateral scour pool along the outside of the meander bend. The bottom half of Glide #9 will form the new tail-out and riffle crest between Pool #16 and Riffle #13, and this area should be left reasonably undisturbed.

The boulder drop and associated mid-channel boulder vane at Structure #27 should be removed, and the boulders utilized to construct a new boulder cross-vane between Pool #18 and Pool #19. Approximately 40 ft of riparian benching will need to be installed along the left river bank upstream of this structure to stabilize the eroding bank that has developed due to increased shear from the miss-aligned existing structure.

Photo 24: Looking Downstream through Riffle #14 & Pool #19 towards Structure #27. Reach 20.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4,000+ 926 FT
5,000+ 040 FT
BF = 7,794.63 FT
Large Habitat Tree
Log/Boulder J-Hook Vane
5,000+ 247 FT
121LP
Log Toe-Slope Riparian Benching
Along the outside of the meander
bend on the left side of Pool #16
and Glide #9
BF = 7,795.87FT
121RP
5,000+ 350 FT
5,000+ 370 FT
122LP
Remove Mid-Channel Island
Large wood, willow and sod mats
close right channel and reconstruct river bank
Remove
Structure #26
122RP
BF = 7,795.97 FT
BF = 7,796.26 FT
Construct a double log / boulder cross vane at the site of Structure #26, between Pool #16 and Pool #17
5,000+ 399 FT
BF = 7,7943 FT
5,000+ 480 FT
BF = 7,796.70 FT
Remove Structure #27
Construct a full channel boulder cross vane
at the site of Structure #27
Riparian Bench to protect eroding left bank
upstream of the cross vane
BF = 7,797.16 FT
5,000+ 589 FT
BF = 7,797.99 FT
5,000+ 738 FT
N
0
30
60
90
120
Scale = 1" : 80 Ft.
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Aquatic Habitat Restoration Plan
Prepared For CUSP / Sportsman's Paradise
Designed by
Gallagher
Checked by
Filename
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Date
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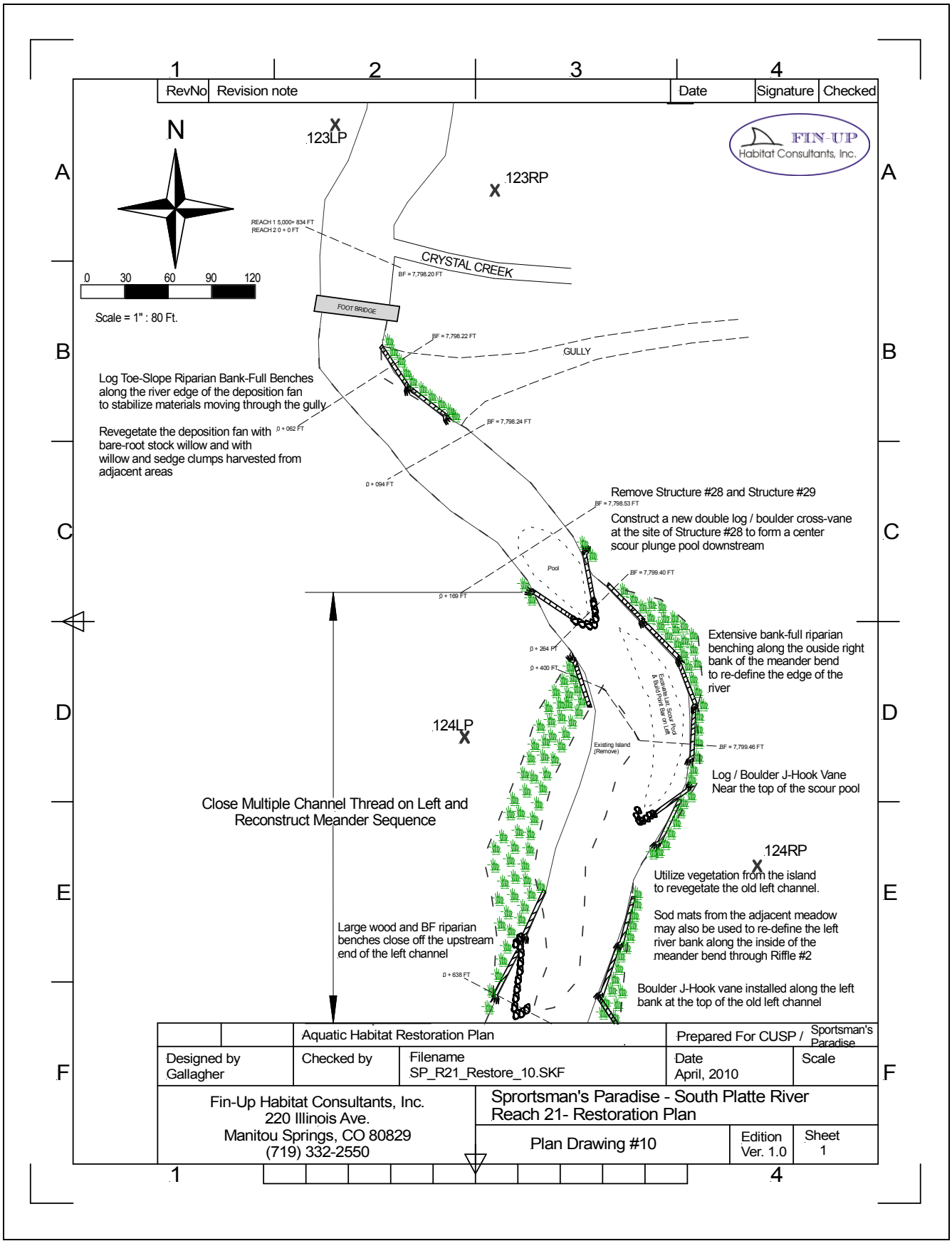
Reach 21 – Enhancement Plan Drawing #10 & #11

Enhancement Plan Drawing #10 shows the segment of Reach 20 from 0+5,050 ft to the end of the reach at the confluence of the South Platte River and Crystal Creek; at 0+5,384 ft., and the beginning segment of Reach 21, extending upstream from the confluence with Crystal Creek to 0+638 ft. Enhancement Plan Drawing #11 continues upstream to 0+1,250ft. No additional work is planned in Reach 20 within this segment. Immediately upstream in Reach 21, the gully that enters the river on the right will be treated to reduce of eliminate sediment entering the stream from this source. The deposition fan along the edge of the river will be removed to the point of the original river bank to return the channel to it's original bank-full width in Riffle #1. The edge of the deposition fan will be stabilized using large wood along the toe of the bank, and the deposition bar will be planted with willow clumps, sedge mats, and bare-root stock willow. Some directional felling of small trees to create rolling vanes in the gully may be utilized to reduce movement of sediment in this channel.

Upstream, beginning at the partially failed Structure #28, the river begins to exhibit some of the worst over-wide and habitat limited characteristics within the entire project area. A reconfiguration of the river channel meander sequence between 0+265ft and 0+850 ft is the best alternative for addressing the problems of habitat and sediment transport in this segment. First, all of the existing structures should be removed from the channel (Str #28 - #32) along this segment. Additionally, the large mid-channel island that has formed downstream of Structure #30 should be eliminated, and the willow/sedge vegetation preserved for use as mats in the bank restoration that follows.

Photo 25: Island removal and river narrowing project. S. Platte River - Elevenmile Canyon PG - 2006

The new meander sequence will start at Pool #3, and extend upstream to the top of the current Riffle #4. The new meander channel sequence will follow a typical C channel scour pool/riffle transition form, with new pools created along the outside bend of each meander. Bank-full width of the channel through this segment should not exceed 80 ft, and the width/depth ratio within the riffle transition habitats should be 35 or less, however, channel narrowing through this segment may be limited by the available vegetation on hand. Large wood along the toe of the bank on the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123LP
123RP
FIN-UP
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REACH 1 5,000+ 834 FT
REACH 2 0 + 0 FT
CRYSTAL CREEK
BF = 7,798.20 FT
0 30 60 90 120
Scale = 1" : 80 Ft.
FOOT BRIDGE
BF = 7,798.22 FT
GULLY
Log Toe-Slope Riparian Bank-Full Benches along the river edge of the deposition fan to stabilize materials moving through the gully
Revegetate the deposition fan with bare-root stock willow and with willow and sedge clumps harvested from adjacent areas
0 + 062 FT
BF = 7,798.24 FT
0 + 094 FT
Remove Structure #28 and Structure #29
BF = 7,798.53 FT
Construct a new double log / boulder cross-vane at the site of Structure #28 to form a center scour plunge pool downstream
Pool
BF = 7,799.40 FT
0 + 169 FT
0 + 264 FT
0 + 400 FT
Extensive bank-full riparian benching along the ouside right bank of the meander bend to re-define the edge of the river
Existing Lat. Scour Pool & Bar/Point Bar on Left
124LP
Existing Island (Remove)
BF = 7,799.46 FT
Log / Boulder J-Hook Vane Near the top of the scour pool
Close Multiple Channel Thread on Left and Reconstruct Meander Sequence
124RP
Utilize vegetation from the island to revegetate the old left channel.
Sod mats from the adjacent meadow may also be used to re-define the left river bank along the inside of the meander bend through Riffle #2
Large wood and BF riparian benches close off the upstream end of the left channel
0 + 638 FT
Boulder J-Hook vane installed along the left bank at the top of the old left channel
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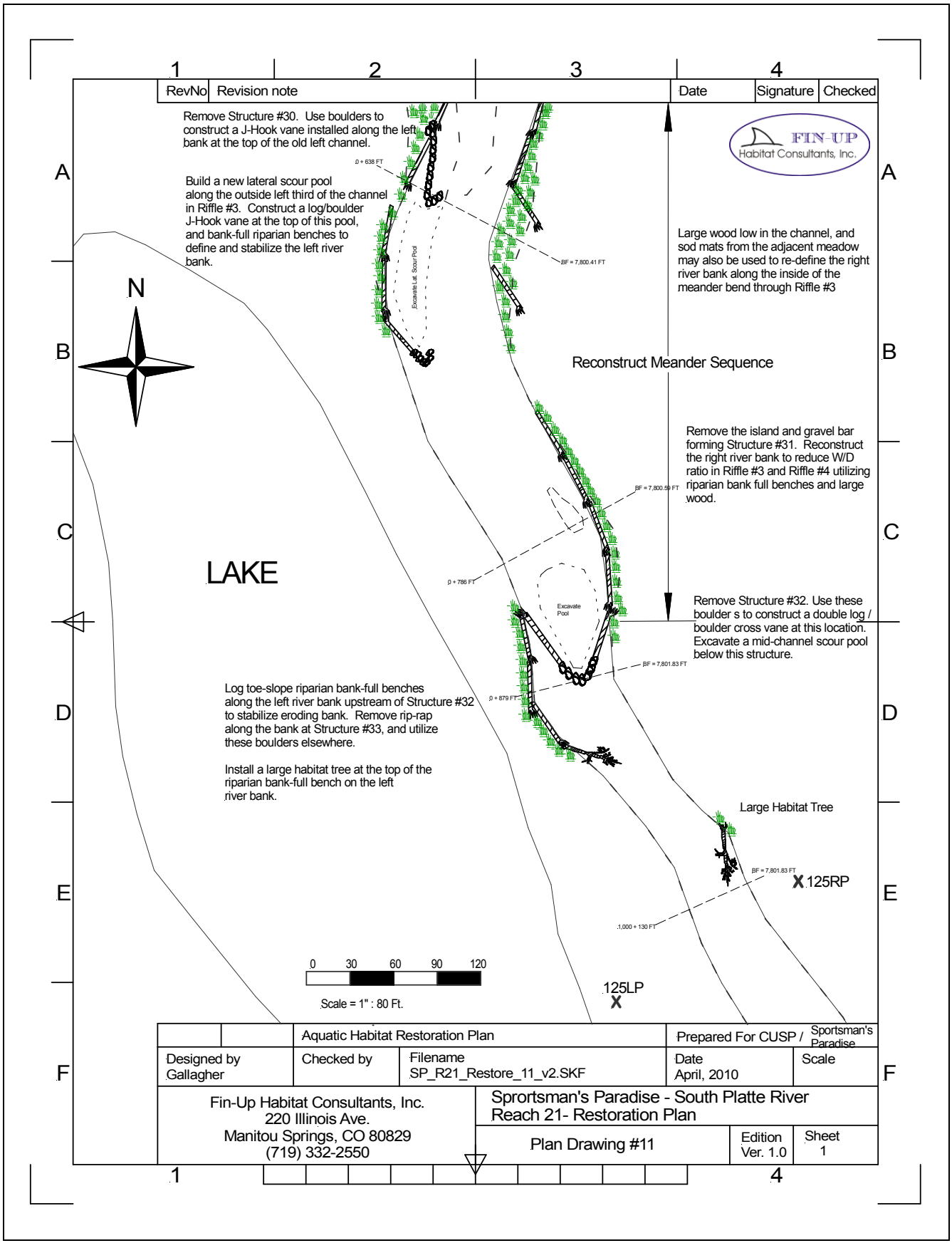
outside bend of each meander, along with riparian bank-full benches and transplanted willow, will be utilized to provide stable banks along these features, and to create over-hanging combination cover for brown trout. Approximately 600 ft of this bank treatment will be required along this segment. Large wood and bank-full benching will also be utilized to close off the old left channel in Riffle #2. Along the inside bends of the meander sequence, large wood will be placed low in the channel, and extensive sedge and willow will be planted to form a stable inside river bank and point bar. Substrates excavated from the new pools will be utilized to form the point bars along the inside of the meander bend in the pool habitats.

Several in-channel structure types will be employed to assure vertical channel bed stability in the reconstructed segment, protect newly constructed river banks, and provide initial scour for the meander bend pools. A double log / boulder cross-vane will be constructed at the downstream end of the new meander sequence at the location of the existing structure #28. The cross-vane will provide a stable tail-out for the new lateral scour pool upstream, as well as additional pool habitat immediately downstream of this feature. Immediately upstream of the initial scour point of the first pool in the sequence, a log / boulder J-Hook vane will be installed along the right river bank, at approximately 0+450 ft, to create initial scour for the new pool, and to reduce shear along the new river bank immediately upstream and downstream.

At 0+638 ft, near the top of the old left channel formed by the large island, a large boulder J-Hook vane will be installed along the outside, left river bank to direct the thalweg away from the closed channel, and reduce the shear at high flows along the newly constructed river bank immediately downstream. The structure will be constructed in a manner not to exceed the bank-full elevation (7,800.41ft) so not to limit the floodplain function of the closed channel. An additional log / boulder J-Hook vane will be installed 100 ft further upstream along the left river bank at the initial scour point of the second new lateral scour pool. This feature will provide benefit similar the log/boulder J-Hook vane on the right bank in the new scour pool downstream.

At the upstream boundary of the newly reconfigured meander, another double log / boulder cross-vane will be installed to create the upstream pool in the sequence, and to provide protection from head-cutting in the channel upstream of this segment. The rip-rap toe forming Structure #33 will be removed , and the actively eroding left river bank between this structure and the double log / boulder cross-vane will be stabilized, utilizing riparian benching techniques described previously. In addition to the bank-full bench work, a large habitat tree will be anchored into the left bank at the upstream end of the bank treatments, and will extend upstream into the channel to form a vane that may reduce shear along the restored bank. A second large habitat tree may also be installed along the right bank at the top of Glide #2, 30 ft downstream of Cross-Section 125 at approximately 0+1,100ft, to provide additional habitat complexity and cover for resident trout.

Photo 26: S. Platte River - Elevenmile PG project, immediately following completion in 2006.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Remove Structure #30. Use boulders to construct a J-Hook vane installed along the left bank at the top of the old left channel.
Build a new lateral scour pool along the outside left third of the channel in Riffle #3. Construct a log/boulder J-Hook vane at the top of this pool, and bank-full riparian benches to define and stabilize the left river bank.
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Large wood low in the channel, and sod mats from the adjacent meadow may also be used to re-define the right river bank along the inside of the meander bend through Riffle #3
Reconstruct Meander Sequence
Remove the island and gravel bar forming Structure #31. Reconstruct the right river bank to reduce W/D ratio in Riffle #3 and Riffle #4 utilizing riparian bank full benches and large wood.
Remove Structure #32. Use these boulder s to construct a double log / boulder cross vane at this location. Excavate a mid-channel scour pool below this structure.
Log toe-slope riparian bank-full benches along the left river bank upstream of Structure #32 to stabilize eroding bank. Remove rip-rap along the bank at Structure #33, and utilize these boulders elsewhere.
Install a large habitat tree at the top of the riparian bank-full bench on the left river bank.
Large Habitat Tree
125RP
125LP
LAKE
N
0 + 638 FT
BF = 7,800.41 FT
Excavate Lat. Scour Pool
BF = 7,800.59 FT
0 + 786 FT
Excavate Pool
BF = 7,801.83 FT
0 + 879 FT
BF = 7,801.83 FT
1,000 + 130 FT
0 30 60 90 120
Scale = 1" : 80 Ft.
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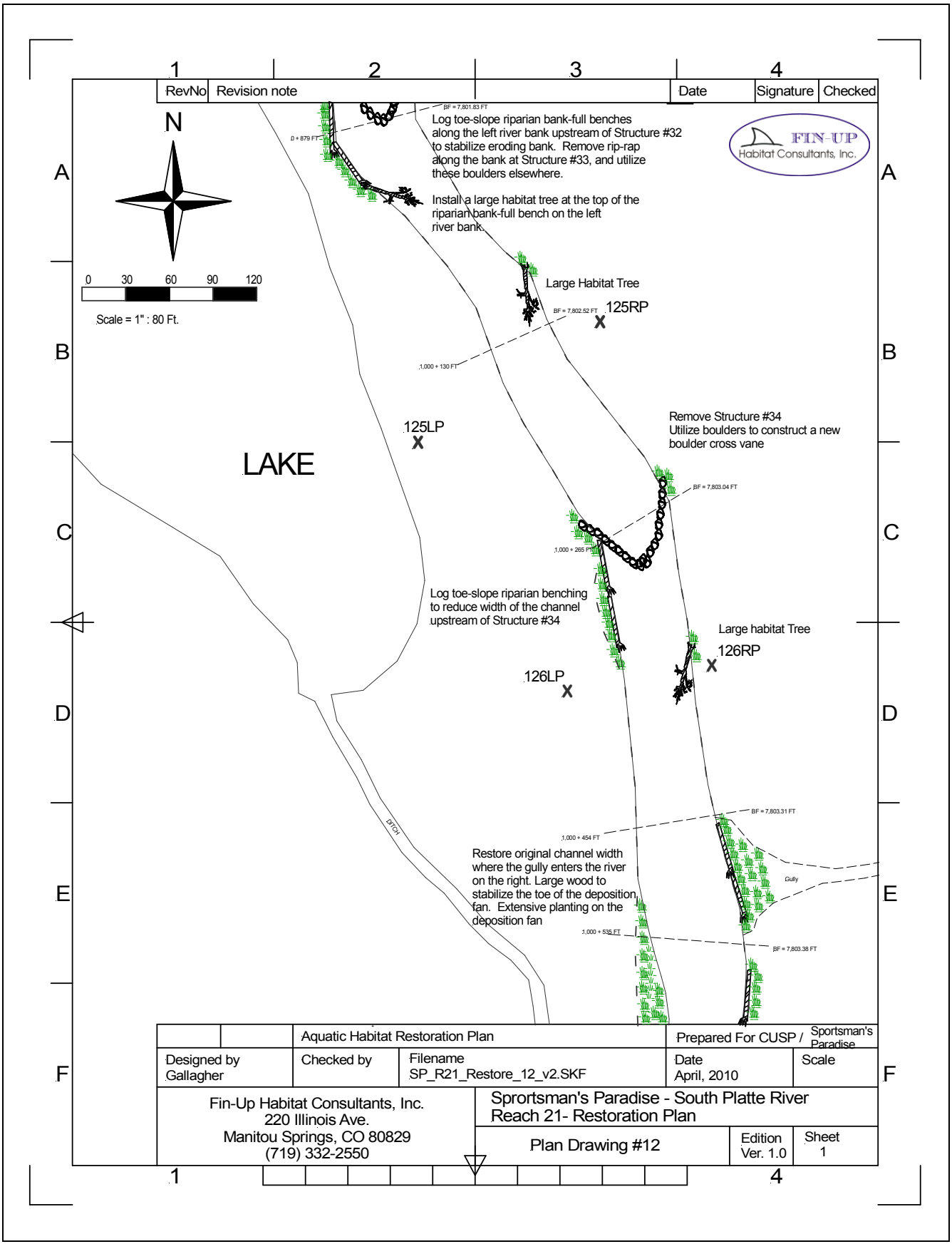
Reach 21 – Enhancement Plan Drawing #12

This drawing shows the segment of Reach 21 from 0+880 ft to 0+1,600 ft along the longitudinal axis of the river. The prescribed restoration work downstream of Cross-Section #125 has been described in the previous section. Upstream of Cross-Section 125, the existing full-channel boulder drop structure identified as Structure #34 will need to be re-configured into a boulder cross-vane extending upstream into the rive channel. As with the other cross-vanes described in this project, the elevations of this structure will be critical to its successful function of creating pool habitat while sufficiently transporting the sediment load through the feature.

Upstream of the boulder cross-vane, the unstable left river bank will be treated with large wood and riparian benches, slightly reducing the width of the river channel through the downstream half of Pool #4. A large habitat tree may be installed as a vane on the right bank within Pool #4 to provide additional habitat complexity and cover. The branches should be left intact in order to maximize cover and velocity shelter in this feature.

The gully that enters the river on the right at 0+1,464 ft (Grid E-4), will be treated to reduce of eliminate sediment entering the stream from this source. The existing deposition fan is significantly confining the river channel within Glide #3, and has greatly reduced the channel cross-section throughout this habitat. The edge of the deposition fan extending into the river will be removed to the point of the original river bank, in order to return the channel to the pre-fire, original bank-full width in Glide #3. Following the re-definition of this deposition fan edge, the new river bank will be stabilized using large wood along the toe of the bank, and the deposition bar will be planted with willow clumps, sedge mats, and bare-root stock willow. As with the other gullies entering the river from the burned areas to the east, some directional felling of small trees to create rolling vanes and velocity reducing structure may be utilized to reduce movement of sediment in these ephemeral channels.

Photo 27: Example of river over-widening due to poorly configured drop structures. Wigwam Club, CO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Scale = 1" : 80 Ft.
Log toe-slope riparian bank-full benches along the left river bank upstream of Structure #32 to stabilize eroding bank. Remove rip-rap along the bank at Structure #33, and utilize these boulders elsewhere.
Install a large habitat tree at the top of the riparian bank-full bench on the left river bank.
Large Habitat Tree
125RP
125LP
LAKE
Remove Structure #34
Utilize boulders to construct a new boulder cross vane
Log toe-slope riparian benching to reduce width of the channel upstream of Structure #34
Large habitat Tree
126RP
126LP
Restore original channel width where the gully enters the river on the right. Large wood to stabilize the toe of the deposition fan. Extensive planting on the deposition fan
DITCH
Gully
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Reach 21 – Enhancement Plan Drawing #13

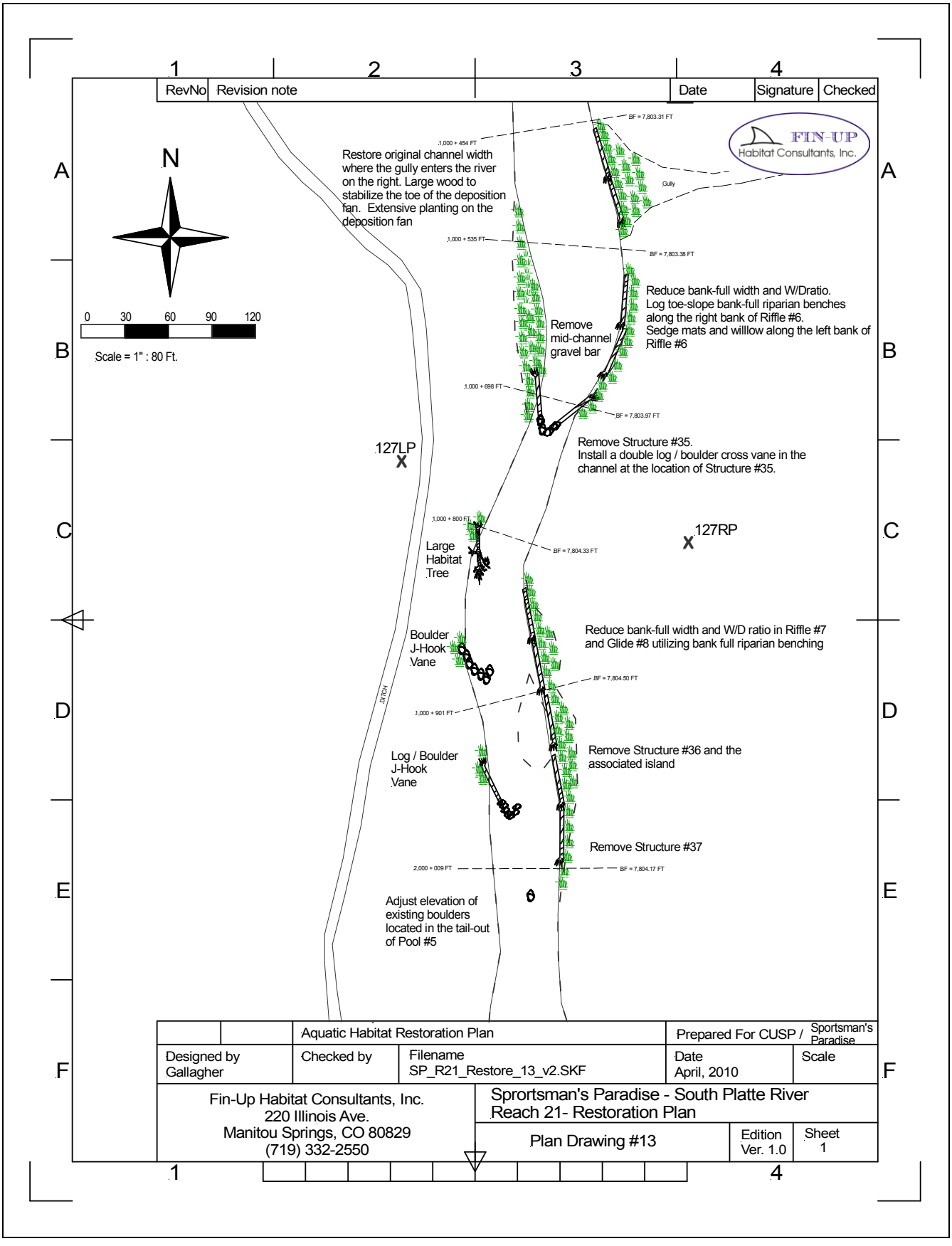
Enhancement Plan Drawing #13 shows the segment of Reach 21 from 0+1,450 ft to 0+2,100 ft along the longitudinal axis of the river. The treatments for the gully entering the river at 0+1,454 ft have been described in the previous section. Upstream of this point, the over-wide channel in Riffle #6 will be treated by removing Structure #35, and excavating the large mid-channel gravel/sediment bar down to the cobble bed of the river. This material will be utilized to back-fill the bank-full riparian bench structures that will be constructed along the right river bank in this riffle. The left bank will also be reconstructed to reduce the overall bank-full width of the riffle, using sedge and sod mats harvested from the adjacent meadow. Some large wood may be placed low in the channel as vanes along the left bank to further stabilize the new vegetation treatments.

Another double log / boulder full channel cross-vane will be installed at 0+1,698 ft, at the former location of Structure #35, to create a new pool at this location. This structure will also serve to reduce erosion and shear forces along the restored river banks on either side of the channel downstream, and will also provide vertical channel and river bed stability upstream in Glide #4.

Upstream of Cross-Section 127, the boulder cluster at Structure #36, and the associated island, will be removed from the channel. Structure #37 is also not currently functioning, and will be removed as well. The width of the channel through Riffle #7 and Glide #5 will be reduced by re-constructing the right river bank using riparian bank-full benches. Vegetation mats preserved from the island and harvested from the adjacent meadow will be used to plant behind these structures.

Reducing the bank-full channel width through Glide #5 should covert this habitat to more of a riffle-like form. In order to increase pocket-water habitat throughout the increased length of the riffle, several features will be added along the left bank of the channel in this segment. Near the downstream left side of Riffle #7, a large habitat tree may be installed as a vane to provide habitat complexity and cover along this section of the bank. Directly across from where the island currently exists in the channel, a boulder J-Hook vane will provide in-channel object cover and velocity shelter, as well as protection of the left river bank from high flow events. Approximately 75 ft upstream, a log/boulder J-Hook vane will serve a similar purpose, as well as providing refugia for juvenile and young-of-the-year trout.

Photo 28: Example of a boulder J-Hook Vane. Tarryall River – Eagle Rock Ranch, Park County, CO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N
0 30 60 90 120
Scale = 1" : 80 Ft.
Restore original channel width where the gully enters the river on the right. Large wood to stabilize the toe of the deposition fan. Extensive planting on the deposition fan
1,000 + 454 FT
BF = 7,803.31 FT
Gully
1,000 + 535 FT
BF = 7,803.38 FT
Reduce bank-full width and W/Dratio.
Log toe-slope bank-full riparian benches along the right bank of Riffle #6.
Sedge mats and willlow along the left bank of Riffle #6
Remove mid-channel gravel bar
1,000 + 698 FT
BF = 7,803.97 FT
127LP
Remove Structure #35.
Install a double log / boulder cross vane in the channel at the location of Structure #35.
1,000 + 800 FT
BF = 7,804.33 FT
127RP
Large Habitat Tree
Boulder J-Hook Vane
Reduce bank-full width and W/D ratio in Riffle #7 and Glide #8 utilizing bank full riparian benching
DITCH
BF = 7,804.50 FT
1,000 + 901 FT
Log / Boulder J-Hook Vane
Remove Structure #36 and the associated island
Remove Structure #37
2,000 + 009 FT
BF = 7,804.17 FT
Adjust elevation of existing boulders located in the tail-out of Pool #5
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Reach 21 – Enhancement Plan Drawing #14

This drawing shows the segment of Reach 21 from 0+2,000 ft to 0+2,700 ft along the longitudinal axis of the river. The elevation and orientation of the boulders in the tail-out of Pool 5 (Grid A-4) will be adjusted so that sediment will not deposit behind these features, forming small mid-channel bars. The elevations of these boulders should be set no higher than ½ of the bank-full stage of the channel at this location. Habitat in Pool #5 may be further enhanced, and sediment transport improved, by installing a double log / boulder cross-vane at the initial scour point of the riffle at 0+2,108 ft. This structure will also provide an anchor point along the right bank for the new right bank in Riffle #8 described below.

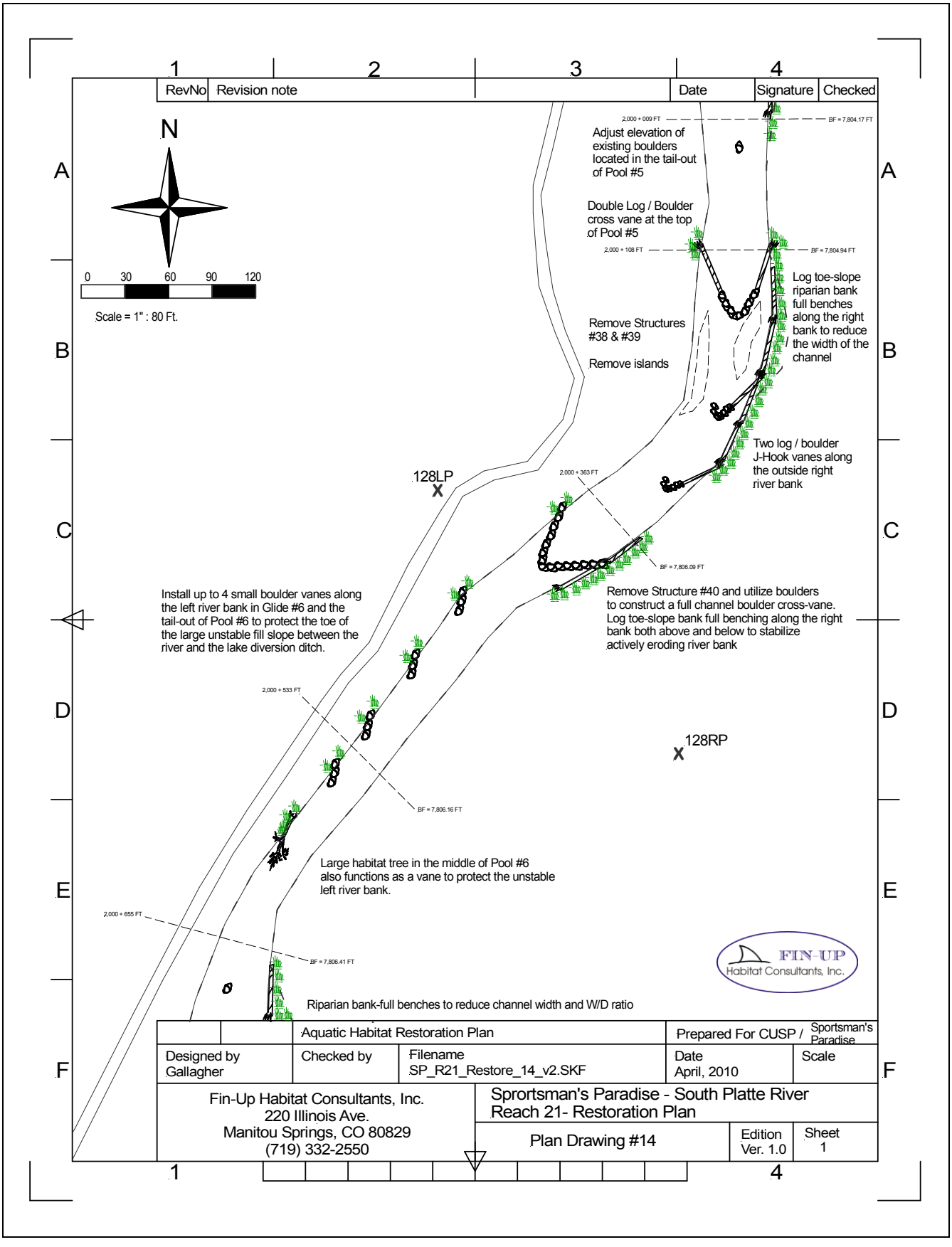
The over-wide channel at Riffle #8 (Grid B-4) can be treated by removing Structure #38, Structure #39, and the two islands that have formed in the channel between the two structures. The right river bank can then be re-constructed to reduce the bank-full width of the channel through the riffle to 70 – 80 ft, with a consequent reduction of width/depth ratio to less than 35. The right river bank will be constructed utilizing large wood and riparian bank-full benching, vegetation taken from the islands removed from the channel, and sod / sedge mats from the adjacent meadow. To further protect the new right river bank from high flow shear forces, two log / boulder J-Hook vanes will be installed at intervals along the outside of the meander bend. These vanes will provide useable slow-water habitat immediately adjacent to the new bank both upstream and downstream of the structure, and additional pocket-water habitat and in-channel object cover within the small scour zones downstream of the "hook".

The mostly failed boulder vane/drop structure between Riffle #8 and Glide #6 (Structure #40 / Grid C-3) and the associated mid-channel sediment bar immediately downstream, will be completely removed from the channel. In it's place, a full channel boulder cross-vane may be installed 65-75 ft upstream in Glide #6 to form a new pool in the channel extending downstream to the existing riffle crest at the top of Riffle #8. The blown out right bank will be restored using the large wood and riparian benching techniques previously described.

The generally unstable left river bank formed by the fill slope of the diversion ditch throughout Glide #5 and Pool #6 (Grid D-2) will be treated using small boulder vanes and groins at intervals along the bank to flatten the water surface slope and reduce bank shear forces along the "at-risk" river bank. The river is already relatively narrow through this segment, and these small features should reduce pressure along the bank without significantly affecting the overall cross-sectional area and capacity of the channel. Up to four of these structures will be utilized within this segment. In addition to protecting the river bank, these features will provide additional velocity shelter, holding and feeding areas for resident fish.

Following construction of the boulder vanes, bare-root stock willow should be planted along the toe of the fill slope throughout the entire length of the right bank from 0+2,375 ft to 0+2,650 ft. Additionally, a large habitat tree may be installed as a vane along the left bank in Pool #6 (Grid E-2) to provide additional bank protection and habitat complexity.

Photo 29: TU volunteers planting bare-root stock willow – Arkansas River – Canon City, CO.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0 30 60 90 120
Scale = 1" : 80 Ft.
Adjust elevation of existing boulders located in the tail-out of Pool #5
2,000 + 009 FT
BF = 7,804.17 FT
Double Log / Boulder cross vane at the top of Pool #5
2,000 + 108 FT
BF = 7,804.94 FT
Log toe-slope riparian bank full benches along the right bank to reduce the width of the channel
Remove Structures #38 & #39
Remove islands
Two log / boulder J-Hook vanes along the outside right river bank
128LP
2,000 + 363 FT
BF = 7,806.09 FT
Remove Structure #40 and utilize boulders to construct a full channel boulder cross-vane. Log toe-slope bank full benching along the right bank both above and below to stabilize actively eroding river bank
Install up to 4 small boulder vanes along the left river bank in Glide #6 and the tail-out of Pool #6 to protect the toe of the large unstable fill slope between the river and the lake diversion ditch.
2,000 + 533 FT
BF = 7,806.16 FT
128RP
Large habitat tree in the middle of Pool #6 also functions as a vane to protect the unstable left river bank.
2,000 + 655 FT
BF = 7,806.41 FT
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Riparian bank-full benches to reduce channel width and W/D ratio
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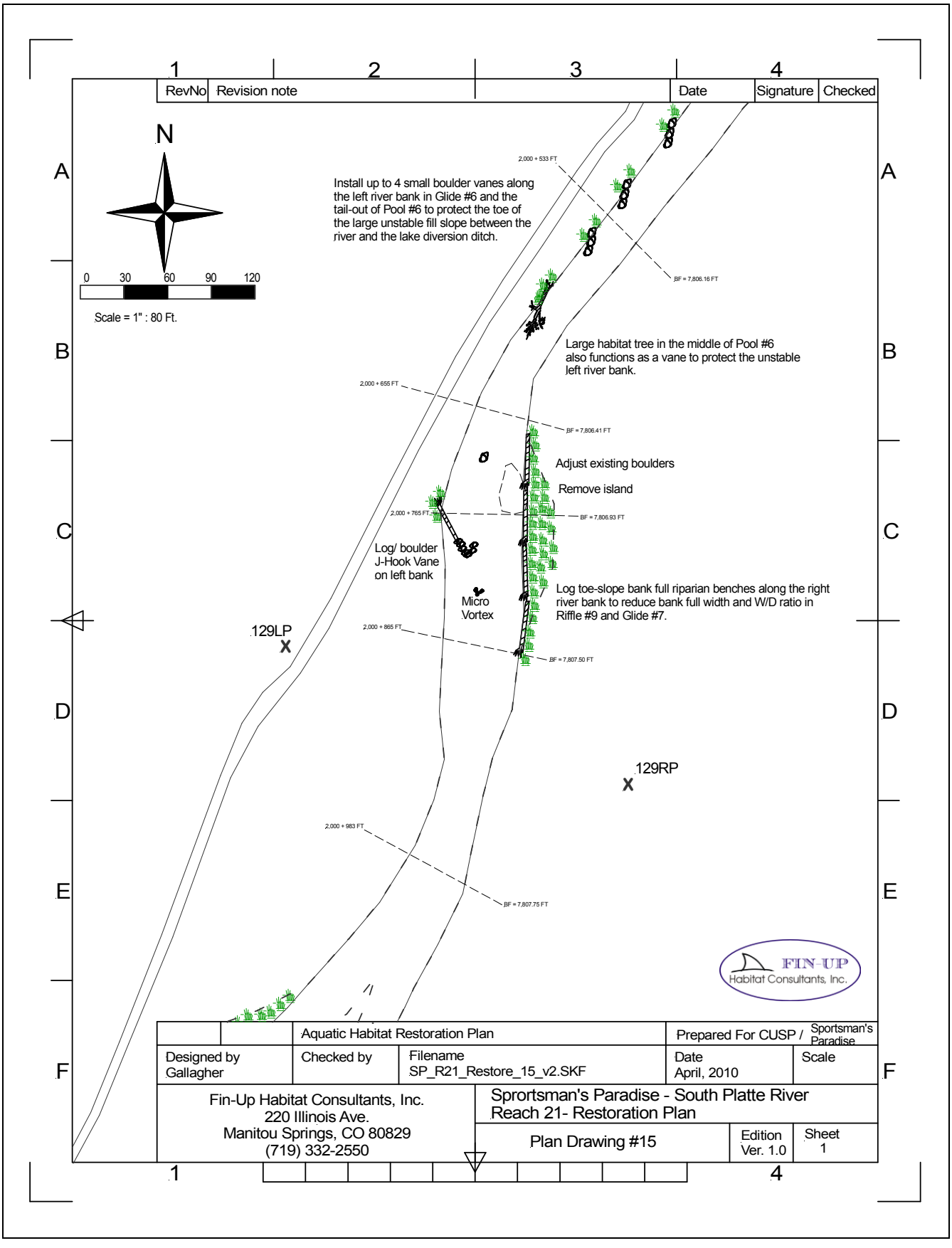
Reach 21 – Enhancement Plan Drawing #15

Habitat Map Drawing #15 shows the segment of Reach 21 from 0+2,450 ft to 0+3,100 ft along the longitudinal axis of the river. The treatments proposed for Glide #6 and Pool #6 were described in the previous section. The only other area within this segment that is proposed for treatment is the over-wide channel within Riffle #9 and Glide #7 (Grid C-3).

The channel over-widening in this segment is directly associated with Structure #41, and this feature will be removed, and the boulders salvaged for use elsewhere. The small island that has formed downstream of the structure will also be removed, and the vegetation preserved for use along the right river bank. The right river bank throughout Riffle #9 and Glide #7 will be re-built to reduce the bank-full width of the river to 80 ft or less. Large wood should be used along the toe of the bank to protect the transplanted vegetation on the new bank-full riparian benches. We anticipate that the reduction of bank-full channel width should convert Glide #7 back to more of a riffle like form, and several in channel treatments have been identified to create additional useable habitat in this expanded riffle habitat. Several existing boulders in this segment can be adjusted to function more efficiently in creating useable habitat in the riffle. Modification of elevation and orientation will result in better scour and deeper in-channel object cover in these existing features. Additional micro-vortex in-channel object cover structures may be added in the former glide to create additional habitat complexity and to break up the laminar flow along this segment of river channel. A log / boulder J-Hook vane will also be installed on the left bank at 0+2,765 ft to reduce the added shear along this outside bank caused by reducing the width of the channel. This feature will also provide additional pocket-water habitat and combination cover along the left bank in the riffle.

Photo 30: River over-widening due to miss-aligned boulder vanes. Swayback Ranch, CO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Install up to 4 small boulder vanes along the left river bank in Glide #6 and the tail-out of Pool #6 to protect the toe of the large unstable fill slope between the river and the lake diversion ditch.
2,000 + 533 FT
BF = 7,806.16 FT
Large habitat tree in the middle of Pool #6 also functions as a vane to protect the unstable left river bank.
2,000 + 655 FT
BF = 7,806.41 FT
Adjust existing boulders
Remove island
2,000 + 765 FT
BF = 7,806.93 FT
Log/ boulder J-Hook Vane on left bank
Micro Vortex
Log toe-slope bank full riparian benches along the right river bank to reduce bank full width and W/D ratio in Riffle #9 and Glide #7.
129LP
2,000 + 865 FT
BF = 7,807.50 FT
129RP
2,000 + 983 FT
BF = 7,807.75 FT
FIN-UP
Habitat Consultants, Inc.
Aquatic Habitat Restoration Plan
Prepared For CUSP / Sportsman's Paradise
Designed by Gallagher
Checked by
Filename SP_R21_Restore_15_v2.SKF
Date April, 2010
Scale
Fin-Up Habitat Consultants, Inc.
220 Illinois Ave.
Manitou Springs, CO 80829
(719) 332-2550
Sprortsman's Paradise - South Platte River
Reach 21- Restoration Plan
Plan Drawing #15
Edition Ver. 1.0
Sheet 1

Reach 21 – Enhancement Plan Drawing #16

Habitat Map Drawing #16 shows the final segment of Reach 21, from 0+2,900 ft to the end of the reach at the confluence with Vermillion Creek at 0+3,655 ft. The channel is severely impacted throughout this segment, and will require significant treatment to restore river function and enhance habitat.

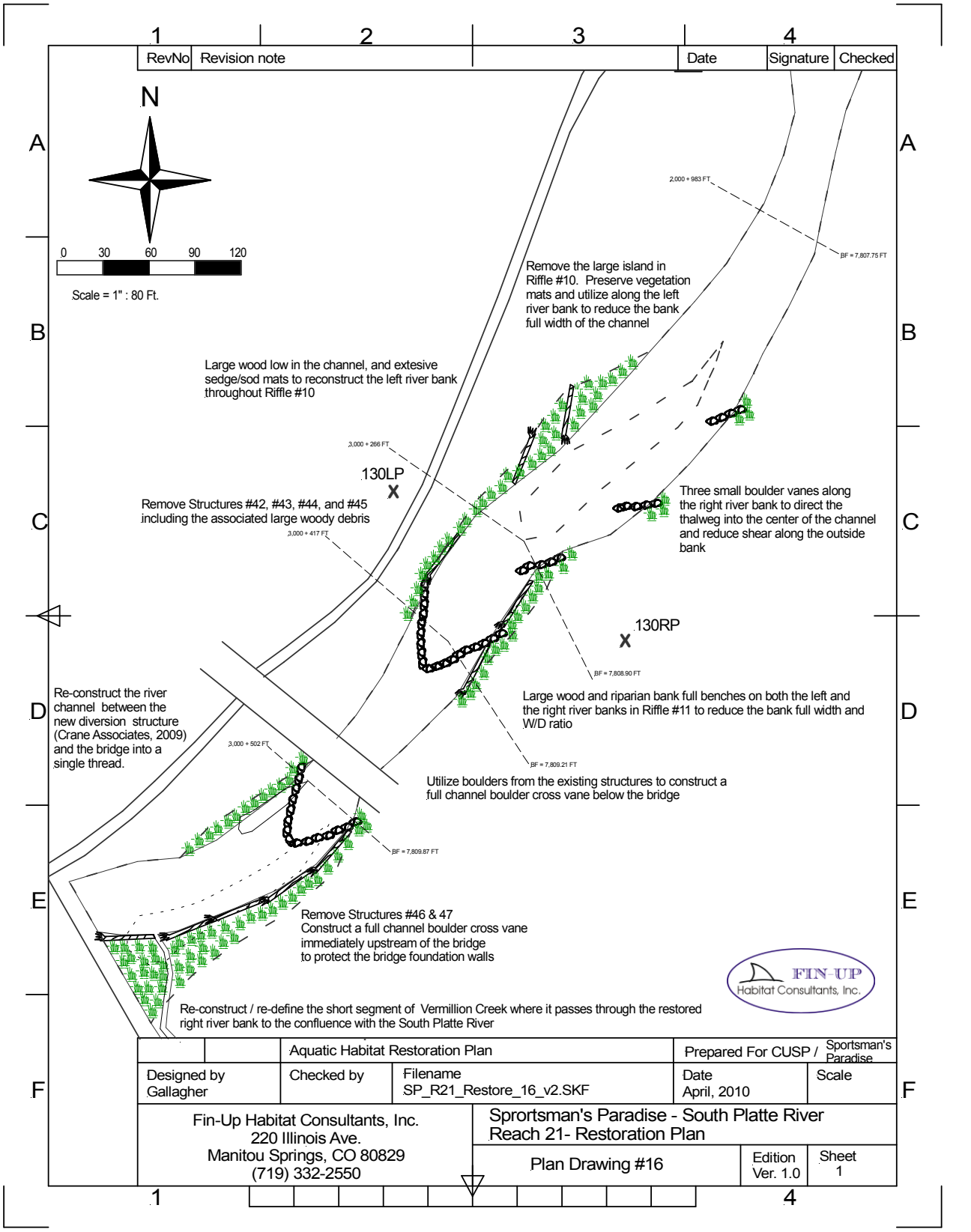
The six existing structures, and the large wood that is associated with these features, are no longer providing any habitat benefit and in most cases are contributing the degradation of the channel throughout this segment. These structures should be removed, and the boulders salvaged for use in the re-configured channel described below. The large island that has formed in Riffle #10 (Grid B-4 and C-3) will be removed from the channel, and the vegetation preserved for use along the restored stream banks in this habitat.

The bank-full width of Riffle #10 may be reduced to 75 ft - 85 ft by reconstructing the left river bank utilizing large wood as vanes, low in the channel, and sedge plantings and sod mats to re-form the river bank on the inside of this gradual meander bend. Although the outside right river bank is relatively well vegetated with willow through this habitat, we recommend that three boulder vanes be installed at intervals along the bank reduce water surface slope and any additional shear along the bank that may result from reducing the bank-full width of this riffle. These features should also provide some additional pocket-water habitat and fishing opportunities along this bank.

Upstream in Riffle #11, both river banks will need to be restored in order to address the severe over-wide condition of the channel in this habitat. Log toe-slope bank-full riparian benching will be used throughout this segment of the channel, with the goal of reducing the bank-full width to 70 ft and the width/depth ratio to 35 or better. A full channel boulder cross-vane recommended near the top of this habitat. This structure will allow us to define the thalweg through the restored channel below, as well as protect the newly restored river banks in Riffle #11. The structure will provide vertical stability in the river channel, protecting critical infrastructure (a bridge) immediately upstream, as well as creating some additional pool cover in the center scour immediately downstream of the structure. A boulder cross-vane is also recommended immediately upstream of the bridge to protect the bridge foundation supports, and to enhance scour and sediment transport through the pool downstream.

The segment of the river from the bridge upstream to the diversion structure at the SPHOA property boundary will be reduced to a single th read channel, with extensive riparian planting on both banks to significantly reduce the width of the channel through this segment. At the confluence with Vermillion Creek, a new channel for Vermillion Creek will be constructed through the river bank and floodplain restoration. This segment is part of a separate project to replace the diversion structure. A detailed design has been completed Crane Associates (2009) for the SPHOA and the Coalition for the Upper South Platte.

Photo 31: One possible definition of successful restoration.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Scale = 1" : 80 Ft.
2,000 + 983 FT
BF = 7,807.75 FT
Remove the large island in Riffle #10. Preserve vegetation mats and utilize along the left river bank to reduce the bank full width of the channel
Large wood low in the channel, and extesive sedge/sod mats to reconstruct the left river bank throughout Riffle #10
3,000 + 266 FT
130LP
Remove Structures #42, #43, #44, and #45 including the associated large woody debris
Three small boulder vanes along the right river bank to direct the thalweg into the center of the channel and reduce shear along the outside bank
3,000 + 417 FT
130RP
BF = 7,808.90 FT
Large wood and riparian bank full benches on both the left and the right river banks in Riffle #11 to reduce the bank full width and W/D ratio
Re-construct the river channel between the new diversion structure (Crane Associates, 2009) and the bridge into a single thread.
3,000 + 502 FT
BF = 7,809.21 FT
Utilize boulders from the existing structures to construct a full channel boulder cross vane below the bridge
BF = 7,809.87 FT
Remove Structures #46 & 47
Construct a full channel boulder cross vane immediately upstream of the bridge to protect the bridge foundation walls
FIN-UP
Habitat Consultants, Inc.
Re-construct / re-define the short segment of Vermillion Creek where it passes through the restored right river bank to the confluence with the South Platte River
Aquatic Habitat Restoration Plan
Prepared For CUSP / Sportsman's Paradise
Designed by Gallagher
Checked by
Filename SP_R21_Restore_16_v2.SKF
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Prioritization and Implementation:

Ideally, this project should be undertaken in coordination with the Sportsman's Paradise diversion structure reconstruction and the restoration effort currently planned by CUSP and the USFS in the Happy Meadows Reach of the South Platte River immediately upstream. If time and budgets allow, the project should be fully implemented, in order to take advantage of the economies of scale of a larger effort in the basin, and to quickly address some of the significant issues identified in this assessment. The reality of limited budget, resources, and timing, however, may dictate that the work be implemented over an extended period of time. If this is indeed the case, the treatments outlined in this document may be prioritized for implementation over a period of years. The greatest potential for further degradation of the channel and associated habitat in the project reaches is directly related to the many existing structures indentified in this assessment, and it is strongly recommended that, if the project cannot be undertaken all at once, that these features be addressed first. If structural issues are addressed as a first phase of the project, it is important to recognize that any structure that is removed should be immediately replaced by the recommended alternative treatment so as to not introduce further instability into the river channel.

If the project is divided into phases, and following treatment of the existing structures; the remaining channel width and river bank restoration should proceed beginning at the upstream end of Reach 21, and proceeding downstream to the property boundary below the confluence with Beaver Creek. This portion of the project may be divided into as many phases as necessary to complete the work as budgets allow, but it is important that as each channel segment is worked on, the recommended treatments for the given channel segment need to be completed in full.

The project will require the use of heavy equipment to complete the treatments as prescribed. At a minimum, we recommend the following equipment be contracted to implement the project. A large excavator (200 series or greater) with a functional hydraulic "thumb" will be necessary. Excavators utilizing a fixed "thumb" are not suitable for work of this complexity, and are not recommended. A large loader will be required, with a minimum bucket size of 4 yd^3, and equipped with a hardened steel cutting edge on the bucket to allow for efficient harvest of vegetation mats from the islands and surrounding meadows. The loader may be either tracked or wheeled, but if wheel driven, it should have large balloon style tires to minimize compression of riparian soils. Tandem dump trucks and/or a side dump truck will be required to move materials to the project sites. While not absolutely required, a second excavator can be very useful, particularly with the log toe-slope and riparian bank-full bench work, and can significantly reduce the time necessary to build these features.

180 to 200 large trees will need to be harvested from the surrounding SPHOA lands, or secured from other sources, to provide the large wood required to implement the restoration plan. It is possible that these trees could be obtained through cooperative agreements with the USFS, Colorado State Forest Service, and other watershed organizations and private land owners, and from recent blow-down sites in the vicinity of Lake George and the Manitou Experimental Forest.

Although substantial quantities of boulders are already available on site in the existing structures, a few hundred cubic yards of additional boulders will still be required, and represent a significant cost to complete the project reaches. There are a few sites within the SPHOA property that may be suitable for boulder collection that could supply the necessary boulders for the project. Using low impact boulder harvest techniques demonstrated during the 2005 Eleven-mile Canyon River Restoration "Centennial" Project and the 2009 Camp Alexander Restoration Project, boulders for this restoration may be harvested with little disturbance from these areas. Using local boulders not only substantially reduces the overall cost of the work, but is esthetically desirable to enhance the

natural appearance and reduce the visual impact of the project. Ideally, the project should be relatively "invisible" to the untrained eye three years following completion of the work. The use of native materials greatly increases the probability of achieving this goal.

Native coyote and sand bar willow is relatively abundant in the project area, and will allow for quick and easy transplant by backhoe, excavator or front loader. Sedge is less abundant in the project reach, and will likely have to be harvested from areas outside of the project reach. A large source of sedge has been identified on private property adjacent to the large lakes in the town of Lake George, and the owners have agreed to allow harvest of sedge necessary for the project from this nearby site. Areas where sod mats can be taken to restore river banks are abundant in the project area, but noxious weed survey and mapping will need to be conducted before project implementation to assure that sod mats are not infested with undesirable vegetation. Sod mat harvest areas will need to be reclaimed and re-seeded following project implementation to assure that these disturbed areas do not become additional sources of week infestation. Extensive hand planting of bare-root stock willow by SPHOA volunteers and others will require purchase of these plants from the Colorado State Forest Service. As many as 6,000 bare-root stock plants may eventually be planted to fully revegetate the restored river banks in the reach.

Post Project Effectiveness Monitoring:

Effectiveness monitoring is recommended following completion of the project to assess the performance of the work outlined in this document. At a minimum, photo-points will be established in the treatment areas to monitor the vegetation and channel over time. It is also strongly recommended that the habitat mapping survey and a channel morphology survey be repeated five to ten years following completion of the project. Responsibility for post project monitoring is expected fall to the Sportsman's Paradise Home Owners Association following completion of the restoration, with some assistance in data collection and analysis provided by the Coalition for the Upper South Platte and / or other watershed related agencies in the region.

Glossary of Terms:

Benthic Zone - The benthic zone is the lowest level of a body of water. It is inhabited mostly by organisms that tolerate cool temperatures and low oxygen levels, called benthos or benthic organisms.

Cascade - A meso-habitat type. Cascades are the steepest riffle habitat types, in terms of gradient, in streams. These riffles consist of alternating small waterfalls and shallow pools. These habitats may appear to have the characteristics of a Step-pool system. Cascades are characterized by swift current flows and often have exposed rocks and boulders above the water surface, which creates considerable turbulence and surface agitation. The substrate normally found in cascades is bedrock or accumulations of boulders.

Cover - Locations where fish prefer to rest, hide and feed are called cover. Cover serves to visually isolate fish, which increases the number of territories in the same space. Additionally, cover can create areas of reduced velocities providing critical resting and feeding stations for fish. The amount of cover available in a stream can influence the production of a number of fish and invertebrate species.

Cross-Vane - A structure spanning the entire width of the channel, constructed of large boulders and/or large wood, that provides vertical stability, increased scour, increased stage upstream, and reduced stream power. This structure type is commonly used as a diversion structure for irrigation ditches, as well as for treating active down cutting and head cuts in the stream channel.

Embeddedness - The degree to which the interstitial spaces between larger substrate particles are filled with finer sediments. Embeddedness tends to armor the substrate, thus limiting available habitat for benthic dwelling macroinvertebrates and spawning habitat for salmonids.

Glide - A meso-habitat type. Glides are those portions of streams which have relatively wide uniform bottoms, low to moderate velocity flows, lack pronounced turbulence, and have substrates usually consisting of either cobble, gravel or sand. Glides are usually described as stream habitat with characteristics intermediate between those of pools and riffles. These habitats are commonly found in the transition between a pool and the head of a riffle, however they are occasionally found in low gradient stream reaches with stable banks and no major flow obstructions.

Head-Cut - An area of active down-cutting in the channel where a river or stream is eroding down to a new, lower flood plain.

Intermittent - An intermittent stream is one that only flows for part of the year.

Lotic - Of, relating to, or living in moving water such as streams and rivers.

Meso-Habitat - A channel scale habitat form. Typically a pool, riffle, rapid, cascade or glide habitat. A meso-habitat occupies the entire width of the stream channel, and with few exceptions (most notably plunge pools in high gradient step-pool systems) is at least as long as the channel is wide.

Micro-Habitat - Micro habitats are small, site specific habitats within a meso-habitat form, and may include spawning redds, in-stream or overhead cover, and velocity shelters.
Micro-Vortex - A small rock cluster structure that replicates pocket water habitat in riffles, rapids and cascades.

Over-Wintering Habitat - Areas of a stream or water body exhibiting depths that may sustain a population through the winter months.

Perennial - A perennial stream is one that flows year round.

Pocket Water - A micro-habitat type. Pocket water habitats are typically found in higher gradient riffles, rapids, and cascades with large cobble, boulder, and large woody debris. These pocket water habitats provide small areas for velocity shelter and cover within these fast-water habitat forms.

Pool - A meso-habitat type. Pools are channel segments exhibiting areas of scour and deposition where the water is deeper and slower moving.

Primary Producers - Primary producers are those organisms in an ecosystem that produce biomass from inorganic compounds. In almost all cases these are photosynthetically active organisms.

Rapid - A meso-habitat type. Rapids are riffles associated with high gradients (greater than 4%) with swiftly flowing (greater than 1.5 ft/sec), moderately deep, and highly turbulent waters. These riffles are generally associated with boulder substrates, which protrude through the surface of the water.

Residual Pool Depth (RPD) - Residual pool depth is estimated as the depth of water which would be retained in a pool under highly reduced flows or the stoppage of flows in the stream. This area of pools would be utilized by fish in low flow conditions. Residual pools would also provide habitat for overwintering of fish when ice buildup restricts movement in riffles or glides between pools. Residual pool depth is calculated by locating and measuring the greatest depth of the pool at the riffle crest (deepest point of the downstream boundary cross-section of the pool), and subtracting this value from the greatest measured depth of the pool habitat. The difference in these measurements is described as the RPD. RPD may be difficult to determine in some habitats, particularly dam pools with woody debris structural associations. In many of these habitat units, the RPD may actually be a very low value or zero due to water flowing through these debris dams.

Riffle - A meso-habitat type. Riffles are those areas of the stream in which turbulence in the water column is the major identifying characteristic, as a result of relatively high gradients. These units contain moderately deep to shallow, swift flowing water, and are characterized by boulder or cobble substrates. Riffles are very important for macroinvertebrate production, due to the availability of light and oxygen, and the corresponding vegetative growth on the bottom substrate. The quality of riffles, including low sediment deposition and resulting embeddedness can have a direct impact on fish populations. The cleaner and healthier the vegetative growth and benthic macroinvertebrate community, the more food there is for the fish population.

Salmonids - Salmonidae is a family of ray-finned fish, the only family of order Salmoniformes. It includes the well-known salmons and trouts; the Atlantic salmons and trouts of genus Salmo give the family and order their names.

Subfamily - Salmoninae
Brachymystax - lenoks
Oncorhynchus - Pacific salmon and trout
Salmo - Atlantic salmon and trout
Salvelinus - Char and trout (Brook trout, Lake trout)

Substrate - Stream substrate (sediment) is the material that rests at the bottom of a stream.

Thermal Refugia - Micro habitats found in streams and lakes that provide thermal protection for cold water species such as trout. These may include shaded areas, cool water springs, and deep water habitats.

Toe-Slope - The foot, or bottom, of the sloping bank of a stream. This is the area of the highest sheer stress and erosion potential on a stream bank, and is typically the point of failure leading to mass wasting and collapse.

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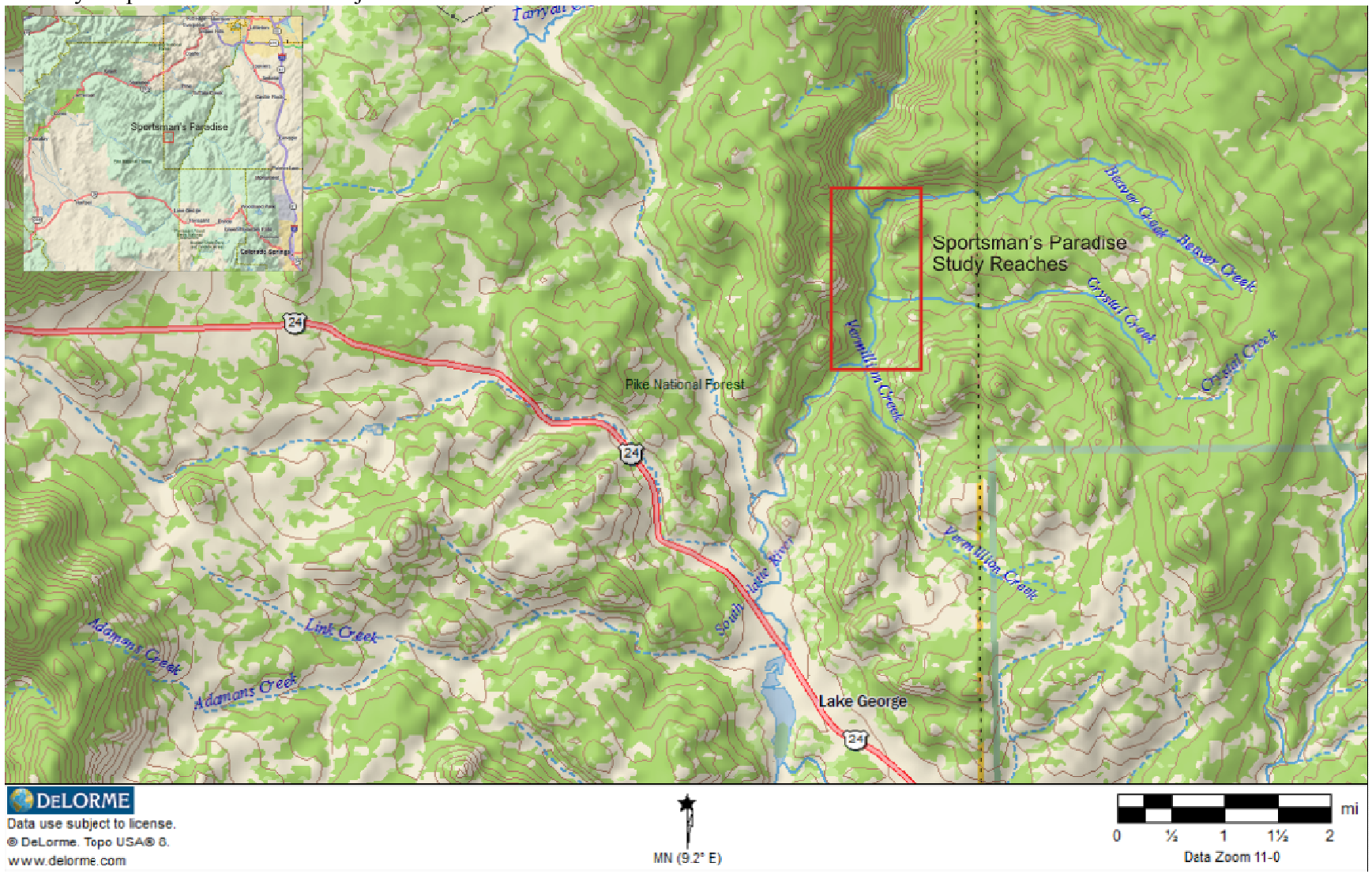
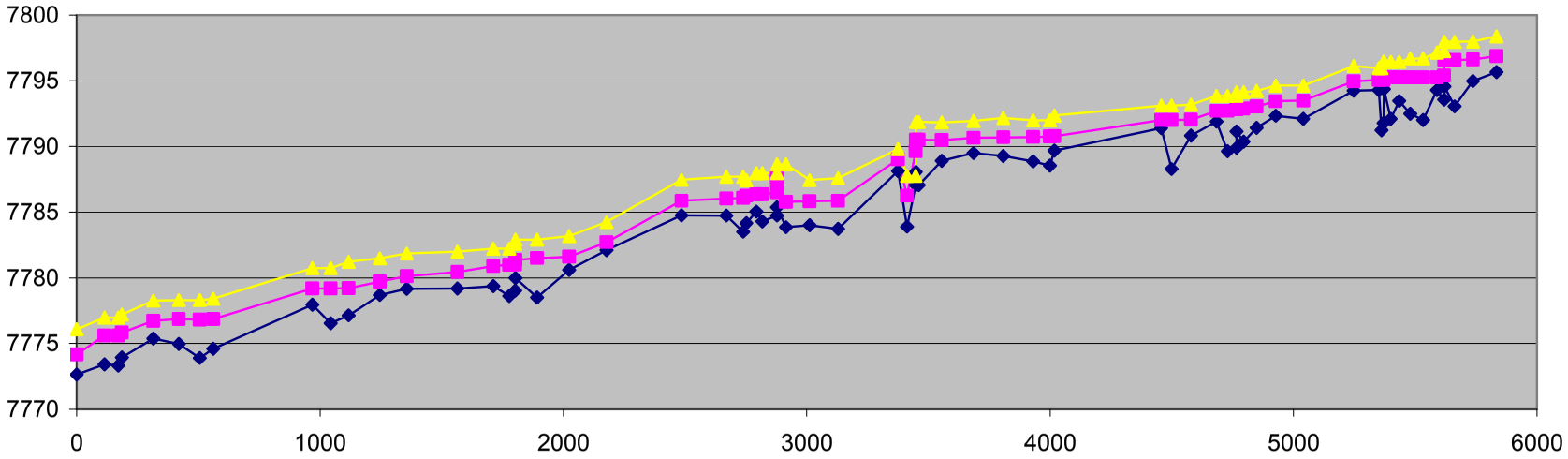
Ariel Photography provided by the US Forest Service. Topographical maps created using USGS and Delorme TOPO 6.0

APPENDICES

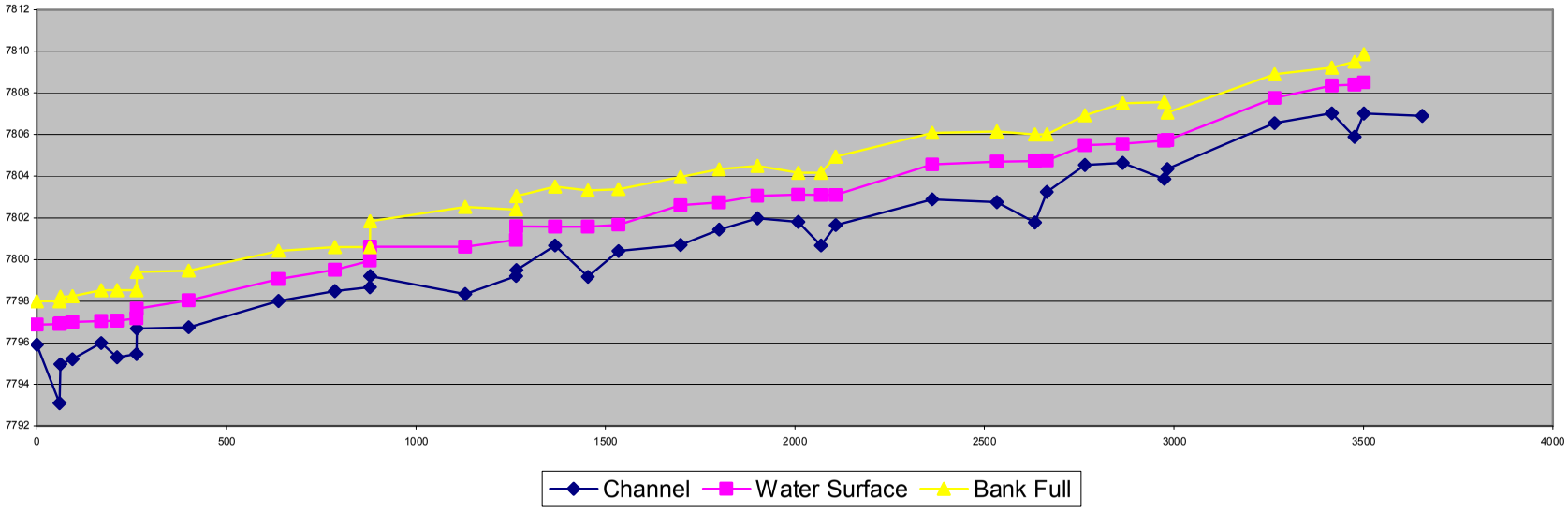
Vicinity Map - Location of the Project Area



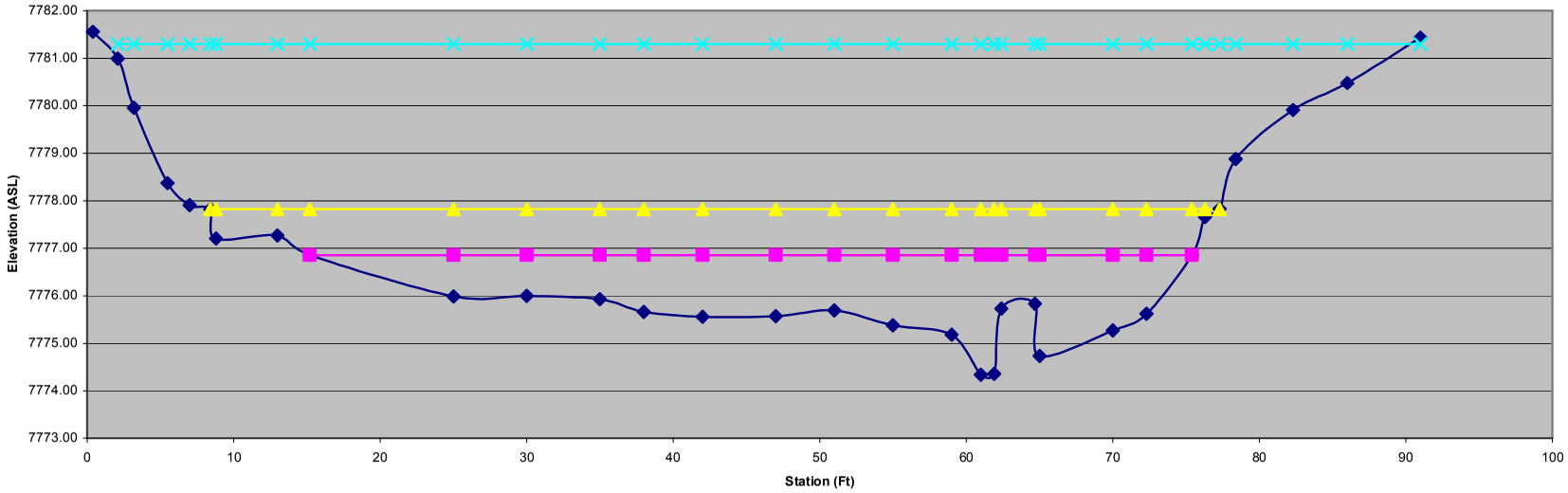
South Platte River - Reach 20 - Longitudinal Profile



South Platte River - Reach 21 - Longitudinal Profile



South Platte River - Reach 20 - Cross-Section 110



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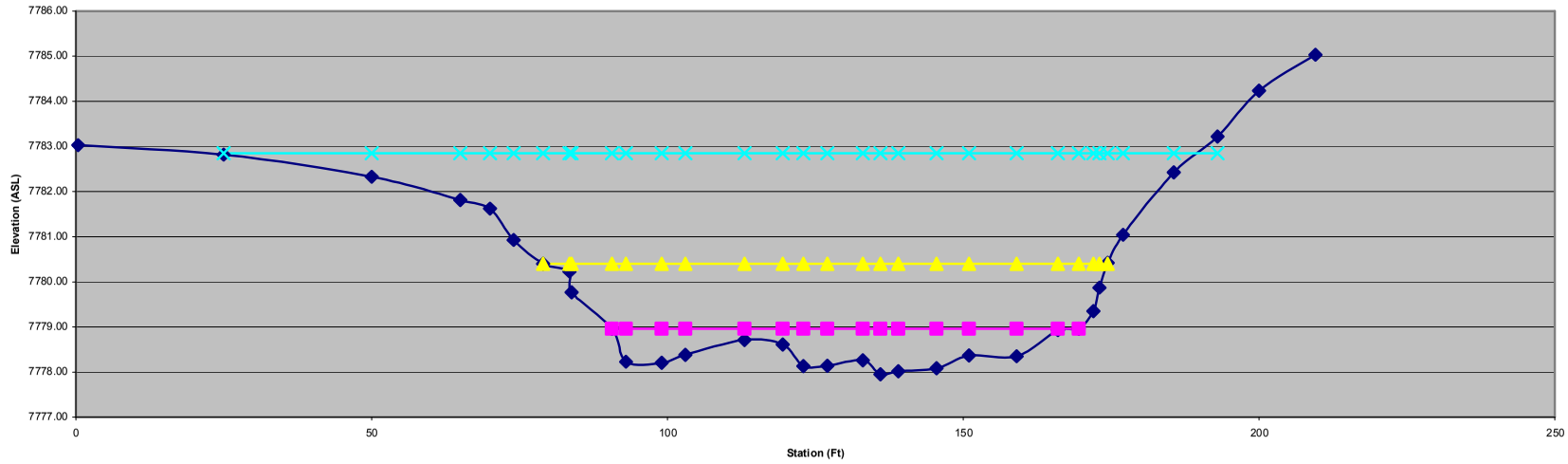

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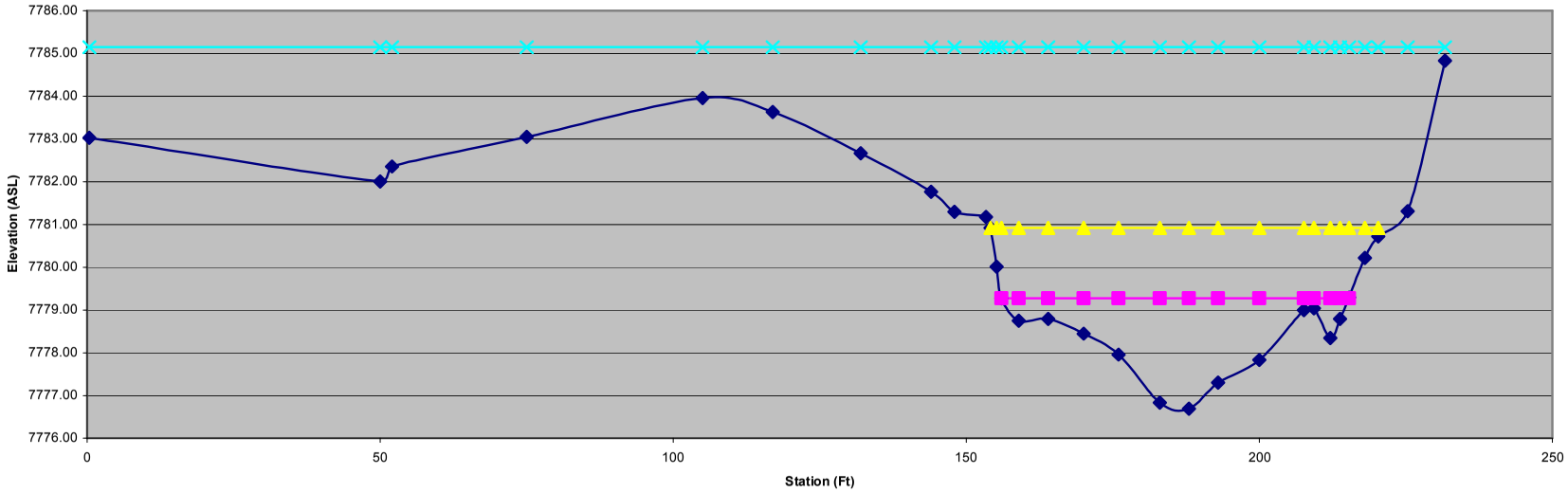

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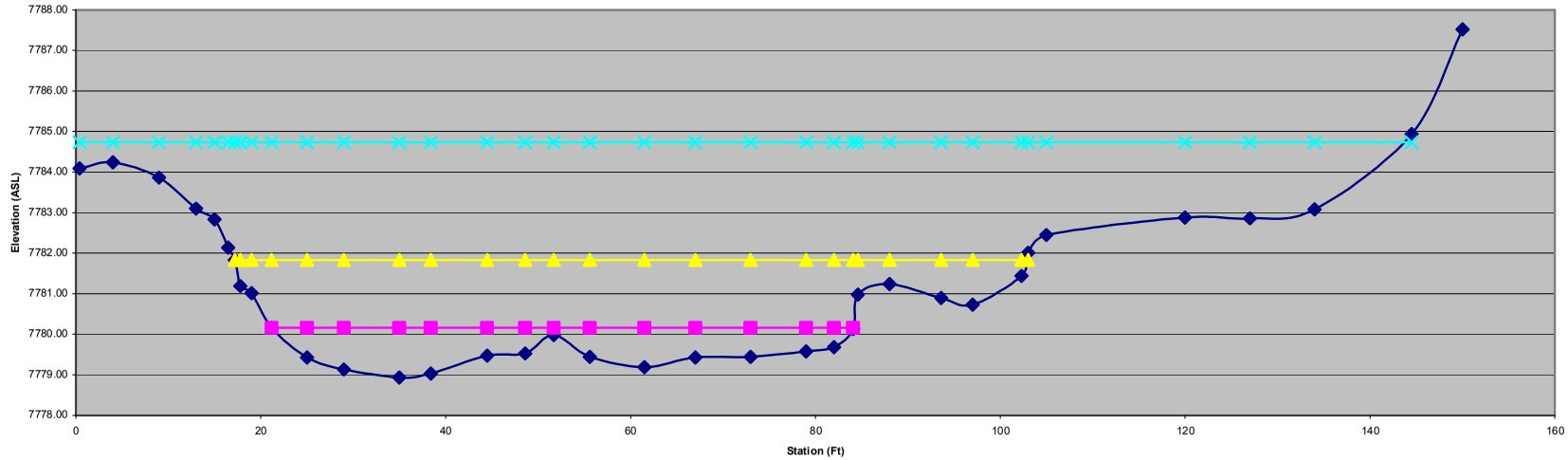

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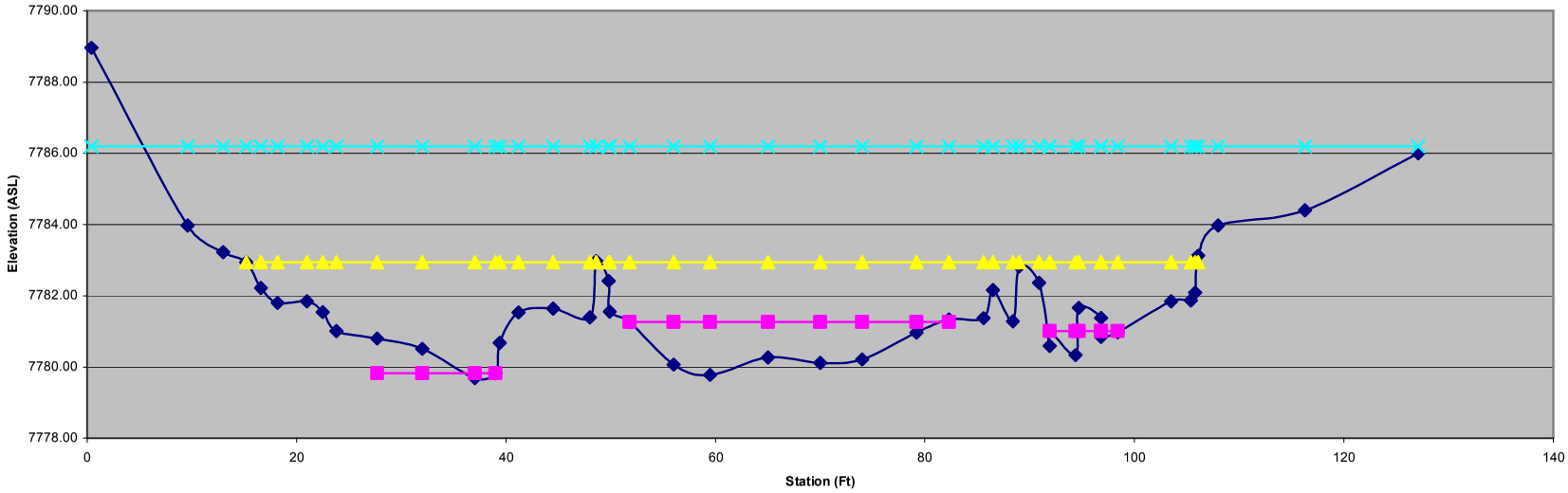

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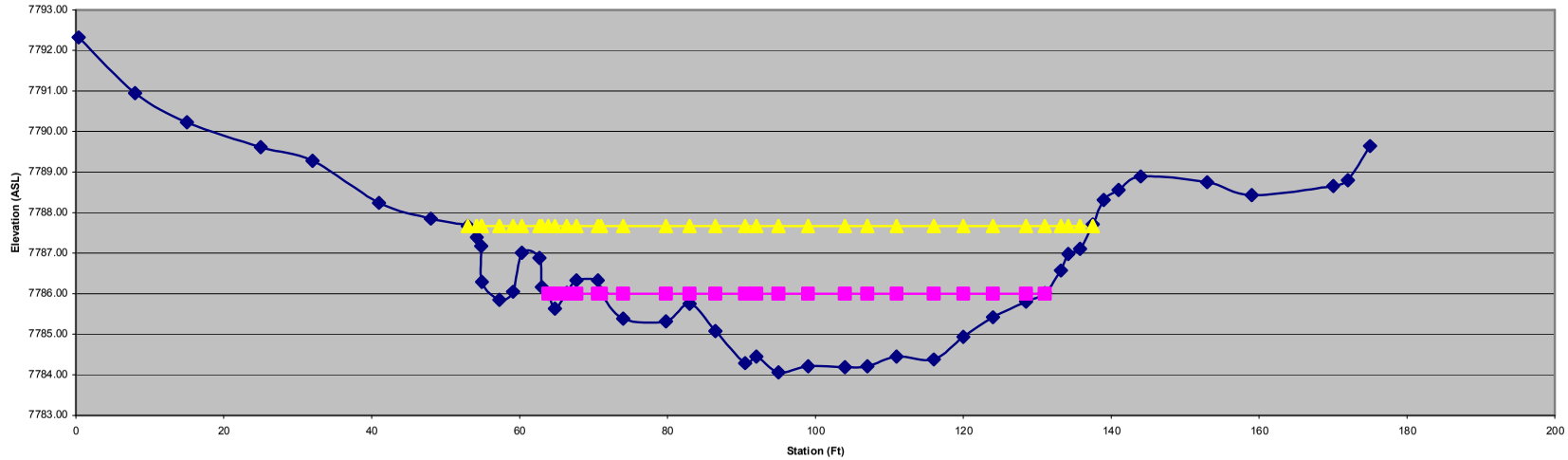

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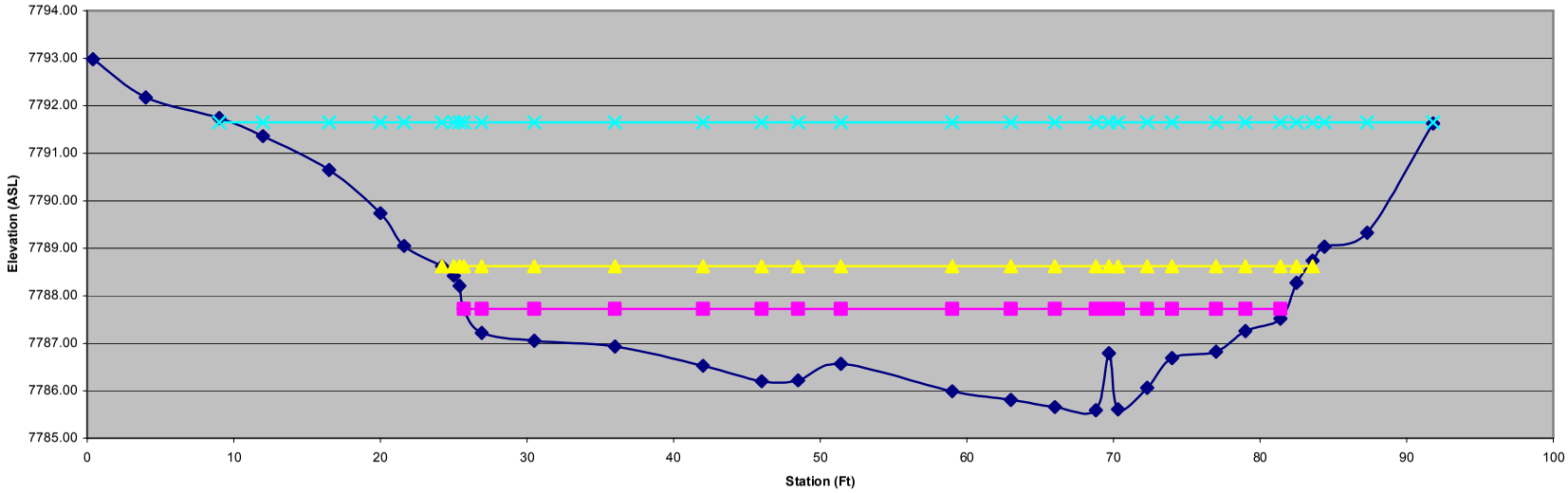

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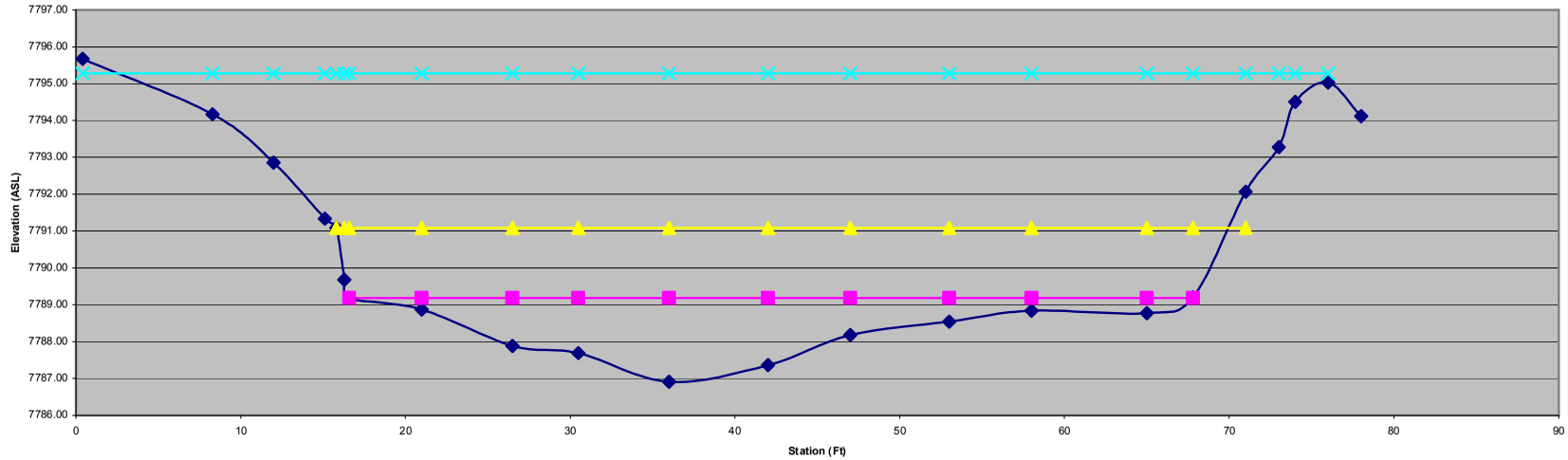
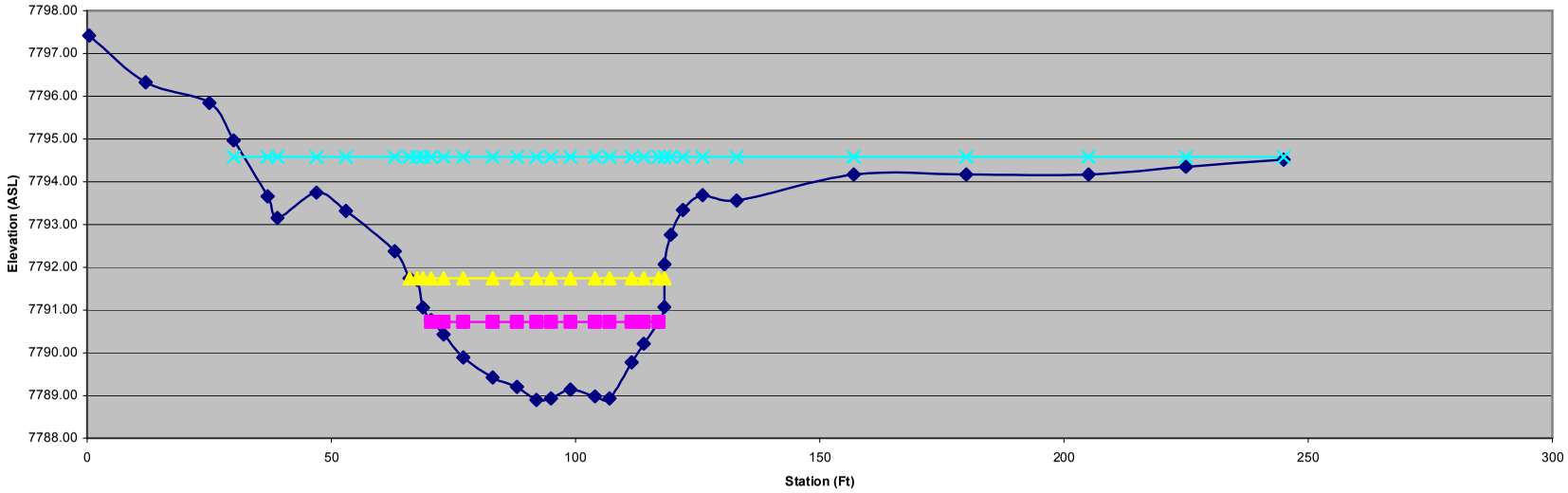
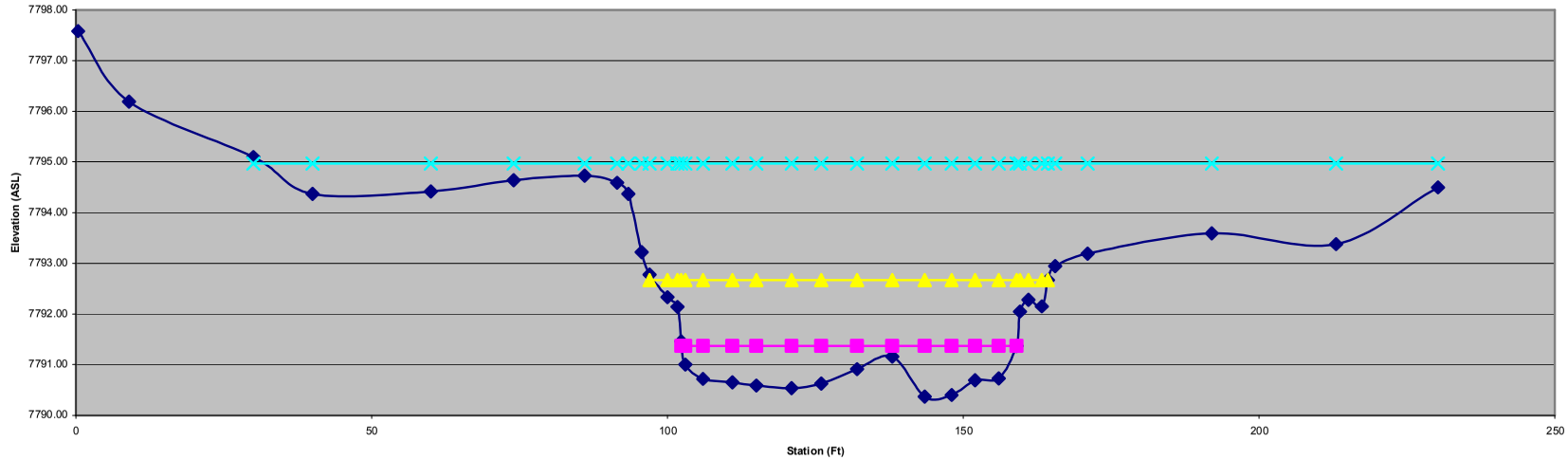


South Platte River - Reach 20 - Cross-Section 118

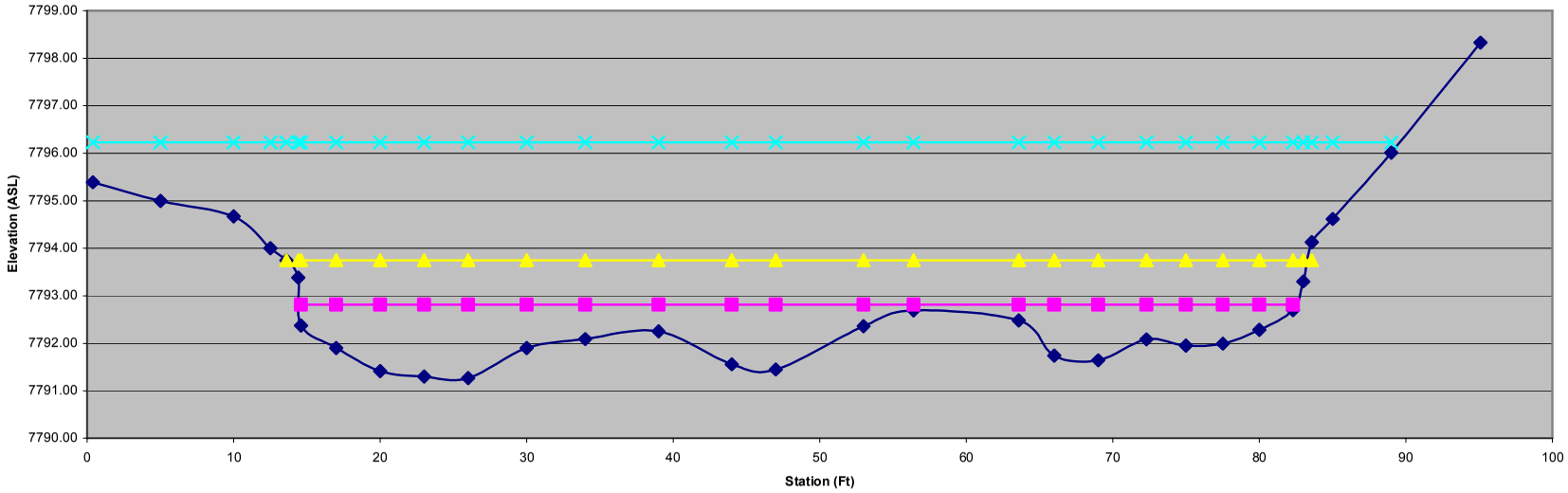


South Platte River - Reach 20 - Cross-Section 119

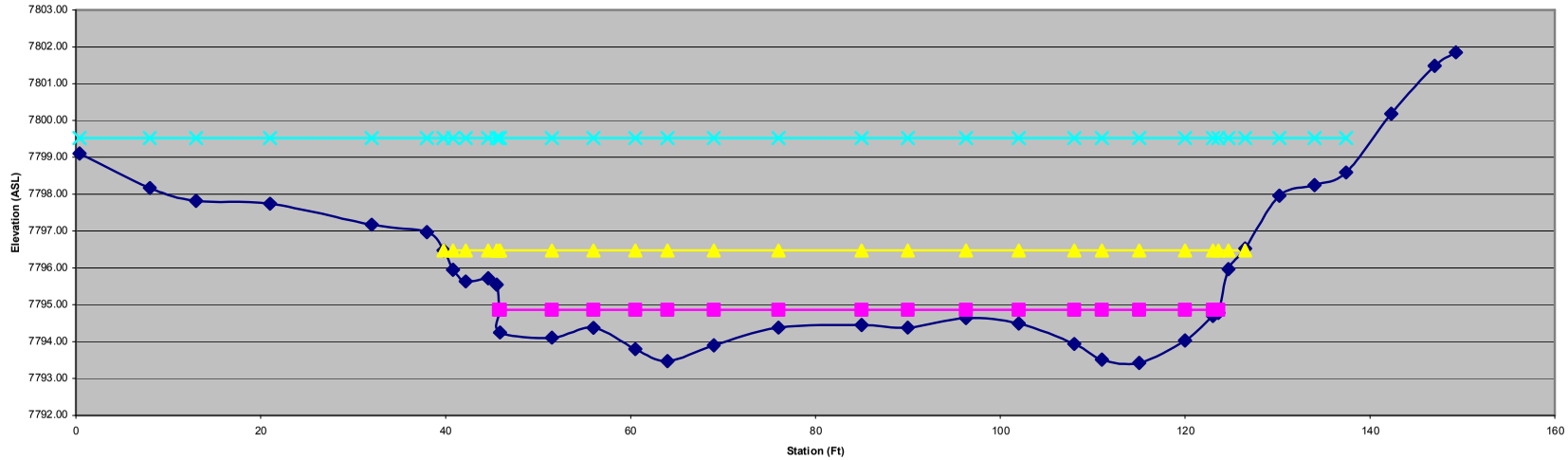


Channel — Water Surface — Bank Full — Flood Prone Width

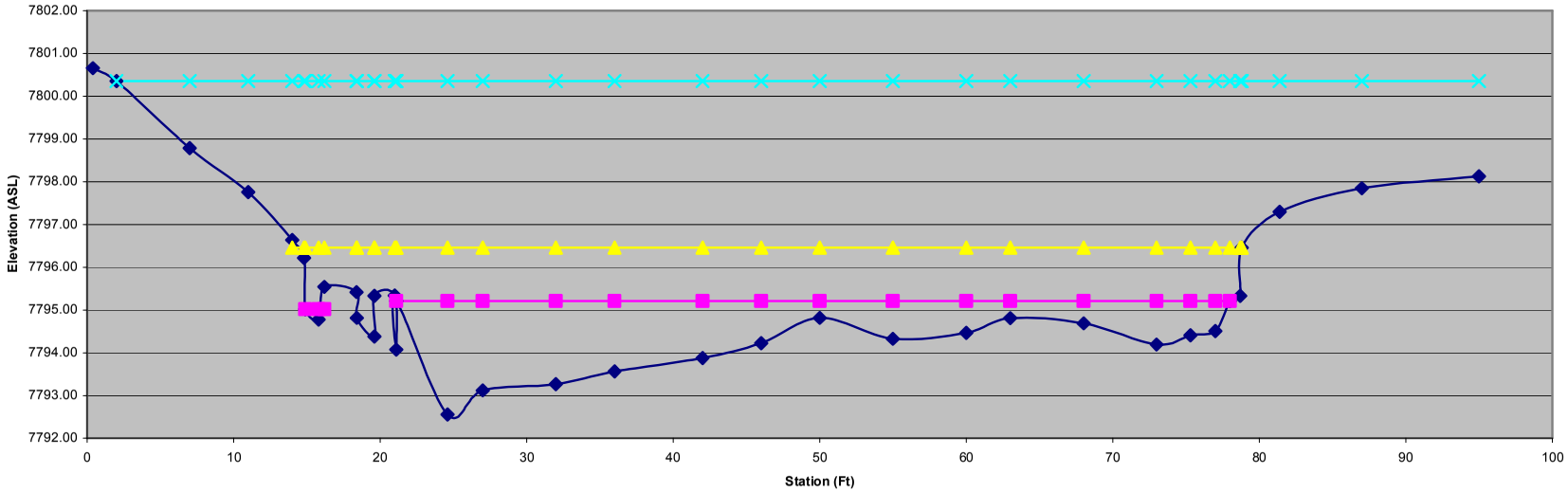
South Platte River - Reach 20 - Cross-Section 120



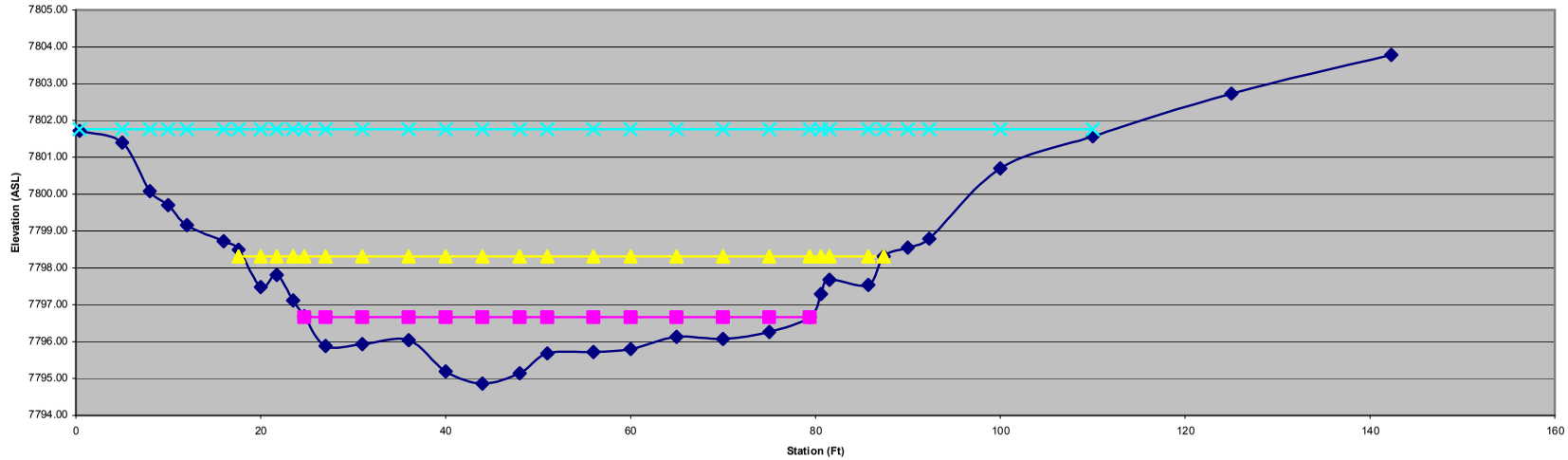
South Platte River - Reach 20 - Cross-Section 121



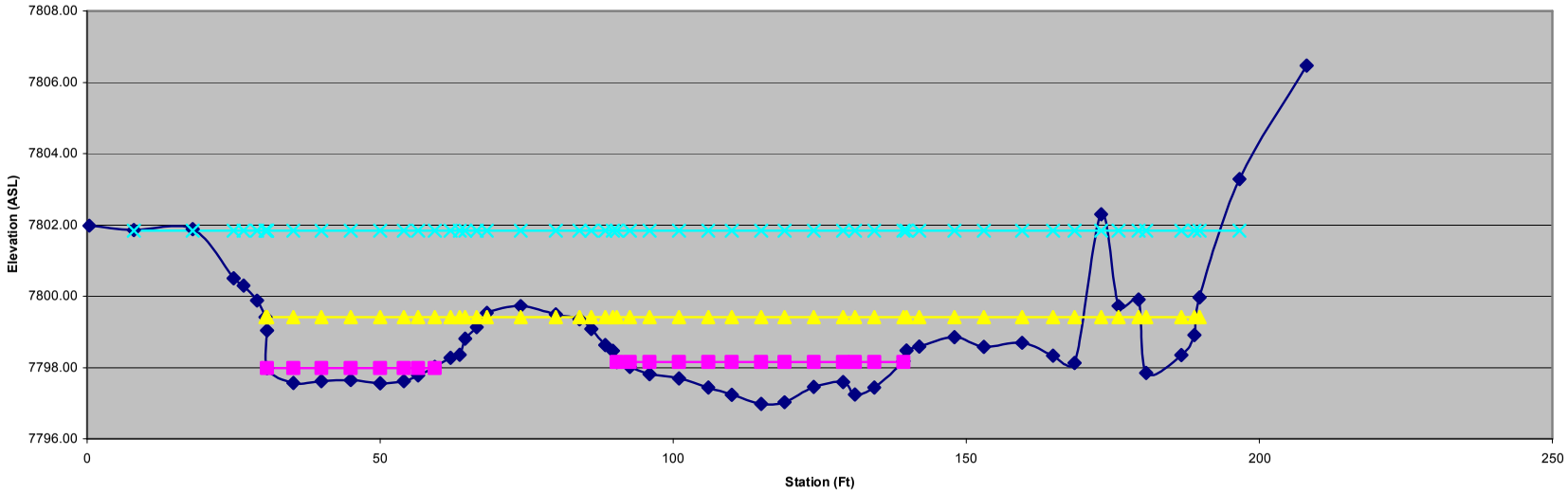
South Platte River - Reach 20 - Cross-Section 122



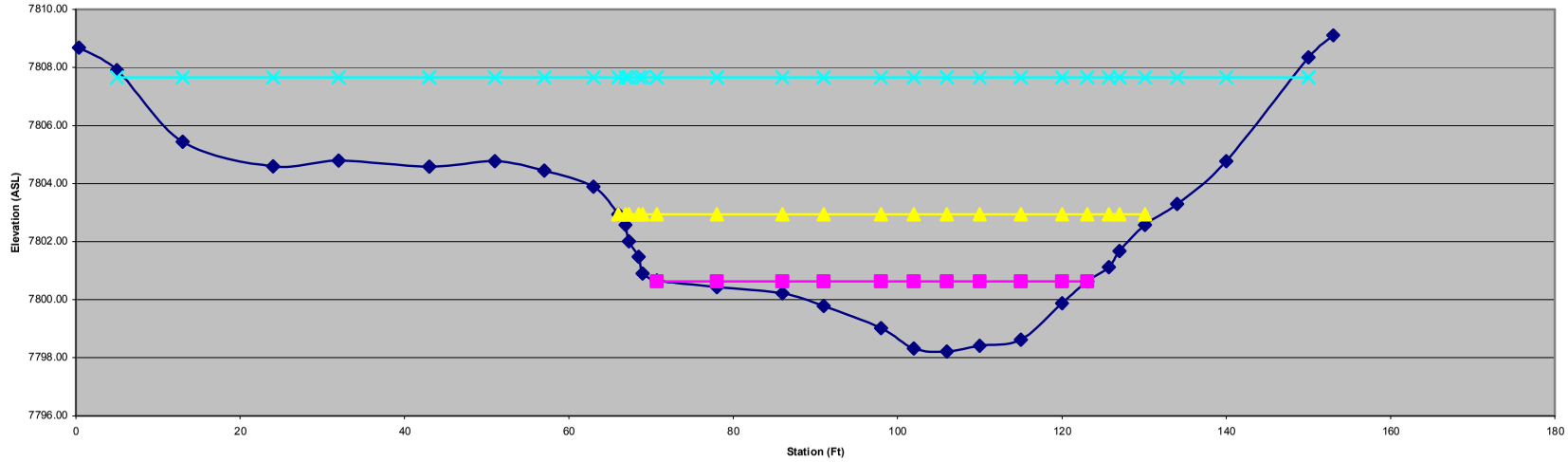
South Platte River - Reach 20 - Cross-Section 123



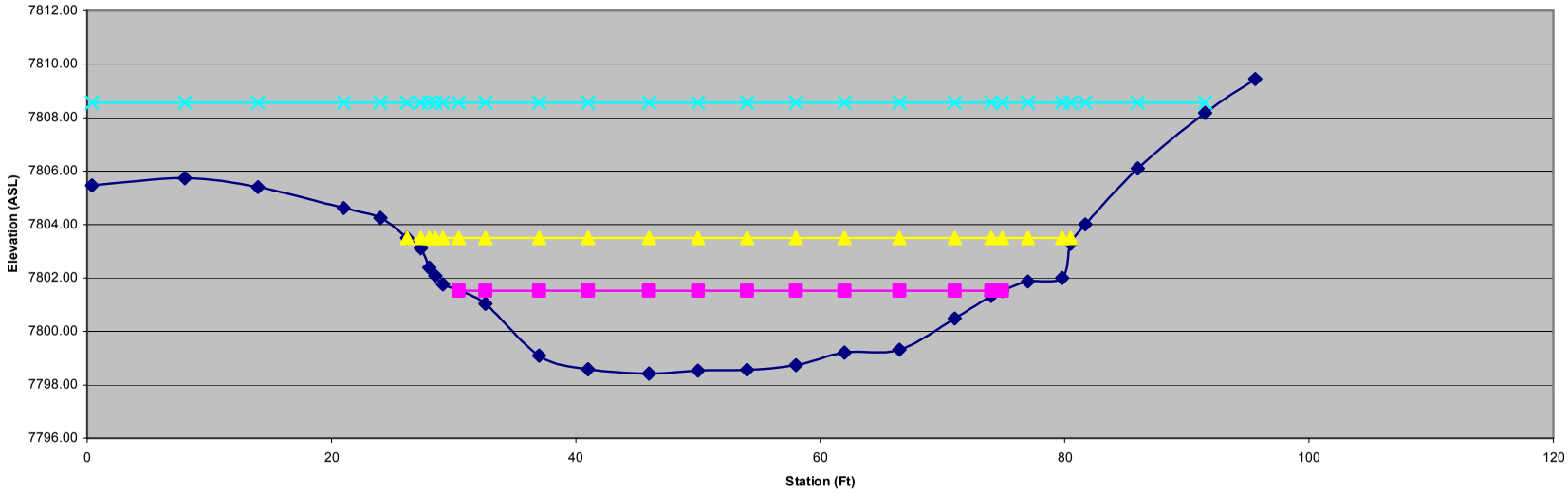
South Platte River - Reach 21 - Cross-Section 124



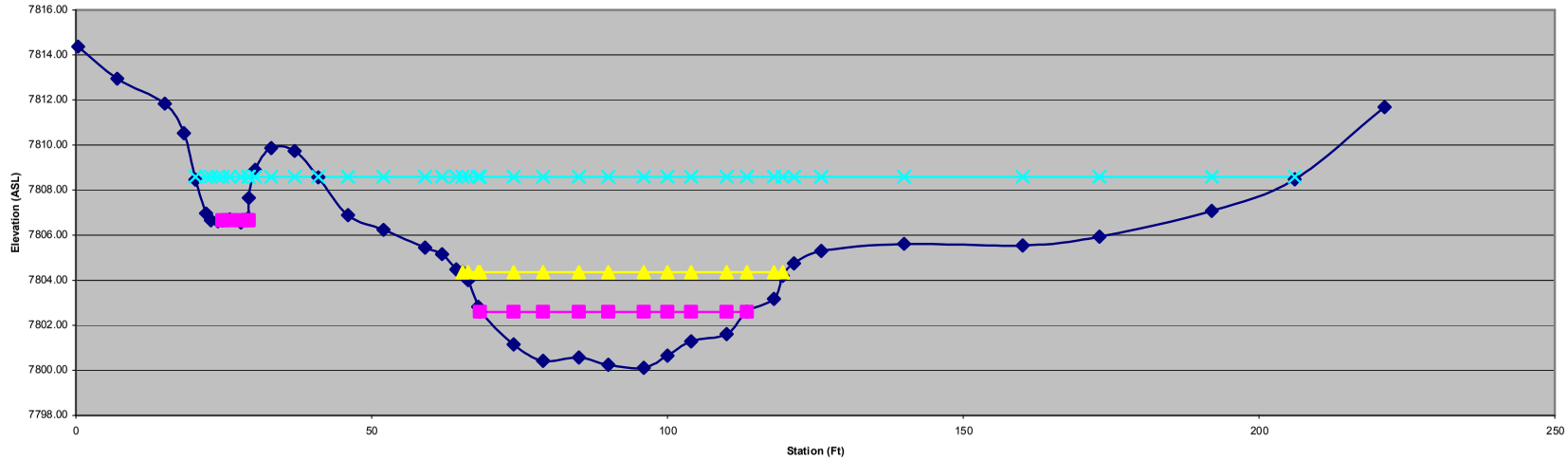
South Platte River - Reach 21 - Cross-Section 125



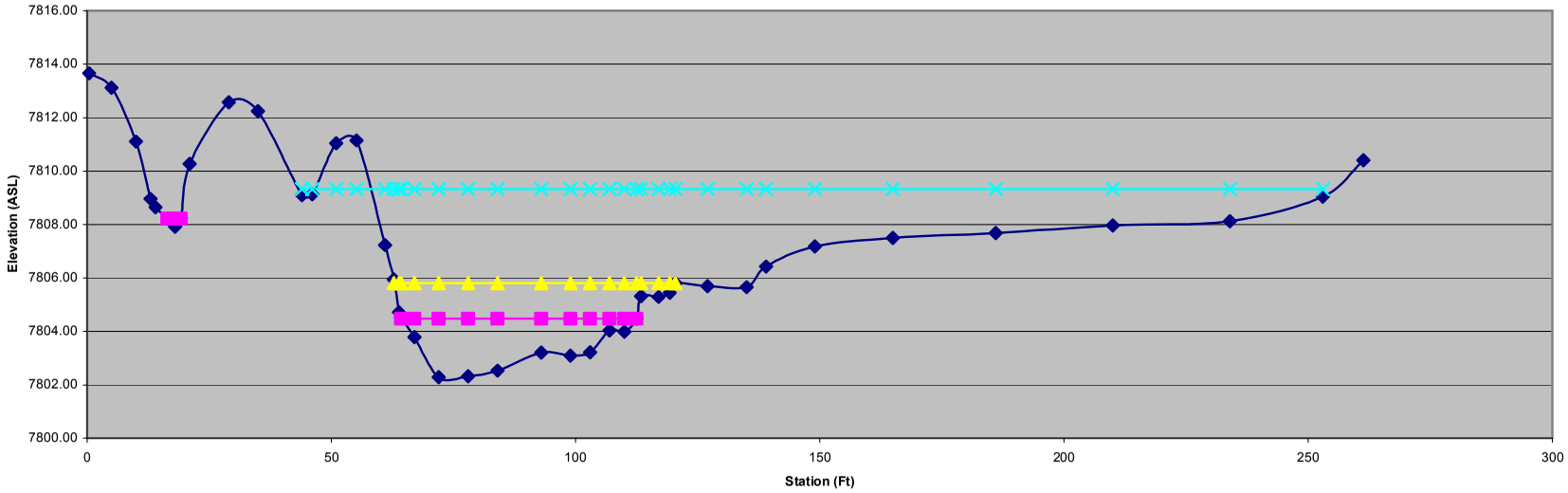
South Platte River - Reach 21 - Cross-Section 126



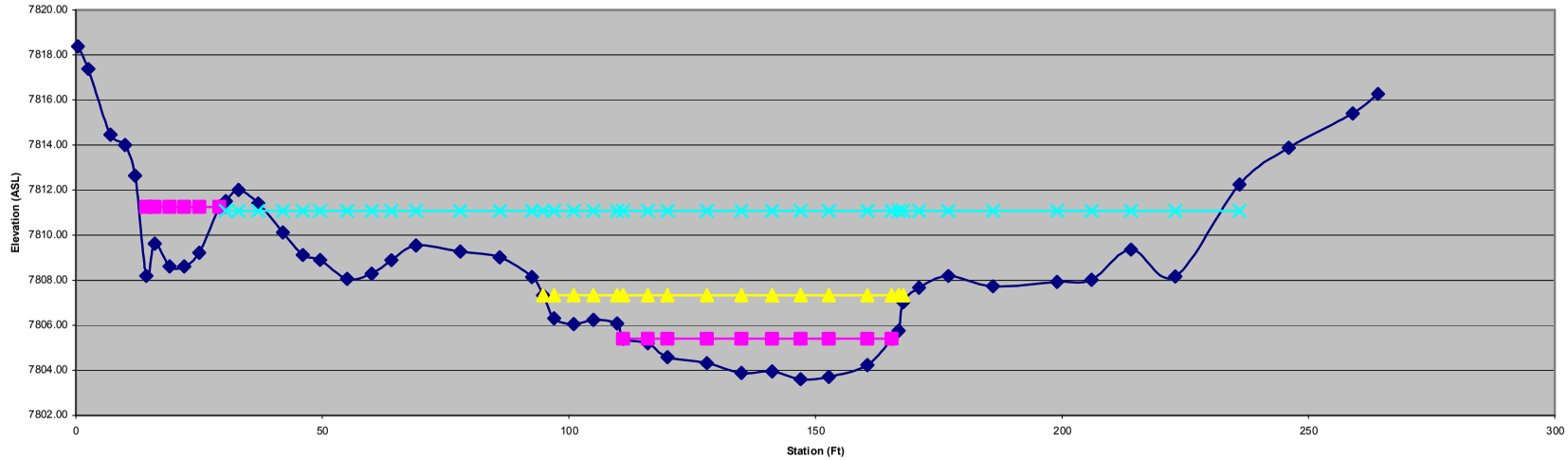
South Platte River - Reach 21 - Cross-Section 127



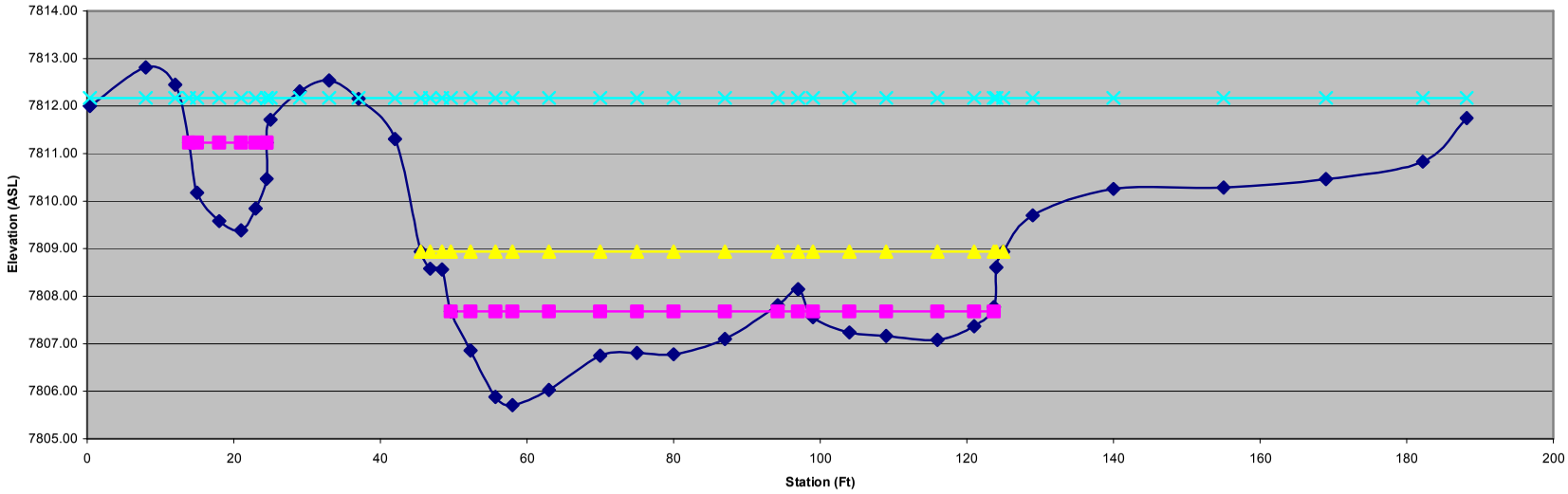
South Platte River - Reach 21 - Cross-Section 128



South Platte River - Reach 21 - Cross-Section 129



South Platte River - Reach 21 - Cross-Section 130



BWSHI Habitat Survey Results

Reach 20

STREAMNAME	SOUTH PLATTE RIVER	CHANNEL TYPE	C
REACH NO.	20	MIN. TEMP.	
DATE	9/22/2009	MAX. TEMP	
PERSONNEL	GALLAGHER, NUSS	DISTRICT	SPORTSMANS PARADISE
DESCRIPTION			

	HABITAT UNIT TYPE		LENGTH	WIDTH	RESIDUAL DEPTH	AVE. DEPTH	MAX. DEPTH	COVER TYPES				BANK STABILITY		BANK ROCK CONTENT		ERODING BANKS		
NO.	TYPE	SA	(FT.)	(FT.)	(FT.)	(FT.)	(FT.)	2	3	4	5	LEFT	RIGHT	LEFT	RIGHT	(FT.)	LOD	COMMENTS
R1	10	O	114.00									1	1	7	7	20.00		
P1	7	SA	71.00									1	1	7	7			
R2	11	O	130.00									1	1	7	7			
G1	1		105.00									1	1	7	7			
P2	6	M	141.00									1	1	8	7			STRUCTURE @ TOP / VANE
R3	11	O	407.00									1	1	6	6			
P3	6	M	150.00									1	1	6	6	50.00		BOULDER CLUSTER @ 4321FT
R4	11	O	127.00									1	1	6	6	40.00		
G2	1		111.00									1	1	6	6			BOULDER CLUSTER @ 4633FT
R5	10	O	209.00									1	1	6	6			LOCATED ON MEANDER
G3	1		147.00									1	1	5	5			DROP STRUCTURE
P4	5	SA	90.00									1	1	7	7			
P5	7	SA	221.00									1	1	7	7			
R6	11	O	154.00									1	1	7	7			
R7	10	P	308.00									1	1	5	5			
G4	1		185.00									1	1	4	4			
P6	4	D	82.00									1	1	4	4			
R8	10	O	40.00									1	1	4	4			
P7	5	SA	85.00									1	2	4	6	50.00		
P8	7	SA	135.00									1	1	7	7			
G5	1		116.00									1	1	7	6			
R9	10	P	247.00									1	1	4	6			
P9	5	SA	72.00									4	1	4	6	40.00		
P10	7	S/D	107.00									2	1	7	7			
G6	1		131.00									1	1	7	7			
P11	6	M	122.00									1	1	7	7			
G7	1		123.00									1	1	7	7			
P12	6	M	87.00									1	1	7	7			
R10	12	O	439.00									1	2	7	7	100.00		
P13	4	B	123.00									1	1	4	7			
R11	12	O	105.00									1	1	7	7			
P14	6	S	81.00									2	1	7	7			
P15	7	S	83.00									2	1	7	7			
R12	11	O	78.00									2	1	7	7			
G8	1		114.00									1	1	7	7			
R13	11	O	207.00									1	1	7	7			
G9	1		103.00									1	1	7	7			
P16	5	S	20.00									1	1	7	7			
P17	7	S	64.00									1	1	7	7			
G10	1		46.00									1	1	4	2	30.00		
P18	4	S	139.00									1	1	4	2			
P19	7	S	119.00									1	1	7	7			
R14	12	O	96.00									1	1	4	4			END OF REACH @ CONFLUENCE W/ CRYSTAL CREEK

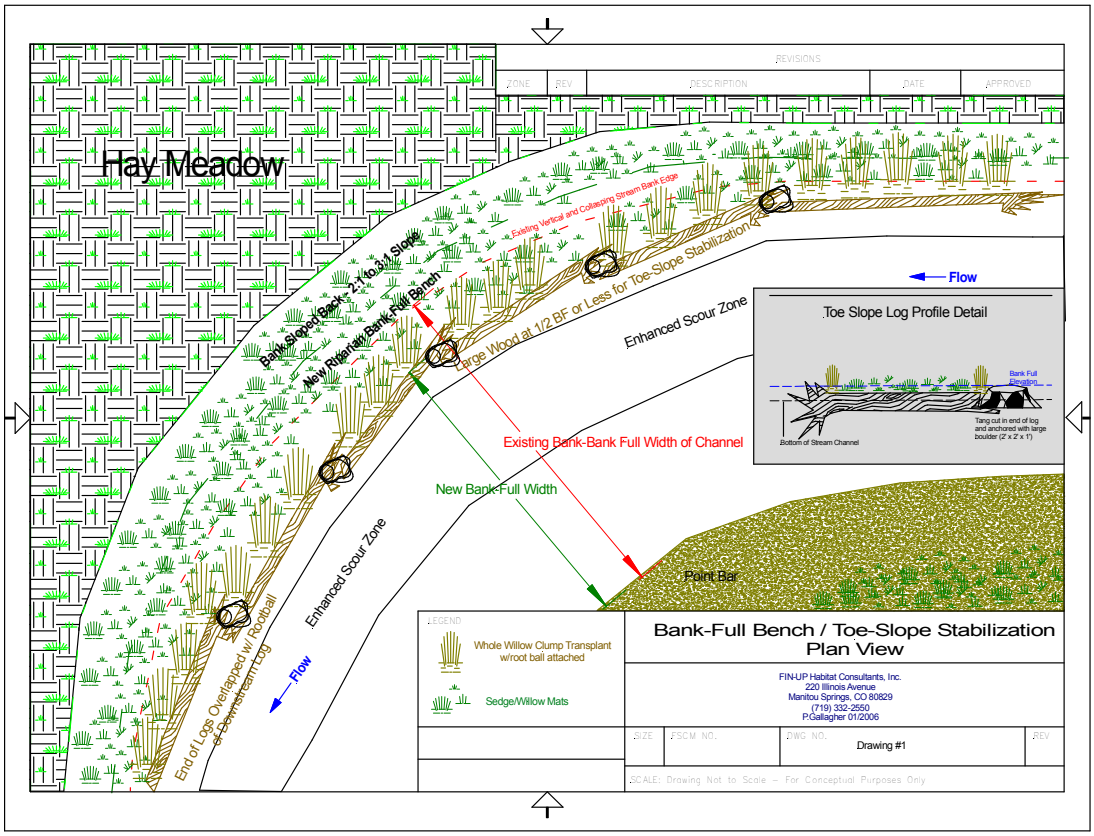
BWSHI Habitat Survey Results (cont.)

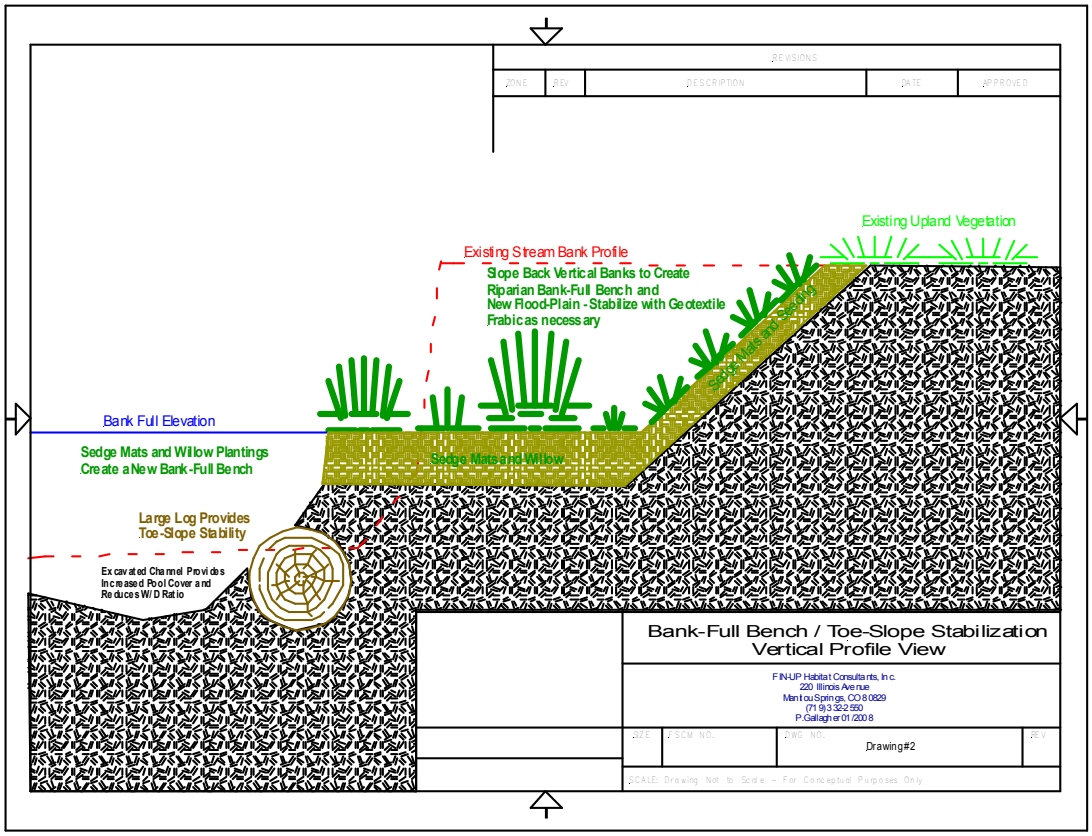
Reach 21

STREAMNAME	SOUTH PLATTE RIVER	CHANNEL TYPE	C
REACH NO.	21	MIN. TEMP.	
DATE	9/22/2009	MAX. TEMP	
PERSONNEL	GALLAGHER / NUSS	DISTRICT	SPORTSMANS PARADISE
DESCRIPTION			

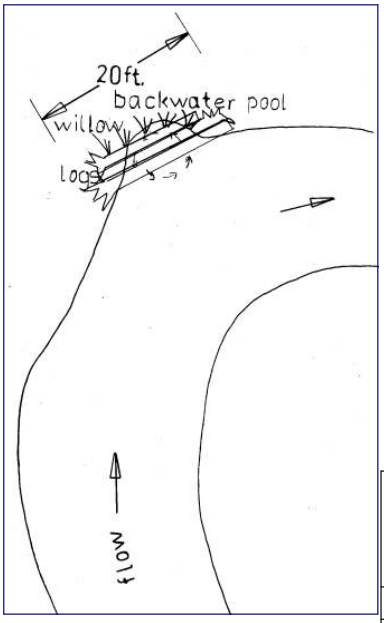
	HABITAT UNIT TYPE		LENGTH	WIDTH	RESIDUAL DEPTH	AVE. DEPTH	MAX. DEPTH	COVER TYPES				BANK STABILITY		BANK ROCK CONTENT		ERODING BANKS		
NO.	TYPE	SA	(FT.)	(FT.)	(FT.)	(FT.)	(FT.)	2	3	4	5	LEFT	RIGHT	LEFT	RIGHT	(FT.)	LOD	COMMENTS
P1	6	SA	62.00									1	1	6	2			FOOTBRIDGE
R1	11	O	32.00									2	1	4	7			
G1	1		75.00									1	1	7	7			
P2	6	SA	94.00									1	2	7	6	30.00		
P3	7	SA	137.00									1	1	7	7			
R2	11	O	238.00									1	1	7	7			BRAIDED CHANNEL BOULDER VANE @ 587FT OUTLET OF POND
R3	12	O	148.00									1	1	7	7			
R4	10	P	93.00									1	1	7	7			BELOW STRUCTURE
G2	1	SA	251.00									1	2	7	6	80.00		ABOVE STRUCTURE - SOME POOL POCKETS @ 1000FT
R5	10	P	134.00									1	7	7				BELOW STRUCTURE
P4	7	SA	190.00									1	1	7	7			
G3	1		81.00									1	1	7	7			
R6	11	O	163.00									1	1	7	7			STRUCTURE AT TOP ON RIGHT
G4	1	SA	102.00									1	2	7	7			
R7	11	O	101.00									1	2	7	7	6.00		STRUCTURE AT TOP
G5	1	SA	108.00									1	1	7	7			
P5	4	G	99.00									1	1	7	7			GULLY ON LEFT @ 2068FT
R8	11	O	255.00									2	1	7	7	80.00		STRUCTURE @ 2190FT
G6	1	SA	170.00									1	1	7	7			STRUCTURE AT BOTTOM
P6	6	M	132.00									1	1	7	7			
R9	11	O	100.00									1	1	7	7			
G7	1		100.00									1	1	7	7			
P7	6	M	118.00									1	1	7	7			
R10	11	P	283.00									1	1	5	5			
R11	12	O	151.00									1	1	7	7			SERIES OF STRUCTURES CAUSING OVERWIDENING OF RIVER
P8	4	SA	85.00									1	1	7	7			BRIDGE POOL
R12	11	O	153.00									1	1	4	4			END OF REACH BELOW DIV DAM @ CONFL W/ VERMILLION CREEK

Drawings and Photos of Treatment Types

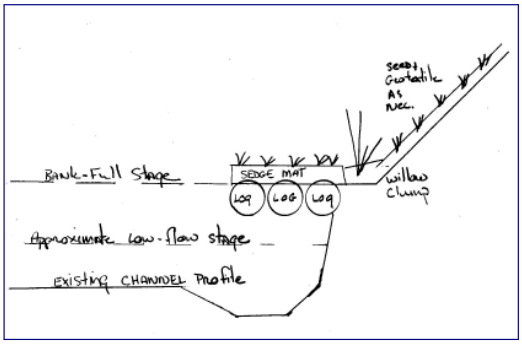




Plan View



Profile View



REVISIONS

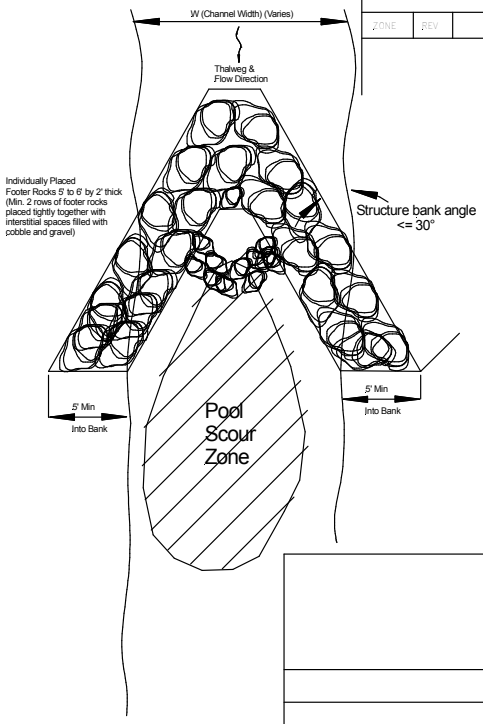
ZONE	REV.	DESCRIPTION	DATE	APPROVED

LUNKER Bench / Bank Stabilization
Plan and Profile View

FIN-UP Habitat Consultants, Inc.
220 Illinois Avenue
Manitou Springs, CO 80829
(719) 332-2550
P.Gallagher 01/2008

SIZE	FSCM NO.	DWG NO.	REV
		Drawing #1	

SCALE: Drawing Not to Scale – For Conceptual Purposes Only



REVISIONS

ZONE	REV.	DESCRIPTION	DATE	APPROVED

Cross-Vane Plan View

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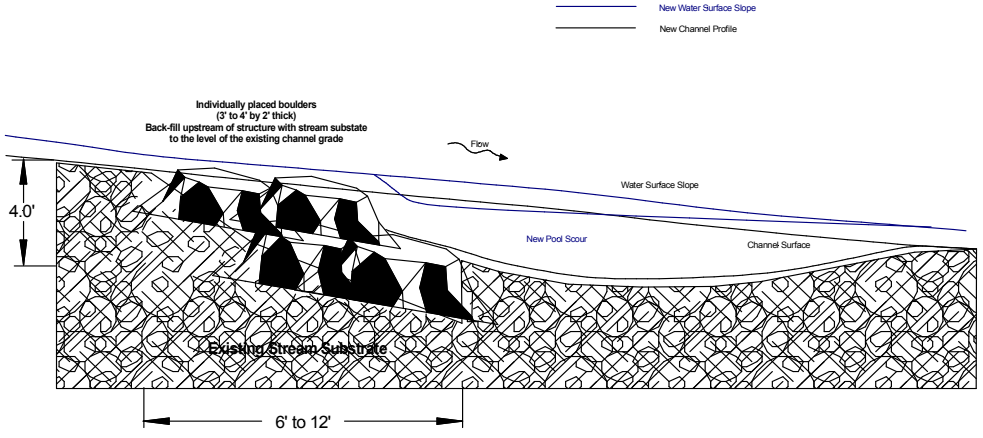
P.Gallagher 02/2005

SIZE	FSCM NO.	DWG NO.	REV
		Drawing #1	

SCALE: Drawing Not to Scale – For Conceptual Purposes Only

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED



Cross-Vane Vertical Profile (Center of Structure)

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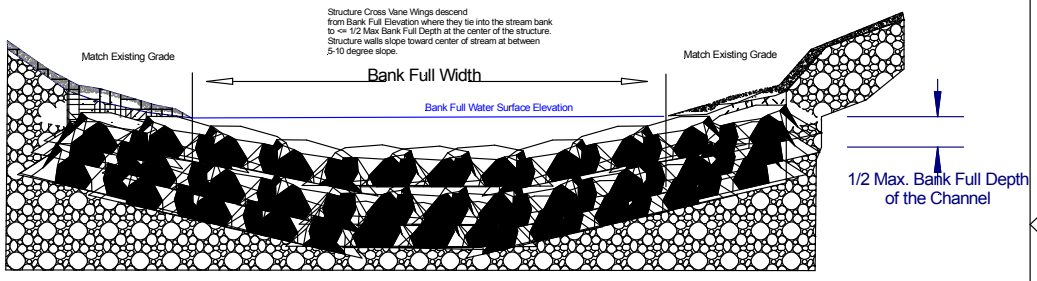
SIZE	FSCM NO:	DWG NO:	REV
		Drawing #2	

SCALE: Drawing Not to Scale – For Conceptual Purposes Only

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED



Cross-Vane Vertical Profile Cross Section Elevations)

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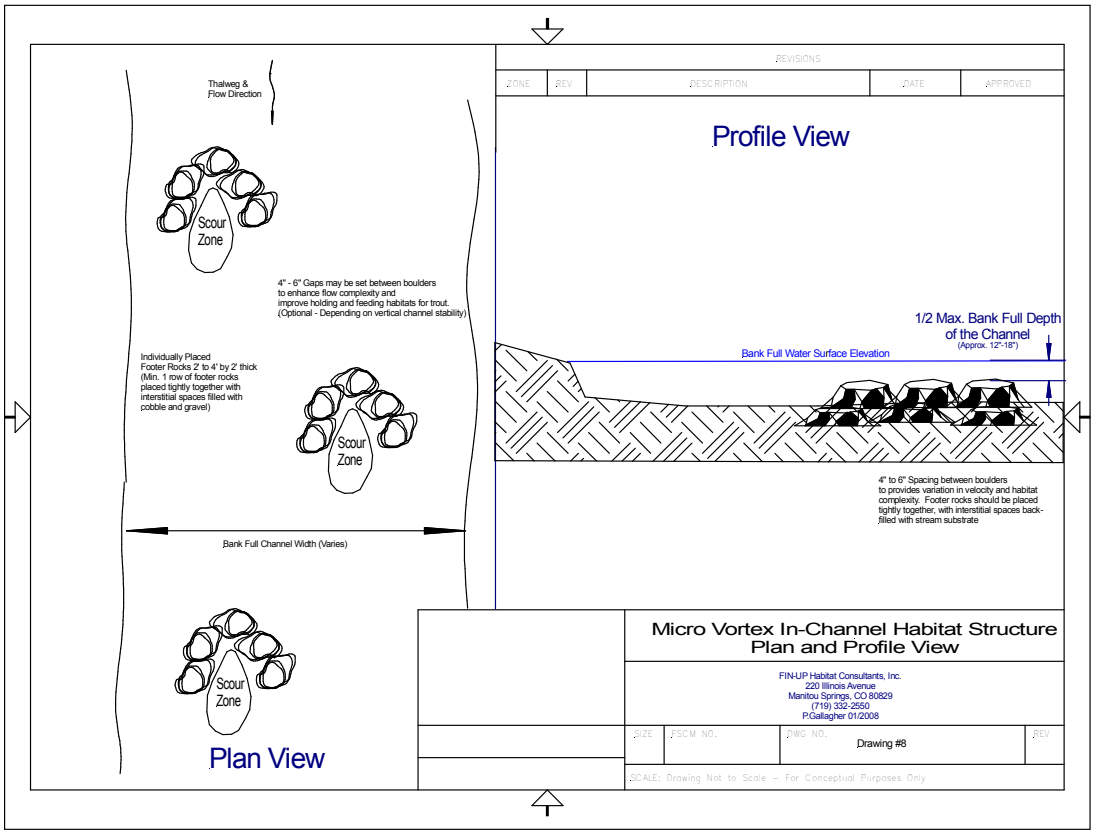
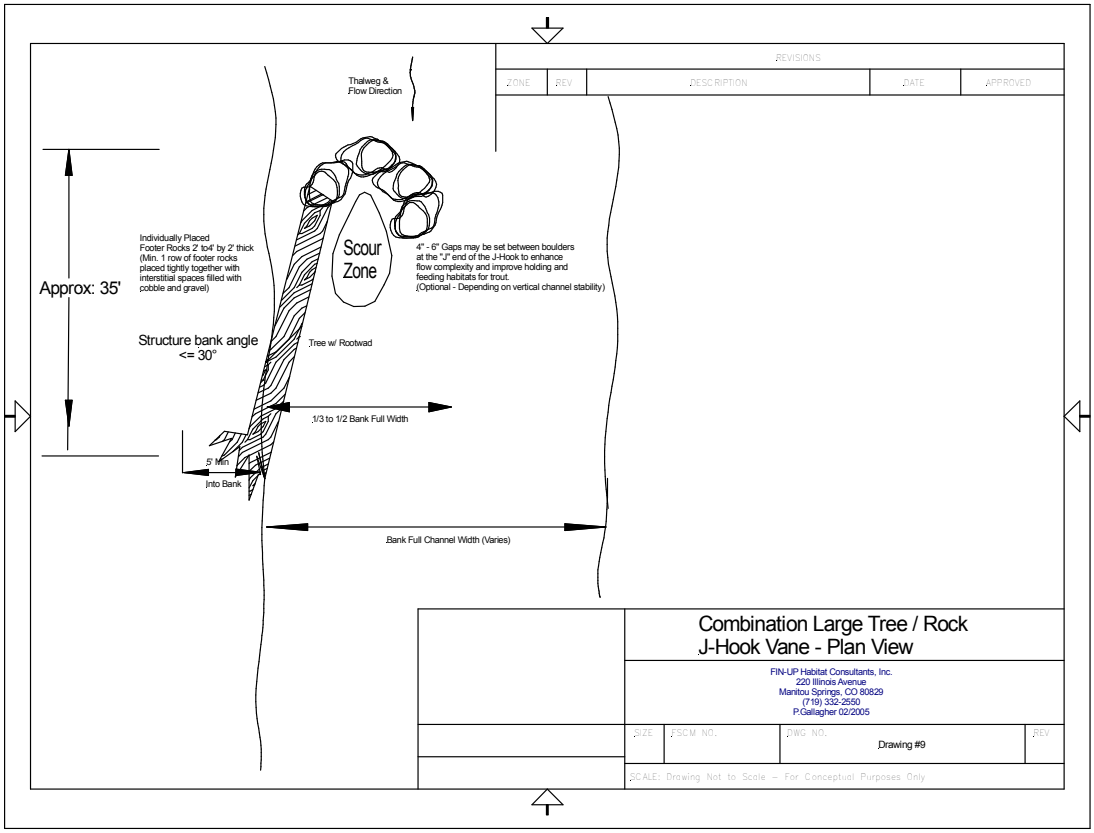
(719) 332-2550
P.Gallagher 09/2005

SIZE	FSCM NO:	DWG NO:	REV
		Drawing #3	

SCALE: Drawing Not to Scale – For Conceptual Purposes Only


Thalweg & Flow Direction
Scour Zone
4" - 6" Gaps may be set between boulders to enhance flow complexity and improve holding and feeding habitats for trout. (Optional - Depending on vertical channel stability)
Individually Placed Footer Rocks 2' to 4' by 2' thick (Min. 1 row of footer rocks placed tightly together with interstitial spaces filled with cobble and gravel)
Scour Zone
Bank Full Channel Width (Varies)
Scour Zone
Plan View
REVISIONS
ZONE
REV
DESCRIPTION
DATE
APPROVED
Profile View
1/2 Max. Bank Full Depth of the Channel
(Approx. 12"-18")
Bank Full Water Surface Elevation
4" to 6" Spacing between boulders to provides variation in velocity and habitat complexity. Footer rocks should be placed tightly together, with interstitial spaces back-filled with stream substrate
Micro Vortex In-Channel Habitat Structure
Plan and Profile View
FIN-UP Habitat Consultants, Inc.
220 Illinois Avenue
Manitou Springs, CO 80829
(719) 332-2550
P.Gallagher 01/2008
SIZE
FSCM NO:
DWG NO:
Drawing #8
REV
SCALE: Drawing Not to Scale – For Conceptual Purposes Only


Thalweg & Flow Direction
Scour Zone
Individually Placed Footer Rocks 2' to4' by 2' thick (Min. 1 row of footer rocks placed tightly together with interstitial spaces filled with cobble and gravel)
4" - 6" Gaps may be set between boulders at the "J" end of the J-Hook to enhance flow complexity and improve holding and feeding habitats for trout. (Optional - Depending on vertical channel stability)
Approx: 35'
Structure bank angle <= 30°
Tree w/ Rootwad
1/3 to 1/2 Bank Full Width
5' Min
Into Bank
Bank Full Channel Width (Varies)
REVISIONS
ZONE
REV
DESCRIPTION
DATE
APPROVED
Combination Large Tree / Rock
J-Hook Vane - Plan View
FIN-UP Habitat Consultants, Inc.
220 Illinois Avenue
Manitou Springs, CO 80829
(719) 332-2550
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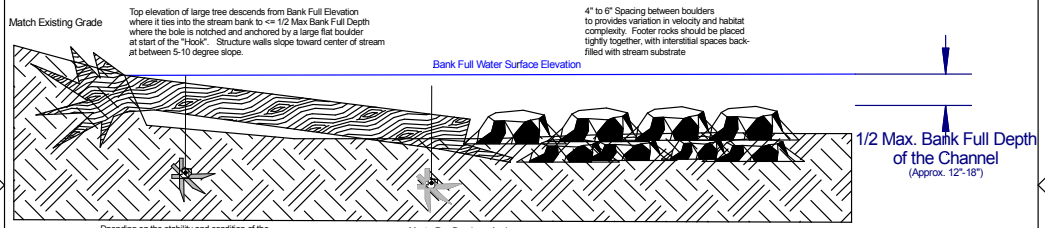
SIZE
FSCM NO:
DWG NO:
Drawing #9
REV
SCALE: Drawing Not to Scale – For Conceptual Purposes Only

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED



Combination Large Tree / RockJ-Hook Vane Vertical Profile

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Manitou Springs, CO 80829
(719) 332-2550
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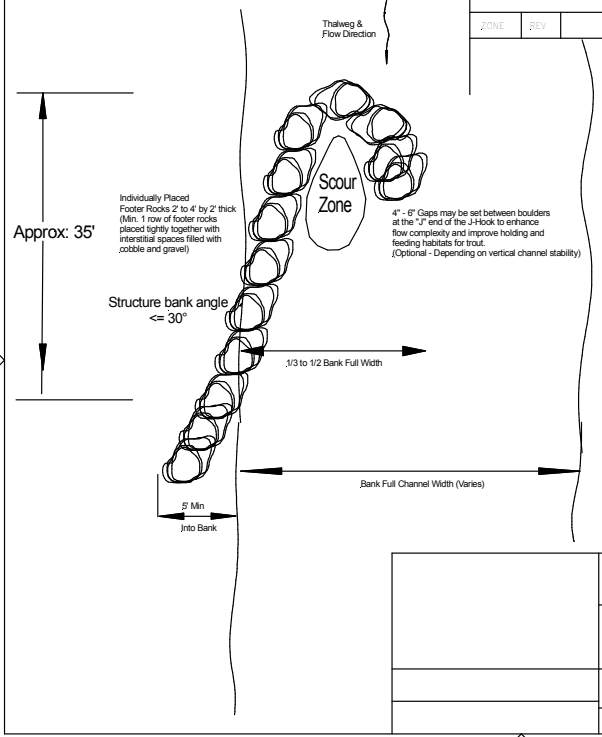
SIZE	FSCM NO.	DWG NO.	REV
		Drawing #7	

SCALE: Drawing Not to Scale – For Conceptual Purposes Only

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED



Rock J-Hook Vane - Plan View

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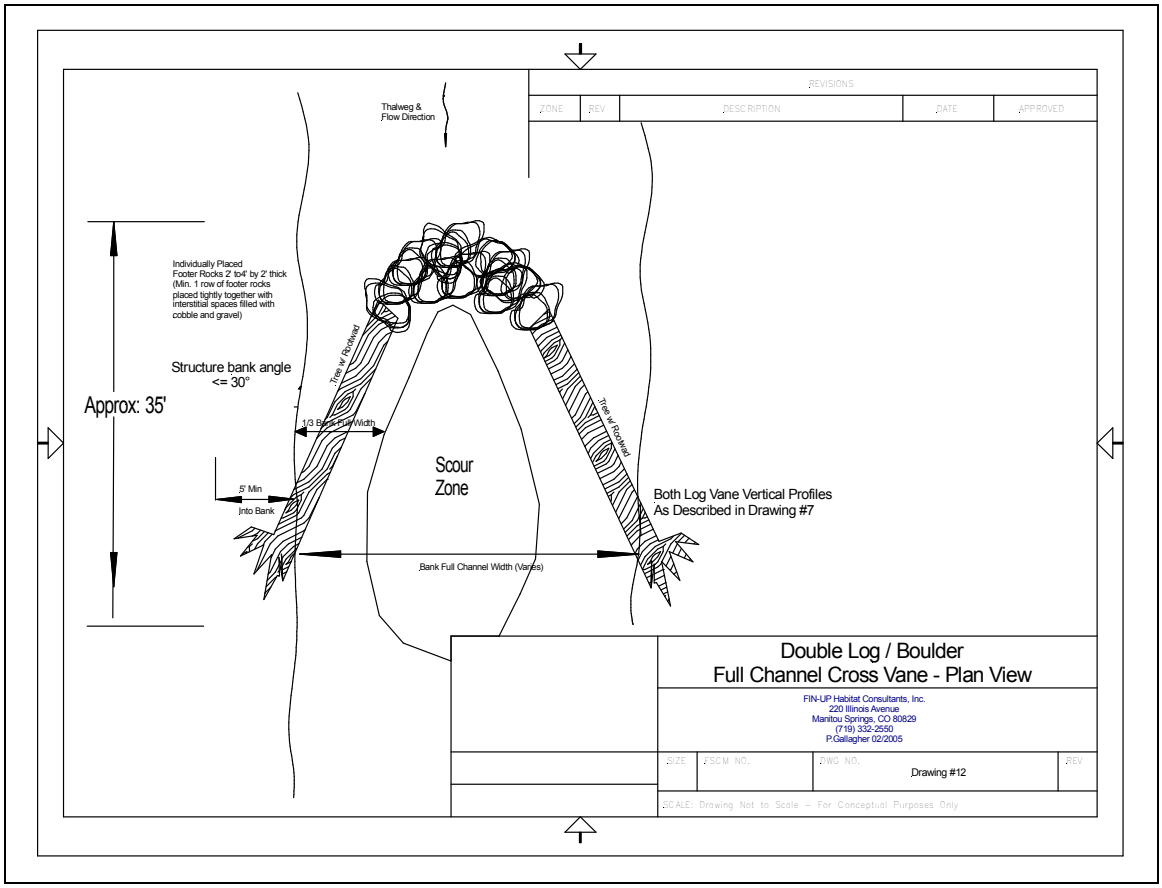
SIZE	FSCM NO.	DWG NO.	REV
		Drawing #8	

SCALE: Drawing Not to Scale – For Conceptual Purposes Only


REVISIONS
ZONE
REV.
DESCRIPTION
DATE
APPROVED
Thalweg &
Flow Direction
Individually Placed
Footer Rocks 2' to4' by 2' thick
(Min. 1 row of footer rocks
placed tightly together with
interstitial spaces filled with
cobble and gravel)
Structure bank angle
<= 30°
Approx: 35'
Tree w/ Rootwad
1/3 Bank Full Width
Scour
Zone
Tree w/ Rootwad
5' Min
Into Bank
Both Log Vane Vertical Profiles
As Described in Drawing #7
Bank Full Channel Width (Varies)
Double Log / Boulder
Full Channel Cross Vane - Plan View
FIN-UP Habitat Consultants, Inc.
220 Illinois Avenue
Manitou Springs, CO 80829
(719) 332-2550
P.Gallagher 02/2005
SIZE
FSCM NO.
DWG NO.
Drawing #12
REV
SCALE: Drawing Not to Scale – For Conceptual Purposes Only