a. Appendix A - Public Meeting Minutes

South St. Vrain Creek Restoration at Hall Ranch

Meeting Minutes

Public Meeting #1

Date: May 24, 2016, 5:00-6:30 pm

Location: Rogers Hall

4th and High Street

Lyons, Colorado 80540

Attendees: 16 members of the public present. See Attached Sign In Sheet.

Project Team Members Present:

Matrix: Scott Schrieber – Project Manager

Robert Krehbiel – Senior Civil / Quality Control

THK: Kevin Shanks – Revegetation and Public Involvement

Otak: Julie Ash – Senior / Quality Control

Meeting Purpose

This first public meeting was for the purpose of providing information to the community about the project team and project process. The project team facilitated an open discussion for the public to voice concerns and issues that they would like to see addressed by this project. These issues will be categorized to form the evaluation criteria the design team will use to evaluate the alternative design strategies for the restoration of the creek.

This meeting addressed these specific topics:

1. Introduce the design team
2. Explain the project funding and objective
3. Collect important input from the public and stakeholders

Summary of Discussion

The following is a collated list of critical issues and concerns voiced by the public and stakeholders at the first public meeting. These issues are grouped by topic to better organize and understand the key values that were discussed at this meeting.

Community

- Does this project affect only private or only public entities along the creek? How are we determining the extent of who and what is affected by these alternatives?

- Adjacent recreational trails and public creek access should be considered. It is important to create connections to existing trail systems and to provide new opportunities for this experience.

- Consideration should be given to how the work done on this reach will affect the homes and amenities downstream.

Resiliency

- The type and size of material used to re-establish the creek channel should be considered and applied in context to the surrounding area. Debris and large rocks have proven to be unstable and movable during flood events.

- The current rise of the creek bed should be addressed. The project should take into account sediment deposition that will continue to make the creek bed shallower.

- The current increase in creek velocity should be addressed. The project should aim to decrease velocity and to make sure this does not continue to be a hazard in the future.

- Should the stream be put into a single channel or into multiple channels at different places along the reach? The stream should be allowed to take its path of least resistance.

- The flood plain should be altered or expanded in certain areas of the project to afford seasonal increased flows and provide room for flood events.

- Affects that may take place outside the project limits from creek stormwater runoff and diverted debris flow should be considered.

- The project should aim to reduce future flood impacts and damage risk.

- The project should evaluate existing engineered elements currently in place along the creek and utilize smarter infrastructure concepts.

Safety

- Human life and safety should be a top priority for the project, for those in the immediate surroundings of the creek and others who will interact with the creek.

- The project should take into consideration the safety of recreational users of the creek, eg: kayakers. Large rocks and woody debris jutting out incorrectly or placed in improper places can prove harmful and devastating.

Environment

- The project should ensure the creek channel allows for the passage of key fish species.
- The creek and associated flood plain should provide aquatic and terrestrial habitat that allows for many different types of plant and animal species to thrive within the corridor.
- The channel and adjacent stream bank should be re-established to a natural state and avoid highly-engineered solutions to the reach. A terraced bank system can be utilized to provide a space where native plant and animal species can thrive.
- The project should follow a natural model to mimic the conditions that would occur as the creek restores itself to a healthy condition. The creek should be as Mother Nature intended.
- Criteria should be established for future mitigation of natural disasters. There should be planned vegetation control with awareness of the potential future hazard posed by large woody debris during flooding conditions.
- There is a need for an assessment of the environmental consequences, positive or negative, of the proposed alternatives.

Project Implementation

- The Andesite Quarry stormwater management plan significantly impacts the adjacent stream channel. The operation of the Andesite Quarry reclamation is an important part of the corridor and something should be done to mitigate current negative impacts. The design team should review the Andesite Quarry reclamation and stormwater management plans and push to work in conjunction with the reclamation of the Quarry site to help expedite and coordinate mutual positive outcomes such as flood risk reduction.
- Where are key / funded sections and how has the allocation of funds been determined for this reach? The project should not just focus on key / funded reaches but address the complete creek system.
- The project should provide an understanding of the current grant money opportunities and strategize ways to continue to receive funds for recovery and maintenance.

Continued Discussion

After the public meeting, the public and stakeholders were invited to continue to send any comments addressing critical issues and concerns of this project. See attached for the recorded comments. The following is a summary of the extended commentary:

Safety

- There is specific interest in modifying the current Longmont Diversion dam to create a passable structure for personal watercraft and fish.

- New infrastructure used to control the creek should not include any new dams. Proposed dams should be safe for recreation, even if they are in an area along the creek that is not sanctioned as such.

South St. Vrain Creek Restoration at Hall Ranch

Public Comment – By Email / Website

Sent to : Ernst Strenge

Date sent: 05-26-2016, 4:30 pm

Subject: South St. Vrain Creek Comments (#1)

Name: Matt Booth

Email: georgiavet1@gmail.com

Comments:

The Longmont diversion should be modified to address life safety issues that are created by the current low head dam that exists. A downstream sloping retrofit is an easy way to address this problem. This section of creek is boated during runoff and is considered a run for beginner intermediate boaters. This structure is life threatening and also allows no route for fish to migrate up stream

Please do not harvest large boulders from the riverbed or banks to use as materials for other areas.

Sent to: Ernst Strenge

Date sent: 05-26-2016, 5:39 pm

Subject: South St. Vrain Creek Comments (#2)

Name: Chris Cope

Email: chris@purecope.com

Address: 340 Vasquez Rd PO Box 608 Lyons, CO 80540

Phone: (3030)817-9037

Comments:

Please recommend diversion structures that are safe for personal watercraft to pass over.

Sent to: Ernst Strenge

Date sent: 05-26-2016, 8:11 pm

Subject: South St. Vrain Creek Comments (#3)

Name: Pam Stone

Email: pgand3@gmail.com

Address: Lyons, CO 80540

Comments:

Please keep the rivers safe for kayaks, tubes, and swimmers! Please do not create any new low head dams and modify the existing low head dams to allow safe passage. Even if it's an area where recreation is not sanctioned, all it takes is for someone to fall in the river or to lose control of a boat, and it could be deadly. Please, the river claims enough lives, make the dams safe.

South St. Vrain Creek Restoration Project

Planning and Preliminary Design

May 24, 2016

Name	Organization, Neighbor, or Affiliation (if applicable)	E-mail Address	Mailing Address (please indicate if you prefer to receive communication by mail)
Prashant KC	BCPOS	PKC@bouldercounty.org	
Darrell Beck	S.V. Creek Coll.		
DAVE LEVY + LOR/GIAB	RESIDENT/SVCC	DAVELEVY@QWESTOFFICE.NET	
Jim Kerr	Town of Lyons/Resident	kerrjamesf@gmail.com	
VINCE ZOUNEK	SOUTH ST VRAIN	VZOUNEK@MSN.COM	
WANDA GRIEST	125 CO Rd 69 LYONS	wgriest@gmail	
Roy GRIEST	" "	" "	
Bob Snell	2693 Riverside Dr	rnsnell@msn.com	
Judee Snell	"	judeesnell@msn.com	
Matt Jaeckel	31820 S. StVrain	Matt_Jaeckel@yahoo.com	
Nathan Werner	Local Kayaker	nathan@s2odesign.com	
Shera Sumerford	DWR	shera.sumerford@state.co.us	
Gary Gorman	Meadow Ditch	ggorman22@gmail.com	
LaVern Johnson	Lyons P&R	LaVern921@aol.com	

South St. Vrain Creek Restoration Project

Planning and Preliminary Design

May 24, 2016

Name	Organization, Neighbor, or Affiliation (if applicable)	E-mail Address	Mailing Address (please indicate if you prefer to receive communication by mail)
Larry Quinn	Prop Owner	LQUINN1134@GMAIL.COM	89 Co Rd 69 Lyons 80540
John Hall	Property Owner	~~JaHallCattle.com~~	7901 Woodland Rd Longmont 80503
		jahallcattle@gmail.com	

South St. Vrain Creek Restoration at Hall Ranch

Meeting Minutes

Public Meeting #2

Date: June 30, 2016, 5:00-6:30 pm

Location: Rogers Hall
4th and High Street
Lyons, Colorado 80540

Attendees: 19 members of the public present. See Attached Sign In Sheet.

Project Team Members Present:
Matrix: Scott Schrieber – Project Manager
Robert Krehbiel – Senior Civil / Quality Control

THK: Kevin Shanks – Revegetation and Public Involvement
Brandon Parsons – Revegetation and Public Involvement

OTAK: Tracy Emmanuel – Fluvial Geomorphologist
Luke – Fluvial Geomorphologist

Meeting Purpose

The purpose of the second public meeting for the South St. Vrain Creek Restoration at Hall Ranch was to present the public with four alternatives and explain the prioritization process by which the design team developed each alternative and how they will be evaluated and combined into a final preferred alternative.

Meeting Summary

The design team gave a presentation which summarized the work the design team had done to date and outlined the goals for the meeting and next steps for the project moving forward.

Scott Schreiber (Matrix) introduced the team, and summarized the progress of the project since the last public meeting. Mr. Schreiber discussed how the design team had continued to gather public input, through meeting with private landowners and progressed the design approach based on the input and technical observations they have received to date.

Kevin Shanks (THK) gave an in depth explanation of how the input received from stakeholder groups and the public had been distilled and incorporated into a set of prioritization criteria that would be used to place emphasis on aspects the four alternatives. This process was presented to the public in the form of a flow chart showing how the design team used public and stakeholder input to develop the prioritization criteria (Decisions Making Process) and how this criteria will be used to evaluate the alternatives (Decision Matrix).

The design team presented each of the four alternatives. Tracey Emmanuel (OTAK) presented Floodplain Connectivity, Luck Swan (OTAK) presented Channel Complexity, Brandon Parsons (THK) presented Revegetation and Scott Schreiber (Matrix) presented Infrastructure protection.

Following the presentations, each member of the design team was stationed at a table where maps showing each alternative was presented and explained in more detail. The public was encouraged to visit each table, ask questions and provide comments about each alternative to the design team. These comments were written directly on the maps of each alternative and compiled for consideration in the preferred alternative.

Summary of Alternatives Presented and Comments Received:

Floodplain Connectivity:

Floodplain connectivity involves activating the floodplain at frequent intervals to enable critical floodplain functions, including:

- Sediment storage
- Reduction of erosive forces in main channel
- Nutrient transfer
- Healthy riparian/wetland ecosystem

Strategies that were presented to illustrate floodplain connectivity include:

- Activating overflow channels
- Incorporating channel/floodplain benching (sediment removal)

Comments:

General comments:

- Hall 2 deed restrictions may preclude use of onsite materials – BCPOS to investigate
- Concern for wood removal maintenance ("to keep channel clear") – who is responsible?
- Take into consideration where the river wants to go.

Comments from upstream to downstream:

- Quarry:
  - Consider using excess cut at quarry for fill as part of their reclamation area
  - Could take it from the area adjacent to the quarry and stream to lower floodplain
- Add sinuosity to reach downstream of quarry/upstream of bedrock bend?
- @ bedrock bend:
  - New road/embankment design includes benching on the inside (2-yr, 25-yr flow), does not include instream structures – proposed slope ~0.6%
  - Public suggestion to move road to improve conveyance
  - Move channel further west to take pressure off road
- Matthews and Holcombe combined diversion (across from John Hall's property)
  - Include proposed location in our design
  - New location in stream – 2 ft. high (+/-)
  - Potentially move diversion upstream to bedrock bend

- Andesite bridge
  - 2x wider, need to coordinate design
  - Pipe for diversion tied into design
  - Addition of floodplain culvert(s) on left bank, may not be feasible given wider span
  - Need to stabilize area on right bank downstream of bridge (river was in this location, but the County moved it back)
- Plug area
  - Illegal levee built on the upstream side of the 2 houses in the floodplain, expand floodplain benching to include removal of the levee? Or keep?
  - Some folks want to keep plug so overflow does not occur
  - Concern with avulsion potential (re: overflow channel at plug)… can the overflow channel be moved further downstream?
  - Downstream of plug, improve channel/floodplain connection to provide “slow” crest over into floodplain
  - Concern expressed over overflow channels near road – worried about flow moving over the road again. Would like to see different options (away from road)
  - Maybe utilize “pilot channels” to encourage flow in floodplain without having a defined channel
  - Plug area is very important in terms of what the channel does downstream at the diversion
- South Ledge/Meadows Diversion:
  - Is anything planned in this area? Floodplain grading? Overflow channels?
- Longmont Diversion
  - Would like to see sediment removed downstream of diversion (concerned that Longmont filled in the channel alignments, instead of just leaving as overflow
  - Water is being sent to the east by raising the terrace
- Old South St. Vrain Bridge area
  - A lot of concern re: overflow channel that comes off of main channel upstream of bridge, crosses road and runs through private properties (house proposed on one of the parcels).
  - Interested in another option that sends flow around and back to the main channel without going very far into private property
  - Can the flow be optimized through bridge? What is the current capacity
  - Reroute channel to improve flow through bridge

Channel Complexity:

Channel complexity refers to channel features that contribute to geomorphically effective bedforms, as well as habitat quality and diversity. These features include:

- Low Flow Channel
- Pools, riffles, steps
- Bars (point, lateral, mid-channel)

- Large woody material (bank protection/habitat enhancement)
- Roughened channels/boulder clusters

Comments:

Folks were generally interested in the how the in-channel structures would help with sediment. Lots of interest in the wood structures but mostly curiosities.

Summary of comments, which mostly came from Boulder County:

- BCPOS is combining two points of diversion into one structure – looking for guidance on placement and structure type. Proposed location circled on map
- BCPOS wants our survey data as they need to get out and collect more data but don't want to duplicate effort
- BCPOS can send bridge drawings if we still need them
- Received one random comment to re-visit the suggestions in the master plan for the Old SSV Bridge and Longmont diversion. I suspect this mostly refers to replacing the current structure with a fish passable structure.

Revegetation:

Revegetation will provide the framework for increased ecosystem function and aesthetic appeal along the corridor. Our team presented strategies that include:

- Protecting and preserving existing stands of vegetation.
- Incorporating bioengineering measures to increase habitat maturation and resiliency.
- Planting a diverse palette of native plant species.

Comments:

- A long conversation took place between Brandon Parsons (THK), Vince Zounek and Ron Gosnell. Mr. Parsons (THK) was asked to consider revegetation measures along the embankment of Old St. Vrain Road, across the street from Vince's property. This area use to be heavily vegetated but pre-flood work eliminated both upland vegetation and willows in this area. Specific revegetation measures discussed include:
  - Installing coyote willows into the rip-rap.
  - Re-seeding the upland area currently used for parking.
  - Incorporating new bio-engineering measures along the embankment to establish more robust riparian zone.
- Brandon (THK) explained to Cecily Mui, from the St. Vrain Creek Coalition (SVCC), the methods behind the revegetation alternative.
- Ms. Mui (SVCC) inquired as to the exact location of the EPW project boundaries. Erst Strenge (BCPOS), drew the project limits on the map of the alternative and a brief discussion arose regarding their placement and connection to one another.
- Ms. Mui (SVCC) asked if a reference reach had been used to develop the revegetation plan and methods. Mr. Parsons (THK) explained that while a healthy reference reach had not been identified our experience in similar river systems helped guide the approach. David Hirt (BCPOS)

stepped in to share his expertise on the native plant species and the approach we will be taking to revegetate this corridor based on his experience in this area.

- Mr. Gosnell, asked the design team and BCPOS to consider a maintenance strategy and criteria to prevent woody debris from causing an issue. Ron, would like to develop a way to understand at what point mature vegetation could become a hazard during a flood. A discussion arose between Tim Shafer (BCPOS), Mr. Parsons (THK) and Mr. Gosnell regarding this issue.
- Mr. Gosnell, identified areas along the stretch where woody debris gathered during the floods. It was discussed that a way to decrease obstructions caused of woody debris would be to open up these "choke points" along the creek.

Infrastructure Protection:

Infrastructure Protection includes the protection of key infrastructure elements and onsite item that are considered "assets" to the corridor. Infrastructure elements include:

- Roads
- Bridges
- Houses
- Ditches

Strategies presented for infrastructure projection include:

- Bank Stabilization
    - Bioengineering
    - Buried Rootwads
- Offset Buried Natural/Structural Aspects
    - Buried Riprap Revetment
    - Buried Boulders
    - Structural Walls
- Channel Alignment: In-depth Analysis Required
    - Slope, Sinuosity, Wavelength, Belt Width
- Detention
- Cost

Comments:

- Moth Mullein: State priority list B along the roadside
- Approximate 2:1 Slope for Mine reclamation
- New combined ditch location for Matthews and Holcomb near Hall property
- will need to protect new diversion pipeline by Old South St Vrain Bridge
- Box culvert will be provided for Holcomb Matthews Ditch at Old South St Vrain Bridge
- Might need to protect diversion pipeline near Redmond's
- Ok to move South Ledge and Meadows diversion as part of this project
- Vince Property: Parking along street, killing vegetation, need to plant willows
- Option to move Longmont diversion upstream
- Important to combine Longmont diversion into the EWP project limits.
- Sediment is starting to fill in downstream of Longmont Diversion.
- Option to straighten Highway 7 crossings should be evaluated

- Than 3' Diameter
- Place Large Instream Boulders In The Channel
- Provide Boat And Fish Passage
- Create Low Flow Channel Throughout Reach
- Do Not Harvest Boulders or Break Boulders Greater than 3' diameter.
- Place Large Instream Boulders In The Channel

South St. Vrain Creek Restoration at Hall Ranch
Flood Planning and Preliminary Design Services
Public Meeting #2: Discussion of Alternatives

	Name	Email	Organization/Affiliation
1	WANDA & Roy GRIEST	wgriest@gmail.com	Lyons Meadow Ditch
2	VINCE ZOUNEK	VZOUNEK@MSN.COM	455 OLD SAINT VRAIN RD.
3	DAVE LEVY + LORI GIBB	DAVELEVY@QWESTOFFICE.NET	RESIDENT + SVCC
4	Connie Davis	connie.davis@aggregate-us.com	Aggregate Ind.
5	JOHN BALLEGEER	john.ballegeer@hdrinc.com	HDR Engineering
6	Travis Snyder	travis.snyder@hdrinc.com	HDR Engineering
7	Jim Kerr	kerrjamesf@gmail.com	Lyons / Resident
8	Prashant KC	pkc@bouldercounty.org	BCPOS
9	Shera Sumerford	shera.sumerford@state.co.us	DWR
10	MICHAEL BLAZEWICZ	MICHAEL@ROUNDRIVERDESIGN.COM	TA TEAM
11	Ken Huson	Ken.Huson@LongmontColorado.gov	Longmont
12	Tim KATERS	tim.katers@state.co.us	DOLA
13			
14			
15			Others
16			Larry Quinn
17			Ron Gosnell
18			Matt Booth
19			Cecily Mui } St. Vrain Creek Coalition
20			Erika }
21			
22			

b. Appendix B - Applicable Sections of St Vrain Creek Master Plan

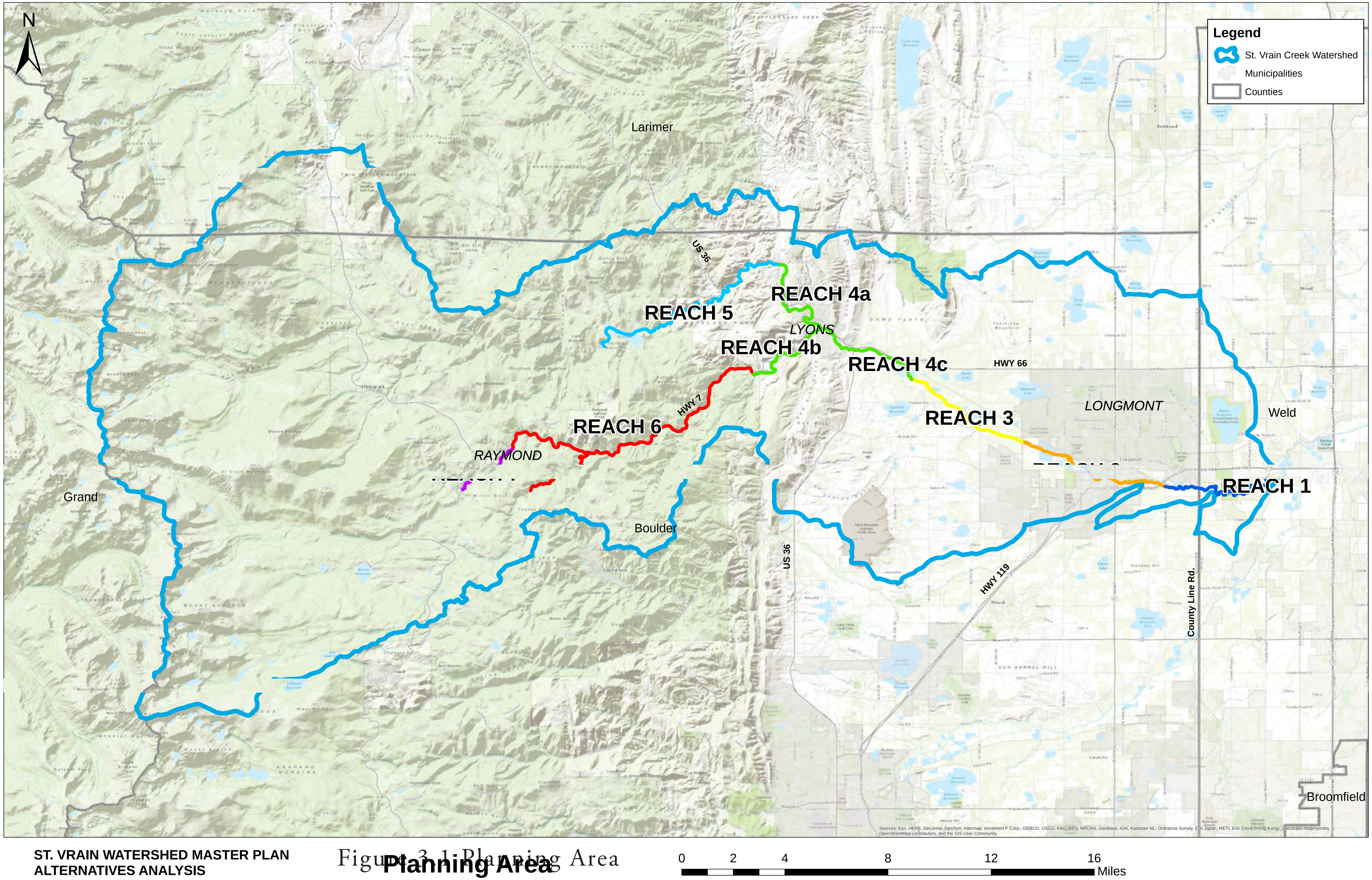


Figure 3-1: Planning Area

Lyons Recovery Action Plan Stream PDGs
1. Re-vegetate the N., S., and combined Creek corridor in Lyons
2. Improve riparian habitats and bank stabilization from the confluence to McConnell Bridge
3. Restore and improve North, South and combined St. Vrain corridor in Lyons
4. Assess the ongoing water quality in the St. Vrain during flood response, recovery, and restoration
5. Restock the native fisheries in the St. Vrain River, and improve aquatic habitat for fish species
6. Design & implement the ponds and associated wetlands to promote increased natural areas, and provide a variety of recreational and hazard mitigation
7. Mitigate high water mark debris and sediment deposits
8. Mitigate Highway 36 CDOT bridges near the Planet Bluegrass property
9. Mitigate channelization of the North St. Vrain from 5th Ave to confluence
10. Develop detention and retention units on South St. Vrain Creek to Boulder County Open Space as a means of flood mitigation

The Lyons Flood Recovery Task Force identified six objectives for this area:

1. Flood Mitigation – The mitigation of flood impacts by addressing bridges, by creating detention and retention and by restoring the river in a way that maintains and improves existing flood boundaries.

2. Recreation – The creation of in-stream and bank side recreational opportunities that invite people to kayak, float, camp, cycle, walk, fish, tube, spectate, and otherwise enjoy the river and its bank.

3. Economic Impact - Connect the river to the downtown in a way that revitalizes the Lyons economy through increased opportunities to recreate along the river for locals and visitors alike.

4. Aquatic & Riparian Habitat - The creation and preservation of a showcase example corridor that features a continuous and connected riparian and in-stream habitat that is designed to optimize the natural habitat within the reach.

5. Infrastructure - Set a standard for infrastructure in the river corridors that is robust, aesthetically appropriate to the river corridor, and that contemplates recovery from the next major event.

6. Private Property - Definition of a process that encourages future property (Re)Development in a responsible way such that it fosters a healthy river and riparian system and respects flood impacts to neighboring properties.

Plan Recommendations

The primary issues within these reaches include lateral channel migration and bank erosion, sediment deposition/aggradation, sediment erosion/degradation, debris blockages throughout the reach and at drainageway crossings, and infrastructure damage. There are large areas of riparian habitat that are still intact and should be preserved where possible. In locations where the channel needs to be restored, both cutting and filling will be required depending on what portion of the reach restoration will occur. The results of the geomorphic assessment state that the South St. Vrain Creek and North St. Vrain creek should be restored in the post-flood channel alignment while the Saint Vrain Creek should be restored in the pre-flood channel alignment. Channel restoration recommendations for these reaches generally follow this guidance except for in some instances where special accommodations needed to be made. These instances include moving the channel away from the road to reduce erosion potential, moving the channel to address needs of irrigators, and moving the channel to improve stream stability, provide fish habitat, and reduce flood risk.

Some of the priorities identified by stakeholders include increasing flood conveyance capacity, debris removal, optimizing flood conveyance at drainageway crossings, and incorporating projects that address multiple objectives. In addition, anglers and in-stream recreation enthusiasts have both been dramatically affected by the changes to the waterways in Reach 4. These groups should be engaged throughout the implementation process to ensure local buy-in and restore the economic advantages these recreations bring to the Town of Lyons. See public comments in Appendix D for additional details.

A significant amount of planning, design, and construction has already taken place for the reaches in this area and somewhat constrain restoration options. As a result, the recommended plan for this area focused restoring the channel to work in concert with ongoing flood recovery efforts that address objectives for this area.

Reach 4a - North St. Vrain

The recommended plan for Reach 4a is shown in the following figures. The purpose of this alternative is to implement a channel alignment that will optimize the interaction with completed, ongoing, and funded projects while being sensitive to the constraints presented by the presence of numerous private residences throughout this river corridor. The implementation of this alternative will expedite the maturation of this reach by re-establishing a natural channel, repairing erosion scars, re-establishing floodplain benches, building point-bars and excavating pools, re-vegetating denuded areas, and stabilizing channel banks.

Reach 4b - South St. Vrain

The recommended plan for Reach 4b is shown on the following Figures. The purpose of this alternative is to implement a channel alignment that will optimize the interaction with completed, ongoing, and funded projects while being sensitive to the constraints presented by the presence of numerous private residences throughout this river corridor. The implementation of this alternative will expedite the maturation of this reach by re-establishing a natural channel, repairing erosion scars, re-establishing floodplain benches, building point-bars and excavating pools, re-vegetating denuded areas, and stabilizing channel banks. The Baker Team conducted a feasibility analysis during the planning process to evaluate the potential for detention in the vicinity of Andesite Quarry as outlined in PDG 10. The analysis showed a lack of significant reduction in downstream flood risk and concluded that such a facility would not be cost beneficial as a result of the large cost of designing, building, maintaining, and operating such a facility with limited public benefit. Thus, the study did not recommend this flood control measure. If desired by the Town of Lyons and others, additional analysis could be undertaken to further evaluate the feasibility of detention at this location and whether it could be made more cost beneficial. Any further analysis would require additional engineering studies, cost-benefit analysis, and environmental investigations including an evaluation of the potential impacts to in-stream and riparian habitats that such a facility would create both upstream and downstream. See Appendix D and G for more information.

Reach 4c - St. Vrain Creek

The focus of the improvements for this reach is at the site of the McConnell ponds. The reconstruction of these ponds is important to the community because of the social, recreational, and aesthetic benefit that they provided to the community. There has been ongoing discussion within the Lyons community about where the McConnell Ponds should be reconstructed in their pre-flood location on the south side of St. Vrain Creek or a new location on the north side. The qualitative analysis for the two alternative locations yielded very close results. The recommendation is to perform a more in-depth analysis as additional information (survey and hydraulic modeling) become available to further inform the pros and cons of the location of the McConnell Ponds. Note that the qualitative scoring in Appendix D has been redacted so as not to influence this future analysis.

General Recommendations

Additional site-specific studies, including environmental and engineering evaluations, are recommended prior to finalizing design.

Drainageway Crossings

- Evaluate all drainageway crossings and optimize the flood conveyance capacity using the design flows published in the CDOT/CWCB study, when it becomes available.
- Design new/improved drainageway crossings so that the low-flow channel remains unobstructed in order to maintain channel stability and achieve ecological connectivity. Provide additional floodplain conveyance capacity by utilizing floodplain culverts in the overbank areas.
- Remove debris blockages.

Channel Restoration

- Incorporate/stabilize a low flow/bankfull channel section with the following general design parameters:

Design Parameter	Min	Max
Low flow/bankfull Channel Top Width	50	150
Slope	0.005	0.02
Ave. Low flow/bankfull Channel Top Width-to-Depth Ratio	30	
Ave. Sinuosity	1.2	

- Increase in-stream habitat complexity by incorporating pools, rock clusters, boulders and large woody debris.
- Revegetate the riparian corridor with native species where needed.
- Site-specific bank stabilization to protect adjacent infrastructure and private property.
- Fill areas and revegetate areas that are at high risk of avulsion.
- Remove debris blockages.
- Consider in-stream recreation and safety.
- Coordinate channel improvements with ditch companies to ensure desired level of operation is maintained.

Work In Progress

As mentioned above, there is a substantial amount of work that has been completed, or currently in progress in this reach. Additional restoration work should coordinate with all work being completed in this area prior to commencing.

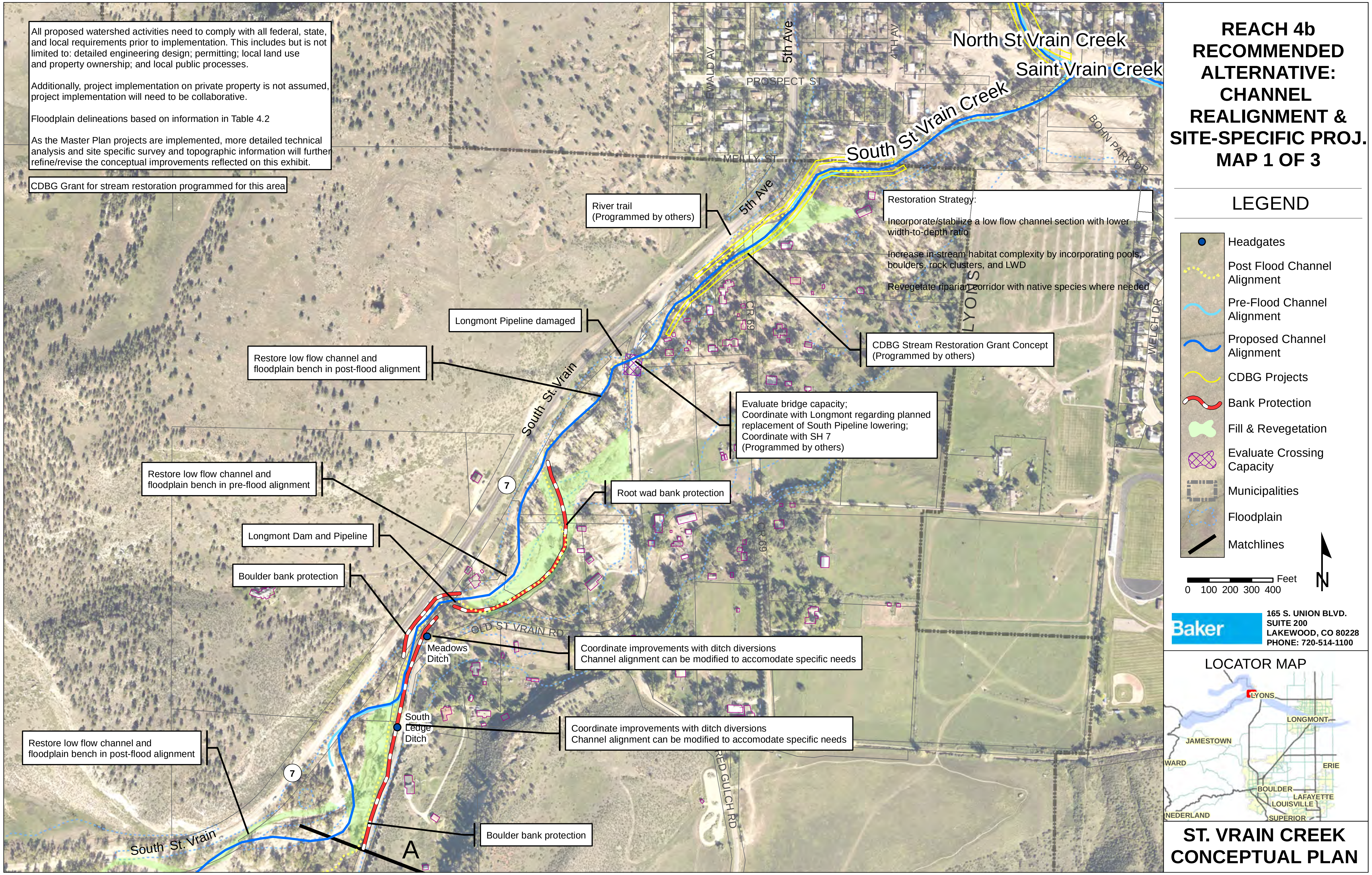
Upcoming repair work is planned along State Highway 7. It is recommended that all future restoration work in this corridor be coordinated with CDOT. Opportunities to expand the floodplain should be considered during all future improvements along State Highway 7. There are several locations where State Highway 7 has truncated historical channel migration areas. In these locations, resiliency could be improved by realigning State Highway 7 to be outside of these disconnected migration areas.

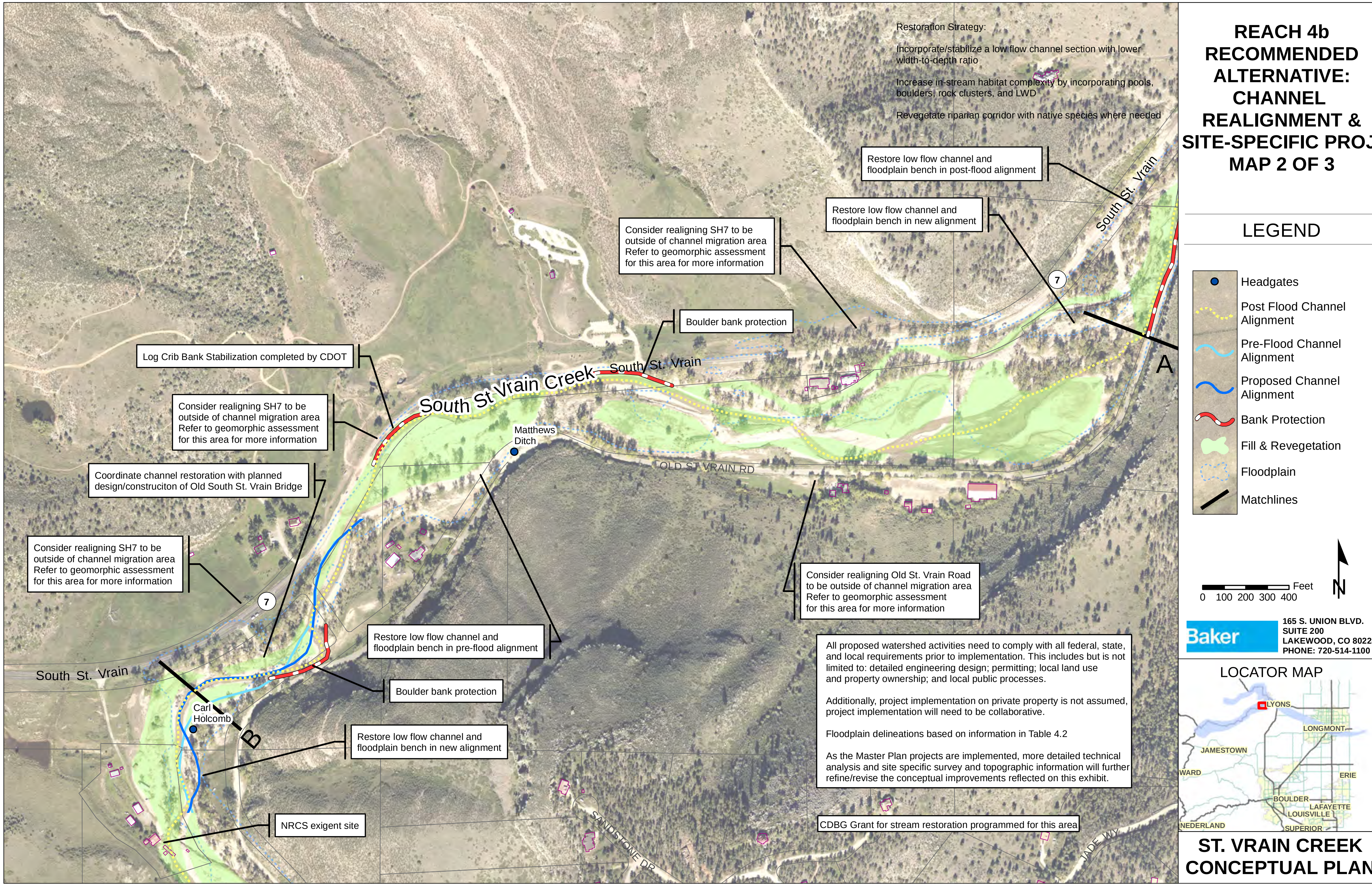
Estimated Cost of Unmet Needs

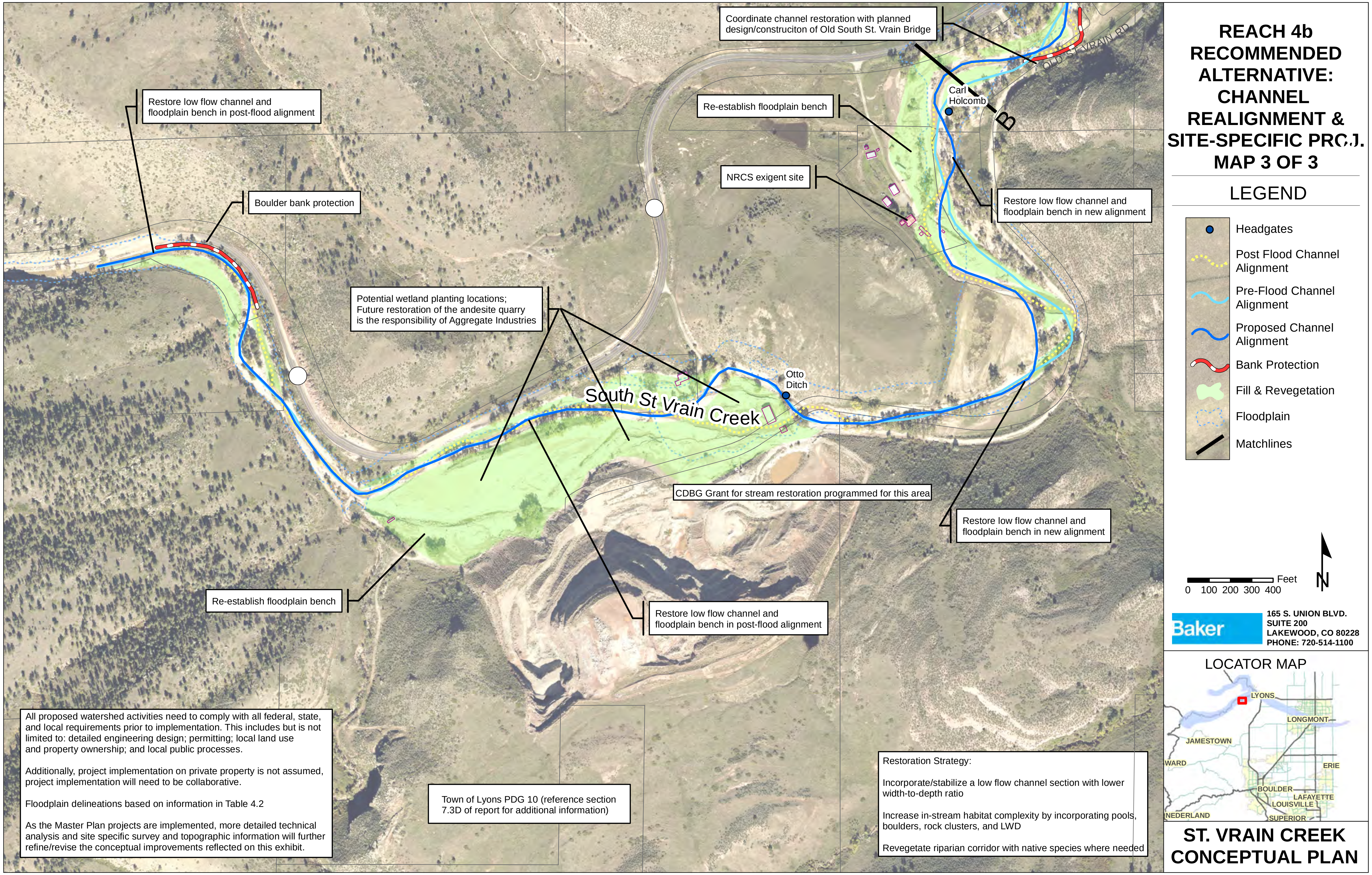
Estimated costs for unmet needs were prepared to capture the capital that could be required to implement plan recommendations. These estimated costs do not include projects that are currently being completed or that are programmed. The estimated costs for unmet needs in this reach are provided in Table 7.2.

Table 7.2 Estimated Cost for Reach 4

Reach 4a	Qty	Unit	Unit Cost	Cost
Low flow/bankfull Channel Restoration	8531	LF	$300	$2,559,270
Fill	76735	CY	$10	$767,347
Revegetate	1035919	SF	$1	$1,035,919
Bank Protection - Boulder	4843	LF	$275	$1,331,825
Bank Protection - Root Wad	2732	LF	$165	$450,780
			Subtotal:	**$6,145,141**
Land Acquisition	5%			$307,257
Engineering	15%			$921,771
Legal/Administrative	5%			$307,257
Contract Admin/Construction Management	10%			$614,514
Contingency	25%			$1,536,285
			Total:	**$9,832,226**
Reach 4b	**Qty**	**Unit**	**Unit Cost**	**Cost**
Low flow/bankfull Channel Restoration	10851	LF	$300	$3,255,420
Fill	249320	CY	$10	$2,493,202
Revegetate	2243882	SF	$1	$2,243,882
Bank Protection - Boulder	3235	LF	$275	$889,625
Bank Protection - Root Wad	1056	LF	$165	$174,240
Subtotal				**$9,056,370**
Land Acquisition	5%			$452,818
Engineering	15%			$1,358,455
Legal/Administrative	5%			$452,818
Contract Admin/Construction Management	10%			$905,637
Contingency	25%			$2,264,092
			Total:	**$14,490,191**
Reach 4c	**Qty**	**Unit**	**Unit Cost**	**Cost**
Low flow/bankfull Channel Restoration	11173	LF	$350	$3,910,690
Fill	21001	CY	$10	$210,009
Revegetate	141756	SF	$1	$141,756
Bank Protection - Root Wad	2113	LF	$165	$348,645
HWY 36 Bridge Crossing Improvement	8733	SF	$125	$1,091,625
Lyons CDBG grants that weren't funded	1	EA	$2,268,108	$2,268,108
			Subtotal:	**$7,970,833**
Land Acquisition	5%			$398,542
Engineering	15%			$1,195,625
Legal/Administrative	5%			$398,542
Contract Admin/Construction Management	10%			$797,083
Contingency	25%			$1,992,708
			Total:	**$12,753,333**


All proposed watershed activities need to comply with all federal, state, and local requirements prior to implementation. This includes but is not limited to: detailed engineering design; permitting; local land use and property ownership; and local public processes.
Additionally, project implementation on private property is not assumed, project implementation will need to be collaborative.
Floodplain delineations based on information in Table 4.2
As the Master Plan projects are implemented, more detailed technical analysis and site specific survey and topographic information will further refine/revise the conceptual improvements reflected on this exhibit.
CDBG Grant for stream restoration programmed for this area
River trail (Programmed by others)
Longmont Pipeline damaged
Restore low flow channel and floodplain bench in post-flood alignment
Restore low flow channel and floodplain bench in pre-flood alignment
Longmont Dam and Pipeline
Boulder bank protection
Root wad bank protection
Restoration Strategy:
Incorporate/stabilize a low flow channel section with lower width-to-depth ratio
Increase in-stream habitat complexity by incorporating pools, boulders, rock clusters, and LWD
Revegetate riparian corridor with native species where needed
CDBG Stream Restoration Grant Concept (Programmed by others)
Evaluate bridge capacity; Coordinate with Longmont regarding planned replacement of South Pipeline lowering; Coordinate with SH 7 (Programmed by others)
Coordinate improvements with ditch diversions Channel alignment can be modified to accomodate specific needs
Coordinate improvements with ditch diversions Channel alignment can be modified to accomodate specific needs
Restore low flow channel and floodplain bench in post-flood alignment
Boulder bank protection
Meadows Ditch
South Ledge Ditch
North St Vrain Creek
Saint Vrain Creek
South St Vrain Creek
South St. Vrain
5th Ave
PROSPECT ST
MEILLY ST
OLD ST VRAIN RD
RED GULCH RD
LYONS
A
REACH 4b RECOMMENDED ALTERNATIVE: CHANNEL REALIGNMENT & SITE-SPECIFIC PROJ. MAP 1 OF 3
LEGEND
Headgates
Post Flood Channel Alignment
Pre-Flood Channel Alignment
Proposed Channel Alignment
CDBG Projects
Bank Protection
Fill & Revegetation
Evaluate Crossing Capacity
Municipalities
Floodplain
Matchlines
Feet
0 100 200 300 400
N
Baker
165 S. UNION BLVD. SUITE 200 LAKEWOOD, CO 80228 PHONE: 720-514-1100
LOCATOR MAP
LYONS
LONGMONT
JAMESTOWN
WARD
ERIE
BOULDER
LAFAYETTE
LOUISVILLE
NEDERLAND
SUPERIOR
ST. VRAIN CREEK CONCEPTUAL PLAN


REACH 4b RECOMMENDED ALTERNATIVE: CHANNEL REALIGNMENT & SITE-SPECIFIC PROJ. MAP 2 OF 3
LEGEND
Headgates
Post Flood Channel Alignment
Pre-Flood Channel Alignment
Proposed Channel Alignment
Bank Protection
Fill & Revegetation
Floodplain
Matchlines
Feet
0 100 200 300 400
N
Baker
165 S. UNION BLVD.
SUITE 200
LAKEWOOD, CO 80228
PHONE: 720-514-1100
LOCATOR MAP
LYONS
LONGMONT
JAMESTOWN
WARD
ERIE
BOULDER
LAFAYETTE
LOUISVILLE
NEDERLAND
SUPERIOR
ST. VRAIN CREEK CONCEPTUAL PLAN
Restoration Strategy:
Incorporate/stabilize a low flow channel section with lower width-to-depth ratio
Increase in-stream habitat complexity by incorporating pools, boulders, rock clusters, and LWD
Revegetate riparian corridor with native species where needed
Restore low flow channel and floodplain bench in post-flood alignment
Restore low flow channel and floodplain bench in new alignment
Consider realigning SH7 to be outside of channel migration area Refer to geomorphic assessment for this area for more information
Boulder bank protection
Log Crib Bank Stabilization completed by CDOT
Consider realigning SH7 to be outside of channel migration area Refer to geomorphic assessment for this area for more information
Coordinate channel restoration with planned design/construciton of Old South St. Vrain Bridge
Consider realigning SH7 to be outside of channel migration area Refer to geomorphic assessment for this area for more information
Restore low flow channel and floodplain bench in pre-flood alignment
Boulder bank protection
Restore low flow channel and floodplain bench in new alignment
NRCS exigent site
Consider realigning Old St. Vrain Road to be outside of channel migration area Refer to geomorphic assessment for this area for more information
All proposed watershed activities need to comply with all federal, state, and local requirements prior to implementation. This includes but is not limited to: detailed engineering design; permitting; local land use and property ownership; and local public processes.
Additionally, project implementation on private property is not assumed, project implementation will need to be collaborative.
Floodplain delineations based on information in Table 4.2
As the Master Plan projects are implemented, more detailed technical analysis and site specific survey and topographic information will further refine/revise the conceptual improvements reflected on this exhibit.
CDBG Grant for stream restoration programmed for this area
South St Vrain Creek
South St. Vrain
South St. Vrain
South St. Vrain
Matthews Ditch
Carl Holcomb
OLD ST VRAIN RD
SANDSTONE DR
JADE WY
7
7
A
B


REACH 4b RECOMMENDED ALTERNATIVE: CHANNEL REALIGNMENT & SITE-SPECIFIC PROJ. MAP 3 OF 3
LEGEND
Headgates
Post Flood Channel Alignment
Pre-Flood Channel Alignment
Proposed Channel Alignment
Bank Protection
Fill & Revegetation
Floodplain
Matchlines
Feet
0 100 200 300 400
N
Baker
165 S. UNION BLVD.
SUITE 200
LAKEWOOD, CO 80228
PHONE: 720-514-1100
LOCATOR MAP
LYONS
LONGMONT
JAMESTOWN
WARD
ERIE
BOULDER
LAFAYETTE
LOUISVILLE
NEDERLAND
SUPERIOR
ST. VRAIN CREEK CONCEPTUAL PLAN
Coordinate channel restoration with planned design/construciton of Old South St. Vrain Bridge
OLD ST VRAIN RD
Carl Holcomb
B
Re-establish floodplain bench
NRCS exigent site
Restore low flow channel and floodplain bench in new alignment
Restore low flow channel and floodplain bench in post-flood alignment
Boulder bank protection
Potential wetland planting locations; Future restoration of the andesite quarry is the responsibility of Aggregate Industries
South St Vrain Creek
Otto Ditch
CDBG Grant for stream restoration programmed for this area
Restore low flow channel and floodplain bench in new alignment
Re-establish floodplain bench
Restore low flow channel and floodplain bench in post-flood alignment
All proposed watershed activities need to comply with all federal, state, and local requirements prior to implementation. This includes but is not limited to: detailed engineering design; permitting; local land use and property ownership; and local public processes.
Additionally, project implementation on private property is not assumed, project implementation will need to be collaborative.
Floodplain delineations based on information in Table 4.2
As the Master Plan projects are implemented, more detailed technical analysis and site specific survey and topographic information will further refine/revise the conceptual improvements reflected on this exhibit.
Town of Lyons PDG 10 (reference section 7.3D of report for additional information)
Restoration Strategy:
Incorporate/stabilize a low flow channel section with lower width-to-depth ratio
Increase in-stream habitat complexity by incorporating pools, boulders, rock clusters, and LWD
Revegetate riparian corridor with native species where needed

c. Appendix C - EWP Damage Survey Report and Scope of Work

United States Department of Agriculture — **OMB No. 0578-0030**
Natural Resources Conservation Service — **NRCS-PDM-20**

DAMAGE SURVEY REPORT (DSR)
Emergency Watershed Protection Program - Recovery

Section 1A

NRCS Entry Only				
Eligible:	YES		NO	
Approved:	YES		NO	
Funding Priority Number(from Section 4)				2ae
Limited Resource Area:	YES		NO	

DSR Number: Boulder_South St Vrain_Reach 4b_2015_High

Date: 9/14/15 Project Number: 0

Section 1B Sponsor

Sponsor Name: Colorado Department of Natural Resources -CWCB

Address: 1313 Sherman St. Room 721

City/State/Zip: Denver/CO/80203

Phone Number: (303) 866-3441 Fax: (303) 866-4474 Email: KEVIN.HOUCK@STATE.CO.US

Section 1C Site Location Information

County: Boulder State: Colorado Congressional District: 2

Latitude: 0 Longitude: 0 Section: 0 Township: 0 Range: 0

UTM Coordinates Easting: 475914 UTM Coordinates Northing: 4451051

Drainage Name: South St Vrain Reach: Reach 4b

Damage Description: Large amounts of sediment and debris deposits, from erosion caused by the 2013 flooding. There were changes in the river channel and flood plains.

Section 1D Site Evaluation

All answers in this section must be YES in order to be eligible for EWP assistance.

Site Eligibility	YES	NO	Remarks
	Y		2013 Colorado Flood P2
Recovery measures would be for runoff retardation or soil erosion prevention?*	Y		0
Threat to life and/or property?*	Y		0
Event caused a sudden impairment in the watershed?*	Y		0
Imminent threat was created by this event?**	Y		0
For structural repairs, not repaired twice within ten years?**	Y		0
Access to property granted by landowner(s)?	Y		0
Site Defensibility			
Economic, environmental, and social documentation adequate to warrant action? (Go to pages 3,4,5 and 6***)	Y		0
Proposed action technically viable? (Go to Page 9***)	Y		0

Have all the appropriate steps been taken to ensure that all segments of the affected population have been informed of the EWP program and its possible effects? YES: Y NO:

Comments:

0

* Statutory

** Regulation

*** DSR Pages 3 through 6 and 9 are required to support the decisions recorded on this summary page. If additional space is needed on this or any other pages in this form, add appropriate pages.

DSR NO: Boulder_South St Vrain_Reach 4b_2015_High

Section 1E Proposed Action

Describe the preferred alternative from Findings: Section 5 A:

Restore river to pre flood measures to withhold a 100 year event contingent upon completion of CR investigation and in compliance with requirements of F&WS emergency consultation and all applicable categorical exclusions.

Total installation cost identified in this DSR: Section 3: $2,409,099

Section 1F NRCS State Office Review and Approval

Reviewed By: ______________________ Date Reviewed: ______________________

State EWP Program Manager

Approved By: ______________________ Date Approved: ______________________

State Conservationist

PRIVACY ACT AND PUBLIC BURDEN STATEMENT

NOTE: The following statement is made in accordance with the Privacy Act of 1974, (5 U.S.C. 552a) and the Paperwork Reduction Act of 1995, as amended. The authority for requesting the following information is 7 CFR 624 (EWP) and Section 216 of the Flood Control Act of 1950, Public Law 81-516, 33 U.S.C. 701b-1; and Section 403 of the Agricultural Credit Act of 1978, Public Law 95334, as amended by Section 382, of the Federal Agriculture Improvement and Reform Act of 1996, Public Law 104-127, 16 U.S.C. 2203. EWP, through local sponsors, provides emergency measures for runoff retardation and erosion control to areas where a sudden impairment of a watershed threatens life or property. The Secretary of Agriculture has delegated the administration of EWP to the Chief or NRCS on state, tribal and private lands.

Signing this form indicates the sponsor concurs and agrees to provide the regional cost-share to implement the EWP recovery measure(s) determined eligible by NRCS under the terms and conditions of the program authority. Failure to provide a signature will result in the applicant being unable to apply for or receive a grant the applicable program
authorities. Once signed by the sponsor, this information may not be provided to other agencies. IRS, Department of Justice, or other State or Federal Law Enforcement agencies, and in response to a court or administrative tribunal.

The provisions of criminal and civil fraud statutes, including 18 U.S.C. 286, 287, 371, 641, 651, 1001; 15 U.S.C. 714m; and 31 U.S.C. 3729 may also be applicable to the information provided. According to the Paperwork Reduction Act of 1995, an agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information collection is 0578-0030. The time required to complete this information collection is estimated to average 117/1.96 minutes/hours per response, including the time for reviewing instructions, searching existing data sources, field reviews, gathering, designing, and maintaining the data needed, and completing and reviewing the collection information.

USDA NONDISCRIMINATION STATEMENT

“The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, martial status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who
require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202)720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office
of Civil Rights, 1400 Independence Avenue, SW., Washington, DC 20250-9410, or call (800)795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Civil Rights Statement of Assurance

The program or activities conducted under this agreement will be in compliance with the nondiscrimination provisions contained in the Titles VI and VII of the Civil Rights Act of 1964, as amended; the Civil Rights Restoration Act of 1987 (Public Law 100-259); and other nondiscrimination statutes: namely, Section 504 of the Rehabilitation Act of 1973, Title IX of the Amendments of 1972, the Age Discrimination Act of 1975, and the Americans with Disabilities Act of 1990. They will also be in accordance with regulations of the Secretary of Agriculture (7 CFR 15, 15a, and 15b), which provide that no person in the United States shall on the grounds of race, color, national origin, gender, religion, age or disability, be excluded from participation in, be denied the benefits of, or otherwise subjected to discrimination under any program or activity receiving Federal financial assistance from the U.S. Department of Agriculture or any agency thereof.

DSR NO: Boulder_South St Vrain_Reach 4b_2015_High

Section 2 Environmental Evaluation

2A Resource Concerns	2B Existing Condition	2C Alternative Designation		
		Proposed Action	**No Action**	**Alternative**
		Streambank Stabilization, Floodplain Establishment, and Debris Removal	Site continues to degrade and adversely affects environment and community.	
		2D Effects of Alternatives		
Soil				
Excessive bank erosion from stream banks or conveyance channels	Extensive Erosion Affecting Soil Stability. SVAP2=1 for bank stability/condition.	Reduce erosion to quality criteria. SVAP2=5 for bank condition/stability.	Continued degradation of stream bank and stream. SVAP2=1 for bank stability/condition.	
Sheet and rill, wind and/or irrigation-induced	Extensive sheet and rill erosion.	Reduced erosion due to a stable system.	Continued loss of soil through sheet and rill erosion.	
Water				
Water Quality Degradation – Excessive sediment in surface waters	Bank erosion has created excess dissolved sediment in surface waters. SVAP2=1 for bank stability/condition.	Stabilize banks to reduce water quality degradation. SVAP2=5 for bank stability/condition.	Continued degradation of streambank and stream. SVAP2=1 for bank stability/condition.	
Excess water - Flooding	Risk from more flooding, Single event or spring runoffs.	Practice will reduce risk from 100 year storm event.	Continued risk from flooding	
Air				
No Resource Concern Identified	No Effect	No Effect	No Change	No Change
Plant				
Inadequate structure and composition	Early successional species cover landscape not helping hold ground.	Removal of vegetation and new plantings	Continued unbalance in ecological processes	
Excessive plant pressure	Weeds in some areas cover the landscape, water is transporting weed seed down stream	Removal / Increased Control of pest plant and planting, and reduced transport of seeds.	Continued overtake possibly and unbalanced in ecological processes, and continued transport of seeds.	
T&E plants-in range where Ute ladies'-tresses and Colorado butterfly plant could occur.	Potential habitat areas for Ute ladies'-tresses and CO butterfly plant was damaged by bank erosion, sedimentation, & debris deposits.	Bank stabilization & sediment/debris removal will open up areas and allow habitat to recover.	Continued damage to potential habitat areas from erosion, sediment, and debris.	
T&E plant habitats-Outside of range for North Park phacelia. No depletions to affect Western prairie fringed orchid.	No Effect	No Effect	No Effect	
Animal				
Habitat degradation for typical species (fish, migratory birds, etc.) that use aquatic or riparian areas	Damage or destruction to habitat for T&E species and other native species. SVAP2=2.7 overall.	Bank stabilization and protection measures will safeguard/improve habitat over current conditions for T&E and natives species. SVAP2=5.6 overall.	Unstable riparian conditions will continue to erode habitat areas, preventing vegetative recovery in the near future. SVAP2=2.7 overall.	
Potential Preble's meadow jumping mouse (PMJM)	PMJM habitat has been damaged or destroyed	Bank treatments will improve habitat over current conditions.	Unstable riparian conditions will continue to erode habitat areas, preventing vegetative recovery in the near future	
No suitable habitat for other Phase II listed species: sage grouse, MSO, ferret, lynx, greenback cutthroat trout	No Effect	No Effect	No Effect	
No water depletions so no effect on South Platte species: sturgeon, p. plover, l. tern, & whooping crane	No Effect	No Effect	No Effect	
Other				
No Resource Concern Identified	No Effect	No Effect	No Change	

DSR NO: Boulder_South St Vrain_Reach 4b_2015_High

Section 2E Special Environmental Concerns

Resource Consideration	Existing Condition	Alternatives and Effects		
		Proposed Action	No Action	Alternative
Clean Water Act Waters of the U.S.	The stream and adjacent riparian area were damaged in the flood. Debris was deposited on the floodplain and in the river.	Debris removal and bank stabilization will improve the stream and adjacent riparian areas.	Damaged areas will recover slowly and with additional bank and riparian area losses. Downstream deposition will continue to occur in Waters of the U.S.	
Coastal Zone Management Areas	Not applicable to Colorado as determined by NOAA	Not Applicable to Colorado	Not Applicable to Colorado	
Coral Reefs	Not applicable to Colorado as determined by the US Coral Reef Task Force	Not Applicable to Colorado	Not Applicable to Colorado	
Cultural Resources	No Effect	Reports on file in State Office for Cultural Resources Management, contact Marsha Sims or State Archeologist.	No Effect	
Endangered and Threatened Species	Habitat for PMJM, Ute ladies-tresses, & CO butterfly plant was damaged or destroyed.	Bank stabilization and debris removal will prevent or slow further loss of habitat.	Banks and riparian areas will be slow to recover, having negative effects on habitats.	
Environmental Justice	No Effect	No Effect	No Effect	
Essential Fish Habitat	Not applicable to Colorado as determined by NOAA	Not applicable to Colorado as determined by NOAA	Not Applicable to Colorado	
Fish and Wildlife Coordination	Not Applicable	NRCS is in consultation with USFWS and other federal and state agencies.	Not Applicable	
Floodplain Management	Debris & sediment deposition and bank erosion are negatively affecting the floodplain and adjacent and downstream areas.	Debris removal and bank stabilization will improve floodplain condition in the immediate area and downstream.	Continued deposition and erosion will negatively affect floodplain for the near future	
Invasive Species	Flooding created a seedbed and may have provided a seed source for common weed species.	Practices will help trap some weed seed before it gets into the water course.	Invasive species will likely spread.	
Migratory Birds	Habitat for many migratory bird species was harmed or destroyed.	Bank stabilization will help suitable migratory bird habitat to re-establish.	Habitat will recover slowly with continued bank erosion.	
Natural Areas	None known	None known	None known	
Prime and Unique Farmlands	No conversions of prime/unique farmlands to non-ag uses expected.	No conversions of prime/unique farmlands to non-ag uses.	No conversions of prime/unique farmlands to non-ag uses expected.	
Riparian Areas	Riparian areas suffered extreme damage from the flood-loss of vegetation, unstable banks, poor water quality. SVAP2=2.7 overall.	Riparian areas will be partly restored through debris removal, stabilizing streambanks and bank reconstruction. SVAP2=5.6 overall.	Riparian areas will continue to degrade into the near future. Stream will likely continue to move around the floodplain. SVAP2=2.7 overall.	
Scenic Beauty	Flood removed woody vegetation and left behind debris which has made the area less scenic.	Debris removal and bank work will help the area to revegetate to a more normal condition, improving scenic beauty	Debris will continue to harm the scenic beauty of the area.	
Wetlands	Riparian wetland areas are covered with debris and are subject to loss through bank erosion.	Debris removal and bank stabilization will restore some wetland function and prevent further loss from erosion.	Continued wetland losses from erosion and debris.	
Wild and Scenic Rivers	Not Applicable to Site	Not Applicable to Site	Not Applicable to Site	

Completed By: J. Tashiro   Date: 9/15/15

DSR NO: Boulder_South St Vrain_Reach 4b_2015_High

Section 2F Economic

This section must be completed by each alternative considered

Reach	Reach 4b
UTM Easting:	475914
UTM Northing:	4451051

		Future Damages ($)	Damage Factor (%)	Near Term Damage Reduction
	Properties Protected (Private)			
1.	Houses: 10	$2,000,000	75%	$1,500,000
2.	Town Of Lyons	$2,000,000	75%	$1,500,000
3.				$0
4.				$0
	Properties Protected (Public)			
1.	County Bridge	$500,000	75%	$375,000
2.	SH 7	$1,000,000	75%	$750,000
3.	Meill Street Bridge	$500,000	75%	$375,000
4.				$0
	Business Losses			
1.	Town of Lyons			$0
2.				$0
3.				$0
4.				$0
	Other			
1.				$0
2.				$0
3.				$0
4.				$0
5.				$0
	Total Near Term Damage Reduction			$4,500,000
	Net Benefit (Total Near Term Damage Reduction minus Cost from Section 3)			$2,090,901

Section 2G Social Considerations. This section must be completed by each alternative considered

	Yes	No	Remarks
Has there been a loss of life as a result of the watershed impairment?	☐	☑	
Is there the potential for loss of life due to damages from the watershed impairment?	☑	☐	
Has access to a hospital or medical facility been impaired by watershed impairment?	☐	☑	
Has the community as a whole been adversely impacted by the watershed impairment (life and property ceases to operate in a normal capacity)	☑	☐	
Is there a lack or has there been a reduction of public safety due to watershed impairment?	☑	☐	

Completed By: J. Tashiro Date: 9/14/15

DSR NO: Boulder_South St Vrain_Reach 4b_2015_High

Section 2H Group Representation and Disability Information

This section is completed only for the preferred alternative selected

Group Representation	Number
American Indian/Alaska Native Female Hispanic	
American Indian/Alaska Native Female Non-Hispanic	5
American Indian/Alaska Native Male Hispanic	
American Indian/Alaska Native Male Non-Hispanic	3
Asian Female Hispanic	
Asian Female Non-Hispanic	14
Asian Male Hispanic	
Asian Male Non-Hispanic	13
Black or African American Female Hispanic	5
Black or African American Female Non-Hispanic	
Black or African American Male Hispanic	4
Black or African American Male Non-Hispanic	
Hawaiian Native/Pacific Islander Female Hispanic	
Hawaiian Native/Pacific Islander Female Non-Hispanic	
Hawaiian Native/Pacific Islander Male Hispanic	
Hawaiian Native/Pacific Islander Male Non-Hispanic	
White Female Hispanic	449
White Female Non-Hispanic	817
White Male Hispanic	48
White Male Non-Hispanic	817
Total Group	2175

Census tract(s) 80130136.012

Completed By: Tboldt Date: 10/31/15

Section 2I. Required consultation or coordination between the lead agency and/or the RFO and another government unit including tribes:

Easements, permissions, or permits:

Need to work with the Army Corps of Engineers on appropriate 404 permit needed for the bank reconstruction and protection work. May be able to use Nationwide Permit #37 for this work. Boulder County permits.

Mitigation Description:

Agencies, persons, and references consulted, or to be consulted:

Army Corps of Engineers, SHPO, USFWS, CWCB, Boulder County, St Vrain Watershed Coalition.

DSR NO: Boulder_South St Vrain_Reach 4b_2015_High

Section 3 Engineering cost Estimate

Completed By: J. Tashiro   Date: 9/14/2015

This section must be completed by each alternative considered

Reach	Reach 4b
UTM Easting:	475914
UTM Northing:	4451051

	Proposed Recovery Measure (including mitigation)	Quantity	Units	Unit Cost ($)	Amount ($)
1.	Cross Vane	0	EA	$2,000	$0
2.	J-Hook Vane	0	EA	$2,000	$0
3.	Armored Resiliency	1362	LF	$300	$408,600
4.	In-Stream Structures	0	LF	$200	$0
5.	Bioengineering	0	LF	$35	$0
6.	Streambank Shaping	4932	LF	$175	$863,100
7.	Sediment Removal	11920	CY	$20	$238,400
8.	Fill	0	CY	$25	$0
9.	Debris Removal	267	CY	$20	$5,340
10.	Seeding & Mulching	1462980	FT2	$0	$146,298
11	Erosion Control Fabric	0	FT2	$7	$0
12	Trees & Shrubs	0	FT2	$1	$0
13	Topsoil	747361	FT2	$1	$747,361
14	Wetland Restoration	0	FT2	$25	$0
				Total Installation Cost (Enter in Section 1F)	**$2,409,099**

Section 4 NRCS EWP Funding Priority

Complete the following section to compute the funding priority for the recovery measures in this application (see instructions on page 14)

Priority Ranking Criteria(if more than one number applies enter the highest ranking number, 1 is the highest ranking with 4 being the lowest)		**Enter number selection (one number only) (1,2,3,or 4)**
1.	Is this an exigency situation?	**2**
2.	Is this a site where there is serious, but not immediate threat to human life?	
3.	Is this a site where buildings, utilities, or other important infrastructure components	
4.	Is this site a funding priority established by the NRCS Chief?	
The following are modifiers for the above criteria		**Modifier (enter all alpha characters (no commas) that apply, i.e., abf)**
a.	Will the proposed action or alternatives protect or conserve federally-listed threatened and endangered species or critical habitat?	**ae**
b.	Will the proposed action or alternatives protect or conserve cultural sites listed on the National Register of Historic Places?	
c.	Will the proposed action or alternatives protect or conserve prime or important farmland?	
d.	Will the proposed action or alternatives protect or conserve existing wetlands?	
e.	Will the proposed action or alternatives maintain or improve current water quality conditions?	
f.	Will the proposed action or alternatives protect or conserve unique habitat, including but not limited to, areas inhabited by State-listed species, fish and wildlife management area, or State identified sensitive habitats?	
	Priority Ranking Value	**2ae**

Enter priority computation in Section 1A, NRCS Entry, Funding priority number.

Remarks:

See Pages 3 and 4

Section 5A Findings

Findings: Indicate the preferred alternative from Section 2 (Enter to Section 1E):

Restore river to pre flood measures to withhold a 100 year event contingent upon completion of CR investigation and in compliance with requirements of F&WS emergency consultation and all applicable categorical exclusions.

I have considered the effects of the action and the alternatives on the Environmental Economic, Social; the Special Environmental Concerns; and the extraordinary circumstances (40 CFR 1508.27). I find for the reasons stated below, that the preferred alternative:

☑ Has been sufficiently analyzed in the EWP PEIS (reference all that apply)

Chapter 2.3.1
Chapter 2.3.2.1
Chapter 2.3.5.1
Chapter 5.2.2.1
Chapter 5.2.2.5

☐ May require the preparation of an environmental assessment or environmental impact statement.
The action will be referred to the NRCS State Office on this date: ____________

NRCS representative of the DSR team

Title: Todd Boldt, EWP SPC Date: 11/2/15

Section 5B Comments:

Section 5C **Sponsor Concurrence:** ____________________

Sponsor Representative

Title: ____________________ Date: ____________________

Section 6 Attachments:

A. Location Map
B. Site Plan or Sketches
C. Other (explain)

Preliminary Scope of Work

For: South St Vrain

EWP Phase 2 Project

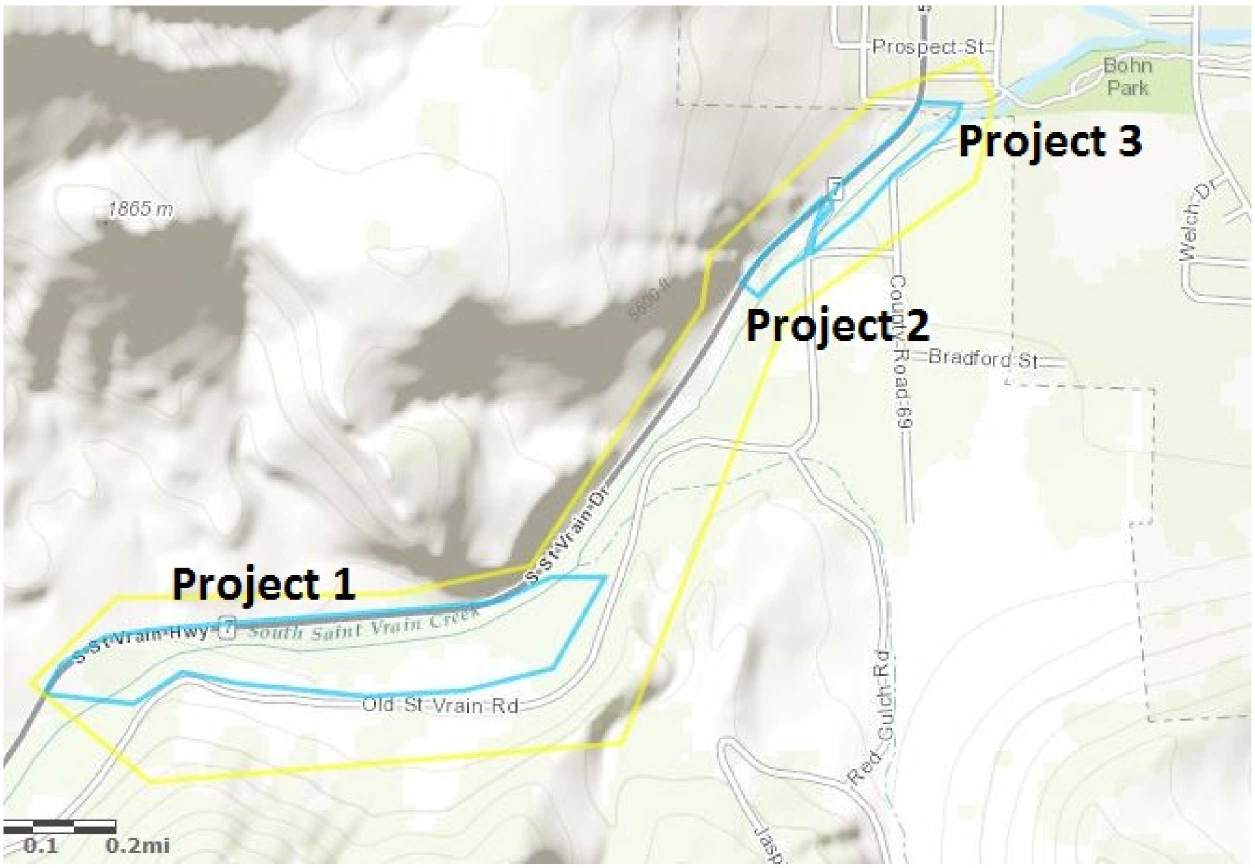
Revised: 10/31/2015; TDB

The following preliminary information was prepared to assist with completion of the Damage Survey Report. Information may be revised as more project information is obtained.

Project	**Fall River Estes Valley Coalition**
Existing Conditions	Flooding, stream bank erosion and sedimentation along South St Vrain affect residences, roads, and bridges. There are 3 project areas within this South St Vrain DSR: South St Vrain 1, South St Vrain 2, and South St Vrain 3 (Upstream to downstream).
Watershed	South St Vrain
Elevation Range (ft.)	7400-7100
Lat-Long	South St Vrain 1 Lat: 40.209522 Long: 105.283037 (from ArcGIS online) South St Vrain 2 Lat: 40.216767 Long: -105.275005 South St Vrain 3 Lat: 40.218529 Long: -105.272615
Stream Flow	Perennial
Aquatic Habitat	Average
Potential Habitat Uplift	Greatly
Proposed Work	All project areas have one or more of the following treatments: Sediment removal to establish a flood plain, bioengineering to stabilize stream banks, armored resiliency to stabilize stream banks, critical area treatment (CAT) including willow planting, seeding, mulching and top soiling. Refer to the attached maps and corresponding engineering cost estimate for details.
Project Boundary (Acres)	South St Vrain 1: 60 acres South St Vrain 2: 4 acres South St Vrain 3: 9.2 acres Total: 73.2 acres (sf)
Construction Equipment	Excavator and/or front end loader to place large rock toe boulders and logs and to remove sediment. Small bobcat to spread and incorporate topsoil. Hand labor to broadcast seed, spread mulch and plant willows.
Total Project Length (ft.)	6500

Drainage Area (mi²)	
Q_2 (cfs)	
Q_{100} (cfs)	
	Preliminary flow estimates from regression analysis, USGS, Stream Stats
Cost Estimate	$2,409,099

South St. Vrain: Overview Map



South St Vrain: ALL PROJECTS SUMMARY

DSR NO: Boulder_South St Vrain_Reach 4b_2015_High

Section 3 Engineering cost Estimate

Completed By: J. Tashiro Date: 9/14/2015

This section must be completed by each alternative considered

Reach	Reach 4b
UTM Easting:	475914
UTM Northing:	4451051

	Proposed Recovery Measure (including mitigation)	Quantity	Units	Unit Cost ($)	Amount ($)
1.	Cross Vane	0	EA	$2,000	$0
2.	J-Hook Vane	0	EA	$2,000	$0
3.	Armored Resiliency	1362	LF	$300	$408,600
4.	In-Stream Structures	0	LF	$200	$0
5.	Bioengineering	0	LF	$35	$0
6.	Streambank Shaping	4932	LF	$175	$863,100
7.	Sediment Removal	11920	CY	$20	$238,400
8.	Fill	0	CY	$25	$0
9.	Debris Removal	267	CY	$20	$5,340
10.	Seeding & Mulching	1462980	FT2	$0	$146,298
11	Erosion Control Fabric	0	FT2	$7	$0
12	Trees & Shrubs	0	FT2	$1	$0
13	Topsoil	747361	FT2	$1	$747,361
14	Wetland Restoration	0	FT2	$25	$0
				Total Installation Cost (Enter in Section 1F)	**$2,409,099**

Project: South St Vrain 1

DSR NO: Boulder_South St Vrain_Reach 4b_2015_High

Section 3 Engineering cost Estimate

Completed By: J. Tashiro Date: 9/14/2015

This section must be completed by each alternative considered

Project 1 Name:	South St Vrain 1
UTM Easting:	475914
UTM Northing:	4451051

	Proposed Recovery Measure (including mitigation)	Quantity	Units	Unit Cost ($)	Amount ($)
1.	Cross Vane	0	EA	$2,000	$0
2.	J-Hook Vane	0	EA	$2,000	$0
3.	Armored Resiliency	300	LF	$300	$90,000
4.	In-Stream Structures	0	LF	$200	$0
5.	Bioengineering	0	LF	$35	$0
6.	Streambank Shaping	3440	LF	$175	$602,000
7.	Sediment Removal	7082	CY	$20	$141,640
8.	Fill	0	CY	$25	$0
9.	Debris Removal	0	CY	$20	$0
10.	Seeding & Mulching	1322880	FT2	$0	$132,288
11.	Erosion Control Fabric	0	FT2	$7	$0
12.	Trees & Shrubs	0	FT2	$1	$0
13.	Topsoil	607261	FT2	$1	$607,261
14.	Wetland Restoration	0	FT2	$25	$0
	Total Installation Cost (Enter in Section 1F)				**$1,573,189**

Project: South St Vrain 2

DSR NO: Boulder_South St Vrain_Reach 4b_2015_High

Section 3 Engineering cost Estimate

Completed By: J. Tashiro　　　　Date: 9/14/2015

This section must be completed by each alternative considered

Project 2 Name:	South St Vrain 2
UTM Easting:	476600
UTM Northing:	4451853

	Proposed Recovery Measure (including mitigation)	Quantity	Units	Unit Cost ($)	Amount ($)
1.	Cross Vane	0	EA	$2,000	$0
2.	J-Hook Vane	0	EA	$2,000	$0
3.	Armored Resiliency	0	LF	$300	$0
4.	In-Stream Structures	0	LF	$200	$0
5.	Bioengineering	0	LF	$35	$0
6.	Streambank Shaping	430	LF	$175	$75,250
7.	Sediment Removal	1129	CY	$20	$22,580
8.	Fill	0	CY	$25	$0
9.	Debris Removal	0	CY	$20	$0
10.	Seeding & Mulching	58000	FT2	$0	$5,800
11.	Erosion Control Fabric	0	FT2	$7	$0
12.	Trees & Shrubs	0	FT2	$1	$0
13.	Topsoil	58000	FT2	$1	$58,000
14.	Wetland Restoration	0	FT2	$25	$0
				Total Installation Cost (Enter in Section 1F)	**$161,630**

Project: South St Vrain 3

DSR NO: Boulder_South St Vrain_Reach 4b_2015_High

Section 3 Engineering Cost Estimate

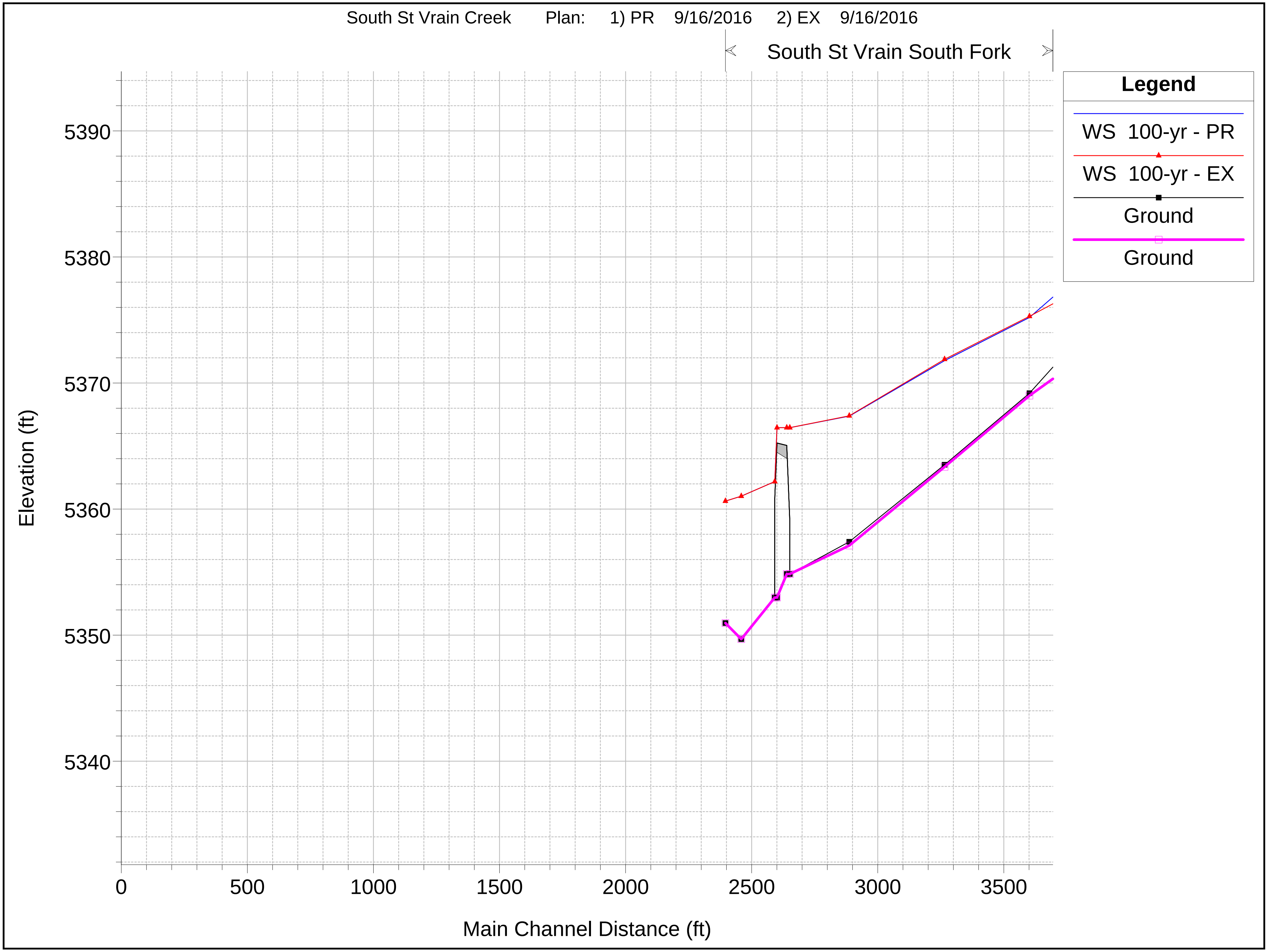
Completed By: J. Tashiro Date: 9/14/2015

This section must be completed by each alternative considered

Project 3 Name:	South St Vrain 3
UTM Easting:	476804
UTM Northing:	4452048

	Proposed Recovery Measure (including mitigation)	Quantity	Units	Unit Cost ($)	Amount ($)
1.	Cross Vane	0	EA	$2,000	$0
2.	J-Hook Vane	0	EA	$2,000	$0
3.	Armored Resiliency	1062	LF	$300	$318,600
4.	In-Stream Structures	0	LF	$200	$0
5.	Bioengineering	0	LF	$35	$0
6.	Streambank Shaping	1062	LF	$175	$185,850
7.	Sediment Removal	3709	CY	$20	$74,180
8.	Fill	0	CY	$25	$0
9.	Debris Removal	267	CY	$20	$5,340
10.	Seeding & Mulching	82100	FT2	$0	$8,210
11.	Erosion Control Fabric	0	FT2	$7	$0
12.	Trees & Shrubs	0	FT2	$1	$0
13.	Topsoil	82100	FT2	$1	$82,100
14.	Wetland Restoration	0	FT2	$25	$0
				Total Installation Cost (Enter in Section 1F)	**$674,280**

d. Appendix D - HEC-RAS Hydraulic Model Output and Floodplain Work Map



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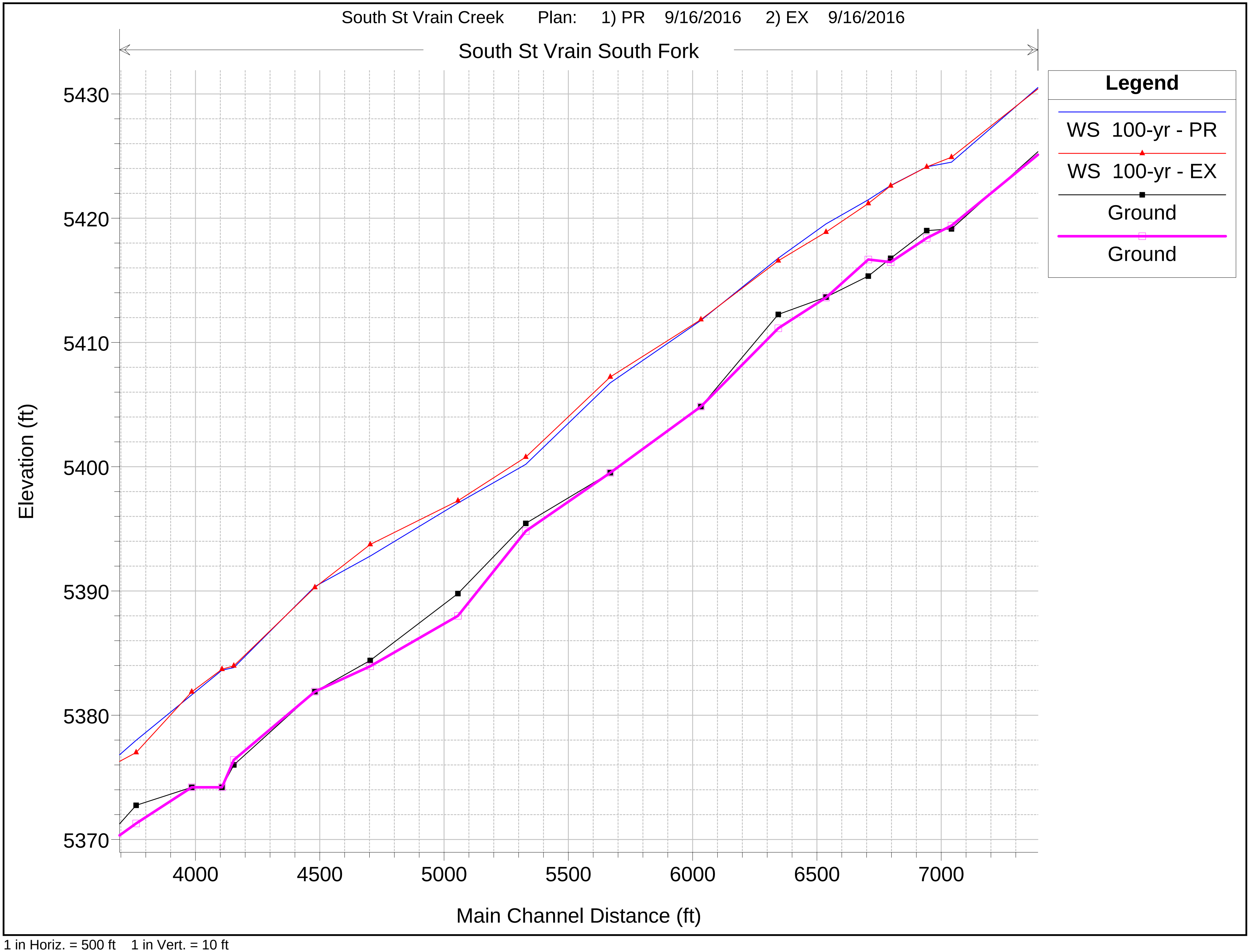
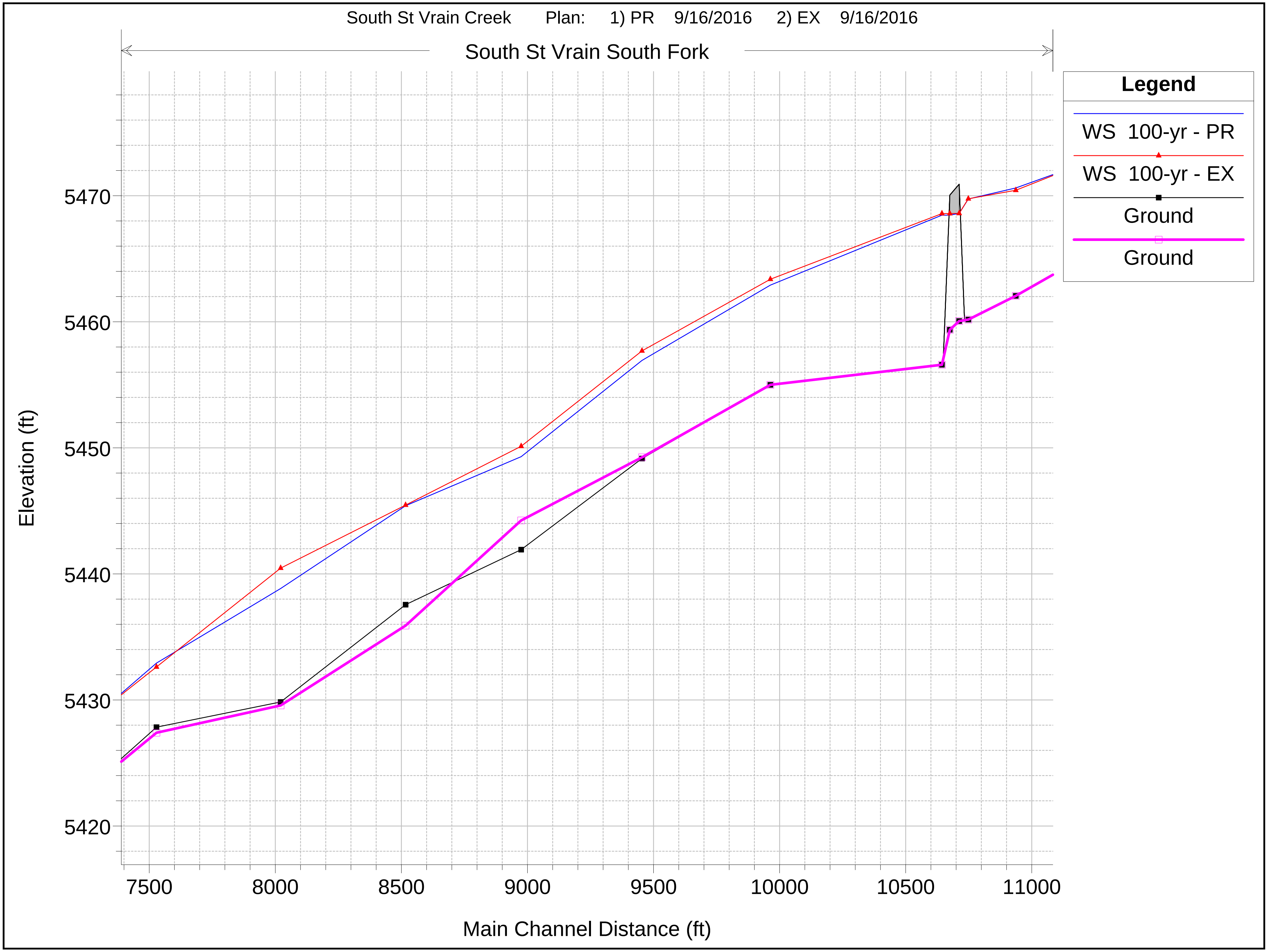
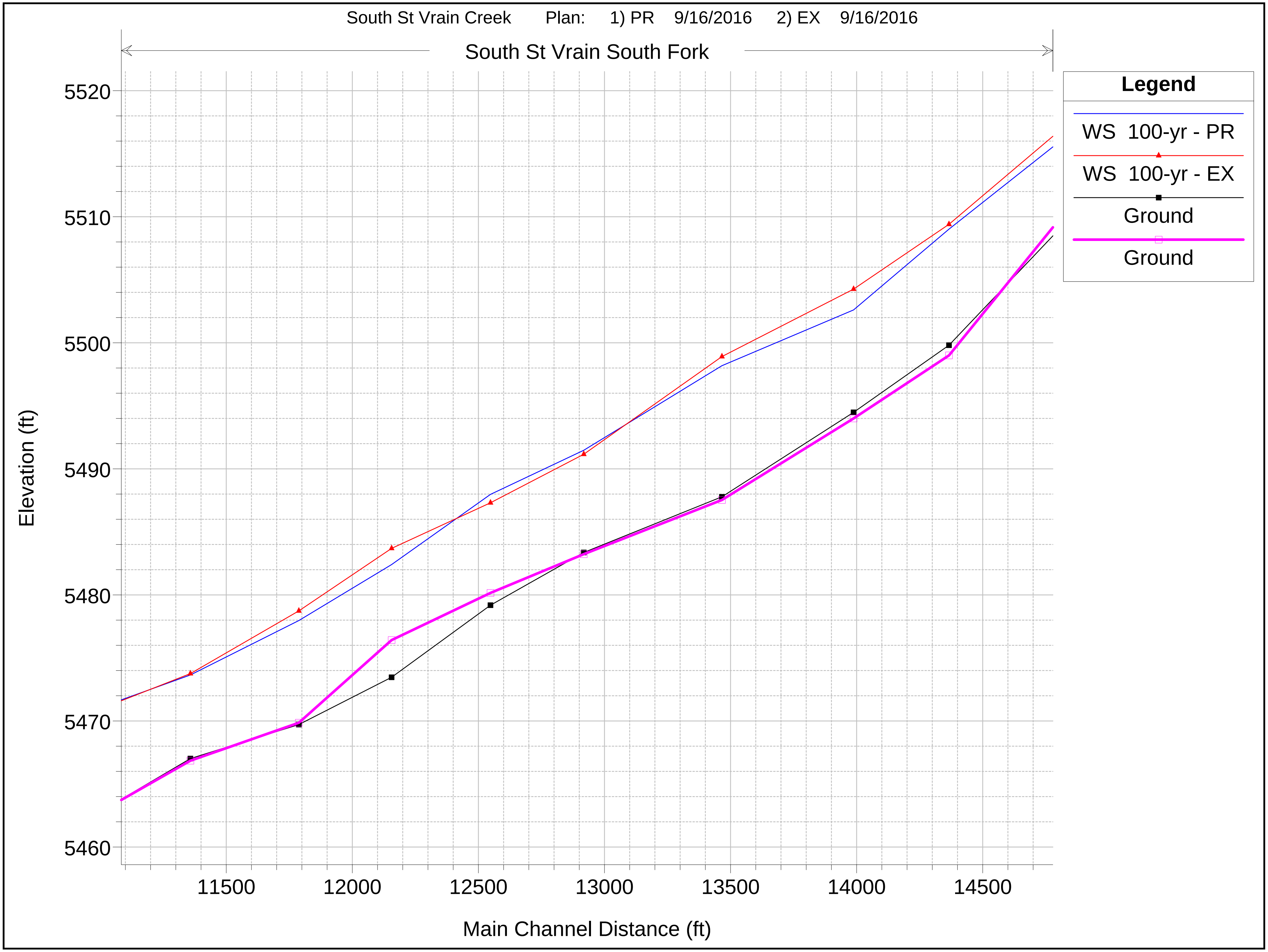

South St Vrain Creek Plan: 1) PR 9/16/2016 2) EX 9/16/2016
South St Vrain South Fork
Legend
WS 100-yr - PR
WS 100-yr - EX
Ground
Ground
Elevation (ft)
5430
5420
5410
5400
5390
5380
5370
4000
4500
5000
5500
6000
6500
7000
Main Channel Distance (ft)
1 in Horiz. = 500 ft 1 in Vert. = 10 ft

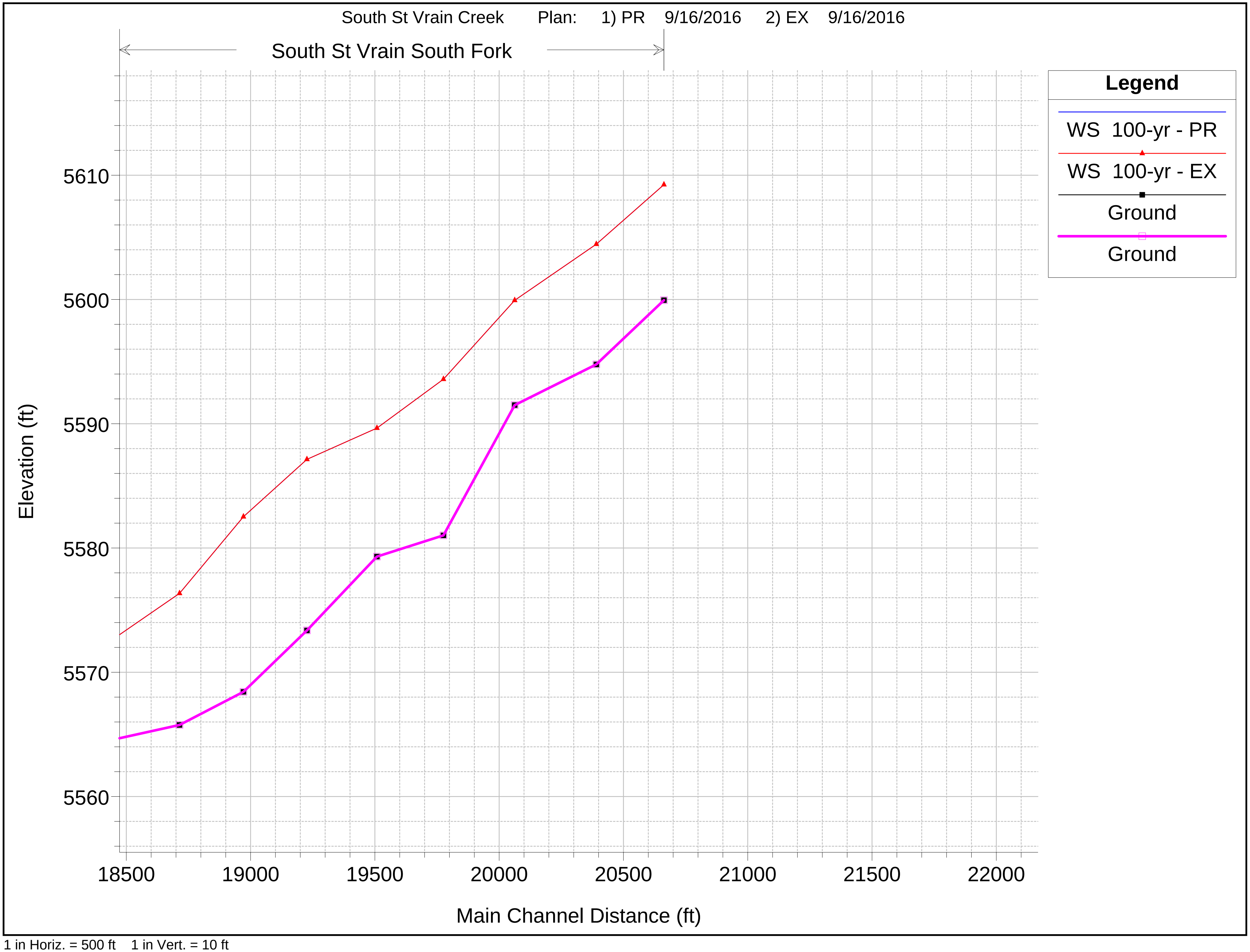


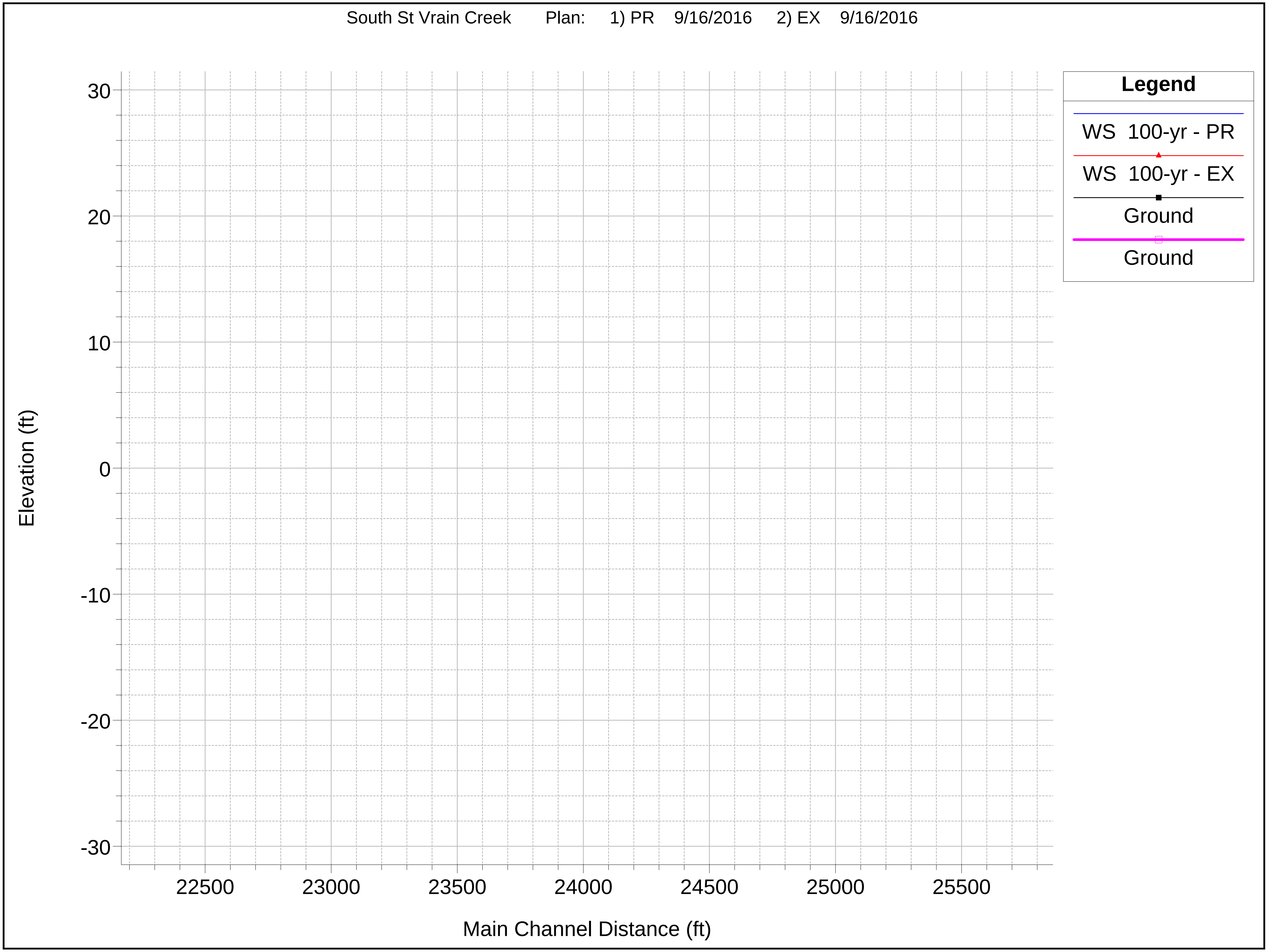
1 in Horiz. = 500 ft 1 in Vert. = 10 ft



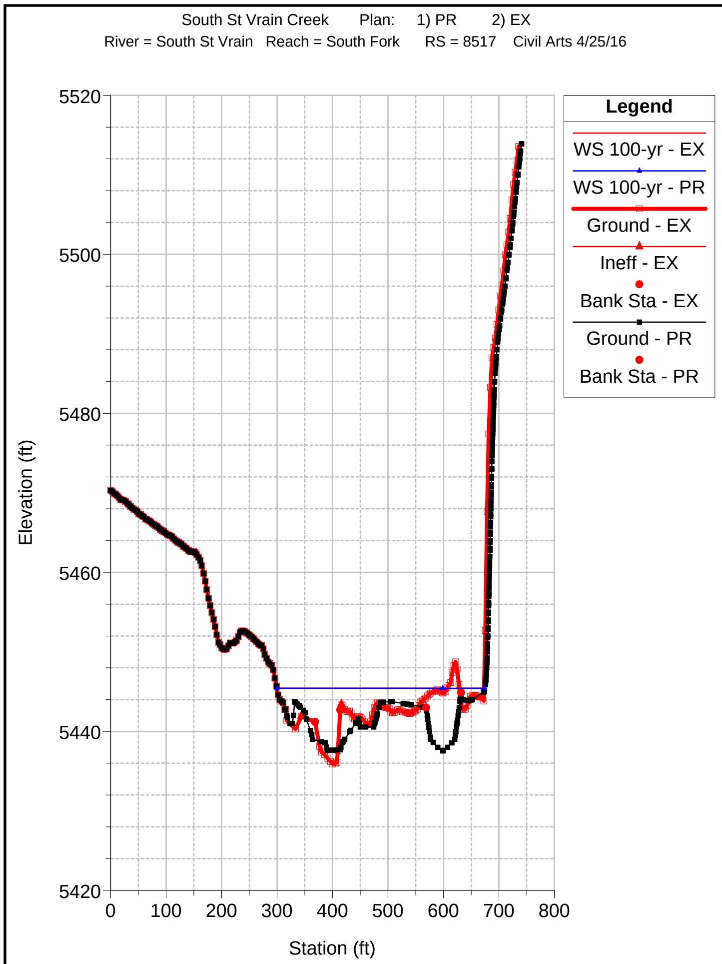
1 in Horiz. = 500 ft 1 in Vert. = 10 ft

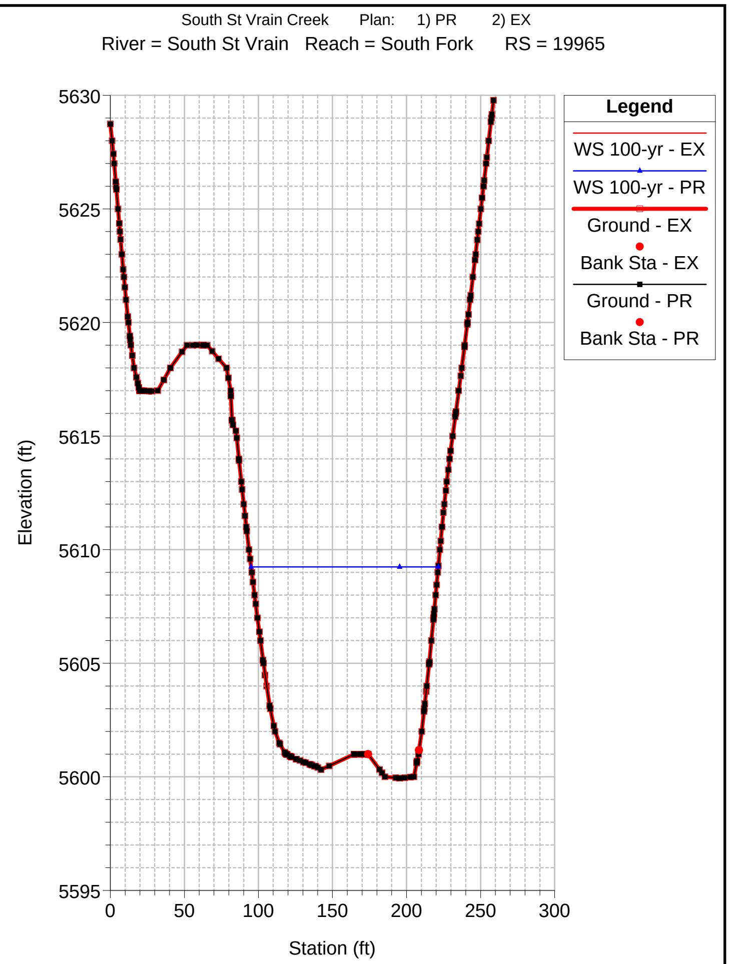
1 in Horiz. = 500 ft 1 in Vert. = 10 ft


South St Vrain Creek Plan: 1) PR 9/16/2016 2) EX 9/16/2016
South St Vrain South Fork
Legend
WS 100-yr - PR
WS 100-yr - EX
Ground
Ground
Elevation (ft)
5560
5570
5580
5590
5600
5610
18500
19000
19500
20000
20500
21000
21500
22000
Main Channel Distance (ft)
1 in Horiz. = 500 ft 1 in Vert. = 10 ft



1 in Horiz. = 500 ft 1 in Vert. = 10 ft


South St Vrain Creek Plan: 1) PR 2) EX
River = South St Vrain Reach = South Fork RS = 8517 Civil Arts 4/25/16
Legend
WS 100-yr - EX
WS 100-yr - PR
Ground - EX
Ineff - EX
Bank Sta - EX
Ground - PR
Bank Sta - PR
Elevation (ft)
Station (ft)
5520
5500
5480
5460
5440
5420
0
100
200
300
400
500
600
700
800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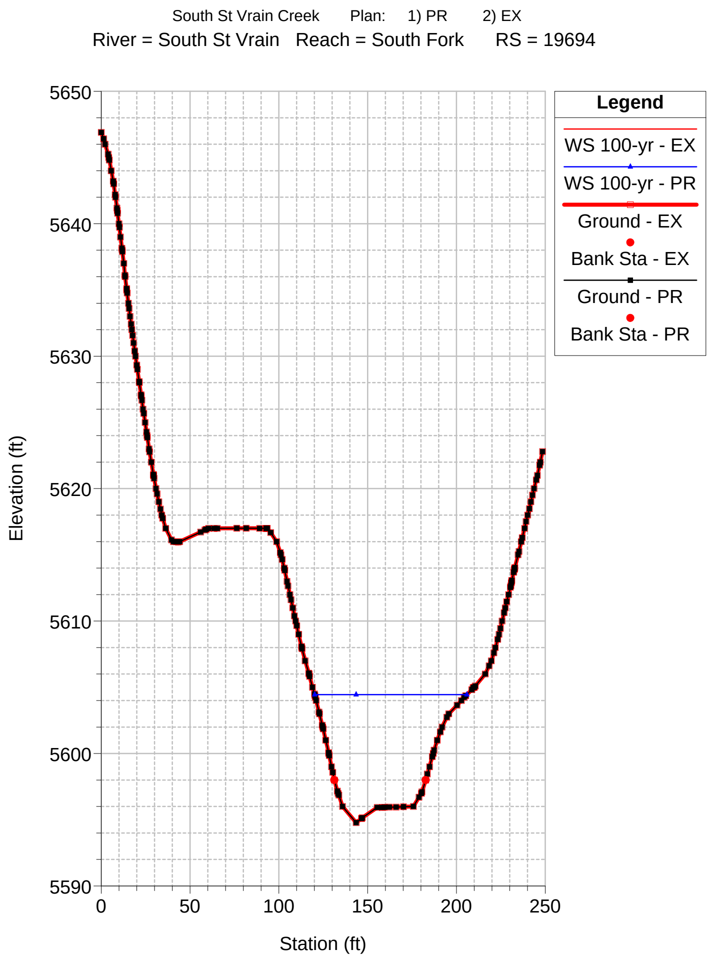
River = South St Vrain Reach = South Fork RS = 19965
Legend
WS 100-yr - EX
WS 100-yr - PR
Ground - EX
Bank Sta - EX
Ground - PR
Bank Sta - PR
Elevation (ft)
Station (ft)
5630
5625
5620
5615
5610
5605
5600
5595
0
50
100
150
200
250
300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Legend
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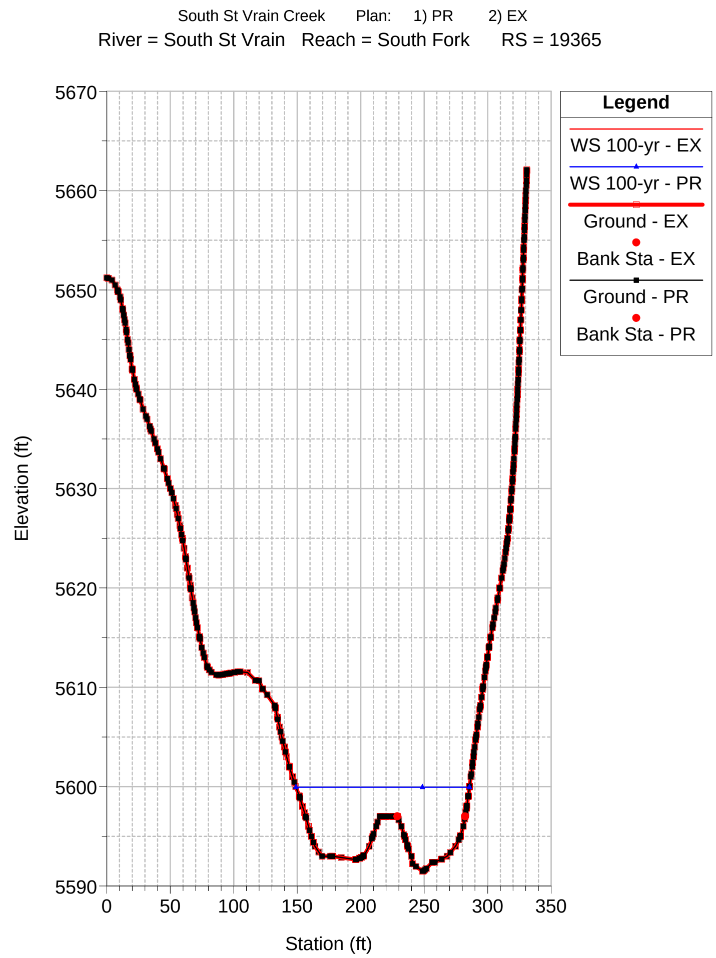
WS 100-yr - PR
Ground - EX
Bank Sta - EX
Ground - PR
Bank Sta - PR
Elevation (ft)
Station (ft)
5650
5640
5630
5620
5610
5600
5590
0
50
100
150
200
250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River = South St Vrain Reach = South Fork RS = 19365
Legend
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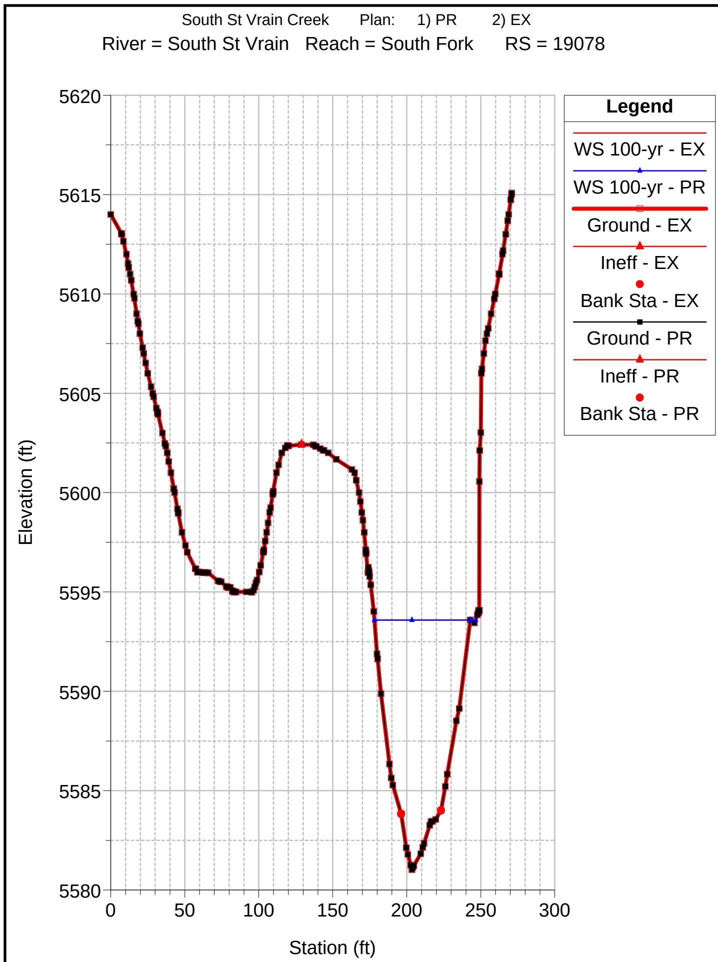
WS 100-yr - PR
Ground - EX
Bank Sta - EX
Ground - PR
Bank Sta - PR
Elevation (ft)
Station (ft)
5670
5660
5650
5640
5630
5620
5610
5600
5590
0
50
100
150
200
250
300
350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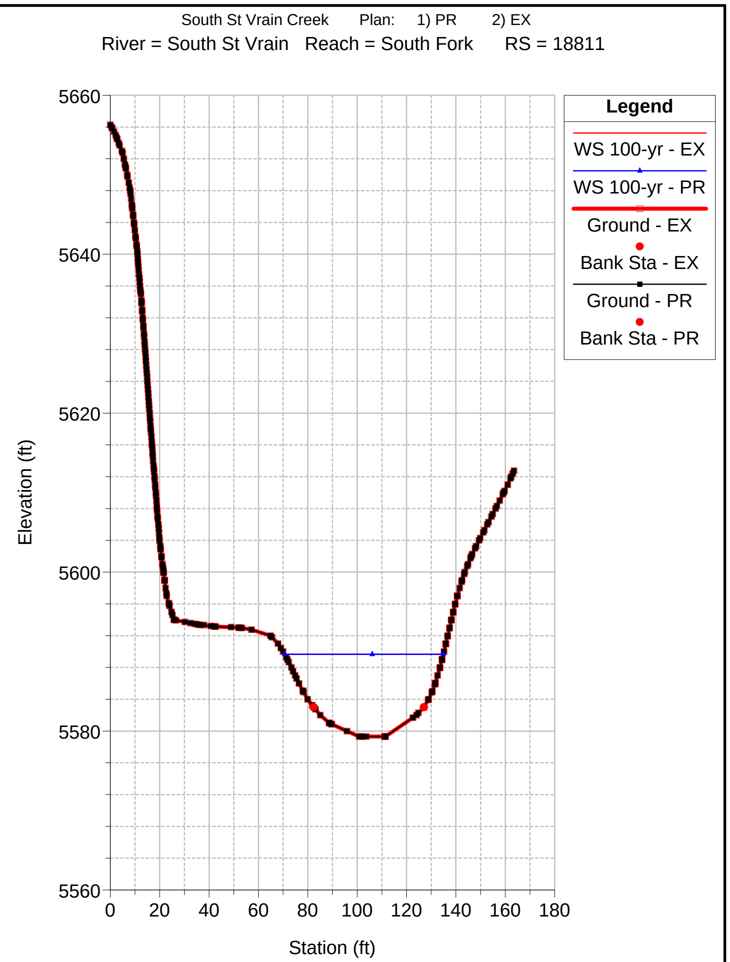
River = South St Vrain Reach = South Fork RS = 19078
Legend
WS 100-yr - EX
WS 100-yr - PR
Ground - EX
Ineff - EX
Bank Sta - EX
Ground - PR
Ineff - PR
Bank Sta - PR
Elevation (ft)
Station (ft)
5620
5615
5610
5605
5600
5595
5590
5585
5580
0
50
100
150
200
250
300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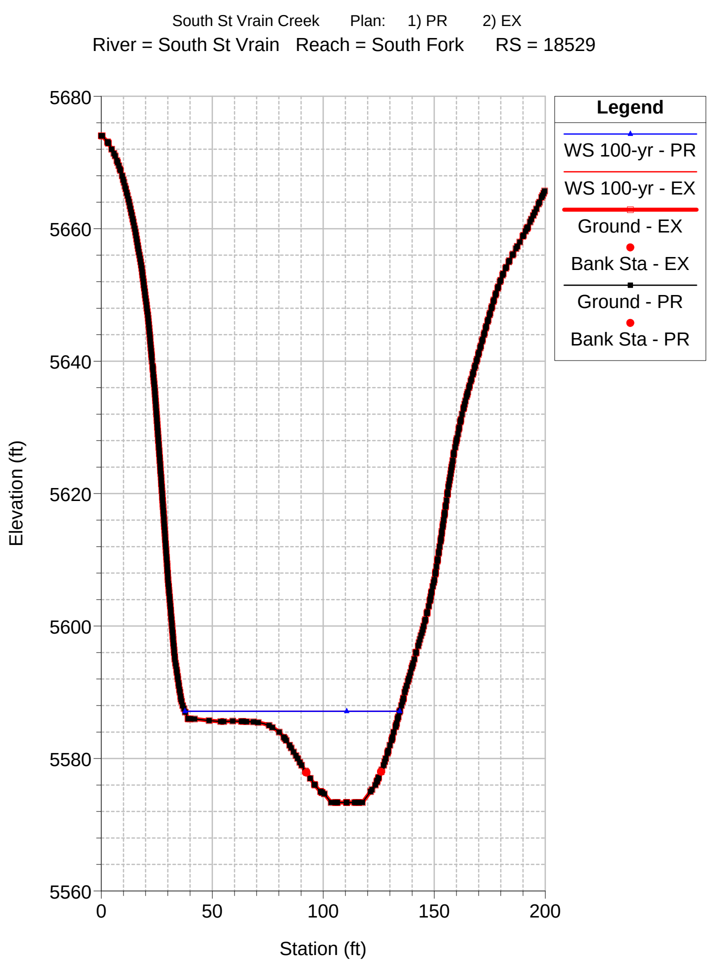
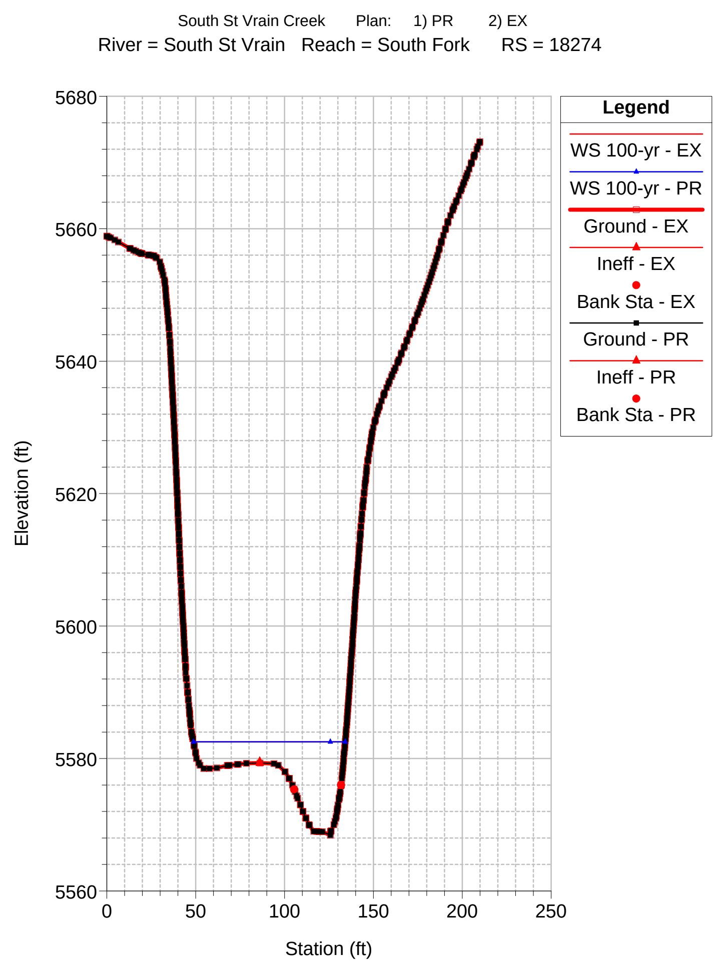
River = South St Vrain Reach = South Fork RS = 18811
Legend
WS 100-yr - EX
WS 100-yr - PR
Ground - EX
Bank Sta - EX
Ground - PR
Bank Sta - PR
Elevation (ft)
Station (ft)
5660
5640
5620
5600
5580
5560
0
20
40
60
80
100
120
140
160
180


South St Vrain Creek Plan: 1) PR 2) EX
River = South St Vrain Reach = South Fork RS = 18529
Legend
WS 100-yr - PR
WS 100-yr - EX
Ground - EX
Bank Sta - EX
Ground - PR
Bank Sta - PR
Elevation (ft)
Station (ft)
5680
5660
5640
5620
5600
5580
5560
0
50
100
150
200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Legend
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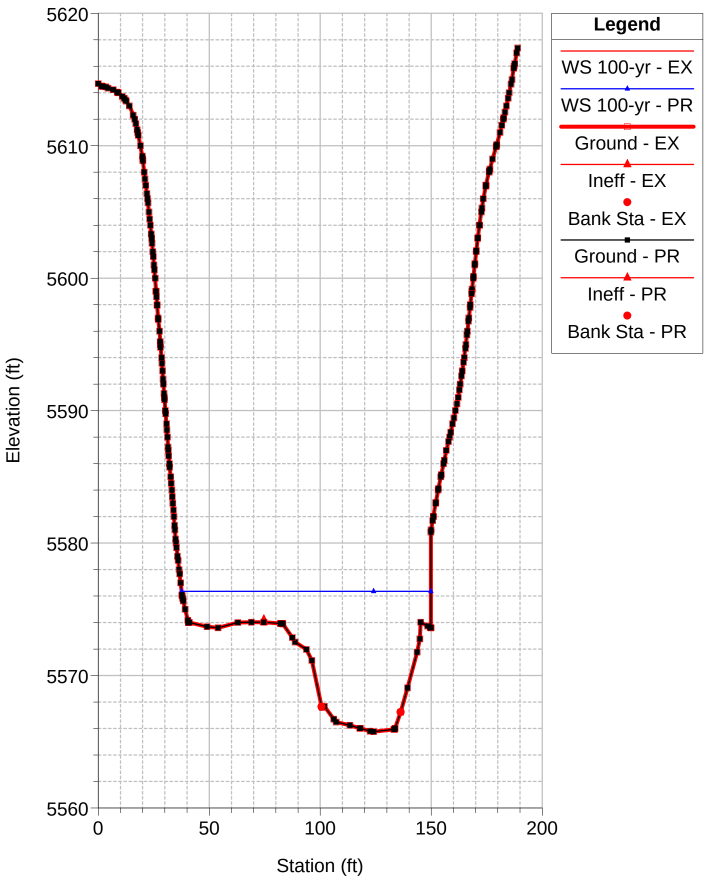
WS 100-yr - PR
Ground - EX
Ineff - EX
Bank Sta - EX
Ground - PR
Ineff - PR
Bank Sta - PR
Elevation (ft)
Station (ft)
5680
5660
5640
5620
5600
5580
5560
0
50
100
150
200
250

South St Vrain Creek Plan: 1) PR 2) EX
River = South St Vrain Reach = South Fork RS = 18017



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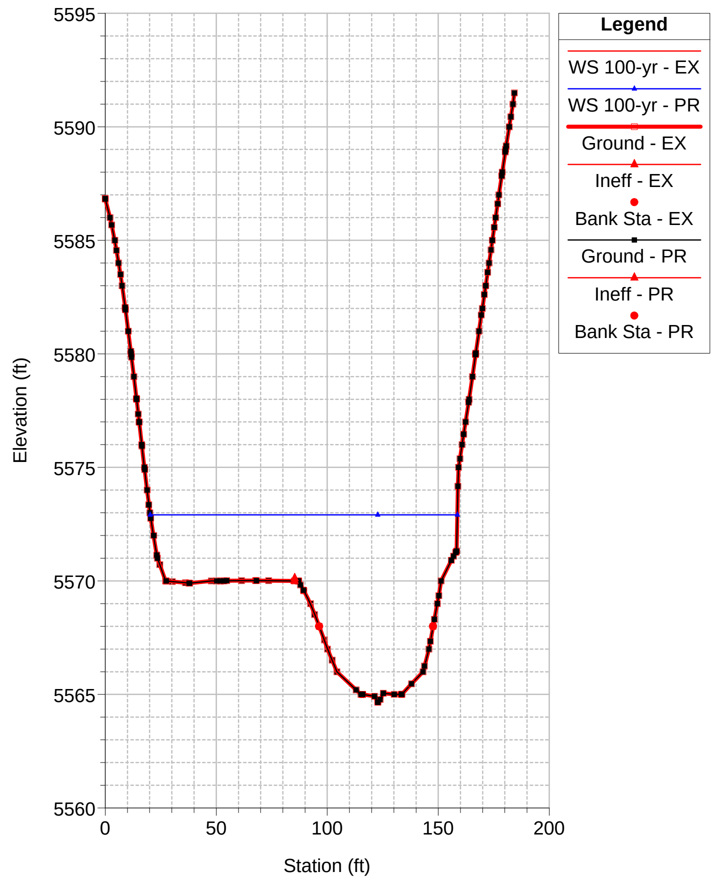

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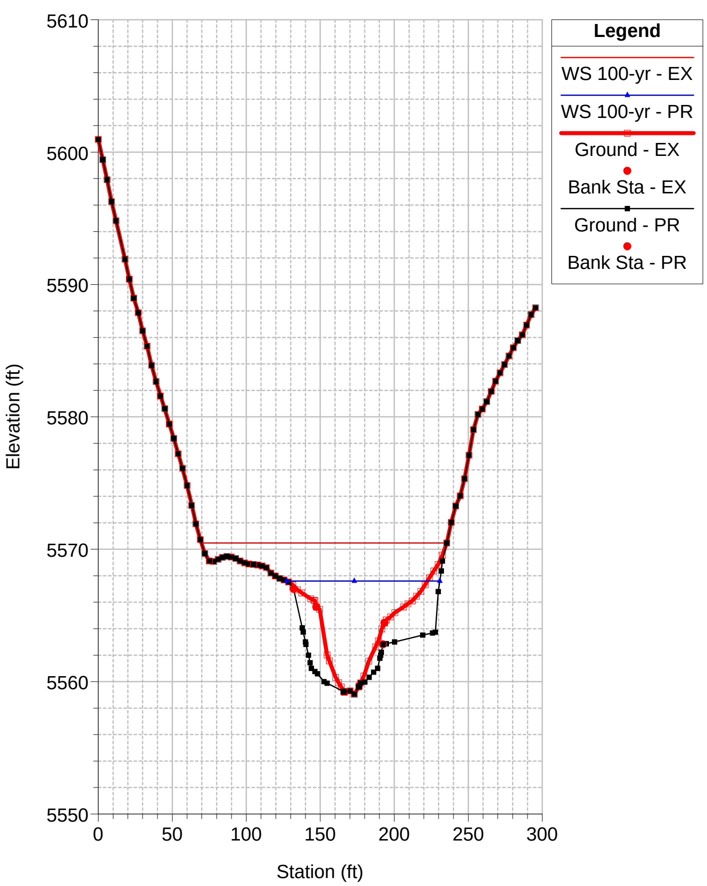

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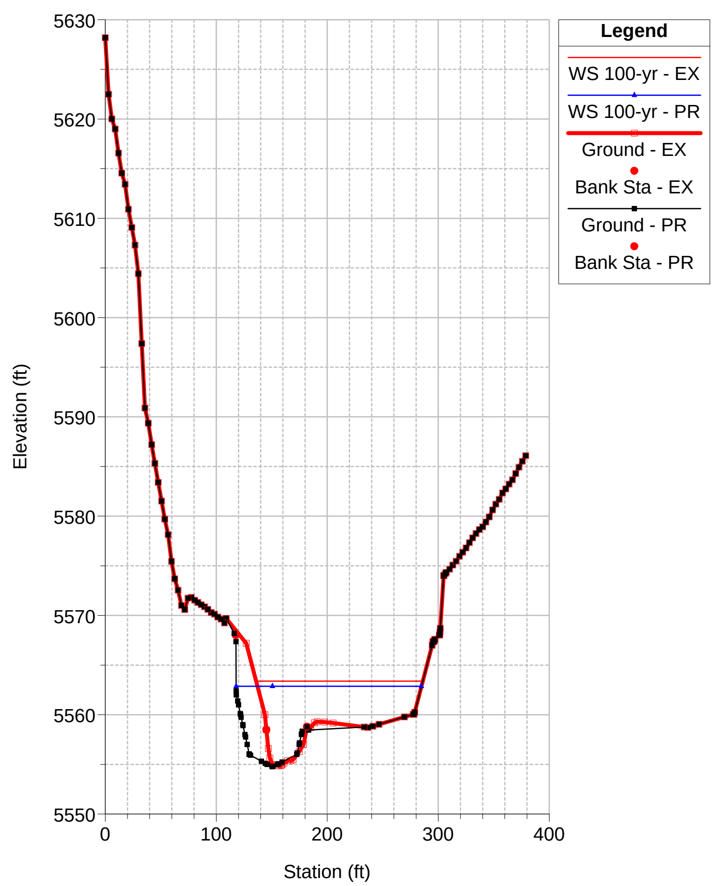

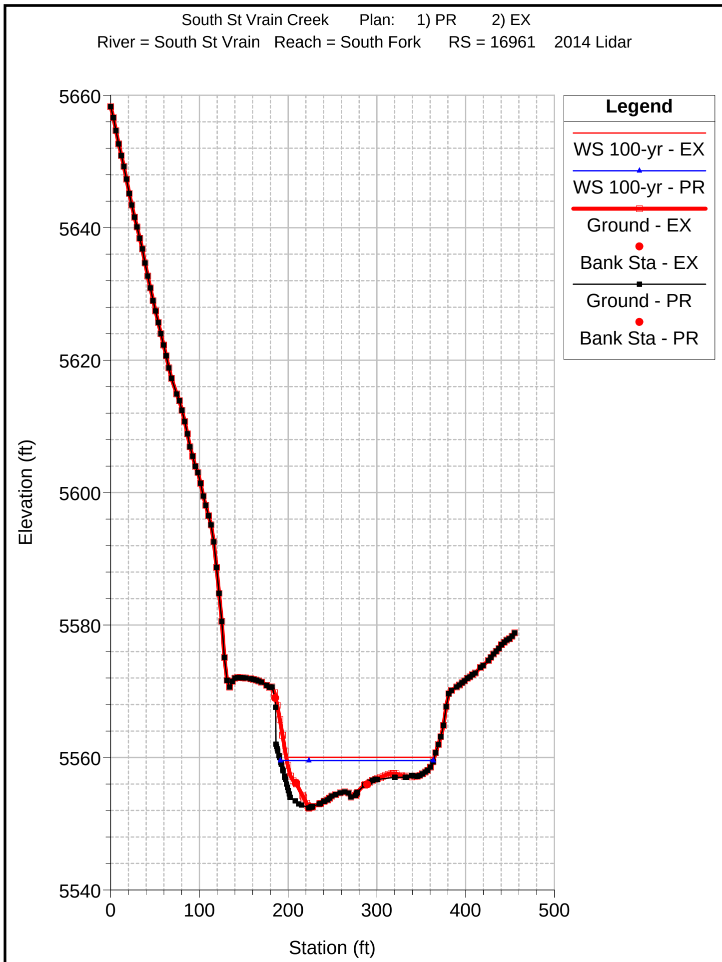
South St Vrain Creek Plan: 1) PR 2) EX
River = South St Vrain Reach = South Fork RS = 16961 2014 Lidar
Legend
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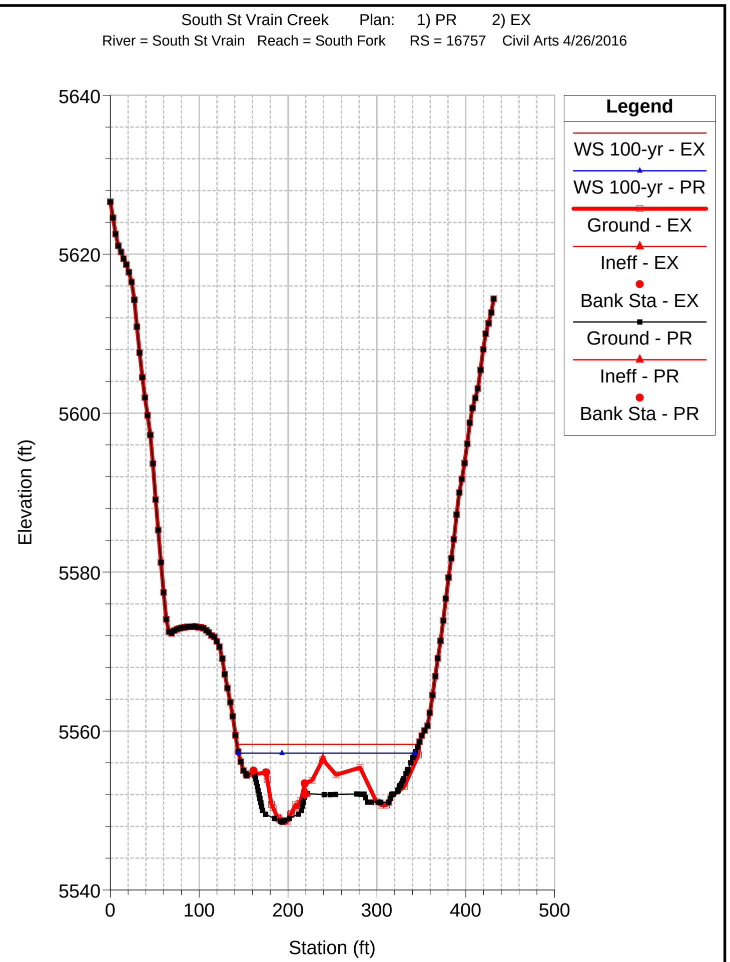
WS 100-yr - PR
Ground - EX
Bank Sta - EX
Ground - PR
Bank Sta - PR
Elevation (ft)
Station (ft)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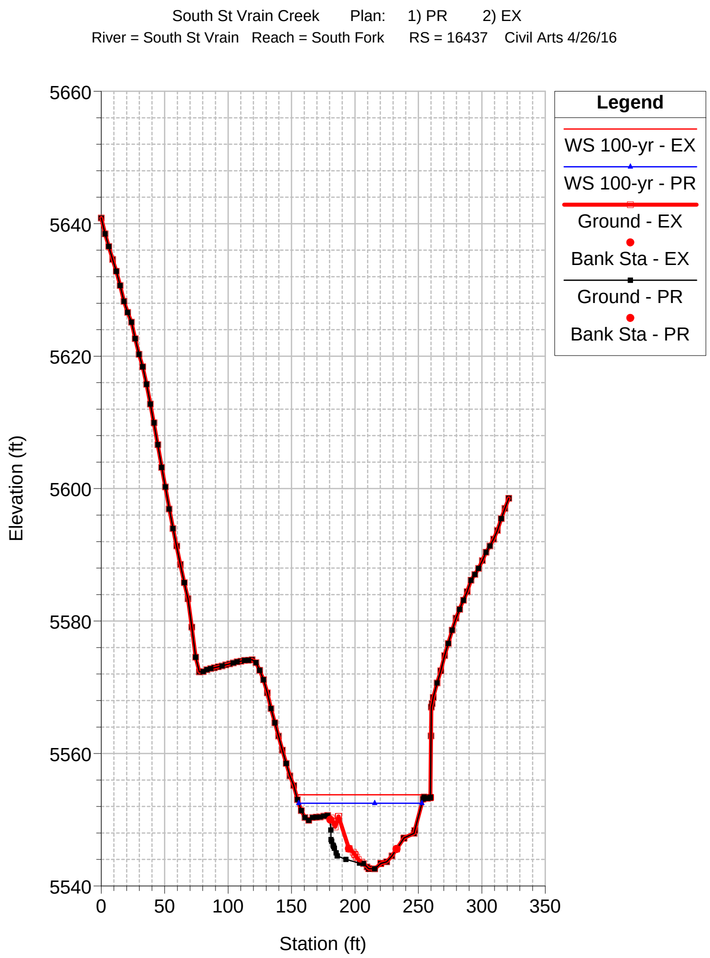
Legend
WS 100-yr - EX
WS 100-yr - PR
Ground - EX
Ineff - EX
Bank Sta - EX
Ground - PR
Ineff - PR
Bank Sta - PR
Elevation (ft)
Station (ft)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Legend
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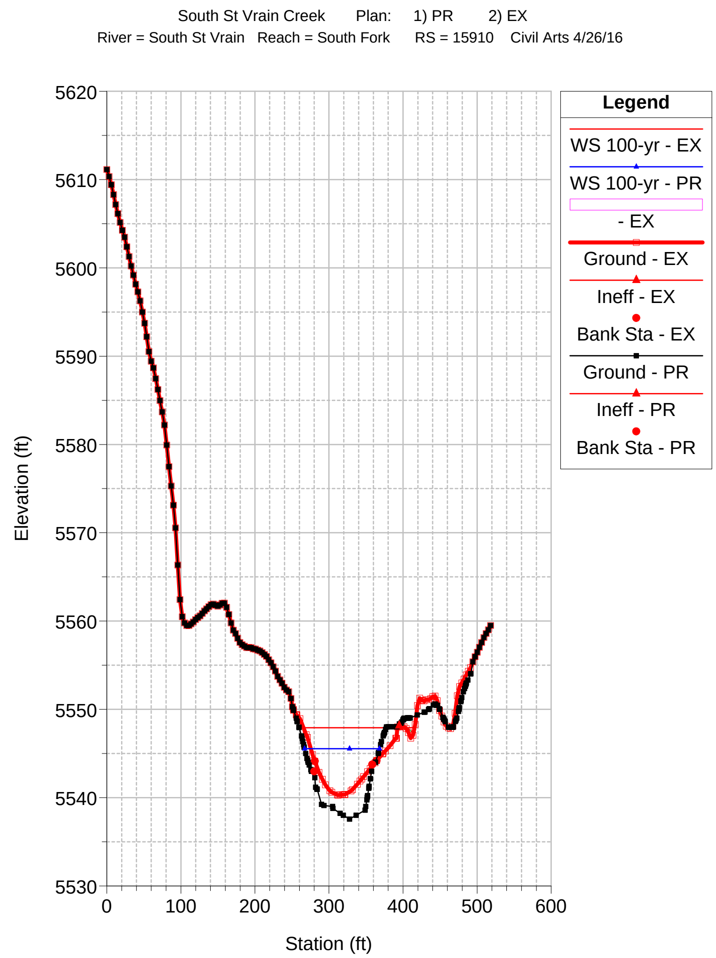
WS 100-yr - PR
Ground - EX
Bank Sta - EX
Ground - PR
Bank Sta - PR
Elevation (ft)
Station (ft)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Legend
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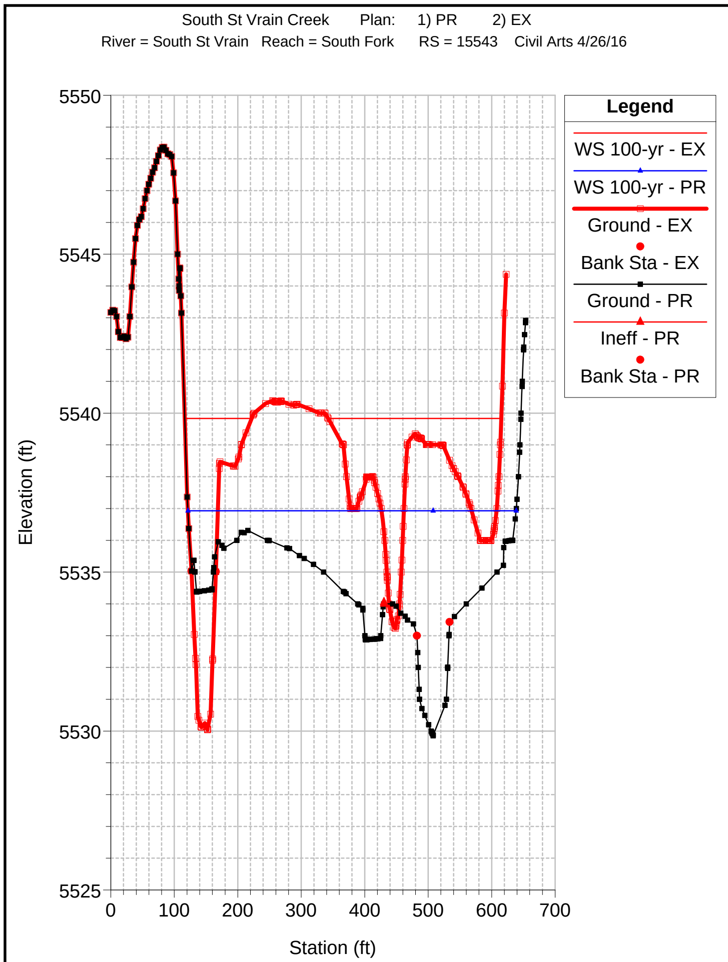
WS 100-yr - PR
- EX
Ground - EX
Ineff - EX
Bank Sta - EX
Ground - PR
Ineff - PR
Bank Sta - PR
Elevation (ft)
Station (ft)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River = South St Vrain Reach = South Fork RS = 15543 Civil Arts 4/26/16
Legend
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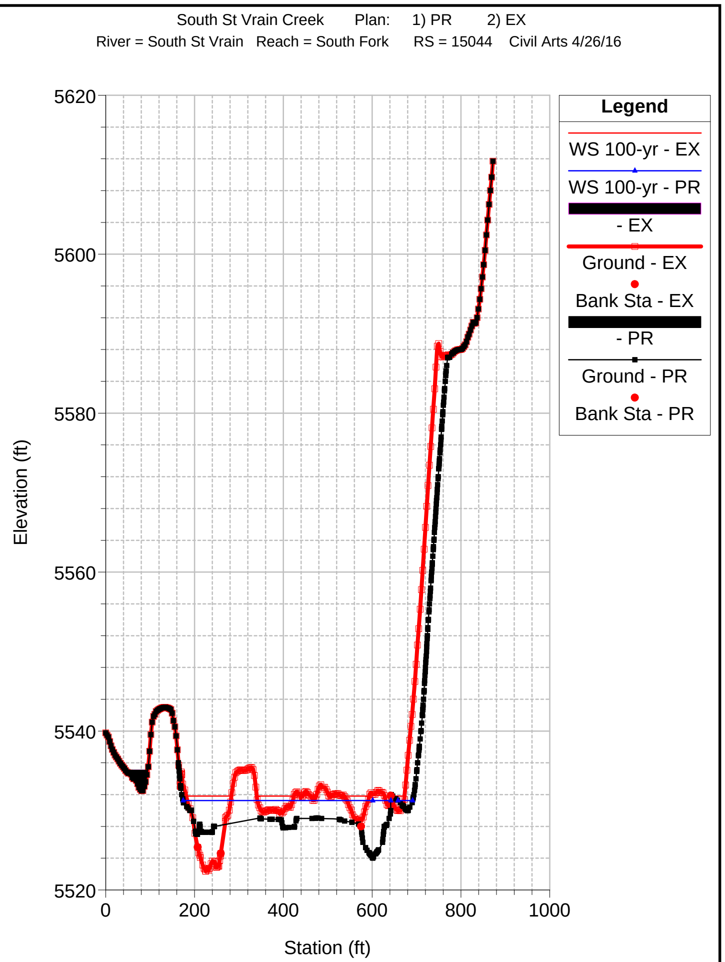
WS 100-yr - PR
Ground - EX
Bank Sta - EX
Ground - PR
Ineff - PR
Bank Sta - PR
Elevation (ft)
Station (ft)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Legend
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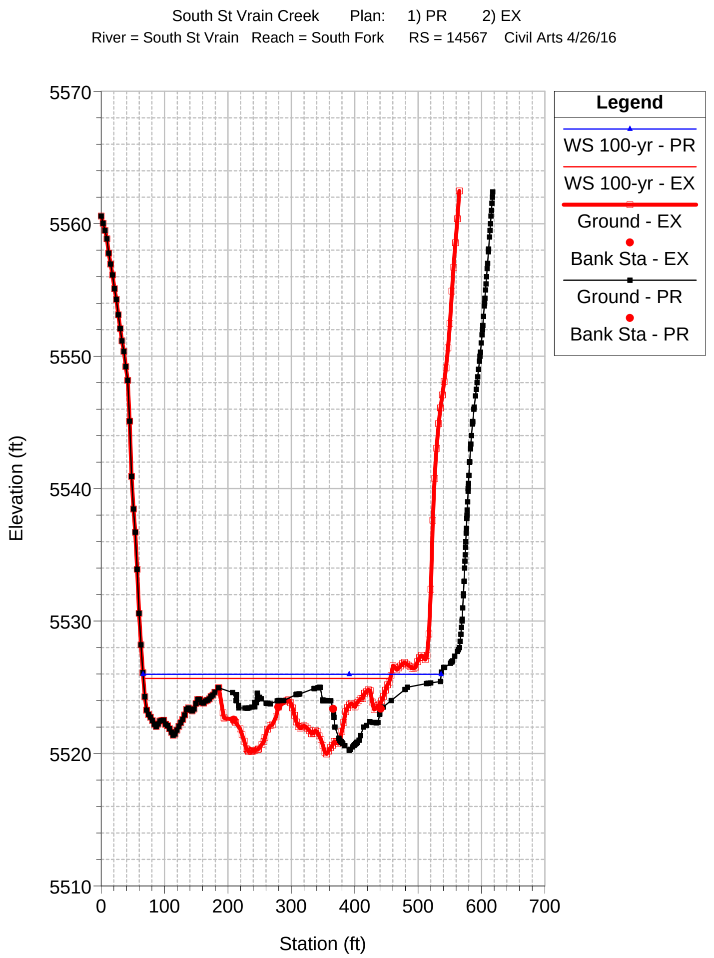
WS 100-yr - PR
- EX
Ground - EX
Bank Sta - EX
- PR
Ground - PR
Bank Sta - PR
Elevation (ft)
Station (ft)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River = South St Vrain Reach = South Fork RS = 14567 Civil Arts 4/26/16
Legend
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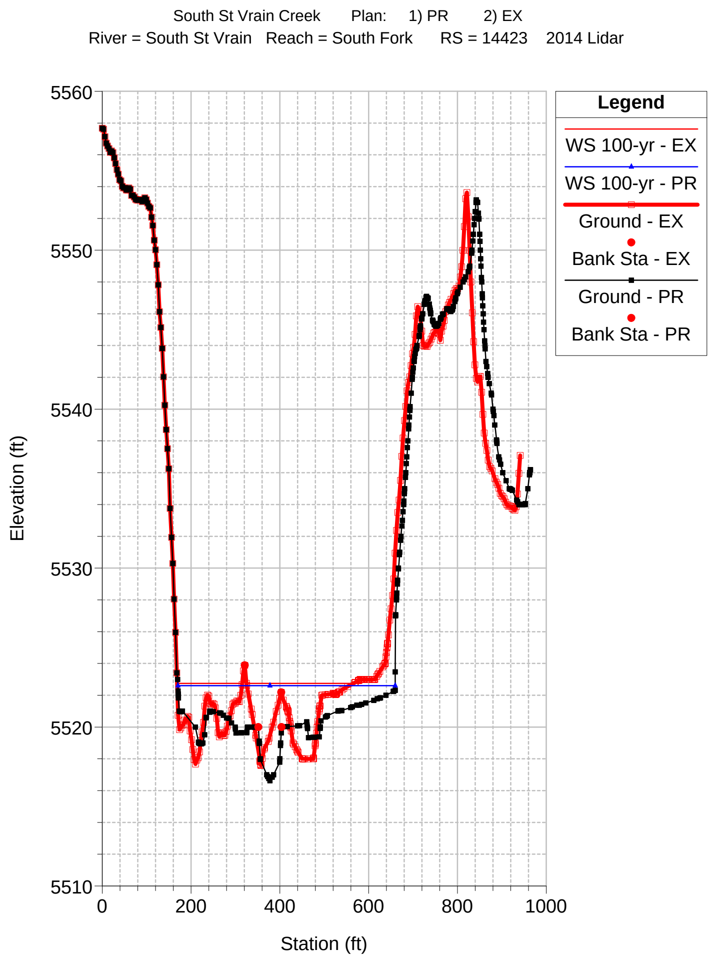
WS 100-yr - EX
Ground - EX
Bank Sta - EX
Ground - PR
Bank Sta - PR
Elevation (ft)
Station (ft)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River = South St Vrain Reach = South Fork RS = 14423 2014 Lidar
Legend
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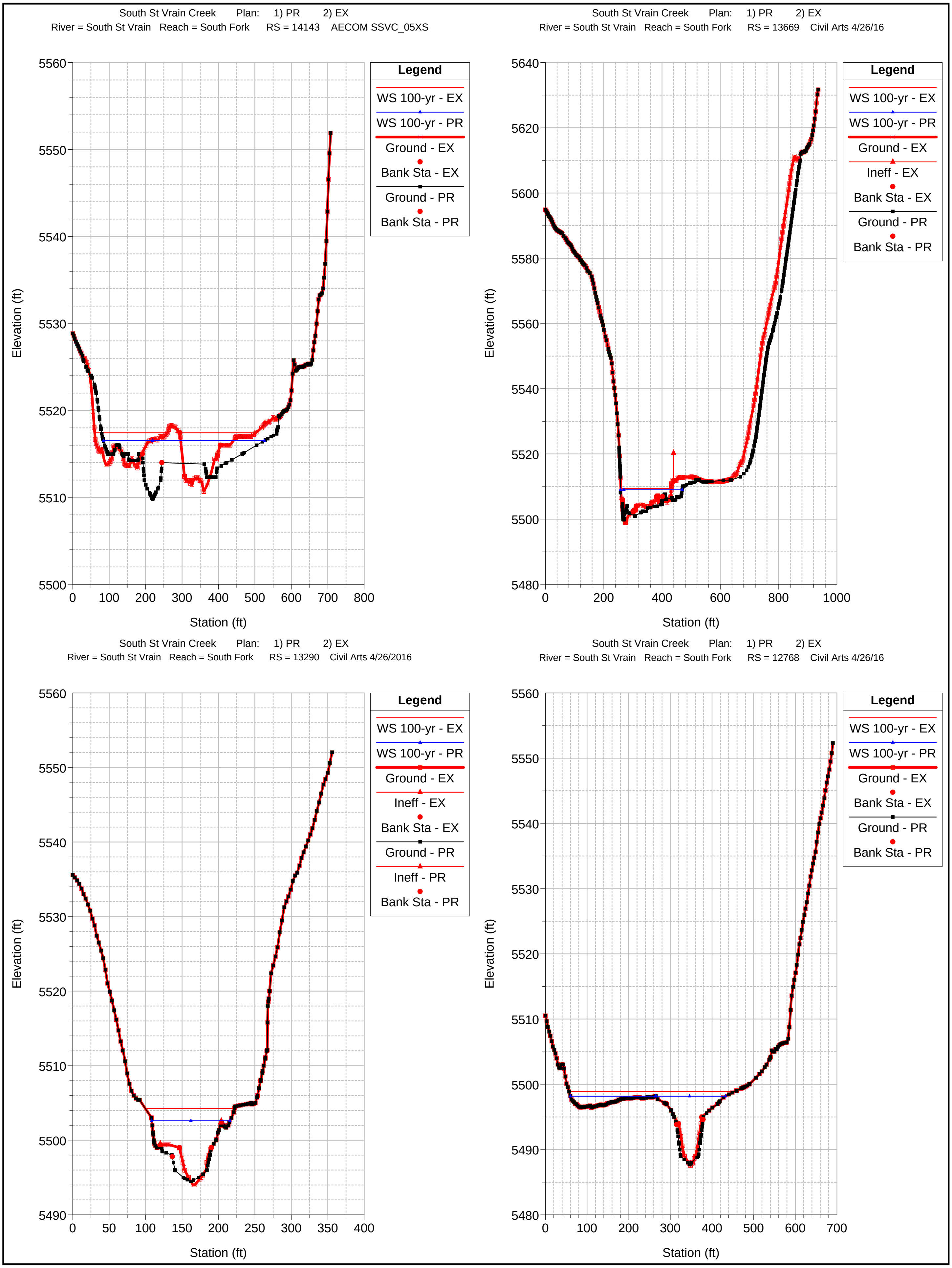
WS 100-yr - PR
Ground - EX
Bank Sta - EX
Ground - PR
Bank Sta - PR
Elevation (ft)
Station (ft)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River = South St Vrain Reach = South Fork RS = 14143 AECOM SSVC_05XS
Legend
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WS 100-yr - PR
Ground - EX
Bank Sta - EX
Ground - PR
Bank Sta - PR
Elevation (ft)
Station (ft)
South St Vrain Creek Plan: 1) PR 2) EX
River = South St Vrain Reach = South Fork RS = 13669 Civil Arts 4/26/16
Legend
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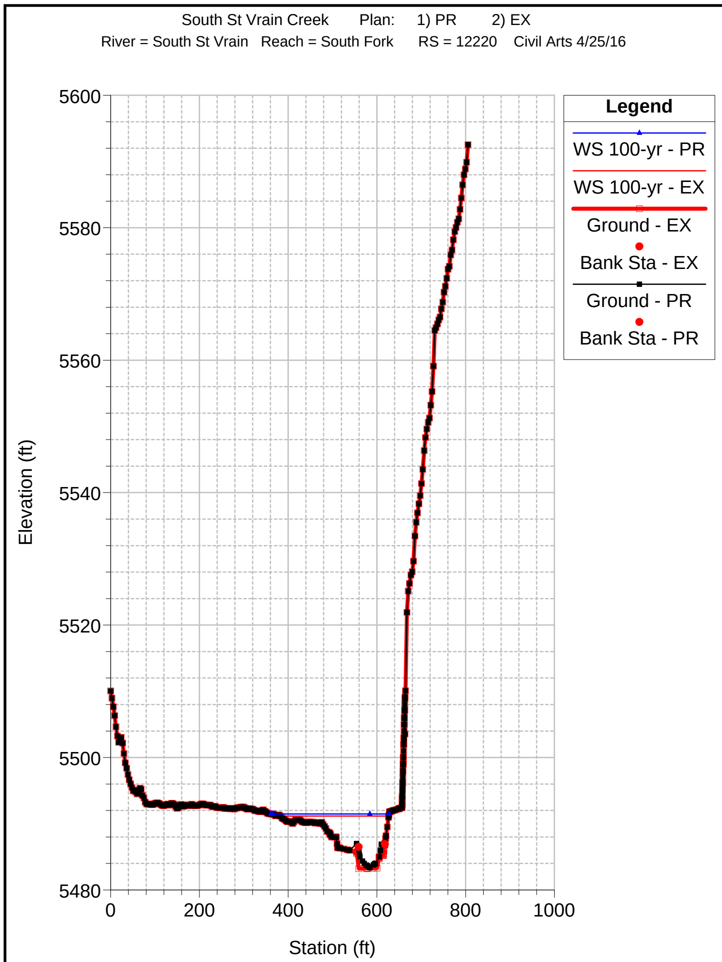
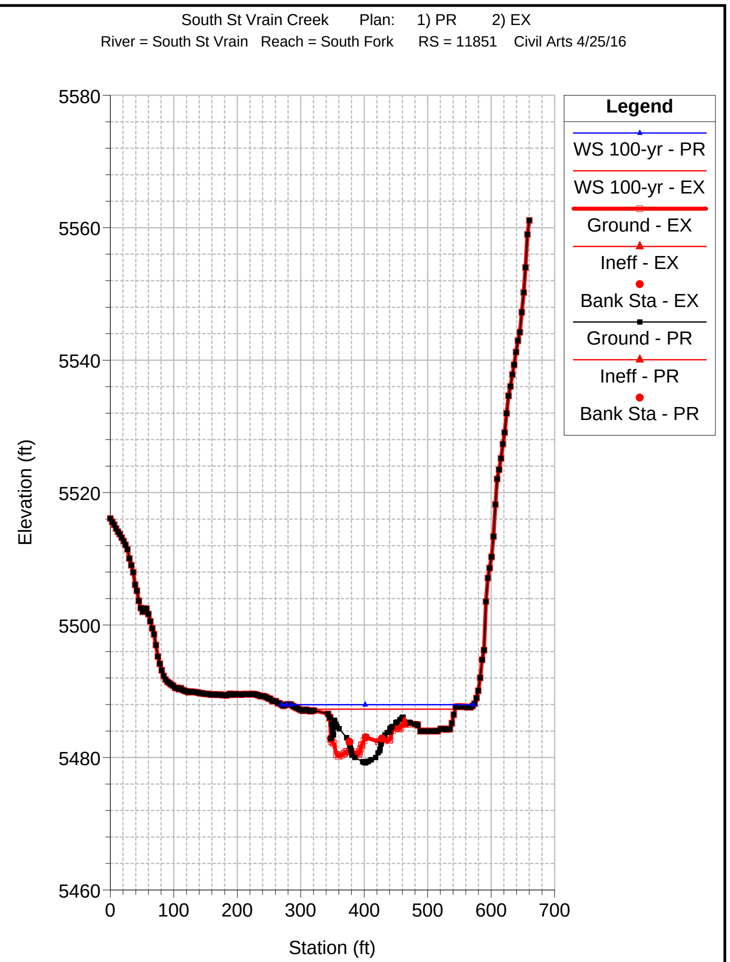
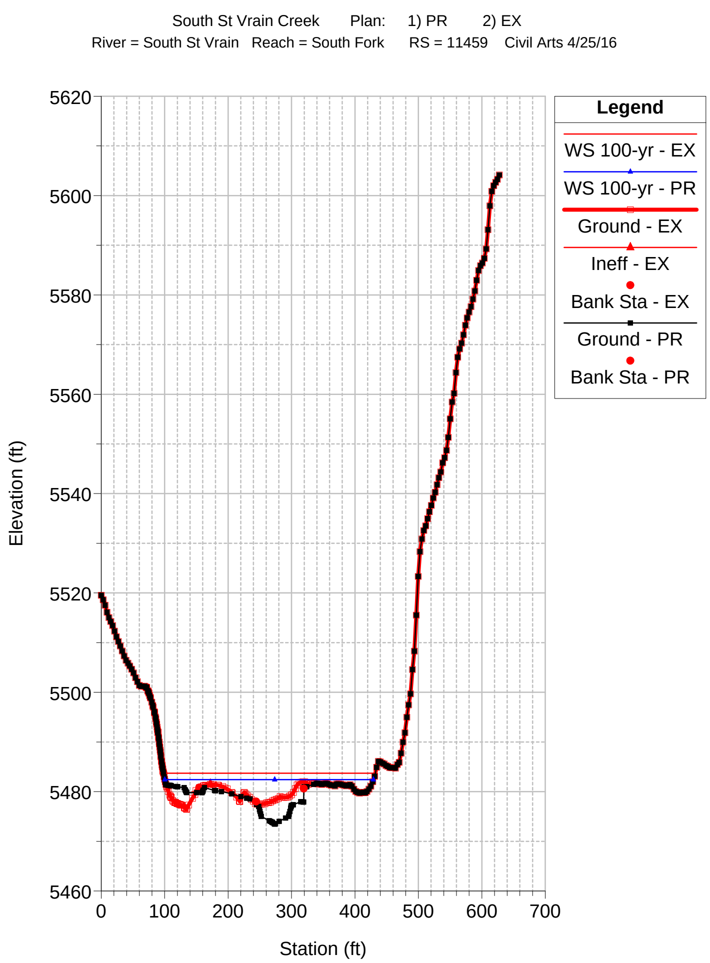
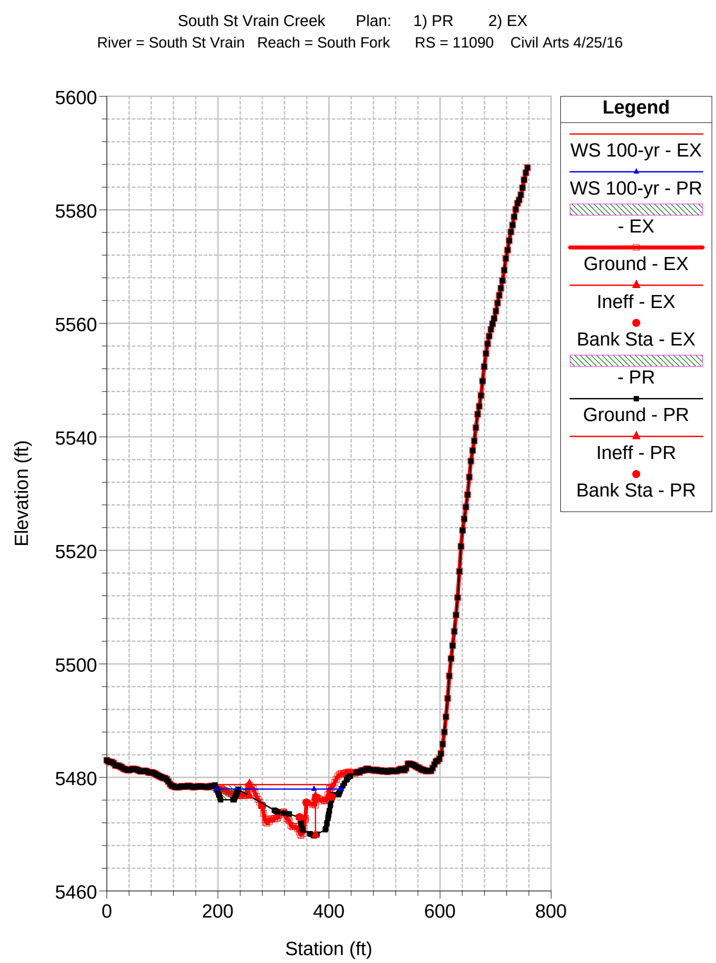
WS 100-yr - PR
Ground - EX
Ineff - EX
Bank Sta - EX
Ground - PR
Bank Sta - PR
Elevation (ft)
Station (ft)
South St Vrain Creek Plan: 1) PR 2) EX
River = South St Vrain Reach = South Fork RS = 13290 Civil Arts 4/26/2016
Legend
WS 100-yr - EX
WS 100-yr - PR
Ground - EX
Ineff - EX
Bank Sta - EX
Ground - PR
Ineff - PR
Bank Sta - PR
Elevation (ft)
Station (ft)
South St Vrain Creek Plan: 1) PR 2) EX
River = South St Vrain Reach = South Fork RS = 12768 Civil Arts 4/26/16
Legend
WS 100-yr - EX
WS 100-yr - PR
Ground - EX
Bank Sta - EX
Ground - PR
Bank Sta - PR
Elevation (ft)
Station (ft)

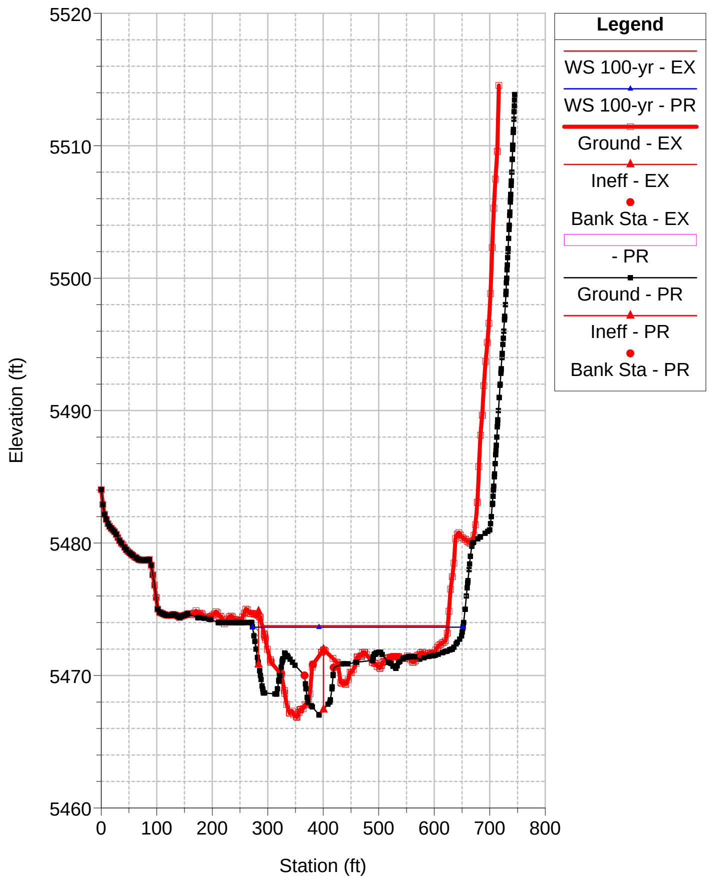

South St Vrain Creek Plan: 1) PR 2) EX
River = South St Vrain Reach = South Fork RS = 12220 Civil Arts 4/25/16
Legend
WS 100-yr - PR
WS 100-yr - EX
Ground - EX
Bank Sta - EX
Ground - PR
Bank Sta - PR
Elevation (ft)
Station (ft)
5600
5580
5560
5540
5520
5500
5480
0
200
400
600
800
1000


South St Vrain Creek Plan: 1) PR 2) EX
River = South St Vrain Reach = South Fork RS = 11851 Civil Arts 4/25/16
Legend
WS 100-yr - PR
WS 100-yr - EX
Ground - EX
Ineff - EX
Bank Sta - EX
Ground - PR
Ineff - PR
Bank Sta - PR
Elevation (ft)
Station (ft)
5580
5560
5540
5520
5500
5480
5460
0
100
200
300
400
500
600
700

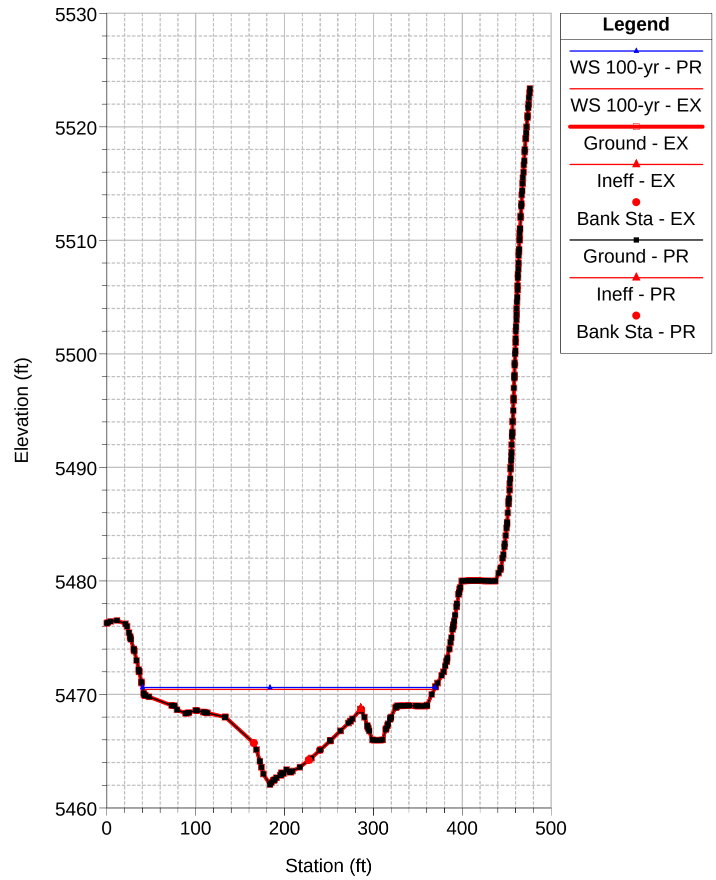

South St Vrain Creek Plan: 1) PR 2) EX
River = South St Vrain Reach = South Fork RS = 11459 Civil Arts 4/25/16
Legend
WS 100-yr - EX
WS 100-yr - PR
Ground - EX
Ineff - EX
Bank Sta - EX
Ground - PR
Bank Sta - PR
Elevation (ft)
Station (ft)
5620
5600
5580
5560
5540
5520
5500
5480
5460
0
100
200
300
400
500
600
700


South St Vrain Creek Plan: 1) PR 2) EX
River = South St Vrain Reach = South Fork RS = 11090 Civil Arts 4/25/16
Legend
WS 100-yr - EX
WS 100-yr - PR
- EX
Ground - EX
Ineff - EX
Bank Sta - EX
- PR
Ground - PR
Ineff - PR
Bank Sta - PR
Elevation (ft)
Station (ft)
5600
5580
5560
5540
5520
5500
5480
5460
0
200
400
600
800

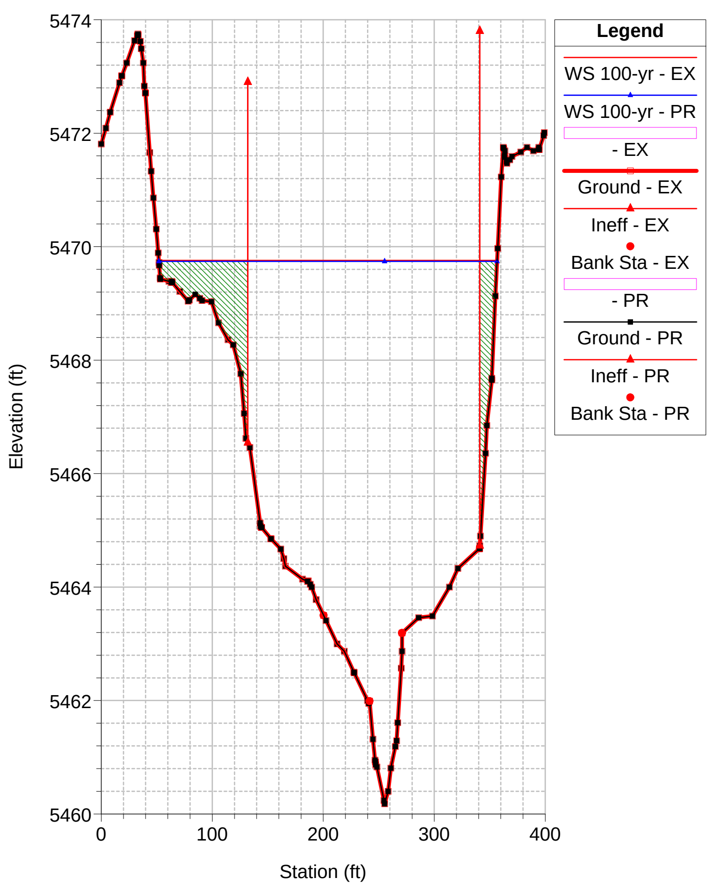
South St Vrain Creek   Plan: 1) PR   2) EX
River = South St Vrain   Reach = South Fork   RS = 10660   Civil Arts 4/25/16



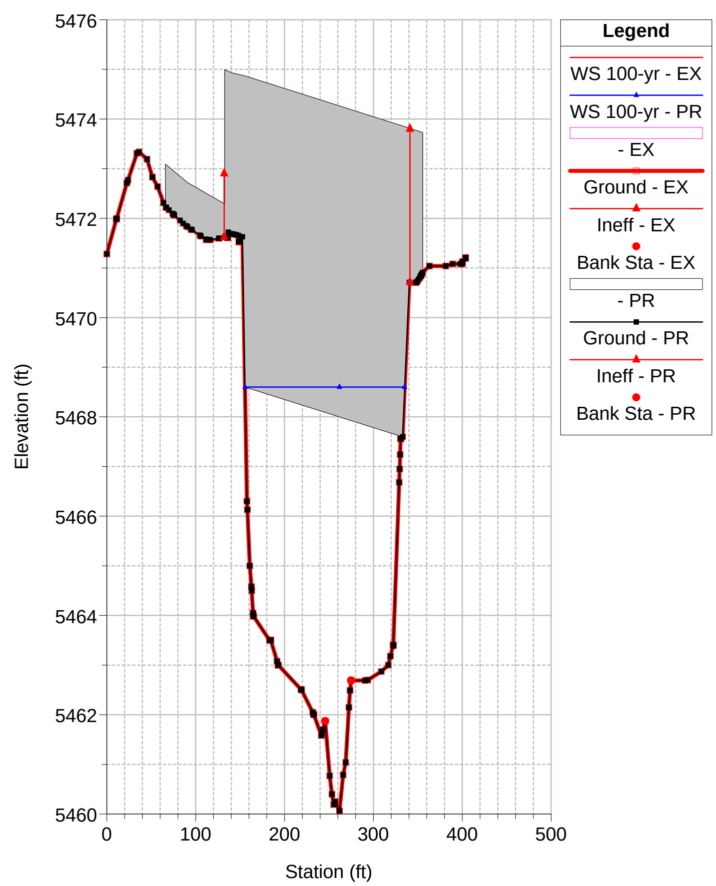
South St Vrain Creek   Plan: 1) PR   2) EX
River = South St Vrain   Reach = South Fork   RS = 10427

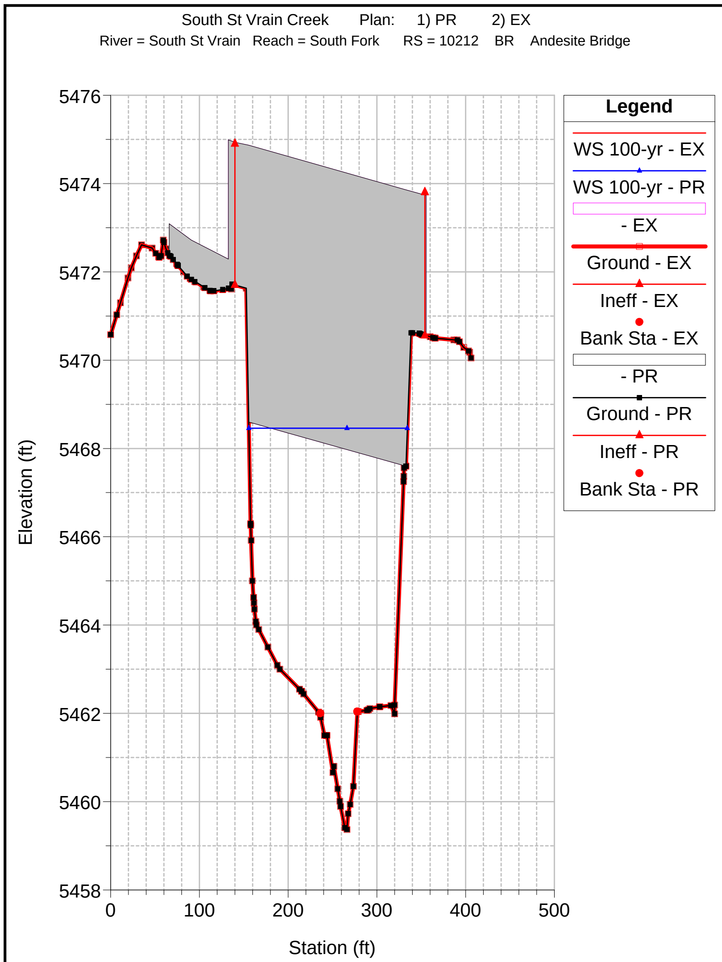


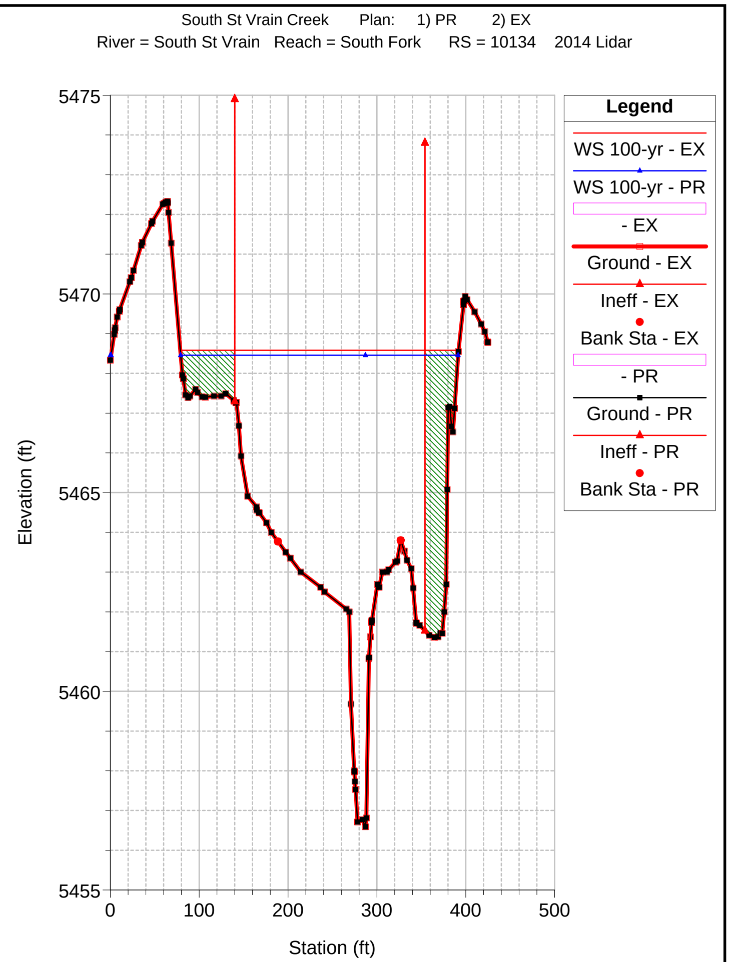
South St Vrain Creek   Plan: 1) PR   2) EX
River = South St Vrain   Reach = South Fork   RS = 10239   AECOM SSVC_04XS

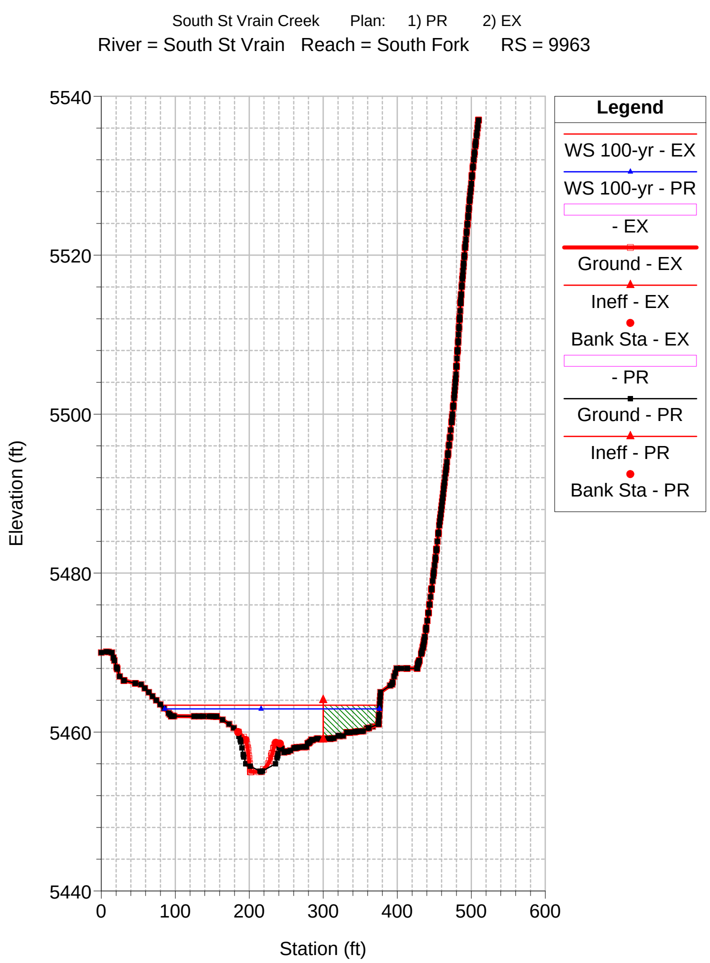


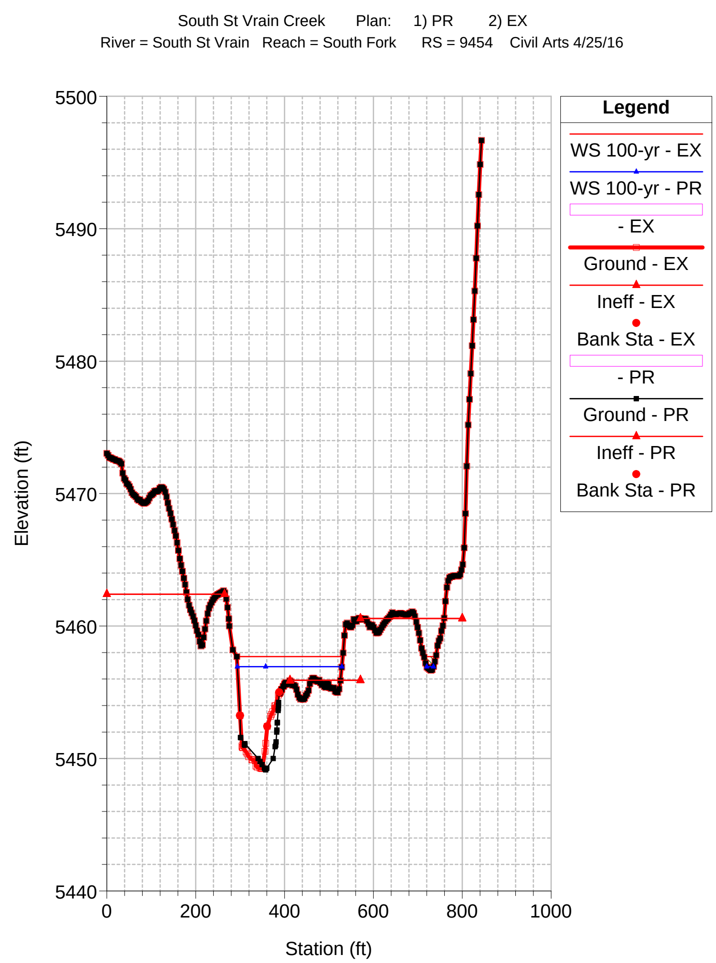
South St Vrain Creek   Plan: 1) PR   2) EX
River = South St Vrain   Reach = South Fork   RS = 10212   BR   Andesite Bridge



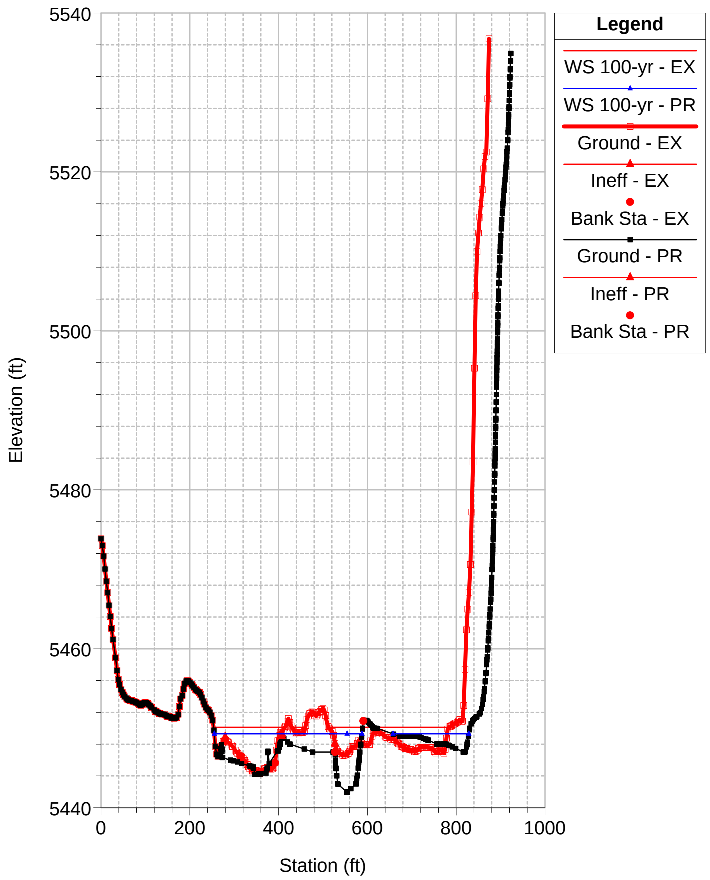

South St Vrain Creek Plan: 1) PR 2) EX
River = South St Vrain Reach = South Fork RS = 10212 BR Andesite Bridge
Elevation (ft)
Station (ft)
Legend
WS 100-yr - EX
WS 100-yr - PR
- EX
Ground - EX
Ineff - EX
Bank Sta - EX
- PR
Ground - PR
Ineff - PR
Bank Sta - PR


South St Vrain Creek Plan: 1) PR 2) EX
River = South St Vrain Reach = South Fork RS = 10134 2014 Lidar
Elevation (ft)
Station (ft)
Legend
WS 100-yr - EX
WS 100-yr - PR
- EX
Ground - EX
Ineff - EX
Bank Sta - EX
- PR
Ground - PR
Ineff - PR
Bank Sta - PR

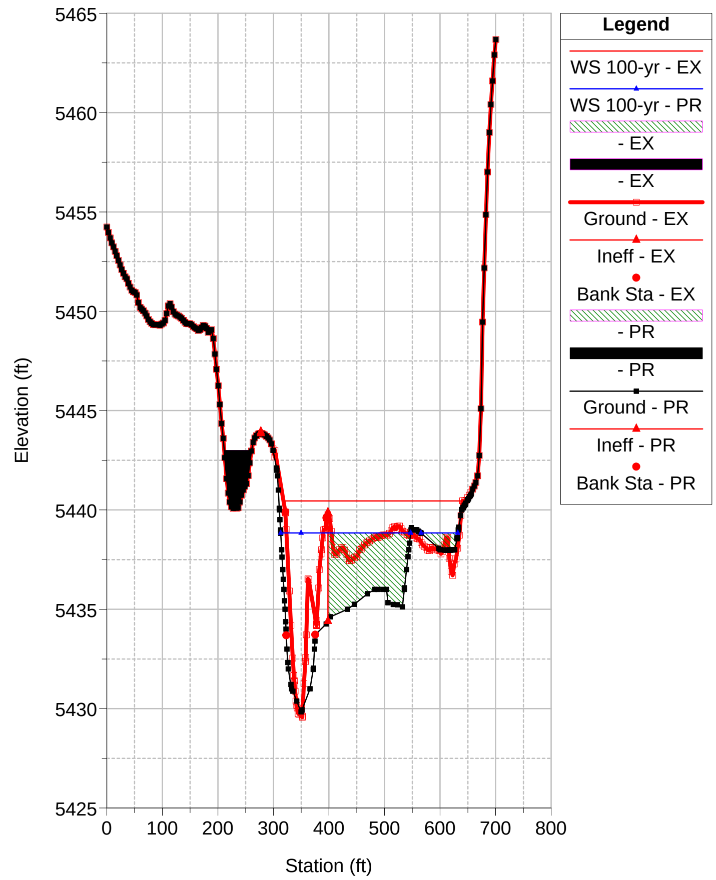

South St Vrain Creek Plan: 1) PR 2) EX
River = South St Vrain Reach = South Fork RS = 9963
Elevation (ft)
Station (ft)
Legend
WS 100-yr - EX
WS 100-yr - PR
- EX
Ground - EX
Ineff - EX
Bank Sta - EX
- PR
Ground - PR
Ineff - PR
Bank Sta - PR


South St Vrain Creek Plan: 1) PR 2) EX
River = South St Vrain Reach = South Fork RS = 9454 Civil Arts 4/25/16
Elevation (ft)
Station (ft)
Legend
WS 100-yr - EX
WS 100-yr - PR
- EX
Ground - EX
Ineff - EX
Bank Sta - EX
- PR
Ground - PR
Ineff - PR
Bank Sta - PR

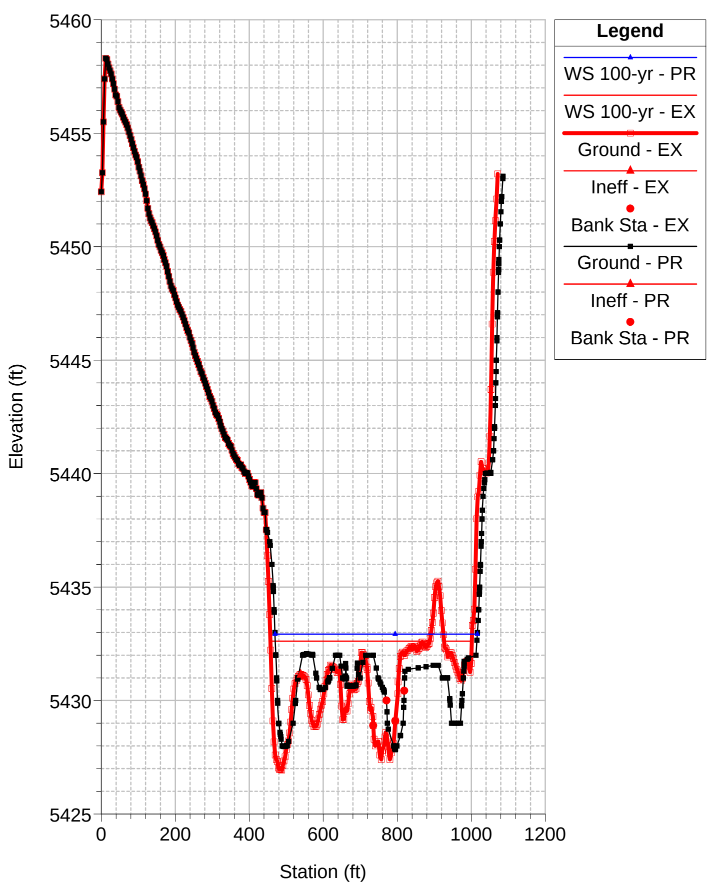
South St Vrain Creek Plan: 1) PR 2) EX
River = South St Vrain Reach = South Fork RS = 8975 2014 Lidar



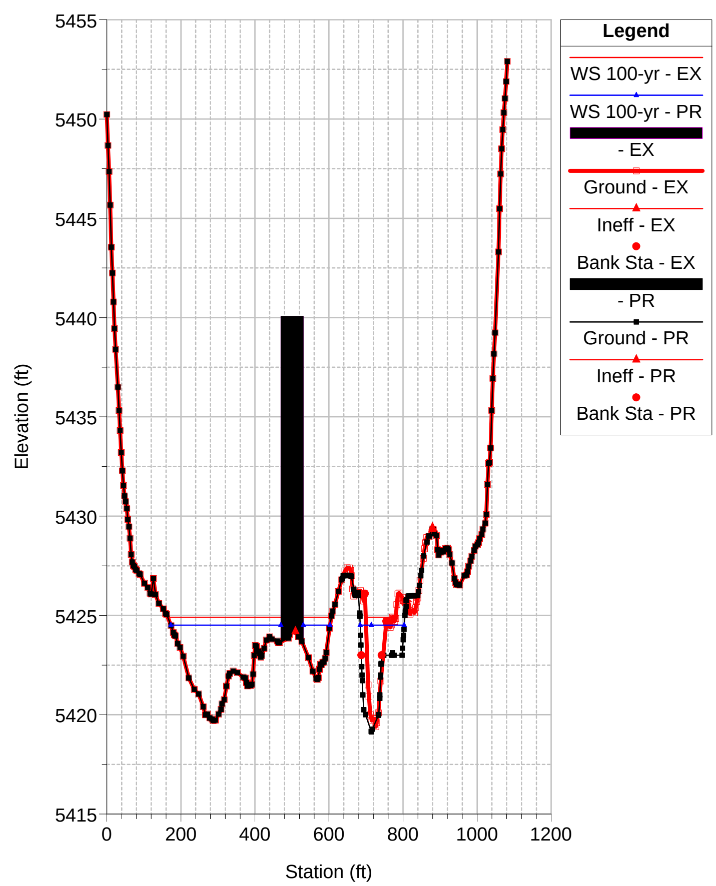
South St Vrain Creek Plan: 1) PR 2) EX
River = South St Vrain Reach = South Fork RS = 8021 Civil Arts 4/25/16

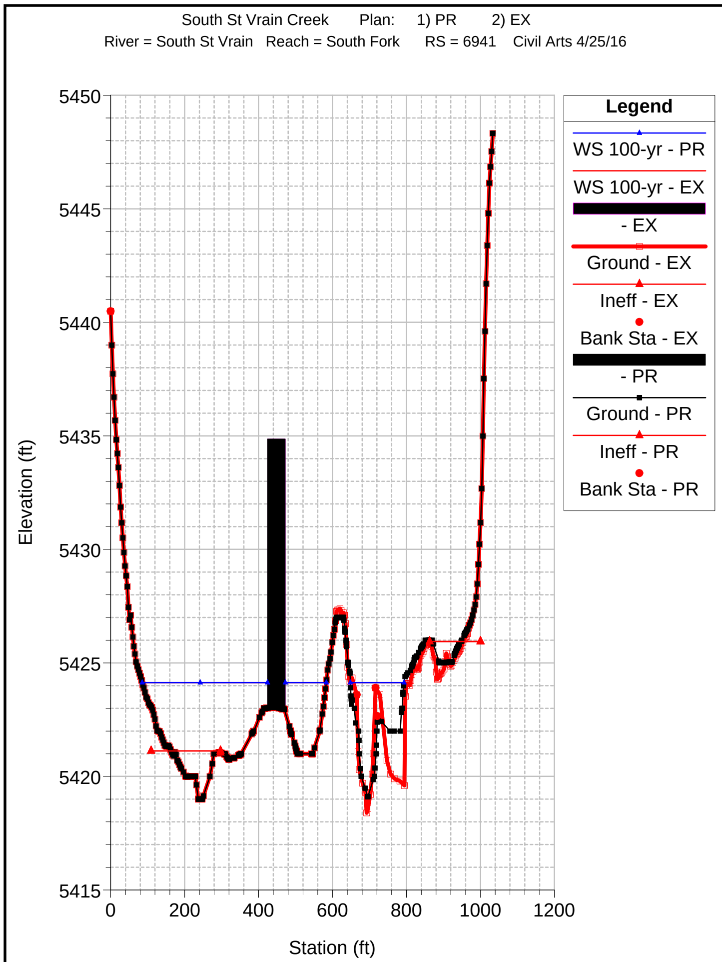


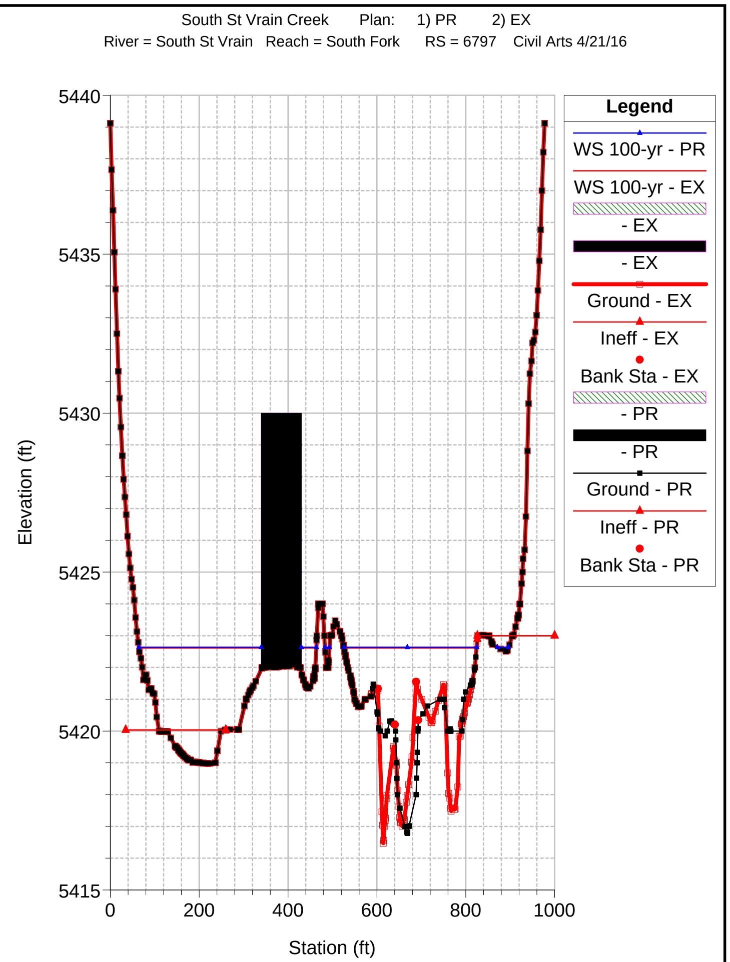
South St Vrain Creek Plan: 1) PR 2) EX
River = South St Vrain Reach = South Fork RS = 7529 Civil Arts 4/25/16

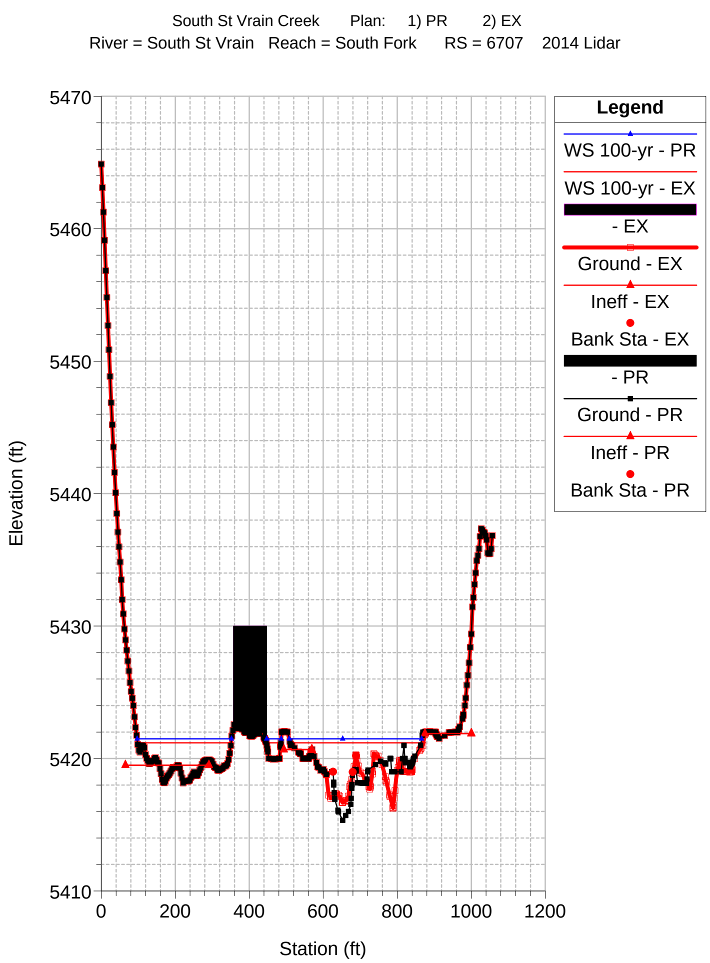


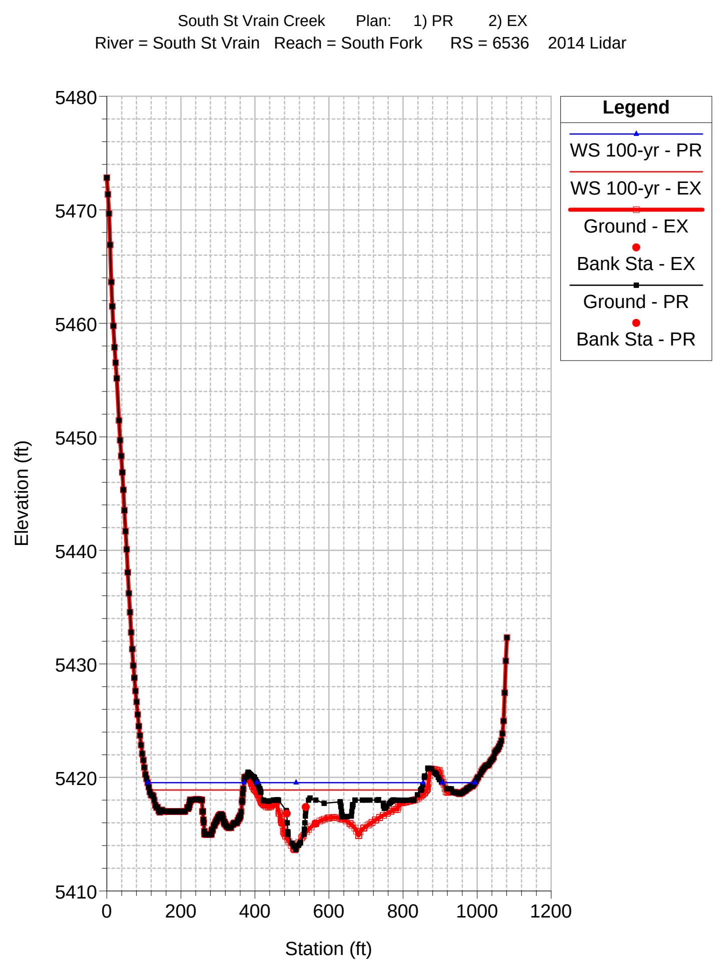
South St Vrain Creek Plan: 1) PR 2) EX
River = South St Vrain Reach = South Fork RS = 7041 Civil Arts 4/25/16



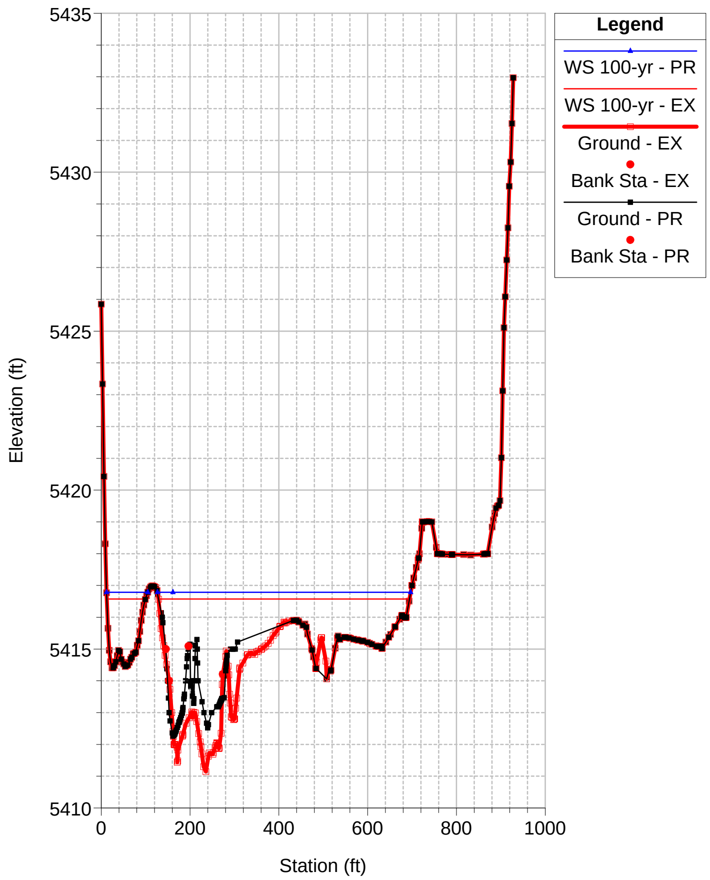

South St Vrain Creek Plan: 1) PR 2) EX
River = South St Vrain Reach = South Fork RS = 6941 Civil Arts 4/25/16
Legend
WS 100-yr - PR
WS 100-yr - EX
- EX
Ground - EX
Ineff - EX
Bank Sta - EX
- PR
Ground - PR
Ineff - PR
Bank Sta - PR
Elevation (ft)
Station (ft)
5450
5445
5440
5435
5430
5425
5420
5415
0
200
400
600
800
1000
1200


South St Vrain Creek Plan: 1) PR 2) EX
River = South St Vrain Reach = South Fork RS = 6797 Civil Arts 4/21/16
Legend
WS 100-yr - PR
WS 100-yr - EX
- EX
- EX
Ground - EX
Ineff - EX
Bank Sta - EX
- PR
- PR
Ground - PR
Ineff - PR
Bank Sta - PR
Elevation (ft)
Station (ft)
5440
5435
5430
5425
5420
5415
0
200
400
600
800
1000

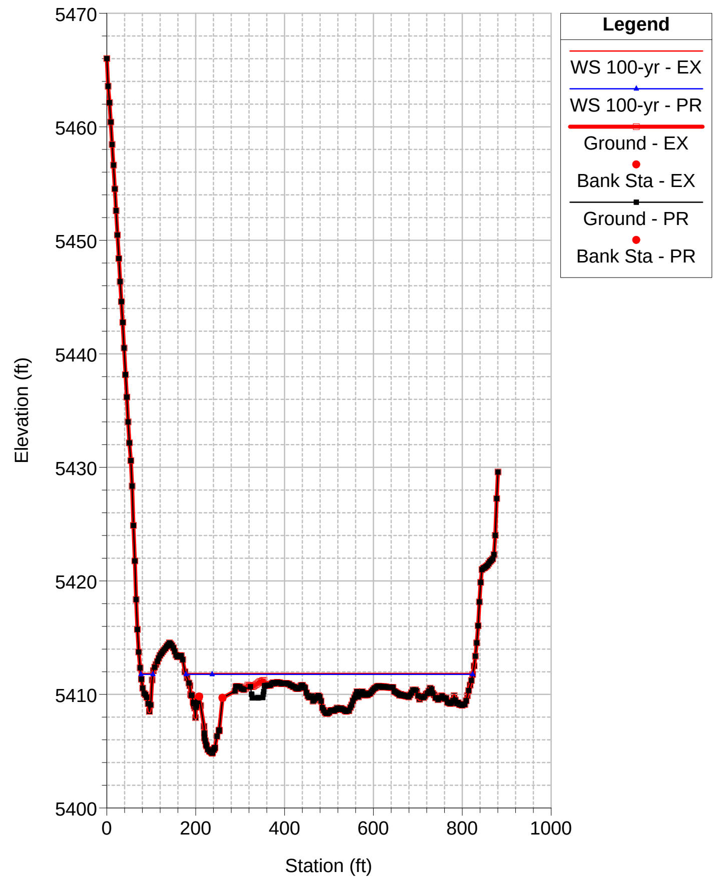

South St Vrain Creek Plan: 1) PR 2) EX
River = South St Vrain Reach = South Fork RS = 6707 2014 Lidar
Legend
WS 100-yr - PR
WS 100-yr - EX
- EX
Ground - EX
Ineff - EX
Bank Sta - EX
- PR
Ground - PR
Ineff - PR
Bank Sta - PR
Elevation (ft)
Station (ft)
5470
5460
5450
5440
5430
5420
5410
0
200
400
600
800
1000
1200


South St Vrain Creek Plan: 1) PR 2) EX
River = South St Vrain Reach = South Fork RS = 6536 2014 Lidar
Legend
WS 100-yr - PR
WS 100-yr - EX
Ground - EX
Bank Sta - EX
Ground - PR
Bank Sta - PR
Elevation (ft)
Station (ft)
5480
5470
5460
5450
5440
5430
5420
5410
0
200
400
600
800
1000
1200

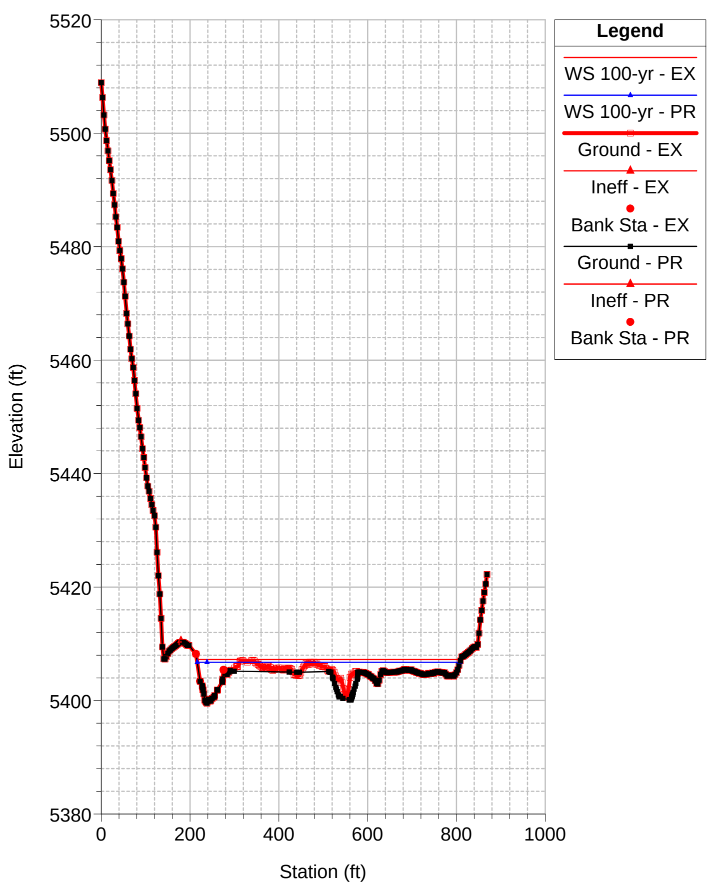
South St Vrain Creek Plan: 1) PR 2) EX
River = South St Vrain Reach = South Fork RS = 6344 AECOM SSVC_03XS



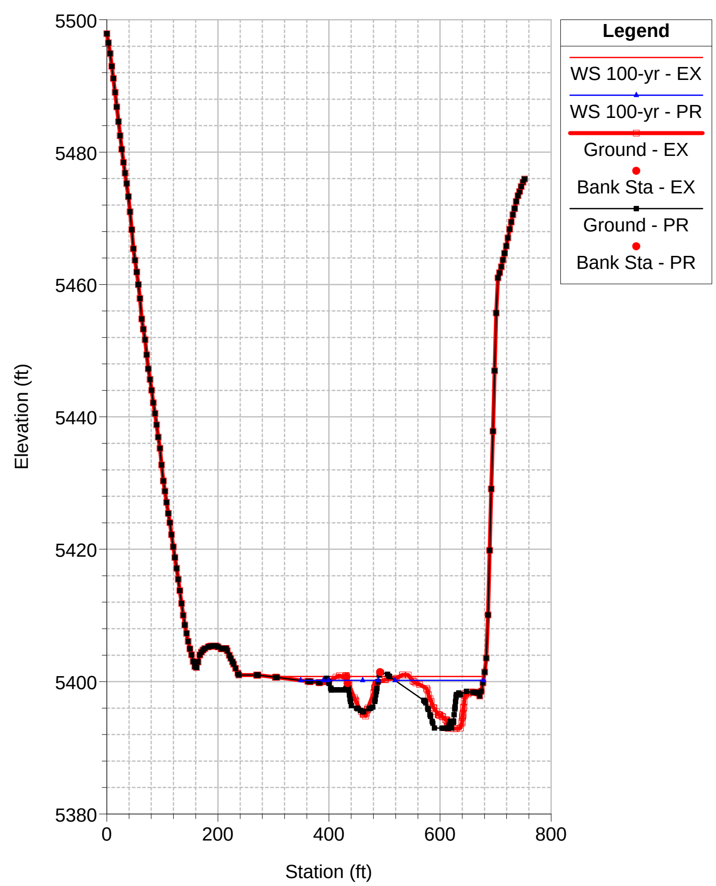
South St Vrain Creek Plan: 1) PR 2) EX
River = South St Vrain Reach = South Fork RS = 6033 Civil Arts 4/21/16

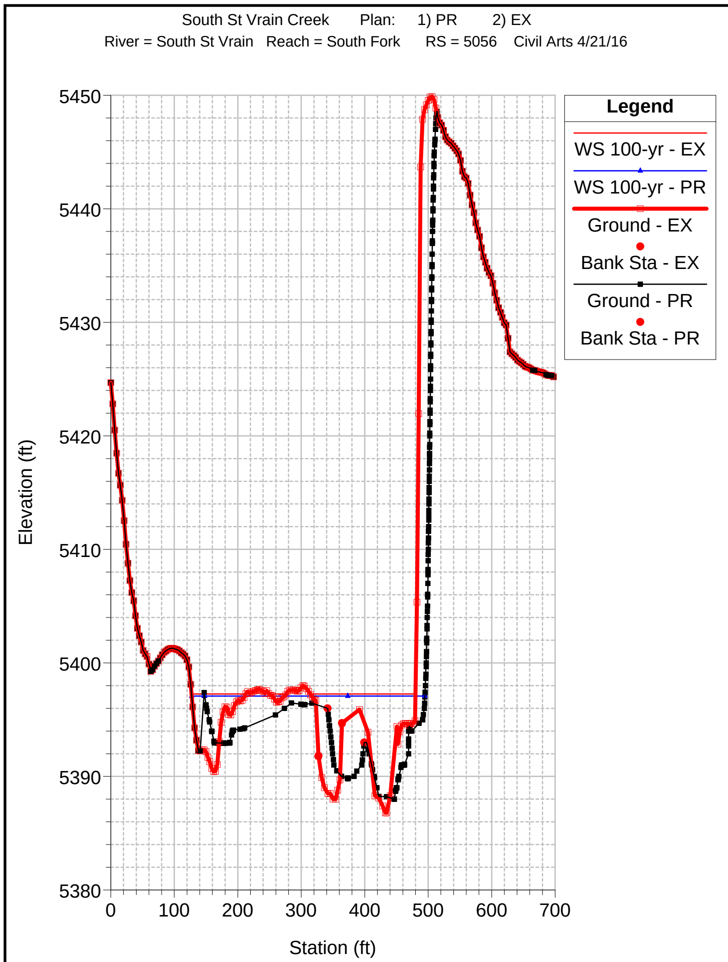


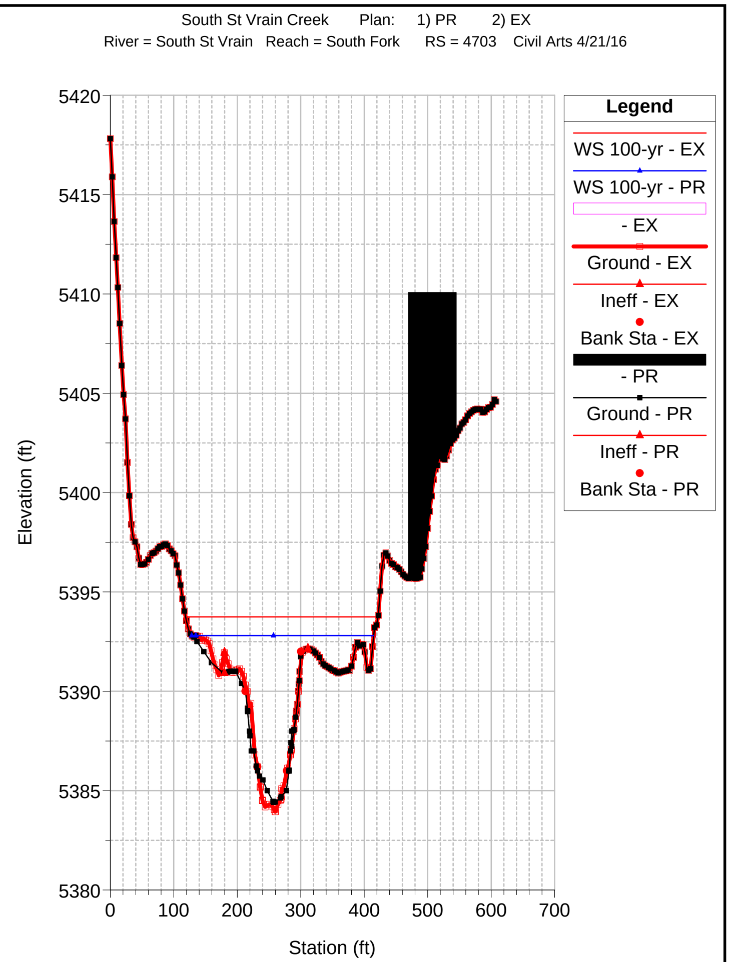
South St Vrain Creek Plan: 1) PR 2) EX
River = South St Vrain Reach = South Fork RS = 5668 Civil Arts 4/25/16

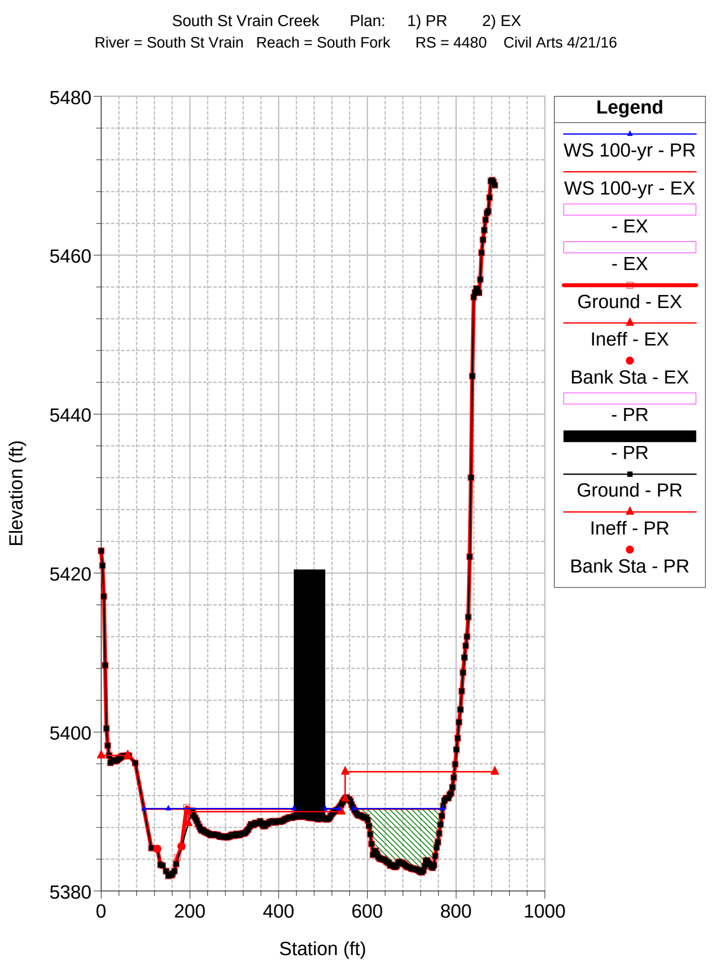


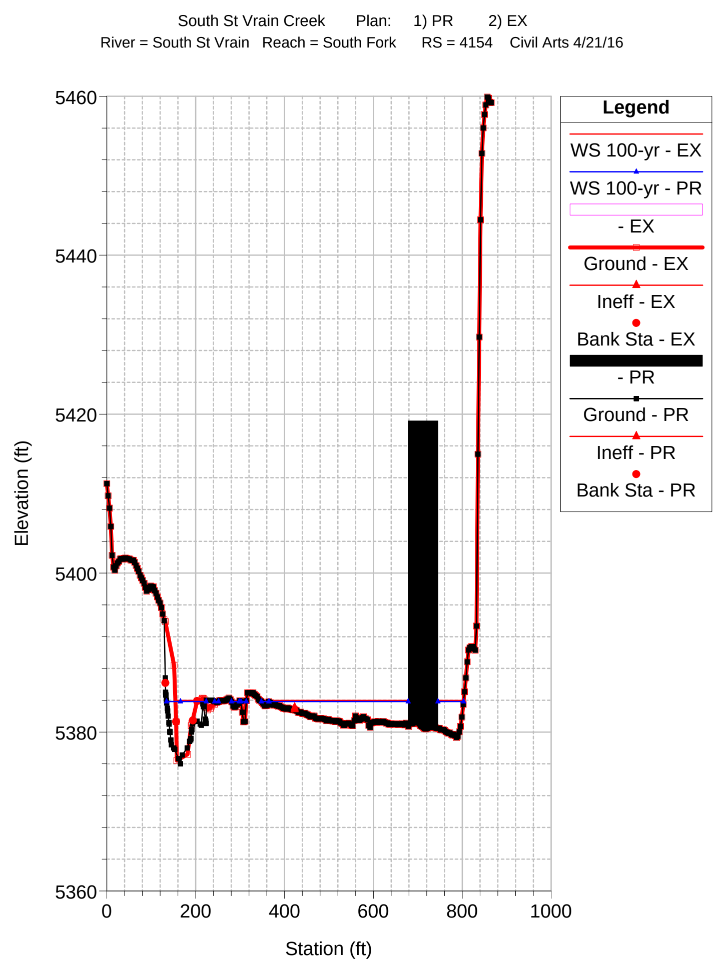
South St Vrain Creek Plan: 1) PR 2) EX
River = South St Vrain Reach = South Fork RS = 5329 2014 Lidar



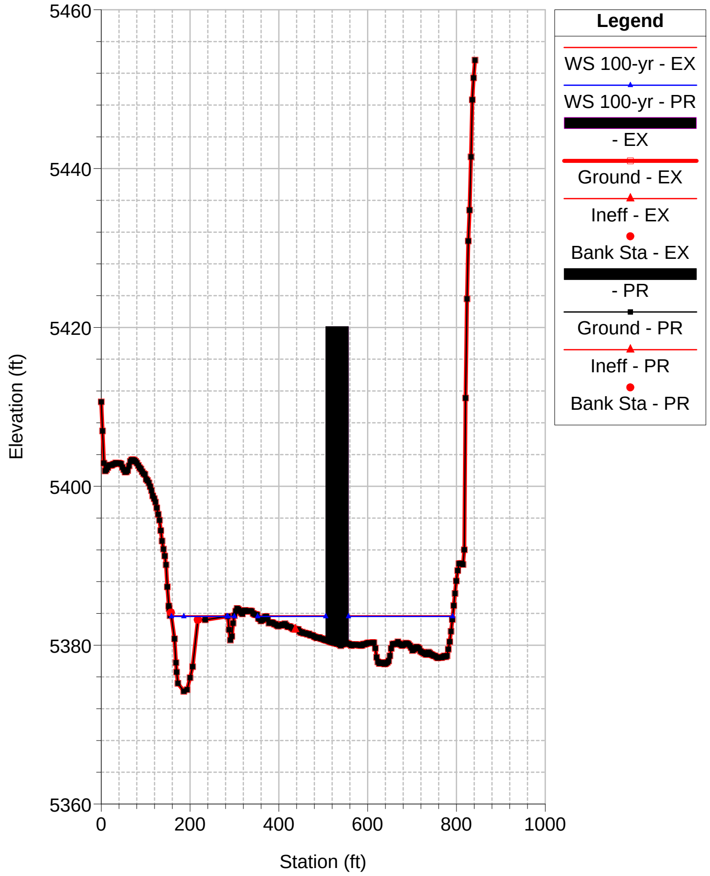

South St Vrain Creek Plan: 1) PR 2) EX
River = South St Vrain Reach = South Fork RS = 5056 Civil Arts 4/21/16
Legend
WS 100-yr - EX
WS 100-yr - PR
Ground - EX
Bank Sta - EX
Ground - PR
Bank Sta - PR
Elevation (ft)
5380
5390
5400
5410
5420
5430
5440
5450
Station (ft)
0
100
200
300
400
500
600
700


South St Vrain Creek Plan: 1) PR 2) EX
River = South St Vrain Reach = South Fork RS = 4703 Civil Arts 4/21/16
Legend
WS 100-yr - EX
WS 100-yr - PR
- EX
Ground - EX
Ineff - EX
Bank Sta - EX
- PR
Ground - PR
Ineff - PR
Bank Sta - PR
Elevation (ft)
5380
5385
5390
5395
5400
5405
5410
5415
5420
Station (ft)
0
100
200
300
400
500
600
700

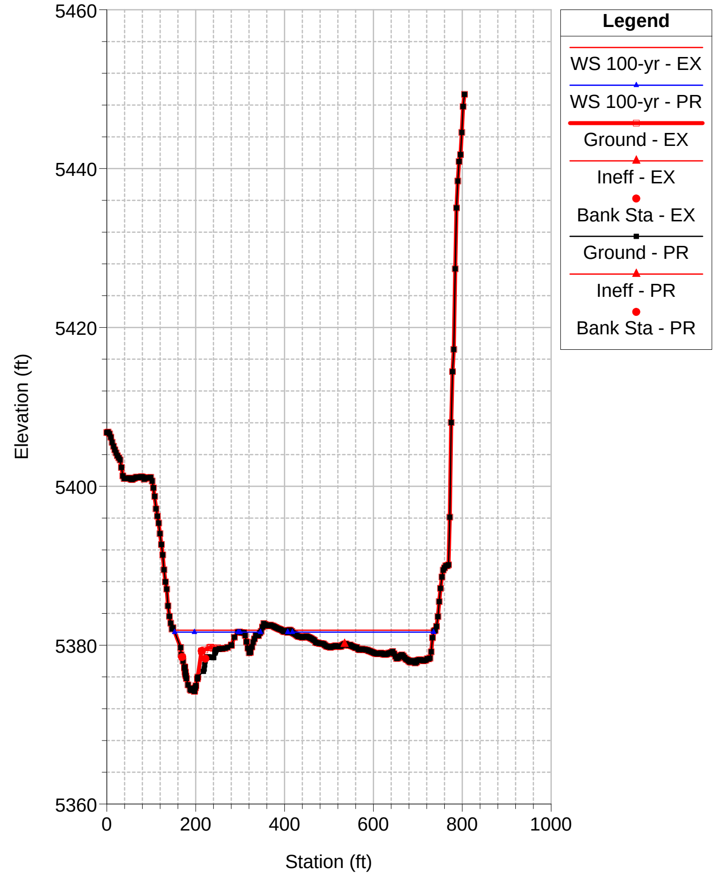

South St Vrain Creek Plan: 1) PR 2) EX
River = South St Vrain Reach = South Fork RS = 4480 Civil Arts 4/21/16
Legend
WS 100-yr - PR
WS 100-yr - EX
- EX
- EX
Ground - EX
Ineff - EX
Bank Sta - EX
- PR
- PR
Ground - PR
Ineff - PR
Bank Sta - PR
Elevation (ft)
5380
5400
5420
5440
5460
5480
Station (ft)
0
200
400
600
800
1000


South St Vrain Creek Plan: 1) PR 2) EX
River = South St Vrain Reach = South Fork RS = 4154 Civil Arts 4/21/16
Legend
WS 100-yr - EX
WS 100-yr - PR
- EX
Ground - EX
Ineff - EX
Bank Sta - EX
- PR
Ground - PR
Ineff - PR
Bank Sta - PR
Elevation (ft)
5360
5380
5400
5420
5440
5460
Station (ft)
0
200
400
600
800
1000

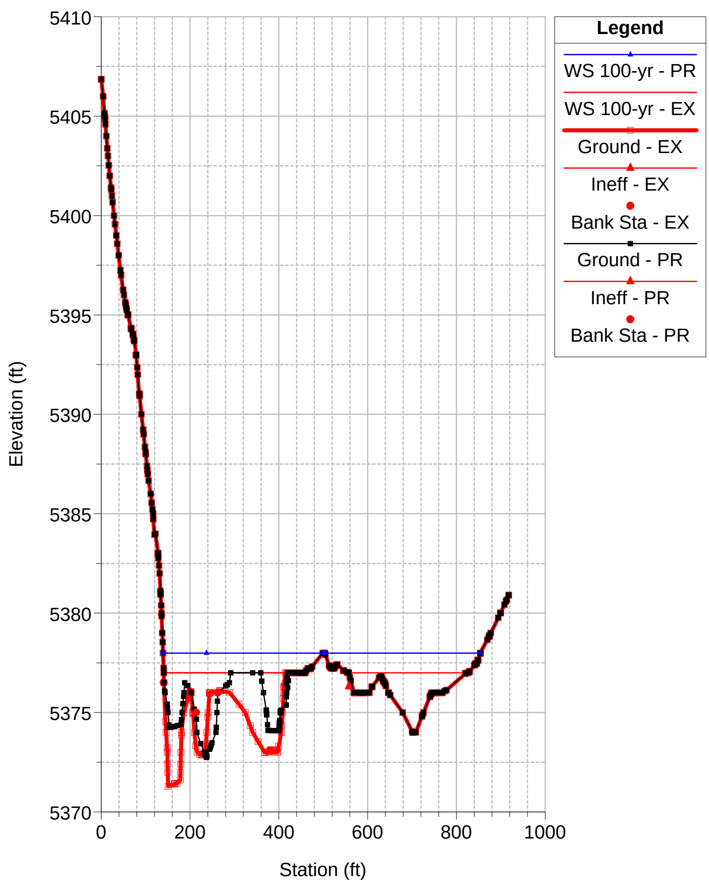
South St Vrain Creek Plan: 1) PR 2) EX
River = South St Vrain Reach = South Fork RS = 4107 Civil Arts 4/21/16



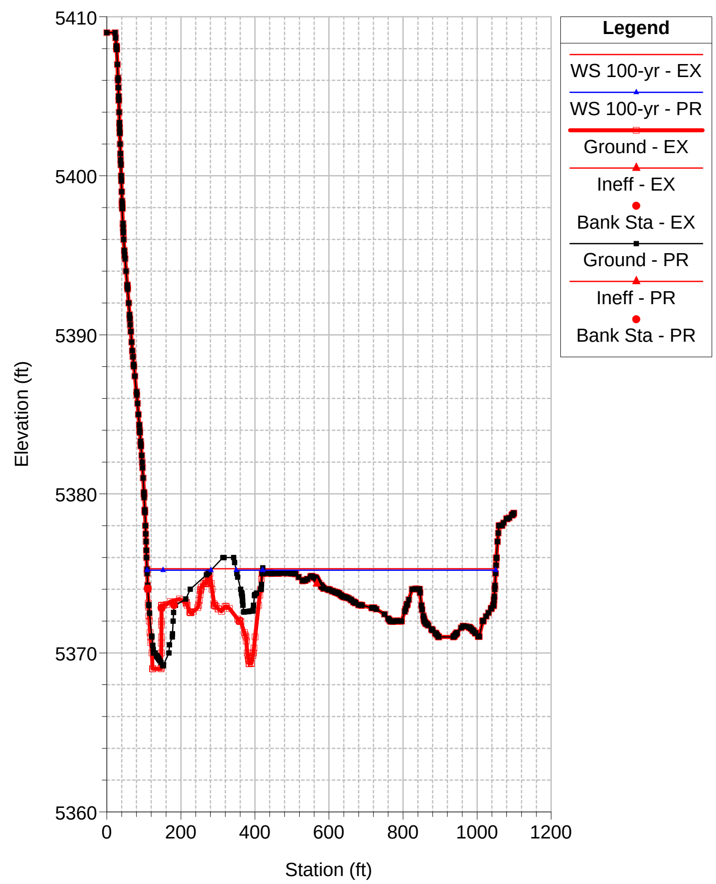
South St Vrain Creek Plan: 1) PR 2) EX
River = South St Vrain Reach = South Fork RS = 3985 Civil Arts 4/21/16

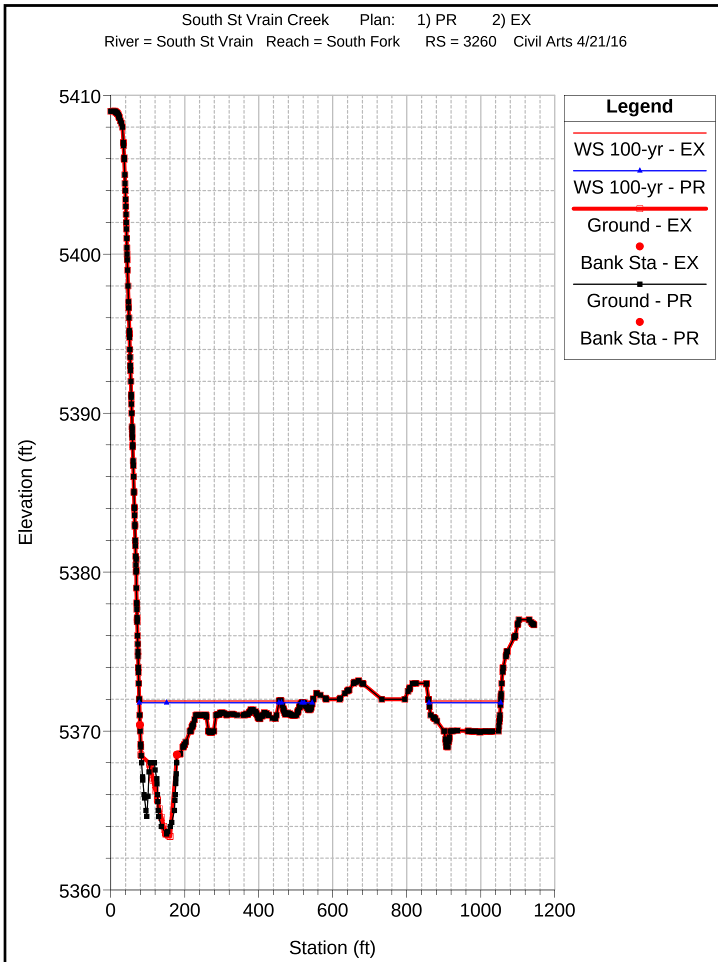


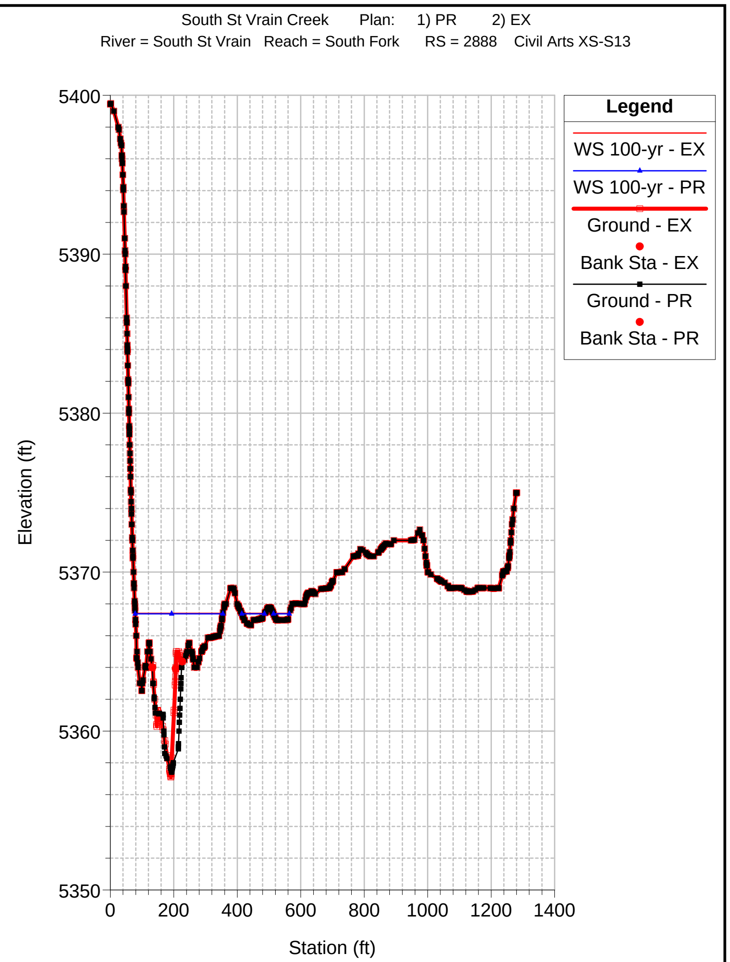
South St Vrain Creek Plan: 1) PR 2) EX
River = South St Vrain Reach = South Fork RS = 3763 Civil Arts 4/21/16

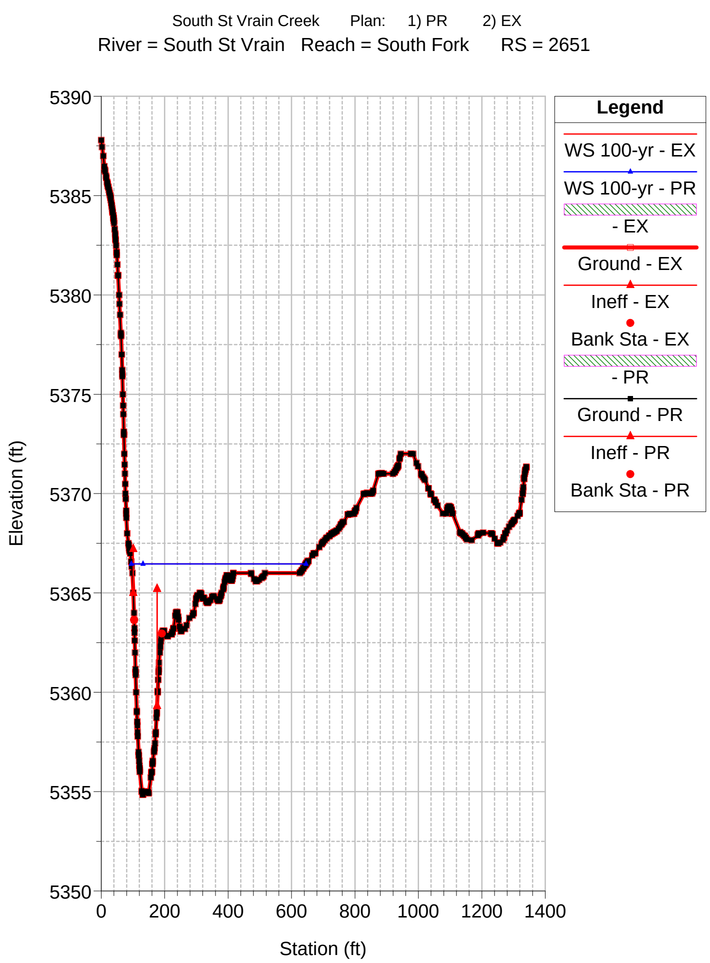


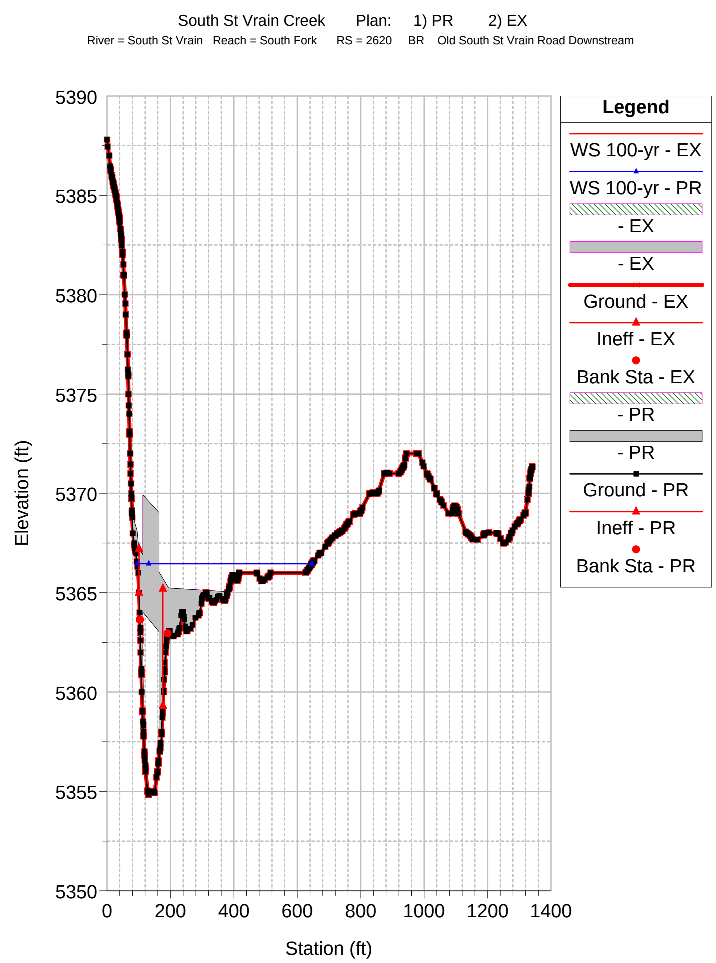
South St Vrain Creek Plan: 1) PR 2) EX
River = South St Vrain Reach = South Fork RS = 3602



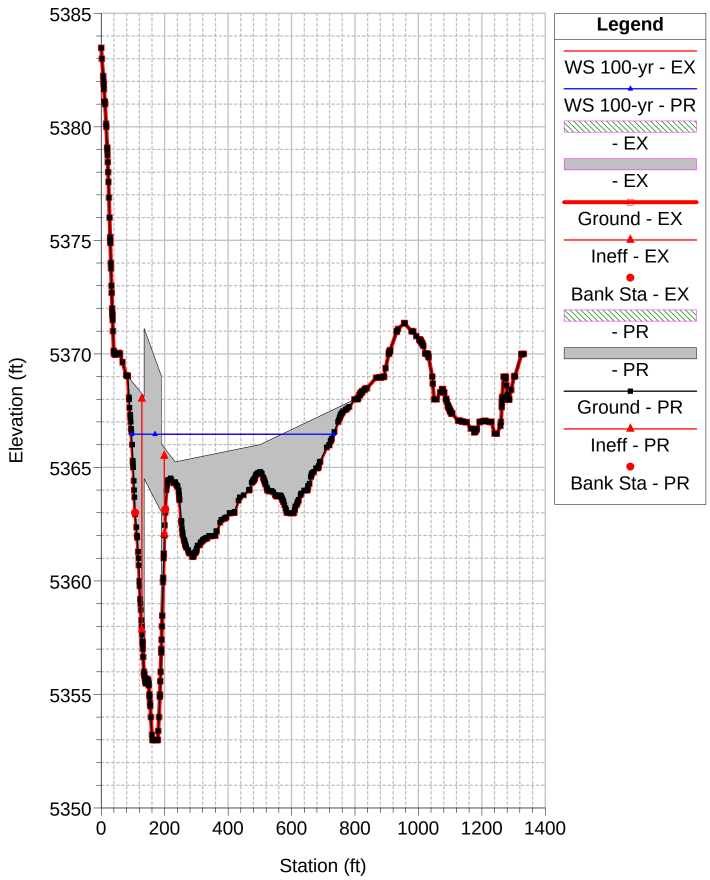

South St Vrain Creek Plan: 1) PR 2) EX
River = South St Vrain Reach = South Fork RS = 3260 Civil Arts 4/21/16
Elevation (ft)
Station (ft)
Legend
WS 100-yr - EX
WS 100-yr - PR
Ground - EX
Bank Sta - EX
Ground - PR
Bank Sta - PR


South St Vrain Creek Plan: 1) PR 2) EX
River = South St Vrain Reach = South Fork RS = 2888 Civil Arts XS-S13
Elevation (ft)
Station (ft)
Legend
WS 100-yr - EX
WS 100-yr - PR
Ground - EX
Bank Sta - EX
Ground - PR
Bank Sta - PR

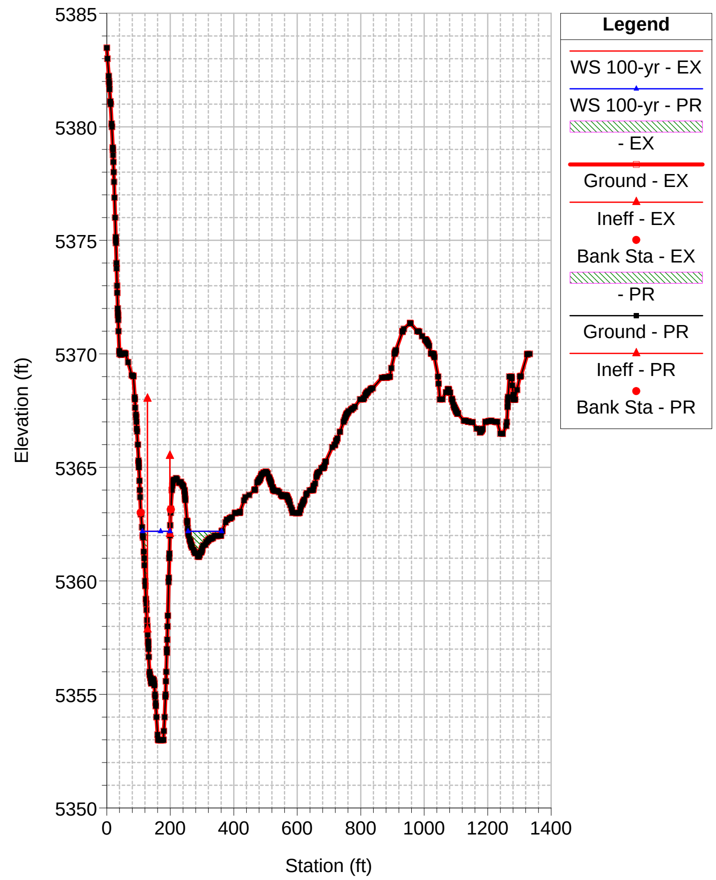

South St Vrain Creek Plan: 1) PR 2) EX
River = South St Vrain Reach = South Fork RS = 2651
Elevation (ft)
Station (ft)
Legend
WS 100-yr - EX
WS 100-yr - PR
- EX
Ground - EX
Ineff - EX
Bank Sta - EX
- PR
Ground - PR
Ineff - PR
Bank Sta - PR


South St Vrain Creek Plan: 1) PR 2) EX
River = South St Vrain Reach = South Fork RS = 2620 BR Old South St Vrain Road Downstream
Elevation (ft)
Station (ft)
Legend
WS 100-yr - EX
WS 100-yr - PR
- EX
- EX
Ground - EX
Ineff - EX
Bank Sta - EX
- PR
- PR
Ground - PR
Ineff - PR
Bank Sta - PR

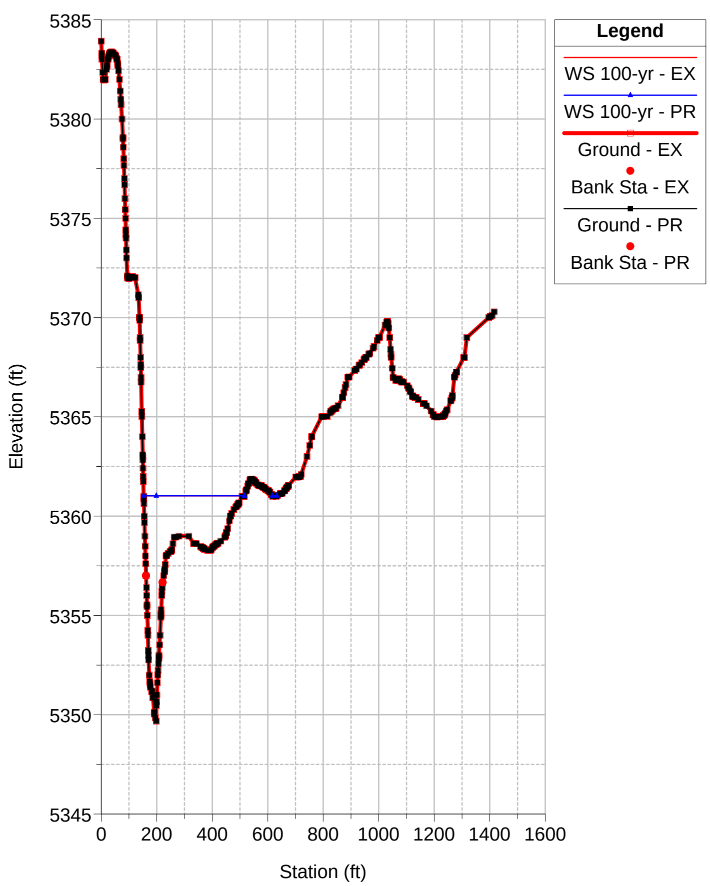
South St Vrain Creek Plan: 1) PR 2) EX
River = South St Vrain Reach = South Fork RS = 2620 BR Old South St Vrain Road Downstream



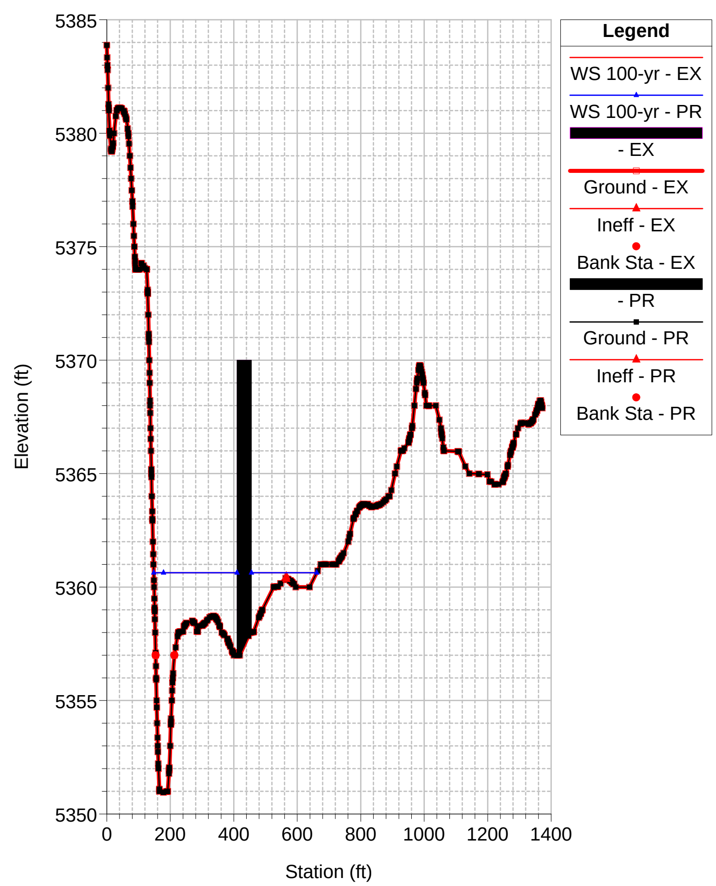
South St Vrain Creek Plan: 1) PR 2) EX
River = South St Vrain Reach = South Fork RS = 2588 DS Bridge



South St Vrain Creek Plan: 1) PR 2) EX
River = South St Vrain Reach = South Fork RS = 2458 AECOM SSVC 01



South St Vrain Creek Plan: 1) PR 2) EX
River = South St Vrain Reach = South Fork RS = 2396 Civil Arts XS-S12



HEC-RAS River: South St Vrain Reach: South Fork Profile: 100-yr

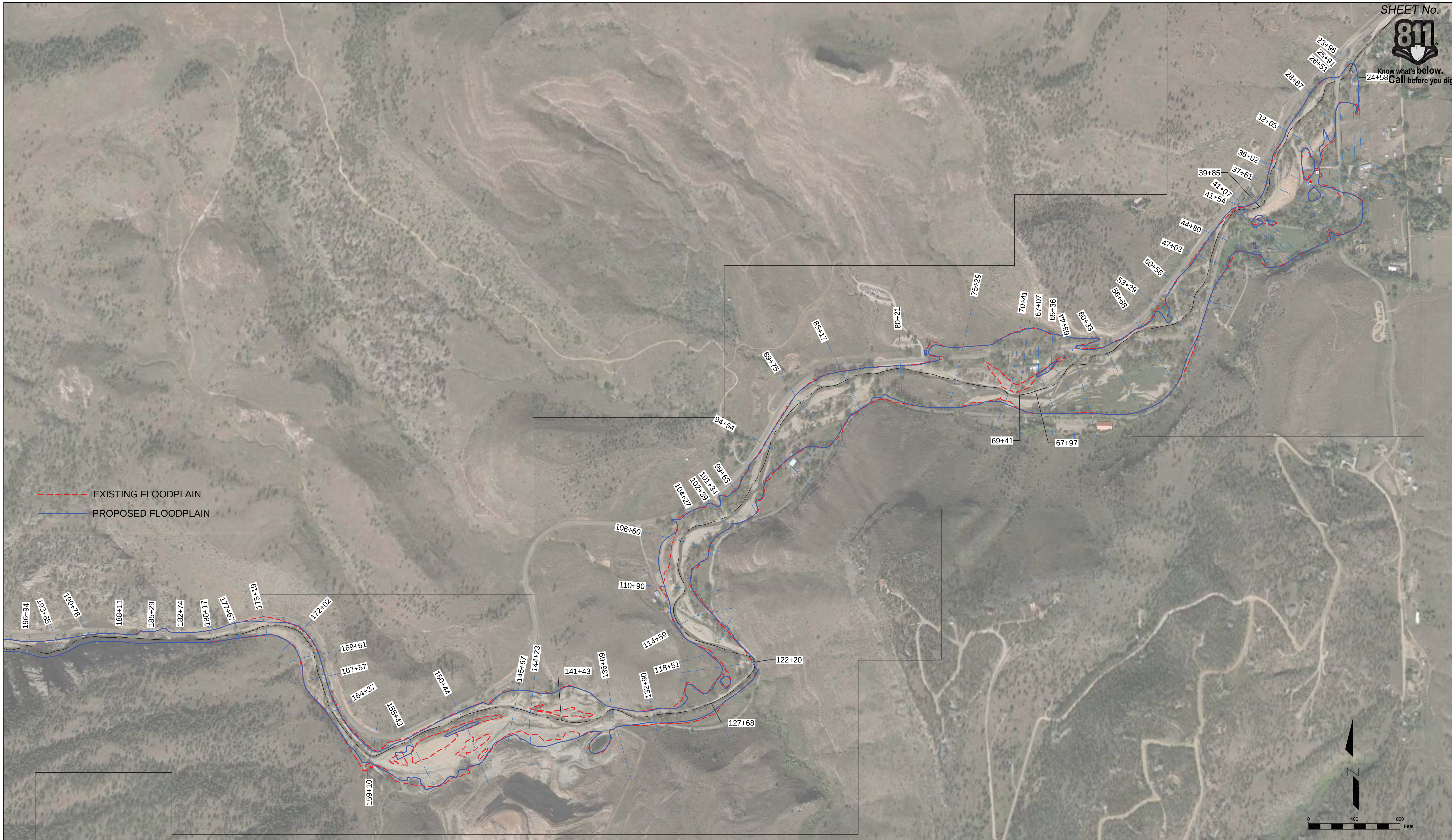
Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
South Fork	19965	100-yr	EX	7234.00	5599.94	5609.24		5610.27	0.004903	9.98	961.06	126.40	0.59
South Fork	19965	100-yr	PR	7234.00	5599.94	5609.24		5610.27	0.004903	9.98	961.06	126.40	0.59
South Fork	19694	100-yr	EX	7234.00	5594.78	5604.45	5604.45	5607.98	0.013026	15.52	526.29	85.72	0.94
South Fork	19694	100-yr	PR	7234.00	5594.78	5604.45	5604.45	5607.98	0.013026	15.52	526.29	85.72	0.94
South Fork	19365	100-yr	EX	7234.00	5591.50	5599.94		5601.50	0.010566	11.63	772.33	136.64	0.80
South Fork	19365	100-yr	PR	7234.00	5591.50	5599.94		5601.50	0.010566	11.63	772.33	136.64	0.80
South Fork	19078	100-yr	EX	7234.00	5581.02	5593.58	5593.58	5597.86	0.013207	18.47	508.81	68.10	0.98
South Fork	19078	100-yr	PR	7234.00	5581.02	5593.58	5593.58	5597.86	0.013207	18.47	508.81	68.10	0.98
South Fork	18811	100-yr	EX	7234.00	5579.31	5589.66	5589.66	5593.72	0.013592	16.63	481.16	64.29	0.97
South Fork	18811	100-yr	PR	7234.00	5579.31	5589.66	5589.66	5593.72	0.013592	16.63	481.16	64.29	0.97
South Fork	18529	100-yr	EX	7234.00	5573.37	5587.13	5587.13	5590.04	0.007284	14.61	604.28	96.77	0.73
South Fork	18529	100-yr	PR	7234.00	5573.37	5587.13	5587.13	5590.04	0.007278	14.60	604.47	96.77	0.73
South Fork	18274	100-yr	EX	7234.00	5568.43	5582.52	5582.52	5585.52	0.009048	14.30	527.38	85.45	0.73
South Fork	18274	100-yr	PR	7234.00	5568.43	5582.52	5582.52	5585.52	0.009048	14.30	527.38	85.45	0.73
South Fork	18017	100-yr	EX	7234.00	5565.76	5576.36	5576.36	5578.74	0.008006	13.67	617.45	112.32	0.76
South Fork	18017	100-yr	PR	7234.00	5565.76	5576.36	5576.36	5578.74	0.008006	13.67	617.45	112.32	0.76
South Fork	17767	100-yr	EX	7234.00	5564.66	5572.91	5572.91	5575.10	0.009987	12.23	624.71	138.36	0.80
South Fork	17767	100-yr	PR	7234.00	5564.66	5572.91	5572.91	5575.10	0.009987	12.23	624.71	138.36	0.80
South Fork	17519	100-yr	EX	7234.00	5559.05	5570.48	5570.48	5572.47	0.008279	12.69	740.19	165.81	0.74
South Fork	17519	100-yr	PR	7234.00	5559.05	5567.60	5567.60	5570.43	0.018693	14.42	567.60	103.60	0.98
South Fork	17202	100-yr	EX	7234.00	5554.85	5563.39	5563.39	5565.61	0.014001	14.61	716.37	150.19	0.93
South Fork	17202	100-yr	PR	7234.00	5554.78	5562.87	5562.38	5564.48	0.010982	11.67	800.08	167.01	0.81
South Fork	16961	100-yr	EX	7234.00	5552.40	5560.03	5560.03	5562.14	0.013930	12.60	702.64	166.78	0.92
South Fork	16961	100-yr	PR	7234.00	5552.40	5559.54	5559.54	5561.54	0.014485	12.01	701.89	172.41	0.92
South Fork	16757	100-yr	EX	7234.00	5548.57	5558.32	5557.36	5559.41	0.006799	10.51	1025.11	204.94	0.66
South Fork	16757	100-yr	PR	7234.00	5548.58	5557.22	5555.53	5558.11	0.005534	9.10	1073.14	198.43	0.59
South Fork	16437	100-yr	EX	7234.00	5542.58	5553.77	5553.16	5556.63	0.009864	15.04	646.27	105.82	0.84
South Fork	16437	100-yr	PR	7234.00	5542.58	5552.48	5552.20	5555.40	0.011772	14.36	584.17	97.03	0.86
South Fork	15910	100-yr	EX	7234.00	5540.29	5547.92	5547.92	5550.43	0.013804	13.07	612.94	143.47	0.92
South Fork	15910	100-yr	PR	7234.00	5537.57	5545.56	5545.56	5548.46	0.014757	13.79	549.14	101.16	0.95
South Fork	15543	100-yr	EX	7234.00	5530.04	5539.83	5539.83	5541.54	0.010160	13.22	1039.15	377.98	0.81
South Fork	15543	100-yr	PR	7234.00	5529.85	5536.93	5536.93	5537.89	0.009382	10.68	1293.69	517.13	0.75
South Fork	15044	100-yr	EX	7234.00	5522.35	5531.81	5531.81	5533.77	0.008568	12.62	895.18	311.06	0.76
South Fork	15044	100-yr	PR	7234.00	5524.01	5531.25		5531.83	0.007280	8.31	1433.86	501.05	0.64
South Fork	14567	100-yr	EX	7234.00	5520.16	5525.66		5526.42	0.010982	9.19	1179.48	389.51	0.78
South Fork	14567	100-yr	PR	7234.00	5520.24	5525.98	5525.98	5527.01	0.014033	10.57	1115.87	470.42	0.88
South Fork	14423	100-yr	EX	7234.00	5517.59	5522.74	5522.74	5523.93	0.027326	11.43	902.74	387.90	1.22
South Fork	14423	100-yr	PR	7234.00	5516.62	5522.60	5522.60	5523.59	0.015125	10.95	1138.08	489.62	0.85
South Fork	14143	100-yr	EX	7234.00	5510.69	5517.44	5517.44	5518.64	0.012082	10.03	1012.49	408.36	0.82
South Fork	14143	100-yr	PR	7234.00	5509.79	5516.53	5516.53	5517.69	0.013686	11.61	1099.29	441.78	0.88
South Fork	13669	100-yr	EX	7234.00	5499.00	5509.40	5508.45	5510.67	0.007423	10.85	928.93	173.00	0.67
South Fork	13669	100-yr	PR	7234.00	5499.81	5509.02		5509.86	0.004814	7.61	1061.81	211.75	0.53
South Fork	13290	100-yr	EX	7234.00	5494.00	5504.26	5504.26	5507.03	0.012435	14.89	643.16	122.30	0.90
South Fork	13290	100-yr	PR	7234.00	5494.48	5502.61	5502.58	5506.38	0.018852	16.50	520.61	107.36	1.09
South Fork	12768	100-yr	EX	7234.00	5487.53	5498.91	5498.91	5500.39	0.006427	11.08	1092.94	398.76	0.65
South Fork	12768	100-yr	PR	7234.00	5487.78	5498.18	5498.18	5500.06	0.007242	11.62	886.57	371.53	0.69
South Fork	12220	100-yr	EX	7234.00	5483.23	5491.15	5490.18	5492.94	0.009590	12.01	866.94	244.29	0.78
South Fork	12220	100-yr	PR	7234.00	5483.37	5491.47	5491.47	5493.26	0.011310	12.50	877.86	265.82	0.84
South Fork	11851	100-yr	EX	7234.00	5480.16	5487.31	5487.31	5489.00	0.012898	12.55	831.06	245.95	0.89
South Fork	11851	100-yr	PR	7234.00	5479.18	5487.98	5487.98	5489.57	0.008599	11.99	979.17	295.35	0.75
South Fork	11459	100-yr	EX	7234.00	5476.42	5483.69	5482.76	5484.32	0.007929	8.46	1244.93	333.79	0.66
South Fork	11459	100-yr	PR	7234.00	5473.47	5482.41	5482.24	5483.72	0.008168	10.43	1019.87	328.99	0.70
South Fork	11090	100-yr	EX	7234.00	5469.86	5478.74	5478.74	5480.99	0.012911	12.62	673.40	293.62	0.88
South Fork	11090	100-yr	PR	7234.00	5469.72	5477.97	5477.97	5480.05	0.012422	13.07	726.92	224.46	0.88
South Fork	10660	100-yr	EX	7234.00	5466.85	5473.76	5473.76	5475.04	0.011945	11.56	1018.96	334.37	0.84

HEC-RAS River: South St Vrain Reach: South Fork Profile: 100-yr (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
South Fork	10660	100-yr	PR	7234.00	5467.02	5473.65	5473.41	5474.62	0.010041	10.52	1136.54	379.38	0.77
South Fork	10427	100-yr	EX	7234.00	5462.06	5470.44	5469.99	5471.49	0.006614	9.65	1133.24	327.80	0.65
South Fork	10427	100-yr	PR	7234.00	5462.06	5470.62	5470.07	5471.59	0.006172	9.68	1192.28	329.38	0.63
South Fork	10239	100-yr	EX	7234.00	5460.18	5469.76	5467.47	5470.44	0.003883	7.99	1310.97	304.87	0.51
South Fork	10239	100-yr	PR	7234.00	5460.18	5469.74	5467.75	5470.46	0.005058	9.78	1307.50	304.75	0.58
South Fork	10212			Bridge									
South Fork	10134	100-yr	EX	7234.00	5456.59	5468.58	5466.11	5469.19	0.003398	6.64	1254.26	314.87	0.46
South Fork	10134	100-yr	PR	7234.00	5456.59	5468.46	5466.11	5469.09	0.003634	6.78	1227.83	313.13	0.47
South Fork	9963	100-yr	EX	7234.00	5455.00	5463.37	5463.37	5465.17	0.011685	13.08	821.77	295.48	0.85
South Fork	9963	100-yr	PR	7234.00	5455.00	5462.91	5462.91	5464.86	0.011951	12.74	766.66	290.45	0.86
South Fork	9454	100-yr	EX	7234.00	5449.25	5457.69	5457.69	5459.55	0.009650	12.25	906.63	265.20	0.79
South Fork	9454	100-yr	PR	7234.00	5449.15	5456.93	5456.93	5458.87	0.010739	11.65	794.30	250.21	0.81
South Fork	8975	100-yr	EX	7234.00	5444.24	5450.13	5450.06	5451.24	0.011854	10.60	1180.99	461.89	0.83
South Fork	8975	100-yr	PR	7234.00	5441.93	5449.30	5449.30	5449.88	0.011058	6.55	1264.40	503.35	0.48
South Fork	8517	100-yr	EX	7234.00	5435.90	5445.46	5445.25	5446.77	0.008570	11.55	1149.64	351.52	0.72
South Fork	8517	100-yr	PR	7234.00	5437.56	5445.41		5445.87	0.004412	7.19	1504.07	374.88	0.51
South Fork	8021	100-yr	EX	7234.00	5429.57	5440.46	5440.46	5441.89	0.011933	11.23	957.74	322.70	0.81
South Fork	8021	100-yr	PR	7234.00	5429.84	5438.84	5438.84	5442.04	0.013843	15.15	544.50	300.56	0.95
South Fork	7529	100-yr	EX	7234.00	5427.40	5432.62	5432.57	5433.61	0.013912	10.71	1124.62	505.20	0.88
South Fork	7529	100-yr	PR	7234.00	5427.84	5432.93	5432.93	5433.80	0.015517	11.06	1211.78	546.94	0.92
South Fork	7041	100-yr	EX	7234.00	5419.40	5424.91	5424.54	5425.67	0.018480	10.33	1210.23	461.45	0.96
South Fork	7041	100-yr	PR	7234.00	5419.14	5424.51	5424.51	5425.56	0.018188	11.75	1187.65	488.32	0.99
South Fork	6941	100-yr	EX	7234.00	5418.40	5424.13	5423.00	5424.49	0.008625	7.56	1716.84	603.48	0.66
South Fork	6941	100-yr	PR	7234.00	5419.00	5424.13	5422.97	5424.45	0.004763	4.59	1635.58	594.85	0.48
South Fork	6797	100-yr	EX	7234.00	5416.47	5422.61	5422.17	5423.21	0.010181	8.49	1498.84	638.52	0.73
South Fork	6797	100-yr	PR	7234.00	5416.78	5422.64	5422.48	5423.39	0.012040	10.34	1447.62	643.79	0.82
South Fork	6707	100-yr	EX	7234.00	5416.68	5421.19	5421.19	5422.04	0.017299	10.18	1286.03	650.58	0.94
South Fork	6707	100-yr	PR	7234.00	5415.34	5421.49	5421.49	5422.35	0.012019	10.73	1434.63	652.43	0.83
South Fork	6536	100-yr	EX	7234.00	5413.62	5418.89		5419.35	0.008691	7.42	1653.28	769.96	0.67
South Fork	6536	100-yr	PR	7234.00	5413.65	5419.54		5420.11	0.009519	9.27	1668.74	798.70	0.73
South Fork	6344	100-yr	EX	7234.00	5411.14	5416.57	5416.57	5417.49	0.011057	9.14	1293.57	652.16	0.78
South Fork	6344	100-yr	PR	7234.00	5412.26	5416.78	5416.78	5417.60	0.020586	11.07	1234.31	663.43	1.03
South Fork	6033	100-yr	EX	7234.00	5404.84	5411.85	5411.85	5412.69	0.011531	10.58	1394.50	674.10	0.81
South Fork	6033	100-yr	PR	7234.00	5404.84	5411.77	5411.77	5412.62	0.011875	10.63	1383.26	672.66	0.82
South Fork	5668	100-yr	EX	7234.00	5399.52	5407.23	5407.23	5408.25	0.011451	11.19	1418.03	594.56	0.82
South Fork	5668	100-yr	PR	7234.00	5399.52	5406.75	5406.65	5407.54	0.011968	10.19	1458.77	591.75	0.81
South Fork	5329	100-yr	EX	7234.00	5394.82	5400.78	5400.78	5402.25	0.023045	11.43	802.41	360.56	1.07
South Fork	5329	100-yr	PR	7234.00	5395.44	5400.19	5400.19	5401.76	0.025616	12.42	779.95	290.64	1.14
South Fork	5056	100-yr	EX	7234.00	5388.00	5397.26		5398.29	0.007515	10.78	1121.16	277.98	0.67
South Fork	5056	100-yr	PR	7234.00	5389.79	5397.08		5397.73	0.005433	8.01	1369.17	366.18	0.57
South Fork	4703	100-yr	EX	7234.00	5383.94	5393.75	5393.75	5395.47	0.007383	12.28	1072.61	303.17	0.72
South Fork	4703	100-yr	PR	7234.00	5384.41	5392.81	5392.81	5394.73	0.010809	11.65	824.75	286.72	0.81
South Fork	4480	100-yr	EX	7234.00	5381.90	5390.28	5390.28	5391.86	0.010184	12.14	1069.61	560.00	0.81
South Fork	4480	100-yr	PR	7234.00	5381.90	5390.36	5390.36	5391.76	0.009098	11.60	1132.74	569.90	0.76
South Fork	4154	100-yr	EX	7234.00	5376.40	5383.98	5383.98	5385.07	0.016908	12.04	1209.84	525.25	0.93
South Fork	4154	100-yr	PR	7234.00	5376.00	5383.83	5383.83	5384.91	0.012711	11.17	1271.14	515.31	0.85
South Fork	4107	100-yr	EX	7234.00	5374.20	5383.70	5382.32	5384.20	0.005153	7.85	1681.53	530.70	0.54
South Fork	4107	100-yr	PR	7234.00	5374.20	5383.63	5382.32	5384.15	0.005441	8.02	1639.87	527.83	0.56
South Fork	3985	100-yr	EX	7234.00	5374.20	5381.89	5381.89	5383.12	0.013861	12.51	1276.43	541.33	0.90
South Fork	3985	100-yr	PR	7234.00	5374.20	5381.65	5381.65	5383.01	0.014071	12.45	1209.47	507.86	0.91
South Fork	3763	100-yr	EX	7234.00	5371.29	5377.00	5377.00	5378.30	0.027786	12.97	1066.06	564.55	1.18
South Fork	3763	100-yr	PR	7234.00	5372.75	5377.99	5377.99	5378.84	0.016095	11.22	1415.20	710.21	0.94
South Fork	3602	100-yr	EX	7234.00	5369.00	5375.29	5374.36	5375.57	0.006266	7.57	2288.75	942.25	0.57
South Fork	3602	100-yr	PR	7234.00	5369.19	5375.20	5374.51	5375.69	0.007974	8.29	1911.63	872.83	0.67

HEC-RAS River: South St Vrain Reach: South Fork Profile: 100-yr (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
South Fork	3260	100-yr	EX	7234.00	5363.35	5371.89	5371.89	5373.03	0.008579	9.70	1299.50	658.50	0.71
South Fork	3260	100-yr	PR	7234.00	5363.52	5371.78	5371.78	5372.94	0.007963	9.59	1272.22	647.23	0.69
South Fork	2888	100-yr	EX	7234.00	5357.11	5367.40	5366.95	5368.71	0.007412	10.34	1073.79	400.70	0.68
South Fork	2888	100-yr	PR	7234.00	5357.41	5367.38		5368.34	0.004778	8.56	1181.19	398.42	0.55
South Fork	2651	100-yr	EX	7234.00	5354.85	5366.46	5363.44	5367.37	0.003405	8.14	1399.46	550.59	0.48
South Fork	2651	100-yr	PR	7234.00	5354.85	5366.46	5363.44	5367.37	0.003405	8.14	1399.46	550.59	0.48
South Fork	2620			Bridge									
South Fork	2588	100-yr	EX	7234.00	5352.98	5362.19	5362.19	5365.57	0.015965	14.77	489.89	193.08	0.99
South Fork	2588	100-yr	PR	7234.00	5352.98	5362.19	5362.19	5365.57	0.015965	14.77	489.89	193.08	0.99
South Fork	2458	100-yr	EX	7234.00	5349.68	5361.03	5360.62	5362.30	0.006051	10.41	1133.95	379.48	0.63
South Fork	2458	100-yr	PR	7234.00	5349.68	5361.03	5360.62	5362.30	0.006051	10.41	1133.95	379.48	0.63
South Fork	2396	100-yr	EX	7234.00	5350.96	5360.63	5360.63	5361.89	0.006717	10.58	1164.82	468.08	0.66
South Fork	2396	100-yr	PR	7234.00	5350.96	5360.63	5360.63	5361.89	0.006717	10.58	1164.82	468.08	0.66



REFERENCE DRAWINGS

AERIALS
Old St Vrain Road Bridge_JUB
South St Vrain Topo 05-23-2016
812-TITLEBLOCK-22x34
812-TITLEBLOCK-22x34

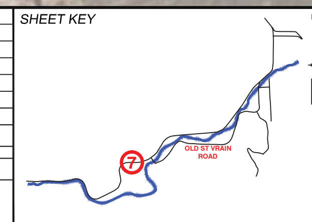
No.	DATE	DESCRIPTION	BY
#	#	#	#
#	#	#	#
#	#	#	#
#	#	#	#
#	#	#	#

REVISIONS

COMPUTER FILE MANAGEMENT

FILE NAME: R:\16.812.003 (South St Vrain Stream Restoration)\Dwg\Xref\FLOODPLAIN MAP 1.dwg
CTB FILE: ----
PLOT DATE: 9/18/2016 11:31 PM
THIS DRAWING IS CURRENT AS OF PLOT DATE AND MAY BE SUBJECT TO CHANGE.

SHEET KEY



PREPARED FOR:

Boulder County Parks & Open Space

PREPARED BY:

Matrix DESIGN GROUP
AN EMPLOYEE-OWNED COMPANY

PRELIMINARY
THIS DRAWING HAS NOT BEEN APPROVED BY GOVERNING AGENCIES AND IS SUBJECT TO CHANGE

FOR AND ON BEHALF OF MATRIX DESIGN GROUP, INC.
PROJECT No. ##########

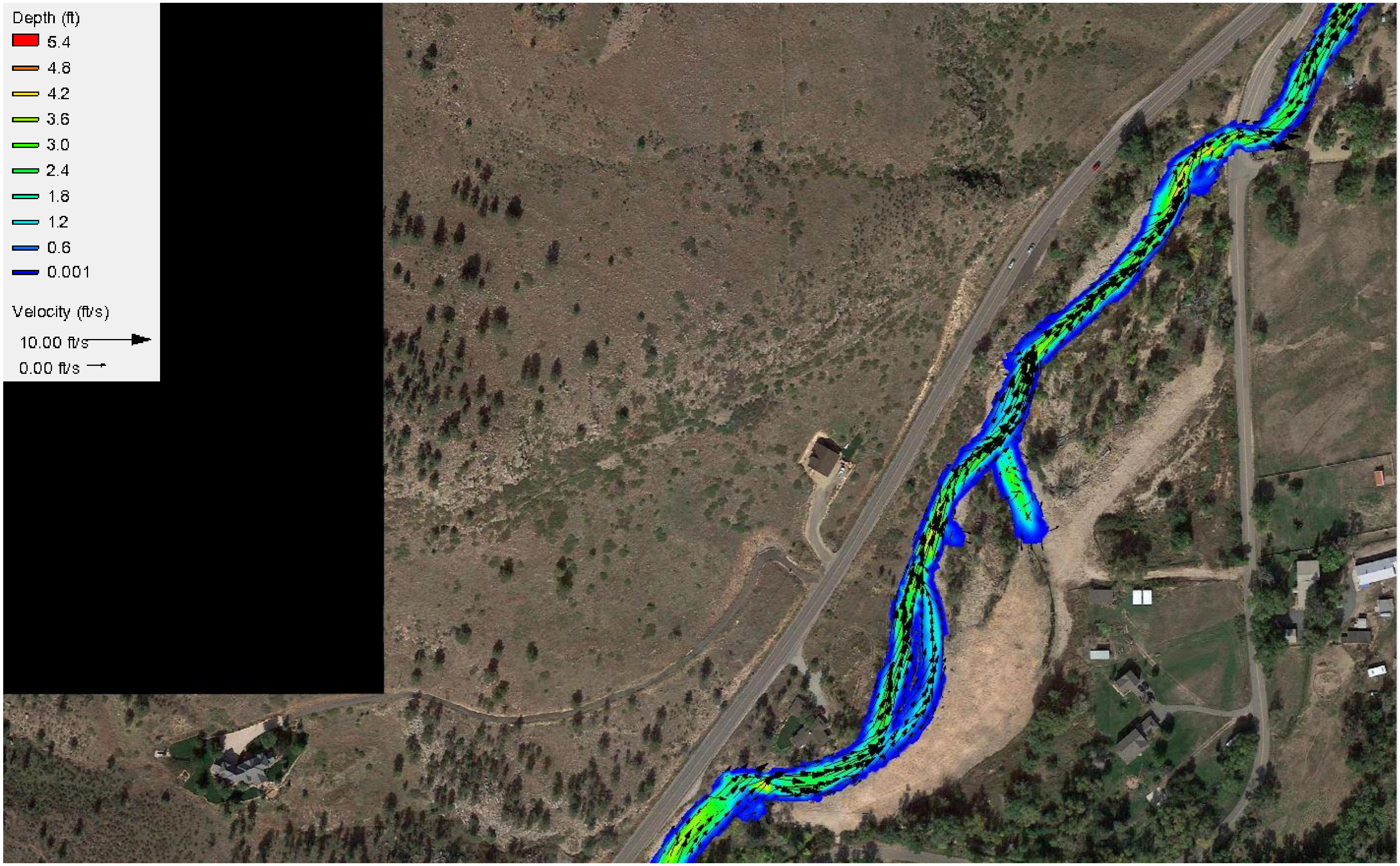
SOUTH ST. VRAIN CREEK RESTORATION

BOULDER COUNTY PARKS AND OPEN SPACE
30% DESIGNS

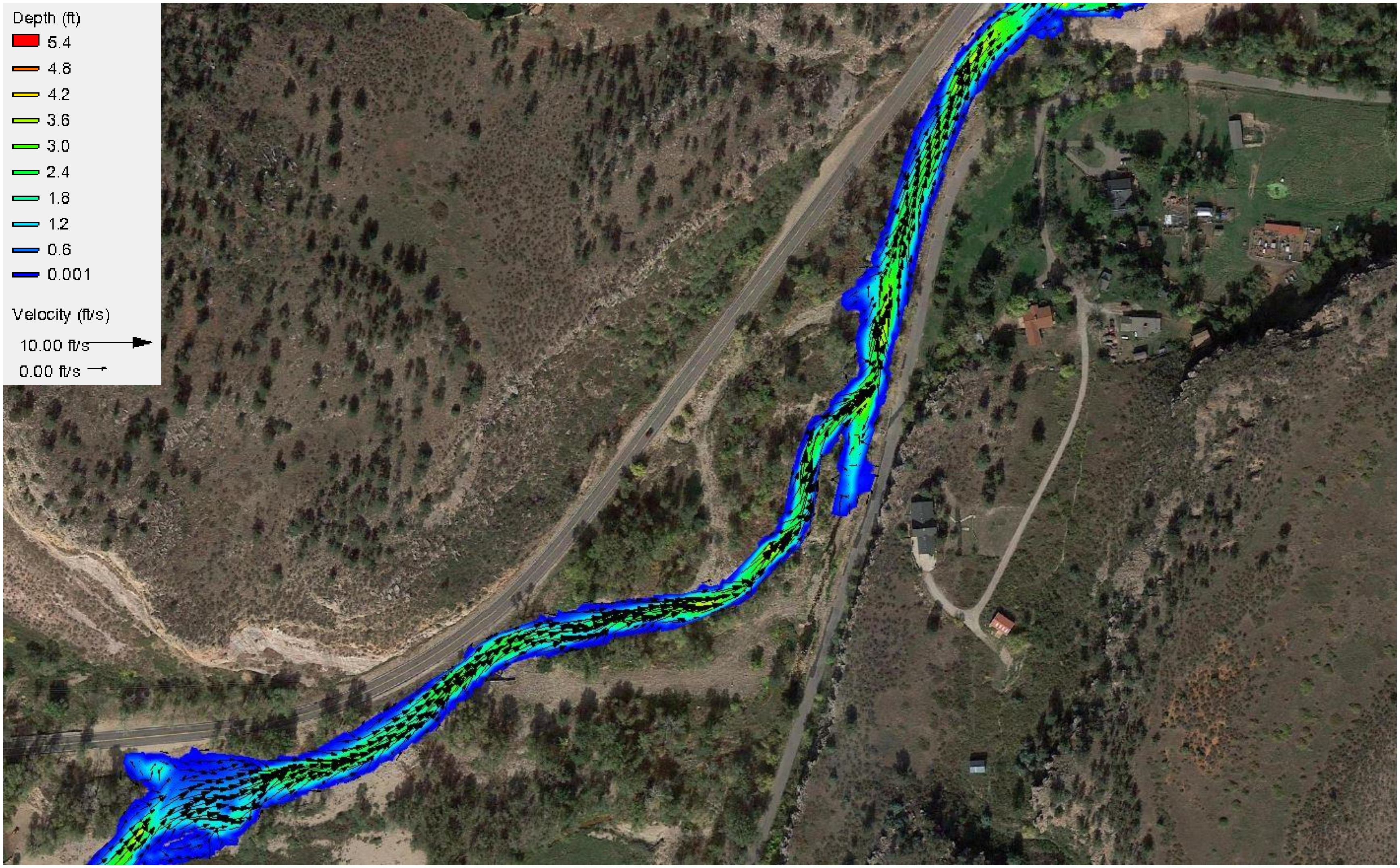
PRELIMINARY FLOODPLAIN MAP

DESIGNED BY: SDS	SCALE (22" X 34")	DATE ISSUED: 9/19/16	DRAWING No.
DRAWN BY: SDS	HORIZ. 1" = 400'	SHEET 1 OF 1	FPM
CHECKED BY: RDK	VERT. N/A		

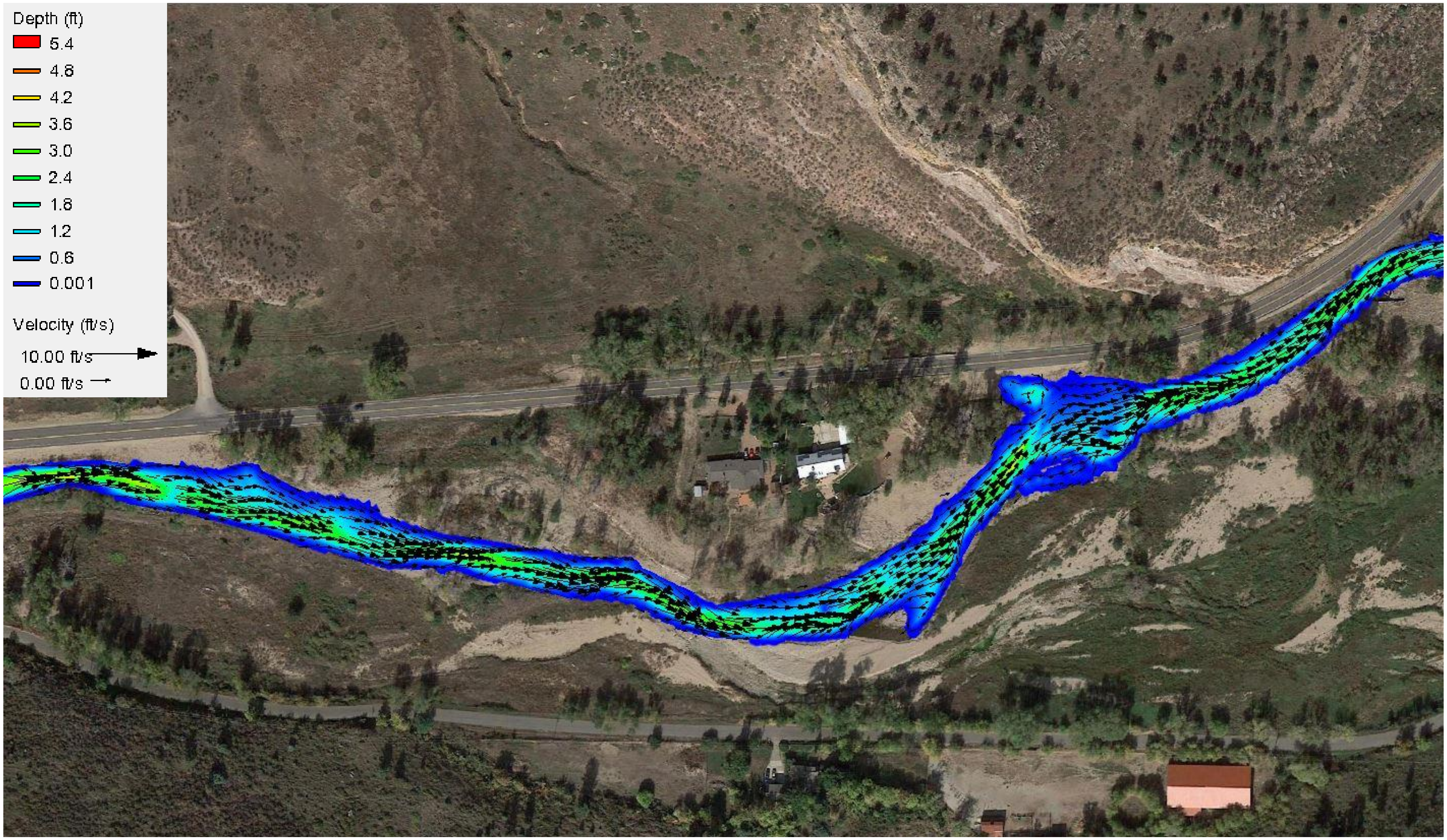
e. Appendix E – SRH 2D Hydraulic Model Output



Existing Conditions – $Q_{1.5}$ – Lower Section (Map 1)



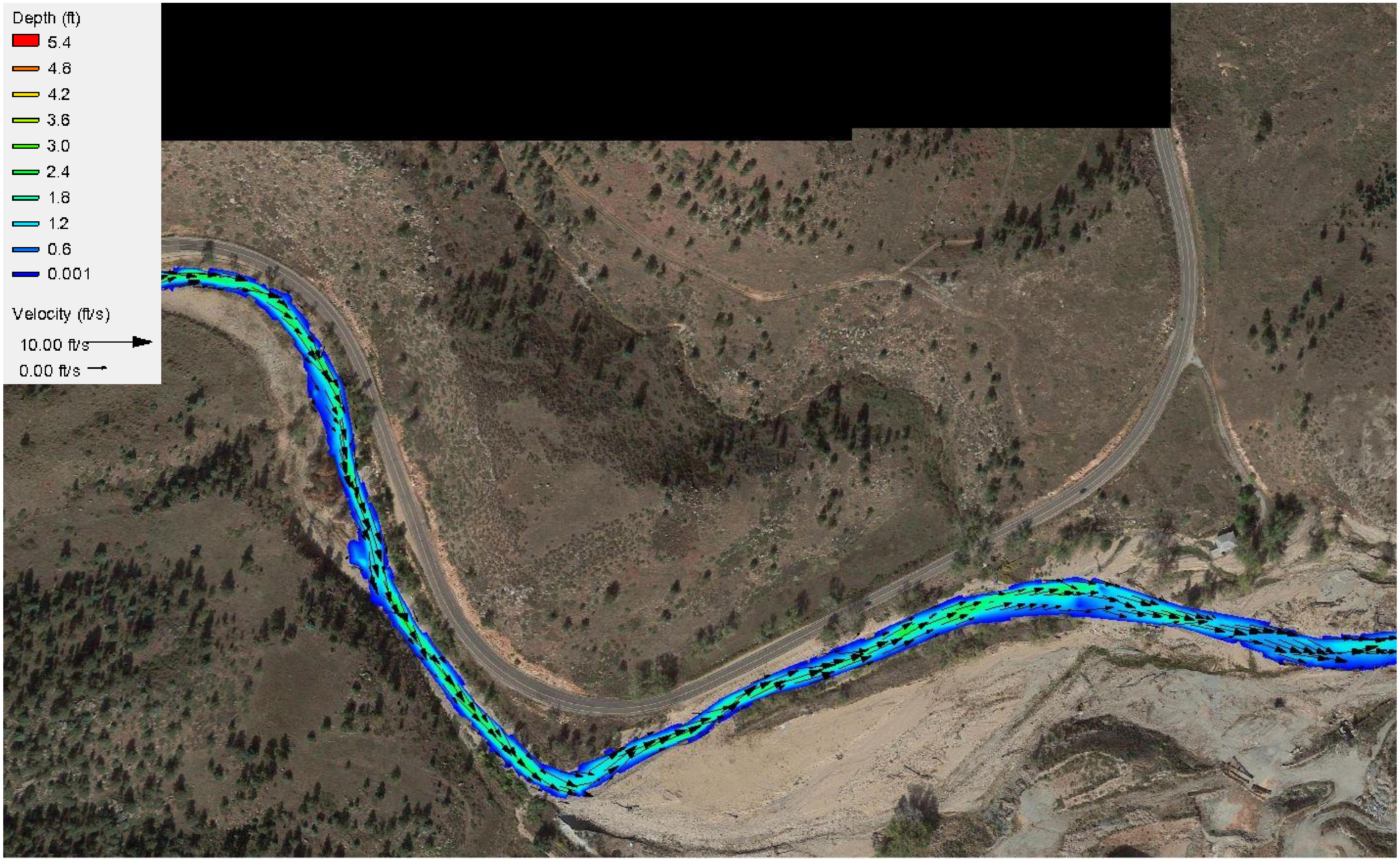
Existing Conditions – $Q_{1.5}$ – Lower Section (Map 2)



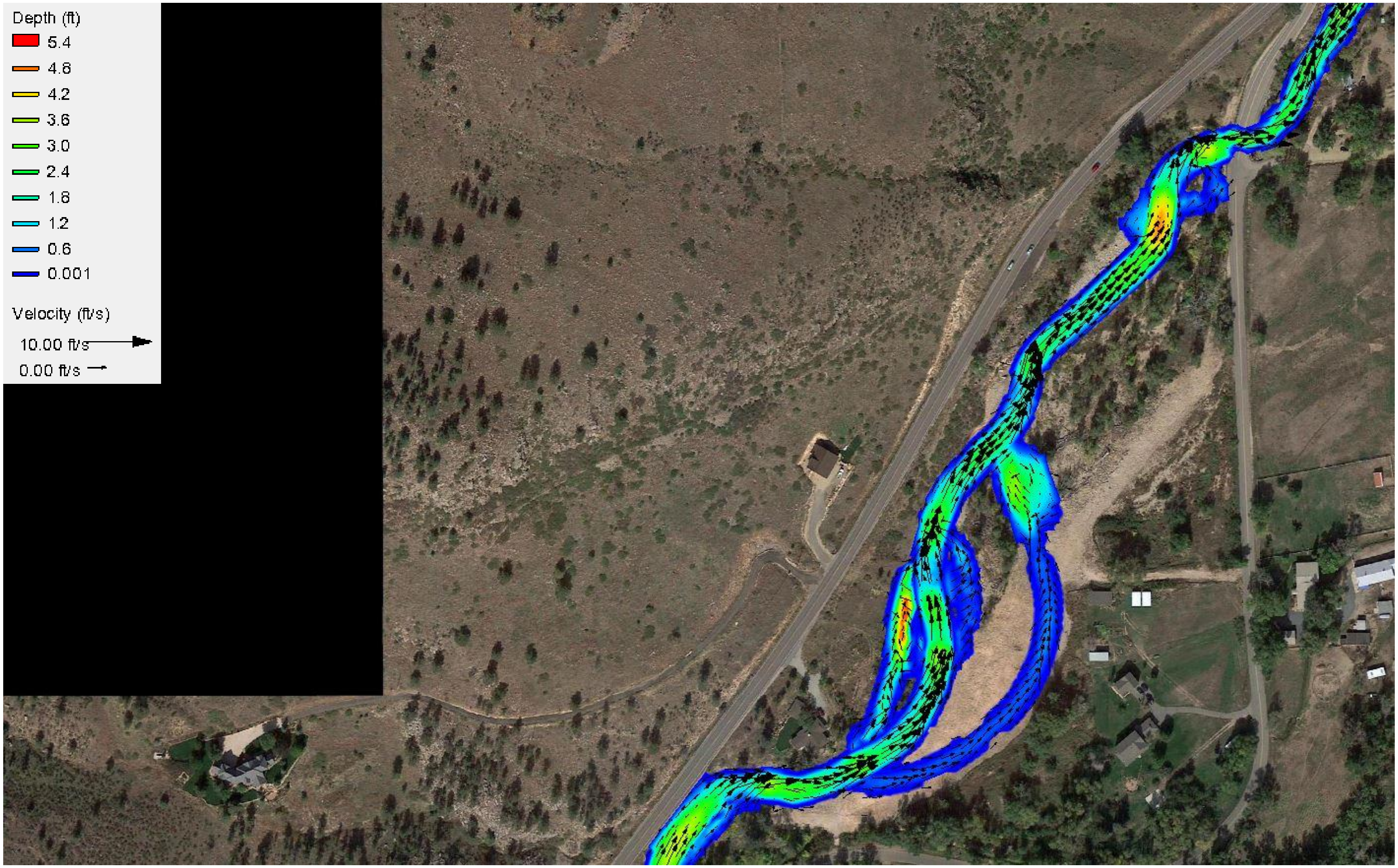
Existing Conditions – $Q_{1.5}$ – Lower Section (Map 3)

Existing Conditions – $Q_{1.5}$ – Upper Section (Map 1)

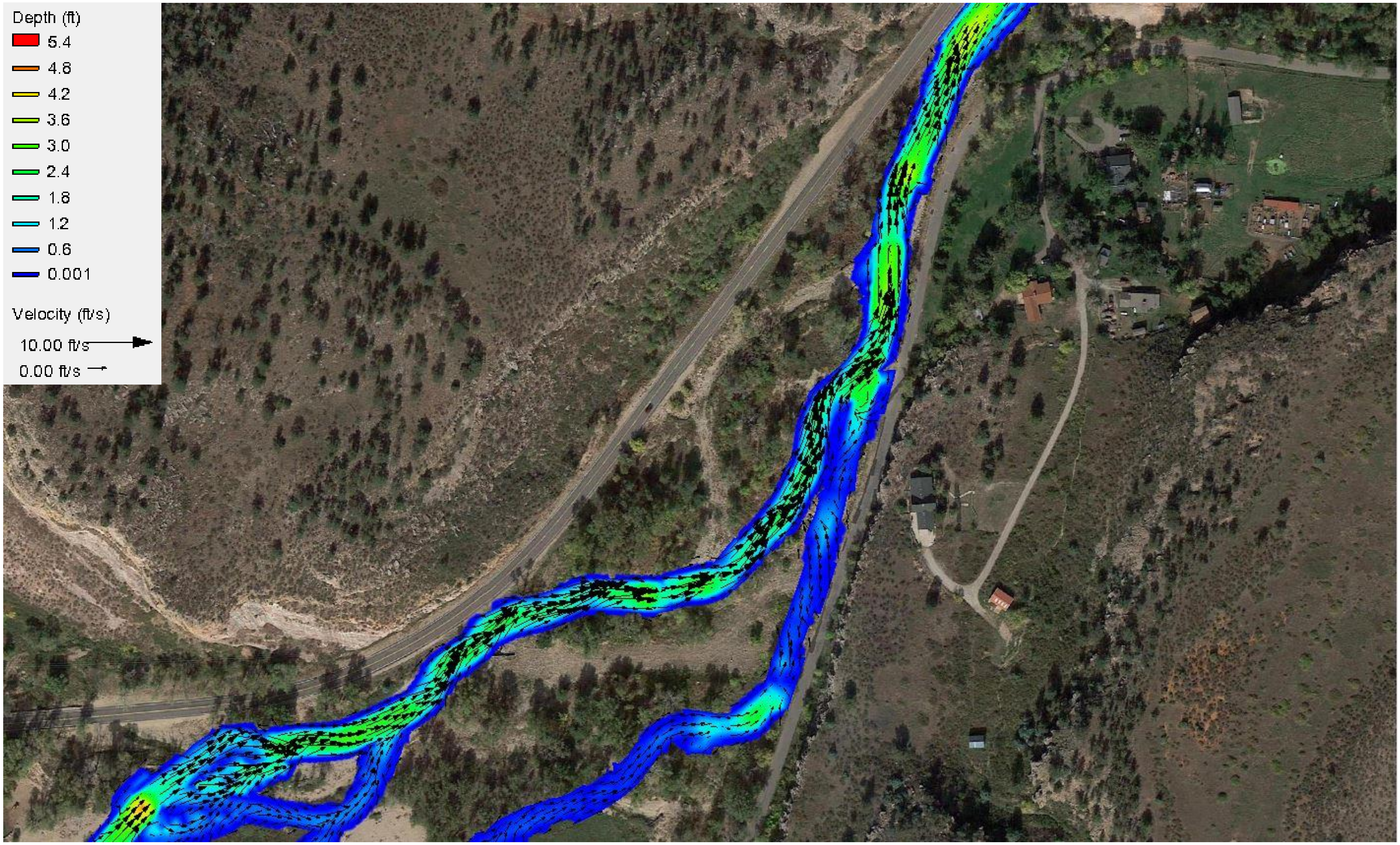
Existing Conditions – $Q_{1.5}$ – Upper Section (Map 2)



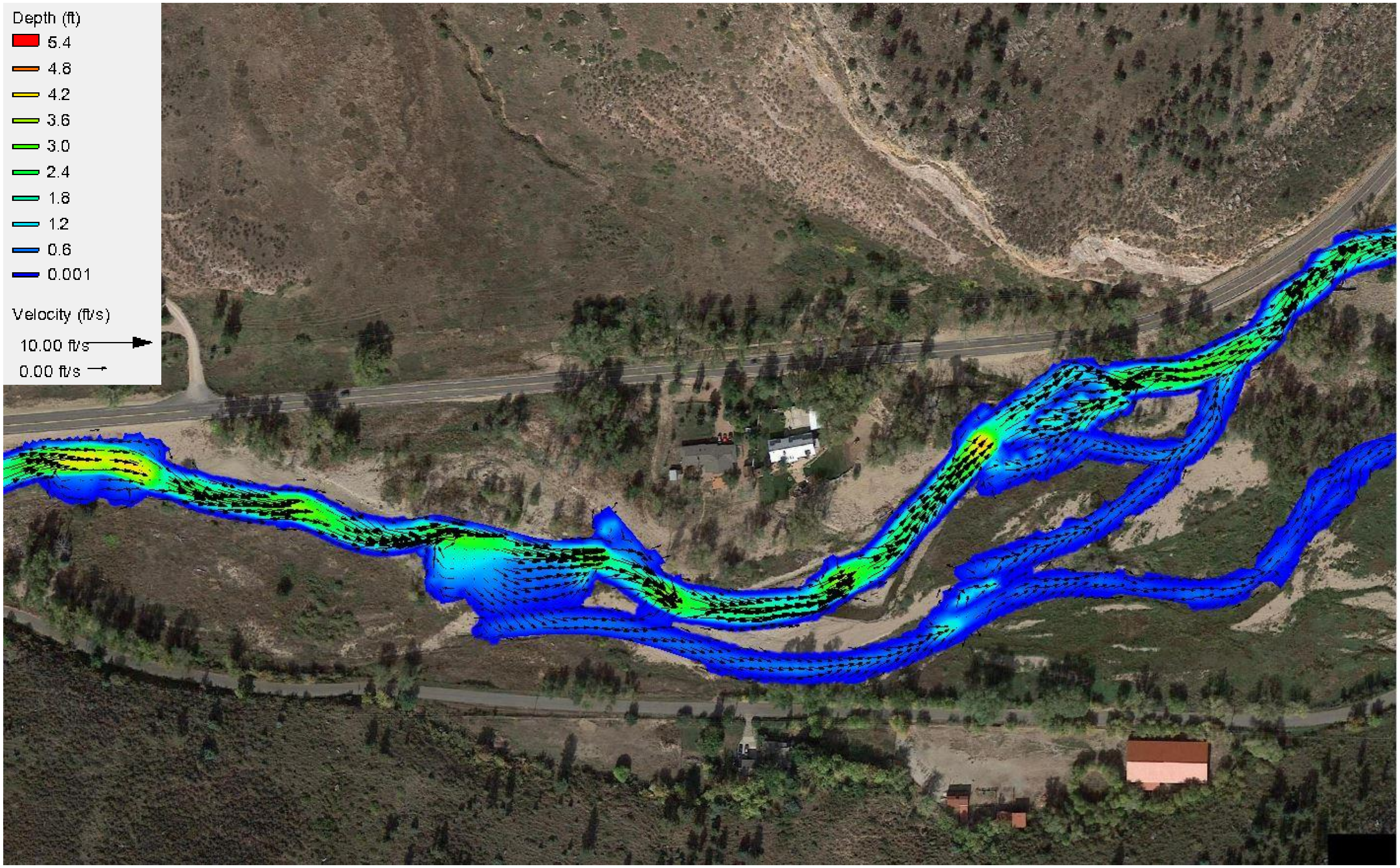
Existing Conditions – $Q_{1.5}$ – Upper Section (Map 3)



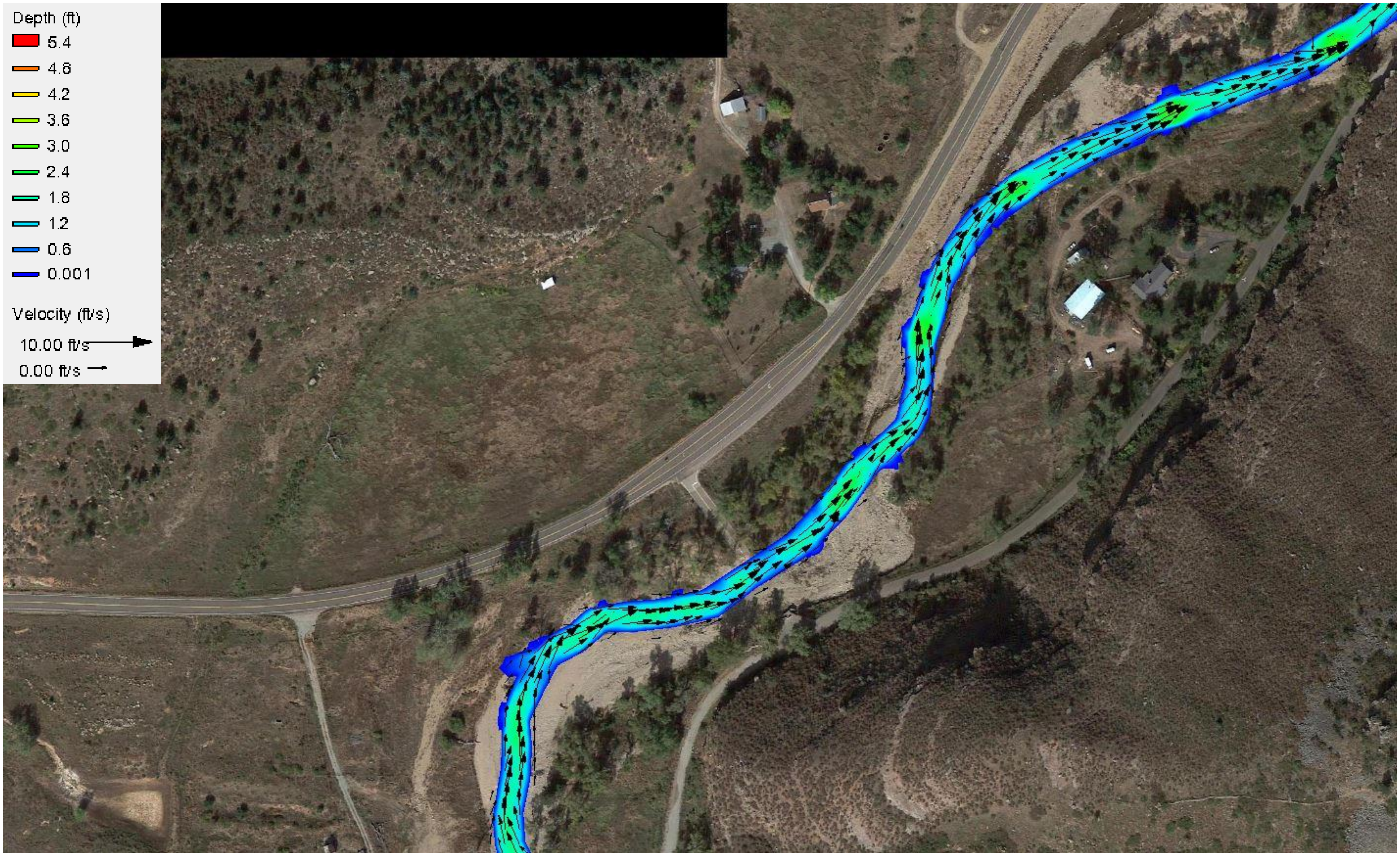
Proposed Conditions – $Q_{1.5}$ – Lower Section (Map 1)



Proposed Conditions – $Q_{1.5}$ – Lower Section (Map 2)

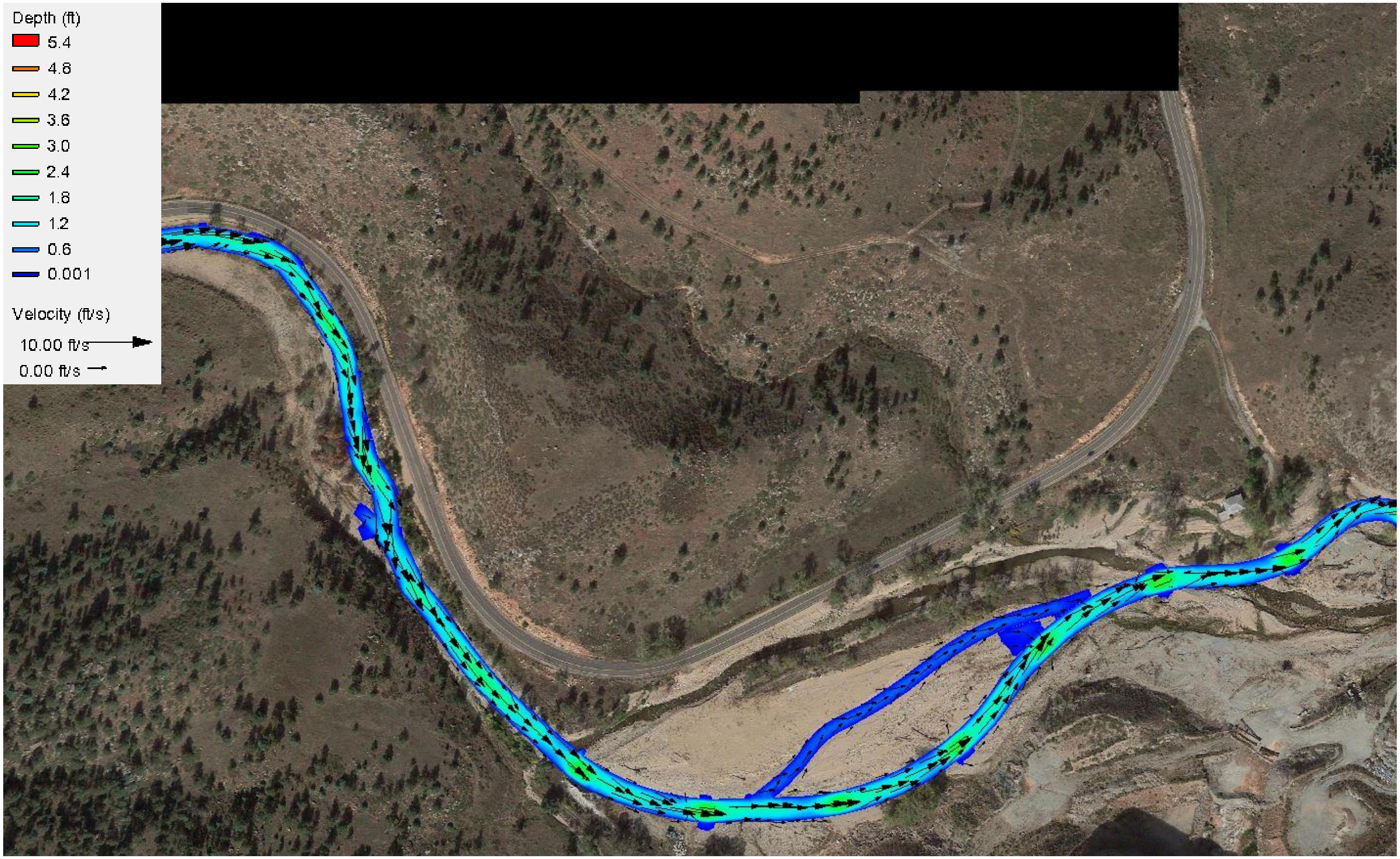


Proposed Conditions – $Q_{1.5}$ – Lower Section (Map 3)

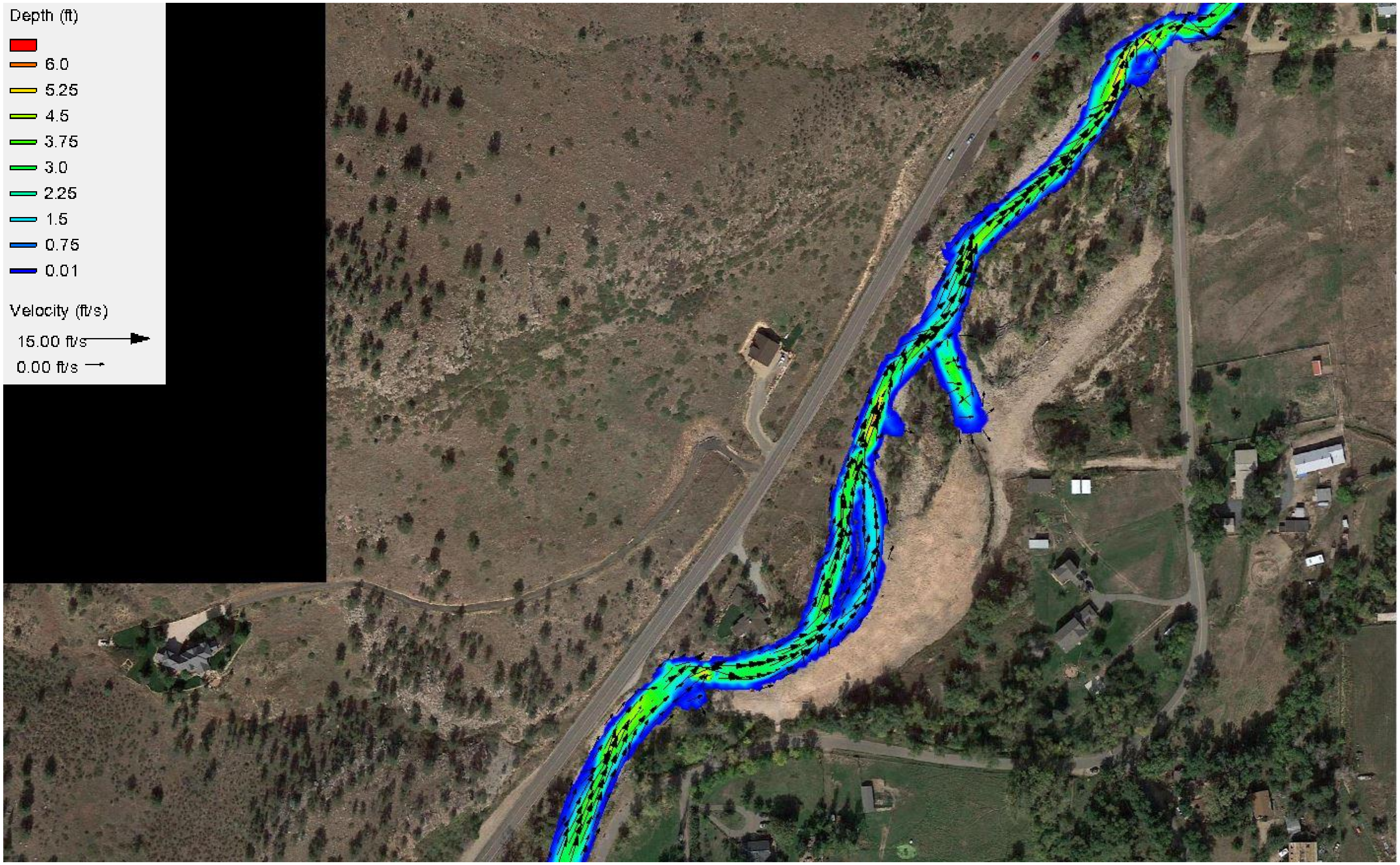


Proposed Conditions – $Q_{1.5}$ – Upper Section (Map 1)

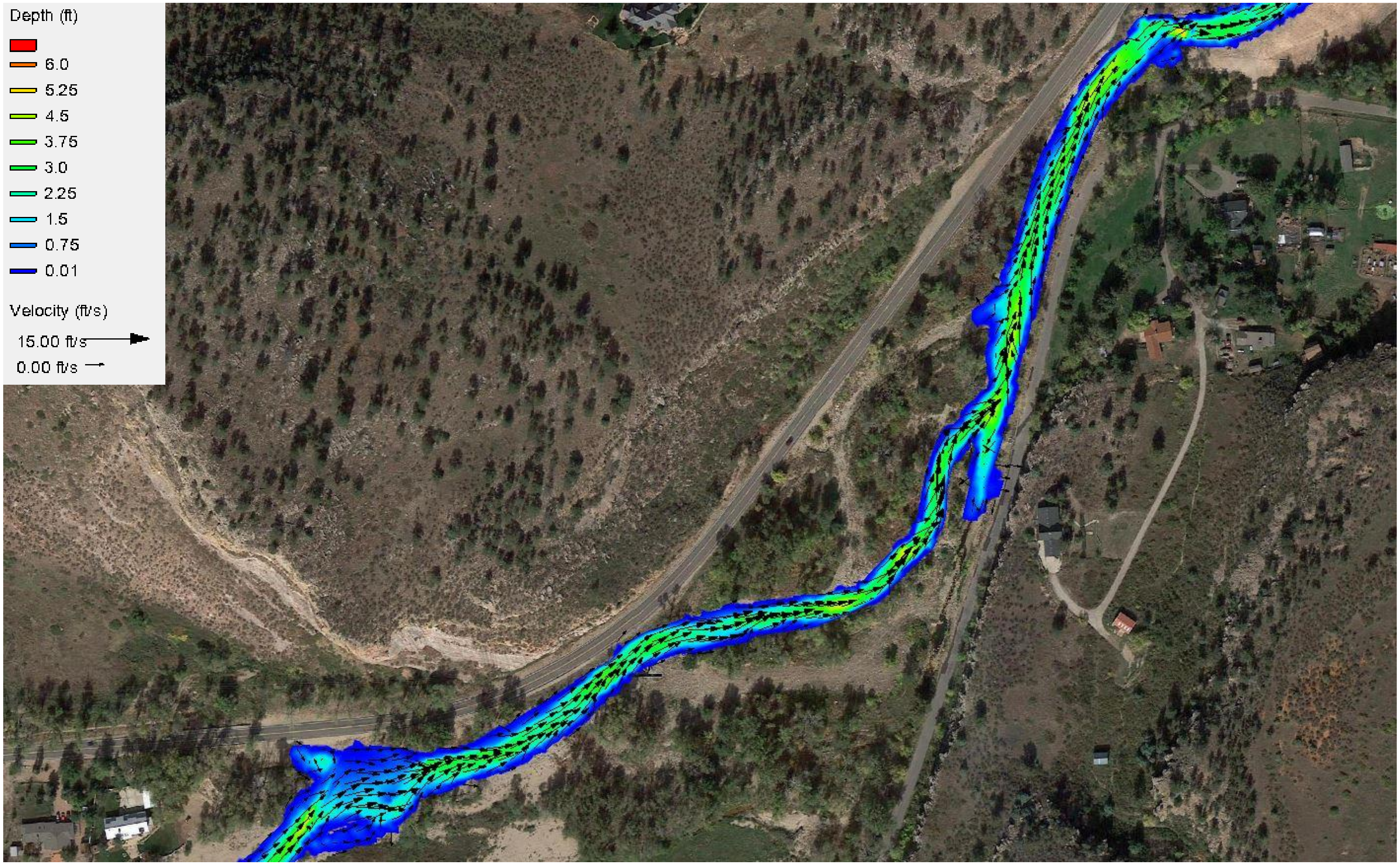
Proposed Conditions – $Q_{1.5}$ – Upper Section (Map 2)



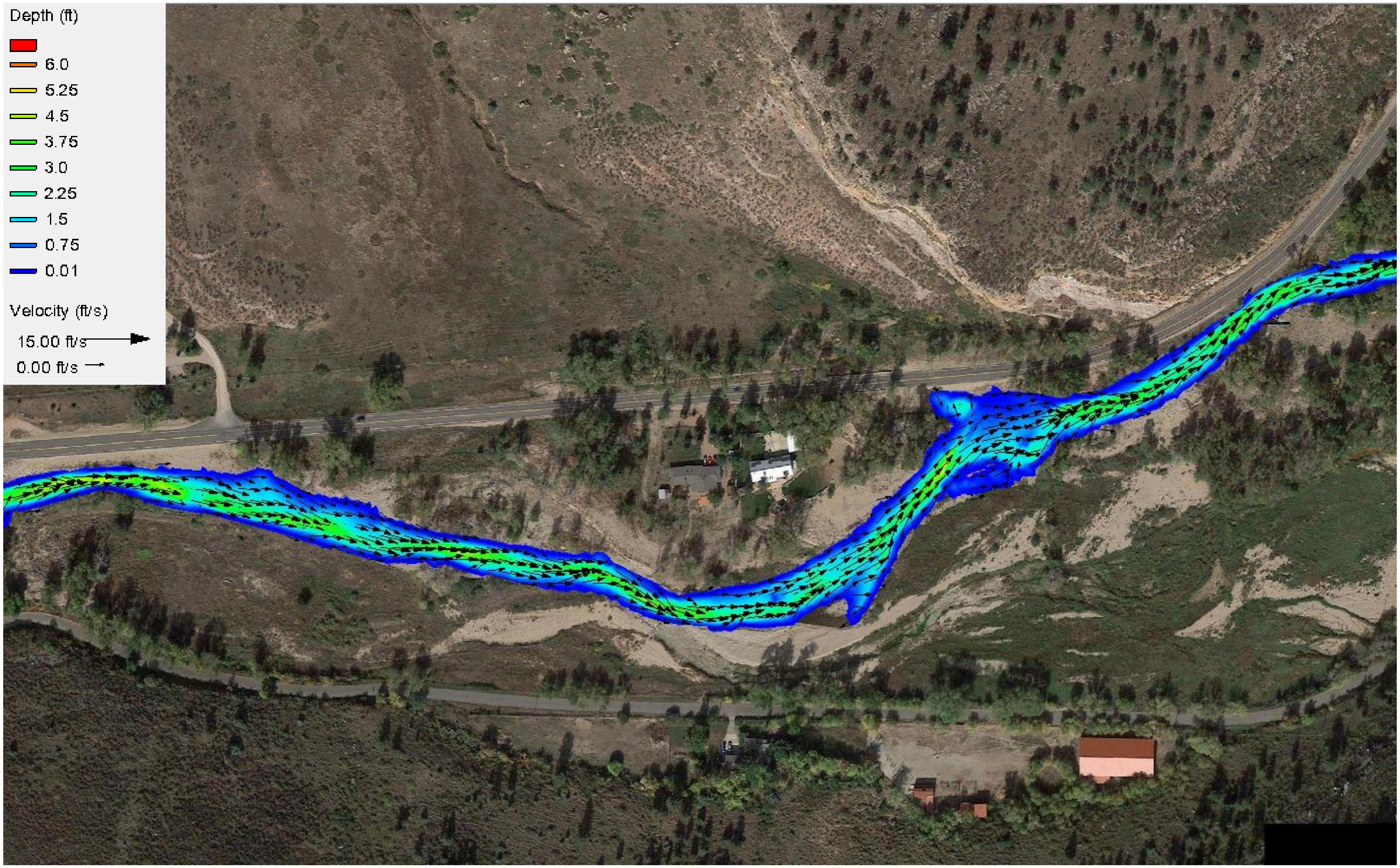
Proposed Conditions – $Q_{1.5}$ – Upper Section (Map 3)



Existing Conditions – Q_5 – Lower Section (Map 1)



Existing Conditions – Q_5 – Lower Section (Map 2)



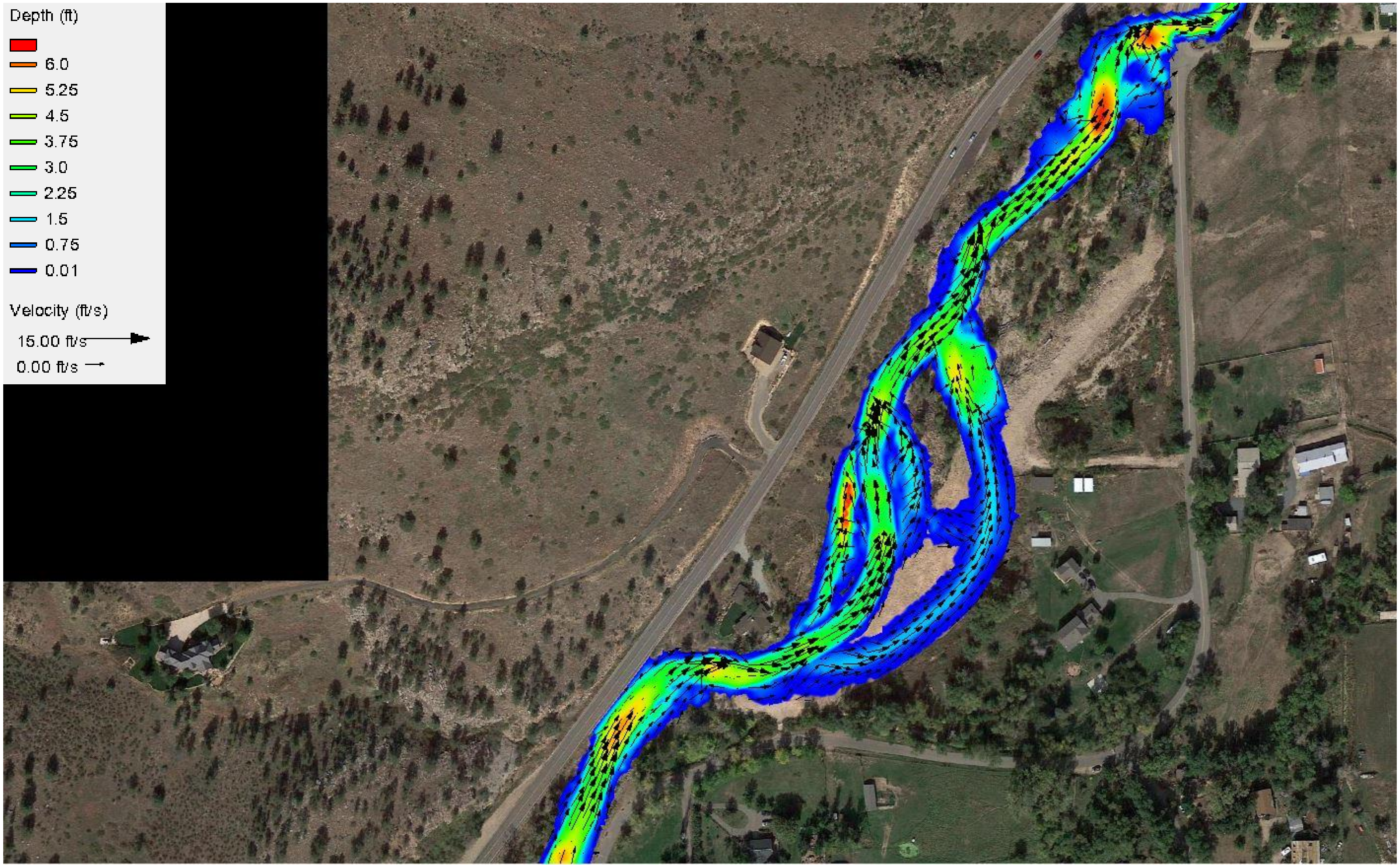
Existing Conditions – Q_5 – Lower Section (Map 3)

Existing Conditions – Q_5 – Upper Section (Map 1)

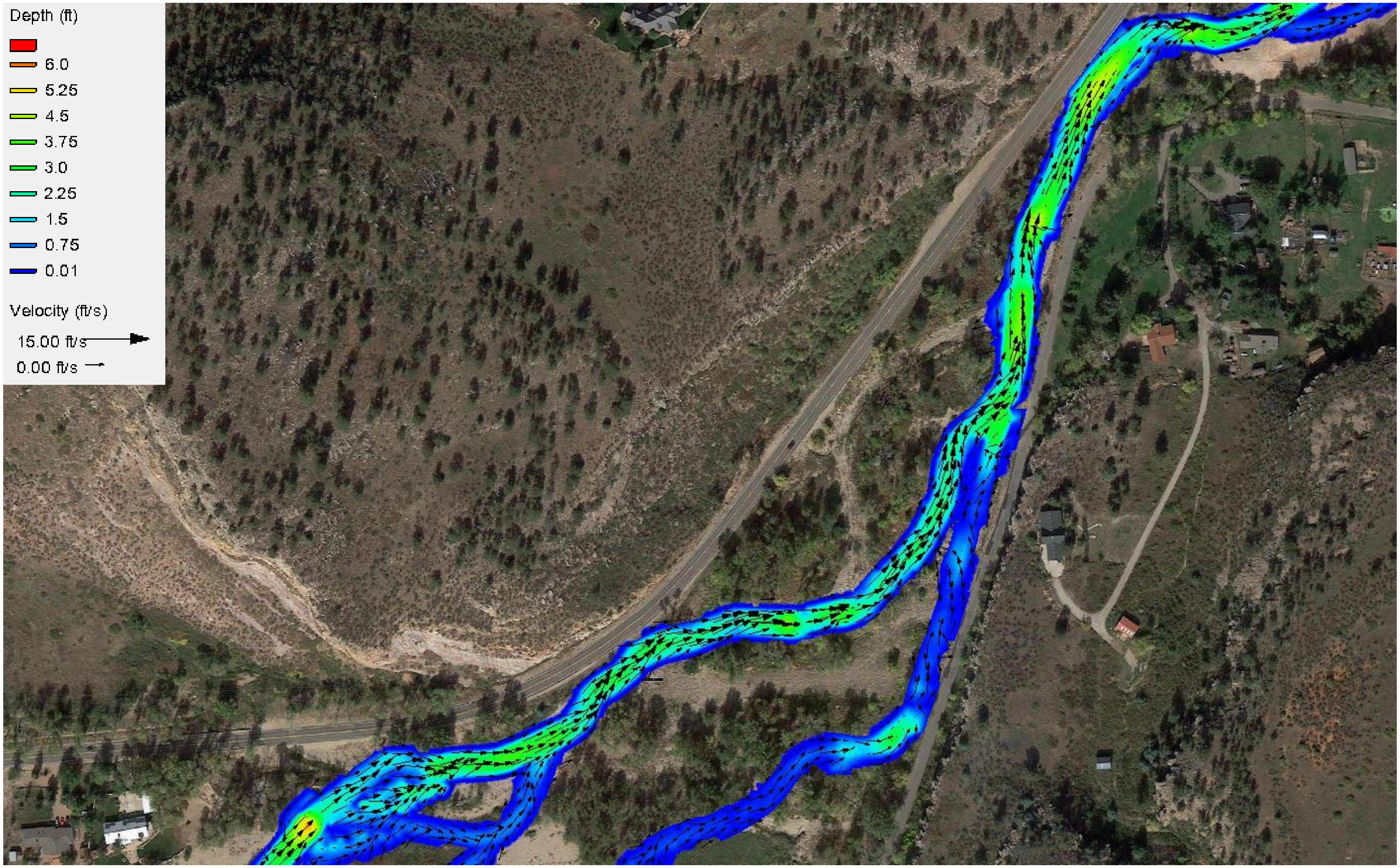
Existing Conditions – Q_5 – Upper Section (Map 2)

[redacted]

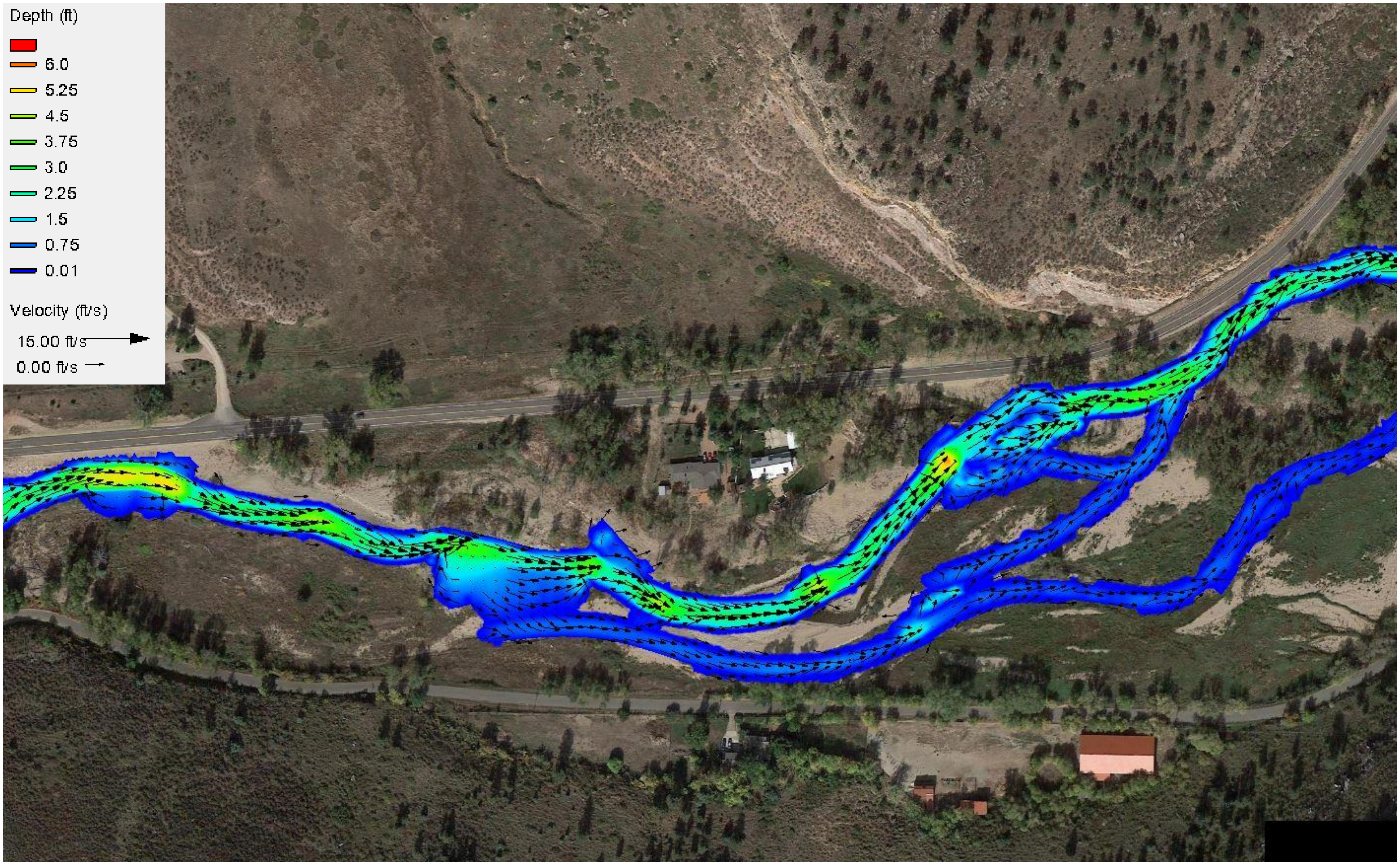
Existing Conditions – Q_5 – Upper Section (Map 3)



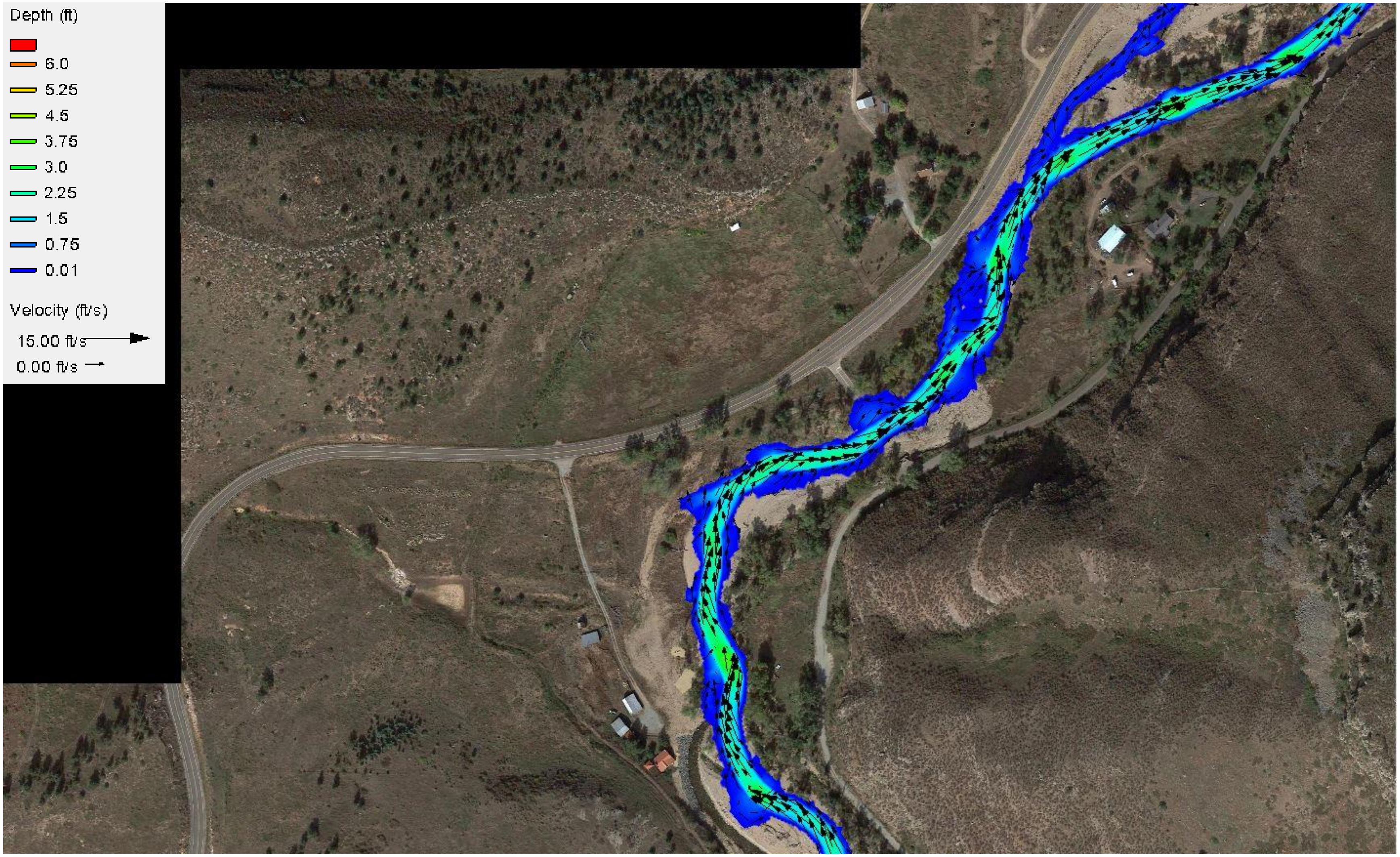
Proposed Conditions – Q_5 – Lower Section (Map 1)



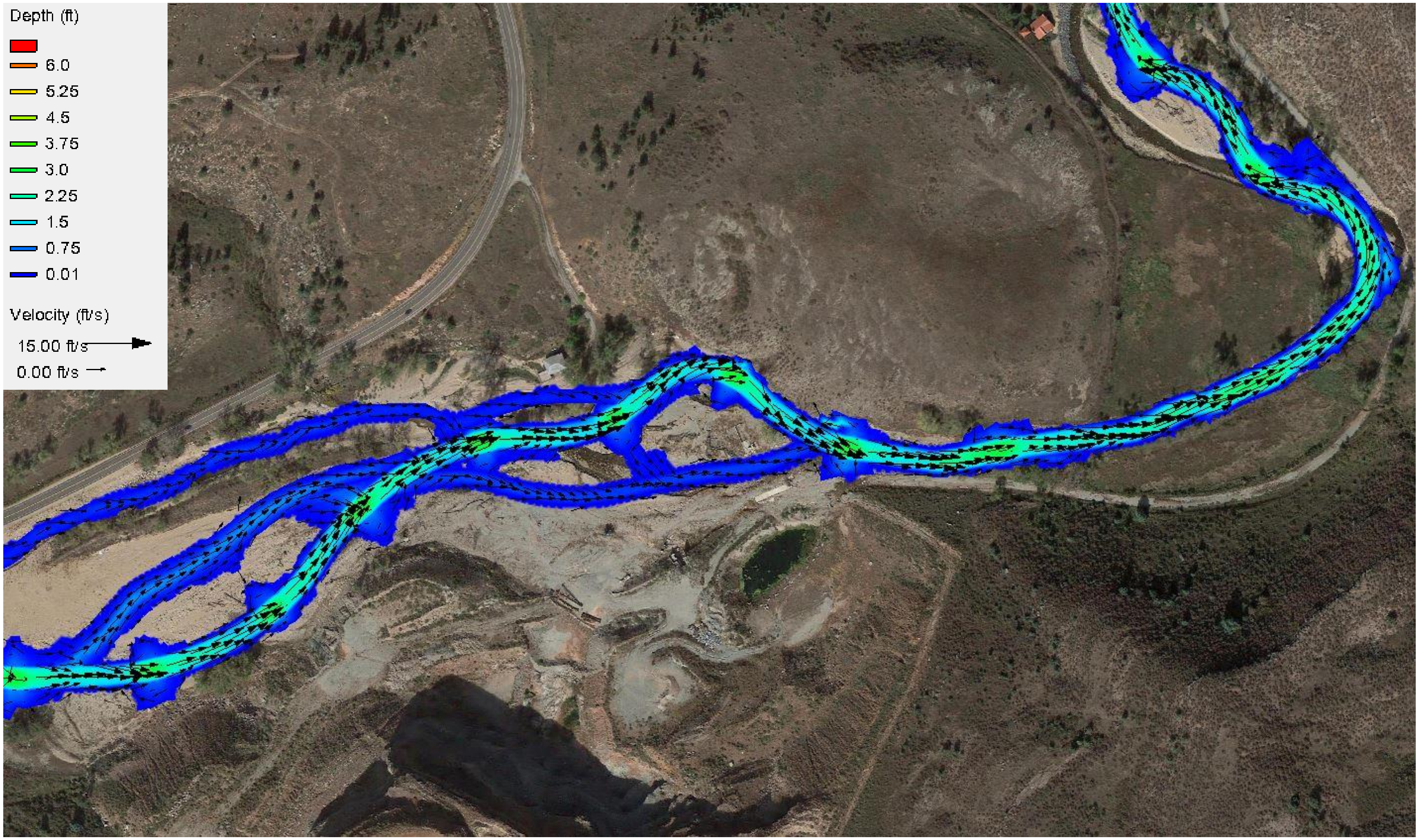
Proposed Conditions – Q_5 – Lower Section (Map 2)



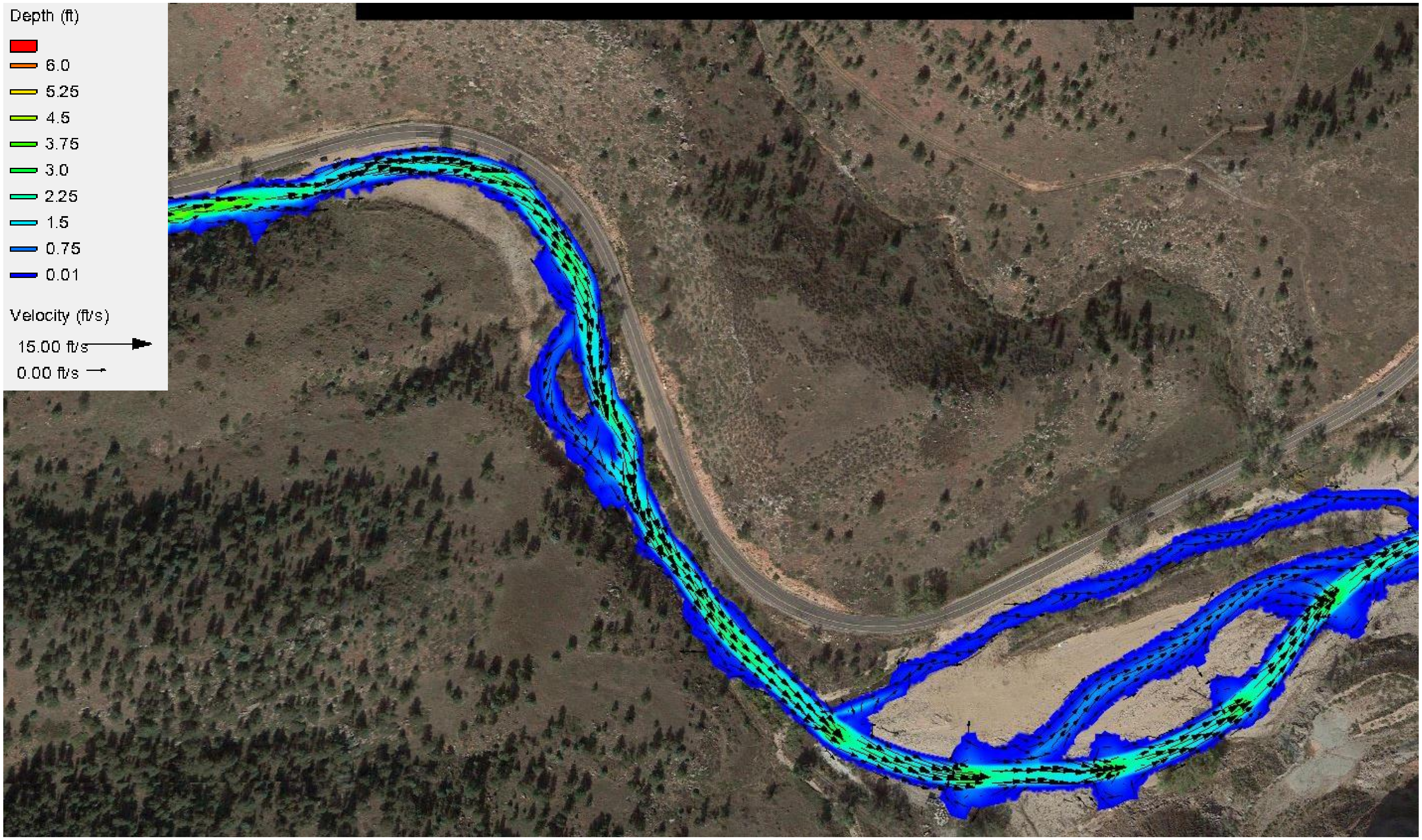
Proposed Conditions – Q_5 – Lower Section (Map 3)



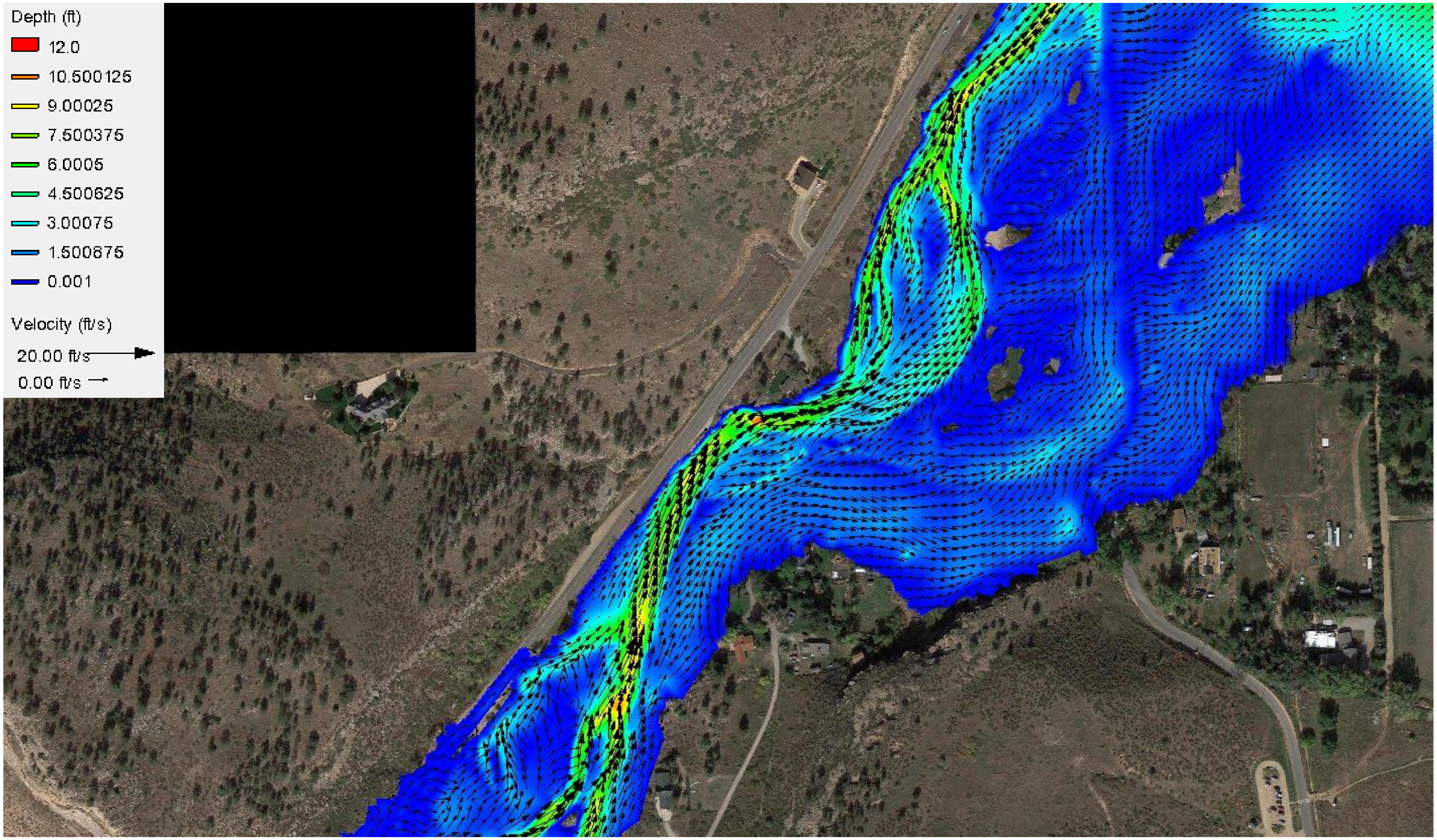
Proposed Conditions – Q_5 – Upper Section (Map 1)



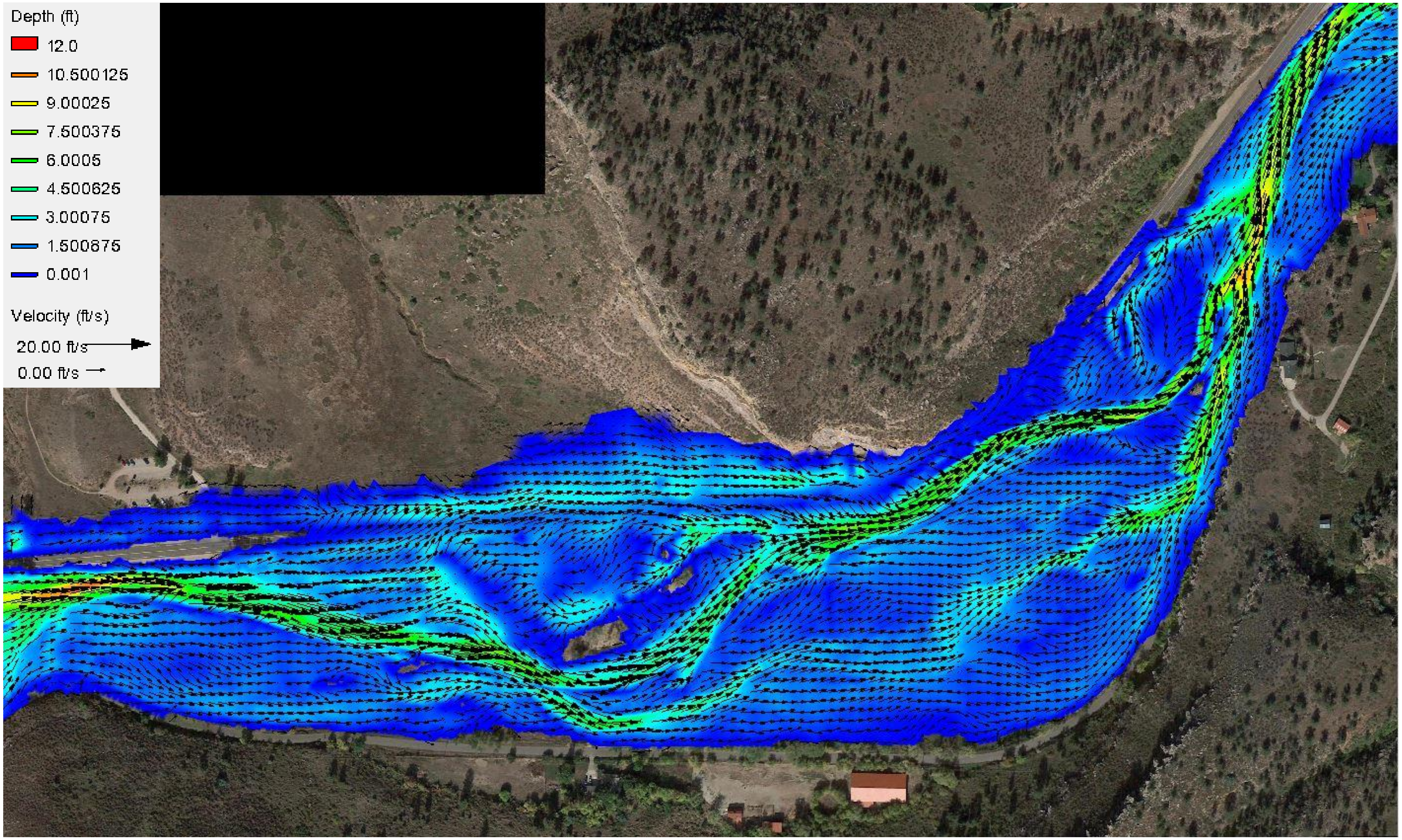
Proposed Conditions – Q_5 – Upper Section (Map 2)



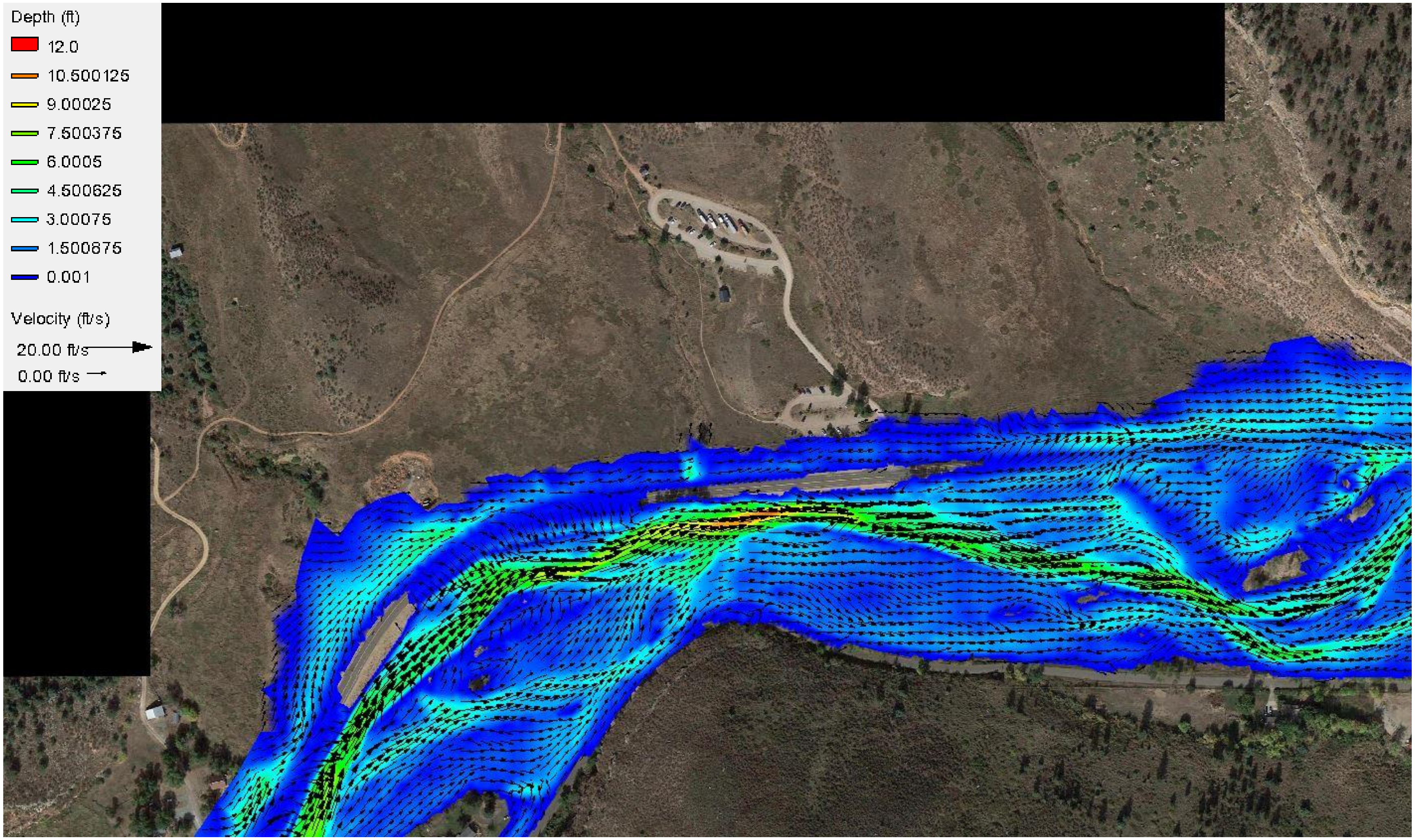
Proposed Conditions – Q_5 – Upper Section (Map 3)



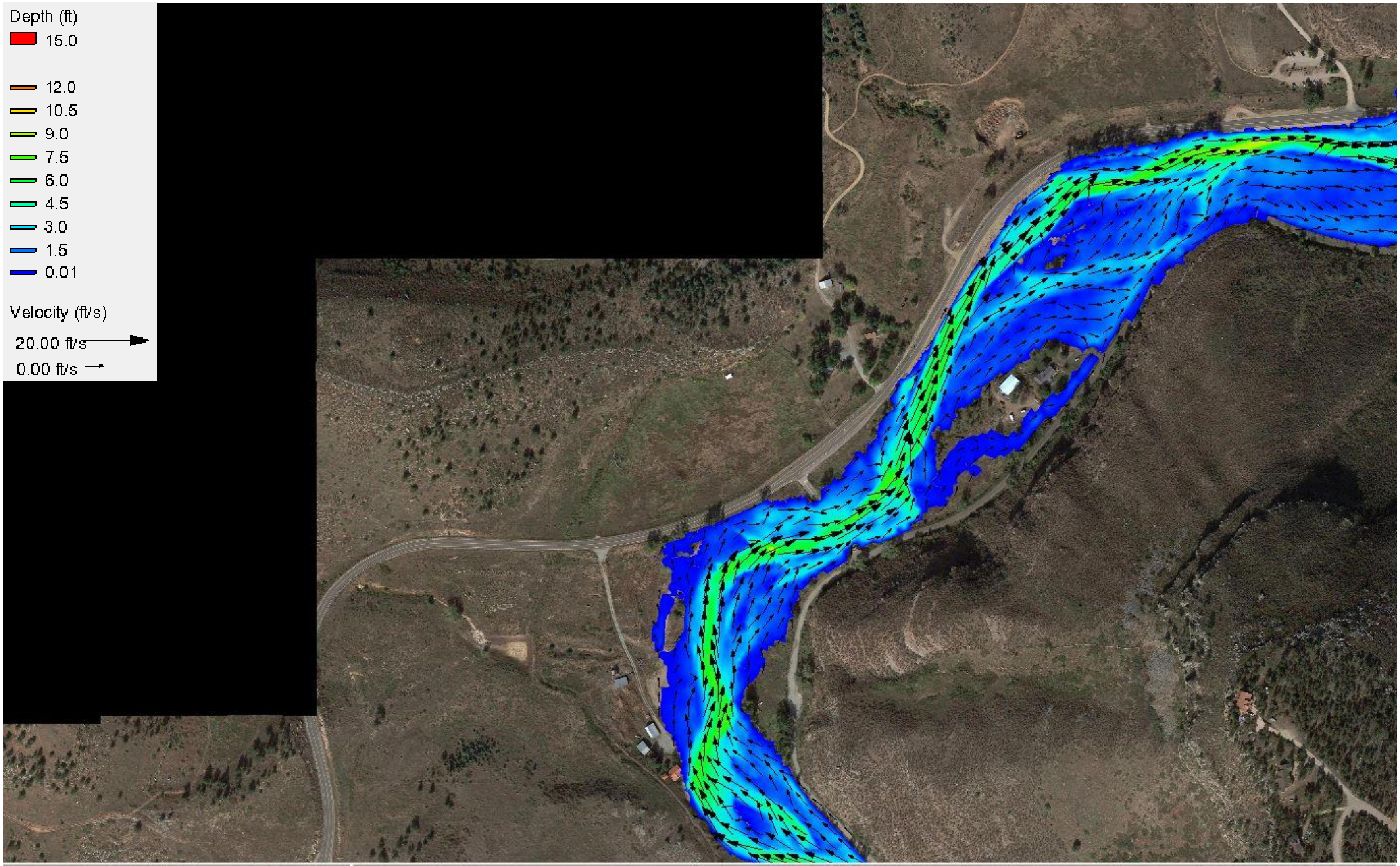
Existing Conditions – Q_{100} – Lower Section (Map 1)



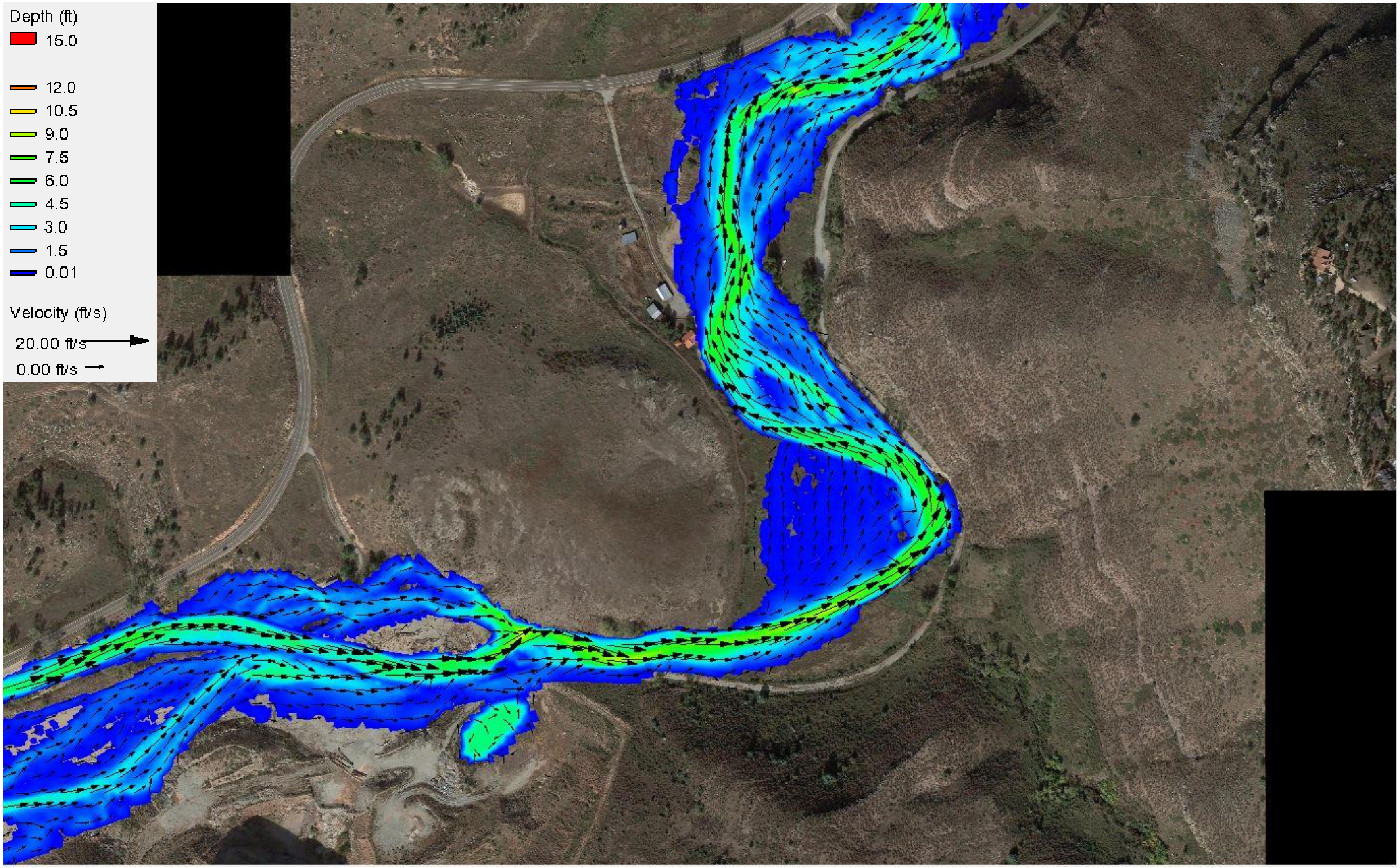
Existing Conditions – Q_{100} – Lower Section (Map 2)



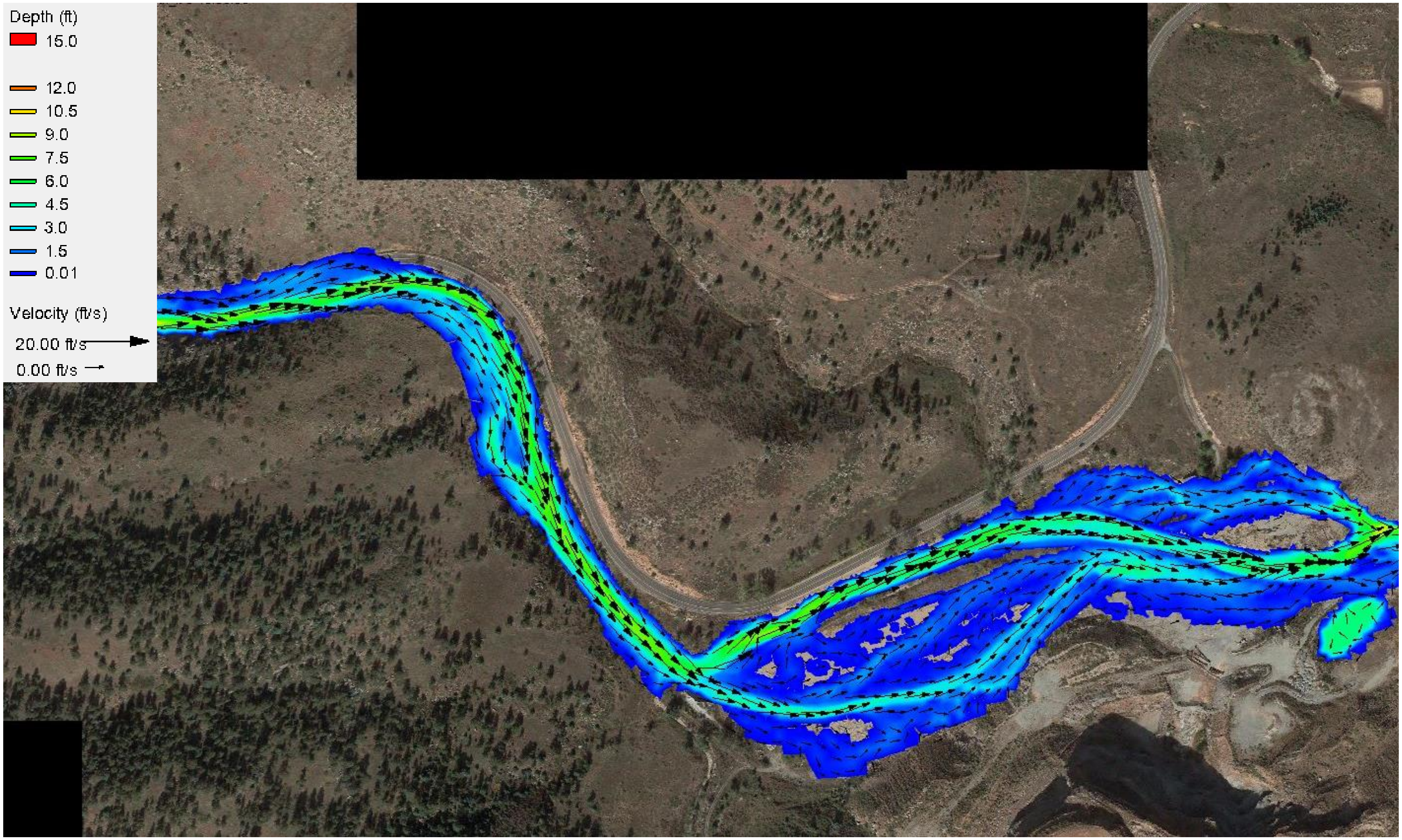
Existing Conditions – Q_{100} – Lower Section (Map 3)



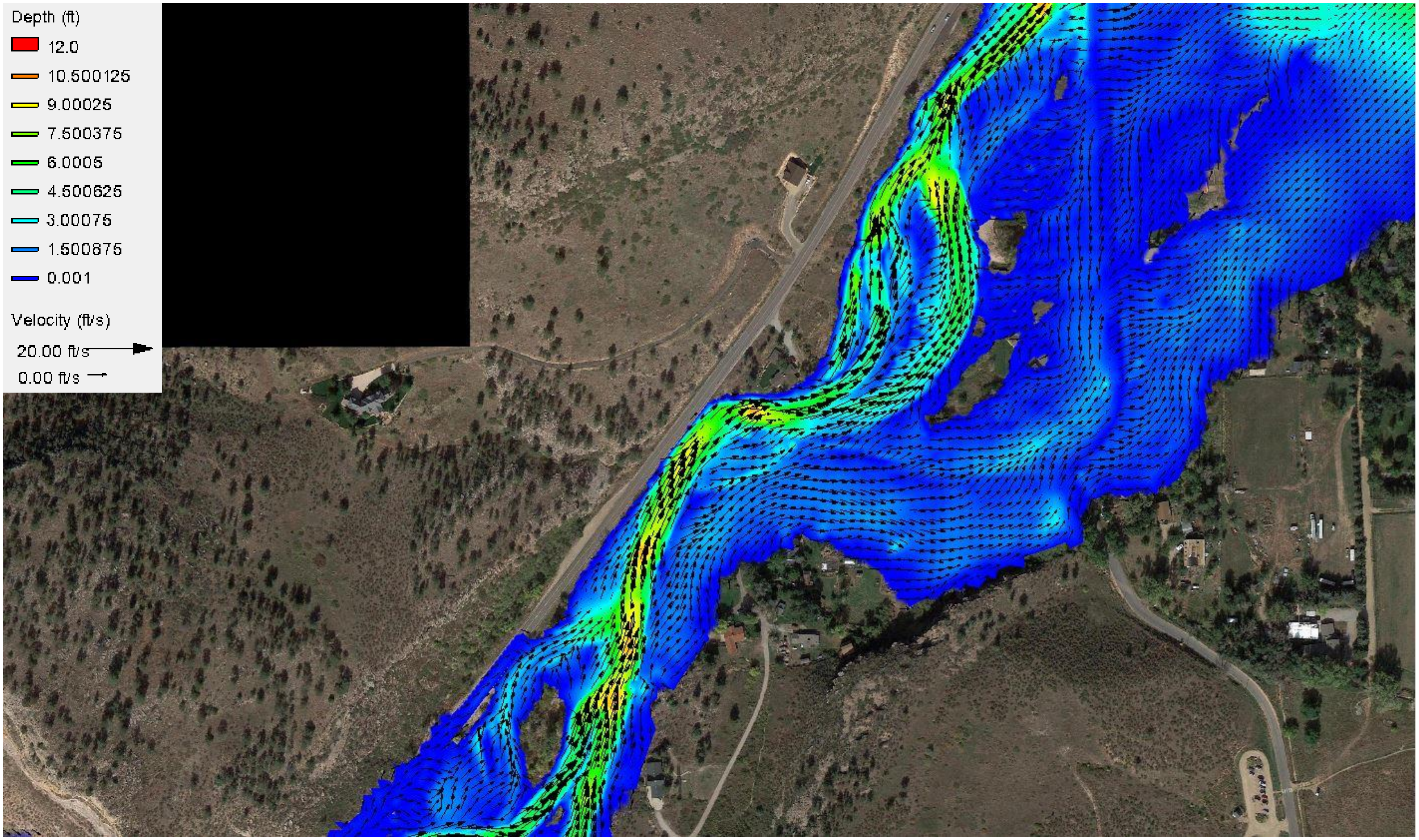
Existing Conditions – Q_{100} – Upper Section (Map 1)



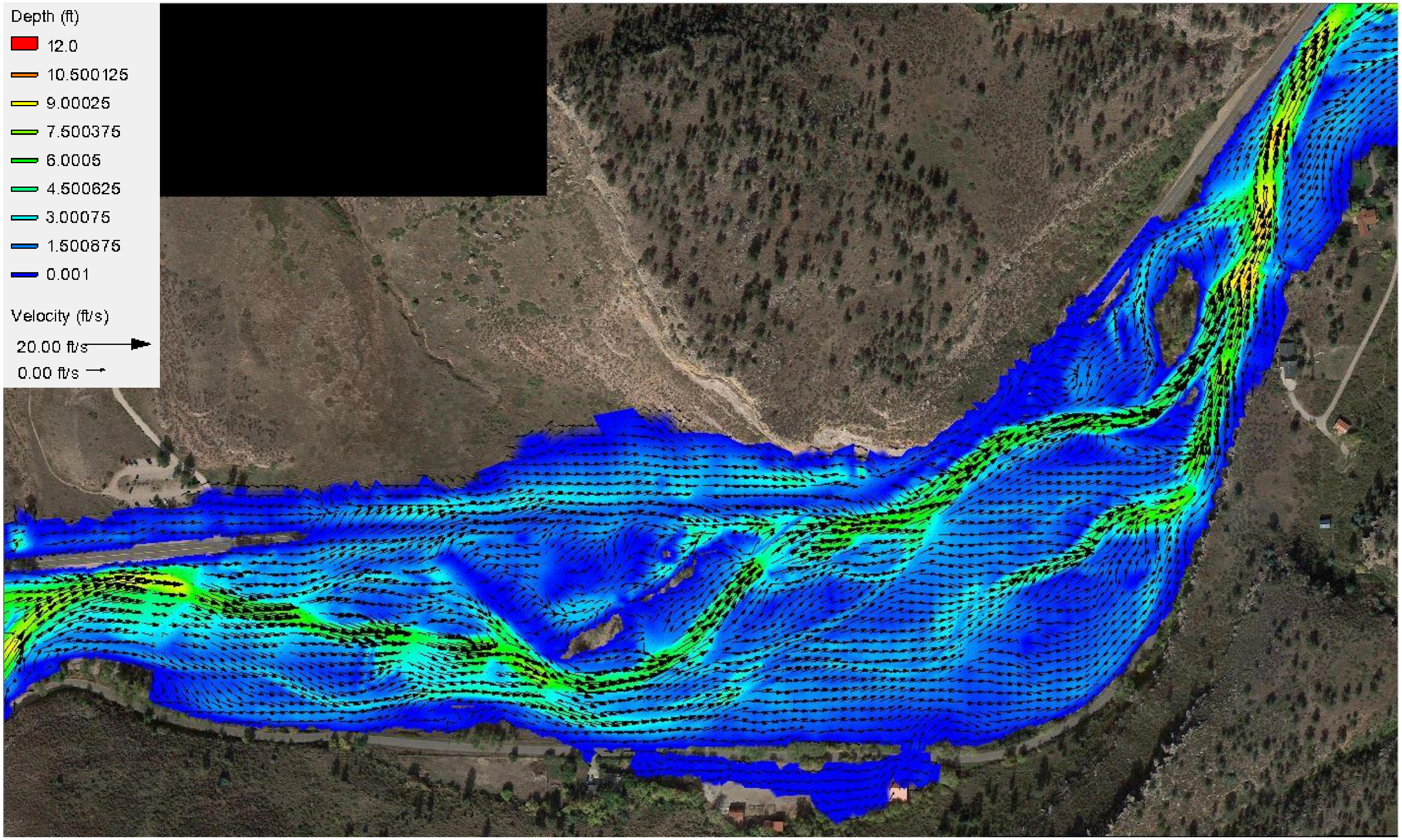
Existing Conditions – Q_{100} – Upper Section (Map 2)



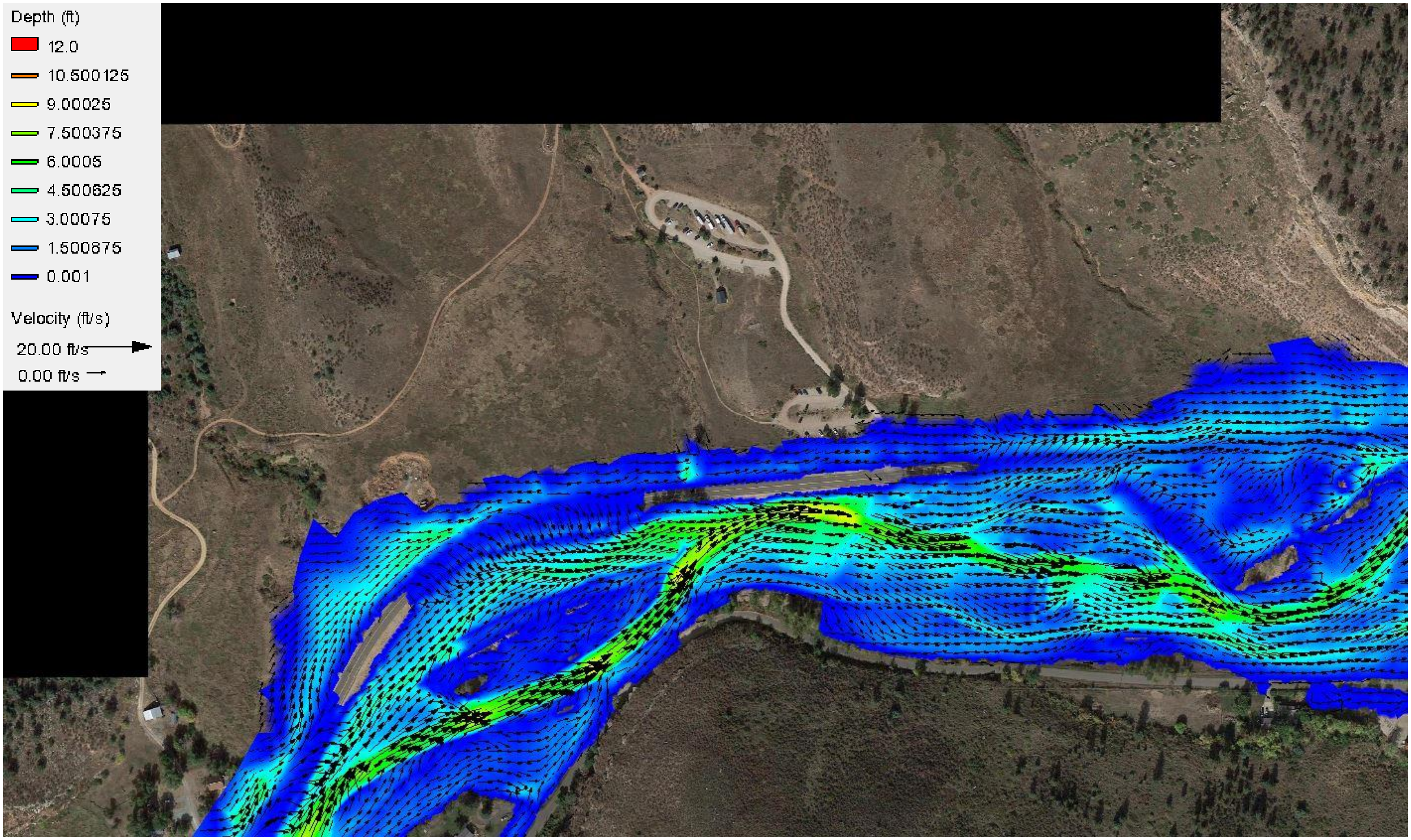
Existing Conditions – Q_{100} – Upper Section (Map 3)



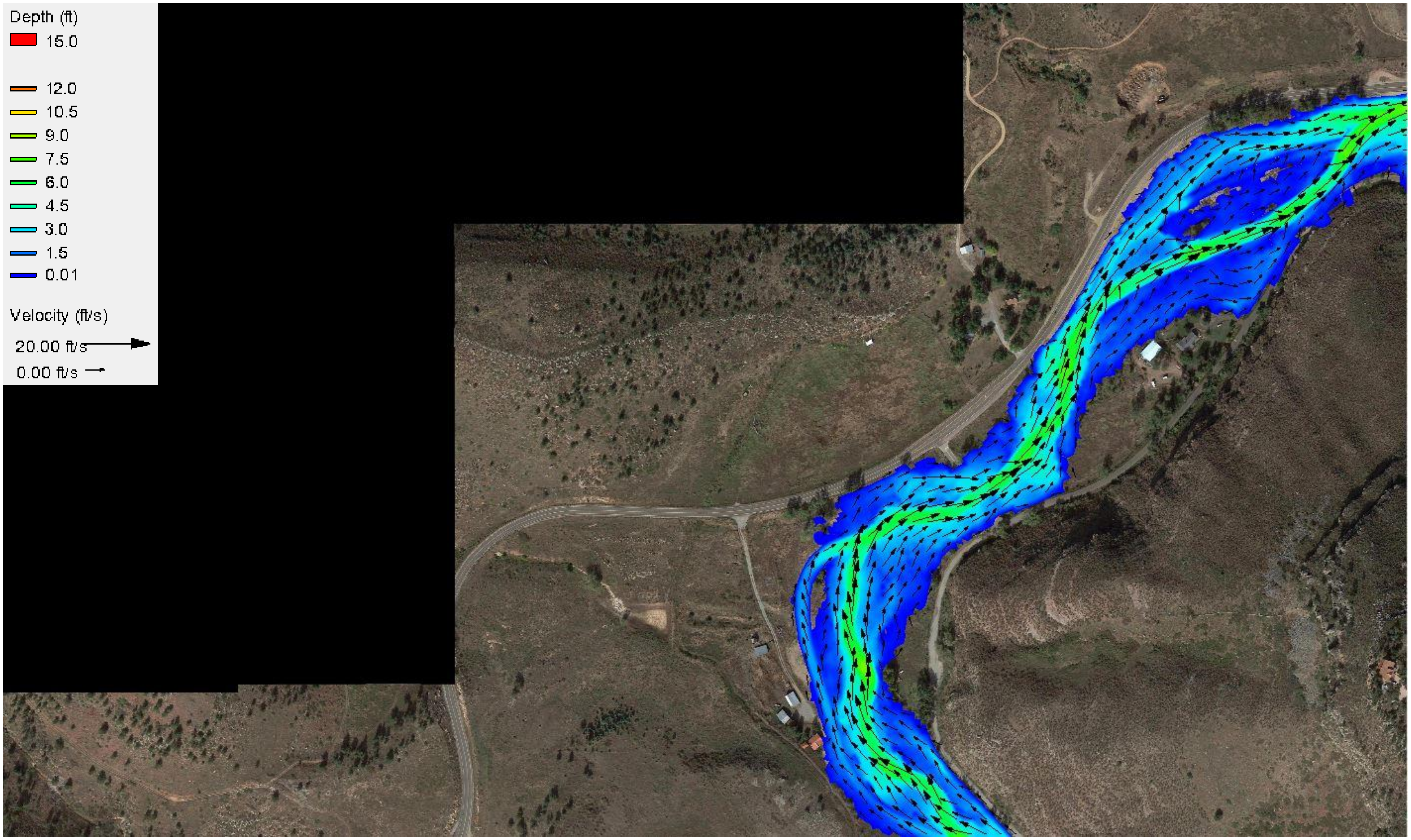
Proposed Conditions – Q_{100} – Lower Section (Map 1)



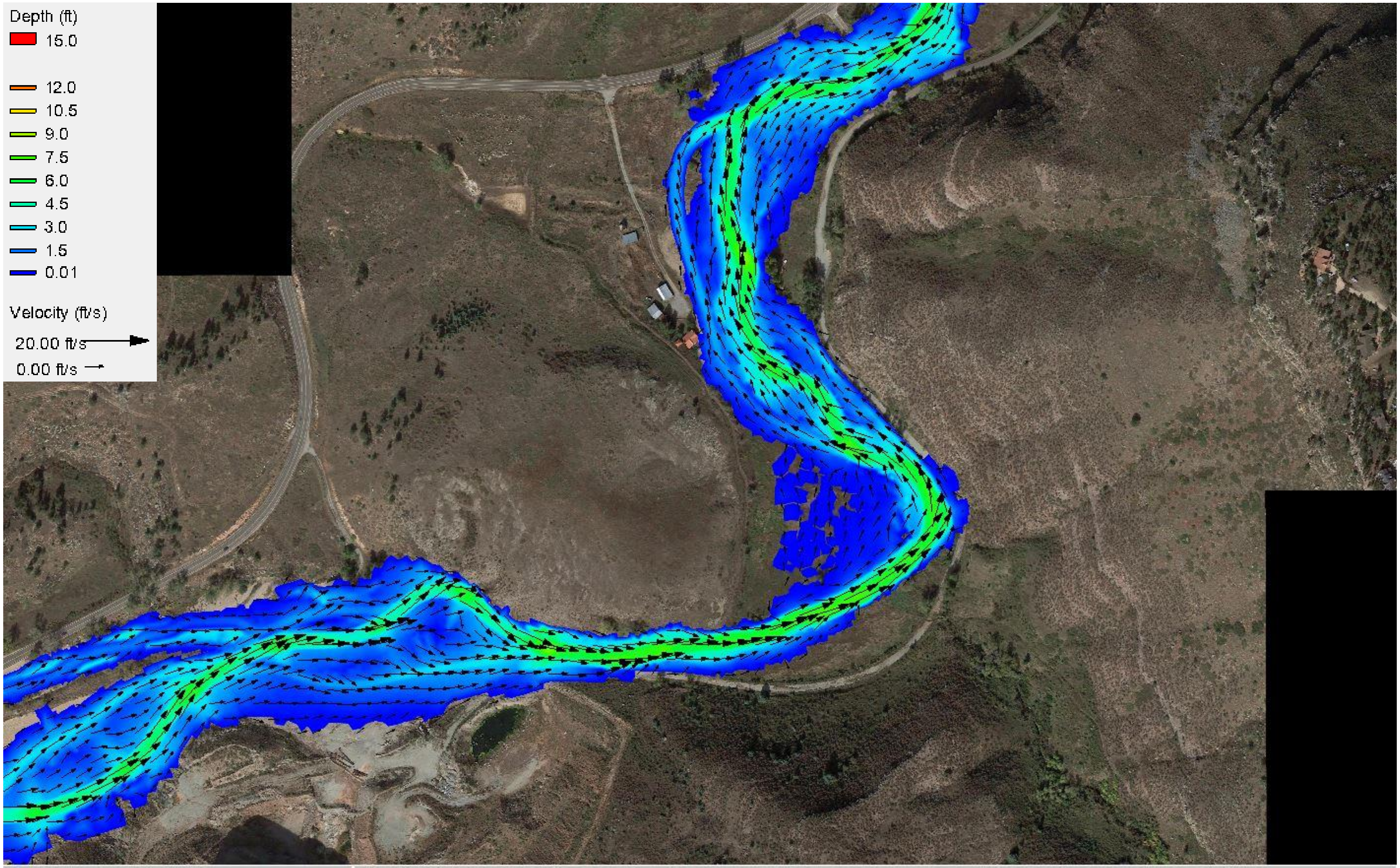
Proposed Conditions – Q_{100} – Lower Section (Map 2)



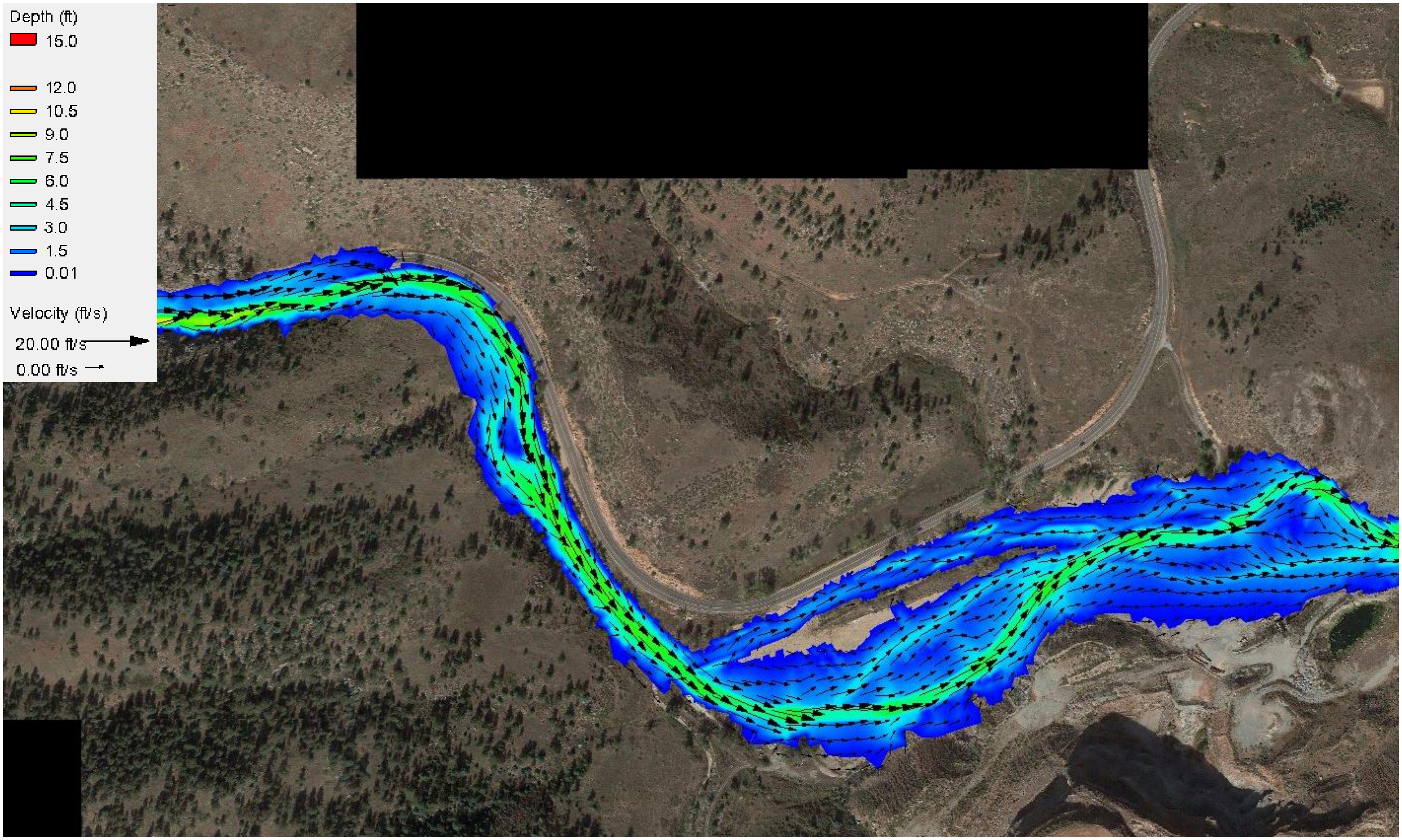
Proposed Conditions – Q_{100} – Lower Section (Map 3)



Proposed Conditions – Q_{100} – Upper Section (Map 1)



Proposed Conditions – Q_{100} – Upper Section (Map 2)



Proposed Conditions – Q_{100} – Upper Section (Map 3)

f. Appendix F – Stream Power Maps

1.5yr Stream Power

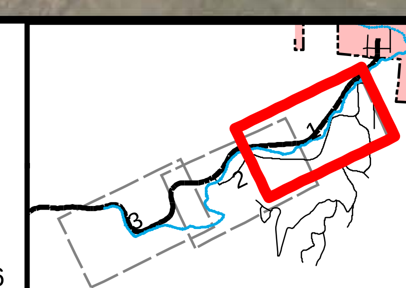
Low — Medium — High

HIGHWAYS

MAJOR ROADS

EXISTING CONDITIONS
STREAM POWER MAPBOOK
1.5 YEAR FLOW

Date: 9/14/2016



0 250 500 Feet

*This map contains data compiled from multiple sources and is for information purposes only. The data used to create the map are not guaranteed to be complete or accurate. The locations of all features are approximate.

1.5 YEAR FLOW

MAP

1

1.5yr Stream Power

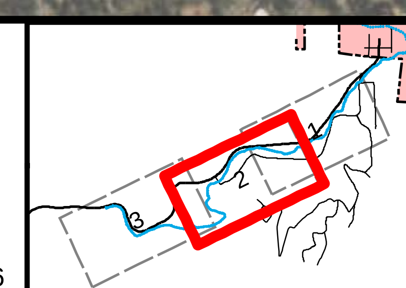
Low — Medium — High

HIGHWAYS

MAJOR ROADS

EXISTING CONDITIONS
STREAM POWER MAPBOOK
1.5 YEAR FLOW

Date: 9/14/2016



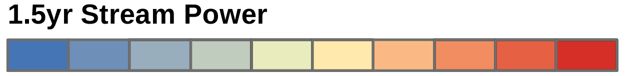
0 250 500 Feet

N

*This map contains data compiled from multiple sources and is for information purposes only. The data used to create the map are not guaranteed to be complete or accurate. The locations of all features are approximate.

1.5 YEAR FLOW

MAP
2



1.5yr Stream Power

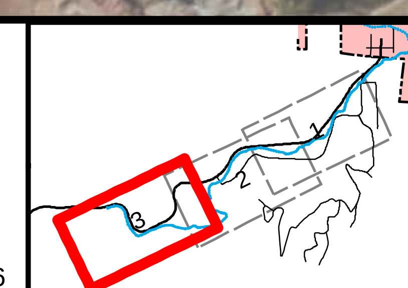
Low Medium High

HIGHWAYS

MAJOR ROADS

EXISTING CONDITIONS
STREAM POWER MAPBOOK
1.5 YEAR FLOW

Date: 9/14/2016

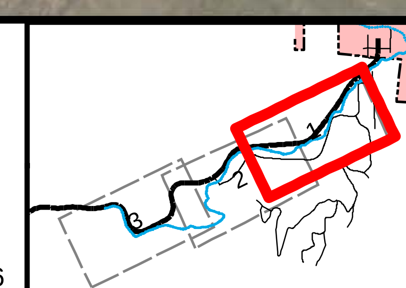


0 250 500 Feet

*This map contains data compiled from multiple sources and is for information purposes only. The data used to create the map are not guaranteed to be complete or accurate. The locations of all features are approximate.

1.5 YEAR FLOW

MAP 3



5yr Stream Power

Low — Medium — High

HIGHWAYS

MAJOR ROADS

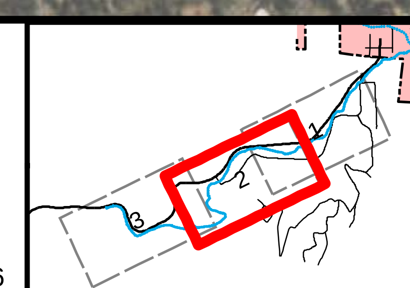
EXISTING CONDITIONS
STREAM POWER MAPBOOK
5 YEAR FLOW

Date: 9/14/2016

0 250 500 Feet

*This map contains data compiled from multiple sources and is for information purposes only. The data used to create the map are not guaranteed to be complete or accurate. The locations of all features are approximate.

5 YEAR FLOW
MAP
1



5yr Stream Power

Low | Medium | High

HIGHWAYS

MAJOR ROADS

EXISTING CONDITIONS
STREAM POWER MAPBOOK
5 YEAR FLOW

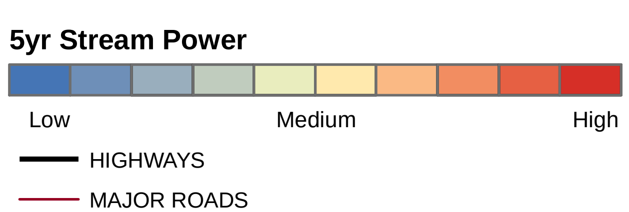
Date: 9/14/2016

0 250 500 Feet

N

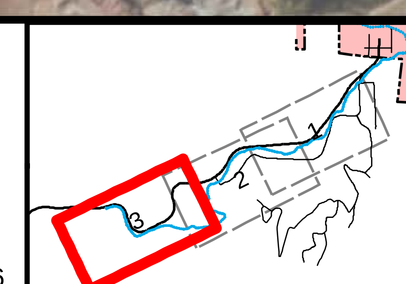
*This map contains data compiled from multiple sources and is for information purposes only. The data used to create the map are not guaranteed to be complete or accurate. The locations of all features are approximate.

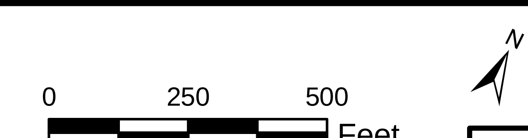
5 YEAR FLOW
MAP
2



EXISTING CONDITIONS STREAM POWER MAPBOOK 5 YEAR FLOW

Date: 9/14/2016

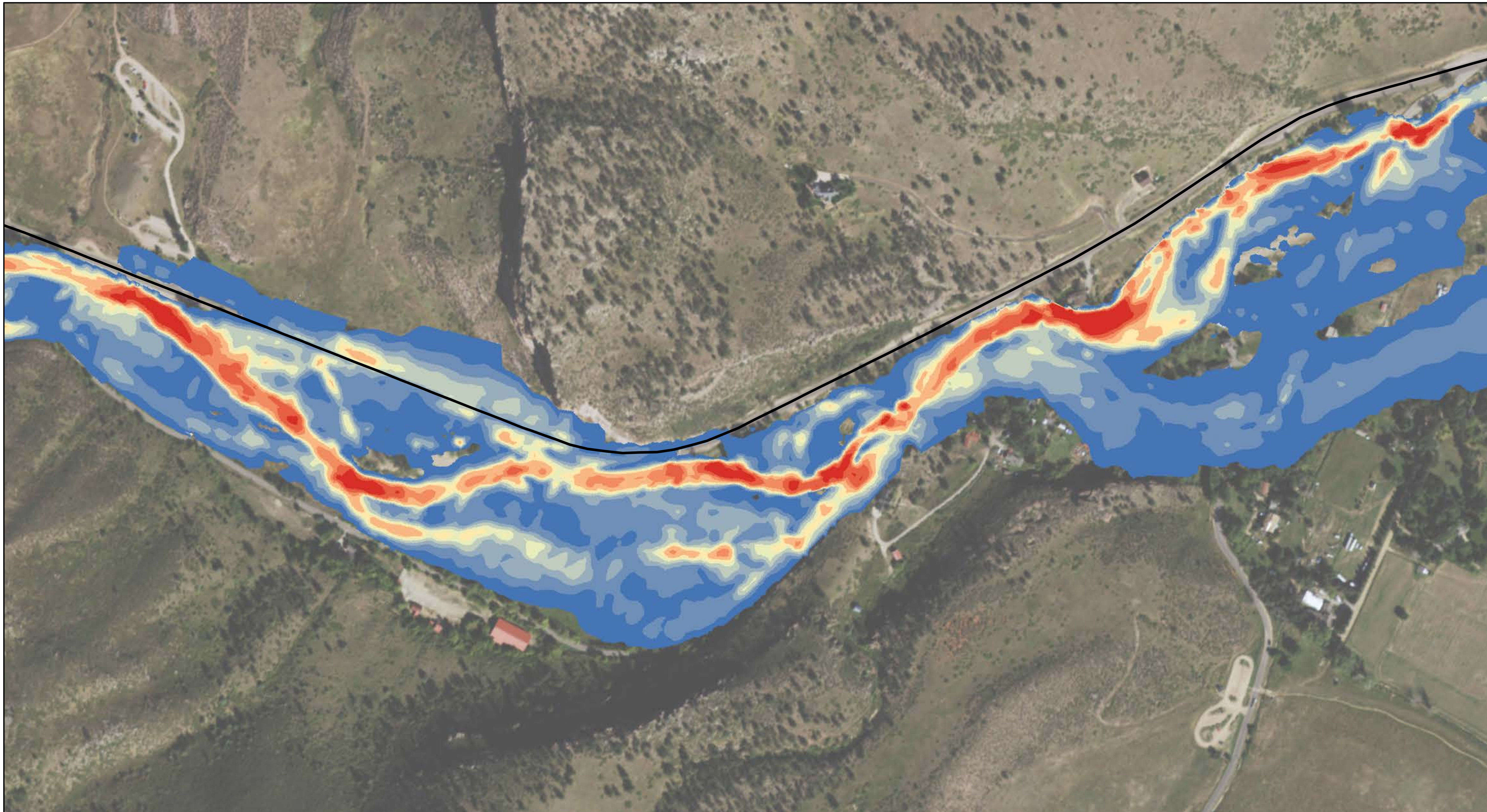




*This map contains data compiled from multiple sources and is for information purposes only. The data used to create the map are not guaranteed to be complete or accurate. The locations of all features are approximate.

5 YEAR FLOW

MAP 3



100yr Stream Power

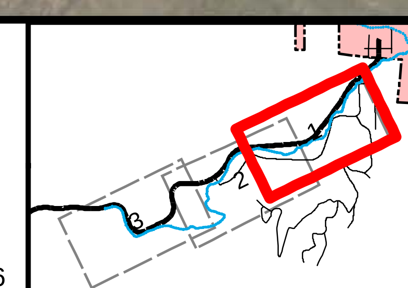
Low Medium High

HIGHWAYS

MAJOR ROADS

EXISTING CONDITIONS STREAM POWER MAPBOOK 100 YEAR FLOW

Date: 9/14/2016



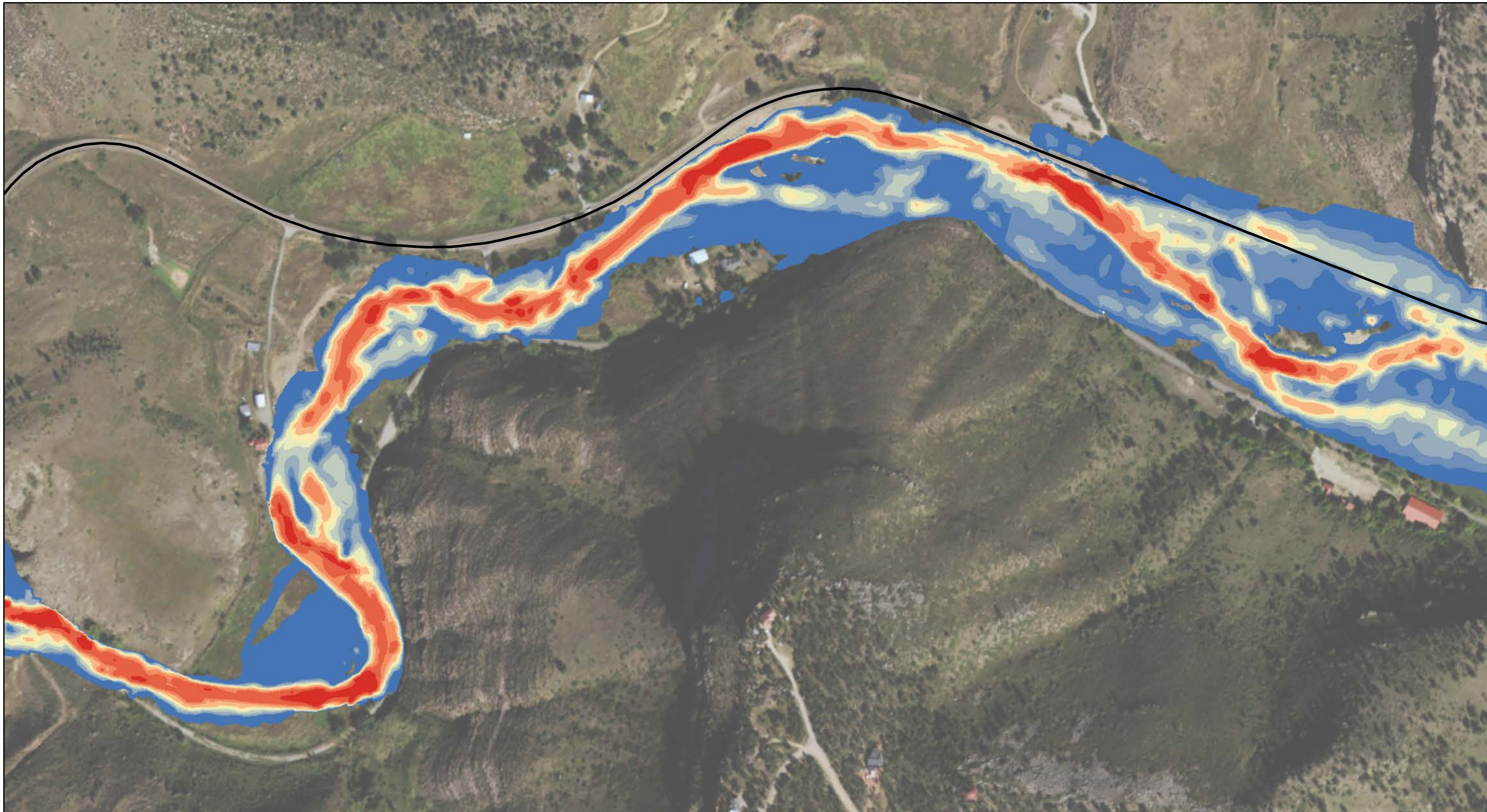
0 250 500 Feet

N

*This map contains data compiled from multiple sources and is for information purposes only. The data used to create the map are not guaranteed to be complete or accurate. The locations of all features are approximate.

100 YEAR FLOW

MAP 1



100yr Stream Power

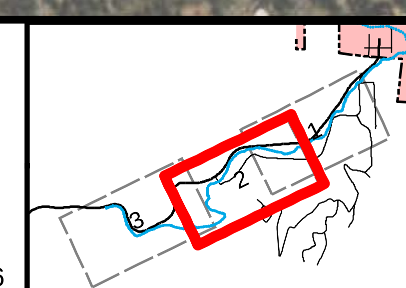
Low Medium High

HIGHWAYS

MAJOR ROADS

EXISTING CONDITIONS
STREAM POWER MAPBOOK
100 YEAR FLOW

Date: 9/14/2016



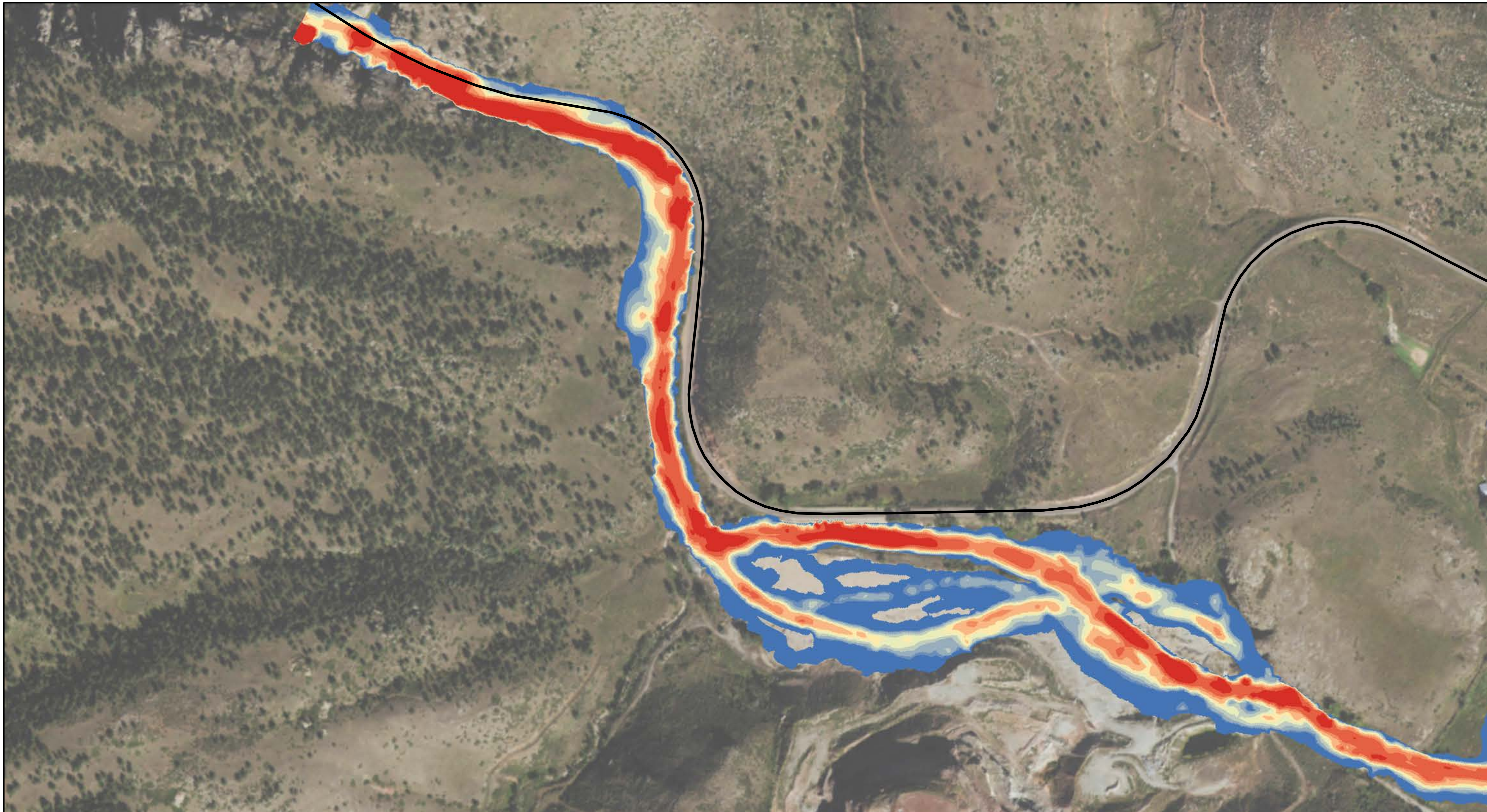
0 250 500 Feet

N

*This map contains data compiled from multiple sources and is for information purposes only. The data used to create the map are not guaranteed to be complete or accurate. The locations of all features are approximate.

100 YEAR FLOW

MAP 2



100yr Stream Power

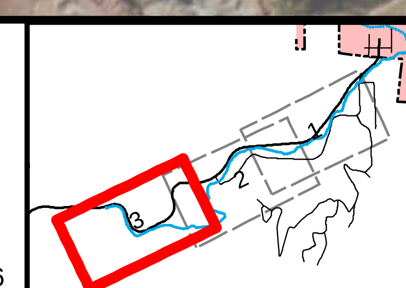
Low — Medium — High

HIGHWAYS

MAJOR ROADS

EXISTING CONDITIONS STREAM POWER MAPBOOK 100 YEAR FLOW

Date: 9/14/2016



0 250 500 Feet

N

*This map contains data compiled from multiple sources and is for information purposes only. The data used to create the map are not guaranteed to be complete or accurate. The locations of all features are approximate.

100 YEAR FLOW

MAP 3

1.5yr Stream Power

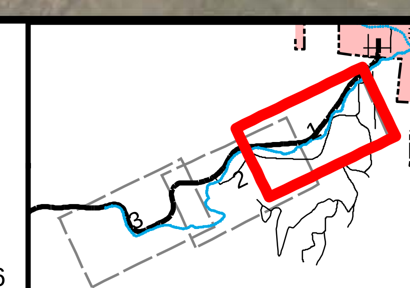
Low — Medium — High

HIGHWAYS

MAJOR ROADS

PROPOSED CONDITIONS
STREAM POWER MAPBOOK
1.5 YEAR FLOW

Date: 9/14/2016



0 250 500 Feet

*This map contains data compiled from multiple sources and is for information purposes only. The data used to create the map are not guaranteed to be complete or accurate. The locations of all features are approximate.

N

1.5 YEAR FLOW

MAP

1

1.5yr Stream Power

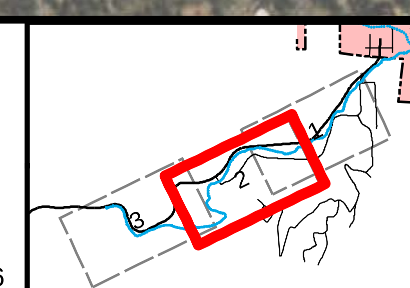
Low — Medium — High

HIGHWAYS

MAJOR ROADS

PROPOSED CONDITIONS STREAM POWER MAPBOOK 1.5 YEAR FLOW

Date: 9/14/2016



0 250 500 Feet

N

*This map contains data compiled from multiple sources and is for information purposes only. The data used to create the map are not guaranteed to be complete or accurate. The locations of all features are approximate.

1.5 YEAR FLOW

MAP 2

1.5yr Stream Power

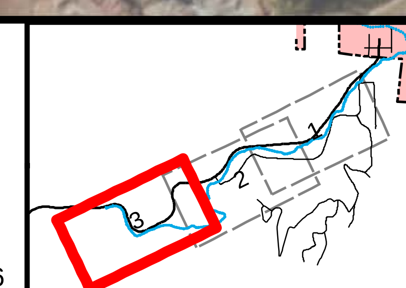
Low Medium High

HIGHWAYS

MAJOR ROADS

PROPOSED CONDITIONS
STREAM POWER MAPBOOK
1.5 YEAR FLOW

Date: 9/14/2016



0 250 500 Feet

*This map contains data compiled from multiple sources and is for information purposes only. The data used to create the map are not guaranteed to be complete or accurate. The locations of all features are approximate.

1.5 YEAR FLOW

MAP 3

5yr Stream Power

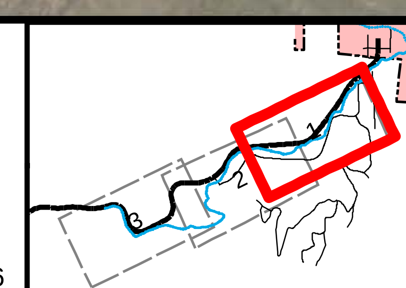
Low Medium High

HIGHWAYS

MAJOR ROADS

PROPOSED CONDITIONS
STREAM POWER MAPBOOK
5 YEAR FLOW

Date: 9/14/2016



0 250 500 Feet

*This map contains data compiled from multiple sources and is for information purposes only. The data used to create the map are not guaranteed to be complete or accurate. The locations of all features are approximate.

5 YEAR FLOW

MAP

1

5yr Stream Power

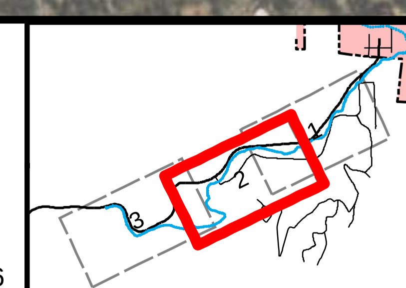
Low — Medium — High

HIGHWAYS

MAJOR ROADS

PROPOSED CONDITIONS
STREAM POWER MAPBOOK
5 YEAR FLOW

Date: 9/14/2016



0 250 500 Feet

N

*This map contains data compiled from multiple sources and is for information purposes only. The data used to create the map are not guaranteed to be complete or accurate. The locations of all features are approximate.

5 YEAR FLOW

MAP 2

otak

5yr Stream Power

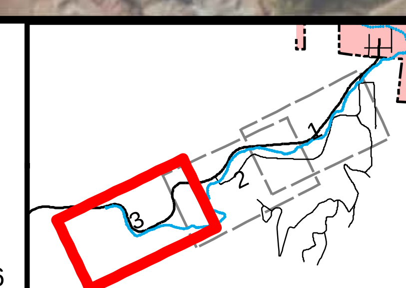
Low — Medium — High

HIGHWAYS

MAJOR ROADS

PROPOSED CONDITIONS
STREAM POWER MAPBOOK
5 YEAR FLOW

Date: 9/14/2016



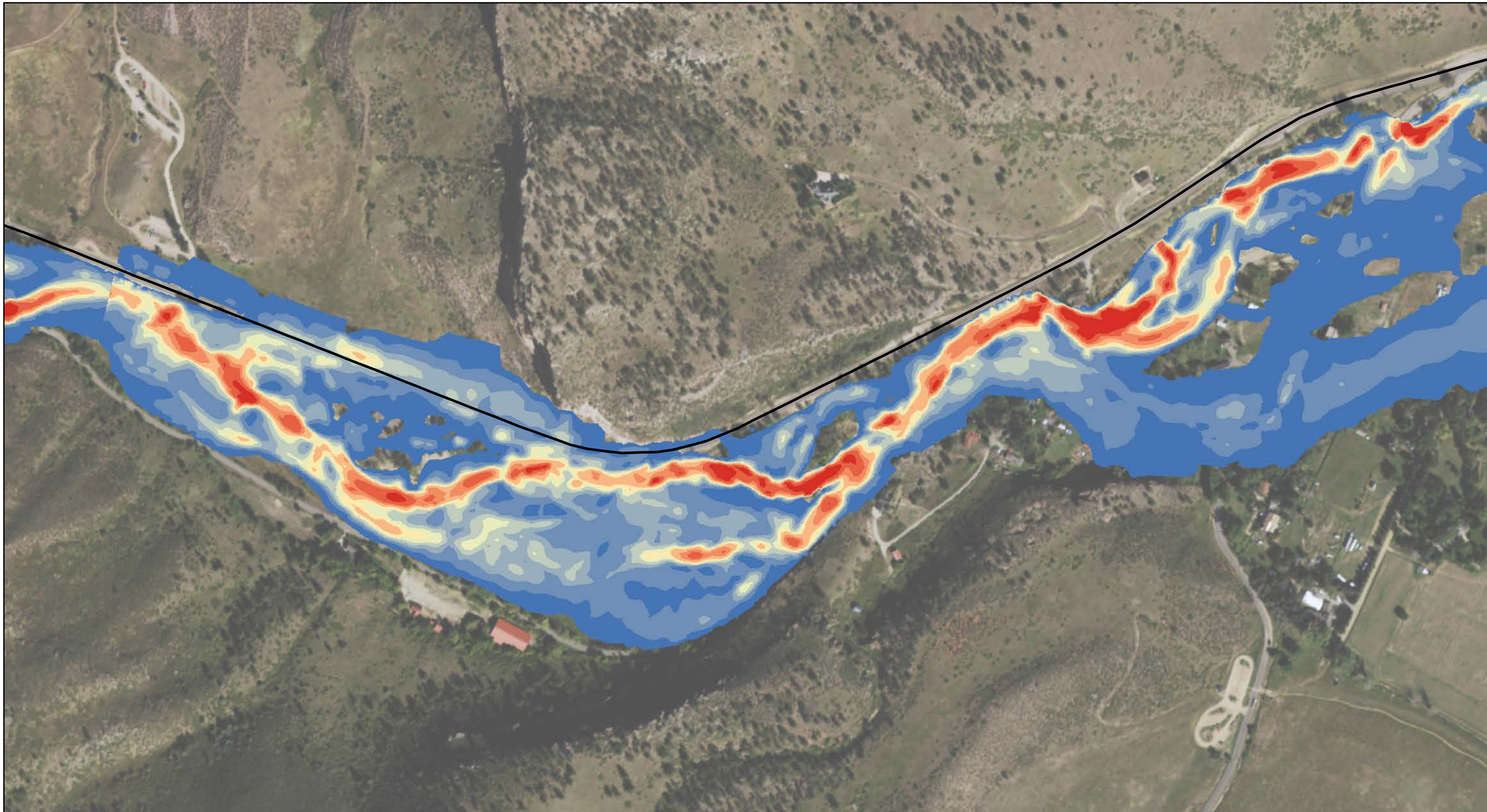
0 250 500 Feet

N

*This map contains data compiled from multiple sources and is for information purposes only. The data used to create the map are not guaranteed to be complete or accurate. The locations of all features are approximate.

5 YEAR FLOW

MAP 3



100yr Stream Power

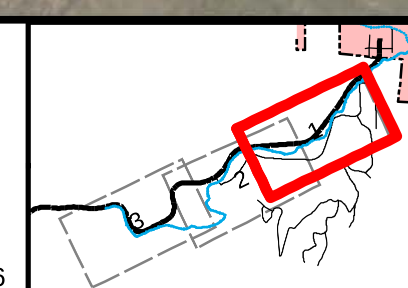
Low | Medium | High

HIGHWAYS

MAJOR ROADS

PROPOSED CONDITIONS
STREAM POWER MAPBOOK
100 YEAR FLOW

Date: 9/14/2016



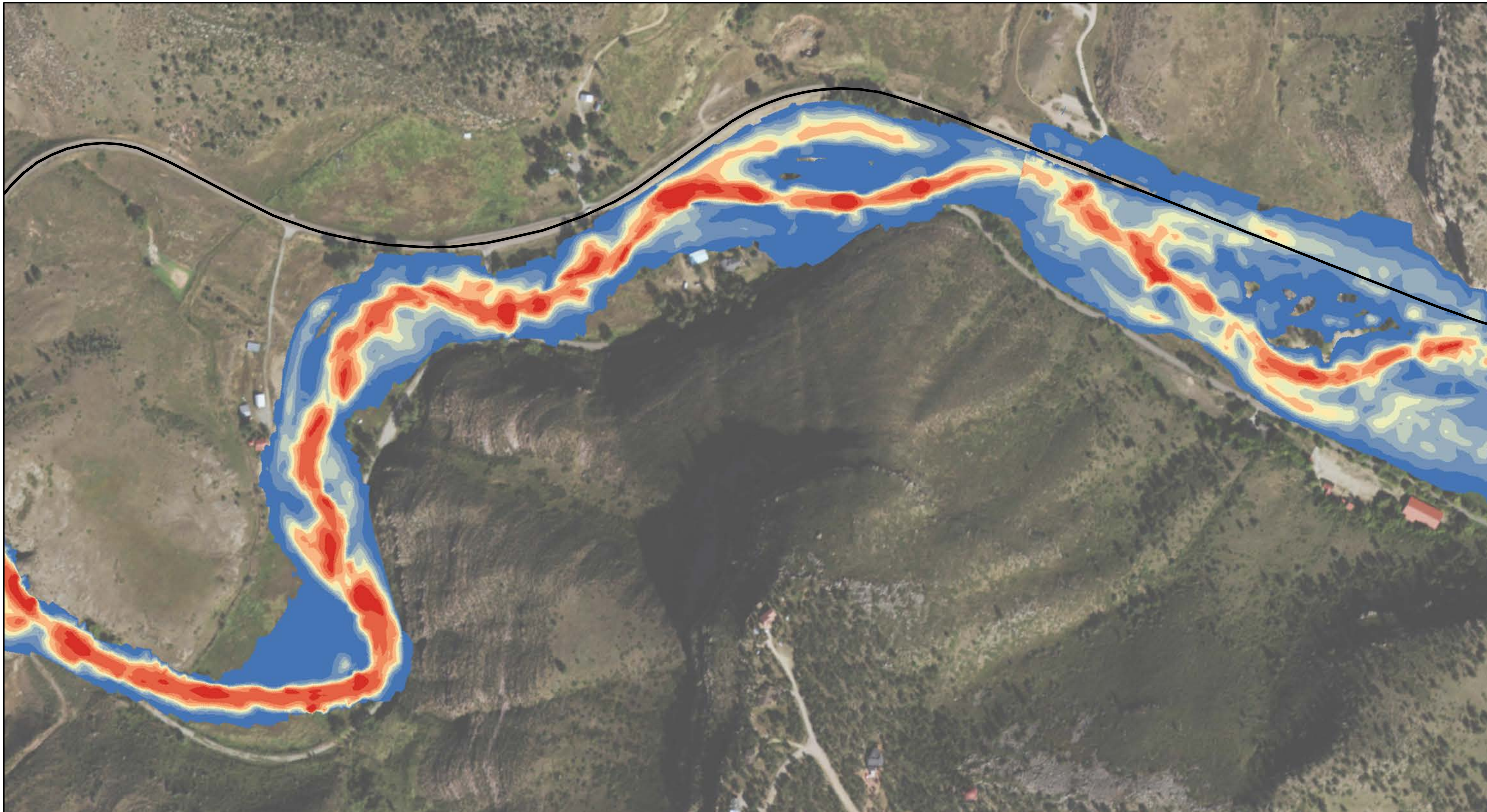
0 250 500 Feet

*This map contains data compiled from multiple sources and is for information purposes only. The data used to create the map are not guaranteed to be complete or accurate. The locations of all features are approximate.

N

100 YEAR FLOW

MAP
1



100yr Stream Power

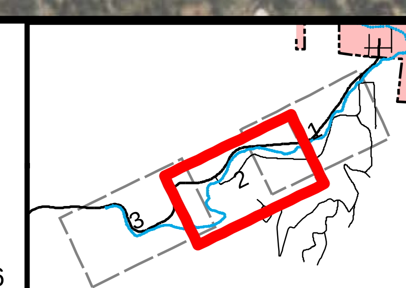
Low — Medium — High

HIGHWAYS

MAJOR ROADS

PROPOSED CONDITIONS
STREAM POWER MAPBOOK
100 YEAR FLOW

Date: 9/14/2016



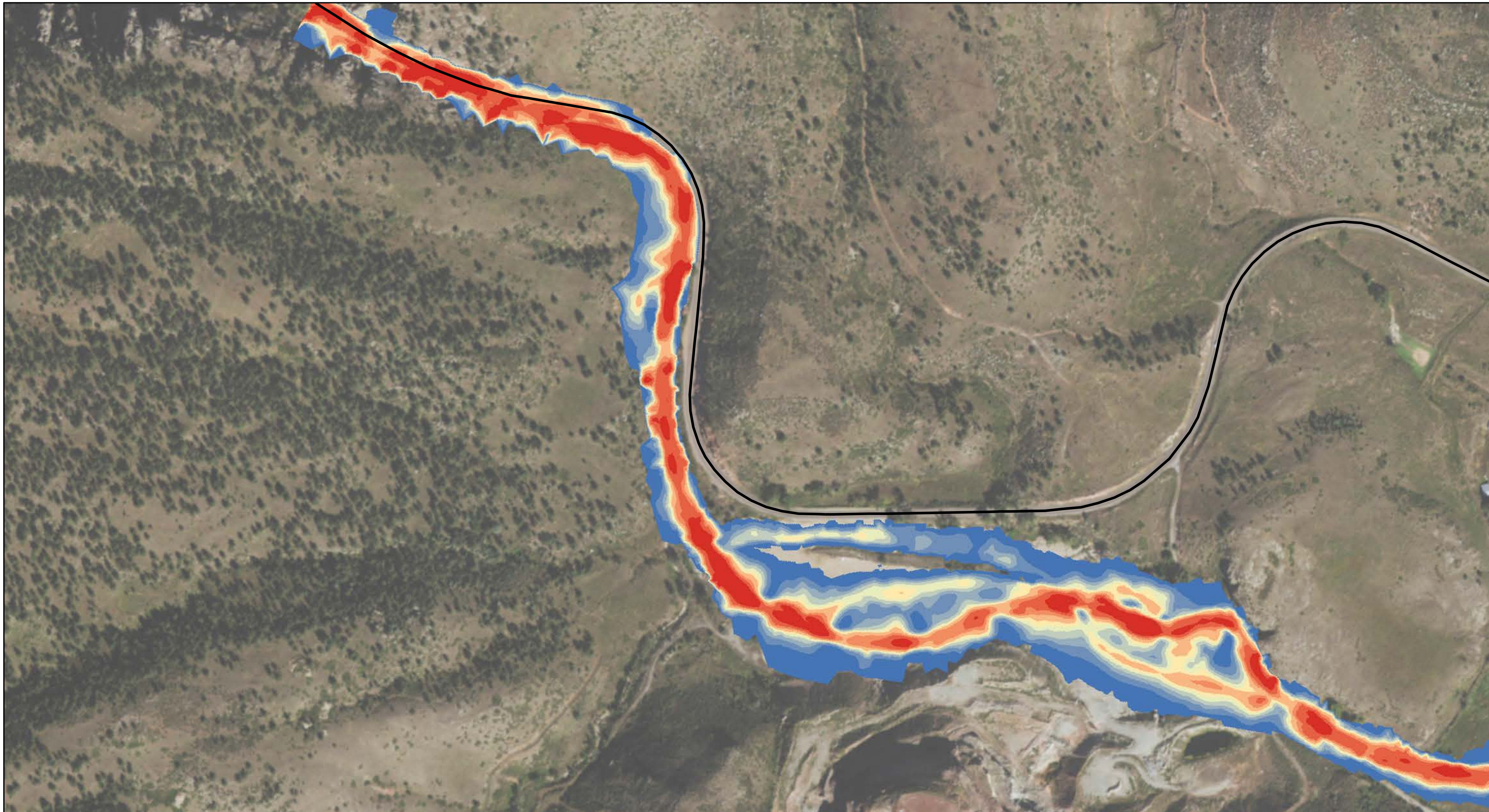
0 250 500 Feet

N

*This map contains data compiled from multiple sources and is for information purposes only. The data used to create the map are not guaranteed to be complete or accurate. The locations of all features are approximate.

100 YEAR FLOW

MAP 2



otak

100yr Stream Power

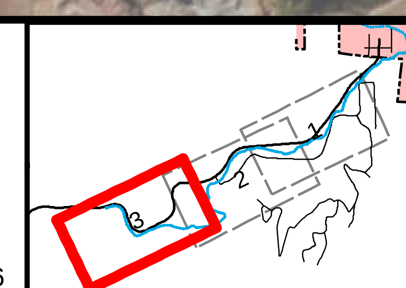
Low — Medium — High

HIGHWAYS

MAJOR ROADS

PROPOSED CONDITIONS
STREAM POWER MAPBOOK
100 YEAR FLOW

Date: 9/14/2016



0 250 500 Feet

N

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100 YEAR FLOW

MAP 3

g. Appendix G – Sediment Transport Capacity and Balance Maps

otak

2yr Transport Capacity Balance (tons/hr)

Degradation Aggradation

<-5 | -5 -3 | -3 -1 | -1-1 | 1-3 | 3-5 | >5

2yr Reach Capacity (tons/hr)

<2 | 2-5 | 5-8 | 8-10 | >10

Reach Break

- Mainstem
- North
- South

N

0 500 1,000 2,000 Feet

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EXISTING CONDITIONS
SEDIMENT TRANSPORT CAPACITY AND BALANCE

2 YEAR FLOW

Last Modified: 9/14/2016

otak

2yr Transport Capacity Balance (tons/hr)

Degradation — Aggradation

<-5, -5 - -3, -3 - -1, -1 - 1, 1 - 3, 3 - 5, >5

2yr Reach Capacity (tons/hr)

<2, 2-5, 5-8, 8-10, >10

Reach Break

- Mainstem
- North
- South

N

0 500 1,000 2,000 Feet

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PROPOSED CONDITIONS
SEDIMENT TRANSPORT CAPACITY AND BALANCE

2 YEAR FLOW

Last Modified: 9/14/2016

h. Appendix H - Decision Making Process Diagram and Decision Matrix

South St. Vrain Creek Restoration at Hall Ranch Decision Making Process:

Project Goals	Core Values	Critical Issues Paraphrased from Stakeholder Comments	Prioritization Criteria

Boulder County Parks & Open Space

Matrix Design Group

THK associates, inc.

otak
HanmiGlobal Partner

SOUTH ST. VRAIN CREEK RESTORATION AT HALL RANCH DECISION MATRIX - FOR THE PRIORITIZATION OF THE PREFERRED ALTERNATIVE 7/12/2016

Fair | Better | Best

ID	Critical Issues	Prioritization Criteria	Alternatives Evaluation: Floodplain Connectivity	Channel Complexity	Revegetation	Infrastructure Protection
Prioritization Criteria						
1	Community	Protect critical public and private infrastructure?	The best way to increase flood volume and reduce flood energy throughout the system. Note: (Detention ponds can not provide enough volume to mitigate flood impacts. Water rights are needed to detain water. Detention ponds would fill full of sediment. There is physically not enough room to detain the appropriate amount of water needed.)	Can provide some channel stability.	Once vegetation is established can provide some flood-plain stability.	Can provide immediate site specific protection to infrastructure. No system wide mitigation.
2	Community	Avoids negative impacts to downstream infrastructure, channel and storm water systems?	Returns the river corridor to a more natural channel condition with minimal downstream impacts.	Minimal downstream negative impacts.	Minimal downstream negative impacts.	While the technique might provide protection for the immediate element of infrastructure being protected, the technique can cause negative impacts downstream.
3	Community	Improves aesthetics to the creek corridor?	Returns the river corridor to a more natural channel condition. Time needed for naturalization of vegetation	Improves the aesthetics of the channel.	Jump starts revegetation of the entire river corridor.	Most techniques appear engineered.
4	Community	Consider recreation where allowed? (1)	Improves the quality of the recreational experience.	Provides instream structures that could act as a recreational amenity to kayakers and fishermen.	Improves the quality of the recreational experience.	Recreational objectives could be included with infrastructure protection.
5	Resiliency	Benefits larger area of creek corridor?	Benefits the larger creek corridor by jump starting the natural systems.	Benefits the channel by moderating sediment load.	Benefits the larger creek corridor but without floodplain connectivity the results will be diminished.	Very site specific benefits at the point where the improvement is made.
6	Resiliency	Re-establishes floodplain connectivity?	Yes. Floodplain connectivity is the most holistic approach to re-establish a functioning floodplain.	Yes. Cannel complexity would contribute to inundation of floodplain benches.	Yes. Revegetation provides roughness to slow floodwater down and establishes long lasting ecosystem benefits.	No
7	Resiliency	Restores affected areas of the South St. Vrain Creek channel and surrounding areas to stable, resilient and ecologically rich habitats?	Yes	Yes	Jump starts terrestrial and riparian habitat.	Makes certain reaches more stable.
8	Resiliency	Reduces future recovery time?	Jump starts the natural systems of the corridor most holistic approach.	Not a holistic approach, focuses on channel.	Not a holistic approach. Some established vegetation, soil structure and seedbanks would survive a flood event and secondary succession would occur.	Not a holistic approach. Infrastructure protection would protect existing features and reduce future work needed after a flood event.
9	Resiliency	Moderates conveyance of sediment?	Yes for the entire reach.	Yes for the entire reach.	Traps sediment during a flood and minimizes erosion.	Could be part of the strategy at diversions, bridges and culverts.
10	Safety	Reduce flood risk to the public and residents by providing long term solutions that increase resiliency?	Increases flood storage volume and reduces flood energy throughout the system.	Provides some creek channel resiliency.	Once allowed to mature the vegetation provides some resistance to future floods.	Hardened points are created in the corridor not always resilient.
11	Environment	Natural ecosystem processes restored?	Most holistic approach.	Partial approach, not all ecosystems addressed.	Partial approach, not all ecosystems addressed.	Least holistic approach.
12	Environment	Protects or improves existing habitat and significant ecological resources?	Improves both terrestrial and aquatic habitat.	Improves aquatic habitat.	Improves terrestrial and riparian habitat	Not the focus of infrastructure protection techniques.
13	Environment	Incorporates locally available materials and environmentally friendly processes?	Not a differentiator. All alternatives can incorporate locally available materials and environmentally friendly processes.			
14	Environment	Protects and improves water quality and the geomorphology of the creek?	Protects geomorphology and jump starts natural systems of the corridor.	Protects geomorphology and jump starts natural systems of the creek.	Reduces erosion.	Reduces erosion in site specific areas.
15	Implementation	Creates infrastructure investments that are reasonable to construct and provides the best value for their lifecycle, function and purpose?	Because it jump starts the corridor's natural systems it is the best value for their life-cycle.	Reasonable to construct and jump starts natural system of the creek.	Without regrading, the revegetation effort will have diminished results.	Protects infrastructure but requires on-going maintenance.
16	Implementation	Can be supported by current land use regulations or revised land use regulations?	Not a differentiator. All alternatives can be supported by the current land use regulations.			
17	Implementation	Provides funding, partnering and collaboration opportunities by meeting multiple stakeholder objectives?	Not a differentiator. There are opportunities with all alternatives for partnering.			

Notes:

Definitions:
Fair - What is thought to be right acceptable
Better - Higher in quality
Best - Better than all others in quality or value

i. Appendix I - Public Comments

South St. Vrain Comments

Comment	Source	Safety	Habitat	Conveyance	Recreation	Environmental	Stabilization	Coordination
GENERAL ISSUES AND CONCERNS								
"Creek conveyance" should be the most important design component	BCPOS			X				
How closely will the alignment and design match the alignment and objectives that were presented in the Master Plan?	BCPOS			X				
Need coordination amongst various entities on repairs throughout the reach (e.g. creek restoration, ditches, bridges, etc.)	BCPOS							X
How do we handle historic channel changes, especially within and above Hall Meadows area	BCPOS			X				
County open space was protected primarily for the natural resource and open space values that the creek and floodplain provide.	BCPOS					X		
Project should be focused on creek restoration design, not general land management planning for the county's open space lands. General land management (e.g. recreation, agriculture, etc.) is provided in the St. Vrain Creek Corridor Open Space Management Plan and North Foothills Open Space Management Plan.	BCPOS					X		
Restoring the natural process is more important than existing or pre-flood conditions (e.g. think about system first).	BCPOS			X				
Look at potential for multi-stage channel with floodplain bench to provide both ecological and public safety benefits	BCPOS			X				
Minimize hardscape as much as possible. Instead, use soft engineering, while protecting infrastructure.	BCPOS			X				
How will this project be a partnership amongst BCPOS, residents, and SVCC?	Public							X
Private property owner considerations with meaningful engagement and study participation	Public							X
Boulder County-Lyons IGA / Lyons Annexation: Concern about notifying and receiving neighborhood input	Public							X
I am looking to access the creek for mini-hydroelectric power. I could create nice fishing habitat. How does my situation fall in this study?	Dave Levy		X	X				
Since the Hall Ranch work is upstream from us, the Longmont pipeline work re-routed the creek adjacent to us, and the riparian area downstream was wrecked (BCPOS?) to the Old Road bridge, we would like to see a coordinated effort to cover the whole reach. This area has high visibility for everyone on Highway 7, and the flow of water upstream from Lyons is critical for public safety. In addition, I have 500 feet of creek side property which could be rehabilitated.	Dave Levy	X	X	X		X		
Now we appear to be proceeding with "conceptual design plans" for improvements in this area without an overall planning process or public involvement in the concepts. Boulder County is currently in process of approving Longmont water intake improvements in this segment also. It appears to me that the Longmont intake project coupled with the BCPOS design will fix the corridor without the type of integrated and collaborative process that our expanded SVCC is promoting. The types of overall flood mitigation and potentially detention alternatives that were requested in the Lyons PDGs are being ignored.	Larry Quinn			X				
I would like to reinforce the comments of Ron Gosnell on the need to integrate the thoughts and ideas of the SS Vrain residents in this Hall Meadows planning. Boulder County made verbal commitments to the residents during the walking tour completed during the master plan preparation. (see notes in Appendix A of Master Plan)	Larry Quinn							X
This is a very important stretch of river for boaters and as a revenue generator for Lyons. Fish passages does not always equal passable by boat or similar. Whenever in-channel structures are installed, safe navigable boating structures, in addition to plans for fish passage, should also be installed. In channel rehabilitation should create in-channel features such as eddies, pools and drops, consistent with a natural river bed, that promote in stream recreation including boating and angling. Plans for public and private access for recreation should be considered, as appropriate, in all locations where floodplain rehabilitation will occur.	Matt Booth		X		X			
After the recent deluge of rain, we had water coming into our crawl space for the last several days and requiring some round-the-clock vigilance on our part. We think that the flooding occurred for at least 3 reasons:	Bonnie Richards & Sam Miller							
1. Before the flood, the river was at a lower elevation in our backyard. Water went easily down from the yard and drained into the river. Now that the river is at a higher elevation, and further away, we have a berm helping to keep the river from flowing into the yard. However, we have pools of water collecting in the basin that was the old river bed.	Bonnie Richards & Sam Miller	X		X				
2. To further complicate matters, we have natural springs in the vicinity around our house. These never caused flooding before the flood, as when the springs were running on the surface, they drained directly into the river. Now these springs are releasing into the backyard in the old riverbed and helping to create pools of standing water in the back yard.	Bonnie Richards & Sam Miller	X		X				
3. Finally, we have noticed a great deal of standing water on Boulder County Open Space land across the street from us on Highway 7. Before the flood, there was a ditch on the other side of the road that carried water into a culvert that fed back into the river. The ditch was filled in by sand after the flood and is no longer feeding directly into the riverbed. The water has been collecting through April and May and gets worse with each new rain. We believe that some of this water is moving into our yard and contributing to the flooding in our crawl space. We now hear a chorus of frogs living in the open space pools and singing day and night. In the 27 years I have lived in this house, there have never been frogs anywhere near us. Charming as their song may be, the presence of frogs in the area signals a change in the landscape that also features the more unfortunate result of having water directed toward our hour that ultimately ends up with us having to pump water from our crawl space.	Bonnie Richards & Sam Miller	X		X				

Comment	Source	Safety	Habitat	Conveyance	Recreation	Environmental	Stabilization	Coordination
Regarding concern about water in crawl space and emergency repairs in Hall Meadows, which they felt caused the problem: There are three easy fixes that would stop the water from coming through the berm:	Bonnie Richards & Sam Miller							
1. Correct the mistakes that were made when the second channel was shut off. This is the root cause of the new problems we have seen since then. Correcting the problem would require several hours of stone relocation and re-building the weir further downstream, but it would be the best possible solution.	Bonnie Richards & Sam Miller	X		X				
2. Deepen the channel that exists now. This channel was originally opened over a year ago with a 1 foot depth, and has scrubbed deep enough that it has never been a problem until the dam was put in place. The dam increased the water level, but did not lower the river bed. Fixing this problem would require digging and moving a lot of stone and sand, which could be used to rebuild the field (which is part of the Flood Recovery Plan already).	Bonnie Richards & Sam Miller	X		X				
3. The simplest solution, that should help somewhat with the problem is to clear the blockages in the river that are holding the water artificially high. There are very obvious rapids around woody debris just East of John Dabbs and Karen Liben's house (next door). The post-flood river was cleaned of debris before the current channel was opened. The local channel has not been cleared of deepened, like the rest of the local river, because it is part of Open Space land. This is the easiest solution, but may not stop the water coming through the berm.	Bonnie Richards & Sam Miller	X		X				
There is still a stream running through my basement, and I am running two sump pumps to keep up with it. This high water problem will not solve itself. The solutions all involve working on the river, and on Open Space property. Open Space has created a problem that cannot be fixed without their involvement. I have already added a lot of dirt to try to cover the standing water in my yard, but the ponds, puddles, and streams still run through the yard, they just run at a higher level.	Bonnie Richards & Sam Miller	X		X				
Notes from an e-mail from POS staff based on site visit with Ms. Libin in February 20, 2014: Their 2 biggest concerns appear to be:	Karen Liblin							
1. They have a water right to pump 1 acre-foot of water out of the creek. They said they used to pump directly out of the creek. Now their pump is buried 8 – 10 feet down (by their estimate) and of course the river is too far away to pump from and on county property. They also mentioned groundwater and uncertainty on how it would fluctuate in the coming years, so they may also be able to pump groundwater too to access their water.	Karen Liblin			X				
2. They also mentioned that they have lost $250,000 in equity from their home because the river is no longer right behind their house, and they are concerned about the aesthetic and financial losses. At a minimum, they are hoping to have the creek moved closer to their home to be able to get their water. They feel the creek could be put back just south of the cottonwoods where a secondary channel formed during the flood.	Karen Liblin			X				
Our concerns are that until something definitive is concluded, we are not in a position to move forward with our planning and recovery process. The three main issues that are related to the river location that we, ourselves, need to consider are:	Jason Dabbs							
1. removal of the tons of debris and protection of the trees whose roots are currently smothered	Jason Dabbs		X			X		
2. long term viability of our well with a remote location of the river	Jason Dabbs			X				
3. rehabilitation of our septic system	Jason Dabbs							X
Previously, above our 457 Old Saint Vrain Road location, the creek was pushed next to highway 7 with a large rock rip rap walled barrier on the south side of the stream. This was done after the 1969 flood. This action resulted in a long straight stream path followed by two very sharp right angle turns for the stream. The first sharp turn was at an easterly tributary diversion culvert installed to limit flows to the South Ledge Ditch head gate. The main stream flow here was directed North. The second right angle turn was where the stream then headed sharply east toward the County road and our property, before it again was redirected north along the west side of County road. This former main streambed with the two sharp right angle turns (north and then east)is now dry.	Ron Gosnell			X				
The flood broke from the artificial rip-rap walled confines above and spread out. As the creek subsided after about a week of flood flows, there were several minor channels being formed and flowing. Now, after a meandering shallow flow over the meadow, there is one relatively distinct gathering with a single flow location near a cottonwood grove. That single flow takes the stream through a swale that existed before this flood and to a location South of the South Ledge Ditch head gate. Here the former muskrat pond was cut five feet deeper and breached.	Ron Gosnell			X				
It is my opinion that the stream below the meadow is closer to an earlier pre-1969 flood location just above our property. And because of its present location above us and its widened breadth near us, the stream can better accommodate high water flows than before this flood. I understand, neighbors above us want the stream restored to its former location north of the pasture across from Dean and Elaine Readmond, and reestablished at a location just south of the two homes adjacent to Highway 7 that previously had stream front property. I think that this is a reasonable action and still enables the present downstream location to be enhanced and approximate its present path above the South Ledge Ditch head gate.	Ron Gosnell			X				

Comment	Source	Safety	Habitat	Conveyance	Recreation	Environmental	Stabilization	Coordination
That is my preference. Namely to NOT RESTORE any long straight steam paths and sharp angle turns and instead allow gradual stream bed turns to put the stream on a northerly course near the South Ledge Ditch head gate and along side the County Road, instead of being directed at it. Furthermore. encouraging the stream to spread out somewhat where there is space for it to do so without threatening structures, rather than attempting confinement with rip-rapped walls, seems to me to be a reasonable strategy for flood mitigation. I think that my stated preference is consistent with the City of Longmont's need to supply their municipal water intake, and the South Ledge Ditch Company and Meadow Ditch Company needs to lift a portion of the stream flow above its present deep cut depth and feed their head gates. Because the flood deepened the channel so greatly, near the South Ledge Ditch and Meadow Ditch head gates, some engineered work will be necessary to gravity feed these two head gates/ditches. ... I do not claim expertise but I think it is appropriate to express my preference and opinion after I have observed the river's behavior over 40 years and during several flood events.	Ron Gosnell			X				
DEBRIS								
Overall concern about woody debris throughout reach including short- and long-term plans for its management	BCPOS					X		
Concerned about log jams at bridges in future floods	BCPOS	X		X				
LYONS QUARRY								
What are the reclamation plans and timeline for reclamation at Lyons Quarry	BCPOS					X		
Is there anything that can be done in the quarry that would reduce flood risks?	BCPOS	X		X				
During Master Plan process, flood detention at Lyons Quarry was discussed, but deemed infeasible by the Michael Baker Jr. consulting team	BCPOS			X				
PRIVATE RESIDENCES ALONG HWY 7								
Concerned about groundwater levels and its impact on adjacent homes	BCPOS	X						
Mound of sand and rock was pushed up between residences and open space following flood	BCPOS		X					
HALL MEADOWS/ SPLIT FLOW								
Following the flood, neighbors had a lot of concern about the split flow that occurred in Hall Meadows, including potential impacts to Old St. Vrain Road during spring run-off. Temporary repairs were completed in spring 2014 and fixed again in spring 2016. A long-term plan needs to be developed for this area.	BCPOS	X						
Need to consider interaction of creek and road	BCPOS	X						
Need planning that can determine specific strategies and mitigations to address the flooding that occurred due to the breach in this area	BCPOS	X						
LONGMONT PIPELINE/ DIVERSION								
A number of issues identified including channel capacity downstream, root wads remaining on bank, revegetation, future plans for post-flood channel to the south	BCPOS		X	X		X	X	
How will the stream alignment be determined and how does this affect private land and Boulder County open space land?	Larry Quinn		X	X				
What will be required in regard to conveyance capacity of the stream in this reach alongside the new pipeline? Will the pre-flood capacity be restored or merely a 5-year channel as was done downstream of the bridge?	Larry Quinn			X				
Will the diversion structure include fish passage design elements as has been mentioned verbally by Longmont staff to neighbors?	Larry Quinn		X					
Can the proposed fill on the east side of the SSV channel proposed in the draft basin plan be included in this project?	Larry Quinn			X				
What are the Boulder County Open Space plans for the triangular section of Hall open space upstream of the bridge?	Larry Quinn		?					
How do the new 100-year hydrology figures in the draft SVCC affect the hydraulics of the existing bridge?	Larry Quinn			X				
The Longmont diversion should be modified to address life safety issues that are created by the current low head dam that exists. A downstream sloping retrofit is an easy way to address this problem. This section of creek is boated during runoff and is considered a run for beginner intermediate boaters. This structure is life threatening and also allows no route for fish to migrate up stream Please do not harvest large boulders from the riverbed or banks to use as materials for other areas.	Matt Booth	X			X			
The Longmont South Pipeline flood repair project is funded by FEMA to "restore the function of the water utility" including compliance with permit requirements. The pipeline project has seeded the construction area to comply with the United States Army Corps of Engineers authorization, Colorado Department of Public Health and Environment permit for storm water discharges associated with construction activities, and the Boulder County grading permit.	Jon Robb			X				X
OLD SOUTH ROAD BRIDGES								
Ability of existing intact downstream bridge to handle future floods – concern about how creek is angled at bridge	BCPOS	X		X				
Potentially look at increasing capacity for water and debris	BCPOS			X				
Need coordination of creek restoration with replacement of destroyed upstream bridge	BCPOS							X

Comment	Source	Safety	Habitat	Conveyance	Recreation	Environmental	Stabilization	Coordination
DITCHES								
Want to ensure ditch representatives are involved in the planning	BCPOS			X				
What are plans for replacing diversions?	BCPOS			X				
South Ledge / Meadows was rebuilt – concern about how this was designed / constructed	BCPOS			X				
Need fish passages	BCPOS		X	X				
COMMUNITY								
Does this project affect only private or only public entities along the creek? How are we determining the extent of who and what is affected by these alternatives?	Public							X
Adjacent recreational trails and public creek access should be considered. It is important to create connections to existing trail systems and to provide new opportunities for this experience.	Public				X			
Consideration should be given to how the work done on this reach will affect the homes and amenities downstream.	Public							X
RESILIENCY								
The type and size of material used to re-establish the creek channel should be considered and applied in context to the surrounding area. Debris and large rocks have proven to be unstable and movable	Public	X	X			X	X	
The current rise of the creek bed should be addressed. The project should take into account sediment deposition that will continue to make the creek bed shallower.	Public			X				
The current increase in creek velocity should be addressed. The project should aim to decrease velocity and to make sure this does not continue to be a hazard in the future.	Public			X				
Should the stream be put into a single channel or into multiple channels at different places along the reach? The stream should be allowed to take its path of least resistance.	Public			X				
The flood plain should be altered or expanded in certain areas of the project to afford seasonal increased flows and provide room for flood events.	Public			X				
The project should aim to reduce future flood impacts and damage risk.	Public	X		X			X	
The project should evaluate existing engineered elements currently in place along the creek and utilize smarter infrastructure concepts.	Public			X				
SAFETY								
Human life and safety should be a top priority for the project, for those in the immediate surroundings of the creek and others who will interact with the creek.	Public	X						
The project should take into consideration the safety of recreational users of the creek, eg: kayakers. Large rocks and woody debris jutting out incorrectly or placed in improper places can prove harmful and devastating.	Public	X			X			
There is specific interest in modifying the current Longmont Diversion dam to create a passable structure for personal watercraft and fish.	Public		X		X			
New infrastructure used to control the creek should not include any new dams. Proposed dams should be safe for recreation, even if they are in an area along the creek that is not sanctioned as such.	Public				X			
Please recommend diversion structures that are safe for personal watercraft to pass over.	Chris Cope	X			X			
Please keep the rivers safe for kayaks, tubes, and swimmers! Please do not create any new low head dams and modify the existing low head dams to allow safe passage. Even if it's an area where recreation is not sanctioned, all it takes is for someone to fall in the river or to lose control of a boat, and it could be deadly. Please, the river claims enough lives, make the dams safe.	Pam Stone	X			X			
ENVIRONMENT								
The project should ensure the creek channel allows for the passage of key fish species.	Public		X					
The creek and associated flood plain should provide aquatic and terrestrial habitat that allows for many different types of plant and animal species to thrive within the corridor.	Public		X			X		
The channel and adjacent stream bank should be re-established to a natural state and avoid highly-engineered solutions to the reach. A terraced bank system can be utilized to provide a space where native plant and animal species can thrive.	Public					X	X	X
The project should follow a natural model to mimic the conditions that would occur as the creek restores itself to a healthy condition. The creek should be as Mother Nature intended.	Public			X				
Criteria should be established for future mitigation of natural disasters. There should be planned vegetation control with awareness of the potential future hazard posed by large woody debris during flooding conditions.	Public					X	X	X
There is a need for an assessment of the environmental consequences, positive or negative, of the proposed alternatives.	Public					X		
PROJECT IMPLEMENTATION								
The Andesite Quarry storm water management plan significantly impacts the adjacent stream channel. The operation of the Andesite Quarry reclamation is an important part of the corridor and something should be done to mitigate current negative impacts. The design team should review the Andesite Quarry reclamation and storm water management plans and push to work in conjunction with the reclamation of the Quarry site to help expedite and coordinate mutual positive outcomes such as flood risk reduction.	Public			X				

Comment	Source	Safety	Habitat	Conveyance	Recreation	Environmental	Stabilization	Coordination
Where are key / funded sections and how has the allocation of funds been determined for this reach? The project should not just focus on key / funded reaches but address the complete creek system.	Public							X
The project should provide an understanding of the current grant money opportunities and strategize ways to continue to receive funds for recovery and maintenance.	Public							X
	TOTAL	22	14	46	8	12	5	14
PUBLIC MEETING #1								
Community:								
Does this project affect only private or only public entities along the creek? How are we determining the extent of who and what is affected by these alternatives?	Public							
Adjacent recreational trails and public creek access should be considered. It is important to create connections to existing trail systems and to provide new opportunities for this experience.	Public							
Consideration should be given to how the work done on this reach will affect the homes and amenities downstream.	Public							
Resiliency:								
The type and size of material used to re-establish the creek channel should be considered and applied in context to the surrounding area. Debris and large rocks have proven to be unstable and movable during flood events.	Public							
The current rise of the creek bed should be addressed. The project should take into account sediment deposition that will continue to make the creek bed shallower.	Public							
The current increase in creek velocity should be addressed. The project should aim to decrease velocity and to make sure this does not continue to be a hazard in the future.	Public							
Should the stream be put into a single channel or into multiple channels at different places along the reach? The stream should be allowed to take its path of least resistance.	Public							
The flood plain should be altered or expanded in certain areas of the project to afford seasonal increased flows and provide room for flood events.	Public							
Affects that may take place outside the project limits from creek stormwater runoff and diverted debris flow should be considered.	Public							
The project should aim to reduce future flood impacts and damage risk.	Public							
The project should evaluate existing engineered elements currently in place along the creek and utilize smarter infrastructure concepts.	Public							
Safety:								
Human life and safety should be a top priority for the project, for those in the immediate surroundings of the creek and others who will interact with the creek.	Public							
The project should take into consideration the safety of recreational users of the creek, eg: kayakers. Large rocks and woody debris jutting out incorrectly or placed in improper places can prove harmful and devastating.	Public							
Environment:								
The project should ensure the creek channel allows for the passage of key fish species.	Public							
The creek and associated flood plain should provide aquatic and terrestrial habitat that allows for many different types of plant and animal species to thrive within the corridor.	Public							
The channel and adjacent stream bank should be re-established to a natural state and avoid highly-engineered solutions to the reach. A terraced bank system can be utilized to provide a space where native plant and animal species can thrive.	Public							
The project should follow a natural model to mimic the conditions that would occur as the creek restores itself to a healthy condition. The creek should be as Mother Nature intended.	Public							
Criteria should be established for future mitigation of natural disasters. There should be planned vegetation control with awareness of the potential future hazard posed by large woody debris during flooding conditions.	Public							
There is a need for an assessment of the environmental consequences, positive or negative, of the proposed alternatives.	Public							
Project Implementation:								
The Andesite Quarry stormwater management plan significantly impacts the adjacent stream channel. The operation of the Andesite Quarry reclamation is an important part of the corridor and something should be done to mitigate current negative impacts. The design team should review the Andesite Quarry reclamation and stormwater management plans and push to work in conjunction with the reclamation of the Quarry site to help expedite and coordinate mutual positive outcomes such as flood risk reduction.	Public							
Where are key / funded sections and how has the allocation of funds been determined for this reach? The project should not just focus on key / funded reaches but address the complete creek system.	Public							
The project should provide an understanding of the current grant money opportunities and strategize ways to continue to receive funds for recovery and maintenance.	Public							

Comment	Source	Safety	Habitat	Conveyance	Recreation	Environmental	Stabilization	Coordination
PUBLIC MEETING #2								
Summary of Alternatives Presented and Comments Received:								
Floodplain Connectivity:								
Hall 2 deed restrictions may preclude use of onsite materials – BCPOS to investigate	Public							
Concern for wood removal maintenance ("to keep channel clear") – who is responsible?	Public							
Take into consideration where the river wants to go.	Public							
Consider using excess cut at quarry for fill as part of their reclamation area	Public							
Could take it from the area adjacent to the quarry and stream to lower floodplain	Public							
Add sinuosity to reach downstream of quarry/upstream of bedrock bend?	Public							
New road/embankment design includes benching on the inside (2-yr, 25-yr flow), does not include instream structures – proposed slope ~0.6%	Public							
Public suggestion to move road to improve conveyance	Public							
Move channel further west to take pressure off road	Public							
Matthews and Holcombe combined diversion (across from John Hall's property): Include proposed location in our design	Public							
Matthews and Holcombe combined diversion (across from John Hall's property): New location in stream – 2 ft. high (+/-)	Public							
Matthews and Holcombe combined diversion (across from John Hall's property): Potentially move diversion upstream to bedrock bend	Public							
Andesite bridge: 2x wider, need to coordinate design	Public							
Andesite bridge: Pipe for diversion tied into design	Public							
Andesite bridge: Addition of floodplain culvert(s) on left bank, may not be feasible given wider span	Public							
Andesite bridge: Need to stabilize area on right bank downstream of bridge (river was in this location, but the County moved it back)	Public							
Plug area: Illegal levee built on the upstream side of the 2 houses in the floodplain, expand floodplain benching to include removal of the levee? Or keep?	Public							
Plug area: Some folks want to keep plug so overflow does not occur	Public							
Plug area: Concern with avulsion potential (re: overflow channel at plug)… can the overflow channel be moved further downstream?	Public							
Plug area: Downstream of plug, improve channel/floodplain connection to provide "slow" crest over into floodplain	Public							
Plug area: Concern expressed over overflow channels near road – worried about flow moving over the road again. Would like to see different options (away from road)	Public							
Plug area: Maybe utilize "pilot channels" to encourage flow in floodplain without having a defined channel	Public							
Plug area: Plug area is very important in terms of what the channel does downstream at the diversion	Public							
South Ledge/Meadows Diversion: Is anything planned in this area? Floodplain grading? Overflow channels?	Public							
Longmont Diversion: Would like to see sediment removed downstream of diversion (concerned that Longmont filled in the channel alignments, instead of just leaving as overflow	Public							
Longmont Diversion: Water is being sent to the east by raising the terrace	Public							
Old South St. Vrain Bridge area: A lot of concern re: overflow channel that comes off of main channel upstream of bridge, crosses road and runs through private properties (house proposed on one of the parcels).	Public							
Old South St. Vrain Bridge area: Interested in another option that sends flow around and back to the main channel without going very far into private property	Public							
Old South St. Vrain Bridge area: Can the flow be optimized through bridge? What is the current capacity	Public							
Old South St. Vrain Bridge area: Reroute channel to improve flow through bridge	Public							
Channel Complexity:								
BCPOS is combining two points of diversion into one structure – looking for guidance on placement and structure type. Proposed location circled on map	Public							
BCPOS wants our survey data as they need to get out and collect more data but don't want to duplicate effort	Public							
BCPOS can send bridge drawings if we still need them	Public							
Received one random comment to re-visit the suggestions in the master plan for the Old SSV Bridge and Longmont diversion. I suspect this mostly refers to replacing the current structure with a fish passable structure.	Public							
Revegetation:								

Comment	Source	Safety	Habitat	Conveyance	Recreation	Environmental	Stabilization	Coordination
A long conversation took place between Brandon Parsons (THK), Vince Zounek and Ron Gosnell. Mr. Parsons (THK) was asked to consider revegetation measures along the embankment of Old St. Vrain Road, across the street from Vince's property. This area use to be heavily vegetated but pre-flood work eliminated both upland vegetation and willows in this area. Specific revegetation measures discussed include: Installing coyote willows into the rip-rap, Re-seeding the upland area currently used for parking, Incorporating new bio-engineering measures along the embankment to establish more robust riparian zone.	Public							
Brandon (THK) explained to Cecily Mui, from the St. Vrain Creek Coalition (SVCC), the methods behind the revegetation alternative.	Public							
Ms. Mui (SVCC) inquired as to the exact location of the EPW project boundaries. Erst Strenge (BCPOS), drew the project limits on the map of the alternative and a brief discussion arose regarding their placement and connection to one another.	Public							
Ms. Mui (SVCC) asked if a reference reach had been used to develop the revegetation plan and methods. Mr. Parsons (THK) explained that while a healthy reference reach had not been identified our experience in similar river systems helped guide the approach. David Hirt (BCPOS) stepped in to share his expertise on the native plant species and the approach we will be taking to revegetate this corridor based on his experience in this area.	Public							
Mr. Gosnell, asked the design team and BCPOS to consider a maintenance strategy and criteria to prevent woody debris from causing an issue. Ron, would like to develop a way to understand at what point mature vegetation could become a hazard during a flood. A discussion arose between Tim Shafer (BCPOS), Mr. Parsons (THK) and Mr. Gosnell regarding this issue.	Public							
Mr. Gosnell, identified areas along the stretch where woody debris gathered during the floods. It was discussed that a way to decrease obstructions caused of woody debris would be to open up these "choke points" along the creek.	Public							
Infrastructure Protection:								
Moth Mullein: State priority list B along the roadside	Public							
Approximate 2:1 Slope for Mine reclamation	Public							
New combined ditch location for Matthews and Holcomb near Hall property	Public							
Will need to protect new diversion pipeline by Old South St Vrain Bridge	Public							
Box culvert will be provided for Holcomb Matthews Ditch at Old South St Vrain Bridge	Public							
Might need to protect diversion pipeline near Redmond's	Public							
Ok to move South Ledge and Meadows diversion as part of this project	Public							
Vince Property: Parking along street, killing vegetation, need to plant willows	Public							
Option to move Longmont diversion upstream	Public							
Important to combine Longmont diversion into the EWP project limits.	Public							
Sediment is starting to fill in downstream of Longmont Diversion.	Public							
Option to straighten Highway 7 crossings should be evaluated	Public							
Create Low Flow Channel Throughout Reach	Public							
Do Not Harvest Boulders Or Break Boulders Greater than 3' diameter	Public							
Place Large Instream Boulders In The Channel	Public							
Provide Boat And Fish Passage	Public							

j. Appendix J - South St. Vrain Creek Restoration at Hall Ranch – Alternative Analyses and Preferred Alternative

July 8, 2016

Cecily Mui
Saint Vrain Creek Coalition
1251 S. Bowen St,
Longmont, CO 80501

Submitted via email to: CMui.svcc@gmail.com

Re: South St Vrain Creek Restoration at Hall Ranch – Alternative Analyses and Preferred Alternative

Dear Cecily Mui and Coalition;

This memorandum is to discuss the alternatives that have been developed as part of this South St. Vrain Creek Restoration at Hall Ranch along with steps to determine the preferred alternative. From our understanding there was some concern with our approach to developing the alternatives and then the process of developing a preferred alternative, therefore would like to clarify. This is a tried and true process that has been vetted through other coalitions and other projects throughout the state. We are confident in our approach and the ability to develop a safe, natural, resilient, functioning, and ecologically rich habitat along the South St. Vrain Creek corridor.

In summary, issue and reach based alternatives were developed based upon stakeholder's comments including homeowners, Coalition members, and Boulder County Parks and Open Space employees. In order to design a holistic, resilient project design some of these alternatives will be used in combination to address the issues of the corridor at various locations. Once the various alternative combinations have been developed, they will be evaluated and analyzed using a decision matrix along with sound engineering, science and geomorphological studies.

The information below will develop in more detail how the alternatives were determined and how a combination of alternatives will become the preferred alternative for various locations along the corridor.

Alternatives

The alternatives developed as part of this project have been developed based upon multiple constraints and criteria. These constraints and criteria were developed into a Decision Making Process diagram that was presented at the June 30 public meeting and is also attached. This Decision Making Process diagram was developed based upon critical issues from stakeholder comments, which were developed into the Project Goals Statement, Core Values and Prioritization Criteria. The alternatives for this project will not only be evaluated for the Emergency Watershed Protection (EWP) eligible areas (SSV 1 and SSV 2), but **for the entire 3.2 mile reach**. Below is a list of some of the constraints and criteria used to determine the alternatives:

- Public comments
- Landowner meetings
- Known existing and proposed projects
- History of flooding
- St Vrain Creek Master Plan
- Costs
- Property ownership
- Natural channel design process
- Feasibility

Numerous visits with the landowners and members of the Coalition have taken place to develop the alternatives for this project, including one-on-one, on site meetings with landowners throughout the corridor. The design team has attended a Coalition supported working group meeting (May 11) along with two presentations to the Coalition (May 25 and June 29) and two presentations to the public (May 24 and June 30) with regard to this project.

Having two to three "alternatives" for the entire 3.2 mile reach would not meet the goals of this project, nor would it propose a resilient design that can be implemented. The fact that this project is composed of a 3.2 mile reach of the South St Vrain Creek from above the andesite quarry down to the eastern Old South St. Vrain Road Bridge leads to an issue and sub-reach based alternative development approach. Understanding that each sub-reach of the project has its own stream processes and constraints means that each will have its own alternative or combination of alternatives. Therefore, there is the potential for multiple alternatives for each sub-reach. Consequently each sub-reach was evaluated on its own and then the entire 3.2 miles will be holistically evaluated to determine the preferred alternative from a combination of alternatives.

Therefore, our team developed issue and reach based alternatives to address the specific concerns for various sub-reaches. The main issues facing the corridor are dis-connection of the floodplain from the channel, minimal instream structures for geomorphically effective bedforms and habit, lack of vegetation to support a diverse ecosystem, and risk of infrastructure to future flooding. The four alternatives developed to address each of the aforementioned issues are Floodplain Connectivity, Channel Complexity, Revegetation and Infrastructure Protection, respectively. Descriptions and illustration of these alternatives were provided at the Coalition and public meetings and can be supplied as requested.

These alternatives and the location of each alternative were presented at the public meeting on June 30th with a PowerPoint presentation to explain each alternative and the benefit of each alternative along with their location on aerial roll maps, which were available for the public to view. Meeting participants had an opportunity to ask questions and comment on each alternative and its location. These comments will be addressed to refine the alternatives prior to developing a preferred alternative.

While this is not a master planning process and is a 30% design, evaluation of existing infrastructure constraints will take place. But it must be understood that the purpose of this project is not to modify existing infrastructure, but to work within the corridor and provide a robust design that can be implemented based upon various sources of funding now and in the future. Planning elements will be added to the plan set to inform future designs of potential aspects that could be evaluated in more depth to provide an even more resilient and ecologically healthy ecosystem. It will be the option of the owners of the various infrastructures to further these designs as they feel appropriate.

Preferred Alternatives

The next steps the design team will take will be to use the Decision Matrix based upon the Decision Making Process diagram along with performing in depth hydraulic analyses on alternatives developed to determine which combination of alternatives at various locations throughout the corridor should be implemented. The Decision Matrix developed was presented at the public meeting on June 30th and was based upon the project goals statement and stakeholder comments and feedback. The Decision Matrix has been completed by the design team and is attached to this memorandum. This matrix will help lead the team in determining what was most important to the stakeholders.

The hydraulic analyses will include modeling of the entire corridor using HEC-RAS 1-D and Sedimentation and River Hydraulics (SRH) 2-D, along with a sediment transport analysis and geomorphological study. These analyses and studies will be developed based upon multiple recurrence interval flows from the bankfull discharge of the 1.5 year storm to the 100 year storm. The preferred alternative will be decided based upon sound engineering and science including stream power, water levels, velocity, shear stresses and geomorphological constraints. Existing and proposed projects will be included with this evaluation to ensure a holistic design throughout the corridor.

Once the preferred alternative throughout the corridor has been decided, then another in-depth site visit will take place with the stakeholders to walk them through the preferred alternative decision process and the preferred alternative.

j. Appendix J - South St. Vrain Creek Restoration at Hall Ranch – Alternative Analyses and Preferred Alternative

Summary of Sediment Samples: South St. Vrain Creek 2016

Date	Time	Estimated Discharge (cfs)	Bedload Captured on Sieve (g)						
			32 mm	16 mm	8 mm	4 mm	2 mm	Pan	Total
6/14/2016	6:00 AM	437	48.4	85.7	100	449.7	2647.6	3483.2	6814.6
6/14/2016	8:00 AM	411	0	128.9	131.6	503.7	2625.0	4636.9	8026.1

Date	Time	Particle Size (mm)		Sampler Width (ft)	Stream Widh (ft)	No. of Samples	Duration (seconds)	Bedload Trans. Rate (kg/s)	Susp. Sediment (mg/l)	
		Largest	2nd Largest						Wash Load	Sand Load
6/14/2016	6:00 AM	43	34	0.5	47.0	10	120	3.0144	27.72	83.16
6/14/2016	8:00 AM	34	30	0.5	47.0	10	120	3.1254	25.00	161.40

DISCHARGE MEASUREMENT FIELD SHEET AND TEMPLATE

STREAM NAME: South St Vrain Creek abv Lyons

DATE: 6/14/2016 **gh: START:** 0.92 **END:** 0.92

TIME: START: 10 MDT **END:** 10:50 MDT **Crew:** **jmn.br, ss**

COMMENTS: Wading measurement just downstream of "plug" where channel width was conducive to wading swift current. Stage taken at Longmont weir right bank side.

Meter: AA **SPIN TEST: BEFORE:** ok **AFTER:** ok

Distance (ft)	Increment of Width (ft)	Depth (ft)	Increment of Area (Sq. ft)	Revolutions	Seconds	Velocity (ft/sec)	Increment of Discharge (cfs)
4.6		0.00					
5.5	1.70	0.82	1.394			1.619	2.257
8.0	2.75	1.35	3.713			3.041	11.290
11.0	3.00	1.70	5.100			2.355	12.011
14.0	3.00	1.40	4.200			4.010	16.842
17.0	3.00	1.10	3.300			3.049	10.062
20.0	3.00	0.85	2.550			3.283	8.372
23.0	3.00	1.05	3.150			3.615	11.387
26.0	3.00	1.05	3.150			4.613	14.531
29.0	3.50	1.20	4.200			4.075	17.115
33.0	3.00	1.10	3.300			4.700	15.510
35.0	2.50	1.35	3.375			4.164	14.054
38.0	3.00	1.45	4.350			5.477	23.825
41.0	3.00	1.90	5.700			4.508	25.696
44.0	3.00	2.00	6.000			5.486	32.916
47.0	3.00	2.00	6.000			4.821	28.926
50.0	2.75	2.00	5.500			5.581	30.696
52.5	2.75	2.00	5.500			4.532	24.926
55.5	2.75	1.70	4.675			4.337	20.275
58.0	2.50	1.70	4.250			4.188	17.799
60.5	2.50	1.10	2.750			3.827	10.524
63.0	2.25	0.72	1.620			2.516	4.076
65.0	3.10	0.35	1.085			1.790	1.942
69.2		0.00					
TOTALS OR MEANS	64.60	1.31	84.862			4.184	355.030

l. Appendix L - Channel Geometry and Rock Structure Design Calculations

South St Vrain Hall Ranch Restoration Project

Preliminary Channel Geometry Design Calculations

Created by: Michael Rafferty, PE **Last Revision Date:** 18-Sep-16

Design Constants

Parameter	Symbol	Value	Units	Notes
Acceleration of Gravity	g	32.2	ft/s^2	
Specific Weight of Water	γ_w	62.4	lb/ft^3	Value at 50 degrees F
Relative Submerged Density of Rock	S_g	1.65	-	
Kinematic Viscosity of Water	ν	1.41E-05	ft^2/s	Value at 50 degrees F

Design Inputs

			South St Vrain Main Stem								
Parameter	**Symbol**	**Units**	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**Source**
Existing Width - 1.5-Year Flow	$W_{1.5,ex}$	ft	42	53	62	54	42	57	46	42	1D HEC-RAS Output
Base Flow Peak Discharge	Q_{Base}	cfs	25	25	25	25	25	25	25	25	St. Vrain gage data
1.5-yr Peak Discharge	$Q_{1.5}$	cfs	470	470	470	470	470	470	470	470	St. Vrain gage data
2-yr Peak Discharge	Q_2	cfs	681	681	681	681	681	681	681	681	St. Vrain gage data
10-yr Peak Discharge	Q_{10}	cfs	1,464	1,464	1,464	1,464	1,464	1,464	1,464	1,464	Jacobs (2014)
25-yr Peak Discharge	Q_{25}	cfs	2,890	2,890	2,890	2,890	2,890	2,890	2,890	2,890	Jacobs (2014)
100-yr Peak Discharge	Q_{100}	cfs	6,598	6,598	6,598	6,598	6,598	6,598	6,598	6,598	Jacobs (2014)
Upstream Station	Sta	ft	47+69	85+17	107+41	121+06	131+37	144+22	159+59	177+73	
Downstream Station	Sta	ft	26+14	47+69	85+17	107+41	121+06	131+37	144+22	159+59	
Design Length	L_{design}	ft	2,155	3,748	2,224	1,365	1,032	1,285	1,537	1,814	
Maximum Elevation	E_{max}	ft	5,384.25	5,434.31	5,467.08	5,483.50	5,494.71	5,518.58	5,538.61	5,564.61	
Minimum Elevation	E_{min}	ft	5,353.00	5,384.25	5,434.31	5,467.08	5,483.50	5,494.71	5,518.58	5,538.61	
Change in Elevation	ΔE	ft	31.25	50.06	32.77	16.42	11.21	23.87	20.03	26.00	
Design Longitudinal Bed Slope	S_{des}	ft/ft	0.0145	0.0134	0.0147	0.0120	0.0109	0.0186	0.0130	0.0143	

South St Vrain - Hall Ranch Restoration Project

Hydraulic Geometry Calculations

Unit Conversion	Q_2 (cfs)	Q_2 (cms)
Bankfull Discharge	470	13.31

Bankfull Width - Calculations

Method	Equation (Q_2 in cms)	Units	Value	Notes
Andrews - Thick Vegetation	$W_{BF} = 3.91\ Q_{1.5}^{0.49}$	m to ft	46	
Andrews - Thin Vegetation	$W_{BF} = 4.94\ Q_{1.5}^{0.48}$	m to ft	56	
Hey & Thorne - 0% Trees and Shrubs	$W_{BF} = 4.33\ Q_{1.5}^{0.5}$	m to ft	52	
Hey & Thorne - 1-5% Trees and Shrubs	$W_{BF} = 3.33\ Q_{1.5}^{0.5}$	m to ft	40	
Hey & Thorne - 5-50% Trees and Shrubs	$W_{BF} = 2.73\ Q_{1.5}^{0.5}$	m to ft	33	
Hey & Thorne - >50% Trees and Shrubs	$W_{BF} = 2.34\ Q_{1.5}^{0.5}$	m to ft	28	

		Selected Design Range		
Method	Units	Min	Typ	Max
Selected Design W_{BF} Range	ft	40	48	55

Riffle Width

			Selected Design Range		
Method	Equation	Units	Min	Typ	Max
Hey & Thorne - Gravel-bed Rivers	$W_R = 1.034\ W_{BF}$	ft	41	50	57

Bankfull Depth

Method	Equation	Units	Value
Hey & Thorne - Bankfull Mean Depth	$y_{BF,avg} = 0.22\ Q^{0.37}\ (D_{50} / 1000)^{-0.11}$	m to ft	2.5

		Selected Design Range		
Method	Units	Min	Typ	Max
Selected Design y_{BF} Range	ft	2.5	3	3.5

South St Vrain Hall Ranch Restoration Project

Required Median Grain Size and Bed Slope to Achieve Equilibrium at $Q_{1.5}$

Design Equations (Reference: USDA, NRCS. (2007). NEH part 654: Stream Restoration Design Guide)

[1] Unit Discharge: $q = Q / W$

[2] Mannings Roughness Coefficient: $n = (0.0926 * R^{1/6}) / (1.16 + 2 \log (R/D_{84}))$; Limerinos Method

[3] Critical Dimen. Shields Stress: $\theta_c = (0.24/D_*) + 0.055 [1 - \exp(-0.02D_*)]$; often assumed to be 0.047 for this analysis

[4] Dimensionless Shear Stress: $\theta = \tau / (S_g * \gamma_w * D_{50})$

[5] Minimum required D_{50}: $D_{50} = \tau / (S_g * \gamma_w * \theta_c)$; Shields Method

Equilibrium Bed Slope:

[6] Manning and Shields (D_{50} > 6mm) $S_{eq} = [\theta_c * D_c * S_g]^{10/7} * [1.486 / (q * n)]^{6/7}$

Substrate Gradation Analysis (Metric Units)

SSVCR Reach (Lyons Reach #)	Units	R1 (SSV-03)	R2 (SSV-04)	R3 (SSV-05)	R4 (SSV-06)	R5 (SSV-07)	R6 (SSV-08)	R7 (SSV-09)	R8 (SSV-10)	Avg
D10	mm	8.9	4.3	5.8	6.9	40.6	5.3	2.3	2.0	9.5
D16	mm	19	15	23	11	61	18	4	4	19.4
D25	mm	56	28	49	19	79	39	8	35	39.0
D50	mm	101	54	85	64	115	86	78	80	82.9
D75	mm	153	98	141	109	167	129	167	132	137.1
D84	mm	185	125	171	133	207	174	271	153	177.4
D90	mm	218	148	252	189	250	221	344	168	223.8
D_{MAX}	mm	1024	310	730	350	660	600	650	500	603.0

Req'd Stable Median Grain Size Analysis

Parameter	Symbol	Units	South St Vrain Main Stem								
			R1	R2	R3	R4	R5	R6	R7	R8	Source
Existing Median Grain Size	D_{50}, D_c	ft	0.332	0.177	0.278	0.210	0.378	0.282	0.256	0.263	Wolman Pebble Count
Existing 84th Percentile Grain Size	D_{84}	ft	0.607	0.410	0.562	0.436	0.678	0.570	0.891	0.501	Wolman Pebble Count
Existing 90th Percentile Grain Size	D_{90}	ft	0.714	0.487	0.825	0.619	0.820	0.727	1.130	0.551	Wolman Pebble Count
Width - 1.5-Year Flow	$W_{1.5}$	ft	41.6	53.5	62.3	54.1	42.5	56.8	46.1	42.2	1D HEC-RAS Output
Shear Stress in Channel at $Q_{1.5}$	$\tau_{1.5}$	lb/ft^2	1.29	1.20	1.07	0.91	1.26	1.22	1.22	1.30	1D HEC-RAS Output
Hydraulic Radius at $Q_{1.5}$	$R_{1.5}$	ft	1.89	1.59	1.52	1.47	1.74	1.38	1.76	1.79	1D HEC-RAS Output
1.5-yr Unit Discharge	$q_{1.5}$	cfs / ft	11.3	8.8	7.5	8.7	11.1	8.3	10.2	11.1	[Eq. 1]
Mannings Roughness Coefficient	n	-	0.048	0.043	0.049	0.045	0.051	0.051	0.058	0.045	[Eq. 2]
Critical Dimensionless Shields Stress	θ_c	-	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	[Eq. 3]
Dimensionless Shear Stress at $Q_{1.5}$	$\theta_{1.5}$	-	0.038	0.066	0.038	0.042	0.032	0.042	0.046	0.048	[Eq. 4]
Req'd Stable Median Grain Size at $Q_{1.5}$	$D_{50,req}$	ft	**0.266**	**0.247**	**0.222**	**0.187**	**0.260**	**0.253**	**0.253**	**0.268**	[Eq. 5]
Is Existing Median Grain Size Stable at 1.5-Year Flow?			**Yes**	**No**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Close**	

Equilibrium Bed Slope Analysis

Method	Symbol	Units	South St Vrain Main Stem								
			R1	R2	R3	R4	R5	R6	R7	R8	
Manning and Shields Method	S_{eq}	ft/ft	0.0127	0.0071	0.0137	0.0088	0.0147	0.0126	0.0081	0.0097	[Eq. 6]
Design Longitudinal Bed Slope	S_{des}	ft/ft	0.0145	0.0134	0.0147	0.0120	0.0109	0.0186	0.0130	0.0143	
Is Design Bed Slope Stable at 1.5-Year Flow?			**Close**	**No**	**Close**	**No**	**Yes**	**No**	**No**	**No**	

Conclusion: The design bed slopes are greater than the equilibrium bed slope in most of the design reaches during the 1.5-year recurrance flow given the existing bed gradation. This indicates that many of these reaches are susceptible to downcutting. Additional grade control measures, such as riffles, planform adjustments, and floodplain connectivity improvements may reduce this risk. Reach 5 is a notable exception, since it is subject to aggradation, which is likely acceptable.

South St Vrain - Hall Ranch Restoration Project

Main Channel - Riffle and Habitat Boulder Design

Rock Sizing Reference: USDA, NRCS, 2007. NEH part 654: Stream Restoration Design Guide

Riffle Spacing

Design Reach	Design Channel		Riffle Spacing Design Targets					
			Low (5x BFW)		Mid (6x BFW)		High (7x BFW)	
	Length	BFW	Spacing	Qty	Spacing	Qty	Spacing	Qty
Reach 1	2,155	48	240	9.0	288	7.5	336	6.4
Reach 2	3,748	48	240	15.6	288	13.0	336	11.2
Reach 3	2,224	48	240	9.3	288	7.7	336	6.6
Reach 4	1,365	48	240	5.7	288	4.7	336	4.1
Reach 5	1,032	48	240	4.3	288	3.6	336	3.1
Reach 6	1,285	48	240	5.4	288	4.5	336	3.8
Reach 7	1,537	48	240	6.4	288	5.3	336	4.6
Reach 8	1,814	48	240	7.6	288	6.3	336	5.4

Riffle Face and Ramp Rock Sizing

Note - The rock sizing for the riffle face and ramp was based on the maximum shear stress values from the 2-Year Peak Discharge output table from the HEC-RAS 1-D proposed conditions model at each site. Rock sizes were found using using the following equation (Shield's Method of Incipient Motion):

D_{84} Rock Size: $D_{84} = \theta / \theta_c (S_g * \gamma_w)$; assuming θ_c = 0.03 or 0.047 (0.003 was used for design)

Design Reach	Peak Flow Event	Shear Stress (lb/sq ft)	Exist D_{84} (ft)	Rock Sizing Min D_{84} (ft)		Is Exist D_{84} Stable?
				θ_c = 0.047	θ_c = 0.03	
Reach 1	1.5 YR	1.59	0.61	0.33	0.51	Yes
Reach 2	1.5 YR	1.48	0.41	0.31	0.48	Close
Reach 3	1.5 YR	1.62	0.56	0.33	0.52	Yes
Reach 4	1.5 YR	1.59	0.44	0.33	0.51	Close
Reach 5	1.5 YR	1.47	0.68	0.30	0.47	Yes
Reach 6	1.5 YR	1.44	0.57	0.30	0.47	Yes
Reach 7	1.5 YR	2.00	0.89	0.41	0.65	Yes
Reach 8	1.5 YR	1.63	0.50	0.34	0.53	Close

Riffle Crest and Habitat Boulder Rock Sizing

Note - The minimum riffle crest rock and habitat boulder sizing were based on the maximum shear stress values from the 10, 50, and 100-Year Peak Discharge output table from the HEC-RAS 1-D proposed conditions model at each site. The minimum rock size was found using using the following equation (Shield's Method of Incipient Motion):

Minimum Rock Size: $D_{84} = \theta / \theta_c (S_g * \gamma_w)$; assuming θ_c = 0.03 or 0.047 (0.003 was used for design)

Design Reach	Peak Flow Event	Shear Stress (lb/sq ft)	Exist D_{90} (ft)	Minimum Crest Rock Sizing (ft)		Is Exist D_{90} Stable?	Design Crest Rock (FS 1.5) (ft)
				$\theta_c = 0.047$	$\theta_c = 0.03$		
Reach 1	100 YR	2.44	0.71	0.50	0.79	Close	1.19
Reach 2	50 YR	2.30	0.49	0.47	0.74	No	1.12
Reach 3	100 YR	2.38	0.83	0.49	0.77	Yes	1.16
Reach 4	100 YR	3.00	0.62	0.62	0.97	No	1.46
Reach 5	100 YR	3.15	0.82	0.65	1.02	No	1.53
Reach 6	100 YR	2.38	0.73	0.49	0.77	Close	1.16
Reach 7	50 YR	3.01	1.13	0.62	0.97	Yes	1.46
Reach 8	100 YR	3.21	0.55	0.66	1.04	No	1.56

Reach 1

Riffle and Habitat Boulder Design - Rock Gradation Summaries

Ramp and Riffle Face Rock Gradation (Typical)

Design Parameters	Symbol	Sta	ft	in	mm	
Minimum Grain Size	D_{min}	All	0.007	0.08	2	*Need 5% to 10% fines
16th Percentile Grain Size	D_{16}	All	0.09	1.0	26	$D_{16} = D_{50} / 3$
Median Grain Size	D_{50}	All	0.26	3.0	79	$D_{50} = D_{50} / 2.5$
84th Percentile Grain Size	D_{84}	All	0.65	8.0	197	Largest D_{84} from calcs
Maximum Grain Size	D_{max}	All	1.61	20.0	492	$D_{max} = 6.25 * D_{50}$

Riffle Crest Rock Gradation

Note - D_{max} assumed to be equal 2.5 * D_{min}

Design Reach	Minimum Size		Maximum Size	
	ft	in	ft	in
Reach 1	1.19	15.0	2.96	36.0
Reach 2	1.12	14.0	2.79	34.0
Reach 3	1.16	14.0	2.89	35.0
Reach 4	1.46	18.0	3.64	44.0
Reach 5	1.53	19.0	3.83	46.0
Reach 6	1.16	14.0	2.89	35.0
Reach 7	1.46	18.0	3.65	44.0
Reach 8	1.56	19.0	3.89	47.0

Habitat Boulder Rock Gradation (Typical)

Note - Habitat boulder sizes were upsized from the maximum rock sizes in the above Riffle Crest Rock Gradation table

Design Reach	Minimum Size		Maximum Size	
	ft	in	ft	in
Habitat Boulder Size	2.50	30.0	5.00	60.0

South St Vrain Hall Ranch Restoration Project

Main Channel - Bank Protection - Rock Toe

Created by: Michael Rafferty, PE **Last Revision Date:** 18-Sep-16

Design Equations (Reference: USACE, EM 1110-2-1601: Hydraulic Design of Flood Control Channels)

[1] Minimum required D_{30}: $D_{30} = S_f C_s C_V C_T d [((\gamma_w/(\gamma_s - \gamma_w))^{0.5}) * ((V/(K_1 g d)^{0.5})]^{2.5}$

[2] C_V on outside of bend: $C_V = 1.283 - 0.2 \log (R/W_{BF})$ [if R/WBF > 26]

[3] Slope factor (Carter et al., 1953): $K_1 = (1 - (\sin^2\theta/\sin^2\phi))^{0.5}$

[4] Minimum required D_{50}: $D_{50} = D_{30} (D_{85} / D_{15})^{1/3}$

* These design equations are applicable to channels with bed gradients less than 2% and Fr < 1.2

Constants

Parameter	Symbol	Value	Units	Notes
Acceleration of Gravity	g	32.2	ft/s^2	
Unit Weight of Water	γ_w	62.4	lb/ft^3	Value at 50 deg F
Unit Weight of Rock	γ_s	165.36	lb/ft^3	
Ratio of D_{85} to D_{15}	D_{85}/D_{15}	2.60	-	USACE = 1.7 to 5.2

Design Inputs

Parameter	Description	Notes
Type of Rock	Angular Rock	
Type of Channel Planform	Outside of Bend	
Hydraulic Data Source	2D Model	
Average Return Interval of Design Discharge	Revised 100-Yr Flow	

Parameter	Symbol	Value	Units	Notes
Safety Factor	S_f	1.50	-	Range: 1.1 to 1.5
Local Depth Averaged Velocity	V	11.00	ft/s	2-D Model
Local Flow Depth	d	10.00	ft	2-D Model
Proposed Bankfull Width	W_{BF}	48.0	ft	
Proposed Radius of Curvature	R	150	ft	
Side Slope of Bank	z	2.50	__ ft : 1 ft	

Calculations

Parameter	Symbol	Value	Units	Notes
Angle of Side Slope of Bank with Horizontal	θ	21.80	deg	
Angle of Repose of Riprap Material	ϕ	40.0	deg	Normally 40 deg
Radius of Curvature / Bankfull Width	R/W_{BF}	3.13	-	
Stability Coefficient for Incipient Failure	C_s	0.30	-	
Vertical Velocity Distribution Coefficient	C_V	1.18	-	[Eq. 2]
Thickness Coefficient	C_T	1.00	-	Assumes T = 1*D_{100}
Slope Factor	K_1	0.816	-	[Eq. 3]
Minimum Required D_{30}	D_{30}	1.08	ft	[Eq. 1]

Toe Protection Rock Gradation Design

		Minimum Value		Design Value		
Design Parameters	Symbol	ft	in	ft	in	
15th Percentile Grain Size	D_{15}	0.74	8.9	0.75	9.0	
Median Grain Size	D_{50}	1.49	17.8	1.50	18.0	[Eq. 4]
85th Percentile Grain Size	D_{85}	1.93	23.2	1.95	23.4	
Maximum Grain Size	D_{max}	2.38	28.5	2.40	28.8	
Minimum Required Thickness	T	2.97	35.7	3.00	36.0	

m. Appendix M – Wetland Delineation

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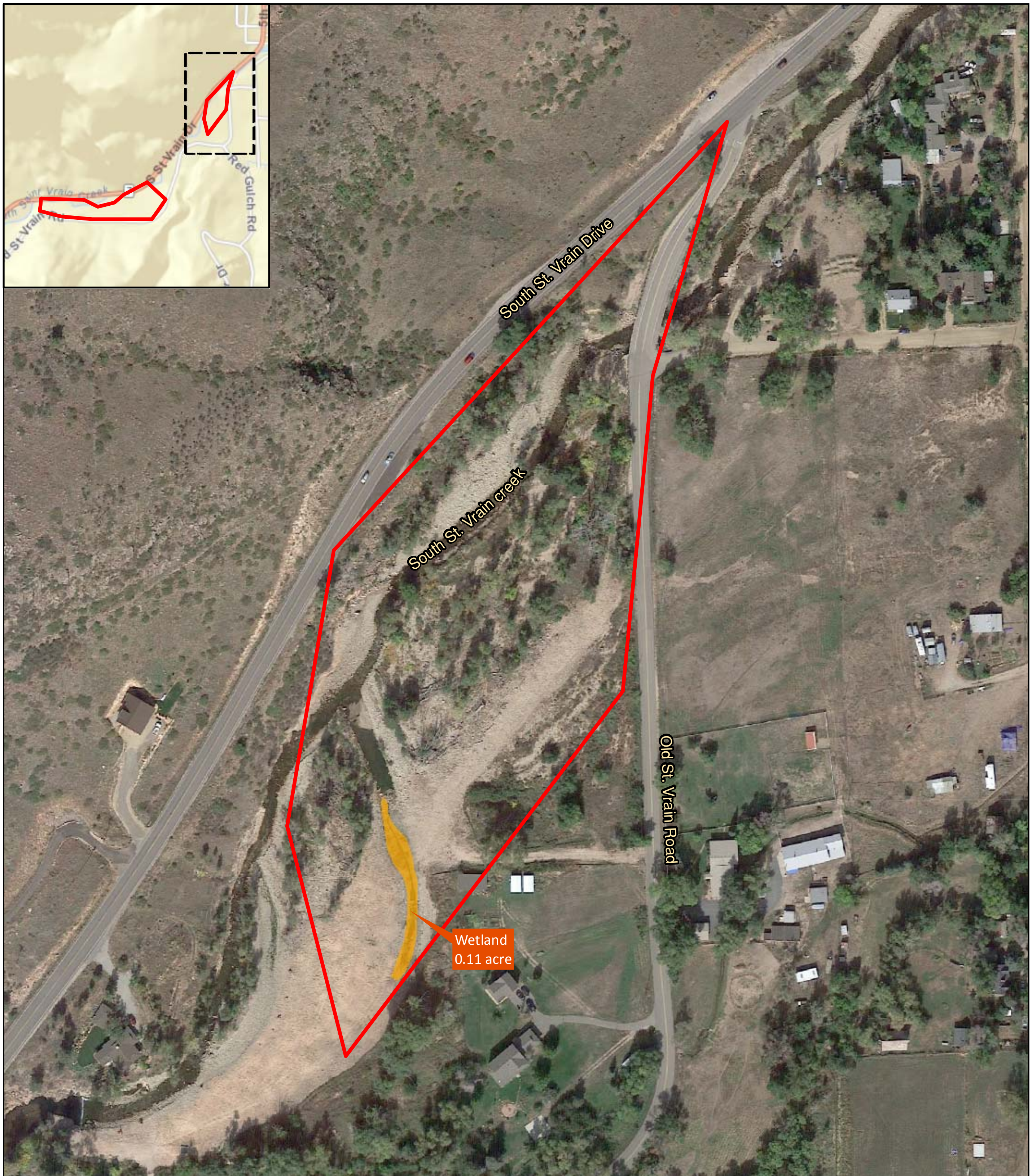

South St. Vrain Creek Restoration at Hall Ranch

- Suvey Area
- Data Point
- Comment
- BCOS Enhancement Areas
- Wetland

0 100 200 feet

N

Figure 2
Existing Conditions

Prepared for: Boulder County
File: 6560 Figure 2.mxd [dlH]
October 5, 2016

ERO Resources Corp.

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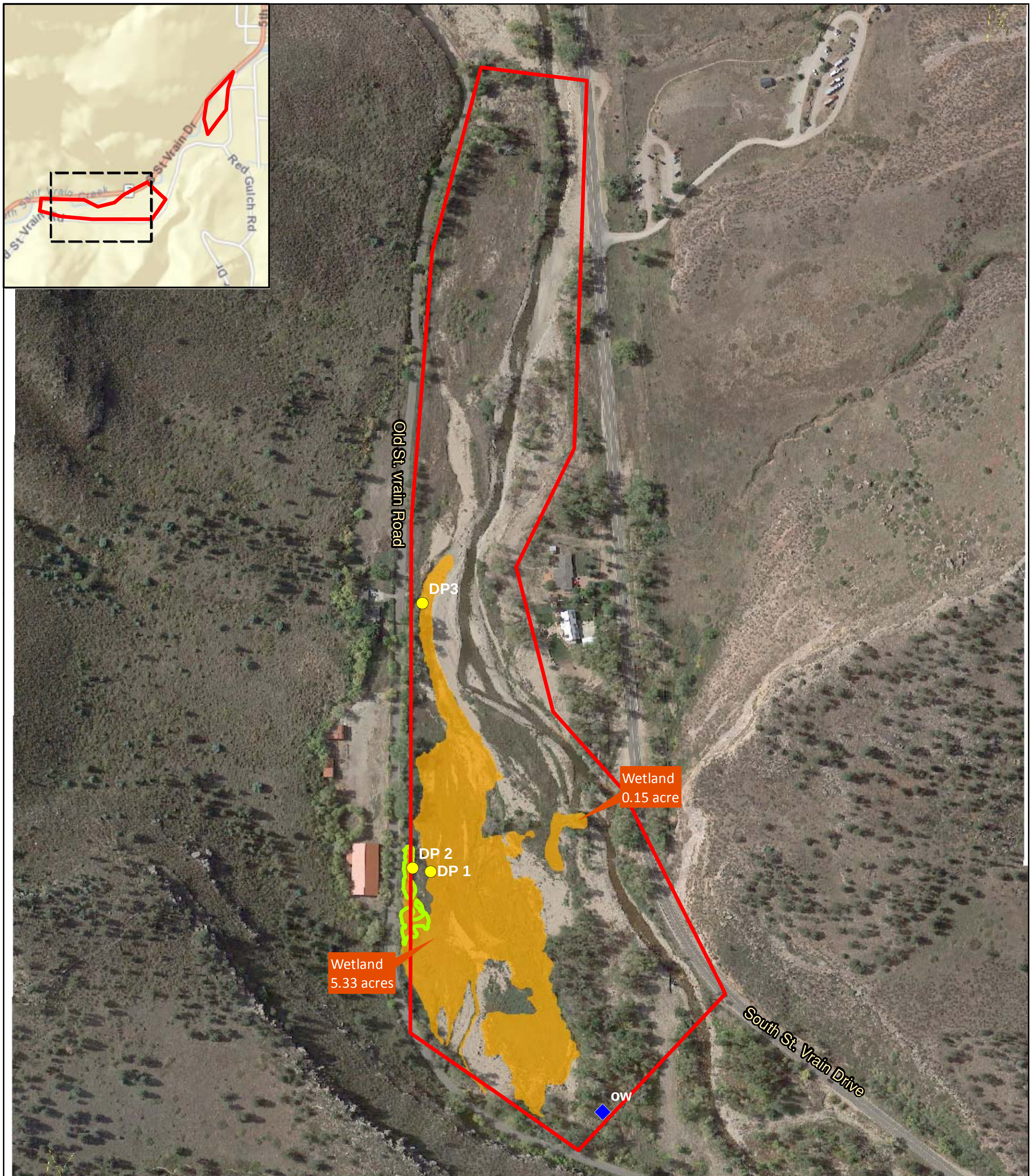


South St. Vrain Creek Restoration at Hall Ranch

- Suvey Area
- Data Point
- Comment
- BCOS Enhancement Areas
- Wetland

0 175 350 feet N

Figure 2
Existing Conditions

Prepared for: Boulder County
File: 6560 Figure 2.mxd [dlH]
October 5, 2016

ERO
ERO Resources Corp.

Aerial Image: © Copyright Google Earth Pro 10/9/2015

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: South Saint Vrain City/County: Boulder Sampling Date: Aug 1, 2016
Applicant/Owner: Boulder County OS State: CO Sampling Point: DP1
Investigator(s): CRH Section, Township, Range: 19, 3N, 71W
Landform (hillslope, terrace, etc.): Floodplain Local relief (concave, convex, none): Concve Slope (%): 0.1
Subregion (LRR): G Lat: 40.209705 Long: 105.283511 Datum: NAD 83
Soil Map Unit Name: N/A NWI classification: PEM

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☒ No ☐ (If no, explain in Remarks.)
Are Vegetation N, Soil Y, or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes ☒ No ☐
Are Vegetation N, Soil N, or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ☒	No ☐
Hydric Soil Present?	Yes ☒	No ☐
Wetland Hydrology Present?	Yes ☒	No ☐

Is the Sampled Area within a Wetland? **Yes** ☒ **No** ☐

Remarks:

Soils consist largely of fluvial deposits from past flooding

VEGETATION – Use scientific names of plants.

Stratum / Species	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size:)			
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size:)			
1. Populus deltoides	15	Y	FAC
2. Populus angustifolia	5	Y	FAC
3. Salix amygdaloides	5	Y	FAC
4.			
5.			
= Total Cover	25		
Herb Stratum (Plot size:)			
1. Carex nebrasensis	25	Y	OBL
2. Conyza canadensis	25	Y	FACU
3. Juncus dudleyi	10	N	FACW
4. Verbascum thapsus	15	Y	UPL
5. Rubus ideaus	5	N	FACU
6. Agrostis gigantea	10	N	FACW
7. Cirsium arvense	5	N	FACU
8.			
9.			
10.			
= Total Cover	95		
Woody Vine Stratum (Plot size:)			
1.			
2.			
= Total Cover			
% Bare Ground in Herb Stratum			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): 4 (A)
Total Number of Dominant Species Across All Strata: 6 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 66 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	25	x 1 = 25
FACW species	20	x 2 = 40
FAC species	25	x 3 = 75
FACU species	10	x 4 = 40
UPL species	40	x 5 = 200
Column Totals:	120 (A)	380 (B)

Prevalence Index = B/A = 3.1

Hydrophytic Vegetation Indicators:

☐ 1 - Rapid Test for Hydrophytic Vegetation
☒ 2 - Dominance Test is >50%
☐ 3 - Prevalence Index is ≤3.0[1]
☐ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** ☒ **No** ☐

Remarks:

Passes dominance test

SOIL

Sampling Point: DP 1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-4	10YR 4/3	100	-	-	-	-	Sand	
4-6	10YR 3/1	100	-	-	-	-	SaLo	
6-12	10YR 3/1	80	2.5YR 4/8	20	D	M	SaLo	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5) (**LRR F**)
- ☐ 1 cm Muck (A9) (**LRR F, G, H**)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ 2.5 cm Mucky Peat or Peat (S2) (**LRR G, H**)
- ☐ 5 cm Mucky Peat or Peat (S3) (**LRR F**)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1)
- ☐ Loamy Gleyed Matrix (F2)
- ☒ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ High Plains Depressions (F16) (**MLRA 72 & 73 of LRR H**)

Indicators for Problematic Hydric Soils[3]:

- ☐ 1 cm Muck (A9) (**LRR I, J**)
- ☐ Coast Prairie Redox (A16) (**LRR F, G, H**)
- ☐ Dark Surface (S7) (**LRR G**)
- ☐ High Plains Depressions (F16) (**LRR H outside of MLRA 72 & 73**)
- ☐ Reduced Vertic (F18)
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ______

Depth (inches): ______

Hydric Soil Present? **Yes** ☒ **No** ☐

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1)
- ☒ Sediment Deposits (B2)
- ☒ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Salt Crust (B11)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Dry-Season Water Table (C2)
- ☐ Oxidized Rhizospheres on Living Roots (C3) (**where not tilled**)
- ☐ Presence of Reduced Iron (C4)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Oxidized Rhizospheres on Living Roots (C3) (**where tilled**)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ FAC-Neutral Test (D5)
- ☐ Frost-Heave Hummocks (D7) (**LRR F**)

Field Observations:

Surface Water Present? Yes ☐ No ☒ Depth (inches): ______

Water Table Present? Yes ☐ No ☒ Depth (inches): ______

Saturation Present? (includes capillary fringe) Yes ☐ No ☒ Depth (inches): ______

Wetland Hydrology Present? **Yes** ☒ **No** ☐

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: South Saint Vrain City/County: Boulder Sampling Date: Aug 1, 2016

Applicant/Owner: Boulder County OS State: CO Sampling Point: DP 2

Investigator(s): CRH Section, Township, Range: 19, 3N, 71W

Landform (hillslope, terrace, etc.): Floodplain Local relief (concave, convex, none): Concve Slope (%): 0.1

Subregion (LRR): G Lat: 40.209705 Long: 105.283511 Datum: NAD 83

Soil Map Unit Name: N/A NWI classification: PEM

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☒ No ☐ (If no, explain in Remarks.)

Are Vegetation N, Soil Y, or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes ☒ No ☐

Are Vegetation N, Soil N, or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ☐	No ☒
Hydric Soil Present?	Yes ☒	No ☐
Wetland Hydrology Present?	Yes ☒	No ☐

Is the Sampled Area within a Wetland? **Yes** ☐ **No** ☒

Remarks:

Vegetation consists of upland plants.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size:)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size:)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Herb Stratum (Plot size:)			
1. Bromus inermis	60	Y	UPL
2. Elymus trachycaulus	20	Y	FACU
3. Carex emoryi	5	N	OBL
4.			
5.			
6.			
7.			
8.			
9.			
10.			
= Total Cover	85		
Woody Vine Stratum (Plot size:)			
1.			
2.			
= Total Cover			

% Bare Ground in Herb Stratum 15

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): ____ (A)

Total Number of Dominant Species Across All Strata: ____ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ____ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A = ____

Hydrophytic Vegetation Indicators:

- ☐ 1 - Rapid Test for Hydrophytic Vegetation
- ☐ 2 - Dominance Test is >50%
- ☐ 3 - Prevalence Index is ≤3.0[1]
- ☐ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** ☐ **No** ☒

Remarks:

SOIL

Sampling Point: DP 2

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-6	10YR 3/2	100	-	-	-	-	SaLo	
6-15	10YR 3/1	90	2.5YR 4/8	10	D	M	SaLo	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5) (**LRR F**)
- ☐ 1 cm Muck (A9) (**LRR F, G, H**)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ 2.5 cm Mucky Peat or Peat (S2) (**LRR G, H**)
- ☐ 5 cm Mucky Peat or Peat (S3) (**LRR F**)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1)
- ☐ Loamy Gleyed Matrix (F2)
- ☒ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ High Plains Depressions (F16) (**MLRA 72 & 73 of LRR H**)

Indicators for Problematic Hydric Soils[3]:

- ☐ 1 cm Muck (A9) (**LRR I, J**)
- ☐ Coast Prairie Redox (A16) (**LRR F, G, H**)
- ☐ Dark Surface (S7) (**LRR G**)
- ☐ High Plains Depressions (F16) (**LRR H outside of MLRA 72 & 73**)
- ☐ Reduced Vertic (F18)
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ____________

Depth (inches): ____________

Hydric Soil Present? Yes ☒ No ☐

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1)
- ☒ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Salt Crust (B11)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Dry-Season Water Table (C2)
- ☐ Oxidized Rhizospheres on Living Roots (C3) (**where not tilled**)
- ☐ Presence of Reduced Iron (C4)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Oxidized Rhizospheres on Living Roots (C3) (**where tilled**)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ FAC-Neutral Test (D5)
- ☐ Frost-Heave Hummocks (D7) (**LRR F**)

Field Observations:

Surface Water Present? Yes ☐ No ☒ Depth (inches): ____

Water Table Present? Yes ☐ No ☒ Depth (inches): ____

Saturation Present? (includes capillary fringe) Yes ☐ No ☒ Depth (inches): ____

Wetland Hydrology Present? Yes ☒ No ☐

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: South Saint Vrain City/County: Boulder Sampling Date: Aug 1, 2016
Applicant/Owner: Boulder County OS State: CO Sampling Point: DP 3
Investigator(s): CRH Section, Township, Range: 19, 3N, 71W
Landform (hillslope, terrace, etc.): Floodplain Local relief (concave, convex, none): Concve Slope (%): 0.1
Subregion (LRR): G Lat: 40.209705 Long: 105.283511 Datum: NAD 83
Soil Map Unit Name: N/A NWI classification:
Are climatic / hydrologic conditions on the site typical for this time of year? Yes [x] No [ ] (If no, explain in Remarks.)
Are Vegetation N, Soil Y, or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes [x] No [ ]
Are Vegetation N, Soil N, or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes [ ] No [x]	**Is the Sampled Area within a Wetland?** Yes [ ] No [x]
Hydric Soil Present?	Yes [ ] No [x]	
Wetland Hydrology Present?	Yes [ ] No [x]	

Remarks:

Large deposit of sand - becoming vegetated by upland plants.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size:)			
1.			
2.			
3.			
4.			
	= Total Cover		
Sapling/Shrub Stratum (Plot size:)			
1.			
2.			
3.			
4.			
5.			
	= Total Cover		
Herb Stratum (Plot size:)			
1. Festuca pratensis	30	Y	FACU
2. Elymus canadensis	20	Y	FACU
3. Bouteloua gracilis	5	N	UPL
4.			
5.			
6.			
7.			
8.			
9.			
10.			
	55 = Total Cover		
Woody Vine Stratum (Plot size:)			
1.			
2.			
	= Total Cover		
% Bare Ground in Herb Stratum 45			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): ____ (A)

Total Number of Dominant Species Across All Strata: ____ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ____ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

- [ ] 1 - Rapid Test for Hydrophytic Vegetation
- [ ] 2 - Dominance Test is >50%
- [ ] 3 - Prevalence Index is ≤3.0[1]
- [ ] 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- [ ] Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes [ ] No [x]

Remarks:

SOIL

Sampling Point: DP 3

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-20	10YR 4/3	100	-	-	-	-	Sand	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5) (**LRR F**)
- ☐ 1 cm Muck (A9) (**LRR F, G, H**)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ 2.5 cm Mucky Peat or Peat (S2) (**LRR G, H**)
- ☐ 5 cm Mucky Peat or Peat (S3) (**LRR F**)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1)
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ High Plains Depressions (F16) (**MLRA 72 & 73 of LRR H**)

Indicators for Problematic Hydric Soils[3]:

- ☐ 1 cm Muck (A9) (**LRR I, J**)
- ☐ Coast Prairie Redox (A16) (**LRR F, G, H**)
- ☐ Dark Surface (S7) (**LRR G**)
- ☐ High Plains Depressions (F16) (**LRR H outside of MLRA 72 & 73**)
- ☐ Reduced Vertic (F18)
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ______

Depth (inches): ______

Hydric Soil Present? Yes ☐ No ☒

Remarks:

Sandbar

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Salt Crust (B11)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Dry-Season Water Table (C2)
- ☐ Oxidized Rhizospheres on Living Roots (C3) (**where not tilled**)
- ☐ Presence of Reduced Iron (C4)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Oxidized Rhizospheres on Living Roots (C3) (**where tilled**)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ FAC-Neutral Test (D5)
- ☐ Frost-Heave Hummocks (D7) (**LRR F**)

Field Observations:

Surface Water Present? Yes ☐ No ☒ Depth (inches): ______

Water Table Present? Yes ☐ No ☒ Depth (inches): ______

Saturation Present? (includes capillary fringe) Yes ☐ No ☒ Depth (inches): ______

Wetland Hydrology Present? Yes ☐ No ☒

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

n. Appendix N – Berm Analysis

Technical Memorandum

5341 Arapahoe Avenue
suite 1B
Boulder, CO 80303
phone (303) 575-4405

To:	Ernst Strenge, Boulder County Parks and Open Space
From:	Luke Swan
Copies:	[Electronic Submittal]
Date:	9/30/2016
Subject:	South St. Vrain Creek Restoration at Hall Ranch Project – Analysis of Berm Removal near 31842 South Saint Vrain Drive
Project No.:	32706

As part of the development of the design for the South St. Vrain Creek Restoration at Hall Ranch project, Otak was asked to evaluate the hydraulics around a berm constructed on Boulder County Parks and Open Space (BCPOS) land near the residence at 31842 South Saint Vrain Drive. This memorandum summarizes the analysis and results of the hydraulic implications of potentially removing the berm.

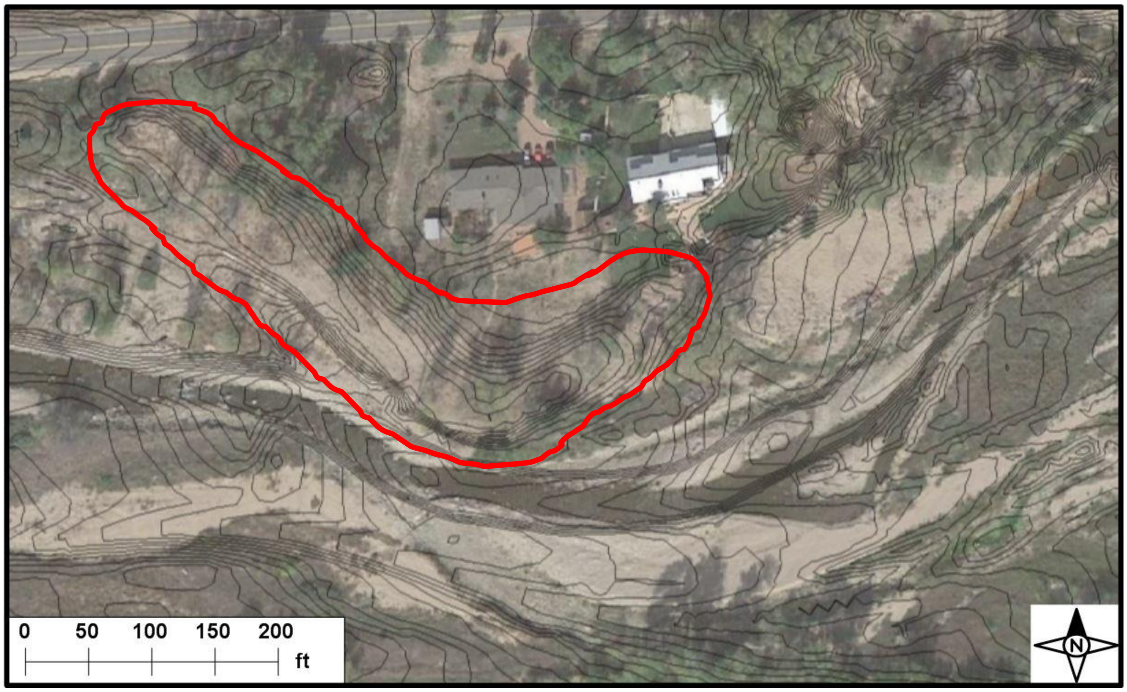
Background and Model Setup

In response to the 2013 flooding along South St. Vrain Creek, private landowners constructed an earthen berm with flood deposits around their home. Unfortunately, the berm was built on BCPOS land and not the privately owned parcel. As constructed, the berm encroaches on the floodplain and deflects flow to the south.

Investigation of the effectiveness of the berm, as well as the implications of potentially removing it, was conducted by removing the berm from the terrain model, then running design flows with all other variables kept the same. Methods and results are discussed further, below.

Model Setup

The no-berm scenario was developed on the proposed conditions (PC) terrain model by removing the berm from the data. Removal of the berm was accomplished by identifying points on flat ground adjacent to the berm and straight-grading between them (Figure 1). Therefore, the terrain does not represent a designed condition. In the event that a decision is made to remove the berm, the bank and adjacent will undergo a design process aimed to reconfigure the area to align with the project goals. Simulation boundary conditions in SRH-2D (Lai, 2008) were setup following the methods outlined in the Preliminary Basis of Design Report (Matrix, 2016). Design flows were run to a stable solution for both berm and no-berm scenarios. Results from selected flows are presented below.



A)

B)

Figure 1. Contour map showing focus area with the berm (A) and without the berm (B). The approximate extent of the berm has been outlined in red in (A).

Results

Since the berm does not impact flows below Q5, results are only reported for Q5, Q10, Q25, Q50, and Q100. Results for the Q5 flow, with the berm, show that the area around the home is inundated with flow flanking the upstream end of the berm, closest to the road. As a result of the extensive tree cover immediately upstream of the homes, flow energy is dissipated, reducing velocity through the property. The floodplain roughness provided by the trees is likely the main reason that the channel avulsed to the south, deflecting flood energy away from the home. In the immediate post-flood aerials, extensive deposition can be seen on the properties, but the structures remained. Under these conditions, velocities remain high in the main channel.

Figures 2 through 6, below, show inundation extents and depths for the range of design flows examined in this analysis. Figure 7 shows plots of velocity sampled from the model output down the main channel and water surface elevation (WSE) across the floodplain as shown in Figure 7(A). The blue line, denoted A-A' is the cross section and the yellow profile line, denoted B-B', is the location of the velocity data sampled along the profile.

As can be seen in Figure 7 (B) (C) and (D) for Q5 through Q25, removal of the berm lowers WSEs (e.g., ~0.4 ft at Q10) in the locations around the house (behind the existing berm). This behavior can be attributed to flow flanking around the northwest end of the berm and ponding behind the berm. This flanking of the berm is seen at all evaluated flows, starting with Q5. Removal of the berm provides an easier path back to the channel and also spreads flow out, lowering the water surface elevations. At higher discharges, Q50 and Q100 (Figure 7 E, F), the berm holds more flow in the main channel, causing elevated water surface elevations in the main channel. When the berm is removed, those higher discharges spread across the floodplain, decreasing WSEs in the main channel (e.g., ~1.0 ft at Q100) and increasing WSEs (e.g., ~0.4 ft at Q100) in the location behind the berm.

Figure 7 (G) shows the difference in velocity between the berm and no berm scenarios, as sampled in the main channel along B-B'. Positive numbers along the left vertical axis mean a decrease in velocity while negative numbers equal an increase in velocity. The model results suggest that the berm has a backwater effect at flows above Q10, as velocities locally increase (e.g., ~2 ft/s at Q100) upon removal of the berm just upstream of the berm location. Closer to the berm location, velocities decrease (e.g., ~4 ft/s at Q100) upon removal of the berm. For reference, under the with berm scenario, in-channel velocities range from 13-15 ft/s and are reduced to 9-11 ft/s11 under the no berm scenario.

Discussion

The results suggest that removing the berm will have positive impacts on the channel by reducing both channel velocity and channel water surface elevations. The results also suggest that water surface elevations will decrease behind the berm at lower magnitude, more frequent floods, but increase at the higher magnitude, less frequent floods. Additionally, the homes will experience flood inundation issues at all flows Q5 and greater under both the with berm and no berm scenarios. As a result of the roughness provided by the stand of trees located immediately west of the homes, the channel avulsed away from the home in the 2013 flood, to the south across the open floodplain. The proposed design encourages this behavior in future floods by establishing an overflow channel through the southern floodplain.

This analysis comes with two important caveats that pertain to the grading and the nature of the model. First, the grading was kept very simple, removing the berm from the data by straight-grading points on either side of the berm. This is not a designed condition and removal of the berm would require a design for the floodplain space currently occupied by the berm. While that design will likely change the hydraulics at that location, the general trends shown here are not anticipated to change.

The second caveat is that the model is necessarily simplified, representing a fixed bed condition and assuming the berm grading will not change. Bed mobility calculations (Matrix, 2016) suggest that the entire channel bed will be mobile by Q50, meaning that the channel geometry will be changing in response to the flood. That behavior is not captured in this analysis. Furthermore, it raises serious questions as to whether or not the berm will withstand higher magnitude floods. It is assumed that the berm was constructed from flood deposits, the majority of which likely consist of smaller grains (i.e., sands, gravels). This material will easily erode under flood conditions. Figure 6(B) shows a portion of the berm overtopping during Q100, which is expected to damage, if not destroy, the berm.

The homes sit in a precarious place, from flood inundation and flood energy perspectives. They are located at nearly the same elevation as the channel banks making them susceptible to inundation. The existing dense stand of trees helps to protect the homes from the more destructive aspects of flooding (e.g., avulsion) and did so in the 2013 flood. However, given the ease at which the 2013 flood carved new channels and leveled mature trees, it is not safe to assume that future floods will behave similarly. To the contrary, a high probability exists that future floods will take different direction(s) and could pose new problems for the homes, with or without the berm.

With the homes in jeopardy at the Q5 and all larger floods with or without the berms, an option to consider is the creation of additional small overflow channel(s) on the northern floodplain, in addition to the larger overflow on the southern floodplain. The small northern overflow channels could be located between the houses and the road. The intent of the northern overflow channels would be to best accommodate the unavoidable flooding, providing (as capacity allows) more controlled routing around the houses and thereby reducing risk to the houses at lower magnitude flows (i.e., Q5 to Q10). The study and/or potential implementation of this option may be more appropriate as a private landowner endeavor or as a joint effort between landowner(s) and BCPOS.

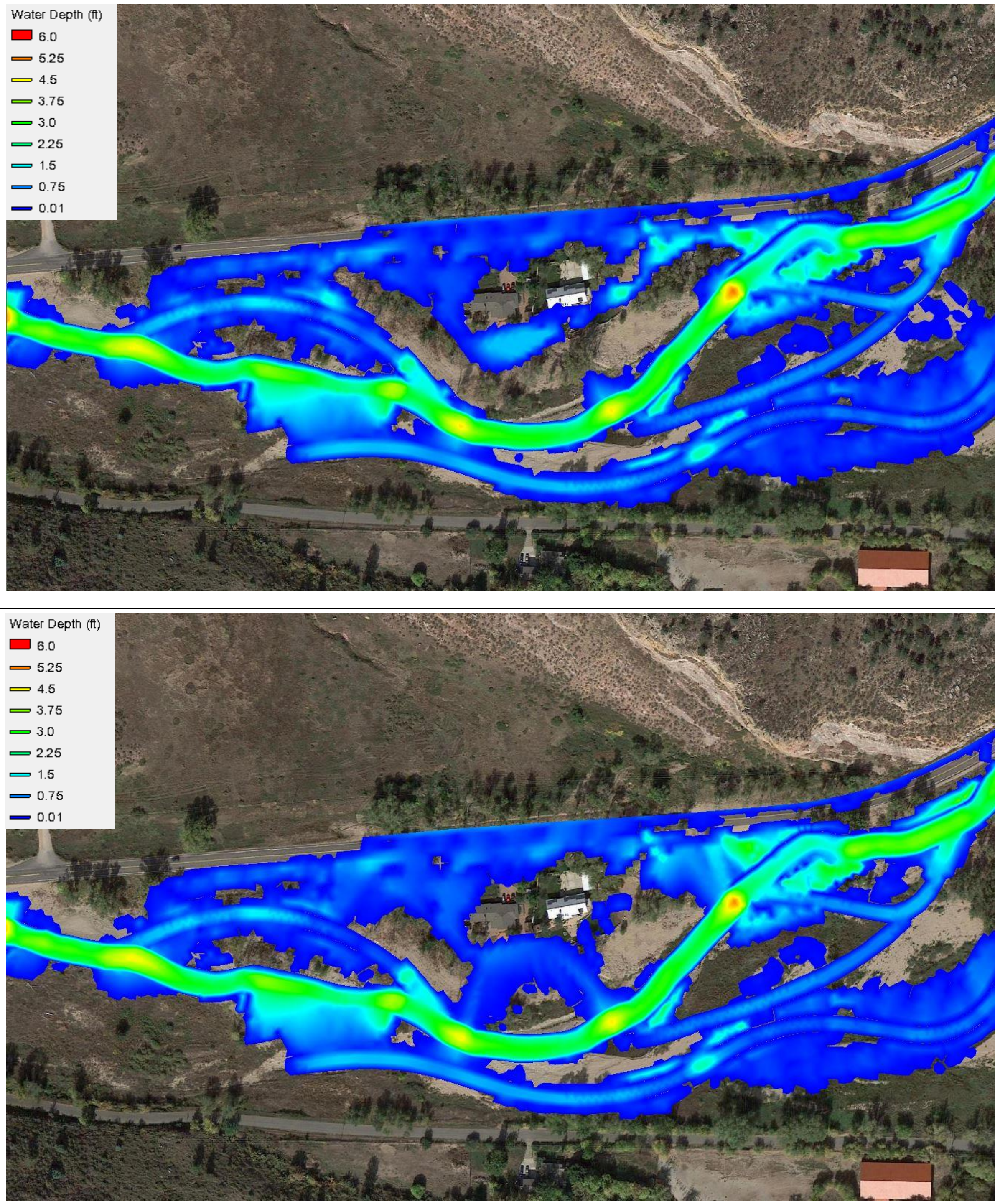
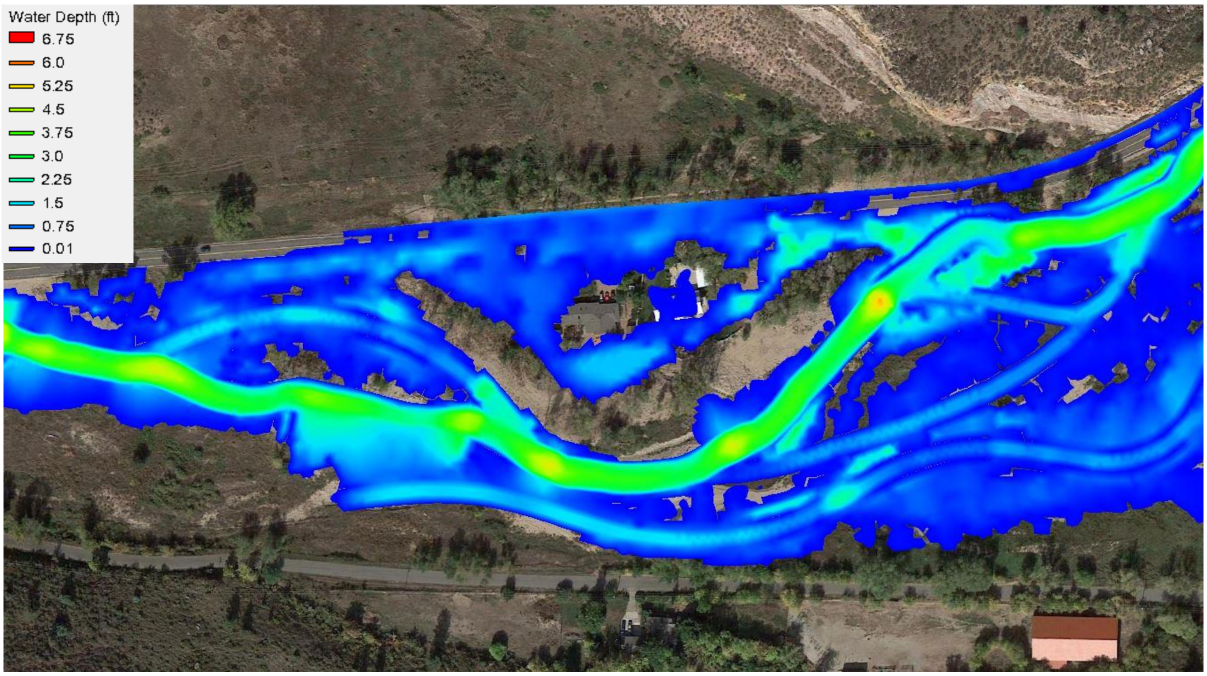


Figure 2. Inundation extent and depths at Q5 for the berm (A) and no berm (B) scenarios. The berm is clearly visible in (A) as a U-shaped dry patch between the homes and the main channel.

A)



B)

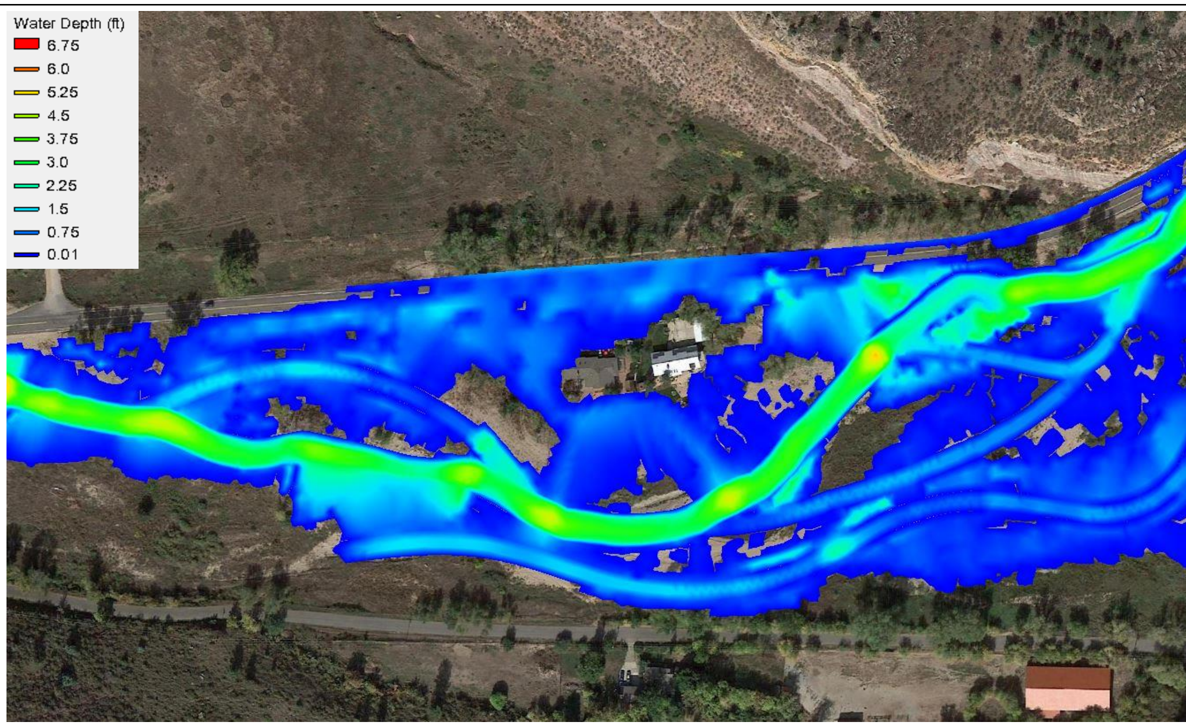
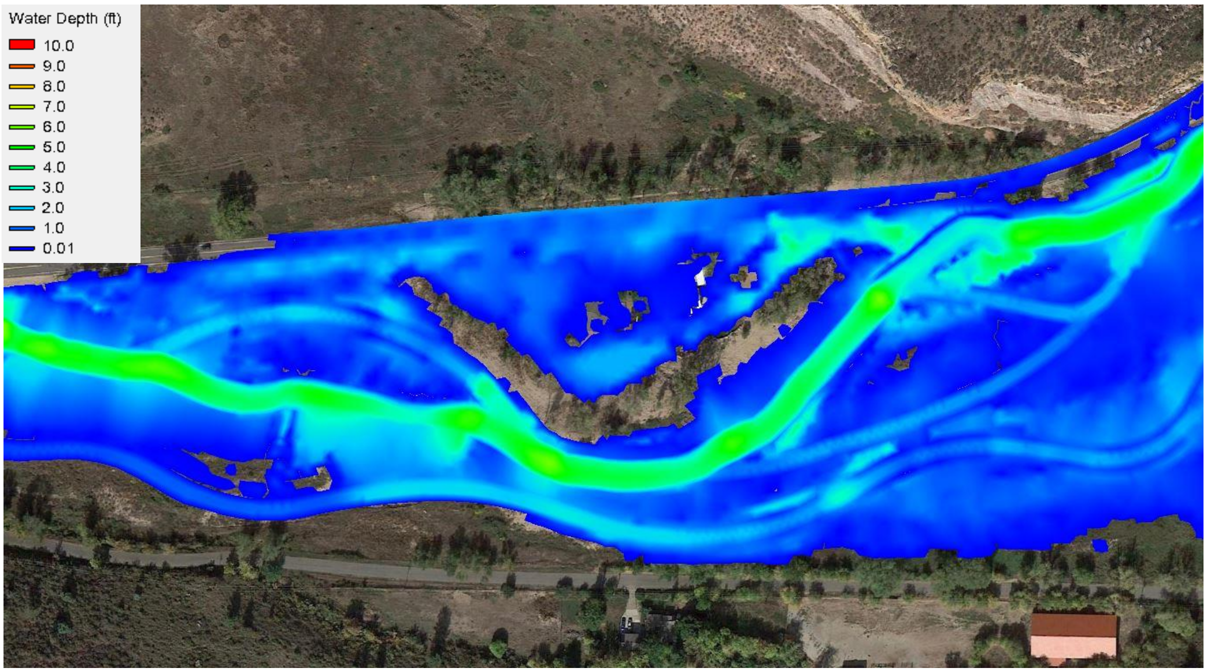
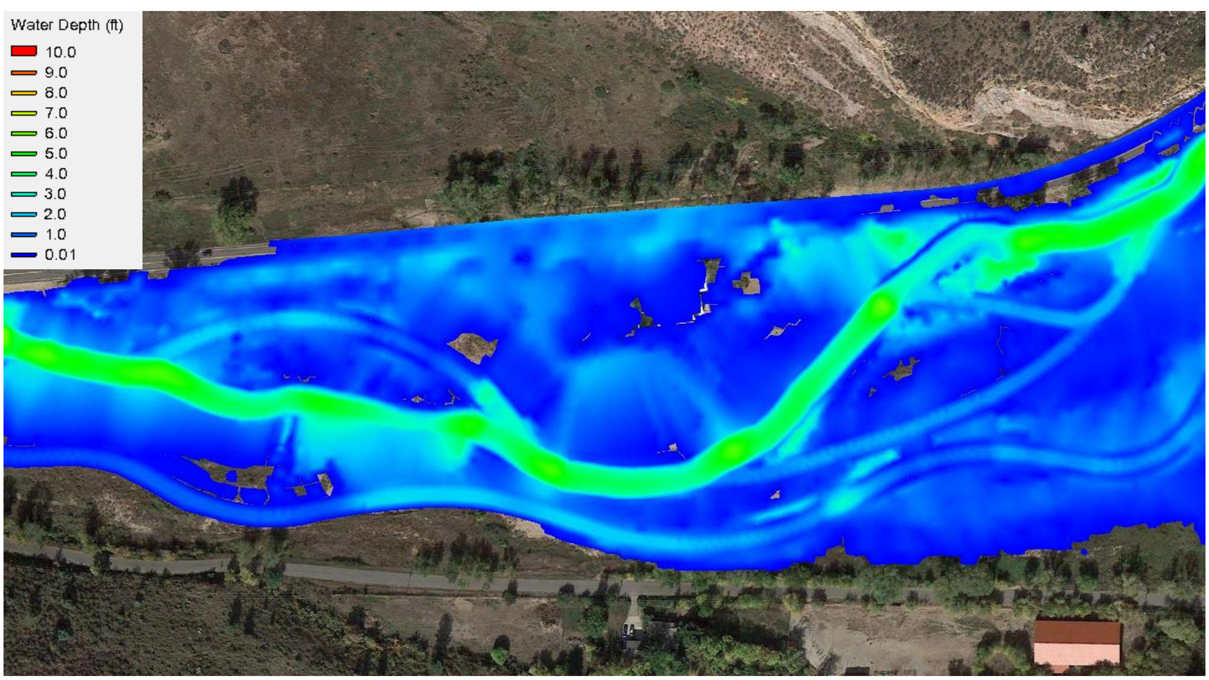


Figure 3. Inundation extent and depths at Q10 for the berm (A) and no berm (B) scenarios.

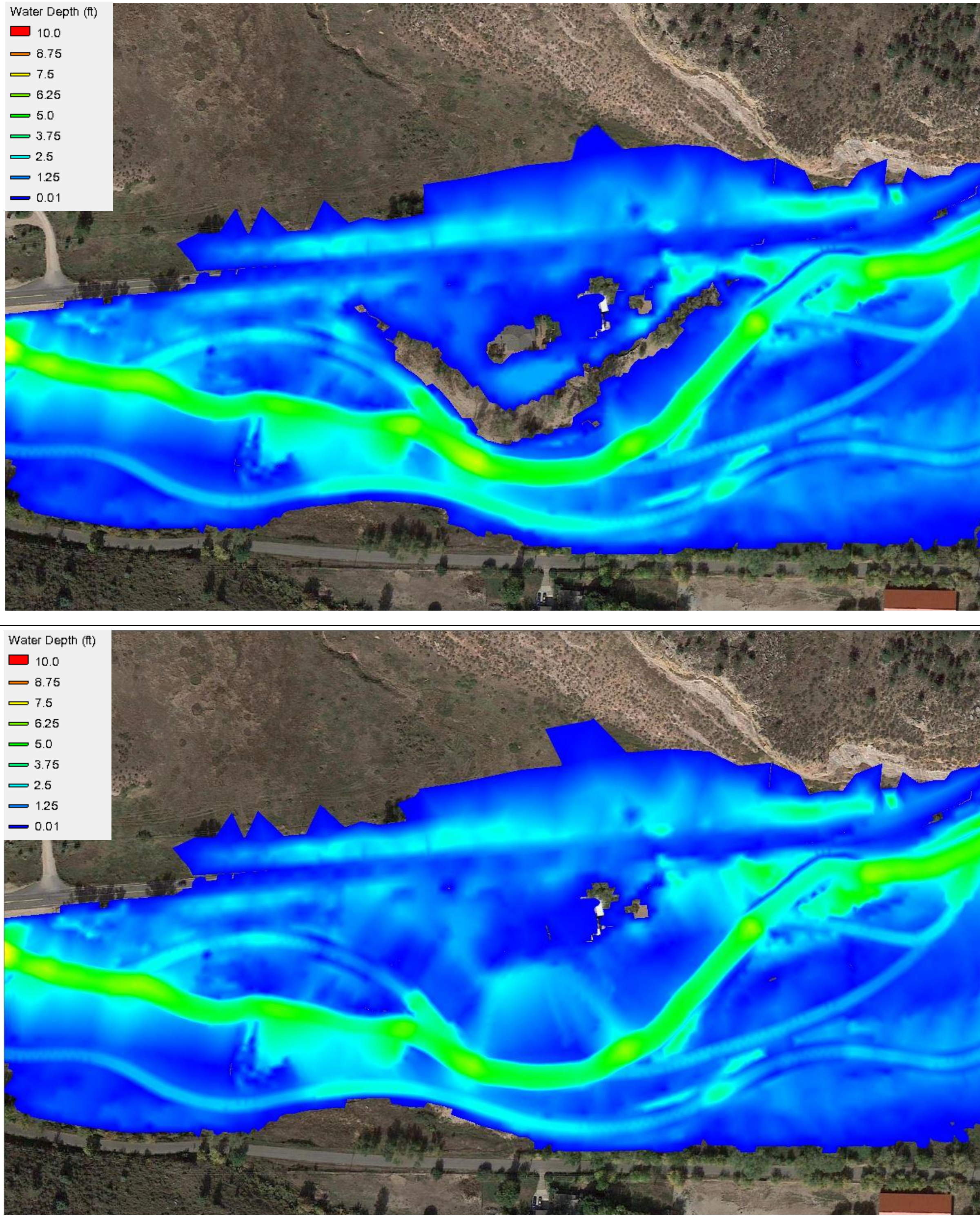


A)



B)

Figure 4. Inundation extent and depths at Q25 for the berm (A) and no berm (B) scenarios.



A)

B)

Figure 5. Inundation extent and depths at Q50 for the berm (A) and no berm (B) scenarios.

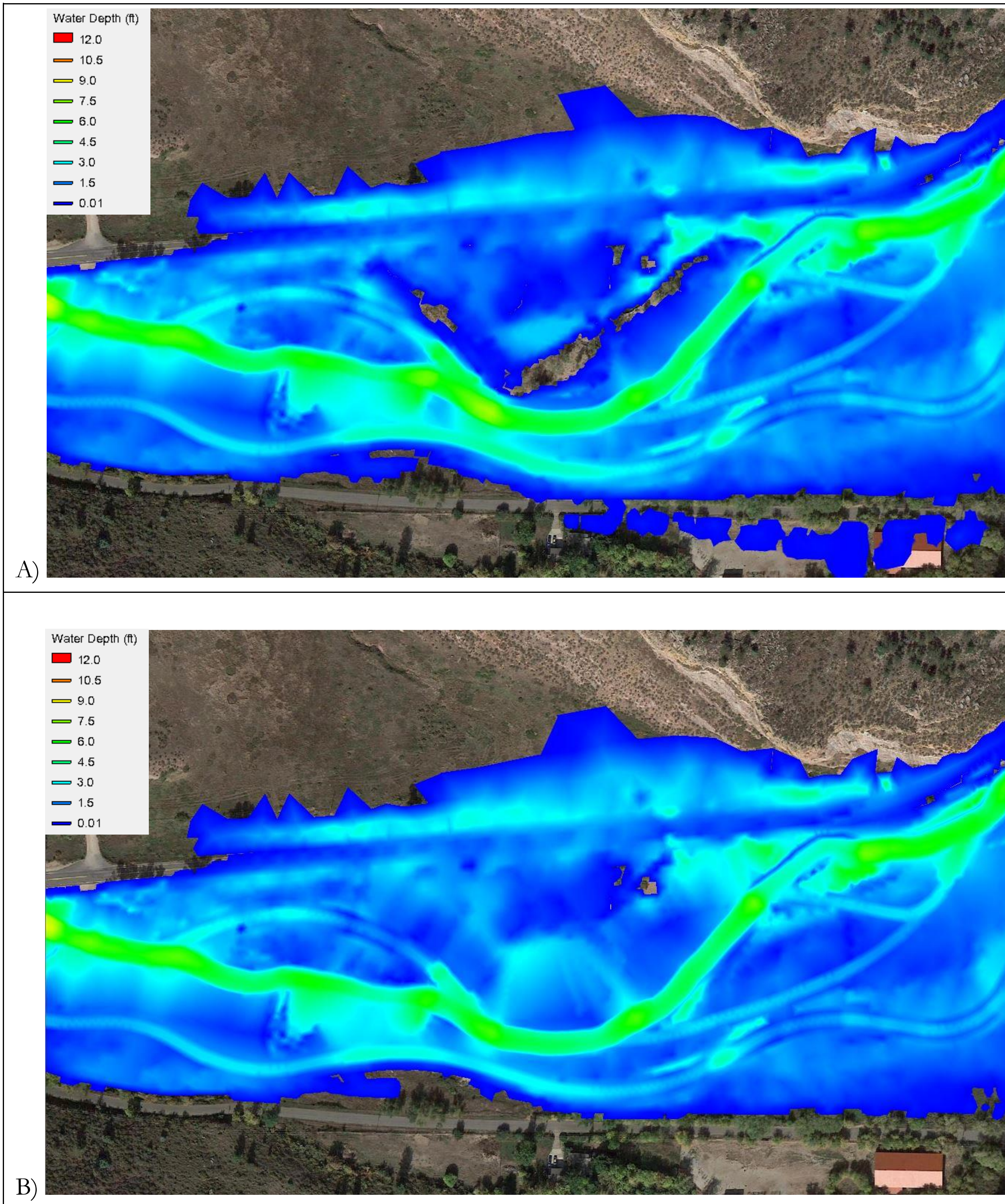
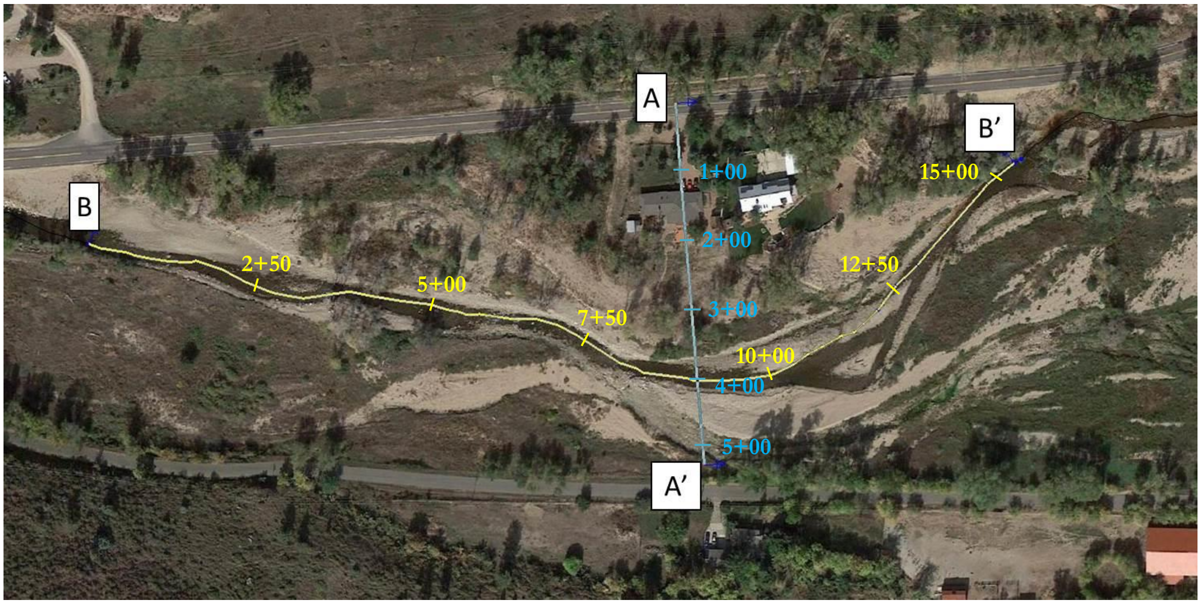


Figure 6. Inundation extent and depths at Q100 for the berm (A) and no berm (B) scenarios.

A)



B)

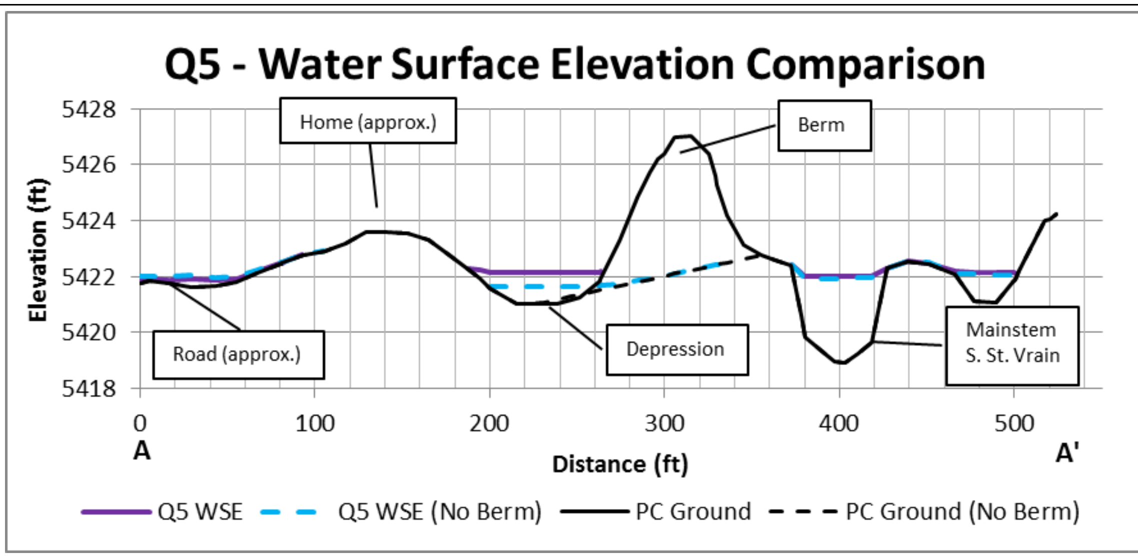
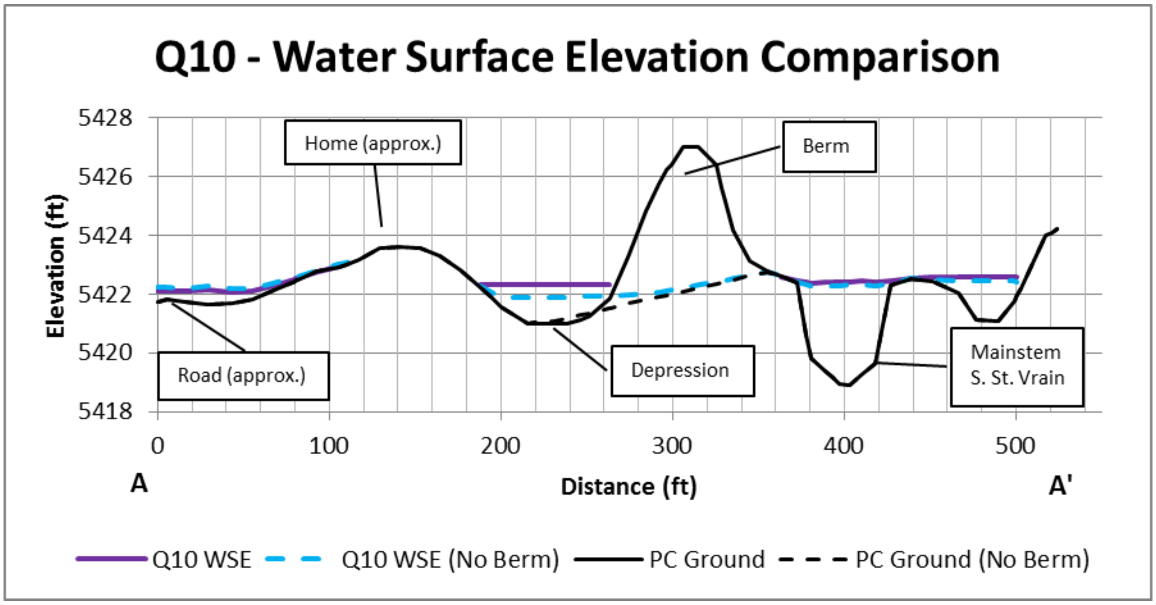
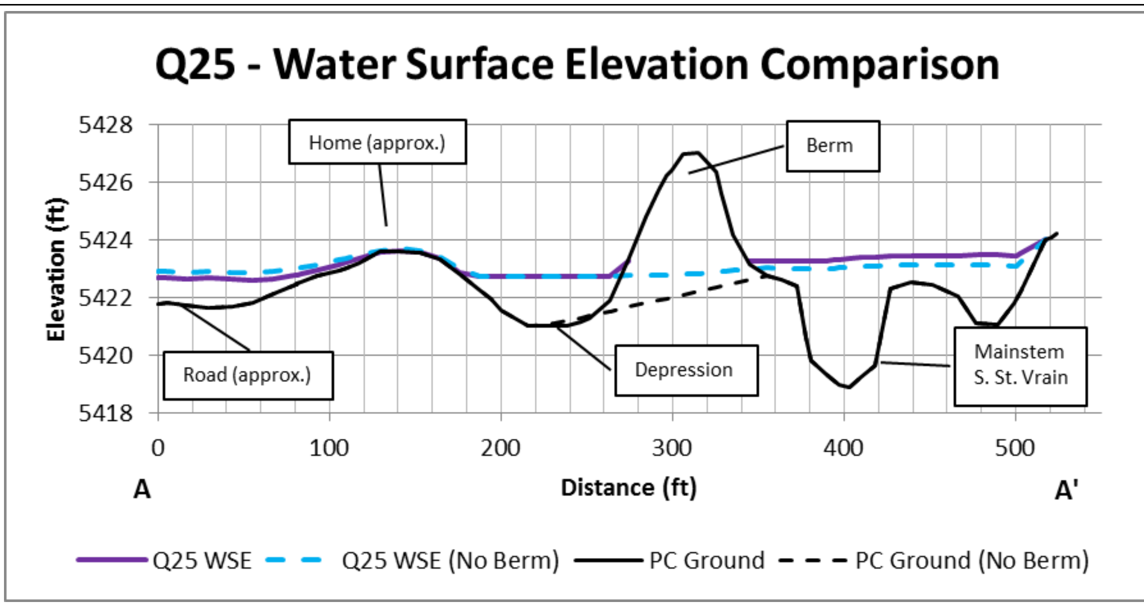


Figure 7. Water surface elevations sampled along cross section A-A' shown in (A). Velocity plot in 7(G) sampled along the main channel, B-B' shown in (A). Removal of the berm lowers WSEs behind the berm at Q5, as shown in (B), largely due to the severe reduction in available floodplain width caused by the berm.

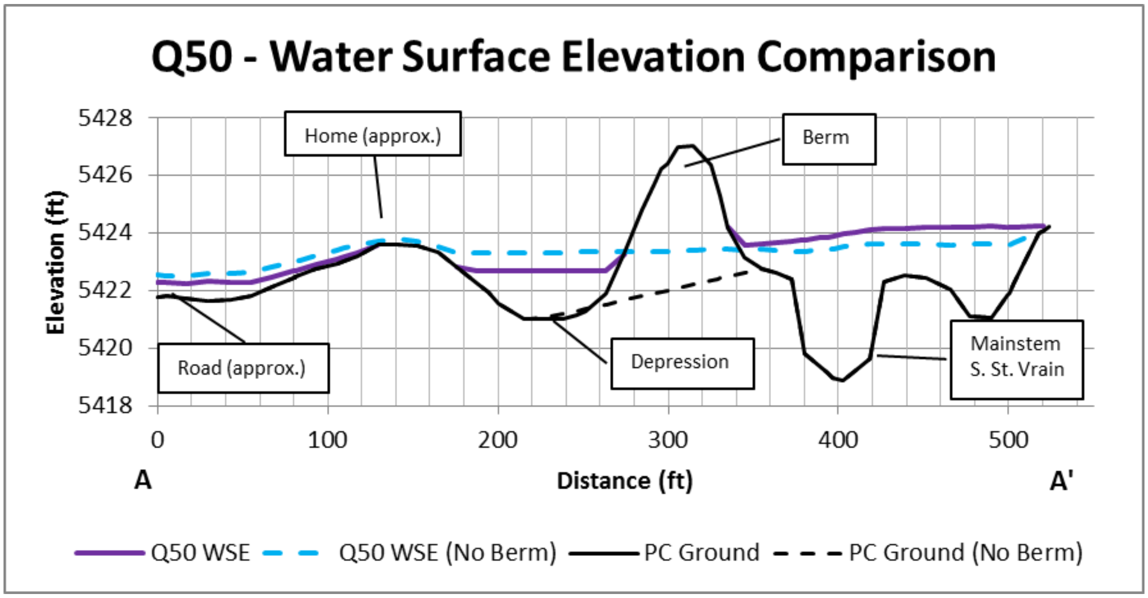


C)

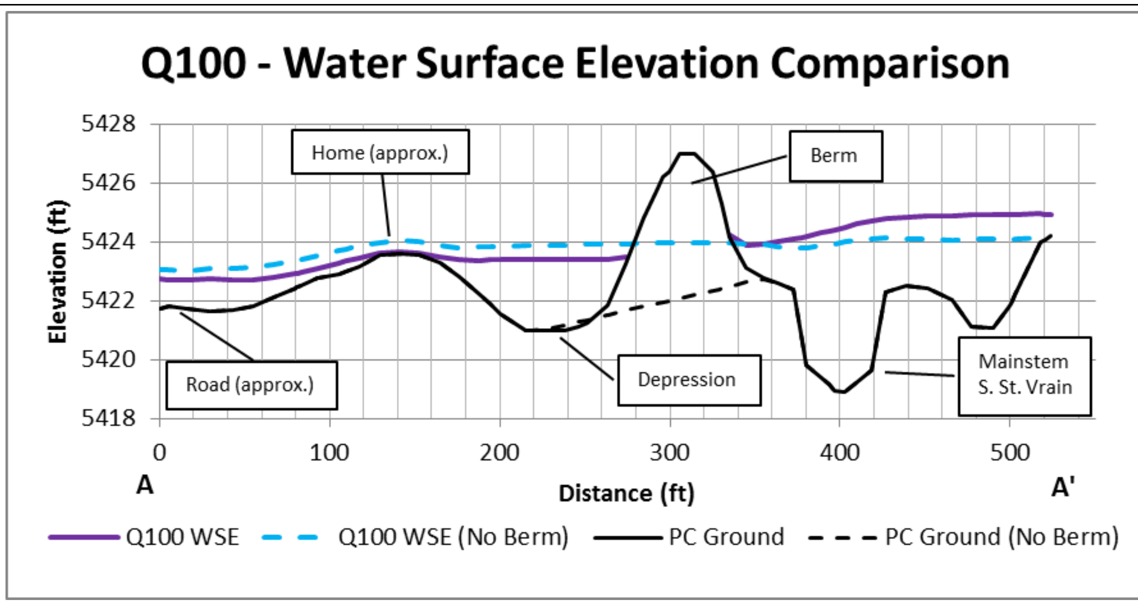


D)

Figure 7 (continued)**.** At Q25, removal of the berm lowers WSEs in the main channel but has little effect on WSEs behind the berm (D).

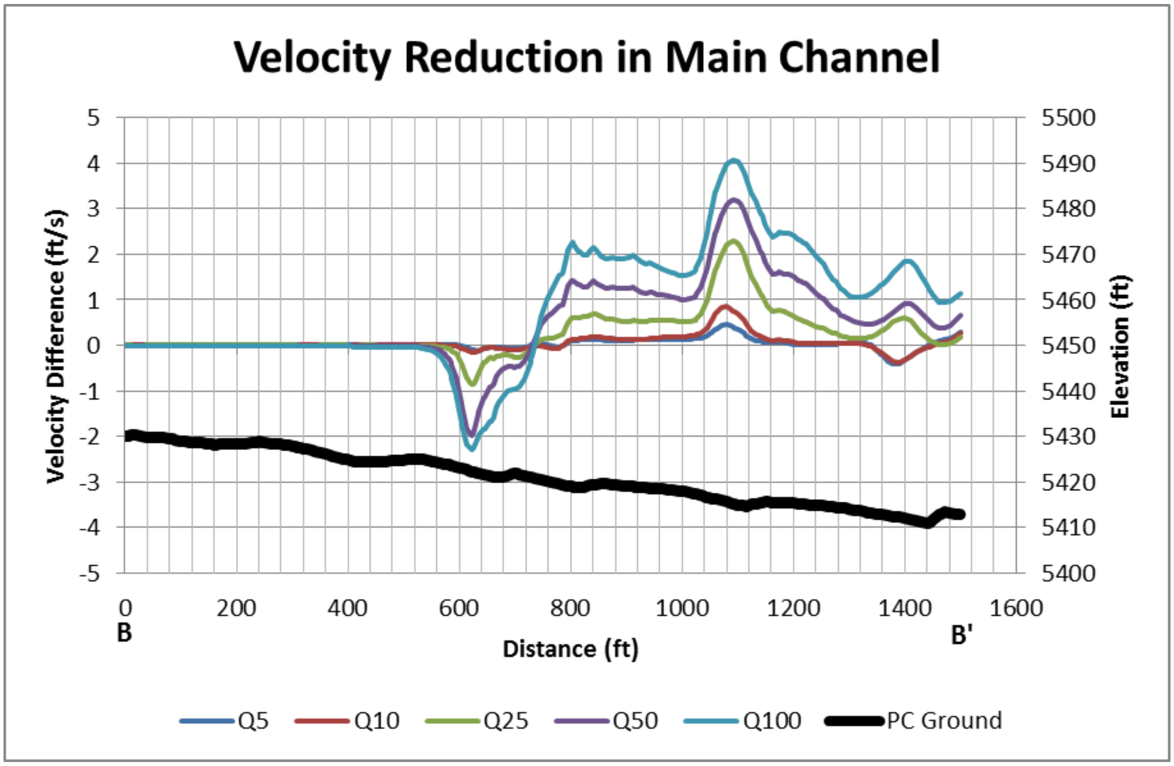


E)



F)

Figure 7 (continued)**.** At higher magnitude events, removal of the berm lowers WSEs in the main channel but raises WSEs behind the berm (E), (F) because the berm may hold more flow in the main channel, while its removal spreads flow across the floodplain. At the higher magnitudes shown in (E) and (F), it is not likely that the berm will remain intact – the model assumes a fixed bed.



G)

Figure 7 (continued)**.** Velocity reduction was calculated along profile line B-B' shown in 7(A) by subtracting velocity from the no-berm scenario from the with berm scenario. Negative values indicate an increase in velocity and positive values indicate a velocity reduction. Removal of the berm removes a constriction from the floodplain, reducing backwater and locally increasing velocity (distance 600 ft) upstream of the berm, at the location of a riffle. Velocity adjacent to and downstream of the berm is reduced (G).

References

Lai, Yong G. 2008. SRH-2D version 2: Theory and User's Manual.U.S. Department of the Interior Bureau of Reclamation. Denver, CO.

Matrix, 2016. Preliminary Basis of Design Report – South St. Vrain Creek Restoration at Hall Ranch. Prepared for Boulder County Parks and Open Space.