



**Parks &
Open Space**

St. Vrain Creek Breaches Restoration Alternatives Analysis

August 10, 2016

Jesse Rounds & Clint Brown



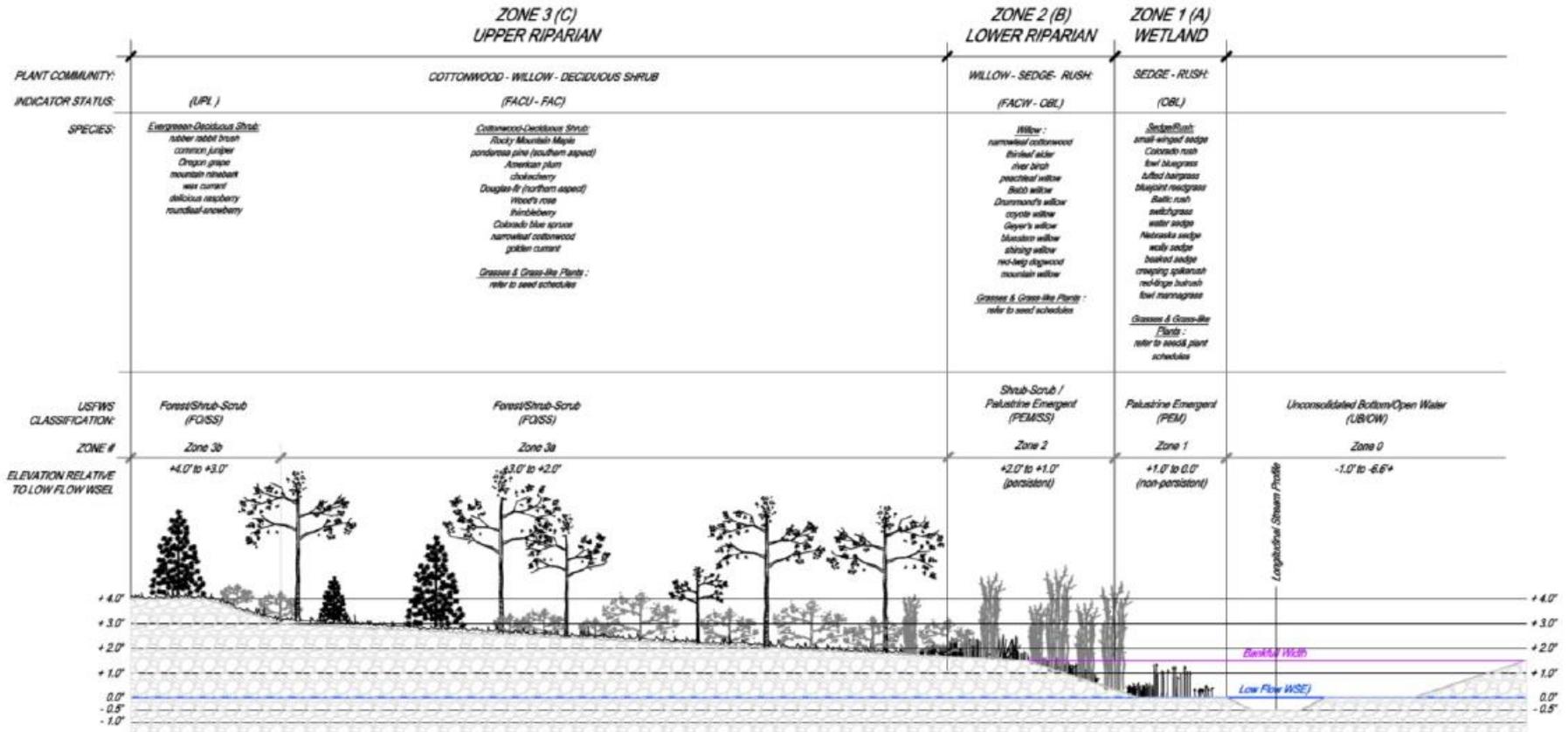
Stream Restoration



Stream Restoration Goals

- Sub-Reach 1
 - Floodplain Connectivity
 - Sediment Conveyance
 - Bank Stabilization
- Sub-Reach 2
 - Floodplain Connectivity
 - Grade Control
 - Bank Stabilization
- Sub-Reach 3
 - Bank Stabilization
 - Sediment Conveyance
 - Backwater Habitat Development

Restoration – Typical Cross Section



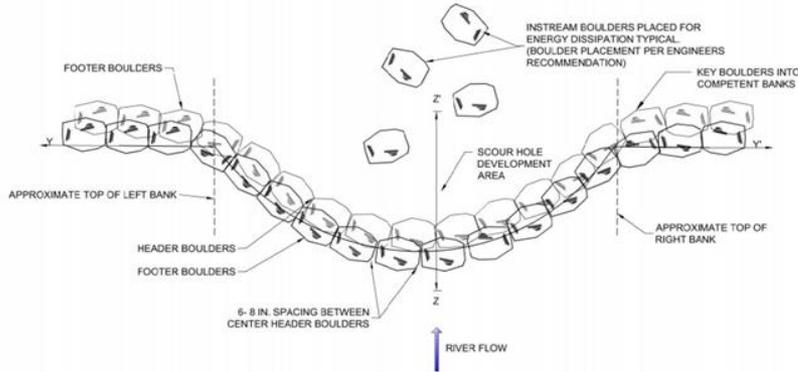
NOTES:

1. ALL ZONES ARE TO BE SEEDING WITH ONE BROAD-SPECTRUM SEED MIX CONTAINING THE SPECIES SHOWN ON THE SEED SCHEDULES.
2. REFER TO PLANTING AND SEEDING SCHEDULES FOR SPECIES SIZEFORM AND QUANTITY.
3. UPLAND SPECIES MAY BE FOUND AND LOCATED IN WETLAND AREAS, AND CONVERSELY WETLAND SPECIES IN UPLAND AREAS DEPENDING ON FIELD CONDITIONS ESTABLISHED DURING GRADING OPERATIONS. PLANT ZONATION SHOWN IS A GENERAL GUIDELINE. TRANSITION OR EXTENSION OF SPECIES BETWEEN ZONES MAY VARY DEPENDING ON ACTUAL FIELD CONDITIONS, SLOPE, HYDROLOGY, MICRO-HABITAT, SOIL TEXTURE & MOISTURE CONDITIONS. THE ECOLOGIST OVERSEEING PLANTING OPERATIONS MUST MAKE DISCRETIONARY CALLS ON PLANT LOCATIONS CONSIDERING THAT OVERFLOW SWALES INCLUDE ZONE 1(A) WETLAND PLANT MATERIALS THAT MAY EXTEND UP INTO ZONE 2(B), ZONE 2(B) PLANT MATERIALS MAY EXTEND DOWN INTO ZONE 1(A), ZONE 3(C) PLANTS MAY EXTEND IN TO ZONE 2(B).

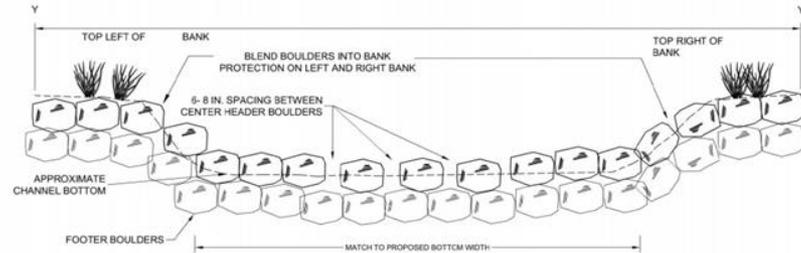
Restoration Details – Cross Vanes

CROSS VANE PURPOSE:

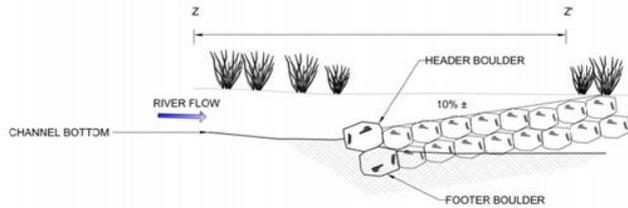
- GRADE CONTROL
- CENTRALIZING FLOW
- ENERGY DISSIPATION
- ENCOURAGE POOL AND RIFLE FORMATION



1
1 ROCK CROSS VANE - PLAN VIEW
NOT TO SCALE



2
1 ROCK CROSS VANE - SECTION VIEW Y-Y
NOT TO SCALE



3
1 ROCK CROSS VANE - SECTION VIEW Z-Z
NOT TO SCALE



GENERAL NOTES

PRELIMINARY DRAWINGS TO SHOW CONCEPT ONLY. NOT FOR CONSTRUCTION

NOTES

1. ROCK CROSS VANE BOULDERS SHALL BE GENTLY AND UNIFORMLY SLOPED FROM CENTER OF CHANNEL TO TOP OF BANK. ENGINEER MAY MODIFY PLACEMENT OF BOULDERS BASED ON SITE CONDITIONS AT TIME OF CONSTRUCTION.
2. ALL BOULDERS SHALL BE TIGHTLY SPACED EXCEPT FOR CENTER HEADER BOULDERS WHICH SHALL HAVE 6 TO 8 IN. GAPS. ALL FOUNDATION BOULDERS SHALL BE TIGHTLY SPACED.
3. CENTER HEADER BOULDERS TO STICK UP 1.5 FT. ABOVE CHANNEL BED. REMAINDER OF HEADER BOULDERS TO STICK UP 2 FT. MAXIMUM ABOVE CHANNEL BED.
4. ROCK VANES AND ROCK CROSS VANES SHOULD BE KEYED INTO THE LEFT AND RIGHT BANKS.
5. EACH ROCK LAYER SHALL BE KEYED OR LOCKED INTO UNDERLYING LAYER.
6. IN AREAS WHERE CHANNEL BANKS ARE DEVELOPED FROM FILL, BANKS SHALL BE COMPACTED TO 95% STANDARD PROCTOR PRIOR TO ROCK INSTALLATION.



Lichstone and Associates - A Wenck Company

ST. VRAIN BREACHES PROJECT
Restoration Alternatives
DETAILS

PROJECT NUMBER: CDEA101	DESIGN NUMBER: Z5B
DATE: 7/12/18	DESIGNER: ELR
NOTE NO.: 2	PROJECT STATUS: SENSITIVE/CRITICAL DETAILS

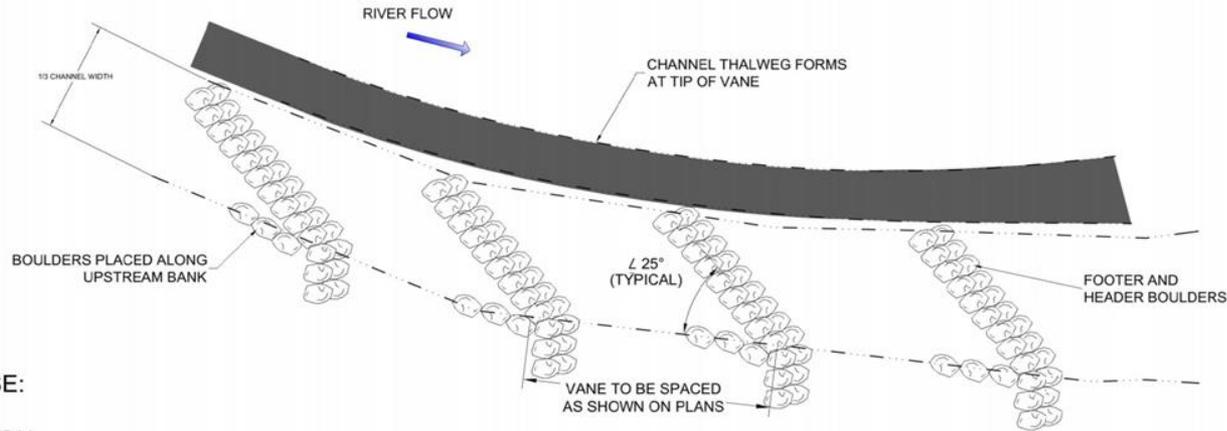
ROCK CROSS VANE
DETAIL

REVISIONS:

SHEET

1

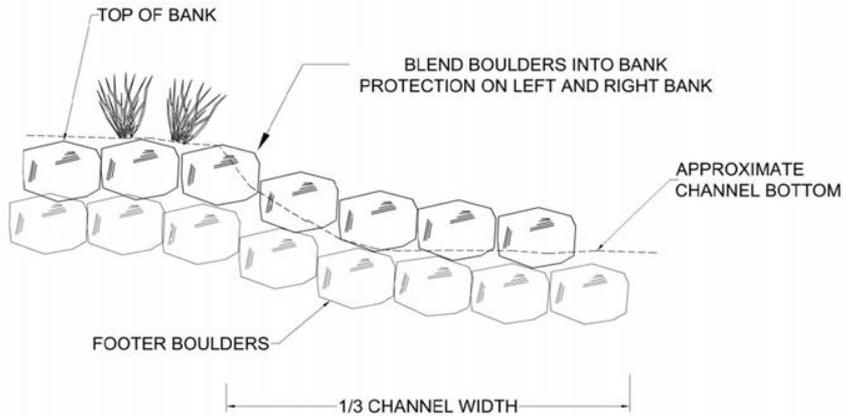
Restoration Details - Vanes



ROCK VANE PURPOSE:

- BANK PROTECTION
- FORMATION OF THALWEG
- REDIRECT NEAR BANK VELOCITIES
- SEDIMENT STORAGE

1 TYPICAL ROCK VANE DETAIL - PLAN VIEW
2 NOT TO SCALE



2 TYPICAL ROCK VANE DETAIL - PROFILE VIEW
2 NOT TO SCALE



BEFORE



AFTER

GENERAL NOTES

PRELIMINARY DRAWINGS TO SHOW CONCEPT ONLY. NOT FOR CONSTRUCTION

NOTES

1. ROCK VANE BOULDERS SHALL BE GENTLY AND UNIFORMLY SLOPED FROM CENTER OF CHANNEL TO TOP OF BANK. ENGINEER MAY MODIFY PLACEMENT OF BOULDERS BASED ON SITE CONDITIONS AT TIME OF CONSTRUCTION.
2. ALL BOULDERS SHALL BE TIGHTLY SPACED.
3. ROCK VANES AND ROCK CROSS VANES SHOULD BE KEED INTO THE LEFT AND RIGHT BANKS.
4. EACH ROCK LAYER SHALL BE KEED OR LOCKED INTO UNDERLYING LAYER.
5. IN AREAS WHERE CHANNEL BANKS ARE DEVELOPED FROM FILL, BANKS SHALL BE COMPACTED TO 95% STANDARD PROCTOR PRIOR TO ROCK INSTALLATION.



Lidstone and Associates - A Wenck Company
ST. VRAIN BREACHES PROJECT
Restoration Alternatives
DETAILS

PROJECT NUMBER: COEA101 DESIGN NUMBER: Z5B
DRAWN BY: ELR CHECKED BY: ELR
DATE: 7/12/16 CDL
SCALE: 1/2" = 1'-0" (SEE PLAN FOR DIMENSIONS)

ROCK VANE
DETAIL

REVISIONS	SHEET
	2

Restoration Details – Root Wads

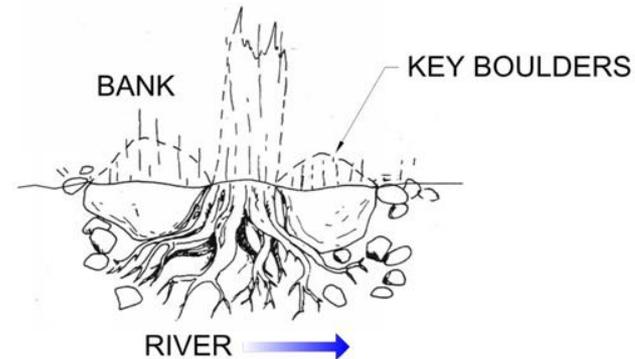
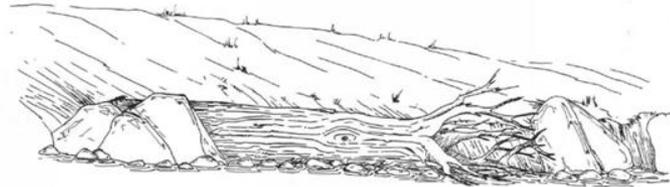


SERIES OF ROOT WADS
DEFLECTING FLOW



ROOT WAD PURPOSE:

- BANK PROTECTION
- HABITAT IMPROVEMENT
- LIMITED STORAGE OF SEDIMENT



GENERAL NOTES

PRELIMINARY DRAWINGS TO
SHOW CONCEPT ONLY. NOT
FOR CONSTRUCTION

NOTES



Lidstone and Associates - A Wenck Company
ST. VRAIN BREACHES PROJECT
Restoration Alternatives
DETAILS

PROJECT NUMBER: COEA101 GEOGRAPHY: Z5B
DRAWN BY: ELR
DATE: 7/12/18 SCALE: CDL

FILE PATH: Z:\PROJECTS\KANSAS\STVRAIN\BENCHMKT\DETAILS

ROOT WAD
DETAIL

REVISIONS	SHEET
	4

Alternative Analysis – Minimum Design Evaluation Criteria

- Reduce hazards and protect life safety and property.
- No increase in hazard over pre-flood condition.
- Technically sound design.
- Meets the objectives of CDBG-DR.
- Meets the objectives of NRCS/EWP.

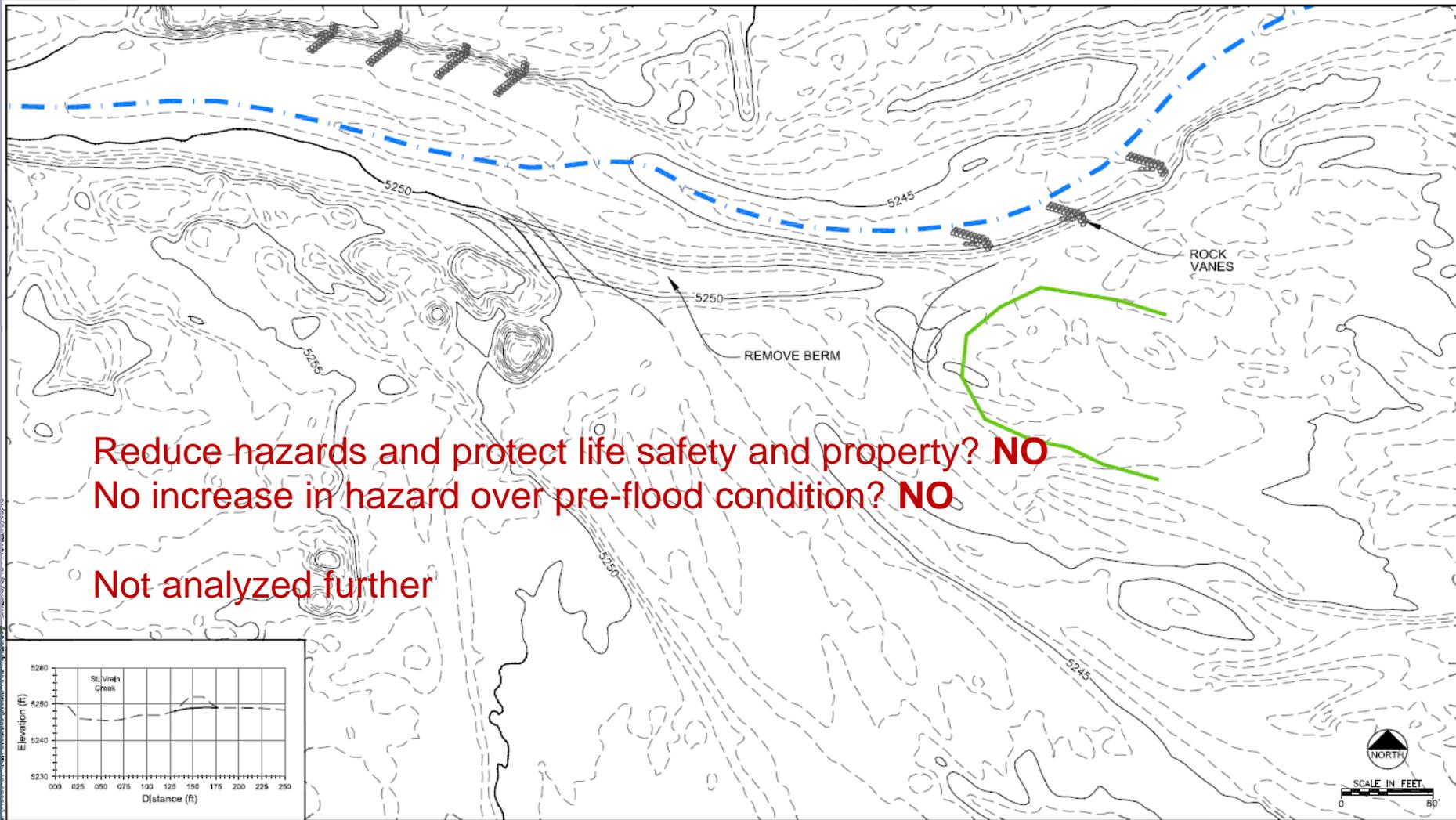
Alternative Analysis – Additional Parameters to Assess and Compare

- Additional benefits of design
 - Threatened and Endangered Species
 - Native Fish Passage
 - Riparian improvements
 - Maximizes bioengineering
 - Reconnects floodplain
 - Restores natural processes
 - Time to complete final design

Alternative Analysis – Additional Parameters to Assess and Compare

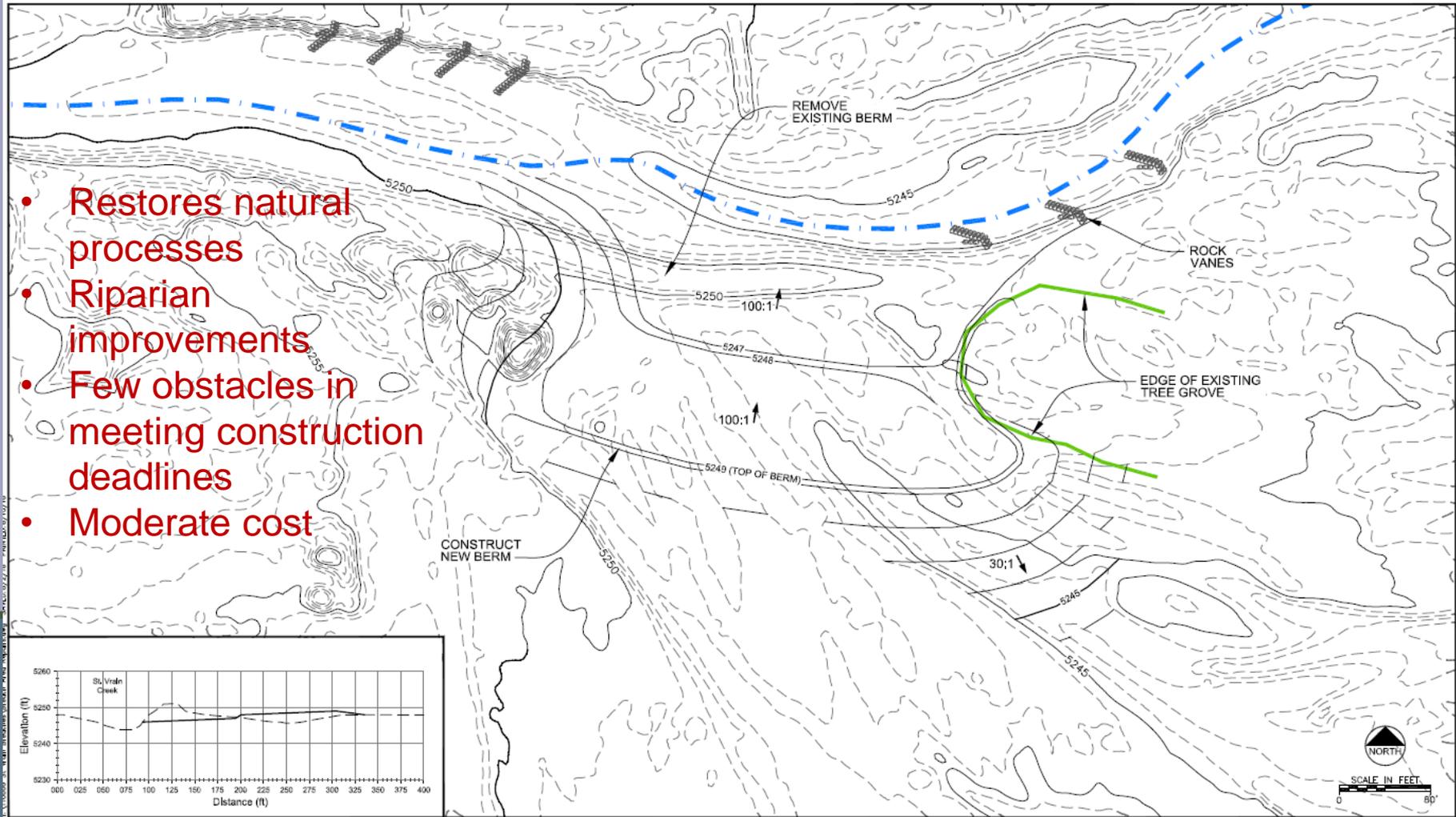
- Construction considerations
 - Time for construction
 - Obstacles for timely implementation
 - Difficulty in meeting construction period
- Cost Considerations
 - Construction Cost
 - Operation and Maintenance Cost (O&M)
 - Lifetime Cost

BREACH 1 – Alternative 1: No Action

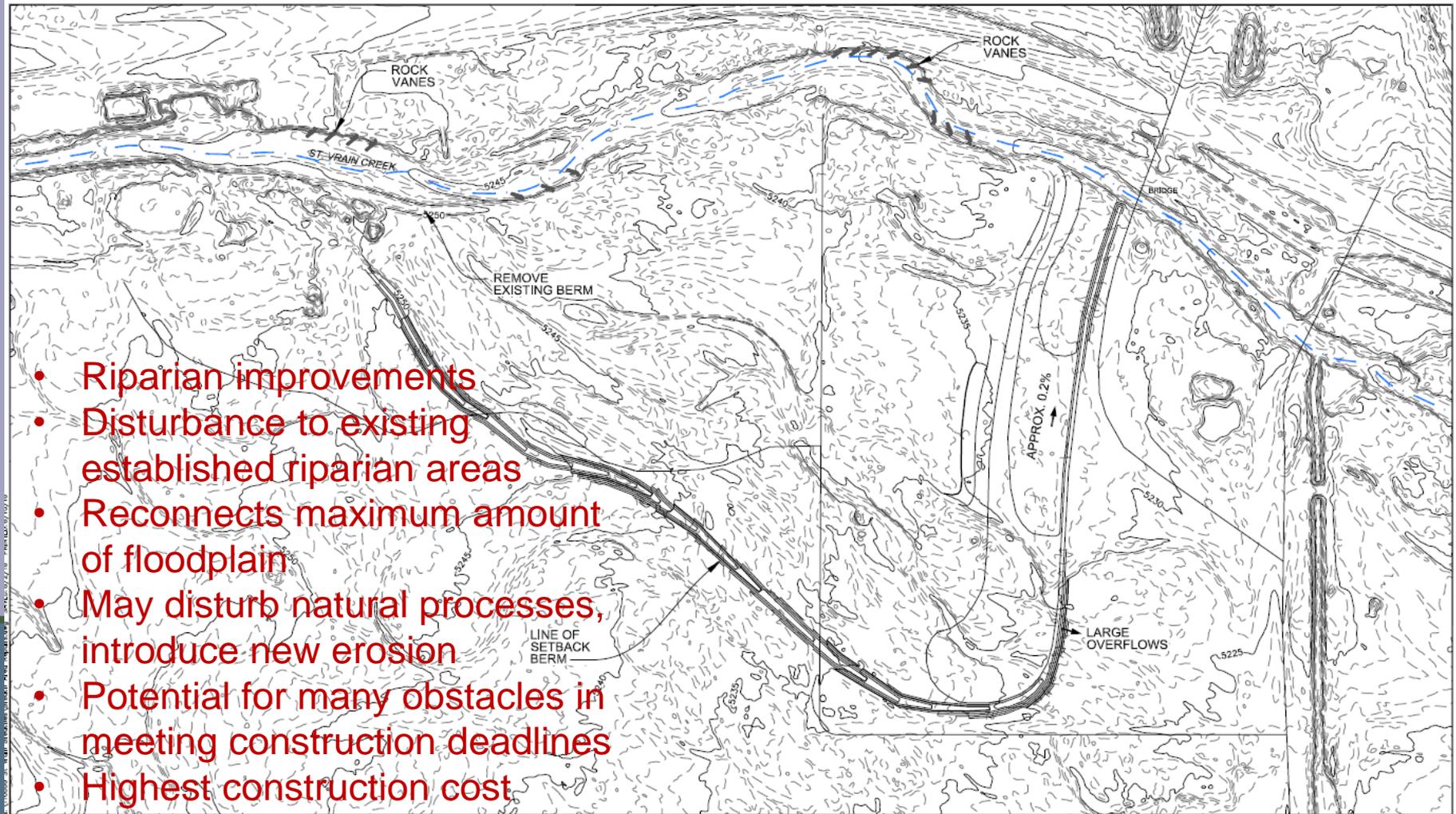


BREACH 1 – Alternative 2: Gradual Low-Profile Setback Berm

- Restores natural processes
- Riparian improvements
- Few obstacles in meeting construction deadlines
- Moderate cost



BREACH 1 – Alternative 3: Maximum Floodplain Setback Berm



- Riparian improvements
- Disturbance to existing established riparian areas
- Reconnects maximum amount of floodplain
- May disturb natural processes, introduce new erosion
- Potential for many obstacles in meeting construction deadlines
- Highest construction cost

BREACH 1 – Comparative Analysis

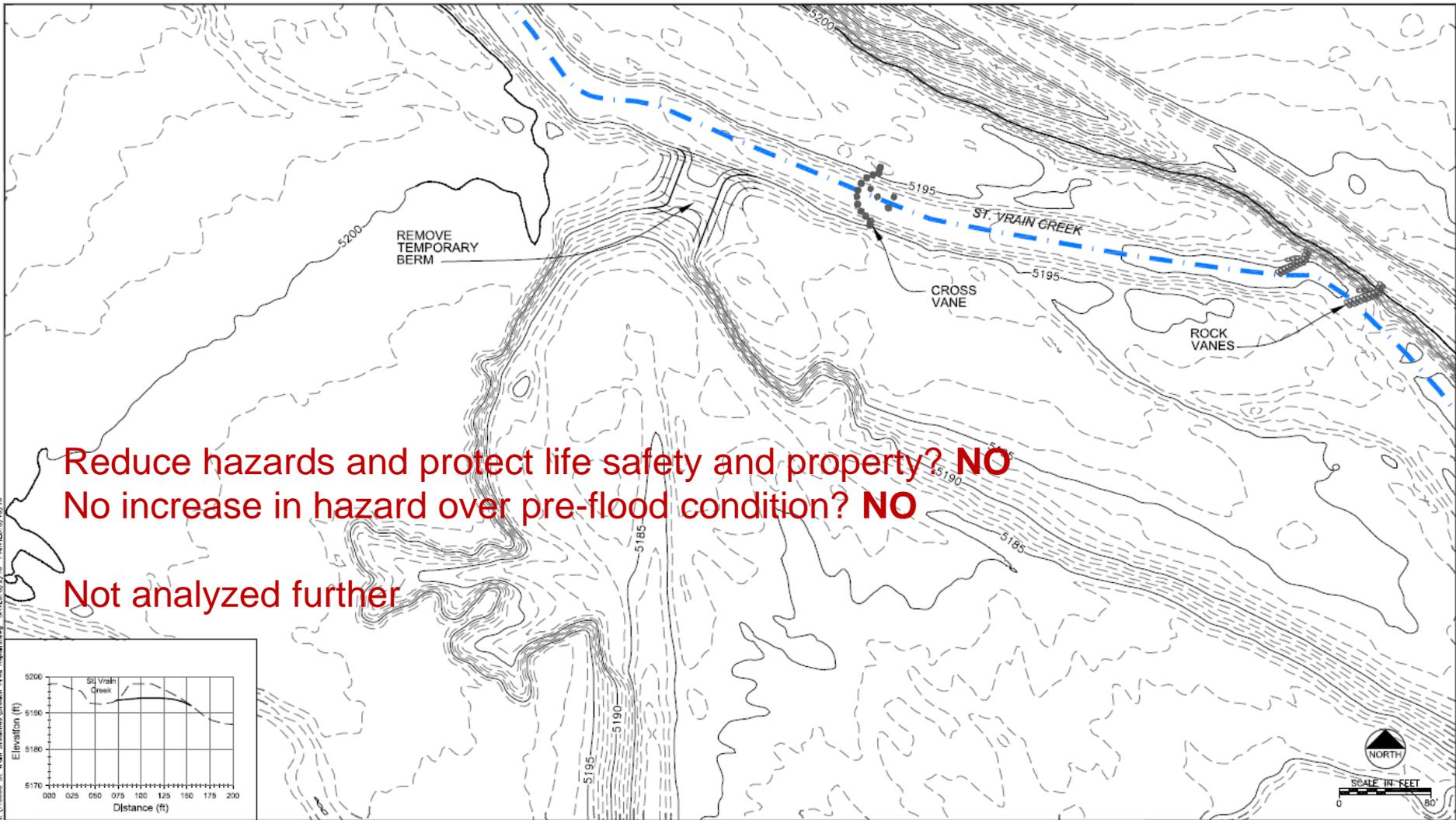
Table 1 – Breach 1 Alternatives Comparative Analysis

Criteria		Alt #1 – No Action	Alt #2 – Gradual Low-Profile Setback Berm	Alt #3 – Maximum Floodplain Setback Berm	Edge
Design Evaluation Criteria	Reduce hazards and protect life safety and property	No	Yes	Yes	Alt 2 / 3
	No increase in hazard	No	Yes	Yes	Alt 2 / 3
	Technically sound	Yes	Yes	Yes	Alt 2 / 3
	Meets objectives of CDBG-DR	No	Yes	Yes	Alt 2 / 3
	Meets objectives of NRCS/EWP	No	Yes	Yes	Alt 2 / 3
Additional Benefits of Design	T&E Species	-	Med	Med	Neutral
	Native fish passage	-	Med	Med	Neutral
	Riparian improvements	-	Med	High	Alt 3
	Maximizes bioengineering	-	High	High	Neutral
	Reconnects floodplain	-	Med	High	Alt 3
	Restores natural processes	-	Med	Low	Alt 2
	Time frame for final design	-	Med	High	Alt 2
Cost Considerations	Initial cost	-	Med	High	Alt 2
	Lifecycle cost	-	Low	Med	Alt 2
	O&M cost	-	Low	Low	Neutral
Construction Considerations	Construction time	-	Med	High	Alt 2
	Obstacles for timely implementation	-	Med	High	Alt 2
	Difficulty in meeting construction period	-	Med	High	Alt 2
Overall Edge					Alt 2

**Preferred Alternative:
Alternative 2
Gradual Low-Profile
Setback Berm**

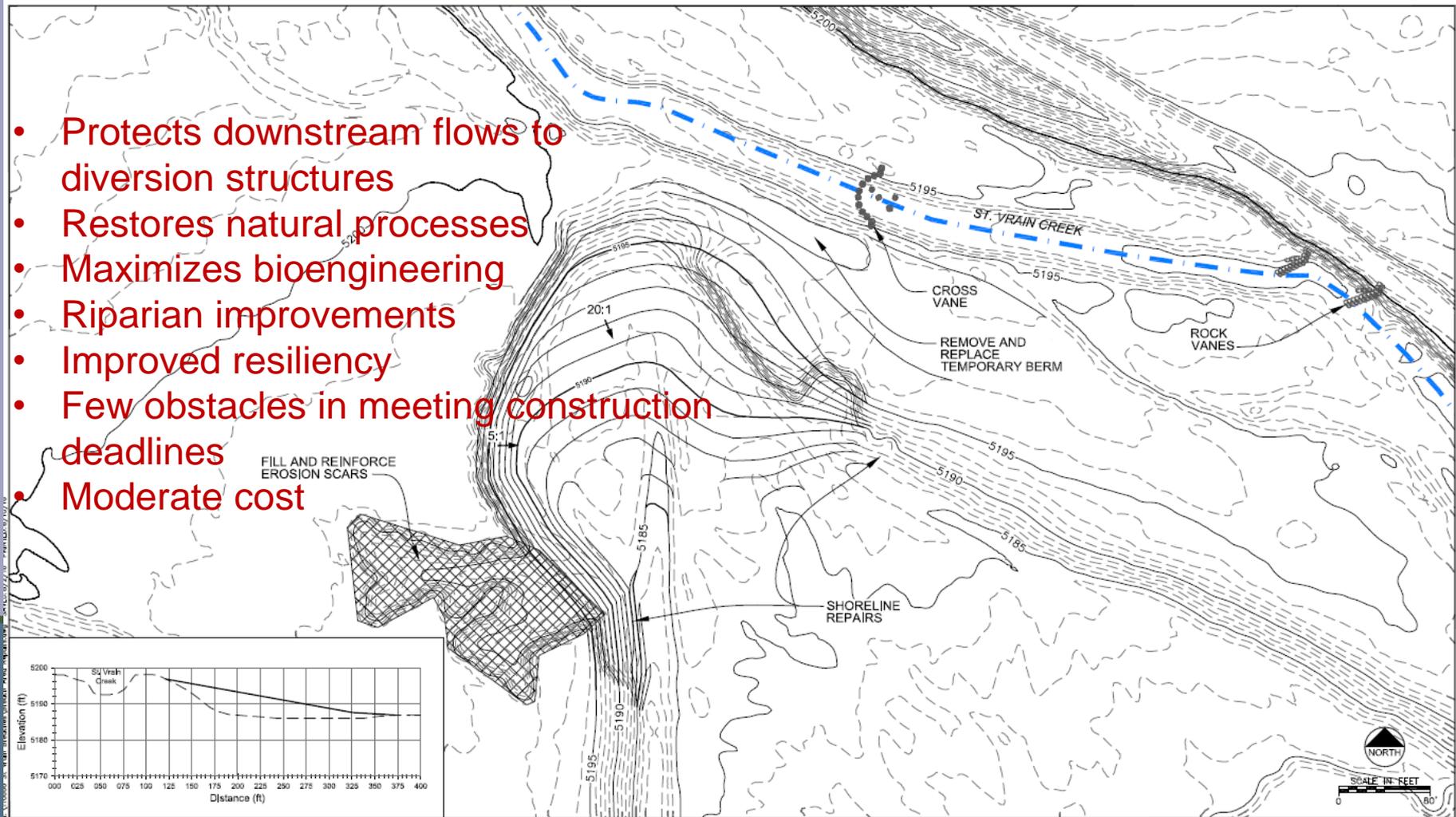
Note: No further analysis performed for alternatives not meeting minimum design evaluation criteria.

BREACH 2 – Alternative 1: No Action



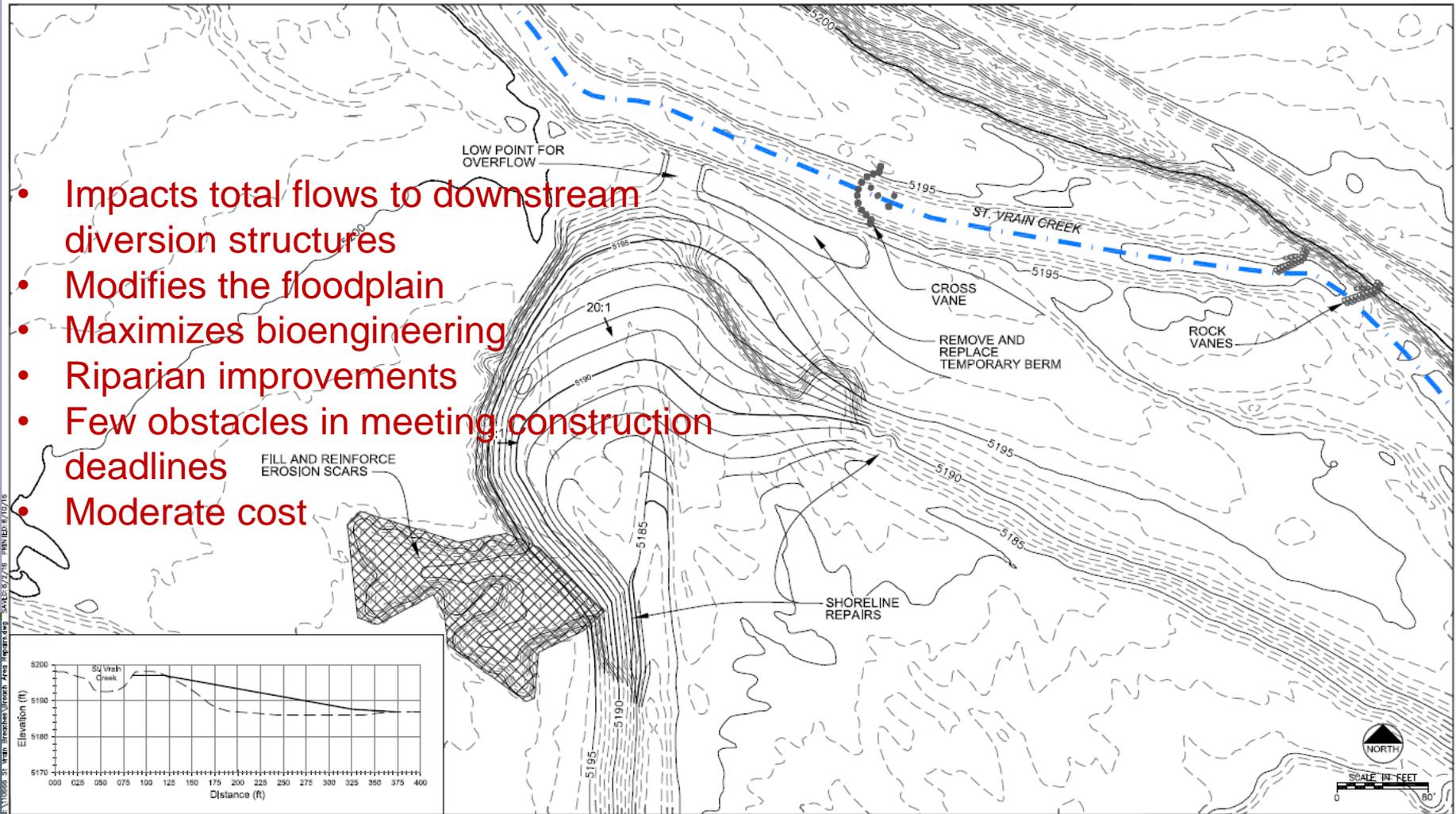
BREACH 2 – Alternative 2: Berm and Downslope Grading

- Protects downstream flows to diversion structures
- Restores natural processes
- Maximizes bioengineering
- Riparian improvements
- Improved resiliency
- Few obstacles in meeting construction deadlines
- Moderate cost



BREACH 2 – Alternative 3: Overflow Berm and Downslope Grading

- Impacts total flows to downstream diversion structures
- Modifies the floodplain
- Maximizes bioengineering
- Riparian improvements
- Few obstacles in meeting construction deadlines
- Moderate cost



BREACH 2 – Comparative Analysis

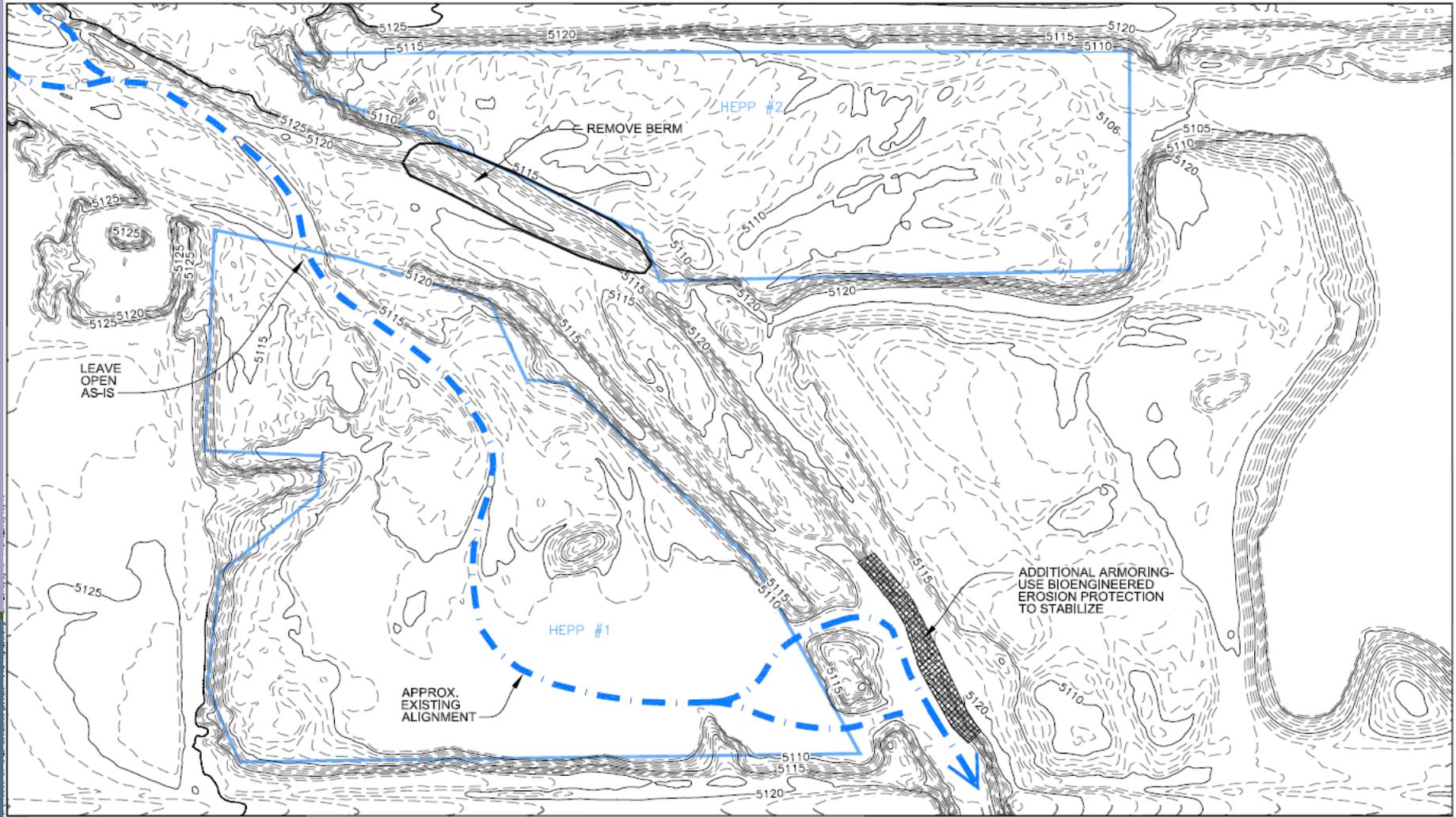
Table 2 – Breach 2 Alternatives Comparative Analysis

Criteria		Alt #1 – No Action	Alt #2 – Berm and Downslope Grading	Alt #3 – Overflow Berm and Downslope Grading	Edge
Design Evaluation Criteria	Reduce hazards and protect life safety and property	No	Yes	Yes	Alt 2 / 3
	No increase in hazard	No	Yes	Yes	Alt 2 / 3
	Technically sound	Yes	Yes	Yes	Alt 2 / 3
	Meets objectives of CDBG-DR	No	Yes	Yes	Alt 2 / 3
	Meets objectives of NRCS/EWP	No	Yes	Yes	Alt 2 / 3
Additional Benefits of Design	T&E Species	-	Med	Med	Neutral
	Native fish passage	-	Med	High	Alt 3
	Riparian improvements	-	Med	Med	Neutral
	Maximizes bioengineering	-	Med	Med	Neutral
	Reconnects floodplain	-	Low	Med	Alt 3
	Restores natural processes	-	Low	Med	Alt 3
	Time frame for final design	-	Med	Med	Neutral
Cost Considerations	Initial cost	-	Low	Med	Alt 2
	Lifecycle cost	-	Low	Med	Alt 2
	O&M cost	-	Low	Med	Alt 2
Construction Considerations	Construction time	-	Med	Med	Neutral
	Obstacles for timely implementation	-	Med	Med	Neutral
	Difficulty in meeting construction period	-	Med	Med	Neutral
Overall Edge					Alt 2

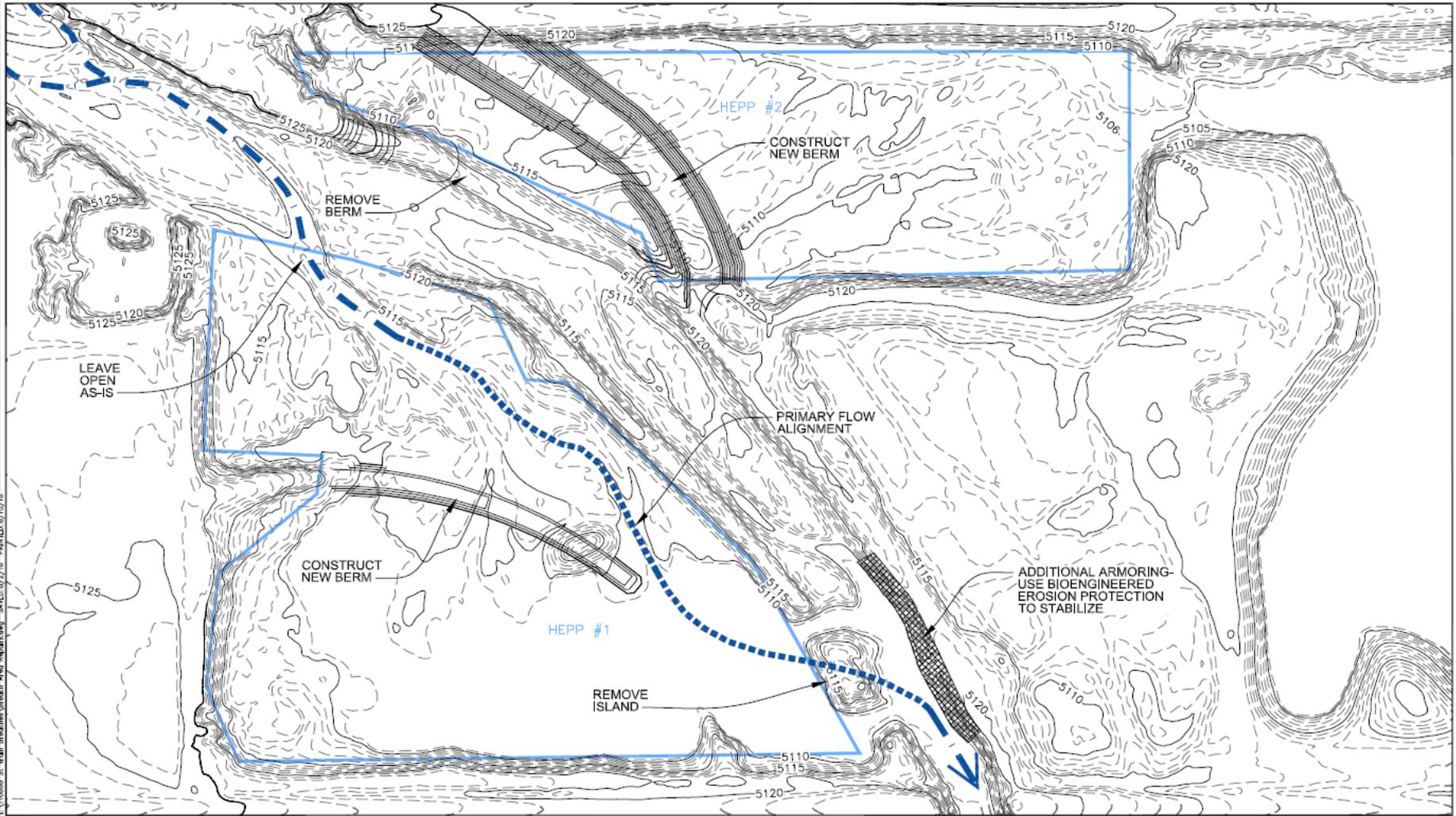
**Preferred Alternative:
Alternative 2
Berm and
Downslope Grading**

Note: No further analysis performed for alternatives not meeting minimum design evaluation criteria.

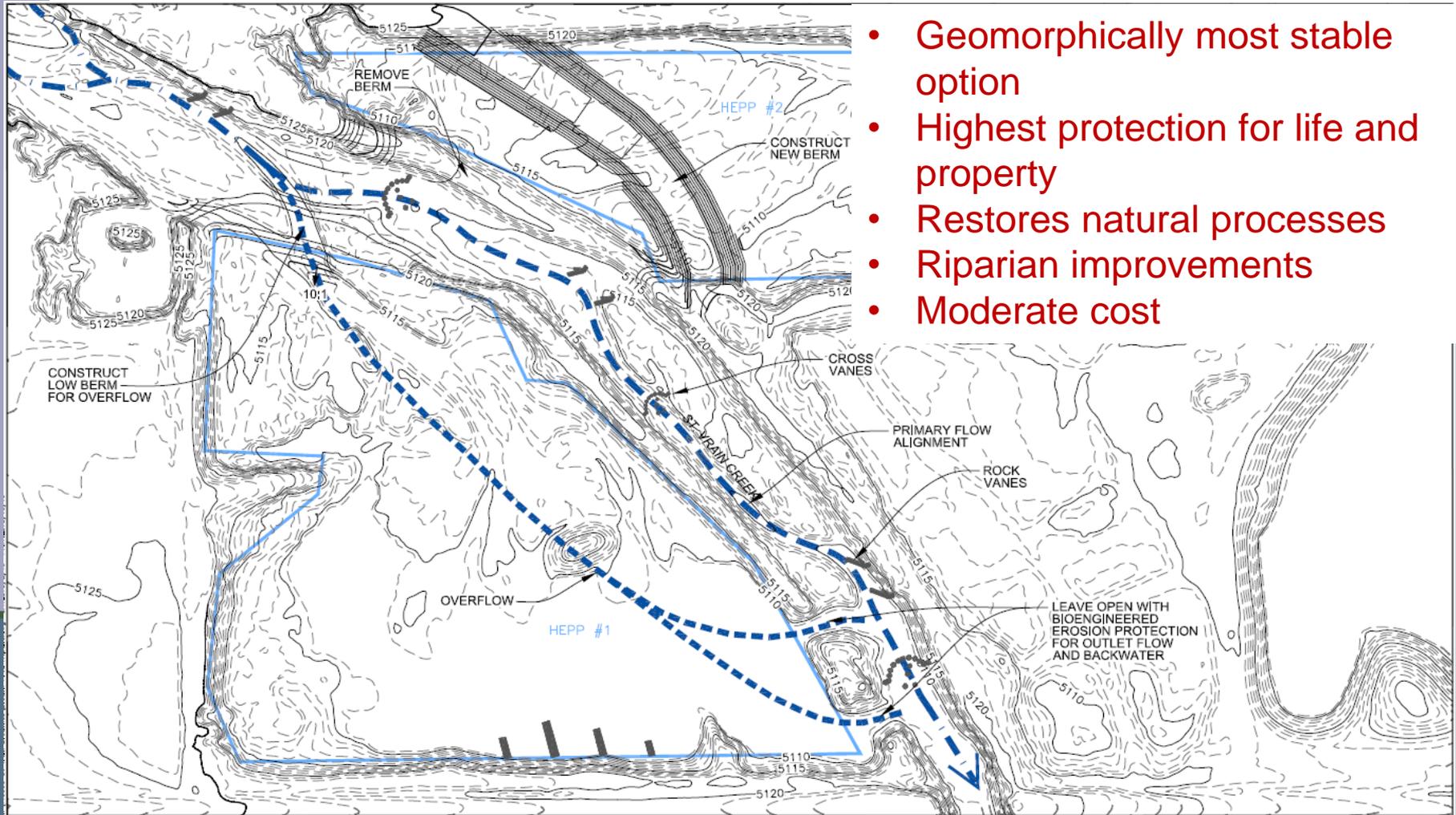
BREACHES 5-9 – Alternative 1: No Action



BREACHES 5-9 – Alternative 2: Redirect Flow and Full Berm



BREACHES 5-9 – Alternative 3: Overflow Berm and Full Berm



- Geomorphically most stable option
- Highest protection for life and property
- Restores natural processes
- Riparian improvements
- Moderate cost

BREACH 5-9 – Comparative Analysis

Table 3 – Breaches 5-9 Alternatives Comparative Analysis

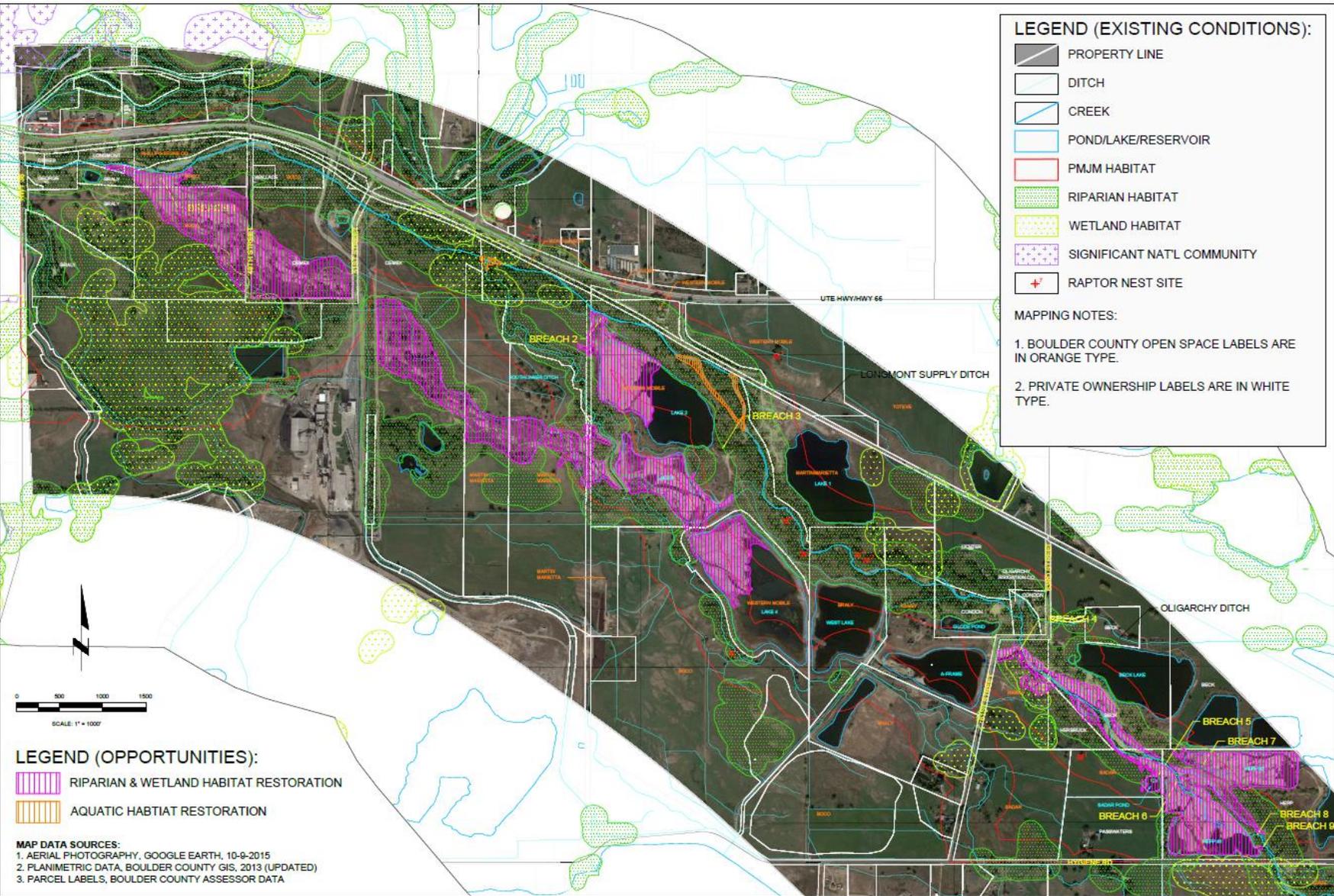
Criteria		Alt #1 – No Action	Alt #2 – Redirect Flow and Full Berm	Alt #3 – Overflow Berm and Full Berm	Edge
Design Evaluation Criteria	Reduce hazards and protect life safety and property	No	Yes	Yes	Alt 2 / 3
	No increase in hazard	No	Yes	Yes	Alt 2 / 3
	Technically sound	Yes	Yes	Yes	Alt 2 / 3
	Meets objectives of CDBG-DR	No	Yes	Yes	Alt 2 / 3
	Meets objectives of NRCS/EWP	No	Yes	Yes	Alt 2 / 3
Additional Benefits of Design	T&E Species	-	High	High	Neutral
	Native fish passage	-	High	High	Neutral
	Riparian improvements	-	Med	High	Alt 3
	Maximizes bioengineering	-	High	High	Neutral
	Reconnects floodplain	-	Med	Med	Neutral
	Restores natural processes	-	Med	Med	Neutral
	Time frame for final design	-	High	Med	Alt 3
Cost Considerations	Initial cost	-	High	Med	Alt 3
	Lifecycle cost	-	High	Low	Alt 3
	O&M cost	-	Med	Low	Alt 3
Construction Considerations	Construction time	-	High	Med	Alt 3
	Obstacles for timely implementation	-	High	Med	Alt 3
	Difficulty in meeting construction period	-	High	Med	Alt 3
Overall Edge					Alt 3

**Preferred Alternative:
Alternative 3
Overflow Berm and
Full Berm**

Note: No further analysis performed for alternatives not meeting minimum design evaluation criteria.

Habitat Restoration Opportunities

C:\Users\Jon.Donovan\Documents\0_Eco\0-Projects\2018-6-5_BCo\8_Vrain Breaches\Mapping\CAD\envs_Breaches_Base_5-25-16.dwg

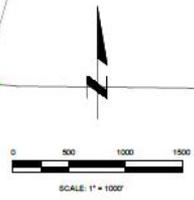


LEGEND (EXISTING CONDITIONS):

- PROPERTY LINE
- DITCH
- CREEK
- POND/LAKE/RESERVOIR
- PMJM HABITAT
- RIPARIAN HABITAT
- WETLAND HABITAT
- SIGNIFICANT NAT'L COMMUNITY
- RAPTOR NEST SITE

MAPPING NOTES:

- BOULDER COUNTY OPEN SPACE LABELS ARE IN ORANGE TYPE.
- PRIVATE OWNERSHIP LABELS ARE IN WHITE TYPE.



LEGEND (OPPORTUNITIES):

- RIPARIAN & WETLAND HABITAT RESTORATION
- AQUATIC HABITAT RESTORATION

MAP DATA SOURCES:

- AERIAL PHOTOGRAPHY, GOOGLE EARTH, 10-9-2015
- PLANIMETRIC DATA, BOULDER COUNTY GIS, 2013 (UPDATED)
- PARCEL LABELS, BOULDER COUNTY ASSESSOR DATA

FIGURE 3

ST. VRAIN BREACHES CREEK RESTORATION

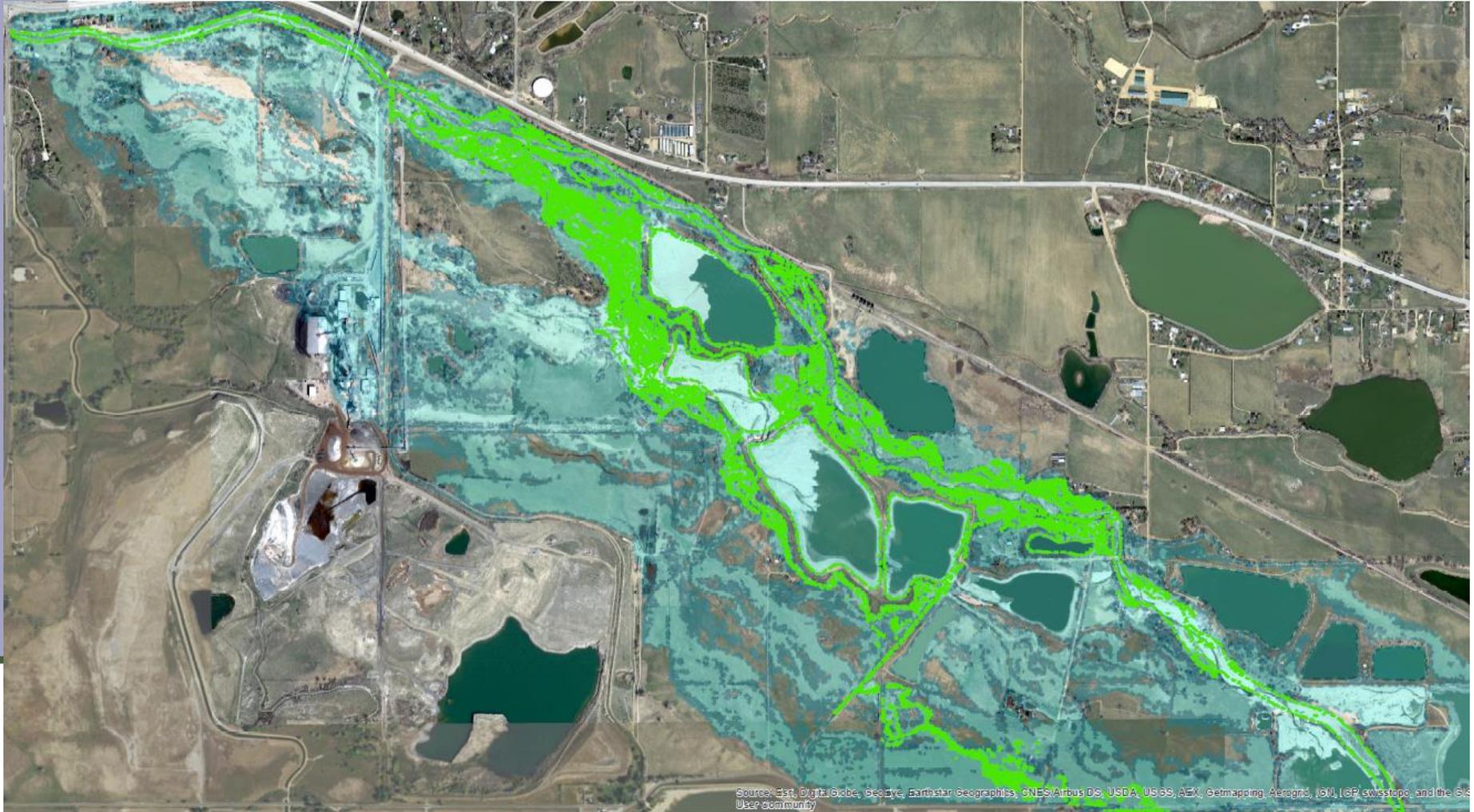
EXISTING CONDITIONS & HABITAT RESTORATION MAP

NO. REVISIONS:	DATE:	BY:
#1		
#2		
#3		
#4		

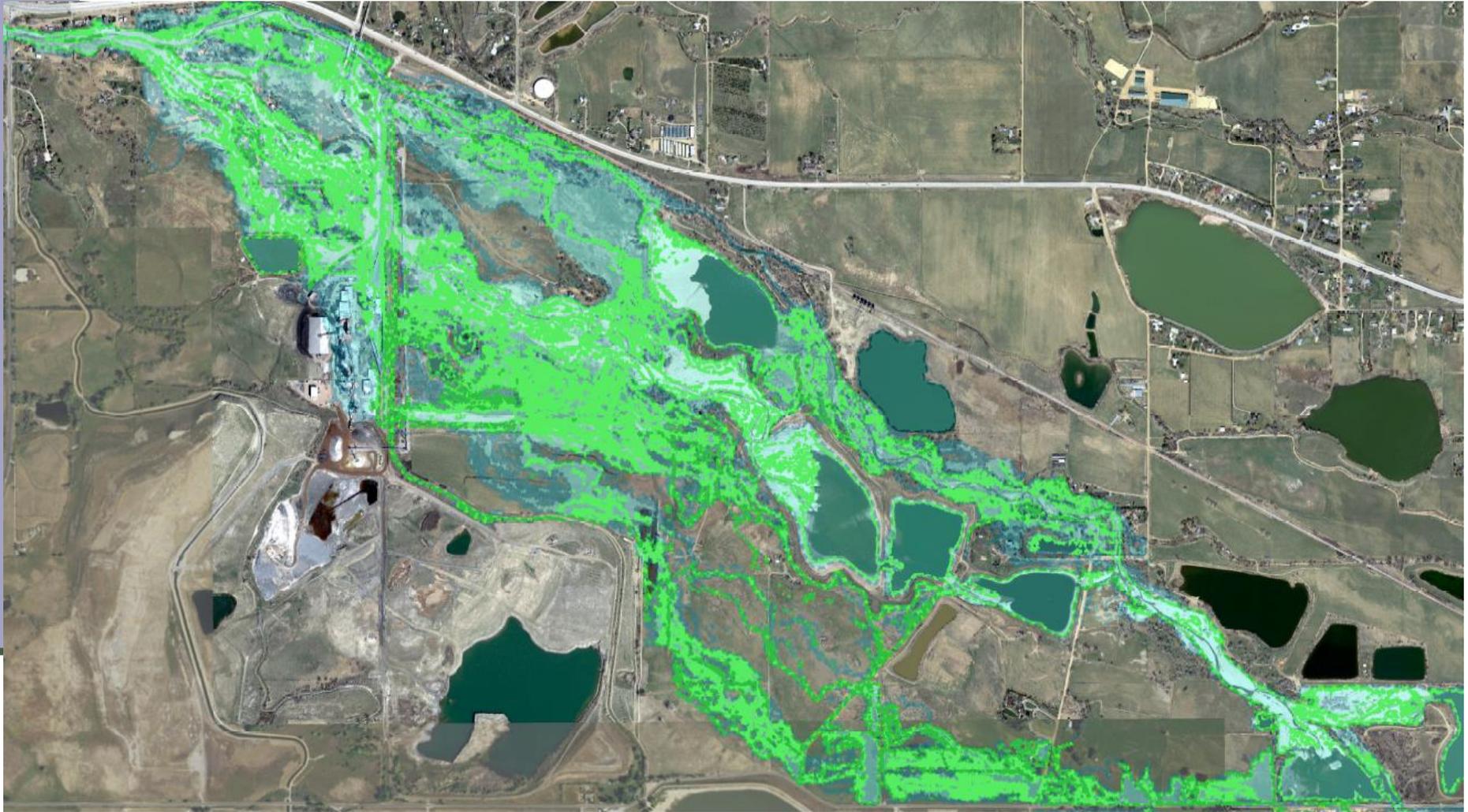
DRAWN BY:	DATE:
4-29-16	
CHECKED BY:	PROJECT NO.:
2018-6-5	

ecos
ECOSYSTEM SERVICES
1455 W. 10th Street
Boulder, Colorado 80516
(970) 441-3227

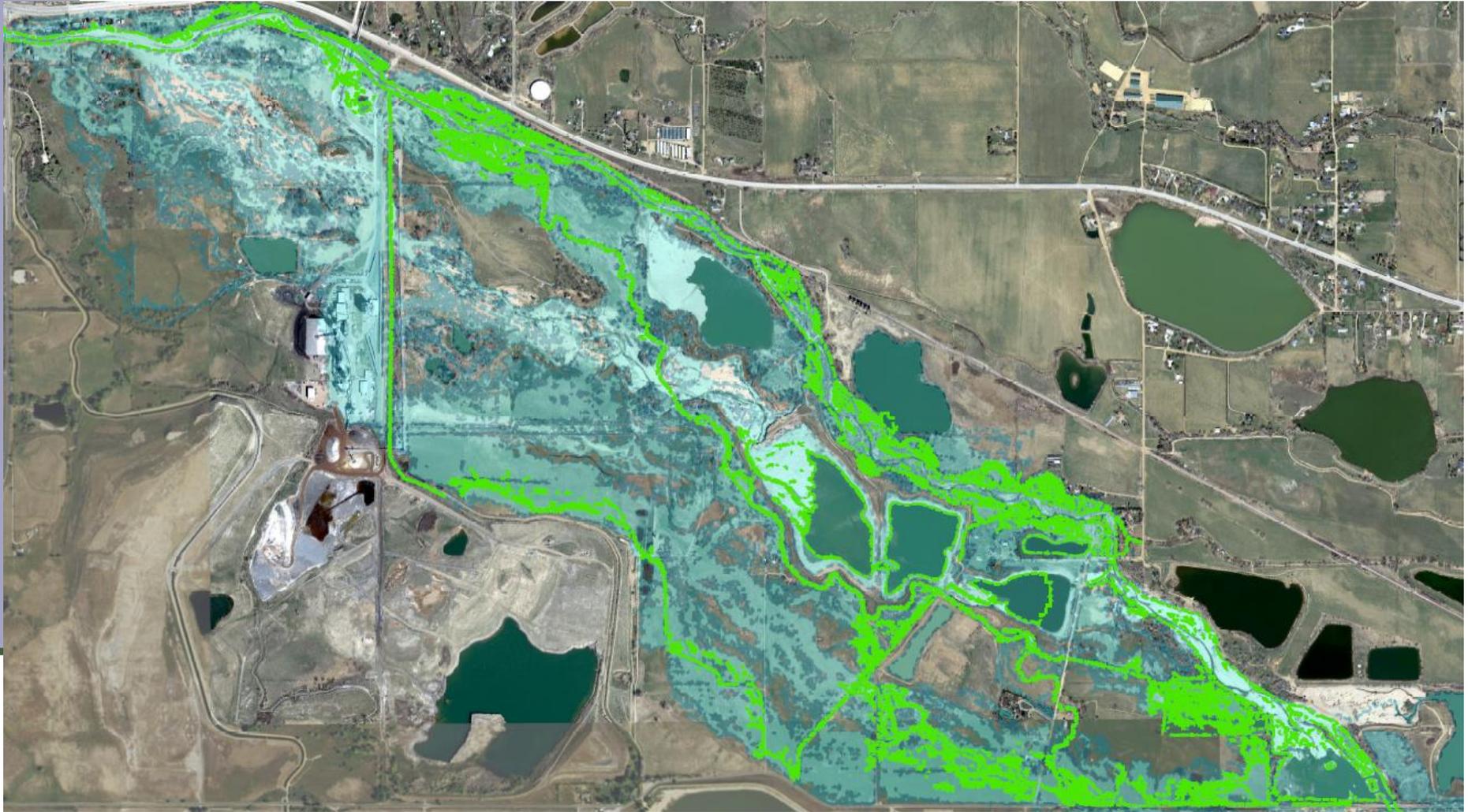
Pre-Flood Inundation Map



Post-Flood Inundation Map



Current Inundation Map





Parks &
Open Space

Thank you!

For more information, visit the project website

<http://www.bouldercounty.org/os/openspace/pages/ssv-36-to-airport.aspx>

or contact

Jesse Rounds at BCPOS

jrounds@bouldercounty.org

303-678-6271