There goes the neighborhood! Water quality challenges in a changing environment

TOWN OF BRECKENRIDGE
OPEN SPACE & TRAILS

EcoMetrics
Stream and Riparian Monitoring, Assessment and Restoration

Jessica Doran, EcoMetrics
Anne Murphy, Town of Breckenridge

Cucumber Gulch Preserve

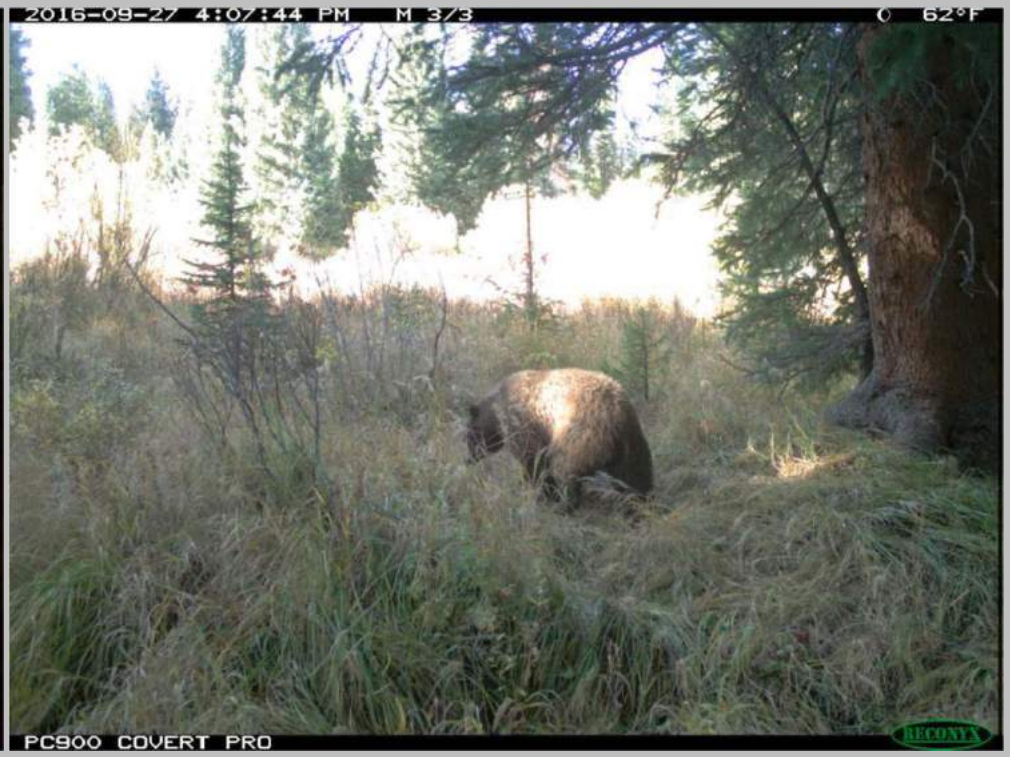
The Background:

- 117-acre open space in Breckenridge
- Fen wetland (EPA “ARNI”- Aquatic Resource of National Importance)
- High biodiversity
- “Crown Jewel” open space property - genesis of Town open space program
- Located at the base of the Breckenridge Ski Area

Cucumber Gulch Preserve

Management Plan priorities:

- Preserve wetland ecosystem and natural resources
- Provide public recreational access
- Monitor and track management objectives



Cucumber Gulch Preserve

In Practice:

- Breckenridge Nordic Center - in operation for past 35+ years
- Summer non-motorized trail network
- Management informed by long-term monitoring program (Example: Seasonal trail closures)

Cucumber Gulch Preserve

Cucumber Gulch Preserve

Political Setting:

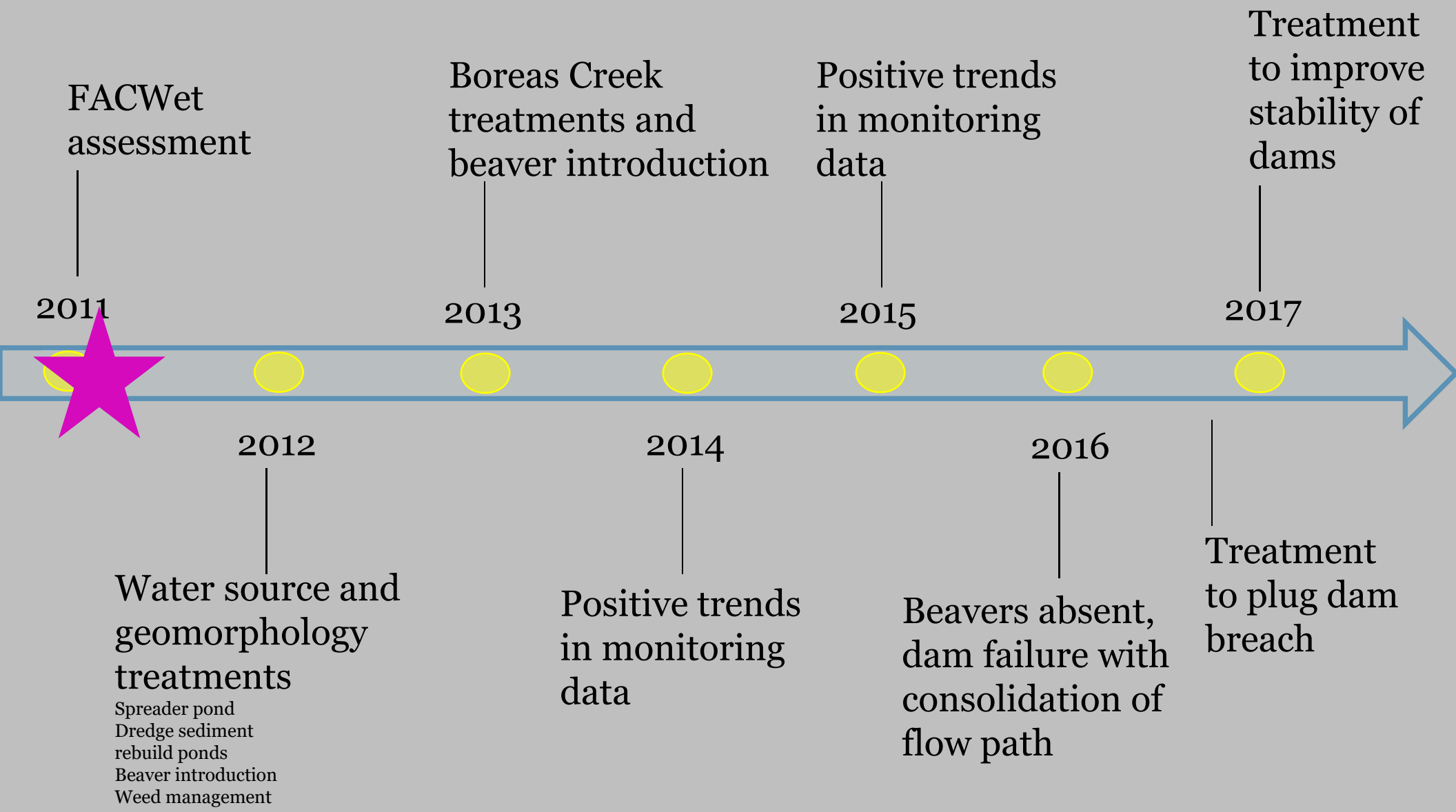
- Significant open space investment *(Over $9.5M in land acquisition since 1998)*
- Breckenridge Ski Area downstream impacts
- Area development
- BreckConnect Gondola: Construction and operation
- Highly visible and sensitive

Cucumber Gulch Preserve

Stakeholders:

- Public: recreationists, wildlife viewing, ski area visitors, future citizens
- Town of Breckenridge: Town Council, BOSAC, Citizens
- Ski areas: Vail Resorts & shareholders, Breck Nordic Center
- Local Homeowners
- Developers/Builders/Realtors: Vail Resorts, timeshare owners
- Press

Timeline of activity in CGP 2011-2017



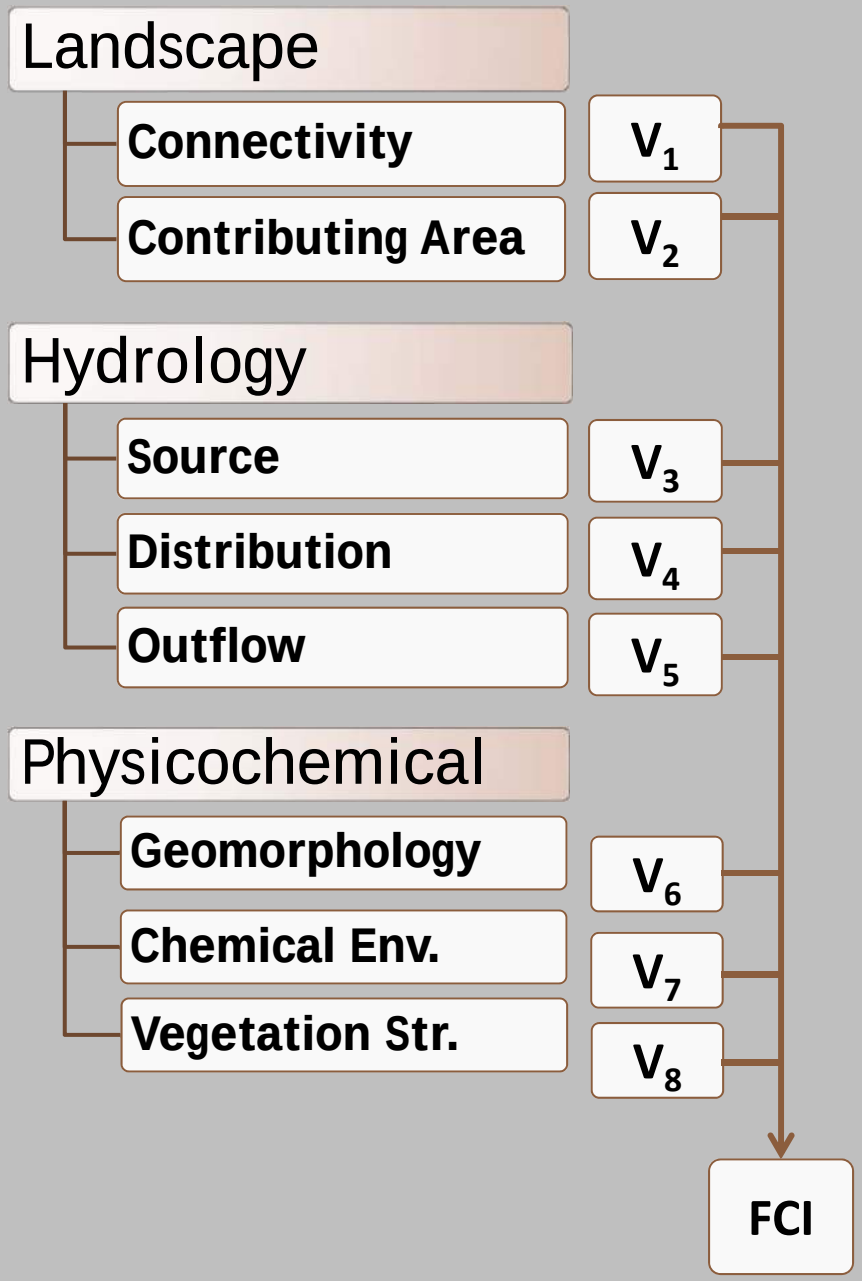
Wetland Functions & Values

- Terrestrial Habitat (Wildlife)
- Aquatic Habitat (Fish)
- Water Quality
- Water Quantity
- Nutrient/Organic Cycling
- “Infinite” functions

Ecological/Functional Assessment

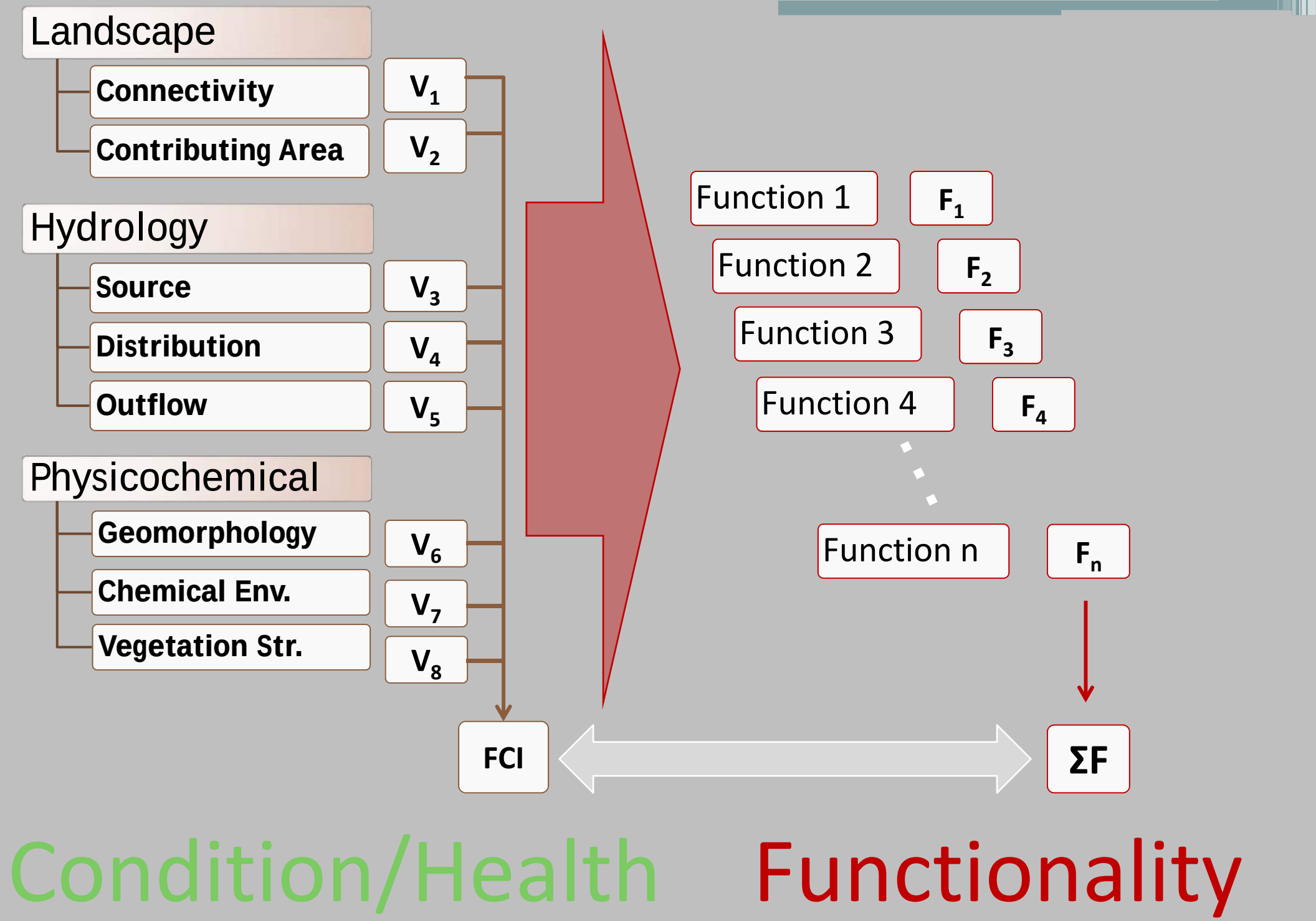
Health

- Assessment (opinion)
  - Interview/exam
  - Detailed tests
- Diagnosis
- Treatment (prescription)
- Monitoring (follow-up)



FACWet

Functional Assessment of Colorado Wetlands


Landscape
Connectivity
Contributing Area
Hydrology
Source
Distribution
Outflow
Physicochemical
Geomorphology
Chemical Env.
Vegetation Str.
V1
V2
V3
V4
V5
V6
V7
V8
FCI
Function 1
Function 2
Function 3
Function 4
Function n
F1
F2
F3
F4
Fn
ΣF
Condition/Health
Functionality

60” culvert outlet

Reset Pond

Diagnosis

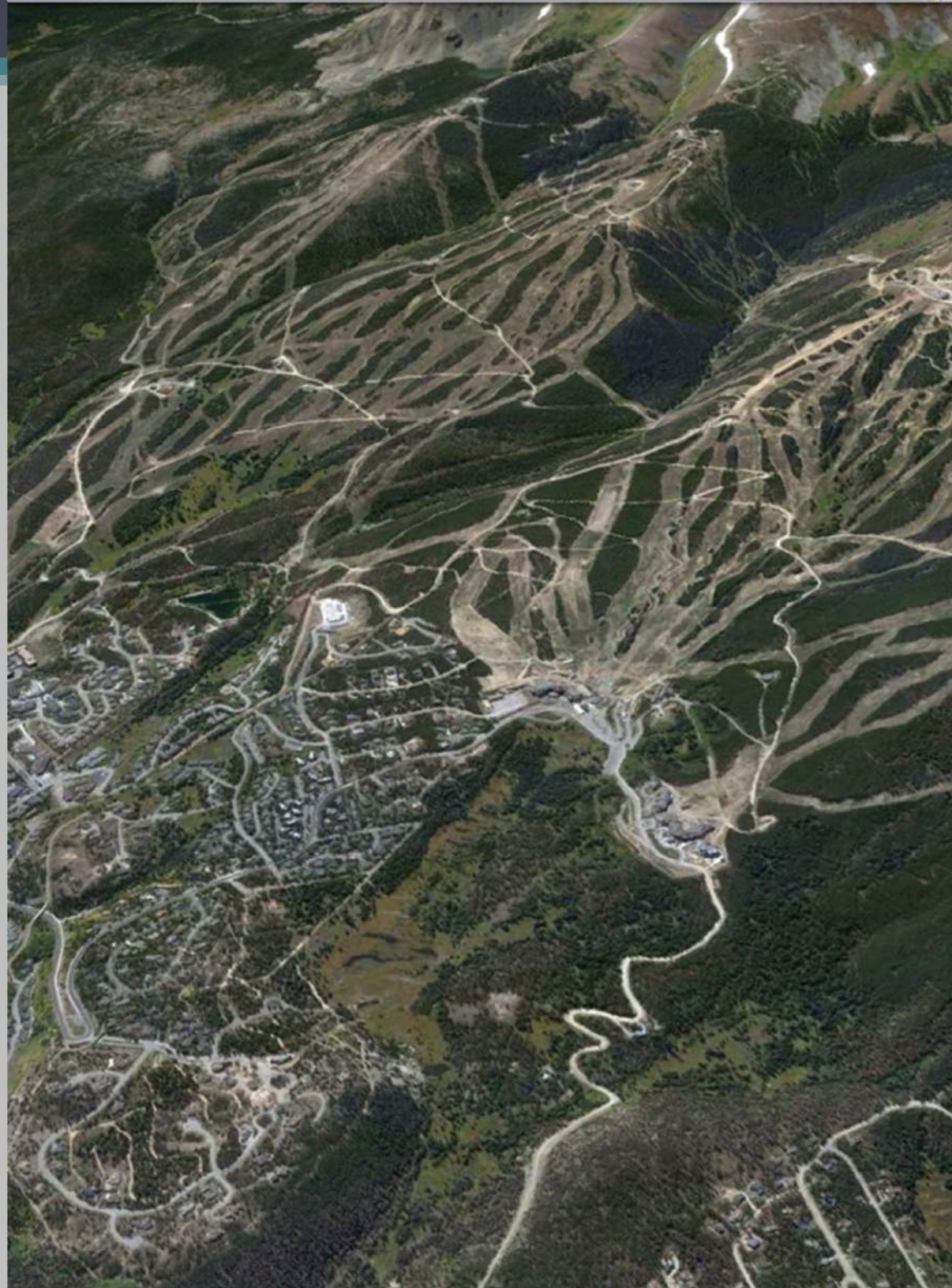
Landscape		
	Connectivity	C
	Contributing Area	D
Hydrology		
	Source	D
	Distribution	D-
	Outflow	D
Physicochemical		
	Geomorphology	D
	Chemical Environment	D
	Vegetation Structure	C+


2011
2012

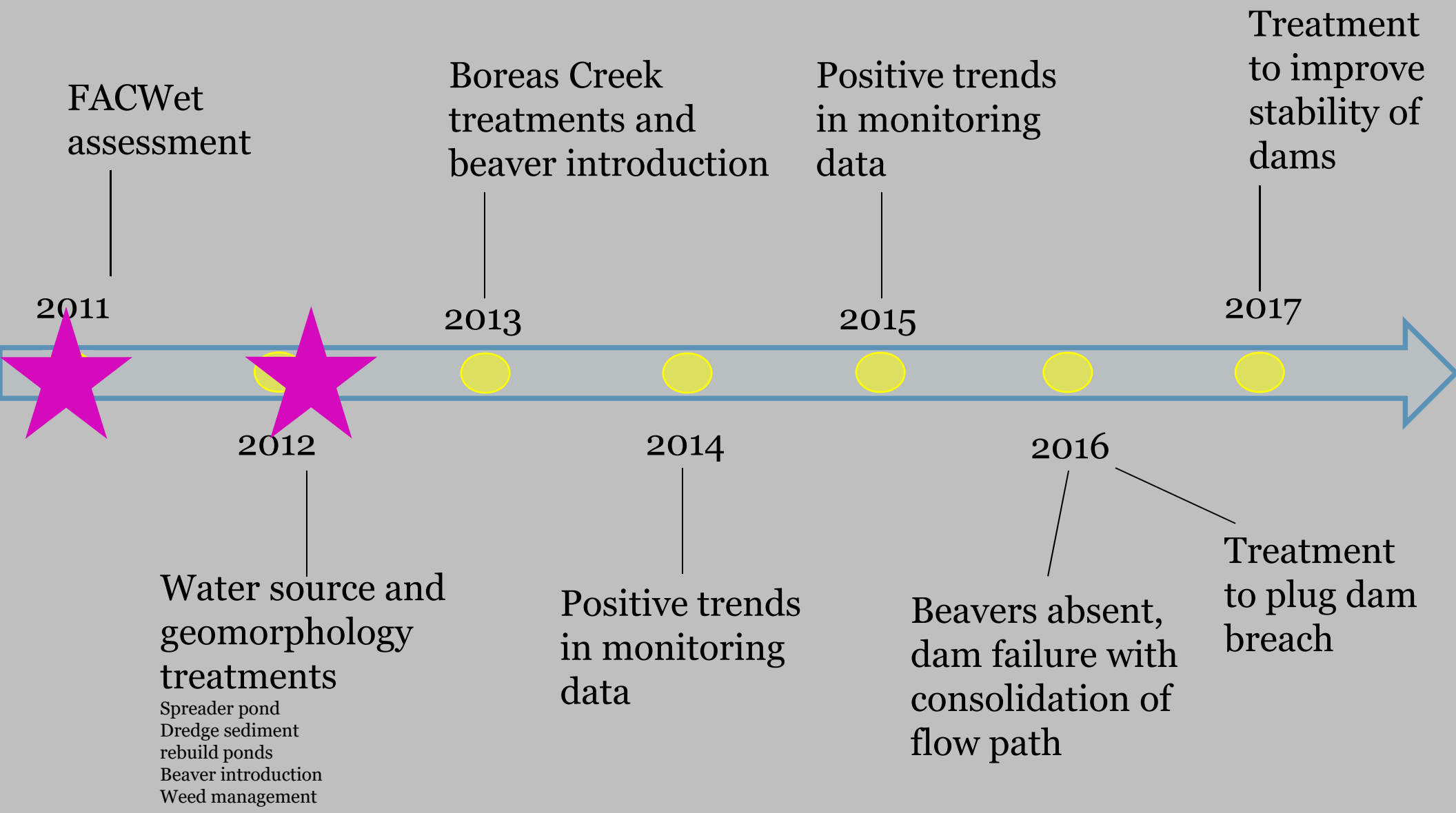
Diagnosis

- **Landscape**
  - Connectivity — C
  - Contributing Area — D
- **Hydrology**
  - Source — D
  - Distribution — D-
  - Outflow — D
- **Physicochemical**
  - Geomorphology — D
  - Chemical Environment — D
  - Vegetation Structure — C+

Functioning Impaired — **D**



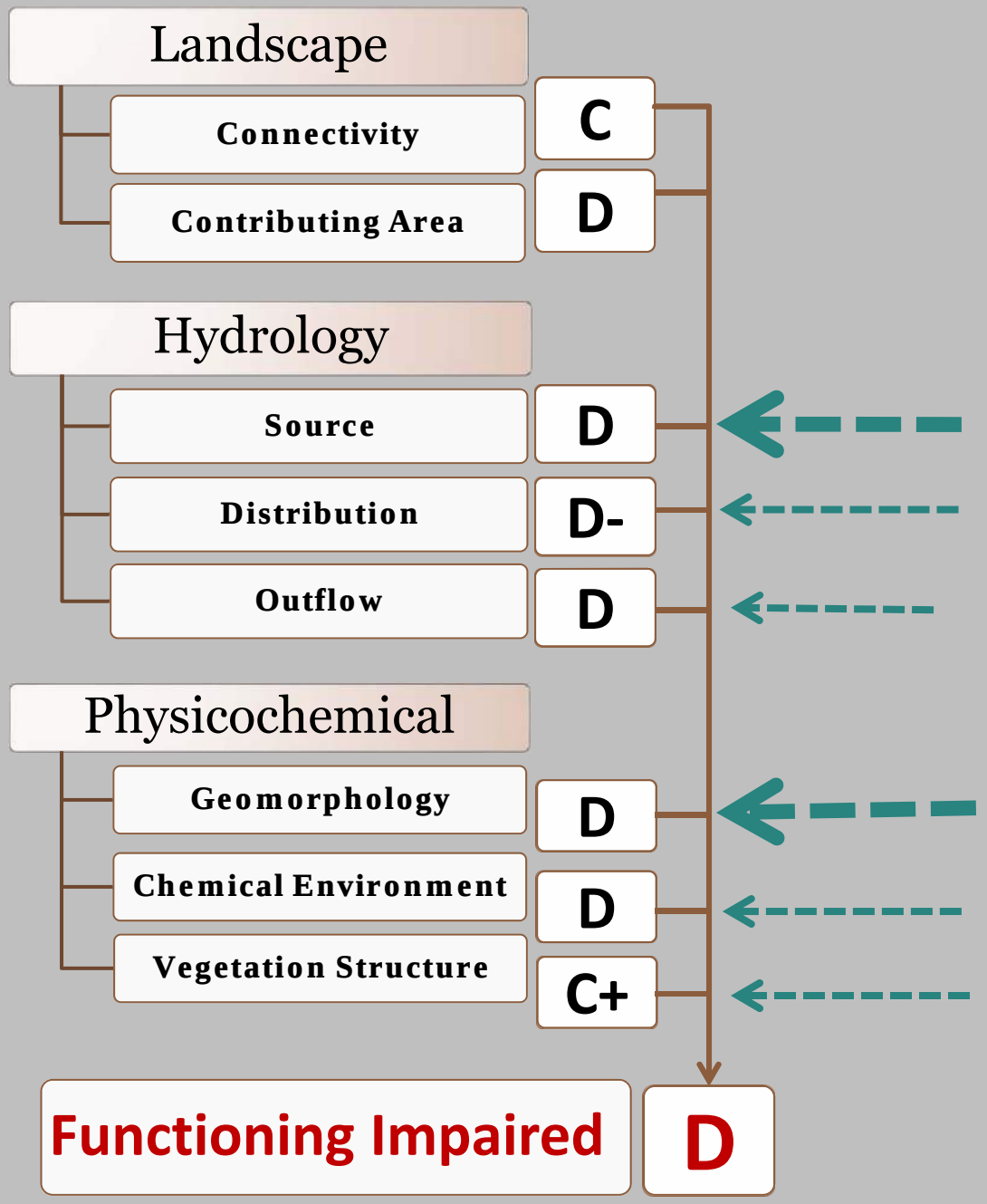
Timeline of activity in upper CGP 2011-2017




CAT


CAT

Diagnosis



Treatments

"spreader pond"

pond/dam repair

beaver re-intro.

dredge sediment

ski area BMPs

weed control

Treatment

“Spreader pond”

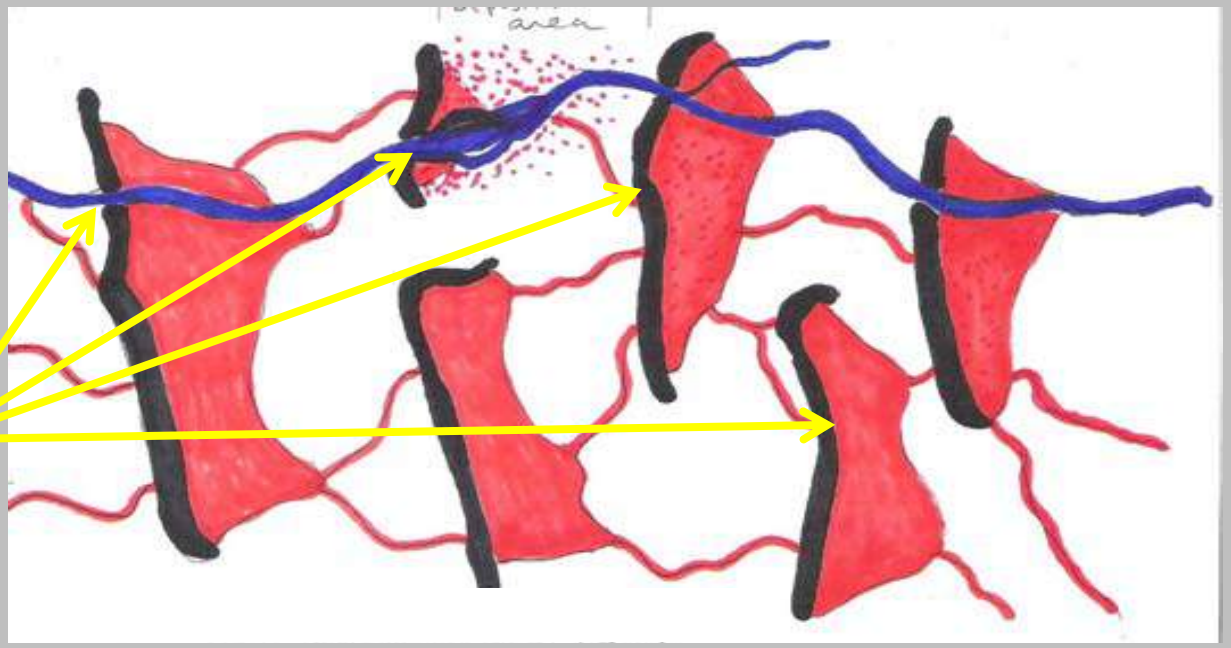
Treatments

"Spreader pond"

Dredge sediment

Treatments

- "Spreader pond"
- Dredge sediment
- Pond/dam repair



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- “Spreader pond”
- Dredge sediment
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Treatments

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- Weed control

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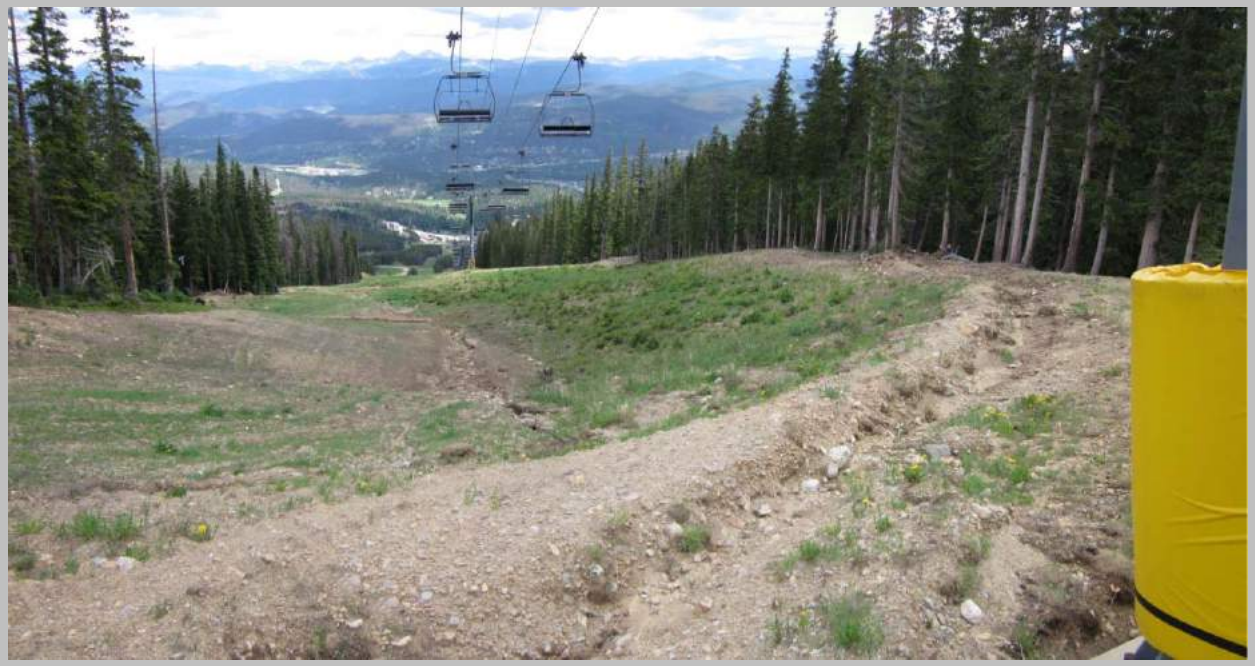

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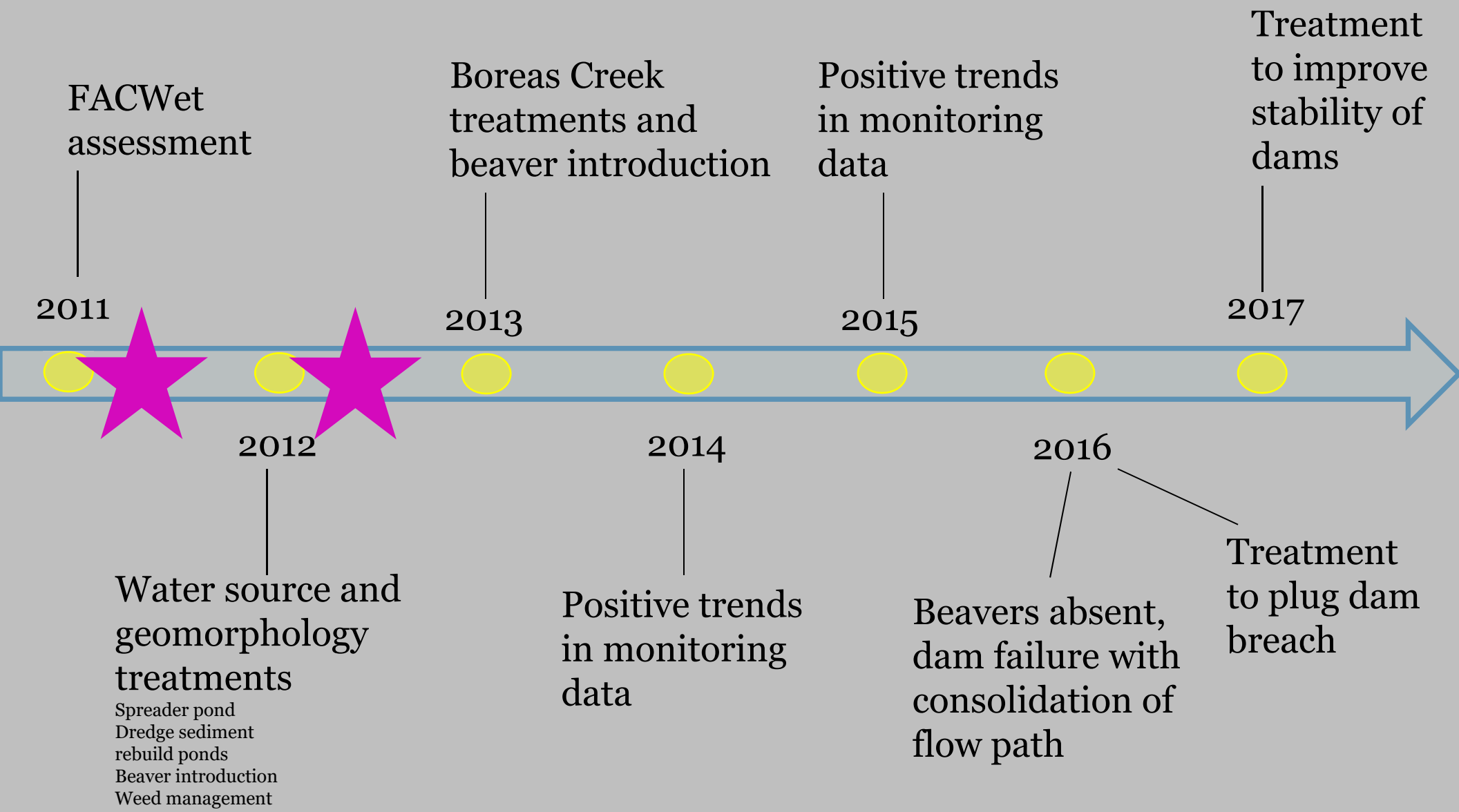
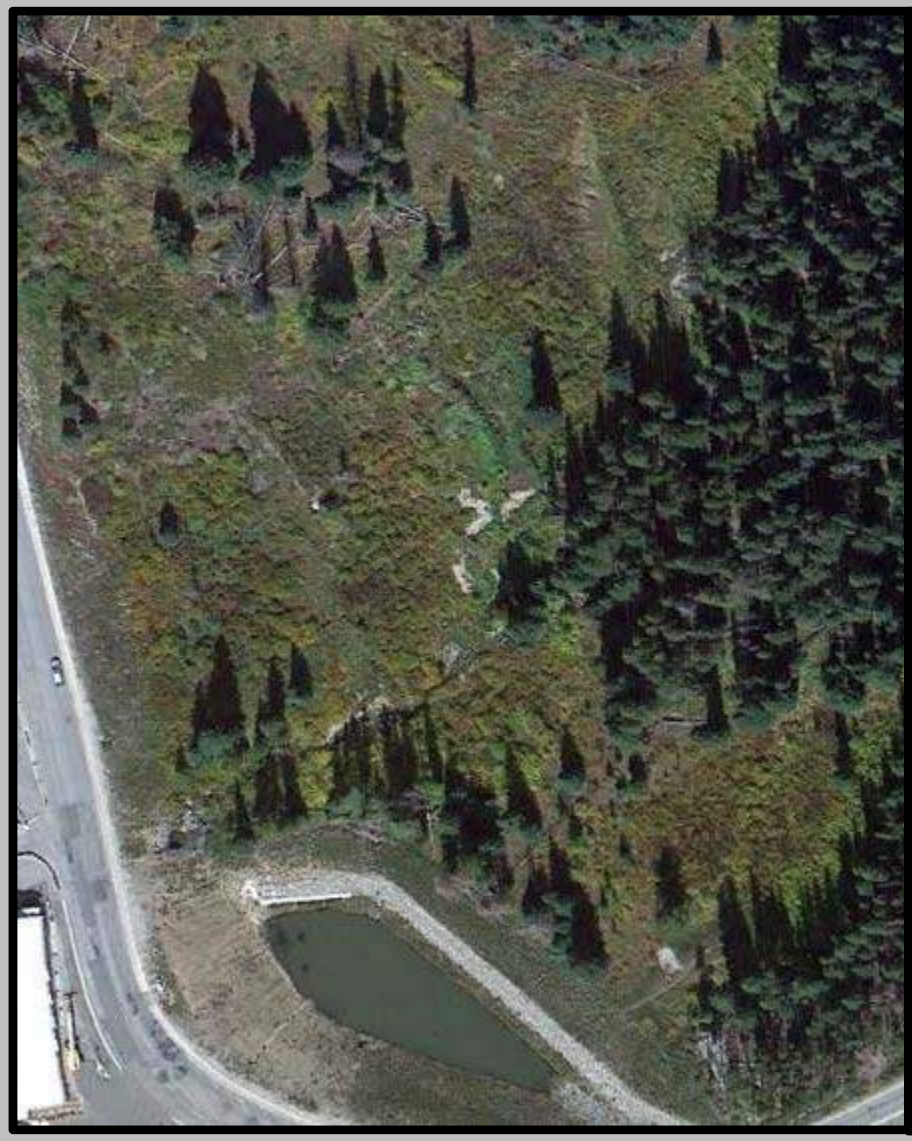
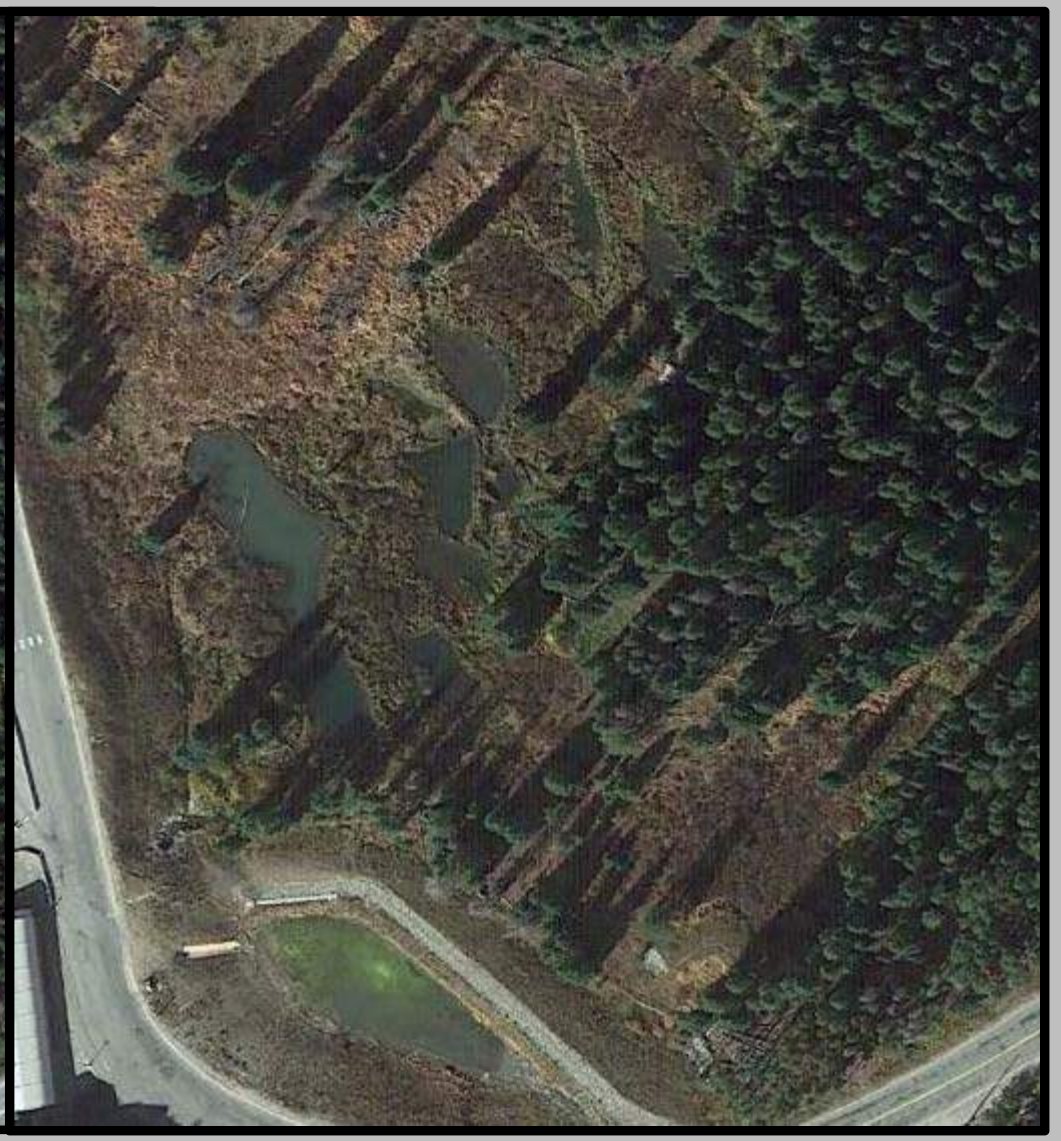




2011

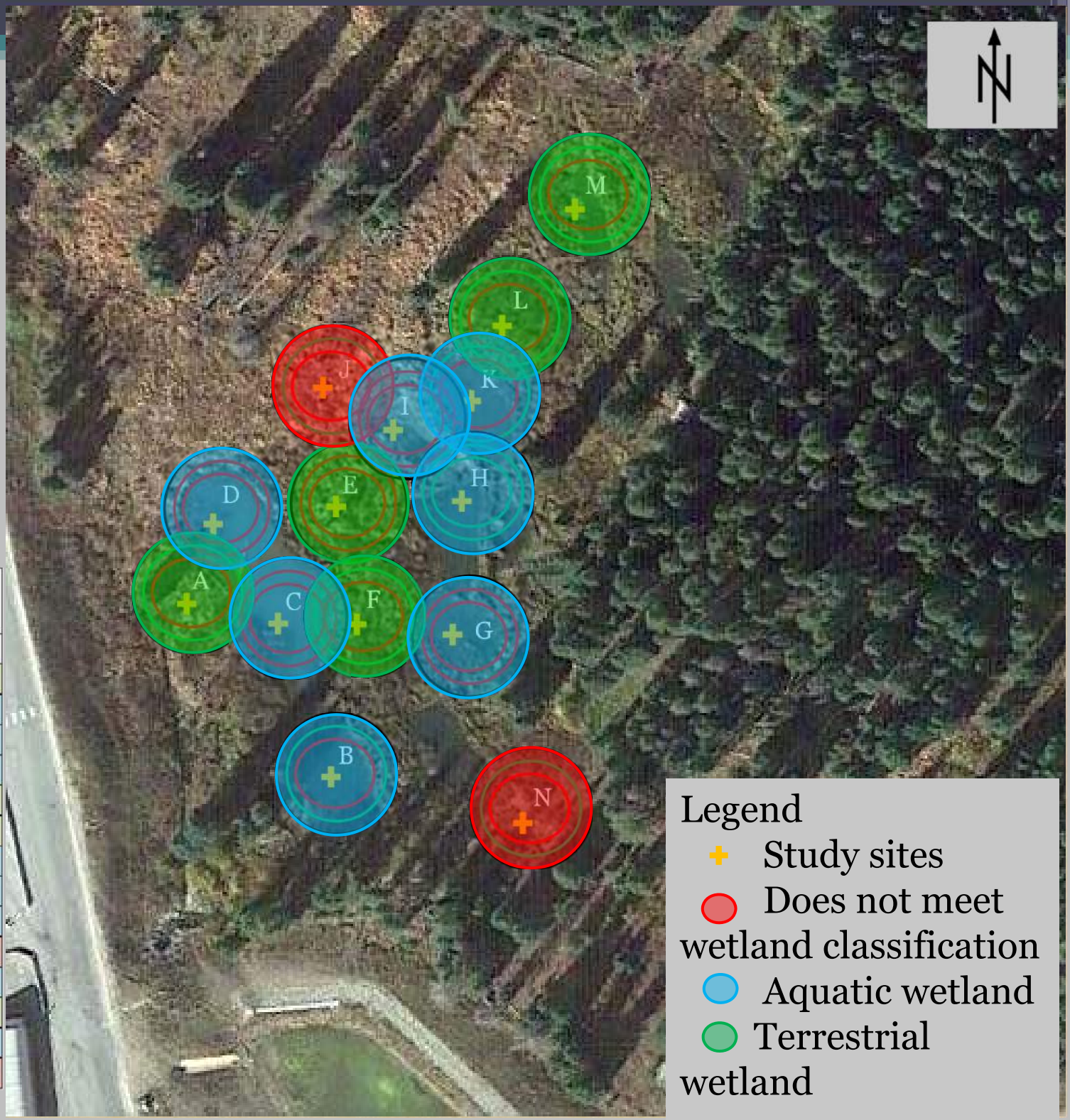


2015

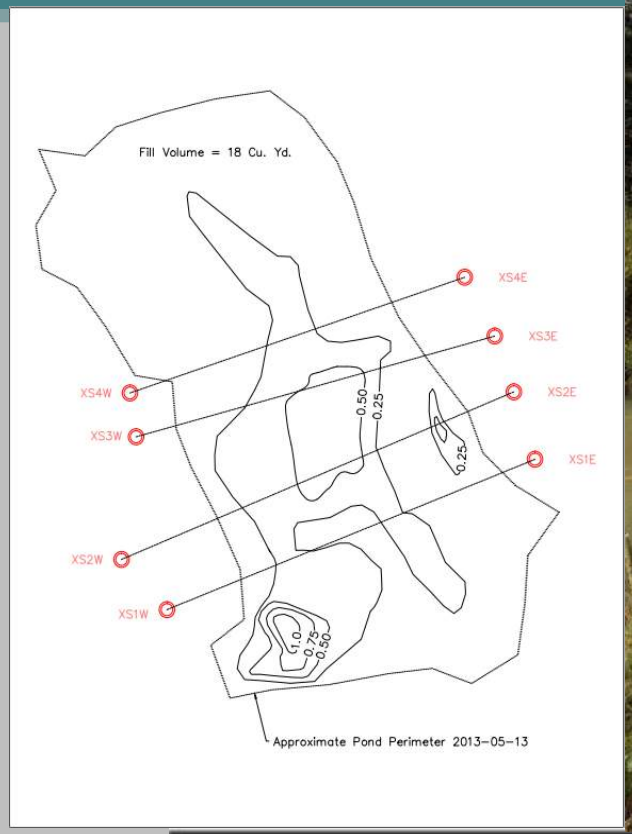
Study site locations and the wetland delineations from 1997 and 2011. The wetland area decrease from 1997 to 2011 and results from the study sites in 2012 show that much of the 2011 delineated wetland did not actually meet jurisdictional standards due to lack of hydrology.

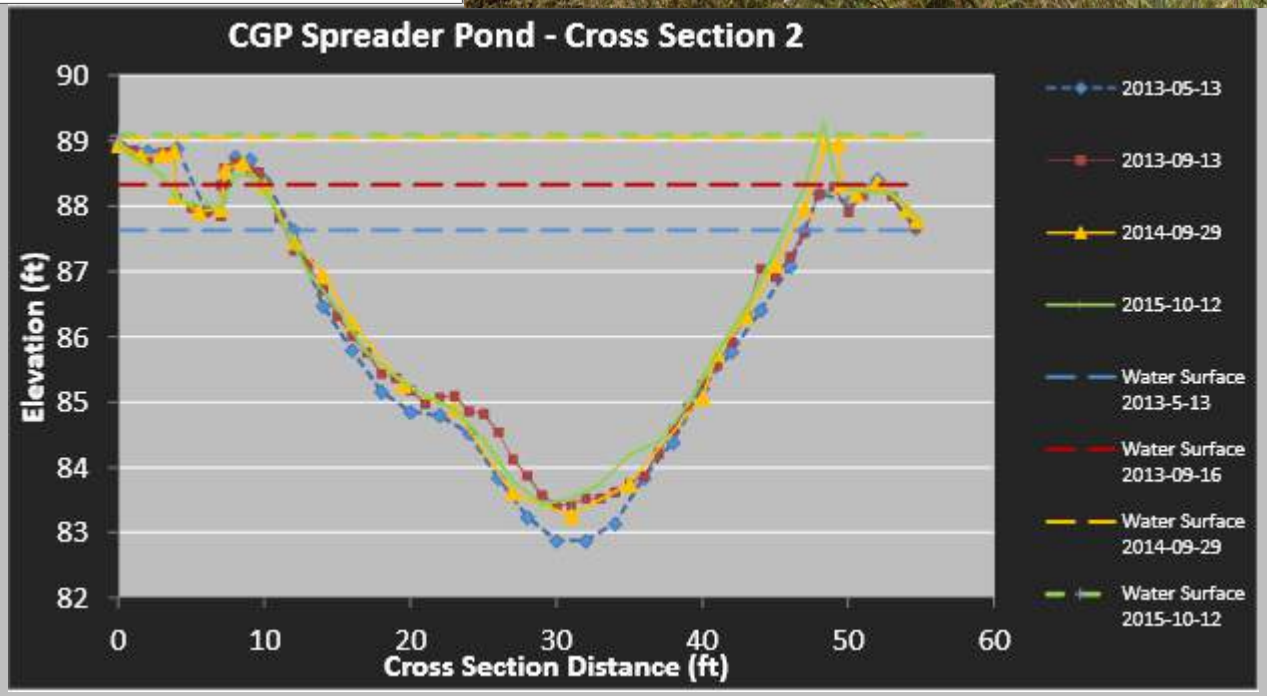
Wetland status in 2016. The only non-wetland sites are J and N on the perimeter. Study sites E and F have been wavering between wetland and non-wetland based on the hydrology from year to year.

Site	Redox patterns indicative of anaerobic soil chemistry			
	2012	2013	2014	2015
A	negative	positive	positive	positive
B	negative	pond	pond	pond
C	negative	pond	pond	pond
D	negative	pond	pond	pond
E	negative	negative	negative	positive
F	negative	negative	positive	positive
G	negative	positive	pond	pond
H	positive	pond	pond	pond
I	negative	pond	pond	pond
J	negative	negative	negative	negative
K	negative	positive	pond	pond
L	negative	positive	positive	positive
M	negative	positive	positive	pond
N	negative	negative	negative	negative

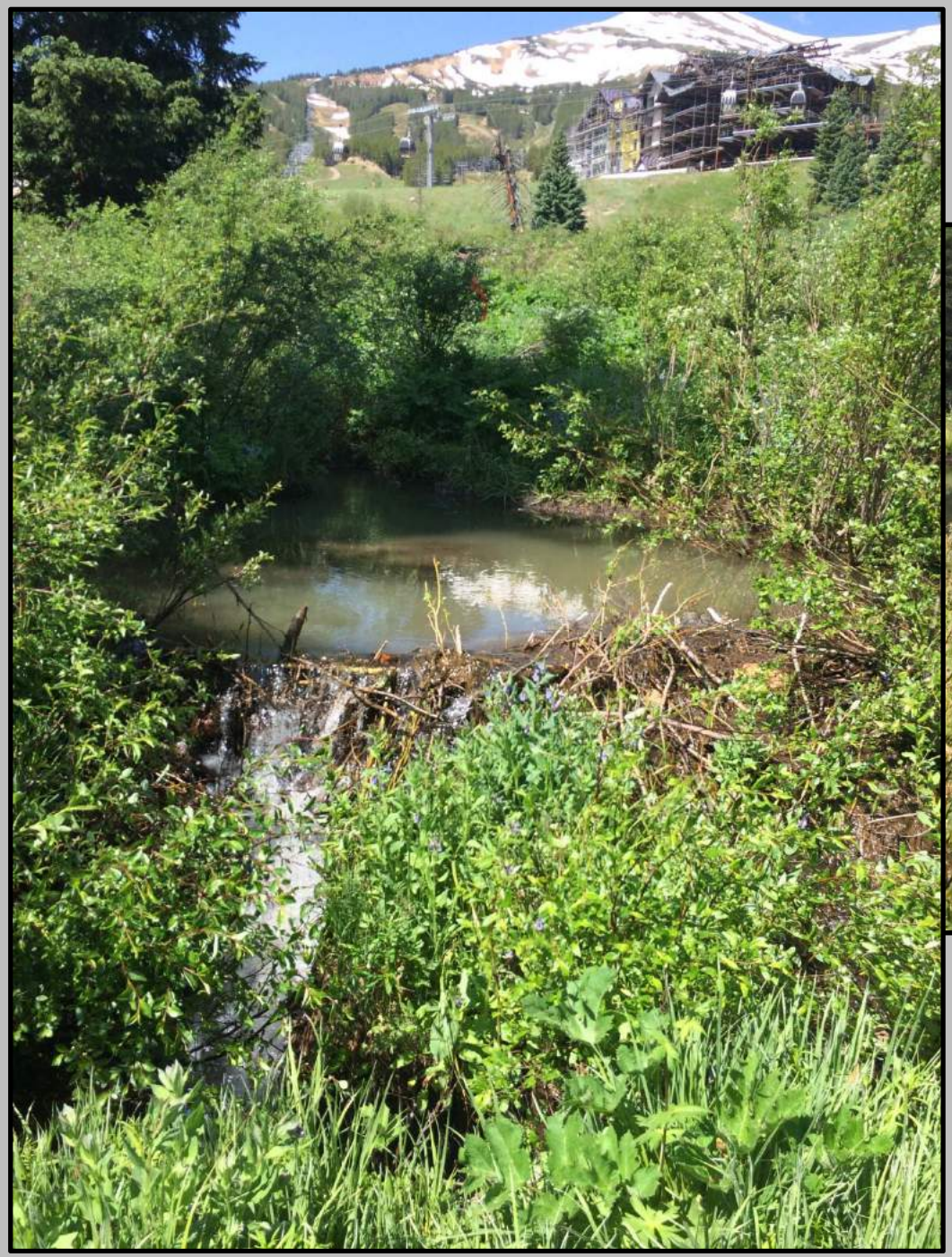



MOULTRIE
20.72 inHg - 2℃ 10/06/2015 07:31PM RESET1
MOULTRIE
20.76 inHg - 1℃ 01/04/2015 11:50PM SSP2 1
MOULTRIE


Fill Volume = 18 Cu. Yd.
XS4E
XS3E
XS2E
XS1E
XS4W
XS3W
XS2W
XS1W
0.50
0.25
0.25
1.0
0.75
0.50
Approximate Pond Perimeter 2013-05-13


CGP Spreader Pond - Cross Section 2
Elevation (ft)
90
89
88
87
86
85
84
83
82
0
10
20
30
40
50
60
Cross Section Distance (ft)
2013-05-13
2013-09-13
2014-09-29
2015-10-12
Water Surface 2013-5-13
Water Surface 2013-09-16
Water Surface 2014-09-29
Water Surface 2015-10-12

Year	Amount of sediment
2013	17.2 cubic yards
2014	31.6 cubic yards
2015	19.6 cubic yards



FACWet Variable #	Variable Description	Pre-project score	Target score	Present score	Current Status Relative to Success Criterion (Summary)	Supporting Data/Evidence (reference to section iii)
1/2	Connectivity	C	C	C	N/A	N/A
3	Buffer Capacity	D	D	D	N/A	N/A
4	Water Source	D	B	B-	1. Lateral branch channel required active maintenance to remove sediment that was blocking flow. The spreader pond maintains elevated water stage and supplies flow to distributary channels that hydrate the width of the complex. Beavers are actively maintaining the dam and increasing stage.	1. Observations (4a), Boreas Creek discharge monitoring (4b)
5	Water Distribution	D-	B	B	1. Extent and depth of ponds is restored. Beavers present, actively maintaining dams and distributary channels, building new dams, expanding distribution. 2. Hydrographs show wetland hydrology in most of the historic wetland area.	1. Observations (5a), Spreader pond survey (5b) 2. Water table monitoring (5c)
6	Water Outflow	D	B	B	1. Outflow is distributed in branched channels and as groundwater. Reset pond is functioning though it is currently unoccupied by beavers.	1. Observations (6a)
7	Geo-morphology	D	B	B	1-2. Beaver dams are functioning and maintained by beavers (Phase 1-2). New dams and ponds on Boreas Creek channel (Phase 3). 3. Hydric soil present before treatment, supporting hydrology present. 4. Negligible erosion on Boreas Creek channel, some deposition. 5. Net deposition of sediment, but depth and extent increased as dam raised.	1. Observations (7a) 2. Observations (7a) 3. Observations (7a), 4. Channel surveys (7b) 5. Sprd. pond surveys (7c)
8	Chemical Environment	D	B	B	1. Redox monitoring at 12" depth shows positive indication of anaerobic soil at 12 of the 14 sites indicating successful restoration of soil redox characteristics over most of the site. 2. No significant changes to water chemistry parameters were observed.	1. Observations (8a), redox monitoring (8b) 2. Observations (8a), Water chemistry monitoring (8c)
9	Vegetation Structure and Complexity	C	B	B	1. Most plots still had remnant wetland vegetation prior to project, and vegetation conditions improved at all sites. 2. Weed cover appears to be decreasing, aggressive weed management efforts in place.	1. Observations (9a), Quant. veg. monitoring (9b) 2. Observations (9a)

The Beaver Restoration Guidebook

Working with Beaver to Restore Streams, Wetlands, and Floodplains

Version 2.0, June 30, 2017

Photo credit: North American Beaver Foundation (northamericanbeaver.org)

Prepared by

US Fish and Wildlife Service — Janine Castro
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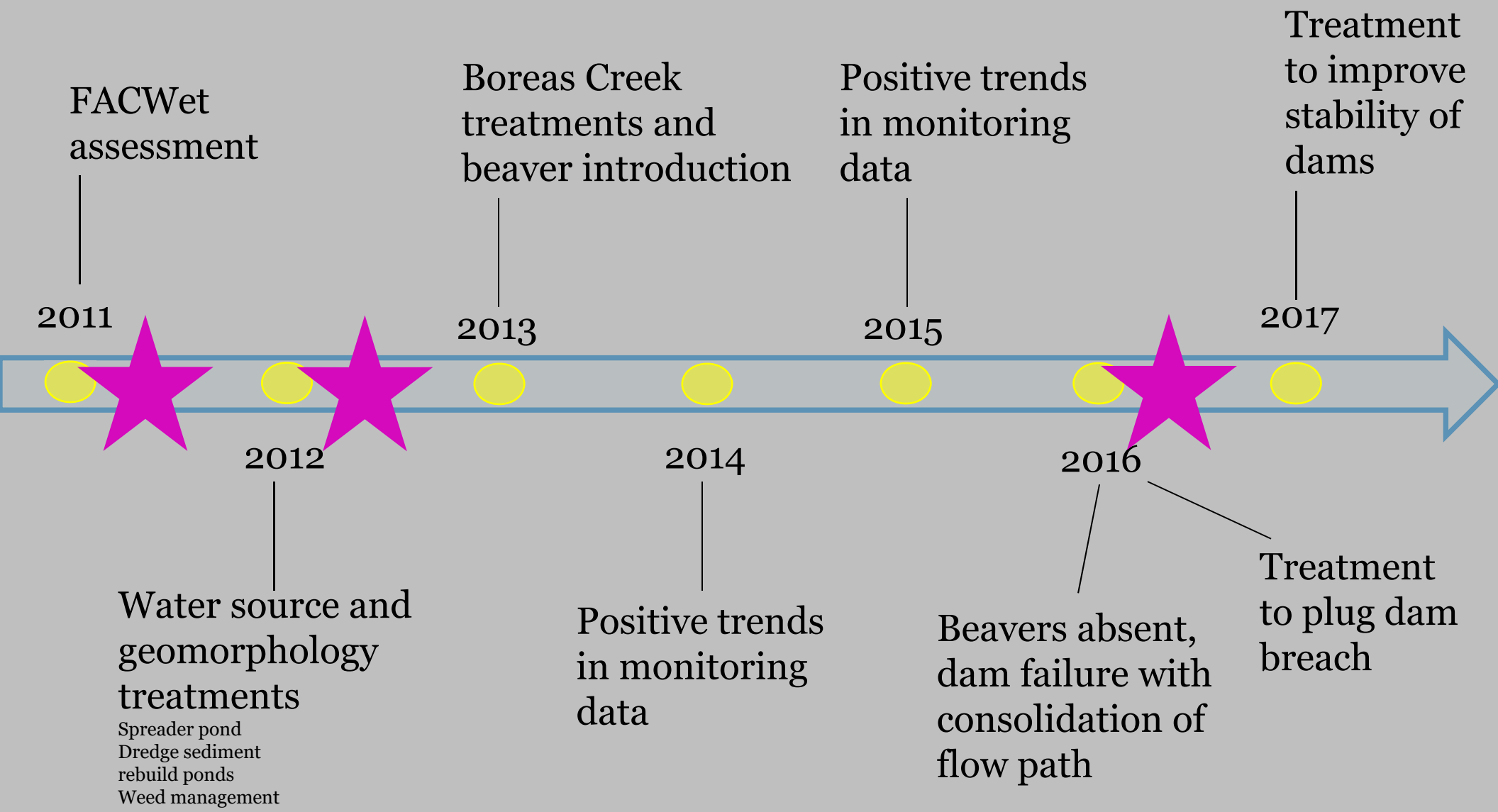
US Forest Service — Kent Woodruff

Funded by

North Pacific Landscape Conservation Cooperative

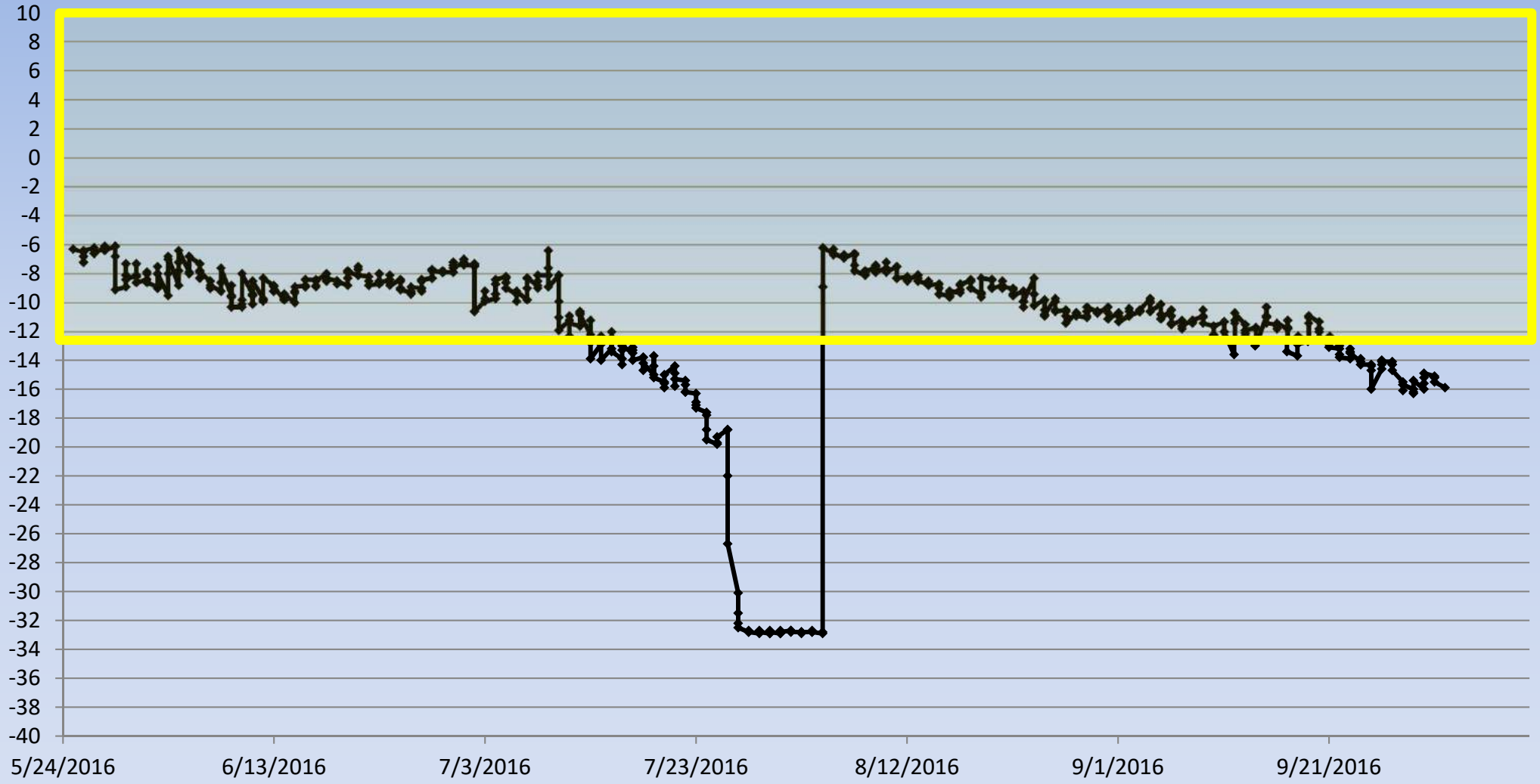
Timeline of activity in upper CGP 2011-2017




culvert outlet
spreader pond
secondary dam breach
main dam breach


May 2012
July 2013
July 2015

CGP-A 2016 Hydrograph

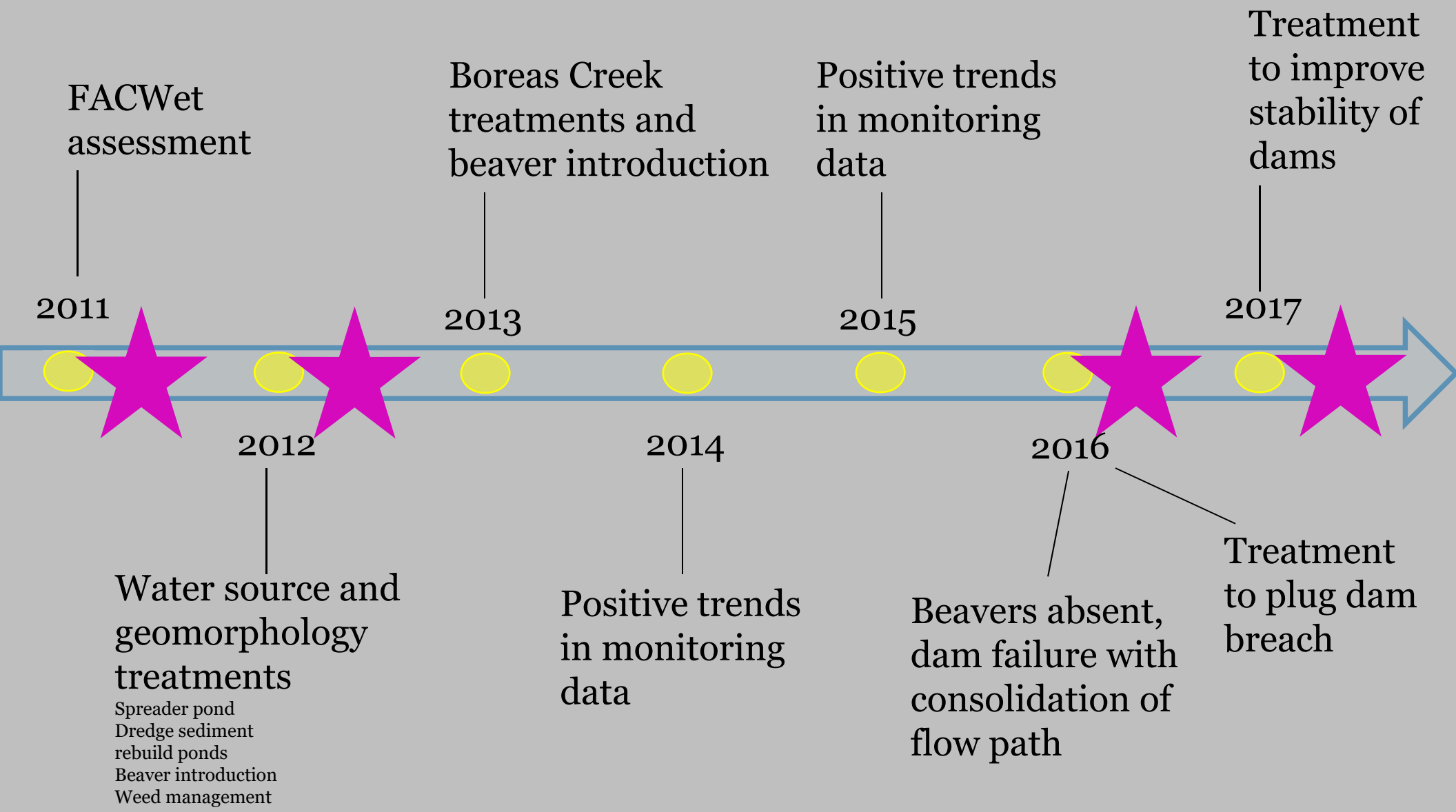


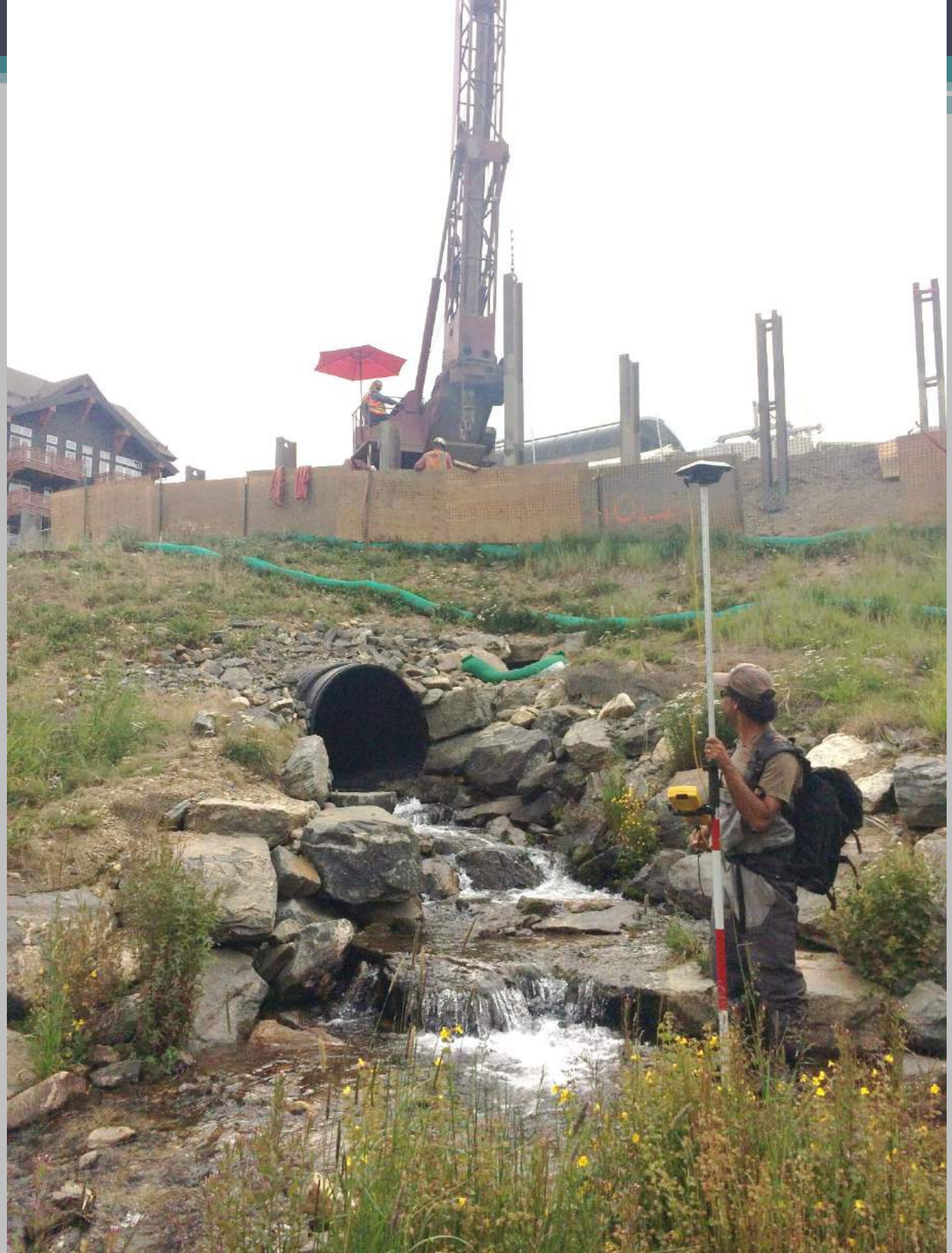
Status of Well A for 2012 -2016. THD is total hydraulic days, and CHD is consecutive hydraulic days when the static water table less than 12 inches deep. A minimum of 14 CHD is required to classify as wetland hydrology.

Site	2012 THD	2012 CHD	2012 Wetland hydrology	2013 THD	2013 CHD	2013 Wetland hydrology	2014 THD	2014 CHD	2014 Wetland hydrology	2015 THD	2015 CHD	2015 Wetland hydrology	2016 THD	2016 CHD	2016 Wetland hydrology
A	0	0	Neg	99	98	Pos	106	105	Pos	130	130	Pos	92	92	Positive

Coir logs were used on the downstream side of dams to increase dam strength and to create roughness at the outflow locations. The coir logs are held in place with wooden spikes. The picture on the lower left is of the main dam breach. The upper and right photos show preventive measures taken on ponds below the spreader.

Timeline of activity in upper CGP 2011-2017

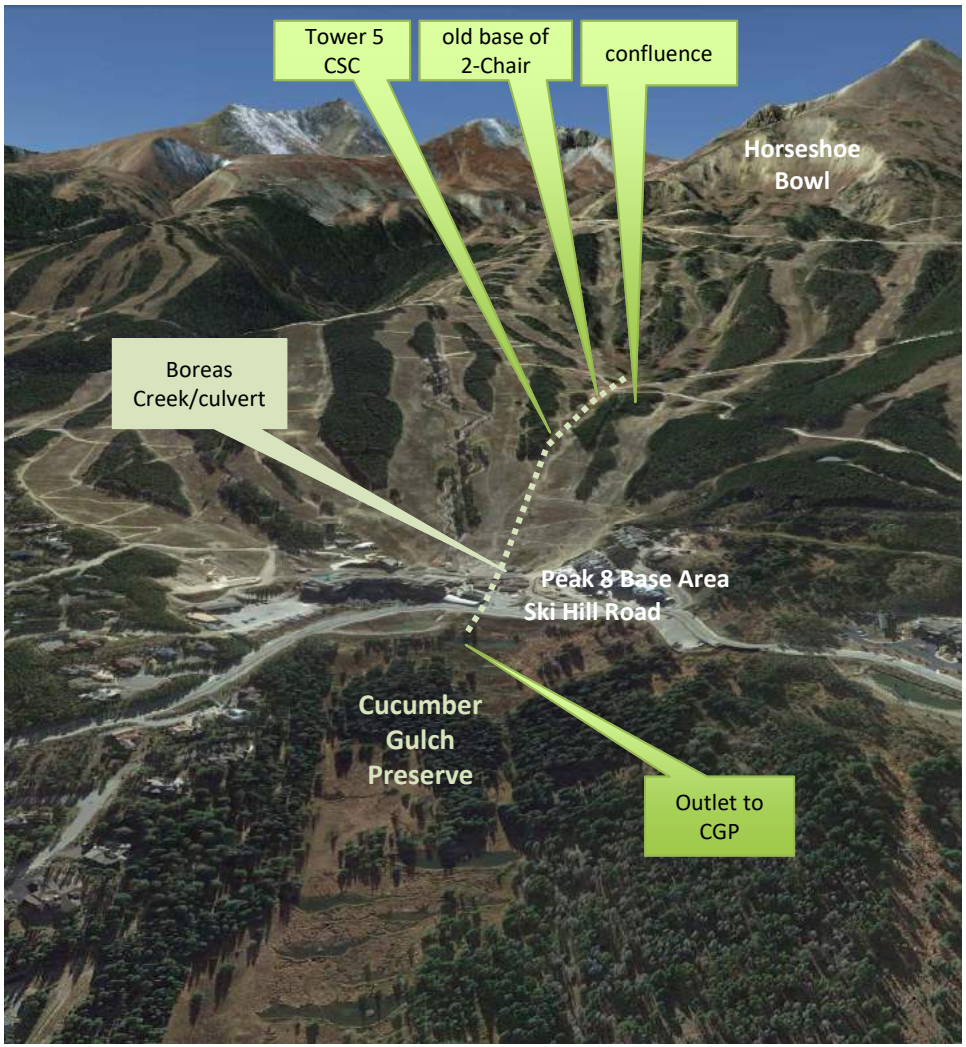




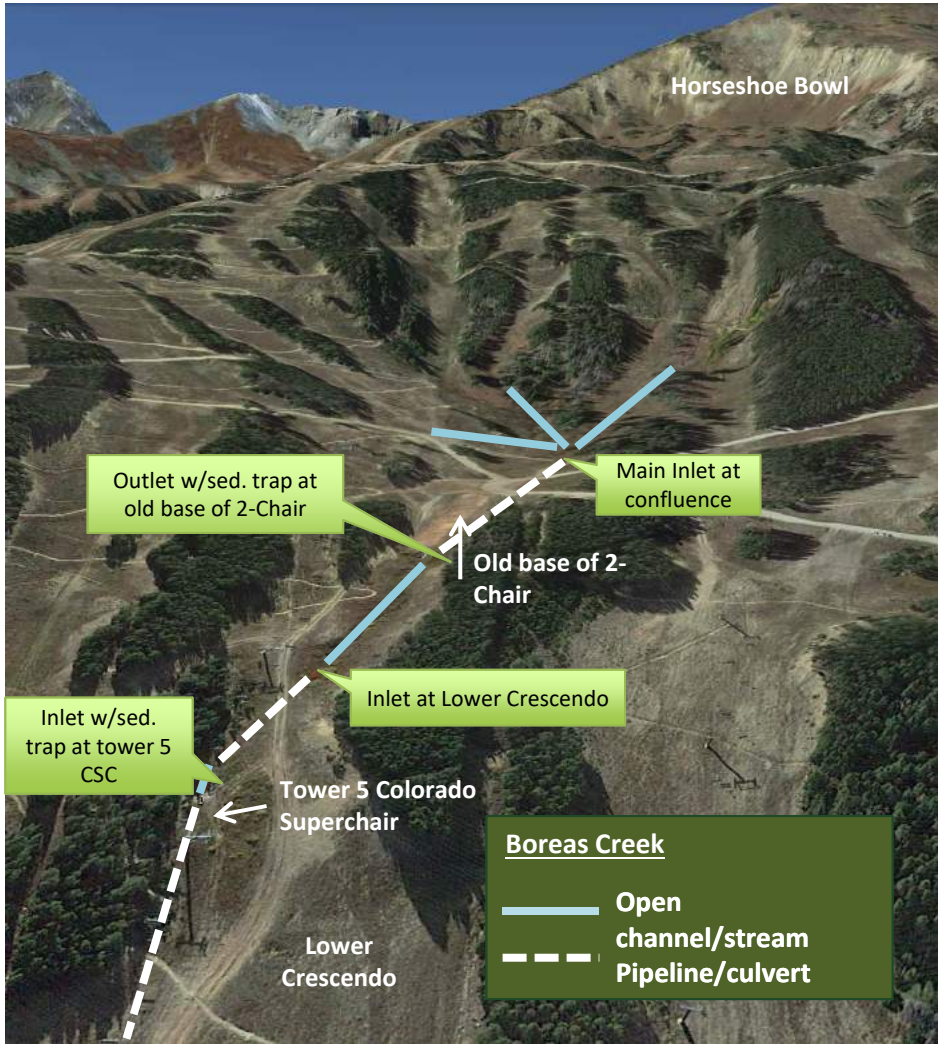
Overview of Boreas Creek and drainage that feeds Cucumber Gulch Preserve

The mean annual volume of sediment accumulation in Upper Cucumber Gulch is about 22 CY /year with a range of about 10-30 CY/year). The sediment sources are within the contributing watershed (the central portion of Peak 8 on the Breckenridge Ski Area), and sediment is transported to Cucumber Gulch via the Boreas Creek channel and pipeline system. Sediment is currently managed by capturing it in a beaver pond within Cucumber Gulch Preserve. Capturing sediment on Boreas Creek upstream of the Preserve would greatly lessen the amount of disturbance and risk to the Preserve, minimize the maintenance burden, and provide a more efficient means of managing sediment. This study revealed three feasible opportunities to construct sediment traps along Boreas Creek to meet this need.

Cucumber Gulch Preserve and its watershed on Peak 8 of the Breckenridge Ski Area. Most of the sediment entering the Preserve originates upstream of the main inlets to the Boreas Creek channel and pipeline.



Main structures along the upper portion of Boreas Creek and pipeline



email: markecometrics@gmail.com

NOTES :

DRAWING: Overview of Boreas Creek and drainage that feeds CGP

PROJECT: Opportunities to trap sediment on Boreas Creek above CGP

LOCATION: Breckenridge Ski Area, Peak 8

DATE: September 8, 2017

SHEET: 1 of 3

Structures and sediment trap priorities on Boreas Creek and pipeline

email: markecometrics@gmail.com

NOTES :

DRAWING: Structures and sediment trap priorities

PROJECT: Opportunities to trap sediment on Boreas Creek above CGP

LOCATION: Breckenridge Ski Area, Peak 8

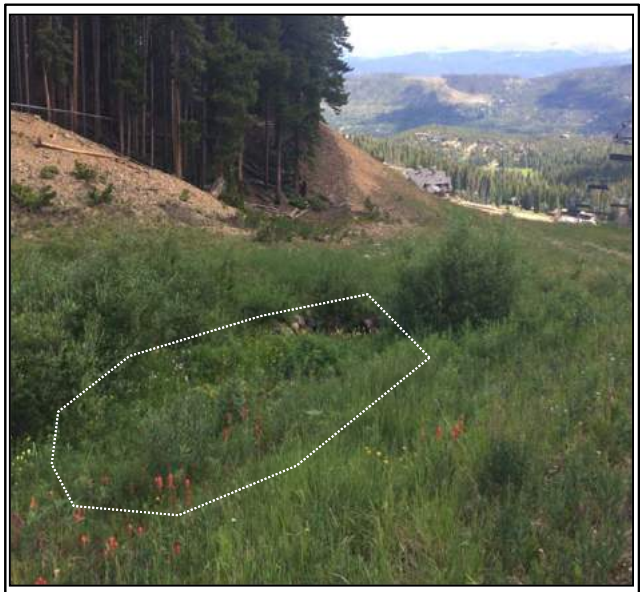
DATE: September 8, 2017

SHEET: 2 of 3

Plan for capturing sediment on Boreas Creek and pipeline: Priorities

1. Outlet at old base of 2-Chair

The existing trap has a storage capacity of about 1-2 CY of sediment and is currently full. If this basin was enlarged for an effective storage capacity of 10 CY, it could function as a sediment trap for most of a normal season as long as it was cleaned out annually. There is room to construct a larger basin at this site by making the existing basin longer, wider, and deeper. The site has good access for construction and cleaning from the service road and no major permitting issues.



2. Inlet at Lower Crescendo

There is currently no sediment trap or storage capacity at this site, but there is room to construct a 10-CY basin to capture sediment that passes through the traps upstream plus any additional sediment entering below them. The site has good access for construction and cleaning from the service road and no major permitting issues.

3. Inlet at tower 5 Colorado Superchair

The existing trap has a storage capacity of less than 1 CY of sediment and is currently full. Storage capacity is too low for it to function as an effective sediment trap. A 10-CY basin could be constructed at this site by making the existing basin longer and deeper. Without interfering with the ski run. There is good access for construction and cleaning and no major permitting issues.

Additional opportunities

Additional opportunities for capturing sediment on Boreas Creek may exist, especially at structures upstream of the old base of 2-Chair. These sites are lower priority due to more difficult access and potential wetland permitting issues.

email: markecometrics@gmail.com

NOTES :

DRAWING: Plan for capturing sediment on Boreas Creek and pipeline

PROJECT: Opportunities to trap sediment on Boreas Creek above CGP

LOCATION: Breckenridge Ski Area, Peak 8

DATE: September 8, 2017

SHEET: 3 of 3

There goes the neighborhood! Water quality challenges in a changing environment

Jessica Doran, EcoMetrics
Anne Murphy, Town of Breckenridge