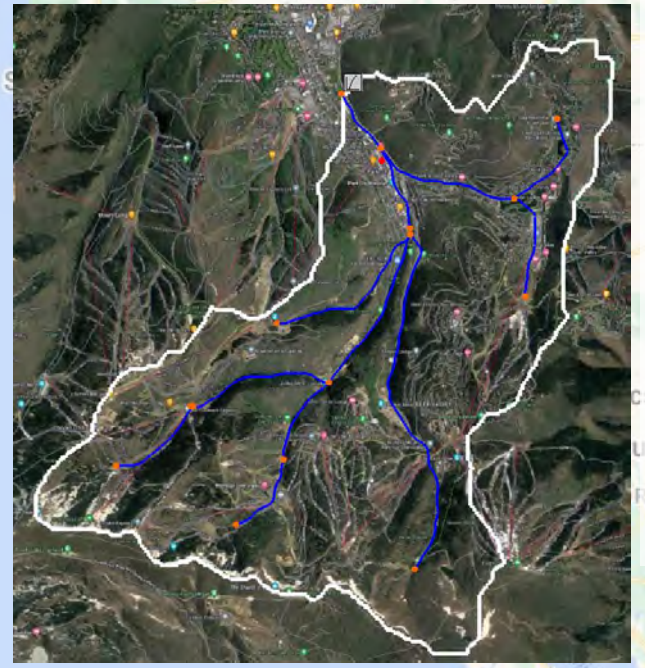
GSSHA MODELS:
TESTING & VISUALIZING SCENARIO OUTCOMES

Kaile Johnson & Ronnisha Davis
Aaron Byrd
Hydrologic Systems Branch
August 2nd, 2023

U.S. ARMY
US Army Corps of Engineers
CHL COASTAL & HYDRAULICS LABORATORY

STUDY AREAS

Park City Ski Slopes



- Located in Park City, Utah
- 7.3 mi^2
- Steep mountainous terrain
- Challenge: Erosion on ski slopes

8 Mile Creek

- A sub-watershed located in the upper part of Eau Galle River Basin in Wisconsin
- 0.95 mi^2
- Flat farmland terrain
- Challenge: Erosion and nutrient runoff

GSSHA

It stands for Gridded Surface-Subsurface Hydrologic Analysis Model.

GSSHA is a physics-based numerical modeling system that was created to allow engineers to simulate the hydrologic flow processes.

GSSHA is used to analyze and test watershed management scenarios to show the changes in flooding, erosion, and nutrient runoff.

Aim: Use GSSHA models to assess watershed management alternatives for their impacts on flow and sediment.

METHODOLOGY

Types of watershed management practices tested

U.S. ARMY

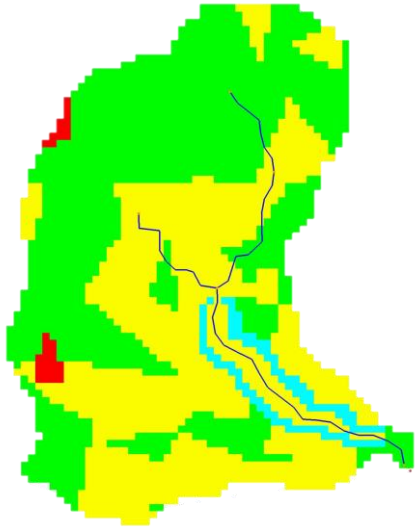
US Army Corps of Engineers

8 MILE CREEK:
WATERSHED MANAGEMENT PRACTICES

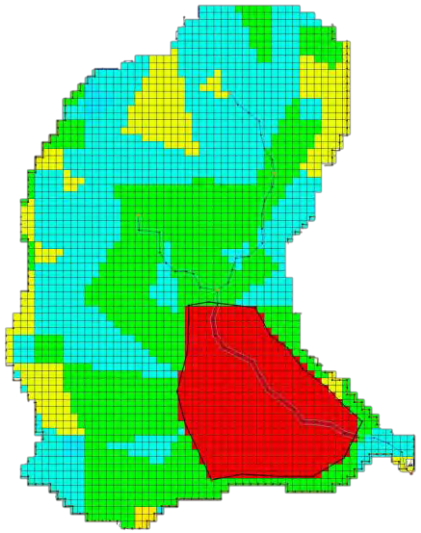
- Challenges: surface flooding, erosion, and nutrient runoff from agricultural areas
- Management Practices tested:
  - Changing crop types
  - Adding buffer strips
  - Adding infiltration basins
  - Adding wetlands

Example of a wetland

Example of a Buffer Strip

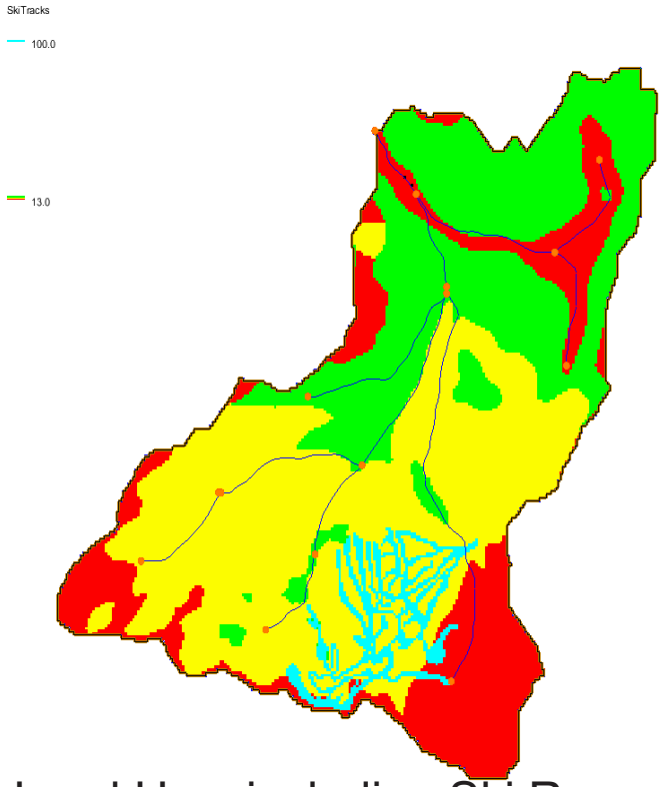


Example of an Infiltration Basin



PARK CITY SKI SLOPES:
WATERSHED MANAGEMENT PRACTICES

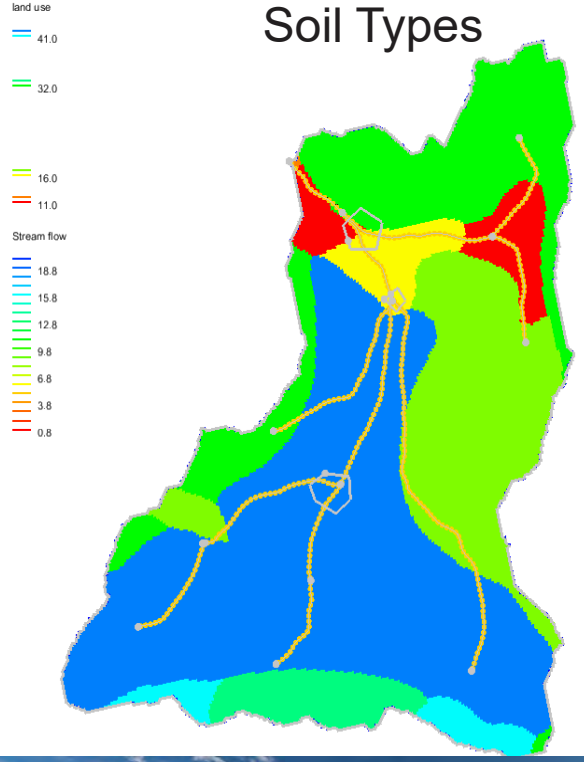
- Challenges: surface flooding, erosion



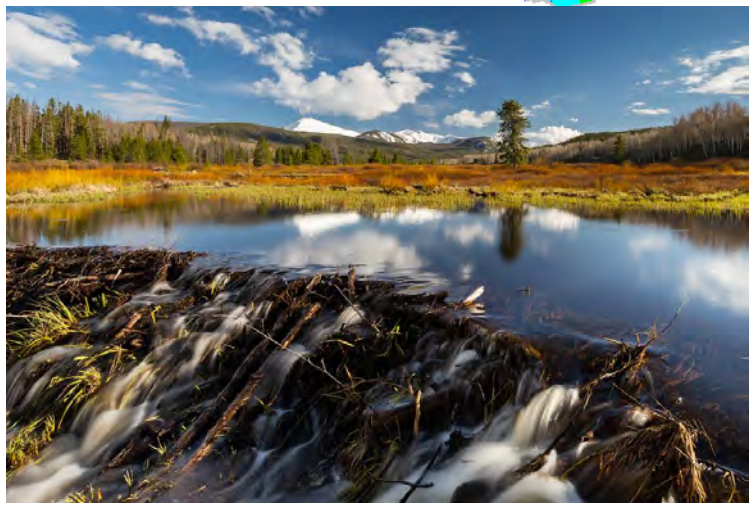
Land Use, including Ski Runs

- Management Practices tested:
  - Modifying land cover
  - Multiple size beaver dams, detention basins
  - Adding wetlands

A wetland in Utah



Soil Types

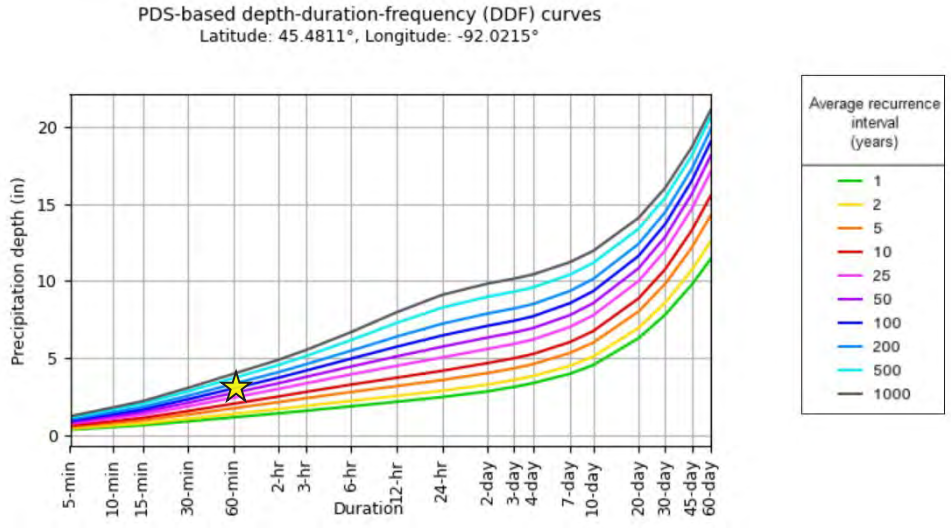


A beaver dam in Utah

PRECIPITATION

8 Mile Creek

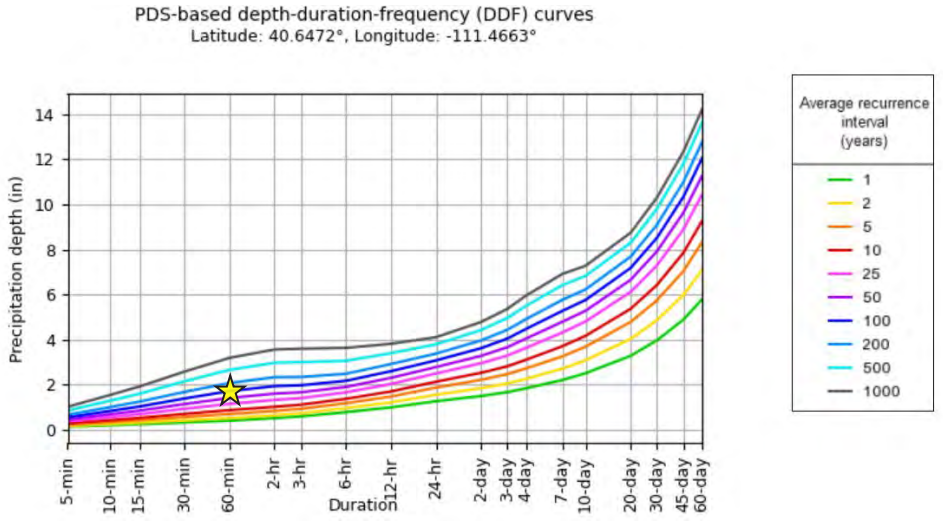
100-year Average Recurrence Interval (1% Annual Probability)
60-minute Storm
Uniform Duration



3.04 in (77 mm) Total Depth of Rainfall

Park City

100-year Average Recurrence Interval (1% Annual Probability)
60-minute Storm
Uniform Duration



1.71 in (43 mm) Total Depth of Rainfall

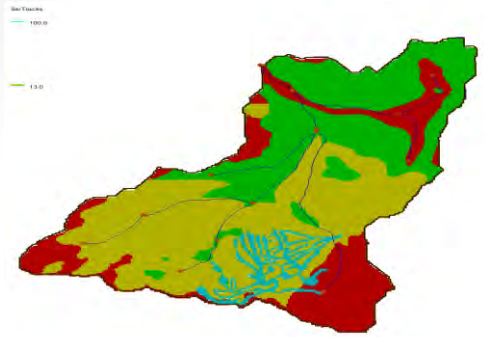
SENSITIVITY ANALYSES

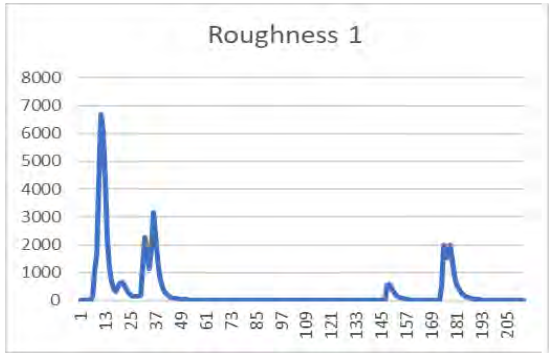
U.S. ARMY

US Army Corps of Engineers®

PARK CITY SKI SLOPES ROUGHNESS SENSITIVITY TEST (LAND USE ROUGHNESS VALUES)

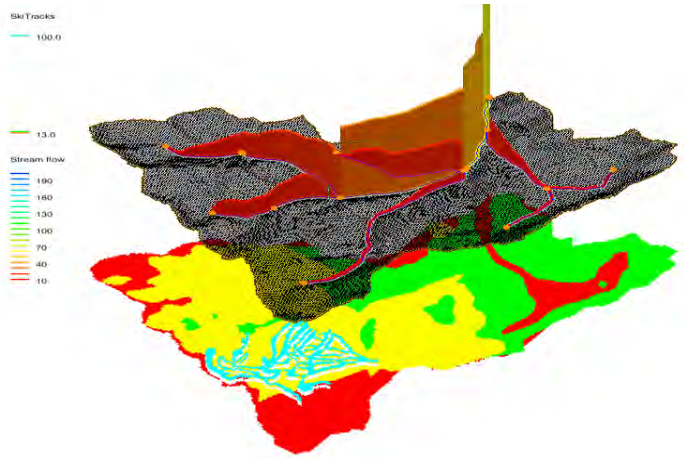
- Original Run

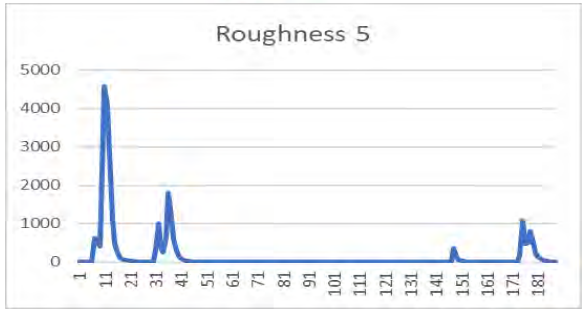




Initial values of the model run through GSSHA

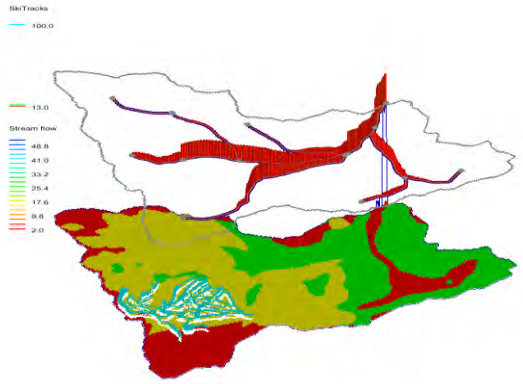
RoughnessRun_5

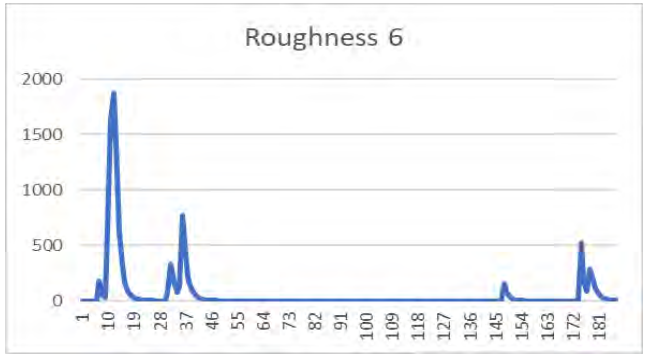




Decreased the values 2000-300 cms

RoughnessRun_6

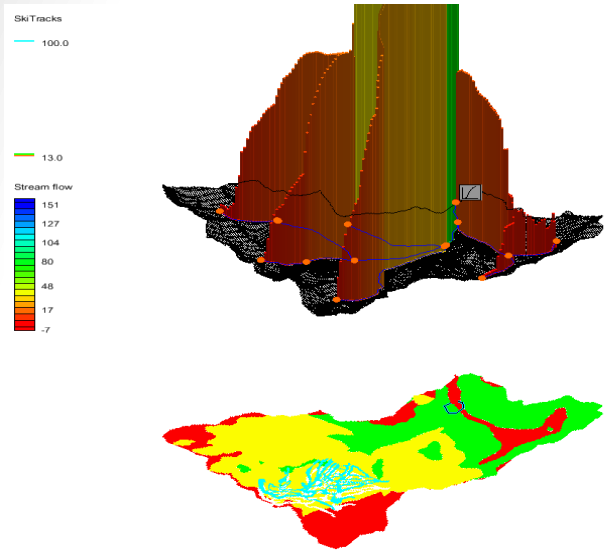




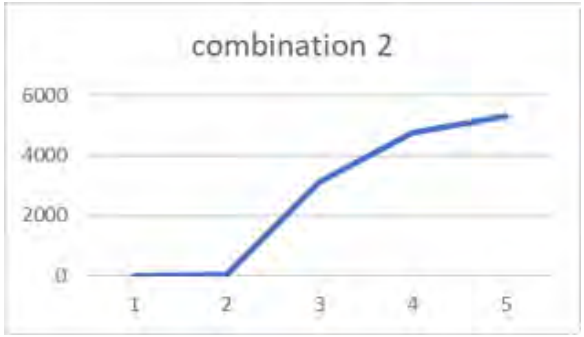
Decreased the values another 2000-3000 cms

PARK CITY SKI SLOPES SENSITIVITY RESULTS CONT.

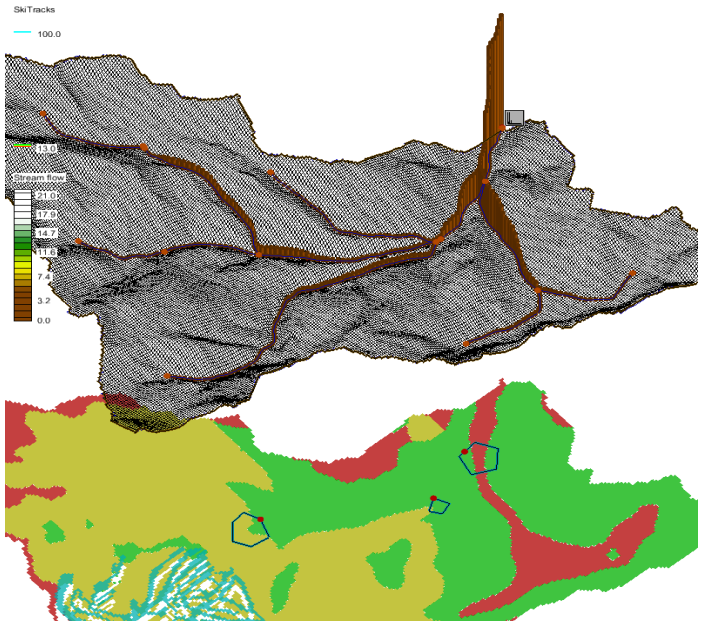
ComboRun_1



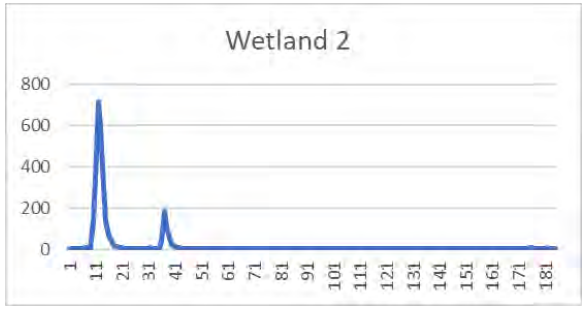
Based off Surface Roughness run 6, kept the same roughness values but increased the infiltration values.



WetlandRun_2



Based off Combo Run 1, increased the roughness values and added 3 wetlands

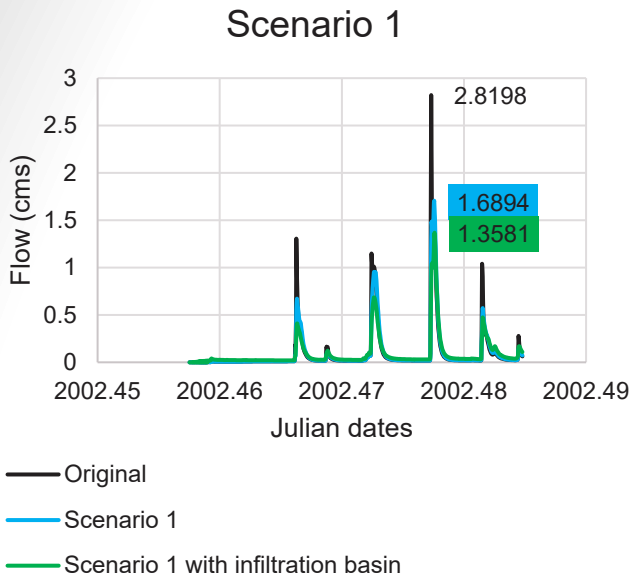


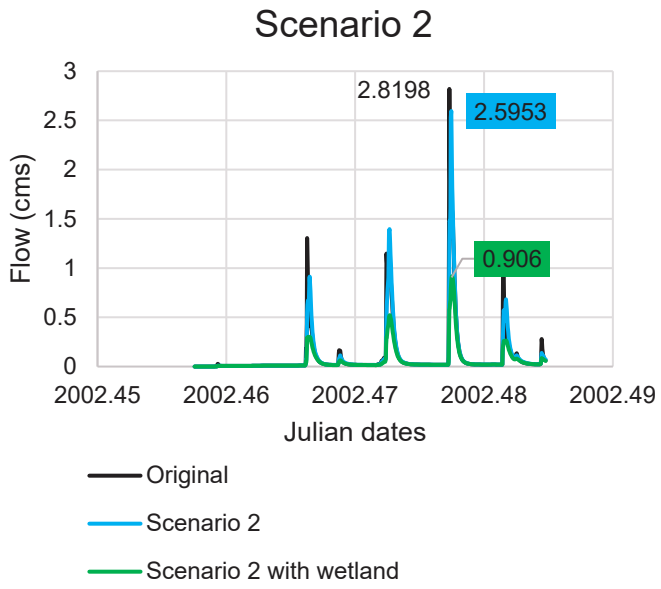
RESULTS AND CONCLUSIONS

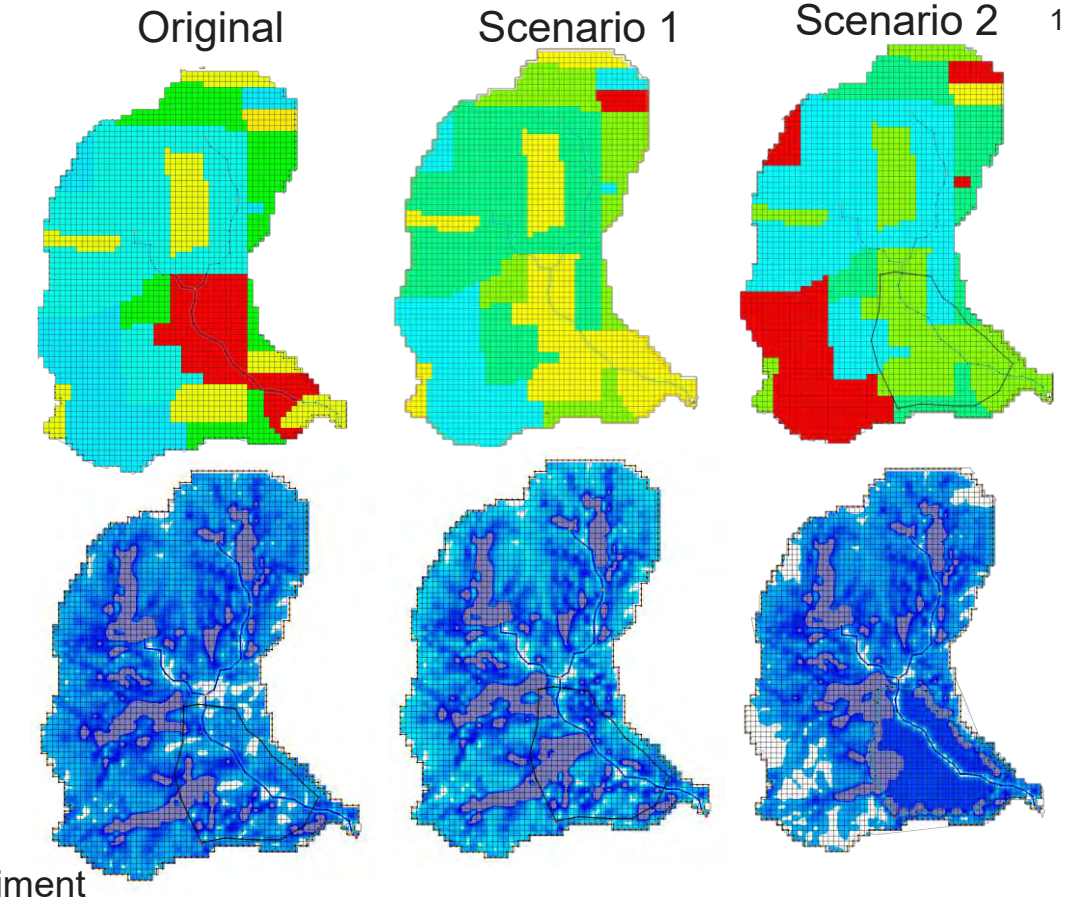
U.S. ARMY

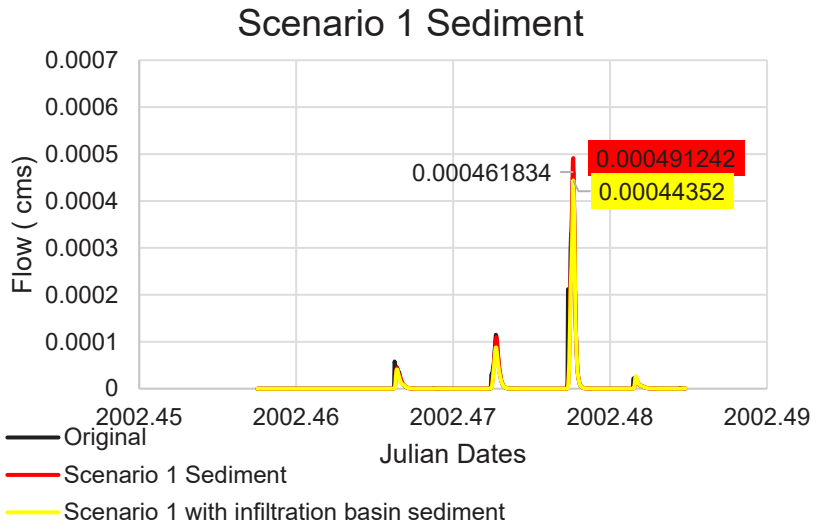
US Army Corps of Engineers

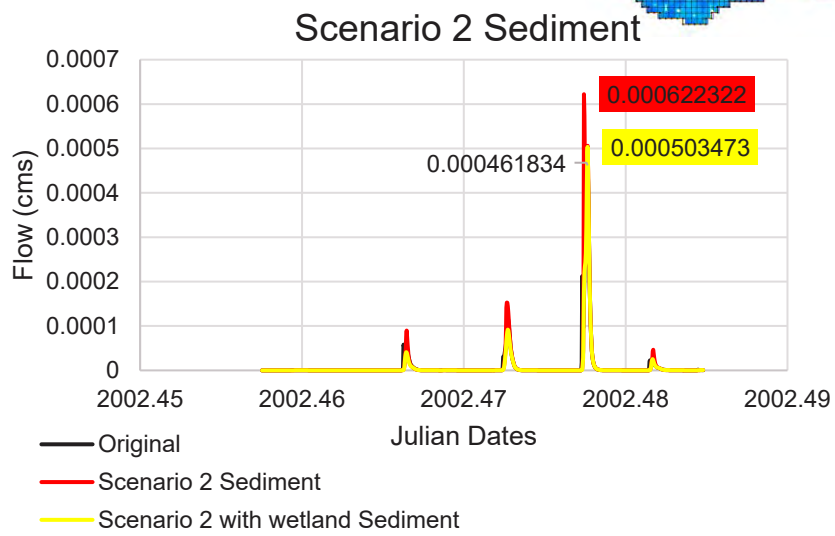
8 MILE CREEK: RESULTS











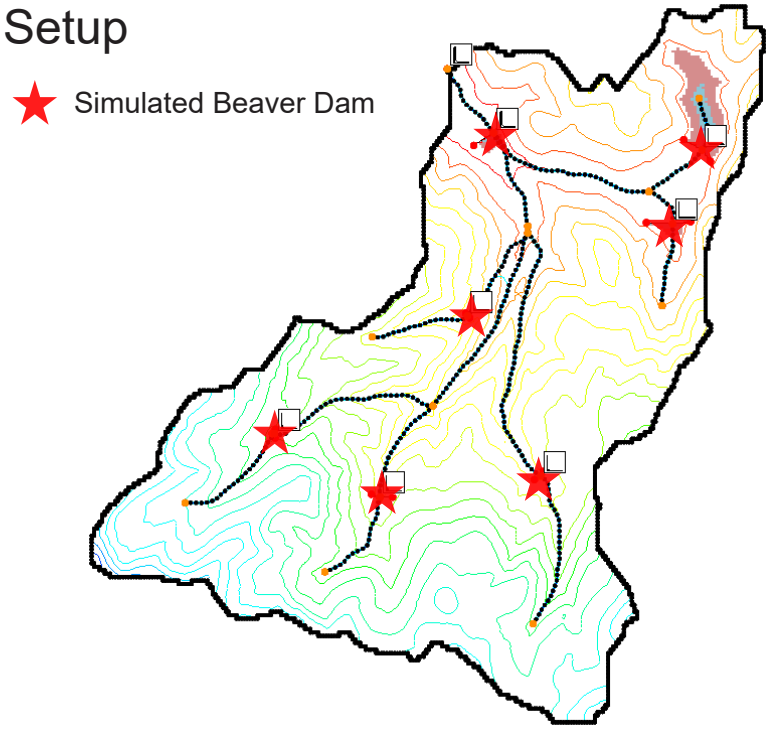
The colorful models show the change in land cover and crop types. The models below them show the flood map depths after running the scenario models (0.01m-0.1m).

COURSE OF ACTION: ADD BEAVER DAMS

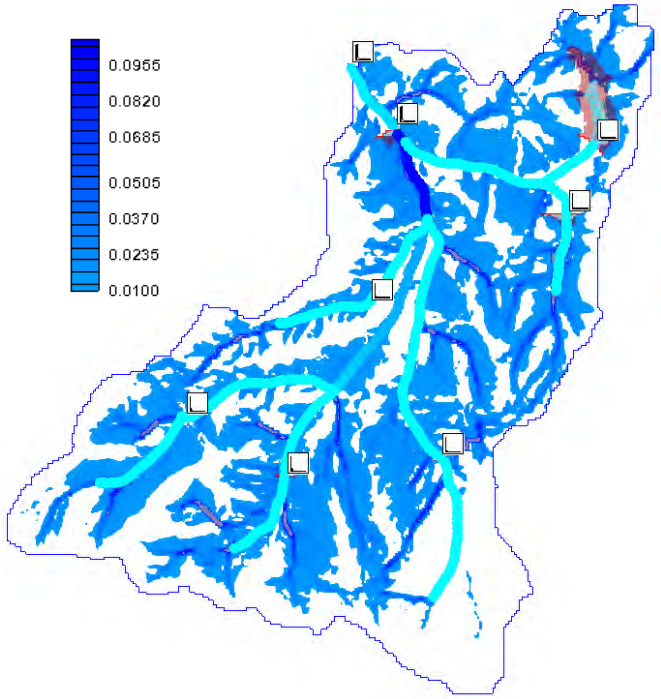
Aim: Simulate adding multiple small detention basins to trap water as though there are multiple beaver dams in the watershed. This area historically had an abundance of beavers.

To simulate a beaver dam a small detention basin with a broad-crested weir of 1m was used. The outlet was 1-2 meters above the thalweg.

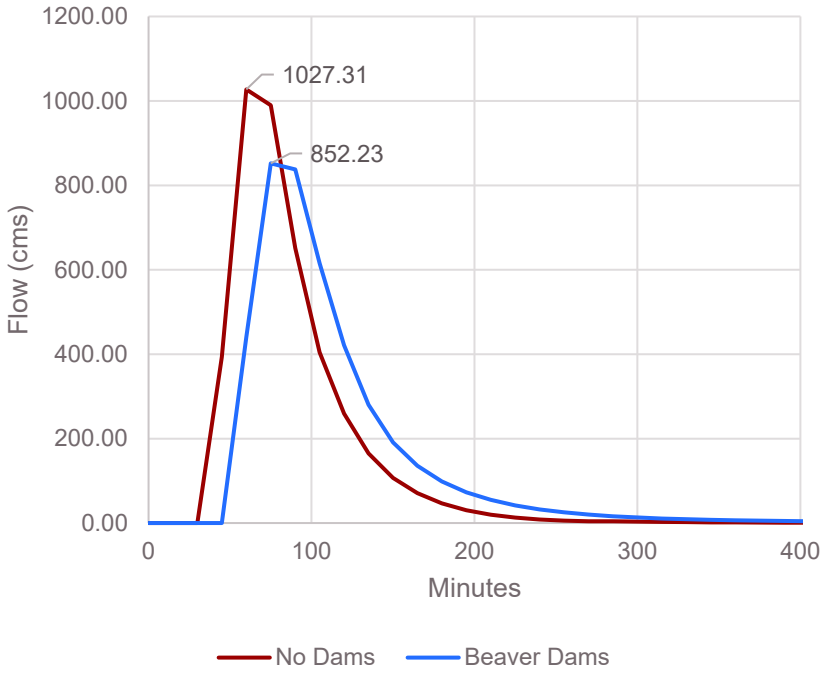
Setup



Flooding from 100-year storm



Outlet Flow with and without Beaver Dams

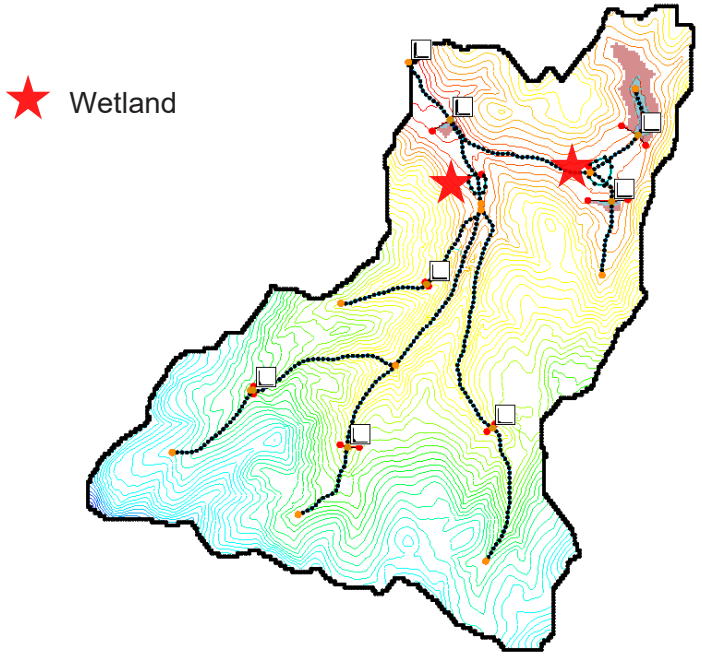


COURSE OF ACTION: ADD BEAVER DAMS AND WETLANDS

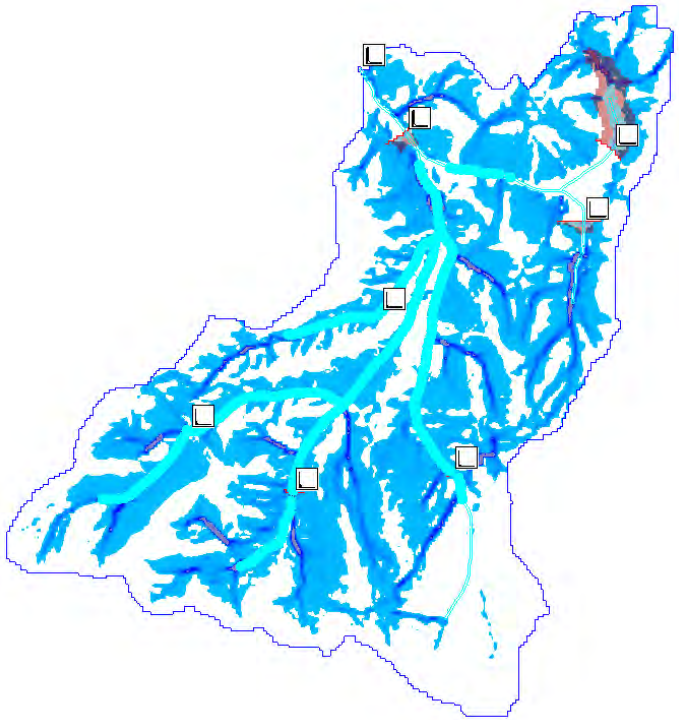
Aim: Add wetlands in relatively flat locations and see if there are additional changes to flows

Wetlands about with 1m of vegetation were simulated. They only impacted the area around streams and not the streams directly.

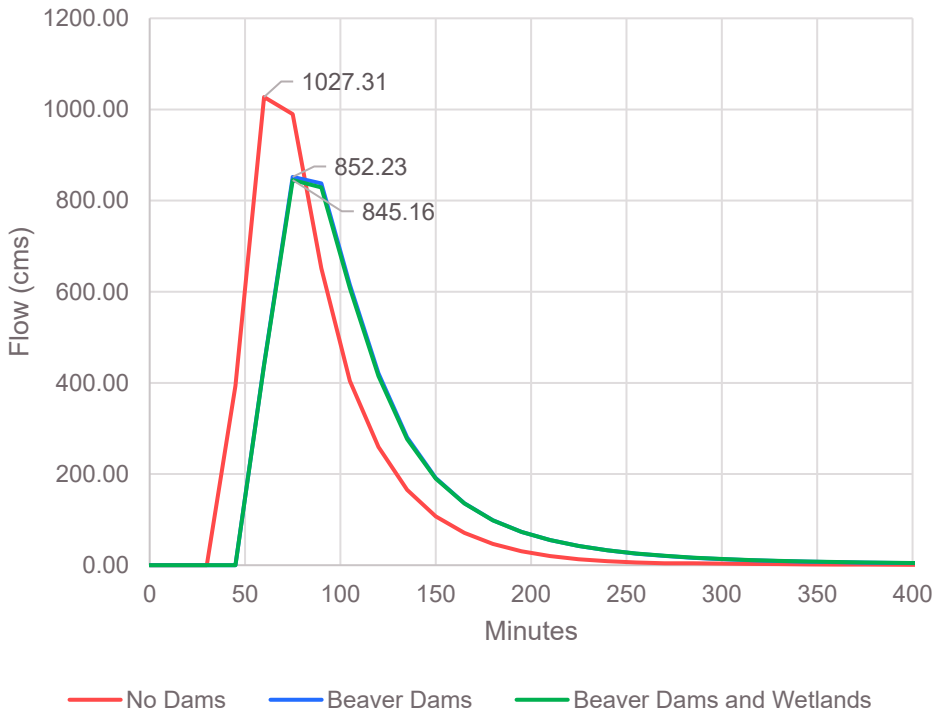
Setup



Flooding from 100-year storm



Outlet Flow with and without Beaver Dams and Wetlands



CONCLUSIONS

8 Mile Creek

- Making land use changes and adding wetlands had the most positive effect on the overland flow depths.
- Adding infiltration basins did not work as well as wetlands due to the lack of vegetation at the location. It was covered mostly with hay.
- Buffer strips work well for reducing flooding around the channel because of the interception from plants.
- The next steps would be to test adding forest to various locations in the watershed.

Park City Ski Slopes

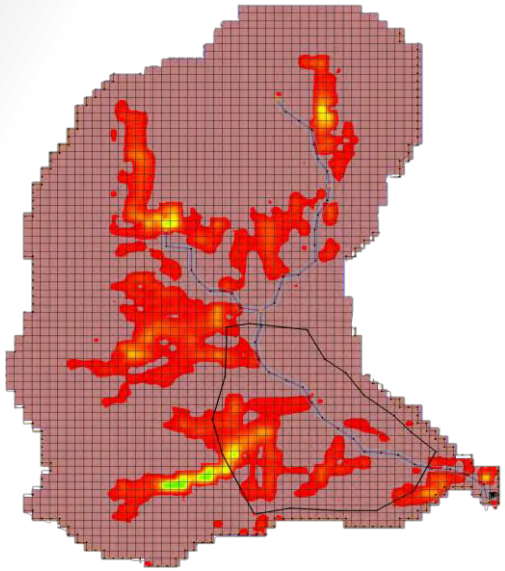
- The model was very sensitive to surface roughness values. Changing land cover or adding different vegetation to the ski slopes would likely make a big change.
- The beaver dams did make a big change. They are historically present in the watershed.
- Wetland can make a difference, but the channels in the wetlands will need to be modified as well.
- Changing the channels and/or adding more wetlands to the watershed would be the next step to decreasing the values of the hydrograph.

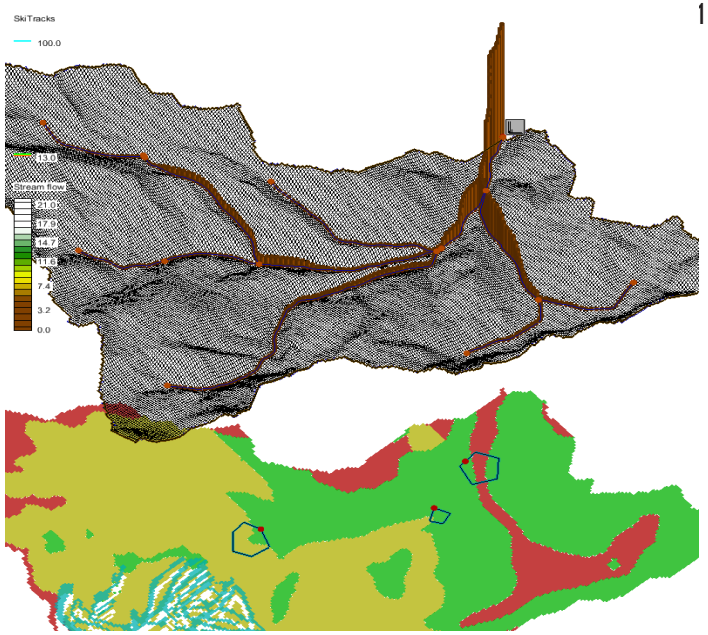
ACKNOWLEDGEMENT'S

Aaron Byrd: for guiding, helping, and encouraging us to think outside the box.

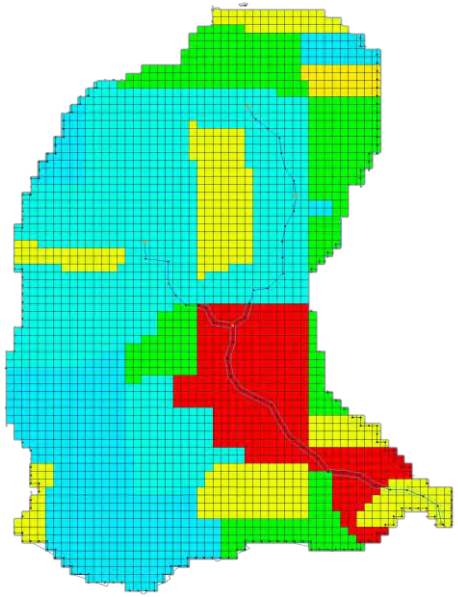
Pearce Cheng: for motivating us to keep up the good work and checking to make sure that we were having a productive day.

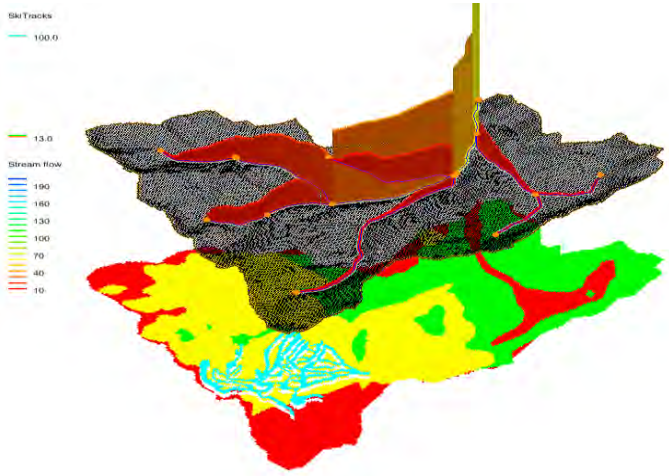
Nawa Pradhan: for sharing ideas and helping us solve problems when the model just was not cooperating.





QUESTIONS ?





CHL COASTAL & HYDRAULICS LABORATORY