

Rio de Flag Drainage Study

BY: ARTEMIS DESIGNS

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CENE 486 CAPSTONE PRESENTATION

Presenters:

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Figure 1: Channel Station 78+87, downstream near
Foxglenn Park (photo taken by Jenna McCaffrey)

Project Introduction

- ❖ **Project focus:** analyze the channel conditions for section of Rio de Flag flowing from Herold Ranch Road to Foxglenn Park and identify the major improvement areas
- ❖ **Current Conditions:**
 - ❖ Area suffers from poor stream conveyance
 - ❖ Standing water pools in areas of heavy public use
 - ❖ Increased insect load
 - ❖ Excessive erosion and reduced flow available to downstream portions of the reach



Figure 2: Location of Channel in Flagstaff Area [1]

Hydrologic Data

- ❖ Discharge Rates
 - ❖ FEMA FIS
 - ❖ City of Flagstaff
- ❖ Determined flowrates for 10-yr storm (Table 1)
- ❖ WSS Soil Analysis
 - ❖ 13—Lynx loam, 0 to 2 percent slopes
 - ❖ *Mean annual precipitation: 18 to 24 in.*
 - ❖ *Drainage class: Well drained*
 - ❖ *Runoff class: Low*

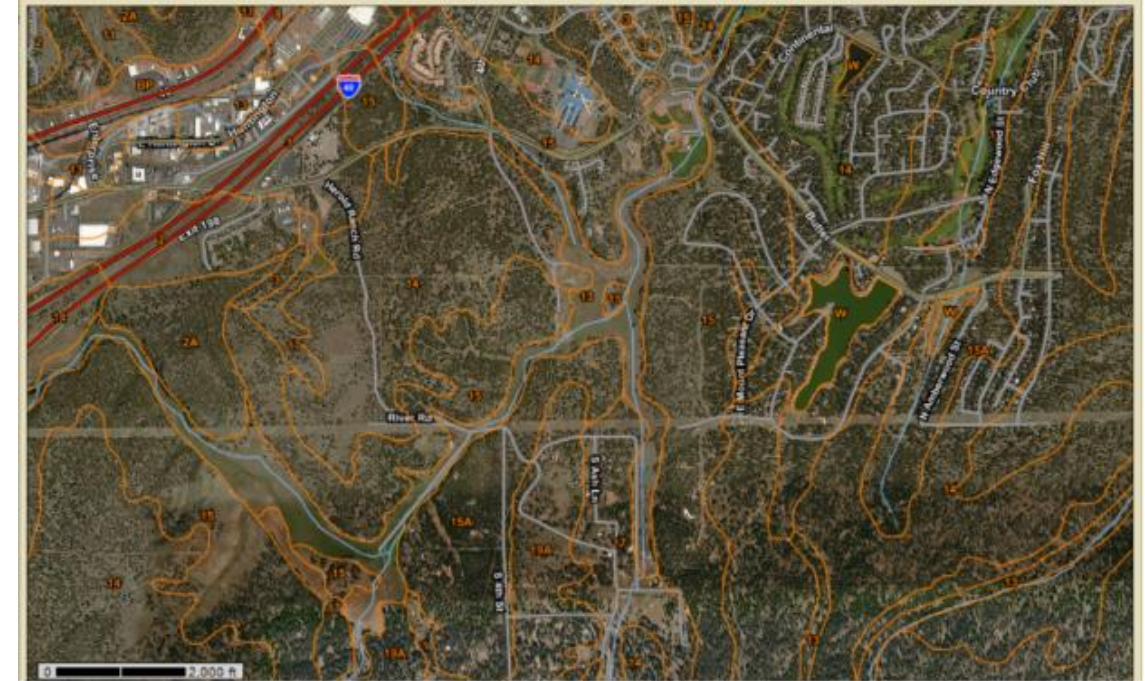


Figure 3: WSS Soil Map-Lynx Loam [2]

Location	Drainage Area (sq. miles)	Peak Discharge (cfs)
RIO DE FLAG-at confluence of Switzer Canyon Wash	98.9	1050
SWITZER CANYON WASH-at confluence with Rio de Flag	11	280

Table 1: FIS 10 Percent Discharge

Site Investigation

- ❖ Completed Site Investigation
 - ❖ Field Visit Safety Checklist
 - ❖ FAST Form
- ❖ Photo Log

Figure 4: Rio de Flag channel station 71+84, looking west. Silting is present. Photo taken by Emily Frazer.



Figure 5: Rio de Flag channel station 60+13, upstream (south). This section shows garbage pollution within the reach. Photo taken by Jenna McCaffrey.



Figure 6: Rio de Flag channel station 23+42, looking west. This section shows retention. Photo taken by Destiny Gourley.

Improvement Areas

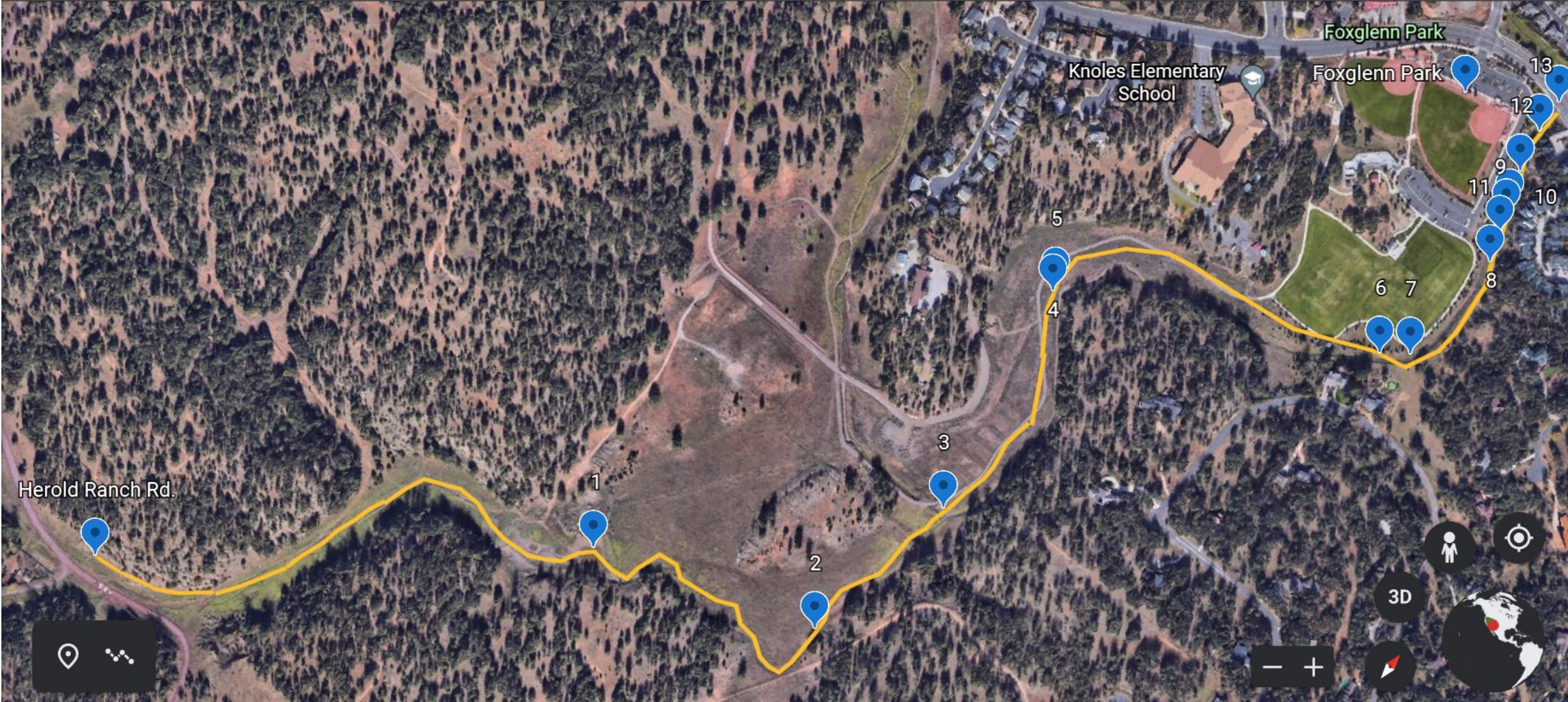


Figure 7: Improvement Areas via Google Earth

9 Selected Sites

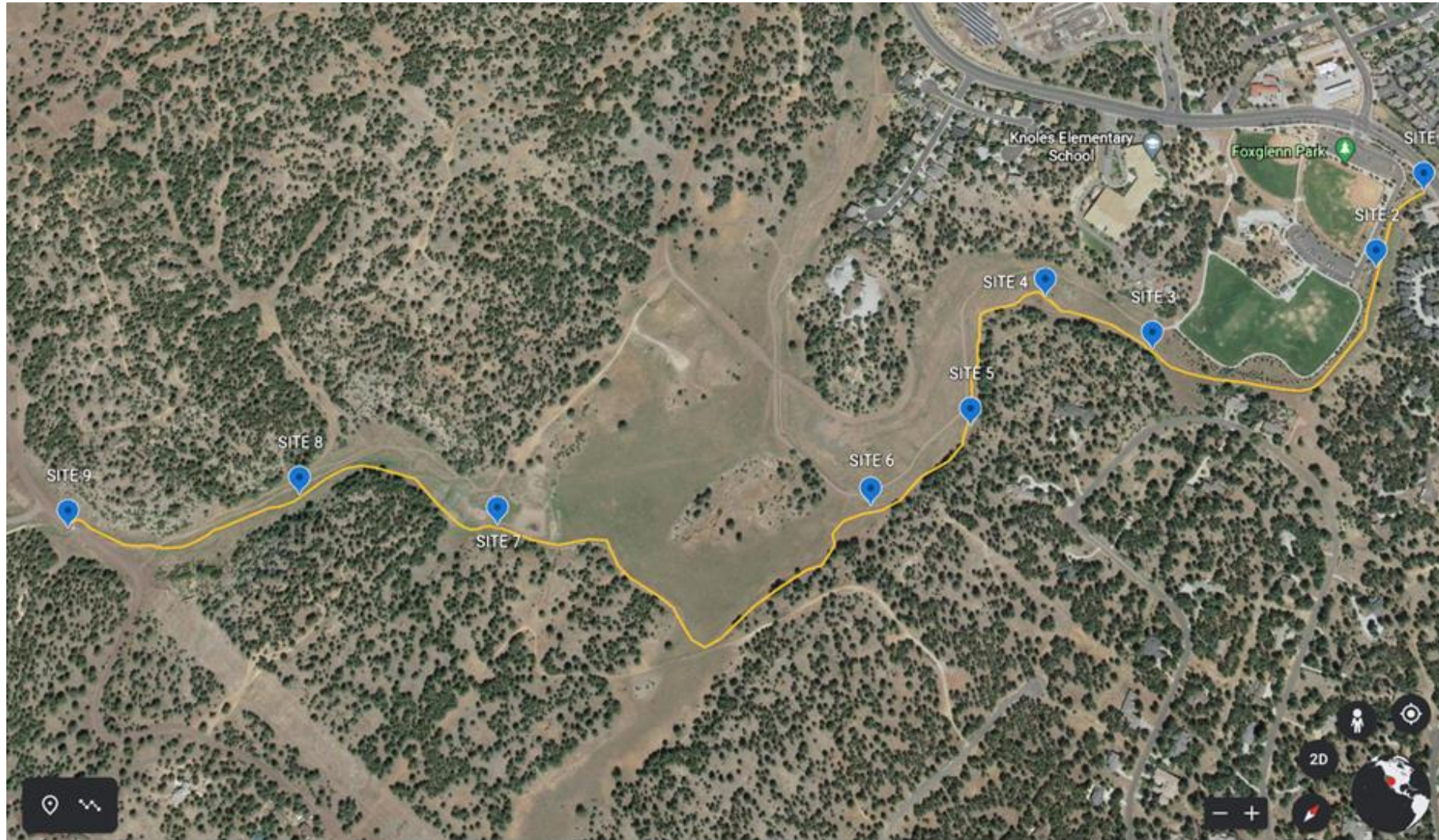


Figure 8: Map of 9 Surveying Sites via Google Earth

SITE 1



Figure 9: Site 1 looking upstream. Photo taken by Destiny Gourley.

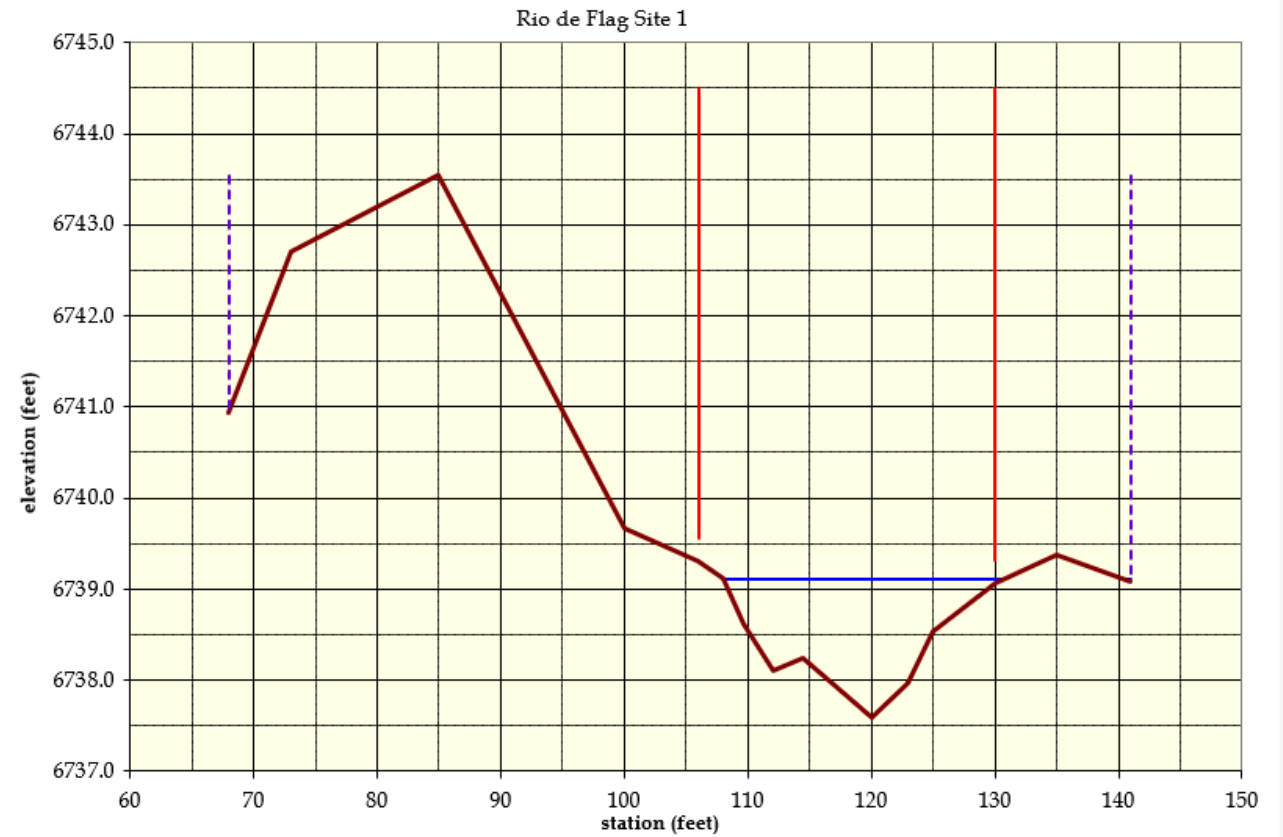


Figure 10: NRCS Results Site 1 [3]

SITE 2



Figure 11: Influent culvert at site 2. Photo taken by Dan Segal.

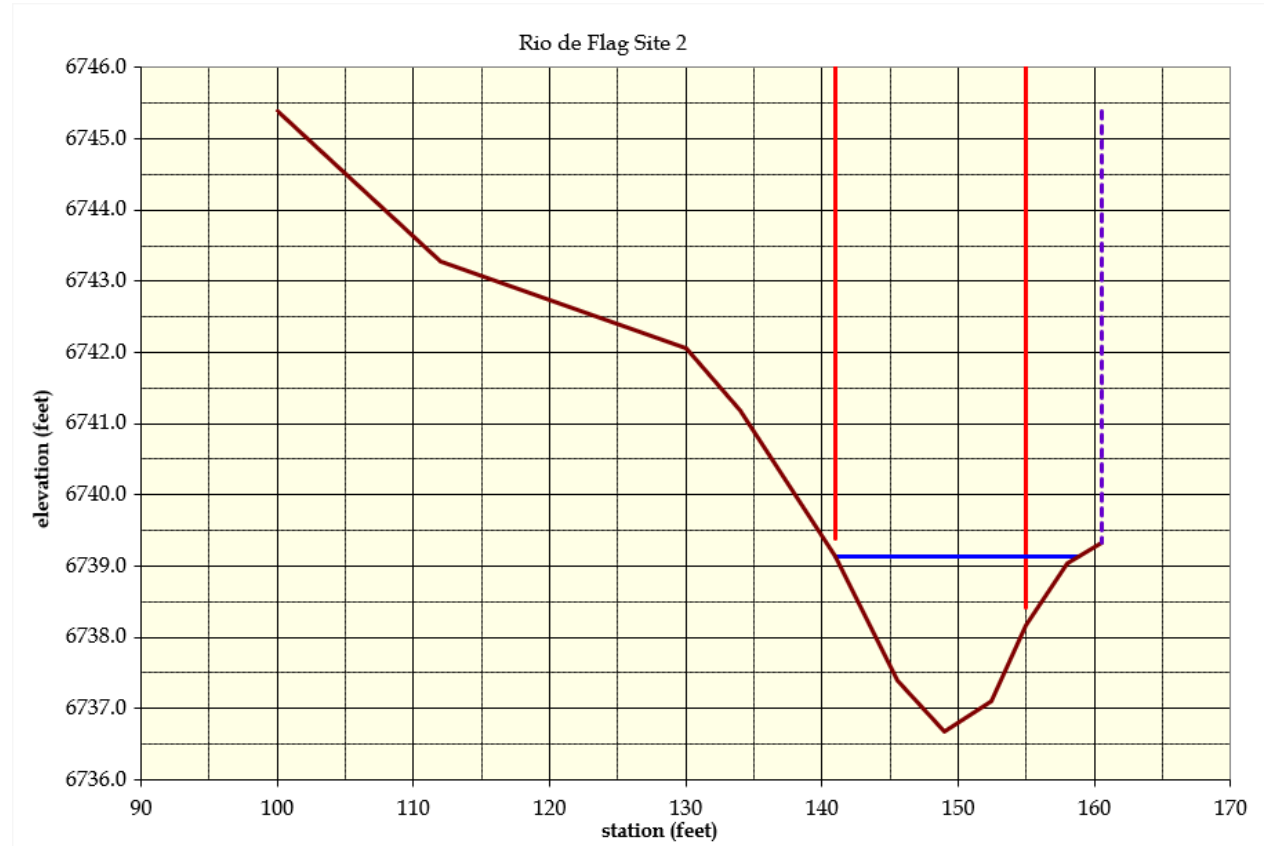


Figure 12: NRCS Results Site 8

SITE 3



Figure 13: Site 3 looking upstream. Photo taken by Destiny Gourley.

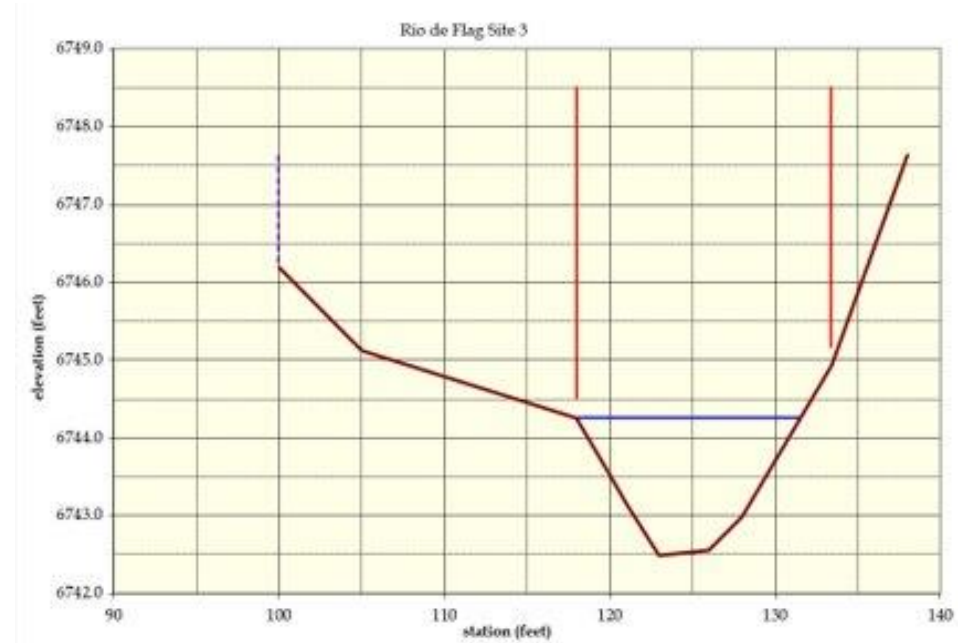


Figure 14: NRCS Results Site 3

SITE 4



Figure 15: Site 4 looking downstream.
Photo taken by Destiny Gourley.

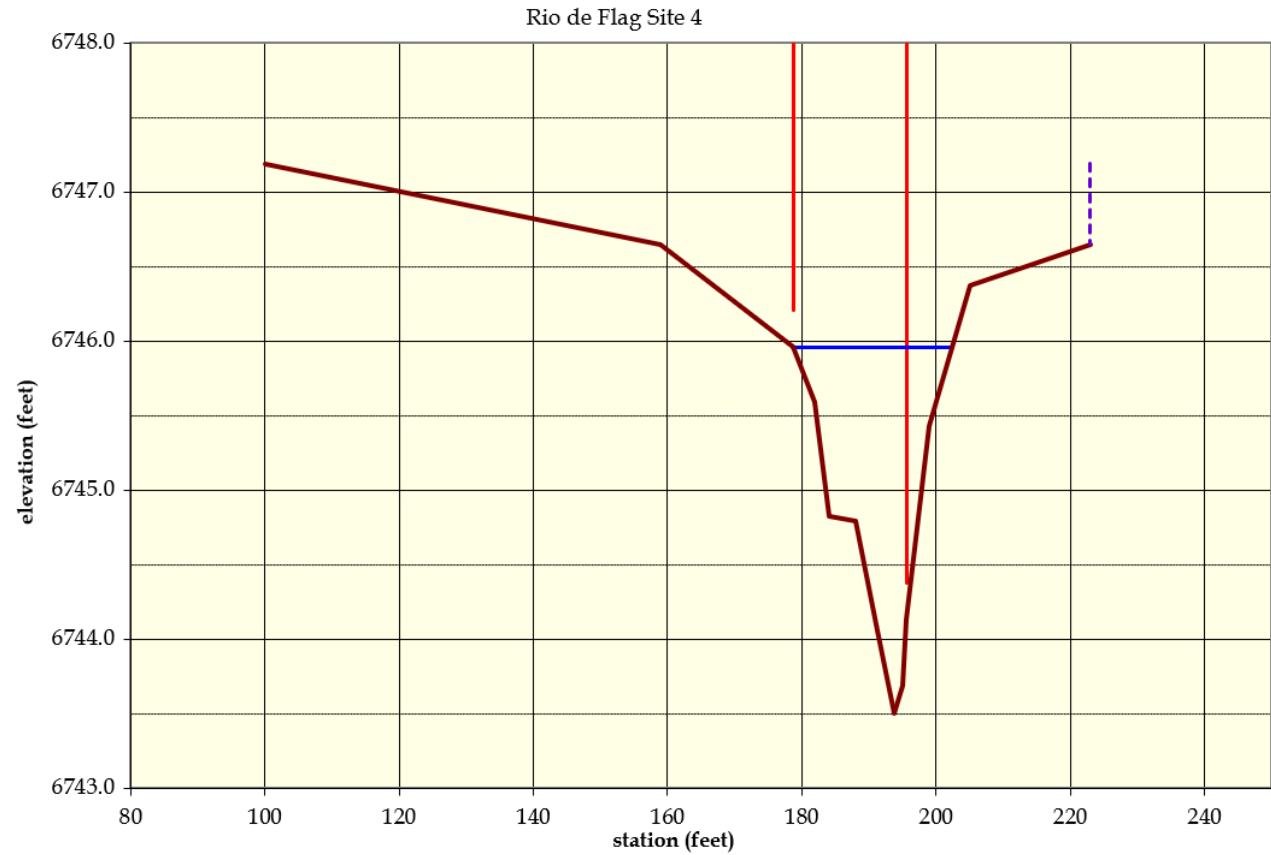


Figure 16: NRCS Results Site 4

SITE 5



Figure 17: Site 5 looking downstream. Photo taken by Emily Frazer.

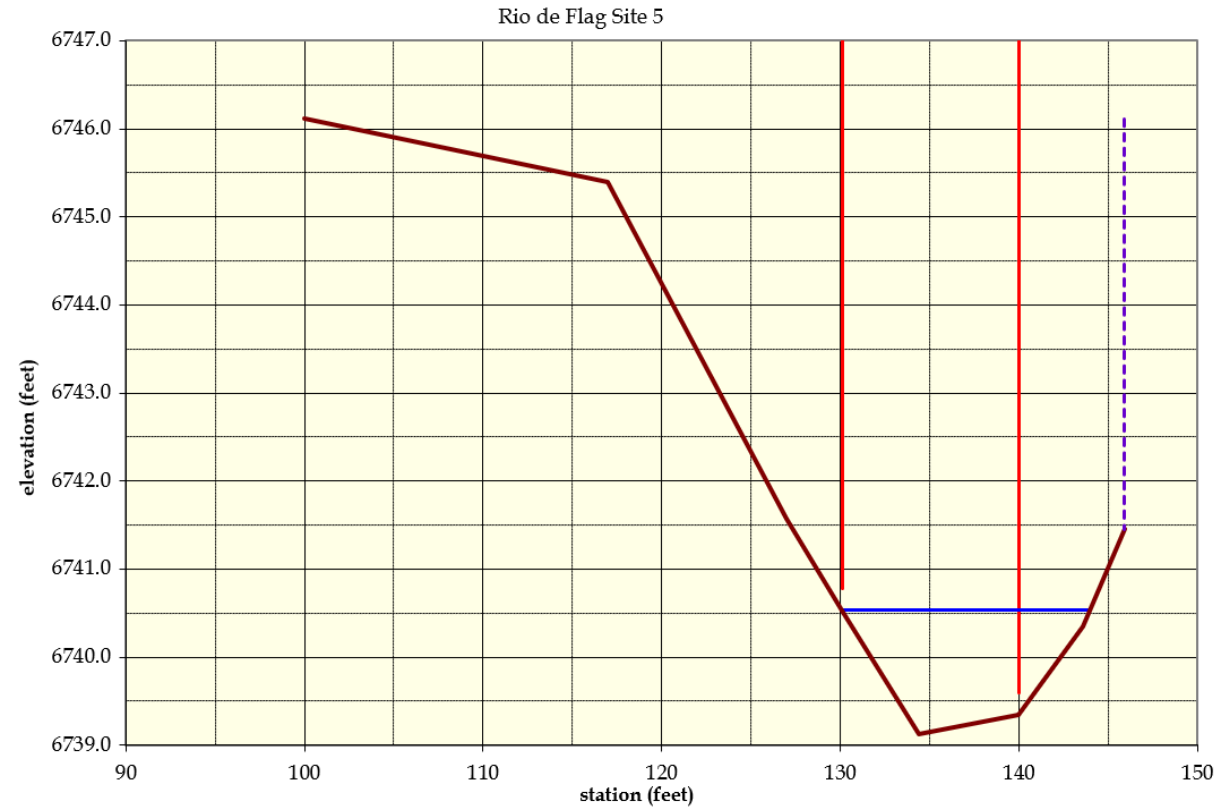


Figure 18: NRCS Results Site 5

SITE 6



Figure 19: Site 6 looking west. Photo taken by Destiny Gourley.

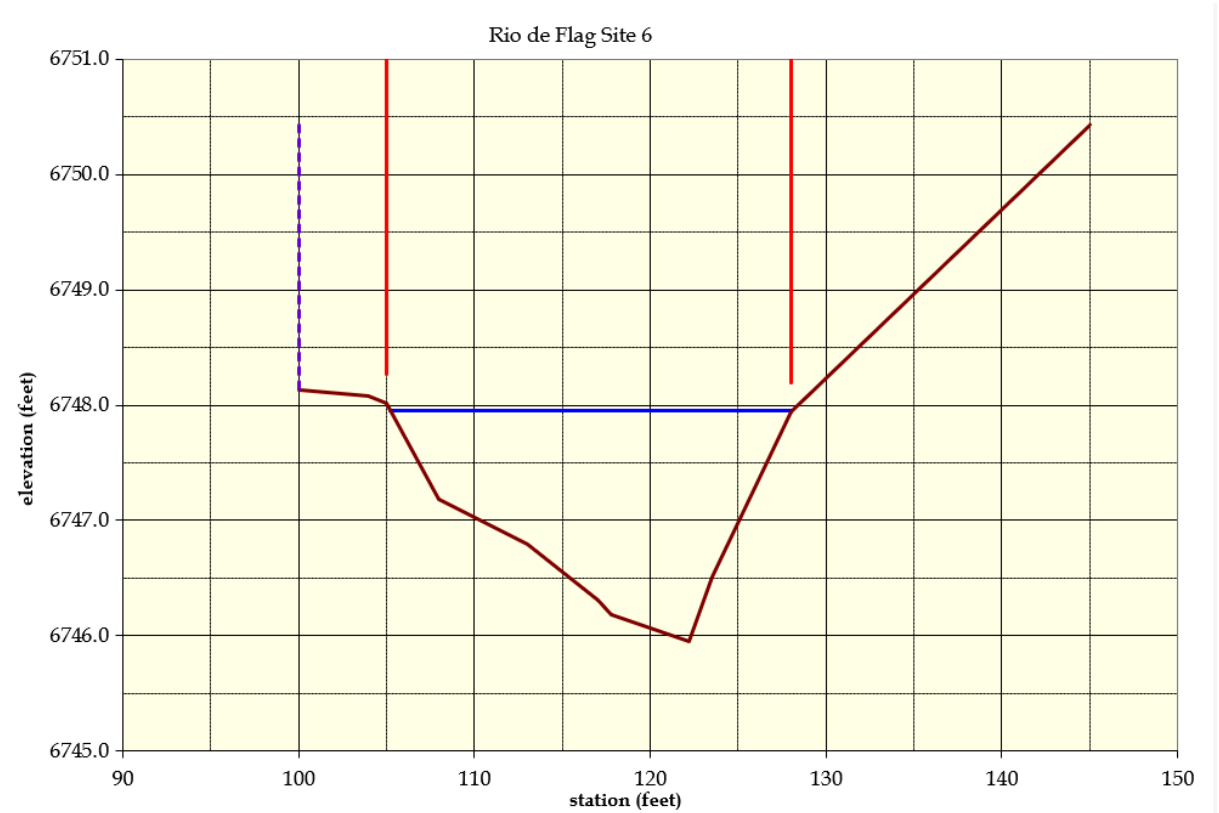


Figure 20: NRCS Results Site 6

SITE 7



Figure 21: Site 7 looking upstream. Photo taken by Dan Segal.

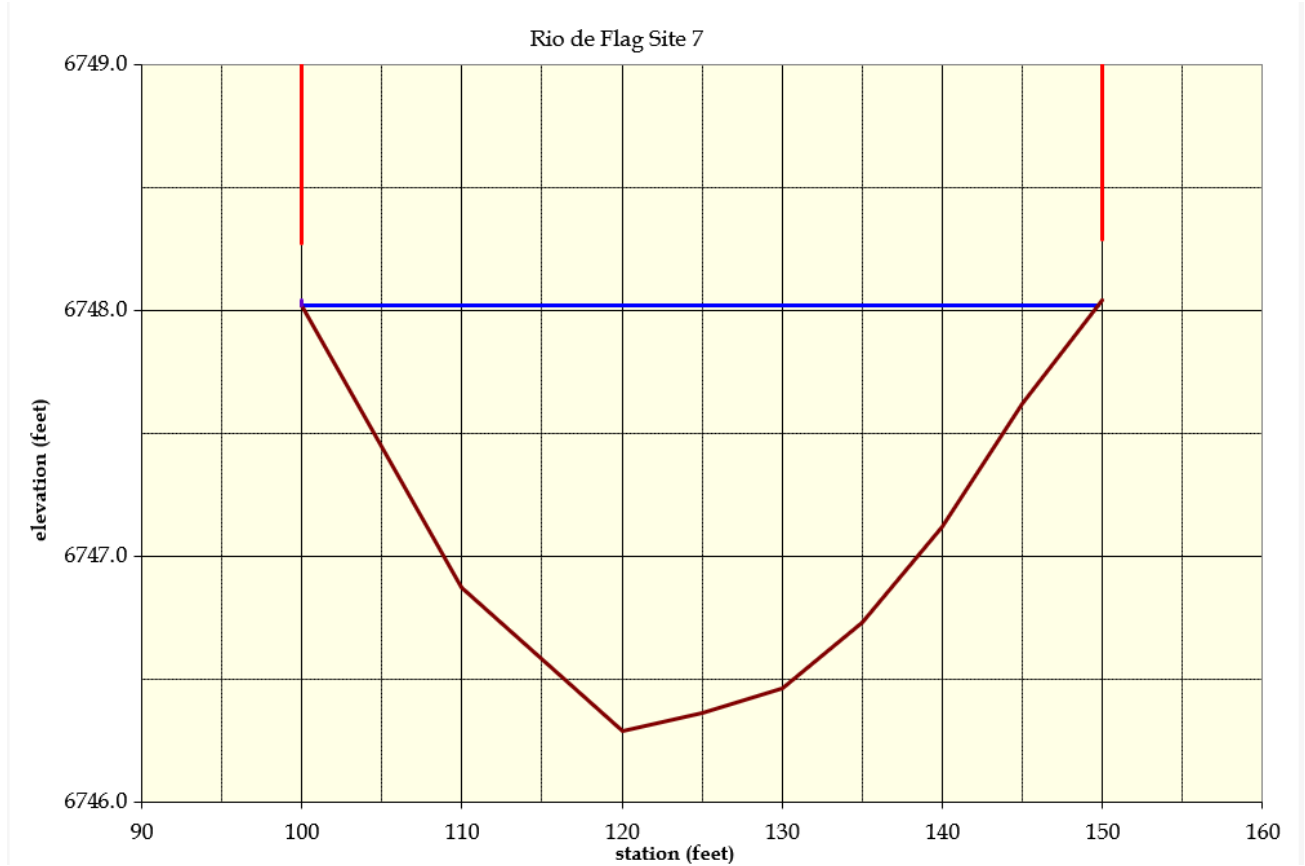


Figure 22: NRCS Results Site 7

SITE 8



Figure 23: Site 8 looking upstream. Photo taken by Jenna McCaffrey.

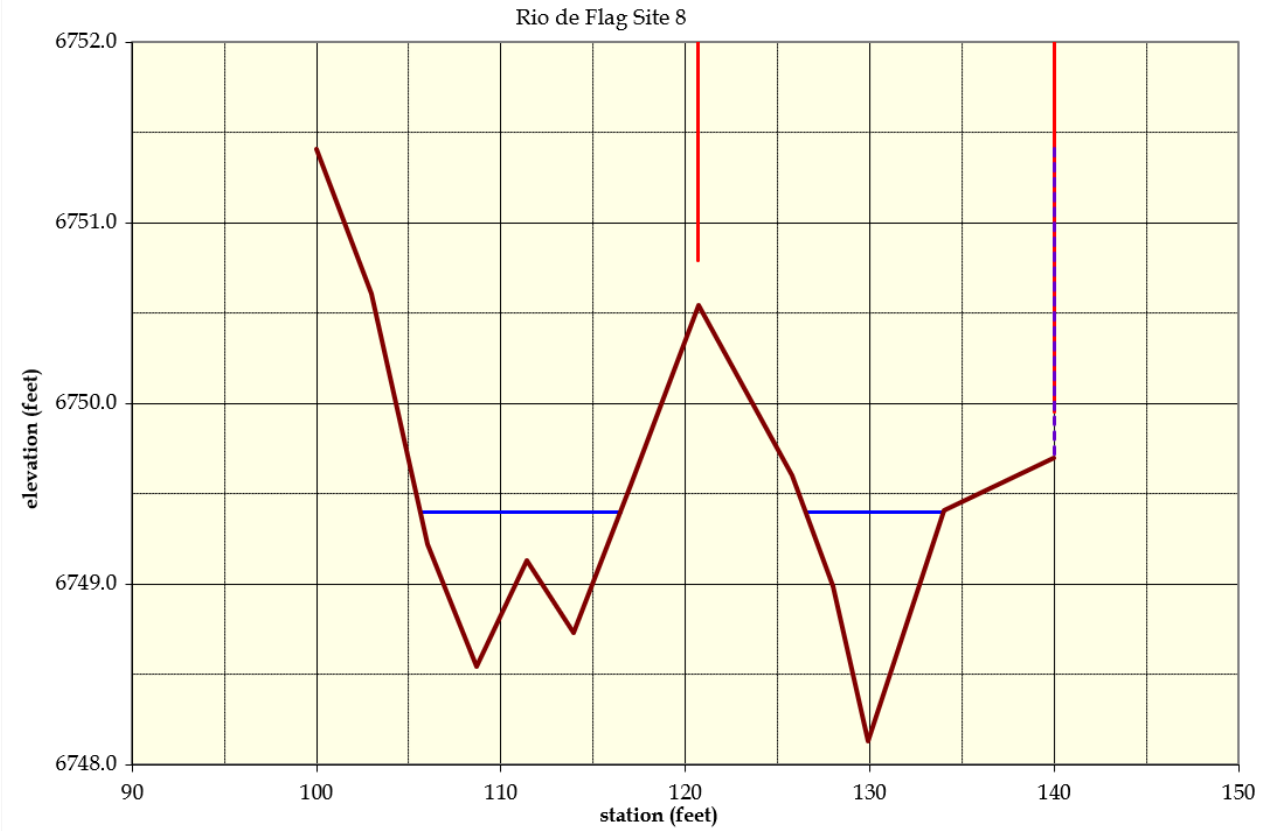


Figure 24: NRCS Results Site 8

SITE 9



Figure 25: Site 9 looking upstream. Photo taken by Jenna McCaffrey.

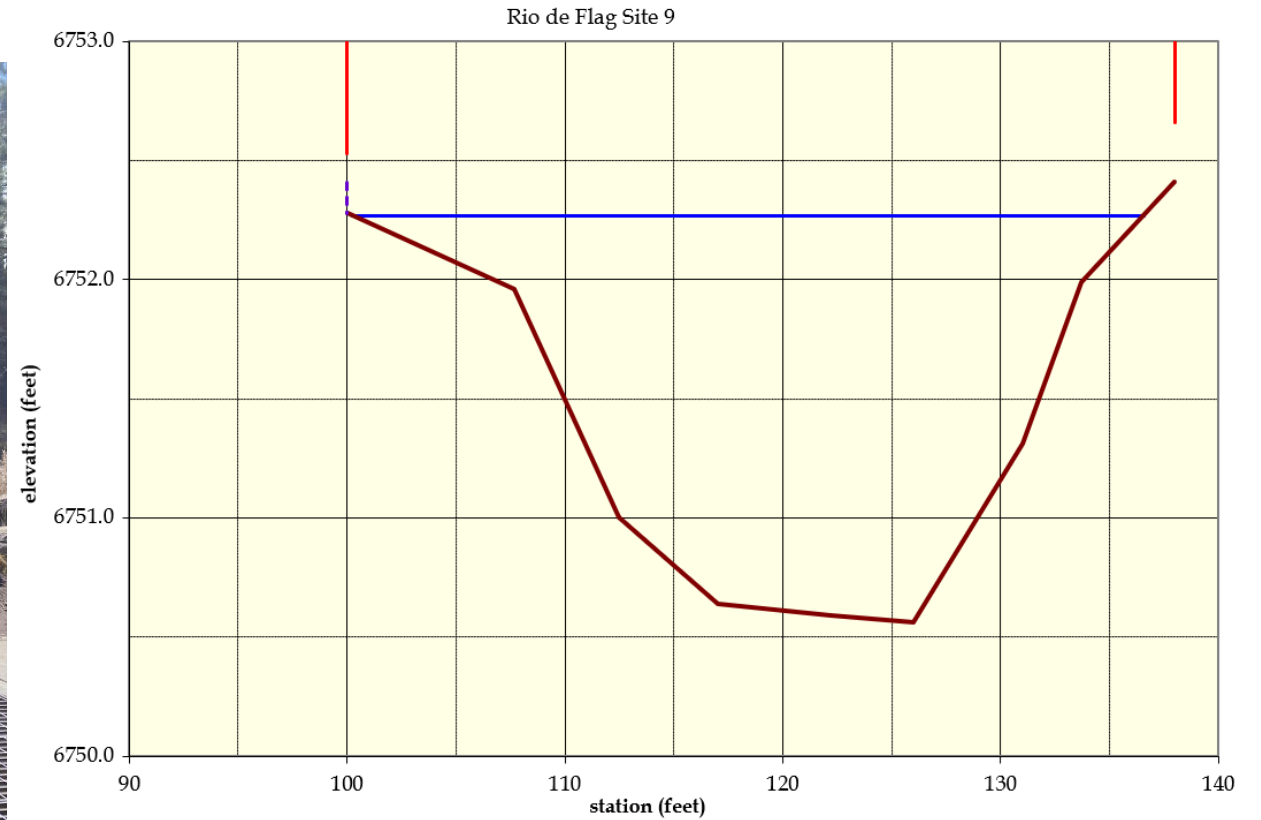


Figure 26: NRCS Results Site 9

Categorical Analysis of Improvement Areas

- ❖ 4.1 Detention
- ❖ 4.2 Retention
- ❖ 4.3 Erosion
- ❖ 4.4 Silting
- ❖ 4.5 Garbage Pollution



Figure 27: Rio de Flag channel station 54+77. This section of the channel shows erosion. Photo taken by Emily Frazer.



Figure 28: Rio de Flag channel station 44+06. This section of the channel shows detention and silting. Photo taken by Destiny Gourley.

Suite of Potential Solutions

- ❖ Detention: Excavating, Extended Detention Basin, Subsurface Extended Detention Basin & Emergency Spillway
- ❖ Erosion: Terraces, Alternative Materials, Bio-Engineering, Retaining Wall, Coir Logs
- ❖ Silting: Weirs, Check Dams, Sediment Traps, Alternative Materials, Bio-Engineering, Coir Logs
- ❖ Retention: Fill, Reroute Flow & Aquatic Bench
- ❖ Garbage: Grates, Garbage Cans, Increased Signage, Netting System, Trash Trap



Figure 29: Coir Logs



Figure 30: Culvert with Grate



Figure 31: Erosion Control Blanket

Erosion

- ❖ Affects
 - ❖ Site 1, 3, 5, & 8*
- ❖ Solutions
 - ❖ Alternative Materials
 - ❖ Armor the banks with Riprap
 - ❖ *Include excavation to ensure proper flow



*Figure 32: Erosion within the reach.
Photo taken by Emily Frazer.*

Detention and Silting

- ❖ Affects
 - ❖ Site 2 and 4
- ❖ Solutions
 - ❖ Excavate
 - ❖ Around Culvert
 - ❖ Alternative Materials
 - ❖ Armor the Inlet Riprap
 - ❖ Prevents Silting Downstream



Figure 33: Detention & Silting at Culvert. Photo taken by Destiny Gourley.

Detention and Silting

❖ Affects

- ❖ Site 6 and 9

❖ Solutions

- ❖ Excavate

- ❖ Alternative Materials

- ❖ Armor the banks with Riprap

- ❖ Weir

- ❖ Excavate to make wider & more trapezoidal
 - ❖ Maintenance excavation to prevent further silting downstream



Figure 34: Detention & Silting. Photo taken by Jenna McCaffrey.

Retention

- ❖ Affects
 - ❖ Site 7
- ❖ Solutions
 - ❖ Excavate
 - ❖ Fill
 - ❖ Reroute channel to avoid retention ponds
 - ❖ Further Engineering Study Required



Figure 35: Retention Pond. Photo taken by Destiny Gourley.

Garbage Pollution

❖ Affects

- ❖ All Sites

❖ Solutions

- ❖ Culvert Grate
- ❖ Install signage
- ❖ Plant hedges and trees



*Figure 36: Garbage in Reach 1.
Photo taken by Destiny Gourley.*



*Figure 37: Garbage in Reach 2.
Photo taken by Jenna McCaffrey.*

Proposed Cross-Section

- ❖ Created Proposed Cross-section for Channel
 - ❖ Based on City of Flagstaff Standards [4]

Flow Rate (5-year flood) (cfs)	770
Average Channel Slope (%)	0.12
Side Slope	2:1
Roughness Coefficient (n)	0.03
Top Width (ft)	20

Table 2: Design Specifications

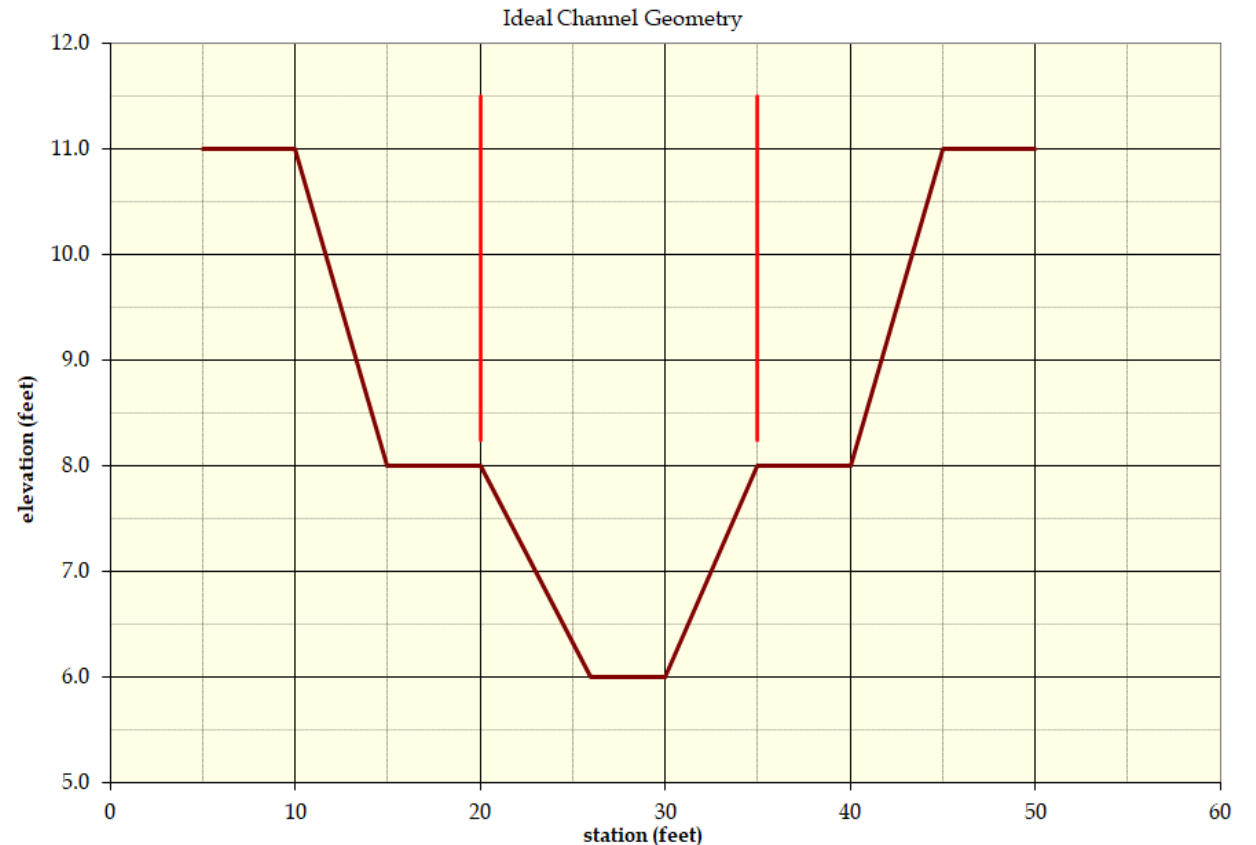


Figure 38: Ideal Channel Geometry

Estimated Cost of Project

❖ Costs Include

- ❖ Riprap
- ❖ Excavation
- ❖ Fill
- ❖ Concrete
- ❖ Labor
- ❖ Transport
- ❖ Other Materials
- ❖ *Site 7: Requires further engineering analysis and evaluation

Construction Cost	
	Total Cost (\$)
Site 1	4,460
Site 2	1,361
Site 3	1,368
Site 4	1,368
Site 5	532
Site 6	2,691
Site 7*	NA
Site 8	344
Site 9	2,506
Garbage Pollution Cost	1,016
Total Cost for Transport of Equipment and Materials	5,000
Total Cost for Soil Transport	2,000
Total Construction Cost	\$22,646

Table 3: Total Construction Costs

Impacts of Project

❖ **Social:**

- ❖ Space for more recreational activities
- ❖ Inconvenience ATV users who normally use the channel as a trail

❖ **Environmental:**

- ❖ Promote proper function of the channel, floodplain health, plant diversity, and wildlife habitat
- ❖ ATV impacts on the channel and surrounding environment will be reduced

❖ **Economical:**

- ❖ Not likely produce revenue for the city or future landowners
- ❖ May promote more visitors to the area and surrounding businesses

Citations

- [1] *Google Maps*. [Online]. Available: <https://www.google.com/maps>. [Accessed: 15-Oct-2021].
- [2] NRCS, *Web soil survey - home*. [Online]. Available: <https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm>. [Accessed: 30-Nov-2021].
- [3] “Natural Resources Conservation Service,” *Cross-Section Hydraulic Analyzer*. [Online]. Available: <https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/?cid=stelprdb1042510>. [Accessed: 30-Nov-2021].
- [4] *City of Flagstaff Stormwater Management Design Manual*. pp. 1–216, Mar-2009.