Sinclair Wash Restoration Feasibility Study Final Presentation



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Photo by: Eric Lima

# 1.0 Project Introduction

#### 1.1 Background

- Purpose: Identify three sites for repair and restoration.
- ✤ Client-Mark Lamer
- Stakeholder-Northern Arizona University, Client, City of Flagstaff and Coconino County
- 1.2 Current Conditions
- Sediment deposits building up
- Overgrown vegetation
- Flood eroded and flooded area



Fig. 1 - Site location map outlining Sinclair Wash Project.

# 2.0 Site Selection

2.1 Analysis of Previous Studies and Civil 3D data

- Using the previous teams topographic models and hydraulic models as base point of study.
- Civil 3D determine the low points, path of thalweg.



# 2.0 Site Selection Cont.

2.2 Site 1 Selected

Lots of trees and low points within the site



Fig. 3 - AutoCAD Drawing of Site 1.

Fig. 4 - Field image of Site 1.

## 2.0 Site Selection Cont.

2.3 Site 2 Selected

Cutback in thalweg line and lots vegetation problem



## 2.0 Site Selection Cont.

2.4 Site 3 Selected

The channel lining to be replaced with dirt and gravel



Fig. 8 - Field image for Site 3.



# Task 2.0 Effective Hydraulic Model

- ◆ Account for San Francisco Street Culvert and Knolls Drive
- Rating table made to account for the changes in flow.



Fig. 9 - Liszewski's 100 yr flood profile [1].

# Task 3.0 Corrected Effective Model

- Site 1 culvert/cross section thalweg reach output
- Slope/Velocity/Top width/Channel decreased while Water Surface Elevation/Area increased
- Similar process done for site 2 and 3

Culvert Output				8.07	- 🗆 X
File Type Options Hel	р				
River: Sinclair Site 1	Profile: P	= 1	<b>•</b>	Culv Group: Cu	lvert #1 _▼
Reach Thalweg	▼ RS: 49	91.04	↓ ↑ Plan:	test	<u>•</u>
Plan: tes	t Sindair Site 1 Th	alweg RS: 49	1.04 Culv Group: Culvert	#1 Profile: PF 1	
Q Culv Group (cfs)		29.84	Culv Full Len (ft)		47.84
# Barrels		3	Culv Vel US (ft/s)		4.54
Q Barrel (cfs)		9.95	Culv Vel DS (ft/s)		4.54
E.G. US. (ft)		6864.82	Culv Inv El Up (ft)		6857.16
W.S. US. (ft)		6864.79	Culv Inv El Dn (ft)		6857.76
E.G. DS (ft)		6863.17	Culv Frctn Ls (ft)		1.12
W.S. DS (ft)		6863.09	Culv Exit Loss (ft)	1 A	0.24
Delta EG (ft)	3 K.	1.65	Culv Entr Loss (ft)	1 A	0.29
Delta WS (ft)	3 K.	1.70	Q Weir (cfs)		320.16
E.G. IC (ft)		6864.59	Weir Sta Lft (ft)	1	60.61
E.G. OC (ft)		6864.82	Weir Sta Rgt (ft)		105.71
Culvert Control		Outlet	Weir Submerg		0.24
Culv WS Inlet (ft)		6858.83	Weir Max Depth (ft)	1	3.47
Culv WS Outlet (ft)		6859.43	Weir Avg Depth (ft)	1 A	1.85
Culv Nml Depth (ft)			Weir Flow Area (sq ft)		83.28
Culv Crt Depth (ft)		1.19	Min El Weir Flow (ft)		6861.39
		Errors, Warnin	igs and Notes		

Fig. 10 - Site 1 culvert output table.

				H	EC-RAS	Plan: test	River: S	Sinclair Sit	e 1 Rea	ch: Thalw	eg Prot	file: PF 1
Reach	River Sta	Profile	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)	
Thalweg	537.45	PF 1	350.00	6858.52	6864.79		6864.83	0.000404	0.74	366.21	94.83	0.06

Fig. 11 - Site 1 cross section output table.



# Task 4.0 Proposed Restoration Plans for all sites

#### 4.1 Vegetation

- **\*** Remove invasive species.
- Promoting native species and restoring natural habitats.
- 4.2 Geomorphologic
- Repair and prevent further erosion.
- Reduce sediment deposition.
- 4.3 Hydraulic
  - Optimized the final channel conditions.
  - Update the manning's value based on the vegetation plan and match the City of Flagstaff Criteria and Guidelines.



Fig. 12 - Portion of Sinclair Wash near Lone Tree.



Fig. 13 - Overview of Site 1.



- Remove trees in channel
- Remove overgrown grasses
- Remove culvert at
   Flagstaff Urban Trail
   Crossing
- Remove invasive species in the area



Photo by: Eric Lima

Fig. 14 - Portion of Sinclair Wash Near I-17 & FUTS Trail Crossing.

- Utilize bankfull information to find average bankfull in Site 1
- Accommodate average bankfull area determined by previous study (10.95ft<sup>2</sup>)



Fig. 15 - Channel modification template Site 1.



- Implement cross section template to all sections in Site 1
- Change channel center to allow river to meander
- Stabilize banks with slopes of 3H:1V [3]
- Seed channel and banks with City of Flagstaff seeding mix [3]



Fig. 16 - Template cut applied to cross section in Site 1.

- Implement riffle, run, pool, glide [4]
- Ensure slope connects
   beginning and ending cross
   section
- Install three-sided bridge at site of FUTS crossing
- Install hedge blocking path access to McConnel/Pine Knoll intersection
- Cut: 262  $yd^{3}$
- **♦** Fill: 650 yd<sup>3</sup>



Fig. 17 - Modified channel cross section Site 1.



Figure 18. - Overview of Site 2.

- Remove invasive species
- Remove culvert at FUTS trail crossing
- Remove large rocks
   located within the
   channel



Photo by: Eric Lima

Fig. 19 - Portion of Sinclair Wash near Hilltop Townhomes.

- Utilize bankfull data to determine the average bankfull area of Site 2 [2].
- Accommodate
   bankfull area
   (20.55ft<sup>2</sup>)



Fig. 20 - Channel modification template Site 2.

- Implement cross section template to all sections in Site 2
- Seed channel and banks with City of Flagstaff seeding mix [3]
- Stabilize banks greater than
  3:1 slope [3]



Fig. 21 - Modified channel cross section Site 2.

- Implement riffle, run, pool, glide [4].
- Ensure slopes connects beginning and ending cross section
- Alter direction of
   Flagstaff Urban Trail to
   not cross channel
- Cut: 541 yd<sup>3</sup>
- ✤ Fill: 6544 yd<sup>3</sup>



Fig. 22 - Proposed channel slope Site 2.



Fig. 23 - Overview of Site 3.

- Remove invasive
   species found in the
   area
- Remove large deposits of gravel and rocks



Fig. 24 - Portion of Sinclair Wash near Lone Tree Road.

- Use bankfull data to determine average bankfull area in Site 3
   [2].
- Create cross section template
- Accommodate bankfull area (20.23ft<sup>2</sup>)



Fig. 25 - Proposed channel slope Site 3.

- Apply template to all cross sections
- Apply cuts in a way for channel to meander
- Stabilize banks with greater than 3:1 slope [3]
- Seed channel and banks with City of Flagstaff seeding mix [3].



Fig. 26 - Modified channel cross section Site 3.

- Implement riffle, run, pool, glide [4].
- Ensure slope lines up with beginning and ending cross section
- Cut:  $4327 \text{ yd}^3$
- Fill: 709  $yd^3$



Fig. 27 - Proposed channel slope Site 3.



# Task 5.0 Plan Sets

- $\bullet \quad \text{Cover sheet}$
- ✤ Typical Details
- Plan and Profile (per site)
- Cross Sections (per site)



Sinclair Wash Restoration Feasibility Study





List of	S	heets	
Sheet	1:	Cover Sheet	
Sheet	2:	Overall Sheet	
Sheet	3:	Typical Detail Sheet	
Sheet	4:	Sub reach 1 plan and profi	le
Sheet	5:	Sub reach 2 plan and prof	il
Sheet	6:	Sub reach 3 plan and prof	il
Sheet	7:	Sub reach 1 cross sections	ł.
Sheet	8:	Sub reach 2 cross sections	8
Sheet	9:	Sub reach 3 cross sections	



## 5.0 Plan Sets Cont. - Typical Details



Fig. 29 - Typical Riffle, Run, Pool, Glide detail for Site 1.



Fig. 30 - Typical Channel Cut detail for Site 1

#### 5.0 Plan Sets Cont. -Plan and Profile



Fig. 31 - Plan and Profile for Site 1.

# 5.0 Plan Sets Cont. -Cross Section



Fig. 32 - Cross Sections for Site 1.



#### **Project Impacts**

Social Impact

- $\bullet \qquad \text{Increased use of the area}$
- $\boldsymbol{\ast} \qquad \text{Increase in the use of the site for recreation}$
- Better for health and quality of life

**Environmental Impact** 

- Improve and promote the growth of native plants
- reduce the sediment buildup and blockage of the stream
   Economic Impact
  - Required regular maintenance
  - Increase spending both on and around campus



#### Conclusion

- ✤ Total Engineering Cost: \$68,500
- Velocities Range from 1-8 ft/s (COF <18 ft/s)</li>
- ♦ Side Slopes = 3H:V1 (COF ≤ 3H:1V)
- Remove invasive species
- Promote native growth



Photo by: Eric Lima

Fig. 33 - Sinclair Wash Upstream of Site 1.





#### References

[1] Liszewski, C. and Najjar, A., 2019. *Feasibility Analysis For Stream Revitalization And Electronic Flood Monitoring*.

[2] Xu, M., Yao, S. and Li, T., 2019. Sinclair Wash Channel Classification.

[3] City of Flagstaff Engineering Division Stormwater Management Section, "City of Flagstaff Stormwater Management Design Manual"; Flagstaff, 2009.

[4] The Federal Interagency Stream Restoration Working Group, "Stream Corridor Restoration: Principles, Processes, and Practices," 2001.