Ryan's Trail Road Redesign

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Photo by: McKenzie Moten

Figure 1: Ryan's Trail South-bound

Problem Statement

Our client, Dianne McDonnell, has requested that our team perform a feasibility analysis of potential road alternatives and prepare an asphalt design for future use.

Deliverables

- Feasibility of Alternatives
  - Capital Costs
  - Operations and Maintenance Costs
  - Salvage Costs
- Proposed Design
  - Construction Plan Set
  - Hydrology/Hydraulics Analysis

Photo by: McKenzie Moten

Figure 2: Ryan's Trail North-bound

Project Location

Figure 3: Location of Flagstaff, in Arizona[1]

Project Location

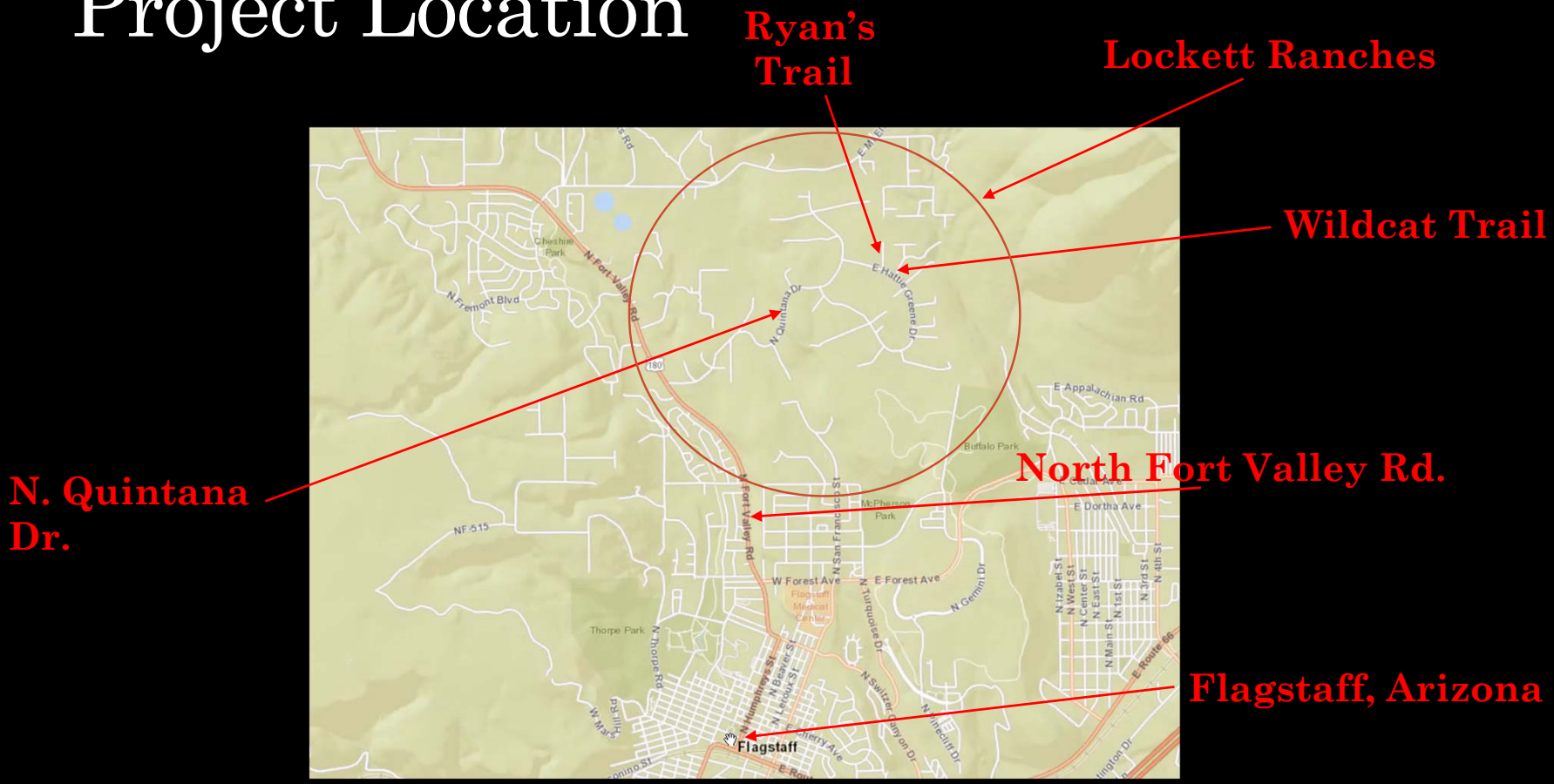


Figure 4: Location of Ryan's Trail in Flagstaff [1]

Existing Utilities

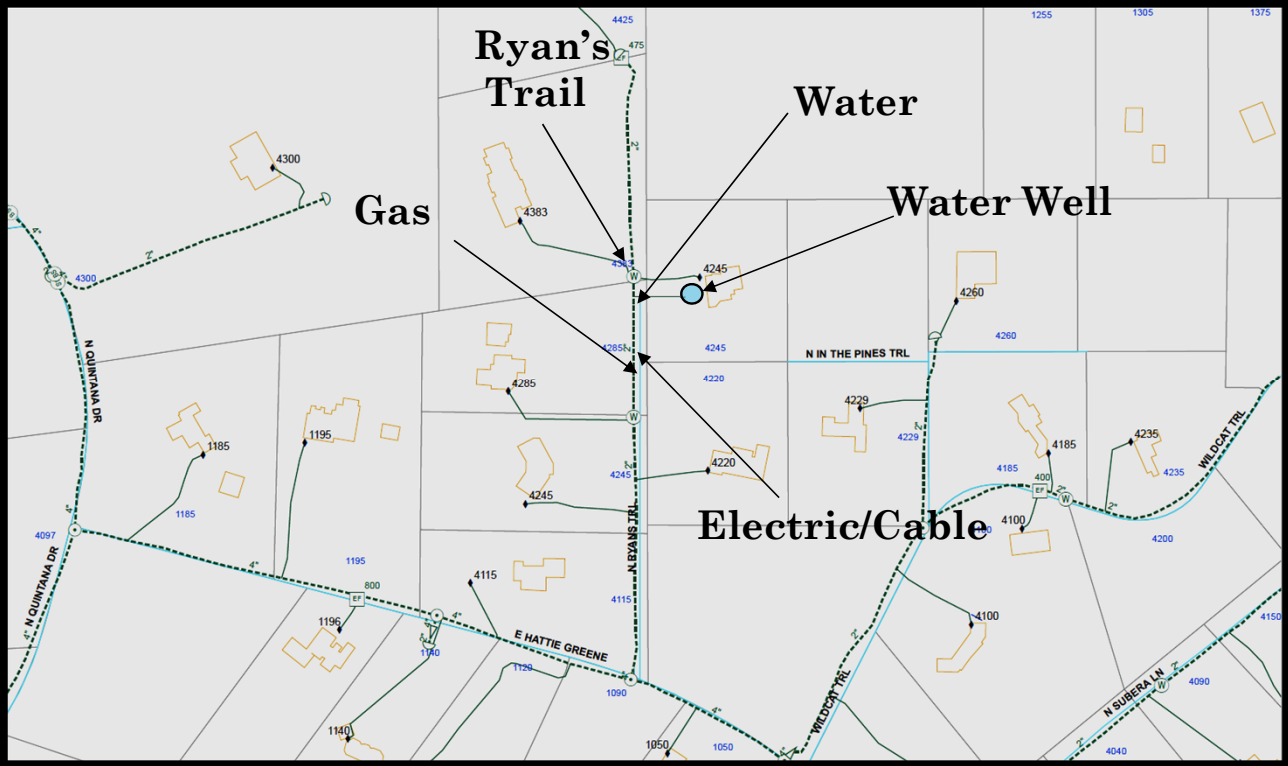


Figure 5: Blue Stake Results[2]

*Site uses septic sewer system

Existing Conditions

- Current Road Length: 1,420 ft.
- Current Road Area: 21,000 ft.^{2}
- Average Road Width: 12-16 ft.
- Current Materials: Crushed cinder and loam

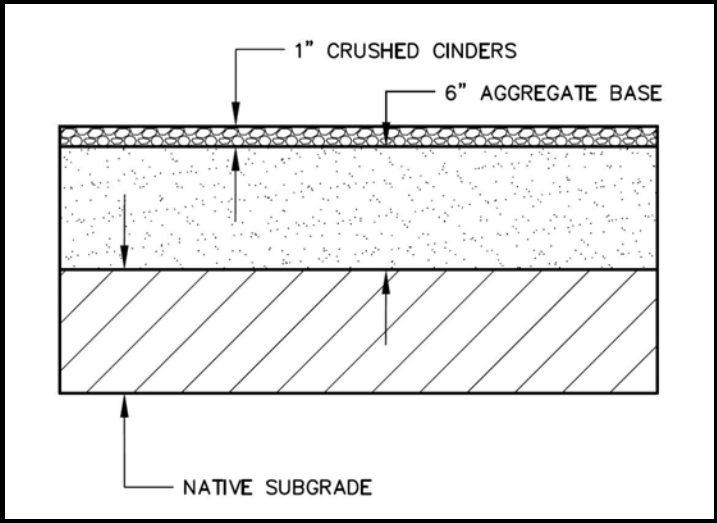


Figure 6: Typical Section Detail of Ryan's Trail
Drawing by: Trevor Snipes

Figure 7: Typical Section Detail of Ryan's Trail

Figure 8: Typical Section Detail of Ryan's Trail

Feasibility Analysis

- Brought all costs and values back to present worth using a service life of 20 years to make all alternatives equivalent and comparable.
- Used 3% for compound interest factors
- Alternatives chosen based off of:
  - Professional Advice
  - Client Preference
  - Background Research
  - Site Conditions

Alternative 1: Aggregate Base

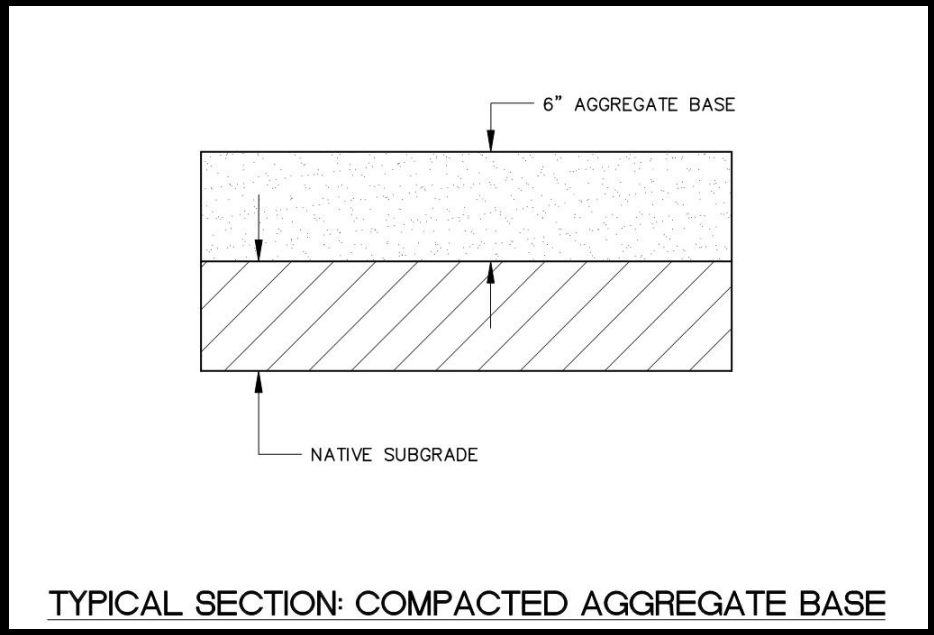


Figure 9: Compacted Aggregate Base

Drawings by: Trevor Snipes

Table 1: Cost Breakdown for dirt over 20 year span

Item	Cost ($)
Capital Costs	$20,900
Operation & Maintenance Costs	$7,195
Salvage Value	(-$730)
TOTAL	$27,365

<u>Positive Impacts</u>

- Non-intrusive material
- Rural appearance

<u>Negative Impacts</u>

- Dust
- Potholes

Alternative 2: Gravel

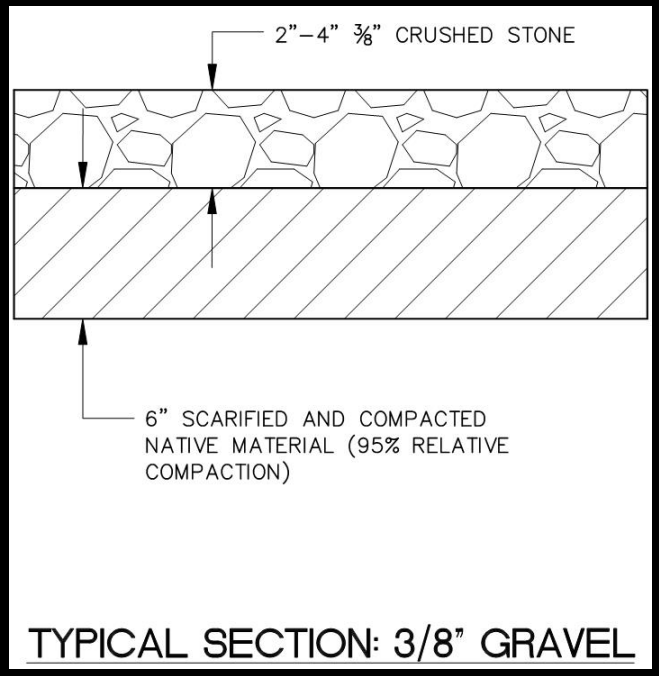


Figure 10: Proposed Crushed Stone Section
Drawings by: Trevor Snipes

Table 2: Cost Breakdown For Gravel Over 20 Year Span

Item	Cost ($)
Capital Costs	$20,350
Operation & Maintenance Costs	$21,460
Salvage Value	(-$3,946)
TOTAL	$37,864

<u>Positive Impacts</u>
- Reduces dust
- Improves appearance

<u>Negative Impacts</u>
- Uneven surface
- New material every year

Alternative 3: Asphalt

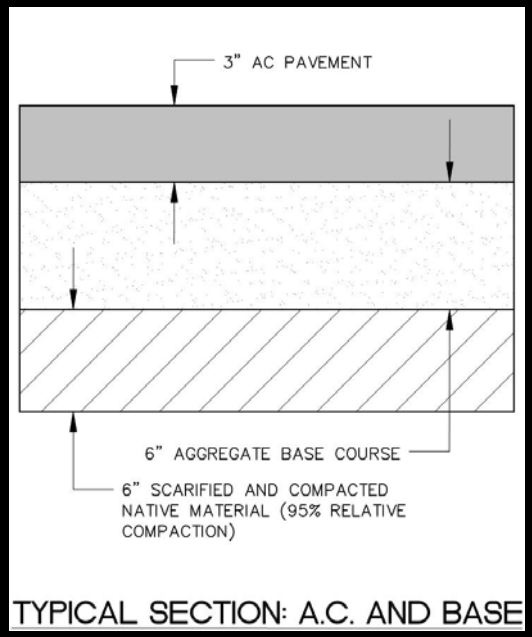


Figure 11: Proposed A.C. Over Base Pavement Section
Drawing by: Trevor Snipes

Table 3: Cost Breakdown for asphalt over 20 year span

Item	Cost ($)
Capital Costs	$108,000
Operation & Maintenance Costs	$81,982
Salvage Value	(-$30,452)
TOTAL	$159,530

<u>Positive Impacts</u>

- Snow removal
- Longer life
- Increase home value
- All weather access

<u>Negative Impacts</u>

- Cracking
- Annual inspections
- Sealant every 5 years

Summary of Costs

Table 4: Total Cost of Individual Alternatives Over 20 Year Span

Alternatives	Cost
Dirt	$27,365
Gravel	$37,864
Asphalt	$159,530

Design Criteria

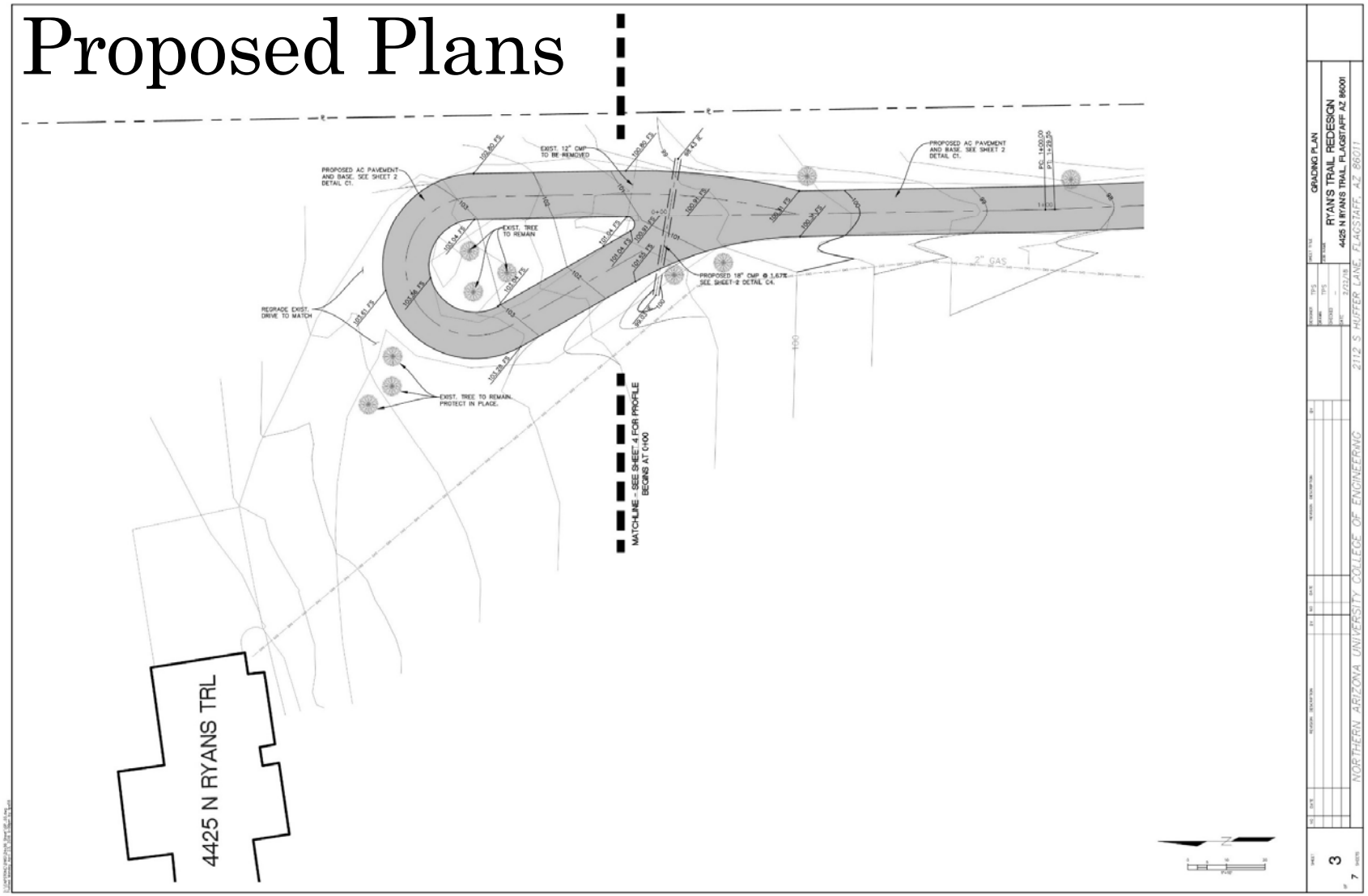
Design Requirements
- Cost effective
- Maintain durable road structure
- Maintain proper drainage

Design Goals
- Ease of snow removal
- Reduce damage to vehicles and homes
- Suitable for all vehicles, bicycles, and pedestrians

Photo by: McKenzie Moten

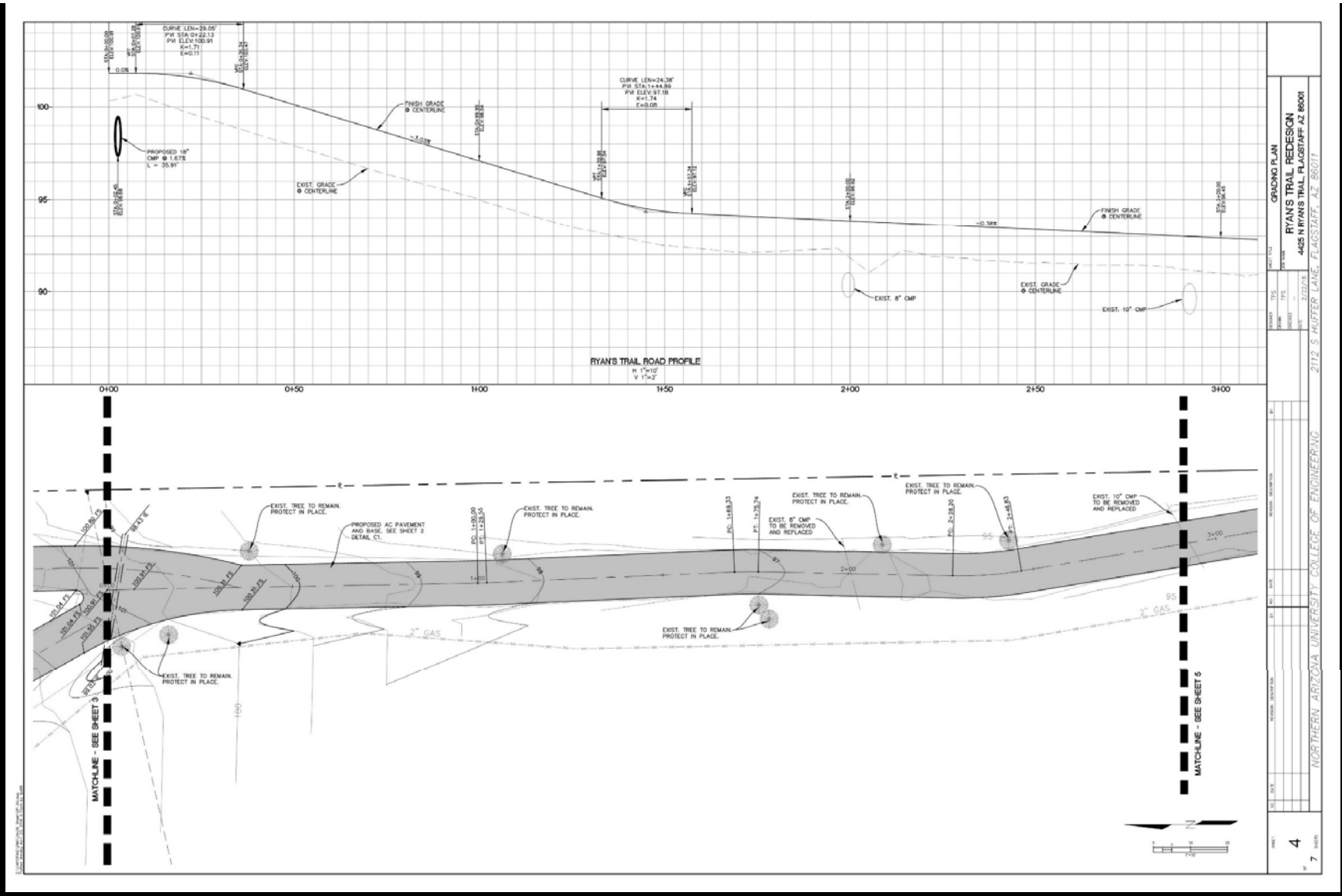
Figure 12: Ryan's Trail North-bound 12 Foot Wide Section

Proposed Plans



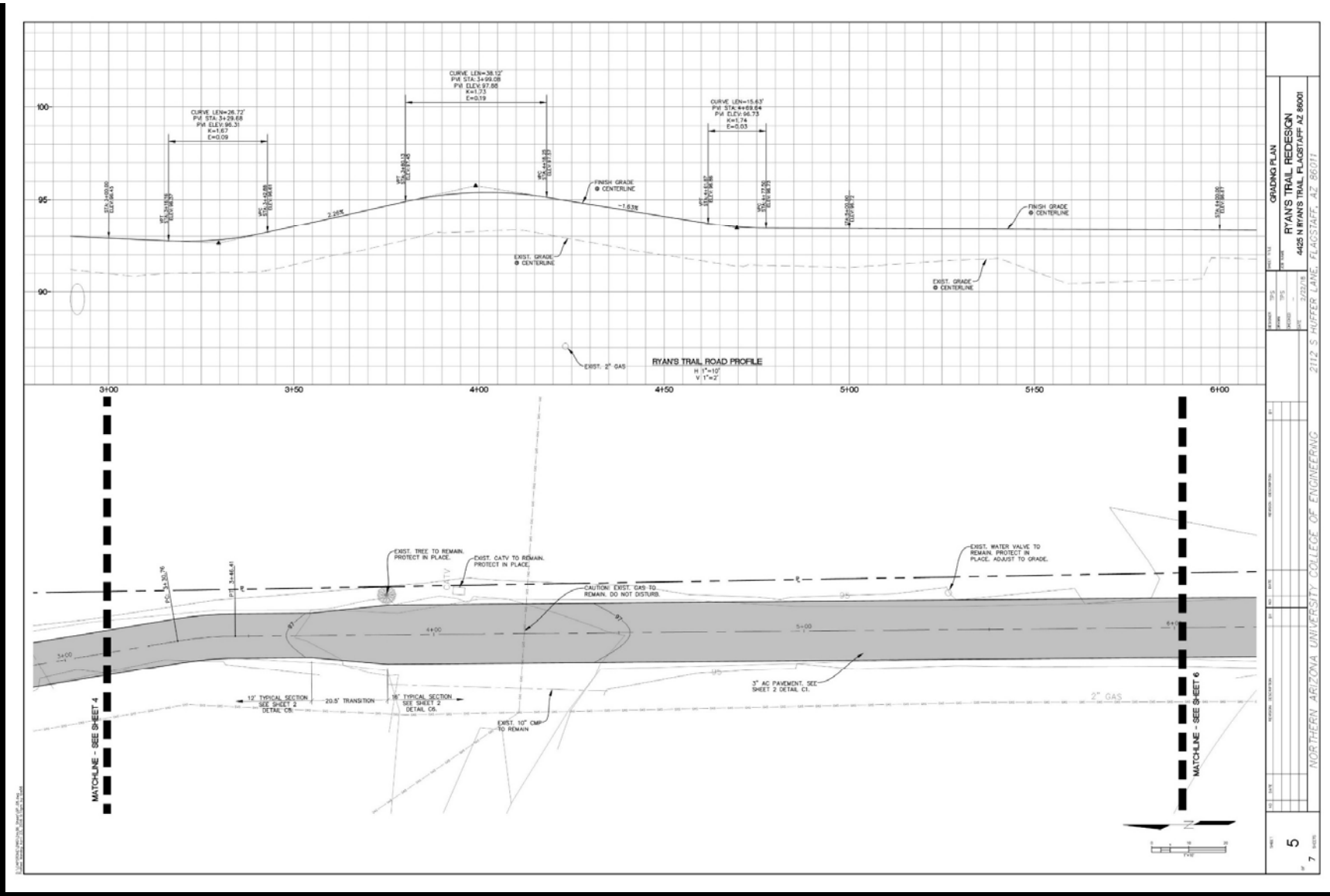
Drawing by: Trevor Snipes

Figure 15: Proposed Plans of Ryan's Trail



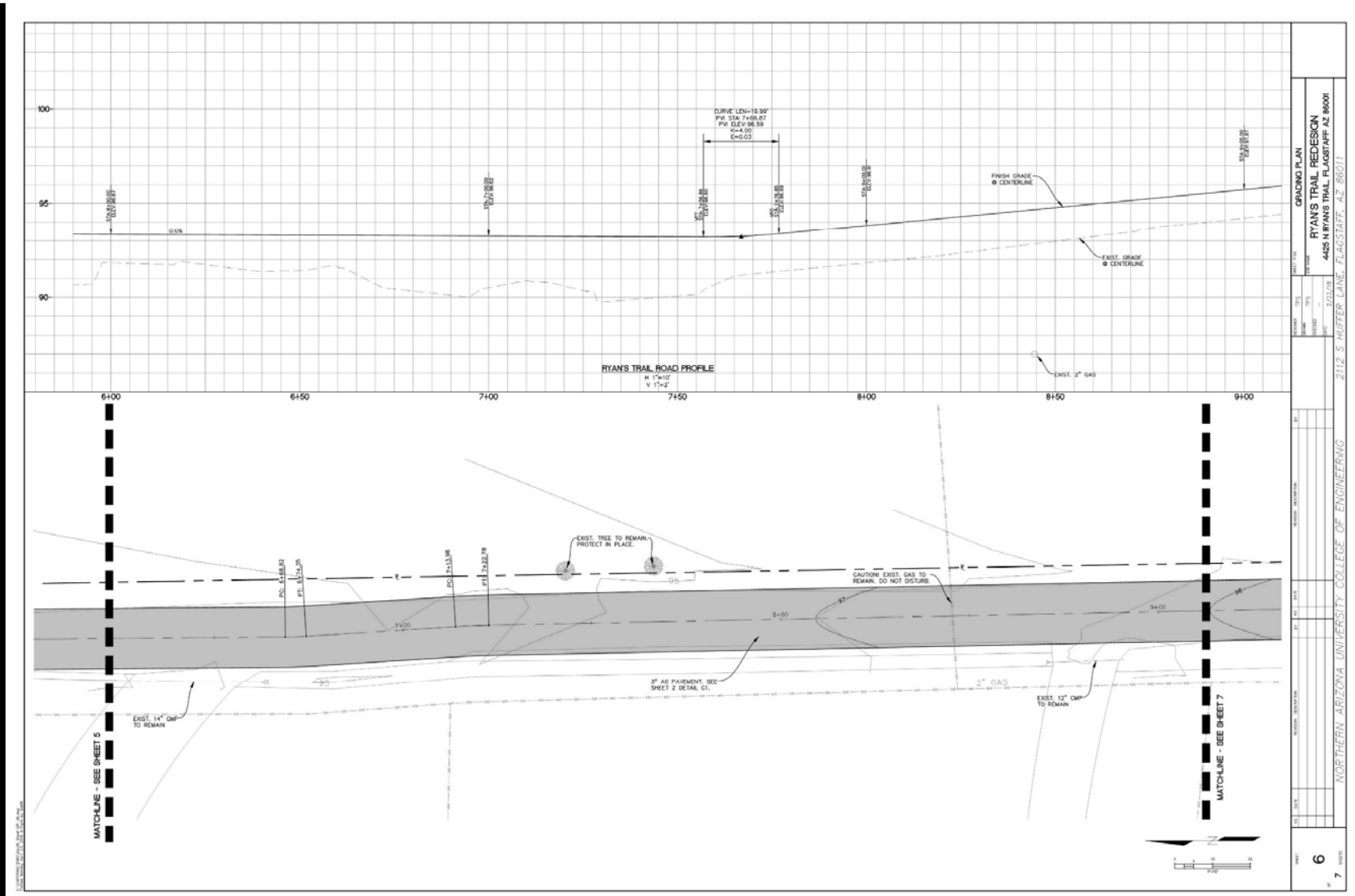
Drawing by: Trevor Snipes

Figure 16: Profile of Ryan's Trail Proposed Improvement



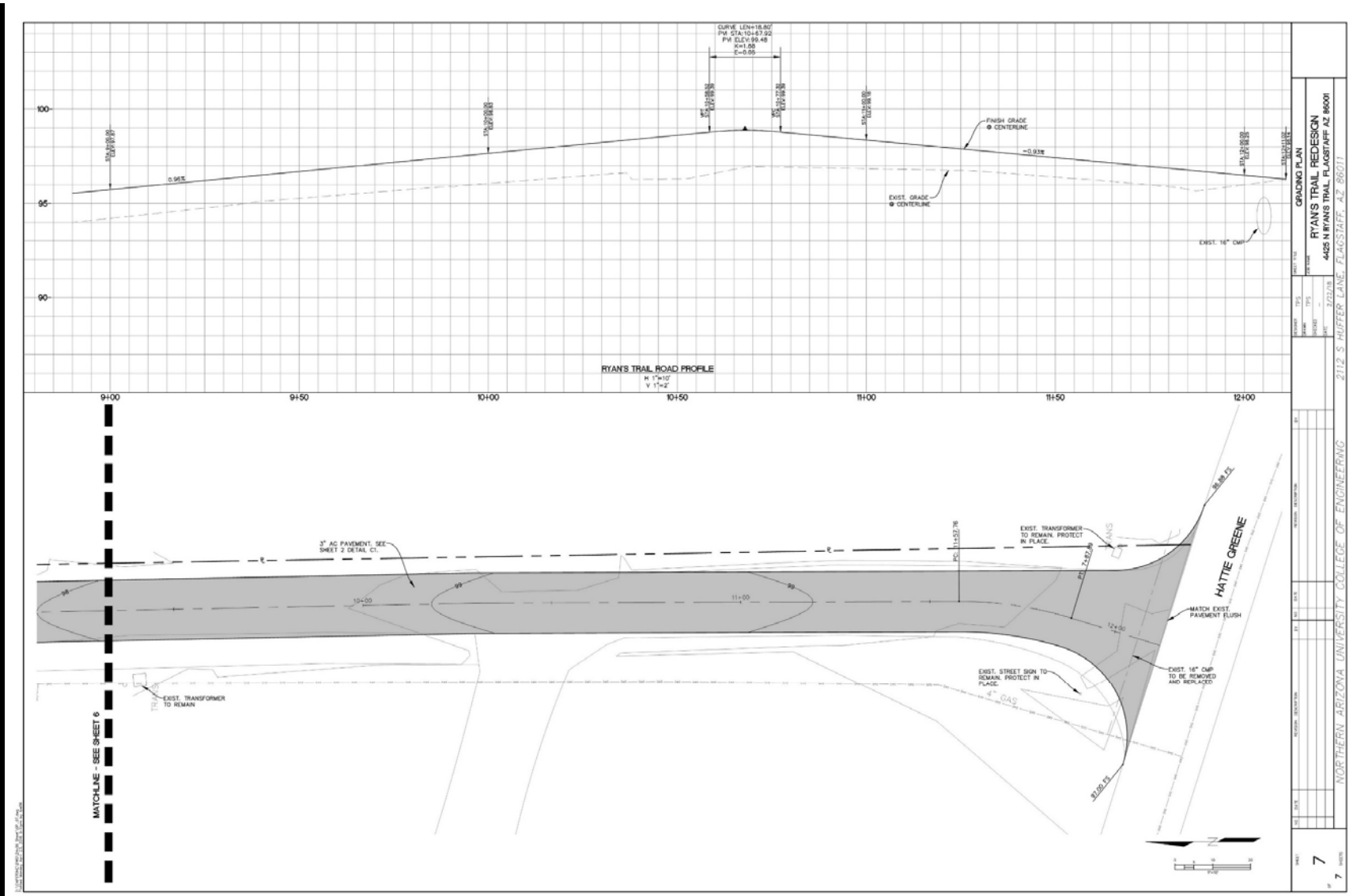
Drawing by: Trevor Snipes

Figure 17: Profile of Ryan's Trail Proposed Improvement



Drawing by: Trevor Snipes

Figure 18: Profile of Ryan's Trail Proposed Improvement



Drawing by: Trevor Snipes

Figure 19: Profile of Ryan's Trail Proposed Improvement

Proposed Typical Road Section

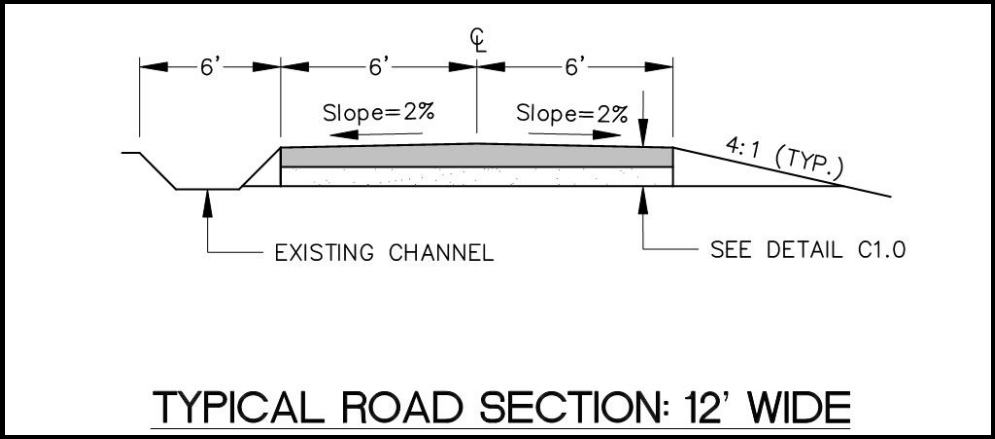


Figure 13: Typical 12' Road Section

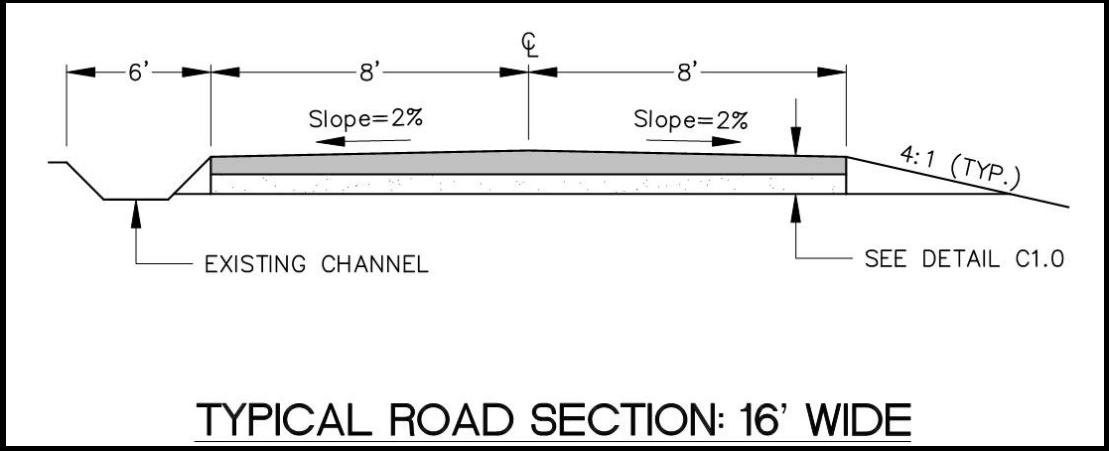


Figure 14: Typical 16' Road Section

Drawings by: Trevor Snipes

Quantities

Table 5: Quantities on Ryan's Trail

Item	Quantity
Asphaltic Concrete	190 CU YDS
Aggregate Base Course	380 CU YDS
Culvert	36 LF
Cut	50 CU YDS
Fill	550 CU YDS

Table 6: Protect in Place Values for Ryan's Trail

Object	Quantity
Trees	18 EA
Water Valve	1 EA
Utility Boxes	3 EA

Proposed Site Hydrology

Table 7: Pre and Post Development Hydrology [3]

	Rational (50 yr.)	**Rational (100yr.)**
Pre Development:	5.07 cfs	6.12 cfs
Post Development:	6.05 cfs	7.30 cfs

- **Rational Equation: Q=CiA**
- Q= Flow
- C= Runoff Coefficient
- i= Rainfall Intensity
- A= Area of Interest

Hydraulic Analysis - Culverts

50 Year Storm

Table 8: 50 Year Storm Culvert Analysis

Culvert	Discharge (cfs)	Slope (ft/ft)	Velocity (ft/s)
1Existing	.34	.037	2.80
1Proposed	.34	.017	2.18
2	.39	.004	2.26
3	.41	.001	2.30
4	1.56	.004	3.31
5	1.41	.003	3.21
6	.59	.001	2.53
7	.34	.004	2.18

100 Year Storm

Table 9: 100 Year Storm Culvert Analysis

Culvert	Discharge (cfs)	Slope (ft/ft)	Velocity (ft/s)
1Existing	.41	.037	2.96
1Proposed	.41	.017	2.3
2	.47	.004	2.38
3	.49	.001	2.4
4	1.86	.004	3.48
5	1.68	.003	3.38
6	.70	.001	2.65
7	.40	.004	2.28

Proposed Culvert Detail

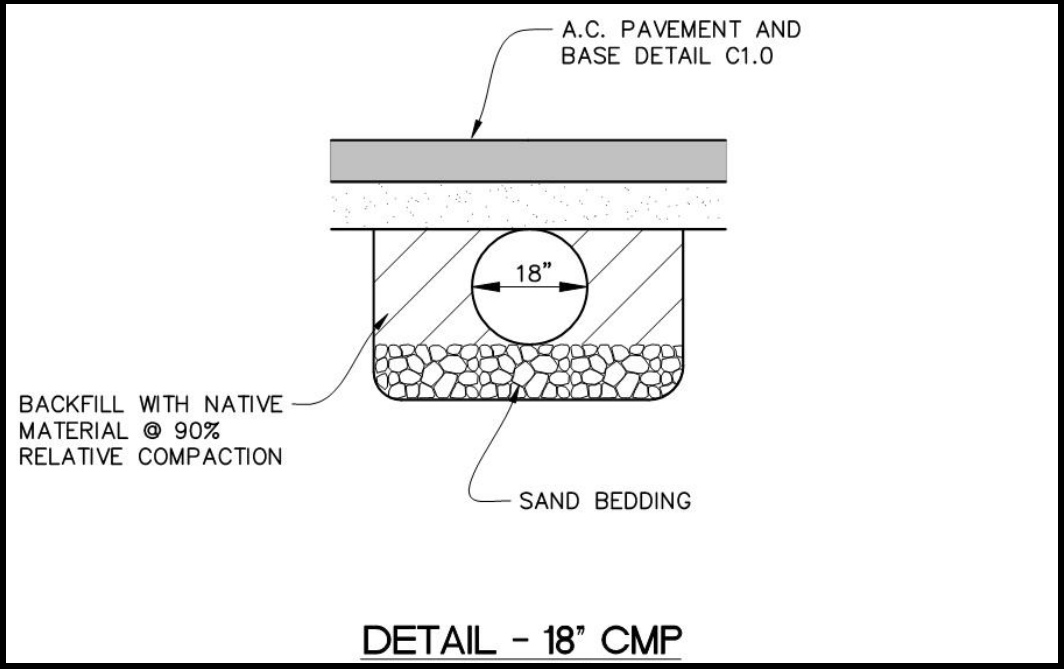


Figure 20: Proposed Culvert Detail

Drawing by: Trevor Snipes

Cost of Services and Staffing

Table 10: Cost of Engineering Services and Staffing

	Project Manager (60%)	Design Engineer (55%)	Drafter (40%)	Survey Crew (60%)	Technician (50%)	**Total for Services**	**Estimated Cost of Services**
Pay Rate ($/hr.)	$ 55.00	$ 45.00	$ 40.00	$ 50.00	$ 20.00	**$ 210.00**	
Task Breakdown							
1. Site Investigation	10	15	10	25	0	60	72
2. Site Map	10	0	25	15	0	50	20
3. Conceptual Design	20	45	20	0	0	85	120
4. Hydrology	15	10	5	0	30	60	68
5. Life Cycle Cost Analysis	35	35	0	0	0	70	95
6. Final Design	20	40	30	0	10	100	80
7. Project Management	40	25	15	0	5	85	100
Subtotal (hr.)	150	170	105	40	45	510	555
Subtotal Pay ($)	$ 8,250.00	$ 7,650.00	$ 4,200.00	$ 2,000.00	$ 900.00	$ 23,000	$ 23,765
Benefits (% compensation)	$ 4,950.00	$ 4,207.50	$ 1,680.00	$ 1,200.00	$ 450.00	$ 12,488	$ 13,266
Profit Margin ($)	$ 523.81	$ 428.57	$ 380.95	$ 476.19	$ 190.47	$ 2,000	$ 2,000
Overhead ($)	$ 2,095.24	$ 1,714.29	$ 1,523.81	$ 1,904.76	$ 761.90	$ 8,000	$ 8,000
Total ($)	**$ 15,819.05**	**$ 14,000.36**	**$ 7,784.76**	**$ 5,580.95**	**$ 2,302.37**	**$ 45,487**	**$ 47,031**

Scheduling

Table 11: Tasks and Their Corresponding Start and Finish Dates

Task	Start	Finish
1.0 Site Investigation	1/19/2018	1/26/2018
2.0 Site Map	1/26/2018	2/02/2018
3.0 Conceptual Design (Some Drafting)	2/02/2018	2/22/2018
4.0 Hydraulics/ Hydrology	2/22/2018	3/15/2018
5.0 Life Cycle Cost Analysis	3/15/2018	3/30/2018
6.0 Final Design (Drafting)	3/30/2018	4/25/2018
7.0 Project Management	1/19/2018	5/11/2018

Future Work

- Design Phase has been completed
- Implementation Phase is remaining
  - Provide the plans and conducted research to a professional licensed engineer
  - Hire a contractor to perform the work
- Resident may implement an alternative prior to asphalt design

Acknowledgements

Dianne McDonnell

- Resident of Lockett Ranches
- Professor at Northern Arizona University

Brendan Russo

- CEFNS Professor
- Specializes in Traffic Operations

Earth Pro

- Local contractor
- Served as a resource throughout duration of the project

References

[1]*Global Information System Arc Map*. ESRI, 2018.

[2]"Arizona 811 - Know whats below. Call or Click before you dig.", *Arizona 811*, 2018. [Online]. Available: http://www.azbluestake.com/. [Accessed: 27-Apr- 2018].

[3] Stormwater (Multi-Sector General Permit/MSGP) | City of Flagstaff Official Website. [Online]. Available: https://www.flagstaff.az.gov/3281/Industrial-Stormwater. [Accessed: 20-Mar-2018].

Questions?