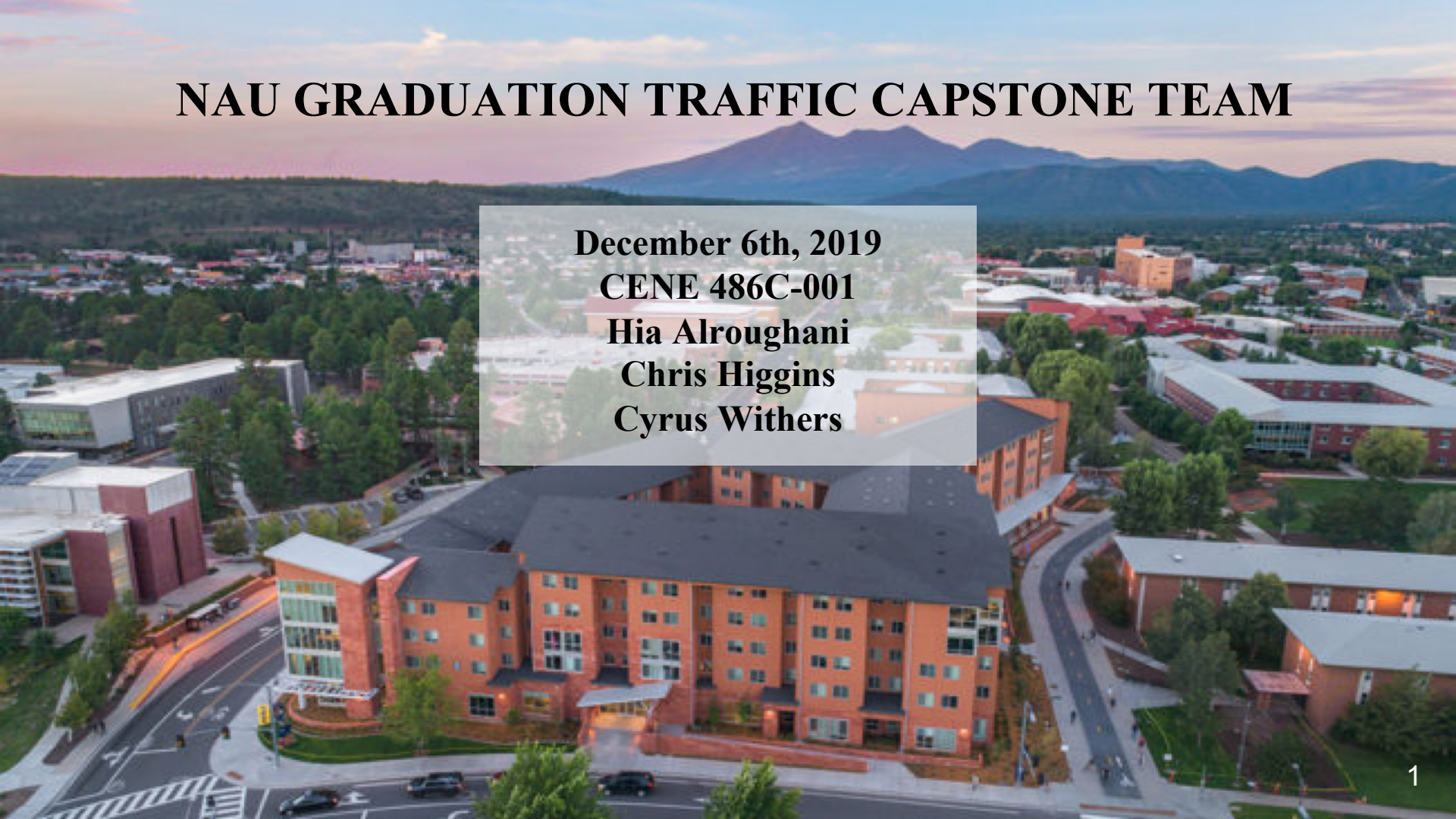
NAU GRADUATION TRAFFIC CAPSTONE TEAM



December 6th, 2019
CENE 486C-001
Hia Alroughani
Chris Higgins
Cyrus Withers

PROJECT BACKGROUND

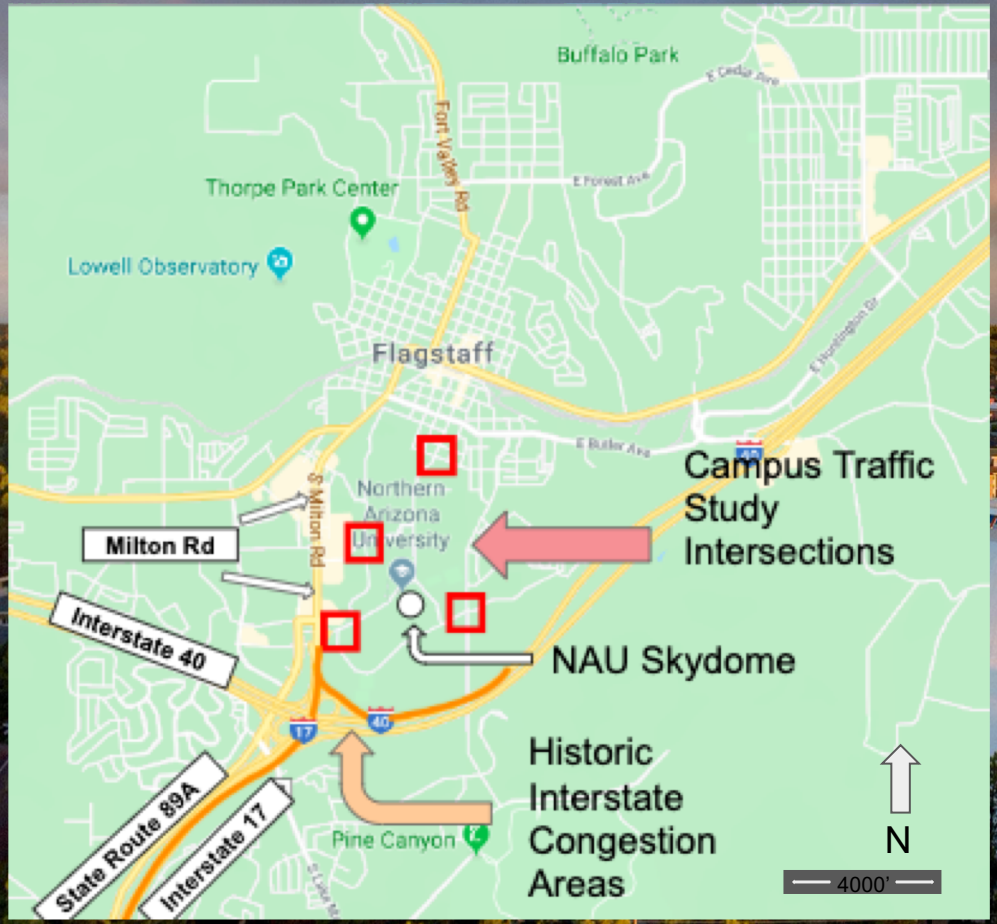


Figure 1: Site Map [1]



Figure 2: NAU intersections location [2]

PROJECT PURPOSE

Purpose

- ❑ Collect Traffic Volume Data for ADOT, NAU PD, Parking Services
- ❑ Design a Traffic Management Plan
  - ❑ Reduce special event traffic congestion: I-40,I-17,SR 89A, NAU Campus
  - ❑ Recommend short, moderate, and long term traffic improvement solutions



Figure 3: University and Knoles intersection; photo taken by Chris

GRADUATION TRAFFIC STUDY

Jamar Boards + Road Tube Counters

- ❑ Jamar boards used at four study intersections from 8 am to 12pm Friday, May 10th, 2019
- ❑ Tube counters collected volume data from May 9th to the 13th



Figure 4: Jamar board used to collect intersection turning movements of traffic during May 2019 NAU Graduation [3]

BASELINE TRAFFIC STUDY

Road Tube Counters

- ❑ Placed at four study intersections
- ❑ Collected traffic volume data from September 19th to the 26th, 2019
- ❑ Established the magnitude of graduation traffic events for NAU campus



Figure 5: Road Tube Counter control box, taken by Hia

TRAFFIC ANALYSES

Road Tube Counter and Jamar Board Volume Analysis

- ❑ Turning Movement Vehicles
- ❑ Pedestrian
  - ❑ Baseline Study

    (September 19th-26th)
  - ❑ Graduation Study

    (May 10th-11th)



Figure 6: Road Tube Counter at University Drive behind Target; photo by Chris

Table 1: Graduation and Baseline Traffic Study Road Tube Volumes

Intersection	Total Vehicles 8a-11a on Friday, September 20, 2019		Total Vehicles 8a-11a on Friday, May 10, 2019		Changes from Graduation vs. Baseline	
	Ingress	Egress	Ingress	Egress	Ingress	Egress
1. University Dr and Knoles Dr	632	538	931	802	+ 299	+ 264
2. San Francisco St and Franklin Ave	13	120	843	637	+ 830	+ 517
3. Lone Tree Rd and Pine Knoll Dr	623	402	655	682	+ 32	+ 280
4. McConnell Dr and Pine Knoll Dr	941	671	1517	694	+ 576	+ 23

TRAFFIC SIMULATION INTERSECTIONS USING VISSIM



Figure 7: NAU Campus Map of study intersections highlighted in (pink) [1]

Study Intersections:

1. University Dr and Knoles Dr
2. San Francisco St and Franklin Ave
3. Lone Tree Dr and Pine Knoll Dr
4. McConnell Dr and Pine Knoll Dr

VISSIM Software Purpose:

- ❑ Test performance of:
  - ❑ Traffic movement simulation
  - ❑ Current/Proposed roadway geometry
  - ❑ Mode of transportation
  - ❑ Traffic efficiency
  - ❑ Variable traffic volume tests
  - ❑ Vehicle movement and interaction [4]

VISSIM ROADWAY SIMULATIONS



Figure 8: University Dr and Knoles Dr intersection [1]

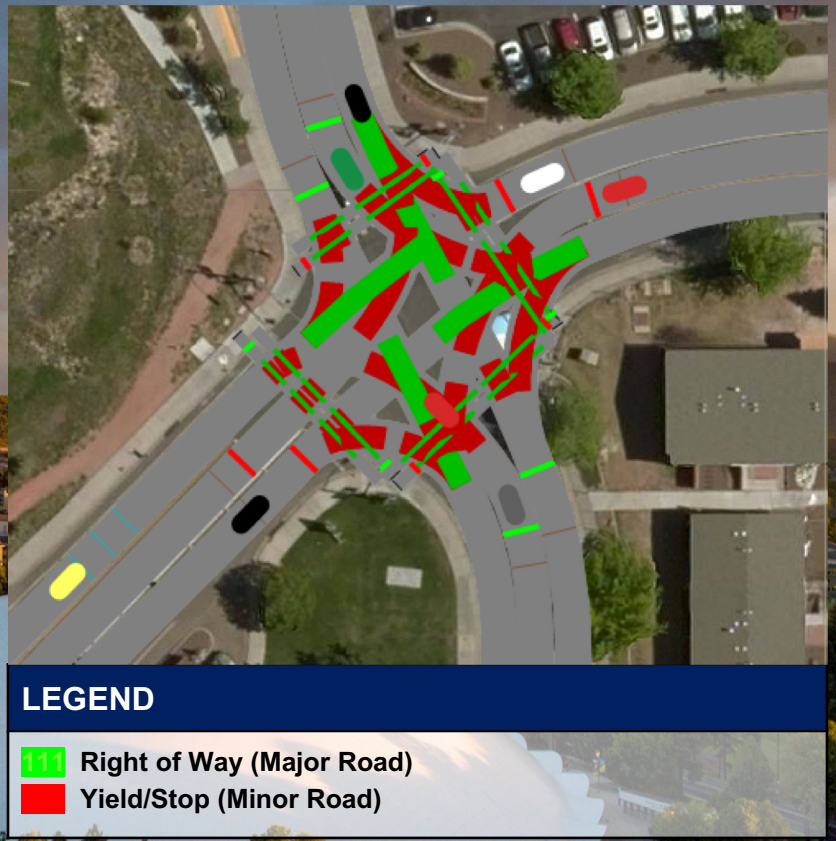


Figure 9: VISSIM Model of University Dr and Knoles Dr intersection

VISSIM ROADWAY SIMULATIONS



Figure 10: San Francisco St and Franklin Ave intersection [1]

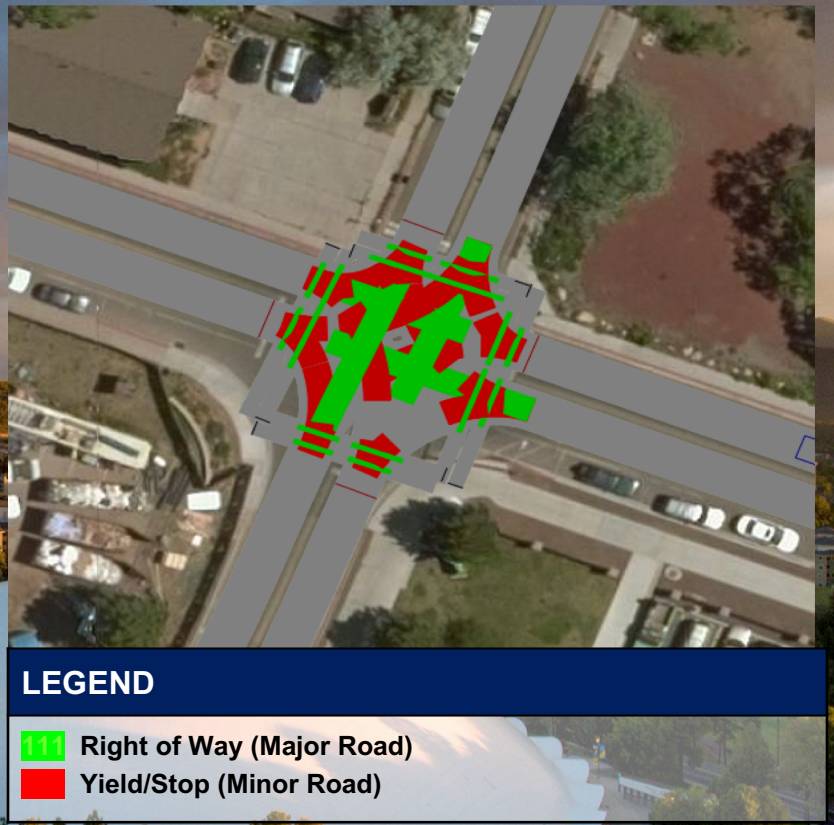


Figure 11: VISSIM Model of San Francisco St and Franklin Ave intersection

VISSIM ROADWAY SIMULATIONS



Figure 12: Lone Tree Rd and Pine Knoll Dr intersection [1]

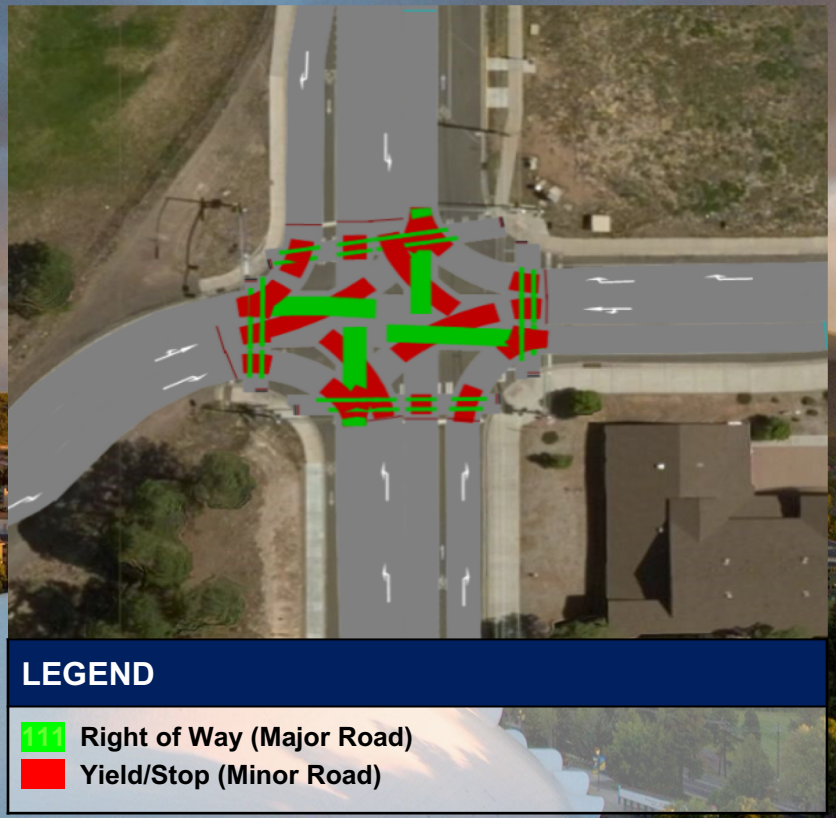


Figure 13: VISSIM Model of Lone Tree Rd and Pine Knoll Dr intersection

VISSIM ROADWAY SIMULATIONS



Figure 14: McConnell Dr and Pine Knoll Dr intersection [1]

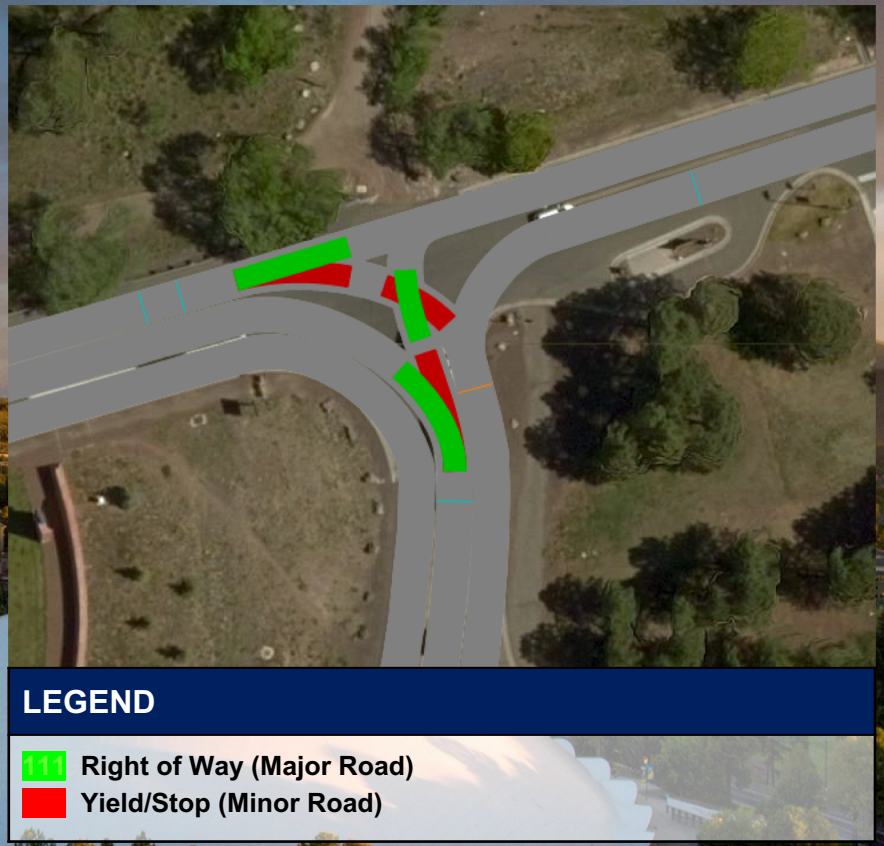


Figure 15: VISSIM Model of McConnell Dr and Pine Knoll Dr intersection

EVALUATION OF ALTERNATIVES

Table 2: Project Solution Decision Matrix rated on a scale of 1 to 10

Traffic Circulation Possible Recommendations							
Solution	**Cost**	**Weight**	**Effectiveness**	**Weight**	**Safety**	**Weight**	**Total**
Electronic Signs [5]	6	0.5	9	0.25	8	0.25	**7.25**
Personnel (flaggers)	8	0.5	9	0.25	7	0.25	**8**
Traffic Cones	6	0.5	9	0.25	9	0.25	**7**
Promote public transit (bus service) usage for in-town event-goers	9	0.5	5	0.25	10	0.25	**8.25**
Promote bicycle usage	10	0.5	0	0.25	5	0.25	**6.25**
Additional campus bus shuttle frequency (every 10 minutes instead of 15)	7	0.5	8	0.25	9	0.25	**7.75**
Add roundabout at McConnell and Pine Knoll	5	0.5	9	0.25	10	0.25	**7.25**
Route traffic down JW Powell Blvd from I-17	6	0.5	9	0.25	8	0.25	**7.25**

SHORT-TERM/LOW COST ALTERNATIVES

Table 3: Short-term Roadway Recommendations with minimal NAU investment

Improvements	One Semester Budget Estimation	Total Cost Est.
• Rent electronic changing message highway signs for interstate and surface street traffic	~$750/week for each rental sign needed (10 signs recommended)	$7,500
• Traffic operators (student workers or NAU Police Officers)	~$1,600/day for 14 student workers working 12 hour shifts	$3,200
• Rent additional traffic safety cones	$10/cone/week	$5,000
• Promote public transit (bus service) usage for in-town event-goers	$430 (each semester)	$430
	Total Cost: Friday & Saturday Ceremonies	$16,130

MID-TERM/MODERATE COST ALTERNATIVES

Table 4: Mid-term Roadway Recommendations

Improvements	One Semester Budget Estimation	Total Cost Est.
• Increase Shuttle Van Service to every 10 minutes on campus	$2,340/day for South Commuter and San Francisco Garage	$4,680
• Promote public transit (bus service) usage for in-town event-goers	$470 (each semester)	$470
• Rent electronic changing message highway signs for interstate and surface street traffic	~$750/week for each rental sign needed (6 signs recommended)	$5,600
• Rent additional traffic safety cones	$12/cone/week	$6,000
• Traffic operators (student workers or NAU Police Officers)	~$2,000/day for 14 student workers working 12 hour shifts	$4,000
• Use Knoles Parking Garage as spillover if San Francisco Garage is full	$1,170/day	$2,340
	Total Cost: Friday & Saturday Ceremonies	**$23,090**

LONG-TERM/HIGH COST ALTERNATIVES

Table 5: Long-term Roadway Recommendations

Improvements	One Semester Budget Estimation	Total Cost Est.
• Roundabout Construction at McConnell and Pine Knoll	~$500,000 [6]	$500,000 (one-time)
• Route traffic down a new alternate route on JW Powell	$3,300/day for electronic signs and additional Police Officers	$6,600
• Additional Park'N'Ride Bus shuttle from Knoles Parking Garage	$1,456/day for 2 additional shuttles	$2,912
• Promote public transit (bus service) usage for in-town event-goers	$500 (each semester)	$500
• Shuttle Van Service every 10 minutes on campus	$2,900/day for South Commuter and San Francisco Garage	$5,800
	Total Cost: Friday & Saturday Ceremonies	**$528,112**

PRESENT WORTH OF ALTERNATIVES

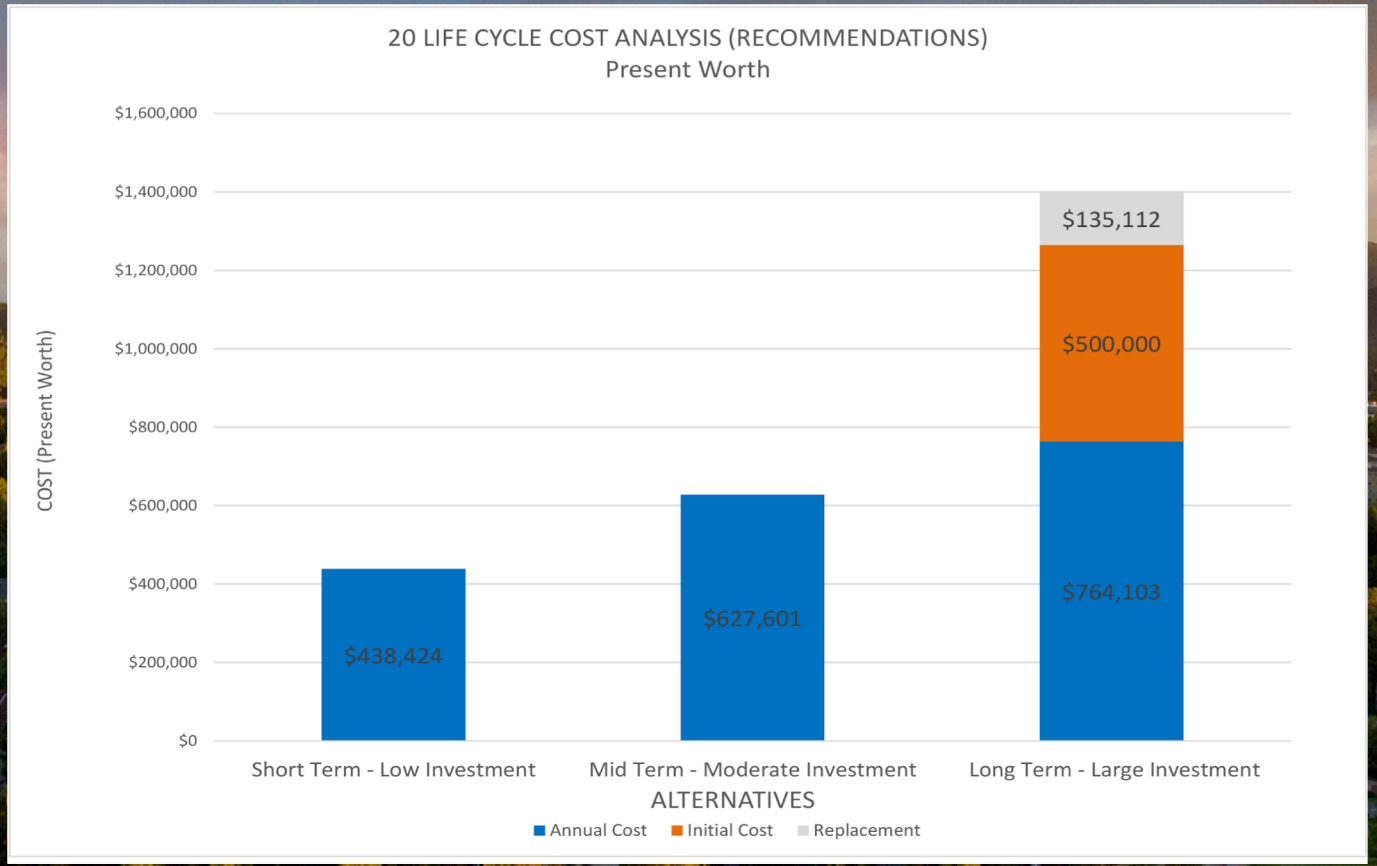


Figure 16: Present Worth Analysis of short, mid, and long-term alternatives.

POTENTIAL LONG-TERM TRAFFIC MANAGEMENT ALTERNATIVES

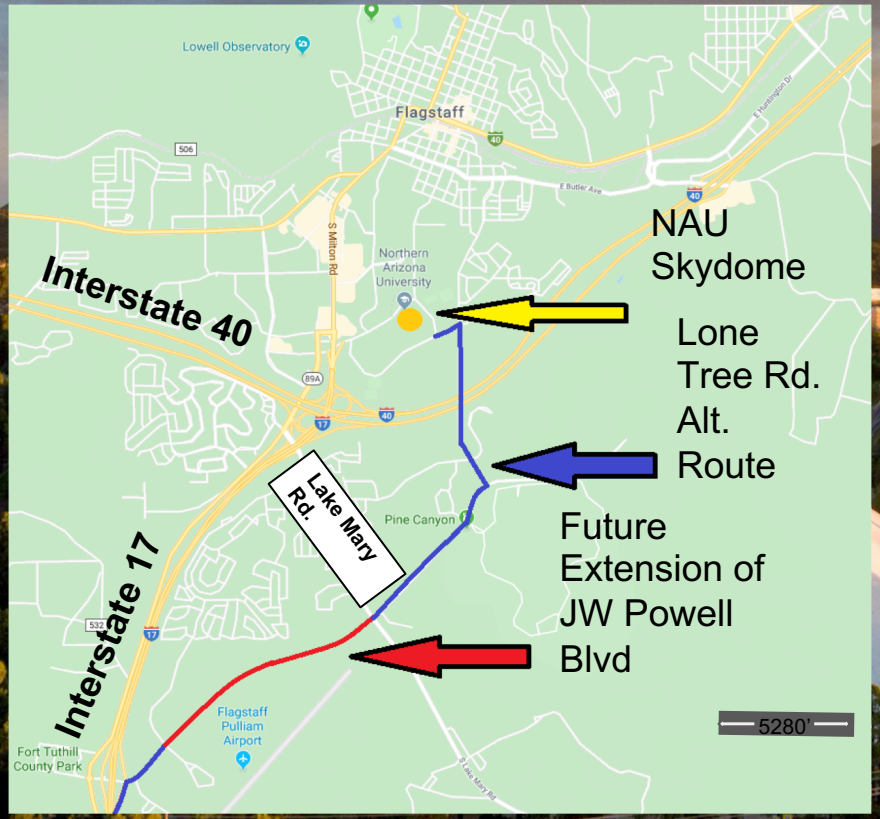


Figure 16: Map of Alternate Route [1]

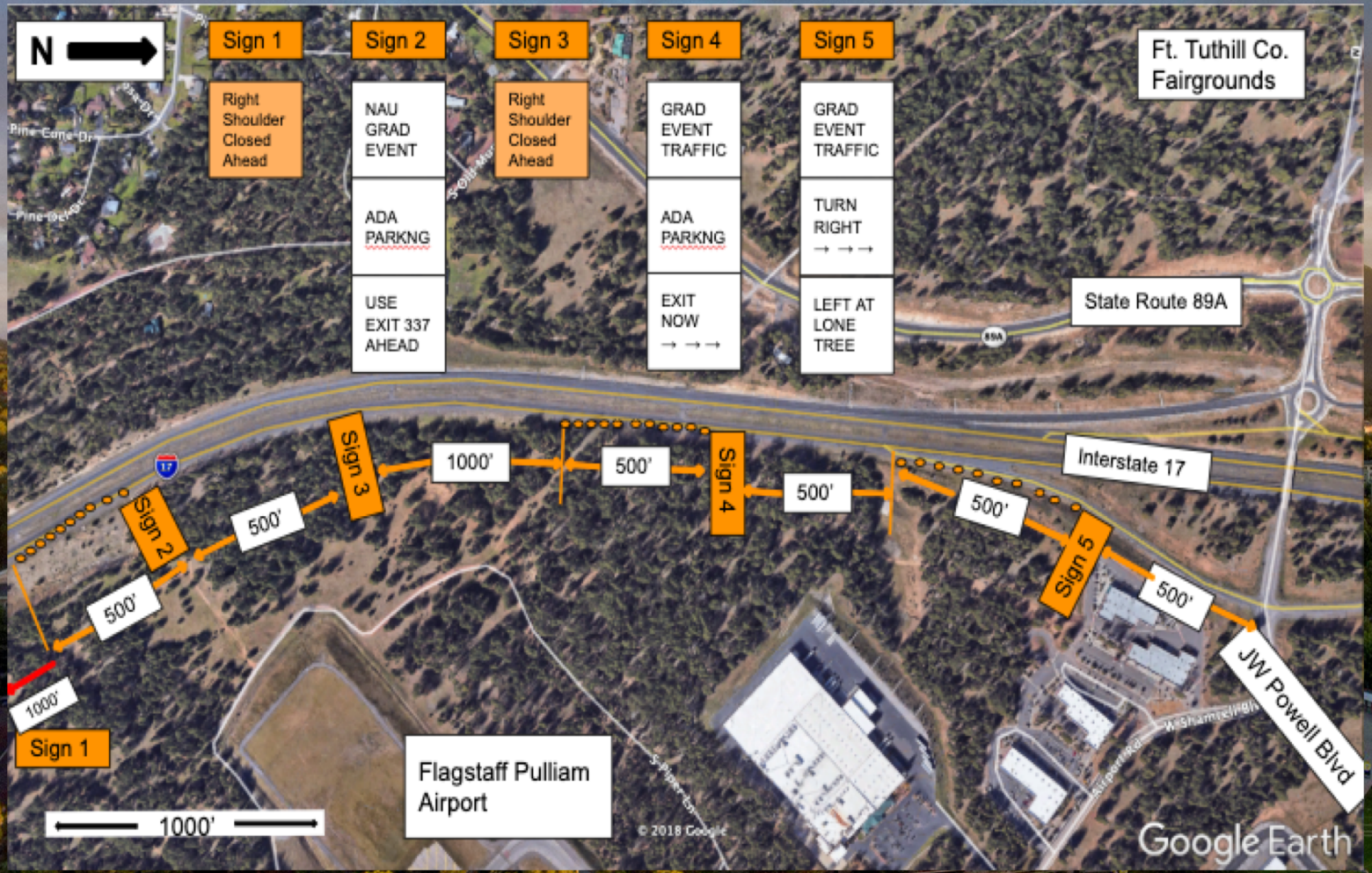


Figure 17: Possible Alternate Route, Long-Term Traffic Circulation Plan by Flagstaff Pulliam Airport [1]

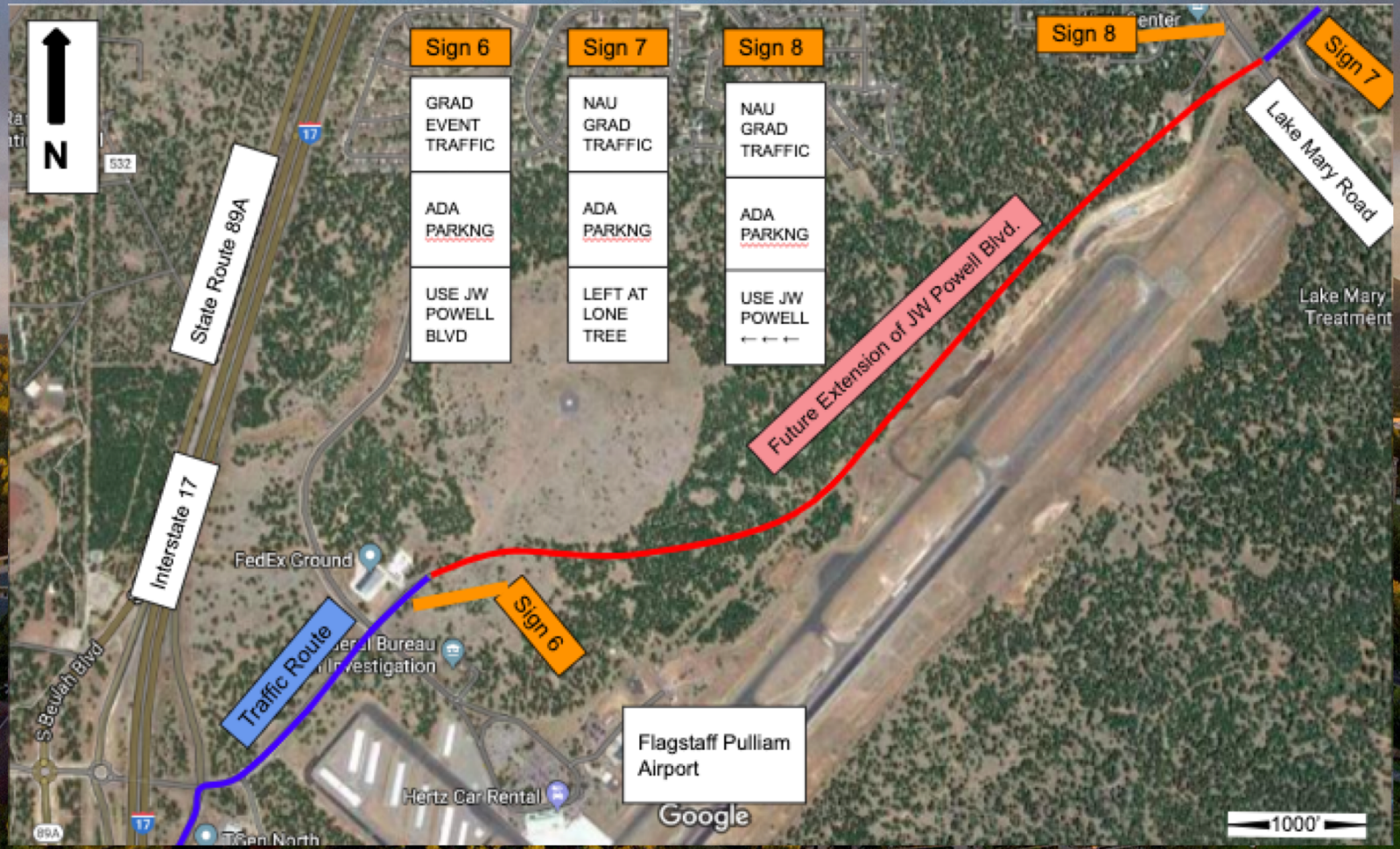


Figure 18: Possible Alternate Route, Long-Term Traffic Circulation Plan by Flagstaff Pulliam Airport [1]



Figure 19: Alternate Route, Long-Term Traffic Circulation Plan by JW Powell Blvd. [1]

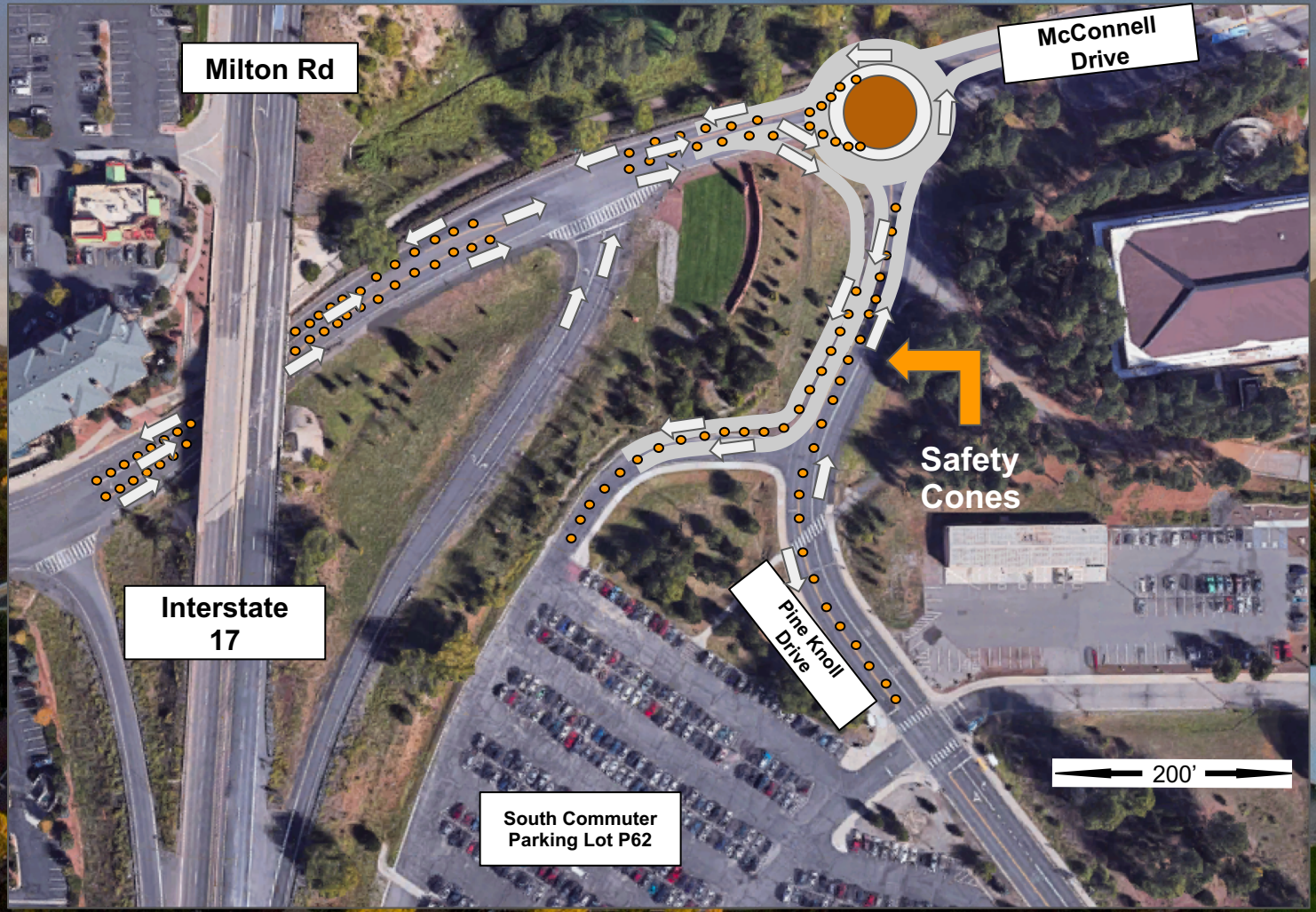


Figure 20: Long-Term Traffic Circulation Plan Roundabout [1]

PROJECT IMPACTS

Table 8: Positive and Negative Impacts

	Public Safety		Socio-Economic		Environmental	
	Positive	Negative	Positive	Negative	Positive	Negative
Short Term - Low Cost	Traffic Speed Reduction	Safety of Flaggers and Workers	Low Installation Cost	Increased Special Event Cost		Short Material Life Cycle
	Increased Efficiency		Reusable Equipment	Possible Injury to Workers		
Mid Term - Moderate Cost	Traffic Speed Reduction	Possible Confusion	Moderate Installation Cost	Increased Special Event Cost	Decrease in Energy Use	
	Decreased Traffic Congestion	More Difficult for ADA Accessibility	Fuel Efficiency			
Long Term - High Cost	Increased Efficiency	Pedestrian Access	Decrease in Traffic Incidents	Increased Special Event Cost	Decreased Wait Time (Delay)	Materials and Energy Used for Installation
	Decreased Wait Time (Delay)	Possible Confusion	Decreased Wait Time (Delay)	High Installation Cost	Number of Vehicle Stops	

SUMMARY OF ENGINEERING WORK



Figure 21: Jamar Board Volume Study at Lone Tree and Pine Knoll intersection; photo credit Hia Alroughani



Figure 22: Road Tube Counter Assemble at Lone Tree and Pine Knoll intersection; photo credit Chris Higgins

1. Engineering Work Completed To Date
   - Graduation Traffic Study
   - Baseline Traffic Study
   - Traffic Volume Analysis
   - Traffic Simulations
   - Traffic Flow Maps
   - Short Term, Moderate Term, and Long Term Recommendations
   - Recommendation Cost Analysis
   - Impacts Report

SUMMARY OF ENGINEERING COSTS

Table 9: Positive and Negative Public Safety Impacts of the Proposed Solutions

	Classification	Rate, [$/hr]	Hours	Cost [$]
1.0 Personnel	Senior Engineer	$200/hr	99	$19,800
	Engineer	$70/hr	261	$18,270
	Intern	$25/hr	190	$4,750
	Total Personnel			$42,820
2.0 Travel	N/A	N/A	N/A	$0
3.0 Supplies	4 Jamar Boards and 3 Road Tubes	$45/hr	24	$4,320
4.0 Subcontract	N/A	N/A	N/A	$0
5.0 Total			**Actual Total**	**$47,140**
			Proposed Total	**$49,545**

Gantt Chart

Northern Arizona University Graduation Traffic Circulation Capstone Schedule

ID	Task Mode	Task Name	Duration	Start	Finish
0		CENE 476 - Schedule	164 days	Fri 4/26/19	Tue 12/10/19
1		1: Preliminary Site Visit	4 days	Fri 4/26/19	Wed 5/1/19
6		1: Preliminary Site Visit	4 days	Fri 4/26/19	Wed 5/1/19
11		2: Traffic Study	99 days	Fri 5/10/19	Tue 9/24/19
18		2: Traffic Study	109 days	Fri 5/10/19	Tue 10/8/19
25		3: Data Analysis	27 days	Mon 9/16/19	Tue 10/22/19
30		3: Data Analysis	42 days	Tue 8/27/19	Tue 10/22/19
35		4: Traffic Mgmt. Recommendations	25 days	Wed 10/23/19	Tue 11/26/19
40		4: Traffic Mgmt. Recommendations	25 days	Wed 10/23/19	Tue 11/26/19
45		5: Impacts	20 days	Wed 10/30/19	Tue 11/26/19
50		5: Impacts	20 days	Wed 10/30/19	Tue 11/26/19
55		6: Deliverables	78 days	Mon 8/26/19	Tue 12/10/19
69		7: Project Management	78 days	Mon 8/26/19	Tue 12/10/19

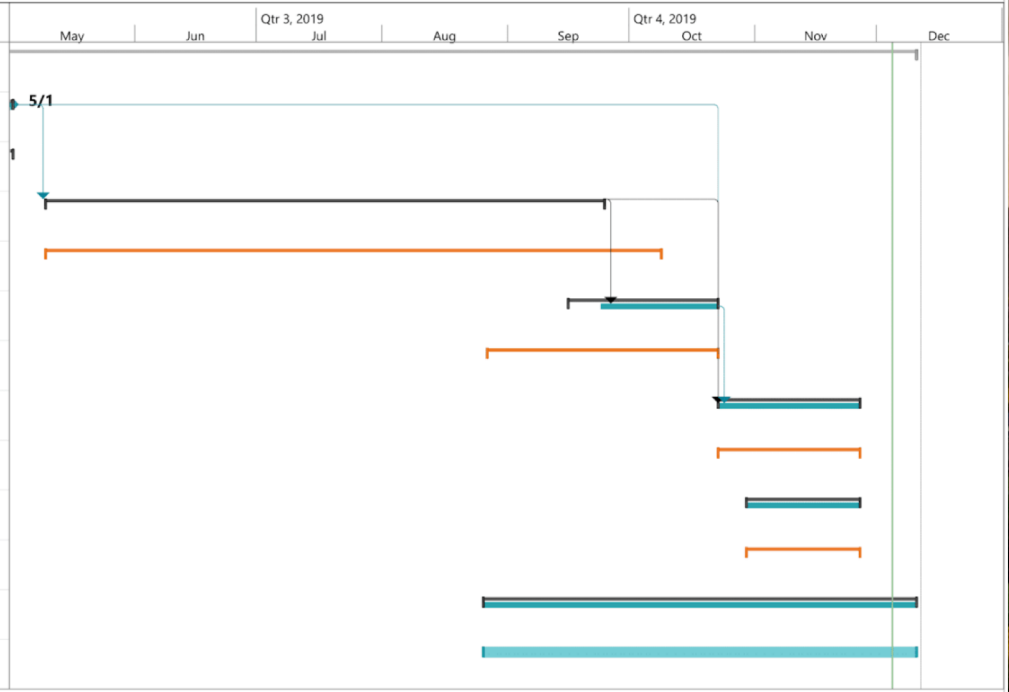


Figure 23: Gantt Chart with Updated Work Schedule

Legend:
Orange – Updated Schedule
Green/Black – Original Schedule

Acknowledgments

Sponsors

AZTrans at NAU



City of Flagstaff



Special Thanks to:

Stephanie Sarty, P.E:
For lending and assisting with road tube counters and Jamar Boards

Abdullah Alenezi:
For his help with the NAU Traffic Capstone Team's Design Website coding

Hunter Schnoeblen:
For his help with collecting graduation traffic data at San Francisco St & Franklin Ave

Grace Garwin:
For her assistance with learning Microsoft project

David Lemke:
For his assistance with learning the VISSIM modeling software

CONCLUSION

- Final Engineering Costs - **$47,140**
- Total Engineering Hours - **550**

Final Design Recommendations

- Short-Term Investment Cost - **$16,130**
- Mid-Term Investment Cost - **$23,090**
- Long-Term Investment Cost - **$528,112**

REFERENCES

[1] Google Maps. (2019). Google Maps. [online] Available at: https://www.google.com/maps/@35.1388312,-111.6869679,140a,35y,38.97t/data=!3m1!1e3 [Accessed 3 Dec. 2019].

[2] In.nau.edu. (2019). [online] Available at: https://in.nau.edu/wp-content/uploads/sites/119/2019/02/Campus-Map-FY19-Y-P62-change.pdf [Accessed 16 Apr. 2019]

[3] Annarelli, S. (2014). *State College Area School District begins traffic count near high school*. [online] Centre Daily Times. Available at: https://www.centredaily.com/news/local/community/state-college/article42861729.html [Accessed 5 Dec. 2019].

[4]"PTV Vissim new", *PTV-Group*, 2019. [Online]. Available: https://www.ptvgroup.com/en/solutions/products/ptv-vissim/. [Accessed: 05- Dec- 2019]

[5] Arizona Dept. of Transportation (2018). NAU Graduation December 2018. Flagstaff: ADOT, pp.1-3.

[6]"Safety | Federal Highway Administration", *Safety.fhwa.dot.gov*, 2019. [Online]. Available: https://safety.fhwa.dot.gov/intersection/innovative/roundabouts/case_studies/fhwasa09018/. [Accessed: 26- Nov- 2019]

McConnell Dr & Pine Knoll Dr Roundabout
VISSIM Simulation

