ARROWHEAD CENTER TIS Traffic Impact Study Project ID: CEEn_2017CPST_003

by

GSM Engineers Josh Gibbons Gabrielle Jones Shanna Carroll Mitchell Hadfield

Capstone Project Final Report

Submitted to

Bob Tandler Fritzi Realty

Department of Civil and Environmental Engineering Brigham Young University

April 18, 2018

Executive Summary

PROJECT TITLE:

PROJECT ID: PROJECT SPONSOR: TEAM NAME: Arrowhead Center - Transportation & Urban Planning Design Data Review & Assessment CEEn-2017CPST-003 Fritzi Realty GSM Engineers

This project focuses on transportation and urban planning design located at Arrowhead Center in Spanish Fork, Utah. Design is dependent upon the new residential developments planned for the four parcels of land provided for the project. Based on this information, Trip Generation Manuals provided by the Institute of Transportation Engineering (ITE), and growth rates for the area were used to project traffic patterns according to the Utah Department of Transportation's (UDOT) Traffic Impact Study Guidelines. This information was used to produce a traffic impact study as required by the city of Spanish Fork to support an application for a Master Plan, PUD or Redevelopment Plan.

To create the traffic impact study, traffic counts were performed at five intersections surrounding the property during weekday peak hours from 7 to 9 am and 4 to 6 pm to satisfy Spanish Fork city requirements. Volumes were projected using information from the ITE Trip Generation Manuals, and modeled in Synchro traffic modeling software. Recommendations and discussion for intersection and/or roadway changes were determined with corresponding Level of Service (LOS) analysis. During this process, the project team consulted with the project manager, Joshua Gibbons, and BYU transportation engineering professor, Dr. Grant Schultz.

All traffic counts for five major intersections surrounding the parcels had been conducted by March 1st, 2018 and the corresponding peak hour factors (PHF) and growth rates have been calculated. A Synchro model for the roadways surrounding the parcels was created, and contains the traffic volumes, PHFs, and growth rate values inserted into it for current and projected conditions. The Traffic Impact Study has been created by GSM Engineers, which includes the results of the Synchro model.

The following information is contained in this final report: a figure containing a representation of the Synchro model with pertinent roadways and intersections, traffic count data, PHF values, and growth rates, and a traffic impact study.

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Introduction

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The following information is contained in this progress report: a figure containing a representation of the Synchro model with pertinent roadways and intersections, traffic count data, PHF values, growth rates, and a traffic impact study.

<u>Schedule</u>

Our original schedule, shown in Table 1, created for the project proposal differs from the actual schedule due to a few minor setbacks.

Dates	Task		
Last Day of each month from Jan 2018 to April 2018	Monthy reports		
1/8/2018	Kickoff Team meeting		
1/8/2018	Identify Locations for Traffic Counts		
1/8/2018-1/27/2018	Traffic Counts		
1/29/2018-2/3/2018	Software Modeling (Current Conditions)		
2/5/2018-2/17/2018	New Development Impact Study		
2/19/2018-2/24/2018	Software Modeling (Future Conditions)		
2/26/2018-3/17/2018	Traffic Impact Study		
3/19/2018-3/24/2018	Poster		
3/26/2018-3/31/2018	Presentation		

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The original schedule has been updated to represent the actual timeline for the project. These changes are reflected in Table 2.

Dates	Task
1/8/2018	Kickoff Team Meeting
1/8/2018	Identify Locations for Traffic Counts
1/26/2018	January Status Report Complete
1/29/2018	Begin Synchro Model Set up
2/17/2018	Begin Traffic Impact Study Draft
2/26/2018	February Status Report Complete
3/1/2018	All Traffic Counts Complete
3/5/2018	50% Design Report Complete
4/10/2018	Finish Traffic Impact Study/Modeling
4/12/2018	Finish Poster
4/12/2018	Presentation in class, booth presentation
4/12/2018	Presentation to sponsor
4/18/2018	Submit final report, hours, evaluations

 Table 2. Updated schedule timeline for project.

Assumptions & Limitations

One of the limitations encountered was in conducting traffic counts. There were more intersections that needed to be counted than team members to conduct the counts, and only one of the team members was able to count the AM peak hours due to schedule conflicts. To overcome this limitation, the team recruited several people including friends and family to assist the team members in doing the traffic counts. Even with this assistance, counts were taken at different times, which made the volumes between intersections uneven. Appropriate adjustments were made in order to allow the Synchro model to function smoothly.

One assumption made was that the PM peak hour traffic counts would always be higher than the AM or vice versa. We assumed that if we found that one of them was always higher than the other, we would only need to do PM counting or only AM counting. After comparing the Arrowhead and Main Street intersection and the Calpac and Arrowhead intersection, it was concluded that sometimes the AM traffic counts were greater and sometimes the PM traffic was greater. We disregarded our original assumption and proceeded to collect traffic count data at every intersection for both AM and PM hours. Because the traffic was greater for the larger intersection in the morning, an AM peak hour was selected.

The BYU Civil Engineering 201 class came up with three different scenarios for land use that they wanted the team to model using Synchro. Another capstone group also sent us a site plan to model in Synchro. An original assumption made was that we would model all three scenarios in Synchro Software. Due to time limitations and quantity of work, the team decided to model the plan provided by Fritzi Realty. Trip generation numbers are provided for one other scenario received in the Traffic Impact Study.

Design, Analysis & Results

Using Annual Average Daily Traffic (AADT) data provided by UDOT, the following growth rates were calculated for major roadways surrounding the project:

Table 3: Growth Rates

Roadway	Arrowhead	N Main	Mid Main St/	S Main St/State	E Woodland
	Trail Rd/164	St/State Rd/198	State Rd/198	Rd/198	Hills Dr
Growth Rate	5.35%	1.80%	-2.32%	-1.32%	-3.72%

Because the nature of the project will increase the traffic in the area, a positive growth rate is necessary. The team calculated and applied a growth rate of 3.6% by averaging the two positive growth rates.

According to the City of Spanish Fork TransPlan40, by 2024 South State Road (SR-198) is going to be widened from 2 lanes to 4 lanes between the intersections of Main Street and Woodland Hills Drive. The Synchro Model for future traffic conditions in 2027 was modified with the assumption that the lane widening will be completed by 2027 in accordance with projected pavement design found in TransPlan40.

The Synchro Models for current and future conditions were developed from the site plan sent by Fritzi Realty. Signal Timing for the intersections involved in the project were obtained from UDOT and input into the models. Reports for the analysis of current, future 2020, and 2027 traffic volumes were developed by Synchro and are included in appendix of the traffic impact study.

Lessons Learned

One of the biggest challenges encountered during this project was coordinating traffic counts. Due to the small windows of viable traffic data collection hours, only one member of the team was able to conduct the AM traffic counts. Because only one team member did all five intersection traffic counts, this delayed and altered the original schedule provided in the proposal. The counts were finished by March 1st, 2018, and other necessary tasks were completed or started in the meantime, such as the start of the Traffic Impact Study, calculation of PHFs and growth rates, creation of the Synchro model, and review of trip generation principles.

Other challenges consisted of schedule coordination, deciding which intersections to count, and learning necessary Synchro software and principles for the creation of a Traffic Impact Study. Challenges were all resolved with the help of a graduate mentor taking time during our bi-weekly meetings to teach us what we needed to know and answer any questions.

One of the most important challenges the team faced was involved with Synchro Modeling. The team originally was planning to model current and future conditions for each of the site plans. Three site plans were sent: one from BYU Engineering 201 Class, one from the Arrowhead Managing BYU Capstone Team, and one from Fritzi Realty. A final decision was made by GSM engineers to use the site plan sent from Fritzi Realty to model the current and future traffic conditions.

Conclusions

From the results of this project, our team has learned how to set up and use Synchro Software to model traffic data obtained from traffic counts. Our team has also learned how to calculate peak hour volumes as well as peak 15 minute volumes in Microsoft Excel. The team has effectively compared the intersections and determined which intersections had the unacceptable Levels of Service.

Our team has also gained a lot of insight from the graduate mentor and Dr. Schultz about how to determine the trip generation using trip generation manuals, as well as other useful resources online on how to create a formal traffic impact study according to Spanish Fork City requirements and Utah Department of Transportation guidelines. The graduate mentor also taught our team how to accurately determine trip distribution and trip assignment in order to find a good estimate for future traffic.

Our team has learned how to write a formal traffic impact study according to the guidelines set forth by UDOT with data obtained in accordance with the city of Spanish fork requirements. Based on the information gathered from Synchro reports, our team has been able to make recommendations to Fritzi realty in order to provide ideal traffic situations based on land usage.

Recommendations

Based on the Synchro Modeling LOS reports, two of the intersections, Woodland Hills Drive with SR-198 and South Mill Road with Arrowhead Trail Road are already failing in 2018. The same two intersections were also reported to fail in future years (2022 and 2027), as well. In order to improve these intersections to LOS C, GSM Engineers recommend to Fritzi Realty:

At the intersection of South Mill Road and Arrowhead Trail road, add traffic signals. The modification to convert it to a signalized intersection will bring the LOS to a C in 2027 without any lane modifications.

At the intersection of Woodland Hills Drive and SR-198, convert the westbound road segment to a combined through and left turn lane with two right turn pockets. This modification along with increasing the maximum initial green signal time and increasing the maximum split time for the same approach, will bring the LOS to a C in 2027.

The intersection of Del Monte Road and Arrowhead Trail road was reported LOS C in 2018 and both future years so no recommendations are required at this intersection because it will operate at minimum optimal levels. The intersection of Calpac Avenue and Arrowhead Trail road was reported LOS B in 2018 and future years so no recommendations were required. The intersection of Arrowhead Trail Road and Main Street is reported LOS B for current and future years so no modifications need to be made.

Two new intersections will be added along SR-198, one three-way intersection and one four-way intersection. In 2022, the three-way intersection was reported LOS D and the four-way intersection was reported LOS F. Both intersections were reported LOS F by 2027. To improve these intersections, modifications adding another lane to the minor approach did not yield an acceptable LOS. Thus, through and left turn movements should be disallowed, which will bring LOS to a C in 2027.

Appendix A

BYU | CIVIL & ENVIRONMENTAL ENGINEERING **IRA A. FULTON COLLEGE**

AM

Time

		SR-164/Arrowhead Trail Road				SR	-198/N	1ain Str	eet				
	-		EASTBOUNE)	6	WESTBOUND)		NORTHBOUN	ID	S	OUTHBOUN	D
		٦		ſ	1		ſ	٦	Î	ſ	7	Ţ	ſ
	a (3	LEFT	THROUGH	RIGHT	LEFT	THROUGH	RIGHT	LEFT	THROUGH	RIGHT	LEFT	THROUGH	RIGHT
	7:00:00 AM	73		6				17	214			115	91
Y	7:15:00 AM	71		5				20	202			107	97
g	7:30:00 AM	67		11				25	224			121	100
e e	7:45:00 AM	95		5				21	280			173	134
=	8:00:00 AM	108		7				19	228			107	106
2	8:15:00 AM	99		5				4	170			98	65
4	8:30:00 AM	49		5				1	185			110	49
	8:45:00 AM	70		2				3	220			112	45
	4:00:00 PM	80		5				7	170			164	68
V	4:15:00 PM	71		6				9	156			159	72
a	4:30:00 PM	48		3				4	151			196	65
e	4:45:00 PM	71		9				8	158			205	64
-	5:00:00 PM	74		10				8	148			239	93
2	5:15:00 PM	76		9				5	161			250	94
Δ	5:30:00 PM	55		9				6	173			250	85
	5:45:00 PM	49		10	7			7	145			217	82
	Peak V	341		28			17	85	934			508	437
	V15	95		5				21	280			173	134
	PHF	0.897		1.400	0			1.012	0.834			0.734	0.815
	Overa	all.											
	Peak V	2333											
	V15	708											
	PHF	0.824											

Figure 1. Arrowhead and Main Street Example Traffic Count Excel Sheet



Figure 2. Aerial view of the project location

876 N University Ave Apt. 2 Provo, UT 84604	801-889-4218 jdgibbons19@gmail.com
EDUCATION	 Master of Science, Brigham Young University; Provo, UT – April 2018 Performing research with Utah DOT regarding intersection safety Serving as President of BYU ITE student chapter
	 Bachelor of Science, Brigham Young University; Provo, UT – April 2017 3.77 GPA Civil Engineering; ACTFL Spanish Certificate Member of ASCE and ITE
WORK EXPERIENCE	 Transportation Engineer Intern, Hales Engineering; Lehi, UT – April 2016-Present Complete traffic impact studies, parking studies, and safety studies for clients in both the private and public sector Assist in the development of transportation master plans and estimating travel demand using QRS II modeling software Create a new company website to improve marketing efforts
	 Research Assistant, Brigham Young University; Provo, UT – July 2015-Present Work with a team of students and faculty researching traffic and safety for the Utah Department of Transportation Use VBA code in Microsoft Excel to automate data manipulation processes to save client several hours of time Write a manual with clear instructions of how to use the Excel spreadsheets
	 Project Engineer Intern, Okland Construction; Lehi, UT – August 2014-August 2015 Managed the digital plans of over 10 projects on site including hyperlinks, revision updates, and historical plan sets Lead a structural and architectural takeoff worth over \$250,000
SKILLS & ABILITIES	Proficient in Synchro/SimTraffic, AutoCAD, Microstation, and Bluebeam Revu
	Highly skilled in VBA coding in Microsoft Excel
	Trained in Cube and QRS II travel demand modeling software
	Strong problem-solving and analytical skills
	Spanish Language – Read, write, and speak fluently
OTHER EXPERIENCE	 BYU ITE Student Chapter Officer Secretary: April 2016 – April 2017 Chapter President: April 2017 – Present
	 LDS Church Mission to Oaxaca, Mexico – March 2011-April 2013 Led up to 20 other missionaries at a time in leadership positions Worked in mission office organizing dozens of new member records
	 Extra-curricular Activities Team captain of high school cross country team Taught piano lessons to 10 students and performed in several piano concerts

Gabrielle Jones

761 East 820 North Apt #212 Provo, Utah 84606 (206) 718-5149 gabriellejones06@gmail.com

EDUCATION

- Brigham Young University, Provo, UT
 - · Civil Engineering major, Mathematics minor
 - (Planning to take the FE Exam in 2018 and GRE 2018)

EXPERIENCE

Structural Engineering Intern - King County Metro Transit, Seattle, WA

June 2017 - August 28, 2017

- Designed a luminaire attachment to an existing jersey barrier
- Calculated seismic loads on a fluid filled tank and determined anchor embedment depth using Hilti Profis Anchor software
- · Determined total length of overhead trolley wire assets in AutoCAD
- · Plotted architectural CAD drawings for a bus driver comfort station project
- Attended construction site inspections and meetings with contractors/consultants

Executive Council Service Representative – Tribe of Many Feathers Club BYU, Provo, Utah September 2017 – present

- Initiate and supervise all service projects and requests
- · Work with other council members to incorporate events into the schedule
- Document all service projects and attend weekly council meetings

Lifeguard/Swim Instructor - Mary Wayte Pool, Mercer Island, WA

March 2014 - August 2016

Lifeguard/Swim instructor, cashier, facility preparation, and merchandise sales.

SKILLS

- Familiarity with IBC, ACI 318-14, ASCE 7-10, USGS, and Hilti Profis Anchor Software
- Taken an AutoCAD and Revit class; completed a team Revit project
- Proficient in Microsoft Word, Excel, Outlook, PowerPoint, and can type 70 words/minute
- Certified Lifeguard/AED/CPR/First Aid expires 2/20/2018

ACHIEVEMENTS

- Regional Concrete Canoe Competition, 2nd place Women Sprint; 2016 & 2017
- Materials Class Concrete Design Competition 3rd place; December 2016
- Engineering group team leader China study abroad; Spring semester 2016
- High School National Honor Society; 2011 2014

INTERESTS/ACTIVITIES

Structural Engineers Association of Washington Student Member	2017 present
Women in Engineering Peer Mentor	2016 - present
Concrete Canoe Club	2015 - present
Tribe of Many Feathers Club	2014 - present
American Society of Civil Engineers National/Local Student Member	2014 - present
Other Interests include swimming, tennis, painting, and ceramics	
VOLUNTEER EXPERIENCE	

Tribe of Many Feathers Club	2014 - present
The Church of Jesus Christ of Latter-day Saints	2008 - present
Rural Housing Development	2014 - 2015

2014 - (graduation December 2018)

Shannadeen Carroll

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enrolled)

EDUCATION

Bachelor of Science

Brigham Young University, Provo, UT

- Major: Civil Engineering with Structural or Transportation Emphasis
- Honors: Full and Half Scholarship Recipient, GPA: 3.76/4.00
- **Course Highlights:**
 - **Computational Methods** 0
 - Required use of Excel and Word
 - Drafting with CAD Applications 0
 - Structural Analysis
 - Elementary Soil Mechanics

PROFESSIONAL EXPERIENCE

Transportation Engineering Intern

AECOM, Murray, UT

- Wrote crash analyses and turn lane warrant memos for areas along US-40 and in Nampa, ID
- Assisted in BRT design and/or quality assurance for Phoenix, AZ, Omaha, NE, and Provo, UT
- Performed design and/or analysis in ArcMap, AutoCAD, Civil 3D, Microsoft Excel, MicroStation, SignCAD, and Synchro

Supervisor on the Floor

doTERRA International, Pleasant Grove, UT

- Applied Excel experience in assistance of the Shipping Department's reporting .
- Trained a team of 8-10 people on weekly company updates
- Mentored 10-12 newly trained international agents to improve confidence and knowledge
- Employed appropriate language and tact to calm upset customers
- Predicted possible problems customers may encounter and resolved them before they occurred
- Interacted with coworkers to find the best solutions for each individual customer

General Laundry Specialist

BYU Laundry, Provo, UT

- Worked in an efficient, detail-oriented fashion and quickly learned skills for specific tasks
- Provided quality, individualized service to customers and fulfilled last minute requests •
- Managed cleaning services to ensure timely completion of orders/products .

ACTIVITIES AND VOLUNTEER EXPERIENCE

- Member of American Society of Civil Engineers and Local Member of BYU ASCE
- Habitat for Humanity Volunteer
- Collected data for research in transportation engineering department .

June 2017 – Present

August 2014 - April 2015

Geometric Design of Highways

Reinforced Concrete Design (Currently)

Required use of Civil 3D and HCS

June 2015 - January 2017

Expected Graduation April 2018

Mitchell G. Hadfield

612 East 700 North • Provo, UT 84606 • (801) 739-4499 mitch.hadfield1@gmail.com

Education • Brigham Young University – Provo, Utah Major: Civil Engineering GPA 3.6	Class of 2018
 Brigham Young University-Idaho- Rexburg, Idaho Graduated with an Associate's Degree of Science - GPA 3.8 	December 2014
Work Experience	
Engineering Intern for American Fork City Public Works Department	July 2016 -Present
 Collected traffic information manually and using road tubes for the city engine Used AutoCAD to accomplish design projects from the city engineer Collected GPS data 	er
Supervisor at the Missionary Training Center	December 2014 - Present
 Oversaw training of 15,000 residents in proper care for buildings and facilities cleaning of buildings and facilities. Supervised a team of six other college students as lead student. 	and oversaw resident's

Signature Greens Landscaping

 Mowed and watered lawns, fed and trimmed shrubs, tended flower beds and regularly inspected assigned work areas to insure proper standards were maintained.

• Operated lawn and grounds equipment to include power mowers, tillers, and other power equipment.

Service

Served a full time church mission in Ukraine.

Computer Skills

- Proficient with Microsoft Word, PowerPoint, Excel
- Working knowledge of AutoCad and ArcMap

October 2012 September 2014

March 2011 - September 2011

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