

**KIEWIT NORTH CAROLINA LNG STORAGE  
FACILITY GEOTECHNICAL EVALUATION  
Project ID: CEEEn\_2018CPST\_008**

**by**

**MZM Enterprises  
Matthew Martino  
Zachary Farnsworth  
Melanie Latham**

**A Capstone Statement of Work**

**Submitted to**

**Jaren Knighton  
Kiewit Engineering Group, Inc.**

**Department of Civil and Environmental Engineering  
Brigham Young University**

**October 8, 2018**

## Introduction

**PROJECT TITLE:** KIEWIT NORTH CAROLINA LNG STORAGE FACILITY  
GEOTECHNICAL EVALUATION  
**PROJECT ID:** CEEEn\_2018CPST\_008  
**PROJECT SPONSOR:** Kiewit Engineering Group, Inc.  
**TEAM NAME:** MZM Enterprises

In North Carolina, a facility for storing liquefied natural gas is to be constructed. The facility will consist of two LNG storage tanks, auxiliary buildings for equipment and operations, and asphalt roads for truck and shipping traffic.

The project submittal is to consist primarily of a Geotechnical Review Memorandum. The memorandum will include foundation recommendations, pavement design, soil data, and other information needed to produce an accurate cost prediction for the geotechnical design of the project.

Data regarding soil properties will be extracted from soil profiles provided by the client. Other specifications such as allowable settlements will be either provided by the client or determined by the team from the North Carolina Amended International Building Code. Data will be provided by the client sufficient to determine the loads on the proposed foundations. Based off those loads, deep foundations will be sized for the LNG storage tanks, and shallow spread footing foundations will be sized for the auxiliary buildings. Estimated annual truck traffic will be provided by the client to determine equivalent single axle loads (ESALs). From the traffic information and the soil specifications, the pavement will be designed.

The sequence in which these engineering steps are completed will be dependent upon the sequence in which the client sees fit to provide the necessary data. However, should the preference be left to MZM Enterprises or should all the data be supplied simultaneously, the project will be completed in the following proposed order: soil property analysis, shallow spread footing foundation engineering, deep foundation engineering, pavement design, and compilation.

In addition to the memorandum, a poster will be created describing the conclusions of the memorandum. An exhaustive report describing the design process and the final product will also be prepared. The poster will be used to communicate the results of the report and the memorandum to the client in a presentation near the end of the project.

It is estimated that 30% of the work will be completed by 10 December 2018 and that the project will be completed in April 2019. See included for additional reference.

## Proposed Work Plan

The project will be completed in five steps as follows:

1. Soil analysis – Based off of the soil profiles and design parameters we receive from the client, we will analyze the soil for settlement rates and then bearing capacity in each of the locations where foundation or pavement are to be located. This will be accomplished using accepted methods of soil analysis and will be completed using the necessary computer software found on computers local to BYU. This task will be completed before December 10<sup>th</sup>.
2. Shallow Spread Footing Foundation Design – Based off of the structural data provided by the client, we will determine the amount of load to be transferred to the soil by the on-site auxiliary structures. We request line and point load values, but we could determine these values from structural drawings if the client prefers. Once the loads have been determined, the shallow spread footing foundations will be designed for all auxiliary structures using the soil analysis. This will be done using methods outlined in the North Carolina Amended International Building Code and using accepted practices of foundation design unless the client requests otherwise. We will attempt to complete this task by December 31<sup>st</sup>, but we will have it completed by January 31<sup>st</sup>.
3. Deep Foundation Design – Based off of the structural data provided by the client and the soil analysis, deep foundations will be designed for the LNG storage tanks. We will use accepted design practice as outlined in the North Carolina IBC and as instructed by our mentor. Our deadline for this is February 28<sup>th</sup>.
4. Pavement Design – Based off of the ESAL demand provided by the client, and based off of the soil analysis, the paved road will be designed following methods outlined by AASHTO. The deadline for this design will be March 31<sup>st</sup>.
5. Project Compilation – We will compile all of our regular status reports and additional information into a final report that argues our conclusion on the design. The conclusion will be summarized by a poster that we will also create. We will likewise have the Geotechnical Memorandum completed using the data and conclusions from the design processes. All of the deliverables for the project are to be completed in time for a presentation before April 30<sup>th</sup>.

This outline of work will be executed with adaptations and amendments as instructed or suggested by our mentor or the client. We request the client to provide the necessary data to maintain the schedule unless the client prefers otherwise.

## Schedule

The following schedule is effective immediately and will continue until the team, mentor, or client expresses contrary plans. Each week on Monday at 3:00 PM, we will have a regular team meeting to review tasks that are due that week and the following. Assignments will be given to team members, and more detailed planning will take place on how to complete each task. Immediately following at 4:00 PM will be the classroom instruction, which will usually last two hours. In the event that an instruction ends early, an optional team meeting may be held as needed. A status report will be submitted each week to the instructor and the client.

### Week 5 (October 8 – October 14)

- Finalize and submit Statement of Work
  - Matthew Martino: Executive Summary, Proposed Work Plan, Schedule
  - Zachary Farnsworth: Facilities, Tools, Data and Equipment; Project Budget
  - Melanie Latham: Deliverables, Statement of Qualification
- (No status report this week)
- Throughout week – Brainstorm revised lead measures

### Week 6 (October 15 – 21)

- Finalize and submit revised lead measures
- Throughout week – Begin soil analysis

### Week 7 (October 22 – 28)

- Throughout week:
  - Brainstorm team scoreboard
  - Zachary: Determine soil settlement

### Week 8 (October 29 – November 4)

- Finalize and submit team scoreboard
- Report on soil settlement analysis
- Throughout week – Zachary: Determine soil settlement

### Week 9 (November 5 – November 11)

- Finalize soil settlement analysis
- Throughout week – Melanie: Determine soil bearing capacity

### Week 10 (November 12 – 18)

- Report on soil bearing capacity analysis
- Throughout week – Melanie: Determine soil bearing capacity

### Week 11 (November 19 – 25)

- Finalize soil bearing capacity analysis
- Throughout week – Matthew: Design shallow spread footing foundations

### Week 12 (November 26 – December 2)

- Finalize soil analysis
- Report on shallow spread footing foundation design
- Throughout week:
  - Begin 30% completion report
  - Matthew: Design shallow spread footing foundations

Week 13 (December 3 – December 9)

- No meetings
- Throughout week:
  - 30% completion report
  - Matthew: Design shallow spread footing foundations

December 10

- Finalize shallow spread footing foundation design
- Finalize and submit 30% completion report
- Preliminary plan for Winter Semester (January – April)
- Throughout following weeks – Design Shallow spread footing foundations if still incomplete

### **Winter Semester**

January

- Finalize plan for Winter Semester
- Complete shallow spread footing foundation design if still incomplete
- Begin deep foundation design

February

- Complete deep foundation design

March

- Complete pavement design

April

- Compile deliverables
  - Geotechnical Memorandum
  - Poster
  - Presentation
  - Final Report

This schedule is subject to change as the team, mentor, or client sees fit. We request the client supply the necessary data promptly so as to maintain this proposed schedule. The schedule may be revised if requested.

## **Facilities, Tools, Data and Equipment**

The necessary tools for this project and their purposes include:

- Geological investigation data—essential data for the design of all aspects of the project
- Graphing calculators and Excel spreadsheets—settlement, bearing capacity, and pavement design calculations
- Terzaghi bearing capacity factors and correlations—bearing capacity calculations
- Meyerhof and Hanna bearing capacity for two layer systems equations—bearing capacity calculations
- North Carolina Amended International Building Code—essential to executing accepted practices of foundation design
- ESALs for the roadway—pavement design calculations
- AASHTO—methods for pavement design

## **Project Budget**

Soil analysis will take place from October 7–December 10, occurring concurrently with the design of shallow footings. An estimated three hours a week will be spent on analysis during this time. Shallow footing design will be completed by January 31, and will constitute about five hours a week from the team. Design of deep foundations will commence starting in January, and be finished by February 28. As these foundations are the most vital to the project outcome, eight hours a week will be assigned to this task. Pavement design will be done from March 1–31, and take five hours a week from team members. Finally, the compilation of the project will be an ongoing task from October 1–April 30, with one hour a week given to this task until April 1, when nine hours a week will be devoted to complete all remaining deliverables.

## Deliverables

The deliverables of this project will include the following:

- Monthly status reports
  - Details of recent progress
  - Difficulties we are facing
  - Proposed solutions for those difficulties
  - Plans for further action
  - Schedule status
- Final report
  - Status of final project
  - Tasks that were completed
  - Final recommendations
  - Report on project success
- Presentation with accompanying poster
  - Project summary
  - Key charts, diagrams, or other figures
  - Project conclusions
  - Acknowledgements
- Geotechnical Review Memorandum
  - Soil Analysis
  - Shallow Spread Footing Foundation Design
  - Deep Foundation Design
  - Pavement Design
  - Project Summary



## **Performance Standards**

Team will provide work for this Capstone project “as is” using best practices and with best efforts. Project results cannot be construed as work performed by licensed professionals and cannot be used as “stamped deliverables” without first being reviewed, approved, and stamped by a qualified and relevant licensed professional engineer.

## Statement of Qualification

This project will be completed with the assistance of the following individuals:

- Jaren Knighton, M.S.
  - Geotechnical Design Engineer, Kiewit
  - Relevant Certification:
    - American Concrete Institute Field Grade I Certification
  - Related Projects:
    - Orem City Pavement Evaluation and Redesign
    - Dark Concrete Pavements
- Kyle Rollins, Ph.D.
  - Professor, Brigham Young University
  - Relevant Skills:
    - Geotechnical Engineering
    - Foundation Design
    - Soil Mechanics
  - Related Projects:
    - Foundation Testing in Liquefied Sand for Cooper River Bridge in Charleston, South Carolina
- Spencer Guthrie, Ph.D.
  - Professor, Brigham Young University
  - Relevant Skills:
    - Materials & Pavements
    - Pavement Engineering
    - Concrete Durability

Our team consists of three student members: Zachary Farnsworth, Melanie Latham, and Matthew Martino. The three of us are seniors in the civil engineering program at Brigham Young University. All of us have had coursework in asphalt & concrete, soil mechanics, and basic pavement design. Zachary and Melanie are currently enrolled in a foundation design course, and Matthew is a current production engineer at Acute Engineering, a structural engineering firm that often designs shallow spread footing foundations.

## Appendix A

## *Matthew D. Martino*

**EIT**

4925 North Canyon Road, Provo, UT, 84604 | 940-365-4944 | matthew.d.martino@gmail.com

### **EDUCATION**

#### **PASSED CIVIL FUNDAMENTALS OF ENGINEERING EXAMINATION**

*Apr 2018*

#### **BACHELOR'S OF SCIENCE: CIVIL ENGINEERING**

*Dec 2019*

#### **BRIGHAM YOUNG UNIVERSITY**

*Provo, UT*

- GPA: 3.70
- Relevant Coursework: Linear Finite Element Methods, Reinforced Concrete Design, Structural Analysis, Computational Methods, Drafting with CAD Applications, ArcGIS
- Civil Engineering Capstone: Collaborated with a team to engineer deep and shallow foundations for a liquefied natural gas storage complex in North Carolina for Kiewit Engineering, Inc.

### **EXPERIENCE**

#### **PRODUCTION ENGINEER - STUDENT**

*Jul 2018 -*

#### **ACUTE ENGINEERING, INC.**

*Orem, UT*

- Engineered 100+ light frame residential homes
- Communicated with 15+ clients and researched code to provide 100+ building official letters

#### **RESEARCH ASSISTANT - CIVIL ENGINEERING**

*Apr 2018 - Jun 2018*

#### **BRIGHAM YOUNG UNIVERSITY**

*Provo, UT*

- Analyzed and extracted 50+ highway coupons for structural maintenance tests

#### **TEACHER'S ASSISTANT**

*Aug 2016 - Jul 2017, Jan 2018 - Jul 2018*

#### **BRIGHAM YOUNG UNIVERSITY**

*Provo, UT*

- Taught Structural Analysis and Engineering Mechanics: Statics, Strength of Materials, and Dynamics
- Created 50+ online class components, including quizzes and homework assignments
- Led 4+ review sessions of 20-60 students each in preparation for exams

#### **ENGINEERING INTERN**

*Jul - Aug 2016*

#### **HOMEYER ENGINEERING, INC.**

*Flowermound, TX*

- Engineered 3+ specialized water resource improvements currently in development
- Qualified 3+ civil construction plans to comply with local code
- Met deadlines for 5+ individually prepared submittals

### **SKILLS & ABILITIES**

- AutoCAD, Revit, Civil 3D, ArcGIS Pro, Microsoft Excel (including Visual Basic), and Microsoft Word

### **VOLUNTEER EXPERIENCE**

- Served in leadership positions for groups of 14+ missionaries while serving a 2-year proselytizing mission for the Church of Jesus Christ of Latter-Day Saints in Las Vegas, NV

### **INTERESTS**

- Music, skiing, and food

**Melanie Latham**

718 W 1720 N #126, Provo, UT 84604 \* 678-630-9083 \* [byumelanie12@gmail.com](mailto:byumelanie12@gmail.com)

**EDUCATION**      **Expected Bachelor of Science in Civil Engineering**      4/2019  
**Brigham Young University**—Provo, UT  
GPA: 3.51

**EXPERIENCE**      **Research Intern**      6/2018—8/2018  
**Texas A&M University**—College Station, TX  
\*Work in groundwater modeling for the civil engineering department.  
\*Examine recharge rates in the Gulf Coast aquifer of Texas using MODFLOW and Excel.  
\*Develop contour maps to compare the aquifer at different recharge rates.  
\*Complete research in groundwater modeling and recharge and contribute to a funded research project and its associated journal article.

**Research Intern**      6/2017—8/2017  
**North Carolina State University**—Raleigh, NC  
\*Work in hydrologic modeling for the civil engineering department.  
\*Model dams in Excel.  
\*Create and modify maps in ArcGIS.  
\*Present a report regarding Tennessee Valley Authority dams and river networks at a university-wide symposium.

**Mission Trip**      8/2013-2/2015  
\*Serve 18 months in southern Chile as a volunteer missionary for the Church of Jesus Christ of Latter-day Saints.  
\*Learn the Spanish language to communicate with locals.  
\*Work in a companionship setting with another young woman.  
\*Participate in local service for communities in southern Chile.

**SKILLS**      Microsoft Office, ArcGIS, GMS-MODFLOW, Spanish

**ACTIVITIES**      **American Society of Civil Engineers**      2015—present

**HONORS**      **Tau Beta Pi Induction**      Spring 2016  
Engineering honor society for students with high grades.

**Language Certificate**      Spring 2017  
Spanish, Advanced Level—based on American Council of the Teaching of Foreign Languages proficiency guidelines and supporting course work.

# Zachary Farnsworth

**EIT**

496 North 750 East, Provo, UT 84606 | (210) 332-7640 | [zachfarns@gmail.com](mailto:zachfarns@gmail.com)

## Education

**Passed Civil Fundamentals of Engineering Examination** *Mar 2018*

**Bachelor of Science, Civil Engineering; Minor, Mathematics** *(anticipated Apr 2019)*  
*Brigham Young University* *Provo, UT*

- 3.76 GPA
- Civil Engineering Capstone: Designed deep and shallow foundations for a liquified natural gas storage facility in North Carolina for Kiewit Engineering, Inc.
- Relevant Coursework: Foundation Engineering, Reinforced Concrete Design, Structural Steel Design, Structural Analysis, Computational Methods, Drafting with CAD Applications

## Engineering Experience

**Research Assistant - Civil Engineering** *Jun 2018–*  
*Brigham Young University* *Provo and Lehi, UT*

- Oversaw the design and analysis of all 25+ structural steel components of the project
- Collaborated with a team on the geotechnical analysis of data from over 900 strain gauges
- Performed 30+ nuclear density gage tests and 200+ total station, digital electronic level, and surveyors level measurements
- Operated light and heavy excavation and compaction machinery on the dismantling and rebuilding of an MSE wall

**Field Assistant - Civil Engineering** *Mar–Jun 2018*  
*Brigham Young University* *Provo, UT*

- Conducted a GIS survey and detailed inventory of 400+ catch basins and manholes
- Performed data entry for the hydraulic computer modeling of BYU's storm water system

## Other Work and Volunteer Experience

**Delivery Driver** *May–Aug 2017*  
*Domino's Pizza* *San Antonio, TX*

- Demonstrated a willingness to act as a team player in taking undesirable shifts, assignments, and responsibilities

**Missionary Representative** *Jun 2014–Jun 2016*  
*The Church of Jesus Christ of Latter-day Saints* *Anchorage and Fairbanks, AK*

- Trained and oversaw groups of 8–16 other volunteers; resolving conflicts and fostering unity
- Developed interpersonal and intercultural skills, confidence in public speaking, and professionalism

## Skills and Honors

- Proficient in Microsoft Excel with Visual Basic; limited ability in SAP 2000, Mathcad, and Revit
- Tau Beta Pi member: Engineering Honor Society
- Heritage Scholarship recipient: 4-Year, Full Tuition (merit based)
- Eagle Scout