# A YEAR IN THE WORKS: A RECORD OF ENGINEERING AND MANAGEMENT EXPERIENCE AT FREESE AND NICHOLS, INC.

A Record of Study

by

TYSON ORION HANN

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF ENGINEERING

December 2011

Major Subject: Engineering
College of Engineering

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Approved by:

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| Chair of Committee, | Ralph Wurbs |
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# ABSTRACT

A Year in the Works: A Record of Engineering and Management Experience at Freese and Nichols, Inc.. (December 2011)

Tyson Orion Hann, B.S.; B.S.; M.E., Texas A&M University

Chair of Advisory Committee: Dr. Ralph Wurbs

This manuscript presents the author's experience as a full-time graduate engineer at Freese and Nichols, Inc. (FNI), a professional engineering an service-based consulting firm, as a Record of Study (ROS) for the Doctor of Engineering (DE) degree at Texas A&M University. Through the course of the internship, the author was to familiarize himself with FNI organizational procedures and fulfill established internship objectives concerning technical, managerial, strategic, and societal achievement.

In meeting the above requirements, the author describes the history and key aspects of the FNI business, discusses established managerial procedures at FNI, presents direct work experience on projects during the DE internship period, and presents outcomes towards the internship objectives. FNI has a storied history, and the FNI business model centers around its ability to sell its employees time on projects; it requires technical expertise and client relationships that facilitate selection for the work. FNI's organizational structure and managerial procedures are designed to emphasize the company's differentiated strategy towards high quality customer service. The author worked on several projects throughout the internship; however, the primary role was via

the Highlands Bond Program, which involved the design of multiple water resources structures. Through the awareness of the FNI business concept and these projects, the key outcomes of the DE internship were noted, as numbered below.

1) The author fulfilled all internship objectives.

2) As a function of the projects, technical/engineering skills were applied and learned, and a greater appreciation for the inter-connectedness of technical disciplines was developed.

3) The author concluded that the Assistant Project Manager (APM) role, of which the author served while on the internship, offers significant managerial and strategic benefits to FNI, and that the role can facilitate faster individual growth and greater project ownership.

4) Strategically, all projects are important in a business, even if they are less technically advanced.

5) Recommendations that could potentially improve the engineering programs at Texas A&M include a) providing greater emphasis on developing the soft skills of engineering, and b) potentially adding dam management/design and pipeline/pump station design to the water resources portions of the Texas A&M Curriculum.

6) The author noted that FNI is a well-managed company, and that his observations during the DE internship reinforced this statement.

# DEDICATION

This Record of Study is dedicated to my father, Dr. Roy W. Hann, Jr., Ph.D., P.E., D.E.E., and Professor Emeritus at Texas A&M University. Dad spent over 45 years on the faculty as a loyal professor at Texas A&M in the Environmental Division of the Civil Engineering Department, and dedicated his work to the students of Texas A&M and the citizens of the State of Texas—which I think is one of the best perspectives a professor can undertake. Countless students' lives were touched by his career, and his teaching lives on through their contributions to society through the engineering community.

Dad has been a loving and caring mentor, teacher, and coach throughout my life, and I attribute much of my personal growth to him. He raised a wonderful family and would be considered an exemplary parent by any definition. As he has said, we are partners. There is no person that was closer to me throughout my academic career, and I cannot begin to express my gratitude for all of the advice that he gave throughout my life. He is undoubtedly the single greatest factor that led me to undertaking the Doctor of Engineering program and a career as a water resources engineer.

# ACKNOWLEDGEMENTS

I first acknowledge my family for their love, support, and guidance throughout my academic career. All family members, including my wife Hailey, pets, mother and father, sister, and extended family supported me greatly, and their patience, love, and support is greatly appreciated.

Next, I acknowledge and thank Mr. Cody Cockroft, P.E. ’00 of Freese and Nichols for his mentorship and coaching. Cody consistently goes above and beyond the call of duty to contribute to the success of me, my coworkers, our group, and Freese and Nichols, Inc. (FNI) as a whole. He advised and taught me daily throughout my internship, and I can easily say that the breadth and depth of my development over the past year would not have occurred without his tutelage. This Record of Study would not be what it is without his support, and the lessons he taught me will prove beneficial throughout my career.

Next, I thank Freese and Nichols as a company, especially its current and former leaders, other members of my group and the Southeast Region, the project team members that were a part of my work, and all of those who directly affected my development over the past year. FNI is truly a special place to be a part of, and I hope to enjoy a long and beneficial career there.

Finally, I thank my advisory committee members, including Mike Reedy my internship advisor at FNI, for their willingness to serve in the Doctor of Engineering process. I specifically thank Dr. Wurbs for serving as my committee chair.

# NOMENCLATURE

| | |
|---|---|
| APM | Assistant Project Manager |
| CI | Continuous Improvement |
| DE | Doctor of Engineering |
| EIT | Engineer in Training |
| FNI | Freese and Nichols, Inc. |
| GCWA | Gulf Coast Water Authority |
| GIS | Geographic Information System |
| GM | Group Manager |
| GRP | Groundwater Reduction Program |
| KFA | Key Focus Area |
| KFI | Key Focus Indicator |
| P.E. | Professional Engineer |
| PER | Preliminary Engineering Report |
| PM | Project Manager |
| Prj.Eng. | Project Engineer |
| RFQ | Request for Qualifications |
| ROS | Record of Study |
| SJRA | San Jacinto River Authority |
| TEP | Technical Excellence Program |
| WRD | Water Resources Design |

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# 1. INTRODUCTION

This Record of Study (ROS) serves to chronicle the author's fifteen months of engineering experience as a graduate engineer for Freese and Nichols, Inc. (FNI), which is a consulting firm located throughout the State of Texas. This ROS further serves to fulfill the author's degree requirements for the Doctor of Engineering degree (DE) at Texas A&M University.

The Doctor of Engineering Degree at Texas A&M University is a doctoral degree that emphasizes a broad approach to engineering education and focuses on practical applications in industry. Rather than completing research and a dissertation, a student completes technical and nontechnical coursework, practices over a yearlong internship in industry, and completes a Record of Study. For the internship, the student and advisory committee develop objectives that incorporate the personal situation of the internship and the stated DE program goals. The published goals of the DE internship are as follows:

1. "To enable the student to demonstrate an ability to apply knowledge and technical education by making an identifiable engineering contribution in an area of practical concern to the organization or industry in which the internship is served.

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This record of study follows the style of *Journal of Hydraulic Engineering*.

2. To enable the student to function in a nonacademic environment in a position where the student becomes familiar with the organizational approach to problems in addition to traditional engineering design or analysis. These may include, but are not limited to, problems of management, environmental protection, labor relations, public relations and economics" (TAMU 2009).

After the internship, the candidate develops the ROS, which details the experiences gained, describes the outcomes learned, and most importantly, demonstrates the successful completion of the internship objectives (TAMU 2009).

For this ROS, the author chose to write in the first person because of the personal nature of the internship experience and the resulting outcomes. Additionally, the title of the ROS ("A Year in the Works: A Record of Engineering and Management Experience at Freese and Nichols, Inc.") was patterned after the title of a book developed at FNI chronicling its history from beginning in 1894 to its 100 year anniversary in 1994. The book was entitled *A Century in the Works*.

Subsequent portions of the introduction briefly describe the internship objectives, provide background information on Freese and Nichols, Inc. (the company at which the internship occurred), and present the organization for subsequent portions of the manuscript.

## 1.1 INTERNSHIP OBJECTIVE OVERVIEW

The internship objectives of the DE Internship serve as a guideline for the successful completion of the internship and subsequent graduation from Texas A&M. The objectives are developed to meet the goals of the DE internship specified by the program manual; however, they are also tailored to the specific situation of the student and internship location. The advisory committee and internship supervisor assist in developing the objectives. Preliminary objectives are developed in the internship proposal before starting the internship, and subsequently finalized in the "Statement of Final Objectives" after the internship has commenced. By approving of the Final Objectives, the advisory defines the work that meets the spirit of the DE goals.

The objectives I developed for my DE Internship promoted four major emphasis areas that underline the stated goals of the DE degree (Hann 2010). The objectives called for 1) technical achievement via application and learning of engineering skills, 2) managerial achievements via application, observation, and skill acquisition of effective (and ineffective) managerial practices, 3) organizational achievement via learning, analyzing, and recommending organizational strategy, and 4) societal achievement via analysis of the technical effects on society and via information feedback to Texas A&M University (Hann 2010). The objectives were finalized in December 2010 with approval from my advisory committee and internship supervisor. The objectives are presented in detail in subsequent sections of this ROS as I defend their successful completion.

## 1.2 FREESE AND NICHOLS, INC. SELECTION AND COMPANY INFORMATION

When selecting a firm for my internship, I approached the selection process with the mindset that I was searching for a full-time and permanent position. I sought a company that would maintain my employment beyond the one year internship period, but also one that would allow me to meet the goals and objectives of the DE program. As such, I searched for a company that would provide a mutually beneficial culture, offer high-profile technical projects in water resources engineering, provide personal development, and present growth opportunities for my career. Based on my previous experience with Freese and Nichols as a summer intern, my interview in November 2009, and the company's willingness to work with me on the DE, I chose to work at Freese and Nichols, Inc. in their Houston office.

Freese and Nichols is a well-respected Texas-based consulting company that provides a variety of technical services for clients. The firm was established in 1894 as a water resources firm, and has grown to offer additional services across the architecture, construction services, engineering, environmental science, and planning markets. The company employed just fewer than 450 people at the start of my internship. The company boasts a mission of "Innovation approaches…practical results…outstanding service," and a vision statement, "Be the firm of choice for clients and employees" (FNI 2011d). The company further lists guiding principles for its employees that focus on ethics, delivering quality, responsiveness, adding value, continuously improving, innovation, professional development, respecting others, and giving back to the

community (FNI 2011d). In 2002, FNI developed a "Hedgehog Concept" that emphasizes customer service as an activity that can guide all employees. The Hedgehog Concept, based on a section of Jim Collins's book *Good to Great* (2001), represents something that drives the economics of a company, brings passion to all employees, and provides the company an opportunity to be "the best." From my previous internship and fifteen month work experience, I believe that these company-defining values are held throughout the employees of the firm.

As indicated by the mission, vision statement, guiding principles, and Hedgehog Concept, FNI competes with an overall differentiated strategy based on customer service, and backs the customer service up with strong technical knowledge and 117 years of project history in Texas. This strategy aligns well with the FNI business markets because the majority of FNI clients are public-based governmental authorities. As such, the clients are required by state law to select consultants based on their qualifications, rather than the proposed cost of the engineering work. The customer strategy has proven successful. Despite the slowing economy in the United States, Freese and Nichols has continued to grow and generate profits in recent years. FNI research of other similar consulting firms showed the company has significantly outperformed the competition over the recent time period.

Finally, Freese and Nichols boasts an active corporate Continuous Improvement (CI) program that utilizes a plan-do-check-act approach to systematize company improvement efforts. The CI program is applied at every organization level, and the program has generated additional programs such as a Technical Excellence Program

(TEP), a project management improvement group, and a client centered marketing program based on the Miller-Heiman sales system. As a full-time employee over the course of the internship, I was actively involved in several of these management initiatives.

Freese and Nichols has been recognized locally, state-wide, and nationally with several technical and business management awards (FNI 2011b). In particular, FNI was recently one of seven companies selected to receive the prestigious 2010 Malcolm Baldrige National Quality Award, and was the first architectural/engineering firm to receive the award (FNI 2011b). The award is managed by part of the U.S. Department of Commerce, and it recognizes organizations for excellence in performance and management (FNI 2011b). The award evaluates a company based on seven criteria: "leadership, strategic planning, customer focus, measurement, analysis and knowledge management, workforce focus, and process management and results" (FNI 2011c). The award serves to validate the excellent management processes of the company and provides direct evidence supporting my decision to work at the company.

## 1.3 RECORD OF STUDY PURPOSE AND ORGANIZATION

The primary purposes of the ROS are 1) to present the experience attained over the internship period, and 2) to demonstrate that the internship objectives have been fulfilled (TAMU 2009). As such, I have organized the ROS in the following manner:

- Freese and Nichols Organizational Overview (Section 2): Provides an overview of FNI organizational structure, and my roles within the organization as an intern.

- Freese and Nichols Business and Project Management (Section 3): Discusses the Freese and Nichols business and efforts towards project management.
- Projects Overview (Section 4): Summarizes the major project efforts and their outcomes from the internship.
- Highlands Bond Program Projects (Section 5): Details the major project assignment during the internship and presents outcomes of the projects.
- Objective #1 Review (Section 6): Presents the technical achievement objective and defends its completion over the internship.
- Objective #2 Review (Section 7): Presents the managerial achievement objective and defends its completion over the internship.
- Objective #3 Review (Section 8): Presents the strategic achievement objective, provides additional information, and defends its completion over the internship.
- Objective #4 Review (Section 9): Presents the societal achievement objective, provides additional information, and defends its completion over the internship.
- Summary (Section 10): Summarizes the internship, the ROS, and the defense of the internship objectives.

# 2. FNI ORGANIZATIONAL SETTING

This section serves to describe the overall organizational structure at Freese and Nichols, with a primary focus on the corporate structure, the group based structure centered on technical excellence, and micro-level structure within the group. Discussion is offered concerning the specific group with which I worked as a DE intern (and continue to work as a full-time employee), my roles and responsibilities within the group over the internship period, and the known differences between the FNI organization model and other similar service-based engineering companies.

## 2.1 ORGANIZATIONAL STRUCTURE

The major levels of the FNI organizational model include the corporate-level structure, the division level structure, the group structure, and the less-apparent project level.

### 2.1.1 Corporate Level Organization

The corporate level organization structure of FNI is depicted as Figure 2.1. The exhibit does not depict the Board of Directors, which reviews the overall company performance and defines the role of the President and Chief Executive Officer (CEO), Bob Pence, P.E. ’73. At the corporate level, the company is organized based on corporate business focused functions, such as operations, marketing, and accounting/finances. Each of these major divisions is led by a “Chief Officer.” Of the corporate areas, “Operations” is the primary platform by which the company is measured on in key performance metrics (which are discussed in Section 3 of the ROS)—it is where the primary external service work (engineering, etc.) of the firm is conducted. The

operations division drives the marketing effort, whereas the finance and accounting groups provide the tools and effort to consolidate and manage the overall financial well-being of the firm, per Generally Accepted Accounting Practices.

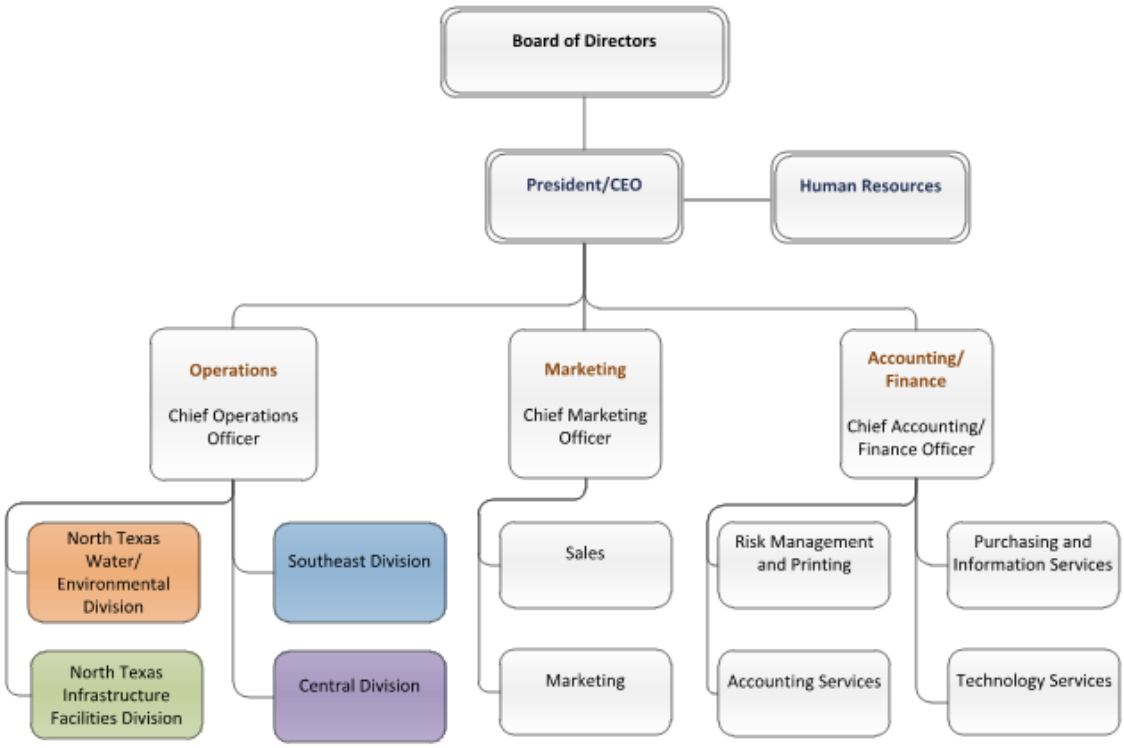


**Figure 2.1. FNI corporate-level organizational chart.**

The operations group represents the division level structure, and is further subdivided into four major Divisions, as depicted in Figure 2.2. The divisions are formed based on geography (North, Central, and South East Texas) and technically (North Texas Water/Environmental vs. North Texas Infrastructure). Subsequently, groups are formed within each division based primarily on the technical focus of the group.

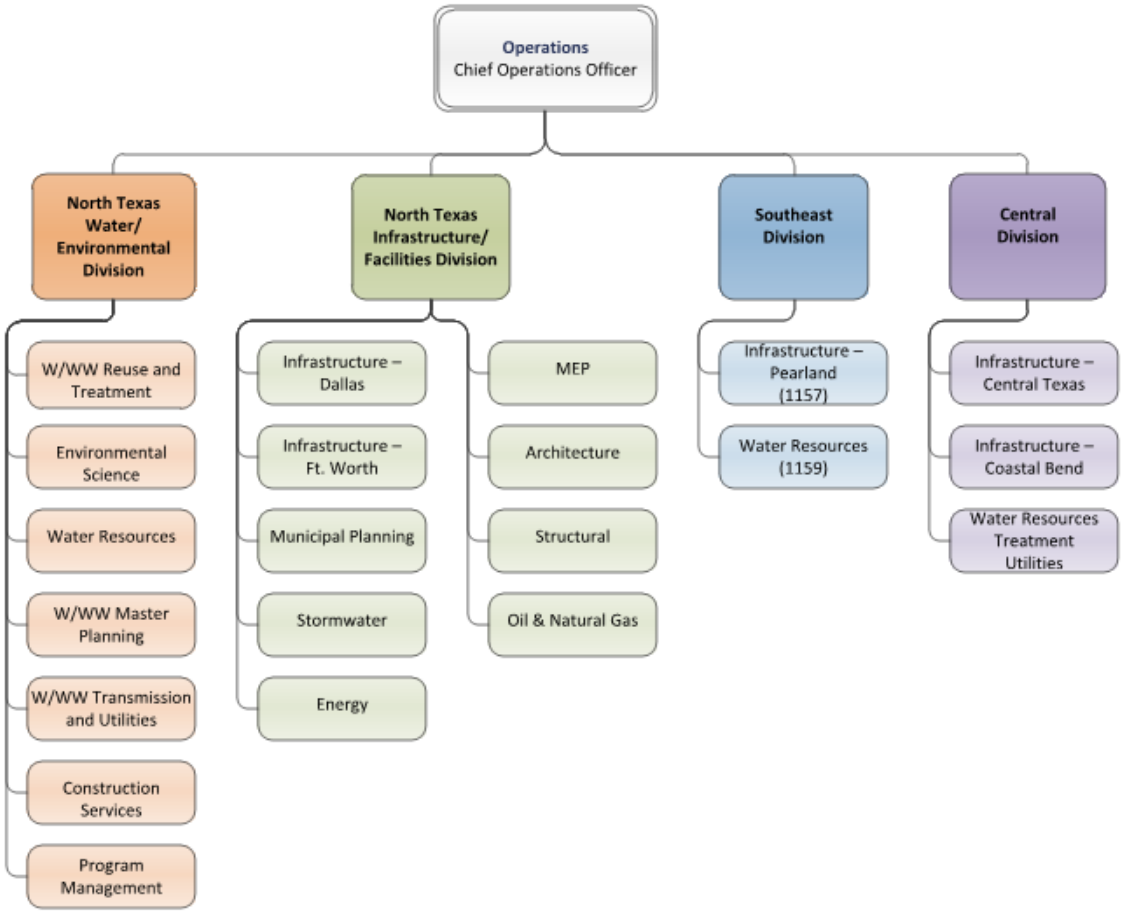


**Figure 2.2. Organizational structure of the FNI Operations Division.**

### 2.1.2 Group Level Organization

From the bottom-up, the heart of the organizational hierarchy is a matrix-based "group" system. It is through the groups that the technical employees (engineers, architects, environmental scientists, and specialists) perform the work of the company and generate revenues. The majority of FNI employees are assigned to a group based primarily on their technical area of interest, but also on the general geographic location

of their home office. The groups tend to focus on a specific type of work (water resources design, environmental sciences, storm water, etc.).

Each group is expected to be an individually profitable entity of the company, and the FNI accounting system tracks the revenues and expenses of each group separately. It should be emphasized that groups and office locations (i.e. the Austin, Houston, or Dallas offices) are not necessarily tied together. Two employees could potentially work out of two local offices, but still be members of the same group. I saw this first-hand during my internship because there were people in my assigned group (Houston—Water Resources) working in the Austin office, and there were people working in Houston that were assigned to groups in the North Texas Water/Environmental Division.

The matrix-based group level organizational structure practiced at FNI offers a hybrid between a project-based organizational system and a functional organization (Shtub 2005). The essence of the structure is that project managers borrow resources throughout the group to execute projects. Any given project manager can borrow any group member needed to complete the project, provided that the resource is available to work on the project. Advantages of this group model include effective accumulation of expertise within a group that can be applied to any of the projects owned by the project manager, effective use of resources, good interface with outside contacts such as clients or individuals in the company, an increased ease for using multi-disciplinary teams, and that it offers personal and career growth (Shtub 2005). Disadvantages include a dual

accountability between the project and the group manager, and conflicts on daily activities between the project managers and group manager (Shtub 2005).

For the FNI engineering model application, this structure emphasizes the project managers as directly accountable under the group manager. Other significant entities include the assistant project managers, the project engineers, the specialists (i.e. GIS or CAD specialists), and "other" support personnel that are not directly assigned to the group. Each of these entities is led, directly or indirectly, by the group manager or a senior project manager to coordinate the assignments of pertinent individuals to the projects. Figure 2.3 presents an overview of this matrix-based group system.

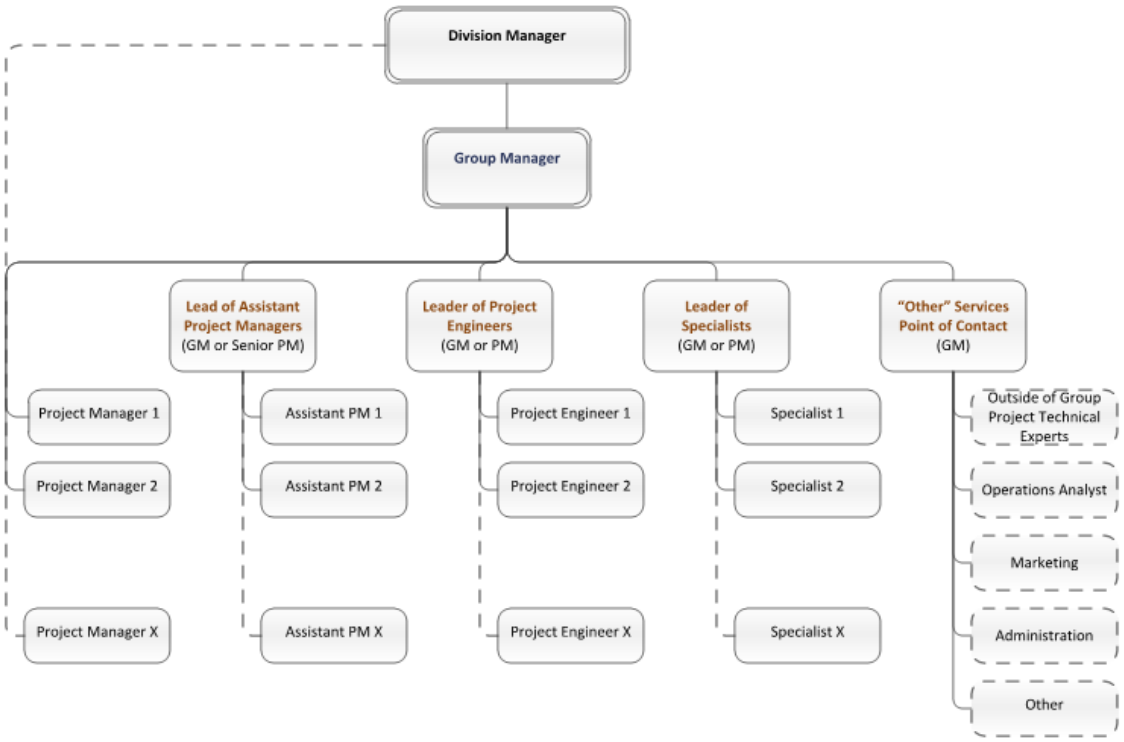


**Figure 2.3. Typical FNI matrix-based group hierarchy.**

Over the course of my internship, I was assigned to "Group 1159: Water Resources, Houston," which falls under the Southeast Division. The Southeast Division is tasked with developing business in the geographical southeast regions of Texas. This includes predominantly the Houston area, but also extends from near Corpus Christi to the Louisiana border, and as far north as the Bryan/College Station area. Strategically, the southeast Texas business markets represent a major potential growth area in terms of revenue generation for the company because it affords growth in new geographical regions and in additional service markets, which are the two primary means of growth in a consulting engineering firm. The growth potential and details of the group are discussed in subsequent sections.

### 2.1.3 Project Level Organization

The project level is another level of the FNI organizational approach, but it is undefined in the company organization charts. The projects are separate entities that must be managed, and they carry significant implications on reporting structures and group organization. Figure 2.4 presents a typical project-level organizational chart. Project teams are generally staffed starting at the group level, per the matrix based groups discussed earlier. When situations arise where the project requires expertise not available in the group, or where the group members do not have availability to work on projects, resources are readily "borrowed" from other groups to fill in the project team. Members of a project teams can potentially come from multiple groups within the company, especially on multi-disciplined projects.

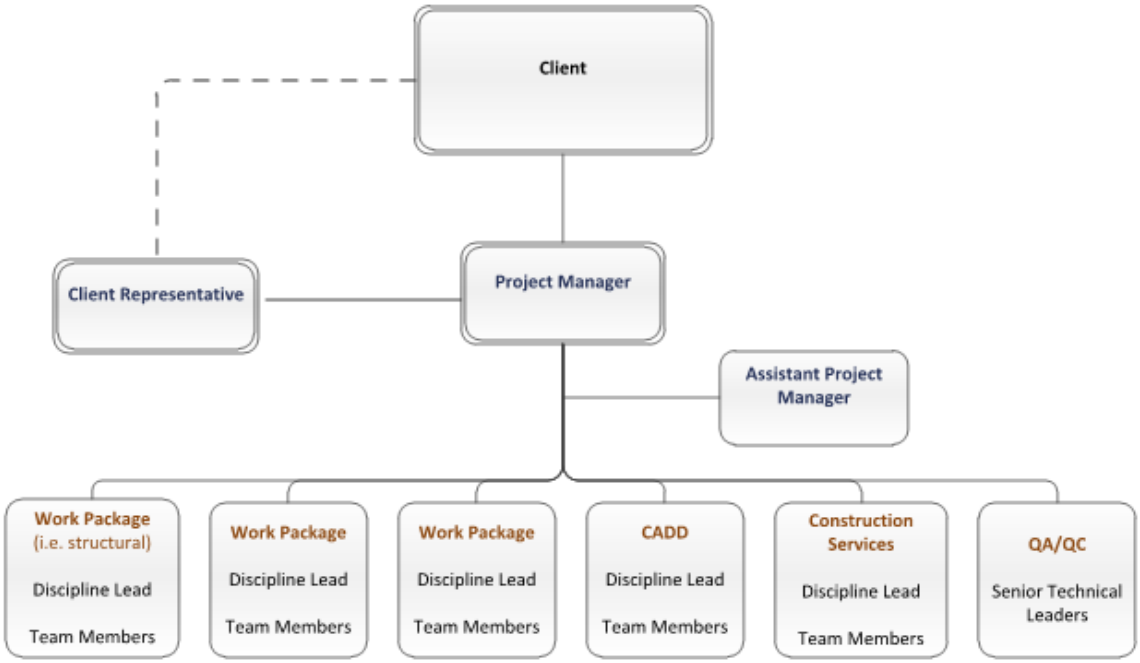


**Figure 2.4. Typical project-level organizational chart.**

## 2.2 FNI SOUTHEAST REGION HISTORY AND PROFILE

The southeast Texas region is currently a high-growth potential area in terms of additional revenue and company size for Freese and Nichols because opportunities exist to add new geographical markets beyond those previously served and to expand the types of services offered in those areas. Historically, FNI purposely shied away from the southeast Texas geographical areas, starting in the 1950s through the 1990s, as indicated by the company President and CEO, Bob Pence, in a presentation to the region (2011). Instead, FNI chose to focus its efforts in the North Texas area, and subsequently grew the business to a strong market position in the North Texas area, almost to the point of saturation. The desire for further growth in the North Texas Market was limited by the

market share gained over the course of 100 years. FNI leadership was aware of the new opportunities in the southeast Texas region; however, they were hesitant to proceed with significant investments in the area until the early 2000s. Since the region has a need for the services provided by FNI, the potential existed for the company to grow in the area.

The FNI presence in the Houston area was established in the early 2000s with the acquisition of a small civil engineering firm in Pearland, Texas called Walsh Engineering. Walsh offered a long operational history and a significant client base relationship necessary to break into the Houston markets. From there, FNI began to establish a Houston office by growing organically; however, growth in the Houston market was slow for an extended period of time. There were likely many reasons for the slow growth; however, the growth trajectory changed significantly in 2008 with a string of outside strategic hires, significant employee relocations to the area, and the establishment of the groups that make up the "Southeast Division" of the FNI organizational hierarchy. Today, two FNI offices comprise the southeast Texas region (Houston and Pearland).

The two southeast region offices host individuals from a variety of FNI groups. Primarily, the offices function to house the two groups of the Southeast Division, including the Houston Water Resources Group (Group 1159), and the Pearland Municipal Infrastructure Group (Group 1157—many are former employees of Walsh Engineering). Additionally, the offices host individuals from North Texas technical groups, such as environmental sciences, construction services, and water/wastewater master planning. Finally, the offices host individuals from the corporate-level administrative support groups, such as administration, marketing, and accounting.

Growth in the southeast Texas market region, the Southeast Division of FNI, and particularly Group 1159 was readily apparent throughout my DE internship period. The division and group saw increased bookings (projects and sizes of projects), revenues, profits, and numbers of employees. This growth trajectory is expected to continue to occur. Figure 2.5 presents Southeast Division bookings (potential revenues for projects won by individuals from the Southeast Region) since 2000, which shows explosive growth in the area in since 2008.

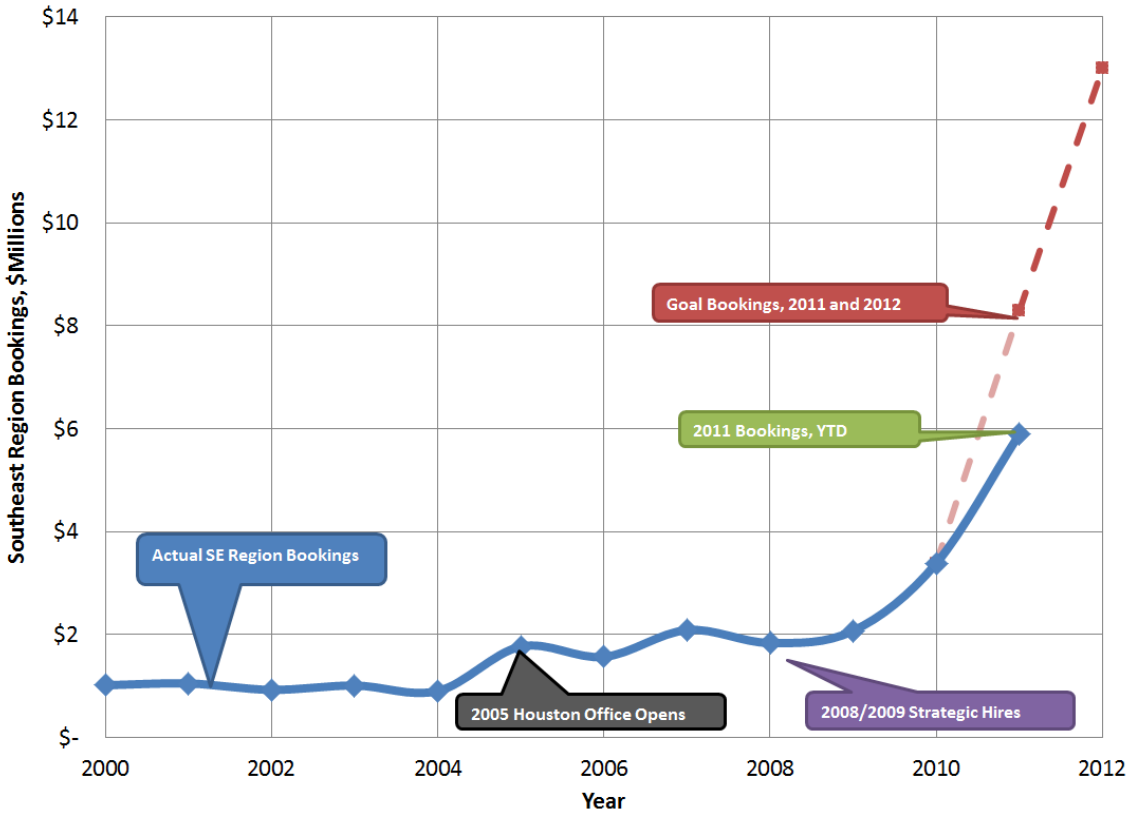


**Figure 2.5. FNI southeast region bookings since 2000 (FNI 2011l).**

The reasons for the recent growth in the southeast region are numerous, and some major reasons noted during the DE internship can be summarized as follows:

- Market appetite for FNI services: The Houston market had a need for high quality technical services in the areas in which FNI is most specialized, specifically in water resources and the design of large hydraulic structures. Additionally, the FNI "high quality customer service" was an unusual marketing strategy for the area.
- Key strategic hires and staff relocation: In 2008 and 2009, FNI made strategically important hires for leadership of the Southeast Division and for group

management positions, and FNI leadership convinced talented FNI employees to move to the Houston area to facilitate project execution and grow the client base. Particular strategic hires that I noted over the internship as having direct success in market growth included Jeff Taylor as Division Manager (brought relationships in the Houston area), Mike Reedy (brought additional relationships and a strong knowledge of the area projects) as Group Manager of the Houston Water Resources group, and Cody Cockroft as a lead project manager from within FNI.

- Key project "wins": FNI was (and continues to be) selected to provide services on certain key projects in the area. Some projects brought brand notoriety because they were public and highly visible, whereas other projects were important because they allowed for staffing development and/or provided additional work (this includes the Highlands Bond Program projects discussed later).
- Successful leverage of FNI services in other groups: FNI utilized its expertise from the north and central Texas regions to provide technical expertise on key projects. In fact, most projects drew to some degree on technical expertise from other FNI offices, including pump station and pipeline design, water/wastewater treatment plant design, hydraulic modeling, geotechnical, structural, and architecture.
- FNI Brand: The FNI brand from its 117 history of projects carries significance to water districts and river authorities throughout the state. In some ways, FNI was

more easily able to penetrate the Houston market area because of its brand as experts, particularly in water resources.

- Effective staffing of project managers: FNI selected appropriate project managers to understand and work with the clients in the area. This developed and strengthened the project managers' relationships with clients, which allowed for the development of additional work opportunities.

## 2.3 GROUP 1159 PROFILE

Throughout my internship, I was assigned to the Southeast Division's Group 1159: Houston Water Resources. This group was established to lead growth in all water/engineering related markets of the southeast Texas region. In particular, the group was formed to market the water districts and river authorities of the area, rather than municipalities. The group actively provides services in water resources design, water resources planning, and water transmission (pipeline and pump station design). Additional efforts are underway to market water and wastewater treatment and storm water engineering services. Group 1159 is a unique group at FNI due to the range of services it provides. Whereas most groups are solely focused on one of the services listed above, Group 1159 markets and has staff interested in each service. This is mostly due to the infancy of the group and FNI's efforts in the southeast Texas region. Eventually, FNI management and employees expect the group to split into several groups based on disciplines (per the organizational structures listed previously).

Figures 2.6 and 2.7 present the organizational structure and team members of Group 1159 at the beginning and end of my internship period, respectively. The figures

indicate the growth and significant change that occurred in the group. As indicated in Figure 2.6, Group 1159 was significantly incomplete in its personnel for completing heavy engineering production work at the start of my DE internship. Producing detailed construction drawings and/or high quality geographic information system (GIS) exhibits required significant resources from outside the group, particularly from the Pearland infrastructure group (Group 1157).

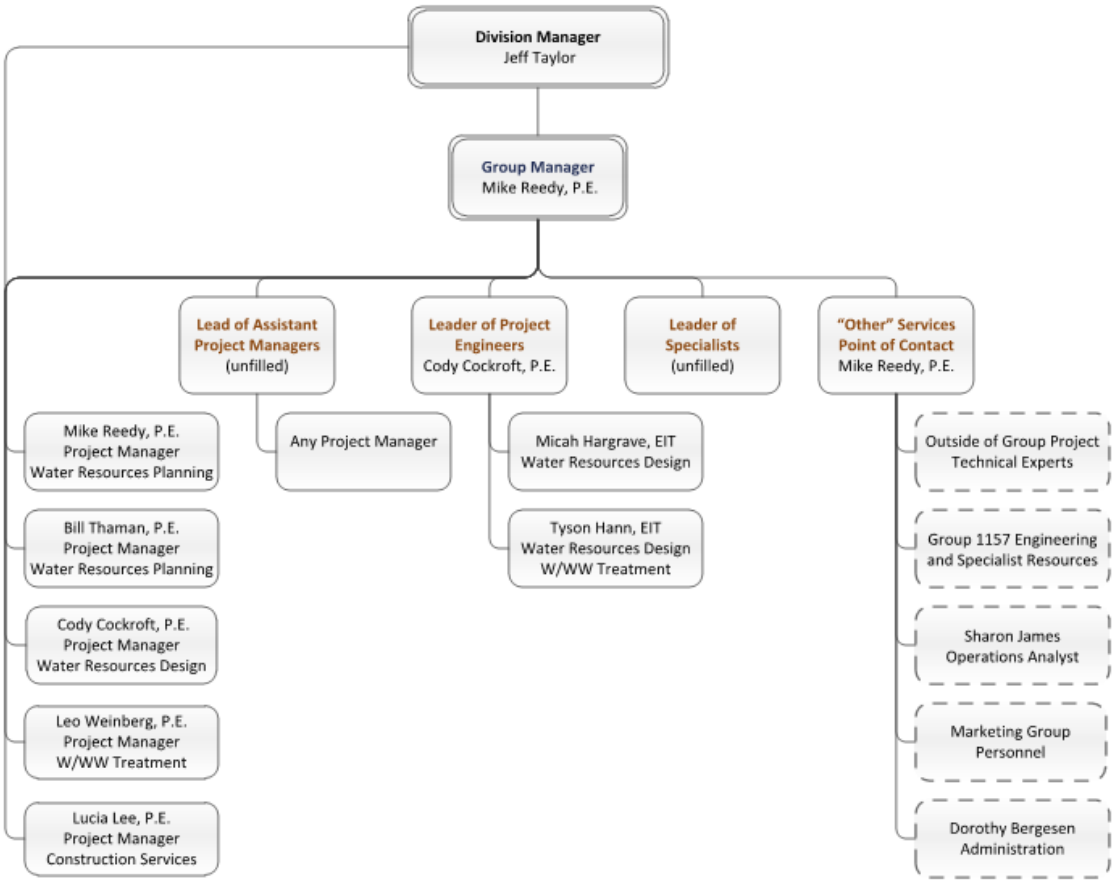


**Figure 2.6. Group 1159 structure and personnel in June 2010.**

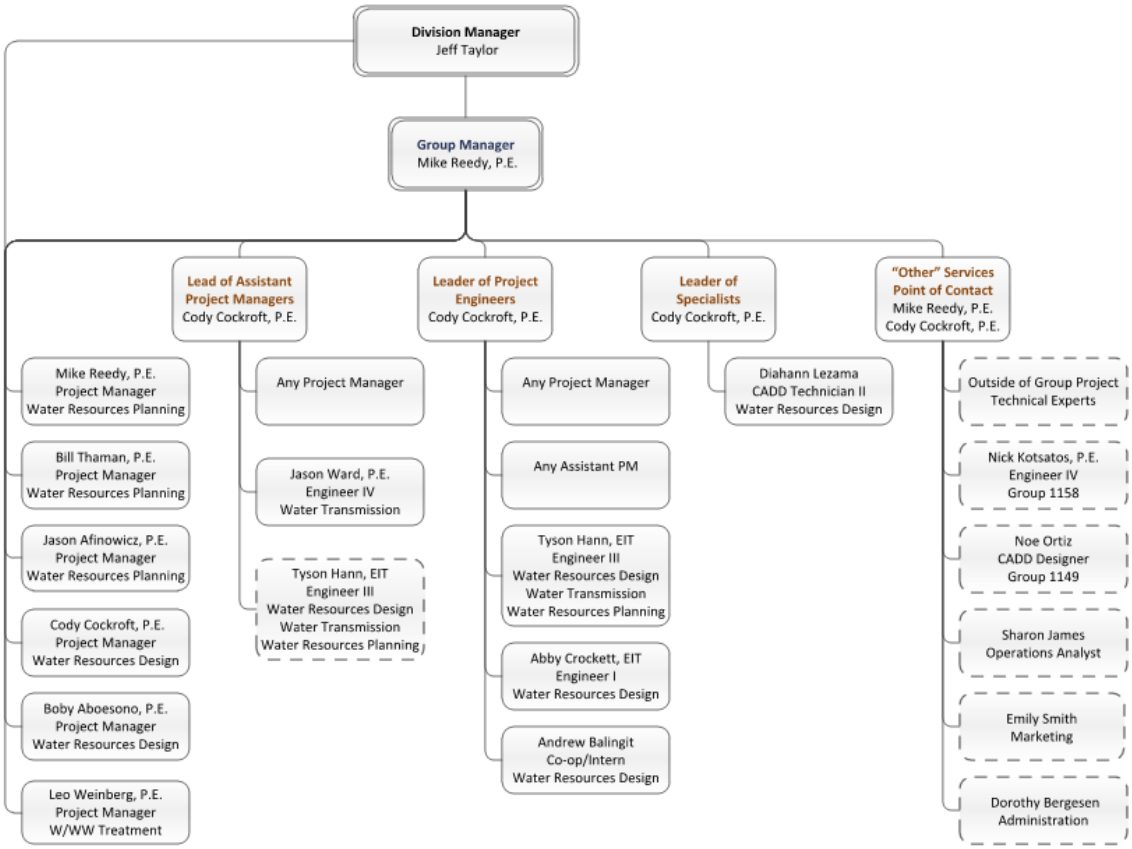


**Figure 2.7. Group 1159 structure, personnel, and significant points of contact as of early September 2011.**

From these figures, the growth in Group 1159 is readily apparent. Despite losing two members over the year, the group has grown from seven (7) people in June 2010 to eleven (11) in September 2011 on its full time staff, and it currently hosts two semi-permanent technical resources from other groups in the company. Cody Cockroft has stepped up to serve as the group leader for APMs, project engineers, and specialists, and it is he who actively seeks resources from other groups within FNI to complete work. These activities include daily group coordination towards project production, analysis of staffing needs for the group, making staffing recommendations on all group projects, and

advising and mentoring junior staff. This serves as a reminder that a position of leadership is not necessary for one to be a leader. The positions described above are not formalized within the Group 1159 until very recently (when I developed the organization exhibits). It should also be noted that the group is far from complete as expected workload projections support the need for several additional employees.

## 2.4 MY POSITIONS AND RESPONSIBILITIES

I carried the positions of Engineer I, Engineer II, and Engineer III over the course of my internship, and I was an Engineer I or II for the breadth of my internship. These positions describe entry-level and less experienced engineers that are "Engineers-in Training" (E.I.T.'s). The primary differences between the Engineer I, II, and III levels are increased experience and increased autonomy in project work (greater independence on project tasks and an increased role in the management of projects). As I became more experienced and served in an additional capacity as an Assistant Project Manager (APM) on projects, I was promoted through these positions. My additional school experience facilitated a faster-track through this promotion process than is normal at FNI (Cockroft, 2011). Upon successfully receiving the Professional Engineering (P.E.) license, FNI employees are promoted to the Engineer IV position.

My responsibilities as an Engineer I and II were simple: successfully execute projects under the direction of the project's Project Manager, participate in group activities and initiatives as assigned, develop an Individual Development plan, and manage my own personal development. These roles and responsibilities are further expanded in the project descriptions and project work; however, some initiatives were

outside of the project setting, such as leading a lunch meeting of the Water Resources Design (WRD) Technical Excellence Program (TEP) group by presenting a status update of the Highlands Bond Program.

My responsibilities were expanded over the course of the internship to include a role of Assistant Project Manager (APM) on the Highlands Bond Program projects. This brought personal accountability for the successful execution of the projects. The roles associated with this effort are discussed further in subsequent sections; however, it is worthwhile to note that it is non-typical for an Engineer I or II at Freese and Nichols. In fact, my assignment to the position as assistant project manager occurred before the role was formalized and adopted at FNI. In fact, defined training programs were just starting to be developed in the latter half of my DE internship period. It would by non-typical for an engineering graduate to step into this role within the first year of experience. I was afforded this opportunity because the staffing situation in the group brought a need for my use in the APM capacity, my degree program as a DE student necessitated involvement in management activities, and I am on a "fast-track" through the early stages of the engineering career.

These activities were formally supervised by Mike Reedy, my Group Manager and Texas A&M Internship Supervisor. Mike reviewed my progress twice during the DE internship at six month intervals. Additionally, Mike provided an Internship Supervisor's Review, per DE requirements, which can be found as Appendix A. In practice, Cody Cockroft, who was the Project Manager on most projects that I worked on, directed me through these activities on a daily basis. During this time, I was not directly responsible

for the work or responsibilities of any other individuals in the group; however, I helped to make staffing selections for, and helped to guide two summer undergraduate interns during the summer of 2011.

# 3. FNI BUSINESS CONCEPT AND PROJECT MANAGEMENT

At FNI, engineers are the foundation of the company's history; however, beyond engineering, a successful business model must be employed that facilitates profitability and growth. This business model is combined with the framework of the organizational structure discussed previously. This section discusses the essence of the FNI business, added aspects of the FNI business model that improve the viability of the business as a whole, the foundations of project management, and the comparison between the FNI business concept and other water resources entities.

## 3.1 FNI BUSINESS CONCEPTS

Subsequent portions of this subsection present the simplified FNI business concept, the expanded FNI business concept, and FNI business performance metrics.

### 3.1.1 Simplified Business Concept

At its core, the FNI business concept is simple: the company sells the time of its employees. This is similar to most consulting firms across many industries; however FNI truly focuses on the "trusted advisor" role by offering non-typical human relations to the buyer-seller relationship. This further separates FNI's ability to delivery technical services that may otherwise be considered commodity based engineering services. To further expand on the concept, FNI employees are technical experts (engineers, environmental scientists, architects, CAD designers, GIS technicians, etc.) whose expertise makes them specifically qualified to complete specific project tasks for which a client has a particular use or need.

The keys to the FNI business concept are that 1) employees must be capable of efficiently performing the types of work for which the client has a need, and 2) the company must be able to locate potential clients who have a need for the engineering services. FNI focus is on clients of choice, not on projects of choice (FNI chases clients not projects). In this regard, FNI focuses on those clients that have a good potential to provide repeat work.

### 3.1.2 Expanded Business Concept

Beyond this simple concept, the FNI business model becomes significantly more complex. Most corporate functions do ultimately go towards safeguarding the above keys to the business concept; however, FNI adds significant depth and processes to its business activities in its efforts to promote company stability and consistent growth in a competitive business environment. Additionally, the company must operate within the legal framework of the business. These and other factors are what add complexity to the FNI business model.

To promote stability and continued growth, FNI has implemented several corporate activities through its Continuous Improvement program. The following activities are presented as key operational activities on the new FNI intranet (2011d):

- Hedgehog Concept: The Hedgehog concept of "being the very best at client service, resulting in long-term mutually beneficial relationships" (FNI 2011k) engages all FNI employees and focuses them on a common goal.

- Personnel Development: FNI facilitates the recruiting, coaching, and development of talented employees that are prepared to do the work through several human resources related activities.
- Technical Excellence Program (TEP): The TEP program institutionalizes the technical information that has been developed over the course of projects. This is an attempt to safeguard the knowledge that individual employees have gained in the event that an employee no longer works for the firm. The TEP program also helps to train and develop employees to be more skilled in their work.
- Supplier Management: In many cases, FNI (like most major engineering consulting firms) engages "subconsultants" to do work on projects because FNI does not provide all of the services necessary to complete projects for clients, does not want to take on the risk of certain parts of the project, or engages other companies to be involved in parts of the project for strategic or legal purposes. In these cases, the subconsultants essentially become a supplier to FNI for a part of the project. The subconsultants work directly for FNI—rather than the original client, and the subconsultant generally bills FNI directly (FNI subsequently bills the client, with a negotiated multiplier—which increases the potential revenues for FNI).
- Business Technology: FNI has developed an active business technology department that continually upgrades FNI technologies. The current era of engineering requires technically-advanced solutions and analysis methods, and the Business Technology department helps maximize FNI's edge in technology.

Without effective use of technology, the execution of efficient projects is minimally possible, even on "simple" project endeavors.

- Marketing: FNI generally markets itself as a company via traditional broad-based advertisement campaigns. Known media for marketing includes the internet, appearances at technical conferences, writing technical papers and giving presentations, print advertisements in technical magazines, presentations in educational situations, and through its Freese and Nichols University programs that present additional information to clients.
- Client Relationships: FNI systematizes its approach towards developing client relationships with its "Gold Sheet" process (FNI 2011c). This approach allows for the institutionalization of the relationships with key clients that provide work. As part of this process, FNI grades the relationship levels (Levels 1 through 5) in the hopes that most client relationships become mutually beneficial and position FNI to guide the client throughout its business processes. This process is completed separately from any specific project efforts.
- Sales: Sales refers to the pursuit of specific project opportunities. When project opportunities arise, the company implements a specific process that incorporates marketing, potential project staffing, and project approach research to competitively position FNI to be selected to do project work.
- Projects: Projects are the primary unit of work in the operations of the company. Projects and project management are further discussed in subsequent portions of this section.

- Risk Management: FNI engages in risk management efforts to mitigate risk associated with project management (FNI profitability focus), with quality assurance and control on projects to promote technical viability, and with potential claims in the event that projects do not go as planned. This protects FNI and its clients, and is conducted before, during, and after a project.
- Corporate-Level Planning activities: FNI engages in strategic planning processes at three major levels. These plans help FNI to anticipate client and organizational needs such that the continued success of the business is maintained. Phases of the planning process are as follows:
- Futures planning: Long-term visionary level (5 to 20 years) focusing on general industry trends
- Strategic planning: Short-term vision and mission level (1 to 3 years) focusing on all facets of the company progress in the near-term. Includes the development of performance areas, developing quantifiable means of measuring progress in the areas, and designating responsibility to individuals within the firm to accomplish the strategic goals.
- Operational planning: Yearly planning efforts at the group level that identifies potential project endeavors and evaluates staffing needs.

### 3.1.3 FNI Business Performance Metrics

FNI uses several performance metrics to gauge the effectiveness of the company in several areas, which FNI calls Key Focus Areas (KFAs). The actual performance measures used to quantify the performance in these areas are called Key Focus Indicators (KFIs). FNI develops KFAs yearly during the development of its strategic plan, and it subsequently quantifies the KFIs to set targets. FNI's strategic plan (2011l) presents goal values for all KFAs and KFIs. Ultimately, the company attempts to measure its performance through multiple areas, including financial, client relations, technical growth, and employee relationships.

Table 3.1 summarizes pertinent KFIs related to the financial and project management areas of the company. Though all KFIs are relevant, the KFIs presented here are particularly related to the project management efforts that I experienced as an assistant project manager on projects.

**Table 3.1 Description of pertinent key focus indicators.**

| Key Focus Indicator | Rough Interpretation | Detailed Description | Importance |
|---|---|---|---|
| Bookings | Potential monetary value ($) of a project | • Represents the potential value of a contract agreement between FNI and a client<br>• Reflects successful sales effort | Provides an estimate for the amount of future work for FNI employees and estimates the length that people can stay busy (backlog) |
| Raw salary | Amount paid to an employee per hour of work | • Raw salary represent the billing rate to a client | It is roughly how much each employee gets paid hourly |
| Labor Multiplier | Amount that the raw salary is increased when charging a client | • Multiplier applied to employee's hourly raw salary when charging a client.<br>• Can vary between projects | Ties directly to the potential profits that the company can make |
| Utilization | Percentage of time billed to a client | • In practice, it is more complex than a time percentage<br>• It is actually the actual revenue earned on projects compared to the potential revenue earnings on a project<br>• Incorporates the actual project multiplier for a project and the goal labor multipliers for the employee's group. | Each employee is expected to have a certain utilization; "Lower level" personnel are expected to have a higher utilization |
| Effort | Amount of work done on a project | • Amount of work completed on a project in monetary terms<br>• Typically calculated by multiplying the hours worked, labor multiplier, and raw salary | Measures work completed on a project |
| Revenue Factor | Labor Multiplier times Utilization | • Combines the labor multiplier and utilization, which reflects profitability | Profitability measure |
| Variance | Difference between expected effort and actual effort | • Positive variance: Less effort has been completed on the project than expected<br>• Negative variance: More effort has been completed on the project than expected<br>• Negative variances decrease profitability of a project (bad)<br>• Positive variances increase profitability | Measures the effectiveness of a project and project manager |

## 3.2 FNI PROJECT MANAGEMENT

Projects are the foundation through which FNI exchanges the completion of tasks for clients and through which revenue is earned. In fact, it could be argued that the company is a conglomerate of projects. From this, it logically follows that the success of FNI as a company is directly dependent upon the aggregate success of each project individually. If each project is profitable, the company as a whole should be profitable; however, if projects are not profitable, they decrease the profitability of the company. For this reason, effective project management is likely the single-most important factor that leads to the success of the company. At FNI, the accountability for project management falls on a designated project manager for each project (FNI 2008).

### 3.2.1 Project Management Goals

Project management goals can fall under FNI business concepts or the successful technical execution of the projects. At its core, project management has two primary goals related to the business concepts of FNI:

1. To keep the client happy with the work that is being completed.
2. To safeguard the profitability of the project.

These two essential goals reinforce the FNI business concept in several ways. In particular, keeping clients happy is what leads to additional work in the future, and project profitability benefits the Freese and Nichols bottom line.

### 3.2.2 Project Management Activities

The following represent project management activities that occur over the course of a project:

- Project Sales: The primary purpose of this phase is to be selected for the project over competitors by the client. Activities at this phase include selecting personnel for key project roles (project manager, key discipline leads, client representative, etc.), developing a project approach, assessing the need for subconsultants on the project (either for technical or strategic reasons), selecting subconsultants, and preparing marketing materials required by the client to be selected for the project. This phase is required by Texas law for government projects to meet qualifications based selection requirements for engineering services.
- Contract Preparation: Once selected for a project, FNI (principally the project manager) and the client enter the contract preparation phase with the goal of agreeing on a contract. The primary components of the contract preparation phase include 1) developing a scope of work for the project, 2) agreeing on the fee (compensation structure and amount) to be paid to FNI for the work, and 3) developing the schedule for delivering primary deliverables for the project. All project components must be agreeable for the client. Each of these components of the contract preparation phase is pertinent to the eventual success of the projects. Successful contracting on a project requires effective project planning.

  For example, most FNI fees are developed by building the project team (all personnel for the project), estimating the time to be spent by each person on each item of the scope in completing the project, and multiplying that time spent by each individual's raw salary and the project goal level multiplier (which must be agreed to by the client). Effective fee development requires a well-defined scope

of work and a detailed project plan. The potential exists to leave money on the table if the project is not planned effectively. The end result of the contract preparation phase is a "booking" for the project.

- Project Planning: Project planning is accomplished at all phases of the project; however, the initial project plan is pertinent to project success. The project plan should detail individual responsibilities for project components, specify when the actions should occur, and provide expectations for each project component. The project plan helps the project manager negotiate the contract with the client (more accurate scope and fee), and the project plan facilitates the effective execution of the project within the design team. A popular quote throughout the FNI project management training is that "failing to plan is planning to fail" (Cockroft 2009).
- Project Setup: FNI project setup includes primarily project accounting setup, though additional activities (such as holding project kick-off meetings) also occur. The significant activity at this phase is allocating project budget through the FNI accounting system (note that Appendix B provides direct examples of the magnitude of this process).

  Here, the project budget must be designated to each FNI organizational group that has employees working on the project. Through this, the employee's home groups collect revenues on the projects in relation to the amount of work completed by the employee and the employee's billable rate. Additionally, planned effort to complete the project is entered into resource allocation software

called eResources. This software can be used as a project management tool to determine the effort required to complete a project. Additionally, the software collects each individual's project assignments throughout the company to forecast upcoming project assignments, employee availability, and generate estimates of future workload and company revenues.

- Project Technical Execution: Executing the project technical activities is the heart of the project from the client's perspective. During this phase, the project manager must coordinate the project activities in a logic manner. This is typically done according to the project plan; however, occasionally the plan is modified to deal with project experiences.
- Regular Project Activities: Regular project activities include leading regular client meetings, updating progress related to the technical project execution and project budget, updating eResources to reflect accurate employee hour assignments, providing progress reports to the client and the project team, and billing the client. These activities must be completed as part of the project, and require time and effort to complete. Client meetings and contact play a significant role in client satisfaction on projects. Additionally, effective coordination with the project team is essential for employee satisfaction with the projects.
- Project Submittals: Project submittals refer to the primary project deliverables submitted to the client throughout the project.

- Project Closeout: After all quality assurance and quality control steps are completed and the project submittals have been made, the project is closed in the FNI accounting system. At this point, project personnel must move on to new projects (if this has not happened earlier).

### 3.2.3 Additional Project Management Considerations

As a DE intern, several additional project management considerations were noted that are not necessarily reflected in the above items. These are discussed below:

- Art of project management: Project management is as much of an art as it is a science. Scientific parts of the project include managing scope, schedule, and budget, which is a fairly simple task. The art of project management is interjected with complexities of virtual teams, dealing with the emotional ups and downs of team members, managing individuals across multiple groups and geographical areas, client relations, etc.
- Contract preparation: There is typically a limit on how much money a client is willing to pay for a particular project. This is often less than the originally proposed fee that is estimated by the project manager. Additionally, the client may not agree to pay higher labor multipliers, which potentially limits the profitability of the projects.
- Staff ownership: A project manager often does not have direct authority over the specific assignments of his project team members. For example, an individual from another group assigned to a project reports to that individual's group manager, rather than the project manager. Thus, the group manager could affect

project performance by prioritizing different projects for the employee (this relates to the art of project management discussed above).

- Personal utilization goals: Each employee has a goal for utilization within the company, and this goal potentially works against project profitability, potentially causing negative variances. Thus, it is in the employee's interest to charge as much time against a project as is reasonably possible. Alternatively, it is often the interest of the profitability of the project (depending upon project fee type—particularly in lump sum situations) to have employees work on the project as little as possible. A project manager must manage both aspects, which emphasizes the art of project management.
- Client relations: Building relationships and effectively managing clients can be a difficult task of project management.

## 3.3 COMPARISON TO OTHER WATER RESOURCES ENTITIES

Another topic for discussion is the comparison between the FNI organization structure, business model, and project management and other water resources entities. This topic was discussed as part of my Preliminary Exam and helps satisfy portions of my internship objectives. Information presented is based on discussions with coworkers and multiple presentations by the company president. The following points of comparison are noted:

- Non-service based entities: Many water resources entities are non-service based companies, meaning that they derive major portions of their revenue by selling products other than employee's time. Instead, they could be the water providers

(i.e. they sell water)—which are most of FNI clients, or equipment manufacturing companies and vendors (included in the project design), or are contractors that construct the projects (though contractors are service providers as well—they also deal with raw materials). Its stands to reason that each entity will have a significantly different business philosophy than FNI. For FNI to offer the highest level of service, they must know how these organizations work.

- Service-based: Other engineering service companies (consulting firms) are likely to have similar business concepts and performance metrics. FNI must find ways to differentiate itself from these companies, and has done this via its customer service mentality.
- Raw salary, labor multiplier, and utilization relationship: FNI differs in the raw salary, labor multiplier, and utilization relationship compared to other consulting firms. FNI tends to pay lower raw salaries to its employees, ask for higher labor multipliers, and requires lower utilization of its employees as compared to its competitors. Lower raw salaries benefit employees through increased firm stability (According to Bob Pence, FNI's President and CEO, the firm has only gone through one layoff in its 117 year history); however, the modified labor multiplier creates confusion among clients. Though FNI generally charges clients the same rates for equivalent level employees, some clients see high multipliers as an attempt to leverage added profit.
- Marketing focus: FNI tends to focus its marketing efforts on client relationships, rather than securing chasing big-time projects. This decreases FNI's marketing

costs associated with landing each job (the relationships make the marketing job easier).

- Job security and turnover: FNI is a low-turnover company. Many of its employees start and spend their entire career at FNI, whereas many consulting firms replace employees regularly depending on high performance metrics and the market conditions. FNI has shown to be someone immune to market fluctuations, especially in recent years.
- Company ownership: FNI is an employee-owned corporation, whereas some competitors are public (stock is traded publicly), partnerships, or other. Whereas public company owners may have almost no interaction with clients, FNI owners are often group managers and work directly with the projects and employees. As such, many of them inherently understand the projects and what FNI employees go through. That helps the owners develop more realistic expectations for the performance of the company; whereas less engaged owners will be more willing to overlook project details or employee well-being to get better performance. This model also allows our clients to directly interface with the owners, which yield similar benefits.
- Technical groups: The FNI group system is somewhat similar to many companies; however, FNI groups are slightly more specialized than other companies. This carries significant advantages when attempting to establish a company as technical specialists in a particular area; however, this limits potential project variety for inexperienced engineers, which could be viewed as a

negative to someone that wants a breadth of experience, especially as new college graduates.

- Succession Planning: FNI has developed a defined business direction over an extended period of time, and the consistent direction helps the company continue growth despite changing market conditions.
- Company organizational structure: FNI's group-based organizational approach is significantly different than any other large consulting engineering firm (Taylor 2011). Whereas some firms have centralized production facilities (i.e. a major office in a certain city where all work is sent for completion), FNI decentralizes its production such that its people can develop more intimate relationships with clients (Taylor 2011). FNI's approach works given its differentiated customer service business strategy, whereas the competitors attempt to differentiate based on standardization and efficiency.

# 4. PROJECTS OVERVIEW

Though understanding FNI business and project management activities are pertinent components of the Doctor of Engineering degree, projects are the heart of the experience gained throughout the internship. As an engineer in training with little practical engineering experience coming out of school, gaining experience on projects is the most important part of early development. Projects afford the ability to gain technical and managerial knowledge. As a DE student, the project work at FNI was my first chance to work widespread on real-world projects.

I worked on a several water resources projects that varied in technical type and purpose throughout my internship. These projects form a foundation for the completion of my internship objectives. Subsequent parts of this section outline major projects of the internship that involved considerable time and effort, or presented an opportunity for significant observations related to the internship objectives. Each project is briefly discussed based on the timeline of the internship for reference in future sections. It should be noted that the Highlands Bond Program projects are briefly discussed here; however, they are discussed in much greater detail in Section 5 because they were the most significant projects of the internship.

## 4.1 SJRA LAKE CONROE DAM SAFETY AND SITE ACCESS REPORTS

- Client: San Jacinto River Authority (SJRA)
- Timeline: June 2010 to September 2010. The project was my first project after starting at FNI.
- Project Scope: The scope of the project specified the completion of two reports related to dam safety and site security at Lake Conroe Dam. The first report was submitted to the Texas Commission on Environmental Quality (TCEQ) as part of its dam safety requirements, and the second report was an evaluation of potential new access roads to SJRA facilities adjacent to the dam. The evaluation of the roadway alternatives was based primarily on dam safety and site security concerns.
- Project Outcomes: I primarily worked on the access road report, which was a managerial tool for the client to aide in deciding which potential road route to use (FNI 2010). The projects were delivered on-schedule to SJRA and were met favorably by the client and TCEQ. The successful execution of this project aided in FNI's selection for the Highlands Bond Program projects, and the dam safety projects demonstrated a potential need for Texas A&M water resources curriculum to include more information about the design and operation of dams (and/or add additional focus between the collaboration of structural and geotechnical engineering in the water resources field).

## 4.2 SJRA HIGHLANDS BOND PROGRAM

- Client: San Jacinto River Authority (SJRA)
- Timeline: June 2010 to ongoing.
- Project Scope: The projects involved the preliminary and final design of water resource infrastructure, including open channel flow measurement (FNI 2011f), canal road crossings called siphons (FNI 2011h, 2011i, 2011j), and various reservoir improvements (FNI 2011g). Scopes for each project component are discussed in detail in Section 5.
- Project Outcomes: These projects had mixed outcomes for both FNI and the client. Overall, the outcomes were mostly positive in nature. These outcomes are discussed on project-specific and overall program levels in Section 5.

## 4.3 BIG CREEK DROP STRUCTURE REHABILITATION

- Client: Fort Bend County Drainage District
- Timeline: July 2010 to ongoing.
- Project Scope: This project involved the emergency rehabilitation, forensic analysis, and subsequent permanent rehabilitation design of a drainage structure that was in the process of failing in June 2010 (FNI 2011a). The structure conveys up to 9,000 cubic feet per second (cfs) of flow, and dissipates up to 25 feet of hydraulic head across the structure (FNI 2011a). Figure 4.1 presents photographs of the structure before and during emergency stabilization efforts.

a)

b)

**Figure 4.1. Pictures of drop structure before (a) and during (b) emergency stabilization efforts. Photos are reproduced (FNI 2011a) with permission of FNI and client.**

- Project Outcomes: FNI successfully executed the emergency rehabilitation and forensic analysis stage. The structure was temporarily stabilized from immediate failure. The client decided to pursue legal action against the original engineer on the project. Additionally, FNI was able to foster client trust, leading to later preliminary engineering and final design contracts to provide a permanent fix for the structure. This opportunity arose for FNI in part because Jeff Taylor, the Southeast Region Manager, was at a client visit to the county when the potential failure of the structure was discovered, and FNI's eventual selection for the work was a function of FNI's reputation for designing hydraulic structures. Strategically, this project has garnered recognition for FNI's abilities in the Houston area. Personally, this project exposed me to the importance and liability of work as an engineer, higher levels of hydraulic analysis, and the importance of structural and geotechnical considerations in water resources design projects.

## 4.4 RICHMOND/ROSENBERG WATER TREATMENT PLANT RFQ

- Client: FNI marketing effort.
- Timeline: August 2010 to December 2010.
- Project Scope: FNI responded to the Richmond/Rosenberg Local Government Corporation's (LGC) request for engineering qualifications (RFQ) to design a new water treatment plant, intake and pump station on the Brazos River, and distribution pipelines.
- Project Outcomes: FNI was not selected to complete the engineering work for this project; however, FNI was asked to present a shortlist presentation and made

a significant impression on the selection committee with a unique marketing strategy for the project. FNI was not expected to compete for this project, so the unique marketing strategy was helpful. For this strategy, FNI focused on providing a less expensive design for the water treatment plant by using a conventional treatment process. FNI believed that salinity problems in the Brazos River could be managed, rather than treated by more expensive treatment processes. The unique marketing approach on this project demonstrated the importance of organizational strategy at multiple business levels. FNI typically focuses on differentiation by customer service in marketing; however, in this case, FNI differentiated itself on a cost leadership approach for construction cost.

## 4.5 GCWA JONES CREEK SPILLWAY REPLACEMENT

- Client: Gulf Coast Water Authority (GCWA)
- Timeline: February 2011 to June 2011
- Project Scope: FNI conducted detailed design on a spillway replacement structure for the GCWA canal system. The structure causes the redirection of water into part of the canal system during dry periods, and the structure allows storm flows to pass during wet periods. The existing structure was in the process of failing, and FNI's scope was to design a similar replacement structure.
- Project Outcomes: FNI has completed design and initiated bid-phase activities as of the writing of this manuscript. The project is projected to carry a significant negative variance, which will lead to a loss of profitability for FNI. Client satisfaction on this project was mixed due to professional differences in the

technical applications for the project. Personally, I practiced my expertise in hydraulics through this project. I used weir equations to developed discharge relationships through the structure, and I used HEC-RAS modeling software to conduct a steady state analysis through the structure. I ultimately recommended that the downstream plunge pool slab elevation of the structure be lowered to minimize the potential for supercritical flow and hydraulic jumps. The analysis also provided forensic reasons for the failure of previous structures on site.

## 4.6 SJRA GRP LAKE CONROE INTAKE, PUMP STATION, AND PIPELINES

- Client: San Jacinto River Authority (SJRA)- Groundwater Reduction Program (GRP) Division; and Jones and Carter, Inc. (subconsultant on finished water pipeline project)
- Timeline: April 2011 to ongoing.
- Project Scope: These projects involved the preliminary design of a raw water intake and pump station on Lake Conroe, a raw water pipeline from the pump station to a new treatment plant, and a portion of a finished water pipeline adjacent to the Lake Conroe Dam from a new high service pump station to distribution points around Conroe.
- Project Outcomes: These projects are in preliminary stages before deliverables have been sent to clients. These projects helped me identify one deficiency in the Texas A&M water resources course offering. In my involvement with this

project, I observed that, though the Texas A&M water resources curriculum does a good job of teaching fundamental pipeline and pump hydraulics, more detailed instruction could be given concerning both pump station and pipeline design. Specific pump station design parameters, such as pump types, station configurations, applicable pump standards, pump station hydraulic modeling etc. could be taught. Additionally, pipeline design considerations, such as pipe materials, embedment conditions, appurtenant valves, air relief, special condition hydraulics, etc. should be considered for implementation in an engineering program. In my opinion, students would receive great value from this instruction because pipeline projects are becoming increasingly important in the Texas water resources markets. Finally, pipeline and pump station projects tend to be highly profitable from a business standpoint.

Another observation from these projects is the importance of consulting firm technical and historic knowledge when clients select engineers for projects. Freese and Nichols designed the Lake Conroe Dam, and FNI continues to consult for SJRA as a dam safety consultant. This expertise with the dam helped FNI be selected for these projects, particularly for the finished water pipeline project. The route of this pipeline is planned to cross the service outlet and emergency spillway channels, and traverse along much of the toe of the dam.

Finally, knowledge of these projects helped teach me the current water industry trends in the Houston area. In this case, the projects were a function of the groundwater reduction efforts in Montgomery County.

# 5. HIGHLANDS BOND PROGRAM

The San Jacinto River Authority (SJRA) Highlands Bond Program (HBP) and its associated projects were my primary experience over the course of the internship. I was involved in all phases of the projects (from the project sales steps, through contract preparation, and ultimately project execution), and the projects, which are still ongoing, accounted for 69.5% of my billable time (1,270 of 1,830 hours) as a DE intern (FNI 2011l). I served on the project teams as a project engineer, technical discipline leader, and as an assistant project manager.

Ultimately, these projects were straight-forward from a technical/engineering perspective; however, the complexity of the projects was significantly increased due to project management and the consequences associated with failing to meet deadlines or developing ineffective designs. Subsequent portions of this section discuss in detail the client, the various components of the HBP, present project outcomes, and account for the project activities per Texas A&M DE requirements for the ROS, as described on pages 9 and 10 of the DE program manual (TAMU 2009).

## 5.1 THE CLIENT (SJRA)

The San Jacinto River Authority (SJRA) is a state water entity (agency of the state) that was created by special acts of the Texas legislature in 1937 whose purpose is "to develop, conserve and protect water resources of the San Jacinto River Basin" (SJRA 2011). It has four primary operating divisions, including the Highlands Division, the Lake Conroe Division, the Woodlands Division, and the newly-formed the Groundwater Reduction Plan (GRP) Division (SJRA 2011), each serving a specific purpose within the

basin. Over the course of my internship, I assisted in consulting work for three of these divisions.

The majority of my work was with the Highlands Division. The Highlands Division transports raw water from Lake Houston to a multiple raw water customers located in east Harris County via a system of canals. The canal system is comprised of a pump station at Lake Houston, its canals (Main Canal, North Canal, East Canal, and South Canal), and an off-channel reservoir (Highlands Reservoir) that provides emergency storage (approximately 1,000 acre-feet) for downstream customers if upstream components are out of commission (FNI 2011g). Figure 5.1 shows a map of the Highlands system and its customers. The Highlands canal system was originally constructed in 1943 as part of the effort of World War II.

It should be noted that the primary customers of the system are the Chevron and Exxon refineries. The raw water supplied to the refineries is used for cooling water, and is pertinent to their operation. According to SJRA personnel during project discussions, the loss of this water supply, particularly for an extended period of time, would cause gas prices in the area and around the country to skyrocket. Historically, the Highlands Division has provided the majority of the revenues for the SJRA.

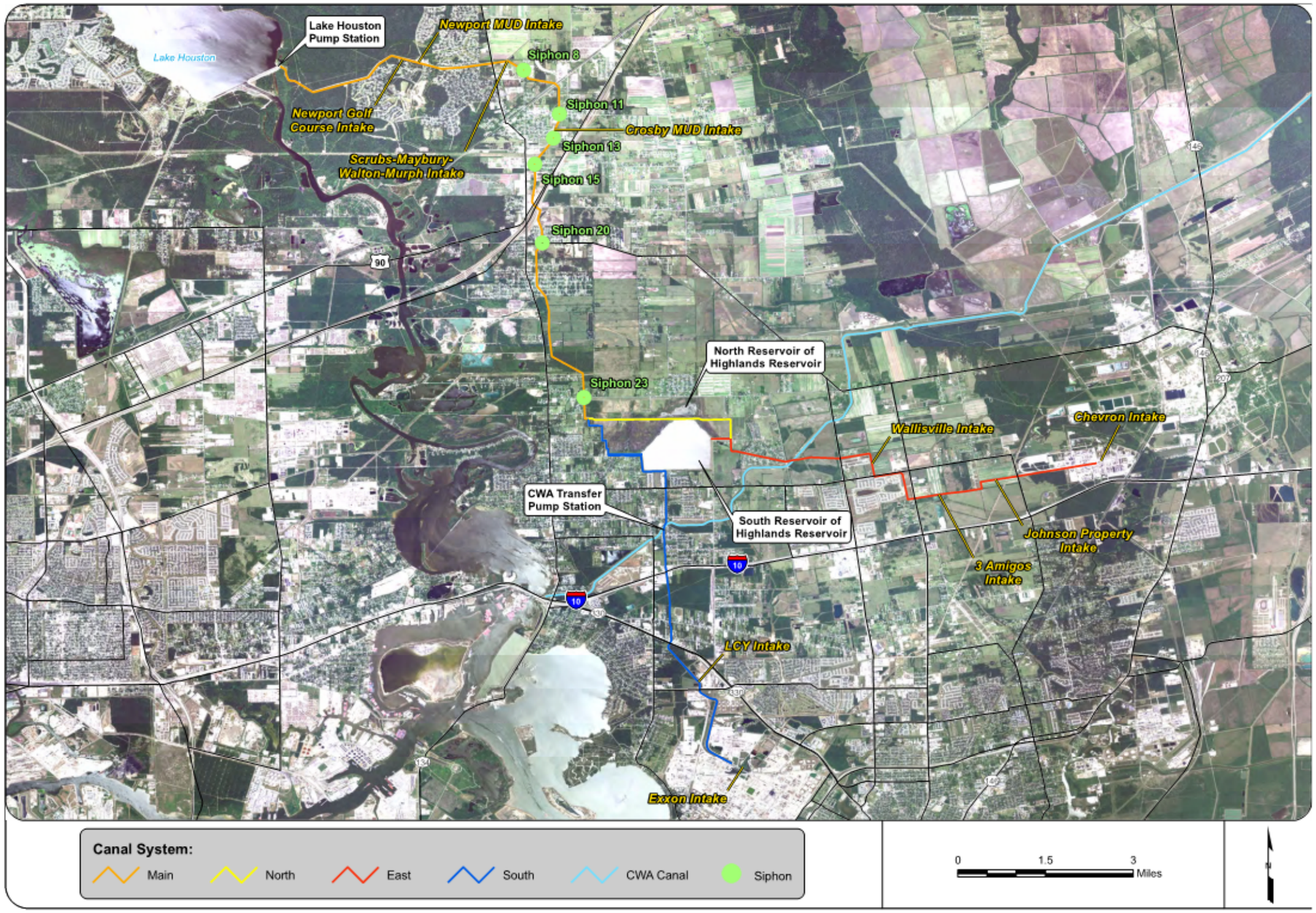


**Figure 5.1. Overview map of Highlands system. Reproduced (FNI 2011g) with permission of FNI and SJRA.**

## 5.2 PROJECTS HISTORY AND MY ROLES

The projects associated with the Highlands system were a function of the Highlands Bond Program (HBP). The HBP was established as a funding mechanism to provide $25 million for various capital improvements throughout the Highlands Division in a three year period. SJRA decided to implement this bond program partially as a function of a 2009 dam safety inspection performed by FNI, including primarily Mr. Cody Cockroft of my group (1159). In the TCEQ-mandated inspection, Mr. Cockroft recommended that SJRA make significant improvements to the Highlands Reservoir, including shoreline riprap protection and spillway rehabilitation (FNI 2011g). Additionally, another consultant, Espey Consultants, Inc., had previously developed a Capital Improvements Program in a 2008 Highlands facility assessment (FNI 2011g). With these recommendations, SJRA decided to implement the HBP to advance funding for these projects. Capital improvements to the Highlands System would help mitigate risk of being unable to supply water to customers, including the refineries after construction.

SJRA issued Requests for Qualifications (RFQs) for work associated with the HBP in May 2010. The RFQs were developed based on Program Management of the HBP, Siphon Improvements (seven total siphons), Reservoir Improvements and Flow Measurement, and Supervisory Control and Data Acquisition (SCADA) system development. FNI submitted a Statement of Qualifications for the Siphon Improvements and Reservoir/Flow Measurement improvements and was subsequently selected in July 2010, which was just after I started the DE internship. It should be noted that two other

consultants were also selected for portions of the Siphon Improvements, creating a direct comparison opportunity in terms of engineering cost, design attributes, project management, and client satisfaction; however, FNI was selected as the responsible engineer for over 60% of the bond program. This created an interesting dynamic whereby competition and politics between consultants were sometimes perceived, which added complexity to the client/consultant/professional relationship during project execution.

SJRA decided to split the contracts for the HBP work into a preliminary engineering phase, a final design phase, and potentially a construction phase services for each separate project. Thus, within the HBP work, there are actually several "projects" with individual budgets and deliverables. This approach complicated the project management and delivery of the projects by creating additional points to manage. The goal of the preliminary engineering phase was to develop options for rehabilitation or replacement, develop potential construction costs, identify key design issues, and provide recommendations via a report. For final design, the goals included the development of detailed engineering construction drawings, contract documents, and technical specifications for use in obtaining a contractor to construct the improvements. During construction, it is expected that FNI will enter into agreements for construction phase services to assist SJRA to ensure the projects are constructed as intended by the engineers.

With these projects, my primary roles included Assistant Project Manager (APM) and Project Engineer (Prj.Eng.). As APM, I served as an extension of the project manager on the projects, and assisted in all tasks related to project management. This role is further described in the managerial summary section. As a project engineer, I conducted technical work on the projects per assignments dictated by the project management plan (defined by the project manager), or I filled in where a need for my effort was realized on the project. Table 5.1 presents a breakdown of FNI's various contracts associated with the HBP, including my role with the individual project. Additionally, Appendix B presents budget tracking spreadsheets that offer insight into the project management efforts and project performance associated with each of the projects for which I served as an assistant project manager.

Subsequent portions of this section discuss in detail the specific scope of work associated with these projects, the technical activities, the managerial issues, and the project outcomes of each specific project.

**Table 5.1. Summary of Highlands Bond Program contracts and project roles**

| Date of Agreement | Project | Primary Deliverable Date | Engineering Fee (Bookings) | My Role |
|---|---|---|---|---|
| **Preliminary Engineering Phase** | | | | |
| August 2010 | Siphon 15 PER | December 2010 | $62,000 | APM & Prj.Eng. |
| August 2010 | Siphon 20 PER | December 2010 | $60,000 | APM & Prj.Eng. |
| August 2010 | Siphon 23 PER | December 2010 | $63,100 | APM & Prj.Eng. |
| August 2010 | Flow Measurement PER | February 2011 | $69,000 | APM & Prj.Eng. |
| August 2010 | Reservoir PER | February 2011 | $299,300 | APM & Prj.Eng. |
| | | *Total PER Phase Booking* | *$553,400* | |
| **Final Design Phase** | | | | |
| March 2011 | Siphon 15 Final Design | September 2011 | $81,900 | APM & Prj.Eng. |
| March 2011 | Siphon 20 Final Design | September 2011 | $80,000 | APM & Prj.Eng. |
| April 2011 | Siphon 23 Final Design | September 2011 | $101,000 | APM & Prj.Eng. |
| April 2011 | Reservoir Final Design | December 2011 | $420,000 | Prj.Eng. |
| July 2011 | Reservoir-Siphon 24 Replacement Design | December 2011 | $43,600 | Prj.Eng. |
| September 2011 | Reservoir- North Levee Improvements (Additional Subconsultant Authorization) | December 2011 | $70,000 | Prj.Eng. |
| | | *Total Final Design Phase* | *$796,500* | |
| | | ***Total Highlands Projects Booking Fees to Date*** | ***$1,349,900*** | |
| Siphon Projects | | Flow Measurement Project | Reservoir Projects | |

## 5.3 FLOW MEASUREMENT PROJECT

As originally scoped in July 2010, the purpose of the flow measurement project was to provide preliminary designs for four flow measurement structures (i.e. flumes or weirs) associated with the Highlands Reservoir area; however, over the course of the project, the project scope morphed into a study of the water balance associated with the Highlands System as a whole. This change in scope for the project led to some negative consequences in profitability for Freese and Nichols; however, the project ultimately added significant value to SJRA as more cost-effective solutions were identified.

### 5.3.1 Problem

Ultimately, the problem SJRA needed to have addressed by this project was that SJRA records indicated a disparity between the inputs (volume of water pumped at the Lake Houston Pump Station) and outputs (the volume of water sold to SJRA customers) of the Highlands System. The records indicated that more water was sold to customers than SJRA pumped into the system, which is opposite to expectations. The Texas Commission on Environmental Quality (TCEQ) had noted the issue as a part of a water conservation report on the system. Conservation efforts would be expected due to the potential for evaporation and seepage that the earthen-lined canals would exhibit. Another potential issue with TCEQ is associated with water rights. According to TCEQ, the question of who owned the water rights of the water that was apparently entering the SJRA system needed to be addressed. Before FNI studied the project in greater detail, the initial approach to these issues focused on measuring the flows entering and leaving

the Highlands Reservoir. SJRA was directed to put flow measurement devices on all known canal inflows into and out of Highlands Reservoir.

Figure 5.2 presents a flow schematic of the Highlands Reservoir area, while Figure 5.3 presents aerial images of the Highlands Reservoir area and the potential locations for flow measurement as originally scoped—both reproduced with permission of SJRA from Preliminary Engineering Report (FNI 2011f).

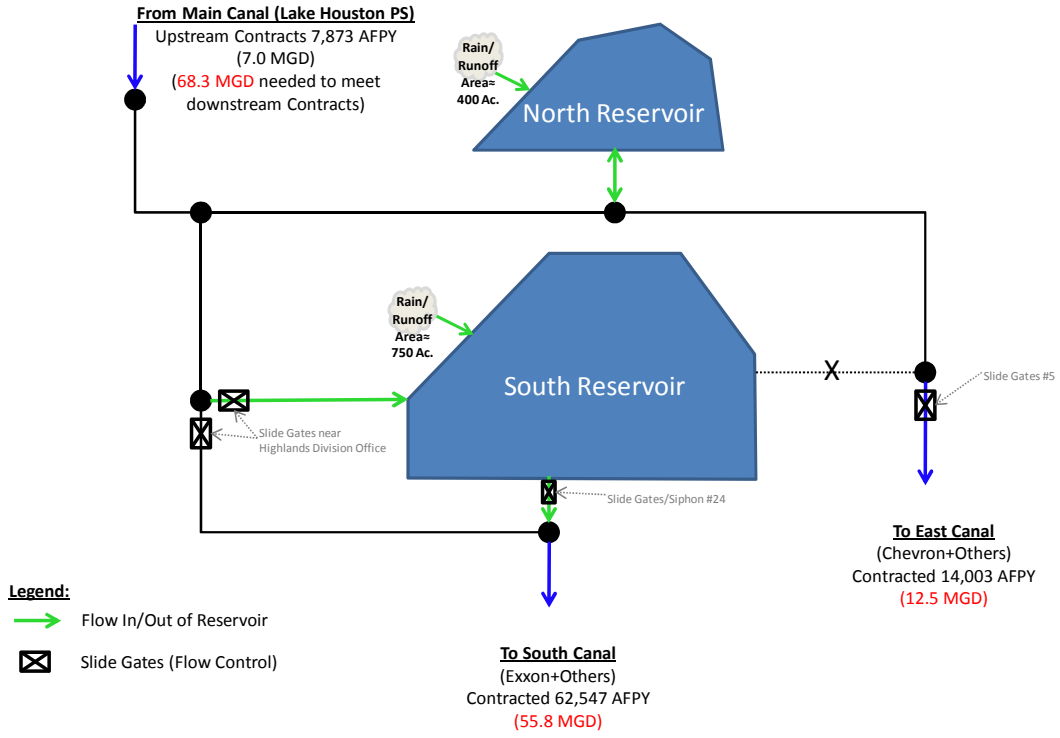


**Figure 5.2. Flow schematic of Highlands Reservoir. Reproduced (FNI 2011f) with permission of FNI and SJRA.**

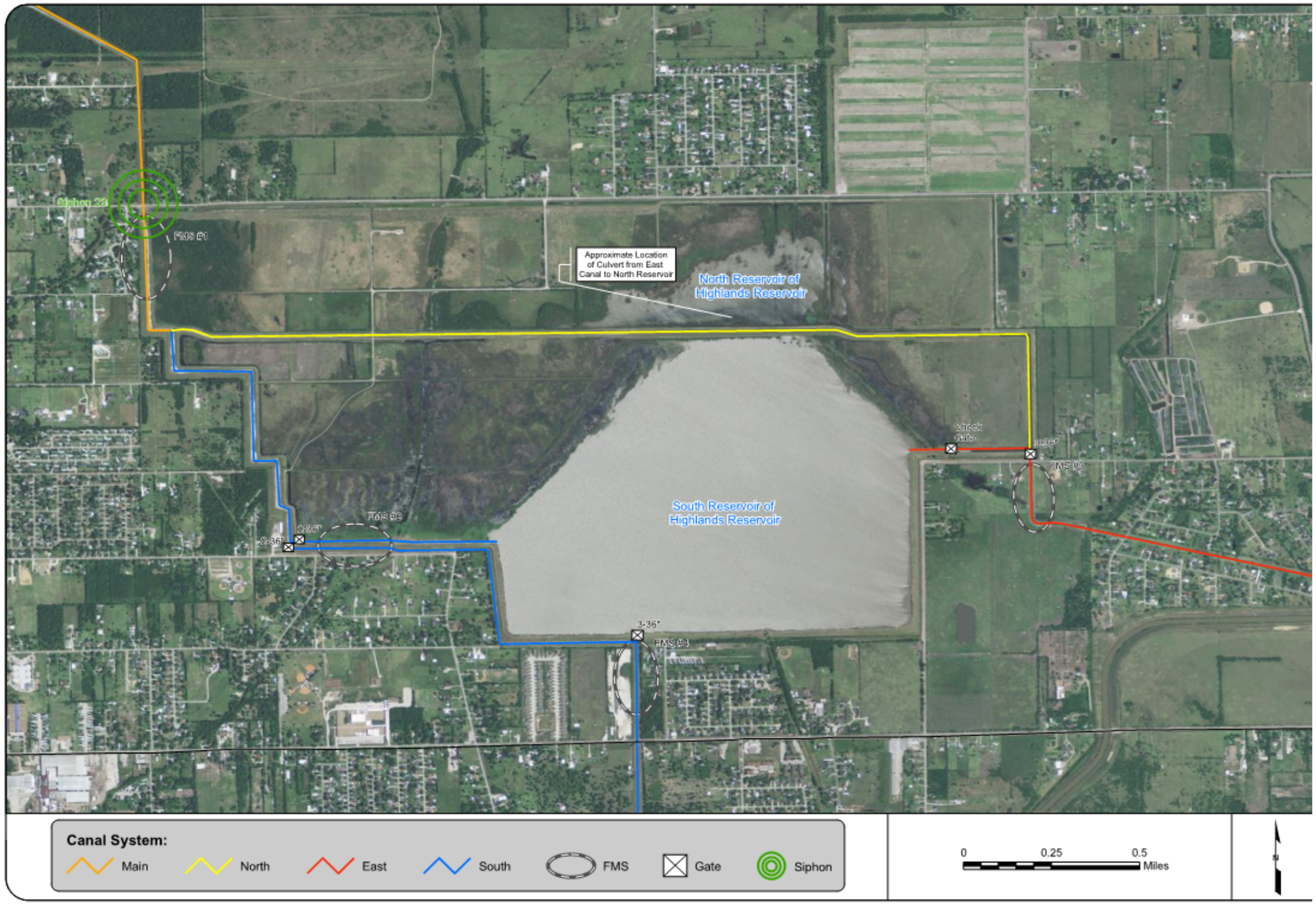


**Figure 5.3. Aerial image of the Highlands Reservoir area. Depicts canal segments, flow measurement station locations, and pertinent structures. Reproduced (FNI 2011g) with permission of FNI and SJRA.**

### 5.3.2 Technical

With this project, the primary technical activities included a water balance study for the entire Highlands system, system operations investigations, open channel flow measurement device research, canal hydraulics studies (including the impact of adding flumes), and site investigations (FNI 2011f). I was personally involved with all technical aspects of this project, except for conducting site survey and geotechnical investigations, which were performed by subconsultants.

The water balance study for the Highlands system was pertinent to the overall management of the project. For this study, I set up the water balance equations with appropriate inputs, outputs, and boundary conditions; however, I did not actually perform calculations of the water balance because SJRA did not provide the data to FNI. Instead, the study allowed for more definitive recommendations concerning the potential locations and reasons for including flow measurement structures (which is more management related).

The flow measurement device studies were also significant to the study. Specific technical calculations were generally minimal due to the conceptual nature of the project; however, the information collected allowed FNI to make recommendations about types of devices (flumes, weirs, or Doppler flow measurement technologies) for specific locations of interest in the system. Hydraulic studies of the system led to the elimination of weirs and flumes in several potential flow measurement locations because of their potential impact on canal and reservoir hydraulics.

### 5.3.3 Managerial

The managerial tasks associated with this project were both client-oriented and FNI-oriented. The PER eventually turned into a management tool for the client to use in making decisions about flow measurement. Technical details about proposed technologies and locations were deemphasized in favor of big picture decision making points. Ultimately, this decision was based on a meeting that I attended alone with the client where they communicated that the report needed to say "where to put flow measurement, what type of measurement technology to use, how accurate the technology would be, and what would it cost." The project was met with favorable response from the client because these issues were clearly addressed in our report.

From the FNI-standpoint, I was involved with all phases of the project management in my role as assistant project manager. For the flow-measurement project specifically, the major management issues with the project included staffing issues and scope creep. Scope creep was discussed at the beginning of this section, and primarily refers to the "where to put flow measurement" questions associated with the project. FNI's initial scope and fee was written and calculated based on developing a preliminary design for flow measurement structures at particular locations; however, during the project, FNI found that the locations and need for the structures was not specified. Eventually, all questions were addressed. In hindsight, FNI and the client should have discussed the project needs in greater detail before agreeing to contract terms.

Alternatively, the project management of this project was also imperfect. I attribute this to staff inexperience, to project precedence being lower compared to the siphon projects, and personnel assignments to the project that did not fit the roles.

From the inexperience perspective, there was not a flow measurement subject matter expert assigned to the project. This brought about inherent inefficiencies because we had to learn how to approach the project as we went. Thus, a concerted effort was not developed at the start of the project to define tasks, order them logically, and assign action to specific team members.

From a precedence perspective, the effort associated with the SJRA siphon projects took precedence over flow measurement for our project team, further harming our ability to plan effort. This did make sense from a HBP strategic perspective because FNI perceived that we were in direct competition with other consultants for the siphon projects. It was more imperative for us to successfully execute the siphon projects on time and within budget compared to other projects.

From the staffing perspective, FNI staffed the project with individuals for management operational purposes rather than technical reasons. In particular, southeast division management dictated that a highly experienced water/wastewater treatment engineer be assigned as the work package manager for the project. As work package manager, this individual was tasked with developing the work plan for the project; however, the role was not effectively executed by the individual. He was placed on the project in an effort to improve his utilization and increase revenues for the group (1159) and southeast region because there was not treatment work available for him to do (a

management decision versus a technical decision). With my role as APM and his experience, the chain of command on the projects was ultimately ineffective, and we struggled as a group to organize our effort towards the completion of the project. He ultimately cost more money against the project budget per hour of work, and the assignment led to non-productive times associated with project work. This is an example of the importance of effectively staffing and developing teams to work effectively and efficiently.

### 5.3.4 Project Outcomes

This project yielded mixed results. Positive project outcomes for this project were that that the client was happy with the project and that flow measure structures were not needed at the time (saving the client money), whereas the negative project outcome was that the project was not highly profitable for FNI.

Based on the PER, SJRA determined that flow measurement is not needed at the locations identified because the water balance information lead to a recommendation that the existing flow meter accuracy should be verified. Evidence suggested that the flow meter accuracy at the customer take points versus the flow meter at the influence pump station was incorrect. Resolving this issue would reduce operational complexity associated with installing new flow measurement stations. However, if flow measurement is eventually needed at the defined locations, SJRA can implement the technologies recommended by FNI at a time later in the future. This project outcome was expected to satisfy TCEQ concerns, and it ultimately led to significant client satisfaction and “value-added” services.

On the other hand, this project was not seen as profitable as it was set up to be from the Freese and Nichols perspective. The project finished $12,296.99 over budget, resulting in a negative variance of 17.8% on the entire project, and a labor multiplier of 2.46 (FNI 2011l). This is significantly below FNI goals for the southeast region, and the labor multiplier being below 2.7 means that the project had a negative profit (FNI 2008) on its employee's labor of -$3,285.26 (note that this is partially offset by profits earned on subconsultant expenses). This negative project outcome can be attributed to multiple factors, including scope creep, inefficiency (employees worked on the project for more time than budgeted), disparity in hourly rates between employees (people worked on the project with higher raw salaries than was originally budgeted), and simply not budgeting enough labor hours to complete the project's tasks. FNI did work on the project outside the originally specified scope of work—fully knowing that the additional effort was not accounted for in the contract, but that it would add value and was the right thing to do.

Additionally, from a revenue perspective, FNI lost the potential revenues from a Final Design phase because it was determined that the projects were not needed. From a FNI management perspective, these losses were still seen as worthwhile because it did generate revenue for the company, it improved the employee's utilization for a period of time, and the success of the project lead to additional work on other parts of the Highlands Bond Program.

## 5.4 SIPHONS 15, 20, AND 23 REHABILITATION PROJECTS

The purpose of the siphon rehabilitation projects was to provide designs for the rehabilitation or replacement of the existing inverted siphon road crossings for the SJRA canal system. These crossing had been in service for over 60 years, and were likely approaching the end of their useful life. For this reason, the projects were included as part of the Highlands Bond Program. Siphons 15, 20, and 23 were all very similar projects in concept; however, they are located at different road crossings along the SJRA canal. These projects all included a preliminary engineering phase (completed in April 2011), and a final design phase, which is still ongoing at the time of this report.

In this context, a "siphon" refers to a canal crossing at a road or drainage ditch that causes water (generally of the canal) to be diverted underground through pipes. The hydraulic gradient between the water before and after the pipes causes water to flow through the siphon. In theory, siphons could be considered culverts that flow full on both sides; however, in some SJRA applications, the flowline of the pipe is approximately ten to twelve feet below the flowline of the canal bottom. Alternatively to a siphon, roadway bridges could be built over the canal; however, this would create problems in conveying storm water across the canal. One water flow (either the canal or storm water) must be diverted over or under the other, and it is likely more hydraulically reliable to have the constant canal flow diverted, rather than storm flows. Figure 5.4 depicts pictures of the existing siphons. Figure 5.5 depicts plan and profile drawings of the proposed siphon concepts, as presented in the Pre-100% submittal to SJRA (FNI 2011e).

a)

b)

c)

**Figure 5.4. Pictures of existing siphon crossings. This includes the upstream inlet of Sipon 15 (a), the downstream outlet of Siphon 20 (b), and upstream of Siphon 23 (c). Images reproduced (FNI 2011h, 2011i, 2011j) with permission from FNI and SJRA.**

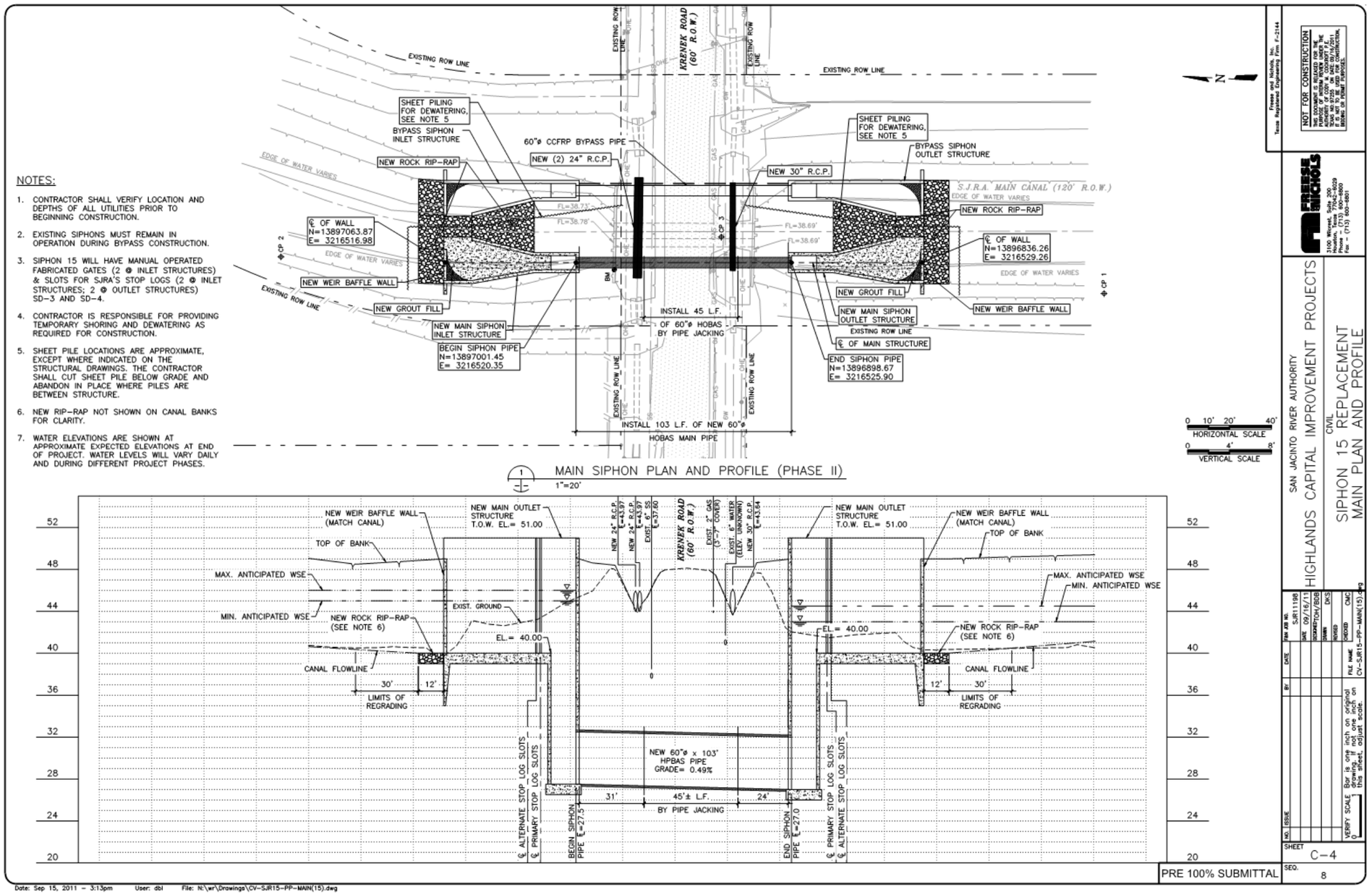


**Figure 5.5. Plan and profile drawings of the proposed Siphon 15 concepts. Image presents a typical detailed draing deliverable. Portions of text may be unreadable as produced in this document; however, the image is still presented as an example of a typical engineering deliverable.Reproduced (FNI 2011f) with permission of FNI and SJRA.**

### 5.4.1 Problem

The primary problem to be addressed was the age and integrity of the existing siphons. SJRA required a reliable long-term crossing that would minimize future maintenance, which suggested that the existing siphons needed to be replaced. The secondary problem encountered was the constructability of a new siphon. Flows of between 40 million gallons per day (MGD) and 65 MGD must be maintained across the roadways throughout all phases of construction.

### 5.4.2 Technical

From a technical perspective, siphon designs are relatively simple projects; however, the requirement of maintaining flow in the canal throughout construction adds significant complexity to the projects. For this reason, we developed four conceptual approaches to construction the siphon during the preliminary engineering phase. The options included temporarily bypassing the existing siphon via bypass pumping or temporary gravity siphons, only constructing a bypass siphon while leaving the existing siphon in place, bypassing the existing siphon with dual pipes and demolishing the existing siphon in place, or a phased approach where a permanent bypass would be installed that becomes a permanent part of the siphon system and is used to convey water while the existing siphon would be removed and replaced. Ultimately, the phased approach was recommended and selected by the client.

Additional technical activities during the preliminary engineering phase included hydraulic analysis to size piping and quantify headlosses, site investigations (geotechnical, surveying, utility location), construction sequencing, analysis of design

alternatives, development of preliminary engineering drawings, and estimating construction costs. I was involved to some level with all components technically; however, my lead role was the hydraulic analysis of the siphons. In this analysis, I recommended that two 60 inch diameter pipes be used per siphon because a single pipe would have similar headlosses compared to the existing siphons. Thus, either pipe could be removed from service for operation or maintenance reasons with minimal negative hydraulic consequences.

Also, estimated construction costs were developed as part of the preliminary (and subsequent final design) phases of these projects. Providing construction costs is a significant part of the design process; however, it is difficult at the conceptual level when material quantities are subject to change and unit prices for materials are unknown. For these projects, FNI engineers contacted construction companies directly to get ballpark unit prices. Additionally, a contingency of 30 percent was added to the cost to account for potential changes.

During final design, the focus of the projects shifted towards the development of detailed design drawings and specifications. This included developing plan sets, site layout and grading, sizing concrete walls, designing concrete rebar, providing relevant details to the design, developing traffic control plans, and reviewing the constructability of the projects. I assisted with the development of the plan set, site layout and grading, standard details, and portions of the technical specifications for each siphon project. The primary area of learning through this effort was via the development of the plan and specifications sets. For constructability review, I developed a hydraulic model in HEC-

RAS to analyze if sheet piling in the canals would cause flow constrictions during all construction phases.

### 5.4.3 Managerial

Throughout the PER and final design phases, I engaged in management activities pertinent to the project. In general, the management activities during the PER phase had mixed results; however, in final design contract negotiations and during the project, project management went much more smoothly.

During the PER phase, positive management activities included the development of a list of design needs for the siphons and effective meetings with permitting agencies. The list of design needs helped justify SJRA's decision to replace the existing siphons in their entirety (rather than rehabilitating them). Though the existing siphons were in relatively acceptable structural condition compared to other siphons within the SJRA system, the long-term operational needs would not be met by leaving the existing siphons in place. This section of the report would have helped justify the project cost to members of the SJRA Board of Directors had they questioned the projects. Additionally, FNI met with permitting agencies, including Harris County Precincts 2 and 4, the Texas Department of Transportation, and Harris County Flood Control District to determine permitting requirements, to discover design requirements, and to secure preliminary approval for road closures during construction. These meeting allowed designs to proceed, and SJRA and FNI were perceived as a good neighbor to the permitting agencies. This could potentially result in favorable relationships for future projects.

Alternatively, there were negative management activities in the PER phase, including inefficient team management and overcomplicating portions of the report. Inefficient team management occurred in the final month of the draft PER development (November to early December). In this case, the project manager allowed me to coordinate between our group (1159) and our Pearland office (group 1157). Like the flow measurement PER, Southeast Division Management assigned individuals with low work utilization to be part of the project team. These individuals, including an engineer and all of the CAD technicians in the region, were based out of the Pearland office, complicating communication and work efforts. Consequently, the individuals prioritized work from their own office over work from the Houston office, delaying its completion.

Quality expectations between the Houston office and Pearland office were different, causing further complications. Expectations for the report organization and structure were not communicated effectively between Houston and Pearland engineers. Though I developed a "skeleton report" outline describing each report section, the report was either not accepted or possibly not read by the other team members. I proceeded to develop the PER expecting them to provide details for the report. Their work ultimately did not fit with the report as intended; however, given time constraints and pressure to deliver the draft reports on schedule, we included their content. Ultimately, this confusion caused the reports to be overcomplicated, which confused the client. It took subsequent meetings with the client to streamline the information and present it effectively. Ultimately, we were successful at convincing the client to move forward with the final design of our siphons.

Between the PER phase and the final design phase, I was significantly involved in the development of the scope, fee, and schedule for the final design phase. For this, I helped generate scope language and calculated engineering fees. Calculating the engineering fees was unique because of the similarities between the projects. Typically, engineering fees are calculated at FNI by estimating the number of hours required for each member of the project team to complete portions of the scope. The hours are multiplied by each person's hourly rate and the labor multiplier associated with the project. In this case, I developed a unique approach to compensate for the increased efficiency associated with learning curves. It stood to reason that lessons learned on the first siphon design would be applied to the second and third siphon designs, meaning that less labor would be required. However, when presenting the engineering fees to SJRA for approval, SJRA requested that the fee for each siphon be approximately equivalent to the other similar siphons. To compensate, I developed spreadsheets that allowed FNI to balance the effort between projects for presentation purposes. FNI and SJRA ultimately reached contract agreement based on my proposed method.

During the final design phase, the project management efforts were significantly improved, despite adding team members from other offices (groups from Corpus Christi, Fort Worth, and Austin). In this case, the Houston office workload required additional resources to meet schedule requirements. In this case, I developed drawings and specifications lists at the start of the projects, and then tasked specific individuals with activities on the team. Each task manager was asked to develop a work plan for each submittal such that the work was effectively planned. High quality submittals were

made on time at each deliverable date. Success factors associated with the final design can be attributed to developing a more effective staffing team, providing a clear path forward, and empowering other individuals to move towards the completion of the activities.

An overarching managerial theme in the siphon projects was direct competition between consultants. SJRA selected two other consulting firms to design four other similar siphons. Whereas engineering is typically more focused on the engineer's qualifications and the technical issues of the projects, the perception of outperforming the competitors was a major emphasis in management. For FNI to maintain their stated business strategy of differentiated products by higher quality service, FNI needed to deliver superior technical products, better customer service, and meeting or exceeding schedule. From SJRA's perspective, FNI's engineering fees and design features needed to match the other consultants. In contract negotiations, this led to SJRA requiring engineering fees to be similar between consultants (FNI's fee estimates tended to be higher compared to the consultants). In the PER phase, FNI was pressured to accelerate the project schedule, and FNI developed the PER reports with the mindset that they needed to be more complete than the competitors (this may have partially led to the over-complication of the initial writing). During final design, issues arose with regard to the acceptance of the technical specifications for the project (FNI was asked to use other consultant's specifications that FNI engineers felt were lacking technically). These issues were ultimately resolved; however, they created interesting and competitive project dynamics.

### 5.4.4 Project Outcomes

At this point, these projects are perceived as having positive outcomes, both from the client's and FNI's viewpoints:

- Our PER reports were more complete compared to our competitors; however, our reports almost had too much information, which confused the client at first submittal. This was mostly due to overcomplicating portions of the report—and was partially a function of managing others on the project team. This experience stressed to our group the importance of streamlining reports.
- At the present time, SJRA is happy with FNI's siphon designs; however, the ultimate verdict will be reached after our siphons bid. If our projects are significantly more expensive than our competitors, our designs would be negatively perceived compared to the competition of other consultants.
- The projects were profitable for FNI, and they resulted in further work (design contract and likely a construction phase services contract). The PER projects were all completed slightly over budget; however, the extra effort was still within FNI's profitable area, so the earned profit was slightly less than goal. For final design, FNI is currently poised to finish under-budget, meaning that the projects are likely to be more profitable than goal. The budget tracking spreadsheets of Appendix B provide further insight into this outcome.
- From a strategic standpoint, FNI was able to show differentiated products compared to its competitors. During both project phases, SJRA trusted FNI's judgment concerning technical issues on the projects. For FNI's business growth

in the SE region, it was imperative for us to perform well. SJRA is an influential client in the water industry in the area (Region H meetings are held at their offices).

## 5.5 HIGHLANDS RESERVOIR REHABILITATION PROJECTS

The purpose of the Highlands Reservoir Rehabilitation projects was to design reservoir rehabilitation projects for the reservoir embankment and its appurtenant structures. These activities will mitigate risk for dam safety, improve operational flexibility of the reservoir, and potentially increase storage volumes in the reservoir (thereby reducing SJRA's risk of being unable to meet downstream customer water demands). The project was divided into a preliminary engineering phase, and then a subsequent final design phase. Ultimately, several problems and portions of projects resulted from the inspection, and subsequent phases of the engineering process.

### 5.5.1 Problems

Problems to be addressed through the project can be described as follows:

- Storage Volume: The reservoir has historically stored 1,500 acre-feet of water (three to seven days of emergency storage), whereas the reservoir is permitted to store up to 3,800 acre-feet (FNI 2011g). By increasing storage volume, SJRA could increase the available emergency storage for downstream water customers. FNI considered dredging and raising the operating water level in the reservoir as potential alternatives to increase storage volume during the PER phase. Figure 5.6 presents an inundation map of areas flooded by increasing the water surface elevation of the reservoir.

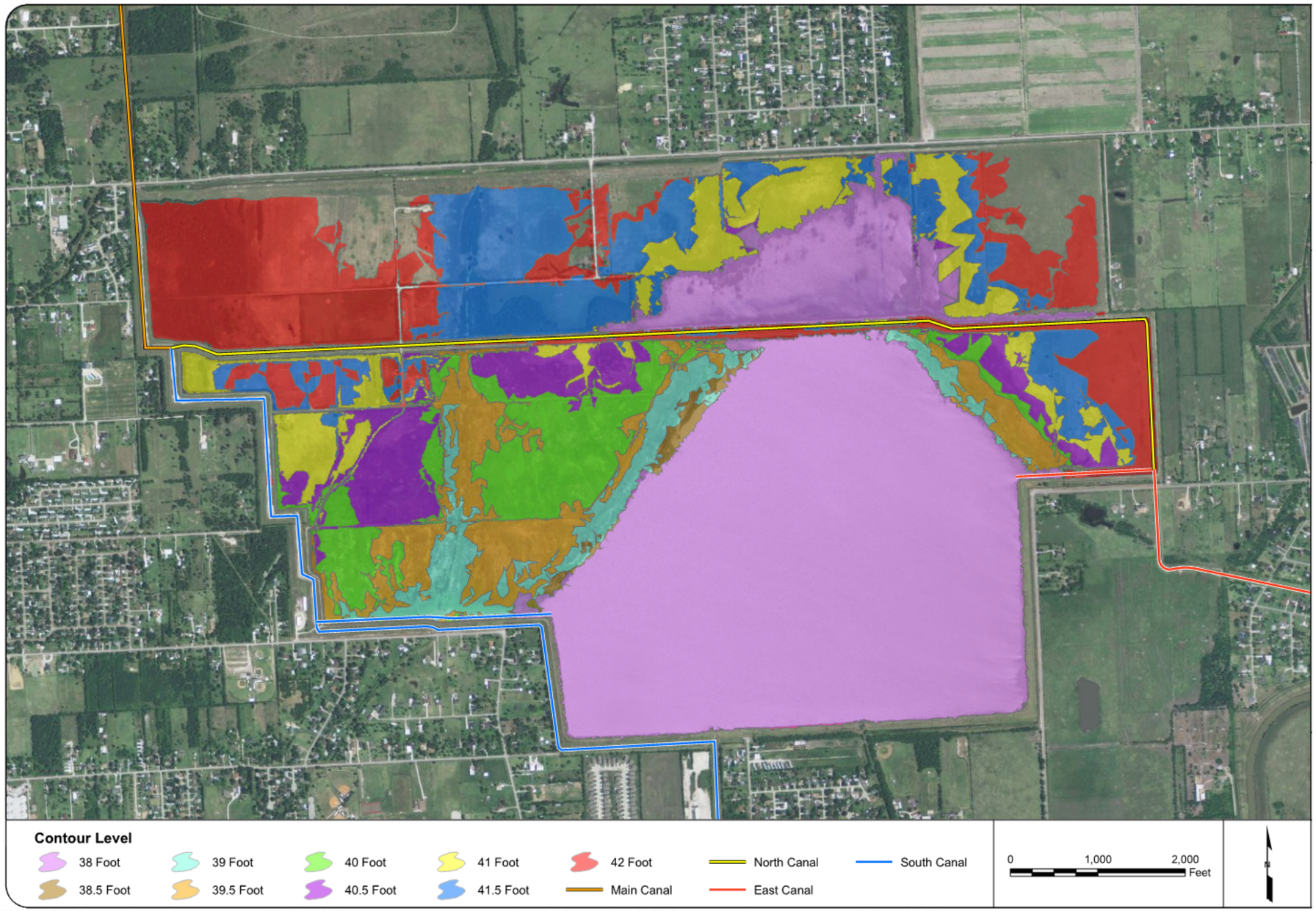


**Figure 5.6. Potential inundation map of Highlands Reservoir at varying water levels. Reproduced (FNI 2011g) with permission of FNI and SJRA.**

- Ring Levee Embankment: Primarily, erosion of portions of the embankment due to wave action was noted in the 2009 Dam Safety Inspection. Erosion was particularly noticeable in sections without reed growth, even where concrete rubble riprap was present. Embankment improvements for wave erosion were originally focused on the south levee; however, over the course of the project, sections of the north levee needing erosion protection were also identified. Figure 5.7 presents photographs of the existing embankment levee, including eroded portions of the embankment.
    - A secondary problem with the embankment was reed growth that was used to prevent erosion. The tall, dense reeds do not allow for dam safety inspection of embankment, and it provides habitat for burrowing animals. Reed growth is also presented in Figure 5.7.
    - Another problem with the embankment discovered during the project was inconsistent top of levee elevations in some widespread areas. It was discovered that levee embankment heights varied such that portions of the embankment would potentially be overtopped during a Probable Maximum Flood (PMF) storm event, which did not meet TCEQ dam safety regulations.

a)  b) 

c) 

**Figure 5.7. Pictures of Highlands Reservoir embankment levee. This includes (a) picture showing concrete rubble riprap and erosion, (b) unprotected embankment section with significant wave erosion, and (c) tall, dense reed growth that prevents inspection and provides burrowing habitat for animals. Images produced with permission from FNI and SJRA.**

- Emergency Spillway: The existing emergency spillway was in disrepair at the start of the project, as depicted by Figure 5.8. SJRA decided to completely replace the existing spillway as part of the bond program.
- Outlet Structure #3 (Siphon 24): During a final design inspection, FNI engineers noted water flowing behind a headwall to the outlet structure from the reservoir into the South Canal System. This was a potential dam safety risk because water flow could indicate piping through the embankment, which could ultimately lead to failure. SJRA decided to completely replace the outlet structure as part of the bond program.

**Figure 5.8 Picture of existing emergency spillway in disrepair. Produced with permission from FNI.**

### 5.5.2 Technical

Technical project items are discussed below as related to each project component identified in the previous "problems" section:

- Storage Volume: Technical analysis of the storage volume of the reservoir primarily focused on the use of GIS technology with elevation files. This information was primarily developed and analyzed by previous consultants (bathymetric survey data for the reservoir area). LiDAR data was used to project storage volume added in previously dry areas by increasing the operating level in the reservoir. FNI did employ a subconsultant to further study the dredging efforts associated with the reservoir. The subconsultant used GIS raster tools to project potential increases in storage volume based on dredging certain areas.
- Embankment: Embankment improvements primarily focused on erosion protection techniques (i.e. using rock riprap as erosion protection—and conducting calculations to determine the rock size requirements) and site grading. Riprap sizing was based on expected wave height and rock size and weight. These calculations were performed primarily by other members of the design team.

  The other substantial part of the embankment improvements involved site grading. Effective site grading is required to place riprap at an appropriate slope, to enhance the aesthetics of the embankment, and to ensure constructability of the design. Grading was developed based on existing grades (obtained via a large surveying project for the entire levee), typical sections of the slope embankment

(defined riprap slopes, starting and ending elevations of the riprap and typical embankment widths). FNI used available tools, primarily AutoCAD Civil 3-D to enhance grading during the final design stages. Riprap protection and grading enhancements were designed for over 13,000 linear feet of the embankment.

For other sections of embankment where levee elevations were low, GIS was used to develop maps that facilitated the identification of low spots along the levee. I assisted with all parts of this project; however, other members of my group were more pertinent to the design efforts.

- Emergency Spillway: The spillway redesign included hydrologic analysis, hydraulic calculations, HEC-RAS modeling of downstream channel segments, energy dissipation calculations, and detailed design of the proposed spillway structure. I was involved in all phases of this work. In particular, hydrologic calculations were performed to determine the water surface elevation during a Probable Maximum Flood (PMF) event. Based on this data, it was determined that the spillway flowline needed to be lowered, such that water would discharge from the spillway at lower water elevations, and that the embankment height around the entire ring levee must be raised in low spots up to the PMF elevation.

  Hydraulic calculations primarily included the development of the discharge rating curve for the proposed spillway, studying the downstream channel via HEC-RAS to determine expected water elevations downstream of the spillway, and energy dissipation calculations to design the spillway to minimize erosion downstream of the spillway when the spillway engages. Using these

calculated values, design drawings were developed that included the site layout, the grading adjacent to the structure, the sizing of the spillway structure, and conceptual level details for the spillway.

- Outlet Structure #3 (Siphon 24): The redesign of the outlet structure was similar in technical scope to previous siphon projects. In this case, I completed discharge capacity calculations for the siphon based on pipe friction and orifice equations. Additionally, I helped the design team when my familiarity with the reservoir warranted by providing advice with site layout and grading issues.
- Detailed construction drawings and cost estimates were eventually developed for all parts of the reservoir rehabilitation. Cost estimates required detailed quantities to be assessed for the proposed designs, and unit costs for building materials were collected from contractors and riprap suppliers.

### 5.5.3 Managerial

My managerial roles for the reservoir repair projects were somewhat limited compared to the flow measurement and siphon projects. Though I was assistant project manager during the PER phase, my workload did not allow me to continue that role through final design. Nonetheless, the following managerial issues were noted through the project:

- Understaffing of the design team (PER): The design team was understaffed for this project, particularly in the preliminary engineering phase. This was in part due to the size of the FNI group (1159) at the start of the project, and in part due to the staff's inexperience in using the design tools needed for the project. The

project staff was essentially limited to Cody Cockroft and me during the initial 80% of the project—during which our focus was on the Siphons 15, 20, and 23 projects. For the last month of the final deliverable development, the group added a new engineer that had just graduated with her Bachelor's Degree. Additionally, the CAD technicians assigned to the project during the PER stage were located in the Pearland office and had mere familiarity, rather than the needed expertise, in the Civil 3D design tools necessary to grade a project of this magnitude.

During final design, these issues were addressed to a point. Additional engineers were hired into the group, a Pearland CAD technician was moved to the Houston office for better face time on projects, and we sought Civil-3D expertise from other groups in the company.

- Mismanaged Deliverable: As part of the final design, FNI presented SJRA with an Interim Submittal between the PER and the 60% design. The intent of this deliverable was to provide the client with updated design information, increase their confidence in the design progress, address questions between the client and the design team, and provide construction costs.

  Unfortunately, almost every portion of the intent was not met by the deliverable. Though some necessary design questions were answered in response to the spillway design, the deliverable raised significant questions concerning the constructability and cost estimates of the riprap design. This lowered the client's confidence in the riprap deliverable, which was expected to represent the largest

portion of the bond money for the project. Because of this deliverable, progress on other portions of the bond program with other consultants was delayed.

In my opinion, the primary reason for this mismanaged deliverable was staffing and workload related. A new FNI engineer was asked to manage the riprap project. This engineer was unfamiliar with parts of the PER work on the project. Potential problems with this assignment were compounded because Mr. Cockroft, the project manager, was overworked and unable to follow the project progress consistently.

- Accelerated Schedule: As a result of the mismanaged deliverable, FNI was asked to reconsider the technical presentation from the interim submittal and accelerate the project schedule. The intent of this was to regain client confidence and to mitigate risk to the bond program such that the project could be bid earlier, effectively locking in a contract price. The accelerated schedule caused staffing to become overworked—and required a significant use of overtime hours; however, the compressed timeline may help the project be completed within the engineering budget.
- Unified project direction: In my opinion, the mismanaged deliverable and accelerated schedule were caused in part by project team members being non-unified in their efforts towards project completion. Each project area was seen as an individual project, rather than an interconnected set of projects. To minimize problems for the 60% submittal, I suggested that the project team having frequent coordination meetings to unify individual effort to project completion. At the

time, at least nine people were working on the project. These informal meetings were held, and the meetings facilitated the submittal of the 60% deliverable with portions of the deliverable closer to 70% to 85% design levels.

- Additional work authorizations: Through the final design of the project, several situations occurred where additional contracts were needed to cover the work required by the project. In particular, the decisions to replace the Outlet Structure #3 and to provide slope protection on the northern levee were not accounted for in the original Reservoir Final Design scope and fee. As a result, FNI and SJRA developed additional work orders to complete the work. This was in part due to the contractual nature of the SJRA agreements as "lump sum" contracts. Advantages to this situation is that both parties were covered when additional work was needed; however, disadvantages existed in that the contracts required approval by the SJRA board member, and the additional contracts create separate projects that must be managed.
- Client Relations: Through this project, I was exposed to some of the difficulties involving client relations. Difficulties included slow response times, variation in primary client contacts points and decision making, differences of opinion in design issues, and problems related to meeting attendance (FNI was forced to send younger staff to client meetings without the project manager, despite protests; the client was ultimately unhappy that Mr. Cockroft could not attend the meetings).

Despite FNI's best efforts in providing excellent client service, the client may have perceived mixed results in that regard. It should be noted that client service is a dual-responsibility for both the consultant and the client. As a design team, we could not control many of the "problems" related to client service.

### 5.5.4 Project Outcomes

The following project outcomes can be summarized for each project phase:

- **PER phase outcomes were mostly positive**. The client was happy with the final report product and recommendations despite some initial questions after receiving the draft report. After providing additional information and meeting with the client to discuss concerns, the client accepted FNI's recommendations and decided to move forward with the final design phase. Freese and Nichols management also viewed the PER phase project as a success. The project finished within budget and was ultimately profitable for the company (see Appendix B). It kept Mr. Cockroft, another engineer in training, and me billable and utilized for several months. Additionally, FNI was able to do significant additional work with the client related to final design phase services.
- **Final Design Phase outcomes are incomplete as of the writing of this manuscript.** Ultimate outcomes for the final design phase depend upon the client's acceptance of management and technical findings at future submittals, the successful bid of the project to contractors, and FNI's efficiency at completing the work. To date, the project has mixed results, primarily due to the mismanaged interim submittal and the difficulties associated with client relations

that were specific to this issue. As the design team, we expect these issues to be resolved by the end of the project.

From the FNI perspective, the projects are set up well (as of the writing of this manuscript) to be completed under budget due to the acceleration of the project. By accelerating the project, increased efficiency has been seen because team members focused entirely on the one project (rather than multiple projects).

## 5.6 SUMMARY OF OVERALL PROJECT MANAGEMENT ACTIVITIES

Managerial or nontechnical items to be discussed that were overarching between the Highlands Bond Program projects include my role as assistant project manager and its implications, and the contract types for the HBP projects.

### 5.6.1 Assistant Project Manager Role

As previously discussed, I was named the assistant project manager (APM) for many of the HBP projects. As APM, my duties included helping to set up the projects in the FNI accounting system, helping to assign team members to work on the project (via the FNI eResource system), tracking employee's efforts throughout the projects, tracking project budgets on a weekly basis, managing project components and personnel to ensure on-time delivery of the project to the client, interfacing with the client, coordinating with subconsultants to complete work and receive payment, completing monthly reports concerning project progress, and reviewing the invoice given to the client each month.

**Based on my experience with these projects, the widespread utilization of the APM role could benefit the FNI project delivery system greatly.** The APM role

can allow project managers the ability to manage more projects, especially if the APM understands project processes and the APM and PM have a trusting relationship. From a business development standpoint, this relationship can enhance the ability of the company to win projects where the project manager is in high demand. Often, clients perceive project managers as the reason to select an engineering company. Potentially, project managers with strong reputations and under high client demand can undertake more projects because the APM role allows them more time to manage other projects. From a project management standpoint, having a more energetic individual assigned to the projects with intimate knowledge of all project details can potentially improve client service, which would likely lead to improved client service—enhancing FNI's differentiated customer service-based business strategy.

In my opinion, my role as APM on the Highlands projects allowed both of the potential benefits to be met. Mr. Cockroft was overworked as a project manager because he was in high demand for clients, and my assistance afforded him the ability to emphasize work on other projects with other clients. I became intimately familiar with the Highlands system and projects, which helped enhance our customer service greatly. I often knew details about the Highlands projects of which Mr. Cockroft was unaware, and at times, my knowledge of the details proved valuable to our project delivery. Had I not served at APM for these projects, I likely would not have been as engaged on the projects as I ultimately was.

Based on the above information, I strongly recommend that the APM role be expanded at Freese and Nichols. According to rumors within FNI, management does

plan to significantly expand the APM role in the future, including specialized training and potentially including bonus structures based on project performance. To some degree, APMs do need more experience than I had starting off these projects. I was set as APM in part by necessity, and it worked primarily due to 1) a strong buy-in from Mr. Cockroft as the project manager for the projects, and 2) the relatively non-complex nature of the projects. However, at times, there were pertinent technical details or steps in the project that I just did not understand how to negotiate. FNI has preliminarily stated that the cutoff for APM duties will be the Engineer III level, which I tend to agree with the recommendation; however, it should be noted that I was not promoted to the level until the end of my internship. This effort proved that junior level staff is capable of serving in the APM role, which was previously uncharted at FNI.

### 5.6.2 Lump Sum Contract Type

Another relevant management-related topic from the HBP is the use of the lump sum contract type. With the lump sum contract, the client agrees to pay a set amount of money for a well-defined scope of work. The client agrees to pay this amount regardless of the actual effort used by the engineer in the project. Likewise, the engineering company must complete the work prescribed by the scope of the contract, even if it is inefficient and the project goes over budget. All HBP projects utilized this contract type. Lump sum contract also reduce the risk to an engineer.

- As APM, I noted the following points associated with the contract type:
    - Every hour that is worked actually has the potential to lower the project profit. As a PM, if you are graded for efficiently completing projects with

high profits, you want people to charge as little as possible to your project because their time is associated with a labor cost. The revenue with the project will be received regardless, so minimizing costs increases profits. If projects are very efficiently managed, the potential exists to make very high profits on the projects.

  - Comparatively, project types like "cost plus multiplier" or "time and materials" need employees to work on the project to receive revenue. On these projects, the profit margin is set based on the labor multiplier; however, the potential revenue varies.

- Another common likeness in management due to the lump sum contract types is the method in which the SJRA accounting system accounted for additional work. When FNI negotiated new contracts (i.e. in the reservoir final design stage), each additional work authorization resulted in a new project in FNI's system. This complicated the project management process.

## 5.7 OVERALL HBP OUTCOMES AND LESSONS LEARNED

Several significant outcomes and lessons learned can be extrapolated from the Highlands Bond Program projects. While technical activities, management activities, and project outcomes were discussed for each project separately, outcomes were also present on a wider scale and seen across multiple projects. These outcomes and lessons learned are discussed below:

- Project Presentation and Communication: The design team was continually reminded about the importance of project presentation and effective client

communication throughout the projects. In both project phases and across all projects, there were communications breakdowns between FNI and the client that lead to inefficiency and less effective project delivery. Examples of this included design decisions being delayed, and surprises—for FNI and the client—occurring through the projects. Additionally, the importance of streamlining project reports and deliverables was evident. At times, the client was confused by deliverables and information because it was overly complicated.

- Maintaining Project Schedules: FNI had previously developed a reputation with SJRA of being late in project delivery. Through these projects, our effort was directed to breaking this stigma such that we could improve relationships and client satisfaction. This endeavor was accomplished through these projects (in many cases, deadlines were beat), and should pay dividends in the future.
- Project scoping: Based on HBP projects, it is important to completely understand the needs of the client and the contract language prior to reaching agreement on contract terms. Though this is somewhat self-evident, multiple projects resulted in additional work authorizations (reservoir final design) or significant scope creep (flow measurement PER). These issues were often caused by a mutual lack of understanding of what needed to be studied most on certain projects. This resulted in negative consequences for both parties.
- Subconsultant quality control: In a feedback report to FNI, the Baldrige award committee suggested that our company needed to better define our supplier management strategies (FNI, internal meeting discussion, August 26, 2011). This

includes who we select as subconsultants for projects and how we ask them to present work to us. It stands to reason that if FNI wants to be the best at client service that we should expect the same from those to whom we are a client. The design team used the same survey company and same geotechnical firm across all projects to provide survey and geotechnical information, and these subconsultants essentially became suppliers to the projects.

FNI experienced some poor quality presentation of survey data, and, true to the Baldrige recommendation, our group ineffectively controlled the presentation quality of the survey data. This eventually led to additional effort by FNI employees to develop the survey into a useable format. Since that occurrence, our group developed a survey template specifying quality considerations; however, this is something that could be beneficial across the company.

- Staffing Issues: At several points during the HBP projects, ineffective staffing of the design team was present. This was partially from necessity and based on available resources; however, the problems reflect the partially inefficient (or unspecified) growth plan in the Houston office. New offices and fast-paced growth bring about the potential for projects to not go smoothly if a trust is not developed between the team, and management could likely do a better job of planning group and team members based on technical expertise in areas.
- Goal-Centered Leadership/Management: Experience on these projects reinforced my management and leadership training from TAMU that focused on providing a

defined goal to a team and allowing them to move in the same direction. Simply put, this refers to the section of the book *Good to Great* that says to "get the right people into the right places on the bus, and then let them do their jobs" (Collins 2001).

I found that project activities were accomplished most effectively by setting goals/tasks for the team, communicating them effectively, allowing team members to get the work done, and following through with the plans. This approach was most effective when each team member was focused on a specific goal or part of the goal. When possible, I tried to allow team members to manage their own tasks as much as possible, which gave them more authority and ownership. This was particularly necessary given that I was an inexperienced EIT directing the work of more experienced EITs and PEs.

This approach was often successful; however, as evidenced by some project outcomes, it was not always perfect. Over the course of the internship, I did identify that my personal tendencies gravitate towards the goal approach—almost too much. It was suggested to me through these projects that I look at other means of leadership and management to be more effective. This is a personal future area of interest for further study.

- Project Strategic Value: The HBP projects were extremely valuable to the Southeast Division of FNI and the Houston office development. Though the technical nature of the projects tended to be underwhelming compared to my graduate studies—which was disappointing for me personally as part of the

internship, being involved on the projects taught and reinforced the strategic value that all projects have. The projects strengthened our relationship with SJRA, provided project workload to justify the growth of our group and region, and gave me work through the entirety of my internship period. When building a business, it is important to look beyond the technical appeal of the projects and consider the strategic value that the projects provide.

- Soft Skills: These projects served as an example that effectively using soft skills can be significantly more difficult than the technical execution of projects. Soft skills were absolutely necessary to have successful outcomes for these projects. Examples of soft skills that were applied include client relations, negotiations (particularly in negotiating the scope and fee of the projects), writing (through the development of the deliverables of the project), and communication (through email, phone conversations, and face-to-face meetings with the client and regulatory agencies).

# 6. OBJECTIVE #1: TECHNICAL ACHIEVEMENT

Beyond discussing the internship location and activities of the internship, one of the primary purposes of the DE Record of Study is to present the candidate's final internship objectives and demonstrate their completion. Through the next four sections (Sections 6, 7, 8, and 9), this purpose will be accomplished.

As discussed previously, Internship Objective #1 generally promoted technical achievement via application and learning of engineering skills. This objective was further defined in the "Statement of Final Objectives," and the means of completing the objectives and method of demonstrating its completion were presented. Subsequent portions of this section restate this information and provide further discussion for verifying its completion.

## 6.1 FINAL OBJECTIVE

Objective #1 was developed with the intent of capturing one of the major facets of the DE degree—application and learning of technical (engineering) skills. The final objective read as follows:

"To contribute to the technical completion of available projects at Freese and Nichols 1) via application of learned technical skills and 2) via learning and applying new technical skills.

a. The use of previously learned technical skills in real-world (project) applications will be discussed.
b. The learning of new skills and application of those skills in real-world (project) applications will be discussed.

c. Analysis will be given that discusses and compares previously learned skills to newly acquired skills" (Hann 2010).

As is typical with most of my objectives, the initial statement represents the substance of the objective, whereas the bullets below represent further descriptions and a course of meeting the objective in its entirety. This objective was to be met entirely through working on projects at FNI, describing technical activities in the ROS, and providing comparison between the known and learned technical skills.

## 6.2 OBJECTIVE DISCUSSION AND OUTCOMES

I believe that this objective has been met through the previous discussion of my project roles on all projects (Sections 3 and 4). Though the technical nature of many of my project assignments was less advanced in comparison to the full water-resources graduate curriculum, the projects did offer multiple opportunities to apply, learn, and strengthen technical skills. Significant technical activities on projects previously discussed include the following (note that bolded items were significantly new technical skills) hydraulic modeling through the application of basic hydraulic principles and the use of HEC-RAS, pump station design, **pipeline design and embedment**, **hydrologic modeling for reservoir discharges under the probable maximum flood (PMF) event**, water balance analysis, construction sequencing, cost estimation, geotechnical investigations, detailed structural design of reinforced concrete, **embankment erosion protection (riprap) design**, site civil grading, and **the development of detailed engineering drawings and specifications**.

Prior to the DE internship, I had been aware of most of the above technical activities to an extent; however, every application of a technical skill represented a deepened understanding of the concepts in a practical setting. Learning occurred throughout the projects. Some of the activities referenced knowledge from undergraduate coursework in general civil engineering classes (particularly surveying for site civil grading, geotechnical investigations, and structural design), rather than my coursework as a graduate student. It is also worthwhile to note that many of the above technical activities were completed as part of an overall project, and that I saw some of the technical components from somewhat of a distance, rather than being intimately involved in the design.

Significant outcomes from this objective include the following:

- Projects that seem to be less technically appealing still serve as opportunities to learn and develop technically.
- The projects demonstrated the importance of a well-rounded engineering education. Structural, geotechnical, and surveying were all very pertinent to these projects, even if I had not further developed the skills since taking undergraduate level classes.
- Potential opportunities exist for the Texas A&M Water Resources Division to further develop its technical curriculum. I identified areas for improvement, including dam design and operations (not covered at all), linking geotechnical and structural design to water resources, and pipeline and pump station design.

- In my opinion, this objective was met through my DE internship and the writing of this ROS.

# 7. OBJECTIVE #2: MANAGERIAL ACHIEVEMENT

Objective #2 promoted managerial achievements via the application, observation, and skill acquisition of managerial practices. Like the previous section, this section further defines the objective, discusses it completion during the DE internship, and presents the major outcomes resulting from the objective.

## 7.1 FINAL OBJECTIVE

The nature of this objective was motivated by the stated managerial goals of the DE degree. One of its primary purposes was to influence my focus towards the managerial aspects of the company, rather than the technical application of projects. As stated in the "Statement of Final Objectives," the major objective statement and qualifying additional points are as follows:

"To learn and practice managerial responsibilities through available projects and corporate functions at FNI.

a. FNI project management processes needed to complete projects from a managerial standpoint will be learned.
b. FNI corporate procedures that contribute to organizational efficiency will be learned.
c. Comparisons should be offered that provide correlation between project management and project success, corporate management to corporate success, project management to corporate success, and corporate management to project success.

d. Management processes will be practiced during the internship. Commentary should be offered to the effectiveness of the management processes towards positive and negative outcomes" (Hann, 2010).

The "Statement of Final Objectives" further specified that the objective be met via project work, daily office interactions, and continual learning opportunities and that writing sections of the ROS would chronicle the completion of the objectives.

## 7.2 OBJECTIVE DISCUSSION AND OUTCOMES

This objective was met through DE internship activities, and has been demonstrated through discussion in all previous sections of the ROS. In my opinion, Freese and Nichols is a well-managed company from top to bottom, and the experience gained during the internship helped me to see many managerial practices. I participated in several corporate, group, and project level activities that showed learning, participation, and development from a managerial perspective. The following points describe further where this ROS presents information that indicates the completion of these objectives:

a. FNI project management processes are discussed in detail in Section 3.
b. FNI corporate management, including organizational structure, business philosophies, and corporate activities are discussed in detail in Sections 2 and 3.
c. The interrelatedness of project management, corporate management, project success, and corporate success are discussed throughout this manuscript. It is implied through connections between the FNI business

concept and project management in Section 3. The relationship between organizational structures and project management is discussed in Section 2. Project discussions from Sections 4 and 5 elaborate on specific project situations that can offer insights into the relatedness of the concepts.

d. Management practices were practiced throughout my internship, particularly in my role as assistant project manager on the Highlands Bond Program. This objective is demonstrated primarily through the project discussions of Sections 4 and 5.

Managerial achievement outcomes that arise when viewing the DE internship from the Objective #2 perspective are listed below in bullet form.

- Group-level production meetings can contribute to project success and organizational balance. At the start of my DE internship, my group did not hold regular meetings to organize the group towards project endeavors; however, these meetings were held to an increasing level as the group expanded, and the meetings ultimately helped complete projects in several periods of high workload. The group was more aware of the activities of its members, increasing *espirit de corps*.
- General activity towards a common goal is a simple, yet effective managerial practice. This builds from many direct points discussed in the Highlands Bond Program, and is also seen in FNI's successful implementation of its Hedgehog Concept.

- Corporate project requirements such as the eResources resource management system can be very useful corporately, if the tools are used correctly. FNI attempts to use this system to forecast employee workloads, to forecast group productivity and workload, and to facilitate staffing decisions. Over the DE internship, I observed mixed results with these policies, in part because it delayed hiring of necessary personnel for my group.
- When developing the internship objectives, I overlooked the impact of the client in project and organizational management. The client contributes significantly to the success of a project. The most successful projects will have a client that is active, consistent, intelligent, and understanding of the developments that occur throughout the project.
- The assistant project manager role has the potential to greatly improve project success, personal development, and ultimately corporate success at FNI.
- I personally contributed to the successful management of multiple projects, including eight projects as an assistant project manager. These projects represented $816,300 in FNI total revenues on the projects, and they successfully contributed to the bottom line profitability of FNI as a program.
- In my opinion, this objective was met over the course of the DE internship and its completion is demonstrated within this manuscript.

# 8. OBJECTIVE #3: STRATEGIC ACHIEVEMENT

Objective #3 promoted organizational achievement through learning, analyzing, and recommending organizational strategy. Subsequent portions of this section restate the objective in full, provide further organizational strategy discussion, and present major outcome resulting from the objective.

## 8.1 FINAL OBJECTIVE

This objective was motivated mainly by my personal interest in organizational strategy and partially by its tendency to further develop the non-technical focus points of the DE program. Unlike the other objectives, the strategic objective did not carry several suggested subparts. The "Statement of Final Objectives" defines the objective as follows:

> "To contribute to FNI organizational success by familiarization with, analysis of, and recommendations for organizational strategy" (Hann, 2010).

As described in the "Statement of Final Objectives," this objective was to be met by observing the existing organizational strategy, conducting additional research, and making strategic recommendations. This objective was to be demonstrated via strategy discussions within the ROS and a strategic analysis similar to corporate management classes to be provided as an appendix.

## 8.2 OBJECTIVE DISCUSSION AND OUTCOMES

All portions of this objective were met through my DE internship program. In particular, the familiarization and analysis portions of the objective were discussed as parts of Sections 1 (FNI Company Profile) and Section 3 (FNI Business Model).

Appendix C presents a brief strategic analysis snapshot of FNI as a whole that is based a management course I took as part of the DE program. Strategy recommendations are provided as outcomes of this objective.

- There are multiple levels of organizational strategy, and strategy at each level requires careful consideration to optimize organizational effectiveness. Levels of strategy to consider include the following:
  - Project level marketing/sales
  - Service level marketing and market positioning (such as water transmission, treatment, water resources design, etc.)
  - Group level strategy (such as "growth" for a particular group of the company)
  - Regional strategies (such as the Southeast Region)
  - Firm-level strategy

  When developing the internship objectives, my primary focus was at the firm-level; however, experience showed me the individualized level of consideration that is required. In particular, the work on the Richmond/Rosenberg RFQ project enlightened me to this fact.
- FNI's firm-level strategy is a differentiated strategy based on high quality customer service (as opposed to cost-leadership). In my opinion, this corporate-level strategic plan is logical, well developed, and appropriate for the FNI business model. A general recommendation would be to continue this approach.

- FNI does a very good job of strategic planning. The company's recent success verifies this assertion. For this reason, providing broad-level strategic recommendations is difficult.
- One strategic recommendation is for continued investment in growth in the Southeast Region. Specific growth areas with a high potential for growth and strategic impact include storm water, water transmission, water resources design, and energy.
- In my opinion, this objective was fulfilled over the course of the internship.

# 9. OBJECTIVE #4: SOCIETAL ACHIEVEMENT

Objective #4 promoted societal achievement by analyzing the effects of engineering on society and by providing informational feedback to Texas A&M. This section presents the final objective

## 9.1 FINAL OBJECTIVE

This objective was motivated by the stated DE emphasis on preparing engineers to be leaders within society. As such, this objective was developed such that I would have to consider the environment around my actions as a project engineer. The "Statement of Final Objectives" defines the objective as follows:

"To examine and to participate in the role of a consulting engineering professional in societal relationships.

a. Major categories of a consulting engineer's relationships with society will be defined and discussed.
b. Analysis should be provided as to the effect of the engineer's work on each of the relationships above.
c. Feedback dialogs with Texas A&M University (or other educational institutions) will be maintained. Purposes of this dialog include 1) corresponding with the committee to ensure progress on the internship, and 2) to provide educators information from practice that can enhance the educational experience at Texas A&M University" (Hann, 2010).

This objective was completed, as specified, through normal work experiences, business meetings and conferences, internal reflection, and in writing ROS documents.

## 9.2 OBJECTIVE DISCUSSION AND OUTCOMES

Appendix D presents a summary of the subparts a) and b) discussed above. This document serves to verify the objective completion, and for future reference in my endeavors. The appendix could be considered a working document that can be refined as my knowledge of these relationships matures. During my time as a DE intern, I participated in several events that are societal in nature, such as regular meetings at professional society events and permitting activities related to projects.

Additionally, the objective focused on my relationship with Texas A&M University, the water resources division of civil engineering, and the DE program. Communications with my advisory committee were conducted throughout the DE internship, particularly as required to complete necessary academic activities and provide status updates. The other major initiative of the objective was to provide feedback to the Texas A&M departments that could enhance the educational experience, as discussed throughout this manuscript and summarized below. I also presented preliminary findings at the April 2011 Zachry Department of Civil Engineering Career Day.

- Increased marketing of DE degree: In my opinion, the College of Engineering and the individual departments could do a significantly better job of marketing and promoting the DE degree. Though the degree does not bring direct research value to the individual departments, it offers significant benefits to engineers wanting higher level degrees, increased technical coursework, and business

emphasis. In some instances, I have heard the DE subjected to negative marketing, and I think this overlooks the degree's value.

- DE-Specific Seminar Course: The DE program would benefit from a designated seminar course discussing a variety of topics related to the program, particularly given the number of seminar courses the degree requires. Topics could include internship selection, program requirements, degree processing requirements, etc.
- Pipeline and Pump Station Classes: In my opinion, a pipeline and pump station course should be added to the water resources curriculum in civil engineering. Despite teaching basic hydraulics, there are significant additional design and construction considerations that could be very useful for students of the department to take. Given that current water management strategies call for significant use of inter-basin transfer in the future, the potential exists that many graduates will be involved in the design of these projects. Additionally, based on my discussions with coworkers at FNI, these types of projects tend to be highly profitable. Relevant topics for consideration in the class include types of pump stations, types of pumps, pump station layouts, piping materials, hydraulics in special cases (pipes flowing partially full), piping embedment materials, pipe deflection and flotation, pipe current protection, air relief valves, design standards, etc. FNI has two similar courses through its Freese and Nichols University program around which a course could be developed.
- Dam Design and Management: A significant portion of my DE internship involved the design of hydraulic structures, such as dams, and the importance of

these structures was missed through my coursework. There are significant learning opportunities related to the structural and geotechnical fields of study (discussed below); however, there are also several hydraulic, hydrologic, management, and risk management activities associated with dams and reservoirs that could be brought into the water resources curriculum.

- Increased emphasis on shared disciplines: In general, college instruction should find ways to connect shared discipline problems into the curriculum, rather than focusing on a single technical concept. My experience through the water resources and environmental curriculum yielded few memorable interconnections between major discipline topics; however, my experience during the DE internship showed that this happens very often. For example, in many water resources design projects, some of the most technically challenging aspects of the design were geotechnical and structural in nature.
- Projects in courses: Project should continue to occur in coursework—this is a good simulation of my experience as a DE intern. I would offer the following suggestions as a means of improving projects in general:
    - Consider asking students to develop detailed work plans for all projects that specify responsibility for project components and a generalized work plan for when major tasks will be completed. As discussed in the project management sections of this manuscript, project planning is one of the keys to project success. It should also be noted that "last minute" plans are not necessarily bad plans, provided the risks and consequences are fully understood. If

projects cannot be completed with a "last minute" effort with the project team, then intermittent deadlines with significant project deliverables should be considered. This would mimic real-world engineering practice.

  - When developing project teams, care should be exercised to determine the relative strengths and weaknesses of a team, such that the teams are strengthened. In consulting practice, teams are typically developed based on the technical and managerial skills of the team members, based on the tasks at hand; however, this was not necessarily the case in my experience as a student.

- Engineering "soft skills": My experience as a DE intern emphasized the importance of soft skills for success as a consulting engineer. Soft skills can be best summarized as "communication." I roughly estimate that seventy to eighty percent of my time as a DE intern was spent doing communication-related activities, rather than engineering analysis. In particular, one of the most important skills for an engineer is an ability to effectively write in a manner that is clear, logical, and concise. Additional soft skills to consider would include presentation skills, negotiation tactics, persuasive arguments, and risk analysis classes.
- In my opinion, this objective was fulfilled met over the course of the DE internship and this ROS.

# 10. SUMMARY

The purposes of the DE Record of Study are to chronicle the internship experience and to demonstrate that the agreed-upon objectives of the internship have been met. This record of study describes the history, organizational structure, and business model for Freese and Nichols, Inc., where I worked as a full-time graduate intern while conducting the DE internship. Management processes are discussed, and the primary projects of the internship are presented. Significant outcomes from the projects, from technical, managerial, and strategic perspectives are presented. From this effort, my DE internship yielded the following outcomes:

- In my opinion, I fulfilled my internship objectives, which promote technical, managerial, strategic, and societal achievement.
- Technical/engineering skills learned through the course of my academic career were utilized in practical project situations.
- As a function of my projects at FNI, I learned new technical/engineering skills, and, perhaps more importantly, I developed a greater appreciation for the inter-connectedness of technical disciplines that are often separated in an academic environment.
- My most significant managerial experience was serving as Assistant Project Manage (APM) on the Highlands Bond Program project group. As a result of this experience, I have concluded that the APM role offers significant managerial and strategic promise to the consulting engineering industry and FNI. Additionally, my experienced showed that it is possible for less experienced engineers to

successfully serve in the APM role on projects, which can benefit the project manager, project execution, FNI strategy, and the engineer through faster development, increased morale, and greater ownership of projects.

- Strategically, all projects are important in a business, even if they are less technically advanced. Many of the projects I worked on were less technically challenging than much of my graduate work; however, all of the projects significantly contributed to the company's growth in southeast Texas. Other levels of firm strategy were learned and discussed.
- Societal relationships were explored and recommendations were provided that could potentially improve the water resources, civil engineering, and engineering programs at Texas A&M. Most significantly, movements towards the soft skills of engineering should be significantly emphasized (soft skills are the primary differentiator in FNI's business philosophy), and additional water resources coursework, such as dam management and design and pipeline and pump station design, could enhance the Texas A&M Curriculum.
- FNI is a well-managed company, based on several business performance metrics. My observations during my DE internship reinforce this statement.

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# APPENDIX A

# FNI SUPERVISOR FINAL EVALUATION

## Introduction

Throughout Tyson's tenure at Freese & Nichols, Inc. (FNI), I have served as his direct supervisor and manager. As the Water Resources Group Manager, one of my responsibilities is the direction and management of staff including workload and project assignments. I have had the opportunity to both, work alongside of Tyson on projects, as well as observe his interaction on projects working under the supervision of other senior engineers in my group. The following sections summarize my review of Tyson's performance as it relates to the key objectives of his internship with FNI.

## Project Assignments and Performance

1. Highlands Bond Improvements Program

Tyson was assigned a diverse array of projects requiring varying skill sets, levels of responsibility, and reporting structures. Tyson was heavily involved in our Highlands Bond Improvements Program for the San Jacinto River Authority (SJRA) including work on the following projects as part of this program:

a. Highlands Reservoir Embankment and Spillway Improvements Project
b. Siphon 15 Improvements Project
c. Siphon 20 Improvement Project
d. Siphon 23 Improvement Project
e. Siphon 24 Improvement Project
f. Highlands Flow Monitoring System

Tyson served in various capacities including project engineer, design package manager, and Assistant Project Manager (APM) on different projects executed as part of this program. Tyson's technical contributions to the projects were invaluable to the project team, especially in the form of hydraulic analyses and his role as APM. He had the opportunity to develop many new skill sets as a result of his work on this program including:

a. Detailed hydraulic analysis and modeling
b. Developing detailed design plans and specifications
c. Developing detailed construction cost estimates
d. Developing detailed scopes and fees
e. Client communications
f. Project management processes and procedures
g. Managing and working in different project teams and personality dynamics
h. Interpersonal skills

2. SJRA Raw Water Intake and Pump Station Project

The SJRA is in the process of implementing a County-wide surface water conversion program in Montgomery County. One of the key components of this program is the construction of a new raw water intake and pump station on Lake Conroe to feed a new surface water treatment plant for delivery of ultimately 90 MGD of treated surface water to residents in Montgomery County. Tyson is serving as a graduate engineer on this project and is working closely with one of FNI's talented pump station and pipeline designers and project managers. The project is currently in the Preliminary Engineering Report (PER) phase. Tyson's contributions have been largely focused on the hydraulic analysis and preliminary sizing and configuration of the high-capacity pumps.

**Individual Strengths and Character Traits**

Tyson's strengths are many and include technical astuteness, management skills, and a strong desire to increase his involvement and experience in FNI's various practice areas. He is a solid technical resource who can be trusted to deliver superior technical deliverables in a professional and timely manner. He is a fast learner, a self-starter, and can apply his academic knowledge to real world applications with little supervisions and guidance. In addition, he is also not apprehensive in asking for assistance and guidance when he needs it.

Tyson will serve the engineering community and the general public well throughout his career. He is a thoughtful young man with a well-grounded work ethic.

**Internship Objective Performance**

Tyson established the following objectives for his internship experience with FNI:

1) *Technical achievement via application and learning of engineering skills*
2) *Managerial achievement via application, observation, and skill acquisition of effective (and ineffective) managerial practices*
3) *Organizational achievement via learning, analyzing, and recommending organizational strategy*
4) *Societal achievement via analysis of the technical effects on society and via information feedback to Texas A&M University*

I believe that Tyson has met all of the above objectives. However, rather than discussing each objective separately, I will instead describe the process that we used to ensure that these objectives were met and provide some detail as to why I believe that he was successful in meeting these objectives.

I was involved in the development of Tyson's key objectives for his internship that would eventually become part of his Record of Study. In addition, I was also responsible for guiding Tyson in the development of his Individual Development Plan (IDP) at FNI. The IDP is an integral part of every staff member's development at FNI and Tyson's key internship objectives were considered heavily by me when developing Tyson's IDP. Tyson's development plan was crafted around the following key skill sets to ensure compliance with Tyson's key objectives:

1. Technical Excellence

Tyson has had the opportunity to become engaged in many of our high-profile projects and programs in the Houston, Texas office of FNI. Tyson has served in multiple roles on various project assignments over the course of his internship including Work Package

Manager, Lead Technical Engineer, Assistant Project Manager, and supporting staff engineer. Tyson has excelled in all of his technical roles and assignments during his internship at FNI.

A significant portion of the projects in our Houston office this year have been in our Water Resources Design market segment. These projects have included the planning and design of large hydraulic structures such as inverted siphons, drop structures, spillways, and embankment improvements. The clients that these projects have been completed for include our most visible and strategically important including the San Jacinto River Authority (SJRA), Gulf Coast Water Authority (GCWA), and Fort Bend County Drainage District (FBCDD). Tyson was instrumental in the delivery of quality project deliverables with aggressive project schedules. Tyson also had the opportunity to work with and be mentored by some of industry's most highly-qualified engineers in the Water Resources Design practice in our Fort Worth headquarters, and, because of this training, has quickly become one of our local experts in hydraulic design for our water resources design projects.

Along with his involvement in our Water Resources Design projects, Tyson has also been heavily involved in the development of the Preliminary Engineering Report (PER) for the design of a new raw water intake and pump station on Lake Conroe for SJRA. The project is being designed by FNI and is being executed as part of a larger surface water program managed at SJRA through an alternative project delivery system called Construction Manager at Risk (CMAR). Tyson's special skills in hydraulic analysis has made him acutely valuable to the project team for this assignment and his involvement in a project utilizing an alternative and unique project delivery system has exposed Tyson to a host of other engineering firms and a diverse group of individuals and management styles.

Tyson's advanced academic course work at Texas A&M University that he has been exposed to while seeking his Doctorate degree, along with the high-level training that he has been given while interning at FNI, has helped to develop Tyson into a high-producing technical resource. Tyson has a very good grasp of engineering design concepts and has been successful in adapting those concepts to everyday practical design solutions for our clients.

2. Management

Another focus within Tyson's IDP is project management. FNI has a very formal and process-driven Project Management (PM) system. Tyson, partly because of his Doctorate degree plan and key objectives for his Record of Study, has been exposed to many PM responsibilities and the tools to assist him with those responsibilities earlier in his career than would be normal for a graduate level engineer at FNI.

Tyson has served as an Assistant Project Manager (APM), under the direct supervision of one of the firm's most highly-valued PM's Cody Cockroft, P.E. The position of APM has been formalized and is valued at FNI. Only those employees that exhibit the potential to become and to be successful as a PM are considered to perform as an APM. This is especially true for the strategically important types of clients that Tyson has had the opportunity to serve as an APM.

Tyson's responsibilities as an APM include most of the same responsibilities of a PM at FNI including, but not limited to, the following:

a) client communication
b) development of scopes of work and fee estimates
c) project set-up
d) assistance with project kick-off meetings
e) project schedule development and monitoring
f) budget monitoring
g) subcontractor oversight
h) development of subcontractor contract documents

i) overall project performance review and oversight
j) internal accounting reporting.

Under Cody's excellent tutoring and guidance, Tyson has developed into a dependable and reliable APM for the firm. The Houston office has grown this year from less than $2 million in bookings in 2010 to over $4 million in bookings projected in 2011. Houston revenues and profitability have also increased significantly this year and our office has the lowest percentage of negative variance (effort on a job that can't be converted to revenue as a result of budget overruns) than any other group at FNI. The ability to responsibly manage a client's project budget, the labor hours being charged to any specific project, and converting project effort to revenue and ultimately profit is a fundamental necessity to the long-term financial health and growth of any service industry including the consulting engineering industry.

Our success has been, in part, due to the efforts and diligence of Tyson and his role as APM. He has assisted Cody in the execution of quality and financially successful projects for our firm.

3. Marketing

Tyson has also had the opportunity to take part in our firm's marketing efforts. This involvement has taken the shape in the form of developing project scopes and fees for some of our existing accounts as well as the development of Statements of Qualifications (SOQ) and client presentations for specific Requests for Qualifications (RFQ) and/or Proposals (RFP).

Tyson had the opportunity to serve on the proposal team for the development of the SOQ and the follow-on interview for the design of a new surface water treatment plant for the Cities of Richmond and Rosenberg, Texas. The SOQ that was developed sufficiently presented our firms qualifications to allow a presentation to the selection team representing the Cities. Tyson was heavily involved and had the opportunity to become

part of and observe the marketing process and strategic selling of a project team and concept to a client to secure our services.

While our firm was not selected for this assignment, Tyson's experience in the process was invaluable to his overall career growth. The successful consulting engineer will transition over time to competently apply learned skills as a technical expert, manager, and marketing professional. While ultimately what FNI provides to our clients are excellently engineered solutions to complex and demanding problems, we will not get the opportunity to provide those solutions if we can't first convince the client that we are the obvious engineering provider of choice. This is only achieved through experience in actively marketing and selling our services, people, and ideas to our clients. Tyson has started to experience and observe these activities and skills early in his career which will be beneficial to both him and FNI.

4. Strategic Planning

FNI is a very process-oriented firm that includes a detailed and goal specific annual strategic plan to guide our operations. In addition to being process-oriented, FNI is also very open and transparent with all financial information and strategic plan goals and measures and share this information with all their employees. In addition to the firm's annual strategic planning goals and plans, the Houston office also has its own strategic plan that incorporates the firm's overall missions and goals but also specifically addresses the offices distinct market, client, and staffing pressures.

Tyson has been exposed to these plans both at a corporate level as well as a local office level. The President of our firm, Bob Pence, P.E., has on numerous occasions visited the Houston, Texas office and presented the company's vision and strategic plan as well as a status on where the firm stands in achieving its specific goals. In addition, these same types of presentations are provided to the Houston office staff on a monthly basis. At

these meetings, the strategic plan for the Houston office, including a long-term vision for the office and a briefing on the status of achieving individual office goals, is provided. Tyson has had the opportunity on numerous occasions to see the process of developing a strategic plan and identifying measurable goals, then also see the actions taken over the course of a year result in the achievement of those goals.

While the actual development of a strategic plan for any operation is ultimately market and client-driven and therefore generally requires much more experience than Tyson currently has, Tyson has exhibited the skill sets and certainly the desire to become more heavily involved and valuable to the firms strategic planning process. In addition, Tyson has also begun to use the information provided to him to evaluate his own long-term career goals and begin to make some decisions on how he would like to envision his career developing over time, what fields of practice he might prefer, and where he might best fit into the FNI organization and culture.

**Summary and Conclusions**

As stated previously, it is my opinion that Tyson has achieved the intent of his internship objectives over the course of his internship with FNI. I believe that the internship program structured as part of Tyson's Doctorate degree program is a very good option for the student who desires a highly advanced degree and coursework, while not necessarily having an interest in a research related degree program and/or career path. The internship program allows for the student, in concert with his employer and university, to develop a detailed goal oriented plan for the first year of the student professional career. This plan, and the goals that are developed as part of this plan, have been helpful to me, as Tyson's manager, to identify and assign project assignments to try and address each identified goal.

Sincerely,

**Michael V. Reedy, P.E.**
Group Manager
Principal and Vice President
Water Resources

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# APPENDIX B

# HIGHLANDS BOND PROGRAM BUDGET TRACKING SPREADSHEETS

This appendix presents budget tracking spreadsheets for the Highlands Bond Program Projects for which I served as Assistant Project Manager. Spreadsheets were updated throughout the projects on a weekly to monthly timeframe, and the versions presented are current as of the development of this manuscript. Through these spreadsheets, the financial progress of a project can be monitored.

As presented, these spreadsheets show final project performance on the PER phase projects, and current and expected future performance of the Siphons 15, 20, and 23 Final Design Phase projects. The spreadsheets also offer additional insight into the FNI accounting system, the group-based organizational structure, and typical project management activities that occur over the course of a project.

## SJR 10343-Flow Measurement PER

| Task | Group | Original Budget | Current Budget | **Effort Used** | **Variance or Budget Remaining** | % Effort Used (Current |
|---|---|---|---|---|---|---|
| 0BC0 (Project Management) | 1159 | $ 3,850.00 | $ 6,552.68 | **$ 6,324.14** | $ 228.54 | 97% |
| 0NA0 (Wtr. Res. Design) | 1159 | $ 15,568.00 | $ 19,608.00 | **$ 22,186.29** | $ (2,578.29) | 113% |
| | 1157 | $ 2,200.00 | $ 2,200.00 | **$ 2,526.41** | $ (326.41) | 115% |
| 0BQ0 (Report Preparation) | 1159 | $ 5,000.00 | $ 6,612.24 | **$ 13,887.55** | $ (7,275.31) | 210% |
| | 1110 | $ 500.00 | $ - | **$ -** | $ - | |
| | 1158 | $ 500.00 | $ - | **$ -** | $ - | |
| 0HC0 (Environmental) | 1170 | $ 3,750.00 | $ 1,000.00 | **$ 2,682.39** | $ (1,682.39) | 268% |
| 0BJ0 (Geotech) | 1110 | $ 1,730.00 | $ 235.08 | **$ 235.08** | $ - | 100% |
| | 1153 | $ - | $ - | **$ -** | $ - | |
| 0BO0 (Estimates) | 1129 | $ 1,760.00 | $ - | **$ -** | $ - | |
| 0FA0 (Misc. Construction) | 1158 | $ 1,850.00 | $ - | **$ -** | $ - | |
| | 1151 | $ - | $ - | **$ -** | $ - | |
| General Expenses | 1159 | $ 101.05 | $ 601.05 | **$ 1,263.62** | $ (662.57) | 210% |
| | | $ 36,809.05 | $ 36,809.05 | $ 49,105.48 | $ (12,296.43) | 133% |
| | | | | | | |
| | | | | | | |
| Diver Sub | | $ - | $ - | $ - | | |
| Survey Sub | | $ 5,478.00 | $ 5,478.00 | $ 5,478.00 | $ - | 100% |
| Geotech Sub | | $ 26,712.95 | $ 26,712.95 | $ 26,713.51 | $ (0.56) | 100% |
| SubConsultant Total | | $ 32,190.95 | $ 32,190.95 | $ 32,191.51 | | 100% |
| | | | | | | |
| Project Total | | $ 69,000.00 | $ 69,000.00 | $ 81,296.99 | $ (12,296.99) | 118% |

| SJR 10344-Reservoir PER | | | | | | |
|---|---|---|---|---|---|---|
| Task | Group | Original Budget | Current Budget | **Effort Used** | **Variance or Budget Remaining** | % Effort Used (Current |
| 0BC0 (Project Management) | 1159 | $ 10,000.00 | $ 23,339.88 | **$ 21,034.53** | $ 2,305.35 | 90% |
| 0NA0 (Wtr. Res. Design) | 1159 | $ 33,157.00 | $ 41,412.99 | **$ 41,412.99** | $ - | 100% |
| | 1149 | | $ 2,775.07 | **$ 2,775.07** | $ - | 100% |
| | 1157 | $ 15,000.00 | $ 9,438.47 | **$ 9,438.47** | $ - | 100% |
| 0BQ0 (Report Preparation) | 1159 | $ 10,000.00 | $ 9,495.92 | **$ 9,632.42** | $ (136.50) | 101% |
| | 1157 | $ - | $ - | **$ -** | $ - | |
| | 1158 | $ - | $ - | **$ -** | $ - | |
| 0HC0 (Environmental) | 1170 | $ 29,000.00 | $ 24,506.07 | **$ 25,105.70** | $ (599.63) | 102% |
| 0BJ0 (Geotech) | 1110 | $ 11,000.00 | $ 619.07 | **$ 619.07** | $ - | 100% |
| | 1153 | $ - | $ - | **$ -** | $ - | |
| 0BO0 (Estimates) | 1129 | $ 2,500.00 | $ - | **$ -** | $ - | |
| 0FA0 (Misc. Construction) | 1158 | $ 3,800.00 | $ 601.45 | **$ 601.45** | $ - | 100% |
| | 1151 | $ - | $ - | **$ -** | $ - | |
| General Expenses | 1159 | $ 20,000.00 | $ 13,734.58 | **$ 13,614.75** | $ 119.83 | 99% |
| | | $ 134,457.00 | $ 125,923.50 | $ 124,234.45 | $ 1,689.05 | 99% |
| | | | | | | |
| | | | | | | |
| Moffat and Nichol | | $ - | $ 8,533.80 | $ 8,533.80 | | 100% |
| Survey Sub | | $ 120,560.00 | $ 120,560.00 | $ 120,560.00 | | 100% |
| Geotech Sub | | $ 44,283.00 | $ 44,282.70 | $ 44,282.70 | | 100% |
| SubConsultant Total | | $ 164,843.00 | $ 173,376.50 | $ 173,376.50 | | 100% |
| | | | | | | |
| Project Total | | $ 299,300.00 | $ 299,300.00 | $ 297,610.95 | $ 1,689.05 | 99% |

**SJR 10345-Siphon 15 PER**

| Task | Group | Original Budget | Current Budget | **Effort Used** | **Variance or Budget Remaining** | % Effort Used (Current |
|---|---|---|---|---|---|---|
| 0BC0 (Project Management) | 1159 | $ 5,000.00 | $ 4,874.11 | **$ 6,043.52** | $ (1,169.41) | 124% |
| 0NA0 (Wtr. Res. Design) | 1159 | $ 4,300.00 | $ 7,681.36 | **$ 7,681.36** | $ - | 100% |
| | 1157 | $ 14,170.00 | $ 14,156.73 | **$ 14,156.73** | $ - | 100% |
| 0BQ0 (Report Preparation) | 1159 | $ 6,500.00 | $ 11,136.91 | **$ 11,136.91** | $ - | 100% |
| | 1110 | $ - | $ - | **$ -** | $ - | |
| | 1158 | $ - | $ - | **$ -** | $ - | |
| 0HC0 (Environmental) | 1170 | $ 3,750.00 | $ 2,197.59 | **$ 2,197.59** | $ - | 100% |
| 0BJ0 (Geotech) | 1110 | $ 1,550.00 | $ 309.21 | **$ 309.21** | $ - | 100% |
| | 1153 | $ 780.00 | $ - | **$ -** | $ - | |
| 0BO0 (Estimates) | 1129 | $ 1,500.00 | $ 482.11 | **$ 482.11** | $ - | 100% |
| 0FA0 (Misc. Construction) | 1158 | $ 2,124.00 | $ 844.56 | **$ 844.56** | $ - | 100% |
| | 1151 | $ 776.00 | $ - | **$ -** | $ - | |
| General Expenses | 1159 | $ 2,355.00 | $ 1,122.25 | **$ 1,122.25** | $ - | 100% |
| | | $ 42,805.00 | $ 42,804.83 | $ 43,974.24 | $ (1,169.41) | 103% |
| | | | | | | |
| | | | | | | |
| Diver Sub | | $ 4,840.00 | $ 4,840.00 | **$ 4,840.00** | | |
| Survey Sub | | $ 8,657.00 | $ 8,657.00 | **$ 8,657.00** | | 100% |
| Geotech Sub | | $ 5,698.00 | $ 5,698.17 | **$ 5,698.17** | | 100% |
| SubConsultant Total | | $ 19,195.00 | $ 19,195.17 | **$ 19,195.17** | | 100% |
| | | | | | | |
| Project Total | | $ 62,000.00 | $ 62,000.00 | **$ 63,169.41** | $ (1,169.41) | 101.9% |

## SJR10346-Siphon 20 PER

| Task | Group | Original Budget | Current Budget | **Effort Used** | **Variance or Budget Remaining** | % Effort Used (Current |
|---|---|---|---|---|---|---|
| 0BC0 (Project Management) | 1159 | $ 6,000.00 | $ 4,200.00 | **$ 5,417.25** | $ (1,217.25) | 129% |
| 0NA0 (Wtr. Res. Design) | 1159 | $ 4,000.00 | $ 7,614.81 | **$ 7,824.21** | $ (209.40) | 103% |
| | 1157 | $ 15,550.00 | $ 14,560.00 | **$ 15,213.18** | $ (653.18) | 104% |
| 0BQ0 (Report Preparation) | 1159 | $ 7,000.00 | $ 14,015.25 | **$ 15,057.81** | $ (1,042.56) | 107% |
| | 1110 | $ - | $ - | **$ -** | $ - | |
| | 1158 | $ - | $ - | **$ -** | $ - | |
| 0HC0 (Environmental) | 1170 | $ 3,750.00 | $ 2,864.27 | **$ 2,864.27** | $ - | 100% |
| 0BJ0 (Geotech) | 1110 | $ 1,550.00 | $ 463.81 | **$ 463.81** | $ - | 100% |
| | 1153 | $ 780.00 | $ - | **$ -** | $ - | |
| 0BO0 (Estimates) | 1129 | $ 1,500.00 | $ 482.11 | **$ 482.11** | $ - | 100% |
| 0FA0 (Misc. Construction) | 1158 | $ 2,124.00 | $ 844.56 | **$ 844.56** | $ - | 100% |
| | 1151 | $ 776.00 | $ - | **$ -** | $ - | |
| General Expenses | 1159 | $ 2,615.00 | $ 600.00 | **$ 672.65** | $ (72.65) | 112% |
| | | $ 45,645.00 | $ 45,644.81 | $ 48,839.85 | $ (3,195.04) | 107% |
| | | | | | | |
| | | | | | | |
| Diver Sub | | | $ - | $ - | | |
| Survey Sub | | $ 8,657.00 | $ 8,657.00 | $ 8,657.00 | | 100% |
| Geotech Sub | | $ 5,698.00 | $ 5,698.19 | $ 5,698.19 | | 100% |
| SubConsultant Total | | $ 14,355.00 | $ 14,355.19 | $ 14,355.19 | | 100% |
| | | | | | | |
| Project Total | | $ 60,000.00 | $ 60,000.00 | $ 63,195.04 | $ (3,195.04) | 105% |

## SJR10347-Siphon 23 PER

| Task | Group | Original Budget | Current Budget | **Effort Used** | **Variance or Budget Remaining** | % Effort Used (Current |
|---|---|---|---|---|---|---|
| 0BC0 (Project Management) | 1159 | $ 6,500.00 | $ 7,085.62 | **$ 6,637.58** | $ 448.04 | 94% |
| 0NA0 (Wtr. Res. Design) | 1159 | $ 4,000.00 | $ 5,990.50 | **$ 5,990.50** | $ - | 100% |
| | 1157 | $ 17,000.00 | $ 13,653.81 | **$ 13,653.81** | $ - | 100% |
| 0BQ0 (Report Preparation) | 1159 | $ 7,000.00 | $ 13,271.50 | **$ 13,271.50** | $ - | 100% |
| | 1110 | $ - | $ - | **$ -** | $ - | |
| | 1158 | $ - | $ - | **$ -** | $ - | |
| 0HC0 (Environmental) | 1170 | $ 4,750.00 | $ 5,614.66 | **$ 5,614.66** | $ - | 100% |
| 0BJ0 (Geotech) | 1110 | $ 1,550.00 | $ 309.21 | **$ 309.21** | $ - | 100% |
| | 1153 | $ 780.00 | $ - | **$ -** | $ - | |
| 0BO0 (Estimates) | 1129 | $ 1,500.00 | $ 438.30 | **$ 438.30** | $ - | 100% |
| 0FA0 (Misc. Construction) | 1158 | $ 2,124.00 | $ 844.56 | **$ 844.56** | $ - | 100% |
| | 1151 | $ 776.00 | $ - | **$ -** | $ - | |
| General Expenses | 1159 | $ 2,765.00 | $ 1,536.65 | **$ 2,035.66** | $ (499.01) | 132% |
| | | $ 48,745.00 | $ 48,744.81 | $ 48,795.78 | $ (50.97) | 100% |
| | | | | | | |
| | | | | | | |
| Diver Sub | | | | | | |
| Survey Sub | | $ 8,657.00 | $ 8,657.00 | $ 8,657.00 | | 100% |
| Geotech Sub | | $ 5,698.00 | $ 5,698.19 | $ 5,698.19 | | 100% |
| SubConsultant Total | | $ 14,355.00 | $ 14,355.19 | $ 14,355.19 | | 100% |
| | | | | | | |
| Project Total | | $ 63,100.00 | $ 63,100.00 | $ 63,150.97 | $ (50.97) | 100.1% |

| SJR 11198-Siphon 15 Final Design | | Current Date | 10/5/2011 | Percent Complete | 85% | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Task | Group | Original Budget | Current Budget | **Effort Used** | % Effort Used (Current Budget) | **Budget Remaining** | eResource Scheduled Effort to Complete | Budget Remaining at Completion | Projected Variance at Completion |
| 0AA4 (Expense) | 1159 | $ 6,345.00 | $ 6,345.00 | **$ 4,493.32** | 71% | $ 1,851.68 | $ 1,500.00 | $ 351.68 | 5.54% |
| 0BC0 (PM) | 1159 | $ 6,140.00 | $ 3,000.00 | **$ -** | 0% | $ 3,000.00 | $ 1,000.00 | $ 2,000.00 | 66.67% |
| 0FB0 (Advertise and Award) | 1158 | $ 2,187.00 | $ 2,187.00 | **$ -** | 0% | $ 2,187.00 | $ 9,210.00 | $ - | 0.00% |
| | 1159 | $ 7,023.00 | $ 7,023.00 | **$ -** | 0% | $ 7,023.00 | | | |
| 0MH0 (Traffic and SWPPP) | 1157 | $ 5,410.00 | $ 3,000.00 | **$ 2,263.05** | 75% | $ 736.95 | $ - | $ 2,459.49 | 36.54% |
| | 1159 | $ 4,915.00 | $ 730.37 | **$ 730.37** | 100% | $ - | | | |
| | 1170 | $ 5,000.00 | $ 3,000.00 | **$ 1,277.46** | 43% | $ 1,722.54 | | | |
| 0NA0 (WRD) | 1110 | $ 1,680.00 | $ - | **$ -** | 0% | $ - | $ 4,367.44 | $ (5,830.91) | -10.30% |
| | 1125 | $ 4,190.00 | $ 8,670.00 | **$ 7,899.96** | 91% | $ 770.04 | | | |
| | 1147 | $ - | $ 2,000.00 | **$ 1,791.88** | 90% | $ 208.12 | | | |
| | 1148 | $ 5,000.00 | $ 15,491.63 | **$ 14,901.92** | 96% | $ 589.71 | | | |
| | 1149 | $ 5,000.00 | $ - | **$ -** | 0% | $ - | | | |
| | 1151 | $ 5,807.00 | $ 2,200.00 | **$ 1,834.74** | 83% | $ 365.26 | | | |
| | 1158 | $ 1,485.00 | $ 3,985.00 | **$ 5,533.32** | 139% | $ (1,548.32) | | | |
| | 1159 | $ 21,718.00 | $ 24,268.00 | **$ 26,116.28** | 108% | $ (1,848.28) | | | |
| Expense Effort | | $ 6,345.00 | $ 6,345.00 | $ 4,493.32 | 71% | $ 1,851.68 | $ 1,500.00 | $ 351.68 | 5.54% |
| Labor Effort | | $ 75,555.00 | $ 75,555.00 | $ 62,348.98 | 83% | $ 13,206.02 | $ 14,577.44 | $ (1,371.42) | -1.82% |
| Total | | $ 81,900.00 | $ 81,900.00 | $ 66,842.30 | 82% | $ 15,057.70 | $ 16,077.44 | $ (1,019.74) | -1.25% |

| SJR 11199-Siphon 20 Final Design | | Current Date | 10/5/2011 | Percent Complete | 85% | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Task | Group | Original Budget | Current Budget | Effort Used | % Effort Used (Current Budget) | Budget Remaining | eResource Scheduled Effort to Complete | Budget Remaining at Completion | Projected Variance at Completion |
| 0AA4 (Expense) | 1159 | $ 6,345.00 | $ 6,345.00 | $ 1,989.87 | 31% | $ 4,355.13 | $ 4,000.00 | $ 355.13 | 5.60% |
| 0BC0 (PM) | 1159 | $ 6,000.00 | $ 4,144.58 | $ - | 0% | $ 4,144.58 | $ 1,000.00 | $ 3,144.58 | 75.87% |
| 0FB0 (Advertise and Award) | 1158 | $ 2,187.00 | $ 2,187.00 | $ - | 0% | $ 2,187.00 | $ 9,210.00 | $ - | 0.00% |
| | 1159 | $ 7,023.00 | $ 7,023.00 | $ - | 0% | $ 7,023.00 | | | |
| 0MH0 (Traffic and SWPPP) | 1157 | $ 5,645.00 | $ 3,000.00 | $ 3,424.20 | 114% | $ (424.20) | $ 455.16 | $ 176.43 | 2.60% |
| | 1159 | $ 4,915.00 | $ 1,785.42 | $ 1,785.42 | 100% | $ - | | | |
| | 1170 | $ 5,000.00 | $ 2,000.00 | $ 944.21 | 47% | $ 1,055.79 | | | |
| 0NA0 (WRD) | 1110 | $ 1,680.00 | $ - | $ - | 0% | $ - | $ 3,744.12 | $ (1,889.27) | -3.53% |
| | 1125 | $ 4,190.00 | $ 8,240.00 | $ 8,080.96 | 98% | $ 159.04 | | | |
| | 1147 | $ - | $ 2,000.00 | $ 1,949.04 | 97% | $ 50.96 | | | |
| | 1148 | $ 5,000.00 | $ 13,117.00 | $ 12,754.28 | 97% | $ 362.72 | | | |
| | 1149 | $ 5,000.00 | $ - | $ - | 0% | $ - | | | |
| | 1151 | $ 5,807.00 | $ 1,450.00 | $ 1,248.24 | 86% | $ 201.76 | | | |
| | 1158 | $ 1,485.00 | $ 5,485.00 | $ 4,931.84 | 90% | $ 553.16 | | | |
| | 1159 | $ 19,723.00 | $ 23,223.00 | $ 22,695.79 | 98% | $ 527.21 | | | |
| Expense Effort | | $ 6,345.00 | $ 6,345.00 | $ 1,989.87 | 31% | $ 4,355.13 | $ 4,000.00 | $ 355.13 | 5.60% |
| Labor Effort | | $ 73,655.00 | $ 73,655.00 | $ 57,813.98 | 78% | $ 15,841.02 | $ 14,409.28 | $ 1,431.74 | 1.94% |
| Total | | $ 80,000.00 | $ 80,000.00 | $ 59,803.85 | 75% | $ 20,196.15 | $ 18,409.28 | $ 1,786.87 | 2.23% |

| SJR 11209-Siphon 23 Final Design | | Current Date | 10/5/2011 | Percent Complete | 85% | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Task | Group | Original Budget | Current Budget | Effort Used | % Effort Used (Current Budget) | Budget Remaining | eResource Scheduled Effort to Complete | Budget Remaining at Completion | Projected Variance at Completion |
| 0AA4 (Expense) | 1159 | $ 6,400.00 | $ 6,400.00 | $ 3,189.37 | 50% | $ 3,210.63 | $ 3,000.00 | $ 210.63 | 3.29% |
| 0BC0 (PM) | 1159 | $ 7,575.00 | $ 7,000.00 | $ - | 0% | $ 7,000.00 | $ 1,000.00 | $ 6,000.00 | 85.71% |
| 0FB0 (Advertise and Award) | 1158 | | | $ - | 0% | $ - | $ 5,000.00 | $ - | 0.00% |
| | 1159 | $ 7,640.00 | $ 5,000.00 | $ - | 0% | $ 5,000.00 | | | |
| 0MH0 (Traffic and SWPPP) | 1157 | $ 5,415.00 | $ 3,915.00 | $ 1,883.01 | 48% | $ 2,031.99 | $ 4,388.45 | $ (22.85) | -0.26% |
| | 1159 | $ 4,585.00 | $ 1,339.05 | $ 1,339.05 | 100% | $ - | | | |
| | 1170 | $ 5,000.00 | $ 3,500.00 | $ 1,166.39 | 33% | $ 2,333.61 | | | |
| 0NA0 (WRD) | 1110 | $ 1,680.00 | $ - | $ - | 0% | $ - | $ 1,900.79 | $ 1,120.17 | 1.52% |
| | 1125 | $ 4,190.00 | $ 8,905.00 | $ 8,364.66 | 94% | $ 540.34 | | | |
| | 1147 | $ - | $ 2,766.39 | $ 2,766.39 | 100% | $ - | | | |
| | 1148 | $ 5,000.00 | $ 12,605.00 | $ 12,379.70 | 98% | $ 225.30 | | | |
| | 1149 | $ 5,000.00 | $ - | $ - | 0% | $ - | | | |
| | 1151 | $ 5,605.00 | $ 441.58 | $ 441.58 | 100% | $ - | | | |
| | 1158 | $ 2,486.00 | $ 6,986.00 | $ 6,916.56 | 99% | $ 69.44 | | | |
| | 1159 | $ 40,424.00 | $ 42,141.98 | $ 39,956.10 | 95% | $ 2,185.88 | | | |
| Expense Effort | | $ 6,400.00 | $ 6,400.00 | $ 3,189.37 | 50% | $ 3,210.63 | $ 3,000.00 | $ 210.63 | 3.29% |
| Labor Effort | | $ 94,600.00 | $ 94,600.00 | $ 75,213.44 | 80% | $ 19,386.56 | $ 12,289.24 | $ 7,097.32 | 7.50% |
| Total | | $ 101,000.00 | $ 101,000.00 | $ 78,402.81 | 78% | $ 22,597.19 | $ 15,289.24 | $ 7,307.95 | 7.24% |

# APPENDIX C

# VREAL STRATEGIC SURVEY OF FNI

The purpose of this memorandum is to apply the VREAL concept to the Freese and Nichols business. The VREAL strategic survey was developed by Dr. G.D. Flint of the Texas A&M University Mays Business School, and is actively taught in his course, MGMT 680: Corporate Strategy. The VREAL concept is used to evaluate the current strategic position of a company relative to several market factors and its competitors. The emphasis of the VREAL approach is to identify business activities that could potentially lead to above-average gains in comparison to competitors. This analysis is somewhat similar to the classic strengths/weaknesses/opportunities/threats (SWOT analysis); however, its emphasis is to identify key parameter that can provide rates of return above the market.

The following points explain the questions of the VREAL analysis:

- **V**-Value: *What does the company do that creates value for its owners? In particular, what are its core competencies that could potentially lead to above average gains?*
- **R**-Rarity: *How rare are the factors above that create value as compared to the competition? Are these activities easily replicated?*
- **E**-Eroding Factors: *What are eroding factors that could cause the company to lose its value producing core competencies or the rareness that the competencies provide?*
- **A**-Managerial Aptitude: *Does the company have the managerial aptitude, wherewithal, intelligence, and experience to make any necessary adjustments to the strategy to improve the position of the above factors?*
- **L**-Longevity: *How long can the market conditions be maintained that provide for the above concepts?*

## Company Background

At its core, the FNI business concept is simple: the company sells the time of its employees. This is similar to most consulting firms across many industries; however FNI

truly focuses on the "trusted advisor" role by offering non-typical human relations to the buyer-seller relationship. This further separates FNI's ability to delivery technical services that may otherwise be considered commodity based engineering services. To further expand on the concept, FNI employees are technical experts (engineers, environmental scientists, architects, CAD designers, GIS technicians, etc.) whose expertise makes them specifically qualified to complete specific project tasks for which a client has a particular use or need.

The keys to the FNI business concept are that 1) employees must be capable of efficiently performing the types of work for which the client has a need, and 2) the company must be able to locate potential clients who have a need for the engineering services. FNI focus is on clients of choice, not on projects of choice (FNI chases clients not projects). In this regard, FNI focuses on those clients that have a good potential to provide repeat work.

Beyond this simple concept, the FNI business model becomes significantly more complex. Most corporate functions do ultimately go towards safeguarding the above keys to the business concept; however, FNI business practices are significantly more in-depth than the simple key concepts. Ultimately, FNI values company stability and consistent growth in a competitive business environment.

## Value

**In my opinion, the main value-creating asset at FNI is its relationships.** This includes its employee relationships and its relationships with its clients/potential clients. FNI employees, including its leadership, serve to create significant value with their time and expertise, and it is the relationships built between FNI and its employees that allow this to last. Employee relationships help FNI keep the staff necessary to market and complete the service-related engineering work. Client relationships facilitate FNI's ability to market and to be selected for projects. FNI has several processes in place to

enhance these relationships. Though the relationships cannot be quantified, they safeguard both of the keys to the FNI business concept.

Additionally, FNI's culture of client-service and ethics multiples the value it creates through its relationships. Because FNI has a culture of optimizing client service through ethical work, the relationships with its employees and clients are strengthened.

Finally, FNI's brand and company history help create value by adding market recognition and a long history of successful high-profile projects, particularly in the water-resources industry.

**Rarity**

FNI's relationships with its employees and clients are rare in its industry. The relationship-focused business philosophy is not practiced by everyone.

FNI's culture, company history, and brand are its rarest assets; however, they could be considered somewhat limited in part because the brand recognition of FNI is weaker outside of Texas, and because the company history and project knowledge fades over time as employees and clients mature and retire (though FNI's succession planning process and TEP programs do mitigate this to some extent).

**Eroding Factors**

Based on the previous analysis, the most significant eroding factors would be things that would destabilize FNI's relationships with employees and clients.

FNI is also subject to not meeting performance expectations. Since FNI aggressively pursues a "differentiation by superior customer service" strategy, it must back up its strategy with good performance on all projects.

**Managerial Aptitude**

FNI managerial aptitude is one of its major strengths. FNI's leadership has adapted to go beyond an engineer's mentality, and has built its management approach on the Baldrige Criteria, which are some of the strongest managerial traits possible. Additionally, FNI consults with business experts when necessary to help implement programs. It stands to reason that FNI would continue this in the future if market changes necessitated a change in business philosophy.

**Longevity**

The FNI business concept appears to be well-positioned for the future, particularly in the water resources engineering field. Water demand will continue to increase in most areas, and new management strategies will provide significant business potential.

In some geographic regions and some markets, FNI has likely tapped out its market share, meaning that it must expand elsewhere if it is to grow company size.

# APPENDIX D

# SUMMARY OF CONSULTING ENGINEERING RELATIONSHIPS IN SOCIETY

This appendix serves to explicitly define relationships between the consulting engineering professional and key segments of the engineering society. The general purpose of this memo is to provide additional information that demonstrates the completion of the fourth internship objective (societal achievement). Major categories of relationships identified include the relationship with the client, with other professionals, with government officials and entities, with educational agencies, and with the general public. Each relationship category is defined and discussed, and analysis is provided relative to my direct experience with the relationship category over the course of the DE internship.

## Client

The client-engineer relationship represents one of the most-regularly practiced relationships outside of the regular work environment (i.e. internal to the company). The foundation of this relationship is that the consulting engineer is completing work for the client and should therefore understand that he is acting on behalf of the client (or in the client's best interest). The consulting engineer is there to provide professional advice, and that is what should be given most prominently. In some cases, managerial decisions may be necessary; however, in those cases, the decision should be made between sound technical options. Losing the client's faith in your technical abilities would be a defining mistake.

To effectively navigate this relationship, I learned that the engineer should keep clients well-versed on the status of their projects, maintain constant communication, and find ways to relate to the client's perspective so they can understand the situations of the project. The engineer must be adaptable to clients' needs (i.e. 6:00 a.m. phone calls, late

board meetings, late evening phone calls, etc.). Experience over the internship showed me that client management was one of the most important parts of being a consultant.

**Engineering Professionals**

The consulting engineer often develops relationships with other engineering professionals, and this relationship can be seen as important in the development of a well-rounded engineer. These relationships are seen via professional society meetings, working on projects with other clients, reviewing journal submissions, interaction at technical conferences, etc.

Some identified benefits of these relationships include helping improve an engineer's network of contacts, advancing the engineer's technical and managerial skills by becoming aware of progress made by others, and potentially helping business by identifying teaming opportunities on projects. In my opinion, the best way to develop these relationships is **to be active and seek them**. This would primarily include participating in events that other engineering professionals are likely to be in attendance (like technical/professional society meetings, etc. that align well with the engineer's technical or strategic initiatives).

Examples of this relationship that I encountered over the DE internship included attendance at several meetings of local chapters of the American Water Works Associations (AWWA) and Water Environment Association of Texas (WEAT). At these meetings, it was typical for potential clients (municipalities) to present their capital improvement programs (potential future business), a variety of consultants and clients to present lessons learned on projects, and for scholarly research to be presented.

As an additional example, FNI's work associated with the SJRA pipeline adjacent to Lake Conroe Dam is as a subconsultant through Jones and Carter. Thus, a FNI project was awarded because FNI developed a relationship with another consultant, and both

parties saw the potential for mutually beneficial business via the relationship (neither consultant would have received a piece of the pie otherwise).

**Government Officials and Entities**

Developing active relationships with government officials and legal entities is also a key part of a well-rounded consulting engineering professional. Government agencies provide a legal or regulatory framework for completing active projects, from a permitting perspective to active discussions throughout a project. Additionally, a consultant can benefit strategically by following legislative changes that can impact the overall industry (i.e. to look for new areas to provide service, or to provide service in new areas). Finally, the potential is high for government entities and officials to become a client in the water resources field.

One example that I saw at FNI chronicling the importance of knowing legislation involved dam safety legislation. FNI has historically been very active in affecting dam safety legislation, and now does a significant amount of work as a result of the statutes—primarily to protect the public.

**Educational entities**

Another relationship that is directly tied to my situation involves the professional engineer and educational entities. As an engineering professional, it is in an individual's interest to maintain a feedback dialog with learning institutions. It could also be argued that it is our duty as professionals to bring advancements to our fields, and this dialog can help in that endeavor. Noted benefits of this relationship include student and professor development via increased knowledge of situations outside academia, better student preparation for engineering activities after leaving school, and potentially learning the current state of academic research that could be applied in practical situations. The engineering professional can also benefit via increased recruiting opportunities for upcoming engineering talent, and the engineer could shape the

acquisition of skills while still in school. The DE program is a superb example of this relationship in practice.

**General Public**

As specified in various national engineering Codes of Ethics, the engineer's highest calling is to protect the health, safety, and welfare of the public. This offers tremendous insight into the relationship between the engineer and the general public at large. Throughout human history, engineering has significantly altered the course of life, and this effect will remain into the future. Engineers have the potential to considerably change/alter/disrupt/enhance the general public with the decisions they make. As such, engineers should consider their role in shaping the public throughout their decision making process. Decisions should be made based on sound, logical, and well-determined engineering judgment, not potential business windfalls.

Major examples of this relationship can be seen via FNI's projects with the Harris-Galveston Subsidence District and the Groundwater Reduction Program at the San Jacinto River Authority/Lake Conroe, which effectively govern the conversion to surface water from groundwater in the Houston area. This conversion carries significant costs; however, it will also provide public value if subsidence and over pumping problems can be minimized.

# VITA


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