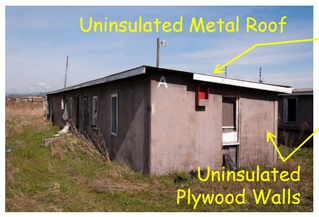
Design Development of a Cultural Village for Migrant Workers

Introduction

Each year thousands of migrant workers come to our state to work in farms picking fruits and vegetables. The housing provided by farmers for the migrant workers and their families is often dramatically substandard – small single room shacks lacking insulation, heating, and proper ventilation.

A non-profit organization (the client) is working with a legal advocacy group to improve the living conditions of these workers. They envision a "cultural village" consisting of improved housing, a community center, garden space and a play area for the children – all owned and operated outside of any single farmer.

Condition of Current Migrant Housing



Migrant Housing Unit

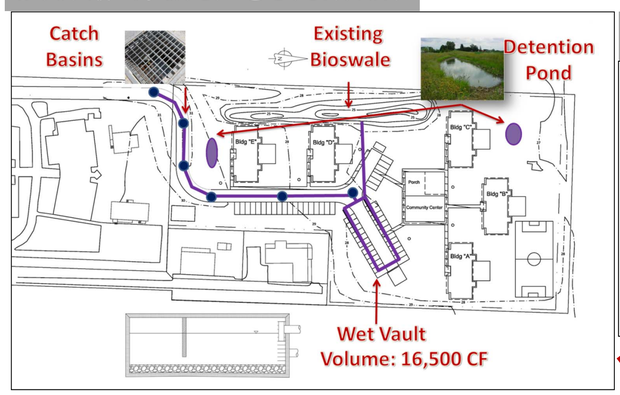

View Inside of a House

Client Needs

- Cultural Village to include:
  - housing to accommodate 20 families, community center for education and outreach, personal and communal vegetable gardens, play area for the children
  - incorporate sustainable features
- Develop 30% civil-site design including: roadway, parking, utilities, grading, drainage plan, and permitting guidelines
- Preliminary structural design for housing and community center
- Develop marketing materials for fundraising and lobbying and preliminary cost estimate for project

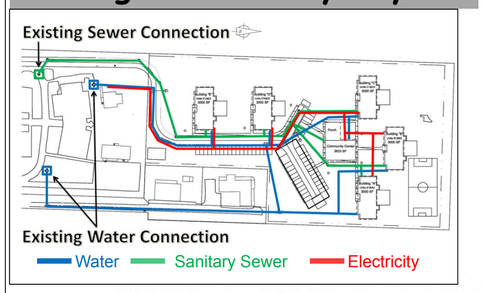
Proposed Cultural Village

Storm Water Detention

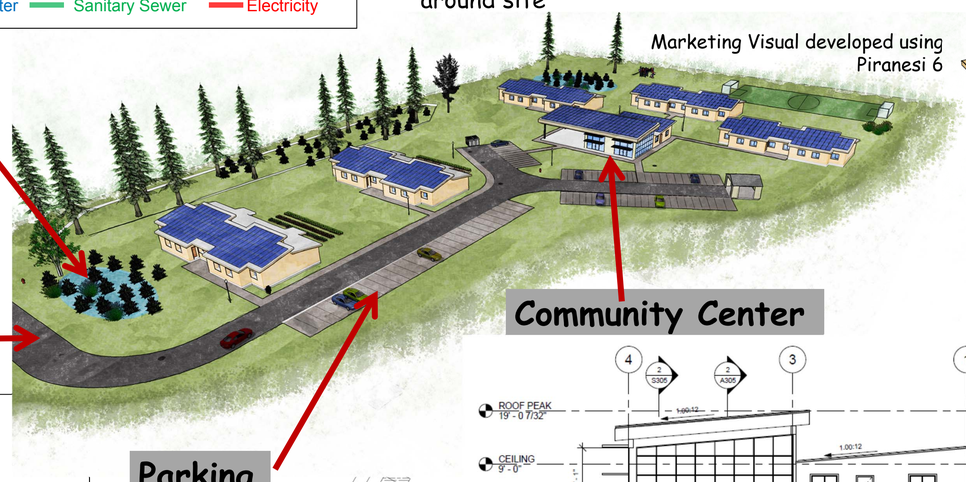


- High water table assumed due to site being in flood plain
- Majority of flow control and treatment occur in wet vault and ponds
- Low Impact Development (LID) techniques will not work due to low infiltration rates of soil.
- Rain barrels recommended for watering the vegetable garden

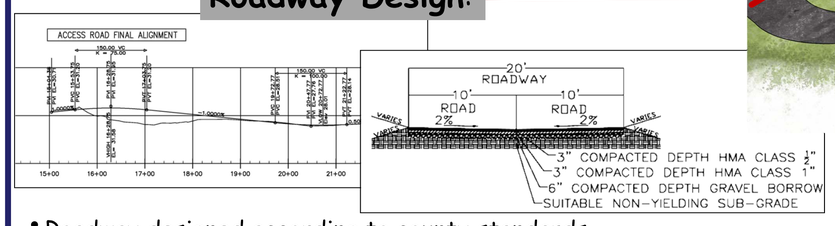
Underground Utility Layout



- Water is provided by the city, sewer services provided by the county public works department; electricity provided by a power company
- To comply with county standards, a minimum of 10 feet horizontal separation and 18 inch vertical separation between sanitary sewer and water pipelines maintained throughout site
- To eliminate stagnant water, water lines looped around site


Marketing Visual developed using Piranesi 6

Roadway Design:

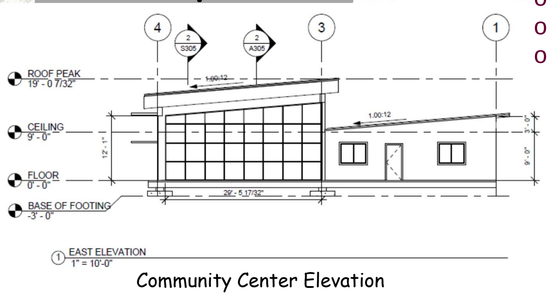


- Roadway designed according to county standards
- Computed cut and fill quantities (17.6 cu.yd of cut and 554 of cu.yd of fill)
- Project site is on a flood plain – therefore native soil to be used as fill material
- Community welfare and safety features: wye turn around at the end of road way for emergency vehicles, exterior lighting

Parking

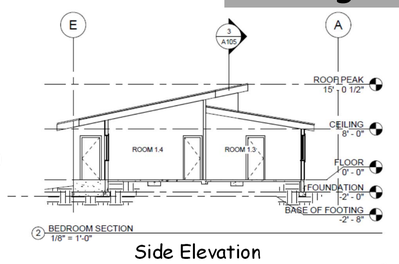
- Client requested two parking stalls per unit; county municipal code required one guest parking for per three units; team designed 48 parking stalls

Community Center

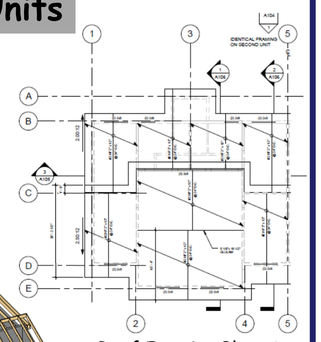


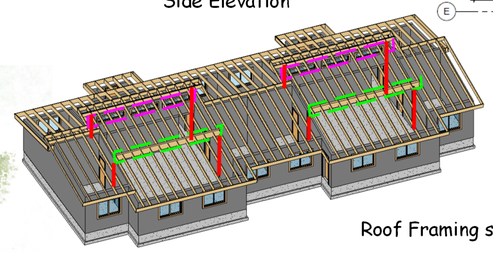
Community Center Elevation

Housing Units



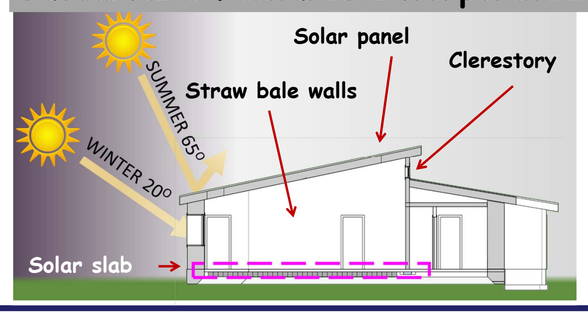
Side Elevation


Roof Framing Plan


Roof Framing shown in Revit

- For both the housing and community center, the team provided engineering drawings of floorplan, elevations, cross sections, roof framing plan, foundations, connection details
- Team prepared various drawing for clients:
  - o Engineering drawings using AutoCAD 2012
  - o Renderings using Revit
  - o Architectural drawings using Piranesi 6 (for fundraising & lobbying)

Sustainable Features Incorporated



Cost Estimation

Civil-Site Development
Permits $9,200
Grading $1.5 Million
Utilities $2,400
Drainage $9,400
Wet Vault $1 Million

Structural Construction
Housing Unit Cost $290,000
Community Center $340,000
Solar Panels:
  Housing Units $149,000
  Community Center $170,000

TOTAL COST = $4.8 Million

Allied Professional Participation

- Obtained base map from licensed land surveyor
- Met with architects to discuss design issues
- Interacted with legal advocacy group on codes governing migrant housing
- A licensed structural engineer advised the team on housing and community center design
- Two licensed civil engineers mentored the team on roadway, parking, stormwater design, utility layout & permitting issues.
- Interacted with straw bale contractor to learn about construction practices
- A community action group and foodbank facilitated a meeting with migrant workers to learn about their experiences and needs
- Attended a state legislative session focused on migrant worker housing and code revisions

Knowledge and Skills Gained

Engineering & Technical Skills

- Working knowledge of American Society of Civil Engineers standard 7-10 (ASCE 7-10), 2015 International Building Code, City Residential Code, County codes, Stormwater Design Manual, presentation software
- Familiarity with Temporary Worker Housing Code

Professional Skills

- Oral presentations to class, professional engineers through the department advisory board, clients and to local professional society members.
- Developed technical writing skills through proposal, final report, and emails.
- Worked with professional engineers, licensed architects, and a broad range of non-engineering partners
- Project management and leadership skills: prepared agenda, ran meetings, followed up on action items; prepared client status reports, managed schedules, budgets; learned to work as a team.

Design Development of a Cultural Village for Migrant Workers
Abstract

Every year farmers around the US hire hundreds of thousands of migrant workers to manually harvest seasonal fruits and vegetables. In many cases farmers provide temporary housing for these workers during the picking season. Often times these houses are stark, offering inhumane living conditions and adversely affecting the safety, health and welfare of the migrant workers and their families. A local non-profit organization (NPO) is attempting to provide a new model for migrant worker housing in our region that is independent of the farmers. The NPO hopes to seek funds from state legislature and private foundations to enact this new vision. Working with the NPO, our goal was to develop the engineering design of a "cultural village" that provides housing, a community center, gardens and a play area for the migrant workers and their families.

Our engineering students are required to complete a team-based, year long, senior capstone project prior to graduation. In this project a team of eight students worked under the supervision of three licensed engineers from a local company that served as the project sponsor and a faculty advisor, also licensed. The eight person team was sub divided into two teams - one was responsible for the civil-site design and the other for the structural design of the main buildings on site. In fall quarter, the team submitted a written proposal to the NPO outlining the project scope and approach, deliverables and schedule. In spring, the work culminated in a final report describing the design methods, engineering drawings, calculations and recommendations.

The "cultural village" consists of housing for 20 families: five structures containing two units each. Each unit has four bedrooms to support two families with shared living rooms, bathrooms and a kitchen. At the center of the cultural village is a community center that consists of a flexible space for community events, laundry, public kitchen, health clinic, and bathrooms. In order to reduce operation costs for the migrant families, the structural team incorporated sustainable features into the buildings including: solar panels, straw bale walls and passive solar techniques such as clerestories, roof overhangs and solar slabs for heating. The civil-site team designed the site layout including: roadway alignment and parking stalls per applicable codes, storm water detention ponds and a wet vault. The team researched required development permits and prepared utility plans for water, sewer and power. Because of the broad range of stake holders, the final design package comprised of AutoCAD engineering drawings, three dimensional renderings using Revit and architectural visuals using Piranesi 6.

Each team member served as the project manager for part of the year, running meetings, setting agendas, assigning tasks and following up on action items. The team interacted with two architects, a straw bale contractor, and a legal advocacy group; volunteered in a food bank serving migrant workers; attended a state legislative session about migrant worker housing. The project strengthened the team's ability to work together, to communicate effectively with engineering and non-engineering audiences and to hone professional and leadership skills.

The NPO and the students mutually benefitted from the project. The NPO used the deliverables for lobbying and fundraising. If successful it plans to implement this model across the state. The students became aware of their social and ethical responsibility towards a marginalized community critical to the American economy.

Design Development of a Cultural Village for Migrant Workers

I. Project Description

Introduction

Migrant farm workers form the backbone of the US agricultural economy for labor intensive crops such as strawberries and apples. Every year farmers around the country, including in our state, collectively hire hundreds of thousands of migrant workers to manually harvest seasonal fruits and vegetables. In many cases the farmers provide temporary housing (TH) for these workers during the picking season which can range from a few weeks to several months. While the TH does fall under a regulatory code, this code is drastically outdated and enforcement of its provisions is infrequent. The result is that the majority of the farmer provided TH fails to provide humane living conditions, adversely affecting the safety, health and welfare of the workers and their families. A local non-profit organization (NPO) is attempting to provide a new model for migrant worker housing; seeking funds from state legislature and private foundations to enact this new vision.

In 2015, a student team partially brought the NPO's dream to fruition by designing a model "cultural village" for a local migrant community. A team of eight students of whom five are currently EITs, under the supervision of four licensed engineers (2 Professional Engineers (PE) and 2 Structural Engineers (SE)) and a licensed faculty member, developed the civil-site design for the cultural village, and the structural design for the housing and a community center for migrant workers. Furthermore, the team incorporated sustainable features into their design and completed a cost analysis for the implementation of the cultural village.

Background and Client Needs

Figure 1 shows an abandoned migrant housing complex provided by the farmers. Typically, TH consists of single room structures that sleep up to 14 people. Most structures are uninsulated with corrugated metal roofs and plywood siding. Families cook on propane stoves that are in the same room as where they sleep, therefore off-gases are a serious health concern, compounded by the lack of ventilation through either openable windows or fans. Communal bathroom facilities are standard for TH compounds with a code mandated one shower per 30 residents and one toilet per 15. Poor lighting around these communal bath houses often leads to unsafe conditions for the residents.

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Figure 1. An Abandoned Migrant Housing Complex a) Housing Units, b) Inside View

The current code governing TH falls far below the standards set by the Residential Code and has not been updated since the 1950s. Many key protections set up in the Residential Code, such as insulation and ventilation standards, are absent from the TH code, significantly reducing the quality of life for the migrant workers and their families. The local office of an international NPO works with the migrant worker community to improve their living and working conditions. This NPO is also working with a legal advocacy group to bridge the gap between migrant housing and the migrant housing code through proposed code revisions.

Complicating the issues, complex power dynamics exist because the farmers provide workers with both their jobs and housing, both of which can be lost in a single action. In order to obtain the federally mandated minimum wage for migrant workers, farmers set steep picking quotas. Workers who do not meet this quota twice are fired, thereby also losing housing for their family. In a globalized economy, farmers too struggle for survival due to international competition combined with high operations and maintenance costs associated with small farms. This makes it particularly difficult to continue with farmer owned TH if higher standards are expected or required.

The NPO (hereafter referred to as the client), in addition to improving the migrant housing code, envisions a "cultural village" for the community that is independent of any single farmer. It consists of dignified housing, a community center to increase opportunities for the migrant population to interact with the local community, personal and community garden space to grow their own produce, and a children's play area. No specific site has yet been chosen for the cultural village.

A religious establishment working closely with the client to provide services to the local migrant community was willing to provide their adjacent land for the student project. The client's hope is that the cultural village model, once developed by a student team, would be used to acquire funding to purchase a property and the preliminary design would help reduce development costs. Also, the proposed model could be general enough to be implemented in other parts of the state as a solution to TH concerns.

Project Scope and Deliverables

Figure 2 shows the approximately five acre land on which the model cultural village is to be developed. The client requested the following deliverables:

Figure 2. Proposed Land and Outline of Cultural Village (source: Google Maps)

- A site layout and a 30% site plan showing utilities, drainage, grading, parking and paving plans, and relevant permits,
- Architectural design and rendering of housing and community center showing 30% structural design,
- Incorporation of sustainable practices in the design,
- An overall cost estimate for the cultural village,
- Develop marketing visuals that could be used by client for fund raising and lobbying.

Because the scope was broad, a team of four students worked on the civil-site design while another worked on the structural design. Both teams collaborated closely.

Civil-Site Design

Figure 3 shows the site layout of the cultural village. In collaboration with the structural design team, the civil-site design team located the housing units and the community center. Next, they designed the roadway alignment and parking stalls according to the local codes. The team sized the detention ponds and a wet vault based upon the impervious service areas of the roadway, parking stalls, and structures on the site. Finally, the team researched the permits needed for the development, and prepared the utility plan for water, sewer, and power for the client. Sample AutoCAD engineering drawings prepared by the team are presented in the poster.

Figure 3. Site Lay-out of Cultural Village

Structural Design

The client requested housing for 20 families. To save on cost and space, the team designed five housing units as shown in Figure 4; each unit consisted of two apartments. Each apartment was planned for two families with each family occupying two bedrooms; the families share a common living room and kitchen.

Figure 5 shows the proposed view and layout of the community center. It provides space for laundry, a health clinic and a multi-purpose covered space and patio that could be used for community events. The team designed the roof, shear walls and the foundations for both structures using appropriate design specifications.

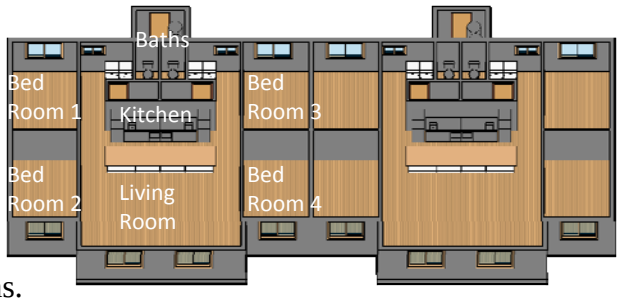

Figure 4. Proposed Migrant Housing Floor Plan

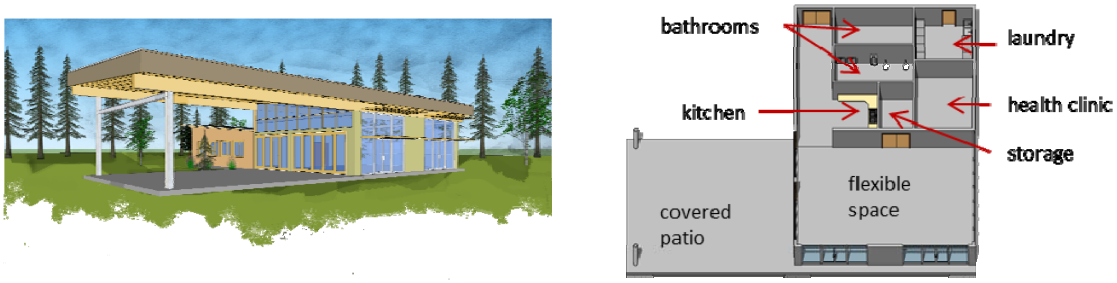

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Figure 5. Proposed Community Center a) Profile View, b) Floor Plan

Incorporation of Sustainable Features in Design

The team incorporated several sustainable features in their design as shown in Figure 6. The team explored the use of solar panels to supplement electricity expenses, straw bale construction as a sustainable building material, and several passive solar techniques to reduce heating and cooling needs. Passive solar methods incorporated into the design include a clerestory for daylighting and ventilation, roof overhangs for shading in the summer and direct heat in the other seasons, and a solar slab to act as a thermal mass to store daytime heat for nighttime use.

The solar slabs consist of concrete masonry units (CMU) that are arranged to form ducts running north-south throughout the unit. The CMU bricks are overlain by a concrete floor that acts as a thermal mass that heats up from direct sun in the fall and winter. Air flowing through the solar slab heats up and keeps the housing units at a comfortable temperature. Straw bale construction uses an agricultural waste material to replace lumber as the main walls in a building, and also has good insulating properties for better energy efficiency. Straw bales that are 18” tall and 24” wide are stacked in a brick pattern and staked with rebar to hold them in place and covered with stucco and mesh. The straw bale is anchored to the foundation with stakes to resist the base shear forces.

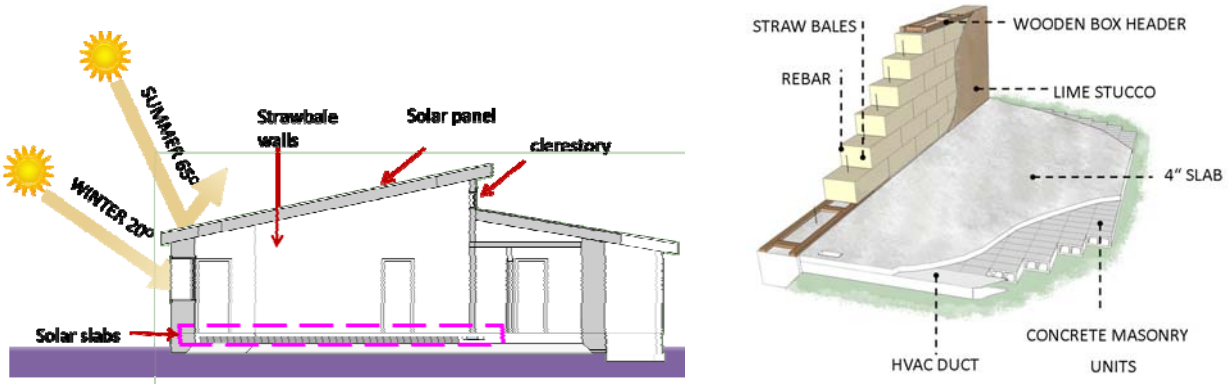

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Figure 6. Sustainable Features in Design a) Global Scheme, b) Wall and Floor Details

Graphical Presentation of Deliverables

The team prepared three types of drawings for the client: a) engineering drawings using AutoCAD® for civil-site and structural design; b) engineering drawings and renderings for structural design of the buildings using Revit®; c) architectural drawing using Piranesi 6® for

fund raising, marketing and lobbying. The various types of drawings are presented throughout this document and poster and appeal to different stakeholders involved in the project.

Cost Estimate
The team came up with a total cost of $4.8 million to develop the cultural village. Of this $ 2.1M was for site development and the rest was for construction of housing and community center. The project poster provides a detailed breakdown of the estimated cost.

II. Collaboration of Faculty, Students and Licensed Professional Engineers
We require that all of our engineering students successfully complete a nine month-long, team-based, capstone project for an external client. The team for this project consisted of eight civil engineering seniors. A local civil engineering company sponsored the project by providing financial support and the time of three licensed civil engineers (2 PEs and 1 SE) who served as professional mentors to the team. A licensed civil engineering faculty member served as the advisor. The senior design course is taught by a licensed faculty member. A licensed structural engineer specializing in residential design assisted the team with the structural aspect of the project.

The students met with the faculty advisor weekly and with professional mentors every two or three weeks. The professional mentors provided technical assistance when needed and provided feedback on the proposals reports, and presentations. The faculty advisor and the instructor provided guidance as necessary and feedback on several drafts of the proposal in fall quarter and the final report in spring quarter.

In addition, two licensed structural engineers reviewed the proposal and report and provided feedback to the teams a week prior to the final submission. The team spent the last week of both fall and spring quarters addressing the reviewers' comments before finalizing the proposal and the report, respectively.

The teams participated in an annual ASCE local section presentation competition where the presentations were judged by a panel of four licensed civil engineers. The format for this competition is a 20 minute oral presentation followed by questions and answers.

Our department has an active advisory board consisting seven local civil engineering practitioners. The board meets quarterly to discuss industry-academic partnership. The student team made an oral presentation to the board in fall describing their project scope and plan for implementation. At the end of the year they presented their final design and recommendations.

III. Protection of Health, Safety and Welfare of the Public
Migrant farm workers are the backbone of the US agricultural economy. However, the wellbeing of this population is largely overlooked and the community stigmatized by political rhetoric. On the other hand, migrant workers continue to come to the US every year, because they believe, despite the hardships they endure, that the US provides a better opportunity that is unavailable in their own country. This project helped the team to be aware of migrant worker issues and how an engineer's skills could be put to good use in improving the lives of this community. The migrant worker's health, safety and welfare were the foci throughout the project.

IV. Multidiscipline and Allied Professional Participation

The team worked with a multitude of allied professionals on this project. The summer prior to the beginning of the academic year, a licensed land surveyor who teaches surveying at a local institution surveyed the property as a student project. They provided the topographic map of the site for the engineering student team to work on. Two architects, one of them licensed, met with the team to discuss the architectural issues and help the team with cost estimates. The team worked with a legal advocacy group to learn the details and deficiencies of the code governing migrant housing. A local community action group and a food bank facilitated the students to work in the field picking produce and at the food bank for a few days in the summer prior to the school year and again in the fall. These experiences helped the team to recognize the struggles of migrant workers, an opportunity to work in a foodbank serving the migrants and to hear their concerns of the farmer provided housing. The team contacted a straw-bale contractor to learn their construction practices. The team attended a legislative session in the state capital where migrant worker housing issues were discussed. This was an enlightening experience for the students to see how legislature plays a role in the implementation of policies and about the complexity of these types of issues due to the myriad of stakeholders involved.

V. Knowledge and Skills Gained

Students developed a wide range of knowledge and skills through this project: technical expertise, communication and project management skills, ability to work in a team setting and to interact with a non-engineering client, and awareness of ethical and social responsibility of the engineering profession.

a) Technical Expertise Gained

The students learned how to carry out a client's dream from the conceptual stage through architectural drawings to engineering design. Through the design process they acquired skills and working knowledge in the following:

- Design Codes and Manuals: Migrant housing code, 2012 International Building Code, ASCE 7-10, City Residential Code, Local County Municipal Code, County Road Standards, County Development Standards, Stormwater Design Manual,
- Design/Computer aided drafting software: SAP 2000, AutoCAD 2007, Revit 2015, Piranesi 6
- Design issues related to zoning, relevant permits, utilities, grading, drainage, roadway design, and sustainable design features.

b) Communication Skills

This project required the students to interact with engineers and a broad spectrum of non-engineers. The team had to translate the "non-engineers' language" of needs and functional requirements to "engineers' language" of design parameters and constraints. Then the team had to prioritize the functional requirements of the client, convert them into measurable parameters prior to the design. They also faced the challenge of explaining engineering terms and constraints to non-engineers. The team had to interact with county and city personnel to learn their codes and practices related to development.

The students were required to make oral presentations to their peers twice a quarter. Each student had to make at least one presentation each quarter. The academic year concluded with a grand event on campus where it presented its work to the entire university community, sponsors of all

capstone projects, prospective sponsors, friends, family and alumni. The team also prepared a trifold poster board which was eventually used by the client for fundraising and lobbying to implement the project.

Improving technical writing skills of our graduates is an important focus in our program. Hence, the team was required to submit a written proposal to the client at the end of fall quarter, describing the scope of work, plan of implementation, schedule and budget. At the end of spring quarter, they submitted a final report describing the work done, engineering calculations, drawings and other deliverables as initially agreed.

The client wanted visuals that could be used for fundraising, marketing and lobbying. Therefore the visuals had to be aesthetically pleasing and audience friendly while effectively communicating technical design information. Therefore in addition to developing engineering drawings using traditional AutoCAD and Revit platforms for engineers' use, it also used the architectural software, Piranesi 6, for developing the visuals.

c) Project Management skills

Each team member played the role of a project manager for part of the academic year and had the following responsibilities: setting up team meetings, developing meeting agendas, conducting the meetings, assigning tasks to the team members and following up on action items. In addition, the project manager was in charge of contacting the client, the liaison engineers, and the faculty advisor in between team meetings, when necessary. The project managers of both teams, civil-site and structural, had to work closely for the project to be successful.

d) Awareness of Ethical and Social Responsibility of Engineers

This project made the students aware of engineers' ethical and social responsibility. It provided a great opportunity for the students to apply their knowledge and skills to improve the health, safety, and welfare of a marginalized community critical to the American economy. This project also showed the students ways in which engineers can contribute to solutions for large social problems, a connection that they may not had previously envisioned.

VI. Summary

At the request of a non-profit organization, a team of civil engineering seniors developed a conceptual design of a "cultural village" for migrant workers, replacing the traditional farmer-owned housing model. The "cultural village" consists of migrant worker housing, a community center, space for vegetable gardens and a play area for the children. The team developed the civil-site design involving zoning, permitting, roadway, utilities, and a structural design of the housing and community center including sustainable elements and alternatives. The project was supervised by two licensed professional engineers, two licensed structural engineers and a licensed faculty member. In addition to developing technical and professional skills, the team was exposed to the migrant worker crisis plaguing this nation and the ethical and social responsibility of engineers in relation to this critical issue. The non-profit organization plans to use the student work to lobby the legislature to revise the temporary housing code for migrant workers, raise funds from state legislature and private foundations to bring its vision to fruition.