2019-2021

Preliminary Design Report
Adams County Health & Human Services Remodel

Civil & Environmental Engineering 578: Senior Capstone Design
University of Wisconsin-Madison

UniverCity Alliance
UNIVERSITY OF WISCONSIN-MADISON

Adams County WISCONSIN

Preliminary Design Report

Adams County Health & Human Services Remodel

Prepared for: Adams County Grounds Department

Prepared by: Castle Rock Consultants

Castle Rock Consultants
1410 Engineering Drive
Madison, WI 53706

April 6, 2021
Jan Kucher, PE Adjunct Professor
2346 Engineering Hall
1415 Engineering Drive
Madison, WI 53706

RE: 100% Preliminary Design: Adams County Health & Human Services Building Remodel

Dear Mr. Kucher, P.E.,

Enclosed is the Preliminary Design Report detailing the investigation of three design alternatives to be considered for the repurposing of the existing Adams County Health and Human Services Building. We are excited to be partnering with the Adams County Grounds Department to positively impact the neighboring Adams and Friendship towns with this renovation intent on serving their community needs.

In preparing the preliminary design, the Castle Rock team has worked to understand and account for existing constraints, conditions and code standards. Our team has worked to provide in-depth technical analysis for each proposed alternative. Each alternative has been extensively examined from construction, hydraulic, geotechnical and structural aspects. Additionally, a cost analysis and comprehensive decision matrix were created to holistically assess each design alternative. A final sustainability assessment providing insight into potential safety, environmental, social and economic impacts has been included in the report as well.

Our team is grateful for the opportunity to work with the Adams County Grounds Department in contributing a socially enhancing and economically profitable final design. The final recommendation posed by Castle Rock Consultants takes into consideration the analysis summarized above, in order to provide the Grounds Department with feasible alternatives to sell to interested developers at a later date. Please direct questions with regards to this report to the team's project manager.

Sincerely,

UW-Madison Student
Project Manager
Castle Rock Consultants

Disclaimer

The concepts, drawings, and written materials provided here were prepared by students in the Department of Civil & Environmental Engineering at the University of Wisconsin-Madison as an activity in the course CEE 578 - Senior Capstone Design. These do not represent the work products of licensed engineers. These are NOT for construction purposes.

Executive Summary

Project Description

The existing Adams County Health and Human Services (HHS) Building located in Friendship, WI is to be repurposed for use in the Adams/Friendship community in a way that is attractive to a developer.

There are three alternative repurposing designs addressed in the following report. Each addresses the building issues outlined by the Adam's County Sheriff's Department utilizing geotechnical, hydraulic, structural, and construction analyses. Building issues include:

- HVAC inconsistencies
- Heat loss from poor insulation
- Limited spacing due to excess wall partitions
- Poor parking lot drainage

The recommended design alternative is available to be sold to a developer. Profits from this sale will fund the construction of the soon to be relocated HHS Building. The enclosed preliminary design analysis provides a thorough review of the site and determines the redesign alternative that best balances economic growth and community needs.

Design Alternatives

Each of the proposed alternatives addressed different aspects of the community's needs.

- Low Modification - Varied commercial space achieved by dividing the space into several separate rentable spaces to accommodate the needs of the area's *small businesses*.
- Medium Modification - Retirement community specifically intended for low-assist living, for the *senior population* for whom home maintenance is becoming burdensome.
- High Modification: Multi-use market rate housing aimed toward *young professionals*, which includes transforming the existing building into residential apartments.

Design Constraints

Constraints integral to the determining the most effective design include: social, economic, environmental, manufacturability, political, ethical, health and safety, and overall sustainability.

Design Evaluation & Final Recommendation

The three design alternatives were assessed on three major categories: cost, construction, and community need. Weighting for each performance criteria was determined based on the engineering team's professional insight and the feedback from Adams County Grounds and Economic Development Departments. The factors in Table 1 range from 1-3 with the lowest factor (1) attributed to the best performing alternative for each itemized criteria.

The design matrix outlined in Table 1 depicts Alternative 2: Medium Modification, Retirement Community as the chosen final design to be used for the repurposing of the HHS Building.

Table 1. Weighted Decision Matrix

Performance Criteria	Weight	1: Low Modification	Weighted Score	2: Medium Modification	Weighted Score	3: High Modification	Weighted Score
Cost							
Annual Income	0.10	2	0.20	1	0.10	3	0.30
O&M Cost	0.10	2	0.20	3	0.30	1	0.10
Payback Period	0.10	2	0.20	1	0.10	3	0.30
Capital Costs	0.20	1	0.20	2	0.40	3	0.60
Life Cycle Costs	0.20	1	0.20	3	0.60	2	0.40
Construction							
Space Limitations/Accessibility	0.10	3	0.30	1	0.10	2	0.20
Structural Efficiency	0.10	1	0.10	2	0.20	3	0.30
Sustainability	0.05	3	0.15	1	0.05	1	0.05
Community Need							
Economic Development	0.05	1	0.05	2	0.10	3	0.15
Residential Amenities	0.05	3	0.15	2	0.10	1	0.05
Total	1.00	**Total Score**	1.6	**Total Score**	2	**Total Score**	2.4

Opinion of Probable Cost

This opinion of probable cost includes the design services and the construction phases of the three alternatives. The capital costs of the selected final design alternative are included in Table 2. These estimations were done primarily using square footage values, which suggest a certain amount of uncertainty is applicable for these values. Estimations were done using RSMeans, previous bids, and experience.

The low, medium and high modification alternatives were estimated at $3.0 million, $3.2 million, $3.8 million for capital costs respectively.

Table 2. Summary of Selected Design Capital Cost

Costs	Alternative 2: Medium Mod Retirement Community
Consulting	$200,000
Construction	$2.34 million
Contigency (20%)	$468,000
Fees	$180,000
Total	$3.2 million

Project Schedule

Figure 1 includes a detailed timeline of completed and upcoming tasks necessary for design and construction services.

The project schedule is split into four primary phases: Preliminary Research, Preliminary Design, Final Design, Pre Construction & Construction.

The preliminary research/design and final design phases for which Castle Rock Consultants is primarily responsible plan to be completed by 04/30/2021.

Permitting included in the final design phase is scheduled to commence on May 1, 2021. Construction is scheduled to last from 10/2021- 08/2022, or approximately 10 months.

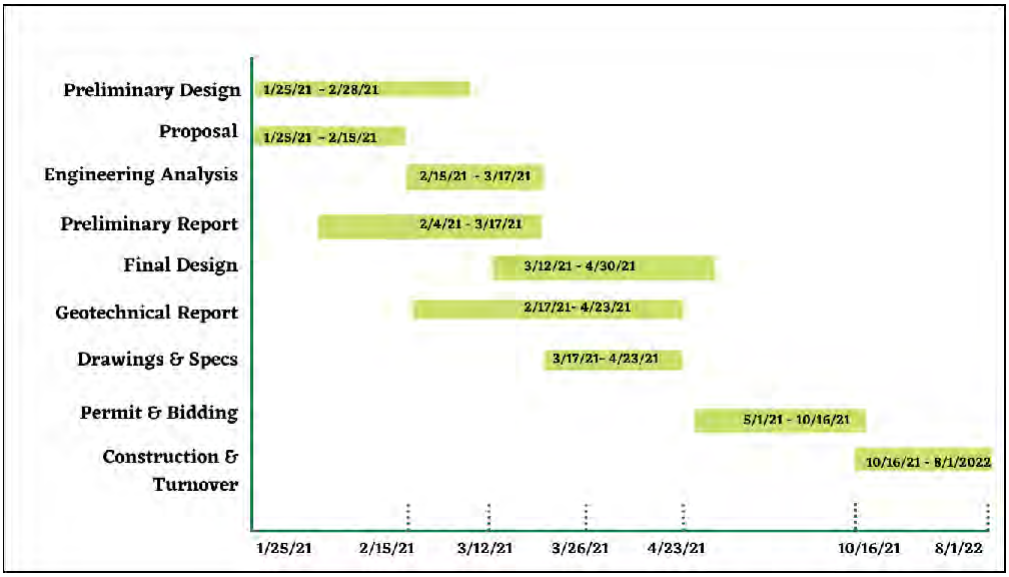

Figure 1. Design & Construction Schedule Overview

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1.0 Introduction

Adams County is actively looking for development alternatives to the existing Adams County Health and Human Services building. This is located at 108 E. North St. Friendship, Wisconsin. The building has become too small to fit current needs and may be renovated by a developer to accommodate community needs. Three renovation alternatives are proposed to solve the issues currently affecting the building as well as to provide incentives to developers with a comprehensive plan for the economic potential of each option.

Project History

The Adams County Health and Human Services building was built in the 1980s. Originally, only half of the building seen today was built, with the second half built about a decade later. This becomes apparent within the building due to a firewall separating the two spaces.

A building of this size serves a small community with many needs. Adams County as a whole has a population of 20,220 people according to the 2019 census estimation [U.S. Census Bureau Quickfacts]. As a result, the current building is used for Veteran's Affairs, helping women and children, as well as some medical care. Rooms within the building are sectioned off and there are few open spaces.

On a larger scale, the Adams community has a rich history. The city itself was created due to the railroad line passing through. As with many railroad towns, population decreased over time as other modes of transportation became more popular. Currently, the community is struggling to promote economic vitality. With some revitalization and new projects, Adams County hopes to enable and encourage growth in a community steeped in history and significance.

Project Needs

The current Health & Human Services department has outgrown the size of their building, citing a need for additional storage and cramped shared office spaces. As they transition to a different building, Adams County would like to sell this building to a development team who can repurpose it to suit the needs of the community as well as correct existing site issues reported by the Sheriff's office and outlined in the following section. The Sheriff's office of Adams County focuses on community safety and property management compliance of local buildings which led to the reporting of issues pertinent to the project scope.

Within the last year, thirty new teachers have been hired in the Adams County School District, but only two reside within the county due to a shortage of market rate housing. This project aims to provide additional housing or commercial space in the Adams/Friendship area to encourage development of the town both socially and economically.

Scope

The scope of this project has two major components. The first is to repair existing issues with the building to provide a facility that is compliant with code and has no outstanding issues. This includes:

- Work to provide consistent heating and cooling throughout the building by examining the HVAC system.
- Identify where heat loss is occurring and how to stop ice from forming on the roof of the building.
- Regrade the existing site to provide proper drainage, especially during the spring months when the snow thaws.

The second component of the scope is to repurpose the building. It includes:

- Redesign the existing layout with community needs in mind.
- Determine the financial benefits of different alternatives for purchase by a developer.
- Work with the existing structure to create a layout that makes sense but is also cost effective.

The scope includes cost estimates for three alternatives, as well as floor plans, calculations, geotechnical information, and feasibility analysis.

2.0 Project Constraints

Economic

The Health and Human Services Building will be sold by the Adams County Grounds Department to a developer. A $4 million fund has been allocated to the design and construction services for the developer remodel. This fixed budget limits the cost to be spent on internal restructuring. Large scale renovations and significant area redesigns may be restricted to simpler and more cost effective options as a result. Project costs also identify utility modifications for HVAC and insulation rework as well as overall site development as it pertains to revamping the parking lot drainage system. Life cycle costs and its implications are discussed further in section 8.0.

Environmental

The existing building is located in a rural commercialized area and the adjacent parking lot is bordered by heavy forestry. There are no nearby large bodies of water. Special consideration was given to the surrounding forestry, frequented by deer and other local wildlife, in an effort to preserve the existing ecosystem.

Social

It is essential to incorporate community feedback with the intent of providing design alternatives with the public’s needs and desires in mind. The public health and veteran services housed within the existing building are to be relocated to a new larger facility closer to Adam’s city center.

Therefore, the intent of this repurposing is focused specifically on filling the need for new facilities and services not currently available to residents. Services offered in the proposed new building designs intend to add value to a predominantly low-income community. The town's growing elderly population provides the motivation to gear these facilities towards the needs of this elderly community. Additionally, this renovation is an opportunity to entice new businesses to positively contribute to the community's economy.

Continued communication with residents can proceed in the form of community forums or surveys as the design and construction phases progress.

Politics

It remains integral, throughout the design process, to incorporate public feedback into each design to take into account the needs of the community. Creating a new space that invites external services and vendors to these small communities, runs a fine line between creating an economic opportunity and driving out current small businesses in the existing small-town economy. Public feedback via in-person and online community forums dually look to the city's economic director for perspective.

Ethics

In renovating this building there is an ethical responsibility to Adams County, its residents, and the engineering profession. As such design and construction teams have complied with the NSPE Code of Ethics for Engineers. Integral to the design process is ensuring that the chosen renovation design is a sustainable choice economically and socially for the community. Canon 1 of NSPE, "Hold paramount the safety, health, and welfare of the public", is a standard to uphold when determining what repurposing option would serve the "welfare of the public". This can be achieved by soliciting community feedback through open public forms and being transparent about design plans going forward.

Health/Safety

The building site neighbors local schools and offices; therefore, human health and safety of the public regularly frequenting the area was considered. The proposed designs include repurposing the space to serve long term residents and/or permanent businesses. In either case, in redesigning existing utility systems (fire suppression, etc.), the safety of future occupants was accounted for. Construction phase work is to be compliant with OSHA guidance to promote a safe work space for on-site crews.

Manufacturability

Manufacturing and constructability constraints involve limited site space and potential noise disturbance during later phases. The remodel includes the building as well as the adjacent parking lot leaving little room for on-site staging. The existing building is in close proximity to Adams Middle and High schools as well as a number of county office buildings that need to be

considered. Additionally, alternative roadways bypassing heavy vehicle construction traffic needs to be accounted for. Regulation-based constraints are discussed further in section 4.0. These disturbances can be constrained to optimal time periods/seasons as determined by locals. Soliciting a town-wide survey and adhering, if possible, to the majority consensus helps to address this constraint.

Sustainability

Proposed resolutions to existing building problems (roofing, insulation, drainage, etc.) need to function effectively over the next 30 years, a timeline pre-determined by the Adams County Grounds Department. Economic sustainability can be achieved through planning for newly housed services to have adequate capacity to fill existing spaces and therefore does not require additional expansions over time. Social and economic sustainability objectives work to create a balance between cost effective design and construction and being mindful of resulting public impact.

3.0 Existing Conditions

The existing site is located at 108 E. North Street, Friendship, WI. The parcel that it sits on is 2.93 acres. On the site, there is a one-story main building with a footprint of about 17,200 square feet, two garages, and a parking lot. Figure 2 provides an aerial view of the property from the Adams County GIS site. The Adams County HHS property is outlined in blue. The surrounding parcels are outlined in green.

Figure 2: Aerial view of the Adams County HHS parcel [Tax Parcel Information Search].

Hydrology

The primary goal for this project from a hydrologic perspective is to address standing water on the parking lot as it is a concern listed in the Sheriff's report. Standing water occurs primarily during high-water storm events, characterized by Figure 3 below for the Adams County area. This figure shows the relationship between storm frequency, duration, and rainfall depth expected based on a 90% confidence interval from data collected by the National Oceanic and Atmospheric Administration (NOAA) climate studies. The data is shown in tabular form in Table 7 in the Appendix.

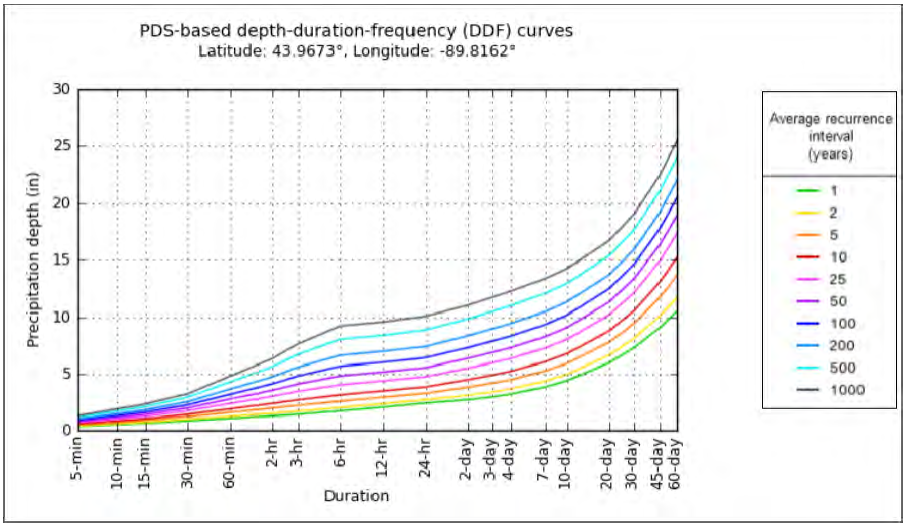


Figure 3. NOAA Climate & Rainfall Frequency Data, Atlas 14 (Table 7, Appendix)

Rainfall depth from a storm of a given recurrence interval can be translated into a peak discharge of water to manage by use of the Rational Method, which creates an estimate based on rainfall intensity and site runoff coefficients. This can then be used to estimate total stormwater volumes per the "New Jersey Stormwater Best Management Practices Manual". For this, the site size, rainfall intensity, and runoff coefficients are needed. The site has a size of 2.93 acres, and its runoff coefficient is calculated to be 0.712, as shown below. This shows infiltration potential, and estimates that 71.2% of stormwater will be translated to runoff or standing water for a given storm event. Relevant equations for drainage volumes are included in the Appendix.

Table 3. Site Runoff Coefficients

	Cover [%]	*Runoff Coefficient*
Paved	*52*	*1.0*
Grass	*48*	*0.40*
Composite	*100*	***0.712***

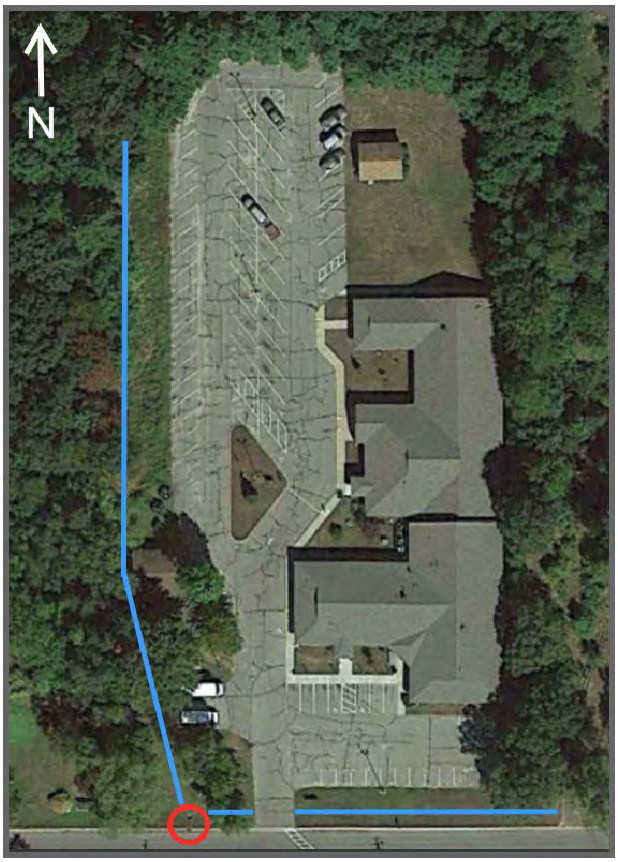


Figure 4. Drainage Flow Path & Outlet

The 2.93 acre site is shown in Figure 4 above, with the 600 linear feet of drainage paths and singular outlet indicated. Building facilities manager, Bill Runnels, relayed that during high-volume water events, water could back up onto the site from neighboring lots due to its low elevation relative to the surrounding area. This is indicative of wider water management issues, and introduces much deeper uncertainty about the volume of water needed to design for.

Structural

The existing structure of the building is structurally sound. There are over 50 rooms in the building, with hallways as narrow as 4’9”. Around 1990, the building was expanded and added a new wing to the building, nearly doubling the overall square footage of 17,200 square feet. A fire wall was added in between the old section and the new section of the building. Since the building is relatively new, and the expansion was done successfully, there are no structural concerns with the building as it stands.

For the proposed alternatives, even with the lowest modification plan, walls need to be removed. Shown in Figure 5, is the estimated structural plan of the building. The red lines in the figure are

load-bearing walls. This plan was devised by using the existing floor plan and extensive structural engineering knowledge from team mentor, Kurt Straus. This plan was used to determine alternative floor layouts. As seen in Figure 5, there are no load bearing walls between the offices that run along the outside ring of the building. Due to this, two alternatives include removing walls to make the rooms more spacious. Load bearing walls are not to be moved or replaced, due to cost constraints.

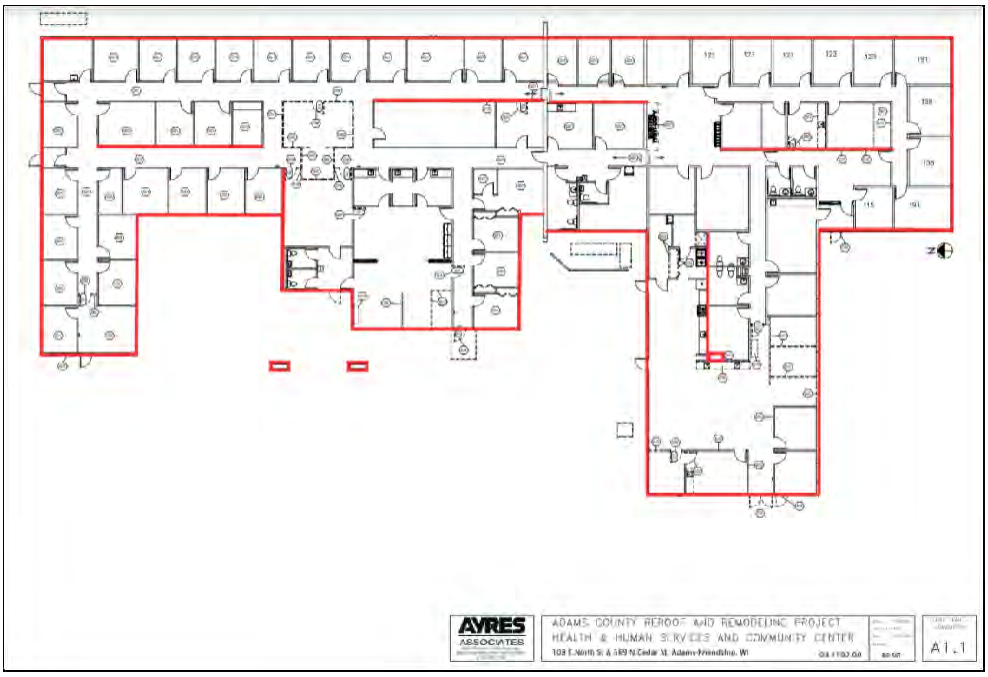


Figure 5. Structural Plans

Geotechnical

The local hydrology and structural integrity of the building could be influenced by the existing geology underlying the Health and Human Services building. Five standard penetration tests (SPT) boring holes were drilled to investigate the subsurface and its composition. Data obtained shows that the site is underlain by a large layer of medium dense loamy sand composed of occasional pockets or seams of fine-grained sediment. Organic grayish brown topsoil was seen to be at most 11 inches thick above this layer.

These findings are consistent with the regional geology of the Wisconsin area which is widely known to be dominated by glacial till and loam deposits from the Pleistocene epoch. With a surface elevation of 971 feet above sea level, the present ground surface is rated to have slopes ranging from 0-3% which means for every 100 feet of distance, the topography rises at a maximum of 3 feet. The water table was also observed to be as shallow as 19 feet below the

ground surface (bgs). Figure 6 depicts a stratigraphic cross section of the soil profile found on site. The water table is represented as the blue dotted line seen in the figure.

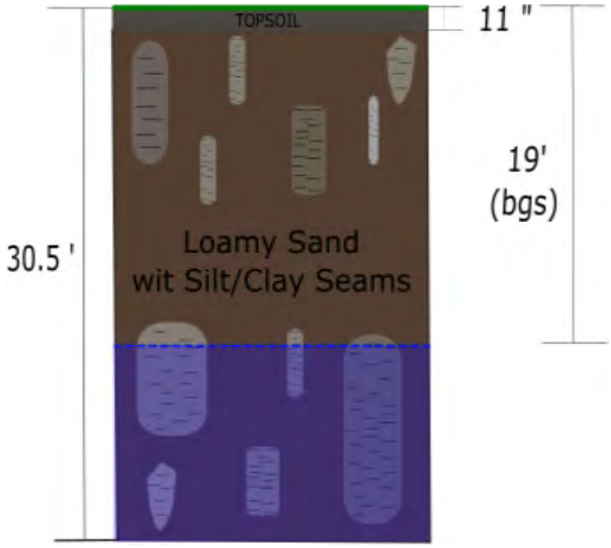


Figure 6. Stratigraphic Soil Profile

Sand has distinct mechanical and physical properties when considering loading and foundation systems. However, dry, medium dense loamy sand, the sand found on site, exhibits more ideal strength parameters. The allowable bearing pressure of this soil was calculated to be approximately 3,550 pounds per square foot (psf), which is equivalent to 54 tons of load being placed on concrete square foundations 5 feet deep and 6 feet wide. Castle Rock's previously provided full Geotechnical Report details more information on the soil mechanics and stratigraphy found on site.

Construction Requirements

The northern portion of the building was built in the early 1980s with the southern portion constructed about a decade later. This was due to additional space requirements. The original building was around 10,600 square feet, and is now approximately 17,200 square feet. There is a firewall between the original building and the existing building. The building has no basement and was built upon a slab-on-grade foundation. There are no existing issues with the foundation known at this time.

There are two garages on site that are small structures with a poured concrete floor. The one near the northern portion of the site is around 600 square feet while the garage in the southwest corner is around 800 square feet. The parking lot is extensive and is approximately 42,000 square feet. It is paved with asphalt, and while there is some cracking, cracks appear to be filled and maintained. Some concerns that need to be addressed during the project include improving the

HVAC system and addressing the heat loss issue associated with the roof. Currently, the HVAC system provides uneven temperature controls throughout the building. Heat from the building is also escaping into the attic space above the building and creating problems such as ice damming. This causes stress on the roof and poses a danger to those near the large icicles formed.

Utilities

Utilities for the site are provided by the City of Adams. This includes city water and sewer. Electricity services are provided by Adams-Columbia Electric Cooperative.

4.0 Related Regulatory Codes

There are multiple regulatory requirements for this site including building codes and codes from the Department of Natural Resources (DNR). This is due to the drainage correction that is planned to be done on site as well as complying with local codes pertaining to protecting water resources during construction.

Drainage Regulatory Codes

FDM 10-5-25: Geometric Considerations - Slopes for drainage and roadside ditches are regulated by the Wisconsin DNR, and design guidelines are further outlined by the Wisconsin DOT. These restrictions limit the amount of on-site water storage available.

Building Regulatory Codes

NR 151 - Runoff management - Detailing clean water and construction site performance standards.

NEC 2017 - During design, the National Electrical Code 2017 edition is needed as that is the code adopted by the State of Wisconsin. This is created by the National Fire Protection Agency (NFPA) and outlines standard electrical design practices.

Adams County Building Construction Ordinance - Provides minimum standards and requirements for the design, construction (services, materials, etc.) of building in the county (including reparations). Code details occupancy, equipment, and maintenance standards for building with consideration for the general public.

Adams County Stormwater Runoff Ordinance - Provides requirements for stormwater management and site drainage, including reparations to existing stormwater systems.

2015 International Existing Building Code (adopted by the state of Wisconsin)

IEBC 302 - Detailing existing materials, new and replacement materials, occupancy, and use.

IEBC 606 - Outlines extent of repair for compliant building and evaluation for structurally based modifications to the existing building.

IEBC 607/608/609 - Detailing electrical, mechanical, and plumbing repairs (respectively) with regards to appropriate materials, limitations, and water flow rates.

IEBC 900 - Level 3 Alterations - intended for remodels with extensive space reconfiguration, exceeding 50 percent of the building area. Detailing limitations with regards to energy conservation, and structural modifications.

IEBC 960 - Accessibility with regards to repurposing and converting facilities from non-dwelling to sleeping and dwelling units.

5.0 Site Staging

The recommendation for staging for the construction portion of this project is fairly streamlined due to the layout of the area. Little site preparation is needed before the construction phase as is consistent with the geotechnical report findings. The building remodel is the main focus of the project and material storage is needed. For the duration of the project, yellow areas indicated on Figure 7 allow for storage area.

These areas are not involved in the building construction phase and can be addressed after the completion of interior work. They provide around 8,500 square feet of storage space while still maintaining room for parking. By having two separate staging areas, construction can be easier to manage and be more efficient due to the shorter length material must be transported.

Figure 7. Site Staging Plan [Google Earth]

6.0 Design Alternatives

This building could be renovated to fit many different purposes and offer several amenities. These three design alternatives were created to outline a broad range of possible use cases for this building, and showcase the potential value of the space.

Alternative 1: Low Modification: Varied Commercial Space

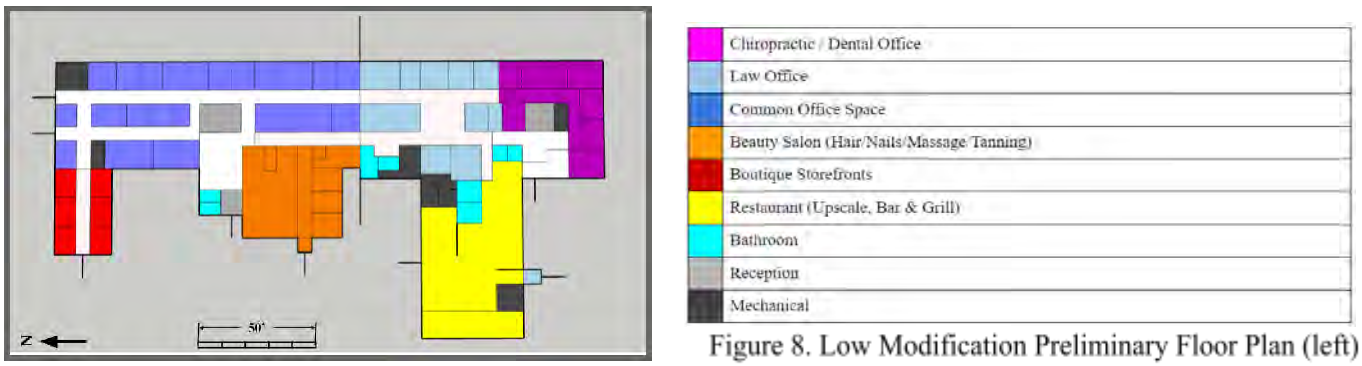


Figure 8. Low Modification Preliminary Floor Plan (left)

The first design proposal utilizes the existing space within the building for an economical remodel focused on low renovation expenses. This option consists of minimal structural demolition and utilities realignments in favor of minor refurbishments of the existing offices. The building is planned to be divided into several separate rentable spaces to accommodate the needs of the area's small businesses. Many of these spaces separate out very naturally to create a dynamic interplay of businesses that can utilize the space.

The purple and light blue sections in Figure 8 are serviced by a shared entrance and waiting area on the south end of the building and are separated from the rest of the building by the fire wall. This makes these two spaces available for more confidential services such as medical, dental, or law offices. The orange space near the main entrance consists of a large open room with water hookup on the eastern wall, making it ideal for a beauty salon with hair and nail services. There are also several rooms to the south included that could offer tanning or massage services. The largest section consists of over 6,000 ft^2 of rentable community office space, shown in the darker blue.

Businesses or individuals would be able to rent offices in this complex and have access to shared breakroom, printing, and conference room facilities. The red section on the northwest corner of the building serves as a boutique storefront with six individual spaces for rent at 150 ft^2 where local artisan sellers and small businesses can have a space to sell their goods. Finally, a feature space of this alternative is a relatively upscale Bar & Grill style restaurant. This 3,200 ft^2 space is shown in the southwest corner in yellow, and has 1,000 ft^2 of kitchen space, a separate room convertible to a conference space planned to be available to rent out for parties or business

dinners. This space is planned to be a draw for members of the community to the space, as well as for tenants of the building during non-business hours.

Alternative 2: Medium Modification: Retirement Community

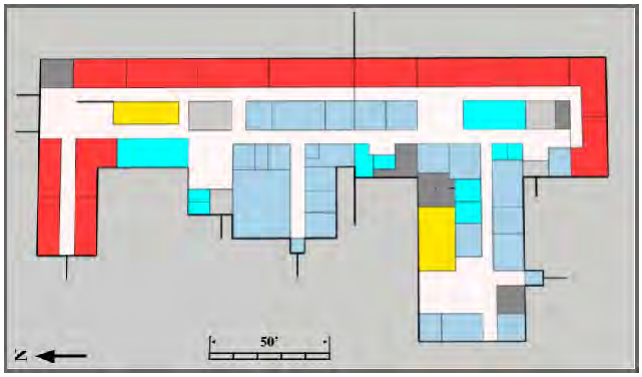


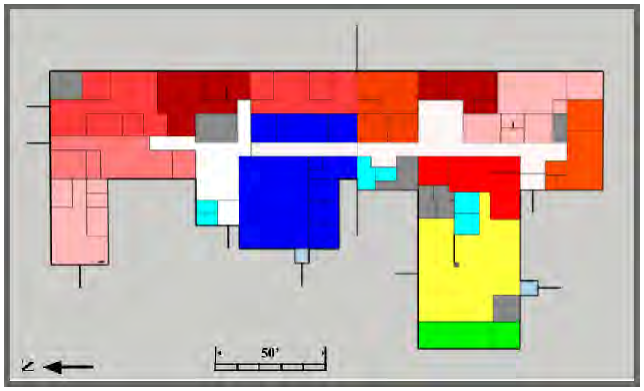
Figure 9. Medium Modification Preliminary Floor Plan (left)

One way to address the community need for housing is providing a retirement community living center for a portion of the aging population for whom home maintenance has become burdensome. This renovation, depicted in Figure 9, offers spacious individual bedrooms at an average of 320 ft^2, with shared dormitory style bathrooms at 320 and 370 ft^2, equipped with several toilet units and shower stalls in each. There are also full service kitchen spaces, at 270 and 420 ft^2. All communal spaces would be kept by a cleaning staff to reduce responsibilities for the residents. While the shared spaces offer less privacy, the spaces offer a more commodious and luxurious alternative than cramped restrooms in each individual room.

The space also offers over 3000 ft^2 of shared living spaces that can be used to foster community through dining spaces, event rooms, game rooms, and media centers such as a library or theater space. This offers the opportunity for residents to build relationships with each other as well as provides plenty of opportunities for visitors to engage with residents. Other spaces in the light blue include general storage and employee offices.

The building's current use as a Health & Human Services center translates well into meeting minimal medical needs for senior residents through on-call nurses and a part-time personal trainer and rehabilitation on-site. As this is not a nursing home or full care facility, these spaces would be supplemental and focused on enriching the lives of the tenants. With a moderate amount of modification, this space could be an attractive alternative for the mid-late retirement age members of the Adams County community.

Alternative 3: High Modification: Multi-use Residential



	Apartments
	Gymnasium
	Restaurant, Shared Dining Space
	Small Restaurant Front
	Bathroom
	Reception / Mechanical

Figure 10. High Modification Preliminary Floor Plan (left)

The third design alternative outlined for this space is an intensive remodel to a multi-use residential space. As seen in Figure 10, this modification consists of 10 separate apartments (denoted by the various shades of red/orange around the exterior of the floorplan), ranging from a studio (510 ft^2) to several 2-bath units (~1200 ft^2). Each of these apartments would have an individual bathroom, kitchen, and living spaces, and are accessible from the building interior (with the exception of the 2 bedroom unit on the northwest corner of the building, which has a private entrance).

In addition to the living spaces, the dark blue represents a 2400 ft^2 gymnasium space, included for residents and open to the public through membership. This gym has space for a yoga studio, spin classes, and tanning beds, as well as the option to fully outfit with showers. The other non-residential draw to the space is the restaurant area in the southwest corner. This offers a small 500 ft^2 storefront, potentially servicing a deli shop, and a larger 2000 ft^2 restaurant with enough open space for shared dining. As there were kitchen hookups and dedicated bathrooms in this section of the building, it translates naturally to this use and can offer additional income for the developers.

7.0 Design Analysis

General

Each design alternative will be coupled with the same resolutions to existing insulation inefficiencies, partitioning issues and parking lot ponding. Insulation can be enhanced through the installation of an aluminum metal roof, and ponding can be mitigated by expanding the existing drainage ditch. Existing structural walls were identified and non-structural partitions were assessed, in each alternative outlined below, for demolition.

HVAC

One existing issue with the building that requires attention for all alternatives is the current HVAC system. For alternative one, the low modification commercial space, the same gas furnaces can be used after some updates to the controls system and ductwork adjustments. To change this, dampers are planned to be installed to better control the different rooms more efficiently and at more specific temperatures compared to what currently exists. This also allows for additional thermostat control.

Alternatives two and three need additional work as each individual living space needs direct control of their home temperatures. A cost-effective way to accomplish this goal is to use PTAC (Packaged Terminal Air Conditioning) units. These provide both heating and cooling options and are often found in hotels and apartments. The units are placed on an exterior wall and exchange outside and inside air. The common spaces of these options can continue to use the gas furnaces with updated ductwork.

Roofing

Each option has the same recommendation for the roofing system. It is recommended that extra expense be used in replacing the entire existing roof with a new metal roof. Metal roofing is a long-lasting and quality alternative to traditional shingles and has been proven to help prevent and reduce ice damming and heat loss [CK Smith Superior]. Metal roofing does this by providing a smooth surface that encourages snow and ice to slide off of it as well as having unique thermal properties such as a higher specific heat. Better ventilation is also to be provided in the attic space by creating more open soffits and adding roof ventilation points. Blown and sheet insulation within the attic space also help prevent heat loss from the building itself. Figure 11 showcases the difference between the Adams County HHS attic and an attic that functions correctly. Overall, while this does negate the investment they have made in heat cable, it provides a permanent fix rather than a temporary one.

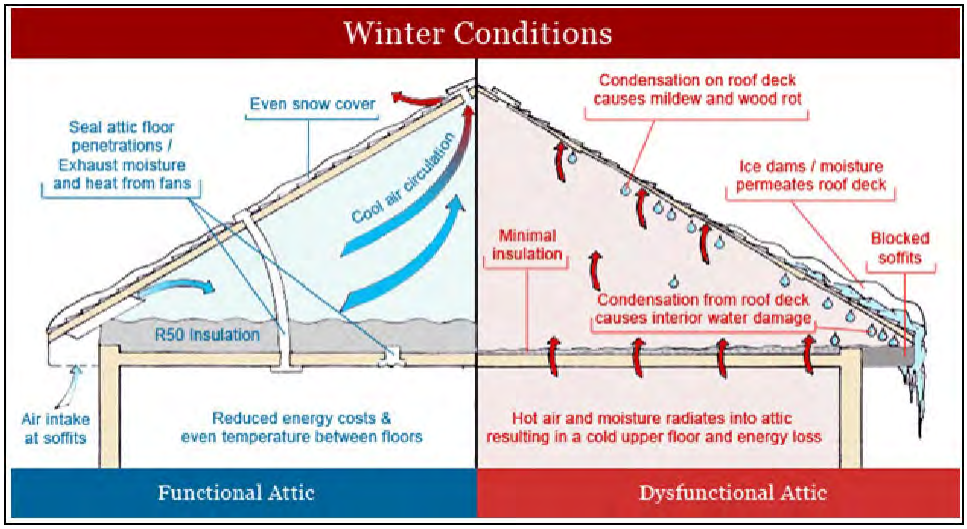


Figure 11. Diagram of Winter Attic Issues [CKSmithSuperior]

Utilities

For the alternatives of this project, plumbing must be addressed based on the proposed repurposing. For alternative one, the low modification commercial space option, plumbing can remain as-is. In alternative two, the moderate modification assisted living option, additional water sources for bathrooms are needed. This requires running additional plumbing lines that need to be run within the slab-on-grade foundation. This requires removing some of the concrete, installing the lines, then patching. This is necessary to provide water to the north side of the building to create additional bathrooms for residents. There also needs to be a smaller line run to the southern central part of the building to create a large bathroom for those residents. This can be seen in Figure 12. It is estimated that the amount of new plumbing lines needed is around 100 linear feet, but this was increased in regards to the probable cost estimate due to uncertainties.

For alternative three, the high modification, multi-use residential space, additional plumbing lines are planned to be run as well. This is done in order to provide water resources for each apartment within the building for bathrooms, kitchens, and laundry facilities. If this alternative were selected, appropriate water main sizing would need to be investigated. The location of proposed new plumbing lines can be seen in Figures 13. It was estimated that the amount added would be around 250 linear feet, but this was upsized in the probable cost estimate due to potential unforeseen conflicts.

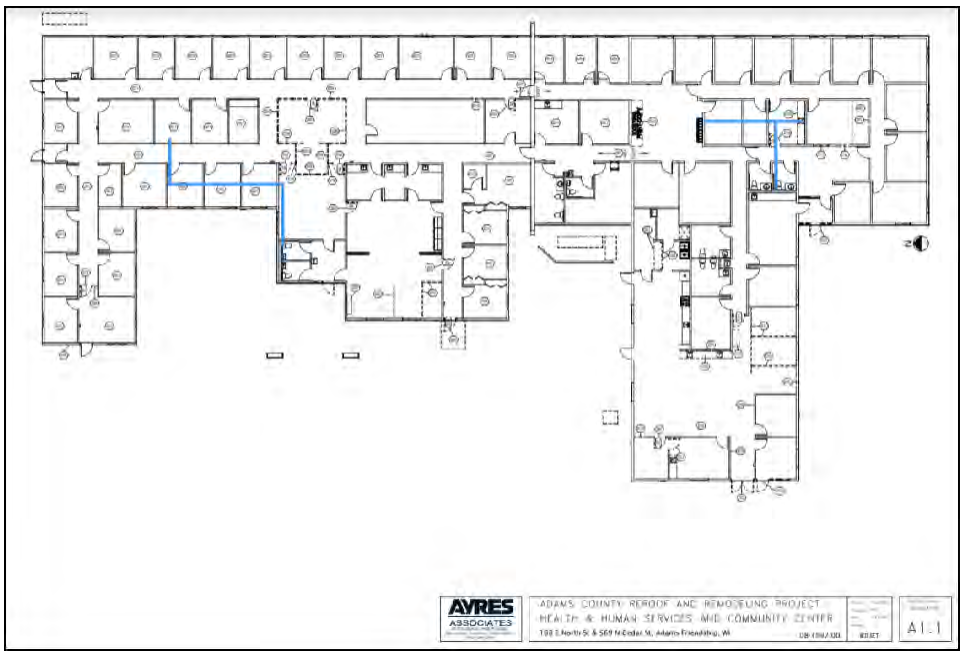


Figure 12. Proposed Plumbing Line Additions for Alternative 2

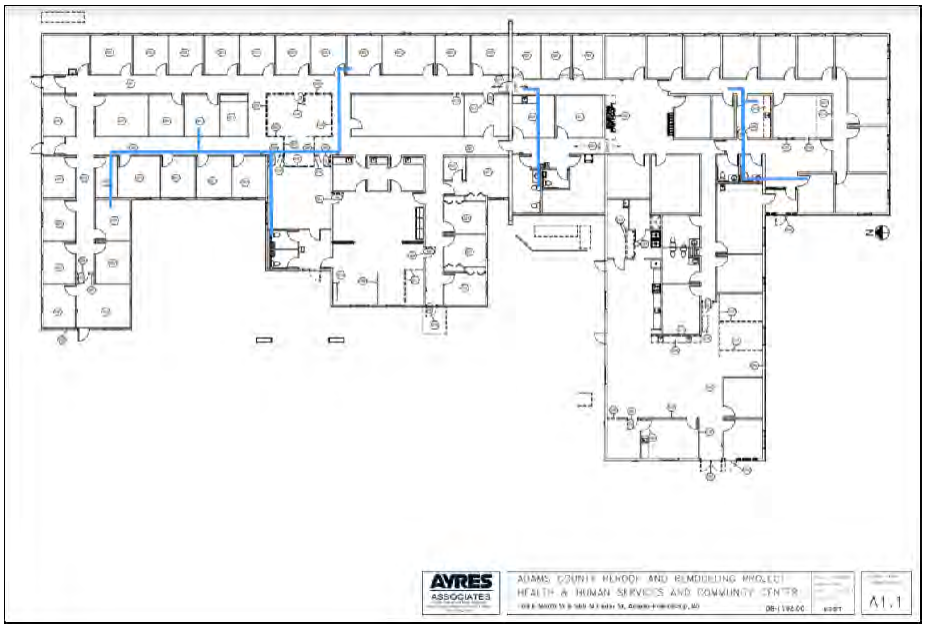


Figure 13. Proposed Plumbing Line Additions for Alternative 3

Geotechnical

The allowable bearing pressure on site was calculated to be approximately 3,550 psf. This value was determined based on the bearing pressure required to cause a total settlement of at least 1 inch, then divided by a factor of safety 2.0. Concrete shallow square foundations 6 feet wide and 5 feet deep were considered for this analysis. An example of shallow spread footing can be seen in Figure 14. The earth pressure coefficients were also calculated. Calculations were done with a factor of safety of 2.0. Deep foundations are not recommended as the water table level may fluctuate seasonally and compromise the effective stress of the surrounding strata, although there wasn't available evidence of this being a strong possibility. Deep foundations are also significantly more expensive to implement compared to shallow foundation systems.

Figure 14. Example of Shallow Spread Footings

The building currently rests on a slab-on grade foundation of unknown dimensions. It is likely that this foundation was used in response to a detailed preliminary investigation performed years before construction; however, there are two concerning issues that could affect its vitality, the first being frost depth and the second being soil corrosivity. The current foundation may rest within the frost depth range (4 ft bgs) and can be at risk to frost heave. Secondly, the surrounding soil was rated on WebSoilSurvey to have high potential to influence concrete corrosion due to its acidity, sodium, sulfate, and moisture contents. It is highly recommended that the foundations be checked and inspected before further renovation or construction commences.

Hydrologic

Along the existing 600 linear feet of ditches, the existing cross-section varies, but has an average of 18 ft^2, as shown in Figure 15 below. This results in a volumetric water storage capacity of 10,800 ft^3 across the site. The proposal for remediation would widen and deepen the ditch by 1 foot, while maintaining the existing slopes of 1:3 vertically on the foreslope, and 1:4 for the backslope. These standards are controlled by the Wisconsin DNR, and further slope guidelines for roadside ditches are outlined by the Wisconsin Department of Transportation. The lower grade on the backslope works as an effort to keep water away from the road (or in this case, parking lot). Further expansion would likely run the drainage ditch too close to the lot lines for the site boundary.

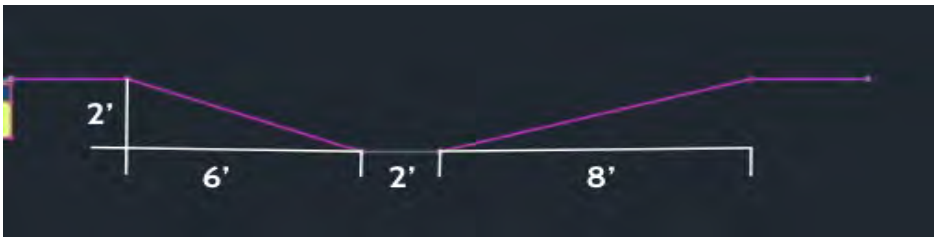


Figure 15. Existing Ditch Cross-section

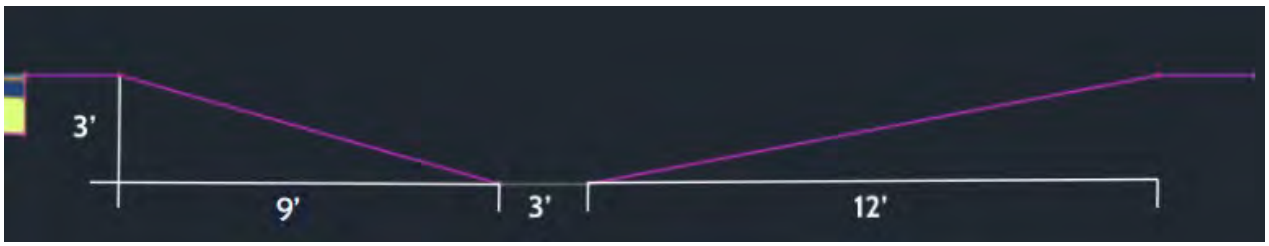


Figure 16. Proposed Ditch Expansion Cross-section

This proposed expansion (Figure 16) increases the cross-sectional area of the ditch from 18 ft^2 to 40.5 ft^2, bringing the total water storage across the site to 24,300 ft^3, a 125% increase from the existing conditions. Based on the Precipitation Depth-Duration-Frequency data from NOAA, this would characterize the site for a 10-year 6-hour storm, or equivalent (5-year 24-hour event covered). The doubling of on-site storage capacity should be able to abate year to year ponding issues as outlined by the Sheriff's Department. This earthworks project can be completed with a budget of $10,000 (Table 4) and is a straightforward and low-cost solution that is recommended alongside all three design alternatives.

Table 4. Drainage Ditch Expansion Cost Breakdown

	Quantity	Unit Cost	Total Cost
Labor	2.5 laborers, 1 week (100 labor-hrs)	$80 / hr.	$8,000
Machine Rental	1 Skid Steer 1 Dump Truck	$500 / wk.	$1,000
Contingency	~10%	---	$1,000
			$10,000

Alternative 1 - Low Modification

Construction

Construction for the commercial option would be less invasive relative to the other two options because it would apply to aesthetic updates and build out of specific retail options. For example, the building would be modified to accommodate a restaurant. Electrical and mechanical updates need to be adjusted for different building loads. This entails moving air ducts around as well as electrical lines. Overall, the construction timeline and budget is the lowest on this option and there is less unforeseen costs potential as this option is closest to its current use.

Structural

This alternative would have limited structural change to the existing building. On the north side of the building, walls would be removed to make room for a small lounge area. On the south side of the building, walls would also be removed by the south side entrance to make more room for a more spacious waiting area by the reception desk. The biggest changes involve the southwest side of the building where walls are being removed to clear space for a restaurant and dining area.

Alternative 2 - Medium Modification

Construction

The assisted living option would require significant building utility work such as rerouting electricity and HVAC. Each room is to be given a PTAC (Packaged Terminal Air Conditioner) so that each resident has control over the temperature in their room whether it be for heating or cooling purposes. This option also requires updates which account for the majority of the costs and timeline.

Structural

This alternative would remove a moderate number of walls. The existing office space in the HHS building would be converted into living spaces. To do this, every other wall that divides the offices would need to be removed. In turn this would make the living areas twice as large as they currently are. On the southwest side of the building, many rooms can remain intact, but some walls would be removed to make room for a 2000 ft^2 dining area.

Alternative 3 - High Modification

Construction

This option is the most construction intensive option as the entire building would be redone to serve a new purpose. The largest concern with this option is updating building utilities such as electrical, HVAC, etc, according to residential codes rather than commercial building codes. It is also an unique situation in that there is both a restaurant and gym attached.

Structural

The highest modification plan would require more substantial changes to the structural layout of the building. To make room for full sized apartments (ranging from 500-1200 ft^2), the walls would need to be reconfigured and additionally existing hallways would have to be made into apartment walls. Due to these changes, extensive interior work would be needed relating to the existing walls. These changes would happen around the outer border of the building where all of the existing offices are. Again, on the southwest side of the building, changes would be made to turn this space into two restaurants. Walls can be cleared out to make room for dining space for both restaurants. To split the two restaurants, additional partitions are to be added to separate them. This alternative would require the most extensive changes to the existing structural layout of the building, however it is important to note that none of these walls would be load bearing, which would keep these costs low.

8.0 Opinion of Probable Cost

An opinion of probable costs and an estimation of costs were prepared for the three alternatives detailed above. This estimate is based on current data and industry estimates which does introduce a level of uncertainty. The level of uncertainty associated with these estimates decreases as more information becomes available and site conditions are verified. Additional information on cost calculations can be found in the Appendix. Fees are allocated within the price for inflation based on project start date, contingency, the previously agreed upon design fee, and site services. These are necessary projections that encompass the managerial costs of design and construction of this project.

Capital Costs

Capital costs were primarily estimated using RSMeans data from the RSMeans Square Foot Costs 31st Edition (2010). This data was then adjusted to account for inflation between the years of 2010 and 2021. Other sources included previous bids and mentor experience. The estimates were broken down into general costs, MEP, finishes, equipment, and other. The other category included fees, contingency, and inflation.

The chosen alternative was projected to be under the four million dollar budget for this project. The four million dollar budget would include design and construction costs, but not the value of the current site as a purchase price. That cost will be determined between a developer and the county and was not included in the estimations.

A contingency of 20% was used for this estimation process as that is considered the contingency for both the rest of the design process and construction process. In summary, the estimated project costs for Alternative 1, the commercial space, is approximately $3.0 million, for Alternative 2, the assisted living facility, $3.2 million, and finally for Alternative 3, the apartment option, $3.8 million.

Operation & Maintenance Costs

Operation and maintenance (O&M) costs were based on research and comparable scenarios. The O&M costs were significantly less for alternatives 1 and 3 while alternative 2 had a considerably larger value due to the nature of providing some limited medical services and more involved cleaning services. Table 5 summarizes the operation and maintenance costs for each alternative.

Salvage Value

Salvage value is the book value of an asset after depreciation has taken place over time. For this particular project, the depreciation value of a building was found using “Civil and Environmental Systems Engineering” [C.S. ReVelle]. For a non-residential building, as is the case with alternatives 1 and 2, the lifetime is considered to be around 40 years which results in a salvage value of around 25% of the original value for a lifetime of 30 years. For alternative 3, residential

properties are considered to have a lifetime of around 30 years, which means that it would be fully depreciated at that time.

Payback Period

Payback period is defined as the amount of time it takes to recover the cost of an investment. Equation 3 (in Appendix) states that the payback period is the capital cost divided by the annual net benefits of the project. Alternative 2 had the lowest payback period at 7.73 years, Alternative 1 had a payback period of 8.42 years, and Alternative 3 had the longest payback period at 24.2 years. This is summarized in Table 6 below. These values were consistent with research in that it is not unusual for apartment buildings to have a longer payback period.

Life Cycle Cost

Life cycle cost is another way to create comparisons between alternatives. This estimates the cost of a building over its lifetime. Equations 1-2 for life cycle costs can be found in the Appendix. Life cycle cost is a way to compare the costs associated with a project over time and includes the initial capital costs, annual costs, and salvage value. It does not account for the benefits that come from each option. This is why Alternative 2, the assisted living option, has the shortest payback period, but the highest life cycle cost.

Annual Benefits

Annual benefits, also known as revenue, is listed in Table 6 for each of the alternatives. These values were obtained using square foot estimates. For the low modification alternative, office space is rented at about $2/square foot/month, while restaurant space is around $3/square foot/month [Facility Costs]. The medium modification alternative, the assisted living facility, had 13 rooms available. In Wisconsin, the average assisted living cost per year per person is $47,205 [S. Witt]. Finally, for the high modification option, the apartment option, rent was figured according to area averages. This alternative would include 10 apartments: one studio apartment, five one-bedrooms, and four two-bedroom apartments. These are rented for around $600, $700, and $850 respectively [QuickFacts Adams County, Wisconsin]. The rent for restaurant and gym spaces is also included.

Table 5. Summary of Capital Costs for the Project

Costs	Alternative 1: Low Mod	Alternative 2: Medium Mod	Alternative 3: High Mod
Consulting	$200,000	$200,000	$200,000
Construction	$2.20 million	$2.34 million	$2.80 million
Contigency (20%)	$440,000	$468,000	$560,000
Fees	$170,000	$180,000	$215,000

Table 6: Summary of Probable Cost Analysis

Costs	Alternative 1: Low Mod	Alternative 2: Medium Mod	Alternative 3: High Mod
Capital Cost	$3 million	$3.2 million	$3.8 million
Operation and Maintenance	$96,000	$200,000	$65,000
Annual Benefits	$451,000	$614,000	$222,000
Salvage Value	$750,000	$800,000	$0
Life Cycle Cost	$4,572,600	$6,790,400	$5,074,000
Payback Period (years)	8.45	7.73	24.2
Lifetime (years)	30	30	30

9.0 Final Recommendation

The three design alternatives were assessed across three major categories: cost, construction and community need. Weighting for each performance criterion was determined based on the engineering team's professional insight and the feedback from Adams County Grounds and Economic Development Departments. The factors in Table 1 range from 1-3 with the lowest factor (1) attributed to the best performing alternative for each itemized criteria.

The medium modification (Retirement Community - low assist living) received the lowest score of 1.8 and high modification (Multi-use Residential) received the highest score of 2.15. Based on the insight provided by the engineers at Castle Rock Consultants and the decision matrix outlined in Table 1, the final design recommendation is to have the existing Health and Human Services Building repurposed into a low-assist Retirement Community (Medium Modification - Alternative 2). This medium modification alternative would keep both cost and community in mind, with a short payback period and ability to meet the needs of the aging community.

Comparatively, this retirement community option was top ranked in the categories of annual income, payback period, sustainability, and space limitations. Though it ranked poorly in the categories of life cycle and capital costs, the significant profitability of this kind of community is shown in the payback period and annual income, superseding the other financial concerns.

Socially, this redesign option serves the unmet needs of the senior population and therefore ranks relatively well in the community needs categories as well. Within a 0.2 mile radius of the proposed retirement center is the community's grocery market, a local park, and two convenience stores. These surrounding facilities would further serve to benefit future retirement residents.

Table 1. Weighted Decision Matrix (revisited)

Performance Criteria	Weight	1: Low Modification	Weighted Score	2: Medium Modification	Weighted Score	3: High Modification	Weighted Score
Cost							
Annual Income	0.10	2	0.20	1	0.10	3	0.30
O&M Cost	0.10	2	0.20	3	0.30	1	0.10
Payback Period	0.10	2	0.20	1	0.10	3	0.30
Capital Costs	0.20	1	0.20	2	0.40	3	0.60
Life Cycle Costs	0.20	1	0.20	3	0.60	2	0.40
Construction							
Space Limitations/Accessibility	0.10	3	0.30	1	0.10	2	0.20
Structural Efficiency	0.10	1	0.10	2	0.20	3	0.30
Sustainability	0.05	3	0.15	1	0.05	1	0.05
Community Need							
Economic Development	0.05	1	0.05	2	0.10	3	0.15
Residential Amenities	0.05	3	0.15	2	0.10	1	0.05
Total	1.00	**Total Score**	1.6	**Total Score**	2	**Total Score**	2.4

10.0 Project Schedule

The Gantt Chart for design and construction of the HHS facility is included as Figure 18 in the appendix.

The Gantt charts includes a detailed timeline of completed and upcoming tasks necessary for design and construction services. The preliminary and final design phases are planned to be complete by 04/30/2021.

Permitting included in the final design phase is scheduled to commence on May 1, 2021. Construction is expected to last from October 16th 2021 through August 1st 2022, approximately 10 months.

11.0 Sustainability Assessment

Economic

Local

As previously stated, the burden of the building cost will fall on the local community unless the county is able to secure federally or state funding prior to selling to a developer. The retirement community design is the most costly of the three alternatives proposed in life cycle and operations and maintenance costs. However, this is compensated by the comparatively shorter payback period of 7.73 years and high annual income the facility would provide.

National/Global

On a national and global level, this repurposing can be looked to as an example of how to revitalize the economy of small town communities. Being aware of and playing into the needs of a community allows for its economic growth in the long term. For this particular repurposing, this meant working with town officials to recognize the aged population could be better provided for and proposing an alternative that was costly in the short term but allowed for rapid future benefits. Proposing similar sustainability minded designs in this way on a larger scale, would ultimately allow for heightened growth and create a balance between taxpayer buy in and community profit.

The Garver Feed Mill Renovation located in Madison, Wisconsin and completed in 2019, is a prime example of this. The mill, once a sugar factory turned feed mill, is now redeveloped as an event and eatery space. This facility now serves to benefit the growing small business community developing in the area. The Adams County Health and Human Services remodel would look to fill a similar community need and to create a positive community impact.

Environmental

Local

The Human and Health Services Building is located in a rural commercialized area, bordered by residential homes, correctional facilities, middle and high schools, and heavy forestry. The latter is frequented by deer and local wildlife and as such efforts will be made during the construction phase to preserve the existing ecosystem. In particular, this residential community alternative has a lifetime of 30 years which indicates the environmental concerns listed above will be realized every 30 or so years.

National/Global

Beyond the local community or state level, environmentally this design has small scale impacts. This redesign can serve as an example for future construction projects in small town areas with similar constraints. Taking the ecosystem of wildlife such as deer in consideration nationwide can be a means of actively promoting conservation and preservation practices in the industries known for their destruction.

Social

Local

Social sustainability is integral when performing construction services in small town communities like that of Adams and Friendship. Construction and operation phases may result in localized disturbances and pollution. As previously mentioned, for this reason it is important to restrict disruptive work to non-school hours so as not to disturb the surrounding Adams-Friendship School District/High School. Construction hours often overlap school hours, since work is done during daytime hours. Therefore, it is recommended for sound barriers to be installed and for site activities to be limited to 100 decibels.

Equally important is maintaining acceptable road conditions throughout the construction phase. This works to reduce the disruption to the community. With it being such a small town, reducing the number of road closures on adjacent roads like Main Street and East North Street is critical. Rerouting large vehicles along these main roads is also notable.

National/Global

On a larger scale, social sustainability implemented in this way can be a lesson to take forward into projects on national and global scales. Regardless of location, working around existing facilities and environments poses a constraint on the construction work conducted in these congested areas. Construction noise and traffic disturbances are often the source of community complaints and as such it is necessary to keep the community involved as these changes are being proposed. To mitigate the political and communal backlash that often comes with introducing the building of new facilities, it is important to come to an agreement with local officials and residents. This can be achieved through community forums where the course of action can be discussed.

12.0 Design Uncertainties

Data Based

Some of the uncertainties in the design stem from a lack of available data and information that would have supplemented the analyses. The client was only able to provide floor plans and was not able to provide structural plans for the Health and Human Services Building. This made it difficult to determine the structural load bearing walls from the floor plans alone. Engineering judgment and mentor guidance were used to assume the location of these walls and then appropriately predict the structural layout of the building. However, this uncertainty is supplemented by the knowledge of which walls are load and non-load bearing. No load bearing walls would be removed. This would aid with construction and serve as a cost saving measure.

There is uncertainty with regards to the present geology on site due to lack of access to the actual SPT borings drilled on site. There are no records of logs that show that borings were drilled on site. Without these logs, the underlying geology was interpreted using boring logs from another site in Wisconsin and WebSoil Survey. WebSoil Survey was able to confirm that the soil underneath the Health and Human Services building was in fact loamy sand. The boring logs examined for the site were provided as a reference by UW-Madison and showed soil layers similar to what would be expected on site. Those boring logs were used to supplement the geotechnical analysis and foundation recommendations. Nevertheless, if boring holes were drilled on site, this interpretation would closely mirror what is found.

Further uncertainty from lack of data came on the hydrologic side of the project. Offsite water has been reported to be backing up onto the lot, compounding the ponding concerns. This is due to the low relative elevation of the site, and is indicative of an overwhelmed or lacking water management plan for the wider area. Proposed hydrologic intervention was proposed based on designing for known data and managing onsite water. Additional data could change the water storage necessary on the lot. However, the ditch expansion would more than double onsite storage capacity and should more than compensate for the amount of water reported as ponding on the parking lot.

Knowledge Based

The design alternatives were heavily influenced by specific needs and demands of the community. There was no outspoken demand for new business space yet the team decided to consider the prospect of commercial office space in order to stay consistent with the legacy of the Health and Human Services building.

Knowledge of the community was supplemented by meeting with the county's Executive Director of Economic Development, Daric Smith. Smith was able to comment on the economic

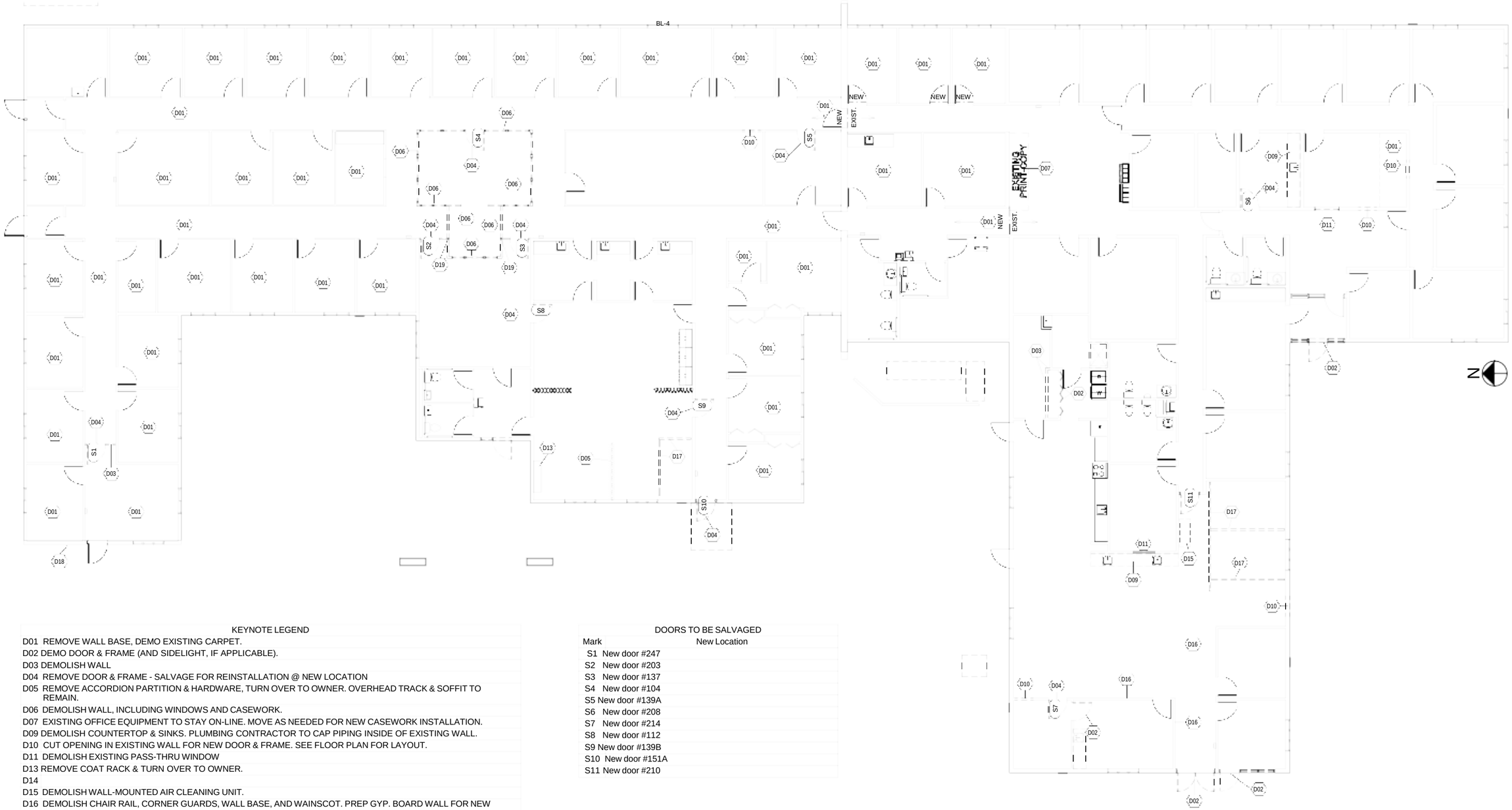
viability of different project potentials and provided a deeper understanding of the economic status of the county and its residents. In addition to this, Smith primarily outlined housing as a major community need.

The example Smith cited for this was that while 30 new teachers were hired by the Adams County School District since 2018, only two reside within the county while the rest commute. This is a result of a lack of available market rate housing. Many of the community's senior residents are not leaving their existing homes that they have occupied for over 30 years, meaning that the existing stock of homes in the area sees little turnover. Despite utilizing these community resources, there was still little information about specific demands (specifically for business and office space rentals). In the end, this meant the design alternatives were generated based on generalities and assumptions consistent with other smaller, rural communities in the state.

Closing

Castle Rock Consultants is grateful for the opportunity to work with the Adams County Grounds Department in contributing a socially enhancing and economically profitable final design. The final recommendation made in this report by Castle Rock Consultants takes into consideration the analysis summarized above, in order to provide the Grounds Department with feasible alternatives to sell to interested developers at a later date.

APPENDICES



KEYNOTE LEGEND
D01 REMOVE WALL BASE, DEMO EXISTING CARPET.
D02 DEMO DOOR & FRAME (AND SIDELIGHT, IF APPLICABLE).
D03 DEMOLISH WALL
D04 REMOVE DOOR & FRAME - SALVAGE FOR REINSTALLATION @ NEW LOCATION
D05 REMOVE ACCORDION PARTITION & HARDWARE, TURN OVER TO OWNER. OVERHEAD TRACK & SOFFIT TO REMAIN.
D06 DEMOLISH WALL, INCLUDING WINDOWS AND CASEWORK.
D07 EXISTING OFFICE EQUIPMENT TO STAY ON-LINE. MOVE AS NEEDED FOR NEW CASEWORK INSTALLATION.
D09 DEMOLISH COUNTERTOP & SINKS. PLUMBING CONTRACTOR TO CAP PIPING INSIDE OF EXISTING WALL.
D10 CUT OPENING IN EXISTING WALL FOR NEW DOOR & FRAME. SEE FLOOR PLAN FOR LAYOUT.
D11 DEMOLISH EXISTING PASS-THRU WINDOW
D13 REMOVE COAT RACK & TURN OVER TO OWNER.
D14
D15 DEMOLISH WALL-MOUNTED AIR CLEANING UNIT.
D16 DEMOLISH CHAIR RAIL, CORNER GUARDS, WALL BASE, AND WAINSCOT. PREP GYP. BOARD WALL FOR NEW PAINT.
D17 DISASSEMBLE PARTITION WALLS AND TURN OVER TO OWNER
D18 REMOVE WALL-MOUNTED LETTERING "VETERAN SERVICES".
D19 STRUCTURAL COLUMN - REMOVE AND REPLACE PER STRUCTURAL

DOORS TO BE SALVAGED	
Mark	New Location
S1	New door #247
S2	New door #203
S3	New door #137
S4	New door #104
S5	New door #139A
S6	New door #208
S7	New door #214
S8	New door #112
S9	New door #139B
S10	New door #151A
S11	New door #210

1/8" = 1'-0"

4/27/2011 10:01:20 AM,EC5001\arccad\PROJECTS\08159200 Adams Co HHS remodel - reroof\DWG\Adams Co HHS.rvt

AYRES ASSOCIATES
3433 Oakwood Hills Parkway
Eau Claire, Wisconsin 54701-7698
(715) 834-3161

ADAMS COUNTY REROOF AND REMODELING PROJECT
HEALTH & HUMAN SERVICES AND COMMUNITY CENTER

108 E.North St & 569 N.Cedar St, Adams-Friendship, WI

08-1592.00

Drawn : P.GORDON
Checked : MJB
Date : 4/22/2011
Revised : -
BID SET

FLOOR PLAN - DEMOLITION

A1.1

Rainfall Data

Table 7. Tabular Precipitation Frequency Estimates [NOAA Climate Data]

PDS-based precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.352** (0.302-0.420)	**0.406** (0.348-0.485)	**0.500** (0.427-0.598)	**0.583** (0.496-0.700)	**0.705** (0.583-0.874)	**0.805** (0.649-1.00)	**0.910** (0.708-1.16)	**1.02** (0.762-1.32)	**1.18** (0.845-1.56)	**1.30** (0.907-1.73)
10-min	**0.515** (0.442-0.615)	**0.594** (0.510-0.710)	**0.732** (0.626-0.876)	**0.853** (0.726-1.02)	**1.03** (0.853-1.28)	**1.18** (0.950-1.47)	**1.33** (1.04-1.69)	**1.50** (1.12-1.94)	**1.73** (1.24-2.28)	**1.91** (1.33-2.54)
15-min	**0.628** (0.539-0.750)	**0.724** (0.622-0.866)	**0.892** (0.763-1.07)	**1.04** (0.885-1.25)	**1.26** (1.04-1.56)	**1.44** (1.16-1.80)	**1.63** (1.26-2.07)	**1.83** (1.36-2.36)	**2.11** (1.51-2.78)	**2.33** (1.62-3.09)
30-min	**0.849** (0.730-1.01)	**0.989** (0.848-1.18)	**1.23** (1.05-1.47)	**1.44** (1.22-1.73)	**1.75** (1.44-2.16)	**2.00** (1.61-2.49)	**2.26** (1.76-2.87)	**2.54** (1.89-3.29)	**2.92** (2.10-3.86)	**3.23** (2.25-4.29)
60-min	**1.07** (0.919-1.28)	**1.26** (1.08-1.51)	**1.60** (1.37-1.92)	**1.91** (1.63-2.30)	**2.38** (1.97-2.96)	**2.77** (2.23-3.47)	**3.18** (2.48-4.06)	**3.63** (2.72-4.72)	**4.27** (3.07-5.66)	**4.79** (3.33-6.36)
2-hr	**1.29** (1.11-1.53)	**1.53** (1.32-1.82)	**1.98** (1.70-2.35)	**2.38** (2.04-2.84)	**3.01** (2.52-3.74)	**3.54** (2.88-4.42)	**4.11** (3.23-5.22)	**4.73** (3.56-6.12)	**5.62** (4.07-7.40)	**6.34** (4.45-8.37)
3-hr	**1.43** (1.24-1.69)	**1.71** (1.48-2.02)	**2.21** (1.91-2.62)	**2.69** (2.31-3.20)	**3.44** (2.90-4.28)	**4.08** (3.34-5.10)	**4.79** (3.78-6.08)	**5.57** (4.22-7.19)	**6.69** (4.87-8.79)	**7.61** (5.36-10.0)
6-hr	**1.73** (1.50-2.03)	**2.02** (1.75-2.37)	**2.58** (2.24-3.03)	**3.13** (2.70-3.69)	**4.01** (3.41-4.98)	**4.79** (3.95-5.96)	**5.65** (4.50-7.15)	**6.62** (5.06-8.51)	**8.03** (5.89-10.5)	**9.20** (6.53-12.0)
12-hr	**2.06** (1.80-2.40)	**2.35** (2.06-2.74)	**2.92** (2.55-3.41)	**3.48** (3.01-4.07)	**4.36** (3.73-5.36)	**5.14** (4.27-6.34)	**6.01** (4.82-7.53)	**6.97** (5.36-8.89)	**8.38** (6.19-10.9)	**9.54** (6.82-12.4)
24-hr	**2.42** (2.13-2.80)	**2.71** (2.38-3.13)	**3.27** (2.87-3.79)	**3.83** (3.34-4.45)	**4.72** (4.06-5.76)	**5.52** (4.61-6.75)	**6.40** (5.17-7.96)	**7.39** (5.73-9.36)	**8.84** (6.59-11.4)	**10.0** (7.24-12.9)
2-day	**2.71** (2.40-3.11)	**3.10** (2.74-3.56)	**3.81** (3.35-4.38)	**4.47** (3.92-5.16)	**5.49** (4.72-6.59)	**6.36** (5.32-7.68)	**7.30** (5.91-8.97)	**8.33** (6.48-10.4)	**9.82** (7.35-12.5)	**11.0** (8.01-14.1)
3-day	**2.96** (2.63-3.39)	**3.39** (3.01-3.88)	**4.17** (3.68-4.78)	**4.88** (4.29-5.61)	**5.97** (5.14-7.13)	**6.88** (5.78-8.27)	**7.87** (6.39-9.62)	**8.95** (6.99-11.1)	**10.5** (7.88-13.3)	**11.7** (8.56-14.9)
4-day	**3.20** (2.85-3.65)	**3.65** (3.25-4.17)	**4.47** (3.96-5.10)	**5.21** (4.59-5.97)	**6.34** (5.47-7.54)	**7.29** (6.13-8.72)	**8.30** (6.76-10.1)	**9.41** (7.36-11.7)	**11.0** (8.28-13.9)	**12.3** (8.97-15.6)
7-day	**3.82** (3.42-4.33)	**4.33** (3.87-4.91)	**5.23** (4.66-5.95)	**6.04** (5.35-6.88)	**7.25** (6.27-8.54)	**8.25** (6.96-9.79)	**9.31** (7.61-11.2)	**10.5** (8.22-12.9)	**12.1** (9.15-15.1)	**13.4** (9.84-16.9)
10-day	**4.38** (3.93-4.94)	**4.93** (4.42-5.57)	**5.90** (5.27-6.68)	**6.76** (6.00-7.67)	**8.02** (6.94-9.38)	**9.05** (7.66-10.7)	**10.1** (8.31-12.2)	**11.3** (8.92-13.8)	**12.9** (9.83-16.1)	**14.2** (10.5-17.9)
20-day	**5.97** (5.38-6.69)	**6.65** (5.98-7.45)	**7.79** (6.99-8.75)	**8.78** (7.84-9.89)	**10.2** (8.85-11.8)	**11.3** (9.63-13.2)	**12.5** (10.3-14.8)	**13.7** (10.9-16.6)	**15.4** (11.8-19.0)	**16.7** (12.5-20.9)
30-day	**7.31** (6.61-8.15)	**8.11** (7.33-9.05)	**9.45** (8.50-10.6)	**10.6** (9.47-11.9)	**12.2** (10.6-13.9)	**13.4** (11.4-15.5)	**14.7** (12.1-17.3)	**16.0** (12.7-19.2)	**17.7** (13.6-21.8)	**19.1** (14.3-23.7)
45-day	**9.02** (8.18-10.0)	**10.0** (9.08-11.1)	**11.7** (10.5-13.0)	**13.0** (11.7-14.5)	**14.9** (12.9-16.9)	**16.3** (13.9-18.7)	**17.7** (14.6-20.7)	**19.1** (15.2-22.8)	**21.0** (16.2-25.6)	**22.4** (16.8-27.7)
60-day	**10.5** (9.54-11.6)	**11.7** (10.6-13.0)	**13.6** (12.3-15.1)	**15.2** (13.7-16.9)	**17.3** (15.1-19.6)	**18.9** (16.2-21.7)	**20.5** (17.0-23.9)	**22.0** (17.6-26.2)	**24.0** (18.5-29.2)	**25.5** (19.2-31.4)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Table 8. Alternative 1 - Cost Table

Alternative 1: Varied Commercial Use					
Item	**Approx. Qty**	**Units**	**Unit Price**	**Total Cost**	**Reference**
General Costs					
Mobilization	1	each	$50,000	$50,000	Previous bid
Permitting	17200	sq. ft	$0.23	$3,900	Adams County Planning and Zoning
Zoning Inspections	1	each	$100.00	$100	Adams County Planning and Zoning
Erosion Permit	1	-	$50.00	$100	Adams County Planning and Zoning
Final Inspections	12	each	$50.00	$600	Mentor
In wall Inspections	12	each	$50.00	$600	Mentor
Below Grade Inspections	4	each	$50.00	$200	Mentor
Drainage Work Allowance	1			$10,000	Based on one week of labor with 2.5 people and one skid steer
Demolition	17200	sq. ft	$7.00	$120,400	Mentor
Sound Insulation	34400	sq. ft	$3.28	$112,800	RS Means Square Foot Costs 31st Edition (2010)
Roofing	19264	sq. ft	$5.50	$106,000	Mentor
Roof Insulation (Blown)	19264	sq. ft	$0.98	$18,900	RS Means Square Foot Costs 31st Edition (2010)
MEP					
Plumbing					
Offices	14035	sq. ft	$7.76	$108,900	RS Means Square Foot Costs 31st Edition (2010)
Restaurants	3165	sq. ft	$16.71	$52,900	RS Means Square Foot Costs 31st Edition (2010)
HVAC					
Offices	14035	sq. ft	$23.28	$326,700	RS Means Square Foot Costs 31st Edition (2010)
Restaurant	3165	sq. ft	$39.76	$125,800	RS Means Square Foot Costs 31st Edition (2010)
Fire Protection					
Offices	14035	sq. ft	$5.28	$74,100	RS Means Square Foot Costs 31st Edition (2010)
Restaurants	3165	sq. ft	$7.91	$25,000	RS Means Square Foot Costs 31st Edition (2010)
Electrical					
Offices	14035	sq. ft	$30.98	$434,800	RS Means Square Foot Costs 31st Edition (2010)
Restaurants	3165	sq. ft	$20.65	$65,400	RS Means Square Foot Costs 31st Edition (2010)
Finishes					
Offices	14035	sq. ft	$30.22	$424,100	RS Means Square Foot Costs 31st Edition (2010)
Restaurants	3165	sq. ft	$27.85	$88,100	RS Means Square Foot Costs 31st Edition (2010)
Equipment					
Offices	1	each	$20,275	$20,300	RS Means Square Foot Costs 31st Edition (2010)
Restaurant (Large)	1	restaurant	$31,246	$31,200	RS Means Square Foot Costs 31st Edition (2010)

	Sub Total:				$2,200,900	
	Other					
	Design Fee				$200,000	From Proposal
	Contigency (20%)				$440,200	Design Phase Contigency
	Inflation (3.5%)				$77,000	Mentor
	Site Services				$5,500	Previous Bid
	Construction Fee (3%)				$87,700	Mentor
	Grand Total:				$3,011,300	

Table 9. Alternative 2 - Cost Table

Alternative 2: Retirement Community					
Item	**Approx. Qty**	**Units**	**Unit Price**	**Total Cost**	**Reference**
General Costs					
Mobilization	1	each	$50,000.00	$50,000	Previous bid
Permitting	17200	sq. ft	$0.23	$3,900	Adams County Planning and Zoning
Zoning Inspections	1	each	$100.00	$100	Adams County Planning and Zoning
Erosion Permit	1	-	$50.00	$100	Adams County Planning and Zoning
Final Inspections	12	each	$50.00	$600	Mentor
In wall Inspections	12	each	$50.00	$600	Mentor
Below Grade Inspections	4	each	$50.00	$200	Mentor
Drainage Work Allowance	1	-	-	$10,000	Based on one week of labor with 2.5 people and one skid steer
Demolition	17200	sq. ft	$7.00	$120,400	Mentor
Sound Insulation	51600	sq. ft	$3.28	$169,200	RS Means Square Foot Costs 31st Edition (2010)
Relocation of Plumbing Allowance	200	lf	$200.00	$40,000	[2021 Sewer Line Replacement & Repair Costs]
Relocation of Sewer Lines	200	lf	$200.00	$40,000	[2021 Sewer Line Replacement & Repair Costs]
Resizing of Utilities Allowance	1			$15,000	[R. Womeldorf and G. Evans]
Concrete Saw Cutting	200	lf	$8.00	$1,600	[How Much Does Saw Cutting Concrete Cost?]
Replacing HVAC Equipment	4202	sq. ft	$8.00	$33,600	[2021 HVAC System Costs]
Patch Concrete Slab	200	sq. ft	$6.00	$1,200	[2021 Concrete Slab Costs: Cost To Pour]
Roofing	19264	sq. ft	$5.50	$106,000	Mentor
Roof Insulation (Blown)	19264	sq. ft	$0.98	$18,900	RS Means Square Foot Costs 31st Edition (2010)
Roof Insulation (Sheets	19264	sq. ft	$1.55	$29,900	RS Means Square Foot Costs 31st Edition (2010)
MEP					
Plumbing					
Nursing Home	15815	sq. ft	$17.88	$282,800	RS Means Square Foot Costs 31st Edition (2010)
HVAC					
Nursing Home	15815	sq. ft	$17.52	$277,100	RS Means Square Foot Costs 31st Edition (2010)
Fire Protection					
Nursing Home	15815	sq. ft	$6.83	$108,000	RS Means Square Foot Costs 31st Edition (2010)
Electrical					
Nursing Home	15815	sq. ft	$15.19	$240,200	RS Means Square Foot Costs 31st Edition (2010)
Finishes					
Nursing Home	15815	sq. ft	$28.64	$452,900	RS Means Square Foot Costs 31st Edition (2010)
Room Changes					
New Kitchen	690	sq. ft	$150.00	$103,500	[Kitchen Remodel Cost Guide and Calculator for 2021]
New bathrooms	695	sq. ft	$300.00	$208,500	[Learn about the cost of projects in the Bathrooms category.]
Equipment					

	Nursing Home	13	rooms	$2,000	$26,000	RS Means Square Foot Costs 31st Edition (2010)
	Kitchens	2	each	$31,246	$62,500	RS Means Square Foot Costs 31st Edition (2010)
	Sub Total:				$2,340,300	
	Other					
	Design Fee				$200,000	From Proposal
	Contigency (20%)				$468,100	Design Phase Contigency
	Inflation (3.5%/year)				$81,900	Mentor
	Site Services				$5,900	Previous Bid
	Construction Fee (3%)				$92,900	Mentor
	Grand Total:				$3,189,100	

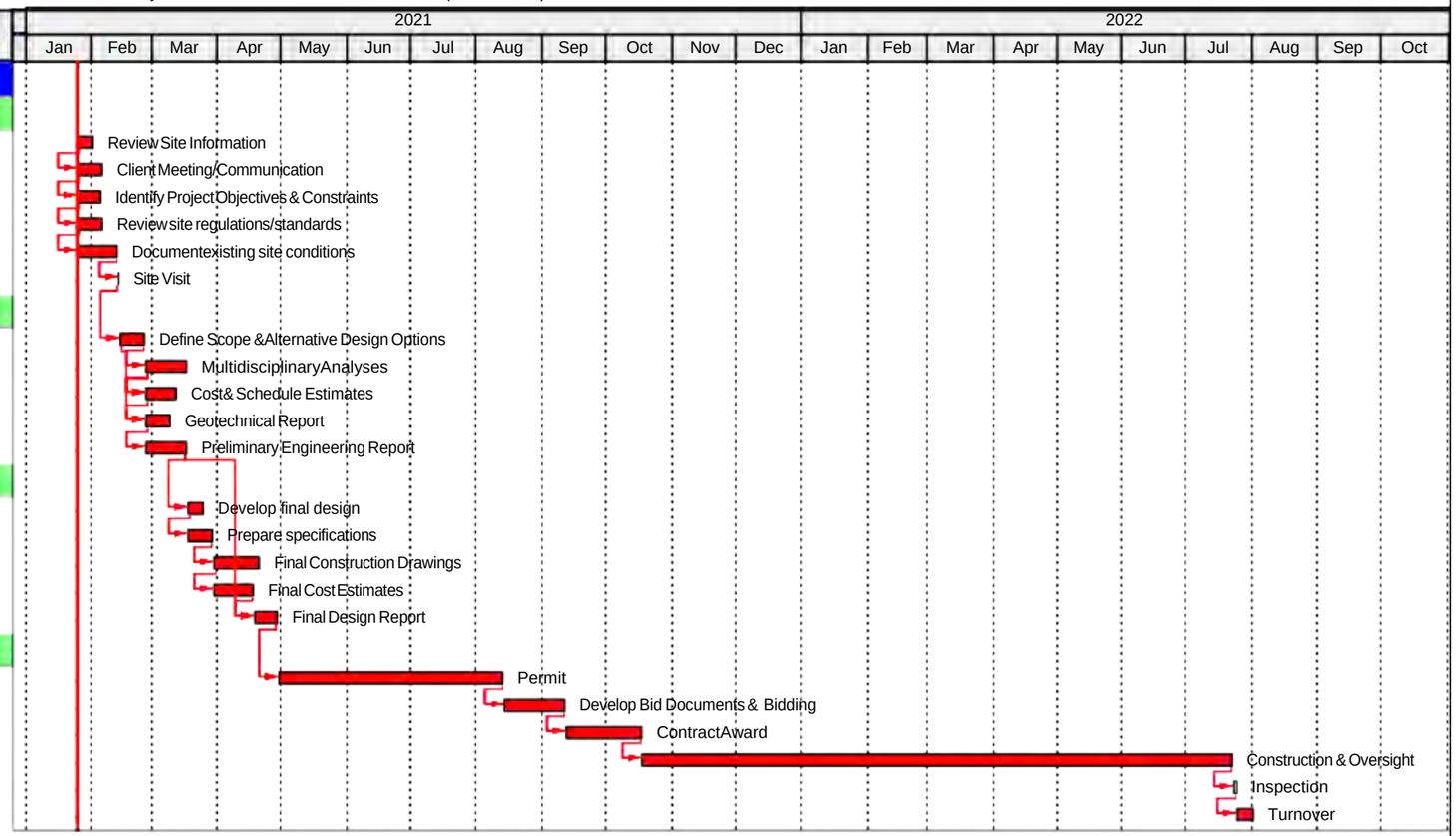
Table 10. Alternative 3 - Cost Table

Alternative 3: Multi-Use Residential					
Item	**Approx. Qty**	**Units**	**Unit Price**	**Total Cost**	**Reference**
General Costs					
Mobilization	1	each	$50,000.00	$50,000	Previous bid
Permitting	17200	sq. ft	$0.23	$3,900	Adams County Planning and Zoning
Zoning Inspections	1	each	$100.00	$100	Adams County Planning and Zoning
Erosion Permit	1	-	$50.00	$100	Adams County Planning and Zoning
Final Inspections	12	each	$50.00	$600	Mentor
In wall Inspections	12	each	$50.00	$600	Mentor
Below Grade Inspections	4	each	$50.00	$200	Mentor
Drainage Work Allowance	1	-	-	$10,000	Based on one week of labor with 2.5 people and one skid steer
Demolition	17200	sq. ft	$7.00	$120,400	Mentor
Sound Insulation	51600	sq. ft	$3.28	$169,200	RS Means Square Foot Costs 31st Edition (2010)
Relocation of Plumbing	375	lf	$200.00	$75,000	[2021 Sewer Line Replacement & Repair Costs]
Relocation of Sewer Lines	375	lf	$200.00	$75,000	[2021 Sewer Line Replacement & Repair Costs]
Resizing of Utilities Allowance	1			$50,000	[R. Womeldorf and G. Evans]
Concrete Saw Cutting	375	lf	$8.00	$3,000	[How Much Does Saw Cutting Concrete Cost?]
Patch Concrete Slab	375	sq. ft	$6.00	$2,250	[2021 Concrete Slab Costs: Cost To Pour]
Replacing HVAC Equipment for Apartment Style	17200	sq. ft	$8.00	$137,600	[2021 HVAC System Costs]
Roofing	19264	sq. ft	$6.00	$115,600	Mentor
Roof Insulation (Blown)	19264	sq. ft	$0.98	$18,900	RS Means Square Foot Costs 31st Edition (2010)
Roof Insulation (Sheets)	19264	sq. ft	$1.55	$29,900	RS Means Square Foot Costs 31st Edition (2010)
Landscaping Allowance	1	each		$30,000	[ProgressiveBuildersAdmin]
Exterior aesthetics and updates (Paint, etc.)	9100	sq. ft	$6.00	$54,600	Previous bid
Parking Lot Repairs	42000	sq. ft	$3.00	$126,000	[W. Stanley]
Outdoor Recreation Area Allowance	1			$15,000	[Learn about the cost of projects in the Outdoor Living category.]
MEP					
Plumbing					
Living Space	12297.4	sq. ft	$19.63	$241,400	RS Means Square Foot Costs 31st Edition (2010)
Restaurants	2526.1	sq. ft	$16.71	$42,200	RS Means Square Foot Costs 31st Edition (2010)
Gym	2376.5	sq. ft	$7.76	$18,400	RS Means Square Foot Costs 31st Edition (2010)
HVAC					
Living Space	12297.4	sq. ft	$9.05	$111,300	RS Means Square Foot Costs 31st Edition (2010)
Restaurants	2526.1	sq. ft	$39.76	$100,400	RS Means Square Foot Costs 31st Edition (2010)
Gym	2376.5	sq. ft	$23.28	$55,300	RS Means Square Foot Costs 31st Edition (2010)
Fire Protection					
Living Space	12297.4	sq. ft	$3.10	$38,100	RS Means Square Foot Costs 31st Edition (2010)
Restaurants	2526.1	sq. ft	$7.91	$20,000	RS Means Square Foot Costs 31st Edition (2010)
Gym	2376.5	sq. ft	$3.79	$9,000	RS Means Square Foot Costs 31st Edition (2010)
Electrical					
Living Space	12297.4	sq. ft	$13.09	$161,000	RS Means Square Foot Costs 31st Edition (2010)
Restaurants	2526.1	sq. ft	$20.65	$52,200	RS Means Square Foot Costs 31st Edition (2010)
Gym	2376.5	sq. ft	$30.98	$73,600	RS Means Square Foot Costs 31st Edition (2010)

	Finishes					
	Living Space	12297.4	sq. ft	$30.48	$374,800	RS Means Square Foot Costs 31st Edition (2010)
	Restaurants	2526.1	sq. ft	$27.85	$70,400	RS Means Square Foot Costs 31st Edition (2010)
	Gym	2376.5	sq. ft	$30.22	$71,800	RS Means Square Foot Costs 31st Edition (2010)
	Gym Showers (materials)	4	each	$1,391.40	$5,600	RS Means Square Foot Costs 31st Edition (2010)
	Equipment					
	Living Space (appliances)	10	apartments	$10,000	$100,000	RS Means Square Foot Costs 31st Edition (2010)
	Restaurant (Large)	2	restaurant	$31,246	$62,500	RS Means Square Foot Costs 31st Edition (2010)
	Gym	1	equipment	$100,000	$100,000	[What is the Cost of Owning a Gym?]
	Sub Total:				$2,795,950	
	Other					
	Design Fee				$200,000	From Proposal
	Design and Construction Contigency (20%)				$559,200	Design Phase Contigency
	Inflation (3.5%/year)				$97,900	Mentor
	Site Services				$7,000	Previous Bid
	Construction Fee (3%)				$109,800	Mentor
	Grand Total:				$3,769,850	

Adams County Health and Human Services Remodel (Critical Path)

Activity ID	Activity Name	Start	Finish
Capstone - HHS		25-Jan-21	01-Aug-22
Preliminary Design and Research		25-Jan-21	13-Feb-21
A1000	Review Site Information	25-Jan-21	01-Feb-21
A1010	Client Meeting/Communication	25-Jan-21	05-Feb-21
A1020	Identify Project Objectives & Constraints	25-Jan-21	04-Feb-21
A1030	Review site regulations/standards	25-Jan-21	05-Feb-21
A1040	Documentexisting site conditions	25-Jan-21	12-Feb-21
A1050	Site Visit	13-Feb-21	13-Feb-21
Preliminary Design Alternatives		14-Feb-21	17-Mar-21
A1060	Define Scope &Alternative Design Options	14-Feb-21	25-Feb-21
A1070	MultidisciplinaryAnalyses	26-Feb-21	17-Mar-21
A1080	Cost& Schedule Estimates	26-Feb-21	12-Mar-21
A1090	Geotechnical Report	26-Feb-21*	09-Mar-21
A1100	Preliminary Engineering Report	26-Feb-21	17-Mar-21
Final Design		18-Mar-21	29-Apr-21
A1110	Develop final design	18-Mar-21	25-Mar-21
A1120	Prepare specifications	18-Mar-21	29-Mar-21
A1130	Final Construction Drawings	30-Mar-21	20-Apr-21
A1140	Final Cost Estimates	30-Mar-21	17-Apr-21
A1160	Final Design Report	18-Apr-21	29-Apr-21
PreCon & Construction		30-Apr-21	01-Aug-22
A1170	Permit	30-Apr-21	13-Aug-21
A1180	Develop Bid Documents & Bidding	14-Aug-21	11-Sep-21
A1190	ContractAward	12-Sep-21	17-Oct-21
A1200	Construction & Oversight	18-Oct-21	22-Jul-22
A1210	Inspection	23-Jul-22	24-Jul-22
A1220	Turnover	25-Jul-22	01-Aug-22



Actual Level of Effort
Actual Work
Remaining Work
Critical Remaining Work

Capstone - HHS, 1,1

Date	Revision	Checked	Approved
16-Mar-21	2	Y	Y

Life Cycle Calculations

Life cycle cost is calculated by adding the capital cost and annual costs over the lifetime of a project and subtracting the present value of the salvage value.

Equation 1:

$$Life\ Cycle\ Cost = Capital\ Cost + Annual\ Cost\ (P/A,\ 3\%,\ 30) - Salvage\ Value\ (P/F, 3\%, 30)$$

Equation 2:

$$Life\ Cycle\ Cost = Capital\ Cost + Annual\ Cost\ (19.600411) - Salvage\ Value\ (0.411987)$$

Sample Calculation for Alternative 2:

$$Life\ Cycle\ Cost = \$3,200,000 + \$200,000\ (P/A,\ 3\%,\ 30) - \$800,000\ (P/F, 3\%, 30)$$

$$Life\ Cycle\ Cost = \$3,200,000 + \$200,000\ (19.600411) - \$800,000\ (0.411987) = \$6,790,400$$

Payback Period

Payback period is calculated by dividing the capital costs by the difference between the annualized benefits and annualized costs. This can help determine how quickly the project will "pay for itself". This does not take into account the present value of money.

Equation 3:

$$Payback\ Period = \frac{Capital\ Costs}{Annual\ Benefits - Annual\ Costs}$$

Sample calculation for Alternative 2:

$$Payback\ Period = \frac{\$3,200,000}{\$614,000 - \$200,00} = 7.73\ years$$

Drainage Calculations

The amount of water needed to be stored on site is primarily a function of rainfall intensity, site size, and site surface conditions (paved/unpaved). The rational method is used to measure peak discharge rates, and this is used to estimate the volume of water held on-site.

Equation 4. Rational Method

$$Estimated\ Runoff\ Volume = Runoff\ Coefficient\ [-] \times Rainfall\ Intensity\ [in/hr] \times Site\ Size\ [acres$$

$$V = [(1.0 \times 0.52) + (0.4 \times 0.48)]\ [-] \times 3.27\ [in/hr] \times 2.93\ [acres]$$

$$= 0.712\ [-] \times 3.27\ [in/hr] \times 2.93\ [acres]$$

$$= 6.82\ [acre - in\ /\ hr]$$

$$= 24,760\ [\ ft^3]$$

Equation 5. Volume Calculation

$$Site\ Storage\ Volume\ =\ Drainage\ Ditch\ Cross\ Sectional\ Area\ [ft^2] \times Ditch\ Length\ [ft]$$

$$V^{original} = 18\ [ft^2] \times 600\ [ft]$$

$$V^{original} = 10,800\ [ft^3]$$

$$V^{new} = 40\ [ft^2] \times 600\ [ft]$$

$$V^{new} = 24,000\ [ft^3]$$

References

"CKSmithSuperior," *Home Heating Oil Propane Air Conditioning Worcester*. [Online]. Available: https://www.cksmithsuperior.com/. [Accessed: 17-Mar-2021].

C. S. ReVelle, E. E. Whitlatch, and J. R. Wright, "Engineering Economics III: Depreciation, Taxes, Inflation, and Personal Financial Planning," in *Civil and Environmental Systems Engineering*, 2nd ed., Upper Saddle River, New Jersey: Pearson Education, Inc. , 2004.

Google Earth. [Online]. Available: https://earth.google.com/. [Accessed: 17-Mar-2021].

"New Jersey Stormwater Best Management Practices Manual Computing Stormwater Runoff Rates and Volumes," 2004. [Online]. Available: https://www.njstormwater.org/bmp_manual/NJ_SWBMP_5%20print.pdf.

"Tax Parcel Information Search," *Home " Adams County, WI Land Records System*. [Online]. Available: http://www.adamscountylandrecords.com/. [Accessed: 17-Mar-2021].

"U.S. Census Bureau QuickFacts: Adams County, Wisconsin; Wisconsin," *Census Bureau QuickFacts*. [Online]. Available: https://www.census.gov/quickfacts/fact/table/adamscountywisconsin,WI/PST045219. [Accessed: 17-Mar-2021].

Cost References

"2021 Concrete Slab Costs: Cost To Pour (Per Square Foot + Per Yard)," *HomeGuide*. [Online]. Available: https://homeguide.com/costs/concrete-slab-cost. [Accessed: 18-Mar-2021].

"2021 HVAC System Costs: Installation & Replacement Cost Estimator," *HomeGuide*. [Online]. Available: https://homeguide.com/costs/hvac-cost. [Accessed: 18-Mar-2021].

"2021 Sewer Line Replacement & Repair Costs: Main & Drain Pipe," *HomeGuide*. [Online]. Available: https://homeguide.com/costs/sewer-line-repair-cost. [Accessed: 18-Mar-2021].

B. Balboni, C. Babbitt, and T. Baker, Eds., *RSMeans Square Foot Costs*, 31st ed. Gordian, 2010.

"How Much Does Saw Cutting Concrete Cost?," *What is the Price How Much Does Saw Cutting Concrete Cost Comments*. [Online]. Available: https://www.howmuchisit.org/saw-cutting-concrete-cost/. [Accessed: 18-Mar-2021].

"Facility Costs," *Facility Services Partners, Inc. (FSP)*, 12-Aug-2014. [Online]. Available: http://www.facilityservicespartners.com/facility-costs/. [Accessed: 18-Mar-2021].

K. Vandenboss, "The Costs to Start an Assisted Living Facility," *Vandenboss Commercial*, 18-May-2020. [Online]. Available: https://vandenboss.com/cost-to-start-assisted-living-facility/. [Accessed: 18-Mar-2021].

"Kitchen Remodel Cost Guide and Calculator for 2021," *Home Stratosphere*, 11-Mar-2021. [Online]. Available: https://www.homestratosphere.com/kitchen-cost-guide/#:~:text=A%20medium,%20inexpensive%20kitchen%20will%20cost%20between%20$50,per%20square%20foot.%20Large%20Kitchens%20(200%20square%20feet). [Accessed: 18-Mar-2021].

"Learn about the cost of projects in the Bathrooms category.," *2021 Cost to Add a Bathroom | Basement Bathroom Additions, Half Baths - HomeAdvsior*. [Online]. Available: https://www.homeadvisor.com/cost/bathrooms/. [Accessed: 18-Mar-2021].

"Learn about the cost of projects in the Outdoor Living category.," *HomeAdvisor*. [Online]. Available: https://www.homeadvisor.com/cost/outdoor-living/. [Accessed: 18-Mar-2021].

M. SEO, "Office Space Rent Cost: Renting an Office Space: How Much Does it Cost?," *Clifton Park Office Leasing | Rental Properties | Atrium Properties*, 24-Sep-2020. [Online]. Available: https://atriumproperties.net/office-space-rent-cost#:~:text=Office%20space%20rentals%20in%20the%20US%20average%20anywhere,amenities%20are%20typically%20more%20expensive%20than%20older%20properties. [Accessed: 18-Mar-2021].

ProgressiveBuildersAdmin, "The Importance of Landscaping and How a Landscaping Allowance Can Help," *Progressive Builders*, 29-Jun-2015. [Online]. Available: https://progressivebuildersmn.com/2015/06/04/the-importance-of-landscaping-and-how-a-landscaping-allowance-can-help/#:~:text=A%20landscaping%20allowance%20is%20used%20by%20builders%20and,complete,%20your%20overall%20budget%20will%20not%20be%20exhausted. [Accessed: 18-Mar-2021].

"QuickFacts Adams County, Wisconsin," *United States Census Bureau*. [Online]. Available:

https://www.census.gov/quickfacts/fact/table/adamscountywisconsin,WI/PST045219. [Accessed: 29-Mar-2021].

R. Womeldorf and G. Evans, “How Much Does It Cost to Set Up Utilities on Land?,” *Upgraded Home*, 30-Sep-2020. [Online]. Available: https://upgradedhome.com/how-much-does-it-cost-to-set-up-utilities-on-land/. [Accessed: 18-Mar-2021].

S. Witt, J. Hoyt, Reviewed By Scott Witt Elder Home Care Expert, and Written By Jeff Hoyt Editor in Chief, “[year] Assisted Living Costs & Pricing by State: Monthly & Annual Costs,” *SeniorLiving.org*, 23-Feb-2021. [Online]. Available: https://www.seniorliving.org/assisted-living/costs/#:~:text=Assisted%20Living%20Cost%20by%20State%20(Updated%20October,%202021),%20%20$47,940%20%2047%20more%20rows. [Accessed: 18-Mar-2021].

W. Stanley, “2020 Asphalt Paving Cost Per Square Foot For Driveways,” William Stanley of Willies Paving, 24-Sep-2020. [Online]. Available: https://www.williespaving.com/service/paving/asphalt-paving-ultimate-guide/. [Accessed: 18-Mar-2021].

“What is the Cost of Owning a Gym?,” *ABC Fitness*, 16-Mar-2020. [Online]. Available: https://abcfitness.com/owning-a-gym/cost-of-owning-a-gym/#:~:text=For%20a%20commercial%20gym,%20equipment%20costs%20can%20range,once%20and%20you%20should%20be%20good%20to%20go. [Accessed: 18-Mar-2021].

100% Geotechnical Report

Adams County Health
& Human Services Remodel

Prepared for: Adams County
Grounds Department

Prepared by: Castle Rock
Consultants

Mr. Jan Kucher, PE Adjunct Professor
2346 Engineering Hall
1415 Engineering Drive
Madison, WI 53706

Subject: 100% Geotechnical Exploration and Report
Adams County Health and Human Services Building Remodel
108 E. North St.
Friendship, WI

Dear Mr. Kucher,

Attached is the geotechnical investigation requested on behalf of the client, Adams County. In this report, findings from five soil borings as well as previous well data was obtained. From this, information about the soil stratigraphy, soil types, and groundwater levels was found. This data will be analyzed with respect to the information found following common practice. Recommendations for the site will then be put forth following this analysis.

The intent of this report is to inform the client of the current site conditions and use engineering models to predict the strength of the subsurface conditions. This will in turn provide information for the proposed renovation of the Adams County Health and Human Services building. While there is an existing foundation and building that is stable, Castle Rock Consultants will confirm if there are any changes needed to the current system due to the repurposing of the building.

The geotechnical report will also aim to provide information about how to alleviate drainage issues on the site. Castle Rock Consulting is here to obtain the testing data, verify subsurface conditions and groundwater levels, as well as provide recommendations to the best of their abilities based on the data available.

Our team is grateful for the opportunity to work with the Adams County Grounds Department in contributing a socially enhancing and economically profitable final design. Please direct questions with regards to this report to the team's geotechnical engineer, Devin Welch.

Sincerely,

Dalila Ricci
Project Manager
Castle Rock Consultants

Devin Welch
Geotechnical Lead
Castle Rock Consultants

Disclaimer:

The concepts, drawings, and written materials provided here were prepared by students in the Department of Civil & Environmental Engineering at the University of Wisconsin-Madison as an activity in the course CEE 578 - Senior Capstone Design. These do not represent the work products of licensed engineers. These are NOT for construction purposes.

Table of Contents

1.0 Introduction

Adams County, the owner of the Adams County Health and Human Services Building, has tasked Castle Rock Consulting with completing this geotechnical report in regards to their site in Friendship, Wisconsin. In Appendix 1, Figure 1, the location of the site relative to the state of Wisconsin is pictured. This report is designed to provide information as to how different alternative design plans will be impacted based on soil geology and strength. There will also be recommendations that pertain to improving drainage over the site. Discussion related to foundations will be provided with recommendations to follow. These recommendations will work to reduce the effect the site conditions have on the design and construction processes.

2.0 Project Description

This site contains the existing Adams County Health and Human Services building which is a one story building with a footprint of around 17,200 square feet. The parcel of land for the site is 2.93 acres in total and an aerial image of this can be seen in Appendix 1, Figure 2. There is also a parking lot on the site that is approximately 42,000 square feet. The parking lot is sloped west towards a small creek that drains underneath North St., south of the building and land parcel, but there continues to be flooding issues. These grading issues will need to be addressed throughout due to improper drainage.

Overall, the area is low lying which also exacerbates the drainage issues associated with the area. There is no basement underneath this structure. The current building was constructed in two sections. The first half of the building was constructed in the 1980s while the second part was built a decade later. The two are connected with a fire wall and there are two access doors that go through the fire wall. The exterior of the building is constructed using masonry with wood framing on the interior of the building. Utilities for the site are provided by the City of Adams.

As the Adams County Health and Human Services move to a new building to further accommodate their needs, the existing building on site will be put up for sale. In order to maximize its usefulness to the community, alternative solutions to efficiently repurpose the building will be discussed. The future use and sustainability of the existing building will depend on the evaluation performed in this project. This report accounts for any changes in loading or structural integrity and determines if the current foundation is projected to be suitable for these options.

2.1 Soil Boring Disclaimer

Due to the fact that no soil borings were conducted on this specific site, subsurface data was approximated using Web Soil Survey and from borings logs featuring similar geology. The information presented in the following sections are based on the analysis of these soil borings and thus cannot be viewed as an absolute representation of the geology on site. However, these boring logs have aided analysis efforts in interpreting the soil subsurface on site. For this capstone project, Castle Rock Consultants proceeded with these boring logs as if they were found on site. Historical water level data was also utilized by collected well data from the surrounding area. Ground surface elevations on site were determined using data on Google Earth. Please note that any development moving forward should obtain soil borings from the site to verify the following recommendations.

3.0 Surface Exploration

Subsurface conditions on site were explored by drilling five (5) Standard Penetration Test (SPT) soil borings to a target depth of 30.5 feet each. Boring locations were chosen accordingly in order to gather a realistic spread of the geology present. A site map with the locations of Borings 1 through 5 can be seen in Appendix 2. Borings were drilled in October 2020 by the drill company *DC*, subcontracted by Castle Rock Consulting. The team's geotechnical engineers logged each boring hole, classified the soil observed, and collected the samples. Boring holes were drilled using a truck-mounted rotary CME 45 Drill rig along with $4^{1/4}$" diameter Hollow Stem Augers. Split spoon (SS) barrels with 2" outside diameters were used to capture soil samples.

All five bores were started at a depth of 1 foot. Split spoon barrels were pushed 1.5 feet (18") per sample and were taken at intervals of 1 foot until a depth of 10 feet was reached. After this depth, samples were taken every 5 feet until the designated depth of 30.5 feet was reached. Borings generally returned 8 samples per hole unless auger refusal ended drilling early. Auger refusal was encountered at Boring 2 and terminated boring drilling at a depth of 27.5 feet. Refusal is typically indicative of the presence of bedrock, boulders, or other anomalies that indicate hard material. Groundwater was encountered upon completion in each borehole. Drillers observed water levels typically at a range of 19-22 feet below ground surface.

After the completion of each hole, boreholes were then backfilled with bentonite chips and water as required by the State of Wisconsin Department of Natural Resources (DNR). Soil borings were done in accordance with ASTM Designation D 1586, the standard test method for standard penetration test (SPT) and split-barrel sampling.

3.1 Laboratory Testing

Samples taken from the split spoon samplers were subjected to a few laboratory tests to help determine properties of the soil layers. All samples were classified using the Unified Soil Classification System (USCS) and the explanations of those guidelines can be found in Appendix 2. The majority of the soil in the boring logs were found to be sand with some silt (SM) or low plasticity clay deposits (CL).

One piece of information that was provided is the unconfined compressive strength. This is described on the boring logs briefly as it is only applicable to cohesive soils. This was found according to ASTM D 2166. In some soil boring samples, a water content value was found. This was done by taking a sample of soil and weighing it in its natural state, then weighing it after it has been dried in an oven. By comparing these values, the percentage of water in a soil can be determined. This is important for settlement and other calculations.

Finally, the liquidity index was found for a soil sample in soil boring 2. The liquidity index uses water content, the plastic limit, and the liquid limit. This determines the limits for the natural soil regarding water content.

All results can be found in the boring logs in Appendix 2.

4.0 Site Description

4.1 Regional Geology

The Adams County Health and Human Services Project is located within the Central Lowland physiographic province of the United States, the largest physiographic province in the continuous US according to the National Park Service. The region typically rises at most 990 feet above sea level in the Eastern section of the province and at most 2000 feet above seal level in the west. The Central Lowlands derive its name and distinction from its geologic history. This province was subject to the movement of multiple Pleistocene glaciers which carved the land and generated characteristic glacial features.

Essentially all of the Central Lowlands are covered in a top layer of dense glacial till, nearly 150 feet thick. Till is composed of rock and soil sediment that can be as large as boulders and as small as very fine sand. The composition of till is always some type of non-uniform mixture of sediment, thus what makes it distinct. Underlying the glacial till are largely horizontal Paleozoic sandstones, shales, limestones, and conglomerates (Physiographic Provinces).

4.2 Subsurface Stratigraphy

This site location ranges in elevation from about 958 to 971 feet above sea level. This is consistent with the maximum elevation (984 feet) known to the region as stated in the regional

geology section. This information indicates that bores were probably drilled within the top most recently deposited section of the geologic record, glacial till and loam. Using the data from the five SPT boring logs, this theory was further proved.

The subsurface profile on site is slightly varied but can generally be described by the following strata as:

- **Topsoil.** Topsoil on site ranged from about 9-11 inches in thickness. It generally consisted of very dark grayish brown organic loam with silt or clay. USDA classification: Silty Loam. In 3 out of the 5 bores, engineered fill was observed.

- **Loam- Silty Sand (SM).** Underlying the topsoil, a layer of medium dense brown fine to medium sand was seen. Ranging from depths as early as 11 inches to as deep as the target depth, this silty sand layer can be interpreted as the primary soil in the first 30.5 feet of the subsurface. It was observed to have varying degrees of silt concentration and trace clay which is characteristic to loam.

- **Fine Grained Seams- Lean Clay, Silt (CL, ML).** Seams of fine-grained brown to grayish brown sediment were found at varying depths throughout the site. 3 out of the 5 bores captured thick pockets of silt between 20-30.5 feet of depth. The largest silt pocket was found to be 7 feet thick at a depth of 23.5 to 30.5 feet. All 5 boring locations captured thick pockets of lean clay either from 0-6 feet or 18.5-28.5 (largest pocket).

Average SPT N-values in the upper 30.5 feet of silty sand ranged from 4-21 blows/ft indicating loose to medium dense soil.

4.3 Groundwater

The water table on site was generally observed to be anywhere from 19 to 22 feet below ground surface. Friendship Lake, which is a distance of 0.5 miles away, is observed to be at the same elevation as the site's water table according to data found on Google Earth. This lake may be an indicator for groundwater flow as it is a nearby equipotential signifying water level. A shallow water table may pose as a hindrance to deep foundation considerations. For the scope of this renovation project, the groundwater flow patterns should not impact the construction process as there will not be any new foundation elements installed.

4.4 Potential Environmental Considerations

According to Web Soil Survey, there is a concern about corrosion of concrete due to the soil conditions. This is based upon sulfate and sodium content, moisture content, texture, and the

acidity of the soil. The risk for this particular area is high due to the texture of the soil. This is important to note and will be discussed further in the construction related issues section.

Within soil boring 4, samples 2-4, a petroleum odor was detected. While this is something to note, it should not affect the surface of the site as there will be little to no earthwork done on this project.

A full Environmental Site Assessment can be done to provide more information, but this is outside of the scope for this particular report. This may be beneficial to examine the effect of the possible petroleum contamination on the groundwater.

5.0 Discussion & Recommendations

Castle Rock Consulting offers the following comments and recommendations for the alternative design process for the existing Adams County Human Health and Services building. The current building rests on a slab-on grade foundation so there is generally no need to suggest the implementation of new foundations as long as the proposed loads are equal to the present conditions. Nevertheless, an analysis of the current geology was provided in order to decide a range of foundations and buildings suited for this location. The slab-on grade foundation is expected to be suitable for this location. However, frost heave and corrosion may be potential geohazards for shallow concrete foundations.

It is expected that no site preparation will be needed for this project due to most of the construction coming from the interior redesign of the existing building. Nevertheless, water drainage is still a large issue on site and will need further considerations. It is suggested that silt socks are used if further renovation is performed to control erosion and limit leakage to drainage.

5.1 Foundation Design & Recommendations

Castle Rock Consulting has determined that it is feasible to utilize shallow concrete square foundations on the native soil present on site. This type of foundation will be the most economical choice for this site. The bottom of exterior footings should be placed 5 or more feet below finished exterior grade to account for frost depth which is typically 4 feet in Wisconsin. Footings in heated building areas or footings not affected by freezing temperatures can be placed directly below the floor slab-on-grade.

The calculations have determined that a bearing pressure of at least 7088 psf will influence a total footing settlement greater than or equal to 1 inch with that differential settlement not exceeding 0.5 in. The width of the foundations were calculated to be 6 ft wide and starting at a depth of 5 feet below ground surface. Considering a factor of safety of 2.0 for this design, the

recommended maximum bearing capacity of 3544 psf to be applied on site if foundations were reconstructed with spread footings. This figure is equivalent to a max load of 54 tons applied to the foundation. The calculation of these parameters can be seen in Section 7.0 of this report.

5.2 Lateral Earth Pressure

The lateral earth pressure was also evaluated for this site. Due to the primary soil being loamy sand, the internal friction angle was noted to be a minimum of 31 degrees. Using its friction angle, the coefficients of earth pressure can be noted. The lateral coefficient of earth pressure for the active, passive, and at-rest case were found to be 0.32, 3.12, and 0.48 respectively.

5.3 Conclusion

In conclusion, the current slab-on grade foundation was considered to be acceptable for the renovation of the Adams County Health and Human Services Building. If the finalized building alternative design requires loads greater than the ones previously placed, it is important that bearing loads and capacities are considered as previously mentioned. No site preparation is needed for this project as there will be no foundation system installed.

6.0 Geotechnical-Related Construction Issues

Geotechnical-related construction complications can be difficult to predict. This is due to the ever changing weather patterns that Wisconsin experiences throughout the year. Below are some potential issues that may come up during the construction process due to soil composition.

- Due to drainage concerns on the site, it is important to move heavy equipment needed onto the site during dry periods. This will help prevent damage to the existing areas.
- Any drainage remediation that will be done should be completed during the drier periods of the summer or fall. Due to the melting of ice and snow, it would be difficult to perform earthwork in the spring.
- Some drainage issues may be due to the drainage plan for the broader area. It may be beneficial to look into the flow of water over the township area to understand why water is unable to leave this site.
- Little site work preparation is needed for the site as there is no major earthwork proposed. However, it is important to note that existing foundations and structures should be protected and accounted for during the construction process.
- Due to the potentially corrosive nature of the soil found on site, the concrete will be inspected on site prior to construction work to confirm that it is in good condition. Additional concrete would need to be protected from corrosion.

- The water level may fluctuate due to seasonal changes. Deep foundations are not recommended as it will be in close proximity to the fluctuating water table. The water level at Friendship Lake will serve as a good indicator for groundwater flow patterns. Further evaluation must be taken before considering the use of deeper foundations.

Thank you for the opportunity to provide our expertise on this project. If there are additional questions or concerns, please contact Castle Rock Consulting.

7.0 Engineering Analysis Calculations

Hough's Method for Granular Settlement of Foundations

The amount of settlement that a foundation will induce in granular soils was calculated through Hough's Method. Since the geology on site consisted of predominantly sandy soil, this method was preferred. The depth of influence was determined to be the width of the foundation × 3 (18 feet). The strata was then divided into discrete layers of 3 feet thickness. The sum of settlement in each layer was measured using the following equation. The calculation of the settlement in the layer directly below the foundation (5-8 feet bgs) is shown.

Equation 1- Total Settlement:

$$\delta = \frac{H}{C'} \; x \; log\left(\frac{\sigma'o + \Delta\sigma b}{\sigma'}\right)$$

Parameters:

H = soil layer thickness (ft)

C' = bearing capacity index

$\sigma'o$= initial effective stress (lb/ft^2)

$\Delta\sigma b$ = change in effective stress (lb/ft^2)

δ = settlement (in)

Total Settlement in Layer 1:

$$.4763 = \frac{3}{50} \; x \; log\left(\frac{672 + 2410.05}{67}\right)$$

Allowable Bearing Capacity

The maximum bearing pressure to induce a settlement of 1 inch was calculated from Hough's method. This pressure, also known as ultimate bearing capacity, was divided by a safety factor of 2.0 to determine the allowable bearing capacity.

Equation 2- Allowable Bearing Capacity:

$Q_{all} = Q_u/F.S.$

Parameters:

Q_u= Ultimate bearing capacity (lb/ft^2)

F.S. = Factor of Safety
Q_{all} = Allowable Bearing capacity (lb/ft^2)

Allowable Bearing Capacity:
3544.2 = 7088.4/2.0.

Lateral Earth Pressure Coefficients
The lateral earth pressure coefficients of the underlying soil strata were calculated for the active, passive, and at rest conditions.

Equation 3 - Active Earth Pressure Coefficient:
$K_a = \tan^2(45\text{-}f/2)$

Parameters:
f = friction angle (degrees)

Active Earth Pressure Coefficient:
$.32 = \tan^2(45\text{-}31/2)$

Equation 4 - Passive Earth Pressure Coefficient:
$K_p = \tan^2(45+f/2)$

Parameters:
f = friction angle (degrees)

Passive Earth Pressure Coefficient:
$3.12 = \tan^2(45+31/2)$

Equation 5 - At-Rest Earth Pressure Coefficient:
$K_0 = 1\text{-}\sin(f)$

Parameters:
f = friction angle (degrees)

Active Earth Pressure Coefficient:
$.48 = 1\text{-}\sin(31)$

8.0 Appendices

Appendix 1: Site Location Information

Appendix 2: Soil Boring Location Plan
Logs of Soil Borings (5)
Unified Soil Classification System

Appendix 3: Well Data

Appendix 1:
Site Location Information

Figure 1: Adams County Location within Wisconsin (Wikimedia)

Figure 2: Aerial Image of Adams County HHS Parcel
(Adams County Tax Parcel Information)

Appendix 2:
Site Map with Boring Locations and Boring Logs


SB-1
SB-2
108
SB-5
SB-3
SB-4
1" = 40'
N
⊕ Denotes Boring Location
All locations are approximate
SOIL BORING LOCATIONS
Adams County HHS
108 E. North St.
Friendship, Wisconsin
Castle Rock Consultants

Castle Rock Consulting

LOG OF TEST BORING

Project: Adams County HHS Building
108 E North St.,
Location: Friendship, Wisconsin

Boring No. 1
Surface Elev. (ft)
Job No.
Sheet 1 of 1

SAMPLE No.	Rec (in.)	Moist	N	Depth (ft)	VISUAL CLASSIFICATION and Remarks	SOIL PROPERTIES qu (qa) (tsf)	W	LL	PL	LI
					9" Clayey TOPSOIL (OL)					
1	18	M	12		USDA: 10 YR 3/2 Silty Clay Loam					
					Very Stiff, Brown/Gray (Mottled) Lean CLAY, Little Sand, Trace Gravel (CL - Possible Fill)	(2.5)				
2	12	W	15	5	USDA: 10 YR 4/3 Silty Clay Loam (Redox C2D 10 YR 6/6)					
3	18	W	15		Medium Dense, Brown Fine SAND, Little to Some Silt (SP-SM/SM)					
4	18	W	12	10	USDA: 10 YR 6/3 Loamy Fine Sand					
5	18	W	20	15	Medium Dense, Brown Fine to Medium SAND, Trace to Little Silt (SP/SP-SM)					
					USDA: 10 YR 5/3 Loamy Sand					
6	18	M/W	17	20	Stiff to Very Stiff, Brown Lean CLAY, Laminated with Silt and Sand Seams (CL)					
					USDA: 10 YR 6/3 Silty Clay Loam	(2.0)				
7	18	M/W	23	25						
8	18	M	36	30	Dense, Brown Fine to Medium SAND, Some Silt and Clay, Little Gravel					
					USDA: 10 YR 54/4 Sandy Clay Loam					
					End Boring at 30.5 ft					
					Borehole backfilled with bentonite grout and chips					
				35						

This boring log has been prepared for a UW Capstone Engineering Class for educational use ONLY. It does not represent actual conditions and should NOT be used for any other purpose.

WATER LEVEL OBSERVATIONS

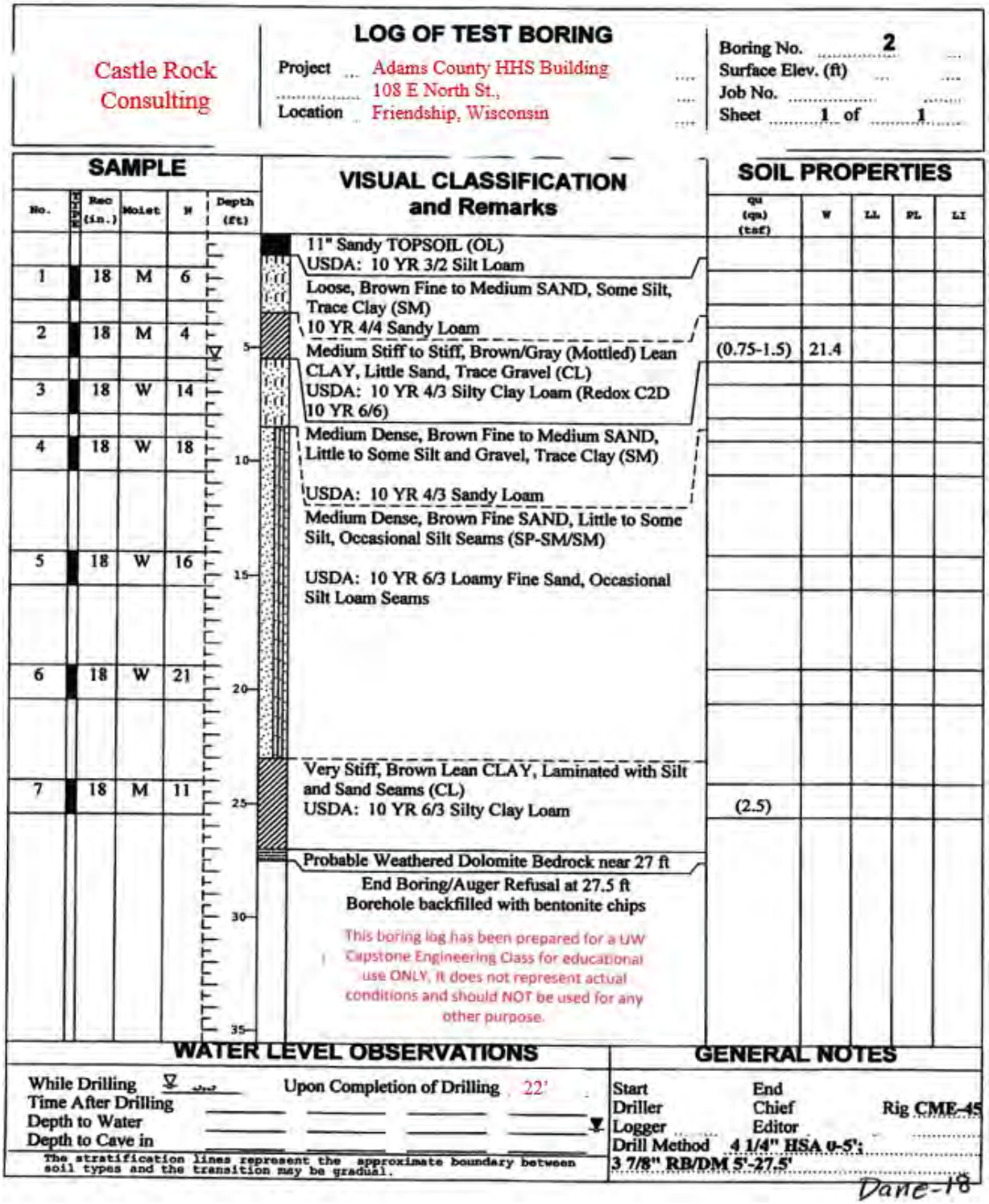
While Drilling ▽ Upon Completion of Drilling 19'
Time After Drilling
Depth to Water
Depth to Cave in

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start End
Driller Chief Rig CME-45
Logger Editor
Drill Method 4 1/4" HSA 0-5';
3 7/8" RB/DM 5'-30.5'

Dane-18



Castle Rock Consulting

LOG OF TEST BORING

Project Adams County HHS Building
108 E North St.,
Location Friendship, Wisconsin

Boring No. 2
Surface Elev. (ft)
Job No.
Sheet 1 of 1

SAMPLE No.	Rec (in.)	Moist	N	Depth (Ft)	VISUAL CLASSIFICATION and Remarks	qu (qa) (tsf)	W	LL	PL	LI
					11" Sandy TOPSOIL (OL)					
1	18	M	6		USDA: 10 YR 3/2 Silt Loam					
					Loose, Brown Fine to Medium SAND, Some Silt, Trace Clay (SM)					
2	18	M	4		10 YR 4/4 Sandy Loam					
				5	Medium Stiff to Stiff, Brown/Gray (Mottled) Lean CLAY, Little Sand, Trace Gravel (CL)	(0.75-1.5)	21.4			
3	18	W	14		USDA: 10 YR 4/3 Silty Clay Loam (Redox C2D 10 YR 6/6)					
4	18	W	18	10	Medium Dense, Brown Fine to Medium SAND, Little to Some Silt and Gravel, Trace Clay (SM)					
					USDA: 10 YR 4/3 Sandy Loam					
					Medium Dense, Brown Fine SAND, Little to Some Silt, Occasional Silt Seams (SP-SM/SM)					
5	18	W	16	15	USDA: 10 YR 6/3 Loamy Fine Sand, Occasional Silt Loam Seams					
6	18	W	21	20						
					Very Stiff, Brown Lean CLAY, Laminated with Silt and Sand Seams (CL)					
7	18	M	11	25	USDA: 10 YR 6/3 Silty Clay Loam	(2.5)				
					Probable Weathered Dolomite Bedrock near 27 ft					
					End Boring/Auger Refusal at 27.5 ft					
				30	Borehole backfilled with bentonite chips					
					This boring log has been prepared for a UW Capstone Engineering Class for educational use ONLY. It does not represent actual conditions and should NOT be used for any other purpose.					
				35						

WATER LEVEL OBSERVATIONS

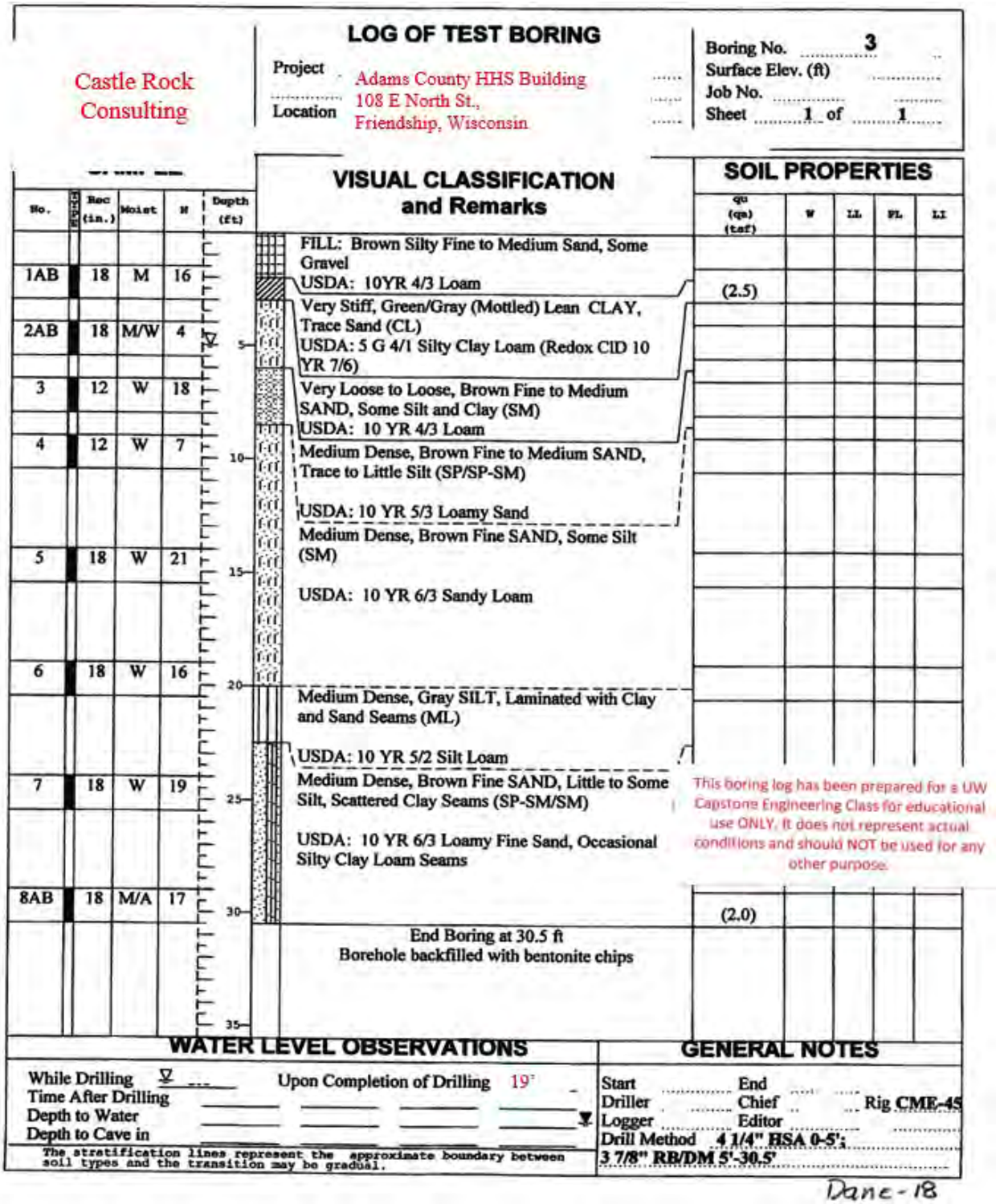
While Drilling ▽ ---
Upon Completion of Drilling 22'
Time After Drilling
Depth to Water
Depth to Cave in

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start End
Driller Chief Rig CME-45
Logger Editor
Drill Method 4 1/4" HSA 0-5';
3 7/8" RB/DM 5'-27.5'

Dane-18



LOG OF TEST BORING

Castle Rock Consulting

Project: Adams County HHS Building
Location: 108 E North St., Friendship, Wisconsin

Boring No. 3
Surface Elev. (ft)
Job No.
Sheet 1 of 1

No.	Rec (in.)	Moist	N	Depth (ft)	VISUAL CLASSIFICATION and Remarks	qu (qa) (tsf)	W	LL	PL	LI
					FILL: Brown Silty Fine to Medium Sand, Some Gravel					
1AB	18	M	16		USDA: 10YR 4/3 Loam	(2.5)				
2AB	18	M/W	4	5	Very Stiff, Green/Gray (Mottled) Lean CLAY, Trace Sand (CL) USDA: 5 G 4/1 Silty Clay Loam (Redox CID 10 YR 7/6)					
3	12	W	18		Very Loose to Loose, Brown Fine to Medium SAND, Some Silt and Clay (SM) USDA: 10 YR 4/3 Loam					
4	12	W	7	10	Medium Dense, Brown Fine to Medium SAND, Trace to Little Silt (SP/SP-SM) USDA: 10 YR 5/3 Loamy Sand					
5	18	W	21	15	Medium Dense, Brown Fine SAND, Some Silt (SM) USDA: 10 YR 6/3 Sandy Loam					
6	18	W	16	20	Medium Dense, Gray SILT, Laminated with Clay and Sand Seams (ML) USDA: 10 YR 5/2 Silt Loam					
7	18	W	19	25	Medium Dense, Brown Fine SAND, Little to Some Silt, Scattered Clay Seams (SP-SM/SM) USDA: 10 YR 6/3 Loamy Fine Sand, Occasional Silty Clay Loam Seams					
8AB	18	M/A	17	30		(2.0)				
					End Boring at 30.5 ft Borehole backfilled with bentonite chips					
				35						

This boring log has been prepared for a UW Capstone Engineering Class for educational use ONLY. It does not represent actual conditions and should NOT be used for any other purpose.

WATER LEVEL OBSERVATIONS

While Drilling ▽ --- Upon Completion of Drilling 19'
Time After Drilling
Depth to Water
Depth to Cave in

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start End
Driller Chief Rig CME-45
Logger Editor
Drill Method 4 1/4" HSA 0-5'; 3 7/8" RB/DM 5'-30.5'

Dane-18

Castle Rock Consulting

LOG OF TEST BORING

Project Adams County HHS Building
108 E North St.,
Location Friendship, Wisconsin

Boring No. 4
Surface Elev. (ft)
Job No.
Sheet 1 of 1

SAMPLE No.	Rec (in.)	Moist	N	Depth (ft)	VISUAL CLASSIFICATION and Remarks	qu (qa) (tsf)	W	LL	PL	LI
					FILL: Loose, Dark Brown Silty Fine to Medium Sand, Intermixed with Gravel, Concrete, etc.					
1	1	M	10		USDA - FILL: 10 YR 4/2 Loam					
					Dark Gray Lean to Organic CLAY (CL/OL - Probable Buried Topsoil)					
2	18	M	5	5	USDA: 10 YR 3/2 Silty Clay Loam	(1.5)	28.1			4.2
3	18	W	17		Stiff, Greenish Gray Lean CLAY, Trace Sand and Organic Material (CL)					
					USDA: 5 BG 4/1 Silty Clay Loam (Redox fld 10 YR 6/6)					
4	18	W	10	10	*Probable Petroleum Odor in Sample 2*					
					Medium Dense, Brown Fine SAND, Little to Some Silt (SP-SM/SM)					
					USDA: 10 YR 6/3 Loamy Fine Sand					
5	18	W	23	15	*Petroleum Odor Noted in Samples 3 and 4*					
					Medium Dense, Brown Fine SAND, Some Silt (SM)					
					USDA: 10 YR 6/3 Sandy Loam					
					Color Change to Gray and Scattered Silt Seams near 20'					
6	18	W	12	20						
					Medium Dense, Gray SILT, Laminated with Clay and Sand Seams (ML)					
7	18	M/W	14	25	USDA: 10 YR 5/2 Silt Loam					
					Loose to Medium Dense, Brown Fine SAND, Some Silt, Occasional Silt Seams (SM)					
8	18	W	10	30	USDA: 10 YR 6/3 Loamy Fine Sand, Occasional Silt Loam Seams					
					End Boring at 30.5 ft					
					Borehole backfilled with bentonite chips					
				35						

This boring log has been prepared for a UW Capstone Engineering Class for educational use ONLY. It does not represent actual conditions and should NOT be used for any other purpose.

WATER LEVEL OBSERVATIONS

While Drilling ▽
Time After Drilling
Depth to Water
Depth to Cave in
Upon Completion of Drilling 21' ▼

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start End
Driller Chief Rig CME-45
Logger Editor
Drill Method 4 1/4" HSA 0-5';
3 7/8" RB/DM 5'-30.5'

Dane-18

Castle Rock Consulting

LOG OF TEST BORING

Project: Adams County HHS Building
108 E North St.,
Location: Friendship, Wisconsin

Boring No. 5
Surface Elev. (ft)
Job No.
Sheet 1 of 1

SAMPLE No.	Rec (in.)	Moist	N	Depth (ft)	VISUAL CLASSIFICATION and Remarks	qu (qa) (tsf)	W	LL	PL	LI
					FILL: Brown Lean Clay, Trace to Little Sand and Gravel					
1	14	M	6		USDA: 10 YR 3/1 Silty Clay Loam					
					FILL: Dark Gray Lean Clay, Intermixed with Wood, Gravel, etc.					
2AB	18	M/W	12	5	USDA-FILL: 10 YR 3/1 Silty Clay Loam					
3	18	W	12		FILL: Medium Dense, Gray/Brown Fine to Medium Sand, Some Silt, Scattered Clay Seams	(2.5)				
4	18	W	10	10	USDA-FILL: 10 YR 4/2 Sandy Loam with Silty Clay Loam Seams *Probable Petroleum Odor in Sample No. 2*					
					Medium Dense, Brown Fine SAND, Little to Some Silt, Occasional Black Sand Seams (SP-SM/SM) *Probable Petroleum Odor in Sample 3*					
5	18	W	7	15	USDA: 10 YR 6/3 Loamy Fine Sand					
					Loose to Medium Dense, Gray/Brown Fine SAND, Little to Some Silt, Occasional Silt Seams (SP-SM/SM)					
6	18	W	12	20	USDA: 10 YR 6/3 Loamy Fine Sand Increasing Silt Content with Depth					
7	18	M/W	12	25	Medium Dense, Gray SILT, Laminated with Clay and Sand Seams (ML)					
					USDA: 10 YR 5/2 Silt Loam					
8	18	M/W	12	30						
					End Boring at 30.5 ft Borehole backfilled with bentonite chips					
				35						

This boring log has been prepared for a UW Capstone Engineering Class for educational use ONLY. It does not represent actual conditions and should NOT be used for any other purpose.

WATER LEVEL OBSERVATIONS

While Drilling ▽
Upon Completion of Drilling 22'
Time After Drilling
Depth to Water ▼
Depth to Cave in

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start End
Driller Chief Rig CME-45
Logger Editor
Drill Method 4 1/4" HSA 0-5';
3 7/8" RB/DM 5'-30.5'

Dane-18

LOG OF TEST BORING
General Notes

Descriptive Soil Classification

GRAIN SIZE TERMINOLOGY

Soil Fraction	Particle Size	U.S. Standard Sieve Size
Boulders	Larger than 12"	Larger than 12"
Cobbles	3" to 12"	3" to 12"
Gravel: Coarse	3/4" to 3"	3/4" to 3"
Fine	4.76 mm to 3/4"	#4 to 3/4"
Sand: Coarse	2.00 mm to 4.76 mm	#10 to #4
Medium	0.42 to mm to 2.00 mm	#40 to #10
Fine	0.074 mm to 0.42 mm	#200 to #40
Silt	0.005 mm to 0.074 mm	Smaller than #200
Clay	Smaller than 0.005 mm	Smaller than #200

Plasticity characteristics differentiate between silt and clay.

GENERAL TERMINOLOGY

Physical Characteristics
Color, moisture, grain shape, fineness, etc.
Major Constituents
Clay, silt, sand, gravel
Structure
Laminated, varved, fibrous, stratified, cemented, fissured, etc.
Geologic Origin
Glacial, alluvial, eolian, residual, etc.

RELATIVE DENSITY

Term	"N" Value
Very Loose	0-4
Loose	4-10
Medium Dense	10-30
Dense	30-50
Very Dense	Over 50

RELATIVE PROPORTIONS OF OF COHESIONLESS SOILS

Proportional Term	Defining Range by Percentage of Weight
Trace	0%-5%
Little	5%-12%
Some	12%-35%
And	35%-50%

CONSISTENCY

Term	q_u-tons/sq. ft.
Very Soft	0.0 to 0.25
Soft	0.25 to 0.50
Medium	0.50 to 1.0
Stiff	1.0 to 2.0
Very Stiff	2.0 to 4.0
Hard	Over 4.0

ORGANIC CONTENT BY COMBUSTION METHOD

Soil Description	Loss on ignition
Non Organic	Less than 4%
Organic Silt/Clay	4-12%
Sedimentary Peat	12-50%
Fibrous and Woody Peat	More than 50%

PLASTICITY

Term	Plastic Index
None to Slight	0-4
Slight	5-7
Medium	8-22
High to Very High	Over 22

The penetration resistance, N, is the summation of the number of blows required to effect two successive 6" penetrations of the 2" split-barrel sampler. The sampler is driven with a 140 lb. weight falling 30" and is seated to a depth of 6" before commencing the standard penetration test.

SYMBOLS

DRILLING AND SAMPLING

CS--Continuous Sampling
RC--Rock Coring: Size AW, BW, NW, 2"W
RQD--Rock Quality Designator
RB--Rock Bit
FT--Fish Tail
DC--Drove Casing
C--Casing: Size 2 1/2", NW, 4", HW
CW--Clear Water
DM--Drilling Mud
HSA--Hollow Stem Auger
FA--Flight Auger
HA--Hand Auger
COA--Clean-Out Auger
SS--2" Diameter Split-Barrel Sample
2ST--2" Diameter Thin-Walled Tube Sample
3ST--3" Diameter Thin-Walled Tube Sample
PT--3" Diameter Piston Tube Sample
AS--Auger Sample
WS--Wash Sample
PTS--Peat Sample
PS--Pitcher Sample
NR--No Recovery
S--Sounding
PMT--Borehole Pressuremeter Test
VS--Vane Shear Test
WPT--Water Pressure Test

LABORATORY TESTS

q_p--Penetrometer Reading, tons/sq. ft.
q_u--Unconfined Strength, tons/sq. ft.
W--Moisture Content, %
LL--Liquid Limit, %
PL--Plastic Limit, %
SL--Shrinkage Limit, %
LI--Loss on Ignition, %
D--Dry Unit Weight, lbs/cu. ft.
pH--Measure of Soil Alkalinity or Acidity
FS--Free Swell, %

WATER LEVEL MEASUREMENT

▽ --Water Level at time shown
NW--No Water Encountered
WD--While Drilling
BCR--Before Casing Removal
ACR--After Casing Removal
CW--Caved and Wet
CM--Caved and Moist

Note: Water level measurements shown on the boring logs represent conditions at the time indicated and may not reflect static levels, especially in cohesive soils.

Page 18

UNIFIED SOIL CLASSIFICATION SYSTEM

COARSE-GRAINED SOILS

(More than half of material is larger than No. 200 seive size.)

GRAVELS More than half of coarse fraction larger than No. 4 sieve size	**Clean Gravels** (Little or no fines)	
	GW	Well-graded gravels, gravel-sand mixtures, little or no fines
	GP	Poorly graded gravels, gravel-sand mixtures, little or no fines
	Gravels with Fines (Appreciable amount of fines)	
	GM^{d}_{u}	Silty gravels, gravel-sand-silt mixtures
	GC	Clayey gravels, gravel-sand-clay mixtures
SANDS More than half of coarse fraction smaller than No. 4 sieve size	**Clean Sands** (Little or no fines)	
	SW	Well-graded sands, gravelly sands, little or no fines
	SP	Poorly graded sands, gravelly sands, little or no fines
	Sands with Fines (Appreciable amount of fines)	
	SM^{d}_{u}	Silty sands, sand-silt mixtures
	SC	Clayey sands, sand-clay mixtures

FINE-GRAINED SOILS

(More than half of material is smaller than No. 200 sieve.)

SILTS AND CLAYS Liquid limit less than 50%	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity
	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
	OL	Organic silts and organic silty clays of low plasticity
SILTS AND CLAYS Liquid limit greater than 50%	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
	CH	Inorganic clays of high plasticity, fat clays
	OH	Organic clays of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS	PT	Peat and other highly organic soils

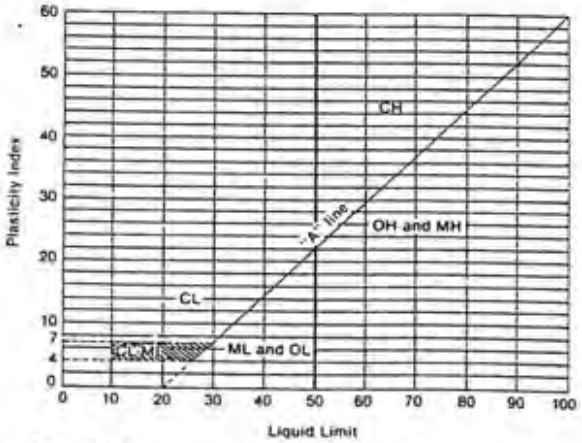
LABORATORY CLASSIFICATION CRITERIA

GW	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
GP	Not meeting all gradation requirements for GW	
GM	Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
GC	Atterberg limits above "A" line with P.I. greater than 7	
SW	$C_u = \frac{D_{60}}{D_{10}}$ greater than 6; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
SP	Not meeting all gradation requirements for SW	
SM	Atterberg limits below "A" line or P.I. less than 4	Limits plotting in hatched zone with P.I. between 4 and 7 are borderline cases requiring use of dual symbols.
SC	Atterberg limits above "A" line with P.I. greater than 7	

Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows:

Less than 5 per cent	GW, GP, SW, SP
More than 12 per cent	GM, GC, SM, SC
5 to 12 per cent	Borderline cases requiring dual symbols

PLASTICITY CHART



For classification of fine-grained soils and fine fraction of coarse-grained soils.

Atterberg Limits plotting in hatched area are borderline classifications requiring use of dual symbols.

Equation of A-line: PI = 0.73 (LL - 20)

Appendix 3:
Well Log Data

Well Construction Report — **TW324**
WISCONSIN UNIQUE WELL NUMBER

Drinking Water and Groundwater - DG/5 Form 3300-077A
Department of Natural Resources, Box 7921
Madison WI 53707

Property Owner: BLOSSOM SHOP	Phone #: (608)339-6447
Mailing Address: 699 S MAIN ST	
City: FRIENDSHIP	State: WI Zip Code: 53934
County: Adams	Co. Permit #:
Notification #: 25027001	Completed: 01-11-2007
Well Constructor (Business Name): QUINNELL'S QUALITY SEPTICS INC	Lic. #: 7257
Facility ID # (Public Wells):	
Address: PO BOX 68 DELLWOOD WI 53927	
Well Plan Approval #:	
Approval Date (mm-dd-yyyy):	
Hicap Permanent Well #:	Common Well #:
Specific Capacity:	
3. Well serves: 1 # of	
Private,potable	
Heat Exchange____# of drillholes	
Hicap Well ?: No	
Hicap Property ?: No	
Hicap Potable ?	

1. Well Location

Village of FRIENDSHIP	Fire # (if avail.): 601
Street Address or Road Name and Number: WEST ST	
Subdivision Name:	Lot #: 1 Block #:
Latitude / Longitude in Decimal Degree (DD): 43.9682 °N -89.8183 °W	Method Code: GCD013
SE SE or Govt Lot #:	Section: 6 Township: 17 N Range: 6 E

2. Well Type Replacement
of previous unique well # constructed in
Reason for replaced or reconstructed well ?
HOLE IN WELL
Construction Type: Jetted

4. Potential Contamination Sources - ON REVERSE SIDE

5. Drillhole Dimensions and Construction Method

Dia. (in.)	From (ft.)	To (ft.)
6	Surface	5
2	5	46

Upper Enlarged Drillhole / Lower Open Bedrock
Rotary - Mud Circulation .....
Rotary - Air .....
Rotary - Air & Foam .....
Drill-Through Casing Hammer
Reverse Rotary
Cable-tool Bit ____in. dia...
Dual Rotary .....
Temp. Outer Casing ____in. dia
Removed? ____depth ft. (if NO explain on back side)

Geology Codes	8. Geology Type, Caving/Noncaving, Color, Hardness, etc...	From (ft.)	To (ft.)
- - S -	SAND	Surface	30
- - C -	CLAY	30	35
- - Y -	SAND & GRAVEL	35	46

6. Casing, Liner, Screen

Dia. (in.)	Material, Weight, Specification Manufacturer & Method of Assembly	From (ft.)	To (ft.)
2	WHEATLAND ASTM-A589 .154 WALL 3.75#/FT 2 INCH THREADED COUPLINGS	Surface	42
Dia. (in.)	Screen type, material & slot size	From (ft.)	To (ft.)
1.25	CAMPBELL 4 FT 80 GAUZE	42	46

7. Grout or Other Sealing Material
Method

Kind of Sealing Material	From (ft.)	To (ft.)	# Sacks Cement
SAND	Surface		

9. Static Water Level
22 ft. below ground surface

10. Pump Test
Pumping level 22 ft. below surface
Pumping at 10 GP M for 1 Hrs.
Pumping Method ?

11. Well Is
12 in. above grade
Developed ? Yes
Disinfected ? Yes
Capped ? Yes

12. Notified Owner of need to fill & seal ?
Filled & Sealed Well(s) as needed? Yes

13. Constructor / Supervisory Driller	Lic #	Date Signed
CQ		01-18-2007
Drill Rig Operator	Lic or Reg #	Date Signed
CDQ		01-18-2007

WISCONSIN UNIQUE WELL NUMBER **TW324**

Well Construction Report
WISCONSIN UNIQUE WELL NUMBER **XL205**

Drinking Water and Groundwater - DG/5 Form 3300-077A
Department of Natural Resources, Box 7921
Madison WI 53707

Property Owner: ROSEBERRYS FUNERAL HOME	Phone #: (608)339-3551
Mailing Address: PO BOX 620	
City: FRIENDSHIP	State: WI Zip Code: 53934

County	Co. Permit #	Notification #	Completed
Adams		51095678	06-23-2014

Well Constructor (Business Name)	Lic. #	Facility ID # (Public Wells)
QUINNELLS SEPTIC & WELL SERVICE INC	97	

Well Plan Approval #

Address: 1894 DAKOTA AVE
FRIENDSHIP WI 53934-9802

Approval Date (mm-dd-yyyy)

Hicap Permanent Well # | Common Well # | Specific Capacity

3. Well serves 1 # of IRRIGATION
Private, non-potable
Heat Exchange____# of drillholes

Hicap Well ? No
Hicap Property ? No
Hicap Potable ?

1. Well Location

City of FRIENDSHIP | Fire # (if avail.): 512

Street Address or Road Name and Number: MAIN ST

Subdivision Name	Lot #	Block #
ASSESSORS PLAT #1	9 & P	

Latitude / Longitude in Decimal Degree (DD)	Method Code
43.96853 °N -89.81588 °W	GPS008

SW SW or Govt Lot #	Section	Township	Range
	5	17 N	6 E

2. Well Type New Well
of previous unique well # constructed in

Reason for replaced or reconstructed well ?

Construction Type: Jetted

4. Potential Contamination Sources - ON REVERSE SIDE

5. Drillhole Dimensions and Construction Method

Dia. (in.)	From (ft.)	To (ft.)
6	Surface	5
2	5	67

Upper Enlarged Drillhole / Lower Open Bedrock
Rotary - Mud Circulation .....
Rotary - Air .....
Rotary - Air & Foam .....
Drill-Through Casing Hammer
Reverse Rotary
Cable-tool Bit ____in. dia...
Dual Rotary .....
Temp. Outer Casing ____in. dia
Removed? ____depth ft. (If NO explain on back side)

Geology Codes	8. Geology Type, Caving/Noncaving, Color, Hardness, etc...	From (ft.)	To (ft.)
- N S -	FINE SAND	Surface	5
- N X -	FINE SAND & CLAY	5	30
- - C -	CLAY	30	47
- M S -	MED SAND	47	67

6. Casing, Liner, Screen

Dia. (in.)	Material, Weight, Specification Manufacturer & Method of Assembly	From (ft.)	To (ft.)
2	JAZEENA STEEL ASTM A53 ERW SCH 40 HEAT #A111/153	Surface	63
Dia. (in.)	Screen type, material & slot size	From (ft.)	To (ft.)
1.25	4' JOHNSON 7 SLOT	63	67

7. Grout or Other Sealing Material
Method

Kind of Sealing Material	From (ft.)	To (ft.)	# Sacks Cement
SAND	Surface		

9. Static Water Level
19 ft. below ground surface

10. Pump Test
Pumping level 19 ft. below surface
Pumping at 10 GP for 1 Hrs.
Pumping Method ?

11. Well Is
12 in. above grade
Developed ? Yes
Disinfected ? Yes
Capped ? Yes

12. Notified Owner of need to fill & seal ?
Filled & Sealed Well(s) as needed?

13. Constructor / Supervisory Driller	Lic #	Date Signed
DDQ		06-23-2014
Drill Rig Operator	Lic or Reg #	Date Signed

WISCONSIN UNIQUE WELL NUMBER **XL205**

References

"Adams County Tax parcel information search." [Online]. Available: http://www.adamscountylandrecords.com/. [Accessed: 05-Mar-2021].

"Bearing Capacity," *SD&W*. [Online]. Available: http://www.sd-w.com/channel_flow/bearing_capacity/. [Accessed: 08-Mar-2021].

"Central Lowland Province (U.S. National Park Service)," *National Parks Service*. [Online]. Available: https://www.nps.gov/articles/centrallowlandprovince.htm. [Accessed: 08-Mar-2021].

"Critical bulk density values," *Urban Design - Landscape plants - Edward F. Gilman - UF/IFAS*. [Online]. Available: https://hort.ifas.ufl.edu/woody/critical-value.shtml. [Accessed: 08-Mar-2021].

"GEOTECHNICAL INFO .COM," *Bearing Capacity Technical Guidance on the Geotechnical Information Website*. [Online]. Available: http://www.geotechnicalinfo.com/bearing_capacity_technical_guidance.html#2shallowfoundations. [Accessed: 08-Mar-2021].

L. L. C. Engineers Edge, "Soil Cohesion Table," *Engineers Edge - Engineering, Design and Manufacturing Solutions*, 03-Feb-2017. [Online]. Available: https://www.engineersedge.com/civil_engineering/soil_cohesion_table_13905.htm. [Accessed: 08-Mar-2021].

"Physiographic Provinces," *National Parks Service*. [Online]. Available: https://www.nps.gov/subjects/geology/physiographic-provinces.htm. [Accessed: 08-Mar-2021].

"Regional Geology of the United States," *GotBooks.MiraCosta.edu*. [Online]. Available: https://gotbooks.miracosta.edu/geology/regions/index.html. [Accessed: 08-Mar-2021].

S. User, "Angle of friction," *My Site*. [Online]. Available: http://www.geotechdata.info/parameter/angle-of-friction. [Accessed: 08-Mar-2021].

StructX.com, “Typical Angle of Repose Values for Various Soil Types,” *Angle of Repose Values for Various Soil Types*. [Online]. Available: https://structx.com/Soil_Properties_005.html. [Accessed: 08-Mar-2021].

“Well Construction Reports.” [Online]. Available: https://wi-dnr.maps.arcgis.com/apps/LocalPerspective/index.html?appid=0cc1b8d9c40749ba9b9e5c2c90848e23. [Accessed: 07-Mar-2021].

“Wikimedia.” [Online]. Available: https://upload.wikimedia.org/wikipedia/commons/thumb/0/06/Adams_County_Wisconsin_incorporated_and_unincorporated_areas_Monroe_highlighted.svg/1200px-Adams_County_Wisconsin_incorporated_and_unincorporated_areas_Monroe_highlighted.svg.png .

UniverCity Alliance
UNIVERSITY OF WISCONSIN–MADISON

About UniverCity Year

UniverCity Year is a three-phase partnership between UW-Madison and communities in Wisconsin. The concept is simple. The community partner identifies projects that would benefit from UW-Madison expertise. Faculty from across the university incorporate these projects into their courses, and UniverCity Year staff provide administrative support to ensure the collaboration's success. The results are powerful. Partners receive big ideas and feasible recommendations that spark momentum towards a more sustainable, livable, and resilient future. Join us as we create better places together.

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