Civil and Environmental Engineering

Bethel AME Memorial Site Design

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Executive Summary

The Bethel African Methodist Episcopal (AME) Church Memorial Site Project proposes the development of a permanent memorial in Clinton, Iowa to preserve the legacy of the historic church. Established in 1868 and constructed in 1884, the church served as a central institution for Clinton's African American community and reflects the city's broader historical significance in African American history. Due to severe structural deterioration, the existing building must be demolished. This project ensures that the cultural, historical, and community significance of the site is retained through a thoughtfully designed public space.

The objective of the project is to deliver a feasible, cost-effective site design that preserves the historical identity of the church while creating an accessible and sustainable community space. The proposed design maintains the original footprint and spatial experience of the church and incorporates preserved architectural elements, including the stained-glass windows. These elements are supported by durable structural systems designed for long-term performance. Additional features include an elevated viewing platform aligned with the original entrance, interpretive walls for historical education, accessible walkways compliant with ADA standards, site lighting, and grading improvements.

Multiple design alternatives were evaluated based on cost, constructability, maintenance, historical representation, and community input. Options ranged from partial structural reconstructions and enclosed gathering spaces to open-air interpretive concepts. Alternatives that introduced complex structural systems, such as roofed enclosures or full reconstructions, were determined to be less feasible due to higher costs, increased maintenance, and site constraints. The selected design reflects a "present but not" approach, which preserves the presence and spatial memory of the church without reconstructing the full structure, resulting in a balanced solution that maximizes historical impact while maintaining simplicity and long-term sustainability.

Engineering analysis confirms the feasibility of the proposed design. Structural systems for preserved elements were designed in accordance with applicable standards to ensure safety and durability. A hydraulic analysis determined that post-development conditions will maintain hydraulic performance, eliminating the need for additional stormwater infrastructure. Accessibility features, including stairs, ramps, railings, and site circulation, comply with applicable design standards. Lighting design meets safety requirements while minimizing operational and maintenance costs.

Key constraints influencing the design include limited funding, a confined site footprint, proximity to adjacent structures, and the need to balance historical authenticity with constructability and long-term maintenance. These constraints guided the selection of a streamlined design that minimizes structural complexity while preserving the cultural and historical significance of the site. The estimated total project cost is $180,448, including construction, contingency, and engineering expenses. This cost reflects a financially achievable project that aligns with anticipated funding sources, including grants and public investment. Final deliverables include a complete set of construction drawings, existing conditions, demolition, grading and site plans, structural and hydraulic calculations, and a detailed cost estimate. These materials provide a clear path forward for implementation.

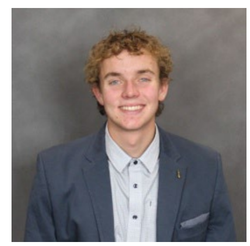
Organization Qualifications and Experience

Design Team Description and Experience

The design team consisted of Samuel Vis, Eli Friesen, and Marista Fraley, senior civil and environmental engineering students from the University of Iowa with a focus on structural analysis, site development, and hydraulic modeling. The team leveraged academic expertise and industry-standard software to deliver a compliant, sustainable site design. Samuel Vis served as the project manager and main point of contact for this project. Eli Friesen served as the technology support, and Marista Fraley was the editor.

Samuel Vis, the project manager for this team, worked as a construction superintendent for multiple years, overseeing the work of park and playground implementation for Chicago Public Schools. Although this project is less of a park and more of a memorial site, this on-site experience will prove to be meaningful. He also spent a summer as a land development engineering intern.

Eli Friesen has worked as a civil engineering intern in downtown Chicago, focused on pedestrian transportation. He has experience engaging with communities and incorporating their input into the design process. He has also navigated the registration and codes of the National Register of Historic Places/Sites on various projects.



Marista Fraley has nearly two years of experience as a civil engineering intern, with a strong focus on developing plans tailored to community needs. She also served as the construction manager for a pedestrian footbridge project in Eswatini. Marista was responsible for creating work schedules and collaborating closely with community members to ensure meaningful community involvement throughout the project.

Design Services

Project Scope

This project involved the design of a memorial site for Bethel AME Church in Clinton, Iowa. The design preserves the historical significance of the site while accommodating the necessary demolition of the existing structure due to structural deterioration. The proposed site reflects the original footprint and incorporates elements that represent the cultural and historical importance of the church.

The design aligns with criteria for potential eligibility for the National Register of Historic Places by maintaining historical character and recognizing the site's association with significant historical events and community contributions. Key design elements include preserved architectural features such as stained-glass windows, as well as interpretive components that convey the history of the church and its role in the community.

The final design package includes an existing conditions, demolition, grading, and site plan, structural details and hydraulic analysis (Appendices B–G Respectively). A formal presentation and project poster were also developed. The demolition plan identifies elements to be removed and those to be preserved. It is acknowledged that some materials may not be recoverable due to age and condition. The site plan reflects the original layout of the church while incorporating low-maintenance vegetation, consistent with Park and Recreation Department requirements. The structural details include support systems for preserved elements, particularly stained-glass windows, as well as freestanding wall features. The grading and hydraulic design ensure adequate stormwater management without the need for additional storm sewer infrastructure.

Work Plan

The project began with two site visits to Clinton. The first visit provided an initial understanding of the church and surrounding site conditions. We were able to meet our client, Gregg Obren, as well as Kathryn Wynn-Calvin, an involved stakeholder, in person. During this meeting, Gregg and Kathryn shared important context regarding the project, the history of Clinton, and the significance of Bethel.

The second visit was more technical and focused on collecting measurements to preserve the footprint of the church. Exterior measurements were taken, including wall dimensions, distances from adjacent sidewalks, and the locations and sizes of windows and stairs (Figure 1). This visit also provided the first opportunity to document interior conditions through photographs and measurements. Features of the church were recorded to be considered for preservation in the design.

Following these visits, initial design concepts were developed. These concepts were inspired by both site documentation and research into the rich history of Bethel and the broader Clinton community. The process highlighted influential individuals associated with the church, bolstered by the expertise of University of Iowa professor Dr. Ashley Howard—a researcher in Midwest African American Studies—and doctoral history student Will Tjeltveit, who specializes in memorialization. Their insights were instrumental during the research phase, shaping the "present but not" concept that guided subsequent iterations. This concept emphasizes key elements of the church, allowing visitors to experience the essence of the space even in the absence of the full structure.

Through biweekly client meetings, several design alternatives were refined. Each design incorporated elements discussed with the client, including the integration of stained-glass features and masonry structures, like the stair columns at the entrance of the church (Figure 1), to match the current structure. Four distinct concepts were ultimately developed and presented at a community forum in Clinton, providing an opportunity for public input and the synthesis of preferred elements. Following the forum, a final design was selected that reflects client feedback. The final design is supported by technical drawings and three-dimensional models (Appendix A).

Figure 1. Entrance of Bethel showing brick columns to be replicated

Constraints, Challenges, and Impacts

Constraints

There are multiple constraints attached to the design and implementation of the memorial site where Bethel AME Church now stands. Budget limitations represent a primary restriction, as funding is limited and largely dependent on government grants. This limited the possibilities and the overall creativity of the designs. In addition, the project schedule presented a significant challenge. Providing a limited timeframe to become familiar with the project requirements, local context, and community stakeholders while developing a memorial of considerable historical and cultural significance to Clinton's African American community.

Space is an additional design constraint for the memorial site. The church is situated on a small lot, 40' wide by 100' long, cornered by buildings to its south and east, as well as 3rd Street and 3rd Avenue to its west and north, respectfully (Figure 2). The proximity of the southern property line to the existing structure further limits opportunities for expansion or construction in that area.

Figure 2. Property limits of Bethel shown by the cyan colored box, emphasizing the city of right of way

Challenges

The primary challenges encountered during the design process included maintaining an appropriate aesthetic character, ensuring compliance with Americans with Disabilities Act (ADA) guidelines, and integrating the original stair configuration into the new site. There is a prominent red barn located immediately south of the site. Its strong visual presence had the potential to distract from the intended solemnity and reverence of the memorial (Figure 3). Developing a design strategy that established visual separation between this adjacent structure and the memorial environment proved challenging, particularly within project budget constraints. After evaluation, the client determined that the barn did not significantly compromise the experience of the site, and design efforts were focused on drawing visitors into the history of Bethel AME.

Compliance with ADA requirements presented an additional design constraint, particularly given the limited site area. The design needed to incorporate accessible routes, including ramps and landings, to ensure that all visitors could fully experience the site. With aesthetics in mind, the ramp also could not take away from the overall historical theme and accuracy of the site. This challenge was further compounded by the original stairs' condition. Although the existing stairs could not be preserved, the design incorporates a reconstructed version to maintain historical continuity. Due to their size and prominence at the front of the church, the stairs imposed spatial constraints that required careful coordination with other site elements.

Figure 3. Bethel, white building pictured on the left, with the red barn on the right

Societal Impact within the Community

Bethel AME Church was organized in 1868, with its building constructed in 1884. For generations, it stood as a cornerstone of the African American community in Clinton, Iowa. One of its most influential founding members, Melissa Glanton, played a pivotal role in bringing the church to life by selling $600 worth of books to help fund its construction. As a formerly enslaved woman, Glanton left a legacy through both her contributions and her descendants. In the early stages of this project, the design team met with former church member Kathryn Wynn-Calvin, who shared that this spirit of dedication and community was led largely by African American women. Women like LaMetta Wynn (Figure 4), the first Female African American Mayor in the state of Iowa and a faithful member of Bethel AME, were central to the church's identity.

That strong leadership sustained the church for over a century, until 2020, when it was ultimately overcome by the COVID-19 pandemic. Although the historic building is now slated for demolition, its story endures. Future generations may never have the opportunity to step inside Bethel AME Church, but the vision for this site is to ensure it is never forgotten. Clinton itself holds a rich history as a place of refuge for African Americans, playing an important role in the Underground Railroad. During harsh Midwestern winters, enslaved individuals crossed the frozen Mississippi River near Clinton, where a network of homes provided shelter and safety. This project is further driven by the hope of transforming the site into a National Historic Site, preserving both the legacy of the church and the city's role in this history for generations to come.

Figure 4. LaMetta Wynn, first black female mayor in Iowa and former Bethel AME congregant

Alternative Solutions Considered

Figure 5. President's House Site in Philadelphia, Pennsylvania, an inspiration for the design

The site of the nation's early executive mansion (Figure 5) served as a foundational real-life example that inspired the preservation methods utilized in our alternative designs. Namely, the strategy of preserving or recreating certain elements of the original structure allowed the site's history to be perceived as "present but not." Because the original stained-glass windows remained in good condition compared to other on-site elements, their natural beauty led to their selection as the focal point for each design concept. Ultimately, these windows served as an anchor to the past while providing a structural framework for modern integration.

Option 1: Preservation of Original Church Layout

This alternative preserved the original footprint and spatial organization of the church. Under this concept, the front staircase columns were to be removed and reconstructed; by removing the existing stairs and regrading the site to ground level, the design utilized those original columns and a protected stained-glass archway to create a unified, standalone entrance feature. This element was intended to mimic the present entrance, which features a stained-glass window overhead—to maintain a familiar visual threshold (Figure 1). Additionally, a rear wall was incorporated to provide space for a community mural or a backdrop for weddings and events.

Key advantages included maintaining the original church layout and historical character, preserving and highlighting key architectural elements, and providing space for community events. However, challenges included potential structural instability of stand-alone elements, along with exposure to weather and environmental deterioration. From a structural and maintenance perspective, these factors may reduce the long-term durability of the design. Additionally, this option does not address aesthetic differences with adjacent buildings.

Option 2: Simple

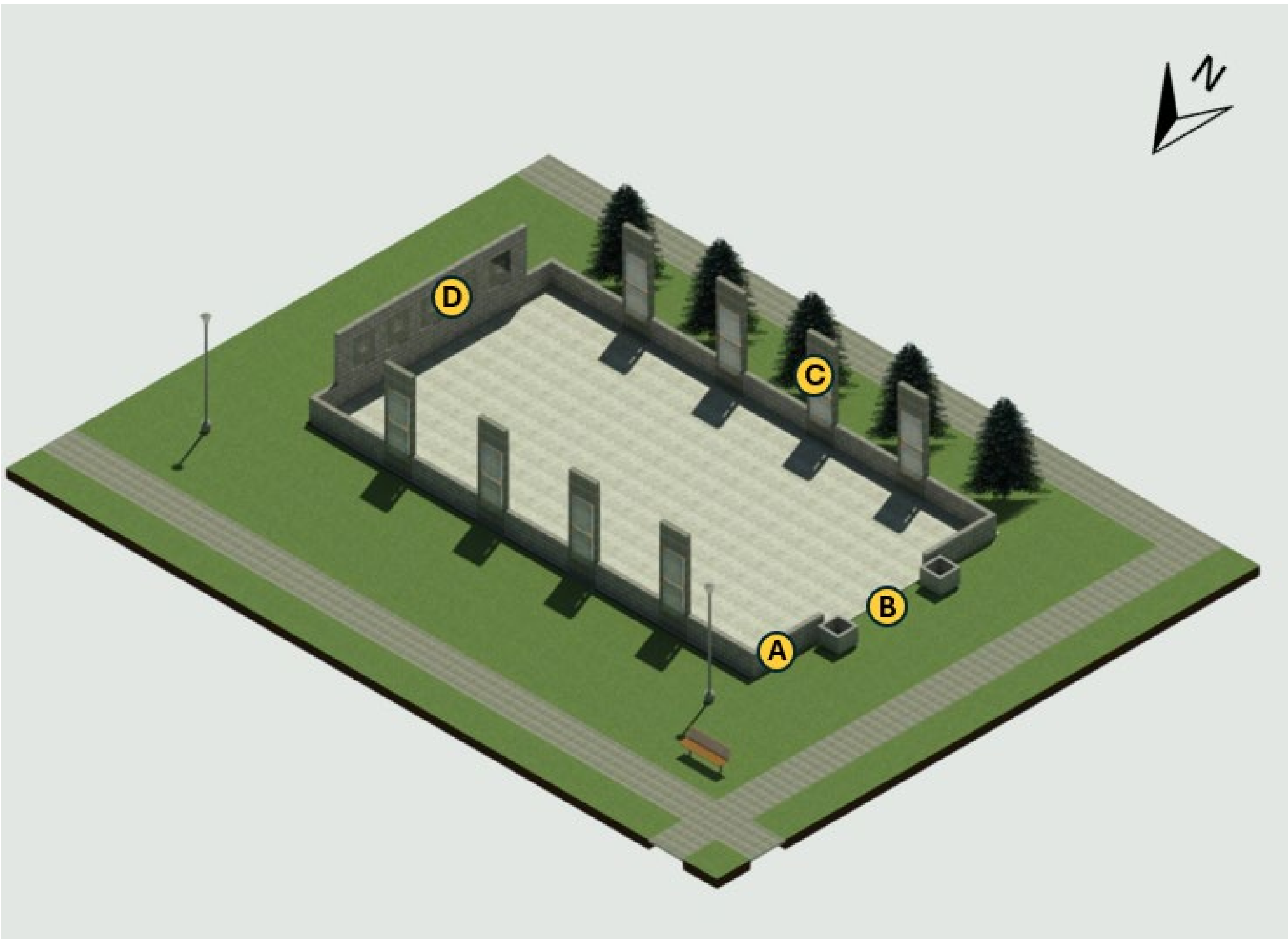


Figure 6. Alternative maintains original layout with a short wall on the east and a tree barrier to the south

This design featured 2-foot-tall walls (Figure 6A) extending around the north, south, and portions of the west sides, intentionally leaving a 14-foot opening to provide access to the site (Figure 6B). The layout matched the original footprint of the church, with the stained-glass windows positioned in their original locations on the north and south sides (Figure 6C). The east side featured an 8-foot-tall, 18-foot-long wall (Figure 6D) to accommodate plaques and interpretive elements designed to convey the site's history.

This approach preserved the footprint while emphasizing interpretation and education, allowing visitors to engage with the site's history in a meaningful way. However, it provided limited vertical enclosure and may offer less functional space for events compared to other alternatives.

Option 3: Choir Loft

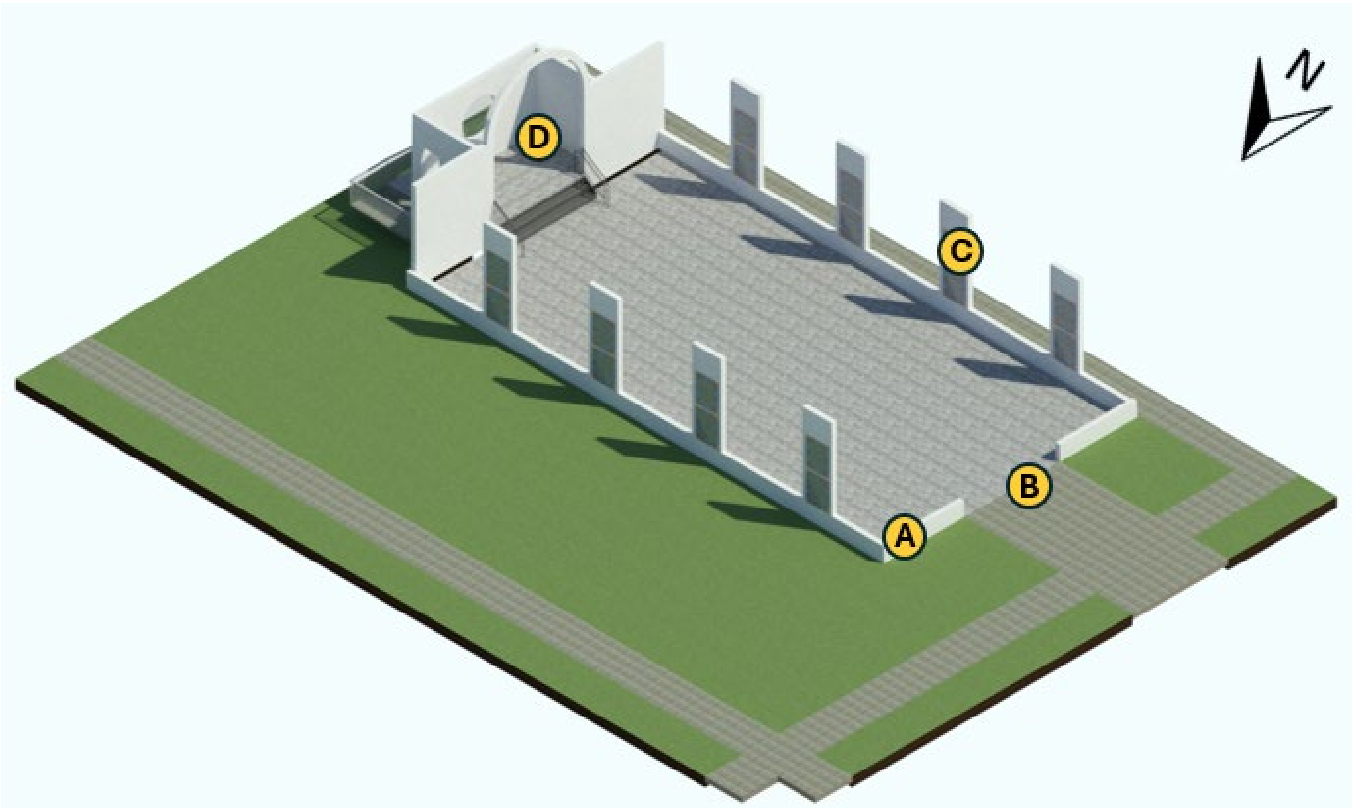


Figure 7. Alternative maintains the church layout and includes a redesign of the existing choir loft with ADA accessibility

This design had two-foot-tall walls, (Figure 7A) extending around the north, south, and portions of the west sides (excluding the 14’ opening to the park, Figure 7B). The wall matched the original footprint of the church with the stained-glass windows in their original locations on the north and south sides (Figure 7C). On the east side, the original choir loft was recreated with 9’ walls on either side and an archway spanning the middle (Figure 7D). This archway matched the existing interior of the building. The choir loft was 8’ by 16’ and elevated 2’ from ground level. The loft was accessible by stairs and an ADA-compliant ramp.

Benefits of this concept included preserving the church’s character, incorporating original architectural elements, and creating a functional space for events such as weddings or worship services. However, it would have higher construction costs, a more complex structural system, and may have raised concerns related to vandalism and security, given the project location. From a cost and site security perspective, these factors impacted overall feasibility.

Option 4: Mural Wall

Figure 8. Alternative retains the design features of option 3 while including a buffer wall between the neighboring site

This alternative built upon the choir loft concept by introducing a full, free-standing wall (Figure 8A) intended for a local artist to paint a mural reflecting the history of the Black community in Clinton. The concept stemmed from an existing municipal tradition, the "Paint it Back Festival," where the community commissions artists for an annual mural competition. This wall was designed to facilitate a similar event, providing a dedicated space to celebrate, record, and educate the public on local Black history. By integrating this feature, the design aimed to strengthen the project's societal impact while providing a significant visual buffer for the site.

A primary benefit is the creation of a visual buffer between the site and the adjacent property, which contains a large red structure, thereby improving privacy and solemnity of the site. However, this introduces additional structural elements and increased cost. From a constructability and budget standpoint, the added wall increases project complexity.

Option 5: Frame Structure

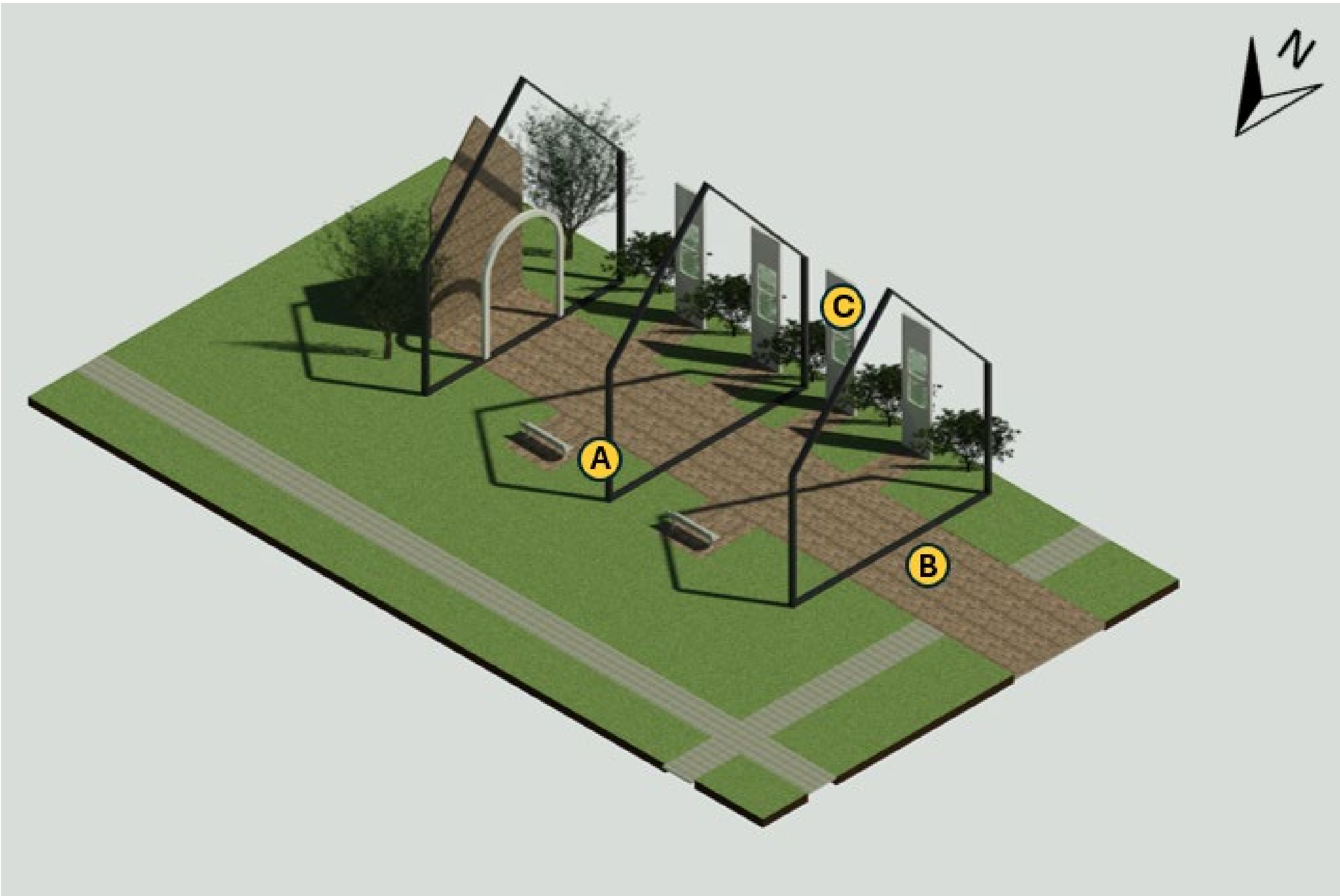


Figure 9. Alternative with brick "aisle" walking path with steel frames overhead to simulate the church

This design utilized a steel frame (Figure 9A) to represent the structural form of the church. The frame system simulated the walls and roof of the church with three frames equally spaced along the length of the structure. A central brick pathway (Figure 9B) guides visitors through space, representing the aisle of the original church. Trees on the south side, along with four stained-glass windows (Figure 9C), will create a buffer between our site and the neighboring building. This approach offers a modern interpretation of the original structure while preserving its form and spatial experience. It creates a visually engaging and symbolic representation of the church.

Option 6: Ground-Level Pavilion with Shelter Roof

This concept introduces a park-style shelter roof constructed over a ground-level foundation. The stained-glass would be encased within brick columns that reflect the original church's color and architecture. These columns serve a dual purpose by providing structural support for the roof and providing framing and protection for the stained-glass windows.

Advantages include providing weather protection for both the stained-glass and occupants, integrating historic materials with new construction, improving structural stability, and supporting community gatherings. However, this option may reduce the perceived sacredness of the site and result in a partial loss of the original church form. The roof and brick pillars increase the complexity of the implementation. From a constructability and cost standpoint, the added structural elements may require additional resources and coordination.

Option 7: Gazebo Structure

This option departs from the original church geometry to introduce a gazebo-style structure. The stained-glass panels would be installed between columns surrounding the perimeter of the structure. This would provide space with 360-degree access and visibility. Visitors would be surrounded by the historical elements of the church.

This approach creates an open and welcoming environment, provides weather protection, allows the stained-glass to be viewed from multiple perspectives, and supports community events. However, this design does not preserve the historic church geometry and may be seen as a significant departure from the site's origin. From a historical preservation standpoint, this alternative may not adequately reflect the original architectural intent.

Option 8: Stained-Glass Roof Feature

In this design, the stained-glass would be incorporated into a roof structure, creating a prominent visual feature visible both from within the space and from surrounding areas. The roof could serve as a focal point and landmark, drawing visitors from the local community and beyond.

This concept creates a unique and visually striking destination, maximizes the visibility of the stained-glass, provides weather protection, and has potential for a strong regional tourism draw. This would require higher structural and construction costs, increase the maintenance requirements for the site, and raise concerns about durability.

Selected Design

Selection of the preferred alternative resulted from an iterative design process that prioritized community input, recognizing that the project ultimately serves the public. Through a public forum, the designs were refined according to the ideas gathered. In addition to public input, key factors influencing the final design included cost, constructability, maintenance requirements, structural feasibility, and site constraints. The site width of approximately 40 feet in the north-south direction limited the placement and scale of design elements (Figure 2). Cost and maintenance considerations also led to minimizing structural components, particularly roofed structures, to improve long-term feasibility. The selected alternative maintains the original layout and spatial experience of the church while minimizing walls, roofing, and structural enclosure. This approach preserves the presence and memory of the church without fully reconstructing it, achieving a balance between historical representation, cost efficiency, and long-term maintainability.

Final Design Details

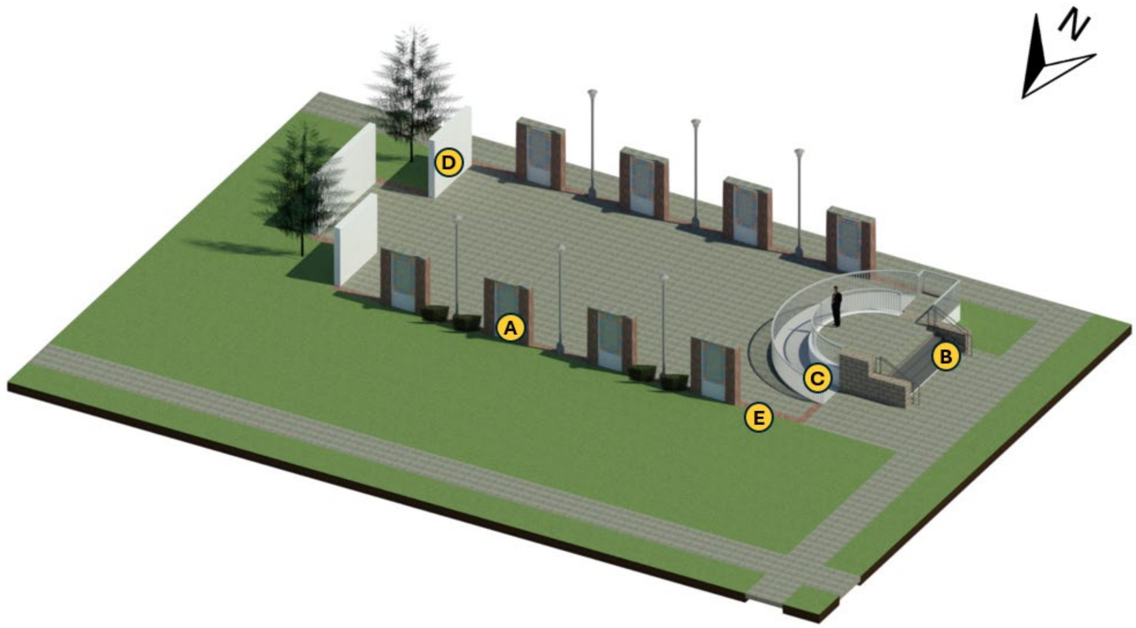


Figure 10. Final design rendering featuring an open-air, low maintenance design

Site Plan

The final design to memorialize Bethel AME (Figure 10) highlights three key elements of the original church: its stained-glass windows (Figure 10A), front steps (Figure 10B), and choir loft walls (Figure 10D). It then revitalizes the space through an open-air design, creating a fresh yet reverent atmosphere. Stained-glass windows become an exhibit on the north and south sides of the site. They are seated between two sturdy columns and on top of a concrete foundation with an exterior brick façade to mirror the appearance of the original church. The front steps remain in their original location, preserving the feel of stepping up into the church. A lookout landing is implemented to replace the entrance into the building, allowing extra space for plaques to emphasize the people and the history of the building that stood before this memorial. The ADA compliant ramp and landing allow all visitors to experience the memorial and history of Bethel (Figure 10C). The ramp matches the shape of the viewing platform, so as not to distract or take away attention from the stairs.

Three standalone walls are the final addition. A 14-ft wide, 8-ft high wall is the centerpiece of this exhibit. It is accompanied by two 9-ft wide, 8-ft high walls, completing a symmetrical aesthetic. All three walls have the same brick façade, identical to the bases of the stained-glass window structures. Like the front step landing platform, these walls provide a place to add specific memorial elements. This large canvas allows the community to honor Bethel AME Church however they wish, ranging from scattered plaques about people of the church to a painted mural across all three walls. The final element is a 1-ft wide brick outline of the true dimensions and location of where Bethel AME Church sits now (Figure 10E), this aspect of the design educates visitors where the physical boundaries sat, finalizing the present-but-not ambiance.

This plan shows the location and dimensions for each design element (Appendix F). The site plan incorporates the existing sidewalks, as well as the new walkways to be installed. The walkways are designed to professional standards (SUDAS Chapter 12). The trees and bushes on the site plan provide shade and greenery to bring life to the site. There are also overhead lights on the site plan.

Structural Plan

The structural design and detailing were developed to preserve the existing footprint of Bethel while providing durable support for key elements. A primary focus of the design is the preservation of the historic stained-glass windows. To best preserve these windows, support structures were designed to stabilize, display, and protect the windows for long-term serviceability. Each window support structure consists of 16-inch-wide columns located on both sides of the window opening. The columns are composed of 8-inch reinforced concrete columns with a masonry brick facade to match the existing conditions of Bethel (Appendices G & H). Structural sizing and reinforcement of the columns for this site were determined in accordance with applicable ASCE standards (Appendix U).

The base of each stained-glass window is supported by a 2-foot-tall concrete masonry wall, matching the columns. A 2-inch concrete cap is provided at the top of the masonry wall to replicate the original windowsill while also serving as a protective and decorative element. The top of the windows will be capped with a 2-inch aluminum cap. There is an opportunity for decorative elements to be added to the aluminum cap in future design choices. On each side, there are plexiglass panels that will protect the windows from wear and tear as well as potential vandalism. Together, the side columns, masonry wall, caps, and plexiglass create a complete structural support system that provides lateral and vertical stability for the windows while preserving their original placement (Figure 11).

Figure 11. View directed south depicts original layout of the stained-glass windows

The foundations for the window support structures were designed in accordance with the procedures outlined in *Foundation Design: Principles and Practices (Coduto, 3rd ed.)*. Structural dead loads were calculated based on the self-weight of all structural components, as well as the weight of the windows themselves. The load was estimated as a point load in the center of each footing to find the required footing dimension, thickness, and reinforcement (Appendices S & T).

The final design features three free-standing walls located at the south end of the property. Each wall is 8 feet in height and is supported by a rectangular spread footing (Appendices I & J). Footing design was completed using the same methodology described by Cuduto, with vertical loads modeled as concentrated loads in the center of each footing. Each wall is designed as a brick masonry wall with a 2-inch reinforced concrete core. The masonry bricks for the walls match the window support structures. The center wall has a width of 14 feet, while the two adjacent side walls each have widths of 9 feet.

Railings and Stairs

The design is best viewed from a two-and-a-half-foot landing that mimics the original entrance to the church (Figure 12). The stairs and railings are designed to provide accessible entry from the three-foot landing, which reflects the original church entrance elevation. Stairs and railings were designed in accordance with professional standards (SUDAS Section 9080 and ADA Standards Sections 504 and 505). The risers are six inches in height, and the treads are one foot in length, in accordance with SUDAS guidance. The total elevation change of two and a half feet requires five risers and four treads. The top rail height is thirty-four inches above the stair nosing, with an intermediate rail at twenty-two inches to improve safety and accessibility. Rail supports were spaced to maintain a span of less than five feet, resulting in the use of two vertical support posts on the run.

For a rise of greater than 30 inches, it is required to implement a guardrail. While it was not necessary for ADA compliance, the guardrail was incorporated as an aesthetic feature to support plaques and storytelling elements. The guardrail has a top rail at forty-two inches in height, and a bottom rail located four inches above the concrete, meeting the SUDAS minimum height requirement and four-inch sphere standard for guardrail systems (Appendix R). The pickets are also spaced at four inches, in accordance with SUDAS guidelines. A two-and-a-half-by-two-and-a-half-inch post is placed every eight feet. The top and bottom rails have the same cross-sectional dimensions as the posts.

Figure 12. Existing entrance to church

Lighting

The site lighting design provides minimal illumination to enhance visibility and deter vandalism while maintaining cost efficiency. Lighting was designed in accordance with SUDAS Design Manual Chapter 11, which specifies illumination requirements based on pedestrian conflict classification. This area was classified as a low pedestrian conflict area due to its limited nighttime use. The lumen method was used to determine illumination levels, and a minimum average maintained illuminance of 0.5 foot-candles was selected in accordance with SUDAS guidance for low conflict areas. Based on an estimated total site area of 4,000 square feet, the required output was calculated to be 3,600 lumens. To account for uniformity requirements and to reduce dark areas, it is best practice for the final design to total 4,000 lumens. The lighting system consists of six thirty-watt LED luminaires mounted on poles located along both sides of the site. Each fixture provides approximately 2,500 lumens and is mounted at a height of 10 feet. Lighting uniformity was designed to meet a maximum average-to-minimum ratio of 4:1, consistent with SUDAS requirements. Look at Appendix N for lighting calculations.

Hydraulic Analysis

A hydraulic analysis was performed to verify that post-development conditions would match or improve upon pre-development conditions. Although referred to as “pre-development,” the site is currently developed, with an existing building and associated impervious surfaces. The proposed post-development conditions maintain the total impervious area compared to existing conditions; therefore, additional stormwater storage is not required.

To confirm this, peak flow rates for both pre- and post-development conditions were calculated using the Rational Method. These calculations are provided in Appendix O. Rainfall intensity values were based on the 24-hour, 100-year storm event for Clinton, Iowa. Runoff coefficients were selected in accordance with the Iowa SUDAS Design Manual, Section 2B-4, which bases values on the hydrologic soil group. The site’s hydrologic soil group was determined using data from the United States Department of Agriculture (Appendix P).

Engineer’s Cost Estimate

DEMOLITION				
Item Description	Unit	Unit Cost	Quantity	Cost
BUILDING DEMOLITION - MASONRY	CF	0.52	54400	$ 28,288.00
BUILDING FOUNDATION CONCRETE 6" THICK	SF	0.8	2176	$ 1,740.80
BUILDING FOUNDATION 8" WALL	SF	1.19	2120	$ 2,522.80
4" CONCRETE REMOVAL	SY	15.3	23.11	$ 353.60
DUMPSTER, WEEKLY RENTAL, 40 C.Y., 1 DUMP/WEEK	WEEK	850	13	$ 11,050.00
REMOVAL OF SIGN	EACH	107	1	$ 107.00
STAINED GLASS WINDOW REMOVAL AND RESTORATION	SF	200	273	$ 54,600.00

CONCRETE				
Item Description	Unit	Unit Cost	Quantity	Cost
PCC, CLASS C, 4 IN	SY	54	350	$ 18,900.00
80 LBS BAG OF CONCRETE (WALL FOOTINGS, 14')	EACH	6	216	$ 1,296.00
80 LBS BAG OF CONCRETE (WALL FOOTINGS, 9')	EACH	6	324	$ 1,944.00
80 LBS BAG OF CONCRETE (WINDOW FOOTINGS)	EACH	6	140	$ 840.00
80 LBS BAG OF CONCRETE (COLUMNS)	EACH	6	118	$ 708.00
CONCRETE FORMING (8X8 COLUMNS), 4 USE	EACH	14.9	4	$ 59.60
FORM IN PLACE, STAIR	EACH	35	1	$ 35.00
CONCRETE LABORERS	HR	35	40	$ 1,400.00

BRICK				
Item Description	Unit	Unit Cost	Quantity	Cost
BRICK BUILDING OUTLINE	EACH	0.55	750	$ 412.50

SUBBASE				
Item Description	Unit	Unit Cost	Quantity	Cost
GRANULAR SUBBASE	SY	7.74	325	$ 2,515.50

FILL				
Item Description	Unit	Unit Cost	Quantity	Cost
EXCAVATION CLASS 10 ROADWAY AND BORROW	CY	4.3	515	$ 2,214.50
HAULING CLASS 10 ROADWAY AND BORROW	CY	4.5	515	$ 2,317.50

LIGHTING + SIGNAGE				
Item Description	Unit	Unit Cost	Quantity	Cost
14' ALUMINUM LIGHT POLE	EACH	1050	6	$ 6,300.00
NEW SIGN, 3' X 5'	EACH	1000	1	$ 1,000.00

WALLS + STAIR LANDING				
Item Description	Unit	Unit Cost	Quantity	Cost
8' WALLS, 2" CONCRETE + REBAR, 8" MASONRY	LF	180	32	$ 5,760.00
STAIR LANDING WALL, 2.5'	LF	120	25	$ 3,000.00
LANDING RAILING, 42"	LF	30	25	$ 750.00
STAIR RAILING, 36", ALUMINUM	LF	60	8	$ 480.00
ADA RAILING, 42"	LF	30	37	$ 1,110.00

LANDSCAPING				
Item Description	Unit	Unit Cost	Quantity	Cost
BLUE SPRUCE (2'-3')	EACH	138	2	$ 276.00
AMERICAN HAZELNUT SHRUB (2.5'-3')	EACH	98	4	$ 392.00
SODDING	SF	1.8	117	$ 210.60

CONSTRUCTION	$ 150,372.80
CONTINGENCY (5%)	$ 7,518.64
ENGINEERING/ ADMINISTRATION (15%)	$ 22,555.92
TOTAL PROJECT COST	$ 180,447.36

Appendices

Appendix A – Design Renderings

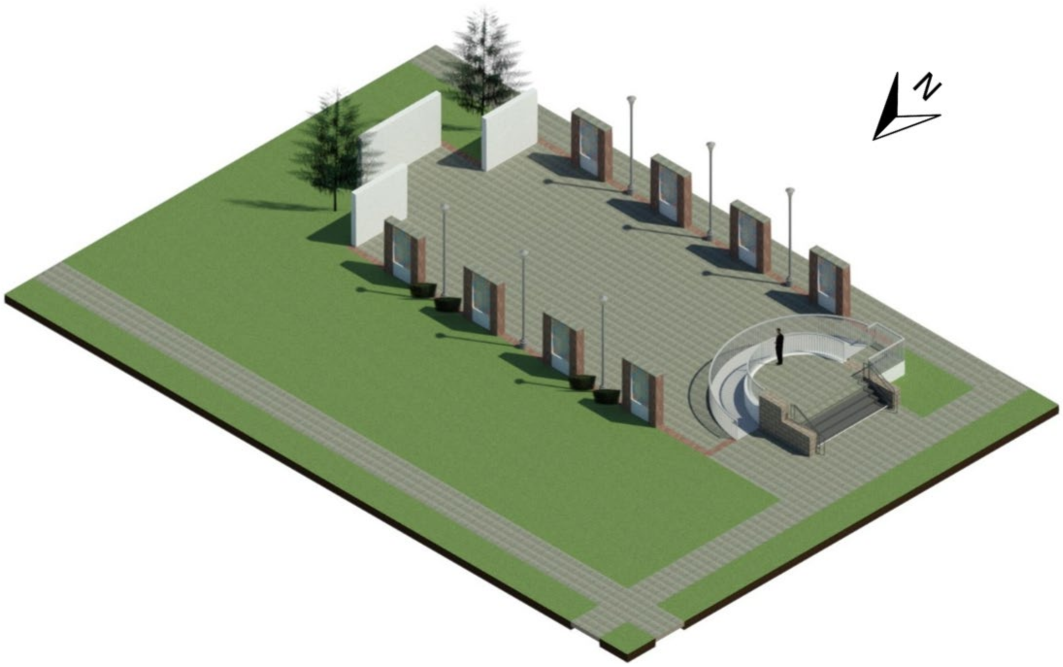


Figure 13. Design view from northwest corner.

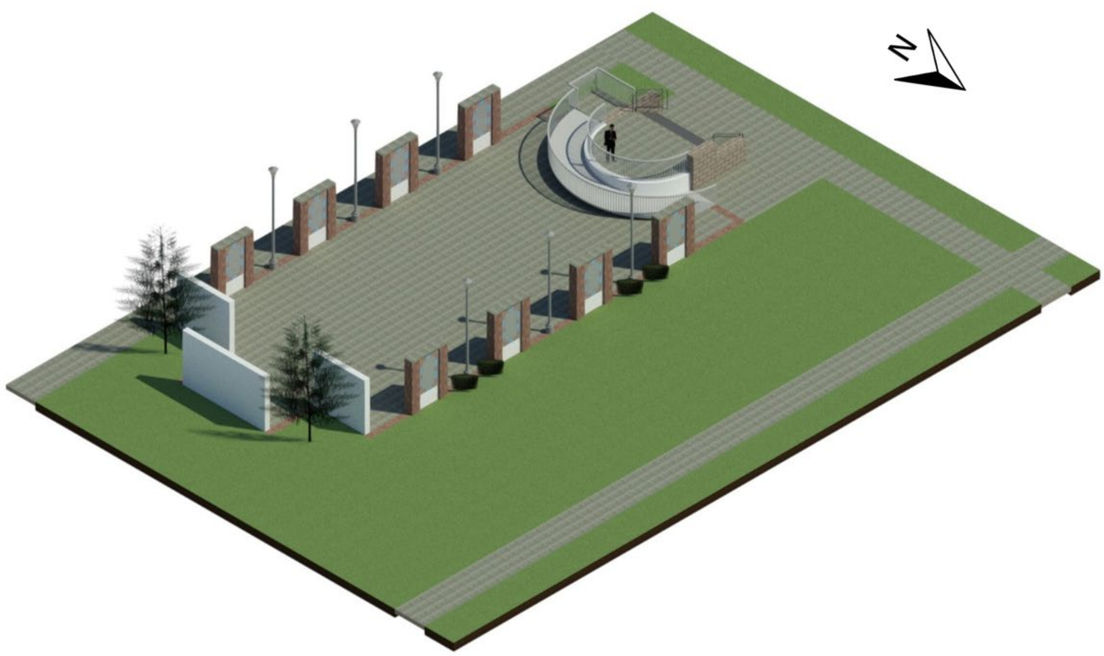


Figure 14. Northeast perspective of the design.

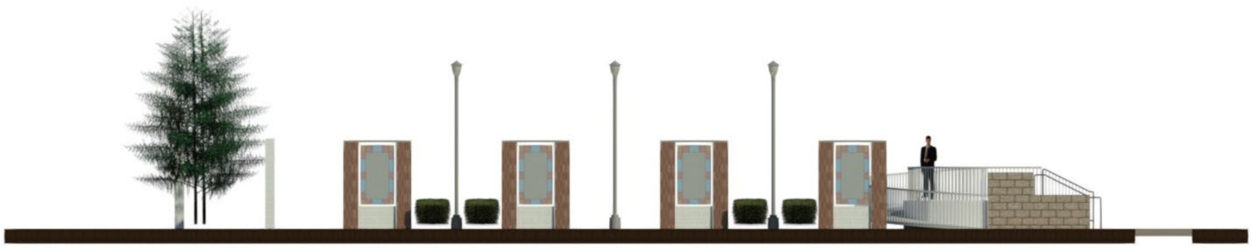


Figure 15. Side view from 3rd Avenue (north looking south).

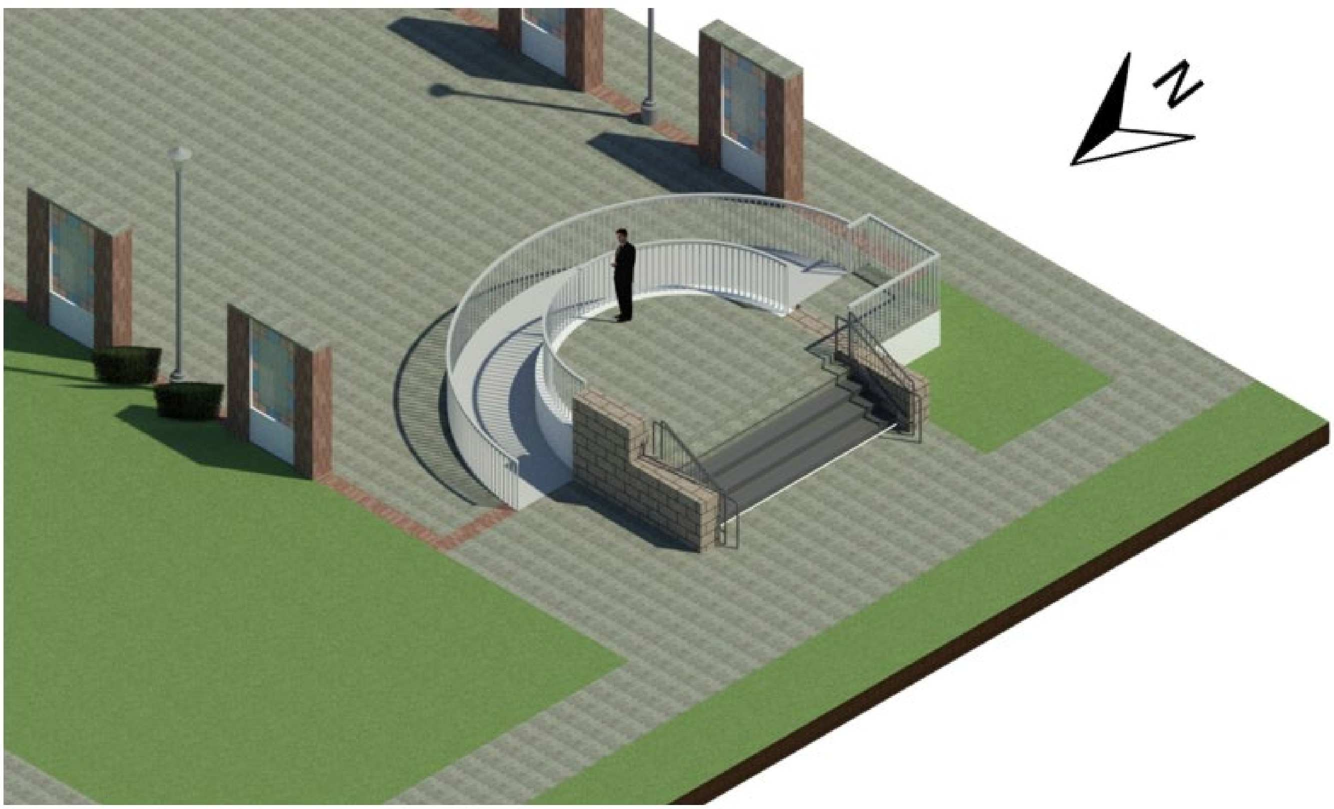


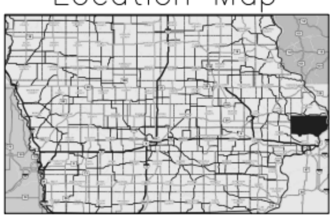
Figure 16. Detail view of stairs and accessible ramp

Appendix B – Drawing Set Title Page

BETHEL AME CHURCH MEMORIAL SITE

UNIVERSITY OF IOWA COLLEGE OF ENGINEERING

Location Map



DRAWING INDEX

SHEET NUMBER	SHEET TITLE
C–100	TITLE SHEET
C–101	EXISTING CONDITIONS
C–201	DEMOLITION PLAN
C–301	GRADING PLAN
C–401	SITE PLAN
C–501	WINDOW DETAILS
C–502	WINDOW DETAILS
C–503	STRUCTURAL DETAILS
C–504	STRUCTURAL DETAILS
C–505	LANDING DETAILS
C–506	LANDING DETAILS
C–507	MISCELLANEOUS DETAILS

PROJECT: CEE: 4850
DATE : 5/8//2026
DRAWN BY: ehf
REVISION:

THE UNIVERSITY OF IOWA
CIVIL AND ENVIRONMENTAL ENGINEERING
4105 SEAMANS CENTER FOR THE ENGINEERING ARTS AND SCIENCES
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IOWA CITY, IOWA 52242
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FAX: 319.335.5660
EMAIL: civil-hawks@uiowa.edu

EDUCATIONAL - NOT FOR CONSTRUCTION

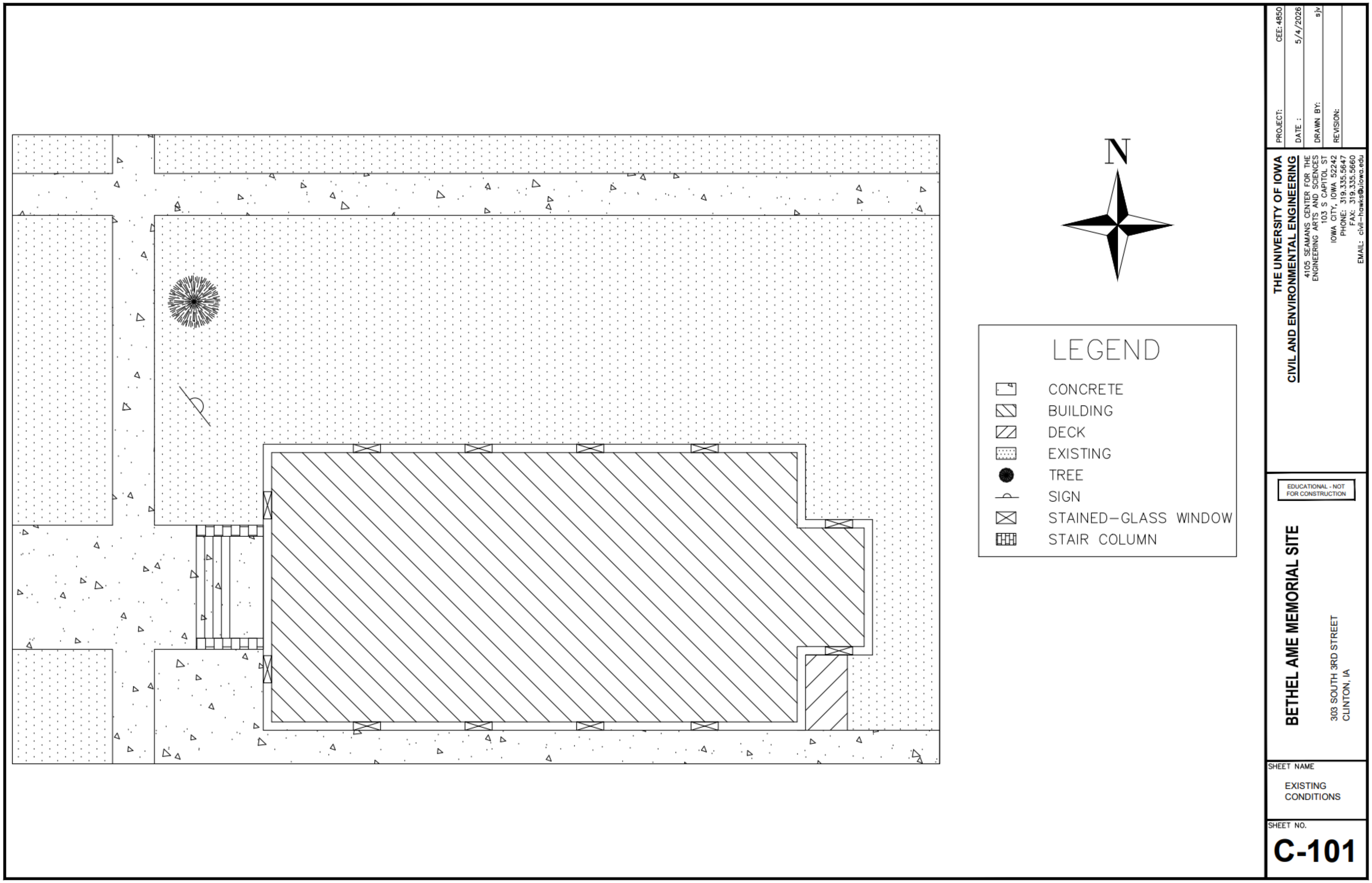
BETHEL AME MEMORIAL SITE

303 S 3RD STREET
CLINTON, IA

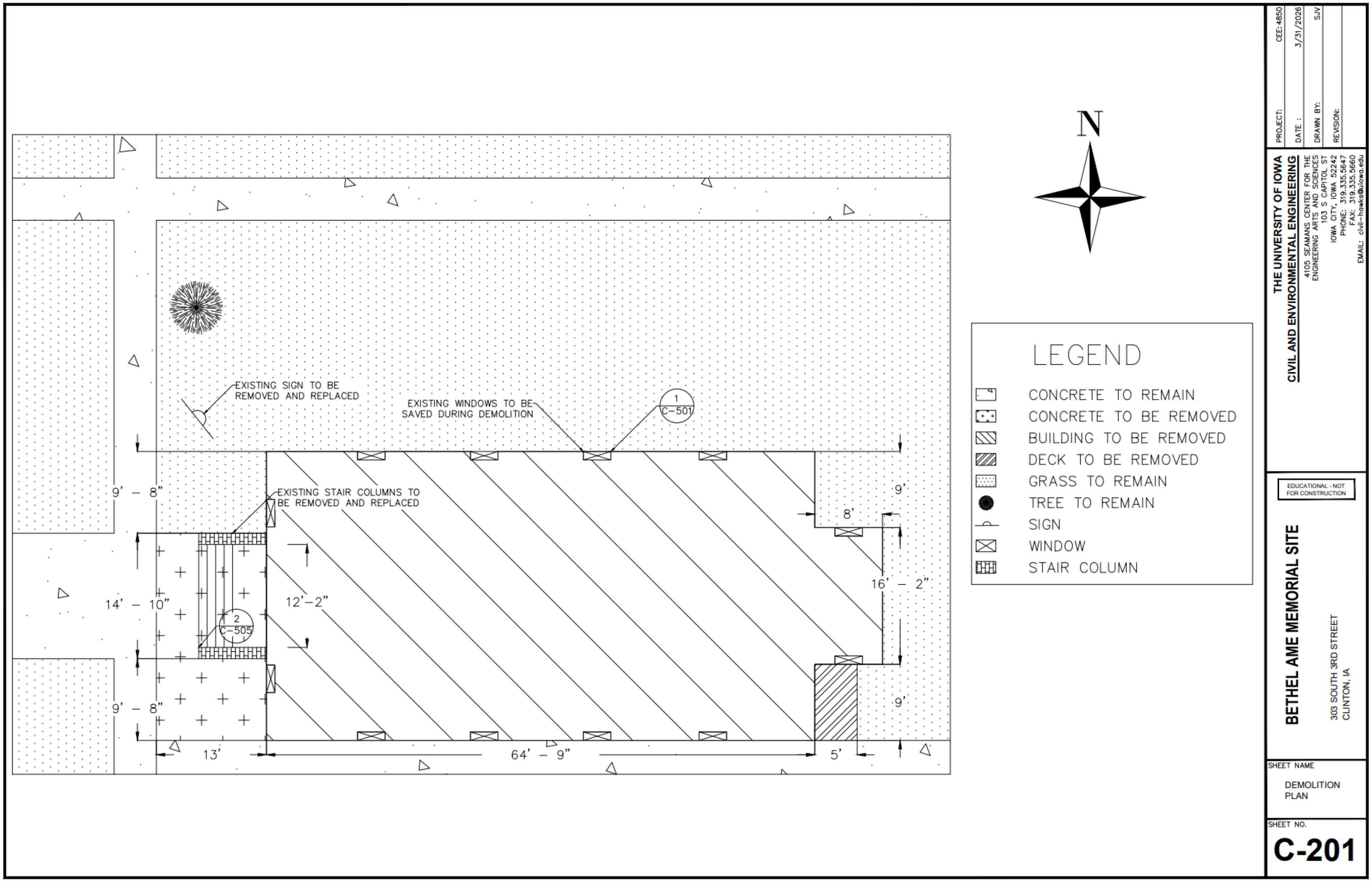
SHEET NAME
TITLE SHEET

SHEET NO.
C-100

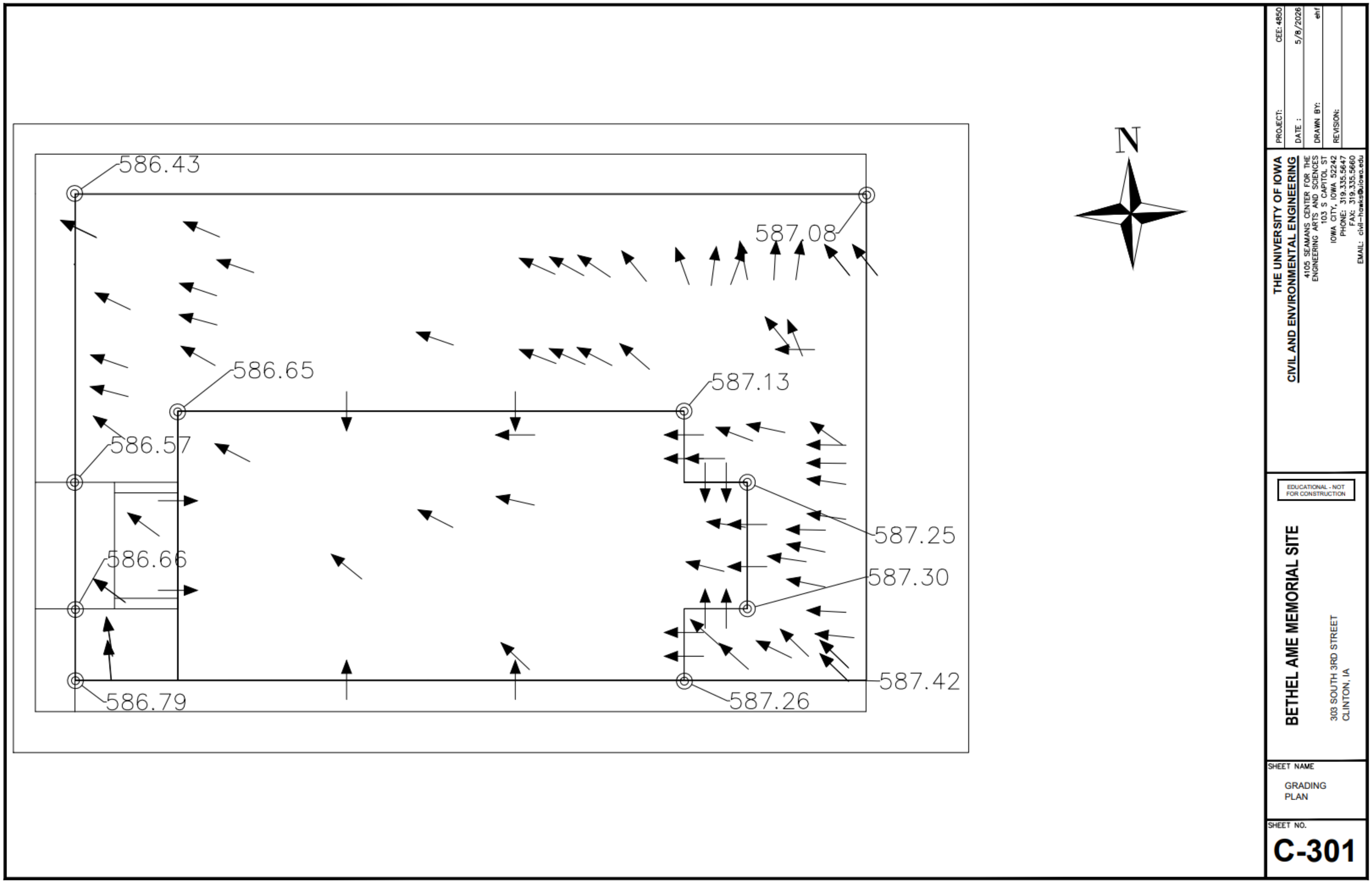
Appendix C – Existing Conditions



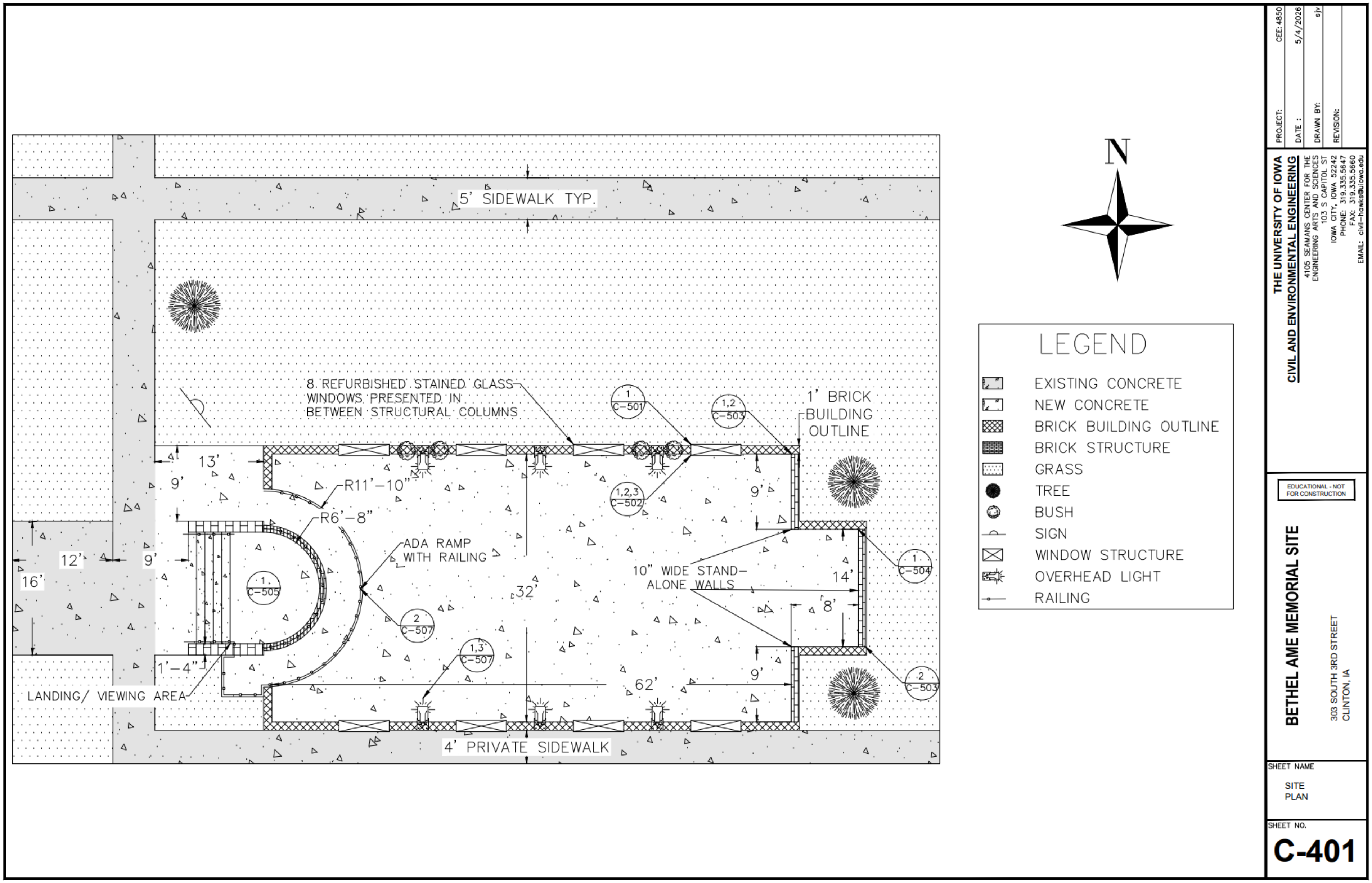
Appendix D – Demolition Plan



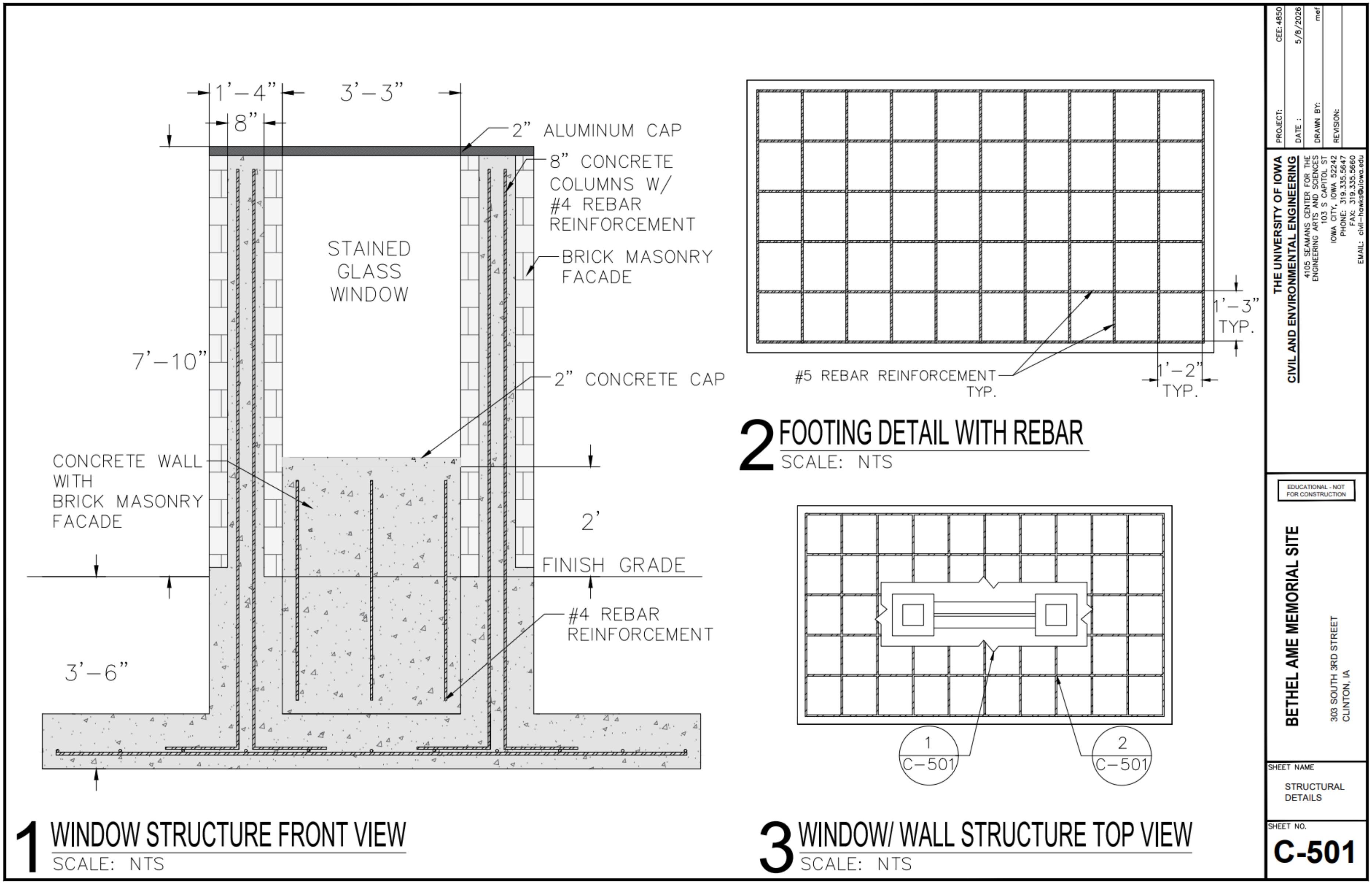
Appendix E – Grading Plan



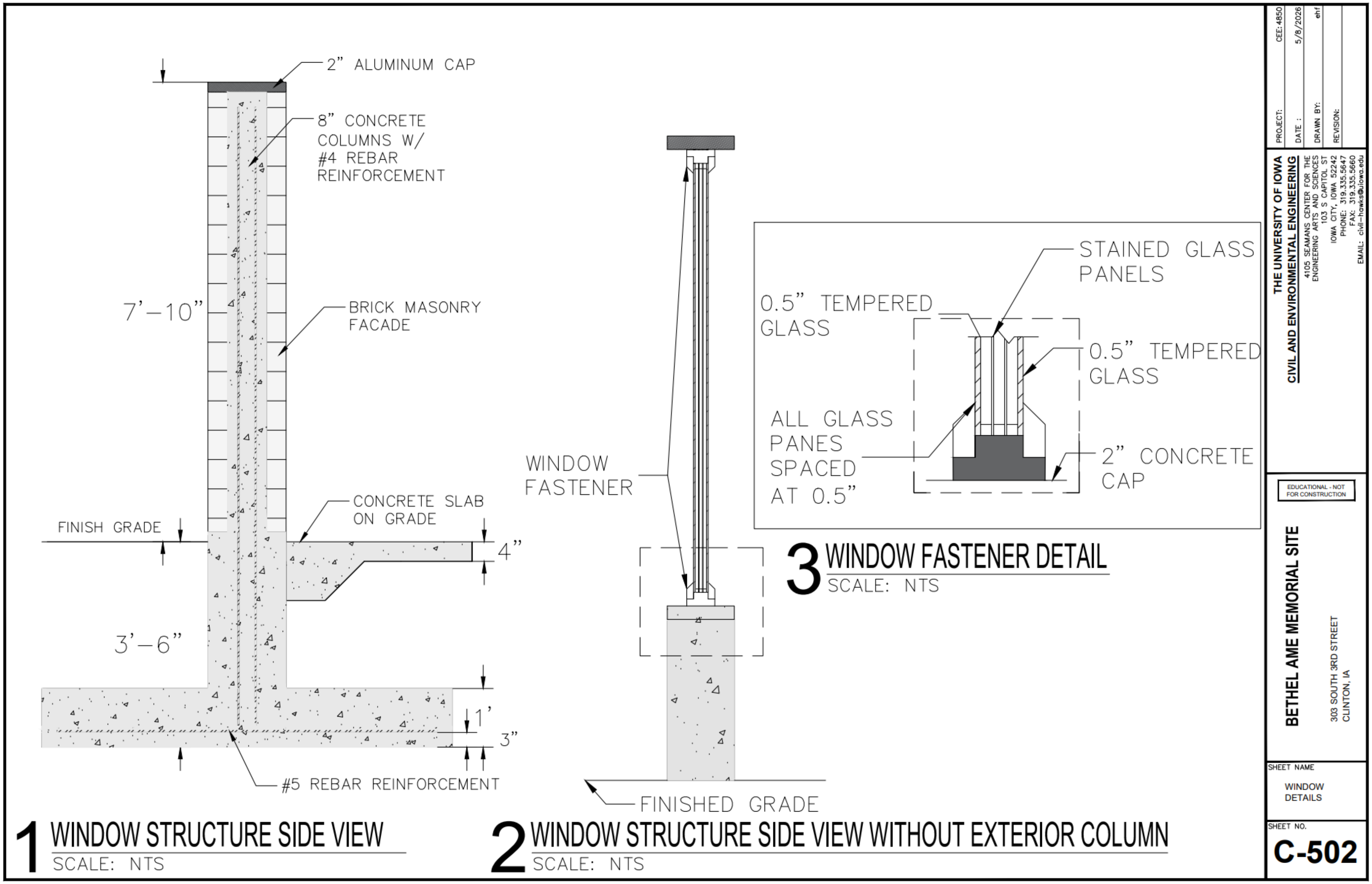
Appendix F – Site Plan



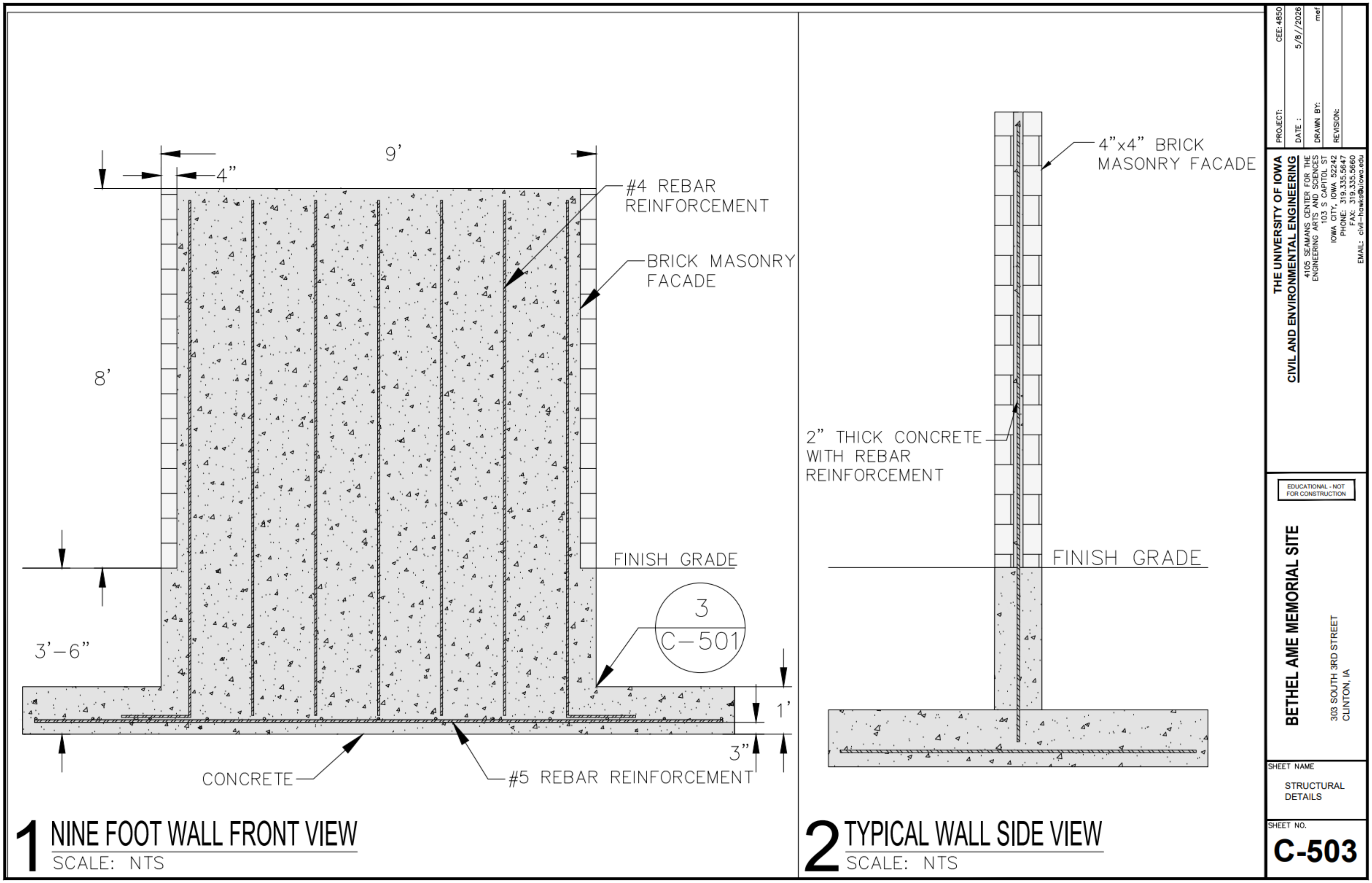
Appendix G – Window Details



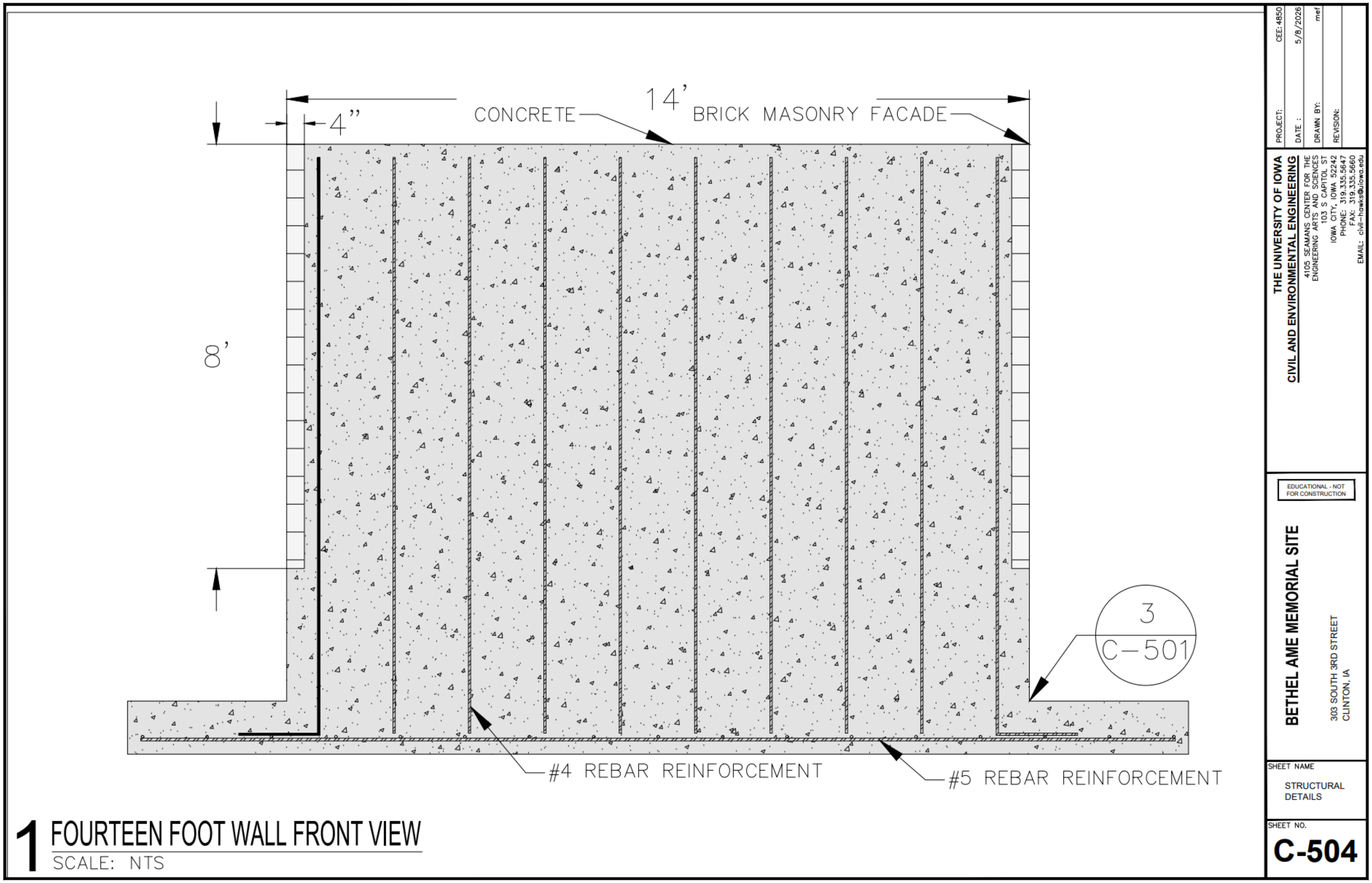
Appendix H – Window Details Continued



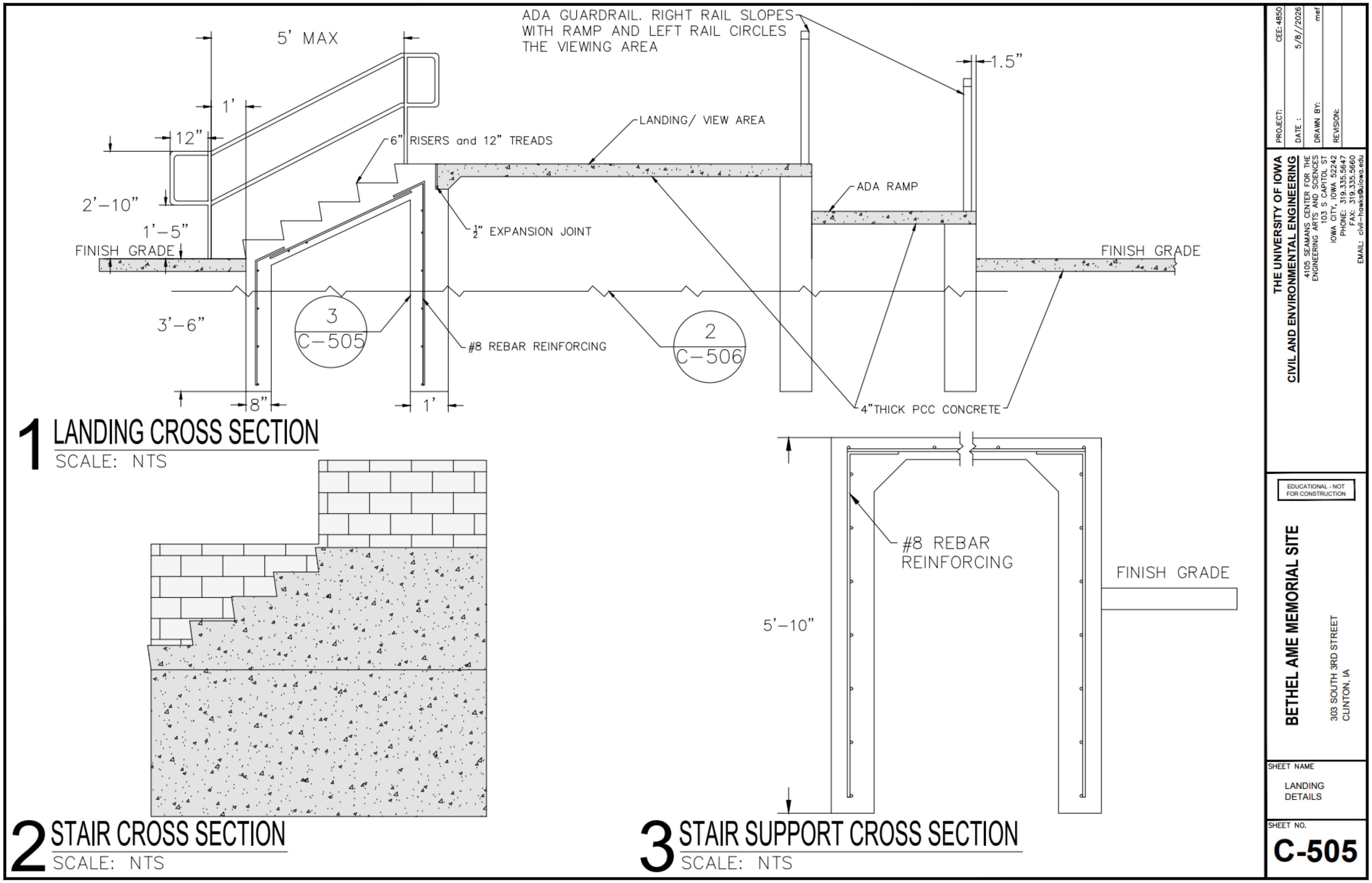
Appendix I – Structural Details



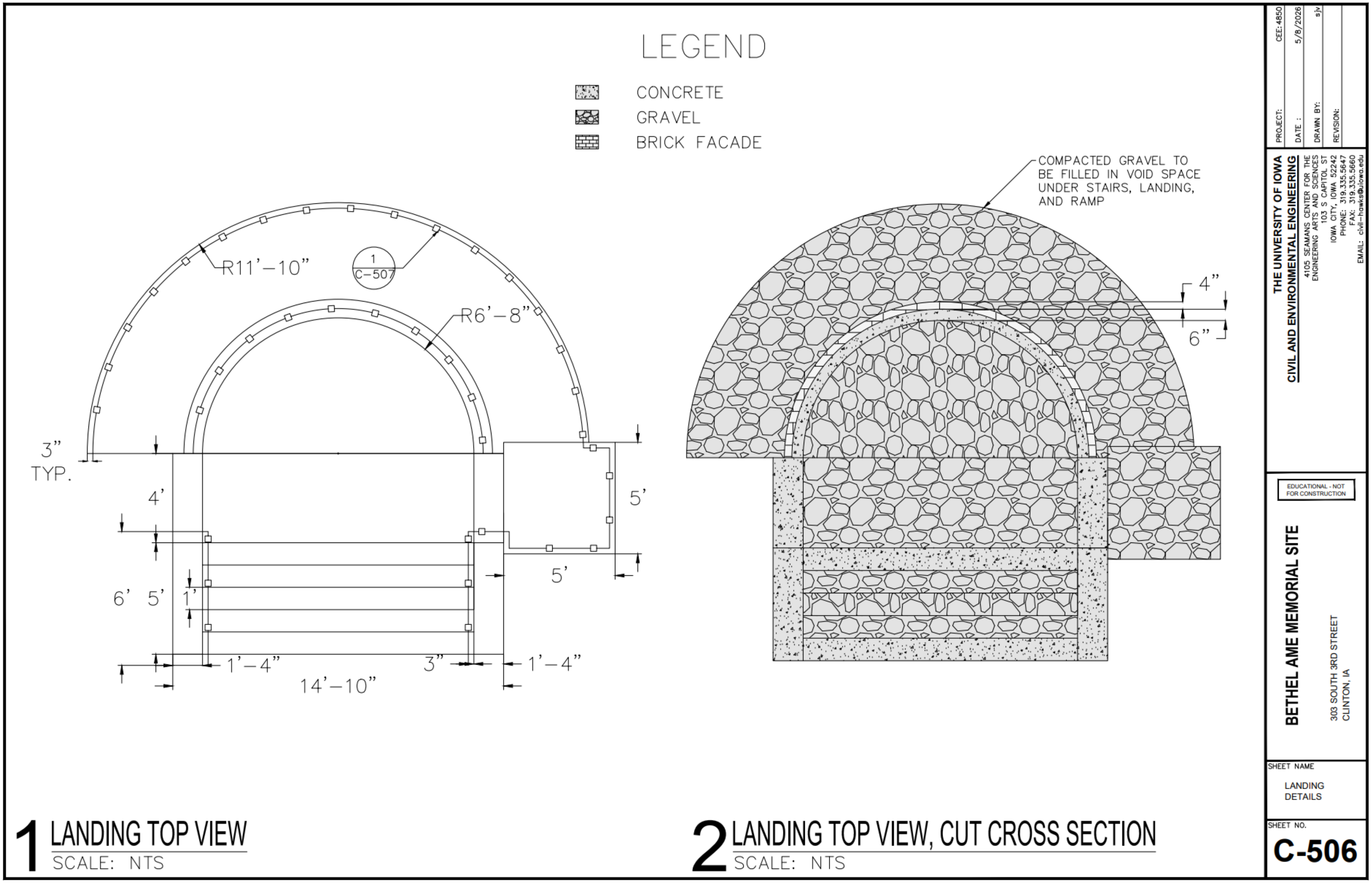
Appendix J – Structural Details Continued



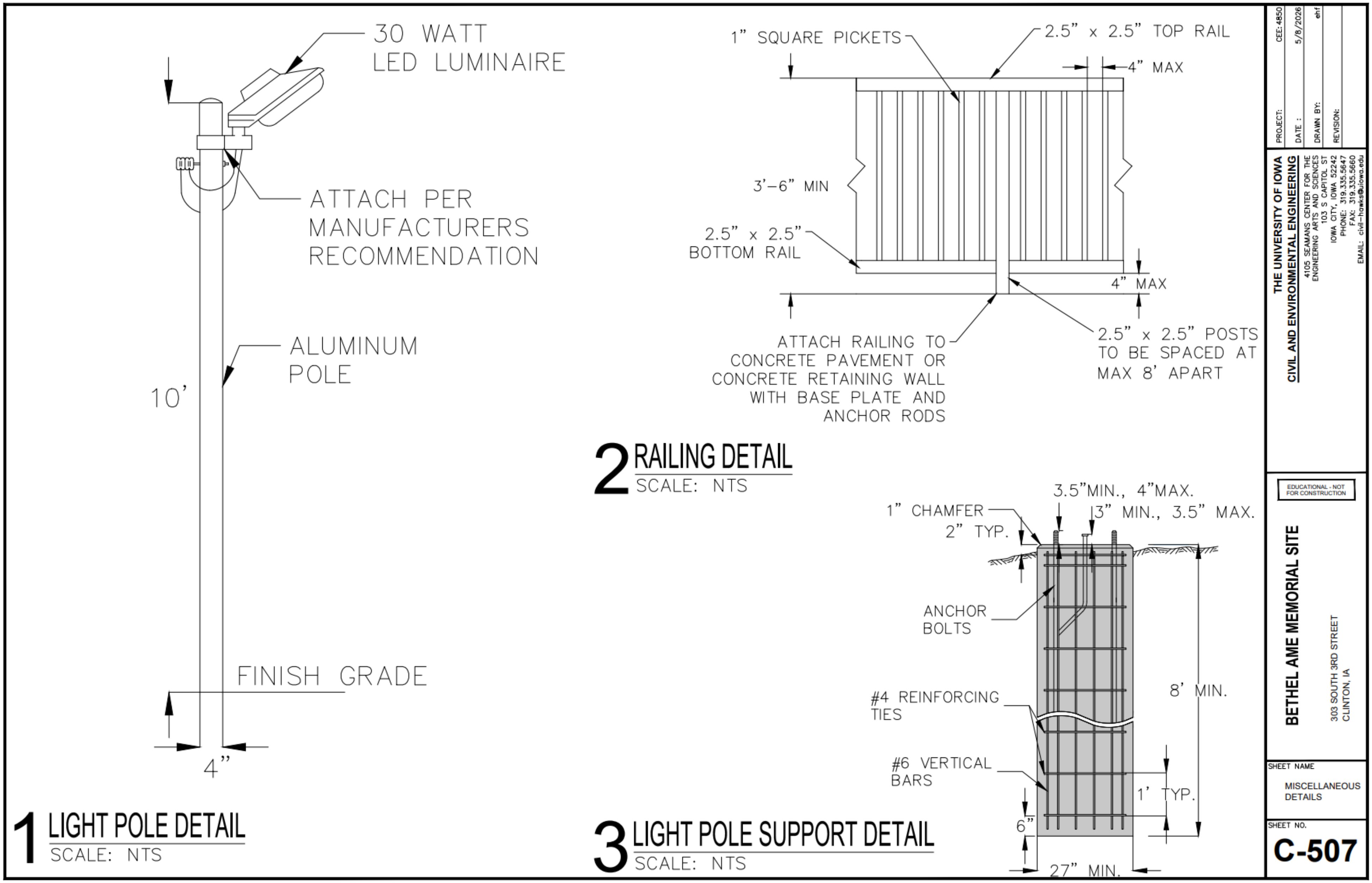
Appendix K – Landing Details



Appendix L – Landing Details Continued



Appendix M – Miscellaneous Details



Appendix N – Lighting Calculations

Illumination Method per SUDAS Standards

Variable	Definition	Selection Criteria
E	Target Illuminance	Minimum per SUDAS low conflict
CU	Coefficient of Utilization	Assumed
LLF	Light Loss Factor	Assumed

$E := 0.5$

$A := 2300$

$CU := 0.4$

$LLF := 0.8$

$$N\phi := \frac{E \cdot A}{CU \cdot LLF}$$

$N\phi = 3593.75$ Lumens

Appendix O – Hydraulic Analysis

Pre-Development Conditions

	Total Area		8376.50	sqft
	Pervious area		4256.45	sqft
	Impervious area		4120.04	sqft
24 hr, 100 yr storm event		i	0.3	in/hr
Clinton County Iowa			6.9444E-06	ft/s
Soil Group B				
Recurrence Interval 100		c (pervious)	0.35	
Good Condition Grass cover				
		c (impervious)	0.98	
Q=CIA		Q	0.03838473	cfs

Post-Development Conditions

	Total Area		8376.50	sqft
	pervious area		4190.21	sqft
	impervious area		4186.28	sqft
24 hr, 100 yr storm event		i	0.3	in/hr
Clinton County Iowa			6.9444E-06	ft/s
Soil Group B				
Recurrence Interval 100		c (pervious)	0.35	
Good Condition Grass cover				
		c (impervious)	0.98	
	Q		0.03867452	cfs

% change	0.755%

Appendix P – Soil Report

Clinton County, Iowa

976—Raddle silt loam, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: fkws
Landscape: River valleys
Elevation: 680 to 1,300 feet
Mean annual precipitation: 31 to 39 inches
Mean annual air temperature: 41 to 50 degrees F
Frost-free period: 120 to 190 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Raddle and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Raddle

Setting

Landscape: River valleys
Landform: Stream terraces
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Silty alluvium

Typical profile

H1 - 0 to 19 inches: silt loam
H2 - 19 to 60 inches: silt loam

Properties and qualities

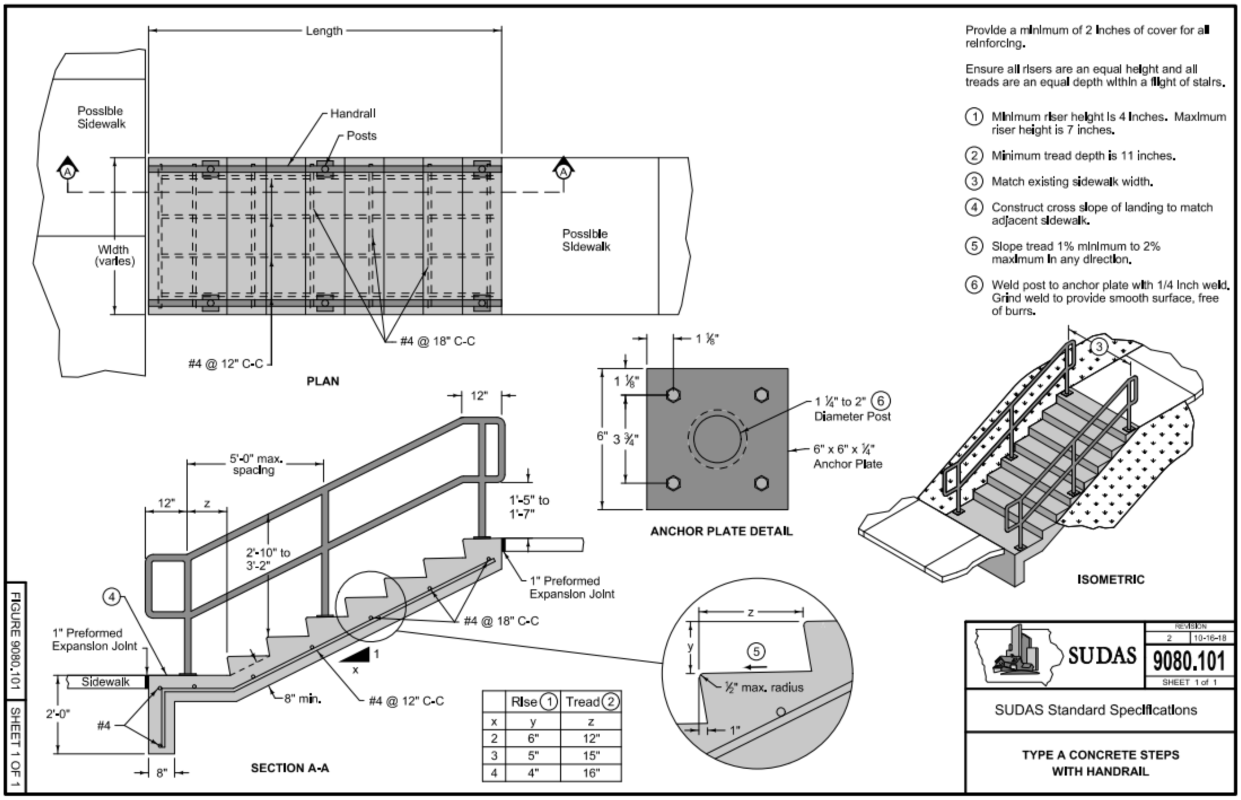
Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.14 to 1.42 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Very high (about 12.9 inches)

Interpretive groups

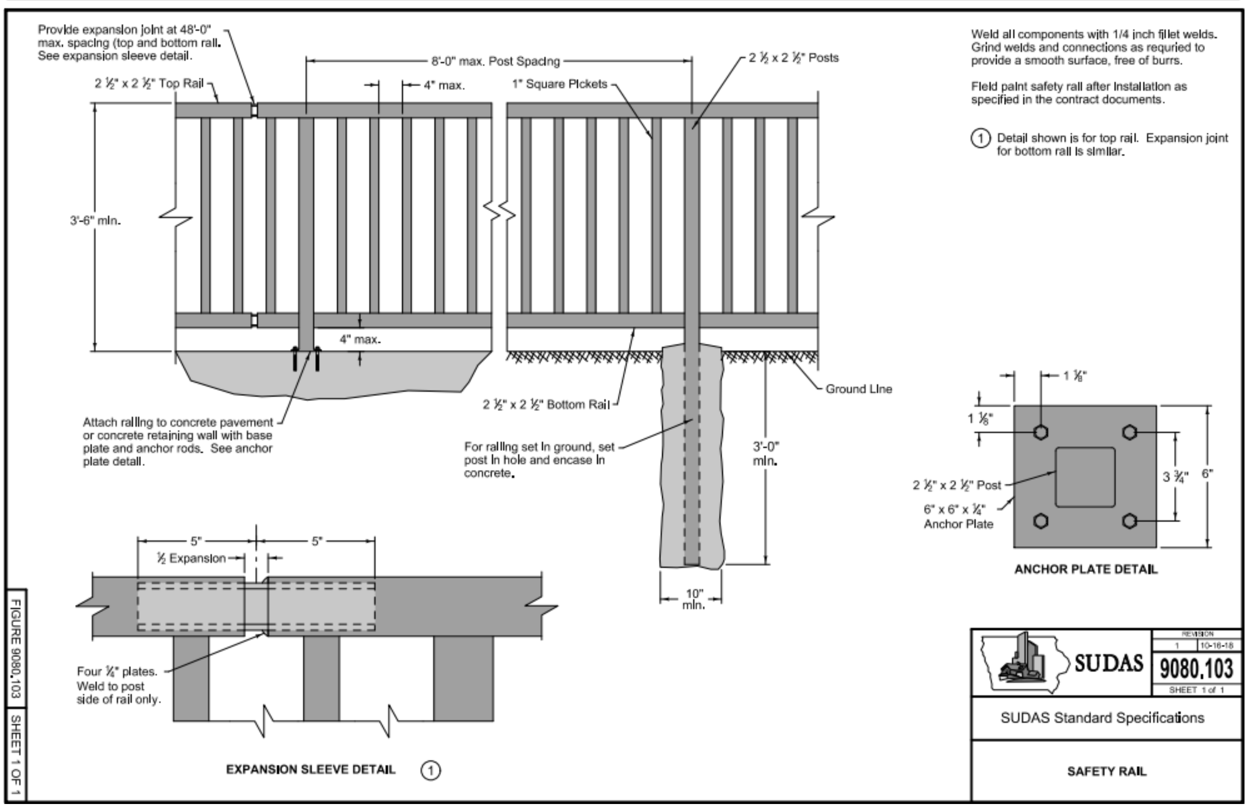
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 1
Hydrologic Soil Group: B
Ecological site: R105XY011WI - Mollic Loamy-Silty Upland
Hydric soil rating: No

Appendix Q – Community Forum Poster with Client Feedback

Appendix R – SUDAS Stair and Railing Specifications



x	Rise (1) y	Tread (2) z
2	6"	12"
3	5"	15"
4	4"	16"



Appendix S – Window Footing Rebar Calculations Along Length

$h_{window} := 5.5\ ft$

$b_{window} := 3\ ft + 3\ in = 3.25\ ft$

$w_c := 145\ pcf$

$h_{base} := 2\ ft$

$b_{column} := 16\ in$

$h_{top} := 1\ ft$

$t_{wall} := 10\ in$

$D := 3\ ft + 6\ in = 3.5\ ft$

$A_{base} := 2\ b_{column}{}^2 + t_{wall} \cdot b_{window} = 6.264\ ft^2$

$Vol_{base\_conc} := A_{base} \cdot (D - 12\ in) = 15.66\ ft^3$

$Vol_{wall\_conc} := 2\ ft \cdot 2\ in \cdot \left(b_{window} + 8\ in\right) = 1.306\ ft^3$

$Vol_{column\_conc} := 2\ (8\ in)^2 \cdot (7\ ft + 8\ in) = 6.815\ ft^3$

$V_{cap\_conc} := 2\ in \cdot b_{window} \cdot 1\ ft = 0.542\ ft^3$

$W_{conc} := 150\ pcf \cdot \left(Vol_{wall\_conc} + Vol_{column\_conc} + V_{cap\_conc}\right) = 1.299\ kip$

$V_{wall\_brick} := 2 \cdot 4\ in \cdot 2\ ft \cdot b_{window} = 4.333\ ft^3$

$V_{column\_brick} := 2 \cdot \left(b_{column}{}^2 - 8\ in^2\right) \cdot (7\ ft + 8\ in) = 26.407\ ft^3$

$W_{brick} := 120\ pcf \cdot \left(V_{wall\_brick} + V_{column\_brick}\right) = 3.689\ kip$

$t_{glass} := \dfrac{5}{16}\ in$

$w_{glass} := 4\ \dfrac{lbf}{ft^2}$

$W_{glasspane} := w_{glass} \cdot h_{window} \cdot b_{window} = 71.5\ lbf$

$P_u := W_{conc} + W_{brick} + 2\ W_{glasspane} = 5.131\ kip$

Assumptions

$f'_c := 4000\ psi$

$\gamma_c := 150\ pcf$

$f_y := 60\ ksi$

$cc := 3\ in$

$\phi_v := 0.75$

$\psi_e := 1.0$

$\beta := 1$ **Uncoated bars**

$\psi_t := 1.0$

$\propto_s := 40$ **Middle of Footing**

Footing Size

$B := 7\ ft$

$L := 12\ ft = 144\ in$

$t_f := 12\ in$

$c_1 := 16\ in$

$c_2 := 72\ in$

$$q_{net} := \frac{P_u}{B \cdot L} = 61.086\ psf$$

Check Footing Size

$d := t_f - cc - 1\ in = 8\ in$

Check Shear Strength

***one way shear**

$$l_2 := \frac{L - c_2}{2} - d = 28\ in$$

$V_u := q_{net} \cdot B \cdot l_2 = 0.998\ kip$

$V_n := 2 \cdot \sqrt{4000}\ psi \cdot B \cdot d = 85.002\ kip$

$\phi_v \cdot V_n = 63.752\ kip$

$\phi_v \cdot V_n > V_u$

***two way shear**

$b_u := 2\ (c_1 + d) + 2\ (c_2 + d) = 208\ in$

$$V_{n1} := \left(2 + \frac{4}{\beta}\right) \cdot \sqrt{4000}\ psi \cdot b_u \cdot d = 631.444\ kip$$

$$V_{n2} := \left(\frac{\propto_s \cdot d}{b_u} + 2\right) \cdot \sqrt{4000}\ psi \cdot b_u \cdot d = 372.39\ kip$$

$V_{n3} := 4\ \sqrt{4000}\ psi \cdot b_u \cdot d = 420.962\ kip$

$V_n := min\left(V_{n1}, V_{n2}, V_{n3}\right) = 372.39\ kip$

$\phi_v \cdot V_n = 279.292\ kip$

$V_u := q_{net} \cdot \left(B \cdot L - \left(c_1 + d\right)\ \left(c_2 + d\right)\right) = 4.317\ kip$

$\phi_v \cdot V_n > V_u$

Reinforcement Design

$$l_f := \frac{L - c_2}{2} = 36\ in$$

$$M_u := \frac{q_{net} \cdot L \cdot {l_f}^2}{2} = 3.299\ kip \cdot ft$$

$\phi := 0.90$

$j := 0.9$

$$A_s := \frac{M_u}{\phi \cdot f_y \cdot j \cdot d} = 0.102\ in^2$$

***minimum required for loading**

$A_g := L \cdot t_f = 1728\ in^2$

$A_{s\_min} := 0.0018\ A_g = 3.11\ in^2$

***minimum required for geometry**

(11) #5 bars selected based on minimum Steel Area

$$\frac{d_b}{2}=0.026041667\ ft$$

$$A_b:=0.310\ in^2$$

$$n:=11$$

$$d_b:=0.625\ in$$

$$A_s:=n \cdot A_b=3.41\ in^2$$

$$d=8\ in$$

$$\beta_1:=0.85$$

$$a:=\frac{A_s \cdot f_y}{0.85\ f'_c \cdot L}=0.418\ in$$

$$c:=\frac{a}{\beta_1}=0.492\ in$$

$$\varepsilon_s:=0.003\left(\frac{d}{c}\right)=0.049$$

$$\varepsilon_s>0.002$$

$$f_s:=f_y=60\ ksi$$

$$M_N:=A_s \cdot f_s \cdot \left(d-\frac{a}{2}\right)=132.837\ kip \cdot ft$$

$$\phi \cdot M_N=119.554\ kip \cdot ft$$

$$M_u=3.299\ kip \cdot ft$$

$$OCR:=\frac{M_u}{\phi \cdot M_N}=0.028$$

$$\phi \cdot M_N>M_u$$

$$s:=\frac{L-2\ cc-d_b}{n-1}=13.7375\ in$$

$$s_{max}:=min\left(18\ in,3\ t_f\right)=18\ in$$

$$s<s_{max}$$

Use (11) #5 along Length of Footing

Development Length Check

$$S_{CLR}:=s-d_b=13.113\ in$$

$$cc=3\ in$$

$$d_b=0.625\ in$$

$$l_d:=\frac{f_y \cdot \psi_t \cdot \psi_e}{20 \cdot \sqrt{4000}\ psi}\ d_b=29.646\ in$$

$$l_{ext}:=l_f-cc=33\ in$$

$$l_{ext}>l_d$$

Appendix T – Window Footing Rebar Calculations Along Width

$h_{window} := 5.5\ ft$

$b_{window} := 3\ ft + 3\ in = 3.25\ ft$

$w_c := 145\ pcf$

$h_{base} := 2\ ft$

$b_{column} := 16\ in$

$h_{top} := 1\ ft$

$t_{wall} := 10\ in$

$D := 3\ ft + 6\ in = 3.5\ ft$

$A_{base} := 2\ b_{column}{}^2 + t_{wall} \cdot b_{window} = 6.264\ ft^2$

$Vol_{base\_conc} := A_{base} \cdot (D - 12\ in) = 15.66\ ft^3$

$Vol_{wall\_conc} := 2\ ft \cdot 2\ in \cdot (b_{window} + 8\ in) = 1.306\ ft^3$

$Vol_{column\_conc} := 2\ (8\ in)^2 \cdot (7\ ft + 8\ in) = 6.815\ ft^3$

$V_{cap\_conc} := 2\ in \cdot b_{window} \cdot 1\ ft = 0.542\ ft^3$

$W_{conc} := 150\ pcf \cdot (Vol_{wall\_conc} + Vol_{column\_conc} + V_{cap\_conc}) = 1.299\ kip$

$V_{wall\_brick} := 2 \cdot 4\ in \cdot 2\ ft \cdot b_{window} = 4.333\ ft^3$

$V_{column\_brick} := 2 \cdot (b_{column}{}^2 - 8\ in^2) \cdot (7\ ft + 8\ in) = 26.407\ ft^3$

$W_{brick} := 120\ pcf \cdot (V_{wall\_brick} + V_{column\_brick}) = 3.689\ kip$

$t_{glass} := \frac{5}{16}\ in$

$w_{glass} := 4\ \frac{lbf}{ft^2}$

$W_{glasspane} := w_{glass} \cdot h_{window} \cdot b_{window} = 71.5\ lbf$

$P_u := W_{conc} + W_{brick} + 2\ W_{glasspane} = 5.131\ kip$

Assumptions

$f'_c := 4000\ psi$

$\gamma_c := 150\ pcf$

$f_y := 60\ ksi$

$cc := 3\ in$

$\phi_v := 0.75$

$\psi_e := 1.0$

$\beta := 1$ **Uncoated bars**

$\psi_t := 1.0$

$\propto_s := 40$ **Middle of Footing**

Footing Size

$B := 7\ ft$

$L := 12\ ft = 144\ in$

$t_f := 12\ in$

$c_1 := 16\ in$

$c_2 := 72\ in$

$$q_{net} := \frac{P_u}{B \cdot L} = 61.086\ psf$$

Check Footing Size

$d := t_f - cc - 1\ in = 8\ in$

Check Shear Strength

***one way shear**

$$l_1 := \frac{B - c_1}{2} - d = 26\ in$$

$V_u := q_{net} \cdot B \cdot l_1 = 0.926\ kip$

$V_n := 2 \cdot \sqrt{4000}\ psi \cdot B \cdot d = 85.002\ kip$

$\phi_v \cdot V_n = 63.752\ kip$

$\phi_v \cdot V_n > V_u$

***two way shear**

$b_u := 2\ (c_1 + d) + 2\ (c_2 + d) = 208\ in$

$$V_{n1} := \left(2 + \frac{4}{\beta}\right) \cdot \sqrt{4000}\ psi \cdot b_u \cdot d = 631.444\ kip$$

$$V_{n2} := \left(\frac{\propto_s \cdot d}{b_u} + 2\right) \cdot \sqrt{4000}\ psi \cdot b_u \cdot d = 372.39\ kip$$

$V_{n3} := 4\ \sqrt{4000}\ psi \cdot b_u \cdot d = 420.962\ kip$

$V_n := min\left(V_{n1}, V_{n2}, V_{n3}\right) = 372.39\ kip$

$\phi_v \cdot V_n = 279.292\ kip$

$V_u := q_{net} \cdot \left(B \cdot L - \left(c_1 + d\right)\ \left(c_2 + d\right)\right) = 4.317\ kip$

$\phi_v \cdot V_n > V_u$

Reinforcement Design

$$l_f := \frac{B - c_1}{2} = 34\ in$$

$$M_u := \frac{q_{net} \cdot B \cdot l_f^{\,2}}{2} = 1.716\ kip \cdot ft$$

$\phi := 0.90$

$j := 0.9$

$$A_s := \frac{M_u}{\phi \cdot f_y \cdot j \cdot d} = 0.053\ in^2$$

***minimum required for loading**

$B = 84\ in$

$A_g := B \cdot t_f = 1008\ in^2$

$A_{s\_min} := 0.0018\ A_g = 1.814\ in^2$

***minimum required for geometry**

(6) #5 bars based on minimum Steel Area

$A_b := 0.310\ in^2$

$n := 6$

$d_b := 0.625\ in$

$A_s := n \cdot A_b = 1.86\ in^2$

$d = 8\ in$

$\beta_1 := 0.85$

$a := \dfrac{A_s \cdot f_y}{0.85\ f'_c \cdot B} = 0.391\ in$

$c := \dfrac{a}{\beta_1} = 0.46\ in$

$\varepsilon_s := 0.003 \left(\dfrac{d}{c}\right) = 0.052$

$\varepsilon_s > 0.002$

$f_s := f_y = 60\ ksi$

$M_N := A_s \cdot f_s \cdot \left(d - \dfrac{a}{2}\right) = 72.583\ kip \cdot ft$

$\phi \cdot M_N = 65.325\ kip \cdot ft$

$M_u = 1.716\ kip \cdot ft$

$OCR := \dfrac{M_u}{\phi \cdot M_N} = 0.026$

$\phi \cdot M_N > M_u$

$s := \dfrac{B - 2\ cc - d_b}{n - 1} = 15.475\ in$

$s_{max} := min\left(18\ in, 3\ t_f\right) = 18\ in$

$s < s_{max}$

Use (6) #5 along Width of Footing

Development Length Check

$S_{CLR} := s - d_b = 14.85\ in$

$cc = 3\ in$

$d_b = 0.625\ in$

$l_d := \dfrac{f_y \cdot \psi_t \cdot \psi_e}{20 \cdot \sqrt{4000}\ psi}\ d_b = 29.646\ in$

$l_{ext} := l_f - cc = 31\ in$

$l_{ext} > l_d$

Appendix U – Window Column Rebar Calculations

Wind Load Calcs

$K_z := 0.57$ Exposure B

$K_{zt} := 1$

$K_e := 0.96$ Ground Elevation

$V := 107$ Risk Category 2

$q_h := 0.00256\ K_z \cdot K_{zt} \cdot K_e \cdot V^2 \cdot psf = 16.038\ psf$

$K_d := 0.85$ Solid Freestanding Walls

$G := 0.85$

$B := 6\ ft$

$h := 7\ ft + 10\ in = 7.833\ ft$ $\qquad s := h$

$AspectRatio := \dfrac{B}{s} = 0.766$ $\qquad ClearanceRatio := \dfrac{s}{h} = 1$

$C_f := 1.50$

$A_{sign} := (h) \cdot (B) = 47\ ft^2$

$F_{wind} := q_h \cdot K_d \cdot G \cdot C_f \cdot A_{sign} = 0.817\ kip$

$h_{force} := \dfrac{h}{2} + .05 \cdot h = 4.308\ ft$

$M_{max} := \dfrac{F_{wind}}{2} \cdot h_{force} = 1.76\ kip \cdot ft$

$V_{max} := \dfrac{F_{wind}}{2} = 0.408\ kip$

Shear Resistance of Concrete Section

$A_g := 16\ \mathbf{in} \cdot 16\ \mathbf{in} = 256\ \mathbf{in}^2$

$cc := 2\ \mathbf{in}$

$w_c := 145\ \mathbf{pcf}$

$\lambda := 1$

$N_u := 5.131\ \mathbf{kip}$

$b_w := 8\ \mathbf{in}$

$d := 16\ \mathbf{in} - cc$

$f'_c := 4000\ \mathbf{psi}$

$f_{yt} := 60\ \mathbf{ksi}$

$s := 16\ \mathbf{in} - 2\ cc$

$\tau_1 := 5\ \lambda \cdot \sqrt{4000}\ \mathbf{psi} = 316.228\ \mathbf{psi}$

$\tau_2 := 2\ \lambda \cdot \sqrt{4000}\ \mathbf{psi} + min\left(0.05\ f'_c, \dfrac{N_u}{6\ A_g}\right) = 129.832\ \mathbf{psi}$

$\tau_a := min\left(\tau_1, \tau_2\right) = 129.832\ \mathbf{psi}$

$V_c := \tau_a \cdot b_w \cdot d = 64682.21\ \mathbf{N}$

$\phi_v := 0.75$

$\phi_v \cdot V_c = 10.906\ \mathbf{kip}$

$DCR := \dfrac{V_{max}}{\phi_v \cdot V_c} = 0.037$

$A_{v\_min} := s \cdot \max\left(0.75 \cdot \sqrt{4000}, 50\right)\ \mathbf{psi} \cdot \dfrac{b_w}{f_{yt}} = 0.08\ \mathbf{i}$

$\dfrac{A_{v\_min}}{4} = 0.02\ \mathbf{in}^2$

$A_{bar} := 0.20\ \mathbf{in}^2$

$A_v := 4\ A_{bar} = 0.8\ \mathbf{in}^2$

Select #4 bars

$V_s := \dfrac{A_v}{s} \cdot f_{yt} \cdot d = 56\ \mathbf{kip}$

$A_s := A_v = 0.8\ \mathbf{in}^2$

$f_y := 60\ \mathbf{ksi}$

$b := b_w = 8\ \mathbf{in}$

$d_{bar} := 0.50\ \mathbf{in}$

$a := \dfrac{A_s \cdot f_y}{0.85 \cdot f'_c \cdot b} = 1.765\ \mathbf{in}$

$d := 16\ \mathbf{in} - \left(cc + \dfrac{d_{bar}}{2}\right) = 13.75\ \mathbf{in}$

$M_n := A_s \cdot f_y \cdot \left(d - \dfrac{a}{2}\right) = 51.471\ \mathbf{kip} \cdot \mathbf{ft}$

$\phi := 0.90$

$\phi \cdot M_n = 46.324\ \mathbf{kip} \cdot \mathbf{ft}$

$M_{max} = 1.76\ \mathbf{kip} \cdot \mathbf{ft}$

$DCR := \dfrac{M_{max}}{\phi \cdot M_n} = 0.038$

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