

Floodproof Construction Requirements



CITY OF REILE'S ACRES,
NORTH DAKOTA
September, 2025

The State of North Dakota requires that you call [1-800-795-0555](tel:1-800-795-0555) at least two business days before you dig.

This handout does not address any covenants or easements assigned to the property, nor does it relieve you of code compliance with items which may not have been included from any other applicable building codes.

ALL PLANS MUST BE DRAWN TO SCALE

The following shall be submitted to the City and approved prior to construction.

1. Building Permit Application (available on City of Reile's Acres website)
2. Propose lowest opening elevation (NAVD 88) of building(s).
3. Plot plan showing exact location of new building or addition and existing buildings.
4. Floor plan(s) of new building(s) (bedrooms are not allowed in basements).
5. Elevation views of two sides of the building. Elevation plans must show grade.
6. Foundation wall and footing sections showing required construction details, drain tile location and meeting Appendix B requirements.

THE FOLLOWING ITEMS ARE INCLUDED IN THIS PACKET

Appendix A. Typical Floodproofing Construction Requirements Exhibit

Appendix B. Floodproof Basement Structural Requirements & Report

Appendix C. Example Inspection Log for Foundation. The actual log is completed by Reile's Acres Building Inspector.

**A CERTIFICATE OF OCCUPANCY WILL BE REQUIRED BEFORE
BUILDINGS CAN BE OCCUPIED**

CITY OF REILE'S ACRES POLICY STATEMENT FOR FLOODPROOFING ELEVATION REQUIREMENTS

Applicable to the following:

This Policy Statement shall regulate development within City of Reile's Acres City Limits and Extra Territorial Areas. The specific areas governed by this policy are the FEMA 1% annual chance floodplain area and any areas within 50' of this area.

All structures, including but not limited to, residential, commercial, and industrial within the city limits and extra territorial areas inside of or within 50' feet of the 100-year flood plain, shall meet the following requirements:

- A. Floodway Setback
 - 1. All structures must be set back 100 feet from floodway line

- B. Watercourse Setbacks
 - 1. All structures must be set back 100 feet from an established water course. A water course is defined as a legal drain, stream or river. A road ditch is not a water course.

- C. Letter of Map Revisions (LOMR)

The City of Reile's Acres requires removal from the Special Flood Hazard Area (SFHA) by Letter of Map Revision (LOMR) via fill. Fill requirements are as follows:

 - 1. All topsoil and organic material must be stripped from fill area prior to placement of any fill.
 - 2. All fill material (from foundation wall to 15 feet out from building for buildings with basements) and (internal to and within 15' of building for slab on grade structures) shall meet the following specifications:
 - Clay shall be cohesive and consist of material classified by ASTM D-2487 as CL or CH.
 - Gradation shall not have less than 40% by weight passing the No. 200 sieve. The liquid limit (L.L.) shall be greater than 25% and plasticity index (P.I.) greater than 10 percent.
 - The material shall be free of ice, snow, frozen earth, trash, debris, sod, roots, organic matter including silts which are unstable, inorganic materials too wet to be stable or stones larger than 3-inches in any dimension.
 - Lifts shall be no thicker than 12" (uncompacted).
 - Each lift shall meet 95% density per AASHTO T-99 and be between -1% and +3% of optimum moisture per Geotechnical Engineer.
 - Density and moisture testing will be required (min. 2 tests per lift) by an approved geotechnical firm or more if required by City Engineer. Testing results to be submitted by

geotechnical firm to City Engineer.

- Fill areas must be protected by either vegetative cover or by other measures approved by City Engineer that will protect the fill from scour, washout or movement.
3. No more than 5 feet of fill may be placed for buildings in areas removed from FEMA SFHA by LOMR
 - Fill in excess of five feet may be permitted, provided the fill is Engineered fill designed by a State of North Dakota registered professional engineer and the design plan is provided to and approved by the City in advance of construction.
 4. All structures constructed within LOMR areas must meet all floodproofing codes.

D. Certifications & Inspections

1. FEMA Elevation Certificate required for all floodproofed structures.
2. FEMA Residential Basement Floodproofing Certificate required for all floodproof basements and must certify the design meets or exceeds the following:

The basement has been designed and built so that any basement area, together with attendant utilities and sanitary facilities below the floodproofed design level, is watertight with walls that are impermeable to the passage of water without human intervention. Basement walls shall be built with the capacity to resist hydrostatic and hydrodynamic loads and the effects of buoyancy resulting from flooding to the floodproofed design level, and shall be designed so that minimal damage will occur from floods that exceed that level. The floodproofed design level shall be an elevation one foot above the level of the base flood where the difference between the base flood and the 500-year flood is three feet or less and two feet above the level of the base flood where the difference is greater than three feet.

This certificate must be completed by a Licensed Professional Engineer in the State of North Dakota.

3. The foundation and floodproofing related components shall be inspected by the building inspector or other authorized representative of the community to verify that the structure is built according to its design and other provisions as dictated in the Floodplain Ordinance, the Floodproof Construction Requirements and as required by Federal Code. Contractors must communicate build progress to the building inspector to allow for scheduling of these inspections and create any needed access for inspector to review the necessary items. Appendix C is the checklist template for floodproof construction related items. Other inspections may be needed for general building construction compliance that do not relate to floodproof construction.

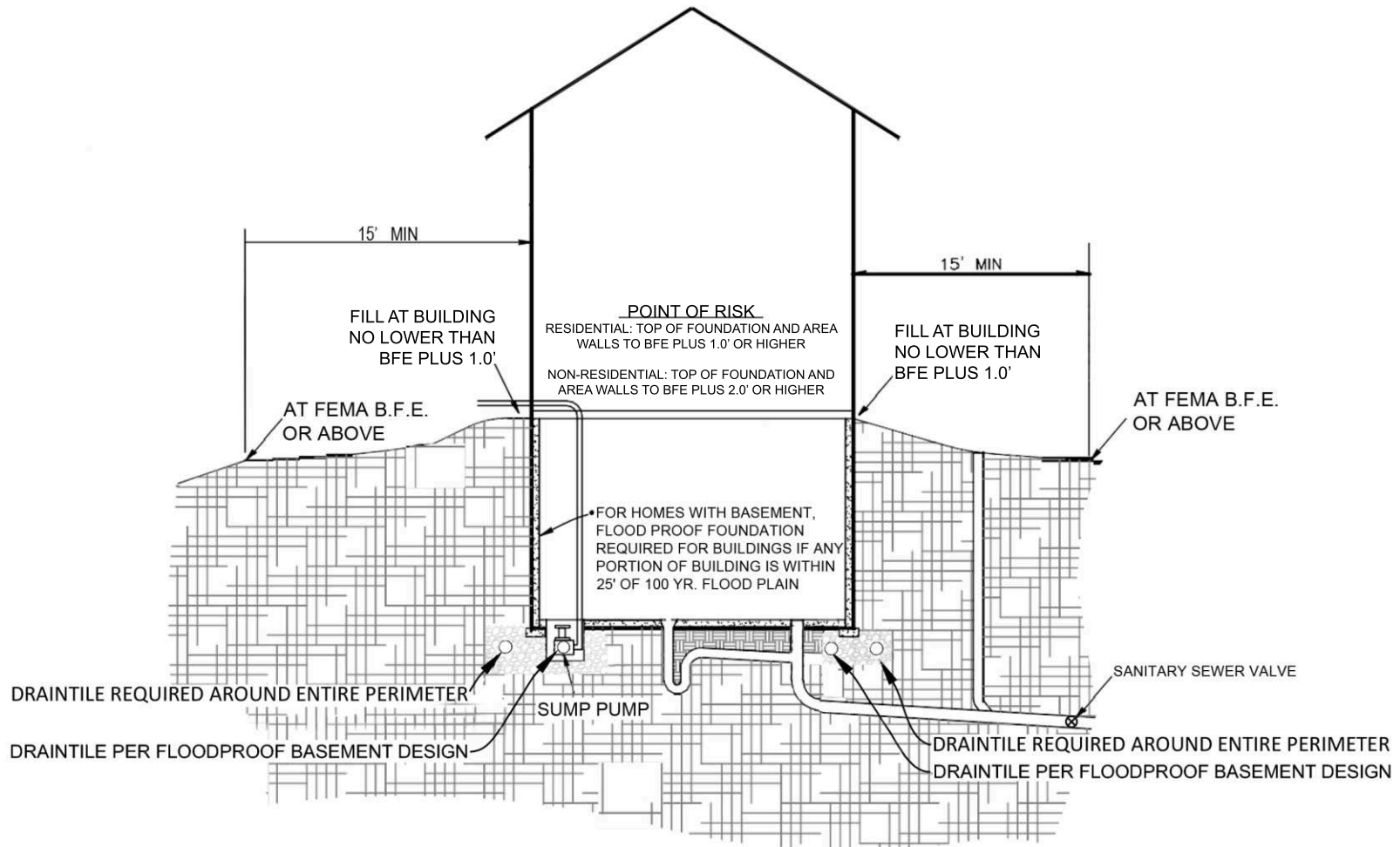
- E. Elevation Requirements
 1. Lowest opening including area walls, shall be equal to FEMA BFE plus 1.0' or higher for residential buildings and FEMA BFE plus 2.0' or higher for non-residential buildings.
 2. Fill around building shall be equal to FEMA BFE plus 1.0' or Higher
 3. Fill 15 feet away from buildings shall be at or above FEMA BFE

- F. All underground parking must meet floodproofing codes including specified elevation and fill requirements.

- G. Structures within a contemplated LOMR area with a proposed depressed loading dock will be allowed to have the loading dock area below the specified adjacent ground elevations if the building is a slab on grade with the lowest finished floor elevation of the structure at the BFE plus 2.0' or higher.

APPENDIX A

TYPICAL FLOODPROOFING CONSTRUCTION REQUIREMENTS EXHIBIT



Residential and Non Residential Structures
 inside of and within 50' of the FEMA 1% Annual Chance Floodplain

APPENDIX B

FLOODPROOF BASEMENT STRUCTURAL REQUIREMENTS & REPORT

(KLJ & Braun Intertec)



July 2025

CITY OF REILE'S ACRES

FLOODPROOF BASEMENT DESIGN GUIDE

FLOODPROOF BASEMENT DESIGN GUIDE

Structural Design Requirements

Floodproof Basements in Reile's Acres, ND

PREPARED FOR:

City of Reile's Acres
4635 35th Ave N
Reile's Acres, ND 58102

PREPARED BY

KLJ Engineering LLC
300 23rd Avenue East, Suite 100
West Fargo, ND 57078

July 30, 2025



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FLOODPROOF BASEMENT DESIGN GUIDE

Executive Summary

KLJ and Braun Intertec Corporation (Braun) were asked to develop a structural design guide for floodproof basements for the City of Reile's Acres as they relate to current industry practices and design codes. This design guide was generated with the understanding that the City of Reile's Acres is pursuing a Federal Emergency Management Agency (FEMA) basement exception. This report provides guidelines for a basement exception under FEMA 44 Code of Federal Regulations (CFR) §60.6(b).

The City of Reile's Acres had previously adopted the 1975 and 2015 City of Fargo's Floodproof Construction Requirements. As part of the March 2025 Final Determination Letter for the Western Cass Flood Insurance Study completed by FEMA, each community requesting an exception is required to update their floodproof basement design guide. It is understood that Reile's Acres is developing a Floodproof Construction Requirements document to be issued in late 2025, which will supplement this design guide. Although the previous codes have performed well under flooding conditions since its inception and has been tested multiple times including major floods, the structural requirements have changed very little since it was created and were not specific to the City of Reile's Acres. The recommendations included herein are based on industry standards and current building code requirements.

Structural design requirements included herein allow for basements up to nine (9) feet deep that are located within the Sherack formation (impervious fat clay).

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Analysis

Upon review of documents used to develop similar floodproofing codes for surrounding communities, it was determined that more information should be gathered related to the soils in the Reile's Acres area and how they affect the structural design requirements for floodproofing basements. Braun prepared a geotechnical evaluation for this report which included a seepage analysis and recommendations for lateral earth pressures.

Conclusions drawn from the geotechnical evaluation were used to develop the structural design requirements included herein.

Seepage Analysis

Braun performed a seepage analysis on the soils within the City of Reile's Acres, North Dakota jurisdiction. In addition to a hydrograph for the base flood event for the Sheyenne River and Legal Drain, the following information was provided by the City and their engineers to assist with the analysis:

1. Homes are required to have a 100 feet setback from a watercourse (legal drain, stream or river).
2. Grade adjacent to a building shall be one foot higher than the Base Flood Elevation (BFE).
3. Fill 15 feet away from the building shall be at or above the BFE.
4. When fill is required to elevate a lot above the BFE, it typically involves about 2 feet of vertical fill. However, in a small portion of the City, up to 4 feet of fill may be required.

The results of Braun's findings are included in Appendix A of this report. A summary of Braun's findings is as follows:

1. A maximum basement depth of 9 feet deep was considered. The soils within this depth are a part of the Sherack formation. Based on Braun's experience, the fill material used to build up residential lots to the required elevations as well as the foundation wall backfill is typically from this formation.
2. The soils in the Sherack formation consist of fat clay and are relatively impervious, but some sand and silt seams are known to exist. The sand and silt seams might be troublesome as they increase the permeability of the soils.
3. Groundwater elevations vary throughout the year. A groundwater depth of 10 feet below grade is typical and was utilized for the purpose of this design guide.

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4. The typical soil density of the Sherack formation is 115 pounds per cubic feet (PCF) in normal, wet condition. From previous tests performed by Braun, the internal friction angle for this soil is about 25 degrees for well-compacted soil. However, due to common backfill and compaction practices in residential construction, the in-situ friction angle is estimated to be less than this.
5. Laboratory testing was reviewed to determine the hydraulic conductivity of the soils in the Reile's Acres area. Hydraulic conductivity is a measurement used to describe the flow rate of water through the soil. The tests indicate that the soils in the Sherack formation have an average hydraulic conductivity of 1E-4 foot per day vertically. However, Braun's experience on local construction projects indicates the horizontal conductivity of 1E-3 foot per day. These numbers indicate the soils in the Reile's Acres area are relatively impermeable.
6. The seepage analysis concluded it would take two to three weeks with flood waters at full height to reach basement walls that extend 9 feet below grade. A flood at Reile's Acres is typically at peak for less than one week, so it is unlikely flood waters would infiltrate the backfill and basement walls. However, if flood waters were allowed to reach the home or wall backfill, the soil could become saturated causing hydrostatic pressures to be of concern.

Lateral Earth Pressures

Braun recommends using an active equivalent fluid pressure of 65 pounds per cubic foot (PCF) per foot depth for soils in the Sherack formation to design basement walls. In order for this assumption to be accurate, the following criteria must be met:

1. Basements should have a flexible diaphragm and adequate subsurface drainage for this assumption to be accurate. A wood floor and subfloor above the basement is considered a flexible diaphragm.
2. The basement floor can be extended to 9 feet below grade.
3. If silt or sand layers, generally less than 1-inch thick, are found in excavations, the bottom of the excavations should be over-excavated by at least 10 feet horizontally from the basement walls and backfilled with fat clay soils, similar to that of the Sherack formation.
4. If flood water comes in contact with the house or backfill or if the drain tile/sump pump fails, considerations should be made to flood the basement to minimize structural damage due to hydrostatic pressures.
5. Adequate surface drainage must be provided around the perimeter of the home. Grades adjacent to the basements shall be sloped down and away from the

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structure at a minimum gradient of 5 percent to prevent ponding within 10 feet horizontal of the perimeter of the structure.

6. Run-off from roofs shall be collected by gutters and routed to drains with long downspouts and diverted at least 5 to 10 feet from the structure.
7. Structures shall be setback 15 feet horizontally from the BFE and 100 feet from the nearest watercourse.

Structural Design Requirements

KLJ performed an analysis on basement wall construction for full depth basements and bi-level basements in Reile's Acres based on the design parameters provided by Braun and design requirements detailed in the U.S. Army Corps of Engineers *Flood Proofing Regulations, EP 1165-2-314*. A summary of the analysis is included in the following sections.

Design Codes:

Analysis of basement wall construction shall comply with the following building codes:

1. 2024 International Building Code (2024 IBC)
2. 2024 International Residential Code (2024 IRC)
3. American Concrete Institute 332-20: Code Requirements for Residential Concrete and Commentary (ACI 332-20)
4. 2024 National Design Specification (2024 NDS) for Wood Construction
5. American Society of Civil Engineers Standard 7-22: Minimum Design Loads and Associated Criteria for Buildings and Other Structures (ASCE 7-22).

Structural Loads:

1. Hydrostatic loads on the structure need not be considered with a 15-foot setback to the BFE and the parameters outlined in the *Lateral Earth Pressures* section are met. Under these conditions, Braun's seepage analysis determined it would take two to three weeks to saturate the soil adjacent to the basement walls. Given that peak floods only last about one week and homes are being constructed with a subsurface drainage system, the probability is very low that flood waters would reach foundation walls.
2. Hydrodynamic loads on the structure do not need to be considered. As per the *Flood Insurance Study* booklet prepared by FEMA for Cass County, North Dakota (effective January 16, 2015), the mean velocity of the Sheyenne River varies between 0.7 and 2.8 feet per second, and the mean velocity of the Red River ranges from 0.5

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to 3.1 feet per second. The U.S. Army Corps of Engineers *Flood Proofing Regulations, EP 1165-2-314* states hydrodynamic loads need only be considered with velocities of five feet per second or greater.

3. Impact loads do not need to be considered as the probability that flood water elevations would exceed the ground elevation adjacent to the structure would be minimal.
4. Buoyancy is not a concern with flood and groundwater levels being maintained below the basement slab with a subsurface drainage system.
5. Basement walls and their connections shall be designed using an active equivalent lateral earth pressure of 65 PCF. This lateral earth pressure recommendation is only applicable when flexible diaphragms are present, adequate subsurface drainage is provided, and parameters outlined in the *Lateral Earth Pressures* section are met. Conditions other than this are not covered under this design guide.
6. Surcharge due to ground snow load shall be considered concurrently with lateral earth pressures. Ground snow load for Reile's Acres, ND per ASCE 7-22 is 62 PCF.

Analysis:

KLJ completed a structural analysis on full height, bi-level and window well basement walls using the design codes and loads included herein. Tables and figures associated with the analysis are provided in Appendix B. A summary of the design procedure used to develop each table and figure is as follows:

1. Full height basement walls:
 - a. Two reinforcing options are provided in Tables 1A and 1B.
 - i. Case A includes provisions for 2-way slab action in the concrete walls to minimize the connection requirements at the top of the wall.
 - ii. Case B also accounts for 2-way action in the concrete walls and allows for maximum spacing between walls perpendicular (i.e., jogs) to the foundation wall. Minimum reinforcing is based on the worst case between temperature and shrinkage steel or steel required to achieve moment capacity.
 - iii. A detail of the reinforcing requirements is provided in Figure 1.
 - b. The wall is required to be braced at the top where the trusses run parallel to the wall as per the requirements of Table 1B. An approved bracing detail is provided in Figure 5. Alternate wall bracing details may be considered but are required to be designed and sealed by an engineer in the State of North Dakota.

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2. Bi-level basement design was based on a cantilevered concrete foundation wall. Reinforcing requirements are provided in Table 2 and a detail of the wall construction is provided in Figure 2.
3. Window well walls were designed to span horizontally. Reinforcing requirements are included in Table 3. A detail of the wall construction is provided in Figure 3.
4. Reinforcing requirements at wall corners and openings are provided in Figures 4A and 4B, respectively.
5. Homes constructed with a crawl space shall follow provisions of Tables 1A and 1B and Figure 1. Crawl spaces shall have a concrete slab on grade as the finished floor. Earthen floors are not allowed.

Dampproofing

Dampproofing is required on the exterior surface of all basement walls and below all basement slabs. The dampproofing shall be continuous from the top of the soil to the higher of the top of the footing or 6 inches below the top of the basement floor. The following recommendations meet the U.S. Army Corps of Engineers *Flood Proofing Regulations, EP 1165-2-314* Type B. Dampproofing shall be required to be substantially impermeable but may pass water vapor and seep slightly during flooding.

1. Foundation wall: Foundation dampproofing shall meet the requirements of Section R406.1 of the 2024 IRC. In addition, the dampproofing shall have a minimum Class II perm rating.
2. Under slab: The under-slab vapor retarder shall consist of a 10-mil polyethylene with a minimum Class II perm rating.

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Conclusions

An active equivalent lateral earth pressure of 65 PCF shall be used as the basis of design for floodproofing basement structures. Tables and figures are provided in Appendix B to assist with construction of the wall construction types presented herein. The following conditions must be met to comply with the design recommendations included in this report:

1. Basements shall be constructed with a 100-foot setback to a watercourse.
2. Grade adjacent to the basement shall be one foot above BFE.
3. Fill 15 feet away from the building shall be at or above the BFE.
4. Parameters outlined in the *Lateral Earth Pressures* section shall be met.
5. Drain tile or other approved subsurface drainage be provided around interior and exterior basement perimeter and tied into an appropriately sized sump pit with a functioning sump pump.
6. The basement shall be dampproofed with the products included in this report (or approved equivalents).
7. In the event overtopping is eminent or the sump pump fails and is not able to be reinstated in a timely manner, it is recommended the basements be filled with clean water to minimize structural damage that may result from hydrostatic pressure and uplift.
8. Basements are limited to a depth of 9 feet below BFE.

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Appendix A: Geotechnical Report

July 14, 2025

Project B2501975

Cassie McNames, PE
KLJ Engineering LLC
300 23rd Avenue East, Suite 100
West Fargo, ND 58078

Re: Geotechnical Evaluation Letter
City of Reile's Acres Floodproof Basement Structural Review
Reile's Acres, North Dakota

Dear Ms. McNames:

This letter addresses the geotechnical aspects of the City of Reile's Acres Floodproof Basement Structural Review.

Background

We understand the City of Reile's Acres intends to update their FEMA basement exception to align with the Final Determination Letter for the Western Cass Flood Insurance Study of this year. As part of this update we understand KLJ is assisting the City with a structural analysis of the standard basement wall detail. You have requested that we provide recommendations for soil parameters to be used in design of the wall as well as a seepage analysis to estimate whether the soil that imparts lateral loads onto a basement wall will become saturated during the design flood event.

Information Reviewed

To support our seepage analysis, we were provided with information from the City's representative engineers. The information pertinent to our analysis is summarized in this list.

- Structures must be set back 100 feet from the floodway line and from a water course (legal drain, stream, or river).
- Grade adjacent to the building shall be 1 foot higher than the Base Flood Elevation (BFE).
- Fill 15 feet away from the building shall be at or above the BFE.
- When fill is required to raise a lot above the BFE, it is typically on the order of about 2 vertical feet, except the swales may require up to 4 feet.
- A representative hydrograph for the base flood was provided.

To develop a representative soil stratigraphy for the analysis, we reviewed publicly available geologic maps as well as soil borings we have conducted in the City. The soils in the City of Reile's Acres were deposited by



Glacial Lake Agassiz and are rather consistent across the City. The soils within the typical basement depth of not more than 9 feet consist of what is known as the Sherack formation. As they exist in the upper 9 feet, materials from this formation are most often used as basement wall backfill and from our experience they are also most often used as fill on LOMR lots.

The Sherack formation consists of fat clay that is rather impervious, but is sometimes stratified with silt or sand seams and layers that will increase its hydraulic conductivity. The Sherack formation most often weighs about 115 pcf in its normal, wet condition. Numerous shear strength tests we have performed on material from the Sherack formation indicate that if well compacted it will have a typical internal friction angle of about 25 degrees. Since house pad excavations are relatively small in size, they limit the size of compaction equipment and the overall effectiveness of compaction effort. To account for this, we have assumed the internal friction angle for wall design of about 2/3 of this value, or 16 degrees. This assumption should not relieve the contractor from the need for compaction of the backfill.

The hydraulic conductivity of the Sherack formation averages approximately 1E-4 ft/day vertically (as determined from our laboratory testing) and 1E-3 ft/day horizontally (as determined through the in-situ monitoring of pore water pressure dissipation on local embankment construction projects). The conductivity of backfill is highly variable and dependent on material type, placement and level of compaction. Well compacted backfill would likely have conductivity values similar to those stated for the Sherack formation, while poorly compacted backfill is likely 1 to 2 orders of magnitude faster.

Measured groundwater depths typically vary across the City with location and season, but it is common to use a depth of 10 feet below grade in designs. This is the value used for our analysis.

Analysis

We performed a transient seepage analysis using a finite element program called SEEP/W from GeoStudio. We used the inputs discussed in the Information Reviewed section. When evaluating a basement that extends to a depth of up to 9 feet below adjacent grade, the analysis indicates that the flood waters would have to be in place at full height for 2 to 3 weeks for water to infiltrate to the basement wall. A typical flood remains at full height for less than 1 week, indicating water is not anticipated to reach the basement wall in a design flood event. It should be noted that if flood water contacted a basement wall and covered the wall backfill, saturation of the backfill could occur within the normal timeframe of peak flood conditions.

Recommendations

Based on the results of the seepage analysis, we recommend designing basement walls using an active equivalent fluid pressure of 65 pcf per foot of depth (this value does not include a factor of safety). This value assumes the soil conditions noted in this letter, the wall has a flexible diaphragm, and the basement floor is no more than 9 feet below the adjacent grade. The value also assumes that the house has a functioning drain tile system. Many basements are constructed above groundwater, but even those that are below the groundwater (estimated at 1 to 2 feet maximum seasonally) can experience drawdown of the groundwater below the active pressure zone on the wall if a properly functioning drain tile system is in place.



To use this active equivalent fluid pressure value we further recommend the following requirements.

- Grades within 10 feet horizontal of the perimeter of the building should be sloped down and away from the structure at a minimum gradient of 5 percent to prevent ponding.
- All roof run-off should be collected by gutters and routed to drains with long downspouts, which are diverted to areas more than 5 to 10 feet from the structure.

If basement excavations encounter layers of sand or silt, the excavations should be constructed so that the bottom of the excavation extends at least 10 feet away from the basement walls, and the entire excavation should be backfilled with fat clay soils typical of the area to lessen seepage through the sand/silt layer towards the structure.

If flood water comes in contact with the house or wall backfill, or if the drain tile system fails during periods of flooding, the homeowner should consider flooding the basement to limit structural damage to the basement wall.



Remarks

In performing its services, Braun Intertec Corporation (Braun Intertec) used that degree of care and skill ordinarily exercised under similar circumstances by reputable members of its profession currently practicing in the same locality. No warranty, express or implied, is made.


If you have any questions about this Addendum, please contact Nate McKinney at 952.995.2228.

Sincerely,

Braun Intertec Corporation

Professional Certification:

I hereby certify that this plan, specification or report was prepared by me or under my direct supervision and that I am a duly Registered Professional Engineer under the laws of the State of North Dakota.


Nathan L. McKinney, PE
Vice President, Principal Engineer
License Number: 45791
July 14, 2025




Mohd. Rahman
Senior Consultant

Appendix B: Tables and Figures

Table 1A: Minimum Reinforcement Requirements for Floodproofed Basement Walls - Full Height Walls (65 pcf)

Case A: Allows for minimum anchorage at the top of the wall

Case B: Allows for maximum spacing between perpendicular walls

Wall Height (ft)	Case	Wall Thickness (in)	Vertical Reinforcing	Horizontal Reinforcing	Maximum Horizontal Distance between Perpendicular Foundation Walls (ft) ⁷	Dowel Spacing (ft)	
7.5	A	8	# 4 @ 24 " o.c.	# 4 @ 18 " o.c.	7.5	4'-0" o.c.	
				# 5 @ 28 " o.c.			
				# 6 @ 40 " o.c.			
		10		# 4 @ 12 " o.c.			
				# 5 @ 18 " o.c.			
				# 6 @ 28 " o.c.			
	B ¹³	8	# 4 @ 22 " o.c.	# 4 @ 24 " o.c.	15	1'-10" o.c.	
			# 5 @ 30 " o.c.				
			# 6 @ 44 " o.c.				
		10	# 4 @ 24 " o.c.				
			# 5 @ 36 " o.c.				
			# 6 @ 52 " o.c.				
12	# 4 @ 18 " o.c.						
	# 5 @ 28 " o.c.						
	# 6 @ 38 " o.c.						
	8	A	8	# 4 @ 24 " o.c.	8	2'-0" o.c.	
							# 5 @ 28 " o.c.
							# 6 @ 40 " o.c.
10			# 4 @ 12 " o.c.				
			# 5 @ 18 " o.c.				
			# 6 @ 28 " o.c.				
12		# 4 @ 9 " o.c.					
		# 5 @ 15 " o.c.					
		# 6 @ 21 " o.c.					
B	8	# 4 @ 18 " o.c.	# 4 @ 24 " o.c.	16	1'-6" o.c.		
		# 5 @ 26 " o.c.					
		# 6 @ 40 " o.c.					
	10	# 4 @ 24 " o.c.					
		# 5 @ 36 " o.c.					
		# 6 @ 52 " o.c.					
	12	# 4 @ 18 " o.c.					
		# 5 @ 28 " o.c.					
		# 6 @ 38 " o.c.					
9	A	8	# 4 @ 24 " o.c.	9	2'-0" o.c.		
						# 4 @ 14 " o.c.	
						# 5 @ 22 " o.c.	
		10				# 6 @ 28 " o.c.	
						# 4 @ 12 " o.c.	
						# 5 @ 18 " o.c.	
	B	8	# 6 @ 28 " o.c.	# 4 @ 24 " o.c.	18	1'-0" o.c.	
			# 4 @ 9 " o.c.				
			# 5 @ 15 " o.c.				
		10	# 4 @ 12 " o.c.				
			# 5 @ 18 " o.c.				
			# 6 @ 26 " o.c.				
12	# 4 @ 16 " o.c.						
	# 5 @ 24 " o.c.						
	# 6 @ 36 " o.c.						
12	8	# 4 @ 18 " o.c.	# 4 @ 24 " o.c.	18	1'-0" o.c.		
		# 5 @ 28 " o.c.					
		# 6 @ 38 " o.c.					
	10	# 4 @ 18 " o.c.					
		# 5 @ 28 " o.c.					
		# 6 @ 38 " o.c.					
12	# 4 @ 18 " o.c.						
	# 5 @ 28 " o.c.						
	# 6 @ 38 " o.c.						

Notes:

- Chart is based on an active soil pressure of 65 pounds per cubic foot (pcf).
- Reinforcing steel shall be ASTM A615 with a yield stress, F_y , of 60,000 pounds per square inch (psi).
- Vertical reinforcing bars shall be placed between 1-1/2 and 2-1/2 inches from the inside face of the wall.
- Minimum concrete strength, f'_c , shall be 3,000 pounds per square inch (psi).
- Maximum height of soil against foundation walls is 6 inches below top of wall.
- Backfill shall not be placed until first floor framing and sheathing is installed and fastened or adequately braced and the concrete floor slab is in place or the wall is adequately braced.
- Minimum length of perpendicular wall or "jog" shall be 2 feet. Perpendicular wall shall be the same thickness and reinforcing as wall it supports, and may be up to 1'-0" less in height than foundation wall. Perpendicular walls must be placed on minimum 1'-8" strip footing placed integral with foundation wall footing. Window wells are considered to be a perpendicular wall.
- Refer to Table 1B for connection requirements at the top of the wall.
- Refer to Figure 1 for basement wall detail.
- Refer to Figure 4A for reinforcing at wall corners.
- Refer to Figure 4B for reinforcing at openings in walls.
- Refer to Figure 5 for wall bracing at foundation walls parallel to floor trusses.
- Use 7'-6", Case B, for crawl space walls.

Table 1B: Minimum Connection Requirements for Floodproofed Basement Walls - Full Height Walls (65 pcf)

Case A: Allows for minimum anchorage at the top of the wall

Case B: Allows for maximum spacing between perpendicular walls

Wall Height (ft)	Case	Sill Plate	Optional Top Plate Nailing Pattern	Anchor Bolt ¹²	Connection @ Truss	Bracing @ Walls Parallel to Trusses ¹¹	
						Max. Spacing	Conn. to Sill Plate
7.5	A	2-2x	16d @ 6 " o.c.	1/2" ϕ @ 20 " o.c.	A34 @ ea. Truss	4'-0"	2-A35 Clips
				5/8" ϕ @ 26 " o.c.			
				3/4" ϕ @ 32 " o.c.			
	B ¹³	2-2x	16d @ 3 " o.c.	1/2" ϕ @ 11 " o.c.	2-A35 @ ea. Truss	2'-2"	2-A35 Clips
				5/8" ϕ @ 14 " o.c.			
				3/4" ϕ @ 18 " o.c.			
8	A	2-2x	16d @ 5 " o.c.	1/2" ϕ @ 18 " o.c.	A35 @ ea. Truss	3'-6"	2-A35 Clips
				5/8" ϕ @ 24 " o.c.			
				3/4" ϕ @ 30 " o.c.			
	B	2-2x	16d @ 3 " o.c.	1/2" ϕ @ 9 " o.c.	2-A35 @ ea. Truss	1'-10"	2-A35 Clips
				5/8" ϕ @ 12 " o.c.			
				3/4" ϕ @ 15 " o.c.			
9	A	2-2x	16d @ 4 " o.c.	1/2" ϕ @ 14 " o.c.	A35 @ ea. Truss	2'-9"	2-A35 Clips
				5/8" ϕ @ 18 " o.c.			
				3/4" ϕ @ 22 " o.c.			
	B	2-2x	16d @ 2 " o.c.	1/2" ϕ @ 8 " o.c.	2-A35 @ ea. Truss	1'-6"	2-A35 Clips
				5/8" ϕ @ 10 " o.c.			
				3/4" ϕ @ 12 " o.c.			

Notes:

1. Chart is based on an active soil pressure of 65 pounds per cubic foot (pcf).
2. Anchor bolts shall be ASTM F1554 Grade 36.
3. Minimum clear distance between bolt and edge of concrete shall be no less than 2 inches.
4. Minimum concrete strength, f'_c , shall be 3,000 pounds per square inch (psi).
5. Maximum height of soil against foundation walls is 6 inches below top of wall.
6. Backfill shall not be placed until first floor framing and sheathing is installed and fastened or adequately braced and the concrete floor slab is in place or the wall is adequately braced.
7. Refer to Table 1A for reinforcing requirements.
8. Refer to Figure 1 for basement wall detail.
9. Refer to Figure 4A for reinforcing at wall corners.
10. Refer to Figure 4B for reinforcing at openings in walls.
11. Refer to Figure 5 for wall bracing at foundation walls parallel to floor trusses.
12. Use (2) 2x6 sill plates @ 1/2" and 5/8" anchor bolts Use (2) 2x8 sill plates @ 3/4" anchor bolts. Center bolts in sill plate
- 13 Use 7'-6", Case B, for crawl space walls.

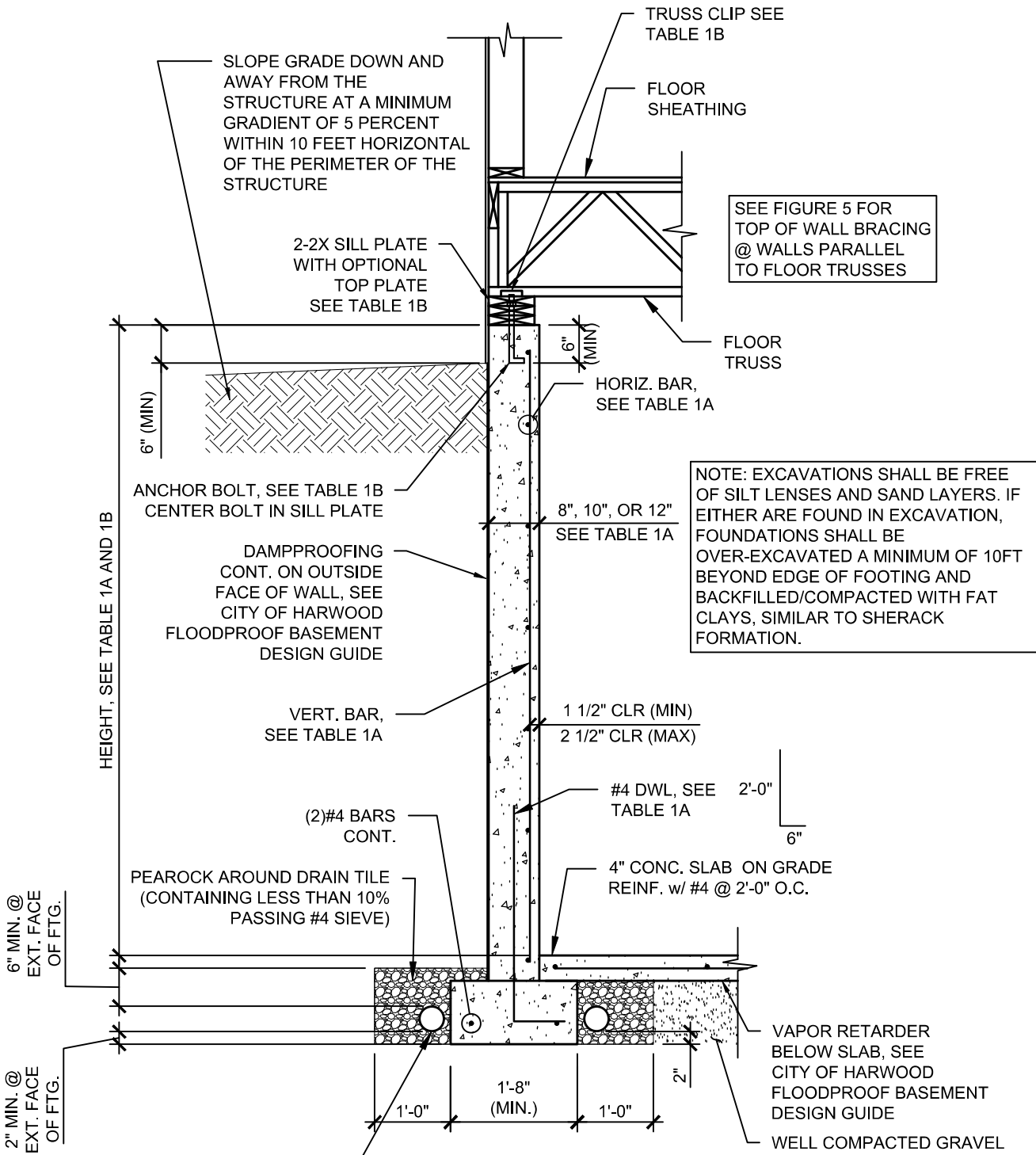
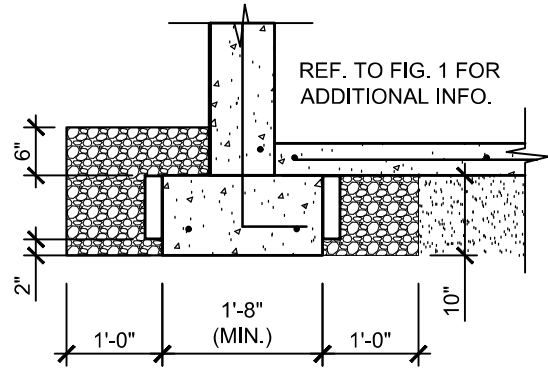


FIGURE 1: BASEMENT & CRAWL SPACE WALL SECTION

4" DRAIN TILE (OR FORM-A-DRAIN) CONT. @ PERIMETER (BOTH SIDES) PROVIDE MIN. 4 CROSSOVERS @ EXT. WALLS FOR DRAIN TILE. DRAIN TILE SHALL TIE INTO A SUMP PIT WITH A WORKING SUMP PUMP.



FORM-A-DRAIN OPTION

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Table 2: Minimum Reinforcement for Floodproofed Basement Walls - Bi-Level Walls (65 pcf)

Wall Height, H (ft)	Wall Thickness (in)	Vertical Reinforcing	Horizontal Reinforcing
5 (max)	8	# 4 @ 18 " o.c.	# 4 @ 24 " o.c.
		# 5 @ 30 " o.c.	
		# 6 @ 40 " o.c.	
	10	# 4 @ 18 " o.c.	
		# 5 @ 26 " o.c.	
		# 6 @ 36 " o.c.	
	12	# 4 @ 12 " o.c.	
		# 5 @ 20 " o.c.	
		# 6 @ 28 " o.c.	

Notes:

1. Chart is based on an active soil pressure of 65 pounds per cubic foot (pcf).
2. Reinforcing steel shall be ASTM A615 with a yield stress, F_y , of 60,000 pounds per square inch (psi).
3. Vertical reinforcing bars shall be placed between 1-1/2 and 2-1/2 inches from the outside face of the wall.
4. Minimum concrete strength, f'_c , shall be 3,000 pounds per square inch (psi).
5. Maximum height of soil against foundation walls is 6 inches below top of wall.
6. Refer to Figure 2 for basement wall detail.
7. Refer to Figure 4A for reinforcing at wall corners.
8. Refer to Figure 4B for reinforcing at openings in walls.

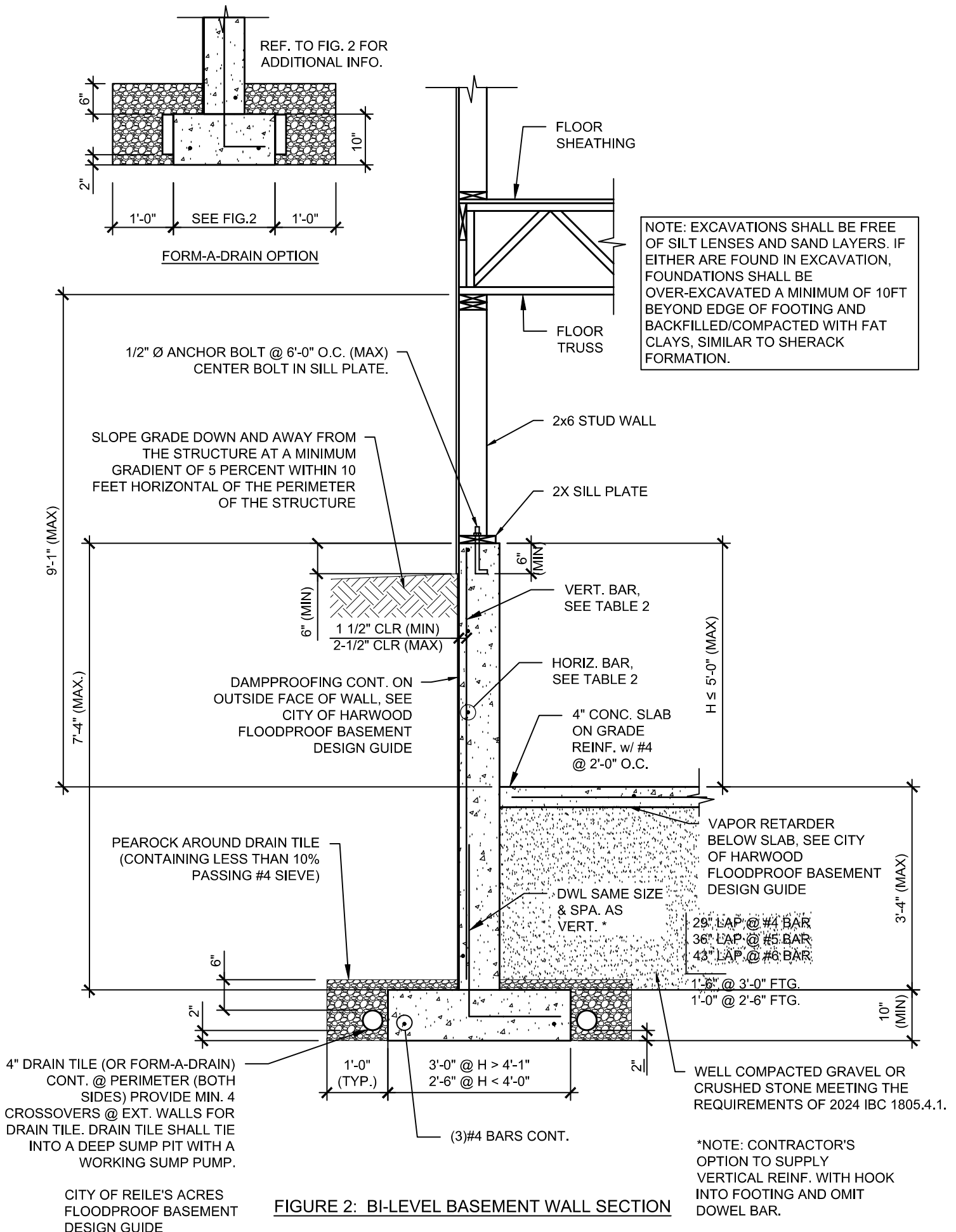


Table 3: Minimum Reinforcement for Floodproofed Basement Walls - Window Well Walls (65 pcf)

Wall Height (ft)	Wall Thickness (in)	Horizontal Reinforcing	Vertical Reinforcing	Max. Horizontal Span between Perpendicular Foundation Walls (ft) ⁹	
7.5	6	# 4 @ 24 " o.c.	# 4 @ 24 " o.c.	4'-0"	
		# 4 @ 18 " o.c.		5'-0"	
		# 4 @ 12 " o.c.		6'-6"	
	8	# 4 @ 18 " o.c.	# 4 @ 24 " o.c.	6'-0"	
				# 4 @ 12 " o.c.	7'-6"
				# 4 @ 9 " o.c.	10'-0"
8	6	# 4 @ 24 " o.c.	# 4 @ 24 " o.c.	4'-0"	
		# 4 @ 18 " o.c.		5'-0"	
		# 4 @ 12 " o.c.		6'-6"	
	8	# 4 @ 18 " o.c.	# 4 @ 24 " o.c.	6'-0"	
				# 4 @ 12 " o.c.	7'-0"
				# 4 @ 9 " o.c.	9'-6"
9	6	# 4 @ 24 " o.c.	# 4 @ 24 " o.c.	3'-6"	
		# 4 @ 18 " o.c.		5'-0"	
		# 4 @ 12 " o.c.		6'-0"	
	8	# 4 @ 18 " o.c.	# 4 @ 24 " o.c.	5'-6"	
				# 4 @ 12 " o.c.	6'-6"
				# 4 @ 9 " o.c.	9'-0"

Notes:

1. Chart is based on an active soil pressure of 65 pounds per cubic foot (pcf).
2. Reinforcing steel shall be ASTM A615 with a yield stress, F_y , of 60,000 pounds per square inch (psi).
3. Vertical reinforcing bars shall be placed between 1-1/2 and 2-1/2 inches from the inside face of the
4. Minimum concrete strength, f'_c , shall be 3,000 pounds per square inch (psi).
5. Maximum height of soil against foundation walls is 6 inches below top of wall.
6. Refer to Figure 3 for basement wall detail.
7. Refer to Figure 4A for reinforcing at wall corners.
8. Refer to Figure 4B for reinforcing at openings in walls.
9. Minimum length of perpendicular wall shall be 2 feet. Perpendicular wall shall be the same thickness and reinforcing as wall it supports, and may be up to 1'-0" less in height than foundation wall. Perpendicular walls must be placed on minimum 1'-8" strip footing placed integral with foundation wall footing.

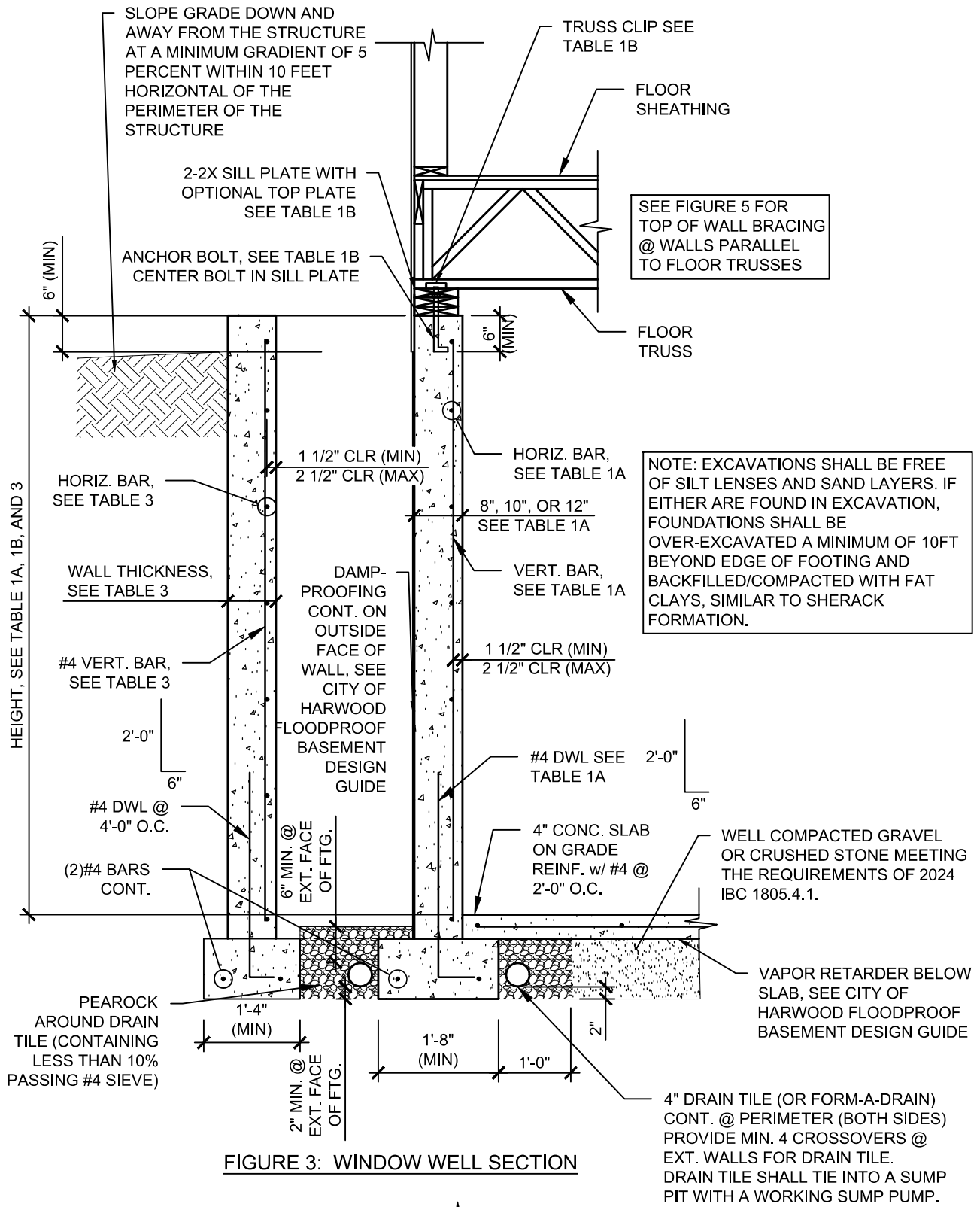
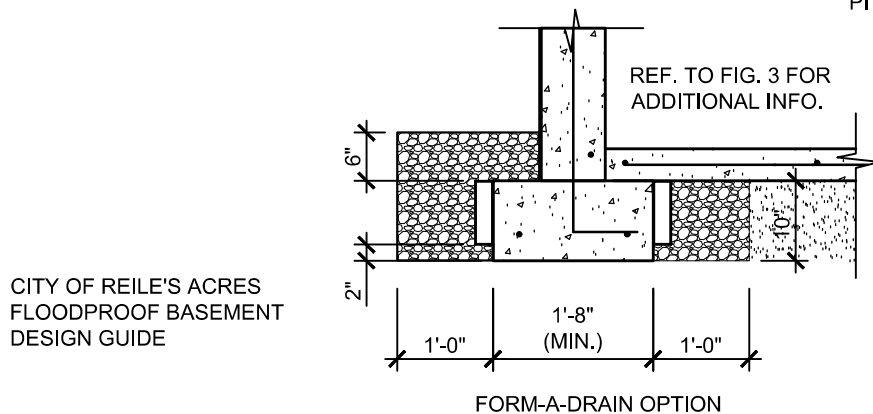
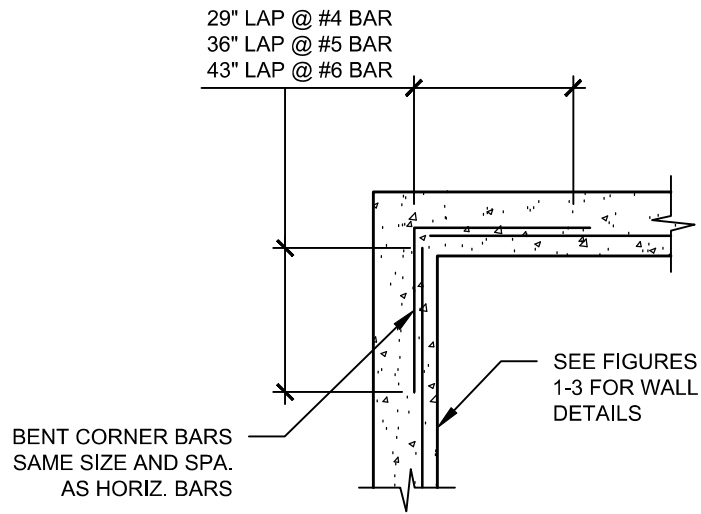


FIGURE 3: WINDOW WELL SECTION

1.



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OR

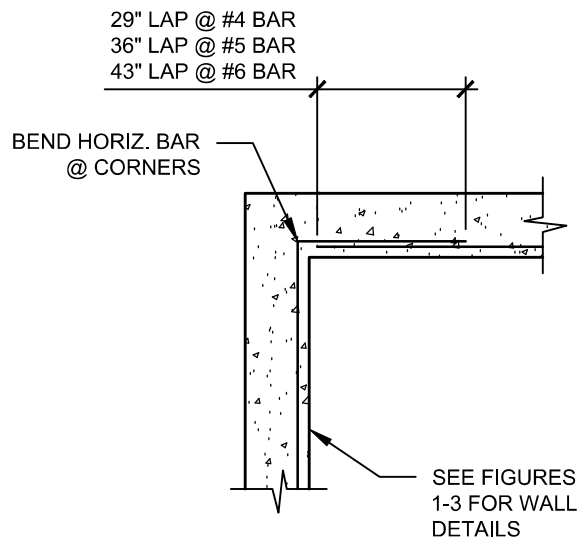


FIGURE 4A: TYP. CONC. WALL CORNER

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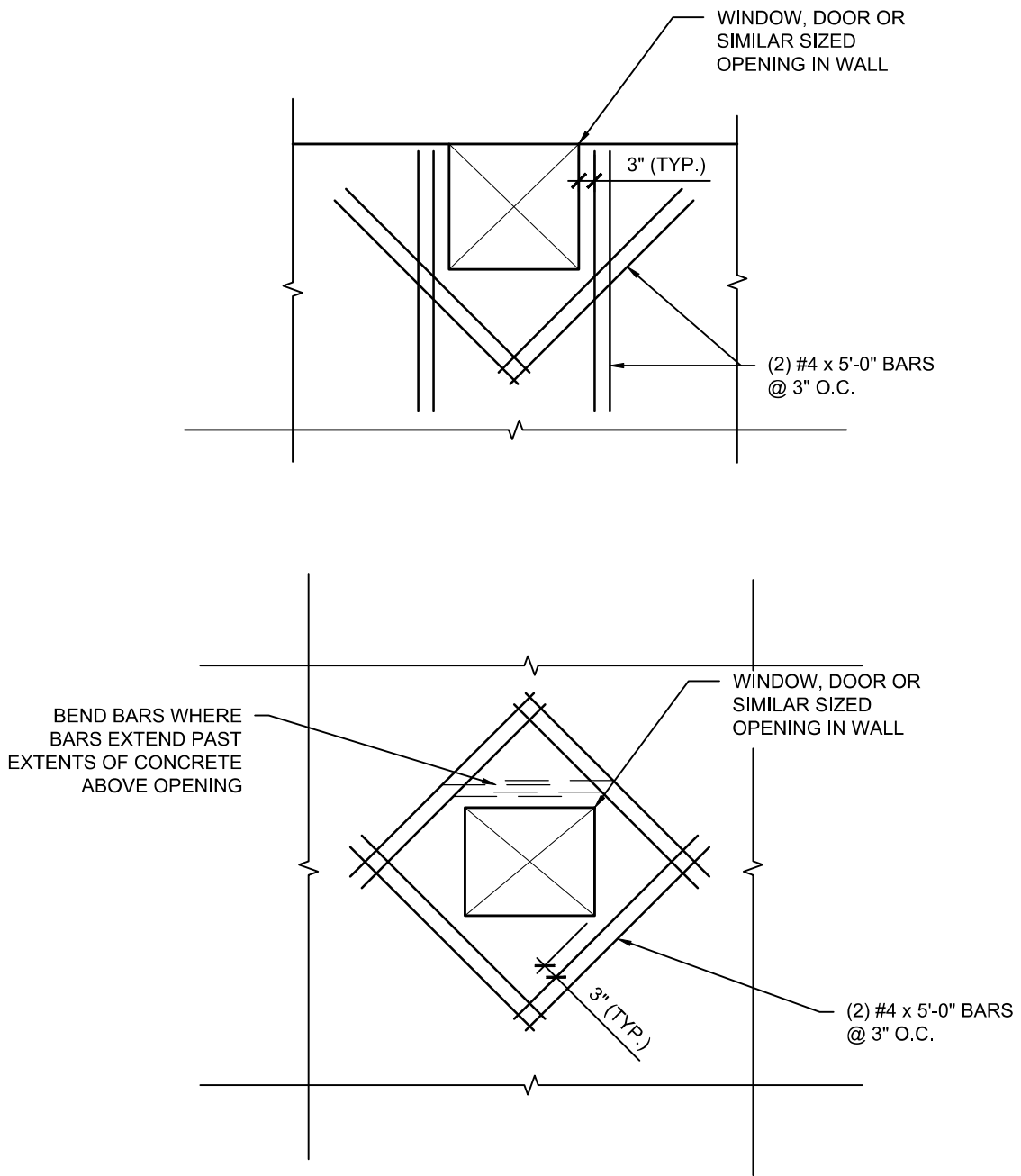
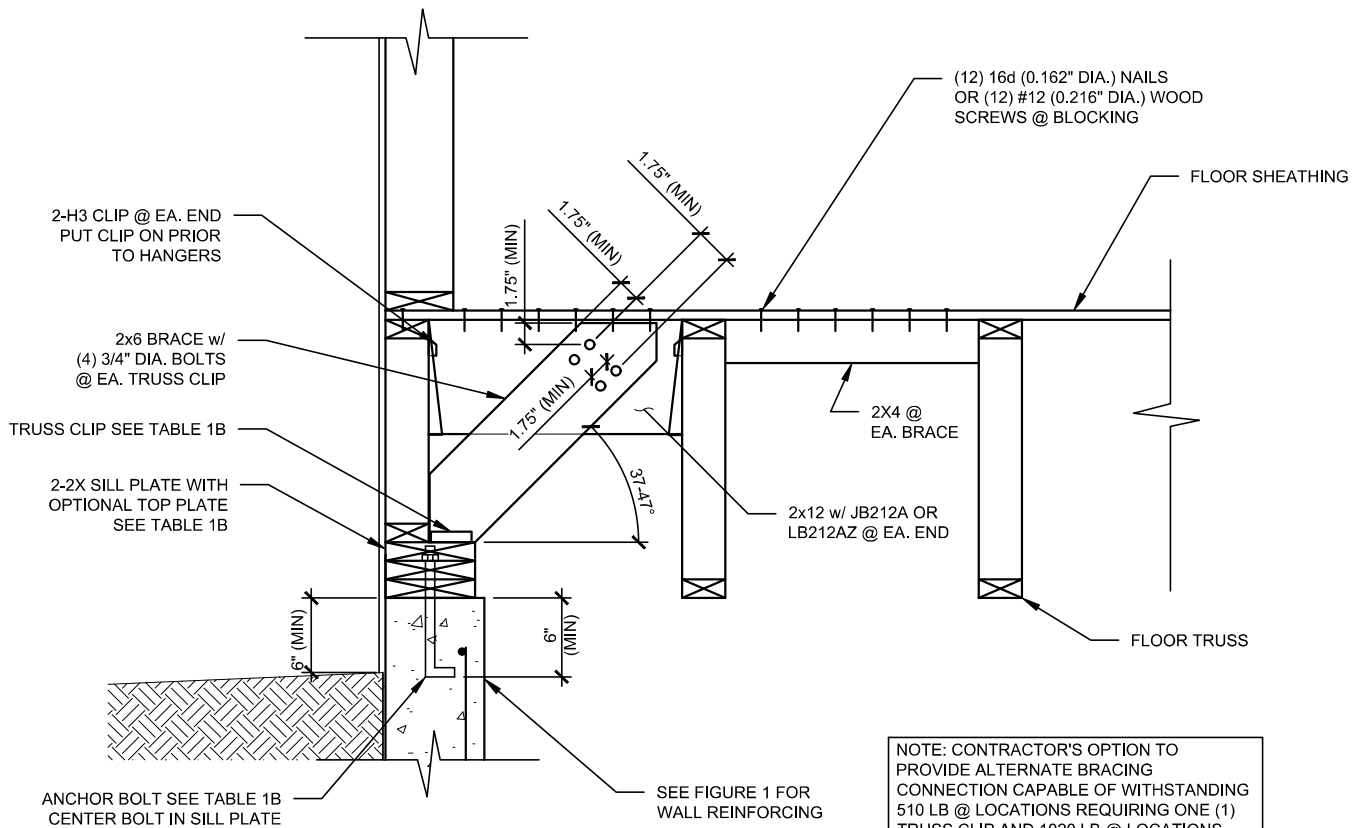


FIGURE 4B: REINFORCING @ WALL OPENINGS

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NOTE: CONTRACTOR'S OPTION TO PROVIDE ALTERNATE BRACING CONNECTION CAPABLE OF WITHSTANDING 510 LB @ LOCATIONS REQUIRING ONE (1) TRUSS CLIP AND 1020 LB @ LOCATIONS REQUIRING TWO (2) TRUSS CLIPS. DESIGN MUST BE STAMPED AND SIGNED BY AN ENGINEER REGISTERED IN THE STATE OF NORTH DAKOTA.

FIGURE 5: PARALLEL WALL BRACING

APPENDIX C

INSPECTION LOG FOR FOUNDATIONS

