Floodproof Construction Requirements

CITY OF FARGO BUILDING
INSPECTION DEPARTMENT

Updated June 2025

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 the International Codes.

REQUIREMENTS TO OBTAIN A BUILDING PERMIT FOR FLOODPROOF CONSTRUCTION

ALL PLANS MUST BE DRAWN TO SCALE

1. Most current version of the Residential Basement Floodproofing Certificate signed by a State of North Dakota registered professional engineer. Required before permit issuance.

2. Plot plan showing existing elevations of property.

3. Plot plan showing exact location of new building or addition and existing buildings.

4. Floor plan(s) of new building(s).

5. Elevation views of two sides of the building. Elevation plans must show grade.

6. Foundation wall sections showing required construction details per City floodproof specifications. (See enclosed details.)

7. Foundation plans showing drain tile location and footings.

THE FOLLOWING ITEMS ARE INCLUDED IN THIS PACKET

1. Typical Floodproofing Construction Requirements Exhibit

2. Foundation and basement wall structural details from *Floodproof Basement Structural Design Requirements Report*, created by KLJ, created: December 17, 2014, Revision 1: April 9, 2015, Revision 2: June 12, 2025.

3. **For informational purposes only** – Inspection log for foundation. Actual log is completed electronically and done by City of Fargo Inspection Department.

4. FEMA Residential Basement Floodproofing Certificate.

5. FEMA Non-Residential Floodproofing Certificate.

A CERTIFICATE OF OCCUPANCY WILL BE REQUIRED BEFORE BUILDING OCCUPANCY

CITY OF FARGO POLICY STATEMENT FOR FLOODPROOFING ELEVATION REQUIREMENTS

Referenced to the following:

Fargo Municipal Code Article 21-06 (Flood Plain Management)
Floodproofing Code of the City of Fargo, North Dakota, prepared by Moore Engineering, Inc., Revised December 9, 1975

Applicable to the following:

This Policy Statement shall regulate development within City of Fargo City Limits and Extra Territorial Areas. The specific area governed by this policy is the FEMA Special Flood Hazard Area (SFHA), also known as the 1% annual chance floodplain.

I. All Structures

All structures, including but not limited to, residential, commercial, and industrial construction within the city limits and extra territorial areas shall meet the following requirements:

A. Floodway Setback
All structures must be set back 100' from the FEMA designated floodway line.

B. Watercourse Setbacks
All provisions of the Minimum and Limited Disturbance Setbacks Zones as identified under City Municipal Code §20-0508 shall be met.
1. One accessory structure not to exceed 120 square feet shall be allowed in the Limited Disturbance Setback Zone as specified in the above referenced Code.

C. Primary Flood Protection Line
1. All properties adjacent to a river, drainage ditch or other flooding source, as determined by the City Engineer, must include a primary flood protection line.
2. Primary flood protection line elevation shall be the FEMA Base Flood Elevation (BFE) plus 4.0’.
3. Primary flood protection line must be constructed throughout a proposed development (not on a lot by lot basis) prior to issuance of any building permits.
    a. Plats approved by City Commission prior to March 4, 2014 may have a primary flood protection line constructed on a lot by lot basis. Protection line must be completed at the time of issuance of occupancy certificate.
4. Primary flood protection line shall be constructed according to the City of Fargo Standard Specifications, Section 3600.

D. Letter of Map Revisions (LOMR)
The City of Fargo encourages construction outside of the FEMA SFHA and requires removal from the SFHA by a Letter of Map Revision via fill (LOMR-F).
1. All fill placement shall follow the current City of Fargo Standard Specifications for Construction, Section 3600.
2. No more than five feet (5') of fill may be placed for buildings in areas removed from the FEMA SFHA by a LOMR-F

a. 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 the City in advance of construction.

3. All structures constructed within LOMR-F areas must meet all floodproofing codes.

E. Infrastructure Elevations for New Construction
1. All streets are to be constructed to a minimum of FEMA BFE minus 0.5' at the low point (Back of Curb to be at FEMA BFE).
2. All sanitary sewer facilities, including private sewer connection manholes, cleanouts, etc. must be protected to an elevation equal to the FEMA BFE. Protection measures include sealing and/or elevating.
3. Storm sewer structures at the point of the storm sewer system crossing the line of protection shall be protected to a level as determined by the City Engineer.

F. Certifications
1. Elevation Certificates are required for all floodproofed structures.
2. Pre-Construction Residential Basement Floodproofing Certificate or Non-Residential Floodproofing Certificate is required for floodproof foundations, and must be provided to the City at the time the Building Permit is requested.

II. Structures Within the SFHA or LOMR-F Areas (See Exhibit A)

All construction within the SFHA or LOMR-F areas, as determined by the City Engineer, shall meet all floodproofing codes, in addition to the following elevation and fill requirements:

A. Elevations

• Lowest opening including top of window wells	Equal to FEMA BFE plus 2.0'
• Fill adjacent to a building	Equal to FEMA BFE plus 1.5'
• Fill 15' away from buildings	At or above FEMA BFE

B. All underground parking must comply with floodproofing codes, including the above specified elevation and fill requirements. To provide a continuous line of protection, the area parallel to the ramp, as well as the top of ramp, must be at an elevation equal to the FEMA BFE plus 2.0'. This ramp area must also be included in the LOMR-F for the building.

C. Elevations of detached, non-primary, slab on grade structures, which are not served by the City's water or sanitary sewer systems, shall have the elevation of the finished floor to be at or above the FEMA BFE plus 1.0'.

D. Structures within a LOMR-F 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 FEMA BFE plus 2.0'.

III. Structures Outside the SFHA or LOMR-F Areas

A. Elevations

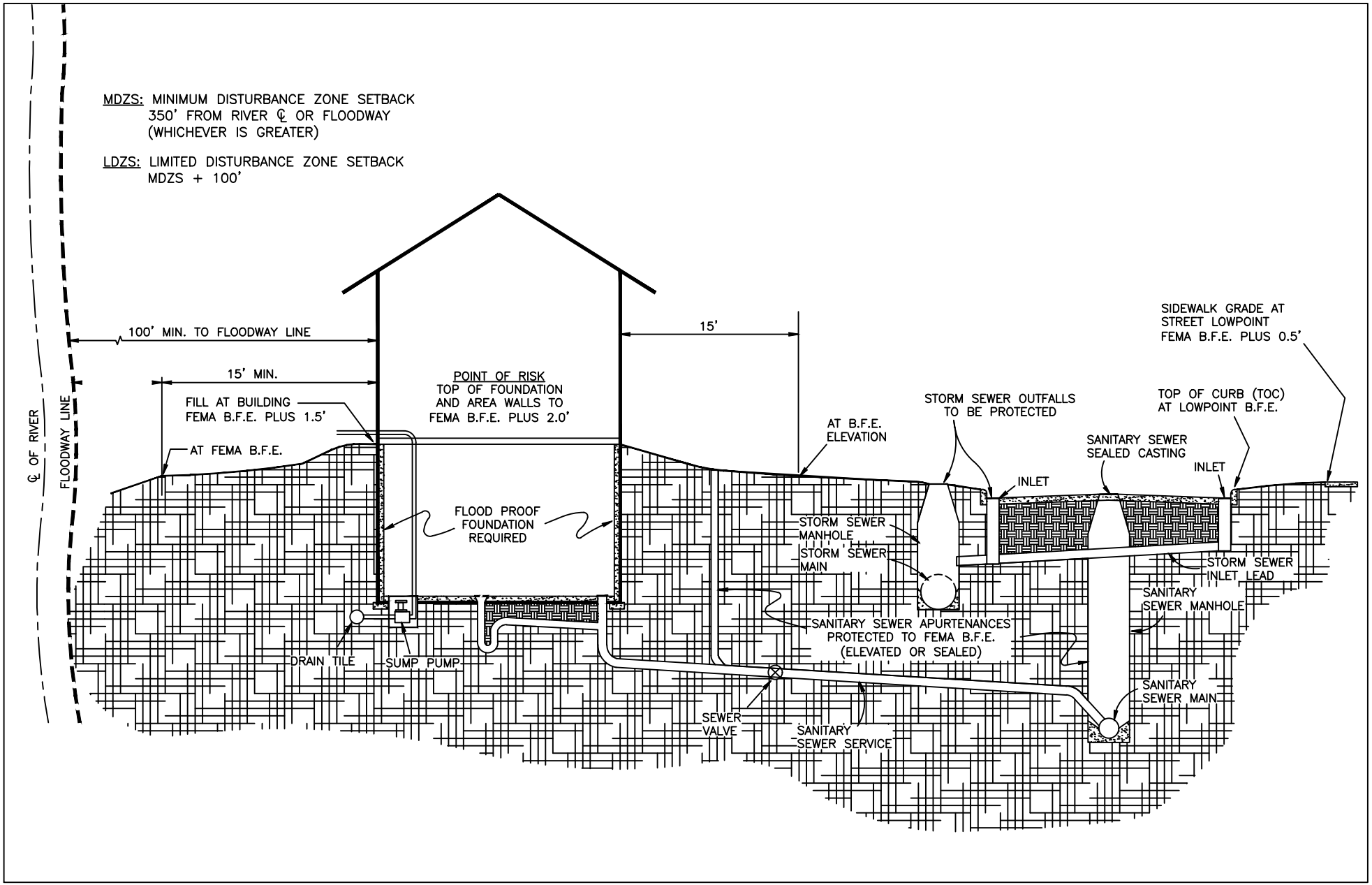
• Lowest opening including window wells	Equal to the elevation of the back of the curb directly adjacent to the lot plus 2.5’
• Fill adjacent to a building	Equal to the elevation required for the lowest opening minus 0.5’

B. Foundations

1. If no portion of the building is within the SFHA or a LOMR-F area, but any portion of the lot it sits on is within the SFHA or a LOMR-F area, standard concrete foundations are required, and floodproof construction is recommended.
2. If no portion of the lot that a building sits upon is within the SFHA or LOMR-F area, there are no floodproof construction requirements, although concrete foundations and/or floodproof construction is recommended.

APPENDIX A

TYPICAL FLOODPROOFING CONSTRUCTION REQUIREMENTS EXHIBIT



STRUCTURES WITHIN THE SFHA OR LOMR-F AREAS

Flood Proofing Construction Requirements Exhibit "A"

Scale: NTS

THE CITY OF Fargo FAR MORE

Engineering Dept.

APPENDIX B

FLOODPROOF BASEMENT STRUCTURAL REQUIREMENTS REPORT

Prepared for:

City of Fargo
Engineering Department
225 4th Street North
Fargo, ND 58102

Prepared by:

KLJ
300 23rd Avenue East
Suite 100
West Fargo, ND 58078

December 17, 2014
Revision 1: April 9, 2015
Revision 2: June 12, 2025

Structural Design Requirements

Floodproofed Basements in Fargo, ND

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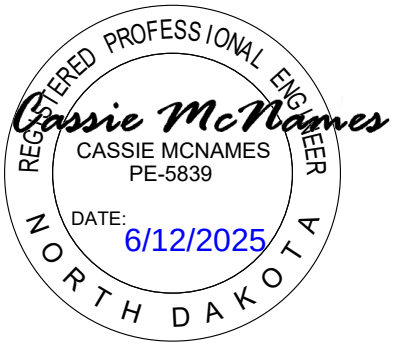

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I. Executive Summary

KLJ and Braun Intertec (Braun) were asked to review the structural requirements of the City of Fargo's existing Floodproofing Code as they relate to current industry practices and design codes. The existing code has performed well under flooding conditions since its inception and has been tested multiple times including major floods of 1997 and 2009. However, the structural requirements have changed very little since it was first created in 1975. The recommendations included herein are based on industry standards and current building code requirements.

II. Analysis

Upon review of documents used to develop previous floodproofing codes, it was determined more information should be gathered related to the soils in the Fargo 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[2] used to develop the structural design requirements included herein.

A. Seepage Analysis

Braun was asked to perform a seepage analysis on the soils in the Fargo, North Dakota area. The results of their 2014[2] findings are included in Appendix A of this report. Braun conducted a revised analysis in 2025 based on observations made between 2014 and 2025 of projects constructed in Letter of Map Revision (LOMR) areas. These observations concluded fill depths to be greater than previously assumed in 2014. The 2025 updated seepage analysis is provided in Appendix C.[2] A summary of Braun's findings are as follows:

1) Based on 2014[2] discussions with the Fargo-Moorhead Home Builder's Association, foundations on most lots are currently being built on fairly shallow excavations. For the Fargo area, the soils at this depth are a part of the Sherack formation. The fill material brought in to build up the sites is also typically from this formation. Fill depth was anticipated to be up to nine (9) feet below finished grade.[2]

2) The soils in the Sherack formation are relatively[2] impervious, but some sand and[2] silt lenses are known to exist. The sand and[2] silt lenses can be troublesome as water can travel through them.

3) Laboratory testing to determine the hydraulic conductivity of the soils in the Fargo area was reviewed.[2] Hydraulic conductivity is a measurement used to describe the flow rate[2] of water through the soil. The tests indicate the soils in the Sherack formation have an average[2] hydraulic conductivity of 1E-4 foot per day vertically. Observation of local construction projects indicates the horizontal conductivity of 1E-3 foot per day. These numbers indicate the soils in the Fargo area are relatively[2] impermeable. It should be noted, however, these values reflect well compacted material, and realistic values for backfill against homes would be "1 to 2 orders of magnitude faster."

4) Groundwater elevations vary throughout the year between five to ten feet below grade. Interviews with local homeowners indicated that bi-level basements (four feet below grade) had sump pumps that ran only during wet seasons and full depth basement sump pumps ran more often and sometimes year-round[2].

5) A seepage analysis concluded that flood waters would not infiltrate basements with a 15-foot setback to the BFE (base flood elevation) for approximately three (3) weeks[2] for a basement that is nine feet below grade. It was noted that if flood waters were allowed to reach the home or wall backfill the soil could become saturated causing hydrostatic pressures to be of concern. A peak flood was assumed to last "several days to 2 weeks before receding" per Braun's 2014 report. In addition, the 2025 report noted that "flood waters along the Red River generally remain at full height for less than 1 week, including the 2009 flood of record."[2]

B. 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.

2) A wood floor and subfloor above the basement is considered a flexible diaphragm.

3) Adequate surface drainage must be provided around the perimeter of the home. If silt lenses or sand are found in excavations, the excavations should be over-excavated by at least ten 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) Grades adjacent to the basements shall be sloped down and away from the structure at a minimum gradient of 5 percent to prevent ponding within 10 feet horizontal of the perimeter of the structure.[2]

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.[2]

C. Structural Design Requirements

KLJ performed an analysis on basement wall construction for full depth basements and bi-level basements in Fargo 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[2] International Building Code (2024[2] IBC)

2) 2024[2] International Residential Code (2024[2] IRC)

3) American Concrete Institute 332-20: Code Requirements for Residential Concrete and Commentary (ACI 332-20)[2]

4) 2024[2] National Design Specification (2024[2] 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).[2]

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 Section II.B are met[2]. Under these conditions, Braun's seepage analysis determined it would take several weeks[2] to saturate the soil adjacent to the basement walls. Given that peak floods only last about two weeks 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 Red River varies between 0.8 and 2.5 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 Section II.B are met. Conditions other than this are not covered under this design guide.[2]

6) Surcharge due to ground snow load shall be considered concurrently with lateral earth pressures. Ground snow load for Fargo, ND per ASCE 7-22 is 63 PCF.[2]

ANALYSIS:

KLJ completed a structural analysis on full height, bi-level and window well basement walls using the design codes and loads listed above. 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.

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.[2]

D. 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[2] top of the footing or 6 inches below the top of the basement floor[2]. The following recommendations meet the U.S. Army Corps of Engineers *Flood Proofing Regulations, EP 1165-2-314* Type B and the City of Fargo Flood Proofing Code (1975) Type D dampproofing. 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[2] 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.

III. 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) Basement shall be constructed as per Exhibit A in the City of Fargo's *Floodproof Construction Requirements* and as noted in Section II.B herein[2].

2) 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.

3) The basement shall be dampproofed with the products included in this report (or approved equivalents).

4) 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[2] hydrostatic pressure and uplift.

[2] *Revised June 12, 2025*

Appendix A

2014 Geotechnical Report

Braun Intertec Corporation
526 10th Street NE, Suite 300
P.O. Box 485
West Fargo, ND 58078

Phone: 701.232.8701
Fax: 701.232.7817
Web: braunintertec.com

November 24, 2014 Project B14-07345

Cassie McNames, PE
KLJ, Inc.
728 East Beaton Drive, Suite 101
West Fargo, ND 58078

Re: Geotechnical Evaluation Letter
City of Fargo Project #MS-14-71
Floodproof Basement Structural Review
Fargo, North Dakota

Dear Ms. McNames:

This Geotechnical Evaluation Letter addresses geotechnical aspects of the City of Fargo's Floodproof Basement Structural Review.

Background

We understand the original design of the City of Fargo's floodproof basement was completed in 1975 and at that time the City was able to receive a basement exception from FEMA. As part of the current FEMA floodplain remapping process, the City is required to renew their basement exception with FEMA. As part of this renewal we understand KLJ is assisting the City with a structural analysis of the standard basement wall detail. The City requested that you engage a geotechnical engineer to provide recommendations for soil parameters to be used in design of the wall as well as a seepage analysis to estimate the timeframe for full saturation of soil adjacent a basement wall.

Information Reviewed

In preparation of this letter, we reviewed a number of documents and resources. These documents and resources are listed below along with some of the key takeaways we considered from each.

- August 27, 1974 letter from Soil Exploration Company to Ulteig Engineers, Inc. Re: Soil Pressures in the Fargo-Moorhead Area.
    - Design walls to withstand an equivalent fluid pressure of 120 pcf.
    - Install a drain tile system at the perimeter and below the floor to control uplift.
    - Backfill utility connection trenches with well compacted clayey soil to prevent easy flow nets for infiltrating water.
    - All sites should be checked by a knowledgeable individual to determine that there is not an unusual uniform silt condition present or pervious fill.
- February 24, 1975 letter from Soil Exploration Company to Ulteig Engineers, Inc. Re: Basement Soil Pressures in the Fargo-Moorhead Area.
    - Ulteig and SEC discussed several homes that were completely surrounded by floodwater for 2 weeks (although overland flow did not reach the basement walls). The homes were

not designed for a maximum soil pressure [120 pcf] and the basement walls were not affected by horizontal soil pressure.
    - A design of less than the maximum soil pressure should provide for construction detail that will insure the maximum stress will not occur.
    - A lesser design soil pressure value was not stated, but it was stated that a "solution within reasonable economic means can be obtained" if freestanding water will not be adjacent the walls, surrounding soils are cohesive and relatively impervious, a drain tile system is in place to collect seepage, easy flow channels to the structure be prevented, utility trenches should be backfilled with cohesive soils and well compacted, gravel fill under driveways and so forth should be kept above flood levels, adequate surface drainage must be maintained away from the structure, and down spouts and local runoff cannot allow ponding adjacent walls.
    - The homeowner should be informed that his basement is not designed to withstand full hydrostatic pressure and he should understand the necessity of maintaining the drain tile system and that if the system fails or if flood waters make approximate contact with the basement walls, the basement should be flooded.
- City of Fargo Code of Ordinances, Article 21-0102, Section 1610.1
    - Exception to International Building Code: Foundation walls extending not more than 9 feet below grade and laterally supported at the top by flexible diaphragms shall be permitted to be designed for active pressure.
- Home Builders Association meeting on October 15, 2014
    - Currently on LOMR lots, excavations to bottom of foundation level are typically about 1 to 3 feet below natural ground and the remainder of the pad is built up from there.

Discussion

Soils

The soils in the City of Fargo 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 this value, or 16 degrees. This assumption should not relieve the contractor from the need for compaction of the backfill.

The 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.

Groundwater
Measured groundwater depths typically vary across the City with location and season, but we have found that most often groundwater is encountered within about 5 to 10 feet of the ground surface seasonally. With regards to sump pump operation, we interviewed 12 homeowners across the City with variability in location, age of home, and depth of basement. The responses were very consistent in that homeowners with split level structures, or 4-foot deep basements, had sump pumps that ran only during rainy periods and homeowners with full basements had sump pumps that ran outside of rainy periods and several stated year round. These interview results would support the groundwater measurements we have observed within 5 to 10 feet of the ground surface.

Analysis

We performed a seepage analysis using a finite element program called SEEP/W from GeoStudio. The analysis was performed for a home with soil conditions typical of the Fargo area. We assumed that the basement is 9 feet below the ground surface and that flood waters would not be closer than 15 feet from the basement wall. The 15-foot distance was selected as it is typically greater than the excavation width for a basement wall and it is also currently the requirement by the City of Fargo for the minimum distance from the BFE for flood proofing construction.

The analysis indicates that the flood waters would have to be in place for several months for water to infiltrate to the house foundation or even the normal backfill wedge against a house. Peak flood conditions in this area typically last several days to as much as about 2 weeks before receding. 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

For design of basement walls we recommend 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 the *Discussion* above, and that the wall has a flexible diaphragm, and also assumes that the house has a functioning drain tile system. Many basements are constructed above the 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 value we further recommend that grades within 10 feet horizontal of the perimeter of the house should be sloped down and away from the structure at a minimum gradient of 5 percent to prevent ponding, and 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 they extend 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.

As noted by Soil Engineering Company, we agree that 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 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 Letter, please contact Nate McKinney or Sean Swartz at 701.232.8701.

Sincerely,

BRAUN INTERTEC CORPORATION

Sean S. Swartz, PE
Principal Engineer

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.

REGISTERED PROFESSIONAL ENGINEER
NATHAN
McKINNEY
PE-6735
DATE 11/24/14
NORTH DAKOTA

Nathan L. McKinney, PE
Principal – Senior Engineer
Registration Number: PE-6735
November 24, 2014

BRAUN INTERTEC

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. # 5 @ 28 " o.c. # 6 @ 40 " o.c.	7.5	4'-0" 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[13]	8	# 4 @ 22 " o.c. # 5 @ 30 " o.c. # 6 @ 44 " o.c.	# 4 @ 24 " o.c.	15	1'-10" 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.	# 4 @ 18 " o.c. # 5 @ 28 " o.c. # 6 @ 40 " o.c.	8	2'-0" 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. # 5 @ 26 " o.c. # 6 @ 40 " o.c.	# 4 @ 24 " o.c.	16	1'-6" 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.	# 4 @ 14 " o.c. # 5 @ 22 " o.c. # 6 @ 28 " o.c.	9	2'-0" 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 @ 12 " o.c. # 5 @ 18 " o.c. # 6 @ 26 " o.c.	# 4 @ 24 " o.c.	18	1'-0" o.c.
		10	# 4 @ 16 " o.c. # 5 @ 24 " o.c. # 6 @ 36 " o.c.			
		12	# 4 @ 18 " o.c. # 5 @ 28 " o.c. # 6 @ 38 " 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 inside face of the wall.
4. Minimum concrete stregnth, 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. 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.
8. Refer to Table 1B for connection requirements at the top of the wall.
9. Refer to Figure 1 for basement wall detail.
10. Refer to Figure 4A for reinforcing at wall corners.
11. Refer to Figure 4B for reinforcing at openings in walls.
12. Refer to Figure 5 for wall bracing at foundation walls parallel to floor trusses.

13 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 stregnth, 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.

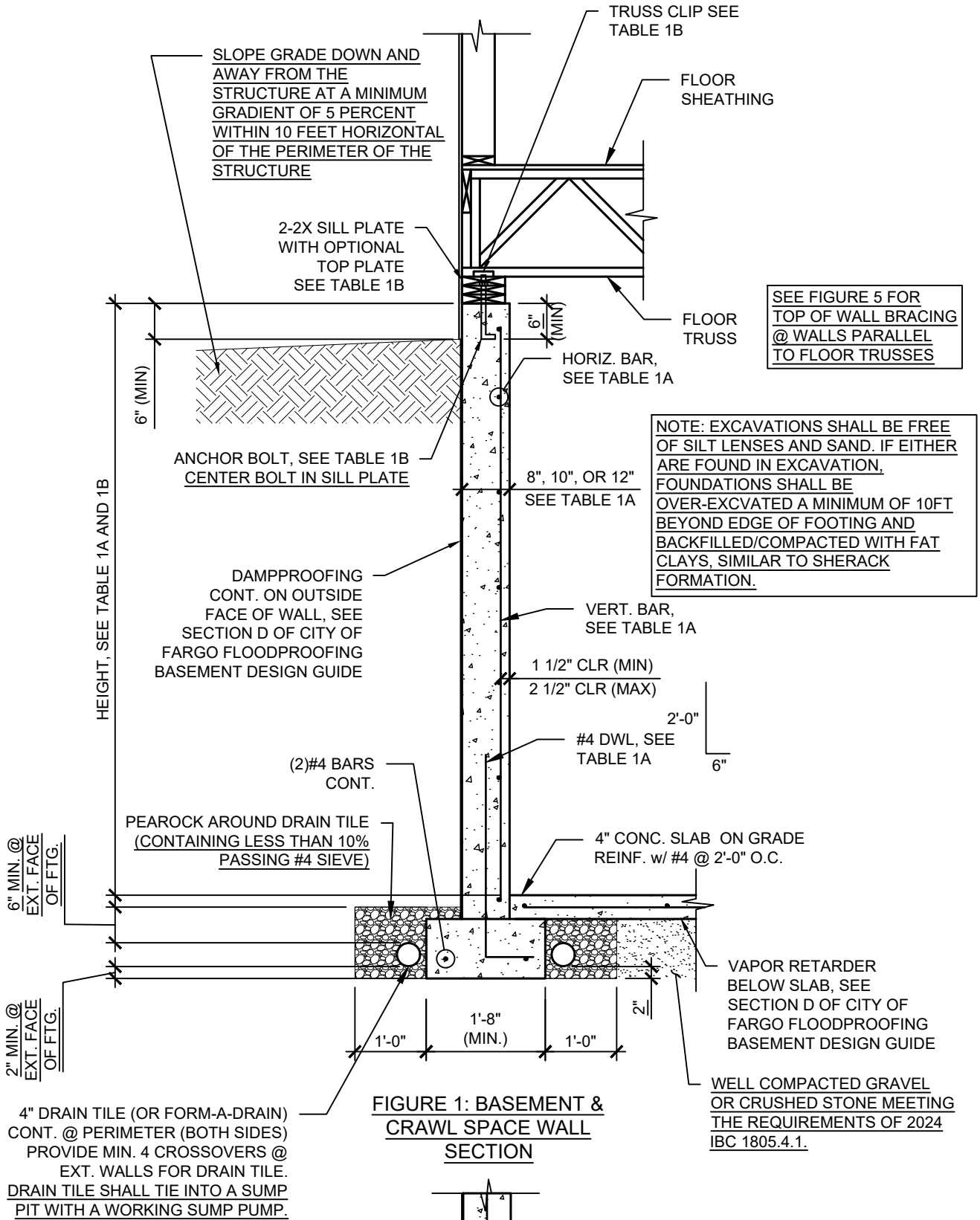
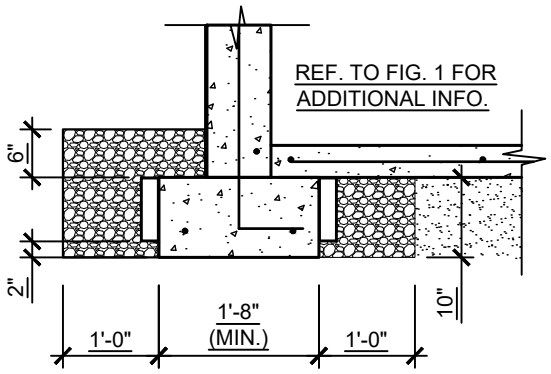


FIGURE 1: BASEMENT & CRAWL SPACE WALL SECTION



FORM-A-DRAIN OPTION

REVISED JUNE 2025

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 stregnth, 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.

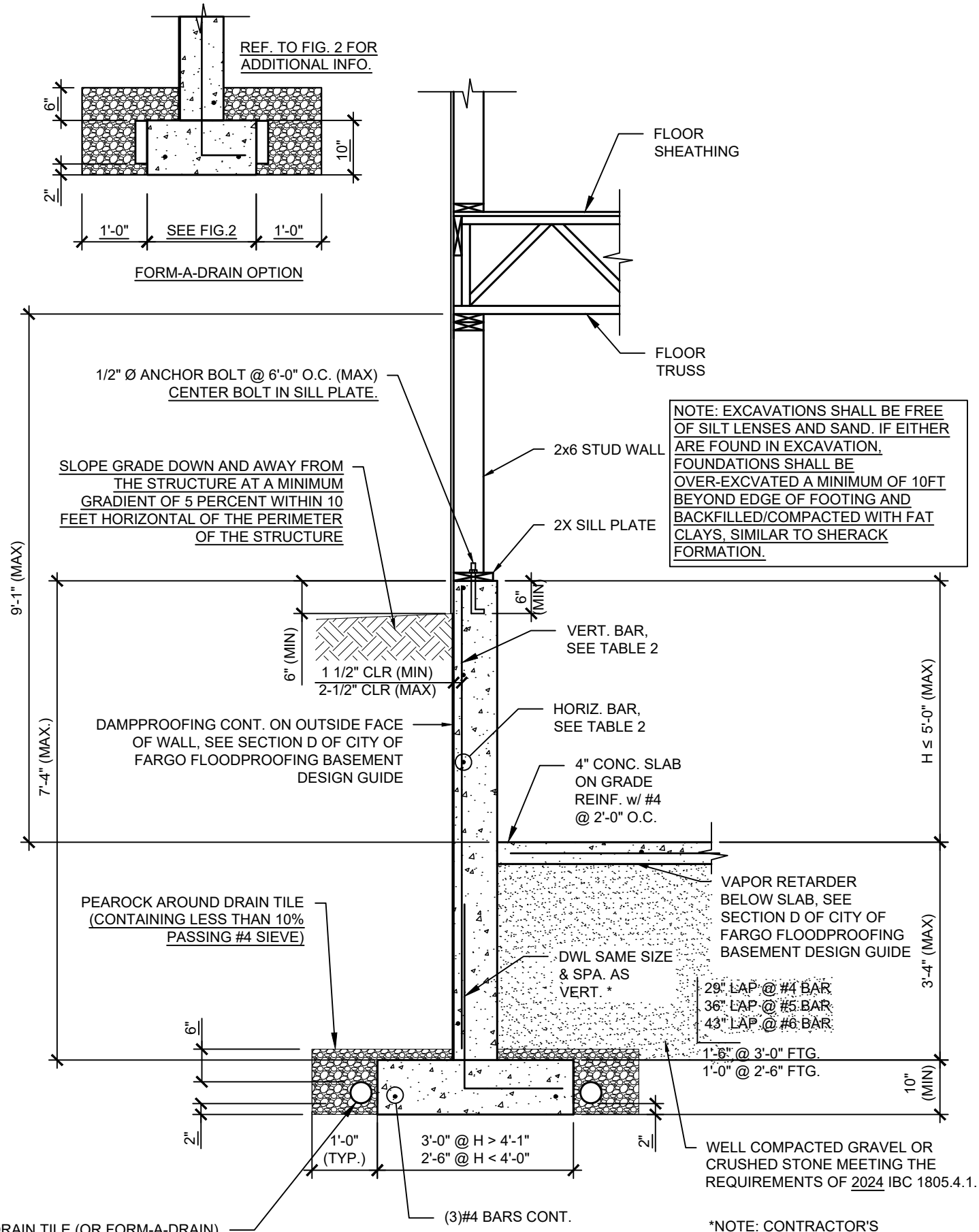


FIGURE 2: BI-LEVEL BASEMENT WALL SECTION

REVISED JUNE 2025

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_v, 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 stregnth,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.

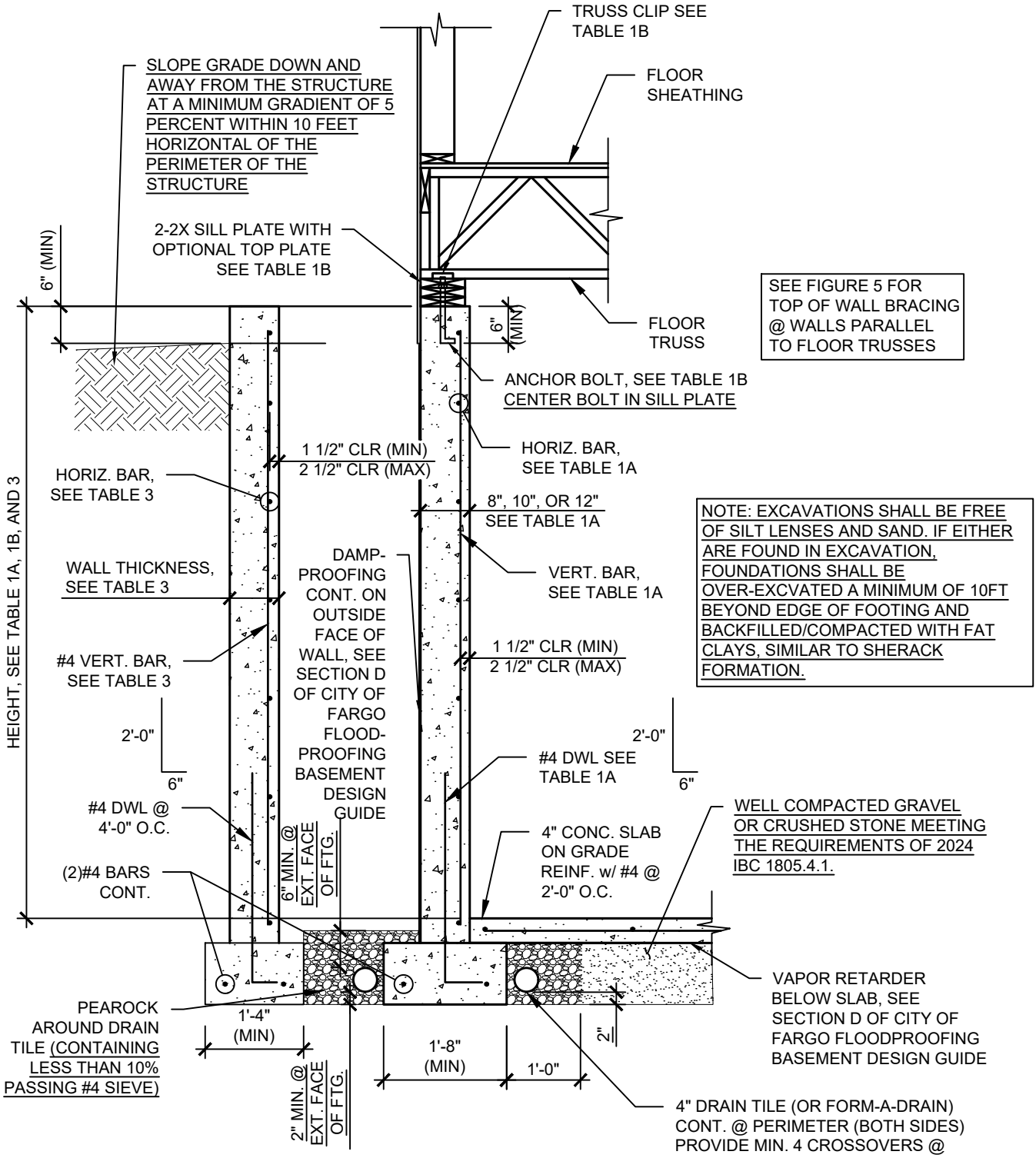
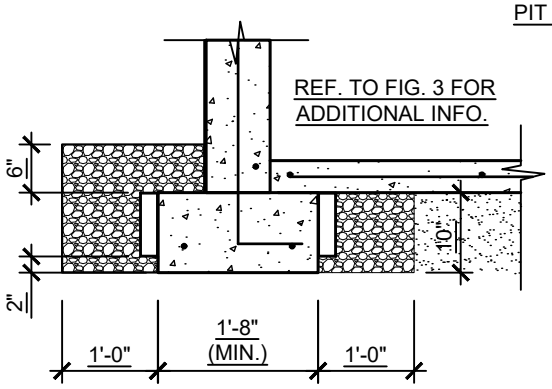


FIGURE 3: WINDOW WELL SECTION

1.



FORM-A-DRAIN OPTION

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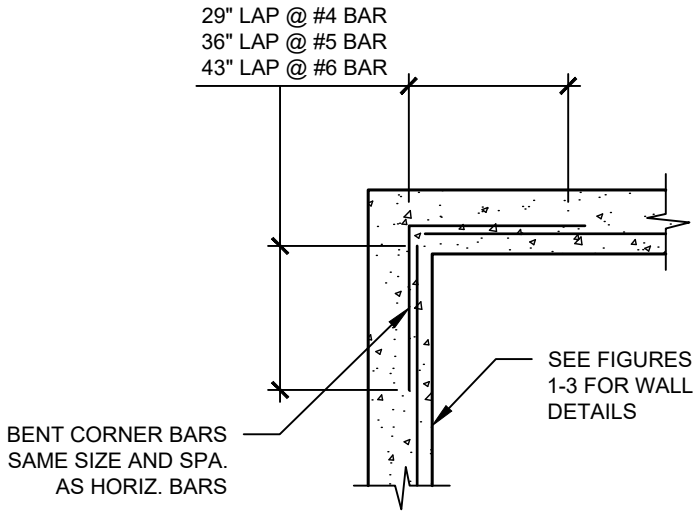


OR

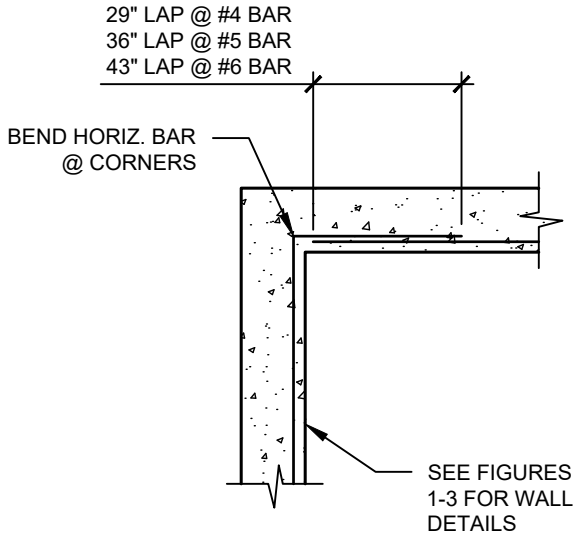


FIGURE 4A: TYP. CONC. WALL CORNER

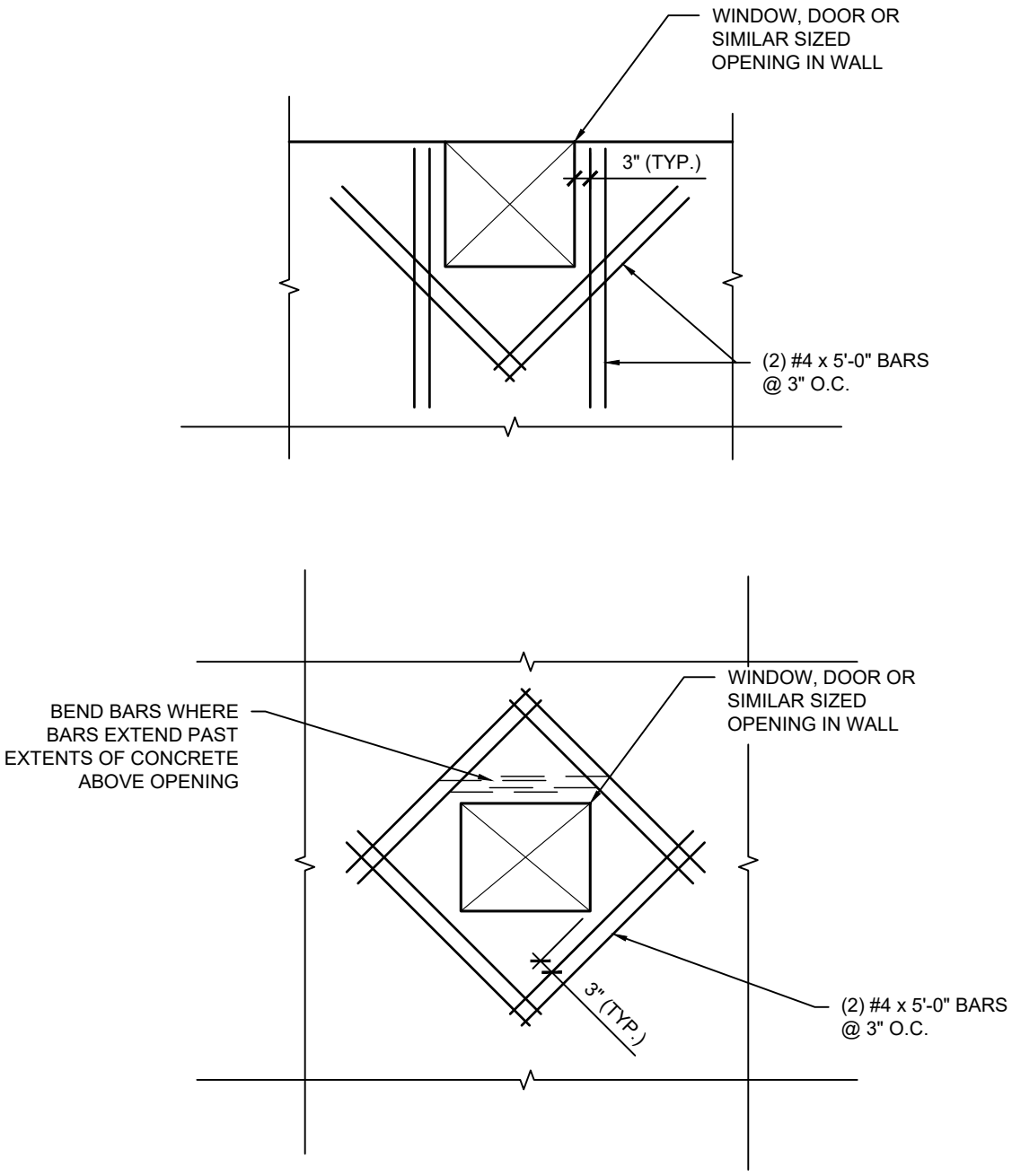
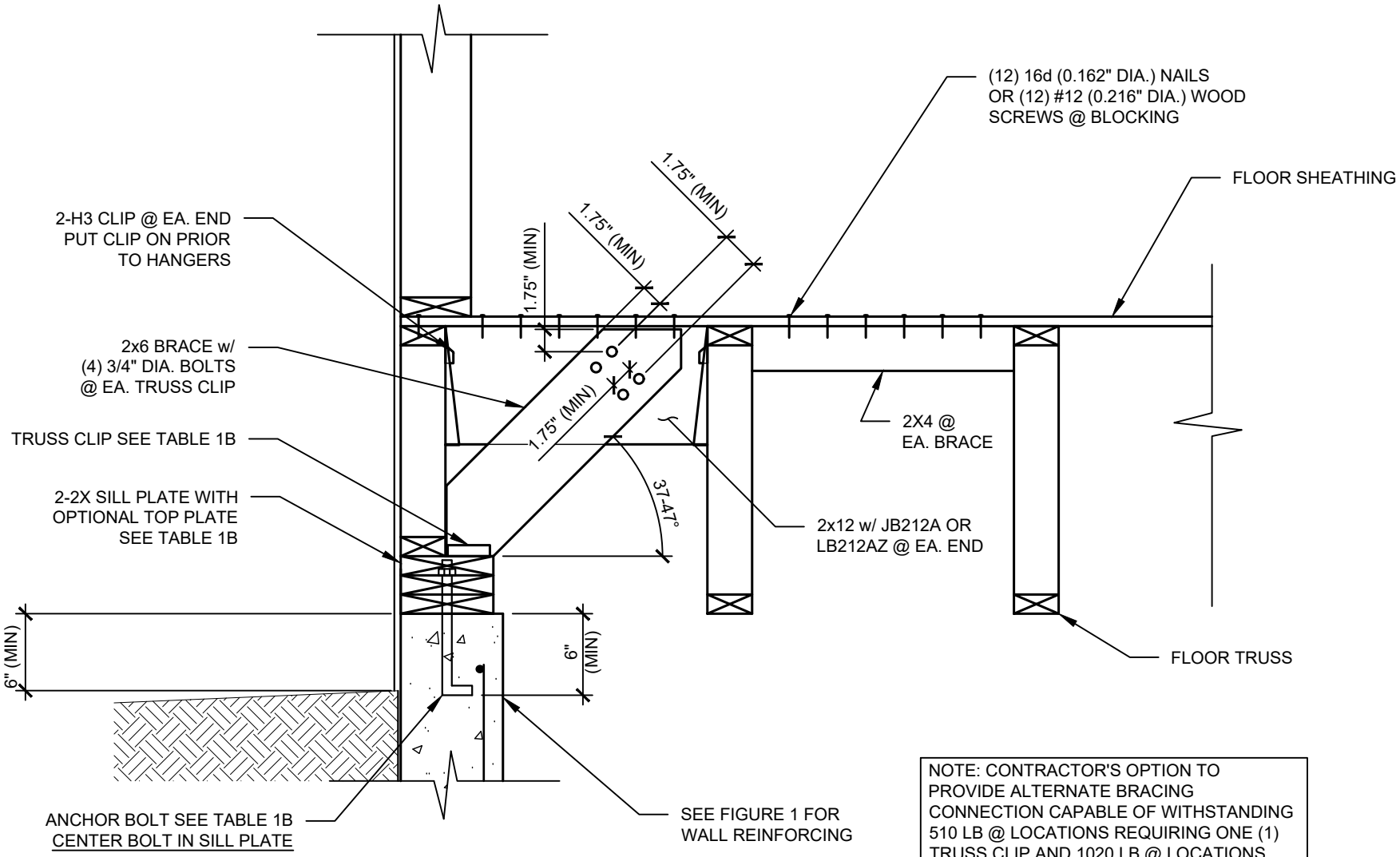


FIGURE 4B: REINFORCING @ WALL OPENINGS



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

REVISED JUNE 2025

Appendix C

2025 Seepage Analysis Letter

BRAUN INTERTEC
The Science You Build On.

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P.O. Box 485
West Fargo, ND 58078

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Fax: 701.232.7817
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April 15, 2025 Project B2501781

Cassie McNames, PE
KLJ Engineering LLC
728 East Beaton Drive, Suite 101
West Fargo, ND 58078

Re: Geotechnical Evaluation Letter
City of Fargo Floodproof Basement Structural Review
Fargo, North Dakota

Dear Ms. McNames:

This Geotechnical Evaluation Letter addresses the geotechnical aspects of the City of Fargo's Floodproof Basement Structural Review.

Background

We understand the City of Fargo 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 such, we were requested to review the geotechnical analysis that we conducted in 2014 (under Braun Intertec project B14-07345 and dated November 24, 2014) for review of floodproof basement guidelines to confirm the analysis is still applicable.

After issuance of the 2014 letter, we were involved with projects where fill depths on lots built in Letter of Map Revision (LOMR) areas were greater than those assumed in the 2014 analysis, and therefore, endeavored to update the seepage analysis that was a part of the 2014 work.

Analysis

We performed a transient seepage analysis using a finite element program called SEEP/W from GeoStudio. The analysis was performed using mostly the same parameters as those from the 2014 analysis. The groundwater depth and seepage properties of the soil formations were left the same. The soil formation depths were also left the same, except that the fill was extended to a depth of 9 feet below finished grade, which coincides with the assumed depth of the basement.

We again assumed that the flood water would not be closer than 15 feet from the basement wall at maximum flood height, which is the current minimum distance from the BFE for flood proofing construction.

Results

The analysis indicates that the flood waters would have to be in place at full height for about 3 weeks for water to infiltrate to the basement wall. This is multiple weeks longer than typical floods of the area remain at full height. Records of major floods indicate flood waters along the Red River generally remain at full height for less than 1 week, including the 2009 flood of record. 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 updated seepage analysis, we recommend designing basement walls still using an active equivalent fluid pressure of 65 pcf per foot of depth (this value does not include a factor of safety). As before, this value assumes the soil conditions noted in the 2014 Letter and updates noted in the Analysis section of this letter, and that the wall has a flexible diaphragm. The value also assumes that the house has a functioning drain tile system. Many basements are constructed above the 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 that grades within 10 feet horizontal of the perimeter of the house should be sloped down and away from the structure at a minimum gradient of 5 percent to prevent ponding, and 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

This Letter should be considered supplemental to the Geotechnical Evaluation letter from November 24, 2014. With the exception of any results or recommendations changed by this Letter, the information contained in our 2014 Letter remains unchanged.

In performing its services, 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 Letter, 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
Registration Number: PE-6735
April 15, 2025

Mohd Rahman
Senior Consultant

BRAUN INTERTEC