

Below Grade Waterproofing

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Into the deep end...

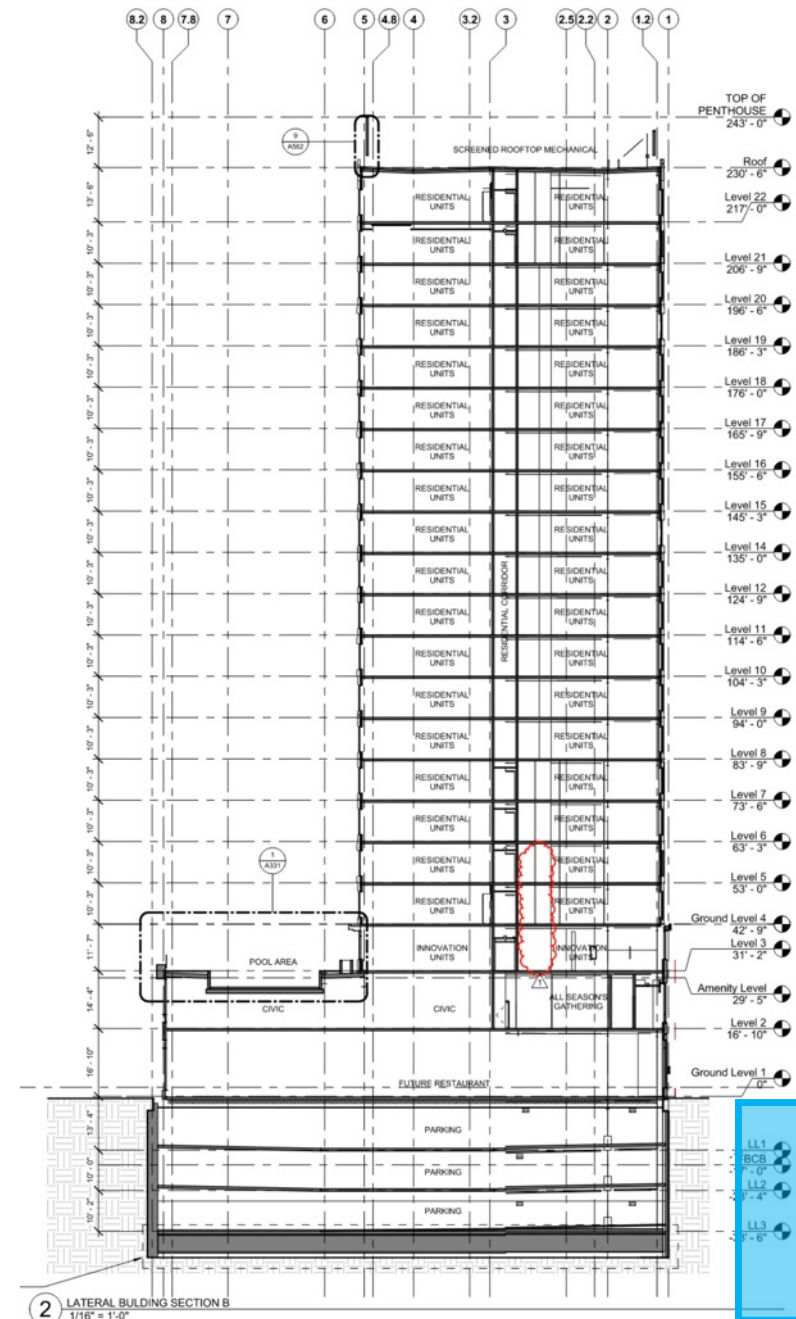
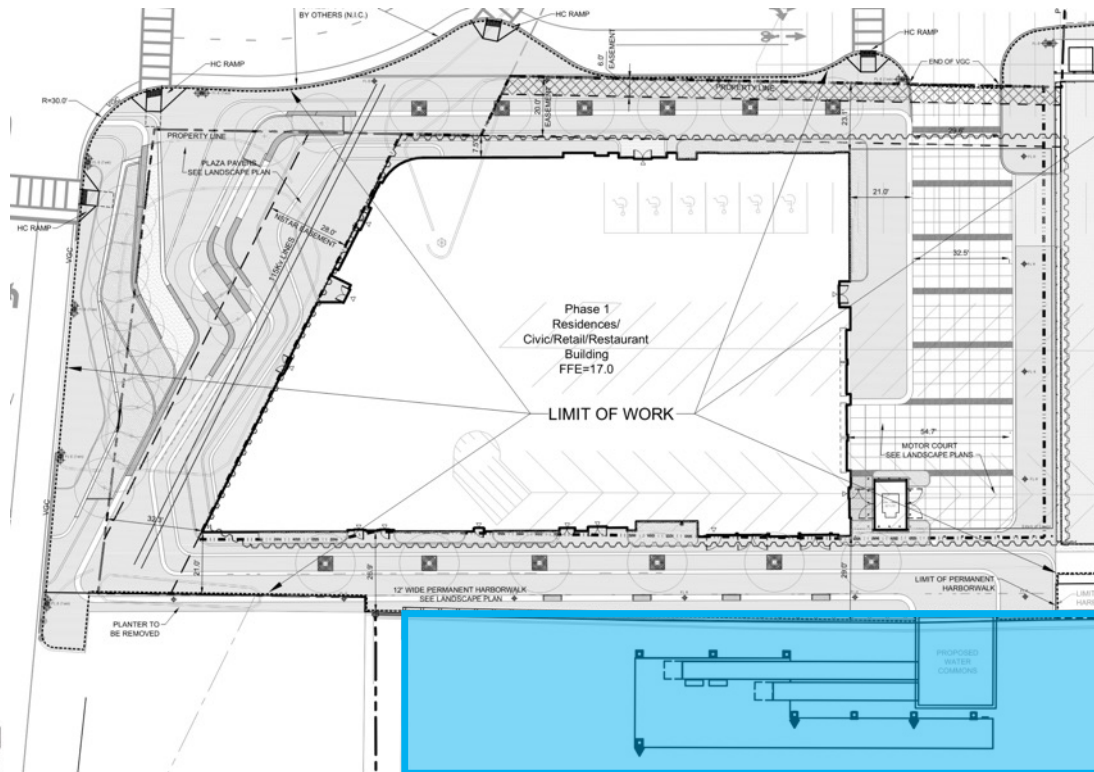
Case Study: Pier 4 Boston, MA

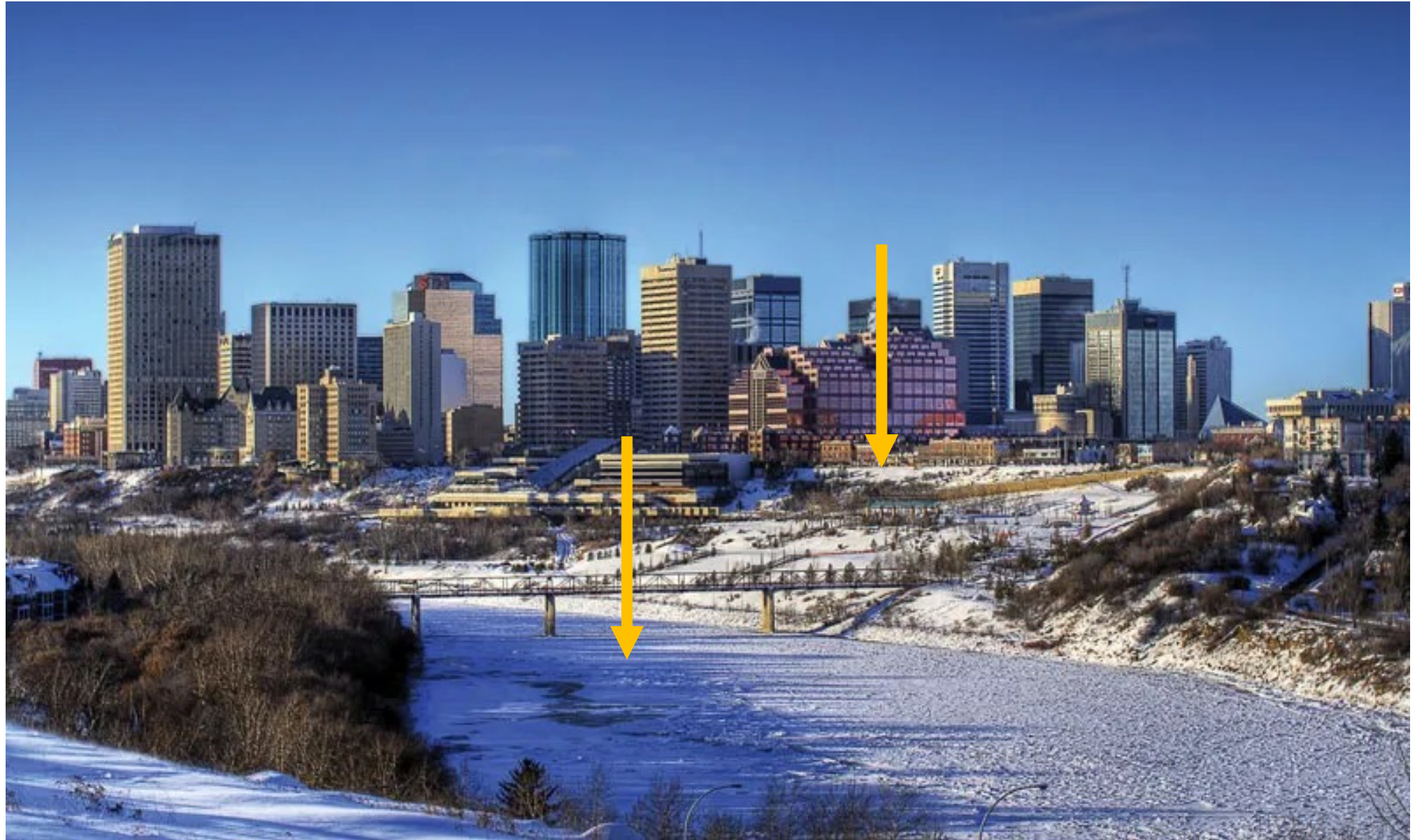




Pier 4

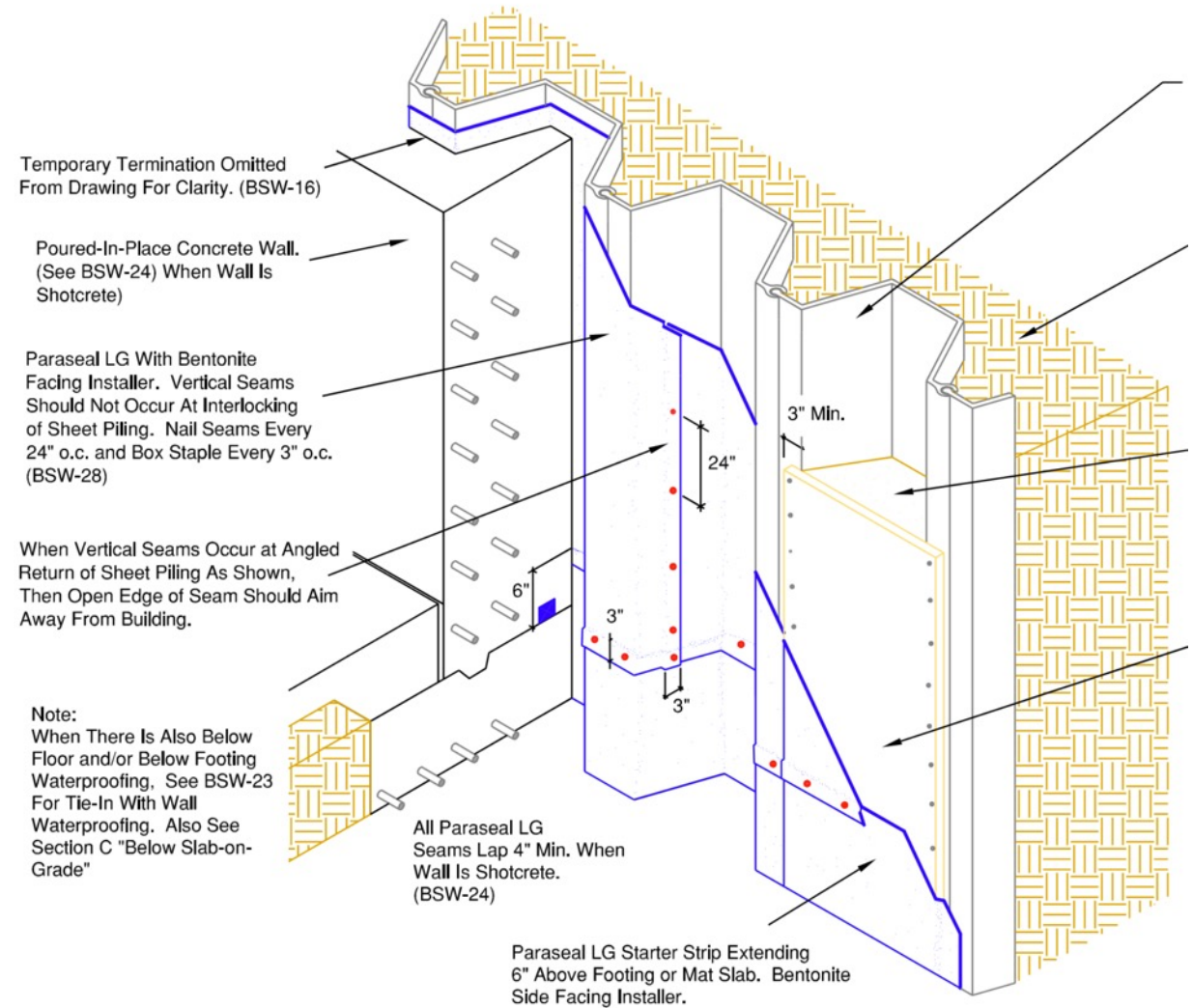
- Located on the Boston Harbor - 27 feet away
- 3 levels of below grade parking
- Depth of 30 + feet below sea level





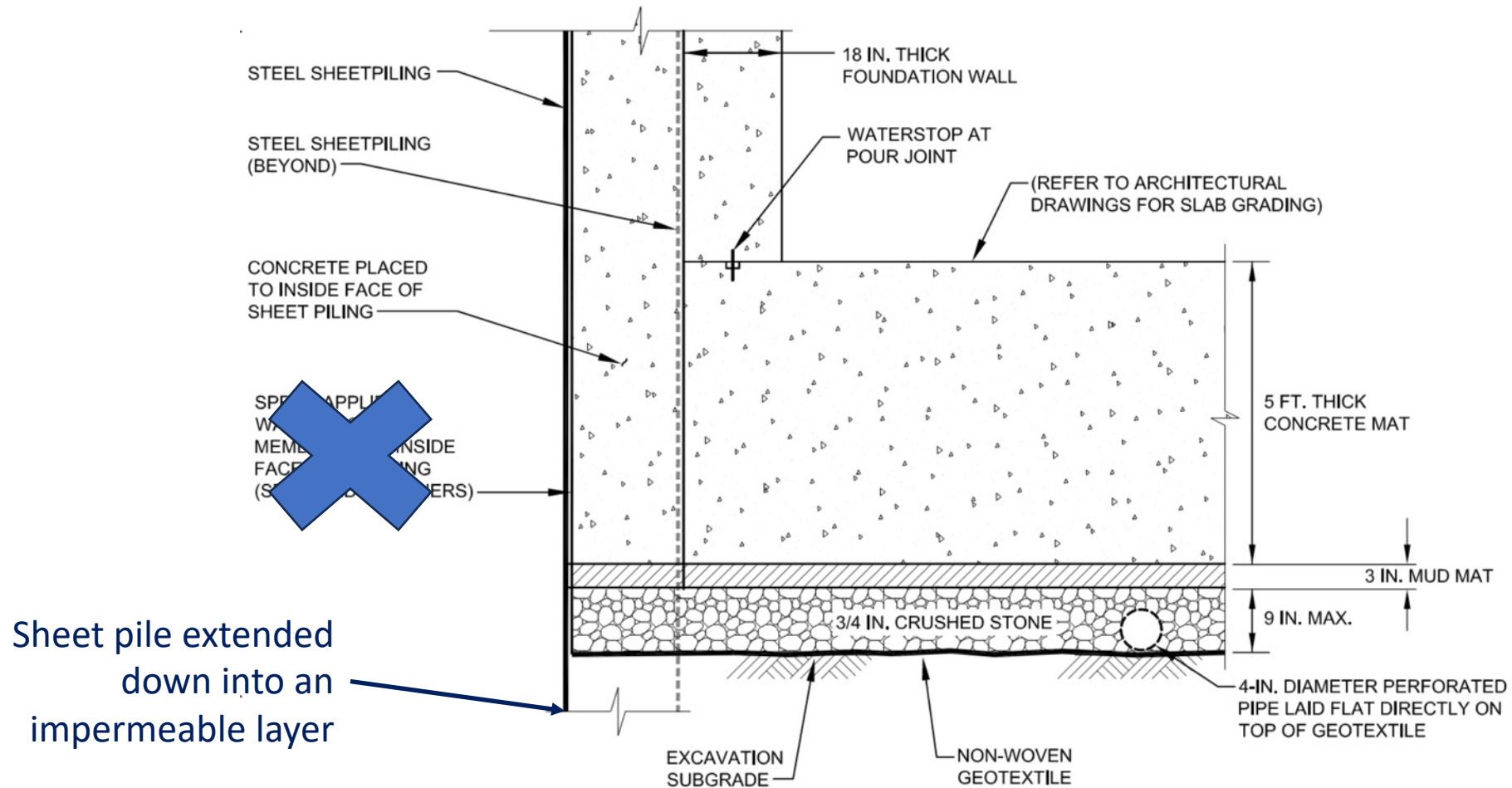
Pier 4

- Initial foundation design
 - Sheet piles
 - Pre-applied membrane waterproofing
 - Concrete Foundation wall
 - Sub-slab dewatering system



Paraseal LG Installation Over Steel Sheet Piling

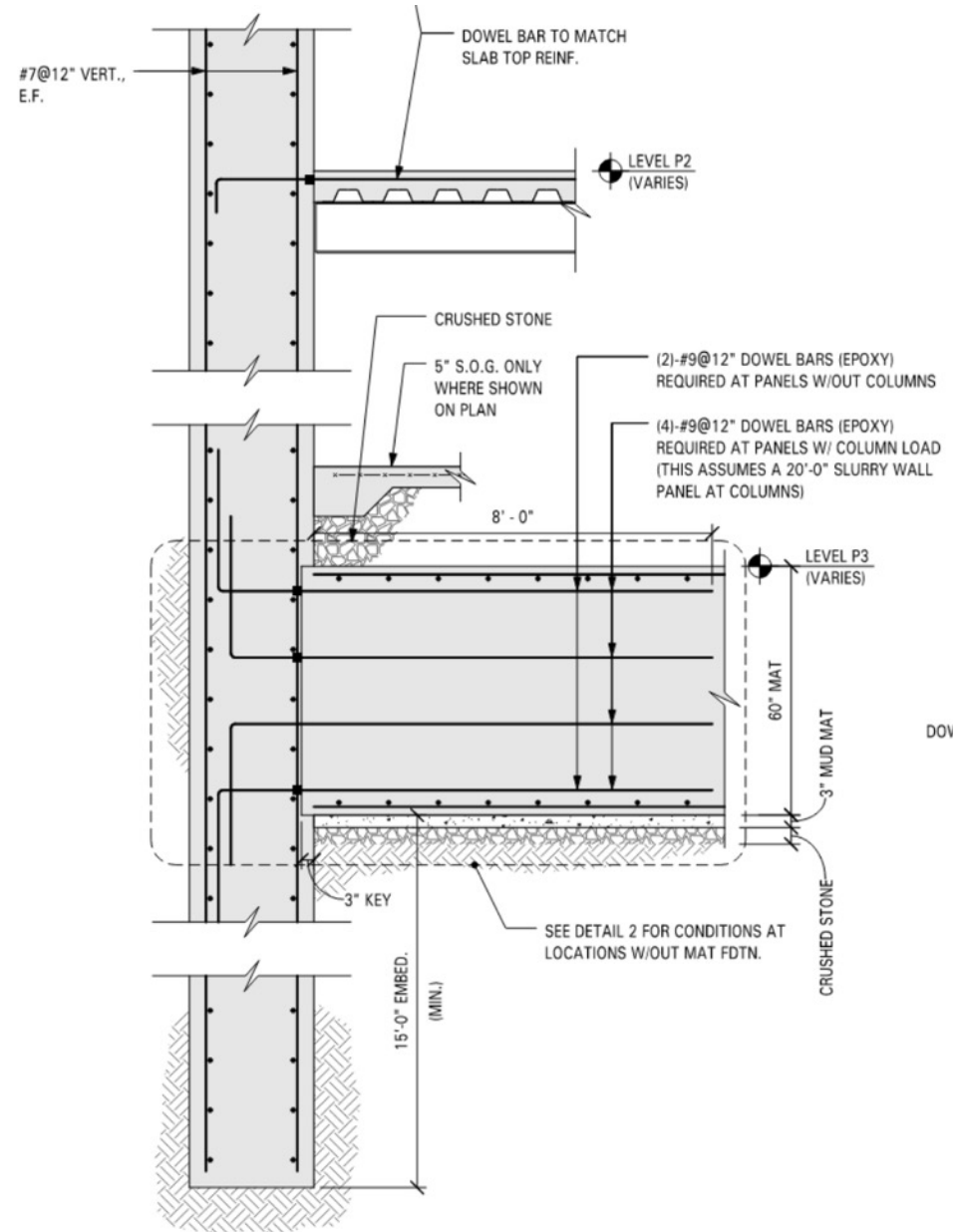
Pier 4



SECTION A-A
SUB-SLAB PRESSURE RELIEF DETAIL
NOT TO SCALE

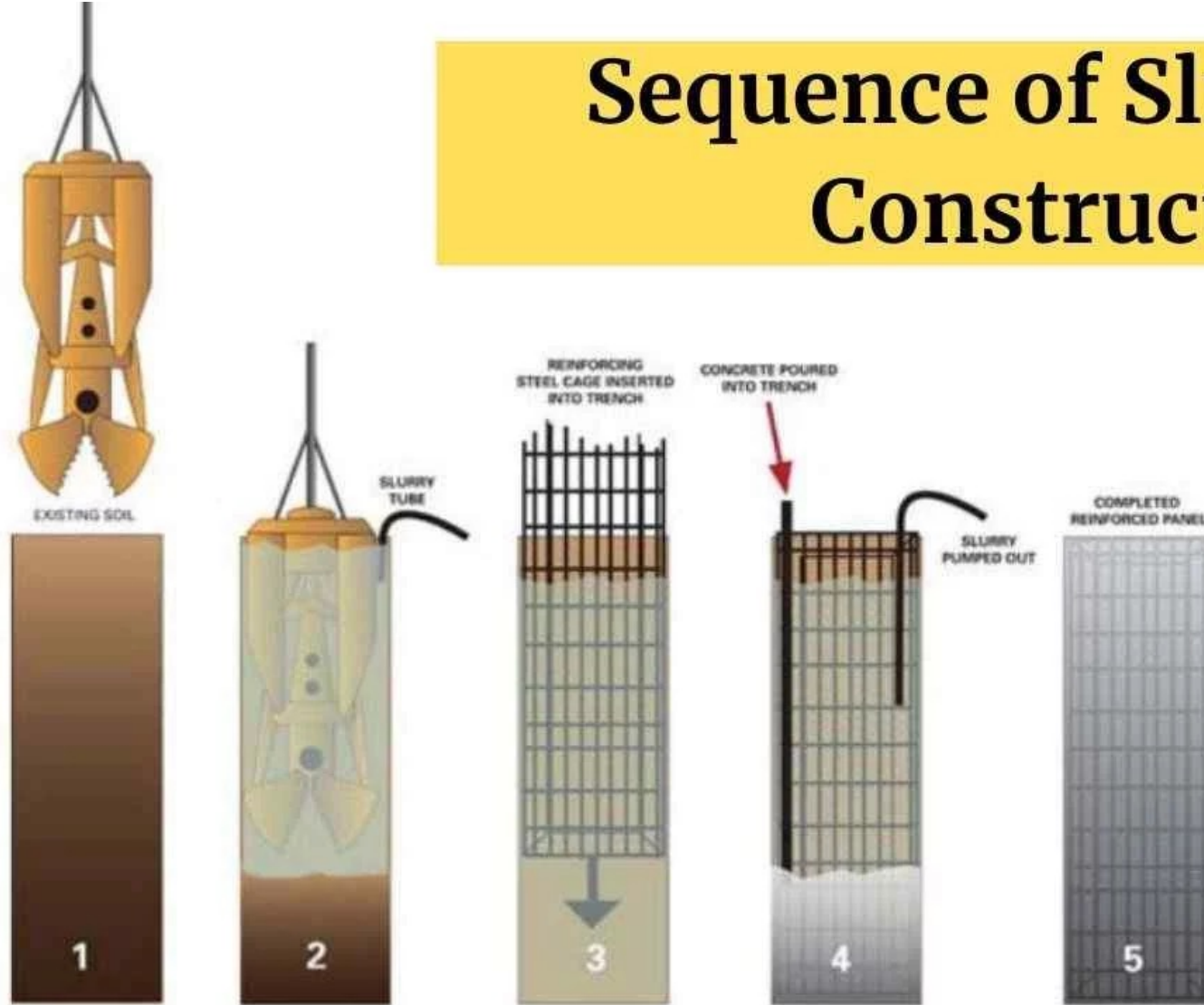
Pier 4

- Foundation Design Final
 - Slurry wall
 - Sub slab dewatering system



1 TYPICAL SECTION AT SLURRY WALL
S10P3N SCALE: 1/2" = 1'-0"

Sequence of Slurry Wall Construction





04/22/2013 12:10







05/09/2013 12:21



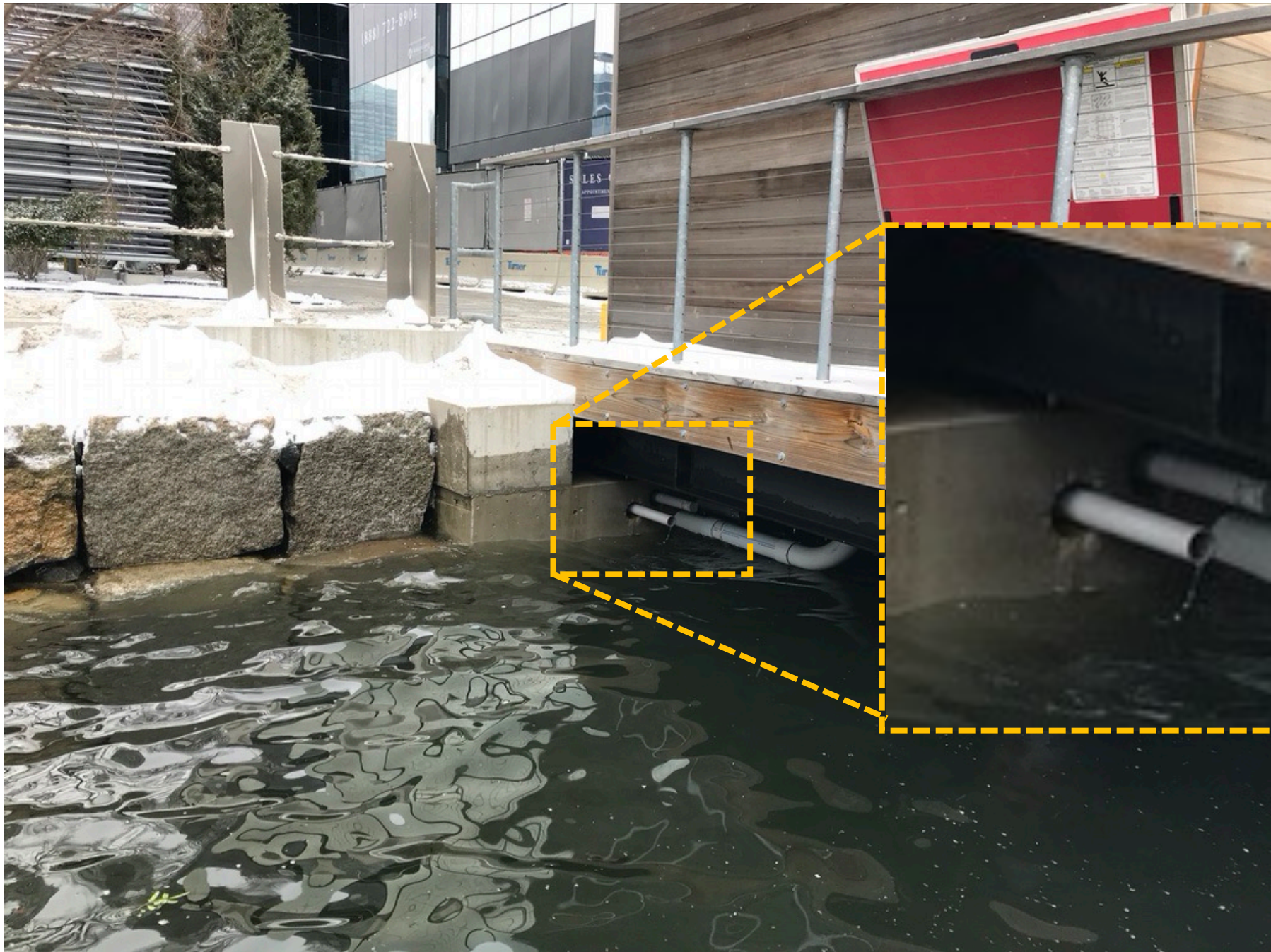




4 years later...









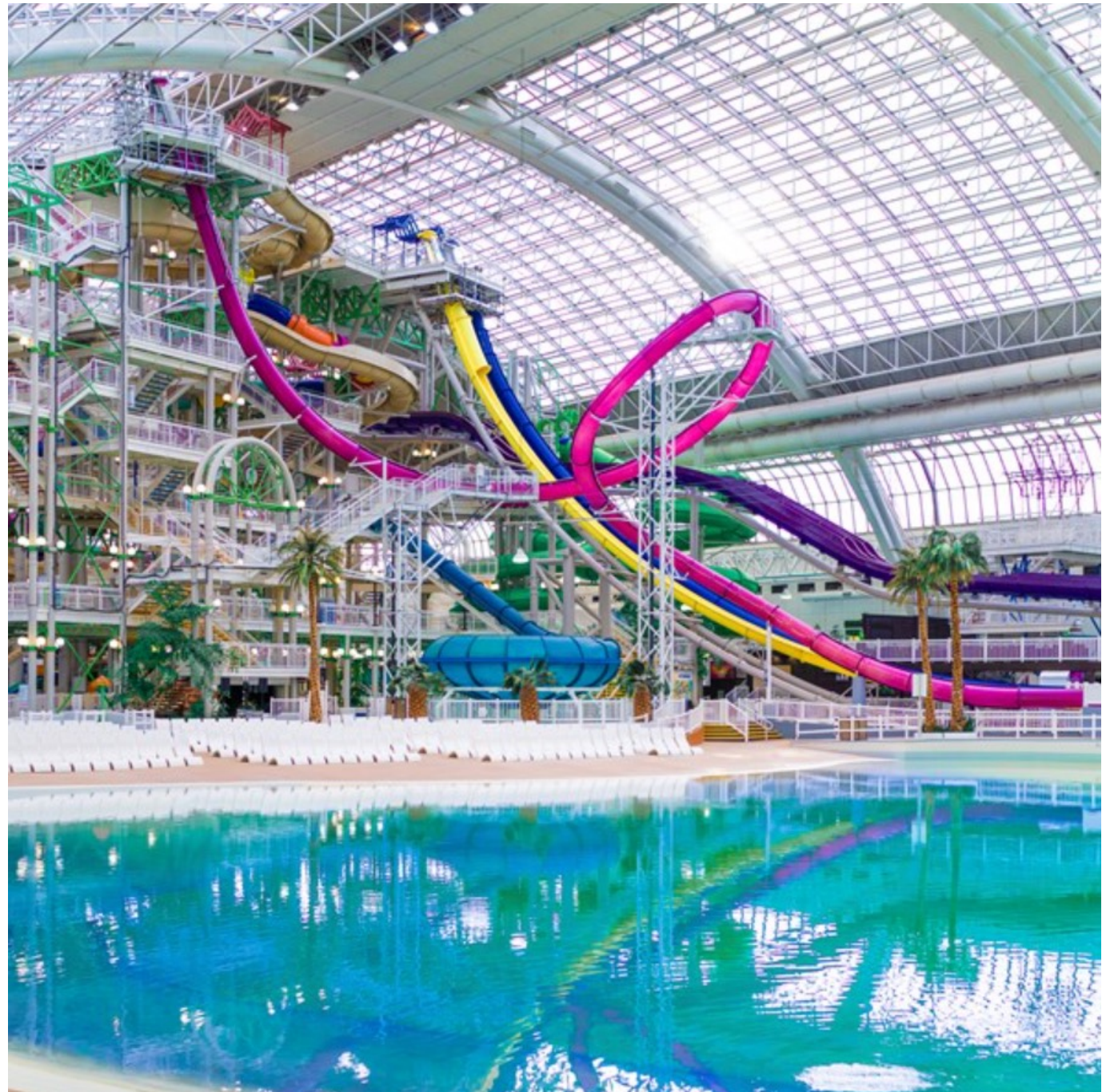


Physics of Water Flow

Tricky tricky tricky

Physics of Liquid Water Flow

- Gravity
- Capillarity
- Hydrostatic



Physics of Liquid Water Flow

- Gravity
- Capillarity
- Hydrostatic



Physics of Liquid Water Flow

- Gravity
- Capillarity
- Hydrostatic



Physics of Liquid Water Flow

- Gravity
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- Hydrostatic



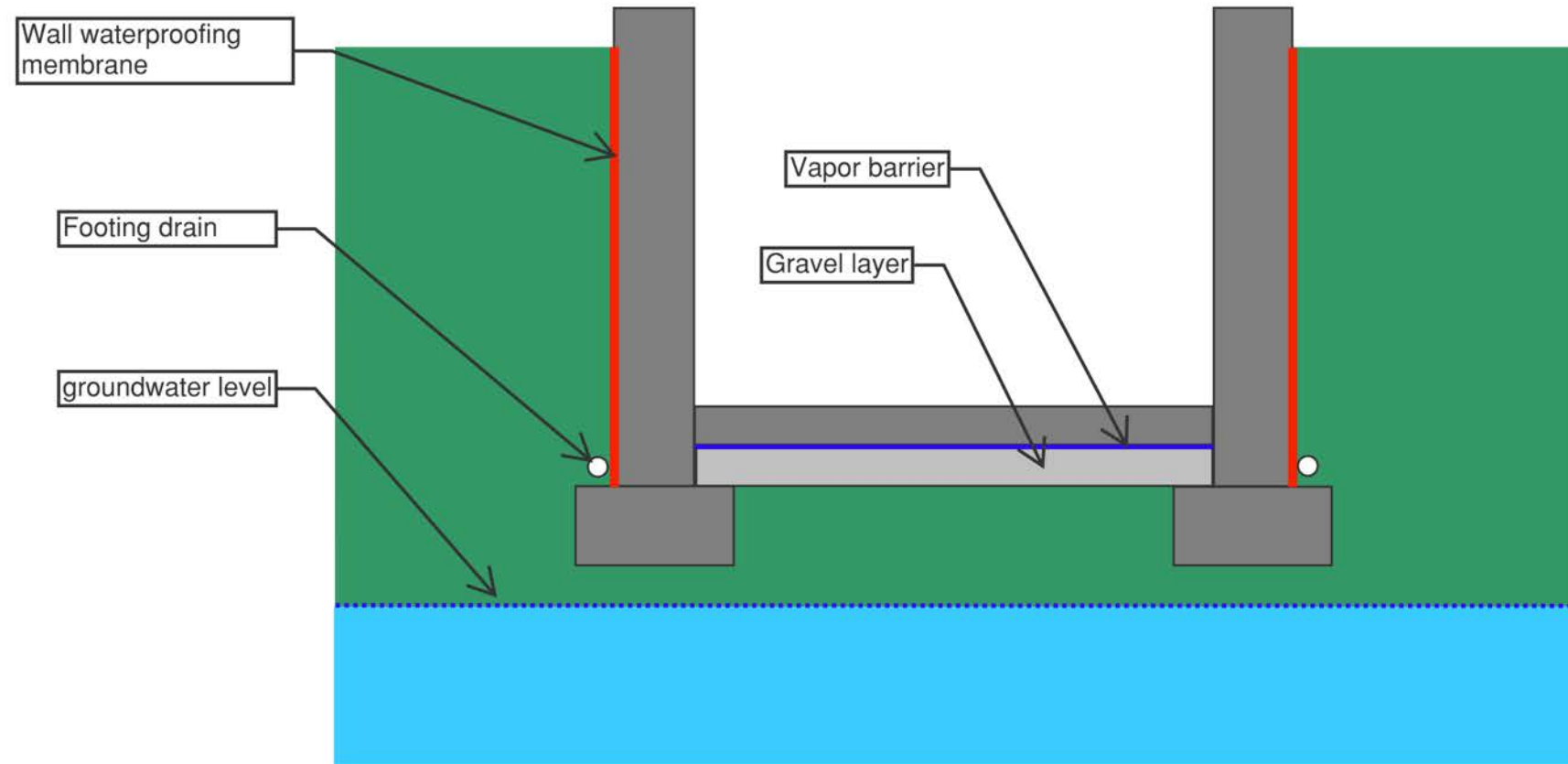


Waterproofing Strategies

What to do, what to do...

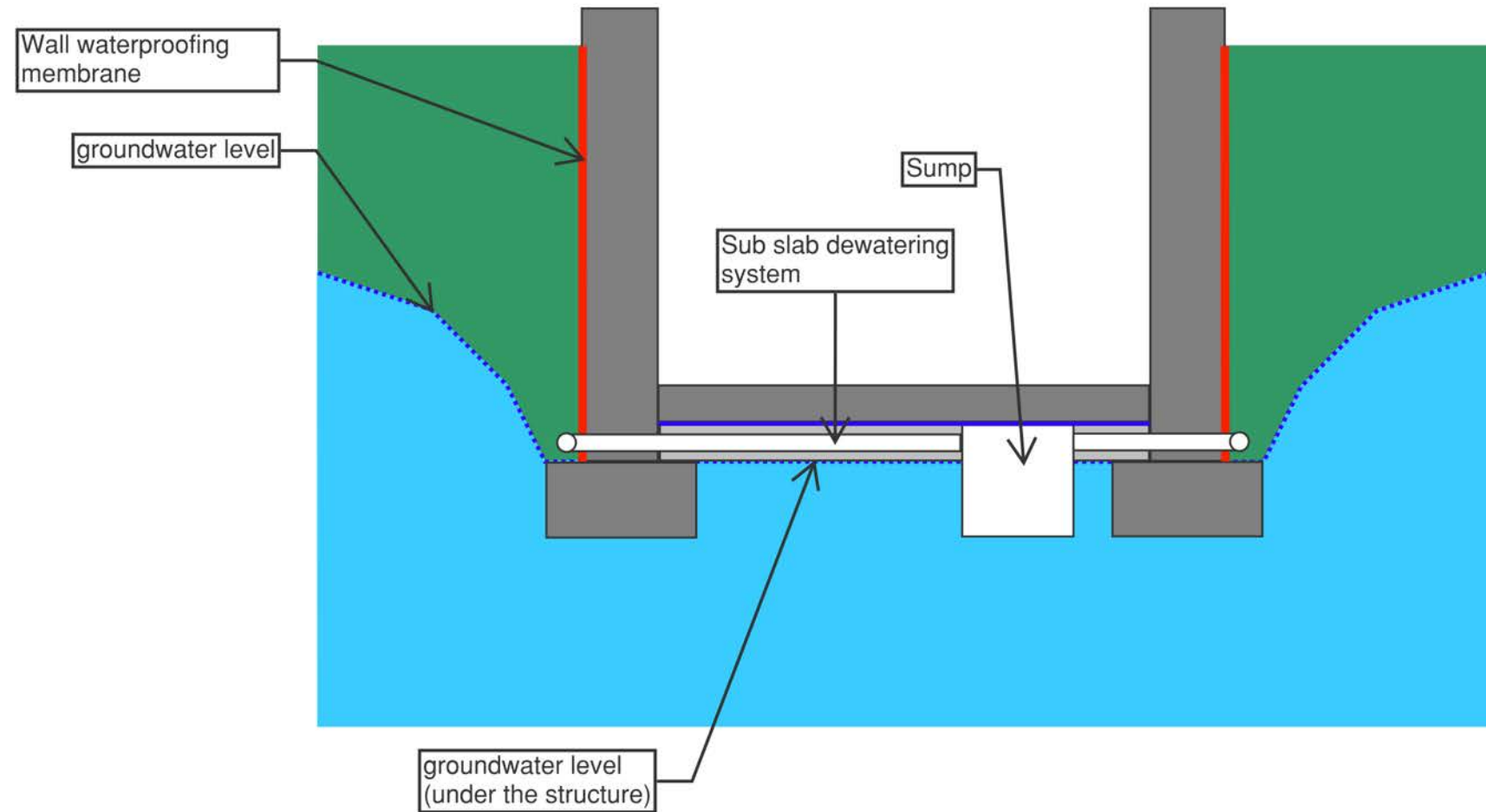
Waterproofing Strategies

- Above the ground water table
- Draw down
- Perimeter cut off and dewatering
- Continuous waterproofing



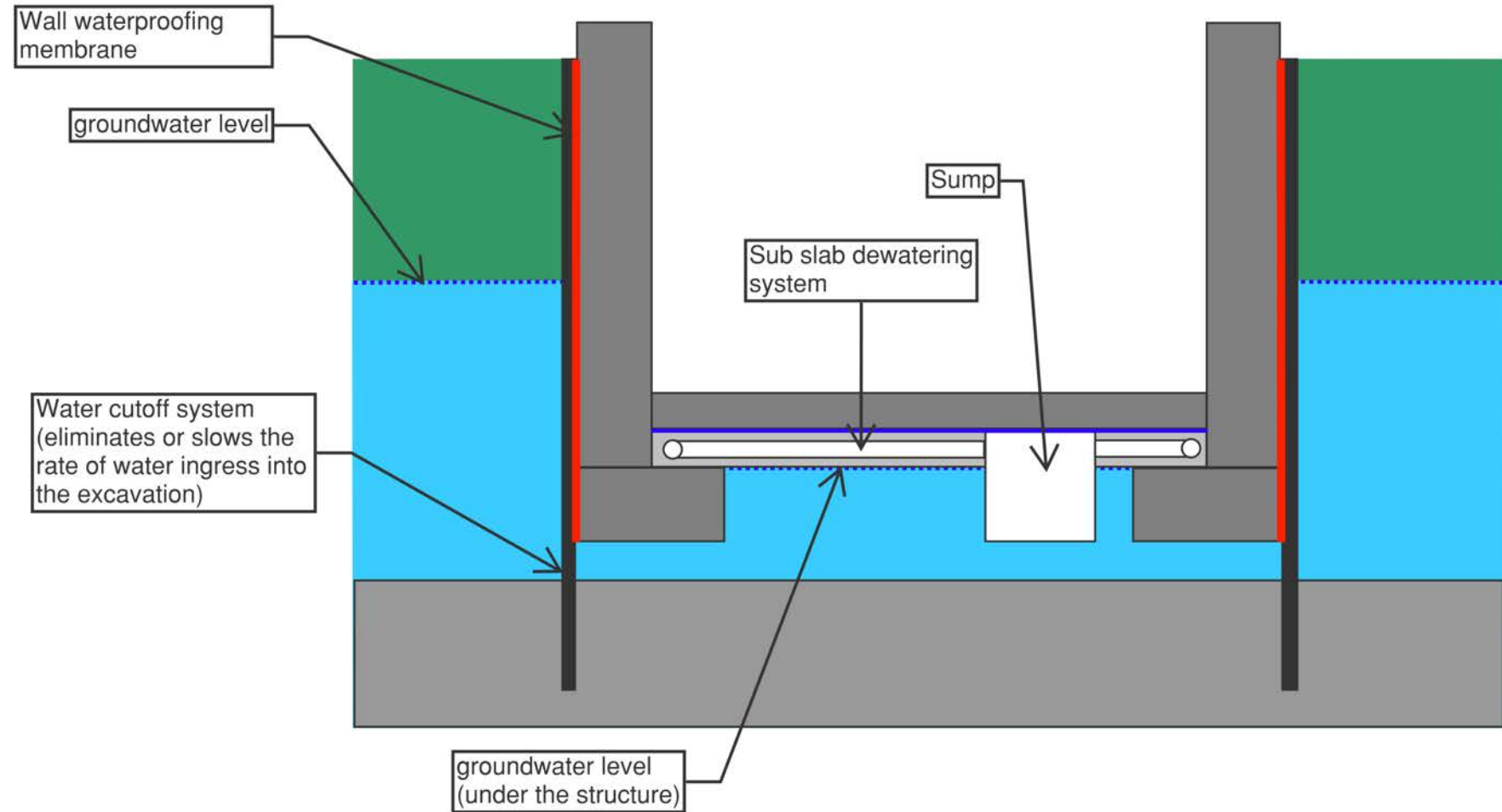
Waterproofing Strategies

- Above the ground water table
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- Perimeter cut off and dewatering
- Continuous waterproofing



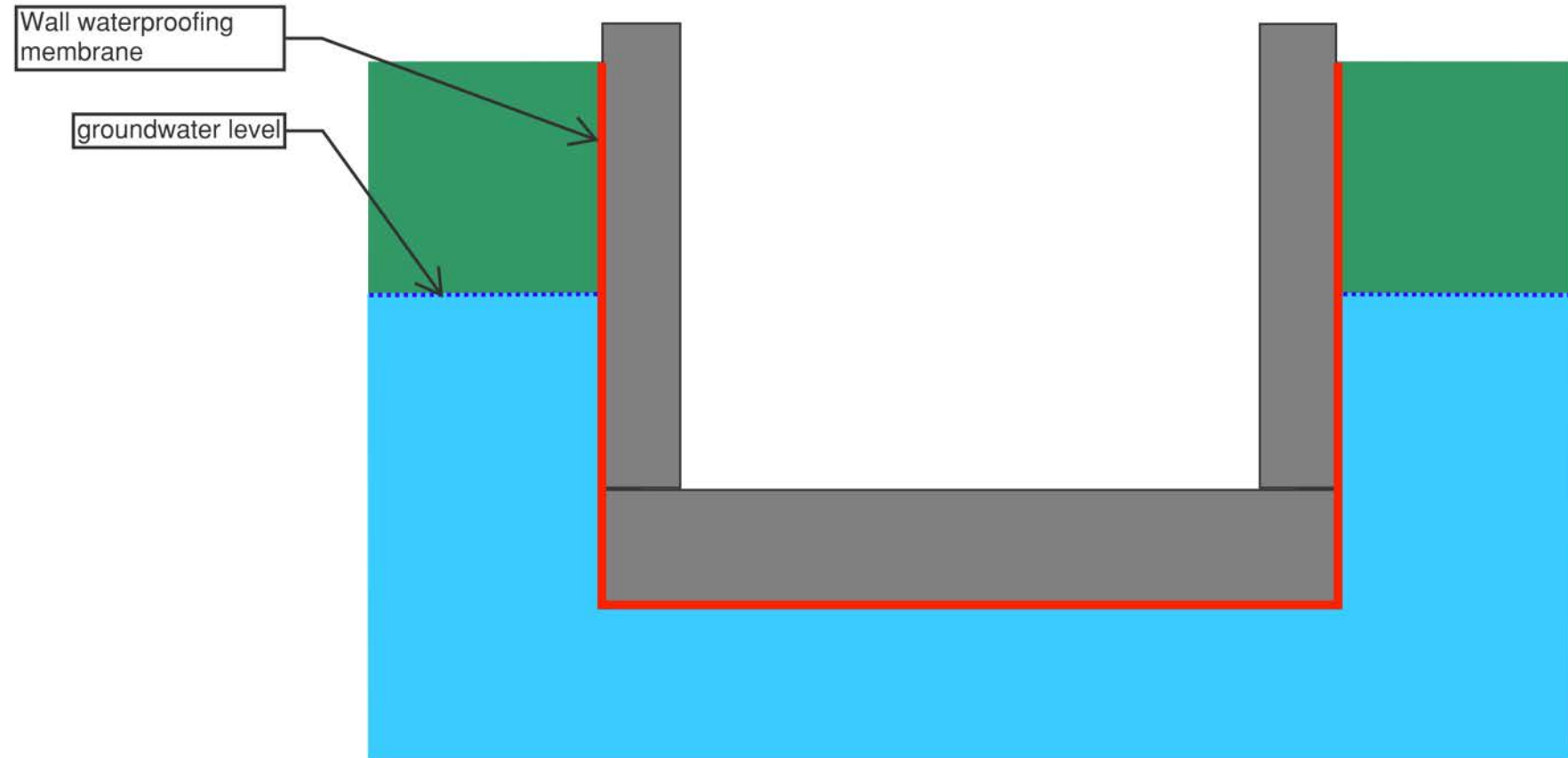
Waterproofing Strategies

- Above the ground water table
- Draw down
- **Perimeter cut off and dewatering**
- Continuous waterproofing



Waterproofing Strategies

- Above the ground water table
- Draw down
- Perimeter cut off and dewatering
- Continuous waterproofing



A low-angle, upward-looking photograph of a construction site. The scene is dominated by concrete walls and large sections of blue plastic sheeting that have been laid out on the ground. The sun is positioned in the upper left corner, creating a strong lens flare and casting long, dark shadows across the plastic. In the background, a concrete structure is under construction, with several vertical wooden rebar rods protruding from the top. The sky is a clear, bright blue with a few wispy clouds.

Materials

The boring and the mysterious

Materials

- Self adhered sheet
- Cold fluid applied
- Bentonite
- Pressure sensitive adhesive



Materials

- Self adhered sheet membranes
 - Typically comprised of 54mils of SBS modified asphalt adhered to a 6mil polypropylene or polyethylene facer (60mil total thickness)
 - Classified as a post applied membrane (after placement of the concrete)
 - Need to take care at seams for wrinkling and fishmouths
 - Use of a liquid membrane or sealant at the seams can greatly reduce the risk
 - Recommend using a protection layer (board or drainage mat) during backfilling.

Materials



Materials



Materials



Materials



Materials



Materials





Materials

- Self adhered sheet
- Cold fluid applied
- Bentonite
- Pressure sensitive adhesive

Materials

- Cold fluid applied membrane
 - Can be a lot of different chemistries
 - Polymer modified asphalt emulsion
 - Modified polyurethane membrane
 - Synthetic rubber
 - Roller or spray applied
 - Classified as a post applied membrane (after placement of the concrete)
 - Need to prepare the substrate and inspect the application
 - Fill voids
 - Check thickness
 - Watch for pinholes
 - Recommend using a protection layer (board or drainage mat) during backfilling.

Materials



Materials



Materials

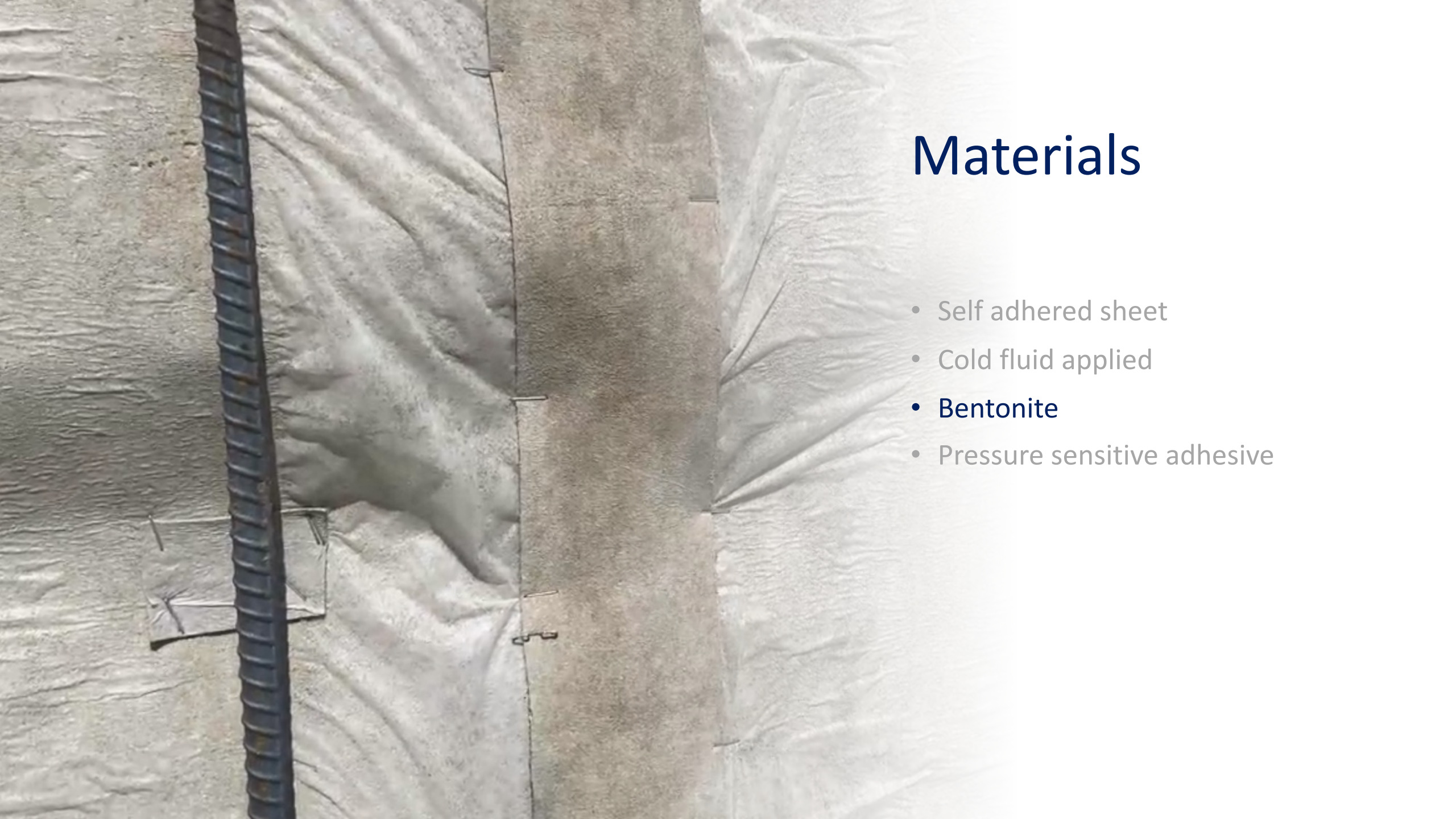


Materials



Materials





Materials

- Self adhered sheet
- Cold fluid applied
- **Bentonite**
- Pressure sensitive adhesive

Materials

- Bentonite
 - Usually used in two forms
 - Geotextile facer
 - HDPE (or other) sheet membrane facer
 - Mechanically attached to the soil retention system
 - Classified usually as a pre-applied membrane (before placement of the concrete), but can be used as a post-applied membrane
 - Proper substrate support
 - Max size of gaps in the lagging
 - Soil compaction
 - Needs to be protected from rain and water exposure prior to concrete placement

Materials



Materials



Materials



Materials



Steve Camarillo ...



Materials

- Self adhered sheet
- Cold fluid applied
- Bentonite
- Pressure sensitive adhesive

Materials

- Pressure sensitive adhesive membrane
 - Usually used in two forms
 - Proprietary pressure sensitive adhesive
 - Butyl adhesive
 - Mechanically attached to the soil retention system
 - Classified as a pre-applied membrane (before placement of the concrete)
 - Proper substrate support
 - Max size of gaps in the lagging
 - Does not need to be protected from rain and water exposure prior to concrete placement

Materials



Materials



Materials

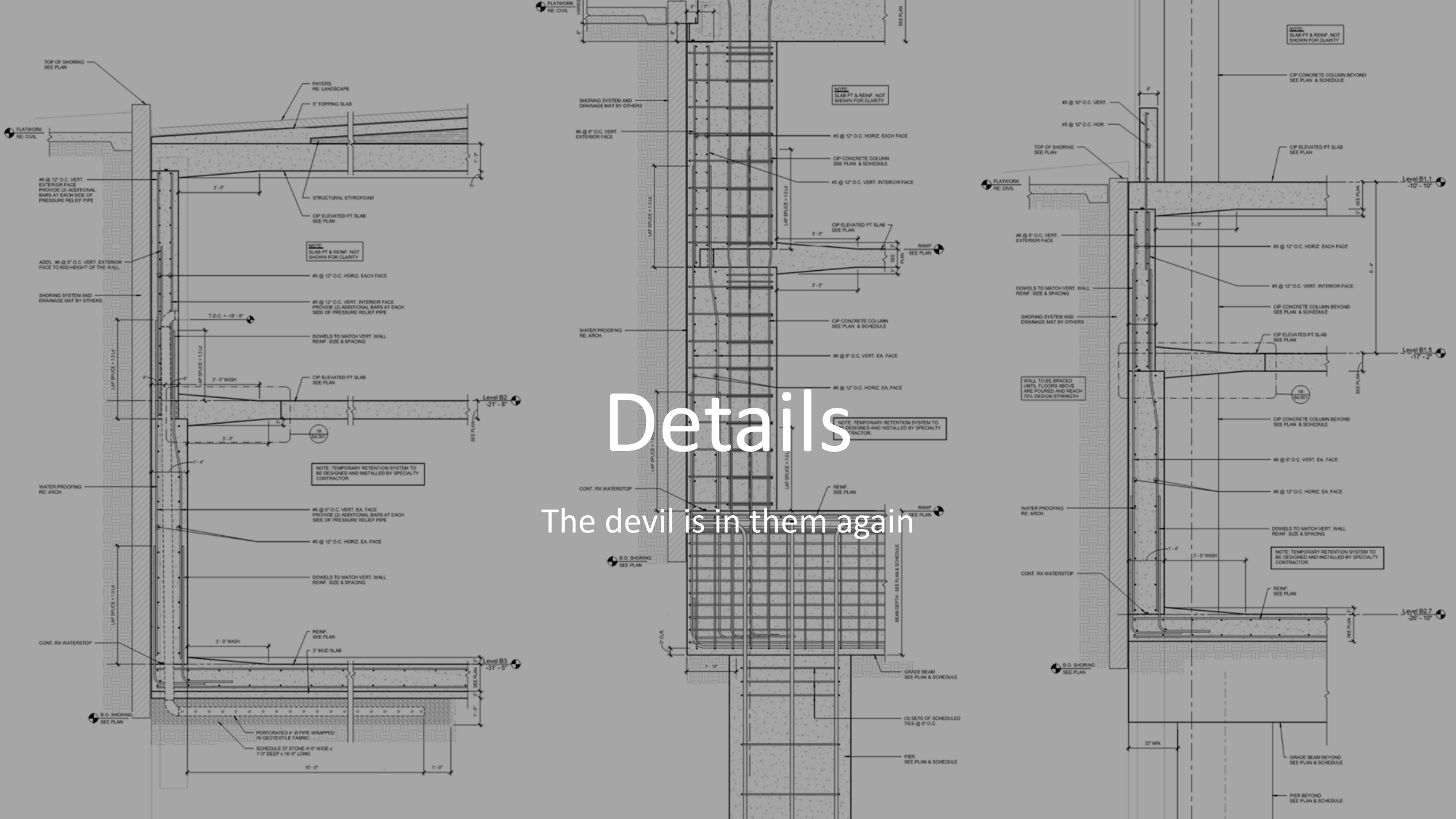


Materials



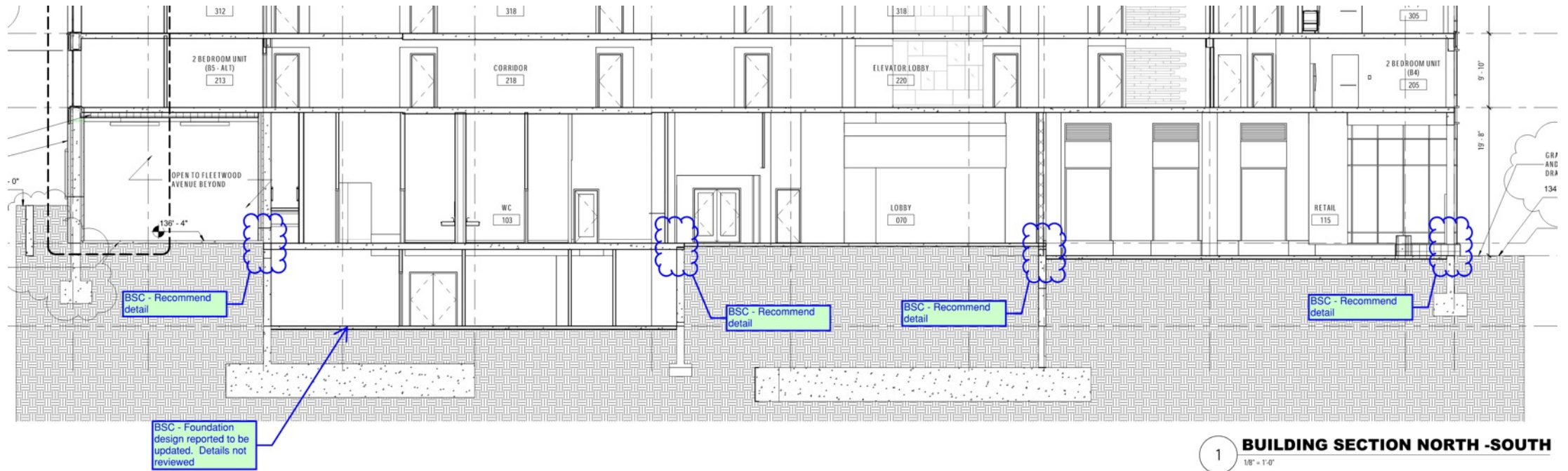
Materials





Details

The devil is in them again



BSC - Recommend detail

BSC - Recommend detail

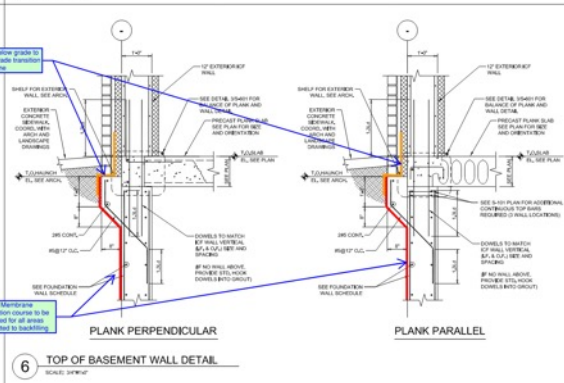
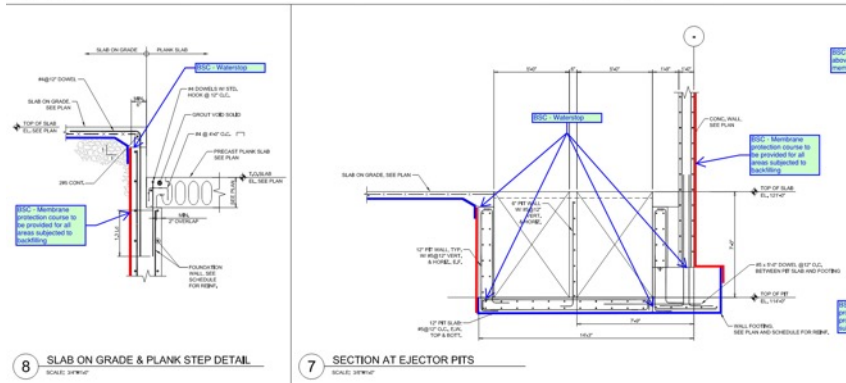
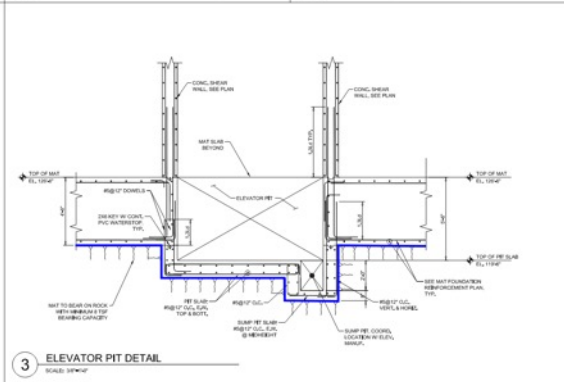
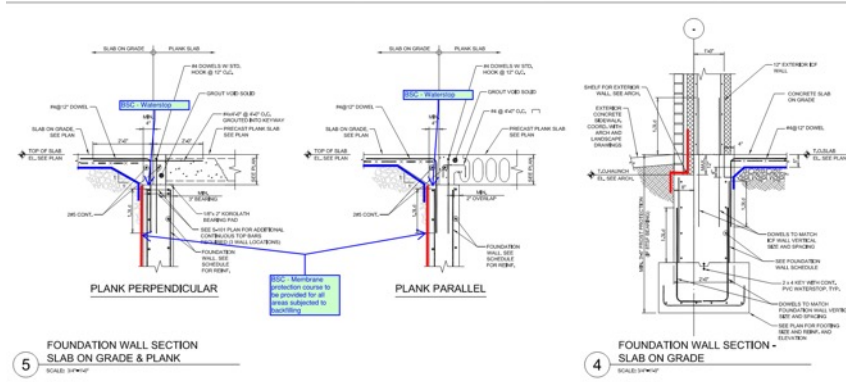
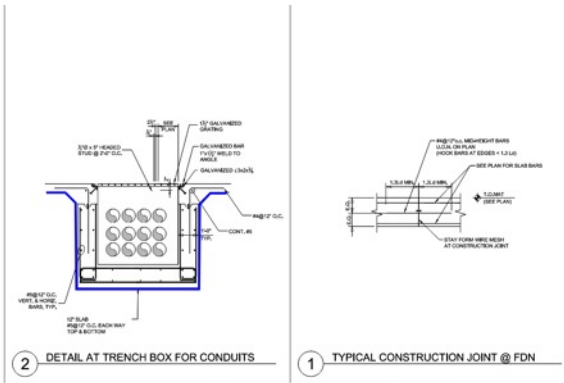
BSC - Recommend detail

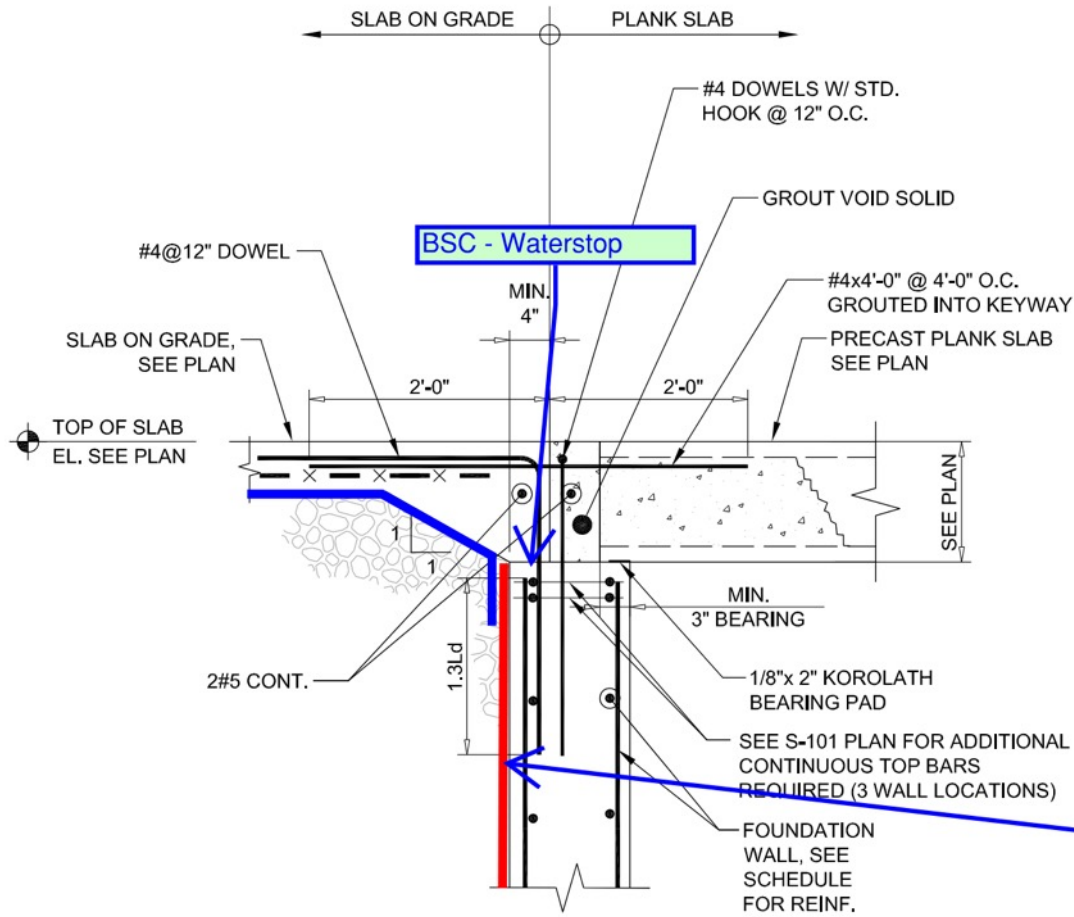
BSC - Recommend detail

BSC - Foundation design reported to be updated. Details not reviewed

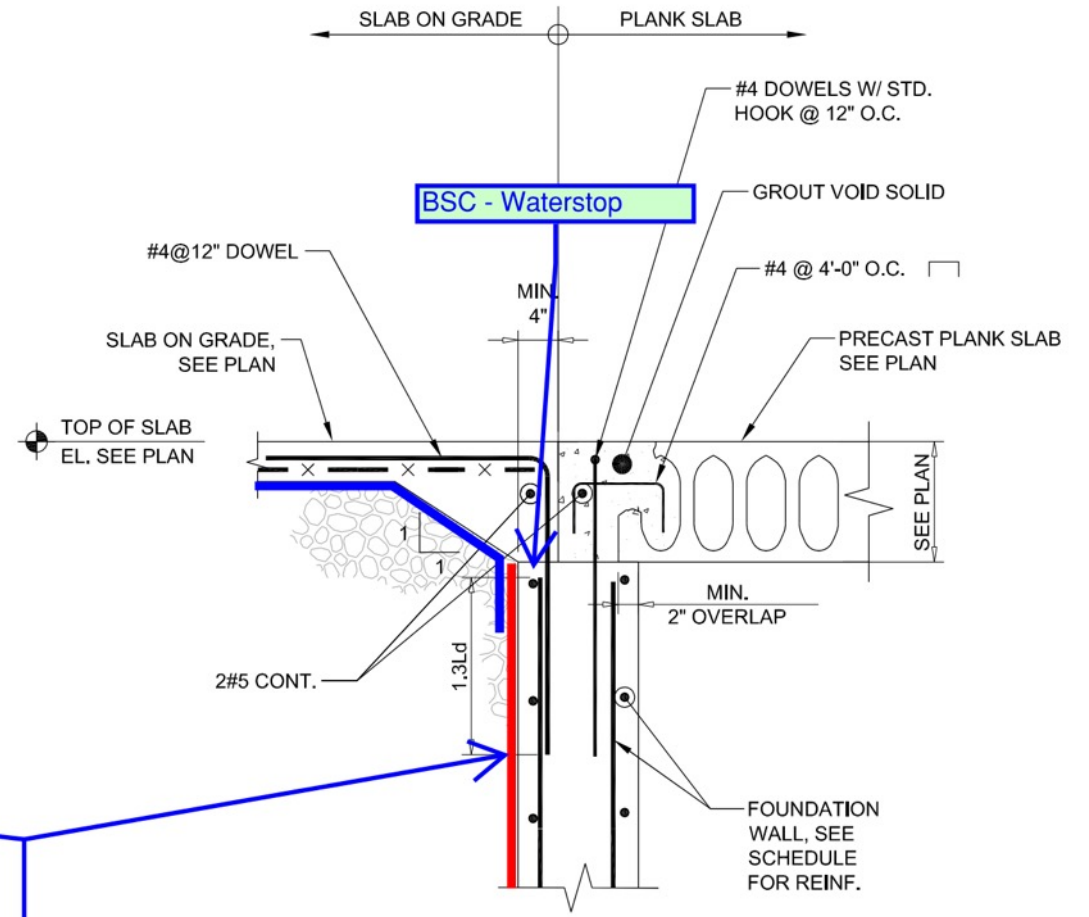
1 BUILDING SECTION NORTH - SOUTH
1/8" = 1'-0"

Review the Structural Drawings!



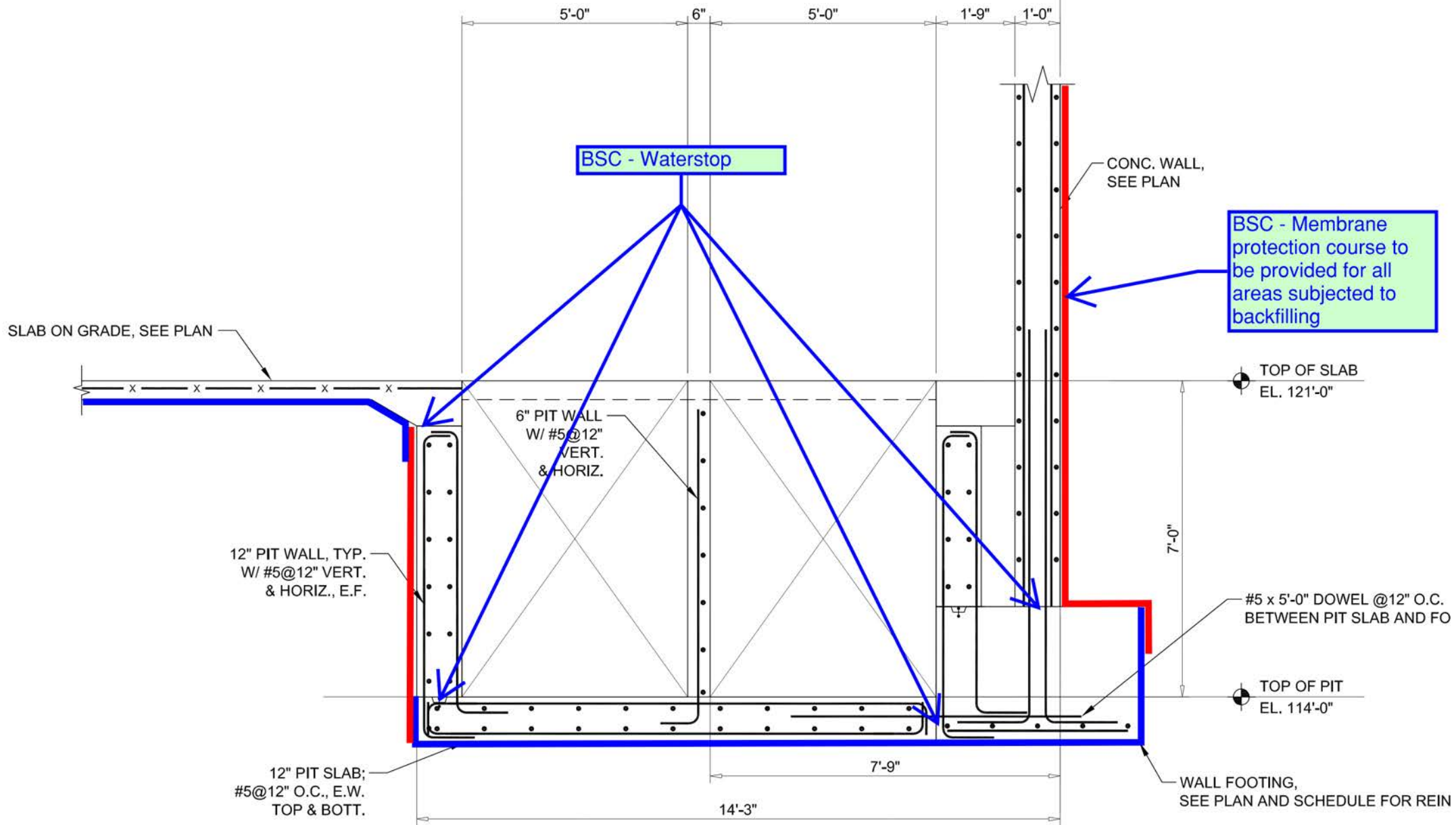


PLANK PERPENDICULAR

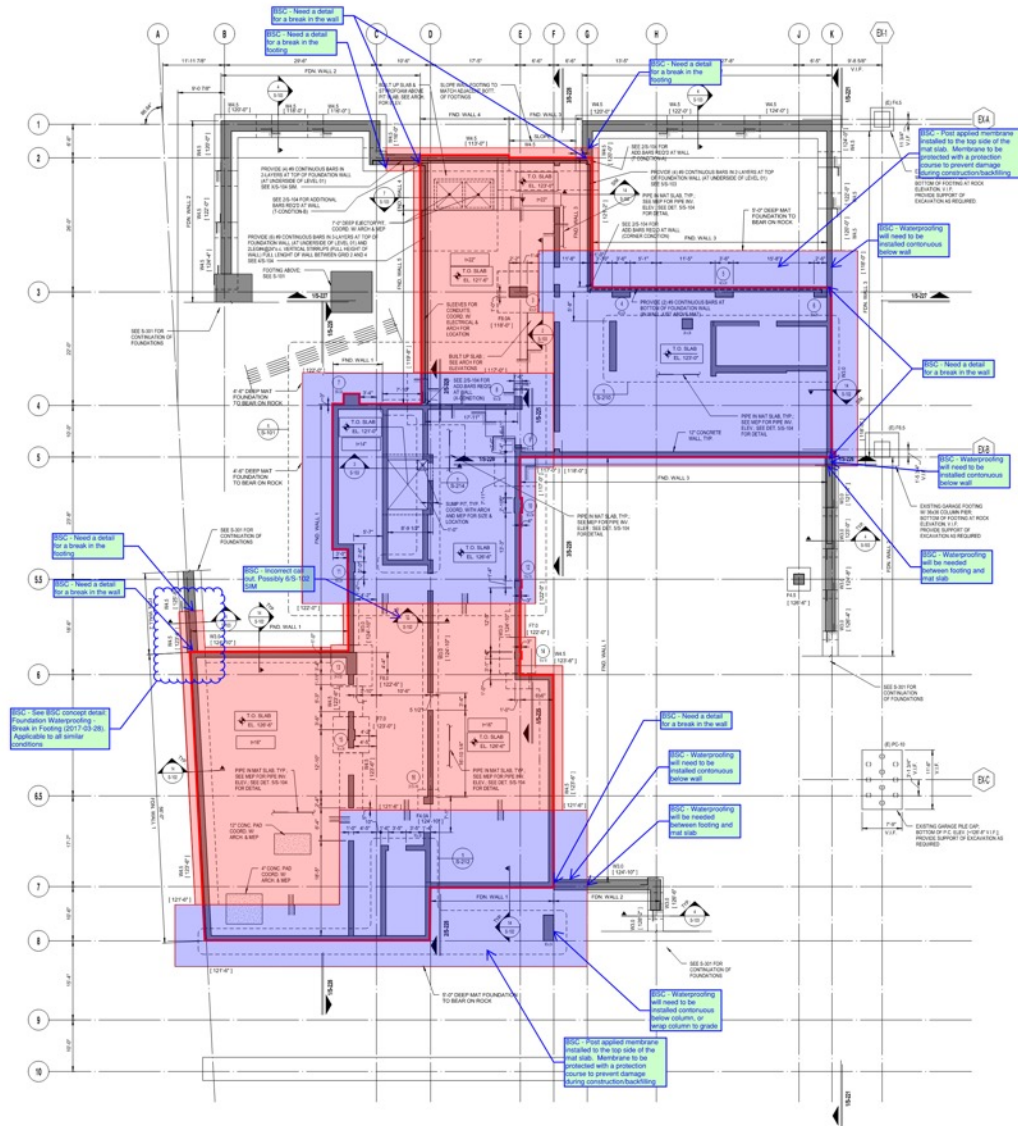


PLANK PARALLEL

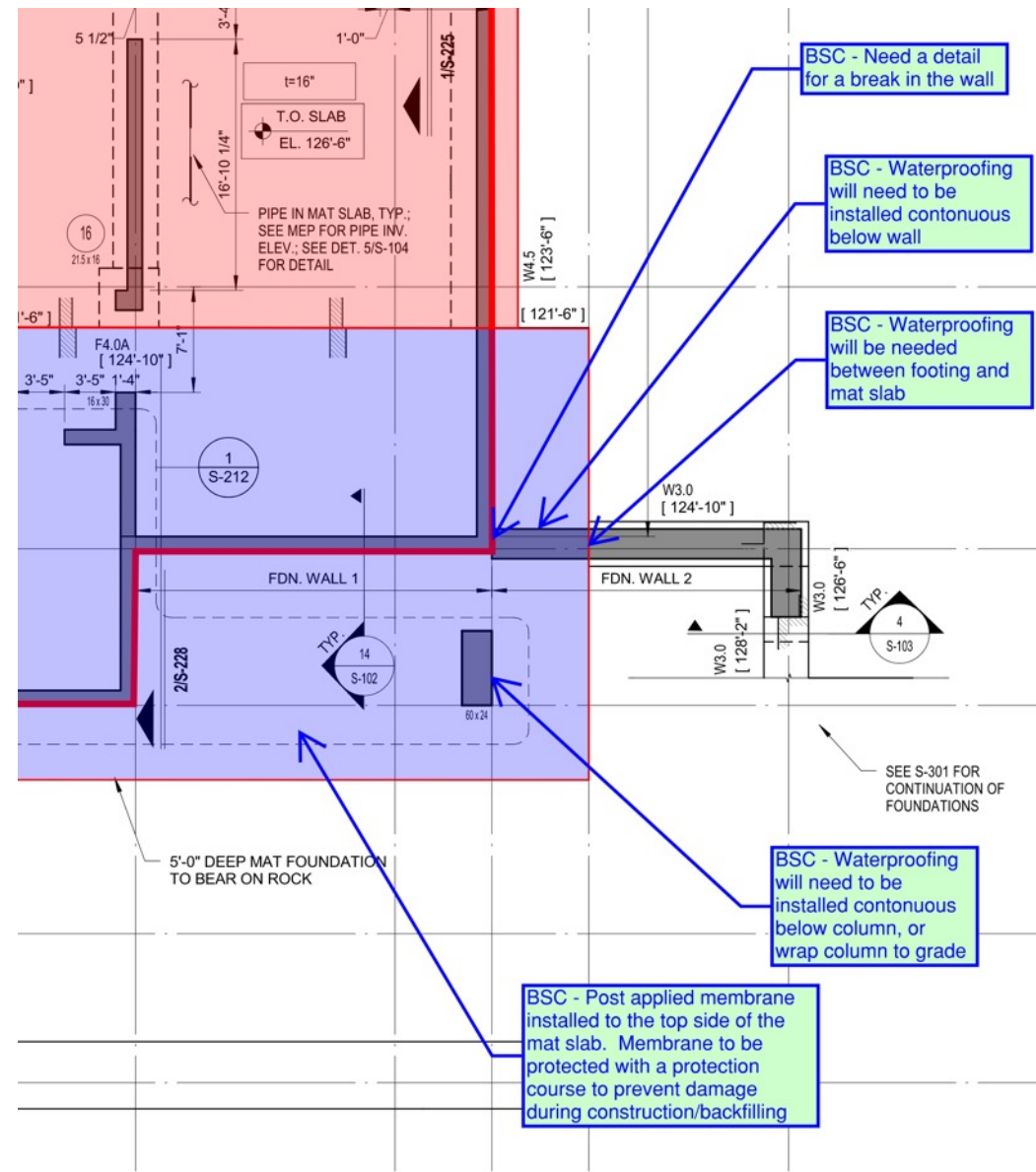
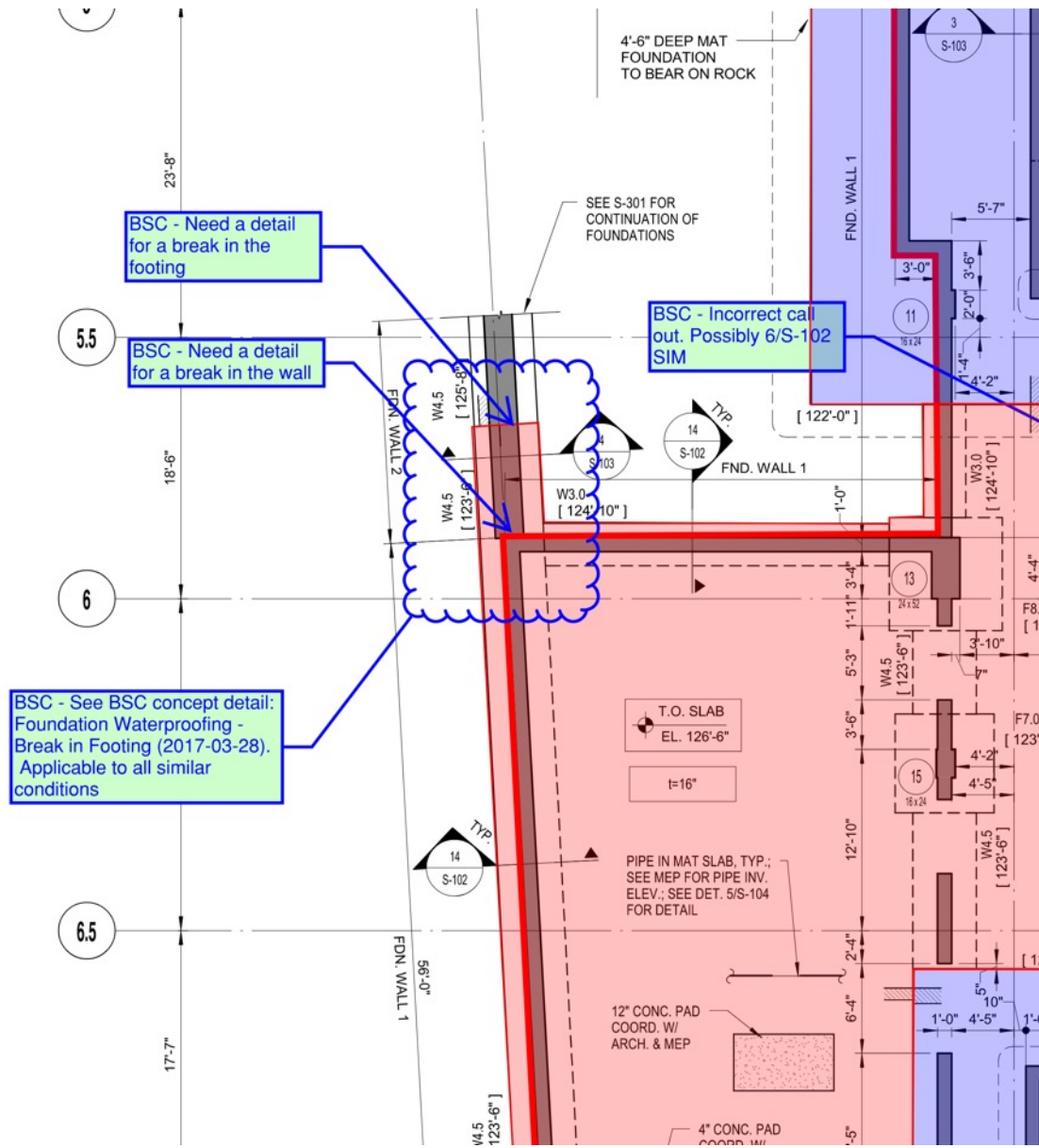
BSC - Membrane protection course to be provided for all areas subjected to backfilling



Look at the Plans and Sections and coordinate the details



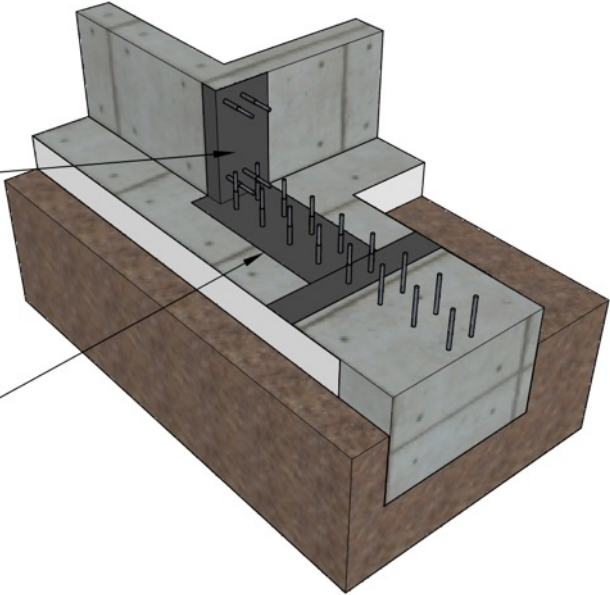
BASEMENT FOUNDATION PLAN
SCALE: 1/8" = 1'-0"



Provide specific details where needed

Step 7

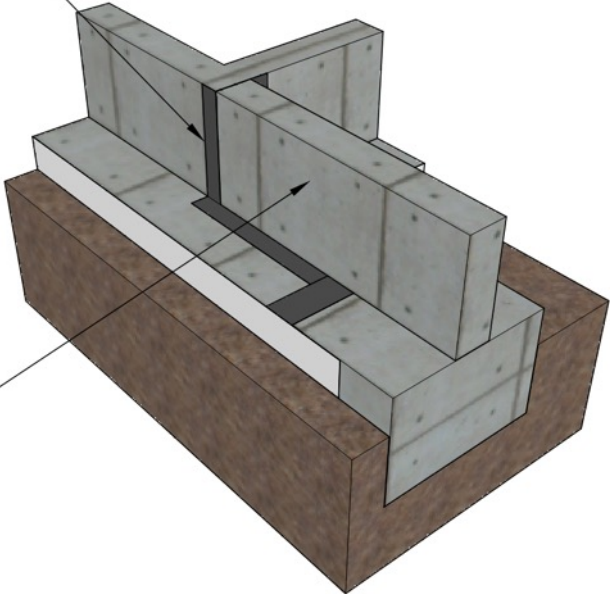
Sheet or fluid applied membrane installed on top of the footing and vertically up the foundation wall. Seal the waterproofing around all dowels.



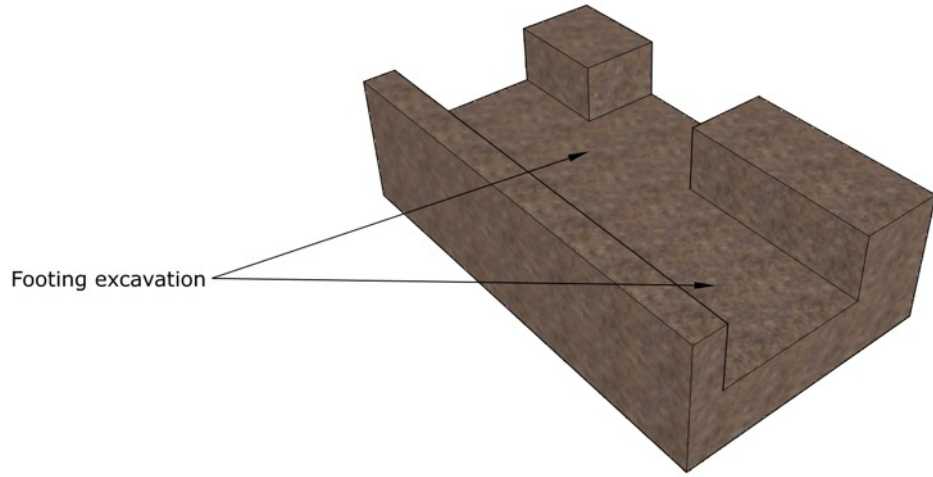
Extend waterproofing out in all directions to allow for tie-in with post applied membrane waterproofing system

Step 8

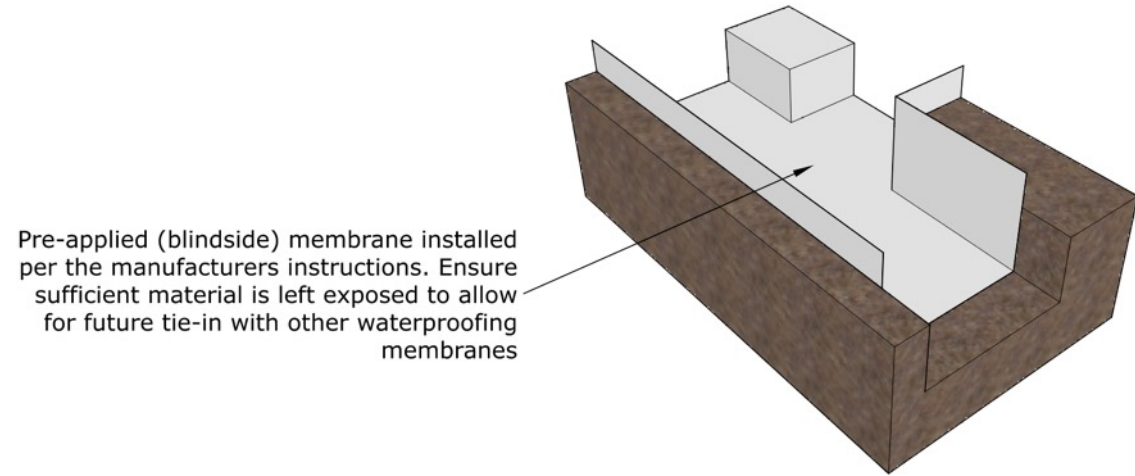
Foundation stem wall



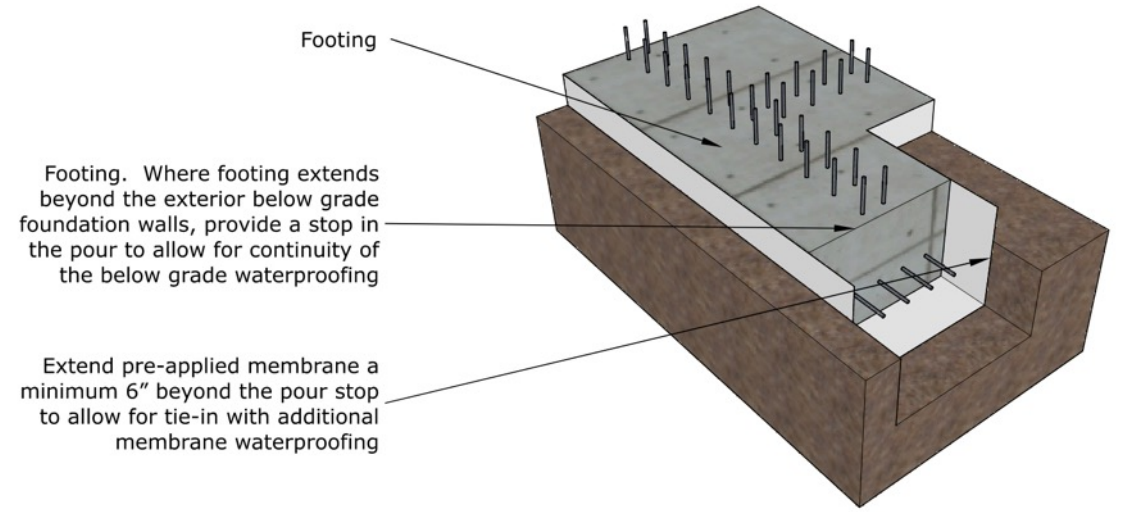
Step 1



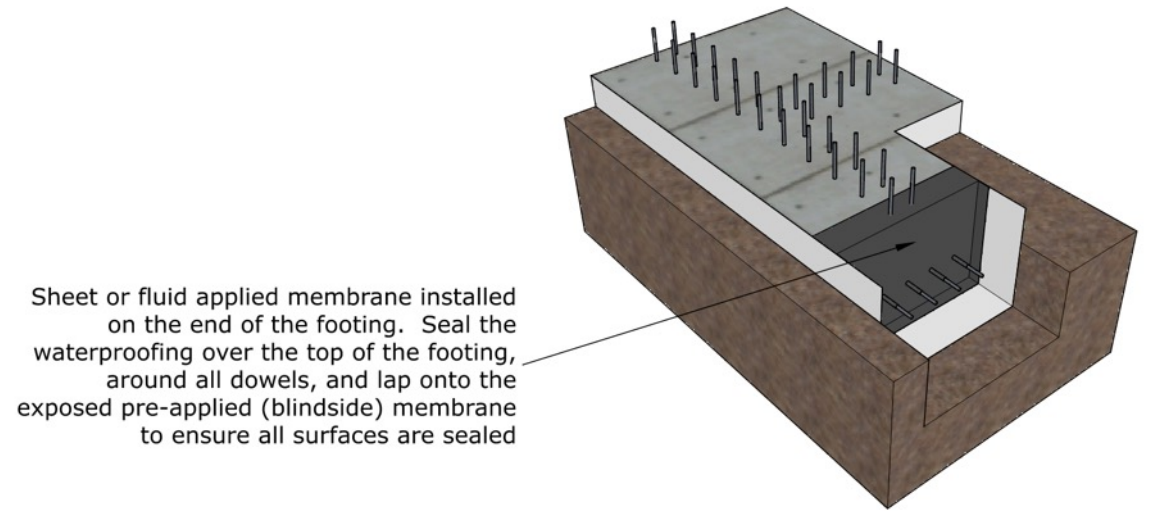
Step 2



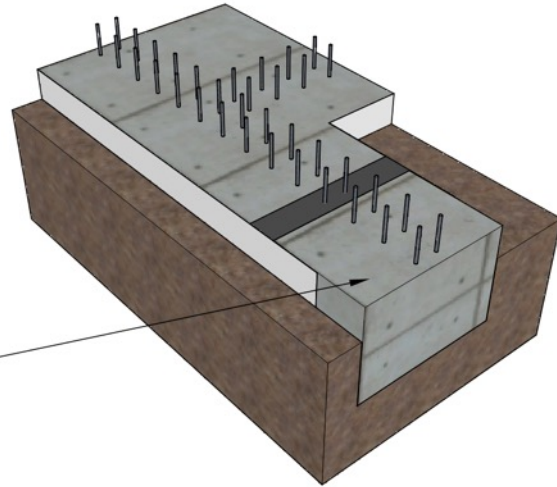
Step 3



Step 4

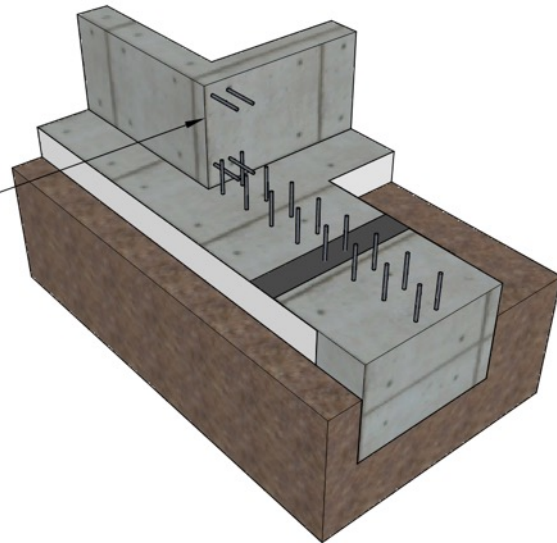


Step 5



Continuation of footing pour

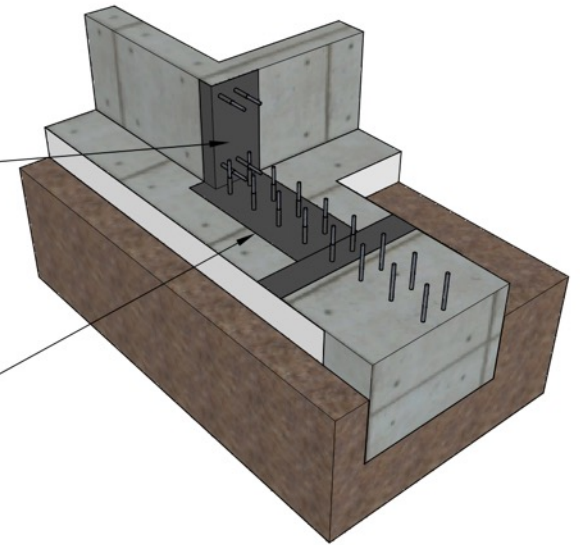
Step 6



Exterior below grade foundation wall
(occupied space on other side of wall)

Step 7

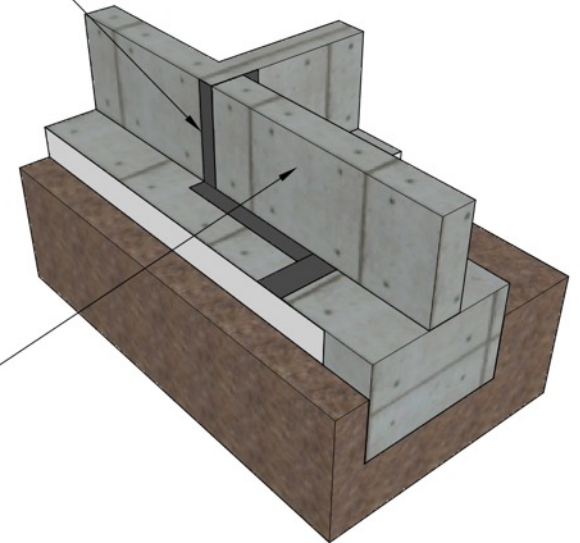
Sheet or fluid applied membrane installed on top of the footing and vertically up the foundation wall. Seal the waterproofing around all dowels.



Extend waterproofing out in all directions to allow for tie-in with post applied membrane waterproofing system

Step 8

Foundation stem wall

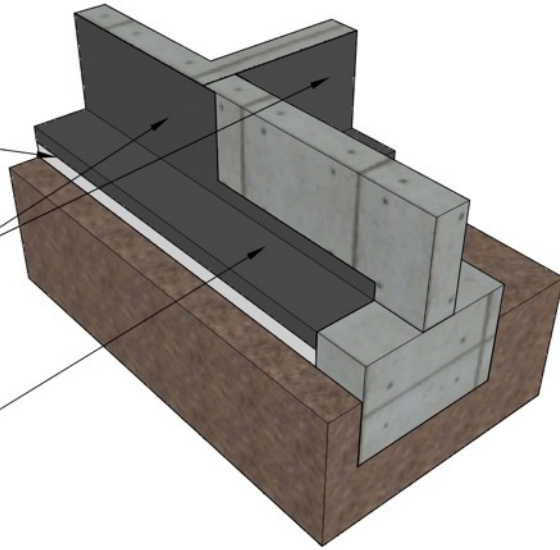


Step 9

Membrane must tie in to all below slab/
footing pre-applied (blindsided) membrane

Post applied membrane waterproofing
sealed over all below grade foundation
walls.

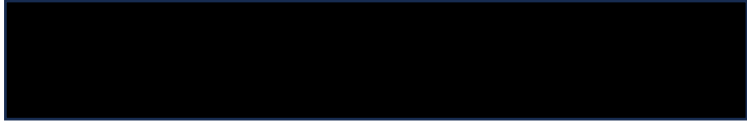
Membrane must tie in to all sheet or fluid
applied membrane at the footing break
and wall to stem wall interface



Details

- Water Cut Off
 - Continuous waterproofing on the vertical perimeter surfaces that wrap the foundation
 - Continuous sub slab drainage below the building (footings, shear walls, etc.)
 - Sump pump system with back up
- Continuous waterproofing
 - Provide continuous waterproofing!!! (Seriously, no joke)
 - Move penetrations out of the ground water level
 - Pay close attention to the details
 - Construction sequence
 - Material use
 - Manufacturer's requirements
 - It is a three-dimensional puzzle

Case Study:

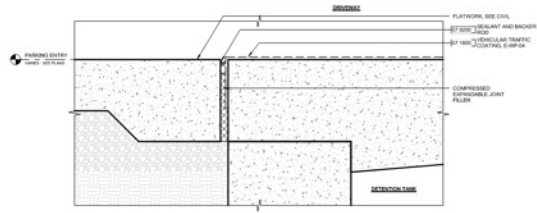




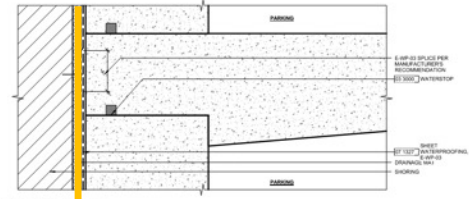
- Hydrostatic conditions
 - 10+ feet below the ground water table
- Combination
 - Lot line construction
 - Excavated and backfilled
- Multiple waterproofing strategies were explored but the final decision was for a continuous waterproofing system
- Design team, consultant, manufacturer, construction team, 3rd party inspection all involved



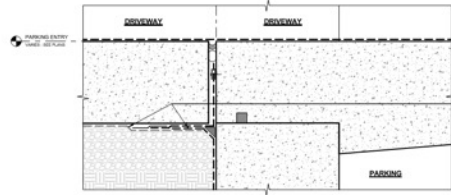
2 PODIUM SECTION - LOOKING WEST
SCALE: 1/8" = 1'-0"



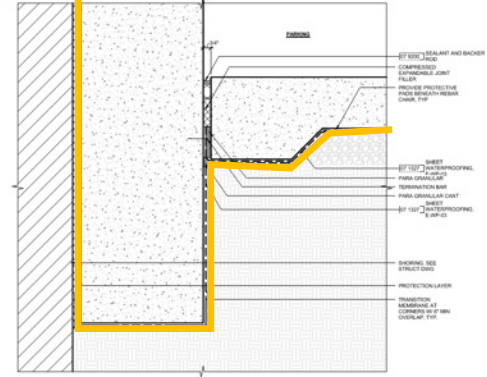
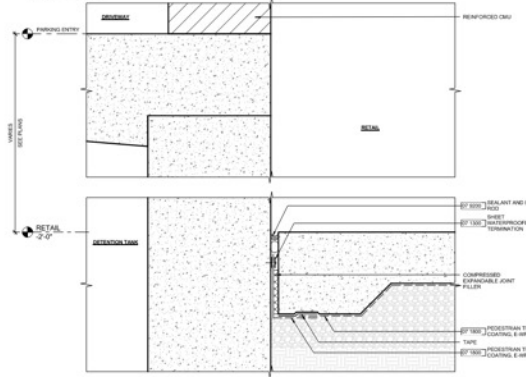
7 SECTION DETAIL
SCALE: 3/4" = 1'-0"



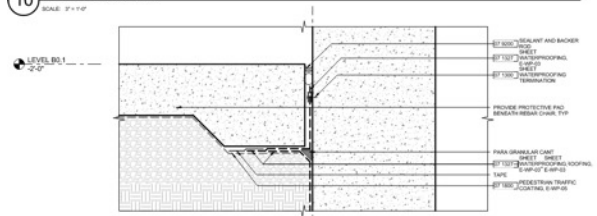
3 SECTION DETAIL
SCALE: 3/4" = 1'-0"



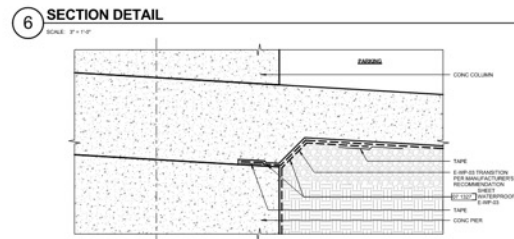
10 SECTION DETAIL
SCALE: 3/4" = 1'-0"



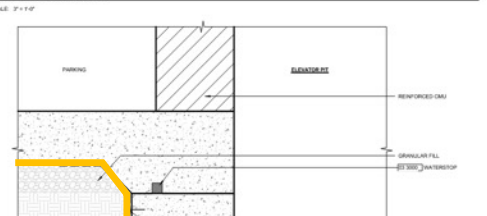
2 SECTION DETAIL
SCALE: 3/4" = 1'-0"



9 SECTION DETAIL
SCALE: 3/4" = 1'-0"



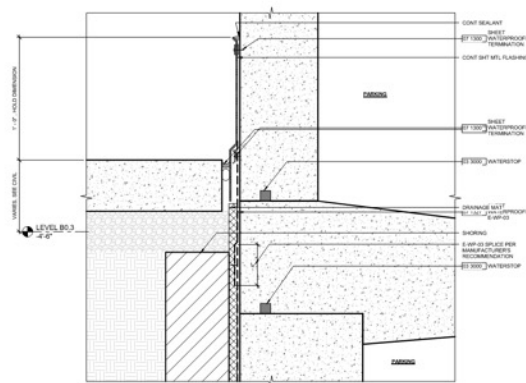
5 SECTION DETAIL
SCALE: 3/4" = 1'-0"



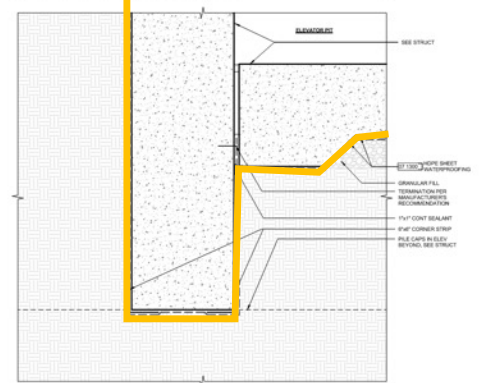
1 SECTION DETAIL
SCALE: 3/4" = 1'-0"



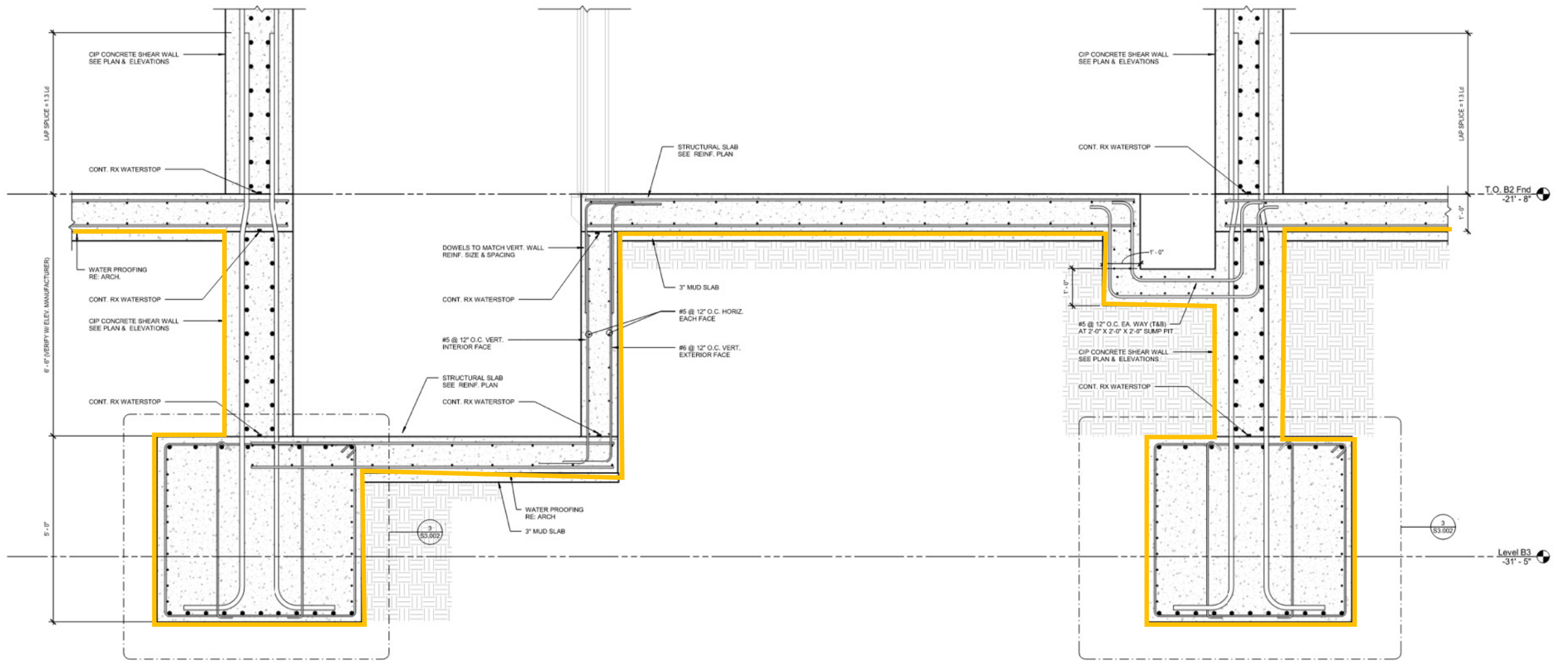
8 NOT USED
SCALE: 3/4" = 1'-0"

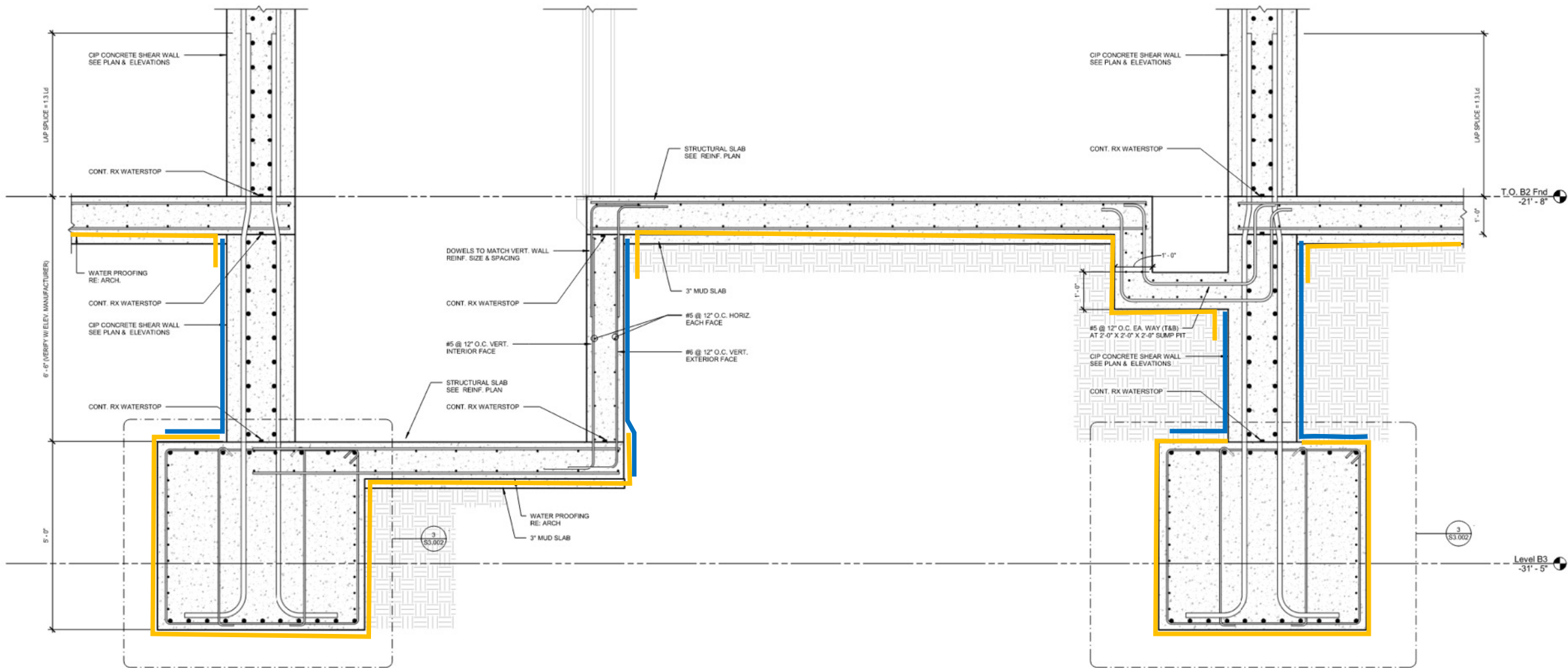


4 SECTION DETAIL
SCALE: 3/4" = 1'-0"



1 SECTION DETAIL
SCALE: 3/4" = 1'-0"





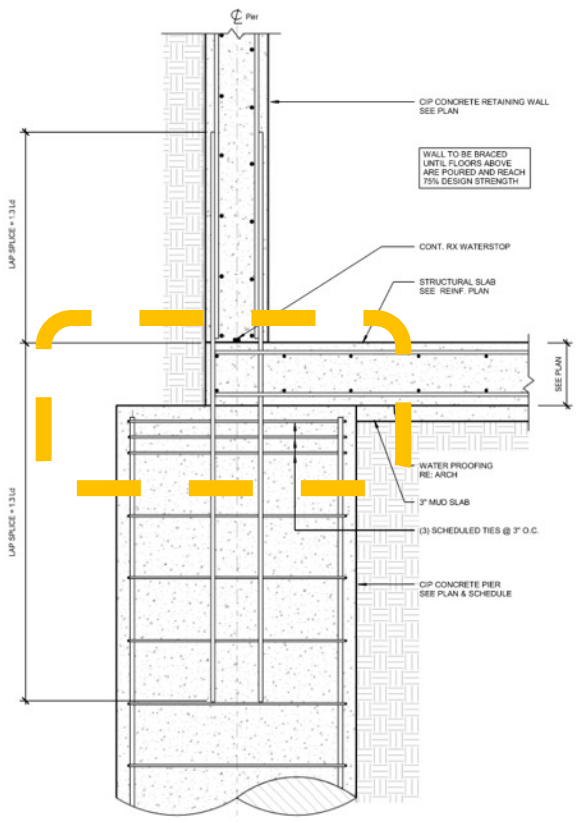
LAP SPICE = 13 LG

6'-0" (VERIFY W/ ELEV. MANUFACTURER)

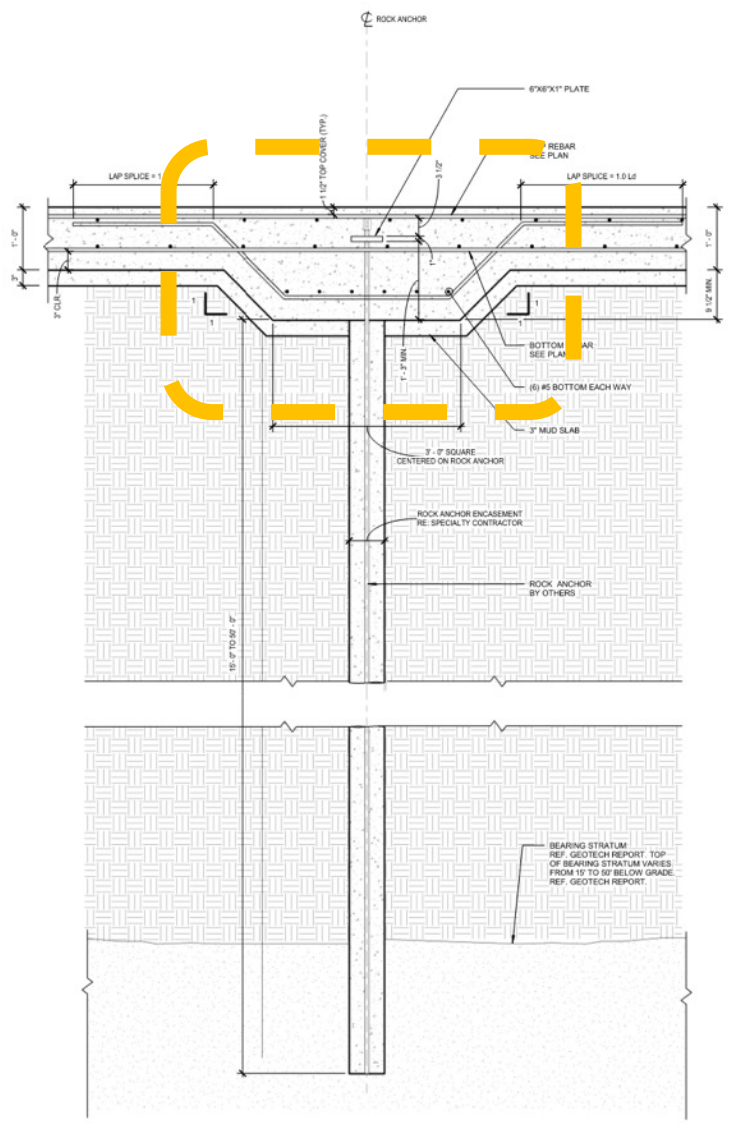
5'-0"

T.O. B2 Fnd
-21'-8"

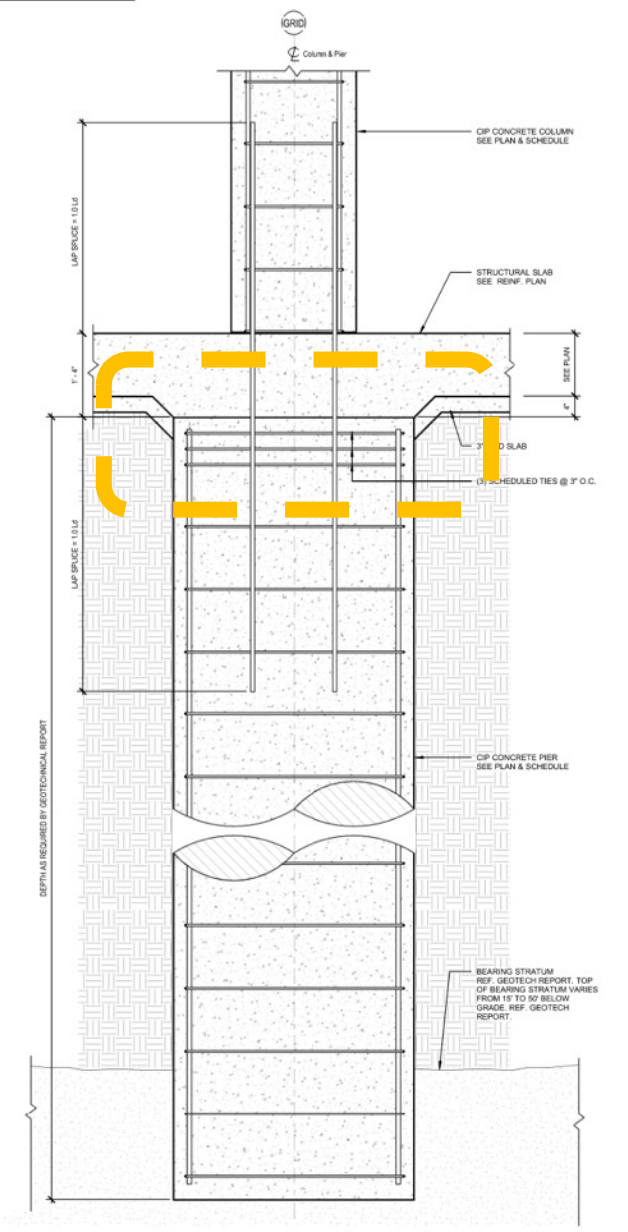
Level B3
-31'-5"



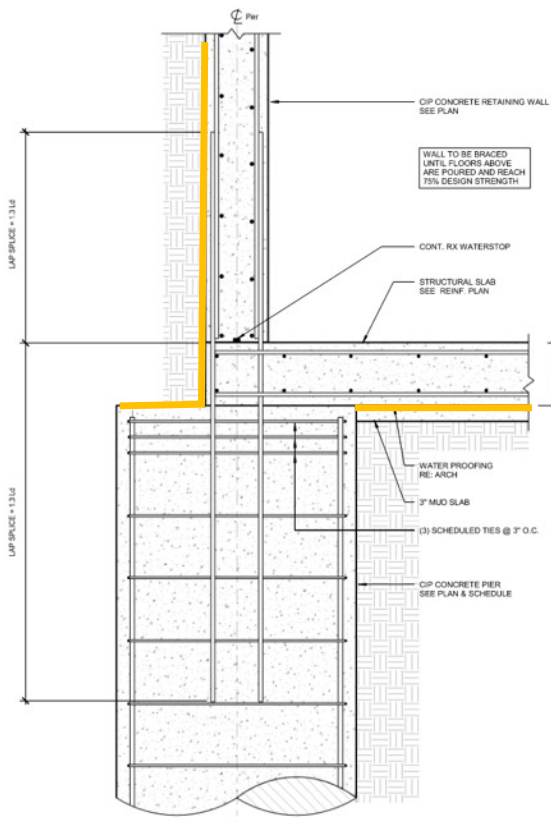
2 Section @ Retaining Wall w/ Pier
1" = 1'-0"



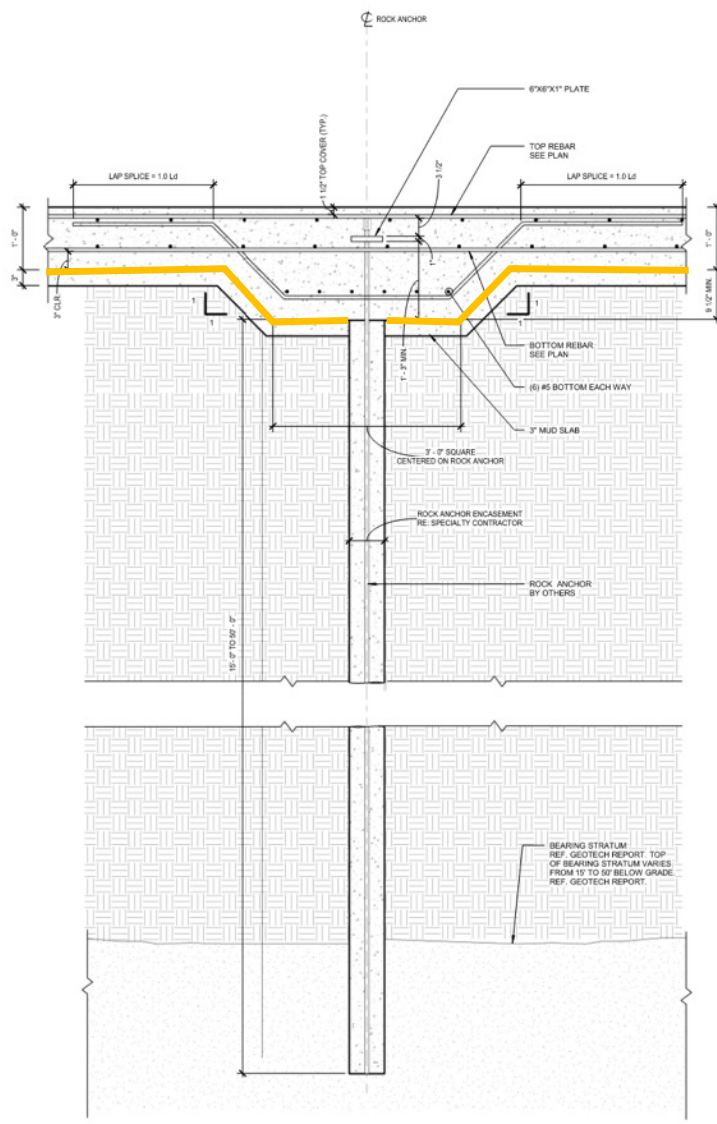
3 Rock Anchor Detail
1" = 1'-0"



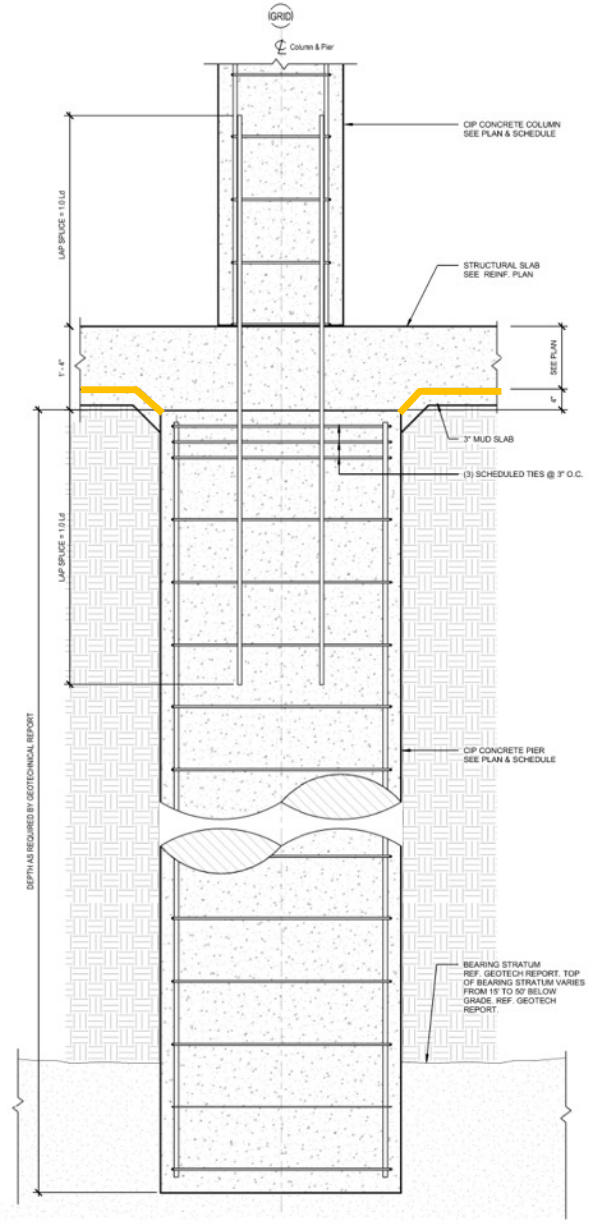
1 Section @ Column w/ Pier
1" = 1'-0"



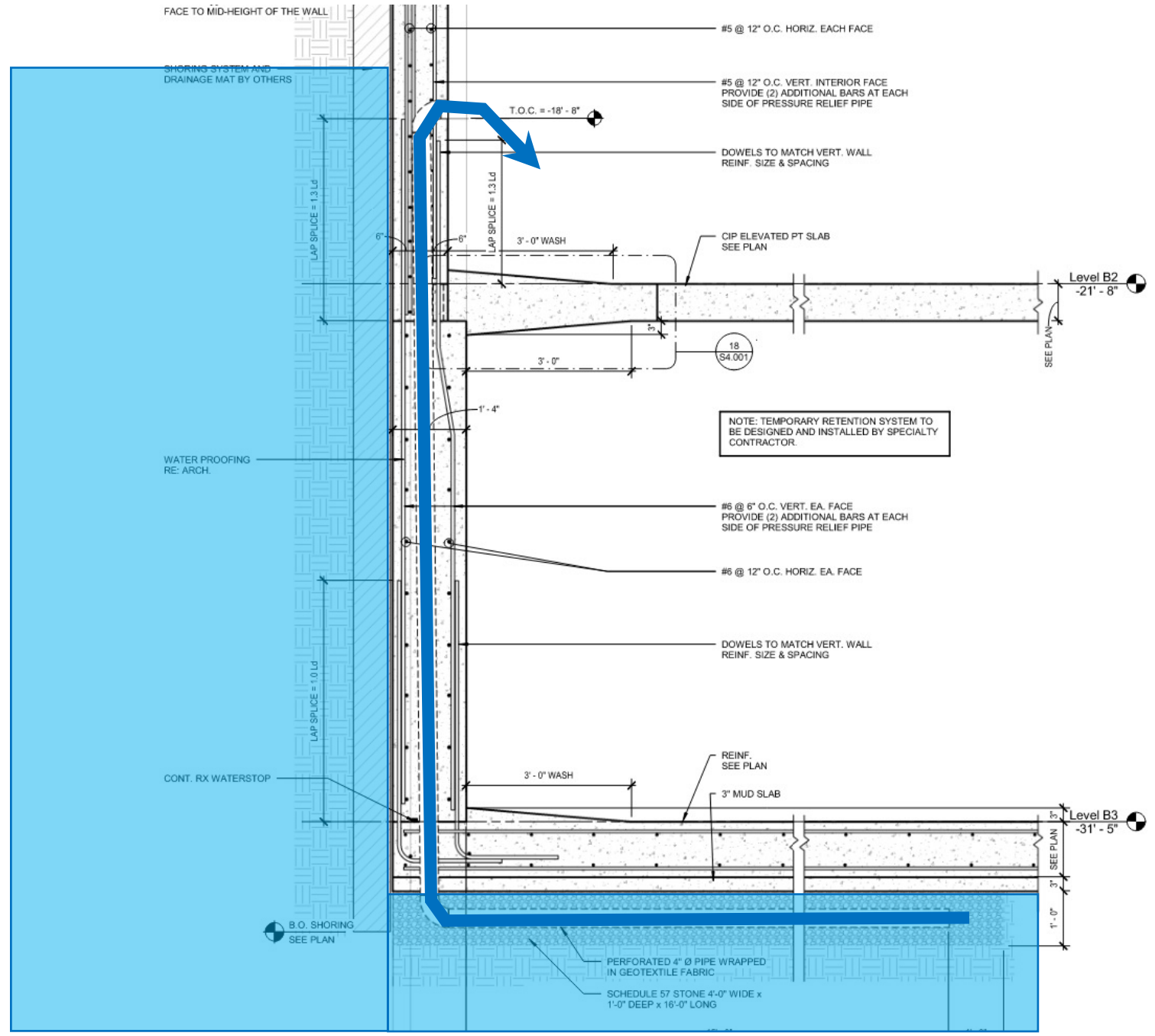
2 Section @ Retaining Wall w/ Pier
1" = 1'-0"

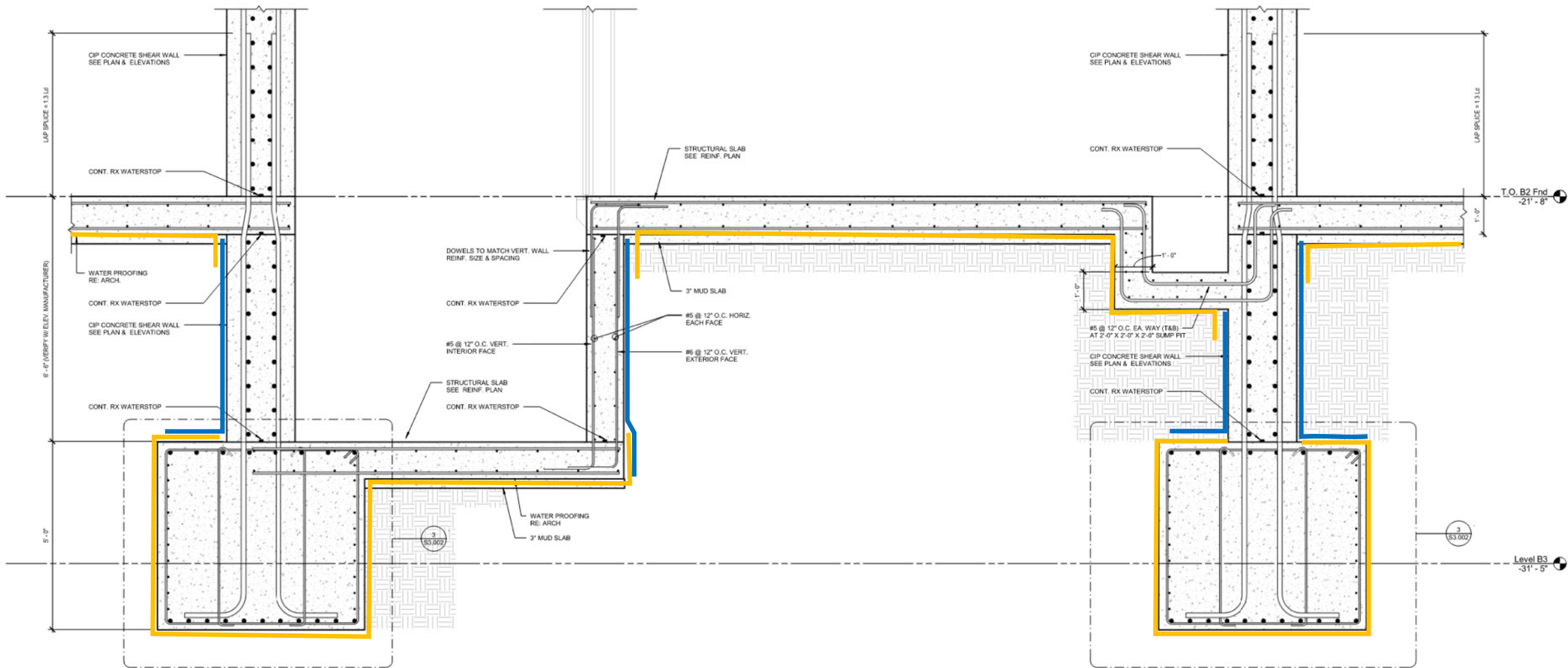


3 Rock Anchor Detail
1" = 1'-0"



1 Section @ Column w/ Pier
1" = 1'-0"





LAP SPICE = 13 LG

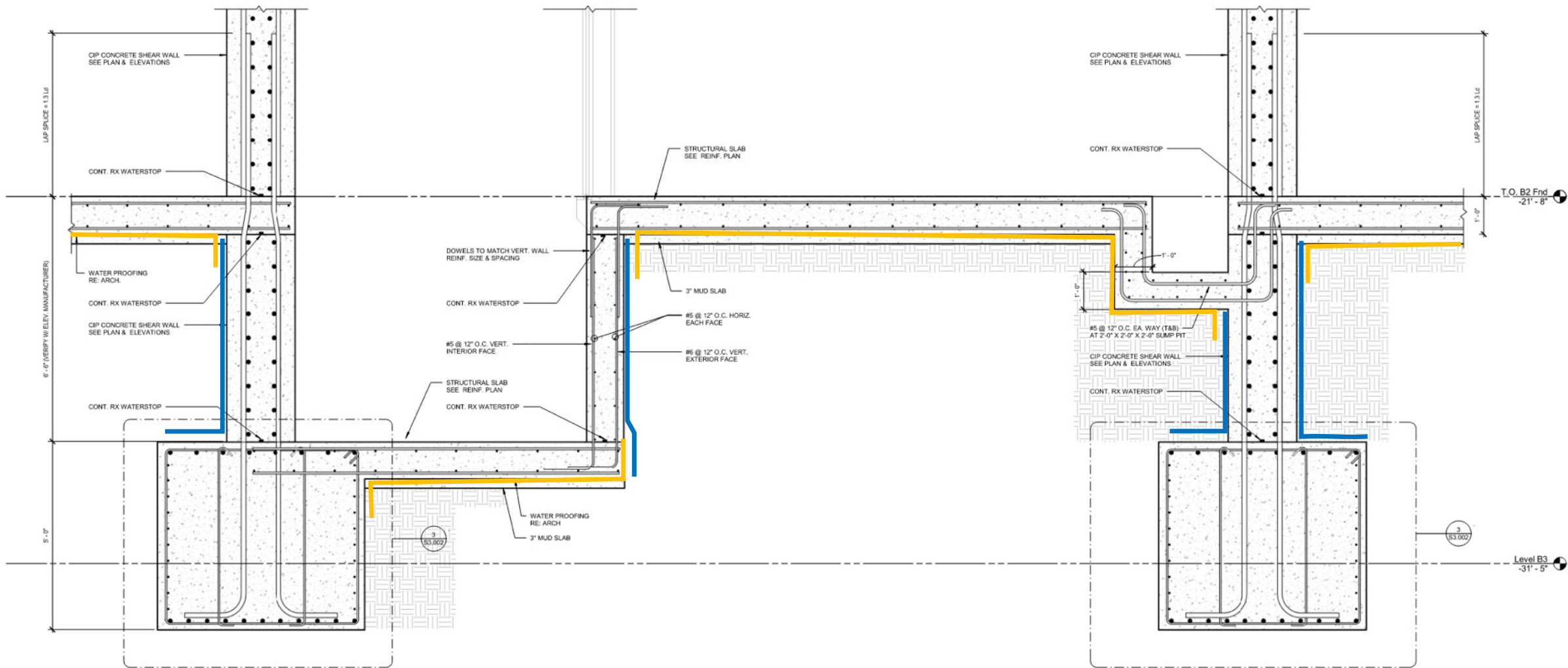
6'-0" (VERIFY W/ ELEV. MANUFACTURER)

5'-0"

LAP SPICE = 13 LG

T.O. B2 Fnd
-21'-8"

Level B3
-31'-5"



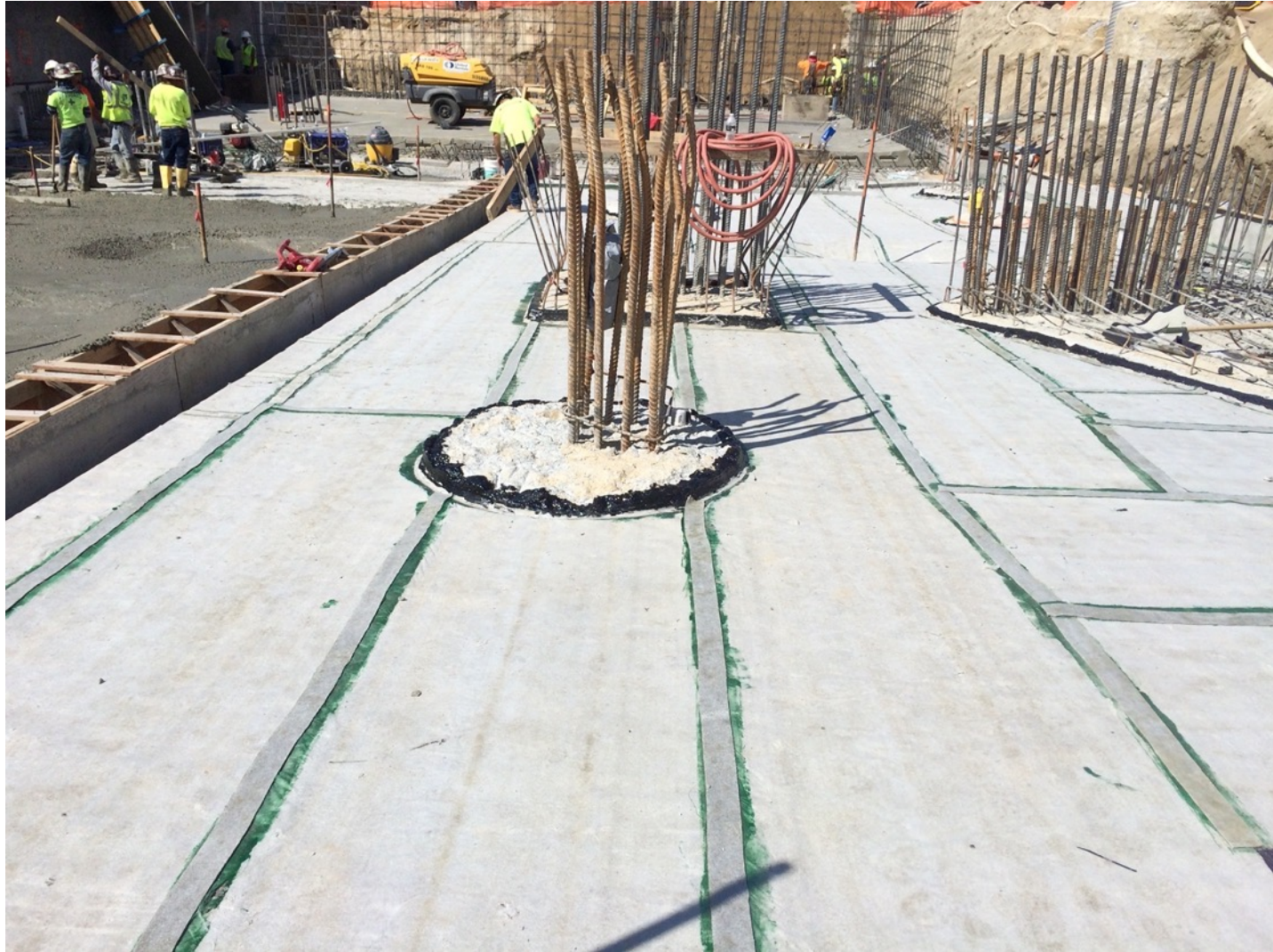










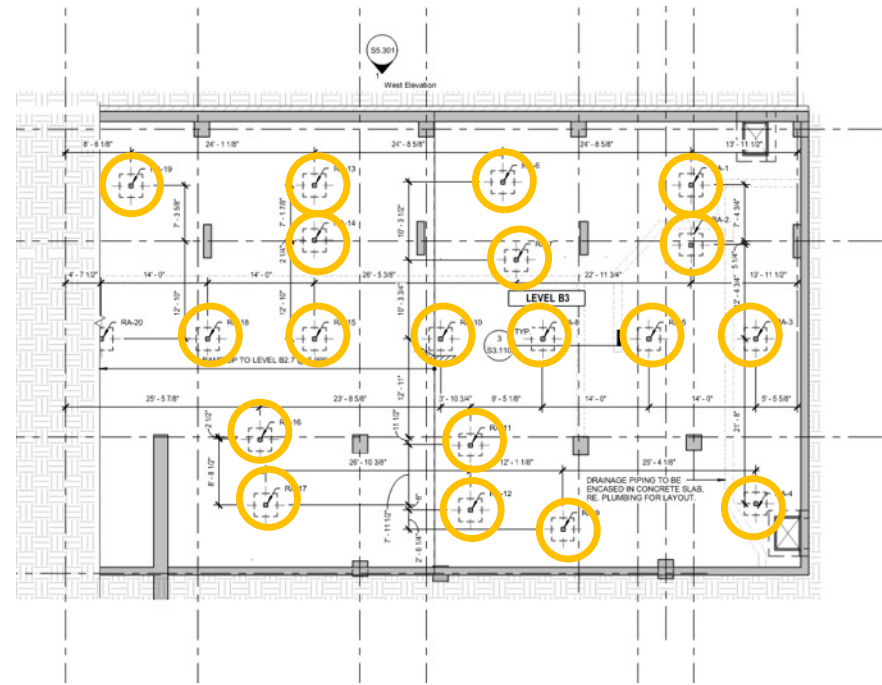
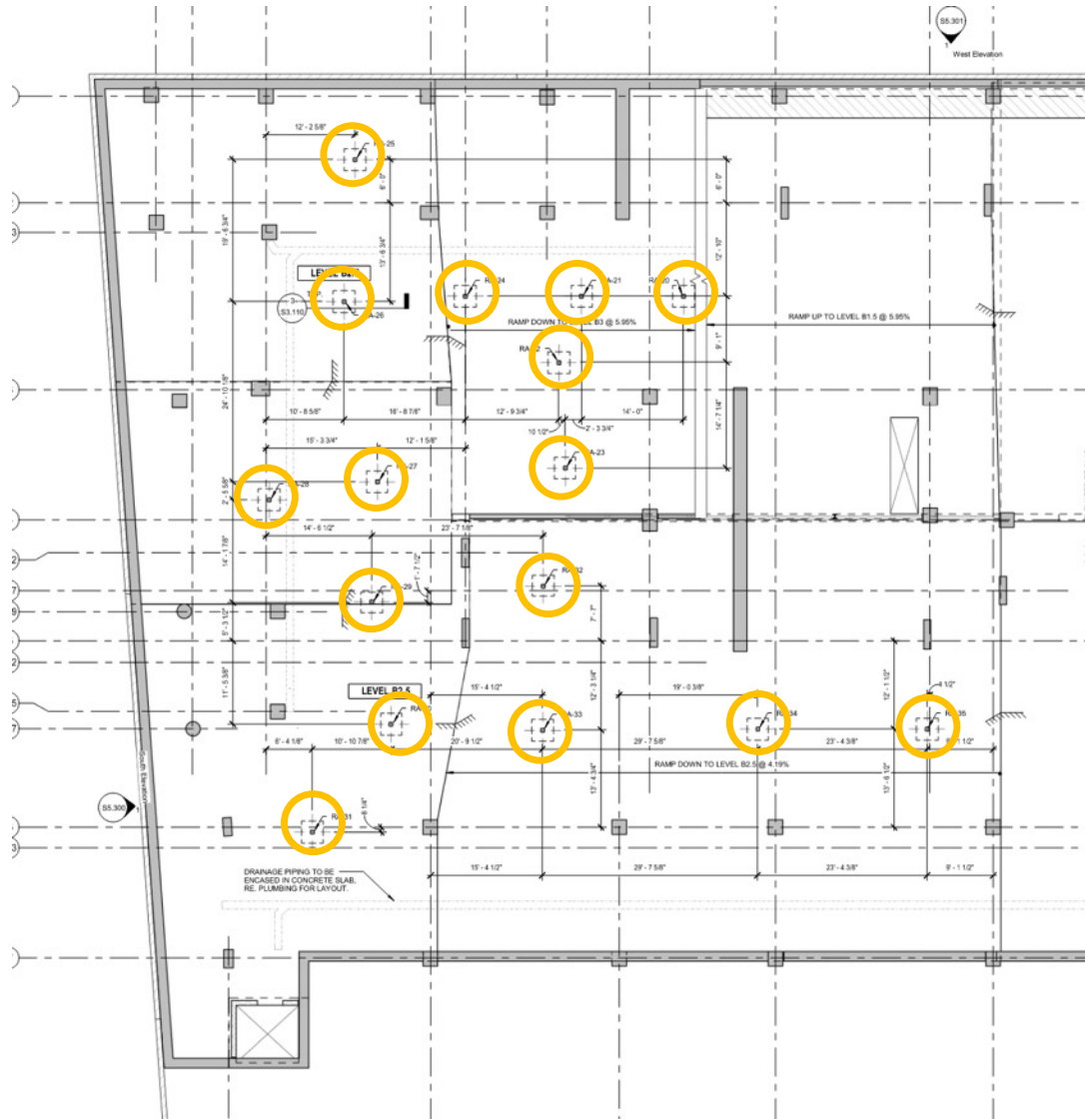














4 months later...











A photograph showing a significant structural failure in a ceiling. A large, irregular hole has formed, exposing the underlying insulation and wooden joists. The surrounding ceiling surface is cracked and crumbling. The text 'Repairs' is overlaid in the center of the image.

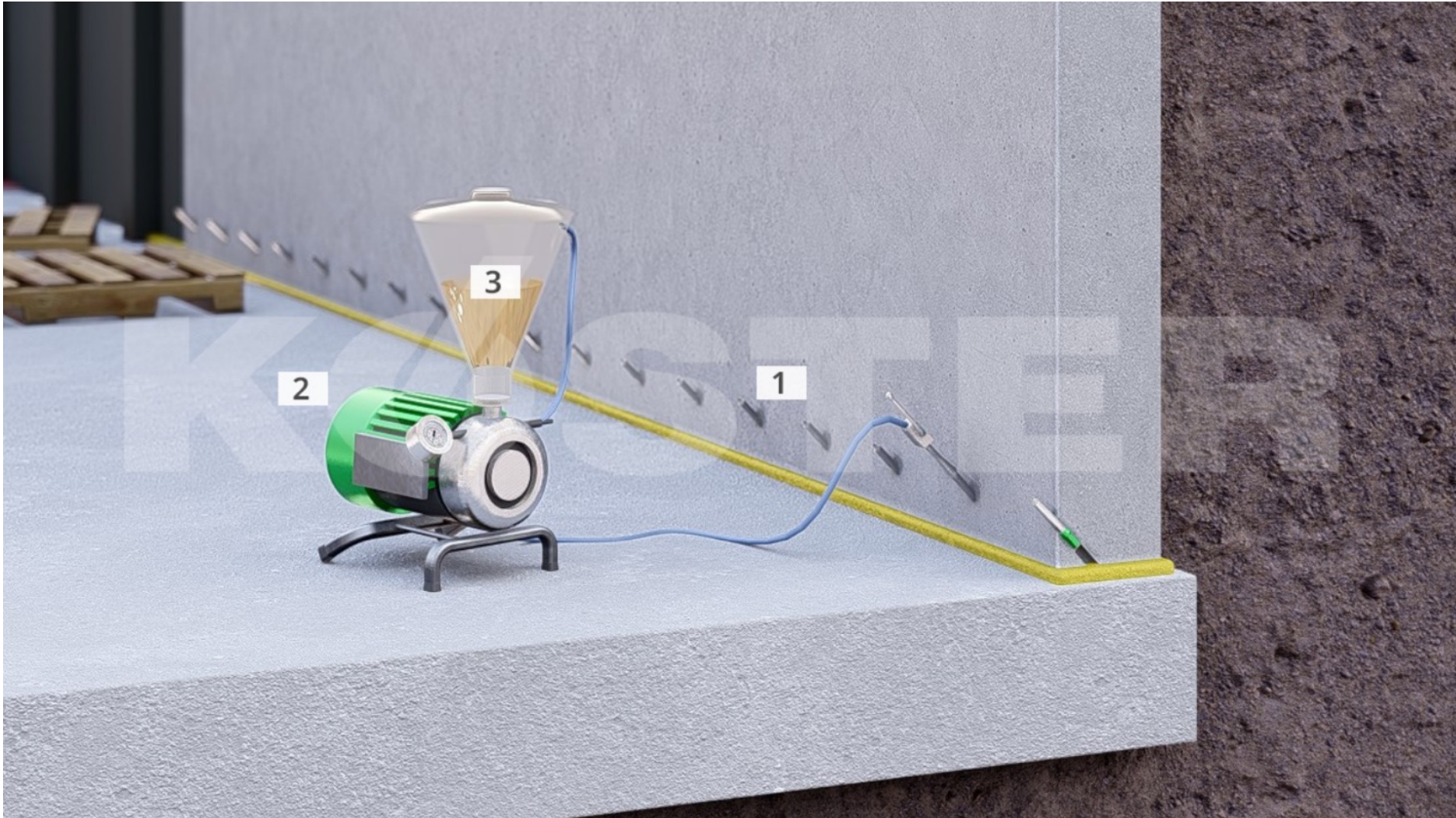
Repairs

What to do when it all goes to hell



Repairs

- There are pretty much 2 things to do:
 - Injection sealing
 - Interior drainage













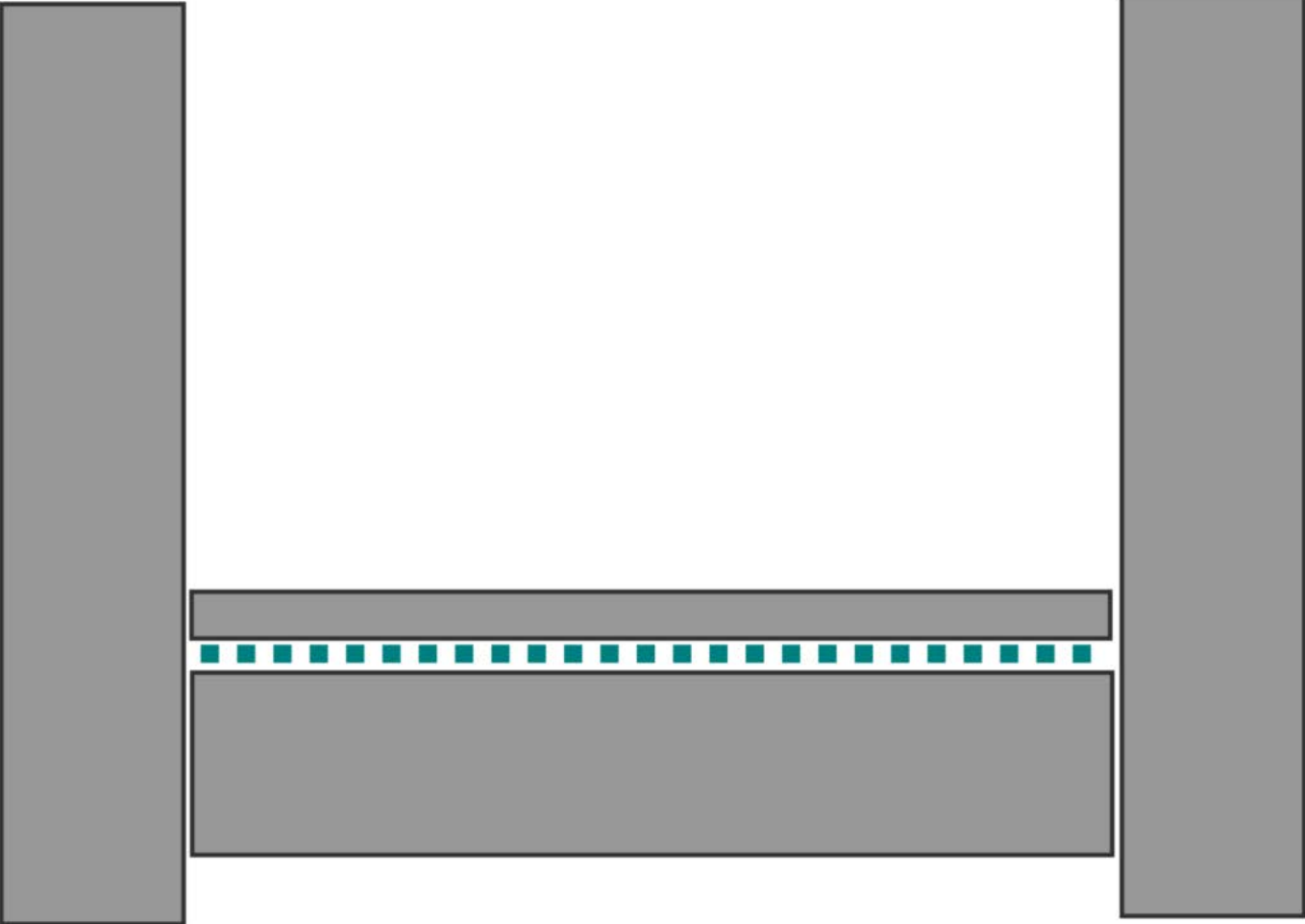


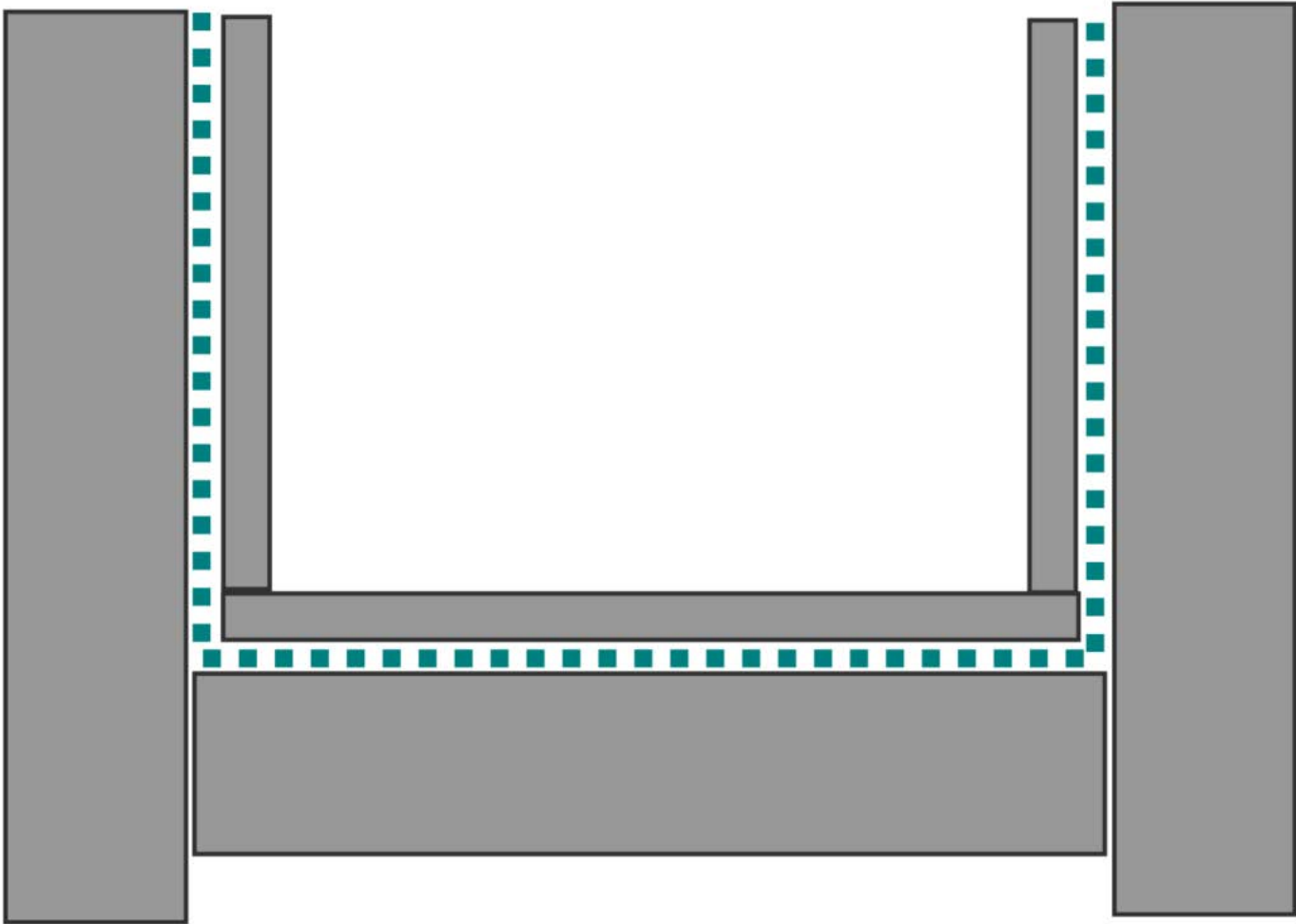












Thank you

pbaker@building science.com