Soil Vapor Intrusion Investigation Work Plan

NYSDEC Site No. C915242
295 Maryland Street Site
Buffalo, New York

October 2020 B0222-020-002

Prepared For:

295 Maryland, LLC

Prepared By:

Benchmark Environmental Engineering & Science, PLLC

2558 Hamburg Turnpike, Suite 300, Buffalo, New York 14218 | phone: (716) 856-0599 | fax: (716) 856-0583

SOIL VAPOR INTRUSION INVESTIGATION WORK PLAN

295 MARYLAND STREET SITE
NYSDEC SITE NO. C915242
BUFFALO, NEW YORK

October 2020 B0222-020-002

Prepared for:

295 Maryland, LLC
366 Elmwood Avenue
Buffalo, NY 14222

Prepared By:

Benchmark Environmental Engineering & Science, PLLC
2558 Hamburg Turnpike, Suite 300
Buffalo, NY 14218
(716) 856-0599

SOIL VAPOR INTRUSION INVESTIGATION WORK PLAN

295 Maryland Street Site

Table of Contents

LIST OF FIGURES

APPENDICES

1.0 INTRODUCTION

The 295 Maryland Street Brownfield Cleanup Program (BCP) Site (the Site) is located in a residential area on the west side of the City of Buffalo, Erie County, New York (see Figure 1). The approximate 1.5-acre Site is bounded by Maryland Street to the northwest, Virginia Street to the southeast, West Tupper Street to the northeast, and West Avenue to the southwest (see Figure 2).

295 Maryland, LLC entered into a Brownfield Cleanup Agreement (BCA) on July 14, 2011 with the New York State Department of Environmental Conservation (NYSDEC) to remediate the Site. After completion of the remedial work, some contamination remained on the property. Institutional and Engineering Controls (IC/ECs) have been incorporated into the Site remedy to control exposure to remaining contamination and ensure protection of public health and the environment. An Environmental Easement granted to the NYSDEC, and recorded with the Erie County Clerk, requires compliance with the November 2015 Site Management Plan (SMP; Ref. 1) and all IC/ECs placed on the Site.

1.1 Site Background

The Site historically operated as an industrial/manufacturing facility for commercial billboards beginning in the 1920s; prior to the current residential redevelopment it was most recently owned by Lamar Advertising. Previous Site uses included vehicle maintenance, use of paints, adhesives, solvents, and other flammables. Lamar Advertising relocated to another location within the City in December 2000; the associated commercial buildings and facilities on 295 Maryland Street as well as former residences at 121 West Avenue were demolished. The Site is currently developed with a three-story apartment building completed in 2017. The 129 West Avenue parcel portion of the BCP Site, located on the southwest corner of the property along Maryland Street and West Avenue, is currently nearing completion of redevelopment with a new four-story apartment building (deemed the "Campus West" building).

The Site was remediated as a 6NYCRR Part 375 Restricted-Residential Track 4 cleanup. Components of the selected remedy included excavation and off-site disposal of non-hazardous polycyclic aromatic hydrocarbon (PAH), grossly contaminated, and heavy metal impacted soil/fill, and installation of a site-wide cover system.

Soil cleanup objectives (SCOs) for 295 Maryland Street Site are Site-Specific Action Limits (SSAL). By meeting these SSALs and constructing the cover system (including placement of a vapor barrier beneath structures), the remedial action objectives (RAOs) have been satisfied. The cover system is comprised of a minimum of 24 inches of clean soil or stone; hardscape in the form of asphalt, concrete pavement and concrete block perimeter wall; and concrete building slab placed over an 8-mil poly vapor barrier.

1.2 Project Objectives

As outlined in the approved SMP, post-remedial soil vapor intrusion (SVI) sampling must be performed for any new buildings developed on-site prior to human use and occupancy and during the heating season, if those events do not coincide. Therefore, NYSDEC is requiring an evaluation of the potential for vapor intrusion, to assess the performance of the remedy and protect public health and the environment.

This Work Plan is intended to fulfill the obligation for development of an acceptable SVI investigation approach. The results of the investigation described herein, once implemented, will allow for decision making concerning the need for further actions to address exposures related to SVI. Additional SVI mitigation, if necessary, will be performed.

2.0 INVESTIGATION SCOPE OF WORK

2.1 Sub-Slab Vapor Field Investigation Methods

The newly erected Campus West building is supported by a perimeter foundation and interior columns centered on spread footers. No interior foundations are present within the building with the exception of the elevator shaft and stairwells. The lowest level of the building, deemed the first floor, is partially below grade and will be furnished with three residential apartments as well as commonplace rooms and storage areas (see foundation and floor plans in Appendix A). The second floor is supported by beams over the first-floor columns and foundation, with subsequent floors supported by load-bearing walls. Accordingly, the first floor represents the lowest occupied space, with indoor and subslab air on that level conservatively representative of any soil vapor intrusion impacts. The SVI investigation will therefore involve the collection of one indoor and one sub-slab sample from an apartment within the first floor of the building. In addition, one outdoor ambient air sample will be collected upwind to distinguish trace concentrations from background levels.

The sub-slab vapor sampling will be completed in general accordance with the Final October 2006 NYSDOH Final Soil Vapor Intrusion Guidance (Ref. 2) as specified in the Benchmark Field Operating Procedure (FOP) 004.5, Soil Vapor Sample Collection Procedures (see Appendix A).

The heating system will be operated to maintain normal indoor air temperatures (i.e., 65-75°F) for at least 24 hours prior to and during the scheduled sampling time. Prior to sample collection, the NYSDOH building inventory questionnaire will be completed (see Appendix C).

2.1.1 *Indoor and Outdoor Air Sample Locations*

Figure 2 shows the proposed locations for the indoor air/subslab samples as well as the outdoor air sample. The indoor air sample location will be directed toward the middle of the sampled apartment, to the extent feasible depending upon finishes in place at the time of the work. The apartment farthest east will be sampled, as this location is closest to petroleum-related impacts and elevated PID readings identified at the Site prior to completion of remedial work. The indoor air sampler will be placed on a stepladder or another surface at approximately 2-5 feet above floor surface, adjacent to the sub-slab sample location. The outdoor air sample will be collected from a location upwind of the Site as determined on the day of sub-slab sampling. The outdoor sample will be placed on a stepladder or other surface at approximately 3-5 feet above grade, or alternatively located on a second-floor balcony.

2.1.2 *Sub-Slab Vapor Probe Installation*

At the sub-slab vapor location, an approximately ¾-inch diameter hole will be drilled through the concrete slab (estimated 6-8 inches thick) using a hand-held hammer drill. Cuttings will be swept aside with a whisk broom to assure an adequate surface seal. A ¼-inch inert tubing (e.g., polyethylene or Teflon) will then be inserted into the concrete core hole no further than 2 inches below the bottom of the concrete slab. The tubing will then be sealed to the surface of the concrete floor with a VOC-free stopper (e.g., Pergamum grout, melted beeswax, natural modeling clay, putty, or other non-VOC and non-shrinking product).

The tubing will be run through a shroud (e.g., plastic pail) creating a tight seal with the concrete floor. The shroud will be enriched with a tracer gas (e.g., helium) and the concentration will be recorded on the Air Canister Field Form (see Appendix C). The shroud and tracer gas are used as a quality assurance/quality control device to verify the integrity of the subslab vapor probe seal. Three volumes will be purged (maximum 0.2 liters per minute) from the tubing using a hand pump before attaching the canister to ensure collection of a representative sample. A sample of the vapor will be analyzed for the tracer gas using a syringe or Tedlar bag. If concentrations greater than 10% of tracer gas are measured, the probe seal will be enhanced to reduce the infiltration of outdoor air and the test will be repeated.

2.1.3 *Air/Vapor Sampling*

Summa Canisters will be attached to the opposite end of the ¼-inch tubing. Each canister, with an initial pressure of approximately 50 millitorr (compared to 760 torr of pressure in the atmosphere at sea level), will be fitted with a sampling valve that uses a critical orifice and mass flow controller (24-hour regulator) to regulate the air flow into the canister for the selected sampling period. The mass flow controller will maintain a relative constant air flow rate throughout the sampling period. All canister valves will remain closed until the vapor probes are installed, seal tested, purged, and all of the canisters are in their respective positions. The valves will then be opened for the 24-hour collection period at a flow rate not to exceed 0.2 liters/minute. The Air Canister Field Form in Appendix B will be used to record the canister vacuum before and after the samples are collected to confirm that the canister maintained pressure during the collection period. The sampler will arrive one hour before the end of the collection period to confirm the canister has residual vacuum and has not reached equilibrium pressure, which would suggest potential sample loss. Canisters will be sealed and start/stop times and vacuums will be recorded.

Prior to departing the site the tubing will be removed and sample holes will be sealed with non-shrinking grout.

2.2 Analytical Program

The canisters will be shipped to a NYSDOH-approved laboratory for analysis of Target Compound List (TCL) VOCs per USEPA TO-15 Methodology. The laboratory will be notified that the data will be evaluated against NYSDOH SVI Guidance (Ref. 2) to assure appropriate low level detection limits for the target compounds[1].

2.3 Reporting

Upon completion of sampling and receipt of analytical data, a letter report will be prepared summarizing the field activities and sampling results. Results of the testing will be compared to the ambient air samples and applicable NYSDOH guidelines. The inventory assessment of all chemicals used/present at the facility will be attached to the letter report. If the results suggest a need for additional investigation or mitigation, recommendations for this work will be made.

2.4 Schedule

Sub-slab vapor and indoor air samples are typically collected during the heating season because soil vapor intrusion is more likely to occur when a building's heating system is in operation and air is being drawn into the building. Benchmark is prepared to procure

[1] Specifically chloroethane; methylene chloride; tetrachloroethene; trichloroethene; vinyl chloride; 1,1-dichloroethane; 1,2-dichloroethane; 1,2-dichloroethene; and trichloroethene.

laboratory-supplied Summa Canisters and schedule the SVI investigation upon receipt of NYSDEC approval of this Work Plan, with a target sampling period of early to mid-November 2020. We will provide NYSDEC with seven days' advance notice of the field activities.

3.0 REFERENCES

1. Benchmark Environmental Engineering & Science, PLLC. *Site Management Plan 295 Maryland Street Site, NYSDEC Site No. C915242, Buffalo, NY*. November 2015.

2. New York State Department of Health. *Guidance for Evaluating Soil Vapor Intrusion in the State of New York*. October 2006 (including June 2007 to August 2015 updates).

FIGURES

F:\CAD\Benchmark\295 Maryland\SVI Work Plan\Figure 1 - Site Location and Vicinity Map.dwg

FIGURE 1

BENCHMARK
ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC
2558 HAMBURG TURNPIKE
SUITE 300
BUFFALO, NY 14218
(716) 856-0599

PROJECT NO.: B0222-020-002

DATE: OCTOBER 2020

DRAFTED BY: CCB

SITE LOCATION AND VICINITY MAP

SOIL VAPOR INTRUSION INVESTIGATION WORK PLAN

295 MARYLAND STREET SITE
BCP SITE NO. C915242
BUFFALO, NEW YORK

PREPARED FOR

295 MARYLAND, LLC

F:\CAD\Benchmark\Campus West\SVI Work Plan - October 2020\Figure 2; Site Plan and Proposed SVI Sampling Locations.dwg

LEGEND:

REDEVELOPMENT AREA BOUNDARY

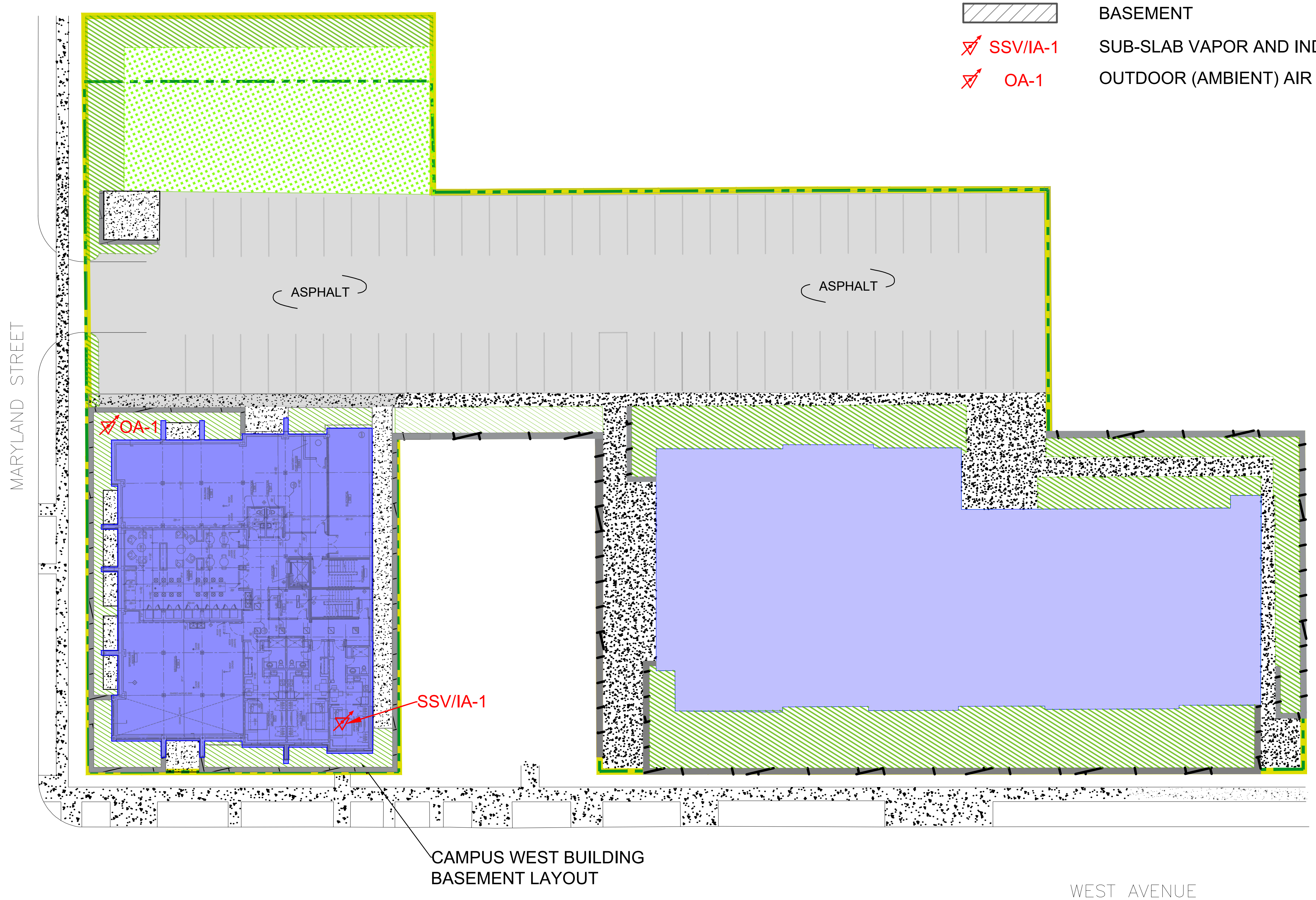
BCP SITE BOUNDARY

BUILDING

BASEMENT

SSV/IA-1 SUB-SLAB VAPOR AND INDOOR AIR SAMPLE

OA-1 OUTDOOR (AMBIENT) AIR SAMPLE



40' 0' 40' 80'

SCALE: 1 INCH = 40 FEET
SCALE IN FEET
(approximate)

DATE: OCTOBER 2020
DRAFTED BY: CCB

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC
2558 HAMBURG TURNPIKE
SUITE 300
BUFFALO, NY 14218
(716) 856-0599

JOB NO.: B0222-020-002

SITE PLAN AND PROPOSED SOIL VAPOR INVESTIGATION LOCATIONS

SOIL VAPOR INTRUSION INVESTIGATION WORK PLAN

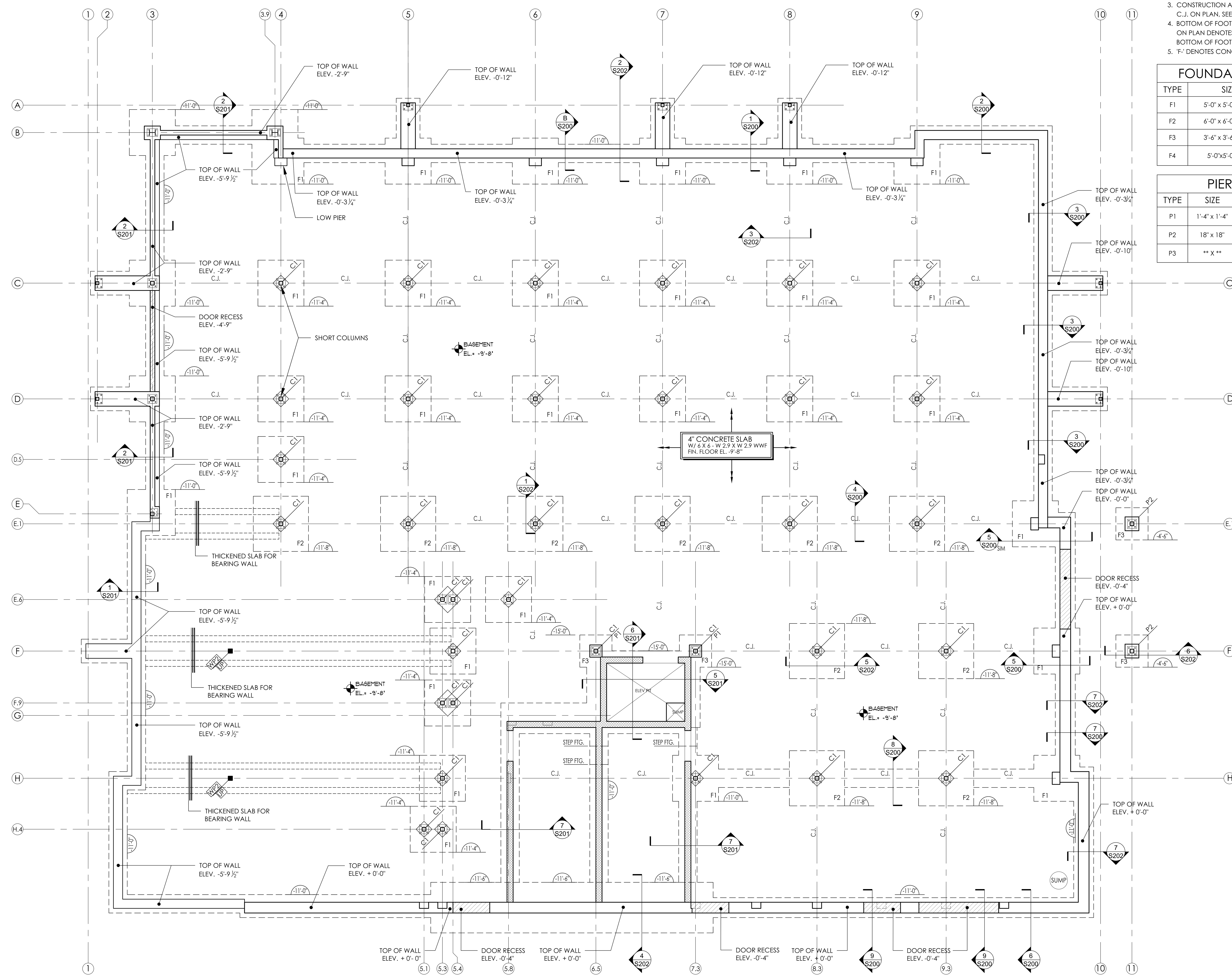
295 MARYLAND STREET SITE
BCP SITE NO. C915242
BUFFALO, NEW YORK

PREPARED FOR
295 MARYLAND, LLC

FIGURE 2

APPENDIX A

FOUNDATION AND FLOOR PLANS



FOUNDATION PLAN
SCALE: 3/16" = 1'-0" 1 S1

NORTH

FOUNDATION NOTES:

1. FLOOR CONSTRUCTION SHALL BE 'X' CONCRETE SLAB ON COMPACTED FILL W/ 6x6xW2.9xW2.9 W.W.F.
2. TOP OF FIRST FLOOR ELEVATION = 0'-0" (EL. 42.101)
3. CONSTRUCTION AND CONTROL JOINTS ARE NOTED THUS C.J. ON PLAN, SEE TYPICAL DETAILS
4. BOTTOM OF FOOTING INDICATOR SHOWN THUS -X'-X" ON PLAN DENOTES DISTANCE FROM FINISH FLOOR TO BOTTOM OF FOOTING
5. 'F-' DENOTES CONCRETE FOOTING (SEE SCHEDULE)

FOUNDATION SCHEDULE

TYPE	SIZE	REINFORCEMENT
F1	5'-0" x 5'-0" x 1'-0"	#5 @ 9" E.W.
F2	6'-0" x 6'-0" x 1'-4"	#6 @ 9" E.W.
F3	3'-6" x 3'-6" x 1'-0"	# @ 9" E.W.
F4	5'-0"x5'-0"x1'-0"	#5 @ 9" E.W. (TOP & BTM)

PIER SCHEDULE

TYPE	SIZE	REINFORCEMENT
P1	1'-4" x 1'-4"	(4) #6 VERTS, #3 TIES @ 12" O.C.
P2	18" x 18"	(4) #4 VERTS, #4 TIES @ 12" O.C.
P3	** X **	--

REVISIONS

NO.	DATE	DESCRIPTION
1	2/7/19	BID SET
2	4/5/19	FOUNDATION REVISIONS

Project No.
4125

CONSULTANTS:

MECHANICAL ENGINEER
COMPANY
ADDRESS
CITY

STRUCTURAL ENGINEER
COMPANY
ADDRESS
CITY

CIVIL ENGINEER
COMPANY
ADDRESS
CITY

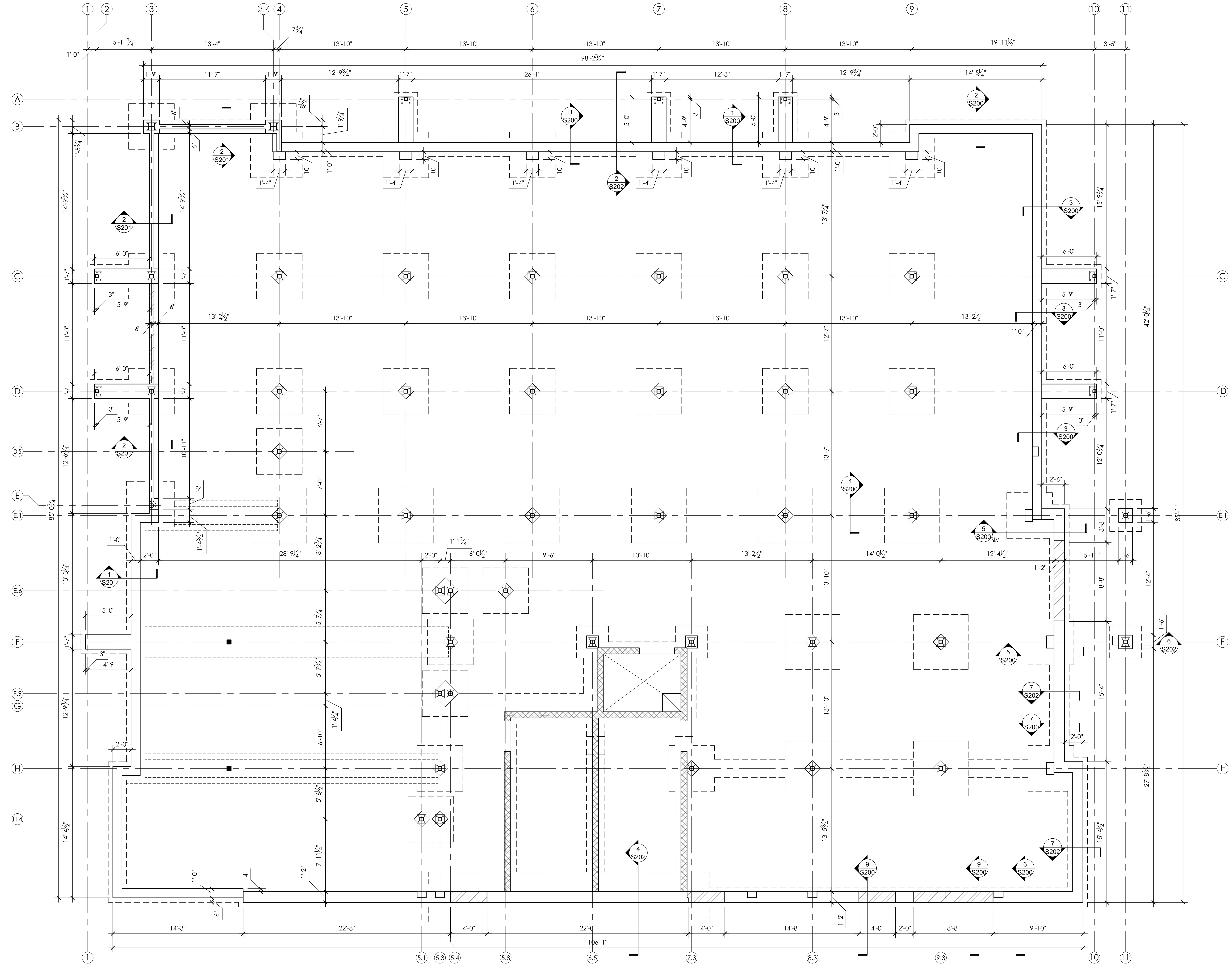
FOUNDATION PLAN

CAMPUS WEST
RESIDENTIAL APARTMENT BUILDING
129 WEST AVENUE
******
BUFFALO, NEW YORK 14201

DATE
4/17/2018

DRAWING NO.
S100

DATE PLOTTED: Fri, 05 Apr 2019 - 12:02pm FILE LOCATION: 4125 A1 Plans_05.dwg



FOUNDATION PLAN DIMENSIONS 1/S1
SCALE: 3/16" = 1'-0"

NORTH

DATE PLOTTED: Fri, 05 Apr 2019 - 12:02pm
FILE LOCATION: 4125 A1 Plans_05.dwg

REVISIONS

NO.	DATE	DESCRIPTION
1	2/7/19	BID SET
2	4/5/19	FOUNDATION REVISIONS

NOTICE
Unauthorized Alterations of This Document Are In Violation of Section #7209 of The State Education Law

Project No.
4125

CONSULTANTS:

MECHANICAL ENGINEER
COMPANY
ADDRESS
CITY

STRUCTURAL ENGINEER
COMPANY
ADDRESS
CITY

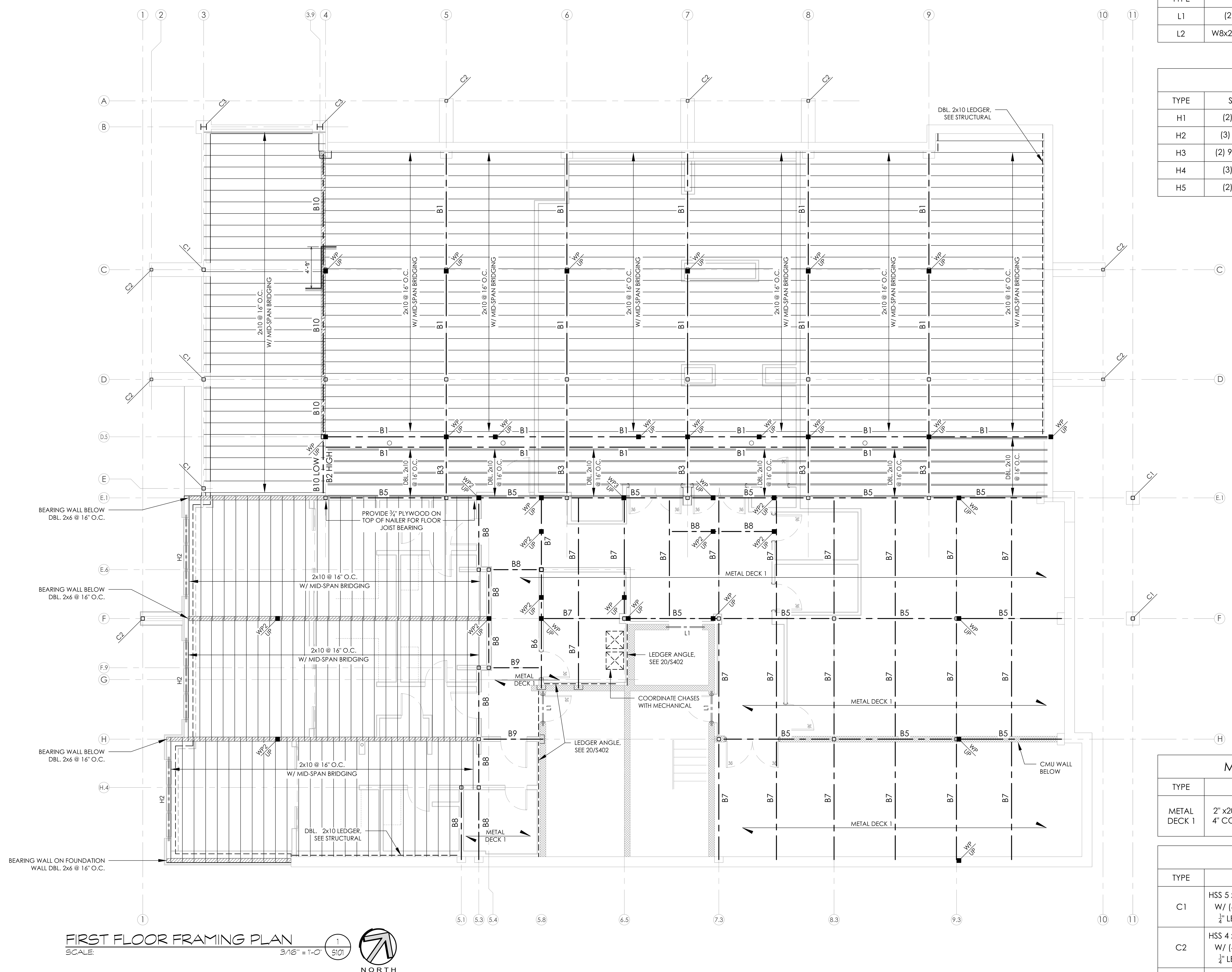
CIVIL ENGINEER
COMPANY
ADDRESS
CITY

FOUNDATION PLAN

CAMPUS WEST
RESIDENTIAL APARTMENT BUILDING
129 WEST AVENUE
******
BUFFALO, NEW YORK 14201

DATE
4/17/2018

DRAWING NO.
S100.1



FIRST FLOOR FRAMING PLAN 1/S101
SCALE: 3/16" = 1'-0"

LINTEL SCHEDULE

TYPE	SIZE	MATERIAL
L1	(2) OR (3) L5 x 3½ x 5/16 W/ 4" BEARING	STEEL
L2	W8x21 W/ 3/8" PLATE, 8" BEARING EACH END	STEEL

HEADER SCHEDULE

TYPE	SIZE	COMMENTS
H1	(2) 2x8	USE (2) 2x6 JACK STUDS AT FIRST
H2	(3) 2x10	USE (2) 2x6 JACK STUDS
H3	(2) 9 ¼" LVL	USE (2) 2x6 JACK STUDS
H4	(3) 2x8	USE (2) 2x6 JACK STUDS AT FIRST
H5	(2) 2x8	USE (2) 2x6 JACK STUDS AT FIRST

POST SCHEDULE

TYPE	SIZE	MATERIAL
WP	(4) 2x6	WOOD
WP2	(3) 2x6	WOOD
WP3	PSL POST 5 x 7¼	WOOD

FLUSH BEAM SCHEDULE

TYPE	SIZE	MATERIAL
FB-1	SEE 1/S402	WOOD/STEEL
FB-2	SEE 2/S402	WOOD/STEEL
FB-3	SEE 3/S402	WOOD/STEEL

BEAM SCHEDULE

TYPE	SIZE	T.O. STEEL
B1	W14x30	-0'-3¼"
B2	W12x29	-0'-3¼"
B3	W14x68	-0'-3¼"
B4	NOT	USED
B5	W16x40	-0'-4"
B6	W14x30	-0'-4"
B7	W12x16	-0'-4"
B8	W8x18	-0'-4"
B9	W8x10	-0'-4"
B10	W14x30	-5'-0¼"
B11	W6x20	+8'-8¾"
B12	W12x30	+9'-9½"
B13	W12x19	+9'-9½"
B14	W12x26	+9'-9½"
B15	W12x22	+9'-9½"

METAL DECK SCHEDULE

TYPE	SIZE	MATERIAL
METAL DECK 1	2" x20 GA. COMPOSITE METAL DECK, 4" CONC. W/ 6x6xW2.1xW2.1 W.W.M.	STEEL

COLUMN SCHEDULE

TYPE	SIZE	MATERIAL
C1	HSS 5 x 5 x 3/8" ON 12 x 12 x 1/2" BASE PLATE W/ (4) 3/4" Ø A.B. x 9" EMBEDMENT ON 1/4" LEVELING PLATE + 3/4" N.S. GROUT	STEEL
C2	HSS 4 x 4 x 1/4" ON 10 x 10 x 1/2" BASE PLATE W/ (4) 3/4" Ø A.B. x 9" EMBEDMENT ON 1/4" LEVELING PLATE + 3/4" N.S. GROUT	STEEL
C3	W8x35 ON 14 x 10 x 3/4" BASE PLATE W/ (4) 1" Ø A.B. x 16" EMBEDMENT ON 1/4" LEVELING PLATE + 3/4" N.S. GROUT	STEEL

DATE PLOTTED: Fri, 05 Apr 2019 - 12:01pm
FILE LOCATION: 4125 S1 Framing Plans_03.dwg

REVISIONS

NO.	DATE	DESCRIPTION
1	2/7/19	BID SET
2	4/5/19	FOUNDATION REVISIONS

Project No. 4125

CONSULTANTS:

MECHANICAL ENGINEER
COMPANY
ADDRESS
CITY

STRUCTURAL ENGINEER
COMPANY
ADDRESS
CITY

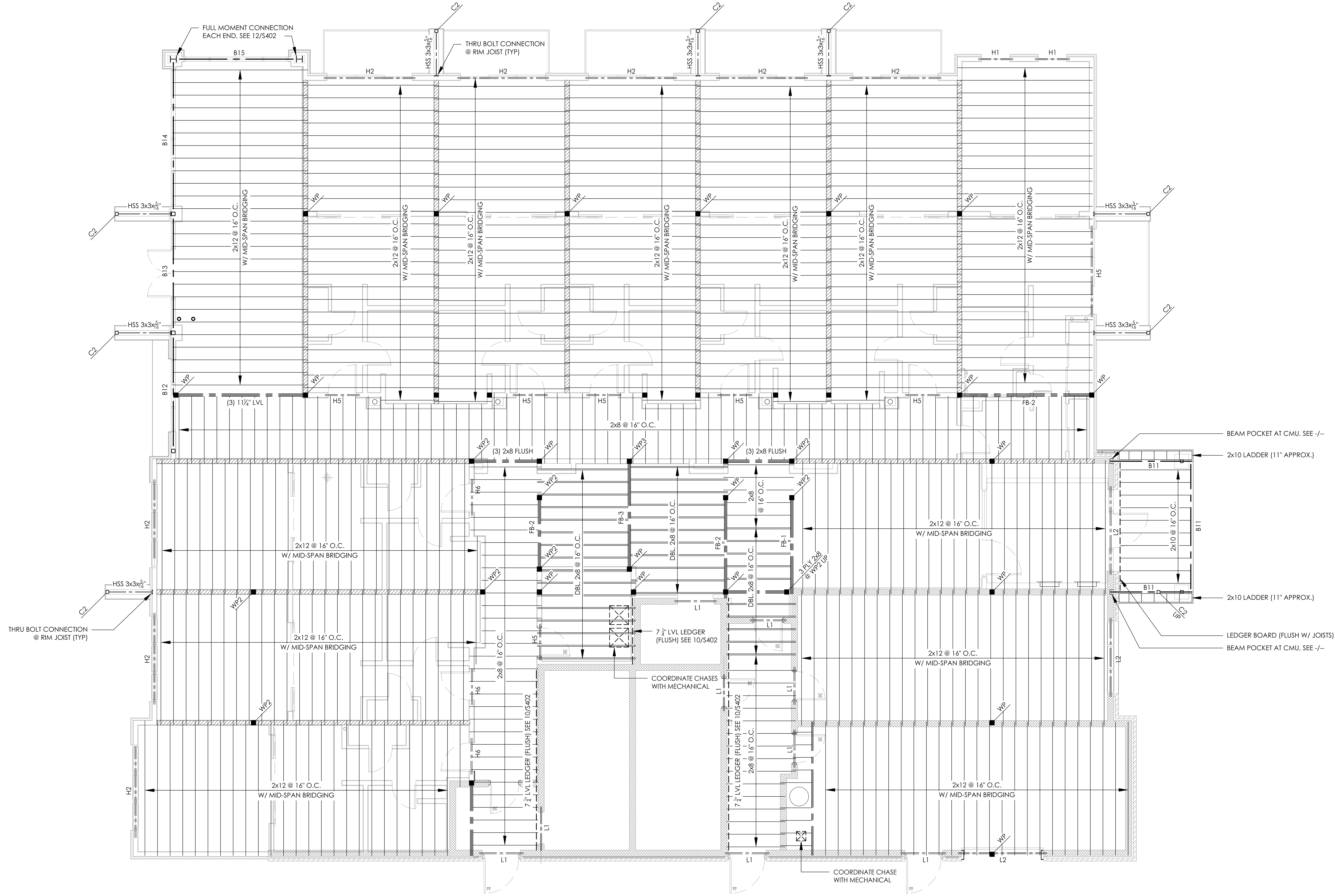
CIVIL ENGINEER
COMPANY
ADDRESS
CITY

FIRST FLOOR FRAMING PLAN

CAMPUS WEST
RESIDENTIAL APARTMENT BUILDING
129 WEST AVENUE
******
BUFFALO, NEW YORK 14201

DATE 4/17/2018

DRAWING NO. S101



SECOND FLOOR FRAMING PLAN (1/S102)
SCALE: 3/16" = 1'-0"

FILE LOCATION: 4125 S1 Framing Plans_03.dwg

DATE PLOTTED: Fri, 05 Apr 2019 - 12:01pm

REVISIONS

NO.	DATE	DESCRIPTION
1	2/7/19	BID SET
2	4/5/19	FOUNDATION REVISIONS

Project No.
4125

CONSULTANTS:

MECHANICAL ENGINEER
COMPANY
ADDRESS
CITY

STRUCTURAL ENGINEER
COMPANY
ADDRESS
CITY

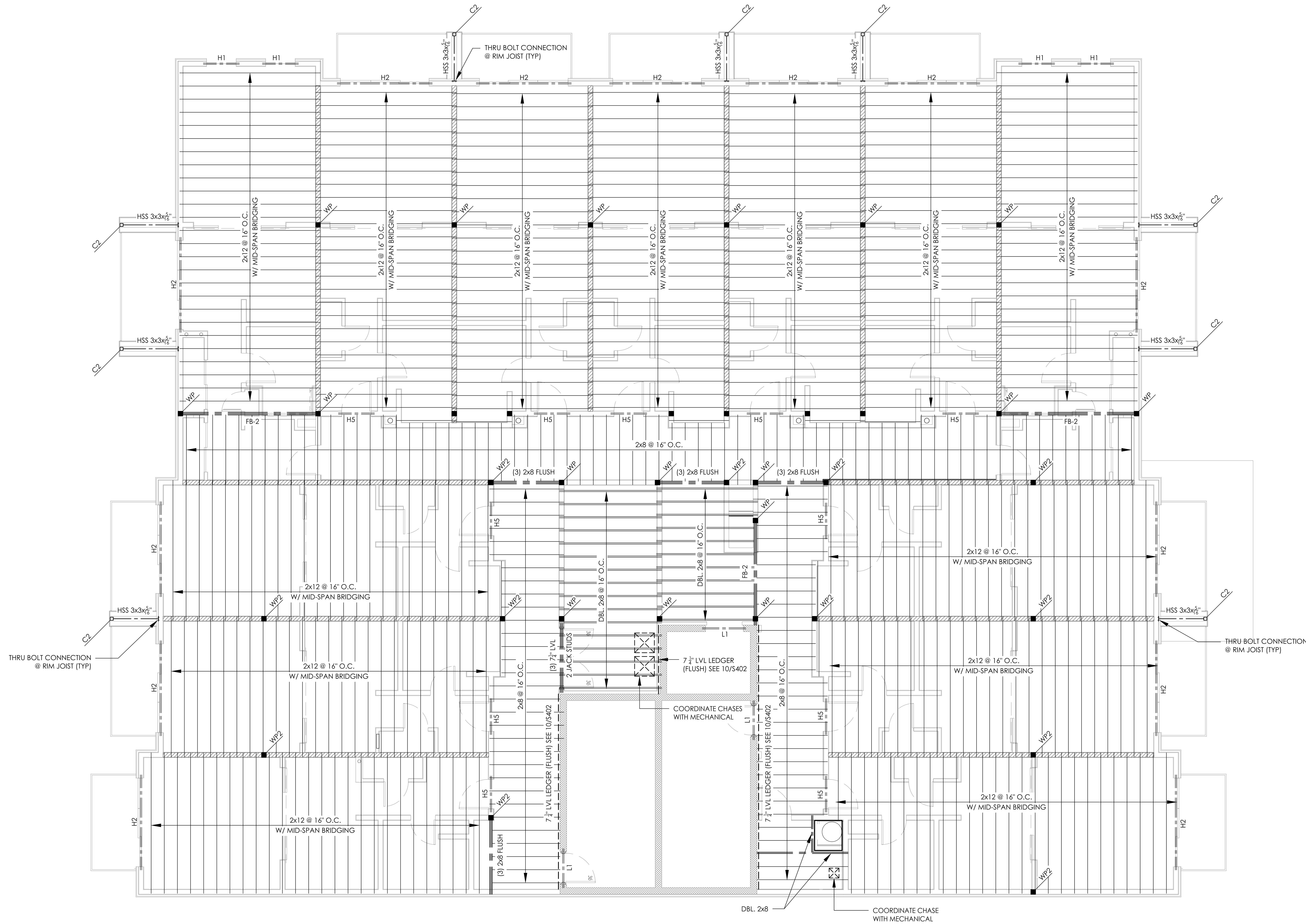
CIVIL ENGINEER
COMPANY
ADDRESS
CITY

SECOND FLOOR FRAMING PLAN

CAMPUS WEST
RESIDENTIAL APARTMENT BUILDING
129 WEST AVENUE
******
BUFFALO, NEW YORK 14201

DATE
4/17/2018

DRAWING NO.
S102



THIRD FLOOR FRAMING PLAN

SCALE: 3/16" = 1'-0" (1 / S103)

NORTH

DATE PLOTTED: Fri, 05 Apr 2019 - 12:01pm

FILE LOCATION: 4125 S1 Framing Plans_03.dwg

REVISIONS

NO.	DATE	DESCRIPTION
1	2/7/19	BID SET
2	4/5/19	FOUNDATION REVISIONS

Project No.
4125

CONSULTANTS:

MECHANICAL ENGINEER
COMPANY
ADDRESS
CITY

STRUCTURAL ENGINEER
COMPANY
ADDRESS
CITY

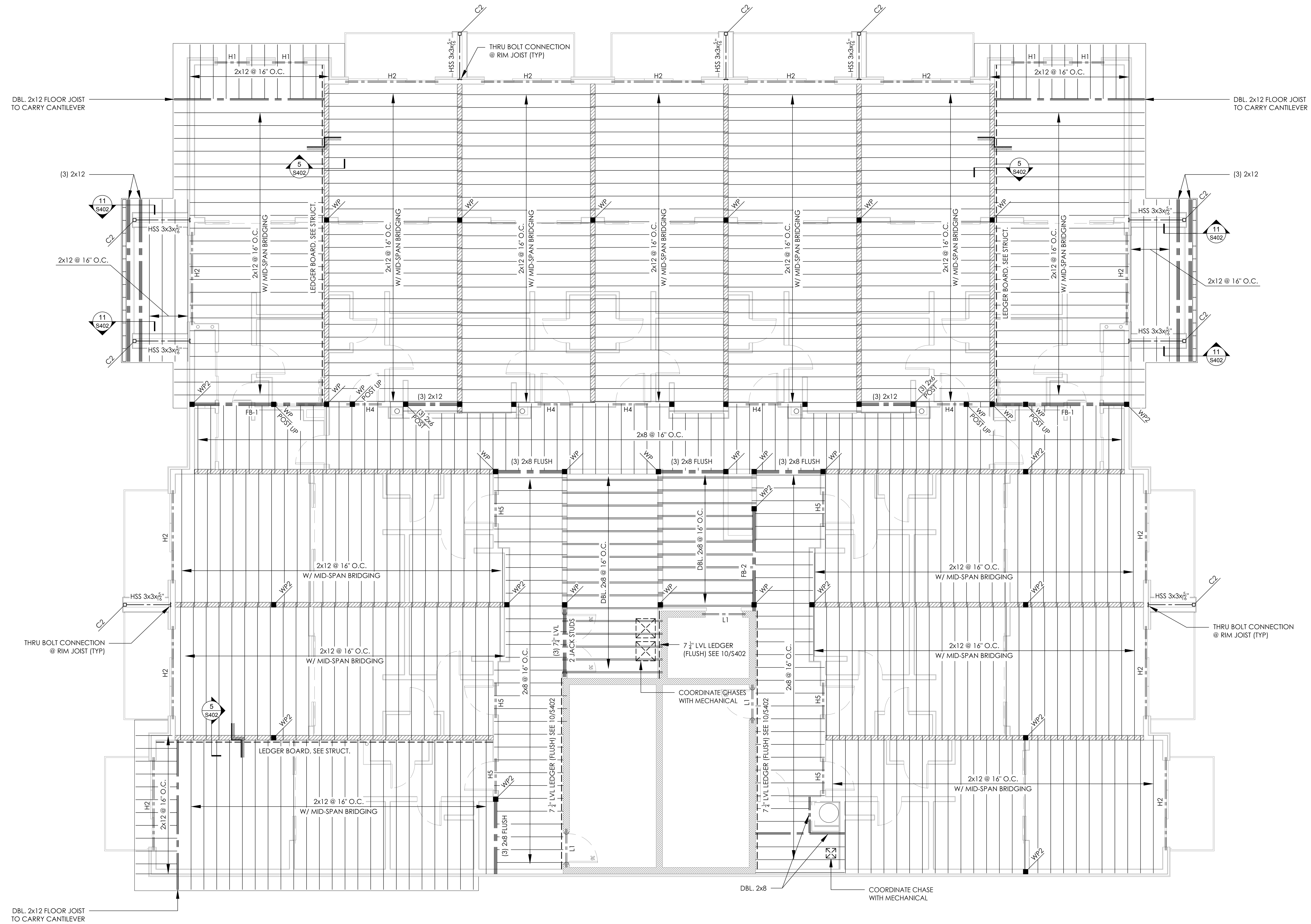
CIVIL ENGINEER
COMPANY
ADDRESS
CITY

THIRD FLOOR FRAMING PLAN

CAMPUS WEST
RESIDENTIAL APARTMENT BUILDING
129 WEST AVENUE
******
BUFFALO, NEW YORK 14201

DATE
4/17/2018

DRAWING NO.
S103



FOURTH FLOOR FRAMING PLAN 1/S104

SCALE: 3/16" = 1'-0"

NORTH

DATE PLOTTED: Fri, 05 Apr 2019 - 12:01pm

FILE LOCATION: 4125 S1 Framing Plans_03.dwg

REVISIONS

NO.	DATE	DESCRIPTION
1	2/7/19	BID SET
2	4/5/19	FOUNDATION REVISIONS

NOTICE

Project No.

4125

CONSULTANTS:

MECHANICAL ENGINEER
COMPANY
ADDRESS
CITY

STRUCTURAL ENGINEER
COMPANY
ADDRESS
CITY

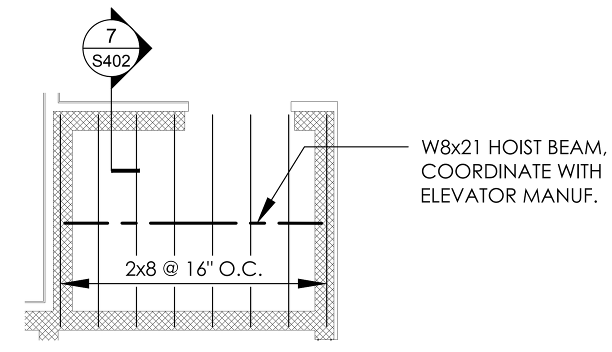
CIVIL ENGINEER
COMPANY
ADDRESS
CITY

FOURTH FLOORN FRAMING PLAN

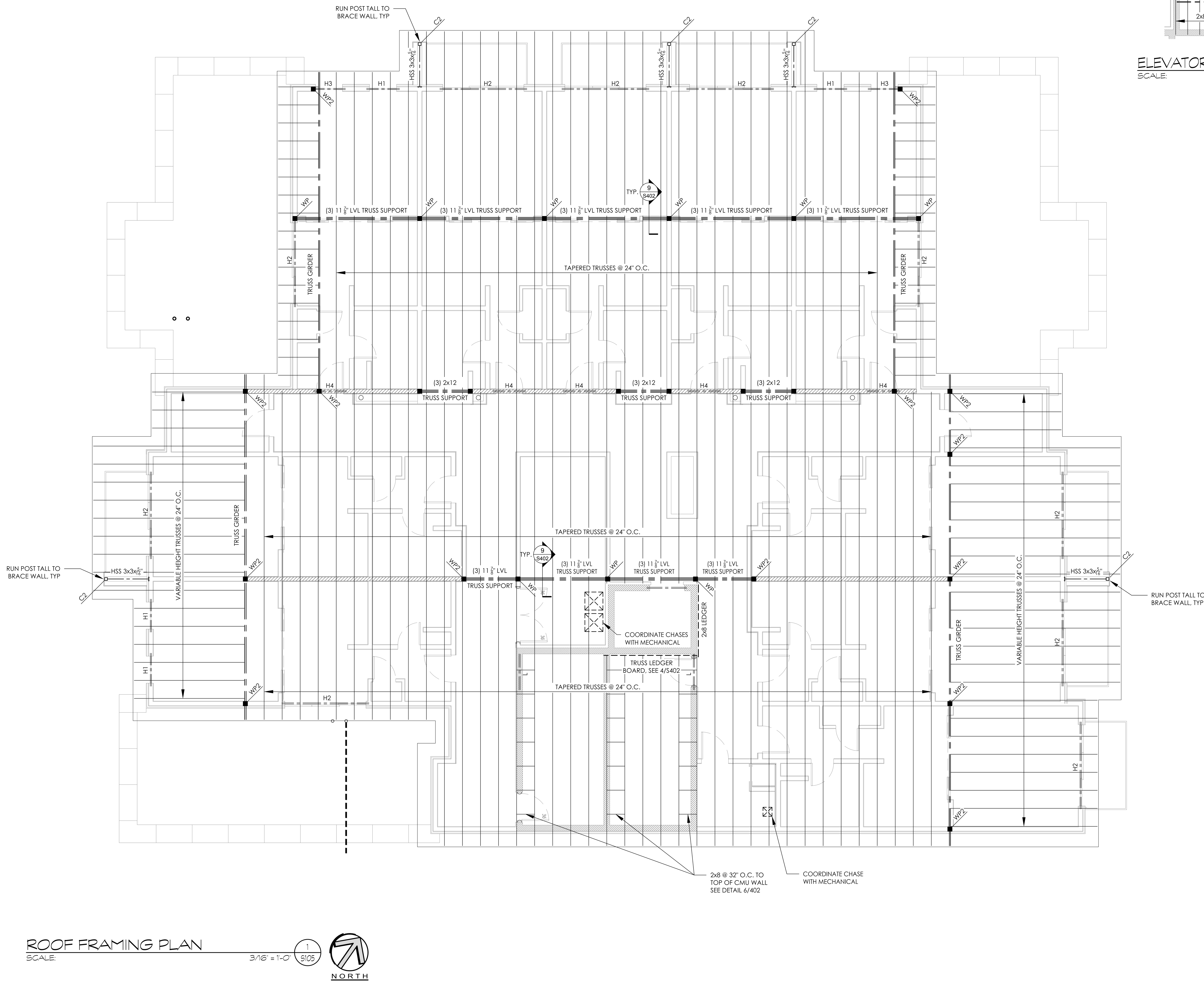
CAMPUS WEST
RESIDENTIAL APARTMENT BUILDING
129 WEST AVENUE
******
BUFFALO, NEW YORK 14201

DATE
4/17/2018

DRAWING NO.
S104



ELEVATOR ROOF FRAMING 2/S105
SCALE: 3/16" = 1'-0"



ROOF FRAMING PLAN 1/S105
SCALE: 3/16" = 1'-0"

DATE PLOTTED: Fri, 05 Apr 2019 - 12:01pm
FILE LOCATION: 4125 S1 Framing Plans_03.dwg

REVISIONS

NO.	DATE	DESCRIPTION
1	2/7/19	BID SET
2	4/5/19	FOUNDATION REVISIONS

Project No.
4125

CONSULTANTS:

MECHANICAL ENGINEER
COMPANY
ADDRESS
CITY

STRUCTURAL ENGINEER
COMPANY
ADDRESS
CITY

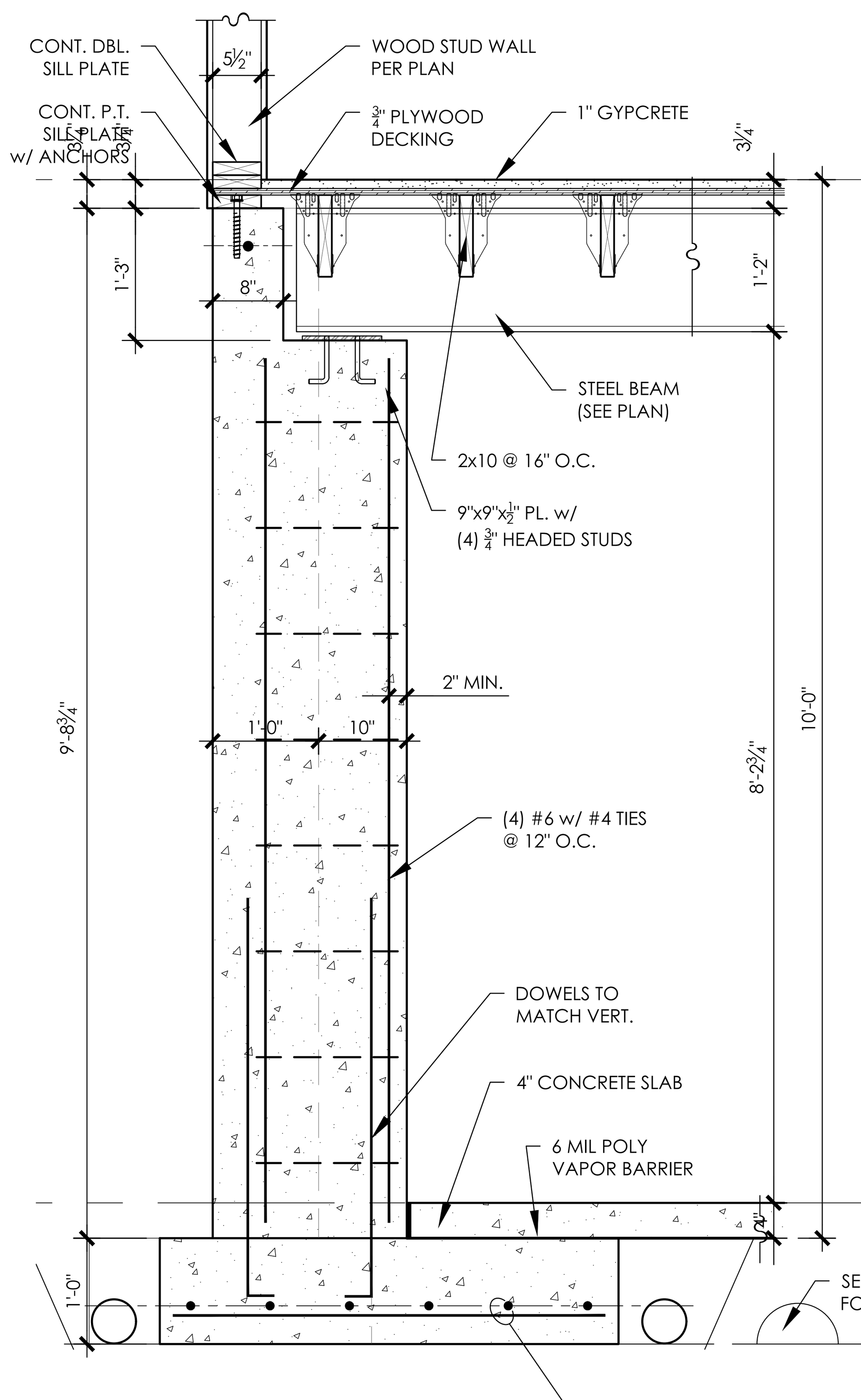
CIVIL ENGINEER
COMPANY
ADDRESS
CITY

ROOF FRAMING PLAN

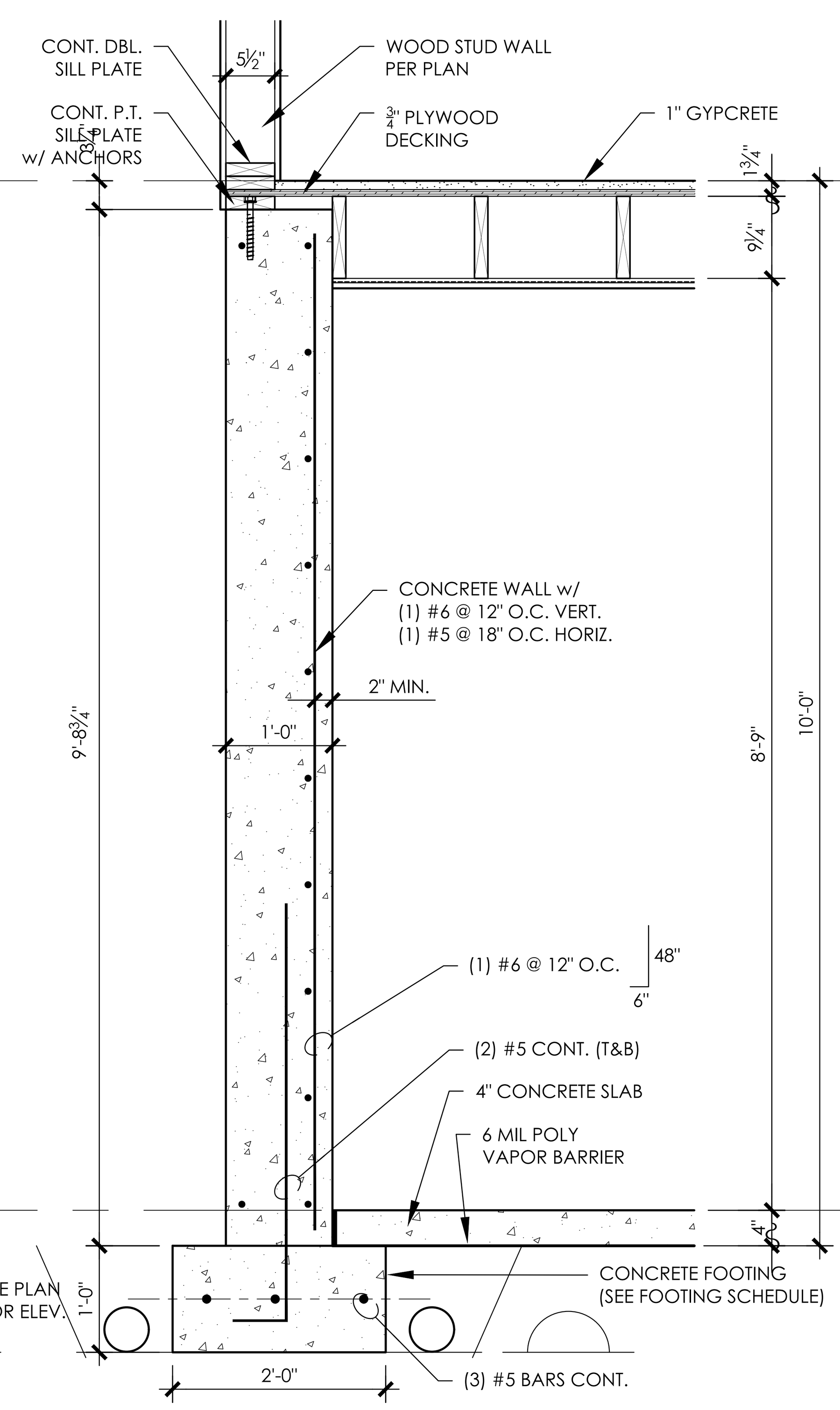
CAMPUS WEST
RESIDENTIAL APARTMENT BUILDING
129 WEST AVENUE
******
BUFFALO, NEW YORK 14201

DATE
4/17/2018

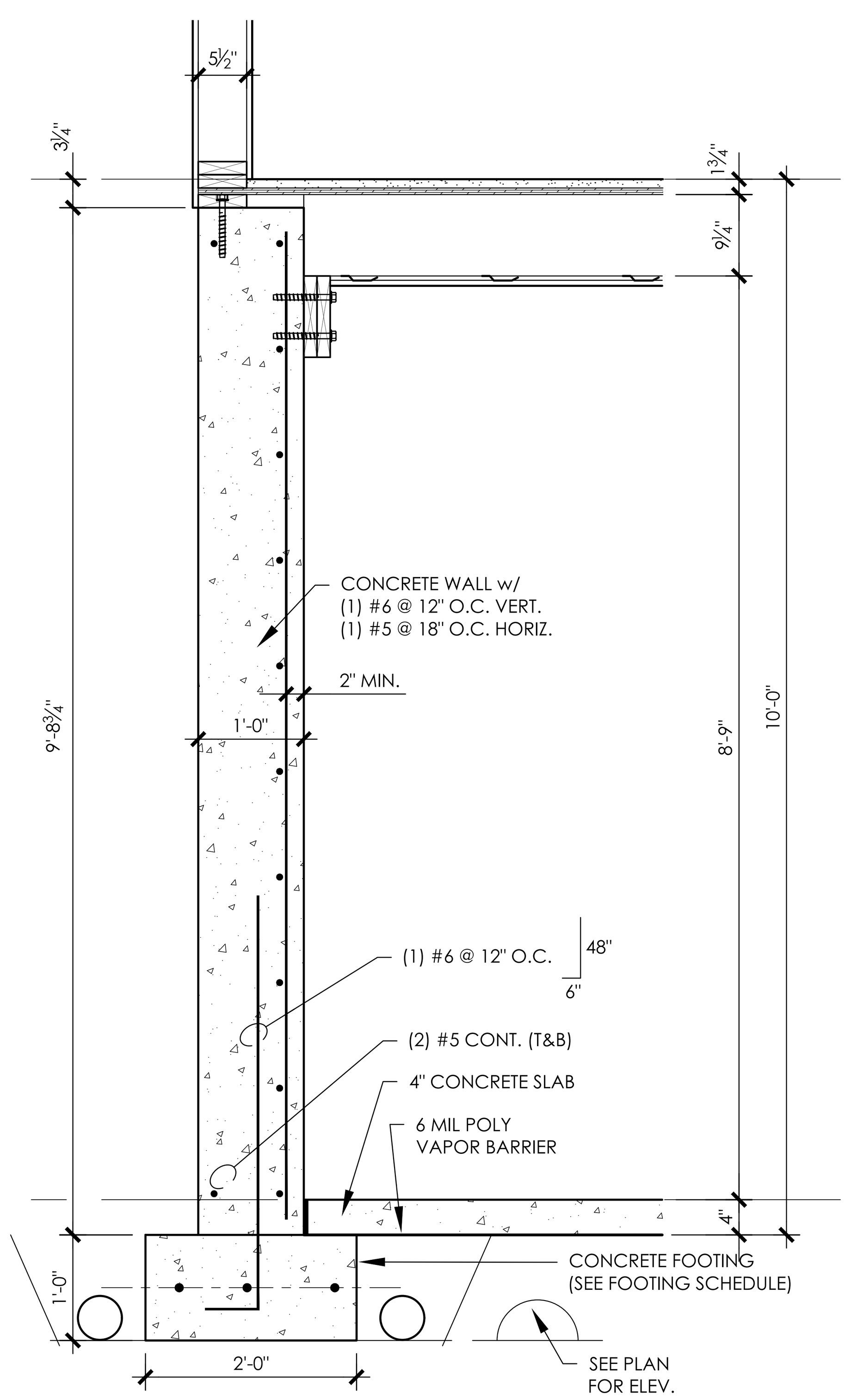
DRAWING NO.
S105



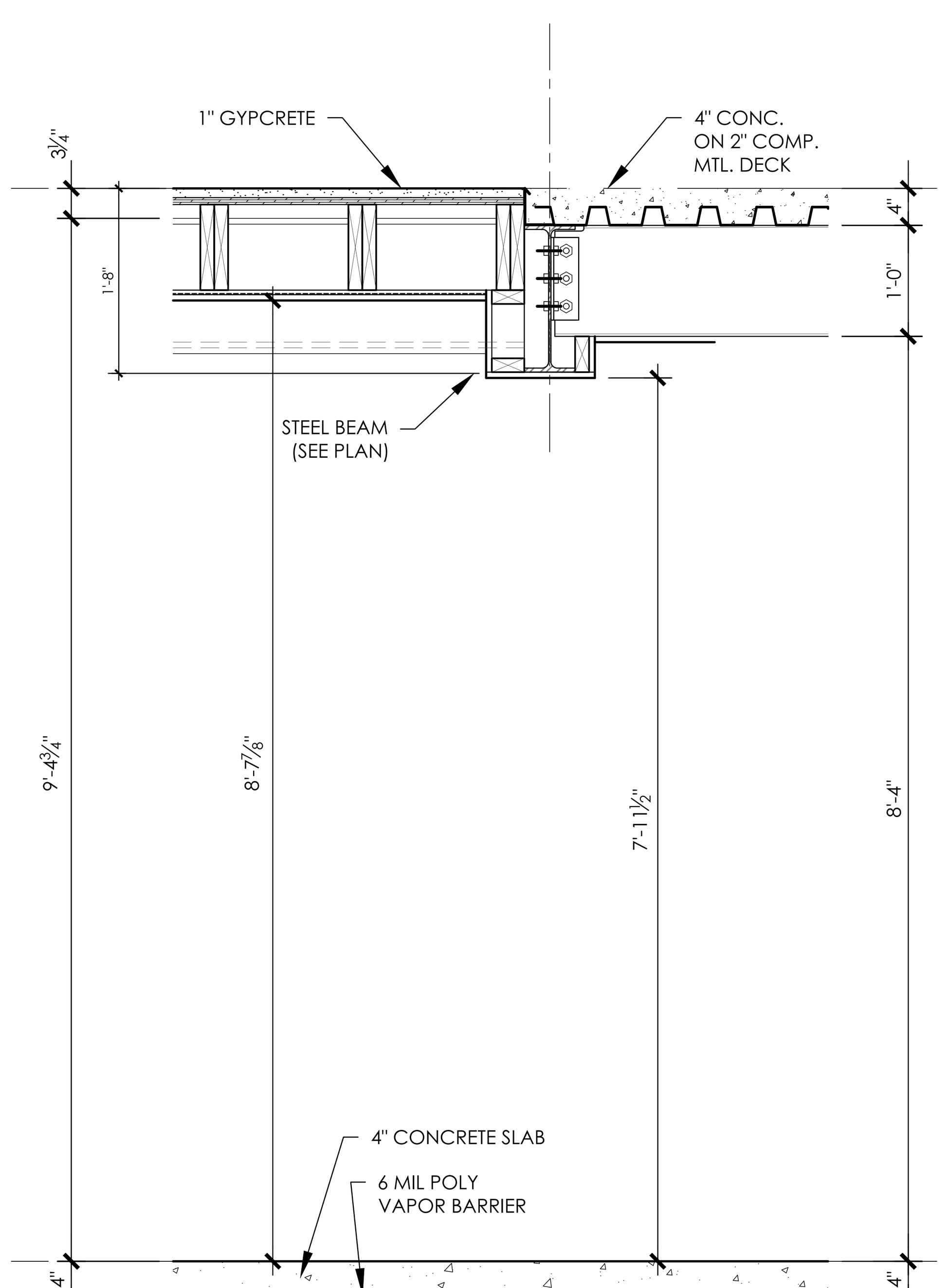
SECTION 1
SCALE: 3/4" = 1'-0" S200



SECTION 2
SCALE: 3/4" = 1'-0" S200

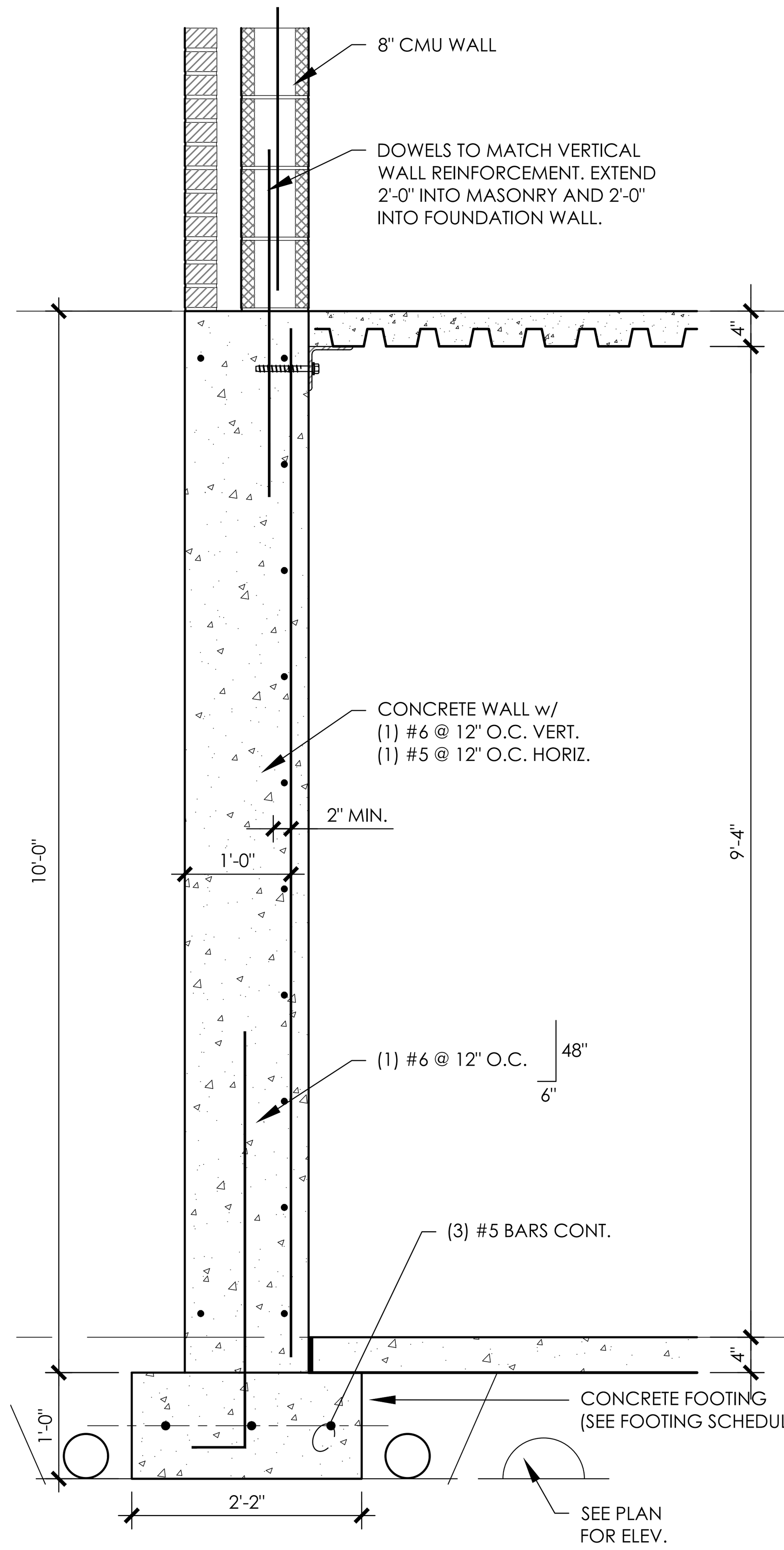


SECTION 3
SCALE: 3/4" = 1'-0" S200

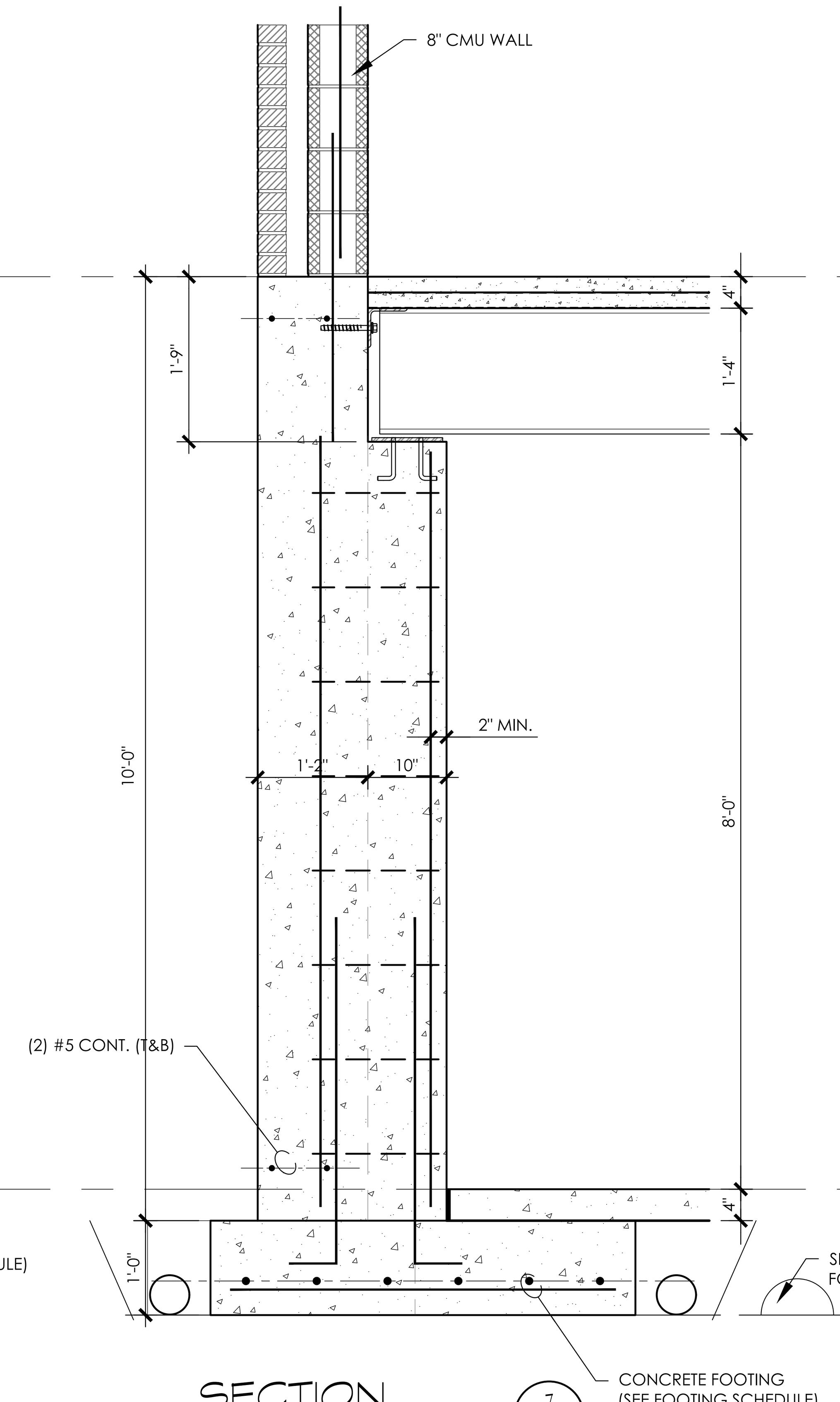


SECTION 4
SCALE: 3/4" = 1'-0" S200

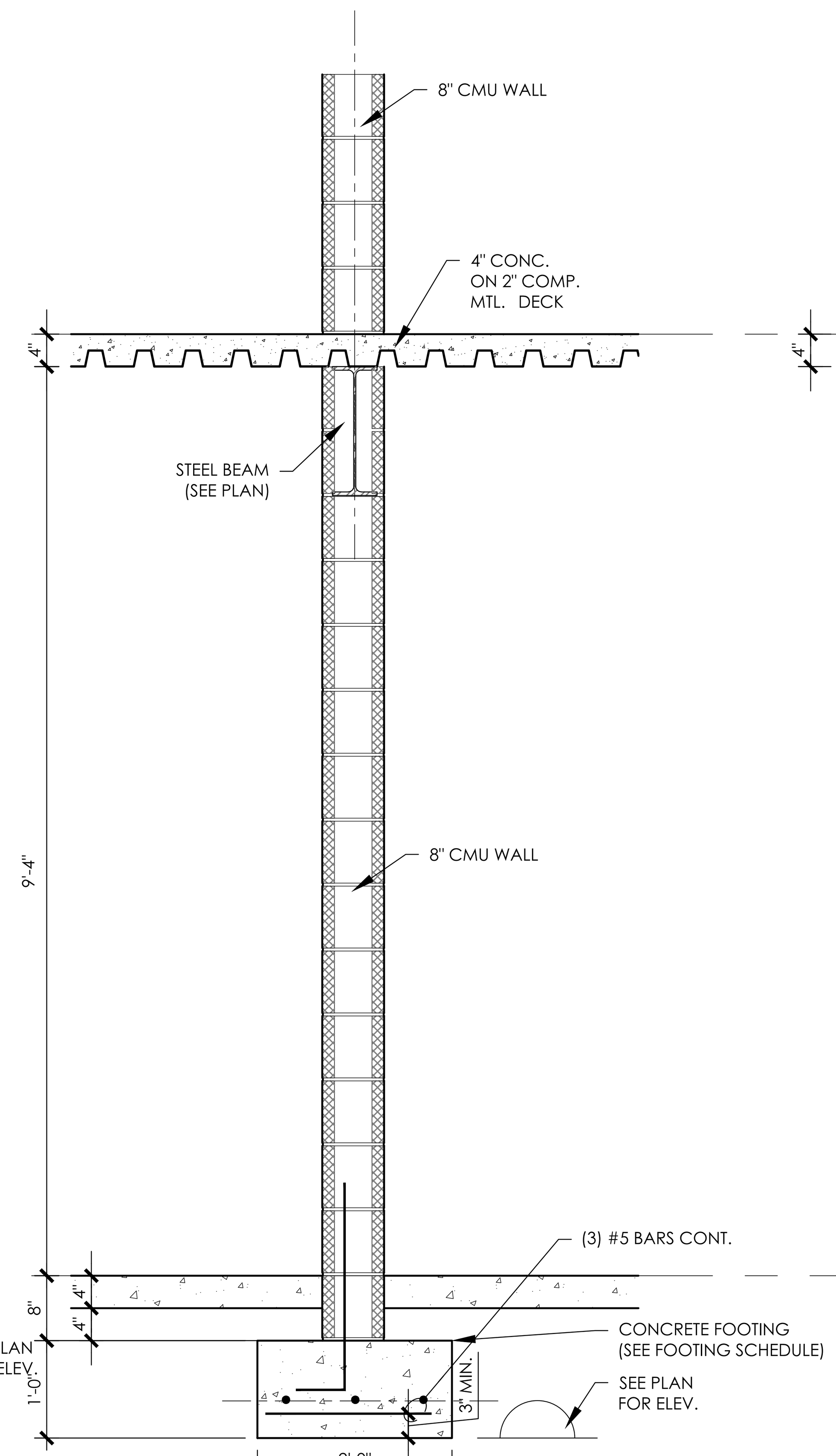
NOT USED 5
SCALE: 3/4" = 1'-0" S200



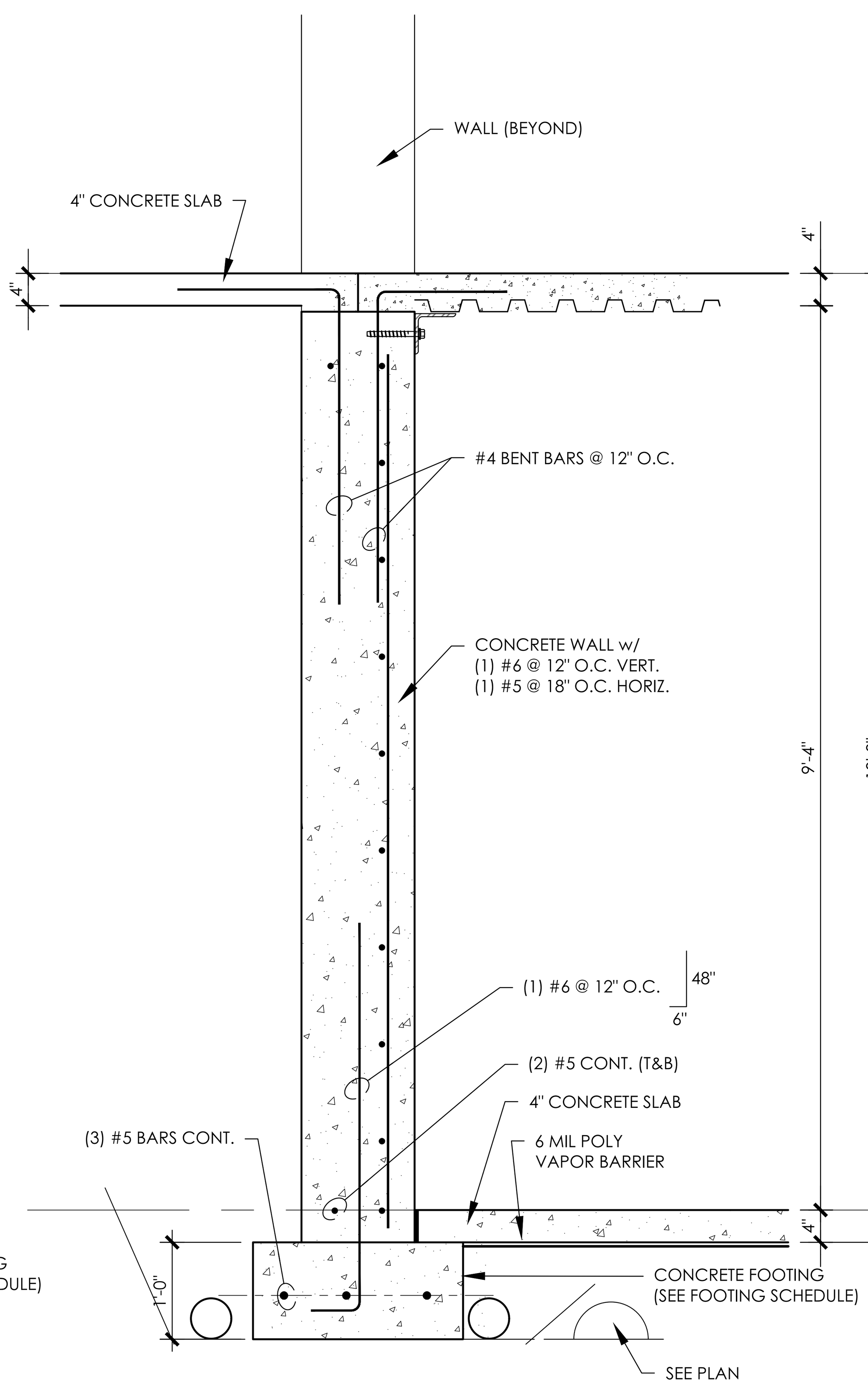
SECTION 6
SCALE: 3/4" = 1'-0" S200



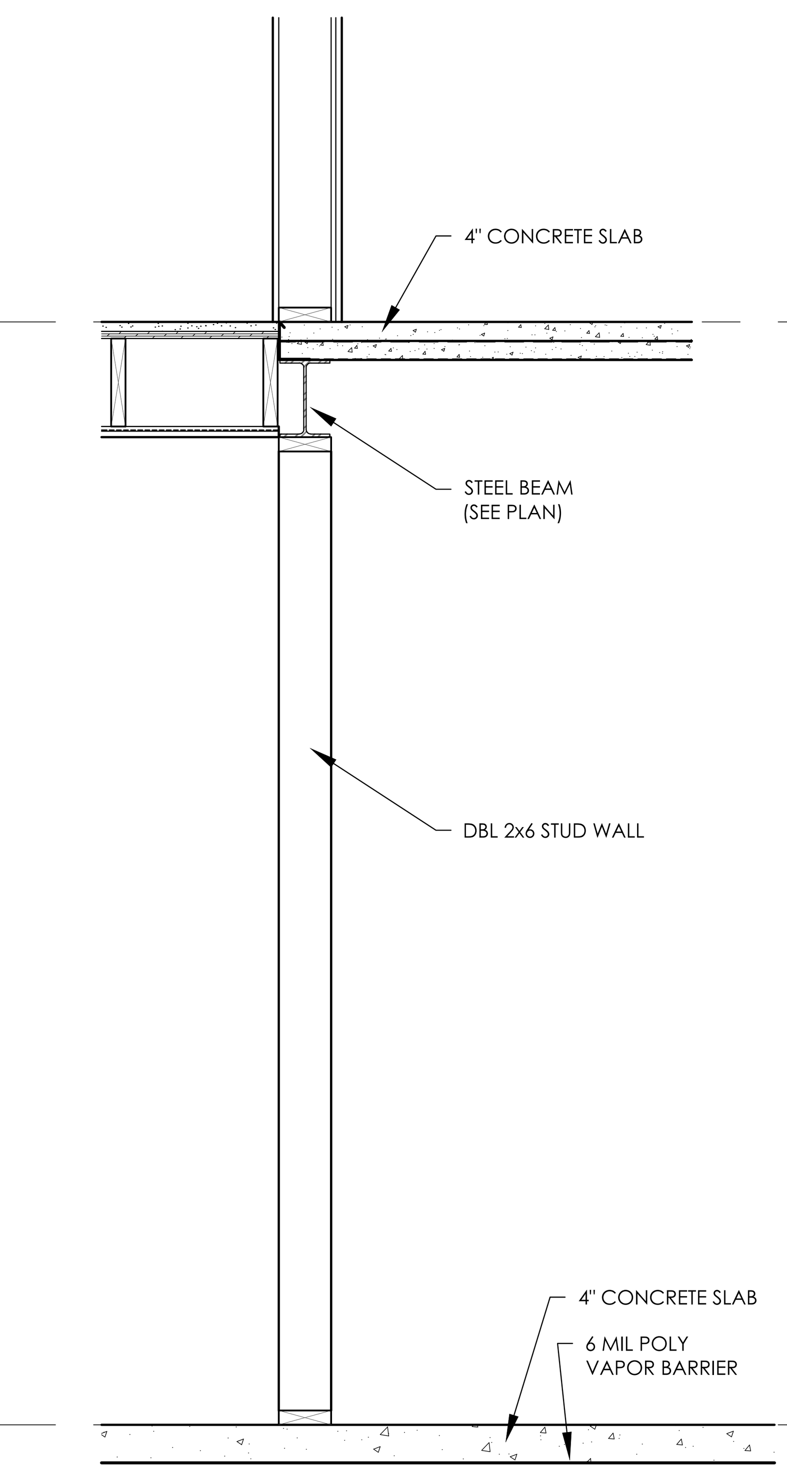
SECTION 7
SCALE: 3/4" = 1'-0" S200



SECTION 8
SCALE: 3/4" = 1'-0" S200



SECTION 9
SCALE: 3/4" = 1'-0" S200



SECTION 10
SCALE: 3/4" = 1'-0" S200

REVISIONS

NO.	DATE	DESCRIPTION
1	2/7/19	BID SET
2	4/5/19	FOUNDATION REVISIONS

NOTICE
Unauthorized Alterations of This Document Are In Violation of Section #7209 of The State Education Law

Project No.
4125

CONSULTANTS:

MECHANICAL ENGINEER
COMPANY
ADDRESS
CITY

STRUCTURAL ENGINEER
COMPANY
ADDRESS
CITY

CIVIL ENGINEER
COMPANY
ADDRESS
CITY

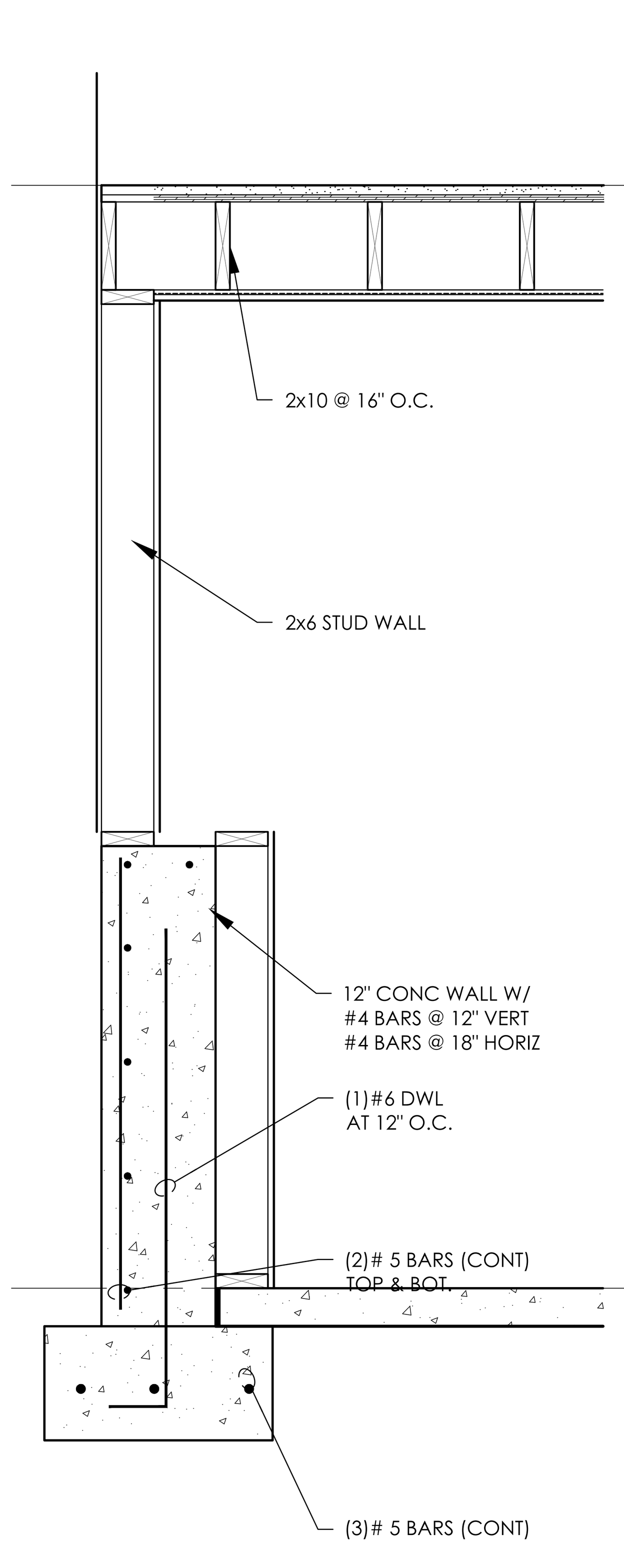
FOUNDATION WALL SECTIONS

CAMPUS WEST
RESIDENTIAL APARTMENT BUILDING
129 WEST AVENUE
******
BUFFALO, NEW YORK 14201

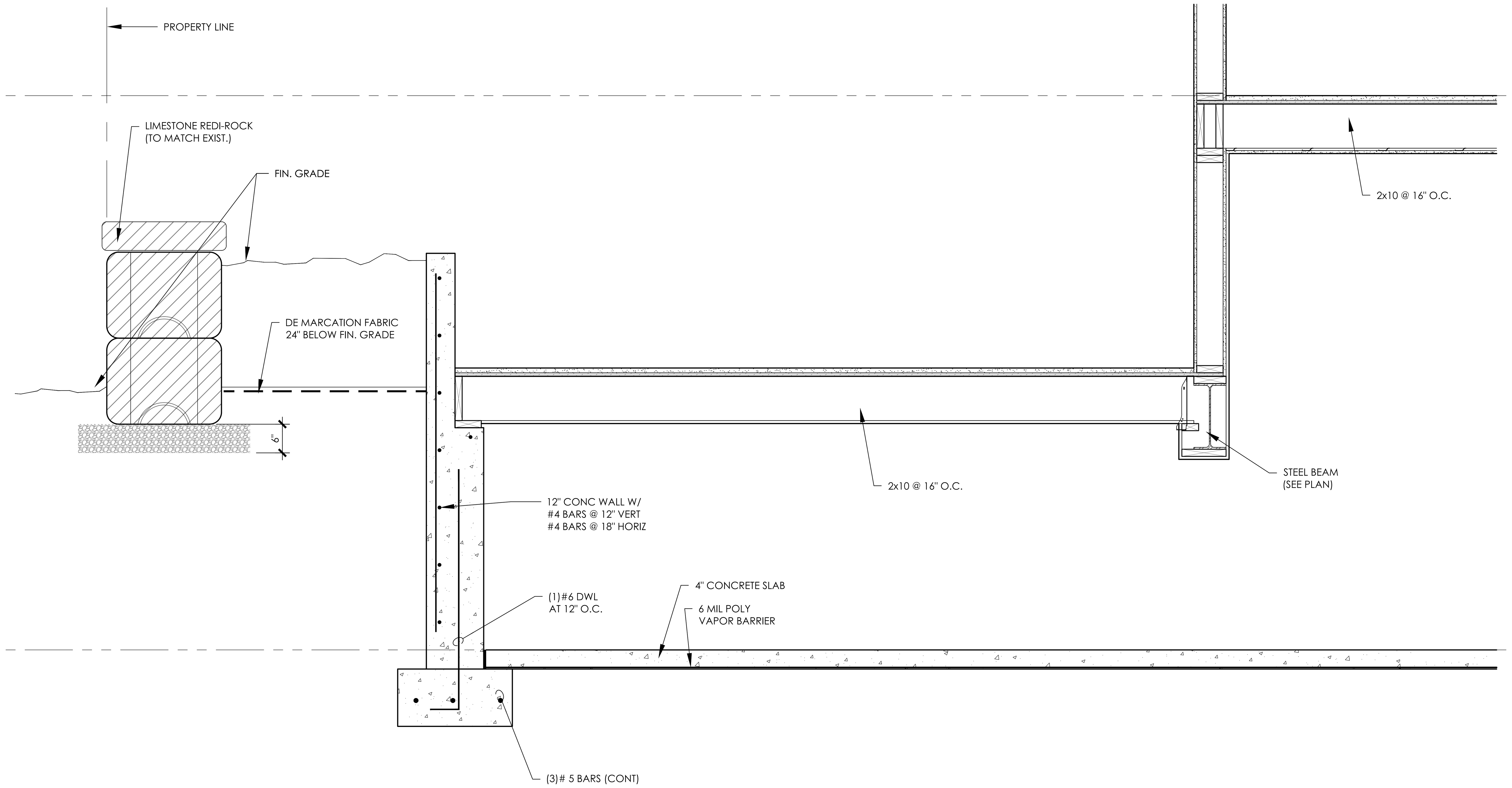
DATE
4/17/2018

DRAWING NO.
S200

DATE PLOTTED: Fri, 05 Apr 2019 - 11:56am
FILE LOCATION: 4125 S2 Foundation Wall Sections_01.dwg



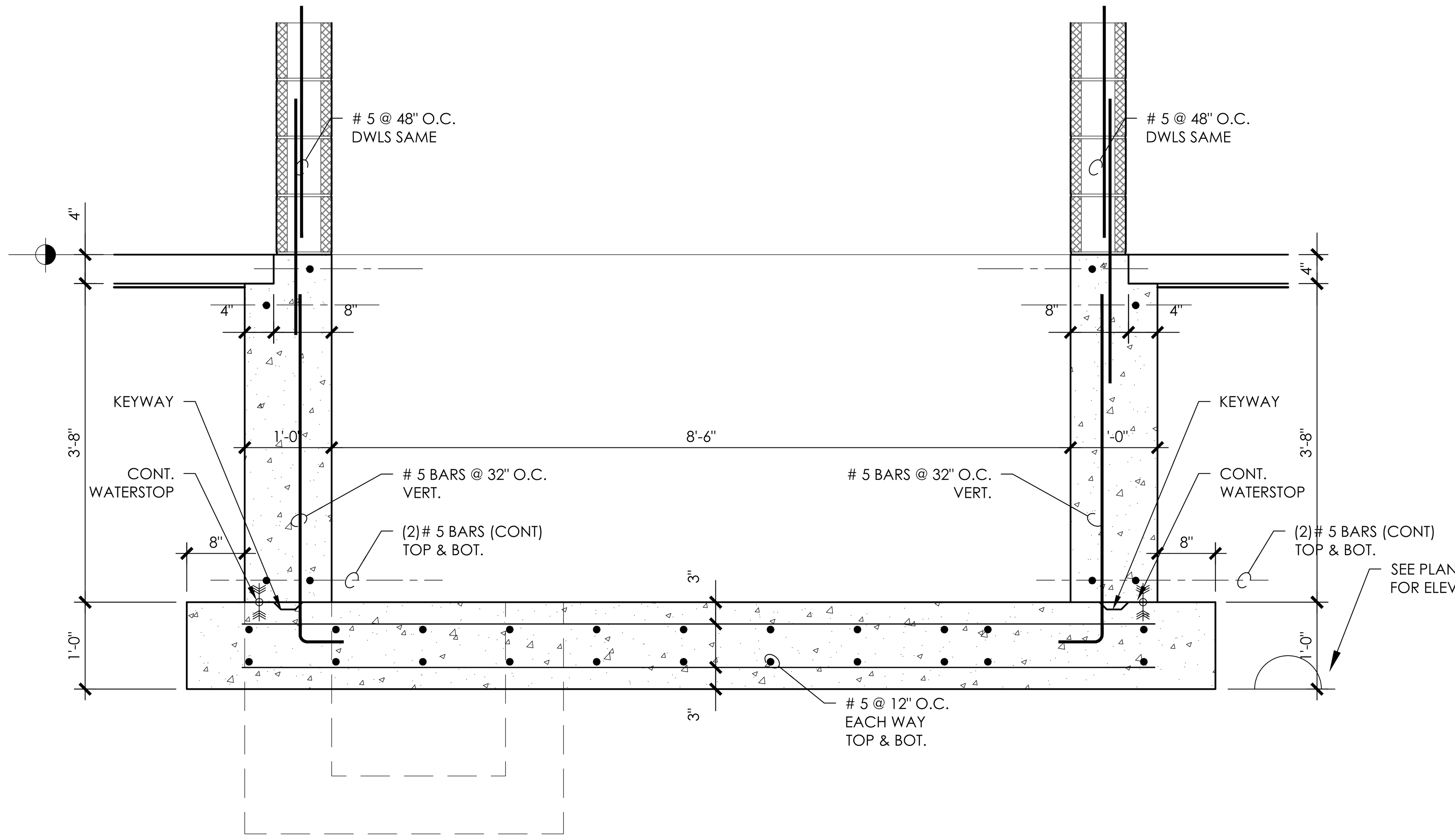
SECTION 1/S201
SCALE: 3/4" = 1'-0"



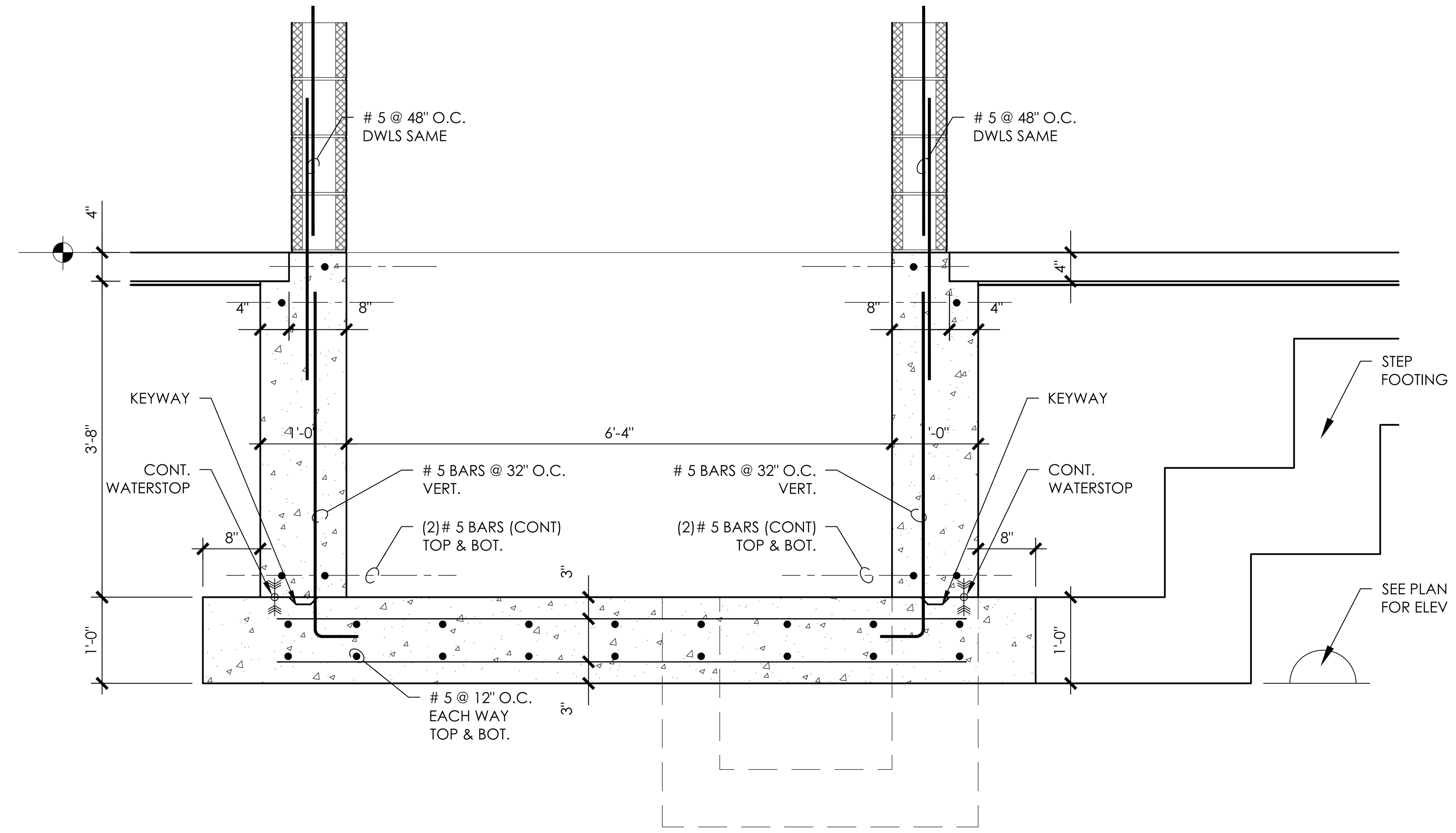
SECTION 2/S201
SCALE: 3/4" = 1'-0"

SECTION 3/S201
SCALE: 3/4" = 1'-0"

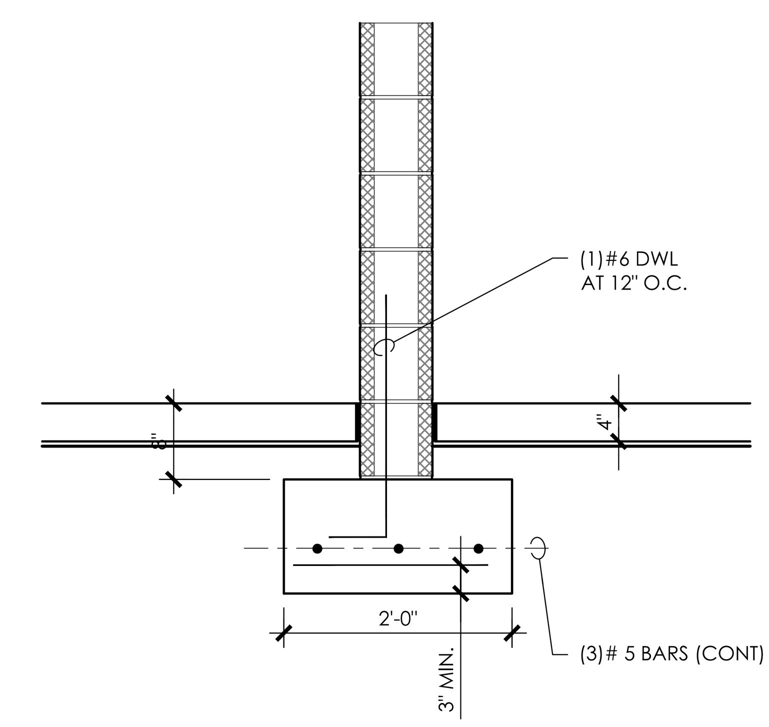
NOT USED 4/S201
SCALE: 3/4" = 1'-0"



SECTION 5/S201
SCALE: 3/4" = 1'-0"



SECTION 6/S201
SCALE: 3/4" = 1'-0"



SECTION 7/S201
SCALE: 3/4" = 1'-0"

DATE PLOTTED: Fri, 05 Apr 2019 - 11:56am
FILE LOCATION: 4125 S2 Foundation Wall Sections_01.dwg

REVISIONS

NO.	DATE	DESCRIPTION
1	2/7/19	BID SET
2	4/5/19	FOUNDATION REVISIONS

Project No.
4125

CONSULTANTS:

MECHANICAL ENGINEER
COMPANY
ADDRESS
CITY

STRUCTURAL ENGINEER
COMPANY
ADDRESS
CITY

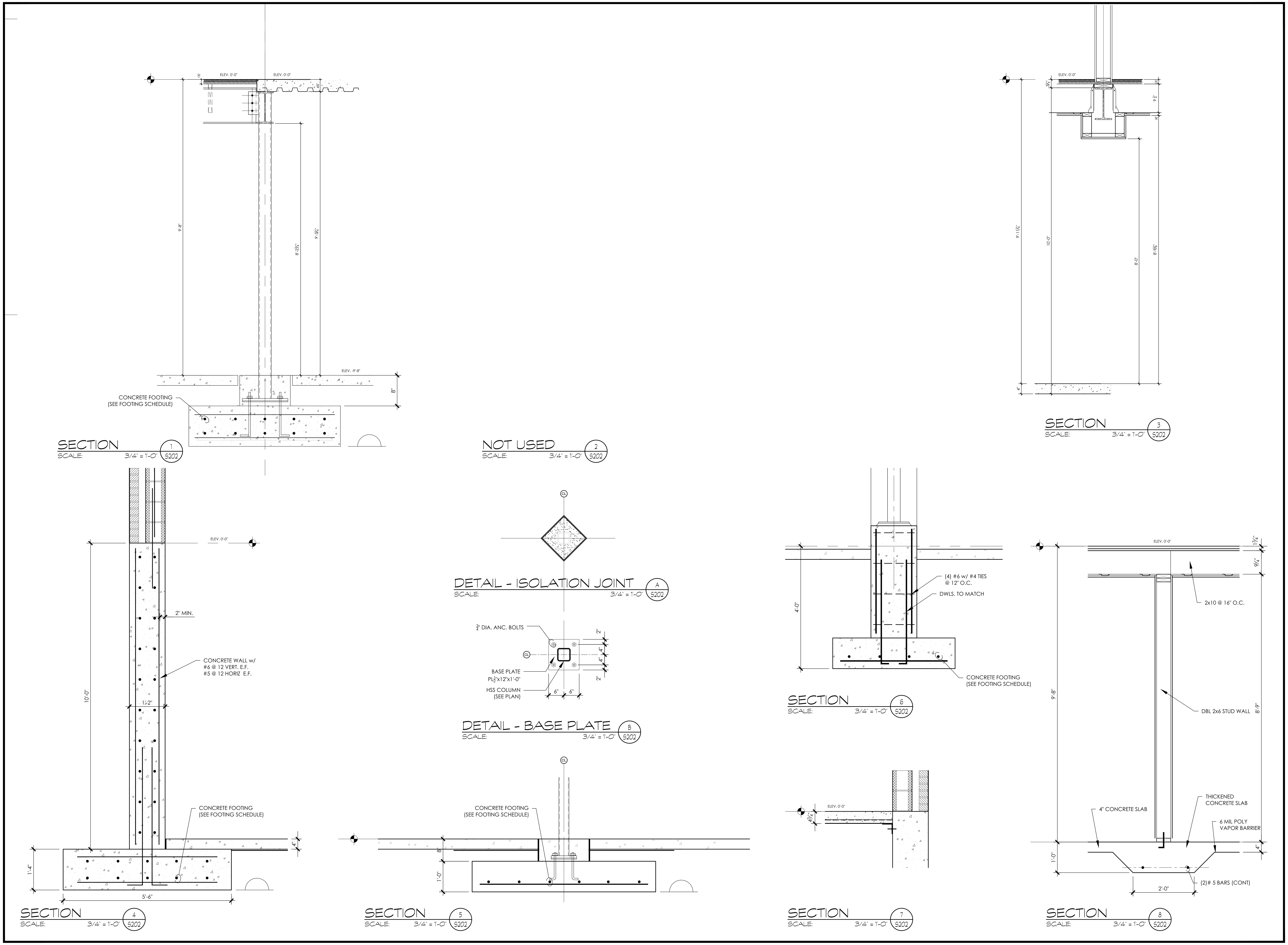
CIVIL ENGINEER
COMPANY
ADDRESS
CITY

FOUNDATION WALL SECTIONS

CAMPUS WEST
RESIDENTIAL APARTMENT BUILDING
129 WEST AVENUE
******
BUFFALO, NEW YORK 14201

DATE
4/17/2018

DRAWING NO.
S201



DATE PLOTTED: Fri, 05 Apr 2019 - 11:56am
FILE LOCATION: 4125 S2 Foundation Wall Sections_01.dwg

REVISIONS

NO.	DATE	DESCRIPTION
1	2/7/19	BID SET
2	4/5/19	FOUNDATION REVISIONS

NOTICE
Unauthorized Alterations of This Document Are In Violation of Section #7209 of The State Education Law

Project No.
4125

CONSULTANTS:

MECHANICAL ENGINEER
COMPANY
ADDRESS
CITY

STRUCTURAL ENGINEER
COMPANY
ADDRESS
CITY

CIVIL ENGINEER
COMPANY
ADDRESS
CITY

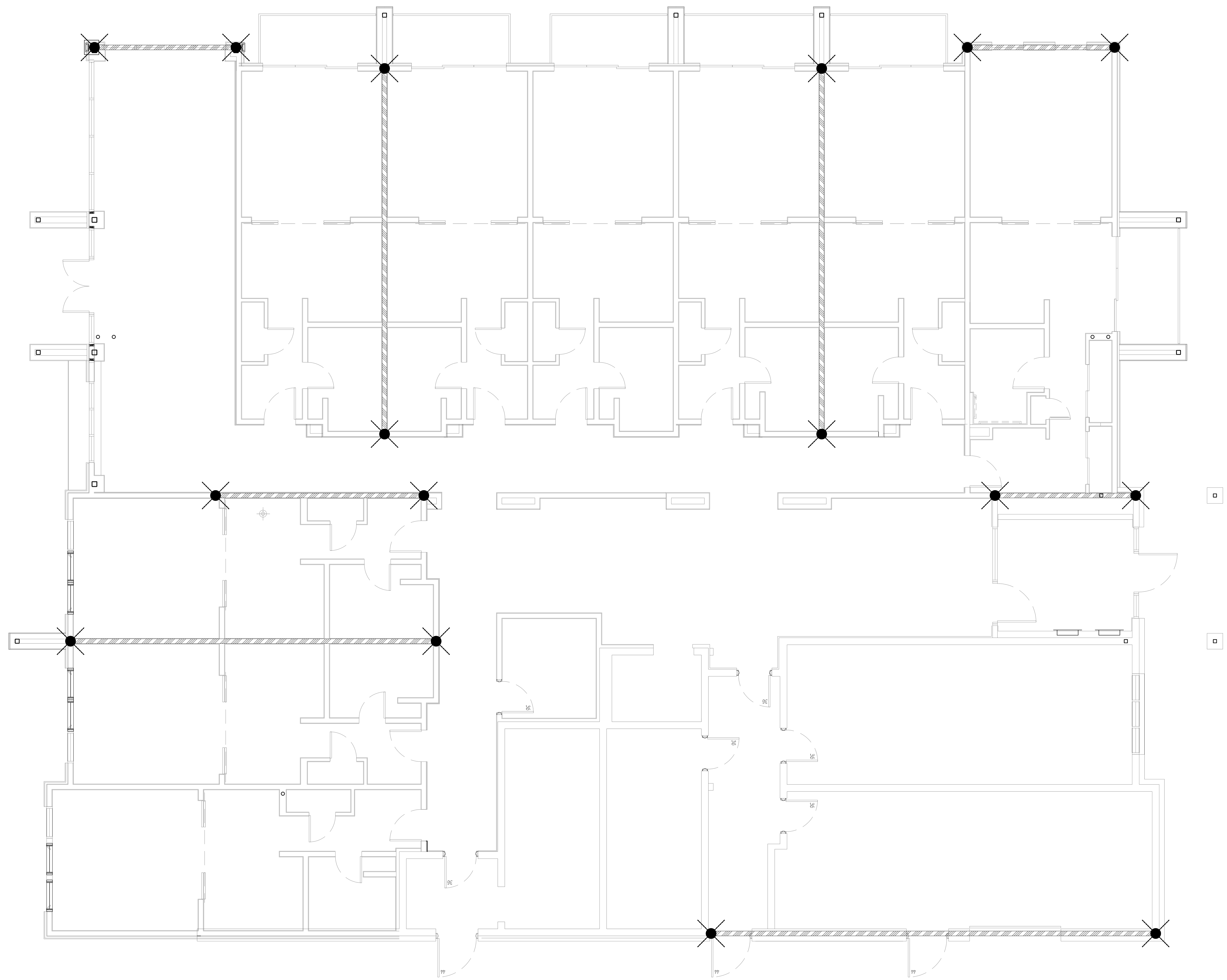
FOUNDATION WALL SECTIONS

CAMPUS WEST
RESIDENTIAL APARTMENT BUILDING
129 WEST AVENUE
******
BUFFALO, NEW YORK 14201

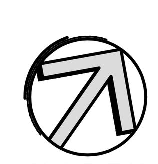
DATE
4/17/2018

DRAWING NO.
S202

DATE PLOTTED: Fri, 05 Apr 2019 - 11:57am FILE LOCATION: 4125 S3 Shear Wall Plans_01.dwg



FIRST FLOOR SHEAR WALL PLAN
SCALE: 3/16" = 1'-0"
1
S301



SHEAR WALL

SHEAR WALL TIE DOWN LOCATION

SHEAR WALL NOTES

1) SHEAR WALLS - FIRST FLOOR
$\frac{15}{32}$" APA RATED SHEATHING ON ONE SIDE WITH 8D NAILS AT 3" O.C. WITH ALL EDGES BLOCKED

2) SHEAR WALLS - UPPER FLOORS
$\frac{7}{16}$" APA RATED SHEATHING ON ONE SIDE WITH 8D NAILS AT 4" O.C.

3) PROVIDE (3) 2x6 AT EACH END OF EACH SHEAR WALL

4) PROVIDE SIMPSON HDU14-SDS2.5 AT EACH END OF EACH SHEAR WALL FOR FIRST FLOOR TIE DOWNS

4) PROVIDE SIMPSON MST60 AT EACH END OF EACH SHEAR WALL FOR ALL FLOOR TO FLOOR TIE DOWNS

REVISIONS

NO.	DATE	DESCRIPTION
1	2/7/19	BID SET
2	4/5/19	FOUNDATION REVISIONS

Project No.
4125

CONSULTANTS:

MECHANICAL ENGINEER
COMPANY
ADDRESS
CITY

STRUCTURAL ENGINEER
COMPANY
ADDRESS
CITY

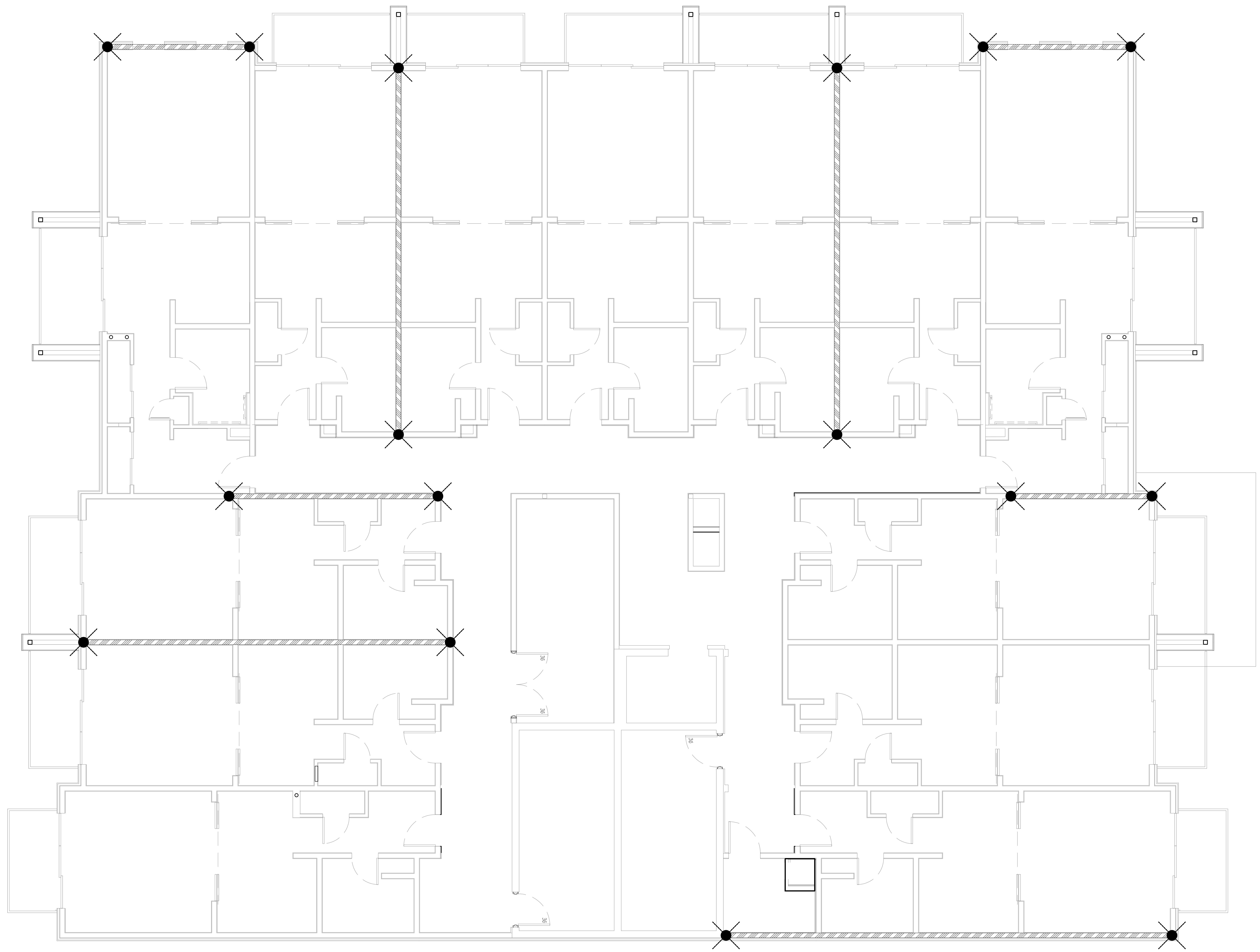
CIVIL ENGINEER
COMPANY
ADDRESS
CITY

FIRST FLOOR SHEAR WALL PLAN

CAMPUS WEST
RESIDENTIAL APARTMENT BUILDING
129 WEST AVENUE
******
BUFFALO, NEW YORK 14201

DATE
4/17/2018

DRAWING NO.
S301



SECOND FLOOR SHEAR WALL PLAN 1/S302
SCALE: 3/16" = 1'-0"

NORTH

NO.	DATE	DESCRIPTION
1	2/7/19	BID SET
2	4/5/19	FOUNDATION REVISIONS

REVISIONS

Project No.
4125

CONSULTANTS:

MECHANICAL ENGINEER
COMPANY
ADDRESS
CITY

STRUCTURAL ENGINEER
COMPANY
ADDRESS
CITY

CIVIL ENGINEER
COMPANY
ADDRESS
CITY

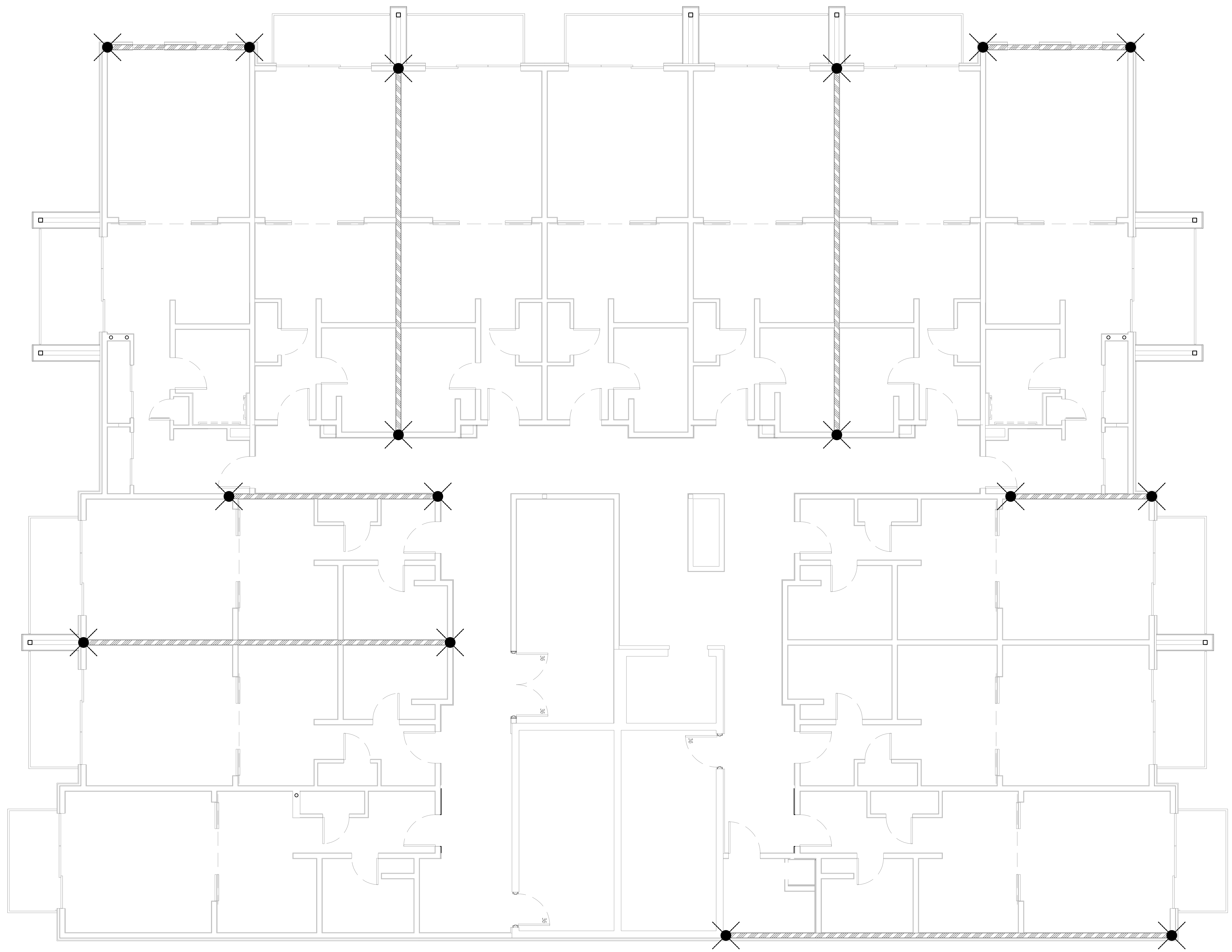
SECOND FLOOR SHEAR WALL PLAN

CAMPUS WEST
RESIDENTIAL APARTMENT BUILDING
129 WEST AVENUE
******
BUFFALO, NEW YORK 14201

DATE
4/17/2018

DRAWING NO.
S302

DATE PLOTTED: Fri, 05 Apr 2019 - 11:57am
FILE LOCATION: 4125 S3 Shear Wall Plans_01.dwg



THIRD FLOOR SHEAR WALL PLAN 1/S303
SCALE: 3/16" = 1'-0"

DATE PLOTTED: Fri, 05 Apr 2019 - 11:57am
FILE LOCATION: 4125 S3 Shear Wall Plans_01.dwg

REVISIONS

NO.	DATE	DESCRIPTION
1	2/7/19	BID SET
2	4/5/19	FOUNDATION REVISIONS

Project No.
4125

CONSULTANTS:

MECHANICAL ENGINEER
COMPANY
ADDRESS
CITY

STRUCTURAL ENGINEER
COMPANY
ADDRESS
CITY

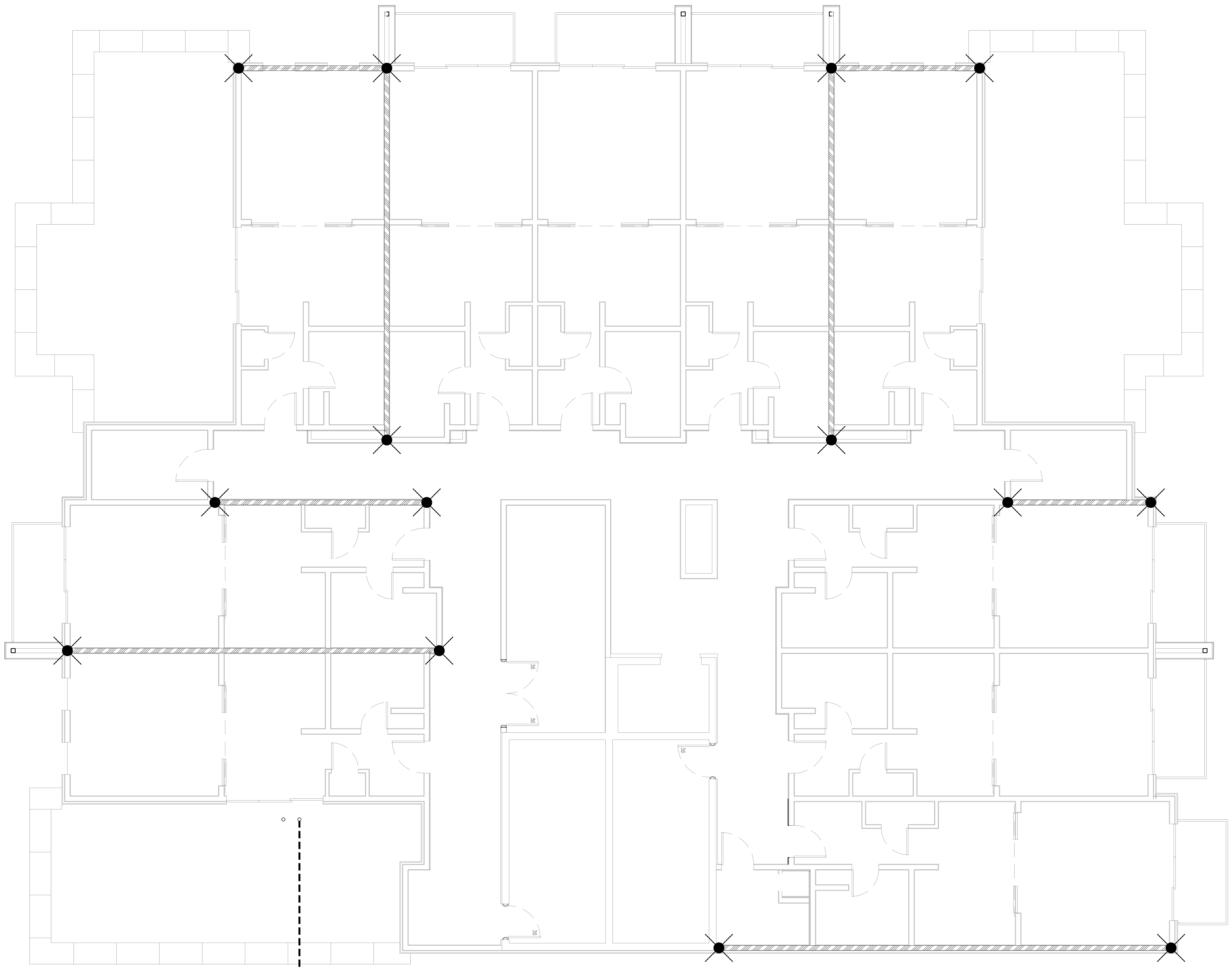
CIVIL ENGINEER
COMPANY
ADDRESS
CITY

THIRD FLOOR SHEAR WALL PLAN

CAMPUS WEST
RESIDENTIAL APARTMENT BUILDING
129 WEST AVENUE
******
BUFFALO, NEW YORK 14201

DATE
4/17/2018

DRAWING NO.
S303



FOURTH FLOOR SHEAR WALL PLAN (1/S304)
SCALE: 3/16" = 1'-0"

NORTH

DATE PLOTTED: Fri, 05 Apr 2019 - 11:57am
FILE LOCATION: 4125 S3 Shear Wall Plans_01.dwg

REVISIONS

NO.	DATE	DESCRIPTION
1	2/7/19	BID SET
2	4/5/19	FOUNDATION REVISIONS

NOTICE
Unauthorized Alterations of This Document Are In Violation of Section #7209 of The State Education Law

Project No.
4125

CONSULTANTS:

MECHANICAL ENGINEER
COMPANY
ADDRESS
CITY

STRUCTURAL ENGINEER
COMPANY
ADDRESS
CITY

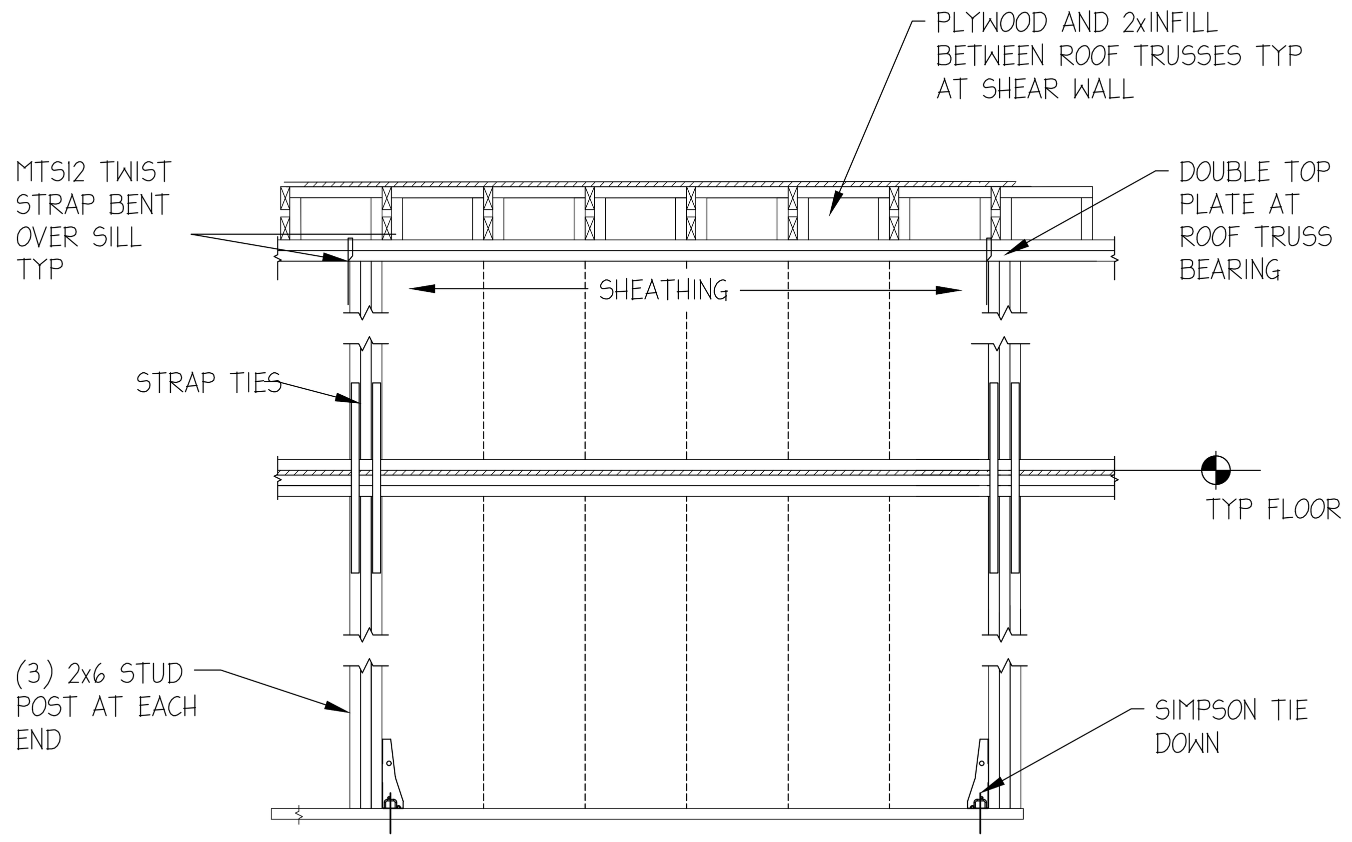
CIVIL ENGINEER
COMPANY
ADDRESS
CITY

FOURTH FLOOR SHEAR WALL PLAN

CAMPUS WEST
RESIDENTIAL APARTMENT BUILDING
129 WEST AVENUE
******
BUFFALO, NEW YORK 14201

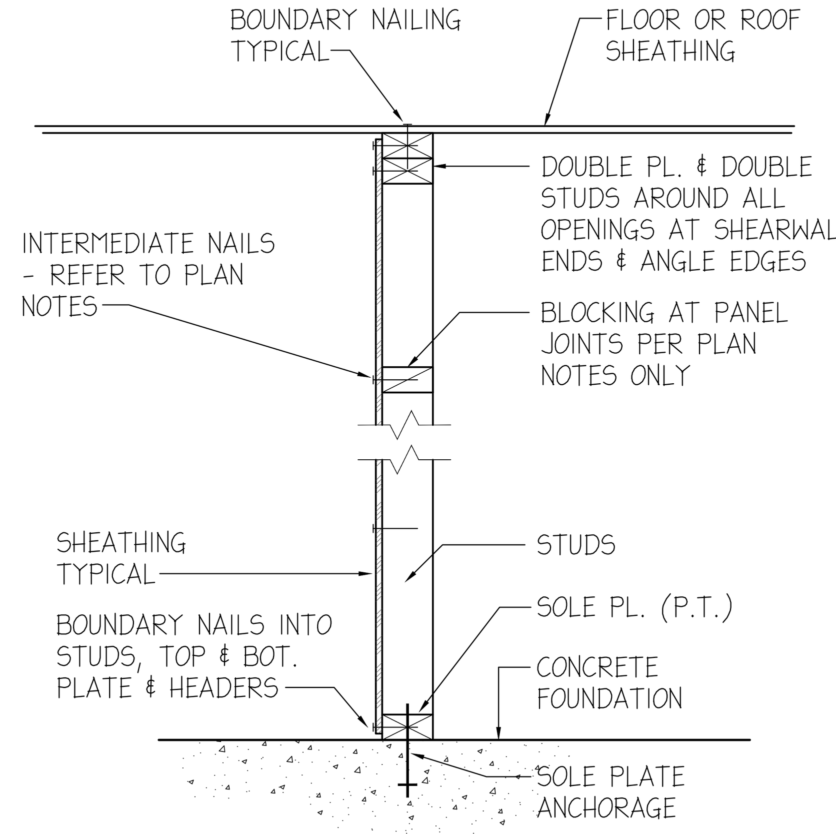
DATE
4/17/2018

DRAWING NO.
S304



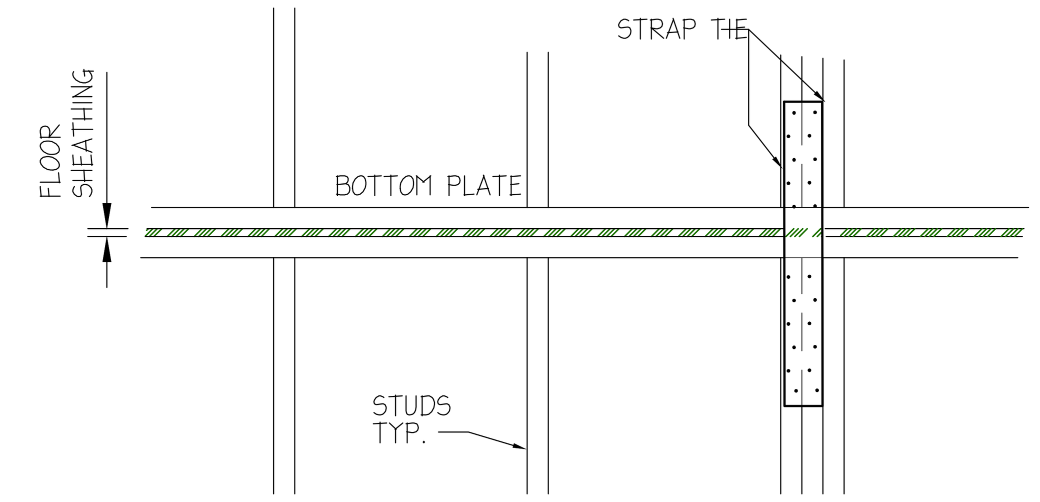
TYP. SHEAR WALL ELEVATION (1 / S401)

SCALE: NTS' = 1-0'



TYP. SHEAR WALL SECTION (2 / S401)

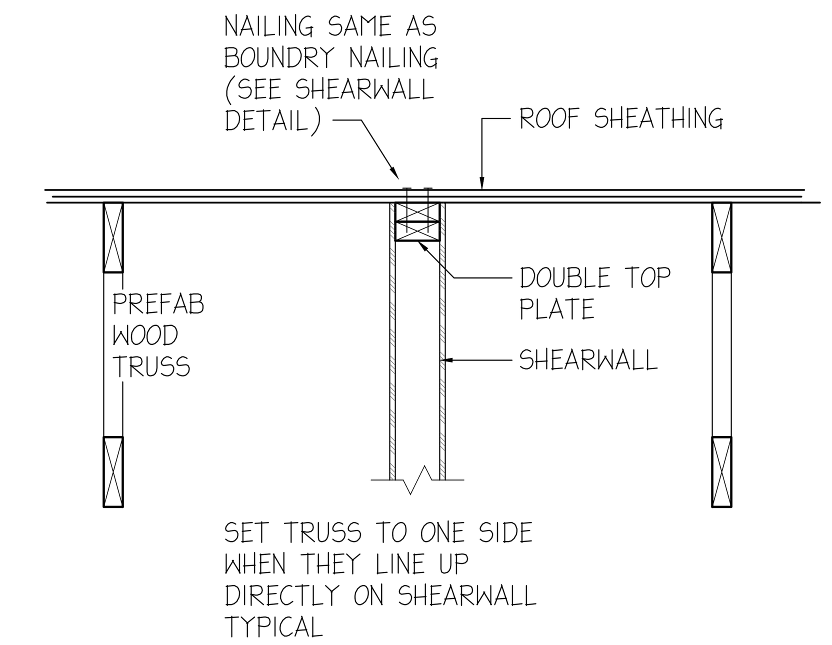
SCALE: NTS' = 1-0'



TYP. TIE DOWN BETWEEN FLOORS (3 / S401)

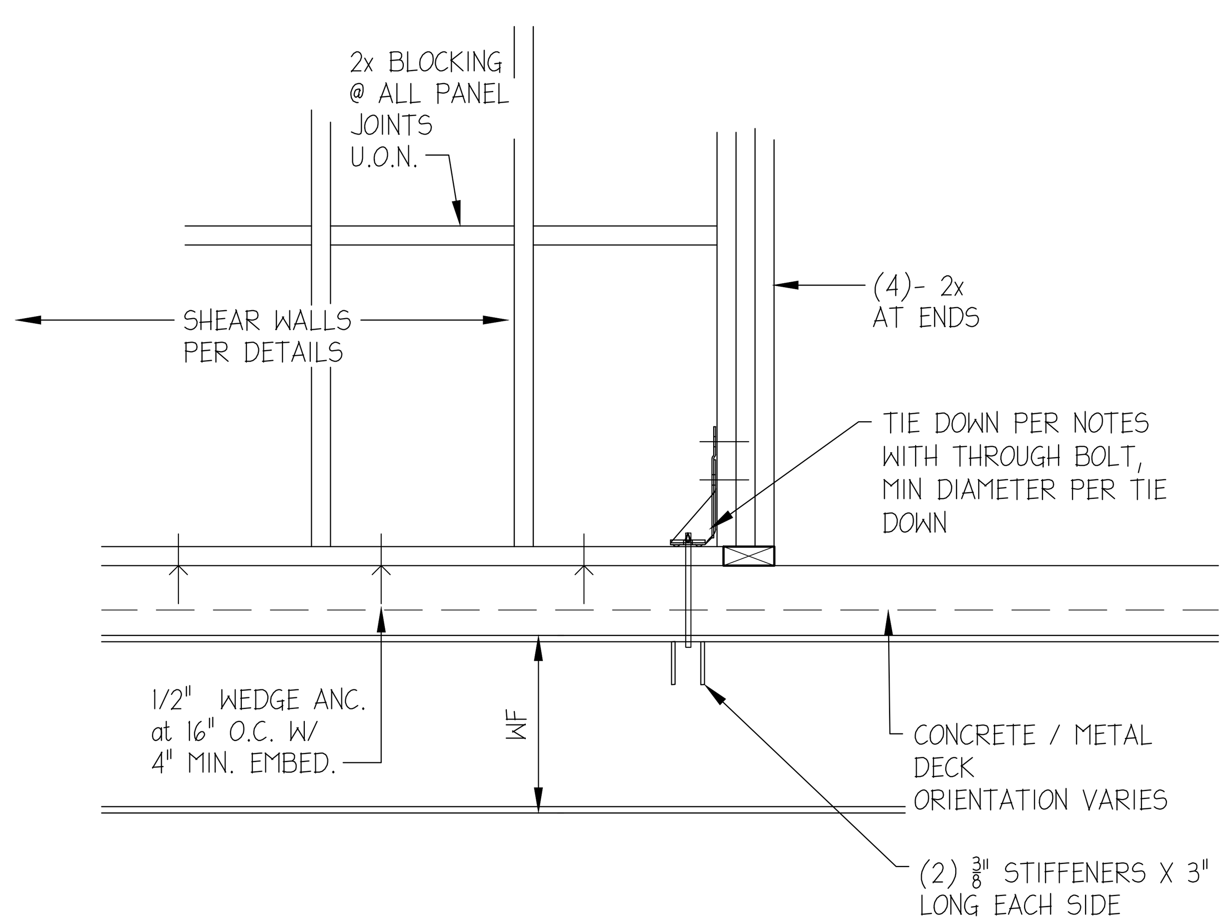
SCALE: NTS' = 1-0'

@ SHEAR WALL ENDS



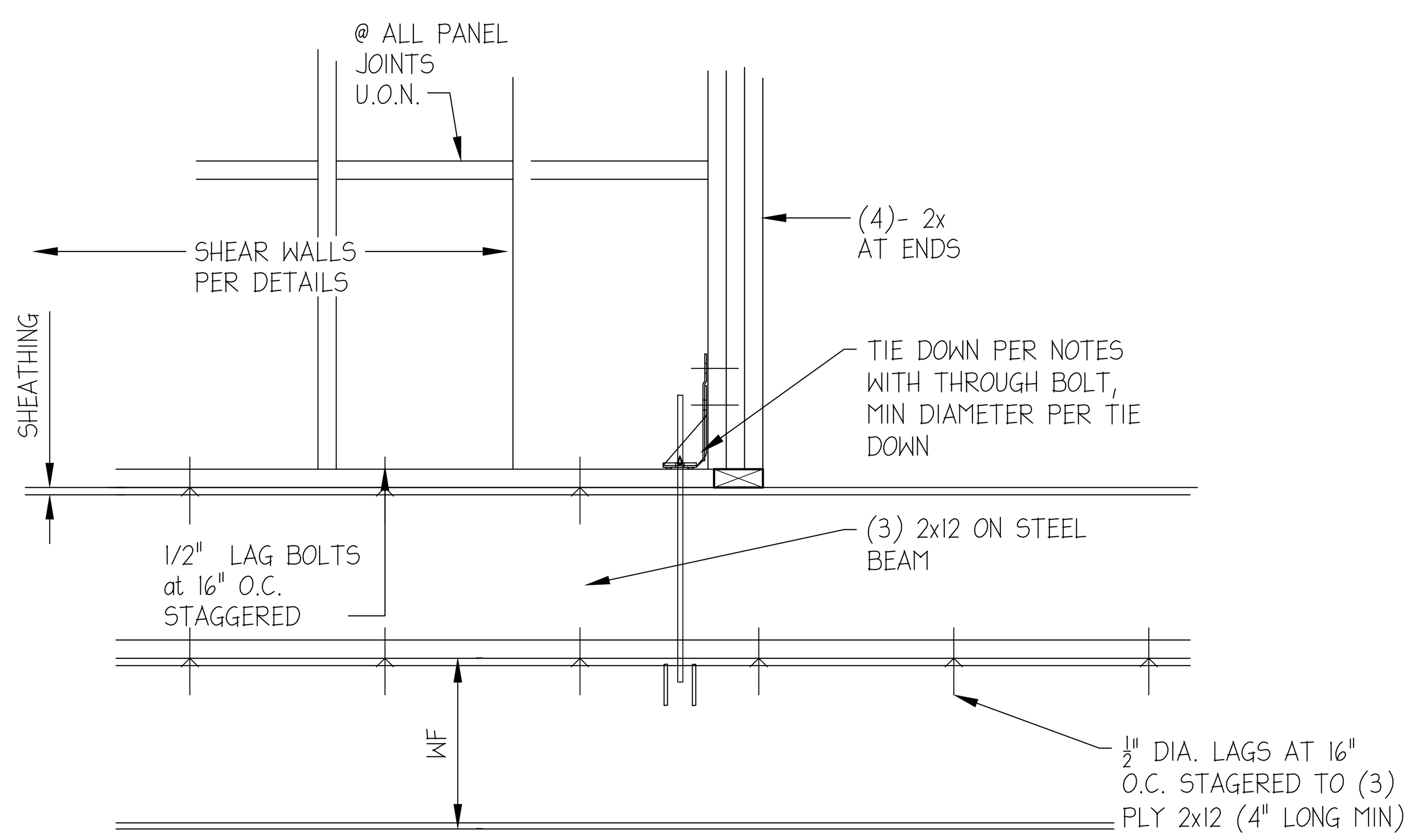
TYP. SHEAR WALL TO ROOF (4 / S401)

SCALE: NTS' = 1-0'



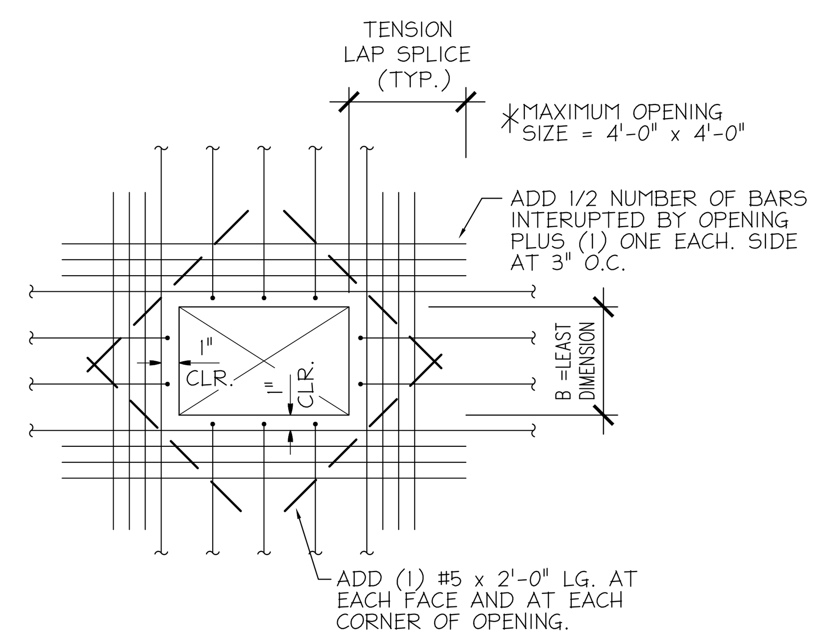
TYP. SHEAR WALL ON CONC. DECK (4 / S401)

SCALE: NTS' = 1-0'



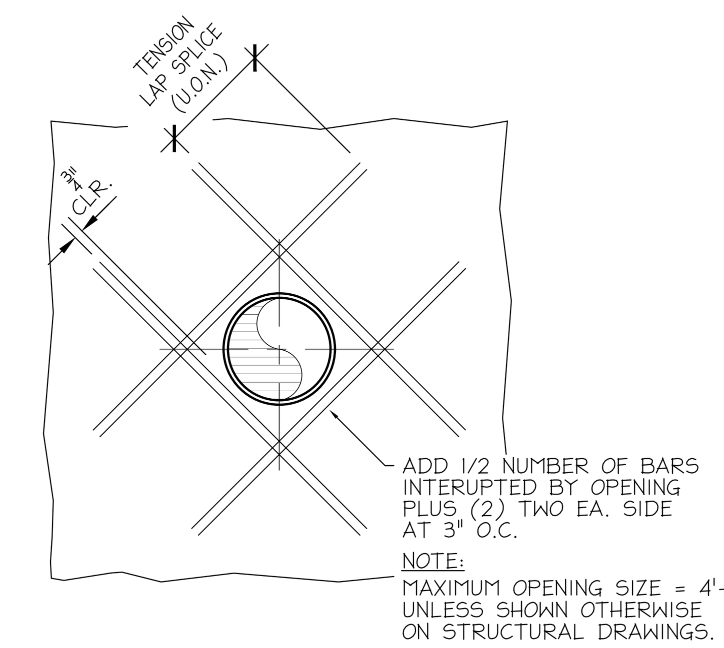
TYP. SHEAR WALL ONSTEEL BEAM (5 / S401)

SCALE: NTS' = 1-0'



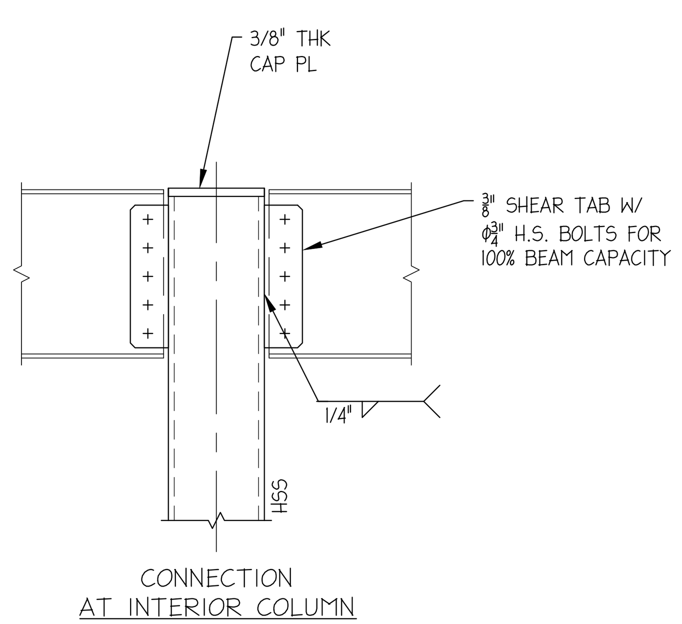
TYP. WALL OPENING (6 / S401)

SCALE: NTS' = 1-0'



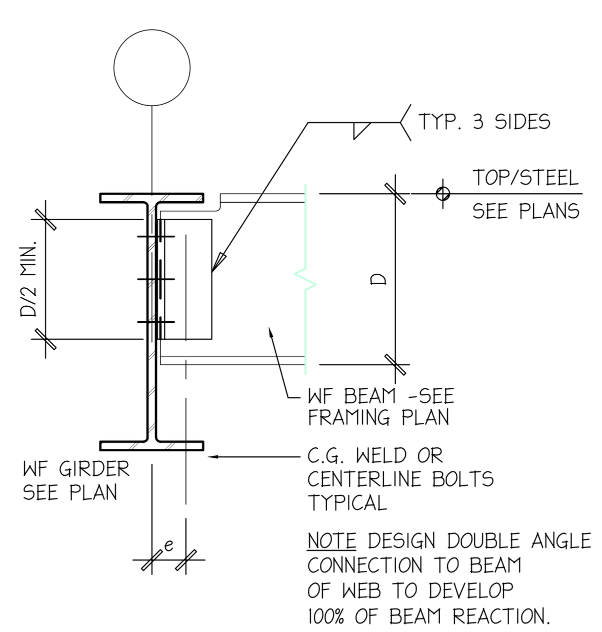
TYP. CIRCULAR WALL OPENING (7 / S401)

SCALE: NTS' = 1-0'



BEAM TO COLUMN CONNECTION (8 / S401)

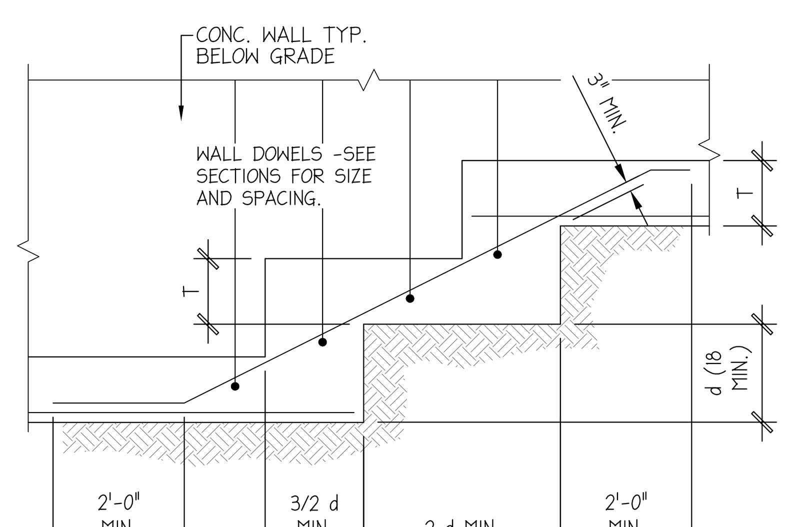
SCALE: NTS' = 1-0'



TYP. FRAMED

BEAM CONNECTION DETAIL (9 / S401)

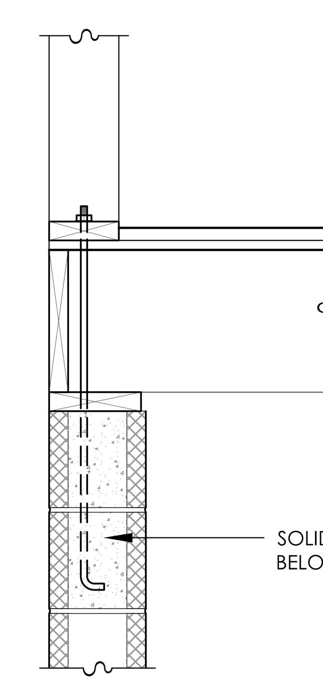
SCALE: NTS' = 1-0'



TYP. STEPPED

WALL FOOTING DETAIL (10 / S401)

SCALE: NTS' = 1-0'



CMU WALL

SHEAR WALL CONNECTION (10 / S401)

SCALE: NTS' = 1-0'

REVISIONS

NO.	DATE	DESCRIPTION
1	2/7/19	BID SET
2	4/5/19	FOUNDATION REVISIONS

NOTICE

Project No. 4125

CONSULTANTS:

MECHANICAL ENGINEER
COMPANY
ADDRESS
CITY

STRUCTURAL ENGINEER
COMPANY
ADDRESS
CITY

CIVIL ENGINEER
COMPANY
ADDRESS
CITY

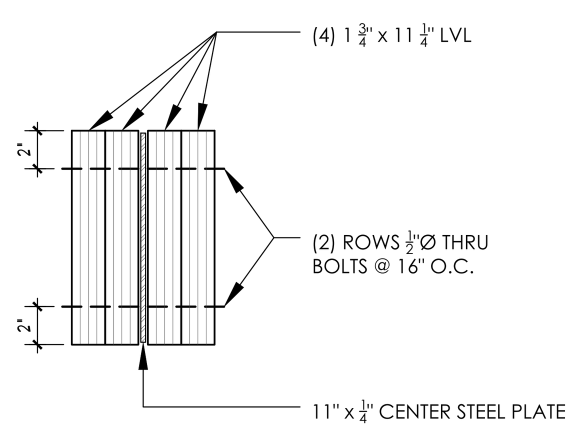
SHEAR WALL AND FOUNDATION WALL DETAILS

CAMPUS WEST
RESIDENTIAL APARTMENT BUILDING
129 WEST AVENUE
******
BUFFALO, NEW YORK 14201

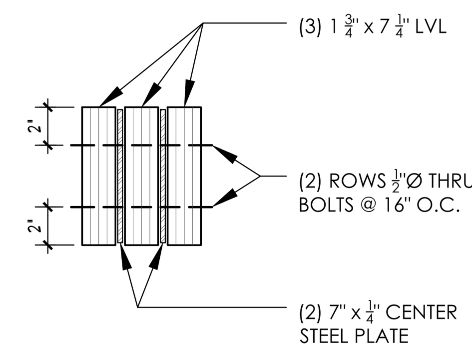
DATE 4/17/2018

DRAWING NO. S401

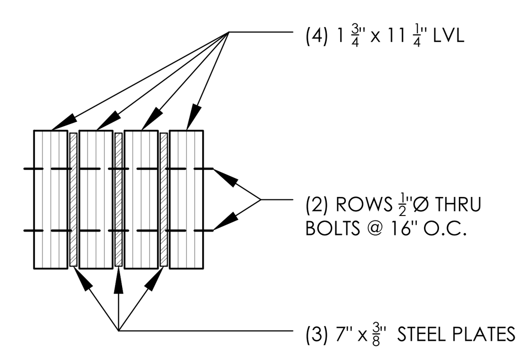
DATE PLOTTED: Fri, 05 Apr 2019 - 11:56am FILE LOCATION: 4125 S4 Structural Details_01.dwg



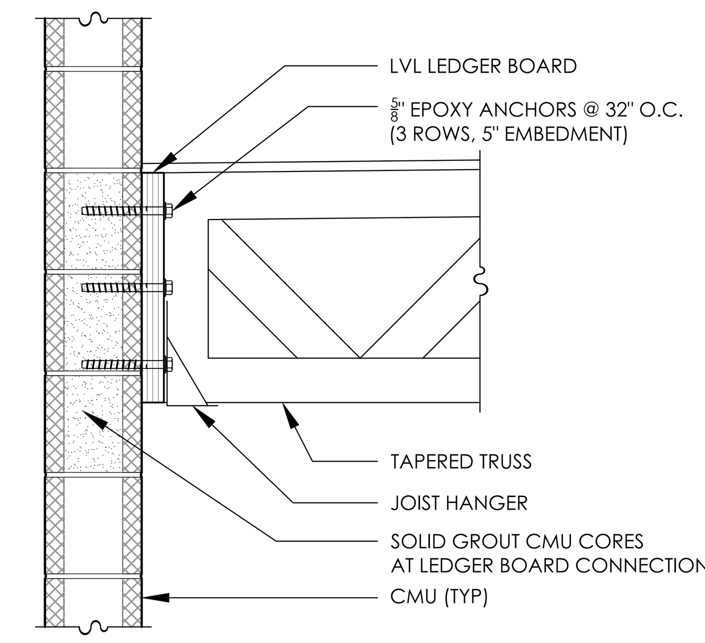
FLUSH BEAM (FB-1) 1 S402
SCALE: 1 1/2" = 1'-0"



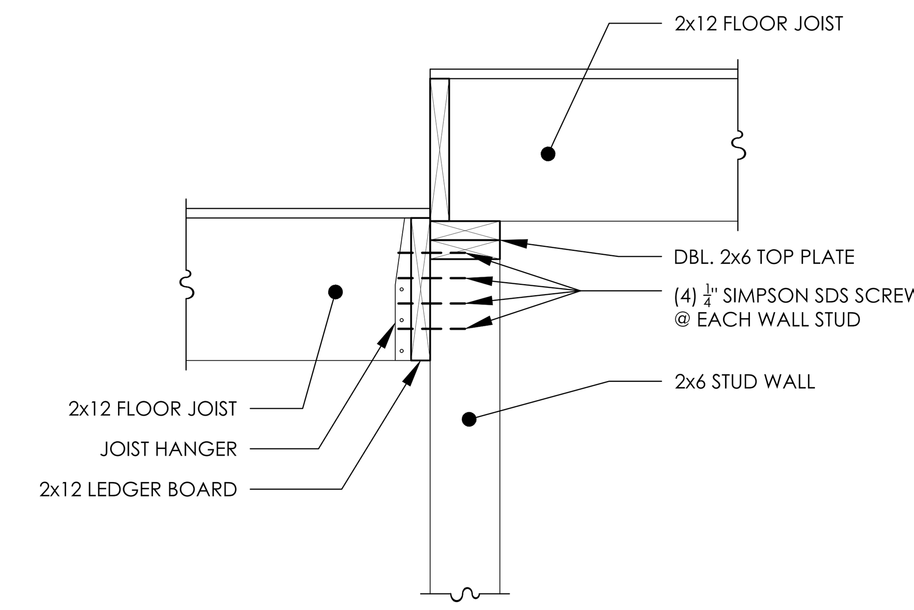
FLUSH BEAM (FB-2) 2 S402
SCALE: 1 1/2" = 1'-0"



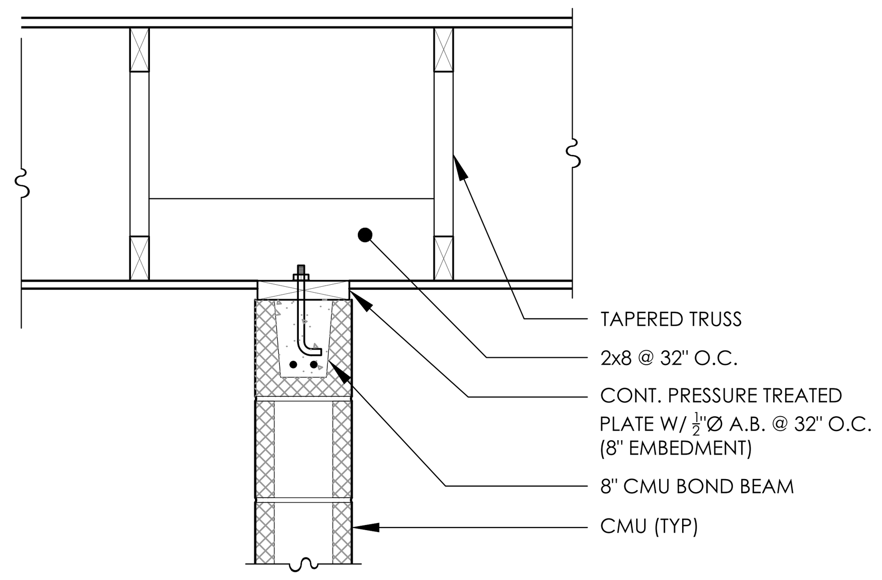
FLUSH BEAM (FB-3) 3 S402
SCALE: 1 1/2" = 1'-0"



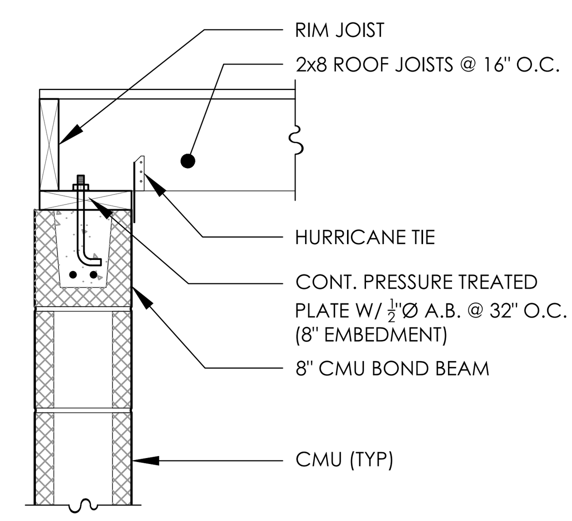
TRUSS LEDGER BOARD 4 S402
SCALE: 1" = 1'-0"



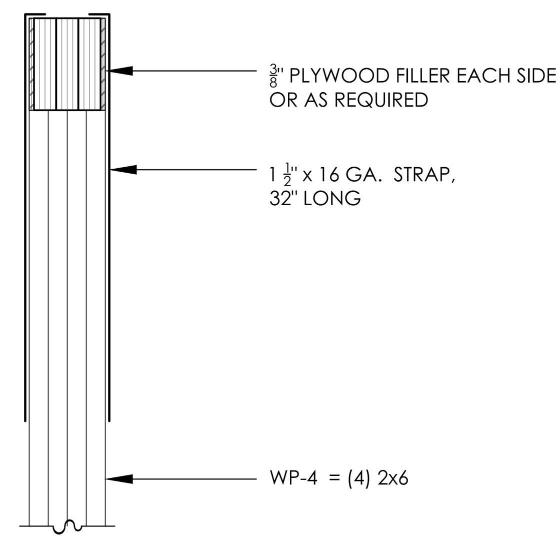
FLOOR LEVEL CHANGE 5 S402
SCALE: 1" = 1'-0"



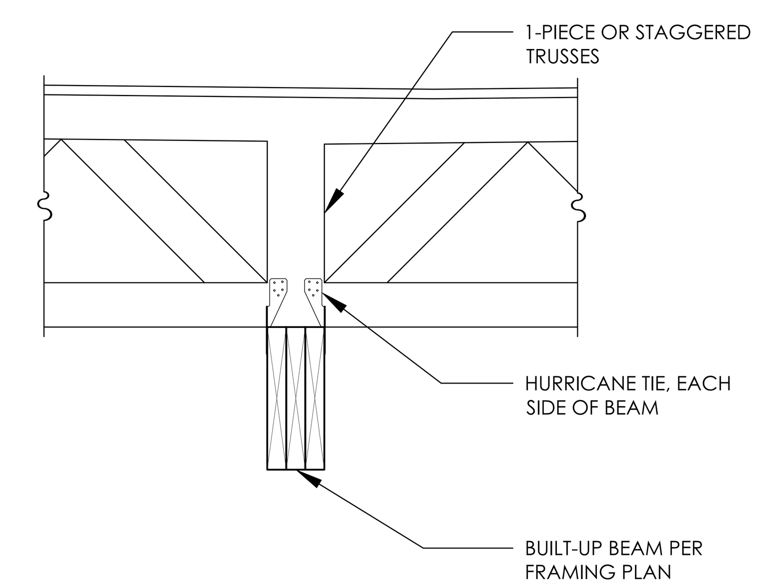
T.O. WALL BRACE @ ROOF 6 S402
SCALE: 1" = 1'-0"



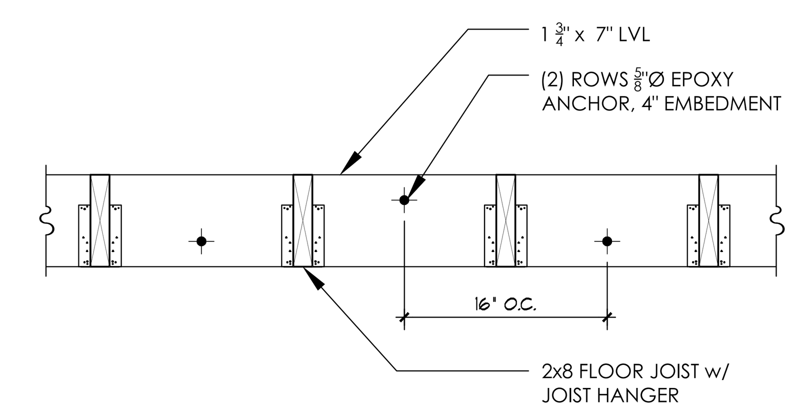
ELEV. ROOF FRAMING 7 S402
SCALE: 1" = 1'-0"



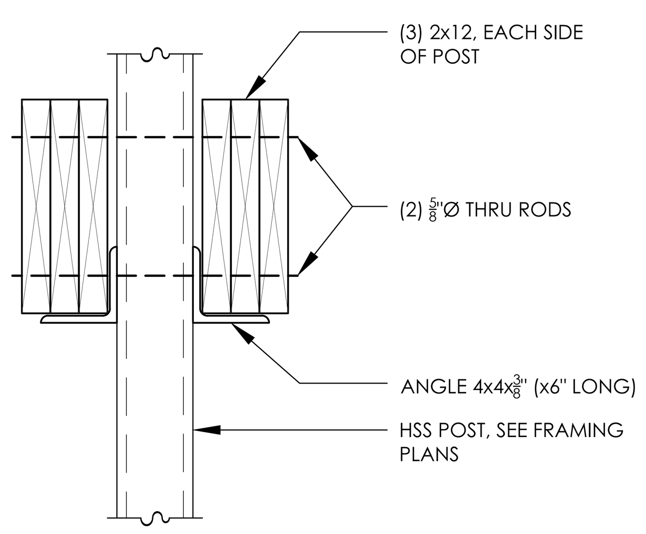
FLUSH BEAM ON POST 8 S402
SCALE: 1" = 1'-0"



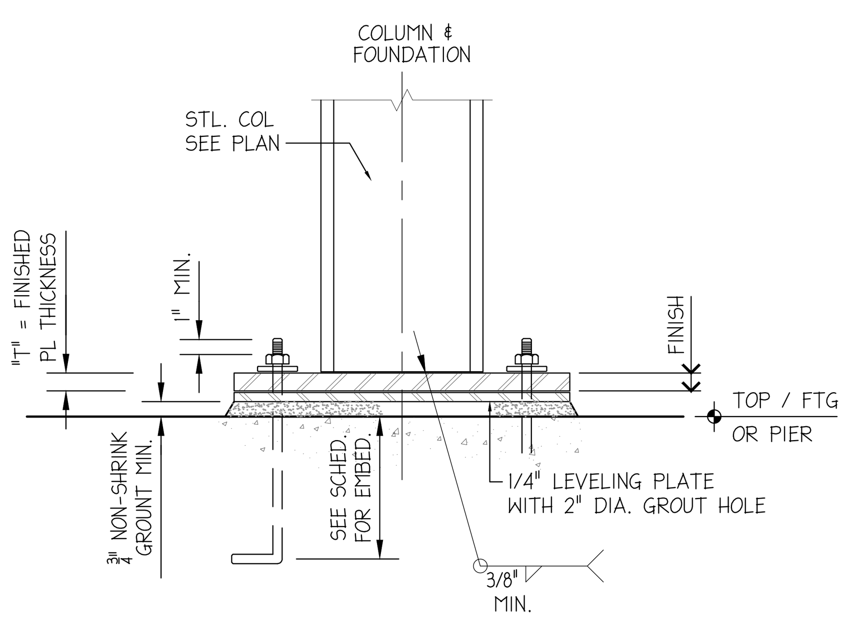
MID-SPAN TRUSS SUPPORT 9 S402
SCALE: 1" = 1'-0"



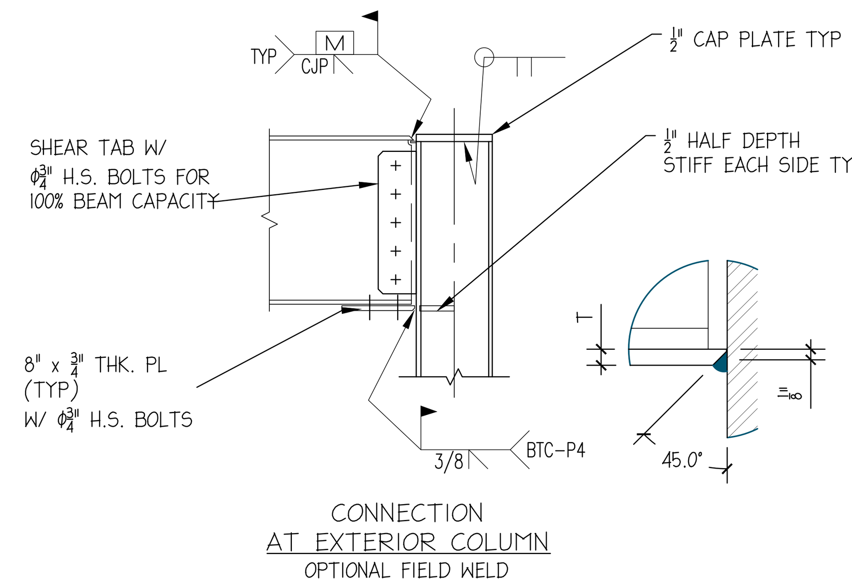
FLUSH LEDGER BOARD 10 S402
SCALE: 1" = 1'-0"



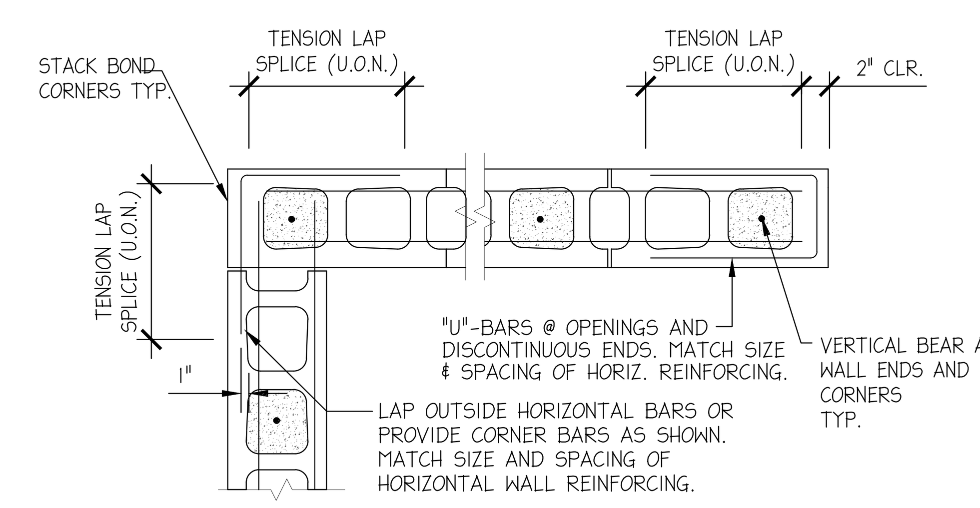
FRAMING DETAIL 11 S402
SCALE: 1" = 1'-0"



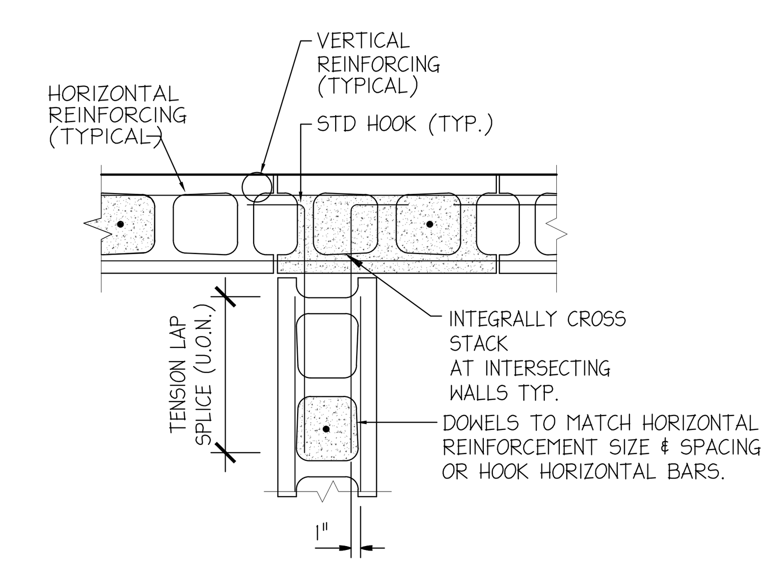
STEEL COLUMN BASE 12 S402
SCALE: 3/4" = 1'-0"



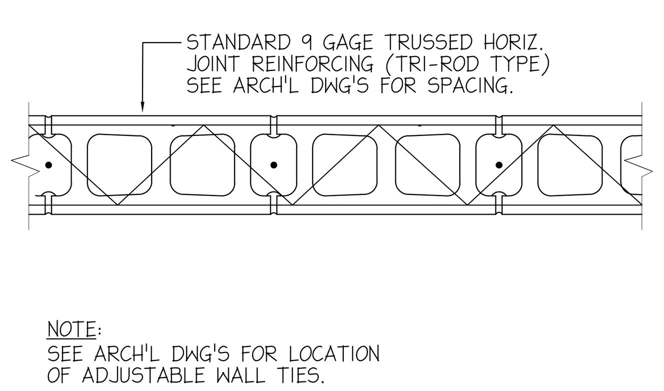
MOMENT CONNECTION DTL. 13 S402
SCALE: 3/4" = 1'-0"



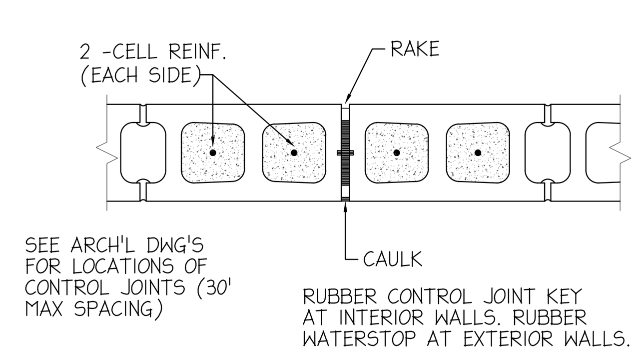
MASONRY CORNERS & ENDS 14 S402
SCALE: 3/4" = 1'-0"



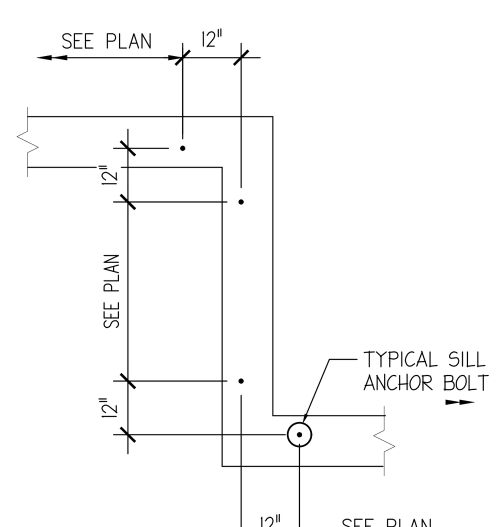
MASONRY WALL INTERSECTION 15 S402
SCALE: 3/4" = 1'-0"



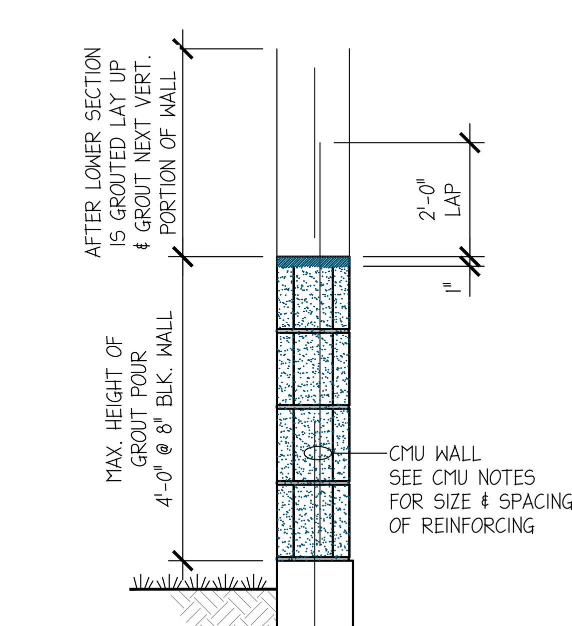
JOINT REINF. AT VENEER WALLS 16 S402
SCALE: 3/4" = 1'-0"



MASONRY CONTROL JOINT 17 S402
SCALE: 3/4" = 1'-0"

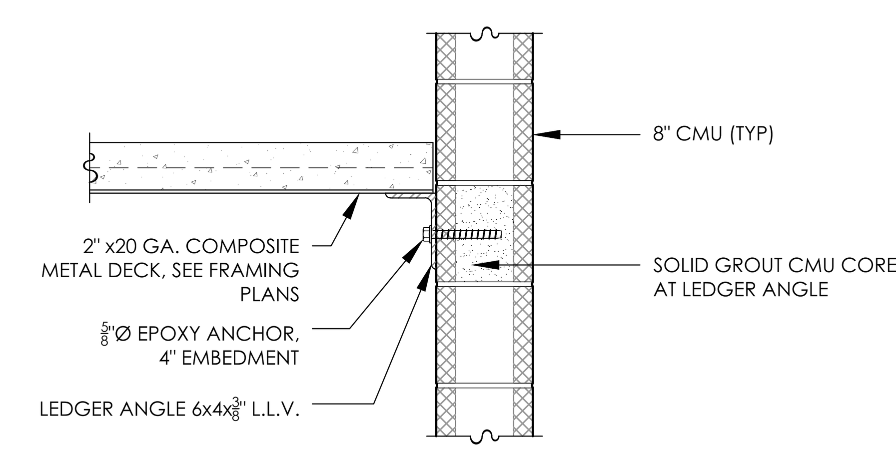


SILL ANCHOR BOLT LAYOUT 18 S402
SCALE: 3/4" = 1'-0"



MASONRY DETAIL

MASONRY GROUTING SEQUENCE 19 S402
SCALE: 3/4" = 1'-0"



LEDGER ANGLE @ CMU 20 S402
SCALE: 3/4" = 1'-0"

REVISIONS

NO.	DATE	DESCRIPTION
1	2/7/19	BID SET
2	4/5/19	FOUNDATION REVISIONS

Project No.
4125

CONSULTANTS:

MECHANICAL ENGINEER
COMPANY
ADDRESS
CITY

STRUCTURAL ENGINEER
COMPANY
ADDRESS
CITY

CIVIL ENGINEER
COMPANY
ADDRESS
CITY

STRUCTURAL FRAMING DETAILS

CAMPUS WEST
RESIDENTIAL APARTMENT BUILDING
129 WEST AVENUE
******
BUFFALO, NEW YORK 14201

DATE
4/17/2018

DRAWING NO.
S402

DATE PLOTTED: Fri, 05 Apr 2019 - 11:56am
FILE LOCATION: 4125 S4 Structural Details_01.dwg

APPENDIX B

FIELD OPERATING PROCEDURES

BENCHMARK
ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

FIELD OPERATING PROCEDURES

Soil Vapor Sample Collection Procedures

FOP 004.5

SOIL VAPOR SAMPLE COLLECTION PROCEDURE

BACKGROUND

In October 2006, the New York State Department of Health (NYSDOH) finalized their vapor intrusion guidance document entitled "Guidance for Evaluating Soil Vapor Intrusion in the State of New York." (www.health.state.ny.us/nysdoh/gas/svi_guidance/), which has been guiding NYSDOH and New York State Department of Environmental Conservation (NYSDEC) decisions concerning the need for subslab vapor mitigation at sites undergoing investigation, cleanup and monitoring under formal NY Sate remedial programs (e.g., Brownfield Cleanup Program sites, Inactive Hazardous Waste Site Remediation Program sites, etc.). The guidance presents two soil vapor/indoor air matrices to assist in interpreting subslab and ambient air data (i.e., "Matrix 1" and "Matrix 2"). As of June 2007, six compounds have been assigned to these two matrices as follows:

Volatile Chemical	Soil Vapor / Indoor Air Matrix
Carbon tetrachloride	Matrix 1
1,1-Dichloroethene	Matrix 2
cis-1,2-Dichloroethene	Matrix 2
Tetrachloroethene	Matrix 2
1,1,1-Trichloroethane	Matrix 2
Trichloroethene	Matrix 1
Vinyl chloride	Matrix 1

Additional matrices will be developed when a chemical's toxicological properties, background concentrations, or analytical capabilities suggest that major revisions are needed. Both matrices are attached as Figures 1 and 2.

SOIL VAPOR SAMPLE COLLECTION PROCEDURE

PURPOSE

The procedures presented herein delineate the scope of additional investigation at a building on the project site to determine if volatile organic compounds (VOCs) detected in groundwater and/or soil near the building are intruding into the building airspace or have the potential, in sufficient concentrations, to adversely impact indoor air quality. The soil vapor, subslab vapor, and ambient air monitoring procedures follow the NYSDOH Final Soil Vapor Intrusion Guidance (October 2006) as well as USEPA Methods TO-14 and TO-15, for volatile organic compounds (VOCs) using Summa passive canisters.

SURVEYS AND PRE-SAMPLING BUILDING PREPARATION (IF REQUIRED)

If required, a pre-sampling inspection should be performed prior to each sampling event to identify and minimize conditions that may interfere with the proposed testing. The inspection should evaluate the type of structure, floor layout, airflows, and physical conditions of the building(s) being studied. This information, along with information on sources of potential indoor air contamination, should be identified on a building inventory form. An example of the building inventory form is attached. Items to be included in the building inventory include the following:

- Construction characteristics, including foundation cracks and utility penetrations or other openings that may serve as preferential pathways for vapor intrusion;
- Presence of an attached garage;
- Recent renovations or maintenance to the building (e.g., fresh paint, new carpet or furniture);
- Mechanical equipment that can affect pressure gradients (e.g., heating systems, clothes dryers or exhaust fans);

- Use or storage of petroleum products (e.g., fuel containers, gasoline operated equipment and unvented kerosene heaters); and

- Recent use of petroleum-based finishes or products containing volatile chemicals.

Each room on the floor of the building being tested and on lower floors, if possible, should be inspected. This is important because even products stored in another area of a building can affect the air of the room being tested.

The presence and description of odors (e.g., solvent, moldy) and portable vapor monitoring equipment readings (e.g., PIDs, ppb RAE, Jerome Mercury Vapor Analyzer, etc.) should be noted and used to help evaluate potential sources. This includes taking readings near products stored or used in the building.

Potential interference from products or activities releasing volatile chemicals may need to be controlled. Removing the source from the indoor environment prior to testing is the most effective means of reducing interference. Ensuring that containers are tightly sealed may be acceptable. When testing for volatile organic compounds, containers should be tested with portable vapor monitoring equipment to determine whether compounds are leaking. The inability to eliminate potential interference may be justification for not testing, especially when testing for similar compounds at low levels. The investigator should consider the possibility that chemicals may adsorb onto porous materials and may take time to dissipate.

In some cases, the goal of the testing is to evaluate the impact from products used or stored in the building (e.g., pesticide misapplications, school renovation projects). If the goal of the testing is to determine whether products are an indoor volatile chemical contaminant source, the removing these sources does not apply.

Once interfering conditions are corrected (if applicable), ventilation may be needed prior to sampling to eliminate residual contamination in the indoor air. If ventilation is appropriate, it should be completed 24 hours or more prior to the scheduled sampling time. Where applicable, ventilation can be accomplished by operating the building's HVAC system to maximize outside air intake. Opening windows and doors, and operating exhaust fans may also help or may be needed if the building has no HVAC system.

Air samples are sometimes designed to represent typical exposure in a mechanically ventilated building and the operation of HVAC systems during sampling should be noted on the building inventory form (see attached sample). In general, the building's HVAC system should be operating under normal conditions. Unnecessary building ventilation should be avoided within 24 hours prior to and during sampling. During colder months, heating systems should be operating to maintain normal indoor air temperatures (i.e., 65 – 75 °F) for at least 24 hours prior to and during the scheduled sampling time.

Depending upon the goal of the indoor air sampling, some situations may warrant deviation from the above protocol regarding building ventilation. In such cases, building conditions and sampling efforts should be understood and noted within the framework and scope of the investigation.

To avoid potential interferences and dilution effects, every effort should be made to avoid the following for 24 hours prior to sampling:

- Opening any windows, fireplace dampers, openings or vents;
- Operating ventilation fans unless special arrangements are made;
- Smoking in the building;
- Painting;
- Using a wood stove, fireplace or other auxiliary heating equipment (e.g., kerosene heater);
- Operating or storing automobile in an attached garage;

- Allowing containers of gasoline or oil to remain within the house or garage area, except for fuel oil tanks;
- Cleaning, waxing or polishing furniture, floors or other woodwork with petroleum- or oil-based products;
- Using air fresheners, scented candles or odor eliminators;
- Engaging in any hobbies that use materials containing volatile chemicals;
- Using cosmetics including hairspray, nail polish, nail polish removers, perfume/cologne, etc.;
- Lawn mowing, paving with asphalt, or snow blowing;
- Applying pesticides; and
- Using building repair or maintenance products, such as caulk or roofing tar.

PRODUCT INVENTORY (IF REQUIRED)

If required, the primary objective of the product inventory is to identify potential air sampling interference by characterizing the occurrence and use of chemicals and products throughout the building, keeping in mind the goal of the investigation and site-specific contaminants of concern. For example, it is not necessary to provide detailed information for each individual container of like items. However, it is necessary to indicate that "20 bottles of perfume" or
"12 cans of latex paint" were present with containers in good condition. This information is used to help formulate an indoor environment profile.

An inventory should be provided for each room on the floor of the building being tested and on lower floors, if possible. This is important because even products stored in another area of a building can affect the air of the room being tested.

The presence and description of odors (e.g., solvent, moldy) and portable vapor monitoring equipment readings (e.g., PIDs, ppb RAE, Jerome Mercury Vapor Analyzer, etc.) should be noted and used to help evaluate potential sources. This includes taking readings near products stored or used in the building. Products in buildings should be inventoried every time air is tested to provide an accurate assessment of the potential contribution of volatile chemicals. If available, chemical ingredients of interest (e.g., analyte list) should be recorded for each product. If the ingredients are not listed on the label, record the product's exact and full name, and the manufacturer's name, address and telephone number, if available. In some cases, Material Safety Data Sheets (MSDS) may be useful for identifying confounding sources of volatile chemicals in air. Adequately documented photographs of the products and their labeled ingredients can supplement the inventory and facilitate recording the information.

SAMPLE LOCATIONS

The following are types of samples that are collected to investigate the soil vapor intrusion pathway:

- Subsurface vapor samples:
  - *Soil vapor* samples (i.e., soil vapor samples not beneath the foundation or slab of a building) and
  - *Sub-slab vapor* samples (i.e., soil vapor samples immediately beneath the foundation or slab of a building);
- Indoor air samples; and
- Outdoor air samples.

The types of samples that should be collected depend upon the specific objective(s) of the sampling, as described below.

- <u>Soil vapor</u>
  Soil vapor samples are collected to determine whether this environmental medium is contaminated, characterize the nature and extent of contamination, and identify possible sources of the contamination. Soil vapor sampling results are used when evaluating the following:
  - The potential for *current* human exposures;

- The potential for *future* human exposures (e.g., should a building be constructed); and
- The effectiveness of measures implemented to remediate contaminated subsurface vapors.

- <u>Sub-slab vapor</u>

  Sub-slab vapor samples are collected to characterize the nature and extent of soil vapor contamination immediately beneath a building with a basement foundation and/or a slab-on-grade. Sub-slab vapor sampling results are used when evaluating the following:
  - *Current* human exposures;
  - The potential for *future* human exposures (e.g., if the structural integrity of the building changes or the use of the building changes); and
  - Site-specific attenuation factors (i.e., the ratio of indoor air to sub-slab vapor concentrations).

  Sub-slab vapor samples are collected after soil vapor characterization and/or other environmental sampling (e.g., soil and groundwater characterization) indicate a need. Subslab samples are typically collected concurrently with indoor and outdoor air samples. However, outside of the heating season, sub-slab vapor samples may be collected independently depending on the sampling objective (e.g., characterize the extent of subsurface vapor contamination outside of the heating season to develop a more comprehensive, focused investigation plan for the heating season).

- <u>Indoor air</u>

  Indoor air samples are collected to characterize exposures to air within a building, including those with earthen floors and crawlspaces. Indoor air sampling results are used when evaluating the following:
  - *Current* human exposures;
  - The potential for *future* exposures (e.g., if a currently vacant building should become occupied); and
  - Site-specific attenuation factors (e.g., the ratio of indoor air to sub-slab vapor concentrations).

Indoor air samples are collected after subsurface vapor characterization and other environmental sampling (e.g., soil and groundwater characterization) indicate a need. When indoor air samples are collected, concurrent sub-slab vapor and outdoor air samples are collected to evaluate the indoor air results appropriately. However, indoor air and outdoor air samples, without sub-slab vapor samples, may be collected when confirming the effectiveness of a mitigation system.

In addition, site-specific situations may warrant collecting indoor air samples prior to characterizing subsurface vapors and/or without concurrent sub-slab sampling due to a need to examine immediate inhalation hazards. Examples of such situations may include, but are not limited to, the following:

- In response to a spill event when there is a need to qualitatively and/or quantitatively characterize the contamination;
- If high readings are obtained in a building when screening with field equipment (e.g., a photoionization detector (PID), an organic vapor analyzer, or an explosimeter) and the source is unknown;
- If significant odors are present and the source needs to be characterized; or
- If groundwater beneath the building is contaminated, the building is prone to groundwater intrusion or flooding (e.g., sump pit overflows), and subsurface vapor sampling is not feasible.

▪ Outdoor air

Outdoor air samples are collected to characterize site-specific background outdoor air conditions. These samples must be collected simultaneously with indoor air samples. They may also be collected concurrently with soil vapor samples. Outdoor air sampling results are primarily used when evaluating the extent to which outdoor sources may be influencing indoor air quality. They may also be used in the evaluation of soil vapor results (i.e., to identify potential outdoor air interferences associated with the infiltration of outdoor air into the sampling apparatus while the soil vapor sample was collected).

SOIL VAPOR SAMPLE COLLECTION PROCEDURES

Soil vapor probe installations (see Figure 3 attached) may be permanent, semi-permanent, or temporary. In general, permanent installations are preferred for data consistency reasons. Soil implants or probes should be constructed in the same manner at all sampling locations to minimize possible discrepancies. The following procedures should be included in any construction protocol:

- Soil vapor probes should be installed using direct push technology or, if necessary to attain the desired depth, using an auger;
- Porous backfill material (e.g., glass beads or coarse sand) should be used to create a sampling zone 1 to 2 feet in length;
- Soil vapor probes should be fitted with inert tubing (e.g., polyethylene, stainless steel, or Teflon®) of the appropriate size (typically 1/8 inch to 1/4 inch diameter) and of laboratory or food grade quality to the surface;
- Soil vapor probes should be sealed above the sampling zone with a bentonite slurry for a minimum distance of 3 feet to prevent outdoor air infiltration and the remainder of the borehole backfilled with clean material;
- For multiple probe depths, the borehole should be grouted with bentonite between probes to create discrete sampling zones; and
- For permanent installations, a protective casing should be set around the top of the probe tubing and grouted in place to the top of bentonite to minimize infiltration of water or outdoor air, as well as to prevent accidental damage.

Soil vapor samples should be collected in the same manner at all locations to minimize possible discrepancies. The following procedures should be included in any sampling protocol:

- At least 24 hours after the installation of permanent probes and shortly after the installation of temporary probes, one to three implant volumes (i.e., the volume of the sample probe and tube) must be purged prior to collecting the samples to ensure samples collected are representative;

- Flow rates for both purging and collecting must not exceed 0.2 liters per minute to minimize outdoor air infiltration during sampling;

- The target final field vacuum after 24 hours will be approximately -5 inches of mercury. Samples with a final field vacuum of greater than -10 inches of mercury, or equal to zero, will be flagged (usability of data will depend on sample volume and reporting limits that can be achieved).

- Samples must be collected, using conventional sampling methods, in an appropriate container — one which meets the objectives of the sampling (e.g., investigation of areas where low or high concentrations of volatile chemicals are expected; to minimize losses of volatile chemicals that are susceptible to photodegradation), meets the requirements of the sampling and analytical methods (e.g., low flow rate; Summa® canisters if analyzing by using EPA Method TO-15), and is certified clean by the laboratory;

- Sample size depends upon the volume of sample required to achieve minimum reporting limit requirements; and

- A tracer gas (e.g., helium, butane, or sulfur hexafluoride) must be used when collecting soil vapor samples to verify that adequate sampling techniques are being implemented (i.e., to verify infiltration of outdoor air is not occurring) (discussed later in this procedure). Once verified, continued use of the tracer gas may be reconsidered.

When soil vapor samples are collected, the following actions should be taken to document local conditions during sampling that may influence interpretation of the results:

- If sampling near a commercial or industrial building, uses of volatile chemicals during normal operations of the facility should be identified;

- Outdoor plot sketches should be drawn that include the site, area streets, neighboring commercial or industrial facilities (with estimated distance to the site), outdoor ambient air sample locations (if applicable), and compass orientation (north);

- Weather conditions (e.g., precipitation, outdoor temperature, barometric pressure, wind speed and direction) should be noted for the past 24 to 48 hours; and

- Any pertinent observations should be recorded, such as odors and readings from field instrumentation.

The field sampling team must maintain a sample log sheet summarizing the following:

- Sample identification,
- Date and time of sample collection,
- Sampling depth,
- Identity of samplers,
- Sampling methods and devices,
- Purge volumes,
- Volume of soil vapor extracted,
- If canisters used, the vacuum before and after samples collected,
- Apparent moisture content (dry, moist, saturated, etc.) of the sampling zone, and
- Chain of custody protocols and records used to track samples from sampling point to analysis.

SUB-SLAB VAPOR SAMPLE COLLECTION PROCEDURES

During colder months, heating systems should be operating to maintain normal indoor air temperatures (i.e., 65 – 75 °F) for at least 24 hours prior to and during the scheduled sampling time. Prior to installation of the sub-slab vapor probe, the building floor should be inspected and any penetrations (cracks, floor drains, utility perforations, sumps, etc.) should be noted and recorded. Probes should be installed at locations where the potential for ambient air infiltration via floor penetrations is minimal.

Sub-slab vapor probe installations (see Figure 4 attached) may be permanent, semi-permanent, or temporary. Sub-slab implants or probes should be constructed in the same manner at all sampling locations to minimize possible discrepancies. The following procedures should be included in any construction protocol:

- Permanent recessed probes must be constructed with brass or stainless steel tubing and fittings;
- Temporary probes must be constructed with polyethylene or Teflon® tubing of laboratory or food grade quality;
- Tubing should not extend further than 2 inches into the sub-slab material;
- Coarse sand or glass beads should be added to cover about 1 inch of the probe tip for permanent installations; and
- The soil vapor probe should be sealed to the surface with permagum grout, melted beeswax, putty or other non-VOC-containing and non-shrinking products for temporary installations or cement for permanent installations.

Sub-slab vapor samples should be collected in the following manner:

- After installation of the probes, one to three volumes (i.e., the volume of the sample probe and tube) must be purged prior to collecting the samples to ensure samples collected are representative;
- Flow rates for both purging and collecting must not exceed 0.2 liters per minute to minimize outdoor air infiltration during sampling;
- The target final field vacuum after 24 hours will be approximately -5 inches of mercury. Samples with a final field vacuum of greater than -10 inches of mercury, or equal to zero, will be flagged (usability of data will depend on sample volume and reporting limits that can be achieved).
- Samples must be collected, using conventional sampling methods, in an appropriate container — one which meets the objectives of the sampling (e.g., investigation of areas where low or high concentrations of volatile chemicals are expected; to minimize losses of volatile chemicals that are susceptible to photodegradation), meets the requirements of the sampling and analytical methods (e.g., low flow rate; Summa® canisters if analyzing by using EPA Method TO-15), and is certified clean by the laboratory;

- Sample size depends upon the volume of sample required to achieve minimum reporting limit requirements [Section 2.9 of the Guidance], the flow rate, and the sampling duration; and
- Ideally, samples should be collected over the same period of time as concurrent indoor and outdoor air samples.

When sub-slab vapor samples are collected, the following actions should be taken to document conditions during sampling and ultimately to aid in the interpretation of the sampling results:

- If sampling within a commercial or industrial building, uses of volatile chemicals in commercial or industrial processes and/or during building maintenance, should be identified;
- The use of heating or air conditioning systems during sampling should be noted;
- Floor plan sketches should be drawn that include the floor layout with sample locations, chemical storage areas, garages, doorways, stairways, location of basement sumps or subsurface drains and utility perforations through building foundations, HVAC system air supply and return registers, compass orientation (north), and any other pertinent information should be completed;
- If possible, photographs should accompany floor plan sketches;
- Outdoor plot sketches should be drawn that include the building site, area streets, outdoor air sample locations (if applicable), compass orientation (north), footings that create separate foundation sections, and paved areas;
- Weather conditions (e.g., precipitation, indoor and outdoor temperature, and barometric pressure) and ventilation conditions (e.g., heating system active and windows closed) should be reported;
- Smoke tubes or other devices should be used to confirm pressure relationships and air flow patterns, especially between floor levels and between suspected contaminant sources and other areas; and
- Any pertinent observations, such as spills, floor stains, smoke tube results, odors and readings from field instrumentation (e.g., vapors via PID, ppb RAE, Jerome Mercury Vapor Analyzer, etc.), should be recorded.

The field sampling team must maintain a sample log sheet summarizing the following:

- Sample identification,

- Date and time of sample collection,
- Sampling depth,
- Identity of samplers,
- Sampling methods and devices,
- Soil vapor purge volumes,
- Volume of soil vapor extracted,
- If canisters used, the vacuum before and after samples collected,
- Apparent moisture content (dry, moist, saturated, etc.) of the sampling zone, and
- Chain of custody protocols and records used to track samples from sampling point to analysis.

The following describes the subslab air sampling procedure:

1. Canisters will be supplied by the laboratory that will be conducting the analysis.

2. Sampling will take place in accordance with the project work plan sufficiently spaced to allow locations to be modified, if necessary.

3. The number of Summa canisters required as well as the flow rate of the constant differential low volume flow controllers will be supplied by the laboratory in accordance with the project work plan.

4. The sampling program will consist of concurrently collecting and analyzing one sub-slab vapor sample and one indoor ambient air sample (discussed in the next section). Sample locations should be selected based on the likelihood for potential continuous human occupancy during the workday (i.e., due to the size of the areas and available infrastructure), and to account for the possibility of varying foundation depths in different areas of the building. In addition, sample locations typically are based upon the results of a subsurface investigation (i.e., soil gas survey or boring advancement) conducted prior to air sample collection activities. Canisters are typically placed in areas where the highest concentrations of soil gas were observed. Indoor air sample locations preferably should be selected near the middle of the sampled room, well away from the edges where dilution is more likely to occur.

5. Collect at least one outdoor ambient air sample from a location on the building roof or designated background area of the site positioned away from building ventilation system equipment on the highest portion of the building roof or site. See the Outdoor Ambient Air Sampling Procedure section in this procedure.

6. Field personnel should assure conservative sampling conditions prior to and throughout the sampling event. The building should be closed (windows and doors shut) and existing building ventilation systems should be turned off 12 to 24 hours before the air sampling is scheduled to begin as well as during sample collection. Any air-handling units that may induce large pressure gradients (i.e., exhaust fans, HVAC units etc.) should also be turned off.

7. Any activity being conducted by current building tenants involving volatile organic compounds, such as the use of lacquer thinner and cleaning solvents, prior to and/or during air sampling activities should be noted in the Project Field Book. These activities have the potential to bias the analytical results.

8. At each location, drill an approximately ¾-inch diameter hole through the concrete slab (typically 6-8 inches thick) using a hand-held hammer drill.

9. Measure and record the concrete thickness in the Project Field Book.

10. Insert polyethylene or Teflon® tubing of laboratory or food grade quality into the drilled hole and <u>no further than 2 inches</u> into the subslab material.

11. Seal the tubing with an appropriately sized volatile organic compound-free stopper (i.e., permagum grout, melted beeswax, putty, or other non-VOC-containing and non-shrinking product) into the concrete core hole and secure in-place making sure the fit is very snug. Supplement any visible gaps between the stopper and concrete slab with a VOC-free sealant, such as beeswax or bentonite slurry.

12. Run the tubing assembly through a shroud (plastic pail, cardboard box, or garbage bag) creating a tight seal with the surface making sure not to disturb the seal around the tubing penetration.

13. Enrich the atmosphere of the shroud with helium. Measure and record the helium concentration within the shroud.

14. Purge approximately 1 to 3 tubing volumes (i.e., the volume of the sample probe and tube) using a hand pump (or similar approved device) to ensure the collection of a representative sample.

15. Flow rates for both purging and sample collection must not exceed 0.2 liters per minute to minimize outdoor air infiltration during sampling.

16. Use a portable monitoring device to analyze a sample of soil vapor for the tracer **prior to and after** sampling for the compounds of concern. Note that the tracer gas samples can be collected via syringe, Tedlar bag etc. They need not be collected in Summa® canisters or minicans.

17. If concentrations greater than 10% of tracer gas are observed either prior to and/or after sampling, the probe seal should be enhanced to reduce the infiltration of outdoor air. Following enhancement of the seal, repeat steps 14 through 17 above until purged concentrations are less than 10% of the tracer gas within the shroud.

18. Following tubing purge and adequate seal integrity testing via helium tracer gas, immediately attach a 6-liter Summa Canister fitted with a 24-hour regulator (or approved other duration) to the opposite end of the tubing. Concurrent with each subslab sample location, prepare an indoor ambient air sample by staging a second Summa Canister on a ladder (approximately 2 to 5-feet above the floor) adjacent to the sub-slab sample location.

19. All Summa Canister valves should remain closed until all subslab borings are complete and all of the canisters in their respective positions.

20. Open the valves to all of the canisters for the required collection period (i.e., 24-hours). Record initial canister pressure on the Air Canister Field Record form.

21. Following sample collection and prior to closing canister valve, record final canister pressure on the Air Canister Field Record form. Close canister valve.

22. Collect all Summa Canisters and ship, under chain-of-custody command to an approved analytical laboratory for VOC analysis in accordance with USEPA Method TO-14 or TO-15.

23. Repair all concrete openings with a cement patch.

24. Analytical results submitted by the laboratory should be reported as concentrations of each VOC at each location, typically in parts per billion by volume (ppbv).

INDOOR AIR SAMPLE COLLECTION PROCEDURES

During colder months, heating systems should be operating to maintain normal indoor air temperatures (i.e., 65 – 75 °F) for at least 24 hours prior to and during the scheduled sampling time. If possible, prior to collecting indoor samples, a pre-sampling inspection, discussed earlier in this procedure, should be performed to evaluate the physical layout and conditions of the building being investigated, to identify conditions that may affect or interfere with the proposed sampling, and to prepare the building for sampling.

In general, indoor air samples should be collected in the following manner:

- Sampling duration should reflect the exposure scenario being evaluated without compromising the detection limit or sample collection flow rate (e.g., an 8 hour sample from a workplace with a single shift versus a 24 hour sample from a workplace with multiple shifts). To ensure that air is representative of the locations sampled and to avoid undue influence from sampling personnel, samples should be collected for at least 1 hour. If the goal of the sampling is to represent average concentrations over longer periods, then longer duration sampling periods may be appropriate. Typically, 24 hour samples are collected from residential settings;

- Personnel should avoid lingering in the immediate area of the sampling device while samples are being collected;

- Sample flow rates must conform to the specifications in the sample collection method and, if possible, should be consistent with the flow rates for concurrent outdoor air and sub-slab samples;

- The target final field vacuum after 24 hours will be approximately -5 inches of mercury. Samples with a final field vacuum of greater than -10 inches of mercury, or equal to zero, will be flagged (usability of data will depend on sample volume and reporting limits that can be achieved); and

- Samples must be collected, using conventional sampling methods, in an appropriate container — one which meets the objectives of the sampling (e.g., investigation of areas where low or high concentrations of volatile chemicals are expected; to minimize losses of volatile chemicals that are susceptible to photodegradation), meets the requirements of the sampling and analytical methods (e.g., low flow rate; Summa® canisters if analyzing by using EPA Method TO-15), and is certified clean by the laboratory.

At sites with tetrachloroethene contamination, passive air monitors that are specifically analyzed for tetrachloroethene (i.e., "perc badges") are commonly used to collect indoor and outdoor air samples. If site characterization activities indicate that degradation products of tetrachloroethene also represent a vapor intrusion concern, perc badges may be used to indicate the likelihood of vapor intrusion (i.e., by using tetrachloroethene as a surrogate) followed, as needed, by more comprehensive sampling and laboratory analyses to quantify both tetrachloroethene and its degradation products. Perc badge samples ideally should be collected over a twenty-four hour period, but for no less than eight hours.

The following actions should be taken to document conditions during indoor air sampling and ultimately to aid in the interpretation of the sampling results:

- A product inventory survey must be completed (discussed earlier);

- The use of heating or air conditioning systems during sampling should be noted;
- Floor plan sketches should be drawn that include the floor layout with sample locations, chemical storage areas, garages, doorways, stairways, location of basement sumps or subsurface drains and utility perforations through building foundations, HVAC system supply and return registers, compass orientation (north), and any other pertinent information should be completed;
- If possible, photographs should accompany floor plan sketches;
- Outdoor plot sketches should be drawn that include the building site, area streets, outdoor air sample locations (if applicable), compass orientation (north), footings that create separate foundation sections, and paved areas;
- Weather conditions (e.g., precipitation, indoor and outdoor temperature, and barometric pressure) and ventilation conditions (e.g., heating system active and windows closed) should be reported;
- Smoke tubes or other devices should be used to confirm pressure relationships and air flow patterns, especially between floor levels and between suspected contaminant sources and other areas; and
- Any pertinent observations, such as spills, floor stains, smoke tube results, odors and readings from field instrumentation (e.g., vapors via PID, ppb RAE, Jerome Mercury Vapor Analyzer, etc.), should be recorded.

The field sampling team must maintain a sample log sheet summarizing the following:

- Sample identification,
- Date and time of sample collection,
- Sampling height,
- Identity of samplers,
- Sampling methods and devices,
- Depending upon the method, volume of air sampled,
- If canisters used, the vacuum before and after samples collected,

- Chain of custody protocols and records used to track samples from sampling point to analysis.

The following describes the indoor air sampling procedure:

1. Canisters will be supplied by the laboratory that will be conducting the analysis.

2. Sampling will take place in accordance with the project work plan sufficiently spaced to allow locations to be modified, if necessary.

3. The number of Summa canisters required as well as the flow rate of the constant differential low volume flow controllers will be supplied by the laboratory in accordance with the project work plan. Indoor air sampling typically requires the continuous collection of samples over a 24-hour period.

4. The sampling program will consist of concurrently collecting and analyzing one sub-slab vapor sample and one indoor ambient air sample. Sample locations should be selected based on the likelihood for potential continuous human occupancy during the workday (i.e., due to the size of the areas and available infrastructure), and to account for the possibility of varying foundation depths in different areas of the building. In addition, sample locations typically are based upon the results of a subsurface investigation (i.e., soil gas survey or boring advancement) conducted prior to air sample collection activities. Canisters are typically placed in areas where the highest concentrations of soil gas were observed. Indoor air sample locations preferably should be selected near the middle of the sampled room, well away from the edges where dilution is more likely to occur.

5. Collect at least one outdoor ambient air sample from a location on the building roof or designated background area of the site positioned away from building ventilation system equipment on the highest portion of the building roof or site. See the Outdoor Ambient Air Sampling Procedure presented in this procedure.

6. Field personnel should assure conservative sampling conditions prior to and throughout the sampling event. The building should be closed (windows and doors shut) and existing building ventilation systems should be turned off 12 to 24 hours before the air sampling is scheduled to begin as well as during sample collection. Any air-handling units that may induce large pressure gradients (i.e., exhaust fans, HVAC units etc.) should also be turned off.

7. Any activity being conducted by current building tenants involving volatile organic compounds, such as the use of lacquer thinner and cleaning solvents, prior to and/or during air sampling activities should be noted in the Project Field Book. These activities have the potential to bias the analytical results.

8. Concurrent with each subslab sample location, prepare an indoor ambient air sample by staging a second Summa Canister on a ladder (approximately 2 to 5-feet above the floor) adjacent to the sub-slab sample location.

9. All Summa Canister valves should remain closed until all subslab borings are complete and all of the canisters in their respective positions.

10. Open the valves to all of the canisters for the required collection period (i.e., 24-hours). Record initial canister pressure on the Air Canister Field Record form.

11. Following sample collection and prior to closing canister valve, record final canister pressure on the Air Canister Field Record form. Close canister valve.

12. Collect all Summa Canisters and ship, under chain-of-custody command to an approved analytical laboratory for VOC analysis in accordance with USEPA Method TO-14 or TO-15.

13. Analytical results submitted by the laboratory should be reported as concentrations of each VOC at each location, typically in parts per billion by volume (ppbv).

OUTDOOR AIR SAMPLE COLLECTION PROCEDURES

Outdoor air samples must be collected simultaneously with indoor air samples and may be collected concurrently with subsurface vapor samples. Outdoor air samples must be collected in the same manner as indoor samples.

The following actions should be taken to document conditions during outdoor air sampling and ultimately to aid in the interpretation of the sampling results:

- Outdoor plot sketches should be drawn that include the building site, area streets, outdoor air sample locations (if applicable), the location of potential interferences (e.g., gasoline stations, factories, lawn movers, etc.), compass orientation (north), footings that create separate foundation sections, and paved areas;

- Weather conditions (e.g., precipitation, indoor and outdoor temperature, and barometric pressure) and ventilation conditions (e.g., heating system active and windows closed) should be reported; and

- Any pertinent observations, such as odors, readings from field instrumentation, and significant activities in the vicinity (e.g., operation of heavy equipment or dry cleaners) should be recorded.

The following describes the outdoor air sampling procedure:

1. Canisters will be supplied by the laboratory that will be conducting the analysis.

2. Sampling will take place in accordance with the project work plan sufficiently spaced to allow locations to be modified, if necessary.

3. The number of Summa canisters required as well as the flow rate of the constant differential low volume flow controllers will be supplied by the laboratory in accordance with the project work plan.

4. Sample locations typically are collected upwind of the facility.

5. Collect at least one outdoor ambient air sample from a location on the building roof or designated background area of the site positioned away from building ventilation system equipment on the highest portion of the building roof or site. Place canisters on the ground or step ladder, with a clear plastic sheet beneath to prevent contamination. Locate the sampling inlet approximately 18-inches above the ground surface.

6. Sample collection should take place on warm, dry days. If rain or high humidity conditions develop during sampling, the sampling event should be suspended. Temperature, barometric pressure, and wind speed should be monitored during the sampling event, for use in analysis of the results.

7. The combination of sampling location, height, and meteorological conditions will assure that sampling will measure VOCs at their highest concentrations.

8. All Summa Canister valves should remain closed until all subslab borings are complete and all of the indoor and outdoor canisters in their respective positions.

9. Open the valves to all of the canisters for the required collection period (i.e., 24-hours). Record initial canister pressure on the Air Canister Field Record form.

10. Following sample collection and prior to closing canister valve, record final canister pressure on the Air Canister Field Record form. Close canister valve.

11. Collect all Summa Canisters and ship, under chain-of-custody command to an approved analytical laboratory for VOC analysis in accordance with USEPA Method TO-14 or TO-15.

12. Air samples will be analyzed by Gas Chromatography/Mass Spectroscopy (GC/MS) in accordance with EPA Method TO-14 or TO-15.

13. Analytical results will be reported as concentrations of each VOC at each location during each sampling event, typically in parts per billion by volume (ppbv).

TRACER GAS

When collecting soil vapor samples as part of a vapor intrusion evaluation, a tracer gas serves as a quality assurance/quality control device to verify the integrity of the soil vapor probe seal. Without the use of a tracer, there is no way to verify that a soil vapor sample has not been diluted by surface air.

Depending on the nature of the contaminants of concern, a number of different compounds can be used as a tracer. Typically, sulfur hexafluoride (SF6) or helium are used as tracers because they are readily available, have low toxicity, and can be monitored with portable measurement devices. Butane and propane (or other gases) could also be used as a tracer in some situations. The protocol for using a tracer gas is straightforward: simply enrich the atmosphere in the immediate vicinity of the area where the probe intersects the ground surface with the tracer gas, and measure a vapor sample from the probe for the presence of high concentrations (> 10%) of the tracer. A cardboard box, a plastic pail, or even a garbage bag can serve to keep the tracer gas in contact with the probe during the testing.

There are two basic approaches to testing for the tracer gas:

- Include the tracer gas in the list of target analytes reported by the laboratory; or
- Use a portable monitoring device to analyze a sample of soil vapor for the tracer prior to and after sampling for the compounds of concern. (Note that the tracer gas samples can be collected via syringe, Tedlar bag etc. They need not be collected in Summa® canisters or minicans.)

The advantage of the second approach is that the real time tracer sampling results can be used to confirm the integrity of the probe seals prior to formal sample collection. Figure 5 (attached) depicts common methods for using tracer gas. In each of the examples, a, b and c, the tracer gas is released in the enclosure prior to initially purging the sample point. Care should be taken to avoid excessive purging prior to sample collection. Care should also be taken to prevent pressure build-up in the enclosure during introduction of the tracer gas. Inspection of the installed sample probe, specifically noting the integrity of the surface seal and the porosity of the soil in which the probe is installed, will help to determine the tracer gas setup. Figure 5(a) may be most effective at preventing tracer gas infiltration; however, it may not be required in some situations depending on site-specific conditions. Figures 5(b) and 5(c) may be sufficient for probes installed in tight soils with well-constructed surface seals. In all cases, the same tracer gas application should be used for all probes at any given site.

Because minor leakage around the probe seal should not materially affect the usability of the soil vapor sampling results, the mere presence of the tracer gas in the sample should not be a cause for alarm. Consequently, portable field monitoring devices with detection limits in the low ppm range are more than adequate for screening samples for the tracer. If high concentrations (> 10%) of tracer gas are observed in a sample, the probe seal should be enhanced to reduce the infiltration of ambient air.

During the initial stages of a soil vapor sampling program, tracer gas samples should be collected at each of the sampling probes. If the results of the initial samples indicate that the probe seals are adequate, the project manager can consider reducing the number of locations at which tracer gas samples are employed. At a minimum, at least 10% of the subsequent samples should be supported with tracer gas analyses. When using permanent soil vapor probes as part of a long-term monitoring program, annual testing of the probe integrity is recommended.

QUALITY ASSURANCE / QUALITY CONTROL (QA/QC)

Extreme care should be taken during all aspects of sample collection to ensure that sampling error is minimized and high quality data are obtained. The sampling team members should avoid actions (e.g., fueling vehicles, using permanent marking pens, and wearing freshly dry-cleaned clothing or personal fragrances), which can cause sample interference in the field. Appropriate QA/QC protocols must be followed for sample collection and laboratory analysis, such as use of certified clean sample devices, meeting sample holding times and temperatures, sample accession, chain of custody, etc. Samples should be delivered to the analytical laboratory as soon as possible after collection. In addition, laboratory accession procedures must be followed including field documentation (sample collection information and locations), chain of custody, field blanks, field sample duplicates, and laboratory duplicates, as appropriate.

Some methods require collecting samples in duplicate (e.g., indoor air sampling using passive sampling devices for tetrachloroethene) to assess errors. Duplicate and/or split samples should be collected in accordance with the requirements of the sampling and analytical methods being implemented.

For certain regulatory programs, a Data Usability Summary Report (DUSR) may be required to determine whether or not the data, as presented, meets the site or project specific criteria for data quality and data use. This requirement may dictate the level of QC and the category of data deliverable to request from the laboratory. Guidance on preparing a DUSR is available by contacting the NYSDEC's Division of Environmental Remediation.

New York State Public Health Law requires laboratories analyzing environmental samples collected from within New York State to have current Environmental Laboratory Approval Program (ELAP) certification for the appropriate analyte and environmental matrix combinations. If ELAP certification is not currently required for an analyte (e.g., trichloroethene), the analysis should be performed by a laboratory that has ELAP certification for similar compounds in air and uses analytical methods with detection limits similar to background (e.g., tetrachloroethene via EPA Method TO-15).

The work plan must state that all samples that will be used to make decisions on appropriate actions to address exposures and environmental contamination will be analyzed by an ELAP-certified laboratory. If known, the name of the laboratory should also be provided. Similarly, the name of the laboratory that was used must be included in the report of the sampling results. For samples collected and tested in the field for screening purposes by using field testing technology, the qualifications of the field technician must be documented in the work plan.

The target final field vacuum of any sample canister after 24 hours will be approximately -5 inches of mercury. Samples with a final field vacuum of greater than -10 inches of mercury, or equal to zero, will be flagged (usability of data will depend on sample volume and reporting limits that can be achieved).

DECISION MATRICES (FIGURES 1 AND 2)

The considerations in assigning a chemical to a matrix include the following:

- Human health risks, including such factors as a chemical's ability to cause cancer, reproductive, developmental, liver, kidney, nervous system, immune system or other effects, in animals and humans and the doses that may cause those effects;
- The data gaps in its toxicological database;
- Background concentrations of volatile chemicals in indoor air [Section 3.2.4]; and
- Analytical capabilities currently available.

To use the matrices accurately as a tool in the decision-making process, the following must be noted:

- The matrices are generic. As such, it may be necessary to modify recommended actions to accommodate building-specific conditions (e.g., dirt floor in basement, crawl spaces, etc.) and/or site-specific conditions (e.g., proximity of building to identified subsurface contamination) for the protection of public health. Additionally, actions more conservative than those specified within the matrix may be implemented at any time. For example, the decision to implement more conservative actions may be based on a comparison of the costs associated with resampling or monitoring to the costs associated with installation and monitoring of a mitigation system.

- Indoor air concentrations detected in samples collected from the building's basement or, if the building has a slab-on-grade foundation, from the building's lowest occupied living space should be used.

- Actions provided in the matrix are specific to addressing human exposures. Implementation of these actions does not preclude the need to investigate possible sources of vapor contamination, nor does it preclude the need to remediate contaminated soil vapors or the source of soil vapor contamination.

- When current exposures are attributed to sources other than vapor intrusion, the agencies must be provided documentation (e.g., applicable environmental data, completed indoor air sampling questionnaire, digital photographs, etc.) to support a proposed action other than that provided in the matrix and to support assessment and follow-up by the agencies.

RECOMMENDED ACTIONS

Actions recommended in the matrix are based on the relationship between sub-slab vapor concentrations and corresponding indoor air concentrations. They are intended to address both potential and current human exposures and include the following:

- *No further action*
  When the volatile chemical is not detected in the indoor air sample and the concentration detected in the corresponding sub-slab vapor sample is not expected to substantially affect indoor air quality.

- *Take reasonable and practical actions to identify source(s) and reduce exposures*
  The concentration detected in the indoor air sample is likely due to indoor and/or outdoor sources rather than soil vapor intrusion given the concentration detected in the sub-slab vapor sample. Therefore, steps should be taken to identify potential source(s) and to reduce exposures accordingly (e.g., by keeping containers tightly capped or by storing volatile chemical-containing products in places where people do not spend much time, such as a garage or shed).

- *Monitor*
  Monitoring, including sub-slab vapor, basement air, lowest occupied living space air, and outdoor air sampling, is needed to determine whether concentrations in the indoor air or sub-slab vapor have changed. Monitoring may also be needed to determine whether existing building conditions (e.g., positive pressure HVAC systems) are maintaining the desired mitigation endpoint and to determine whether changes are needed. The type and frequency of monitoring is determined on a site-specific and building specific basis, taking into account applicable environmental data and building operating conditions.

- *Mitigate*
  Mitigation is needed to minimize current or potential exposures associated with soil vapor intrusion. Methods to mitigate exposures related to soil vapor intrusion are described in Section 4 of the Guidance.

TIME OF YEAR

Sub-slab vapor samples and, unless there is an immediate need for sampling, indoor air samples are typically collected during the heating season because soil vapor intrusion is more likely to occur when a building's heating system is in operation and air is being drawn into the building. In general, heating systems are expected to be operating routinely from November 15th to March 31st throughout the state. However, this timeframe may vary depending on factors, such as the location of the site (e.g., upstate versus downstate) and the weather conditions for a particular year.

A vapor intrusion investigation may also be conducted outside of the heating season. However, the results may not be used to rule out exposures. For example, results indicating "no further action" or "monitoring required" must be verified during the heating season to ensure these actions are protective during the heating season as well.

SAMPLING ROUNDS

Investigating a soil vapor intrusion pathway usually requires more than one round of subsurface vapor, indoor air, and/or outdoor air sampling, for reasons such as the following:

- To characterize the nature and extent of subsurface vapor contamination (similar to the delineation of groundwater contamination) and to address corresponding exposure concerns;

- To evaluate fluctuations in concentrations due to
  - Different weather conditions (e.g., seasonal effects),
  - Changes in building conditions (e.g., various operating conditions of a building's HVAC system),
  - Changes in source strength, or
  - Vapor migration or contaminant biodegradation processes (particularly when degradation products may be more toxic than the parent compounds); or
- To confirm sampling results or the effectiveness of mitigation or remedial systems.

Overall, successive rounds of sampling are conducted until the following questions can be answered:

- Are subsurface vapors contaminated? If so, what are the nature and extent of contamination? What is/are the source(s) of the contamination?
- What are the current and potential exposures to contaminated subsurface vapors?
- What actions, if any, are needed to prevent or mitigate exposures and to remediate subsurface vapor contamination?

Toward this end, multiple rounds of sampling may be required to characterize the nature and extent of subsurface vapor contamination such that

- Both potential and current exposures are adequately addressed;
- Measures can be designed to remediate subsurface vapor contamination, either directly (e.g., SVE system) or indirectly (e.g., soil excavation or groundwater remediation), given that monitoring and mitigation are considered temporary measures implemented to address exposures related to vapor intrusion until contaminated environmental media are remediated; and
- The effectiveness of remedial measures can be monitored and confirmed (e.g., endpoint sampling).

ATTACHMENTS

Figure 1 *Soil Vapor/Indoor Air Matrix 1*
Figure 2 *Soil Vapor/Indoor Air Matrix 2*
Figure 3 *Schematics of a permanent soil vapor probe and permanent nested soil vapor probes*
Figure 4 *Schematic of a sub-slab vapor probe*
Figure 5 *Schematics of tracer gas applications*

Air Canister Field Record

Indoor Air Quality Questionnaire and Building Inventory

REFERENCES

New York State Department of Health, *Guidance for Evaluating Soil Vapor Intrusion in the State of New York*, February 2005.

New York State Department of Health, *Indoor Air Sampling & Analysis Guidance.* (February 1, 2005).

Office of Solid Waste and Emergency Response (OSWER). *Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)*. November 2002.

United States Environmental Protection Agency. *EPA Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air*. 1988

- Method TO-15, Determination of Volatile Organic Compounds (VOCs) in Air Collected in Specially Prepared Canisters and Analyzed by Gas Chromatography/Mass Spectrometry (GC/MS). Pp. 15-1 through 15-62.

- Method TO-17, Determination of Volatile Organic Compounds in Ambient Air using Active Sampling on Sorbent Tubes. Pp. 17-1 through 17-49.

- Compendium of Methods for the Determination of Air Pollutants in Indoor Air, EPA/600/4-90-010.

FIGURE 1

Soil Vapor/Indoor Air Matrix 1

October 2006

	INDOOR AIR CONCENTRATION of COMPOUND (mcg/m³)			
SUB-SLAB VAPOR CONCENTRATION of COMPOUND (mcg/m³)	< 0.25	0.25 to < 1	1 to < 5.0	5.0 and above
< 5	1. No further action	2. Take reasonable and practical actions to identify source(s) and reduce exposures	3. Take reasonable and practical actions to identify source(s) and reduce exposures	4. Take reasonable and practical actions to identify source(s) and reduce exposures
5 to < 50	5. No further action	6. MONITOR	7. MONITOR	8. MITIGATE
50 to < 250	9. MONITOR	10. MONITOR / MITIGATE	11. MITIGATE	12. MITIGATE
250 and above	13. MITIGATE	14. MITIGATE	15. MITIGATE	16. MITIGATE

No further action:
Given that the compound was not detected in the indoor air sample and that the concentration detected in the sub-slab vapor sample is not expected to significantly affect indoor air quality, no additional actions are needed to address human exposures.

Take reasonable and practical actions to identify source(s) and reduce exposures:
The concentration detected in the indoor air sample is likely due to indoor and/or outdoor sources rather than soil vapor intrusion given the concentration detected in the sub-slab vapor sample. Therefore, steps should be taken to identify potential source(s) and to reduce exposures accordingly (e.g., by keeping containers tightly capped or by storing volatile organic compound-containing products in places where people do not spend much time, such as a garage or outdoor shed). Resampling may be recommended to demonstrate the effectiveness of actions taken to reduce exposures.

MONITOR:
Monitoring, including sub-slab vapor, basement air, lowest occupied living space air, and outdoor air sampling, is needed to determine whether concentrations in the indoor air or sub-slab vapor have changed. Monitoring may also be needed to determine whether existing building conditions (e.g., positive pressure heating, ventilation and air-conditioning systems) are maintaining the desired mitigation endpoint and to determine whether changes are needed. The type and frequency of monitoring is determined on a site-specific and building-specific basis, taking into account applicable environmental data and building operating conditions. Monitoring is an interim measure required to evaluate exposures related to soil vapor intrusion until contaminated environmental media are remediated.

MITIGATE:
Mitigation is needed to minimize current or potential exposures associated with soil vapor intrusion. The most common mitigation methods are sealing preferential pathways in conjunction with installing a sub-slab depressurization system, and changing the pressurization of the building in conjunction with monitoring. The type, or combination of types, of mitigation is determined on a building-specific basis, taking into account building construction and operating conditions. Mitigation is considered a temporary measure implemented to address exposures related to soil vapor intrusion until contaminated environmental media are remediated.

MONITOR / MITIGATE:
Monitoring or mitigation may be recommended after considering the magnitude of sub-slab vapor and indoor air concentrations along with building- and site-specific conditions.

See additional notes on page 2.

MATRIX 1 Page 1 of 2

ADDITIONAL NOTES FOR MATRIX 1

This matrix summarizes the minimum actions recommended to address current and potential exposures related to soil vapor intrusion. To use the matrix appropriately as a tool in the decision-making process, the following should be noted:

[1] The matrix is generic. As such, it may be appropriate to modify a recommended action to accommodate building-specific conditions (e.g., dirt floor in basement, crawl spaces, etc.) and/or factors provided in Section 3.2 of the guidance (e.g., current land use, environmental conditions, etc.). For example, resampling may be recommended when the matrix indicates "no further action" for a particular building, but the results of adjacent buildings (especially sub-slab vapor results) indicate a need to take actions to address exposures related to soil vapor intrusion. Additionally, actions more protective of public health than those specified within the matrix may be proposed at any time. For example, the party implementing the actions may decide to install sub-slab depressurization systems on buildings where the matrix indicates "no further action" or "monitoring." Such an action is usually undertaken for reasons other than public health (e.g., seeking community acceptance, reducing excessive costs, etc.).

[2] Actions provided in the matrix are specific to addressing human exposures. Implementation of these actions does not preclude investigating possible sources of vapor contamination, nor does it preclude remediating contaminated soil vapors or the source of soil vapor contamination.

[3] Appropriate care should be taken during all aspects of sample collection to ensure that high quality data are obtained. Since the data are being used in the decision-making process, the laboratory analyzing the environmental samples must have current Environmental Laboratory Approval Program (ELAP) certification for the appropriate analyte and environmental matrix combinations. Furthermore, samples should be analyzed by methods that can achieve a minimum reporting limit of 0.25 microgram per cubic meter for indoor and outdoor air samples. For sub-slab vapor samples, a minimum reporting limit of 5 micrograms per cubic meter is recommended for buildings with full slab foundations, and 1 microgram per cubic meter for buildings with less than a full slab foundation.

[4] Sub-slab vapor and indoor air samples are typically collected when the likelihood of soil vapor intrusion to occur is considered to be the greatest (i.e., worst-case conditions). If samples are collected at other times (typically, samples collected outside of the heating season), then resampling during worst-case conditions may be appropriate to verify that actions taken to address exposures related to soil vapor intrusion are protective of human health.

[5] When current exposures are attributed to sources other than soil vapor intrusion, the agencies should be given documentation (e.g., applicable environmental data, completed indoor air sampling questionnaire, digital photographs, etc.) to support a proposed action other than that provided in the matrix box and to support agency assessment and follow-up.

[6] The party responsible for implementing the recommended actions will differ depending upon several factors, including the identified source of the volatile chemicals, the environmental remediation program, and site-specific and building-specific conditions. For example, to the extent that all site data and site conditions demonstrate that soil vapor intrusion is not occurring and that the potential for soil vapor intrusion to occur is not likely, the soil vapor intrusion investigation would be considered complete. In general, if indoor exposures represent a concern due to indoor sources, then the State will provide guidance to the property owner and/or tenant on ways to reduce their exposure. If indoor exposures represent a concern due to outdoor sources, then the NYSDEC will decide who is responsible for further investigation and any necessary remediation. Depending upon the outdoor source, this responsibility may or may not fall upon the party conducting the soil vapor intrusion investigation.

MATRIX 1 Page 2 of 2

FIGURE 2

Soil Vapor/Indoor Air Matrix 2

October 2006

SUB-SLAB VAPOR CONCENTRATION of COMPOUND (mcg/m³)	INDOOR AIR CONCENTRATION of COMPOUND (mcg/m³)			
	< 3	3 to < 30	30 to < 100	100 and above
< 100	1. No further action	2. Take reasonable and practical actions to identify source(s) and reduce exposures	3. Take reasonable and practical actions to identify source(s) and reduce exposures	4. Take reasonable and practical actions to identify source(s) and reduce exposures
100 to < 1,000	5. MONITOR	6. MONITOR / MITIGATE	7. MITIGATE	8. MITIGATE
1,000 and above	9. MITIGATE	10. MITIGATE	11. MITIGATE	12. MITIGATE

No further action:
Given that the compound was not detected in the indoor air sample and that the concentration detected in the sub-slab vapor sample is not expected to significantly affect indoor air quality, no additional actions are needed to address human exposures.

Take reasonable and practical actions to identify source(s) and reduce exposures:
The concentration detected in the indoor air sample is likely due to indoor and/or outdoor sources rather than soil vapor intrusion given the concentration detected in the sub-slab vapor sample. Therefore, steps should be taken to identify potential source(s) and to reduce exposures accordingly (e.g., by keeping containers tightly capped or by storing volatile organic compound-containing products in places where people do not spend much time, such as a garage or outdoor shed). Resampling may be recommended to demonstrate the effectiveness of actions taken to reduce exposures.

MONITOR:
Monitoring, including sub-slab vapor, basement air, lowest occupied living space air, and outdoor air sampling, is needed to determine whether concentrations in the indoor air or sub-slab vapor have changed. Monitoring may also be needed to determine whether existing building conditions (e.g., positive pressure heating, ventilation and air-conditioning systems) are maintaining the desired mitigation endpoint and to determine whether changes are needed. The type and frequency of monitoring is determined on a site-specific and building-specific basis, taking into account applicable environmental data and building operating conditions. Monitoring is an interim measure required to evaluate exposures related to soil vapor intrusion until contaminated environmental media are remediated.

MITIGATE:
Mitigation is needed to minimize current or potential exposures associated with soil vapor intrusion. The most common mitigation methods are sealing preferential pathways in conjunction with installing a sub-slab depressurization system, and changing the pressurization of the building in conjunction with monitoring. The type, or combination of types, of mitigation is determined on a building-specific basis, taking into account building construction and operating conditions. Mitigation is considered a temporary measure implemented to address exposures related to soil vapor intrusion until contaminated environmental media are remediated.

MONITOR / MITIGATE:
Monitoring or mitigation may be recommended after considering the magnitude of sub-slab vapor and indoor air concentrations along with building- and site-specific conditions.

See additional notes on page 2.

MATRIX 2 Page 1 of 2

ADDITIONAL NOTES FOR MATRIX 2

This matrix summarizes the minimum actions recommended to address current and potential exposures related to soil vapor intrusion. To use the matrix appropriately as a tool in the decision-making process, the following should be noted:

[1] The matrix is generic. As such, it may be appropriate to modify a recommended action to accommodate building-specific conditions (e.g., dirt floor in basement, crawl spaces, etc.) and/or factors provided in Section 3.2 of the guidance (e.g., current land use, environmental conditions, etc.). For example, resampling may be recommended when the matrix indicates "no further action" for a particular building, but the results of adjacent buildings (especially sub-slab vapor results) indicate a need to take actions to address exposures related to soil vapor intrusion. Additionally, actions more protective of public health than those specified within the matrix may be proposed at any time. For example, the party implementing the actions may decide to install sub-slab depressurization systems on buildings where the matrix indicates "no further action" or "monitoring." Such an action is usually undertaken for reasons other than public health (e.g., seeking community acceptance, reducing excessive costs, etc.).

[2] Actions provided in the matrix are specific to addressing human exposures. Implementation of these actions does not preclude investigating possible sources of vapor contamination, nor does it preclude remediating contaminated soil vapors or the source of soil vapor contamination.

[3] Appropriate care should be taken during all aspects of sample collection to ensure that high quality data are obtained. Since the data are being used in the decision-making process, the laboratory analyzing the environmental samples must have current Environmental Laboratory Approval Program (ELAP) certification for the appropriate analyte and environmental matrix combinations. Furthermore, samples should be analyzed by methods that can achieve a minimum reporting limit of 3 micrograms per cubic meter for indoor and outdoor air samples. For sub-slab vapor samples, a minimum reporting limit of 5 micrograms per cubic meter is recommended.

[4] Sub-slab vapor and indoor air samples are typically collected when the likelihood of soil vapor intrusion to occur is considered to be the greatest (i.e., worst-case conditions). If samples are collected at other times (typically, samples collected outside of the heating season), then resampling during worst-case conditions may be appropriate to verify that actions taken to address exposures related to soil vapor intrusion are protective of human health.

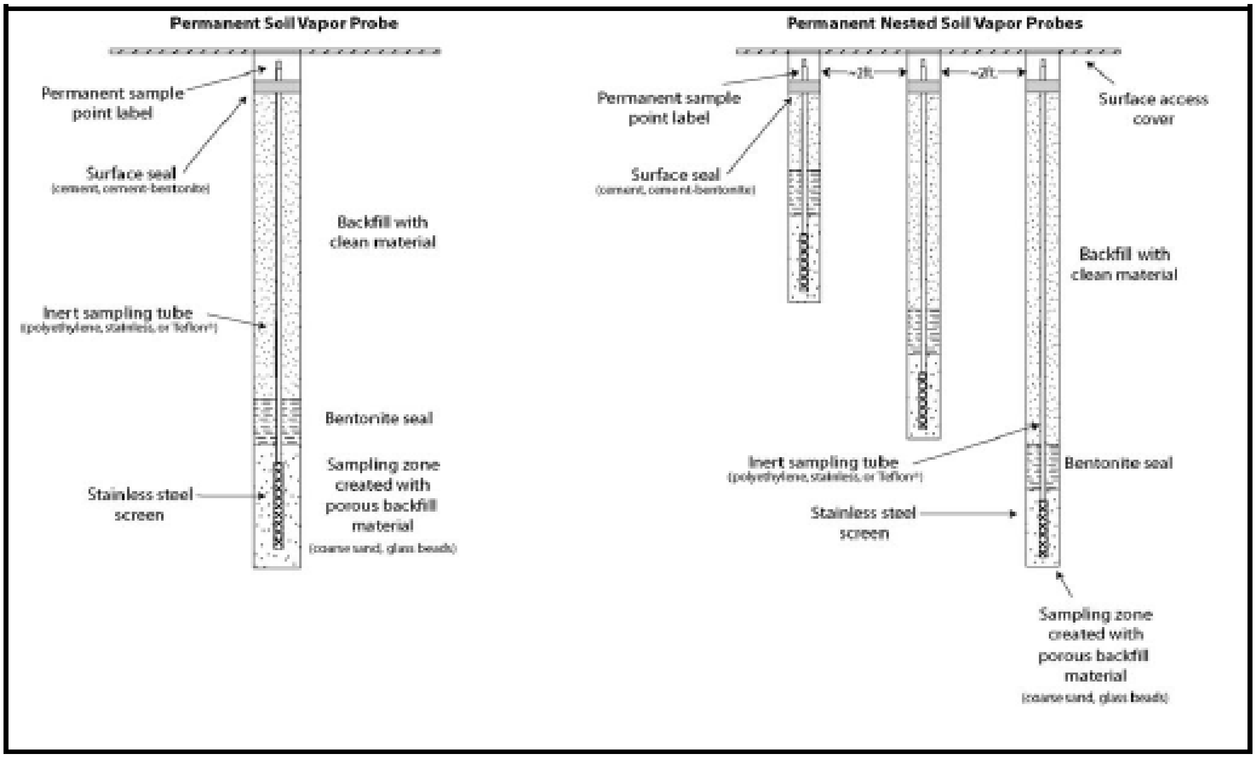
[5] When current exposures are attributed to sources other than soil vapor intrusion, the agencies should be given documentation (e.g., applicable environmental data, completed indoor air sampling questionnaire, digital photographs, etc.) to support a proposed action other than that provided in the matrix box and to support agency assessment and follow-up.

[6] The party responsible for implementing the recommended actions will differ depending upon several factors, including the identified source of the volatile chemicals, the environmental remediation program, and site-specific and building-specific conditions. For example, to the extent that all site data and site conditions demonstrate that soil vapor intrusion is not occurring and that the potential for soil vapor intrusion to occur is not likely, the soil vapor intrusion investigation would be considered complete. In general, if indoor exposures represent a concern due to indoor sources, then the State will provide guidance to the property owner and/or tenant on ways to reduce their exposure. If indoor exposures represent a concern due to outdoor sources, then the NYSDEC will decide who is responsible for further investigation and any necessary remediation. Depending upon the outdoor source, this responsibility may or may not fall upon the party conducting the soil vapor intrusion investigation.

MATRIX 2 Page 2 of 2

FIGURE 3

Schematics of a permanent soil vapor probe and permanent nested soil vapor probes



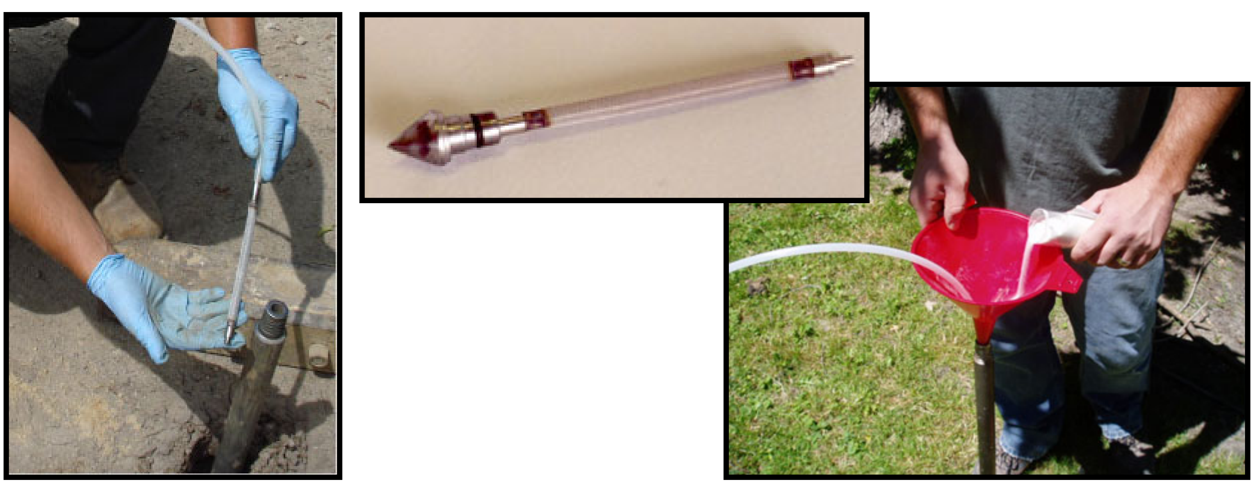
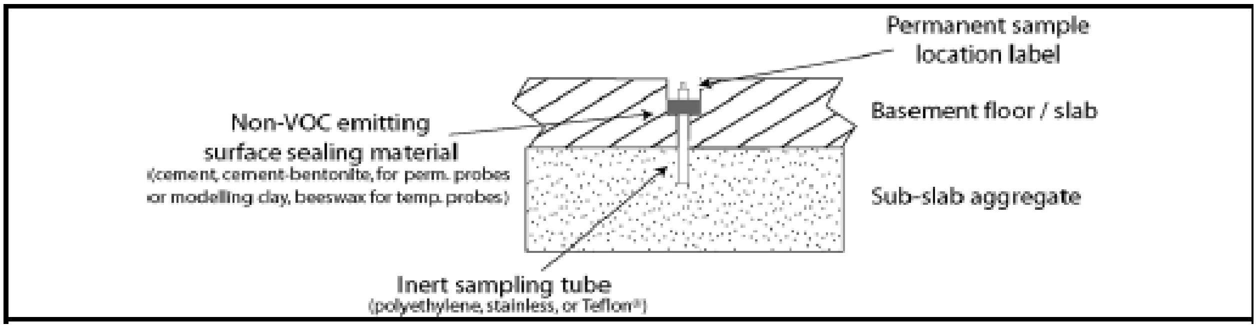


FIGURE 4

Schematic of a sub-slab vapor probe



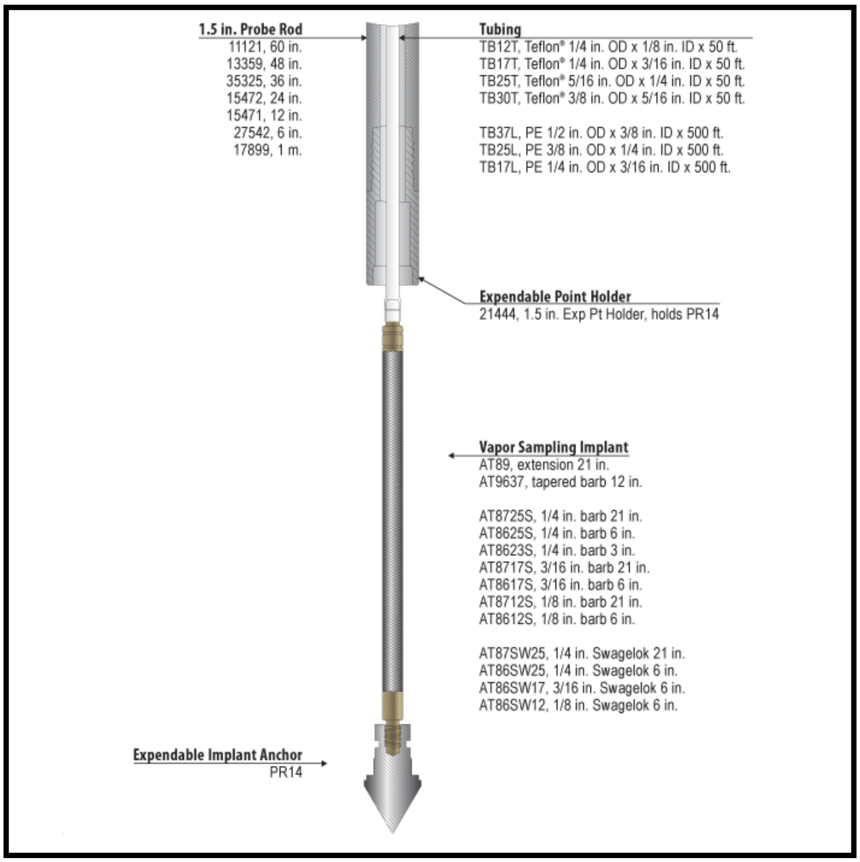
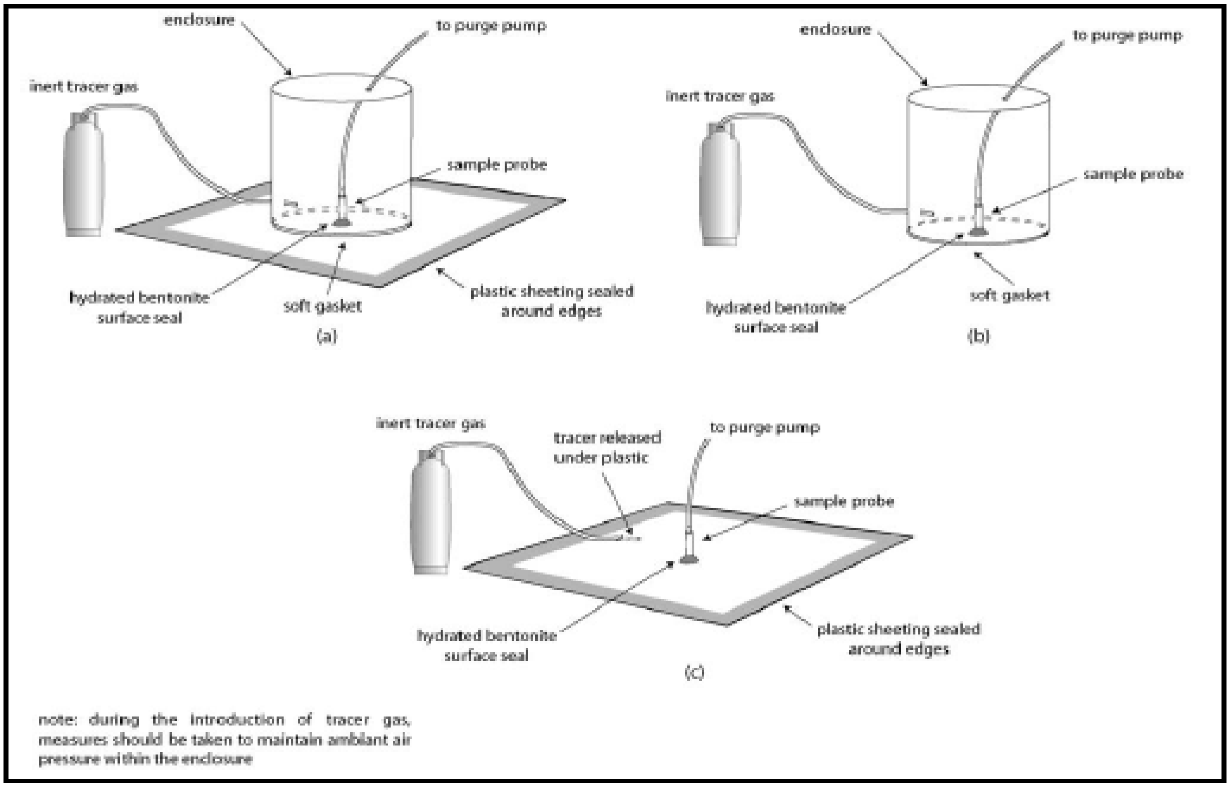


FIGURE 5

Schematics of tracer gas applications



BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

AIR CANISTER FIELD RECORD

PROJECT INFORMATION:

Project:
Job No:
Location:
Field Staff:
Client:

SAMPLE I.D.:

WEATHER CONDITIONS:

Ambient Air Temp. - A.M.:
Ambient Air Temp. - P.M.:
Wind Direction:
Wind Speed:
Precipitation:

Size of Canister:
Canister Serial No.:
Flow Controller No.:
Sample Date(s):
Shipping Date:
Sample Type: ☐ Indoor Air ☐ Outdoor Air ☐ Subslab, complete section below ☐ Soil Gas
Soil Gas Probe Depth:

FIELD SAMPLING INFORMATION:

READING	TIME	VACUUM (inches Hg) or PRESSURE (psig)	DATE	INITIALS
Lab Vacuum (on tag)				
Field Vacuum Check [1]				
Initial Field Vacuum [2]				
Final Field Vacuum [3]				
Duration of Sample Collection				

LABORATORY CANISTER PRESSURIZATION:

Initial Vacuum (inches Hg and psia)		
Final Pressure (psia)		
Pressurization Gas		

SUBSLAB SHROUD:

Shroud Helium Concentration:
Calculated tubing volume: x 3 =
Purged Tubing Volume Concentration:
Is the purged volume concentration less than or equal to 10% in shroud?
☐ YES, continue sampling
☐ NO, improve surface seal and retest

COMPOSITE TIME (hours)	FLOW RATE RANGE (ml/min)
15 Min.	316 - 333
0.5 Hours	158 - 166.7
1	79.2 - 83.3
2	39.6 - 41.7
4	19.8 - 20.8
6	13.2 - 13.9
8	9.9 - 10.4
10	7.92 - 8.3
12	6.6 - 6.9
24	3.5 - 4.0

NOTES:

1 Vacuum measured using portable vacuum gauge (provided by Lab)
2 Vacuum measured by canister gauge upon opening valve
3 Vacuum measured by canister gauge prior to closing valve

Signed:


BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

INDOOR AIR QUALITY QUESTIONNAIRE & BUILDING INVENTORY

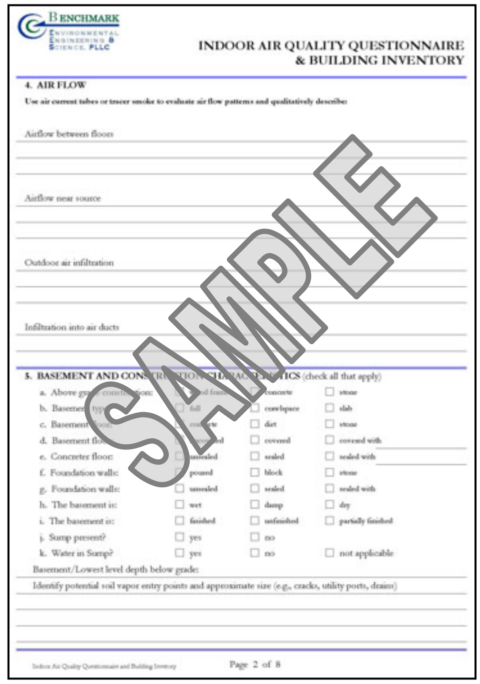
Project Name: Project No.
Project Location: Client:
Preparer's Name: Date/Time:
Preparer's Affiliation: Phone No:
Purpose of Investigation:

1. OCCUPANT:
Interviewed: yes no
Last Name: First Name:
Address:
County:
Home Phone: Office Phone:
Number of Occupants/persons at this location: Age of Occupants:

2. OWNER OR LANDLORD: (check if same as occupant)
Interviewed: yes no
Last Name: First Name:
Address:
County:
Home Phone: Office Phone:

3. BUILDING CHARACTERISTICS
Type of Building: (check appropriate response)
☐ Residential ☐ School ☐ Commercial/Multi-use
☐ Industrial ☐ Church ☐ Other:
If the property is residential, type? (check appropriate response)
☐ Ranch ☐ 2-Family ☐ 3-Family
☐ Raised Ranch ☐ Split Level ☐ Colonial
☐ Cape Cod ☐ Contemporary ☐ Mobile Home
☐ Duplex ☐ Apartment House ☐ Townhouse/Condo
☐ Modular ☐ Log Home ☐ Other:
If multiple units, how many?
If the property is commercial, type?
Business Type(s):
Does it include residences (i.e., multi-use)? yes no If yes, how many?
Other Characteristics:
Number of floors Building age
Is the building insulated? yes no How air tight? tight average not tight

Indoor Air Quality Questionnaire and Building Inventory Page 1 of 8

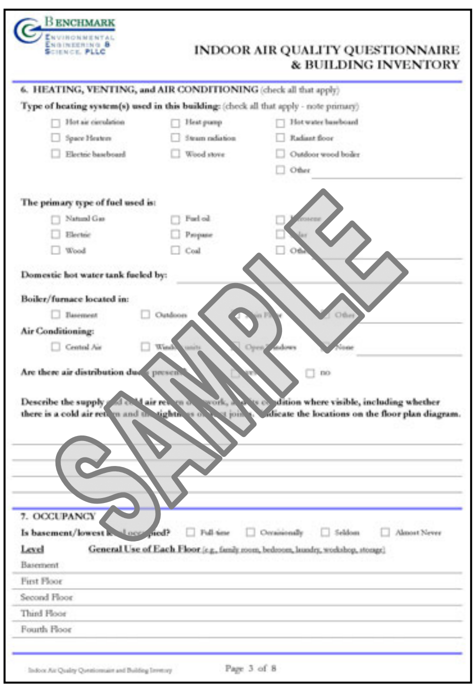

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

INDOOR AIR QUALITY QUESTIONNAIRE & BUILDING INVENTORY

4. AIR FLOW
Use air current tubes or tracer smoke to evaluate air flow patterns and qualitatively describe:
Airflow between floors
Airflow near source
Outdoor air infiltration
Infiltration into air ducts

5. BASEMENT AND CONSTRUCTION CHARACTERISTICS (check all that apply)
a. Above grade construction: ☐ wood frame ☐ concrete ☐ stone
b. Basement type: ☐ full ☐ crawlspace ☐ slab
c. Basement floor: ☐ concrete ☐ dirt ☐ stone
d. Basement floor: ☐ uncovered ☐ covered ☐ covered with
e. Concrete floor: ☐ unsealed ☐ sealed ☐ sealed with
f. Foundation walls: ☐ poured ☐ block ☐ stone
g. Foundation walls: ☐ unsealed ☐ sealed ☐ sealed with
h. The basement is: ☐ wet ☐ damp ☐ dry
i. The basement is: ☐ finished ☐ unfinished ☐ partially finished
j. Sump present? ☐ yes ☐ no
k. Water in Sump? ☐ yes ☐ no ☐ not applicable
Basement/Lowest level depth below grade:
Identify potential soil vapor entry points and approximate size (e.g., cracks, utility ports, drains)

Indoor Air Quality Questionnaire and Building Inventory Page 2 of 8


BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

INDOOR AIR QUALITY QUESTIONNAIRE & BUILDING INVENTORY

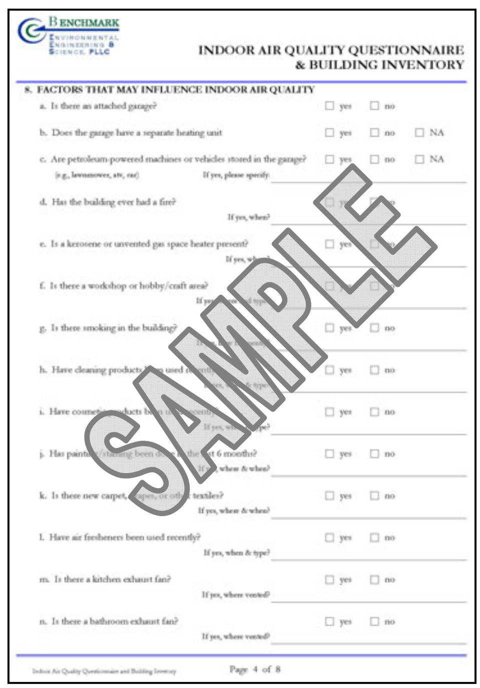
6. HEATING, VENTING, and AIR CONDITIONING (check all that apply)
Type of heating system(s) used in this building: (check all that apply - note primary)
☐ Hot air circulation ☐ Heat pump ☐ Hot water baseboard
☐ Space Heaters ☐ Steam radiation ☐ Radiant floor
☐ Electric baseboard ☐ Wood stove ☐ Outdoor wood boiler
☐ Other

The primary type of fuel used is:
☐ Natural Gas ☐ Fuel oil ☐ Kerosene
☐ Electric ☐ Propane ☐ Solar
☐ Wood ☐ Coal ☐ Other

Domestic hot water tank fueled by:
Boiler/furnace located in:
☐ Basement ☐ Outdoors ☐ Main Floor ☐ Other
Air Conditioning:
☐ Central Air ☐ Window units ☐ Open Windows ☐ None
Are there air distribution ducts present? ☐ yes ☐ no
Describe the supply and cold air return ductwork, and its condition where visible, including whether there is a cold air return and the tightness of duct joints. Indicate the locations on the floor plan diagram.

7. OCCUPANCY
Is basement/lowest level occupied? ☐ Full-time ☐ Occasionally ☐ Seldom ☐ Almost Never
Level General Use of Each Floor (e.g., family room, bedroom, laundry, workshop, storage)
Basement
First Floor
Second Floor
Third Floor
Fourth Floor

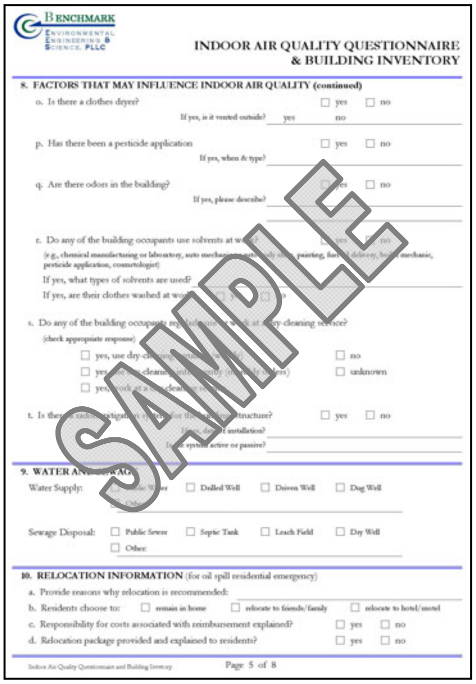
Indoor Air Quality Questionnaire and Building Inventory Page 3 of 8


BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

INDOOR AIR QUALITY QUESTIONNAIRE & BUILDING INVENTORY

8. FACTORS THAT MAY INFLUENCE INDOOR AIR QUALITY
a. Is there an attached garage? ☐ yes ☐ no
b. Does the garage have a separate heating unit ☐ yes ☐ no ☐ NA
c. Are petroleum-powered machines or vehicles stored in the garage? (e.g., lawnmower, atv, car) ☐ yes ☐ no ☐ NA If yes, please specify
d. Has the building ever had a fire? ☐ yes ☐ no If yes, when?
e. Is a kerosene or unvented gas space heater present? ☐ yes ☐ no If yes, where?
f. Is there a workshop or hobby/craft area? ☐ yes ☐ no If yes, where & type?
g. Is there smoking in the building? ☐ yes ☐ no If yes, how frequently?
h. Have cleaning products been used recently? ☐ yes ☐ no If yes, when & type?
i. Have cosmetic products been used recently? ☐ yes ☐ no If yes, when & type?
j. Has painting/staining been done in the last 6 months? ☐ yes ☐ no If yes, where & when?
k. Is there new carpet, drapes, or other textiles? ☐ yes ☐ no If yes, where & when?
l. Have air fresheners been used recently? ☐ yes ☐ no If yes, when & type?
m. Is there a kitchen exhaust fan? ☐ yes ☐ no If yes, where vented?
n. Is there a bathroom exhaust fan? ☐ yes ☐ no If yes, where vented?

Indoor Air Quality Questionnaire and Building Inventory Page 4 of 8



BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

INDOOR AIR QUALITY QUESTIONNAIRE & BUILDING INVENTORY

8. FACTORS THAT MAY INFLUENCE INDOOR AIR QUALITY (continued)

o. Is there a clothes dryer? ☐ yes ☐ no
If yes, is it vented outside? yes no

p. Has there been a pesticide application ☐ yes ☐ no
If yes, when & type?

q. Are there odors in the building? ☐ yes ☐ no
If yes, please describe?

r. Do any of the building occupants use solvents at work? ☐ yes ☐ no
(e.g., chemical manufacturing or laboratory, auto mechanic or auto body shop, painting, fuel oil delivery, boiler mechanic, pesticide application, cosmetologist)
If yes, what types of solvents are used?
If yes, are their clothes washed at work? ☐ yes ☐ no

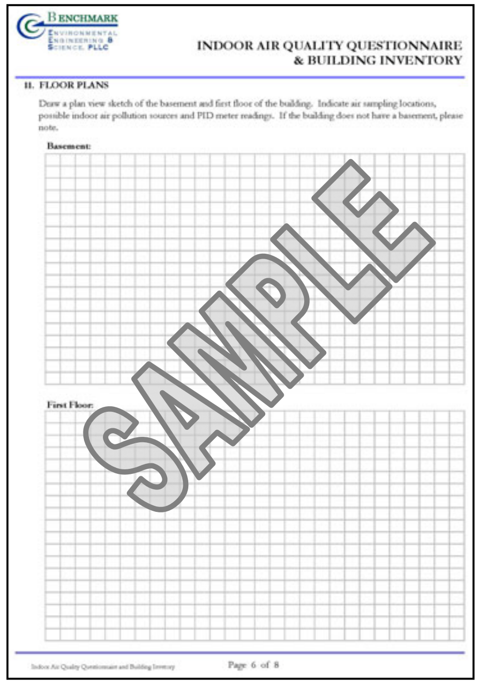
s. Do any of the building occupants regularly use or work at a dry-cleaning service?
(check appropriate response)
☐ yes, use dry-cleaning regularly (weekly) ☐ no
☐ yes, use dry-cleaning infrequently (monthly or less) ☐ unknown
☐ yes, work at a dry-cleaning service

t. Is there a radon mitigation system for the building/structure? ☐ yes ☐ no
If yes, date of installation?
Is the system active or passive?

9. WATER AND SEWAGE
Water Supply: ☐ Public Water ☐ Drilled Well ☐ Driven Well ☐ Dug Well ☐ Other:
Sewage Disposal: ☐ Public Sewer ☐ Septic Tank ☐ Leach Field ☐ Dry Well ☐ Other:

10. RELOCATION INFORMATION (for oil spill residential emergency)
a. Provide reasons why relocation is recommended:
b. Residents choose to: ☐ remain in home ☐ relocate to friends/family ☐ relocate to hotel/motel
c. Responsibility for costs associated with reimbursement explained? ☐ yes ☐ no
d. Relocation package provided and explained to residents? ☐ yes ☐ no

Indoor Air Quality Questionnaire and Building Inventory Page 5 of 8



BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

INDOOR AIR QUALITY QUESTIONNAIRE & BUILDING INVENTORY

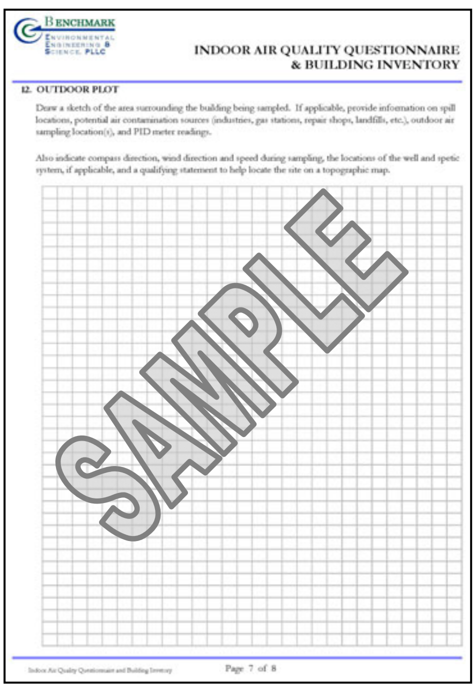
11. FLOOR PLANS

Draw a plan view sketch of the basement and first floor of the building. Indicate air sampling locations, possible indoor air pollution sources and PID meter readings. If the building does not have a basement, please note.

Basement:

First Floor:

Indoor Air Quality Questionnaire and Building Inventory Page 6 of 8



BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

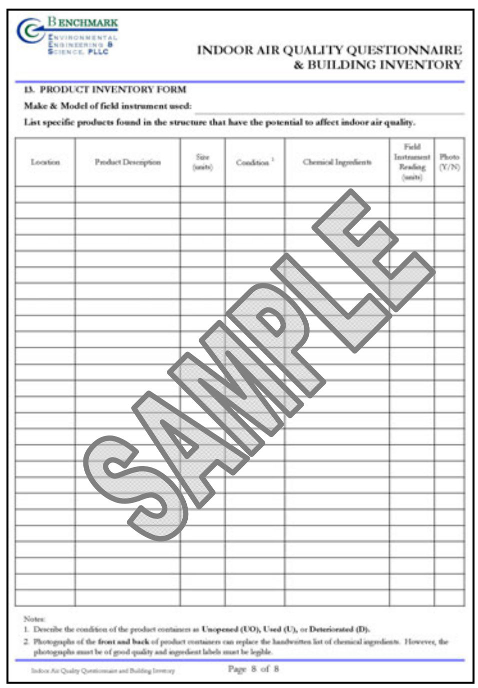
INDOOR AIR QUALITY QUESTIONNAIRE & BUILDING INVENTORY

12. OUTDOOR PLOT

Draw a sketch of the area surrounding the building being sampled. If applicable, provide information on spill locations, potential air contamination sources (industries, gas stations, repair shops, landfills, etc.), outdoor air sampling location(s), and PID meter readings.

Also indicate compass direction, wind direction and speed during sampling, the locations of the well and septic system, if applicable, and a qualifying statement to help locate the site on a topographic map.

Indoor Air Quality Questionnaire and Building Inventory Page 7 of 8



BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

INDOOR AIR QUALITY QUESTIONNAIRE & BUILDING INVENTORY

13. PRODUCT INVENTORY FORM

Make & Model of field instrument used:

List specific products found in the structure that have the potential to affect indoor air quality.

Location	Product Description	Size (units)	Condition [1]	Chemical Ingredients	Field Instrument Reading (units)	Photo (Y/N)

Notes:
1. Describe the condition of the product containers as **Unopened (UO), Used (U), or Deteriorated (D).**
2. Photographs of the **front and back** of product containers can replace the handwritten list of chemical ingredients. However, the photographs must be of good quality and ingredient labels must be legible.

Indoor Air Quality Questionnaire and Building Inventory Page 8 of 8

APPENDIX C

BUILDING INVENTORY QUESTIONNAIRE AND SAMPLE COLLECTION LOG

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

INDOOR AIR QUALITY QUESTIONNAIRE & BUILDING INVENTORY

Project Name:	Project No.
Project Location:	Client:
Preparer's Name:	Date/Time:
Preparer's Affiliation:	Phone No:
Purpose of Investigation:	

1. OCCUPANT:

Interviewed: yes no

Last Name:	First Name:
Address:	
County:	
Home Phone:	Office Phone:
Number of Occupants/persons at this location:	Age of Occupants:

2. OWNER OR LANDLORD: (check if same as occupant_____)

Interviewed: yes no

Last Name:	First Name:
Address:	
County:	
Home Phone:	Office Phone:

3. BUILDING CHARACTERISTICS

Type of Building: check appropriate response)

❑ Residential	❑ School	❑ Commercial/Multi-use
❑ Industrial	❑ Church	❑ Other:

If the property is residential, type? (check appropriate response)

❑ Ranch	❑ 2-Family	❑ 3-Family
❑ Raised Ranch	❑ Split Level	❑ Colonial
❑ Cape Cod	❑ Contemporary	❑ Mobile Home
❑ Duplex	❑ Apartment House	❑ Townhouse/Condo
❑ Modular	❑ Log Home	❑ Other:

If multiple units, how many?

If the property is commercial, type?

Business Type(s):

Does it include residences (i.e., multi-use)? yes no If yes, how many?

Other Characteristics:

Number of floors Building age

Is the building insulated? yes no How air tight? tight average not tight

4. AIR FLOW

Use air current tubes or tracer smoke to evaluate air flow patterns and qualitatively describe:

Airflow between floors

Airflow near source

Outdoor air infiltration

Infiltration into air ducts

5. BASEMENT AND CONSTRUCTION CHARACTERISTICS (check all that apply)

a. Above grade construction:	☐ wood frame	☐ concrete	☐ stone
b. Basement type:	☐ full	☐ crawlspace	☐ slab
c. Basement floor:	☐ concrete	☐ dirt	☐ stone
d. Basement floor:	☐ uncovered	☐ covered	☐ covered with
e. Concreter floor:	☐ unsealed	☐ sealed	☐ sealed with
f. Foundation walls:	☐ poured	☐ block	☐ stone
g. Foundation walls:	☐ unsealed	☐ sealed	☐ sealed with
h. The basement is:	☐ wet	☐ damp	☐ dry
i. The basement is:	☐ finished	☐ unfinished	☐ partially finished
j. Sump present?	☐ yes	☐ no	
k. Water in Sump?	☐ yes	☐ no	☐ not applicable

Basement/Lowest level depth below grade:

Identify potential soil vapor entry points and approximate size (e.g., cracks, utility ports, drains)

6. HEATING, VENTING, and AIR CONDITIONING (check all that apply)

Type of heating system(s) used in this building: (check all that apply - note primary)

☐ Hot air circulation	☐ Heat pump	☐ Hot water baseboard
☐ Space Heaters	☐ Steam radiation	☐ Radiant floor
☐ Electric baseboard	☐ Wood stove	☐ Outdoor wood boiler
		☐ Other ______

The primary type of fuel used is:

☐ Natural Gas	☐ Fuel oil	☐ Kerosene
☐ Electric	☐ Propane	☐ Solar
☐ Wood	☐ Coal	☐ Other ______

Domestic hot water tank fueled by: ______

Boiler/furnace located in:

☐ Basement ☐ Outdoors ☐ Main Floor ☐ Other ______

Air Conditioning:

☐ Central Air ☐ Window units ☐ Open Windows ☐ None ______

Are there air distribution ducts present? ☐ yes ☐ no

Describe the supply and cold air return ductwork, and its condition where visible, including whether there is a cold air return and the tightness of duct joints. Indicate the locations on the floor plan diagram.

______

______

______

______

7. OCCUPANCY

Is basement/lowest level occupied? ☐ Full-time ☐ Occaisionally ☐ Seldom ☐ Almost Never

Level	**General Use of Each Floor** (e.g., family room, bedroom, laundry, workshop, storage)
Basement	
First Floor	
Second Floor	
Third Floor	
Fourth Floor	

INDOOR AIR QUALITY QUESTIONNAIRE & BUILDING INVENTORY

8. FACTORS THAT MAY INFLUENCE INDOOR AIR QUALITY

a. Is there an attached garage? ❑ yes ❑ no

b. Does the garage have a separate heating unit? ❑ yes ❑ no ❑ NA

c. Are petroleum-powered machines or vehicles stored in the garage? ❑ yes ❑ no ❑ NA
(e.g., lawnmower, atv, car) If yes, please specify: ______________

d. Has the building ever had a fire? ❑ yes ❑ no
If yes, when? ______________

e. Is a kerosene or unvented gas space heater present? ❑ yes ❑ no
If yes, where? ______________

f. Is there a workshop or hobby/craft area? ❑ yes ❑ no
If yes, where and type? ______________

g. Is there smoking in the building? ❑ yes ❑ no
If yes, how frequently? ______________

h. Have cleaning products been used recently? ❑ yes ❑ no
If yes, when & type? ______________

i. Have cosmetic products been used recently? ❑ yes ❑ no
If yes, when & type? ______________

j. Has painting/staining been done in the last 6 months? ❑ yes ❑ no
If yes, where & when? ______________

k. Is there new carpet, drapes, or other textiles? ❑ yes ❑ no
If yes, where & when? ______________

l. Have air fresheners been used recently? ❑ yes ❑ no
If yes, when & type? ______________

m. Is there a kitchen exhaust fan? ❑ yes ❑ no
If yes, where vented? ______________

n. Is there a bathroom exhaust fan? ❑ yes ❑ no
If yes, where vented? ______________

8. FACTORS THAT MAY INFLUENCE INDOOR AIR QUALITY (continued)

o. Is there a clothes dryer? ☐ yes ☐ no

If yes, is it vented outside? yes no

p. Has there been a pesticide application? ☐ yes ☐ no

If yes, when & type? ______

q. Are there odors in the building? ☐ yes ☐ no

If yes, please describe? ______

r. Do any of the building occupants use solvents at work? ☐ yes ☐ no

(e.g., chemical manufacturing or laboratory, auto mechanic or auto body shop, painting, fuel oil delivery, boiler mechanic, pesticide application, cosmetologist)

If yes, what types of solvents are used? ______

If yes, are their clothes washed at work? ☐ yes ☐ no

s. Do any of the building occupants regularly use or work at a dry-cleaning service?

(check appropriate response)

- ☐ yes, use dry-cleaning regularly (weekly)
- ☐ no
- ☐ yes, use dry-cleaning infrequently (monthly or less)
- ☐ unknown
- ☐ yes, work at a dry-cleaning service

t. Is there a radon mitigation system for the building/structure? ☐ yes ☐ no

If yes, date of installation? ______

Is the system active or passive? ______

9. WATER AND SEWAGE

Water Supply: ☐ Public Water ☐ Drilled Well ☐ Driven Well ☐ Dug Well ☐ Other: ______

Sewage Disposal: ☐ Public Sewer ☐ Septic Tank ☐ Leach Field ☐ Dry Well ☐ Other: ______

10. RELOCATION INFORMATION (for oil spill residential emergency)

a. Provide reasons why relocation is recommended: ______

b. Residents choose to: ☐ remain in home ☐ relocate to friends/family ☐ relocate to hotel/motel

c. Responsibility for costs associated with reimbursement explained? ☐ yes ☐ no

d. Relocation package provided and explained to residents? ☐ yes ☐ no

11. FLOOR PLANS

Draw a plan view sketch of the basement and first floor of the building. Indicate air sampling locations, possible indoor air pollution sources and PID meter readings. If the building does not have a basement, please note.

Basement:

First Floor:

12. OUTDOOR PLOT

Draw a sketch of the area surrounding the building being sampled. If applicable, provide information on spill locations, potential air contamination sources (industries, gas stations, repair shops, landfills, etc.), outdoor air sampling location(s), and PID meter readings.

Also indicate compass direction, wind direction and speed during sampling, the locations of the well and spetic system, if applicable, and a qualifying statement to help locate the site on a topographic map.

13. PRODUCT INVENTORY FORM

Make & Model of field instrument used: ______________________

List specific products found in the structure that have the potential to affect indoor air quality.

Location	Product Description	Size (units)	Condition [1]	Chemical Ingredients	Field Instrument Reading (units)	Photo (Y/N)

Notes:
1. Describe the condition of the product containers as **Unopened (UO), Used (U),** or **Deteriorated (D).**
2. Photographs of the **front and back** of product containers can replace the handwritten list of chemical ingredients. However, the photographs must be of good quality and ingredient labels must be legible.

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

AIR CANISTER FIELD RECORD

PROJECT INFORMATION:

Project:
Job No:
Location:
Field Staff:
Client:

SAMPLE I.D.:

Size of Canister:
Canister Serial No.:
Flow Controller No.:
Sample Date(s):
Shipping Date:
Sample Type: ☐ Indoor Air ☐ Outdoor Air
☐ Subslab, complete section below ☐ Soil Gas
Soil Gas Probe Depth:

WEATHER CONDITIONS:

Ambient Air Temp. - A.M.:
Ambient Air Temp. - P.M.:
Wind Direction:
Wind Speed:
Precipitation:

FIELD SAMPLING INFORMATION:

READING	TIME	VACUUM (inches Hg) or PRESSURE (psig)	DATE	INITIALS
Lab Vacuum (on tag)				
Field Vacuum Check [1]				
Initial Field Vacuum [2]				
Final Field Vacuum [3]				
Duration of Sample Collection				

LABORATORY CANISTER PRESSURIZATION:

Initial Vacuum (inches Hg and psia)		
Final Pressure (psia)		
Pressurization Gas		

SUBSLAB SHROUD:

Shroud Helium Concentration:
Calculated tubing volume: x 3 =
Purged Tubing Volume Concentration:
Is the purged volume concentration less than or equal to 10% in shroud?
☐ YES, continue sampling
☐ NO, improve surface seal and retest

COMPOSITE TIME (hours)	FLOW RATE RANGE (ml/min)
15 Min.	316 - 333
0.5 Hours	158 - 166.7
1	79.2 - 83.3
2	39.6 - 41.7
4	19.8 - 20.8
6	13.2 - 13.9
8	9.9 - 10.4
10	7.92 - 8.3
12	6.6 - 6.9
24	3.5 - 4.0

NOTES:

1 Vacuum measured using portable vacuum gauge (provided by Lab)
2 Vacuum measured by canister gauge upon opening valve
3 Vacuum measured by canister gauge prior to closing valve

Signed: