CONRAD GREBEL UNIVERSITY COLLEGE RESIDENCE RETROFIT STUDY

FINAL REPORT: JULY 2024

APPENDICES

A	Investigated Retrofit Solutions Packages
B	Cost Report
C	Energy Report
D	Baseline and Proposed Envelope Values
E	Code Analysis

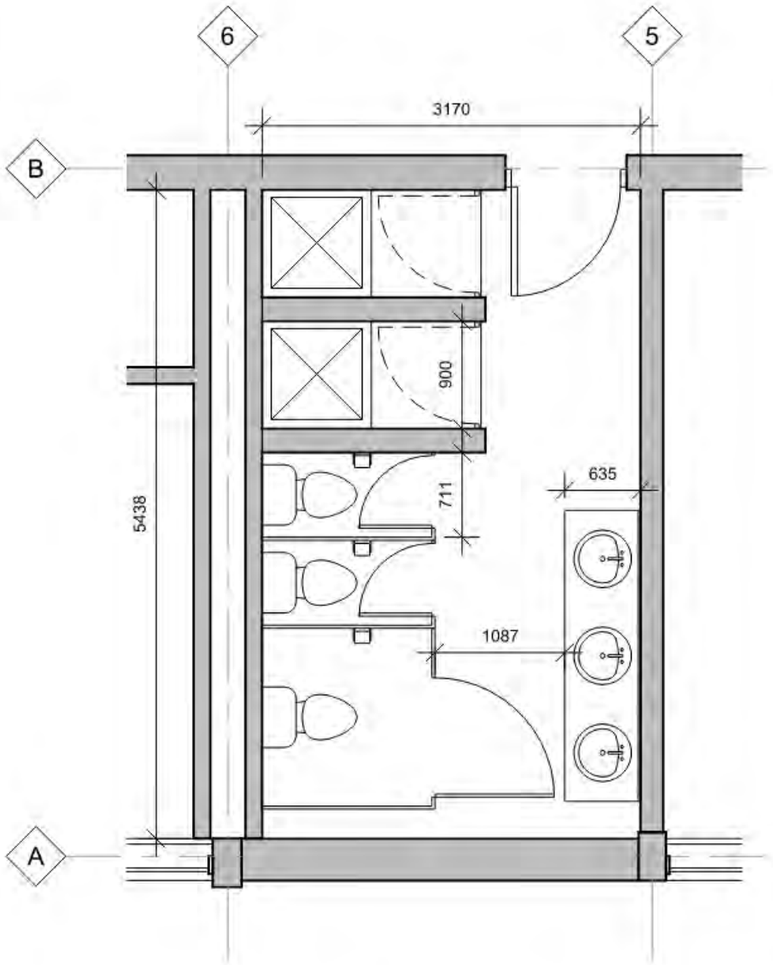
Conrad Grebel University College

Baird Sampson Neuert architects

WALTERFEDY

Appendix A: Investigated Retrofit Solutions Packages

Package 1: Washroom Update (Gender-Neutral)



1 / A20 TYPICAL WASHROOM EXISTING
Scale: 1 : 50

BSN explored several options to convert the existing dormitory washrooms at Conrad Grebel University College into gender neutral washrooms that meet 2024 OBC code requirements. Out of this design exercise came 4 feasible options.

Option 1 is the "refresh" option, where minimal interventions update the existing washroom so that more privacy is given to what is already there. This would include new high privacy water closet partitions and new high privacy doors for the showers. A durable solid surface sink station will replace the existing one. New plumbing fixtures and updated pipes are included. BSN recommends new tiling be installed on the floors and walls for this option, as well as a fresh coat of paint to clearly differentiate between the old gendered and new gender neutral space.

Option 2 and 3 are "ensuite" variations. Dimensions in these options are tighter but provide more privacy (the main objective of a gender neutral washroom) than Option 1. *However Options 2 and 3 require Washroom 4941 to be renovated as Option 1 to satisfy OBC Table 3.8.2.3.B.*

Option 2 includes toilet, sink, and shower in three rooms. The downside of this Option is that only three users may use the washroom at a time.

Option 3 has toilet and shower in three rooms with a sink station in the formed hallway. More users are able to use this option at a given time.

Option 4 includes moving one washroom bay next door to an existing, then knocking down the wall between the two. The vacant unit will be converted to the displaced dorm room. The west and east walls host shower and toilet stalls (the east furred out for a chase) with high privacy partitions, which encircle a central sink station. One new barrier-free toilet and one barrier-free shower will be provided to meet code requirements.

The four (4) gender neutral washroom Options shall be cost separately.

SHOWER STALL DOORS NOT HIGHLY SECURE NOR ROBUST FOR PRIVACY

EXISTING STEP INTO SHOWER STALL IS AWKWARD (NON-ACCESSIBLE)

SHOWER CURTAIN NOT HIGHLY SECURE NOR ROBUST FOR PRIVACY

EXISTING STEP INTO SHOWER STALL IS AN ACCESSIBILITY ISSUE AND TRIPPING HAZARD

STALL DOORS NOT HIGHLY SECURE. GAPS AROUND DOOR DO NOT PROVIDE HIGH-LEVEL PRIVACY

BARRIER-FREE STALL NOT REQ. IN ALL WASHROOMS B/C OF UNIVERSAL WASHROOM RENOVATIONS PER OBC TABLE 3.8.2.3.B.

PINCHPOINT BETWEEN SINKS AND SHOWER WALL

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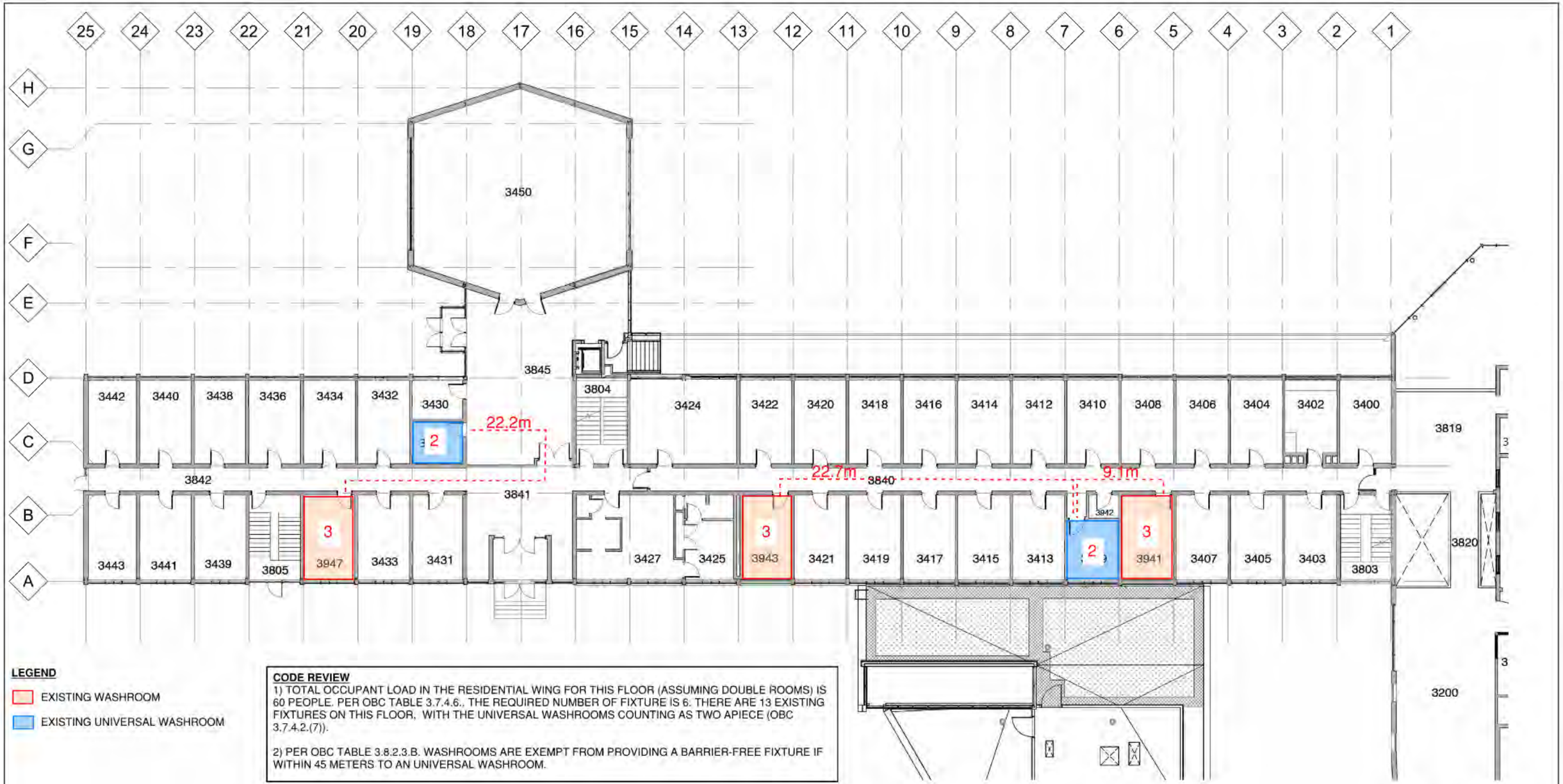
TITLE:
PACKAGE 1 GENDER NEUTRAL WASHROOMS

Scale 1 : 50

0 0.5 1 2.5 5 m

SHEET No.:



LEGEND

- EXISTING WASHROOM
- EXISTING UNIVERSAL WASHROOM

CODE REVIEW

1) TOTAL OCCUPANT LOAD IN THE RESIDENTIAL WING FOR THIS FLOOR (ASSUMING DOUBLE ROOMS) IS 60 PEOPLE. PER OBC TABLE 3.7.4.6., THE REQUIRED NUMBER OF FIXTURE IS 6. THERE ARE 13 EXISTING FIXTURES ON THIS FLOOR, WITH THE UNIVERSAL WASHROOMS COUNTING AS TWO APIECE (OBC 3.7.4.2.(7)).

2) PER OBC TABLE 3.8.2.3.B. WASHROOMS ARE EXEMPT FROM PROVIDING A BARRIER-FREE FIXTURE IF WITHIN 45 METERS TO AN UNIVERSAL WASHROOM.

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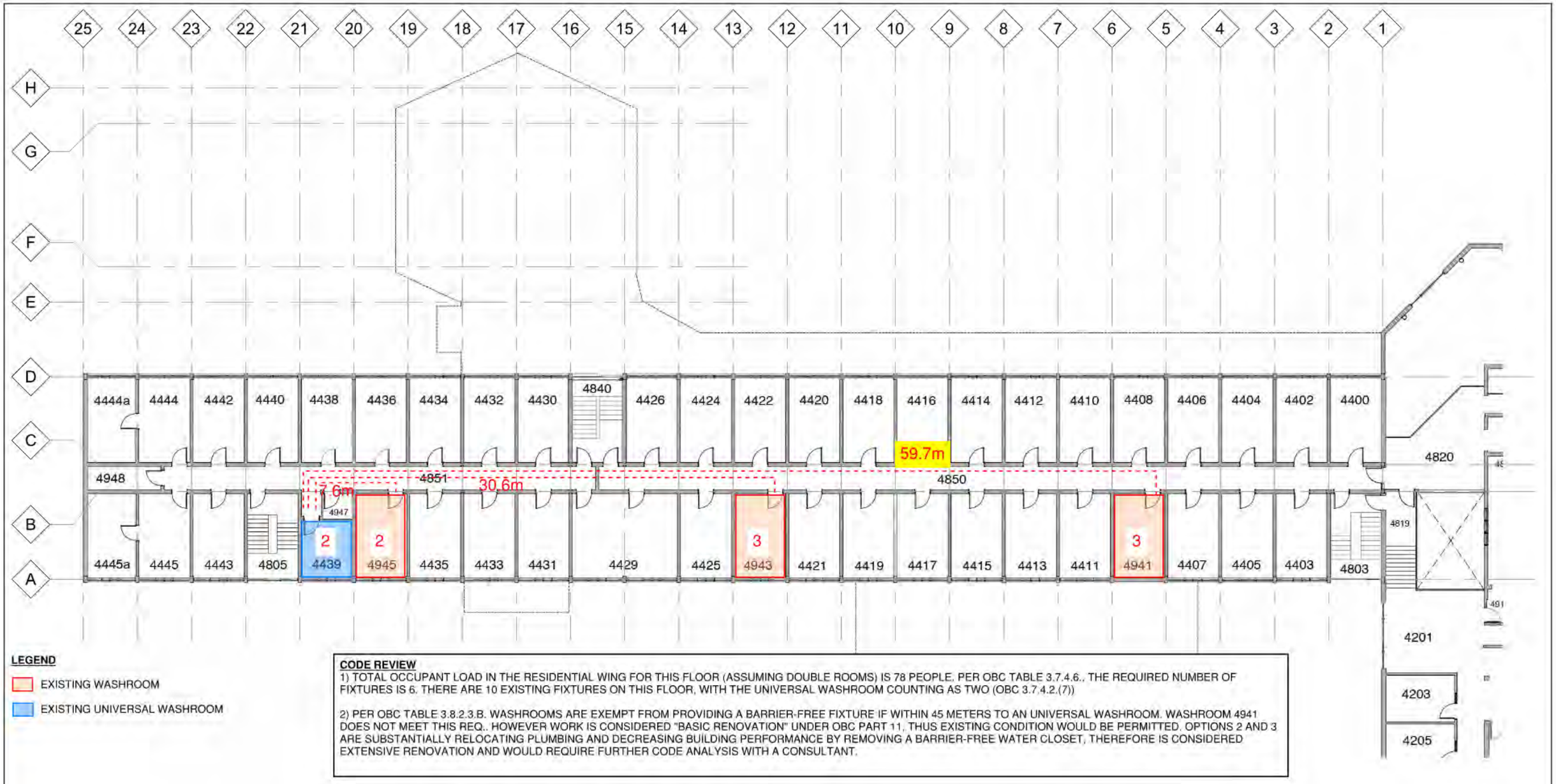
TITLE:
THIRD FLOOR PLAN

Scale 1 : 250

0 2.5 5 12.5 25 m

SHEET No.:



LEGEND

- EXISTING WASHROOM
- EXISTING UNIVERSAL WASHROOM

CODE REVIEW

1) TOTAL OCCUPANT LOAD IN THE RESIDENTIAL WING FOR THIS FLOOR (ASSUMING DOUBLE ROOMS) IS 78 PEOPLE. PER OBC TABLE 3.7.4.6., THE REQUIRED NUMBER OF FIXTURES IS 6. THERE ARE 10 EXISTING FIXTURES ON THIS FLOOR, WITH THE UNIVERSAL WASHROOM COUNTING AS TWO (OBC 3.7.4.2.(7))

2) PER OBC TABLE 3.8.2.3.B. WASHROOMS ARE EXEMPT FROM PROVIDING A BARRIER-FREE FIXTURE IF WITHIN 45 METERS TO AN UNIVERSAL WASHROOM. WASHROOM 4941 DOES NOT MEET THIS REQ.. HOWEVER WORK IS CONSIDERED "BASIC RENOVATION" UNDER OBC PART 11, THUS EXISTING CONDITION WOULD BE PERMITTED. OPTIONS 2 AND 3 ARE SUBSTANTIALLY RELOCATING PLUMBING AND DECREASING BUILDING PERFORMANCE BY REMOVING A BARRIER-FREE WATER CLOSET, THEREFORE IS CONSIDERED EXTENSIVE RENOVATION AND WOULD REQUIRE FURTHER CODE ANALYSIS WITH A CONSULTANT.

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TITLE:
FOURTH FLOOR PLAN

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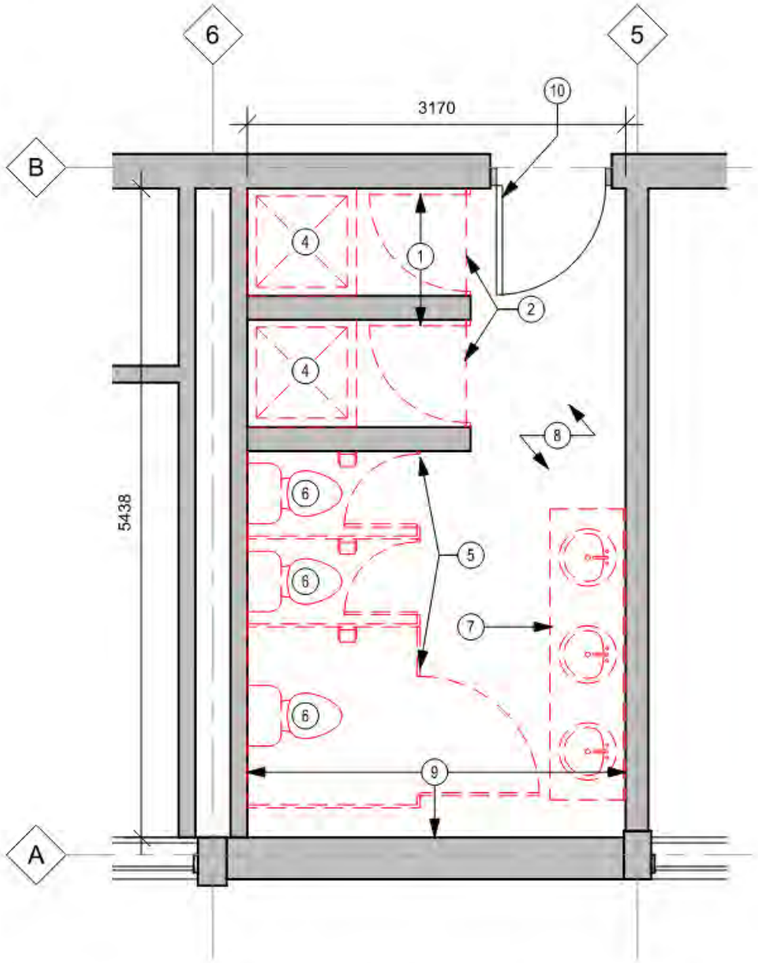
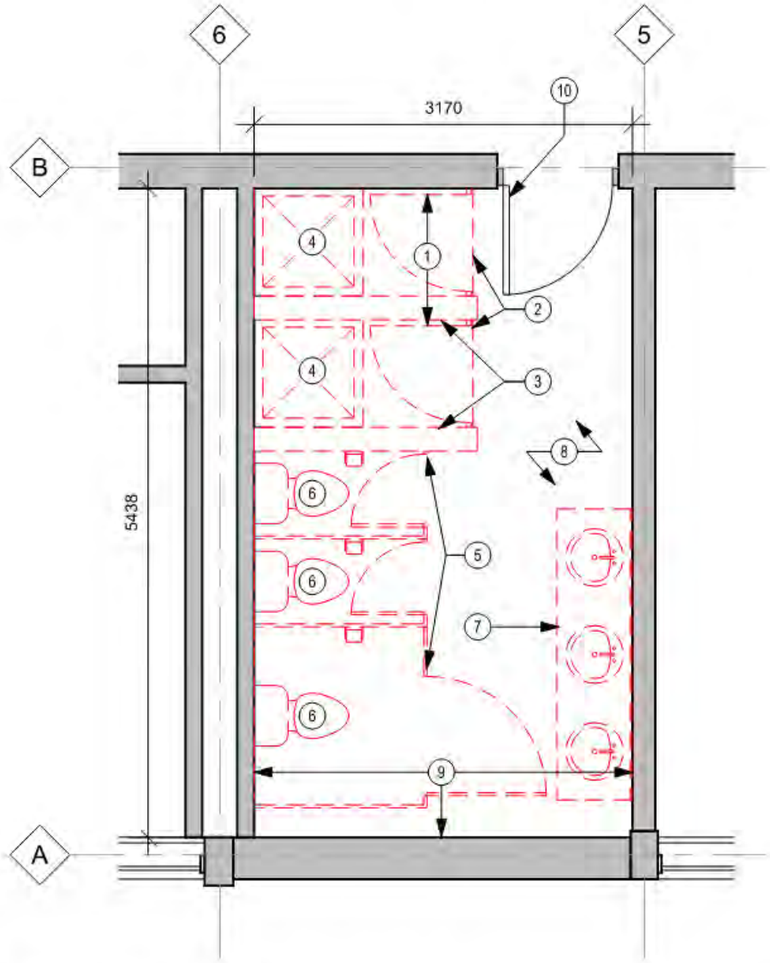
Scale 1 : 250

0 2.5 5 12.5 25 m

SHEET No.:



1 / A21 GENDER NEUTRAL OPTION 1 DEMO
Scale: 1 : 50



2 / A21 GENDER NEUTRAL OPTION 2A&B DEMO
Scale: 1 : 50

DRAWING NOTES:

1. Remove shower doors and hardware.
2. Remove tile on curb face. Prep surface for new tile.
3. Demo CMU wall.
4. Remove shower. Demolish built-up floor in shower. Prep surface for new tile.
5. Remove bathroom stall doors, hardware, and walls.
6. Remove toilet fixture. Patch and repair wall.
7. Remove sink and laminate counter. Patch and repair wall.
8. Remove existing floor tile. Prep slab for new tile.
9. Remove existing tile on walls. Prep surface for new tile.
10. Remove door and hardware.

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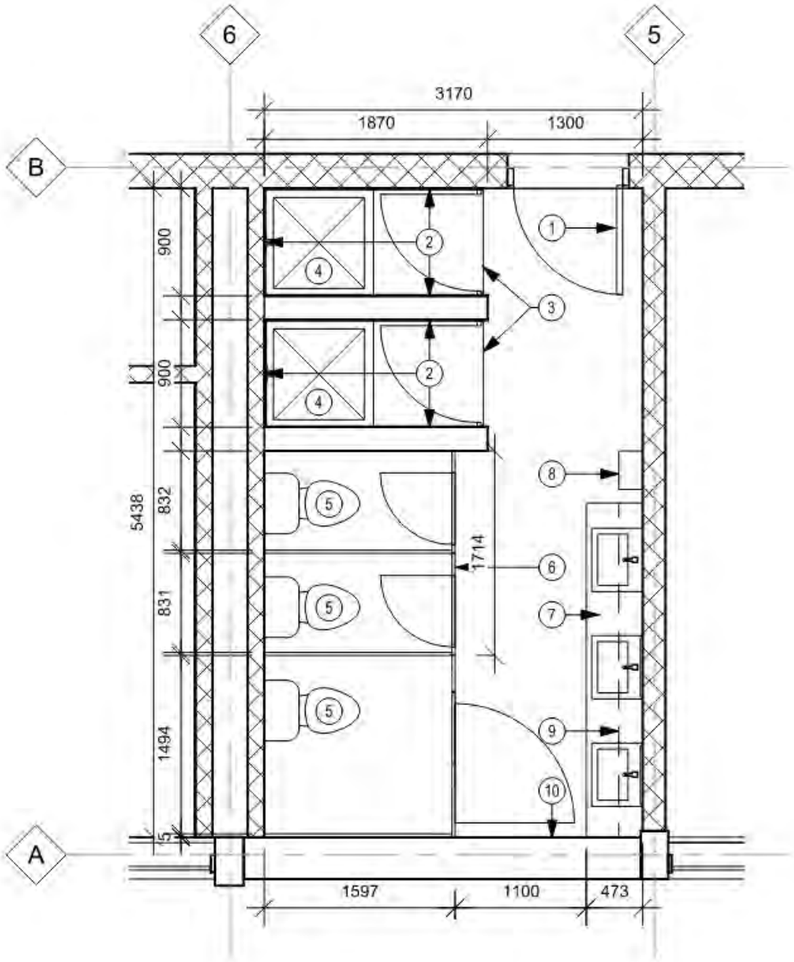
TITLE:
TYPICAL WASHROOM - DEMOLITION PLANS

Scale 1 : 50

0 0.5 1 2.5 5 m

SHEET No.:



DRAWING NOTES:

1. Remove door and switch hardware to reverse door swing.
2. New full-length tile on shower walls.
3. Face of curb. Tile to match shower walls.
4. New shower. New tile on shower floors. Slope floor towards drain. New faucet and drain, refer to mechanical.
5. New wall-mounted toilet fixtures to align with coreslab. Refer to mechanical.
6. New Bobrick Duraline Series Gap-free Maximum Height, or equivalent.
7. New Sloan 3-Station Wall-Mounted Counter Top sink, or equivalent. Corian countertop, faucets and soap dispensers provided.
8. New paper towel dispenser
9. New wall-mounted Formica shelf.
10. Wall-mounted stainless steel hooks along wall.

3RD FLOOR KEY PLAN | 1:600

4TH FLOOR KEY PLAN | 1:600

LEGEND:

- EXISTING WASHROOM UPGRADED TO GENDER NEUTRAL WASHROOM
- EXISTING UNIVERSAL WASHROOM TO REMAIN

SCOPE:

Remove all doors, plumbing fixtures, and floor and wall tiles and replace with new. Demo raised floors in showers - see demo sheet 1.

This is the "refresh" option where existing conditions are updated to provide more privacy. Door to washroom is existing with switched hardware. Plumbing fixtures, floor & wall tiling are updated. Existing water closet partitions are replaced with high privacy variation. See drawing notes for further information.

Existing windows and walls to be removed and reconfigured with existing height IGUs and solid wall beneath. Exclude exterior wall and window costs, which are to be captured in package 2 and 7. Plumbing fixtures are replaced with commercial quality units. Extend exhaust ventilation so that each shower stall and each toilet stall have independent exhaust grilles. Electrical scope includes new lighting fixture replacement, and receptacle modification.

Red washrooms above are upgraded with "refresh" Option 1.

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TITLE:
GENDER NEUTRAL WASHROOM OPTION 1

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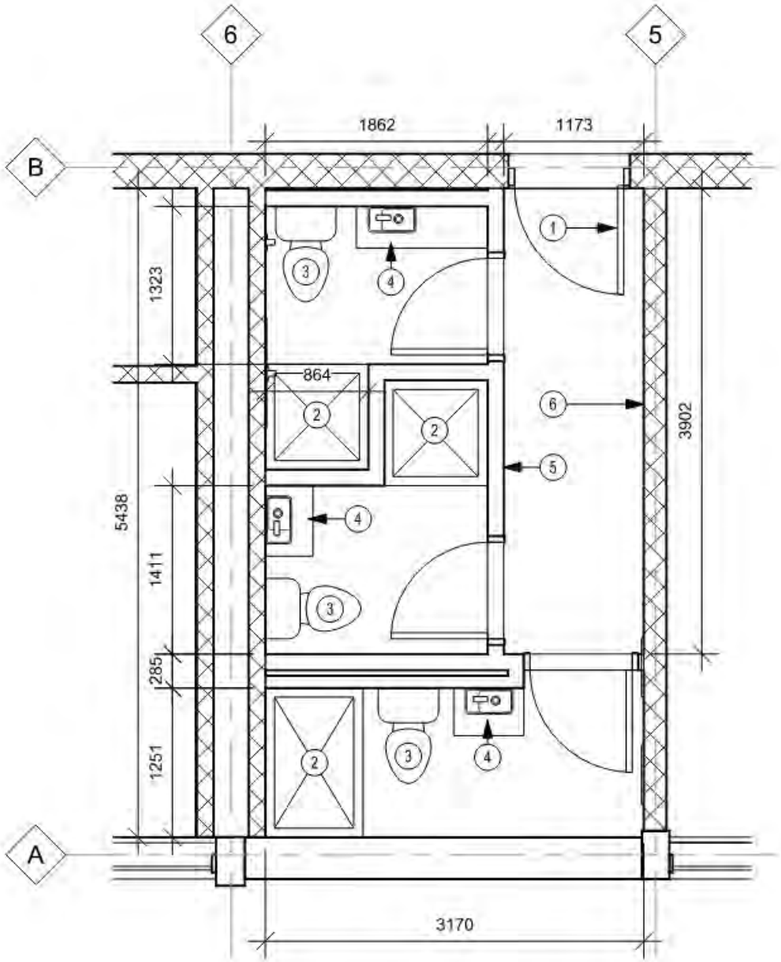
WALTERFEDY

Scale 1 : 50

0 0.5 1 2.5 5 m

SHEET No.:



DRAWING NOTES:

1. Remove door and switch hardware to reverse door swing.
2. New shower tray, faucet, and drain. Tile full walls to edge of tray. Drain to align with Coreslab, refer to mechanical.
3. New wall-mounted toilet fixtures. Refer to mechanical.
4. New surface mount sink on solid surface countertop - DURAVIT AG D-neo hand sink, or equivalent.
5. New metal stud wall with painted gypsum finish.Typical.
6. New full-height tile on wall. Install stainless steel hooks along length of wall.

3RD FLOOR KEY PLAN | 1:600

4TH FLOOR KEY PLAN | 1:600

LEGEND:

- EXISTING WASHROOM UPGRADED TO GENDER NEUTRAL WASHROOM
- EXISTING WASHROOM EXCEEDING ALLOWABLE DISTANCE FROM UNIVERSAL WASHROOM. REQUIRES FURTHER CODE REVIEW FOR EXTENSIVE RENOVATION.
- EXISTING UNIVERSAL WASHROOM TO REMAIN

SCOPE:

Remove all doors, plumbing fixtures, and floor and wall tiles and replace with new. Demo two CMU shower walls and raised floor - see demo sheet 1.

This is the first variation of the "ensuite" option where toilet, shower, and sink are all combined in private rooms ensuring maximum privacy. Door to washroom is existing with switched hardware. Ensuite rooms built with GWB on metal studs. 762 powder-coated steel doors on hollow steel frame. See drawing notes for further information.

Existing windows and walls to be removed and reconfigured with existing height IGUs and solid wall beneath. Exclude exterior wall and window costs, which are to be captured in package 2 and 7. Plumbing fixtures are commercial quality units. Extend exhaust ventilation so that each shower stall and each toilet stall have independent exhaust grilles. Electrical scope includes new lighting fixture replacement, and receptacle modification.

Red washrooms above are upgraded with "ensuite" Option 2b and hatched pink washrooms are upgraded with "refresh" Option 1.

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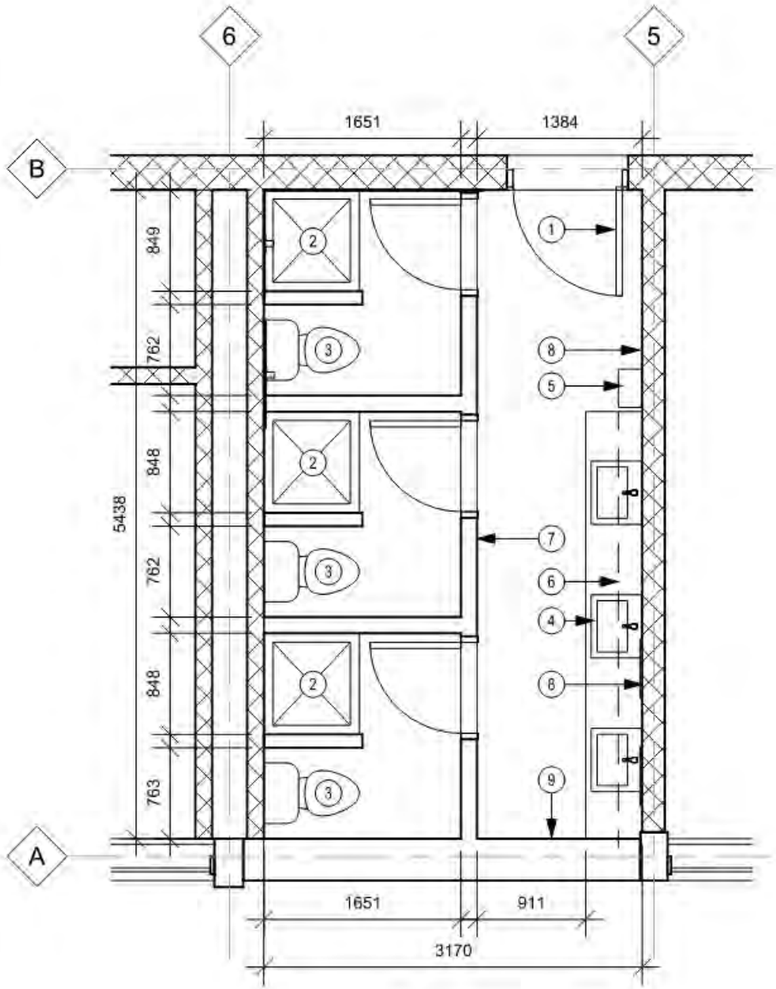
TITLE:
GENDER NEUTRAL WASHROOM OPTION 2A

Scale 1 : 50

0 0.5 1 2.5 5 m

SHEET No.:



DRAWING NOTES:

1. Remove door and switch hardware to reverse door swing.
2. New shower. New full-length tile on shower walls. New tile on shower floors. Slope floor towards drain. New shower hardware and drain. Drain to align with coreslab, refer to mechanical.
3. New toilet fixtures to align with coreslab. Refer to mechanical.
4. New wall-mounted sink station - Sloan 3-Station Wall-Mounted Counter Top sink, or equivalent.
5. New paper towel dispenser
6. New wall-mounted Formica shelf.
7. New metal stud wall with painted gypsum finish.
8. New full-height tile on wall.
9. New stainless steel hooks installed along wall.

3RD FLOOR KEY PLAN | 1:600

4TH FLOOR KEY PLAN | 1:600

LEGEND:

- EXISTING WASHROOM UPGRADED TO GENDER NEUTRAL WASHROOM
- EXISTING WASHROOM EXCEEDING ALLOWABLE DISTANCE FROM UNIVERSAL WASHROOM. REQUIRES FURTHER CODE REVIEW FOR EXTENSIVE RENOVATION.
- EXISTING UNIVERSAL WASHROOM TO REMAIN

SCOPE:

Remove all doors, plumbing fixtures, and floor and wall tiles and replace with new. Demo two CMU shower walls and raised floor - see demo sheet 1.

This is the second variation of the "ensuite" option where toilet and shower are combined in private rooms with a communal sink station in the hallway. Door to washroom is existing with switched hardware. Ensuite rooms built with GWB on metal studs. 762 powder-coated steel doors on hollow steel frame. See drawing notes for further information.

Existing windows and walls to be removed and reconfigured with existing height IGUs and solid wall beneath. Exclude exterior wall and window costs, which are to be captured in package 2 and 7. Plumbing fixtures are commercial quality units. Extend exhaust ventilation so that each shower stall and each toilet stall have independent exhaust grilles. Electrical scope includes new lighting fixture replacement, and receptacle modification.

Red washrooms above are upgraded with "ensuite" Option 2b and hatched pink washrooms are upgraded with "refresh" Option 1.

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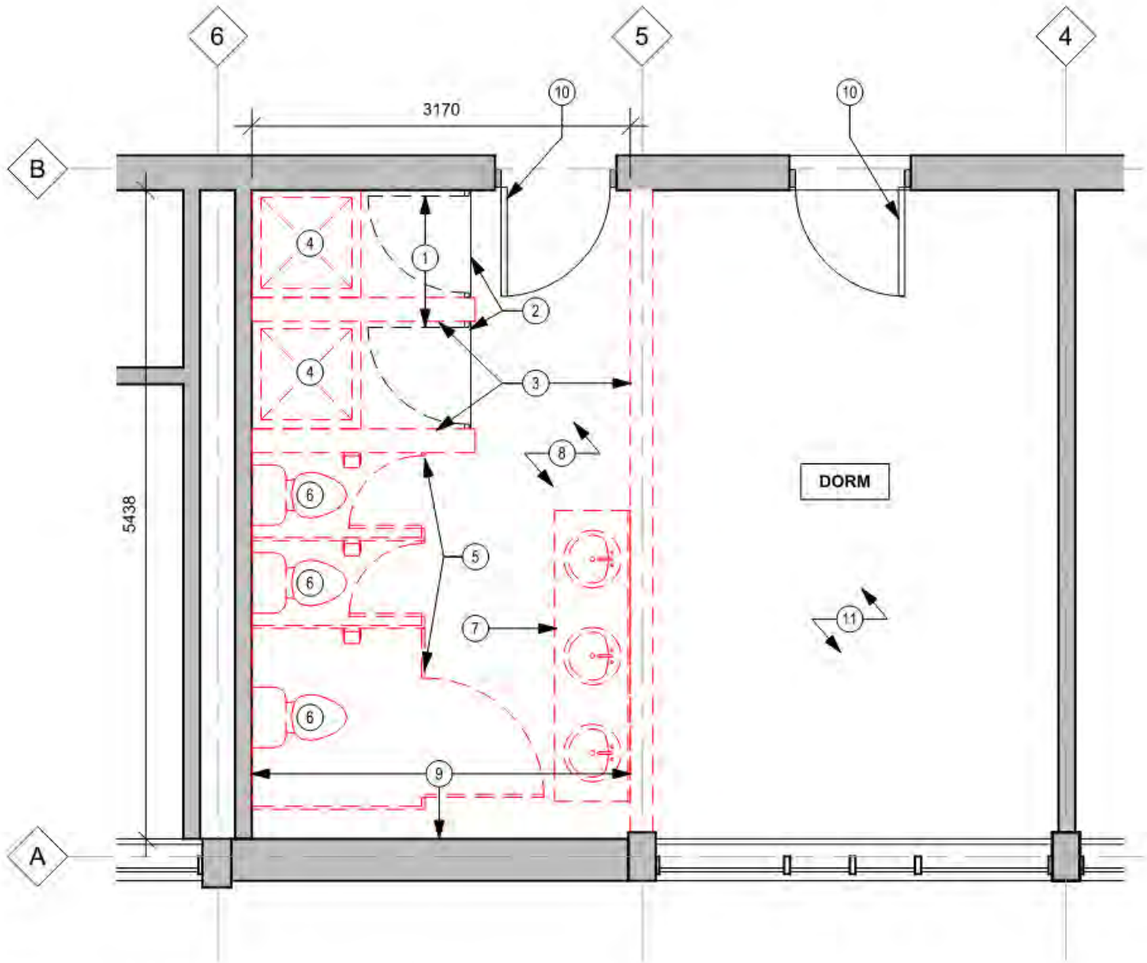
TITLE:
GENDER NEUTRAL WASHROOM OPTION 2B

Scale 1 : 50

0 0.5 1 2.5 5 m

SHEET No.:



1 / A22 GENDER NEUTRAL OPTION 3 DEMO

Scale: 1 : 50

DRAWING NOTES:

1. Remove shower doors and hardware.
2. Remove tile on curb face. Prep surface for new tile.
3. Demo CMU wall.
4. Remove shower. Demolish built-up floor in shower. Prep surface for new tile.
5. Remove bathroom stall doors, hardware, and walls.
6. Remove toilet fixture. Patch and repair wall.
7. Remove sink and laminate counter. Patch and repair wall.
8. Remove existing floor tile. Prep slab for new tile.
9. Remove existing tile on walls. Prep surface for new tile.
10. Remove door and hardware.
11. Remove existing carpet.

Typical for Option 4 demo, with the addition of demolition of partition on grid line 4.

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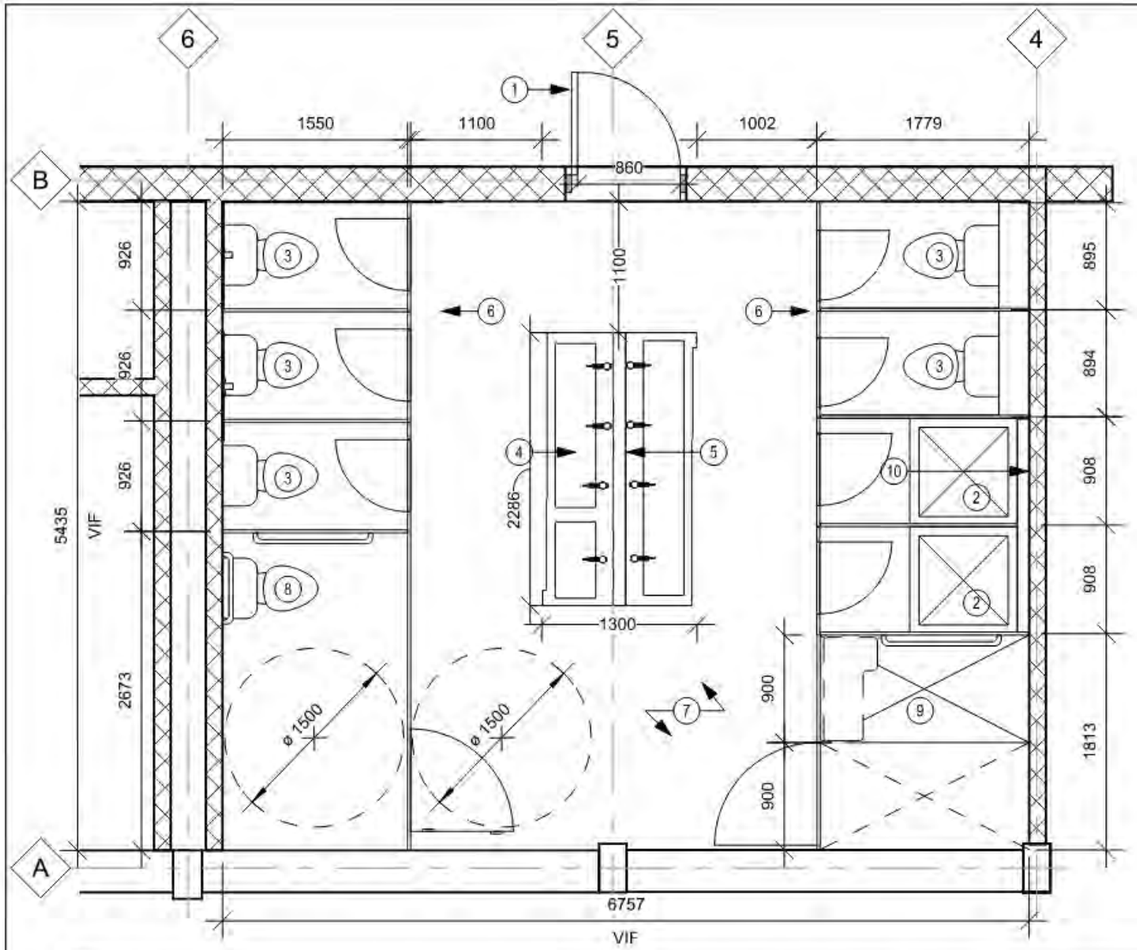
TITLE:
TYPICAL WASHROOM - OPTION 3 DEMOLITION PLAN

Scale 1 : 50

0 0.5 1 2.5 5 m

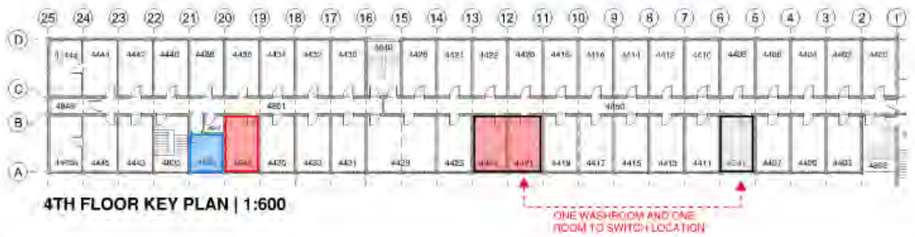
SHEET No.:



DRAWING NOTES:

1. New barrier-free door provided with power operator and other requirements outlined in OBC 3.8.3.3. Structural steel lintel to be provided at new opening.
2. New shower pan and hardware. Drain to align with coreslab, refer to mechanical.
3. New wall-mounted toilet fixtures to align with coreslab. Refer to mechanical.
4. New solid surface sink station. One lavatory to be barrier-free per OBC 3.8.3.11
5. Mirror suspended from ceiling.
6. High privacy partitions - Bobrick duraline series high privacy, or equivalent.
7. New floor tiles throughout.
8. Barrier-free water closet to conform to OBC 3.8.3.8 and 3.8.3.9
9. Barrier-free shower to conform to OBC 3.8.3.13
10. New full-length tile on back wall of toilet and shower stalls. Typical.

3RD FLOOR KEY PLAN | 1:600



4TH FLOOR KEY PLAN | 1:600

LEGEND:

- EXISTING WASHROOM UPGRADED TO GENDER NEUTRAL WASHROOM. SCOPE AS PER OPTION 1
- EXISTING WASHROOM RENOVATED AND EXPANDED (ONE DORMITORY RELOCATED) INTO ADJACENT DORMITORY, PLAN AND SCOPE OF WORK OUTLINED IN OPTION 3.
- EXISTING WASHROOM CONVERTED TO DORMITORY ROOM (RELOCATED ROOM)
- EXISTING UNIVERSAL WASHROOM TO REMAIN

SCOPE:

Demo partitions between bays. Remove all doors, plumbing fixtures, and floor and wall tiles and replace with new. Demo two CMU shower walls and raised floor - see demo sheet 2.

The "double bay" option encircles a central sink station with high privacy toilet and shower stalls. Barrier-free circulation provided around washroom with one barrier-free toilet and shower at the south wall. The sink station also provides one barrier-free sink. Toilets on east wall require carrier w/ GWB enclosure (see mechanical). See drawing notes.

Existing windows and walls to be removed and reconfigured with full-height frosted glazing and solid wall. Exclude exterior wall and window costs, which are captured in package 2 and 7. Plumbing fixtures are commercial quality units. Replace existing ventilation system with a new exhaust fan and make-up air system. Ductwork will be routed vertically in the renovated spaces to equipment located on the roof. Exhaust system is sized for 600 cfm exhaust air flow per Option 3 washroom. Electrical scope includes new lighting fixtures and location, and receptacle modification.

The vacated washroom bays (dotted above) would have plumbing and tiled finishes removed and refinished with carpet on floor and paint on CMU walls to match existing dorm rooms. Washrooms 3947 and 4945 (red with hatch above) are upgraded with the "refresh" Option 1.

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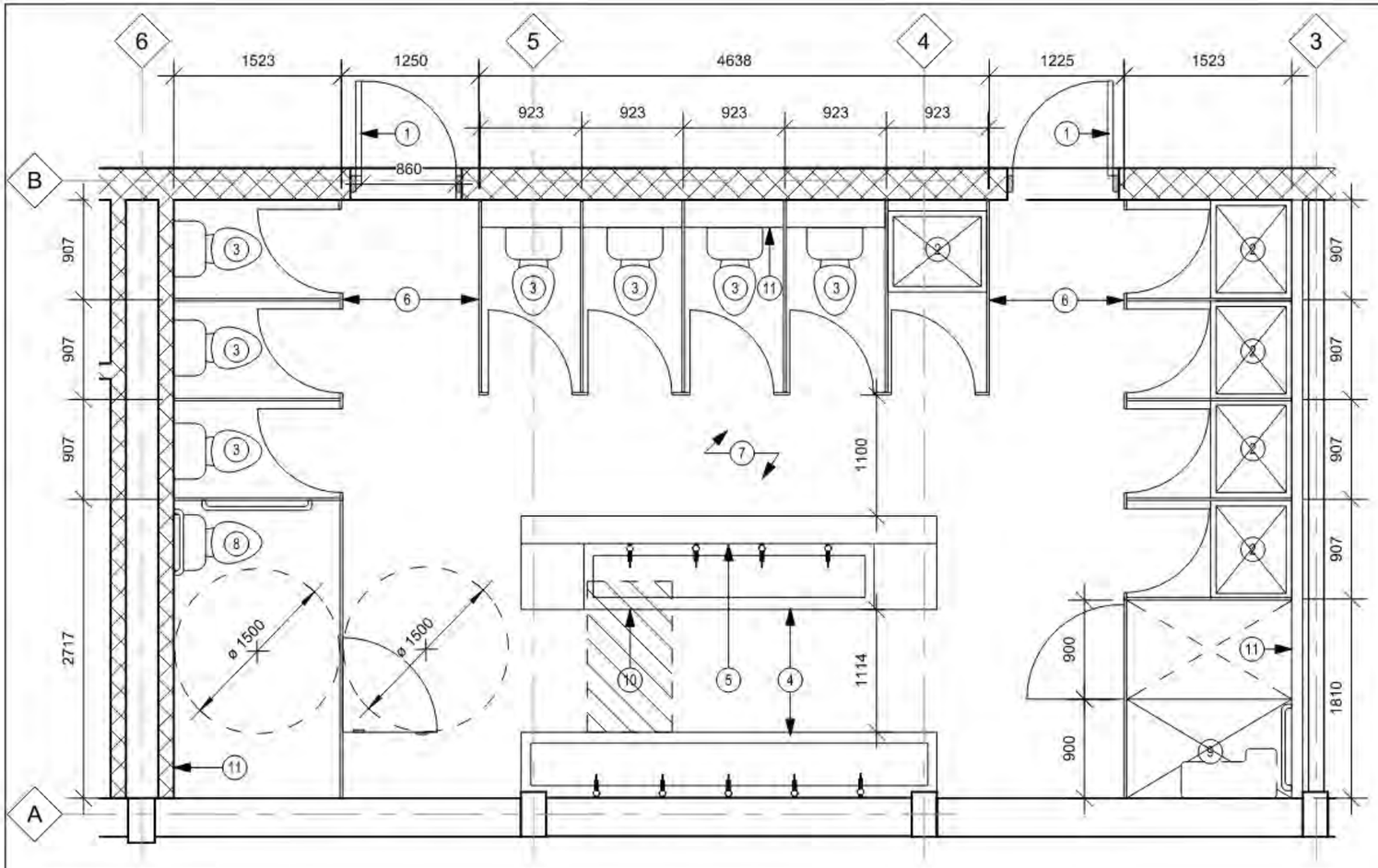
WALTERFEDY

TITLE:
GENDER NEUTRAL WASHROOM OPTION 3

Scale 1 : 50

0 0.5 1 2.5 5 m

SHEET No.:



LEGEND:

- EXISTING WASHROOM UPGRADED TO GENDER NEUTRAL WASHROOM, SCOPE AS PER OPTION 1
- EXISTING WASHROOM RENOVATED AND EXPANDED (ONE DORMITORY RELOCATED) INTO ADJACENT DORMITORY, PLAN AND SCOPE OF WORK OUTLINED IN OPTION 3.
- EXISTING WASHROOM CONVERTED TO DORMITORY ROOM (RELOCATED ROOM)
- EXISTING UNIVERSAL WASHROOM TO REMAIN

SCOPE:

Demo partitions between bays. Remove all doors, plumbing fixtures, and floor and wall tiles and replace with new. Demo two CMU shower walls and raised floor. Remove and reinstate GWB ceiling in level two to accommodate plumbing.

The "triple bay" option encircles a central sink station with high privacy toilet and shower stalls. Barrier-free circulation provided between barrier-free fixtures with one barrier-free toilet and shower at the south wall. The sink station also provides one barrier-free sink. Toilets on east and north wall require carrier w/ GWB enclosure with tile finish (see mechanical).

Existing windows and walls to be removed and reconfigured with full-height frosted glazing and solid wall. Exclude exterior wall and window costs, which are captured in package 2 and 7. Plumbing fixtures are commercial quality units. Replace existing ventilation system with a new exhaust fan and make-up air system. Ductwork will be routed vertically in the renovated spaces to equipment located on the roof. Exhaust system is sized for 1000 cfm exhaust air flow per floor washroom. Electrical scope includes new lighting fixtures and location, and receptacle modifications.

The vacated washroom bays (dotted above) would have plumbing and tiled finishes removed and refinished with carpet on floor and paint on CMU walls to match existing dorm rooms.

DRAWING NOTES:

1. New barrier-free door provided with power operator and other requirements outlined in OBC 3.8.3.3. Structural steel lintel to be provided at new opening.
2. New shower pan and hardware. Drain to align with coreslab, refer to mechanical.
3. New wall-mounted toilet fixtures to align with coreslab. Refer to mechanical.
4. New solid surface sink station. One lavatory to be barrier-free per OBC 3.8.3.11
5. Wall-mounted mirror above sink.
6. High privacy partitions - Bobrick duraline series high privacy, or equivalent.
7. New floor tiles throughout.
8. Barrier-free water closet to conform to OBC 3.8.3.8 and 3.8.3.9
9. Barrier-free shower to conform to OBC 3.8.3.13
10. Barrier-free sink to conform to OBC 3.8.3.11
11. New full-length tile on back wall of toilet (including face of carrier) and shower stalls. Typical.

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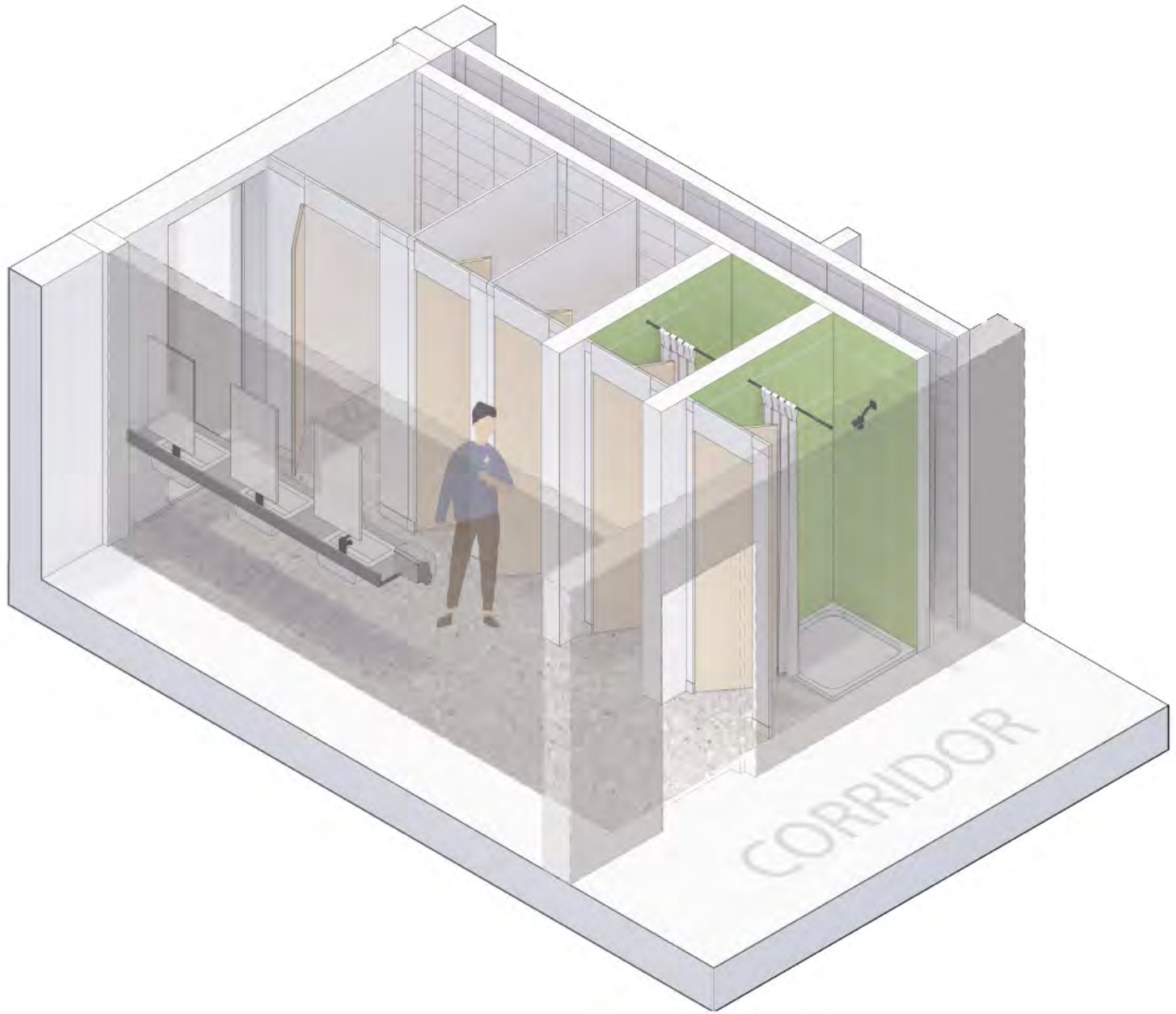
WALTERFEDY

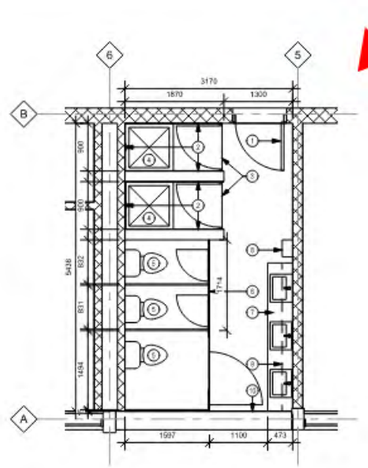
TITLE:
GENDER NEUTRAL WASHROOM OPTION 4

Scale 1 : 50

0 0.5 1 2.5 5 m

SHEET No.:





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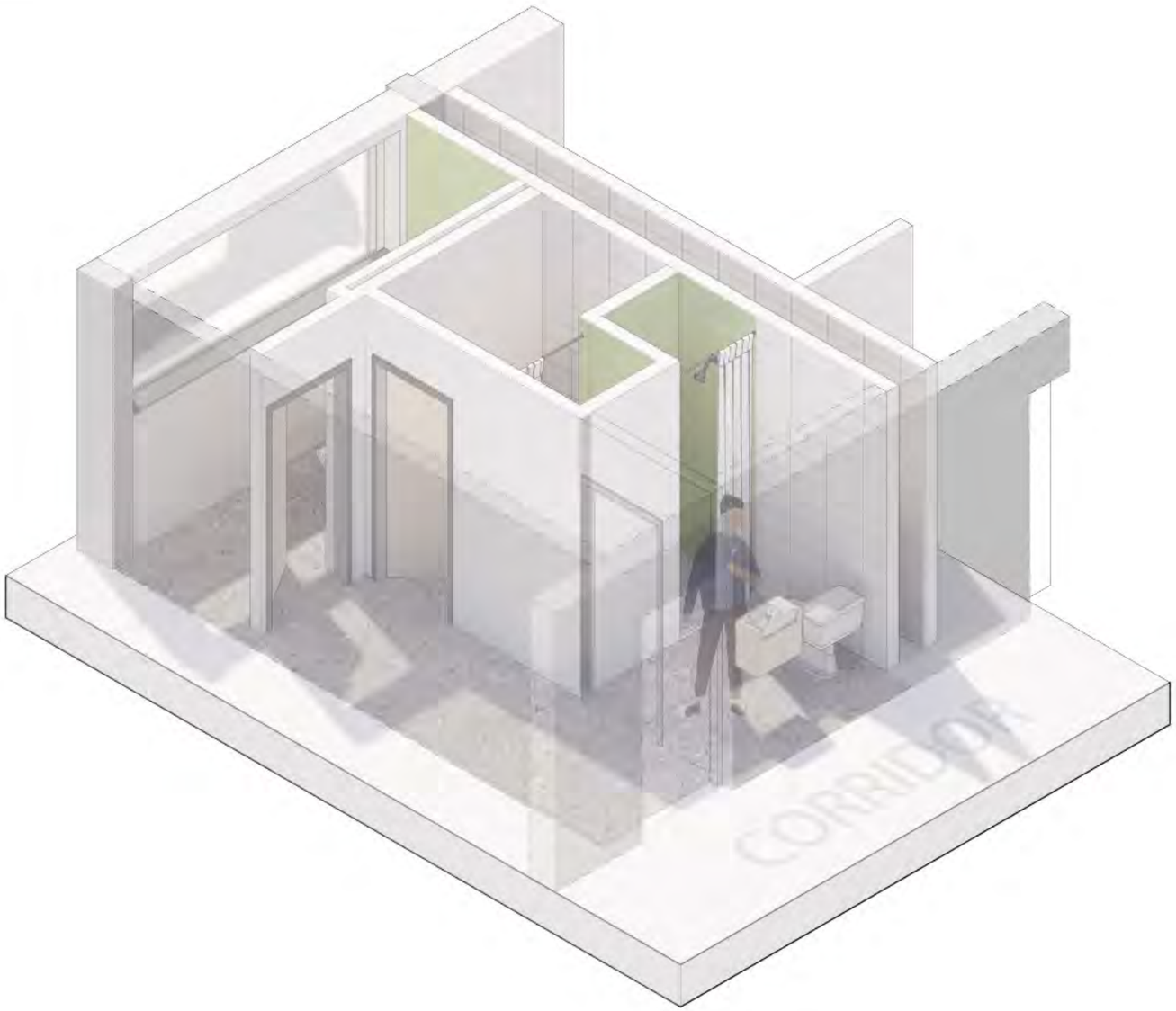
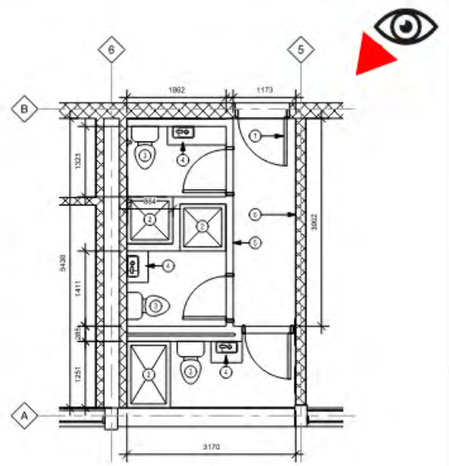
TITLE:
GENDER NEUTRAL WASHROOM AXOS - OPTION 1 REFRESH

SHEET No.:





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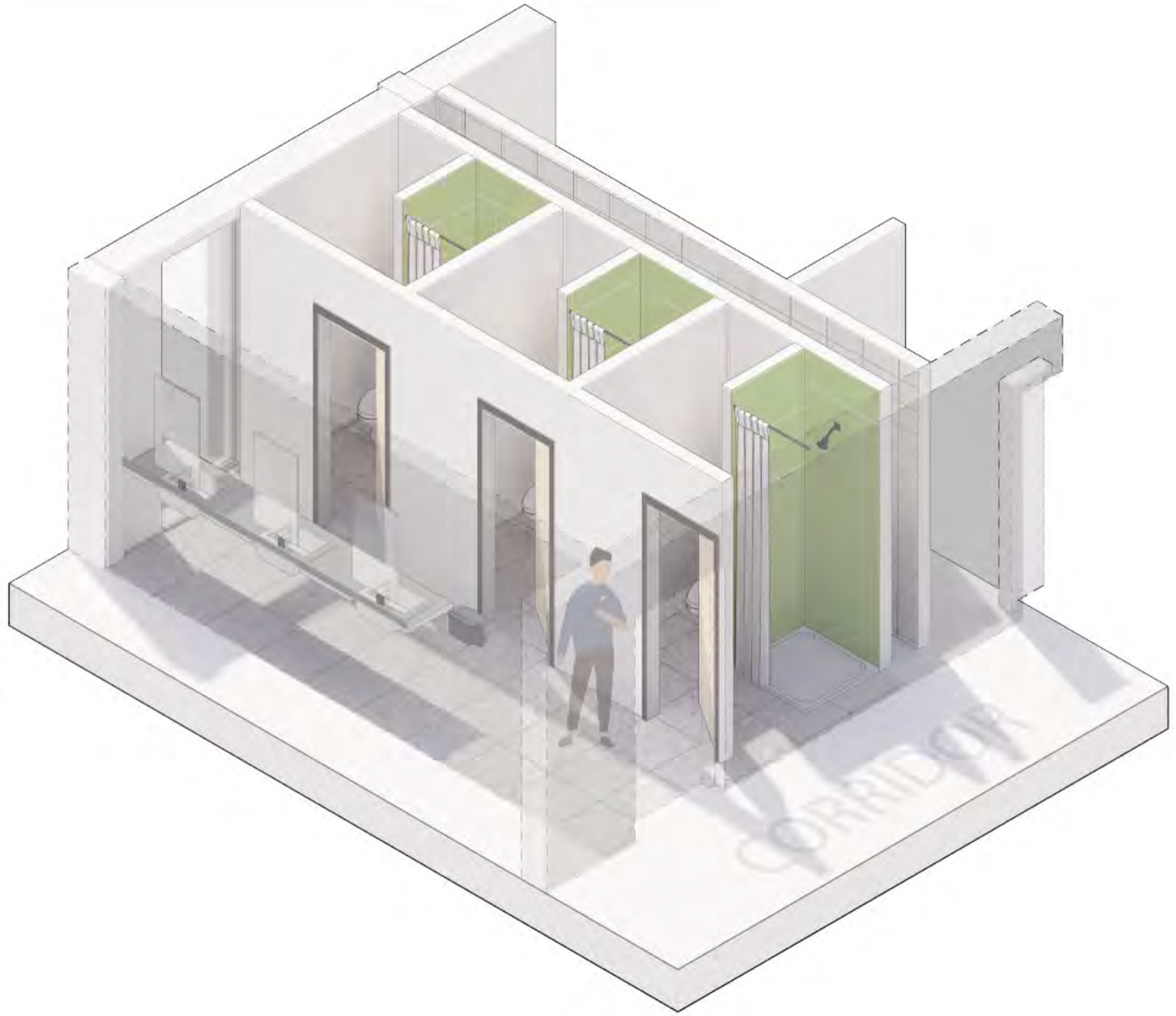
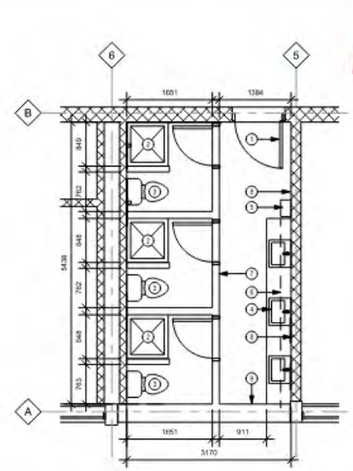
WALTERFEDY

TITLE:
GENDER NEUTRAL WASHROOM AXOS - OPTION 2A ENSUITE

SHEET No.:





PROJECT:
CONRAD GREBEL UNIVERSITY COLLEGE ENVELOPE AND ENERGY RETROFIT STUDY

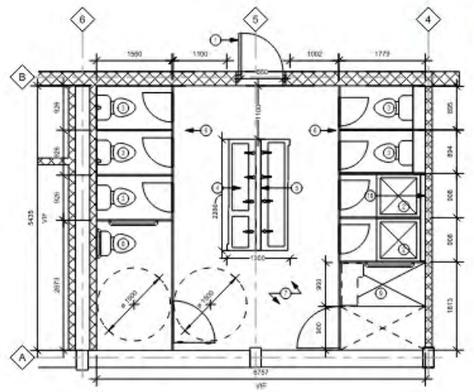
PROJECT NO: 2023-0757-10

Baird Sampson Neuert architects

WALTERFEDY

TITLE:
GENDER NEUTRAL WASHROOM AXOS - OPTION 2B ENSUITE

SHEET No.:



PROJECT:
CONRAD GREBEL UNIVERSITY COLLEGE ENVELOPE AND ENERGY RETROFIT STUDY

PROJECT NO: 2023-0757-10

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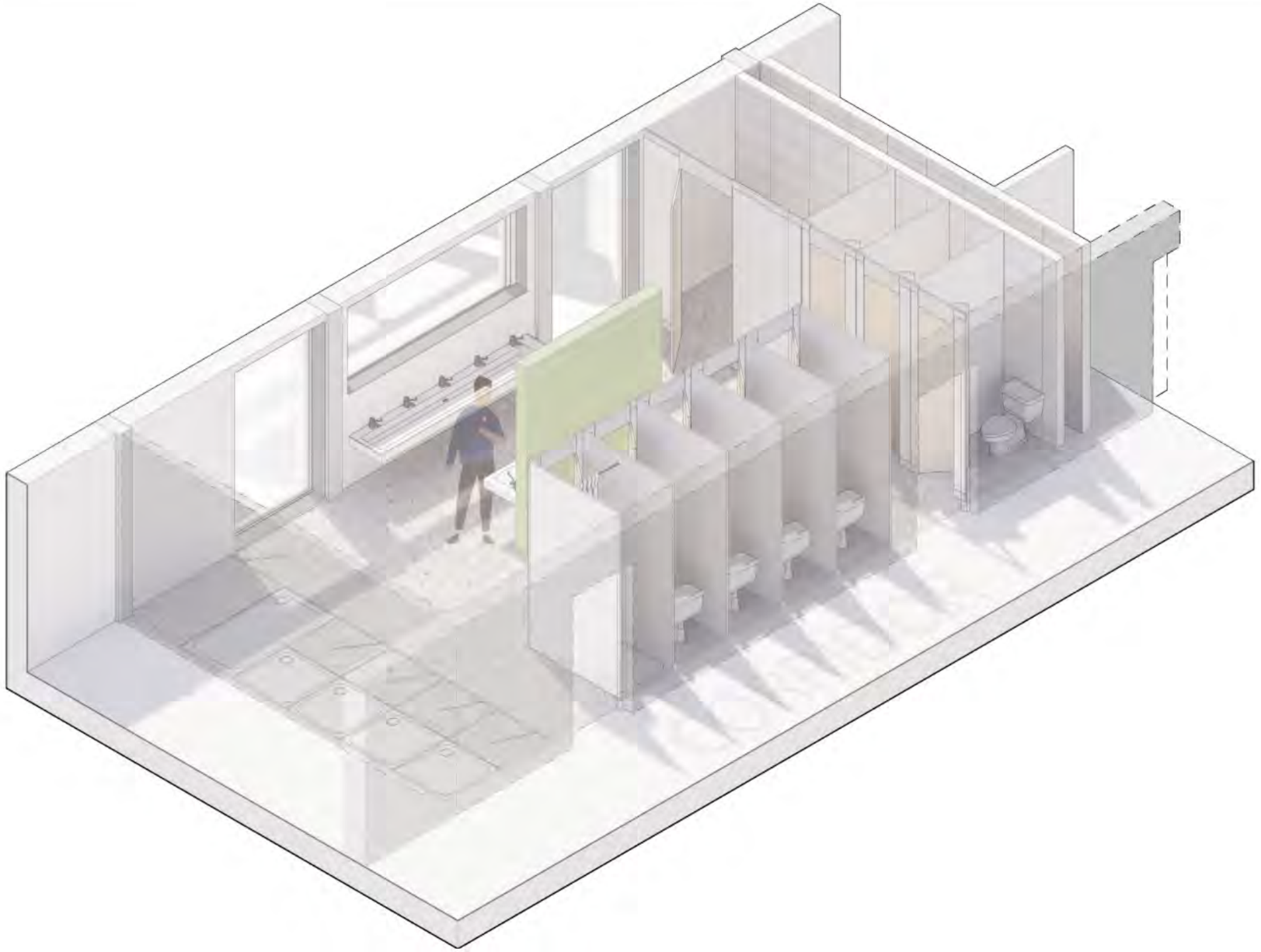
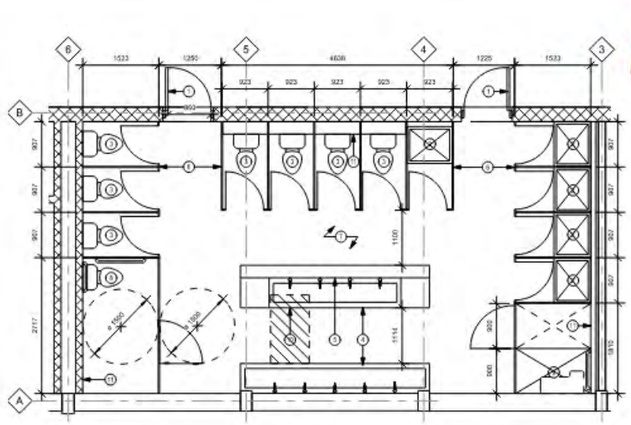
WALTERFEDY

TITLE:
GENDER NEUTRAL WASHROOM AXOS - OPTION 3 DOUBLE

SHEET No.:





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PROJECT NO: 2023-0757-10

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WALTERFEDY

TITLE:
GENDER NEUTRAL WASHROOM AXOS - OPTION 4 TRIPLE

SHEET No.:

Package 2: High Performance Window Upgrade

WINDOW REPLACEMENT OPTION 1

WINDOW REPLACEMENT OPTION 2

In this package, BSN explored two Options for the window replacement for the residence wing at Conrad Grebel University College. The existing dormitory windows are double glazed windows and have been replaced by the client on a case-to-case basis. There have been complaints about curtains sticking to the windows in dormitory rooms. Existing windows in the stairwell are single glazed.

Each Option has two variations - A and B - where A is a replacement with double-glazed windows and B is a replacement with triple-glazed windows. BSN recommends that existing windows are replaced with triple-glazed windows (Variation B).

Option 1A is replacing all windows with triple glazed IGUs.

Option 1B is replacing all windows with double glazed IGUs.

Option 2A is replacing all windows with triple glazed IGUs. The windows on the fourth level will have the "peaks" in-filled with an insulated assembly (aluminum composite panel, 150mm mineral wool insulation, ABV, sheathing, studs, interior drywall).

Option 2B is replacing all windows with double glazed IGUs. The windows on the fourth level will have the "peaks" in-filled with an insulated assembly (same as 2A).

Quantities have been taken with approximate dimensions (see page 3). Cost Tag #'s 18 and 19 for Option 2A and 2B as infill walls instead of IGUs.

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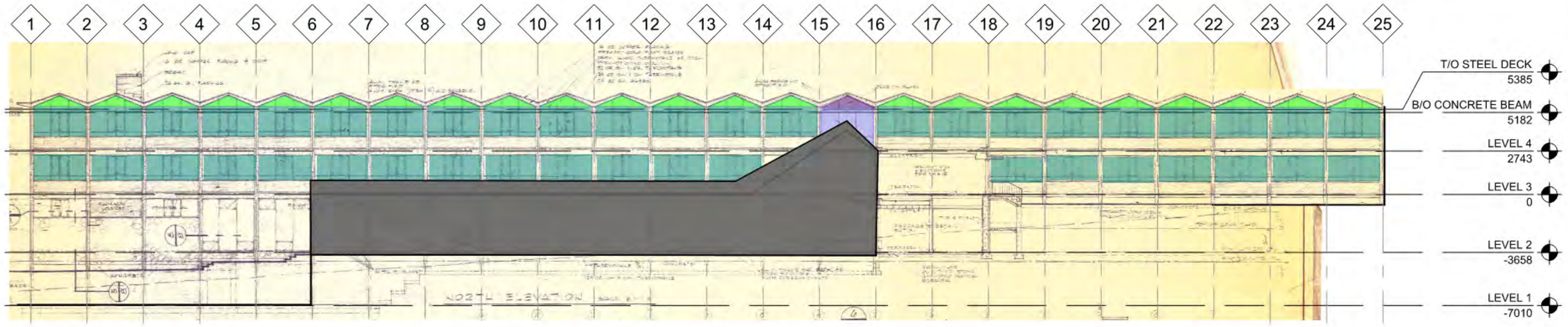
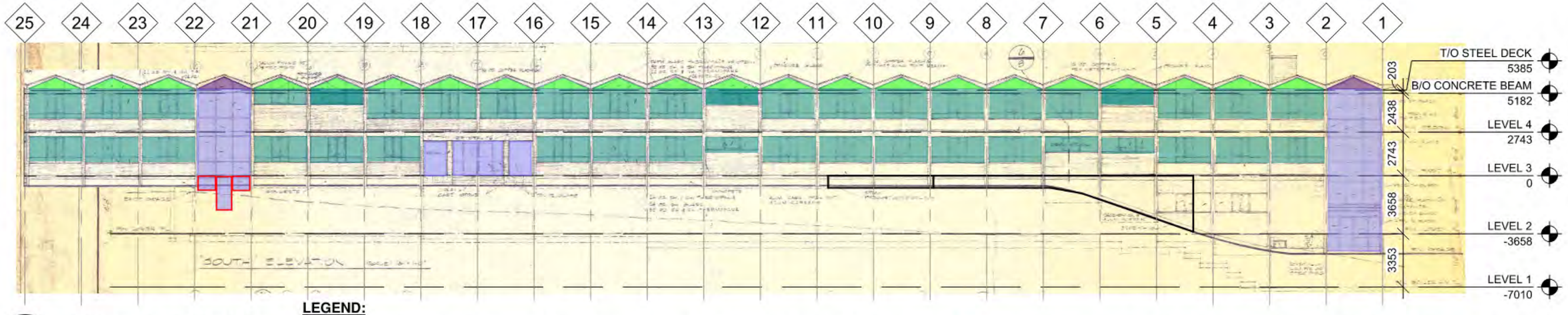
WALTERFEDY

TITLE:
PACKAGE 2 - WINDOW REPLACEMENT

SHEET No.:



1 / A30 **EAST ELEVATION**
Scale: 1 : 250



2 / A30 **WEST ELEVATION**
Scale: 1 : 250

LEGEND:

- EXISTING DOUBLE GLAZE WINDOW, NON THERMALLY BROKEN. TO BE REPLACED WITH IGU IN OPTION 1 VARIATIONS & INFILL WALL IN OPTION 2 VARIATIONS.
- EXISTING SINGLE GLAZE WINDOW, NON THERMALLY BROKEN. TO BE REPLACED WITH IGU IN OPTION 1 VARIATIONS AND IGU IN OPTION 2 VARIATIONS.
- EXISTING DOUBLE GLAZE WINDOW, NON THERMALLY BROKEN. TO BE REPLACED WITH PACKAGE OPTION.
- EXISTING SINGLE GLAZE WINDOW, NON THERMALLY BROKEN. TO BE REPLACED WITH PACKAGE OPTION.

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PROJECT NO: 2023-0757-10

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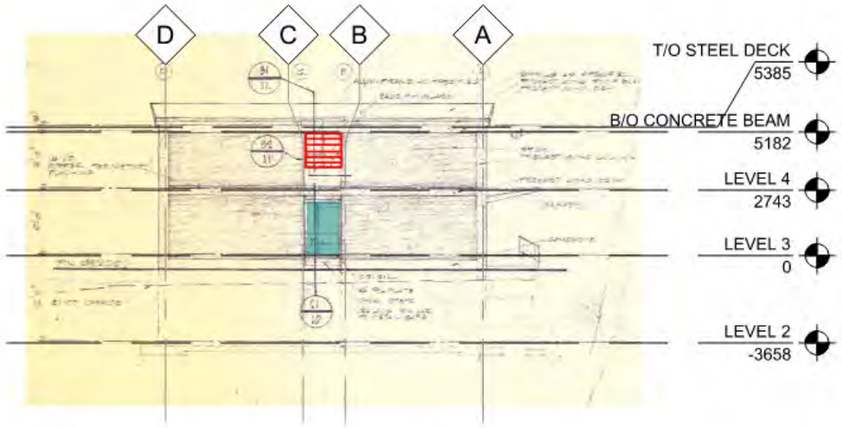
WALTERFEDY

TITLE:
WINDOW REPLACEMENT - EAST & WEST ELEVATIONS

SHEET No.:



1 / A31 NORTH ELEVATION

Scale: 1 : 250

	Tag #	Type	Count	opening DIM wxh (mm) - based on 1963 dwgs
5	1	1st floor - west stairwell R entry window A	2	850x2550
	2	1st floor - west stairwell R entry window B	2	950x400
	3	1st floor - west stairwell R entry door	2	950x2150
	4	2nd-4th floors - west stairwell R	1	3330x7300
	5	2nd floor - west stairwell L window	2	1150x900*
	6	2nd floor - west stairwell L entry door	1	950x2150*
1	7	3rd floor - dormitory	37	3300x1600
2	8	3rd floor - washroom	3	3300x900
5	9	3rd-4th floor - west stairwell L	1	3300x5420
	10	3rd floor - entry window A	2	1450x2150
	11	3rd floor - entry window B	2	650x2150
	12	3rd floor - main entry door	2	960x2150
	13	3rd floor - north entry window	1	500x2150
	14	3rd floor - north entry door	1	960x2150
3	15	4th floor - dormitory	41	3300x1600
4	16	4th floor - washroom	4	3300x900
6	17	4th floor - east central stairwell	1	3300x2800***
3	18	4th floor - dormitory peak	41	3300x700**
4	19	4th floor - washroom peak	4	3300x700**
5	20	4th floor - west stairwell L peak	1	3300x700**
	21	4th floor - west stairwell R peak	1	3300x700**
6	22	4th floor- east central stairwell peak	1	3300x700**

all dimensions to be verified on site.

*** not shown on original elevations. Opening dimensions are approximate.**

****height of triangle**

*****custom shaped window w/ surface area of about 4.8sqm**

LEGEND:

EXISTING DOUBLE GLAZE WINDOW, NON THERMALLY BROKEN. TO BE REPLACED WITH PACKAGE OPTION

COST AS IGU FOR OPTIONS 1A AND 1B. COST AS INFILL WALL FOR OPTIONS 2A AND 2B

1 

TYP. DORM WINDOW 3RD LVL EXTERIOR

2 

TYP. WASHROOM WINDOW 3RD LVL EXTERIOR

3 

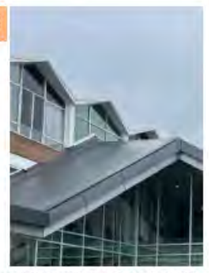
TYP. DORM WINDOW 4TH LVL EXTERIOR

4 

TYP. WASHROOM WINDOW 4TH LVL EXTERIOR

5 

TYP. STAIRWELL WINDOW EXTERIOR

6 

UNIQUE WINDOW FROM EXTERIOR

TYP. DORM WINDOW 3RD LVL INTERIOR

TYP. WASHROOM WINDOW 3RD LVL INTERIOR

TYP. DORM WINDOW 4TH LVL INTERIOR

TYP. WASHROOM WINDOW 4TH LVL INTERIOR

TYP. STAIRWELL WINDOW INTERIOR

UNIQUE WINDOW FROM INTERIOR

PROJECT:
CONRAD GREBEL UNIVERSITY COLLEGE ENVELOPE AND ENERGY RETROFIT STUDY

PROJECT NO: 2023-0757-10

Baird Sampson Neuert architects

WALTERFEDY

TITLE:
WINDOW REPLACEMENT - NORTH ELEVATION

SHEET No.:

TYPICAL BAY - OPTION 1

REPLACE WINDOW

REPLACE BRICK W/ INSULATED ASSEMBLY (PACKAGE 7 OPTION)

OVERCLAD / INSULATION ON CONCRETE FRAME (PACKAGE 7 OPTION)

TYPICAL BAY - OPTION 2

REPLACE WINDOW

INFILL PEAK W/ INSULATED WALL ASSEMBLY

REPLACE BRICK W/ INSULATED ASSEMBLY (SEE PACKAGE 7 FOR OPTIONS)

OVERCLAD / INSULATION ON CONCRETE FRAME (PACKAGE 7 OPTION)

WINDOWS

HIGH PERFORMANCE THERMALLY BROKEN ALUMINUM FRAME WINDOW WITH TRIPLE GLAZED IGU

(DESIGN BASIS: REYNAERS ML8Hi)

U-VALUE 1.36 W/m^2K

STAIRWELL GLAZING AND ENTRY DOORS

HIGH PERFORMANCE THERMALLY BROKEN ALUMINUM FRAME WINDOW WITH DOUBLE GLAZED IGU

(DESIGN BASIS: REYNAERS ECOSYSTEM 50)

U-VALUE 1.9 W/m^2K *(TBC WITH SUPPLIER)*

SCOPE:
-Remove existing window
-Prep opening - existing brick sill to be grouted level and/or continuous plywood strip at sill if required
-Install new window. Transition membrane/ air barrier at full perimeter
-Sealed/caulk at full perimeter interior and exterior
-Metal flashing sloped to drain
-New solid surface stool interior side (Corian or similar)
-Incidental repair/make good to adjacent interior finishes (drywall, paint etc.)

OPTION 1 SCOPE:
-Provide new window with matching configuration. Exception: one central operable, outward-swinging awning window replaces existing two operable inward opening casement windows.
-New metal sill flashing on wall assembly below (existing or new wall assembly). Transition air barrier membrane between full perimeter window frame and concrete assembly.
-Option 1 all windows are replaced with high-performance thermally broken aluminum frame windows with IGU.
-Option 1A: above, with triple glazed IGU
-Option 1B: above, with double glazed IGU

OPTION 2 SCOPE:
-Provide new window with matching configuration. Exception: one central operable, outward-swinging awning window replaces existing two operable inward opening casement windows.
-New metal sill flashing on wall assembly below (existing or new wall assembly). Transition air barrier membrane between full perimeter window frame and concrete assembly.
-Option 2 all windows are replaced with high-performance thermally broken aluminum frame windows with IGU. In peaks of fourth level, install infill wall: 3mm aluminum composite panel with 150mm mineral wool insulation, AVB, sheathing, stud backup, drywall.
-Option 2A: above, with triple glazed IGU
-Option 2B: above, with double glazed IGU

PROJECT:
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PROJECT NO: 2023-0757-10

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WALTERFEDY

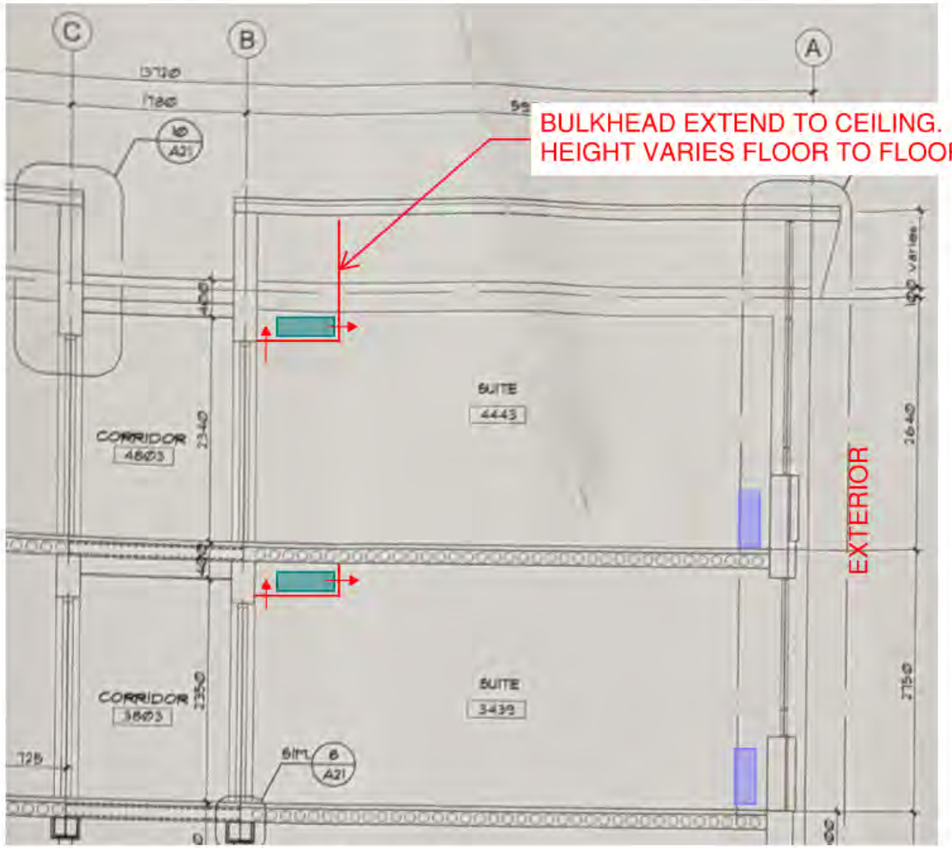
TITLE:
WINDOW UPGRADE OPTIONS 1 & 2

Scale 1 : 200

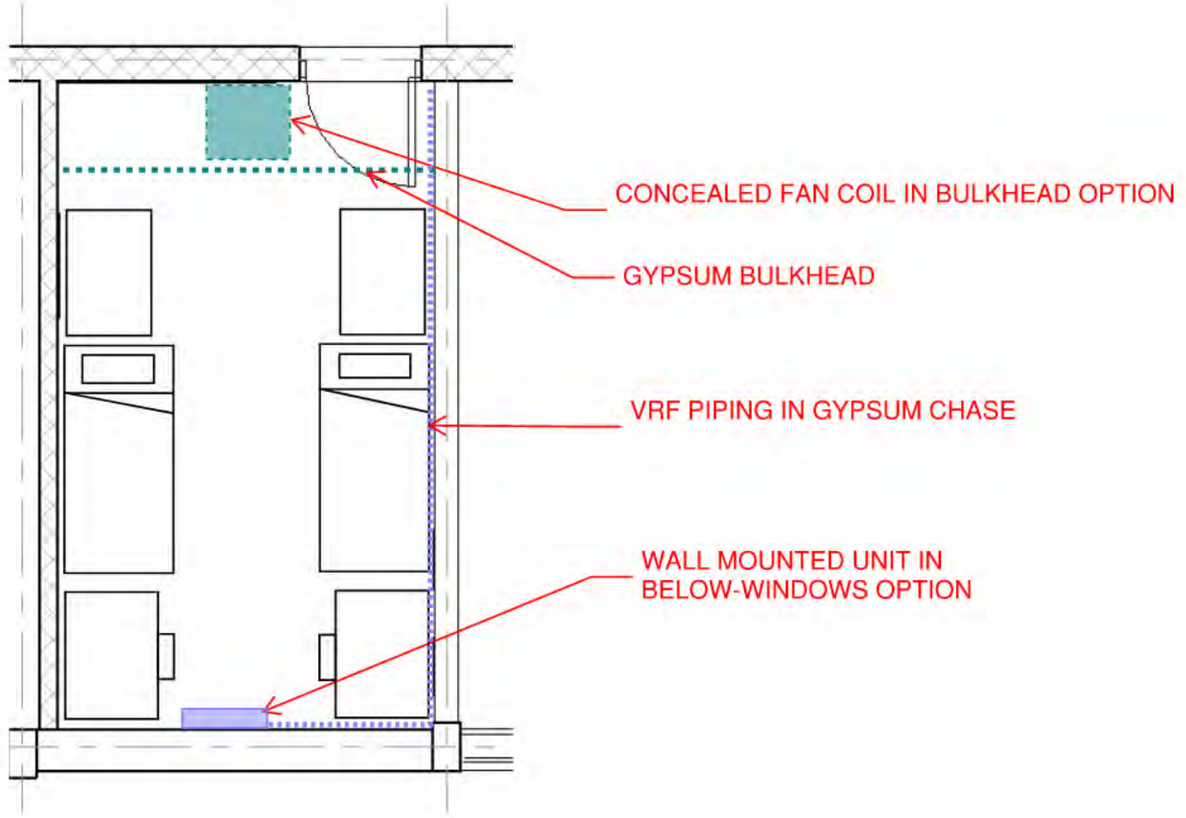
0 2 4 10 20 m

SHEET No.:

Package 3: Residence Heating and Cooling



SECTION THROUGH RESIDENCE ROOMS | SCALE 1:50



TYP. RESIDENCE ROOM FITUP WITH EQUIPMENT OPTIONS | SCALE 1:50

LEGEND

- RESIDENCE HEATING/COOLING BELOW-WINDOWS OPTION
- RESIDENCE HEATING/COOLING BULKHEAD OPTION

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PROJECT NO: 2023-0757-10

architects
Baird Sampson Neuert

WALTERFEDY

TITLE:
RESIDENCE HEATING AND COOLING OPTIONS FITUP

Scale

SHEET No.:

PROJECT:
CONRAD GREBEL UNIVERSITY COLLEGE ENVELOPE AND ENERGY RETROFIT STUDY

PROJECT NO: 2023-0757-10

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WALTERFEDY

TITLE:
ROOF PLAN

Scale 1 : 250

0 2.5 5 12.5 25 m

SHEET No.:

EXISTING VIEW FROM REAR OF BUILDING

VIEW FROM REAR OF BUILDING WITH PROPOSED ROOFTOP EQUIPMENT

PROJECT:
CONRAD GREBEL UNIVERSITY COLLEGE ENVELOPE AND ENERGY RETROFIT STUDY

PROJECT NO: 2023-0757-10

architects
Baird Sampson Neuert

WALTERFEDY

TITLE:
ROOFTOP UNIT SIGHTLINE STUDY

Scale

SHEET No.:

EXISTING VIEW FROM WESTMOUNT RD N

VIEW FROM WESTMOUNT RD N WITH PROPOSED ROOFTOP EQUIPMENT

PROJECT:
CONRAD GREBEL UNIVERSITY COLLEGE ENVELOPE AND ENERGY RETROFIT STUDY

PROJECT NO: 2023-0757-10

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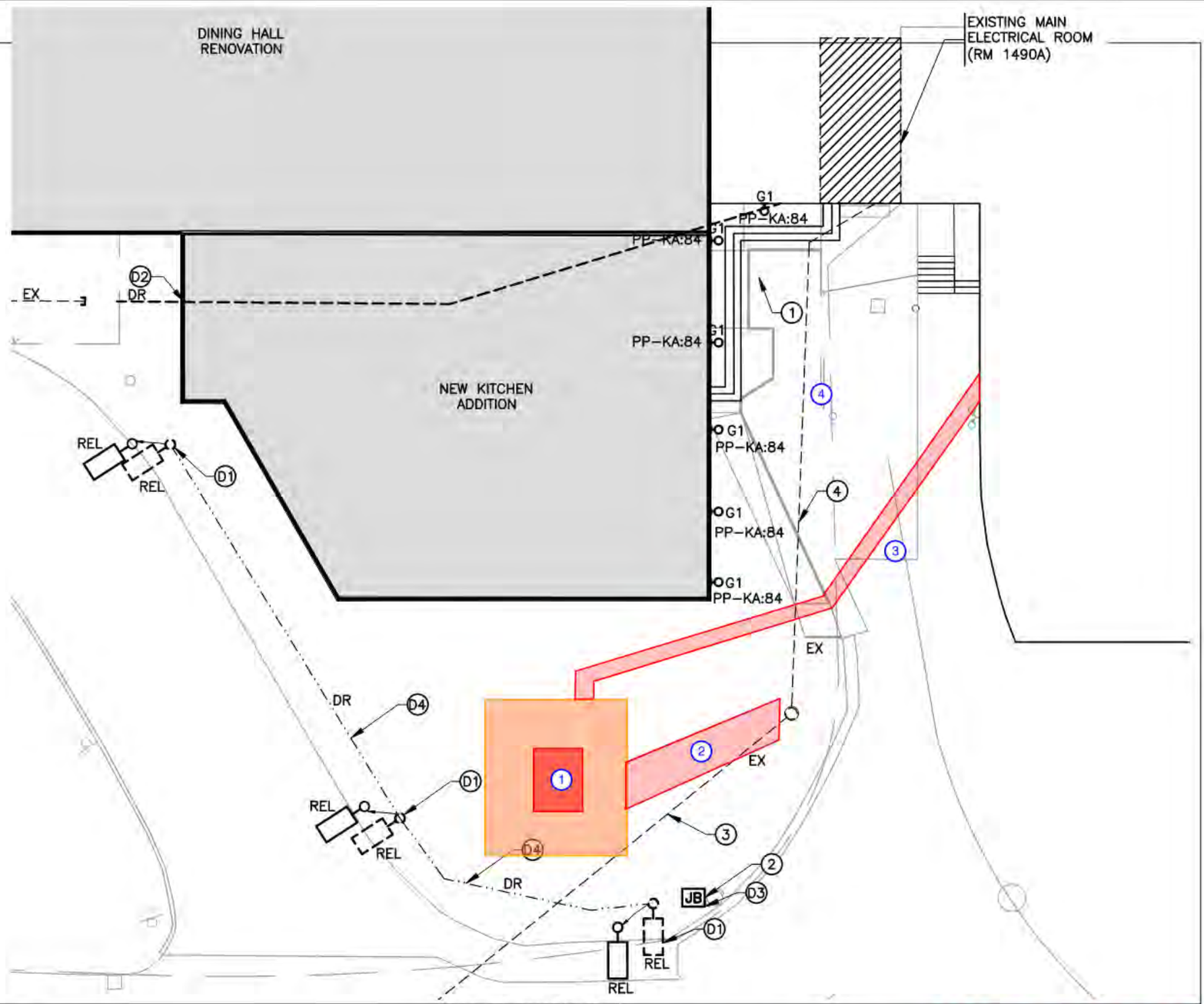
WALTERFEDY

TITLE:
ROOFTOP UNIT SIGHTLINE STUDY

Scale

SHEET No.:

1. NEW ENOVA PADMOUNTED TRANSFORMER (RED) AND EASEMENT (ORANGE)
2. NEW UNDERGROUND PRIMARY DUCTBANK FROM EXISTING POLE
3. NEW UNDERGROUND SECONDARY FROM TRANSFORMER TO NEW SERVICE ENTRANCE SWITCH IN BASEMENT. CAREFUL EXCAVATION REQUIRED DUE TO EXISTING SERVICES IN LANEWAY.
4. EXISTING SECONDARY TO BE REMOVED AND CONDUITS CAPPED.



PROJECT:
CONRAD GREBEL UNIVERSITY COLLEGE ENVELOPE AND ENERGY RETROFIT STUDY

PROJECT NO: 2023-0757-10

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WALTERFEDY

TITLE:

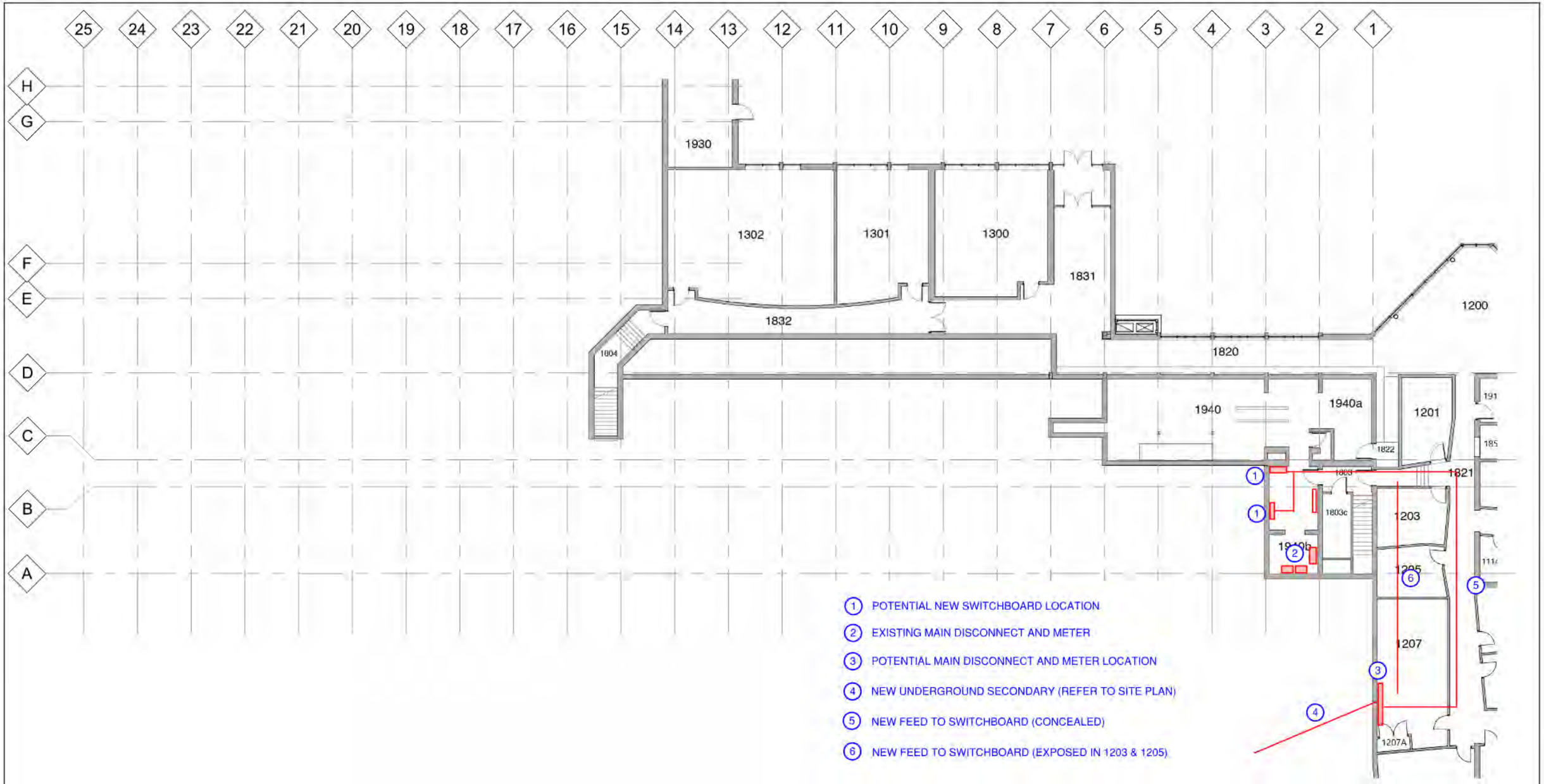
ELECTRICAL SITE PLAN

Scale 1 : 200

0 2 4 10 20 m

SHEET No.:

E1



PROJECT:
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PROJECT NO: 2023-0757-10

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WALTERFEDY

TITLE:
FIRST FLOOR PLAN - ELECTRICAL

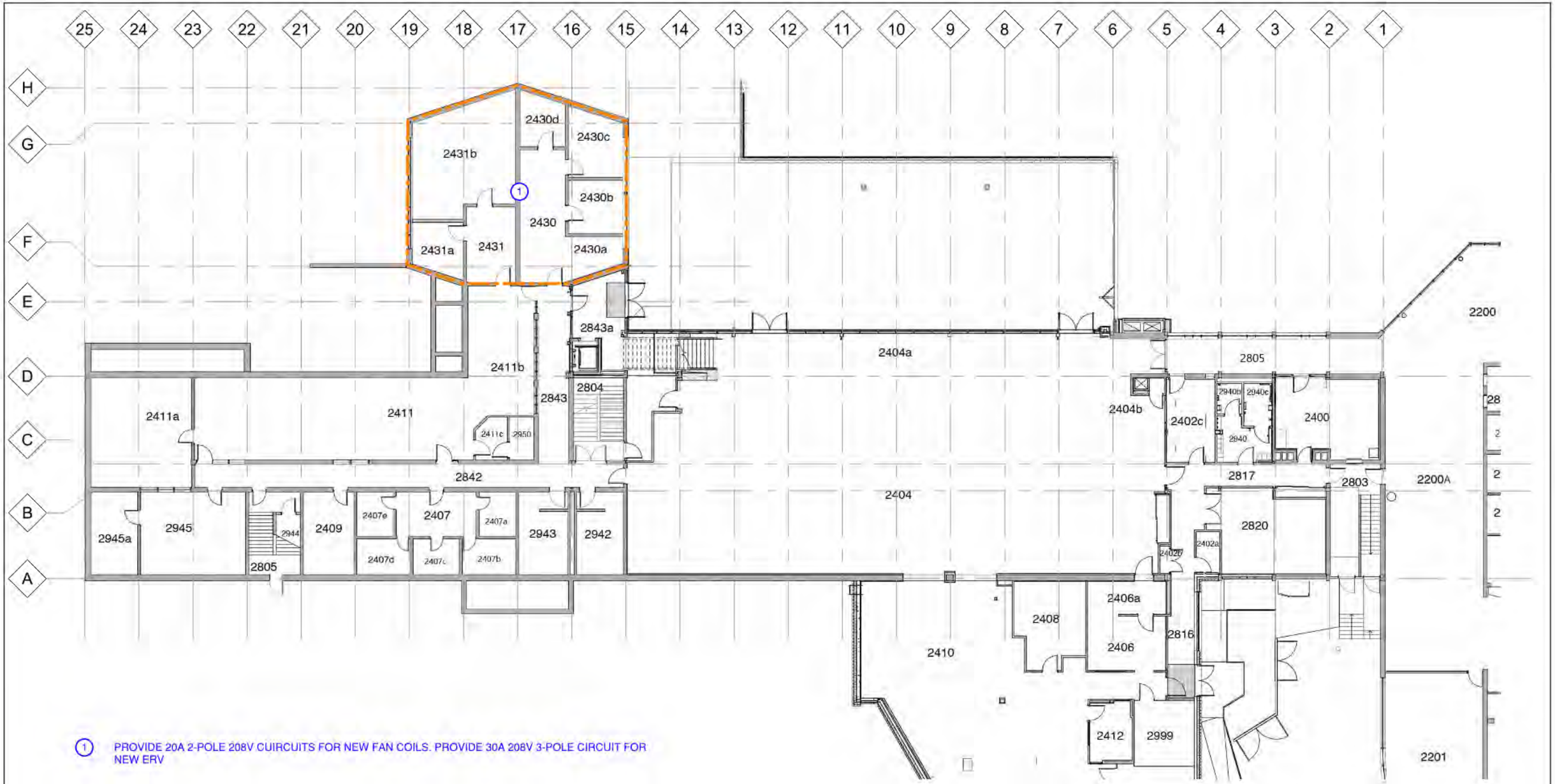
NEW MAIN ELECTRICAL SERVICE

Scale 1 : 250

0 2.5 5 12.5 25 m

SHEET No.:

E2



1 PROVIDE 20A 2-POLE 208V CUIRCUITS FOR NEW FAN COILS. PROVIDE 30A 208V 3-POLE CIRCUIT FOR NEW ERV

PROJECT:
CONRAD GREBEL UNIVERSITY COLLEGE ENVELOPE AND ENERGY RETROFIT STUDY

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WALTERFEDY

TITLE:
SECOND FLOOR PLAN - ELECTRICAL

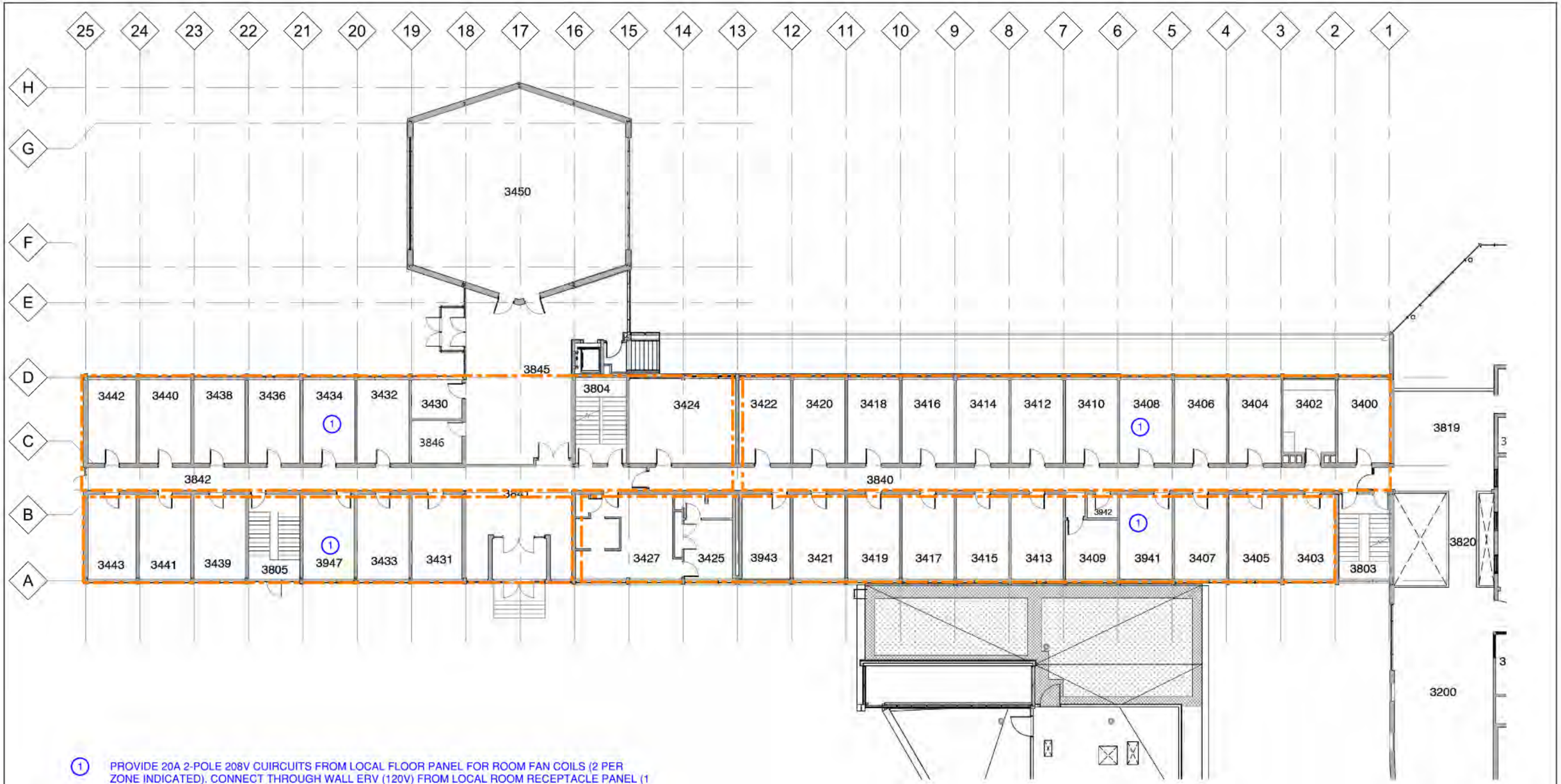
CHAPEL COOLING WORK

Scale 1 : 250

0 2.5 5 12.5 25 m

SHEET No.:

E3



1 PROVIDE 20A 2-POLE 208V CUIRCUITS FROM LOCAL FLOOR PANEL FOR ROOM FAN COILS (2 PER ZONE INDICATED). CONNECT THROUGH WALL ERV (120V) FROM LOCAL ROOM RECEPTACLE PANEL (1 PER ROOM).

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WALTERFEDY

TITLE:
THIRD FLOOR PLAN - ELECTRICAL

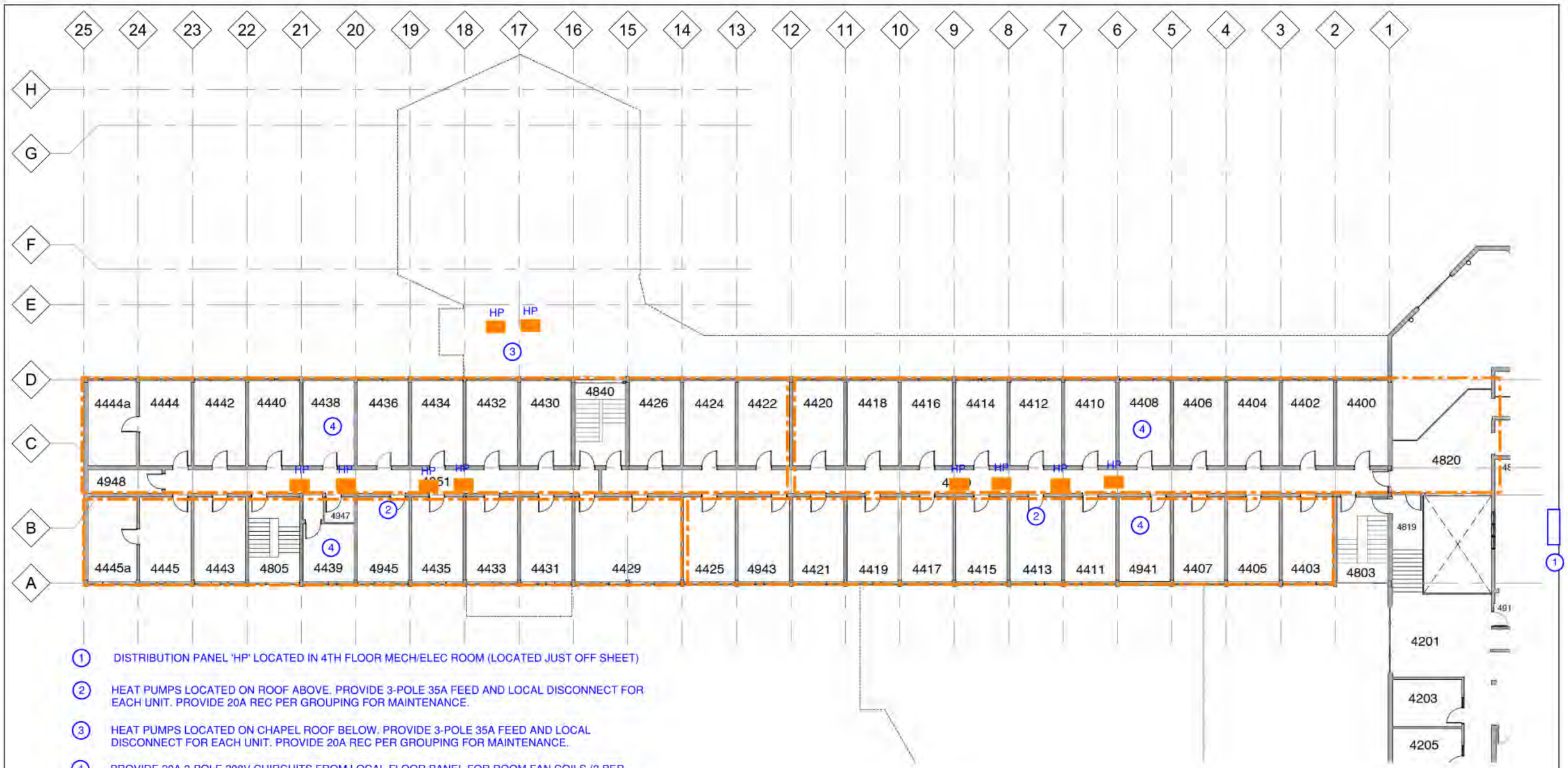
DORM HEAT PUMP WORK

Scale 1 : 250

0 2.5 5 12.5 25 m

SHEET No.:

E4



1. DISTRIBUTION PANEL 'HP' LOCATED IN 4TH FLOOR MECH/ELEC ROOM (LOCATED JUST OFF SHEET)
2. HEAT PUMPS LOCATED ON ROOF ABOVE. PROVIDE 3-POLE 35A FEED AND LOCAL DISCONNECT FOR EACH UNIT. PROVIDE 20A REC PER GROUPING FOR MAINTENANCE.
3. HEAT PUMPS LOCATED ON CHAPEL ROOF BELOW. PROVIDE 3-POLE 35A FEED AND LOCAL DISCONNECT FOR EACH UNIT. PROVIDE 20A REC PER GROUPING FOR MAINTENANCE.
4. PROVIDE 20A 2-POLE 208V CUIRCUITS FROM LOCAL FLOOR PANEL FOR ROOM FAN COILS (2 PER ZONE INDICATED). CONNECT THROUGH WALL ERV (120V) FROM LOCAL ROOM RECEPTACLE PANEL (1 PER ROOM).

PROJECT:
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WALTERFEDY

TITLE:
FOURTH FLOOR PLAN - ELECTRICAL

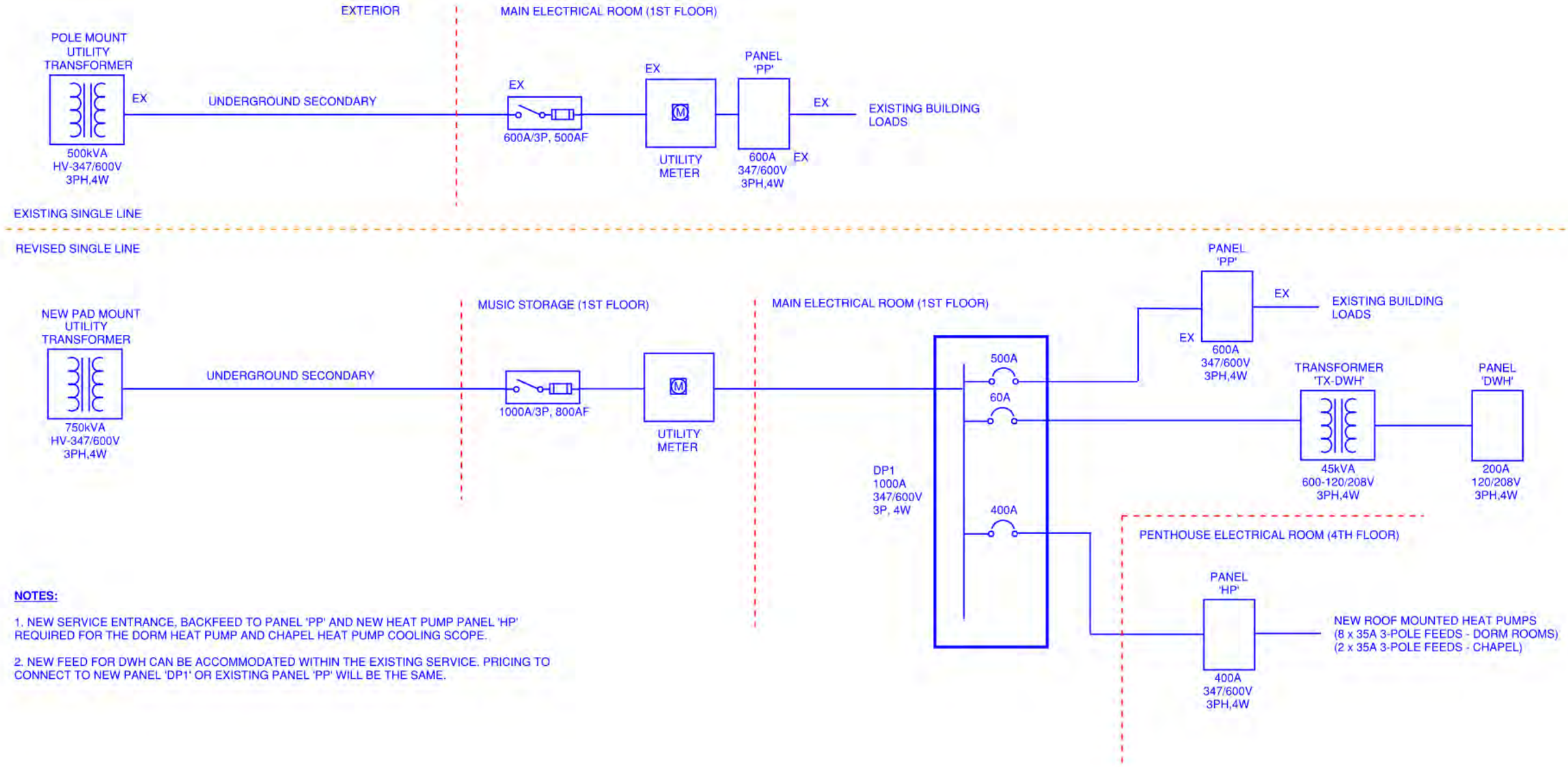
DORM HEAT PUMP WORK

Scale 1 : 250

0 2.5 5 12.5 25 m

SHEET No.:

E5



NOTES:

1. NEW SERVICE ENTRANCE, BACKFEED TO PANEL 'PP' AND NEW HEAT PUMP PANEL 'HP' REQUIRED FOR THE DORM HEAT PUMP AND CHAPEL HEAT PUMP COOLING SCOPE.

2. NEW FEED FOR DWH CAN BE ACCOMMODATED WITHIN THE EXISTING SERVICE. PRICING TO CONNECT TO NEW PANEL 'DP1' OR EXISTING PANEL 'PP' WILL BE THE SAME.

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WALTERFEDY

TITLE:

ELECTRICAL SINGLE LINE DIAGRAM

Scale 1 : 200

0 2 4 10 20 m

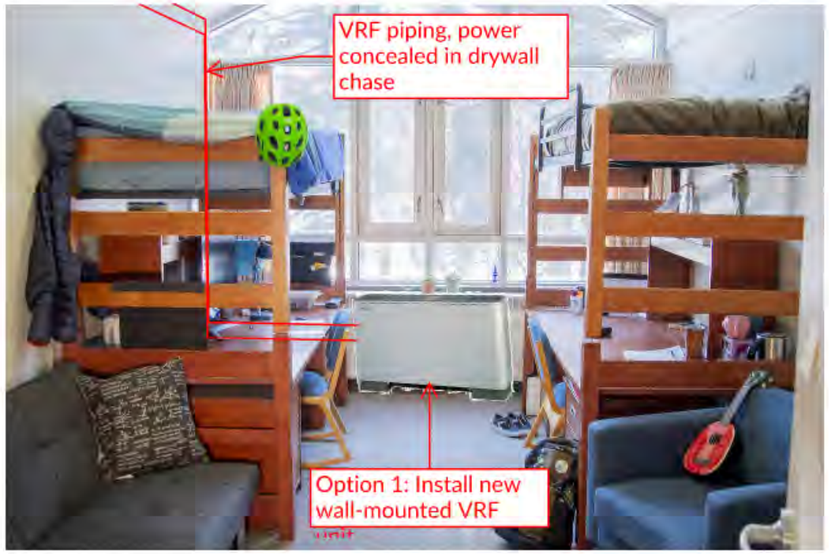
SHEET No.:

E6

WF explored several options to add cooling and ventilation to the residence rooms. Out of this design exercise came the following feasible options. In both cases, a VRF indoor unit will be installed in each residence room to provide heating and cooling to the space. The existing perimeter wallfin equipment will be demolished and removed completely. After the building envelope upgrade, there will be very little air-leakage at the rooms. New single-room energy recovery ventilators (ERVs) will be installed in each room. The following floor plans use colour coding to identify the rooms served by each outdoor unit 'system'. A full system will operate in heating or cooling at any one time. Each residence room will have its own temperature set-point. Refrigerant piping and control wiring will connect each indoor unit with the outdoor VRF units. Example cut sheets for the indoor and outdoor equipment are included with this package.

Option 1 is the "below-windows" option, with the indoor unit mounted at the floor in a similar location to the existing wallfin heaters in the residence rooms. The primary advantage to this approach is that condensate drainage from the cooling system can be directly drained to outside at the wall, and condensate pumps can be minimized.

Option 2 is the bulkhead option, where the indoor unit installed within a bulkhead near the corridor wall. This bulkhead will conceal piping, power, and communications wiring. Each indoor unit will require a condensate pump for delivering the condensate drainage from the cooling coil to a suitable vertical drain near the existing washrooms.



SCOPE:
Remove all perimeter heating equipment.

The wall-mounted option includes a new indoor VRF unit installed similar to the image noted here. Refrigeration piping will run from each room to distribution piping in the corridor, and collect up to a roof-mounted outdoor unit. In the residence rooms, power and piping will be concealed in a drywall chase. Condensate drainage from the VRF unit at the wall will be drained directly outdoors through a wall opening.

Outdoor unit will be installed on a 400 mm high stand on the existing roof. TYP for both options.

Option 2 has this concealed fan coil unit installed in a bulkhead at the corridor wall of the room for each residence space

Room-by-room ERV installed in the wall for each residence room.

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WALTERFEDY

TITLE:
PACKAGE 3 RESIDENCE HEATING / COOLING

Scale 1 : 250

0 2.5 5 12.5 25 m

SHEET No.:

Proposed grouping of residence rooms to be served by each distinct system (outdoor unit). Stairwells will not be included.

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WALTERFEDY

TITLE:
THIRD FLOOR PLAN

Scale 1 : 250

0 2.5 5 12.5 25 m

SHEET No.:

PROJECT:
CONRAD GREBEL UNIVERSITY COLLEGE ENVELOPE AND ENERGY RETROFIT STUDY

PROJECT NO: 2023-0757-10

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WALTERFEDY

TITLE:
FOURTH FLOOR PLAN

Scale 1 : 250

0 2.5 5 12.5 25 m

SHEET No.:

PROJECT:
CONRAD GREBEL UNIVERSITY COLLEGE ENVELOPE AND ENERGY RETROFIT STUDY

PROJECT NO: 2023-0757-10

architects
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WALTERFEDY

TITLE:
ROOF PLAN

Scale 1 : 250

0 2.5 5 12.5 25 m

SHEET No.:

Submittal Data Sheet
8-Ton, 575V VRV AURORA HP
RXLQ96TAYCA

FEATURES

- VRF Industry's first air cooled system that delivers heating down to -22°F (-30°C) as standard
- Daikin's inverter based vapor injection compressor delivers high heating capacity of up to 100% of nominal at 0°F (-18°C), up to 85% of nominal at -13°F (-25°C) and up to 60% of nominal at -22°F (-30°C)
- Refrigerant-cooled efficient and stable inverter board operation, independent of ambient conditions
- Added peace of mind with Auto Changeover ability to back up (auxiliary) heat
- Year round comfort and energy efficiency delivered by combining VRV and VRT technologies
- Available in 6, 8, 10 ton single modules and 12, 16, 20 ton multi-module systems
- Seamless connection to all VRV M, P and T series indoor and air processing units
- Ships factory standard with coil guards
- Assembled in the US to increase flexibility and reduce lead times
- Standard Limited Warranty: 10-year limited parts warranty

BENEFITS

- Refrigerant cooled inverted technology allows installation without an additional drain pan heater
- Designed and optimized for Total Cost of Construction (TCC) and reduced Life Cycle Cost (LCC)
- Modular and lightweight - enables flexibility in system layout and installation
- Engineered with Daikin's inverter based vapor injection compressor for optimized part load efficiency
- Heat exchanger coil wraps around on all 4 sides of the unit to increase the surface area / efficiency
- Corrosion resistant, 1000 hours salt spray tested Daikin PE blue fin heat exchanger
- Long pipe lengths up to 1640 ft total and ability to connect up to 16 indoor units with up to 98 ft vertical separation between indoor units provides design and installation flexibility
- Digital display on the unit for improved and faster configuration, commissioning, and troubleshooting

Submittal Data Sheet
8-Ton, 575V VRV AURORA HP
RXLQ96TAYCA

PERFORMANCE

Outdoor Unit Model No.	RXLQ96TAYCA	Outdoor Unit Name:	8-Ton, 575V VRV AURORA HP
Type:	Heat Pump	Unit Combination:	
Rated Cooling Conditions:	Indoor (°F DB/WB): 80 / 67 Ambient (°F DB/WB): 95 / 75	Rated Heating Conditions:	Indoor (°F DB/WB): 70 / 60 Ambient (°F DB/WB): 47 / 43
Rated Piping Length(ft):			
Rated Height Difference (ft):	0.00		
Rated Cooling Capacity (Btu/hr):	92,000	Rated Heating Capacity (Btu/hr):	10,300
Nom Cooling Capacity (Btu/hr):	96,000	Nom Heating Capacity (Btu/hr):	108,000
Cooling Input Power (kW):	6.09	Heating Input Power (kW):	6.70
EER (Non-Ducted/Ducted):	14.90 / 12.30	Heating COP (Non-Ducted/Ducted):	4.3 / 3.5
IEER (Non-Ducted/Ducted):	24.70 / 18.90	Heating COP 17F (Non-Ducted/Ducted):	2.5 / 2.3

OUTDOOR UNIT DETAILS

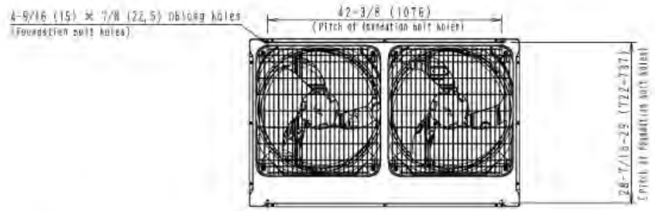
Power Supply (V/Hz/Ph):	575 / 60 / 3	Compressor Stage:	
Power Supply Connections:	L1, L2, L3 Ground	Capacity Control Range (%):	13 - 100
Min. Circuit Amps MCA (A):	28.5	Capacity Index Limit:	67.0 - 124.0
Max Overcurrent Protection (MOP) (A):	35	Airflow Rate (H) (CFM):	7989
Max Starting Current MSC(A):		Gas Pipe Connection (inch):	7/8
Rated Load Amps RLA(A):	14.7	Liquid Pipe Connection (inch):	3/8
Dimensions (Height) (in):	66-11/16	H/L Pressure Connection (inch)	
Dimensions (Width) (in):	48-7/8	H/L Equalizing Connection (inch)	
Dimensions (Depth) (in):	30-3/16	Sound Pressure (H) (dBA):	61
Net Weight (lb):	793	Sound Power Level (dBA):	80.5
		Max. No. of Indoor Units:	16

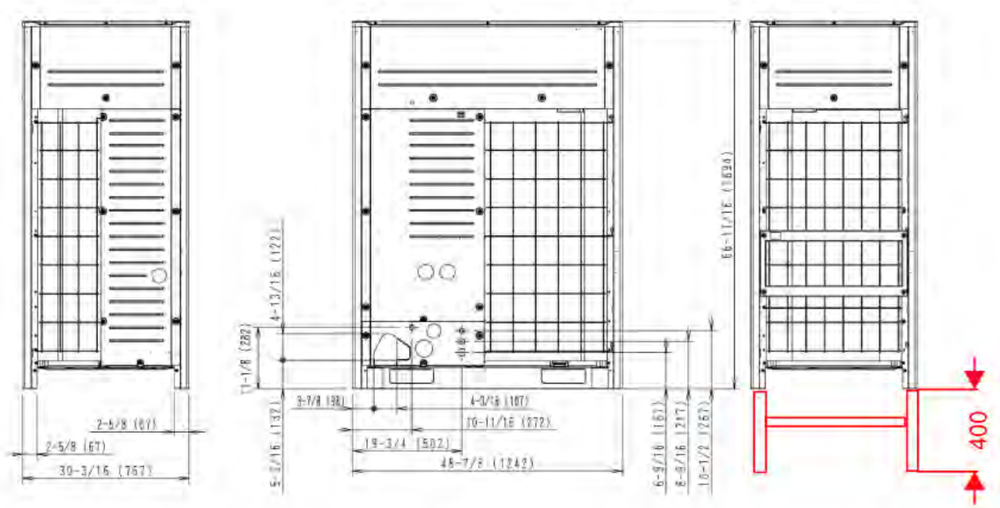
Submittal Data Sheet
8-Ton, 575V VRV AURORA HP
RXLQ96TAYCA

SYSTEM DETAILS

Refrigerant Type:	R-410A	Cooling Operation Range (°F DB):	23 - 122
Holding Refrigerant Charge (lbs):	25.8	Heating Operation Range (°F WB):	-22 - 60
Additional Charge (lb/ft):		Max. Pipe Length (Vertical) (ft):	295
Pre-charge Piping (Length) (ft):		Cooling Range w/Baffle (°F DB):	-
Max. Pipe Length (Total) (ft):	1,640	Heating Range w/Baffle (°F WB):	-
Max Height Separation (Ind to Ind ft):	0		

DIMENSIONAL DRAWING





Submittal Data Sheet
0.6-Ton Floor Standing
FXLQ07MVJU9

FEATURES

- One of our slimmest indoor units (less than 8") fits any interior design
- Wide air discharge outlet distributes a comfortable airflow throughout the entire space
- Silent stream fan technology keeps sound pressure levels low
- Ideal for installation beneath a window
- Unit requires minimal installation space
- Standard Limited Warranty: 10-year warranty on compressor and all parts

R-410A INVERTER VRV

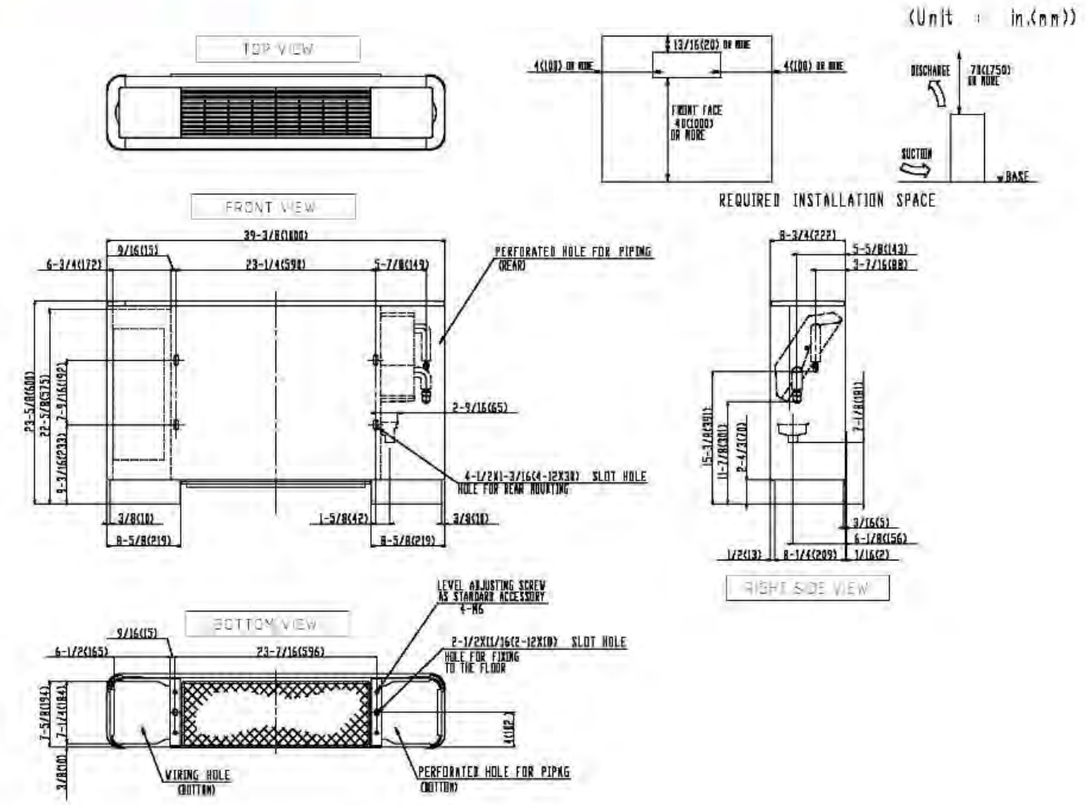
Submittal Data Sheet
0.6-Ton Floor Standing
FXLQ07MVJU9

PERFORMANCE			
Indoor Unit Model No.	FXLQ07MVJU9	Indoor Unit Name:	0.6-Ton Floor Standing
Type	Floor Standing	Rated Cooling Conditions:	Indoor (°F DB/WB): 80 / 67 Ambient (°F DB/WB): 95 / 75
Rated Cooling Capacity (Btu/hr):	7,500	Rated Heating Conditions:	Indoor (°F DB/WB): 70 / 60 Ambient (°F DB/WB): 47 / 43
Sensible Capacity (Btu/hr):	5,800	Rated Piping Length(ft):	
Cooling Input Power (kW):	0.050	Rated Height Separation (ft):	
Rated Heating Capacity (Btu/hr):	8,500		
Heating Input Power (kW):	0.05		

INDOOR UNIT DETAILS			
Power Supply (V/Hz/Ph):	208-230 / 60 / 1	Airflow Rate (H/L) (CFM):	245/210
Power Supply Connections:	L1, L2, Ground	Moisture Removal (Gal/hr):	
Min. Circuit Amps MCA (A):	0.3	Gas Pipe Connection (inch):	1/2
Max Overcurrent Protection (MOP) (A):	15	Liquid Pipe Connection (inch):	1/4
Dimensions (HxWxD) (in):	23-5/8 x 39-3/8 x 8-3/4	Condensate Connection (inch):	25/32
Net Weight (lb):	58	Sound Pressure (H/L) (dBA):	35/32
Ext. Static Pressure (Rated/Max) (inWg):	/	Sound Power Level (dBA):	

Submittal Data Sheet
0.6-Ton Floor Standing
FXLQ07MVJU9

DIMENSIONAL DRAWING



DAIKIN

Submittal Data Sheet

0.5-Ton Slim Duct Built-in Concealed Ceiling Unit

FXDQ07MVJU

FEATURES

- The slim height, at only 7-7/8", makes it suitable for most of the applications where attic / bulkhead space is limited
- With a sound level as low as 29 dBA, these systems are among the quietest on the market
- Washable filter included
- Integral condensate pump with up to 23-5/8" lift
- Blends unobtrusively with any interior decor, only the suction and discharge grills are visible
- Standard Limited Warranty: 10-year warranty on compressor and all parts

R-410A INVERTER VRV C ETL US

DAIKIN

Submittal Data Sheet

0.5-Ton Slim Duct Built-in Concealed Ceiling Unit

FXDQ07MVJU

PERFORMANCE			
Indoor Unit Model No:	FXDQ07MVJU	Indoor Unit Name:	0.5-Ton Slim Duct Built-in Concealed Ceiling Unit
Type:	Ducted	Rated Cooling Conditions:	Indoor (°F DB/WB): 80 / 67 Ambient (°F DB/WB): 95 / 75
Rated Cooling Capacity (Btu/hr):	7,500	Rated Heating Conditions:	Indoor (°F DB/WB): 70 / 60 Ambient (°F DB/WB): 47 / 43
Sensible Capacity (Btu/hr):	6,300	Rated Piping Length(ft):	
Cooling Input Power (kW):	0.090	Rated Height Separation (ft):	
Rated Heating Capacity (Btu/hr):	8,500		
Heating Input Power (kW):	0.07		

INDOOR UNIT DETAILS			
Power Supply (V/Hz/Ph):	208-230 / 60 / 1	Airflow Rate (H/L) (CFM):	280/226
Power Supply Connections:	L1, L2, Ground	Moisture Removal (Gal/hr):	
Min. Circuit Amps MCA (A):	0.9	Gas Pipe Connection (inch):	1/2
Max Overcurrent Protection (MOP) (A):	15	Liquid Pipe Connection (inch):	1/4
Dimensions (HxWxD) (in):	7-7/8 x 27-9/16 x 24-7/16	Condensate Connection (inch):	1-1/32
Net Weight (lb):	51	Sound Pressure (H/L) (dBA):	33/29
Ext. Static Pressure (Rated/Max) (inWg):	0.12" / 0.12"	Sound Power Level (dBA):	

Daikin City Generated Submittal Data
Daikin North America LLC, 5151 San Felipe, Suite 500, Houston, TX, 77056
www.daikinac.com www.daikincomfort.com

(Daikin's products are subject to continuous improvements. Daikin reserves the right to modify product design, specifications and information in this data sheet without notice and without incurring any obligations)

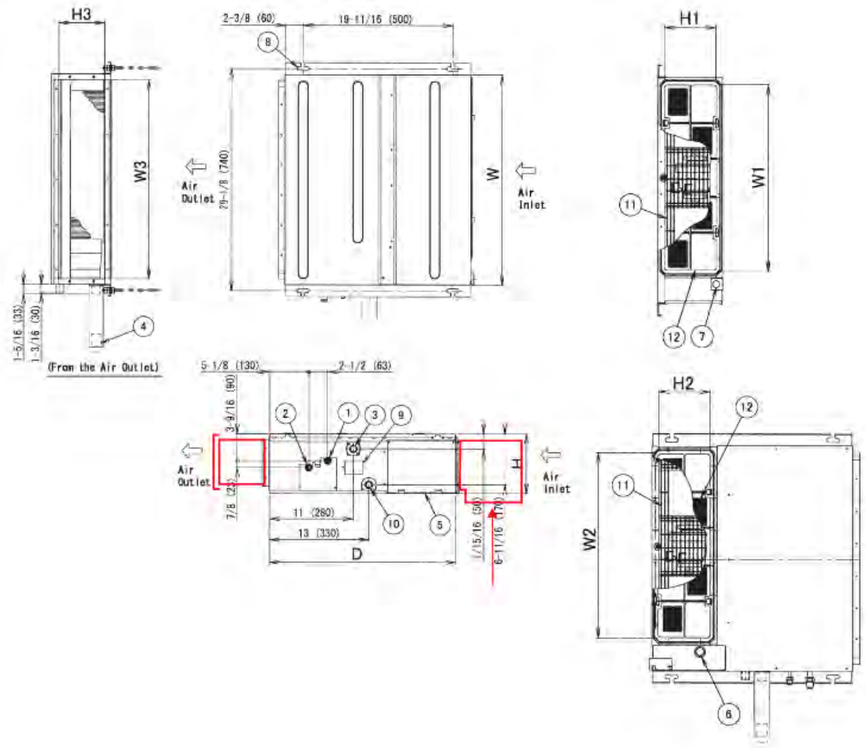
DAIKIN

Submittal Data Sheet

0.5-Ton Slim Duct Built-in Concealed Ceiling Unit

FXDQ07MVJU

DIMENSIONAL DRAWING



12	AIR FILTER(ACCESSORY)	
11	PROTECTION NET	
10	SOCKET FOR DRAIN	
9	INSPECTION DOOR	
8	SUSPENSION BRACKET	
7	POWER SUPPLY CONNECTION	
6	TRANSMISSION WIRING CONNECTION	
5	CONTROL BOX	
4	DRAIN HOSE(ACCESSORY)	I. D. φ31/32(OUTLET)
3	DRAIN PIPE CONNECTION	VP20 (O. D. φ1-1/32,I. D. φ25/32)
2	GAS PIPE CONNECTION	φ1/2 (FLARE CONNECTION)
1	LIQUID PIPE CONNECTION	φ1/4 (FLARE CONNECTION)
ITEM	PART NAME	REMARK

H		7-7/8 (200)
W		27-9/16 (700)
D		24-7/16 (620)
Air Inlet (Side)	H1	6-5/16 (160)
	W1	22-13/16 (580)
Air Inlet (Bottom)	H2	6-5/16 (160)
	W2	22-13/16 (580)
Air Outlet	H3	6 (153)
	W3	26 (660)

Note: For additional dimensional data and clearance information, refer to Engineering Data

Technical Information Sheet

Home Ventilation with Heat Recovery – e²60

LUNOS

Description and functions

After outstanding features, such as barely audible reversing noises and an extremely quiet operating noise have made the e² series so successful, the new e²60 is also convincing in terms of volume flow and pressure stability for the same size. The e²60 is the first device of its type to achieve pressure stability class S1 according to EN 13141-8, making it suitable for use in areas with high wind speeds, such as on the coast or at high altitudes.

Order No. Built-in device 041 157

Installation

The slide-in unit is inserted into the round duct 9/R 160 (drilling ø 162 mm) and with a slight gradient to the outside into the outer wall.

Please note the installation instructions and have the units electrically connected in a professional manner.

Technical data

Volume flow	0 - 60 m³/h
Power consumption	0,4 - 3,3 W
Supply voltage	12V DC
Sound power level	18 - 56 dB(A)
Sound pressure level distance 1 m	10 - 48 dB(A)
Minimum wall thickness	280 mm (lower on request)
Protection class	II
Protection type	IP22

Operating ranges (declared volume flow*)	0-40 m³/h	0-60 m³/h
Efficiency level*	88 %	83 %
Sensitivity to interference pressure** at 20 Pa	Klasse S1	Klasse S2
	0 %	13,80 %
Specific power consumption (SPI)** (two devices + controller + power supply unit)	Klasse 0	Klasse 0
	0,11 W/(m³/h)	0,12 W/(m³/h)

*according EN 13141-8 **according EN 13142

e²60 by LUNOS ensures energy efficient class A+ according to the Ecodesign Directive

A+

Note

Products and illustrations may be subject to slight variation. Due to continuous product development and/or several suppliers e.g. for raw materials, colours, among other things, may vary slightly (not for visible parts) or be shown differently in brochures.

E348 12.19

Package 4: Chapel Cooling and Ventilation

ELECTRICAL SCOPE OF WORK:

1. REFER TO ELECTRICAL SINGLE LINE DIAGRAM AND FLOOR PLANS FOR THE ADDITION OF A NEW ELECTRICAL SERVICE AND SUB PANEL IN THE 4TH FLOOR SERVICE ROOM FOR CONNECTIONS TO HEAT PUMP EQUIPMENT.

2. HEAT PUMPS LOCATED ON CHAPEL ROOF. PROVIDE 3-POLE 35A FEED AND LOCAL DISCONNECT FOR EACH UNIT. PROVIDE 20A REC PER GROUPING FOR MAINTENANCE.

3. PROVIDE 20A 2-POLE 208V CUIRCUITS IN CHAPEL LOWER LEVEL FOR NEW FAN COILS. PROVIDE 30A 208V 3-POLE CIRCUIT FOR NEW ERV.

PROJECT:
CONRAD GREBEL UNIVERSITY COLLEGE ENVELOPE AND ENERGY RETROFIT STUDY

PROJECT NO: 2023-0757-10

Baird Sampson Neuert architects

WALTERFEDY

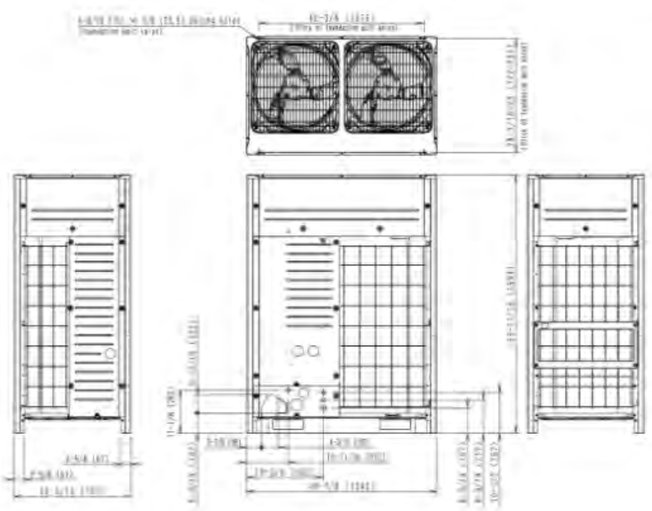
TITLE:
PACKAGE 4 CHAPEL COOLING - ELECTRICAL

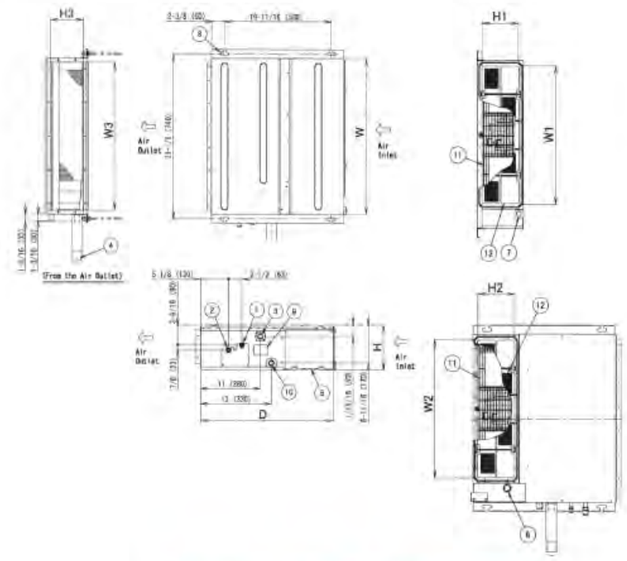
Scale 1 : 200

0 2 4 10 20 m

SHEET No.:

Option 1 - Packaged Outdoor Air Handler





Option 2 - Ducted VRF System

WF Mechanical explored a number of options to add cooling at the Conrad Grebel University College chapel. We have reviewed the following three options below for their suitability for the space.

In Option 1 we looked at installing a 15-Ton packaged air-handling unit (AHU) located by the garden area outside the chapel. Due to the acoustically sensitive nature of the space, special care was taken to size the system based on displacement ventilation principles. Displacement ventilation strategies require larger quantities of airflow in order to satisfy the cooling load, due to the reduced air velocities and warmer air temperature. As a result, the proposed air handling equipment will be larger than one selected for standard design parameters. As we reviewed the overall footprint of the unit at the required parameters, we deemed the unit to be too large for the site and are not recommending we proceed with Option 1.

Option 2 looked at installing a ducted variable refrigerant flow (VRF) system in the basement ceiling space and routing the ventilation/exhaust ductwork to floor registers located by the windows at the north and south sides of the chapel. The associated outdoor condensing units would be located on the residence roof, near the proposed outdoor units for residence heating/cooling. Compared to Option 1 above, the VRF system should be more suitable for site conditions as the indoor and outdoor units are better able to fit inside tight spaces. However, the acoustic performance of the indoor units is significantly impacted by the lower profile footprint required to fit inside the basement level ceiling space. It will be difficult to achieve acceptable acoustic performance for the chapel using this option. If the University wants to proceed with Option 2, we recommend lining the ductwork with acoustic insulation in order to mitigate some of the noise. This option will not be costed at this time.

In Option 3 we looked at keeping the existing central heating system intact, but replacing the perimeter radiators with new two-pipe fan coil units. In order the provide cooling to the chapel, we are proposing a split chiller system to be installed inside Room 2431 and then piped to the two fan coil units located at the chapel windows above. While ventilation air was not initially proposed in the study, we recommend adding an energy recover ventilator (ERV) system for both Option 2 and 3, as there will be appreciable benefits to both space temperature and occupant comfort levels. This option provides good acoustic performance for the chapel, and limited spatial impact in the chapel itself.

PROJECT:
CONRAD GREBEL UNIVERSITY COLLEGE ENVELOPE AND ENERGY RETROFIT STUDY

PROJECT NO: 2023-0757-10

Baird Sampson Neuert architects

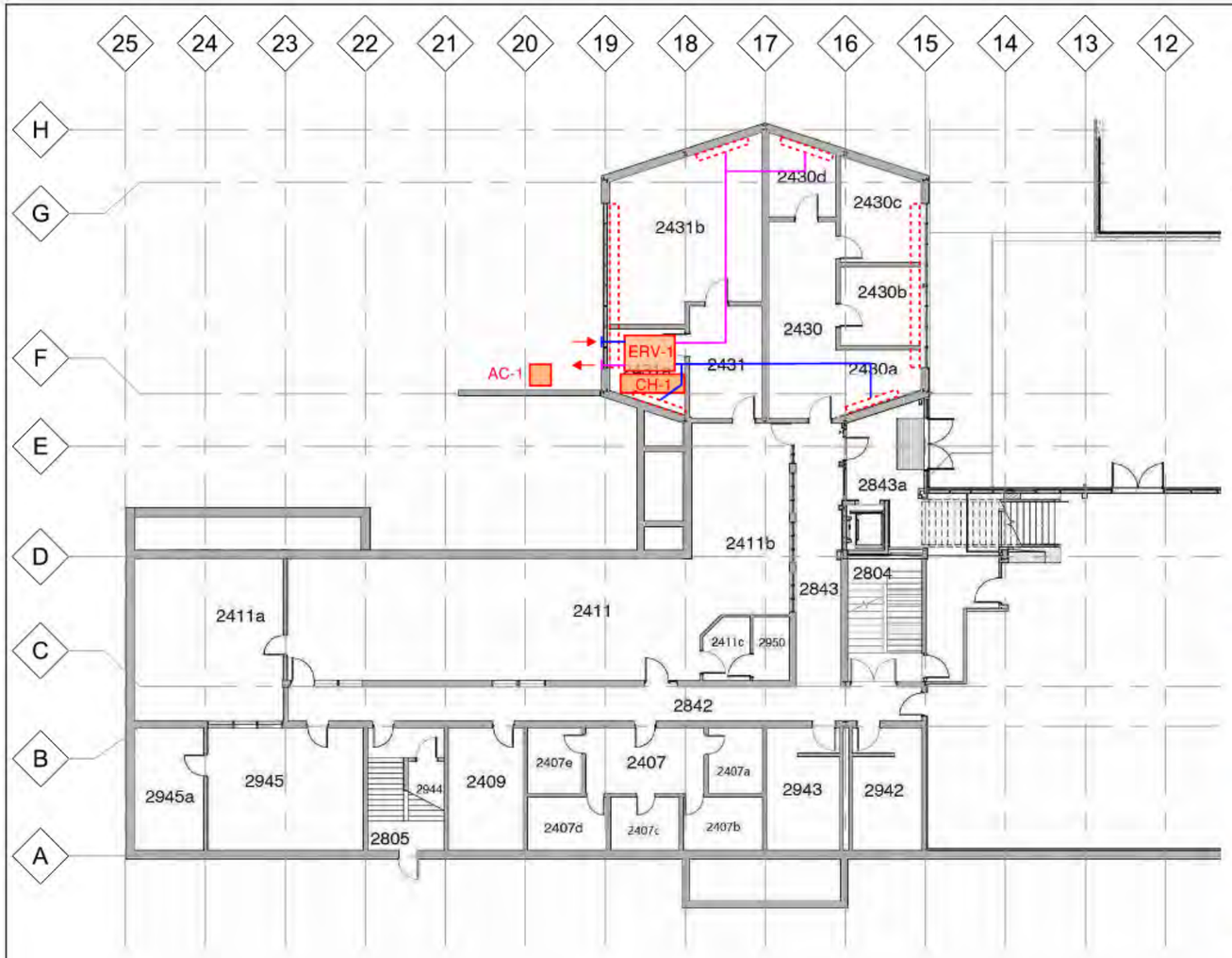
WALTERFEDY

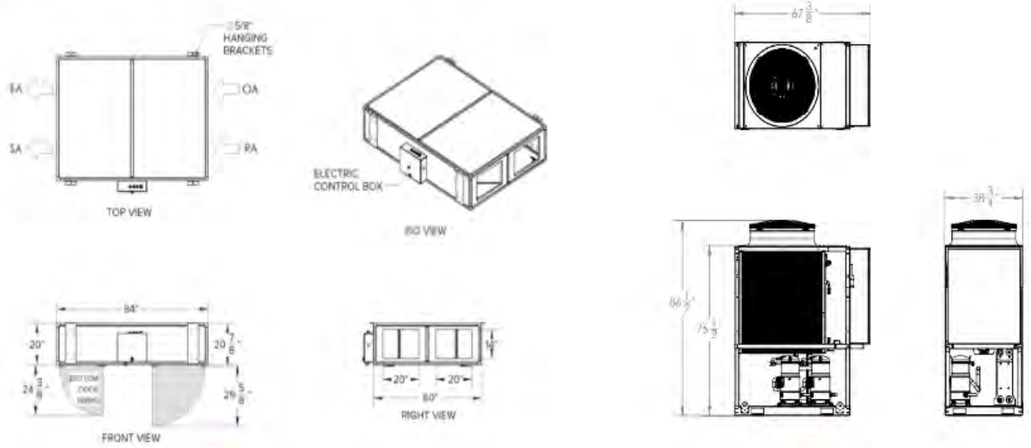
TITLE:
PACKAGE 4 CHAPEL COOLING

Scale 1 : 200

0 2 4 10 20 m

SHEET No.:





ERV-1

CH-1

Proposed location of outdoor condensing unit AC-1. Piping to be routed to/from split chiller CH-1 as shown in Room 2431a.

Notes:

-Existing perimeter heating system units to be disconnected and removed from level above. Main heating distribution equipment, piping and infrastructure to remain in place for future integration to cooling system.

-New 15-Ton split chiller unit CH-1 and associated condensing unit AC-1 to supply cooling to vertical fan coil units FC-1 and 2 on the level above. Integration to

-Optional Item: New 1200 CFM energy recovery ventilator ERV-1 to be installed in ceiling above Room 2431, with ventilation/exhaust ductwork routed to serve floor registers serving the chapel above.

PROJECT:
CONRAD GREBEL UNIVERSITY COLLEGE ENVELOPE AND ENERGY RETROFIT STUDY

PROJECT NO: 2023-0757-10

Baird Sampson Neuert architects

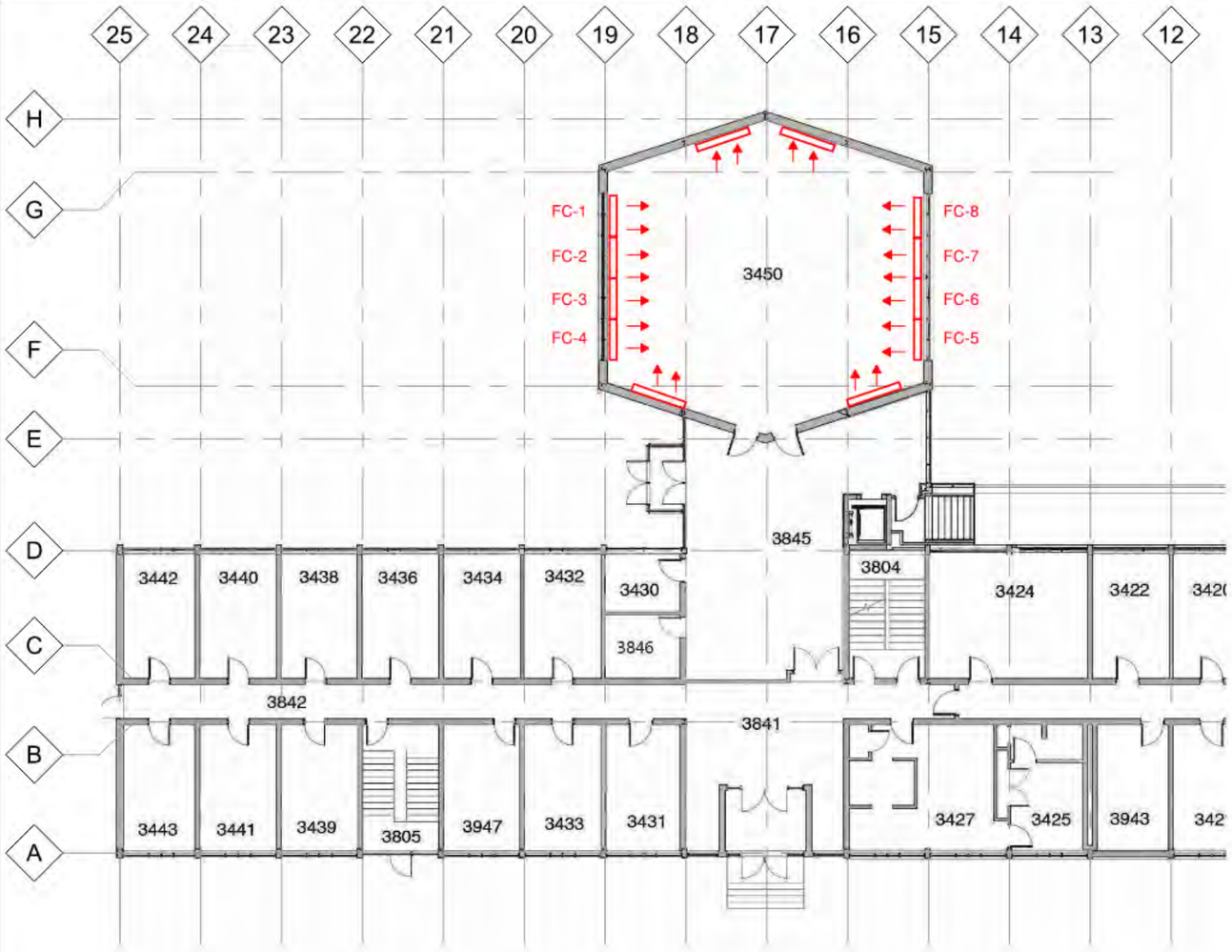
WALTERFEDY

TITLE:
OPTION 3 - CHAPEL COOLING
SECOND FLOOR PLAN

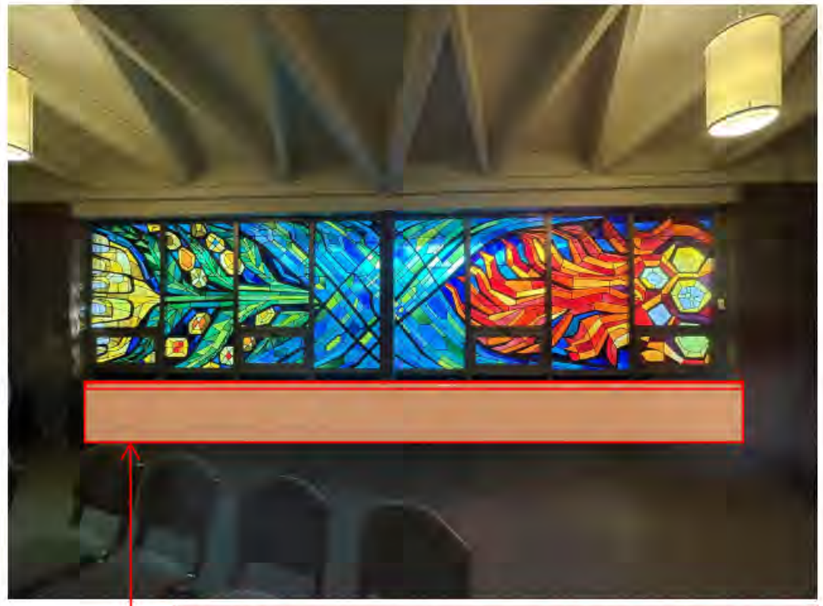
Scale 1 : 250

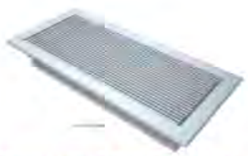
0 2.5 5 12.5 25 m

SHEET No.:



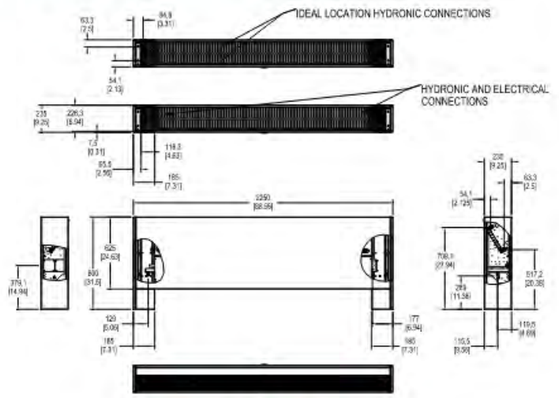
Notes:
-Existing perimeter heating system units to be disconnected and removed. Piping to be cut back to main and capped for future.
-New vertical fan coil units FC-1-8 shall be installed along the perimeter underneath the window sills and piped from below.
-Fan coils to be sized for 90 MBH of sensible cooling and 55 MBH of heating respectively.
-Optional Item: Ventilation air from ERV-1 to be provided through floor registers located at the front and back of the chapel, along with associated supply/return ductwork to run in ceiling space of basement office area.





Proposed floor register for chapel ventilation

TAG: FC-1 TO 6



FC-1,2,3,4,5,6,7,8

PROJECT:
CONRAD GREBEL UNIVERSITY COLLEGE ENVELOPE AND ENERGY RETROFIT STUDY

PROJECT NO: 2023-0757-10

Baird Sampson Neuert architects

WALTERFEDY

TITLE:
OPTION 3 - CHAPEL COOLING
THIRD FLOOR PLAN

Scale 1 : 250
0 2.5 5 12.5 25 m

SHEET No.:

Package 5: Domestic Hot Water Electrification

ELECTRICAL SCOPE OF WORK:

1. REFER TO ELECTRICAL SINGLE LINE DIAGRAM FOR THE ADDITION OF A 45kVA TRANSFORMER AND 200A 208V PANEL FED FROM THE NEW ELECTRICAL SERVICE.

2. DISCONNECT AND REMOVE EXISTING GAS FIRED DOMESTIC HOT WATER BOILERS AND TANKS.

3. PROVIDE 3 x 80A 2-POLE CONNECTIONS FROM NEW DWH PANEL TO NEW HEAT PUMP WATER HEATERS.

PROJECT:
CONRAD GREBEL UNIVERSITY COLLEGE ENVELOPE AND ENERGY RETROFIT STUDY

PROJECT NO: 2023-0757-10

Baird Sampson Neuert architects

WALTERFEDY

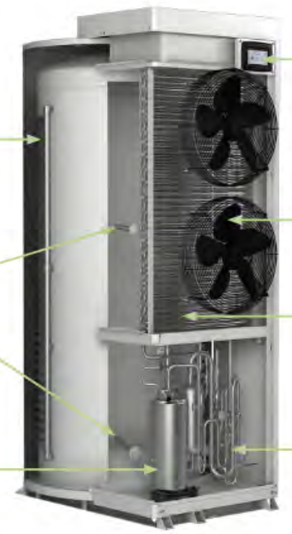
TITLE:
PACKAGE 5 DOMESTIC HOT WATER - ELECTRICAL

Scale 1 : 200

0 2 4 10 20 m

SHEET No.:

WF is recommending replacement of the existing gas fired domestic water heating system with a commercial heat pump domestic water heater. This system includes a self-contained heat pump refrigeration system that pulls heat from the mechanical room and heats the domestic water. There is also an electric resistance heater in the tank that provides a capacity boost in periods of higher demand.
The mechanical room will need to have a stable source of heat. This could be a small electric boiler, or VRF system that ensures the mechanical room stays above a minimum temperature.
The new domestic water heaters will occupy a similar footprint to the existing tanks and heaters in the basement mechanical room.



Existing domestic water tanks pictured here serving the residence washrooms. Propose replacing with three AO Smith CAHP-120 (or similar)

PROJECT:
CONRAD GREBEL UNIVERSITY COLLEGE ENVELOPE AND ENERGY RETROFIT STUDY

PROJECT NO: 2023-0757-10

architects
Baird Sampson Neuert

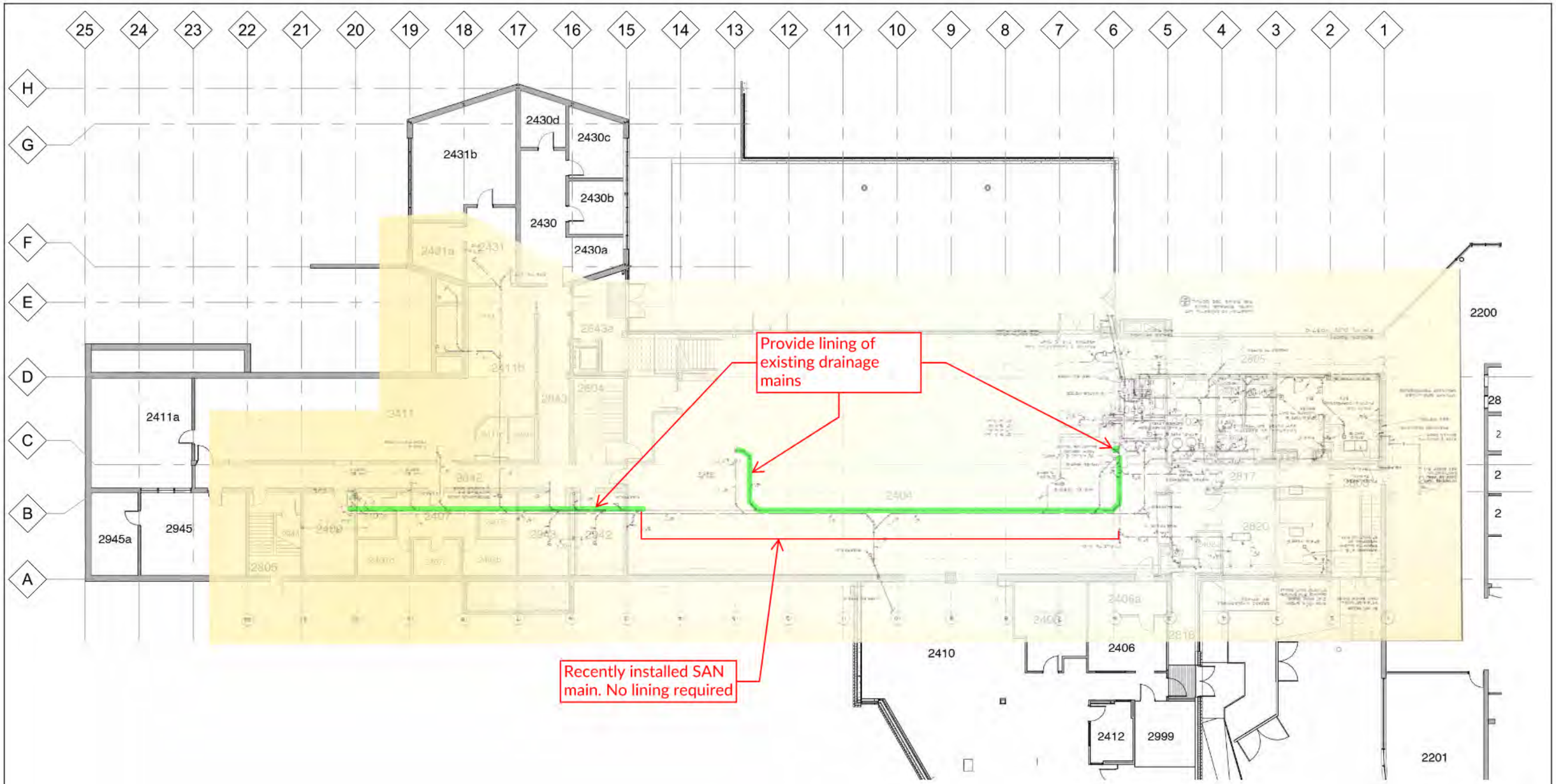
WALTERFEDY

TITLE:
PACKAGE 5 DOMESTIC WATER HEATING

Scale 1 : 200
0 2 4 10 20 m

SHEET No.:

Package 6: Sanitary Plumbing Refurbishment



PROJECT:
CONRAD GREBEL UNIVERSITY COLLEGE ENVELOPE AND ENERGY RETROFIT STUDY

PROJECT NO: 2023-0757-10

TITLE:
SECOND FLOOR PLAN

architects
Baird Sampson Neuert

WALTERFEDY

Scale 1 : 250

0 2.5 5 12.5 25 m

SHEET No.:

1

Blocked, root-intruded and corroded pipes are cleaned with tools and processes appropriate to the situation.

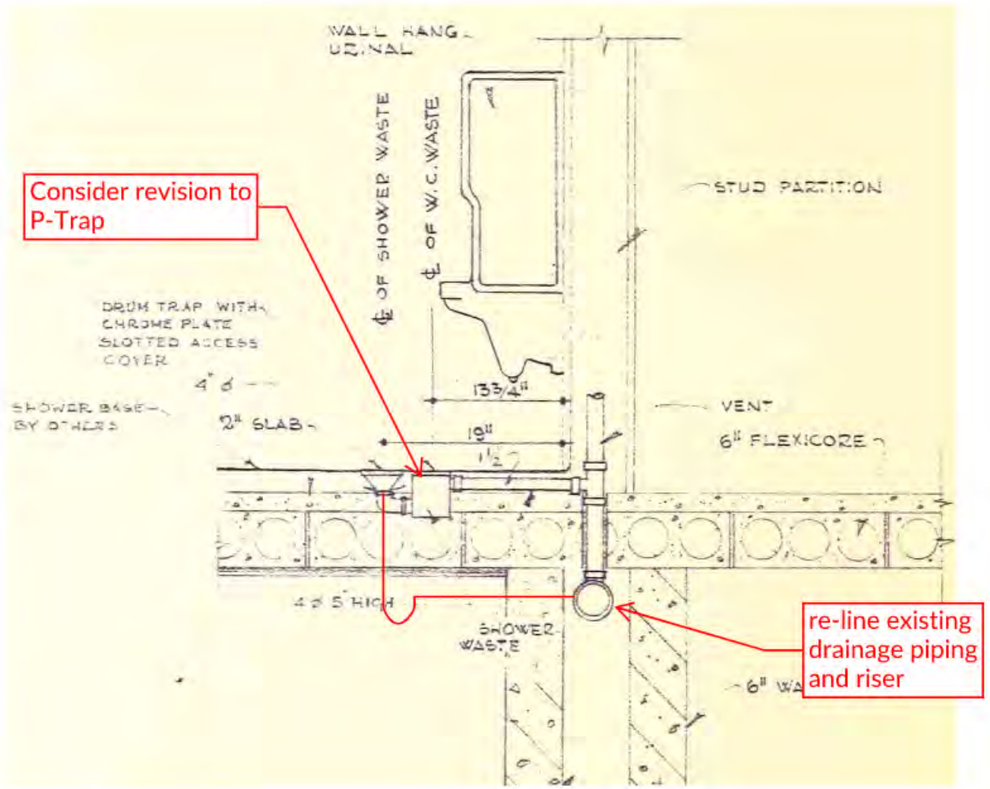
2

A flexible, epoxy saturated liner is pushed or pulled into place through existing access points. An internal bladder is inflated, pressing the liner against the pipe wall.

3

The resin cures, often in a matter of minutes, and the bladder is deflated and removed, leaving behind a clean, seamless "Pipe-within-a-Pipe".

https://nuflow.com/how-nuflow-works/nudrain/



PROJECT:
CONRAD GREBEL UNIVERSITY COLLEGE ENVELOPE AND ENERGY RETROFIT STUDY

PROJECT NO: 2023-0757-10

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WALTERFEDY

TITLE:
PLUMBING DETAILS

Scale 1 : 200

0 2 4 10 20 m

SHEET No.:

Package 7: Envelope Upgrade (Wall Insulation)

OPTION 1: BRICK VENEER INFILL

OPTION 2: FIBER CEMENT PANEL INFILL

OPTION 3: OVERCLAD WITH FIBER CEMENT PANEL INFILL

OPTION 4: FULL OVERCLAD WITH EIFS

The last measure of the Conrad Grebel University College Energy Study is exploring exterior wall upgrades. The existing building envelope (much like many of the buildings of its era) has a poor thermal performance and contain many thermal bridges. For example, the 1963 residence wing only have 1" of insulation in its typical wall assembly, per the original drawings. BSN explored many options, through a variety of means of replacing/infilling/overcladding the exterior walls and exposed concrete structure, and came up with four feasible options.

Scope of work varies through the four options. Options 1 and 2 require similar scopes of work, with the variation being the exterior finish. These two options require the replacement of the existing brick walls located underneath the windows of the residence wing. Options 3 and 4 are also similar to one another, as these two options requirement the over-cladding of the existing brick walls.

Option 1 includes removal of existing two wythes from under bay window. Area is replaced with GWB stud wall topped with solid surface, AVB, 150mm mineral wool insulation, air space and clad with brick veneer. Exposed columns and beams are left as is. North elevation is discluded from scope of work.

Option 2 is the same as Option 1, except clad with fiber cement panel. North elevation is included in the scope of work.

Option 3 is to keep the existing double wythe wall and over-clad with rigid insulation and clad with fiber cement panel. Exposed columns and beams are over-clad with rigid insulation and clad with fiber cement panels. Thickness of insulation varies to maintain look of facade. North elevation is included in the scope of work.

Option 4 is the same as Option 3, except over-clad with mineral wool EIFS.

Option 5 is to keep the existing double wythe wall and replace the interior insulative and finishing layers of the wall assembly beneath windows. Remove existing mechanical unit, enclosure, and existing insulation. Area is replaced with new 75mm spray foam insulation on interior face of double wythe brick, 64mm metal stud wall assembly with 16mm GWB.

PROJECT:
CONRAD GREBEL UNIVERSITY COLLEGE ENVELOPE AND ENERGY RETROFIT STUDY

PROJECT NO: 2023-0757-10

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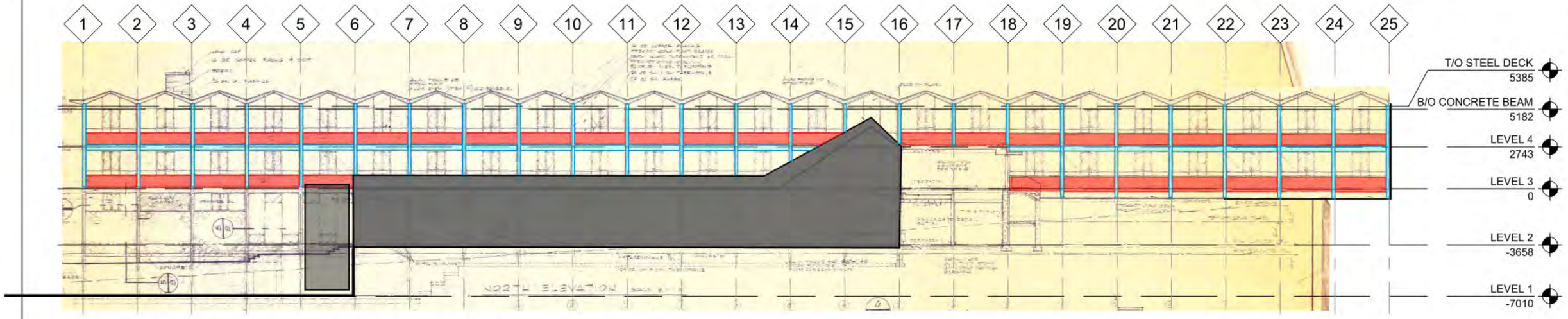
WALTERFEDY

TITLE:
PACKAGE 7 EXTERIOR WALLS COVER PAGE

Scale 1 : 200

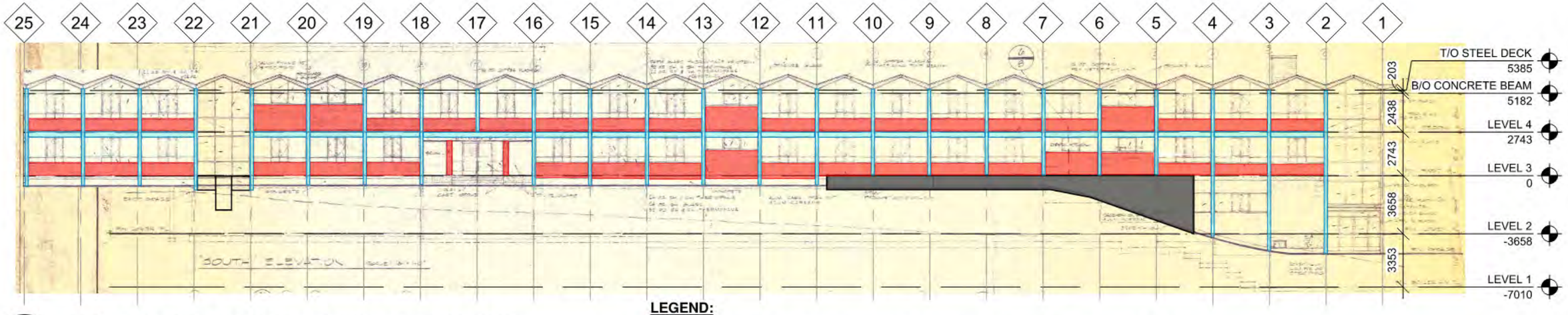
0 2 4 10 20 m

SHEET No.:



1 / A71 WALL REPLACEMENT - EAST ELEVATION

Scale: 1 : 250



2 / A71 WALL REPLACEMENT - WEST ELEVATION

Scale: 1 : 250

LEGEND:

- EXISTING BRICK WALL TO BE REPLACED WITH INFILL OR OVERCLAD WALL PACKAGE OPTION
- EXISTING EXPOSED CONCRETE STRUCTURE TO BE OVERCLAD WITH PACKAGE OPTION

PROJECT:
CONRAD GREBEL UNIVERSITY COLLEGE ENVELOPE AND ENERGY RETROFIT STUDY

PROJECT NO: 2023-0757-10

Baird Sampson Neuert architects

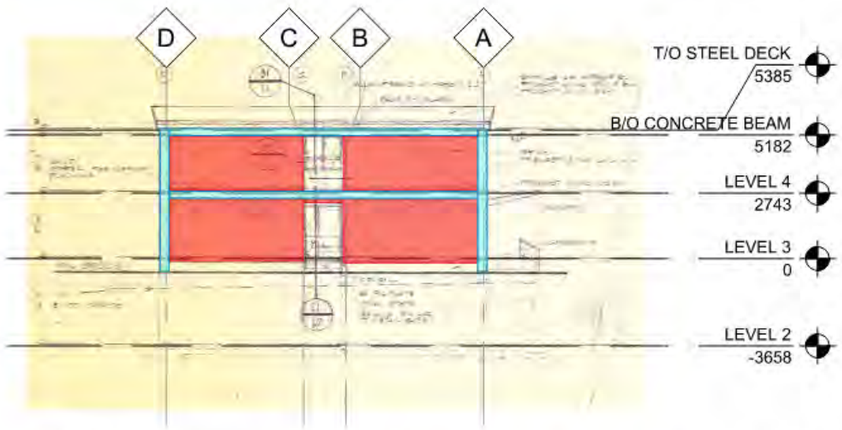
WALTERFEDY

TITLE:
WALL REPLACEMENT - EAST & WEST ELEVATIONS

Scale 1 : 250

0 2.5 5 12.5 25 m

SHEET No.:



1 / A72 WALL REPLACEMENT - NORTH ELEVATION

Scale: 1 : 250

LEGEND:

- EXISTING BRICK WALL TO BE REPLACED WITH OVERCLAD WALL PACKAGE OPTION
- EXISTING EXPOSED CONCRETE STRUCTURE TO BE OVERCLAD WITH PACKAGE OPTION

PROJECT:
CONRAD GREBEL UNIVERSITY COLLEGE ENVELOPE AND ENERGY RETROFIT STUDY

PROJECT NO: 2023-0757-10

Baird Sampson Neuert architects

WALTERFEDY

TITLE:
WALL REPLACEMENT - NORTH ELEVATION

Scale 1 : 250

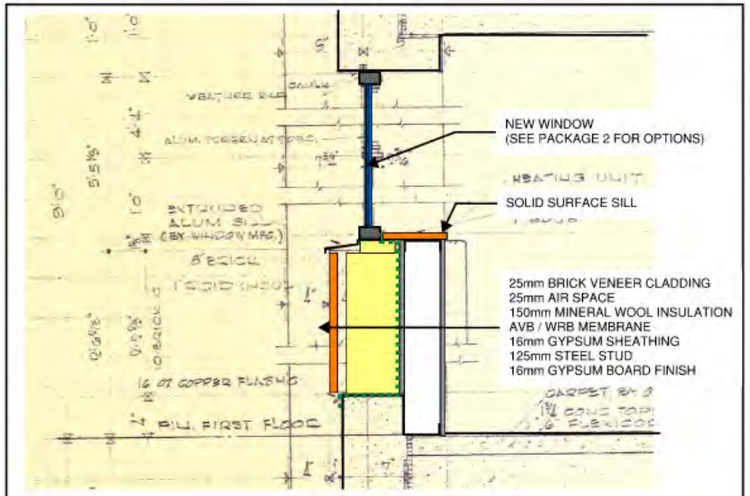
0 2.5 5 12.5 25 m

SHEET No.:

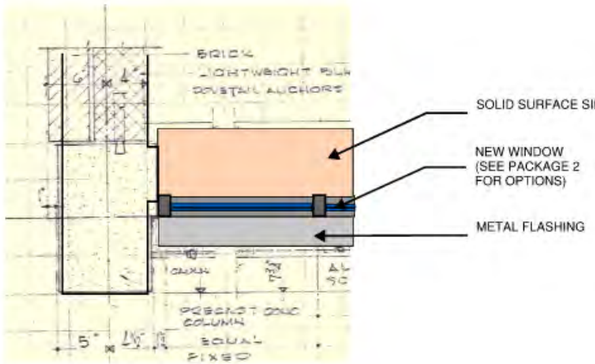
TYPICAL BAY

LEGEND:

- REPLACE WINDOW (SEE PACKAGE 2 FOR OPTIONS)
- REPLACE BRICK WITH INSULATED ASSEMBLY



SECTION A



PLAN DETAIL B

NOTES:

REPLACE EXISTING UNINSULATED BRICK INFILL BELOW WINDOWS WITH BRICK VENEER ON INSULATED / AIR-TIGHT STUD WALL ASSEMBLY. APPROX. 4" INSULATION: R16

THE USE OF PRE-CAST CONCRETE BRICK PANELS AS ALTERNATIVE TO SITE-PLACED MASONRY WILL BE REVIEWED.

EXISTING BRICK WALLS AT NORTH END ARE CIRCA 2003 AND INSULATED. **DISCLUDE** NORTH ELEVATION AS APART OF THIS OPTION'S SCOPE OF WORK.

PROJECT:
CONRAD GREBEL UNIVERSITY COLLEGE ENVELOPE AND ENERGY RETROFIT STUDY

PROJECT NO: 2023-0757-10

Baird Sampson Neuert architects

WALTERFEDY

TITLE:
EXTERIOR WALL UPGRADE OPTION 1: BRICK VENEER INFILL

Scale 1 : 200

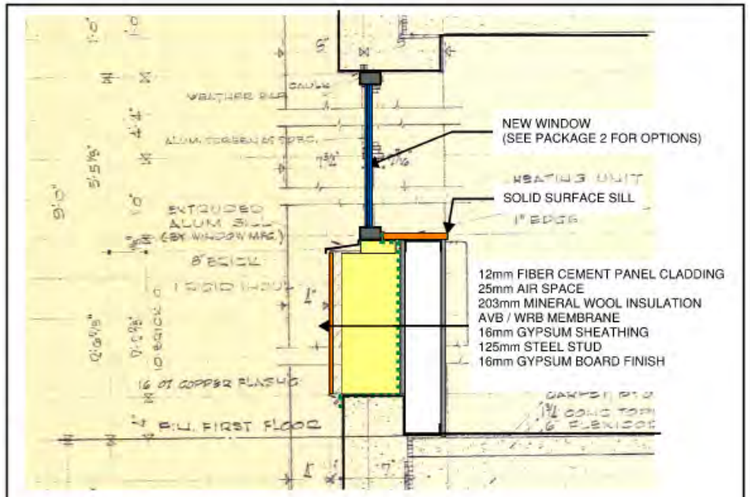
0 2 4 10 20 m

SHEET No.:

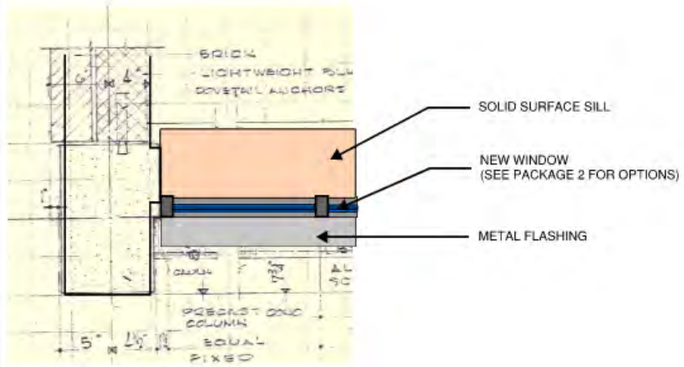
TYPICAL BAY

LEGEND:

- REPLACE WINDOW (SEE PACKAGE 2 FOR OPTIONS)
- REPLACE BRICK WITH INSULATED ASSEMBLY



SECTION A



PLAN DETAIL B

NOTES:

REPLACE EXISTING UNINSULATED BRICK INFILL BELOW WINDOWS WITH FIBER CEMENT PANEL CLADDING OVER INSULATED / AIR-TIGHT STUD WALL ASSEMBLY.
APPROX. 6" INSULATION R24

EXISTING BRICK WALLS AT NORTH END ARE CIRCA 2003 AND INSULATED. **INCLUDE** NORTH ELEVATION AS APART OF THIS OPTION'S SCOPE OF WORK.

PROJECT:
CONRAD GREBEL UNIVERSITY COLLEGE ENVELOPE AND ENERGY RETROFIT STUDY

PROJECT NO: 2023-0757-10

TITLE:
EXTERIOR WALL UPGRADE OPTION 2: FIBRE CEMENT INFILL

architects
Baird Sampson Neuert

WALTERFEDY

Scale 1 : 200

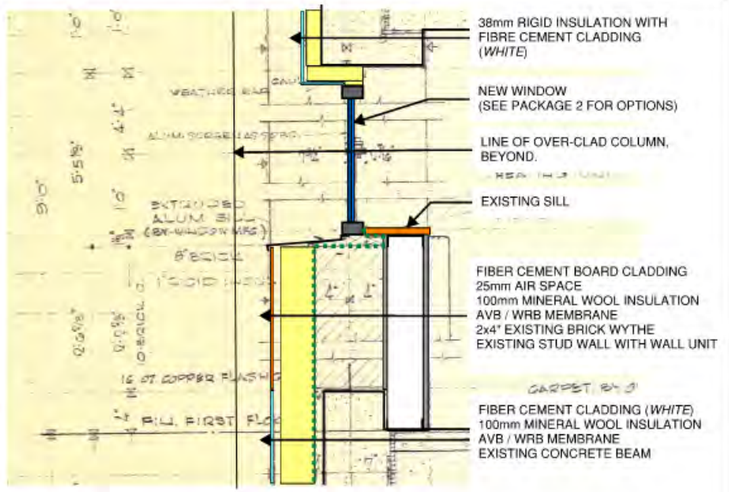
0 2 4 10 20 m

SHEET No.:

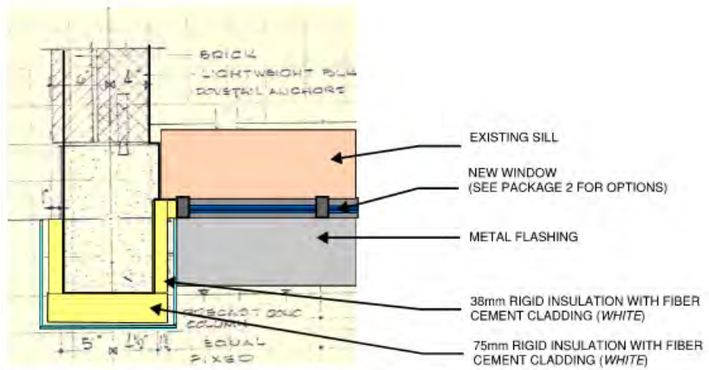
TYPICAL BAY

LEGEND:

- REPLACE WINDOW (SEE PACKAGE 2 FOR OPTIONS)
- OVERCLAD BRICK WITH INSULATED ASSEMBLY
- OVERCLAD / INSULATION ON CONCRETE FRAME



SECTION A



PLAN DETAIL B

NOTES:

OVER-CLAD EXISTING UNINSULATED BRICK INFILL BELOW WINDOWS WITH FIBER CEMENT PANEL CLADDING (GREY / BRICK-COLOURED ETC.), 100mm MINERAL WOOL INSULATION AND AVB. APPLY 100mm RIGID INSULATION AND AIR VAPOUR BARRIER OVER EXPOSED CONCRETE FRAME AND CLAD WITH FIBRE CEMENT PANEL (WHITE) AT COLUMN FACE. APPLY 38mm RIGID INSULATION AND AIR VAPOUR BARRIER OVER EXPOSED CONCRETE FRAME AND CLAD WITH FIBRE CEMENT PANEL (WHITE) AT COLUMN RETURN.

EXISTING BRICK WALLS AT NORTH END ARE CIRCA 2003 AND INSULATED. **INCLUDE** NORTH ELEVATION AS APART OF THIS OPTION'S SCOPE OF WORK FOR CONSISTENCY OF APPEARANCE.

PROJECT:
CONRAD GREBEL UNIVERSITY COLLEGE ENVELOPE AND ENERGY RETROFIT STUDY

PROJECT NO: 2023-0757-10

Baird Sampson Neuert architects

WALTERFEDY

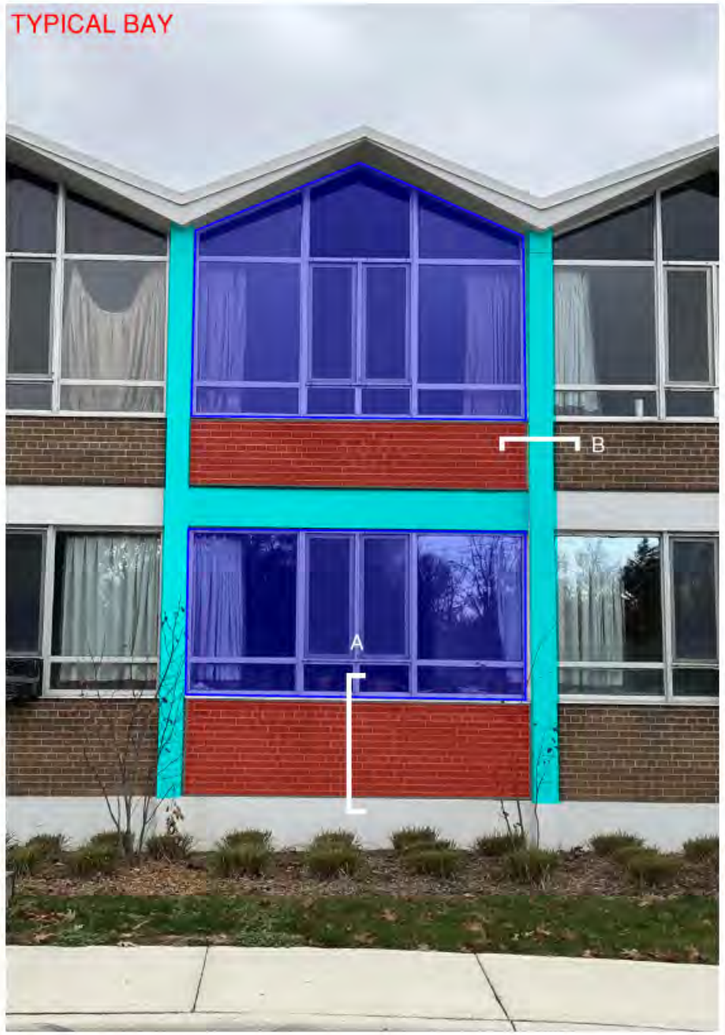
TITLE:
EXTERIOR WALL UPGRADE OPTION 3: FIBRE CEMENT OVERCLAD + OVERCLAD COLUMNS

Scale 1 : 200

0 2 4 10 20 m

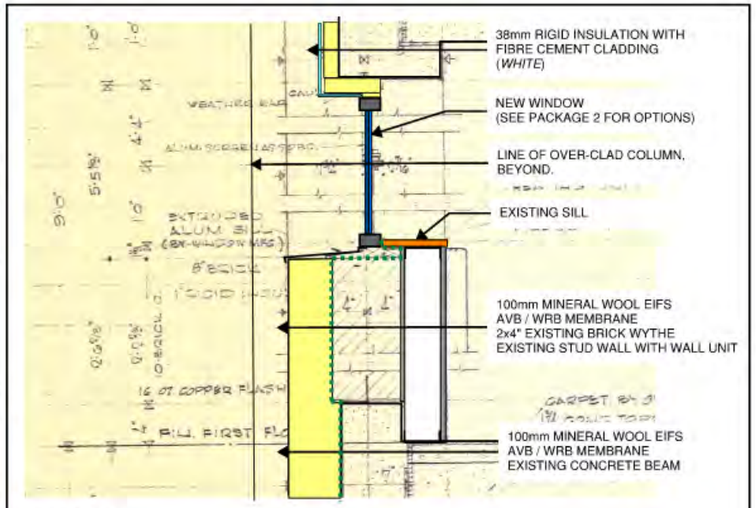
SHEET No.:

TYPICAL BAY

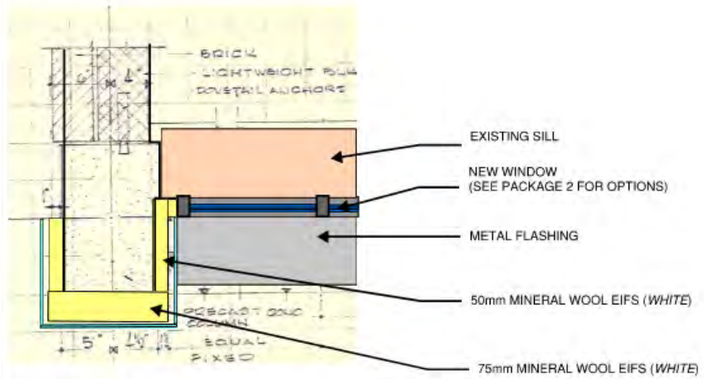


LEGEND:

- REPLACE WINDOW (SEE PACKAGE 2 FOR OPTIONS)
- OVERCLAD BRICK WITH INSULATED ASSEMBLY
- OVERCLAD / INSULATION ON CONCRETE FRAME



SECTION A



PLAN DETAIL B

NOTES:

OVER-CLAD EXISTING UNINSULATED BRICK INFILL BELOW WINDOWS WITH 100mm MINERAL WOOL EIFS AND AVB. APPLY 100mm MINERAL WOOL EIFS AND AIR VAPOUR BARRIER OVER EXPOSED CONCRETE FRAME AT COLUMN FACE. APPLY 50mm MINERAL WOOL EIFS AND AIR VAPOUR BARRIER OVER EXPOSED CONCRETE FRAME AT COLUMN RETURN.

EXISTING BRICK WALLS AT NORTH END ARE CIRCA 2003 AND INSULATED. **INCLUDE** NORTH ELEVATION AS APART OF THIS OPTION'S SCOPE OF WORK FOR CONSISTENCY OF APPEARANCE.

PROJECT:
CONRAD GREBEL UNIVERSITY COLLEGE ENVELOPE AND ENERGY RETROFIT STUDY

PROJECT NO: 2023-0757-10

Baird Sampson Neuert architects

WALTERFEDY

TITLE:
EXTERIOR WALL UPGRADE OPTION 4: OVERCLAD WITH EIFS

Scale 1 : 200

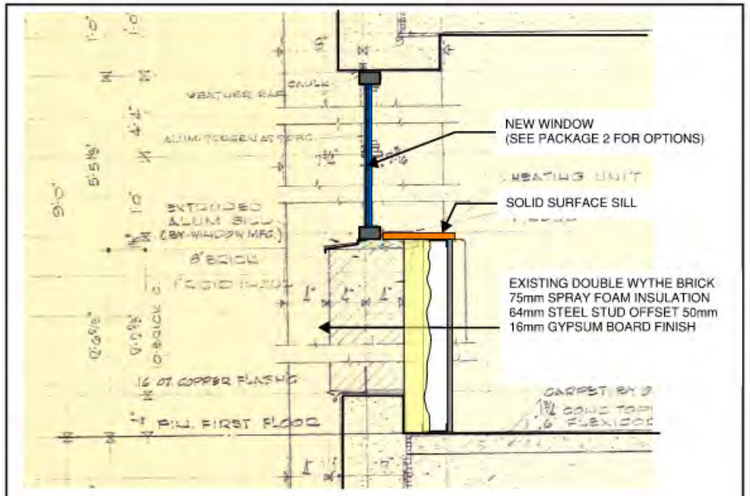
0 2 4 10 20 m

SHEET No.:

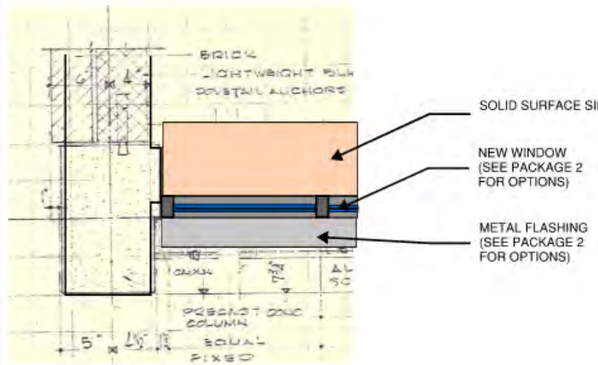
TYPICAL BAY

LEGEND:

- REPLACE WINDOW (SEE PACKAGE 2 FOR OPTIONS)
- RETAIN BRICK AND IMPROVE INSULATIVE LAYER



SECTION A



PLAN DETAIL B

NOTES:

REMOVE EXISTING MECHANICAL UNIT, ENCLOSURE, AND EXISTING INSULATION. EXISTING DOUBLE-WYTHE BRICK TO REMAIN. PROVIDE NEW 75mm SPRAY FOAM INSULATION APPLIED ON INTERIOR FACE OF BRICK, 64mm METAL STUD WALL ASSEMBLY WITH 16mm GYPSUM.

EXISTING BRICK WALLS AT NORTH END ARE CIRCA 2003 AND INSULATED. **DISCLUDE** NORTH ELEVATION AS APART OF THIS OPTION'S SCOPE OF WORK.

PROJECT:
CONRAD GREBEL UNIVERSITY COLLEGE ENVELOPE AND ENERGY RETROFIT STUDY

PROJECT NO: 2023-0757-10

Baird Sampson Neuert architects

WALTERFEDY

TITLE:
EXTERIOR WALL UPGRADE OPTION 5: RETAIN BRICK & IMPROVE EXISTING INSULATIVE LAYER

Scale 1 : 200

0 2 4 10 20 m

SHEET No.:

Appendix B: Cost Report

Conrad Grebel University				February 23, 2024	R2	
Waterloo, Ontario.						
Section	**Description**	**Quantity**		**Unit $**		**Total**
	1. Universal Washrooms Option 1					
02 02 50	**Building Demolition:**					
	..remove shower curb tile	1.00	m2	$85.00	m2	$85.00
	..remove shower doors	2.00	ea	$50.00	ea	$100.00
	..remove shower flooring	2.00	m2	$55.00	m2	$110.00
	..remove toilet partitions	3.00	ea	$85.00	ea	$255.00
	..remove sinks & toilets	6.00	ea	$40.00	ea	$240.00
	..patch wall at fixture removals	6.00	ea	$125.00	ea	$750.00
	..remove vanity	2.00	m	$125.00	m	$250.00
	..remove floor tile	15.00	m2	$45.00	m2	$675.00
	..make good floor	15.00	m2	$35.00	m2	$525.00
	..remove wall tile	28.00	m2	$40.00	m2	$1,120.00
	..make good wall	28.00	m2	$20.00	m2	$560.00
	..remove entry door	1.00	ea	$85.00	ea	$85.00
06 24 00	**Millwork:**					
	..250mm wide Formica shelf	3.00	m	$75.00	m	$225.00
08 11 14	**Hollow Metal:**					
	..single frame for wood door	1.00	ea	$350.00	ea	$350.00
	..install frame	1.00	ea	$125.00	ea	$125.00
08 14 10	**Wood Doors:**					
	..entry door	1.00	ea	$750.00	ea	$750.00
	..install door	1.00	ea	$325.00	ea	$325.00
	..finish hardware	1.00	ea	$1,500.00	ea	$1,500.00
09 30 19	**Ceramic Tile:**					
	..shower floors	3.00	m2	$325.00	m2	$975.00
	..shower curbs	1.00	m2	$350.00	m2	$350.00
	..shower walls	19.00	m2	$290.00	m2	$5,510.00
	..washroom floor tile	13.00	m2	$325.00	m2	$4,225.00
	..tile base	17.00	m	$45.00	m	$765.00
09 90 00	**Painting:**					
	..make good & paint ceilings	18.00	m2	$25.00	m2	$450.00
	..make good & paint walls	38.00	m2	$25.00	m2	$950.00
10 21 13	**Toilet Portions:**					
	..Duraline accessible toilet partitions	1.00	ea	$3,250.00	ea	$3,250.00
	..Duraline toilet partitions	2.00	ea	$2,850.00	ea	$5,700.00
	..Duraline accessible shower partitions	0.00	ea	$3,250.00	ea	$0.00
	..shower seat for above	0.00	ea	$850.00	ea	$0.00
	..Duraline shower partitions	0.00	ea	$2,850.00	ea	$0.00
	..Duraline shower doors	2.00	ea	$1,750.00	ea	$3,500.00
10 28 00	**Washroom Accessories:**					
	..shower soap dish	2.00	ea	$100.00	ea	$200.00
	..shower rod & curtain	2.00	ea	$150.00	ea	$300.00
	..toilet tissue dispenser	3.00	ea	$125.00	ea	$375.00
	..soap dispenser	9.00	ea	$350.00	ea	$3,150.00
	..grab bars	2.00	ea	$225.00	ea	$450.00
	..paper towel dispenser / disposal	1.00	ea	$650.00	ea	$650.00
	..coat hooks	3.00	ea	$75.00	ea	$225.00
	..mirrors	3.00	m2	$350.00	m2	$1,050.00
	..installation	25.00	ea	$50.00	ea	$1,250.00

Conrad Grebel University				***February 23, 2024***	***R2***	
Waterloo, Ontario.						
Section	***Description***	***Quantity***		***Unit $***		***Total***
	1. Universal Washrooms Option 1					
23 05 00	***Mechanical:***					
	..Sloan wall mounted 3 station sink	3.00	m	$6,000.00	m	$18,000.00
	..wall mounted toilets	3.00	ea	$1,000.00	ea	$3,000.00
	..sinks	3.00	ea	$1,000.00	ea	$3,000.00
	..showers	2.00	ea	$1,000.00	ea	$2,000.00
	..domestic water	1.00	sum	$2,985.00	sum	$2,985.00
	..sanitary	1.00	sum	$2,860.00	sum	$2,860.00
	..removal	1.00	sum	$1,370.00	sum	$1,370.00
26 05 01	***Electrical:***					
	..receptacles / switches	4.00	ea	$450.00	ea	$1,800.00
	..lighting revisions	8.00	ea	$750.00	ea	$6,000.00
	..fire alarm	18.00	m2	$75.00	m2	$1,350.00
						$83,720.00
	Contractor General Conditions & fee	25.00%				$20,930.00
						$104,650.00
	contingency	25.00%				$26,163.00
						$130,813.00
	Number of Units to be done	***6.00***	***ea***			***$784,878.00***
						+HST

Conrad Grebel University				February 23, 2024	R2	
Waterloo, Ontario.						
Section	**Description**	**Quantity**		**Unit $**		**Total**
	1. Universal Washrooms Option 2A					
02 02 50	**Building Demolition:**					
	..remove shower curb tile	1.00	m2	$85.00	m2	$85.00
	..remove shower doors	2.00	ea	$50.00	ea	$100.00
	..remove shower flooring	2.00	m2	$55.00	m2	$110.00
	..remove toilet partitions	3.00	ea	$85.00	ea	$255.00
	..remove sinks & toilets	6.00	ea	$40.00	ea	$240.00
	..patch wall at fixture removals	6.00	ea	$125.00	ea	$750.00
	..remove vanity	2.00	m	$125.00	m	$250.00
	..remove floor tile	15.00	m2	$45.00	m2	$675.00
	..make good floor	15.00	m2	$35.00	m2	$525.00
	..remove wall tile	28.00	m2	$40.00	m2	$1,120.00
	..make good wall	28.00	m2	$20.00	m2	$560.00
	..remove entry door	1.00	ea	$85.00	ea	$85.00
	..remove masonry wall	9.00	m2	$85.00	m2	$765.00
	..remove drywall partition	0.00	m2	$60.00	m2	$0.00
06 24 00	**Millwork:**					
	..250mm wide Formica shelf	0.00	m	$75.00	m	$0.00
08 11 14	**Hollow Metal:**					
	..single frame for wood door	1.00	ea	$350.00	ea	$350.00
	..single frame for wood door at washroom	3.00	ea	$350.00	ea	$1,050.00
	..install frame	4.00	ea	$125.00	ea	$500.00
08 14 10	**Wood Doors:**					
	..entry door	1.00	ea	$750.00	ea	$750.00
	..washroom doors	3.00	a	$650.00	a	$1,950.00
	..install door	4.00	ea	$325.00	ea	$1,300.00
	..finish hardware	4.00	ea	$1,500.00	ea	$6,000.00
09 25 00	**Drywall:**					
	..partitions	33.00	m2	$145.00	m2	$4,785.00
09 30 19	**Ceramic Tile:**					
	..shower floors	0.00	m2	$325.00	m2	$0.00
	..shower curbs	1.00	m2	$350.00	m2	$350.00
	..shower walls	17.00	m2	$290.00	m2	$4,930.00
	..washroom floor tile	13.00	m2	$325.00	m2	$4,225.00
	..washroom wall tile	10.00	m2	$325.00	m2	$3,250.00
	..tile base	30.00	m	$45.00	m	$1,350.00
	..corian counter top	2.00	m	$325.00	m	$650.00
09 90 00	**Painting:**					
	..make good & paint ceilings	17.00	m2	$25.00	m2	$425.00
	..make good & paint walls	111.00	m2	$17.50	m2	$1,943.00
10 21 13	**Toilet Partitions:**					
	..Duraline accessible toilet partitions	0.00	ea	$3,250.00	ea	$0.00
	..Duraline toilet partitions	0.00	ea	$2,850.00	ea	$0.00
	..Duraline accessible shower partitions	0.00	ea	$3,250.00	ea	$0.00
	..shower seat for above	0.00	ea	$850.00	ea	$0.00
	..shower trays	3.00	ea	$450.00	ea	$1,350.00
	..Duraline shower partitions	0.00	ea	$2,850.00	ea	$0.00
	..Duraline shower doors	0.00	ea	$1,750.00	ea	$0.00
10 28 00	**Washroom Accessories:**					
	..shower soap dish	3.00	ea	$100.00	ea	$300.00
	..shower rod & curtain	3.00	ea	$150.00	ea	$450.00
	..toilet tissue dispenser	3.00	ea	$125.00	ea	$375.00
	..soap dispenser	3.00	ea	$350.00	ea	$1,050.00
	..grab bars	4.00	ea	$225.00	ea	$900.00
	..paper towel dispenser / disposal	3.00	ea	$650.00	ea	$1,950.00
	..coat hooks	5.00	ea	$75.00	ea	$375.00
	..mirrors	2.00	m2	$350.00	m2	$700.00
	..installation	26.00	ea	$50.00	ea	$1,300.00

Conrad Grebel University				***February 23, 2024***	***R2***	
Waterloo, Ontario.						
Section	***Description***	***Quantity***		***Unit $***		***Total***
	1. Universal Washrooms Option 2A					
23 05 00	***Mechanical:***					
	..Sloan wall mounted 3 station sink	0.00	m	$6,000.00	m	$0.00
	..wall mounted toilets	3.00	ea	$1,000.00	ea	$3,000.00
	..sinks	3.00	ea	$1,000.00	ea	$3,000.00
	..showers	3.00	ea	$1,000.00	ea	$3,000.00
	..domestic water	1.00	sum	$5,090.00	sum	$5,090.00
	..sanitary	1.00	sum	$5,110.00	sum	$5,110.00
	..removal	1.00	sum	$1,370.00	sum	$1,370.00
	..x-ray / core drilling / fire stop	11.00	ea	$450.00	ea	$4,950.00
26 05 01	***Electrical:***					
	..receptacles / switches	4.00	ea	$450.00	ea	$1,800.00
	..lighting revisions	7.00	ea	$750.00	ea	$5,250.00
	..fire alarm	17.00	m2	$75.00	m2	$1,275.00
						$81,923.00
	Contractor General Conditions & fee	25.00%				$20,481.00
						$102,404.00
	contingency	25.00%				$25,601.00
						$128,005.00
	Number of Units to be done	***6.00***	***ea***			***$768,030.00***
						+HST

Conrad Grebel University				February 23, 2024	R2	
Waterloo, Ontario.						
Section	**Description**	**Quantity**		**Unit $**		**Total**
	1. Universal Washrooms Option 2B					
02 02 50	**Building Demolition:**					
	..remove shower curb tile	1.00	m2	$85.00	m2	$85.00
	..remove shower doors	2.00	ea	$50.00	ea	$100.00
	..remove shower flooring	2.00	m2	$55.00	m2	$110.00
	..remove toilet partitions	3.00	ea	$85.00	ea	$255.00
	..remove sinks & toilets	6.00	ea	$40.00	ea	$240.00
	..patch wall at fixture removals	6.00	ea	$125.00	ea	$750.00
	..remove vanity	2.00	m	$125.00	m	$250.00
	..remove floor tile	15.00	m2	$45.00	m2	$675.00
	..make good floor	15.00	m2	$35.00	m2	$525.00
	..remove wall tile	28.00	m2	$40.00	m2	$1,120.00
	..make good wall	28.00	m2	$20.00	m2	$560.00
	..remove entry door	1.00	ea	$85.00	ea	$85.00
	..remove masonry wall	9.00	m2	$85.00	m2	$765.00
	..remove drywall partition	0.00	m2	$60.00	m2	$0.00
06 24 00	**Millwork:**					
	..250mm wide Formica shelf	4.00	m	$75.00	m	$300.00
08 11 14	**Hollow Metal:**					
	..single frame for wood door	1.00	ea	$350.00	ea	$350.00
	..single frame for wood door at washroom	3.00	ea	$350.00	ea	$1,050.00
	..install frame	4.00	ea	$125.00	ea	$500.00
08 14 10	**Wood Doors:**					
	..entry door	1.00	ea	$750.00	ea	$750.00
	..washroom doors	3.00	ea	$650.00	ea	$1,950.00
	..install door	4.00	ea	$325.00	ea	$1,300.00
	..finish hardware	4.00	ea	$1,500.00	ea	$6,000.00
09 25 00	**Drywall:**					
	..partitions	27.00	m2	$145.00	m2	$3,915.00
09 30 19	**Ceramic Tile:**					
	..shower floors	0.00	m2	$325.00	m2	$0.00
	..shower curbs	1.00	m2	$350.00	m2	$350.00
	..shower walls	16.00	m2	$290.00	m2	$4,640.00
	..washroom floor tile	13.00	m2	$325.00	m2	$4,225.00
	..washroom wall tile	13.00	m2	$325.00	m2	$4,225.00
	..tile base	34.00	m	$45.00	m	$1,530.00
	..corian counter top	0.00	m	$325.00	m	$0.00
09 90 00	**Painting:**					
	..make good & paint ceilings	17.00	m2	$25.00	m2	$425.00
	..make good & paint walls	122.00	m2	$17.50	m2	$2,135.00
10 21 13	**Toilet Portions:**					
	..Duraline accessible toilet partitions	0.00	ea	$3,250.00	ea	$0.00
	..Duraline toilet partitions	0.00	ea	$2,850.00	ea	$0.00
	..Duraline accessible shower partitions	0.00	ea	$3,250.00	ea	$0.00
	..shower seat for above	0.00	ea	$850.00	ea	$0.00
	..shower trays	3.00	ea	$450.00	ea	$1,350.00
	..Duraline shower partitions	0.00	ea	$2,850.00	ea	$0.00
	..Duraline shower doors	0.00	ea	$1,750.00	ea	$0.00
10 28 00	**Washroom Accessories:**					
	..shower soap dish	3.00	ea	$100.00	ea	$300.00
	..shower rod & curtain	3.00	ea	$150.00	ea	$450.00
	..toilet tissue dispenser	3.00	ea	$125.00	ea	$375.00
	..soap dispenser	3.00	ea	$350.00	ea	$1,050.00
	..grab bars	4.00	ea	$225.00	ea	$900.00
	..paper towel dispenser / disposal	3.00	ea	$650.00	ea	$1,950.00
	..coat hooks	3.00	ea	$75.00	ea	$225.00
	..mirrors	4.00	m2	$350.00	m2	$1,400.00
	..installation	26.00	ea	$50.00	ea	$1,300.00

Conrad Grebel University				***February 23, 2024***	***R2***	
Waterloo, Ontario.						
Section	***Description***	***Quantity***		***Unit $***		***Total***
	1. Universal Washrooms Option 2B					
23 05 00	***Mechanical:***					
	..Sloan wall mounted 3 station sink	0.00	ea	$2,000.00	ea	$0.00
	..wall mounted toilets	3.00	ea	$1,000.00	ea	$3,000.00
	..sinks	3.00	ea	$1,000.00	ea	$3,000.00
	..showers	3.00	ea	$1,000.00	ea	$3,000.00
	..domestic water	1.00	sum	$5,090.00	sum	$5,090.00
	..sanitary	1.00	sum	$4,940.00	sum	$4,940.00
	..removal	1.00	sum	$1,370.00	sum	$1,370.00
	..x-ray / core drilling / fire stop	11.00	ea	$450.00	ea	$4,950.00
26 05 01	***Electrical:***					
	..receptacles / switches	4.00	ea	$450.00	ea	$1,800.00
	..lighting revisions	7.00	ea	$750.00	ea	$5,250.00
	..fire alarm	16.00	m2	$75.00	m2	$1,200.00
						$82,065.00
	Contractor General Conditions & fee	25.00%				$20,516.00
						$102,581.00
	contingency	25.00%				$25,645.00
						$128,226.00
	Number of Units to be done	***6.00***	***ea***			***$769,356.00***
						+HST

Conrad Grebel University				February 23, 2024	R2	
Waterloo, Ontario.						
Section	**Description**	**Quantity**		**Unit $**		**Total**
	1. Universal Washrooms Option 3					
02 02 50	**Building Demolition:**					
	..remove shower curb tile	2.00	m2	$85.00	m2	$170.00
	..remove shower doors	4.00	ea	$50.00	ea	$200.00
	..remove shower flooring	6.00	m2	$55.00	m2	$330.00
	..remove toilet partitions	3.00	ea	$85.00	ea	$255.00
	..remove sinks & toilets	12.00	ea	$40.00	ea	$480.00
	..patch wall at fixture removals	12.00	ea	$125.00	ea	$1,500.00
	..remove vanity	4.00	m	$125.00	m	$500.00
	..remove floor tile	26.00	m2	$45.00	m2	$1,170.00
	..make good floor	26.00	m2	$35.00	m2	$910.00
	..remove wall tile	20.00	m2	$40.00	m2	$800.00
	..make good wall	20.00	m2	$20.00	m2	$400.00
	..remove entry door	4.00	ea	$85.00	ea	$340.00
	..remove masonry wall	22.00	m2	$85.00	m2	$1,870.00
	..remove carpet	19.00	m2	$35.00	m2	$665.00
06 24 00	**Millwork:**					
	..250mm wide Formica shelf	0.00	m	$75.00	m	$0.00
08 11 14	**Hollow Metal:**					
	..single frame for wood door	1.00	ea	$350.00	ea	$350.00
	..single frame for wood door at washroom	0.00	ea	$350.00	ea	$0.00
	..install frame	1.00	ea	$125.00	ea	$125.00
08 14 10	**Wood Doors:**					
	..entry door	1.00	ea	$750.00	ea	$750.00
	..washroom doors	0.00	ea	$650.00	ea	$0.00
	..install door	1.00	ea	$325.00	ea	$325.00
	..finish hardware	1.00	ea	$1,500.00	ea	$1,500.00
09 25 00	**Drywall:**					
	..partitions	0.00	m2	$145.00	m2	$0.00
09 30 19	**Ceramic Tile:**					
	..shower floors	0.00	m2	$325.00	m2	$0.00
	..shower curbs	0.00	m2	$350.00	m2	$0.00
	..shower walls	0.00	m2	$290.00	m2	$0.00
	..washroom floor tile	33.00	m2	$325.00	m2	$10,725.00
	..washroom wall tile	42.00	m2	$325.00	m2	$13,650.00
	..tile base	28.00	m	$45.00	m	$1,260.00
	..corian counter top	0.00	m	$325.00	m	$0.00
09 68 00	**Carpet:**					
	..carpet to dorm room	18.00	m2	$95.00	m2	$1,710.00
	..wood base	18.00	m2	$35.00	m2	$630.00
09 90 00	**Painting:**					
	..make good & paint ceilings	37.00	m2	$25.00	m2	$925.00
	..make good & paint walls	16.00	m2	$17.50	m2	$280.00
10 21 13	**Toilet Portions:**					
	..Duraline accessible toilet partitions	1.00	ea	$3,250.00	ea	$3,250.00
	..Duraline toilet partitions	5.00	ea	$2,850.00	ea	$14,250.00
	..Duraline accessible shower partitions	1.00	ea	$3,250.00	ea	$3,250.00
	..shower seat for above	1.00	ea	$850.00	ea	$850.00
	..Duraline shower partitions	2.00	ea	$2,850.00	ea	$5,700.00
	..Duraline shower doors	0.00	ea	$1,750.00	ea	$0.00
10 21 16	**Shower & Dressing Cubicles:**					
	..shower pans	2.00	ea	$1,500.00	ea	$3,000.00
	..shower pan accessible	1.00	ea	$2,000.00	ea	$2,000.00

Conrad Grebel University				***February 23, 2024***	***R2***	
Waterloo, Ontario.						
Section	***Description***	***Quantity***		***Unit $***		***Total***
	1. Universal Washrooms Option 3					
10 28 00	***Washroom Accessories:***					
	..shower soap dish	3.00	ea	$100.00	ea	$300.00
	..shower rod & curtain	3.00	ea	$150.00	ea	$450.00
	..toilet tissue dispenser	6.00	ea	$125.00	ea	$750.00
	..soap dispenser	8.00	ea	$350.00	ea	$2,800.00
	..grab bars	4.00	ea	$225.00	ea	$900.00
	..paper towel dispenser / disposal	2.00	ea	$650.00	ea	$1,300.00
	..coat hooks	9.00	ea	$75.00	ea	$675.00
	..mirrors suspended from ceiling	6.00	m2	$400.00	m2	$2,400.00
	..installation	41.00	ea	$50.00	ea	$2,050.00
23 05 00	***Mechanical:***					
	..Sloan wall mounted 8 sink stations	8.00	ea	$1,500.00	ea	$12,000.00
	..wall mounted toilets	6.00	ea	$1,000.00	ea	$6,000.00
	..sinks	0.00	ea	$1,000.00	ea	$0.00
	..showers	3.00	ea	$1,000.00	ea	$3,000.00
	..domestic water	1.00	sum	$8,970.00	sum	$8,970.00
	..sanitary	1.00	sum	$8,505.00	sum	$8,505.00
	..removal	1.00	sum	$2,900.00	sum	$2,900.00
	..x-ray / core drilling / fire stop	15.00	ea	$450.00	ea	$6,750.00
	..ductwork	1.00	sum	$8,750.00	sum	$8,750.00
	..balancing & commissioning	1.00	sum	$1,125.00	sum	$1,125.00
26 05 01	***Electrical:***					
	..receptacles / switches	4.00	ea	$450.00	ea	$1,800.00
	..lighting revisions	3.00	ea	$750.00	ea	$2,250.00
	..fire alarm	0.00	m2	$75.00	m2	$0.00
						$147,795.00
	Contractor General Conditions & fee	25.00%				$36,949.00
						$184,744.00
	contingency	25.00%				$46,186.00
						$230,930.00
	Number of Units to be done	***2.00***	***ea***			***$461,860.00***
	Plus Option 1 Washroom Renovations	***2.00***	***ea***			***$261,626.00***
						$723,486.00
						+HST

Conrad Grebel University				February 23, 2024	R2	
Waterloo, Ontario.						
Section	**Description**	**Quantity**		**Unit $**		**Total**
	1. Universal Washrooms Option 4					
02 02 50	**Building Demolition:**					
	..remove shower curb tile	2.00	m2	$85.00	m2	$170.00
	..remove shower doors	6.00	ea	$50.00	ea	$300.00
	..remove shower flooring	8.00	m2	$55.00	m2	$440.00
	..remove toilet partitions	4.00	ea	$85.00	ea	$340.00
	..remove sinks & toilets	16.00	ea	$40.00	ea	$640.00
	..patch wall at fixture removals	16.00	ea	$125.00	ea	$2,000.00
	..remove vanity	5.00	m	$125.00	m	$625.00
	..remove floor tile	39.00	m2	$45.00	m2	$1,755.00
	..make good floor	39.00	m2	$35.00	m2	$1,365.00
	..remove wall tile	27.00	m2	$40.00	m2	$1,080.00
	..make good wall	27.00	m2	$20.00	m2	$540.00
	..remove entry door	8.00	ea	$85.00	ea	$680.00
	..remove masonry wall	48.00	m2	$85.00	m2	$4,080.00
	..remove carpet	38.00	m2	$35.00	m2	$1,330.00
06 24 00	**Millwork:**					
	..250mm wide Formica shelf	8.00	m	$75.00	m	$600.00
08 11 14	**Hollow Metal:**					
	..single frame for wood door	2.00	ea	$350.00	ea	$700.00
	..single frame for wood door at washroom	0.00	ea	$350.00	ea	$0.00
	..install frame	2.00	ea	$125.00	ea	$250.00
08 14 10	**Wood Doors:**					
	..entry door	2.00	ea	$750.00	ea	$1,500.00
	..washroom doors	0.00	ea	$650.00	ea	$0.00
	..install door	2.00	ea	$325.00	ea	$650.00
	..finish hardware	2.00	ea	$1,500.00	ea	$3,000.00
09 25 00	**Drywall:**					
	..partitions	9.00	m2	$145.00	m2	$1,305.00
09 30 19	**Ceramic Tile:**					
	..shower floors	0.00	m2	$325.00	m2	$0.00
	..shower curbs	0.00	m2	$350.00	m2	$0.00
	..shower walls	14.00	m2	$290.00	m2	$4,060.00
	..washroom floor tile	50.00	m2	$325.00	m2	$16,250.00
	..washroom wall tile	28.00	m2	$325.00	m2	$9,100.00
	..tile base	33.00	m	$45.00	m	$1,485.00
	..corian counter top	0.00	m	$325.00	m	$0.00
09 68 00	**Carpet:**					
	..carpet to dorm room	36.00	m2	$95.00	m2	$3,420.00
	..wood base	40.00	m2	$35.00	m2	$1,400.00
09 90 00	**Painting:**					
	..make good & paint ceilings	91.00	m2	$25.00	m2	$2,275.00
	..make good & paint walls	79.00	m2	$17.50	m2	$1,383.00
10 21 13	**Toilet Partitions:**					
	..Duraline accessible toilet partitions	1.00	ea	$3,250.00	ea	$3,250.00
	..Duraline toilet partitions	7.00	ea	$2,850.00	ea	$19,950.00
	..Duraline accessible shower partitions	1.00	ea	$3,250.00	ea	$3,250.00
	..shower seat for above	1.00	ea	$850.00	ea	$850.00
	..Duraline shower partitions	4.00	ea	$2,850.00	ea	$11,400.00
	..Duraline shower doors	0.00	ea	$1,750.00	ea	$0.00
10 21 16	**Shower & Dressing Cubicles:**					
	..shower pans	5.00	ea	$1,500.00	ea	$7,500.00
	..shower pan accessible	1.00	ea	$2,000.00	ea	$2,000.00

Conrad Grebel University				***February 23, 2024***	***R2***	
Waterloo, Ontario.						
Section	***Description***	***Quantity***		***Unit $***		***Total***
	1. Universal Washrooms Option 4					
10 28 00	***Washroom Accessories:***					
	..shower soap dish	5.00	ea	$100.00	ea	$500.00
	..shower rod & curtain	6.00	ea	$150.00	ea	$900.00
	..toilet tissue dispenser	8.00	ea	$125.00	ea	$1,000.00
	..soap dispenser	9.00	ea	$350.00	ea	$3,150.00
	..grab bars	4.00	ea	$225.00	ea	$900.00
	..paper towel dispenser / disposal	4.00	ea	$650.00	ea	$2,600.00
	..coat hooks	6.00	ea	$75.00	ea	$450.00
	..mirrors	9.00	m2	$350.00	m2	$3,150.00
	..installation	51.00	ea	$50.00	ea	$2,550.00
23 05 00	***Mechanical:***					
	..Sloan wall mounted 8 sink stations	9.00	ea	$1,500.00	ea	$13,500.00
	..wall mounted toilets	8.00	ea	$1,000.00	ea	$8,000.00
	..sinks	0.00	ea	$1,000.00	ea	$0.00
	..showers	6.00	ea	$1,000.00	ea	$6,000.00
	..domestic water	1.00	sum	$12,220.00	sum	$12,220.00
	..sanitary	1.00	sum	$10,845.00	sum	$10,845.00
	..removal	1.00	sum	$4,100.00	sum	$4,100.00
	..x-ray / core drilling / fire stop	20.00	ea	$450.00	ea	$9,000.00
	..ductwork	1.00	sum	$10,625.00	sum	$10,625.00
	..balancing & commissioning	1.00	sum	$1,125.00	sum	$1,125.00
26 05 01	***Electrical:***					
	..receptacles / switches	4.00	ea	$450.00	ea	$1,800.00
	..lighting revisions	3.00	ea	$750.00	ea	$2,250.00
	..fire alarm	0.00	m2	$75.00	m2	$0.00
						$205,588.00
	Contractor General Conditions & fee	25.00%				$51,397.00
						$256,985.00
	contingency	25.00%				$64,246.00
						$321,231.00
	Number of Units to be done	***2.00***	***ea***			***$642,462.00***
						+HST

Conrad Grebel University				***February 23, 2024***	***R2***	
Waterloo, Ontario.						
Section	***Description***	***Quantity***		***Unit $***		***Total***
	2. Window Replacement Option 1A Triple Glazed					
05 50 50	***Aluminum Windows:***					
	..3rd floor remove small window units 3.35x1.0M	3.00	ea	$200.00	ea	$600.00
	..3rd floor remove window units 3.35x1.6m	37.00	ea	$250.00	ea	$9,250.00
	.4th floor remove small window units 3.35x1.0m	4.00	ea	$250.00	ea	$1,000.00
	..4th floor remove window units 3.35x1.9m	41.00	ea	$250.00	ea	$10,250.00
	..4th floor remove triangular window units	45.00	ea	$250.00	ea	$11,250.00
	..remove curtain wall	90.00	m2	$300.00	m2	$27,000.00
	..3rd floor make good surface around windows	397.00	m	$12.75	m	$5,062.00
	..4th floor make good surface around windows	446.00	m	$12.75	m	$5,687.00
	..4th floor triangular M.G. surface around windows	315.00	m	$12.75	m	$4,016.00
	..3rd floor new window units	40.00	ea	$4,500.00	ea	$180,000.00
	..4th floor new window units	45.00	ea	$5,850.00	ea	$263,250.00
	..4th floor new triangular window units	45.00	ea	$1,470.00	ea	$66,150.00
	..curtain wall system	90.00	m2	$1,550.00	m2	$139,500.00
07 90 00	***Sealants:***					
	..exterior caulking to 3rd floor window units	397.00	m	$5.00	m	$1,985.00
	..interior caulking to 3rd floor window units	397.00	m	$4.00	m	$1,588.00
	..exterior caulking to 4th floor window units	446.00	m	$5.00	m	$2,230.00
	..interior caulking to 4th floor window units	446.00	m	$4.00	m	$1,784.00
	..exterior caulking to 4th floor triangular window units	315.00	m	$5.00	m	$1,575.00
	..interior caulking to 4th floor triangular units	315.00	m	$4.00	m	$1,260.00
						$733,437.00
	Contractor General Conditions & fee	25.00%				$183,359.00
						$916,796.00
	contingency	25.00%				$229,199.00
						$1,145,995.00
	2. Window Replacement: Option 1B Double Glazed					
05 50 50	***Aluminum Windows:***					
	..3rd floor remove small window units 3.35x1.0M	3.00	ea	$200.00	ea	$600.00
	..3rd floor remove window units 3.35x1.6m	37.00	ea	$250.00	ea	$9,250.00
	.4th floor remove small window units 3.35x1.0m	4.00	ea	$250.00	ea	$1,000.00
	..4th floor remove window units 3.35x1.9m	41.00	ea	$250.00	ea	$10,250.00
	..4th floor remove triangular window units	45.00	ea	$250.00	ea	$11,250.00
	..remove curtain wall	90.00	m2	$300.00	m2	$27,000.00
	..3rd floor make good surface around windows	397.00	m	$12.75	m	$5,062.00
	..4th floor make good surface around windows	446.00	m	$12.75	m	$5,687.00
	..4th floor triangular M.G. surface around windows	315.00	m	$12.75	m	$4,016.00
	..3rd floor new window units	40.00	ea	$4,200.00	ea	$168,000.00
	..4th floor new window units	45.00	ea	$5,550.00	ea	$249,750.00
	..4th floor new triangular window units	45.00	ea	$1,350.00	ea	$60,750.00
	..curtain wall system	90.00	m2	$1,500.00	m2	$135,000.00
07 90 00	***Sealants:***					
	..exterior caulking to 3rd floor window units	397.00	m	$5.00	m	$1,985.00
	..interior caulking to 3rd floor window units	397.00	m	$4.00	m	$1,588.00
	..exterior caulking to 4th floor window units	446.00	m	$5.00	m	$2,230.00
	..interior caulking to 4th floor window units	446.00	m	$4.00	m	$1,784.00
	..exterior caulking to 4th floor triangular window units	315.00	m	$5.00	m	$1,575.00
	..interior caulking to 4th floor triangular units	315.00	m	$4.00	m	$1,260.00
						$698,037.00
	Contractor General Conditions & fee	25.00%				$174,509.00
						$872,546.00
	contingency	25.00%				$218,137.00
						$1,090,683.00

Conrad Grebel University				February 23, 2024	R2	
Waterloo, Ontario.						
Section	**Description**	**Quantity**		**Unit $**		**Total**
	2. Window Replacement Option 2A Triple Glazed					
05 50 50	**Aluminum Windows:**					
	..3rd floor remove small window units 3.35x1.0M	3.00	ea	$200.00	ea	$600.00
	..3rd floor remove window units 3.35x1.6m	37.00	ea	$250.00	ea	$9,250.00
	.4th floor remove small window units 3.35x1.0m	4.00	ea	$250.00	ea	$1,000.00
	..4th floor remove window units 3.35x1.9m	41.00	ea	$250.00	ea	$10,250.00
	..4th floor remove triangular window units	45.00	ea	$250.00	ea	$11,250.00
	..remove curtain wall	90.00	m2	$300.00	m2	$27,000.00
	..3rd floor make good surface around windows	397.00	m	$12.75	m	$5,062.00
	..4th floor make good surface around windows	446.00	m	$12.75	m	$5,687.00
	..4th floor triangular M.G. surface around windows	315.00	m	$12.75	m	$4,016.00
	..3rd floor new window units	40.00	ea	$4,500.00	ea	$180,000.00
	..4th floor new window units	45.00	ea	$5,850.00	ea	$263,250.00
	..4th floor new triangular window units	0.00	ea	$1,470.00	ea	$0.00
	..curtain wall system	90.00	m2	$1,550.00	m2	$139,500.00
07 42 33	**Composite Wall Panels:**					
	..aluminum composite panels to triangular window units	55.00	m2	$825.00	m2	$45,375.00
07 90 00	**Sealants:**					
	..exterior caulking to 3rd floor window units	397.00	m	$5.00	m	$1,985.00
	..interior caulking to 3rd floor window units	397.00	m	$4.00	m	$1,588.00
	..exterior caulking to 4th floor window units	446.00	m	$5.00	m	$2,230.00
	..interior caulking to 4th floor window units	446.00	m	$4.00	m	$1,784.00
	..exterior caulking to 4th floor triangular units	315.00	m	$5.00	m	$1,575.00
	..interior caulking to 4th floor triangular units	315.00	m	$4.00	m	$1,260.00
09 23 00	**Drywall**					
	..backup wall to aluminum composite panels	55.00	m2	$300.00	m2	$16,500.00
09 90 00	**Painting**					
	..paint drywall	55.00	m2	$50.00	m2	$2,750.00
						$731,912.00
	Contractor General Conditions & fee	25.00%				$182,978.00
						$914,890.00
	contingency	25.00%				$228,723.00
						$1,143,613.00

Conrad Grebel University				***February 23, 2024***	***R2***	
Waterloo, Ontario.						
Section	***Description***	***Quantity***		***Unit $***		***Total***
	2. Window Replacement: Option 2B Double Glazed					
05 50 50	***Aluminum Windows:***					
	..3rd floor remove small window units 3.35x1.0M	3.00	ea	$200.00	ea	$600.00
	..3rd floor remove window units 3.35x1.6m	37.00	ea	$250.00	ea	$9,250.00
	.4th floor remove small window units 3.35x1.0m	4.00	ea	$250.00	ea	$1,000.00
	..4th floor remove window units 3.35x1.9m	41.00	ea	$250.00	ea	$10,250.00
	..4th floor remove triangular window units	45.00	ea	$250.00	ea	$11,250.00
	..remove curtain wall	90.00	m2	$300.00	m2	$27,000.00
	..3rd floor make good surface around windows	397.00	m	$12.75	m	$5,062.00
	..4th floor make good surface around windows	446.00	m	$12.75	m	$5,687.00
	..4th floor triangular M.G. surface around windows	315.00	m	$12.75	m	$4,016.00
	..3rd floor new window units	40.00	ea	$4,200.00	ea	$168,000.00
	..4th floor new window units	45.00	ea	$5,550.00	ea	$249,750.00
	..4th floor new triangular window units	0.00	ea	$1,350.00	ea	$0.00
	..curtain wall system	90.00	m2	$1,500.00	m2	$135,000.00
07 42 33	***Composite Wall Panels:***					
	..aluminum composite panels to triangular window units	55.00	m2	$825.00	m2	$45,375.00
07 90 00	***Sealants:***					
	..exterior caulking to 3rd floor window units	397.00	m	$5.00	m	$1,985.00
	..interior caulking to 3rd floor window units	397.00	m	$4.00	m	$1,588.00
	..exterior caulking to 4th floor window units	446.00	m	$5.00	m	$2,230.00
	..interior caulking to 4th floor window units	446.00	m	$4.00	m	$1,784.00
	..exterior caulking to 4th floor triangular units	315.00	m	$5.00	m	$1,575.00
	..interior caulking to 4th floor triangular units	315.00	m	$4.00	m	$1,260.00
09 23 00	***Drywall***					
	..backup wall to aluminum composite panels	55.00	m2	$300.00	m2	$16,500.00
09 90 00	***Painting***					
	..paint drywall	55.00	m2	$50.00	m2	$2,750.00
						$701,912.00
	Contractor General Conditions & fee	25.00%				$175,478.00
						$877,390.00
	contingency	25.00%				$219,348.00
						$1,096,738.00

Conrad Grebel University				***February 23, 2024***	***R2***	
Waterloo, Ontario.						
Section	***Description***	***Quantity***		***Unit $***		***Total***
	3. Heating & Cooling 75 Units Option 1					
02 02 50	***Building Demolition:***					
	..core drill slabs for piping	16.00	ea	$250.00	ea	$4,000.00
	..core drill corridor wall for piping	75.00	ea	$100.00	ea	$7,500.00
07 46 13	***Metal Siding***					
	..galvanized frame for roof mechanical screens	2.64	mt	$7,000.00	mt	$18,480.00
	..prefinished perforated metal	100.00	m2	$375.00	m2	$37,500.00
07 53 24	***MEMBRANE ROOFING***					
	cut, patch & flash mechanical screen posts	16.00	ea	$750.00	ea	$12,000.00
09 23 00	***Drywall***					
	..3rd floor bulkheads	195.00	m2	$165.00	m2	$32,175.00
	..4th floor bulkheads	220.00	m2	$165.00	m2	$36,300.00
09 90 00	***Painting***					
	..drywall bulkheads	415.00	m2	$25.00	m2	$10,375.00
23 05 00	***Mechanical:***					
	Removals:					
	..Remove wall fin	75.00	ea.	500.00	ea.	$37,500.00
	..Cap piping inside wall	75.00	ea.	300.00	ea.	$22,500.00
	..Isolate and drain wing of building	1.00	sum	5,000.00	sum	$5,000.00
	HVAC					
	..New under window fan coil unit	75.00	ea.	3,750.00	ea.	$281,250.00
	..New condenser on the roof	8.00	ea.	30,000.00	ea.	$240,000.00
	..Refrigeration pipe / switch	75.00	ea.	1,000.00	ea.	$75,000.00
	..Core drill and patch thru roof	8.00	no	2,500.00	no	$20,000.00
	..electric baseboard heaters in washrooms	8.00	ea.	3,500.00	ea.	$28,000.00
	Ventilation					
	..Wall opening	75.00	ea.	750.00	ea.	$56,250.00
	..ERV	75.00	ea.	3,000.00	ea.	$225,000.00
	Controls					
	..VRF fan coil	75.00	ea.	1,000.00	ea.	$75,000.00
	..ERV	75.00	ea.	750.00	ea.	$56,250.00
26 05 01	***Electrical:***					
	VRF condenser c/w disconnect	8.00	no	1,750.00	no	$14,000.00
	VRF fan coil - rooms	75.00	no	350.00	no	$26,250.00
	Demolition	1.00	sum	500.00	sum	$500.00
	ERV rooms	75.00	no	2,895.00	no	$217,125.00
	Branch wiring	75.00	ea	2,200.00	ea	$165,000.00
	service upgrade	1.00	sum	50,000.00	sum	$50,000.00
						$1,752,955.00
	Contractor General Conditions & fee	0.25				$438,239.00
						$2,191,194.00
	contingency	0.25				$547,799.00
						$2,738,993.00

Conrad Grebel University				February 23, 2024	R2	
Waterloo, Ontario.						
Section	**Description**	**Quantity**		**Unit $**		**Total**
	3. Heating & Cooling 75 Units Option 2					
02 02 50	**Building Demolition:**					
	..core drill slabs for piping	16.00	ea	$250.00	ea	$4,000.00
	..core drill corridor wall for piping	75.00	ea	$100.00	ea	$7,500.00
07 46 13	**Metal Siding**					
	..galvanized frame for roof mechanical screens	2.64	mt	$7,000.00	mt	$18,480.00
	..prefinished perforated metal	100.00	m2	$375.00	m2	$37,500.00
07 53 24	**MEMBRANE ROOFING**					
	cut, patch & flash mechanical screen posts	16.00	ea	$750.00	ea	$12,000.00
09 23 00	**Drywall**					
	..3rd floor bulkheads	195.00	m2	$165.00	m2	$32,175.00
	..4th floor bulkheads	220.00	m2	$165.00	m2	$36,300.00
09 90 00	**Painting**					
	..drywall bulkheads	415.00	m2	$25.00	m2	$10,375.00
23 05 00	**Mechanical:**					
	Removals:					
	..Remove wall fin	75.00	ea.	500.00	ea.	$37,500.00
	..Cap piping inside wall	75.00	ea.	300.00	ea.	$22,500.00
	..Isolate and drain wing of building	1.00	sum	5,000.00	sum	$5,000.00
	HVAC					
	..bulkhead fan coil unit	75.00	ea.	3,250.00	ea.	$243,750.00
	..New condenser on the roof	8.00	ea.	30,000.00	ea.	$240,000.00
	..Refrigeration pipe / switch	75.00	ea.	1,000.00	ea.	$75,000.00
	..Core drill and patch thru roof	8.00	no	2,500.00	no	$20,000.00
	Ventilation					
	..Wall opening	75.00	ea.	750.00	ea.	$56,250.00
	..ERV	75.00	ea.	3,000.00	ea.	$225,000.00
	..ductwork off fan coil unit	75.00	ea.	750.00	ea.	$56,250.00
	..supply & return grill	150.00	ea.	250.00	ea.	$37,500.00
	Controls					
	..VRF fan coil	75.00	ea.	1,000.00	ea.	$75,000.00
	..ERV	75.00	ea.	750.00	ea.	$56,250.00
26 05 01	**Electrical:**					
	VRF condenser c/w disconnect	8.00	no	1,750.00	no	$14,000.00
	VRF fan coil - rooms	75.00	no	350.00	no	$26,250.00
	Demolition	1.00	sum	500.00	sum	$500.00
	ERV rooms	75.00	no	2,895.00	no	$217,125.00
	Branch wiring	75.00	ea	2,200.00	ea	$165,000.00
	service upgrade	1.00	sum	50,000.00	sum	$50,000.00
						$1,781,205.00
	Contractor General Conditions & fee	0.25				$445,301.00
						$2,226,506.00
	contingency	0.25				$556,627.00
						$2,783,133.00

Conrad Grebel University				February 23, 2024	R2	
Waterloo, Ontario.						
Section	**Description**	**Quantity**		**Unit $**		**Total**
	3. Heating & Cooling Electrical					
26 05 01	**Electrical:**					
	Service & Distribution:					
	Hydro service fee	1.00	allow	75,000.00	allow	$75,000.00
	Pad mount transformer - included with fee	1.00	nil	0.00	nil	$0.00
	Transformer pad and bollards	1.00	sum	7,500.00	sum	$7,500.00
	Primary conduit from pole	15.00	m	275.00	m	$4,125.00
	Secondary conduit	50.00	m	275.00	m	$13,750.00
	Secondary feeder	50.00	m	225.00	m	$11,250.00
	Main disconnect 1000A	1.00	ea	5,000.00	ea	$5,000.00
	Meter base	1.00	ea	2,500.00	ea	$2,500.00
	Connect to existing PP/TX	1.00	ea	5,000.00	ea	$5,000.00
	New panel HP 400A	1.00	ea	5,500.00	ea	$5,500.00
	New DP1 1000A	1.00	ea	75,000.00	ea	$75,000.00
	Grounding	1.00	sum	1,500.00	sum	$1,500.00
	Testing	1.00	sum	1,500.00	sum	$1,500.00
	Lighting					
	Relocate exterior pole light	3.00	ea	5,000.00	ea	$15,000.00
	Washroom lighting - option 3 or 4	1.00	sum	1,000.00	sum	$1,000.00
	Branch wiring	1.00	sum	82,400.00	sum	$82,400.00
						$306,025.00
	Contractor General Conditions & fee	0.25				$76,506.00
						$382,531.00
	contingency	0.25				$95,633.00
						$478,164.00

Conrad Grebel University				***February 23, 2024***	***R2***	
Waterloo, Ontario.						
Section	***Description***	***Quantity***		***Unit $***		***Total***
	4. Chapel Cooling Option 3					
06 20 00	***MILLWORK / FINISH CARPENTRY***					
	wood veneer panel enclosure 600mm wide	24.00	m	$350.00	m	$8,400.00
	steel brackets to above	40.00	ea	$125.00	ea	$5,000.00
23 05 00	***Mechanical:***					
	Removals:					
	..Remove wall fin	8	ea.	1,000.00	ea.	$8,000.00
	..Cap piping inside wall	8	ea.	750.00	ea.	$6,000.00
	HVAC					
	..chiller 15 tons	1	ea.	45,000.00	ea.	$45,000.00
	..chilled water pumps	2	ea.	6,500.00	ea.	$13,000.00
	..plant equipment	1	sum	10,000.00	sum	$10,000.00
	..fan coil units	12	ea.	4,500.00	ea.	$54,000.00
	..chilled water piping	1	sum	30,000.00	sum	$30,000.00
	..thermal insulation	1	sum	10,000.00	sum	$10,000.00
	Ventilation					
	..ERV	1	ea.	25,000.00	ea.	$25,000.00
	..ductwork	1	sum	20,000.00	sum	$20,000.00
	..supply & return grilles	12	ea.	175.00	ea.	$2,100.00
	Controls					
	.. fan coil	12	ea.	1,500.00	ea.	$18,000.00
	..ERV	1	ea.	4,500.00	ea.	$4,500.00
26 05 01	***Electrical:***					
	..chiller air handler	1	ea	2,500.00	ea	$2,500.00
	..domestic heater	3	ea	850.00	ea	$2,550.00
	..ERV	1	ea	1,000.00	ea	$1,000.00
	..fan coil units	12	ea	350.00	ea	$4,200.00
	..branch wiring	1	sum	1,000.00	sum	$1,000.00
						$270,250.00
	Contractor General Conditions & fee	25.00%				$67,563.00
						$337,813.00
	contingency	25.00%				$84,453.00
						$422,266.00

Conrad Grebel University				February 23, 2024	R2	
Waterloo, Ontario.						
Section	**Description**	**Quantity**		**Unit $**		**Total**
	5. Domestic Water Heating					
23 05 00	**Mechanical:**					
	..remove extg. boiler	2	ea	1,000.00	ea	$2,000.00
	..remove domestic storage tanks	2	ea	1,200.00	ea	$2,400.00
	..remove piping	1	sum	2,500.00	sum	$2,500.00
	..new heat pump domestic heater	3	ea	12,500.00	ea	$37,500.00
	..water piping	1	sum	5,000.00	sum	$5,000.00
	..thermal insulation	1	sum	3,000.00	sum	$3,000.00
26 05 01	**Electrical:**					
	..domestic heater	3	ea	850.00	ea	$2,550.00
	..branch wiring	1	sum	10,000.00	sum	$10,000.00
						$64,950.00
	Contractor General Conditions & fee	25.00%				$16,238.00
						$81,188.00
	contingency	25.00%				$20,297.00
						$101,485.00
	6. Sanitary Drains					
23 05 00	**Mechanical:**					
	..sanitary drains	75	m	300.00	m	$22,500.00
	..remove ceilings & re-install	90	m2	150.00	m2	$13,500.00
	..cut & patch	1	sum	5,000.00	sum	$5,000.00
						$41,000.00
	Contractor General Conditions & fee	25.00%				$10,250.00
						$51,250.00
	contingency	25.00%				$12,813.00
						$64,063.00

Conrad Grebel University				February 23, 2024	R2	
Waterloo, Ontario.						
Section	**Description**	**Quantity**		**Unit $**		**Total**
	7. Exterior Walls: Option 1 Brick Veneer					
02 41 16	**Building Demolition:**					
	..3rd floor remove double brick wall	105.00	m2	$55.00	m2	$5,775.00
	..4th floor remove double brick wall	155.00	m2	$70.00	m2	$10,850.00
	..north wall remove double brick wall	60.00	m2	$70.00	m2	$4,200.00
	..make good floor surface	280.00	m	$50.00	m	$14,000.00
	..make good vertical surfaces	135.00	m	$75.00	m	$10,125.00
04 05 10	**Masonry**					
	..3rd floor brick veneer <25mm thick	120.00	m2	$250.00	m2	$30,000.00
	..4th floor brick veneer <25mm thick	170.00	m2	$250.00	m2	$42,500.00
04 43 23	**Stone**					
	..3rd floor corian window sills 3.35M	40.00	ea	$550.00	ea	$22,000.00
	..4th floor corian window sills 3.35m	44.00	m2	$550.00	m2	$24,200.00
05 50 00	**MISCELLANEOUS METALS**					
	5x3 galvanized steel angle below windows 3.35m long each	78.00	ea	$400.00	ea	$31,200.00
	install steel angles	78.00	ea	$150.00	ea	$11,700.00
07 61 00	**Flashings:**					
	..3rd floor corian windows 3.35M	40.00	ea	$225.00	ea	$9,000.00
	..4th floor corian windows 3.35m	44.00	m2	$225.00	m2	$9,900.00
09 23 00	**Drywall**					
	..3rd floor 125mm steel stud partition	120.00	m2	$135.00	m2	$16,200.00
	..4th floor 125mm steel stud partition	170.00	m2	$135.00	m2	$22,950.00
	..air vapour barrier	290.00	m2	$60.00	m2	$17,400.00
	..150mm insulation	290.00	m2	$125.00	m2	$36,250.00
07 90 00	**Sealants:**					
	..exterior caulking to 3rd floor units	340.00	m	$5.00	m	$1,700.00
	..interior caulking to 3rd floor window units	340.00	m	$4.00	m	$1,360.00
	..exterior caulking to 4th floor units	365.00	m	$5.00	m	$1,825.00
	..interior caulking to 4th floor units	365.00	m	$4.00	m	$1,460.00
	..exterior caulking to 4th floor triangular units	315.00	m	$0.00	m	$0.00
	..interior caulking to 4th floor units	315.00	m	$0.00	m	$0.00
						$324,595.00
	Contractor General Conditions & fee	25.00%				$81,149.00
						$405,744.00
	contingency	25.00%				$101,436.00
						$507,180.00

Conrad Grebel University				February 23, 2024	R2	
Waterloo, Ontario.						
Section	**Description**	**Quantity**		**Unit $**		**Total**
	7. Exterior Walls: Option 2 Fibre Cement Board					
02 41 16	**Building Demolition:**					
	..3rd floor remove double brick wall	105.00	m2	$55.00	m2	$5,775.00
	..4th floor remove double brick wall	155.00	m2	$70.00	m2	$10,850.00
	..north wall remove double brick wall	60.00	m2	$70.00	m2	$4,200.00
	..make good floor surface	280.00	m	$50.00	m	$14,000.00
	..make good vertical surfaces	135.00	m	$75.00	m	$10,125.00
04 05 10	**Masonry**					
	..3rd floor brick veneer <25mm thick	0.00	m2	$250.00	m2	$0.00
	..4th floor brick veneer <25mm thick	0.00	m2	$250.00	m2	$0.00
04 43 23	**Stone**					
	..3rd floor corian window sills 3.35M	40.00	ea	$550.00	ea	$22,000.00
	..4th floor corian window sills 3.35m	44.00	m2	$550.00	m2	$24,200.00
05 50 00	**MISCELLANEOUS METALS**					
	5x3 galvanized steel angle below windows 3.35m long each	78.00	ea	$400.00	ea	$31,200.00
	install steel angles	78.00	ea	$150.00	ea	$11,700.00
07 44 53	**Fibre Cement Board**					
	..3rd floor fibre cement board	120.00	m2	$350.00	m2	$42,000.00
	..4th floor fibre cement board	170.00	m2	$350.00	m2	$59,500.00
07 61 00	**Flashings:**					
	..3rd floor corian windows 3.35M	40.00	ea	$225.00	ea	$9,000.00
	..4th floor corian windows 3.35m	44.00	m2	$225.00	m2	$9,900.00
09 23 00	**Drywall**					
	..3rd floor 125mm steel stud partition	120.00	m2	$135.00	m2	$16,200.00
	..4th floor 125mm steel stud partition	170.00	m2	$135.00	m2	$22,950.00
	..air vapour barrier	290.00	m2	$60.00	m2	$17,400.00
	..150mm insulation	290.00	m2	$125.00	m2	$36,250.00
07 90 00	**Sealants:**					
	..exterior caulking to 3rd floor units	340.00	m	$5.00	m	$1,700.00
	..interior caulking to 3rd floor window units	340.00	m	$4.00	m	$1,360.00
	..exterior caulking to 4th floor units	365.00	m	$5.00	m	$1,825.00
	..interior caulking to 4th floor units	365.00	m	$4.00	m	$1,460.00
	..exterior caulking to 4th floor triangular units	315.00	m	$0.00	m	$0.00
	..interior caulking to 4th floor units	315.00	m	$0.00	m	$0.00
						$353,595.00
	Contractor General Conditions & fee	25.00%				$88,399.00
						$441,994.00
	contingency	25.00%				$110,499.00
						$552,493.00

Conrad Grebel University				February 23, 2024	R2	
Waterloo, Ontario.						
Section	**Description**	**Quantity**		**Unit $**		**Total**
	7. Exterior Walls: Option 3 Fibre Cement Board +Over Clad Columns & Beams					
02 41 16	**Building Demolition:**					
	..3rd floor remove double brick wall	105.00	m2	$55.00	m2	$5,775.00
	..4th floor remove double brick wall	155.00	m2	$70.00	m2	$10,850.00
	..north wall remove double brick wall	60.00	m2	$70.00	m2	$4,200.00
	..make good floor surface	280.00	m	$50.00	m	$14,000.00
	..make good vertical surfaces	135.00	m	$75.00	m	$10,125.00
04 05 10	**Masonry**					
	..3rd floor brick veneer <25mm thick	0.00	m2	$250.00	m2	$0.00
	..4th floor brick veneer <25mm thick	0.00	m2	$250.00	m2	$0.00
04 43 23	**Stone**					
	..3rd floor corian window sills 3.35M	40.00	ea	$550.00	ea	$22,000.00
	..4th floor corian window sills 3.35m	44.00	m2	$550.00	m2	$24,200.00
07 44 53	**Fibre Cement Board**					
	..3rd floor fibre cement board	120.00	m2	$350.00	m2	$42,000.00
	..4th floor fibre cement board	170.00	m2	$350.00	m2	$59,500.00
	..north face fibre cement board	60.00	m2	$350.00	m2	$21,000.00
	..overclad columns	240.00	m2	$350.00	m2	$84,000.00
	..overclad beams	65.00	m2	$350.00	m2	$22,750.00
	..insulation	305.00	m2	$125.00	m2	$38,125.00
07 61 00	**Flashings:**					
	..3rd floor corian windows 3.35M	40.00	ea	$225.00	ea	$9,000.00
	..4th floor corian windows 3.35m	44.00	m2	$225.00	m2	$9,900.00
09 23 00	**Drywall**					
	..3rd floor 125mm steel stud partition	120.00	m2	$135.00	m2	$16,200.00
	..4th floor 125mm steel stud partition	170.00	m2	$135.00	m2	$22,950.00
	..air vapour barrier	290.00	m2	$60.00	m2	$17,400.00
	..150mm insulation	290.00	m2	$125.00	m2	$36,250.00
07 90 00	**Sealants:**					
	..exterior caulking to 3rd floor units	340.00	m	$5.00	m	$1,700.00
	..interior caulking to 3rd floor window units	340.00	m	$4.00	m	$1,360.00
	..exterior caulking to 4th floor units	365.00	m	$5.00	m	$1,825.00
	..interior caulking to 4th floor units	365.00	m	$4.00	m	$1,460.00
	..exterior caulking to 4th floor triangular units	315.00	m	$0.00	m	$0.00
	..interior caulking to 4th floor units	315.00	m	$0.00	m	$0.00
						$476,570.00
	Contractor General Conditions & fee	25.00%				$119,143.00
						$595,713.00
	contingency	25.00%				$148,928.00
						$744,641.00

Conrad Grebel University				February 23, 2024	R2	
Waterloo, Ontario.						
Section	**Description**	**Quantity**		**Unit $**		**Total**
	7. Exterior Walls: Option 4 EIFS +Over Clad Columns & Beams					
02 41 16	**Building Demolition:**					
	..3rd floor remove double brick wall	105.00	m2	$55.00	m2	$5,775.00
	..4th floor remove double brick wall	155.00	m2	$70.00	m2	$10,850.00
	..north wall remove double brick wall	60.00	m2	$70.00	m2	$4,200.00
	..make good floor surface	280.00	m	$50.00	m	$14,000.00
	..make good vertical surfaces	135.00	m	$75.00	m	$10,125.00
04 05 10	**Masonry**					
	..3rd floor brick veneer <25mm thick	0.00	m2	$250.00	m2	$0.00
	..4th floor brick veneer <25mm thick	0.00	m2	$250.00	m2	$0.00
04 43 23	**Stone**					
	..3rd floor corian window sills 3.35M	40.00	ea	$550.00	ea	$22,000.00
	..4th floor corian window sills 3.35m	44.00	m2	$550.00	m2	$24,200.00
07 24 00	**EIFS**					
	..3rd floor EIFS	120.00	m2	$250.00	m2	$30,000.00
	..4th floor EIFS	170.00	m2	$275.00	m2	$46,750.00
	..north face EIFS	60.00	m2	$275.00	m2	$16,500.00
	..overclad columns	240.00	m2	$290.00	m2	$69,600.00
	..overclad beams	65.00	m2	$275.00	m2	$17,875.00
07 44 53	**Fibre Cement Board**					
	..3rd floor fibre cement board	0.00	m2	$350.00	m2	$0.00
	..4th floor fibre cement board	0.00	m2	$350.00	m2	$0.00
	..north face fibre cement board	0.00	m2	$350.00	m2	$0.00
	..overclad columns	0.00	m2	$350.00	m2	$0.00
	..overclad beams	0.00	m2	$350.00	m2	$0.00
	..insulation	0.00	m2	$125.00	m2	$0.00
07 61 00	**Flashings:**					
	..3rd floor corian windows 3.35M	40.00	ea	$225.00	ea	$9,000.00
	..4th floor corian windows 3.35m	44.00	m2	$225.00	m2	$9,900.00
09 23 00	**Drywall**					
	..3rd floor 125mm steel stud partition	120.00	m2	$135.00	m2	$16,200.00
	..4th floor 125mm steel stud partition	170.00	m2	$135.00	m2	$22,950.00
	..air vapour barrier	290.00	m2	$60.00	m2	$17,400.00
	..150mm insulation	290.00	m2	$125.00	m2	$36,250.00
07 90 00	**Sealants:**					
	..exterior caulking to 3rd floor units	340.00	m	$5.00	m	$1,700.00
	..interior caulking to 3rd floor window units	340.00	m	$4.00	m	$1,360.00
	..exterior caulking to 4th floor units	365.00	m	$5.00	m	$1,825.00
	..interior caulking to 4th floor units	365.00	m	$4.00	m	$1,460.00
	..exterior caulking to 4th floor triangular units	315.00	m	$0.00	m	$0.00
	..interior caulking to 4th floor units	315.00	m	$0.00	m	$0.00
						$389,920.00
	Contractor General Conditions & fee	25.00%				$97,480.00
						$487,400.00
	contingency	25.00%				$121,850.00
						$609,250.00

Conrad Grebel University				February 23, 2024	R2	
Waterloo, Ontario.						
Section	**Description**	**Quantity**		**Unit $**		**Total**
	7. Exterior Walls: Option 5 Interior Drywall					
02 41 16	**Building Demolition:**					
	..3rd floor remove double brick wall	0.00	m2	$55.00	m2	$0.00
	..4th floor remove double brick wall	0.00	m2	$70.00	m2	$0.00
	..north wall remove double brick wall	0.00	m2	$70.00	m2	$0.00
	..make good floor surface	0.00	m	$50.00	m	$0.00
	..make good vertical surfaces	0.00	m	$75.00	m	$0.00
	..remove extg. Sill	75.00	ea	$65.00	ea	$4,875.00
04 05 10	**Masonry**					
	..3rd floor brick veneer <25mm thick	0.00	m2	$250.00	m2	$0.00
	..4th floor brick veneer <25mm thick	0.00	m2	$250.00	m2	$0.00
04 43 23	**Stone**					
	..3rd floor corian window sills 3.35M	35.00	ea	$550.00	ea	$19,250.00
	..4th floor corian window sills 3.35m	40.00	ea	$550.00	ea	$22,000.00
07 24 00	**EIFS**					
	..3rd floor EIFS	0.00	m2	$250.00	m2	$0.00
	..4th floor EIFS	0.00	m2	$275.00	m2	$0.00
	..north face EIFS	0.00	m2	$275.00	m2	$0.00
	..overclad columns	0.00	m2	$290.00	m2	$0.00
	..overclad beams	0.00	m2	$275.00	m2	$0.00
07 44 53	**Fibre Cement Board**					
	..3rd floor fibre cement board	0.00	m2	$350.00	m2	$0.00
	..4th floor fibre cement board	0.00	m2	$350.00	m2	$0.00
	..north face fibre cement board	0.00	m2	$350.00	m2	$0.00
	..overclad columns	0.00	m2	$350.00	m2	$0.00
	..overclad beams	0.00	m2	$350.00	m2	$0.00
	..insulation	0.00	m2	$125.00	m2	$0.00
07 61 00	**Flashings:**					
	..3rd floor corian windows 3.35M	35.00	ea	$225.00	ea	$7,875.00
	..4th floor corian windows 3.35m	40.00	ea	$225.00	ea	$9,000.00
09 23 00	**Drywall**					
	..3rd floor 64mm steel stud partition	105.00	m2	$175.00	m2	$18,375.00
	..4th floor 64mm steel stud partition	125.00	m2	$175.00	m2	$21,875.00
	..north wall	55.00	m2	$175.00	m2	$9,625.00
	..air vapour barrier	285.00	m2	$60.00	m2	$17,100.00
	..75mm sprayed insulation	285.00	m2	$125.00	m2	$35,625.00
07 90 00	**Sealants:**					
	..exterior caulking to 3rd floor units	0.00	m	$5.00	m	$0.00
	..interior caulking to 3rd floor window units	340.00	m	$4.00	m	$1,360.00
	..exterior caulking to 4th floor units	0.00	m	$5.00	m	$0.00
	..interior caulking to 4th floor units	365.00	m	$4.00	m	$1,460.00
	..exterior caulking to 4th floor triangular units	0.00	m	$0.00	m	$0.00
	..interior caulking to 4th floor units	0.00	m	$0.00	m	$0.00
						$168,420.00
	Contractor General Conditions & fee	25.00%				$42,105.00
						$210,525.00
	contingency	25.00%				$52,631.00
						$263,156.00

Conrad Grebel University ***March 21, 2024.***
Waterloo, Ontario.

Section	***Description***	***Quantity***		***Unit $***		***Total***
	Light Fixture Replacement					
	Washroom Vanity 12EA					
	..remove existing fixture	12.00	ea	$65.00	ea	$780.00
	..supply new fixture	12.00	ea	$370.00	ea	$4,440.00
	..install new fixture	12.00	ea	$125.00	ea	$1,500.00
	..branch wiring	72.00	m	$15.00	m	$1,080.00
	..cut & patch	12.00	ea	$200.00	ea	$2,400.00
	Corridor Light Fixtures 600x600mm 60EA					
	..remove existing fixture	60.00	ea	$65.00	ea	$3,900.00
	..supply new fixture	60.00	ea	$75.00	ea	$4,500.00
	..install new fixture	60.00	ea	$125.00	ea	$7,500.00
	..branch wiring	360.00	m	$15.00	m	$5,400.00
	..cut & patch	60.00	ea	$200.00	ea	$12,000.00
	Dorm Rooms: 70EA					
	..remove existing fixture	70.00	ea	$65.00	ea	$4,550.00
	..supply new fixture	70.00	ea	$960.00	ea	$67,200.00
	..install new fixture	70.00	ea	$125.00	ea	$8,750.00
	..branch wiring	420.00	m	$15.00	m	$6,300.00
	..cut & patch	70.00	ea	$200.00	ea	$14,000.00
	Shower Rooms: 12EA					
	..remove existing fixture	12.00	ea	$65.00	ea	$780.00
	..supply new fixture	12.00	ea	$25.00	ea	$300.00
	..install new fixture	12.00	ea	$125.00	ea	$1,500.00
	..branch wiring	72.00	m	$15.00	m	$1,080.00
	..cut & patch	12.00	ea	$200.00	ea	$2,400.00
						$150,360.00
	Contractor General Conditions & fee	25.00%				$37,590.00
						$187,950.00
	contingency	25.00%				$46,988.00
						$234,938.00

Section	Description	Quantity		Unit $		Total
Conrad Grebel University				*March 21, 2024.*		
Waterloo, Ontario.						
	Light Fixture Replacement					
	Washroom Vanity 12EA					
	..remove existing fixture	12.00	ea	$65.00	ea	$780.00
	..supply new fixture	12.00	ea	$370.00	ea	$4,440.00
	..install new fixture	12.00	ea	$125.00	ea	$1,500.00
	..branch wiring	72.00	m	$15.00	m	$1,080.00
	..cut & patch	12.00	ea	$200.00	ea	$2,400.00
	Corridor Light Fixtures 600x600mm 60EA					
	..remove existing fixture	60.00	ea	$65.00	ea	$3,900.00
	..supply new fixture	60.00	ea	$75.00	ea	$4,500.00
	..install new fixture	60.00	ea	$125.00	ea	$7,500.00
	..branch wiring	360.00	m	$15.00	m	$5,400.00
	..cut & patch	60.00	ea	$200.00	ea	$12,000.00
	Dorm Rooms: 70EA					
	..remove existing fixture	70.00	ea	$65.00	ea	$4,550.00
	..supply new fixture	70.00	ea	$960.00	ea	$67,200.00
	..install new fixture	70.00	ea	$125.00	ea	$8,750.00
	..branch wiring	420.00	m	$15.00	m	$6,300.00
	..cut & patch	70.00	ea	$200.00	ea	$14,000.00
	Shower Rooms: 12EA					
	..remove existing fixture	12.00	ea	$65.00	ea	$780.00
	..supply new fixture	12.00	ea	$25.00	ea	$300.00
	..install new fixture	12.00	ea	$125.00	ea	$1,500.00
	..branch wiring	72.00	m	$15.00	m	$1,080.00
	..cut & patch	12.00	ea	$200.00	ea	$2,400.00
						$150,360.00
	Contractor General Conditions & fee	25.00%				$37,590.00
						$187,950.00
	contingency	25.00%				$46,988.00
						$234,938.00

Ingersoll & associates inc.

Appendix C: Energy Report

UNIVERSITY OF WATERLOO

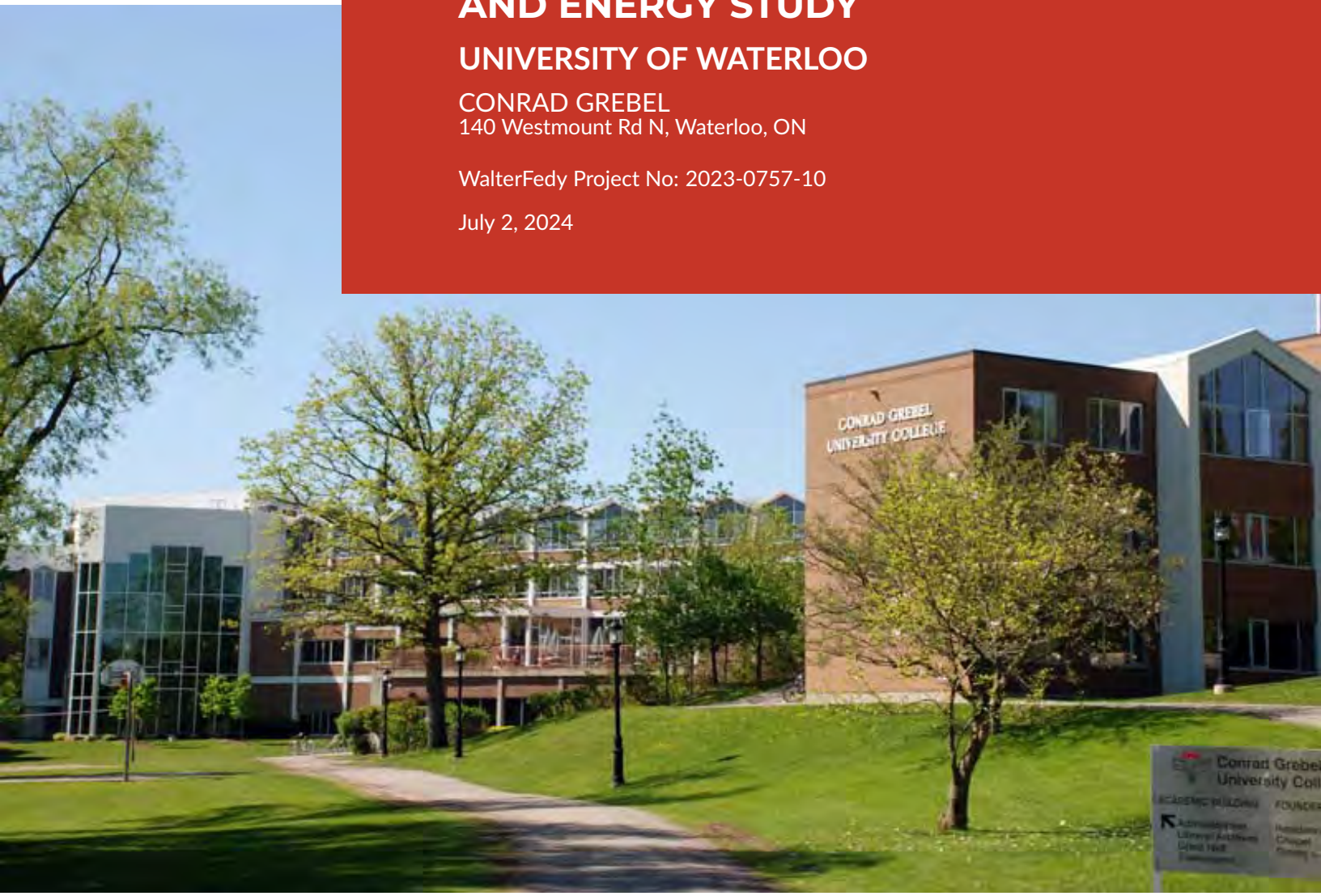
CONRAD GREBEL RESIDENCE ENVELOPE AND ENERGY STUDY

UNIVERSITY OF WATERLOO

CONRAD GREBEL
140 Westmount Rd N, Waterloo, ON

WalterFedy Project No: 2023-0757-10

July 2, 2024



WALTERFEDY

Kitchener | Hamilton | Toronto | walterfedy.com

DISCLAIMER AND LIMITATION OF LIABILITY

This document was prepared by WalterFedy for the above stated client ("Client") for the specific purpose and use by the client, as described in the report and subsequent scope of work agreement. This report was completed based on the information that was available at the time of the report preparation and completion, and is subject to all limitations, assumptions and qualifications contained herein. Any events or circumstances that have occurred since the date on which the report was prepared, are the responsibility of the client, and WalterFedy accepts no responsibility to update the report to reflect these changes.

WalterFedy agrees that this report represents its professional judgement and any estimates or opinions regarding probable costs, schedules, or technical estimates provided represent the professional judgement in light of WalterFedy's experience as well as the information available at the time of report preparation. In addition, WalterFedy accepts no responsibilities for changes in market or economic conditions, price fluctuations for labour and material costs, and therefore makes no representations, guarantees or warranties for the estimates in this report. Persons relying on such estimates or opinions do so at their own risk.

Reported utility company incentive amounts are estimated based on information that was available at the time of report preparation. Actual incentive amounts are to be determined and provided by the utility company. The utility company must be contacted prior to beginning any work for which an incentive will be applied for.

This report may not be disclosed or referred to in any public document without the prior formal written consent of WalterFedy. Any use which a third party makes of the report is at the sole responsibility and risk of the third party.

WalterFedy agrees with the Client that it will provide under this Agreement the standards of care, skill and diligence normally provided in the performance of services in respect of work similar to that contemplated by this Agreement. WalterFedy at its own expense carries professional liability insurance to the extent that it deems prudent and WalterFedy's liability under this Agreement to the Client for any claim in contract or in tort related to the services provided under this Agreement howsoever arising shall be limited to the extent that such liability is covered by such professional liability insurance from time to time in effect including the deductible therein, and which is available to indemnify WalterFedy and in any event WalterFedy's liability under this Agreement shall be limited to loss or damage directly attributable to the negligent acts of WalterFedy, its officers, servants or agents, or its failure to provide the standards of care, skill and diligence aforesaid. In no event shall WalterFedy be liable for loss or damage caused by delays beyond WalterFedy's control, or for loss of earnings or for other consequential damage howsoever caused.

The errors and omissions policies are available for inspection by the Client at all times upon request. If the Client, because of its particular circumstances or otherwise, desires to obtain further insurance to protect it against any risk beyond the coverage provided by such policies, WalterFedy will co-operate with the Client to obtain such insurance at the Client's expense.

The Client, in consideration of the provision by WalterFedy of the services set forth in this Agreement, agrees to the limitations of the liability of WalterFedy aforesaid. The Client shall have no right of set-off against any billings of WalterFedy under this Agreement.

Project Number: 2023-0757-10

July 2, 2024

Mimi Browne,

University of Waterloo
200 University Ave W
Waterloo, ON N2L 3G1

Dear Mimi Browne,

RE: Conrad Grebel Residence Envelope and Energy Study

WalterFedy is pleased to submit the attached Conrad Grebel Residence Envelope and Energy Study report to University of Waterloo. This encompasses the agreed to scope, providing a Conrad Grebel Residence Envelope and Energy Study for Conrad Grebel, located at 140 Westmount Rd N in Waterloo, ON.

Based on the information provided by University of Waterloo, the report was completed with the data supplied and collected, as well as engineering judgement and various analysis tools to arrive at the final recommendations.

All of which is respectfully submitted,

WALTERFEDY

Cory Rosa, P.Eng., PMP
Energy Engineer
Energy and Carbon Solutions

crosa@walterfedy.com
519 635 9805

Table of Contents

1 INTRODUCTION

1.1 Background

WalterFedy was engaged by University of Waterloo to complete a Conrad Grebel Residence Envelope and Energy Study for Conrad Grebel. The objective of this engagement was to identify and analyze measures that reduce utility use, GHG emissions, and utility costs at Conrad Grebel, and to analyze various GHG Reduction Pathways consisting of combinations of measures. Based on these analyses, the objective was also to recommend the preferred GHG Reduction Pathway for implementation.

1.2 Contact information

Contact information for WalterFedy (the Consultant) and University of Waterloo (the Client) is provided in Table 1.

Table 1: Contact information

Description	Consultant	Client
Organization	WalterFedy	University of Waterloo
Address	Suite 111, 675 Queen St South	200 University Ave W
Location	Kitchener, ON	Waterloo, ON
Postal code	N2M 1A1	N2L 3G1
Contact name	Cory Rosa	Mimi Browne
Credentials	P.Eng., PMP	
Title	Energy Engineer	
Phone	519 635 9805	
Email	crosa@walterfedy.com	mimi.browne@uwaterloo.ca

2 FACILITY DESCRIPTION

2.1 Facility overview

An overview of Conrad Grebel is provided in Table 2.

Table 2: Facility overview

Description	Unit	Value
Name	[-]	Conrad Grebel
Address	[-]	140 Westmount Rd N
Location	[-]	Waterloo, ON
Type	[-]	Theatre
Construction year	[-]	1963
Gross floor area	[m2]	1,087
Gross floor area	[ft2]	11,700

An aerial view of Conrad Grebel is presented in Figure 1 for visualization.

Figure 1: Conrad Grebel aerial view

2.2 Space use

Space use summary

Conrad Grebel is a faculty on the campus of the University of Waterloo that consists of both student living and academic space. Originally constructed in 1963, several additions have occurred over the past 60 years expanding the footprint and usage of the facility. A list of the different additions and the respective years of construction is as follows:

- 1963: Original residence
- 1976: Academic building
- 1992: Addition to the student residence
- 2003: Atrium
- 2003: Residence hallway extension and apartment building
- 2013: Academic and library expansion
- 2021: Kitchen and dining room expansion and renovation

2.3 Envelope

Roof

The Grebel residence has a peaked roof for every room with a lower trough above the corridor that provides space for ventilation supply and exhaust vents. The apartments roof at Conrad Grebel is mostly flat roofing but contains 3 peaks, all of it done with a polyvinyl chloride (PVC) membrane roofing system. Adding roof insulation to these peaked roofs would be difficult because of the way in which the flashing is attached to the roofing material. The flat roofs above the atrium, central academic core, and academic wing at Conrad Grebel are a PVC membrane roofing system. Opportunities and other notable conditions are as follows.

Walls

Exterior walls consists primarily of brick, stucco, and metal siding. Exterior walls in most areas are original to construction.

Windows

Exterior windows consist of both fixed and operable type and are primarily metal-framed, double pane windows in punched configurations. Metal-framed single pane windows were noted in the site visit in some residence rooms and in older stairwells. There are some storefront style windows in entrances and some classrooms. Curtainwall glazing was observed in the atrium and some stairwells.

Exterior doors

Exterior doors consist primarily of metal-framed double pane glazed swinging doors that serve main building entrances and stairwells.

Envelope documentation

Envelope documentation, including available drawings and photos from the site survey, is provided in the following images.

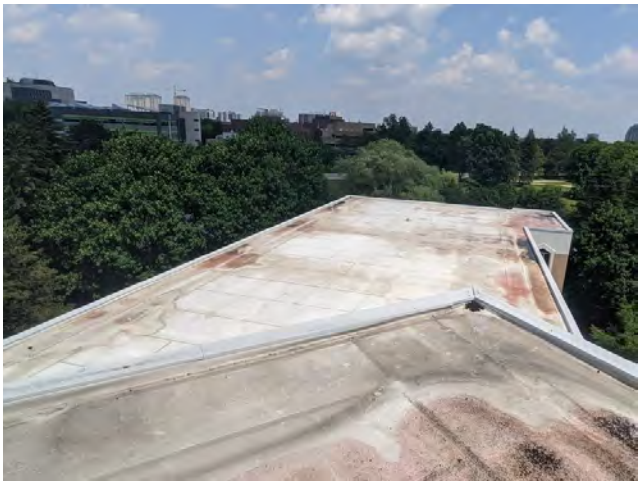


Figure 2: Academic roof

Figure 3: Apartment roof

Figure 4: Atrium roof

Figure 5: Doors

Figure 6: Ext walls

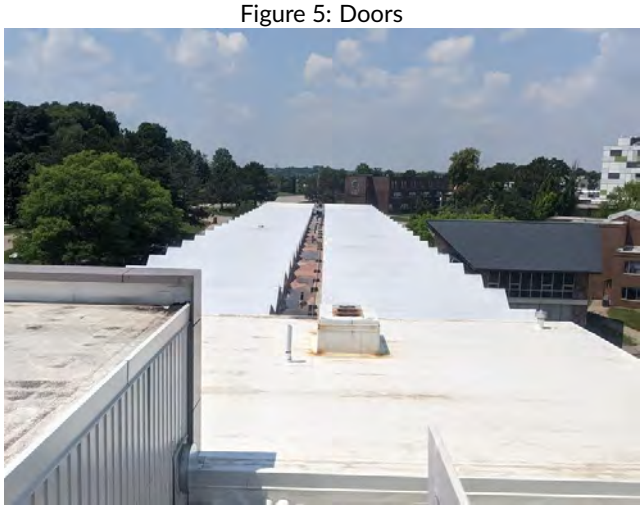


Figure 7: Residence roof

Figure 8: Residence window

2.4 Lighting

Corridor and stairwell space lighting

Corridor and stairway space lighting is provided by T8, T12, CFL, and LED lamps. Most lighting is controlled manually by wall-mounted switches and is not scheduled and does not have occupancy sensors.

Classroom space lighting

Classroom lighting is provided by T8, T12, CFL, and LED lamps. Most lighting is controlled manually by wall-mounted switches and is not scheduled and does not have occupancy sensors. Classrooms in the newer parts of Grebel have occupancy sensors.

Library space lighting

Library space lighting is provided primarily by T8 fluorescent lamps with some LEDs and CFLs. These lights are primarily controlled by occupancy sensors.

Kitchen and dining room space lighting

Kitchen and Dining room space lighting is provided by LEDs. These lights are primarily controlled by occupancy sensors and are not scheduled.

Residence and apartment room space lighting

Residence and apartment room space lighting is provided primarily by compact fluorescent lamps. Lighting is controlled manually by wall-mounted switches by the occupants.

Other space lighting

Other space lighting is provided primarily by T8 lamps but with a mix of LEDs, incandescent and CFL lamps as well. Lighting is generally controlled manually by wall-mounted switches.

Exterior space lighting

Exterior lighting is provided primarily by high intensity discharge (HID) pole-mounted lights and CFL wall-mounted lights with a couple LED lights as well. Exterior lighting is on overnight, and controlled either by a timer or photo-cell.

Lighting system documentation

Lighting system documentation, including available drawings and photos taken during the site survey, is provided in the following images.

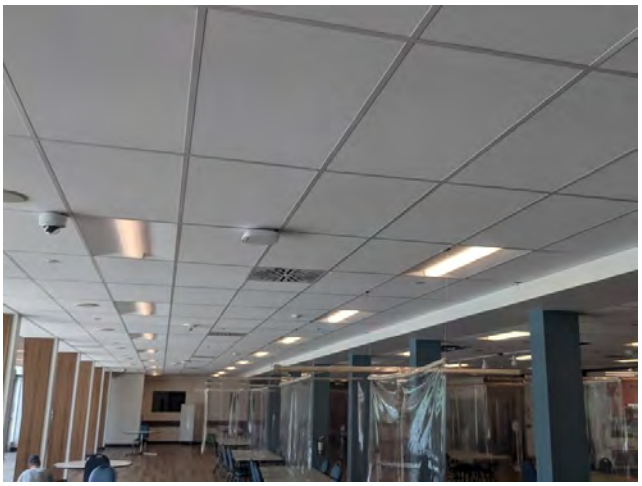


Figure 9: Lighting dining room

Figure 10: Lighting exterior

Figure 11: Lighting library

Figure 12: Lighting old academic hallway

Figure 13: Lighting old academic room

Figure 14: Lighting other

Figure 15: Lighting residence room

2.5 Water fixtures

Water fixture summary

Water fixtures at Conrad Grebel are summarized in Table 3.

Table 3: Water fixture summary

Serves	Flow	Volume	Data source
-	[gpm]	[gpc]	-
Kitchen faucets	2.0	-	Inscription on aerator
Handwashing faucets	1.9	-	Inscription on aerator
Toilets	-	1.6	Assumed.
Urinals	-	1.0	Assumed.

General overview

Plumbing fixtures consist of faucets, showers, toilets, and urinals. Showers and the majority of faucets are controlled manually with some having automatic sensors. Some of these are already low flow fixtures. It is understood that very low-flow options have been installed previously and led to plumbing issues so they were removed.

Water fixture documentation

Water fixture documentation, including available drawings and photos taken during the site survey, is provided in the following images.

Figure 16: Sinks residence

2.6 Heating

Heating system summary

Heating systems at Conrad Grebel are summarized in Table 4.

Table 4: Heating systems summary

Tag	Serves	Utility	Efficiency	Output	Data source
-	-	-	[decimal]	[btuh]	-
Academic_B1	Academic	Natural gas	0.94	500,000	WF EA
Academic_B2	Academic	Natural gas	0.94	500,000	WF EA
Academic_B3	Academic	Natural gas	0.94	500,000	WF EA
Residence_B1	Residence	Natural gas	0.85	900,000	WF EA
Residence_B2	Residence	Natural gas	0.85	900,000	WF EA
Residence_B3	Residence	Natural gas	0.85	900,000	WF EA
Kitchen_DWH_1	Kitchen DHW	Natural gas	0.97	200,000	WF EA
Kitchen_DWH_2	Kitchen DHW	Natural gas	0.97	200,000	WF EA
Apartment_DWH_1	Apartment DHW	Natural gas	0.80	154,000	WF EA
Apartment_DWH_2	Apartment DHW	Natural gas	0.80	154,000	WF EA
Residence_DHW	Residence DHW	Natural gas	0.80	962,000	WF EA
Academic_addition_DHW	Academic DHW	Electricity	1.00	15,000	WF EA

Residence hot water boilers

Space heating at Conrad Grebel is provided primarily by perimeter hydronic baseboard heaters. Hot water for the hydronic baseboard heaters for the residence comes from 3 Thermific non-condensing boilers. One of the boilers was under replacement as of September 2021 with a new condensing boiler. Controls are provided by wall mounted, thermostat dials in residence rooms and lounge spaces and by thermostats in remaining spaces.

Academic hot water boilers

Hot water for the academic multizone unit heating coils, VAV reheat coils, and for the hydronic baseboard heaters in the academic wing comes from 3 Lochinvar condensing boilers rated for 500 MBH input each. The multizone unit also has two humidifier units, one burns natural gas to generate hot steam that slightly heats the air as it is added, and the other is an atomizing unit that sprays very fine water droplets that then evaporate and slightly cools the air as it is added. The new academic core has VAV boxes with hot water reheat coils as the main source of heating with some perimeter hydronic baseboard heaters to supplement. Heaters are controlled to maintain space temperatures set on the thermostats controlling them.

Electric baseboard heaters

There are a few electric baseboard and unit heaters that supplement heating at Conrad Grebel. There is one in the games lounge and each apartment has a 1,500 watt heater in the living room and the apartment stairs and corridors have 2,000 watt heaters.

Apartment furnaces

Each apartment unit has a natural gas furnace with ducted heating to the living room and each bedroom. The basement area has its own furnace in the storage room that conditions the basement space.

Residence and academic domestic hot water

DHW heating for the residence at Conrad Grebel is provided by a natural gas fired boiler with two storage tanks. The firing of the boiler and flow of heating water is controlled to maintain a water temperature setpoint. DHW

is distributed from the storage tank throughout the residence via a DHW circulation pump. DHW heating for the 2013 academic addition at Conrad Grebel is served by 3 small electric DHW heaters dispersed around the addition. DHW for the original academic wing comes from the residence boiler as well.

Kitchen domestic hot water

DHW heating for the kitchen at Conrad Grebel is provided by two high efficiency natural gas fired hot water heaters. The firing of the heaters and flow of heating water is controlled to maintain a water temperature setpoint. DHW is distributed from the storage tank throughout the kitchen via a DHW circulation pump.

Apartment domestic hot water

DHW heating for the apartments at Conrad Grebel is provided by two natural gas fired boiler. The firing of the boilers and the heaters and flow of heating water is controlled to maintain a water temperature setpoint. DHW is distributed from the heaters to the units via a DHW circulation pump.

Heating system documentation

Heating system documentation, including available drawings and photos from the site survey, is provided in the following images.

Figure 17: Boilers residence

Figure 18: DHW apartment

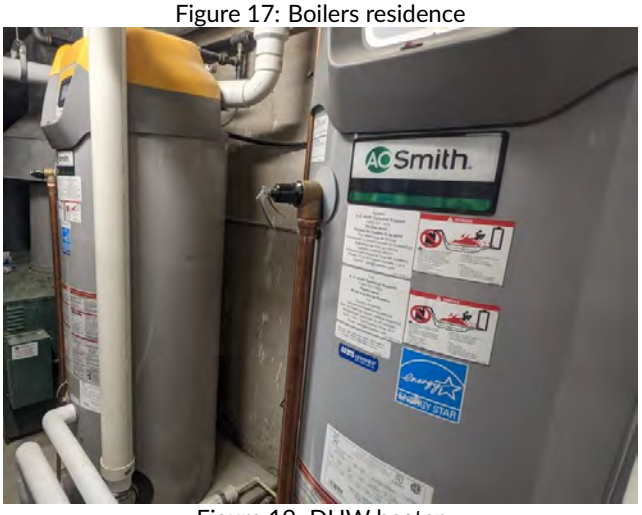


Figure 19: DHW heater

Figure 20: DHW kitchen

Figure 21: DHW residence

Figure 22: Elec heating apartment

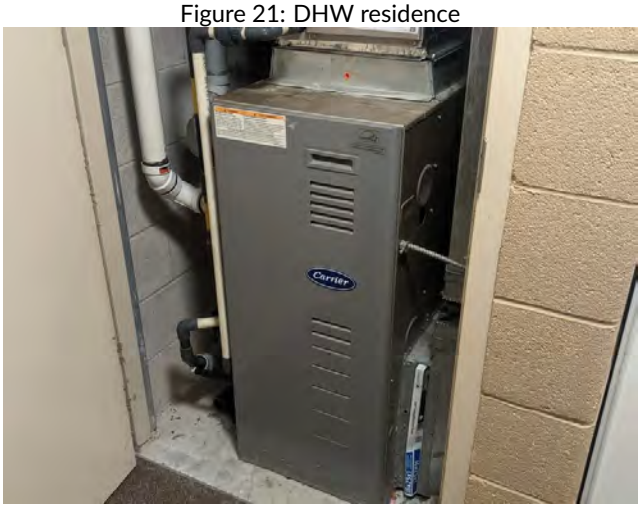


Figure 23: Furnace apartment

Figure 24: Heating academic

Figure 25: VRF

2.7 Cooling

Private dining room AC system

Two split AC units provide cooling for the private dining room, pantry, and kitchen staff change room. The condenser is wall mounted beside the dining room AHU and the lower atrium. It is controlled by a thermostat in the space.

1300, 1301, 1302 classrooms AC systems

Two AC systems in the mechanical room underneath the patio provide cooling and ventilation for the 1300, 1301, 1302 classrooms. This mechanical has solely outdoor access. It is a constant volume system and has condensers outside on the ground concealed by bushes. These two units are controlled by programmable thermostats and there are occupancy schedules implemented that are actively updated by facility staff.

Games lounge, silent study room, and student services AC systems

An AC system installed near the games lounge provides cooling and ventilation for the games lounge, silent study room, and student services. The condenser is in a pit beside the chapel entrance. It runs based on thermostats in the games lounge and the silent study room.

Prayer room window unit

There is a single window AC unit in the window of the prayer room. This unit is unplugged when not in use so it does not contribute significant electricity consumption.

Apartment AC units

Each apartment units has its own AC unit with a condenser on the roof. All eight of these condensers have been replaced in the last four years. These units are controlled with programmable thermostats in the living room of each apartment unit.

Cooling system documentation

Cooling system documentation, including available drawings and photos from the site survey, is provided in the following images.

Figure 26: Cooling 1300s condensers

Figure 27: Cooling apartment

Figure 28: Cooling archives

Figure 29: Cooling MZU

Figure 30: Cooling prayer room

Figure 31: Cooling RTU academic

Figure 32: Cooling RTU lower atrium

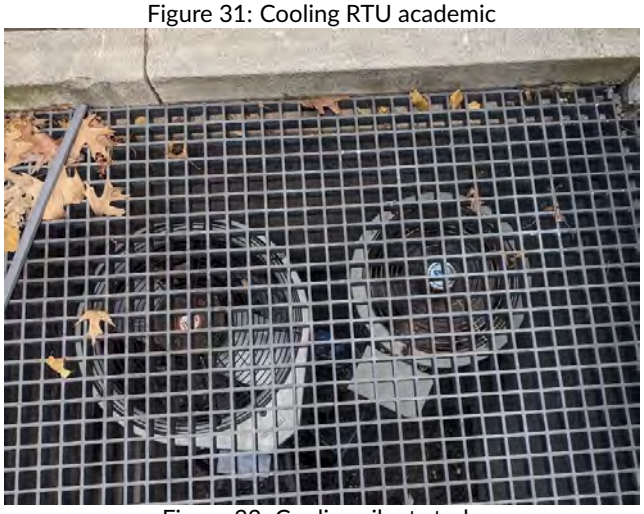


Figure 33: Cooling silent study

2.8 Water distribution

Water distribution system summary

Water distribution systems / pumps are summarized in Table 5.

Table 5: Water distribution systems summary

Tag	Serves	Motor output	Motor output	Data source
-	-	[kW]	[hp]	-
Academic_P1	Academic HW circulation pump	0.37	0.50	NA
Academic_P2	Academic HW circulation pump	1.49	2.00	NA
Residence_P1	Residence HW circulation pump	2.24	3.00	NA
Residence_P2	Residence HW circulation pump	2.24	3.00	NA
Kitchen_P1	Kitchen DHW circulation pump	0.19	0.25	NA

Academic hot water pumps

Two circulation pumps provide hot water to the academic wing. Both pumps are on variable frequency drives (VFDs) but ramp up to their maximum speed and then operate at their maximum speed throughout the winter.

Residence hot water pumps

Two circulation pumps provides hot water to the residence wing. These circulation pump are believed to operate 24/7 at their maximum speed during the winter heating season when the boilers are on. Neither pump has a VFD. Facility staff noted that both pumps together are just enough to supply hot water to the furthest end of the residence and if one of the pumps is off or under maintenance then there are temperature complaints.

Water distribution system documentation

Water distribution system documentation, including available drawings and photos from the site survey, is provided in the following images.

Figure 34: Pump academic

Figure 35: Pump residence

2.9 Air distribution

Air distribution system power summary

Air distribution systems are summarized in Table 6.

Table 6: Air distribution systems summary

Tag	Serves	Design flow	Motor output	Motor output	Data source
-	-	[cfm]	[kW]	[hp]	-
AC1	1300s classroom	1,300	1.1	1.5	WF EA
AC2	1300s classroom	1,300	1.1	1.5	WF EA
AHU	New academic building	21,000	22.4	30.0	WF EA
AHU_EF	New academic building exhaust	5,000	4.5	6.0	WF EA
AHU1	Dining room	7,000	3.1	4.2	WF EA
AHU1_EF	Dining room exhaust	3,500	1.6	2.1	WF EA
AHU2	Kitchen	6,200	5.6	7.5	WF EA
MZU	Original academic building	18,100	5.6	7.5	WF EA
MZU_EF	Original academic building exhaust	18,100	5.6	7.5	WF EA
RTU1_2	Atrium	7,000	0.0	0.0	WF EA
RTU1	Atrium	2,000	0.8	1.1	WF EA
RTU2	Atrium	5,000	2.8	3.7	WF EA
Apartment_furnace	Apartment furnaces	-	0.2	0.3	Assumed
EF_1	Lower atrium exhaust fan	400	0.1	0.1	WF EA
EF_2	Kitchen exhaust fan	6,800	3.7	5.0	WF EA
EF_3	Dishwasher exhaust fan	600	0.2	0.3	WF EA
EF_4	Atrium exhaust fan	2,595	0.6	0.8	WF EA
EF_5	Bathroom exhaust fans	250	0.0	0.0	WF EA
EF_6	Storage room exhaust fan	600	0.2	0.3	WF EA
EF_7	Hallway exhaust fans	250	0.0	0.0	WF EA
EF_8	Bathroom exhaust fans	300	0.0	0.1	WF EA

Orginal academic building multizone unit MZU

A multizone unit in the penthouse mechanical room provides space conditioning and ventilation for the original academic wing. The area served by this unit is divided into 10 zones and a pneumatic thermostat in each zone controls the multizone unit. A compressor with an air dryer supply pressurized air to the pneumatic lines. This unit is original to the building construction and it is a constant volume system. The condenser has leaked the refrigerant in one of it two cooling loops so when cooling is required the entire condenser unit turns on but there is only one cooling loop going through instead of two. This is leading to less energy efficient cooling and poorer humidity control.

New academic building AHU

A Carrier air handling unit (AHU) provides space conditioning and ventilation for the new academic core. It is a variable volume system with VAV boxes that contain hot water reheat coils. This unit is connected to the BAS and has occupancy schedules.

Library archives condensing unit

An Ecosaire condensing unit provides cooling for the library archives. This unit runs all year and has its own control system inside the archives.

Upper and lower atrium RTU1, RTU2

Two Carrier RTUs provide space conditioning and ventilation for the upper and lower atriums and a few surrounding rooms from the 2003 construction. These units are around 20 years old and one has been leaking refrigerant.

Dining room AHU1

A Daikin AHU provides space conditioning and ventilation for the dining room. The unit is outside on the ground beside the lower atrium. The AHU is controlled by the BAS. An energy recovery ventilator (ERV) provides fresh air to the private dining room, pantry, and kitchen staff change room. The ERV is controlled by the BAS.

Kitchen AHU2

A Daikin AHU provides space conditioning and ventilation for the kitchen. The unit is on the roof of the kitchen. The AHU is controlled by the BAS.

Residence and apartment exhaust fans

In the residence and apartments air is exhausted through exhaust fans located in washrooms and kitchen spaces, which are individually ducted to the exterior. The exhaust fans in the residence bathrooms and lounges are controlled by block schedules.

Air distribution system documentation

Air distribution system documentation, including available drawings and photos from the site survey, is provided in the following images.

Figure 36: AHU dining

Figure 37: AHU kitchen

Figure 38: Exhaust fan residence

3 UTILITY USE ANALYSIS

3.1 Utility analysis methodology

The utility use analysis was completed according to the following methodology. Note that the results achieved from applying this methodology are presented in the same order in Sections 3.2 through 3.4.

1. **Utility analysis assumptions**. Assumptions applied in the utility use analysis were identified and summarized in Section 3.2. Assumptions include the following.
   - GHG emissions factors.
   - Utility cost rates.
2. **Metered utility use**. Metered utility use data were obtained from University of Waterloo. These data form the basis of all utility use baseline and measure analyses and are summarized in Section 3.3 into the following sections, as available.
   - Hourly.
   - Monthly.
3. **Utility use baseline**. The utility use baseline is summarized in Section 3.4, and includes the following.
   - Baseline year: Determined as the most recent year with the fewest anomalies in facility operations and utility metering. Metered data for the baseline year is used to establish the baseline performance.
   - Baseline performance: Yearly utility use, GHG emissions and utility costs derived from metered utility use data for the baseline year.

3.2 Utility analysis assumptions

Assumptions applied throughout the methodology are summarized as follows.

- GHG emissions factor assumptions are as per Table 7.

Table 7: GHG emissions factor assumptions

Utility	Unit	Value
Electricity	[tCO2e/kWh]	0.0000500
Natural gas	[tCO2e/m3]	0.0018990

- Utility cost rate assumptions are as per Table 8. Rates are applicable to the baseline year, 2019, and are taken from utility bills provided by the University of Waterloo. Note that throughout this Conrad Grebel Residence Envelope and Energy Study the Federal Carbon Charge is treated separately with respect to associated fuels (rather than being accounted for within the rates of the applicable fuels, the federal carbon charge line item is calculated separately based on the estimated yearly GHG emissions for that fuel). As such, all other utility cost rates exclude the federal carbon charge.

Table 8: Utility cost rate assumptions

Utility	Line item	Unit	Value
Electricity	Electricity consumption - Class B	[$/kWh]	0.0200
Electricity	Global adjustment - Class B	[$/kWh]	0.0735
Electricity	Regulatory	[$/kWh]	0.0057
Electricity	Delivery	[$/kW]	12.1217
Natural gas	Natural gas (blended)	[$/m3]	0.2600
Water	Water (blended)	[$/m3]	4.4800
GHG emissions	Federal carbon charge	[$/tCO2e]	50.0000

3.3 Metered utility use

Monthly

Monthly electricity use is plotted in Figure 39.

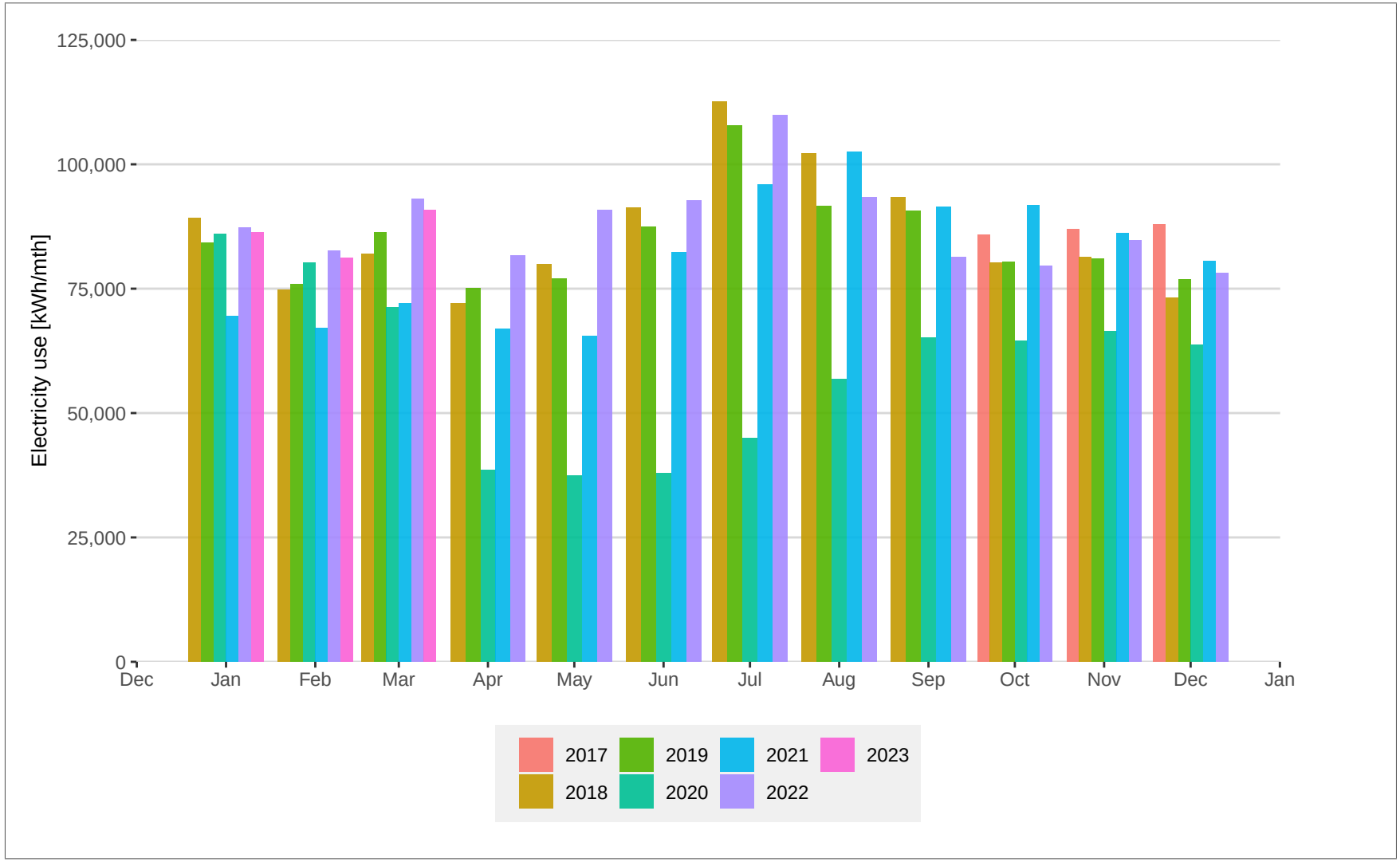


Figure 39: Monthly electricity use

Monthly natural gas use is plotted in Figure 40.

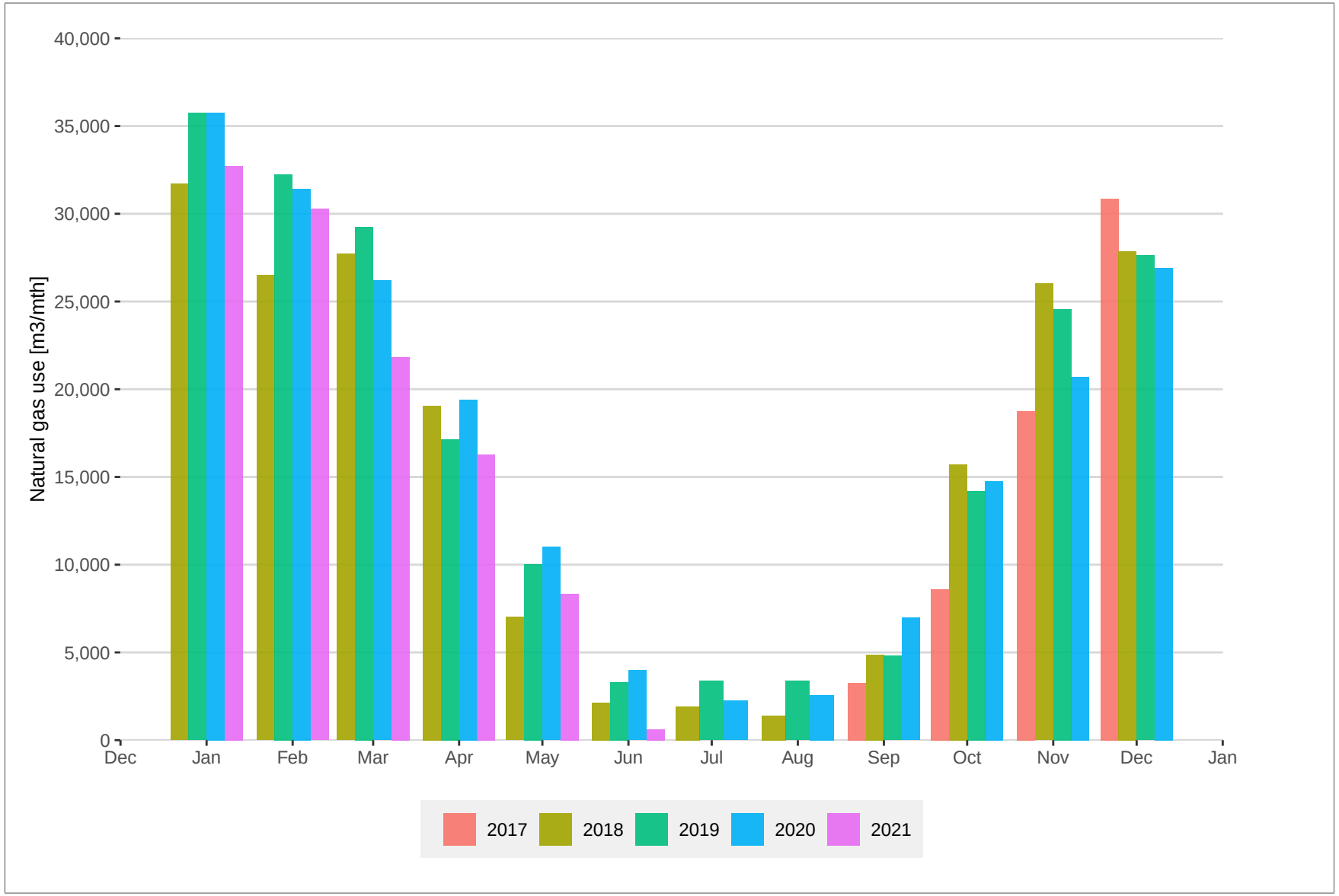


Figure 40: Monthly natural gas use

3.4 Utility use baseline

Baseline year

The baseline year for Conrad Grebel, which is used to establish the baseline performance through the metered utility use data from that year, is as follows.

- **Baseline year**: 2019.

Baseline performance

Baseline utility use performance for the baseline year of 2019 is summarized in Table 9.

Table 9: Baseline utility use performace

Category	Utility	Unit	Value
Utility use	Electricity use	[kWh/yr]	1,014,245
	Monthly peak electricity demand (yearly av)	[kWh/hr]	185
	Natural gas use	[m3/yr]	205,678
	Water use	[m3/yr]	8,940
GHG emissions	Electricity GHGs	[tCO2e/yr]	51
	Natural gas GHGs	[tCO2e/yr]	391
	Carbon offsets GHGs	[tCO2e/yr]	0
	Total GHGs	[tCO2e/yr]	442
Utility cost	Electricity utility cost	[$/yr]	127,549
	Natural gas utility cost	[$/yr]	53,476
	Federal carbon charge	[$/yr]	19,550
	Carbon offsets utility cost	[$/yr]	0
	Water utility cost	[$/yr]	40,050
	Total utility cost	[$/yr]	240,625

4 ENERGY MODEL CALIBRATION

4.1 Energy model calibration methodology

The utility use profile is developed from a bottom-up hourly analysis (spanning one year) of the following energy systems, as applicable. The analysis reflects the existing conditions of the facility as documented in Section 2.

1. **Hourly utility use profiles**. An hourly utility use profile for each utility is developed and calibrated to available metered utility use data through the following methodology. Results are presented in Section 4.2.

   (a) *Utilities and end uses*. Hourly utility use profiles developed through this analysis are assigned to both utilities and end uses. The utilities and end uses tracked in this analysis are summarized in Table 10.

Table 10: Utility and end use summary and definitions

Utility	End use	Definition of end use
Electricity	Cool	Cooling energy use.
	Equipment	Equipment energy use.
	Fans	Fan motor energy use.
	Heat	Heating energy use.
	Lights	Lighting energy use.
	Other	Metered minus modeled.
	Pumps	Pump motor energy use.
Natural gas	DHW heat	Domestic hot water heating energy use.
	DHW heat: Residence	Domestic hot water heating energy use for residential water (faucets, showers, bath).
	Heat	Heating energy use.
	Other	Metered minus modeled.
Water	Faucets	Faucet water use.
	Showers	Shower water use.
	Toilets	Toilet flushing water use.

   (b) *Weather data*. Hourly weather data is obtained from the Government of Canada's website for the weather station identified in Table 11.

Table 11: Weather station details

City	Station name	Station ID
Kitchener	Kitchener/Waterloo	48569

   (c) *Facility spaces*. Facility spaces are grouped according to activities in the spaces and HVAC systems serving them. The thermal characteristics of the exterior building envelope components for each space are assumed based on findings documented in Section 2.3. Thermal loads within each space are calculated based on assumed space temperature and humidity setpoints, hourly weather data, and activities in the space that affect thermal conditions (e.g. lighting or equipment that generates heat).

   (d) *Primary systems*. Primary systems are systems whose utility use can be predicted independent from other systems. Examples include lighting, equipment (e.g. office and process equipment), pumps, etc. The hourly utility demand of primary systems are modeled based on time-of-day operating schedules and power input. Power input is estimated from findings documented throughout Section 2, including lighting power or power density, nameplate horsepower on pump and other motors, etc.

   (e) *HVAC systems*. HVAC system energy use is modeled based on hourly weather data and space condition setpoints defined for the various spaces. The analysis also accounts for system-specific ventilation controls and activities and primary systems that have thermal influences on spaces (e.g. occupancy, lighting, equipment, processes that add heat to spaces). The analysis quantifies hourly energy use of fans, heating (e.g. sensible, humidification, reheat) and cooling (e.g. sensible, dehumidification).

(f) *Calibration*. After developing the above bottom-up analysis, the model is calibrated through the "Other" end use, which is calculated as the difference of metered and modeled utility use. The above modeling steps are iterated as required to achieve a reasonable "Other" end use.

2. **Calibration analysis**. A calibration analysis is completed, in which metered and modeled utility use are compared to assure that the model is reasonably calibrated (i.e. consistent with metered utility use). Results are presented in Section 4.3.
3. **End use analysis**. An end use analysis of each utility is completed. Since the hourly utility use profiles already track the hourly utility use by each end use, the end use analysis involves summarizing data from the hourly utility use profiles to obtain yearly utility use by each end use. Results are presented in Section 4.4.

4.2 Hourly utility use profiles

The calibrated energy model is valuable because it enables the impacts of energy conservation measures to be precisely quantified (e.g. utility use, utility cost, GHG emissions impacts). The precision of the calibrated energy model comes from a bottom-up hourly analysis of each individual utility-consuming system at Conrad Grebel. By assigning appropriate end uses to these utility-consuming systems, the primary output of the calibrated energy model is an hourly utility use profile for each end use, for each utility.

These hourly utility use profiles are presented graphically in this Section 4.2 in a format called a stacked bar plot. For each hour of the year, the utility use for all end uses active during that hour is presented in a single bar pertaining to that hour. The end uses are identified via colour, and all end uses are "stacked" on top of each other within each hour-specific bar such that the total height of each bar represents the total utility use of all end uses combined in that hour.

Electricity

The hourly electricity utility use profile by end use made by the calibrated energy model is plotted in Figure 41. See Table 10 for end use definitions.

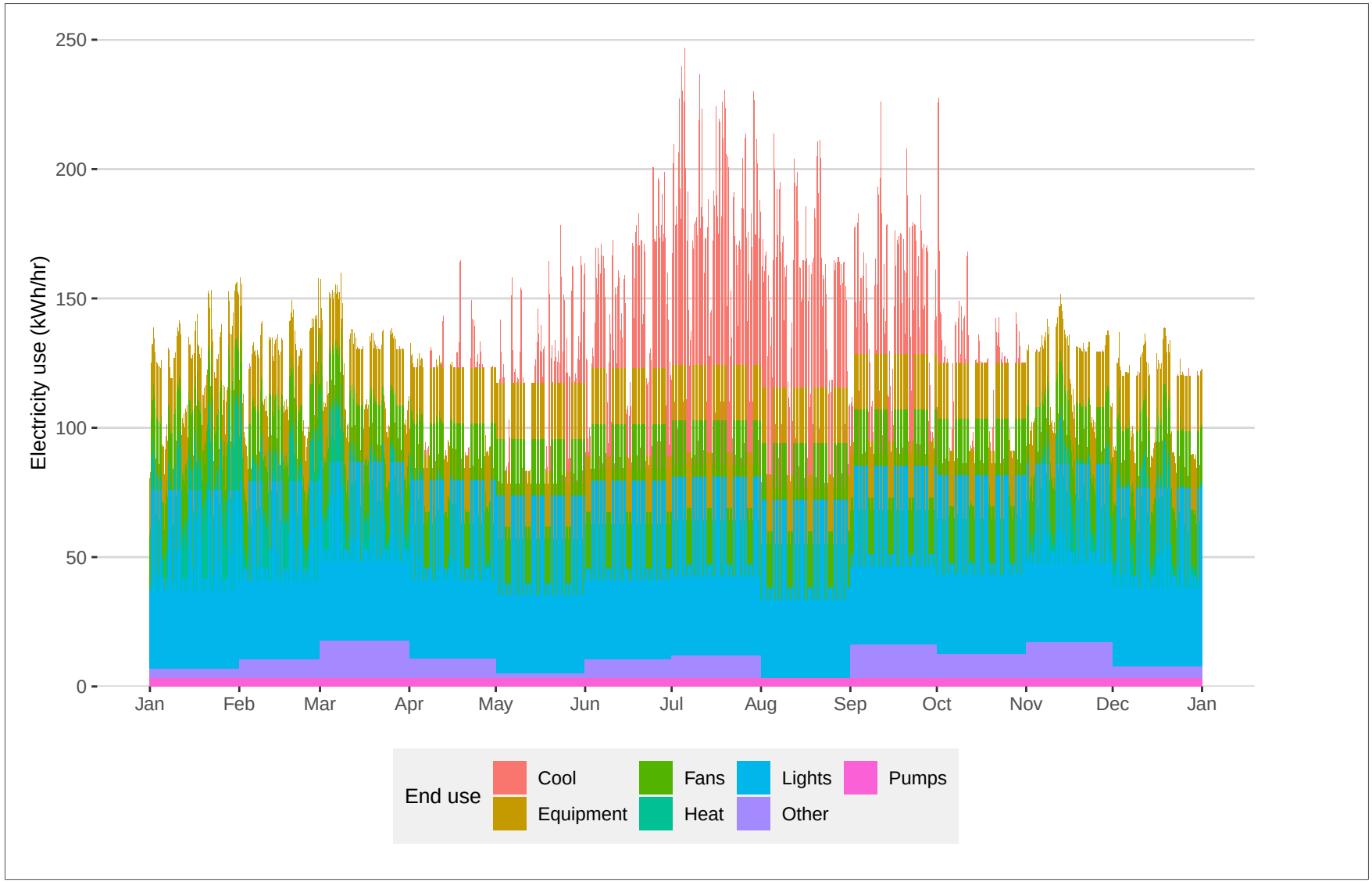


Figure 41: Hourly electricity utility use by end use (made by calibrated energy model)

Natural gas

The hourly natural gas utility use profile by end use made by the calibrated energy model is plotted in Figure 42. See Table 10 for end use definitions.

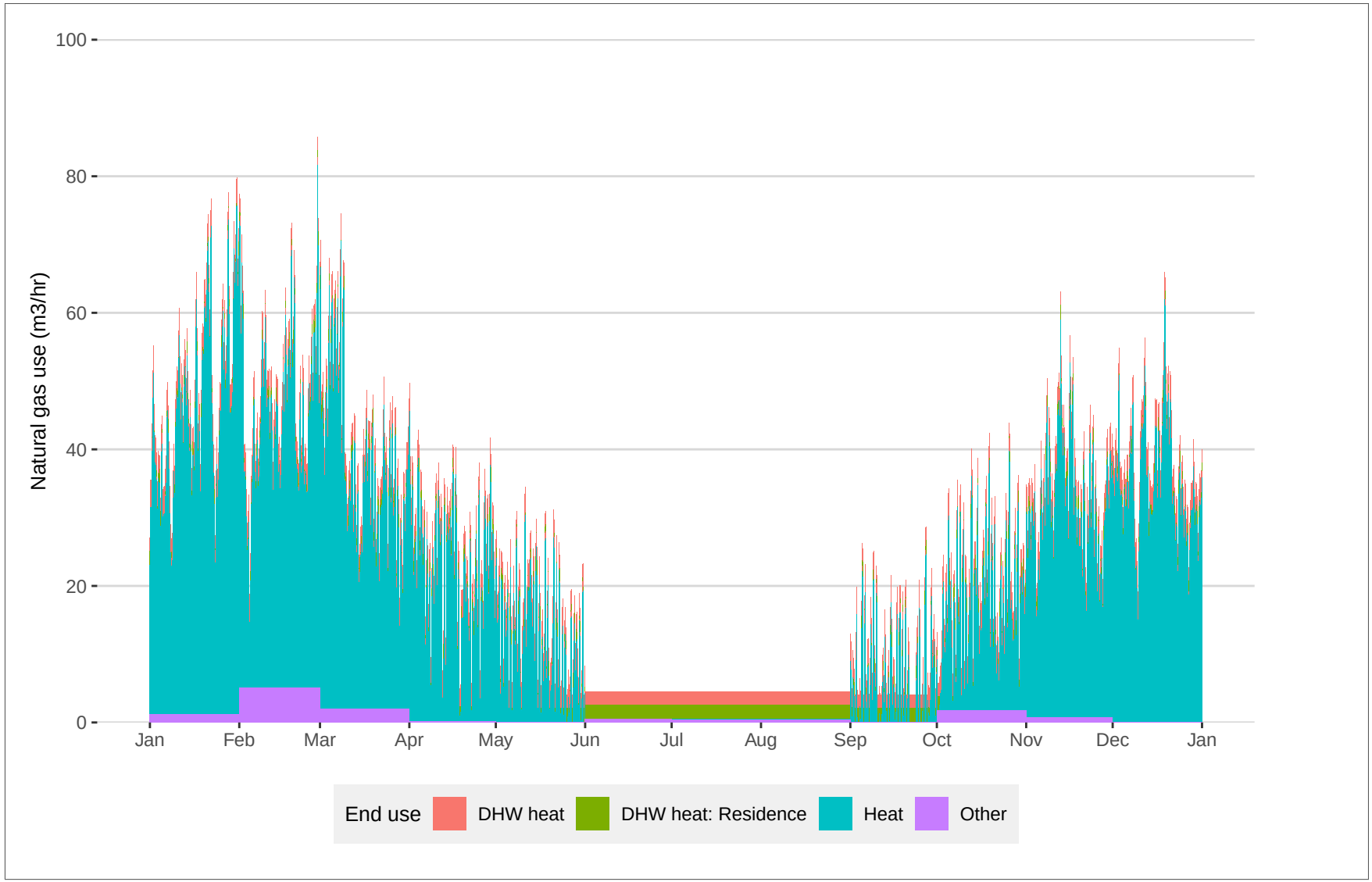


Figure 42: Hourly natural gas utility use by end use (made by calibrated energy model)

4.3 Calibration analysis

Electricity

Figure 43 compares the metered utility use with the modeled use to check how well the model is calibrated.

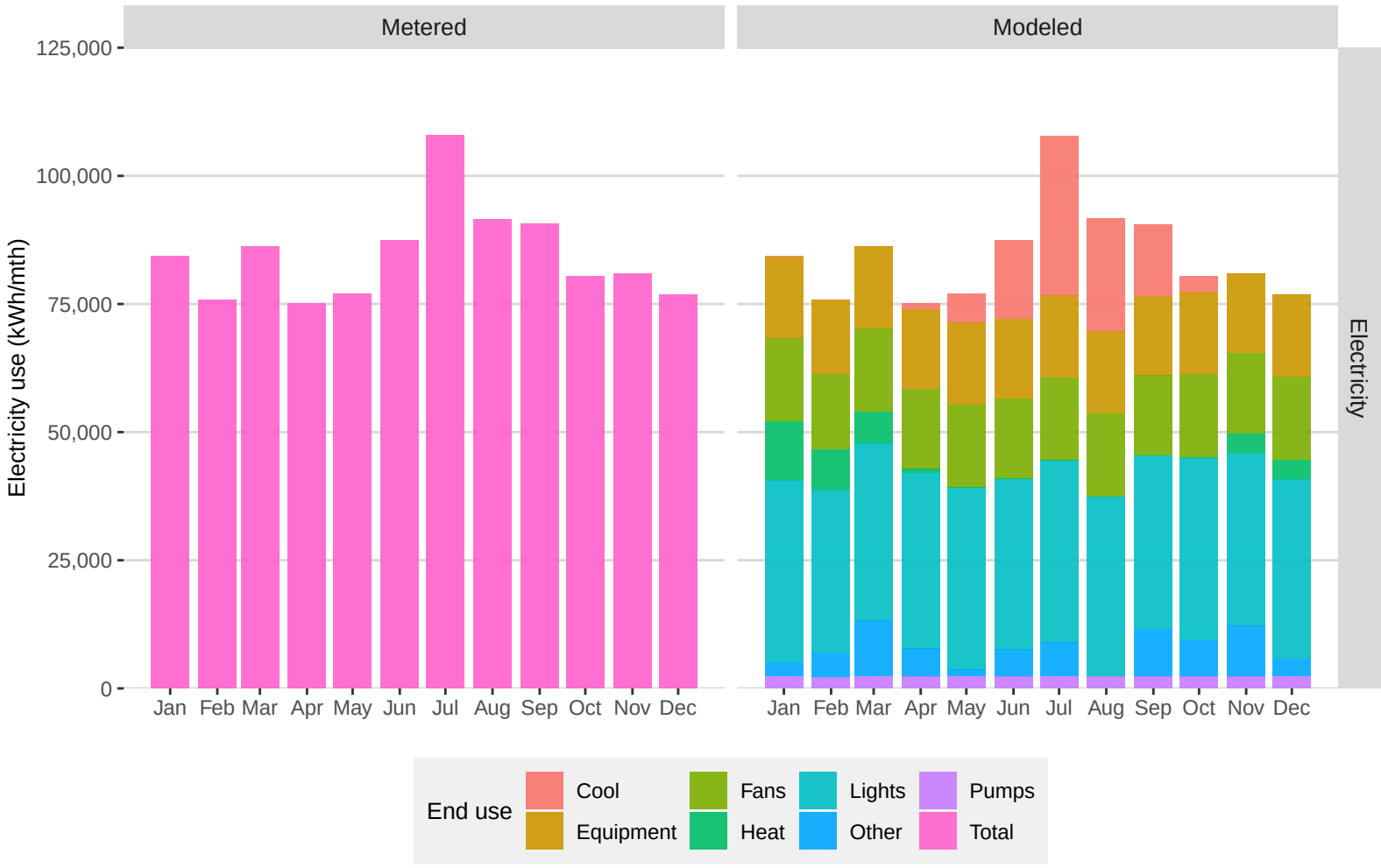


Figure 43: Electricity calibration analysis (metered vs modeled utility use)

Natural gas

Figure 44 compares the metered utility use with the modeled use to check how well the model is calibrated.

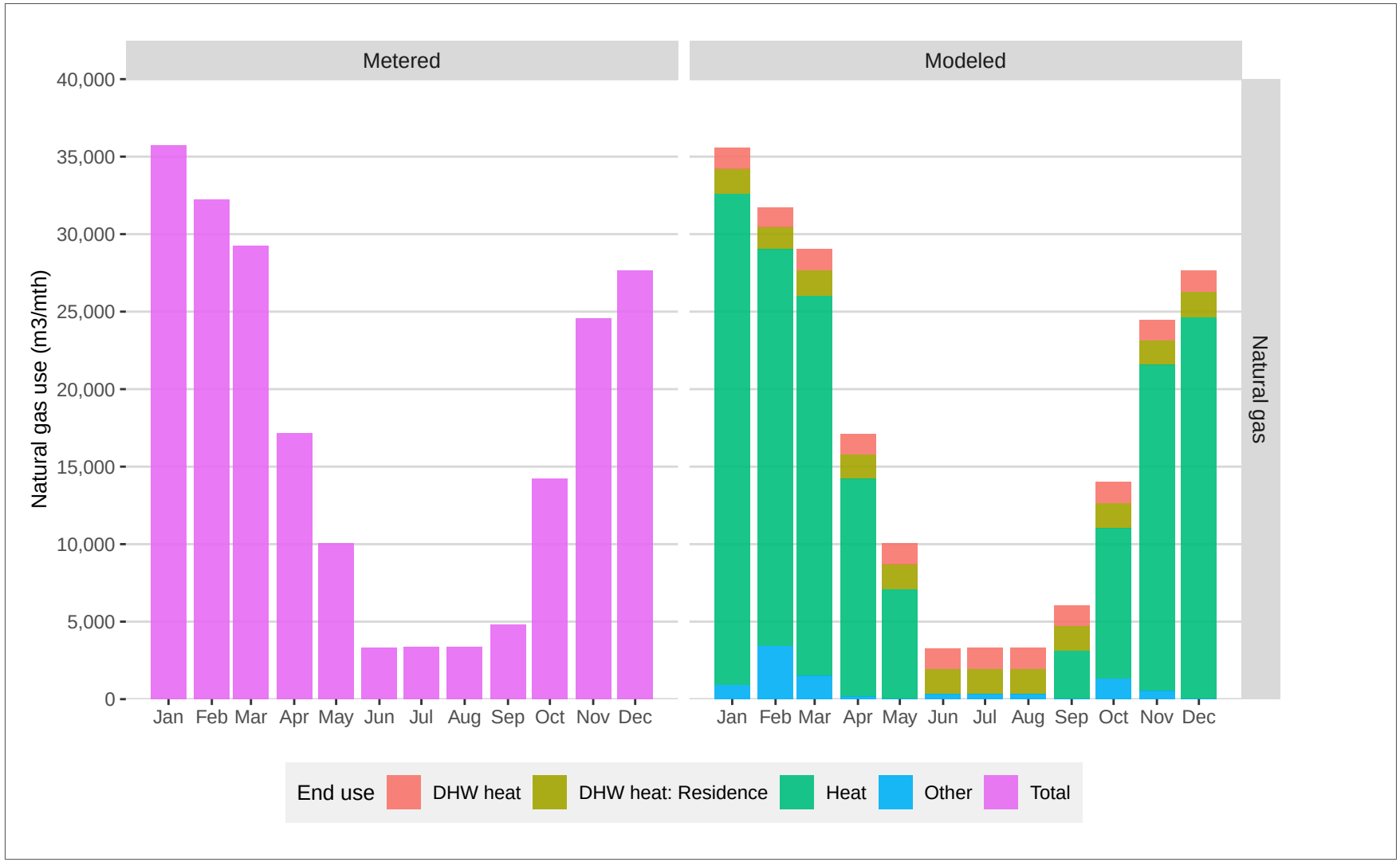


Figure 44: Natural gas calibration analysis (metered vs modeled utility use)

Statistical calibration analysis

ASHRAE Guideline 14 (American Society of Heating, Refrigerating and Air-Conditioning Engineers) suggests maximum allowable values for the mean bias error, and the root mean bias error, which are defined as follows with respect to energy model calibration.

- **Mean bias error (MBE)**. The average monthly error between modeled and metered utility use as a percentage of the mean monthly metered utility use. This metric indicates the ability of the model to accurately predict yearly utility use, despite month-to-month errors, by capturing the direction of all month-to-month errors.
- **Root mean square error (RMBE)**. The square root of the sum of all squared monthly errors as a percentage of the mean monthly metered utility use. This metric indicates the ability of the model to accurately predict month-specific utility use.

Statistical calibration analysis results are summarized in Table 12.

Table 12: Statistical calibration analysis summary

Utility	Description	Unit	ASHRAE 14	Model	Pass/Fail
Electricity	Mean bias error	[%]	< +/- 5	-0.0	Pass
	Root mean square error	[%]	< 15	0.1	Pass
Natural gas	Mean bias error	[%]	< +/- 5	0.0	Pass
	Root mean square error	[%]	< 15	2.4	Pass

It should be noted that the root mean square error test suggested by ASHRAE Guideline 14 places undue emphasis on months that have relatively little utility use (e.g. natural gas use in the summer). This is because the root mean square error test is calculated based on relative errors between monthly metered and modeled utility use. Because of this, a small absolute error between metered and modeled utility use for a certain month may also be a large relative error, causing a significant increase in the root mean square error. Practically, though, the ability of the energy model to accurately quantify utility use overall has little dependence on its ability to quantify utility use in months with relatively little metered use, because overall utility use is more heavily influenced by those months with greater utility use. Therefore, it may not always be suitable for the model to pass the root mean square error test, provided that it reasonably captures utility use in the months of greater use.

4.4 End use analysis

Electricity

The yearly electricity end use breakdown calculated by the calibrated energy model is plotted in Figure 45. See Table 10 for end use definitions.

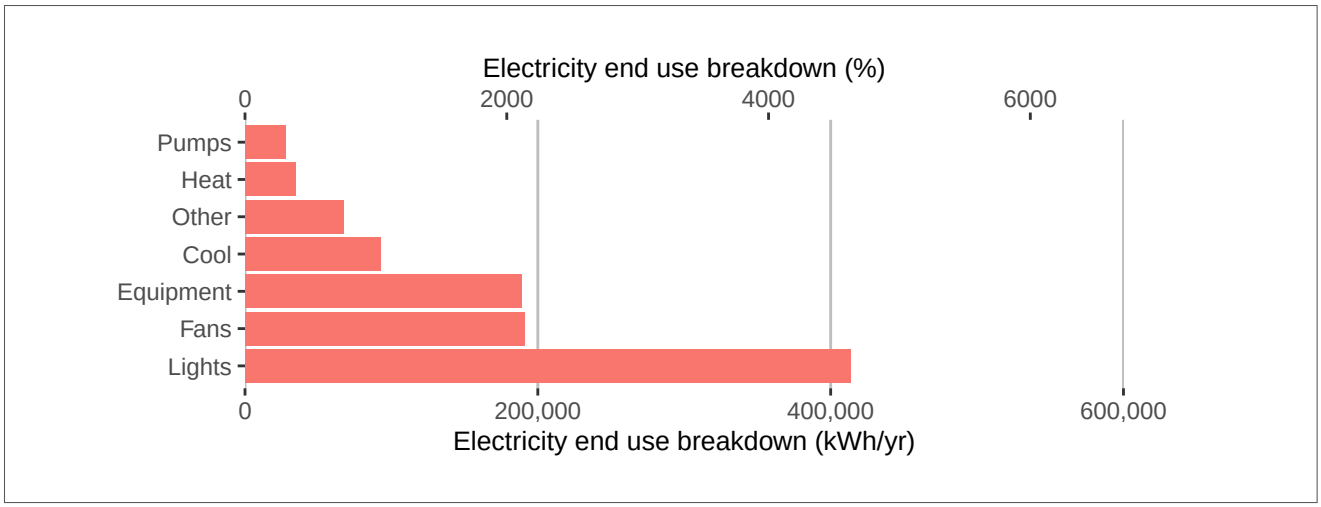


Figure 45: Electricity end use breakdown (calculated by calibrated energy model)

Natural gas

The yearly natural gas end use breakdown calculated by the calibrated energy model is plotted in Figure 46. See Table 10 for end use definitions.

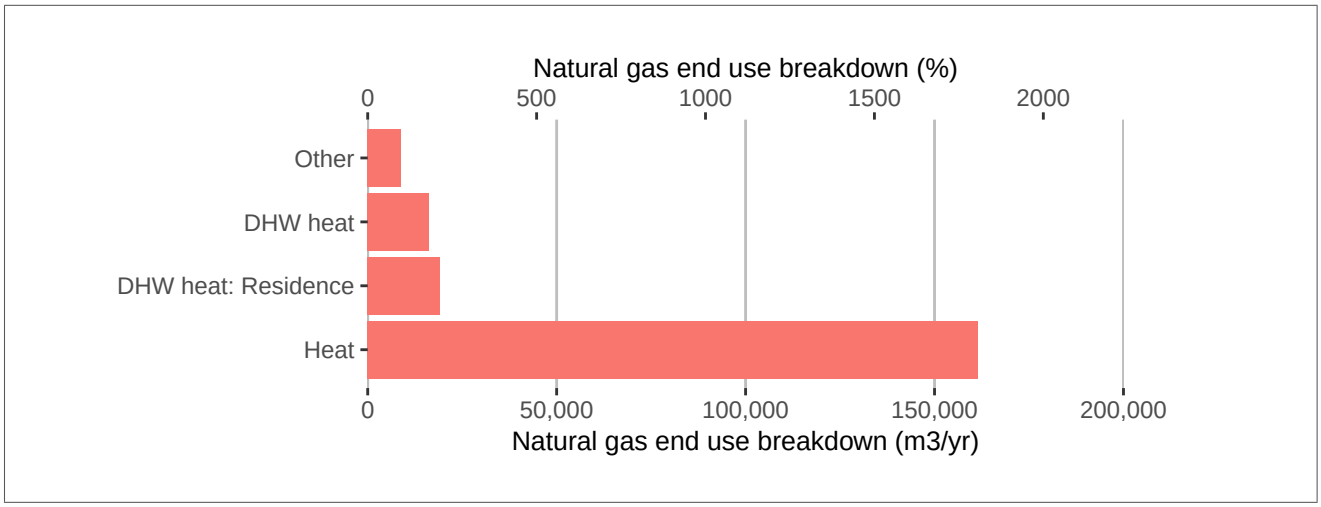


Figure 46: Natural gas end use breakdown (calculated by calibrated energy model)

Water

The yearly water end use breakdown calculated by the calibrated energy model is plotted in Figure 47. See Table 10 for end use definitions.

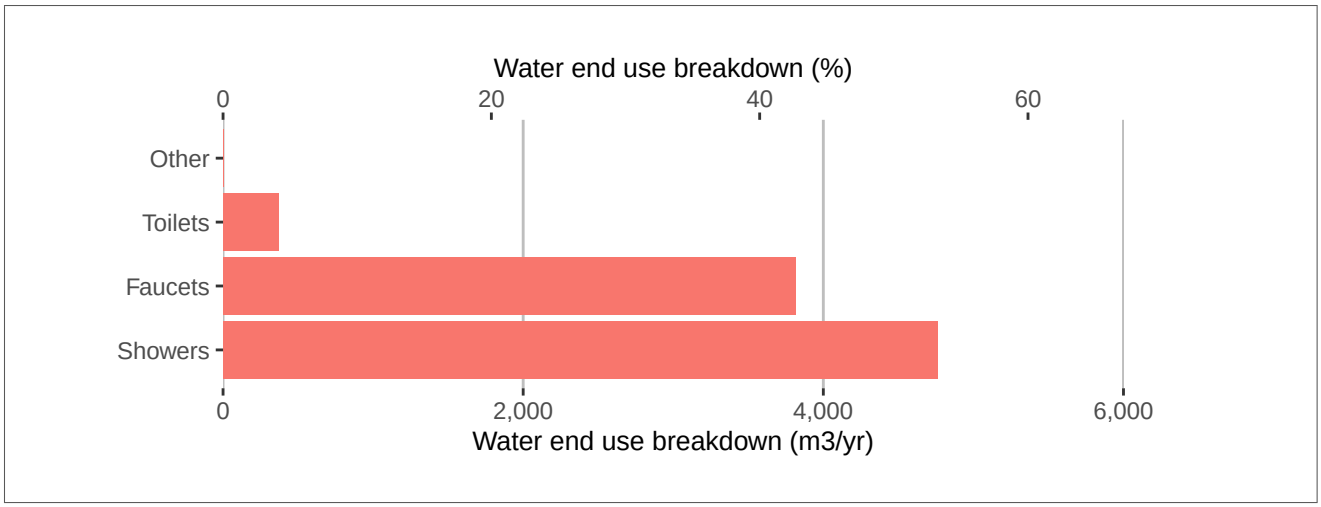


Figure 47: Water end use breakdown (calculated by calibrated energy model)

5 MEASURE ANALYSIS

5.1 Measure analysis methodology

The measure analysis was completed according to the following methodology.

1. **Measure identification and triaging**. Measures that could be implemented to help achieve University of Waterloo's goals were identified based on the findings documented in Sections 2 and 3. Identified measures were triaged by labeling each one as either 'Analyzed' or 'Not analyzed'. Results are summarized in Section 5.3.
2. **Measure analysis**. For each 'Analyzed' measure, the analysis completed for that measure was summarized in a dedicated sub-section named after that measure (see Sections 5.4 through 5.18). In each sub-section, the following was documented.
    - *Measure description*. The relevant existing condition was summarized, an opportunity for improving the stated existing condition was described, and the intended utility-savings mechanism associated with the opportunity was described.
    - *Design description*. A design description was provided, including a written description of the design concept considered in analyzing the measure and the associated project cost estimate.
    - *Utility analysis*. A utility analysis was completed using the calibrated energy model introduced in Section 4. Measure-specific assumptions applied in calculating the impacts on utility use were provided for each measure. For each measure, the expected GHG emissions, utility costs and financial incentives associated with implementing the measure were calculated based on utility use, using the assumptions outlined in Section 5.2. A life cycle cost analysis was completed, applying the assumptions summarized in Tables 8 and 15 according to the following methodology.
        (a) The life cycle cost for each measure (and scenario in Section 6) was calculated based on the assumed implementation year for each measure (for the individual measure analysis of Section 5, each measure was assumed to be implemented in 2025); for the scenario analysis of Section 6, each measure within each scenario was assumed to be implemented in the year indicated by the measure implementation timeline for that scenario). The life cycle cost for each measure and scenario was calculated as the sum of the following future financial cost expenditures, discounted back to present value using the discount rate from Table 15, over the evaluation period of present to 2050.
        (b) Project costs: The future value of project costs was calculated based on the project cost estimate of each measure, inflated to future value associated with the assumed implementation year using the general inflation rate from Table 15. In the life cycle cost calculation, the project cost was amortized over the expected life of the measure such that the yearly present value is constant over every year of the expected life of the measure. This results in the net present value of the project cost being equal to what it would be if the owner was to pay for it via lump sum in the implementation year for that measure.
        (c) Replacement costs: The future value of replacement costs was calculated assuming that a financial cost was incurred to replace equipment associated with each measure at the end of the expected life of that measure equal to 50% of the initial project cost, inflated to future value associated with the estimated time of replacement using the general inflation rate from Table 15. The same amortization approach as for project costs was used.
        (d) Utility costs: The future value of yearly utility costs of the entire facility was accounted for in the life cycle cost calculation for each measure and scenario. The future value of yearly utility costs was calculated by applying the future utility cost rates from Table 13 to the utility use of the entire facility for that year as predicted by the calibrated energy model for each measure and scenario.
3. **Measure analysis summary**. Measure analysis results for all measures are summarized in table format in Section 5.19.

5.2 Measure analysis assumptions

Assumptions general to all measures are as follows.

- GHG emissions factor assumptions are summarized in Table 7, in Section 3.2.
- Utility cost rate assumptions applied to quantify yearly utility cost impacts relative to the baseline are summarized in Table 8, in Section 3.2. Utility cost rate future assumptions applied in the life cycle analysis for each measure are summarized in Table 13. Note that throughout this Conrad Grebel Residence Envelope and Energy Study the Federal Carbon Charge is treated separately with respect to associated fuels (rather than being accounted for within the rates of the applicable fuels, the federal carbon charge line item is calculated separately based on the estimated yearly GHG emissions for that fuel). As such, all other utility cost rates exclude the federal carbon charge.

Table 13: Utility cost rate future assumptions

Year	Class B HOEP	Class B GA	Class B regulatory	Class B Delivery	Natural gas	Water	Federal carbon charge	Carbon offsets
-	[$/kWh]	[$/kWh]	[$/kWh]	[$/kW]	[$/m3]	[$/m3]	[$/tCO2e]	[$/tCO2e]
2019	0.02	0.0735	0.0057	12.12	0.26	4.48	20	24
2020	0.02	0.0735	0.0057	12.12	0.26	4.48	30	24
2021	0.02	0.0735	0.0057	12.12	0.26	4.48	40	24
2022	0.02	0.0735	0.0057	12.12	0.26	4.48	50	24
2023	0.0204	0.075	0.0058	12.36	0.2652	4.57	65	24.48
2024	0.0208	0.0765	0.0059	12.61	0.2705	4.661	80	24.97
2025	0.0212	0.078	0.006	12.86	0.2759	4.754	95	25.47
2026	0.0216	0.0796	0.0061	13.12	0.2814	4.849	110	25.98
2027	0.022	0.0812	0.0062	13.38	0.287	4.946	125	26.5
2028	0.0224	0.0828	0.0063	13.65	0.2927	5.045	140	27.03
2029	0.0228	0.0845	0.0064	13.92	0.2986	5.146	155	27.57
2030	0.0233	0.0862	0.0065	14.2	0.3046	5.249	170	28.12
2031	0.0238	0.0879	0.0066	14.49	0.3107	5.354	170	28.68
2032	0.0243	0.0897	0.0067	14.78	0.3169	5.461	170	29.25
2033	0.0248	0.0915	0.0068	15.07	0.3232	5.57	170	29.84
2034	0.0253	0.0933	0.0069	15.37	0.3297	5.682	170	30.44
2035	0.0258	0.0952	0.007	15.68	0.3363	5.795	170	31.05
2036	0.0263	0.0971	0.0071	15.99	0.343	5.911	170	31.67
2037	0.0268	0.099	0.0072	16.31	0.3499	6.029	170	32.3
2038	0.0273	0.101	0.0073	16.64	0.3569	6.15	170	32.95
2039	0.0278	0.103	0.0074	16.97	0.364	6.273	170	33.61
2040	0.0284	0.1051	0.0075	17.31	0.3713	6.398	170	34.28
2041	0.029	0.1072	0.0077	17.66	0.3787	6.526	170	34.97
2042	0.0296	0.1093	0.0079	18.01	0.3863	6.657	170	35.67
2043	0.0302	0.1115	0.0081	18.37	0.394	6.79	170	36.38
2044	0.0308	0.1137	0.0083	18.74	0.4019	6.926	170	37.11
2045	0.0314	0.116	0.0085	19.11	0.4099	7.064	170	37.85
2046	0.032	0.1183	0.0087	19.5	0.4181	7.206	170	38.61
2047	0.0326	0.1207	0.0089	19.89	0.4265	7.35	170	39.38
2048	0.0333	0.1231	0.0091	20.28	0.435	7.497	170	40.17
2049	0.034	0.1256	0.0093	20.69	0.4437	7.647	170	40.97
2050	0.0347	0.1281	0.0095	21.1	0.4526	7.8	170	41.79

- Financial incentive assumptions are summarized in Table 14.

Table 14: Financial incentive assumptions

Incentive program	Incentive calculation rules

- Life cycle cost analysis assumptions are summarized in Table 15. The general cost inflation rate is used to calculate future cost values of project costs, replacement costs and maintenance costs, as applicable, based on present day estimates. The discount rate is used to discount all future cost values to present value.

Table 15: Life cycle cost analysis assumptions

Description	Unit	Value
General cost inflation	[%]	2.0
Discount rate	[%]	5.2

5.3 Measure identification

Results of the measure identification and triaging process are summarized in Table 16.

Table 16: Measure identification and triaging summary

Measure name	Triage for analysis	Section link
Air source VRF	Analyzed.	Section 5.4
Chapel cooling	Analyzed.	Section 5.5
Domestic hot water air source heat pump	Analyzed.	Section 5.6
LED lighting	Analyzed.	Section 5.7
Low flow water fixtures	Analyzed.	Section 5.8
Residence energy recovery ventilation	Analyzed.	Section 5.9
Wall Upgrade Option 1: New infill wall below windows - brick veneer	Analyzed.	Section 5.10
Wall Upgrade Option 2: New infill wall below windows - fiber cement panel	Analyzed.	Section 5.11
Wall Upgrade Option 3: Overclad existing wall below window and existing exposed concrete beams and columns - fiber cement panel	Analyzed.	Section 5.12
Wall Upgrade Option 4: Overclad existing wall below window and existing exposed concrete beams and columns - EIFS	Analyzed.	Section 5.13
Wall Upgrade Option 5: Retain existing brick below windows, replace insulation	Analyzed.	Section 5.14
Window Upgrade Option 1A: New windows-triple pane	Analyzed.	Section 5.15
Window Upgrade Option 1B: New windows-double pane	Analyzed.	Section 5.16
Window Upgrade Option 2A: New triple pane windows with 4th floor peaks filled in	Analyzed.	Section 5.17
Window Upgrade Option 2B: New double pane windows with 4th floor peaks filled in	Analyzed.	Section 5.18

5.4 Air source VRF

Measure description

Existing condition

Heating in the residence is provided by the gas-fired hydronic system. Cooling is the responsibility of tenants and a limited number of window AC units were observed on site. The model assumes there is no cooling in the residence.

Opportunity

Install an air source VRF system to provide cooling and replace hot water heating in the residence rooms.

Utility-savings mechanism

By converting the heating fuel to electricity, natural gas consumption will be reduced while electricity consumption increases. Overall facility thermal energy demand intensity will be reduced due to efficiency improvement of the heat pump technology over the gas-fired burners, and the lesser GHG intensity of electricity generation compared to that of natural gas combustion will reduce the facility's annual GHG emissions associated with heating. Annual electricity consumption will also be increased by the addition of cooling to the residence.

Design description

Project cost estimate

Table 17: Project cost estimate (Air source VRF)

Line item	Unit	Value
Project cost	[$]	2,777,704
Contingency (10 %)	[$]	277,770
Subtotal (Construction)	[$]	3,055,474
Engineering Design and Field Review (7 %)	[$]	213,883
PM, CM, Commissioning (7 %)	[$]	213,883
Subtotal (Constuction + Design + Management)	[$]	3,483,241
HST (1.76 %)	[$]	61,305
Total	[$]	3,544,546

Utility analysis

Utility analysis methodology

- **Baseline:** Heating to the residence is provided by a gas-fired hydronic system. The boiler is assumed to operate at 85% efficiency. There is assumed to be no cooling to the residence.
- **Proposed:** Heating and cooling are provided by an air source VRF system that is assumed to operate at heating and cooling COPs of 3 and 4, respectively. Electric resistance backup heating is enabled at -15C.

Utility analysis results

Table 18: Analysis results summary

Category	Description	Unit	Baseline	Proposed	Reduction	Reduction (%)
Utility use	Electricity use	[kWh/yr]	1,014,245	1,108,038	-93,793	-9.2
	Monthly peak electricity demand (yearly av)	[kWh/hr]	185	222	-37	-20.1
	Natural gas use	[m3/yr]	205,678	182,812	22,867	11.1
	Water use	[m3/yr]	8,940	8,940	0	0.0
GHG emissions	Electricity GHGs	[tCO2e/yr]	51	55	-4	-7.8
	Natural gas GHGs	[tCO2e/yr]	391	347	44	11.3
	Carbon offsets GHGs	[tCO2e/yr]	0	0	0	-
	Total GHGs	[tCO2e/yr]	442	402	40	9.0
Utility cost	Electricity utility cost	[$/yr]	127,549	142,276	-14,727	-11.5
	Natural gas utility cost	[$/yr]	53,476	47,531	5,945	11.1
	Federal carbon charge	[$/yr]	19,550	17,350	2,200	11.3
	Carbon offsets utility cost	[$/yr]	0	0	0	-
	Water utility cost	[$/yr]	40,050	40,050	0	0.0
	Total utility cost	[$/yr]	240,625	247,207	-6,582	-2.7
Financial	Project cost	[$]	0	3,544,546	-	-
	Life cycle cost	[$]	6,350,514	9,884,073	-	-
	Project cost per GHG reduction	[$yr/tCO2e]	-	88,614	-	-
	Life cycle cost per cumulative GHG reduction	[$/tCO2e]	-	9,504	-	-

5.5 Chapel cooling

Measure description

Existing condition

There is currently no ventilation or cooling in the chapel.

Opportunity

Add a semi-custom AHU to provide cooling and replace hot water heating in the chapel.

Utility-savings mechanism

This measure will increase energy consumption as there is currently no ventilation or cooling in the chapel.

Design description

Project cost estimate

Table 19: Project cost estimate (Chapel cooling)

Line item	Unit	Value
Project cost	[$]	422,266
Contingency (10 %)	[$]	42,227
Subtotal (Construction)	[$]	464,493
Engineering Design and Field Review (7 %)	[$]	32,514
PM, CM, Commissioning (7 %)	[$]	32,514
Subtotal (Constuction + Design + Management)	[$]	529,522
HST (1.76 %)	[$]	9,320
Total	[$]	538,841

Utility analysis

Utility analysis methodology

- **Baseline:** There is no ventilation or cooling in the chapel.
- **Proposed:** Ventilation is provided by an ERV, continuously supplying 1200 CFM to the space. The supply and exhaust fans draw 1 kW of electrical power in total. The primary heat source is the 3.8 kW preheat coil in the ERV, with supplemental heating provided by the hydronic loop, which remains as gas-fired. Cooling is provided by a spilt AC unit.

Utility analysis results

Table 20: Analysis results summary

Category	Description	Unit	Baseline	Proposed	Reduction	Reduction (%)
Utility use	Electricity use	[kWh/yr]	1,014,245	1,045,733	-31,488	-3.1
	Monthly peak electricity demand (yearly av)	[kWh/hr]	185	189	-4	-2.0
	Natural gas use	[m3/yr]	205,678	208,765	-3,086	-1.5
	Water use	[m3/yr]	8,940	8,940	0	0.0
GHG emissions	Electricity GHGs	[tCO2e/yr]	51	52	-1	-2.0
	Natural gas GHGs	[tCO2e/yr]	391	396	-5	-1.3
	Carbon offsets GHGs	[tCO2e/yr]	0	0	0	-
	Total GHGs	[tCO2e/yr]	442	448	-6	-1.4
Utility cost	Electricity utility cost	[$/yr]	127,549	131,204	-3,655	-2.9
	Natural gas utility cost	[$/yr]	53,476	54,279	-802	-1.5
	Federal carbon charge	[$/yr]	19,550	19,800	-250	-1.3
	Carbon offsets utility cost	[$/yr]	0	0	0	-
	Water utility cost	[$/yr]	40,050	40,050	0	0.0
	Total utility cost	[$/yr]	240,625	245,332	-4,708	-2.0
Financial	Project cost	[$]	0	538,841	-	-
	Life cycle cost	[$]	6,350,514	6,972,103	-	-
	Project cost per GHG reduction	[$yr/tCO2e]	-	-89,807	-	-
	Life cycle cost per cumulative GHG reduction	[$/tCO2e]	-	-44,693	-	-

5.6 Domestic hot water air source heat pump

Measure description

Existing condition

DHW is provided by gas-fired DHW tanks.

Opportunity

Replace gas-fired equipment with DHW air source heat pumps.

Utility-savings mechanism

By converting the heating fuel to electricity, natural gas consumption will be reduced while electricity consumption increases. Overall facility energy intensity will be reduced due to efficiency improvement of the heat pump technology over the gas-fired burners, and the lesser GHG intensity of electricity generation compared to that of natural gas combustion will reduce the facility's annual GHG emissions.

Design description

Project cost estimate

Table 21: Project cost estimate (Domestic hot water air source heat pump)

Line item	Unit	Value
Project cost	[$]	101,485
Contingency (10 %)	[$]	10,148
Subtotal (Construction)	[$]	111,634
Engineering Design and Field Review (7 %)	[$]	7,814
PM, CM, Commissioning (7 %)	[$]	7,814
Subtotal (Constuction + Design + Management)	[$]	127,262
HST (1.76 %)	[$]	2,240
Total	[$]	129,502

Utility analysis

Utility analysis methodology

- **Baseline:** DHW heating is provided by a gas-fired DHW tank assumed to operate at 80% efficiency.
- **Proposed:** DHW heating is provided by an air source heat pump assumed to operate at an average COP of 3.5.

Utility analysis results

Table 22: Analysis results summary

Category	Description	Unit	Baseline	Proposed	Reduction	Reduction (%)
Utility use	Electricity use	[kWh/yr]	1,014,245	1,060,415	-46,170	-4.6
	Monthly peak electricity demand (yearly av)	[kWh/hr]	185	190	-5	-2.8
	Natural gas use	[m3/yr]	205,678	186,544	19,134	9.3
	Water use	[m3/yr]	8,940	8,940	0	0.0
GHG emissions	Electricity GHGs	[tCO2e/yr]	51	53	-2	-3.9
	Natural gas GHGs	[tCO2e/yr]	391	354	37	9.5
	Carbon offsets GHGs	[tCO2e/yr]	0	0	0	-
	Total GHGs	[tCO2e/yr]	442	407	35	7.9
Utility cost	Electricity utility cost	[$/yr]	127,549	132,896	-5,347	-4.2
	Natural gas utility cost	[$/yr]	53,476	48,501	4,975	9.3
	Federal carbon charge	[$/yr]	19,550	17,700	1,850	9.5
	Carbon offsets utility cost	[$/yr]	0	0	0	-
	Water utility cost	[$/yr]	40,050	40,050	0	0.0
	Total utility cost	[$/yr]	240,625	239,147	1,478	0.6
Financial	Project cost	[$]	0	129,502	-	-
	Life cycle cost	[$]	6,350,514	6,404,118	-	-
	Project cost per GHG reduction	[$yr/tCO2e]	-	3,700	-	-
	Life cycle cost per cumulative GHG reduction	[$/tCO2e]	-	7,037	-	-

5.7 LED lighting

Measure description

Existing condition

Lighting in the residence is provided by various fluorescent fixtures.

Opportunity

Replace all lighting with LED.

Utility-savings mechanism

As a result of the higher efficiency LED bulbs, the facility's lighting power density and annual electricity consumption will be reduced.

Design description

Project cost estimate

Utility analysis

Utility analysis methodology

- **Baseline:** Lighting power density is assumed to be 8 W/m2.
- **Proposed:** Lighting power density is assumed to be 5 W/m2.

Utility analysis results

Table 23: Analysis results summary

Category	Description	Unit	Baseline	Proposed	Reduction	Reduction (%)
Utility use	Electricity use	[kWh/yr]	1,014,245	976,883	37,361	3.7
	Monthly peak electricity demand (yearly av)	[kWh/hr]	185	179	6	3.3
	Natural gas use	[m3/yr]	205,678	205,759	-80	-0.0
	Water use	[m3/yr]	8,940	8,940	0	0.0
GHG emissions	Electricity GHGs	[tCO2e/yr]	51	49	2	3.9
	Natural gas GHGs	[tCO2e/yr]	391	391	0	0.0
	Carbon offsets GHGs	[tCO2e/yr]	0	0	0	-
	Total GHGs	[tCO2e/yr]	442	440	2	0.5
Utility cost	Electricity utility cost	[$/yr]	127,549	122,967	4,582	3.6
	Natural gas utility cost	[$/yr]	53,476	53,497	-21	-0.0
	Federal carbon charge	[$/yr]	19,550	19,550	0	0.0
	Carbon offsets utility cost	[$/yr]	0	0	0	-
	Water utility cost	[$/yr]	40,050	40,050	0	0.0
	Total utility cost	[$/yr]	240,625	236,064	4,561	1.9
Financial	Project cost	[$]	0	-	-	-
	Life cycle cost	[$]	6,350,514	6,267,525	-	-
	Project cost per GHG reduction	[$yr/tCO2e]	-	-	-	-
	Life cycle cost per cumulative GHG reduction	[$/tCO2e]	-	120,529	-	-

5.8 Low flow water fixtures

Measure description

Existing condition

The majority of water fixtures are manually controlled without any flow restrictors.

Opportunity

Install low flow handwashing faucets, shower heads and toilets.

Utility-savings mechanism

Reduced DHW heating energy use by reducing the volume of water used. Note that the effectiveness of this measure is heavily dependent on occupant habits, as these devices can be used improperly or replaced.

Design description

Project cost estimate

Table 24: Project cost estimate (Low flow water fixtures)

Line item	Unit	Value
Project cost	[$]	784,878
Contingency (10 %)	[$]	78,488
Subtotal (Construction)	[$]	863,366
Engineering Design and Field Review (7 %)	[$]	60,436
PM, CM, Commissioning (7 %)	[$]	60,436
Subtotal (Constuction + Design + Management)	[$]	984,237
HST (1.76 %)	[$]	17,323
Total	[$]	1,001,560

-

Utility analysis

Utility analysis methodology

- **Baseline:** Shower and handwashing faucet flow rates are assumed to be 2.05 and 1.89 GPM, respectively.
- **Proposed:** Shower and handwashing faucet flow rates are assumed to be 1.5 and 1 GPM, respectively.

Utility analysis results

Table 25: Analysis results summary

Category	Description	Unit	Baseline	Proposed	Reduction	Reduction (%)
Utility use	Electricity use	[kWh/yr]	1,014,245	1,014,245	0	0
	Monthly peak electricity demand (yearly av)	[kWh/hr]	185	185	0	0
	Natural gas use	[m3/yr]	205,678	199,322	6,357	3
	Water use	[m3/yr]	8,940	7,400	1,540	17
GHG emissions	Electricity GHGs	[tCO2e/yr]	51	51	0	0
	Natural gas GHGs	[tCO2e/yr]	391	379	12	3
	Carbon offsets GHGs	[tCO2e/yr]	0	0	0	-
	Total GHGs	[tCO2e/yr]	442	430	12	3
Utility cost	Electricity utility cost	[$/yr]	127,549	127,549	0	0
	Natural gas utility cost	[$/yr]	53,476	51,824	1,653	3
	Federal carbon charge	[$/yr]	19,550	18,950	600	3
	Carbon offsets utility cost	[$/yr]	0	0	0	-
	Water utility cost	[$/yr]	40,050	33,152	6,898	17
	Total utility cost	[$/yr]	240,625	231,474	9,151	4
Financial	Project cost	[$]	0	1,001,560	-	-
	Life cycle cost	[$]	6,350,514	7,147,549	-	-
	Project cost per GHG reduction	[$yr/tCO2e]	-	83,463	-	-
	Life cycle cost per cumulative GHG reduction	[$/tCO2e]	-	22,909	-	-

5.9 Residence energy recovery ventilation

Measure description

Existing condition

There is currently no ventilation in the residence units.

Opportunity

Install individual ERVs in each of the units.

Utility-savings mechanism

This measure will increase energy consumption as there is currently no ventilation in the residence.

Design description

Project cost estimate

Table 26: Project cost estimate (Residence energy recovery ventilation)

Line item	Unit	Value
Project cost	[$]	439,453
Contingency (10 %)	[$]	43,945
Subtotal (Construction)	[$]	483,398
Engineering Design and Field Review (7 %)	[$]	33,838
PM, CM, Commissioning (7 %)	[$]	33,838
Subtotal (Constuction + Design + Management)	[$]	551,074
HST (1.76 %)	[$]	9,699
Total	[$]	560,773

Utility analysis

Utility analysis methodology

- **Baseline:** There is no ventilation in the residence.
- **Proposed:** Ventilation to each unit is provided by 3.3 W ERVs, continuously supplying 35 CFM to each unit. Sensible and latent effectiveness are assumed to be 0.75 and 0.25, respectively.

Utility analysis results

Table 27: Analysis results summary

Category	Description	Unit	Baseline	Proposed	Reduction	Reduction (%)
Utility use	Electricity use	[kWh/yr]	1,014,245	1,032,787	-18,542	-1.8
	Monthly peak electricity demand (yearly av)	[kWh/hr]	185	194	-9	-4.8
	Natural gas use	[m3/yr]	205,678	210,037	-4,358	-2.1
	Water use	[m3/yr]	8,940	8,940	0	0.0
GHG emissions	Electricity GHGs	[tCO2e/yr]	51	52	-1	-2.0
	Natural gas GHGs	[tCO2e/yr]	391	399	-8	-2.0
	Carbon offsets GHGs	[tCO2e/yr]	0	0	0	-
	Total GHGs	[tCO2e/yr]	442	451	-9	-2.0
Utility cost	Electricity utility cost	[$/yr]	127,549	130,693	-3,144	-2.5
	Natural gas utility cost	[$/yr]	53,476	54,610	-1,133	-2.1
	Federal carbon charge	[$/yr]	19,550	19,950	-400	-2.0
	Carbon offsets utility cost	[$/yr]	0	0	0	-
	Water utility cost	[$/yr]	40,050	40,050	0	0.0
	Total utility cost	[$/yr]	240,625	245,302	-4,677	-1.9
Financial	Project cost	[$]	0	560,773	-	-
	Life cycle cost	[$]	6,350,514	6,995,625	-	-
	Project cost per GHG reduction	[$yr/tCO2e]	-	-62,308	-	-
	Life cycle cost per cumulative GHG reduction	[$/tCO2e]	-	-29,896	-	-

5.10 Wall Upgrade Option 1: New infill wall below windows - brick veneer

Measure description

Existing condition

Wall sections under the residence unit windows are clad with brick exterior. There is uninsulated exposed concrete on the exterior of the residence building between each of the units.

Opportunity

Remove existing assembly. 25mm brick veneer cladding, 25mm air space, 150mm mineral wool insulation, avb / wrb membrane, 16mm gypsum sheathing, 125mm steel stud, 16mm gypsum board finish

Utility-savings mechanism

By installing additional insulation to increase the thermal performance of the envelope, less heat will be lost to the environment. This measure will reduce the amount of natural gas consumed to provide space heating.

Design description

Project cost estimate

Table 28: Project cost estimate (Wall Upgrade Option 1: New infill wall below windows - brick veneer)

Line item	Unit	Value
Project cost	[$]	507,180
Contingency (10 %)	[$]	50,718
Subtotal (Construction)	[$]	557,898
Engineering Design and Field Review (7 %)	[$]	39,053
PM, CM, Commissioning (7 %)	[$]	39,053
Subtotal (Constuction + Design + Management)	[$]	636,004
HST (1.76 %)	[$]	11,194
Total	[$]	647,197

Utility analysis

Utility analysis methodology

- **Baseline:** The average U value for residence walls is assumed to be 1.87 W/m2/K. It should be noted that U value estimates are taken as a weighted average of all exterior wall elements, including brick walls, concrete columns and beams.
- **Proposed:** The average U value for residence walls is assumed to be 1.47 W/m2/K. Assuming a 10% reduction in outdoor air infiltration associated the wall area.

Utility analysis results

Table 29: Analysis results summary

Category	Description	Unit	Baseline	Proposed	Reduction	Reduction (%)
Utility use	Electricity use	[kWh/yr]	1,014,245	1,014,245	0	0
	Monthly peak electricity demand (yearly av)	[kWh/hr]	185	185	0	0
	Natural gas use	[m3/yr]	205,678	204,701	978	0
	Water use	[m3/yr]	8,940	8,940	0	0
GHG emissions	Electricity GHGs	[tCO2e/yr]	51	51	0	0
	Natural gas GHGs	[tCO2e/yr]	391	389	2	1
	Carbon offsets GHGs	[tCO2e/yr]	0	0	0	-
	Total GHGs	[tCO2e/yr]	442	440	2	0
Utility cost	Electricity utility cost	[$/yr]	127,549	127,549	0	0
	Natural gas utility cost	[$/yr]	53,476	53,222	254	0
	Federal carbon charge	[$/yr]	19,550	19,450	100	1
	Carbon offsets utility cost	[$/yr]	0	0	0	-
	Water utility cost	[$/yr]	40,050	40,050	0	0
	Total utility cost	[$/yr]	240,625	240,271	354	0
Financial	Project cost	[$]	0	647,197	-	-
	Life cycle cost	[$]	6,350,514	6,975,096	-	-
	Project cost per GHG reduction	[$yr/tCO2e]	-	323,599	-	-
	Life cycle cost per cumulative GHG reduction	[$/tCO2e]	-	134,137	-	-

5.11 Wall Upgrade Option 2: New infill wall below windows - fiber cement panel

Measure description

Existing condition

Wall sections under the residence unit windows are clad with brick exterior. There is uninsulated exposed concrete on the exterior of the residence building between each of the units.

Opportunity

Remove existing assembly. 8mm fiber cement paneling, 25mm air space, 200mm mineral wool insulation, avb / wrb membrane, 16mm gypsum sheathing, 125mm steel stud, 16mm gypsum board finish

Utility-savings mechanism

By installing additional insulation to increase the thermal performance of the envelope, less heat will be lost to the environment. This measure will reduce the amount of natural gas consumed to provide space heating.

Design description

Project cost estimate

Table 30: Project cost estimate (Wall Upgrade Option 2: New infill wall below windows - fiber cement panel)

Line item	Unit	Value
Project cost	[$]	552,493
Contingency (10 %)	[$]	55,249
Subtotal (Construction)	[$]	607,742
Engineering Design and Field Review (7 %)	[$]	42,542
PM, CM, Commissioning (7 %)	[$]	42,542
Subtotal (Constuction + Design + Management)	[$]	692,826
HST (1.76 %)	[$]	12,194
Total	[$]	705,020

Utility analysis

Utility analysis methodology

- **Baseline:** The average U value for residence walls is assumed to be 1.87 W/m2/K. It should be noted that U value estimates are taken as a weighted average of all exterior wall elements, including brick walls, concrete columns and beams.
- **Proposed:** The average U value for residence walls is assumed to be 1.47 W/m2/K. Assuming a 10% reduction in outdoor air infiltration associated the wall area.

Utility analysis results

Table 31: Analysis results summary

Category	Description	Unit	Baseline	Proposed	Reduction	Reduction (%)
Utility use	Electricity use	[kWh/yr]	1,014,245	1,014,245	0	0
	Monthly peak electricity demand (yearly av)	[kWh/hr]	185	185	0	0
	Natural gas use	[m3/yr]	205,678	204,703	976	0
	Water use	[m3/yr]	8,940	8,940	0	0
GHG emissions	Electricity GHGs	[tCO2e/yr]	51	51	0	0
	Natural gas GHGs	[tCO2e/yr]	391	389	2	1
	Carbon offsets GHGs	[tCO2e/yr]	0	0	0	-
	Total GHGs	[tCO2e/yr]	442	440	2	0
Utility cost	Electricity utility cost	[$/yr]	127,549	127,549	0	0
	Natural gas utility cost	[$/yr]	53,476	53,223	254	0
	Federal carbon charge	[$/yr]	19,550	19,450	100	1
	Carbon offsets utility cost	[$/yr]	0	0	0	-
	Water utility cost	[$/yr]	40,050	40,050	0	0
	Total utility cost	[$/yr]	240,625	240,271	354	0
Financial	Project cost	[$]	0	705,020	-	-
	Life cycle cost	[$]	6,350,514	7,031,696	-	-
	Project cost per GHG reduction	[$yr/tCO2e]	-	352,510	-	-
	Life cycle cost per cumulative GHG reduction	[$/tCO2e]	-	135,225	-	-

5.12 Wall Upgrade Option 3: Overclad existing wall below window and existing exposed concrete beams and columns - fiber cement panel

Measure description

Existing condition

Wall sections under the residence unit windows are clad with brick exterior. There is uninsulated exposed concrete on the exterior of the residence building between each of the units.

Opportunity

Overclad walls under windows with 8mm fiber cement paneling, 25mm air space, 100mm mineral wool insulation, avb/wrb membrane. For columns, overclad exposed concrete structure with 8mm fiber cement paneling, 25mm air space, 50mm rigid insulation. For beams, overclad with 8mm fiber cement paneling, 25mm air space, 100mm mineral wool insulation, avb/wrb membrane.

Utility-savings mechanism

By installing additional insulation to increase the thermal performance of the envelope, less heat will be lost to the environment. This measure will reduce the amount of natural gas consumed to provide space heating.

Design description

Project cost estimate

Table 32: Project cost estimate (Wall Upgrade Option 3: Overclad existing wall below window and existing exposed concrete beams and columns - fiber cement panel)

Line item	Unit	Value
Project cost	[$]	744,641
Contingency (10 %)	[$]	74,464
Subtotal (Construction)	[$]	819,105
Engineering Design and Field Review (7 %)	[$]	57,337
PM, CM, Commissioning (7 %)	[$]	57,337
Subtotal (Constuction + Design + Management)	[$]	933,780
HST (1.76 %)	[$]	16,435
Total	[$]	950,214

Utility analysis

Utility analysis methodology

- **Baseline:** The average U value for residence walls is assumed to be 1.87 W/m2/K. It should be noted that U value estimates are taken as a weighted average of all exterior wall elements, including brick walls, concrete columns and beams.
- **Proposed:** The average U value for residence walls is assumed to be 0.81 W/m2/K. Assuming a 10% reduction in outdoor air infiltration associated the wall area.

Utility analysis results

Table 33: Analysis results summary

Category	Description	Unit	Baseline	Proposed	Reduction	Reduction (%)
Utility use	Electricity use	[kWh/yr]	1,014,245	1,014,245	0	0
	Monthly peak electricity demand (yearly av)	[kWh/hr]	185	185	0	0
	Natural gas use	[m3/yr]	205,678	203,007	2,671	1
	Water use	[m3/yr]	8,940	8,940	0	0
GHG emissions	Electricity GHGs	[tCO2e/yr]	51	51	0	0
	Natural gas GHGs	[tCO2e/yr]	391	386	5	1
	Carbon offsets GHGs	[tCO2e/yr]	0	0	0	-
	Total GHGs	[tCO2e/yr]	442	437	5	1
Utility cost	Electricity utility cost	[$/yr]	127,549	127,549	0	0
	Natural gas utility cost	[$/yr]	53,476	52,782	694	1
	Federal carbon charge	[$/yr]	19,550	19,300	250	1
	Carbon offsets utility cost	[$/yr]	0	0	0	-
	Water utility cost	[$/yr]	40,050	40,050	0	0
	Total utility cost	[$/yr]	240,625	239,680	944	0
Financial	Project cost	[$]	0	950,214	-	-
	Life cycle cost	[$]	6,350,514	7,256,495	-	-
	Project cost per GHG reduction	[$yr/tCO2e]	-	190,043	-	-
	Life cycle cost per cumulative GHG reduction	[$/tCO2e]	-	55,819	-	-

5.13 Wall Upgrade Option 4: Overclad existing wall below window and existing exposed concrete beams and columns - EIFS

Measure description

Existing condition

Wall sections under the residence unit windows are clad with brick exterior. There is uninsulated exposed concrete on the exterior of the residence building between each of the units.

Opportunity

Overclad walls under windows with 100mm mineral wool EIFS and AVB/WRB membrane. For columns, overclad with 50mm mineral wool EIFS. For beams, overclad with 100mm mineral wool EIFS.

Utility-savings mechanism

By installing additional insulation to increase the thermal performance of the envelope, less heat will be lost to the environment. This measure will reduce the amount of natural gas consumed to provide space heating.

Design description

Project cost estimate

Table 34: Project cost estimate (Wall Upgrade Option 4: Overclad existing wall below window and existing exposed concrete beams and columns - EIFS)

Line item	Unit	Value
Project cost	[$]	609,250
Contingency (10 %)	[$]	60,925
Subtotal (Construction)	[$]	670,175
Engineering Design and Field Review (7 %)	[$]	46,912
PM, CM, Commissioning (7 %)	[$]	46,912
Subtotal (Constuction + Design + Management)	[$]	764,000
HST (1.76 %)	[$]	13,446
Total	[$]	777,446

Utility analysis

Utility analysis methodology

- **Baseline:** The average U value for residence walls is assumed to be 1.87 W/m2/K. It should be noted that U value estimates are taken as a weighted average of all exterior wall elements, including brick walls, concrete columns and beams.
- **Proposed:** The average U value for residence walls is assumed to be 0.82 W/m2/K. Assuming a 10% reduction in outdoor air infiltration associated the wall area.

Utility analysis results

Table 35: Analysis results summary

Category	Description	Unit	Baseline	Proposed	Reduction	Reduction (%)
Utility use	Electricity use	[kWh/yr]	1,014,245	1,014,245	0	0
	Monthly peak electricity demand (yearly av)	[kWh/hr]	185	185	0	0
	Natural gas use	[m3/yr]	205,678	203,052	2,627	1
	Water use	[m3/yr]	8,940	8,940	0	0
GHG emissions	Electricity GHGs	[tCO2e/yr]	51	51	0	0
	Natural gas GHGs	[tCO2e/yr]	391	386	5	1
	Carbon offsets GHGs	[tCO2e/yr]	0	0	0	-
	Total GHGs	[tCO2e/yr]	442	437	5	1
Utility cost	Electricity utility cost	[$/yr]	127,549	127,549	0	0
	Natural gas utility cost	[$/yr]	53,476	52,793	683	1
	Federal carbon charge	[$/yr]	19,550	19,300	250	1
	Carbon offsets utility cost	[$/yr]	0	0	0	-
	Water utility cost	[$/yr]	40,050	40,050	0	0
	Total utility cost	[$/yr]	240,625	239,692	933	0
Financial	Project cost	[$]	0	777,446	-	-
	Life cycle cost	[$]	6,350,514	7,087,832	-	-
	Project cost per GHG reduction	[$yr/tCO2e]	-	155,489	-	-
	Life cycle cost per cumulative GHG reduction	[$/tCO2e]	-	54,522	-	-

5.14 Wall Upgrade Option 5: Retain existing brick below windows, replace insulation

Measure description

Existing condition

Wall sections under the residence unit windows are clad with brick exterior. There is uninsulated exposed concrete on the exterior of the residence building between each of the units.

Opportunity

Remove existing assembly on inside of double wythe brick. Replace with 75mm spray foam insulation, 64mm steel stud offset 50mm from face of brick, 16mm gypsum board finish

Utility-savings mechanism

By installing additional insulation to increase the thermal performance of the envelope, less heat will be lost to the environment. This measure will reduce the amount of natural gas consumed to provide space heating.

Design description

Project cost estimate

Table 36: Project cost estimate (Wall Upgrade Option 5: Retain existing brick below windows, replace insulation)

Line item	Unit	Value
Project cost	[$]	263,156
Contingency (10 %)	[$]	26,316
Subtotal (Construction)	[$]	289,472
Engineering Design and Field Review (7 %)	[$]	20,263
PM, CM, Commissioning (7 %)	[$]	20,263
Subtotal (Constuction + Design + Management)	[$]	329,998
HST (1.76 %)	[$]	5,808
Total	[$]	335,806

Utility analysis

Utility analysis methodology

- **Baseline:** The average U value for residence walls is assumed to be 1.87 W/m2/K. It should be noted that U value estimates are taken as a weighted average of all exterior wall elements, including brick walls, concrete columns and beams.
- **Proposed:** The average U value for residence walls is assumed to be 1.55 W/m2/K. Assuming a 10% reduction in outdoor air infiltration associated the wall area.

Utility analysis results

Table 37: Analysis results summary

Category	Description	Unit	Baseline	Proposed	Reduction	Reduction (%)
Utility use	Electricity use	[kWh/yr]	1,014,245	1,014,245	0	0
	Monthly peak electricity demand (yearly av)	[kWh/hr]	185	185	0	0
	Natural gas use	[m3/yr]	205,678	204,838	840	0
	Water use	[m3/yr]	8,940	8,940	0	0
GHG emissions	Electricity GHGs	[tCO2e/yr]	51	51	0	0
	Natural gas GHGs	[tCO2e/yr]	391	389	2	1
	Carbon offsets GHGs	[tCO2e/yr]	0	0	0	-
	Total GHGs	[tCO2e/yr]	442	440	2	0
Utility cost	Electricity utility cost	[$/yr]	127,549	127,549	0	0
	Natural gas utility cost	[$/yr]	53,476	53,258	218	0
	Federal carbon charge	[$/yr]	19,550	19,450	100	1
	Carbon offsets utility cost	[$/yr]	0	0	0	-
	Water utility cost	[$/yr]	40,050	40,050	0	0
	Total utility cost	[$/yr]	240,625	240,306	318	0
Financial	Project cost	[$]	0	335,806	-	-
	Life cycle cost	[$]	6,350,514	6,671,614	-	-
	Project cost per GHG reduction	[$yr/tCO2e]	-	167,903	-	-
	Life cycle cost per cumulative GHG reduction	[$/tCO2e]	-	128,300	-	-

5.15 Window Upgrade Option 1A: New windows-triple pane

Measure description

Existing condition

Windows consist of both fixed and operable, and are primarily double pane and aluminum framed.

Opportunity

Replace windows with the following:

- Triple glazed high performance aluminum frame windows.

Utility-savings mechanism

Upgrading to windows with higher R value will reduce the amount of heat loss from the facility, thus reducing the amount of natural gas required to provide space heating.

Design description

Project cost estimate

Table 38: Project cost estimate (Window Upgrade Option 1A: New windows-triple pane)

Line item	Unit	Value
Project cost	[$]	1,145,995
Contingency (10 %)	[$]	114,600
Subtotal (Construction)	[$]	1,260,595
Engineering Design and Field Review (7 %)	[$]	88,242
PM, CM, Commissioning (7 %)	[$]	88,242
Subtotal (Constuction + Design + Management)	[$]	1,437,078
HST (1.76 %)	[$]	25,293
Total	[$]	1,462,370

Utility analysis

Utility analysis methodology

- **Baseline:** The average U value for residence windows is assumed to be 4.56 W/m2/K.
- **Proposed:** The target average U value for the residence window area is assumed to be 1.36 W/m2/K. Infiltration associated with window area is assumed to decrease by 15%.

Utility analysis results

Table 39: Analysis results summary

Category	Description	Unit	Baseline	Proposed	Reduction	Reduction (%)
Utility use	Electricity use	[kWh/yr]	1,014,245	1,014,245	0	0
	Monthly peak electricity demand (yearly av)	[kWh/hr]	185	185	0	0
	Natural gas use	[m3/yr]	205,678	202,878	2,800	1
	Water use	[m3/yr]	8,940	8,940	0	0
GHG emissions	Electricity GHGs	[tCO2e/yr]	51	51	0	0
	Natural gas GHGs	[tCO2e/yr]	391	385	6	2
	Carbon offsets GHGs	[tCO2e/yr]	0	0	0	-
	Total GHGs	[tCO2e/yr]	442	436	6	1
Utility cost	Electricity utility cost	[$/yr]	127,549	127,549	0	0
	Natural gas utility cost	[$/yr]	53,476	52,748	728	1
	Federal carbon charge	[$/yr]	19,550	19,250	300	2
	Carbon offsets utility cost	[$/yr]	0	0	0	-
	Water utility cost	[$/yr]	40,050	40,050	0	0
	Total utility cost	[$/yr]	240,625	239,597	1,028	0
Financial	Project cost	[$]	0	1,462,370	-	-
	Life cycle cost	[$]	6,350,514	7,756,510	-	-
	Project cost per GHG reduction	[$yr/tCO2e]	-	243,728	-	-
	Life cycle cost per cumulative GHG reduction	[$/tCO2e]	-	49,721	-	-

5.16 Window Upgrade Option 1B: New windows-double pane

Measure description

Existing condition

Windows consist of both fixed and operable, and are primarily double pane and aluminum framed.

Opportunity

Replace windows with the following:

- Double glazed high performance aluminum frame windows

Utility-savings mechanism

Upgrading to windows with higher R value will reduce the amount of heat loss from the facility, thus reducing the amount of natural gas required to provide space heating.

Design description

Project cost estimate

Table 40: Project cost estimate (Window Upgrade Option 1B: New windows-double pane)

Line item	Unit	Value
Project cost	[$]	1,090,683
Contingency (10 %)	[$]	109,068
Subtotal (Construction)	[$]	1,199,751
Engineering Design and Field Review (7 %)	[$]	83,983
PM, CM, Commissioning (7 %)	[$]	83,983
Subtotal (Constuction + Design + Management)	[$]	1,367,716
HST (1.76 %)	[$]	24,072
Total	[$]	1,391,788

Utility analysis

Utility analysis methodology

- **Baseline:** The average U value for residence windows is assumed to be 4.56 W/m2/K.
- **Proposed:** The target average U value for the residence window area is assumed to be 2.45 W/m2/K. Infiltration associated with window area is assumed to decrease by 15%.

Utility analysis results

Table 41: Analysis results summary

Category	Description	Unit	Baseline	Proposed	Reduction	Reduction (%)
Utility use	Electricity use	[kWh/yr]	1,014,245	1,014,245	0	0
	Monthly peak electricity demand (yearly av)	[kWh/hr]	185	185	0	0
	Natural gas use	[m3/yr]	205,678	204,178	1,501	1
	Water use	[m3/yr]	8,940	8,940	0	0
GHG emissions	Electricity GHGs	[tCO2e/yr]	51	51	0	0
	Natural gas GHGs	[tCO2e/yr]	391	388	3	1
	Carbon offsets GHGs	[tCO2e/yr]	0	0	0	-
	Total GHGs	[tCO2e/yr]	442	439	3	1
Utility cost	Electricity utility cost	[$/yr]	127,549	127,549	0	0
	Natural gas utility cost	[$/yr]	53,476	53,086	390	1
	Federal carbon charge	[$/yr]	19,550	19,400	150	1
	Carbon offsets utility cost	[$/yr]	0	0	0	-
	Water utility cost	[$/yr]	40,050	40,050	0	0
	Total utility cost	[$/yr]	240,625	240,085	540	0
Financial	Project cost	[$]	0	1,391,788	-	-
	Life cycle cost	[$]	6,350,514	7,699,040	-	-
	Project cost per GHG reduction	[$yr/tCO2e]	-	463,929	-	-
	Life cycle cost per cumulative GHG reduction	[$/tCO2e]	-	98,706	-	-

5.17 Window Upgrade Option 2A: New triple pane windows with 4th floor peaks filled in

Measure description

Existing condition

Windows consist of both fixed and operable, and are primarily double pane and aluminum framed.

Opportunity

Replace windows with the following:

- textbfWindows: Triple glazed high performance aluminum frame windows.
- textbfInfill wall at peaks: 3mm aluminum composite panel with 150mm mineral wool insulation, avb, sheathing, stud backup, drywall.

Utility-savings mechanism

Upgrading to windows with higher R value will reduce the amount of heat loss from the facility, thus reducing the amount of natural gas required to provide space heating.

Design description

Project cost estimate

Table 42: Project cost estimate (Window Upgrade Option 2A: New triple pane windows with 4th floor peaks filled in)

Line item	Unit	Value
Project cost	[$]	1,143,613
Contingency (10 %)	[$]	114,361
Subtotal (Construction)	[$]	1,257,974
Engineering Design and Field Review (7 %)	[$]	88,058
PM, CM, Commissioning (7 %)	[$]	88,058
Subtotal (Constuction + Design + Management)	[$]	1,434,091
HST (1.76 %)	[$]	25,240
Total	[$]	1,459,331

Utility analysis

Utility analysis methodology

- **Baseline:** The average U value for residence windows is assumed to be 4.56 W/m2/K.
- **Proposed:** To model the impact of the higher-performing windows and reduced window area, the target average U value for the residence window area is assumed to be 1.17 W/m2/K. This U value is taken as a weighted average between the infilled area (U value of 0.22 W/m2/K) and the new windows (U value of 1.36 W/m2/K). Infiltration associated with window area is assumed to decrease by 15%.

Utility analysis results

Table 43: Analysis results summary

Category	Description	Unit	Baseline	Proposed	Reduction	Reduction (%)
Utility use	Electricity use	[kWh/yr]	1,014,245	1,014,245	0	0
	Monthly peak electricity demand (yearly av)	[kWh/hr]	185	185	0	0
	Natural gas use	[m3/yr]	205,678	202,530	3,148	2
	Water use	[m3/yr]	8,940	8,940	0	0
GHG emissions	Electricity GHGs	[tCO2e/yr]	51	51	0	0
	Natural gas GHGs	[tCO2e/yr]	391	385	6	2
	Carbon offsets GHGs	[tCO2e/yr]	0	0	0	-
	Total GHGs	[tCO2e/yr]	442	436	6	1
Utility cost	Electricity utility cost	[$/yr]	127,549	127,549	0	0
	Natural gas utility cost	[$/yr]	53,476	52,658	818	2
	Federal carbon charge	[$/yr]	19,550	19,250	300	2
	Carbon offsets utility cost	[$/yr]	0	0	0	-
	Water utility cost	[$/yr]	40,050	40,050	0	0
	Total utility cost	[$/yr]	240,625	239,506	1,118	0
Financial	Project cost	[$]	0	1,459,331	-	-
	Life cycle cost	[$]	6,350,514	7,750,430	-	-
	Project cost per GHG reduction	[$yr/tCO2e]	-	243,222	-	-
	Life cycle cost per cumulative GHG reduction	[$/tCO2e]	-	49,682	-	-

5.18 Window Upgrade Option 2B: New double pane windows with 4th floor peaks filled in

Measure description

Existing condition

Windows consist of both fixed and operable, and are primarily double pane and aluminum framed.

Opportunity

Replace windows with the following:

- textbfWindows: Double glazed high performance aluminum frame windows.
- textbfInfill wall at peaks: 3mm aluminum composite panel with 150mm mineral wool insulation, avb, sheathing, stud backup, drywall.

Utility-savings mechanism

Upgrading to windows with higher R value will reduce the amount of heat loss from the facility, thus reducing the amount of natural gas required to provide space heating.

Design description

Project cost estimate

Table 44: Project cost estimate (Window Upgrade Option 2B: New double pane windows with 4th floor peaks filled in)

Line item	Unit	Value
Project cost	[$]	1,096,738
Contingency (10 %)	[$]	109,674
Subtotal (Construction)	[$]	1,206,412
Engineering Design and Field Review (7 %)	[$]	84,449
PM, CM, Commissioning (7 %)	[$]	84,449
Subtotal (Constuction + Design + Management)	[$]	1,375,309
HST (1.76 %)	[$]	24,205
Total	[$]	1,399,515

Utility analysis

Utility analysis methodology

- **Baseline:** The average U value for residence windows is assumed to be 4.56 W/m2/K.
- **Proposed:** To model the impact of the higher-performing windows and reduced window area, the target average U value for the residence window area is assumed to be 2.08 W/m2/K. This U value is taken as a weighted average between the infilled area (U value of 0.22 W/m2/K) and the new windows (U value of 2.45 W/m2/K). Infiltration associated with window area is assumed to decrease by 15%.

Utility analysis results

Table 45: Analysis results summary

Category	Description	Unit	Baseline	Proposed	Reduction	Reduction (%)
Utility use	Electricity use	[kWh/yr]	1,014,245	1,014,245	0	0
	Monthly peak electricity demand (yearly av)	[kWh/hr]	185	185	0	0
	Natural gas use	[m3/yr]	205,678	203,836	1,843	1
	Water use	[m3/yr]	8,940	8,940	0	0
GHG emissions	Electricity GHGs	[tCO2e/yr]	51	51	0	0
	Natural gas GHGs	[tCO2e/yr]	391	387	4	1
	Carbon offsets GHGs	[tCO2e/yr]	0	0	0	-
	Total GHGs	[tCO2e/yr]	442	438	4	1
Utility cost	Electricity utility cost	[$/yr]	127,549	127,549	0	0
	Natural gas utility cost	[$/yr]	53,476	52,997	479	1
	Federal carbon charge	[$/yr]	19,550	19,350	200	1
	Carbon offsets utility cost	[$/yr]	0	0	0	-
	Water utility cost	[$/yr]	40,050	40,050	0	0
	Total utility cost	[$/yr]	240,625	239,946	679	0
Financial	Project cost	[$]	0	1,399,515	-	-
	Life cycle cost	[$]	6,350,514	7,703,547	-	-
	Project cost per GHG reduction	[$yr/tCO2e]	-	349,879	-	-
	Life cycle cost per cumulative GHG reduction	[$/tCO2e]	-	74,073	-	-

5.19 Measure analysis summary

For each analyzed measure, the analysis results are summarized in Table 46.

Table 46: Measure analysis summary

Measure name	Measure life	Electricity use	Electricity use reduction	Monthly peak electricity demand (yearly av)	Electricity demand reduction	Natural gas use	Natural gas use reduction	Water use	Water use reduction	Total GHGs	Total GHG reduction	Total utility cost	Utility cost reduction	Project cost	Life cycle cost	Project cost per GHG reduction	Life cycle cost per cumulative GHG reduction
-	[yr]	[kWh/yr]	[%]	[kWh/hr]	[%]	[m3/yr]	[%]	[m3/yr]	[%]	[tCO2e/yr]	[%]	[$/yr]	[%]	[$]	[$]	[$yr/tCO2e]	[$/tCO2e]
Baseline	25	1,014,245	100.0	185	100.0	205,678	100.0	8,940	100.0	442	100.0	240,625	100.0	0	6,350,514	NaN	Inf
Air source VRF	25	1,108,038	-9.2	222	-20.1	182,812	11.1	8,940	0.0	402	9.0	247,207	-2.7	3,544,546	9,884,073	88,614	9,504
Chapel cooling	25	1,045,733	-3.1	189	-2.0	208,764	-1.5	8,940	0.0	448	-1.4	245,332	-2.0	538,841	6,972,103	-89,807	-44,693
Domestic hot water air source heat pump	25	1,060,415	-4.6	190	-2.8	186,544	9.3	8,940	0.0	407	7.9	239,147	0.6	129,502	6,404,118	3,700	7,037
LED lighting	25	976,883	3.7	179	3.3	205,758	-0.0	8,940	0.0	440	0.5	236,064	1.9	-	6,267,525	-	120,529
Low flow water fixtures	25	1,014,245	0.0	185	0.0	199,322	3.1	7,400	17.2	430	2.7	231,474	3.8	1,001,560	7,147,549	83,463	22,909
Residence energy recovery ventilation	25	1,032,787	-1.8	194	-4.8	210,037	-2.1	8,940	0.0	451	-2.0	245,302	-1.9	560,773	6,995,625	-62,308	-29,896
Wall Upgrade Option 1: New infill wall below windows - brick veneer	25	1,014,245	0.0	185	0.0	204,701	0.5	8,940	0.0	440	0.5	240,271	0.1	647,197	6,975,096	323,599	134,136
Wall Upgrade Option 2: New infill wall below windows - fiber cement panel	25	1,014,245	0.0	185	0.0	204,703	0.5	8,940	0.0	440	0.5	240,271	0.1	705,020	7,031,696	352,510	135,225
Wall Upgrade Option 3: Overclad existing wall below window and existing exposed concrete beams and columns - fiber cement panel	25	1,014,245	0.0	185	0.0	203,007	1.3	8,940	0.0	437	1.1	239,680	0.4	950,214	7,256,495	190,043	55,819
Wall Upgrade Option 4: Overclad existing wall below window and existing exposed concrete beams and columns - EIFS	25	1,014,245	0.0	185	0.0	203,052	1.3	8,940	0.0	437	1.1	239,692	0.4	777,446	7,087,832	155,489	54,522
Wall Upgrade Option 5: Retain existing brick below windows, replace insulation	25	1,014,245	0.0	185	0.0	204,838	0.4	8,940	0.0	440	0.5	240,306	0.1	335,806	6,671,614	167,903	128,300
Window Upgrade Option 1A: New windows-triple pane	25	1,014,245	0.0	185	0.0	202,878	1.4	8,940	0.0	436	1.4	239,597	0.4	1,462,370	7,756,510	243,728	49,721
Window Upgrade Option 1B: New windows-double pane	25	1,014,245	0.0	185	0.0	204,178	0.7	8,940	0.0	439	0.7	240,085	0.2	1,391,788	7,699,040	463,929	98,706
Window Upgrade Option 2A: New triple pane windows with 4th floor peaks filled in	25	1,014,245	0.0	185	0.0	202,530	1.5	8,940	0.0	436	1.4	239,506	0.5	1,459,331	7,750,430	243,222	49,682
Window Upgrade Option 2B: New double pane windows with 4th floor peaks filled in	25	1,014,245	0.0	185	0.0	203,835	0.9	8,940	0.0	438	0.9	239,946	0.3	1,399,515	7,703,547	349,879	74,073
Individual measure totals	-	-	-	-	-	-	-	-	-	-	-	-	-	14,903,909	-	-	-

6 SCENARIO ANALYSIS

6.1 Scenario analysis definitions

Section 6 summarizes the scenario analysis that was completed for Conrad Grebel for this Conrad Grebel Residence Envelope and Energy Study. Certain terms regarding this scenario analysis are defined as follows.

- **Cluster scenario**: A group of one or more measures analyzed in Section 5 assumed to be implemented today. In Section 6, the intent of analyzing a cluster scenario was to understand the impact that the specific group of measures would be expected to have if implemented today, avoiding the need to account for the time at which each measure in the group implemented. Cluster scenarios are hypothetical only (not intended as actionable plans) for the purpose of comparison.

6.2 Scenario analysis methodology

The scenario analysis was completed according to the following methodology.

1. **Scenario analysis assumptions**. General assumptions that were applied throughout the scenario analysis were summarized in Section 6.3.
2. **Cluster scenario development**. All cluster scenarios to be analyzed and their objectives were summarized in Section 6.4. Clusters scenarios were then composed by allocating individual measures analyzed in Section 5 to each applicable cluster based on the objectives of that cluster. The results of the cluster scenario composition were summarized in Section 6.4.
3. **Cluster performance analysis**. Cluster scenario performance analysis was completed for each cluster to quantify the expected performance after implementing all measures within that cluster with respected to project costs, utility use, GHG emissions and utility costs. The cluster performance analysis accounted for interactive effects between all measures within a cluster scenario. The results were summarized in Section 6.5.

6.3 Scenario analysis assumptions

General assumptions that were applied throughout the scenario analysis are summarized as follows.

- **Evaluation period**. The evaluation period over which all scenarios were analyzed is from present until 2050.
- **GHG emissions factor future assumptions**. GHG emissions factor assumptions are summarized in Table 47.

Table 47: GHG emissions factor future assumptions

Year	Electricity	Natural gas	Carbon offsets
-	[gCO2e/kWh]	[gCO2e/m3]	[gCO2e/gCO2e]
2019	50	1899	-1
2020	50	1899	-1
2021	50	1899	-1
2022	50	1899	-1
2023	50	1899	-1
2024	51.3	1899	-1
2025	48	1899	-1
2026	53.1	1899	-1
2027	68.6	1899	-1
2028	67.1	1899	-1
2029	66.3	1899	-1
2030	67.2	1899	-1
2031	71.5	1899	-1
2032	75	1899	-1
2033	70.5	1899	-1
2034	73.5	1899	-1
2035	74.7	1899	-1
2036	76.2	1899	-1
2037	80.3	1899	-1
2038	81.9	1899	-1
2039	87	1899	-1
2040	87.7	1899	-1
2041	92.2	1899	-1
2042	92	1899	-1
2043	92	1899	-1
2044	92	1899	-1
2045	92	1899	-1
2046	92	1899	-1
2047	92	1899	-1
2048	92	1899	-1
2049	92	1899	-1
2050	92	1899	-1

- **Utility cost rate future assumptions**. Utility cost rate assumptions are summarized in Table 13.
- **Life cycle cost analysis assumptions**. Life cycle cost analysis assumptions are summarized in Table 15.

6.4 Cluster scenario development

Cluster scenario identification and objectives

The cluster scenarios that were analyzed and their objectives are summarized in Table 48.

Table 48: Cluster scenario identification and objectives

Cluster scenario	Objectives
Scenario 2	Most basic Scenario of measures. Includes DHW heat pumps.
Scenario 3	Scenario 2 plus low flow water fixtures.
Scenario 4	Scenario 3 plus residence air source VRF, residence ERVS and enhanced wall insulation.
Scenario 5	Scenario 4 plus high-performing windows. This scenario represents the greatest energy savings among the proposed Scenarios.

Cluster scenario composition

Table 49: Cluster composition

Scenario 2	Scenario 3	Scenario 4	Scenario 5
Domestic hot water air source heat pump	Domestic hot water air source heat pump	Air source VRF	Air source VRF
-	Low flow water fixtures	Domestic hot water air source heat pump	Domestic hot water air source heat pump
-	-	Low flow water fixtures	Low flow water fixtures
-	-	Residence energy recovery ventilation	Residence energy recovery ventilation
-	-	Wall Upgrade Option 5: Retain existing brick below windows, replace insulation	Wall Upgrade Option 5: Retain existing brick below windows, replace insulation
-	-	-	Window Upgrade Option 1A: New windows-triple pane

6.5 Cluster performance analysis

Cluster performance analysis summary

Table 50 summarizes the findings from the cluster scenario analysis. Please note that the Baseline life cycle cost includes only utility costs and does not include any capital renewal projects.

Table 50: Cluster performance analysis summary

Scenario	Electricity use	Electricity use reduction	Monthly peak electricity demand (yearly av)	Electricity demand reduction	Natural gas use	Natural gas use reduction	Water use	Water use reduction	Total GHGs	Total GHG reduction	Total utility cost	Utility cost reduction	Project cost	Life cycle cost	Project cost per GHG reduction	Life cycle cost per cumulative GHG reduction
-	[kWh/yr]	[%]	[kWh/hr]	[%]	[m3/yr]	[%]	[m3/yr]	[%]	[tCO2e/yr]	[%]	[$/yr]	[%]	[$]	[$]	[$yr/tCO2e]	[$/tCO2e]
Baseline	1,014,245	100.0	185	100.0	205,678	100.0	8,940	100.0	442	100.0	240,625	100.0	0	6,350,514	NaN	Inf
Scenario 2	1,060,415	-4.6	190	-2.8	186,544	9.3	8,940	0.0	407	7.9	239,147	0.6	129,502	6,404,118	3,700	7,037
Scenario 3	1,045,076	-3.0	189	-1.9	186,544	9.3	7,400	17.2	406	8.1	230,472	4.2	1,131,062	7,193,612	31,418	7,993
Scenario 4	1,151,681	-13.6	231	-24.6	163,677	20.4	7,400	17.2	369	16.5	239,071	0.6	5,572,186	11,462,772	76,331	6,281
Scenario 5	1,143,866	-12.8	228	-22.9	163,677	20.4	7,400	17.2	368	16.7	237,829	1.2	7,034,556	12,816,081	95,062	6,928

Please note that the Baseline life cycle cost includes only utility costs and does not include any capital renewal projects.

Cluster project cost

Figure 48 indicates the total project cost estimated for each cluster by individual measure within each cluster.

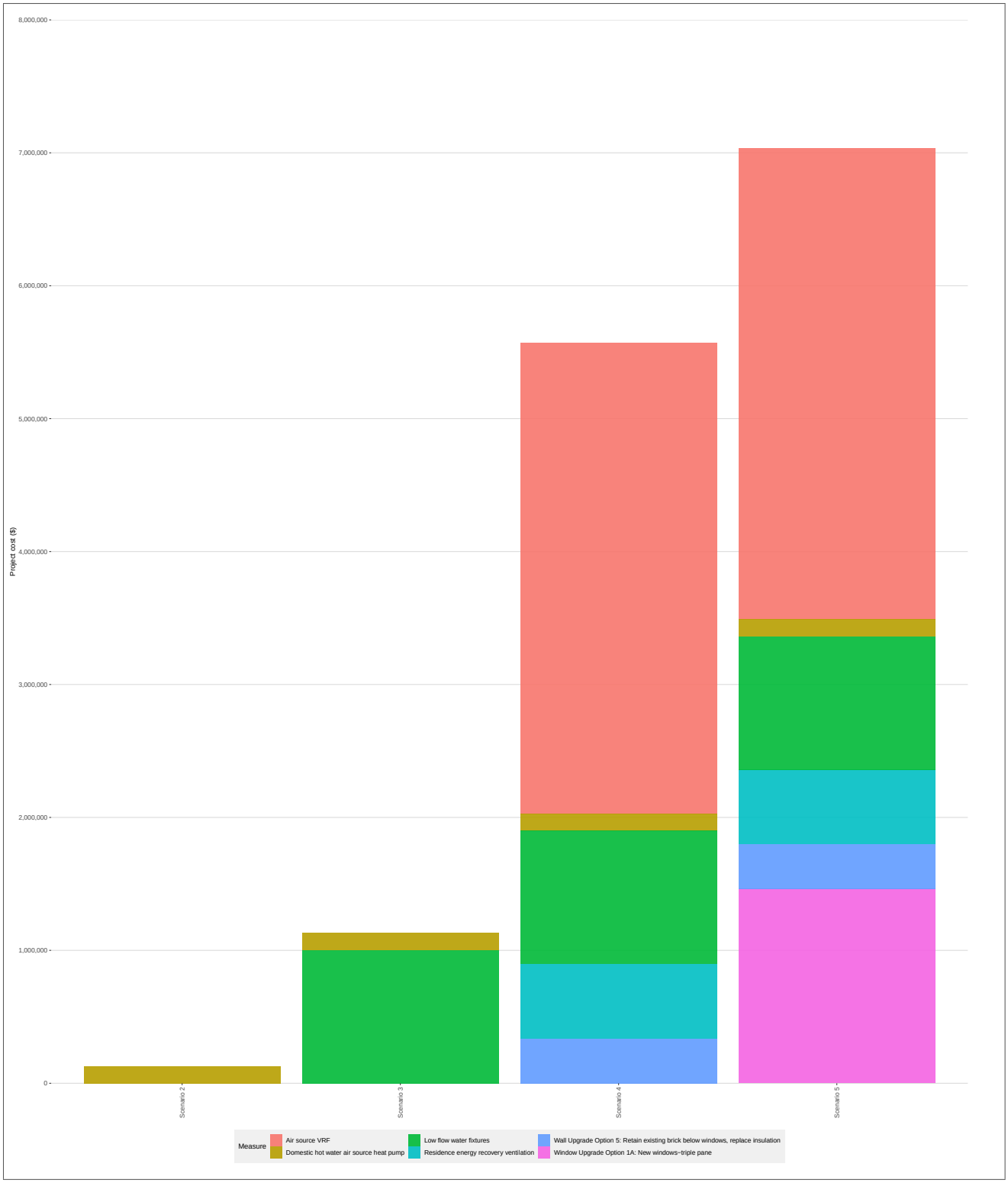


Figure 48: Project cost for each cluster by measure within each cluster

Cluster utility use

Figure 49 indicates the total expected yearly electricity and natural gas utility use by end use for each cluster.

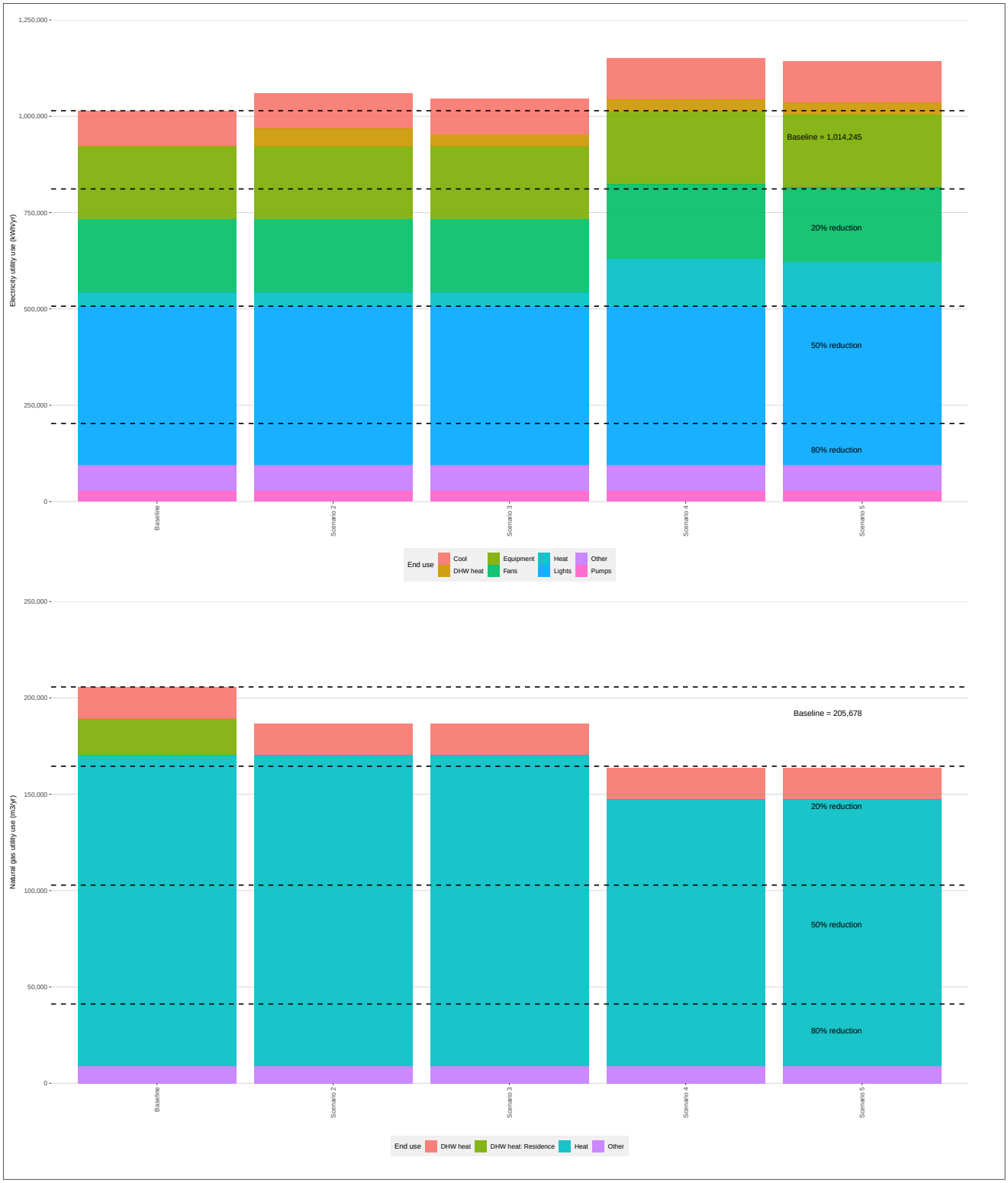


Figure 49: Electricity and natural gas yearly utility use for each cluster by end use

Cluster GHG emissions and utility cost

Figure 50 indicates the total expected yearly GHG emissions and utility cost by end use for each cluster.

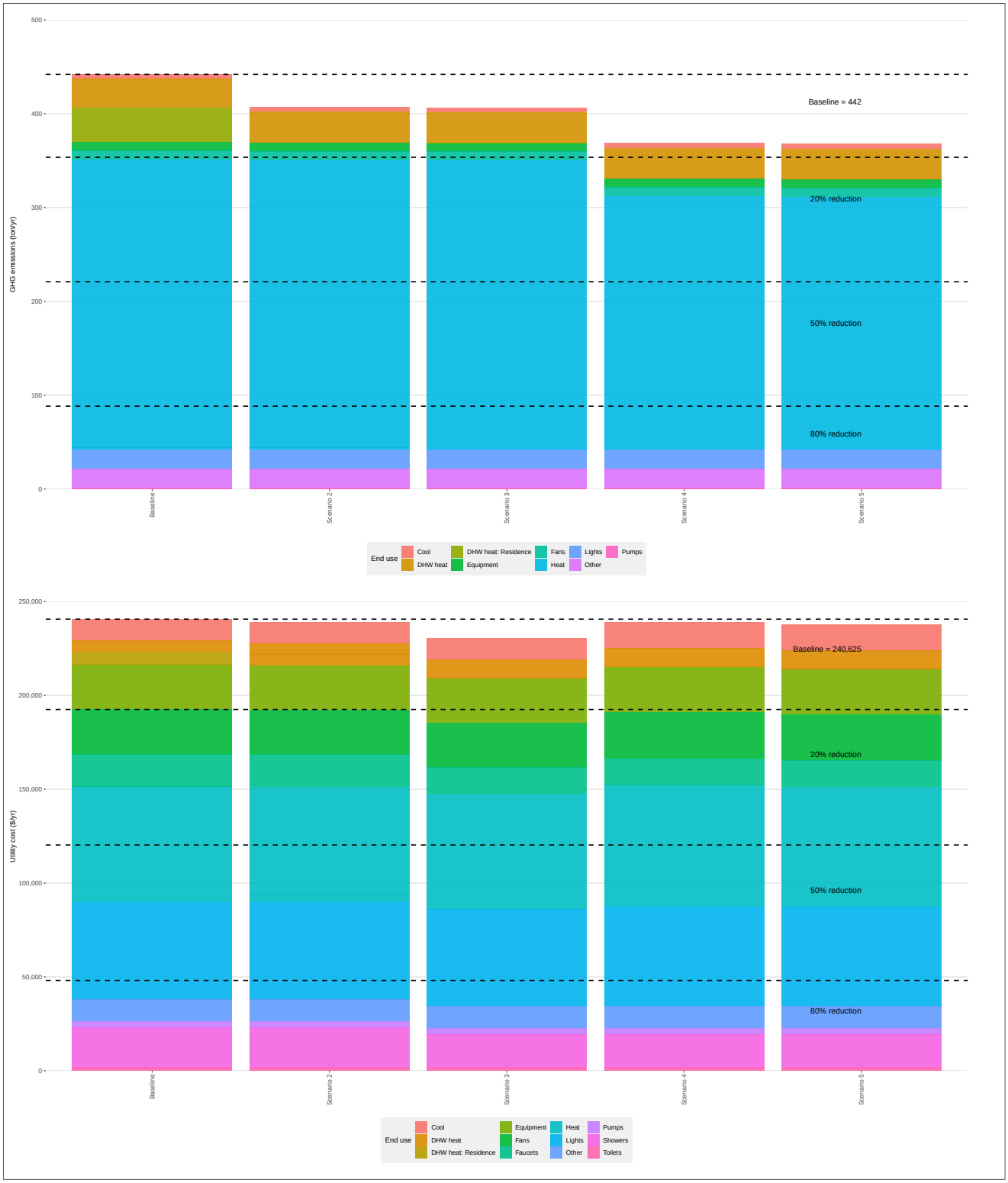


Figure 50: GHG emissions and utility cost yearly for each cluster by end use

7 END

Appendix D: Baseline and Proposed Envelope Values

CG Takeoffs - Residence Block												
location		Surface Area (SQM)										
elevation	floor	windows- stairwell ALUM FRAME & SINGLE GLAZE	windows- dorms ALUM FRAME & DOUBLE GLAZE	doors ALUMINUM FRAME & SINGLE GLAZE	wall-stone panel STONE PANEL & LIGHTWEIGHT BLOCK	wall-louvres ALUMINUM	wall-brick DOUBLE WYTH 4" BRICK AND 1" INSUL	wall-fdn CIP CONC.	wall-stone STONE and MORTAR	column* 9X16" P.C. CONC.	beam* P.C. CONC.	
N	B	-	-	-	-	-	-	-	-	-	-	
	1	-	-	-	-	-	-	-	-	0.52	5.15	
	2	3.45	-	1.35	-	-	30.06	-	-	2.26	5.23	
	3	-	-	2.66	1.38	-	25.24	-	-	2.15	2.62	
S	B	-	-	-	-	-	-	-	-	1.02	4.71	
	1	1.96	-	-	2.57	1.74	46.5	-	-	2.97	5.15	
	2	2.4	-	-	1.3	-	27.77	-	-	2.51	5.23	
	3	2.24	-	-	1.22	-	25.09	-	-	2.42	4.04	
E	B	-	-	-	-	-	-	-	14.87	1.52	-	
	1	30.67	-	-	-	4.01	-	-	46.5	6.96	14.1	
	2	-	110.85	-	-	-	57.24	-	17.43	15.06	31.78	
	3	-	178.54	-	-	-	54.16	-	-	16.41	-	
W	B	1.98	-	2.38	0.48	-	-	-	6.3	0.92	-	
	1	15.03	-	2.63	1.13	-	-	21.61	19.97	5.75	11.6	
	2	28.24	86.79	4	-	-	58.69	-	-	15.68	30.92	
	3	20.26	133.01	-	-	-	71.82	-	-	15.67	-	
TOTAL		**106.23**	**509.19**	**13.02**	**8.08**	**5.75**	**396.57**	**21.61**	**105.07**	**91.82**	**120.53**	
% of BLDG ENV		7.7%	37.0%	0.9%	0.6%	0.4%	28.8%	1.6%	7.6%	6.7%	8.7%	

*columns and beams are thermally-briding exposed structure

**windows and door on north and south elevations assumed to be single glazed. TBC

CG Estimated U-Values	
Element	Existing U-Value (W/(m^2K))
Residence Walls @ Overclad Area	0.906
Residence Stairwell Windows - Single glaze	5.2
Residence Windows - Double glaze*	1.6

estimated values- aluminum frames may affect U-Value

*Double Glazed Dormitory windows have been replaced on a case-by-case basis

	wall-stone panel	wall-louvres	wall-fdn	wall-stone	wall-brick	column*	beam*
	8.08	**5.75**	**21.61**	**105.07**	**396.57**	**91.82**	**120.53**
%	0.010781527	0.007672498	0.028835248	0.140199885	0.529162163	0.122519782	0.160828897

	windows	Peaks	Stairwell	Total window area
	407.352	101.838	106.23	615.42
%	0.66190894	0.165477235	0.172613825	1

6.995731881

	Existing	Option 1	Option 2	Option 3	Option 4	Option 5
Other U	3	3	3	3	3	3
Wall U	0.906	0.159	0.161	0.266	0.265	0.313
Column U	2.681	2.681	2.681	0.516	0.558	2.618
Beam U	3.101	3.101	3.101	0.281	0.334	3.101
Overall U	1.869094338	1.473810202	1.474868527	0.811637738	0.824778338	1.547582429
R	3.037834893	3.852599195	3.849834678	6.995731881	6.884273916	3.66894835

	Existing	Option 1A	Option 1B	Option 2A	Option 2B
Stair U	5.2	1.36	2.45	1.36	2.45
Window U	1.6	1.36	2.45	1.36	2.45
Peak U	1.6	1.36	2.45	0.22	0.22
Overall U'	2.221409769	1.36	2.45	1.171355952	2.080985766
	2.556034496	4.175	2.31755102	4.84737367	2.728514579

CG Proposed U-Values					
Area of Improvement	Proposed Assembly	Proposed U-Value (W/(m^2K))			Reference & Notes
PACKAGE 2 - WINDOWS					
Option 1A: new windows-triple	TRIPLE GLAZED HIGH PRFORMANCE ALUMINUM FRAME WINDOWS	WINDOWS: 0.98			Raynaers ML10Hi (based on modeling from previous project, Sparroway). Aluminum frames may affect U-Value.
Option 1B: New Windows-double	DOUBLE GLAZED HIGH PRFORMANCE ALUMINUM FRAME WINDOWS	WINDOWS: 1.2			Raynaers ML8Hi (based on modeling from previous project, Sparroway). Aluminum frames may affect U-Value.
Option 2A: New Windows with 4th floor "peaks" filled in*	**WINDOWS:** TRIPLE GLAZED HIGH PERFORMANCE ALUMINUM FRAME WINDOWS. **INFILL WALL AT PEAKS:** 3mm ALUMINUM COMPOSITE PANEL WITH 150mm MINERAL WOOL INSULATION, AVB, SHEATHING, STUD BACKUP, DRYWALL	WINDOWS: 0.98		INFILL WALL: 0.22	Raynaers ML10Hi (based on modeling from previous project, Sparroway). Aluminum frames may affect U-Value. Infill wall U-Value calculated atwww.ubakus.de
Option 2B: New windows with 4th floor "peaks" filled in*	**WINDOWS:** DOUBLE GLAZED HIGH PERFORMANCE ALUMINUM FRAME WINDOWS. **INFILL WALL AT PEAKS:** 3mm ALUMINUM COMPOSITE PANEL WITH 150mm MINERAL WOOL INSULATION, AVB, SHEATHING, STUD BACKUP, DRYWALL	WINDOWS: 1.2		INFILL WALL: 0.22	Raynaers ML10Hi (based on modeling from previous project, Sparroway). Aluminum frames may affect U-Value. Infill wall U-Value calculated atwww.ubakus.de
PACKAGE 7 - WALLS					
Walls Option 1: New infill wall below windows - brick veneer	REMOVE EXISTING ASSEMBLY. 25mm BRICK VENEER CLADDING, 25mm AIR SPACE, 150mm MINERAL WOOL INSULATION, AVB / WRB MEMBRANE, 16mm GYPSUM SHEATHING, 125mm STEEL STUD, 16mm GYPSUM BOARD FINISH	WALL: 0.159	COLUMNS (EXISTING): 2.681	BEAMS (EXISTING): 3.101	Exposed concrete columns and beams untreated. Disclude north elevation from work. Source: www.ubakus.de
Walls Option 2: new infill wall below windows - fiber cement panel	REMOVE EXISTING ASSEMBLY. 8mm FIBER CEMENT PANELING, 25mm AIR SPACE, 200mm MINERAL WOOL INSULATION, AVB / WRB MEMBRANE, 16mm GYPSUM SHEATHING, 125mm STEEL STUD, 16mm GYPSUM BOARD FINISH	WALL: 0.161	COLUMNS (EXISTING): 2.681	BEAMS (EXISTING): 3.101	Exposed concrete columns and beams untreated. Source: www.ubakus.de
Walls Option 3: overclad existing wall below window and existing exposed concrete beams and columns - fiber cement panel	OVERCLAD EXPOSED CONCRETE STRUCTURE WITH 8mm FIBER CEMENT PANELING, 25mm AIR SPACE, 50mm RIGID INSULATION. **BEAMS:** OVERCLAD BEAMS WITH 8mm FIBER CEMENT PANELING, 25mm AIR SPACE, 100mm MINERAL WOOL INSULATION, AVB/WRB MEMBRANE.	WALL: 0.266	COLUMNS: 0.516	BEAMS: 0.281	columns and beams proposed to have 75mm insulation on front faces, and 38mm on return faces. 50mm of insulation is noted for simplicity of energy model calculations. Source: www.ubakus.de
Walls Option 4: Walls Option 3: overclad existing wall below window and existing exposed concrete beams and columns - EIFS	OVERCLAD **WALLS** UNDER WINDOWS WITH 100mm MINERAL WOOL EIFS AND AVB/WRB MEMBRANE. **COLUMNS:** OVERCLAD COLUMNS WITH 50mm MINERAL WOOL EIFS. **BEAMS:** OVERCLAD BEAMS WITH 100mm MINERAL WOOL EIFS.	WALL: 0.265	COLUMNS: 0.558	BEAMS: 0.334	MW EIFS R-values from https://www.terraco.com/za/u-values/. Existing assembly U-values from debakus and converted to R-value via https://glowindows.com/calculator/. Calculation done on paper (U=1/RSO+RSI+R1+R2…etc.)
Walls Option 5: retain existing brick below windows, replace insulation	REMOVE EXISTING ASSEMBLY ON INSIDE OF DOUBLE WYTHE BRICK. REPLACE WITH: 75mm SPRAY FOAM INSULATION, 64mm STEEL STUD OFFSET 50mm FROM FACE OF BRICK, 16mm GYPSUM BOARD FINISH	WALL: 0.313	COLUMNS (EXISTING): 2.618	BEAMS (EXISTING): 3.101	Exposed concrete columns and beams untreated. Source: www.ubakus.de

Appendix E: Code Analysis

Ontario Building Code – Part 11: Is This a Basic or Extensive Renovation?

The conclusion based on OBC Part 11 is that the proposed gender-neutral washroom designs are considered an extensive renovation.

Ontario Building Code – Part 3: What Are the Minimum Dimension Requirements to Fit into a Tight Space?

1. Privacy/Sightlines
- As per OBC 3.7.4.2. “Wash fountains in circular or straight trough form are permitted to be provided in lieu of required lavatories provided each 500mm of circumference or trough length is considered to be the equivalent of one lavatory.”

2. Water Closets
- As per OBC 3.7.4.15. “a minimum clearance of 380mm shall be provided in front of a water closet.”

3. Sink/Lavatories
- As per OBC 3.7.4.16. “water closets, urinals, lavatories, showers and bathtubs shall not be visible from the entrances to the room where it contains at least, (a) two water closets, (b) one water closet, (c) one shower stall, or (d) on bathtub.”

4. Doors to Ensuites in Design Options 2a and 2b
- As there was a lack of language in the OBC referring to the width of the door in Part 9, BSN is pulling from OBC 3.8.3.3., which states: “(2) the doorway to at least one bathroom and to each bedroom at the same level as such bathroom within a suite of residential occupancy shall have, when the door is in the open position, a clear width of not less than, (a) 760mm where the door is served by a corridor or space not less than 1060mm wide”.
- As the corridor serving the gender-neutral ensuites is greater than 1060mm wide, the closest language in Part 9 of the OBS states as per 9.5.11.3. “the doorway to such bathroom and to each bedroom at the same level as such bathroom shall have, when the door is in the open position, a clear width of not less than, 760mm where the door is served by a corridor or space not less than 1060mm wide.”.
- In conclusion, there is no direct language in the OBC that refers to this circumstance, however, from the two points above BSN can recommend 760mm door openings.

Ontario Building Code – Part 3: Are There Accessibility/Barrier-Free Requirements?

As concluded above, the proposed gender-neutral washroom designs are an extensive renovation meaning that they need to conform to the current accessibility/ barrier-free design requirements as outlined in the OBC.

1. Barrier-Free Water Closet
- As per OBC 3.8.3.8. “Every barrier-free water closet stall or enclosure in a washroom described in Sentence 3.8.2.3. (3) or (4) shall, (a) have a clear turning space within the stall or enclosure of at least 1500mm in diameter, (b) have a clear floor space in front of the stall or enclosure of at least 1500mm in diameter, (c) be equipped with a door that, (i) is capable of being latched from the inside with a mechanism conforming to Subclause 3.8.1.5.(1)(b)(ii), (ii) in an open position, has a clear opening of at least 860mm wide.”

2. Barrier-Free Showers
- As per OBC 3.8.3.13, the minimum number of barrier free showers required for the proposed design options is 1.

3. Washrooms Required to be Barrier-Free
- As per OBC 3.13.8.5. “(3) Where a washroom required in Sentence 3.13.6.2 (1) contains more than one water closet, the washroom shall be designed in conformance with the requirements in Articles 3.8.3.8. to 3.8.3.11.”

Ontario Building Code – Part 3: What is the Number of Fixtures Required?

The minimum number of water closet stalls or enclosures required to be barrier-free in a washroom is zero, where a universal washroom is provided on the same floor level within 45 meters of the washroom. 1 barrier-free stall is required if exceeding this distance. BSN has designed for a barrier free stall in the gender-neutral washroom proposal. Reference: OBC Table 3.8.2.3.B.

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PART 3: NUMBER OF FIXTURES REQUIRED?

main references:
OBC 3.7 + 3.8

WHEN WERE B.F. STALLS ADDED TO WASHROOMS?

OLDEST OBC AVAILABLE FOR REFERENCE 2012

BASED ON EXISITNG CONDITIONS

If combine for option 4

BASED ON OCCUPANCY

6 w/c total per floor

60 3rd fl total / 2 = 30
70 4th fl total / 2 = 35

CONCLUSION: MUST MAINTAIN EXISTING PERFORMANCE LEVEL OF ALL OR PART OF AN EXISTING BUILDING

PART 11: IS THIS A BASIC OR EXTENSIVE RENOVATION?

main references:
OBC 11.3

BASIC RENO

EXTENSIVE RENO

CONCLUSION: NOT substantially removing interior walls/flrs/clgs in building therefore does not count as extensive renovation.

PART 3: ARE THERE ACCESSIBILITY / BARRIER-FREE REQUIREMENTS?

main references:
OBC 3.13, 3.8

CONCLUSION: APPLICABLE FOR EXTENSIVE RENOVATION, N/A FOR BASIC RENOVATION IF PROVIDING SAME # OF BF FIXTURES

BF watercloset

PART 3: WHAT ARE THE MIN. DIM REQUIREMENTS TO FIT INTO A TIGHT SPACE?

main references:
OBC 3.7
OBC 3.4

NO SIGHTLINES

design requirement

DOORS TO ENSUITES

- NOTHING IN PART 3 OBC
  - 810 CLEARANCE FOR AMBULATORY STALL
  - 860 CLEARANCE FOR BF STALL
  - BOBRICK REFERENCES inswing door 23-26"
    - 584-660mm
    - https://www.bobrick.com/wp-content/uploads/TPMG-297.pdf
    - 24" standard - 600
    - 36" stall width standard - 915

- Not an exit per 3.4.1.4.

applicable to door to corridor and not to ensuites

PART 9's point of view:

CONCLUSION: nothing in OBC to refer to.
But if reference Part 9 and toilet partition standard, can recommend squishing to 760

SINKS / LAVATORIES

WATER CLOSETS

all current options meet this requirement