HOW TO BUILD A MODERN HOUSE

A diary of the build process from concept to completion

C. John Wherry

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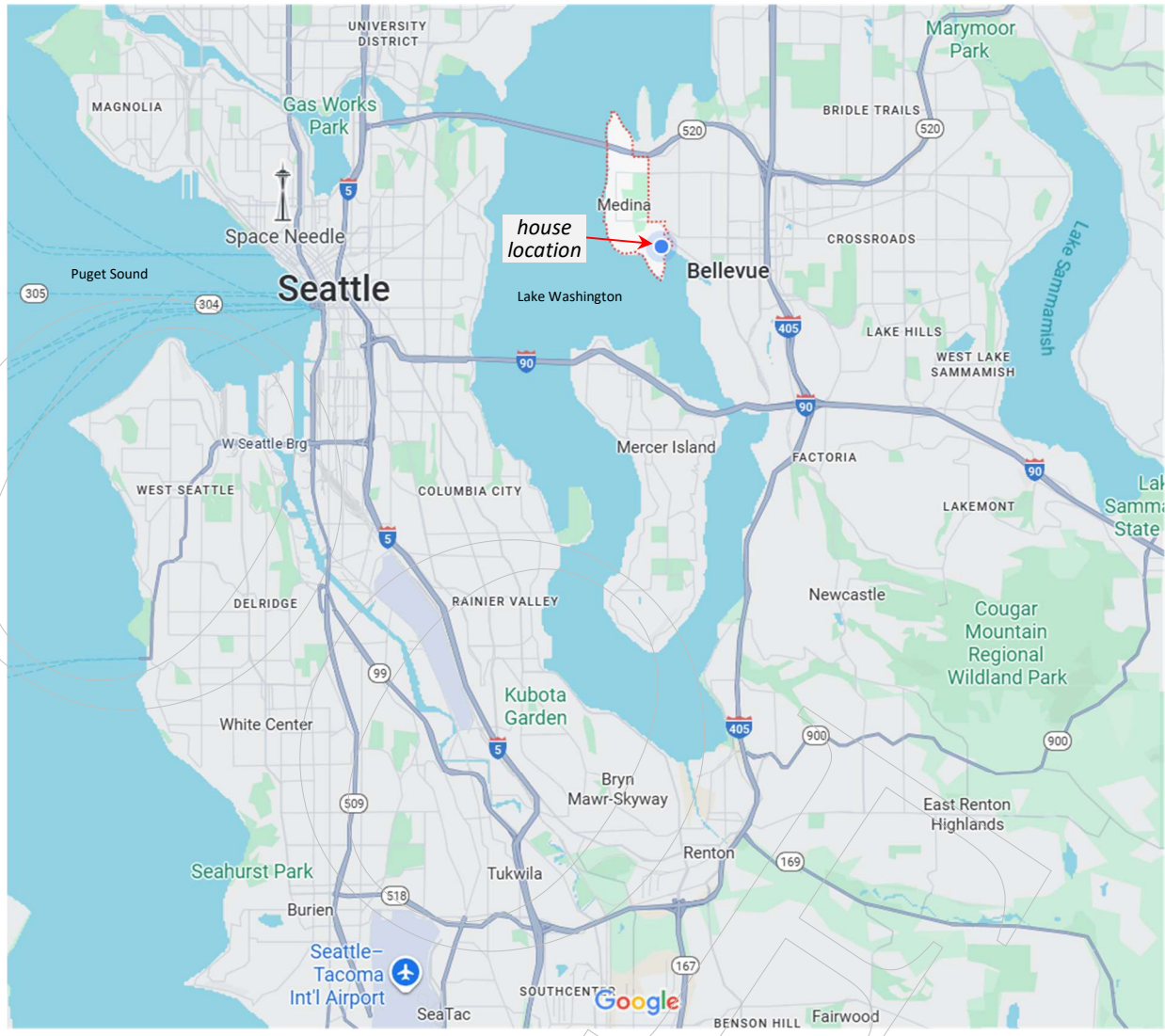
Every day during this project, John and his wife Polly Lau visited the build site. John talked to the subcontractors about construction details. Polly took photographs to serve as a detailed record of the progress. These photographs were used to create this book.

CONTENTS

INTRODUCTION

We have always lived in beautiful homes - first in Toronto, then in Seattle, Hong Kong, San Francisco and New York. We have lived in the Seattle area since retiring. We started looking for a place to build our dream home. It took quite a few years including several misses until we finally got a house in the right neighbourhood with the view we wanted. The property we found is in the City of Medina, east of Seattle across Lake Washington. The location of the house is shown on the map as a blue dot. We purchased the house in 2018 – before we hired an architect. We rented the house until Aug 2023 when the project started. The old house was demolished on Aug 23, 2023 and we moved into our new house May 21, 2025.

This book is the story of how we built our modern house.



NEW HOUSE REQUIREMENTS

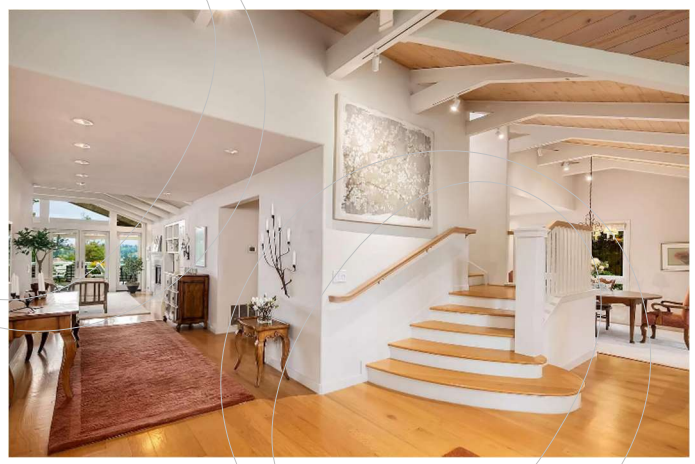
First we started off by creating a list of requirements. We had done many renovation projects and had bought and sold real estate as an investment for over 40 years. So we were knowledgeable of what we liked and disliked and what things we wanted to have in our modern house. Our requirements included:

- open and bright with high ceilings
- solar panels
- heat pumps (electricity) for heating and cooling
  ie, no gas furnace
- a generator and/or batteries for uninterruptible power
- strong internet signal throughout the house
- home automation including WiFi controllable switches and plugs, HVAC, garage doors, irrigation system, security system, exterior cameras, etc.
- a distinctive water feature

We wanted to use this project as an opportunity to learn about the house building process then ultimately enjoy living in a beautiful modern house we had designed from scratch.

OLD HOUSE

The original house was built in 1954 and was non-conforming in height and setbacks. The lot had a significant slope from front to back. The main floor was roughly at street level. It had a Great Room, Powder Room, Master Bedroom with ensuite bathroom, Dining Room, Kitchen, Sitting Room and a 2 car garage. There were stairs to a 2nd floor with 3 bedrooms sharing a bathroom. The square footage of the house was 3140 sq ft. The house had a large deck at the back. Under the deck, there was an unheated, unfinished room with the gas furnace, water heater, built-in vacuum and storage space.



ARCHITECT

We interviewed 3 highly recommended architects. All 3 looked good but we also interviewed a 4th architect who had designed a house that we admired when it was listed for sale. Its design was very much to our taste and it had also been built on a slope. We ended up choosing the 4th architect. That turned out to be a big mistake. We wasted a year, including paying the entire fixed-price fee, before we realized that the construction cost was more than double the budget and the design didn't even meet all our requirements. It also had a main floor plan that was significantly lower than the existing house which harmed our view of Lake Washington and Mt Rainier. When we realized these things, we fired the architect. We had wasted a lot of time and money. We considered giving up and selling the house but instead we contacted Baylis Architects (baylisarchitects.com) who had been our first choice of the 3 recommended architects. We had to start again from scratch but Baylis listened attentively to our requirements and gave us excellent feedback throughout the process. Ultimately we ended up with a superior result.

GENERAL CONTRACTOR SELECTION

Usually, the architect will ask several general contractors to bid on the set of Construction Documents (aka CD set) they have prepared. The owners interview the bidders and make their selection based on experience, cost and references. In our case, the decision-making process was easy. In the process of looking for a potential site to build, one house we considered had been renovated by March MacDonald. Our real estate agent said March MacDonald (march-macdonald.com) was one of the best general contractors in the Seattle area. Then coincidentally, we met Clay March at a design meeting with the first architect who was recommending that we use March MacDonald as the general contractor. When we hired Baylis, they recommended using March MacDonald with whom they had completed many successful projects. Baylis could attest to the quality of work and the ability of March MacDonald to keep projects on schedule and on budget. So with 3 unsolicited references, no further references were necessary.

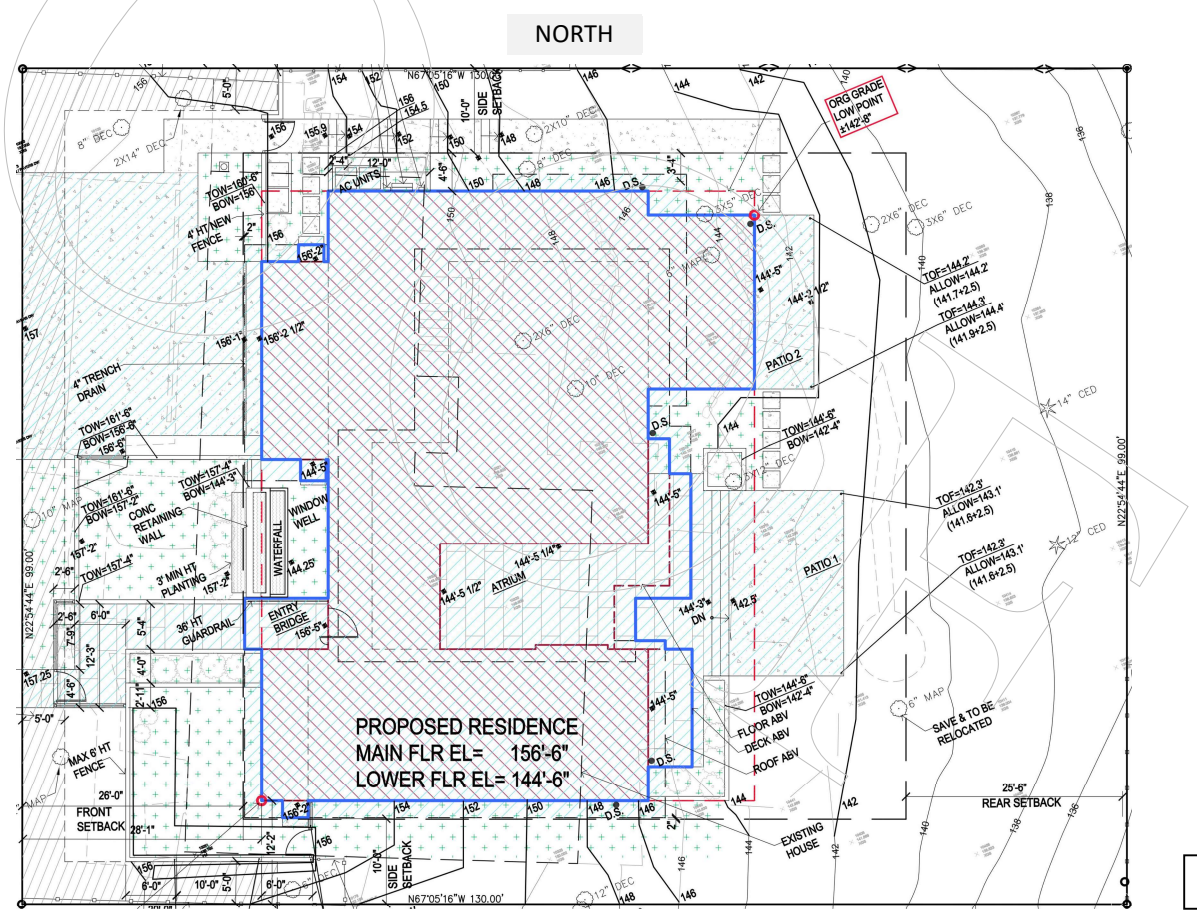
PROPERTY DETAILS

The lot size is 99' N to S and 130' W to E. The significant slope from front to back facilitates great views on the lower level as well as the upper level. For this reason, it required extra attention to capturing drain and ground water in order to avoid a landslide or the flooding of downslope neighbours.

The front of the house faces West. The setback from the street to the front wall of the new house is 26'. The front door is 36' 6" from the street.

The length of the N side of the house is approximately 58'. The distance from the street to the E side of the house is 26+58=84'. So the E side of the house is 130-84=46' from the E property line.

The length of the W side of the house from the N wall to the S wall is approximately 72' 5".



RENDERINGS

I won't go through the process of working with an architect to create the CD set and the types of permits and inspections that were required by the city. The focus of this book is how to build a modern house. But before starting that description, I want to show some of the renderings that were created by Baylis to help us visualize what the house would look like when completed – both from the outside and inside. The front of the house is on the W side of the lot. The setback from the street is 26' to the front wall and 36' 6" to the front door.

street view looking E

street view looking SE

The main level is 2,433 square feet and the lower level is 3,006 square feet for a total of 5,439 square feet.

The main floor elevation is 156.50 ASL ("Above Sea Level"). This is essentially street level. The lower floor elevation is 144.50 ASL – 12 feet lower.

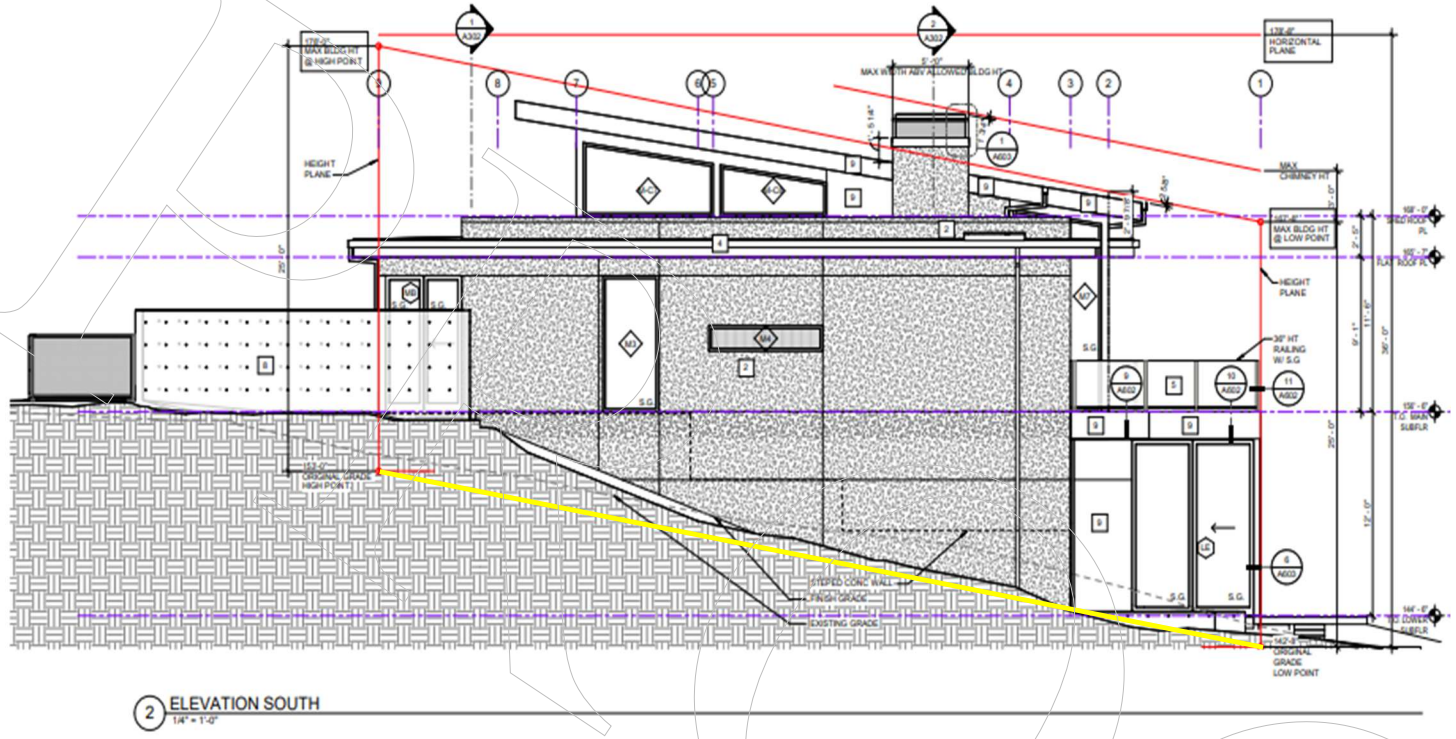
back of house looking W

back bird's-eye view

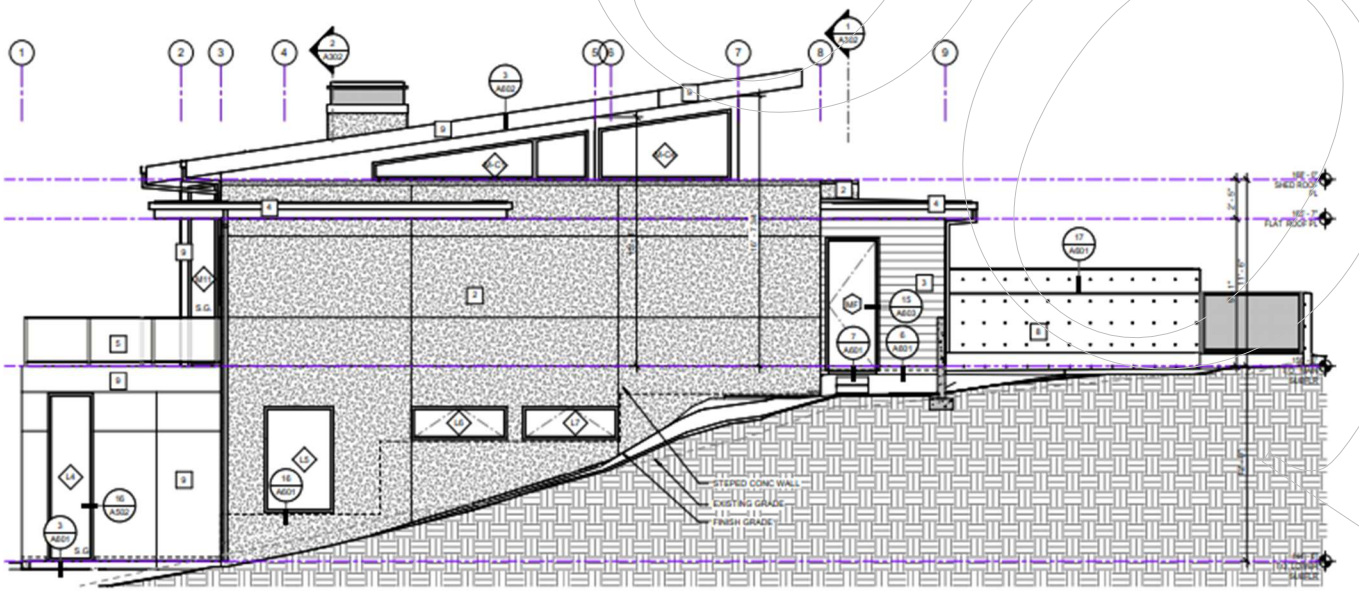
front door

front bird's-eye view

The house roof could not be higher than 25’ above the original grade slope line shown in yellow in the Elevation South drawing. The lower level is 12’ below the main level.

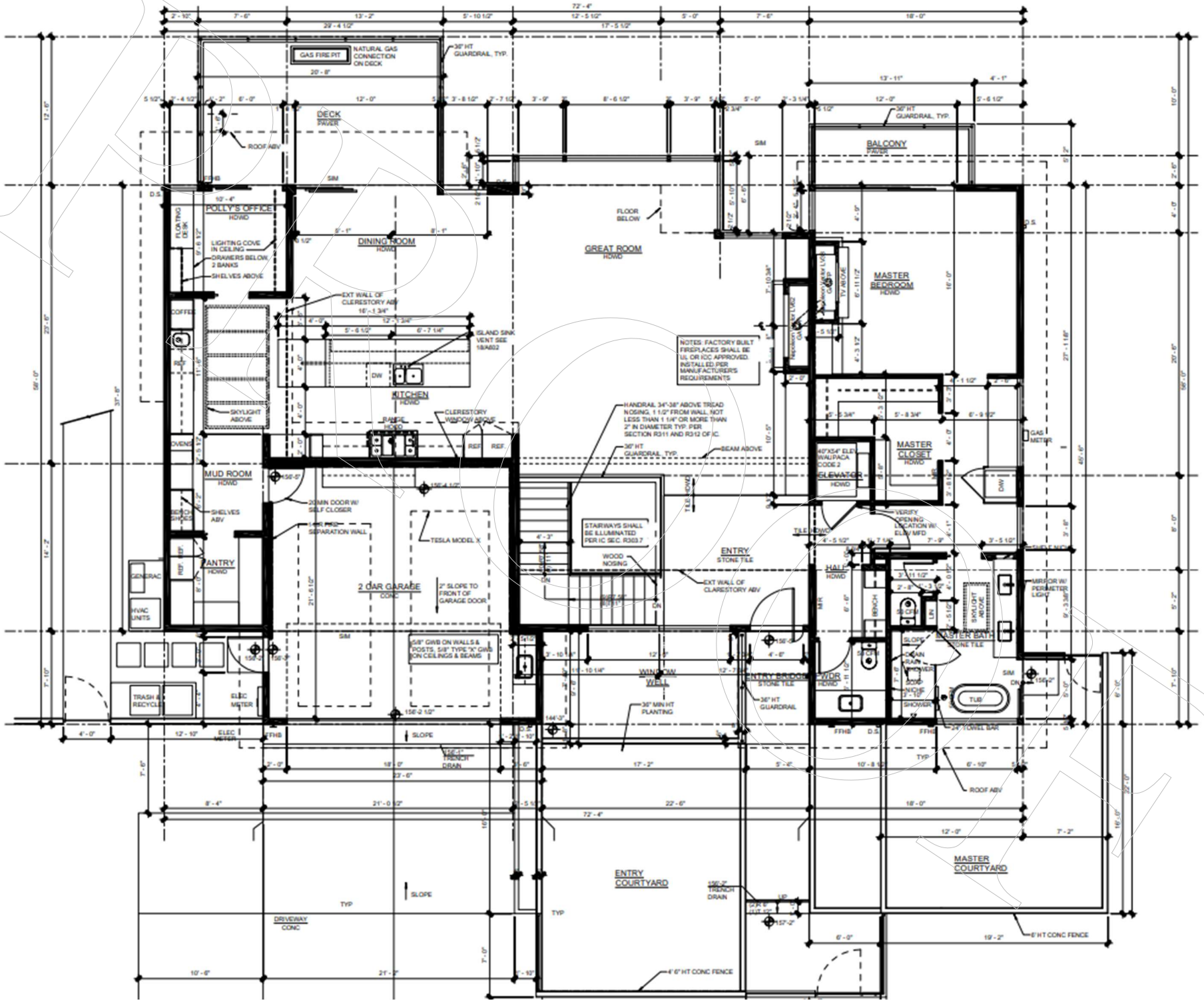


2 ELEVATION SOUTH
1/4" = 1'-0"



2 ELEVATION NORTH
1/4" = 1'-0"

Main Level Floor Plan



The main level has 10 rooms/areas described in detail in Appendix C. The mudroom cupboard and bench were switched before implementation.

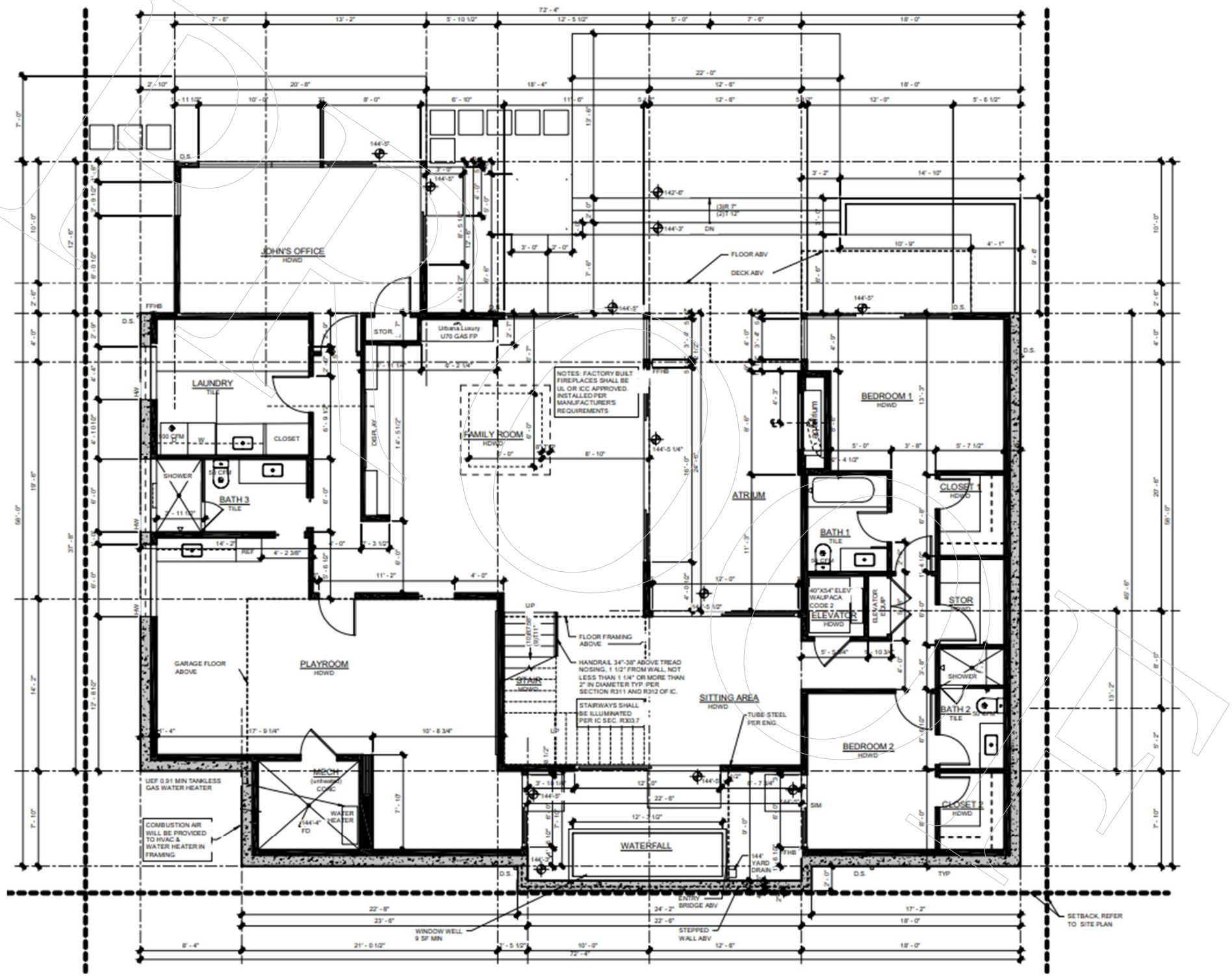
view from Great Room

view of the Great Room from Dining Room / Kitchen

view of Kitchen Island, W wall, N wall and Dining Room

view of N wall, Mud Room, and Pantry door

LOWER LEVEL FLOOR PLAN



The lower level has 12 rooms/areas described in detail in Appendix C.

view of staircase and Sitting Area below

Family Room with 2-sided fireplace

view of Atrium from Family Room

John's office with view of lake and Mt Rainier

CD SET CONTENTS

The CD set includes the following sets of drawings:

ARCHITECTURAL

A001	Coversheet
A002	Site Plan & Site Calculations
A003	CAP Site Plan
A101	Lower Floor Plan
A102	Main Floor Plan
A103	Roof Plan
A201	Building Elevations
A202	Building Elevations
A301	Building Sections
A302	Building Sections
A401	Wall Sections
A402	Int Stair & Railing Details
A501	Window & Ext Door Schedules
A502	Int Door Sch & Window & Door Details
A503	Waterproof Details
A601	Details
A602	Details
A603	Details
A701	Main Floor Interior Elevations
A702	Lower Floor Interior Elevations
E101	Lower Floor Electrical Plan
E102	Main Floor Electrical Plan

STRUCTURAL

S101	General Structural Notes
S201	Foundation Plan
S202	Main Floor Framing Plan
S203	Intermediate Roof Framing Plan
S204	Upper Roof Framing Plan
S301	Shear Wall Schedule Typical Details
S302	Hold-downs & Lateral Details
S303	Foundation Details
S304	Main Floor Details
S305	Roof Details

SURVEY & CIVIL

C1 of 5	Cover Sheet
C2 of 5	Topography & Boundary
C3 of 5	TESC Plan & Details
C4 of 5	Grading, Drainage & Utility Plan
C5 of 5	Notes & Details

LANDSCAPE

L-1	Tree Removal & Preservation Plan
L-2	Landscape Plan

The CD set also included a companion document created by Baylis called the Outline Spec with the following 16 “divisions”:

Site Work	Concrete	Masonry	Metal
Wood	Thermal and Moisture Protections	Doors and Windows	Finishes
Specialties	Equipment	Furnishings	Special Construction
Conveying Systems	Mechanical Systems	Electrical	Low Voltage Systems

These divisions contained instructions needed by the subcontractors. There were also spreadsheets that specified the appliances, plumbing fixtures and decorative lighting (ie, not “can” lights) that were created by John and Polly. The plumbers and electricians needed to know this information beforehand in order to provide proposals/quotes to the general contractor. Often these specifications are created by the architect and/or interior decorator in consultation with the owner. In our case, we researched product options on our own and prepared the spreadsheets, which have been included in Appendix D.

DEMOLITION

On Jul 31, 2023, samples of wall and floor were collected for asbestos and lead testing (required by the City of Medina). On Aug 1, the appliances were disconnected and the electricity was turned off. On Aug 2, the appliances were donated to Habitat for Humanity and the gas was turned off.

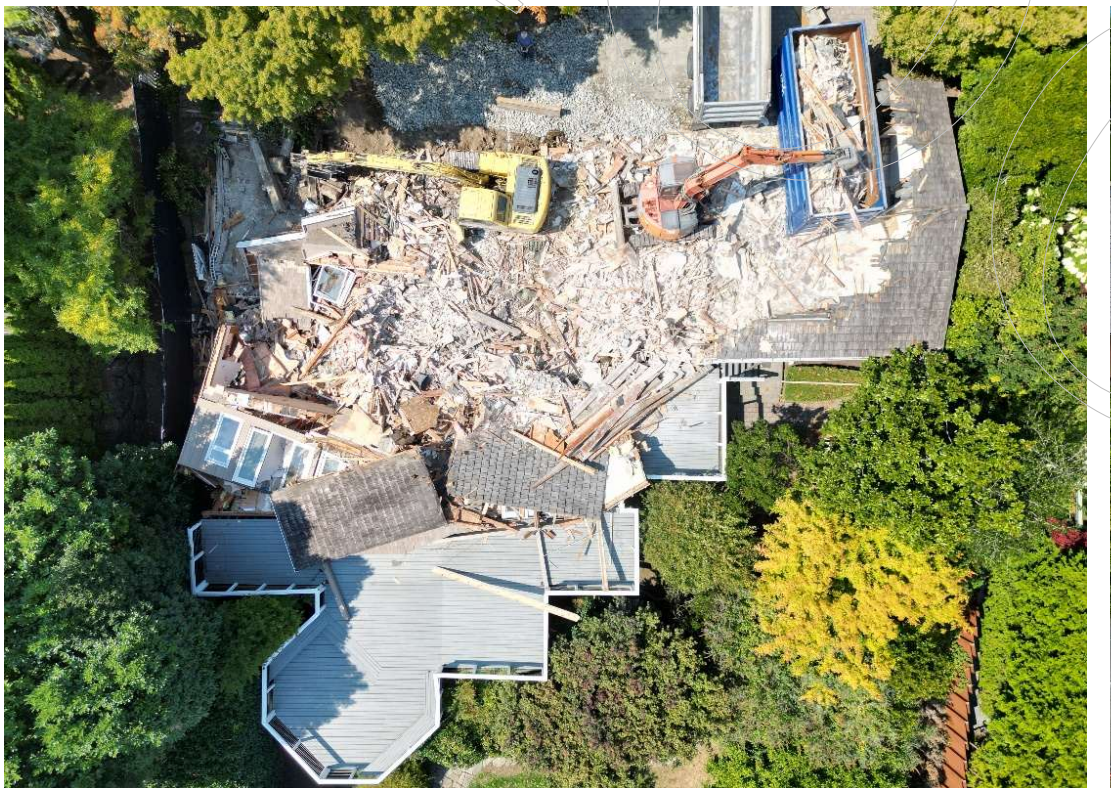
On Wed Aug 23, we met Clay March at the house. An excavator was parked in the driveway accompanied by its operator – Shane. Today, we would start the demolition. This was the point of no return. It was a bit nerve-racking but also exciting anticipating what was to come.

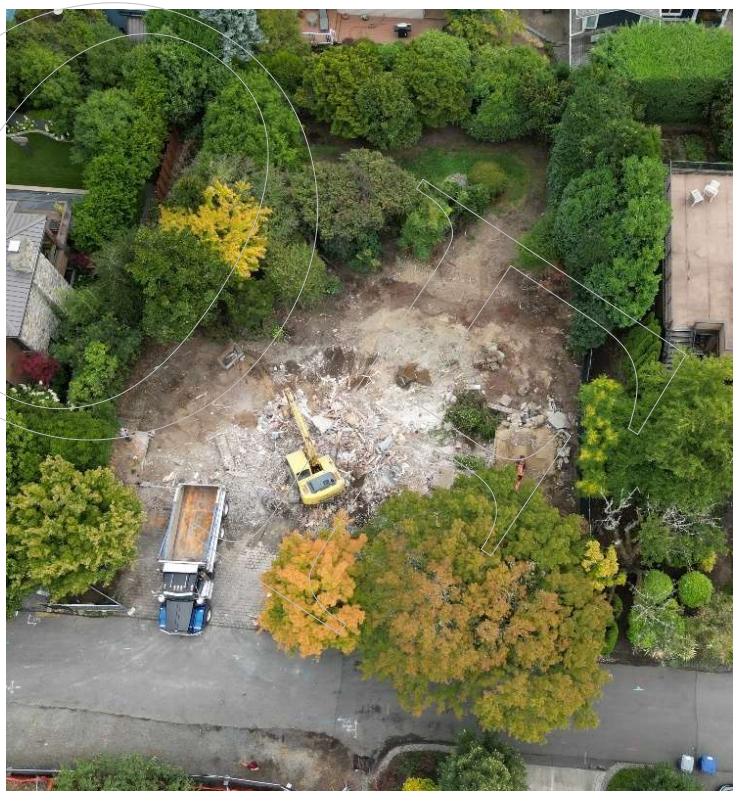
A drone was purchased to take aerial pictures of the project. This was its maiden flight.

The excavator started by pulling the roof off the garage. Most of the house was knocked down the first day.

The next morning, a dumpster was placed in the driveway. The excavator loaded it up then a truck arrived to take it away and another truck arrived with a new empty dumpster. 3-4 dumpsters were filled every day. The excavators needed to remove the debris to make space to knock down more of the house including the decks.

A second excavator arrived on the 2nd day and another operator – Billy. It took a week to remove all the house debris including the foundation pads of the original house. By Aug 31, all remnants of the original house were gone. We were ready to start excavation.





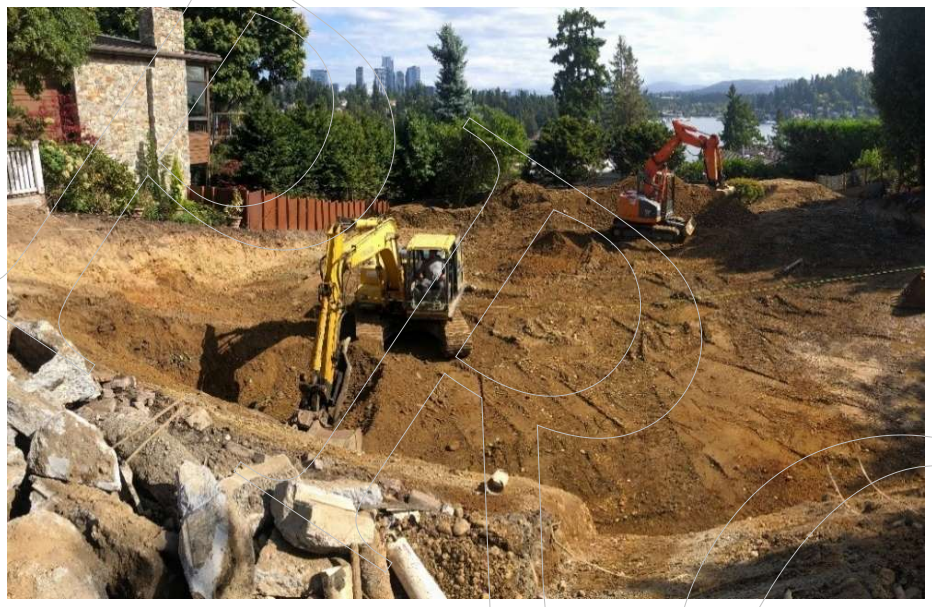
EXCAVATION

On Fri Sep 1, 2023, excavation started. A temporary construction fence was placed along the W and E side of the property. The N and S sides already had a fence – except for where the laurels were on the S side. The excavators removed the existing hedges on the N, E and S sides. Several trees were also removed which required a Tree Permit application that was approved by the City's arborist. The excavators had to remove a lot of earth. Dump trucks were constantly arriving to pick up another load. Earth needed for backfilling after the foundation was completed was piled up on the E side of the lot.

The surveyors came out and identified how far down to excavate for the foundation footing. The required depth was 142.5' ASL which is roughly 15' below the street grade. The excavators had to remove all the earth required to get down to this depth for the foundation.

The Geotech engineers came out to check the soil – important since the house was being built on a slope. The excavators were told to excavate an indent on the W side (window well) and also to go a few feet deeper at the NE corner (John's office) to get better soil. Fortunately, we didn't need to bring in gravel which would have been the case if the soil wasn't good enough.

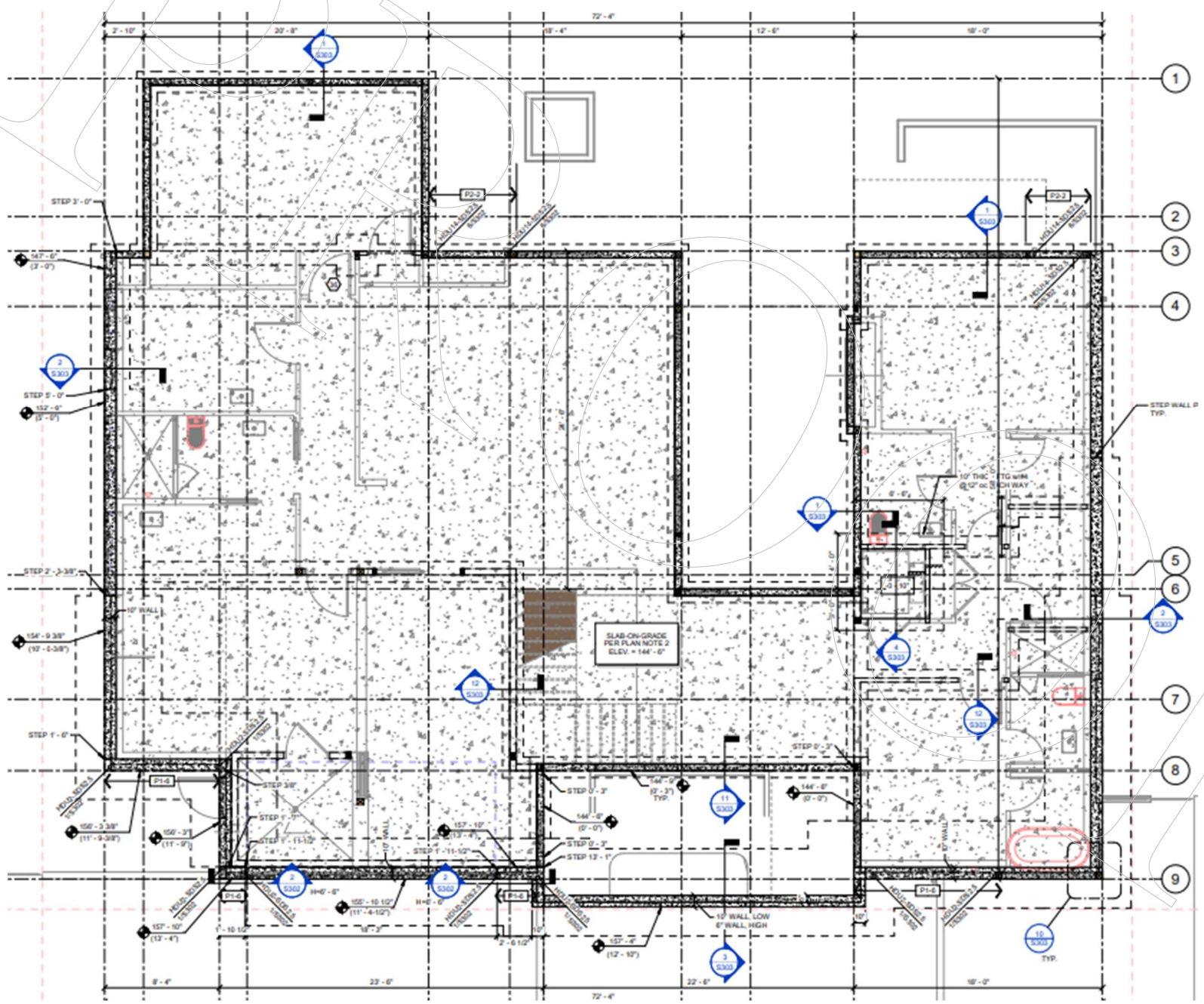
The 2 excavators worked together. One would move earth from A to B, then the other would move it from B to C. A ramp was built on the N side to access the area being excavated. When they were finished excavating, the ramp was removed by an excavator by picking up the earth in front and dumping it behind while backing up the ramp.



The excavated earth remaining on all 4 sides was covered with plastic to protect it from wind and rain. It was secured with weights to hold the plastic in place. As of Sep 19, 2023 the excavation was completed and the site was ready to start constructing the foundation.

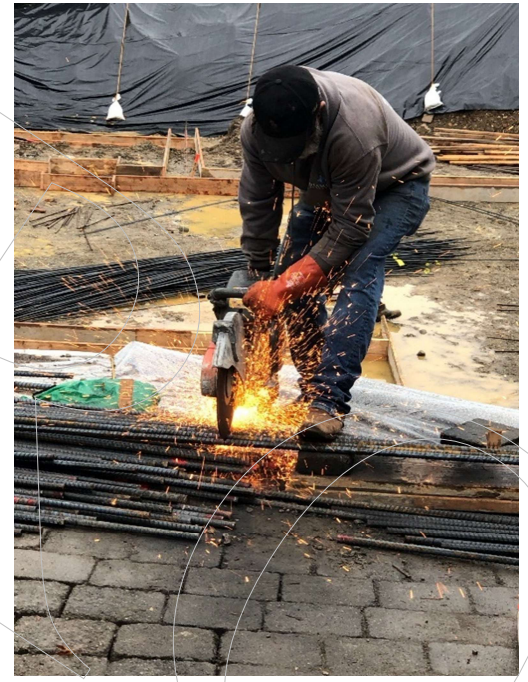
FOUNDATION

On Wed Sep 27, 2023, wood used to create the foundation footings was delivered. The next day, workers arrived to start laying out the wood per the Foundation Plan. The diagram below is the Foundation Plan created by the Structural Engineer. Surveyors came out to specify the location of the foundation corners including the precise elevations of each wall section to be used. This is critical since everything else depends on getting this right – including max house height not exceeding 25' above the original grade.



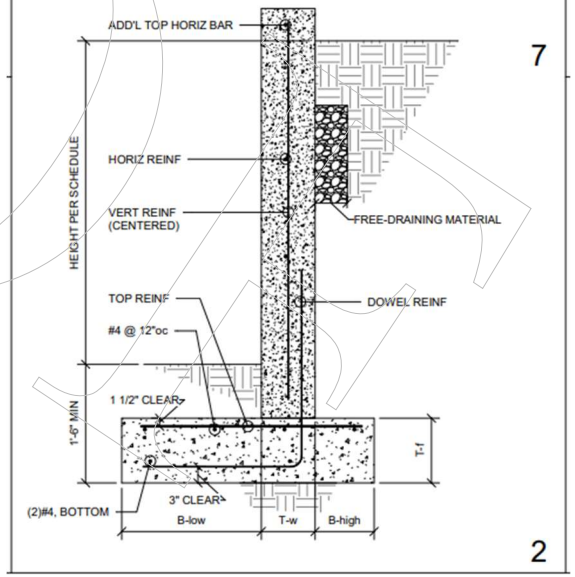
FOUNDATION FOOTINGS

The first step is to construct the footings. A frame is built with boards to contain the concrete to be poured. A red string is used to show the outside of the foundation wall ie, the foundation walls will be built on the foundation footings. Rebar is cut to fit into the frame, then tied together using 16-gauge (0.0625" thick) stainless steel rebar tie wires.



The Foundation Plan in the CD set contains instructions on how to build the footings. This includes the thickness of the footings (based on wall height), the thickness of the rebar, and the required length of vertical rebar ie, horizontal rebar bent 90°. The vertical rebar will connect to the rebar in the foundation walls.

HEIGHT	B-low	T-w	B-high	T-f	DOWEL REINF	DOWEL COVER	LAP	VERT REINF	HORIZ REINF	FOOTING TOP REINF
10' - 0"	3' - 0"	8"	1' - 6"	1' - 0"	#6 @ 7"oc	1 1/2"	42"	#6 @ 7"oc	#5 @ 18"oc	#4 @ 9"oc
8' - 0"	2' - 3"	8"	1' - 3"	1' - 0"	#5 @ 11"oc	1 1/2"	36"	#5 @ 11"oc	#5 @ 18"oc	#4 @ 18"oc
5' - 0"	1' - 3"	8"	9"	1' - 0"	#4 @ 16"oc	1 1/2"	24"	#4 @ 16"oc	#5 @ 18"oc	#4 @ 18"oc

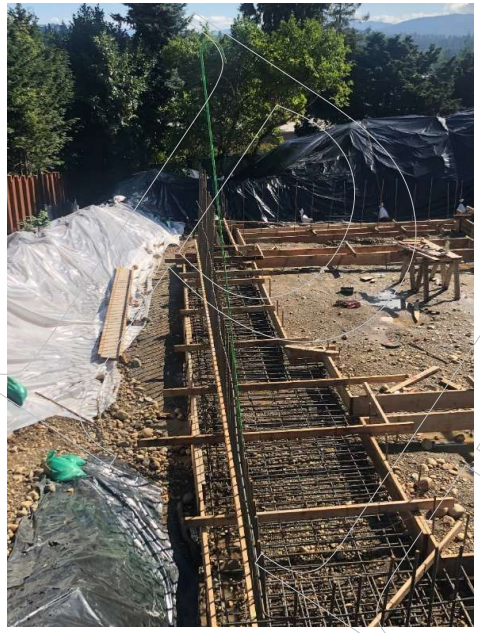


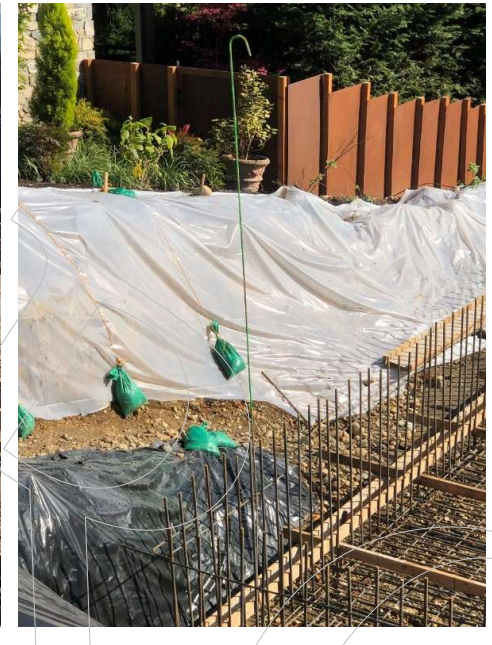
The picture shows what the foundation footing looked like on Oct 5, 2023. Rebar is shown installed in the frames of most of the footings. The section on the lower right (John's office) is a few feet lower.

On Oct 9, a construction inspector came out to check:

- all required rebar was present and that the steel used was the right quality
- the rebar was correctly installed and connected together

We passed the test. On Oct 11, the city inspector visited





A tall piece of rebar about 20 feet high was sticking out of the ground vertically on the N side. The rebar was sprayed green. This rebar had been pounded deep into the ground. It will be the electrical ground for the house.

On Oct 12, 2023, a concrete pump truck arrived then the first concrete truck. The pump truck had a long boom with a hose that could reach the back of our property from the street. One of the workers directed the hose to fill the rebar with concrete. Another worker walked behind with a vibrating rod, used to help the concrete congeal in order not to have air pockets.

A foundation created by pouring concrete directly on the ground is referred to as “slab-on-grade”.

Samples of the concrete were collected by a construction inspector. The concrete is crushed after 5 days to verify the strength of the concrete delivered. We passed.

The following pictures show what the footings looked like the next day (Oct 13). The wood frames were removed the following day (Oct 14). Note the exposed vertical rebar.

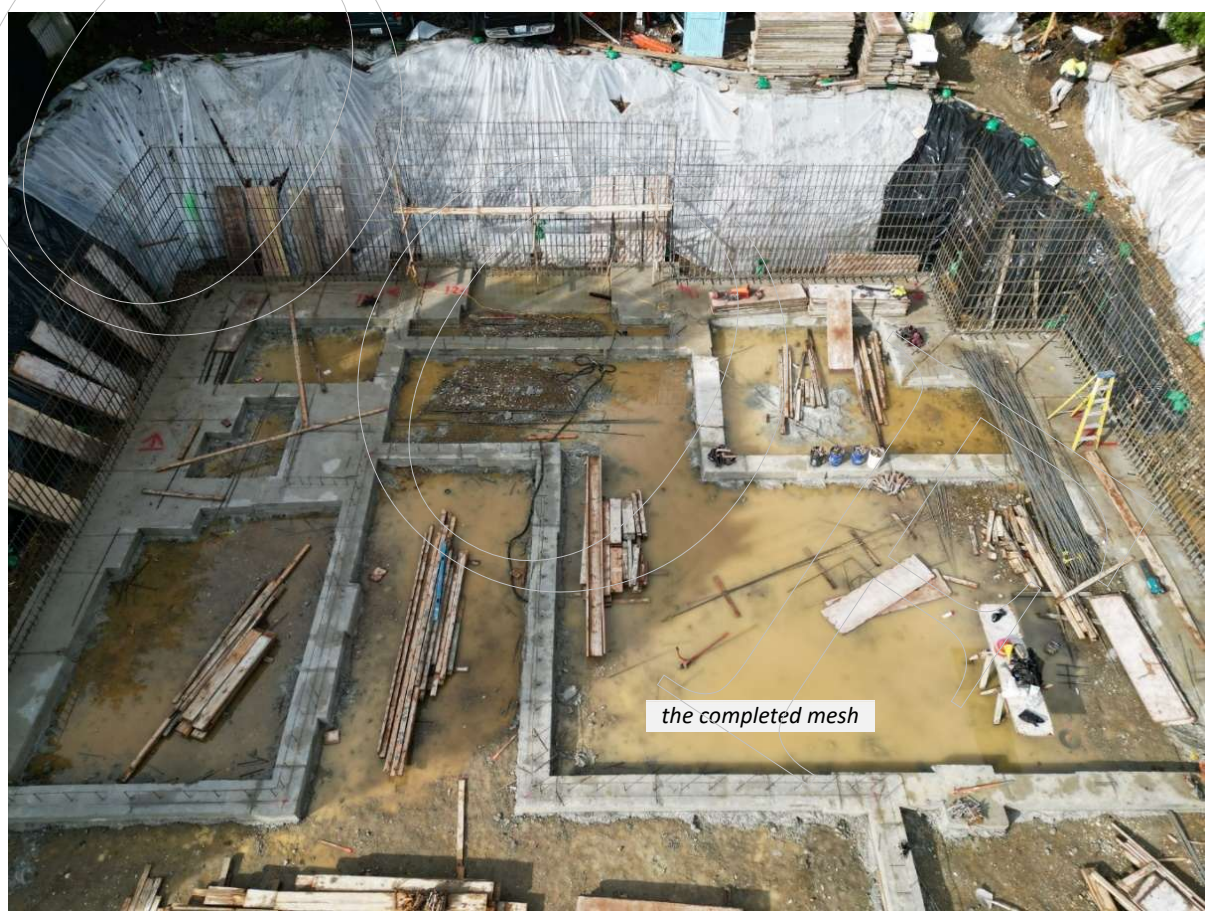
FOUNDATION WALLS

After the foundation footings are completed, the next step is to build the framing for the foundation walls. A mesh of vertical and horizontal rebar was created. The vertical rebar is connected to the rebar projecting from the footings. Rebar tie wires are used to tie the rebar together. On the W side, the mesh is 12' high. A worker is shown climbing up the rebar to connect a higher section of the mesh.

workers climbed up the mesh to construct the higher sections

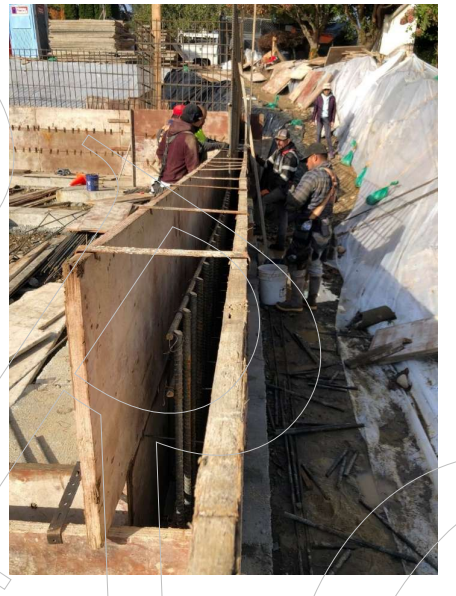
8' boards used to frame the foundation walls were positioned around the mesh. Note that no foundation wall was required on the E side.

8' boards used for foundation walls



the completed mesh

According to the Foundation Plan, the foundation N, S and W walls are 10” wide and the E wall is 6” wide. 8’ wide boards were placed on the foundation footings on both sides of the rebar mesh. Cleats were used at the top of the wood frames to hold the boards at the correct separation ie, 10” or 6” wall. They are removed after the concrete is poured.

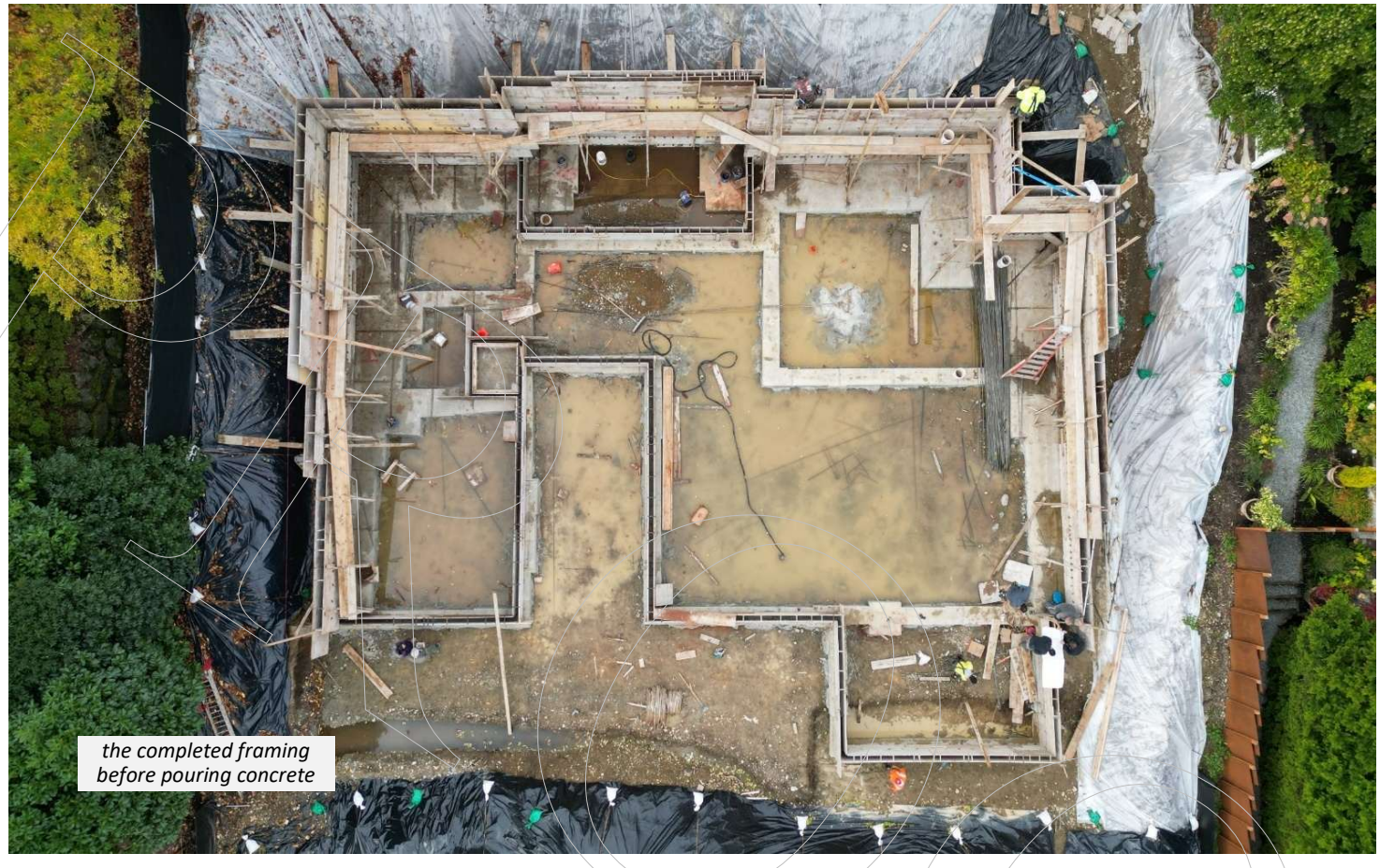


6” and 10” cleats

The foundation walls require 3 to 4 of the 8’ wide boards stacked vertically. A steel rod is used instead of cleats to create the correct gap in preparation for pouring concrete.

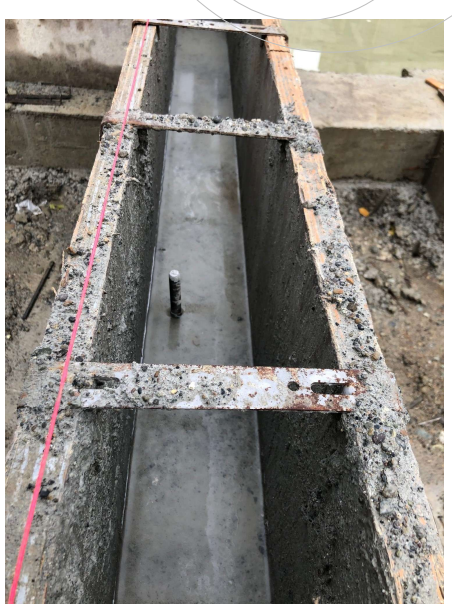
8’ wide boards stacked vertically

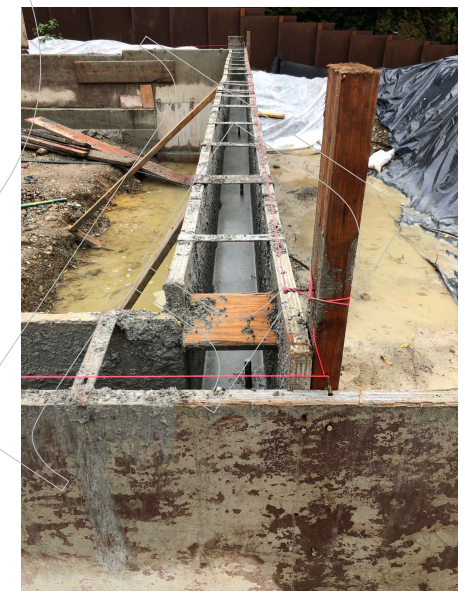
steel rod used to create the correct gap



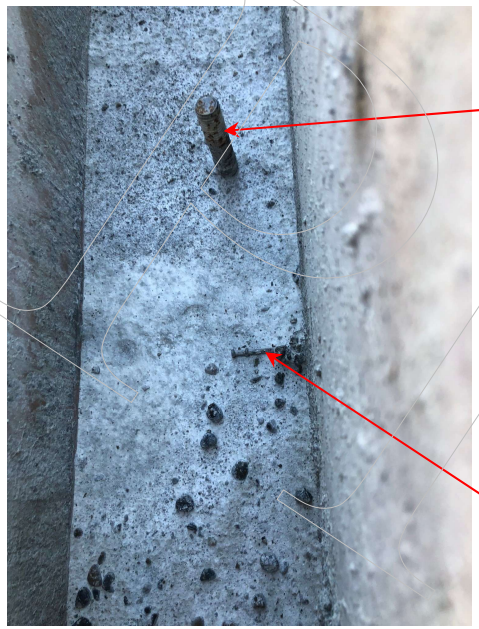
the completed framing before pouring concrete

On Nov 6, concrete was poured between the foundation wall frames. Concrete is not added all the way to the top of the frame. Inside the wood frames, there is a black line showing the height to which concrete is to be added. There are also small nails on the black line every 6". The workers use these indicators to know where to level the top of the concrete wall.

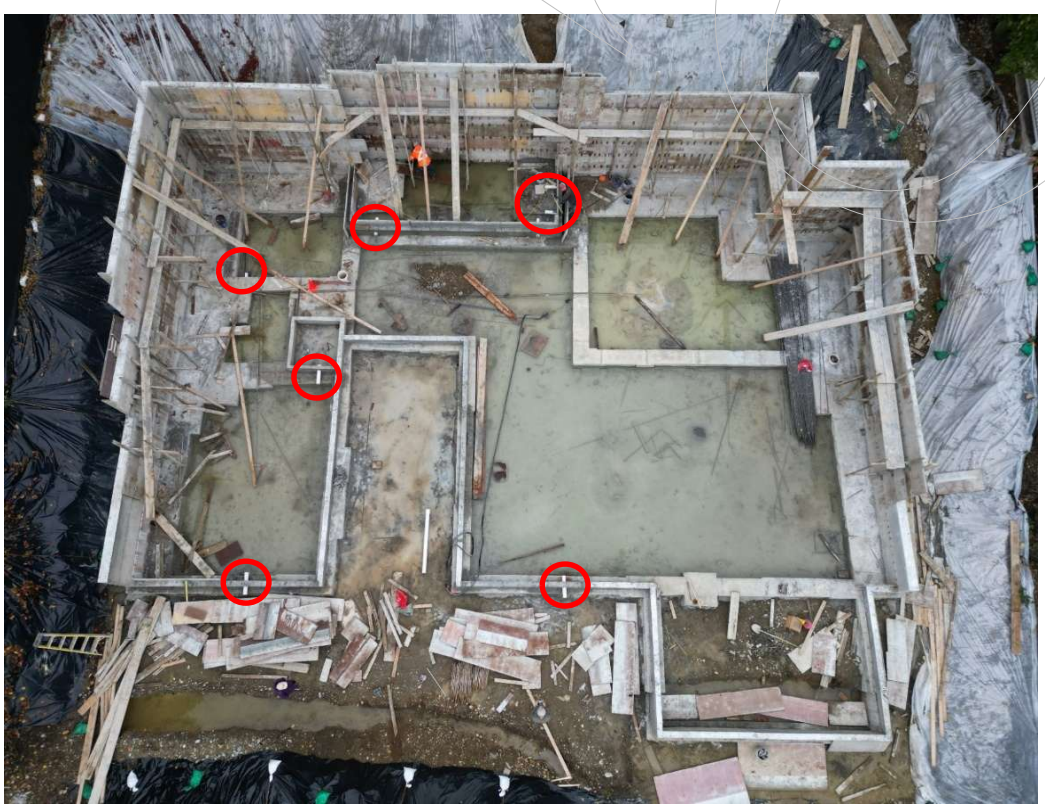




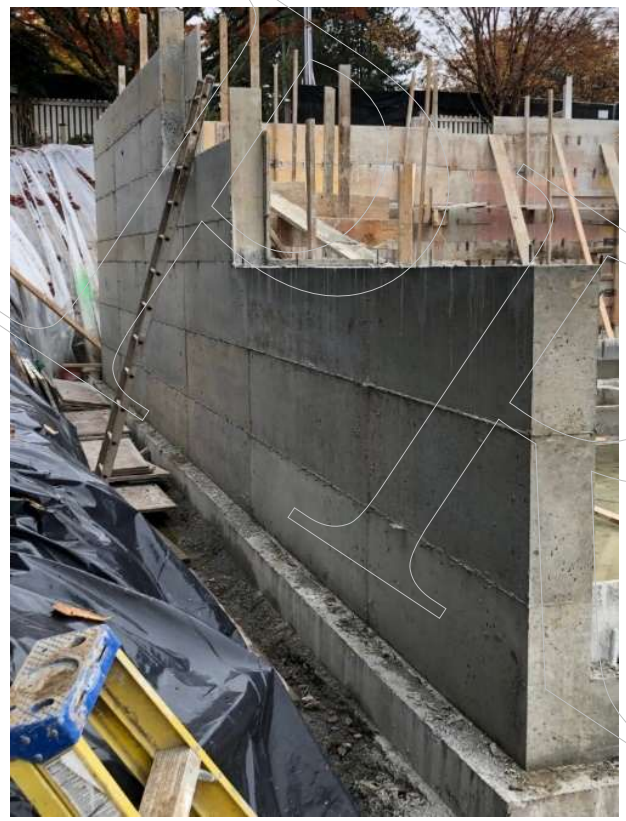
The metal sticking up in the concrete is a threaded bolt that was placed in the concrete during the pouring. This is used to attach the house floor to the foundation with nuts. Note the small nail used to identify the height to fill with concrete.

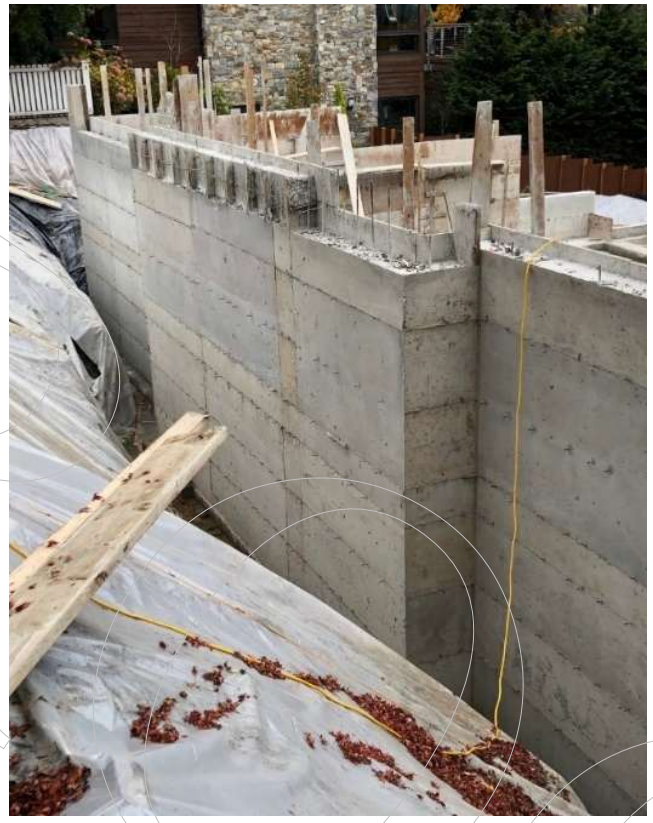


There are white tubes in the foundation wall (identified by red circles in the picture below). These will connect to drain pipes. The house does not have a crawl space.



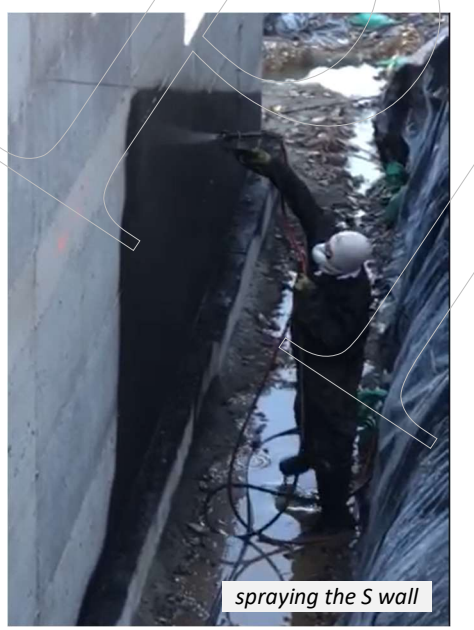
The following pictures show what the wall looked like after the framing boards were removed. The wood removal was completed Nov 14, 2023.





BACKFILL & EXTERIOR DRAINS

With the “slab-on-grade” foundation completed, the next step is to waterproof the concrete. Starting on Nov 15, 2023, the outside of the foundation wall was sprayed with a waterproofing material that covered the sections of the concrete that would be receiving backfill. Then a dimpled, heavy-duty grey plastic membrane called “delta mat” was placed on top of the black waterproofing for additional waterproofing.

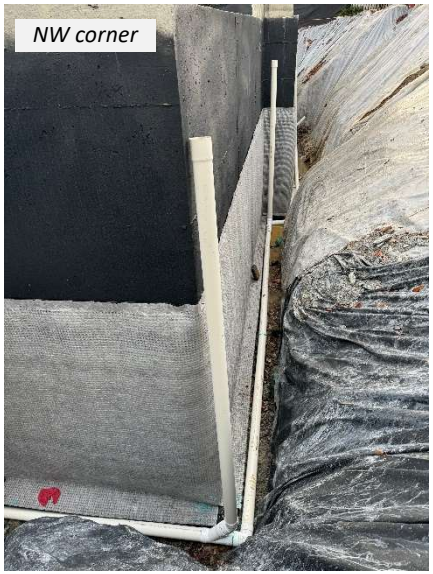


spraying the S wall

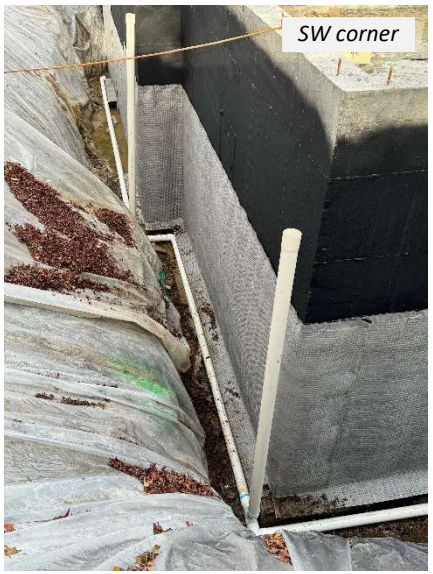
S wall - delta mat applied over spray

NW corner - delta mat applied over spray

Before backfilling, white PVC piping was installed around the foundation walls. These horizontal pipes have vertical connections at the locations where they will connect to the roof and garage drains in the future. The property slopes W to E. The white pipes carry storm water to a catch basin in the SE corner of the property. These will be connected to the roof and garage drains in the future.



NW corner

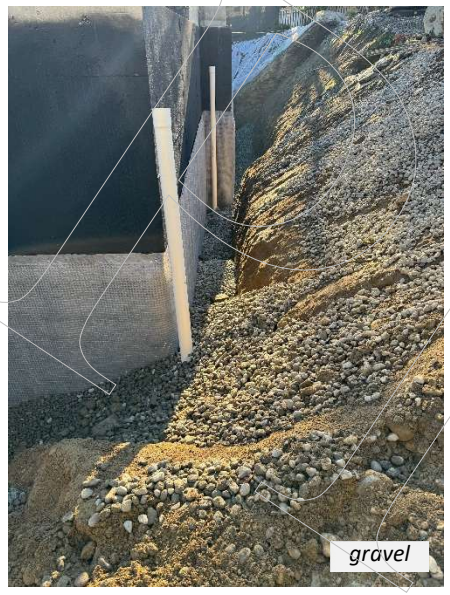


SW corner

SE corner

Note that the pipes on the E side of the property have holes in their sides to capture ground water.

After the spray, delta mat and piping outside the N, W and S foundation walls was completed, the walls were first backfilled to the top of the delta mat with 5/8" clear crushed rock that extended out about 1'. Then "gravel burrow" (a naturally occurring mix of sandy gravel and rock up to 4" in diameter) is used – including on top of the crushed rock.


gravel


gravel


gravel burrow

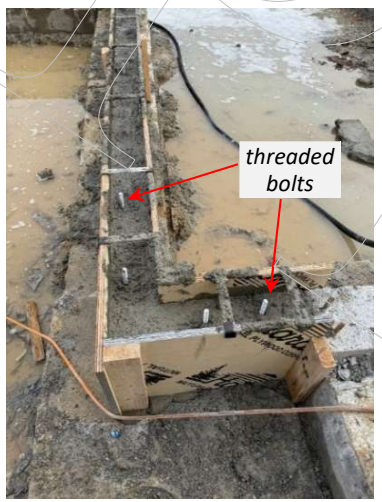
Here are some more pictures showing the backfill on the N, W and S sides of the house. Delta mats were added to the top of the foundation walls. The 3 sides were completely covered by this plastic membrane. The backfill does not touch the concrete wall.


N side

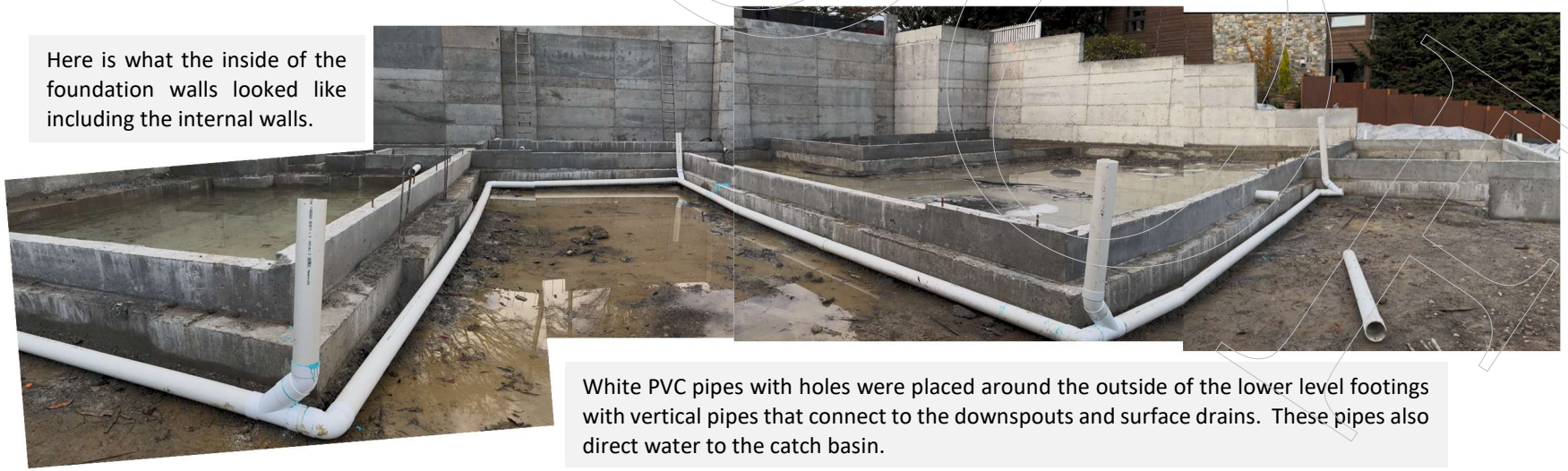

W side


S side

Three short internal walls had to be created. Frames were cut for these walls and concrete was poured on Nov 21. Threaded bolts were inserted in the concrete.



Here is what the inside of the foundation walls looked like including the internal walls.



White PVC pipes with holes were placed around the outside of the lower level footings with vertical pipes that connect to the downspouts and surface drains. These pipes also direct water to the catch basin.

The space inside the foundation walls was filled with gravel burrow and a machine was used to pound it down. Then 5/8” clear crushed rock was placed on top.

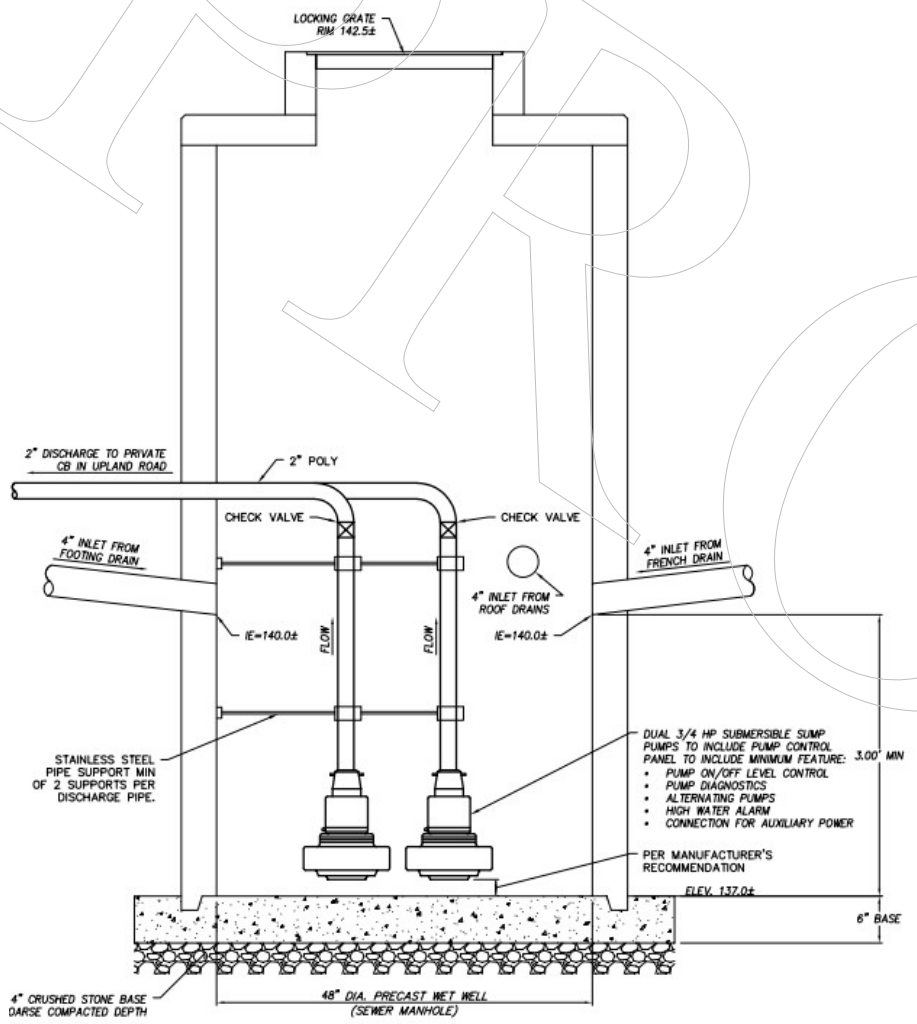
The 2 excavators worked in tandem - the larger excavator dropped the rock over the W wall of the foundation and the smaller excavator distributed it.

bird’s-eye view Dec 1 before foundation filled with gravel burrow and crushed rock fill

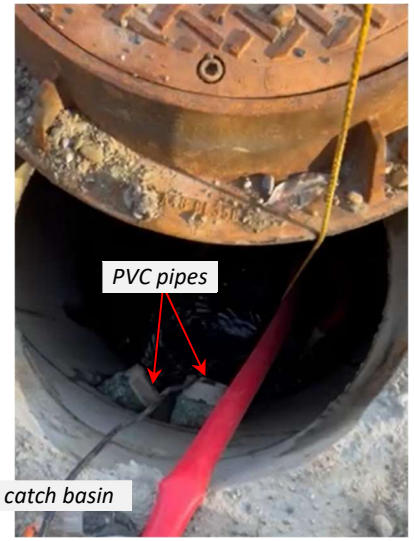
machine used to pound gravel

A “Type 2 catch basin” was installed in the SE corner of the property per the CD set instructions. It is about 10’ deep. The white PVC drain pipes installed around the foundation empty into this catch basin. Two pumps were installed to pump the water through 2 pipes on the S side of the house up to an existing catch basin at the front of the house that connects to the city storm sewer. The PVC drain pipes are visible inside the SE corner catch basin. A temporary electric pump was installed with a red hose that ran up the S side of the house to a PVC pipe connected to the front catch basin.

The excavators dug a trench across Upland Rd for a PVC pipe from the front catch basin to a city catch basin on the opposite side of Upland Rd. The trench was subsequently covered by asphalt.



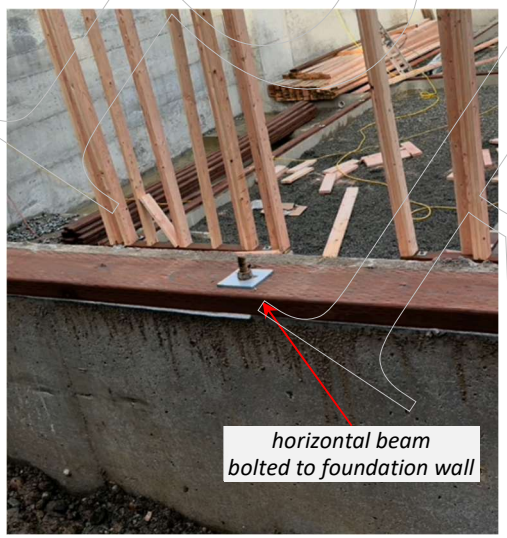

SE corner catch basin

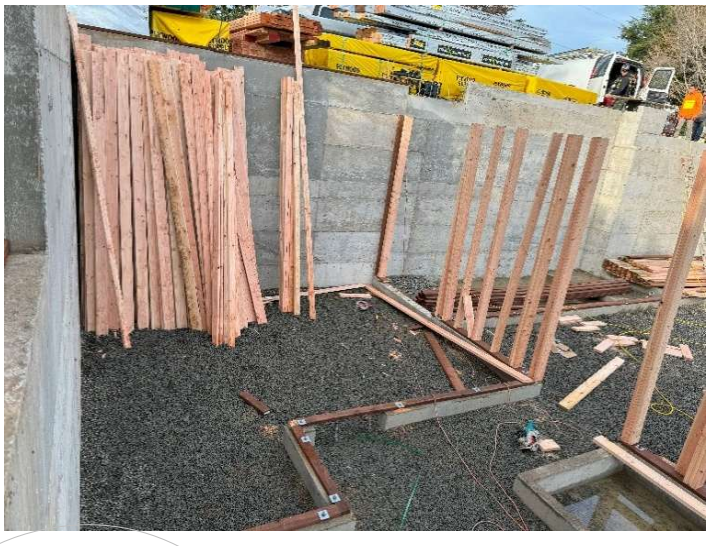



city catch basin grill and new asphalt

LOWER LEVEL FRAMING

The first load of lumber was delivered to the house on Tue Dec 12, 2023 and framing began the next day. A 2x6" horizontal wood beam was bolted to the top of the foundation wall as shown. Vertical wood beams (called "studs") were nailed to the horizontal beam. The studs are positioned taking into account where doors, windows, fireplaces, etc. will be located.

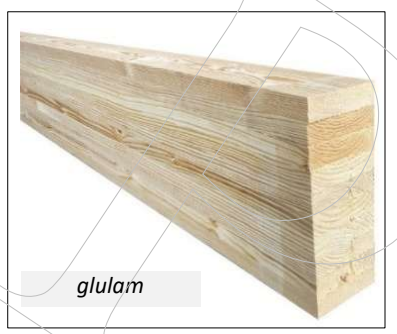




After the studs were completed, 4'x8' sheets of plywood ½" thick were nailed to the outside of the studs. In general, studs are positioned 16" apart (on centre) to line up with the 4' (48") plywood sheets nailed to the studs.

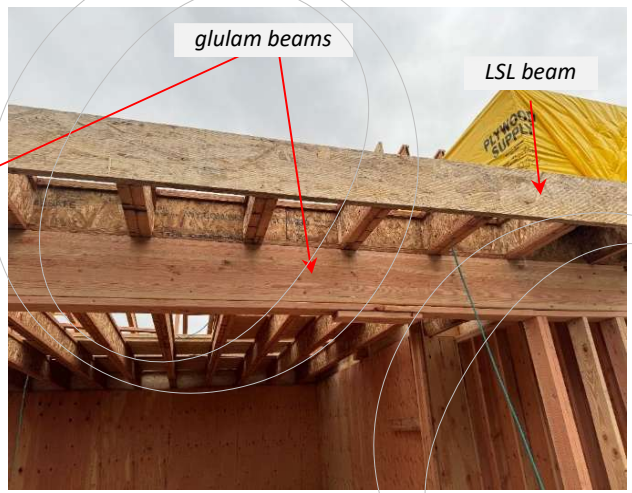
MAIN LEVEL FRAMING

There are 4 types of floor beams used. They were specified by the structural engineering company based on the required strength.


glulam

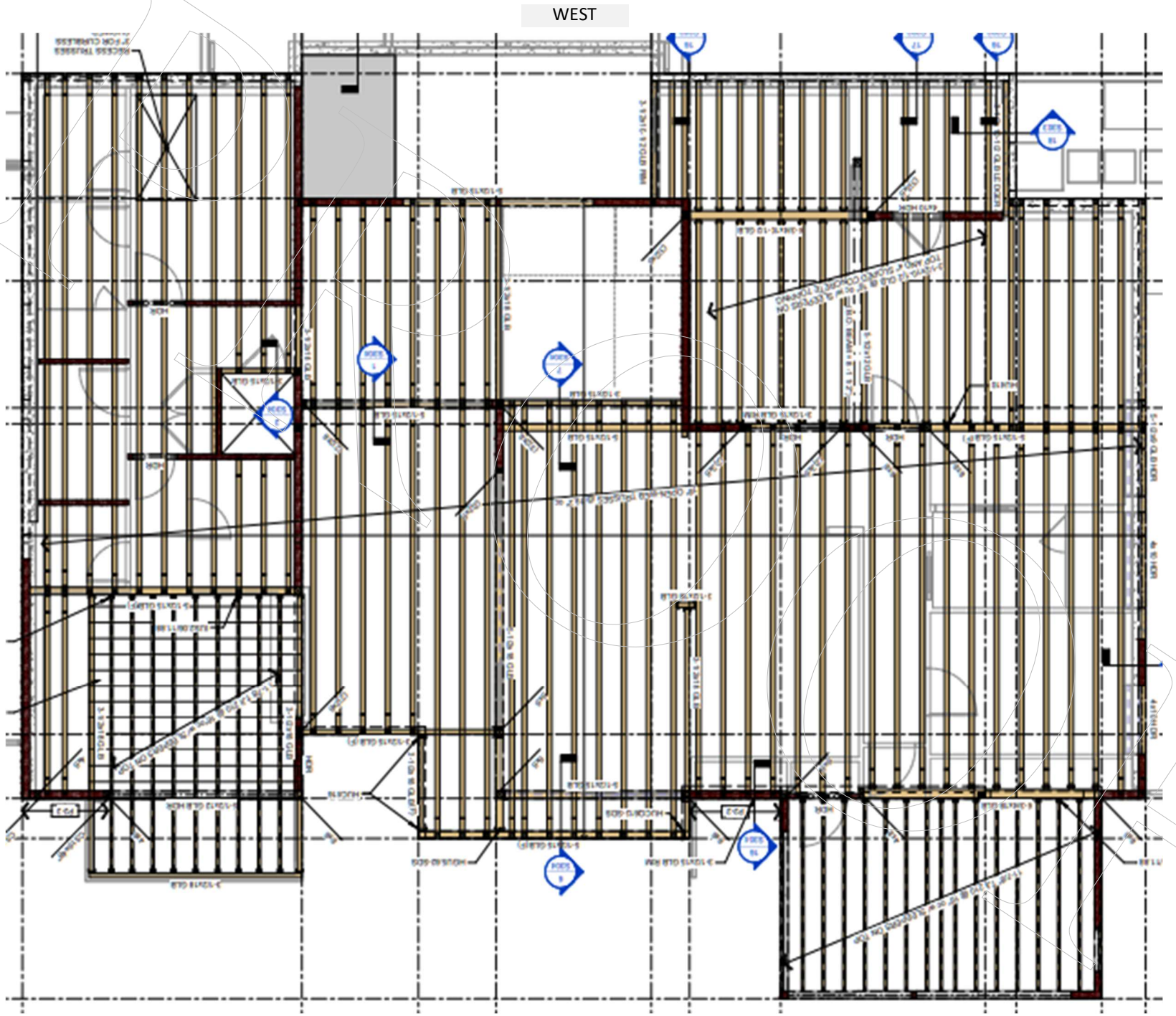

floor trusses

Glulam beams are extremely strong. They are used to support the main floor. They sit on the foundation wall and intermediate walls. They were also used for the garage floor since they will have to support its concrete floor and 2 cars.



Floor trusses are used for the main floor. They are shown being delivered by crane. They have space to accommodate air ducts, plumbing, electrical wiring and sprinkler pipes.

The following diagram from the CD set shows the Floor Framing Plan. It shows the direction of the trusses, TJIs and glulam used for the main floor.

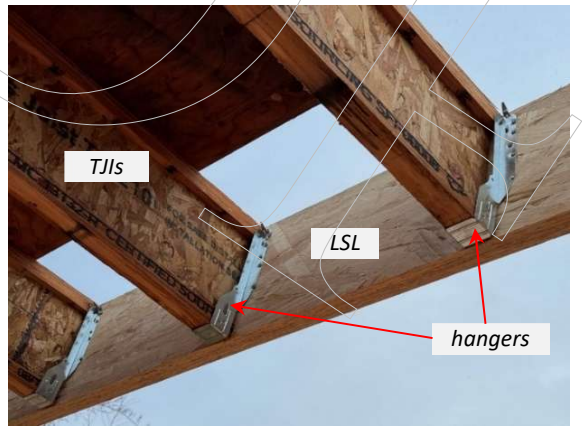


After installing the main floor trusses, sheets of plywood 1⅛" thick were glued to the trusses, then nailed to the trusses. The plywood is then trimmed.

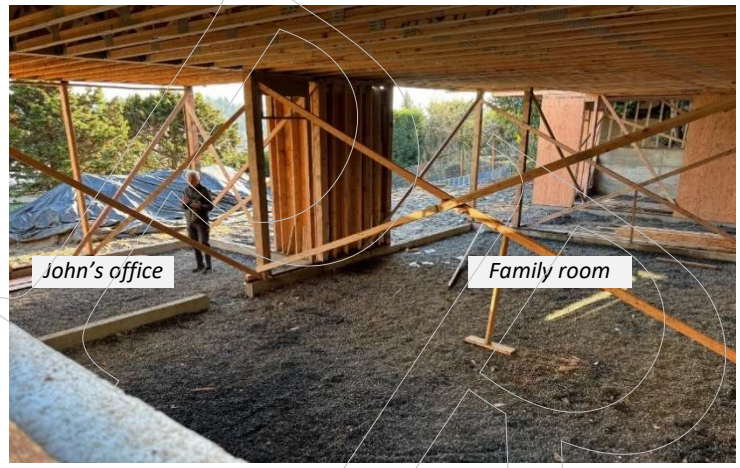
Here are some pictures of the main floor trusses from the lower level after being covered by plywood.

TJIs were used for the deck above John's office to support the weight of the pavers on the deck. They were also used in the garage ceiling.

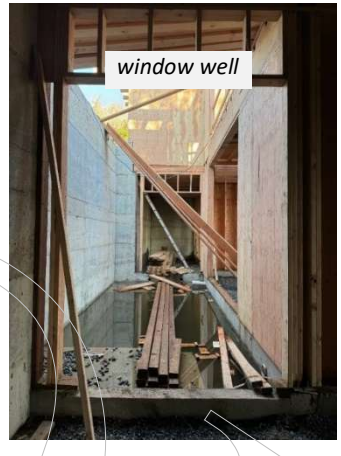
TJIs are supported and connected to the LSL beam using metal "hangers".



The distance from the lower ceiling to the main floor is the 18” truss then the 1⅛” plywood. The main floor wood floor will be installed on top of the plywood. The exception is John’s office ceiling and the garage ceiling. Instead of the open 18” trusses, TJIs are used that are 12”. The remaining 6” is needed for waterproofing and pavers.



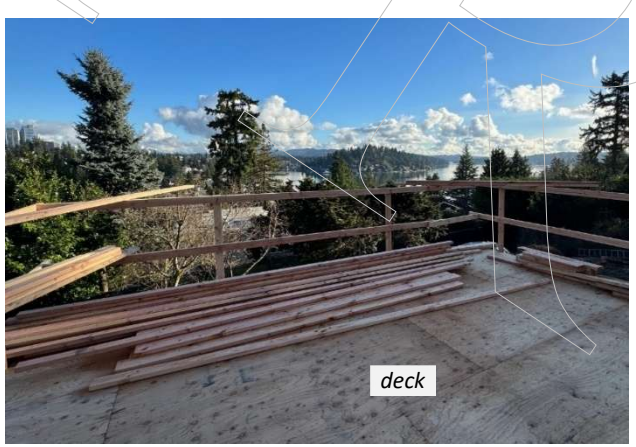
Here are some pictures of the lower level. The interior framing will be completed after the concrete floor is poured.



Here are some pictures of the main level framing. Wall sections were constructed on the floor then tilted vertically and secured.

looking W at front door from Great Room centre windows

Polly's office



deck

pantry

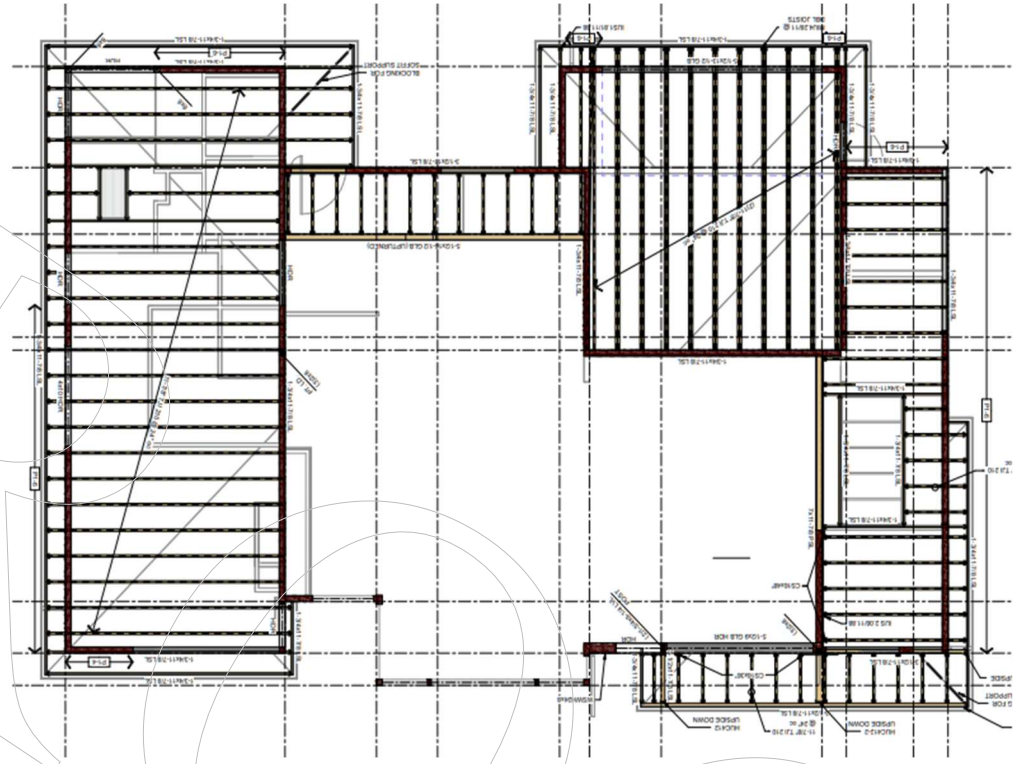
view from street looking E at garage and front door

The garage floor is 5" lower than the main floor since the garage floor will have approximately 5" of concrete.

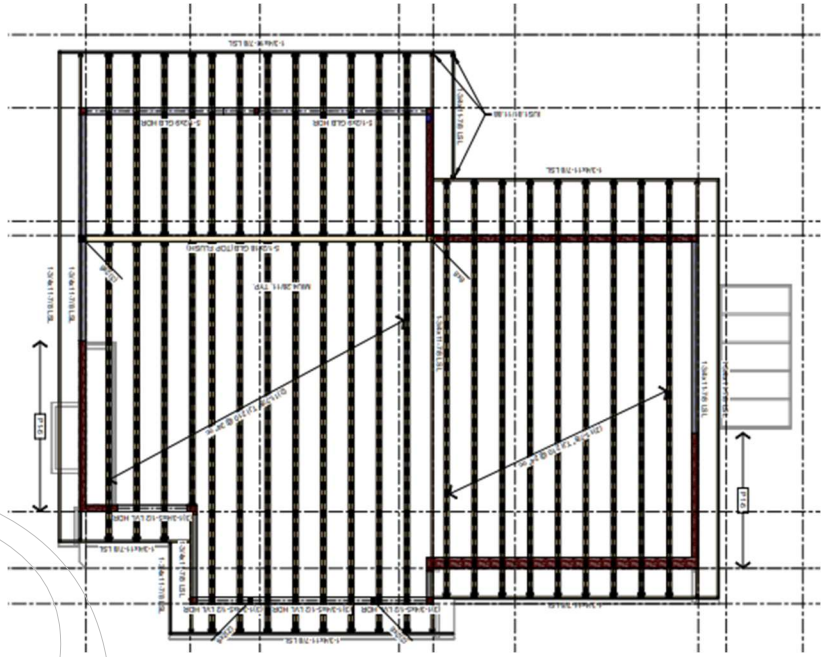
WEST

The drawing shows the lower (flat) roof framing plan from the CD set.

The picture below shows the lower roof being implemented.



WEST



The drawing shows the upper roof framing plan from the CD set.

The pictures below show the upper roof before and after being covered with plywood.

view of upper roof TJI beams from main level before covered with plywood

view of upper roof covered with plywood

The majority of the framing was completed on Jan 12, 2024. This includes:

- the outer wall studs
- the roof beams
- the outer wall plywood
- the roof plywood
- the interior rooms of the upper level

The lower level at this point is the gravel burrow. The framing of the interior rooms of the lower level can't be completed until the concrete floor of the lower level floor is completed.

Here are some pictures taken on Jan 12.


garage


front door


back yard view


view of Great Room from front door


view of front door and kitchen from Dining Room


view of Great Room and Dining Room from Kitchen

view of front door from Great Room

view of Kitchen and Polly's Office studs from Great Room

The internal walls use 2x4" studs – shown in these Master Bedroom pictures.

view of Master Bedroom from hallway

view of Master Bedroom and hallway

Master Bathroom shower studs

The main floor trusses are required to have 2x4s running perpendicular and nailed to the trusses to prevent sideways movement. These 2x4s are referred to as "rat runs". It may also be necessary to have one or more main floor trusses covered with plywood to prevent the spread of smoke and fire through concealed spaces. This is referred to as a "draft stop". This necessitates having to cut holes in the draft stop to accommodate ductwork, plumbing, etc.

rat run

draft stop

INTERIOR DRAINS

MAIN LEVEL

- powder room sink
- powder room toilet
- master bathroom sinks (2)
- master bathroom toilet
- master bathroom shower
- master bathroom tub
- kitchen island sink
- kitchen N counter sink
- garage sink

LOWER LEVEL

- bedroom 1 sink
- bedroom 1 toilet
- bedroom 1 tub
- bedroom 2 sink
- bedroom 2 toilet
- bedroom 2 shower
- bathroom 3 sink
- bathroom 3 toilet
- bathroom 3 shower
- playroom sink
- laundry room washer
- laundry room sink

Holes were cut in the main level plywood floors for 2 toilets.

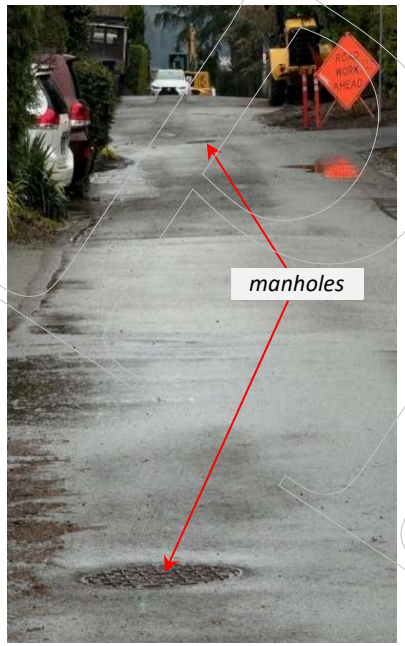
Drain pipes (black) are run through the studs by cutting circular holes. Drain pipes also go up through the studs to the plumbing vents on the roof. This allows fresh air to enter the drain pipes which is required to maintain water flow, prevent sewer gas leaks and to prevent clogs.

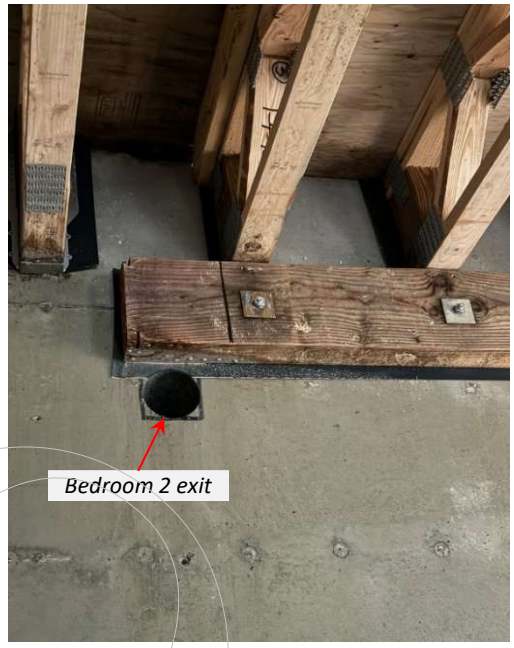
A frost-free faucet was also installed beside the city water meter to supply water when needed during construction.

example of a roof plumbing vent

exterior faucet beside water meter

The city sewer line runs down Upland Rd. The manhole covers in the street are for access to the sewer lines. Before demolition and excavation, a pipe ran from the property line to the city sewer line.





In the new house, waste water from inside the house exits via 2 holes drilled in the lower level W foundation walls of the Mechanical Room and Bedroom 2. Drain pipes from these holes are connected to the city sewer line.

In Bedroom 2, the floor trusses above the hole are supported by a horizontal board bolted to the W foundation wall. This was necessitated by the sunken shower floor in the Master Bathroom since “hangers” were not installed.

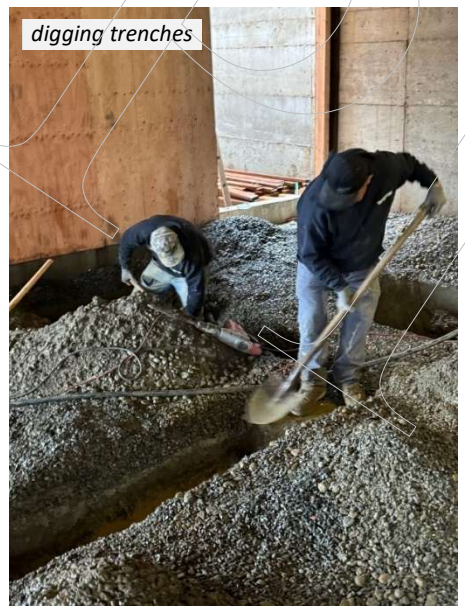
MAIN LEVEL DRAINS

Waste water from the 2 kitchen sinks and 1 garage sink travel by gravity through pipes between the floor trusses to the Mechanical Room exit. This requires the pipe to drop ¼” every foot.

Waste water from the Powder Room and the Master Bathroom toilet, sinks (2), shower and tub will travel by gravity through pipes in the floor trusses to the W wall, then down through the floor to the Bedroom 2 exit.

LOWER LEVEL DRAINS

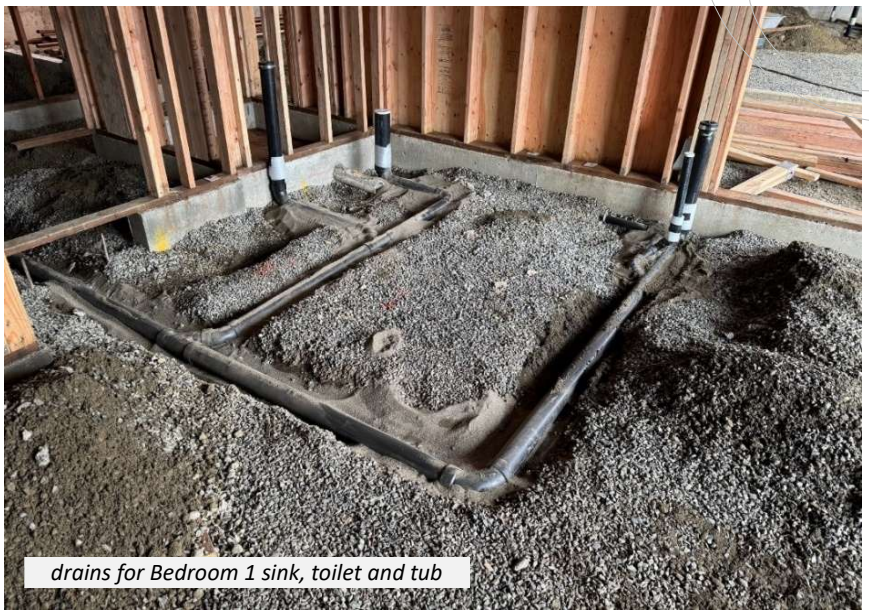
Waste water from the lower level sinks, showers and toilets will travel by gravity under the floor to a macerating pump in the Mechanical Room. This requires digging trenches that are several feet deep stretching from Bedroom 1 and 2 and from the Playroom and Laundry rooms. The pipes must drop at least ¼" per foot for the gravity feed to work. When the lower level waste water reaches the Mechanical Room, it goes into the macerating pump which grinds up any solid waste then pumps it up to the hole in the foundation wall that connects to the sewer line. The macerating pump is almost 6 feet high and about 3 feet in diameter. A deep hole had to be dug in the Mechanical Room floor so that the top of the pump was level with the floor.



digging trenches

John with Javier and macerating pump

Sand is placed under the drain pipes to protect them during the construction of the lower level floor.



drains for Bedroom 1 sink, toilet and tub

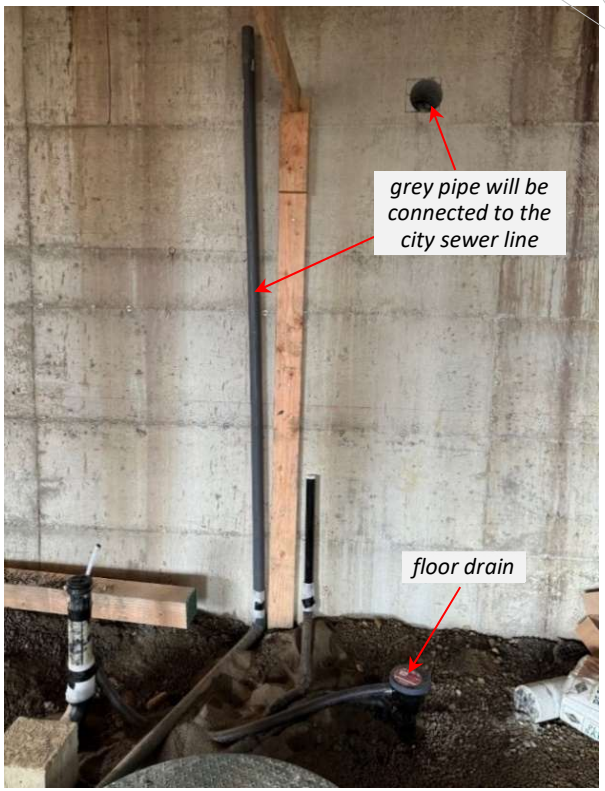
drains for Bedroom 2 sink, toilet and shower

All of the lower level drain pipes lead horizontally to the macerating pump in the Mechanical Room and drop at least ¼" every foot. Sand (rather than gravel) was used as a bed under the drain pipes to prevent the risk of damage when gravel is backfilled then concrete is poured on top.

pipe running from Bedrooms 1 and 2 to Mechanical Room through Sitting Area

drains for Laundry Room sink and drain, Bath 3 toilet, sink and shower, Playroom sink

connecting to the macerating pump



Some of the vertical pipes connect to the drains and toilets of the lower level. Vertical pipes beside the foundation wall run up through framing and insulation to a plumbing vent on the roof.

One of the vertical pipes in the Laundry Room is 10' high. This is temporary. It is filled with water to demonstrate to the city inspector that the pipes will drain water to the macerating pump in the machine room.

Holes were punched in the side of the pump to connect the incoming black drain pipes. The grey pipe is the pipe that takes the waste from the bottom of the pump out to the foundation wall then up and out to the sewer pipe connection. There is also a floor drain.

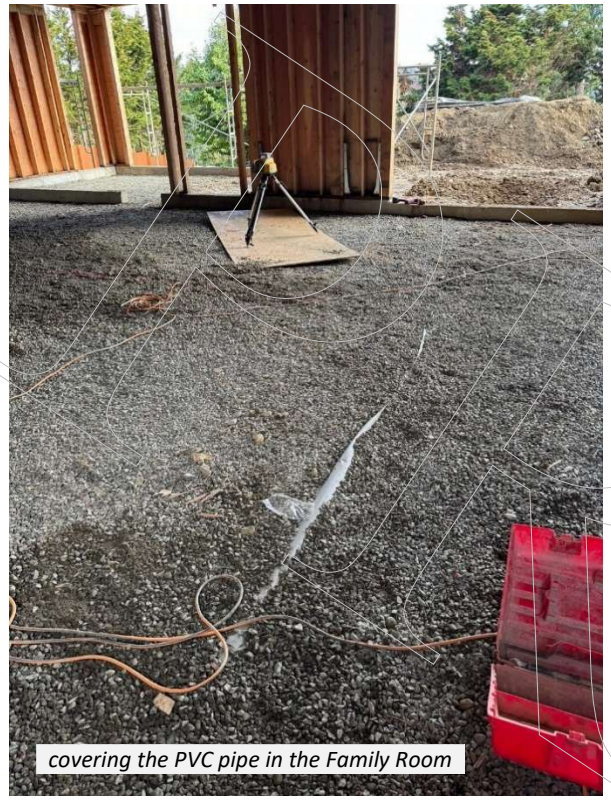
An inspection of the lower level plumbing occurred on Feb 8, 2024. This is required before the pipes can be covered.

After the underground plumbing inspection, the gravel that had been removed was backfilled to cover the black drain pipes.


Mechanical Room


Laundry Room and Play Room

Next, new trenches were created for underfloor drain pipes – white PVC pipes with holes to collect any underground water. Fabric was placed under the white pipes before backfilling. Holes were drilled in the E foundation walls in John's Office, the Family Room, the Atrium and Bedroom 1 for the white pipes to exit the interior where they were connected to the white drain pipes outside the foundation walls that lead to the catch basin.



covering the PVC pipe in the Family Room

covering the PVC pipe in the Atrium

underfloor drain pipe exits the foundation wall in John's office and is connected to the exterior drain pipe

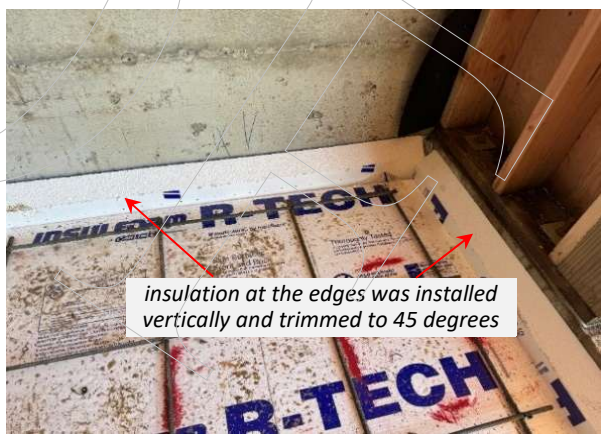
backfilling after connecting to drain pipe

PVC cement used to connect the white pipes

FLOOR PREPARATION

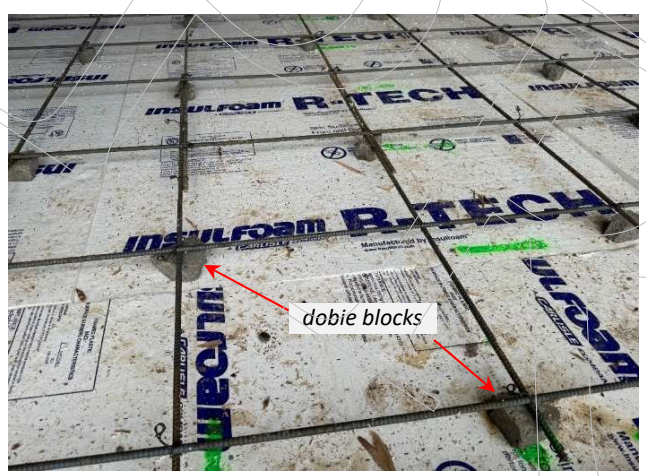
After the white underfloor drain pipes had been backfilled with gravel burrow and 5/8” clear crushed rock, a yellow hard plastic vapour barrier was laid over the gravel and taped together with very strong red tape.

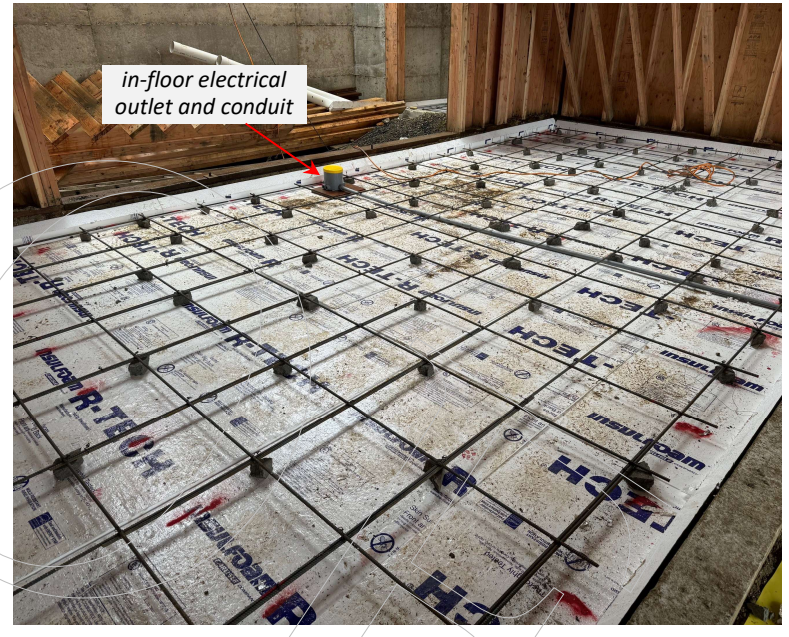
Next, sheets of insulation were placed on top of the vapour barrier. At the edges, a piece of insulation was installed vertically and trimmed to 45 degrees.



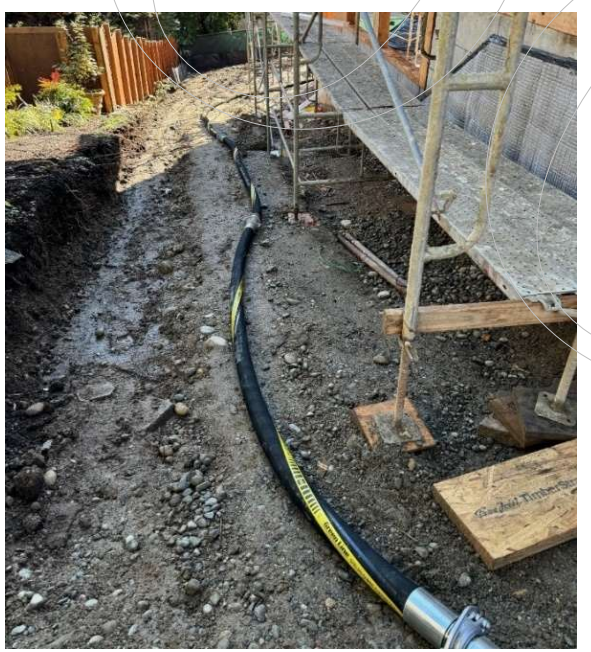
Rebar was placed on top of the insulation in preparation for pouring concrete. "Dobie blocks" (small pieces of concrete) were placed under the rebar.

In-floor electrical outlets were installed in 4 locations – 2 in John's office, 1 in the Family Room, 1 in the Sitting Area. The yellow patch (missing insulation) is the bottom of the staircase. The staircase shown is temporary and was removed before the concrete was poured. The real staircase will be steel and will descend from left to right (not the right to left used by the temporary staircase).





On Feb 22, concrete was delivered to a pump truck with a long hose that ran from the truck around the N side of the house into the lower level. The concrete delivery truck transferred its concrete to the pump truck.



The concrete flow was controllable by a remote operated by one of the workers. One worker held the hose and directed the flow. The other workers spread out the concrete using a “concrete placer” tool (with a 5’ long handle). 5” of concrete was poured. The wood floor will be built on top of the concrete.

using a concrete placer

After the concrete has been spread out, an 8’ long aluminum “H screed” was used to smooth the concrete. In areas where the screed couldn’t reach, a trowel was used.

using a screed

using a trowel

A “bull float” with a long handle and a round end “rock n roll” bracket was used for the final smoothing.

using a bull float

After smoothing, lines are made in the concrete to prevent cracking. We were able to walk on it the next day. It turned out very nicely.

FRAMING

With the lower level concrete floor completed, the lower level framing could now be completed. The dark brown 2x4s showed where the walls were to be constructed.

Also, we decided to make the Playroom and Gym into a single room. Originally, we had a wall with 3 sections that could be hidden in the wall of the Mechanical Room in order to combine the 2 rooms. The ceiling framing was removed.

Being present when the framing was taking place allowed us to make changes. We moved the wall between John's Office and the Laundry Room to enlarge the Laundry Room and eliminate dead space. This was something we didn't previously realize when we were evaluating the architect's floor plans.

FAMILY ROOM CEILING STRUCTURE

A square structure was framed that will have 4 small can lights and a 120V outlet. An LED light strip will be installed to produce indirect lighting.

ROOFING

There is a lower roof (flat) with a higher roof (pitched) in between. The lower roof is “torchdown”. The higher roof is metal.

The roofers started Jan 22, 2024. The bluish-green material on the upper roof is called “ice and water shield”. It protected the plywood until the metal roof was installed. The black material on the lower roof is called “base coat”. It is the first layer of 3 of the torchdown roof.

ice and water shield installation

base coat installation in progress

Here is a picture of the roof on Jan 30. The base coat and ice water shield coverings have been completed. Water can’t penetrate from the roof.

TORCHDOWN ROOF

On Feb 9, the roofers started on the 2nd layer of the lower roof. The 2nd and 3rd layers are a modified bitumen compound rolled out in strips. Then adjacent strips are melted together. The 2nd layer is called “smooth torchdown” because it is entirely smooth on the underside. The 3rd layer is called “granulated torchdown” because it has granules and is rough on the underside.

The edges of smooth and granulated torchdown are both smooth since they are meant to overlap the adjacent strip. Adjacent strips are heat welded together by lifting the upper strip, applying a flame to melt the edge, then using a trowel to press down on the upper edge so that the membranes bond.

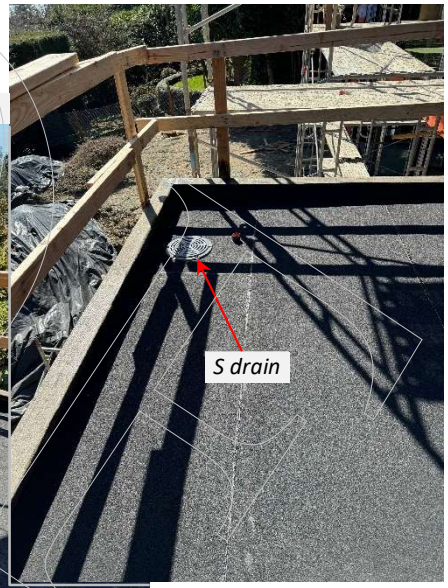
The lower roof had a parapet made of plywood with openings for water to reach the gutter that will be installed on the edge of the roof. Torchdown was installed on all 3 sides of the parapet as well as inside the openings.


SE corner

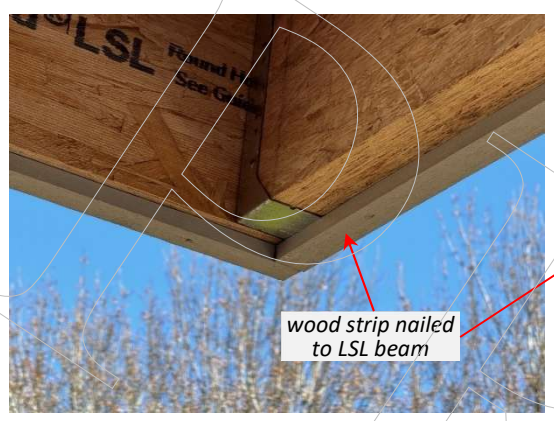

installing torchdown in the parapet opening

The deck and the Master Bedroom (MBR) balcony also had the torchdown layers installed over the plywood. The balcony had 1 drain in the centre and the deck had 2 drains at the NE and SE corners.

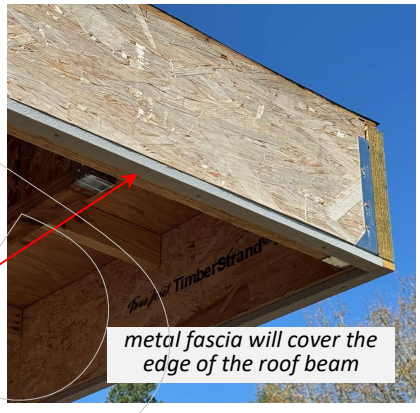

MBR Balcony



After completing the torchdown of the roof, deck and balcony, the fascia ie, the metal covering the edges of the roof, was installed. First, a strip of wood was nailed under the LSL roof beam for the metal fascia to wrap around. The metal was then cut and bent to create the correct shape.



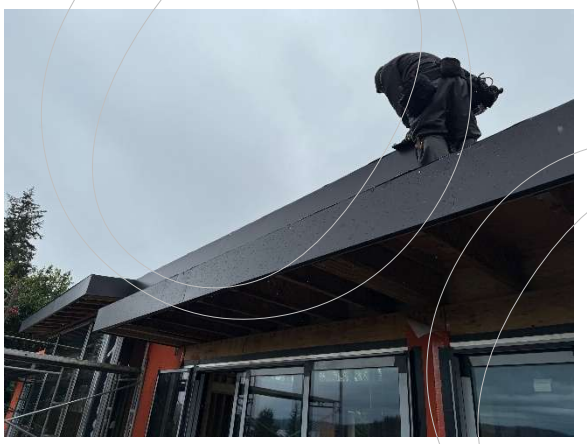
wood strip nailed to LSL beam



metal fascia will cover the edge of the roof beam


cutting metal to desired size


bending metal to fit around roof edge



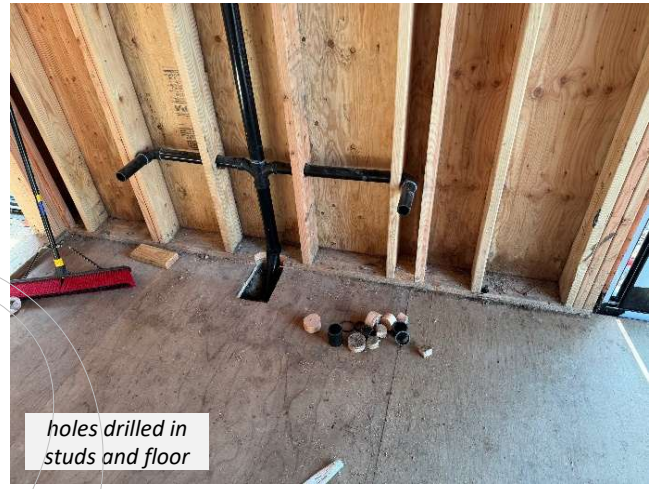
After completing the fascia, the custom gutters were created using the same process of bending the metal.

METAL ROOF

On Apr 12, 2024, the long metal sheets used to construct the upper roof arrived. They were installed as shown in the pictures. The fascia of the metal roof was also installed.

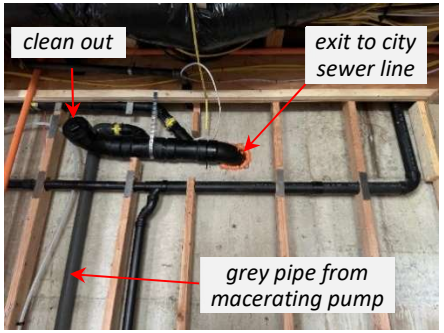
DRAINS

Drains in the lower level had to be installed before the lower level floor could be completed. With the lower level framing completed, the remaining drain pipes were installed. These pipes travelled through holes that were drilled in the studs, joists and floor. They also travelled through the main floor trusses. Some black pipes travelled up through the framing to a plumbing vent on the roof.



Drain pipes were inserted in the foundation wall holes of the Mechanical Room and Bedroom 2. These pipes exit the foundation wall several feet below ground and will be connected to the city sewer lines later in the project.

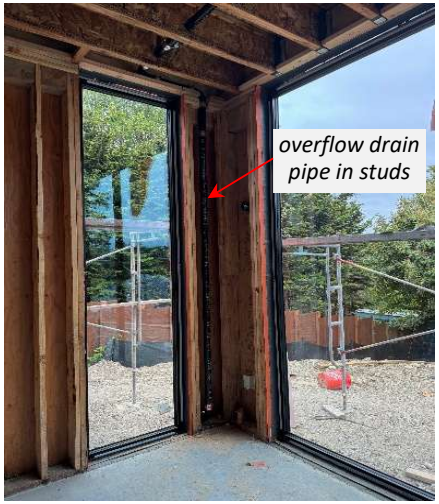
In the picture, the vertical grey pipe from the macerating pump below connects to a large black drain pipe that exits to the city sewer line. The end projecting forward is the clean out.



There are two connected drains in the corners of the deck and one in the centre of the Master Bedroom balcony. There are also overflow drains that travel down the exterior wall through the studs and exit outside.

deck corner drain and overflow

deck corner drain and overflow viewed from John's Office

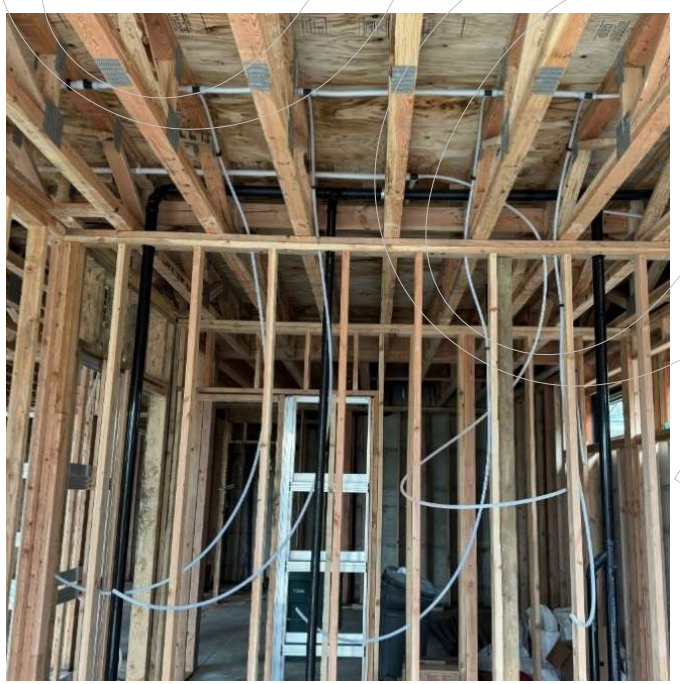


overflow drain pipe in studs

overflow drain exit outside John's Office

SUPPLY LINES

After the drain pipes (black) were completed, the supply lines were installed. The pipes used for supply lines are called "pex". The are made from "cross-linked" polyethelene which is a stronger and more durable plastic than standard polyethelyene. The pex used in the house are white with red lettering for hot water, and white with blue lettering for cold water. These pipes run through the main floor trusses to the sinks, toilets, showers, bathtubs, refrigerators, dishwashers, etc. on the main and lower levels.

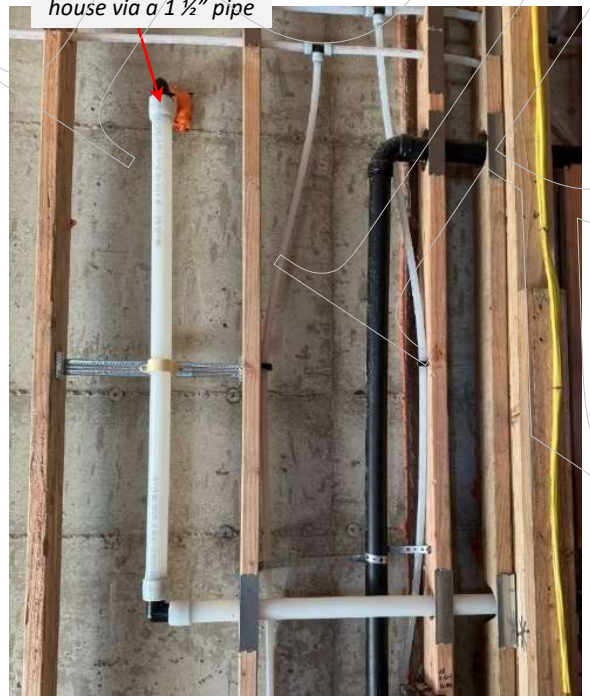


drain and supply lines under kitchen island

Potable water is provided by the City of Medina from its “water main” that runs down the middle of Upland Rd. The “water service pipe” flows through the water meter (located in front of the house at the property line) to the W foundation wall and enters the house at the Playroom on the lower level as a 1 ½” pipe. That pipe then forks into 2 pipes:

- a 1 ¼” pipe that goes to the fire sprinkler system
- a 1 ¼” pipe that forks into two pipes:
  - a 1 ¼” pipe that goes to the cold water fixtures
  - a 1 ¼” pipe that goes to the hot water heater

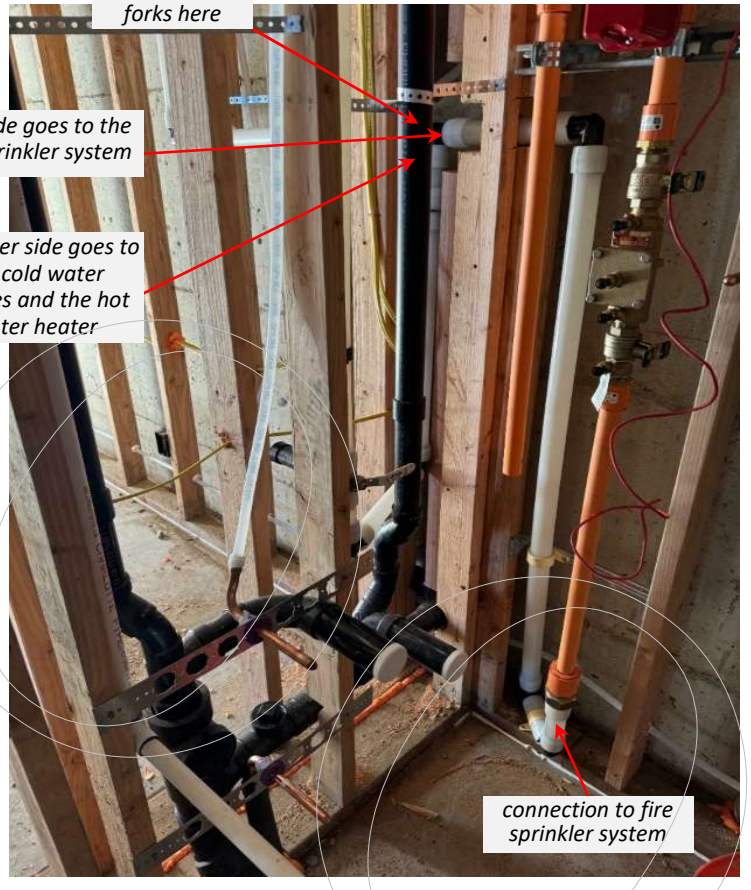
city water enters the house via a 1 ½” pipe



city water pipe forks here

one side goes to the fire sprinkler system

the other side goes to the cold water fixtures and the hot water heater



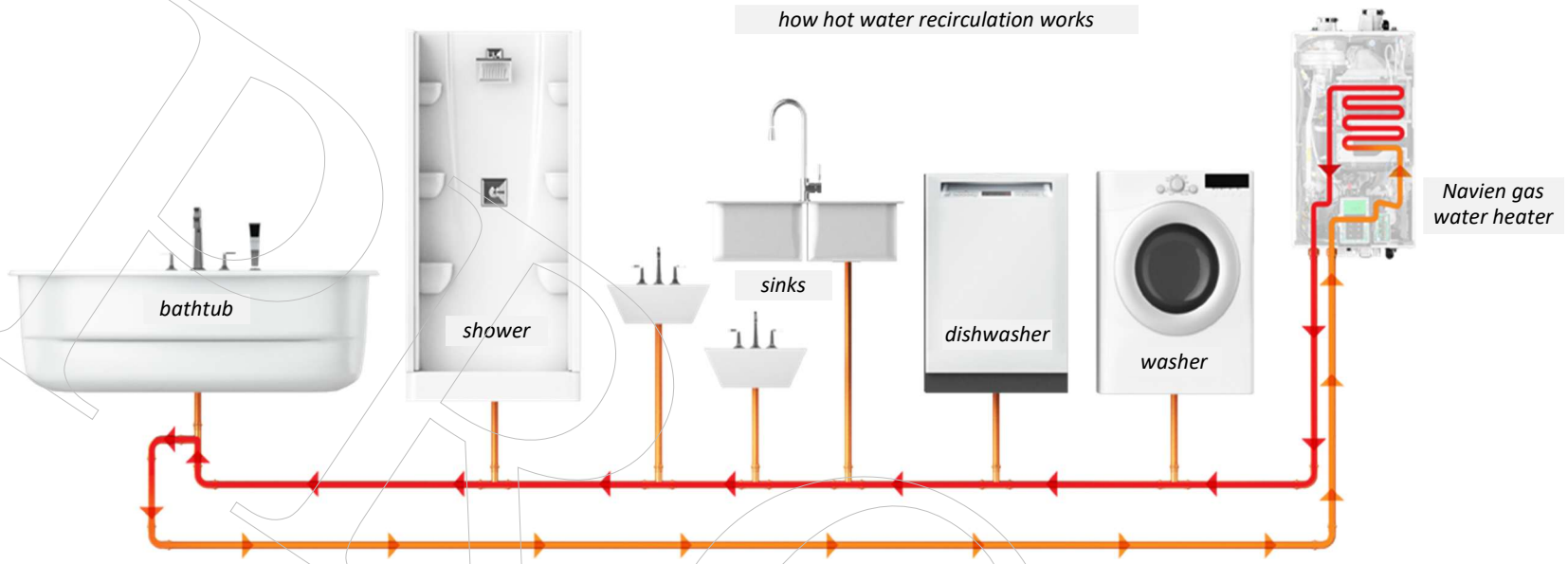
connection to fire sprinkler system

Navien gas water heater

The water heater used is a Navien tankless gas water heater. It is more efficient than traditional gas and electric water heaters because it only heats water when it is needed. It is also much smaller: 17.3” w 27.4” h 13.2” d.

The Navien detects when a hot water tap is opened. Its flow sensor detects the flow and determines how much water is needed. The gas burner ignites a flame to heat the water. The cold water passes through a heat exchanger where it is rapidly heated.

The Navien has a built-in “recirc pump”. Hot water is continually being circulated throughout the house in a loop. Every fixture requiring hot water is fed by a forked connection.



The hot water supply line needs to fork at the furthest location with some of the water returning to the Navien where it is re-heated then recirculated. This decreases the time required for the water to get hot.

Cold water is not a loop. Fixtures are fed from forks off the cold water lines but the water is not recirculated. This is called a "Direct Water Supply" system – the water main from the city directly feeds cold water to all the fixtures that need it. It also feeds the water heater.

The Navien gas water heater was mounted on the S wall of the Mechanical Room. It has 3 supply lines. The right line is a 1 ¼" pipe with potable water from the city. It is converted to a ¾" pipe before entering the Navien. The left line is the output hot water (¾" pipe) and the centre line is the return warm water (¾" pipe).

Pex is connected together using the following tools and fittings. To cut pex to the right length, a ratchet cutter is used. To connect 2 pieces of pex, a fitting is used. Fittings can be straight ("coupling"), 90 degrees ("elbow") or forked ("tee").

ratchet cutter

coupling

elbow

tee

A Poly Expansion Sleeve (or Ring) is placed on the end of the pex. Then it is inserted into the Power Expansion Tool that stretches the pex outward. Then the fitting is pushed into the stretched end. This method for connecting pex is called "Cold Expansion".

Poly Expansion Ring

Power Expansion Tool

elbow fitting connected to pex

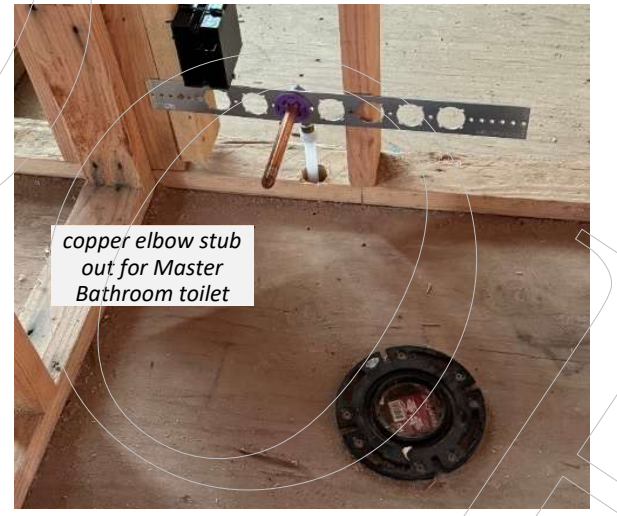
Here are some pictures that show the process.

The cold and hot supply lines used for faucets are terminated in “faucet outlet boxes” that contain small valves. The cold supply lines going to toilets are terminated in a copper tube called a “copper elbow stub out”. These supply lines are ¾” pex.

Master Bathroom
2 faucet outlet boxes for
2 sinks in vanity

Laundry Room
faucet outlet box
for washer

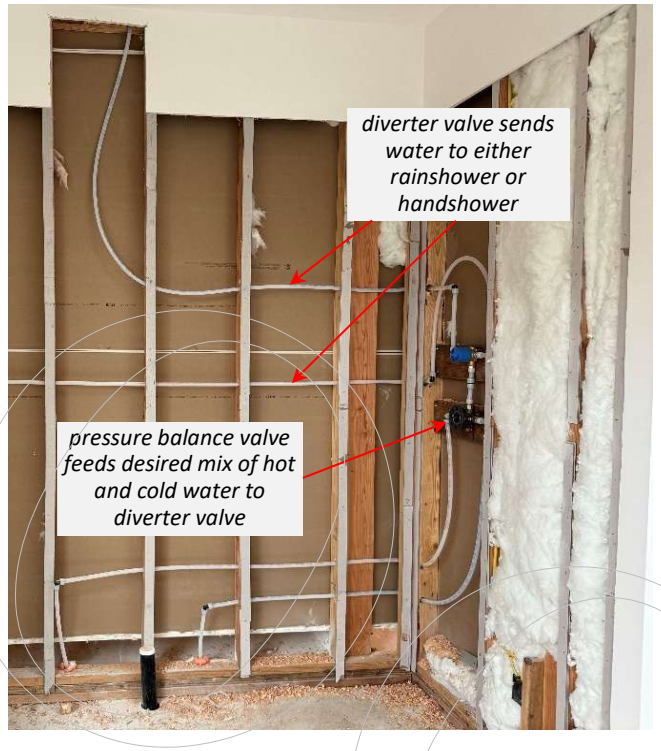
copper elbow stub out
for Powder Room toilet



copper elbow stub
out for Master
Bathroom toilet

Work started Oct 24, 2024 installing the fixtures in the studs after the tile preparation work had begun. The pex supply lines were already in place. They needed to be connected to the plumbing fixtures.

Let's look at the Master Bathroom shower. The other bathrooms shower/tubs are similar. Hot and cold pex supply lines are fed to a "pressure balance valve" used to select the mix of hot and cold in order to achieve the desired water temperature. The water output from the balance valve goes to the "diverter value" which routes the water either to the rainshower or to the handshower.



HOSE BIBS

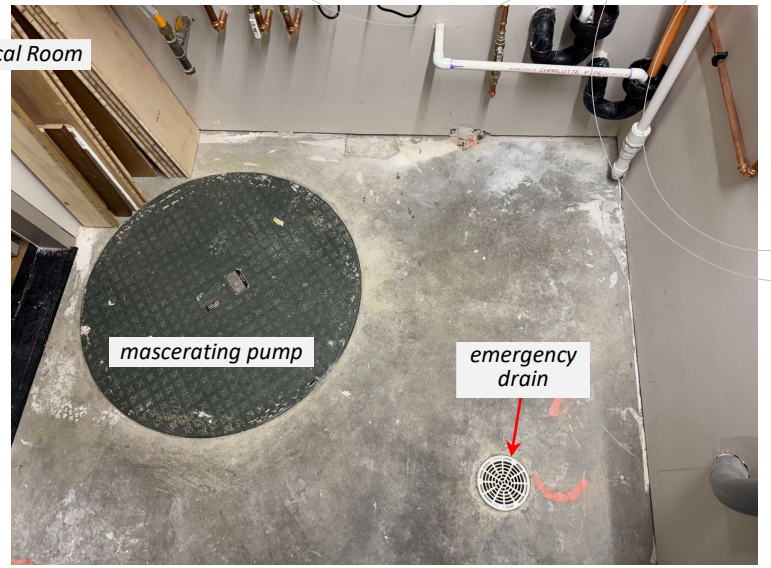
Cold supply lines are used for hose bibs installed in 7 locations:

- window well outside bedroom 2
- Atrium under aquarium (hot and cold water)
- NE corner outside John's office
- SE corner outside Bedroom 1
- right of garage door
- on W wall at front door
- deck

The hose bibs used are called "frost free hose bibs". They slope downward toward the spout to drain water. An interior shutoff value also protects water from building up and freezing in the pipe.

EMERGENCY DRAIN

There is an emergency drain in the floor of the Mechanical Room fed from a supply on the S wall that provides a constant "drip" to block sewer gases (similar to a P- or S-trap).



LINK SEALS

The holes in the foundation wall are larger than the pipes. To create a perfect seal, a device called a “link seal” is used. Link seals are a mechanical seal supplied in a belt form with a series of interconnecting rubber links, pressure places and bolts. When tightened, it creates a gas, air and water tight seal between the outside and inside drain pipes. This stops any ground water from getting into the house.

Link seal

after installed and tightened

after covering with a sealant

drain pipe from Mechanical Room

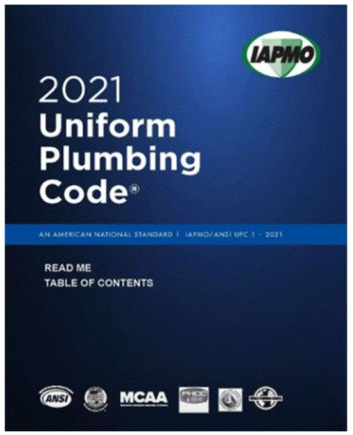
water main pipe from Play Room

The pipes were fitted with a cap until they are connected to the city sewer and water lines respectively.

PLUMBING IMPLEMENTATION PLAN

It is worthwhile pointing out the considerations that go into the implementation of the plumbing in a house. Determining how to implement the water supply for a house starts with calculating the total Water Supply Fixture Units aka WSFUs. We need to know the number of toilets (water closets), lavatories, bathtubs, showers, sinks, dishwashers, washing machines etc. that will be connected. WSFU is a measure of the water flow rate through a specific fixture. Values can be found in the the plumbing code. There are 3 primary plumbing codes used in US: International Plumbing Code (IPC), Uniform Plumbing Code (UPC) and National Plumbing Code (NPC). Washington State uses the UPC. Here are its WSFU values:

Fixture	Type of Control	Quantity	Cold	Hot	Total
water closet	flush tank	4	5	0	20
Lavatory	faucet	4	0.5	0.5	2
sinks (kitchen, laundry, garage)	faucet	3	1.0	1.0	3
shower head	mixing valve	4	3.0	3.0	12
bathtub	faucet	2	1.0	1.0	2
washing machine	automatic	2	3.0	3.0	6
dishwasher	automatic	1	-	1.4	1.4
TOTAL					46.4



The gallons per minute (GPM) value is less than the WSFU value since the use is intermittent. The code specifies a value of 29.1 GPM for a WSFU of 50.

The plumber needs to know the minimum daily static pressure available available from the city. This is needed to ensure that during peak water usage, pressure is available to operate the most demanding fixture. In our case, it is 60 PSI.

Pressure is also lost due to height if water has to travel up pipes. This is not an important consideration in this house.

We need to identify the remote fixture that requires the greatest pressure to produce a flow. In this house, it is the shower head in the Master Bathroom. The manufacturer documentation needs to be consulted to determine the minimum PSI required for proper operation.

There is some pressure loss from the water meter but it isn't a significant consideration. There is also some pressure drop from the water flowing through the pipes and fittings. The plumbing code can be consulted to determine the pipe sizes to use. Our implementation starts with a 1 ¾" pipe from the city which becomes 1 ¼" going to the cold and hot water circuits. The 1 ¼" supply lines travel through the main floor trusses to the target fixture where the supply lines ultimately become ¾".

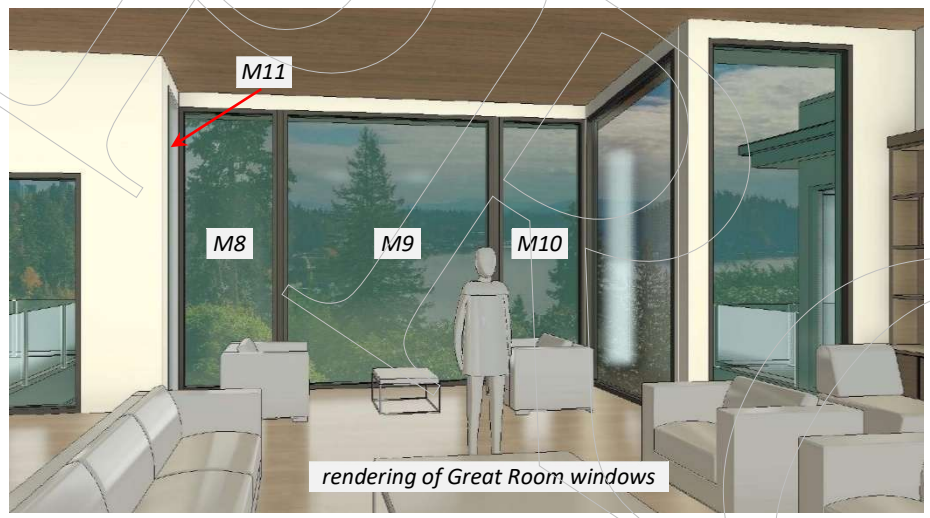
A Pressure Regulating Valve (PRV) may be used to restrict excessive water pressure. This is required when the pressure exceeds 80 PSI to reduce "water hammer" in order to protect the pipes, fixtures and equipment. In the City of Medina, water pressure generally falls between 60 and 80 PSI so there is no need for a PRV.

The total pressure required is determined by adding up all the pressure losses and the required minimum pressure at a remote fixture with the highest requirements. This value needs to be greater than the minimum water pressure available from the city.

In our implementation, the plumbing contractor had the CD set with the floor plans and fixtures. He also knew the water pressure available from the City of Medina. He determined what needed to be implemented for the drains and supply lines.

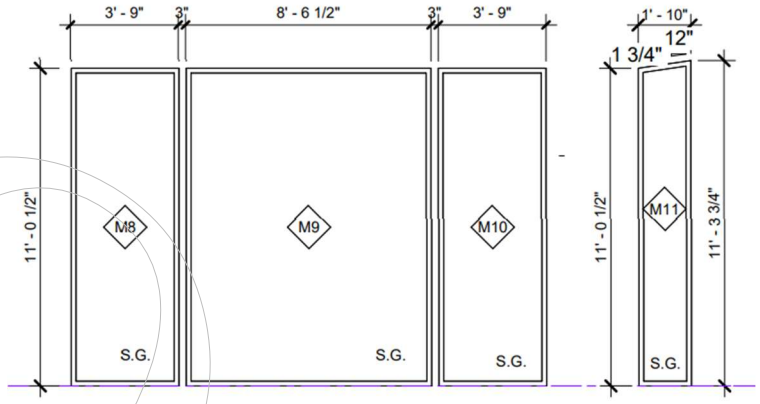
SHOP DRAWINGS

The external doors and windows were provided by a local company called Aeroframe. The aluminum frames were manufactured in Korea and the glass was manufactured in British Columbia, Canada. Aeroframe was chosen since they were able to provide floor-to-ceiling glass without mullions (the separators with multiple panes of glass). The only restriction was that the one side could not exceed 8'. So for the large Great Room window shown in the rendering, it was restricted to 8' wide. It is 11' tall.



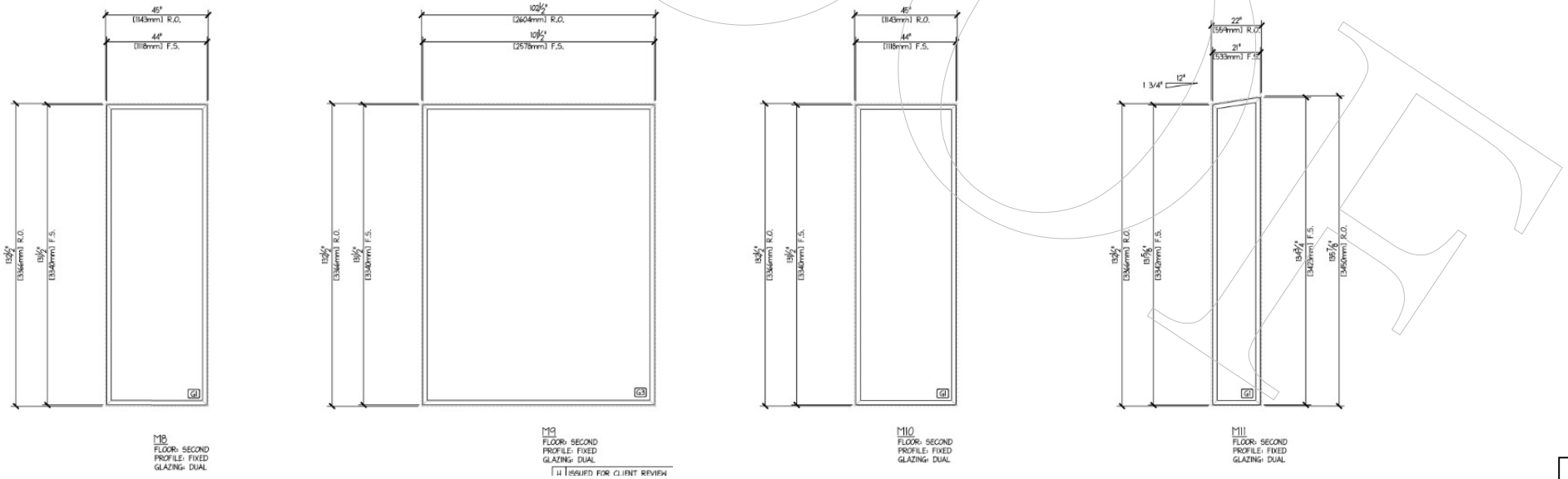
rendering of Great Room windows

Baylis architectural drawings of Great Room windows from CD set



Aeroframe created "shop drawings" for every exterior window and door. They were carefully reviewed by John and by the architects before being approved.

Aeroframe shop drawings for Great Room windows



INSTALLATION

Scaffolding was installed around the house in preparation for the installation of the windows. The window frames are shown leaning against the walls protected by a cardboard wrap. The largest frame is laying in the middle of the floor.

Metal “flanges” (aluminum) are used to connect the frame to the studs. First, the flanges are screwed to the 4 sides of the frame. Then the frame is positioned between the studs and the flanges are screwed into the studs.

flanges as delivered

1 flange screwed to frame

frames with flanges ready to install

Installing the windows and doors properly is a major effort requiring significant attention to detail. They need to be waterproofed. They need to be positioned exactly and they need to be perfectly level.

Before installing the doors to the deck and the Master Bedroom balcony, the roofers had to install the base coat and smooth torchdown layers. This was previously described in the Roofing chapter. Then a thin metal strip (called "flashing") was caulked to the torchdown. The purpose of flashing is to direct water away from vulnerable areas and prevent leaks. Next, orange and black waterproofing products were applied to the studs. These products had an adhesive back that could be peeled off making them easy to apply.

installing smooth torchdown on Master Bedroom balcony

flashing for under door

orange and black waterproofing products applied to a stud

The frames were caulked to the black waterproofing product then the flanges were screwed into the wood. Caulking is not applied at the bottom in order to allow unexpected water to drain. This makes for a very good seal against water intrusion. A wall mounted laser guide was used to ensure that the frames were level. If required, shims are used to adjust the vertical position.

Here are some pictures of the installed frames before the glass was installed.


Dining Room


Polly's Office


Master Bedroom

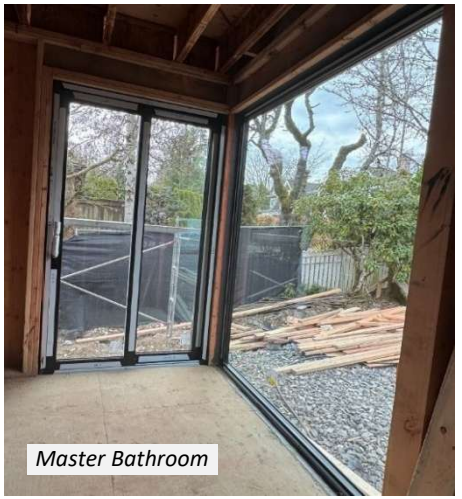

Master Bedroom hall outside

The glass was delivered in large crates. "Grabo" devices were used to create "carrying handles". They were pressed against the glass then turned on to create a vacuum seal. The large window in the Great Room weighed about 800 lbs. It took 6 men to move.

Here are some pictures after the glass was installed:


Dining Room and Great Room


Great Room 8 X 11 centre window


Master Bathroom


Atrium from Sitting Area


Atrium from Family Room


John's Office

WINDOW WRAP

After the exterior windows and doors were installed, white wood called "window wrap" was installed inside around the window and door frames. It is used rather than drywall in quality homes since drywall can be impacted by moisture and condensation that may occur around the windows and doors. It needs to be cut to the exact size for each window.


Master Bedroom hall unit


Laundry Room


Master Bathroom


John's Office

SIDING

There were 8 steps to complete the exterior vertical walls:

1. waterproofing membrane
2. rainscreen system
3. metal lath
4. scratch coat
5. brown coat
6. base coat
7. prime coat
8. finish coat

WATERPROOFING MEMBRANE

The first step was to protect the wood framing by covering the external plywood walls with a waterproofing membrane. The orange Wrapshield product was used (also referred to as “frog skin”). This membrane allows vapor to pass through but not liquid water thus preventing moisture damage.

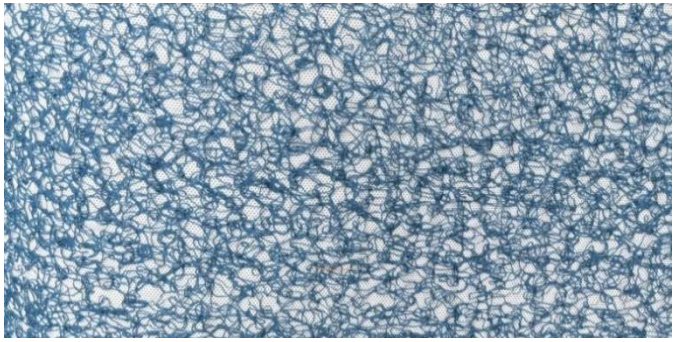

N Wall


S Wall


W Wall

RAINSCREEN SYSTEM

The second step is to install a “rainscreen” layer over the frog skin. WaterWay Rainscreen Drainage Mats were used (made by Stuc-O-Flex). Some are blue and some are white on the inner side. They have an unusual texture – like plastic tendrils - on the inner side to provide a channel for ventilation and for moisture to escape. The mats actually consist of a polypropylene (plastic) core of fused, entangled filaments in varying thicknesses (1/8” to 3/4”) depending on the desired cavity space and cladding selection. The core is bonded to a moisture resistant filter fabric that functions as an additional weather resistant barrier.



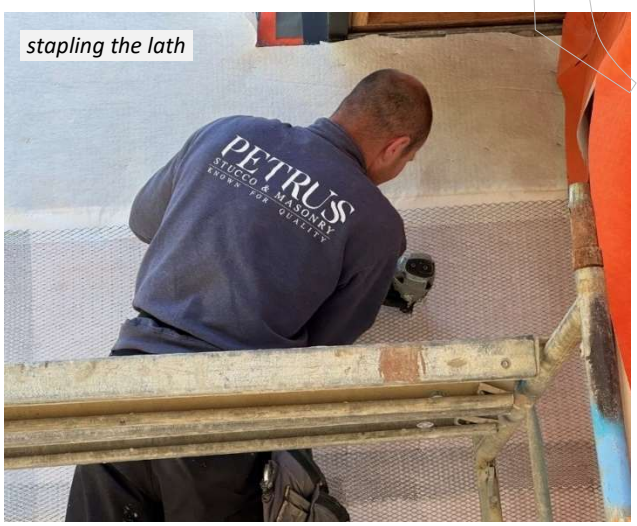
The rainscreen is stapled to the wall.




METAL LATH

The third step is to install a wire mesh referred to as a "self-furring metal lath". It was stapled to the rainscreen using a staple gun connected to a compressor. The lath improves the structural integrity and adhesion of the plaster applied. Lath comes in different sizes. We used a very fine lath which produces a higher quality result.

stapling the lath

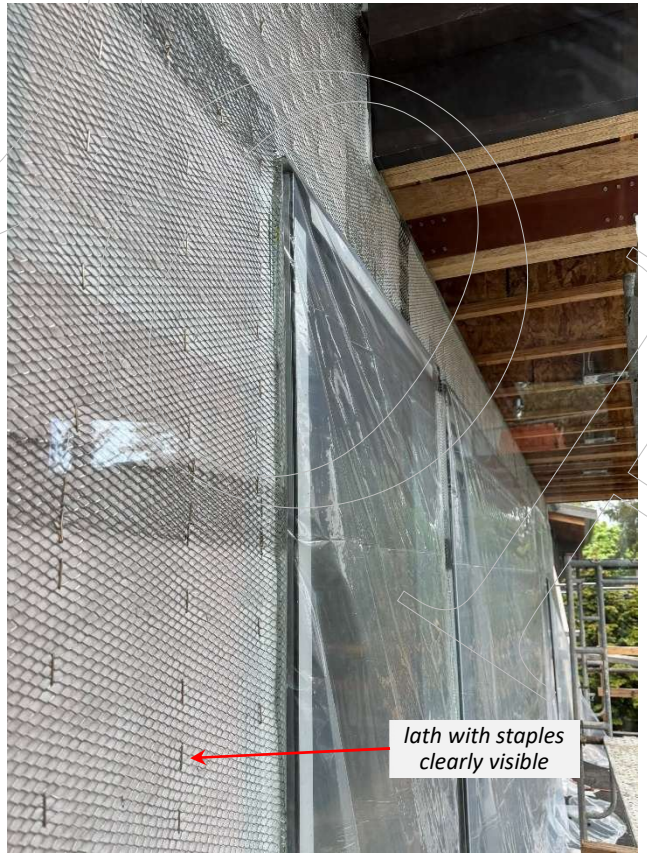


staples on the inside protruding through the plywood wall

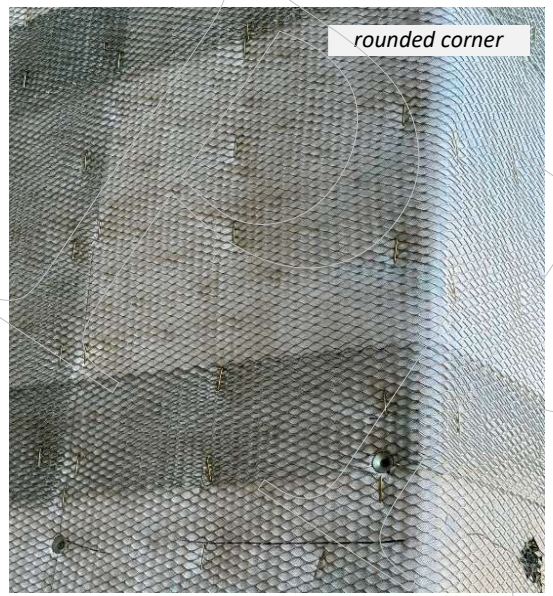
staples

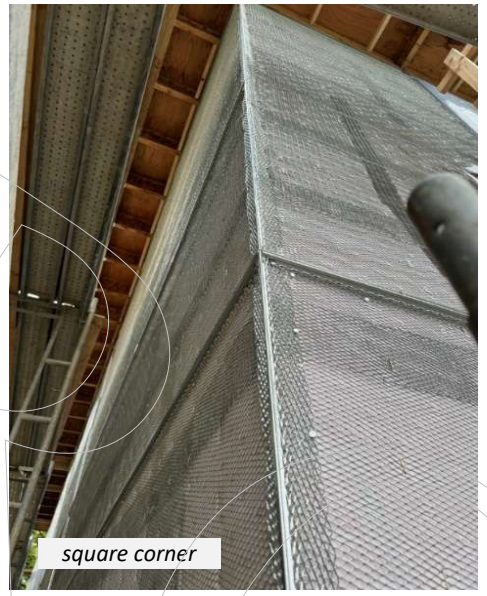
staple gun

compressor



At the corners where the lath was rounded, metal strips were attached to create perfectly square corners. Metal strips were also used to create seams to prevent the future cracking of the stucco from expansion and contraction due to temperature changes.


rounded corner


square corner


square corner

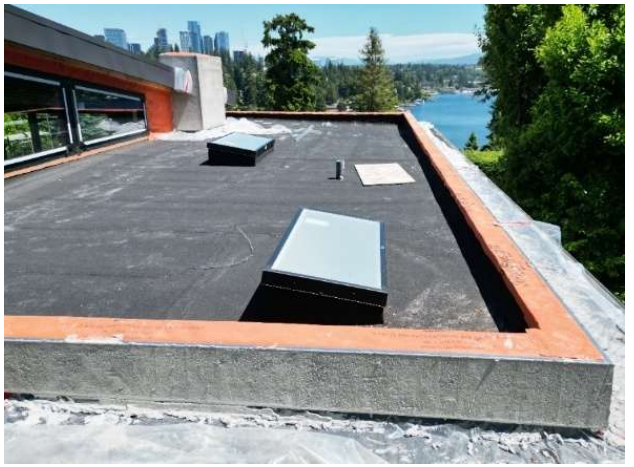

creating seams

SCRATCH & BROWN COATS

A mixer was used to prepare the scratch coat. It is applied over the metal lath. It is rough and streaky to make it easy for the next coat to adhere.

After the scratch coat, the brown coat is applied over the scratch coat using a trowel. The roof parapets also required the same treatment.

The scratch and brown coats are a proprietary blend of Portland cement (the most common type of cement), pozzolans (cement substitutes), durable synthetic fibers and chemical additives. These coats are designed to produce superior adhesion and to reduce cracking.



BASE ACRYLIC COAT

After the brown coat, the base acrylic coat was applied. The Stuc-O-Base product was used. It uses a high quality acrylic polymer that provides an excellent adhesive and underlayment for use with acrylic finish coats. It is mixed 1:1 by weight with Portland cement before applying.

base acrylic coat above, brown coat below

base acrylic coat being applied using a trowel

base acrylic coat above, brown coat below

PRIME ACRYLIC COAT

After the base acrylic coat was completed, the prime acrylic coat was applied using a roller. This extends the lifetime of the finish coat and enhances uniformity in appearance.




FINAL ACRYLIC COAT

The final coat is applied twice using a trowel. It is the final colour that was chosen for the house stucco siding. The Stuc-O-Flex Elastomeric Acrylic Finish product was used since it provides superior resistance to surface cracking. It is extremely durable as well as fade and mildew resistant.


final coat (darker) above, prime coat below


final coat (NW corner)


final coat (front wall)

After the scaffolding is removed, we are able to appreciate the results.


SE corner


NE corner

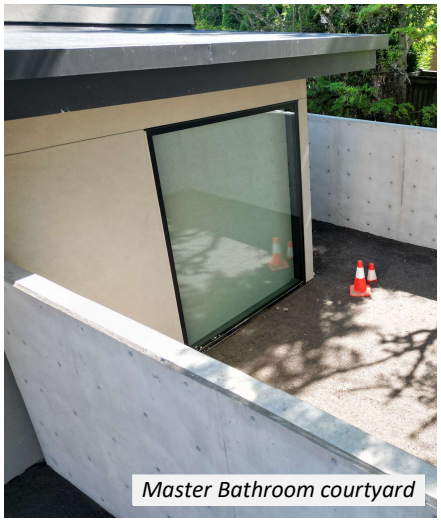

NW corner

This is what the house looked like at the end of the project:


front entry


N side


SE corner

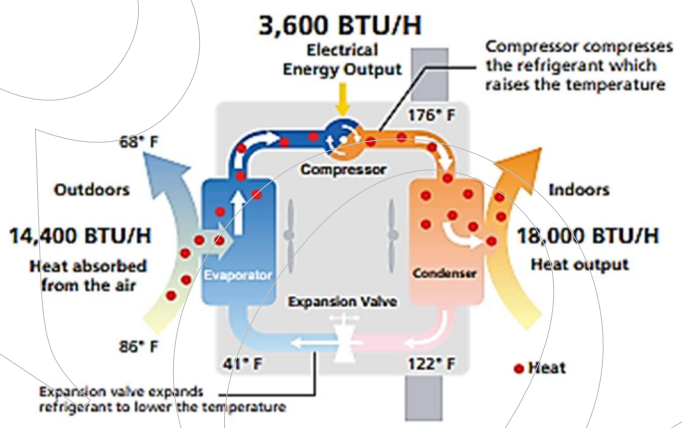

Master Bathroom courtyard


back view

HEAT PUMP SYSTEM

The new house uses a Mitsubishi heat pump system for heating and air conditioning that operates on electricity. There is no gas furnace. There are indoor and outdoor units. The outdoor units are Mitsubishi MXZSM48 multi-zone hyper heat units. They are mounted vertically on the N side of the house on a platform built to accommodate. Each outdoor unit has 2 fans. They can operate at 90% capacity down to -13 deg F. The indoor units are Mitsubishi PEAD air handlers aka "cassettes". They are mounted in the ceilings of the lower level. They require a dedicated 240 V circuit. These systems are referred to as "mini-splits" since they have two functional components: an outdoor condenser/compressor unit, and smaller indoor air handling units.

outdoor unit



how a heat pump works when heating

indoor unit

The indoor and outdoor units are connected by inbound and outbound copper pipes that contain the refrigerant R-410A. This refrigerant replaced R-22 (Freon). It is not harmful to the ozone layer since it doesn't contain chlorine.

A heat pump system exploits the fact that the refrigerant's boiling point is affected by pressure. Lowering the pressure lowers the temperature at which the fluid evaporates, ie, changes from liquid to gas. Raising the pressure raises the temperature at which it condenses ie, changes from gas to liquid.

In heating mode, the outdoor unit's heat exchanger absorbs heat energy from the surrounding outdoor air (which can be below freezing). This raises the temperature of the refrigerant. The hot refrigerant is transferred via the inbound copper pipe to the indoor unit's heat exchanger where the heat energy is transferred to the cooler indoor room via a fan, thereby heating the air.

In cooling mode, the indoor unit's heat exchanger absorbs heat energy from the indoor room air. This raises the temperature of the refrigerant. The refrigerant is transferred via the outbound copper pipe to the outdoor unit's heat exchanger where the heat energy is rejected into the surrounding air outside.

ZONES

The house has 7 zones that are controlled by 7 inside units and 2 outside units. The size of the air handlers is based on the square footage of the service area being heated/cooled. Rule of thumb: need 20 BTUs per square foot.

1 Master Bedroom suite and Powder Room
- approximately 704 sq ft ⇨ need 14,080 BTU
- 18,000 BTU air handler installed in Storage Room ceiling

2 Great Room, Dining Room, Kitchen
- approximately 1440 sq ft ⇨ need 28,800 BTU
- 30,000 BTU air handler installed in Laundry Room ceiling

3 Polly's Office, N Kitchen, Pantry
- approximately 360 sq ft ⇨ need 7,200 BTU
- 9,000 BTU air handler installed in Bath 3 ceiling

4 Family Room and hall
- approximately 936 sq ft ⇨ need 18,720 BTU
- 24,000 BTU air handler installed in Laundry Room ceiling

5 Playroom
- approximately 560 sq ft ⇨ need 11,200 BTU
- 12,000 BTU air handler installed in Mechanical Room ceiling

6 John's Office and Laundry Room
- approximately 384 sq ft ⇨ need 7,680 BTU
- 9,000 BTU air handler installed in Laundry Room ceiling

7 Bedrooms 1 and 2
- approximately 512 sq ft ⇨ need 10,240 BTU
- 15,000 BTU air handler installed in Bedroom 1 Closet ceiling

air handler sitting on floor before installation

air handler mounted in wood framing below the main floor trusses

Zone	Model	BTU	CFM†	Tons
1	PEAD-A18AA8	18,000	600	1.5
2	PEAD-A30AA8	30,000	1000	2.5
3	PEAD-A09AA8	9,000	300	0.75
4	PEAD-A24AA8	24,000	800	2.0
5	PEAD-A12AA8	12,000	400	1.0
6	PEAD-A09AA8	9,000	300	0.75
7	PEAD-A15AA8	15,000	500	1.25

† CFM = cubic feet per minute

As a cross check:

Main level = 2,433 sq ft ⇨ 48,660 BTU. The 3 air handlers servicing the main level supply 62,000 BTU.

Lower level = 3,006 sq ft ⇨ 60,000 BTU. The 4 air handlers servicing the lower level supply 72,000 BTU.

The number of BTU supplied should exceed the rule-of-thumb BTU especially if extra BTUs are needed to handle a large number of windows (floor-to-ceiling, clerestory) that can result in significant heat loss.

CFM	Min Duct Size	Recommended
0 - 400	4"	6"
401 - 600	6"	8"
601 - 900	7"	8 - 10"
901 - 1200	8"	10 - 12"

Each of the zones is a circuit. Input to the air handler is: 1) air from outside, and 2) return air from inside the house. The air handler heats/cools the input air then its blower pushes the air out through flexible ductwork to supply registers in the service area. Return air grilles in the service area collect the air and return it to the air handler via separate ducts where it is filtered before being re-input to the air handler.

The outbound supply ducts are insulated flexible ducts that come off the air handler and travel through the main floor trusses to the supply registers in the service area. The size of these ducts depends on the CFM of the air handler.

Supply registers are usually placed near windows where there is likely to be more heat loss (cold weather) or gain (hot weather). Return air grilles are usually in the middle of the service area. The objective is for air to flow across the room from the supply registers to the return air grille. There is one return air duct per zone unless a door in the middle of the zone cuts off air flow to the duct, requiring a second return air duct. Return air ducts use larger (12") flexible ductwork and they are not insulated. Return air ducts are not put in laundry rooms and bathrooms because they have a fan.

A supply trunk line usually connects to a supply register but it may be forked to connect to smaller registers. For example, for the supply registers in the Master Bathroom and in front of the hall window of the Master Suite, an 8" duct was split into 6" ducts that fed these registers.

To deliver BTU to the service area requires airflow that is created by the air handler's blower. Airflow is measured in CFM. The rule of thumb for CFM required is BTUs/30. The table above shows the CFM produced by the air handler for each zone. The size of a unit is also referenced in "tons" which is CFM/400. 1 ton is 12,000 BTU. As a cross check, Mitsubishi technical data for the Zone 1 model was referenced. It indicated that air flow on the high setting is 600 CFM.

Zone 2 is the Great Room. The air handler delivers 1000 CFM. Five 8" ducts connect to 5 supply registers delivering 200 CFM each.

Zone 1 is the Master Suite. The air handler delivers 600 CFM. There are three 8" ducts. Two are used to supply 200 CFM to the two 6x12" registers in the Master Bedroom. The other 8" duct is forked to become three 6" ducts that supply 200/3 CFM to three 4x10" registers in the Master Bathroom, hall window of Master Suite and the Powder Room.

flexible supply ductwork with insulation

flexible ductwork running through main floor trusses

The return air register(s) need to be large enough so that the CFM is approximately the total supplied CFM. Also, the speed of the air moving through the register's grille should be at least 300 FPM (feet per minute) but not more than 500 FPM. If the speed is too high, it will produce noise. The rule of thumb for grille size is CFM / 2 square inches. For Zone 1, 600 CFM / 2 = 300 square inches. This was accomplished using a 10"x30" grille.

Zone	Location	Type	Register Size	Duct Size
1	Master Bathroom floor under vanity near door	supply	4x10"	6"
1	Master Bedroom hall floor in front of S window	supply	4x10"	6"
1	Master Bedroom floor near balcony door	supply	6x12"	8"
1	Master Bedroom NE corner floor	supply	6x12"	8"
1	Master hall wall right of closet entry	return	10x30"	12"
1	Powder room under vanity	supply	4x10"	6"
2	Front foyer floor in front of window	supply	6x12"	8"
2	Great Room floor in front of SE window	supply	6x12"	8"
2	Great Room floor 2 in front of center window	supply	6x12"	8"
2	Dining Room floor in front near deck door	supply	6x12"	8"
2	Dining Room long vent N wall at floor level	return	5x84"	8"
3	Polly's office on floor near sliding door	supply	6x12"	8"
3	Mud room on floor near garage door	supply	6x12"	8"
3	Polly's office return air in wall in SW corner	return	10x14"	8"(2)

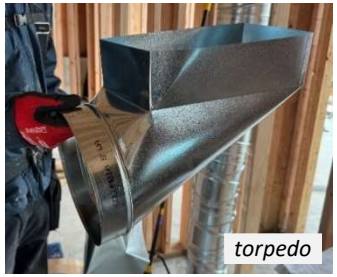
Zone	Location	Type	Register Size	Duct Size
4	Family Room - 3 registers in front of windows	supply	6x12"	8"
4	Family Room ceiling in NE corner	supply	6x12"	8"
4	Hall outside Laundry Room	return	10x30"	†
5	Playroom ceiling near counter	supply	6x12"	8"
5	Playroom wall on S side outside Mechanical room	supply	6x12"	8"
5	Playroom in front of mechanical room entry door	return	7x20"	8"
6	John's office 2 registers near ceiling	supply	6x12"	8"
6	John's office near door	return	8x14"	8"
6	Laundry Room in front of window	supply	6x12"	8"
7	Hall leading to Bedrooms 1 and 2	supply	6x12"	8"
7	Bedroom 2 – 2 ceiling registers on N and E sides	supply	6x12"	8"
7	Bath 2	supply	6x12"	8"
7	Supply room	supply	6x12"	8"
7	Bedroom 1 near ceiling	supply	6x12"	8"
7	Hall outside elevator closet	return	6x12"	8"

† behind the 10x30" grille, there are 3 ducts: 6x6" rectangular duct and 8" circular duct that feed the zone 4 unit; 8" duct that feeds the zone 6 unit

DUCTWORK

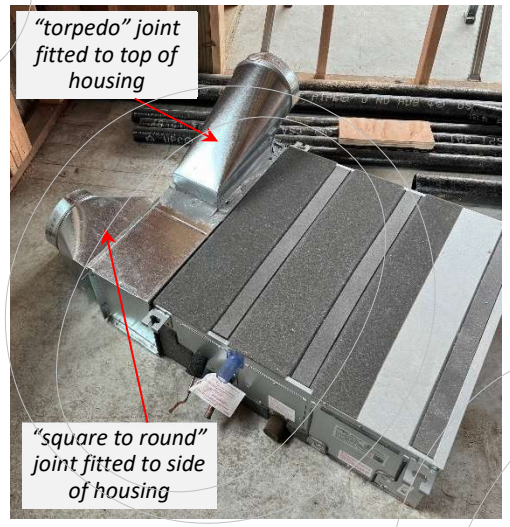
Work started Apr 4, 2024. For each air handler, a metal housing had to be built with “take-offs” connected to the flexible ductwork. “Elbow”, “torpedo” and “boot” joints are used. The sheet metal technician Eric used tin snips to cut holes in the housing where the selected joint would be attached.


housing being built with 5 “elbow” joints for an air handler


torpedo


boot


housing installed on end of air handler


“torpedo” joint fitted to top of housing

“square to round” joint fitted to side of housing


Eric holding an elbow


flexible ductwork running through main floor trusses

At the end of a run, the flexible ductwork needs to be connected to a register. Supply registers use “boot” and “torpedo” joints. That entails the following steps demonstrated in the pictures:

- slide the flexible ductwork over the register end fitting
- use duct tape to secure
- apply 3 screws through duct tape
- attach a cable tie
- apply screws through the cable tie

air handler in the mechanical room showing ductwork running to a supply register in the Playroom wall

supply registers in Great Room floor

supply registers in Great Room floor go from flexible duct to a metal duct in the soffit through a hole cut in the beam

supply registers in John’s Office wall fed from air handler in Laundry Room

supply register in ceiling of Family Room

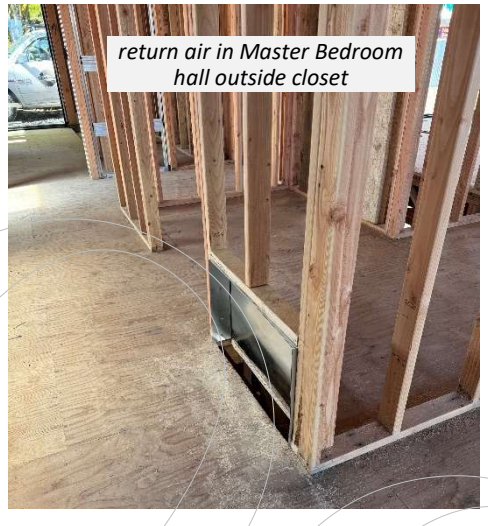
Holes had to be cut in the floor and the walls for supply registers.

The Bedroom 1 closet air handler services Bedrooms 1 and 2. It has a supply line that has a "tee joint" or "duct splitter" connecting it to 2 smaller flexible ducts going to the supply registers in Bedroom 1 and Bedroom 2. Tee joints are available with different input and output sizes.

The return air ducts also had to be constructed. Note that this may require cutting the studs then adding new framing. Grey flexible ductwork is used for the return air. They are not insulated.


tee joint


very wide return air at floor on N side of Dining Room


return air in Master Bedroom hall outside closet

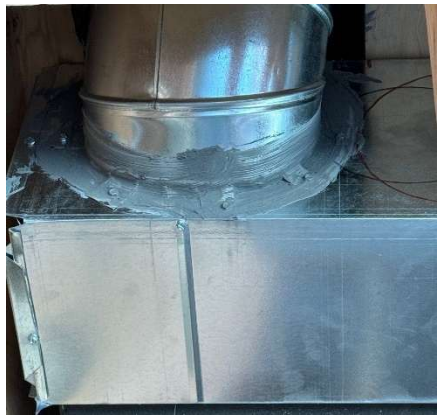

return air in wall beside door to John's Office


grey flexible return air ducts connected to an air handler


ceiling return air outside Laundry Room


ceiling return air outside Mechanical Room door – centering it meant having a beam in the middle (will be hidden by register)

The air handler housing take-offs are screwed to the housing. Then a sealant called “pooky” is applied, including over the screws, in order to make a tight seal. Pooky was also applied around the supply registers to make a tight seal.



A 7” hole had to be drilled in the glulam beam for the ductwork to reach the Great Room supply register in front of the SE window. This was the largest hole allowed by the structural engineer. The flexible ductwork is 8” on both sides of the hole. In non-commercial construction, the exact details of the ductwork are not specified by the architect. The objective is to avoid having a dropped ceiling or bulkhead. This requires examination of options and approvals if holes need to be drilled in beams.

drilling a hole in the glulam beam

duct passes through glulam

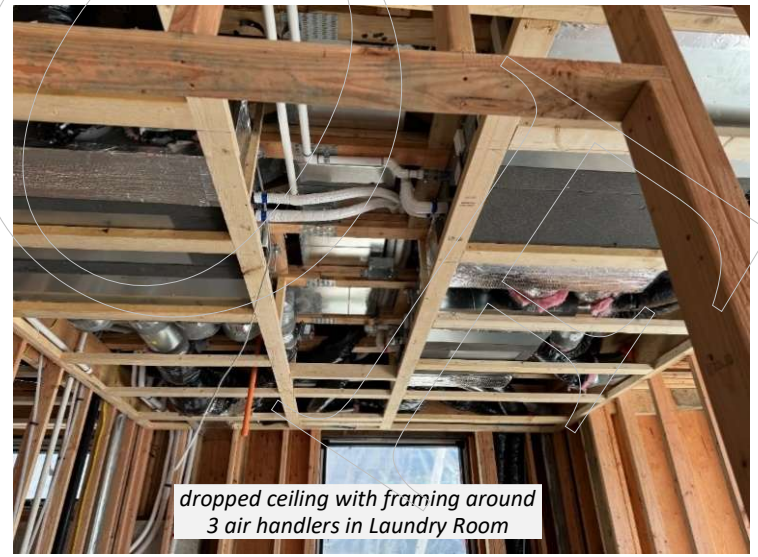
In our construction, we did not require any bulkheads. We dropped the ceiling in the following rooms about 10” from 10’ 6” to accommodate the air handlers:

- Bedroom 1 closet
- Bathroom 1
- Storage Room
- Laundry Room
- Bathroom 3

Dropping the ceiling in these rooms had negligible impact.

Before the drywall can be installed, the air handers need to framed. Also, ceiling access to the air handlers is required to change the air filters. The filters are ½ size requiring less space to access.

air filter



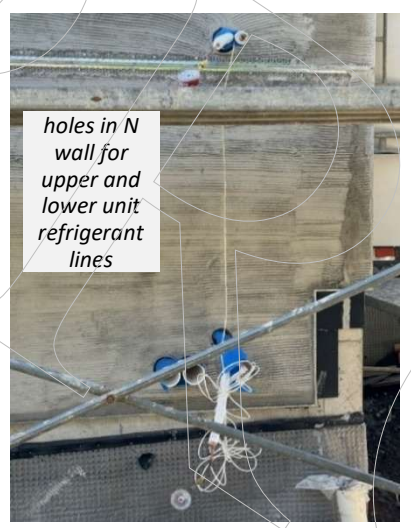
dropped ceiling with framing around 3 air handlers in Laundry Room

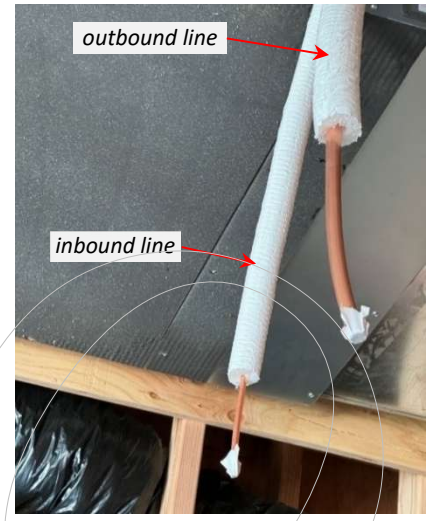
REFRIGERANT LINES

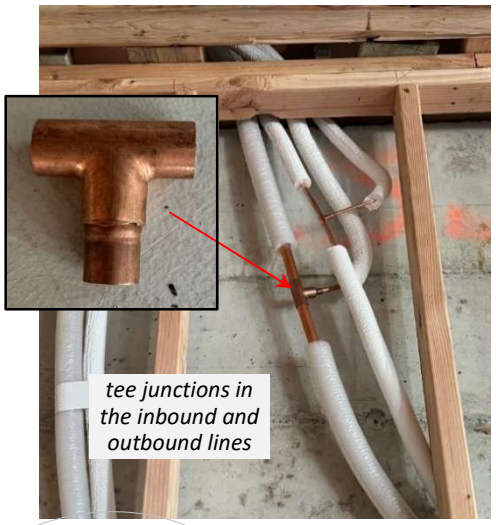
It took a month to install the air handlers and complete the main ductwork. The next step was the installation of the refrigerant lines between the 2 outdoor units on the N side of the house and the 7 indoor air handlers.

There are 2 refrigerant lines (aka "reefer lines") for each outdoor unit. One is outbound and one is inbound. The outbound line has a larger copper pipe and thicker insulation than the inbound line. If the heat pump is in heating mode, the inbound refrigerant is a heated gas and the outbound refrigerant is a liquid. This is reversed in cooling mode. The inbound refrigerant line from an outdoor unit enters the house through a hole in the N wall. The inbound line encounters a "tee junction" that runs off the inbound line to an air handler. The outbound line from an air handler connects via a tee junction to the outbound line that will exit the house through the same hole in the N wall.


upper unit refrigerant lines in pantry studs


holes in N wall for upper and lower unit refrigerant lines



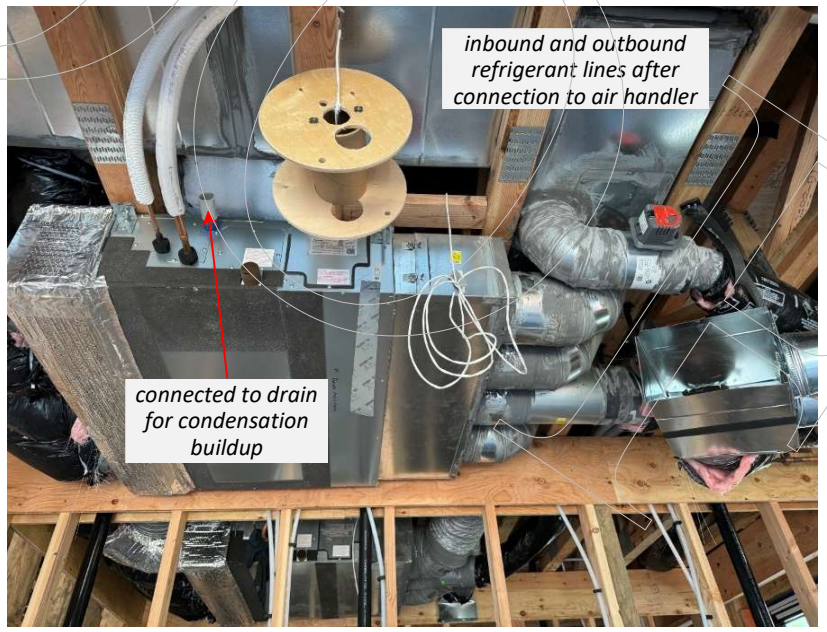


Tee junctions are connected using "brazing". A brazing rod is held in one hand and a gas torch is held in the other hand. The copper pipe is heated at the tee junction which melts the brazing rod. Brazed joints are stronger than soldered joints. After, the tee junctions are covered with styrofoam insulation and taped.


Lou creating tee junction

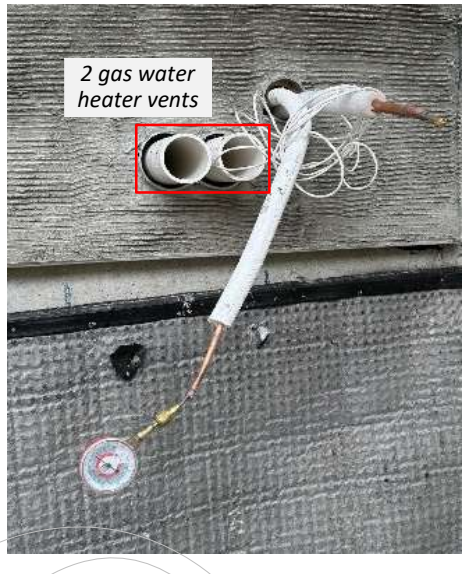

brazing rod


6 tee junctions




tee junctions covered with styrofoam


Lou with swaging tool


2 gas water heater vents

The refrigerant lines had to run across the house from the N side outdoor units to the S side air handlers installed in Bedroom 1 closet and the Storage room. To extend a refrigerant line, one side of the copper tube needs to be expanded to allow another piece of copper to fit inside. This is accomplished using a "swaging tool".

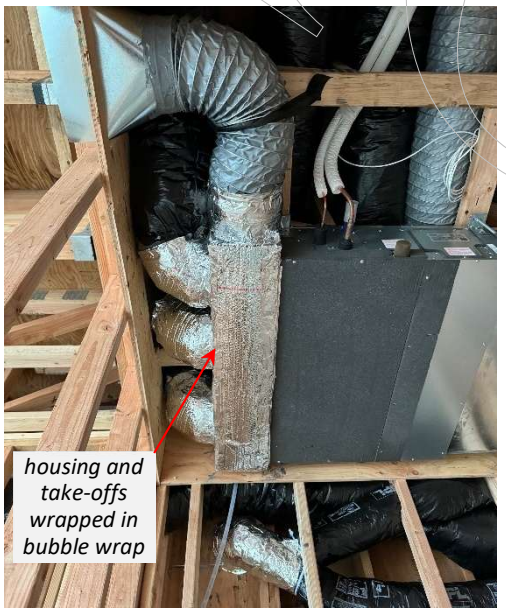
After the refrigerant lines for the upper and lower units were connected to the air handlers, they were filled with refrigerant and pressurized. A gauge was connected to the refrigerant lines to read the pressure in order to verify that there were no leaks. The outdoor units would not be installed till later.

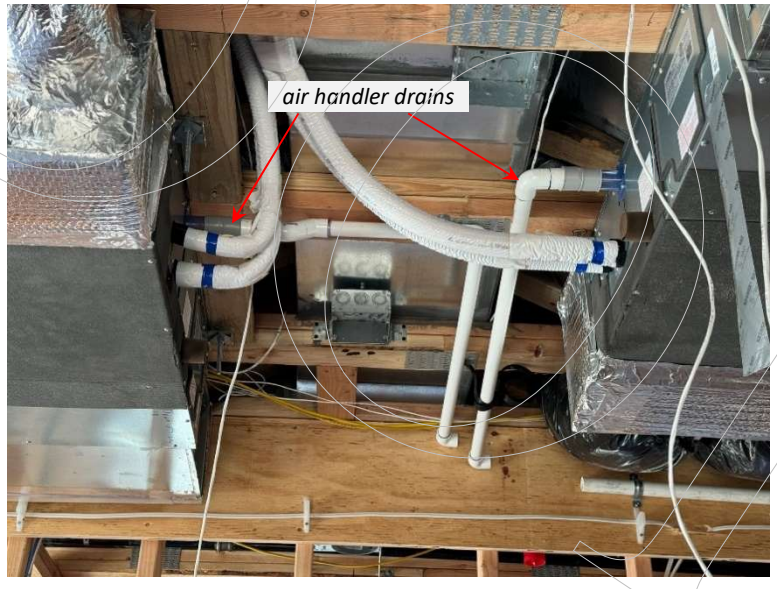
The 2 white pipes are vents for Navien gas water heaters.

INSULATION AND DRAINS

After all the supply lines and return air lines are installed at the air handlers, the housings of the air handlers were wrapped in "bubble wrap" to provide insulation. The drain lines for condensation were also connected.

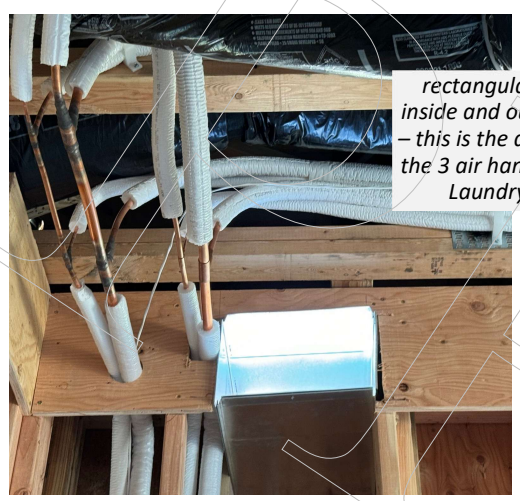

bubble wrap roll

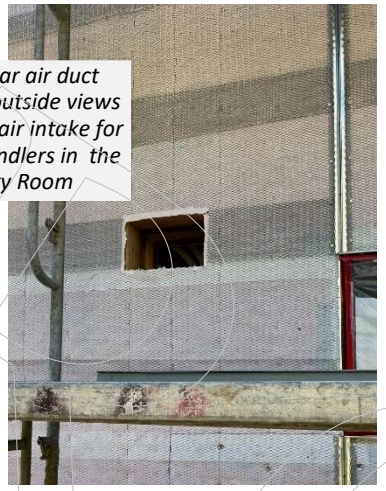

housing and take-offs wrapped in bubble wrap


air handler drains

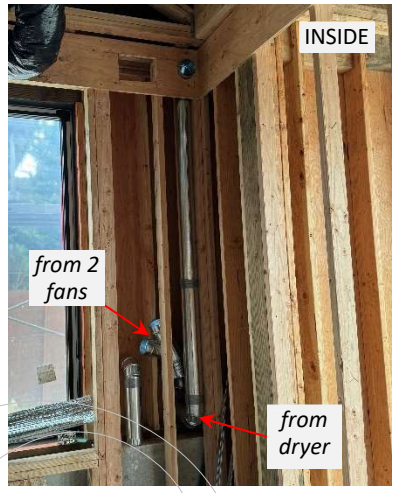
FRESH AIR

The air handlers need fresh air input. Holes were cut in the N and S walls for fresh air ducts. Each air handler has a duct with a motorized damper to control the amount of incoming air for that zone. The motorized damper is controlled by the air handler which supplies the 24V.





rectangular air duct inside and outside views – this is the air intake for the 3 air handlers in the Laundry Room

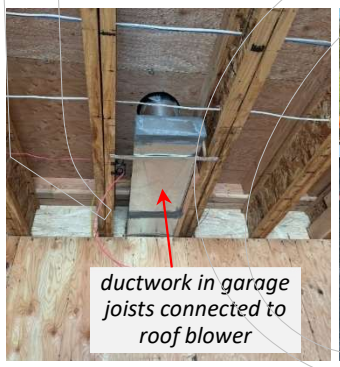


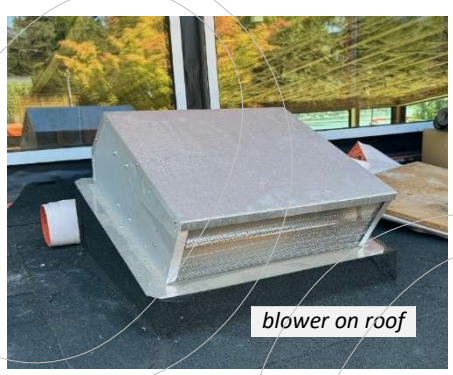
extending the rectangular air duct then creating forks to feed fresh air to air handlers

OTHER DUCTWORK

The sheet metal technicians were also responsible for creating the duct work to vent the bathroom fans to the outside and to vent the Navien gas water heater in the Mechanical Room. We ended up installing only one Navien since it was deemed adequate. The 2nd white pipe is available if we decide to add a 2nd Navien in the future.

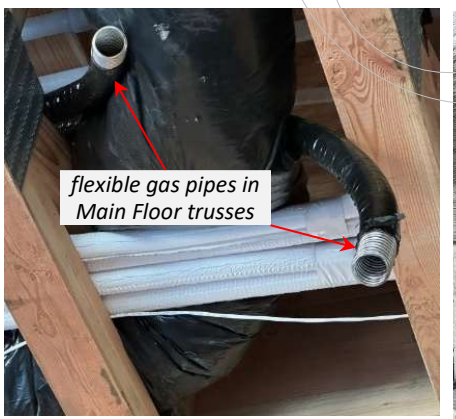
Refer to the Kitchen-W elevation in Appendix C. The hood over the kitchen rangetop has a powerful blower mounted outside on the flat roof above the garage. The ductwork will ultimately be covered by cabinets as shown in the elevation drawing. A 1500 CFM blower would be extremely loud if mounted inside.

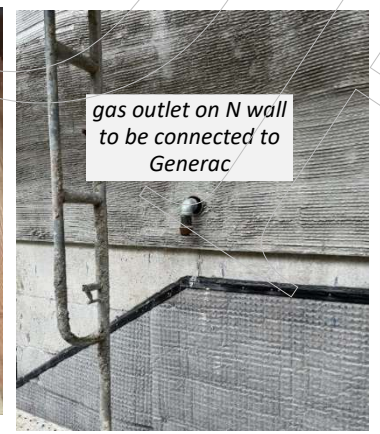




GAS LINES

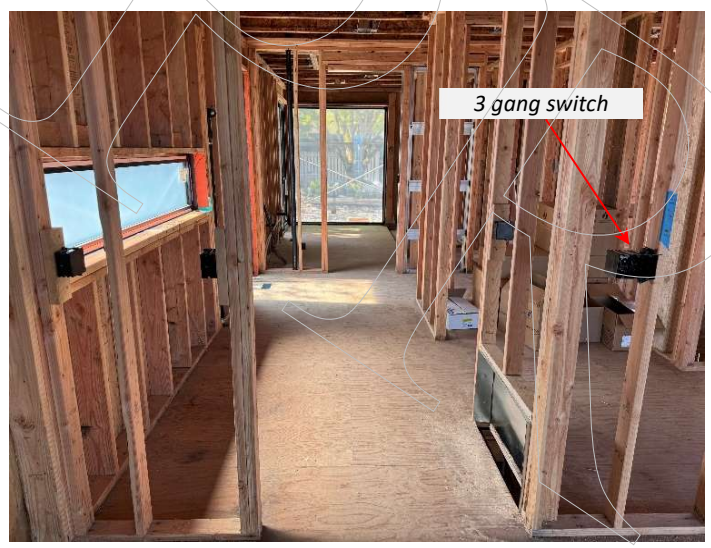
The HVAC contractor also looked after the gas lines. Gas lines are required for the 3 fireplaces, the rangetop in the kitchen, the Navien water heater in the Mechanical Room, and the Generac on the N side of the house. We also wanted to have a gas outlet on the deck for a potential fire pit. Steel as well as flexible gas pipes were run inside the main floor trusses. The gas meter was installed later on the S side of the house.

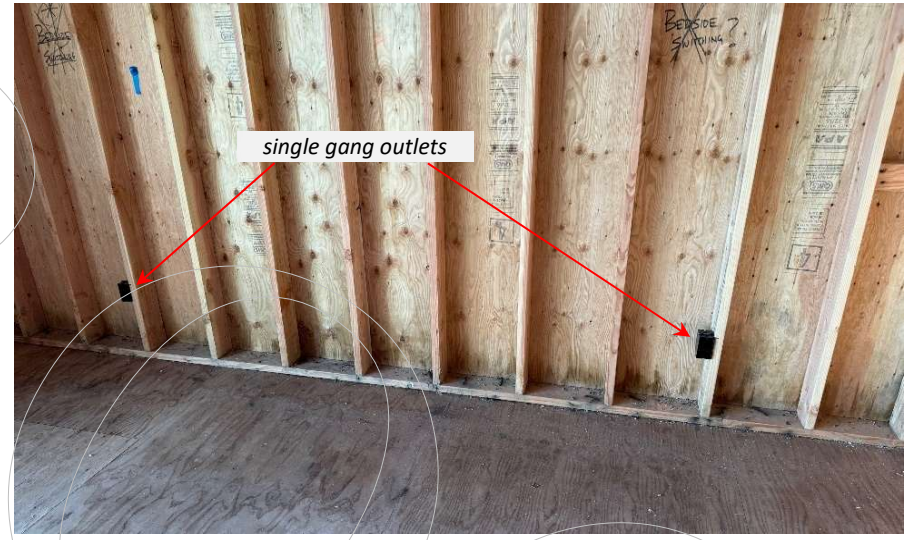




OUTLETS, SWITCHES, CAN LIGHTS, FANS

Electrical installation started Apr 19, 2024 by attaching the boxes used for switches and outlets to the studs. Per the Lower Floor and Main Floor Electrical Plans (E101 and E102 in the CD Set), boxes with the appropriate number of "gangs" were nailed to the studs. Outlets need to be 6' from an entry door then every 12', or a maximum 10' apart in bedrooms and hallways. We did a walk around with the electricians to comment on the placement and to answer questions about intended usage.





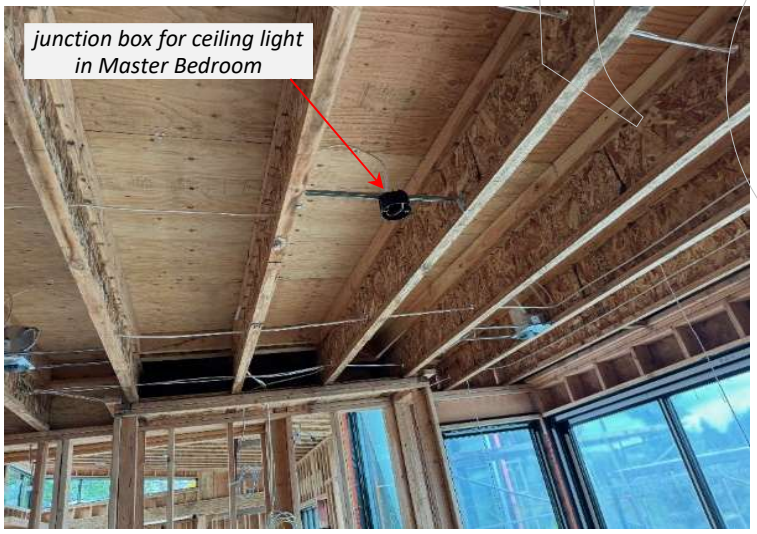
Next, the electricians installed the main floor "can" lights – recessed lights designed to lie flush with the surface. They are called can lights because they are a cylindrical metal can-like structure. We weren't consulted about where we wanted them to go but the results looked reasonable.

individual can light

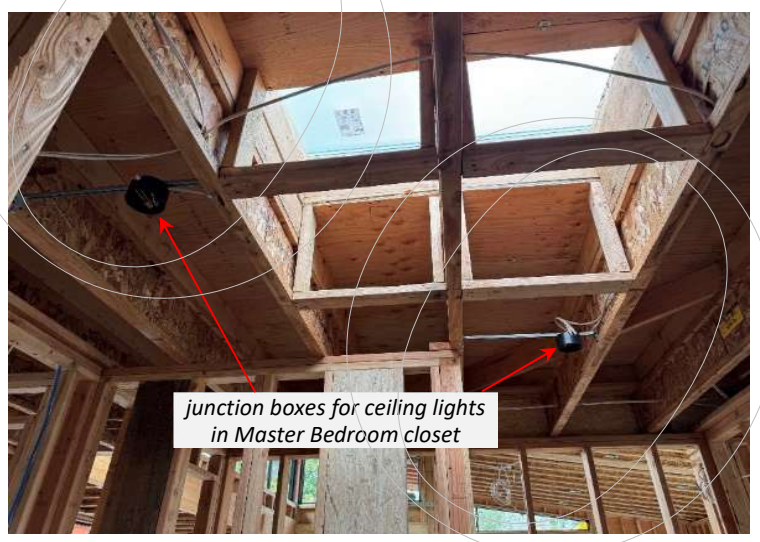
After the main floor cans were completed, the lower level cans were installed. They were more challenging since they had to fit in the main floor trusses with the duct work, drains, plumbing supply lines and refrigerant lines. Next, the electricians installed fans in all 5 bathrooms. They also installed junction boxes in locations where we had specified ceiling (surface) lights. Junction boxes were also installed for outdoor sconce lights.

can lights in Family Room

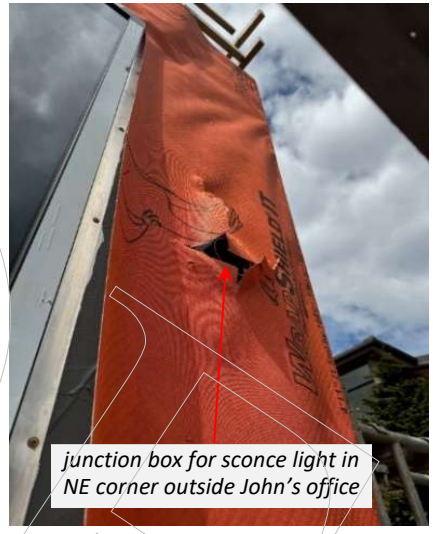
fan installed in Bathroom 1



junction box for ceiling light in Master Bedroom



junction boxes for ceiling lights in Master Bedroom closet

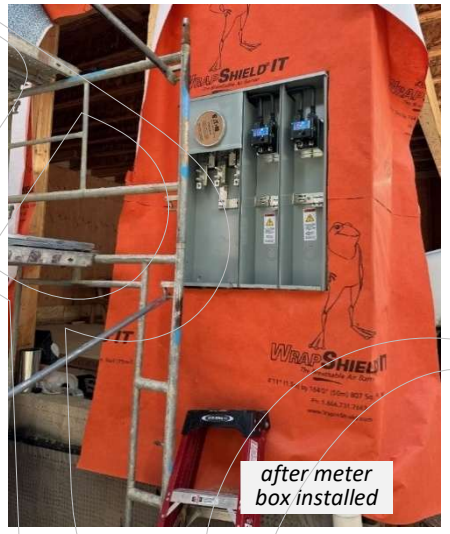


junction box for sconce light in NE corner outside John's office

METER BOX, TRANSFER SWITCHES, BREAKER PANELS

The meter box was installed in the N wall of the garage and 2 breaker panels were installed in the Mechanical Room on the Lower Level. Two transfer switches – one for each breaker panel – were installed in the garage. A transfer switch is a device that either manually or automatically changes the source of power. It has 3 terminals connected to: 1) a breaker panel, 2) the utility and 3) the generator. In our case, the transfer occurs automatically if there is a power outage. The generator (Generac) turns on automatically within 10 seconds and starts producing electricity.

John and Jordan in garage with meter box



after meter box installed

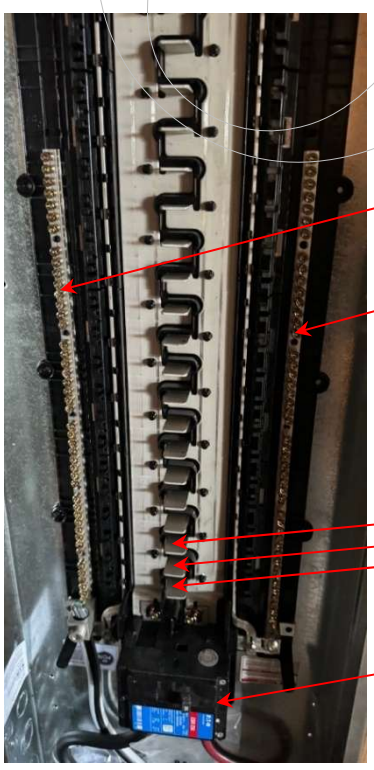
after Generac transfer switches installed

view inside transfer switches

The electric utility company is Puget Sound Energy (PSE). Our service is 400 amps – two 200 amp breaker panels. Two 240V cables (two 120V cables), run from the meter box to the 2 breaker panels in the Mechanical Room. The pictures below show the breaker panels before the circuit breakers have been installed.

cables from meter box

breaker panels



ground bus bar

neutral bus bar

first 3 circuit breaker locations

orange wire on the N side of house that will connect the Generac to the transfer switches

close-up of 200 amp main breaker switch

Two thick grey cables come in at the bottom of each breaker panel. They each contain 2 hot wires (usually black and red) and a neutral wire (white). The hot wires go to the breaker panel's main breaker switch and the neutral wire goes to the neutral bus bar. There is also a ground wire that comes from the ground rebar rods on the N and S sides of the house that were mentioned in the Foundation chapter. The picture shows the bent ground rebar rod in the main floor truss attached to a copper wire that connects to the ground bus bar of the breaker panel. This method of grounding by connecting to a steel rod embedded in a building's concrete foundation is called "Ufer" grounding.

After the main breaker switch, the 240V line splits into two 120V lines. One 120V line goes to the 1st, 3rd, 5th etc. breaker locations. The other 120V line goes to the 2nd, 4th, 6th, etc. breaker locations. 240V uses 2 adjacent breakers.

There are 3 types of breakers:

- Arc Fault Circuit Interrupter (AFCI) – detects arcs (electrical discharge) and light
- Ground Fault Circuit Interrupter (GFCI) – detects current leakage
- Dual Function - performs both AFCI and GFCI functions

The breakers used in this house are all Dual Function. The single pole breakers are either 15 or 20 amps. The double pole breakers use 2 breakers and can handle up to 125 amps.

CIRCUITS

Each circuit breaker on the breaker panel represents a circuit. The electrical wire used is called Romex. Romex is a brand name for non-metallic sheathed cable designed for household appliances and lighting. All Romex contains at least a black, white and copper wire. The copper wire is the ground wire. Current flows out from the breaker over the black wire and returns to the breaker via the white wire which closes the circuit. Therefore the Romex doesn't need to loop back to the breaker panel.

Individual circuits are created in a room by connecting switches or outlets. Usually a circuit contains either all outlets or all switches. 15 amp circuits are used for lights. 20 amp circuits are required for bathrooms and are usually used for kitchens and home offices (multiple computers, multiple screens, printers, etc).

From Ohm's Law, we know that $P = I V$ where P = power (watts), I = current (amps) and V = voltage (volts). Power consumed depends on the current. Lights don't use much power but hair dryers do.

A 20 amp circuit has a max wattage of 2400 watts (20 amps X 120 V) and a 15 amp circuit has a max wattage of 1800 watts. Applying the "80% rule" means that we do not want to exceed 80% of the max wattage which is 1920 watts for 20 amp circuits and 1440 watts for 15 amp circuits. Assuming 100 watts per outlet, we can safely have 18 outlets on a 20 amp circuit. Assuming 100 watts per light, we can safely have 12 lights on a 15 amp circuit and 16 lights on a 20 amp circuit.

After a circuit has been created, another Romex wire (called a "home run") will be run from the circuit breaker to the starting point (first switch/outlet) of the circuit.

There are 3 types of Romex used in 20 and 15 amp circuits:

12-2 yellow contains three (3) 12-gauge wires: Black, White and Copper wires
used for 20 amp circuits with a 20 amp circuit breaker in the breaker panel
used for outlets

14-2 white contains three (3) 14-gauge wires: Black, White and Copper wires
used for 15 amp circuits with a 15 amp circuit breaker in the breaker panel
used for single pole switches

14-3 blue contains four (4) 14-gauge wires: Black, Red, White and Copper wires
used for 15 amp circuits with a 15 amp circuit breaker in the breaker panel
used for 3-way switches

Romex is fed between between the boxes in the circuit. It can be run through the studs or through beams and trusses. The Romex cable is placed on a device called a “wire spinner” that can be conveniently hung to allow the wire to unspool without getting tangled.

Thinner non-Romex wires were installed to handle the low voltage undercounter lights. They are connected to a “driver” which is a transformer that converts 120V to a lower voltage eg, 12V or 24V.

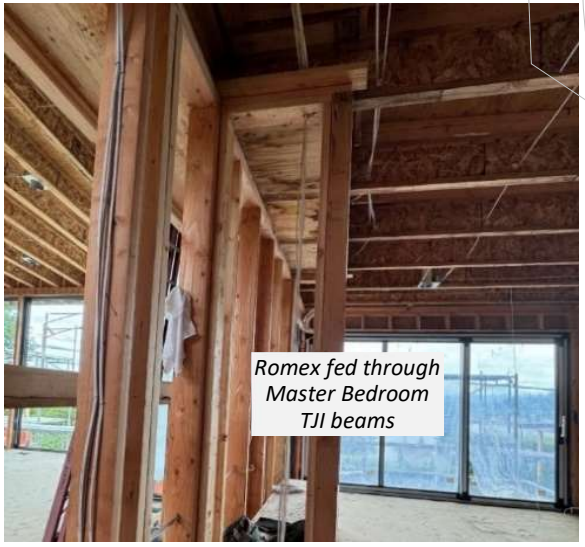

Romex fed through a 4 gang box


wire spinner


Romex fed through studs


yellow Romex for the floor heater

Romex fed through a 3 gang box

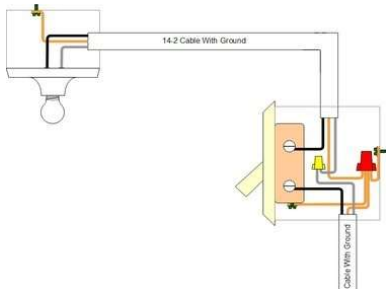

Romex fed through Master Bedroom TJI beams


Romex fed through Great Room TJI beams to the ceiling cans


low voltage (non-Romex) wires

Single Pole Switches

Single pole switches are for lights controlled by only one switch. They have 3 screws: 2 silver on the same side and a green screw on the other side. The input to the switch is 14-2 Romex and the output to the light from the switch is 14-2 Romex. 14-2 Romex has 3 wires: copper (ground), white (neutral) and black (hot).



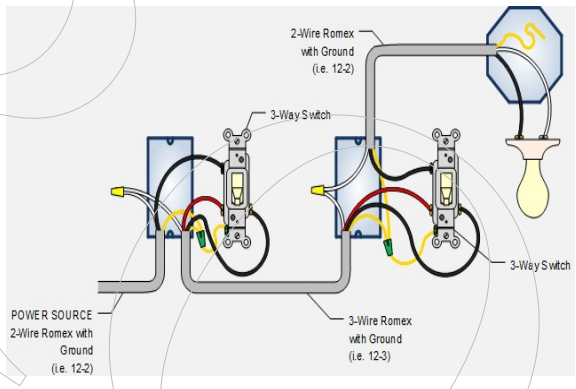
At the switch:

- connect the input copper wire to green screw of switch and to output copper wire
- connect the input white wire to output white wire
- connect the input black wire to a silver screw
- connect the output black wire to the other silver screw

The black and white wires of the output Romex are connected to the light.

Three-Way Switches

3-way switches are for lights controlled by 2 switches. They have 4 screws: 2 copper screws on opposite sides, a green screw and a black screw. The input to switch 1 is 14-2 Romex. The connection between switch 1 and switch 2 is 14-3 Romex. 14-3 Romex has an additional red (hot) wire. The output to the light is 14-2 Romex.



At switch 1:

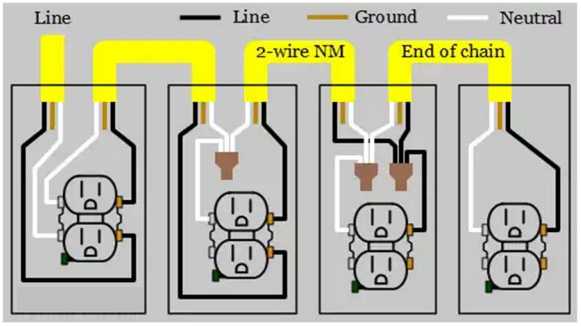
- connect the input copper wire to the green screw of the switch and to the output copper wire
- connect the input white wire to the output white wire
- connect the input black wire to the black screw
- connect the output red wire to a copper screw
- connect the output black wire to a copper screw

At switch 2:

- connect the input copper wire to the green screw of the switch and to the output copper wire to the light
- connect the input white wire to the output white wire to the light
- connect the input black wire to a copper screw
- connect the input red wire to a copper screw
- connect the output black wire to the black screw

Outlets

Outlets are used by small plug-in appliances. They use 12-2 Romex which has 3 wires: hot (black), neutral (white) and ground (copper). Outlets have 5 screws: 2 silver and a green screw on one side, 2 copper on the other side. Current travels from the breaker over the black wire. When something is plugged in to the outlet, the circuit is closed and the current travels back to the breaker via the white wire.



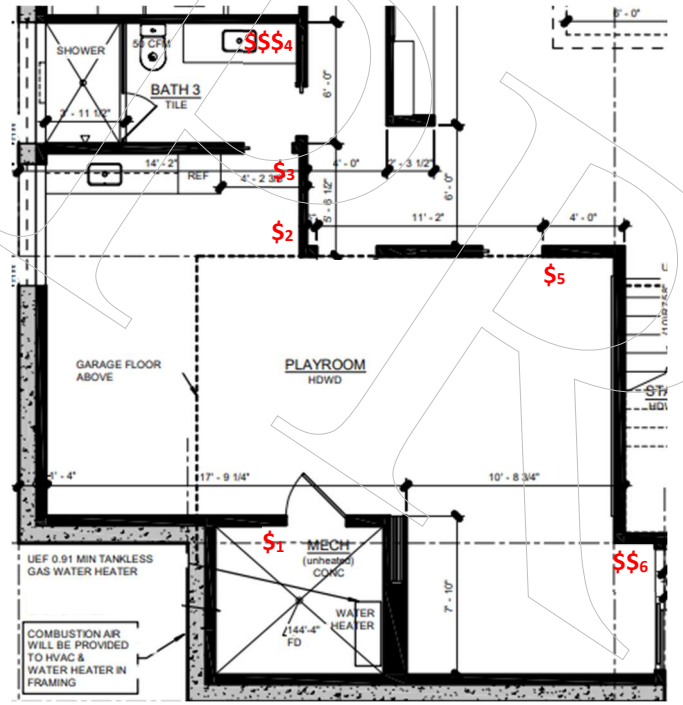
At outlet 1:

- connect the input copper wire to the green screw of the switch and to the output copper wire
- connect the input white wire to a silver screw
- connect the input black wire to a copper screw
- connect the output white wire to the other silver screw
- connect the output black wire to the other copper screw

This repeats at the next outlet in the circuit. At the last outlet in the circuit, there is no output Romex.

SWITCH CIRCUIT EXAMPLE

This doesn't describe setting up the switches at each location. That will follow the process described previously for single pole and 3-way switches. For example, at **$1**, the 14-2 will be split with one side becoming the input Romex to the single pole switch and the other side going to **$2**.



The circuit starts at a 1 gang switch **$1** in the Mechanical Room. A piece of 14-2 Romex (white) is fed through the 1 gang. The free end below (now shown) will later be connected to the breaker panel. The first step is to run the Romex required to provide power to the switches in the circuit.

The **$1** switch will have a single pole switch that controls 1 ceiling can in the Mechanical Room. The 14-2 Romex output runs up the studs, through the main floor trusses then down to the **$2** switch. That will be required for every switch in the circuit.

The **$2** switch is a single pole switch that controls 8 cans in the Playroom ceiling. The input 14-2 Romex is split into two 14-2 Romex. One 14-2 output goes to **$3** and the other goes to **$5**.

The **$3** switch is a 3-way switch that controls the Bath 3 ceiling cans and shower light. The input 14-2 Romex is connected to output 14-3 that goes to **$$$4**.

The **$$$4** switch is a 3 gang that controls:

- 3-way switch that controls the Bath 3 ceiling cans and shower light
- bathroom fan
- 2 wall sconce lights and mirror backlighting

The input 14-3 provides power for the 3 switches as well as the "red" wire for the 3-way switch.

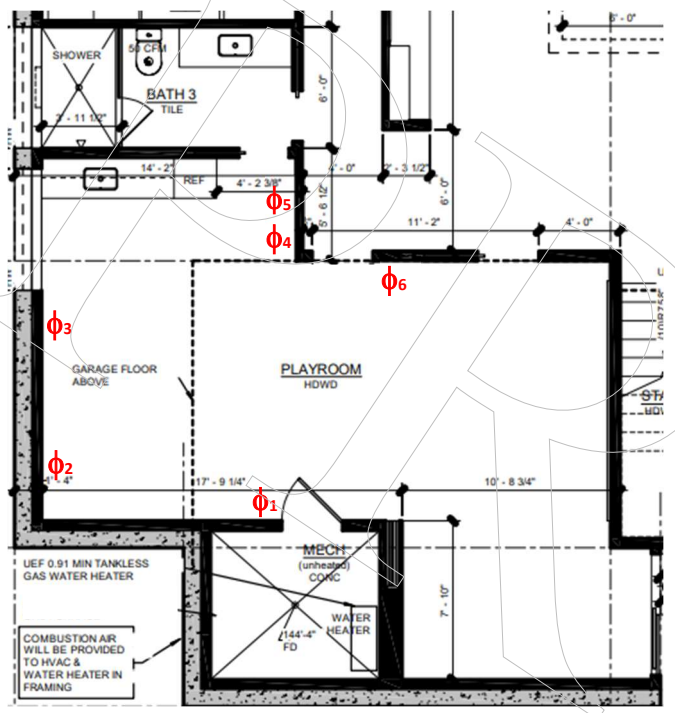
The **$5** switch is a 3-way switch that controls some of the ceiling cans. The input 14-2 Romex is connected to output 14-3 that goes to **$$6**.

The **$$6** switch is a 2 gang that controls:

- 3-way switch for some ceiling cans
- 3-way switch with Bedroom 2 that controls window well lights

The input 14-3 provides power for the 2 switches as well as the "red" wire for the 3-way switch.

OUTLET CIRCUIT EXAMPLE

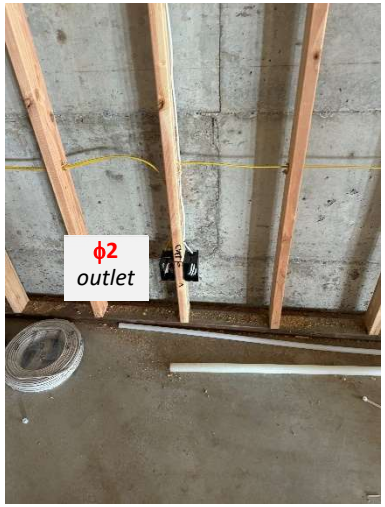


There will be 6 outlets in this circuit labelled **ϕ1** through **ϕ6**. All of them occupy single gang boxes and have 2 receptacles. The first step is to run 12-2 Romex to the boxes. The Romex will be connected to the outlets later as described above.

The circuit starts at **ϕ1** box in the W wall of the Playroom outside the Mechanical Room door. A piece of 12-2 Romex (yellow) is fed from the box through holes drilled in the studs to the **ϕ2** box in the N wall of the Playroom.

A 2nd piece of 12-2 Romex is fed from the **ϕ2** box through holes drilled in the studs to the **ϕ3** box. 3rd, 4th and 5th pieces of 12-2 Romex are fed from **ϕ3** to **ϕ4**, **ϕ4** to **ϕ5** and **ϕ5** to **ϕ6**.

A home run will later be run from the breaker panel to **ϕ1**.



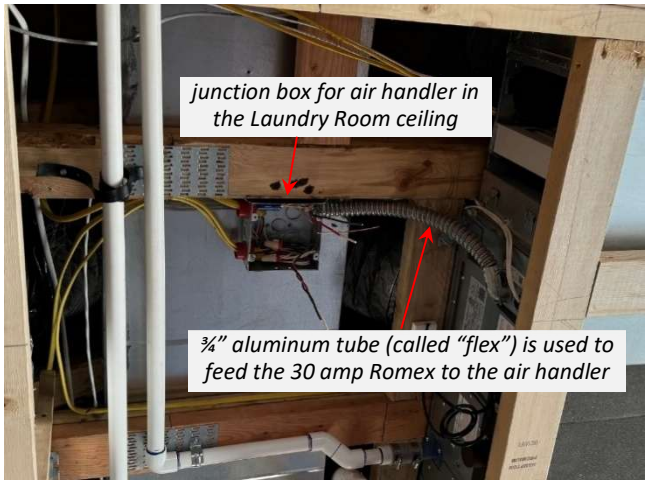
240V CIRCUITS

240V circuits have only one electrical device connected. They are:

- electric dryer in Laundry Room
  - 30 amp breaker
  - use a NEMA 14-30 plug
- 2 Tesla EV chargers in Garage
  - 50 amp breakers
  - use a NEMA 14-50 plug
- SKS range top in Kitchen W counter
  - 30 amp breaker
  - use a junction box
- SKS wall oven in Kitchen N wall
  - 30 amp breaker
  - use a junction box
- 2 Mitsubishi heat pumps outside on N wall
  - 50 amp breakers
  - use a junction box
- 7 Mitsubishi air handlers
  - 30 amp breakers
  - use a junction box

NEMA 14-50 plug

NEMA 14-30 plug



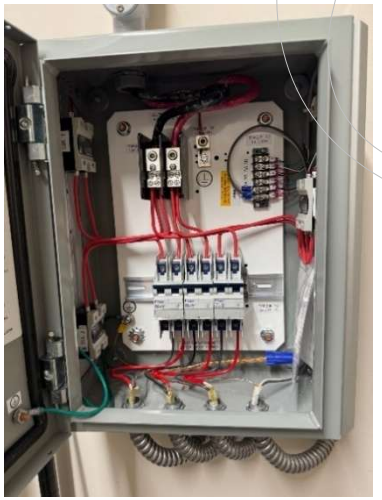
10-3 Romex

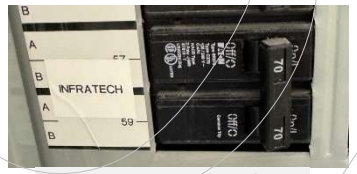
240V circuits use 10-3 Romex (orange) for 30 amp circuits. There are 4 wires: black, red, white, copper. The black wire (hot) connects to the A phase. The red wire (hot) connects to the B phase. The white wire connects to neutral and the copper wire connects to ground.

receptacle for 14-30 plug

There are 3 X 4000 watt ceiling heaters in the Atrium ceiling. There is one 70 amp circuit breaker in the breaker panel and 3 breakers in the Infratech control panel beside the breaker panel in the Mechanical Room.

3 Infratech ceiling heaters





70 amp circuit breaker

HOME RUNS

After the circuits have been wired, another Romex cable is used to connect the circuit to the breaker panel. These are referred to as "home runs". Black plates with 8 holes (called "home run helpers") are attached to joists to support the home run cables which are threaded through the holes. The home run Romex is connected to the starting Romex of the circuit using standard wire connectors or Wago splicing connectors.

home run helper

home run helper attached to joist

standard wire connector

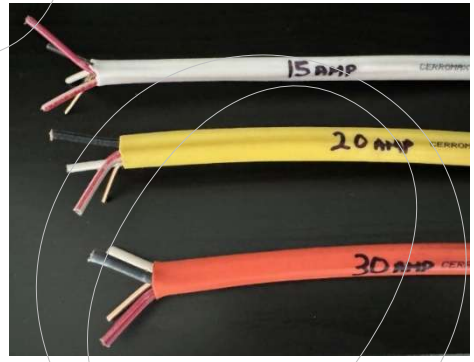
Wago splicing connector

The Romex used for the home run depends on the amperage of the breaker. Here are the types of Romex used in this house for home runs:

14-2-2 white
5 wires – black, white, copper, red, red & white
used for 15 amp circuits

12-2-2 yellow
4 wires – black, white, copper, red & white
used for 20 amp circuits

10-3 orange
4 wires – black, white, copper, red
used for 240V circuits

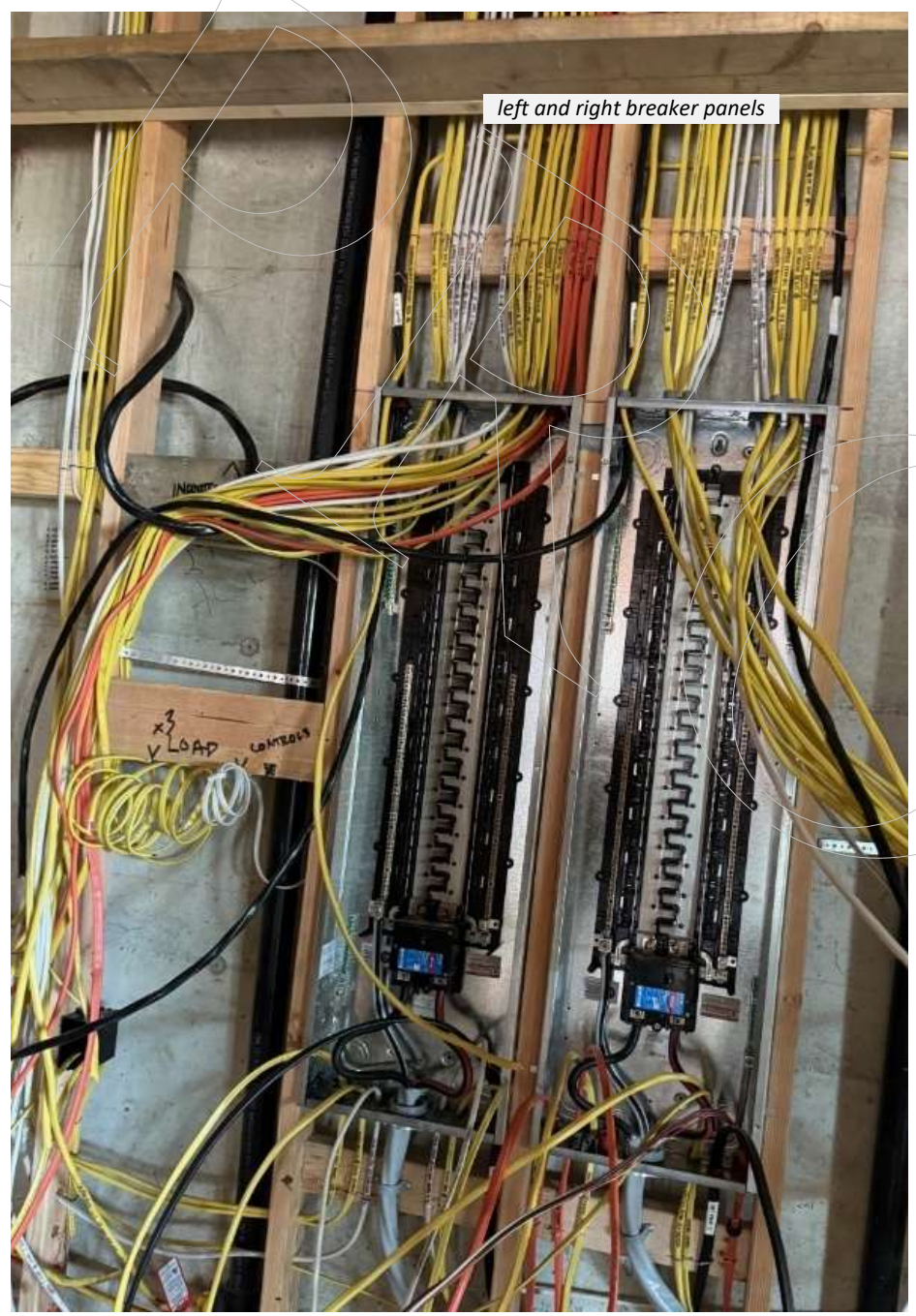


The black, white and copper wires from the circuit are connected as follows at the breaker panel:

- black connects to the circuit breaker
- white connects to the neutral bus bar
- copper connects to the ground bus

The extra red and red & white wires are used as hot and neutral wires if a second home run to the breaker panel is required.

Here are pictures of the 2 breaker panels showing the home run wiring prior to connection to their breakers.

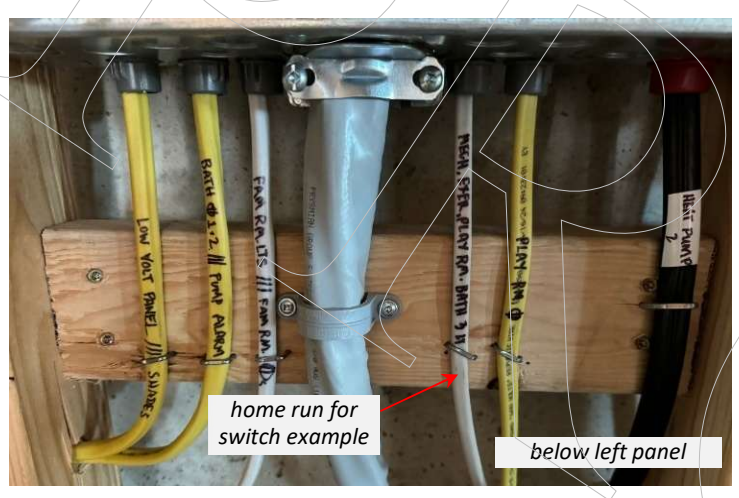


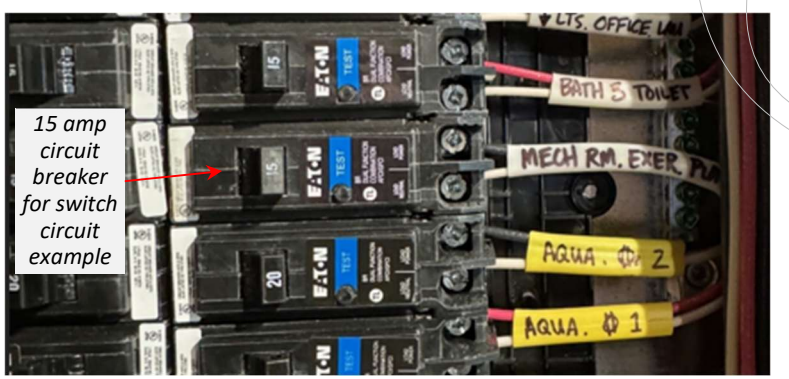
left and right breaker panels

above left breaker panel

below right breaker panel

For the circuit in the switch circuit example, the home run cable enters from below the left breaker panel. Since this is a 15 amp circuit, 14-2-2 white Romex was used. The Romex has been labelled “Mech. Exer. Play Rm. Bath 3” by the electrician since the switches in the circuit are in these rooms. The black (hot) and white (neutral) wires are connected to a 15 amp circuit breaker. The Romex has been labelled “Mech Rm. Exer. Play” at the circuit breaker.





A total of 103 circuits were created in the 2 breaker panels. The pictures on the right show the circuit breakers after the cover with labels has been attached.

SPRINKLERS

On May 29, Evergreen Fire Protection arrived on site to start the installation of the sprinkler system. Orange pipes were installed in the ceilings of both floors.

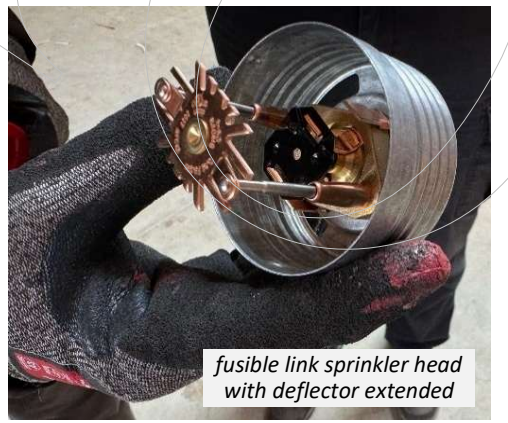

sprinkler pipe running through TJI beams in John's office

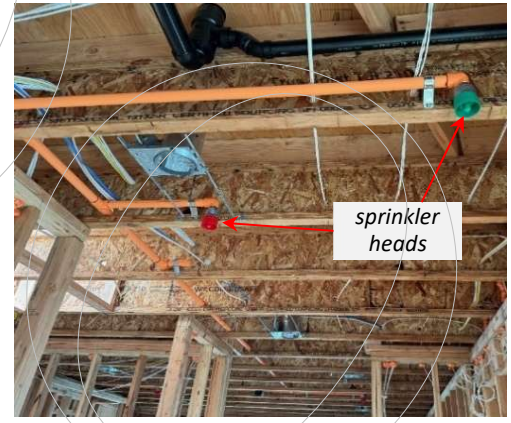

sprinkler pipe running through TJI beams of Great Room


sprinkler pipe running through studs


sprinkler pipes running through main floor trusses

In every room, forks in the orange pipes were connected to sprinkler heads. The sprinkler heads used are RFC43 made by Reliable.

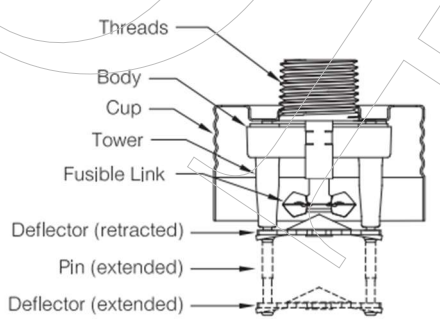

fusible link sprinkler head with deflector extended



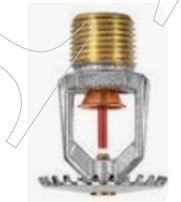
After the installation of the ceilings (drywall, wood), the sprinkler heads are concealed by flat cover plates attached to the skirt using eutectic solder that melts at 135 deg F. When the ceiling temperature reaches 135 deg F, the solder melts releasing the cover which allows the sprinkler to drop down into position.

The RFC43 sprinkler head uses a "fusible link" (as opposed to a "glass bulb" sprinkler head). The fusible link is an alloy that melts at 165 deg F releasing the pressurized water. Glass bulb sprinklers use a glass bulb filled with a heat-sensitive liquid and rely on it exploding when the temperature is high enough.

The deflector ensures that the discharged water is distributed in a hemispherical pattern.



RFC43 components


glass bulb sprinkler head

Potable water is provided by the City of Medina via a 1 ½" pipe. That pipe forks into two pipes – one is the 1 ¼" pipe that goes to the sprinkler system. There is a "double check" valve in the Mechanical Room that connects to the drain. There is also one outside. Double check valves are backflow prevention devices designed to prevent contaminated water from flowing back into the potable water supply.

valve and flow switch gauge

close up

LOW VOLTAGE WIRING

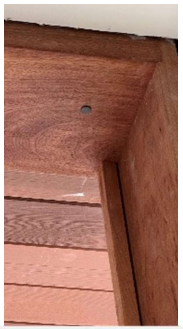
Low voltage wiring refers to the following 4 types of wiring:

- Coaxial cables used for TVs
- Cat 6 ethernet cables used for networking
- 12 volt wiring used by the security system with the door open, glass break and CO / smoke detectors
- 6 conductor wiring used for motorized shades

Coax was run to 4 locations where TVs were going to be installed:

- Kitchen W wall
- Family Room
- Master Bedroom
- Playroom

The coax connects to the cable provider's (Comcast) set top box that is connected to the TV via an HDMI cable.



door open detector in pivot door jamb

door open detector hidden under rubber strip

Cat 6 ethernet was run to RJ45 outlets in the following locations:

- Great Room right shelves
- Kitchen W wall in TV niche
- Master Bedroom in Versa box
- Polly's Office N wall below desk
- Polly's Office S wall
- Family Room in Versa box
- John's Office on N wall
- John's Office W wall
- Sitting area
- Playroom N wall and Versa box on S wall
- Garage E wall
- Elevator closet

glass break detector

CO / smoke detector

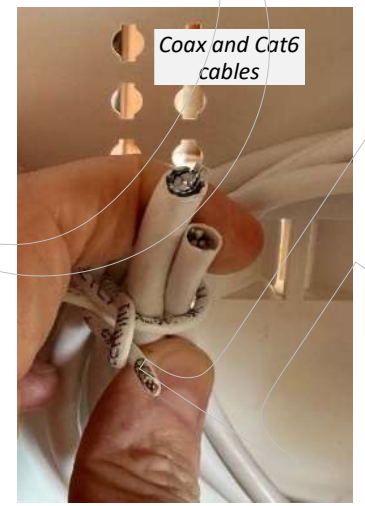
alarm

The 4 types of wires were bundled. For each target location, a bundle was run from the Storage Room through the main floor trusses then through the studs to the end point. The runs were point-to-point, not daisy-chained. Versa boxes were installed in the Family Room, Master Bedroom and Playroom that contained Coax, Cat6 and 120V outlets.

Storage Room origination

running through main floor trusses

Versa box in Family Room



Coax and Cat6 cables

Versa box in Playroom

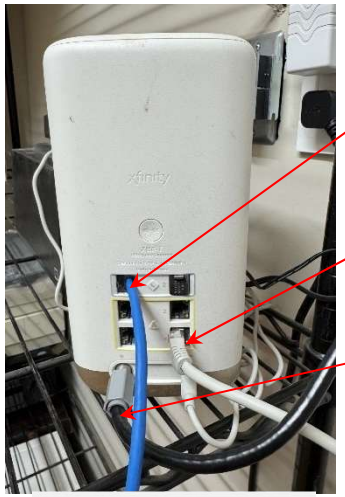
All of the low voltage wiring originated from the low voltage panel in the Storage Room.

The main coax from the cable provider was split to feed the internet gateway box and TVs. The gateway box high speed port was connected to the Power Over Ethernet (POE) network equipment (described in Systems chapter). The Cat 6 wiring connecting the RJ45 outlets was terminated in 2 patch panels located in the low voltage panel. Patch wires (short ethernet cables) were used to connect RJ45 outlets to the POE network.

low voltage panel in Storage Room

wiring bundles in studs and main floor trusses

internet gateway box (white) plugged into Uninterruptible Power Supply (black) beside low voltage panel

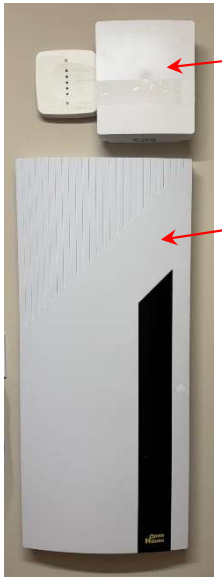


home phone line
required for elevator

high speed port
connected to POE
network equipment

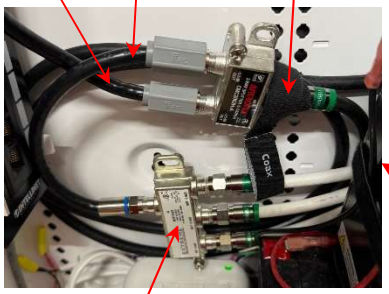
coax
input

back of internet gateway box showing connections



alarm system
controller

low voltage
panel
external view



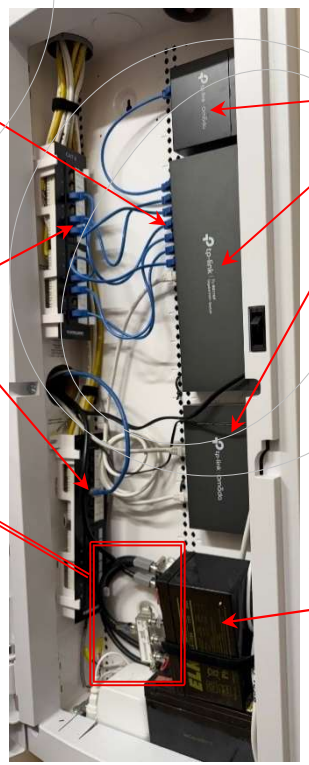
to internet
gateway box

to TVs

main coax
input to 2-way
splitter

3-way splitter
to 3 connected TVs

close-up
view



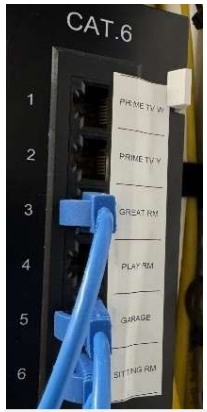
patch
wires

patch
panels

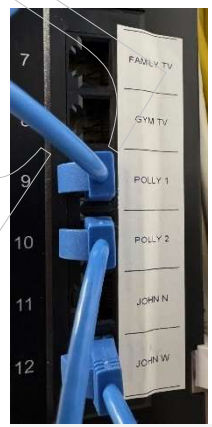
POE
network
equipment

LOW VOLTAGE PANEL CONTENT

alarm
system
battery
backup



upper patch panel



lower patch panel

WATERFALL

The previous architect (that we fired) had incorporated a significant water feature into his design that included a waterfall. We were interested in the concept of having a waterfall in the window well that could be experienced at the front entrance as well as indoor from the upper and lower levels. Our general contractor arranged a meeting with Turnstone – a premier provider of commercial water features in the Seattle area. We liked some of their water features that we had seen and we wanted to implement something similar. In particular, we liked water running down a high black basalt wall and we liked water exiting via scuppers into a pond with stones. Turnstone designed our custom waterfall.

Here are 2 pictures of our waterfall on June 14, 2024 after Turnstone completed the construction. One picture shows the waterfall with no water flowing. The other picture shows the upper and 2 lower reservoirs. The waterfall is approximately 13' high and 12' wide. Water from the upper reservoir spills over the scupper then runs down a 12' basalt wall which creates whitecaps. The intermediate reservoir at the bottom of the basalt wall is about 1' deep and there are 5 scuppers 8" wide where the water exits to fall to a lower reservoir. There, the water exits via a skimmer and goes to a Filtrific pump where it is filtered using a screen then pumped back up to the upper reservoir where the water is filtered using a UV light before entering the upper reservoir.

Ultimately, the pipes and the Filtrific pump will be covered with soil and pavers. Access to the Filtrific pump filter is at ground level which makes emptying the filter basket and adding chlorine tablets easy. Pavers will overlap the edge of the lower reservoir.

Work on the waterfall started Apr 12, 2024. They brought a sample of a stainless steel scupper and a basalt cap. They marked where the waterfall would be located on the vertical wall of the window well.

Filtrific pump after landscaping


pavers overlapping edge

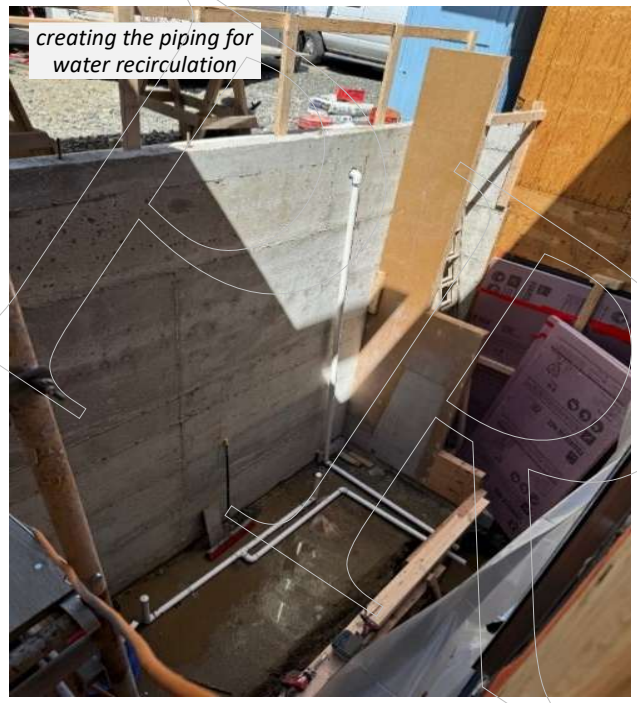

the vertical boards provided a rough indication of the waterfall width


stainless steel scupper


Filtrific pump

Concrete cutting was required to make room for the waterfall and the Filtrific pump.

Building the waterfall:


creating the piping for water recirculation

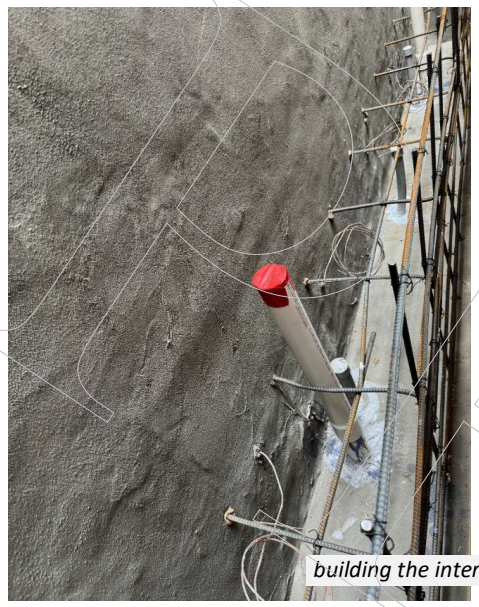

building the intermediate and lower reservoirs


rebar and conduit for underwater lights

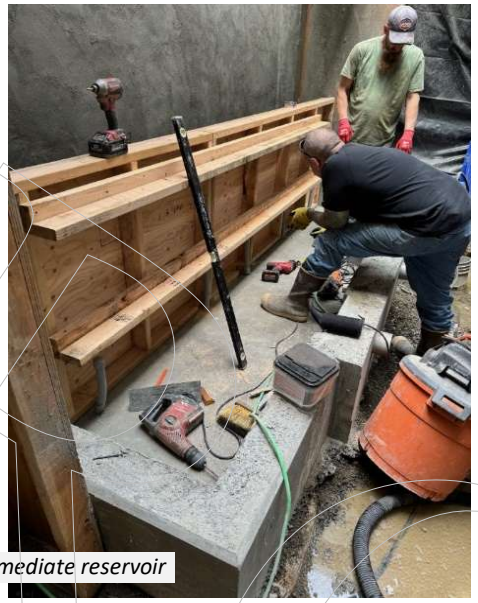

rebar and conduit for underwater lights


concrete was poured May 6, 2024

The intermediate level reservoir was created with gaps for the scuppers and conduits for lights. The Filtrific pumps were installed in the window well and connected to the piping.



building the intermediate reservoir



intermediate reservoir showing scuppers and conduits

connecting the Filtrific pumps

The tiles on the side walls were installed before the basalt. The basalt was installed on the W side for the water to run over. It is a rough surface that will create the white caps for appearance and the waterfall sound.

creating the basalt wall

upper reservoir

basalt tile

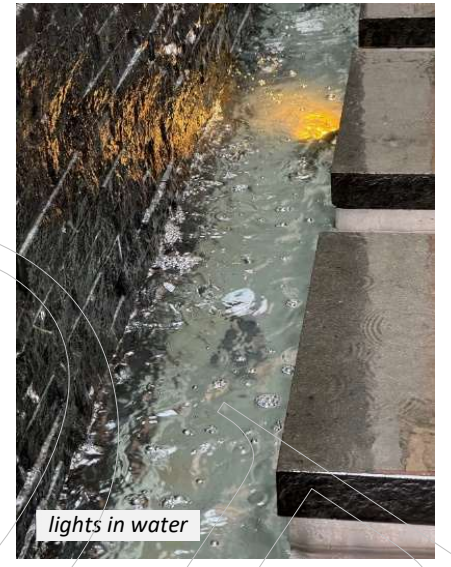
upper reservoir with screen

demonstration

lights in water

the waterfall was covered up to protect it during construction

backflow prevention device



lights in water

After the waterfall operation was demonstrated, it was shut down pending future connection to the city main. Because of evaporation and splashing, the waterfall needs to have access to city water. A backflow preventer was installed in the Mechanical Room to prevent water from the waterfall flowing into the house supply. This is important to ensure that non-potable water from the waterfall can't make its way into the house drinking water.

FIREPLACE INSTALLATION

There are 3 gas fireplaces: Great Room, Master Bedroom, Family Room. The Great Room and Master Bedroom fireplaces have chimneys that connect to the chimney on the roof.

Great Room

after framing the fireplace and connecting the chimney

after installing metal studs

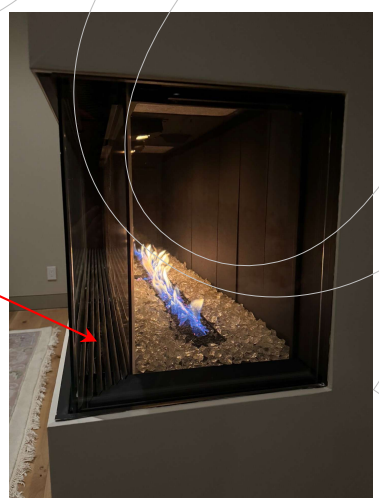
Master Bedroom

after framing the fireplace and connecting the chimney

after installing metal studs

The Family Room fireplace is a 2-sided fireplace that vents out the wall. It does not have a chimney.

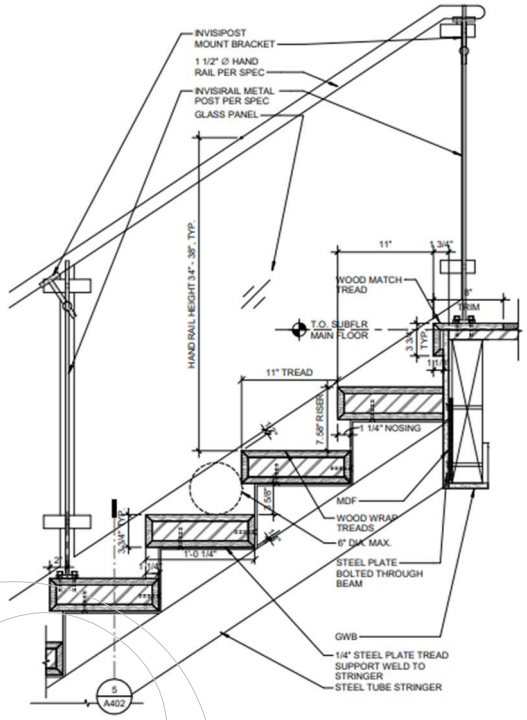
Air enters from a vent at floor level. There is also a vent at the top of the metal studs adjacent to the ceiling to release warm air into the room. The fireplace burner is surrounded by glass on the 2 sides. There are 2 layers of glass separated by an air barrier so the outer glass does not become too hot to touch.



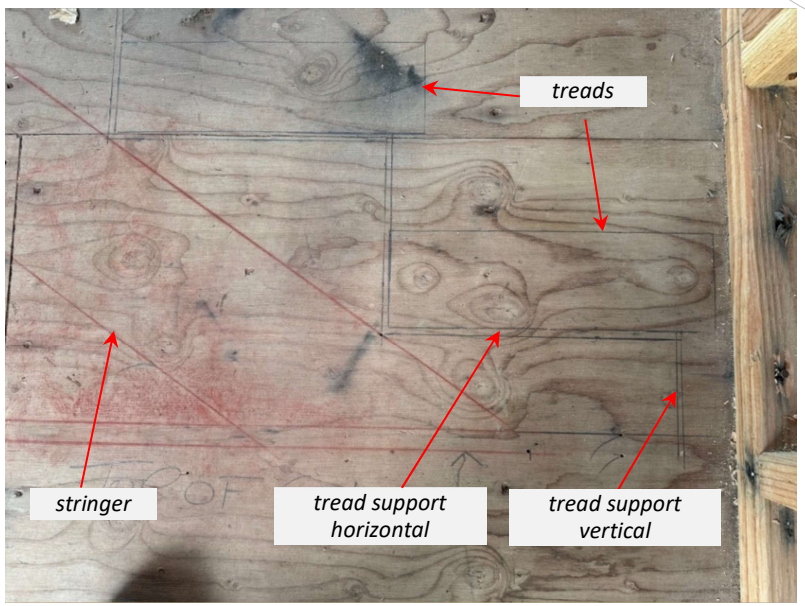
STAIRCASE

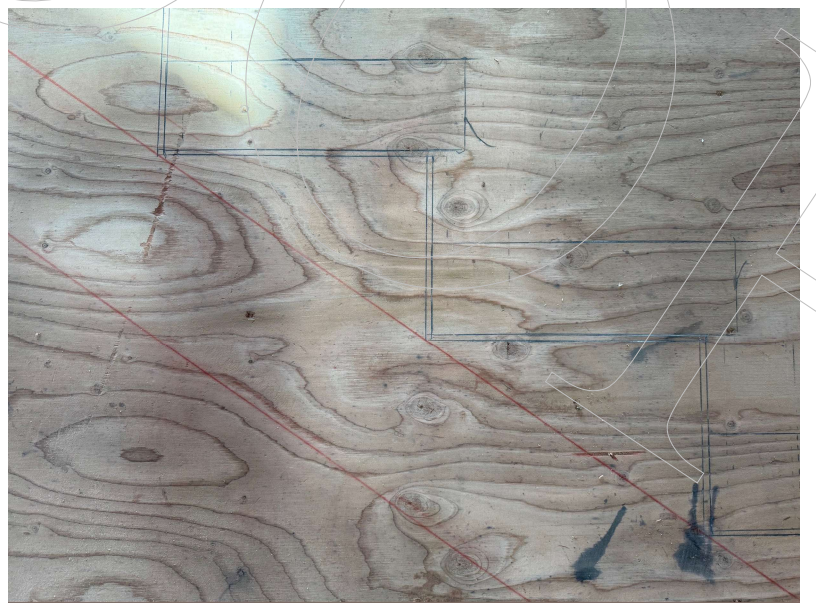
Work on the staircase began May 17, 2024. The picture on the left is the architect's rendering of the staircase as viewed from the lower level. There are 2 stringers of tube steel 4" x 6". There are 2 sets of steps, 8 treads above the landing and 9 treads below. The treads are 4' 2" wide and 4" thick. The landing is 4' 2" square.

The drawing on the right shows the stair tread and railing details from the A402 architectural drawing.



A carpenter drew the stringers and tread supports of the upper and lower sections of the staircase on the plywood floor of the main level – to scale. The red lines in the drawing represent the steel stringers starting at the concrete floor on the lower level. The stringers sit on ¼" thick steel flat bar, 4" wide (the width of the stringer) – shown as double lines ¼" thick in the drawing. The tread supports are welded to the stringers.





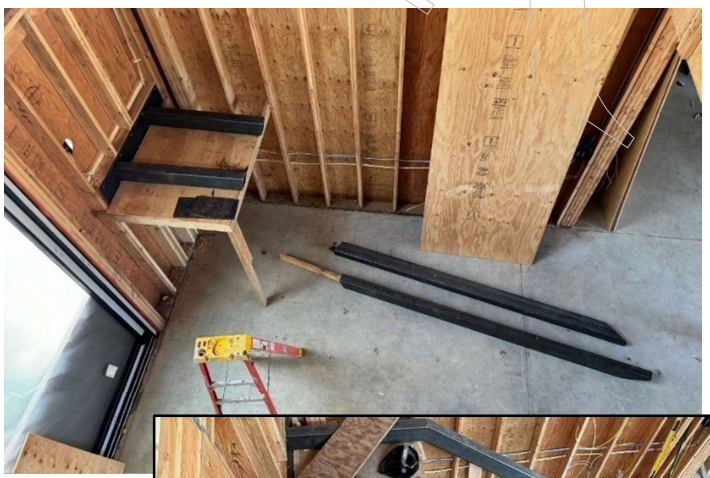
The staircase steel frame was fabricated by Pasha. He brought his drill press and welding equipment to the house and did all the work on site. The first step for Pasha was to construct the plates that the landing, upper and lower stringers would attach to. The plates were screwed into the glulam at the top and into studs on the W wall. Plates were also screwed into the concrete floor for the lower stringers.

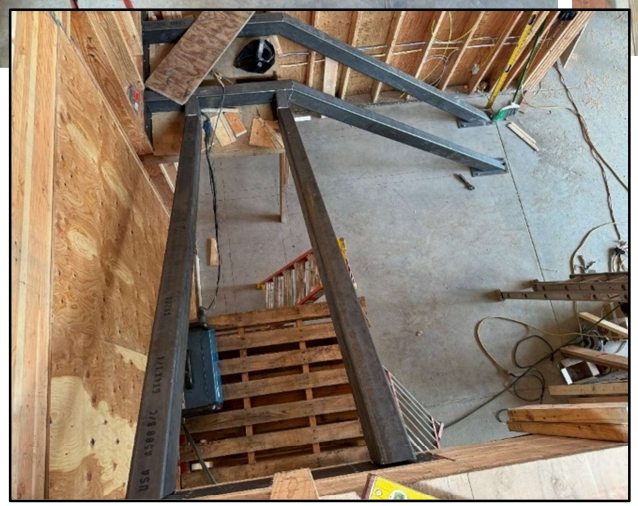
using drill press to create plates

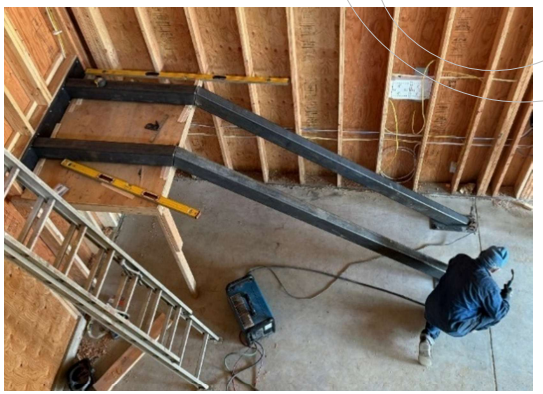
temporary platform built to support the landing

plate where upper stringers will be attached

The stringers were cut to the correct size then spot welded to temporarily hold them in place. A temporary platform was built to support the landing.







The type of welding used on the staircase is called Gas Metal Arc Welding (GMAW). Also known as Metal Inert Gas (MIG) welding. It is a welding process that uses a wire electrode fed through a welding gun and an inert "shielding gas". The electric arc produced melts the steel to be connected as well as the electrode. This creates a very strong weld. Using a shielding gas prevents slag (which is an issue with stick welding and flux core welding – the slag needs to be removed after). Using a shielding gas results in a much cleaner weld.

In our case, a portable Miller welding machine running off 120 V was used. The welding machine has a roll of 035 copper coated steel wire inside (the wire electrode). The green hose on the left side of the Miller unit is from a gas cylinder containing a CO_2 / Argon mix. This is the shielding gas. When the "trigger" of the welding gun is pressed, wire is fed through the hole in the nozzle of the gun. Gas from the cylinder is also released when the trigger is pressed.

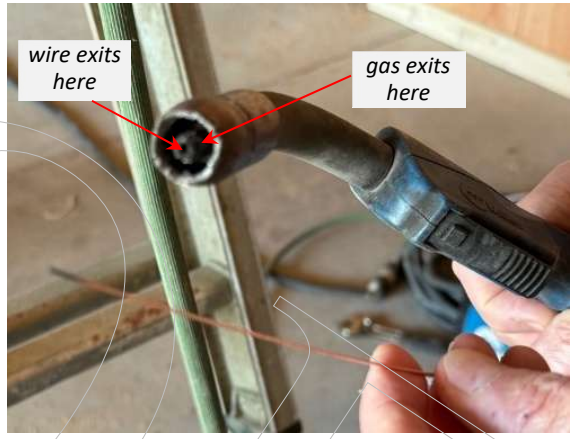
the green hose is the CO_2 / Argon gas feed

roll of 035 copper coated steel wire


Pasha holding welding gun with wire protruding from nozzle


welding the stringers to the floor plates


CO_2 / Argon gas cylinder

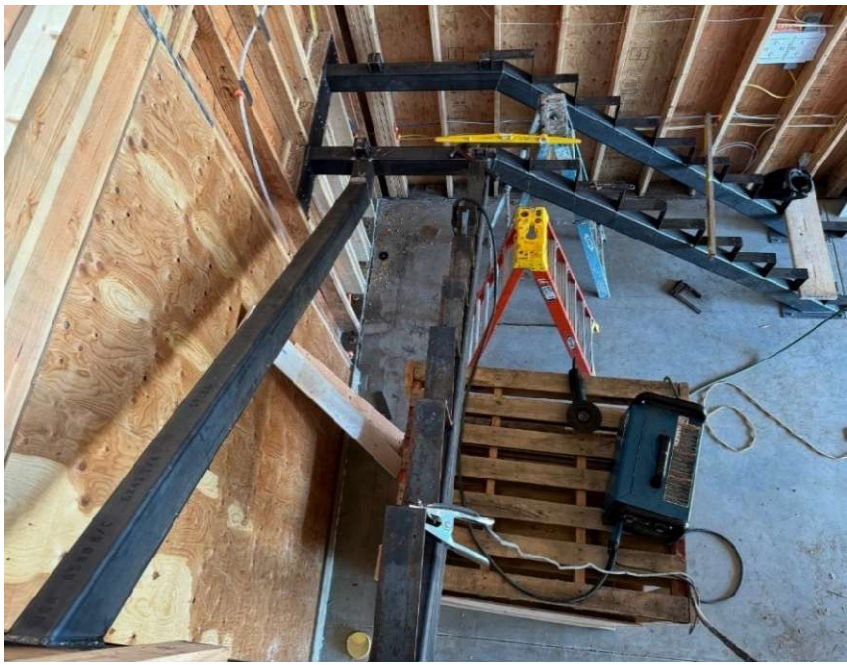

wire exits here

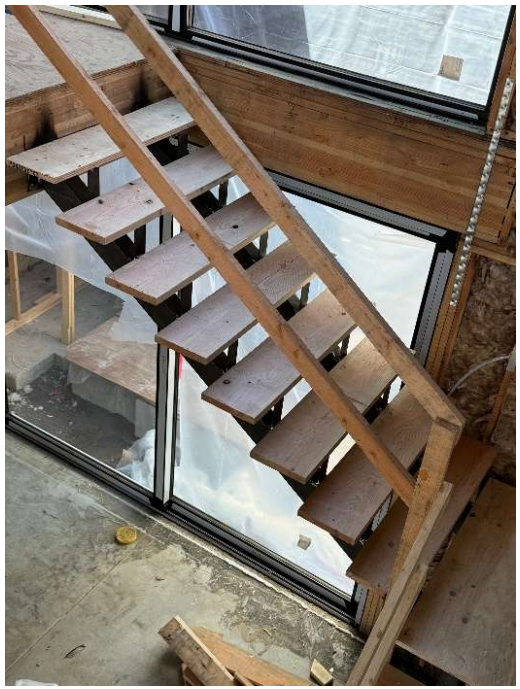
gas exits here


welding the stringers to the upper plate


completed stringers

With the stringers completed, Pasha started building the tread supports. The horizontal and vertical pieces were cut then welded. This had to be done very precisely. Placement of the steps was critical including the lower step which had to take into account the thickness of the future wood floor. The tread supports also had to be perfectly level. If the step spacing or level was slightly off, this would be very noticeable.

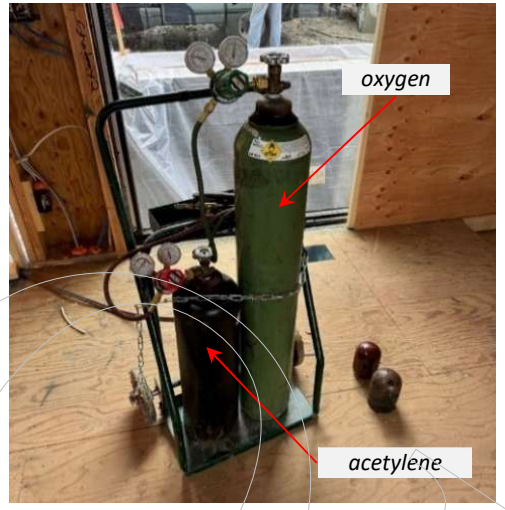




When the stair framing was done, the carpenter constructed temporary stair treads, landing and railings.

ENTRY BRIDGE

Concurrent with the work on the staircase, Pasha also welded the entry bridge. Steel brackets were screwed into the wood beams of the frame. A steel beam across the window well was welded into place. Very strong corrugated steel was then placed in the channel created by the steel beams.



Pasha used “plug welding” to connect the corrugated steel to the steel beams. Plug welding uses oxygen (larger green tank) and acetylene (smaller black tank). It is a process that fuses 2 metals together by making a weld inside small circular holes. The weld fills the hole in the upper material joining the 2 metals together.

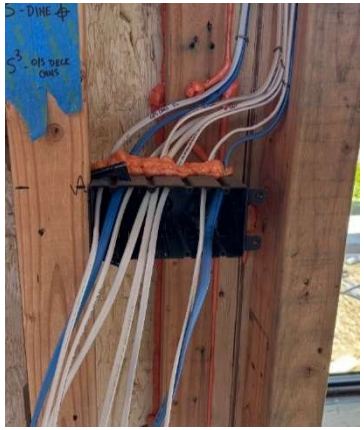
The corrugated steel bridge was temporarily supported with wood. Concrete is very heavy when wet and can cause steel to warp. The wood would be removed after the concrete was poured and had dried. Rebar was placed on the corrugated steel in preparation for concrete.

view of corrugated steel bridge from below

Concrete was poured on Aug 1, 2024. Later, the concrete would be covered by tiles.

SPRAY FOAM INSULATION

On June 3, 2024, Angelica from All Pros Insulation was on site spraying white foam insulation between the exterior windows and doors and their wood frames. Orange foam insulation was sprayed around the holes where there was electrical wiring and plumbing supply lines / drains. Both foams are made of polyurethane but have different applications. The white foam is designed to be used for the perimeter of windows and doors as this foam is more malleable, less rigid and won't bow windows and doors. It also provides an air tight seal. Orange foam is used around wires and pipes and is rated as a fireblock sealant. Installing around the electrical wiring is required to meet the residential fire safety code. This foam is more rigid and also works as an air tight sealant.



SPRINKLER PIPE TENTING

Sprinkler pipes (orange) must be covered with tented batt insulation. Proper tenting keeps the blown in insulation from blocking heat from the house reaching the sprinkler pipe. "Batt" insulation refers to insulation that comes in pre-cut flat pieces (vs. "roll" insulation).


Great Room


Kitchen


Master Bedroom


batt insulation

BLOWN-IN INSULATION

On July 10, 2024, a long hose from a truck was used to spray Huntsman 2 lb closed cell foam. 2 lb spray foam provides the highest available R-value per inch – R7. Since 2 inches are blown in, the R value achieved from the blown-in insulation is R14.

Two hoses were fed from green and black tanks inside their company's truck parked outside the front door. The hoses connect to a nozzle with a chamber where mixing occurs before exiting the nozzle as a spray. The spray sticks to the wood then expands to become very hard although it is very light in weight.

Blown-in insulation was used in the ceiling joists of the main floor – Great Room, Kitchen and Dining Room, Polly's office and Master Suite – where there is roof above. It was also used in the ceiling joists of John's office where there is a deck above. Note the 2" thickness of the spray insulation which is evident in the Master Bedroom closet skylight.

BATT INSULATION

On July 10, 2024, also started installing the R30 brown batt insulation into the main floor studs of the outer walls and into the main floor trusses. The insulation in the floor trusses is for sound insulation. After the blown-in insulation was completed, R30 brown batt insulation was installed under the blown-in insulation for a net R value of 44.

White R13 batt insulation was installed between the studs of the internal walls. The purpose of this insulation is for sound insulation.


Family Room


Bedroom 1


Master Bedroom

WMP INSULATION

Before drywall installation, WMP insulation was added to the 3 fireplaces as a protective cover over the fiberglass insulation.


roll of WMP insulation


Master Bedroom fireplace


Family Room fireplace


Great Room fireplace


Great Room fireplace behind wall

GARAGE

Torchdown roofing was applied to the garage floor to provide waterproofing. Several inches of concrete were poured on the torchdown to bring the garage floor up to the level of the house entrance door and garage side door. In preparation for pouring concrete, insulation and rebar were placed on the floor. Concrete was poured on Aug 1, 2024. The next day, ram board was put down to protect the concrete floor. The walls and ceiling were then drywalled on Aug 6.

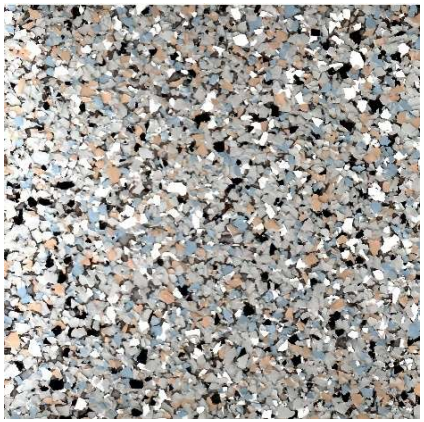
A temporary door with a padlock was constructed from plywood and the space was used to store work equipment and appliances. On Jan 20, 2025, the garage furniture from NewAge arrived and the custom aquarium arrived the next day. The HVAC heat pumps and the appliances also arrived and were stored in the garage until ready for installation.

garage furniture

aquarium

The garage furniture on the E wall was installed Apr 2, 2025 followed by the garage door Apr 14 and the sink on the S wall Apr 24.

On May 12, 2025, a chip epoxy floor was installed in the garage. A base layer of epoxy was applied over the concrete floor then decorative chips were spread into the wet epoxy before it cured. Then a polyaspartic coating was applied with a squeegy then a roller. The result is a highly durable, slip-resistant surface with a visually appealing finish.



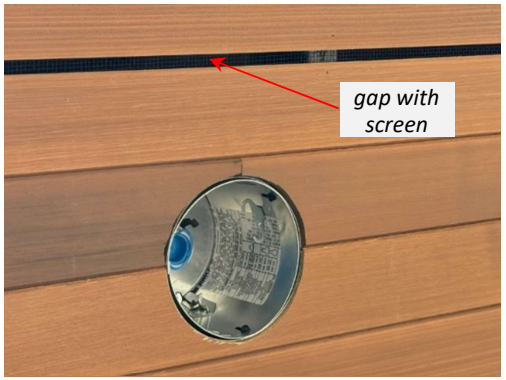
EXTERIOR WOOD & PANELS

SOFFITS

Short 2x4 sections with notches were cut and screwed into the soffits. “Eaves” are the part of a roof that overhangs the wall of a building. “Soffits” are the underside of the eaves.



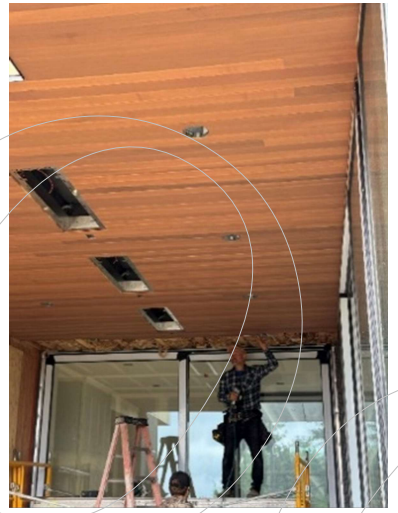
The following pictures show a completed soffit on the E side of the house. Western Red Cedar with clear vertical grain and no knots was used. Note the gap with a screen that allows air to circulate. The soffits were installed in a N-S direction. On the E and W sides of the house, the planks are several feet long. On the N and S side of the house, single shorter planks were used.



The red cedar boards are connected using “tongue and groove” aka T&G. These joints allow 2 flat pieces of wood to be joined strongly together to make a single flat surface. Each piece has a slot (the “groove”) cut along one edge and a thin deep ridge (the “tongue”) on the opposite edge. The joint is normally not glued since shrinkage could pull the tongue off. Here are 2 pieces of red cedar showing how tongue and groove works:


There is no insulation when the soffit is under the roof.

Western Red Cedar was also used for the ceiling of the Atrium.



HARDIE PANELS

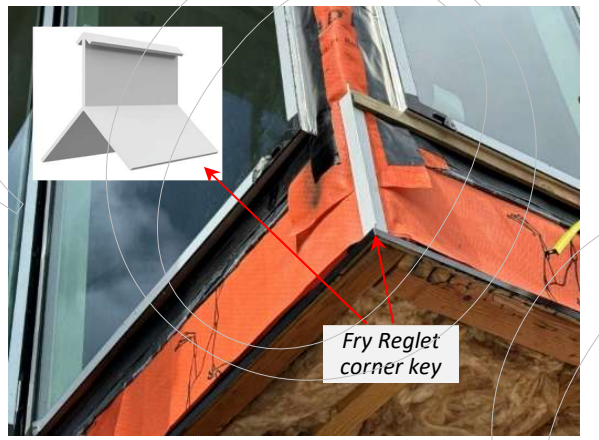
Hardie panel siding is made of fibre cement which is a combination of cellulose fibre, sand and Portland cement. Its advantages are that it is durable and fire resistant. It was chosen since it can be painted to have a metal look. Using actual metal is much more expensive and it is prone to buckling. Metal is also easily dented and scuffed which takes more effort to repair.

Hardie panel outer side

Hardie panel inner side

Hardie panels were used at the back of the house in the areas outlined in red dots. Before installing the Hardie panel, wooden battens were nailed to the orange waterproofing material. The Hardie panel is screwed into the battens. This provides a “rain screen” ie, if water gets behind the Hardie panel, it will be able to exit at the bottom. “Fry Reglet” corner keys were used to connect the Hardie panels at the corners.

installing battens over frog skin



Fry Reglet corner key

looking down at Hardie panels (yellow) and Fry Reglet corner key from the deck above

WOOD WALLS

Wood was used on the walls in 2 places: around the Garage and between the Family Room and John's Office. For the outside walls, Western Red Cedar with clear vertical grain and no knots was used with a Sikkens wood coating product that made it shinier.

Garage and N door

above Window Well

between Family Room and John's office

Garage N door

Garage front

above Window Well

between Family Room and John's office

CONNECTING TO THE UTILITIES

Starting Sep 18, 2024, after the scaffolding used for the stucco and outdoor wood was removed, the excavators came back. Before any landscaping could be done, the following had to be accomplished:

- build trenches and install drain pipes for storm water handling on the N, S and E sides of the house connected to the downspouts; the drain pipes on all 3 sides run to the back catch basin
- build a trench for 2 pipes from the 2 back catch basin pumps to the front catch basin that connect to the city storm drain
- build trenches and install sewer pipes from the Mechanical Room and Bedroom 2 that meet at the city sewer line connection
- build a trench for a conduit from the SW corner of the property to the electrical meter box on the NW side of the garage
- build a trench for a conduit for coax to the NW corner of the house
- build a trench for the water main from the water meter on the property line to the supply line connection on the W foundation wall

STORM WATER HANDLING

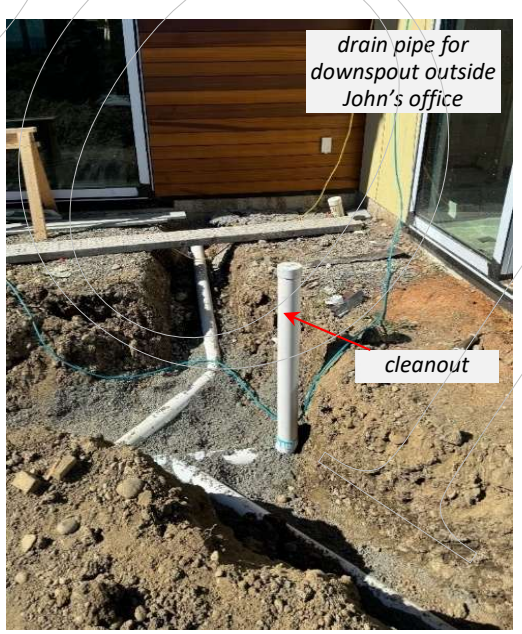
Downspouts are found at the following locations:

- NW corner
- NE corner near Laundry Room window
- E side near Family Room window
- E side under MBR balcony
- SE corner
- SW corner outside MBR

All of the storm water was fed to the catch basin at the back of the house then pumped up to the street. Trenches had to be dug for drainage pipes (white) that would connect the downspouts to the catch basin.

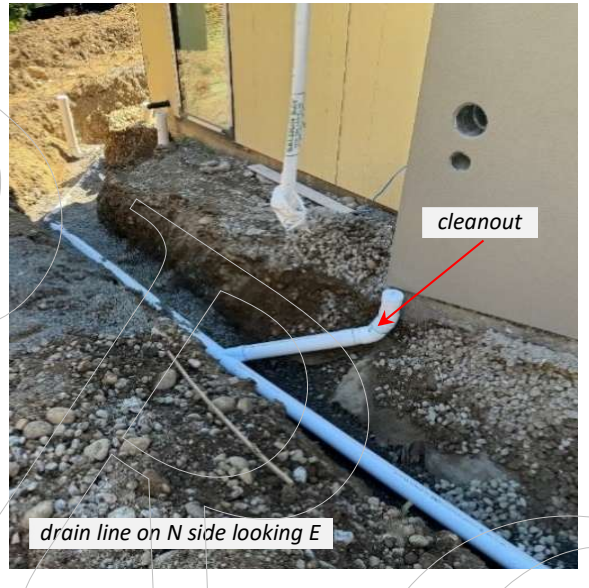

drain pipe connecting Family Room and Bedroom 1 drains

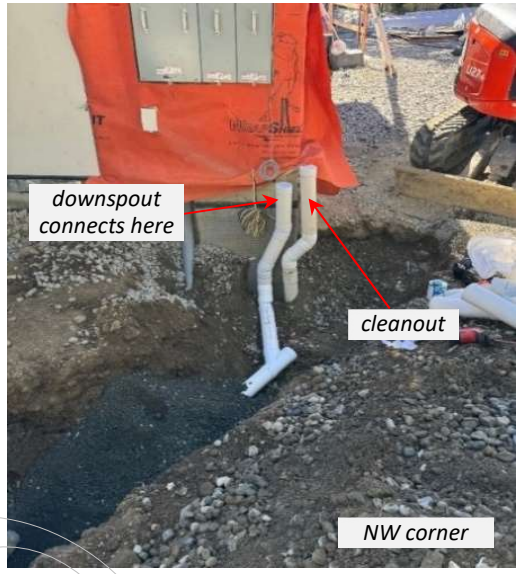

drain pipe for downspout under balcony

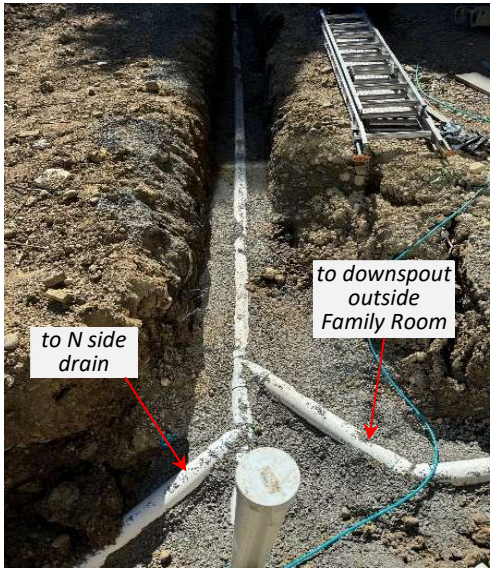


drain pipe for downspout outside John's office

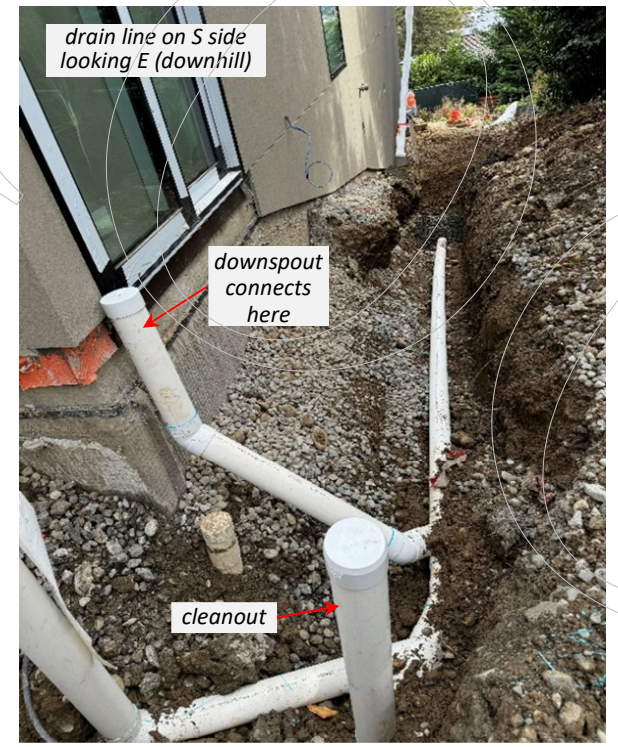

drain line on N side looking W

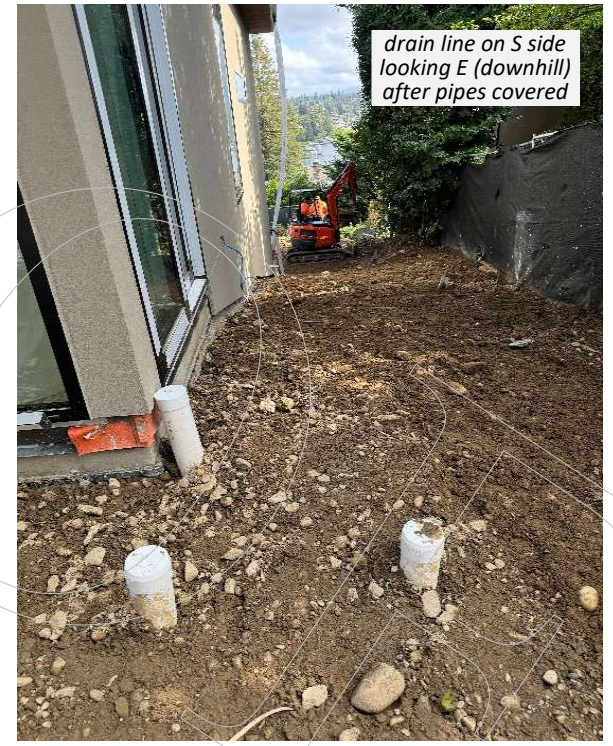

cleanout
drain line on N side looking E


downspout connects here
cleanout
NW corner

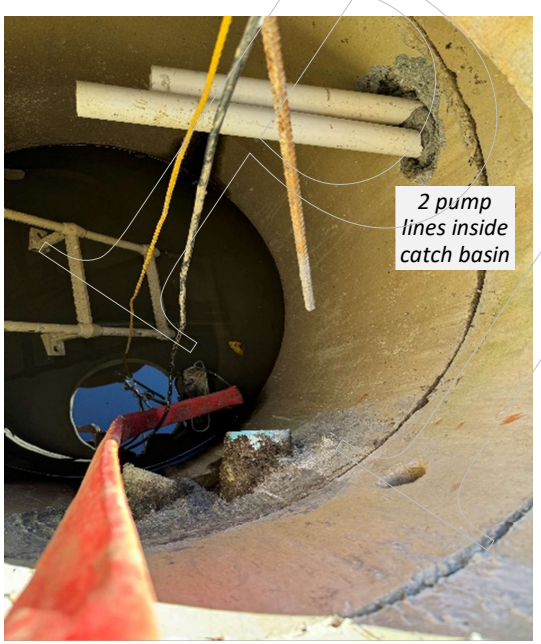

to N side drain
to downspout outside Family Room

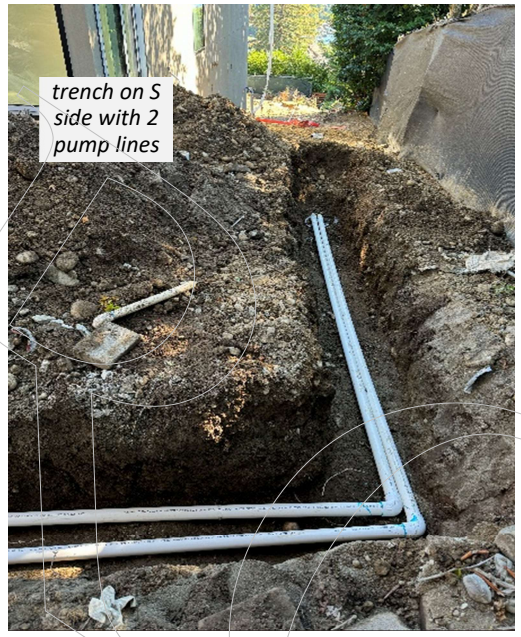

drain line on S side looking W (uphill)


drain line on S side looking E (downhill)
downspout connects here
cleanout

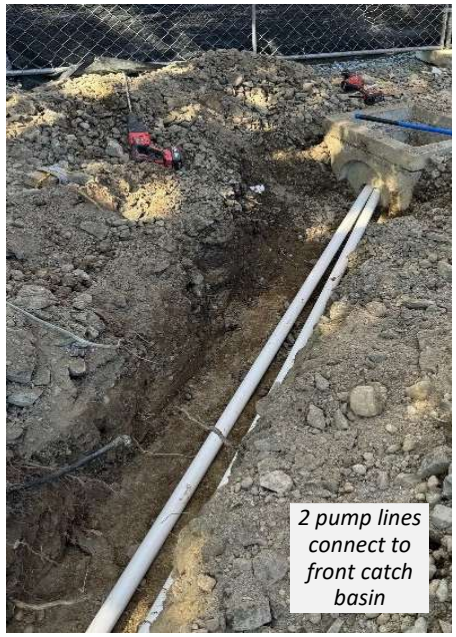

drain line on S side looking E (downhill) after pipes covered

After the S side drain pipe was installed, its trench was covered and a second trench was built. The water in the catch basin has to be pumped up to the front of the house where it is connected to the city storm sewer. The catch basin pumps used were described in the Backfill & Exterior Drains chapter. They also require a conduit for the electrical wiring which was located at the SE corner of the house. The 2 catch basin pumps had separate pipes. A second trench was dug up the S side of the house for these pump lines.


2 pump lines inside catch basin


trench on S side with 2 pump lines


trench on N side with 2 pump lines


2 pump lines connect to front catch basin

After the storm water drains and pump lines were installed, the trenches were backfilled.


N side

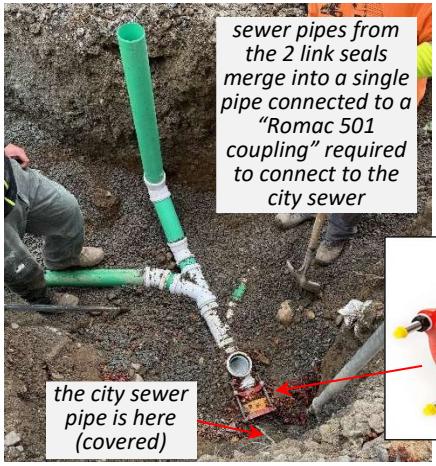

S side


E side


W side

SEWER PIPES

In the Interior Drains chapter, we showed the holes in the W foundation wall of the Mechanical Room and Bedroom 2 where the drain pipes that will connect to the city sewer exit the house. Then in the Plumbing chapter, we showed the link seals that were used in the foundation wall to create a perfect seal. After the trenches for the storm water drains and pump lines were backfilled, 2 new trenches were dug from the 2 link seals on the foundation wall to the existing concrete city sewer pipe near the property line. The green pipes merged into a single pipe connected to a valve that connected to the city sewer pipe. The vertical green pipes were filled with water for the sewer inspection. After the inspection, the trenches were backfilled.



ELECTRICAL SERVICE

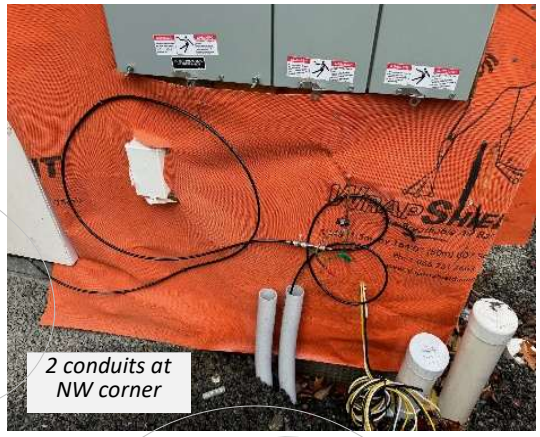
Before demolition began in August 2023, the electricity was shut off. A temporary pole was constructed in the SW corner of the lot and a meter was installed with a temporary breaker panel. A long 120V extension cord was connected to the temporary breaker panel. This was used to provide power for equipment during construction. A trench was dug from the temporary pole in the SW corner to the meter box on the NW side of the house. On Oct 15, 2024, Puget Sound Energy (the local utility company providing both electricity and gas) came out to run a cable with 400 amp service from the temporary pole to the new meter box. They also moved the meter and installed it on the new meter box.

The electricians came out the next day to install temporary outlets inside the house (since the long extension cord was no longer available). They also installed temporary light switches to facilitate indoor work. Two temporary 240V 10,000 watt electric heaters were also connected. Initially, the electricity used came from Puget Sound Energy. Later, the solar panels also provided electricity.

CABLE TV / INTERNET SERVICE

The excavators dug a trench for 2 conduits (one spare) from the property line, across Upland Rd, to a pole on the other side of the street used by the cable provider (Comcast). It was subsequently covered with asphalt. Then a trench was dug to extend the conduit from the property line to the NW corner of the house below the electrical meter.


2 conduits at pole


2 conduits at NW corner

The Comcast "cable guy" came out on Oct 31, 2024 to run the coax. He had to climb up the pole to connect the coax to a box. At the house end, he provided a long coax cable that was connected to a Comcast cable modem in the garage. We setup and tested the WiFi to verify internet connectivity. For the next 5 months, the WiFi of the cable modem temporarily in the garage was used to monitor the solar panels. Later, the cable modem was moved to the Supply Room. The low voltage subcontractor had installed a coax connection between the meter box and the Low Voltage panel in the Supply Room.

WATER SERVICE

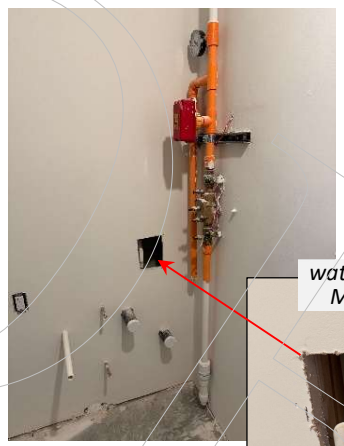
On Nov 21, 2024 the excavators were back to build a trench for the water main running from the water meter near the W property line to the foundation wall connection under the garage. The temporary exterior faucet that was installed Jan 2024 was removed. Black pex was installed to connect the water meter to the pipe extruding from the foundation wall. We now had water inside the house. After inspection by the city, the trench was backfilled.

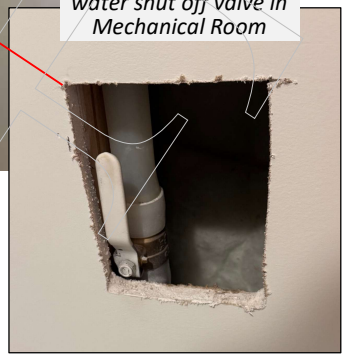
The blue wire in the picture is called the "locate wire". It runs from the water meter to the foundation wall. It helps utilities locate underground water pipes.


water meter


foundation wall

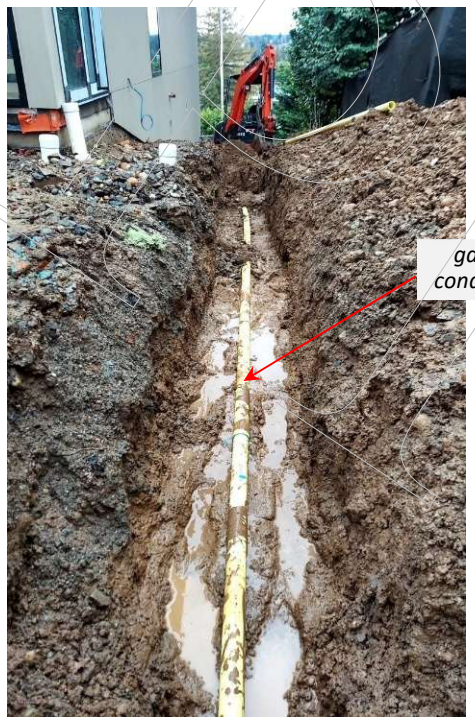

pipe from Playroom exits foundation wall and connects to black pex running to water meter




water shut off valve in Mechanical Room

GAS SERVICE

On Feb 27, 2025 the excavators built a trench for the gas conduit – a yellow pipe running from the PSE gas line on the W property line to the gas inlet on the S side of the house. PSE used the conduit to run a gas line from the PSE gas line to the gas inlet. Note the bags of sand. They are required around the gas connections since sand is more protective than earth/gravel. PSE finally got around to installing our gas meter on Apr 25.



HANGING DRYWALL

Drywall installation started on Jul 19, 2024. Large sheets 4’ X 12’ and 5/8” thick were delivered to each room.


John’s Office

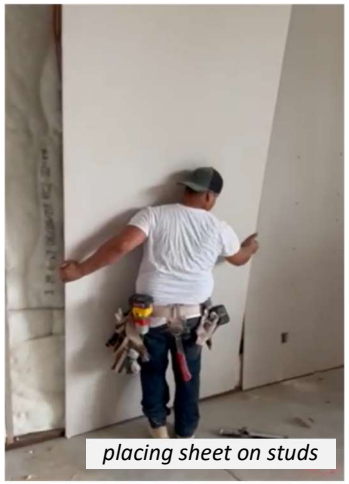

hall outside John’s Office


Great Room

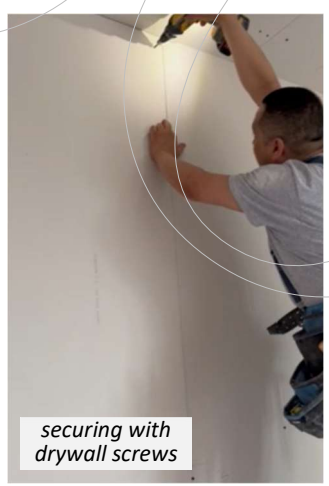

Master Bathroom

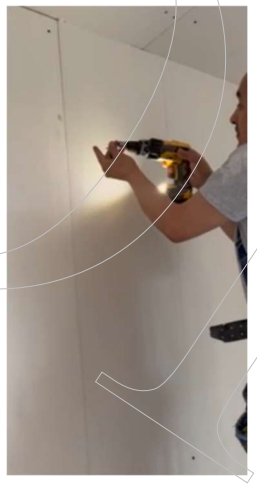
The drywall on the ceiling is done first. The drywall sheets were hung perpendicular to the ceiling joists to maximize support and minimize risk of sagging. For the walls, the drywall sheets were installed vertically on the studs ie, 4’ wide is the width of 3 studs 16” apart. The sheets were butted up to the ceiling using a wedge on the floor. Lines were marked on the drywall 16” apart to show stud location underneath, in order to know where to insert the drywall screws. If the sheet is too long, the excess is marked with a straight edge and a “box cutter” is used to cut a straight line to remove the excess.

Drywall screws are inserted vertically from the top every 12”. A powerful screwdriver with a magnetic tip and light is used which makes the operation very fast. Drywall screws are indented into the drywall when they are inserted. This is intentional. It will be rectified in the taping and sanding steps.


placing sheet on studs

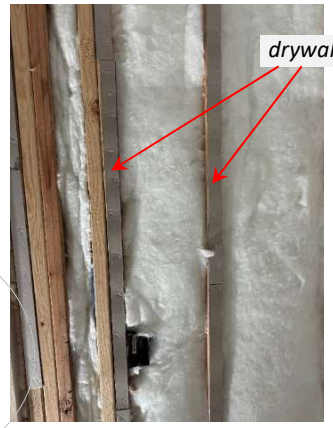

butting up to top

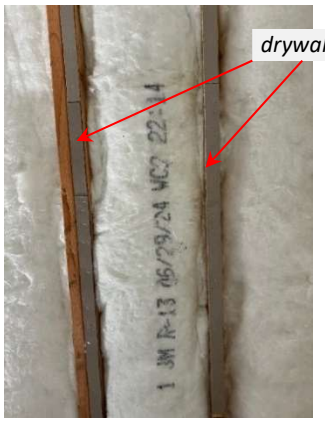

securing with drywall screws



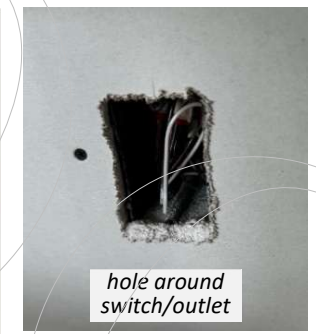

screwdriver

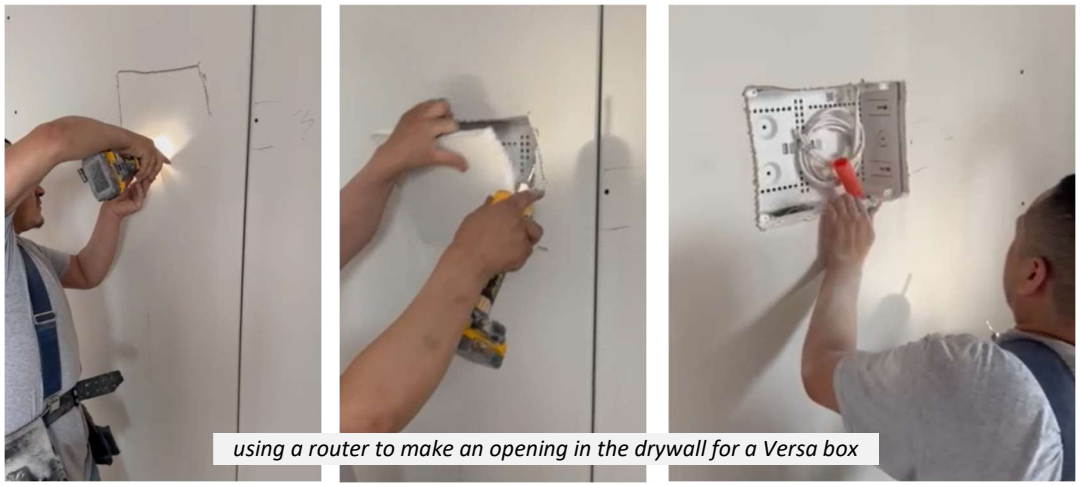
When installing drywall, a 6’ level was used to ensure that the ceiling and walls are level. If not, dry wall shims are used to correct. They come in strips that are 1/16” thick and 45” long. They are stapled to the studs before installing the drywall.

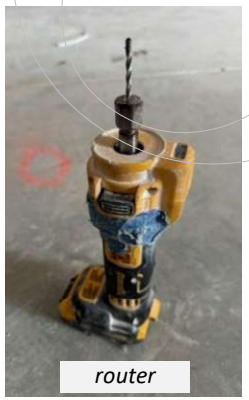




If there is a can light or an electrical switch / outlet or a Versa box behind the drywall, a tool called a “router” is used to make a hole. A router looks like a drill. It has a bit that is used to make a hole in the drywall, then cut the drywall until the inside edge of a can light or electrical switch/outlet is reached. Then the inside edge is traced until a circle or rectangle is completed. The drywall inside is removed exposing the can light or switch/outlet.







Here are some in progress pictures:


Family Room ceiling

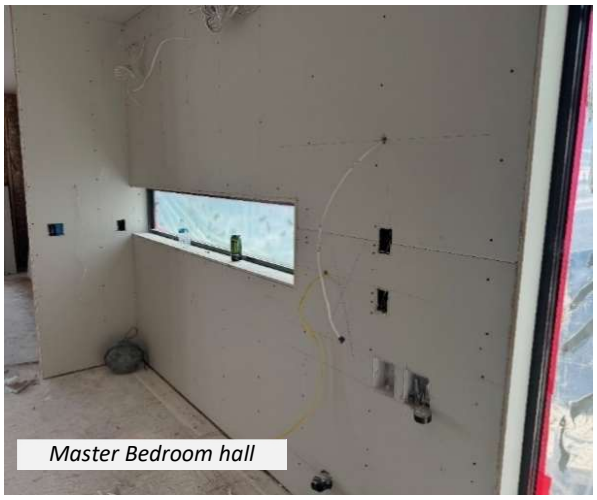

Great Room ceiling looking S


Polly's Office ceiling


Great Room ceiling looking N


Master Bathroom ceiling


Polly's Office cove


Master Bedroom hall


Bedroom 1


Great Room showing the 6' level used

stair well

Family Room including ceiling structure

Master Bedroom

Laundry Room

Garage looking S

Garage looking N

Access was needed to the air handlers to change the air filters and to access the units for maintenance. Bauco access panels were installed. They are quite subtle and blend in with the ceiling drywall after being painted.

Laundry Room ceiling drywall and access panels

TAPING, MUD & SANDING

After the drywall is hung, the next step is taping and mud. The seams between the sheets of drywall are taped then drywall "mud" is applied over the tape using a trowel. To facilitate cleanup after, the floors of both levels were covered with thick paper to catch the drips.

compounds used to fill cracks and indentations ie, drywall mud

tape rolls

The following pictures show a person using an automatic taping tool to apply tape to the ceiling seams. Another person is using drywall stilts to apply the drywall mud over the tape using a trowel.

automatic taping tool

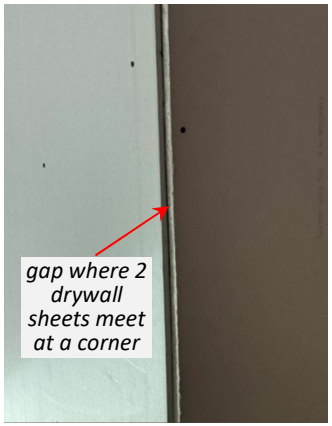
drywall stilts

taped drywall Great Room S wall

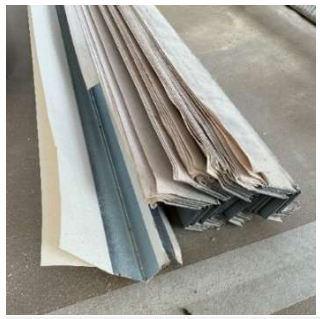
taped drywall Kitchen W wall

taped drywall Kitchen/Dining Room ceiling

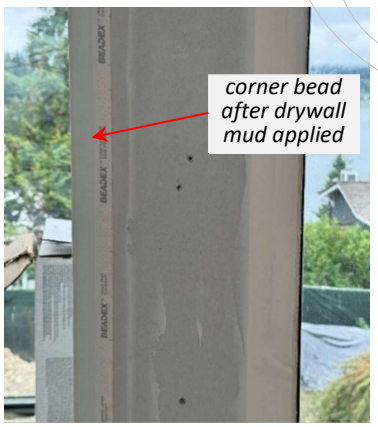
At the corners where drywall sheets meet, there is a gap. This is addressed using “corner bead”. It is a 90 degree L-shaped metal corner with tape on the sides. Corner bead is glued to the wall then drywall mud is applied using a trowel. Corner bead produces beautifully sharp corners.



gap where 2 drywall sheets meet at a corner

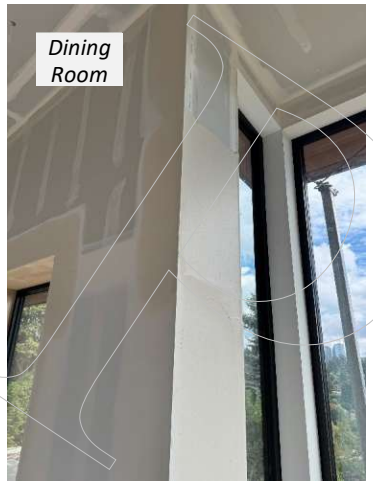


corner bead L shape metal corner with tape



corner bead after drywall mud applied

Master Bedroom hall window



The air handler access panels (formerly green) were removed and mud applied so they would blend in with the ceiling drywall.

The drywall was installed down to the floor. However, we want to have "hidden reveal" baseboards which necessitates removing the lower 6" of the drywall. A laser was used to show exactly where the drywall needed to be cut.

After cutting the drywall for the baseboard, it was necessary to apply corner bead.





After completing the mud and taping, the next step is sanding. All of the windows were covered in plastic in preparation. Then all of the tape was manually sanded. This raised a great amount of dust.

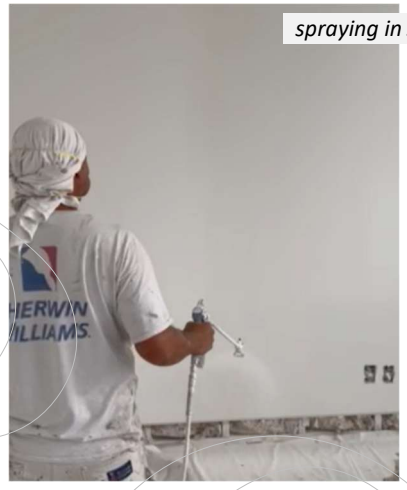


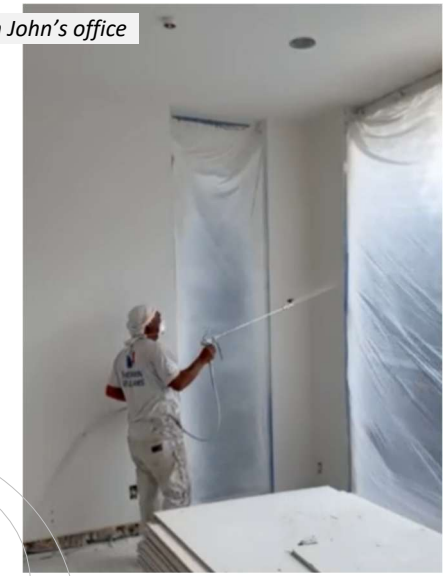
SPRAYING

The final step was applying a spray acrylic. All of the walls were sprayed which produced a beautiful smooth result.

acrylic used for spray


pump used for spraying


spraying in John's office




Family Room after spraying

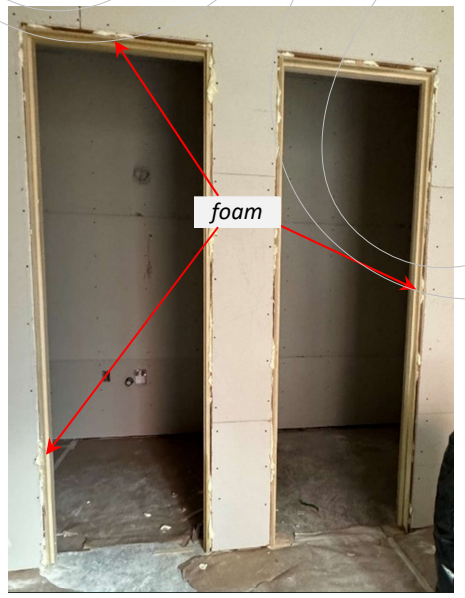

Great Room after spraying

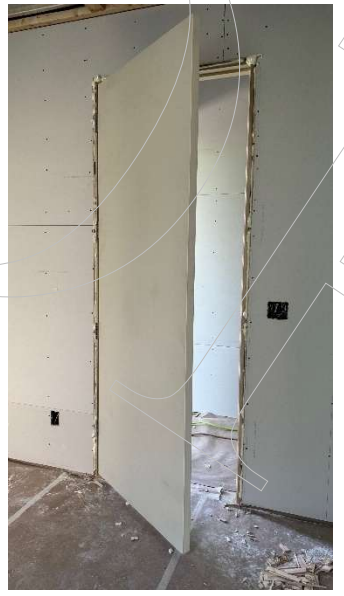
Note that the ceiling of the Great Room was not sprayed. This is because it will be covered with wood. Also, the drywall around the fireplaces was not sprayed since it will be removed (it is not fireproof). It will be replaced with steel (in the case of the Great Room) or Hardie panel that can be painted or covered with MDF (in the case of the Master Bedroom and Family Room).

INTERIOR DOOR FRAMING

There are 3 types of interior doors: single doors, double doors (elevator closet) and pocket doors. The pocket doors do not have hinges. On Aug 14, 2024 the interior doors were delivered from Western Pacific.

Installation began with the door casing being positioned in the target door opening. A long level was used to ensure that the side and head jambs were not tilted. Shims were used for levelling and to make the casing fit tightly into the space. When the framing was perfect, the gap outside the casing was filled with foam that hardened to make the casing rigid.





POCKET DOORS

Pocket doors were installed in 5 locations. The pocket door frames were assembled then installed replacing the studs.


Polly's office


Master Bathroom


pantry

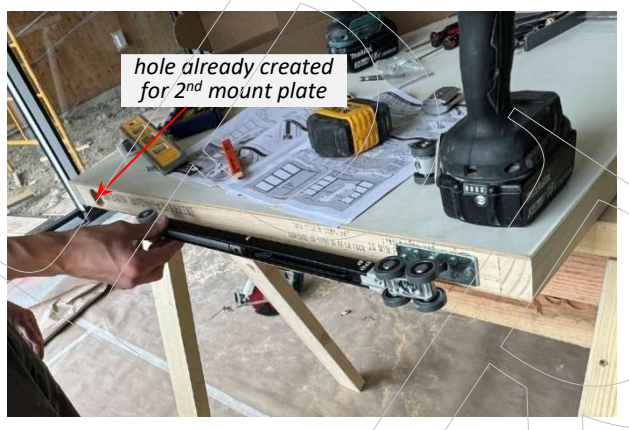

Bath 3 – 2 pocket doors

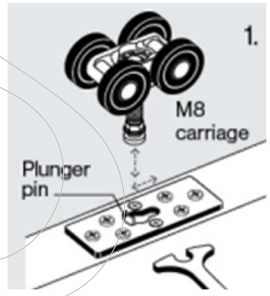

Playroom

installing a mount plate at the top of the pocket door

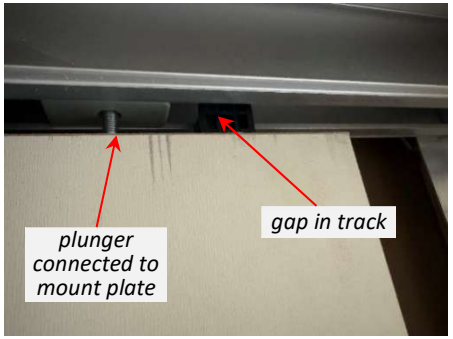
Pocket doors have 2 sets of wheels called "carriages" that slide along a track at the top of the frame. These carriages have a protruding plunger that connects to a mount plate on the top of the pocket door.

The picture below demonstrates one carriage (4 wheels) connected to one mount plate. The black tube between the 2 carriages is a shock absorber used to facilitate a "soft close". When the mount plates were completed, the carriages were slid into the track of the pocket door. This required cutting a hole in the drywall to access the gap at the end of the track provided for this purpose. The plungers of the carriages were inserted into the mount plates and secured using a wrench provided with the pocket door kit.



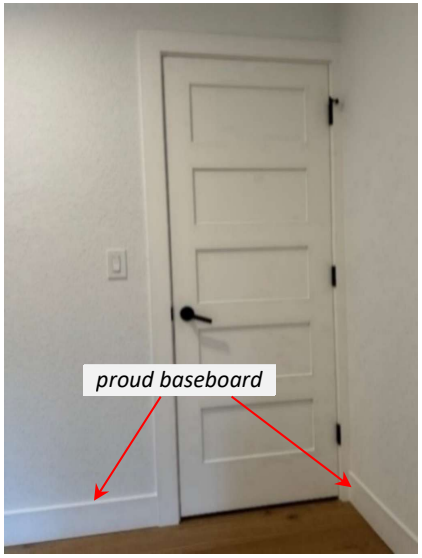


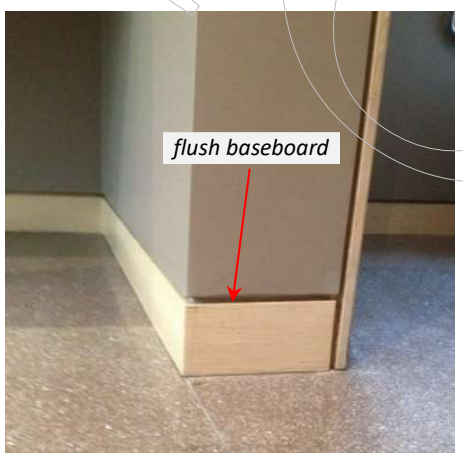
the pocket door and its track are visible from a hole cut in the drywall



HIDDEN REVEAL

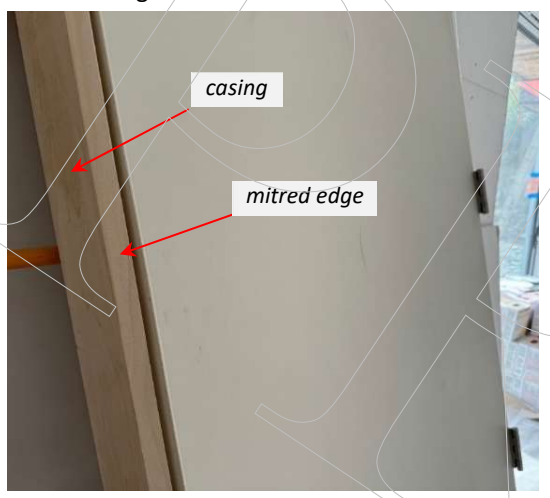
To achieve a clean, modern look, we chose <u>not</u> to use trim around doors and baseboards that protrudes from the wall aka "proud". The picture of the left shows typical baseboard and door trim that sticks out. The picture on the right shows a baseboard that is flush with the wall with a channel in between. There is also a channel around the door frame. This is referred to as "hidden reveal" or "flush baseboard". We first encountered hidden reveal at a previous residence. We liked it so much that we used it in another renovation. So it was a requirement for our new house.



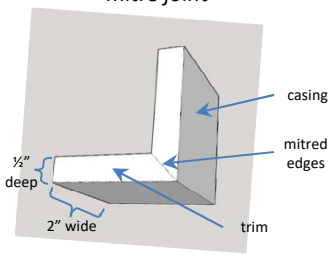


STANDARD DOORS

For typical doors with trim that sticks out, the door casing is flush with the drywall; the trim is nailed over the casing then painted. For hidden reveal doors, the casing delivered by the door manufacturer has been "mitred". This means that the front edge of the casing is 45 degrees. This can also be done with other materials eg, a kitchen island slab with waterfall edges. A table saw was used to create the mitred trim connected to the mitred edge of the casing.

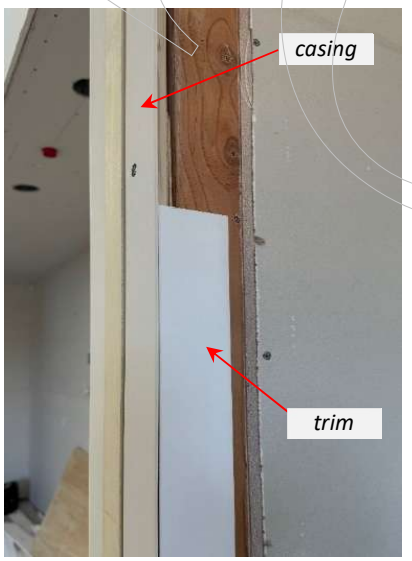


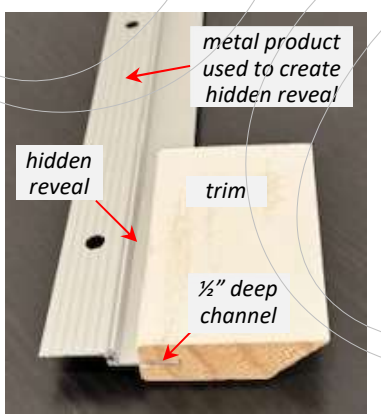
mitre joint

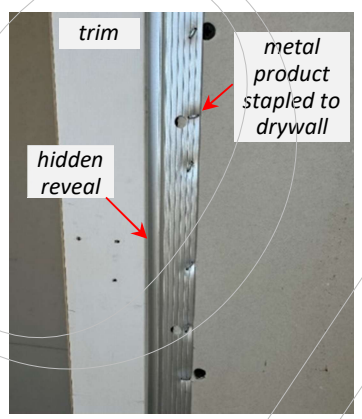


kitchen island with waterfall edges

A portable saw was used to create a 2+" wide gap in the drywall around the door frame. The picture shows the connection of the mitred casing to the mitred trim sitting in the gap cut in the drywall. This results in the trim being flush with the drywall which is the desired effect.

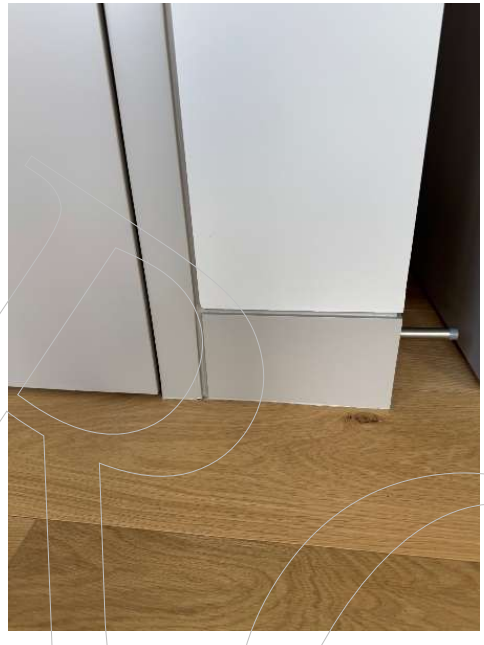


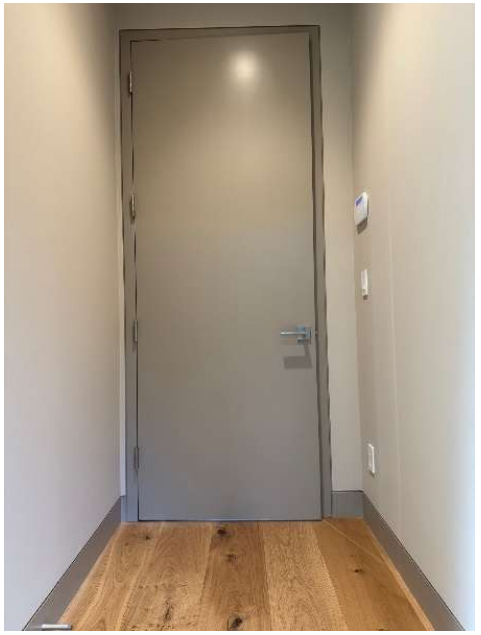




The table saw was also used to cut a ½" deep channel down the centre of the non-mitred side of the trim. A metal product was used to facilitate creating a precise width hidden reveal. After completion, the hidden reveal channel was blocked and drywall mud was applied to cover the ruffled section of the metal product. After applying drywall mud and trowelling over the staples, the hidden reveal looked tremendous.

Here are some pictures of the final result. After sanding, the trim and the wall were flush with a perfect ¼" wide hidden reveal channel.



POCKET DOORS

Unlike the other interior doors, pocket doors do not have a casing. So it was necessary to create a 2nd piece of mitred trim to cover the pocket door frame. The rest of the process is the same as with standard doors.

BASEBOARDS

For the baseboard, a gap was cut in the drywall above the floor. The following pictures show the 6” gap cut above the plywood floor at the bottom of the drywall. A laser was used to show precisely where to cut the drywall using an oscillating saw.

oscillating saw

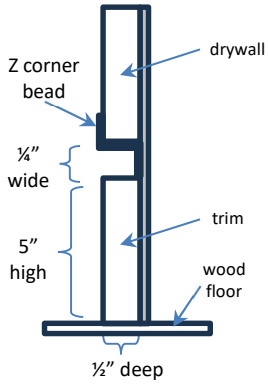
Family Room outside Playroom

Sitting Area

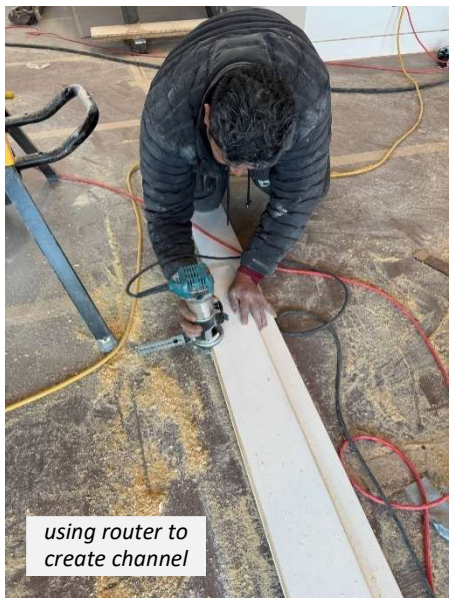
John’s Office

Playroom

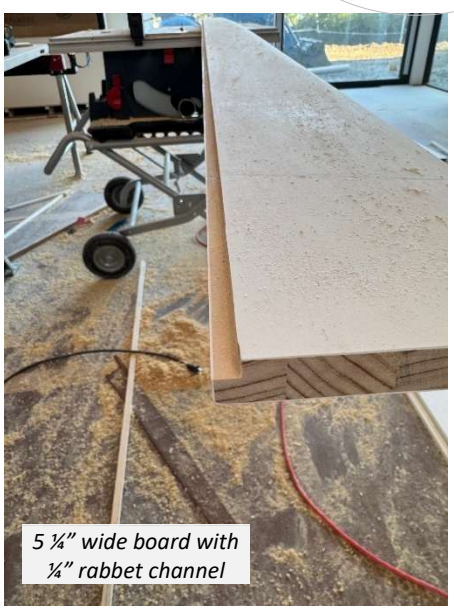
A ⌙ shaped metal product called “drywall shadow mold” or “Z corner bead” manufactured by Flannery Trim was installed at the bottom of the drywall. The wood floor is ¾” thick. So a piece of trim 5” thick is required. The result is a ¼” wide gap between the drywall and flush floor trim.



To create the baseboard, a sheet of wood was cut 5 ¼” wide. Then a router with a guide attachment was used to create a ¼” rabbet channel in the 5 ¼” baseboard.



using router to create channel



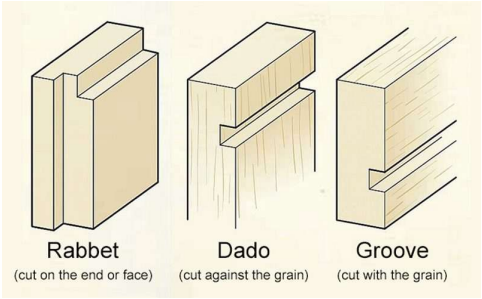
5 ¼” wide board with ¼” rabbet channel

router with guide attachment

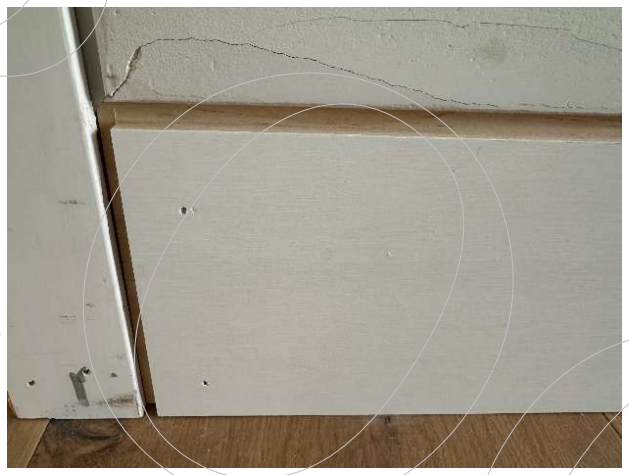
router attachment used for creating different size channels

In carpentry, the 3 main channel types are:

- “rabbet” is an L-shaped channel cut on the edge either with or against the grain
- “dado” - a U shaped channel cut against the grain
- “groove” - a U shaped channel cut with the grain



After creating the floor trim, it is positioned in the gap below the drywall. Since the wood floor is not perfectly level (especially on the lower level), the carpenter had to mark places on the baseboard where it had to be “trimmed” before being installed. Note that baseboards are usually not flush and so this level of precision workmanship is not required. A nail gun was used to nail the trim board to the studs.



WOOD CEILING

Wood was used for the ceiling under the sloped, steel roof section corresponding to the Great Room, Dining Room and Kitchen. The ceilings in the rest of the house are painted drywall.

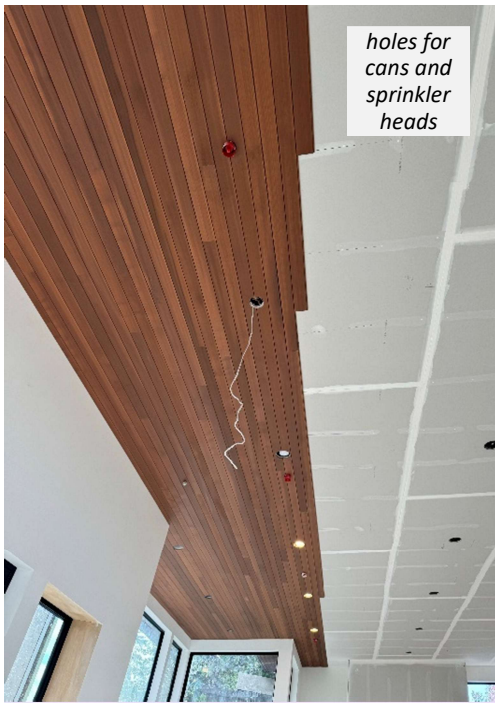
The wood used for the ceiling is ½ X 4" Western Red Cedar with clear vertical grain, no knots. This is the same wood that was used for the soffits. The wood fits together via a "tongue and groove" connection. Also, the ceiling boards align with the exterior soffit wood. Most boards are 10' long but a few are 12'.

Implementation started Oct 28, 2024. Boards run N to S. They started on the E side moving W. Holes were cut for the can lights and sprinkler heads. We had to wait for the electrician to confirm the exact location of the Dining Room chandelier so they constructed a temporary floor in the stair well and continued work from the glulam beam in the ceiling to the W side. They covered the beam with the Red Cedar.

Red Cedar boards

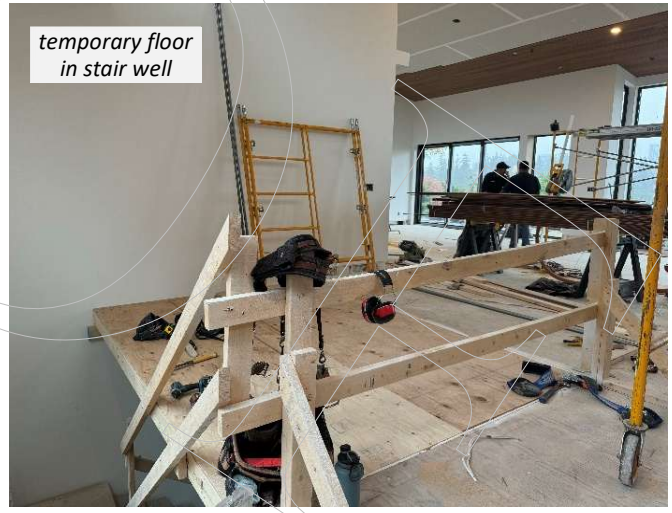
installing the first boards to line up with the soffit outside

first rows installed



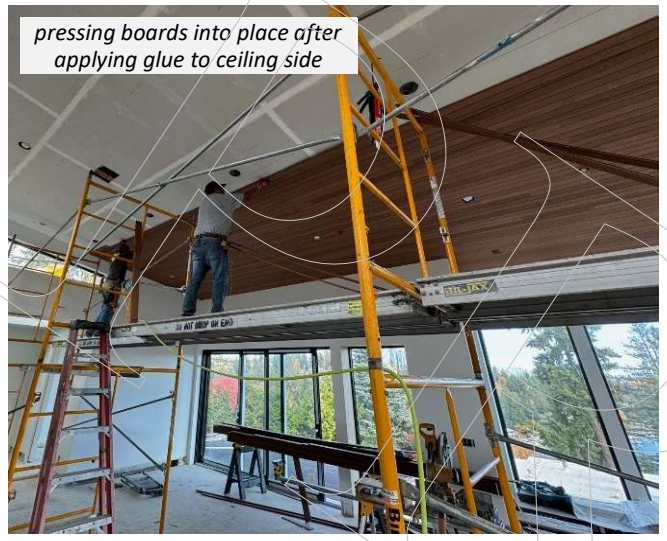
holes for cans and sprinkler heads

covered beam

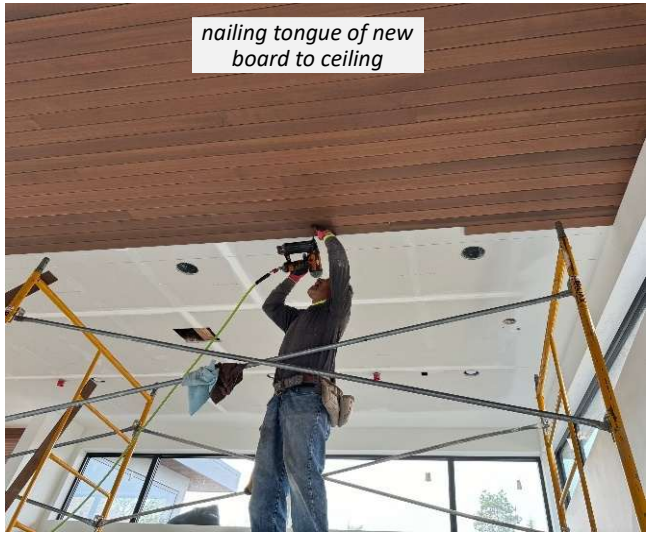


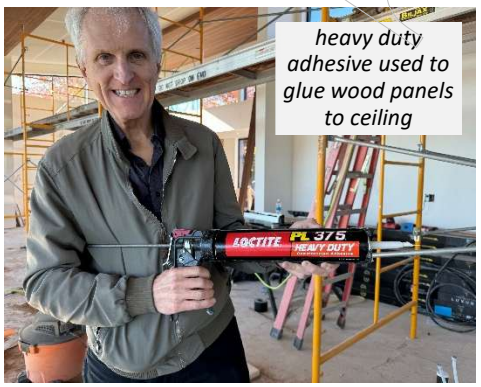
temporary floor in stair well

Boards were cut to the desired length using a table saw. The cut boards were glued to the ceiling then the groove was pressed into the tongue and the new board was tapped with a hammer to make a tight connection. Finally, a nail gun was used with small nails to nail the tongue of the new board to the ceiling.


pressing boards into place after applying glue to ceiling side

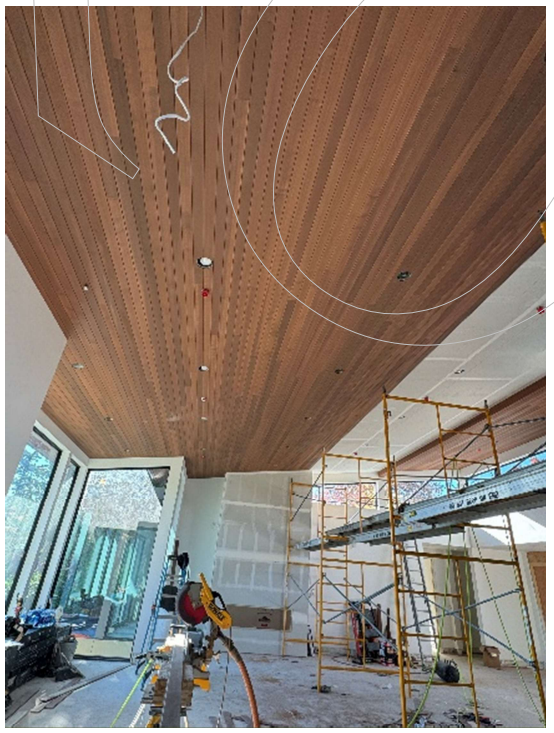

tapping board with hammer to make a tight connection


nailing tongue of new board to ceiling



heavy duty adhesive used to glue wood panels to ceiling

nail gun with skinny 2” nails




ceiling and soffit boards are parallel


ceiling and soffit boards are parallel

WOOD FLOOR

Wood flooring is used throughout the house with the exception of the Master Bathroom, Bathrooms 1, 2 and 3, and the Laundry Room where tile is used. The Mechanical Room has a concrete floor and the Garage has an acrylic floor. Carpet is not used anywhere in the house.

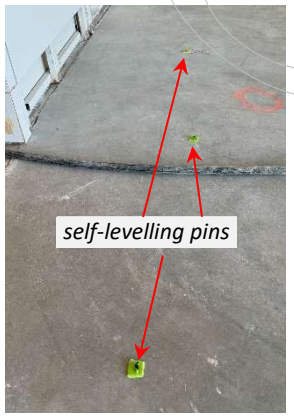
The wood flooring chosen is 9.5" wide with a 6 mm wear layer which is considered the industry maximum. The higher the wear layer, the more times the wood floor can be sanded/refinished. Boxes of Urban Floor Oak Matisse luxury wood flooring were delivered Oct 30, 2024. The wood came in boxes just over 8' long. There were three 8' long boards and either two 4' boards *or* one 2' long and one 6' long board per box. The shorter pieces were used near the walls and other obstacles.

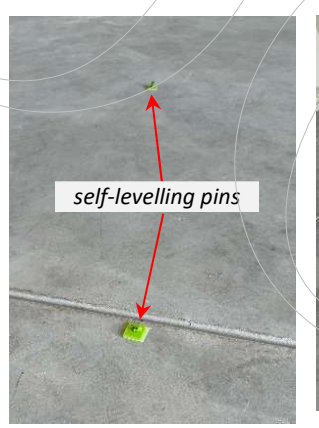
PREPARING THE LOWER LEVEL FLOORS

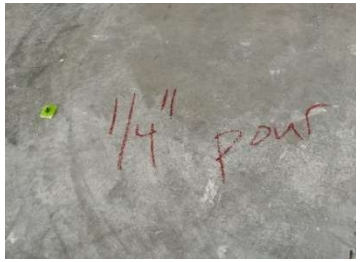
The existing floors on the lower level are concrete. Work began on the lower level Nov 6, 2024. The floor was swept clean then the prep work started. A long level was used to determine where the floor was not level. According to the flooring guidelines, the floor slope should be flat to within 3/16" across a 10' span. A "self-levelling pin" with a ruler is used to show where the floor needs to be slightly raised. The graduations are in 1/8" and millimeters. There is an adhesive strip on the bottom to secure the pin to the floor. The pins are stuck to the floor and the plastic is cut to show the height to which the floor needs to be raised. This was done for every room. Instructions were also marked on the floor with a red marker for how much self-levelling compound was required.

self-levelling pin

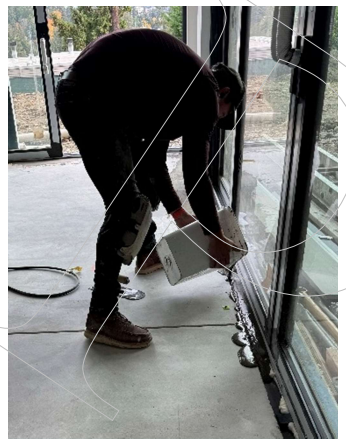
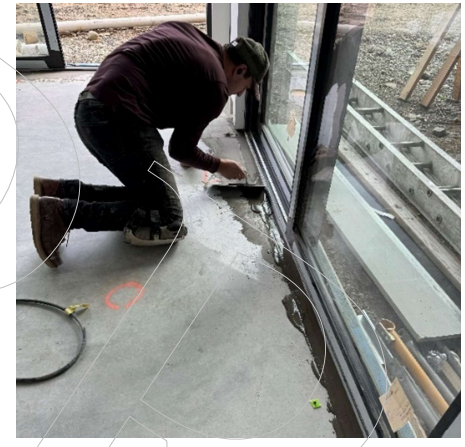
self-levelling pin after being cut







Before applying the self-levelling compound, the gaps between the poured concrete floor and the doors/windows/walls were filled with concrete.

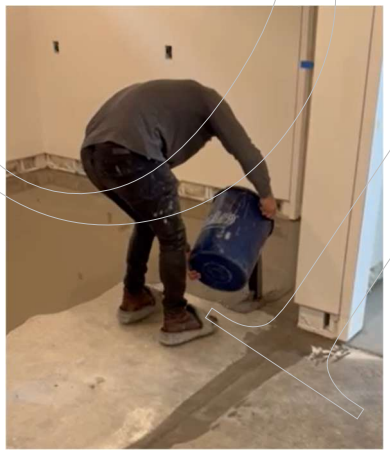






The UZIN NC 150 product was dumped into a bucket and a precise amount of water was added to create a solution of the required consistency. This was achieved using a hose with a nozzle that delivers a specified amount of water. The bucket was used to dump the solution onto the floor.

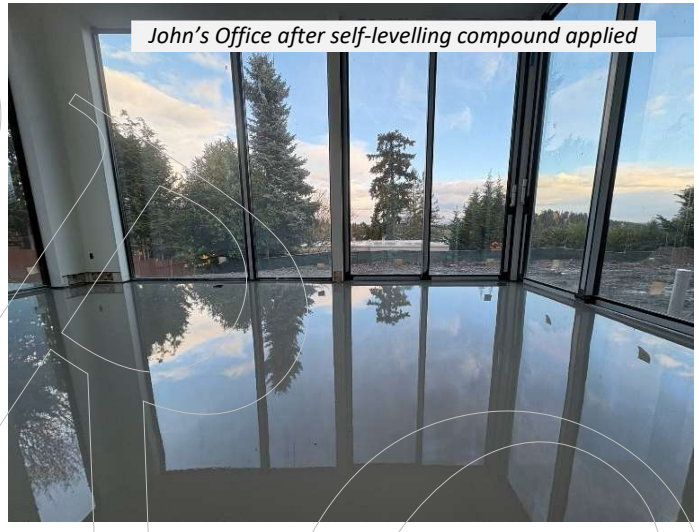


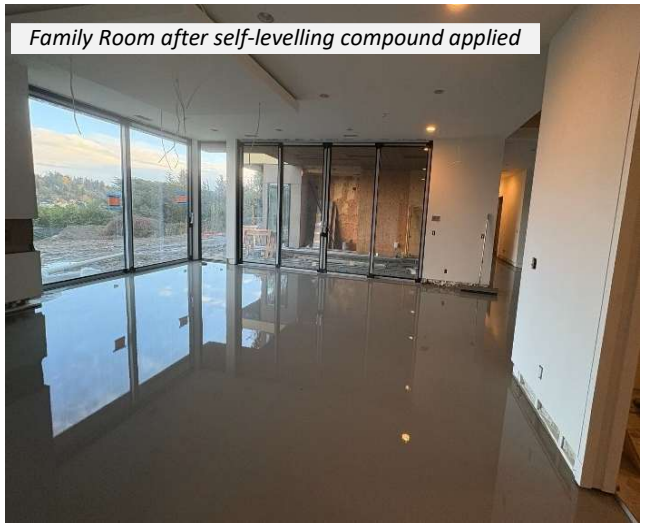
nozzle delivers an exact amount of water

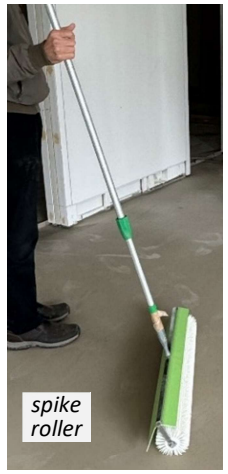



The self-levelling pins identify the amount of solution required to raise the floor level. An adjustable depth "gauge rake" is used to spread the solution. Note that the self-levelling compound does not level itself. The gauge rake is used to achieve a smooth, level surface. A spike roller is also used to eliminate any air pockets or clumps. When the solution reaches the top of the pins, the desired level has been reached. Working time with the compound is 20-40 minutes and it is fast setting (walkable in 2-3 hours).

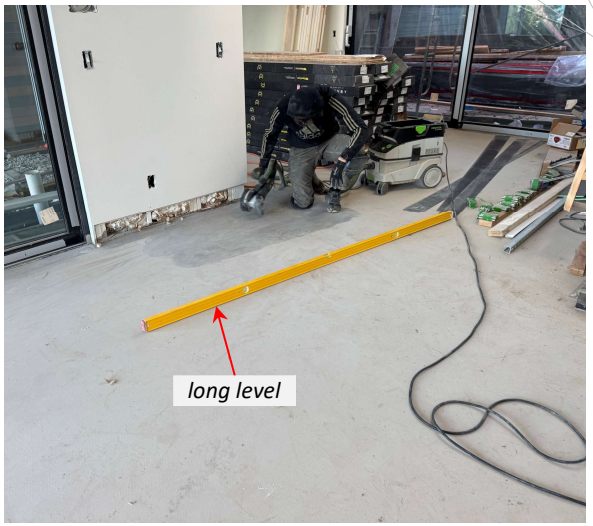

using the gauge rake


John's Office after self-levelling compound applied


Family Room after self-levelling compound applied


spike roller

After the self-levelling compound dried, this is what the floors looked like:


long level

After the self-levelling compound has hardened, the long level is used to ensure that the floor is level as expected. If it is low in an area, more self-levelling compound is added. If it is high in an area, the self-levelling compound is sanded to make it lower.

PREPARING THE MAIN LEVEL FLOORS

The existing floors on the main level are plywood. A long level was used to determine sections that were high or low. High sections were lowered using a sander. Low sections were raised by applying a compound over the plywood.

sanded main level plywood floor

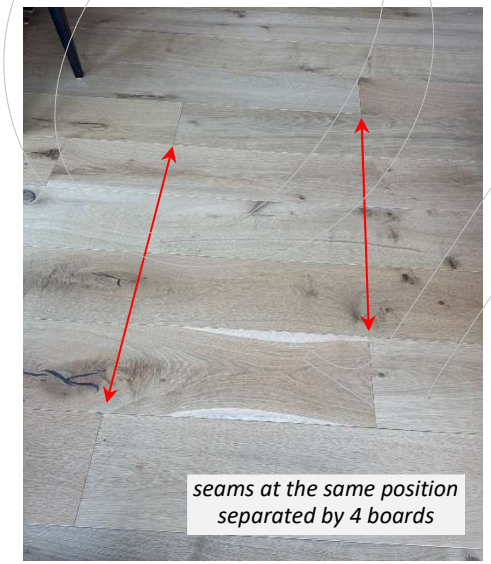
using a sander to lower floor

Kitchen / Dining Room after compound applied to raise floor

Great Room after compound applied to raise floor

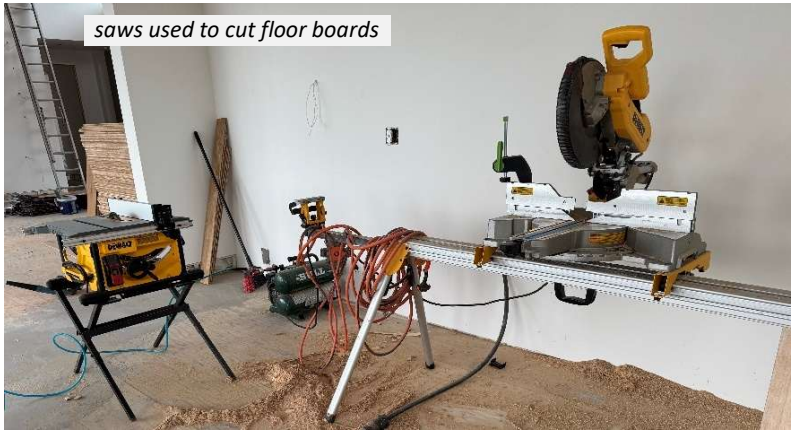
INSTALLING THE MAIN LEVEL WOOD FLOORS

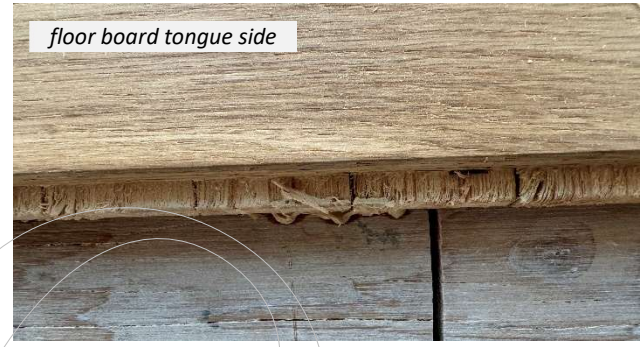
This required planning to take into account the shape of each room. The wood is installed N-S, the same as the wood ceiling direction. The first step is to determine how many 9.5" wide floor boards will fit. This will not be an integer so it is necessary to decide how wide to make the boards on the E and W edges. The 8' long boards were used in the Great Room / Dining Room / Kitchen open area. Shorter boards were used near the N and S walls. Boards were arranged so that the next board with a seam at about the same position is separated by at least 3 floor boards.



seams at the same position separated by 4 boards

Floor board installation started Nov 27. The wood floor adhesive was spread over the plywood. Saws were used to cut the floor boards to fit perfectly. They are tongue-and-groove so adjacent boards fit together. After gluing, the floor boards were hammered using a special hammer to make sure they are flat and fully fitted into the tongue-and-groove connection. Then the tongue side of the floor board is nailed to the plywood using a specialized nail gun.



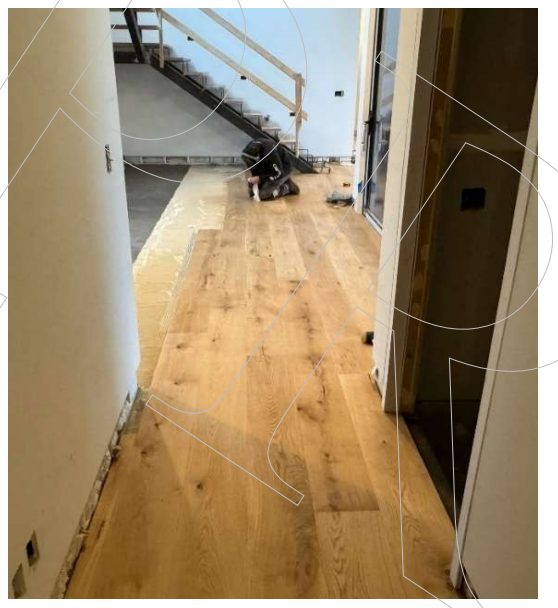


REGISTERS

Custom registers were made of the same wood as selected for the floor. The installers cut a rectangular gap in the floor boards to accommodate. The resultant registers are flush with the wood floor and look beautiful. Circular holes were also cut for the floor electrical outlets.

INSTALLING THE LOWER LEVEL WOOD FLOORS

After the floor has been determined to be level within tolerances, a polyurethane primer was applied over the self-levelling compound. When dry, the floor is ready for the wood to be installed. The primer helps facilitate gluing the tongue-and-groove floor boards to the concrete. Unlike the main level where the wood floor boards are installed over plywood, nails can't be used with concrete.

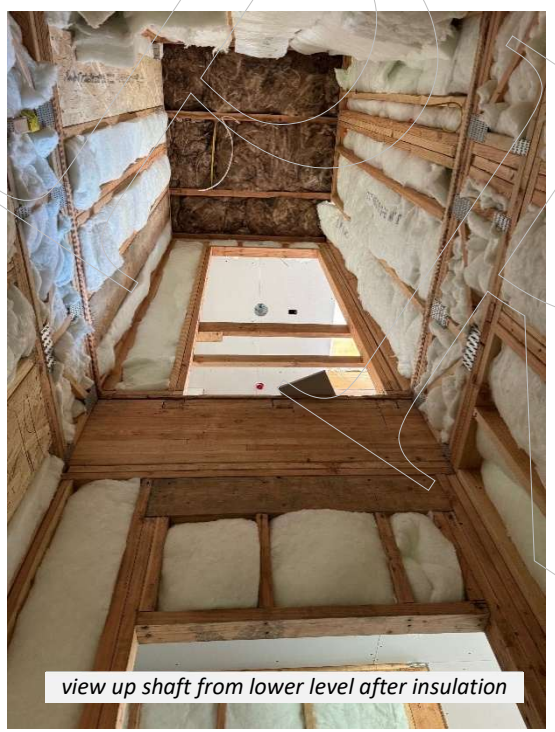


PROTECTING THE NEW WOOD FLOORS

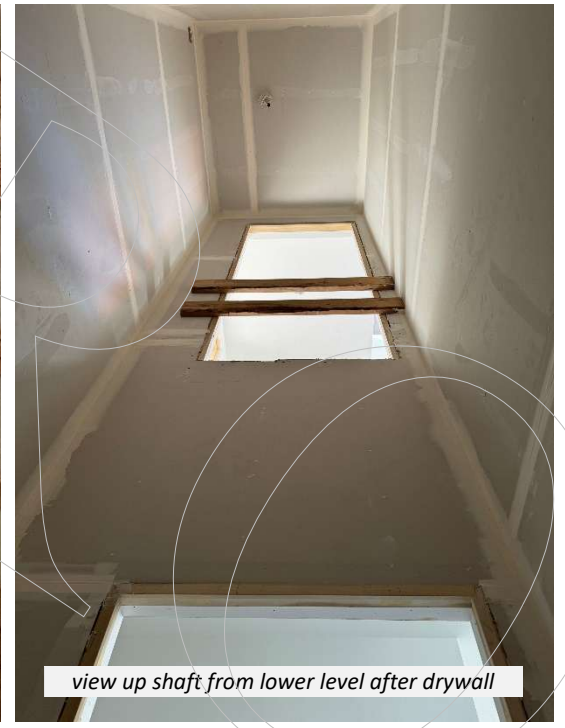
On the main level, after the wood floors were installed, they were covered with a thick, durable paperboard product called Ram Board. It comes in 100' rolls that are 38" wide. It rolls out fast and flat and the seams are taped together. On the lower level, after the wood floors were installed, they were covered with heavier Masonite hardboard sheets.

ELEVATOR

The elevator chosen is the Savaria Eclipse MRL (machine-room-less) elevator. It requires a 240V 20 amp circuit. The elevator operates off a track installed on the S wall of the elevator. The drive system is a 2 HP geared motor roller chain drive with a counterweight. Its speed is 40 ft / minute.



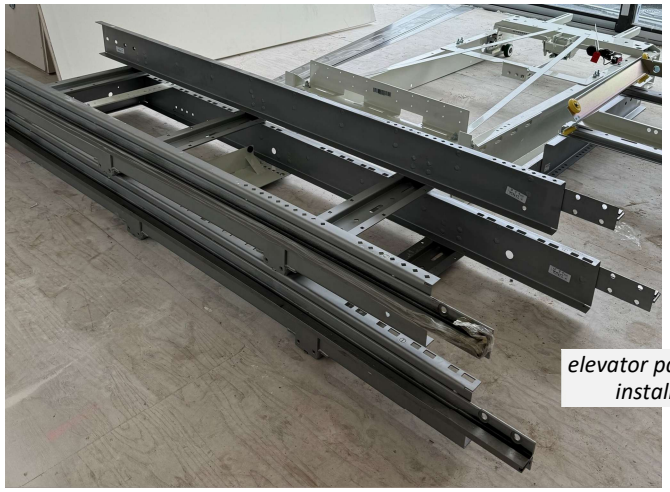
view up shaft from lower level after insulation

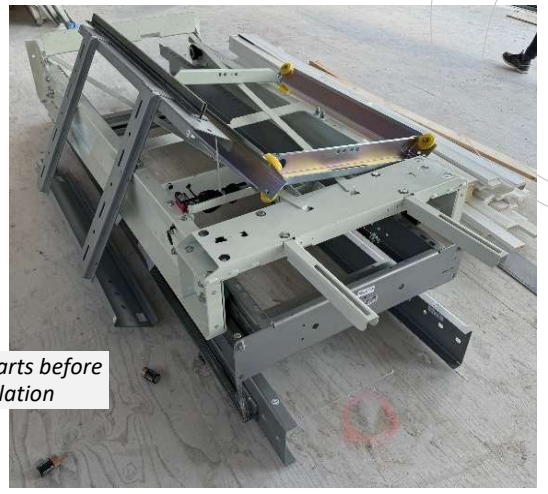


view up shaft from lower level after drywall

lower level floor with drain

The elevator parts arrived Oct 21, 2024. Before installation could start, the insulation and drywall had to be completed.

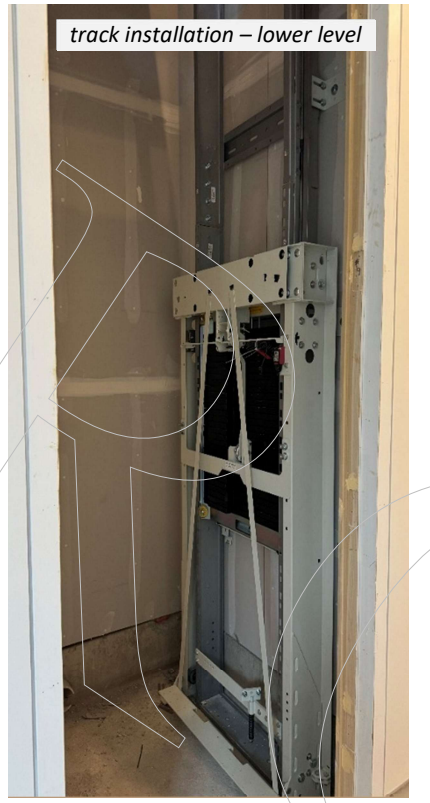




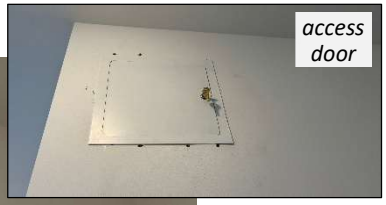
elevator parts before installation

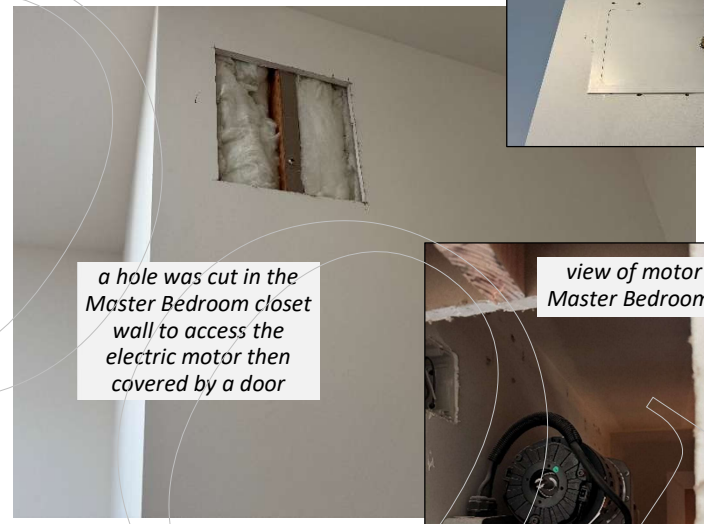
The wall track was completed Oct 30, 2024. The control electronics were completed Jan 10, 2025 and the electric motor was installed Feb 14.

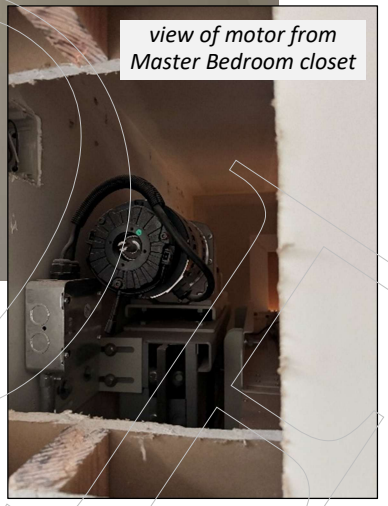

track installation – main level


track installation – lower level

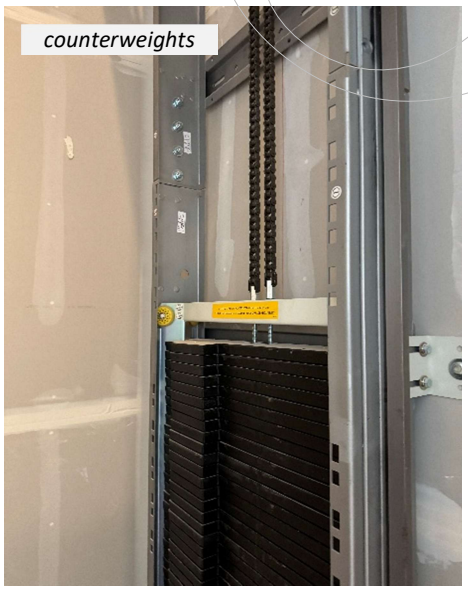

elevator control closet on lower level


access door


a hole was cut in the Master Bedroom closet wall to access the electric motor then covered by a door

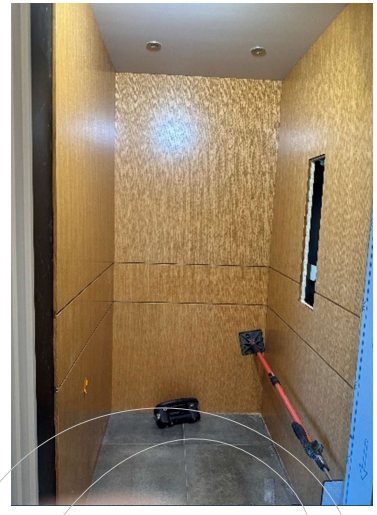

view of motor from Master Bedroom closet


2 HP electric motor


counterweights

The elevator cab was a box constructed of plywood. Tiles were used for the floor (completed Apr 8). The cabinet maker created the wooden walls installed over the plywood (completed May 5). The ceiling was covered with drywall and painted. A hole was cut in a wall for the control panel. Finally, the control panel and a handrail were installed. The elevator was inspected and was usable by May 12, 2025.



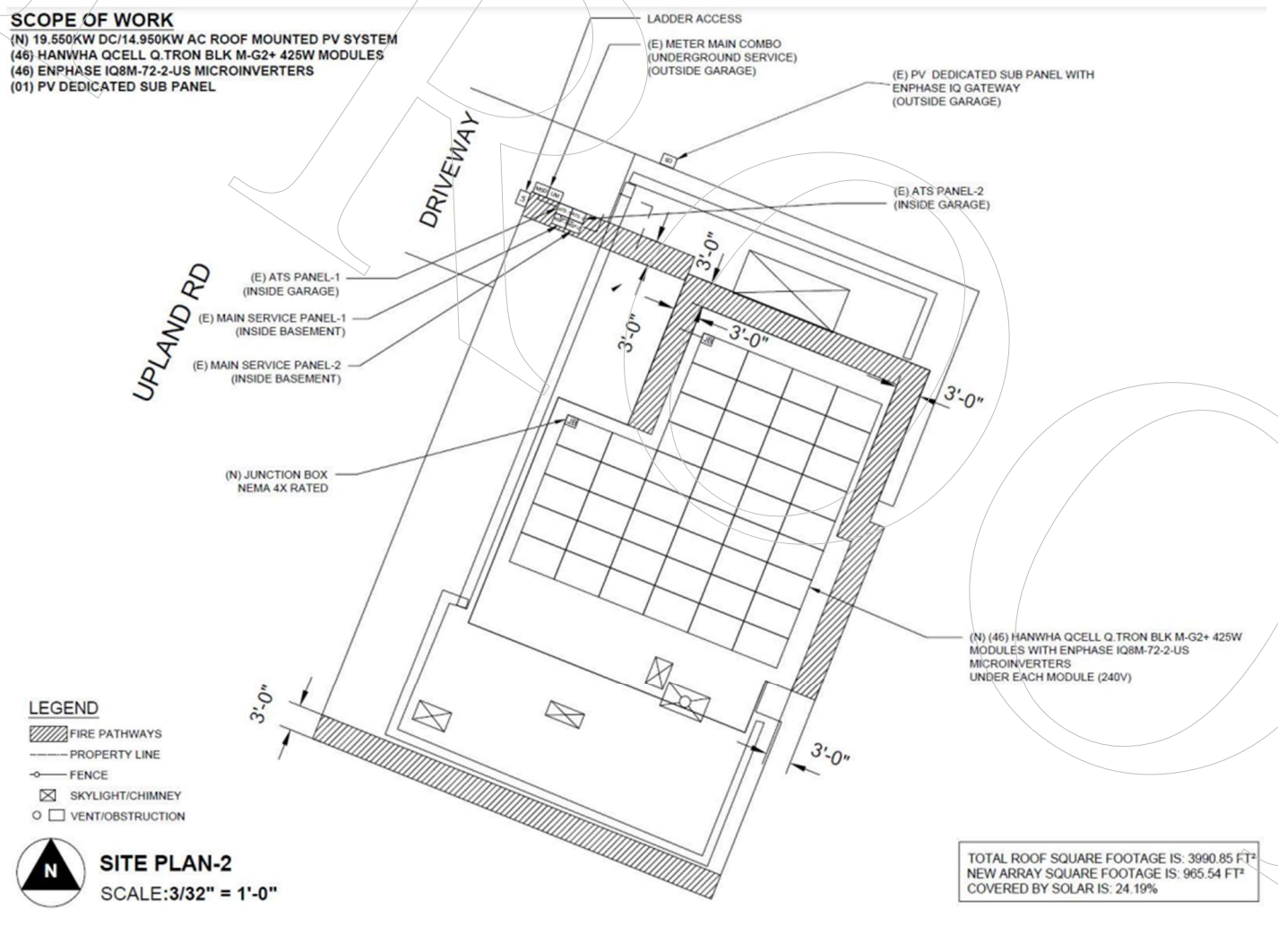


The elevator electronics were installed in the elevator closet on the lower level. A telephone wire was also connected to the phone port of the Comcast gateway box in the Storage Room since all elevators are required to have a phone line connected to their control panel. On the main and lower levels, the elevator had the same doors and hardware as the other rooms. The button on the left side of the door is used to call the elevator.


SOLAR

Forty-six (46) solar panels (aka Photo-Voltaic or PV modules) were installed on the sloped metal roof. Silfab Solar SIL-430 QD modules were used with Enphase IQ8M-72-2-US Microinverters under each module (240V). An inverter is a device that converts DC to AC. Originally Q-Tron modules were specified but we changed to Silfab prior to implementation since they were newer and had a higher efficiency rating. Each Silfab PV module is 67.8" X 44.6", 1.37" thick and weighs 21 kg / 46.3 lbs. Each microinverter is 1.77" x 8.39" x 4.96" and weighs 2.4 lbs.

The original scope of work is shown (before changing modules from Q-Tron to Silfab):

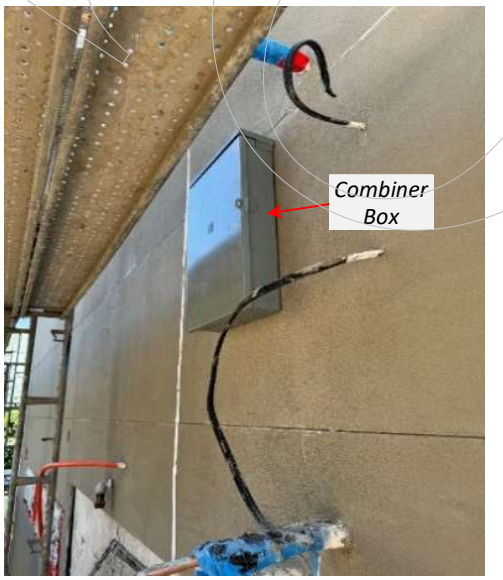


Silfab PV

Enphase IQ8M microinverter

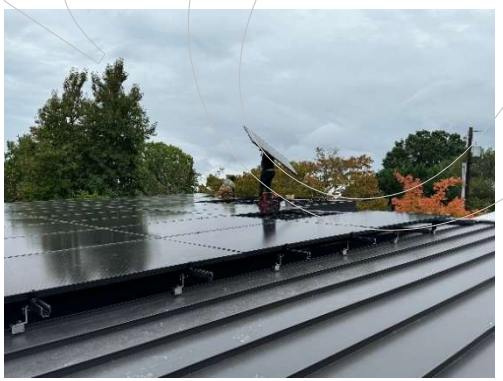
CONDUIT

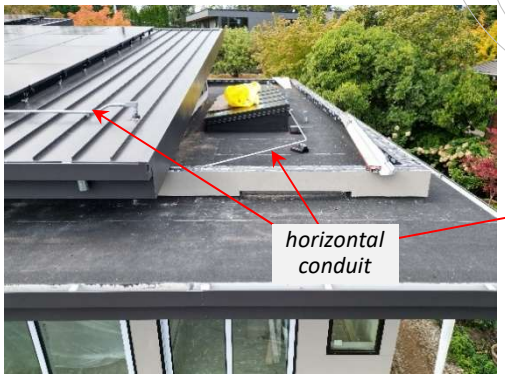
A hole was drilled in the NE corner of the metal roof to accommodate a conduit tube that would run horizontally beside the parapet and above the torchdown surface (in order not to obstruct storm water flow). The conduit was run to the NW corner of the torchdown roof where a hole was made to accommodate a conduit tube that would run down through the studs in the N wall of the pantry. From there, the wire was fed through the wall to the "combiner box" mounted outside on the N wall. Wires were also fed up and through the pantry ceiling to the 2 Generac transfer switches in the garage.



MODULE INSTALLATION

This is what the roof looked like before the installation. 46 Silfab Solar SIL-430 QD modules were installed on the steel roof section.

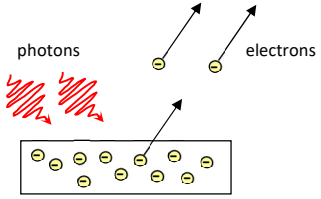




Here are pictures of the final configuration. The arrows point to the conduit that goes from the panels through a hole in the steel roof to the lower roof. Then via another raised conduit, it goes to the the NW corner where it goes down through the studs of the N pantry wall then out to the combiner box.

HOW SOLAR POWER WORKS

If an electron absorbs a photon of light above a minimum frequency, the energy will be sufficient for the electron to escape the electrostatic attraction of its atom. This is called the **Photoelectric Effect**.



Light below a cutoff frequency, no matter how intense, will not cause electrons to be emitted. Light above the cutoff frequency, even if not very intense, will always cause electrons to be emitted. The excess energy (the energy above what is required to liberate an electron) will contribute to the liberated electron's kinetic energy. Also, either all of the photon energy is absorbed and used to liberate the electron, or it is re-emitted.

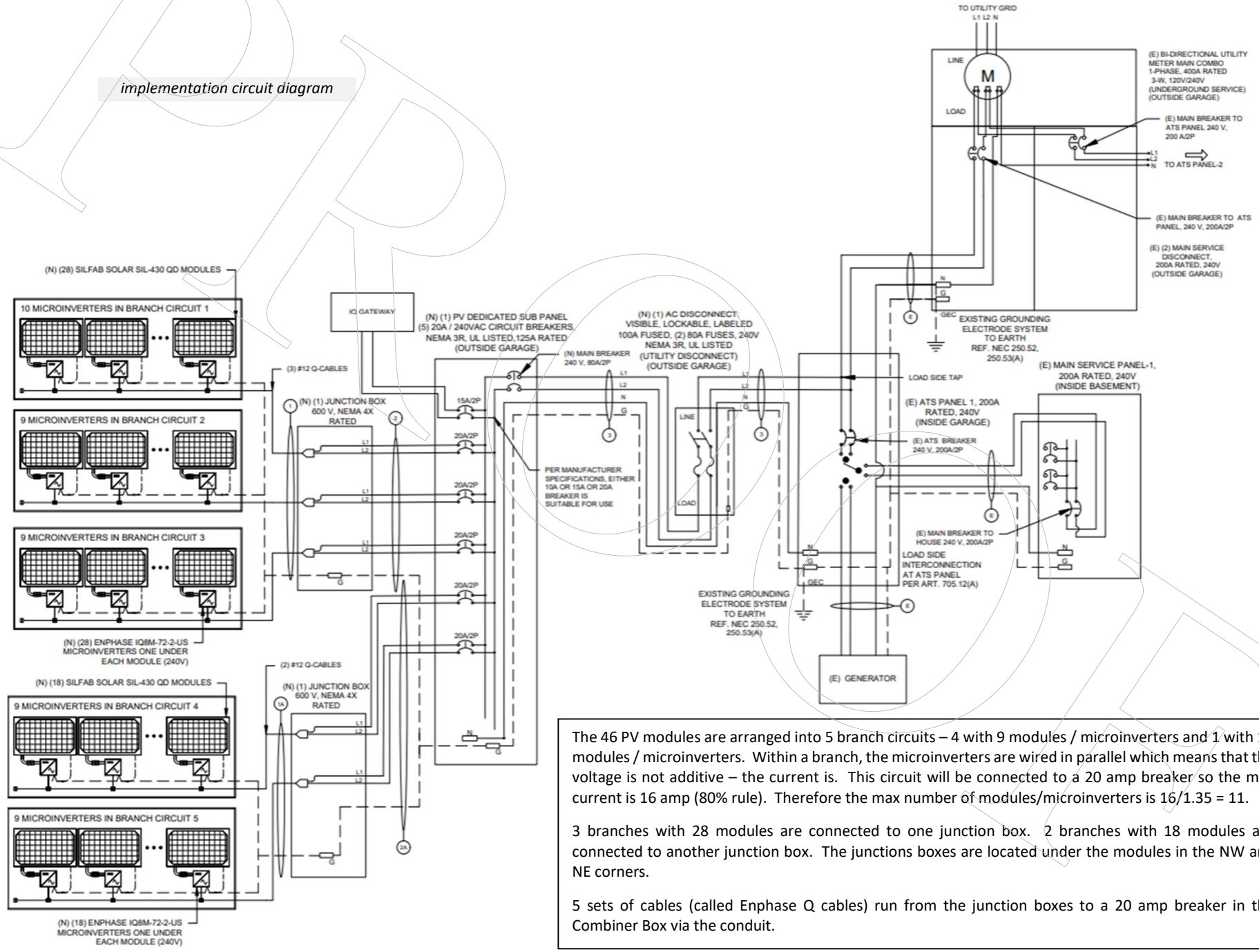
The hypothesis that light energy is carried in discrete quantized packets called photons was proposed by Einstein in 1905. This was a key step in the development of Quantum Mechanics. Einstein received the Nobel Prize in 1921 for his explanation of the Photoelectric Effect. Ironically, he never received a Nobel Prize for Special or General Relativity.

Solar cells exploit the Photoelectric Effect by using materials that are good at absorbing photons and releasing electrons. The free electrons create an electric current that can be used as electricity. The efficiency of a solar panel is the percentage of sunlight converted to usable electricity. The max efficiency is 22-24%. The Silfab SIL-430 QD modules we used are 22.1%.

IMPLEMENTATION

If a voltmeter is connected to the terminals of the Silfab module, the max DC voltage produced is 37.76 volts (referred to as the open circuit voltage or VOC). If an ammeter is connected in series to the terminals of the Silfab module, the max current is 13.81 amps (referred to as the short circuit current or ISC). The DC output of the Silfab module is converted to 240 V AC by the Enphase IQ8M microinverter. The max current output of each microinverter is 1.35 amp.

implementation circuit diagram



The 46 PV modules are arranged into 5 branch circuits – 4 with 9 modules / microinverters and 1 with 10 modules / microinverters. Within a branch, the microinverters are wired in parallel which means that the voltage is not additive – the current is. This circuit will be connected to a 20 amp breaker so the max current is 16 amp (80% rule). Therefore the max number of modules/microinverters is 16/1.35 = 11.

3 branches with 28 modules are connected to one junction box. 2 branches with 18 modules are connected to another junction box. The junctions boxes are located under the modules in the NW and NE corners.

5 sets of cables (called Enphase Q cables) run from the junction boxes to a 20 amp breaker in the Combiner Box via the conduit.

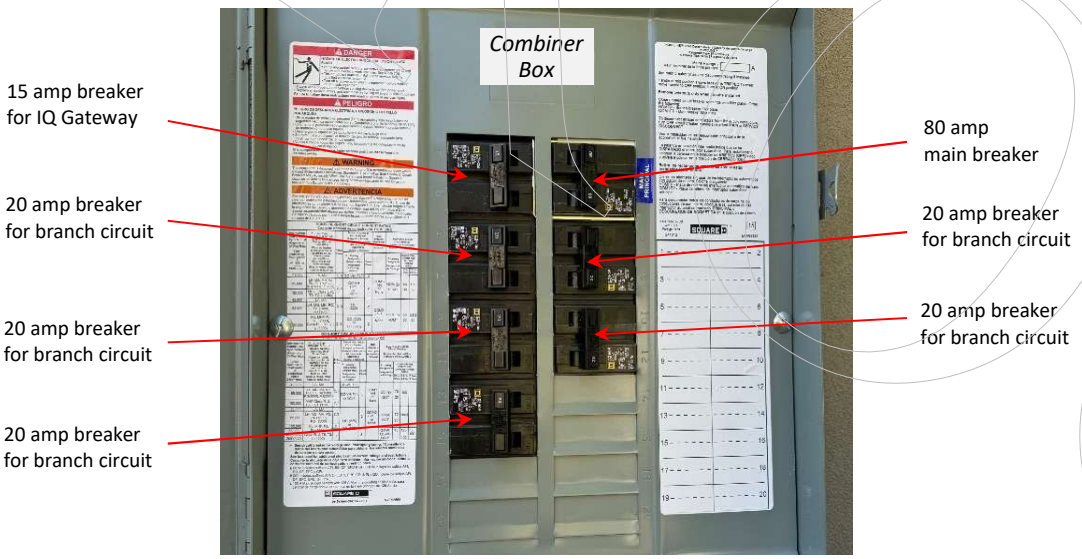
In the circuit diagram on the previous page, the IQ Gateway is a digital device that collects PV module performance data. It uses powerline communication to send the data to the Combiner box. The homeowner has an Enphase Enlighten account on the internet that can be accessed from their mobile phone. Owners are able to see the performance of each PV module and the total system in real time.

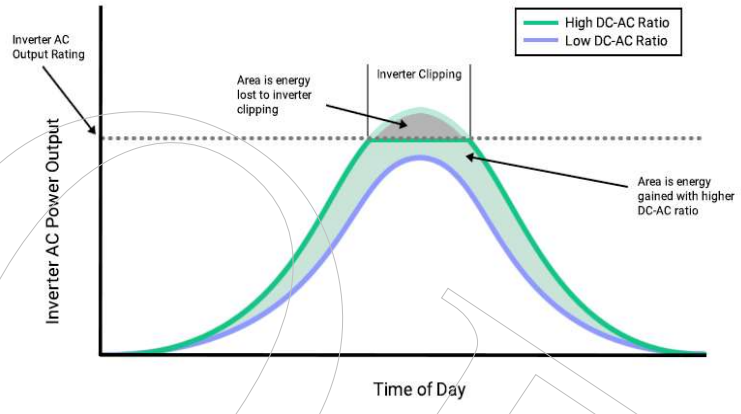
Enphase IQ Gateway (1.77" x 8.39" x 4.96")

The total inverter current output is 46 modules X 1.35 amps/module X 1.25 = 77.63 amp. The extra 1.25 is a corrective factor required for safety when sizing for breakers (obtained from the National Electrical Code aka NEC table). So, the combined output of the 5 circuits goes through an 80 amp main breaker.

The max power of each PV module is 430 watts. This is the Standard Test Conditions (STC) value. Systems are usually sized based on max DC power. In this case, 46 modules X 430 watts = 19.78 kW DC.

The max AC power = I x V = 1.35 amps x 240 volts x 46 modules = 14.9 kW. The ratio of DC to AC is 19.78/14.9 = 1.3. This is known as the Inverter Loading Ratio. It is desirable for this value to be greater than 1. Otherwise energy is lost to "inverter clipping".



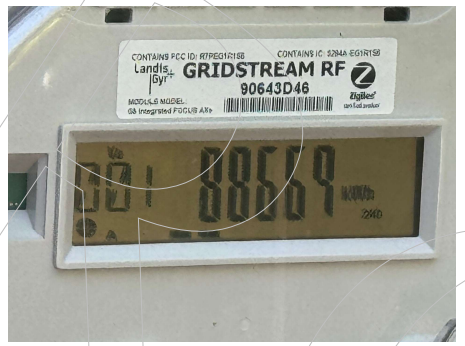


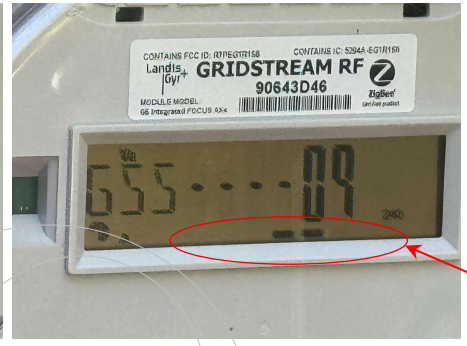
The yearly electrical production of our implementation is estimated to be 18.8 mWh. The average US household uses about 10.8 mWh. The electricity produced by this house will be used for heating (no gas furnace) and cooling, charging 2 electric vehicles, the magnetic induction cooktop, electric dryers (2), electric wall ovens (2), as well as the lights, TVs, electrical appliances and ceiling heaters in the Atrium.

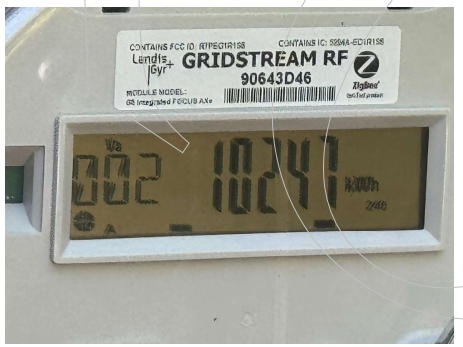
NET METERING

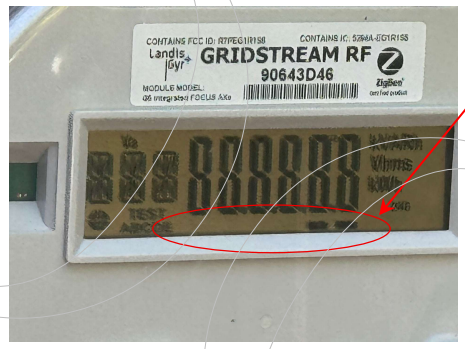
The solar panels were connected to the electric utility Puget Sound Energy (PSE) on Dec 2, 2024. A “net meter” was used that sends excess power to the grid. There are dashes on the meter that move to the right if pulling from the grid, and that move to the left if sending to the grid.

001	total imported kWh from beginning – like an odometer
002	total exported kWh
GSS	low frequency mesh network – communicates to neighbouring meters then ultimately communicates with a tower nearby
dashes	L to R means importing power from PSE, R to L means exporting power to PSE, and speed indicates more or less power





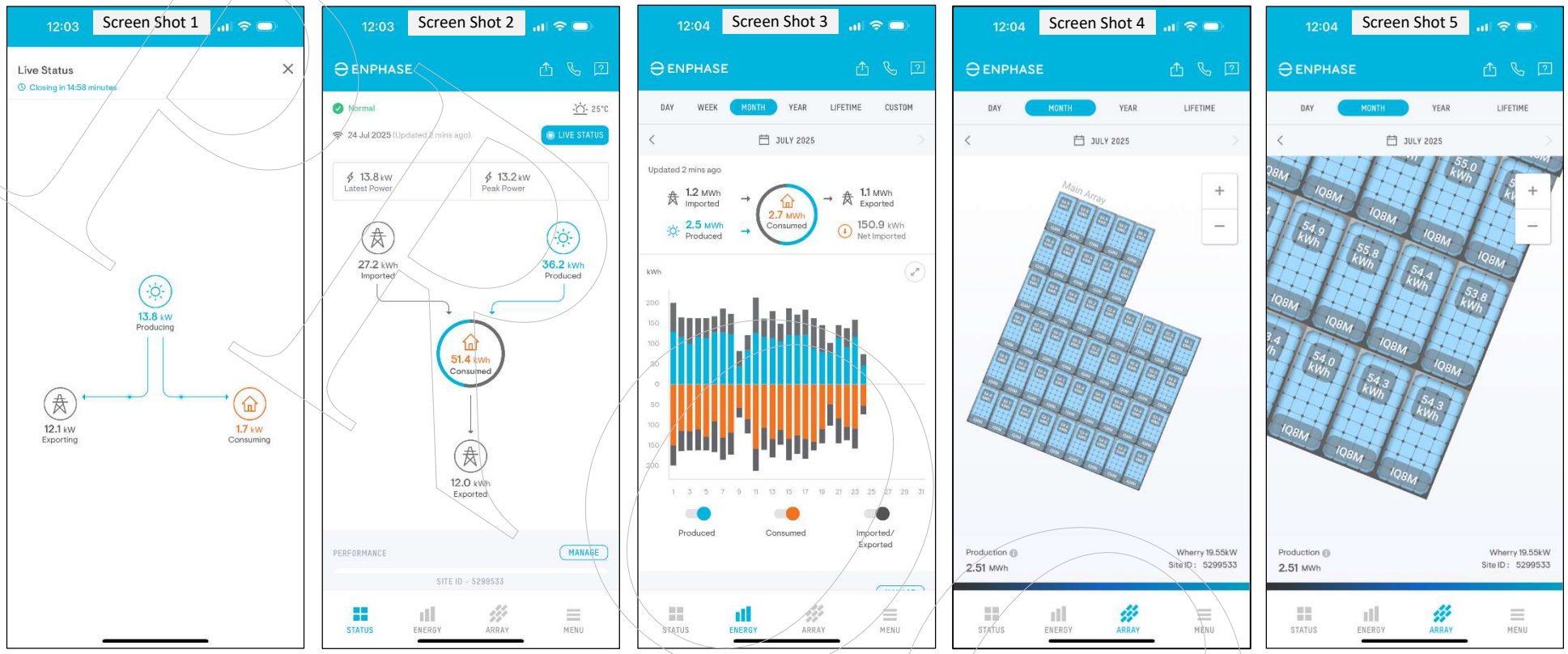




moving dashes

IPHONE APP

The system was turned on by the utility on Dec 2, 2024. The next step was to get the Enphase gateway connected to WiFi so that it could upload performance information that would be visible in the Enphase iPhone Enlighten app. The following iphone screen shots were taken Jul 24, 2025 at 12:03 pm. It was a sunny day.



Screen Shot 1 shows the current real-time solar electricity production and house consumption at 12:03 pm. The house is currently consuming 1.7 kW. 13.8 kw are being generated by the solar panels and 12.1 kW are being exported to the utility.

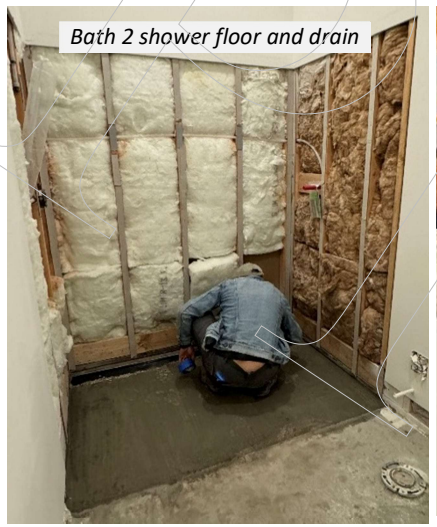
Screen Shot 2 shows the total consumption today from 0:01 am (midnight) till 12:03 pm (noon). 36.2 kWh has been produced from solar. Of that, 12.0 kWh has been exported to the utility. 27.2 kWh was imported from the utility before the solar panels started producing electricity. 36.2-12.0 kWh=24.2 kWh of solar power has been consumed by the house. 24.2 solar + 27.2 imported = 51.4 kWh total consumption.

Screen Shot 3 shows the July month-to-date electricity consumed, produced by solar, imported from the utility and exported to the utility.

Screen Shot 4 shows the array of 46 solar panels. Screen Shot 5 is a zoomed-in view of the lower right corner of Screen Shot 4. It shows the electricity production of the individual solar panels for July.

SHOWER/TUB PREPARATION

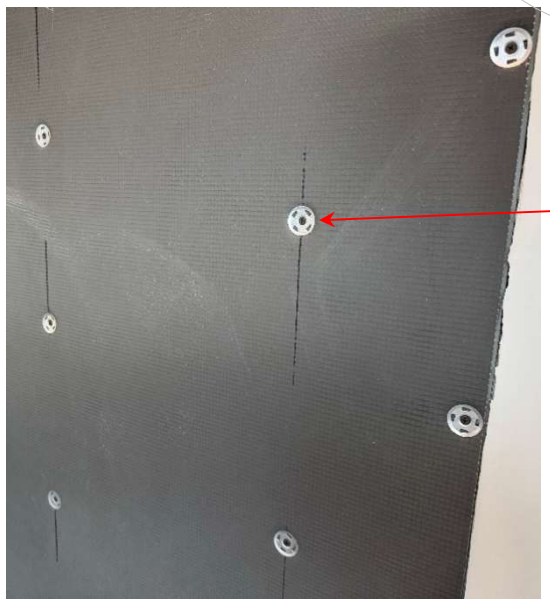
Prep work for tiles started Oct 31, 2024. The focus was Bathrooms 1, 2 and 3 on the lower level. The shower areas of Bathrooms 2 and 3 were not filled with concrete when the lower level floor was poured. So the tile installation prep work entailed pouring concrete and creating the shower/tub drain.

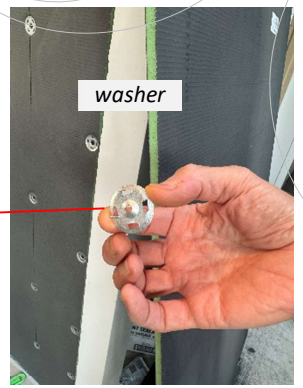

Bath 2 shower floor and drain


Bath 3 shower floor and drain

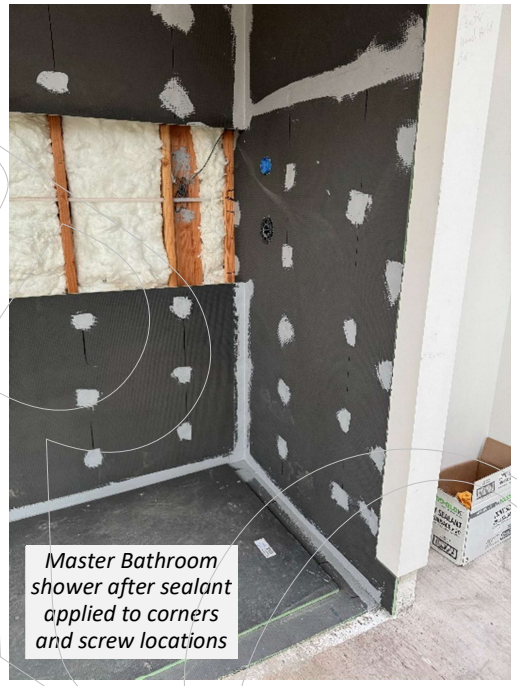
WALL PREPARATION

HydroBlok wallboard was installed on the walls of Bathrooms 1, 2 and 3 to create “perfect” waterproofing. It came in 36” x 60” x 1/2” sheets. Drywall screws were used with the metal washer shown to connect the wallboard to the studs. Similar to drywall, shims were used on the studs to make the walls level.




washer

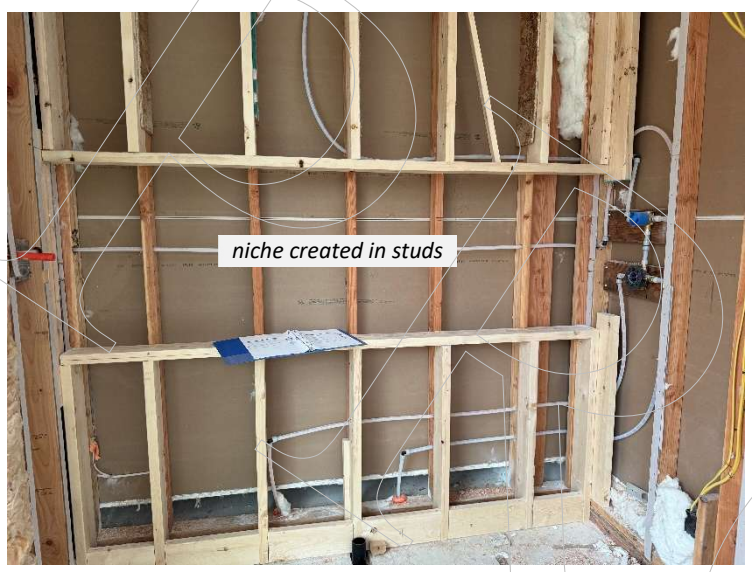
After the wallboard was screwed into the studs, a mesh was applied in the corners and a caulking gun was used to apply the HydroBlok joint sealant product over the mesh and to cover the drywall screws. The green tool shown is a special trowel used for corners.



special trowel

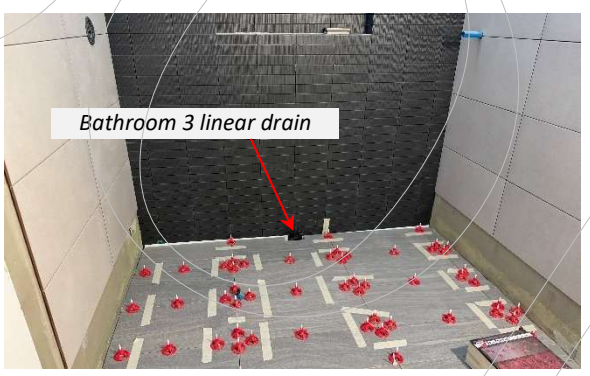
MASTER BATHROOM SHOWER

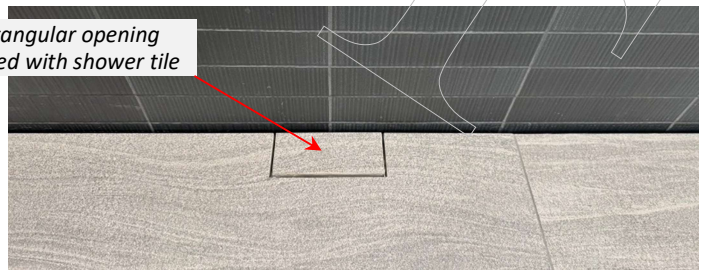
Before installing the wallboard, the N wall studs were cut to create a niche. The HydroBlok linear drain kit was installed in the shower floor. Special HydroBlok shower floor boards with a ramp were used to direct water to the linear drain.



LINEAR DRAINS

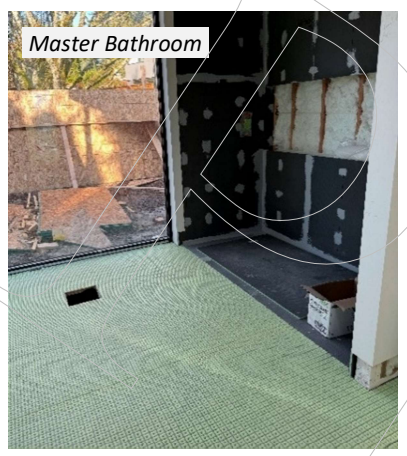
Linear drains were used in the showers of the Master Bathroom, Bathroom 2 and Bathroom 3. A linear drain is installed in the floor adjacent to a wall. It is several feet wide and sloped so that water flows to an opening in the centre. The opening is 2" which is the same as the drain pipe. Usually shower drains have 1" or ¾" openings that flow into the larger drain pipe. This requires a filter to prevent blockage. The beauty of the 2" opening is that it does not require a filter and it is unlikely to get plugged. However, a drain cleaning tool was provided. The linear drain is covered with tile including the rectangular opening at the drain pipe.



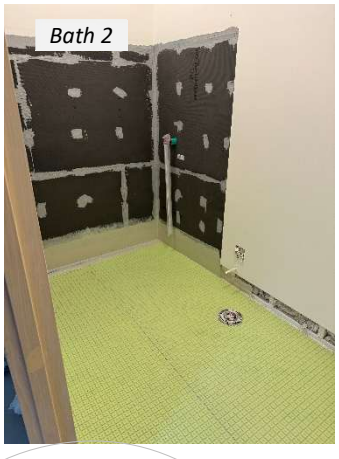


FLOOR PREPARATION

After the wallboards were installed, the HydroBlok uncoupling membrane product (green) was installed on the floor of four bathrooms.


Master Bathroom

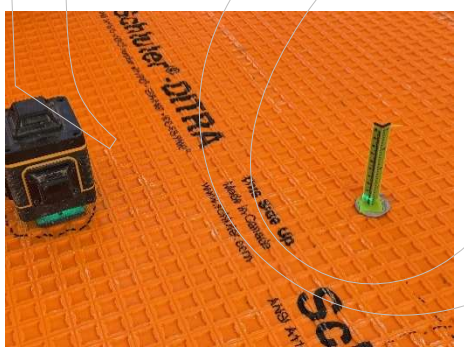

Bath 1


Bath 2


Bath 3

In the case of the laundry room, the Schluter DITRA uncoupling membrane (orange) was installed. Then self-levelling pins were stuck to the floor. A laser was used to determine where to cut the pins. This was used to determine the amount of self-levelling compound required. The Schluter product was also used in part of Bath 1. After putting down the membrane product, the same Uzin NC150 self-levelling compound used for the hard wood floors was used for the tile floors.


Laundry Room




close up after cut

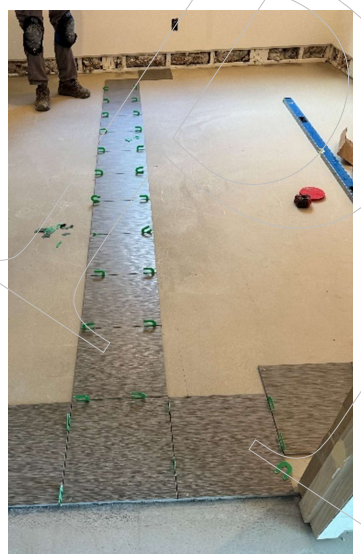

Master Bathroom after self-levelling compound

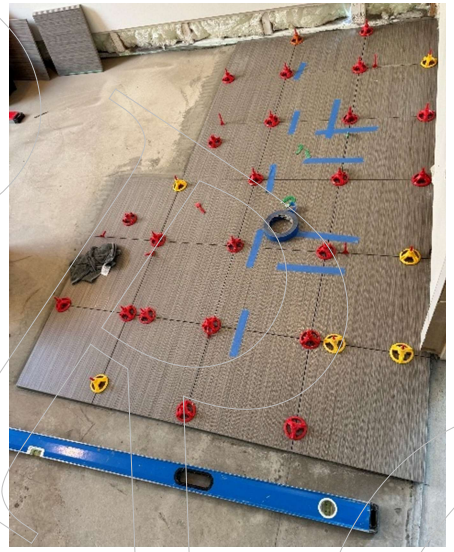
close up

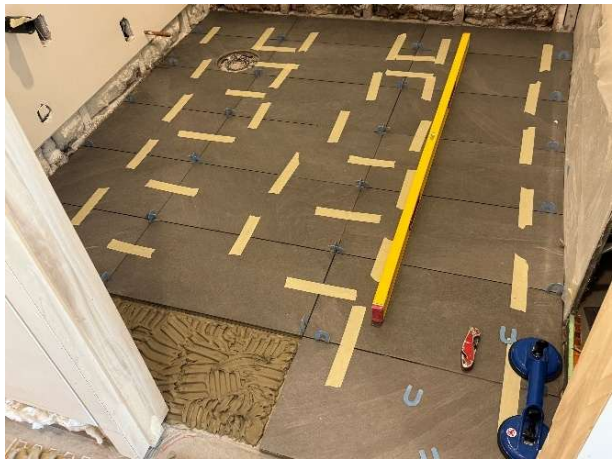
The Master Bathroom has radiant heat. An electric floor warming cable was installed in the uncoupling membrane and in the HydroBlok on the shower floor.

FLOOR TILES

After applying the self-levelling compound, the tiles could be laid. They are laid out in an optimal pattern with spacers. Grout will not be applied until all the tile work has been completed, all cabinets and slabs installed, and all painting completed. Custom floor registers were created for the Foyer, Powder Room and Master Bathroom using the floor tile.

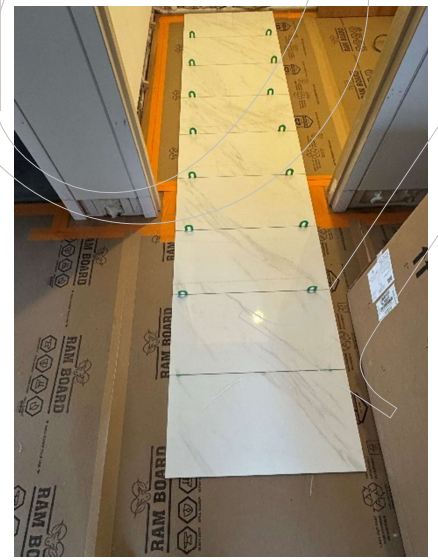






Bath 1 after self-levelling compound

Bath 2 after self-levelling compound



custom floor register

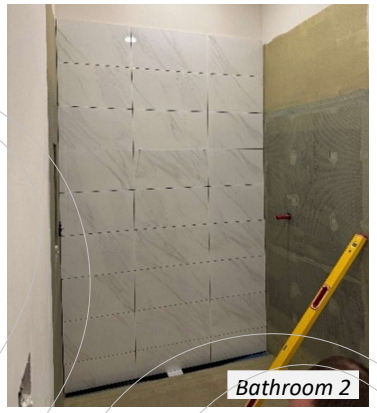
spacers

WALL TILES

Bathroom 1

Bathroom 3

Master Bathroom

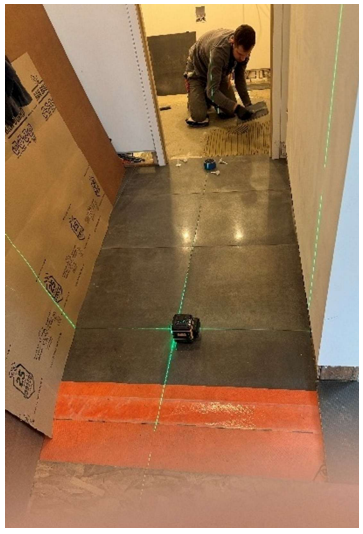


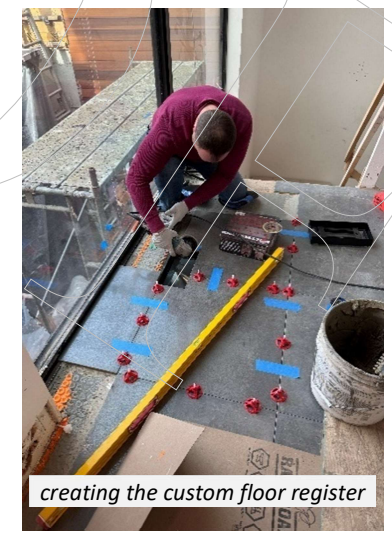
Bathroom 2

niche in Bathroom 2

POWDER ROOM & FOYER

We chose tile for the Foyer instead of wood. We decided to extend the tile from the Foyer to the Master Suite entrance and into the Powder Room. An electric floor warming cable was installed in the floor before applying the self-levelling compound.



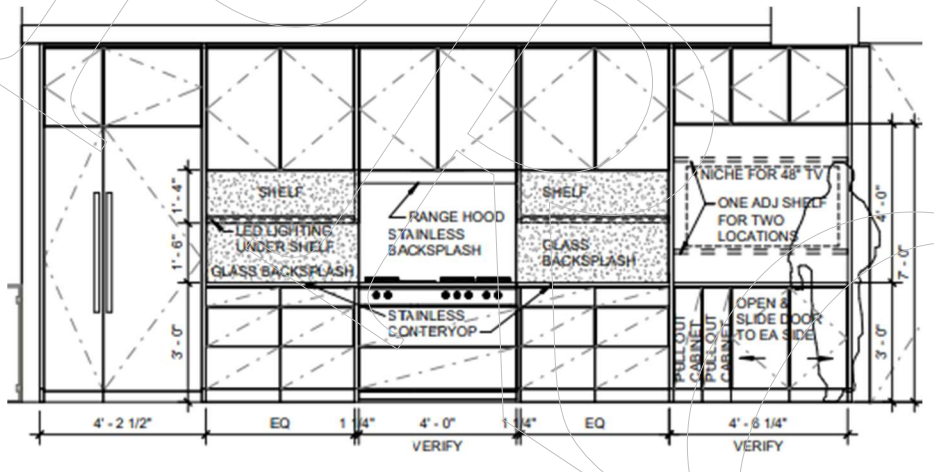


creating the custom floor register

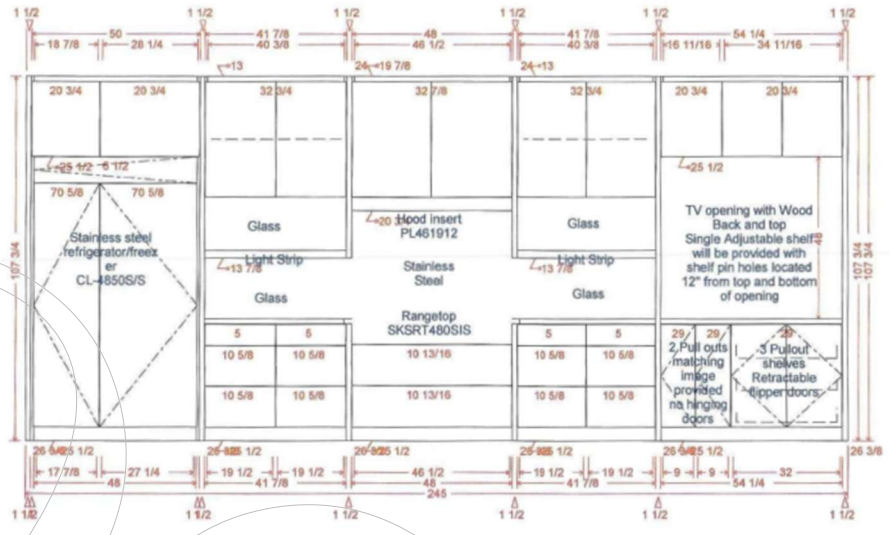
CABINETS & CLOSETS

Based on our requirements, Baylis produced floor plans for each of the rooms as well as "elevation" drawings that showed the shelves, cupboards, drawers, etc. Here is an example of an elevation drawing: Kitchen W wall.

Kitchen W Wall elevation drawing



Kitchen W Wall shop drawing



The elevation drawings were used by the cabinet and closet contractors to produce "shop drawings" that contained the precise specifications for how to build the cabinets and closets. The shop drawings were carefully reviewed by John and the architects before being approved.

Russell Cabinets was used to build the following custom cabinets:

Great Room: S wall
Kitchen: W wall, island, N wall, Pantry
Master Suite: bedroom shelves, hall unit with washer/dryer, bathroom vanity and cupboard
Guest Closet
Polly's Office: desk and shelves
Bath 1, 2 and 3: vanities
Playroom: counter cupboards/drawers
Laundry Room: counter cupboards/drawers and a closet


rift cut oak grain lines

"Rift cut" oak was specified for the face veneer which produces wood with very straight, parallel grain lines. We also had Russell produce samples with different stains to help us decide on the preferred colours.

California Closets was used to build the custom closets for the Master Bedroom, Bedroom 1 and Bedroom 2.

Elevation drawings are included in Appendix C with the room descriptions.

The first Russell Cabinets were delivered Dec 17, 2024. They were installed before the walls were painted. Here are some pictures of the installed cabinets.

Kitchen W wall, N wall, island

Great Room

Polly's Office

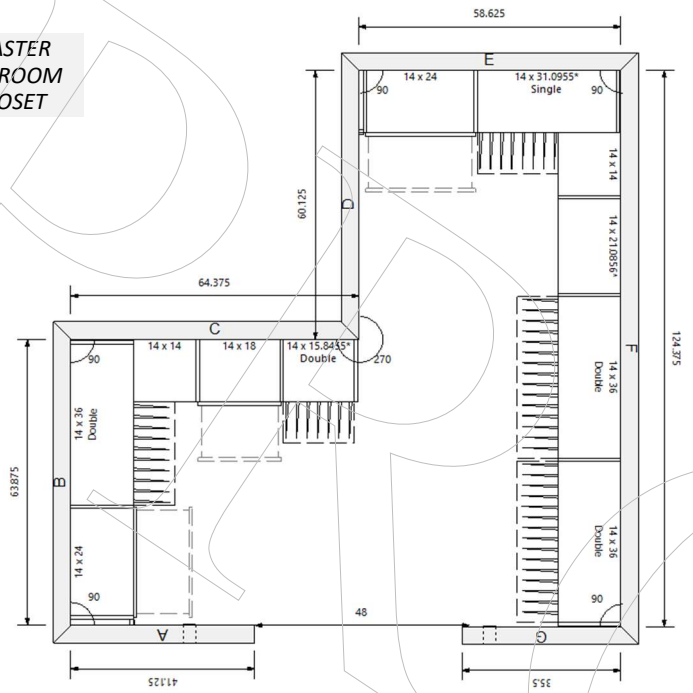
Master Bedroom

laundry room

Master Bathroom vanity

The California Closets were delivered and installed on Feb 25 after the closet trims and walls/ceilings had been painted.

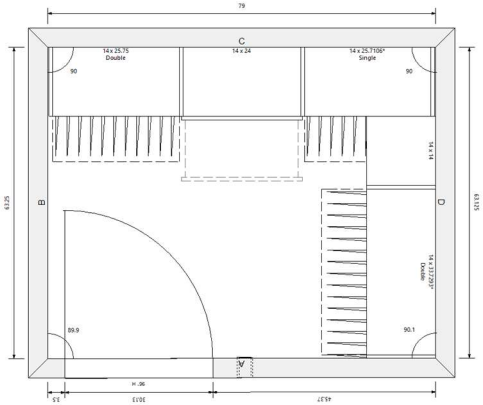
MASTER BEDROOM CLOSET




walls B and C


walls E and F

BEDROOM 1 & 2 CLOSET



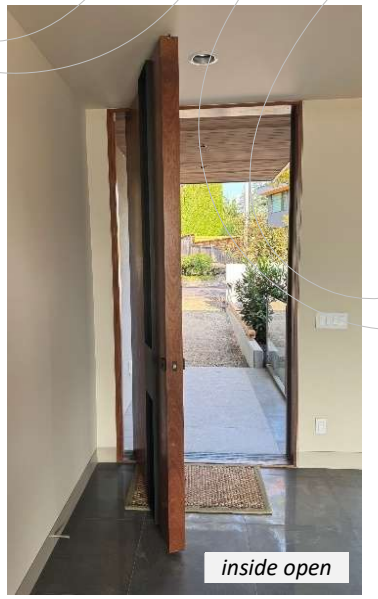

wall C


walls C and D

FRONT DOOR

We chose a pivot door for our front entrance for its wider, grander appearance. A pivot door rotates on a vertical axis using special hinges placed at the top and bottom of the door rather than traditional hinges on the side of the door. The door was custom manufactured by The Pivot Door company. It is 9' high, 4' 6" wide and 3 ½" thick. It has a double steel-reinforced core which makes it extremely heavy. It also has 1" of foam insulation for an R-value of 7. The door has a "bottom closer" hinge that puts constant tension on the door to close.

The door was installed Feb 13, 2025. It took 6 men to install it. It was stained May 8.



SLABS

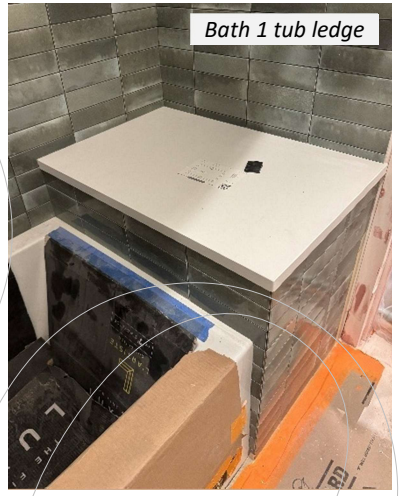
"Slabs" refers to the material used for the kitchen island and bathroom vanity counters. Slab material options are primarily marble, granite, quartz and quartzite. Marble, granite and quartzite are natural stone. The stone needs to be sealed to prevent damage eg, acid from orange juice spilled on the surface. This is an ongoing maintenance requirement. Quartz is a manufactured stone that doesn't need to be sealed. We chose to go with quartz for the lower maintenance.

We used slabs in the following locations:

- Kitchen island
- Kitchen N counter
- Master Bathroom vanity and niches
- Bathroom 1, 2 and 3 vanity counters
- Bath 1 tub ledge
- Laundry room counter
- Great Room mantel and hearth
- Powder Room ramp sink

The slabs for the Kitchen, Baths 1 and 2, and the Laundry room were delivered and installed on Feb 17 and 18.

Kitchen N counter



Bath 1 tub ledge

Laundry room

Great Room fireplace mantel and hearth slabs

The kitchen island slab had waterfall edges. Silicon was used as an adhesive to connect the stone to the island wood surface. Nitro OneShot is an adhesive made specifically for connecting stone surfaces. It was used to connect the mitred waterfall edges.


creating a seamless connection between 2 slabs


preparing the mitred waterfall


applying silicon


applying Nitro Oneshot


the final result

PAINTING

Three categories of items were painted: doors, wood trim and walls/ceiling. The paint colour was the same for the walls and ceiling but the ceiling was lighter (50%). The doors and trims used a different colour – slightly darker. Also, the doors and trims had a sheen whereas the walls and ceilings were matte.

The sequence used for all 3 categories was the following:

- preparation – fixing blemishes in the surface then sanding
- primer coat followed by sanding
- first coat followed by bondo then more sanding
- second (presumably final) coat

Preparation for painting began Jan 27, 2025. All of the wood floors were covered with masonite. The lower level painting was completed before the main level. However the Master Bedroom closet painting was completed before completing the lower level in order to accommodate the closet installation schedule.

PREPARATION

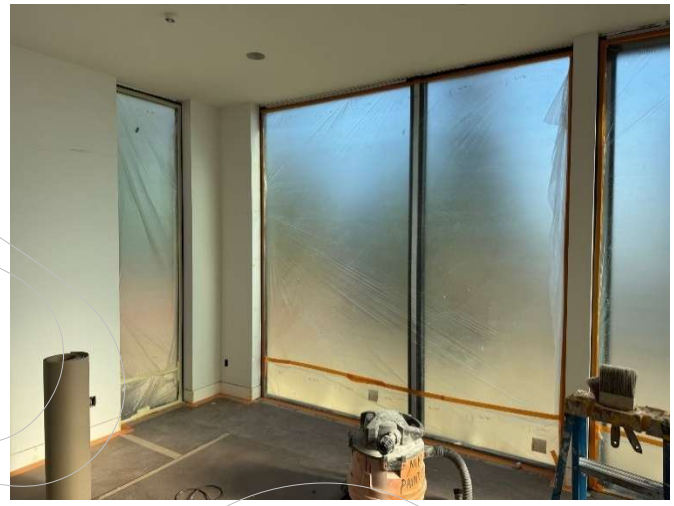
A trowel was used to apply wood filler to blemishes in the doors and wood trims. Then the doors and trim were sanded. Corners were also caulked using an acrylic sealant.

acrylic sealant used to caulk corners

applying wood filler to blemishes


sanding the trim

Before painting began, all of the wood cabinets and windows were covered with plastic.



PRIMER COAT

The primer coat was applied to the doors, wood trim and walls/ceilings. It was sprayed on. To facilitate spraying, the doors were propped up in the Playroom and John's office. After applying the primer coat, the doors, wood trim and walls/ceilings were sanded again.

DOORS & TRIM

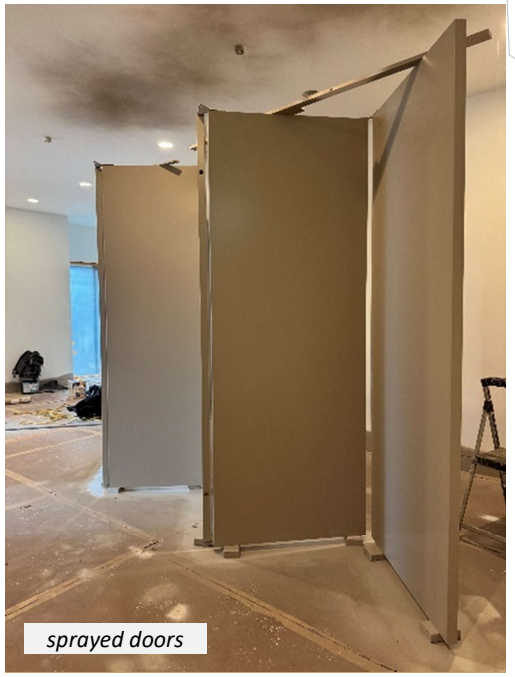
The first coat for the doors and trim was applied by spraying. Then bondo (red) was applied to any imperfections and the doors and trims were sanded again. Then the second coat was applied by spraying.

door frames with bondo applied

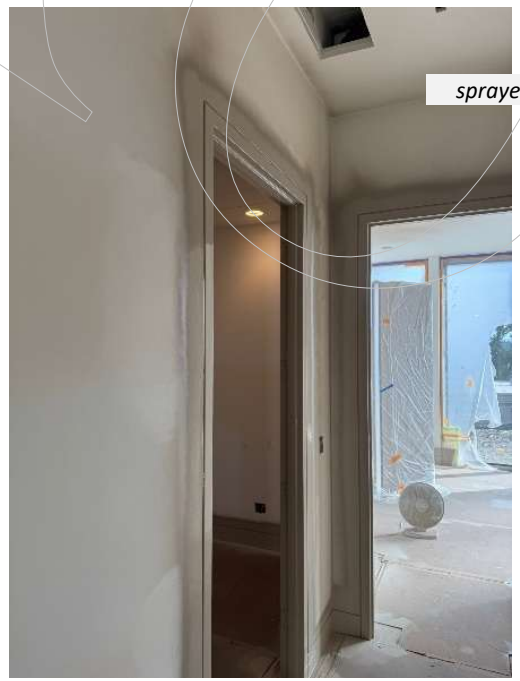
sanding doors before spraying

sanding trim

spraying trim



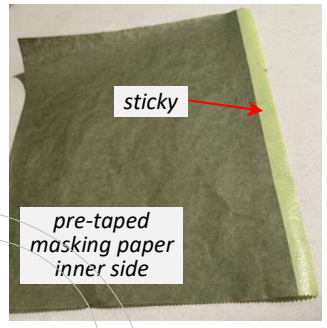
sprayed doors



sprayed trim

WALLS & CEILINGS

After the doors and trims were completed, the doors were covered with plastic and a paper mask was applied to the trims to cover them. The 3M Hand Masker Dispenser was used to quickly apply pre-taped masking paper to the trims.



After covering the completed doors and trims, the walls and ceilings were sanded and imperfections were repaired. Portable lights were used to shine light up the walls to expose minor imperfections. A Mirka HEPA certified dust extractor was used for dust free sanding. The end attachment is an orbital sander.

After removing the imperfections, the walls and ceiling were painted using large and small rollers. Brushes were used for the corners. Two coats were applied.

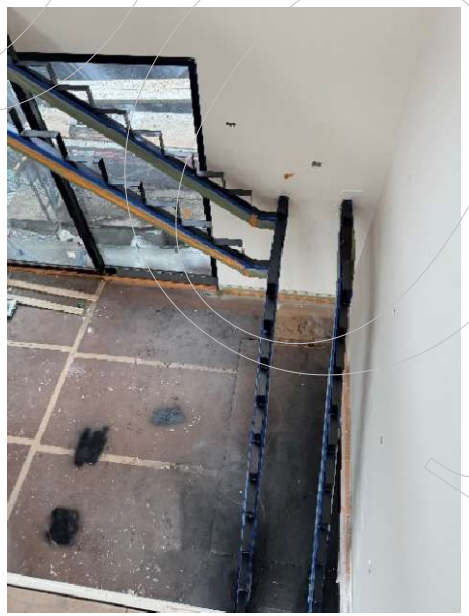


The lower level was completed first. The same sequence was used for the upper level. The painting of the walls, ceilings, doors and trims was completed by Mar 28, 2025.

STAIRCASE PAINTING

The temporary treads were removed and the steel frame of the staircase was cleaned and smoothed to removed any imperfections. Then the steel was sprayed matte black.





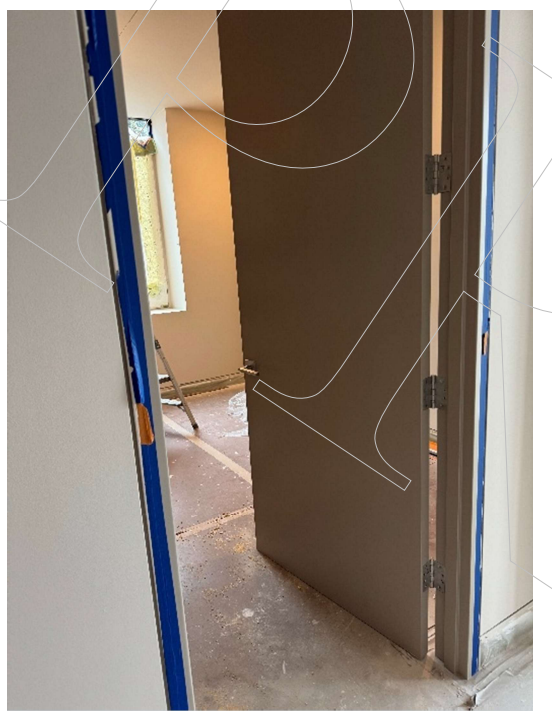
OUTSIDE PAINTING

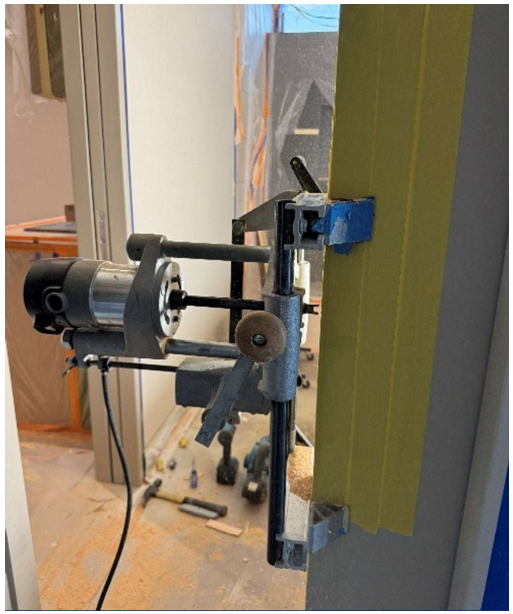
The Hardie panels (previously yellow) were painted to match the metal fascia.

the Hardie panels around the clerestory windows were filled, smoothed then painted

DOOR HANGING

The door hanging was done after the painting was completed. The lower level was done first. The doors have 4 hinges. After the doors were hung, the door handle sets were installed. The mortise locks used in the pocket doors were also installed.





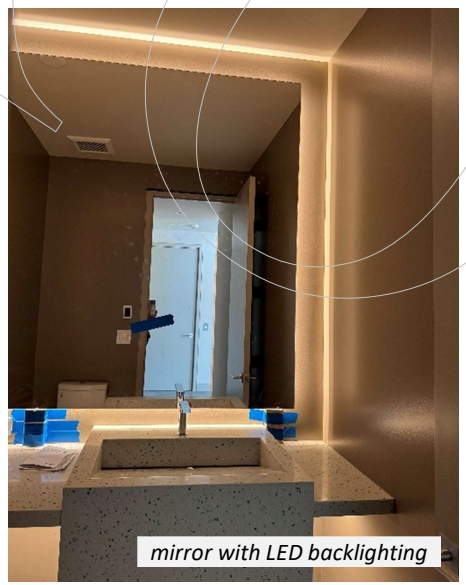
pocket door mortise lock

POWDER ROOM

The powder room sink is a ramp sink with no vanity. The frame is tube steel. It was built by Pasha. The desired slab was cut to create the sink and counters.




A box was constructed 2" smaller on each side than the mirror to be installed. It was about ½" deep and spray painted black on the 4 sides. An LED light strip was installed around the 4 sides. A motion sensitive faucet was installed. This required a low voltage transformer under the sink.

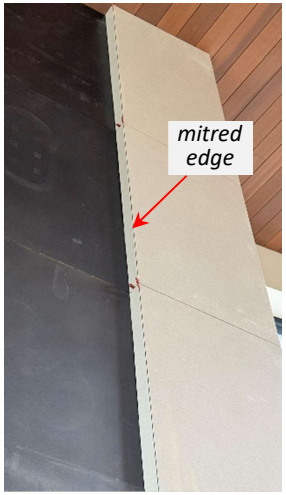


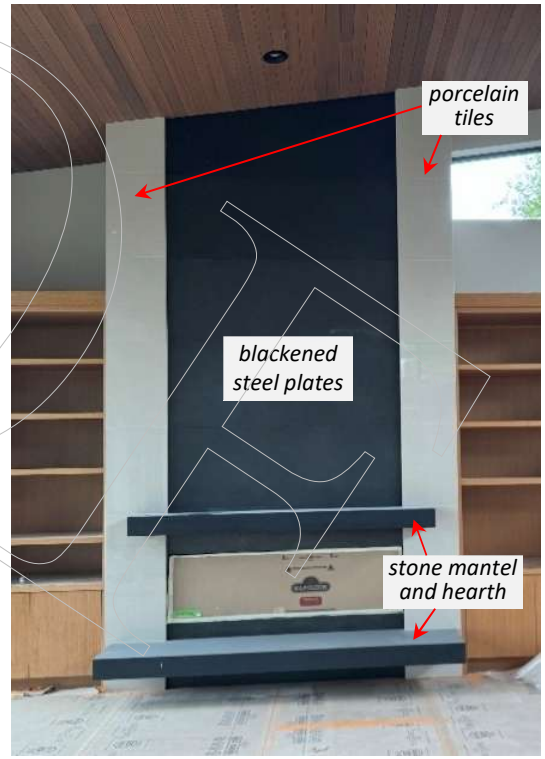
FIREPLACE TRIM

GREAT ROOM

This fireplace has a stone mantel and hearth that was created by Western Artisans who were also responsible for building the quartz island and counters. Steel frames were built to hold the stone mantel and hearth. Blackened steel plates were installed above the mantel up to the ceiling.

2'x4' porcelain tiles were installed on each side of the steel plates. The tiles were not flush which required mitred edges to be built. It was a significant effort.



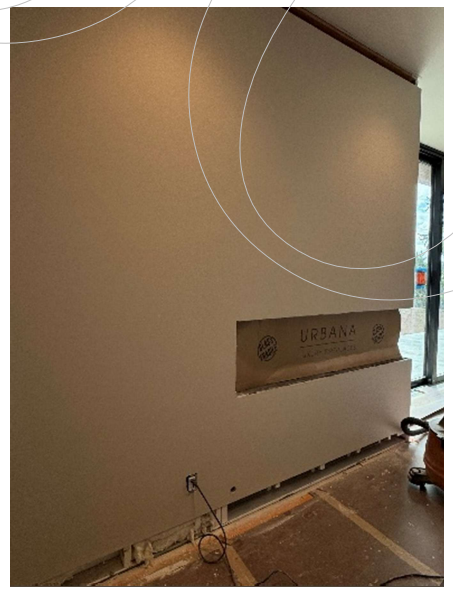


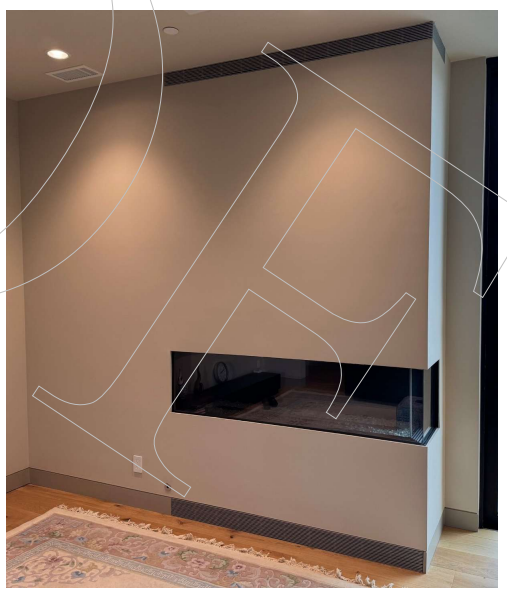
MASTER BEDROOM

This fireplace does not have a mantel or a hearth. Hardie panels were installed around the firebox instead of drywall since they are not combustible. “Reveals” were created similar to the baseboard trim and door trims. Plaster was then applied and the wall was painted.

FAMILY ROOM

This fireplace also does not have a mantel or a hearth. We decided to just paint the wall for the time being since we couldn’t decide on the wall covering. Hardie was installed around the firebox then painted. Potential future options: porcelain tile, milestone, venetian plaster, wood, stone eg, basalt like the waterfall.





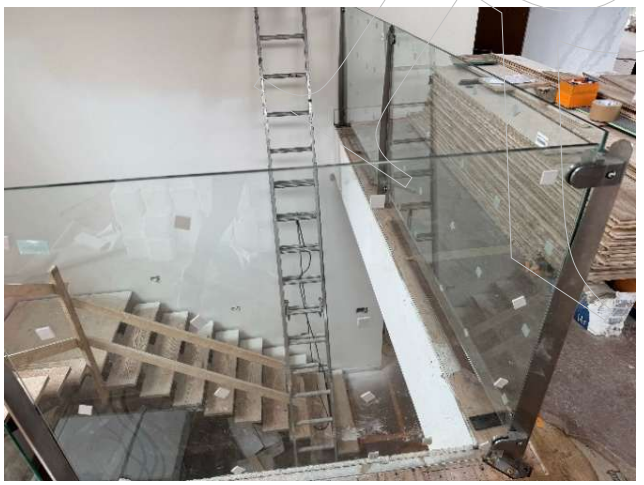
RAILINGS

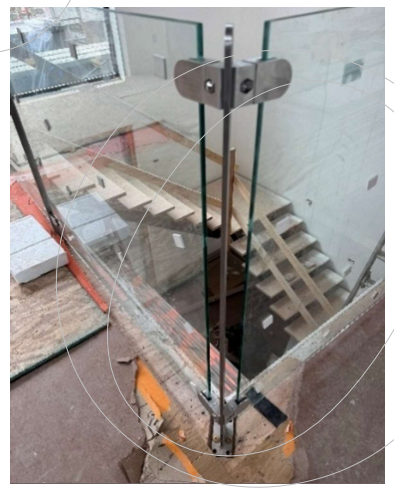
Railings were required in the following locations:

- staircase
- deck
- Master Bedroom balcony
- entry bridge

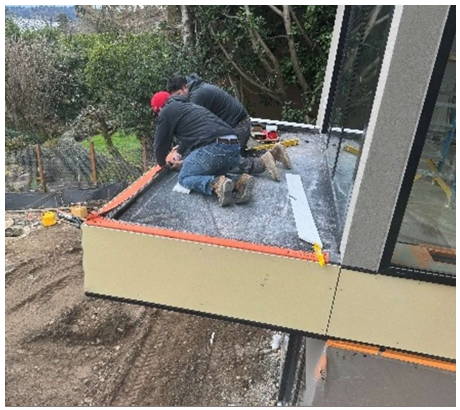
The railings chosen were manufactured by Invisirail. They consisted of glass panels held in place by vertical stainless steel posts with no horizontal rail. This provides minimal visual obstruction.

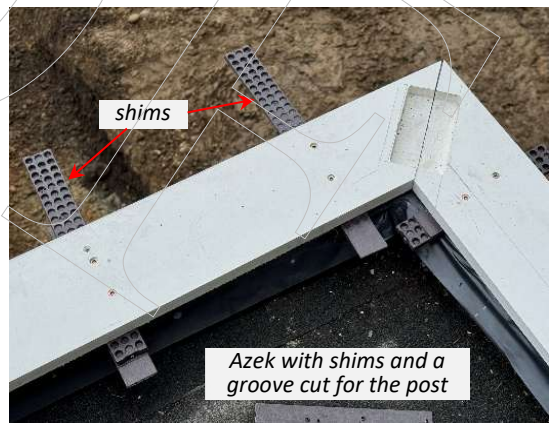
The same railings were used inside and outside. The railings surrounding the stair well were installed first. The glass is connected to 42.5" tall stainless steel posts. The glass is 10 mm thick. The posts are surface mounted with 6" long screws that are covered after installation.

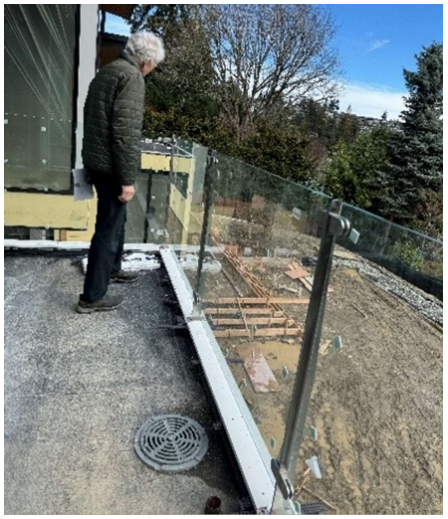




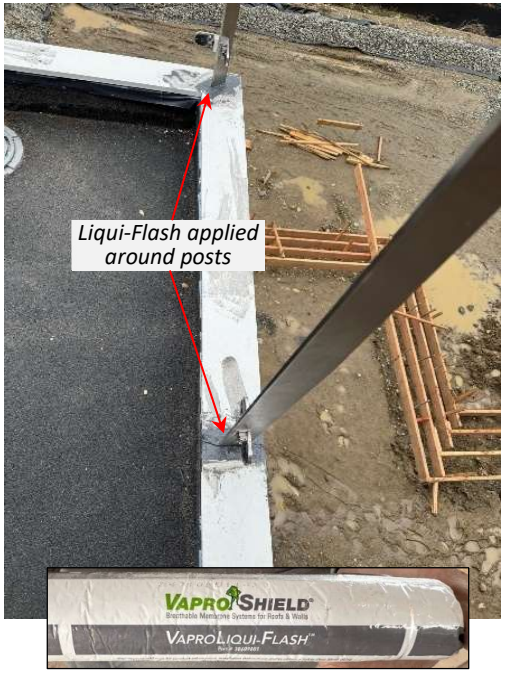
Before installing the posts on the balcony and deck, frog skin (orange) is applied for waterproofing. Then another waterproofing membrane called "Vycor" is used to cover the horizontal surface where the railings are being installed. Vycor is black. It can be peeled off and it is very sticky. After covering the surface with Vycor, a ¾" white plastic material called "Azek" is installed. A groove is cut in the Azek for the base of the railing posts and screws are used to connect the Azek to the wood underneath.

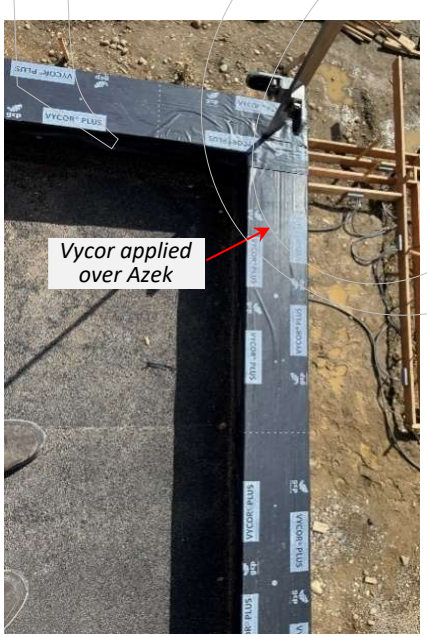


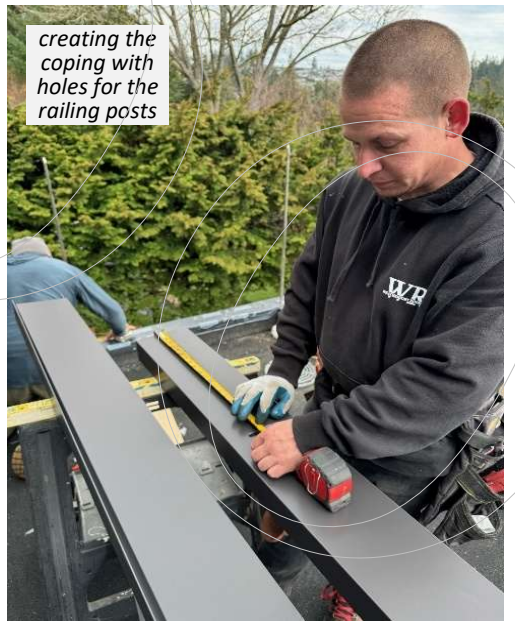


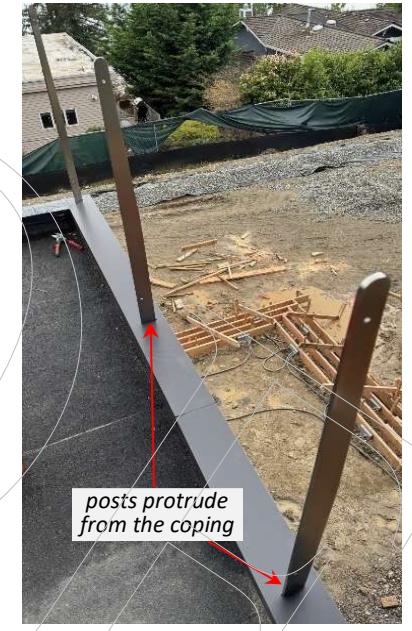


After the glass has been installed and perfectly fitted, it is removed and the Azek is covered with “Liqui-Flash” around the railing posts. Then another layer of Vycor waterproofing membrane is applied. Metal coping is installed over the deck parapets and the glass is re-installed. The final result is that the posts protrude from the coping which provides a simple, clean look.





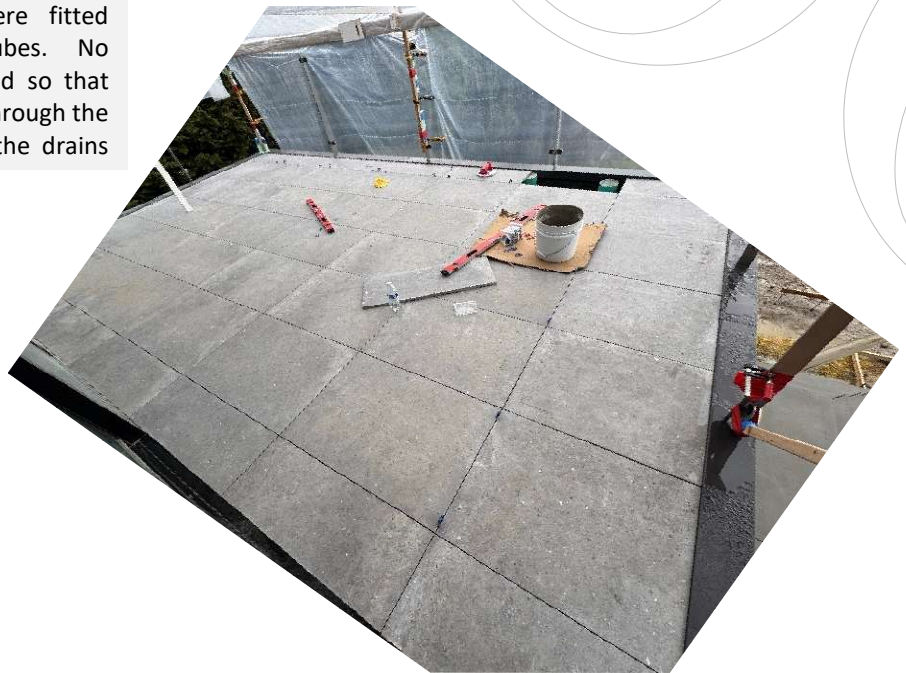


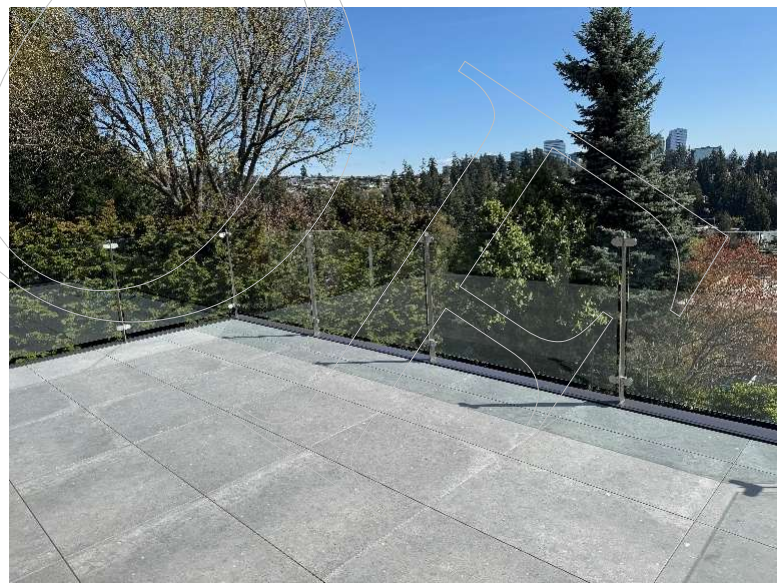


DECK & BALCONY

After completing the deck glass railings including the metal coping, preparation began for laying the pavers on the deck and balcony. The surface was torchdown created by the roofers. It was built with a slope to funnel water to the drains. The pavers laid needed to be level with the metal coping. To accomplish this, PVC tubes (about 6” in diameter) were cut to support the pavers and to ensure that the pavers were level. Then the PVC tubes were filled with concrete to ensure that they would not slide sideways.

2’x4’ pavers were fitted over the PVC tubes. No grout was applied so that water can seep through the cracks to reach the drains

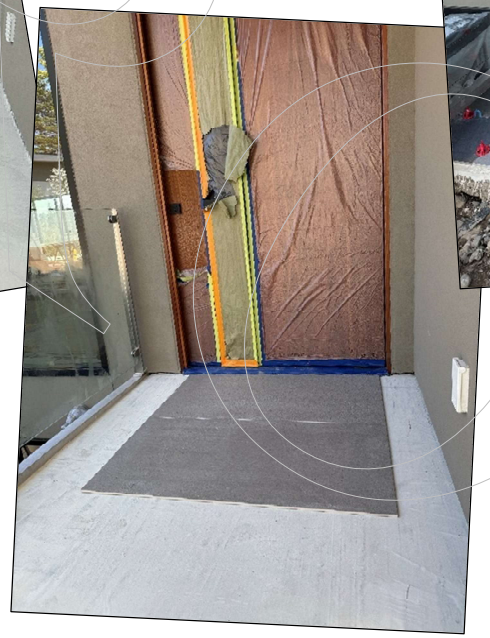




BRIDGE

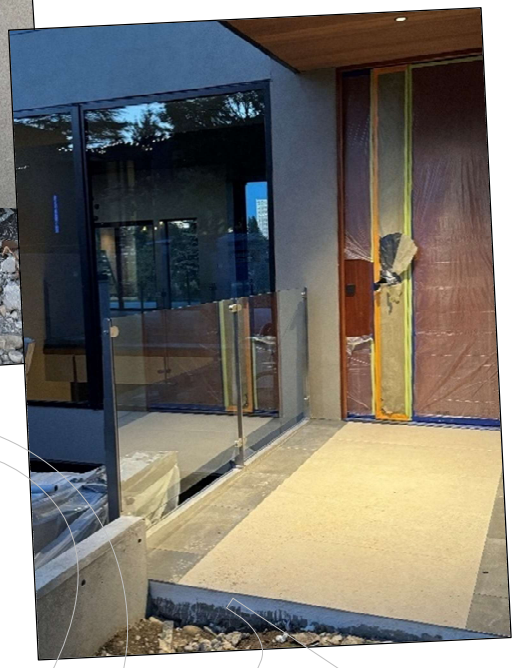
After installing the bridge railings, the bridge surface was prepared then the tiles were installed in the desired pattern with shims to ensure accurate spacing.

preparing the surface



laying the tiles

using shims for spacing



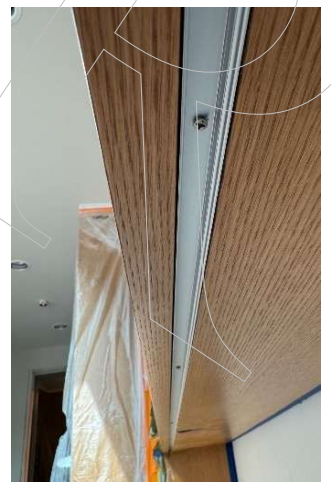
the final product

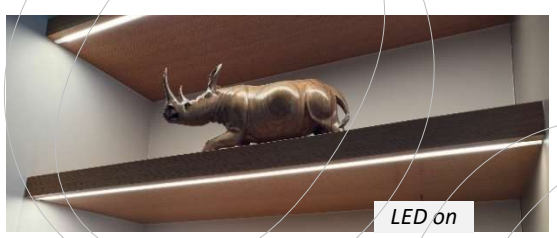
ELECTRICAL TRIM

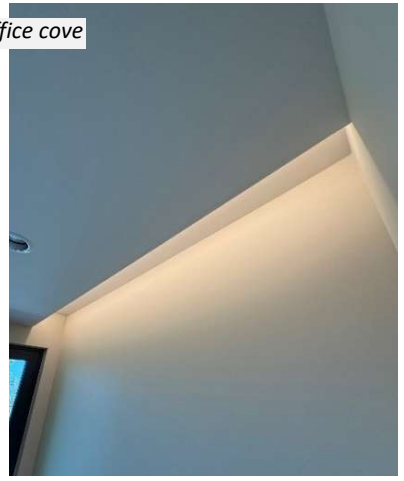
"Electrical trim" is the term used for the final stage or wiring, when all the electrical devices get installed eg, outlets, switches, lighting fixtures, ceiling heaters, and so on. It is the work required to get the house ready for the final electrical inspection.

UNDERSHELF LIGHTING

Many of the shelves have undershelf LED strips. LED strips come on a reel and they can be cut to the desired length. The cabinet maker created a channel in the shelves to insert LED strips. The Surfa 7 product from AlloyLED is an aluminum channel with a snap-in frosted lens. The LED strip is inserted into the aluminum channel then the snap-in frosted lens is placed over top to create a pleasant diffuse effect. In Polly's office cove, the LED strip was inserted into a semi-circular aluminum channel with a frosted lens.

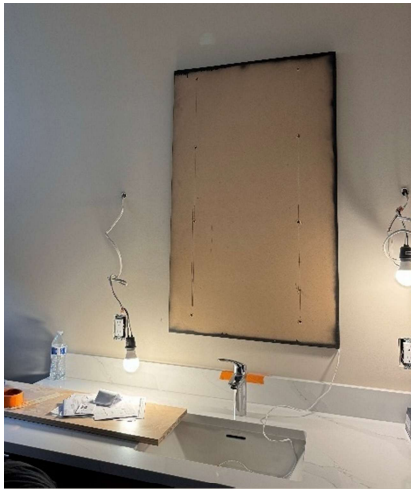


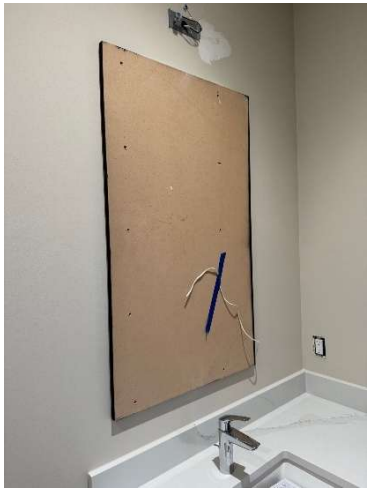


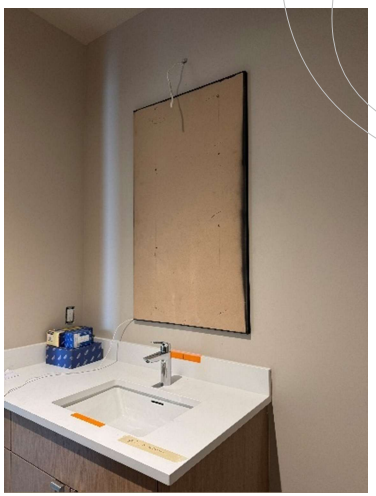


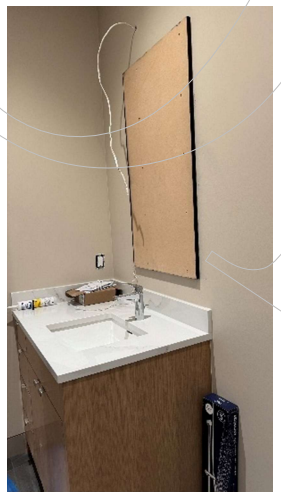
BACKLIT MIRRORS

All of the bathroom mirrors were backlit with LED strips. This is a very pleasant effect. To accomplish this, rectangular "boxes" approximately 1" deep were built. If the mirror is N"xM", the box was N-2"xM-2". The edge of the box was spray painted black then the box was mounted on the wall.

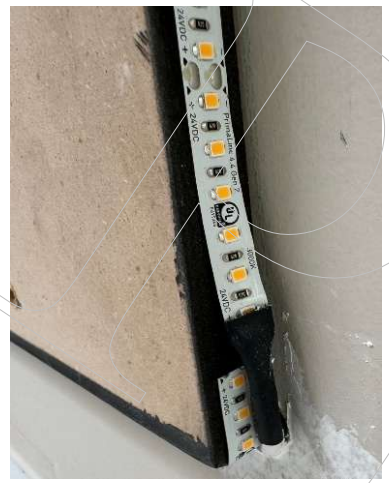






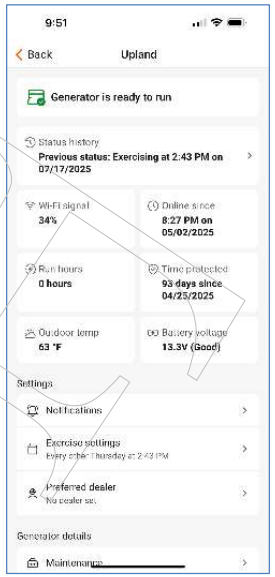


The LED strip is strung around the 4 sides of the box. It is then connected to a wire going to the “driver” ie, transformer. These low voltage wires were previously installed when the circuit wiring was being created.



GENERATOR

We purchased a 26 kW Generac air-cooled, engine-driven generator that runs on natural gas. It produces 120V/240V single phase AC power. The generator is connected to the 2 breaker panels by the 2 transfer switches. The transfer switches continuously monitor the electrical grid. When a drop in voltage or a complete power outage is detected, the Generac receives the signal to start. The transfer switches disconnect the breaker panels from the utility’s meter box and connect them to the Generac in a few seconds. When the transfer switches detect that stable utility power has returned, they switch the breaker panels back to the utility’s meter box. The Generac shuts down after a brief cool-down period. The Evolution 2.0 controller handles sensing utility power (loss and reconnection), initiating and stopping the generator, transferring power, regulating voltage, scheduling and executing exercise cycles and charging the battery. The Mobile Link smartphone app is used to monitor the Generac.

HVAC TRIM OUT

"HVAC trim out" refers to the final phase of installation. In our case, this refers to installing the heat pumps, connecting the refrigerant lines, installing the transformers for the fresh air controllers, connecting the Navien water heater to a drain for condensation, installing ceiling and wall grilles, and installing the thermostats.





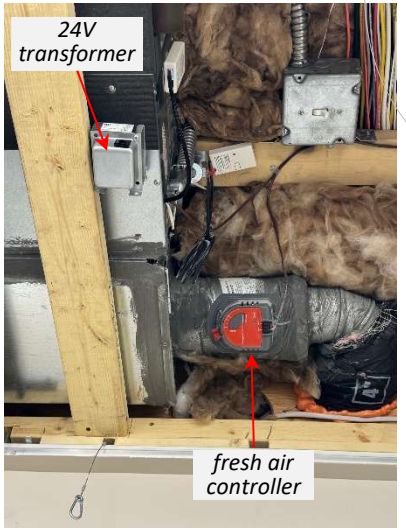
HEAT PUMPS

When the concrete platform on the N side of the house was completed, the 2 large Mitsubishi heat pumps were installed. They were stacked and connected to the house via chains for improved stability. The black conduits are the refrigerant lines.



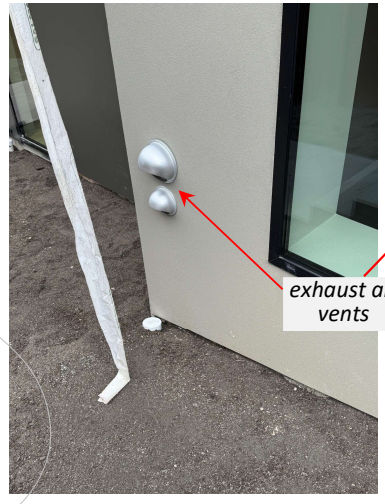
FRESH AIR CONTROLLERS

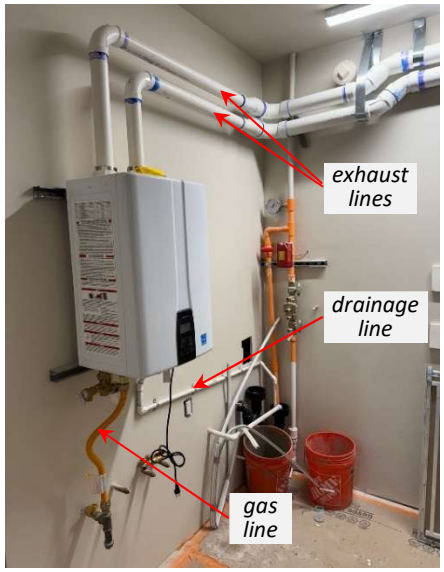
All 7 air handlers have fresh air controllers. An independent 24V transformer was required for each unit to power its fresh air controller. The fresh air intake for all the air handlers was located on the N side of the house.



Exhaust Air Vents

Exhaust air vents for the bathroom fans were located on the N and S sides of the house.



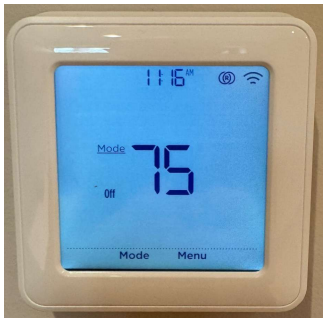


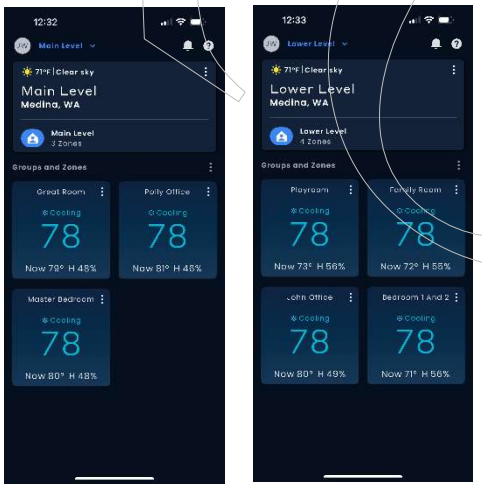
Hot Water Tank

Hot water is provided by a gas "instant" hot water tank from Navien. We wanted to use an electric heater but we were advised to use gas since it has superior performance. The tank was installed by the plumber. The HVAC contractor installed the gas line (orange), exhaust lines (white) and the drainage line (white).

Thermostats

There are 7 thermostats in the house -- one for each air handler. They are not hard wired to their air handler. They communicate using WiFi. The Mitsubishi Comfort smartphone app is used to monitor and control the 7 thermostats – 3 on the Main Level and 4 on the Lower Level.





Comfort app

PLUMBING TRIM

"Plumbing trim" is the term used for the final stage or plumbing installation, where all the plumbing fixtures are installed. This includes everything required to get the house ready for final plumbing inspection. The full list of fixtures and appliances that had to be connected to water is found in Appendix D. This includes the toilets, faucets, showers, tubs and a hot/cold filtered water dispenser. The plumbers also installed the sinks, food waste disposer and Navien hot water heater.

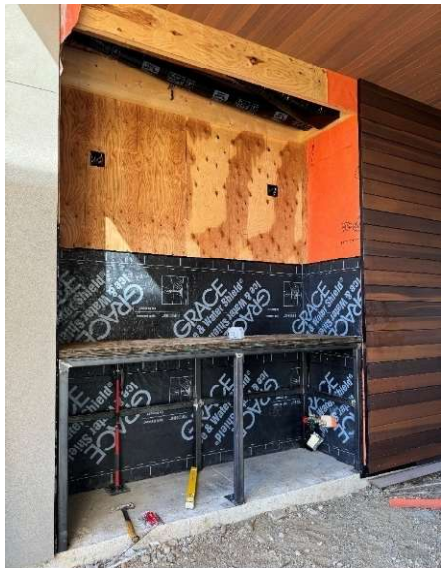
AQUARIUM

The aquarium is located in the Atrium. The front of the aquarium is flush with the adjacent walls. The space is indented 27” to accommodate an aquarium that is 24” deep.



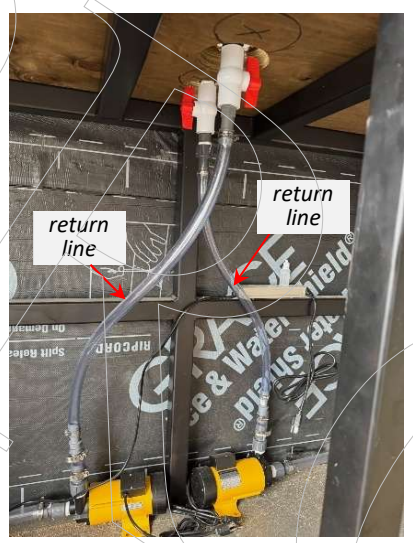

The aquarium is 7’ wide, 3’ high and 2’ deep and holds about 320 gallons of water. It can accommodate 6-12 medium sized koi. Cupboards were installed above and below the aquarium that open to provide access to the space. The lower space is used for pumps, filters and supplies. There is also a hose bib with hot and cold water taps and a spout that can be connected to a hose. The upper space provides access to the top of the aquarium for feeding and cleaning. There is also an auto feeder and a LED light strip that can be turned on to view the fish.

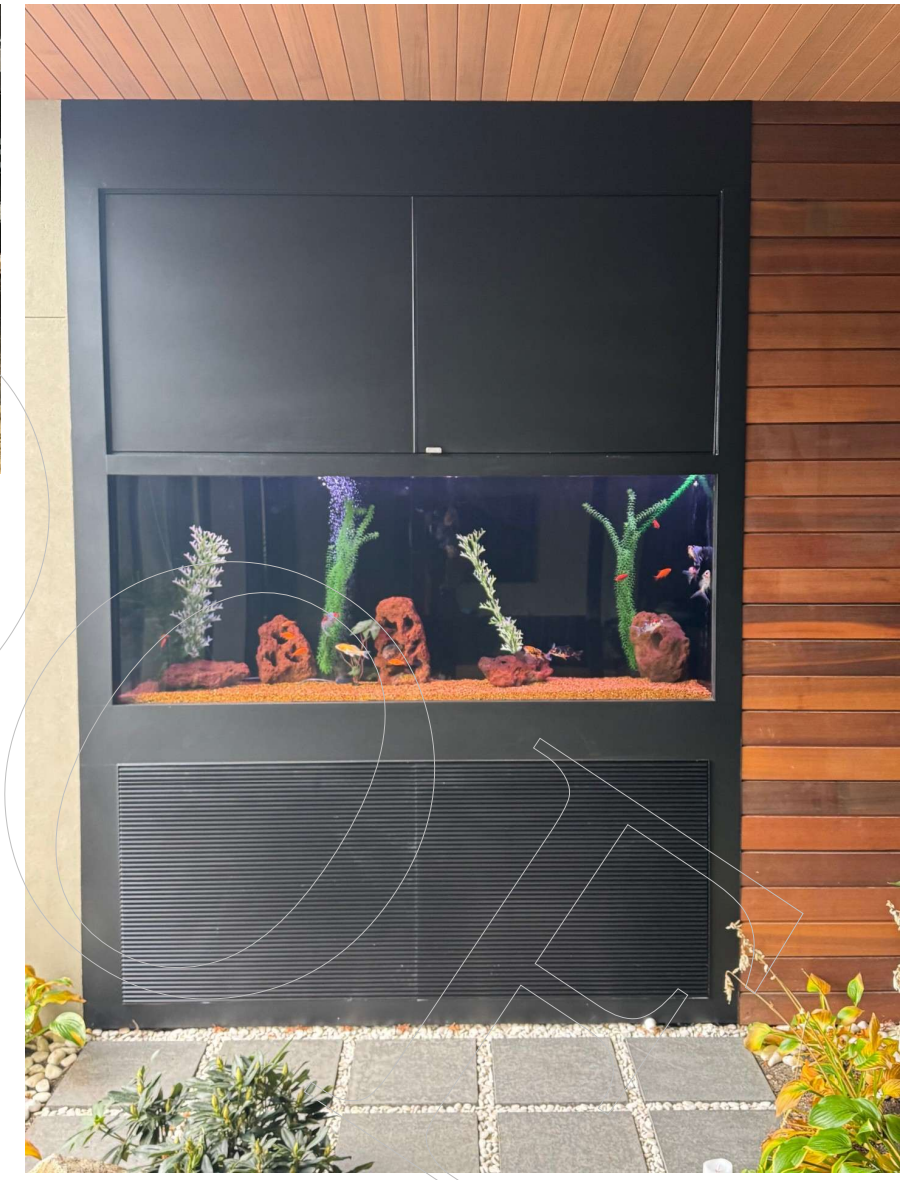
The custom built aquarium was delivered Jan 21, 2025 and stored in the garage. In preparation for moving the aquarium to the Atrium, a black water shield product was installed on the inside walls. Then Pasha welded a frame from tube steel to support the aquarium that weighs 3500 lbs after it is filled with water. Hardie panels were subsequently installed on the walls and ceiling of the enclosure.

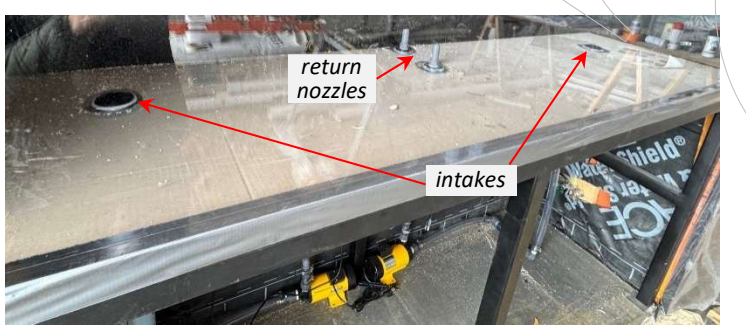



The aquarium was moved to the Atrium and mounted on the steel platform. The next step was to install the heater and the UV sterilizer. Two larger holes were drilled into the floor of the aquarium on the left and right sides that connect to the UV sterilizer and heater intake lines respectively. Two smaller holes were drilled in the middle with grey protruding nozzles for the return lines. Under the aquarium, the intake lines were fed to the UV sterilizer on the left and the heater module on the right then to Pan World Magnet Pumps that pump the sterilized and heated water back into the aquarium.

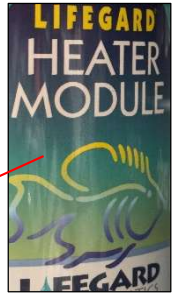
Panels were placed on the floor of the aquarium then rinsed gravel was laid on top of the panels. This acts as a mechanical and biological filter. When the aquarium is serviced, the gravel is vacuumed to remove debris.







The picture on the right shows the final aquarium. Trim was added around the aquarium and upper/lower doors that is flush with the walls. The doors and trim were then painted black.

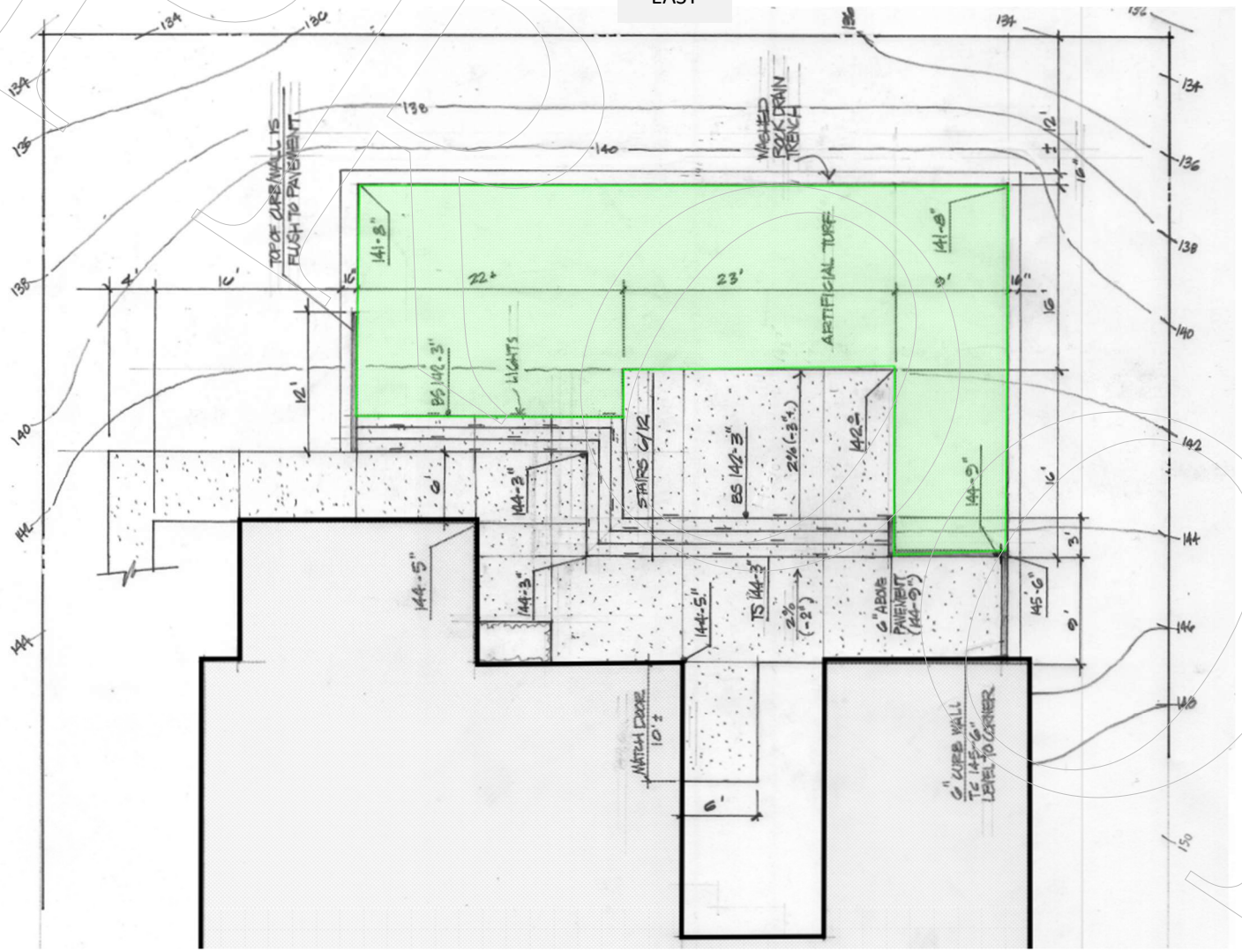


BACK LANDSCAPING

The schematic shows the plan for the back / east side of the house that was developed with a landscape architect. There will be a flat concrete area (dots) then 3 steps down to a flat artificial turf area (green). The ground then slopes down to the E property line. The elevations shown on the schematic are in feet "Above Sea Level" (ASL).

As part of getting approval to build this new house on a slope, the city required a French drain to be installed on the E side of the property to feed into the catch basin. It was installed between the 138' and 140' ASL levels.

EAST



Backyard plan created by landscape architect

The artificial turf was surrounded by river rock (stones). A pyramidalis hedge was installed along 70' of the E property line and 30' of the S property line. Need 1 tree every 3'. They will grow wider to fill the gap. The top will be trimmed to maintain the desired height.

Quality soil was used on the slope between the artificial turf and the pyramidalis hedge. The intention is to plant attractive shrubs eg, hydrangea, rhododendron.

EXCAVATION

The excavators started Feb 28, 2025. They used a device from Topcon to determine how deep to excavate. It consists of a laser mounted on a tripod and a laser detector that can be attached to a measuring rod. From the schematic in the CD set, the height of the ground floor is known to be 143' 3" ASL and the height of the artificial turf is 141' 8" ASL which is 19" lower than the ground floor. The laser is mounted on the tripod at a known reference height ie, the ground floor level + height of the laser above the ground floor level. The measuring rod is placed at the location where the depth is to be measured and the detector is placed at a division on the measuring rod that corresponds to the desired depth. An indicator on the detector shows whether the desired depth is higher or lower. The detector also beeps when the depth is correct. This helps the excavators achieve the required depth.

White lines were sprayed on the ground to show the location of elevation changes. The excavation required for the concrete and artificial turf surfaces was implemented. The trench for the French drain was also constructed.

laser mounted on tripod

measuring rod with laser detector

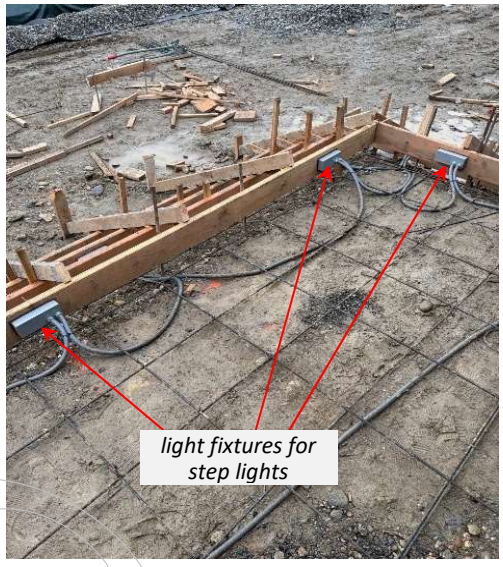
building a trench for the French drain

Drainage pipes with holes were laid in the trench to conduct water to the catch basin then covered with plastic and gravel.

WALKWAY AND STEPS

The framing for the concrete and steps in the plan began Mar 13, 2025 after the excavation at the back and sides of the house was completed. This included the walkway and steps on the N side of the house.

After the framing was completed, rebar was inserted. Also, note the wiring for the light fixtures inserted in the steps.



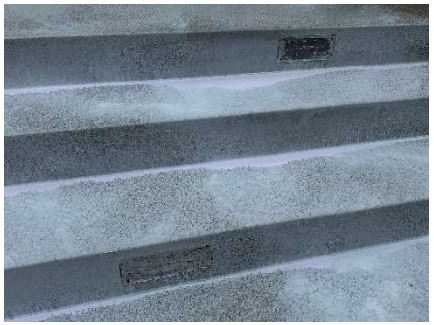
There were 3 concrete pours: #1 – steps and adjacent to house on E side. #2 – N side walkway and platform for heat pumps and Generac. #3 – lower patio area.

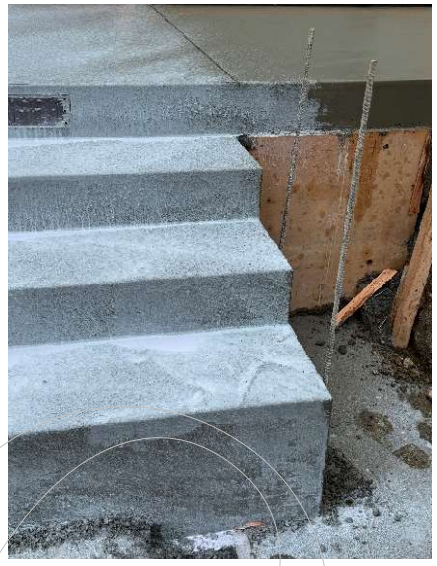
POUR #1

The first pour (Apr 1, 2025) was the steps and walkway at the back. Trowels and a bull float were used to make the surface smooth. A "hand groover" tool was used to create a crease (aka control joint) to help prevent cracking. Then "Top-Cast" was applied to the concrete surface.

This is what the concrete looked like after applying “Top-Cast”:





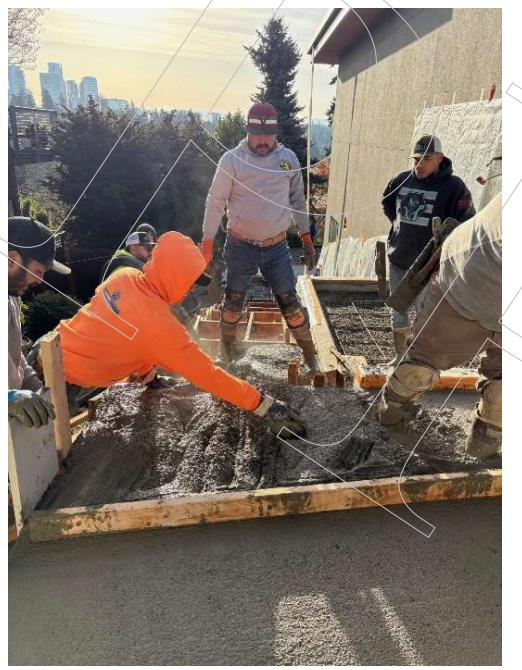



The next day, the Top-Cast was removed using water. The result was a very impressive “pebble-like” finish that resembled sand blasting.

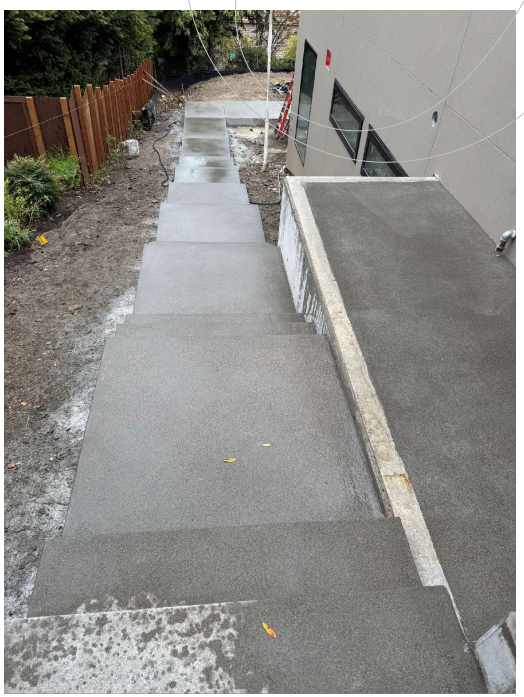


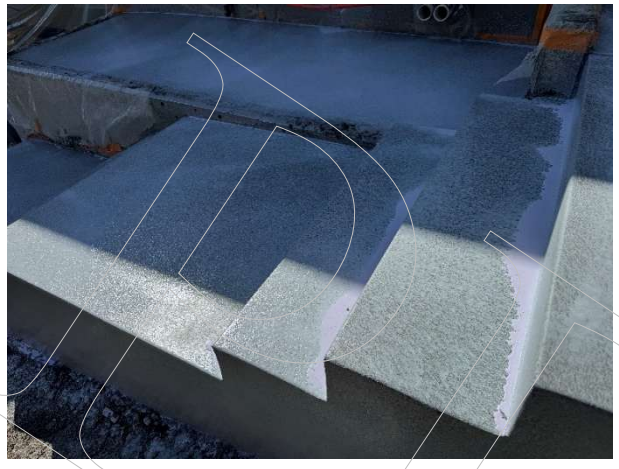
POUR #2

The second pour (Apr 6, 2025) was the walkway on the N side. Hay was placed in the walkway and it was covered with rebar. The same process was used. After the concrete was poured and smoothed, Top-Cast was applied to the concrete surface and removed the next day using water to create a “pebble-like” finish.



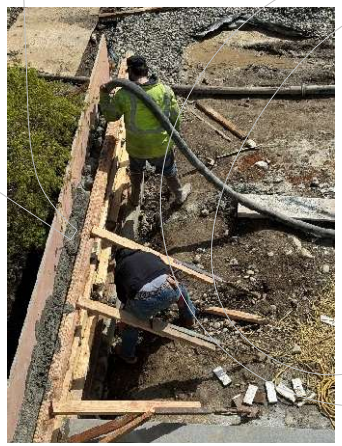


POUR #3

The third pour (Apr 9, 2025) was the patio at the back and the 2 short retaining walls.

SEALING

After all the pours were completed, the horizontal concrete was treated by spraying it with the Dayton Superior Cure & Seal product that is an acrylic copolymer cure, seal and dustproofing compound. This protects the concrete and creates a very nice appearance.

SOIL PREPARATION

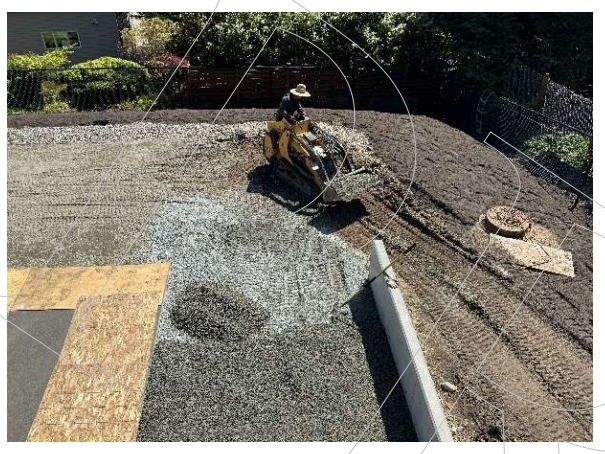
Soil remediation to improve absorption was a requirement of the city and a requirement to be able to plant the pyramidalis hedge as well as shrubs on the slope leading to the property line. Poor quality rocky soil had to be removed and replaced with quality topsoil. Separately, rocks were used to cover the French drain. This provided superior drainage and it was attractive.



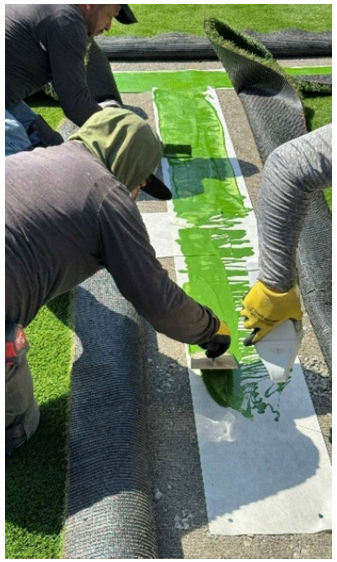
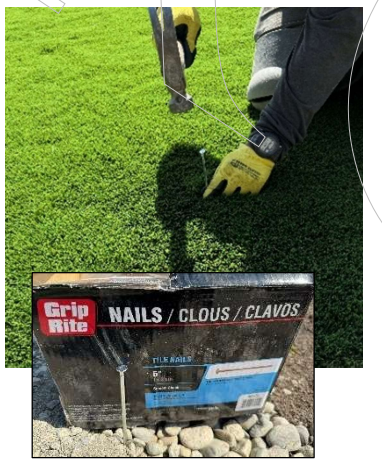



ARTIFICIAL TURF

In preparation for the artificial turf, gravel was laid over the topsoil, raked, then pounded using a machine to make the surface flat and smooth.



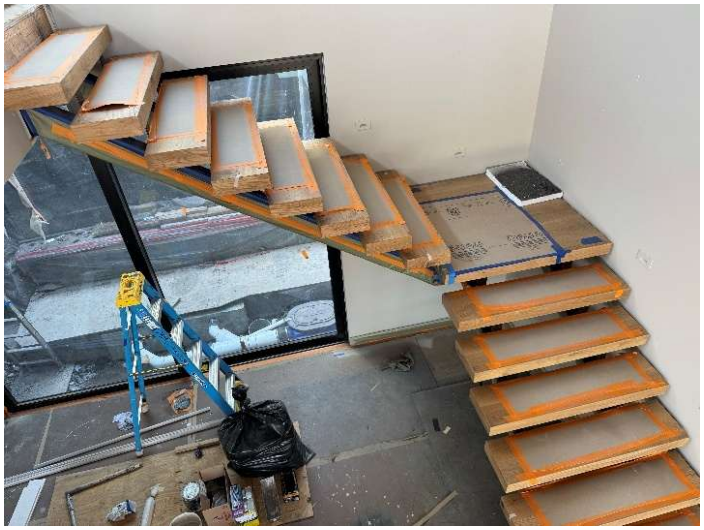
The artificial turf came in long rolls. It was rolled out in sections then nails were used to hold it in place. A white plastic mat was placed between sections, held in place by nails. Then a green glue adhesive was applied using trowels. The sections were glued to the mat. The result was spectacular!

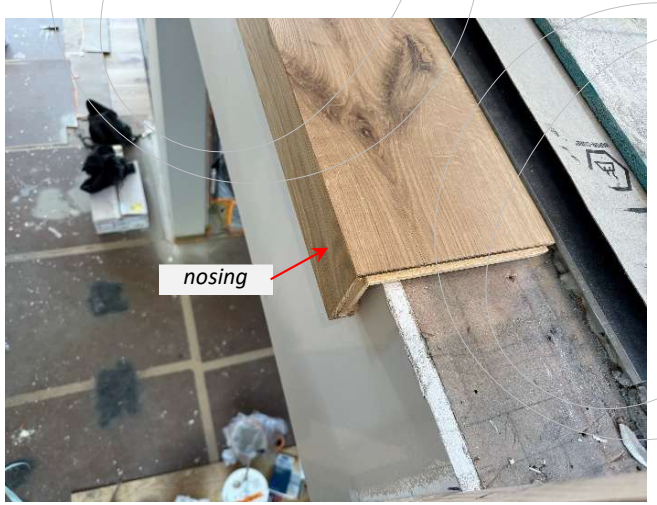


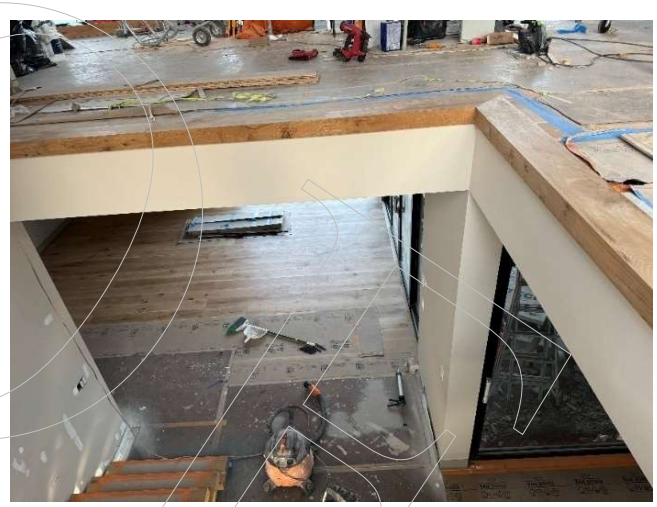
STAIR TREADS & NOSING

The landing and treads were delivered Apr 17, 2025. They are 4" thick. The company that did the wood floors used the same wood as the main and lower level floors to create the landing and treads. They were attached to the stringers using screws.

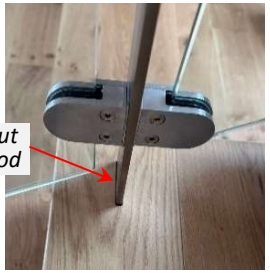


The edge of the floor around the stair well had a custom L-shaped piece of wood created to overlap the wall. This is called "nosing". It butted up against the foyer tiles.

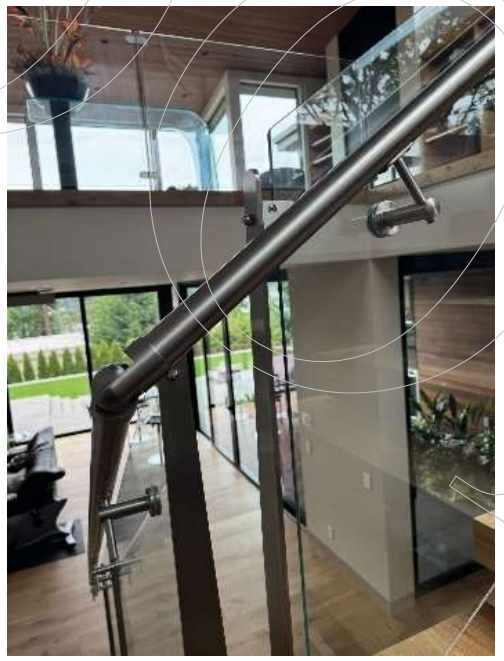




Slots were cut in the nosing to accommodate the posts holding the glass. In the stair treads that had posts, the upper surface of the tread was removed and slots were cut to accommodate the post.



After the treads were completed, the parallelogram-shaped glass on the steps was installed. Then the handrails were installed. The handrails are long stainless-steel cylinders that are connected to the glass as shown in the pictures.



FRONT CONCRETE WALLS MOCKUP

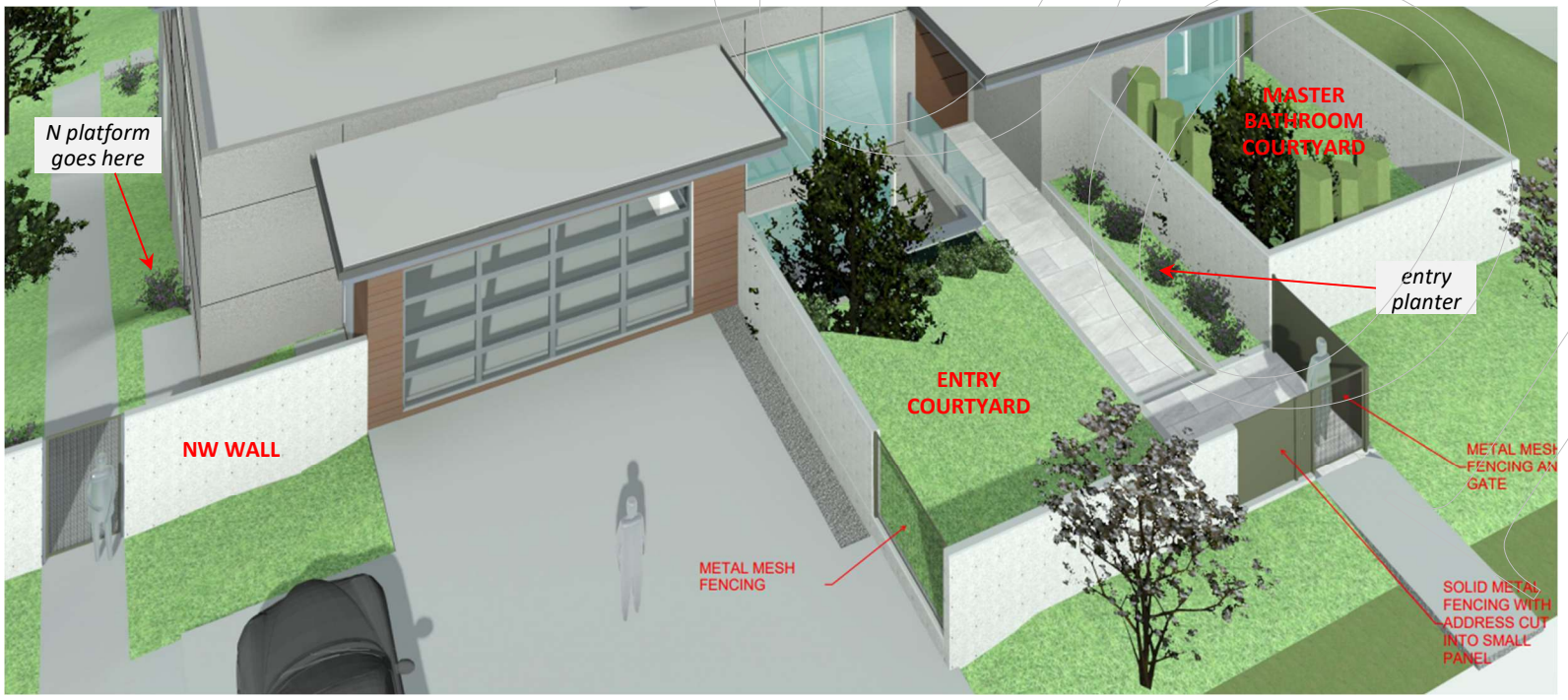
We needed to decide the height and location of the walls of the entry courtyard and Master Bathroom courtyard, taking into account the height and setback restrictions imposed by the City of Medina. To accomplish this, we asked the General Contractor to build plywood walls to simulate the concrete walls. Being able to actually visualize was very helpful.


Master Bathroom courtyard wall


Master Bathroom courtyard wall


entry courtyard wall

When we were content, we asked the architects to update the construction documents accordingly. They also produced the following rendering:



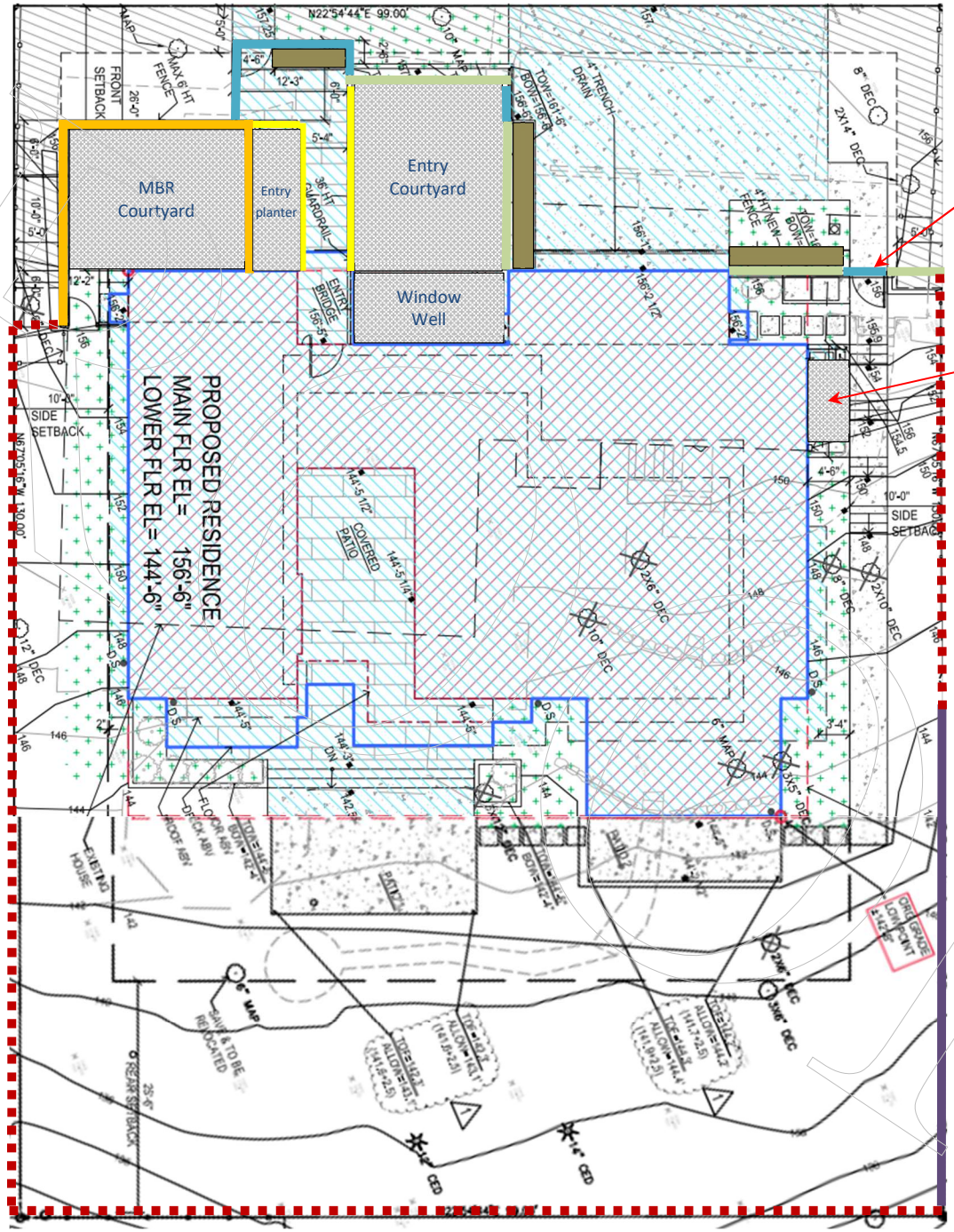
This rendering was later changed to incorporate steel planters on the NW wall and the garage side of the entry courtyard wall. The metal entry gate was also pushed out 2' 6" to accommodate a steel planter. Ultimately we decided to forego the metal fence and gate at the front entrance.

PERIMETER WALLS & FENCES PLAN

The objective was for the property to be completely “fenced in”. The only exterior entry to the rear of the property is a gate on the N side of the garage. The diagram shows the walls / fences planned. The metal fence and gate at the front entrance was later dropped.

LEGEND

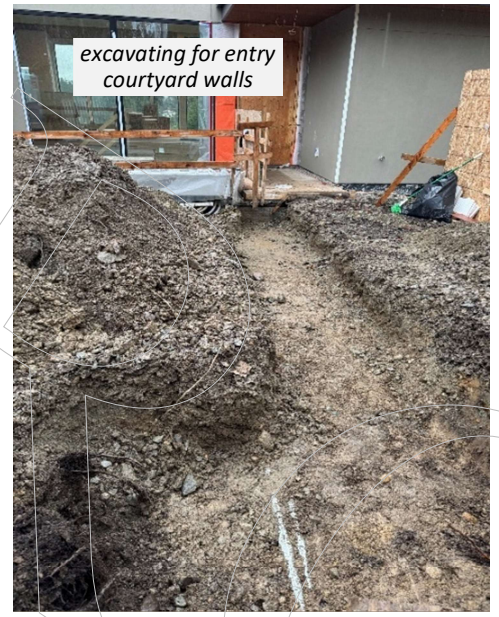
- 4’ 6” concrete wall
- 6’ concrete wall
- 4’ 6” chain link fence
- 4’ 6” metal fence/gate
- N neighbor steel fence
- 18” concrete wall
- steel planter



CONCRETE WALL CONSTRUCTION – N PLATFORM, NW WALL, ENTRY COURTYARD

Work began Dec 31, 2024 on the construction of the N side platform walls (for the heat pumps and Generac) and the 4' 6" NW and entry courtyard concrete walls. The first step was excavating for the footings. A frame was then built for the footings including horizontal rebar with vertical rebar projections.

excavating for N platform



excavating for entry courtyard walls

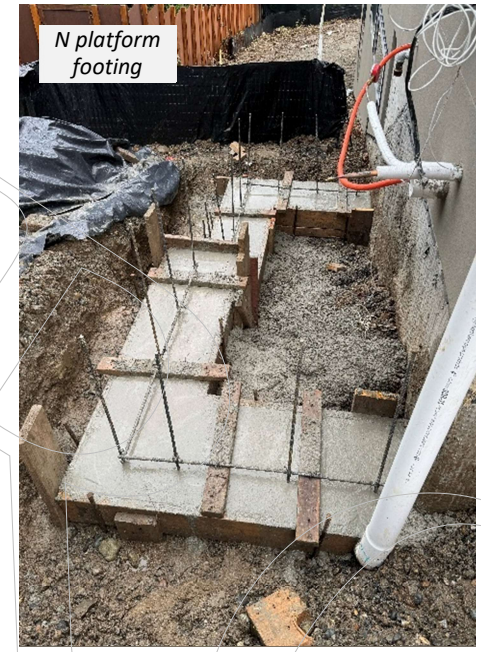
building footing frame for N platform

building footing frame for N wall

building footing frames for entry courtyard walls

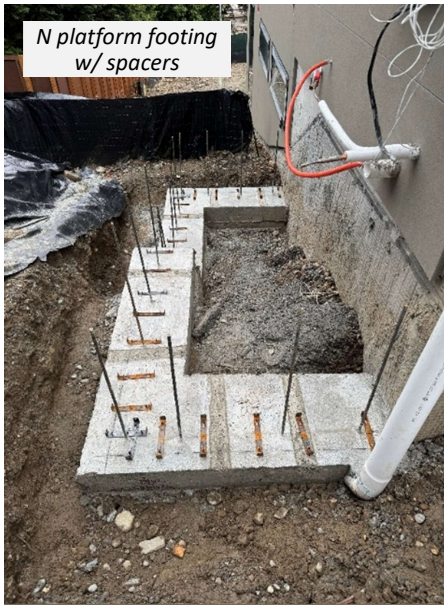
Concrete for the footings was poured on Jan 10, 2025.


NW wall footing


N platform footing


entry courtyard footings

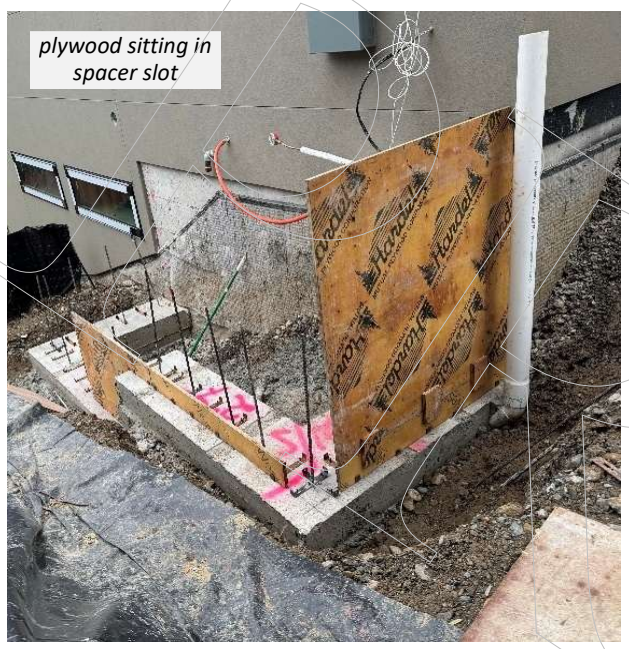
The next step was to put in spacers to hold the vertical boards to ensure the concrete wall is exactly 6” thick.

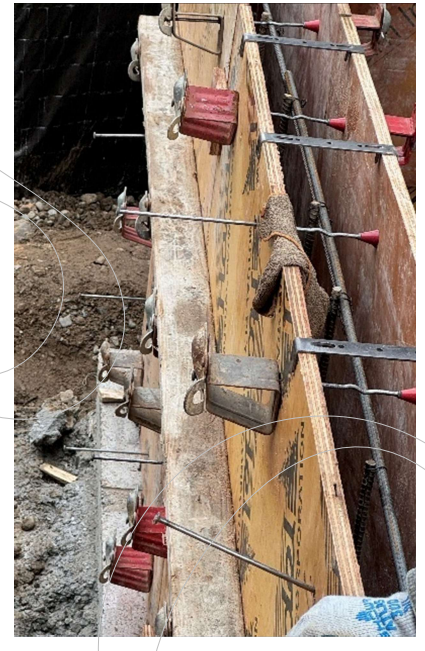

N platform footing w/ spacers

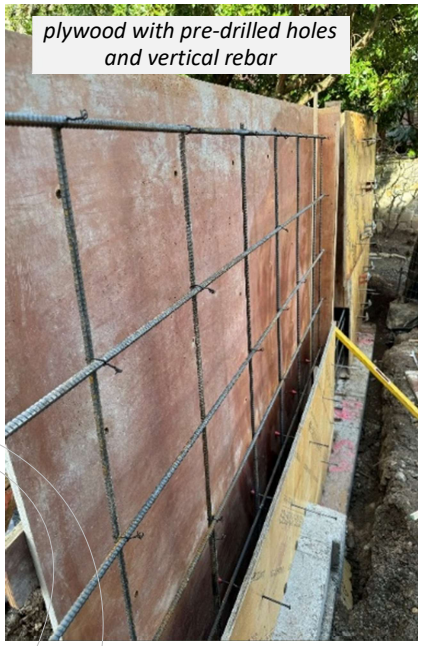

entry courtyard footings w/ spacers

In the picture of the entry courtyard footings, note that the W side wall is not continuous. There is a gap in the wall in order to avoid damaging the roots of a beautiful old tree outside the wall.

The walls are made using special smooth plywood boards. They are installed vertically and sit in the spacers. Spacers are also placed at the top of the plywood. Just like with the house foundation, the rebar projecting vertically from the footings is connected to create a vertical rebar mesh inside the plywood boards. In addition “cone snap ties” are used to connect the vertical boards. The plywood boards have pre-drilled holes for the cone snap ties.

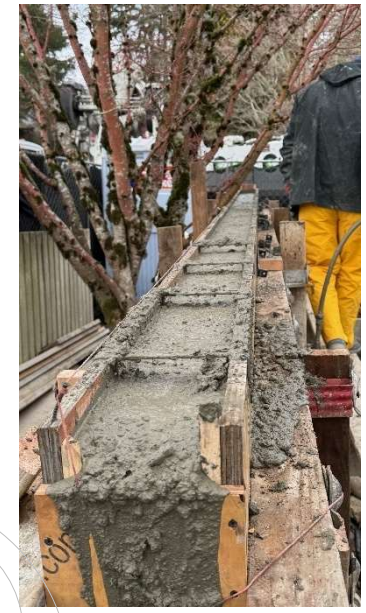

plywood sitting in spacer slot




plywood with pre-drilled holes and vertical rebar


cone snap tie

On Jan 30, 2025, concrete for the N platform, NW wall and entry courtyard walls was poured.



entry courtyard inner walls

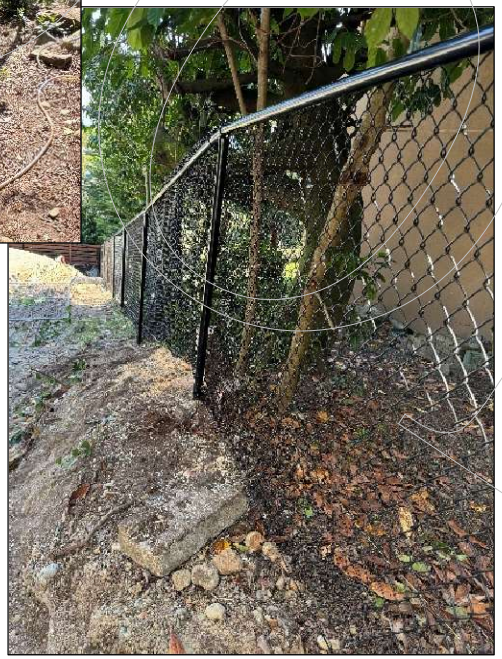
NW wall

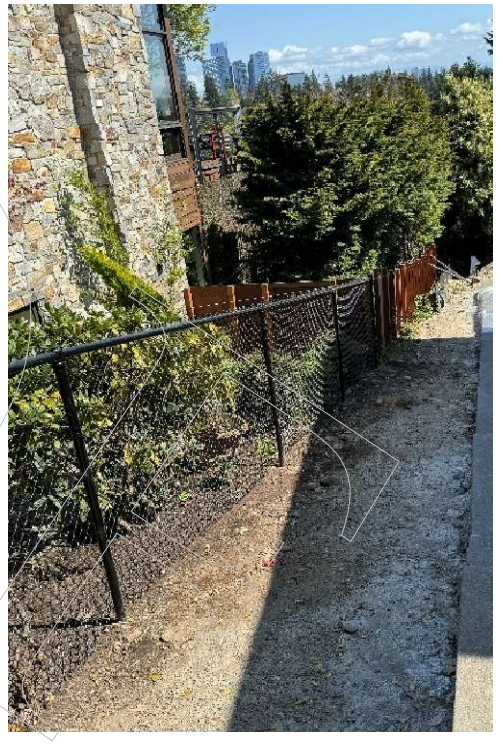
entry courtyard outer walls

N Platform

CHAIN LINK FENCE

A chain link fence was installed on the N, E and S property lines. Starting Apr 10, 2025, the fence line was marked with string. Holes were dug then concrete prepared to create a base for the vertical posts. The posts were connected via horizontal poles then the chain link was unrolled and fastened to the posts and poles.

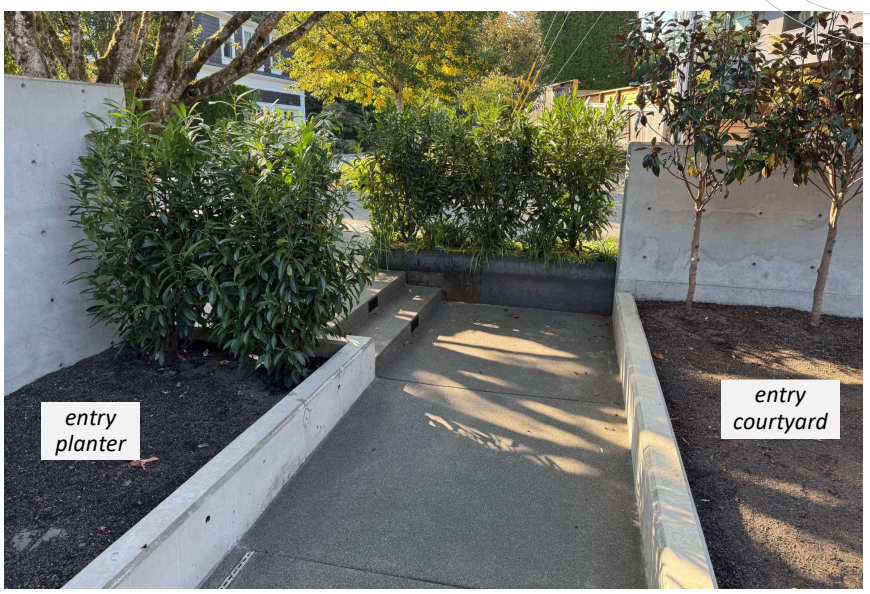




CONCRETE WALL CONSTRUCTION – MASTER BATHROOM COURTYARD, ENTRY PLANTER

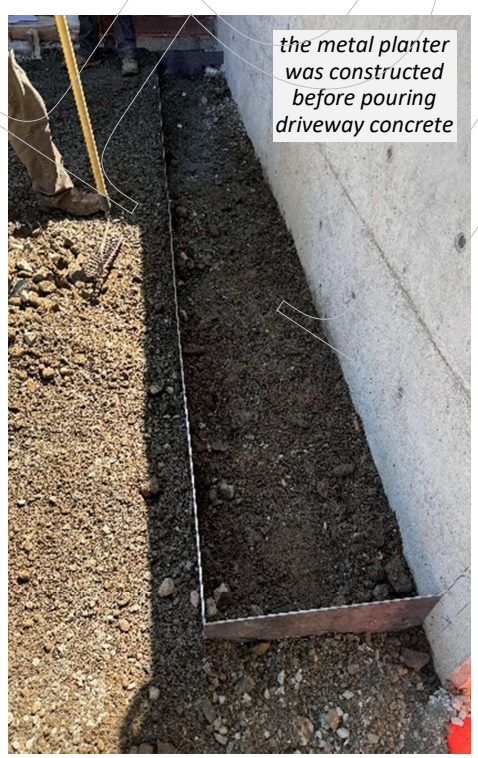
The Master Bathroom courtyard wall and the entry planter could not be constructed until the landscaping work at the back of the house was completed. Work on these concrete walls began Jul 9, 2025 and was completed by Jul 31. The process was the same as the NW and entry courtyard concrete walls so I will not repeat the description. Following the construction of the walls, some the excavated soil was used for backfill but most was removed and replaced with quality topsoil in anticipation of planting trees and shrubs.

We decided to forego the construction of a front metal fence and gate and instead use plants. A metal planter was built for a hedge which provided more privacy. A ⌙ shaped concrete walkway with 2 small steps was constructed running from the street to the entry bridge tile.



BAMBOO HEDGES

After the stacked heat pumps were installed on the N side of the house, we decided to add a 10’ high bamboo hedge in front of the NW concrete wall. We also decided to add a 10’ high bamboo hedge on the driveway side of the entry courtyard concrete wall. Bamboo is quite invasive which requires at least 18” depth to block its roots from spreading. Thin custom steel frames were cut then welded to create the metal planters.



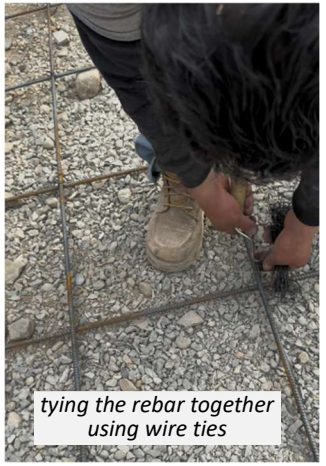
the metal planter was constructed before pouring driveway concrete

in front of NW wall

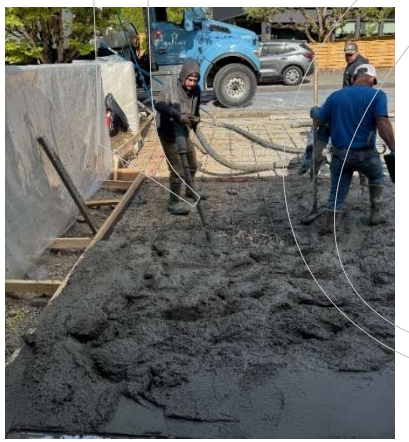
outside entry courtyard wall

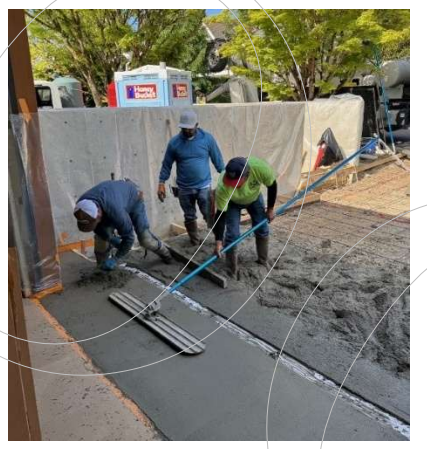
CONCRETE DRIVEWAY

Starting Apr 28, 2025, an excavator created an appropriate slope from Upland Rd to the trench drain constructed in front of the garage door. Gravel was distributed evenly over the area to receive concrete. Then rebar was installed. On May 8, concrete was poured. Similar to the back patio, the driveway was treated with Top-Cast then sealed.

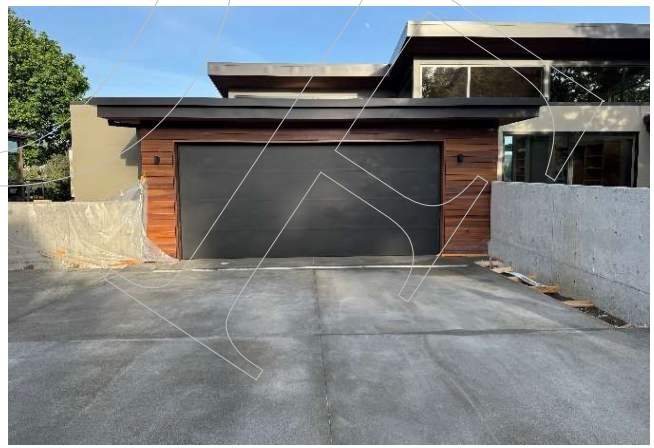


tying the rebar together using wire ties





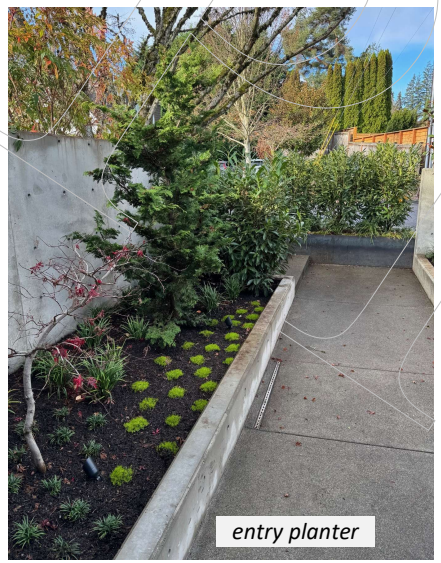
trench drain in front of garage door



ENTRY & MASTER BATHROOM COURTYARDS

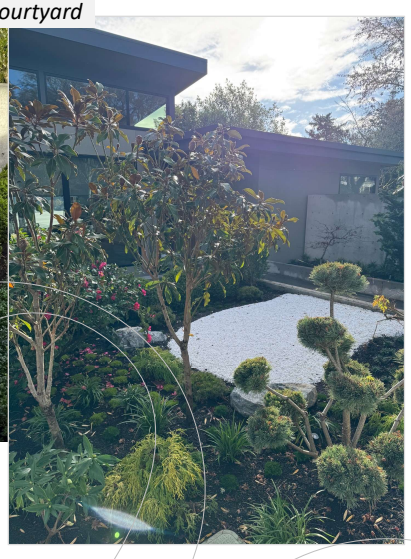
In preparation for planting trees and shrubs in the entry and master bathroom courtyards, the poor quality existing soil was removed and replaced with quality topsoil. Also, in lieu of a retaining wall, 3' boxwoods were planted in front of the waterfall.

Due to the large Foyer and Master Bathroom windows, privacy was an important landscaping consideration. With the help of the landscaper, we experimented with different evergreen tree varieties, sizes and locations until our privacy goals were achieved. The landscaper came up with attractive designs for both courtyards that included trees, shrubs, ground cover plants, Boston Ivy and white rocks that also addressed our low maintenance goal.



entry planter

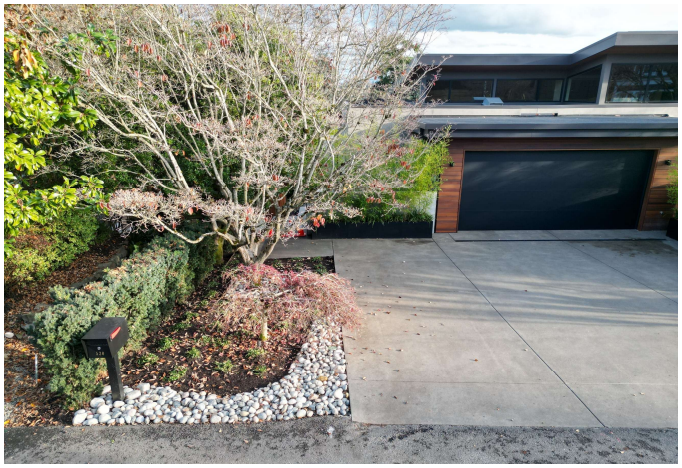
entry courtyard

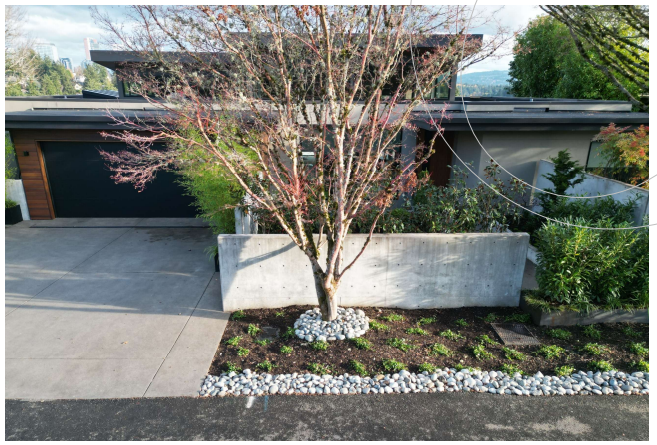


MBR courtyard

STREET SIDE LANDSCAPING

The street side of the entry and master bathroom courtyard walls, and the N side of the driveway also required landscaping. The landscaper's design included quality topsoil, ground cover plants, and river rocks that are attractive and low maintenance.



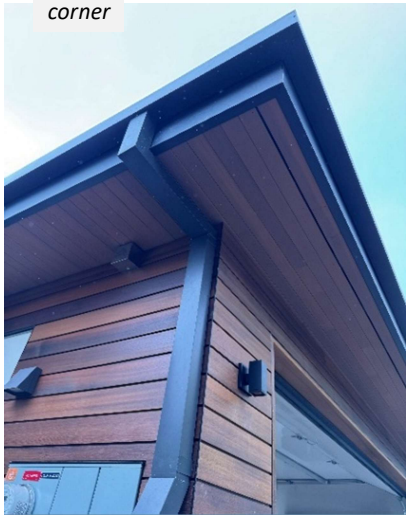


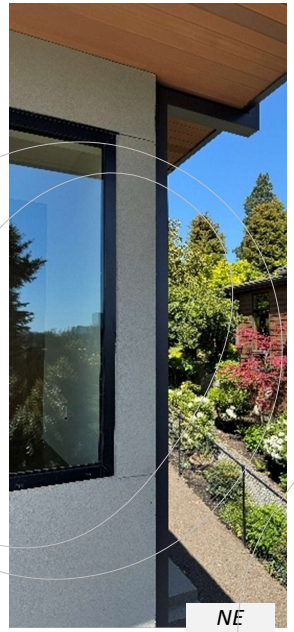
DOWNSPOUTS

The downspouts were installed by the roofer starting Apr 29, 2025. They were installed in 6 locations:

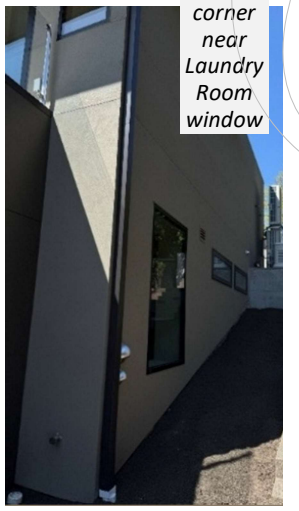
- NW corner
- NE corner near Laundry Room window
- E side near Family Room window
- E side under MBR balcony
- SE corner
- SW corner outside MBR

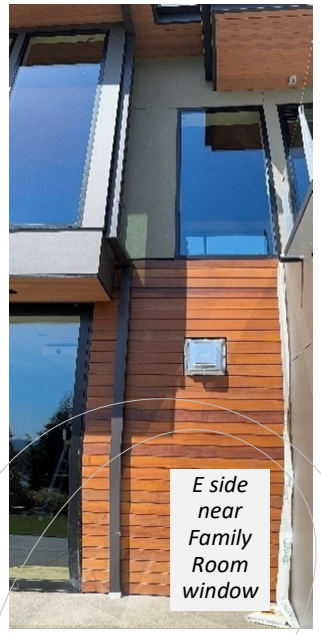
NW corner



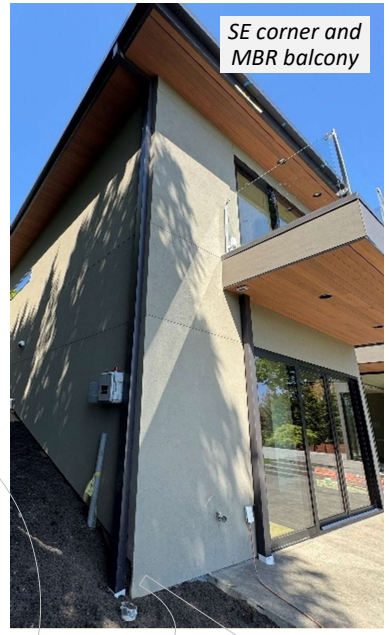


NE corner near Laundry Room window

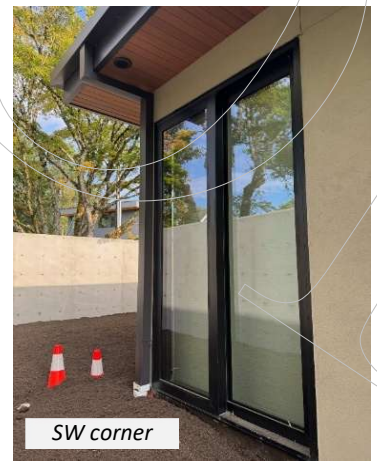




E side near Family Room window



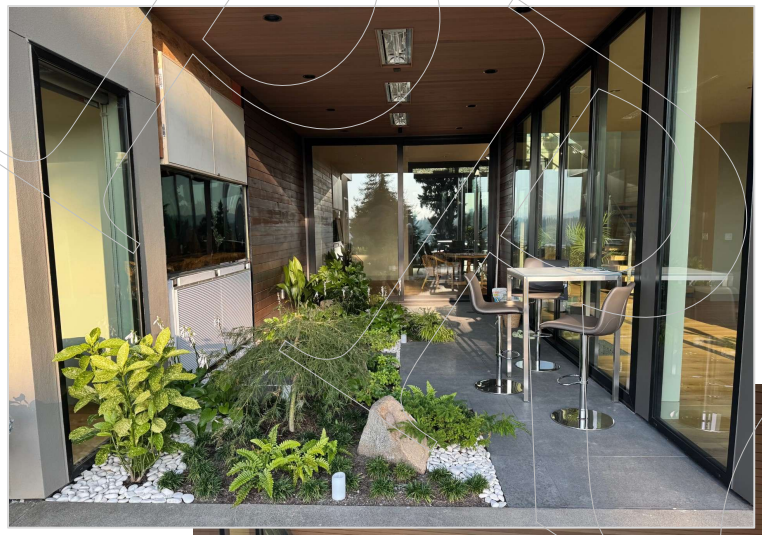
SE corner and MBR balcony

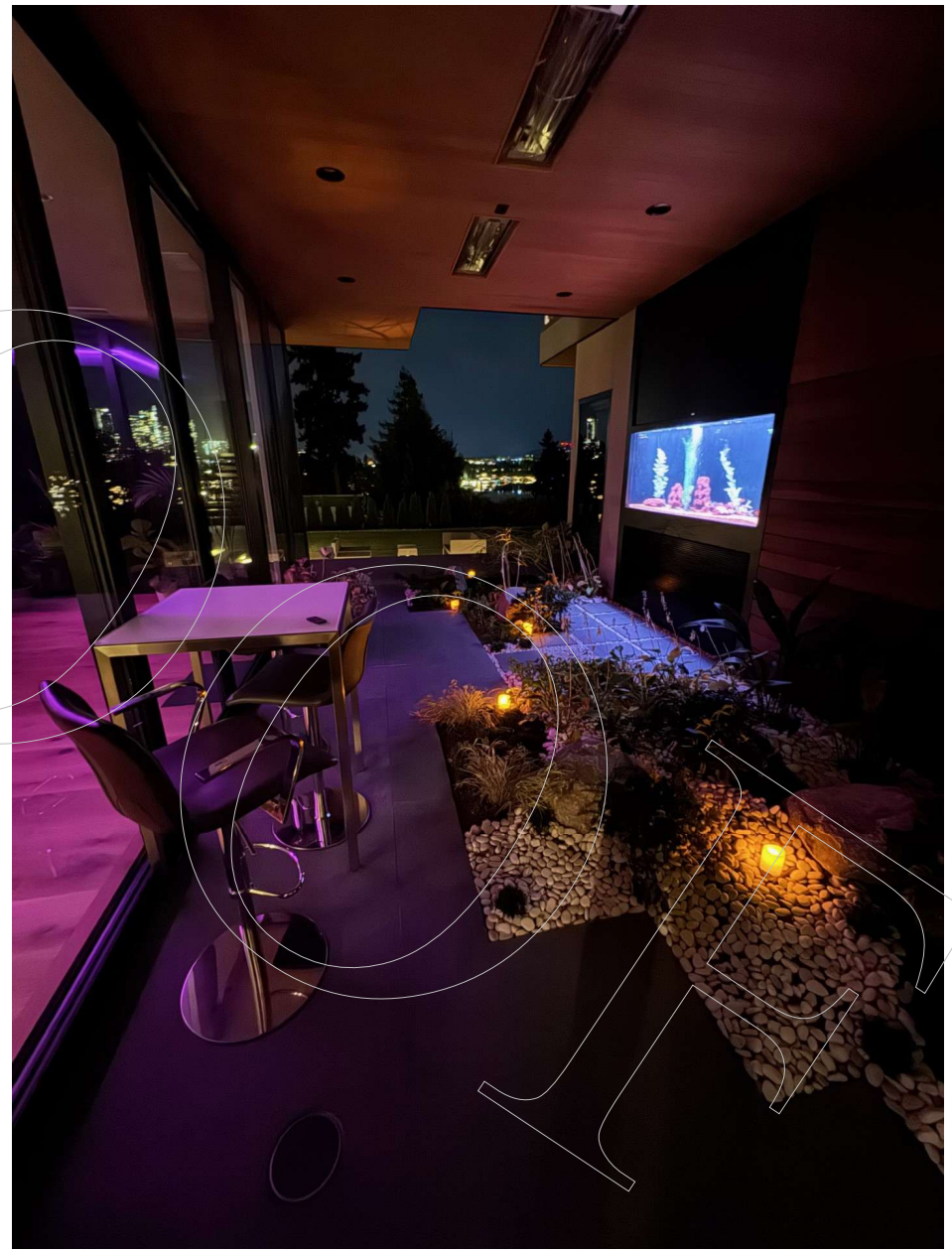


SW corner

ATRIUM

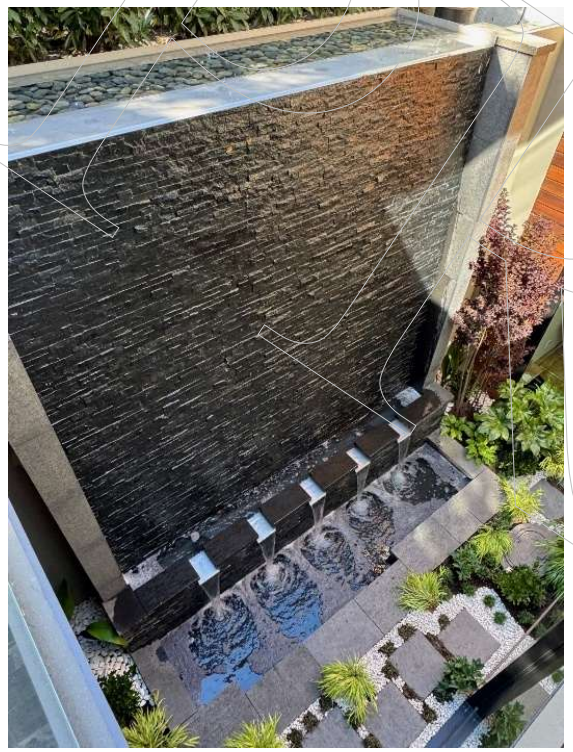
A design for the Atrium was created working with the landscaper that had soil, pavers, small trees, shrubs, ground cover, white stones and larger rocks. Irrigation for the Atrium was provided from the hose bib under the aquarium with a WiFi controlled valve. There are heat lamps in the ceiling that make it comfortable to sit outside any time of year. The aquarium has WiFi-controlled LED lighting. Battery-operated candles (controlled by a remote) were used to produce a very pleasant effect.

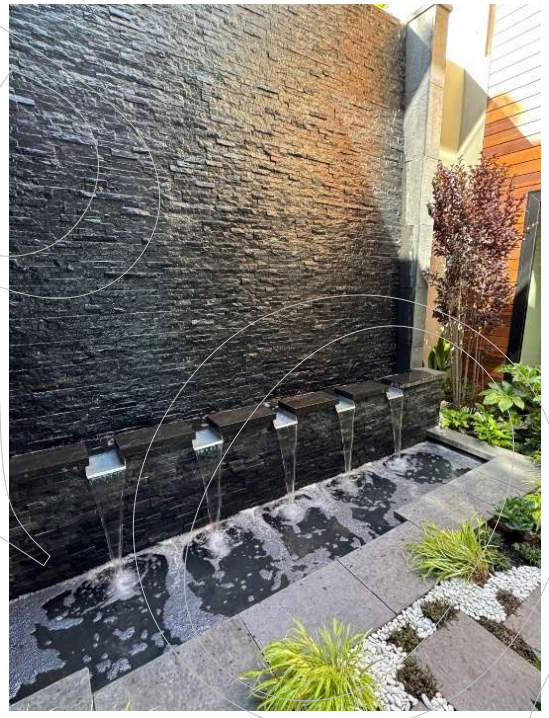


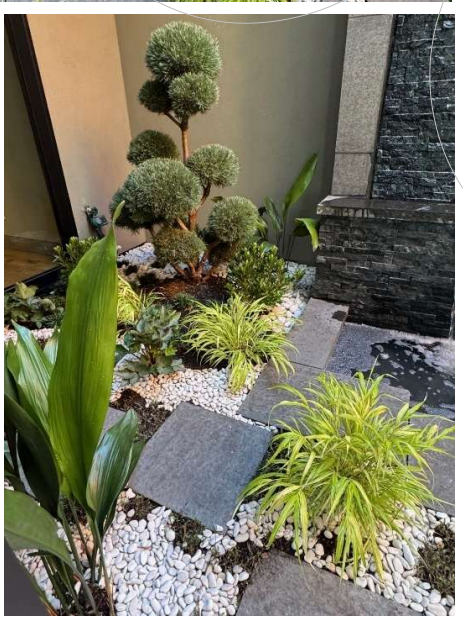


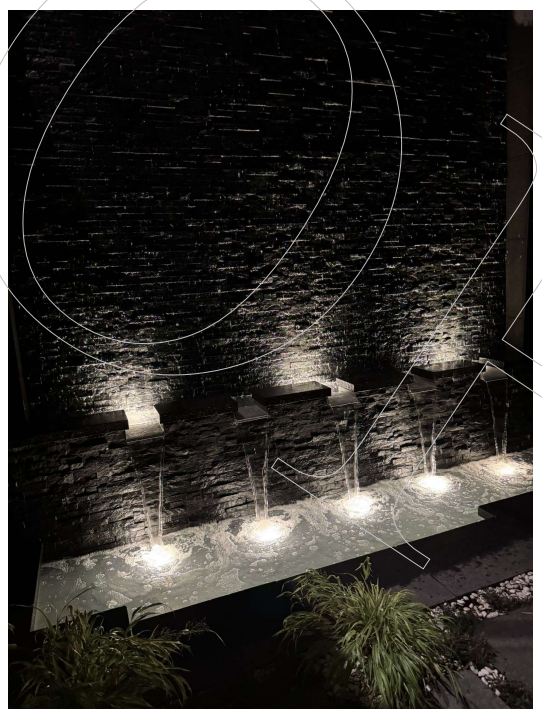
WINDOW WELL

A design for the Window Well was created working with the landscaper that had soil, pavers, 2 trees, shrubs, ground cover and white stones. Irrigation for the plants was provided by the hose bib in the Window Well with a WiFi controlled valve. 5 submersible lights were installed in the lower reservoir under the scuppers and 3 in the intermediate reservoir pointing up the wall.









LANDSCAPE LIGHTING

Landscape lights were installed in the following locations:

- at the front under 4 trees
- in the 2 front steps
- in the entry courtyard and entry planter
- in the master mathroom courtyard
- in the N steps
- in the back steps

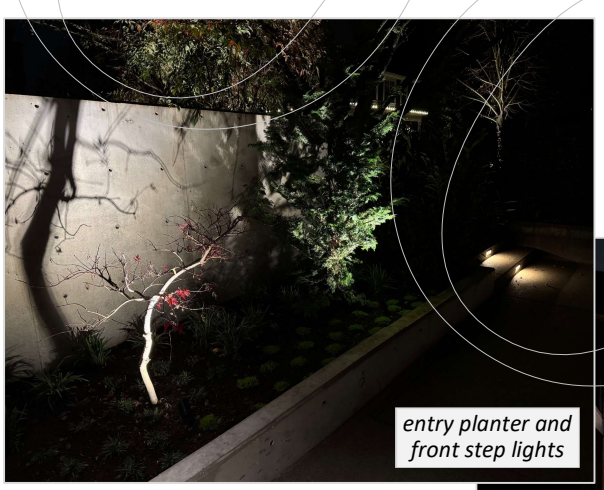
The lights at the front and back are 24 V connected to transformers at the SW and NE corners of the house. The transformers are connected to smart switches in the garage that operate on a daily schedule controlled from a smartphone app. The front / back lights are set to turn on at sunset and turn off at sunrise / 11 pm respectively.

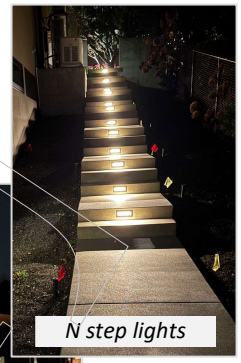

street view looking SE


street view looking NE


entry courtyard


MBR courtyard

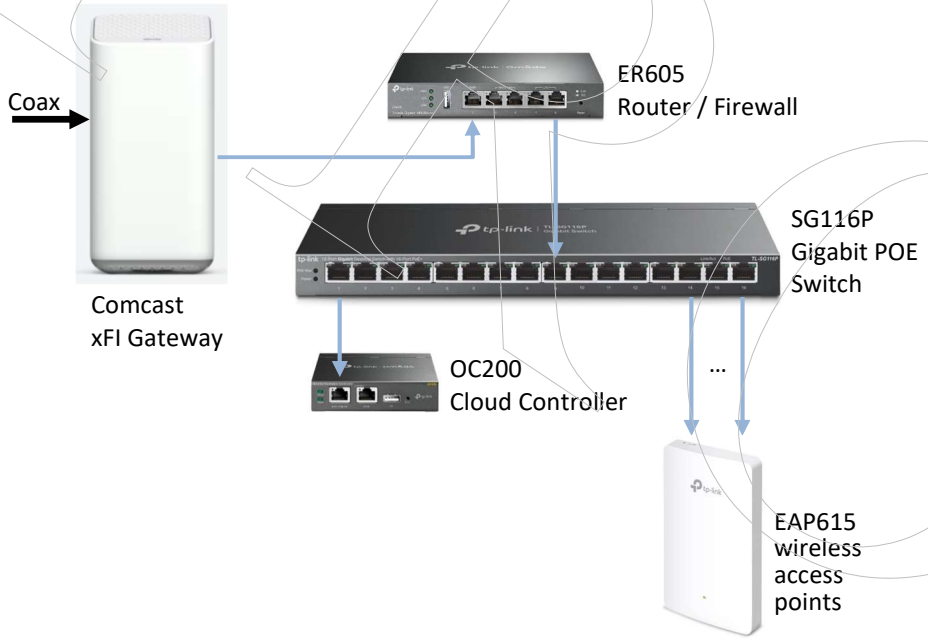

entry planter and front step lights


N step lights


back step lights

NETWORK

Coax from the street connects to a coax cable under the electrical meter at the NW corner of the house which is fed to the Comcast gateway box (aka cable modem) in the Storage Room. The gateway box has 4 network ports. Its high speed port is connected to the WAN port of a router/firewall, and the LAN port of the router/firewall is connected to a Power-Over-Ethernet (POE) switch. Several of the RJ45 outlets throughout the house (labelled on the patch panel) were connected to the POE switch using patch cables. Wireless Access Point devices were plugged into 2 RJ45 outlets on each level. This was sufficient to provide a strong WiFi signal throughout the house. The cloud controller was used to facilitate using the same network name (ie, SSID) throughout the house. The network gear used was TP-Link Omada. The configuration used is shown in the figure. In general, the intention is to only use WiFi ie, no ethernet cables.



Beside desktop computers, laptops, iphones and ipads, the WiFi network was also used to monitor and control the following devices:

- smart lock
- garage door
- HVAC system
- surveillance cameras
- irrigation systems
- alarm system
- motorized shades
- lights and floor lamps
- solar panels
- Generac
- Moen flow smart water usage monitoring

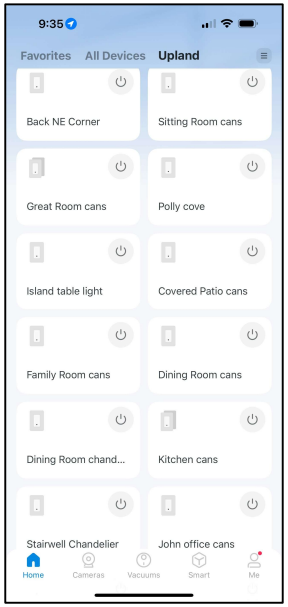
The Omada smartphone app was used to monitor the POE network.

SMART LIGHTS

Many of the light switches in the house are TP-Link WiFi-controllable smart switches. Smart plugs are also used for floor lamps. Smart LED strips are used above the Great Room shelves, above the Kitchen N wall cupboards, in the Family Room structure, and above the aquarium. Many of these lights turn and off on a daily schedule. Others are controlled from the TP-Link Tapo app or using Alexa. There are also smart switches in the Master Bathroom and Garage that turn on when motion is detected and also by the time-of-day.

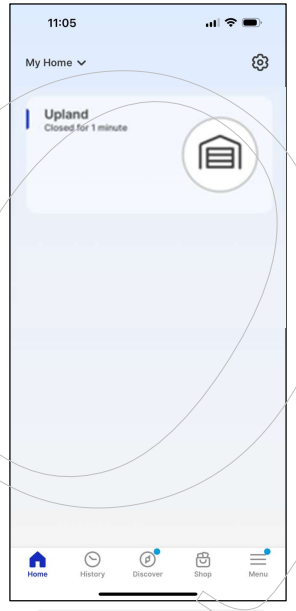
GARAGE DOOR

A LiftMaster Wall Mount WiFi-controllable garage door opener was installed. The MyQ smartphone app is used to monitor and control the garage door. It provides notification every time the garage door is opened or closed. It also maintains a history.

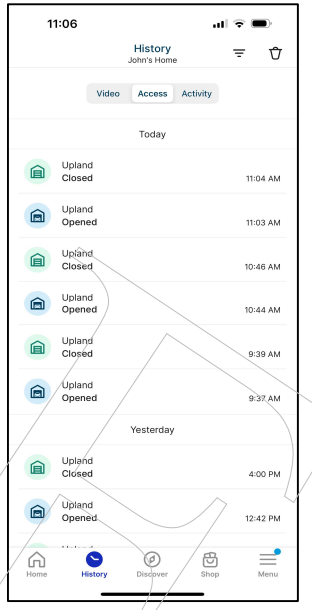


Tapo app

LiftMaster



garage door status



garage door history

SECURITY SYSTEM

The security system monitors unauthorized entry to the house including door openings and glass breaks. It also monitors the Honeywell System Sensor dual CO / smoke detectors located throughout the house. The security system is connected to a monitoring service for 24x7 protection. We used the following security system equipment (installed by the low voltage subcontractor):

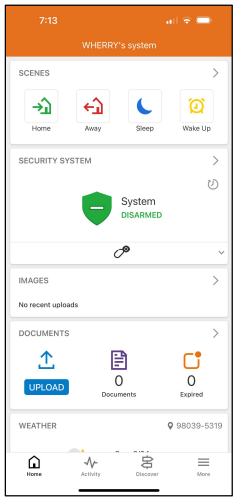
- DSC Qolsys
  - located with the low voltage equipment in the storage room
  - monitors sensors for door openings, glass breaks
  - monitors CO / smoke detectors

- IQ Panel 4 from Johnson Controls
  - touchscreen located in mud room, used to enable / disable security system
  - connected to DSC Qolsys

- DSC keypad
  - keypad located at the Master Bedroom suite entry, used to enable / disable security system
  - connected to DSC Qolsys

- smartphone app
  - use the Alarm.com to arm / disarm and monitor the security system remotely

IQ Panel 4



Alarm.com app


DSC keypad

SMART LOCKS

The main access to the house is from the garage. We installed a TP-Link Tapo DL110 smart lock with the following features:

- lock using fingerprint, smartphone app, Alexa, keypad, key
- unlock using fingerprint, smartphone app, Alexa, keypad, key
- doorbell (rings locally and on smartphone)
- supports Bluetooth for when no WiFi connectivity

Tapo DL110

SURVEILLANCE

Cameras were installed outside in discreet locations for real time smartphone viewing and notification when motion detected.

- 3 Blink cameras at front to monitor N gate and garage, main entrance and S wall
- 3 Blink cameras at back to monitor N view, S view and Atrium
- 3 Blink cameras at front to monitor the street
- video clips are saved to a microSD card installed in the Blink sync modules

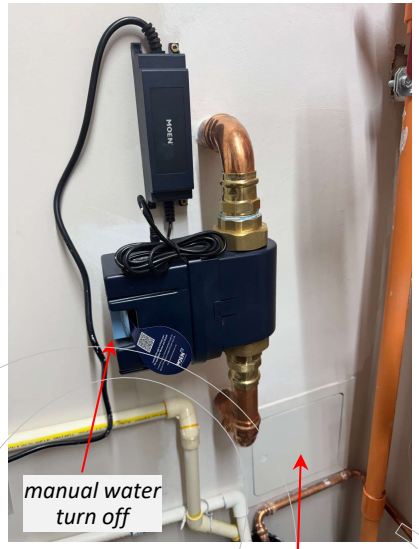
A Tapo Magcam was also installed in the garage for real time smartphone viewing.

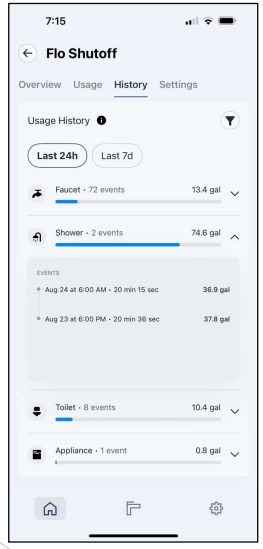
Amazon Blink camera

TP-Link Tapo Magcam

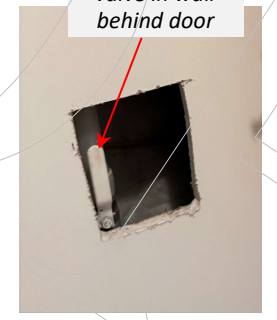
WATER USAGE MONITORING

The Moen Flo Smart monitoring product was installed after the main shutoff valve. It communicates with the Moen smartphone app via WiFi. The Moen app provides a max flow recommendation that the user can modify as desired. If the max flow is exceeded, a notification is sent to the smartphone app and the user can decide whether to turn off the water. Optionally, the water can be turned off automatically. The Moen product maintains a history of water usage and can be used to monitor usage by faucets, toilets, showers, appliances, irrigation system, etc.





Moen app



MOTORIZED SHADES

Although low voltage wires were run to every window that might require shades, we ended up opting for battery operated motorized shades as a more cost-effective solution. We expect the shades to last 1-2 years before they need to be recharged using a long USB-C cable. The shades are controlled using a remote. They can also be controlled using a smartphone app. A schedule can be created for daily opening and closing.

IRRIGATION SYSTEMS

3 irrigation systems were installed: exterior, Atrium, window well

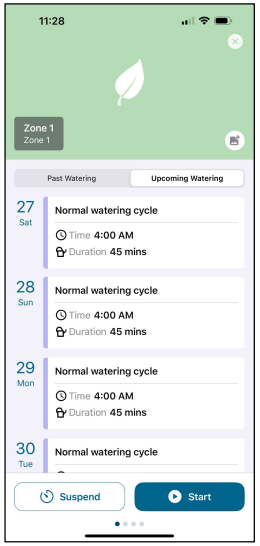
- Exterior: Hunter HCC irrigation controller
  - located near SW corner of the house
  - used for: pyramidalis hedge, bamboo planters, entry courtyard, MBR courtyard
  - controls water flow to drip lines and pop up spray heads
  - includes WV-OM wireless valve output module
    (used to control wireless valves in the Atrium and Window Well)
  - use Hydrawise app to set up, control and monitor

- Atrium: Hunter WVL-100 wireless valve
  - located under the aquarium connected to the hose bib
  - controlled by Hunter HCC
  - used for the Atrium plants
  - controls water flow to drip lines

- Window Well: Hunter WVL-100 wireless valve
  - located under the entry bridge connected to the hose bib
  - controlled by Hunter HCC
  - used for the Window Well plant
  - controls water flow to drip lines

All 3 irrigation controllers are WiFi-controllable using the Hydrawise smartphone app:
  - define zones, set schedule and duration
  - can manually turn on/off zones
  - monitors weather, automatically delay if rain
  - retains watering history

irrigation controller



Hydrawise app

WV-OM


WVL-100 wireless valve


pop-up spray head


drip line

MACERATING PUMP

- Liberty pump controller
  - mounted on the W wall of the Mechanical Room
  - controls pump operation and monitors waste water level
  - alarm light on top (call plumber)

macerating pump controller

CATCH BASIN PUMPS

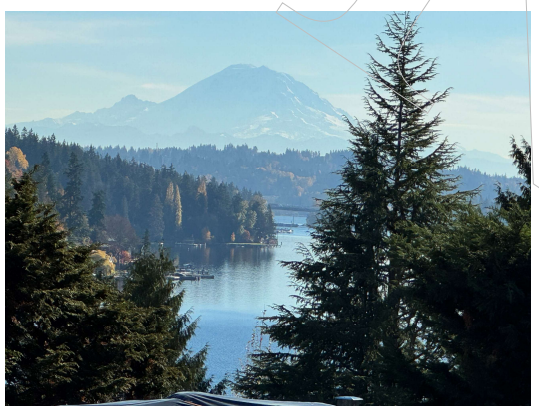
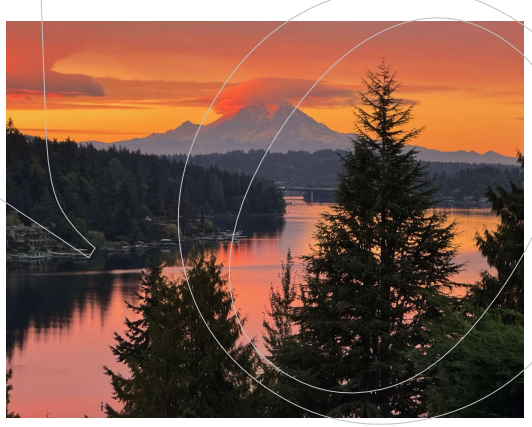
- control panel mounted on S wall near E corner, gets power from house
- controls operation of both pumps and monitors catch basin water level
- alarm light on top (call plumber)

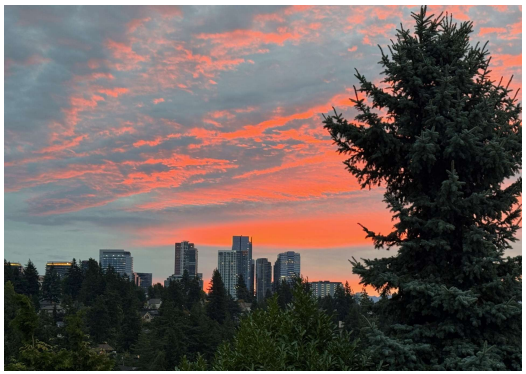
catch basin pumps controller

FEATURES & AMENITIES

Here is a description of the final house that might be used in a real estate listing:





Area & Lot

Living Space: 5,439 Sq. Ft.
Lot Size: 0.35 Acres
View Description: mountain, city, lake
1 mile from downtown Bellevue / Bellevue Square

Interior

Bedrooms: 3 with ensuite bathroom and walk-in closets
lower level Office and the Laundry Room have closets (could be bedrooms)
Bathrooms: 2 full (toilet, sink, shower/tub), 2 ¾ (toilet, sink, shower),
1 ½ (toilet, sink)
Flooring: hardwood floors except ceramic tile in bathrooms and laundry
Fireplaces: 3
Appliances: dishwasher, 2 washers, 2 dryers, food waste disposer,
4 refrigerators, rangetop, range hood with high power remote blower,
2 ovens, instant hot/cold filtered water
Heating: heat pump (electric)
Cooling: heat pump (electric)
Water Heater Type: gas
Main level rooms: Foyer, Great Room, Kitchen, Dining Room, Office,
Mud Room, walk-in pantry, Pantry, Master Suite, Powder Room, Garage
Lower level rooms: Family Room, 2 Bedrooms, Sitting Area, Play Room with
attached Bathroom, Laundry Room, Office
Skylights: Kitchen, Master Bedroom closet, Master Bathroom
Elevator
Cat6 ethernet / WiFi throughout house
Security system

Exterior

Waterfall and entry window well
Atrium on lower level
entry courtyard
Master Bathroom courtyard
Roof: metal and torch down
Walls: stucco, wood, metal fascia
Solar panels
Generac
Irrigation system

CONCLUDING REMARKS

We consider that our project was a total success. We are very happy with the final results and the project was completed within the budget we were given. We moved in about 2 months later than was originally planned which was not an issue for us since this gave us more time to plan and prepare.

There are many decisions required in building a custom house. This includes:

- appliances, fixtures, lights
- wood used for cabinets and flooring
- tiles used for interior floors and walls
- slabs used of counters and islands
- paint colours for every room
- landscaping

We didn't hire an interior designer to help us with these decisions since we didn't think it would help us much. We know what we like and have developed strong opinions from our previous (renovation) projects and from seeing many real estate listings. However, we are probably the exception. It is worth hiring an interior designer if you want help making decisions, don't have the time available, and don't want the aggravation of having to spend a lot of time evaluating options.

Landscaping will involve a landscape architect and landscaper. In our case, the architect (Baylis) came up with an initial design. We hired a landscape architect (KLLA) to help us come up with a detailed design for the back. We hired a landscaper (Folia) to implement the artificial turf and soil remediation at the back. They also helped us design and implement the Atrium, window well and front landscaping which included irrigation and landscape lights.

Recommendations:

- Choose the right architect – one who listens to and addresses their client's requirements.
- Choose a reliable General Contractor. Insist on speaking to the owners of that last few houses they've built and ask for their comments and recommendations.
- Insist that the General Contractor produce a project schedule up front with the major tasks and individual budgets.
- Pay attention to how responsive your General Contractor is. The best way to communicate (beside in-person) is to be able to phone and have your call answered or returned shortly if you leave a voice message. If the General Contractor isn't responsive at the onset, expect this treatment throughout the project from the General Contractor and from the subcontractors.
- Monitor the budgets. Our architect recommended signing a contract with the General Contractor based on the American Institute of Architects A102 Agreement between Owner and Contractor. In this agreement, the owner pays the architect to visit the site regularly and to monitor the General Contractor's monthly invoices to ensure work billed has been completed. In our case, we were sufficiently confident in our ability to monitor the project progress to forego this expense. We don't regret our decision, however, in general, we would recommend engaging the architect to do this monitoring.
- The invoice received from the General Contractor every month will include the invoices from all the subcontractors working on the projects as well as time sheets for labour by the General Contractor's employees. The General Contractor should tie the subcontractor invoices and their employee labour back to the project task in the budget so that this can be accurately monitored.
- Owners should visit the build site regularly to observe progress and ask questions. You should enjoy the learning experience, both from talking to the workers as well as from online research to better understand the build process. Monitoring the build site regularly provides the opportunity to change things you don't like that would be expensive or difficult to change later.
- We weren't sure about some aspects of the architect's design eg, island size, dining room table location, front concrete wall sizes and locations, etc. So we asked the General Contractor to mock it up with plywood. This was inexpensive and easy to implement. It helped us visualize things. This resulted in our getting things exactly the way we wanted.

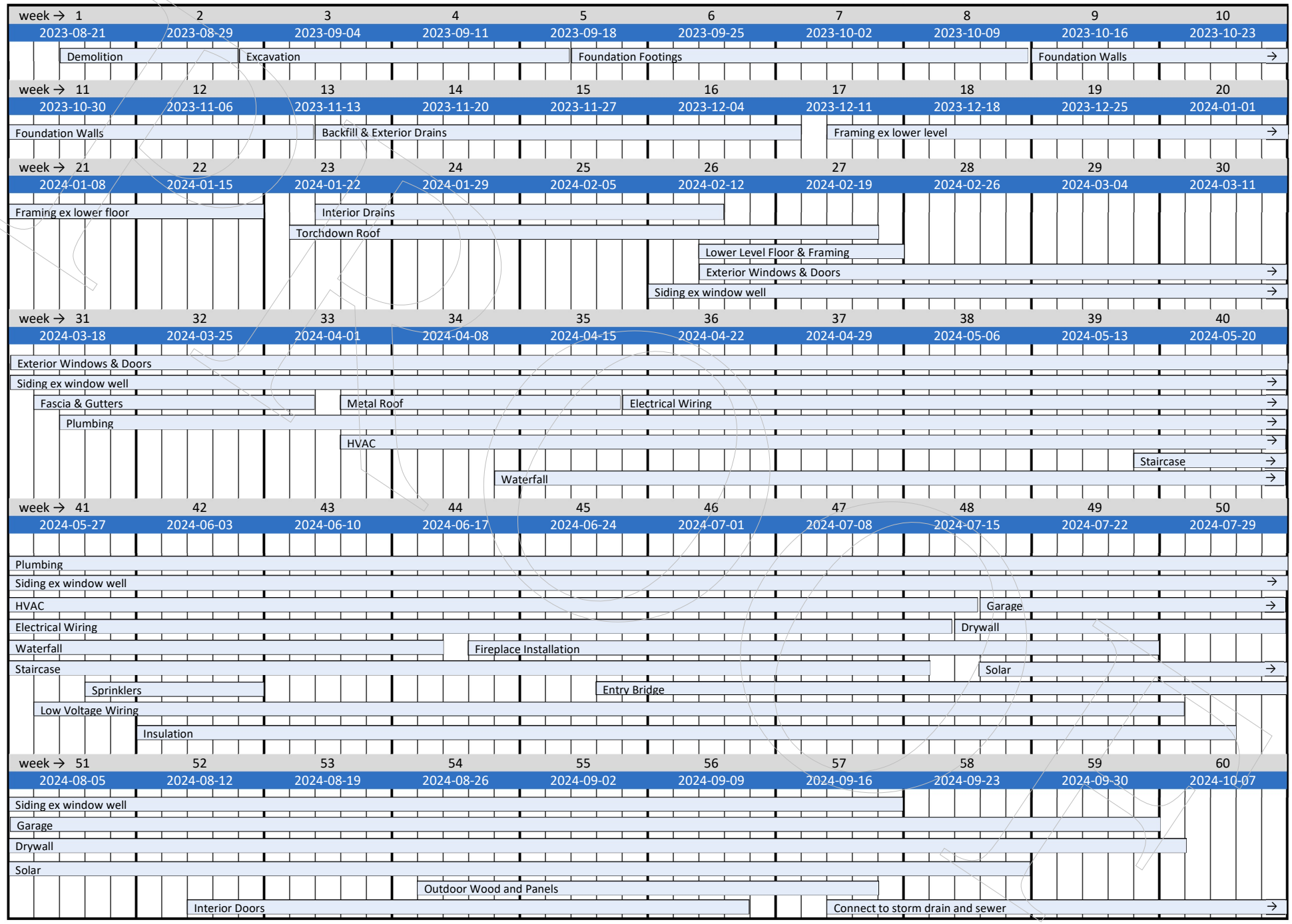
APPENDIX A — PROJECT TIMELINE

The following table shows the date when each major activity was started and when it was substantially completed.

Major Activity	Start Date	End Date	Comments
Demolition	Aug 23, 2023	Aug 31, 2023	
Excavation	Sep 1, 2023	Sep 19, 2023	
Foundation Footings	Sep 20, 2023	Oct 13, 2023	
Foundation Walls	Oct 16, 2023	Nov 14, 2023	
Backfill & Exterior Drains	Nov 15, 2023	Dec 11, 2023	
Framing ex lower floor	Dec 13, 2023	Jan 19, 2024	
Interior Drains	Jan 24, 2024	Feb 14, 2024	
Torchdown Roof	Jan 23, 2024	Feb 22, 2024	
Lower Level Floor & Framing	Feb 14, 2024	Feb 23, 2024	
Fascia & Gutters	Mar 19, 2024	Apr 2, 2024	
Metal Roof	Apr 4, 2024	Apr 18, 2024	
Plumbing	Mar 20, 2024	Aug 2, 2024	drains, supply lines, hose bibs, link seals
Exterior Windows & Doors	Feb 14, 2024	May 24, 2024	
Siding ex window well	Feb 12, 2024	Sep 20, 2024	had to wait for Pivot Door install to finish front stucco
Heating, Ventilation & Air Conditioning (HVAC)	Apr 4, 2024	Jul 17, 2024	air handlers, ductwork, refrigerant lines, gas lines
Electrical Wiring	Apr 19, 2024	Jul 16, 2024	outlets, switches, can lights, fans, meter box, transfer switches, breaker panels, circuits, homeruns
Sprinklers	May 30, 2024	Jun 7, 2024	
Low Voltage Wiring	May 28, 2024	Jul 29, 2024	coaxial cables, Cat 6 ethernet, security system wiring, motorized shades wiring
Waterfall	Apr 12, 2024	Jun 18, 2024	demonstrated operation then turned off / covered till Jun 10, 2025
Fireplace Installation	Jun 20, 2024	Jul 26, 2024	3 fireplaces
Staircase	May 17, 2024	Jul 15, 2024	
Entry Bridge	Jun 27, 2024	Aug 2, 2024	
Insulation	Jun 3, 2024	Jul 31, 2024	
Garage	Jul 18, 2024	Oct 4, 2024	concrete floor and drywall only; painting, furniture, garage door, epoxy floor came later
Exterior Wood and Panels	Aug 27, 2024	Sep 19, 2024	had to wait for front stucco to finish
Connecting storm drain and sewer	Sep 18, 2024	Oct 24, 2024	
Connecting to electrical utility	Oct 14, 2024	Oct 15, 2024	
Connecting to cable provider	Oct 24, 2024	Oct 31, 2024	
Connecting to water utility	Nov 21, 2024	Nov 26, 2024	
Drywall	Jul 17, 2024	Oct 7, 2024	hanging, taping, mud, sanding, spraying
Interior Doors	Aug 14, 2024	Sep 12, 2024	installing frames and pocket doors
Wood Ceiling	Oct 28, 2024	Nov 12, 2024	
Wood Floor	Oct 28, 2024	Dec 31, 2024	wood floors only, stair treads and nosing came later
Elevator	Oct 21, 2024	May 12, 2025	depended on drywallers doing walls and ceiling, cabinet maker providing the wood walls and tile-setters installing the floor tiles of the elevator car
Solar	Jul 18, 2024	Sep 27, 2024	had to wait till Dec 2 for utility to inspect and connect net meter

Activity	Start Date	End Date	Comments
Tiles	Oct 30, 2024	Apr 28, 2025	5 bathrooms, Laundry Room floor and back splash, Playroom backsplash, Foyer and entry bridge
Cabinets & Closets	Dec 17, 2024	May 8, 2025	the custom Russell cabinets were installed over 5 months California Closets (3 closets) were installed on Feb 27, 2025
Concrete walls: NW wall and entry courtyard	Dec 31, 2024	Feb 10, 2025	
Floor Trim	Jan 22, 2025	Jan 30, 2025	
Pivot Door	Feb 13, 2025	Feb 14, 2025	
Slabs	Feb 17, 2025	Mar 10, 2025	
Painting	Jan 27, 2025	Apr 24, 2025	indoor doors, wood trim, ceiling/walls, staircase and outdoor Hardie panels
Railings	Mar 4, 2025	Apr 24, 2025	deck, balcony, staircase and entry bridge
Door Hanging	Mar 3, 2025	Apr 29, 2025	hanging doors and installing locks including pocket doors
Powder Room	Mar 3, 2025	May 15, 2025	ramp sink, electric faucet, mirror
Fireplace Trim	Mar 7, 2025	May 21, 2025	Great Room: steel and mitred tiles MBR: Hardie panels with reveals Family Room: Hardie panels
Trim Out	Apr 10, 2025	May 2, 2025	electrical, HVAC and plumbing fixtures
Aquarium	Mar 3, 2025	May 9, 2025	mounted tank on steel platform, installed equipment, prep for fish
Back Landscaping	Feb 24, 2025	Apr 30, 2025	includes excavating / earth movement, French drain, concrete for N walkway and patio with steps, new soil, artificial turf
Siding - Window Well	Mar 25, 2025	Apr 9, 2024	used same stucco process
Stair Treads & Nosing	Apr 18, 2025	Jul 15, 2025	the railings installation was delayed till after we moved in due to a missing piece
Downspouts	Apr 28, 2025	May 1, 2025	
Connecting to gas utility	Feb 3, 2025	Feb 27, 2025	trench was dug and conduit laid; waited till Ap 28 for PSE to connect gas meter
Front Landscaping	May 1, 2025	> Jul 16, 2025	bamboo hedges, concrete driveway, entry planter, entry courtyard, master bathroom courtyard, street side landscaping
Systems	May 1, 2025	May 26, 2025	set up security system, POE network, smart locks, smart lights/switches, etc. install and configure smartphone apps to control devices
Concrete wall: MBR courtyard	Jul 9, 2025	Jul 31, 2025	includes backfill
Atrium and Window Well Landscaping	Jul 21, 2025	Jul 25, 2025	

The next pages show the project timeline as a Gantt chart. The completion of the remaining landscaping tasks post week 100 has been omitted.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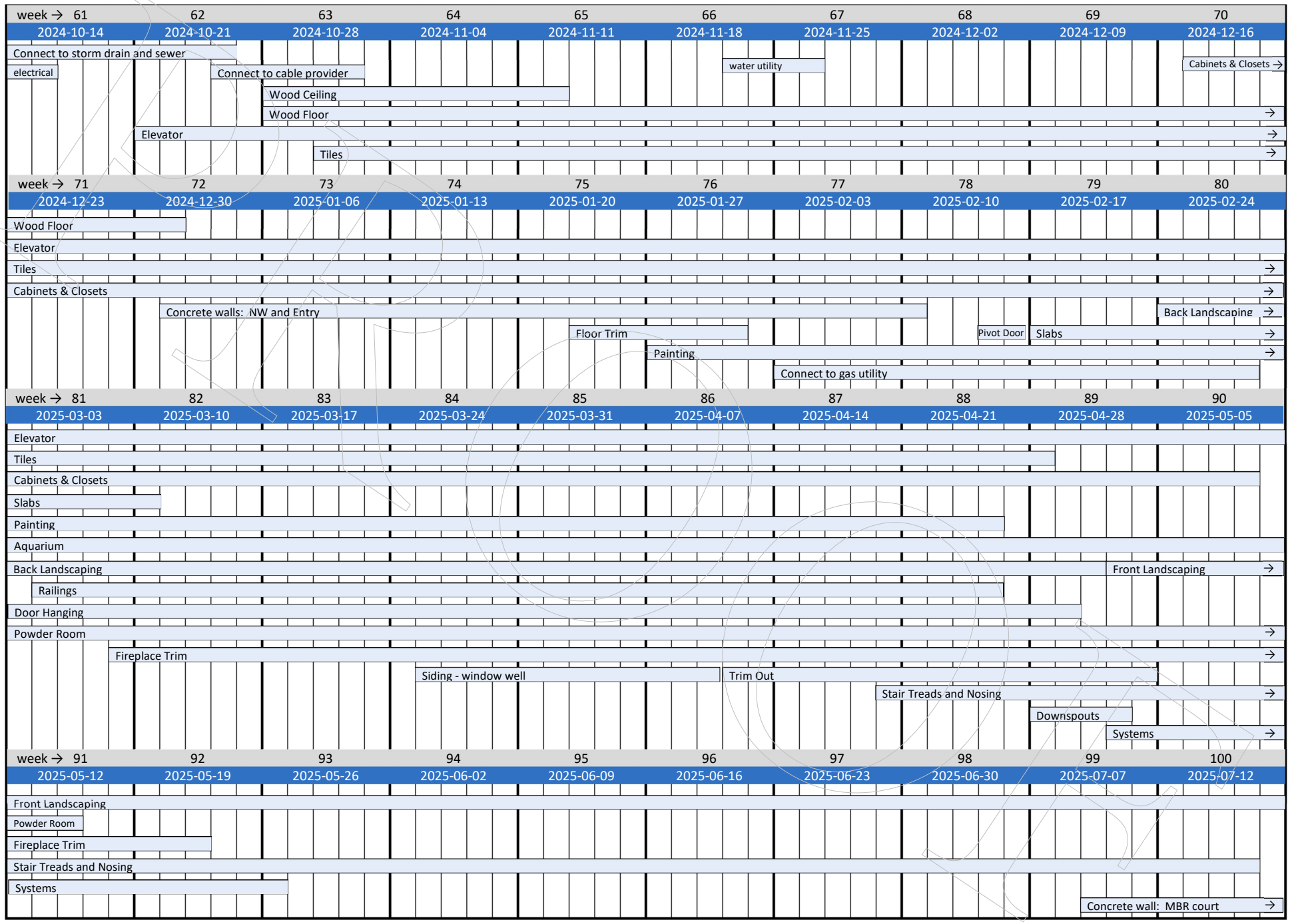
2023-08-29
2023-09-04
2023-09-11
2023-09-18
2023-09-25
2023-10-02
2023-10-09
2023-10-16
2023-10-23
Demolition
Excavation
Foundation Footings
Foundation Walls
week → 11
2023-10-30
2023-11-06
2023-11-13
2023-11-20
2023-11-27
2023-12-04
2023-12-11
2023-12-18
2023-12-25
2024-01-01
Foundation Walls
Backfill & Exterior Drains
Framing ex lower level
week → 21
2024-01-08
2024-01-15
2024-01-22
2024-01-29
2024-02-05
2024-02-12
2024-02-19
2024-02-26
2024-03-04
2024-03-11
Framing ex lower floor
Interior Drains
Torchdown Roof
Lower Level Floor & Framing
Exterior Windows & Doors
Siding ex window well
week → 31
2024-03-18
2024-03-25
2024-04-01
2024-04-08
2024-04-15
2024-04-22
2024-04-29
2024-05-06
2024-05-13
2024-05-20
Exterior Windows & Doors
Siding ex window well
Fascia & Gutters
Metal Roof
Electrical Wiring
Plumbing
HVAC
Staircase
Waterfall
week → 41
2024-05-27
2024-06-03
2024-06-10
2024-06-17
2024-06-24
2024-07-01
2024-07-08
2024-07-15
2024-07-22
2024-07-29
Plumbing
Siding ex window well
HVAC
Garage
Electrical Wiring
Drywall
Waterfall
Fireplace Installation
Staircase
Solar
Sprinklers
Entry Bridge
Low Voltage Wiring
Insulation
week → 51
2024-08-05
2024-08-12
2024-08-19
2024-08-26
2024-09-02
2024-09-09
2024-09-16
2024-09-23
2024-09-30
2024-10-07
Siding ex window well
Garage
Drywall
Solar
Outdoor Wood and Panels
Interior Doors
Connect to storm drain and sewer


week → 61
62
63
64
65
66
67
68
69
70
2024-10-14
2024-10-21
2024-10-28
2024-11-04
2024-11-11
2024-11-18
2024-11-25
2024-12-02
2024-12-09
2024-12-16
Connect to storm drain and sewer
electrical
Connect to cable provider
water utility
Cabinets & Closets
Wood Ceiling
Wood Floor
Elevator
Tiles
week → 71
72
73
74
75
76
77
78
79
80
2024-12-23
2024-12-30
2025-01-06
2025-01-13
2025-01-20
2025-01-27
2025-02-03
2025-02-10
2025-02-17
2025-02-24
Wood Floor
Elevator
Tiles
Cabinets & Closets
Concrete walls: NW and Entry
Back Landscaping
Floor Trim
Pivot Door
Slabs
Painting
Connect to gas utility
week → 81
82
83
84
85
86
87
88
89
90
2025-03-03
2025-03-10
2025-03-17
2025-03-24
2025-03-31
2025-04-07
2025-04-14
2025-04-21
2025-04-28
2025-05-05
Elevator
Tiles
Cabinets & Closets
Slabs
Painting
Aquarium
Back Landscaping
Front Landscaping
Railings
Door Hanging
Powder Room
Fireplace Trim
Siding - window well
Trim Out
Stair Treads and Nosing
Downspouts
Systems
week → 91
92
93
94
95
96
97
98
99
100
2025-05-12
2025-05-19
2025-05-26
2025-06-02
2025-06-09
2025-06-16
2025-06-23
2025-06-30
2025-07-07
2025-07-12
Front Landscaping
Powder Room
Fireplace Trim
Stair Treads and Nosing
Systems
Concrete wall: MBR court

APPENDIX B — PROJECT PERSONNEL

The following table shows the main subcontractors / suppliers who worked on the project.

Role	Company Name
General Contractor	March Macdonald
Excavation	Baer Excavation
Foundation	Blue Concrete
Framers	Rock Quality
Plumbing	Pilchuck Plumbing
Windows	Aeroframe
Roofing	Weathertight Roofing
HVAC	PP&S
Electrical	Action Electric
Low Voltage	Audio Plus
Sprinklers	Evergreen Fire Protection
Welding	Pasha's Ornamental Iron
Insulation	All Pros Insulation
Stucco	Petrus
Outdoor Wood and Hardie	RVP Construction
Cabinetry	Russell Custom Cabinets, California Closets
Tiles	ALS Tileworks
Slabs	Western Artisan
Railings	Invisirail
Floors	Continental Floors
Fireplaces, Garage Door	Cressy Door and Fireplace
Solar	NW Electric and Solar
Waterfall	Turnstone
Elevator	Moore Elevator
Aquarium	Blue Sea Aquarium
Landscaping	KLLA, Folia

APPENDIX C — ROOM DESCRIPTIONS

MAIN LEVEL

ceiling height is 9’ 1” in Foyer, Master Suite, Guest Closet, Powder Room, Kitchen N wall, Polly’s Office
ceiling height slopes from 11’ 10⅞” on the E side and 16’ 7¾” on the W side in the Great Room, Kitchen and Dining Room

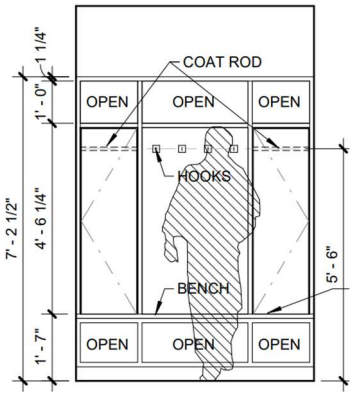
FOYER
pivot door 9’ high, 4’ 6” wide
floor: tile

POWDER ROOM
ramp sink wall-to-wall (6’) with no vanity (design changed before implementation)
mirror with LED backlighting and pendant lights on both sides of mirror
NB. after implementation, this was changed to a pendant on the left side and
a can in the ceiling to better highlight the ramp sink
floor: tile

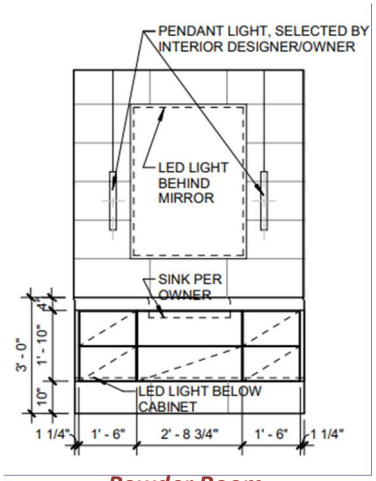
GUEST CLOSET
2 cupboards with doors
open space between closets with hooks on the wall
bench and closet depth is 24”
floor: tile

GREAT ROOM
wide linear gas fireplace
adjustable shelves left of fireplace, fixed shelves on right
floor: wood

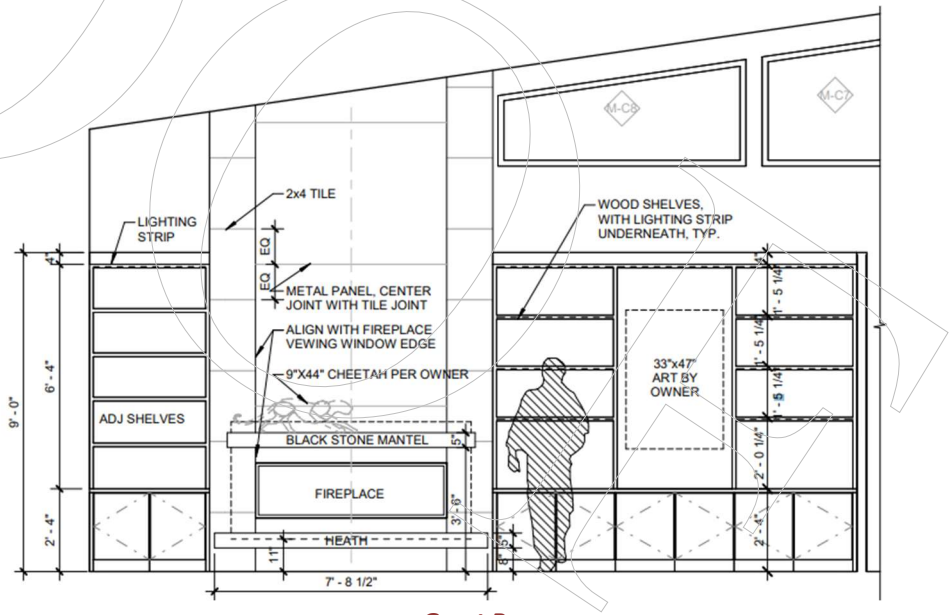
DINING ROOM
dining room table: 11’ x 46” glass top with titanium base and 10 chairs
hanging pendant lights over dining table
floor: wood



Guest Closet



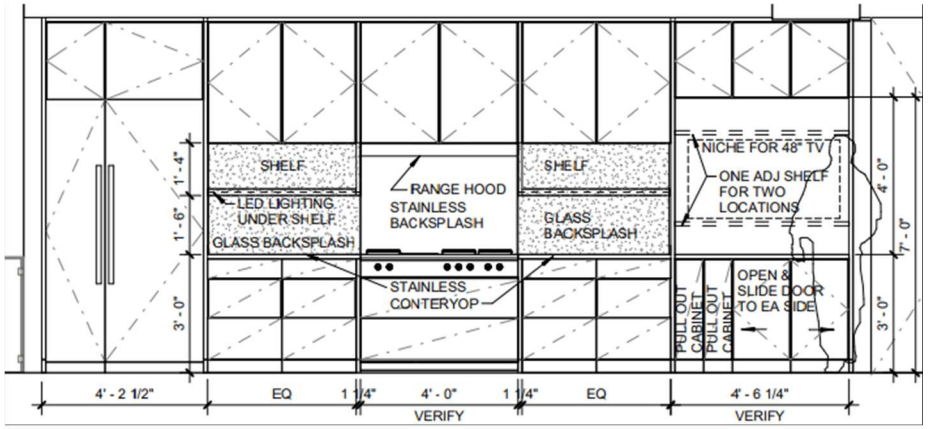
Powder Room



Great Room

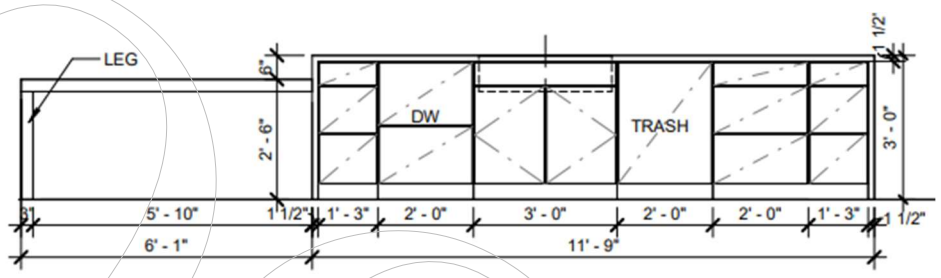
KITCHEN
floor: wood

KITCHEN W WALL
pull out cabinets
48” rangetop, combination magnetic induction and gas
range hood concealed in the cabinetry with blower on roof
counters on both sides of rangetop are stainless steel
stainless steel backsplash behind rangetop
glass backsplash above/below open shelves
undershelf counter lighting
retractable flipper doors under TV

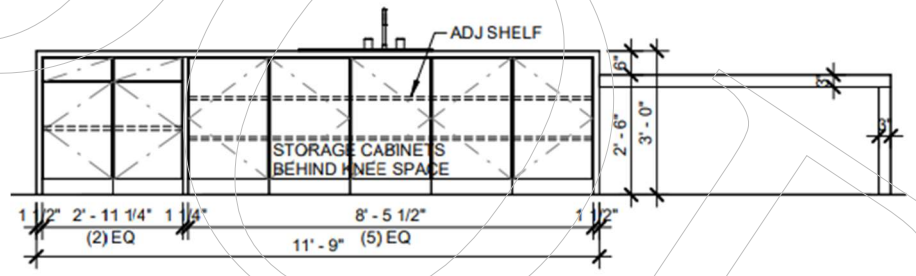


Kitchen W Wall

ISLAND – RANGETOP SIDE
sink: 33” workstation sink and 15” high faucet
instant hot water and filtered water
food waste disposer in sink
dishwasher
double door under sink with 1 pull out drawer at bottom
pull out 4 bin trash drawer: garbage, recycle, food waste, other
hanging pendant lights over main island and island table
bench on rangetop side of island table



Island – Rangetop Side



Island – Dining Table Side

KITCHEN N WALL

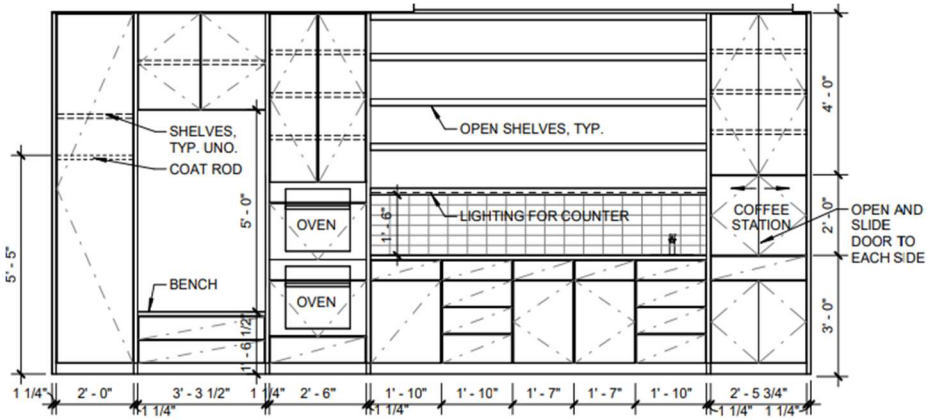
coffee station: retractable flipper doors

coffee machine sits on a pull out platform

wall ovens:

- upper: speed oven
- lower: regular oven

NB. the coat cupboard and bench were swapped before implementation



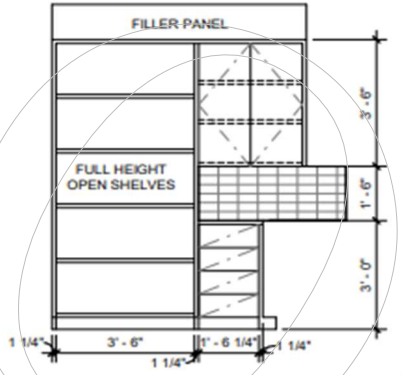
Kitchen N Wall

PANTRY

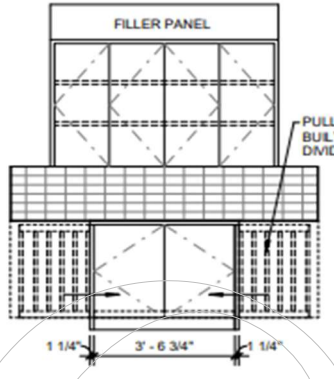
8' 4" wide, 8' deep

floor: wood

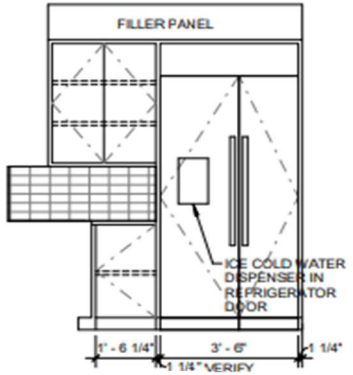
NB. after seeing the installation, we decided that we didn't need a counter so we modified the design to replace the counter with more shelves



Pantry S



Pantry W



Pantry N

GARAGE

20' wide, 21' 6.5" deep

wall unit purchased from NewAge on E wall

sink unit purchased from NewAge on S wall

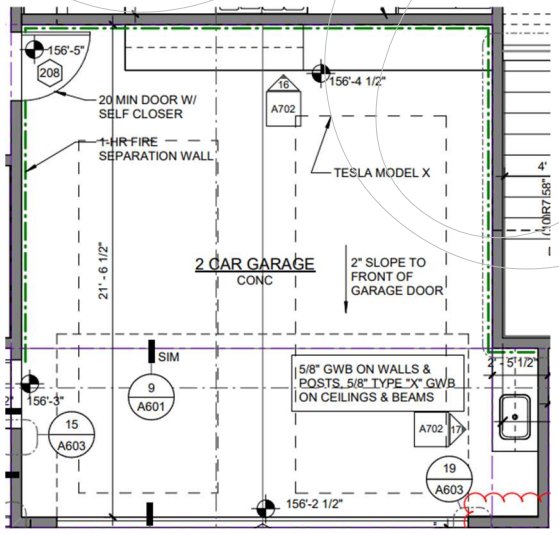
use smart lock for pantry door entry

2 Tesla wall chargers

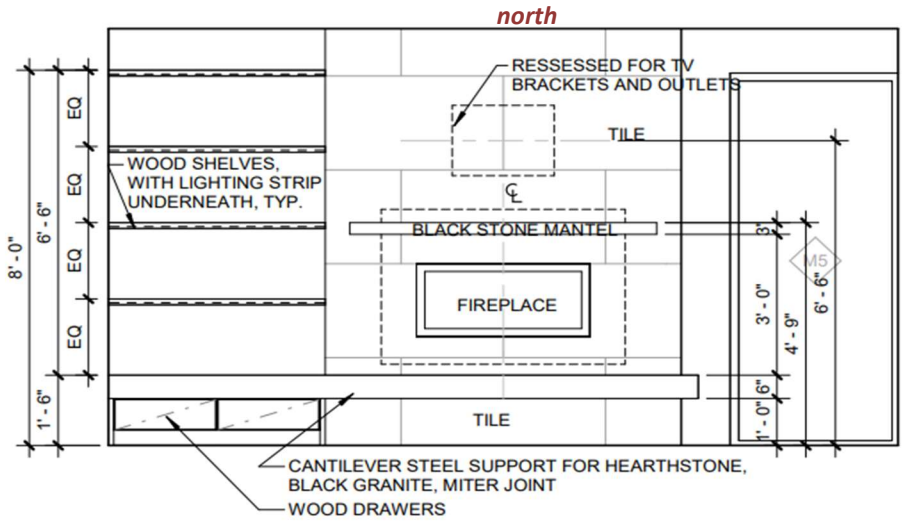
garage door (LiftMaster), WiFi controllable

bright LED ceiling lights

floor: concrete with acrylic cover



MASTER BEDROOM
18’ x 16’
linear gas fireplace
recessed space in wall behind TV for AC outlets, network outlet, Coax outlet, TV box, etc.
floor: wood
NB. before implementation, changed the design to remove the mantel and hearth



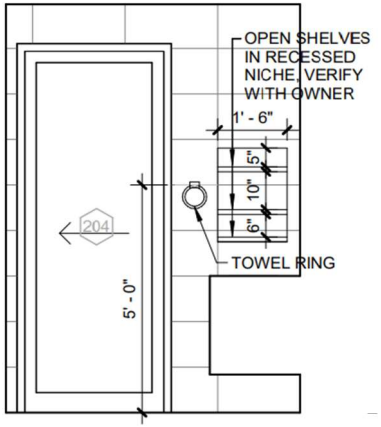
MASTER BATHROOM
hanging vanity
mirrors are backlit with LED strip, no medicine cabinets
top centre drawer has 2 electrical outlets for hair dryer, shaver
AC outlet on wall above counter between mirrors
niche on E wall beside vanity with 3 shelves: 6”, 10” and 5” separations
shower:

- rain shower head in centre
- hand shower on W wall
- the shower door swings in and out
- hinge on right, door opens against wall
- linear drain on N side

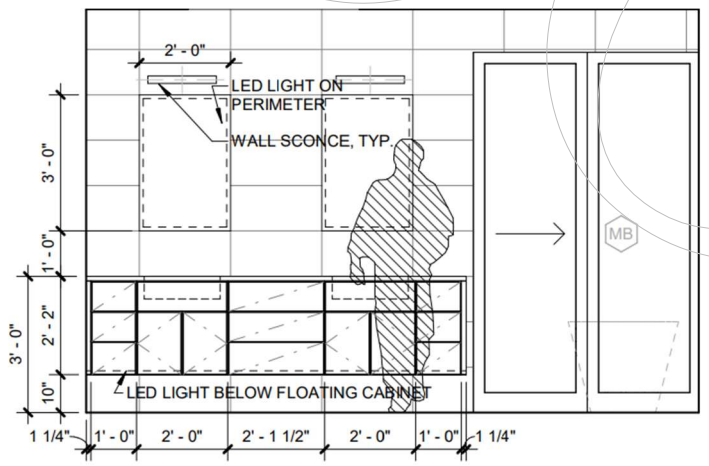
toilet room:

- toilet with bidet seat and electric outlet

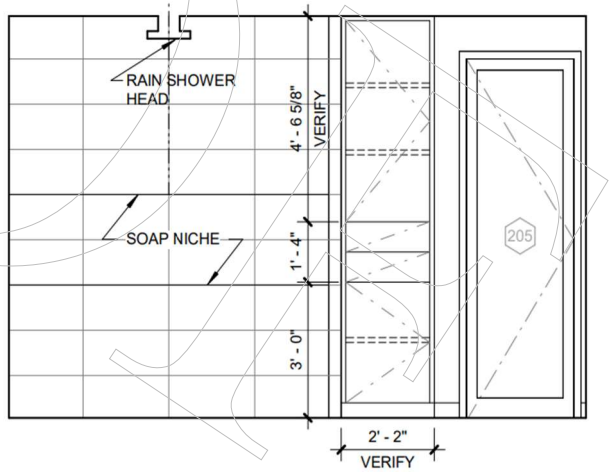
floor: tile



E wall niche

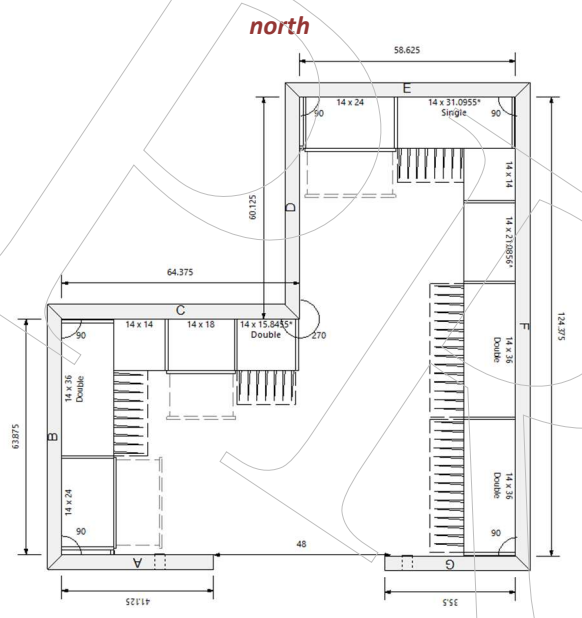


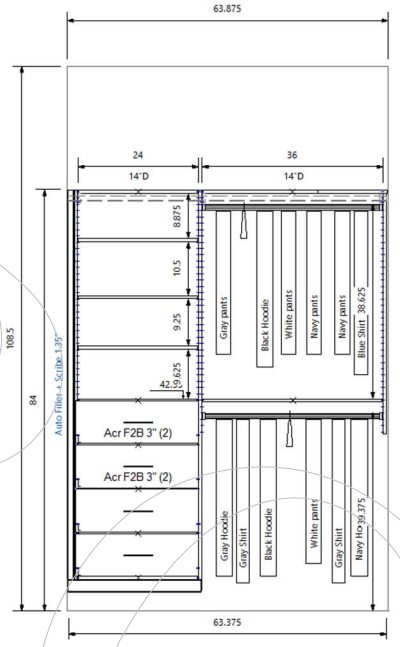
vanity

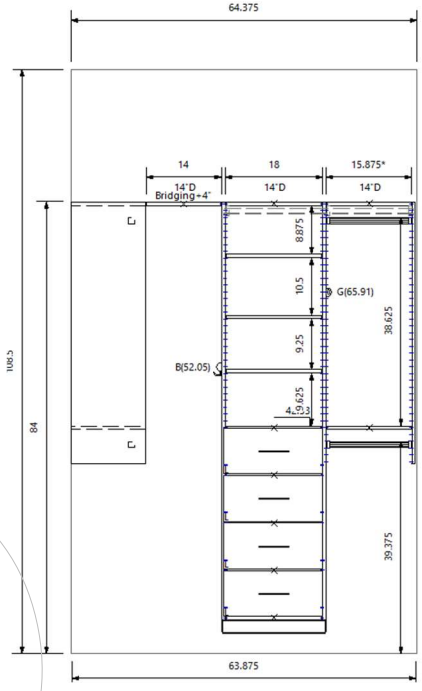


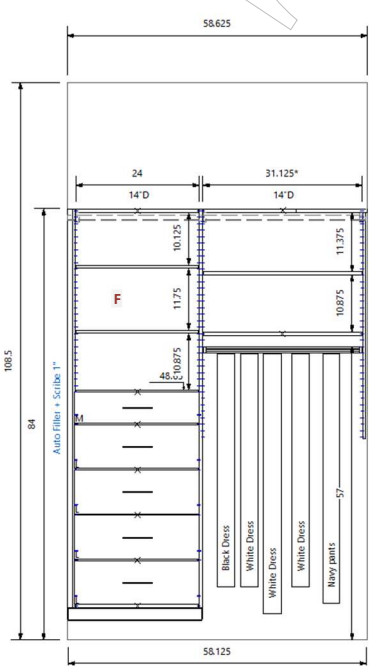
shower and cupboards/drawers

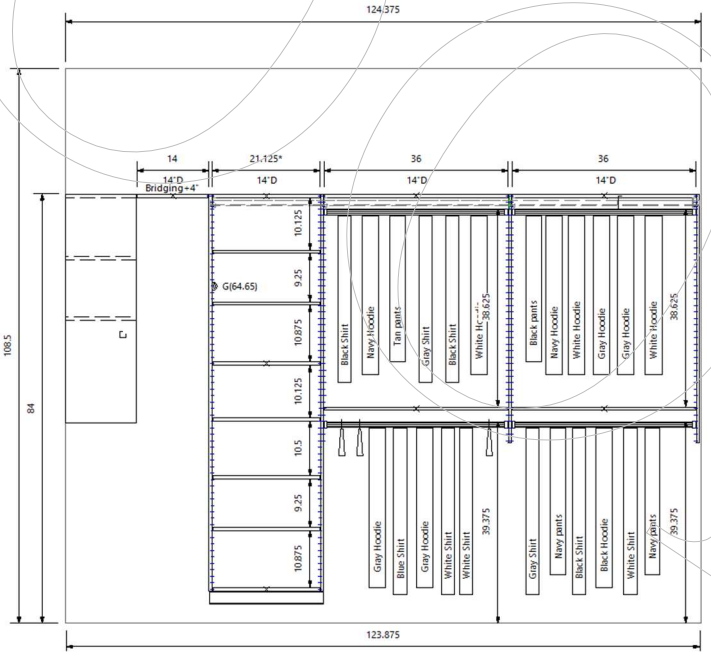
MASTER CLOSET
floor: wood



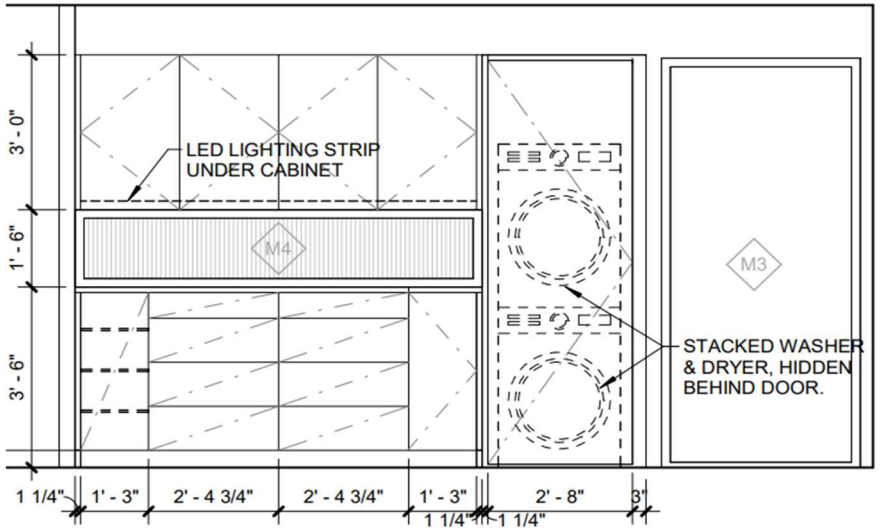






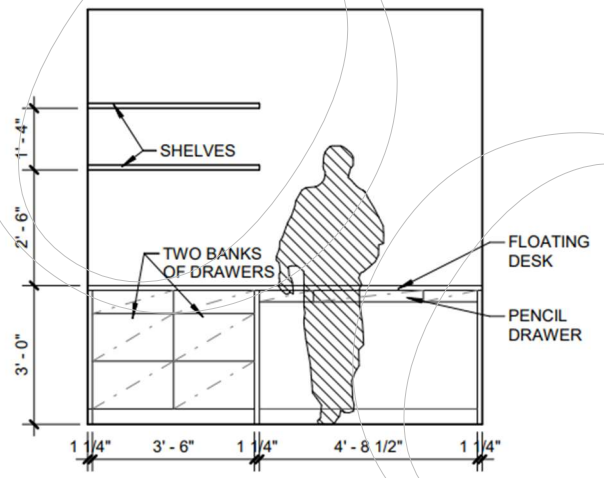


MASTER HALL WALL UNIT
washer/dryer closet has retractable “flipper” doors
smaller stacked Miele washer and dryer
NB. dryer is not vented
washer is 23.5 W 25 D and 33.5 H
dryer is 23.5 W 25 D and 33.5 H



Master Hall Wall Unit

POLLY’S OFFICE
20’ 8” wide and 12’ 6” deep
recessed indirect lighting in cove on S side
floor: wood
NB. changed from 2 independent shelves above to a bookcase with 4 shelves below and 2 cupboards above

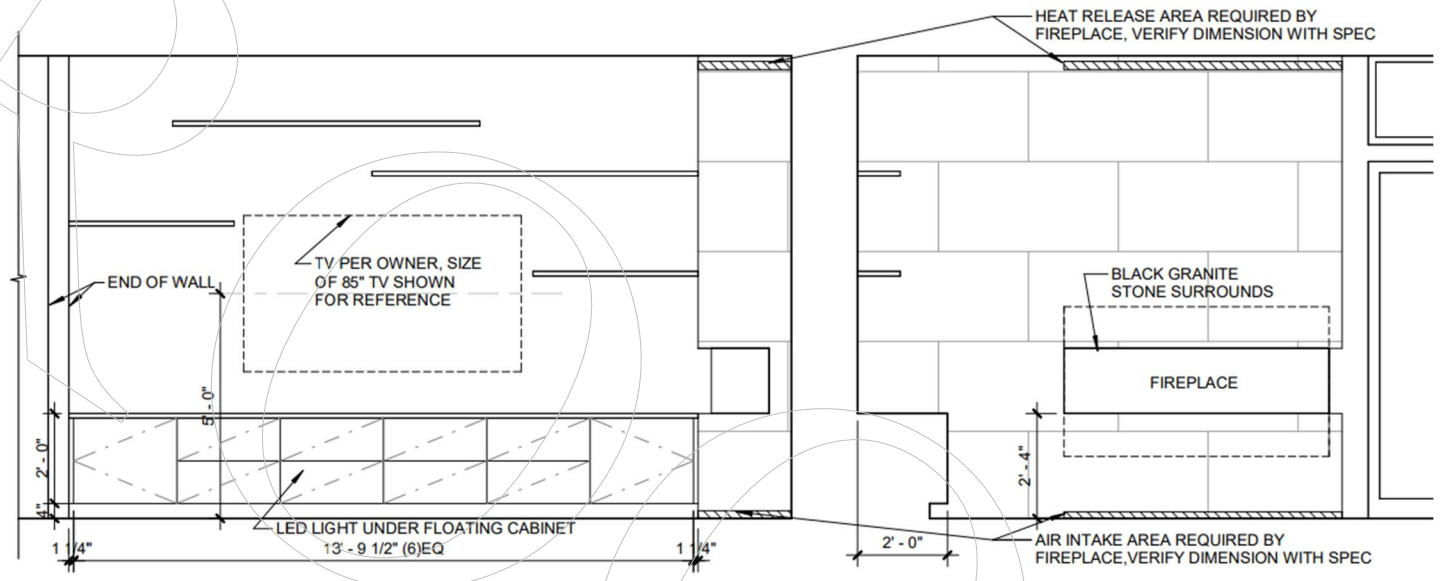


Polly’s

LOWER LEVEL

All lower level room ceilings are 10’ 4⅞” high.

FAMILY ROOM
23’ 3.25” wide and approximately 40’ deep
large TV mounted on N wall
recessed space in wall behind TV for AC outlets, network outlet, Coax outlet, TV box, etc.
2 sided gas fireplace on E wall
floor: wood
NB. changed the design to remove the floating cabinet (replaced by furniture) and the independent shelves



Family Room N and E walls

SITTING AREA
between window well and Atrium, approximately 25’ x 12.5’ including area under the staircase
floor: wood

JOHN’S OFFICE
20’ 8” wide
15’ 4” deep from entry door
floor: wood

LAUNDRY ROOM
12’ wide, 8’ 10” deep
full size washer and dryer, dryer is vented
counter with cupboards, drawers, sink
closet with cupboard above
floor: tile

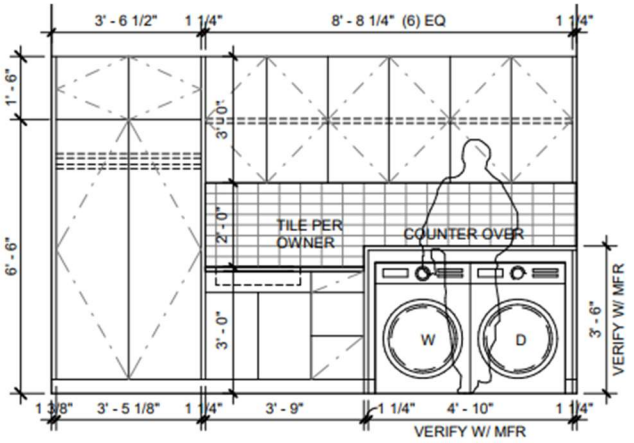
PLAYROOM
counter with cupboards, drawers, sink and refrigerator
pocket door access to Bath 3
recessed box on S wall for AC outlets, network outlet, Coax outlet, TV box, etc.
floor: wood

BATH 3 (connected to Playroom)
portrait mirror with LED backlighting
wall sconce lights on both sides
toilet with bidet seat and electric outlet
floor: tile

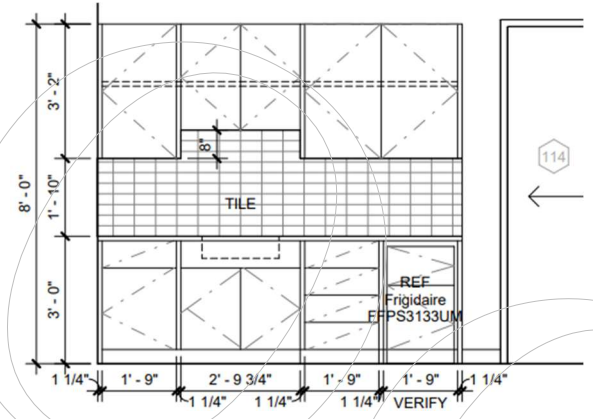
BATH 1
portrait mirror with LED backlighting
wall sconce light above
built-in tub with shower head and a glass enclosure
floor: tile

BATH 2
portrait mirror with LED backlighting
wall sconce light above
shower
floor: tile

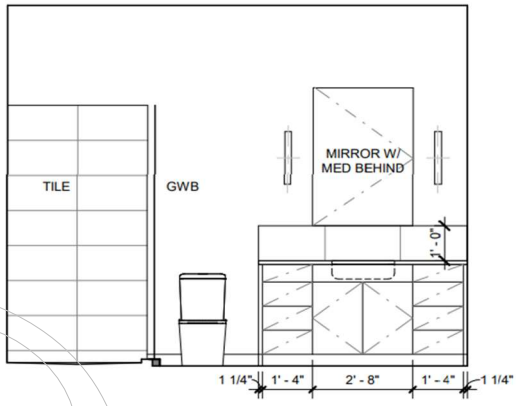
STORAGE ROOM
low voltage panel
network equipment
shelving



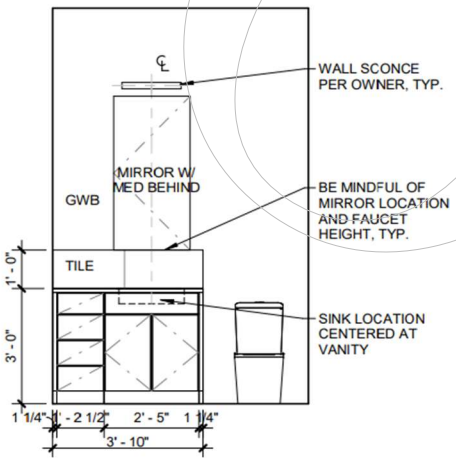
Laundry Room



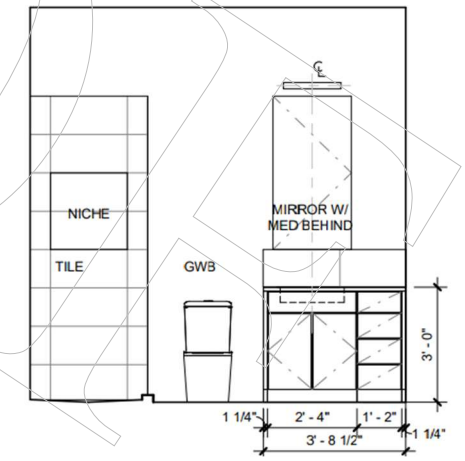
Playroom counter



Bath 3

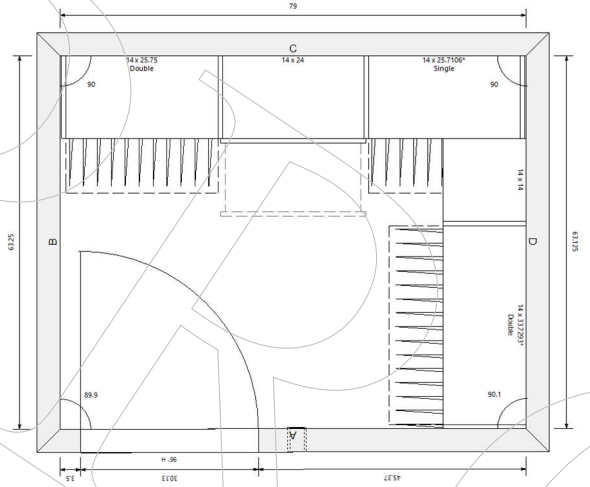


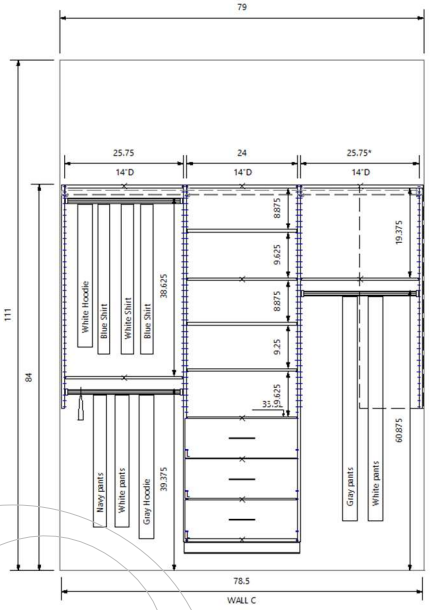
Bath 1

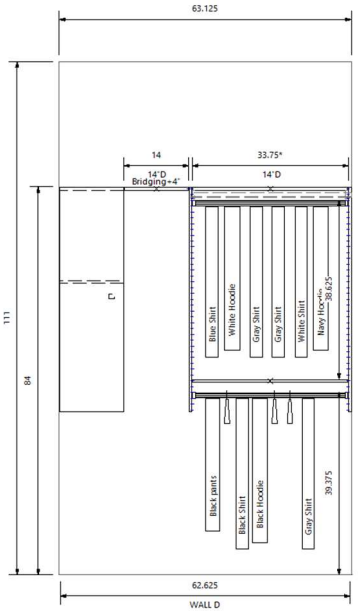


Bath 2

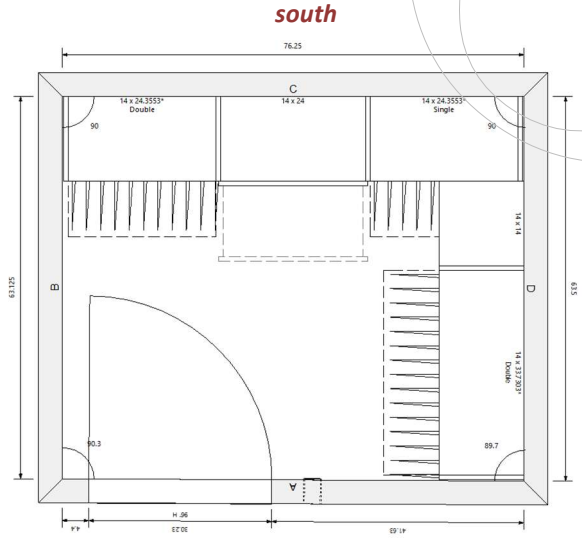
BEDROOM 1 CLOSET

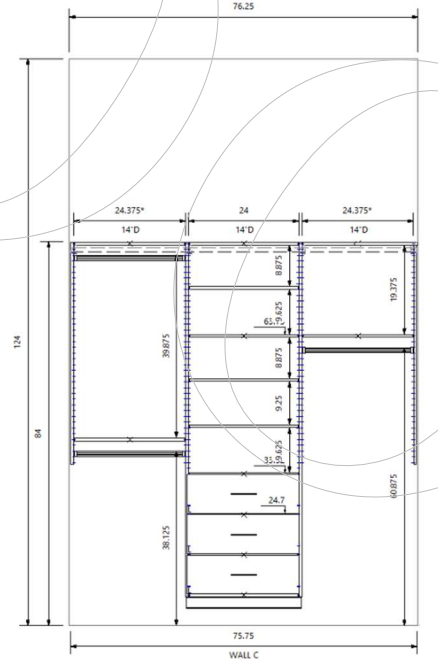


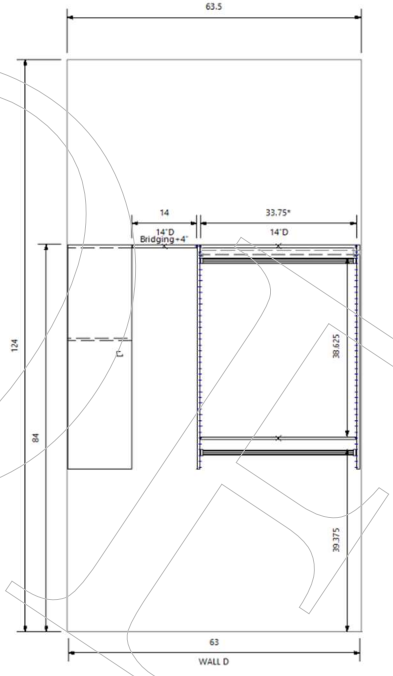




BEDROOM 2 CLOSET







APPLIANCES

Item	Brand / Model	Location	
Oven	SKS Model SKSLV3001S Speed Oven Professional Series	Kitchen N Wall	
Oven	SKS Model SKSSV3001S Single Wall Oven with Steam-combo	Kitchen N Wall	
Refrigerator	Sub Zero Model CL4850S/S 48" classic side by side refrigerator / freezer	Kitchen W Wall	
Dishwasher	Fisher & Paykel Model DD24DAX9 N double drawer	Kitchen island	
Beverage / Wine Cooler	Newair Model AWR-460DB	Kitchen N wall	

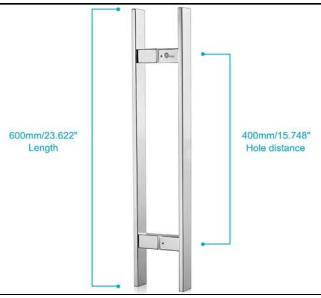
Item	Brand / Model	Location	
Hood liner	Wolf Model PL461912	Kitchen W wall	
Exterior blower	Wolf Model 804701	roof	
Range top	SKS Model SKSRT480SIS with sous vide and induction	Kitchen W wall	
Refrigerator	Frigidaire Model: Gallery side-by-side	Pantry	
Refrigerator	Danby Dual Door 3.1 cu ft compact refrigerator/freezer black stainless steel	Playroom	
Washer	Miele WWH860 M-Nr: 10666200 Type: HW21	Master Bedroom	

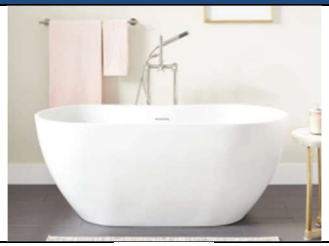
Item	Brand / Model	Location	
Dryer	Miele Nr::11/ 125803882 M-Nr: 10666300 Type HT29 ventless 120V dryer	Master Bedroom	
Washer	Samsung Model: WF45T6000AV	Laundry Room	
Dryer	Samsung Model: DVE45T6000V Vented 240V dryer	Laundry Room	

FIXTURES

Item	Brand / Model	Location	
Toilet	Toto Aquia IV 0.0 1.28 GPF dual flush two piece elongated toilet with push button flush seat included	Powder Room	
Ramp Sink	custom built quartz slab on a welded steel frame	Powder Room	see Powder Room chapter
Faucet	Kohler model K-103C37-SANA touchless, AC powered 0.5 GPM chrome	Powder Room	
Sink	Create Good Sinks Model 5LS33L 33” Workstation Sink stainless steel single bowl offset drain	Kitchen Island	
Faucet	KWC Ono Model 10.151.102.700 15+” high chrome	Kitchen Island	

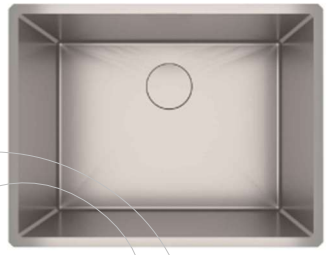
Item	Brand / Model	Location	
Water Dispenser	Insinkerator Indulge instant hot and cold water chrome	Kitchen Island	
under sink system accessories	Insinkerator hot water tank and filtration system	Kitchen Island	
garbage disposal	Insinkerator Pro 750 Mountain air switch MT951 Mountain basket strainer MT300	Kitchen Island	
garbage disposal accessories	Insinkerator	Kitchen Island	
small sink	Create Good Sinks Model 5S14-9 14” undermount sink single bowl stainless steel	Kitchen N Wall	
faucet	Grohe Concetto 1.75 GPM 13.75” high chrome	Kitchen N Wall	

Item	Brand / Model	Location	
toilet	Toto Nexus 1.28 GPF one piece white	Master Bathroom	
bidet seat	Toto Washlet+ needs AC outlet	Master Bathroom	
rain shower	Grohe Rainshower Cosmopolitan shower head with 12” arm chrome	Master Bathroom	
hand shower	Grohe Tempesta Cosmopolitan with 24” slide bar chrome	Master Bathroom	
rain shower / hand shower selector	Grohe Eurosmart single handle 2-way diverter valve valve trim	Master Bathroom	
water on / temp selector	Grohe Eurosmart pressure balanced valve	Master Bathroom	
shower door handle	Togu TG-6018 chrome	Master Bathroom	

Item	Brand / Model	Location	
tub	Hibiscus 59” acrylic soaking freestanding tub with integrated drain white	Master Bathroom	
tub filler	Grohe Essence floor mounted tub filler includes hand shower chrome	Master Bathroom	
vanity sinks (2)	Kohler Brazn undermount bathroom sink vitreous china	Master Bathroom	
vanity faucets (2)	Grohe Eurosmart chrome	Master Bathroom	
toilet	Kohler San Souci white	Bedroom 1	
tub	Sitka 60” three wall alcove acrylic soaking tub white	Bedroom 1	

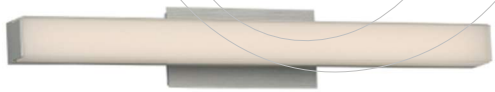
Item	Brand / Model	Location	
tub spout	Grohe Concetto 5” wall mounted spout chrome	Bedroom 1	
hand shower	Grohe Tempesta Cosmopolitan with 24” slide bar chrome	Bedroom 1	
water on / temp selector	Grohe Eurosmart pressure balanced valve	Bedroom 1	
vanity sink	Kohler Brazn undermount bathroom sink vitreous china	Bedroom 1	
vanity faucet	Grohe Eurosmart chrome	Bedroom 1	
toilet	Kohler San Souci white	Bedroom 2	
hand shower	Grohe Tempesta Cosmopolitan with 24” slide bar chrome	Bedroom 2	

Item	Brand / Model	Location	
water on / temp selector	Grohe Eurosmart pressure balanced valve	Bedroom 2	
vanity sink	Kohler Brazn undermount bathroom sink vitreous china	Bedroom 2	
vanity faucet	Grohe Eurosmart chrome	Bedroom 2	
toilet	Kohler San Souci requires white	Bathroom 3	
bidet seat	Kohler C3-420 bidet controls on side of seat requires AC outlet white	Bathroom 3	
hand shower	Grohe Tempesta Cosmopolitan with 24” slide bar chrome	Bathroom 3	
water on / temp selector	Grohe Eurosmart pressure balanced valve chrome	Bathroom 3	

Item	Brand / Model	Location	
vanity sink	Kohler Brazn undermount bathroom sink vitreous china	Bathroom 3	
vanity faucet	Grohe Eurosmart chrome	Bathroom 3	
utility sink	Kraus Standard PRO stainless steel with	Laundry Room	
faucet	Kraus Standard PRO stainless steel	Laundry Room	
bar sink	Create Good Sinks Model 5S14-9 14” undermount sink single bowl stainless steel	Playroom	
bar faucet	Grohe Concetto 1.75 GPM 13.75” high chrome	Playroom	
garage sink and faucet	NewAge SKU 55999	garage	

DECORATIVE LIGHTS

Location	Type	Manufacturer	Specifications	
stairwell	chandelier / pendant	WAC	Synopsis pendant	
dining room	pendant	Currey	Pathos 15-light Linear Multi-Drop Pendant adjustable 12-125"	
kitchen main island	pendant	ET2	Continuum 96" 3CCT LED Pendant in black	
kitchen island table	pendant	Visual Comfort	Element 2" Fixed Cylinder Pendant cord mount black - need 96" cord	

Location	Type	Manufacturer	Specifications	
pantry	surface	Design Classics Lighting	10-inch round white 3000K 1511 lumens	
master bathroom	sconce lights	WAC Brink	WS-77618 brushed aluminum 18" wide junction box cover about 3" x 6" 3000K / 1225 lumens	
master closet	ceiling light	Design Classics Lighting	10-inch round white 3000K 1511 lumens	
bathroom 1	sconce light	WAC Brink	WS-77618 brushed aluminum 18" wide junction box cover about 3" x 6" 3000K / 1225 lumens	
bedroom 1 closet	wall light	Design Classics Lighting	10-inch round white 3000K 1511 lumens	
bathroom 2	sconce light	WAC Brink	WS-77618 brushed aluminum 18" wide junction box cover about 3" x 6" 3000K / 1225 lumens	

Location	Type	Manufacturer	Specifications	
bathroom 3	sconce lights	WAC Brink	WS-77618 brushed aluminum 18" wide junction box cover about 3" x 6" 3000K / 1225 lumens	
garage ceiling	ceiling lights	Lithonia	48" LED ceiling surface mount 4000K cool white 5000 lumens	
storage room	ceiling light	Lithonia	48" LED ceiling surface mount 4000K cool white 5000 lumens	
mechanical room	ceiling light	Lithonia	48" LED ceiling surface mount 4000K cool white 5000 lumens	
laundry room	ceiling light	Design Classics Lighting	10-inch round white 3000K 1511 lumens	
elevator closet	ceiling light	Lithonia	48" LED ceiling surface mount 4000K cool white 5000 lumens	

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