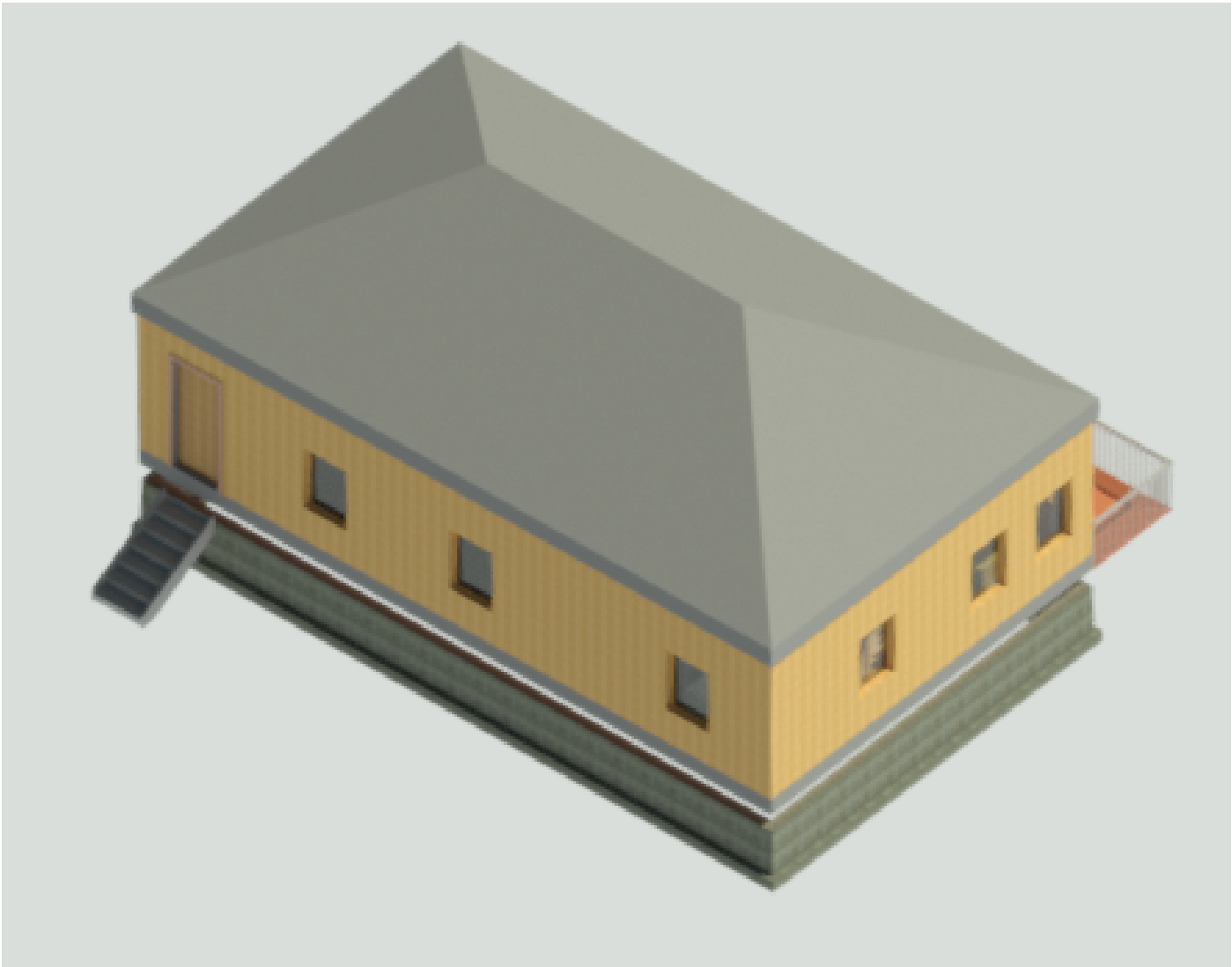
Affordable Housing Design

PLTW
Civil Engineering and Architecture



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Project Description

Project Summary

I was volunteering with Habitat for Humanities when Mr. Bailey requested a home. He, his wife, and his dog required shelter. It was my job to design and model a home for them. I conducted an interview with Mr. Bailey that allowed me to create a few basic designs. After reviewing the designs with Mr. Bailey, he chose a design and I began modeling the house in Revit, a 3D Architecture modeling software.

Site Description

When the house was completed, I placed it on the site. The site was a spacious grassland in Noblesville, IN that was accessible through both Maple Street and 10th Street. After determining the location of the home, there was still a lot of grassland left. The open space could allow for expansion of the home in the future.

Relevant Habitat for Humanity Guidelines

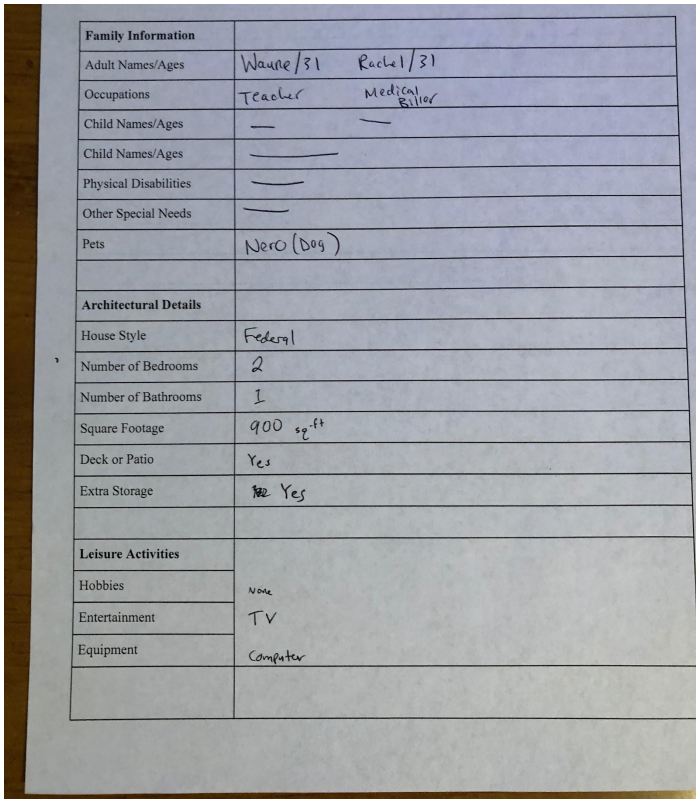
1. Since the home was designed to house two adults, I abided by the size limit of 900 ft^2, which allowed me to incorporate 2 bedrooms and one bathroom.
2. I included a 4 ft crawl space that allowed me to create the necessary foundation to support the house.
3. I abided by the Residential Code Requirements for insulation size and placement, which will keep the house cool in the summer and warm in the winter.
4. I included ceiling light fixtures for incandescent light in every room to provide adequate lighting.
5. The rear porch has exterior light fixtures to provide adequate lighting for the exterior of the home.

Universal Design Examples

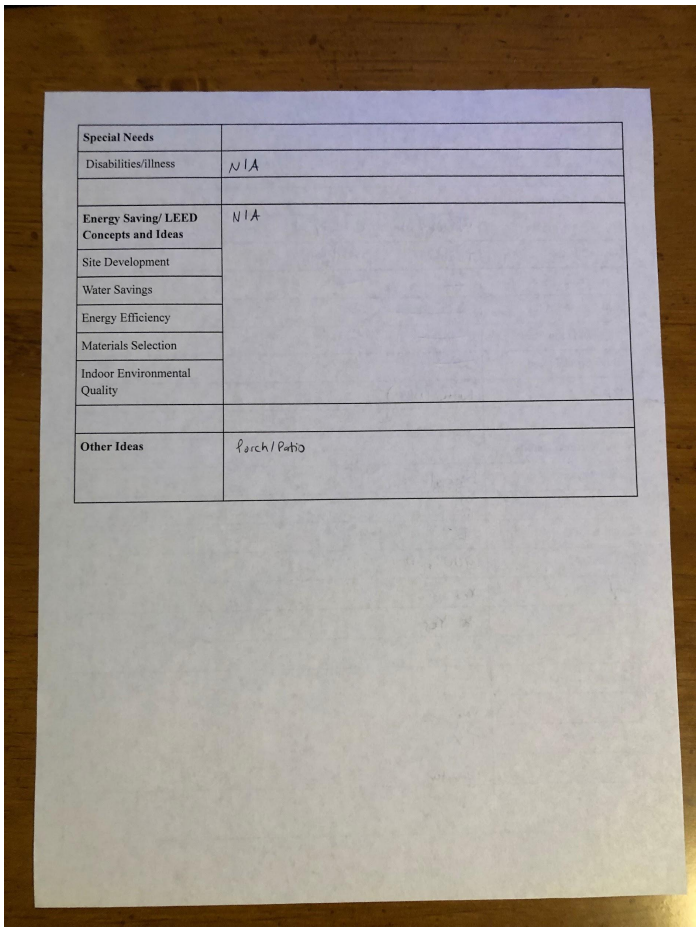
1. All switches and appliance controls are located at accessible heights (44-48 in).
2. All doorways and wall openings are 3ft to allow wheelchairs easy access into all rooms of the home.
3. All phone jacks and electrical outlets are at the accessible heights (18 inches).

Initial Design

Client Survey



Family Information	
Adult Names/Ages	Wayne/31 Rachel/31
Occupations	Teacher Medical Biller
Child Names/Ages	— —
Child Names/Ages	—
Physical Disabilities	—
Other Special Needs	—
Pets	Nero (Dog)
Architectural Details	
House Style	Federal
Number of Bedrooms	2
Number of Bathrooms	1
Square Footage	900 sq-ft
Deck or Patio	Yes
Extra Storage	Yes
Leisure Activities	
Hobbies	None
Entertainment	TV
Equipment	Computer

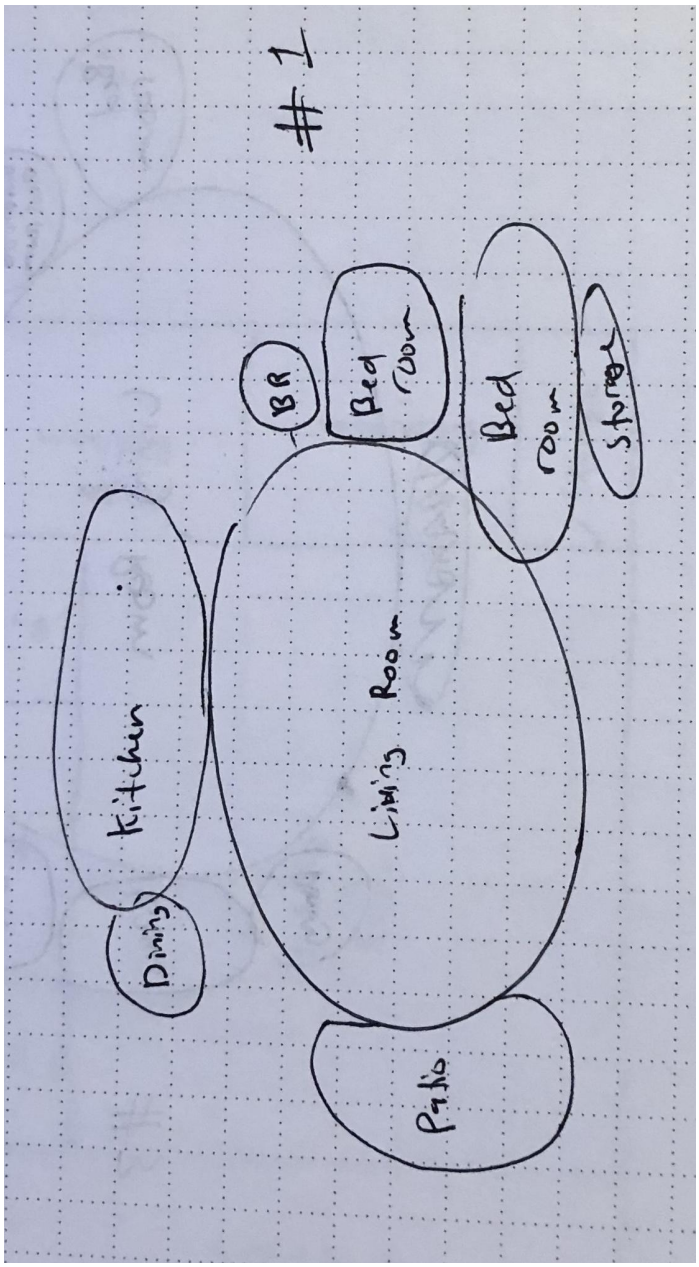
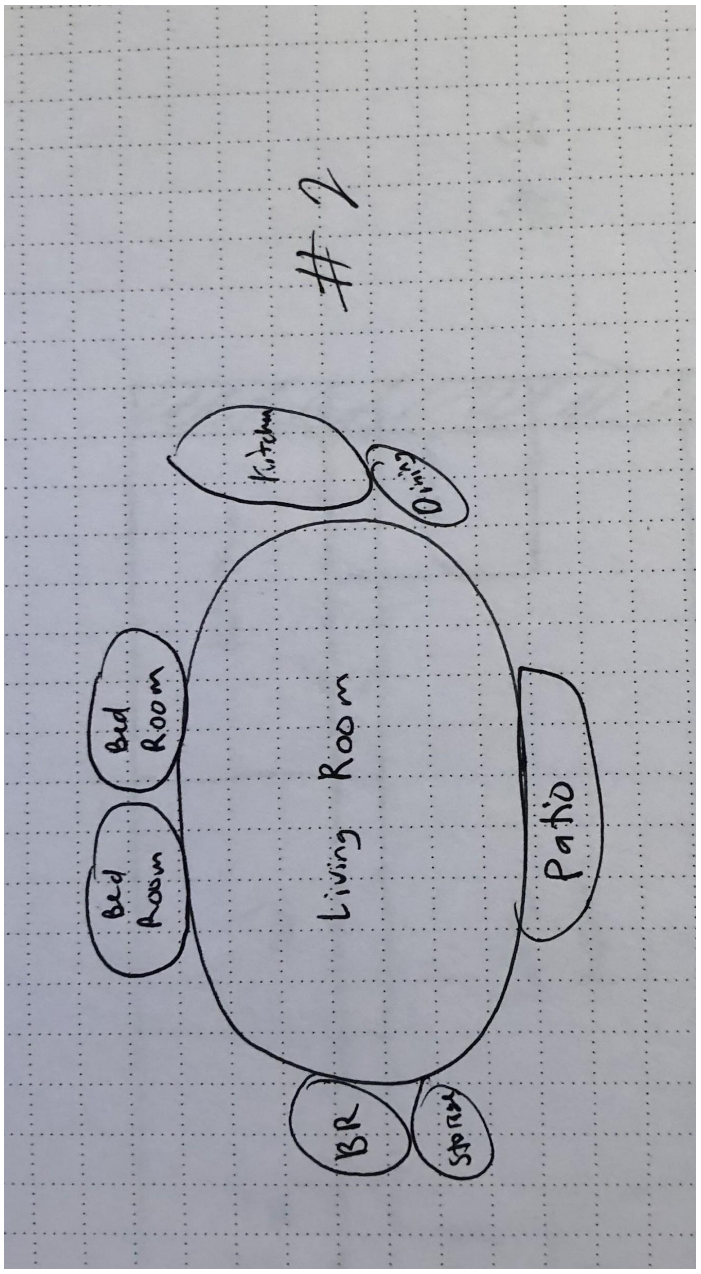


Special Needs	
Disabilities/illness	N/A
Energy Saving/ LEED Concepts and Ideas	N/A
Site Development	
Water Savings	
Energy Efficiency	
Materials Selection	
Indoor Environmental Quality	
Other Ideas	Porch / Patio

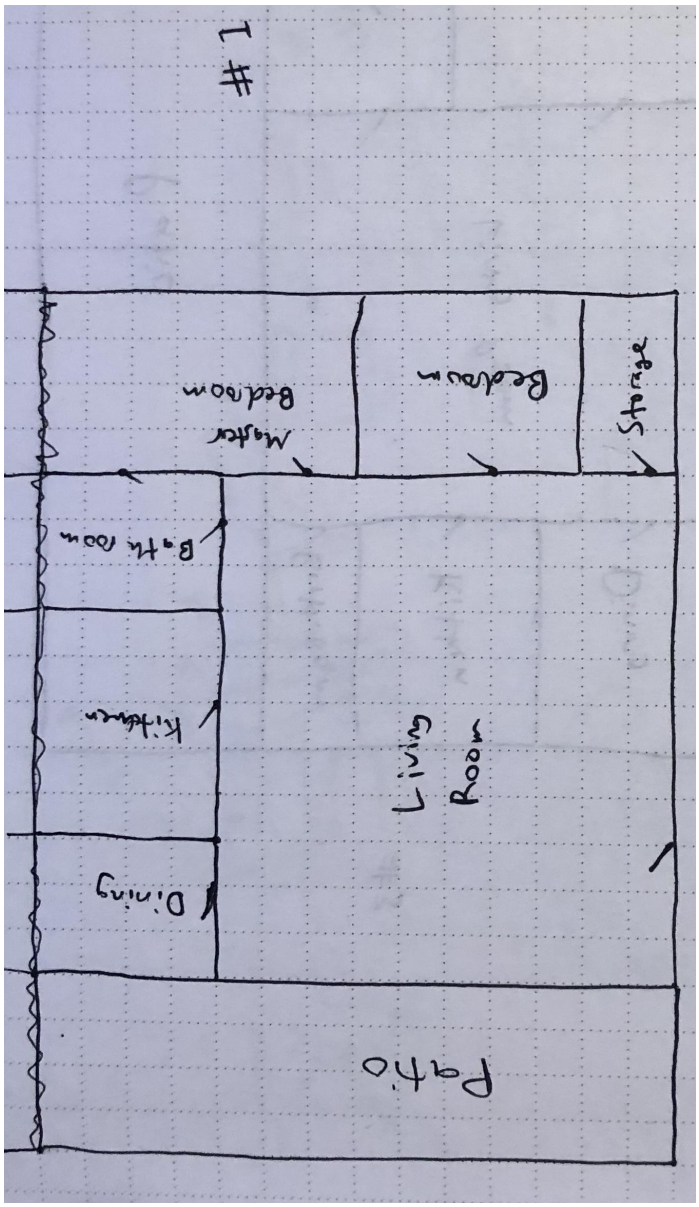
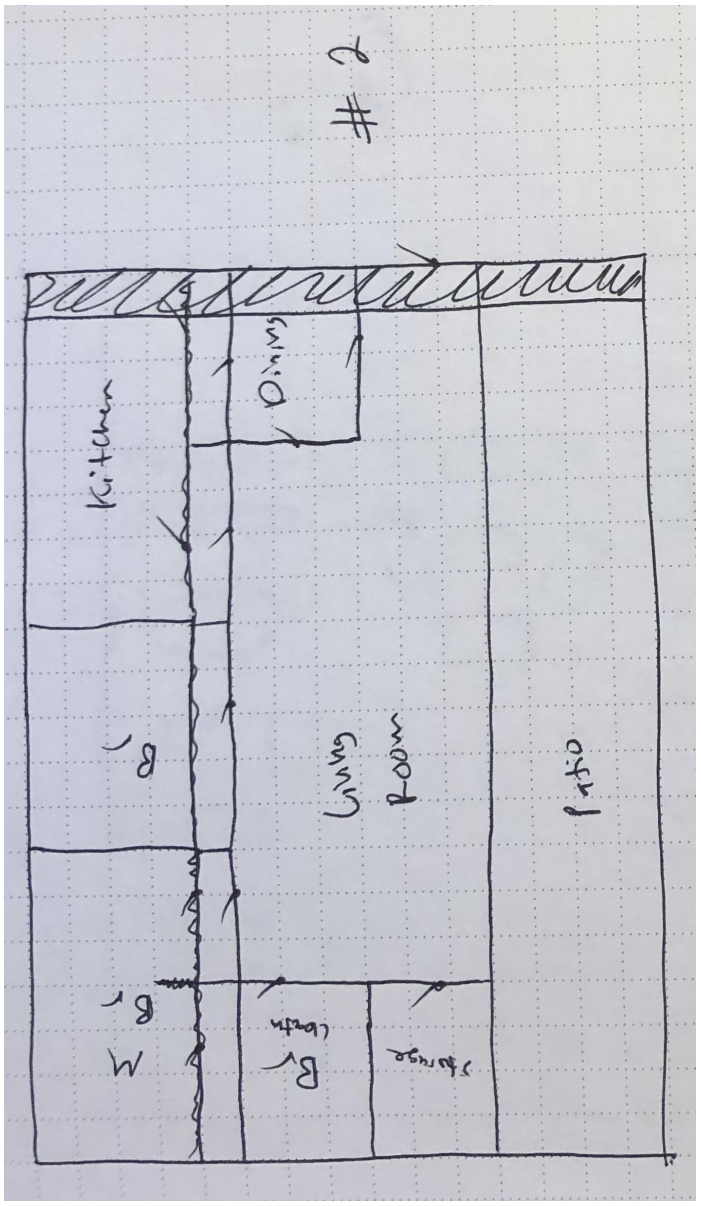
Summary:

After conducting an interview with Mr. Bailey, I learned he requires housing for 2 adults and a dog. According to Habitat for Humanities guidelines, the home will have 2 bedrooms and 1 bathroom. I plan to build a Federal style house with about a 900 ft² area. I will also include a large patio, which is not accounted for in the total area. There will also be entertainment such as a T.V. for leisure time.

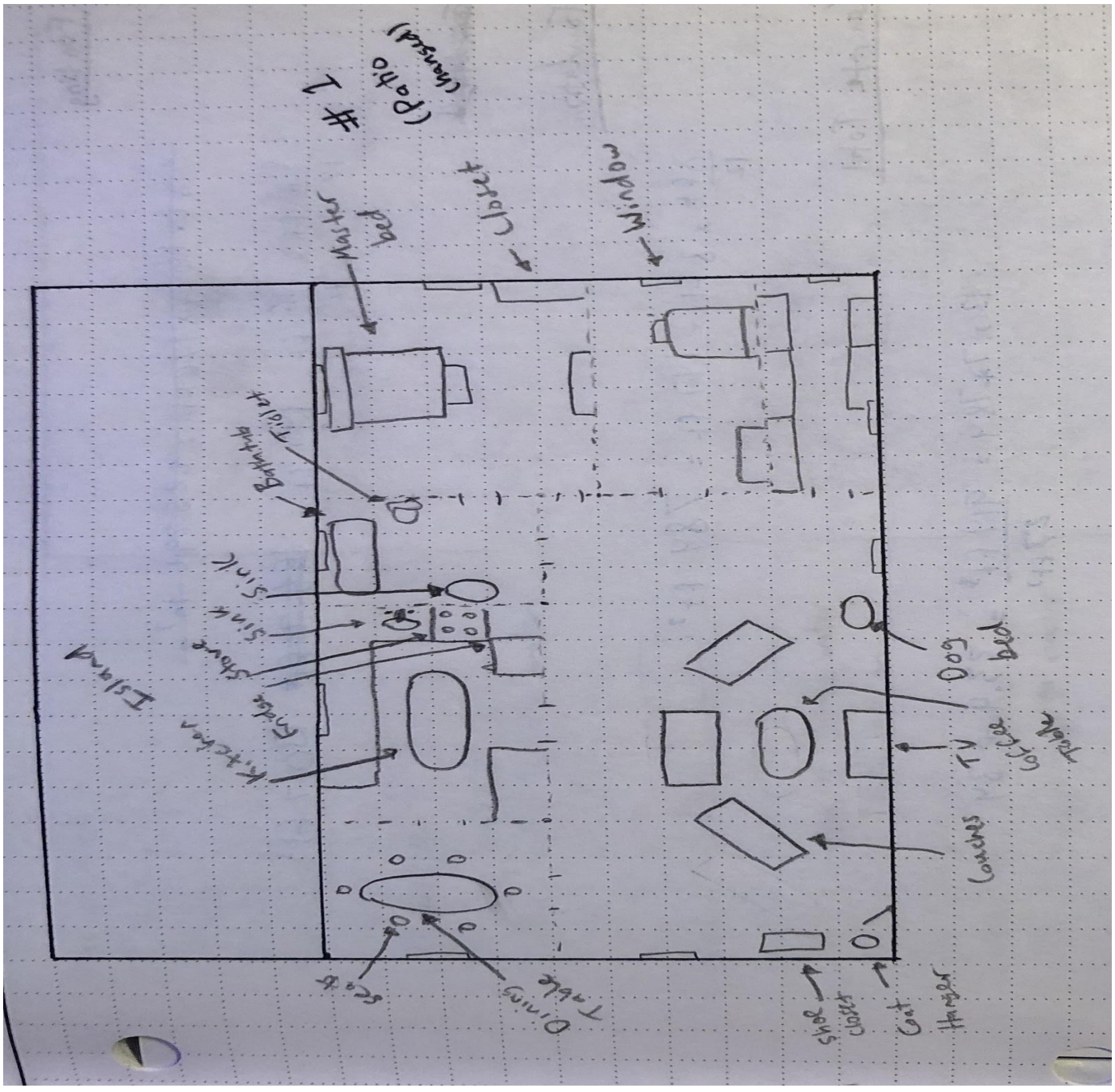
Bubble Diagrams

Bubble Diagram #1	Bubble Diagram #2
	
Summary: My first bubble design includes all of the components I planned on including. This allowed me to create a rough idea of where everything will go.	Summary: My second bubble design includes all of the components I planned on including. This allowed me to move things around to find the most efficient, organized design for the house.

Floor Plan Rough Sketches

Floor Plan Rough Sketch #1	Floor Plan Rough Sketch #2
	
Summary: My first rough floor plan was a scaled sketch of the entire house and patio. Since it was scaled, I decided which rooms needed to be changed and took notes for the Final design	Summary: My second rough floor plan was a scaled sketch of each room and the patio. This helped me compare the scale of both of my designs. It was a visual representation of how efficiently I was using my limited space.

Final Floor Plan Sketch

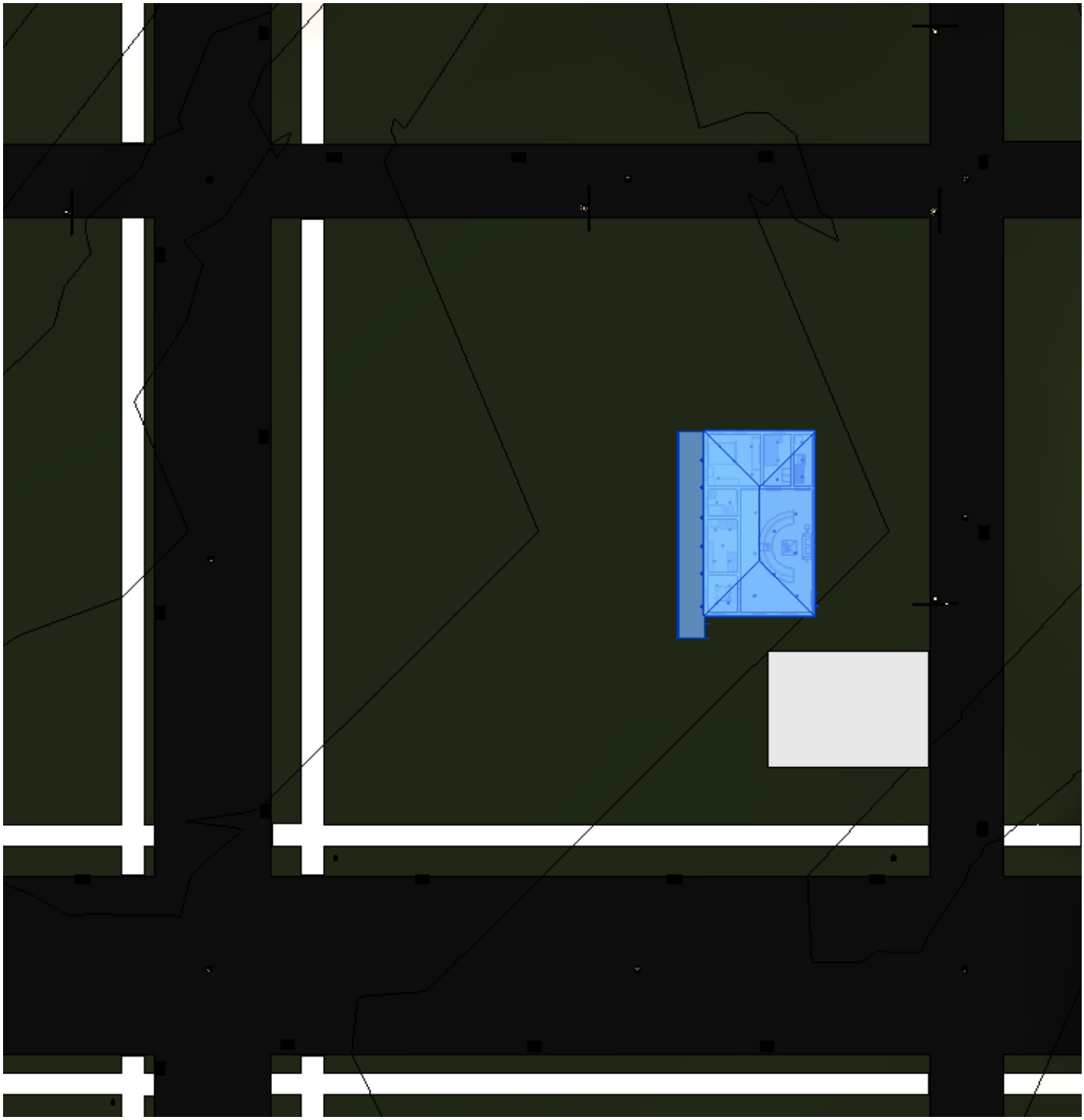


Summary:

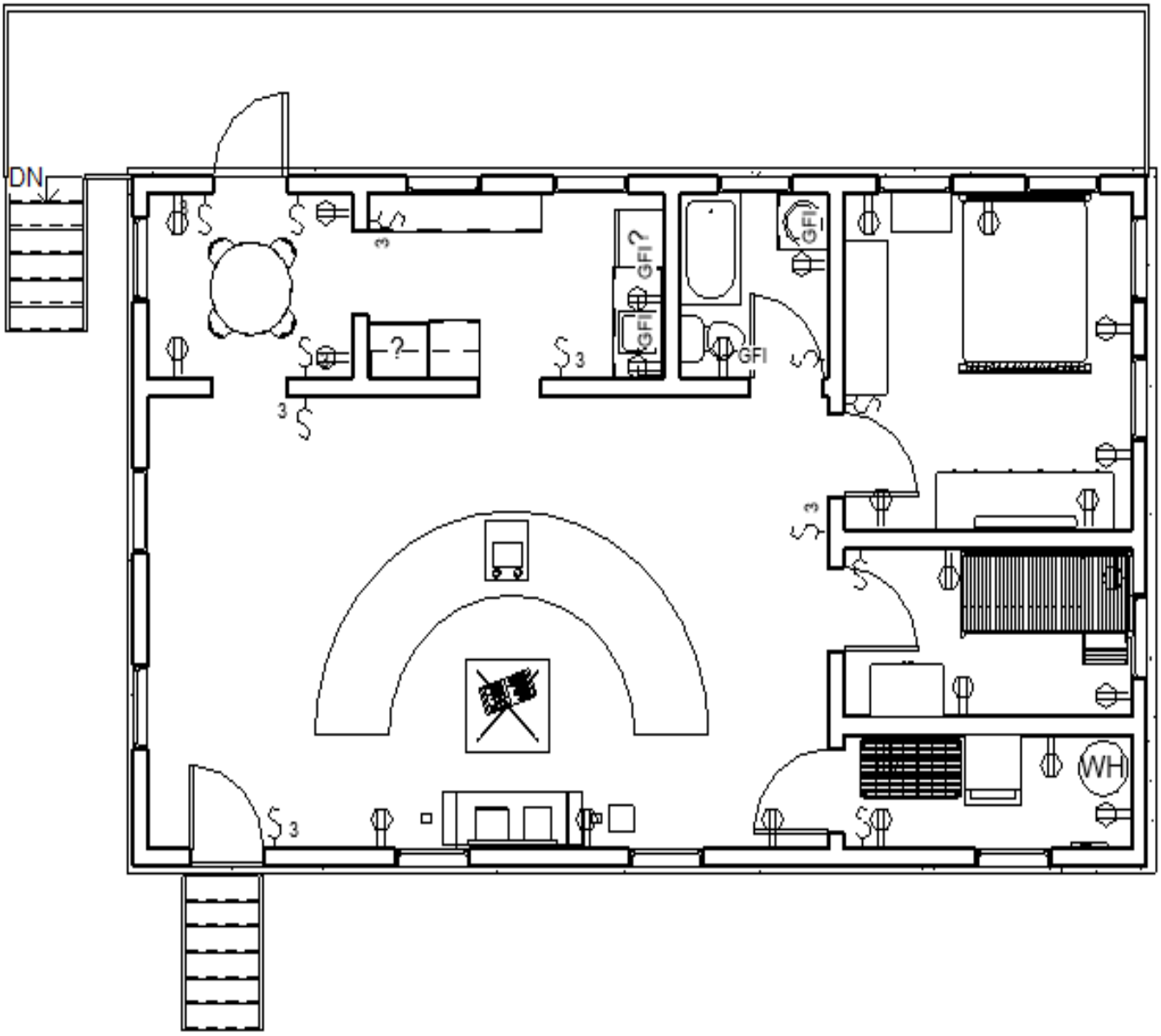
Using both rough sketches, I decided that the first design was a better, simpler plan for the house. I was also a better use of space and would reduce costs such plumbing and water since the bathroom and kitchen are closely placed. Although it was a great design, I made slight adjustments such as room area and I also moved the patio to the rear end of the house rather than the side.

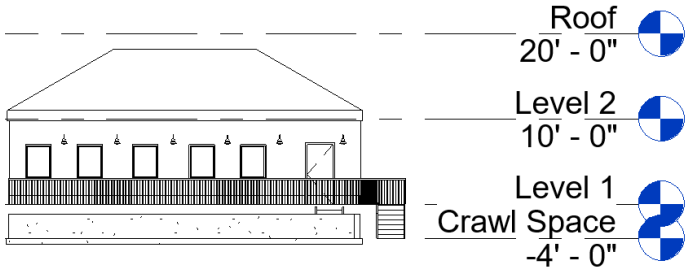
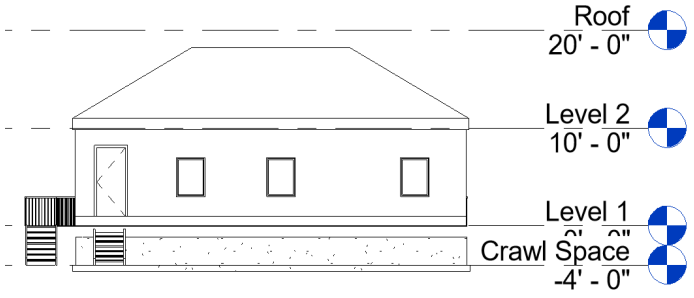
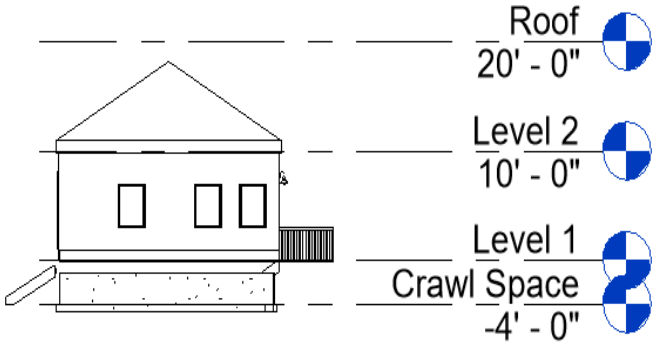
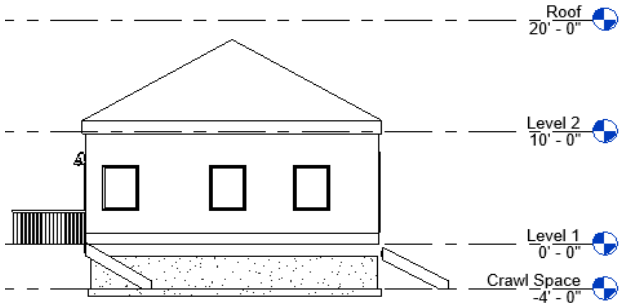
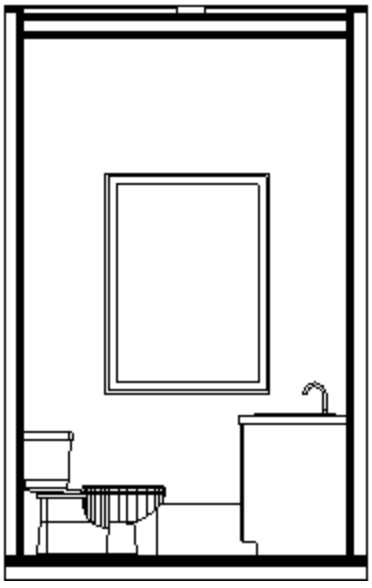
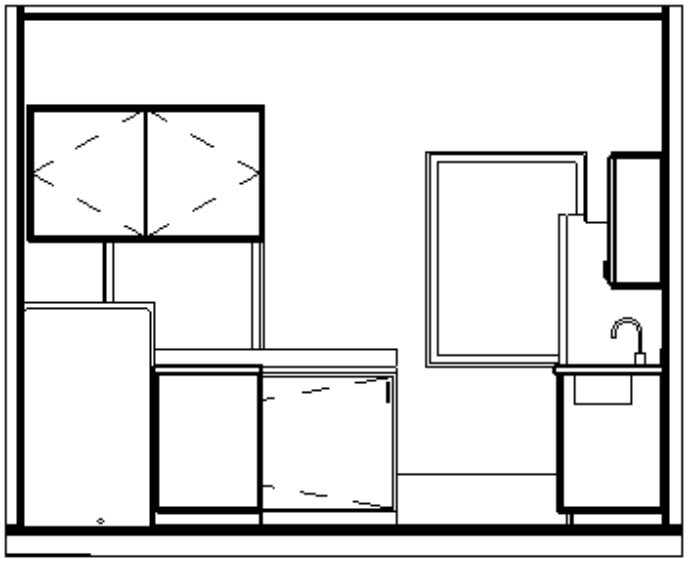
Construction Drawings

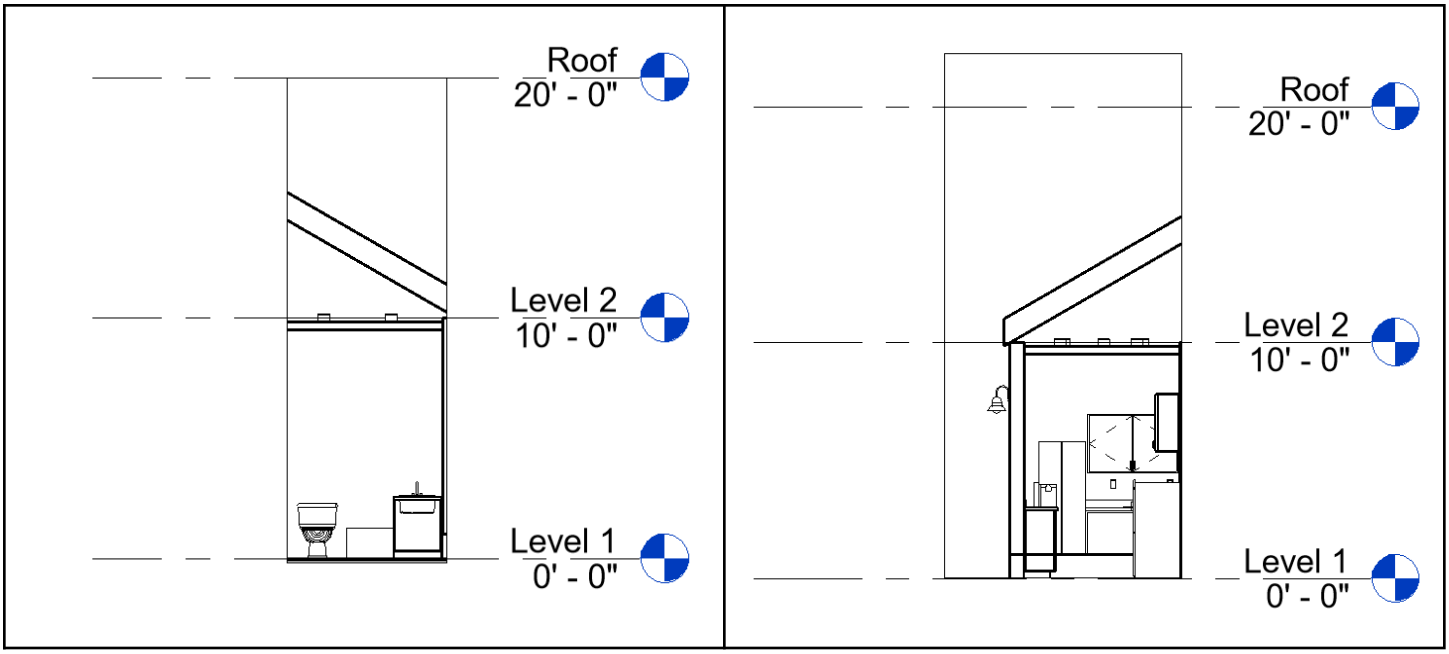
Site Plan



Floor Plan

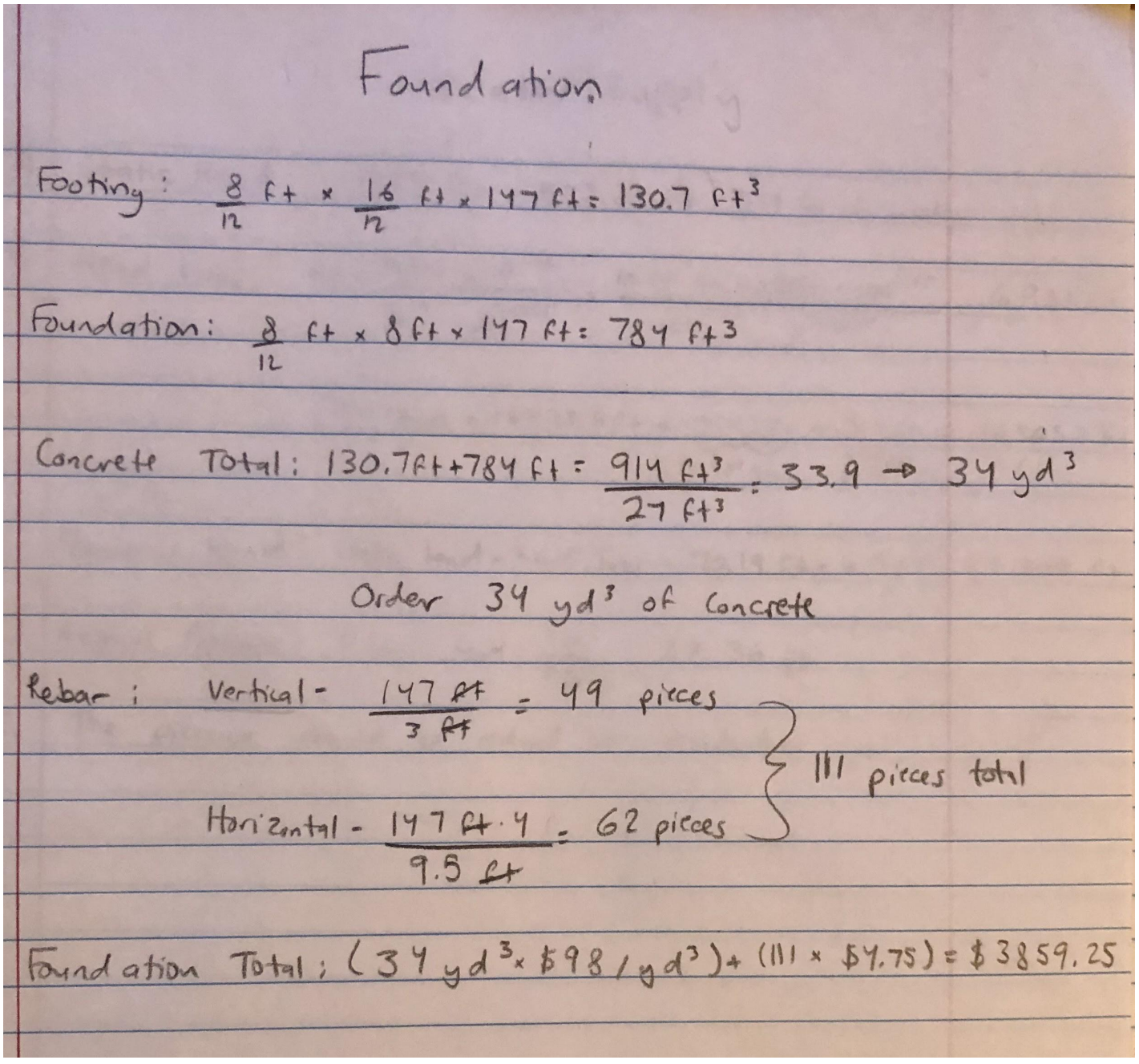


North Elevation	South Elevation
	
East Elevation	**West Elevation**
	
Bathroom Interior Elevation	**Kitchen Interior Elevation**
	


Roof
20' - 0"
Level 2
10' - 0"
Level 1
0' - 0"
Roof
20' - 0"
Level 2
10' - 0"
Level 1
0' - 0"

Calculations

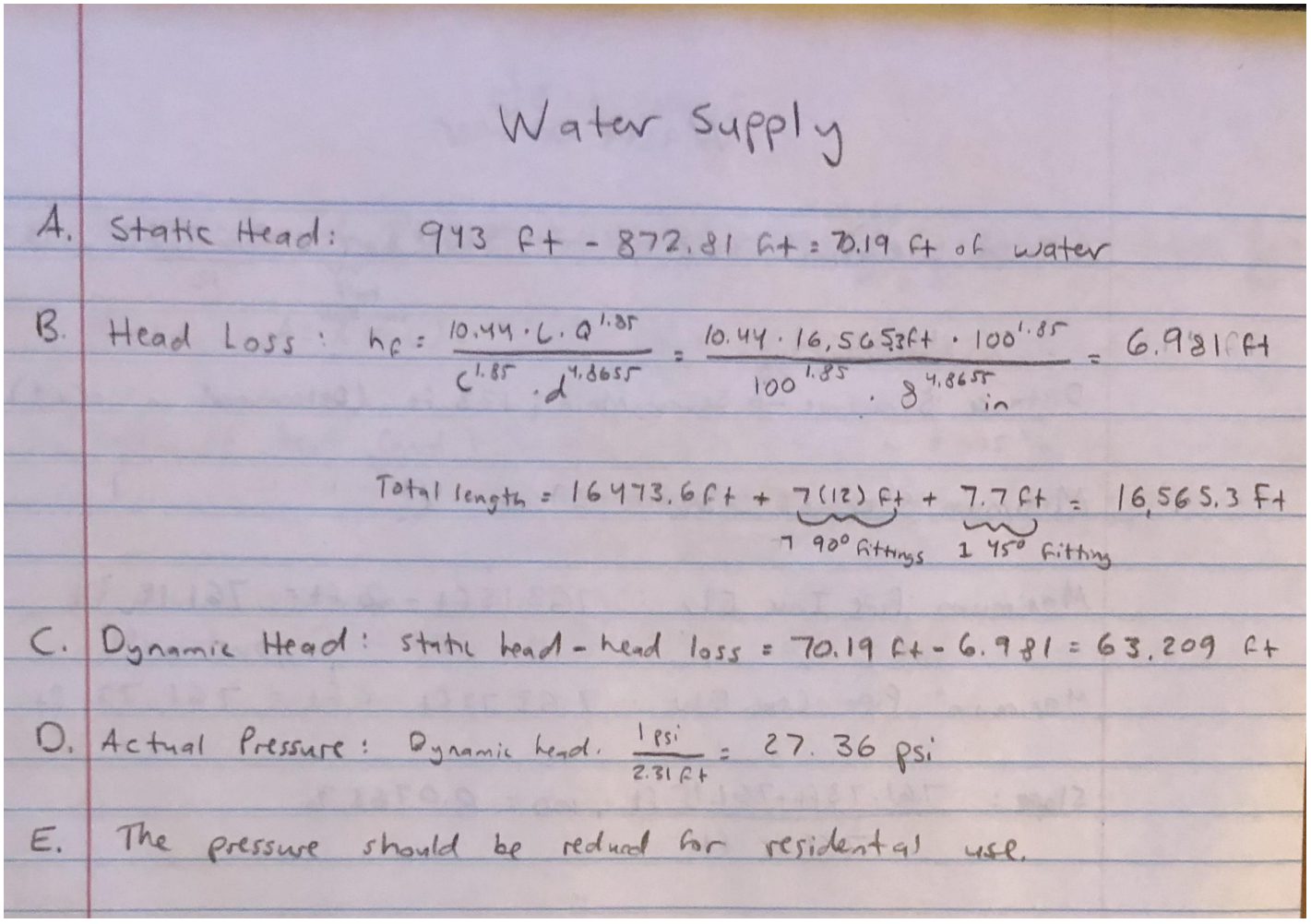
Concrete Foundation Calculation



Conclusion:

It will cost $3,859.25 to pay for the foundation of the house. This only covers supplies and cost for labor will increase the price for the foundation.

Water Supply Calculations



Water Supply

A. Static Head: 943 ft - 872.81 ft = 70.19 ft of water

B. Head Loss: $h_f = \frac{10.44 \cdot L \cdot Q^{1.85}}{C^{1.85} \cdot d^{4.8655}} = \frac{10.44 \cdot 16,565.3\,ft \cdot 100^{1.85}}{100^{1.85} \cdot 8^{4.8655}\,in} = 6.981\,ft$

Total length = 16473.6 ft + 7(12) ft + 7.7 ft = 16,565.3 Ft

7 90° fittings; 1 45° fitting

C. Dynamic Head: static head - head loss = 70.19 ft - 6.981 = 63.209 ft

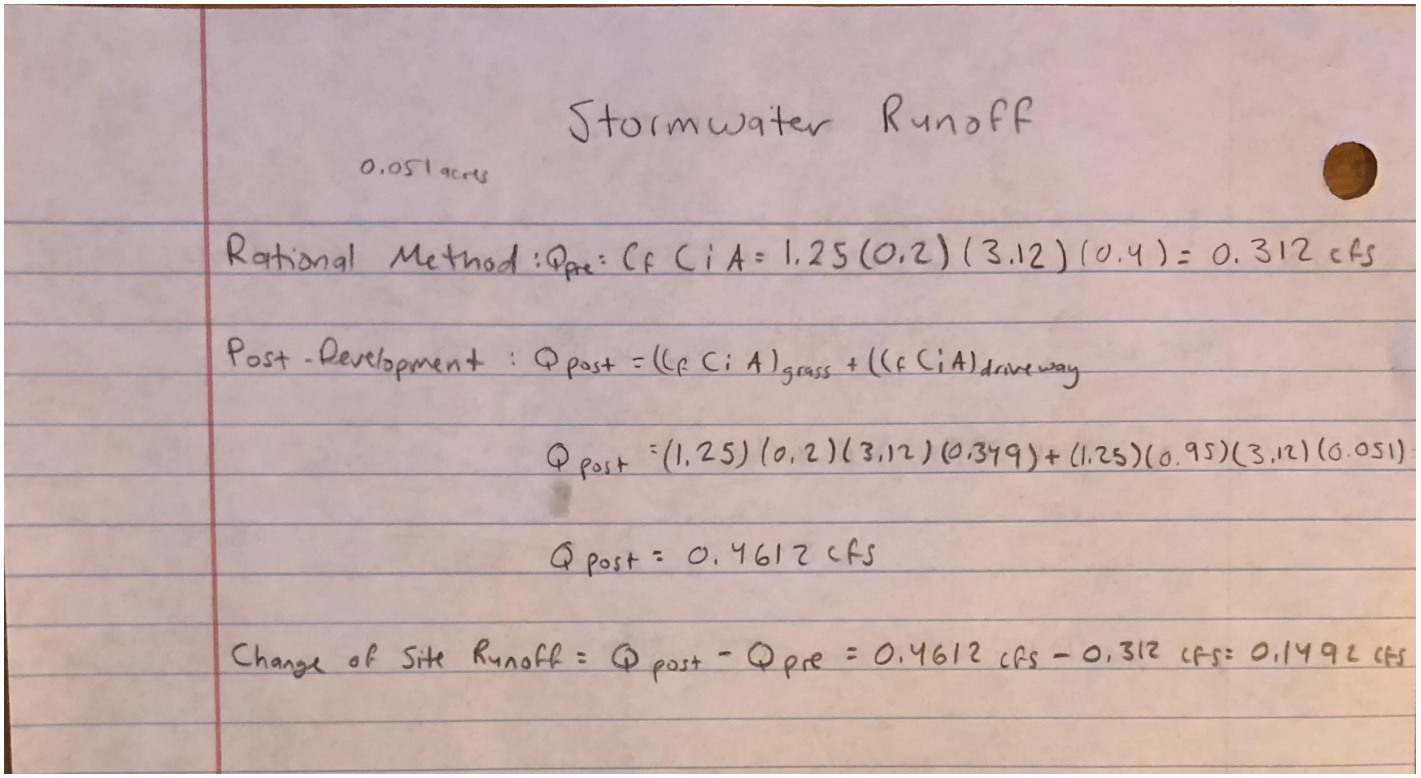
D. Actual Pressure: Dynamic head. $\frac{1\,psi}{2.31\,ft}$ = 27.36 psi

E. The pressure should be reduced for residental use.

Conclusion:

After conducting several calculations, I estimated that the water pressure of the home is 27.36 psi. This pressure is very strong and would cause damage in residential use. A pressure regulator will need to be installed.

Stormwater Runoff Calculations



Stormwater Runoff

0.051 acres

Rational Method: $Q_{pre} = C_f C i A = 1.25(0.2)(3.12)(0.4) = 0.312$ cfs

Post-Development: $Q_{post} = (C_f C i A)_{grass} + (C_f C i A)_{driveway}$

$Q_{post} = (1.25)(0.2)(3.12)(0.349) + (1.25)(0.95)(3.12)(0.051)$

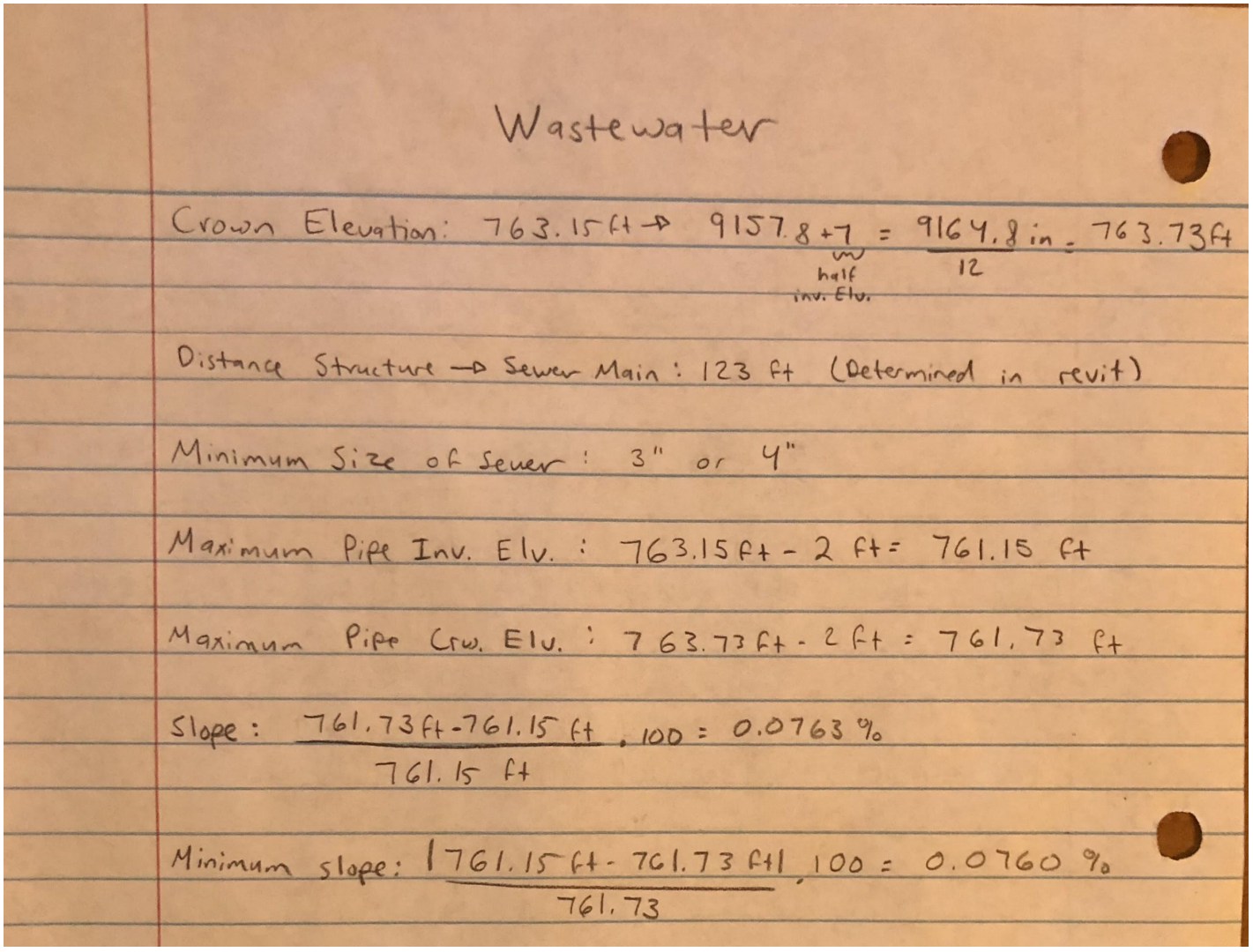
$Q_{post} = 0.4612$ cfs

Change of Site Runoff = $Q_{post} - Q_{pre} = 0.4612$ cfs $- 0.312$ cfs $= 0.1492$ cfs

Conclusion:

The stormwater runoff before the house was less than that of the stormwater runoff after the house. This means that the house and surrounding land is less vulnerable to floods.

Wastewater Calculations



Wastewater

Crown Elevation: 763.15 ft → 9157.8 + 7 (half inv. Elv.) = 9164.8 in / 12 = 763.73 ft

Distance Structure → Sewer Main: 123 ft (Determined in revit)

Minimum Size of Sewer: 3" or 4"

Maximum Pipe Inv. Elv.: 763.15 ft - 2 ft = 761.15 ft

Maximum Pipe Crw. Elv.: 763.73 ft - 2 ft = 761.73 ft

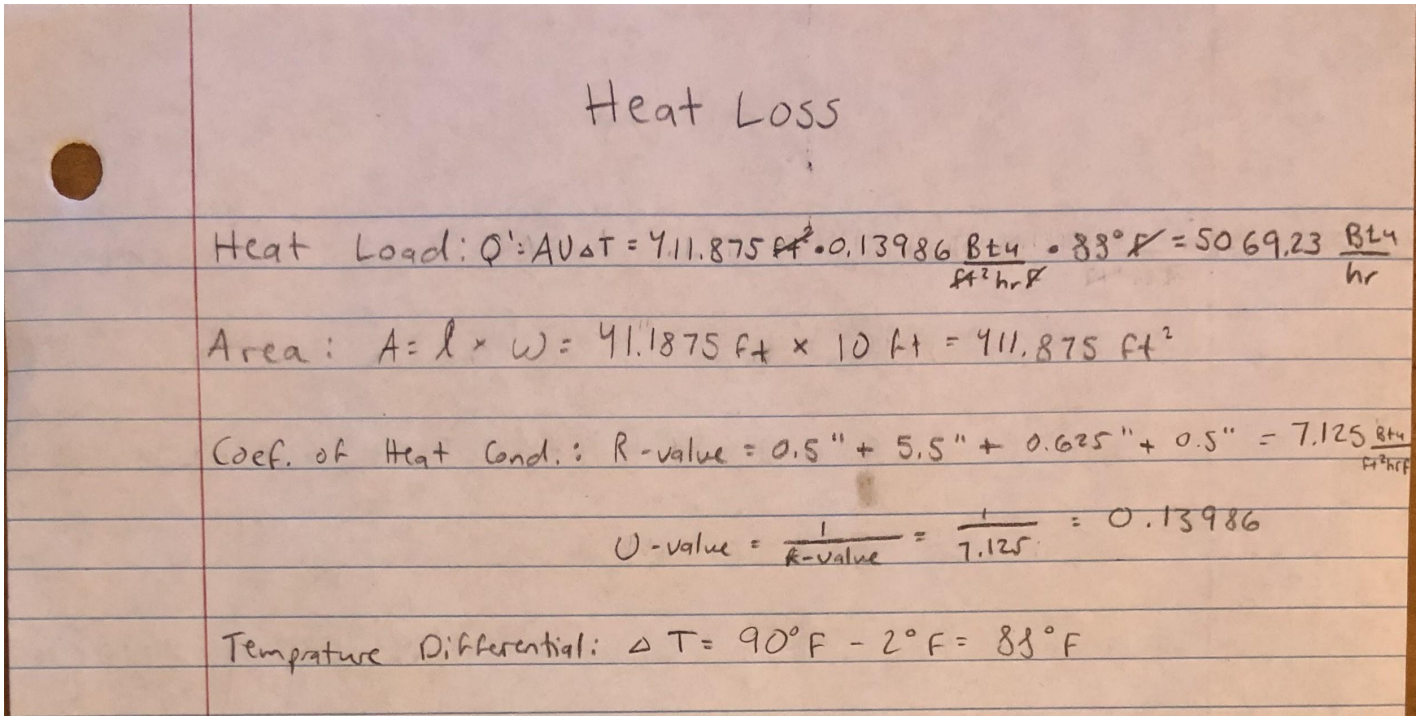
Slope: $\frac{761.73\text{ ft} - 761.15\text{ ft}}{761.15\text{ ft}} \cdot 100 = 0.0763\ \%$

Minimum slope: $\frac{|761.15\text{ ft} - 761.73\text{ ft}|}{761.73} \cdot 100 = 0.0760\ \%$

Conclusion:

Through several calculations, I determined the dimensions for the wastewater plumbing of the house. This data will be used by the construction workers to build the most efficient plumbing system possible for the home.

Heat Loss Calculations



Conclusion:

After several calculations, I determined that the heat loss of the home is 5069.23 Btu/hr