

Sustainable Single-Family Housing that is Affordable for the Average American Family Living in Non- Urban Environments

**Oral Defense Presentation
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Interior Design

Class of 2023

Rochester Institute of Technology



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01: Capstone Query

Capstone Question

Capstone Hypothesis

Why is it Important?

Question & Hypothesis

Question: How can a single-family home be sustainable and affordable for the average American household that lives in a non-urban environment?

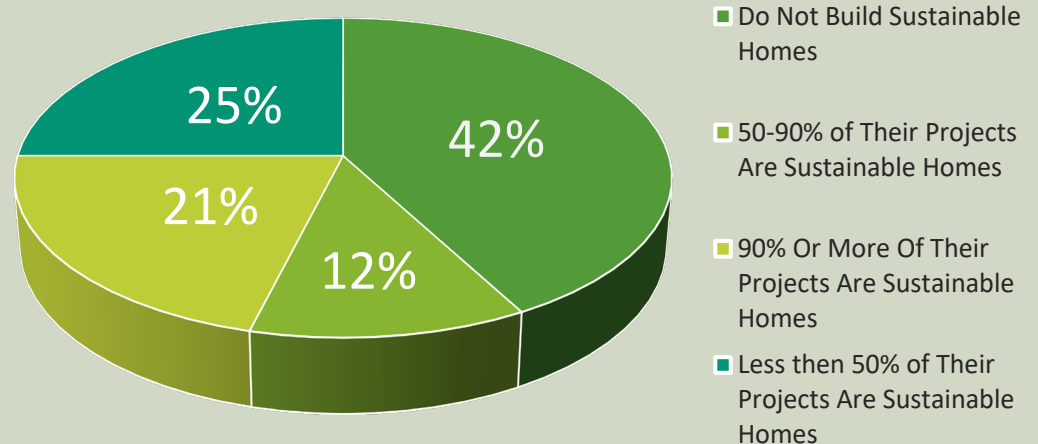
Hypothesis: By selecting the right building materials and methods of construction required for a sustainable home, it can be affordable for an average American family income.

Why Is It Important?

Sustainable houses usually are not affordable for the average American family

Conventional construction methods usually don't use the most sustainable practices and the materials used usually aren't the most sustainable

Percentage of Contractors Who Build Sustainable Homes



02: Literature Review

Definition of Sustainability

Definition of Affordability

Demographics of Naples

Urban vs Non-Urban Environments

Definition of Sustainability & Affordability

Sustainability

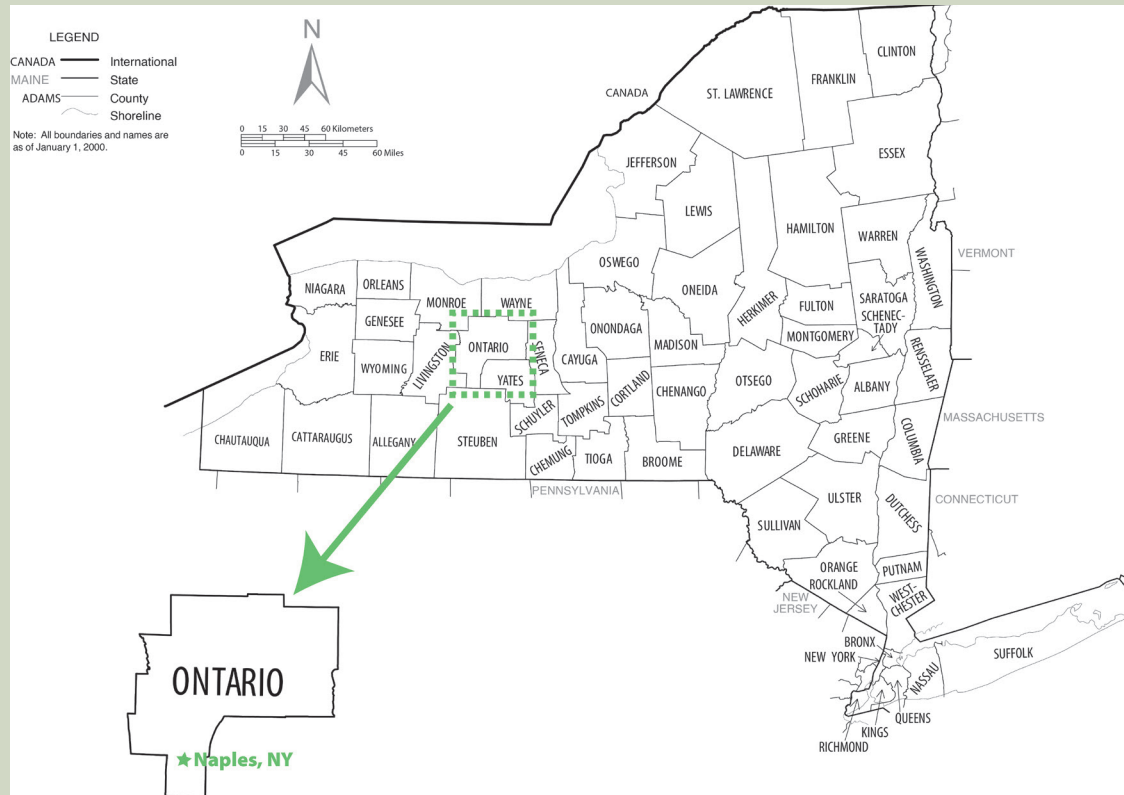
- No uniform definition for sustainability
- Should consider durability of material, make-up, and where the material is sourced/made
- Users are willing to pay up to 5% more for sustainable home

Affordability

- Housing shouldn't be an extra financial burden
- Affordability is relative to location

Demographics of Naples, New York

Location of Naples



Demographics of Naples

Number of Households located in Naples:
45,711 households

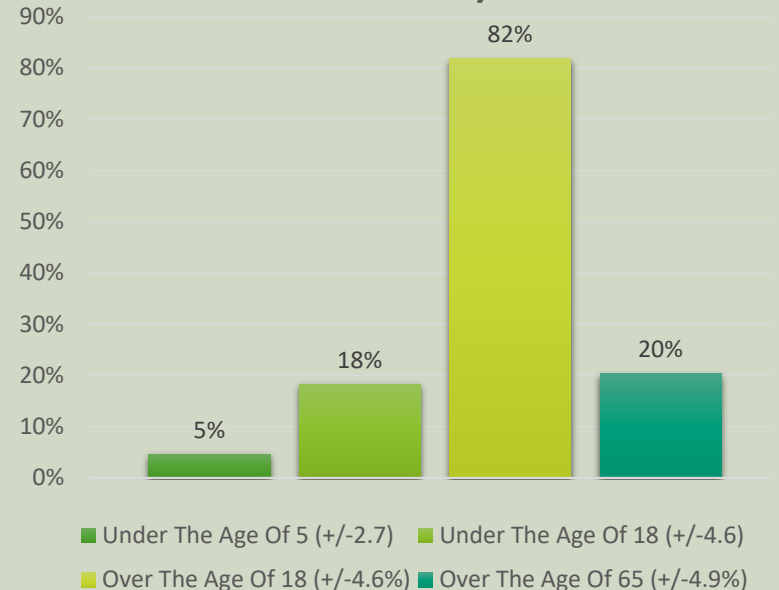
Average Persons Per Household:
2.3 average person per of household

Total Housing Units in Naples:
51,213 total housing units

Median Household Income: \$64,795

Population in Ontario County: 109,774

**Naples Population Age Range
(Rounded To The Nearest Whole
Percent)**



Urban vs Non-Urban Environments

Non-Urban Environment/Rural Areas

- “any population, housing, or territory NOT in an urban area” (My Map Series)

Urban Environment

- Population exceeds 50,000 people

Urban Cluster

- Population ranging from 2,500 to 50,000
- Also known as the suburbs
- Census would consider urban-cluster as part of the urban environment its closes to

Small Towns

- Can be considered rural or urban depending on population, even if its not near urban cluster or urban environment



Example of Non-Urban Environment, Henrico, Virginia



Example of Urban Environment, City of San Francisco, California

03: Research Agenda

Interview Highlights

Site Analysis

Material Analysis

Interview Highlights

Interviewee #1: Sustainable Contractor

- Sustainable design depends on end goals, but should be common sense
- Airtight homes tend to be better for achieving sustainable goals
- To achieve more sustainable building, engineers, architects, and designers need work together

Interviewee #2: Residential Contractor

Traditional towns are:

- Skeptical of sustainable design
- Tend to be not be open to change
- Afraid sustainable design won't match the architectural aesthetics of town

Interviewee #3: Affordable Developer

Affordable sustainable multifamily housing is possible due to:

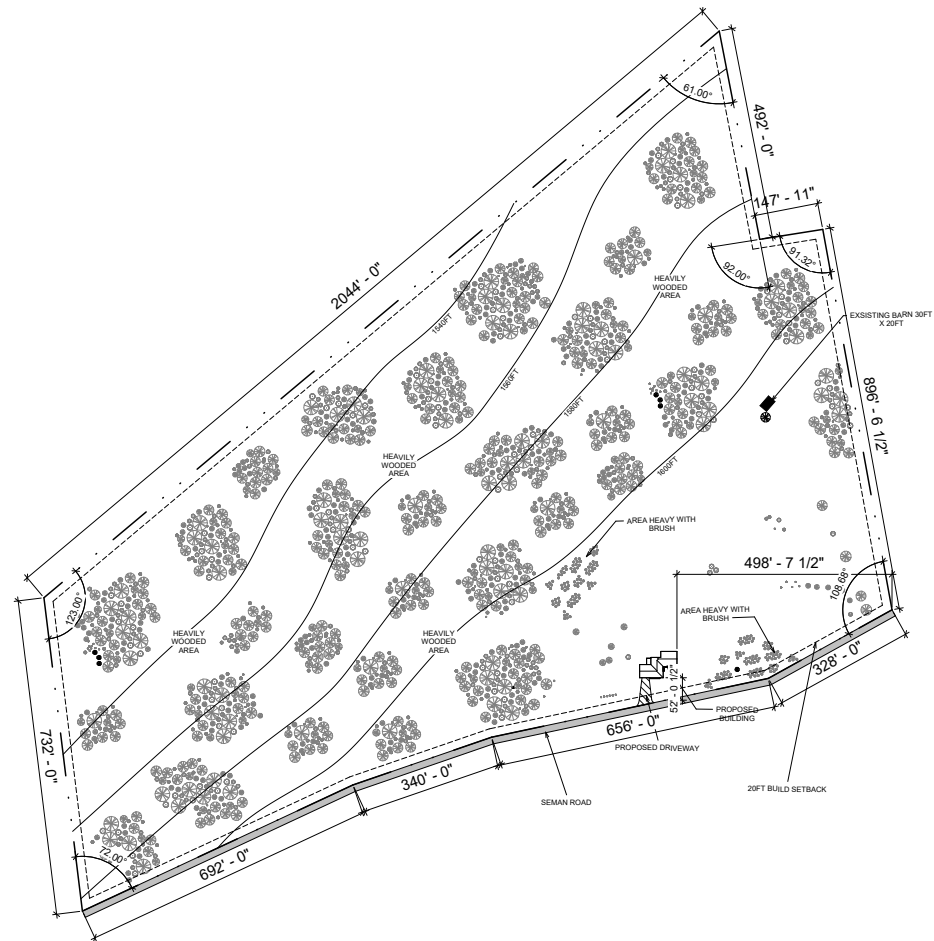
- Operating in Low-Income Tax Bracket
- Money received from the city and investors
- Capital Gain Funding

Site Analysis

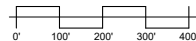
Town to Site Relation



Site Plan



SITE PLAN
1"=100'-0"



Sun Analysis



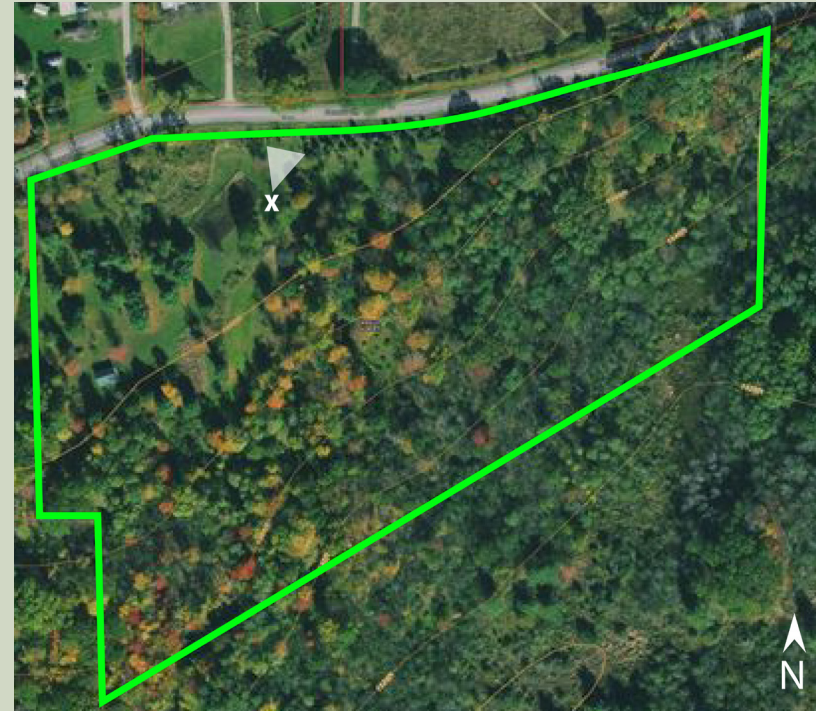
Wind Analysis



Property Street Views



Property Entryway



Potential Build Site



Material Analysis

Key Material Selection



T-Studs



Hemp Fiber Insulation



ZIP Exterior Sheathing

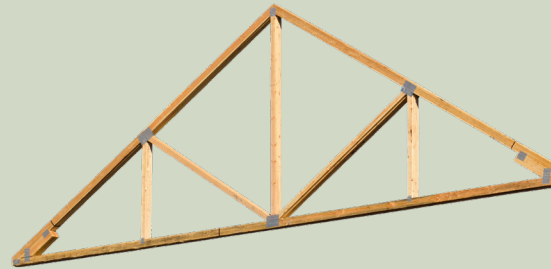


EcoStar Synthetic
Roofing Shingles

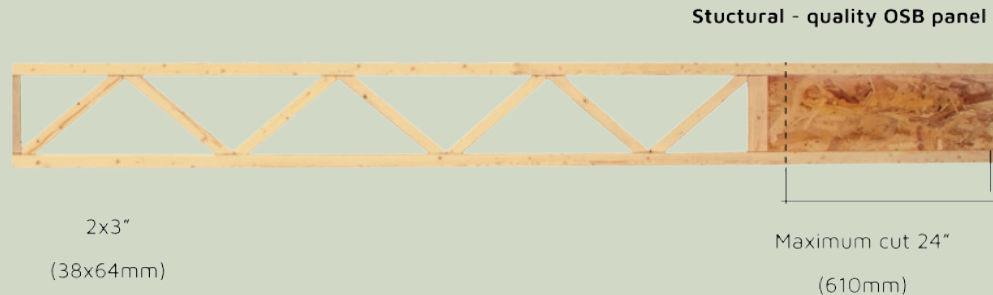


LP SmartSide Siding

Key Material Selection



Pre-Engineered Trusses



Triforce Pre-Engineered Floor Joist

04: Creative Agenda

Concept Statement

Project Goals

User Profiles

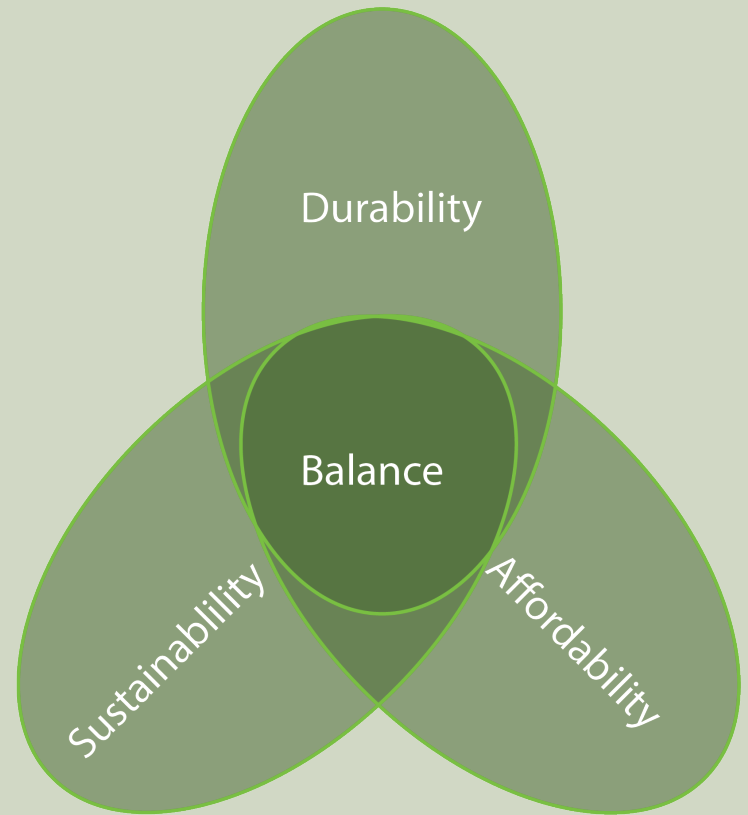
Architectural Drawings

Renderings

Cost Analysis

Concept Statement

Balance is a necessity for life. Without balance every aspect of life would be **unsteady**. Balance will serve as the concept for this project when selecting materials, keeping in mind the three key factors of **sustainability**, **affordability**, and **durability**.



Project Goals

1. Cost of home is equivalent to cost of a conventional home or within a 5% price increase
2. Balance cost and sustainability factors
3. Design a home that is functional for families

User Profiles

The Smith Family



David



Beth



Joey



Sarah

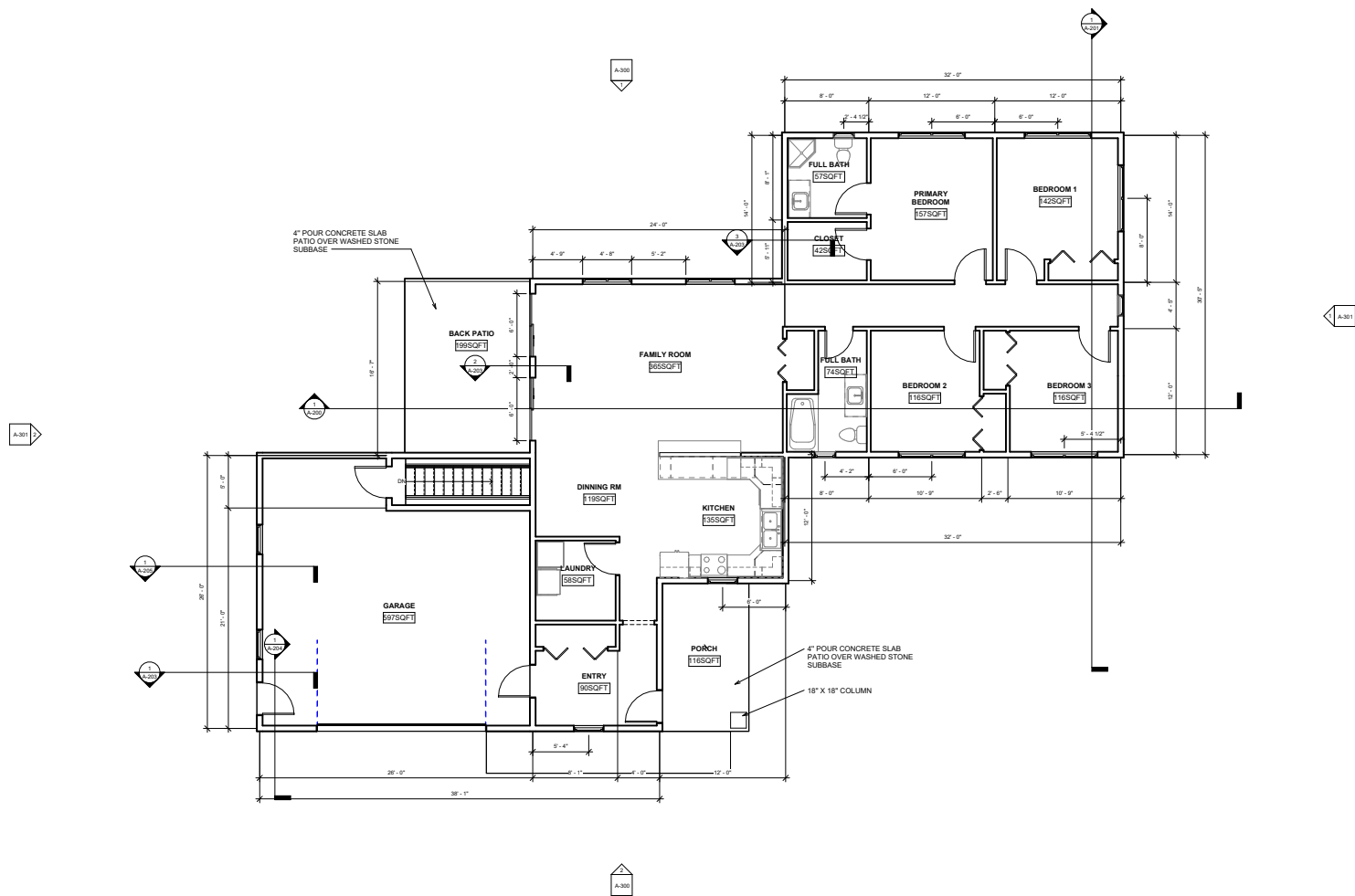


Alice

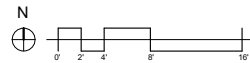
- Very active family that loves the outdoors
- Busy between their three children and their activities
- Family time is important
- David and Beth would like a **4 bed** and **2 bath** home
 - Beth would love if each child has their own room, allowing each child to have their own space
- David wants an **open kitchen** so he can still be part of the family even when he is cooking
- Beth would love if the entry into the home had room for shoe and coat **storage**.

Architectural Drawings

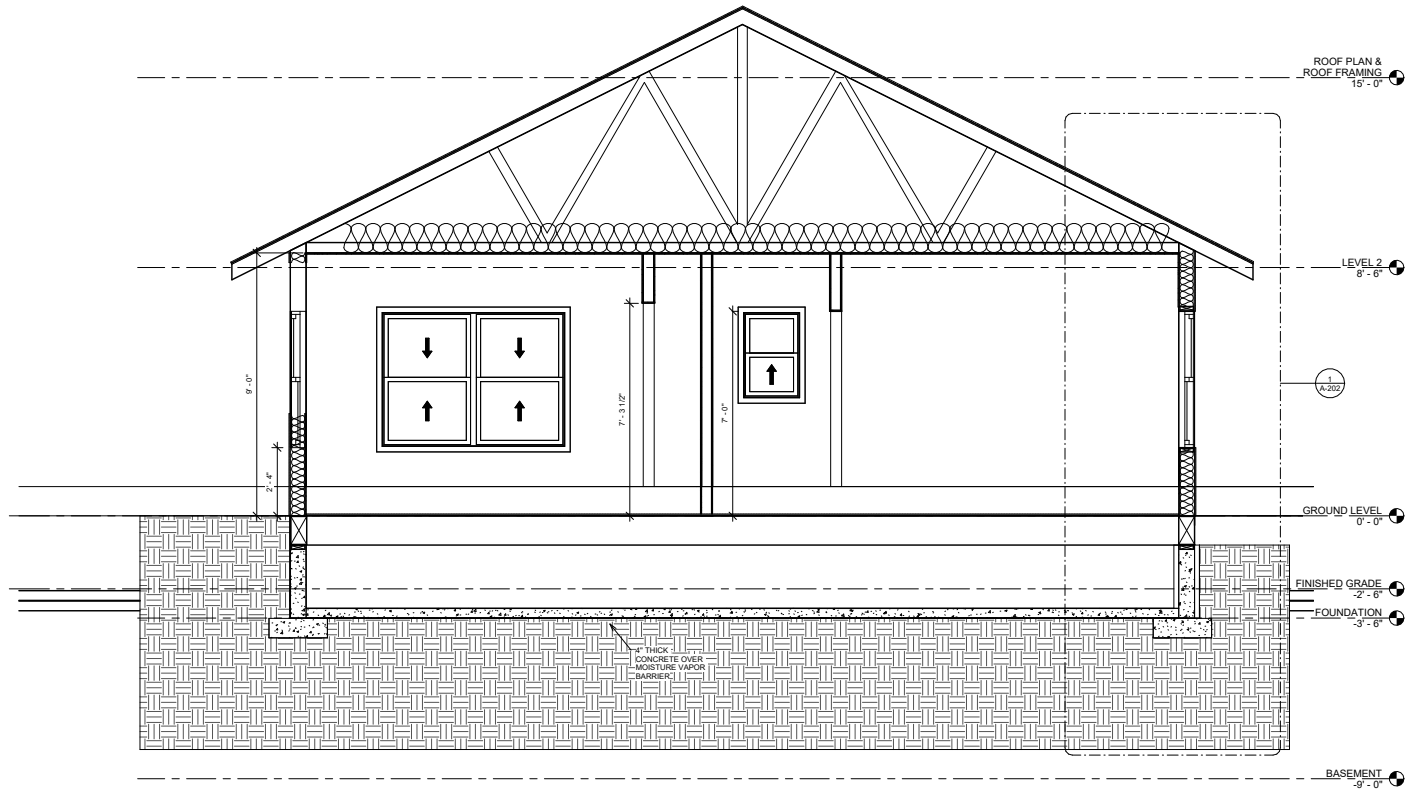
Floor Plan



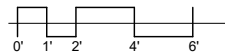
FLOOR PLAN
1/4"=1'-0"



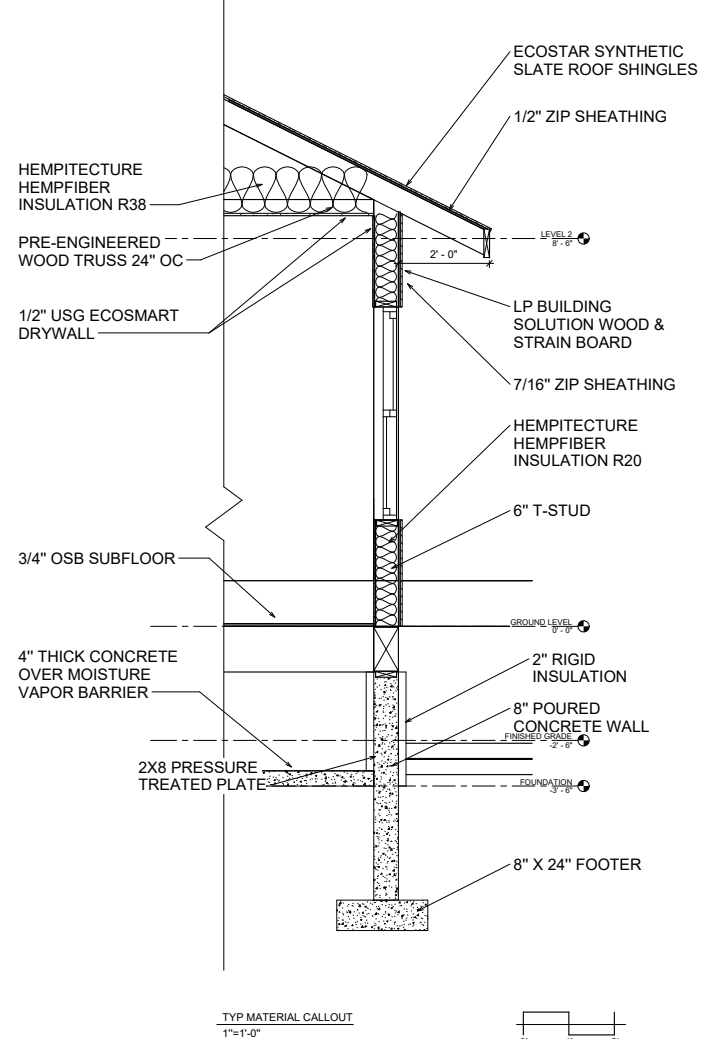
Typical Gable Section



TYP GABLE SECTION
1/2" = 1'



Typical Wall Detail



Renderings

Street View



Back View of House



Cost Analysis

Component	Material Type	Quantity	Unit	Unit Cost	Total
Concrete Foundation		58	cuyds	\$250.00	\$14,500.00
Footings	Concrete	14	cuyds	\$250.00	\$3,500.00
Walls	Concrete	44	cuyds	\$250.00	\$11,000.00
concrete floors		2,700	sqft	\$3.15	\$8,500.00
Crawl Space	Concrete	12	cuyds	\$250.00	\$3,000.00
Basement	Concrete	13	cuyds	\$250.00	\$3,250.00
Garage	Concrete	9	cuyds	\$250.00	\$2,250.00
Floor Framing Assembly		1,842	sqft	\$15.94	\$29,362.50
Sill Plate 2 X 6	Treated 2 X 6	226	linft	\$1.75	\$395.50
Steel Beams	Steel	124	linft	\$150.00	\$18,600.00
Floor Joist 2 X 12	Fir 2 X 12	1,950	linft	\$3.50	\$6,825.00
Floor Sheathing	3/4" Advantech	2,024	sqft	\$1.75	\$3,542.00
Frame Perimeter Walls		278	linft	\$20.74	\$5,765.03
Bottom Plate	Fir 2 X 6	278	linft	\$1.25	\$347.50
Wall Studs	Fir 2 X 6	209	each	\$11.25	\$2,345.63
Top Plate	Fir 2 X 6	278	linft	\$1.25	\$347.50
Second Top Plate	Fir 2 X 6	278	linft	\$1.25	\$347.50
Wall Sheathing	1/2" OSB	2,502	sqft	\$0.95	\$2,376.90
Frame Interior Walls		232	linft	\$12.19	\$2,827.50
Bottom Plate	Fir 2 X 6	232	linft	\$1.25	\$290.00
Wall Studs	Fir 2 X 6	174	each	\$11.25	\$1,957.50
Top Plate	Fir 2 X 6	232	linft	\$1.25	\$290.00
Second Top Plate	Fir 2 X 6	232	linft	\$1.25	\$290.00
Roof Framing		3,800	sqft	\$3.62	\$13,760.00
Rafters	Fir 2 X 12	2,900	linft	\$3.50	\$10,150.00
Roof Sheathing	1/2" OSB	3,800	sqft	\$0.95	\$3,610.00
Roofing		3,800	sqft	\$2.85	\$10,830.00
Roof Weather Barrier	GAF Deck Armor	3,800	sqft	\$0.35	\$1,330.00
Roof Material	Timberline HDZ	3,800	sqft	\$2.50	\$9,500.00
Building Insulation		5,202	sqft	\$1.32	\$6,841.80
Exterior Walls	R-19 Fiberglass	2,502	sqft	\$0.90	\$2,251.80
Ceilings	R-38 Fiberglass	2,700	sqft	\$1.70	\$4,590.00
Drywall Ceilings and Walls		9,378	sqft	\$0.65	\$6,095.70
Drywall Exterior Walls		2,502	sqft	\$0.65	\$1,626.30
Drywall Interior Walls		4,176	sqft	\$0.65	\$2,714.40
Drywall Ceilings		2,700	sqft	\$0.65	\$1,755.00
Siding and Trims		2,784	sqft	\$2.75	\$7,656.00
Walls	Ply Gem Vinyl	2,502	sqft	\$2.50	\$6,255.00
Gables	Ply Gem Vinyl	282	sqft	\$2.50	\$705.00
Exterior Moisture Barrier	Tyvek	2,784	sqft	\$0.25	\$696.00
Windows and Doors		1	lot	\$19,800.00	\$19,800.00
Windows Small	Anderson	6	each	\$450.00	\$2,700.00
Windows Large	Anderson	7	each	\$750.00	\$5,250.00
Sliding Doors	Anderson	2	each	\$1,250.00	\$2,500.00
Interior Doors	Masonite	14	each	\$350.00	\$4,900.00
Exterior Doors	Masonite	3	each	\$650.00	\$1,950.00
Overhead Door	Wayne Dalton	1	each	\$2,500.00	\$2,500.00

Total Cost \$125,938.53

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Concrete Foundation		58	cuyds	\$250.00	\$14,500.00
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Garage	Concrete	9	cuyds	\$250.00	\$2,250.00
Floor Framing Assembly		1,842	sqft	\$7.93	\$14,614.50
Sill Plate 2 X 6	Treated 2 X 6	226	linft	\$1.25	\$282.50
Steel Beams	Steel	124	linft	\$0.00	\$0.00
Floor Joist	Triforce Pre-Eng	1,079	linft	\$10.00	\$10,790.00
Floor Sheathing	3/4" Advantech	2,024	sqft	\$1.75	\$3,542.00
Perimeter Walls		278	linft	\$26.30	\$7,311.40
Bottom Plate	Fir 2 X 6	278	linft	\$1.75	\$486.50
Wall Studs	6" T-Studs	139	each	\$27.00	\$3,753.00
Top Plate	Fir 2 X 6	278	linft	\$1.25	\$347.50
Second Top Plate	Fir 2 X 6	278	linft	\$1.25	\$347.50
Wall Sheathing	1/2" ZIP Sheathing	2,502	sqft	\$0.95	\$2,376.90
Frame Interior Walls		232	linft	\$17.25	\$4,002.00
Bottom Plate	Fir 2 X 6	232	linft	\$1.25	\$290.00
Wall Studs	6" T-Studs	116	each	\$27.00	\$3,132.00
Top Plate	Fir 2 X 6	232	linft	\$1.25	\$290.00
Second Top Plate	Fir 2 X 6	232	linft	\$1.25	\$290.00
Roof Framing		3,800	sqft	\$3.08	\$11,710.00
Rafters	Pre-Eng Trusses	54	each	\$150.00	\$8,100.00
Roof Sheathing	7/16" ZIP Sheathing	3,800	sqft	\$0.95	\$3,610.00
Roofing		3,800	sqft	\$5.50	\$20,900.00
Roof Weather Barrier	GAF Deck Armor	3,800	sqft	\$0.00	\$0.00
Roof Material	EcoStar Synthetic Slate	3,800	sqft	\$5.50	\$20,900.00
Building Insulation		5,202	sqft	\$5.50	\$28,603.13
Exterior Walls	R-20 Hemp Fiber	2,502	sqft	\$4.69	\$11,728.13
Ceilings	R-38 Hemp Fiber	2,700	sqft	\$6.25	\$16,875.00
Drywall Ceilings and Walls		9,378	sqft	\$0.65	\$6,095.70
Drywall Exterior Walls	USG Eco Smart Drywall	2,502	sqft	\$0.65	\$1,626.30
Drywall Interior Walls	USG Eco Smart Drywall	4,176	sqft	\$0.65	\$2,714.40
Drywall Ceilings	USG Eco Smart Drywall	2,700	sqft	\$0.65	\$1,755.00
Siding and Trims		2,784	sqft	\$2.15	\$5,985.60
Walls	LP SmartSide Wood Board	2,502	sqft	\$2.15	\$5,379.30
Gables	LP SmartSide Wood Board	282	sqft	\$2.15	\$606.30
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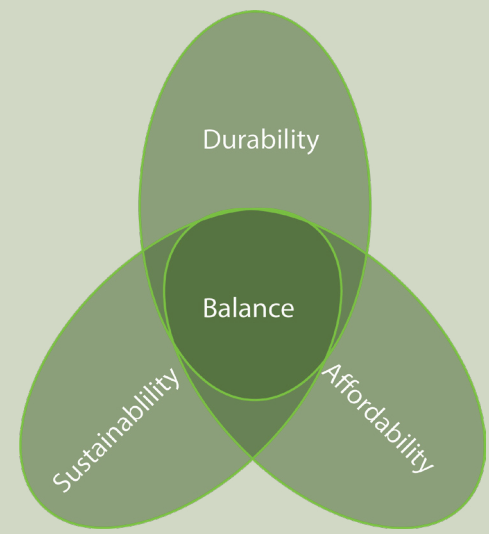
Total Cost \$142,022.33

Added Cost for Prototypical Materials \$16,083.80
Percentage Increase 12.77%

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Exterior Moisture Barrier	Tyvek	2,784	sqft	\$0.25	\$696.00	Exterior Moisture Barrier	Tyvek	2,784	sqft	\$0.00	\$0.00
Total Cost					\$125,938.53	Total Cost					\$142,022.33

Added Cost for Prototypical Materials \$16,083.80
Percentage Increase 12.77%

05: Capstone Conclusion



Constructing a single-family sustainable home will cost 12.77% more compared to the cost of constructing a conventional home

Future investigation should be completed to compare the cost of a home over its life-cycle

THANK YOU!

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