A New Norris House

Sponsored by AIA Housing Knowledge Community

www.aia.org/housing

Good design
makes a difference™

THE AMERICAN INSTITUTE OF ARCHITECTS

Future, Free AIA Webinars

November 6

Everything You Need to Know: AIA Contract Documents for Small Firms

December 3

BY-RIGHT/BY-DESIGN: Los Angeles Housing Designed & Developed

December 10

LEED, IgCC and AIA Sustainable Projects Contract Documents

Register at No Cost

http://network.aia.org/events/webinars

Re-View the Research Series on YouTube

All past webinars are available on the AIA Housing Knowledge Community playlist including:

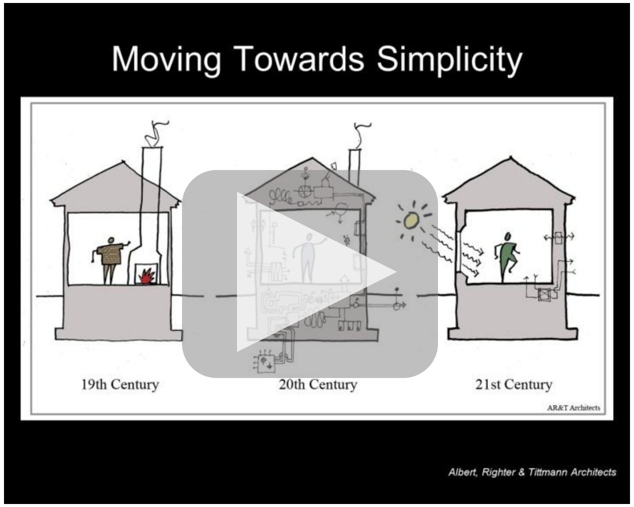
Form Follows Energy

Research, Building Science and Architecture

Detailing for Durability

Healthy Homes Research

Researching Resiliency



http://network.aia.org/hkc/home/WebinarSeries

Copyright Materials

Compliance Statement

“AIA Knowledge” is a Registered Provider with The American Institute of Architects Continuing Education System (AIA/CES). Credit(s) earned on completion of this program will be reported to AIA/CES for AIA members. Certificates of Completion for both AIA members and non-AIA members are available upon request.

This program is registered with AIA/CES for continuing professional education. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the AIA of any material of construction or any method or manner of handling, using, distributing, or dealing in any material or product.

Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

AIA/CES Reporting Details

All attendees will be eligible to receive:
1 HSW/SD CEH (AIA continuing education) or
1 IDP Hour (Supplemental Experience).

All attendees at your site will submit for credit by completing the webinar survey/report form.

The URL to the survey/form will be listed at the end of the presentation *and* emailed to attendees. Certificates of Completion can be download at the end of the survey.

Continuing education questions can be directed to knowledgecommunities@aia.org.

Course Description 1 of 2

Tricia Stuth, AIA, and Samuel Mortimer, Assoc. AIA, of the University of Tennessee in Knoxville use the data collected from the New Norris House's 52 monitoring sensors to discuss water efficiency, modular construction efficiency, community integration, and indoor environmental air quality.

The New Norris House achieved LEED for Homes Platinum certification and was recognized with numerous awards, including the EPA P3 Award, a Residential Architect Merit Award for single-family housing, an AIA East Tennessee Honor Award, and an NCARB Prize for the Creative Integration of Research and Practice.

Course Description

Background: In 1933, the Tennessee Valley Authority created a model community in Norris, Tennessee as part of the Norris Dam construction project. A key feature of this New Deal village was the Norris House, a series of home designs built for modern, efficient, and sustainable living. In light of the 75th anniversary of the Norris Project, a design/build university team created a 21st century New Norris House. Collaborating with a large modular home builder and various regulatory bodies, the team completed the demonstration home and landscape in 2.5 years.

Learning Objectives

1. Integrate water resource systems (such as rainwater, greywater, and stormwater) into residential projects, and understand how they relate to Water Efficiency (WE) within LEED for Homes.
2. Understand the limitations and benefits of off-site fabrication and on-site construction, and how they relate to Materials and Resources (MR) within LEED for Homes.
3. Approach the community design process, the integration of contemporary structures into historic neighborhoods, and arising benefits from Locations and Linkages (LL) within LEED for Homes.
4. Approach indoor environmental air quality (IEQ) in small homes and associated IEQ LEED for Homes issues.

Samuel Mortimer, Assoc. AIA
University of Tennessee
Knoxville
Speaker

Tricia Stuth, AIA
University of Tennessee
Knoxville
Speaker

Stephen Schreiber, FAIA
University of Massachusetts
Amherst
Moderator

Submit a question to the moderator via the Chat box. They will be answered as time allows.

A New Norris House

THE UNIVERSITY of TENNESSEE
KNOXVILLE

College of Architecture & Design

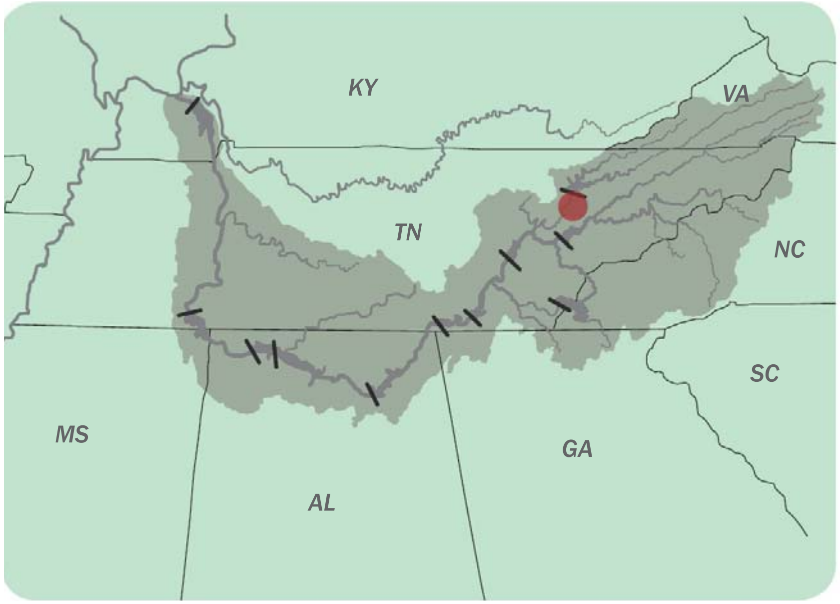
A New Norris House

Webinar Presentation Outline

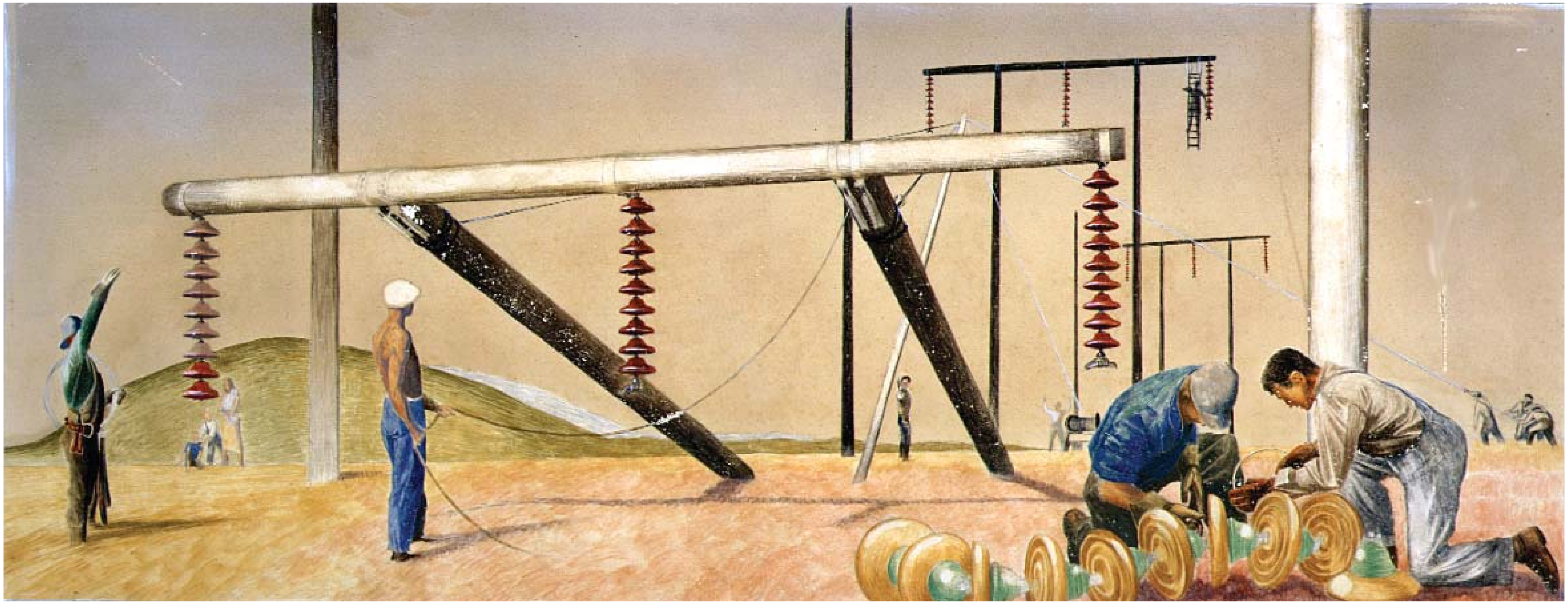
I. History – TVA and The Norris Project
II. Overview – A New Norris House
III. Water Resource Systems
IV: On- and Off-site Construction
V: Post-occupancy Evaluation
VI: Community Design

I. History – TVA and The Norris Project

Geographic and Social Context

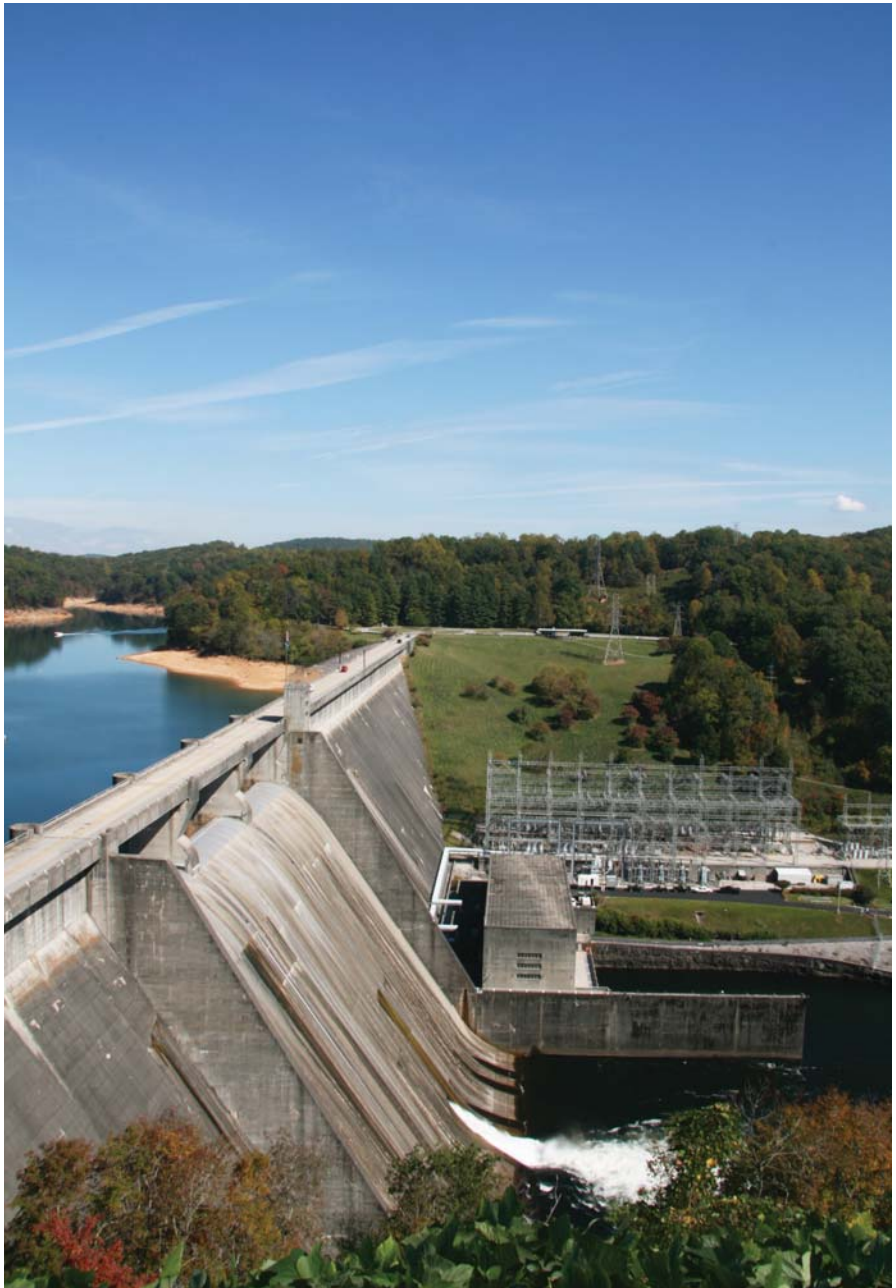


Electrification by David Stone Martin (casein tempura on canvas, 4' 5-1/4" x 11' 10-1/2")
Mural in the Lenoir City Post Office, Loudon County, Tennessee.



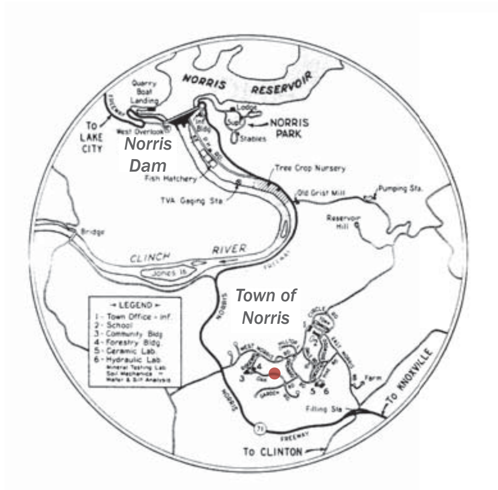
I. History – TVA and The Norris Project

Power and Flood Control



I. History – TVA and The Norris Project

A Planned Garden City



Area: Norris Dam and Town of Norris

Neighborhood

01 Project Site
02 Commercial/Post Office
03 Middle School
04 Town Common
05 Elementary School
06 Forest Conservation Area
07 Shared Parking Garage (all demolished)

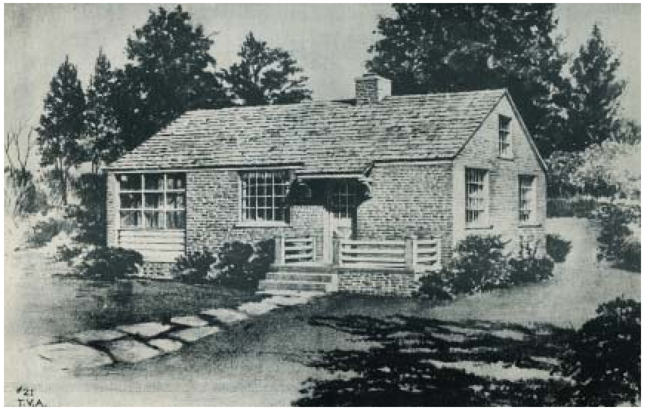
Town Walking Paths
1/2 mile to Town Center
Town Streets

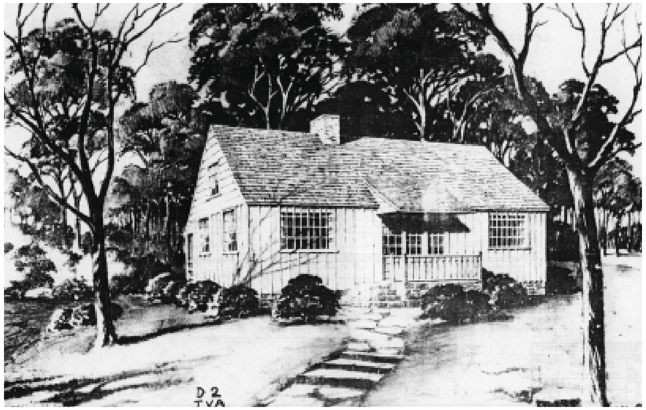
Historically, construction workers for public works lived in temporary camps. Norris Dam workers were joined by technical and professional staff and their families, and remained for longer. The TVA built a permanent town that would, at a smaller scale, reflect its larger vision of stewardship and innovation for the betterment of society. The town is one of the first “planned communities” and “garden cities” in the US.

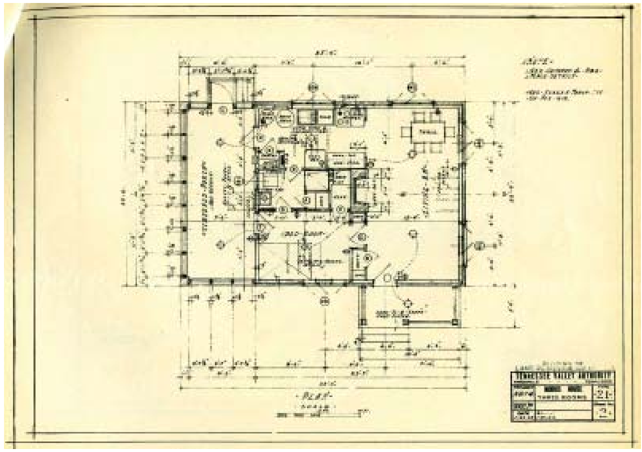
The town was supported by a strong community center (exaclty 1/2 mile from the New Norris House by walking path) and was originally planned to operate economically around several small cooperative industries. The original Norris plan accommodated shared garages, which were utilized by the surrounding cluster of homes and connected by a network of walking paths. While the garages no longer exist, the walking paths remain.

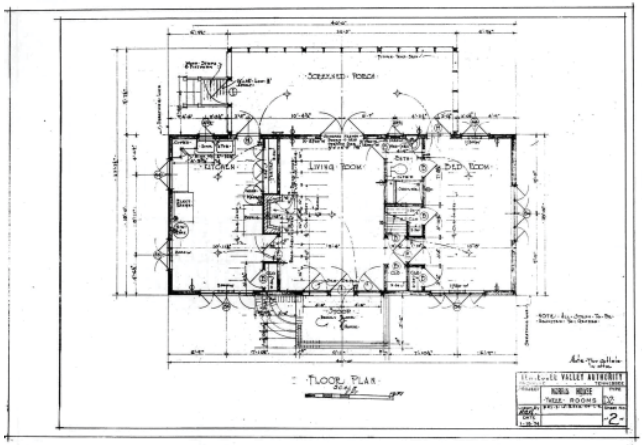
Today, Norris is largely a bedroom community for nearby Oak Ridge and Knoxville. Many original homes have been enlarged and modified to accommodate more contemporary lifestyles.

Norris Homes (1932 - 1936)









Original Homes

- 281 New single homes
- 10 Duplex homes
- Apartments for 30 familes

- Housing for 350 familes
- Approximently 1,500 people

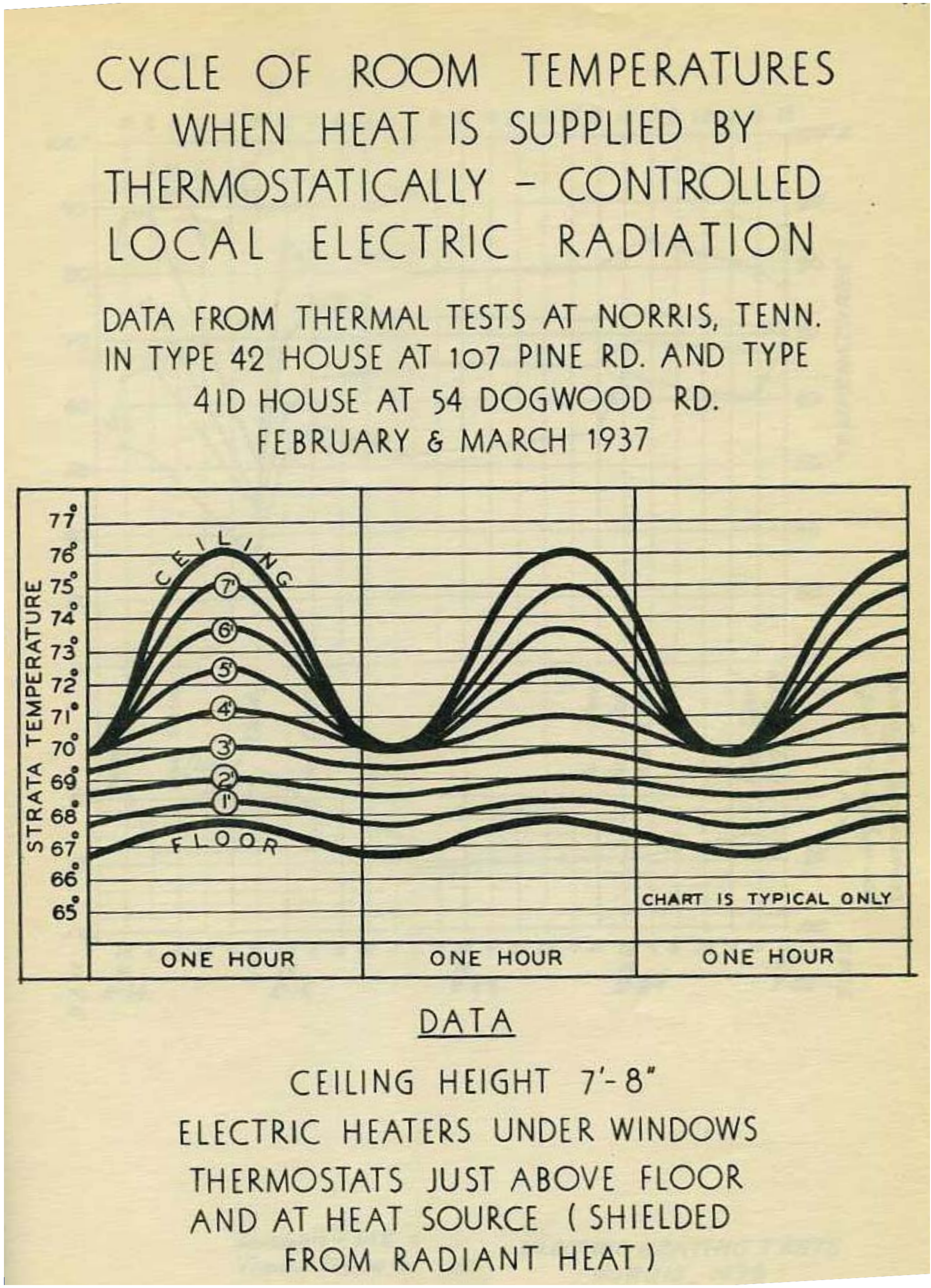
- Average square footage
500 - 1400 sq.ft.

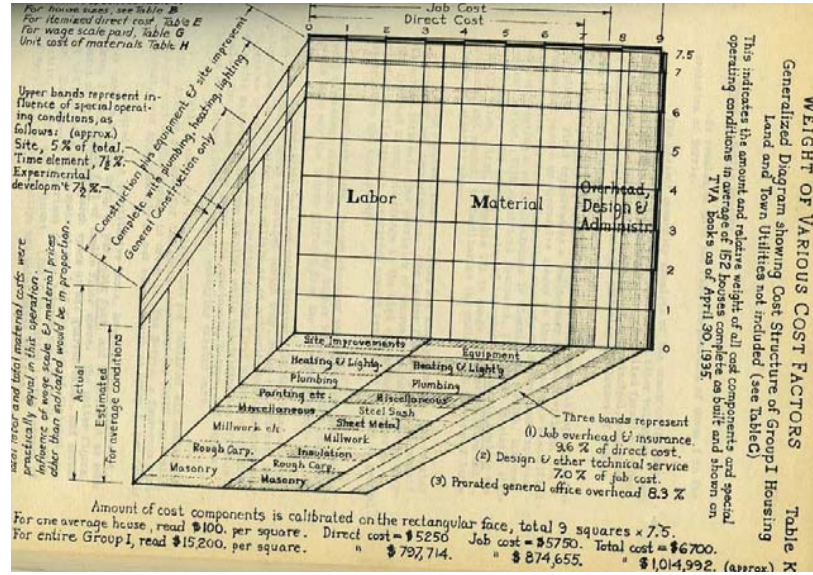
Purpose

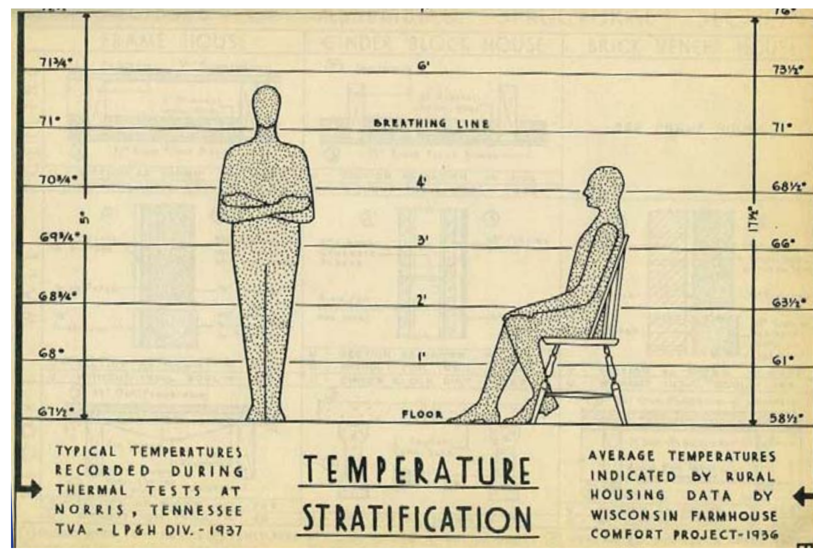
-Built to house TVA workers during the dam project, and

-Built to test and demonstrate domestic use of electric power

Technical Documentation and Analysis







I. History – TVA and The Norris Project

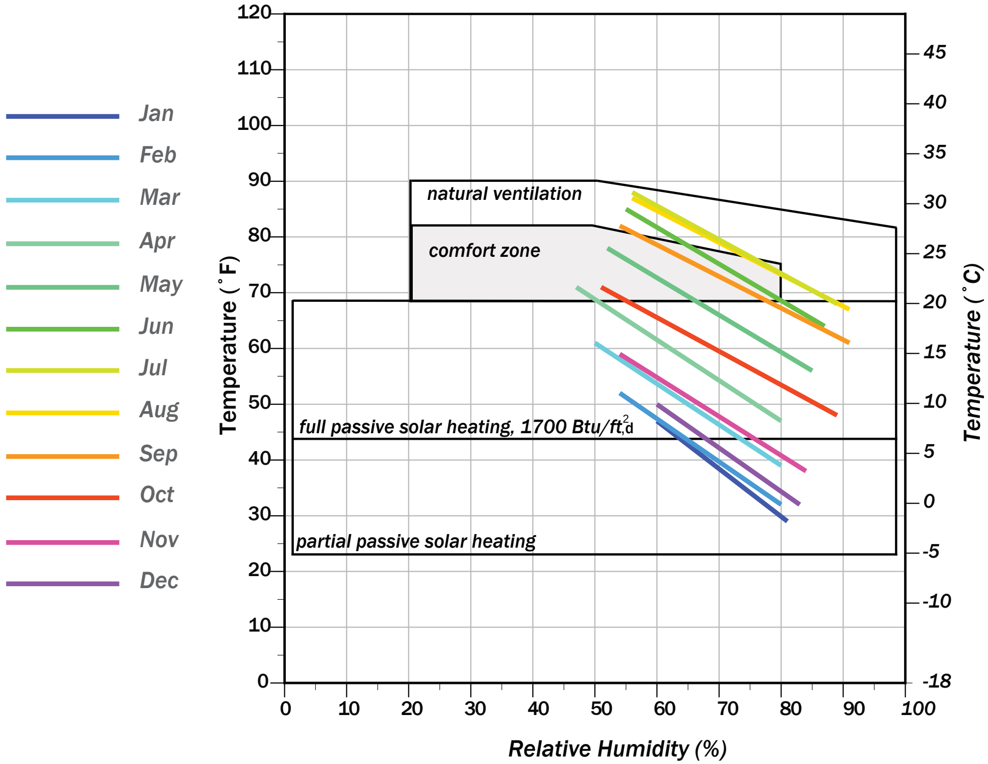
A New Norris House (2009 - 2011)

"The work proceeds along two lines, both of which are intimately connected- the physical land and water and soil end of it, and the human side of it"

franklin delano roosevelt
on the Tennessee Valley Authority

II. Overview - A New Norris House

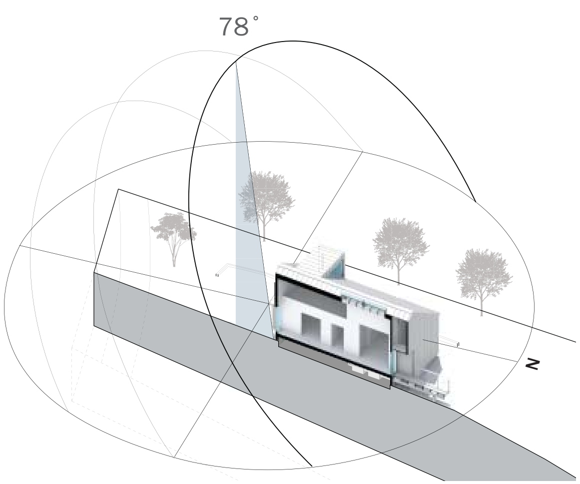
Response to Context



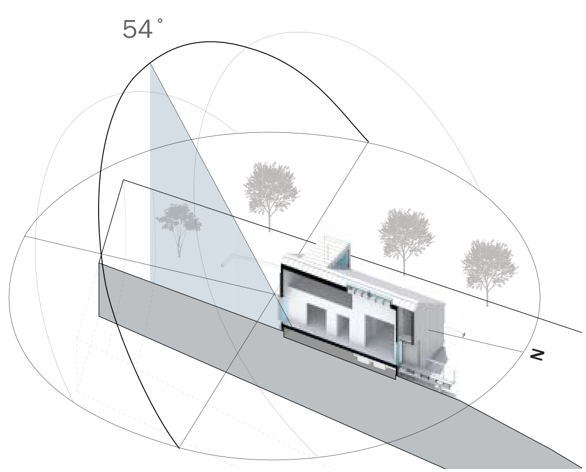
Heating Degree Days
3,937 (yearly total)

Cooling Degree Days
1,266 (yearly total)

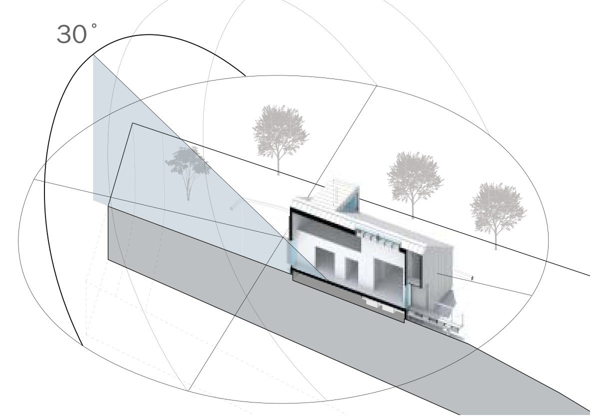
Degrees North Latitude
36˚20’



Summer Solstice

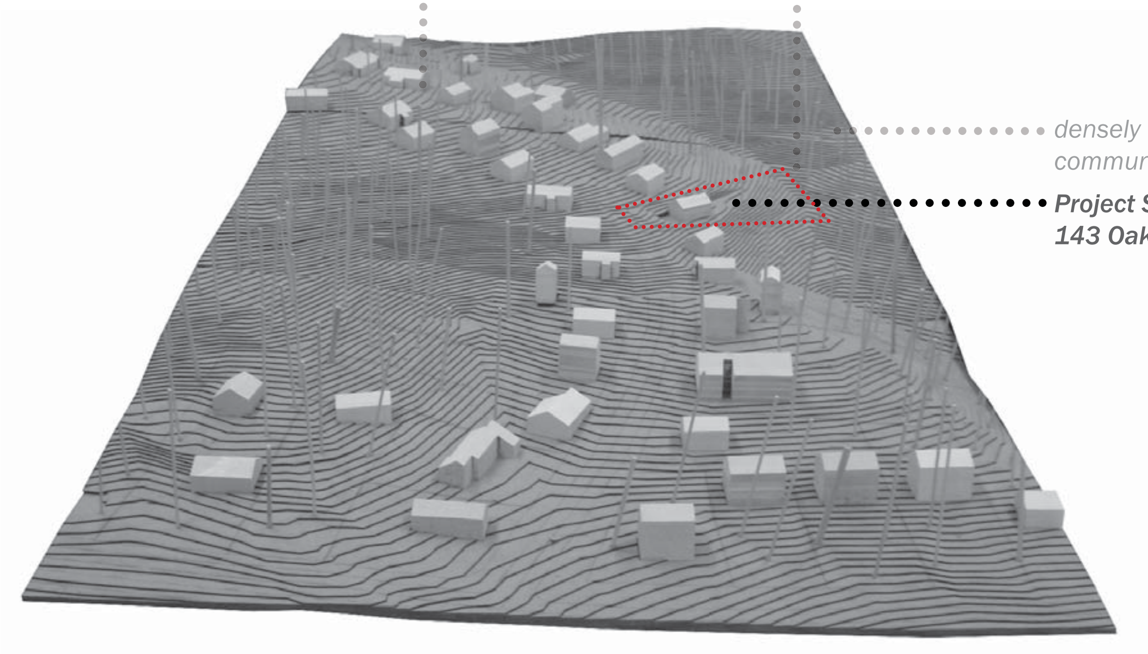


Spring/Fall Equinox



Winter Solstice

Response to Context



The New Norris House seeks to become anonymous in the context of a historic town—the form of the house echoes the form, scale and materiality of original Norris Cottages.

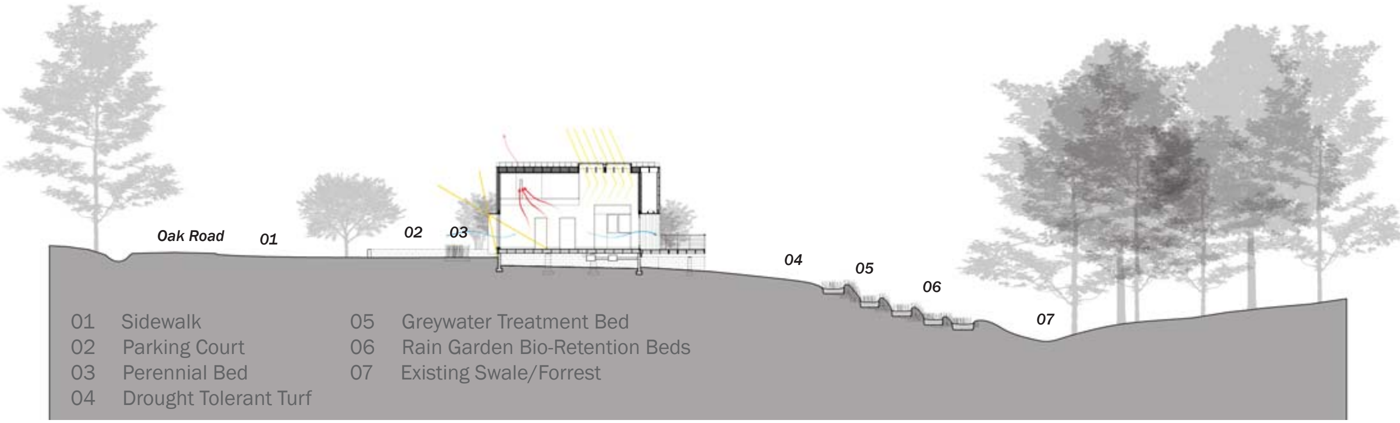
The siting of the home responds to the dominant pattern of existing homes along Oak Road. The new home orients similarly to the road and maintains a similar, minimal footprint. The home is then shifted toward the middle of the site, opening up a front courtyard for the accommodation of a car. The use of gravel softens the nature of the courtyard, allowing water to drain through an impervious surface.

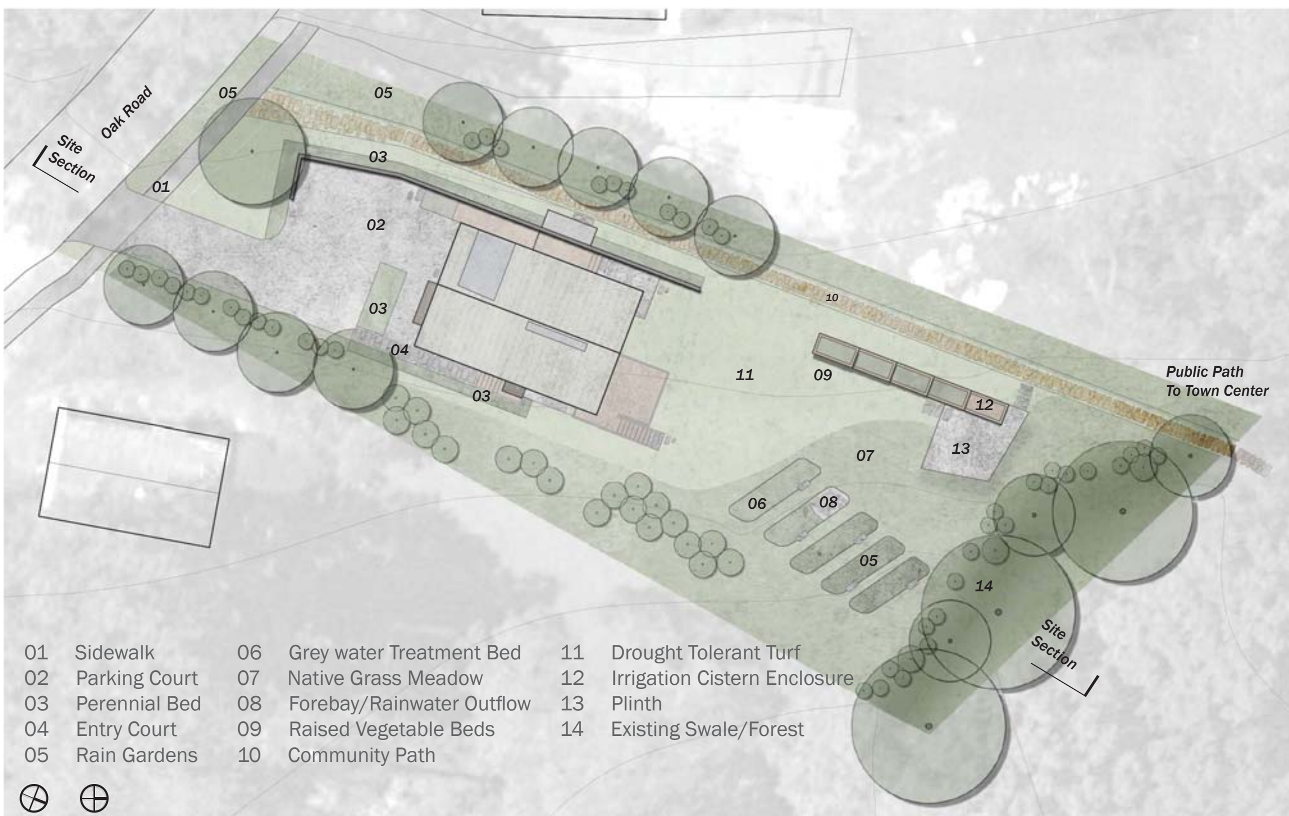
The project also uncovers a long forgotten walking path that once connected Oak Road to the greater network of pathways. Before the automobile, citizens of Norris used these pathways to move between their homes and shared amenities throughout the town. The reconstruction of the pathway furthers a return to a more local lifestyle free of the automobile and further connects the project to the urban scale of Norris.

Context of project site (top)

View uphill along Oak Road (bottom)

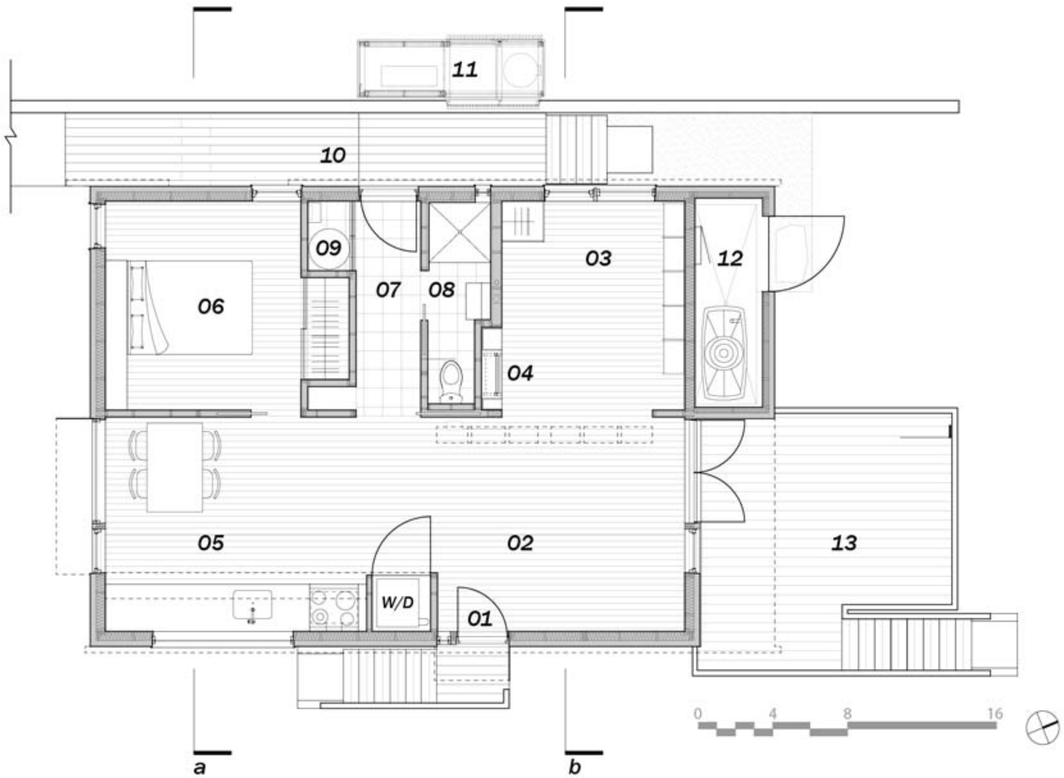
Site and Landscape Design





Street Approach and Drive Court

Spatial Organization

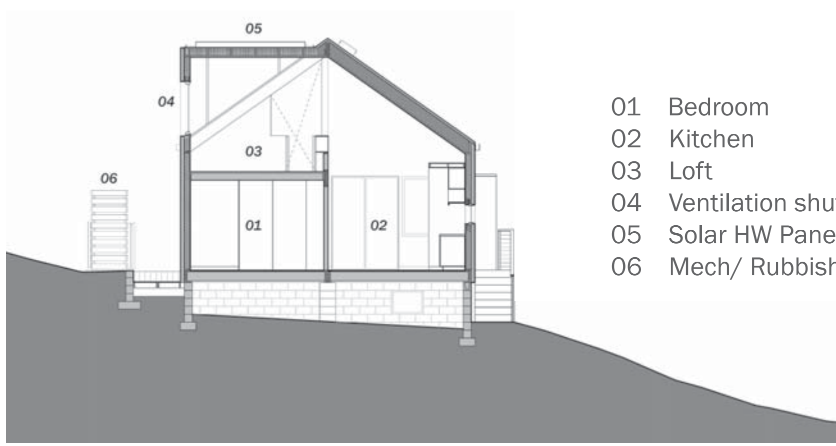


01 Public Entry
02 Living
03 Swing Space
04 Ladder to Loft
05 Kitchen
06 Bedroom
07 Mudroom
08 Bathroom
09 Mech. Room
10 Ramp
11 Mech/Rubbish
12 Cistern Room
13 Deck

The recognizable aspects of original Norris homes and their settings is retained – a simple, rectangular volume with a gable roof is placed within the context of Oak Road. The interior of the home departs from the traditional, opening up the volume and allowing views and natural light to define new relationships between interior and exterior.

The plan of the home separates private and public. The living space becomes an extension of public activity within the home and in the site. A front picture window and rear exterior porch reinforce these connections. Adjacent spaces contain bedrooms, a bathroom, and a loft. These spaces offer the residents a retreat from the compact urbanism of Norris.

Windows and doors transform traditional placement to maximize passive response and views, and refined details reinforce spatial concepts.



01 Bedroom
02 Kitchen
03 Loft
04 Ventilation shutter
05 Solar HW Panel
06 Mech/ Rubbish

First floor plan (top)

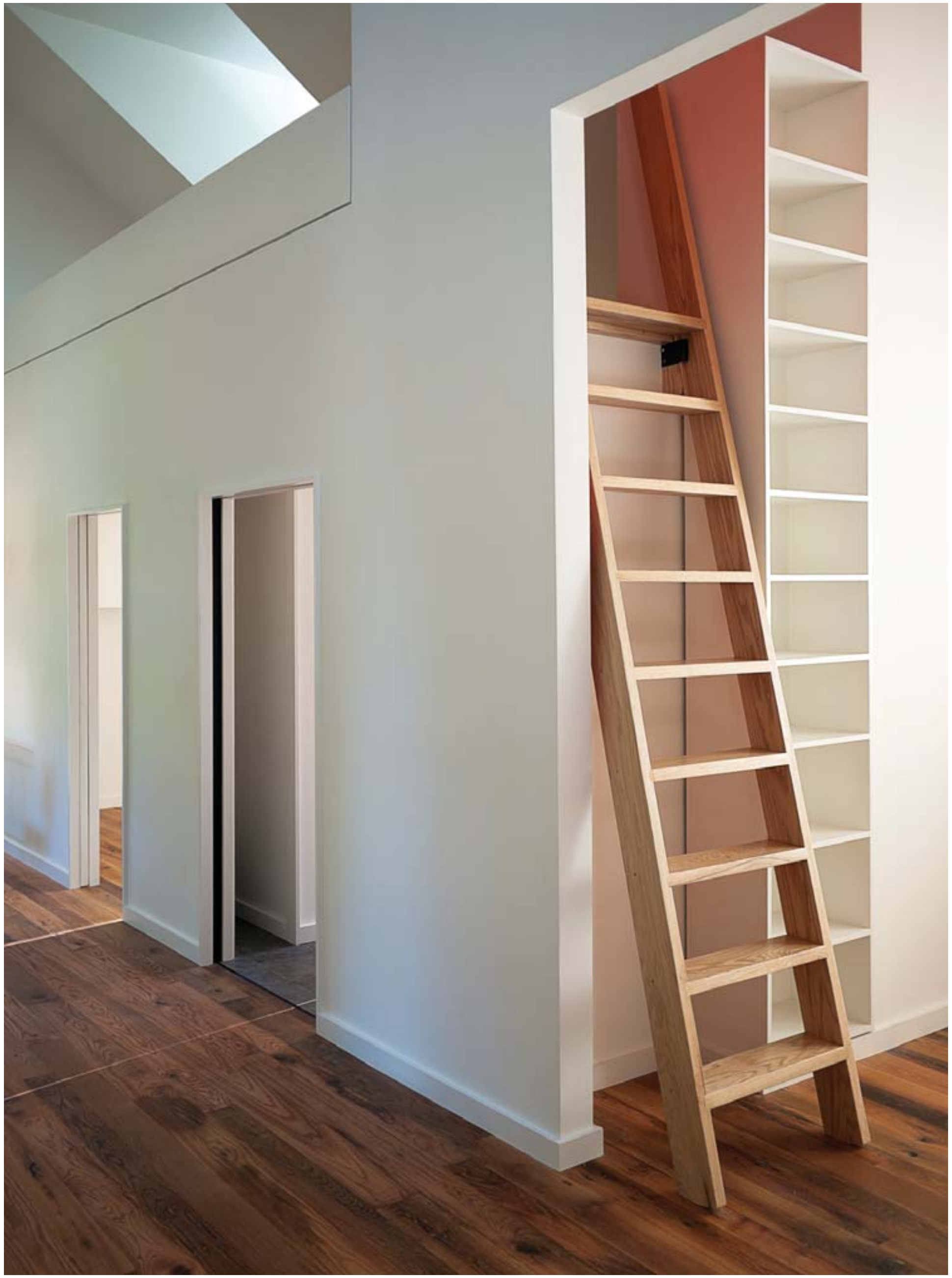
View down marriage wall in loft (bottom left)

Transverse Section A through loft and dormer (bottom right)

Traditional Form and Contemporay Dwelling

Extension of Outdoor Living Space

Interior Volume, Daylight and Views



Flexible Inhabitation

Public and Private Zones

Exposed Structure and Built-in Storage

All Spaces Daylit

Design Recognition

A New Norris House has received numerous accolades for design, pedagogy, and environmental performance.

Achievement and Recognition

LEED for Homes Platinum Rating
(33% over Platinum threshold)

Residential Architecture Design Awards
(RADA) Merit Award

AIA Gulf States Merit Award

AIA Tennessee Award of Excellence

AIA East Tennessee Honor Award

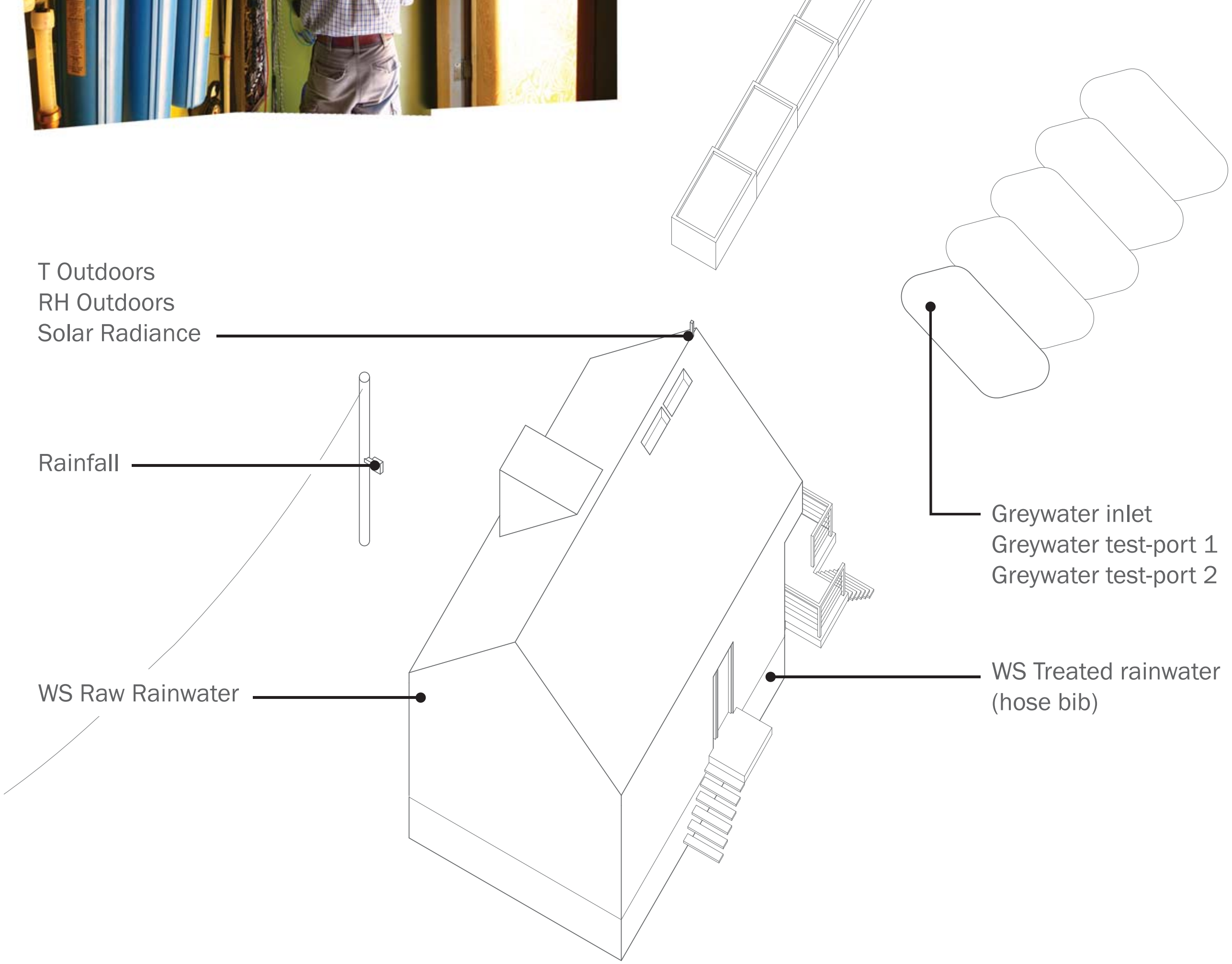
National Modular Housing Council (NMHC)
New Modular Home Design Award

NCARB Prize for the Creative Integration of
Practice and the Academy

US EPA People Prosperity and Planet Sustainable Design Competition for Sustainability

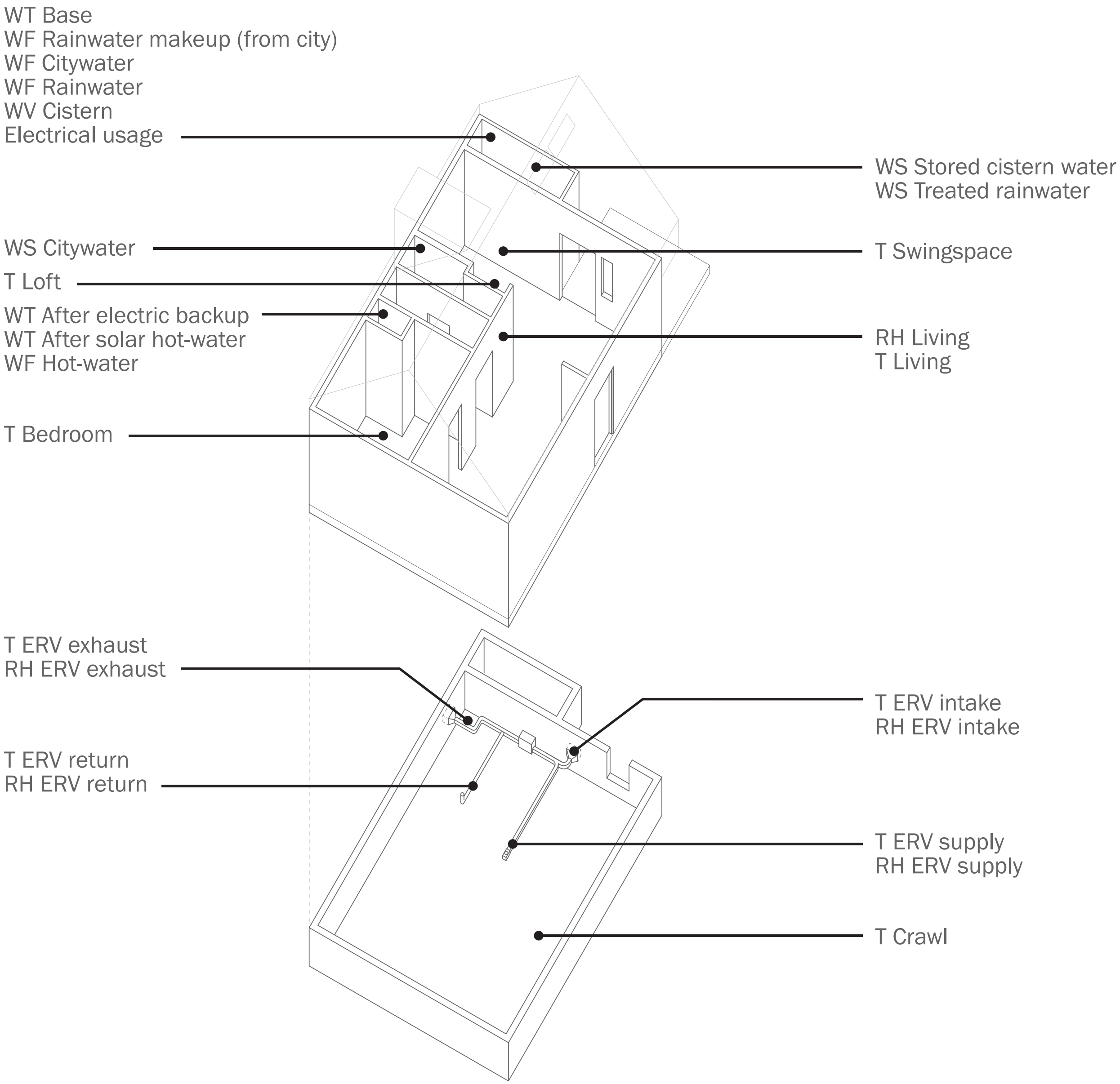
II. Overview - A New Norris House

Phase IV: Monitor and Evalute



WV - Water Volume
WF - Water Flow
WS - Water Sample
T - Temperature
RH - Relative Humidity
WT - Water Temperature

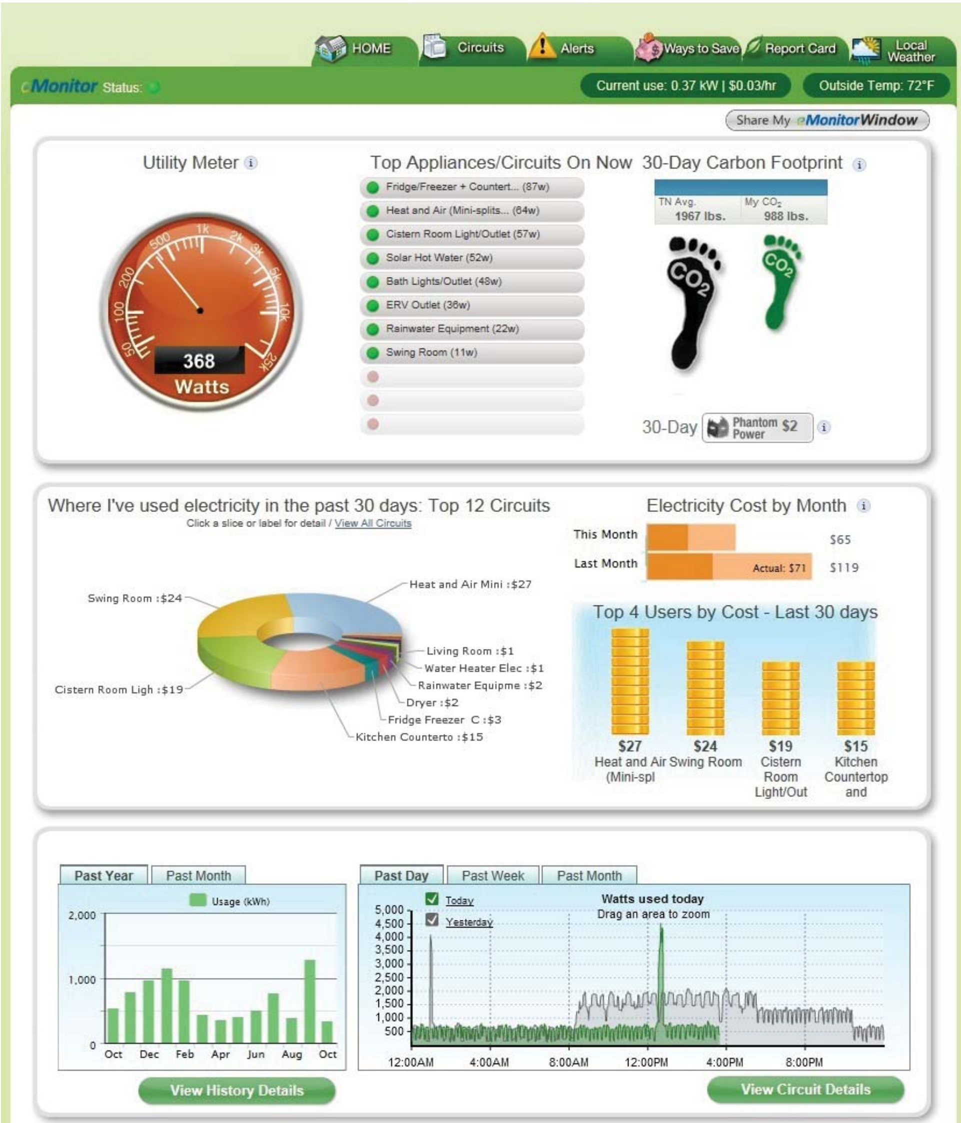
Phase IV: Monitor and Evalute



WV - Water Volume
WF - Water Flow
WS - Water Sample
T - Temperature
RH - Relative Humidity
WT - Water Temperature

Phase IV: Monitor and Evalute

eMonitor System



Phase IV: Monitoring and Evaluation

- User friendly, $1000 off-the-shelf suite of hardware and software

- 24 channels monitoring all primary electrical loads in the home

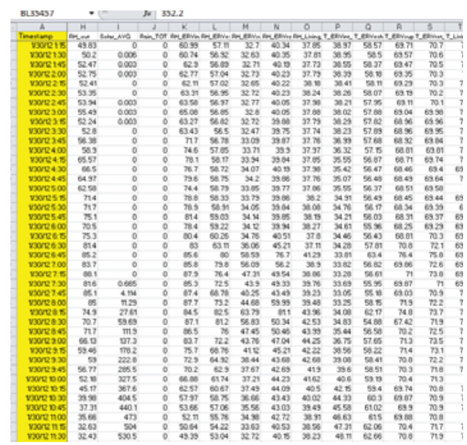
- Realtime data accesible live via web interface

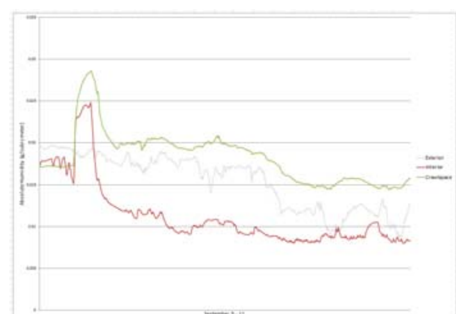
- Automatically generates analysis and recommendations for energy reducation for non-power users

- Exportable at 1 minute resolution

www.powerwisesystems.com

Campbell Scientific Datalogger System





Phase IV: Monitoring and Evaluation

- Partnership with ORNL Building Technologies Research & Integration Center, and UT Biosystems Engineering Department

- Custom system providing advanced monitoring capabilities

- Continually monitors temperature and RH, exterior conditions, water temperatures and flows, and greywater bed infiltration

- Accesible remotely via internet

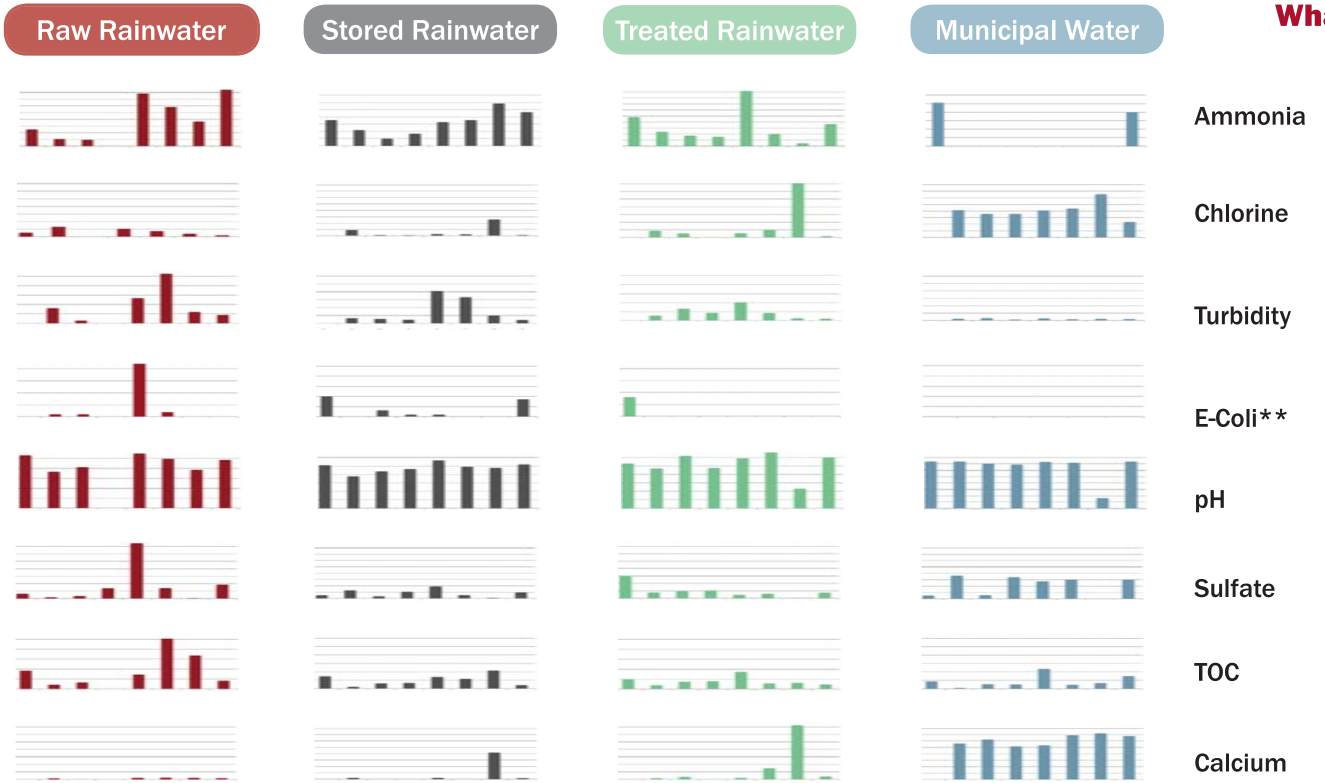
- Logs every 15 minutes to .CSV file (Greywater logged every 1 minute)

A. What were we able to accomplish?
B. How were we able to accomplish this?
C. Key LEED and Design Criteria

Learning Objective:

To better integrate water resource systems (such as rainwater, greywater, and stormwater) into residential projects, and understand how they relate to Water Efficiency (WE) within LEED for Homes.

What were we able to accomplish?



Water for the home

- Able to collect, treat, and provide water that is safe for human contact by EPA Human Health Criteria

- Comparing test results to EPA Maximum Contaminant Levels (MCLs) for drinking water – meeting all standards*

- Able to provide **813** gallons of safe water average/month for home use

EPA Regulated drinking water contaminants

Ammonia (NH3-N)
Total Suspended Solids (TSS)
Turbidity
Chlorine (Cl)
Sodium (Na)
Nitrate (NO3)
Nitrite (NO2

E-coli
Total Coliform
Glyphosate
Cadmium (Cd
Copper (Cu)
Lead (Pb)

Contaminants under EPA Secondary Drinking Water Regulations

Sulfate (SO4)
pH
Aluminum (Al)
Iron (Fe)
Zinc (Zn)

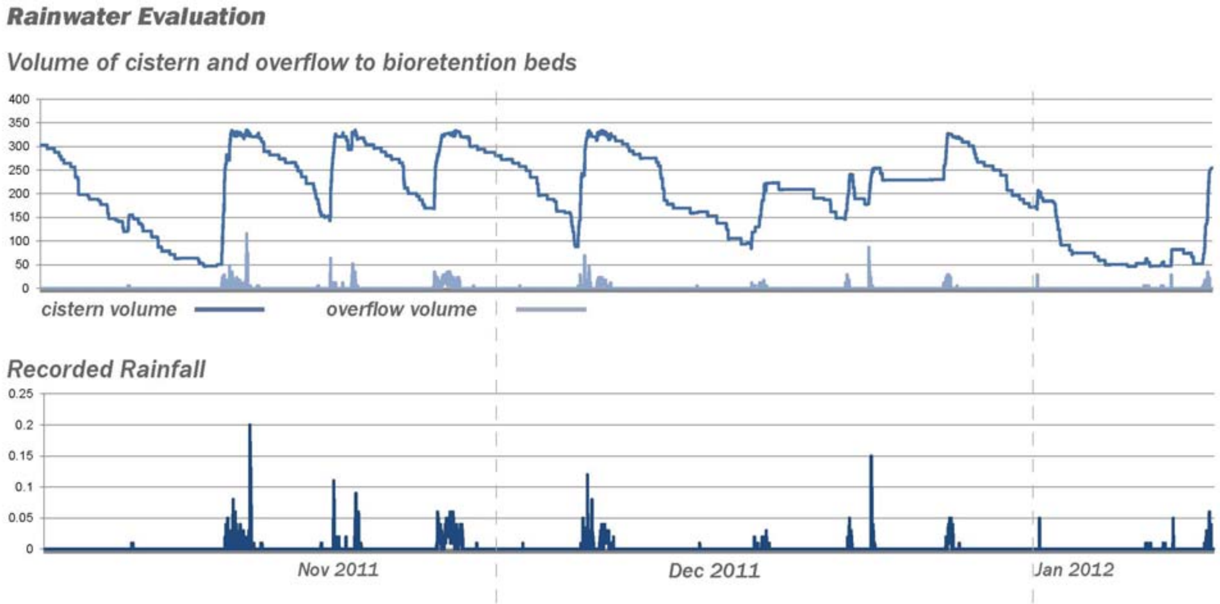
EPA non-regulated drinking water contaminants

Total Organic Carbon (TOC)
Alkalinity
Conductivity
Magnesium (Mg)
Calcium (Ca)
Potassium (K)

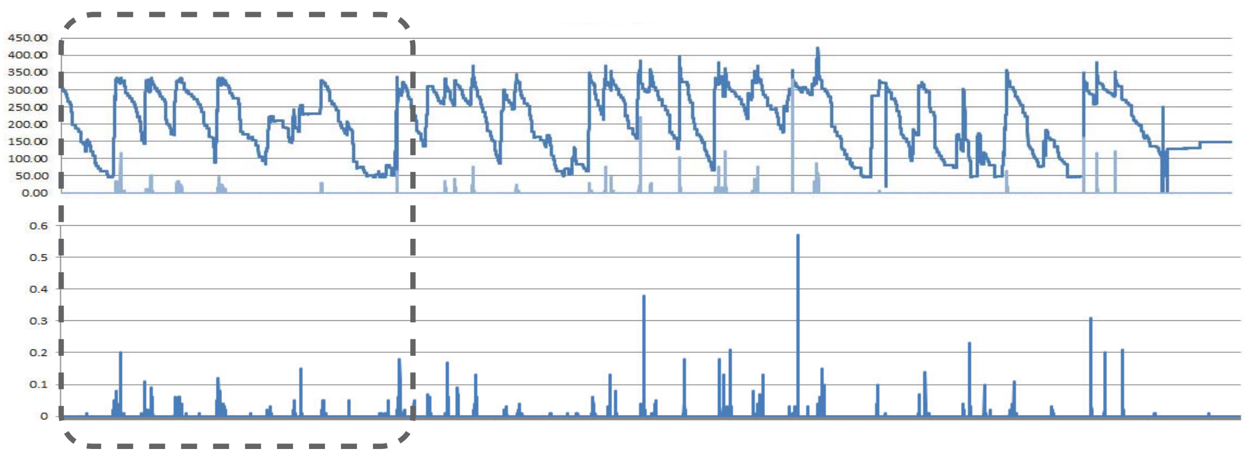
* http://water.epa.gov/drink/contaminants/index.cfm

** Treated rainwater in August of 2011 showed traces of E-Coli. This was tracked back to mold growth within a exterior hose bibb where the sample was collected.

Rainwater - What were we able to accomplish?



November 2011 - July 2012



Water for the home

- Able to provide 813 gallons of safe water average/month

- Average Rainfall that fell on roof was 2,069 gallons/month

- Total rainwater use for first year is 9,755 gallons

-Total rainwater that fell on roof was 24,837 gallons

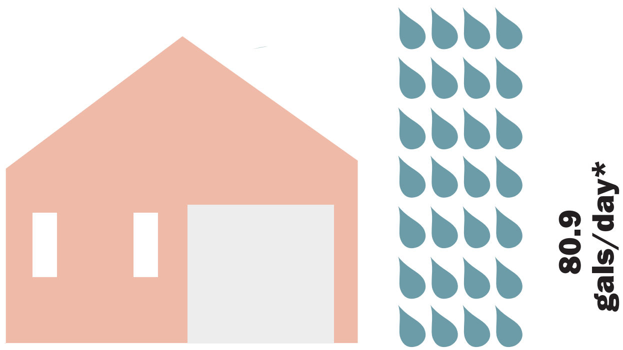
Water for the landscape

- Able to infiltrate 11,484 gallons on-site in rain gardens/vegetable gardens (as overflow from home's 400 gallon cistern)

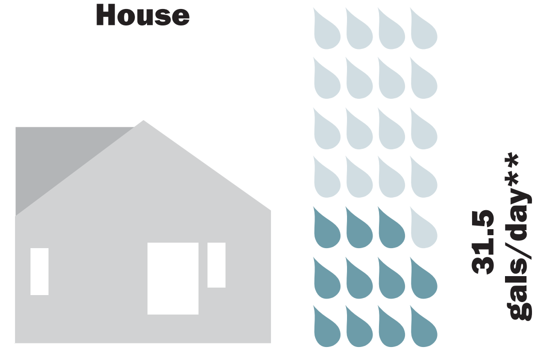
Rainwater - What were we able to accomplish?

Able to reduce potable water consumption of an average house by 61%

Average US Home



A New Norris House



How much water does the average two-person household use?

- New Norris House reduced city water consumption by 61%

- Implementing low-flow fixtures and water wise landscapes as well as supplementing with rainwater could reduce City of Norris household water demands from ~113,000 gallons per day to ~44,100 gallons per day.

Compounded over the scale of the town of Norris (700 homes)...

-A reduction of over 25 million gallons of potable water/ year (34 olympic pools)

113,260 gals/day*

41,339,900 gals/year*

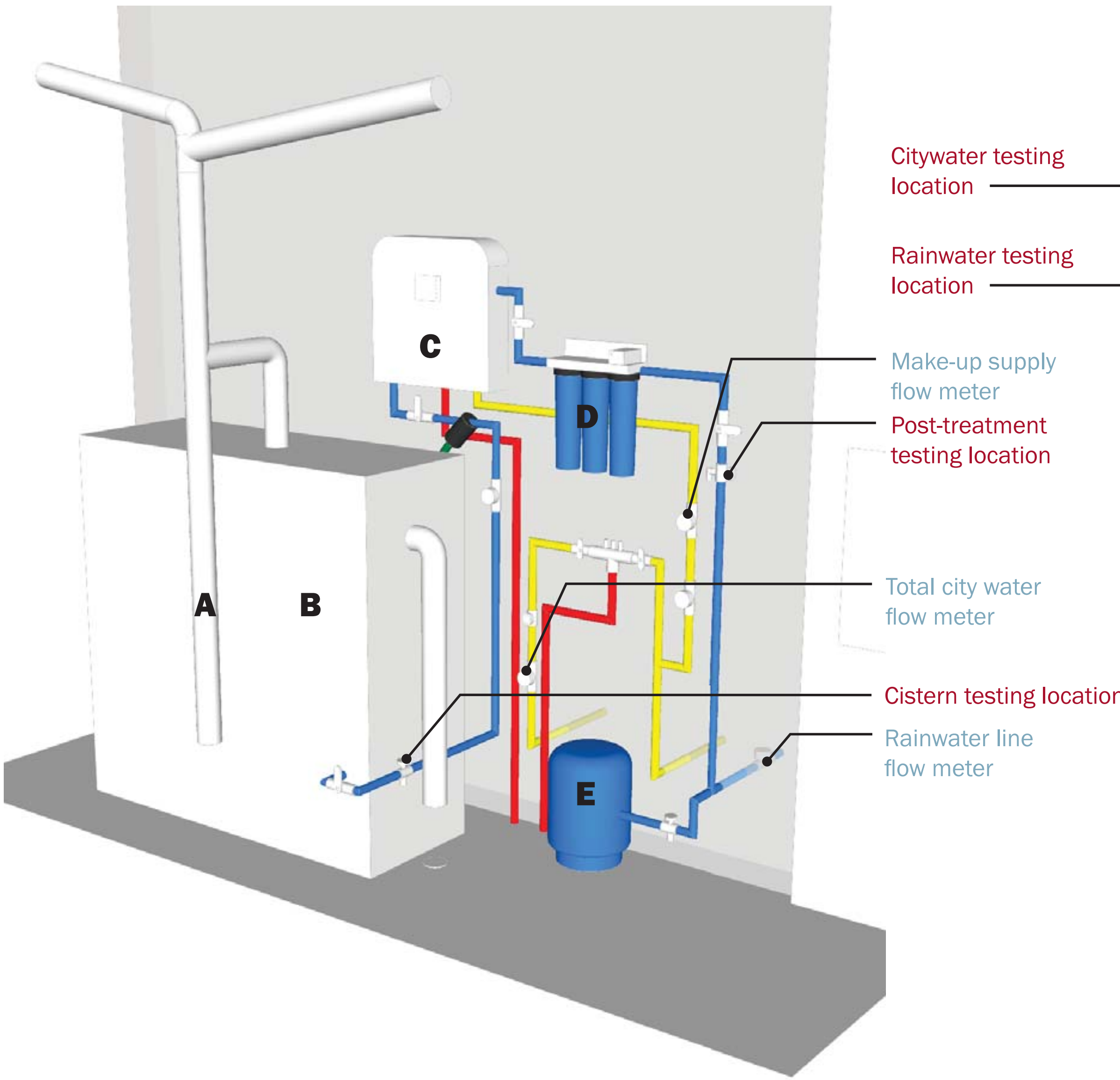
44,171 gals/day*

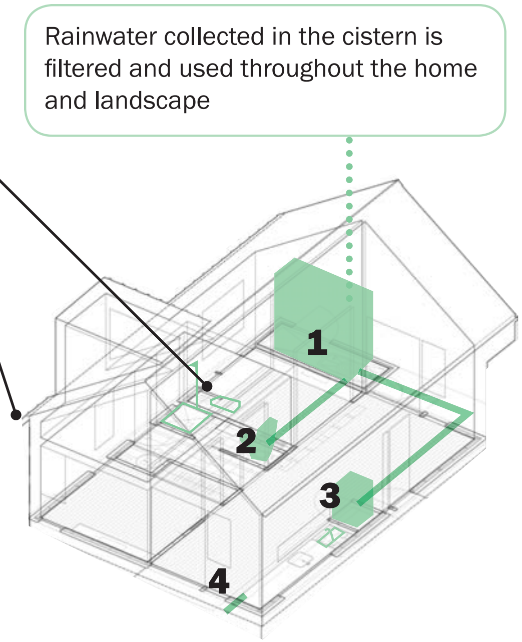
16,122,415 gals/year*

* American Water Works Association, Residential End Uses of Water Report (1999)

** As measured from Aug 2011- July 2012

Rainwater - How were we able to accomplish this?





1. Cistern and Equipment
2. Toilet
3. Clothes Washer
4. Outdoor Faucet

A. First flush diverter
B. 400 Gallon Storage tank
C. Pump and System Comtroller
D. Treatment Assembly
E. Pressurization Tank

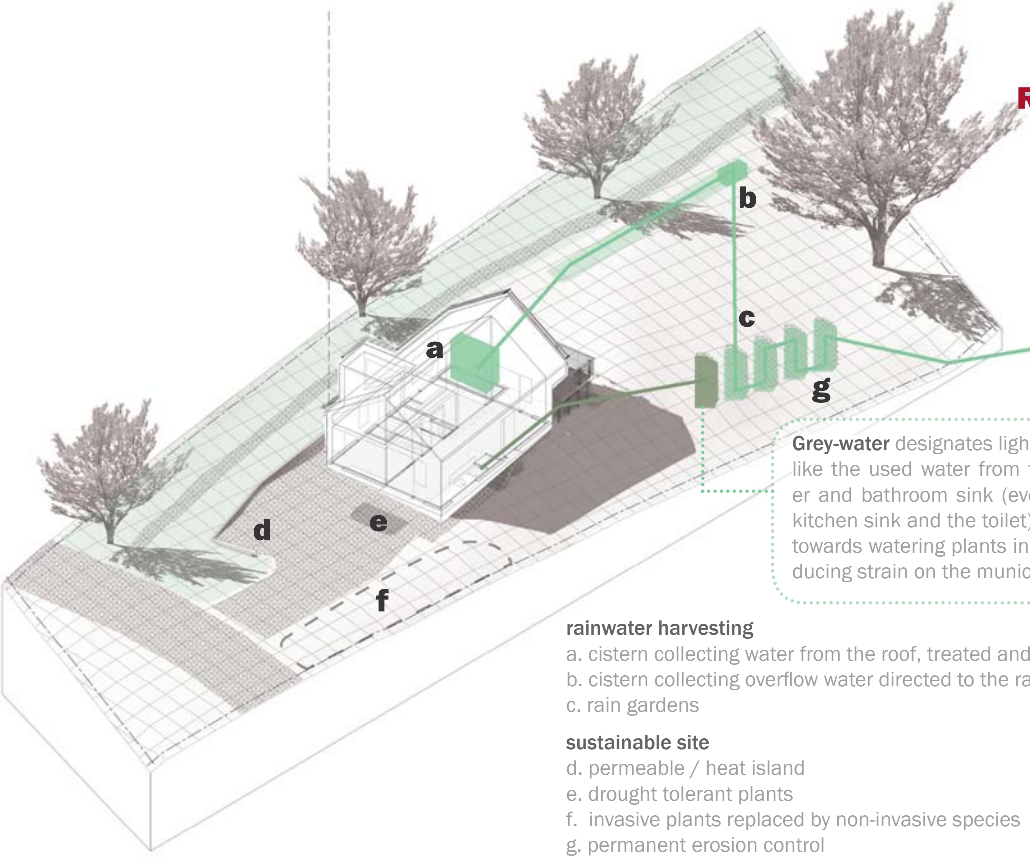
Rainwater Line

Citywater Line

Drainage Line

III. Water Resource Systems

Rainwater - How were we able to accomplish this?



Grey-water designates lightly soiled household water, like the used water from the shower, clothes washer and bathroom sink (every appliance besides the kitchen sink and the toilet). The collected water goes towards watering plants in the grey water garden, reducing strain on the municipal sanitary system.

rainwater harvesting

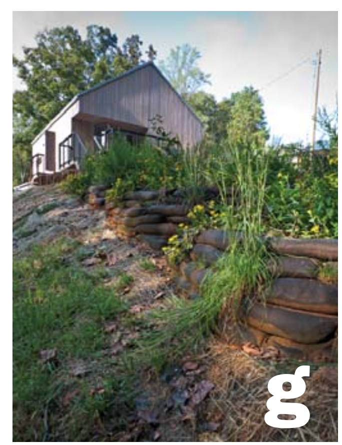
a. cistern collecting water from the roof, treated and used in the house
b. cistern collecting overflow water directed to the rain gardens
c. rain gardens

sustainable site

d. permeable / heat island
e. drought tolerant plants
f. invasive plants replaced by non-invasive species
g. permanent erosion control

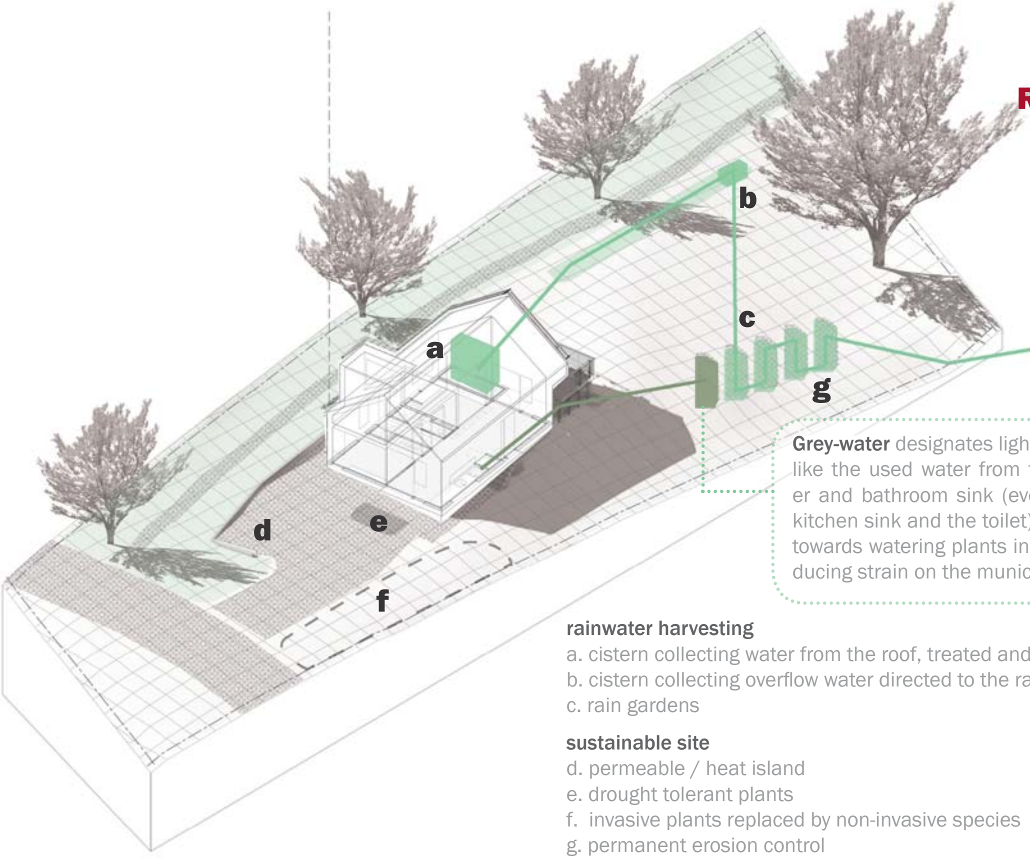
Water for the landscape

- Able to infiltrate 11,484 gallons on-site in rain gardens/vegetable gardens (as overflow from home's 400 gallon cistern)



III. Water Resource Systems

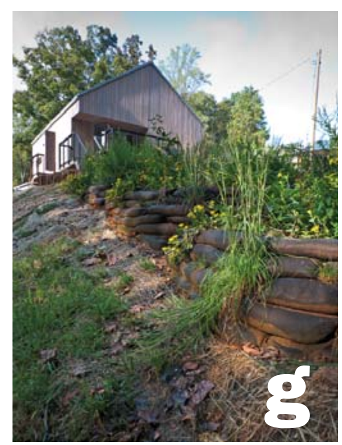
Rainwater - How were we able to accomplish this?



Grey-water designates lightly soiled household water, like the used water from the shower, clothes washer and bathroom sink (every appliance besides the kitchen sink and the toilet). The collected water goes towards watering plants in the grey water garden, reducing strain on the municipal sanitary system.

rainwater harvesting
a. cistern collecting water from the roof, treated and used in the house
b. cistern collecting overflow water directed to the rain gardens
c. rain gardens

sustainable site
d. permeable / heat island
e. drought tolerant plants
f. invasive plants replaced by non-invasive species
g. permanent erosion control



a. Cistern collects rainwater from the roof, the water is treated & used in the house for non-potable sources.

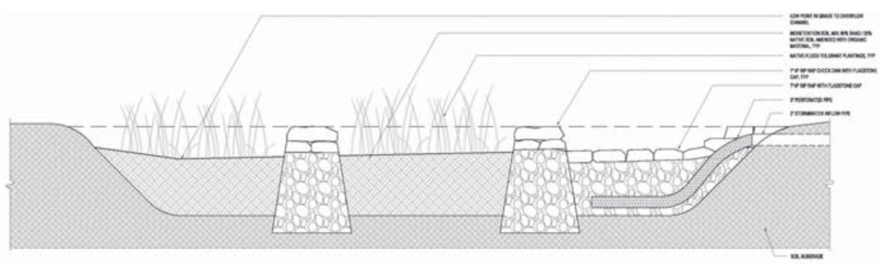
-Galvalume metal roof
-Gutter guards
-First Flush
[- -STORAGE- -]
-100 micron Y Strainer
-10 micron Filter
-0.5 micron Carbon Block Filter
-UV Lamp
[- -END USE- -]

b. A second cistern (200 gallons) collects overflow rainwater via subgrade site plumbing (3in schedule 40) for use in irrigation. Secondary cistern is operated via handpump. Overflow is then directed to the rain gardens.

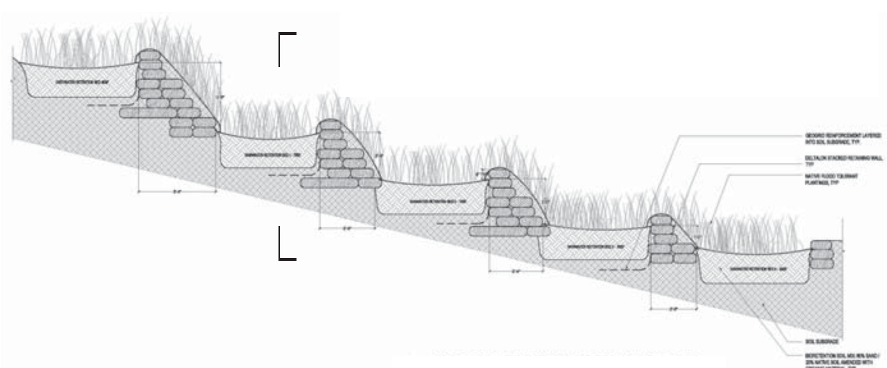
c. Rain gardens accept overflow collection system, as well as captured sheet flow from site. Terraced, snaking design allows for maximum infiltration into site before terminating into natural drainage swale.

III. Water Resource Systems

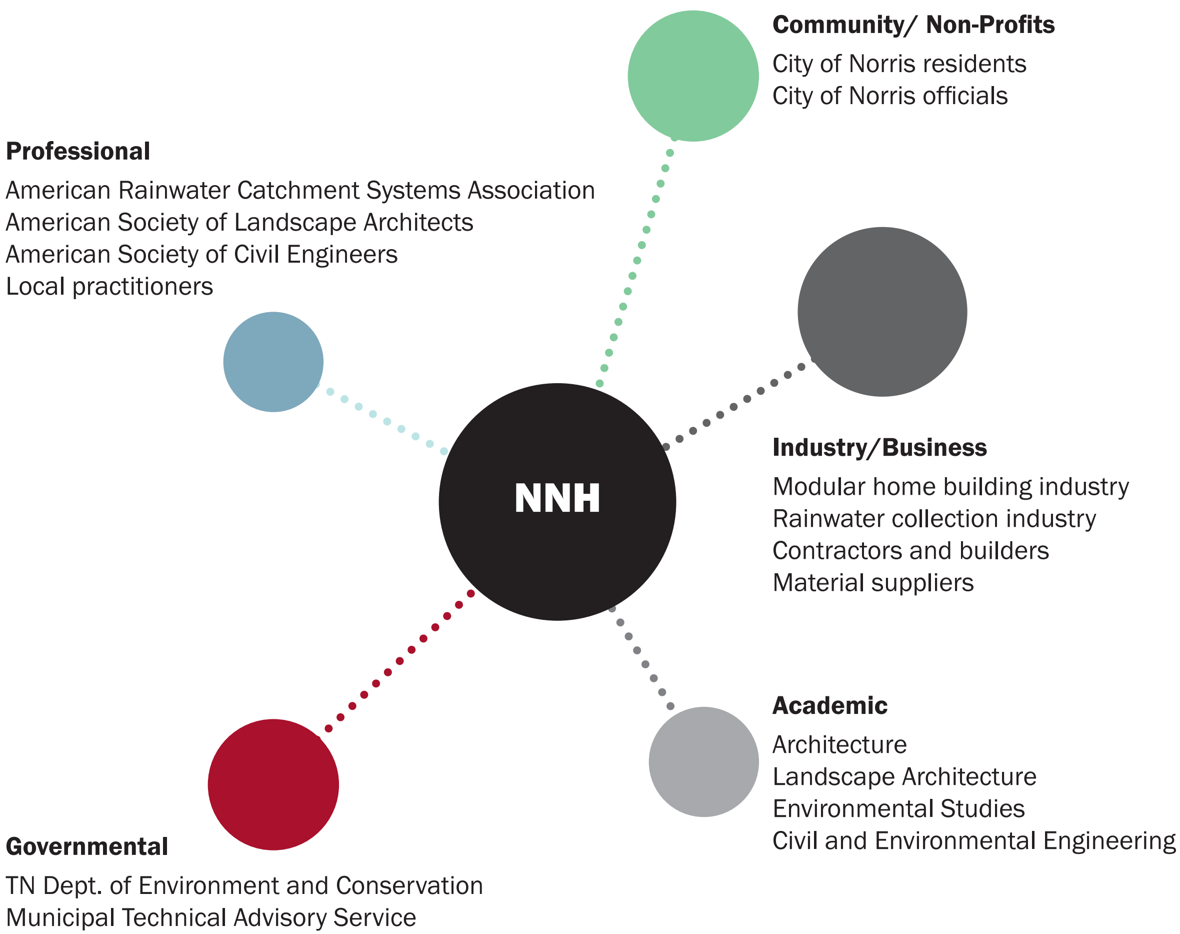
Rainwater - How were we able to accomplish this?



Greywater **Rain Gardens**



Rainwater - How were we able to accomplish this?



2009

November - UTK Team members present initial design to TDEC's Knoxville office. TDEC directs UTK Design Team to consult with the City of Norris for permitting.

2010

February – UTK Design team presents initial design to the Norris Water Board for approval.

February - TDEC's Knoxville office was informed of the City of Norris' approval. UTK Design Team continues to inform both TDEC and the City of Norris Building Department.

July/August – UTK becomes Landowner at 143 Oak Road, submits formal variance request to City of Norris.

2011

March – UTK Design Team holds an on-site meeting to review final system design drawings with TDEC representatives.

May - Norris Water Commission finishes the revised water & sewer code allowing for the rainwater harvesting and treatment systems at the Norris House for a trial period.

May - Norris City Council meeting. Revised codes accepted on first reading.

Late May - Public hearing on the revised code. Revised codes approved.

June - Norris City Council adopts revised codes on second reading.

Early August – Rainwater Harvesting system in operation.

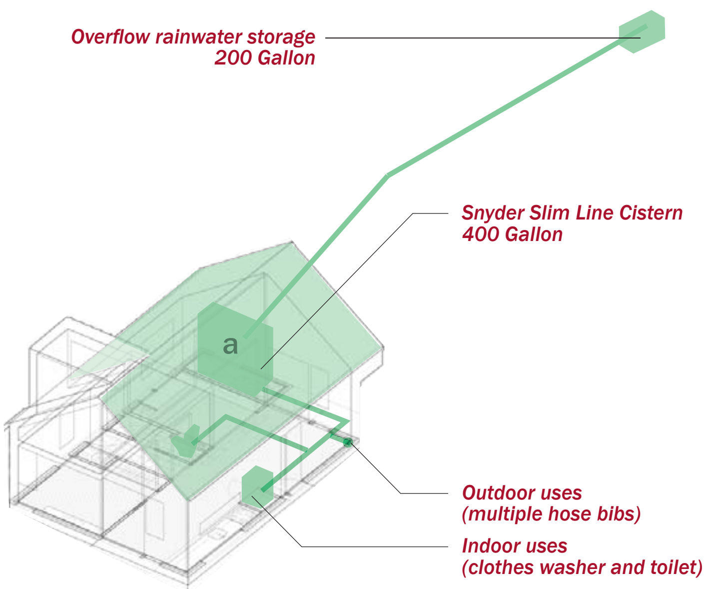
Rainwater - Key LEED and Design Criteria (WE)

CALCULATIONS + TECHNICAL DATA

System Size (%) = Harvest Area / Total Roof Area
System Size (%) = 773 ft^2 / 910 ft^2
System Size (%) = 85%

Minimum Storage Capacity= 0.62 Gal/ft^2 x Harvest Area
Minimum Storage Capacity= 0.62 Gal/ft^2 x 773 ft^2
Minimum Storage Capacity= 479 Gallons
Actual Storage Capacity= 600 gallons

Storage tanks: Snyder Slim Line Above Ground cistern, 400 gallon
Chem-Tainer PCO Transport Tank, 200 gallon



Water Efficiency

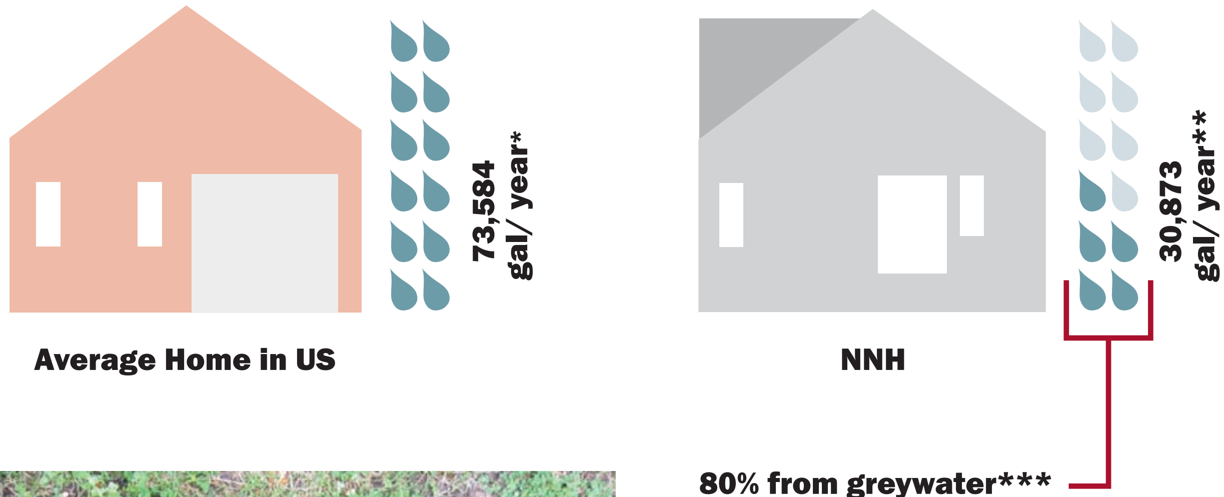
WE 1	**Water Reuse** [Max. Points 5]	
1.1	Rainwater Harvesting System	4
1.2	Greywater Reuse System	1
1.3	Use of Municipal Recycled Water System	4
WE 2	**Irrigation System** [Max. Points 4]	
2.1	High-Efficiency Irrigation System	3
2.2	Third-Party Inspection	1
2.3	Reduce Overall Irrigation Demand by at least 45%	4
WE 3	**Indoor Water Use** [Max. Points 6]	
3.1	High-Efficiency Fixtures and Fittings	1
3.2	Very High Efficiency Fixtures and Fittings	4
	total WE points of 15 points possible	**13**

Sustainable Sites

SS 1	**Site Stewardship** [Max. Points 1]	1
SS 2	**Landscaping** [Max. Points 7]	
2.1	No Invasive Plants	PREQ
2.2	Basic Landscape Design	2
2.3	Limit Conventional Turf	3
2.4	Drought Tolerant Plants	2
2.5	Reduce Overall Irrigation Demand by at Least 20%	6
SS 3	**Local Heat Island Effects** [Max. Points 1]	1
SS 4	**Surface Water Management** [Max. Points 7]	7
SS 5	**Nontoxic Pest Control** [Max. Points 2]	2
SS 6	**Compact Development** [Max. Points 4]	0
	total SS points of 22 points possible	**17**

Greywater - What were we able to accomplish?

Total irrigation water use-- a 60% reduction in establishing year



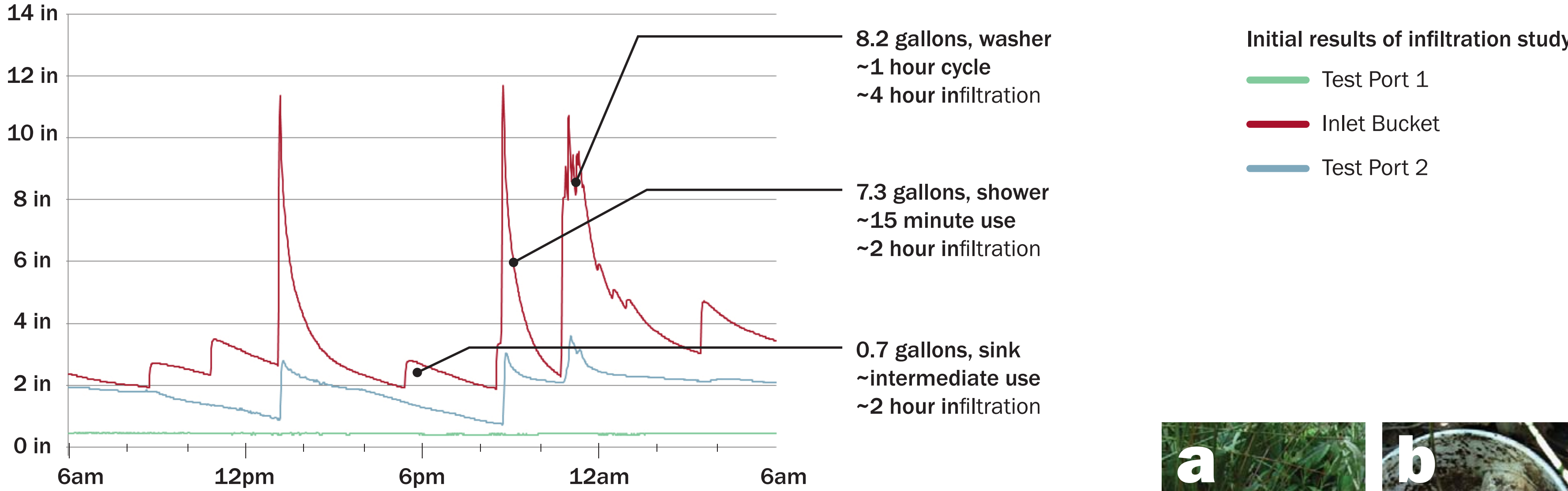
Greywater System

Grey water released below ground to treatment/infiltration beds (lightly used waste water from the bathroom sink, shower, and washing machine, excl. kitchen sink or toilet water. water not unnecessarily moved to and treated in wastewater treatment plant – saving energy and recharging water table.

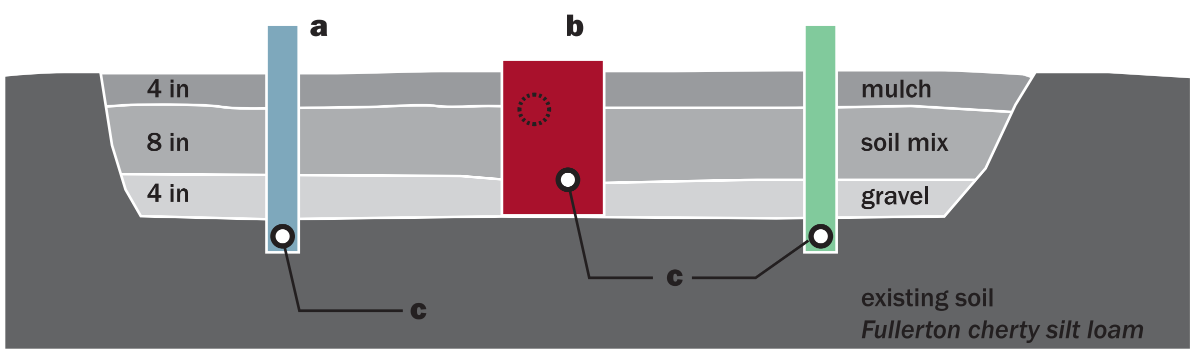
* Based on American Water Works Association, Residential End Uses of Water Report (1999), p.88
** As measured from Aug 2011- July 2012
*** Calculated using 12.8 gallons/person/day

Greywater - What were we able to accomplish?

Water Levels in Test Ports - June 14, 2012

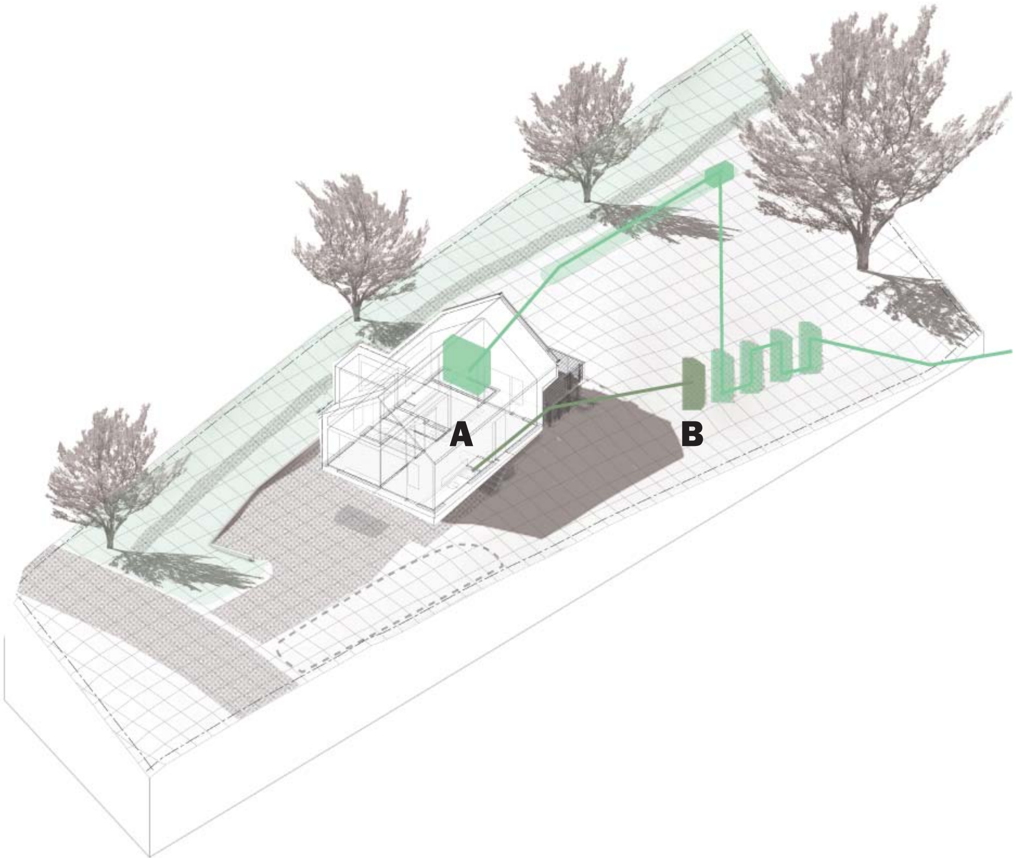


Diagramatic Section of Greywater Monitoring Equipment



III. Water Resource Systems

Greywater - How were we able to accomplish this?



System Diagram (left)

a. greywater from the bathroom sink, shower, and washing machine is piped to a distribution bucket

b. the inlet bucket evenly disperses the greywater into the bed media

What were the design criteria and aspirations ?

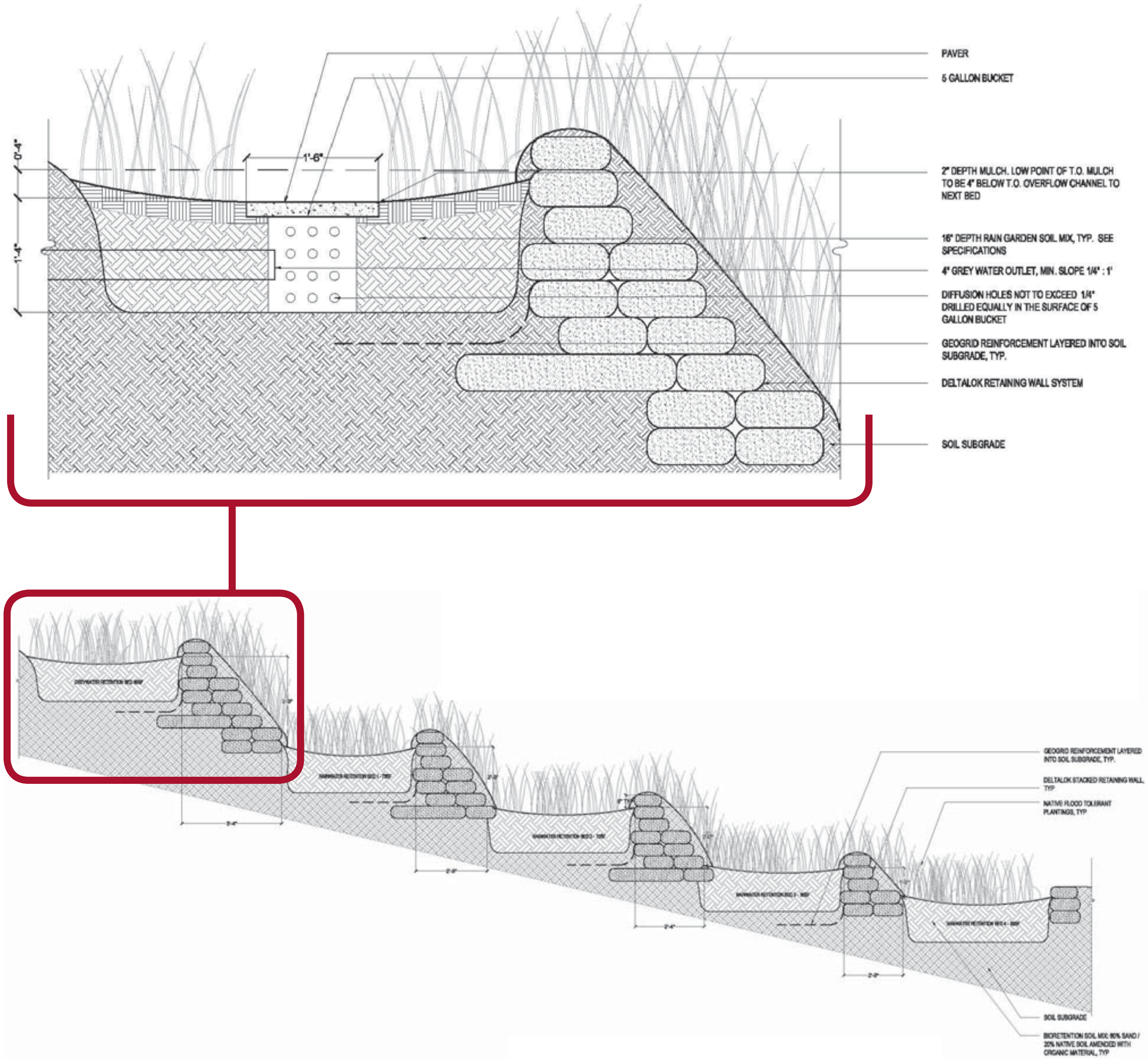
- Amount of greywater produced with our fixtures and 2 people = 40 gallons/day

- Goal is to infiltrate all.

Calculating bed size and bed composition

- Bed is 7.5 times larger than needed to accommodate daily greywater from 2 people

Greywater - How were we able to accomplish this?



Creating an area for infiltration on a slope

- Terraced beds, deltalok bags

Plant selection

- Plants were selected for their drought tolorance and ability to withstand inundation

- Plants with an ability to remediate greywater contaminants (phosphates, sulphates)

Calculation for sizing the holding capacity of the grey water bed

Area of Greywater Bed: (5*15) = 75sf

Depth (4" gravel, 8" soil, 4" mulch) = 16"

Total Volume = 100cf = 750 gal * .4
= 300 gallons total capacity

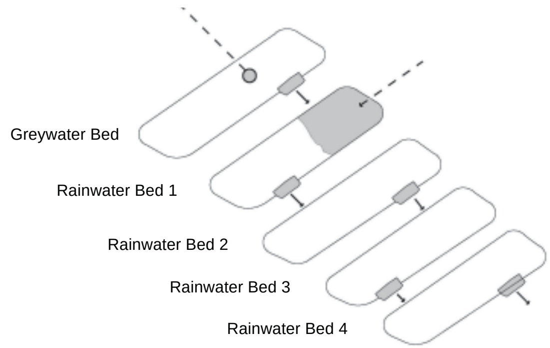
Gravel area 75SF * .333= 25CF = 187gal * .6
= 112 gallons capacity in gravel

III. Water Resource Systems

Greywater – How were we able to accomplish this?

New Norris House Greywater Collection, Treatment and Disposal System
Weekly Inspection Log

Date and Time:	1/15/12, 1:00 p.m.
Observed Conditions:	No standing water in beds
Current Weather Conditions:	Partly cloudy
Weather in past 24 hours:	No precipitation
Are there any signs of leakage or overflow? If yes please indicate location on graphic below.	No
Is maintenance required at this time? If yes, please describe maintenance activity.	No
Inspection performed by:	ML



2009

November - UTK Team members present initial design to TDEC's Knoxville office. TDEC directs UTK Design Team to consult with the City of Norris for permitting.

2010

February – UTK Design team presents initial design to the Norris Water Board for approval.

February - TDEC's Knoxville office was informed of the City of Norris' approval. UTK Design Team continues to inform both TDEC and the City of Norris Building Department.

July/August – UTK becomes Landowner at 143 Oak Road, submits formal variance request to City of Norris.

2011

March – UTK Design Team holds an on-site meeting to review final system design drawings with TDEC representatives.

April - UTK Design Team receives TDEC State Operating Permit for Experimental Greywater Treatment Bed

May - Norris Water Commission finishes the revised water & sewer code allowing for the rainwater harvesting and treatment systems at the Norris House for a trial period.

May - Norris City Council meeting. Revised codes accepted on first reading.

June - Norris City Council adopts revised codes on second reading.

Early August – Greywayer system in operation.

Greywater – How were we able to accomplish this?

(62) "User." The owner, tenant or occupant of any lot or parcel of land connected to a sanitary sewer, or for which a sanitary sewer line is available if a municipality levies a sewer charge on the basis of such availability, *Tennessee Code Annotated*, § 68-221-201.

(63) "Wastewater." The liquid and water carried industrial or domestic wastes from dwellings, commercial buildings, industrial facilities, and institutions, whether treated or untreated, which is contributed into or permitted to enter the WWF.

(64) "Wastewater Facility." Any or all of the following: the collection/transmission system, treatment plant, and the reuse or disposal system, which is owned by any person. This definition includes any devices and systems used in the storage, treatment, recycling and reclamation of municipal sewage or industrial waste of a liquid nature. It also includes sewers, pipes and other conveyances only if they convey wastewater to a WWF treatment plant. The term also means the municipality as defined in section 502(4) of the Federal Clean Water Act, which has jurisdiction over the indirect discharges to and the discharges from such a treatment works. WWF was formally known as a POTW, or Publicly Owned Treatment Works.

(65) "Waters of the state." All streams, lakes, ponds, marshes, watercourses, waterways, wells, springs, reservoirs, aquifers, irrigation systems, drainage systems, and other bodies of accumulation of water, surface or underground, natural or artificial, public or private, that are contained within, flow through, or border upon the state or any portion thereof.

(65) "1200-4-14." Chapter 1200-4-14 of the Rules and Regulations of the State of Tennessee, Pretreatment Requirements.

18-404. Proper waste disposal required. (1) It shall be unlawful for any person to place, deposit, or permit to be deposited in any unsanitary manner on public or private property within the service area of the city, any human or animal excrement, garbage, or other objectionable waste.

(2) It shall be unlawful to discharge to any waters of the state within the service area of the city any sewage or other polluted waters, except where suitable treatment has been provided in accordance with provisions of this ordinance or city or state regulations.

(3) Except as herein provided, it shall be unlawful to construct or maintain any privy, privy vault, cesspool, or other facility intended or used for the disposal of sewage except for new homes built in 2011 with temporary (12 month) commission-approved supplementary gray water systems that have been approved by TDEC for experimental use.

(4) Except as provided in (6) below, the owner of all houses, buildings, or properties used for human occupancy, employment, recreation, or other purposes situated within the service area in which there is now located or may in the future be located a public sanitary sewer, is hereby required at his expense to install suitable toilet facilities therein, and to connect such facilities directly with the proper private or public sewer in accordance with the provisions of this chapter except for new homes built in 2011 with temporary (12 month from issuance of Certificate of Occupancy) commission-approved supplementary gray water systems that have been approved by TDEC for experimental use. Where public sewer is available property owners shall within sixty (60) days after date of official notice to do so, connect to the public sewer. Service is considered "available" when a public sewer main is located in an easement, right-of-way, road or public access way which abuts the property.

(5) Discharging into the sanitary sewer without permission of the city is strictly prohibited and is deemed "theft of service."

(6) Where a public sanitary sewer is not available under the provisions of (4) above, the building sewer shall be connected to a private sewage disposal system complying with the provisions of Section 18-405 of this ordinance.

(7) The owner of a manufacturing facility may discharge wastewater to the waters of the state provided that he obtains an NPDES permit and meets all requirements of the Federal Clean Water Act, the NPDES permit, and any other applicable local, state, or federal statutes and regulations.

(8) Users have a duty to comply with the provisions of this ordinance in order for the city to fulfill the stated Policy and Purpose. Significant Industrial Users must comply with the provisions of this ordinance and applicable state and federal rules according to the nature of the industrial discharge.

18-405. Private domestic wastewater disposal. (1) Availability. (a) Where a public sanitary sewer is not available under the provisions of Section 18-404(4), the building sewer shall be connected, until the public sewer is available, to a private wastewater disposal system complying with the provisions of the applicable local and state regulations.

(b) The owner shall operate and maintain the private sewage disposal facilities in a sanitary manner at all times, at no expense to the city. When it becomes necessary to clean septic tanks, the sludge may be disposed of only according to applicable federal and state regulations.

(c) Where a public sewer becomes available, the building sewer shall be connected to said sewer within sixty (60) days after date of official notice from the city to do so except for new homes built in 2011 with temporary (12 month from issuance of Certificate of Occupancy) commission-approved supplementary gray water systems that have been approved by TDEC for experimental use.

(2) Requirements. (a) The type, capacity, location and layout of a private sewerage disposal system shall comply with all local or state regulations. Before commencement of construction of a private sewerage disposal system, the owner shall first obtain a written approval from the County Health Department. The application for such approval shall be made on a form furnished by the County Health Department which the applicant shall supplement with any plans or specifications that the Department has requested.

(b) Approval for a private sewerage disposal system shall not become effective until the installation is completed to the satisfaction of the local and state authorities, who shall be allowed to inspect the work at any stage of construction.

(c) The type, capacity, location, and layout of a private sewage disposal system shall comply with all recommendations of the Tennessee Department of Environment and Conservation, and the County Health Department. No septic tank or cesspool shall be permitted to discharge to waters of Tennessee.

III. Water Resource Systems

Grey Water – LEED criteria and other key calcs

CALCULATIONS + TECHNICAL DATA

Design storm (gal) = Roof area x 0.62 x Inch of Rainfall
Design storm (gal) = 910ft^2 x 0.62 x 1.5in
Design storm (gal) = 846

Cubic Volume of beds (ft^3) = 12ft x 4ft x 1ft
Cubic Volume of beds (ft^3) = 48ft^3 x 4 beds = 192

Pore spacing of bed soil = 40%
Retention beds porous volume (ft^3) = Cubic Volume of beds x 40%
Retention beds porous volume (ft^3) = 192ft^3 x 40%
Retention beds porous volume (ft^3) = 76.8
Retention beds porous volume (gal) = 574.5

3” Pooling zone = 12ft^3 / bed
3” Pooling zone volume (ft^3) = 48
3” Pooling zone volume (gal) = 360

Total holding capacity of bio-rentetion system (gal) = 934.5

Excessive capacity compared to design storm (gal) = 88.5

LEED For Homes

The project team chose not to pursue LEED for Homes WE 1.2 related to greywater systems. LEED for Homes requires a surge tank, which was not utilized in the implemented design.

VI. On- and Off-Site Construction







A. What were we able to accomplish?
B. How were we able to accomplish this?
C. Key LEED and Design Criteria (MR and LL)

Learning Objective:

To better understand the limitations and benefits of off-site fabrication and on-site construction, and how they relate to Materials and Resources (MR) within LEED for Homes.

01 | Designed and executed a factory-built home that is prototypical yet site-specific

02 | Combined on- and off-site fabrication methods and components to respond effectively to climate and context, achieving LEED for Homes Platinum (30% over threshold)

03 | Used a previously developed, compact infill site overcoming access limitations (LL)

VI. On- and Off-Site Construction

What were we able to accomplish?

"Simple parti done very well, prefab/modular elements have seams that are fully integrated, LEED Platinum rating speaks of thoughtfulness and thoroughness, elegant little design in a historical context..."

Lawrence Scarpa, FAIA, Angela Brooks, and Lorcan O'Herlihy, FAIA,
Jurors, AIA East Tennessee Design Awards

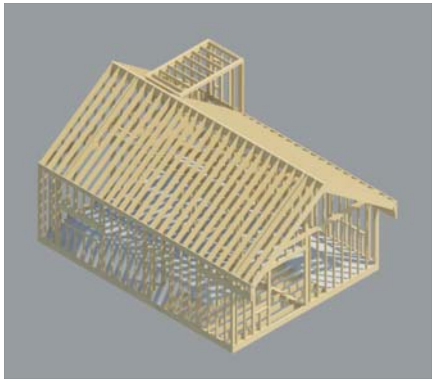
What were we able to accomplish?

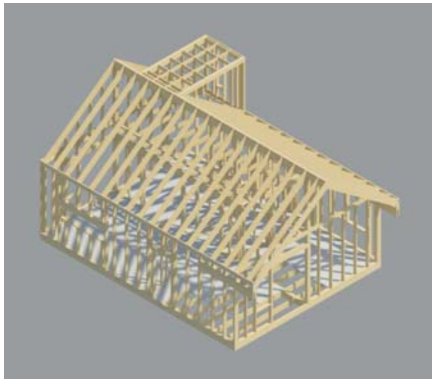
CONSTRUCTION WASTE DIVERSION RATES

Material	Quantity	%	Percentage Chart	Diverted To
Paper	1.0 tons	7%		Tennessee American Recycling
Plastic	0.5 tons	3%		Everst Corporation
Metal	0.7 tons	5%		Tennessee Metals
Aggregates	0.5 tons	3%		Riverside Road
Gypsum	1.4 tons	10%		Monterey Mushroom
Wood	5.7 tons	42%		Natural Resources
Disposed	4.4 tons	30%		Poplar View Landfill
Total Quantity of Waste	14.6		Percentage Diverted 70%	
Total Quantity of Diverted	10.2			

Traditional Framing 16" O.C.

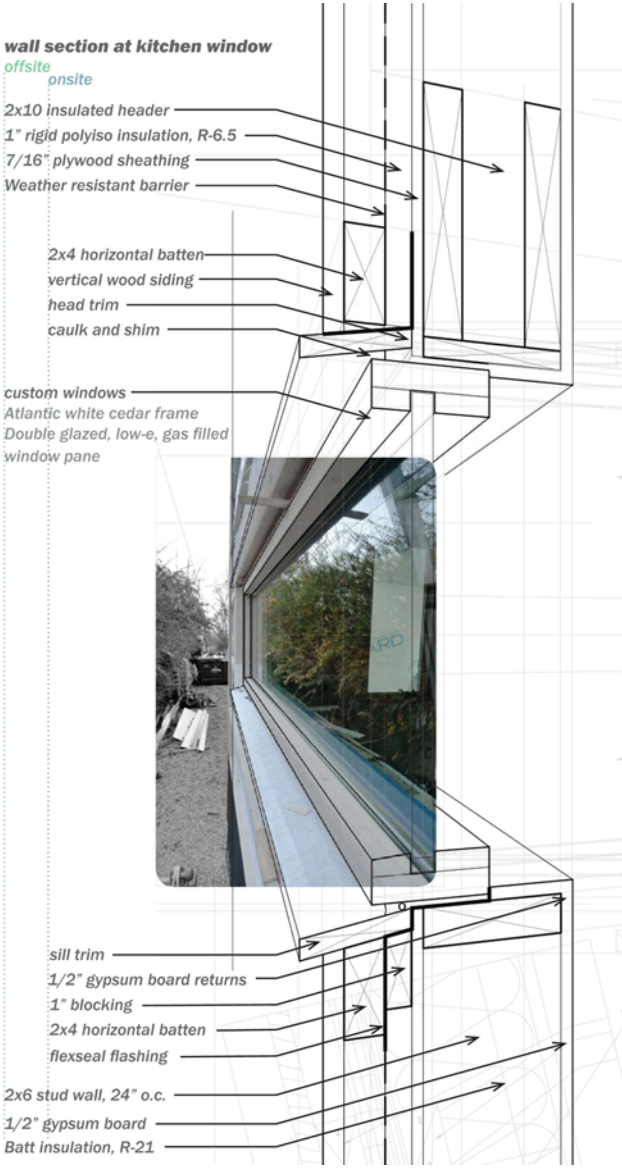
Optimized Framing 24" O.C.

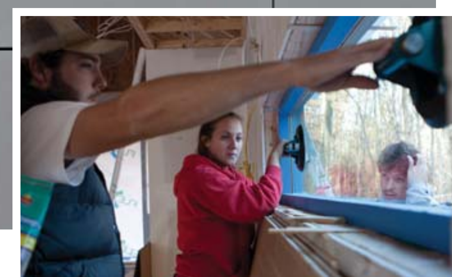




VI. On- and Off-Site Construction

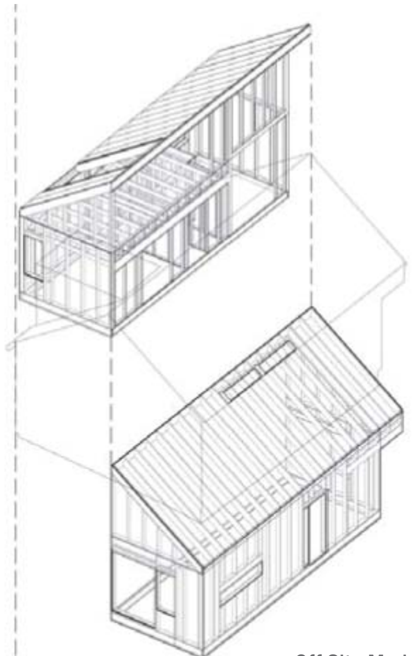
What were we able to accomplish?



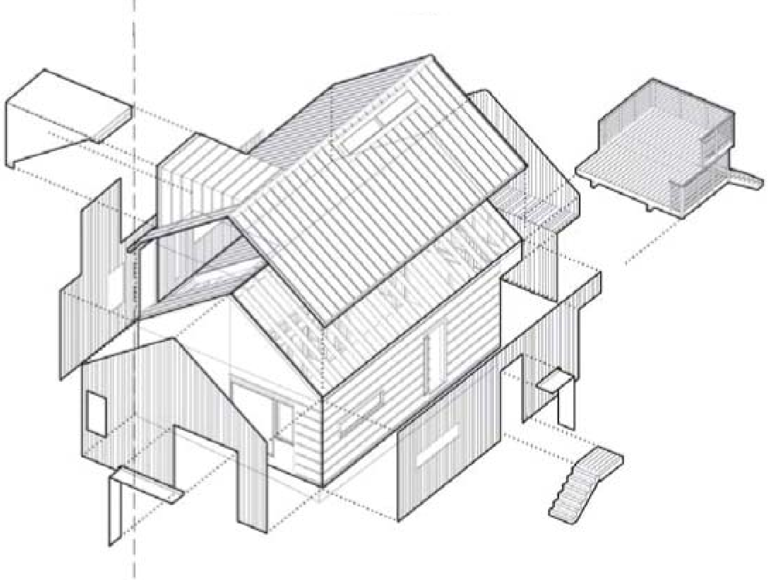


VI. On- and Off-Site Construction

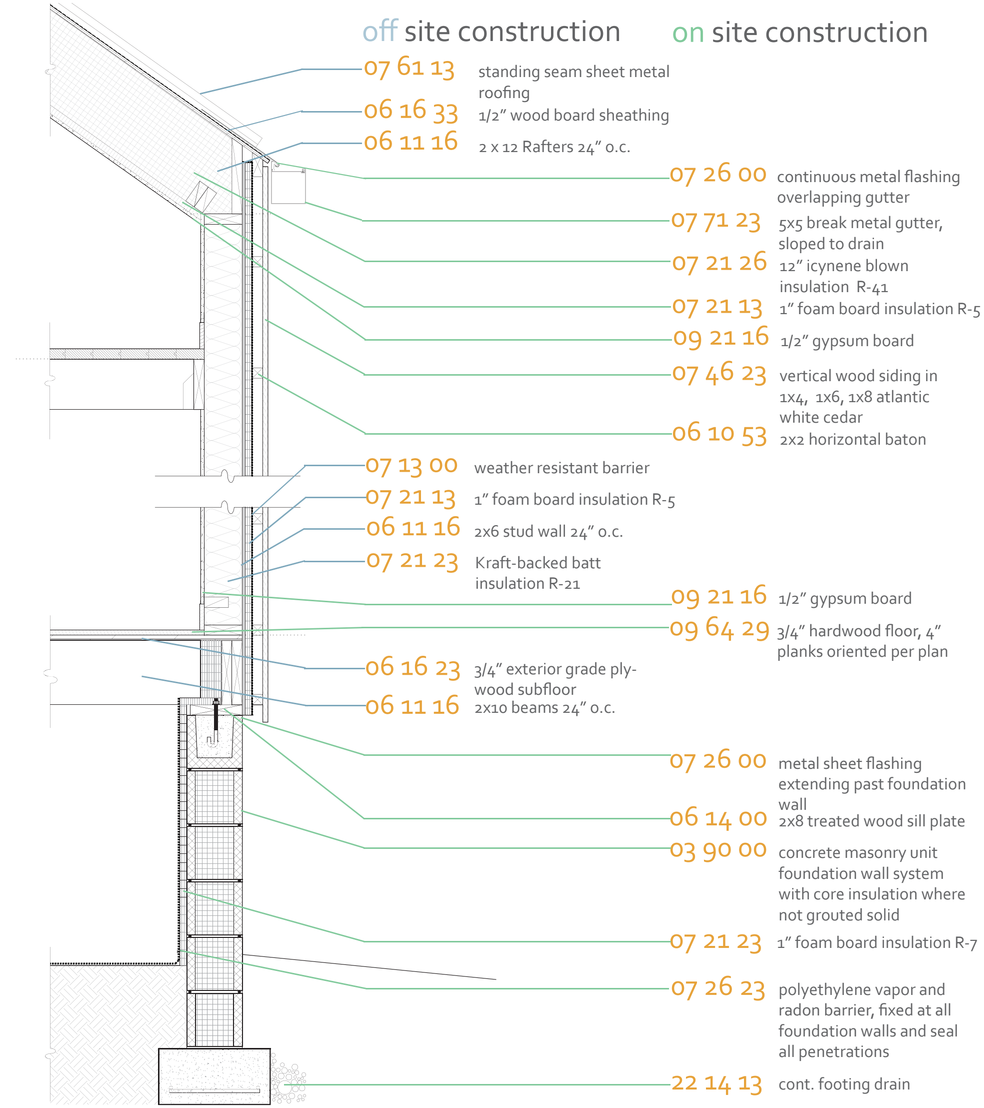
How were we able to accomplish this?



Off-Site Modular Fabrication

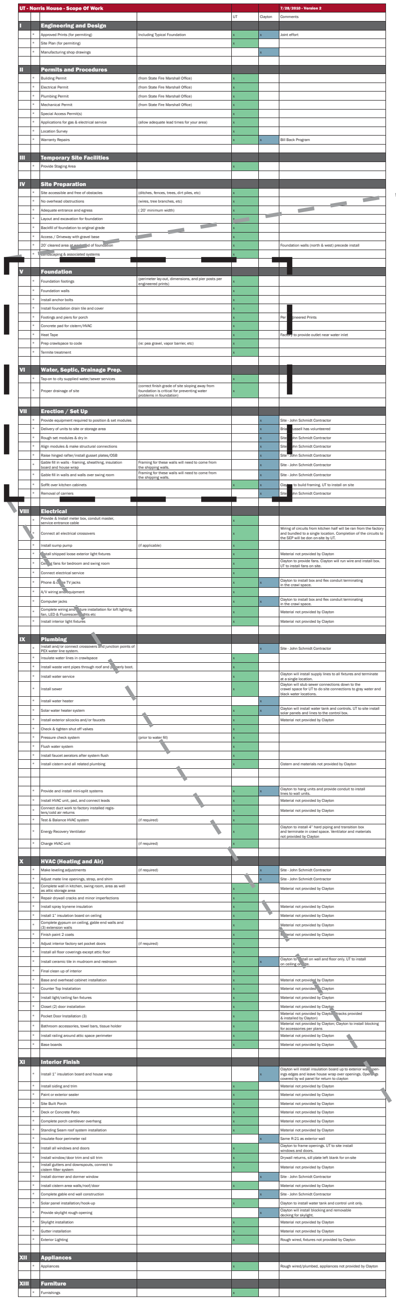


On-Site Construction



VI. On- and Off-Site Construction

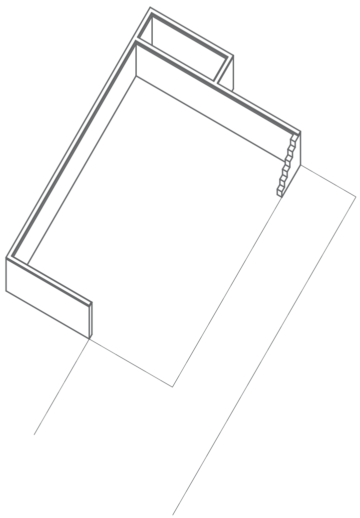
How were we able to accomplish this?



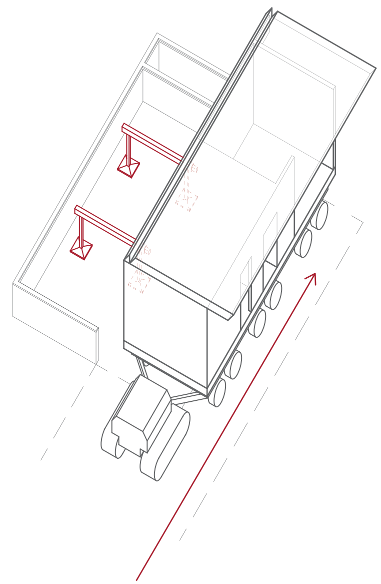
UT - Norris House - Scope Of Work			UT	CH
V	**Foundation**			
	Foundation footings	(perimeter lay-out, dimensions, and pier posts per engineered prints)	x	
	Foundation walls		x	
	Install anchor bolts		x	
	Install foundation drain tile and cover		x	
	Footings and piers for porch		x	
	Concrete pad for cistern/HVAC		x	
	Heat Tape		x	
	Prep crawlspace to code	(ie: pea gravel, vapor barrier, etc)	x	
	Termite treatment		x	
VI	**Water, Septic, Drainage Prep.**			
	Tap-on to city supplied water/sewer services		x	
	Proper drainage of site	(correct finish grade of site sloping away from foundation is critical for preventing water problems in foundation)	x	
VII	**Erection / Set Up**			
	Provide equipment required to position & set modules			x
	Delivery of units to site or storage area			x
	Rough set modules & dry in			x
	Align modules & make structural connections			x
	Raise hinged rafter/install gusset plates/OSB			x
	Gable fill in walls - framing, sheathing, insulation board and house wrap	Framing for these walls will need to come from the shipping walls.		x
	Gable fill in walls and walls over swing room	Framing for these walls will need to come from the shipping walls.		x
	Soffit over kitchen cabinets		x	x
	Removal of carriers			x

How were we able to accomplish this?

Stage 1



Stage 2



Modular installation

Typical modular installations involve the use of a crane, but this was not viable for several reasons:

-Overhanging vegetation and utilties
-Tight infill site
-Steep slope on site
-Lack of staging area

Stage 1

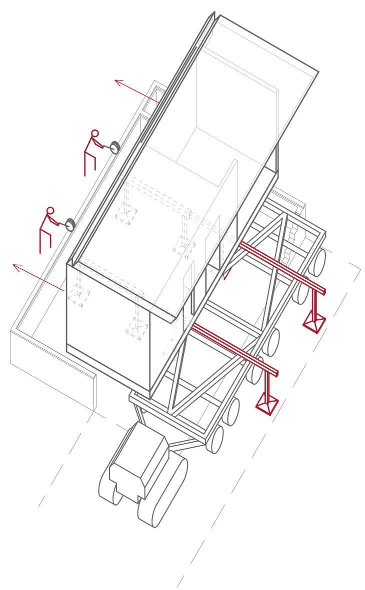
A predetermined portion of the foundation was built based on the ability of the modular units to back into adjacent half and unload.

Stage 2

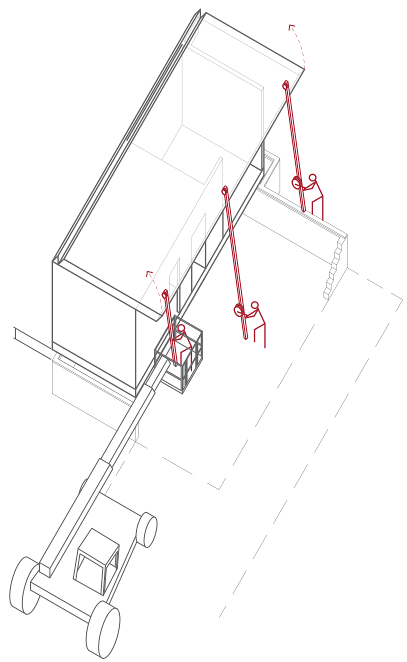
Unit 1 (bedroom and loft) is backed into place on its shipping chassis.

How were we able to accomplish this?

Stage 3



Stage 4



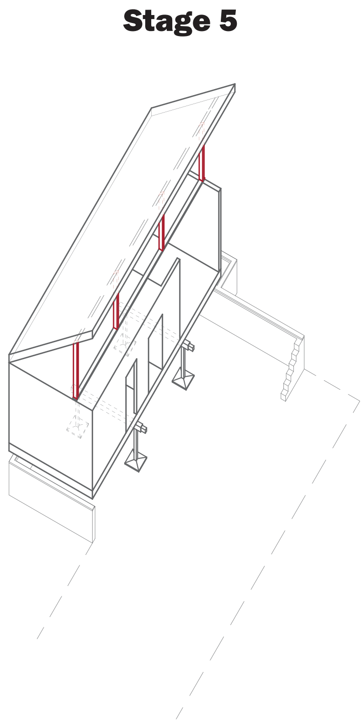
Stage 3

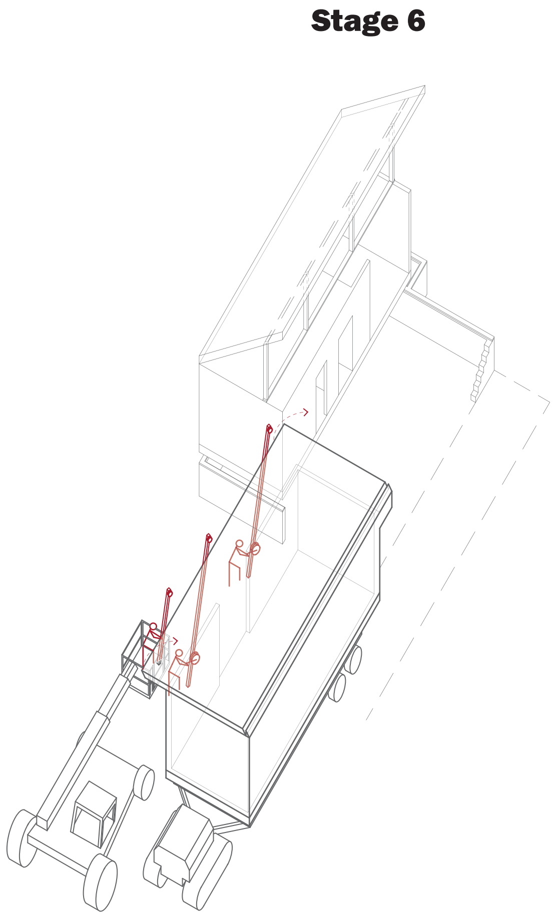
Unit 1 is raised from the shipping chassis and shifted via a roller system over the foundation wall.

Stage 4

The hinged roof of Unit 1 is raised to its full height using several hand operated winches

How were we able to accomplish this?





Stage 5

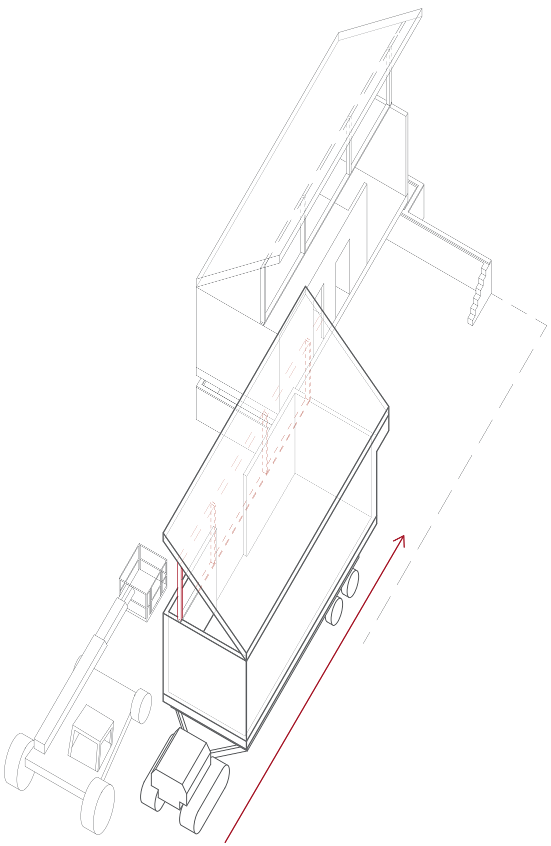
The roof of Unit 1 is temporarily braced and held in place.

Stage 6

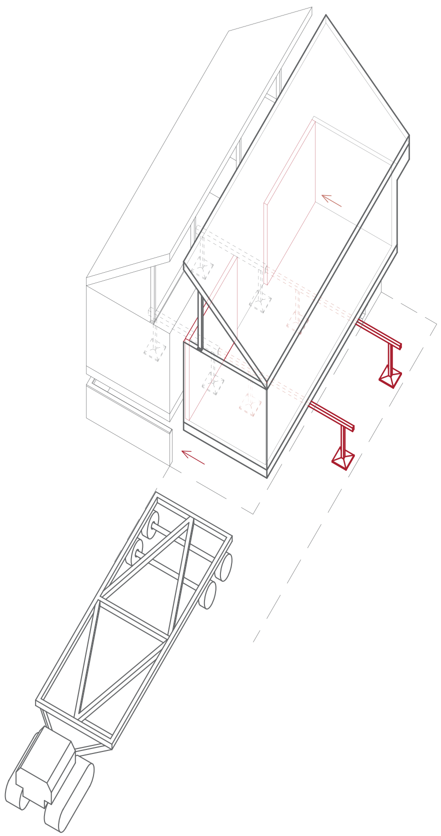
Unit 2 (kitchen and living) is backed into the drive court on its shipping chassis. The roof of Unit 2 is raised with hand winches prior to being backed over the foundation.

How were we able to accomplish this?

Stage 7



Stage 8



Stage 7

The roof of Unit 2 is temporarily braced and held in place. The unit is then backed into place adjacent to Unit 1.

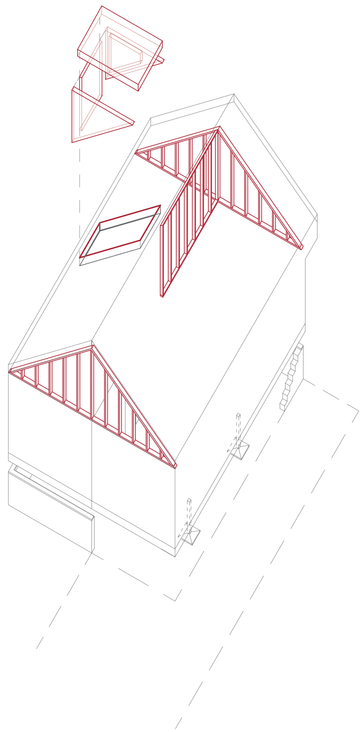
Stage 8

Unit 2 is raised off it's shipping chasis and married with Unit 1 at the ridge beam and marriage wall.

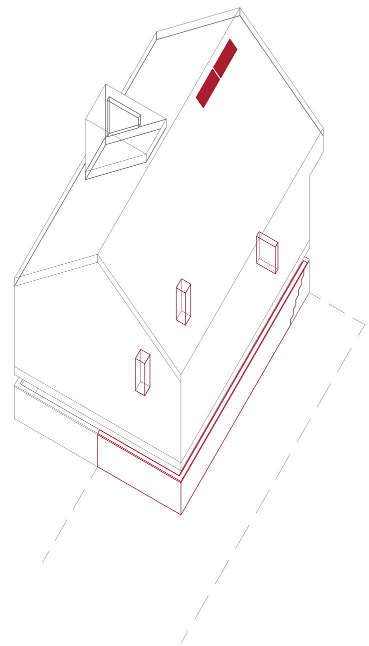
VI. On- and Off-Site Construction

How were we able to accomplish this?

Stage 9



Stage 10



Stage 9

A panelized dormer is installed on the roof. Gabled endwalls (built from framing reused from temporary supports) are installed, as well as the completion of floor to ceiling portions of the interior marriage wall. The units are dried in at this time (roofing felt, remaining building building wrap).

Stage 10

The remaining portion of the foundation wall is installed around the home, in addition to structural piers in the crawlspace. Temporary supports are removed through the crawlspace door.

How were we able to accomplish this?

VI. On- and Off-Site Construction

Key LEED and Design Criteria (MR)

Framing (exterior wall, floor, interior wall, and roof)
Weyerhaeuser iLevel
Regional material: Greenville, North Carolina (461 miles)
Sustainable Forest Initiative Certified

Gypsum (interior walls and ceilings)
US Gypsum SHEETROCK
Regional material: Bridgeport, Alabama (163 miles)
<90% recycled content

Interior Paints and Coatings
KILZ 2 Low VOC Latex Primer (Flat, Walls)
10g/L VOC

Sherwin Williams PROMAR® 200 Zero VOC Interior Latex Semi-Gloss, Ultradeep Base (Non-flat, Walls)
0g/L VOC

Sherwin Williams, ProClassic Interior Acrylic Latex, Semi-gloss (Non-flat, Cabinets and Doors)
145g/L VOC

Osmo 5125 Polyx Professional Hardwax Oil (Floor finish)
50g/L VOC

Insulation
Icynene LD-R-50 Spray Foam
A low-emitting material (LEM) as per CHPS EQ 2.2 Section 01350

Johns Manville Kraft-Faced
Formaldehyde free; <25% recyled content
Regional Material: Winder, Georgia (196 miles)

Adhesives and Sealants
Alpha P5101 (Drywall and Panel Adhesives)
0.000001g/L VOC content

ITW T.A.C.C F6400LVR (Drywall and Panel Adhesives)
GREENGUARD

DAP Alex Plus Arcylic Latex Caulk
39.1g/L content

DOW Corning 795 Silicone Building Sealant
30g/L VOC content

TEC Accucolor Unsanded Siliconized Arcylic Caulk
28g/L VOC content

GE Silicone I Kitchen/Bath Caulk
36g/L VOC content










-The project team worked closely with Clayton Home's purchasing department to source ideal materi-als related to MR2.2

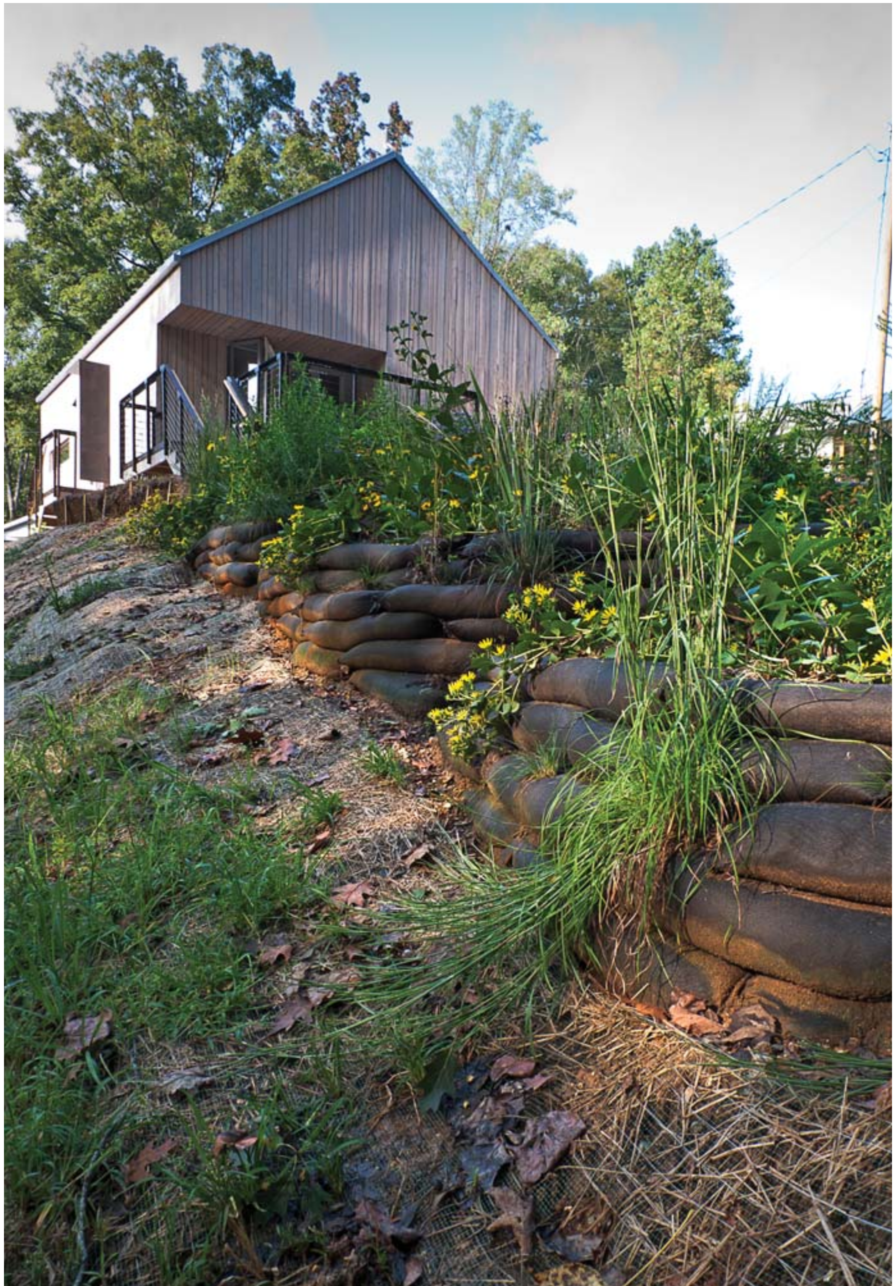
-Being located in the Southeast US was highly beneficial to satistfying regional sourcing requirements

Key LEED and Design Criteria (MR)

Materials and Resources		
MR 1	**Material-Efficient Framing** [Max. Points 5]	
1.1	Framing Order Waste Factor Limit	PREQ
1.2	Detailed Framing Documents	1
1.3	Detailed Cut List and Lumber Order	1
1.4	Framing Efficiencies	3
*1.5	Off-site Fabrication	4
MR 2	**Environmentally Preferable Products** [Max. Points 8]	
2.1	FSC Certified Tropical Wood	PREQ
**2.2	Environmentally Preferable Products	8
MR 3	**Waste Management** [Max. Points 3]	
3.1	Construction Waste Management Planning	PREQ
3.2	Construction Waste Reduction	2
	total MR points of 16 points possible	**14**

Innovation and Design Process		
ID 1	**Integrated Project Planning** [Max. Points 4]	2
ID 2	**Durability Management Process** [Max. Points 3]	3
ID 3	**Innovative or Regional Design** [Max. Points 4]	
3.1	Exemplary Performance: MR 2.2	1
3.2	Exemplary Performance: MR 2.2	1
3.3	Exemplary Performance: SS 2.2/2.5	1
3.4	Exemplary Performance: MR 1.5	1
*3.5	Innovation: Monitoring and Evaluation	0
*3.6	Exemplary Performance: MR 2.2	0
	total ID points of 11 points possible	**9**

* Exemplary performance credit earned in Innovation and Design 3.4
** Exemplary performance credit earned in Innovation and Design 3.1, 3.2, and 3.6



A. What were we able to accomplish?
B. How were we able to accomplish this?
C. Key LEED and Design Criteria

Learning Objective:

To better understand the benefits of post-occupancy evaluation efforts (including building systems; overall energy use; and indoor environmental air quality (IEQ) in small homes and associated IEQ LEED for Homes issues).

Overall Energy Use

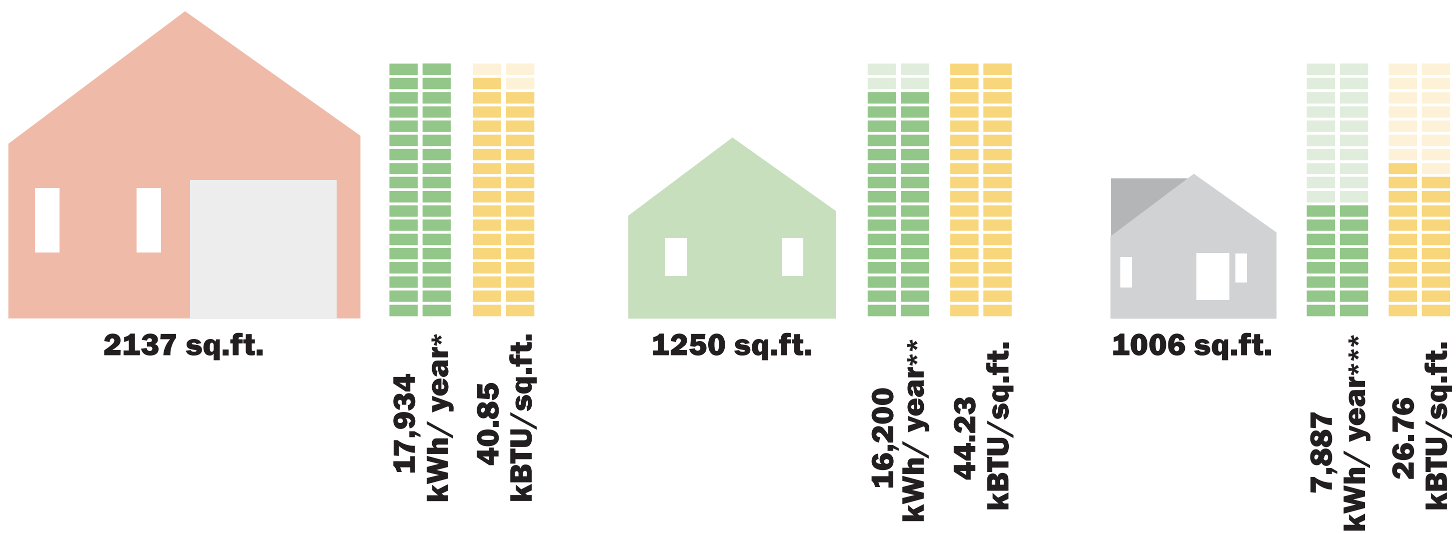
-Able to reduce energy consumption of an average house by 56%

-Conscious decision to use 100% electric power (no combustion)

- -Elimination of potential contaminate source within home
- -Potential for grid expansion by local utility to feed more renewables
- -Potential to install on-site renewables at later date

Through efforts to downsize the home, smart use of passive state-gies, and the utilization of efficient building systems, the New Norris House has achieved signifigant energy reductions over the course of the first year of study. Further-more, the project gained a 10pt. LEED for Homes credit adjustment (maximum available) based on the small size of the home.

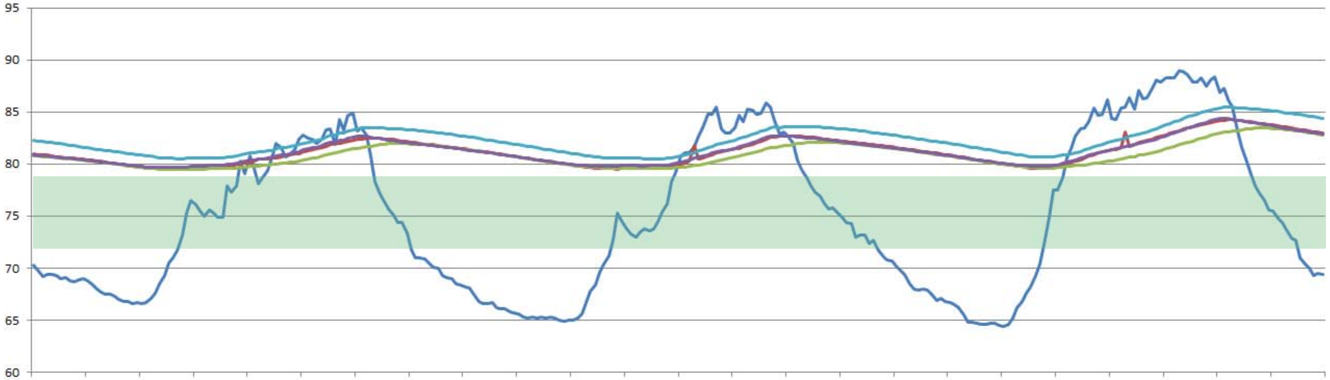
Average Home in East South Central US Region | **Average Home in Norris** | **A New Norris House**



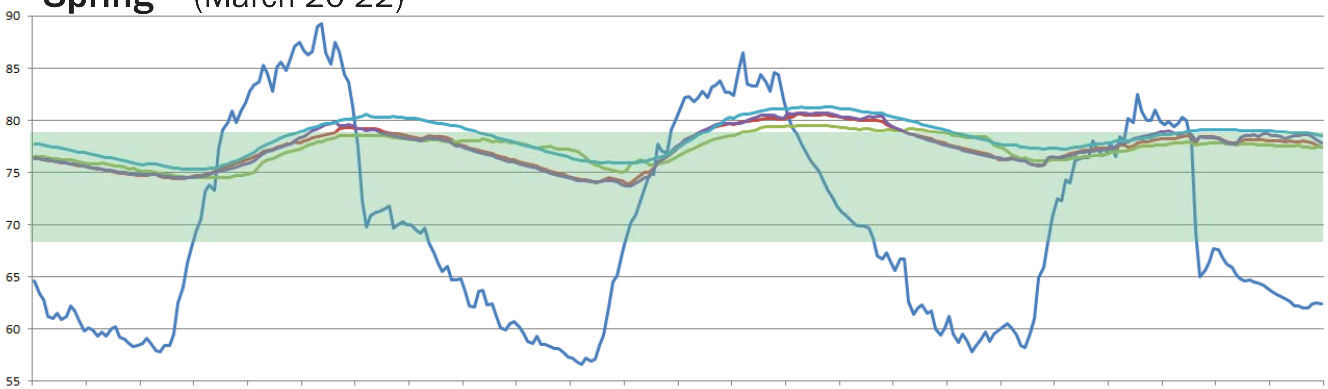
* 2005 US Energy Information Administration Report on Residential Energy Use
** Average value for Clinton Utility Board customers
*** As measured from Aug 2011- July 2012

Overall Energy Use

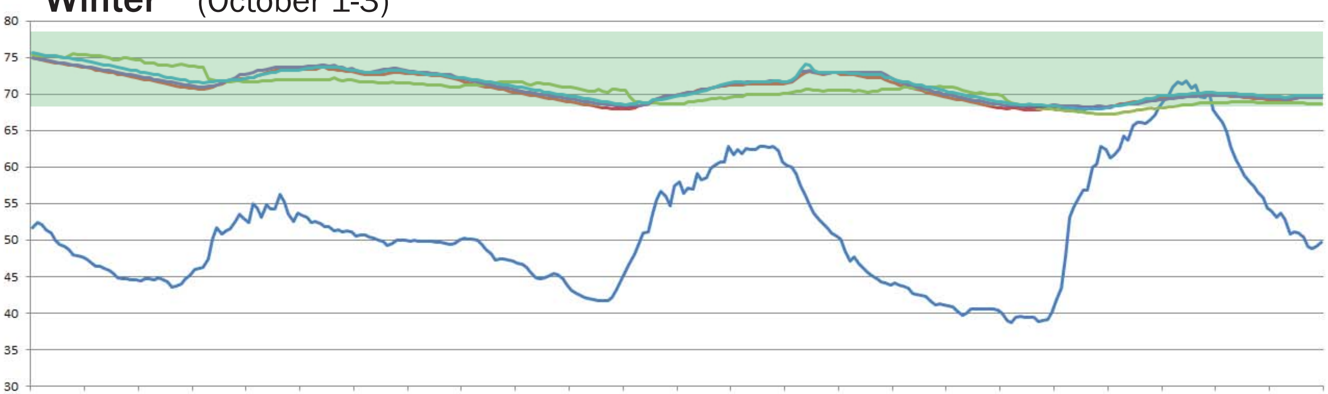
Summer (June 16-18)



Spring (March 20-22)



Winter (October 1-3)



Efforts to heavily insulate the home resulted in a very tight envelope which is capable of passively resisting most external temperature fluxuations.

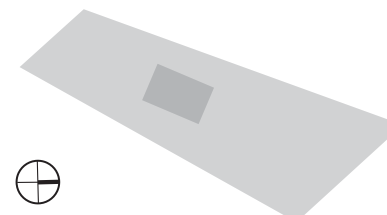
Envelope R-Values

Roof, R-42

Walls, R-29.5

Foundation: R-24

Site Orientation



Comfort Zone

Outdoor

Living

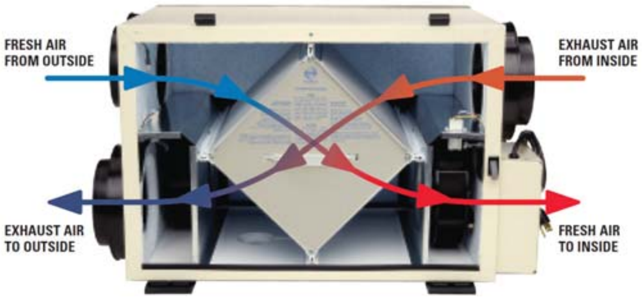
Bedroom

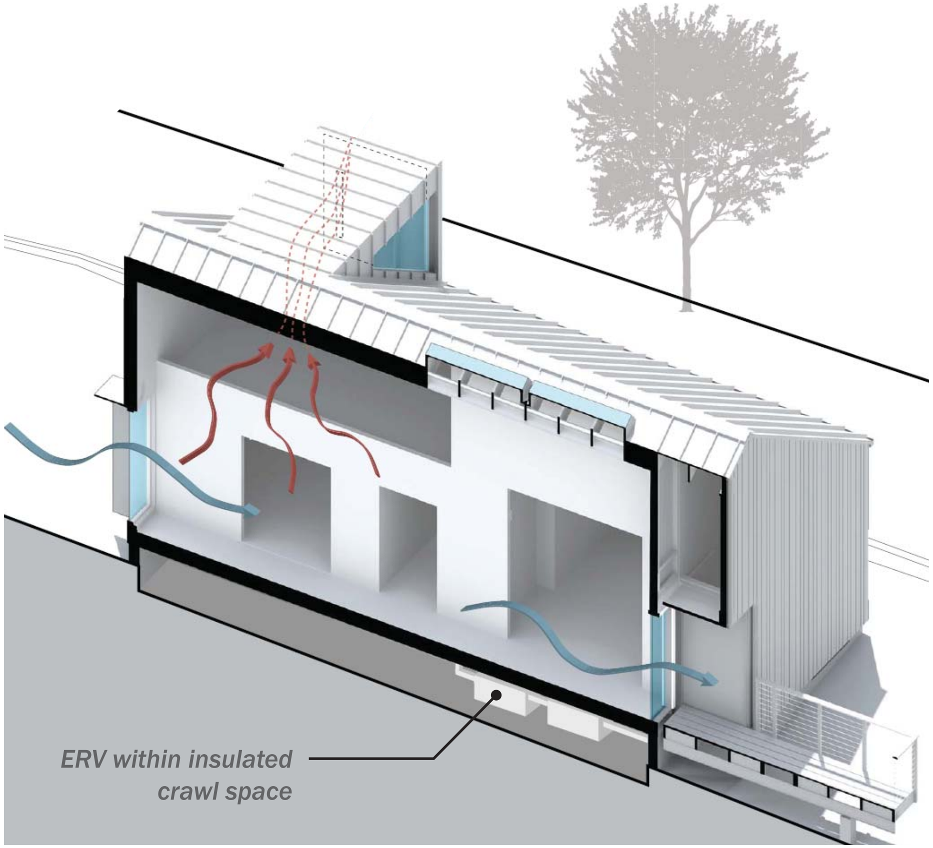
Swingspace

Loft

Energy Recovery Ventilator

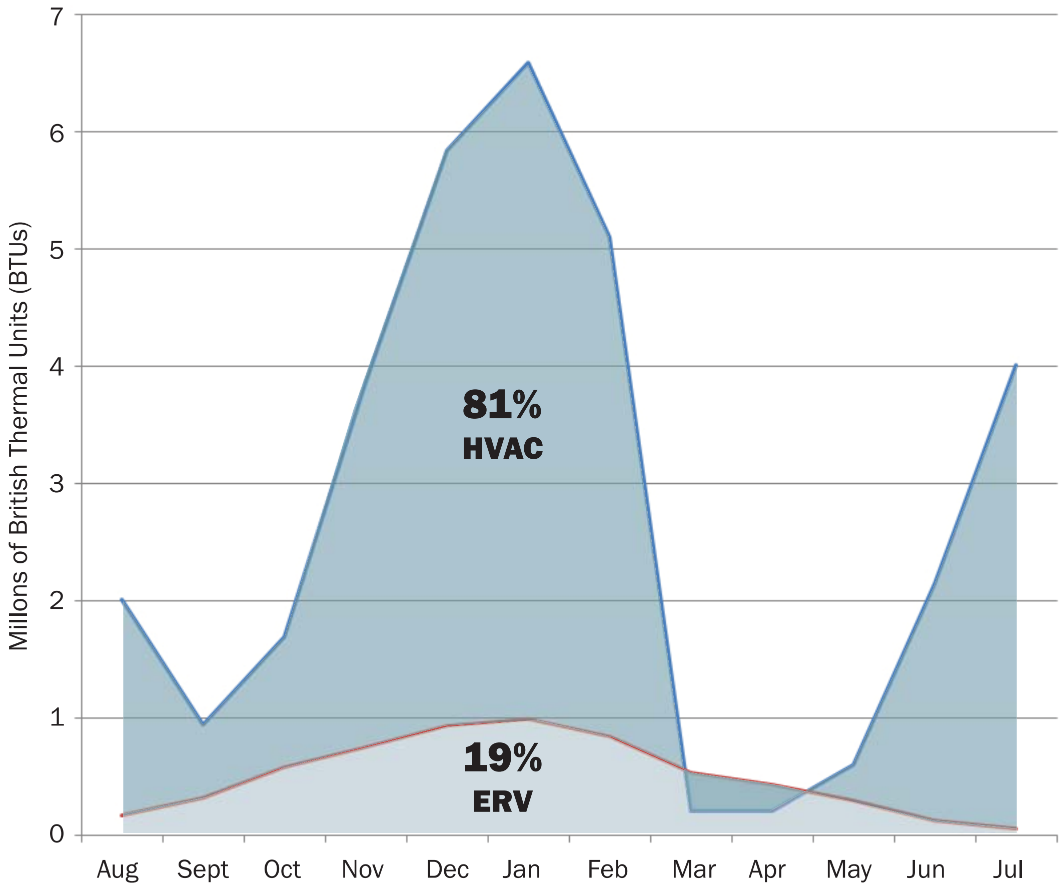
The New Norris House utilizes a Fantech energy recovery ventilator to achieve interior whole house ventilation. Not only does the unit provide code required amounts of fresh air, it reduces the load of the heat and air system, saving energy and money.





Energy Recovery Ventilator

ERV savings Aug 2011 - Jul 2012: $55.69



The New Norris House utilizes a Fantech energy recovery ventilator to achieve code required interior whole house and local ventilation. The unit provide fresh air and reduces the load of the heat and air system, saving energy and money.

HVAC BTU Delivered

ERV BTU Recovered

$27.46
Net savings/ year

~16 year
buy back period

		kWh rate	Hours			HVAC kWh	ERV kWh	ERV Delta T	HVAC Cost	ERV Cost	HVAC BTU Delivered	BTU/h	BTU recovered	% Recovered	$ Saved
2011	august	$ 0.09904	744			200.9	25.0	4.7	$ 19.90	$ 2.48	2008793	228.72	170170	8%	$ 1.69
	sept	$ 0.09822	720			94.8	24.5	9.0	$ 9.31	$ 2.41	947730	439.76	316626	33%	$ 3.11
	oct	$ 0.09190	744			170.0	25.6	16.2	$ 15.62	$ 2.35	1699830	786.58	585218	34%	$ 5.38

As measured (HVAC kWh, ERV kWh)

ERV Delta T: ERV Intake temp *[minus]* ERV Delivered temp

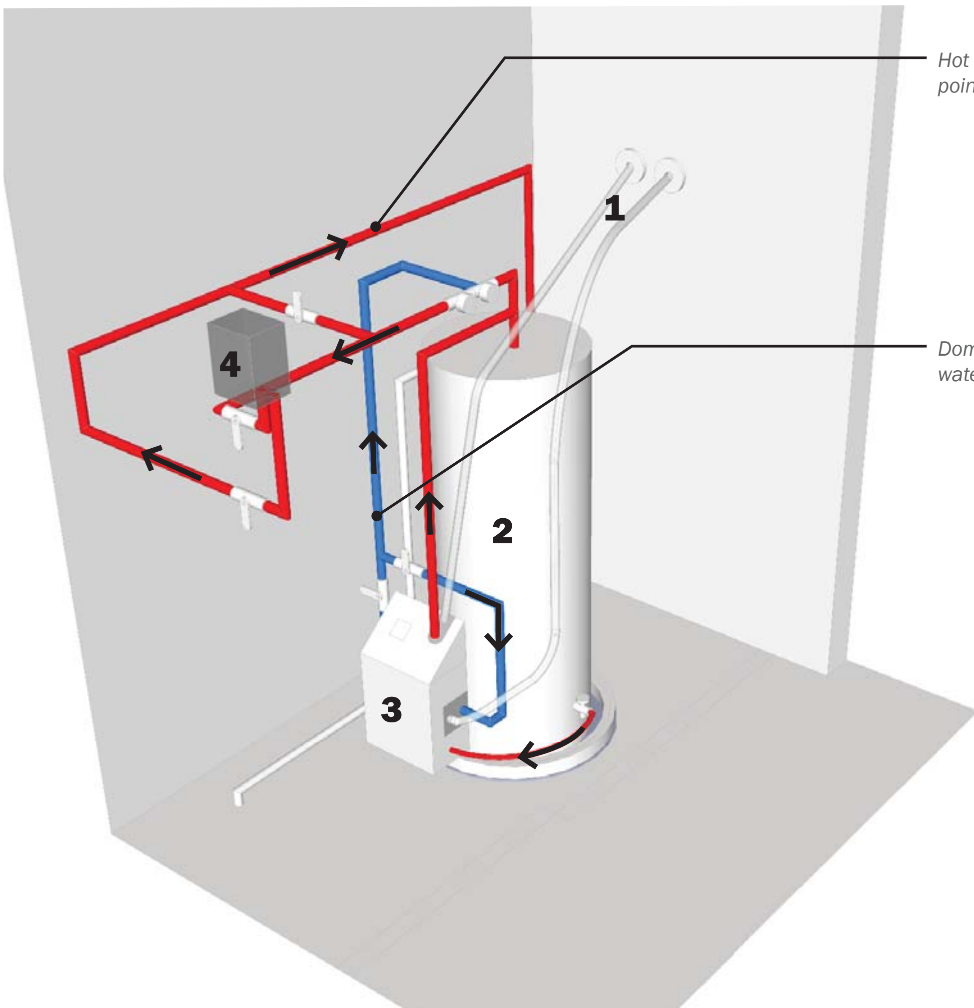
HVAC BTU Delivered: HSPF *[multipled by]* 1000 *[multipled by]* HVAC kWh

BTU/h: Density of air *[multiplied by]* the specific heat of air *[multipled by]* 60 minutes/ hr *[multipled by]* ERV Delta T *[multipled by]* ERV CFM

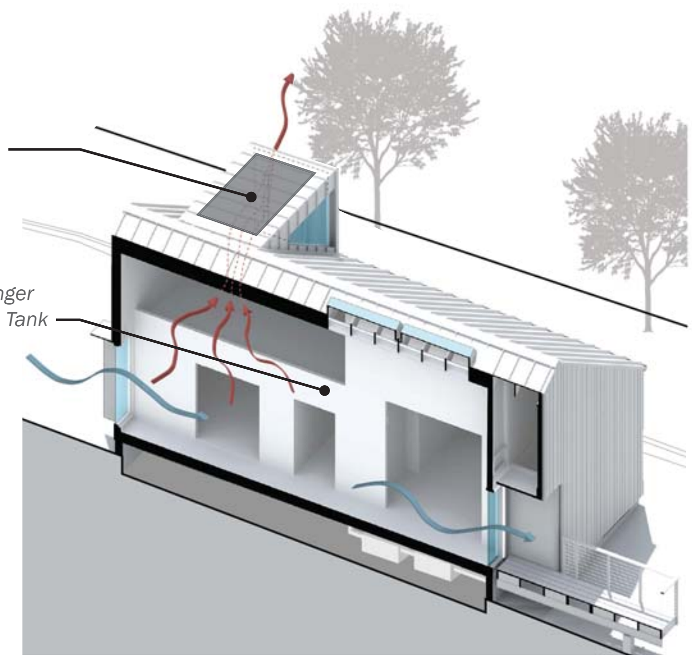
BTU recovered: BTU/h *[multipled by]* Hours/month

Solar Hot Water Heater

Diagram of Solar Hot Water System Equipment in Mud Room Closet



The New Norris House utilizes a solar hot-water panel system made by Enerworks. The system is supplemented by a small Eemax instanteous water heater.



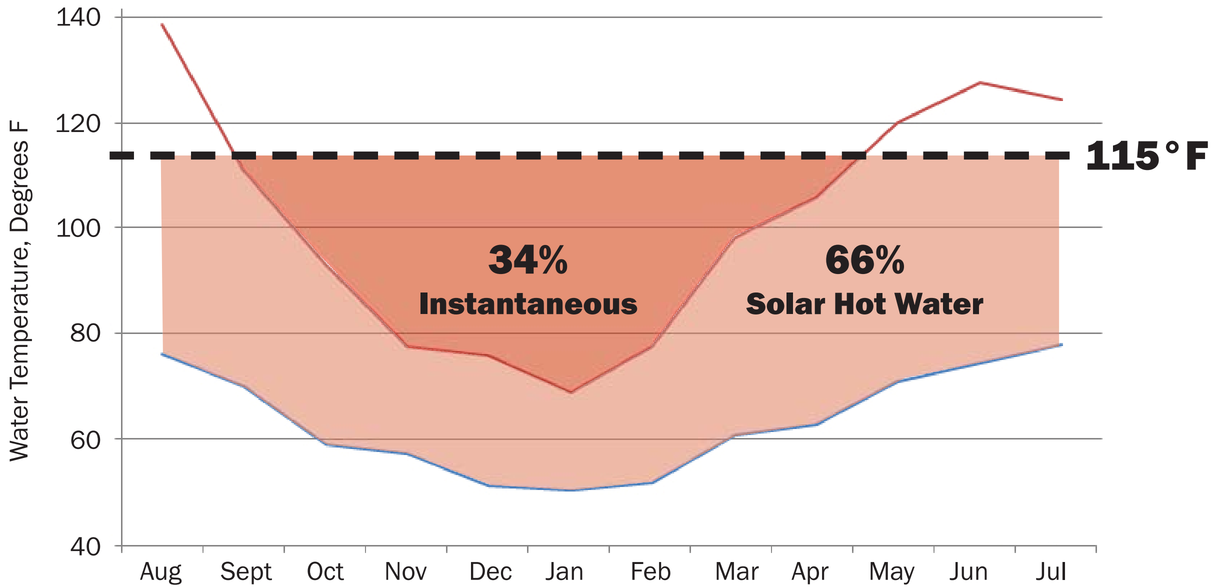
1 Glycol lines to 2.88m² Enerworks solar hot-water panel on roof
2 Rheem 80 gallon storage tank (no elements)
3 Eneryworks Energy Pack (heat exchanger and system controller)
4 11.8kW Eemax instantaeous thermostatic water heater

Solar Hot Water Heater

Hotwater cost Aug 2011 - Jul 2012: $72.80 (a 73% reduction)

-77% of cost result from instantaneous hot-water heater

The New Norris House utilizes a solar hot-water panel system made by Enerworks. The system is supplemented by a small Eemax instanteous water heater.



Average Home in East South Central US Region

NNH

$201.72
Net savings/ year

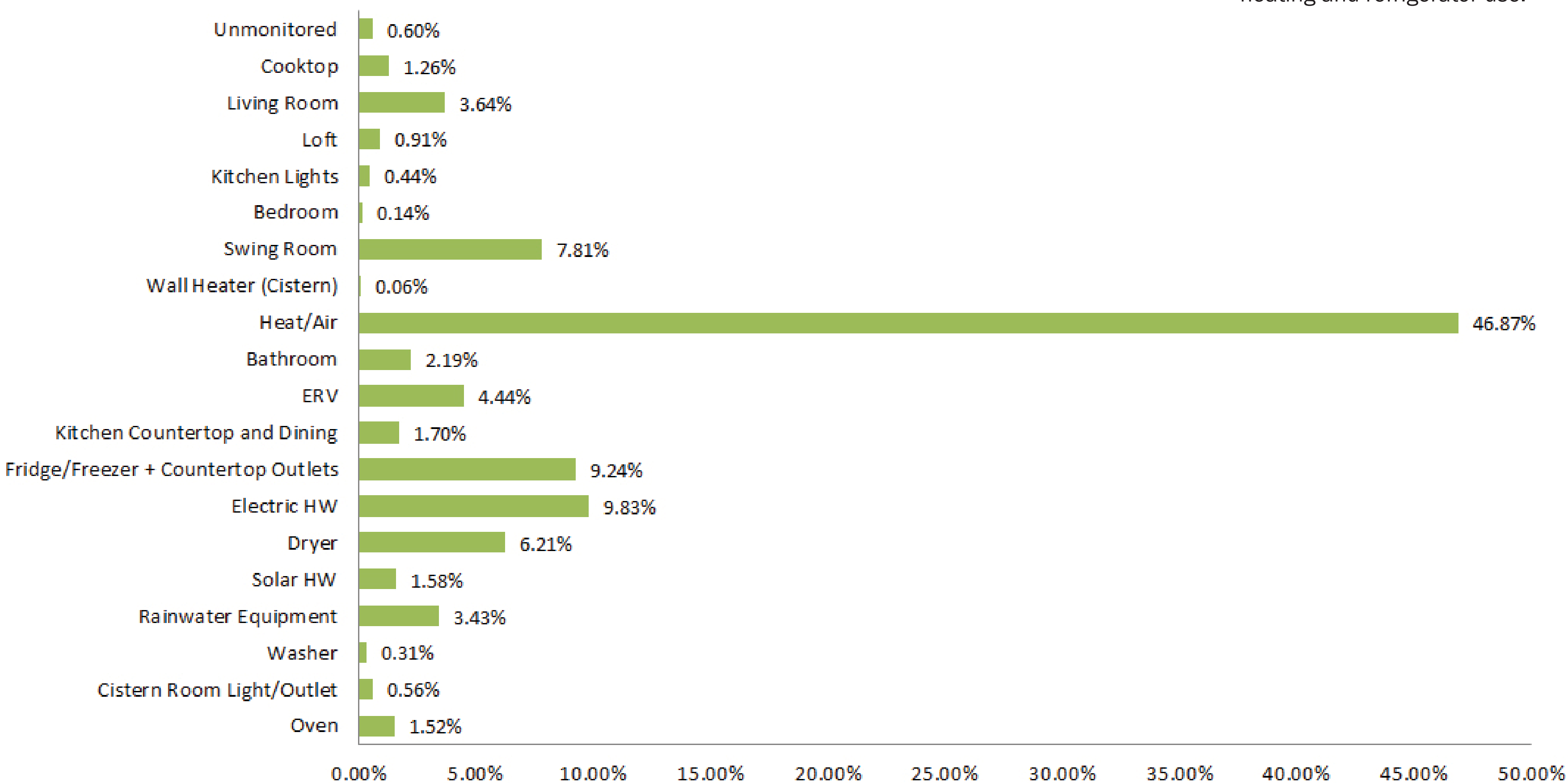
~22.7 year
buy back period***

* 2005 US Energy Information Administration Report on Residential Energy Use
** As measured from Aug 2011- July 2012
*** With federal incentives. Buy back period without incentives is 32.5 years.

Energy Use Distribution Aug 2011 - Jul 2012

-47% of use results from heat and air
-10% of use results from electric water heater

Primary energy loads within the home orginate from the heat and air system, followed by water heating and refrigerator use.



VI. Outreach

What were we able to accomplish?

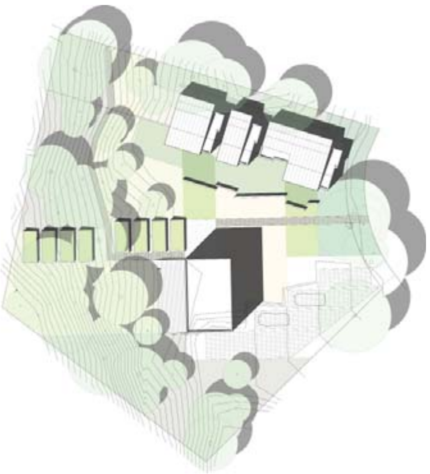
01 | Process generated positive community response to the contemporary home and landscape - in terms of 'fit' with historic community (scale, form, materiality, detail) and in terms of answering to desires for updating historic type (brighter, greater connection to nature, increased storage, improved energy efficiency)

02 | Contemporary, high-performance manufactured "product" (modular shell) working within factory constraints yet "stretching" industry partner's standard supply chains and design ambitions

03 | Revision of local codes for rainwater use in home and approved experimental state permits for grey water discharge

04 | Open-source sharing of lessons learned with design/engineering professions to advance sustainable design initiatives and streamline processes for others in the future

How were we able to accomplish this?

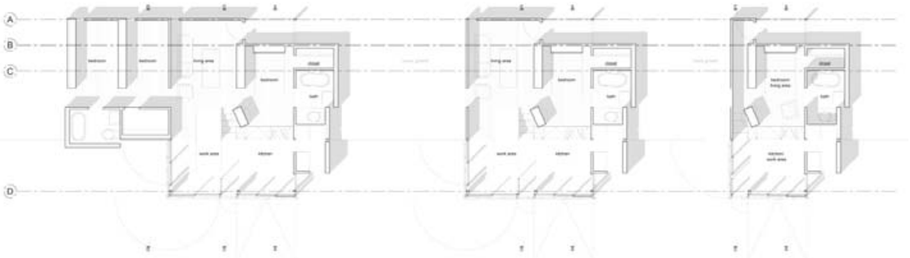


home+1 louvers closed

Home+2 southwest view

House+2 section

Home+2 northwest view

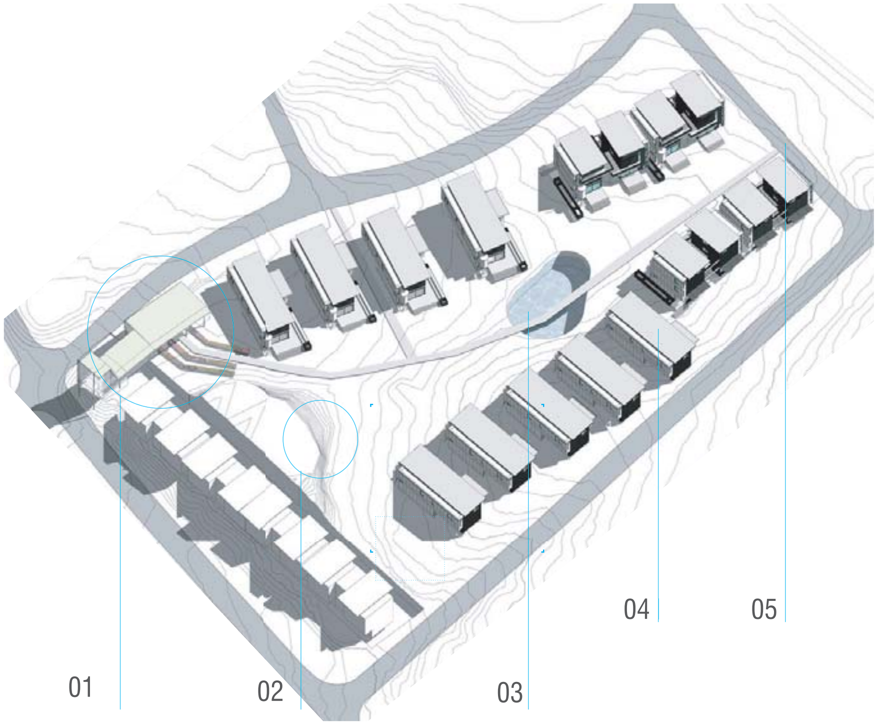


VI. Outreach

How were we able to accomplish this?

Modular Housing Alternatives
- Theoretical Design Studio: Tools of Engagement, 2008
(A collaboration between Clayton Homes and UTK School of Architecture)

- Typical greenfield development within the modular industry



How were we able to accomplish this?

Samuel Mortimer, Assoc. AIA
University of Tennessee
Knoxville
Speaker

Tricia Stuth, AIA
University of Tennessee
Knoxville
Speaker

Stephen Schreiber, FAIA
University of Massachusetts
Amherst
Moderator

Submit a question to the moderator via the Chat box. They will be answered as time allows.

Thank you for joining us!

This concludes the AIA/CES Course #H12011.

The webinar survey/report form URL is listed in the chat box *and* will be included in the follow-up email sent to you in the next few hours.

Report credit for all attendees at your site by completing the webinar survey/report form **within the next 24 hours**. You will be prompted to download a certificate of completion at the end of the survey.

Learn about other AIA webinar offerings at http://network.aia.org/events/webinars/.