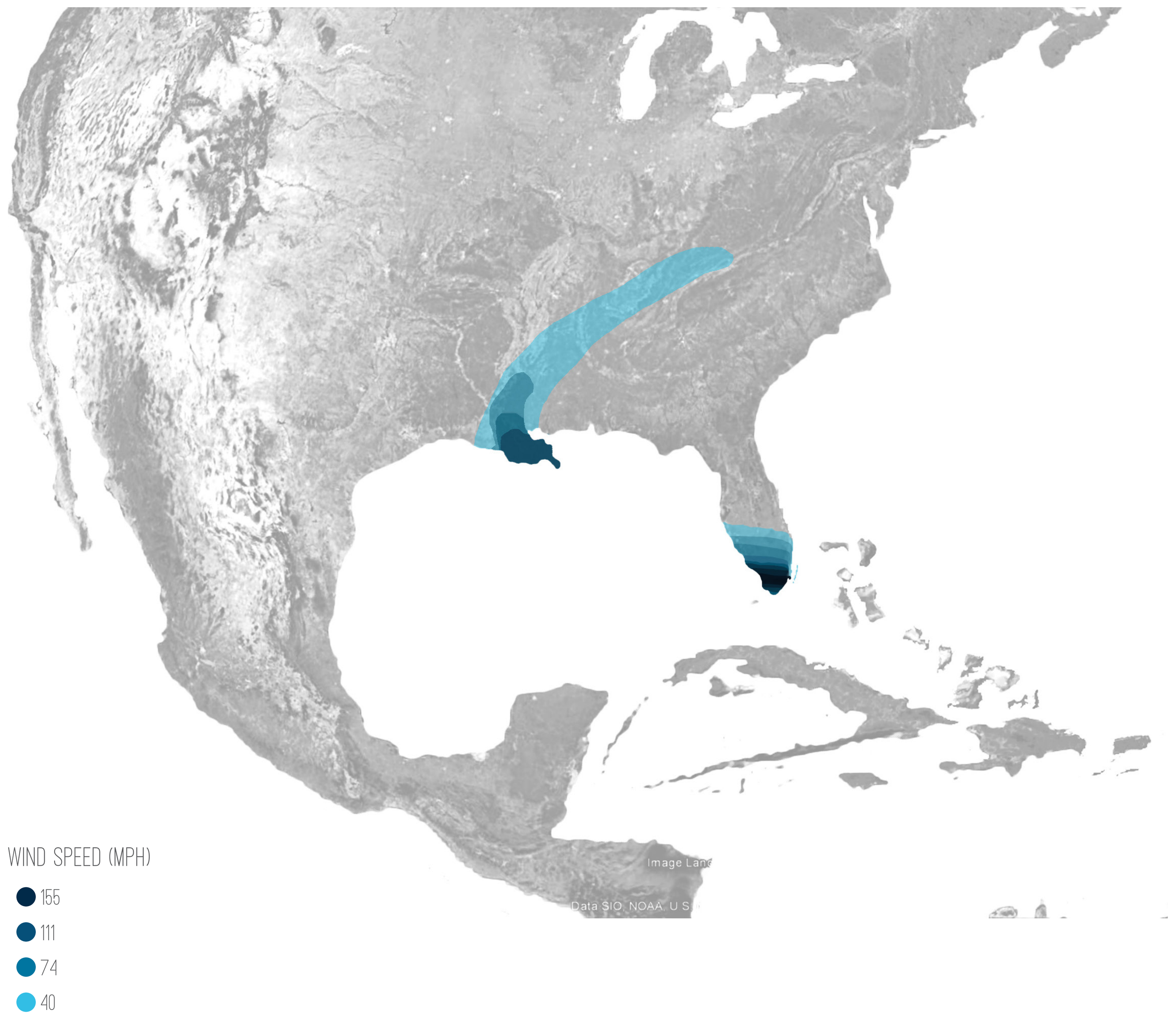
PERSONALIZATION OF MANUFACTURED HOUSING IN LOW-INCOME, HIGH-RISK AREAS

1. RESILIENCE DATA: CASE STUDIES, CODE RESEARCH, AND SURVEYS

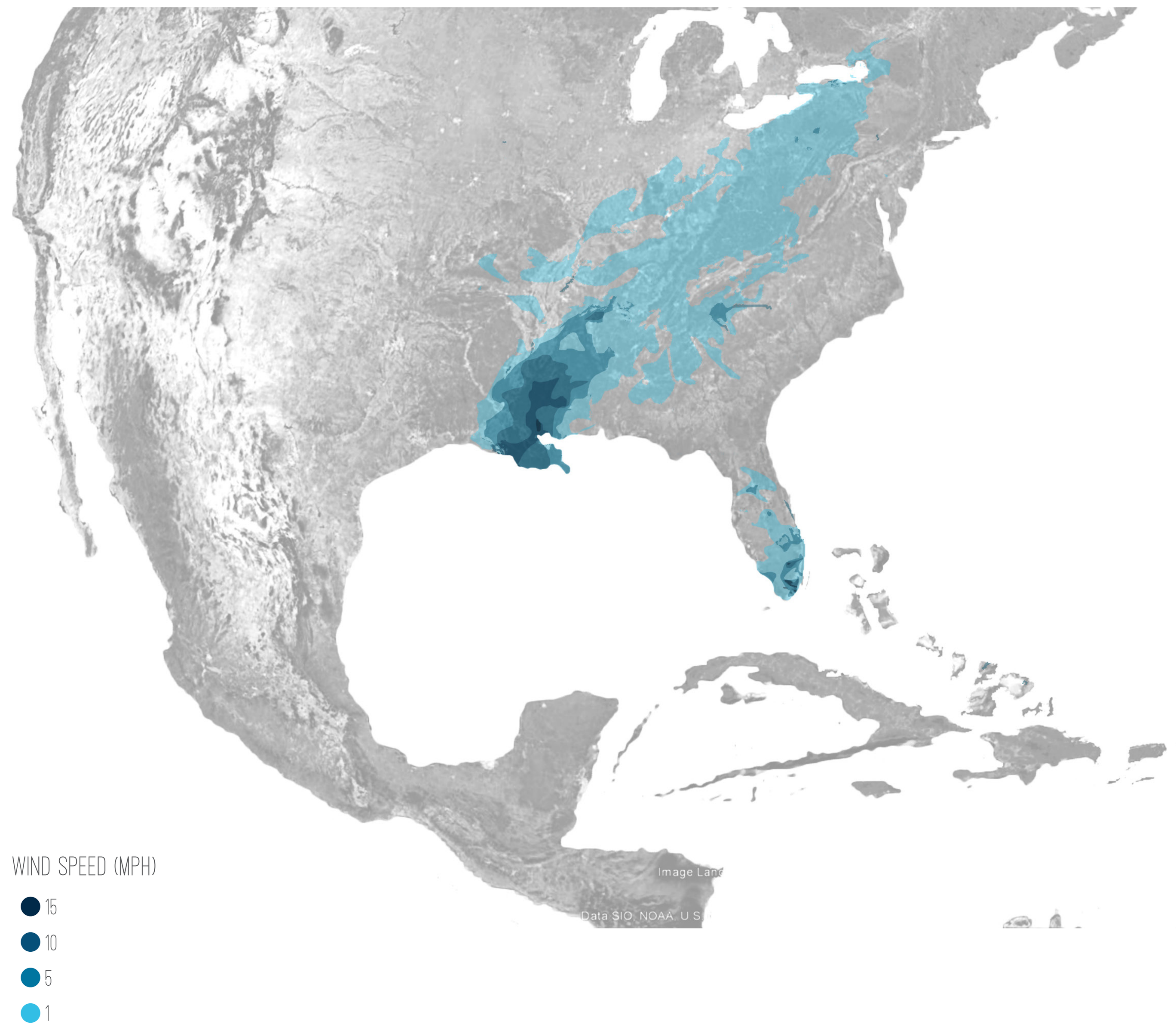
WIND SPEED MAP

CASE STUDY ONE



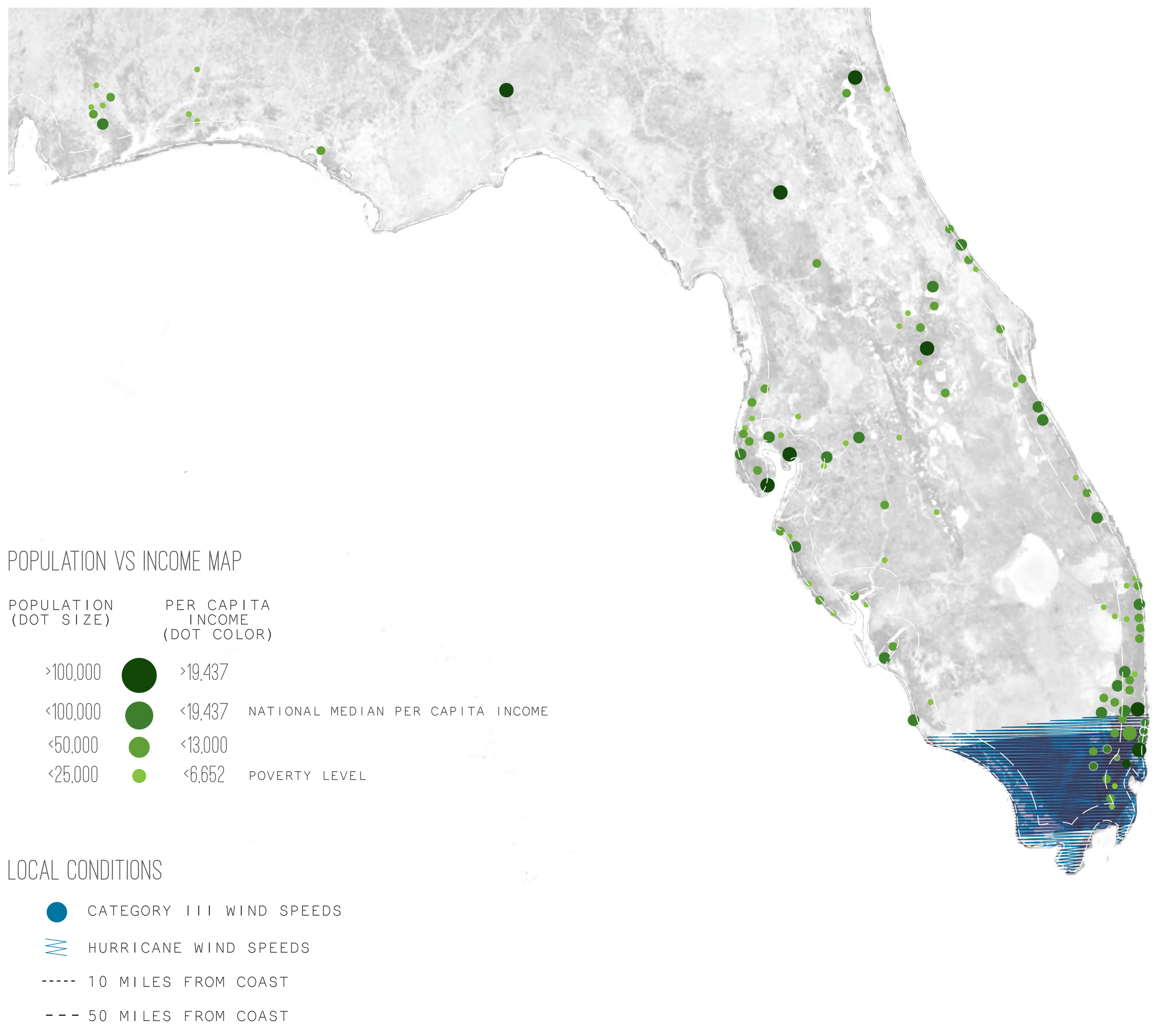
RAINFALL MAP

CASE STUDY ONE



STORM, INCOME, & POPULATION MAP

CASE STUDY ONE

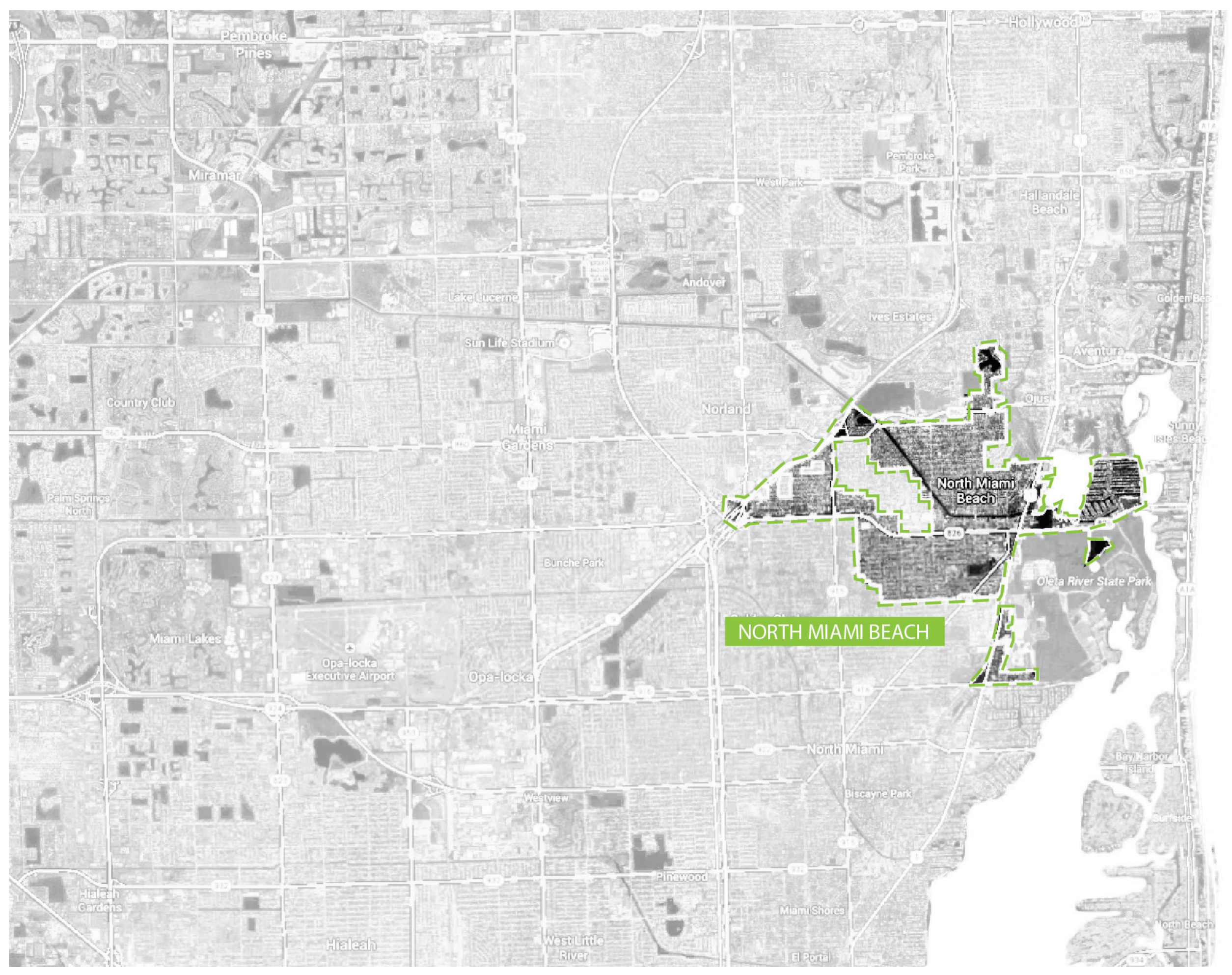


SELECTED CITY

CASE STUDY TWO

NORTH MIAMI BEACH

< 50,000 PEOPLE
< NATIONAL MEDIAN PER CAPITAL INCOME
< ONE MILE FROM THE COAST
WITHIN HURRICANE STRENGTH WINDS

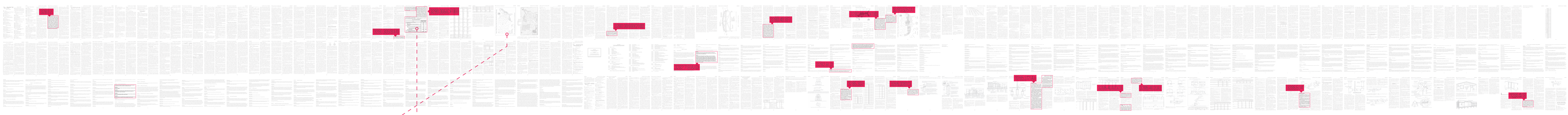


QUALIFYING AREAS VS STORM SURGE

CASE STUDY ONE

MANUFACTURED HOUSING CODE

HUD CODE



3280.2

Manufactured home means a structure, transportable in one or more sections, which in the traveling mode is 8 body feet or more in width or 40 body feet or more in length or which when erected on-site is 320 or more square feet, and which is built on a permanent chassis and designed to be used as a dwelling with or without a permanent foundation when connected to the required utilities, and includes the plumbing, heating, air-conditioning, and electrical systems contained in the structure.

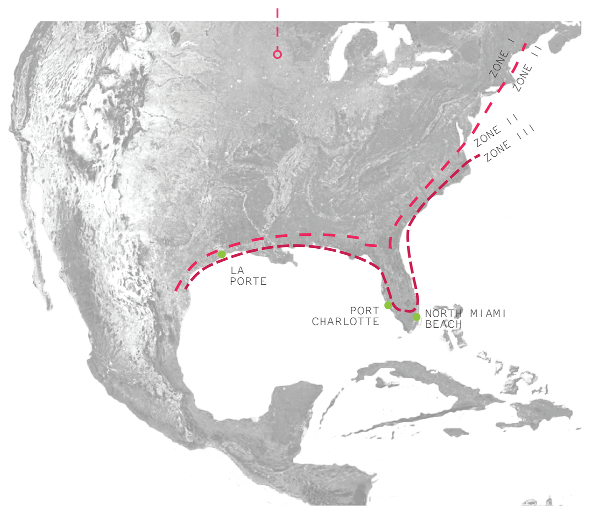
3280.305(B)(4)

Whenever the roof slope does not exceed 20 degrees, the design horizontal wind loads required by §3280.305(c)(1) may be determined without including the vertical roof projection of the manufactured home.

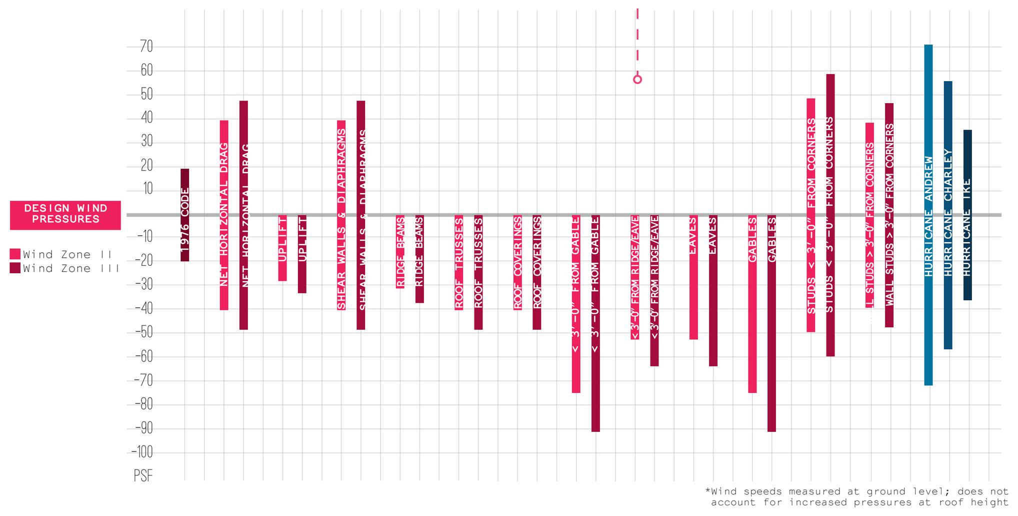
3280.305(C)(1)(II)

Wind loads for high wind areas (Zone II and Zone III). When designed for high wind areas (Zone II and Zone III), the manufactured home, each of its wind resisting parts (including, but not limited to, shear walls, diaphragms, ridge beams, and their fastening and anchoring systems), and its components and cladding materials (including, but not limited to, roof trusses, wall studs, exterior sheathing, roofing and siding materials, exterior glazing, and their connections and fasteners) shall be designed by a Professional Engineer or Architect to resist:

(A) The design wind loads for Exposure C specified in ANSI/ASCE 7-88, "Minimum Design Loads for Buildings and Other Structures," for a fifty-year recurrence interval, and a design wind speed of 100 mph, as specified for Wind Zone II, or 110 mph, as specified for Wind Zone III (Basic Wind Zone Map)



or (B) The wind pressures specified in the following table:



3280.403(F)

Protection of primary window and sliding glass door openings in high wind areas. For homes designed to be located in Wind Zones II and III, manufacturers shall design exterior walls surrounding the primary window and sliding glass door openings to allow for the installation of shutters or other protective covers, such as plywood, to cover these openings. Although not required, the Department encourages manufacturers to provide the shutters or protective covers and to install receiving devices, sleeves, or anchors for fasteners to be used to secure the shutters or protective covers to the exterior walls. If the manufacturer does not provide shutters or other protective covers to cover these openings, the manufacturer must provide to the homeowner instructions for at least one method of protecting primary window and sliding glass door openings. This method must be capable of resisting the design wind pressures specified in § 3280.305 without taking the home out of conformance with the standards in this part.

3280.505(A)

Envelope air infiltration. The opaque envelope shall be designed and constructed to limit air infiltration to the living area of the home. Any design, material, method or combination thereof which accomplishes this goal may be used. The goal of the infiltration control criteria is to reduce heat loss/heat gain due to infiltration as much as possible without impinging on health and comfort and within the limits of reasonable economics.

3282.8(F)

Add-on. An add-on added by the dealer or some other party not the manufacturer (except where the manufacturer acts as a dealer) as part of a simultaneous transaction involving the sale of a new manufactured home, is not governed by the standards and is not subject to these regulations. However, the addition of the add-on must not affect the ability of the basic manufactured home to comply with the standards. If the addition of an add-on causes the basic manufactured home to fail to conform to the standards, sale, lease, and offer for sale or lease of the home is prohibited until the manufactured home is brought into conformance with the standards. While the standards do not govern add-ons, the Secretary has the authority to promulgate standards for add-ons and may do so in the future.

The following are not required to be included in the State plan, but they are urged as necessary to provide full consumer protection and assurances of manufactured home safety:

3282.303(A)

Provision for monitoring of dealers' lots within the State for transit damage, seal tampering, and dealer performance generally;

3282.303(B)

Provision of approvals of all alterations made to certified manufactured homes by dealer in the State. Under this program, the State would assure that alterations did not result in the failure of the manufactured home to comply with the standards;

3282.303(C)

Provision for monitoring of the installation of manufactured homes set up in the State to assure that the homes are properly installed and, where necessary, tied down;

3282.303(D)

Provision for inspection of used manufactured homes and requirements under State authority that used manufactured homes meet a minimal level of safety and durability at the time of sale.

3285.302

In flood hazard areas, foundations, anchorings, and support systems must be capable of resisting loads associated with design flood and wind events or combined wind and flood events, and homes must be installed on foundation supports that are designed and anchored to prevent flotation, collapse, or lateral movement of the structure. Manufacturer's installation instructions must indicate whether:

(a) The foundation specifications have been designed for flood-resistant considerations, and, if so, the conditions of applicability for velocities, depths, or wave action; or,

(b) The foundation specifications are not designed to address flood loads.

3285.306

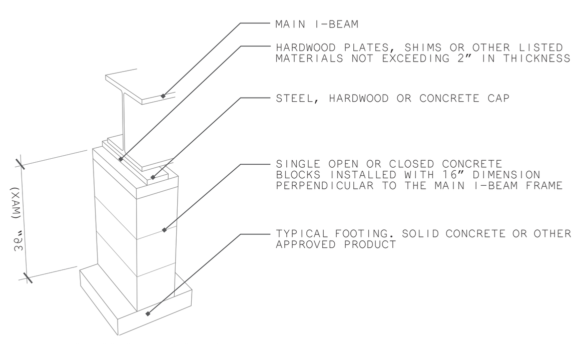
(a) Frame piers less than 36 inches high.
(1) Frame piers less than 36 inches high are permitted to be constructed of single, open, or closed-cell concrete blocks, 8 inches x 8 inches x 16 inches, when the design capacity of the block is not exceeded.
(2) The frame piers must be installed so that the long sides are at right angles to the supported I-beam, as shown in Figure A to this section.
(3) The concrete blocks must be stacked with their hollow cells aligned vertically and must be positioned at right angles to the footings.
(4) Horizontal offsets from the top to the bottom of the pier must not exceed one-half inch.
(5) Mortar is not required, unless specified in the installation instructions or required by a registered professional engineer or registered architect.

3285.306(B)(1)

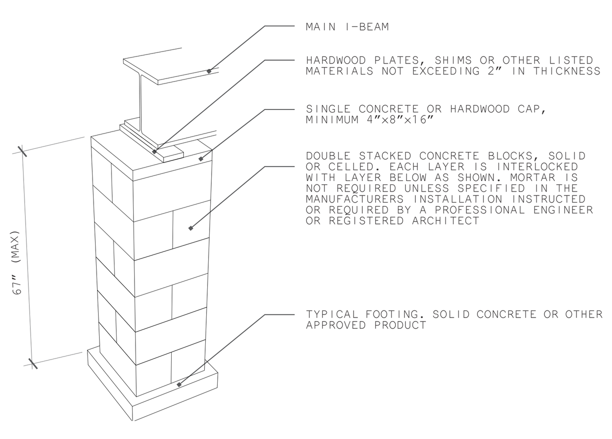
All frame piers between 36 inches and 67 inches high and all corner piers over three blocks high must be constructed out of double, interlocked concrete blocks, as shown in Figure B to this section, when the design capacity of the block is not exceeded. Mortar is not required for concrete block piers, unless otherwise specified in the installation instructions or required by a professional engineer or registered architect.

3285.306(C)

(c) All piers over 67 inches high. Piers over 67 inches high must be designed by a registered professional engineer or registered architect, in accordance with acceptable engineering practice. Mortar is not required for concrete block piers, unless otherwise specified in the manufacturer installation instructions or by the design.



SINGLE CONCRETE BLOCK PIER



DOUBLE CONCRETE BLOCK PIER

3280.305(C)(1)(II)

Materials approved for footings must provide equal load-bearing capacity and resistance to decay, as required by this section. Footings must be placed on undisturbed soil or fill compacted to 90 percent of maximum relative density. A footing must support every pier. Footings are to be either:
(1) Concrete.
(i) Four inch nominal precast concrete pads meeting or exceeding ASTM C 90-02a, Standard Specification for Loadbearing Concrete Masonry Units (incorporated by reference, see § 3285.4), without reinforcement, with at least a 28-day compressive strength of 1,200 pounds per square inch (psi); or (ii) Six inch minimum poured in place concrete pads, slabs, or ribbons with at least a 28-day compressive strength of 3,000 pounds per square inch (psi). Site-specific soil conditions or design load requirements may also require the use of reinforcing steel in cast-in-place concrete footings.
(2) Pressure-treated wood.
(i) Pressure-treated wood footings must consist of a minimum of two layers of nominal 2-inch thick pressure treated wood, a single layer of nominal 3/4-inch thick, pressure-treated plywood with a maximum size of 16 inches by 16 inches, or at least two layers of 3/4-inch thick, pressure-treated plywood for sizes greater than 16 inches by 16 inches. Plywood used for this purpose is to be rated exposure 1 or exterior sheathing, in accordance with PS1-95, Construction and Industrial Plywood (incorporated by reference, see §3285.4).
(ii) Pressure treated lumber is to be treated with a water-borne adhesive, in accordance with AWPA Standard U1-04 (incorporated by reference, see §3285.4) for Use Category 4B ground contact applications.
(iii) Cut ends of pressure treated lumber must be field-treated, in accordance with AWPA Standard M4-02 (incorporated by reference, see § 3285.4).
(3) ABS footing pads.
(i) ABS footing pads are permitted, provided they are installed in accordance with the pad manufacturer installation instructions and certified for use in the soil classification at the site.
(ii) ABS footing pads must be listed or labeled for the required load capacity.
(4) Other Materials. Footings may be of other materials than those identified in this section, provided they are listed for such use and meet all other applicable requirements of this subpart.

3285.402(D)(3)

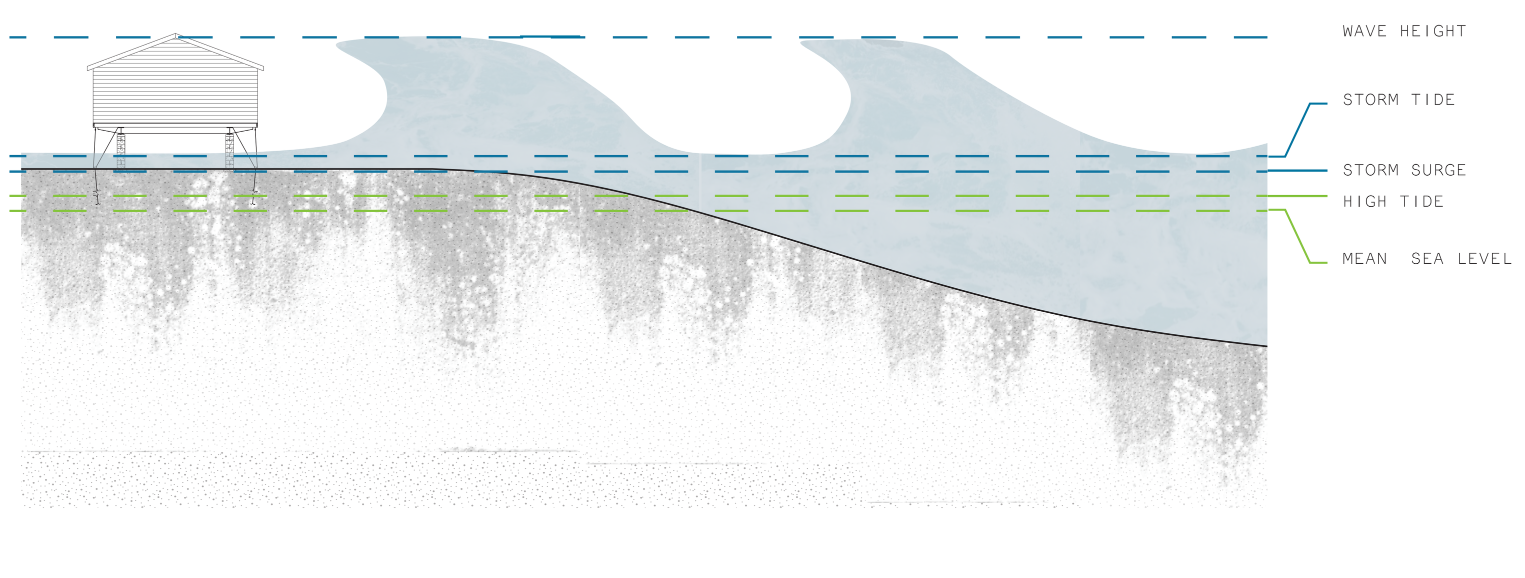
Requirements for connecting the diagonal ties to the main chassis members of the manufactured home. If the diagonal ties are attached to the bottom flange of the main chassis beam, the frame must be designed to prevent rotation of the beam;

3285.402(A)

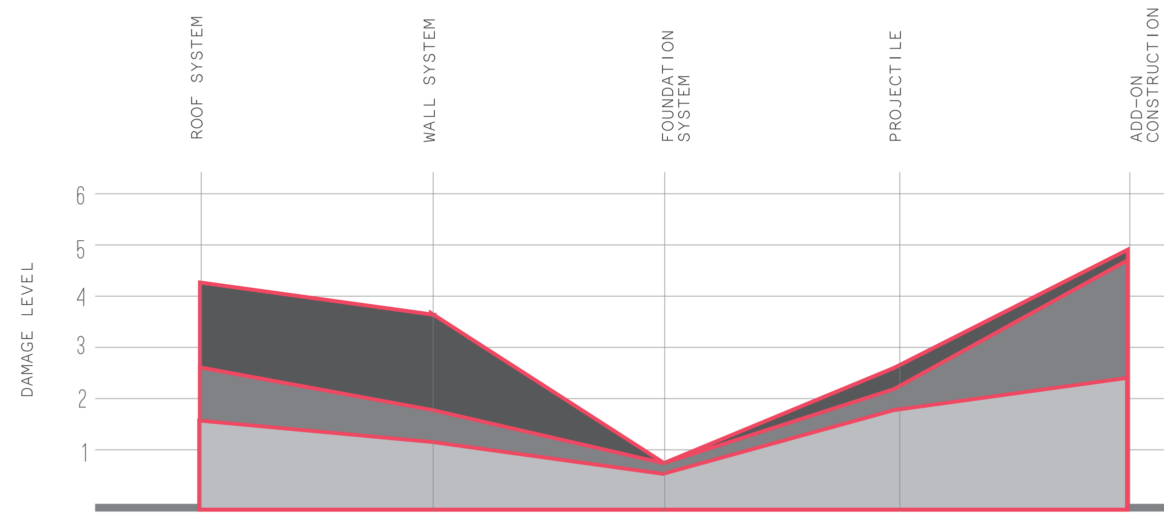
(a) Ground anchor certification and testing. Each ground anchor must be manufactured and provided with installation instructions, in accordance with its listing or certification. A nationally recognized testing agency must list, or a registered professional engineer or registered architect must certify, the ground anchor for use in a classified soil (refer to § 3285.202), based on a nationally recognized testing protocol, or a professional engineer or registered architect must certify that the ground anchor is capable of resisting all loads in paragraph (b) of this section for the soil type or classification.

3285.402(D)(3)

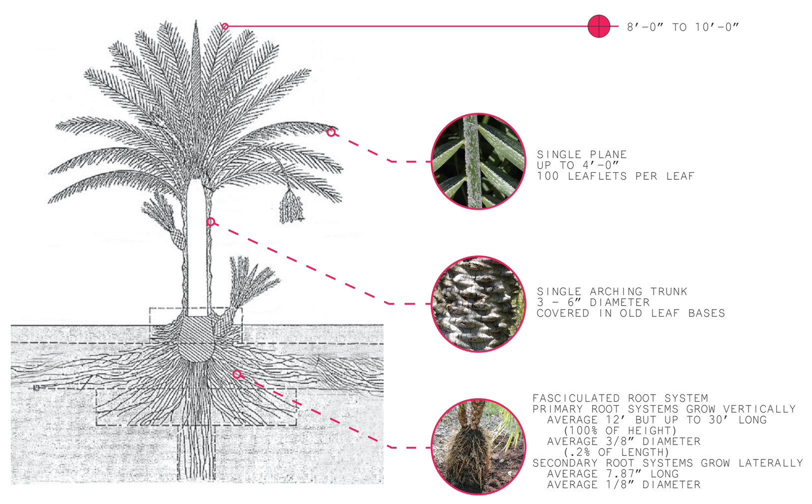
Installation of on-site structures. Each accessory building and structure is designed to support all of its own live and dead loads, unless the structure, including any attached garage, carport, deck, and porch, is to be attached to the manufactured home and is otherwise included in the installation instructions or designed by a registered professional engineer or registered architect.



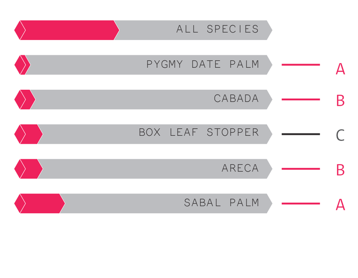
NORTH MIAMI BEACH, FLORIDA CODE VS STORM CONDITIONS



HURRICANE CHARLEY MANUFACTURED HOUSING DAMAGE ASSESSMENT



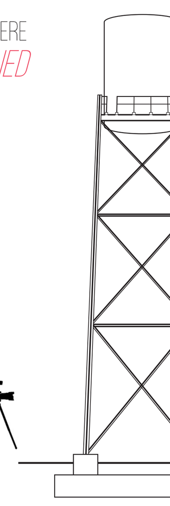
PALM TREE DEFENSE SYSTEMS



FALLEN TREES BASED ON SPECIES

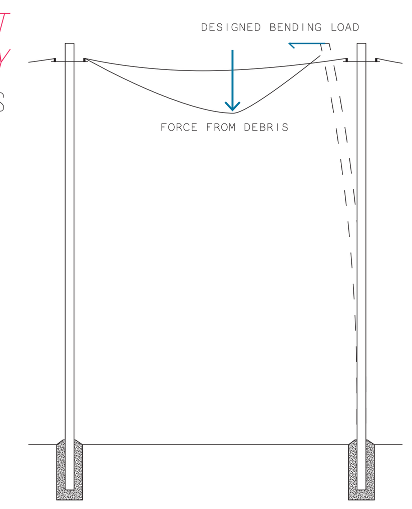
PALM STRATEGIES:

ALTHOUGH TELEVISION AND RADIO TOWERS WERE DOWNED *WATER TOWERS REMAINED INTACT* FOLLOWING HURRICANE ANDREW.



WATER TOWER STRUCTURE STRATEGIES:

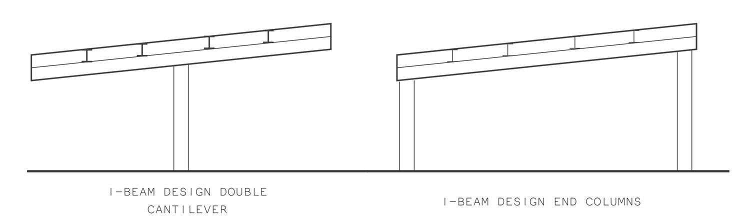
IN EXTREME WIND EVENTS *MOST FAILURES ARE CAUSED BY SECONDARY DAMAGE* SUCH AS FALLING TREES OR *WINDBORN DEBRIS*

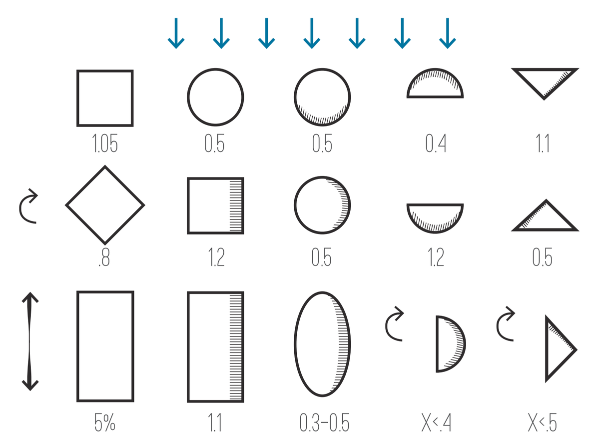


POWER POLE STRATEGIES:

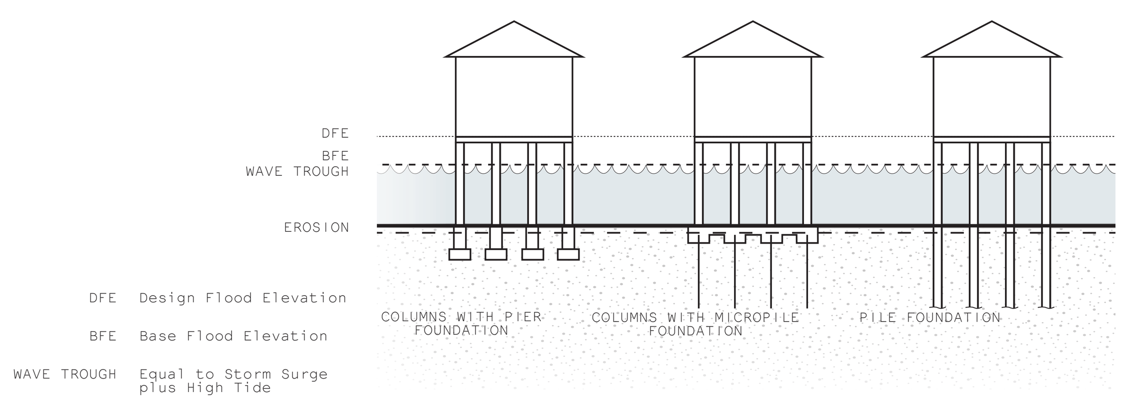
FOLLOWING HURRICANES CHARLEY AND IKE *GAS STATION CANOPIES LOST METAL CLADDING* AND FEW TOPPLED

GAS STATION CANOPY STRATEGIES:

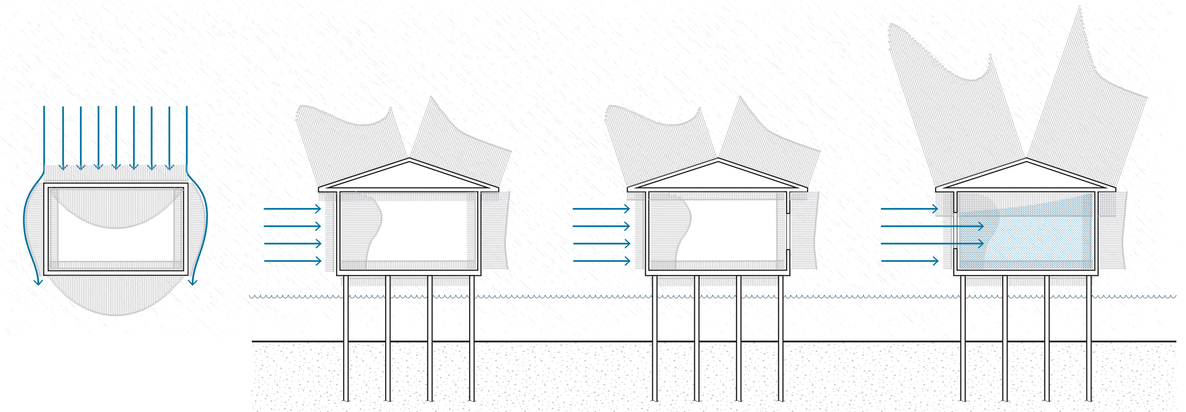




SHAPE BASED DRAG COEFFICIENT



FOUNDATION TYPES FOR ELEVATED STRUCTURES


INTERIOR/EXTERIOR PRESSURE FIELD

TURN TO THE [AIR, WATER] FLOW.

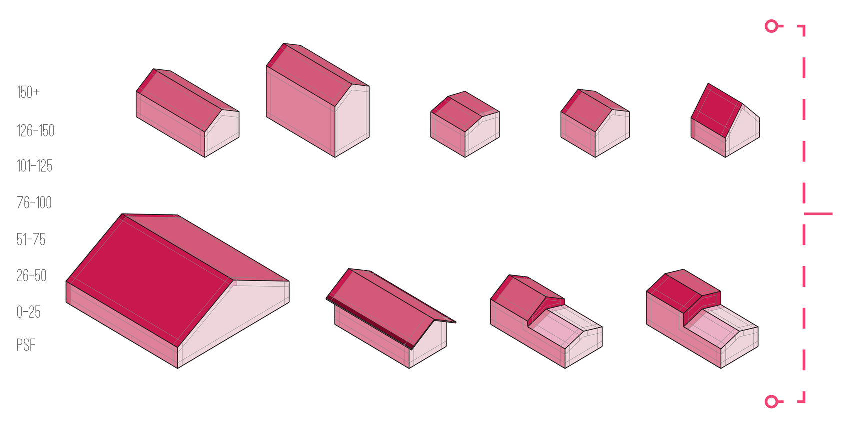
Broad surfaces create high levels of air resistance, which consequently creating pressure and drag behind the surface. By reducing the air resistance, the forces acting on the building are also reduced. This results in lower wind and water pressures on the building, allowing the building to act as its own form of defense. By utilizing aerodynamics, less importance is put on building connections reducing the need for costly connections. This form of defense is one that protects against both water and wind damage.

RISE ABOVE THE SURGE +.

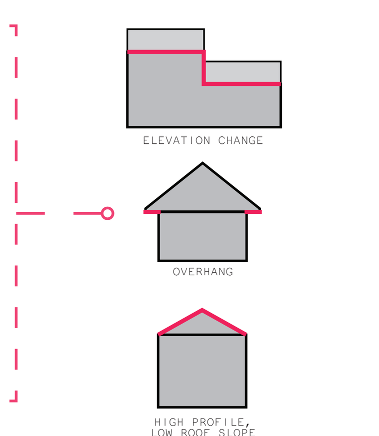
Storm surges create damage through two primary methods: the force of the water against the building and water damage from materials and surfaces getting wet. By raising the building to the design flood elevation (which accounts for wave heights and a safety factor), water is allowed the move below with little resistance. This not only protects against water pressure, but against flood damage.

WHAT GOES IN, MUST GO OUT.

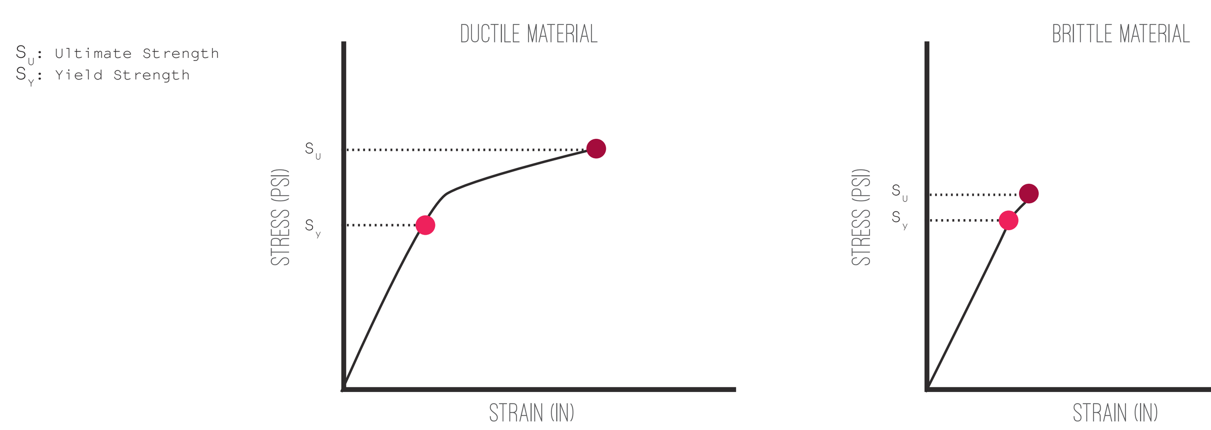
When wind or water is allowed to enter a building, it will try to find a way out. When enough wind or water enters a building, the pressure will build ultimately creating failure within a building assembly. Openings must be protected as research has shown that all it takes is one window to break for uplift pressures on the roof to double. In addition, walls opposite a broken entry point are vulnerable to water damage of heights up to the ceiling. Due to manufactured housing's narrow width, walls are more susceptible to water damage than conventional housing.

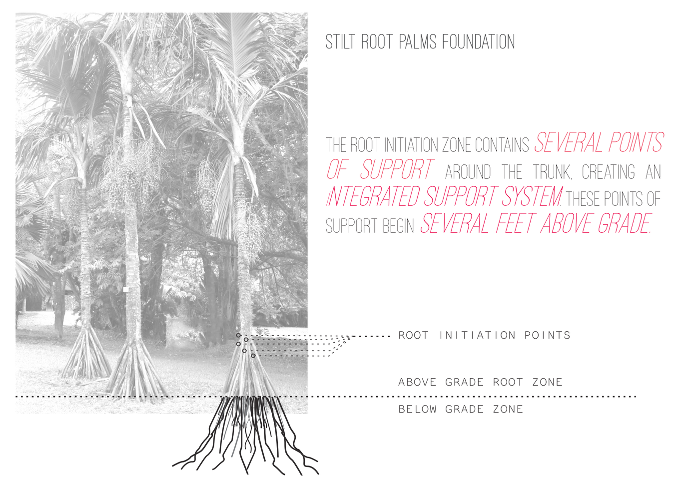


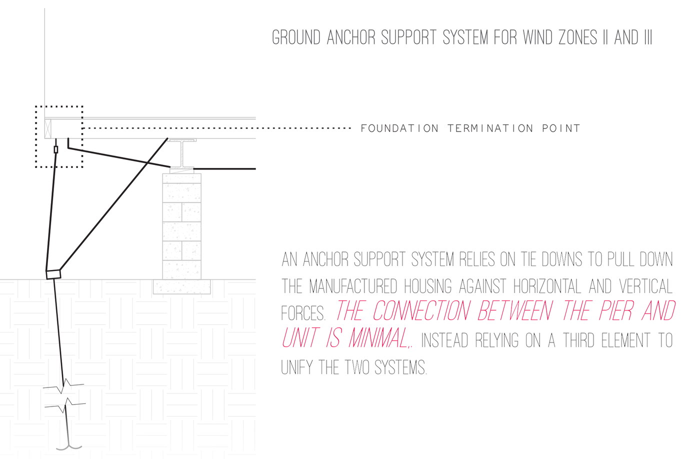
EFFECT OF BUILDING GEOMETRY ON WIND LOADS



GEOMETRIC SHAPES PRODUCING HIGH WIND LOADS







STRENGTH IN SIMPLICITY.

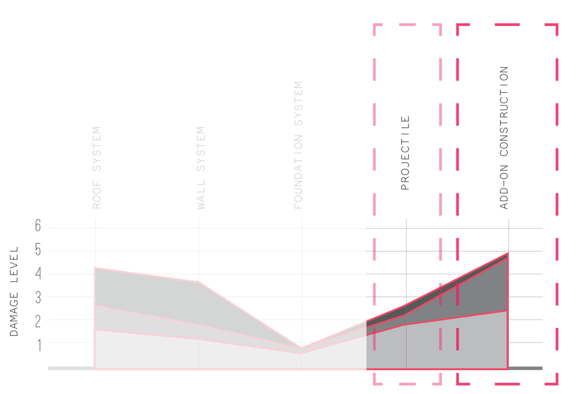
Studies on building geometry have highlighted areas that experience the highest levels of pressure. Gable roofs, overhangs and elevation changes have consistently been shown to experience high levels of wind pressures and stress.

RECOVERY IN DEFORMATION.

Palm trees rarely snap under high wind pressure. They bend with the wind, allowing deformation to occur, in order to avoid breaking. Although they begin to experience strain earlier than brittle materials, ductile materials have a higher ultimate strength or breaking point.

CONTINUE THE FOUNDATION.

The root initiation zone contains several points of support around the trunk, creating an integrated support system. These points of support begin several feet above grade and continue below the soil. This technique allows for greater support and stabilization. Conversely, manufactured homes rely on anchor support systems to tie the home into the soil. This system is independent of the foundation and is does not provide adequate support. In a complete disaster-resistant pier system, several rolled steel beams (the chassis) are supported by an array of adjustable steel piers, which are connected to both the chassis and base pad with high-strength bolts. Several manufacturers offer a secondary support system, or seismic isolator, to prevent the home from dropping too low should the piers fail.

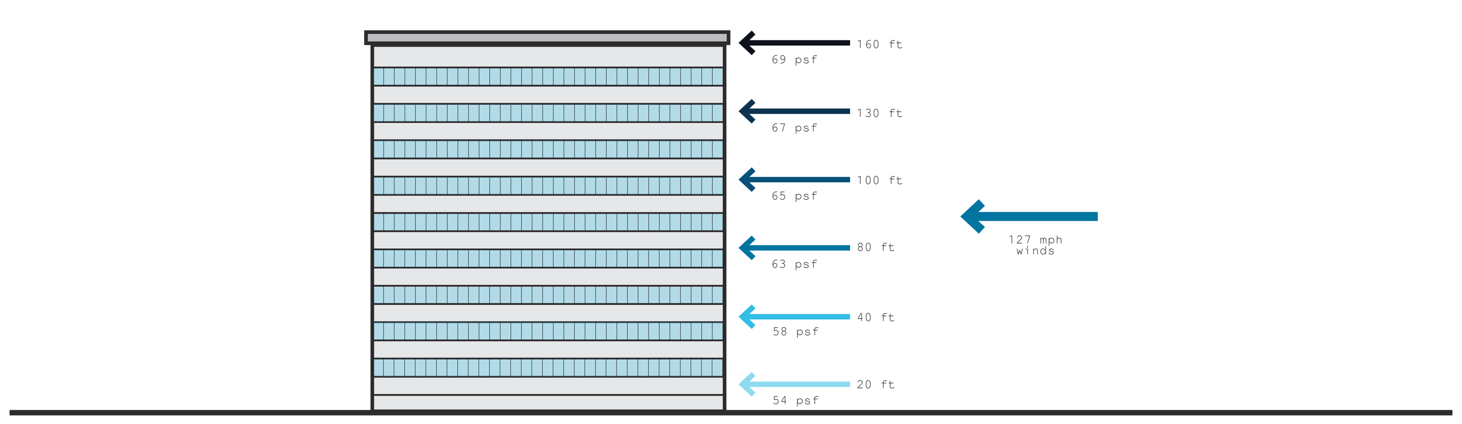


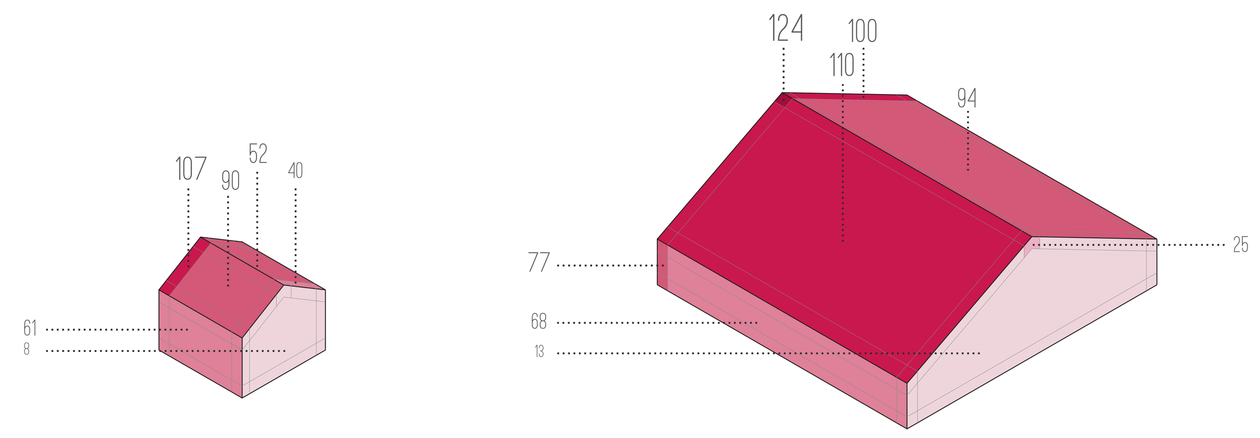
HURRICANE CHARLEY MANUFACTURED HOUSING DAMAGE ASSESSMENT

SOME SPECIES DEFOLIATE (LOSE LEAVES) EASILY DURING WINDS. *LOSING LEAVES* MAY BE A GOOD STRATEGY. HELPING THE TREE *TO BETTER RESIST WINDS.*

GAS STATION CANOPY BEHAVIOR IN HIGH WINDS

IN EXTREME WIND EVENTS *MOST FAILURES ARE CAUSED BY SECONDARY DAMAGE* SUCH AS FALLING TREES OR *WINDBORN DEBRIS*





LOSE THE FAT.

The fat is the extra. Palm trees, telephone poles and gas station canopies are all affected by the extra. In order to decrease surface area, palm trees will defoliate in order to protect the important components. Following a hurricane, a palm tree still has all the necessities to provide sustenance and regrow. The extra can be replaced. Conversely, telephone poles cannot lose the fat and are therefore more prone to failures. The leading cause of failure of telephone poles is a result of debris catching the telephone wire, it is not a result of failure of the pole itself. Gas station canopies are also subject to avoidable failure. When the sheathing of a gas station sheds, it allows the wind to pass through the canopy and leaves the structure intact. However, when it does not shed, the sheathing increases pressure on the structure where overturning is common.

OUT BEFORE UP.

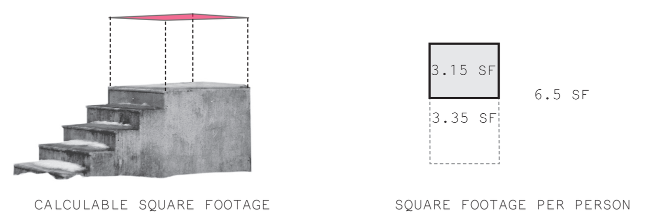
This principle is derived from the distribution of weight, increased wind pressure being proportional to increased height and the growth pattern of palms. By keeping the center of gravity close to the ground, the risk for overturning is reduced. Additionally, there is a direct relationship between building height and wind pressure; as one increases so does the other. Palm trees mitigate these dangers by embodying the growing pattern of "out before up." They grow to their full trunk diameter before growing substantially in height. This creates a wide and broad foundation before exposing the structure to increased heights.

KEEP IT SMALL.

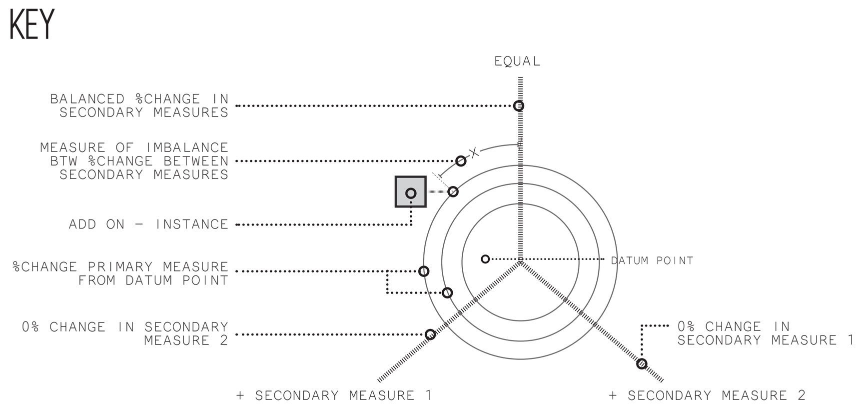
As an obvious principle, smaller objects have less surface area exposed to force. However, the effects of an objects size goes beyond the total surface area pressure. Larger buildings have been found to be subject to increased pounds per square foot, most notably at the joints.

2. ACCESSORY DATA: INVESTMENT, RETURN & USAGE

ATTRIBUTES



KEY

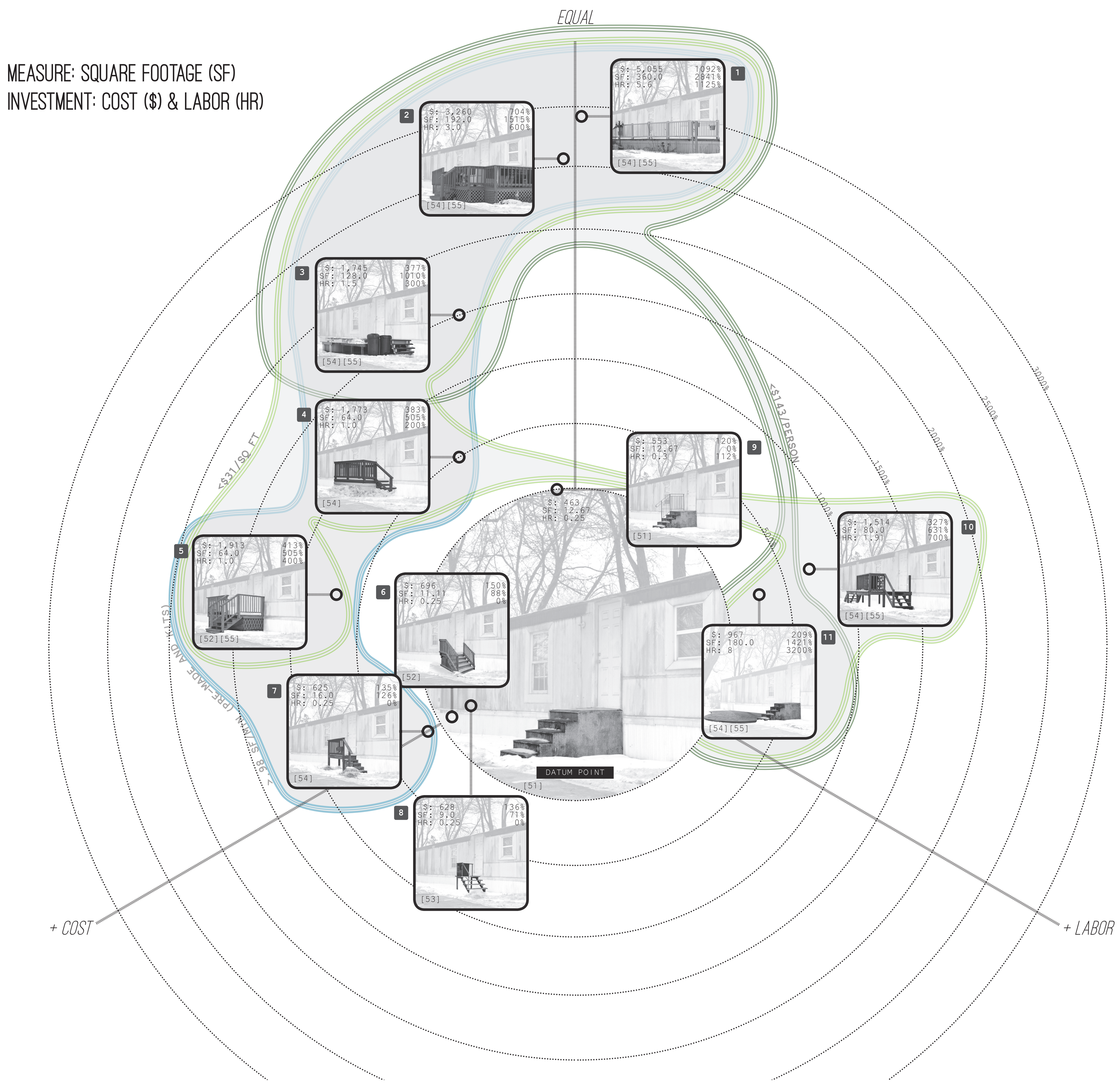


CONNECTED - SITE, STRUCTURE & SOCIAL. The motivation for the stair and porch range from a utilitarian connection with the site to the experiential connection with people. Each physical attribute (i.e., handrail, skiting, platform) translates and contributes to various provisions - site, social, quality, permanence, and emotional. By changing size, material and location a stair develops into a porch or deck, manifesting into a range of provisions.

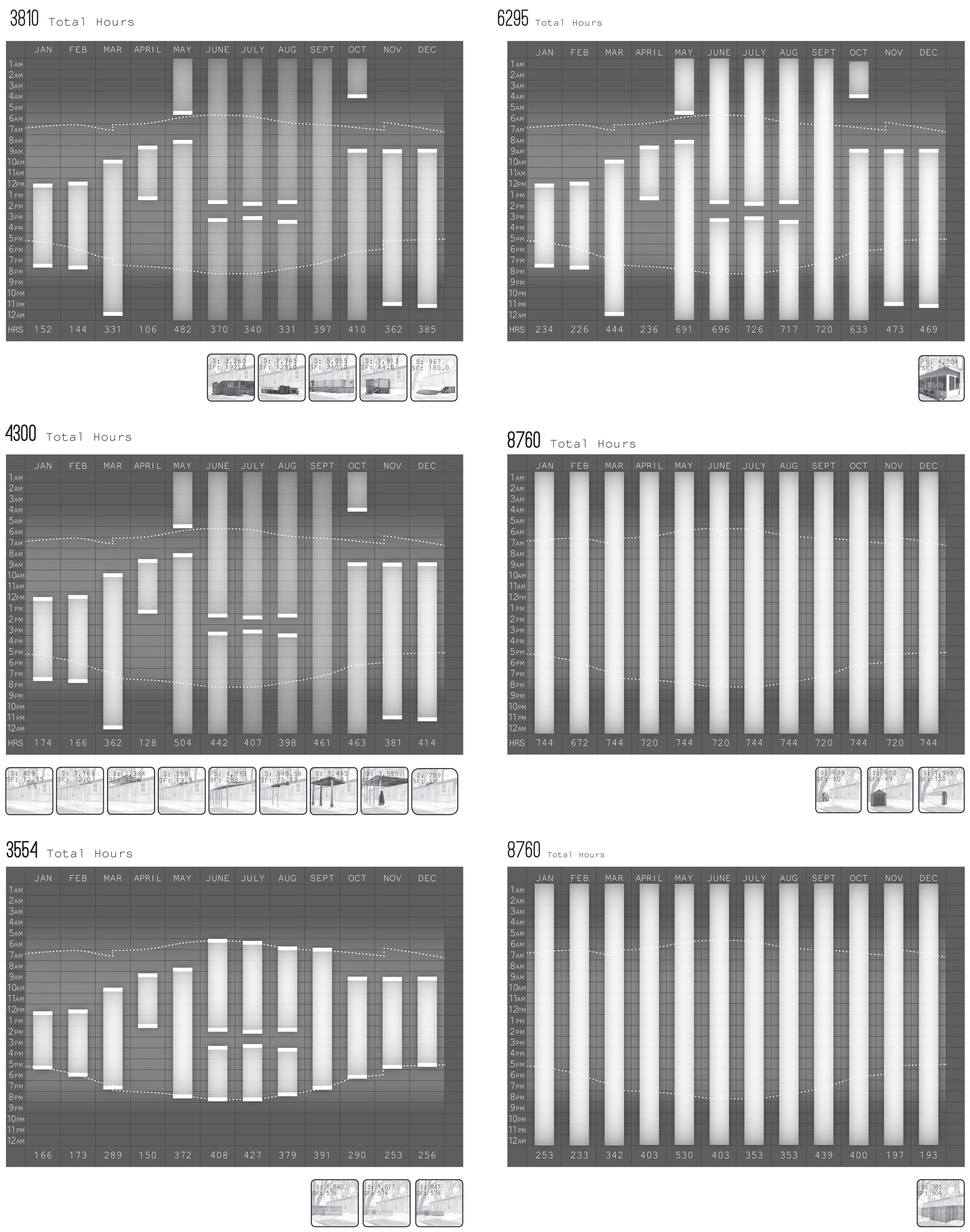
INVENTORY

ABOVE AVERAGE IN 2+ VALUE CATEGORIES

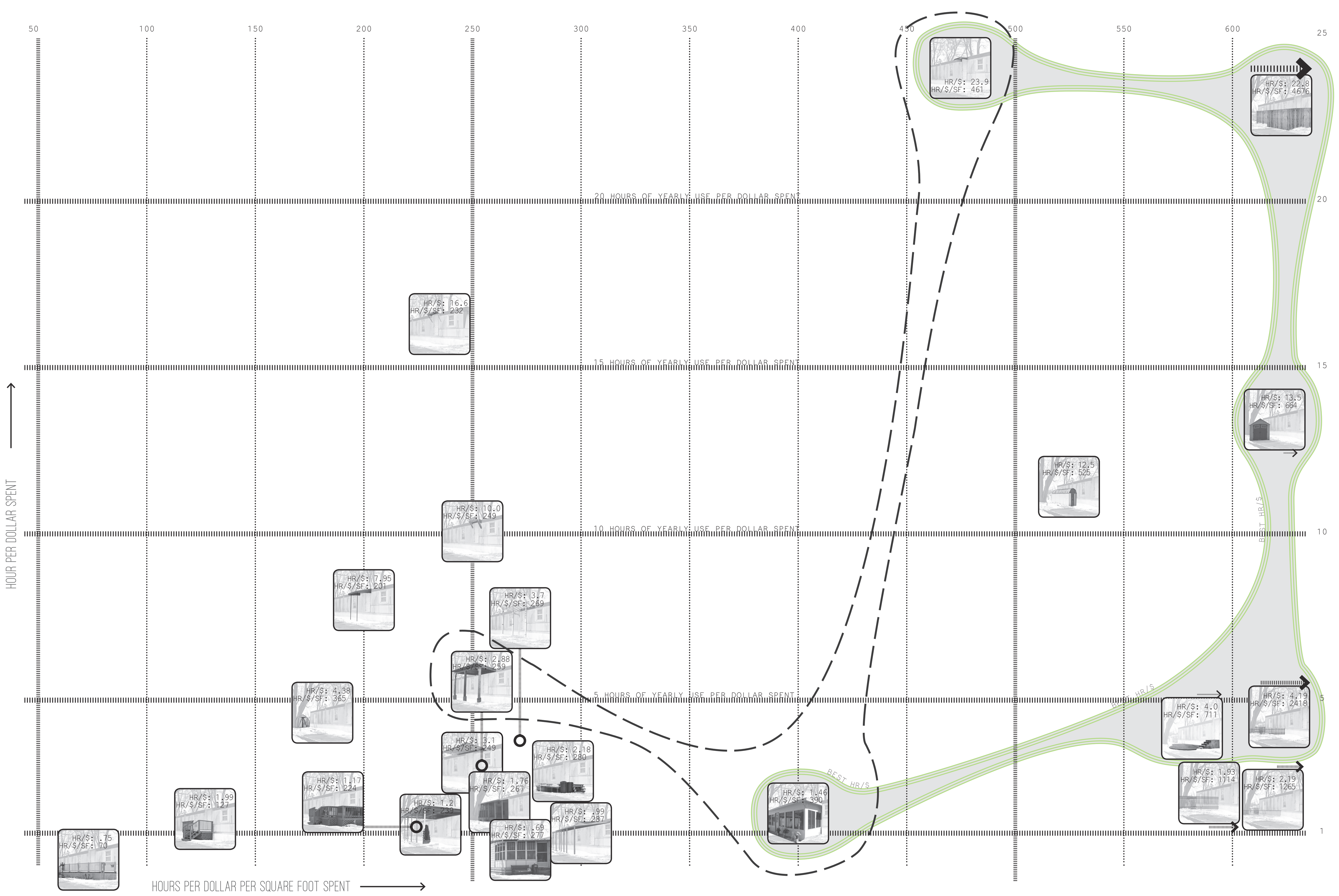
MEASURE: SQUARE FOOTAGE (SF)
INVESTMENT: COST ($) & LABOR (HR)



ACCESSORY USAGE ASSESSMENT: HOURLY USE

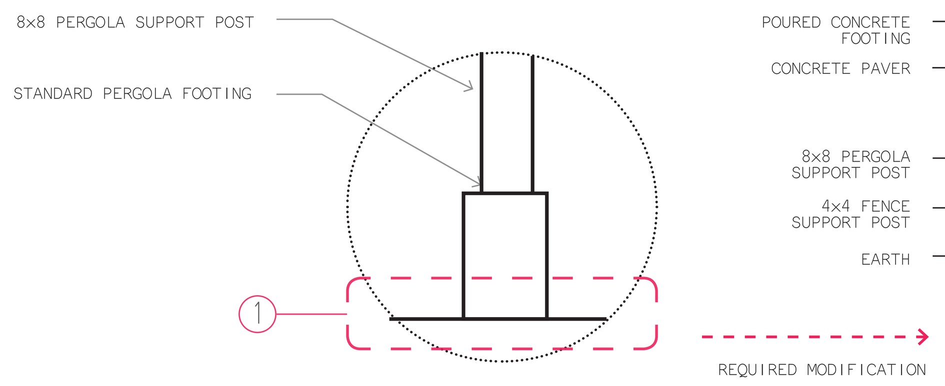


ACCESSORY USAGE ASSESSMENT: HOURLY USE VS COST



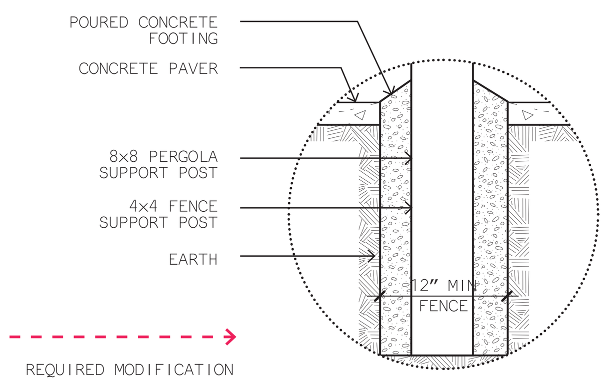
3. ACCESSORY DATA: COMPLIANCE AND PERFORMANCE

OFF THE SHELF ACCESSORIES: COMPLIANCE AND PERFORMANCE



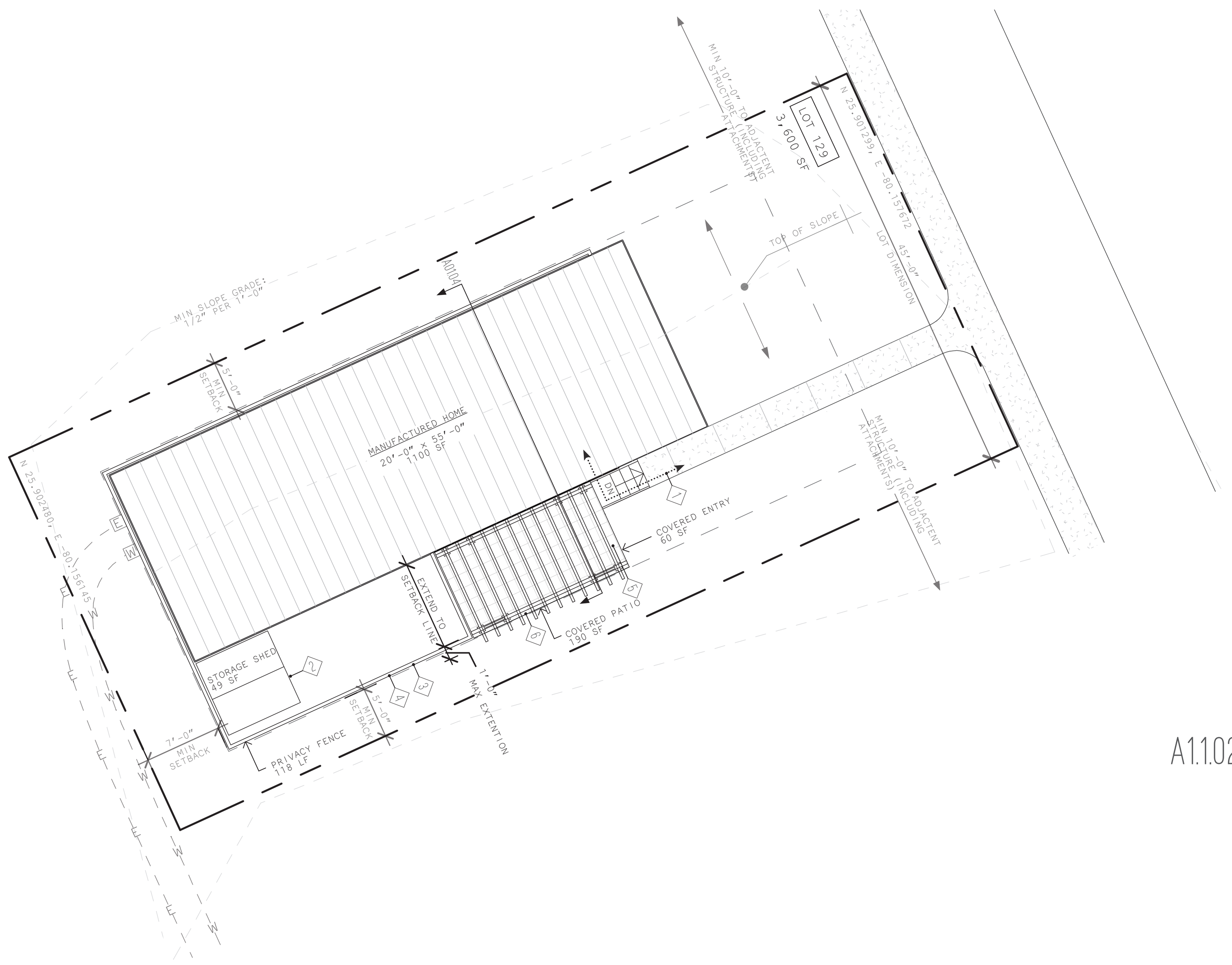
A1.1.05 SECTION DETAIL[1] NOT TO SCALE

[1] NON-COMPLIANT WITH FLORIDA BUILDING CODE

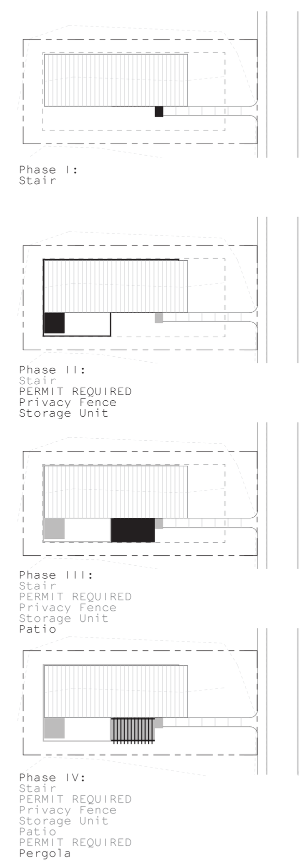


A1.1.06 SECTION DETAIL[2] NOT TO SCALE

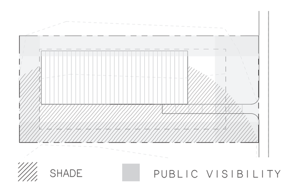
[2] DETAIL REQUIRED PER SECTION 1615 OF FLORIDA BUILDING CODE



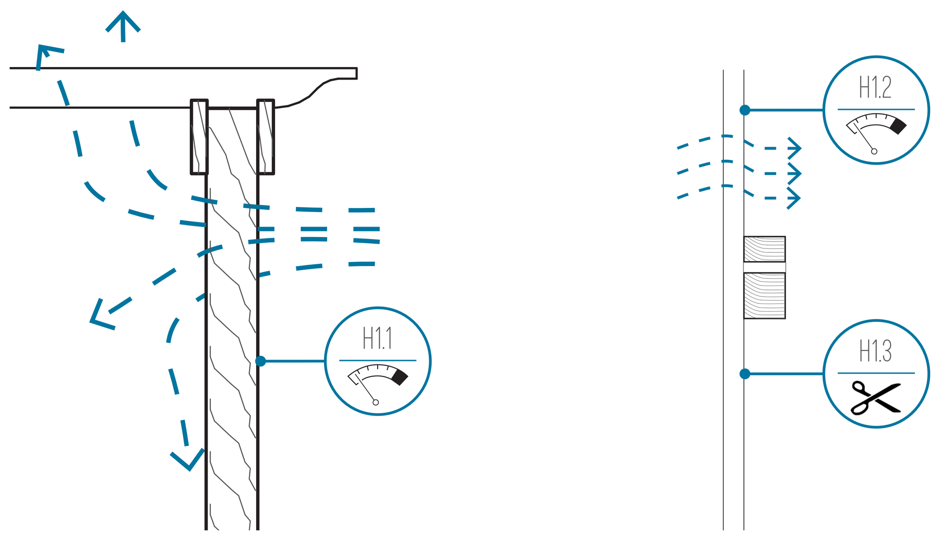
A1.1.01 SITE PLAN - PHASE IV NOT TO SCALE



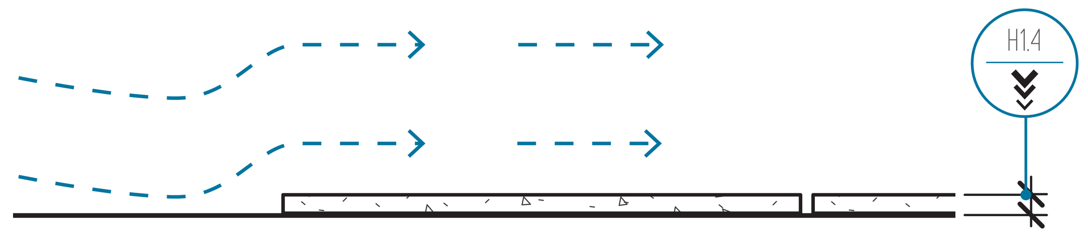
A1.1.02 SITE PLAN - PHASING PROGRESSION NOT TO SCALE



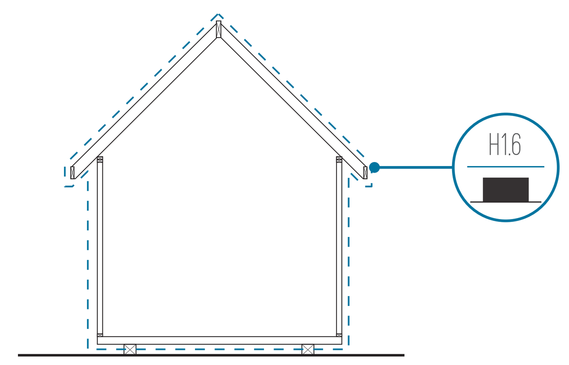
A1.1.03 SITE PLAN - CONTEXT



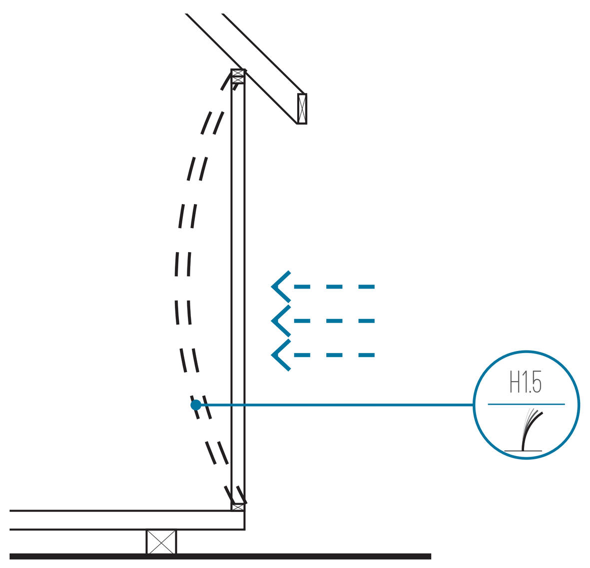
A1.2.09 HURRICANE ASSESSMENT - OPEN FRAME STRUCTURE NOT TO SCALE



A1.2.10 HURRICANE ASSESSMENT - OPEN FRAME STRUCTURE NOT TO SCALE



A1.2.12 HURRICANE ASSESSMENT - OPEN FRAME STRUCTURE NOT TO SCALE



A1.2.11 HURRICANE ASSESSMENT - OPEN FRAME STRUCTURE NOT TO SCALE

H1.1. Broad surfaces create high levels of air resistance, which consequently creating pressure and drag behind the surface. Keeping an open frame reduces the air resistance, therefor forces acting on the building are also reduced.

H1.2. Privacy fences post large, flat surfaces with an equally narrow base. It can easily be modified to increase disaster resilience by removing select panels to allow air to flow through the fence, rather than push against it.

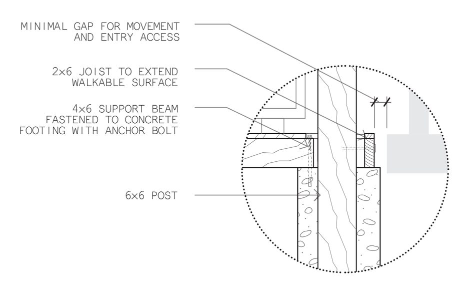
H1.3. Removing fence boards also eliminates excess material. Fencing material is of little use during a storm, making it a high risk, low value during impact. By removing some panels, the unnecessary material is eliminated.

H1.4. Pavers strength is they maintain a low profile, providing a small area that is needed to resist storm forces. Though this is a strength, the pavers still pose a risk. Aside from self weight, pavers have nothing anchoring them in place.

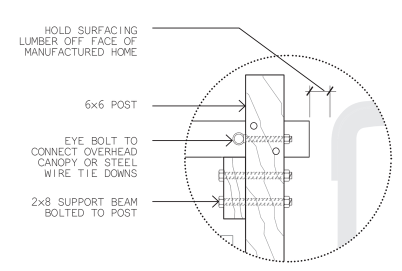
H1.5. The storage unit is made of flexibile, resin material that will flex under pressure. By using a ductile material, the storage unit increases the amount of strain it can undergo before failure.

H1.6. The shape of the storage unit is a simple gable roof with no elevation changes and minimal overhangs. This eliminates any complex geometry that is prone to experiencing high pressure.

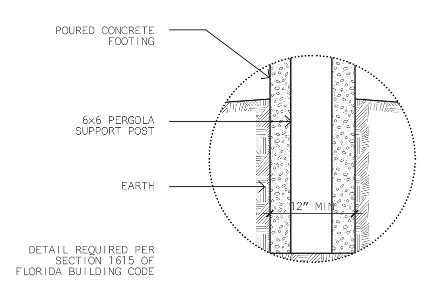
INTEGRATED SYSTEM: COMPLIANCE AND PERFORMANCE



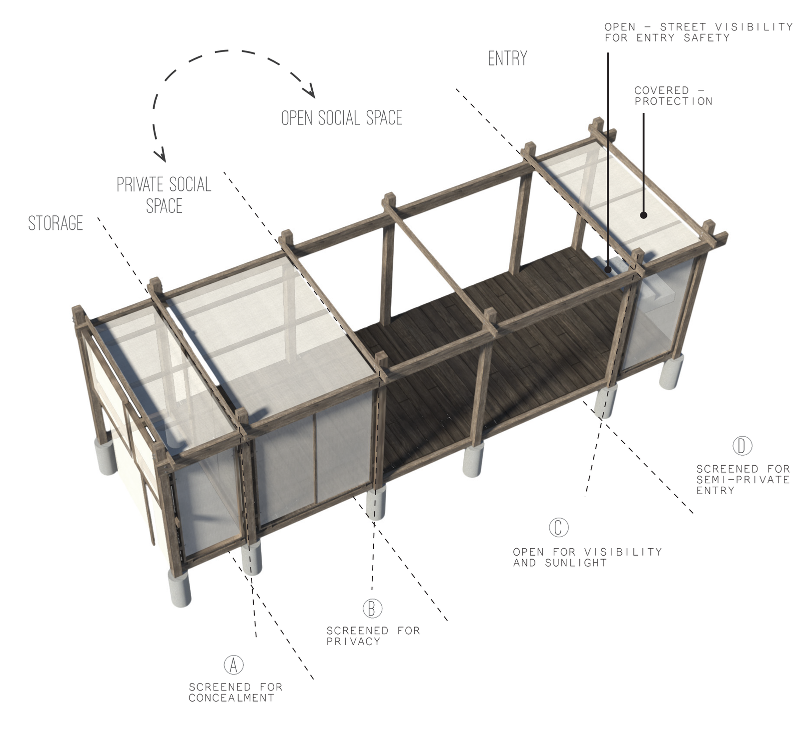
A2.1.07 SECTION DETAIL NOT TO SCALE



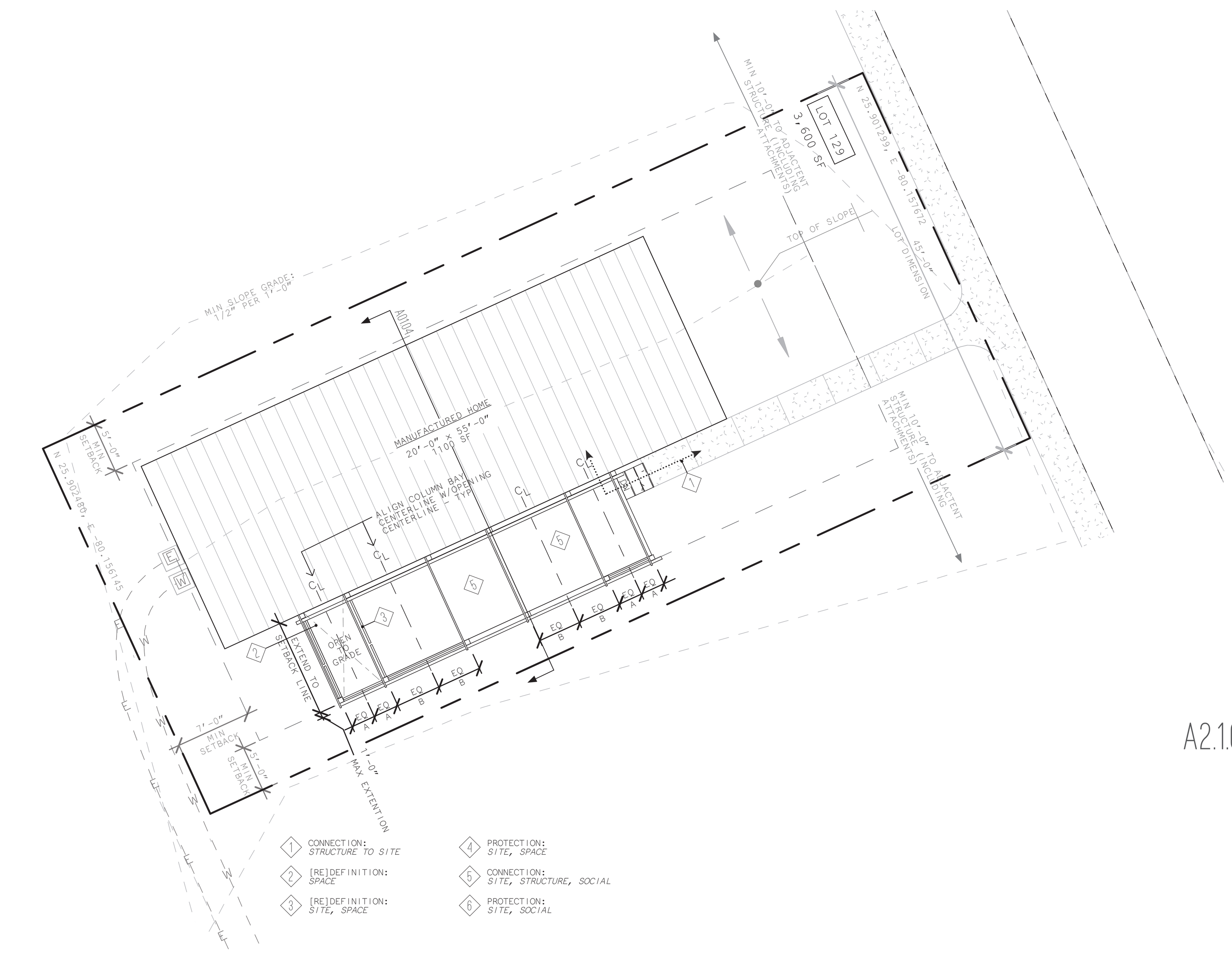
A2.1.06 SECTION DETAIL NOT TO SCALE



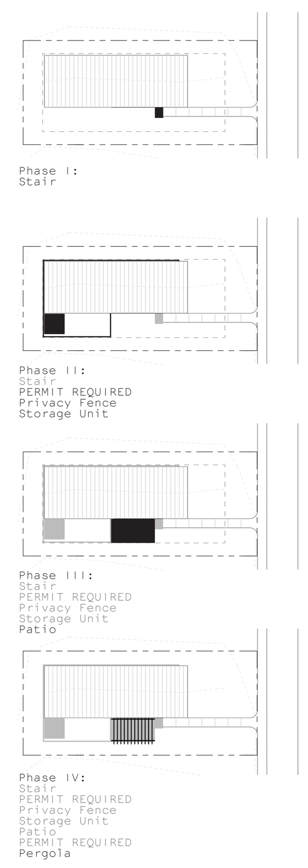
A2.1.05 SECTION DETAIL NOT TO SCALE



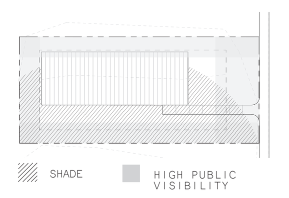
A2.1.09 BAY USAGE - PHASE IV NOT TO SCALE



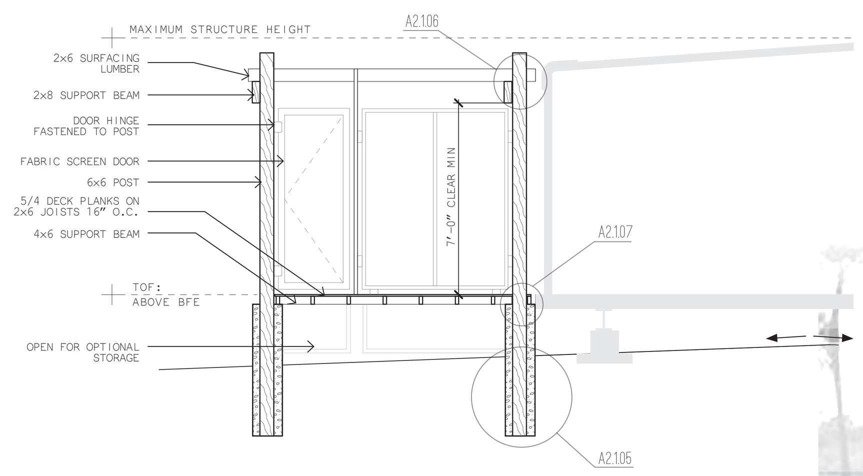
A2.1.01 SITE PLAN - PHASE IV NOT TO SCALE



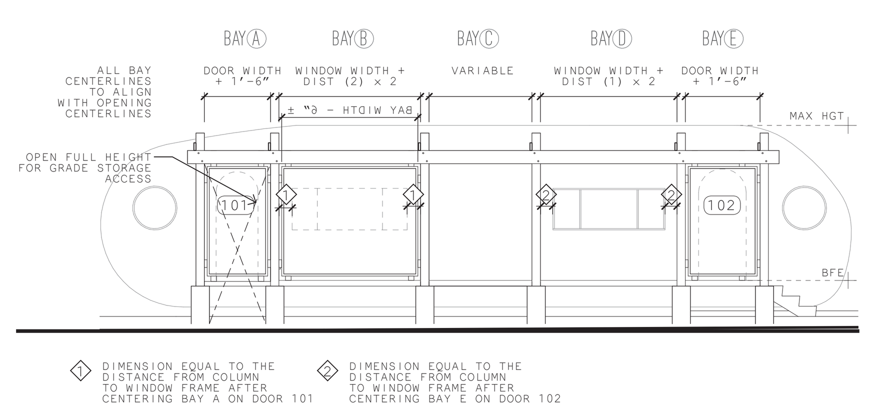
A2.1.02 SITE PLAN - PHASING PROGRESSION NOT TO SCALE

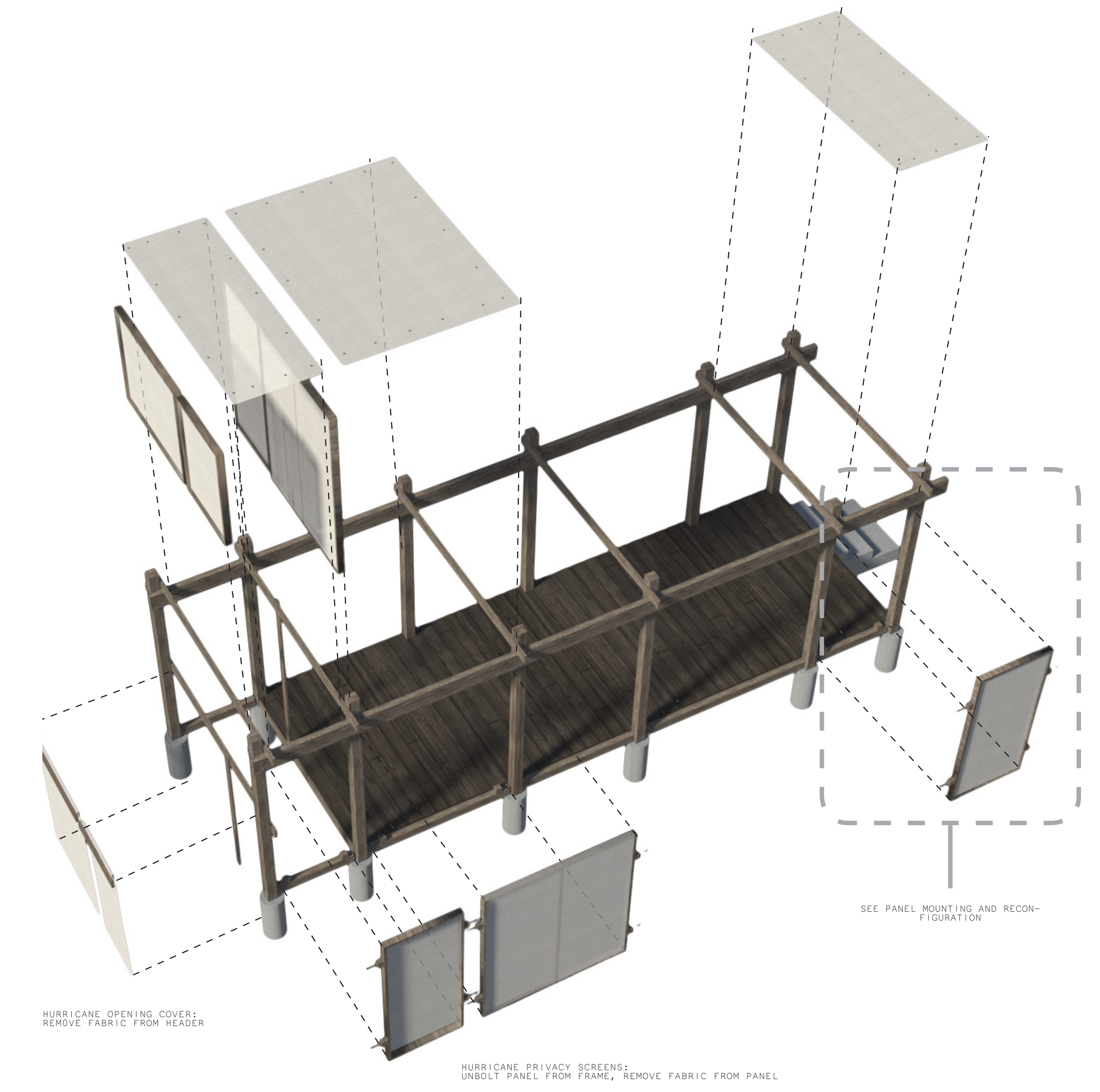


A2.1.03 SITE PLAN - CONTEXT

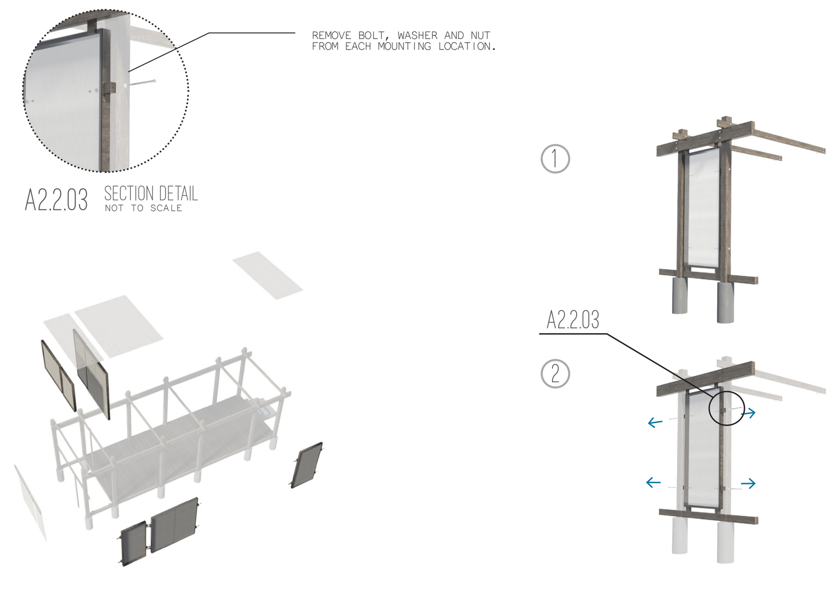


A2.1.04 SECTION - PHASE IV NOT TO SCALE



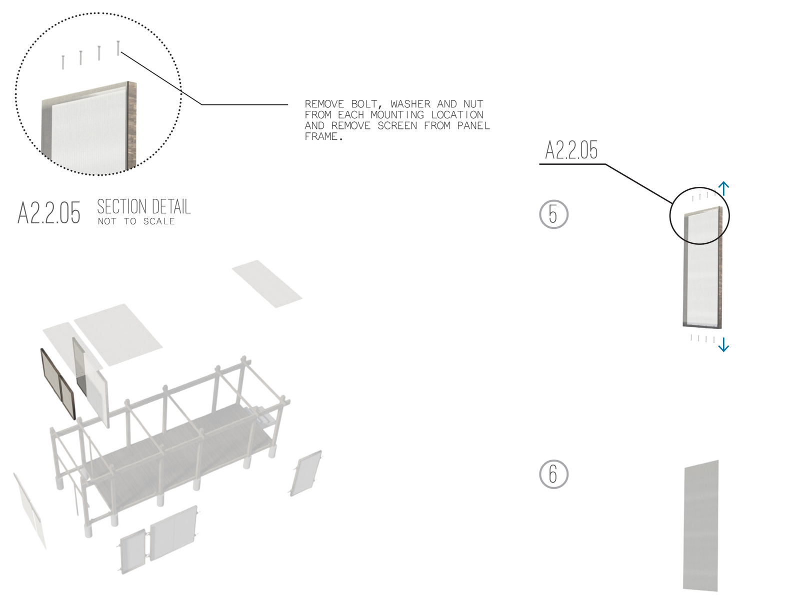


A2.2.01 HURRICANE TRANSITION - PANEL DECONSTRUCTION
NOT TO SCALE

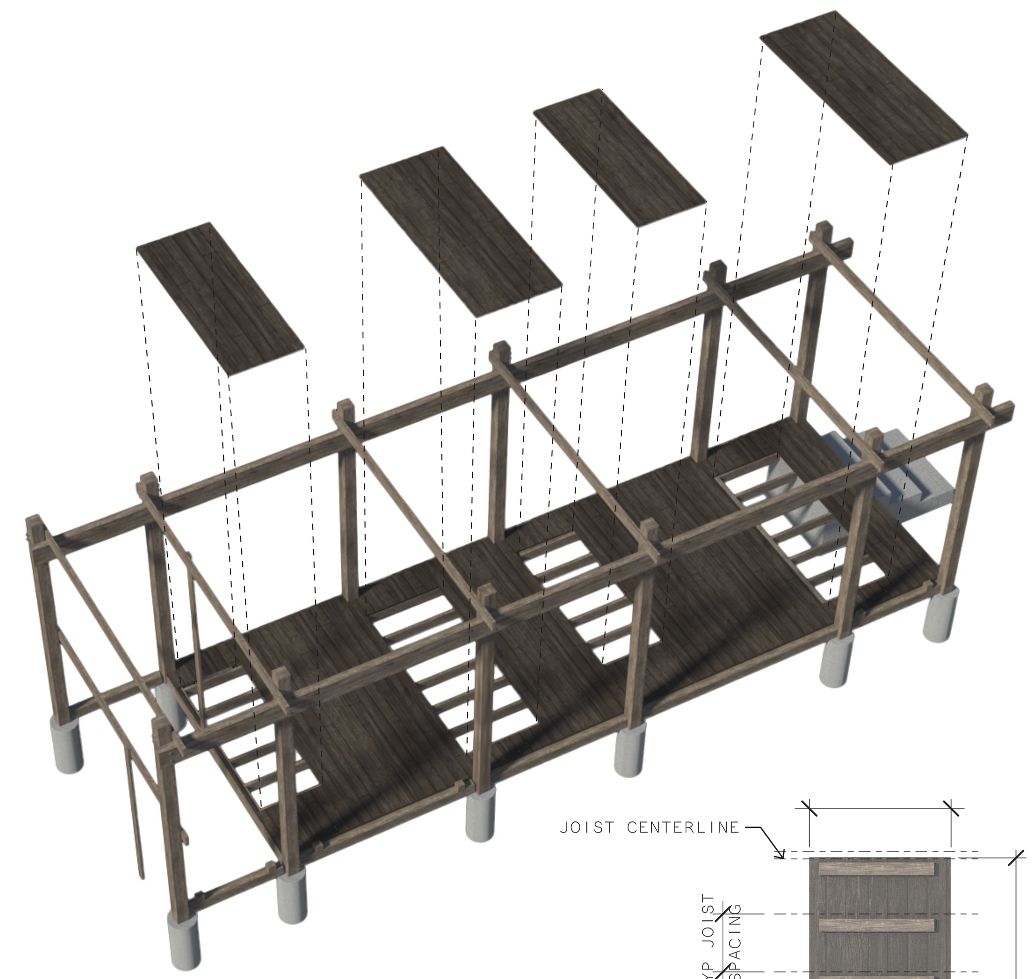


01_A2.2.02 HURRICANE TRANSITION - PANEL DECONSTRUCTION
NOT TO SCALE

FOR OUT OF PANEL SCREENS, CONTINUE TO PHASE II



02_A2.2.04 HURRICANE TRANSITION -SCREEN DECONSTRUCTION
NOT TO SCALE

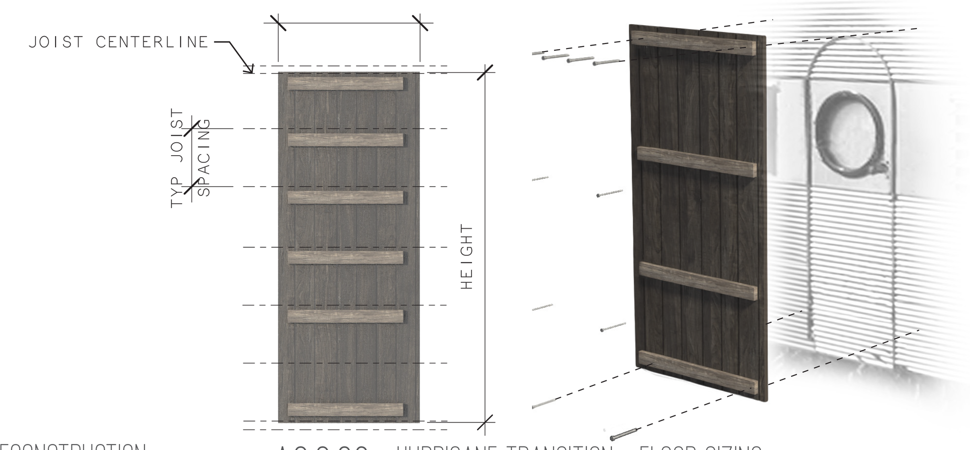


(OPENING WIDTH (IN) + 16") ÷ PLANK WIDTH (IN)
WX.Y ⟶ Z (ROUND UP)

Z = NUMBER OF PLANKS
× PLANK WIDTH (IN)
SHUTTER WIDTH (IN)

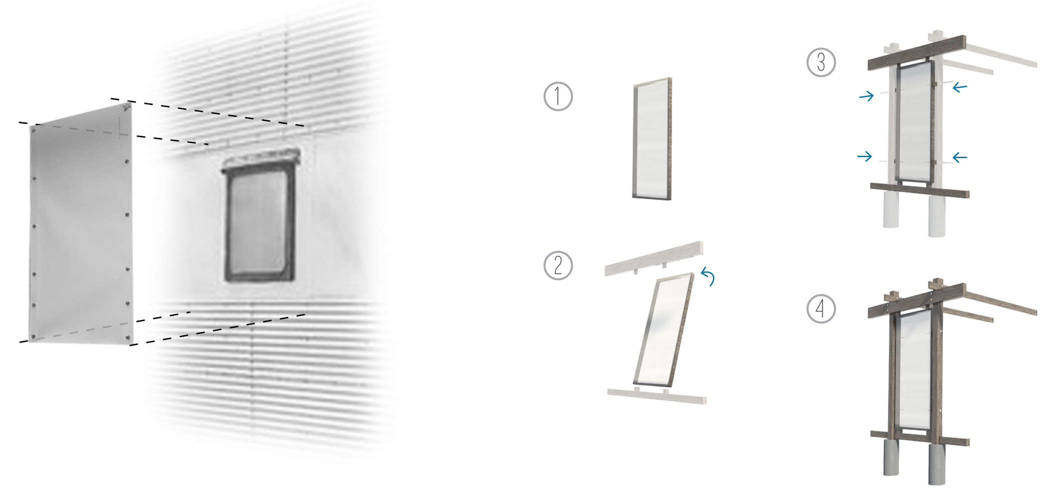
(OPENING HEIGHT (IN) + 16") ÷ JOIST SPACING (IN)
AB.C ⟶ D (ROUND UP)

D = JOISTS TO SPAN
× JOIST SPACING(IN)
SHUTTER LENGTH (IN)

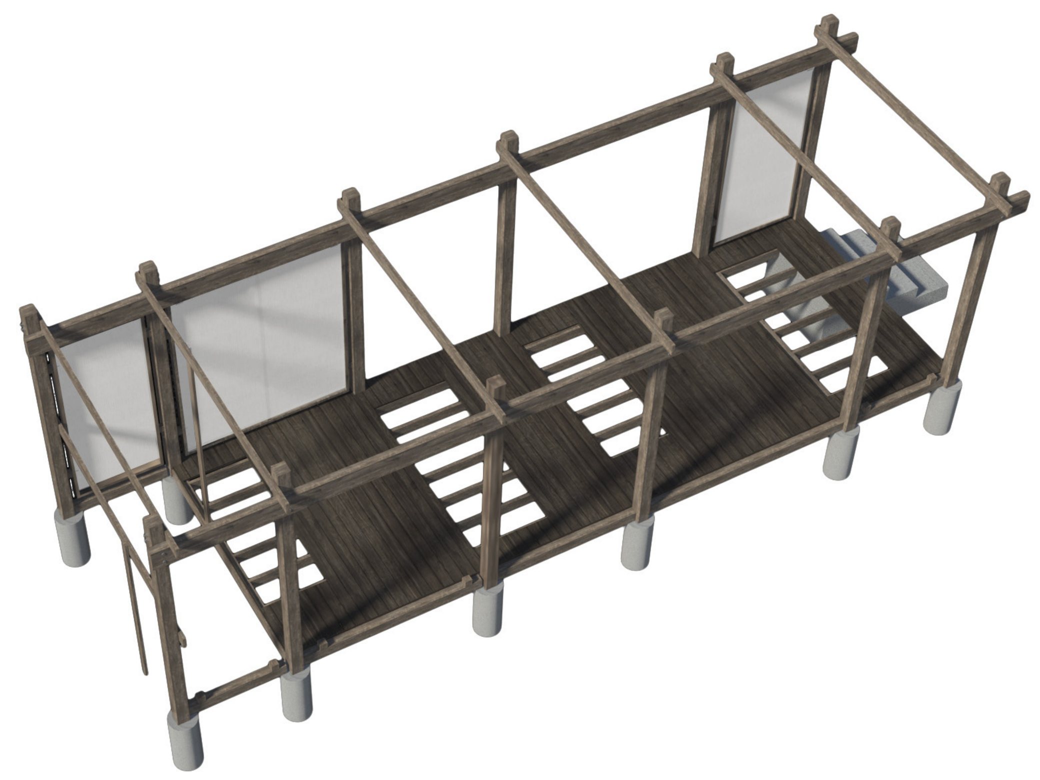


03_A2.2.07 HURRICANE TRANSITION - FLOOR DECONSTRUCTION
NOT TO SCALE

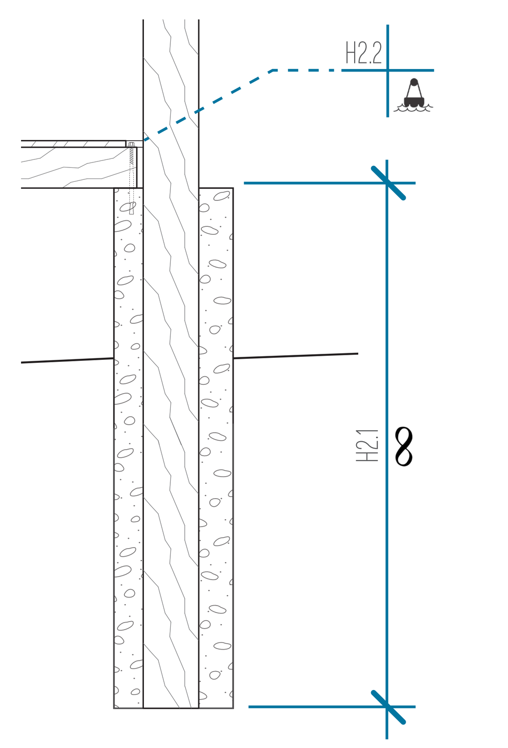
A2.2.06 HURRICANE TRANSITION - FLOOR SIZING
NOT TO SCALE

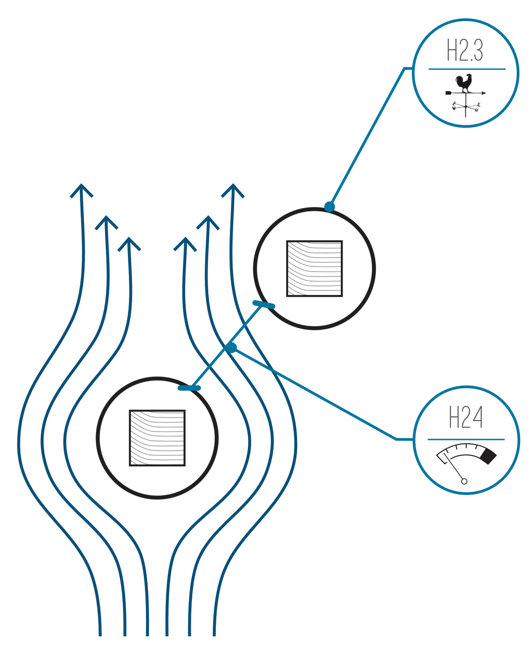


04_A2.2.08 HURRICANE USAGE - SCREEN RECONSTRUCTION
NOT TO SCALE



A2.2.09 HURRICAN USAGE -TRANS-IMPACT CONFIGURATION
NOT TO SCALE





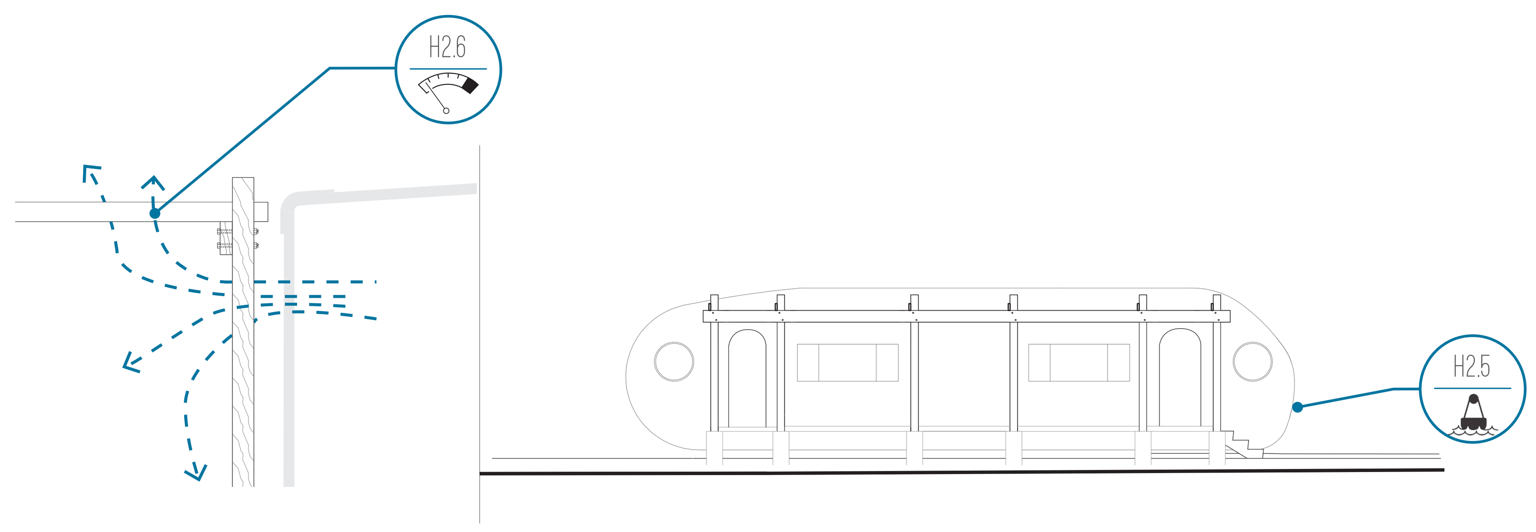
A2.2.10 HURRICANE ASSESSMENT - FOOTINGS
NOT TO SCALE

H2.1. Extending the concrete encasement around the post creates a stronger connection between the post and footing as well as the footing and the ground. The increase in size strengthens the foundation on which the entire system rests.

H2.2. The extension of the footing serves a secondary purpose: it raising the elevation of the impact between the frame and the storm. By keeping it above the main forces of the storm surge, forces on the structure are minimized.

H2.3. The concrete encasement that continues the footing into the ground is a cylinder shape which is proven to have less wind resistance and lessen drag.

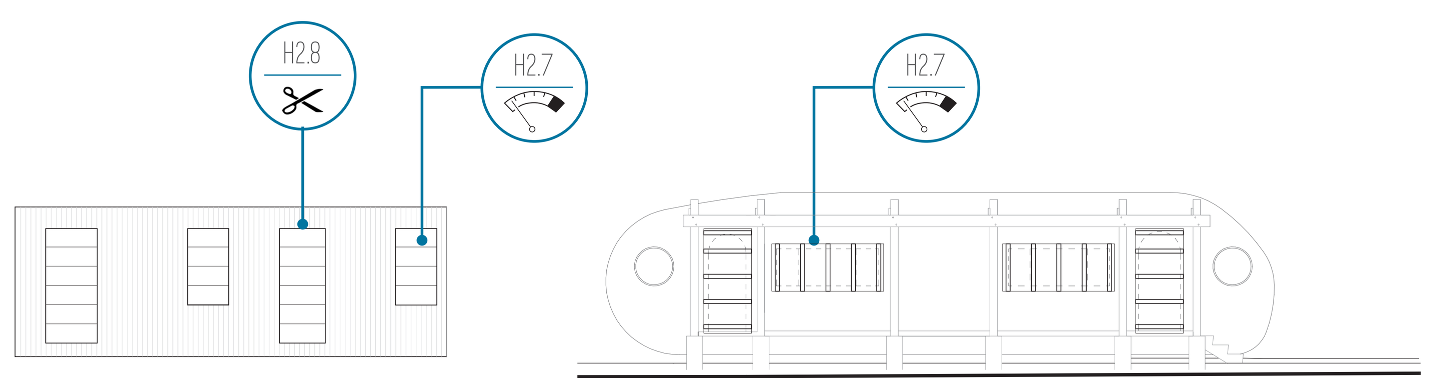
H2.4. The open area between footings allows for open air flow that does not try to fight the wind, but rather avoid it.



A2.2.11 HURRICANE ASSESSMENT - OPEN FRAME STRUCTURE
NOT TO SCALE

H2.5. The continuous footing elevates the point of contact between the frame but also keeps the deck above the flood line. The protects the material from rot and keeps broad surfaces above acting forces.

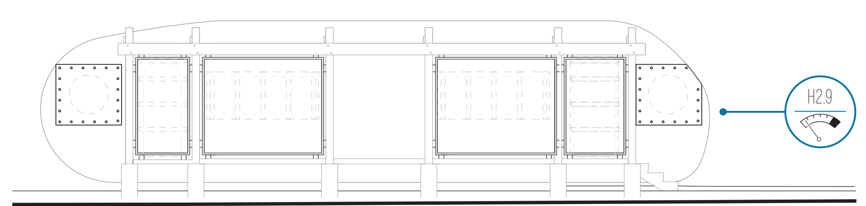
H2.6. The open frame of the structure is inherently strong as it sheds wind to reduce pressure. This tactic lets air move freely in order to reduce damage.



A2.2.12 HURRICANE ASSESSMENT - PRESSURE RELEASED DECKING
NOT TO SCALE

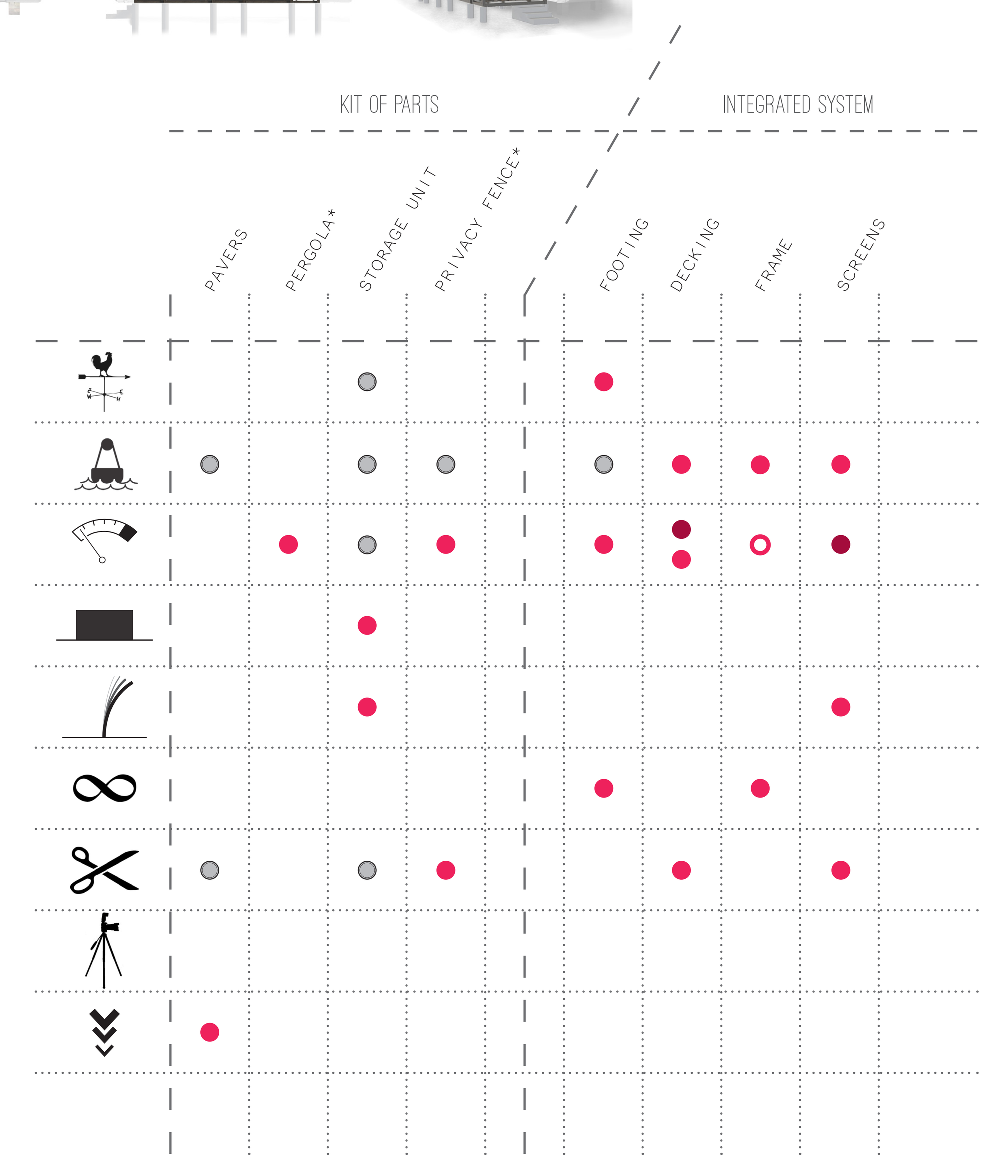
H2.7. The deck panels fight pressure in both their removal and reapplication. By removing the deck panels, are is allowed to move through the deck, minimizing the pressure on the remaining surface. By applying the panels tight against the home's openings, they are strengthened to better withstand wind and projectiles, keeping the pressure low in the interior.

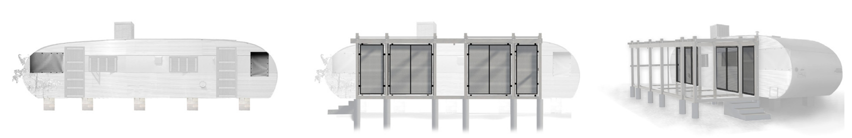
H2.8. The removal of the deck panels removes excess material that will not be used during the storm. This removal reduces the amount of material exposed to the storm's forces.



A2.2.13 HURRICANE ASSESSMENT - PRESSURE RELEASED DECKING
NOT TO SCALE

H2.9. Moving the panels to the back of the structure creates a ductile material held off of the home. This spacing and ductility protects the major openings from projectile that would otherwise hit and potentially pierce the home.





INTEGRATED SYSTEM:
OCCUPANCY AND USE