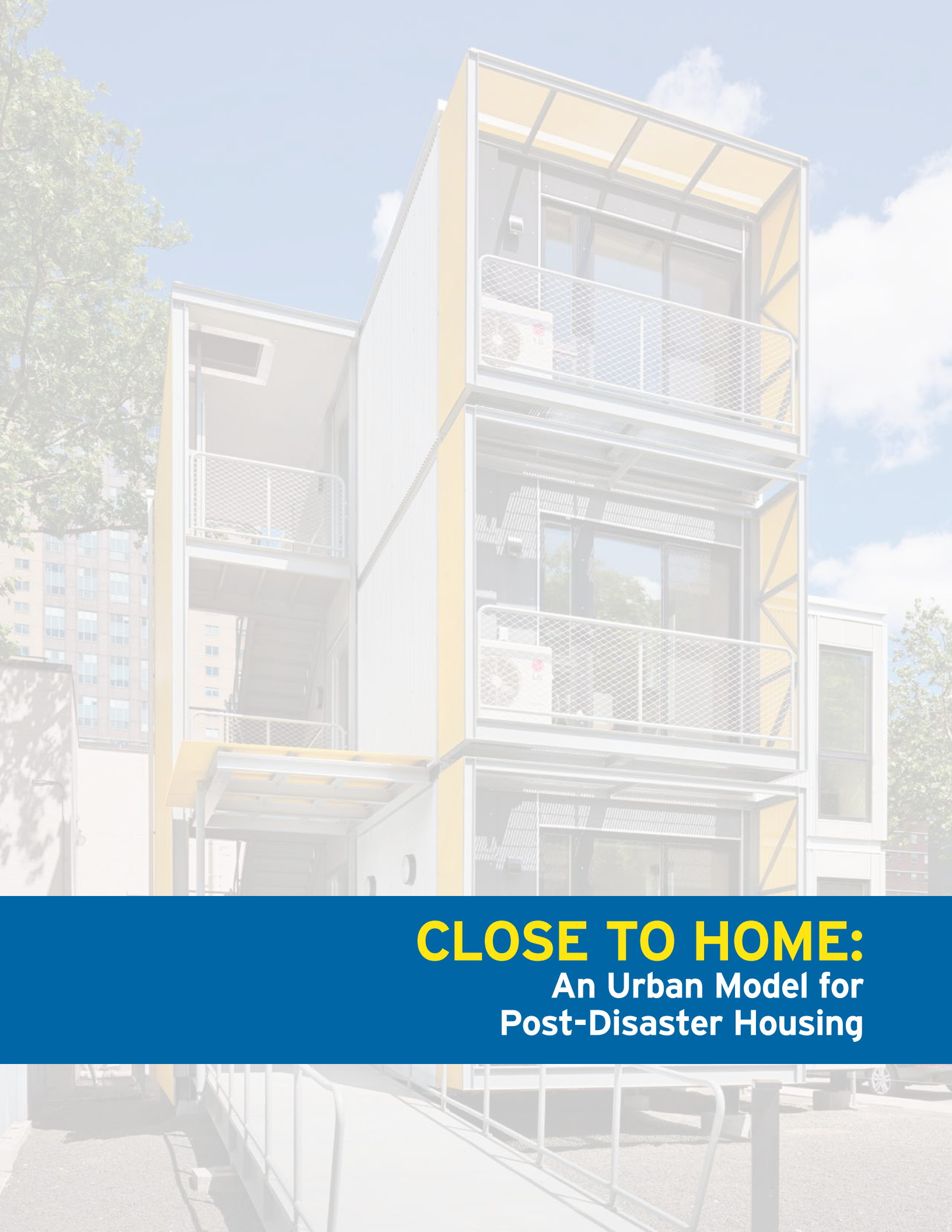
CLOSE TO HOME:
An Urban Model for Post-Disaster Housing

NYC Emergency Management



CLOSE TO HOME:
An Urban Model for Post-Disaster Housing

Bill de Blasio, Mayor

Joseph J. Esposito, Commissioner, NYC Emergency Management Department

Office of the Commissioner, Department of Design and Construction

TABLE OF CONTENTS

FOREWORD

New York City is the most densely populated city in the country. Over 8.3 million people live on land that has 520 miles of waterfront. Approximately a third of the city's housing stock is located in designated hurricane evacuation zones, exposed to the more frequent, more powerful storms caused by climate change.

Not long after Hurricane Katrina's devastating effects, NYC undertook a major revamping of its coastal storm plan. One lesson from Katrina was that the residents of neighborhoods torn apart by storm surge might be dispersed far from their homes. Many may never return to those areas.

As we have seen after disasters in many urban areas, keeping people close to home is critical to restoring the lives of residents, the vitality of neighborhoods, and the economy of the city as a whole. Cities face unique challenges because of already-low vacancy rates for housing and hotels, and there are few places where people can live from the time they are displaced until their homes are repaired or they are able to find a new long-term option. After a storm greater than Hurricane Sandy, where thousands of people may lose their homes, there may be a need to bring in housing units at a massive speed and scale. The Federal Emergency Management Agency (FEMA) currently provides single-story, single family housing units, but these work best in suburban and rural areas, not more densely-populated cities.

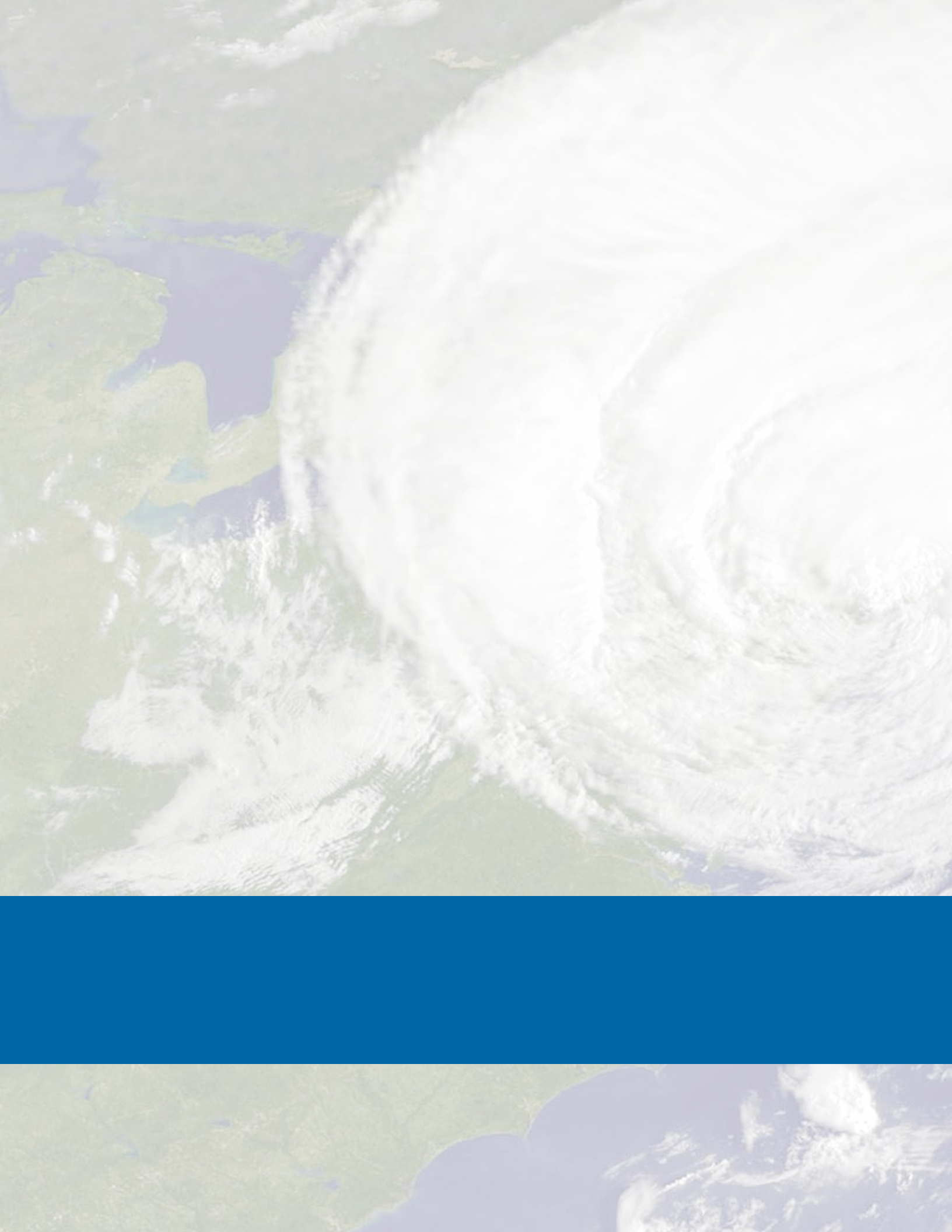
The NYC Emergency Management Department (NYCEM) and the NYC Department of Design and Construction (DDC), with support from FEMA, initiated the Urban Post-Disaster Housing Prototype Program to create rapidly deployable, high-quality housing that helps restore neighborhoods. Its two main objectives: to build and test a prototype of multi-story, multi-family post-disaster interim housing in NYC; and to record best practices enabling any city to procure well-designed post-disaster housing suited to their location.

The central element of the program is a three-story, three-unit prototype assembled next to NYCEM's headquarters, constructed after careful research into what designs are most likely to work for a big city. With what we have learned, we hope to contribute a local solution to a national problem.

Since its arrival in 2014, over 2,000 people have visited the prototype. It has won four design awards and appeared in news stories around the world.

Close to Home: An Urban Model for Post-Disaster Housing describes the key elements of the Urban Post-Disaster Housing Prototype Program. Together, these projects present a broad exploration of essential questions about deployable housing and point to the next challenges for urban recovery. Each resource featured in this document is available on our agency's website, and we welcome all who are planning for more resilient cities to share them.

Joseph J. Esposito, Commissioner
NYC Emergency Management Department



The Challenge

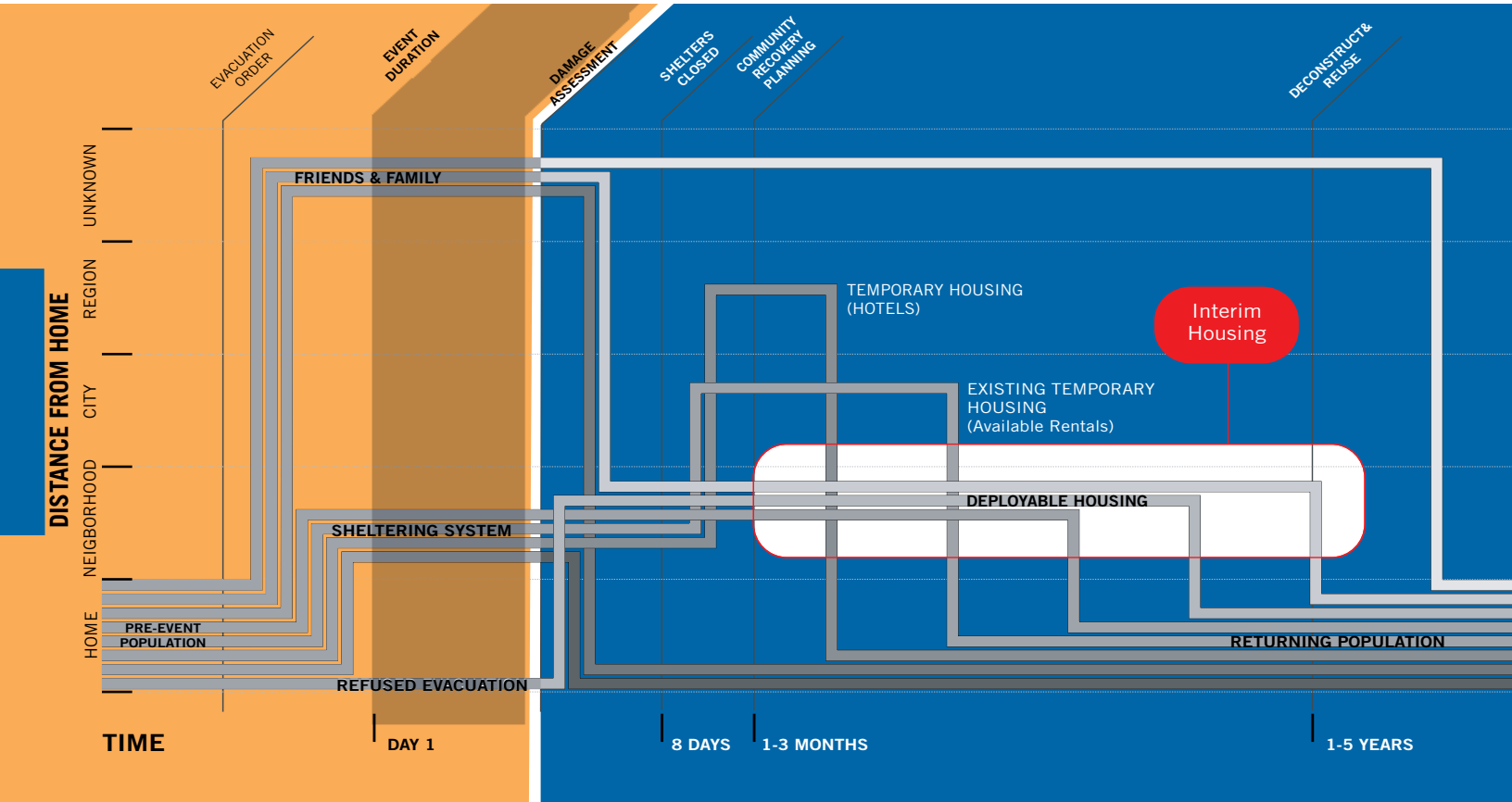
Post-Disaster Housing for Cities

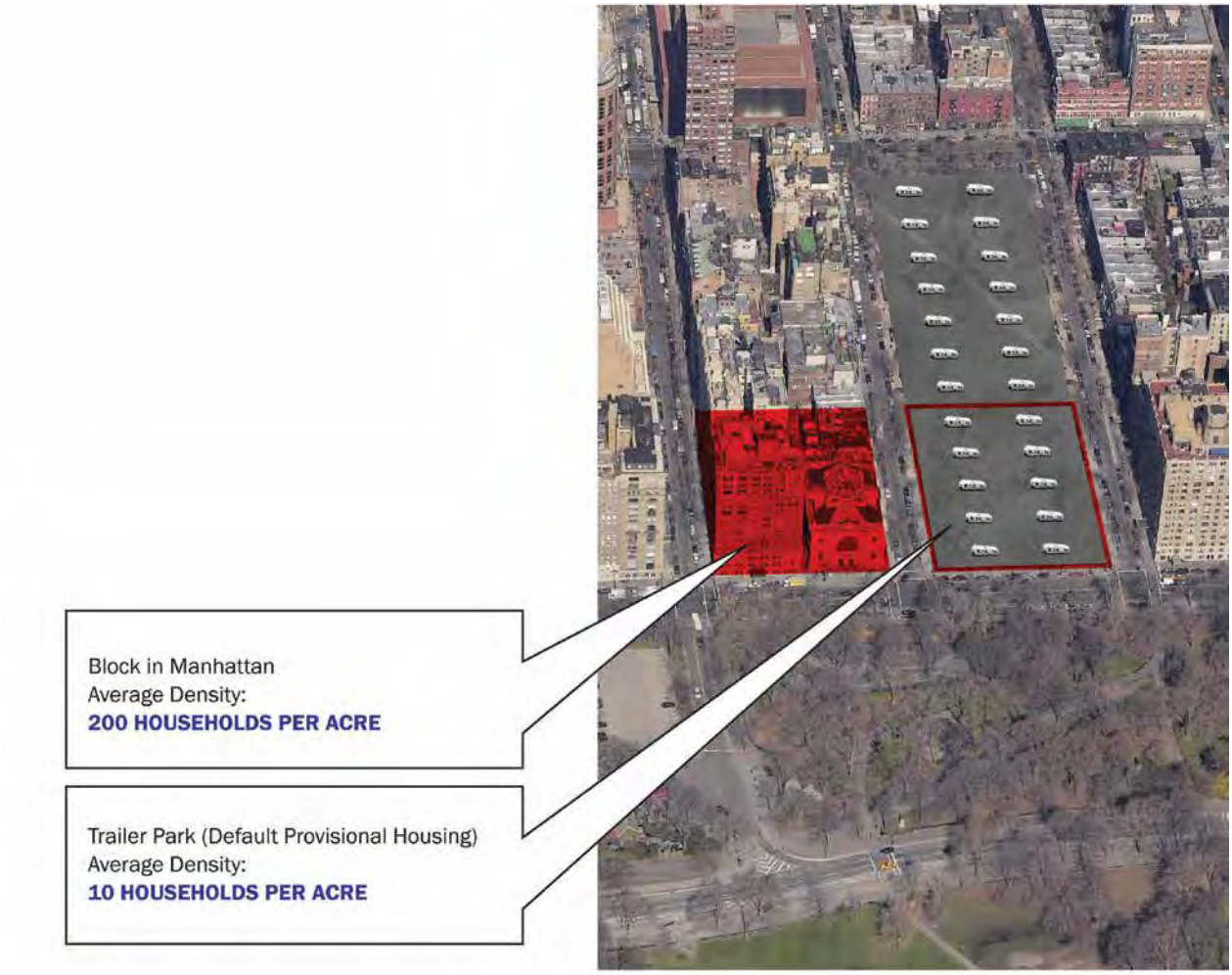
WHAT IS INTERIM HOUSING? WHY DO WE NEED AN URBAN MODEL?

Cities need more options for post-disaster housing. After a disaster where thousands of people lose their homes, there may be a need to deliver deployable housing at a massive speed and scale. The single-story, single-family home models that FEMA can deploy after disaster will not work where there is little available land, and their designs do not take into account the complex challenges of urban conditions. To date, there has been no way for the federal government to provide multi-family, multi-story housing units for urban sites.

With support from FEMA, the New York City Emergency Management Department (NYCEM) and the NYC Department of Design and Construction (DDC) developed the Urban Post-Disaster Housing Prototype Program to address this problem. The Program creates a new paradigm for deployable housing that meets the challenges of urban construction, helps restore neighborhoods and offers high-quality interim housing for displaced people. Interim housing is designed to house displaced people when a disaster strikes until their homes are rebuilt, or they can find housing they can sustain without disaster assistance. Often, the first questions about deployable housing are: How many can we get? How fast will they be here? How much will they cost? Where do they go? Who lives in them? This publication presents our best answers to these and other essential questions, based on results from a multi-year study.

Post-disaster recovery is complex, and deployable housing may not be the right choice for every urban disaster; however, for certain locations it can make the difference between whether people stay or leave the city permanently, and whether local economies





recover in years, rather than decades. We looked at the problem at the scale of the household, the neighborhood, and the city as a whole.

The resources here are designed to help cities around the country evaluate whether, where and when it may work. They can be used to prepare for as well as respond to a disaster. We also provide tools that outline a tested, cost-effective way to procure safe, quality housing tailored to the unique needs of cities.

Like any other type of construction in cities, deployable housing requires complex planning and coordination, and using this guide to prepare for potential needs will result in more efficient operations. Likewise, it can offer realistic benchmarks for time and cost; set standards for quality and safety for those who may supply rapidly-built housing after disasters; serve as an aid for navigating the federal government's post-disaster funding streams; and support self-determination for recovering communities by showing how participatory urban planning for interim housing can be done.

Credit: Carsten Laursen and Morten Norup Fassov

WHO DOES THIS GUIDE HELP AND WHAT DOES IT OFFER?

Deployable housing presents an opportunity to house people quickly, safely and economically. Like almost all post-disaster housing assistance options, it requires large investments of time and money, which can be daunting for people unfamiliar with modular construction or emergency management operations.

For three main audiences, this guide introduces three essential elements of success: leadership, project management, and public engagement:

Government Officials and Community Leaders can understand:

- Whether, where, and when to use deployable interim housing
- How to manage the effort and how to integrate with federal operations
- How to engage the public in key decisions

Housing Operations Leaders and Construction Managers can learn:

- How to coordinate complex operations for siting and planning
- How to procure housing that suits local conditions
- Best practices for on-time delivery

Community Advocates and Urban Planners can help residents determine:

- How deployable interim housing can contribute to overall recovery
- Which sites best suit the needs of the neighborhood
- How sites can be planned to restore the whole community

USING THIS GUIDE

Each chapter profiles studies and projects conducted to understand the many facets of urban interim housing, and describes how the findings might influence future efforts and current resiliency planning.

THE APPROACH explains how central research questions were shaped to find solutions that would work for both New York City and cities around the country. It traces how abstract ideas evolved into operational plans, beginning with some of the most promising strategies proposed in the international design competition, "What if New York City…", and ending with the team and site selected to create the prototype.

THE PROTOTYPE focuses on the practical aspects of creating the prototype, from the procurement process to the day the first residents moved in. Lessons learned about how to reduce costs, save time, and deliver on a big scale are presented here.

LEARNING FROM THE PROTOTYPE summarizes the results of an occupancy evaluation by city employees and journalists who lived in the apartments for a week at a time, and describes some of the public's reaction to the project.

A KEY TO COMMUNITY RECOVERY reveals how the prototype design can inform urban planning strategies with regard to density, open space and inclusion of neighborhood essentials. Background on federal "whole community" planning is presented along with participatory urban planning tools that promote collaboration between the government and community leadership.

RESOURCES offer direction to further information on urban interim housing, and practical support for deployable housing operations. The Annotated Bibliography contains links to all documents mentioned in this guide as well as national professional associations that provide pro-bono assistance for recovery and mitigation planning. The "Design Principles and Performance Specifications for Urban Post-Disaster Housing" can be adapted to help any city in the country procure post-disaster housing that meets its requirements.

The Approach

A Local Solution to a National Problem

A LOCAL SOLUTION TO A NATIONAL PROBLEM

To create a way to rapidly rebuild in New York City that would apply nationally, we began with the challenges most cities share. Our first step was to create a common ground: the fictitious neighborhood of Prospect Shore. Because the Prospect Shore neighborhood was compiled from maps of parts of the City that are typical of many coastal cities, using it ensured that the program focused on shared conditions.

We gathered ideas about what the best housing systems and strategies might be for cities generally, then identified the requirements that need to be adjusted for each city. Within these parameters, we devised ways to leverage the capacity of the modular building industry. Finally, we prepared to build a prototype by establishing a management team, acquiring a site, and establishing a procurement process.

This chapter highlights the milestones that led to the prototype's construction. While community planning is central to urban recovery and an important part of the projects here, it is covered more thoroughly in A Key to Community Recovery.

A hurricane approaches Prospect Shore...

GATHERING IDEAS:

"What If New York City…." Design Competition

- Scenario-based brief illustrating the goals and challenges of deployable interim housing
- Collects creative solutions from design teams around the world

After the Storm: Urban Interim Neighborhood Design Case Study

- "A "Neighborhood Design Playbook" for post-disaster site selection with design principles for restoring whole communities
- Shows how to prioritize sites, streamline permitting processes and bring back neighborhoods

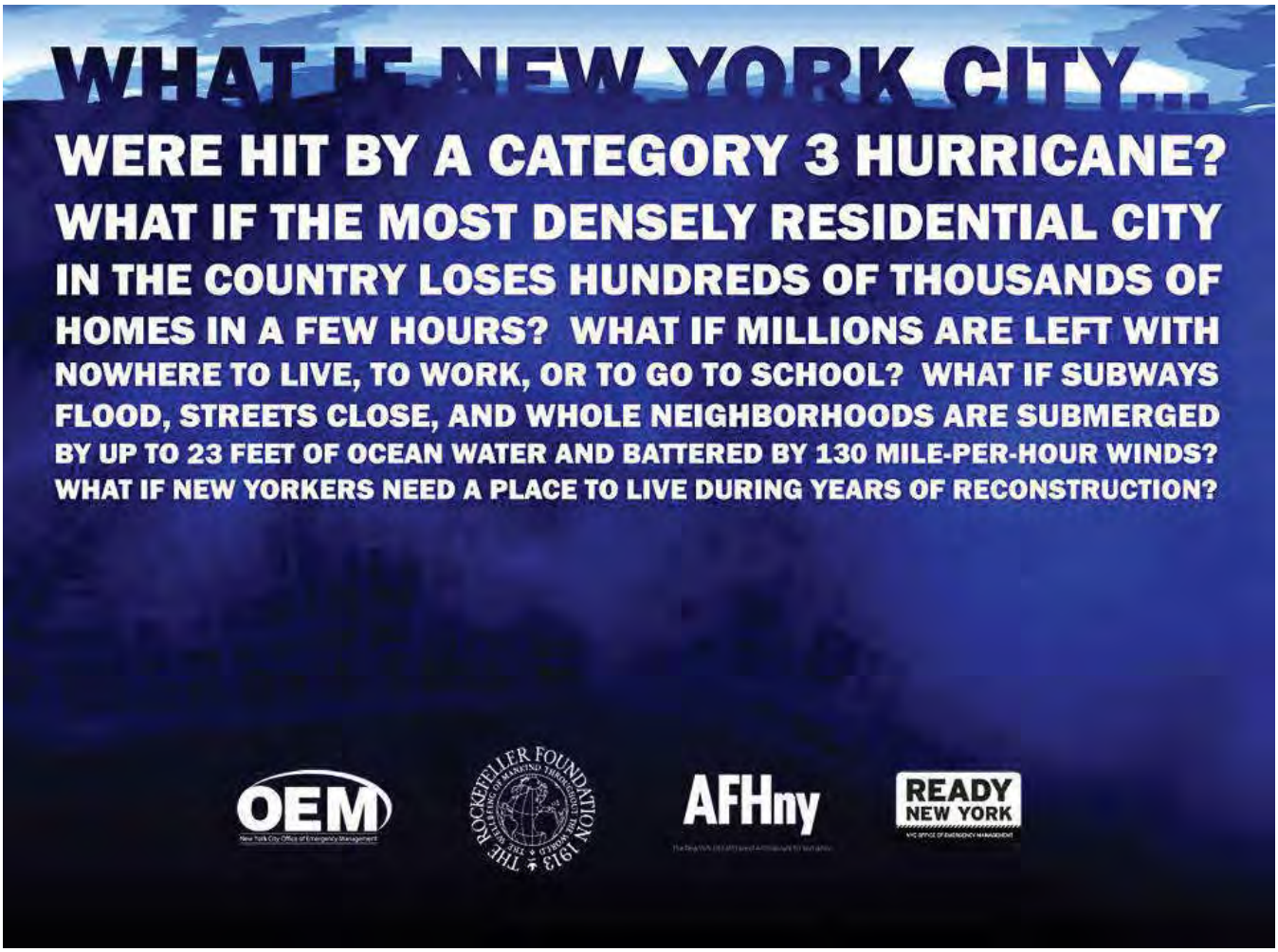
BUILDING FOR THE BIG CITY:

Design Principles and Performance Specifications for Urban Post-Disaster Housing

- Design criteria and requirements for safety, environmental quality, durability and universal design that can be used as the core of a Request for Proposals
- Creates a way for any city to leverage the capacity of the entire manufactured housing industry

Request for Expressions of Interest from the Modular Building Industry

- Survey of experienced manufacturers revealing the capabilities of the industry nationwide
- Establishes benchmarks for housing production speed, scale and cost



WHAT KIND OF INTERIM HOUSING CAN WORK FOR CITIES?

What if New York City..." Design Competition for Post-Disaster Provisional Housing

To gather innovative ideas about urban interim housing, NYCEM hosted a design competition. The scenario presented the fictional coastal neighborhood of Prospect Shore in the wake of a Category 3 hurricane. Along with the impacts to housing and infrastructure, the scenario included the storm's effects on characters who illustrated the variety of housing needs in the City. The competition asked designers to propose ideas for rapidly deployable housing systems that could achieve urban density, serve many family types, conform to a broad range of site conditions and be removed easily when they were no longer needed. Competitors were asked to show the design of the units, the logistics involved in producing and delivering them at a massive speed and scale, the ways they supported neighborhood redevelopment, and the quality of space they offered displaced people. The competition's judging criteria lay out the essential qualities of urban interim housing that should be manifest in all aspects of the prototype program.

Winning Entries Provisional Housing

The competition received a remarkable 117 entries from 30 countries. Ten winners and ten honorable mentions were chosen by a jury of architects, emergency managers, artists, engineers and scholars.

With a $10,000 award from the Rockefeller Foundation, the ten winning projects were further developed and evaluated on constructability, speed of fabrication, ease of transport and potential cost-effectiveness.

The jury found that many entries shared one or more common ideas that held promise for the eventual prototype: modified shipping containers, kit-of-parts systems, expandable structures, projects that focused on sustainability and structures that achieved high population density.

The following pages feature an example of each category.

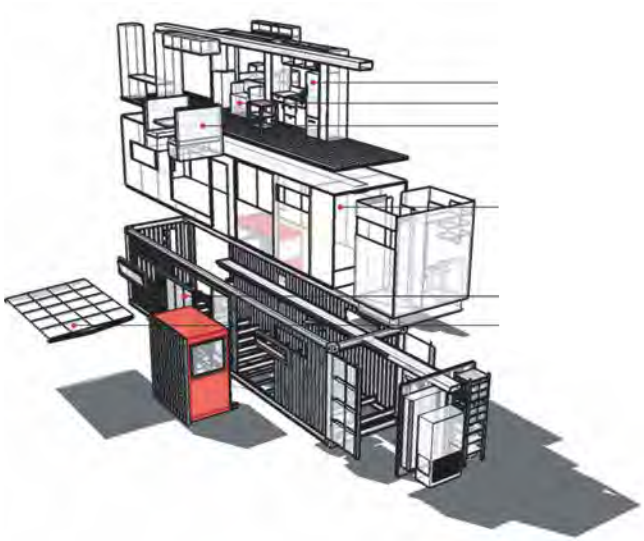
Judging Criteria

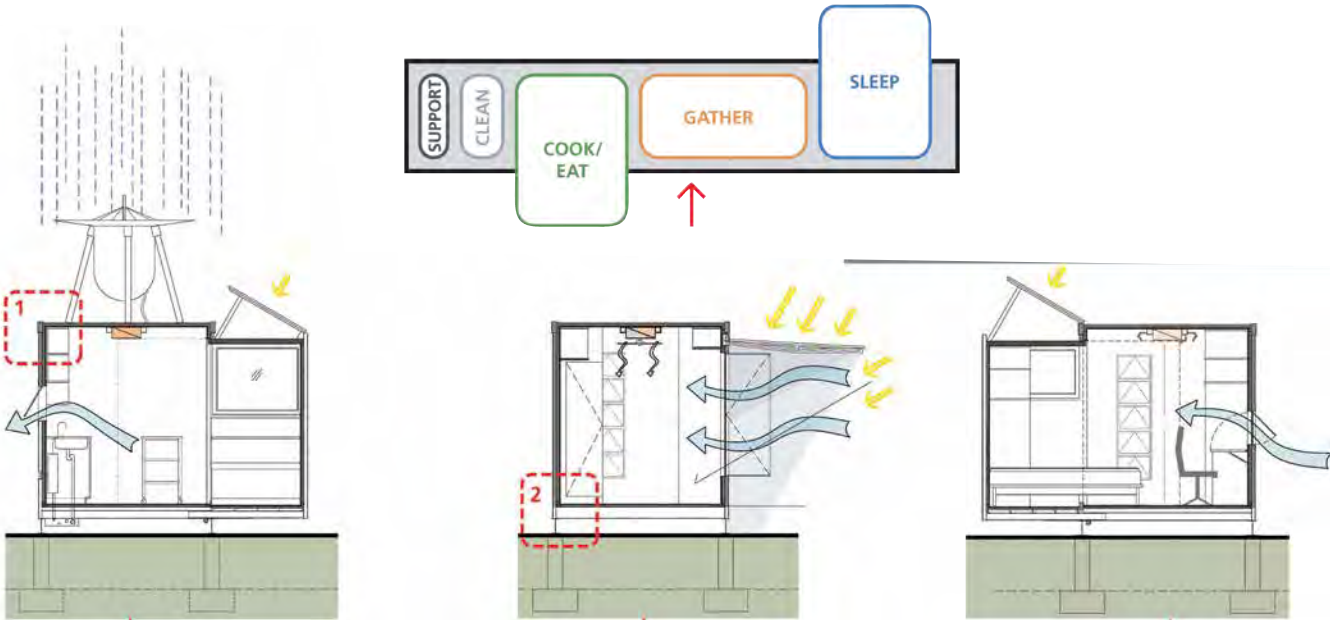
THE JURY WILL FAVOR SUBMISSIONS THAT DEMONSTRATE THE FOLLOWING QUALITIES:

Density	Maximize number of housing units per land area.
Rapid Deployment	Provide units ready to be occupied as soon as possible.
Site Flexibility	Maximize the ability to accommodate as many different sites as possible
Unit Flexibility	Maximize the ability to accommodate as many variable household types and sizes as possible
Reusability	Maximize the potential for reuse of the structures either for future disasters or other purposes
Livability	Maximize the strength, utility, convenience, and comfort of the dwellings
Accessibility	Allow access for people who have limited mobility
Security	Make public space defensible and help people feel safe
Sustainability	Reduce energy costs and the carbon footprint of the dwellings
Identity	Maximize the ability of New Yorkers to feel a sense of identity and even pride in where they live
Cost Efficiency	Maximize the best value for investment

MODIFIED SHIPPING CONTAINERS

The Container Living Apparatus offered pop-out sections that could suit many lifestyles. Using standard-sized containers made the units easy to acquire and transport anywhere in the world. The designers showed compelling configurations that would contribute to lively streetscapes in neighborhoods. The sustainable aspects of the project brought natural light and air to individual units through passive heating and cooling, and generated utility services for the neighborhood through wind power and rainwater collection systems.





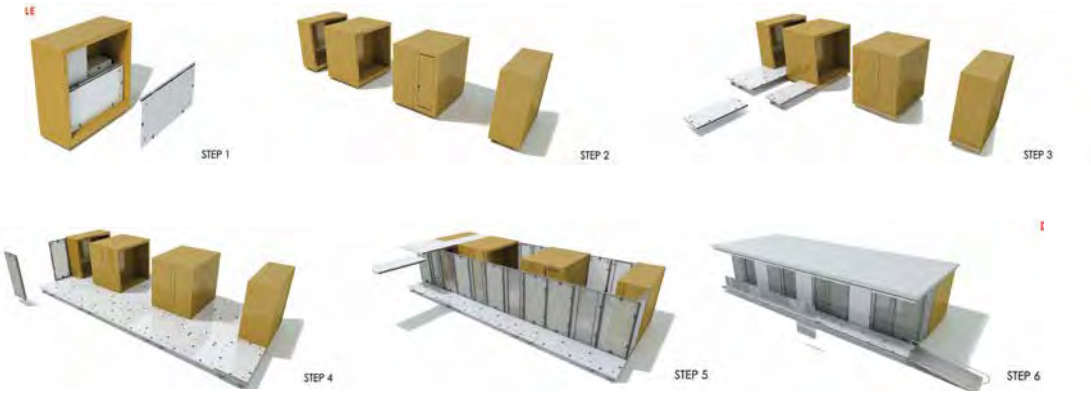
Credits: Darrell Mayer, Elizabeth Mayer-Mayer

KIT-OF-PARTS

Many designers invented collapsible systems that could pack into small boxes for transport and be put together on site. The Community Provisional Residence comprised flat panels that could be compressed into modular containers and unfolded. An advantage of the kit-of-parts systems is that they could be stored easily across the country, ready to be deployed.

"We propose a network of national readiness that can be mobilized anywhere in the U.S. for any location."

Murphy, Burnham & Buttrick Architects LLP



Credits: Murphy, Burham & Buttrick Architects, LLP

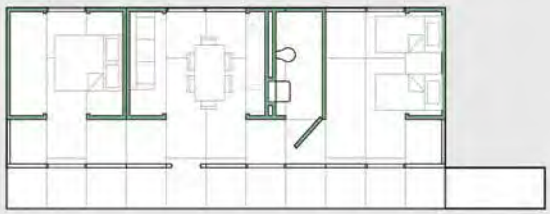
POD 1
(6) 8'-0" FLOOR PANELS
(1) 4'-6" FLOOR PANEL
(10) 4'-6" CEILING PANELS

POD 4
(8) 4'-6" FLOOR PANELS
(2) 9'-0" CEILING PANELS
(6) 8'-0" CEILING PANELS
(2) SECTIONS OF REFLECTIVE LIGHT-WEIGHT RUBBER MEMBRANE ROOF

385 SF STUDIO UNIT : 3 PODS

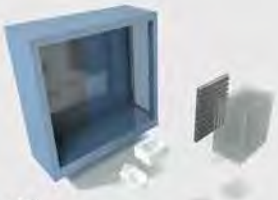
POD 2
(5) 9'-0" FLOOR PANELS
(1) 4'-6" FLOOR PANEL
(3) 9'-0" CEILING PANELS
(1) BISECTING ENTRANCE RAMP AND RAILING

POD 5
(1) 8'-0" EXTERIOR DOOR PANEL
(5) 8'-0" LEXAN WINDOW PANELS
(5) 8'-0" TRANSLUCENT WALL PANELS
(7) 8'-0" OPAQUE WALL PANELS



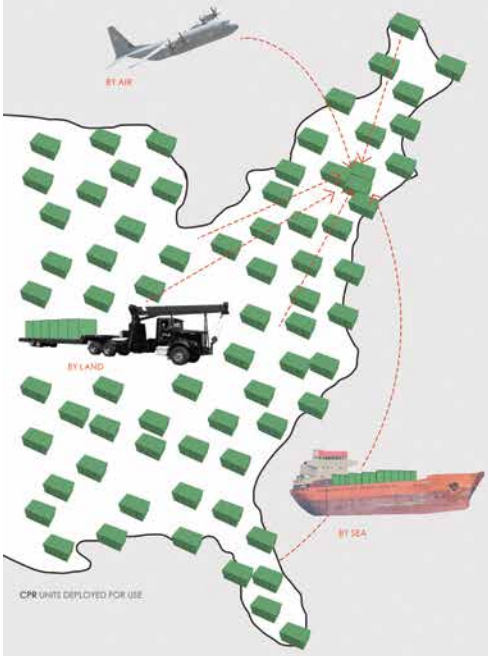
650 SF 2 BEDROOM UNIT : 6 PODS

POD 3
KITCHEN UNIT WITH REFRIGERATOR, OVEN, SINK, RESIDENTIAL FUEL CELL HEAT AND POWER SUPPLY, AND CABINETRY



POD 6
BATHROOM UNIT WITH LAVATORY, WATER CLOSET AND SHOWER. HOUSES EXTERIOR LEXAN RAILING WHILE IN STORAGE MODE.

700 SF 3 BEDROOM UNIT : 7 PODS



CPR UNITS DEPLOYED FOR USE

CPR UNITS STACKED

CPR UNITS AS STAND ALONE

1 WEEK : PERIMETER CPR UNITS

1 STORY CPR UNITS ARE QUICKLY ESTABLISHED ON EXISTING LOTS ALONG WITH REPAIRED EXISTING BUILDINGS.

CPR UNITS AS STACKED

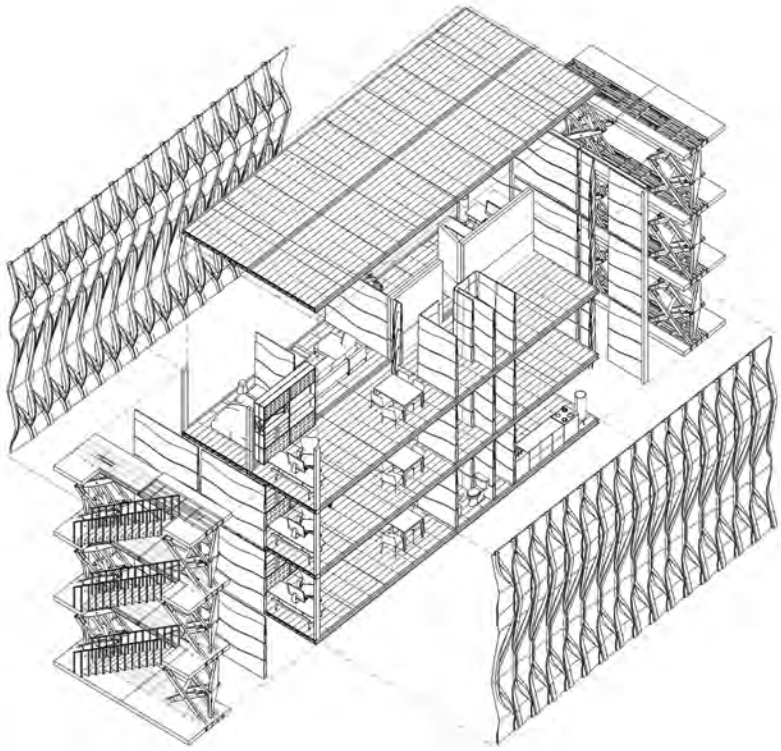
3 WEEKS : INFILL CPR UNITS

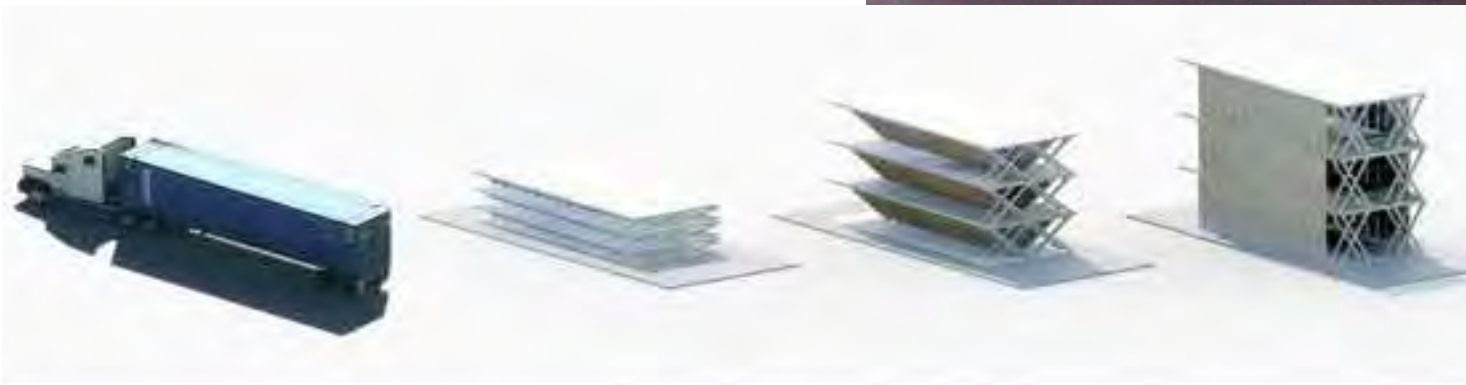
3 AND 4 STORY CPR UNITS ARE CONSTRUCTED IN REAR YARDS USING LOCALLY SUPPLIED SCAFFOLDING WITH STAIRS AND CONSTRUCTION ELEVATORS FOR CIRCULATION.

EXPANDABLE STRUCTURES

The Sustainable Contemporary Adaptive Living Environment is a three-story scaffording system that packs flat for travel. Once it arrives, it can be expanded like an acccordion on sites like streetbeds and highway underpasses.

One way to increase the number of units in production might be to work outside the modular housing industry. SCALE re-tools an automobile factory and uses car-manufacturing technology to create thousands of units per day.





DEPLOYMENT STAGE 1

CONSTRUCTION

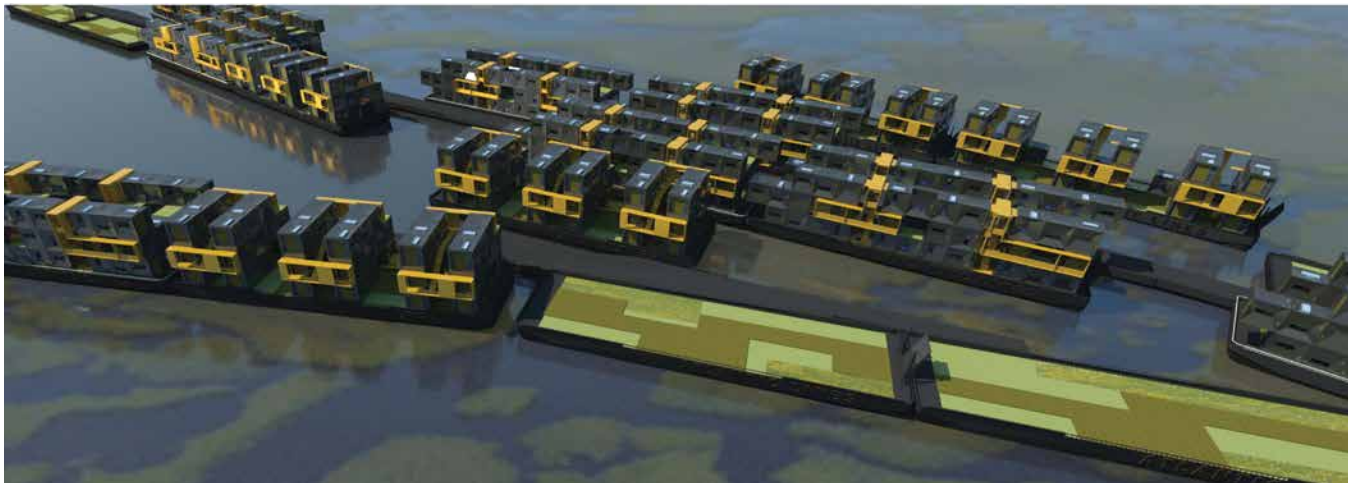
DE-CONSTRUCTION

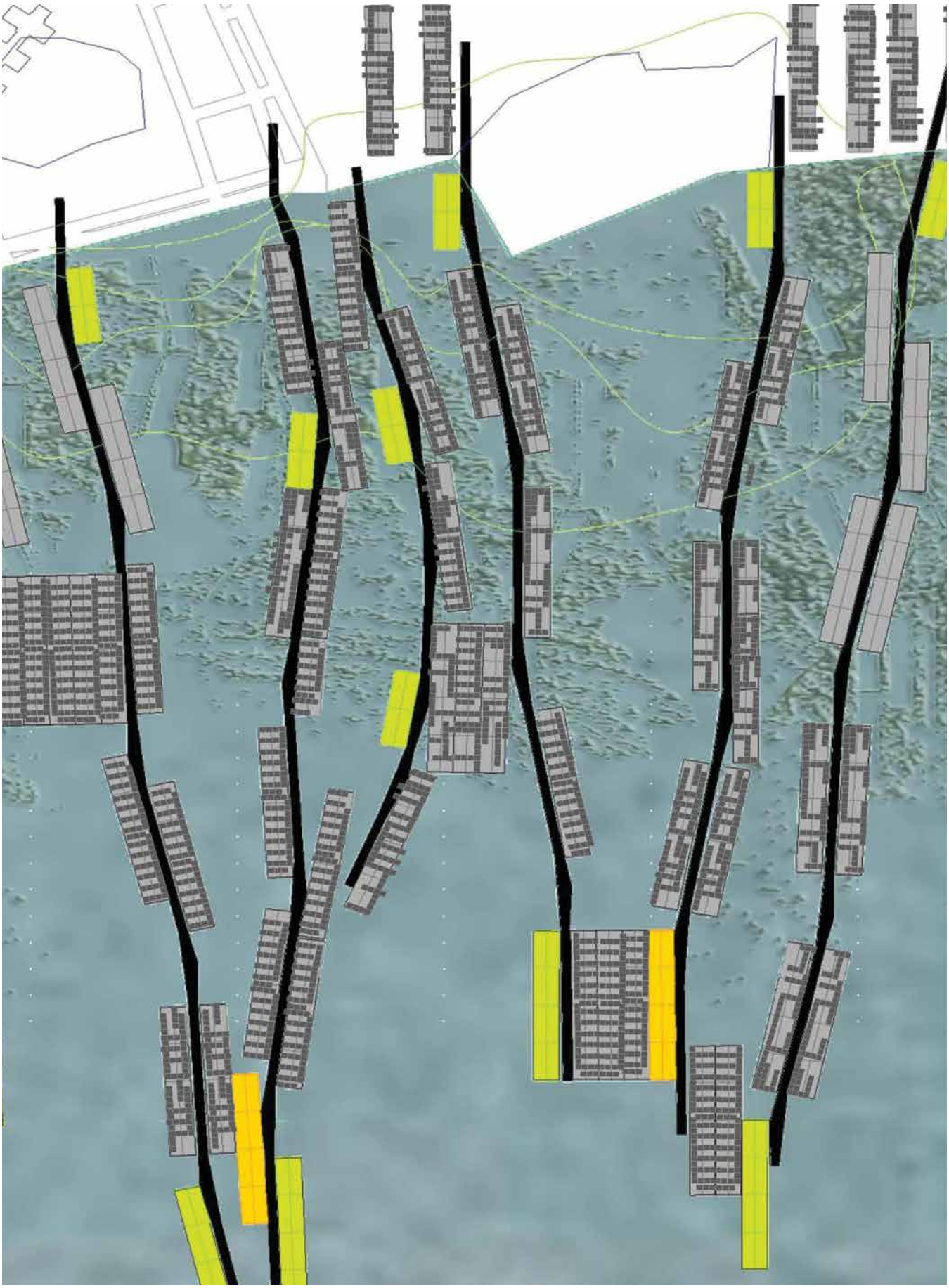
STORAGE STAGE

SUSTAINABILITY

Temporary housing has the potential to make lasting improvements to the environment, as the Threading Water scheme attests. The housing units are attached to barges that could be parked anywhere along the coast, with utility infrastructure threading out to them under dock-like pedestrian pathways. Prefabricated "Blue Box" units would also supply power with photovoltaic panels and collect rainwater. The barges themselves would filter the water, renewing and reinvigorating the shoreline ecosystem.

Credits: David Hill, Laura Garofalo, Nelson Tang, Henry Newell, Megan Casanega





MAXIMUM DENSITY

Using a hybrid design strategy with shipping container-sized modules of flat-packed units that would be inflated after delivery, the Rapidly Deployable Inflatable Containers show a convincing way to achieve high population density in pockets of space along the waterfront. Pop-out sections surrounded by inflatable fabric panels enlarge the units. This technical innovation is a reminder of the ephemeral nature of the project.

Credits: James Vira, Jason Cadorette, Dominic Cullen, Ethan Cotton, Lanson Cosh


natural ventilation:
utility distribution:
solar control/alternative energy:
typical floor:
ground floor:
DO NOT
ENTER


NY
RDIC NY
longitudinal section
side elevation
front elevation
cross section

WHAT IF NEW YORK CITY...

A hurricane has swept through New York City's coastal neighborhood of "Prospect Shore." Many residents are waiting in shelters to hear if they can return to their houses; but unfortunately, many of their homes have been destroyed. They will need somewhere else to go. City officials and their state and federal partners want to keep New Yorkers close to home so that they can be a part of the reconstruction. They implement a plan for interim housing. That usually means trailer parks, but this solution will not serve enough people in the available space. They will have to find a way to provide housing that is more dense-more like the neighborhoods they are serving. They will use multi-storied, pre-manufactured units. But where will they put them and how?

AFTER THE STORM

AN URBAN DESIGN CASE STUDY FOR POST DISASTER INTERIM HOUSING

ESTABLISHING URBAN NEIGHBORHOOD RECOVERY PLANNING PREMISES

These are the essential ideas about how temporary housing can fit into the City:

Respect the Community: Be considerate of the needs of both the existing community as well as the displaced. Aim to integrate into the life of the community without interrupting it.

Avoid Precluding the Best Development of a Site: New York City has limited land and limited resources which it will need to be put to the best possible use over the coming decades. A solution that works for a few months or a few years may not necessarily be the ideal long-term solution so interim housing should always be developed with the emphasis on "interim."

Coordinate with a Citywide Recovery Strategy: Housing is critical to post disaster recovery; however, housing recovery should be carefully coordinated with the broader recovery effort.

Improve Beyond the Standard: Temporary housing can be a model for innovations in terms of construction and sustainability.

Respect the City's Unique Character: New York City's density, the lack of vacant housing and land, the complexity of our housing market, the intricacy of the infrastructure, and the carefully choreographed routines of life all play a part in the complexity of a recovery strategy.

After the Storm: An Urban Design Case Study for Post-Disaster Interim Housing

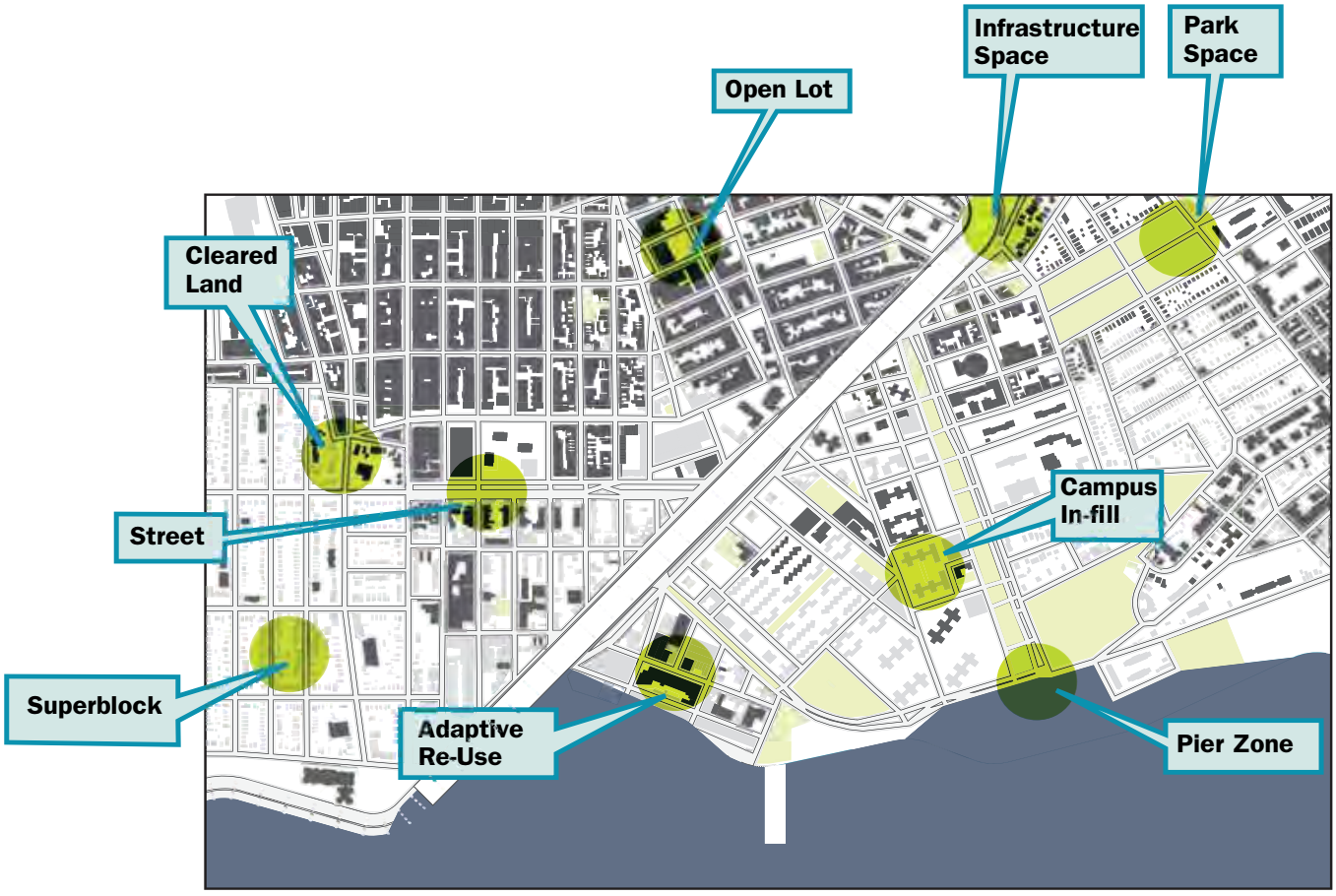
This case study is a "Neighborhood Design playbook." NYCEM and the NYC Department of City Planning returned to the imaginary neighborhood of Prospect Shore to consider standards for constructability, livability, public space and street design as part of urban recovery. To answer the question of where interim housing units might go and how they might be aggregated, the playbook outlines a methodology for post-disaster housing site selection and modular organization.

One of the most complex questions of disaster recovery planning is how to meet immediate needs without precluding the long-term good of a site. The Playbook details a set of planning premises that help consider temporary housing as part of a long-term recovery strategy.

The playbook contains a catalog of potential site types for interim housing, including open lots, street beds, "superblocks" of tall buildings with large yards, and more. Each of the sites poses particular challenges: regulatory compliance, environmental review, infrastructure connectivity, and potential conflicts with long-term development. Analyzing these aspects of each site type can reveal the easiest places to build throughout a city. The playbook also considers post-disaster code and zoning regulations and proposes a streamlined permitting process.

"New Yorkers love their neighborhoods second only to their families. Our neighborhoods depend on durable infrastructure, great design, and most importantly a concentration and diversity of people."

-from the Introduction to "After the Storm"



BUILDING FOR THE BIG CITY

Design Principles and Performance Specifications

One reason it is difficult to acquire post-disaster housing for cities quickly is because there are no stockpiles of urban units. Stockpiling these units is not recommended because storage costs are prohibitive and different code requirements mean that not all units suit all locations. It is likely that production of urban housing units will not begin until after a disaster.

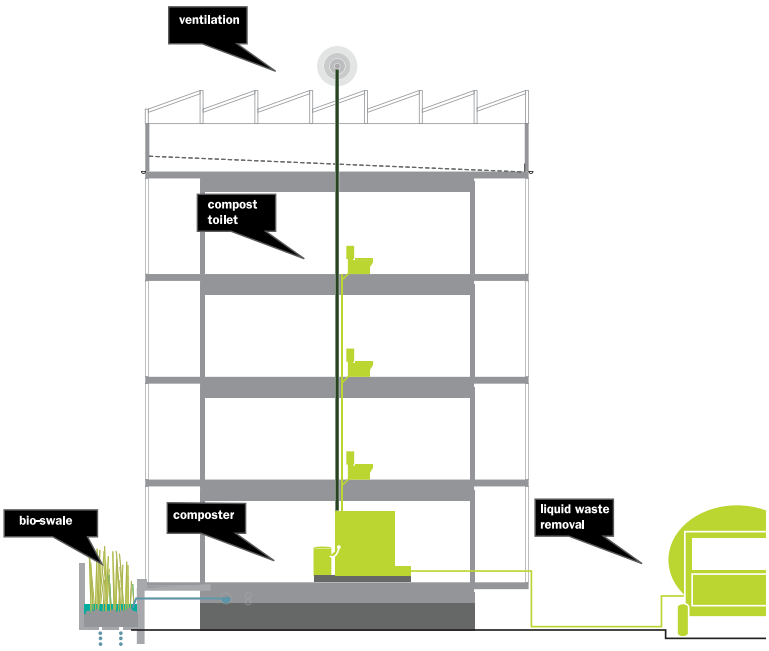
For big cities to obtain large numbers of housing units quickly, they will need to use as many manufacturers as possible. The "Design Principles and Performance Specifications for Urban Post-Disaster Interim Housing Units" presents a way for cities to leverage the full capacity of the manufactured housing industry. It is a technical document that establishes standards for safety, sustainability, accessibility, unit design, neighborhood configurations, building systems, and building complex design that most manufacturers can meet. Because interim housing needs to be as safe as permanent housing and may be in place for many years, the specifications recommend all post-disaster housing be compliant with local codes. As general performance criteria rather than rigid design requirements, the specifications ensure that while not all post-disaster housing will look the same, it will be equally safe, comfortable and well-built.

An earlier version of the document was used to procure the prototype. After evaluating the prototype for a year, the document was edited to reflect input from FEMA, HUD, the U.S. Army Corps of Engineers, seven City agencies, nine private sector entities, and dozens of occupants to align national standards, local regulations, industry practices and resident recommendations.

Any city can download the full document from the Resources chapter and customize it to local codes and climate conditions for use as the basis of a Request for Proposals.

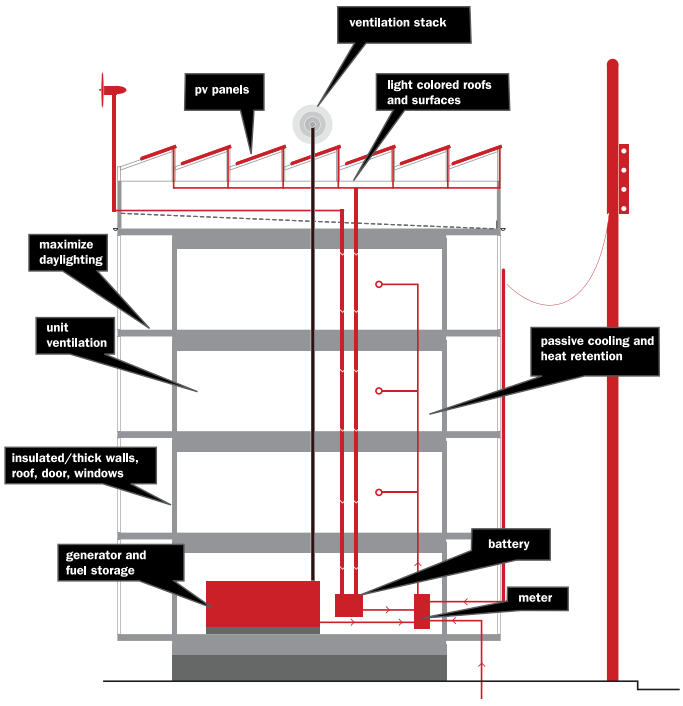
Key Topics

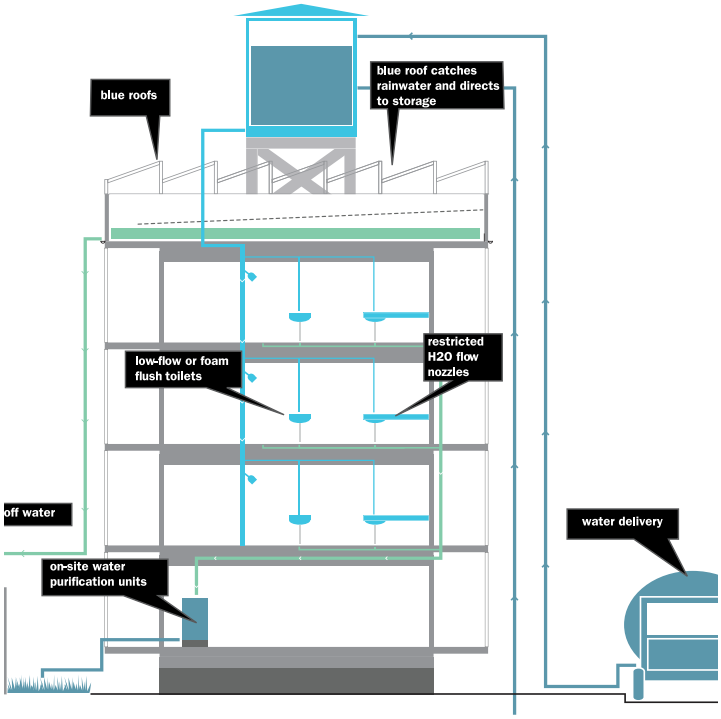
- Design Principles
- Unit Design
- Life Safety
- Building Systems
- Neighborhood Configurations
- Code Compliance
- Zoning Requirements



Improving Beyond the Standard

Even in a post-disaster context, it is possible to provide housing that performs better than some types of traditional construction. For instance, building systems designed to work off the grid after a disaster can set new standards for sustainability. Well-considered Universal Design elements can make apartments, streets and parks easier to navigate for all. Thanks to feedback from advocates who visited the prototype, the Specifications call out simple design opportunities to exceed the standards of the Americans with Disabilities Act.



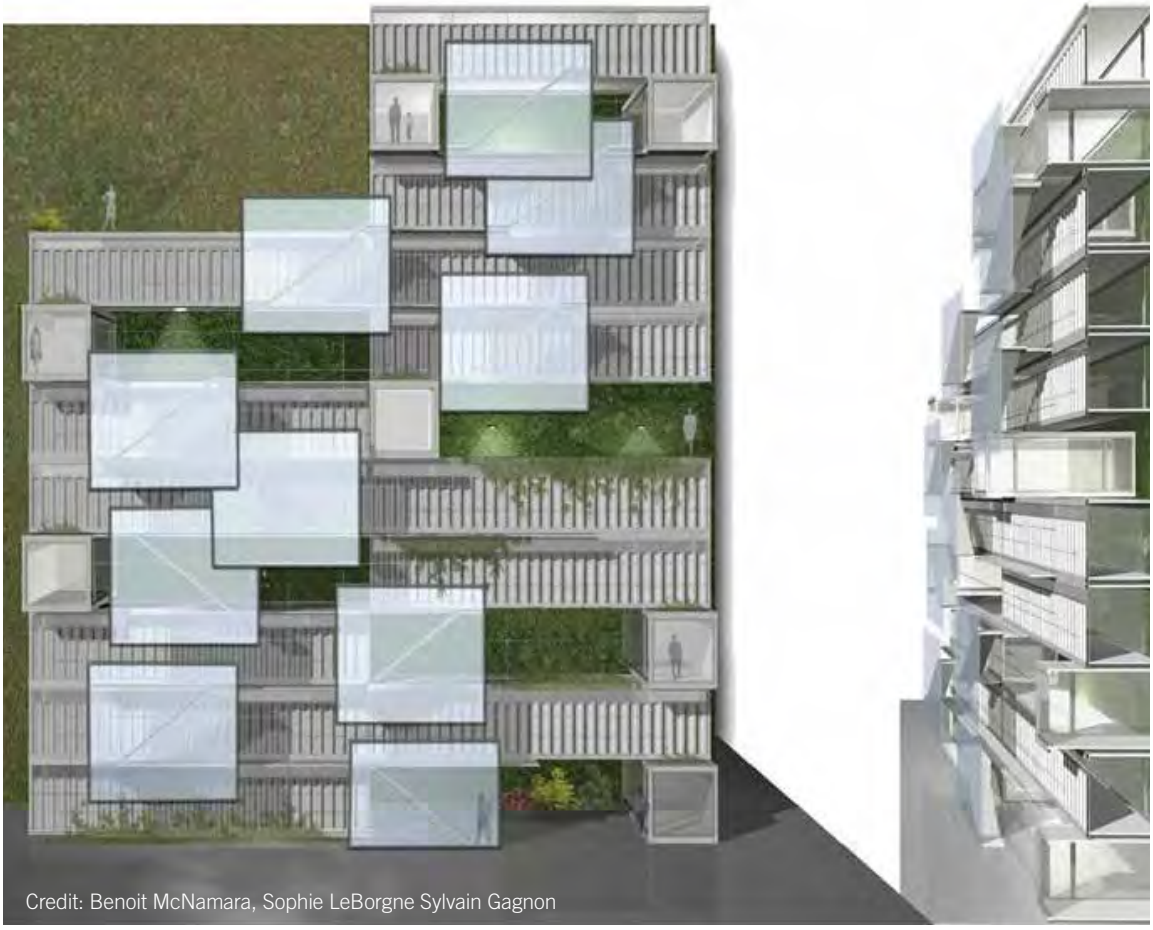


ENGAGING THE INDUSTRY

Request for Expressions of Interest from the Modular Building Industry

The design competition generated excellent but untested possibilities. To understand the current market capabilities, NYCEM and DDC released a "Request for Expressions of Interest" to the modular building industry. Vendors were asked to show how they would approach the scenario presented in the competition, and whether their systems complied with the "Design Principles and Performance Specifications." Based on feedback from the industry, the specifications were revised to allow for the broadest range of eligible suppliers without compromising safety or living standards.

The request called for technical design documents, a description of transport and assembly logistics and cost information for a building system of one- and three-bedroom apartments that could be deployed singly or in configurations up to 16-unit buildings.



Credit: Benoit McNamara, Sophie LeBorgne Sylvain Gagnon

Available Design Options

UNIT DESIGN

Companies showed inventive designs for dormitories, hotels, and affordable housing that have been built around the world. Some projects were similar to entries in the competition, with modern, pod-like designs, or structures made of modified shipping containers that had flexible space and durable materials.

SUSTAINABILITY

Green design features are standard for many companies and generally do not increase cost or add time. Vendors showed large projects with energy-efficient systems, green roofs and eco-friendly certification. Some options had self-contained water and power systems.

Speed, Scale and Cost

The requested benchmark for post-disaster production was 100,000 units within 108 weeks. The responses were significantly below this rate. While production is becoming faster and more companies are joining the market, the number of housing units that can be produced at the time of disaster is challenging to predict. Cities may benefit from establishing a list of approved vendors or contracts for minimum quantities in advance.

In terms of cost, modular construction is comparable to traditional construction. For a building with a one-bedroom unit and two three-bedroom units, cost projections ranged from approximately $400,000 to $900,000. These figures provided a basis for the prototype budget. While the prototype project was not part of these responses, it was priced within this range.

PLANNING FOR THE PROTOTYPE

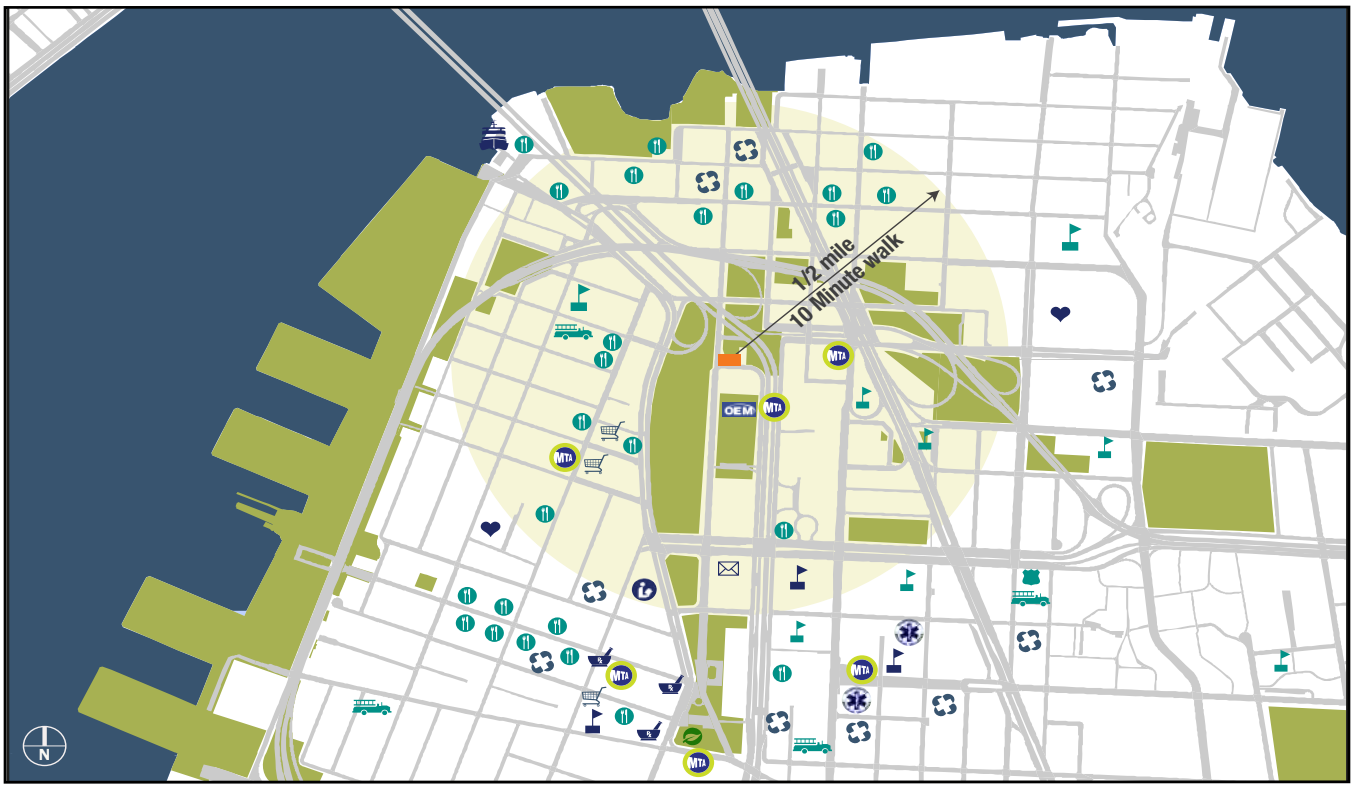
Managing the Project

After a major disaster, plans for deployable interim housing will likely be developed in coordination with citywide construction operations. FEMA's National Disaster Recovery Framework explains how federal operations can support local plans (for more information, see the Resources chapter).

While the prototype was a small construction project, resolving its larger questions required over seventeen agencies. A core team from NYCEM, DDC and the U.S. Army Corps of Engineers (USACE) executed the prototype project's key tasks. An Advisory Council of regulatory agencies, housing specialists, utility providers, and legal experts was convened to troubleshoot issues as they arose. Local governments may find that developing a process of collaboration for post-disaster construction offers the opportunity to streamline current practices.

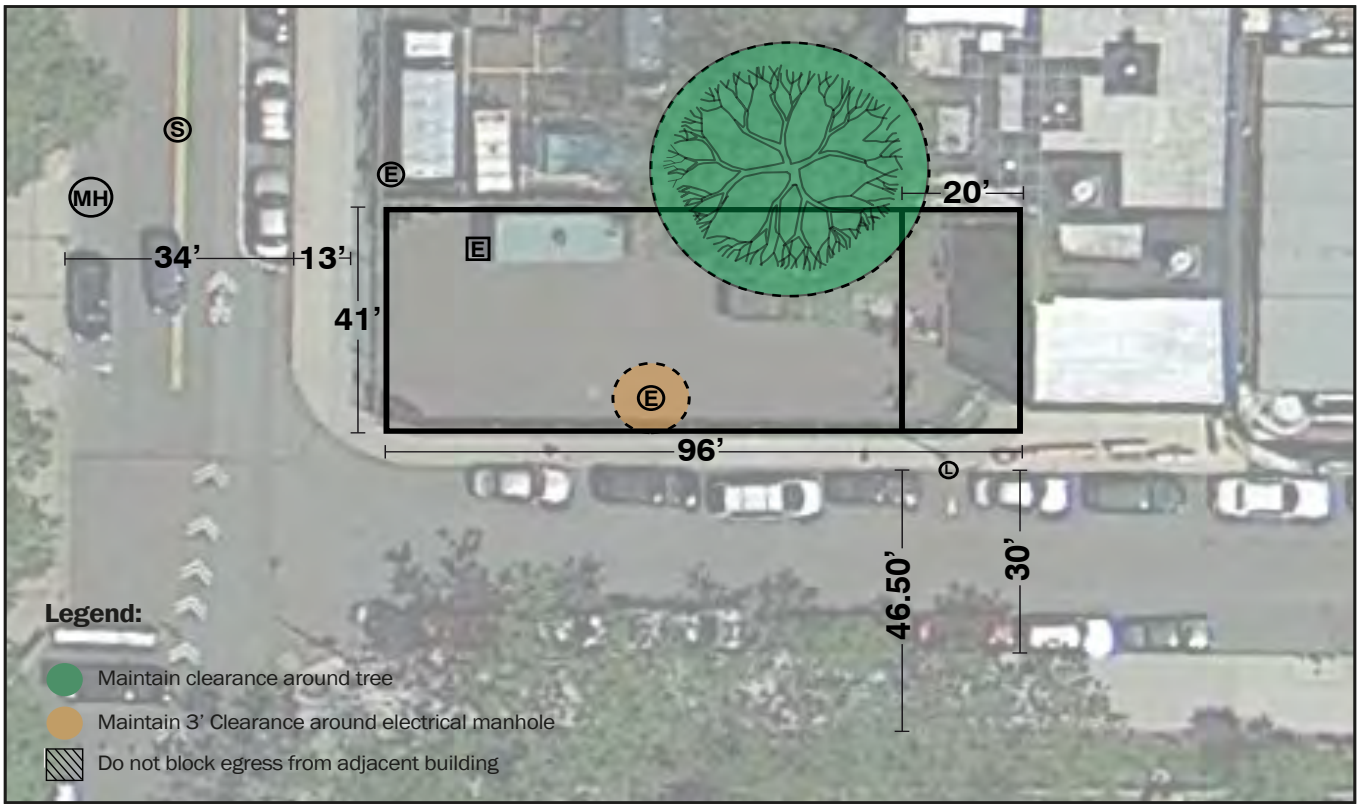
KEY TASKS

- Coordinating Overall Effort
- Obtaining the Site
- Securing Community Support
- Administering Contracts
- Facilitating Permits
- Overseeing Construction
- Troubleshooting obstacles



Legend:

- Day Care Center
- Senior Center
- Pharmacy
- Ferry Terminal
- Grocery
- MTA Subways
- Post Office
- Police Station
- NYC Emergency Management Department
- Public School
- Restaurant
- Fire Station



SELECTING THE SITE

The prototype site is a small paved lot, a type likely to be available after disaster. It was chosen because it presents many of the challenges that would be found during a post-disaster deployment, and happens to be next to NYCEM's headquarters. As shown at left, applying the Neighborhood Design Playbook's liveabilty analysis highlights many elements close by that re-establish a sense of community for displaced residents, including easy access to public transportation, essential goods and services, and park space.

Public engagement is important to large-scale interim housing planning. To secure local support, NYCEM introduced the project to elected officials and neighborhood associations early in the planning stage. A Key to Community Recovery offers more information about planning with the whole community.

The Prototype

Choosing the Design and Making the Model

THE CONSTRUCTION PROCESS FROM START TO FINISH

Having established the principles for design and planning and created a potential means to work on a big scale, NYCEM and DDC set out to test them by building a prototype. This chapter describes the effort and what the process reveals about the potential for using deployable housing on a larger scale. Speed tips offer suggestions based on lessons learned over the course of the project.

CHOOSING THE DESIGN

The prototype is a three-story, three-unit building made of lightweight steel modules. The proposal was chosen as much for the management approach as for the design. Because the project was unprecedented, the team needed to have the right expertise. The general contractor, architect, and structural engineers were specialists in deployable structures, and had completed projects for federal agencies, including the U.S. Army Corps of Engineers. The contractor, American Manufactured Structures and Services, while never having built in NYC, partnered with local companies such as B&R Concrete and Excavation, who had a detailed understanding of NYC construction practices. The design team was made up of architects and engineers with extensive building experience in NYC, including: Garrison Architects; Anastos Engineering for structural design; and the Plus Group for mechanical, electrical and plumbing system design. The manufacturer was Mark Line Industries, a Pennsylvania-based firm with broad experience in prefabricated buildings.

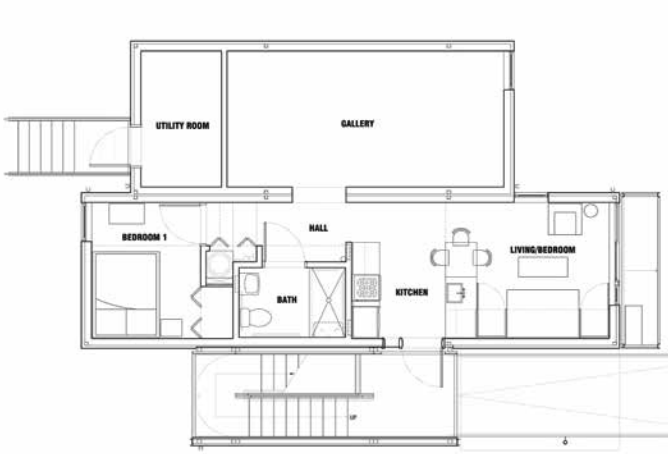
Overall, the system achieved the goals of the Design Principles and Performance Specifications, aiming to be adaptable, healthy, durable, flexible, sustainable, urban, rapidly deployable and cost-effective. The apartments are designed to accommodate displaced families

in a compact but thoughtfully designed environment. With one- and three-bedroom configurations, every unit features a living area, fully accessible bathroom, a complete kitchen and generous storage space. The one-bedroom unit is approximately 480 square feet, and the three-bedroom unit is approximately 813 square feet. For the prototype, the ground floor unit is modified for use as a public gallery.

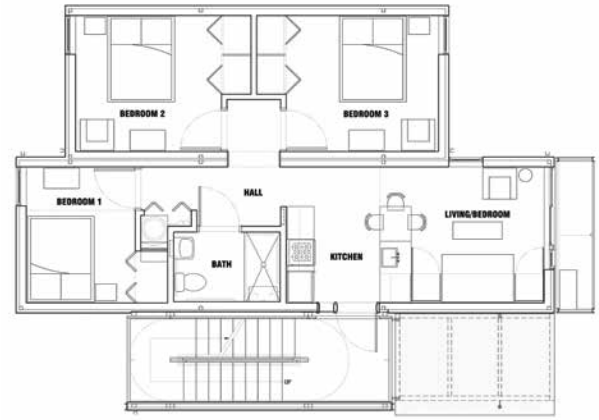
From the outside, the prototype has a well-considered relationship to public space and the street, in that it provides people with access to green space as well as privacy and security. Additionally, its colors and textures give the building a clear identity, and its window placement and lighting provide visibility and enhance safety at night.

Units are built with high-efficiency heating and cooling systems, a well-insulated and thermally broken rain screen façade, as well as recyclable and zero-formaldehyde materials to ensure health and sustainability. Large shaded windows and balcony doors provide a sense of openness and encourage natural ventilation. The heating and cooling systems are also extremely quiet and allow for precise interior temperature control in each unit. Building systems were chosen for accelerated assembly in post-disaster conditions. All mechanical, electrical, and plumbing connections were located for ease of access. Field assembly connections are designed for speed and connection with simple tools. Because of the efficient building envelope and environmental systems the units can be made energy self-sufficient with the addition of photovoltaic panels. This, in combination with battery storage, can allow them to operate without utility grid connections.

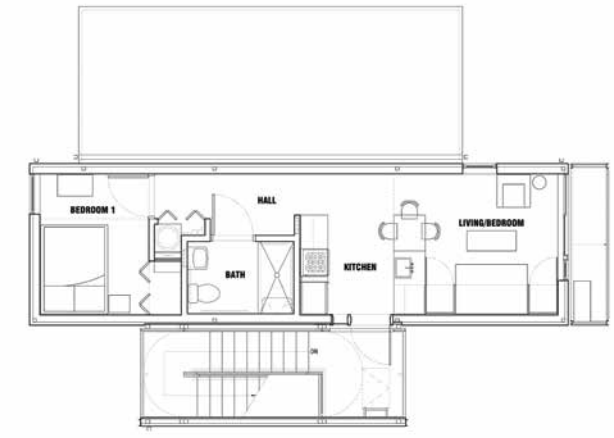
All components of the interior and exterior were designed for durability and mass-production, being built with well tested off-the shelf parts and long-lasting materials that maximize the unit's life-cycle performance.



1 1ST FLOOR PLAN



2 2ND FLOOR PLAN



3 3RD FLOOR PLAN

FABRICATION

Factory-built housing has many advantages in a post-disaster context. One is that production facilities outside the disaster area will likely be available even though local supply chains and labor pools may be compromised. Since many inspections are conducted in the factory, the burden on local inspectors and building departments is lessened.

Speed, Scale and Cost

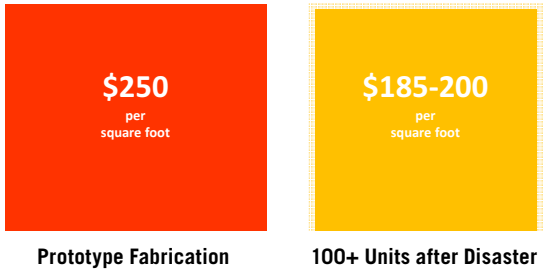
Building indoors means there are fewer construction delays and cost overruns. The fastest estimated time for units to begin arriving from a factory is approximately two-and-a-half months from the Notice to Proceed. Before production can begin, materials and components must be ordered and delivered to the factory. A typical modular factory running one assembly line can complete one one-bedroom module every twenty-four hours. Given multiple factories and shifts, it is estimated that the U.S. modular building industry could produce over 20,000 units in a year.

While several months can initally seem unacceptably long to wait, in past disasters thousands of people have remained in temporary housing for longer than a year, some for longer than a decade. As a point of reference, one year after Hurricane Sandy, over 30,000 people remained displaced in the Greater New York Metropolitan Area.

"This prototype exemplifies why we feel that modular construction is the preferred method for building high quality, high efficiency structures in a reduced timeframe."

-Tom Hardiman, Executive Director, Modular Building Institute

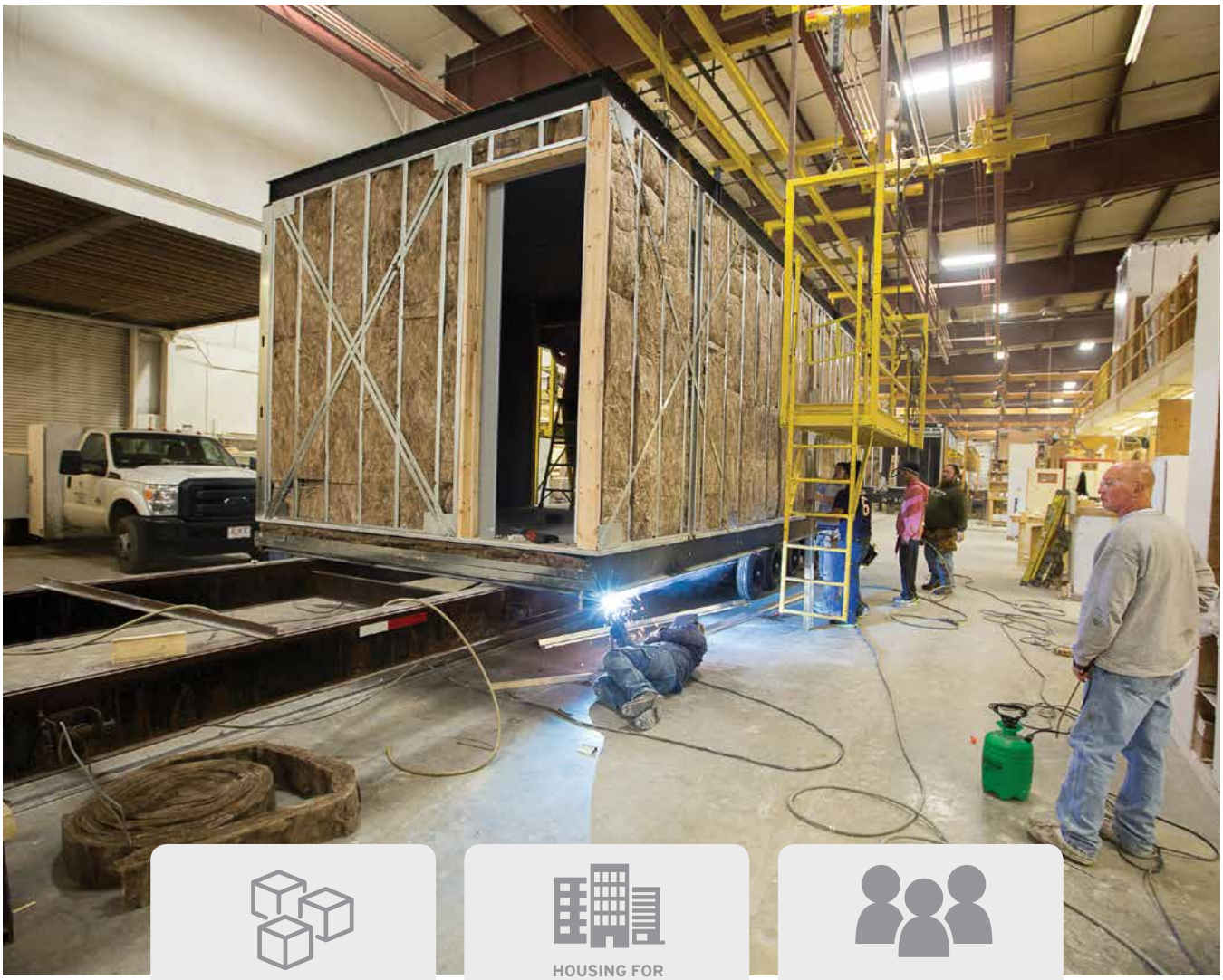
Because NYC codes require non-combustible construction, the interim units are made of steel, and equal to conventional buildings with regard to cost and durability. While the initial investment may seem high, the units can be deployed multiple times, and provide quality housing over the course of a 50-year-plus lifespan. Another consideration is the cost of alternative interim housing: after Hurricane Sandy, the government spent over $73 million on hotel rooms.



Prototype Fabrication **100+ Units after Disaster**

Speed tip: Enable production to begin immediately. Consider establishing contracts with manufacturers to stock materials necessary to begin work.

Speed tip: Have designs ready. Approving plan and developing shop drawings in advance can push the schedule forward by several weeks.



20,000+
MODULES A YEAR COULD BE PRODUCED IN U.S. FACTORIES

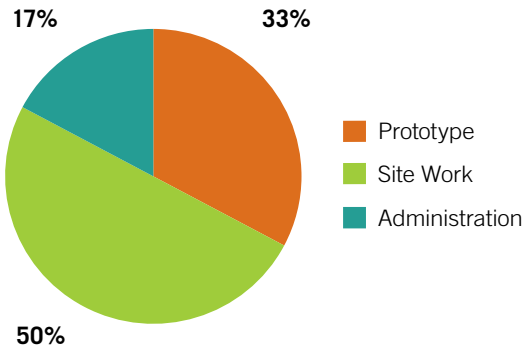
HOUSING FOR
40,000-60,000
PEOPLE

30,000+
PEOPLE DISPLACED IN NEW YORK AND NEW JERSEY ONE YEAR AFTER HURRICANE SANDY[2].

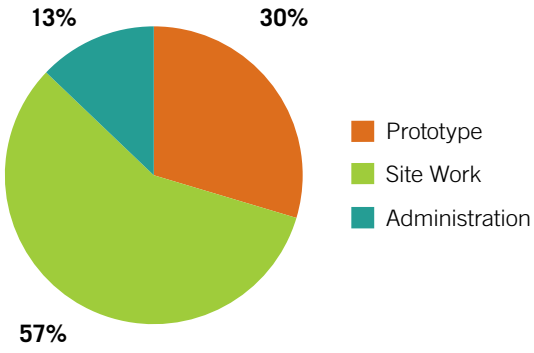
SITE WORK

The goal with interim housing is for the buildings to "sit lightly on the site," meaning their foundations should disturb the ground as little as possible. Even when a building's structural system is designed to be as self-contained as possible, unforeseen aspects of the site can cause complications. More than any other element of the prototype project, unexpected soil conditions within the site resulted in delays and extra costs.

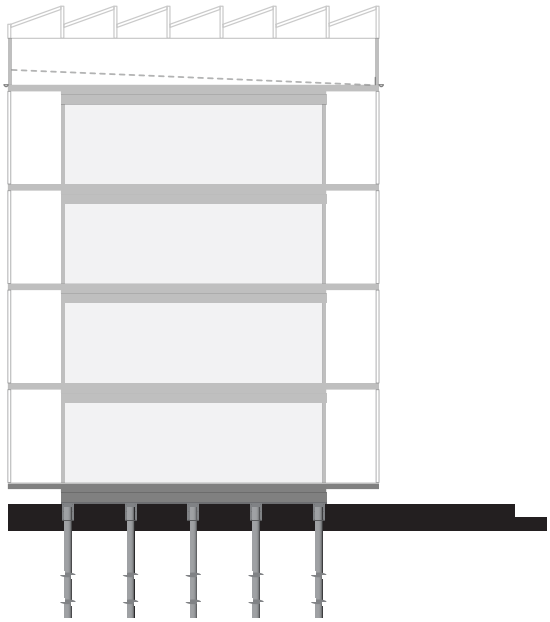
Projected Budget: $1.4 million



Actual Budget: $1.7 million



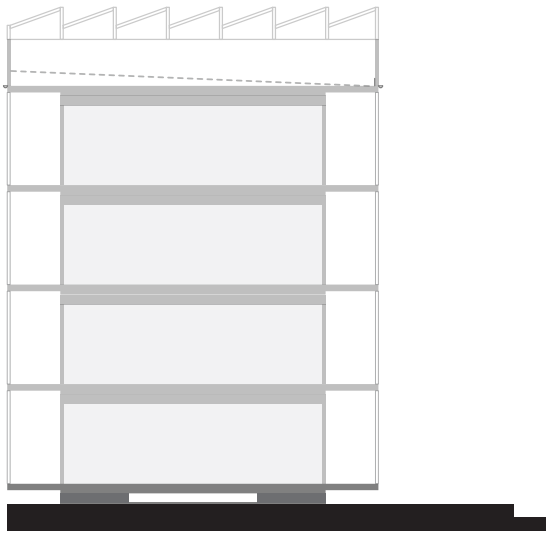
FOUNDATION TYPES - PROS & CONS



HELICAL (SCREW) PILES

+ Fast, all-weather installation
+ Reuseable

– May require specialized contractor
– Expensive

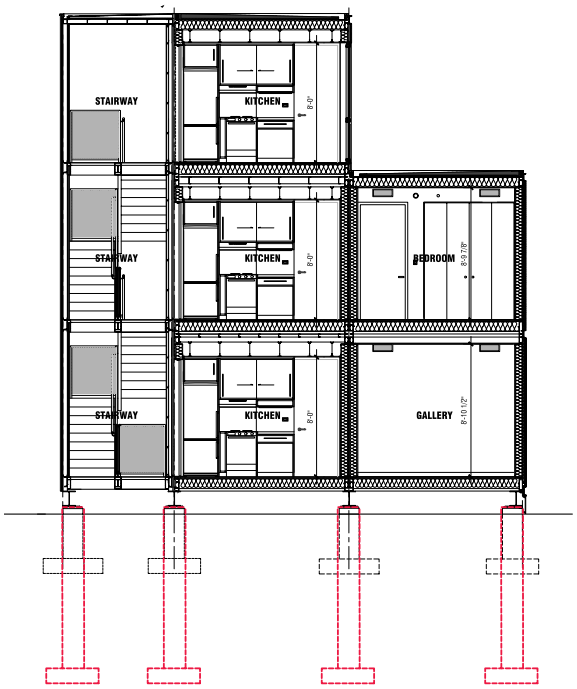


PRE-CAST CONCRETE PLANK-ON-GRADE

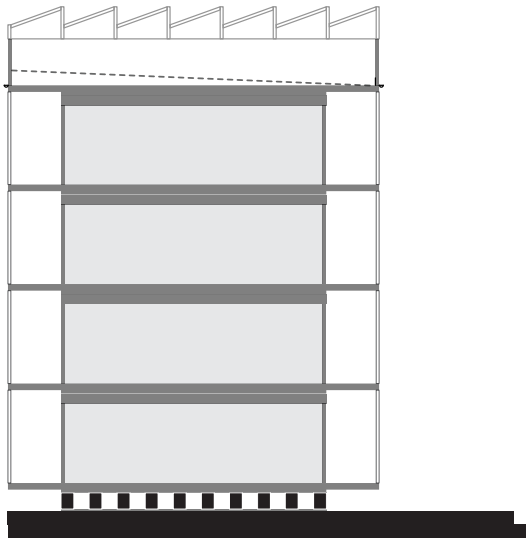
+ No soil penetration

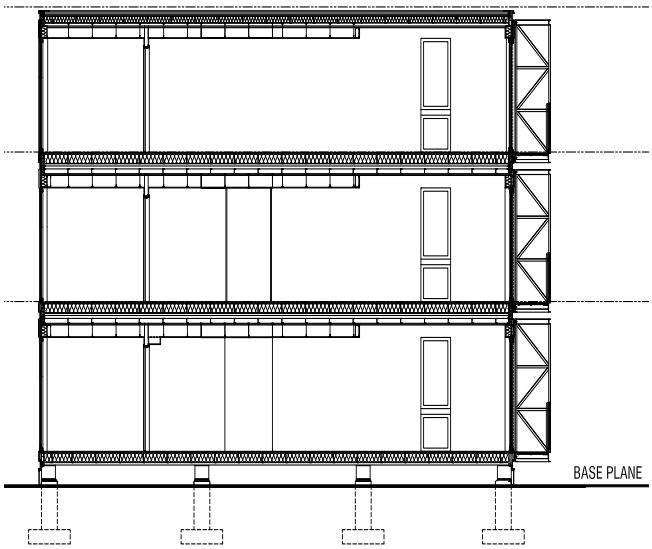
– Requires a graded surface
– May be insufficient for weight of building

TEMPORARY-TO-PERMANENT FOUNDATIONS



After weighing the pros and cons of many foundation types, including helical piles, pre-engineered products, steel plates, and pre-cast concrete elements, the easiest and most economical choice for this particular site was concrete cast-in-place footings and piers. These were intended to extend 4' underground and be easily excavated when it was time to remove the building. However, the site had several unpredicted obstructions and other conditions that required a more complex solution. Ultimately the foundation required 13 piers that were extended 12' below grade and a secondary steel transfer grid. Restoring site is expected to take nine days.





SLAB-ON-GRADE

+ No soil penetration
+ Seismic resistance
+ Can negotiate variable soil condititions

– May conflict with local code

CONCRETE PIERS

+ Low-cost material
+ Technique is commonplace

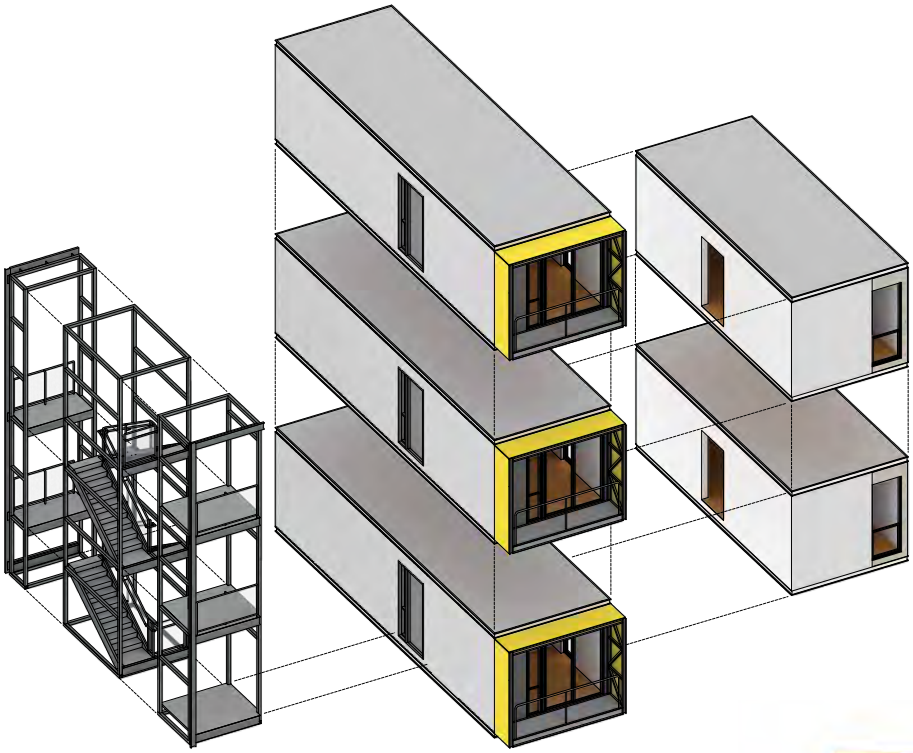
– May require excavation
– Weather-dependent installation

TRANSPORT

Any module below state-mandated shipping dimensions can travel by land or sea along well-established routes. Travel restrictions apply when a module and truck together exceed a certain dimension or weight, with the largest, heaviest loads requiring permits and escort vehicles in front and behind, oversized load signs, several sets of lights, and a height pole.

The prototype modules were designed to fit within the parameters of NYC's infrastructure, and require as few extra permits as possible. While the five living unit modules required oversized load permits, the trucking company obtained these in two days, as is typical. The largest module is 40' long, slightly below the maximum legal module length of 42.5,' and weighs 34,000 lbs., a ton below the 36,000 lb. limit. The stair and balcony sections were distributed on three trucks, all of them light enough not to need a special permit.

The eight-truck caravan traveled mostly on Interstate 80. In two days they traveled from Bristol, Indiana to the New Jersey entrance of the George Washington Bridge, where the drivers awaited their one a.m. entry time into the city. Within NYC, travel routes and allowed travel times are prescribed by the City's Department of Transportation. Because oversized loads are required to drive down the center lane of all bridges, transport is allowed only overnight, though this may be reconsidered during an emergency. According to the drivers, the last 15.4 miles through Manhattan—still full of traffic in the middle of the night—were the hardest part of the nearly 700-mile journey.



8 TRUCKS

<36,000 LBS

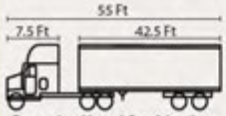
INFORMATION CONCERNING OVERSIZED/OVERWEIGHT VEHICLES

Maximum Dimensions of Vehicles and Combinations in New York City

Width: 96 inches (for school buses and fire vehicles, 98 inches, buses having a carrying capacity of more than seven passengers shall not exceed 102 inches). [34 RCNY §4-15(b)(1)]

Height: 13 1/2 feet. [34 RCNY §4-15(b)(2)]

Length: Articulated buses - 65 feet. [34 RCNY §4-15(b)(3)]
Semi-trailer - 55 feet. [34 RCNY §4-15(b)(4)]
Single vehicles (except articulated buses and semi-trailers) - 35 feet. [34 RCNY §4-15(b)(3)]



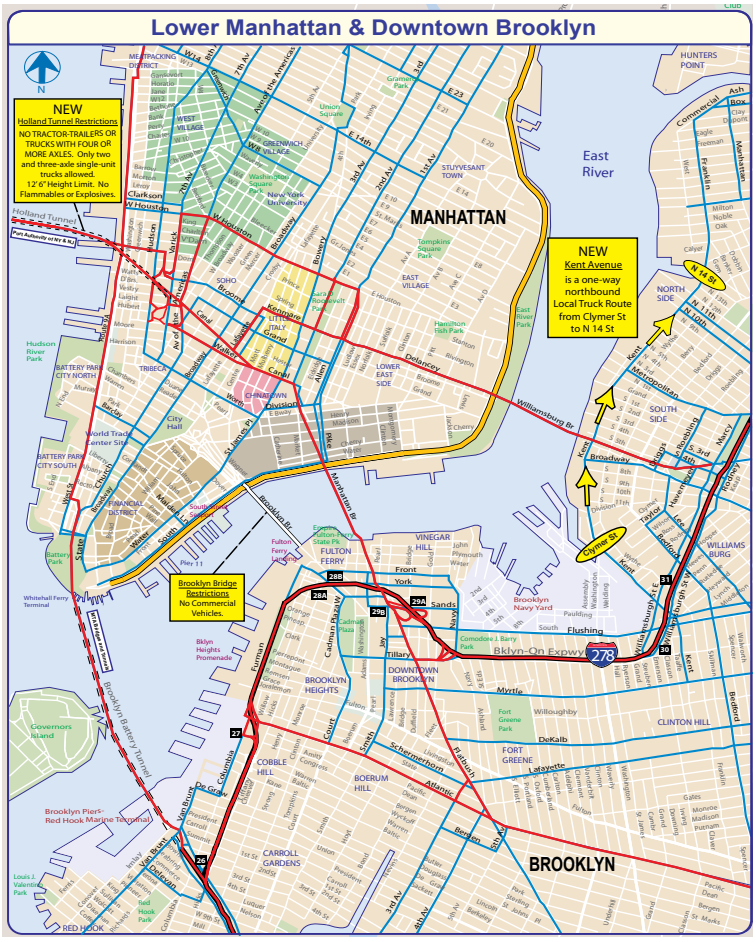
Example of Legal Combination

Example of Illegal Combination

The New York City interstate routes approved for 53 foot trailers are: I-95 between the Bronx-Westchester County line and I-295, and I-295 to I-495 via the Throgs Neck Bridge and I-495 between I-295 and the Queens-Nassau County line.

3.5 HOURS

15.4 MILES FROM MANHATTAN TO BROOKLYN



ASSEMBLY

The prototype system is designed to be put together and taken apart easily so that it can be relocated as needed. The modules are bolted together using the flanges of steel channels that structure their perimeter. To test these connections, the units were put together and taken apart outside the factory before they were loaded onto trucks for NYC. The eight prototype modules were craned into place in 13.5 hours on a weekend in April of 2014. Preparing for the day entailed getting a permit from the Department of Building's Cranes and Derricks unit and coordinating with the NYC Police Department to manage traffic. Around 7 a.m. on Saturday, the crane was positioned exactly as indicated in the permit drawing at right, and setting began. A crew on the ground steered each box into place with long ropes, while one person positioned the module by hand. On the following day, the three stair modules were connected on the ground and then swung into place.

Once modular units have been delivered, there is a period of "finish work." During this time, utilities are connected, fixtures are installed or adjusted, walls are patched and any other work is done. Carpenters, electricians and plumbers all have tasks that require approval before the Certificate of Occupancy (C of O) can be granted and people are allowed to move in. It took several months for the prototype's C of O to be granted due to delays in scheduling required inspections. The icons at right show an optimized timeline: with a coordinated permitting and inspection process, work done after delivery could be reduced to under two weeks.

Speed tip: Keep finishing work simple. Establish independent work areas so that electricians, plumbers and finish workers are not occupying the same small spaces at the same time.

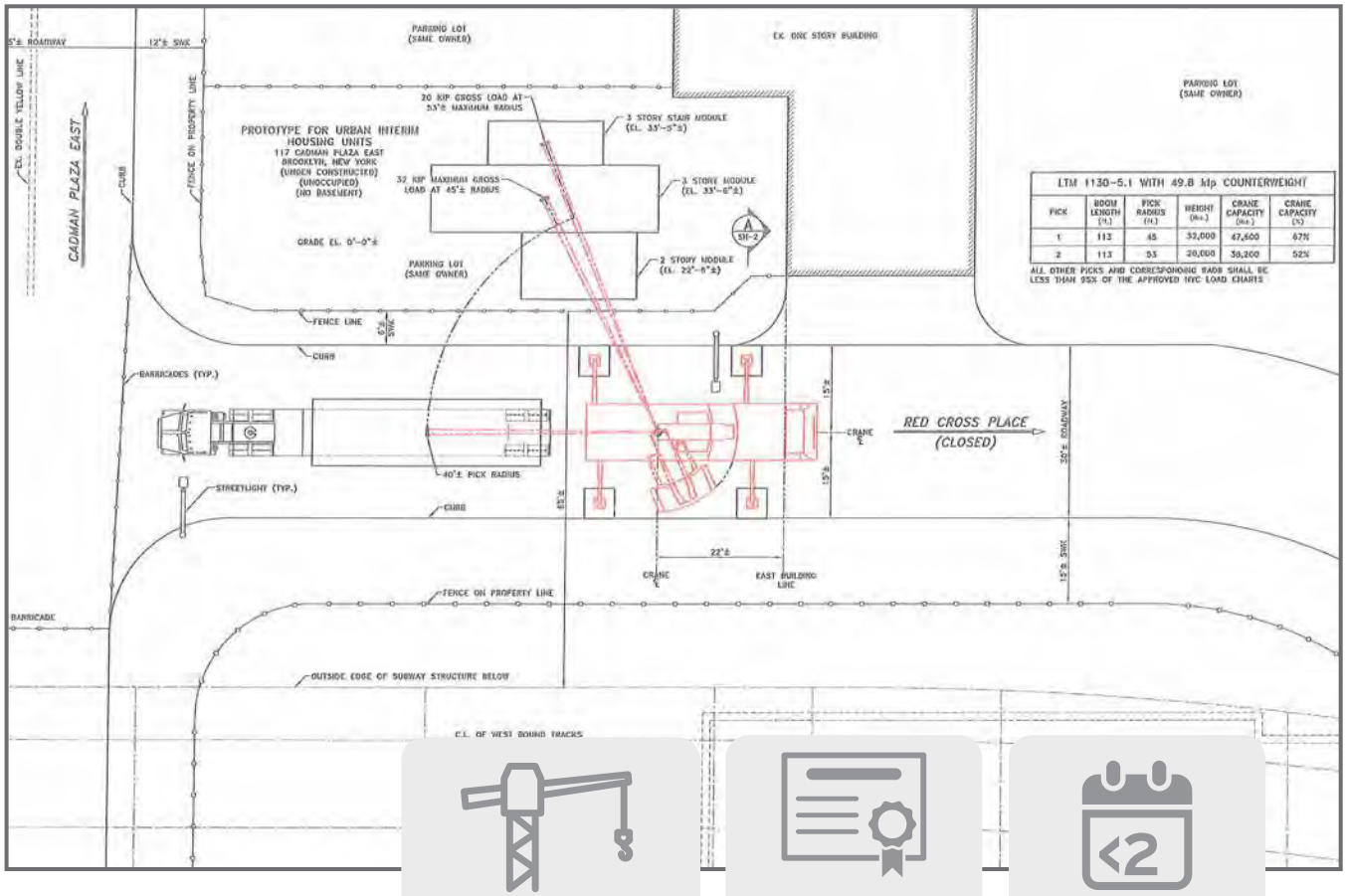
Speed tip: Expedite Certificates of Occupancy. Consider a task force that can coordinate inspections between job sites.

SETTING: DAY 1

+ 1 HR

+ 5 HRS

+ 9 HRS



1 DAY
CRANED INTO PLACE

9 DAYS
CERTIFICATE OF OCCUPANCY

<2 WEEKS
TO MOVE-IN

SETTING: DAY 2

+ 10 HRS

+ 12 HRS

+ 13.5 HRS


vertical
circulation

Learning from the Prototype

Reviews and Recommendations

A NEW HOME

"The space was light and airy, with a full kitchen that made cooking breakfast a breeze."

–Matt Chaban, New York Times [1]

WHAT IS IT LIKE TO LIVE IN?

Often, building performance is evaluated only in terms of structural and mechanical systems, yet understanding how well the building works for residents is equally important. While NYCEM, DDC and USACE evaluated aspects of construction, NYU's Tandon School of Engineering researched questions of environmental psychology. Employees from NYCEM and DDC lived in the prototype apartments for a week at a time for a full year. Their assessments of quality and comfort were incorporated into the design principles and specifications, so future urban post-disaster housing will reflect their recommendations. According to the study, the responses were very positive. Several journalists contributed reviews from overnight stays as well.

"The hope is that these units will never be needed, but the city doesn't want to be caught off guard and these are really fantastic temporary living arrangements."

- Evan Bindelgass, Curbed [2]

WHAT DOES IT OFFER THE PUBLIC?

Since its opening in 2014, over 2,000 people have visited the prototype, along with news broadcasters and reporters from around the world. The design has been widely acclaimed, and for most visitors the project represents a viable way to keep people close to home after disaster. It has sparked discussion about resiliency, and also captured the public imagination for its possibilities beyond disaster-related use, as a way to revolutionize urban construction and to create affordable housing.

4 AWARDS

DESIGN AWARDS

Architectural Design Merit,
American Institute of Architects New York Chapter

Best Relocatable Housing,
Modular Building Institute

MASterworks Best New Infrastructure,
Municipal Art Society

Professional Notable Honor, Design in the Built Environment, *Core 77*

LOOKING AHEAD

WHERE DO WE GO FROM HERE?

FEMA's dedication to developing further housing solutions is highlighted in the 2015 National Preparedness Report, which features the Urban Post-Disaster Housing Prototype as a case study. While there is now a demonstrated way to deliver multistory, multifamily housing after disasters in New York City, a critical next step is to make this option easily available to cities around the country.

As the national conversation about recovery continues, the prototype affirms that design is an important part of the discussion. Including an architect on the project team resulted in a design that could be produced more efficiently and economically than the industry standard, as well as being more comfortable for residents. Making one model also revealed how to optimize the process in a post-disaster context. With advance planning, construction operations can be carried out more easily and predictably.

There are essential questions that remain: Who will pay for urban multistory, multifamily, deployable housing? What are the eligibility requirements for living in such housing? When is interim housing likely to become permanent, and how might that change recovery planning? These questions require thoughtful consideration and collaboration between city, state, and federal agencies responsible for housing recovery. While answers can be most thoroughly considered in advance, much progress has come about during response operations to recent disasters. The NYC prototype's most valuable contribution may be that it provides a concrete starting point for addressing these questions. In the same spirit of innovation that led to the prototype itself, urban residents and government at all levels can move forward toward policy solutions. Keeping people close to home means keeping communities together, and with thoughtful urban planning and local participation, deployable housing can help households and restore community life.

"The project is innovative in its willingness to address the City's climate change challenges and consider the role that prefabrication could play in meeting our urgent housing needs."

Municipal Art Society MASterworks Award, Best New Infrastructure, 2015 [3]

"If post-disaster housing such as this is embraced by large cities, which seems likely given the proven threat of climate change, then architects and planners can expect the opportunity to reconsider how those major cities can function on an extraordinary scale."

– Zachary Edelson, Architectural Record [4]

1 https://www.nytimes.com/2015/10/20/nyregion/new-york-city-tests-post-disaster-housing-that-stacks-up.html
2 https://ny.curbed.com/2014/10/15/10036074/new-yorkers-could-live-in-this-prefab-housing-after-sandy-2-0
3 https://www.mas.org/honorees-announced-2015-masterworks-awards/
4 https://www.architecturalrecord.com/articles/3172-urban-post-disaster-housing-prototype-unveiled-in-new-york-city

A Key to Community Recovery

Participatory Urban Planning

PLANNING WITH THE WHOLE COMMUNITY

The Prototype Program aimed to evaluate the ways interim housing might rebuild neighborhoods as thoroughly as it tested construction operations. Three projects conducted in tandem with the prototype, building upon on ideas from the "After the Storm" Neighborhood Recovery Playbook, reveal how having a model for urban housing can facilitate community preparedness. These projects were funded by the U.S. Department of Homeland Security's Regional Catastrophic Preparedness Grant Program, conceived to improve regional coordination, fix shortcomings in existing plans, and build capacity to respond to disaster.

Participatory Urban Planning (PUP) Toolkit

- Educational materials that help facilitate planning workshops and establish relationships among a broad range of stakeholders
- Establishes a planning process that enhances understanding and trust between the government and community members

Participatory Urban Planning (PUP) Workshop Series

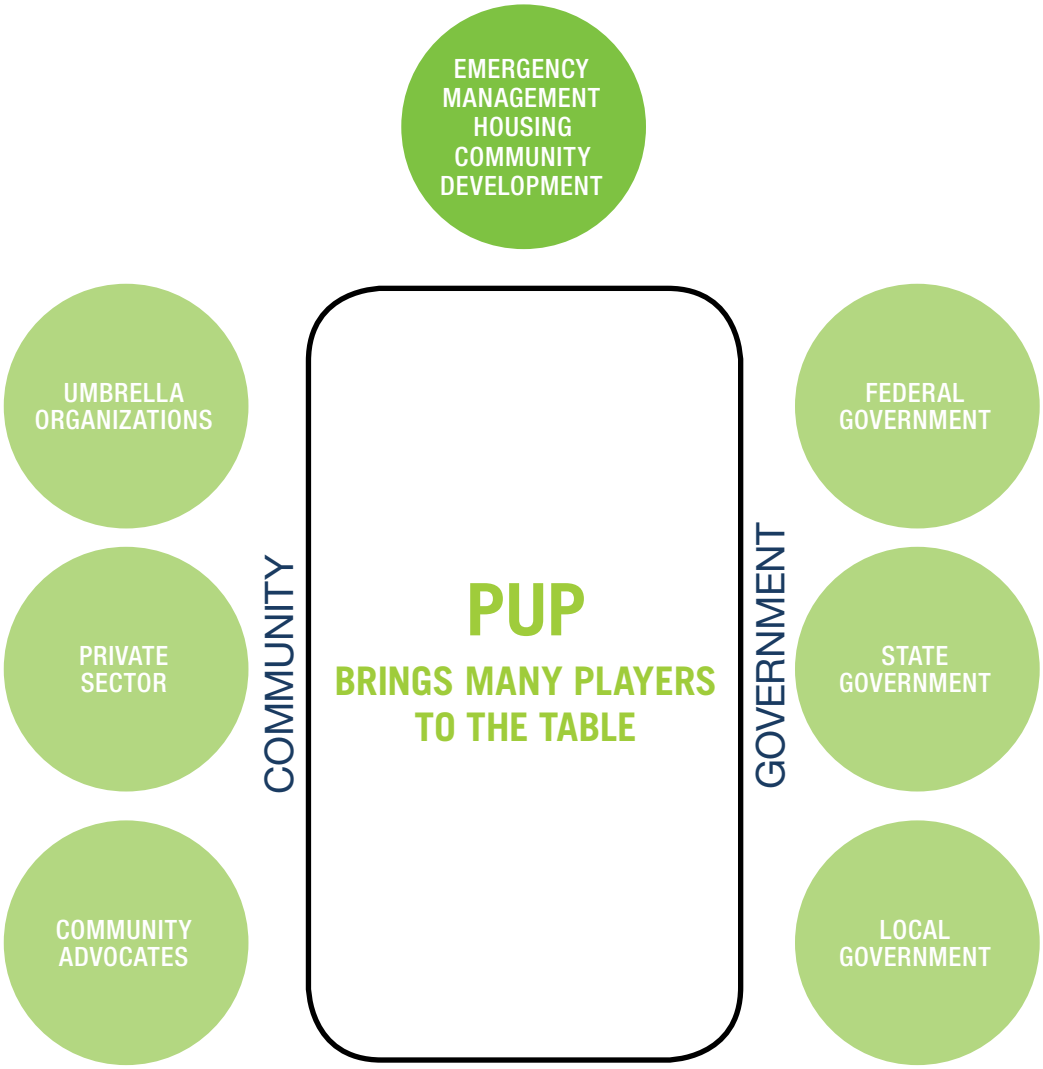
- Five planning exercises conducted in coastal cities using the PUP Toolkit and the Urban Design Study of the Prototype
- Reports results regarding essential planning team members and information needed for key decisions.

Interim Housing Rebuilds a Neighborhood: An Urban Design Study of the Prototype

- Experiments with the prototype form in a variety of combinations on many site types, conducted by designers from the Pratt School of Architecture
- Leads to a better understanding of how urban density and public space can be developed on a range of available sites

"The ability of a community to successfully manage the recovery process begins with its efforts in pre-disaster preparedness, mitigation, and recovery capacity building. These efforts result in resilient communities with an improved ability to withstand, respond to, and recover from disasters... Pre-disaster recovery planning promotes a process in which the whole community fully engages with and considers the needs and resources of all its members."

-from FEMA's "Pre-Disaster Recovery Planning Guide for Local Governments"



BRINGING PEOPLE TO THE TABLE

The Participatory Urban Planning (PUP) Toolkit

The most effective disaster recovery plans are often led by people who know their communities best: local government, community-based organizations, and residents. One of the greatest challenges for increasing community resiliency is connecting these groups, and integrating their work with federal disaster recovery operations. PUP's working principle is to bring all constituencies together from the start to leverage resources and eliminate conflicts between immediate response and long-term goals.

The PUP toolkit supports planning and implementation of collective visions. It promotes effective coordination between the government, community-based organizations and the public. It explains typical roles and responsibilities and identifies specific advantages to working together.

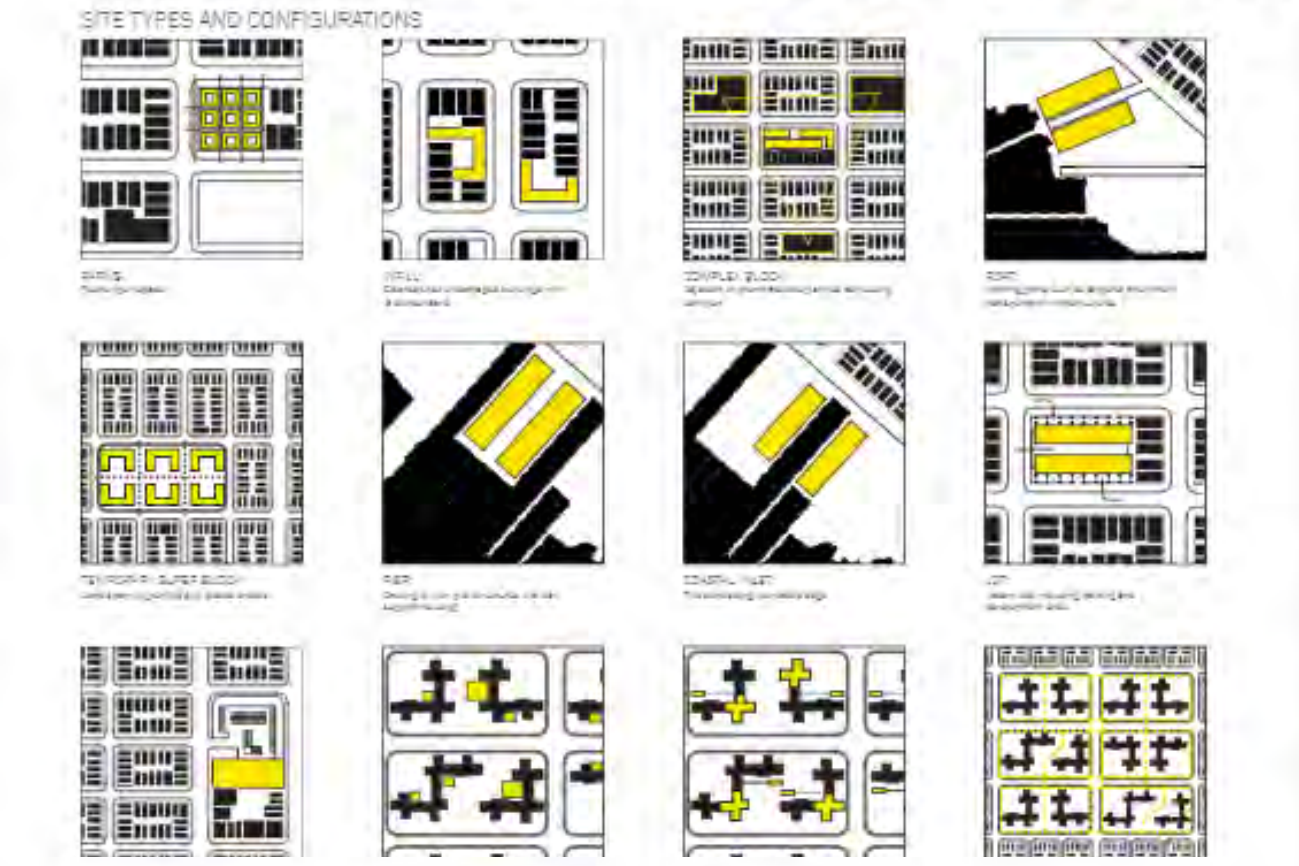
The toolkit contains resources to help host PUP events and sustain planning processes, including a communications guide and an Interagency Task Force framework for initial response and recovery operations.

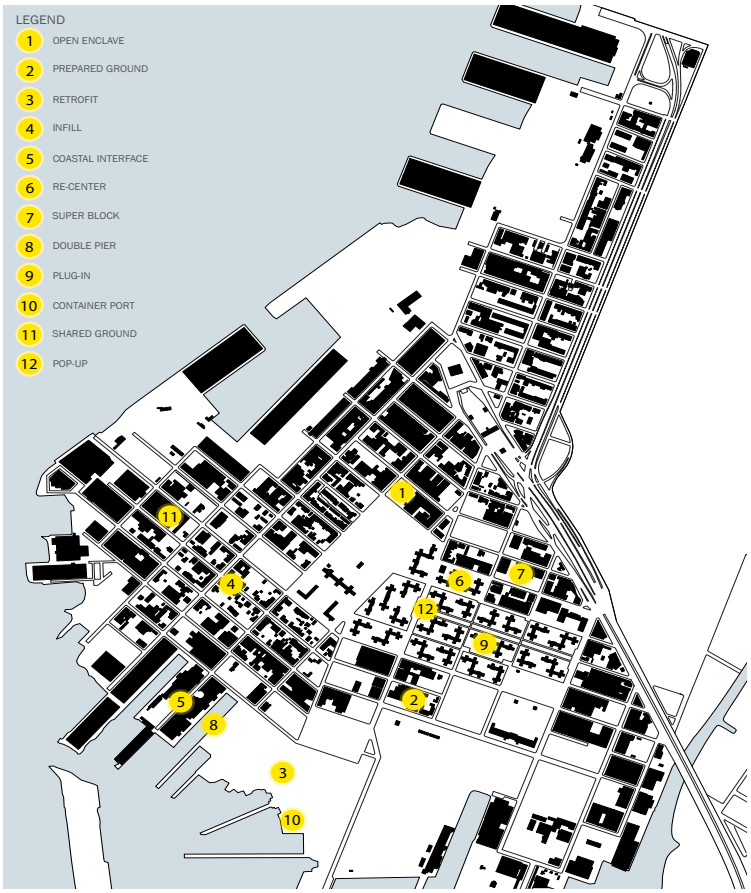
HOW CAN INTERIM HOUSING REBUILD COMMUNITIES?

Interim Housing Builds a Neighborhood: Urban Design Study of the Prototype

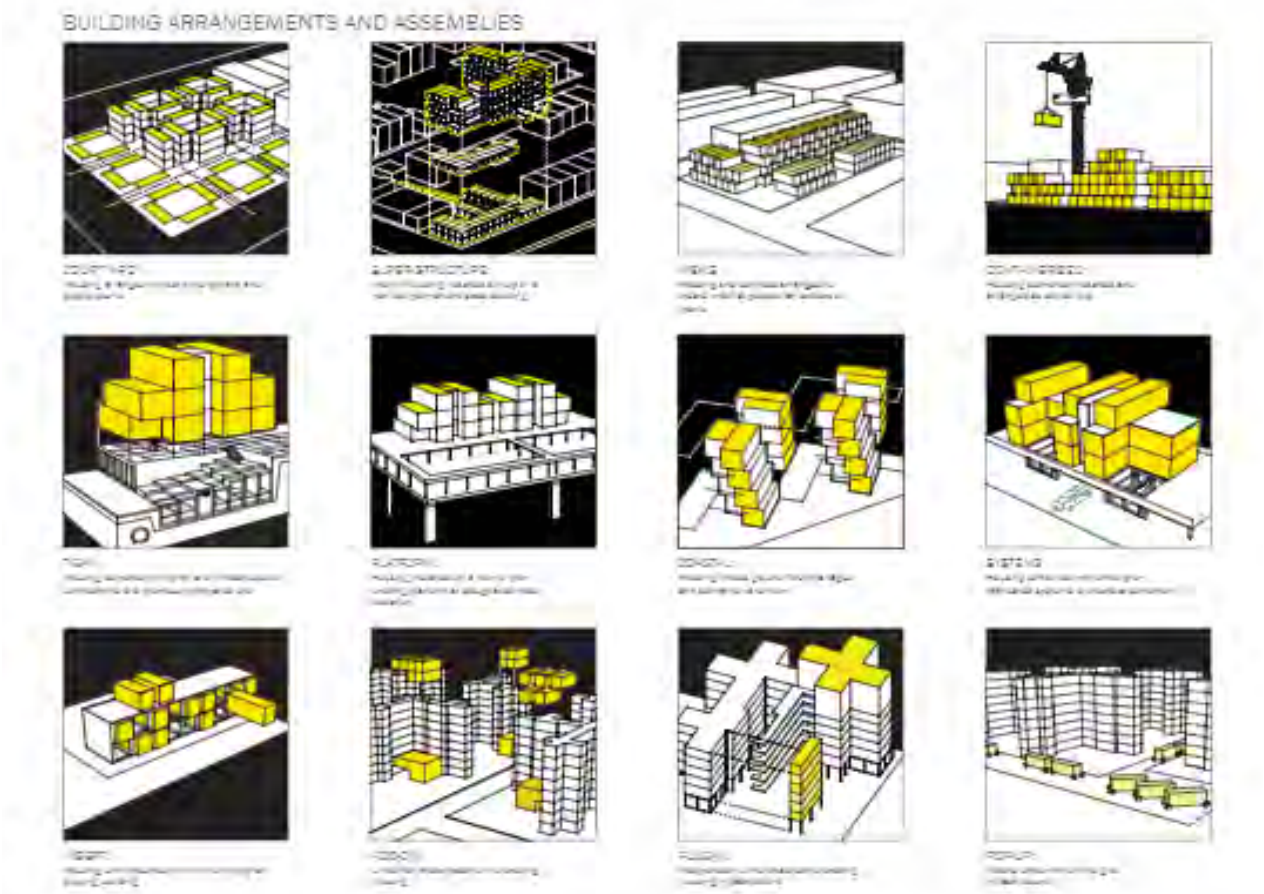
To understand how the prototype might contribute to large-scale urban restoration, the City undertook a study with Pratt School of Architecture's Recovery, Adaptation, Mitigation and Planning (RAMP) program. RAMP was founded after Hurricane Sandy as a multi-disciplinary effort to address the challenges of climate change as part of equitable and inclusive urban planning. In the Red Hook neighborhood of Brooklyn, designers located real-world examples of site types identified in the Neighborhood Design Playbook, and applied the prototype design in a variety of assemblies.

The elements of the study propose ways quickly-built modular construction could be aggregated to restore neighborhoods, and how the units might function at different scales and in a range of site configurations. Using simple graphic summaries, they analyze how buildings like the prototype could support population densities, infrastructures, and public spaces. The information is a window into the ways urban design strategies can offer displaced people places to play, shop and gather, and revitalize their local economic and social networks.





Three of the twelve projects that achieve important goals are featured on the following pages. The Superblock (7) project models high-density housing; the Pop-up (12) proposal integrates retail and service spaces on the ground level, and the Infill (4) strategy shows how even small sites can serve many people.

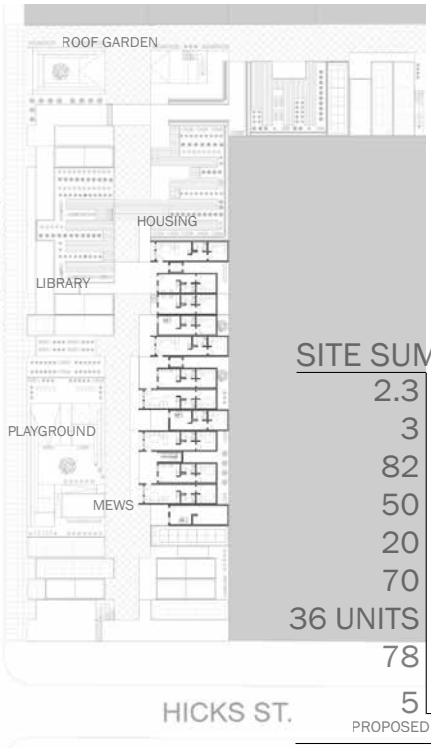


MAXIMUM DENSITY

VIEW FROM MEWS

VIEW FROM COMMUNITY ROOF GARDEN

SUPER BLOCK

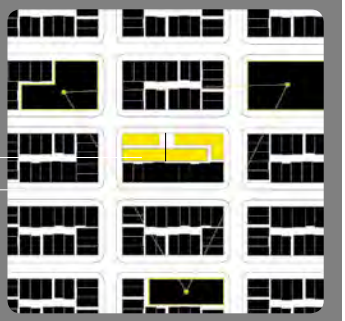


THIRD FLOOR PLAN

SITE SUMMARY:

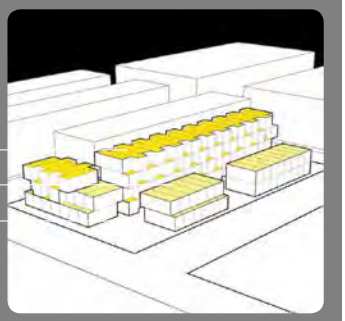
2.3	ACRES
3	BUILDINGS
82	UNITS
50	ONE BEDROOM
20	THREE BEDROOM
70	HOUSEHOLDS
36 UNITS	PER ACRE
78	PEOPLE PER ACRE
5	STORIES TALL

PROPOSED REZONING TO R5



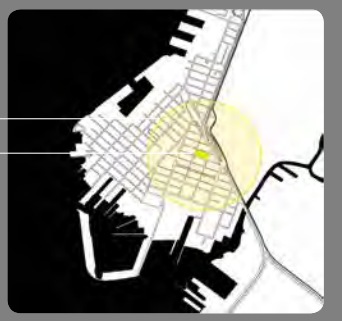
SITE TYPE:
COMPLEX BLOCK

The site is located on high ground, in close proximity to the largest concentration of population in Red Hook, and the social institutions that accompany it. It uses the site to make positive urban as well as social connections, placing the housing along the street above a commercial base with a playground directly opposite the school. In order to maximize the population, there is a mid block mews lined with housing that provides a pedestrian path for the children to move from one school to the other.



ASSEMBLY:
MEWS

In response to the Red Hook Houses' rejection of the street grid, the project proposes that "super block" should refer not to size but the super-saturation of program – for example a corner market that sells the products from the housing roof garden, a shared community dining room, and a library with classrooms bordering the playground that can serve the schools to either side of the site.



CHIN LAU + VALERIE BUSTOS

NEIGHBORHOOD ASSETS

VIEW OF POP-UP MARKET ALONG MEDIAN

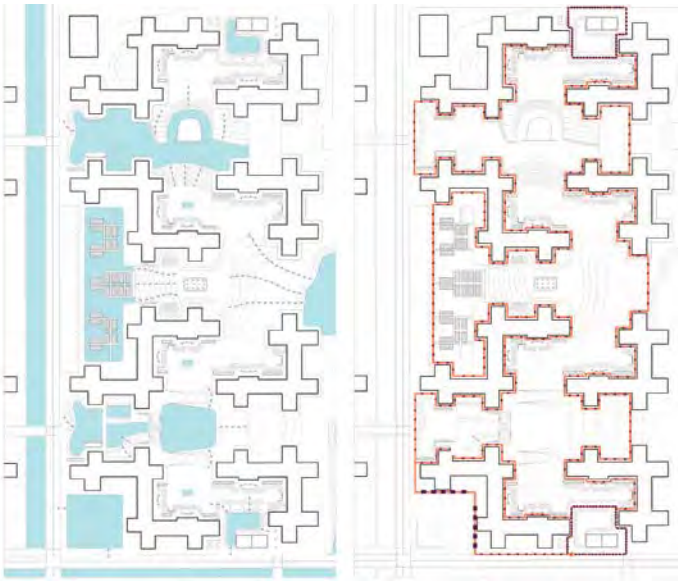
VIEW OF CAMPUS WITH BERMED BUILDINGS

SITE SUMMARY:

5.76	ACRES
28	BUILDINGS
280	UNITS
280	STORE FRONTS
2,016	HOUSEHOLDS
48 UNITS	PER ACRE
231	PEOPLE PER ACRE
7	STORIES TALL

PROPOSED COMMERCIAL OVERLAY ON R6 ZONING

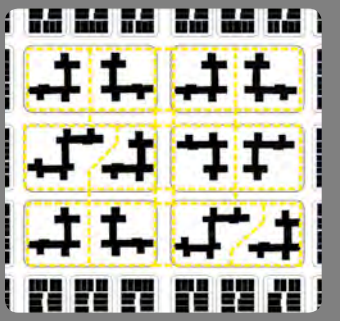
POP-UP



RETAINING PONDS

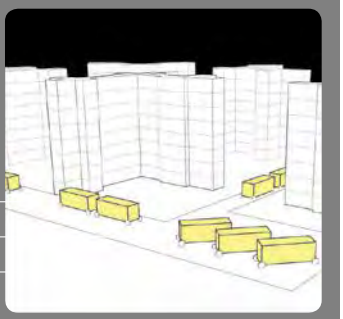
POP UP MARKET

CAMPUS LANDSCAPE PLAN



SITE TYPE:
STREETS

This project proposes that interim units be installed in the paved parking and thoroughfares within the Red Hook Houses as a pop-up market to replace the local stores shuttered by the storm. It also explores ways in which the landscape of the NYCHA campus is a valuable water management device. Sunken skate parks become water retention in the storm; landscape swales direct water to underground systems; new plantings can uptake thousands of gallons a day ; and earth berms protect the ground level apartments and services from flooding.



ASSEMBLY:
POP-UP

A historic vulnerability of the Red Hook Houses has been the limited presence of commercial goods and services- from fresh food to laundries and banks, which the storm exacerbated. Here interim units provide a pop-up market placed on available parking and paving that, once the interim need subsides , could become institutionalized as a weekly flea market.

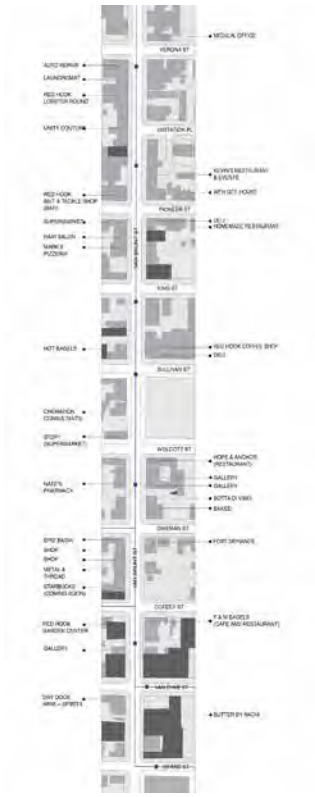
ASHLEY CONNELY + JILLIAN DeLUCA

USING SMALLER SITES

AERIAL OF HOUSING AND COURTYARDS ALONG VAN BRUNT

INFILL

VIEW OF ELEVATED WALKWAY OF INTERIOR COURT



VAN BRUNT FABRIC AND INFILL

SITE SUMMARY:

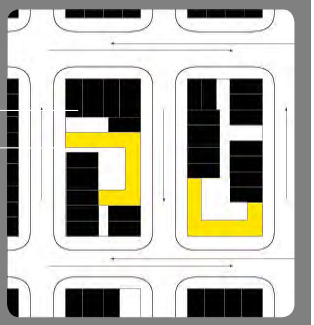
2.3	ACRES
4	BUILDINGS
217	UNITS
55	ONE BEDROOM
100	THREE BEDROOM
155	HOUSEHOLDS
94 UNITS	PER ACRE
222	PEOPLE PER ACRE
8	STORIES TALL

PROPOSED REZONING TO R8 WITH COMMERCIAL OVERLAY

EXISTING FABRIC

EXISTING GRID

INTEREM HOUSING



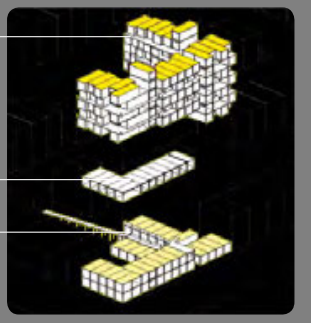
SITE TYPE: INFILL

Locating interim housing in neighborhoods will sustain the local economy but the reciprocal is also true: the rapid restoration of local commerce will sustain the return of residents. This project has chosen a site very well suited to that reciprocal formula- Van Brunt street which is the commercial life blood of Red Hook. It has located two substantial infill sites that ,if developed, will benefit the mixed use fabric of the street and the neighborhood.

HOUSING

TRANSITIONAL LEVEL: COMMUNITY SPACE AND WALKWAY

COMMERCIAL BASE

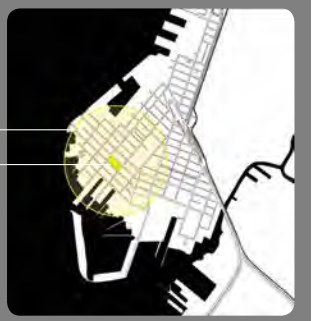


ASSEMBLY: SUPER STRUCTURE

The project suggests that a permanent commercial base could be developed prior to the storm with the intent and capacity to receive interim housing above it if required. This housing would be above design flood elevation requirements. The commercial base, while subject to flooding, has been designed as duplex lofts, so that perishable goods can be stored out of harms way. The project takes advantage of the sites' configurations to create social spaces for the housing and small "bazaar-like" shopping connectors perfect for the local artisanal merchandise and art fairs that would normally take place on the waterfront piers.

20 MINUTE WALK

SITE



MARTHA MADRID + WILFRED YENKO

BEGINNING TO PLAN

The Participatory Urban Planning Workshop Series

The PUP workshops convened diverse groups in five areas severely affected by Hurricane Sandy. Approximately 30 stakeholders representing local, state and federal agencies, community advocates, residents, the private sector and academia brainstormed potential strategies for interim housing and the broader concerns of resiliency planning.

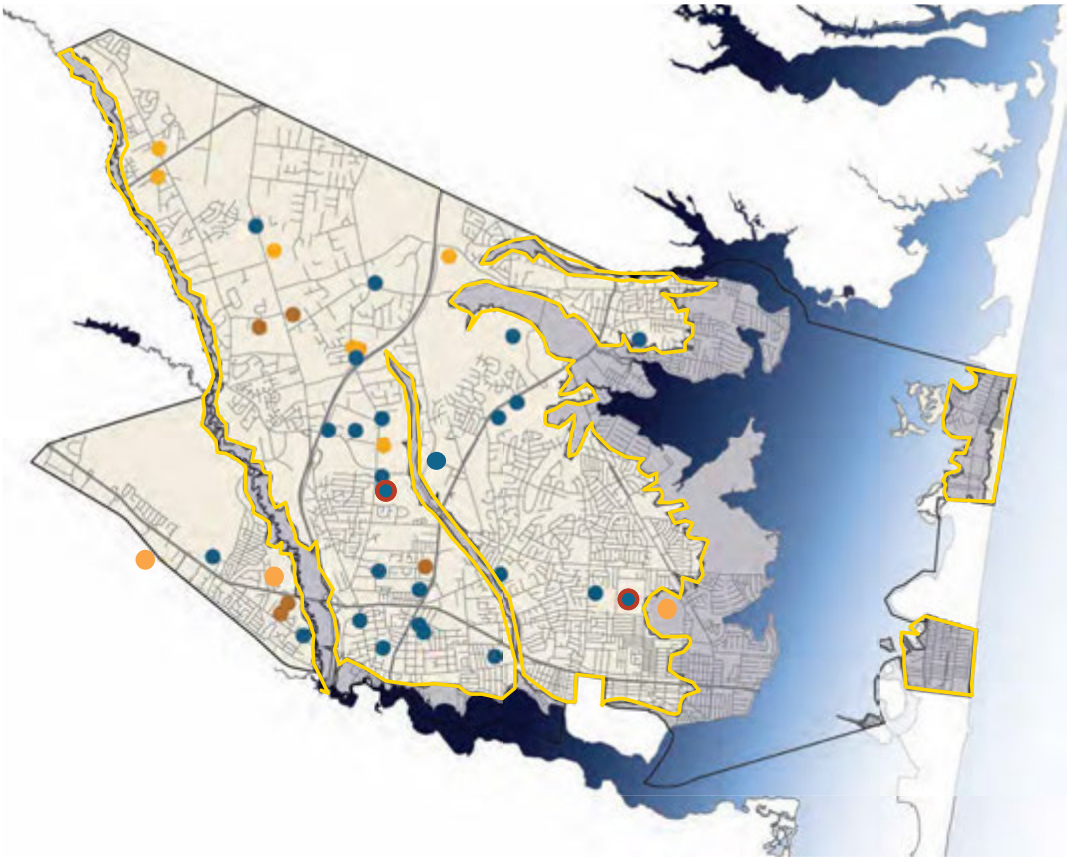
Using elements of the PUP toolkit and the Urban Design Study of the prototype, each event began with an analysis of environmental hazards and social vulnerabilities, then introduced the prototype as one of many resources for the next storm. Groups discussed: Would the city benefit from deployable housing? If so, where it might go? How long would it remain? What other options would be effective? What would the decision-making process be? Who should be included? What policies and political conditions impede planning? In this way, the workshops evaluated challenges and opportunities for the participatory planning process itself as well as those for strengthening community resilience.

Analyze → **Strategize** → **Plan**

COMMUNITY VULNERABILITIES AND RESOURCES

INTERIM HOUSING TOOLS

HOUSING SITES AND CONCEPTS



WHAT TO CONSIDER

PUBLIC FACILITIES

- Schools
- Shelters
- Senior care
- Hospitals
- 100 year flood

GOING FORWARD

The findings from the PUP workshops echo those of many other post-disaster planning events. People universally favored an inclusive, transparent planning process that brings a wider range of stakeholders to the table. Overall, attendees agreed that interim housing options should be coupled with long-term urban development strategies. Participants at each event stressed that forging relationships between the government and the community before disaster makes for better response and recovery coordination and that continuing exercises like these can lead to more resilient communities.

Federal practices are evolving in concert with these recommendations. Recent resources such as FEMA's "Pre-Disaster Recovery Planning Guide for Local Governments" aim to empower local teams, emphasizing that, "the community will provide leadership in developing recovery priorities and activities that are realistic, well-planned, and clearly communicated." While providing interim housing will always be one of the most politically, financially and operationally complex aspects of disaster recovery, as different sectors continue to plan together and share resources, cities around the country will have many options for keeping people close to home after disaster.

ACKNOWLEDGMENTS

The Urban Post-Disaster Housing Prototype Program received support from many experts over many years. Each person named here played a part in creating one or more of the program's resources.

Joseph J. Esposito, Commissioner, NYC Emergency Management Department
Office of the Commissioner, NYC Department of Design and Construction

Special thanks to:
Joseph F. Bruno, Former Commissioner, NYC Emergency Management Department
David J. Burney, Former Commissioner, NYC Department of Design and Construction

Program Team

NYC Emergency Management Department
Cynthia Barton, Urban Post-Disaster Housing Prototype Program Manager
Craig Bonney, Director of Support Services
Omar Bourne, Deputy Press Secretary
Johanna Conroy, Director of Human Services
Andrew D'Amora, Chief of Staff
Calvin Drayton, First Deputy Commissioner
James Esposito, Deputy Commissioner for Planning and Preparedness
Christina Farrell, Deputy Commissioner of External Affairs
James Foster, Esq., Director, DAFN & Compliance
Stella Guarna, Esq., Deputy Commissioner for Legal Affairs
Henry Jackson, Deputy Commissioner of Technology
Francine Kerivan, Chief of Security
James McConnell, Assistant Commissioner for Strategic Data
Sonja Orgias, Esq., Director, Legal Affairs
Allison Pennisi, Director, Communications
Megan Pribram, Assistant Commissioner for Planning and Preparedness
Stacy Rosenfeld, Deputy Commissioner for Administration & Finance
Althea Samuels, Director, Procurement/DACCO
Paul Scott, NYPD Liaison
Nancy Silvestri, Press Secretary
Branch Strickland, Executive Director, Budget and Financial Planning
Robert Wilson II, Esq., Agency Counsel

Special Contributors: William H. Davidson, Esq., Kelly McKinney, Dina Maniotis, Thomas Pollman, Thaddeus Pawlowski

Additional Support: Jonas Ballreich, Kevin Bittner, Tashawn Brown, Setareh Fadaee, Eva Islam, Yana Tukvachinskaya, Catherine Webb

NYC Department of Design and Construction
Chester Onuma, RLA, CCM, Deputy Program Director, Fire Unit
Nicholas V. Peluso, RA, Director, Constructability Review and Bid Packaging, Architecture + Engineering

Special Contributors: Eric Boorstyn, Kate Howe, Irene Kaptzis, Brett Miller, Cynthia Poulton, David Resnick, David Varoli, Maria Yao

Additional New York City Contributors

NYC Department of Buildings
Michael Alacha, Lisa Amoia, James Colgate, John Egnatios-Beene, Dmitri Dits, Dan Eschenasy, Thomas Fariello, John Gallagher, Donald Gottfried, Timothy Hogan, Marshall Kaminer, Patricia Knobloch, Robert LiMandri (Commissioner, 2008-2013), Timothy Lynch, Faisal Muhammed, Fred Mosher, Fatima E. Murillo, Ashraf Omran, Alan Price, Richard Rosen, Frank Schimenti, Constandino (Gus) Sirakis, Dolores Spivack, Edwin Tang, Deborah Taylor, Damian Titus, Keith Wen

NYC Department of City Planning
Pippa Brashear, Skye Duncan, Justine Heilner, Hector Lim, Thaddeus Pawlowski, Ken Schillingford, Jeffrey Shumaker (Chief Urban Designer, 2014-2017), Jay Thrasher, Alexandros Washburn (Chief Urban Designer, 2007-2014)

NYC Department of Environmental Protection
James Luke

NYC Department of Housing Preservation and Development
Shampa Chanda

NYC Department of Parks and Recreation
Legal Department, Michael Lavery, Denise Shanks-Brown

NYC Mayor's Office for People with Disabilities
Victor Calise (Commissioner), Nicholas Kaminsky, Robert Piccolo

NYC Transit Authority
Mohamed Adam, Rajen Udeshi

Federal Contributors

Federal Emergency Management Agency
Iris Epsenhart, Terrence Flynn, Jaime Forero, David Ledet, Joel Pirrone

U.S. Army Corps of Engineers New York District
John Beldin-Quinones, John Boule, COL (Commander, 2012-2015), David Caldwell, COL (Commander, 2015-), Frank Cashman, Donald E. Cresitello, Matthew Emigholz, Emily Eng, Ryan Ferguson, Patsy Fletcher, Michael Hogg (Project Manager), Rudelei Khalil, Janice Lauletta-Weinmann, Matt Lubiak, Kevin Merenda, Sidrah Mirza, Ajmal Niaz, Sean O'Donnell, Paul Owen, COL (Commander, 2012-2015), Allen Roos, Stanley Sedwick, Joseph Seebode, Encer Shaffer, Russell Smith, Paul Tumminello, Kevin Whorton, John Wong

U.S. Department of Housing and Urban Development
Dana Bres, Elizabeth Cocke, Rick Mendlen

Academic Partners

Tandon School of Engineering of New York University, Technology, Culture and Society Department, Sustainable Urban Environments Program
Richard Wener and students

Pratt Institute School of Architecture Recovery, Adaptation, Mitigation and Planning (RAMP) Program
Deborah Gans, Jeremie Carvalho and students: Valerie Bustos, Ashley Connely, Jillian DeLuca, Abraham Dreazen, Jasper Hayes, Azhar Kotadia, Chin Lau, Alex Lee, Martha Madrid, David Martinez, Ana Monteverde, Eunhae Oh, Sung-Jun Park, Carla Perez, Joop Pyo, Alex Restivo, Michelle Rojas, Laura Silvera, Nilasha Srinivas, Wilfred Yenko

Prototype Design and Construction

American Manufactured Structures and Services
Franklin Cox, Alan Rand, Brian Grassia

Garrison Architects
James Garrison, Leah Milcarek, Jeffrey Stewart

Mark Line Industries
Brad Arnsdorf, John Morrison, Ed Zimmerman

Anastos Engineering
Michael Lynch

Participatory Urban Planning Toolkit and Workshop Series

Gans Studio
Deborah Gans, Rosamund Palmer, Cristina Zubilla

Regional Catastrophic Preparedness Grant Program
Orly Amir, Cynthia Barton, Karen Kubey, Nancy Harris, Sarah Lavery, Erin McLachlan

Additional Support

Brooklyn Heights Association
Concord Village
Consolidated Edison, Inc.
Steven Covello, Brian McArdle, Michael Spall

Metropolitan Transportation Authority
NYC Department of Citywide Administrative Services
NYC Department of Health and Mental Hygiene
NYC Fire Department
NYC Mayor's Office of Housing Recovery
NYC Mayor's Office of Operations

NYC Transit Authority
Peter Briffa, Dominick Gallo

NYC Department of Transportation
Nelson Castillo, Leon Heyward, Stacey Hodge, Sharita Hunter, Kevin P. Lobat, Joseph Palmieri, Dorothy Roses

NYC Department of Sanitation
NYS Assembly District 52
Office of the Brooklyn Borough President

Funding and Support

Federal Emergency Management Agency
U.S. Department of Homeland Security Regional Catastrophic Preparedness Grant Program

NYC Emergency Management Department
NYC Department of Design and Construction
The Rockefeller Foundation
The Rockefeller Foundation Bellagio Center

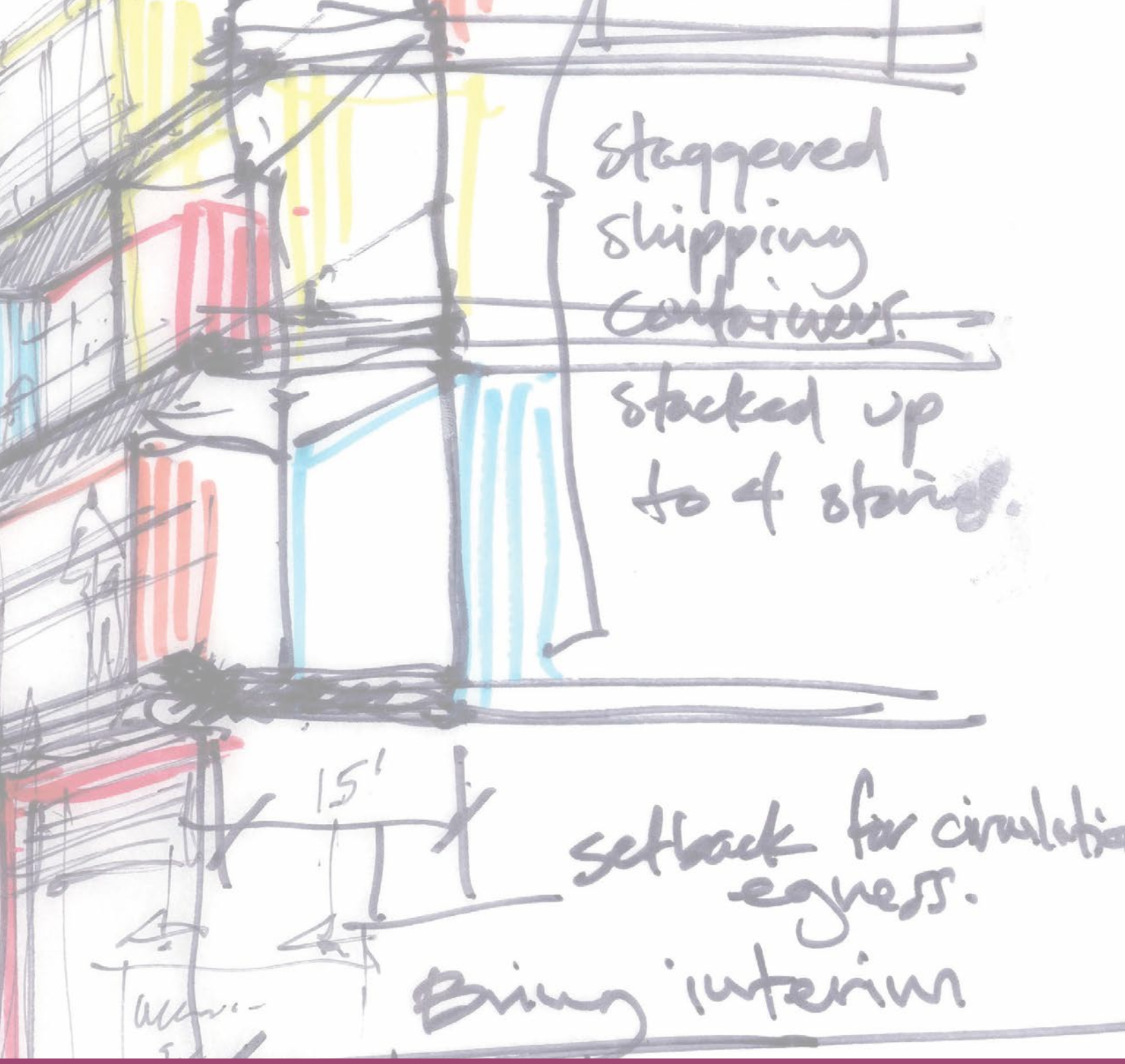
Graphic Design

Vanguard Team

Image Credits

Prototype Images, Andrew Rugge, Archphoto
Factory Images, Josef Samuel Photography
Axonometric and Plan Drawings, Garrison Architects
Perspective Sketches, Jeffrey Shumaker


vertical
circulation.


staggered
shipping
containers
stacked up
to 4 stories
15'
setback for circulation
egress.
Bring interior

Resources

ANNOTATED BIBLIOGRAPHY

NYC Emergency Management Department. Urban Post-Disaster Housing Prototype Program. 2017.

http://www1.nyc.gov/site/whatifnyc/index.page
All resources developed through the prototype program

FEDERAL RESOURCES

Federal Emergency Management Agency (FEMA). National Response Framework. 2016.

https://www.fema.gov/national-response-framework
Describes federal response coordination, including immediate temporary housing operations

Federal Emergency Management Agency (FEMA). National Disaster Recovery Framework. 2016.

https://www.fema.gov/national-disaster-recovery-framework
Explains federal disaster recovery coordination, including long-term community recovery

Federal Emergency Management Agency (FEMA). National Mitigation Framework. 2016

https://www.fema.gov/national-mitigation-framework
Describes risk-based planning principles and practices

Federal Emergency Management Agency (FEMA). Pre-Disaster Recovery Planning Guide for Local Governments. 2017.

https://www.fema.gov/media-library/assets/documents/129203
Guide for local governments to engage with the whole community in planning and recovery activities that are comprehensive and long term

Federal Emergency Management Agency (FEMA). Living in a FEMA Manufactured Housing Unit (MHU). 2016.

https://www.fema.gov/disaster/4277/updates/living-fema-manufactured-housing-unit-mhu
Frequently Asked Questions about services, assistance and regulations for FEMA tenants

Federal Emergency Management Agency (FEMA). Temporary Housing Units (THUs) Fact Sheet. 2016.

https://www.fema.gov/media-library-data/1502374772529-5202ebd2195f9d16541f061d2a439bf3/FACT-SHEETTemporaryHousingUnits.pdf
Explains Temporary Housing Assistance provided through FEMA's Individuals and Households Program

U.S. Department of Housing and Urban Development (HUD) Office of Manufactured Housing Programs. Construction and Safety Program. 2007.

https://portal.hud.gov/hudportal/HUD?src=/program_offices/housing/rmra/mhs/mhshome
Resources for understanding HUD Manufactured Housing

ADDITIONAL REFERENCES

American Institute of Architects. Disaster Assistance Handbook. 2017.

http://aiad8.prod.acquia-sites.com//sites//default//files//2017-03//Disaster_Assistance_Handbook_032017.pdf
Handbook for architects preparing for and responding to disasters including involvement with urban post-disaster housing options.

American Planning Association. Planning for Recovery Management. 2014

https://www.planning.org/publications/document/9139471
Brief on the roles of local government leadership, FEMA and residents in recovery

American Planning Association. Innovations in Planning and Public Engagement for Community Resilience: FEMA Public Engagement. 2017.

https://www.planning.org/nationalcenters/hazards/innovations/
Web-based tools and techniques to help planners engage their communities in order to help them prepare for and recover from disasters

American Planning Association. Community Planning Assistance Teams

https://www.planning.org/communityassistance/teams/
Portal for communities to request volunteer planning teams

Garrison Architects. Modular Architecture Manual. 2008.

http://www.garrisonarchitects.com/projects/buildings/modular_architecture_manual
Reference manual for architects and engineers considering or engaged in modular construction.

NYC Emergency Management Community Emergency Planning Toolkit. 2017.

http://www1.nyc.gov/site/em/community_business/plan.page
Tools to help Communities prepare for emergencies

DESIGN PRINCIPLES AND PERFORMANCE SPECIFICATIONS FOR URBAN POST-DISASTER INTERIM HOUSING UNITS

Introduction

The design of post-disaster housing includes more than what a building or an apartment looks like; the way it is manufactured, transported, and assembled all contribute to how fast it can arrive, how well it serves the occupants, and how easily it can be removed and reused. To provide deployable housing that is humane, healthy, durable and sustainable, cities need to take all these factors into account.

This document helps cities obtain post-disaster housing that suits the needs of urban areas quickly and cost-effectively. Created by the NYC Emergency Management Department and the NYC Department of Design and Construction, it outlines a reliable, start-to-finish approach to house residents quickly, comfortably and safely. The guidance here addresses the design, fabrication, delivery, and installation of deployable housing that has been improved through lessons learned in creating and inhabiting the Urban Post-Disaster Housing Prototype in NYC. It is intended to serve as the basis of a Request for Proposals. All agencies that procure post-disaster manufactured housing ask for different information presented in different forms. This document's organization reflects various proposal requirements from the Federal Emergency Management Agency, the U.S. Army Corps of Engineers, the U.S. Department of Housing and Urban Development, the NYC Department of Design and Construction, and the NYC Department of Housing Preservation and Development.

A well-designed solicitation leads to well-designed buildings, yet in the aftermath of disaster there is often pressure to make hasty decisions. When it comes to deployable housing, this can mean poor design decisions and expensive mistakes that are replicated thousands of times. This document is the core of a procurement package that offers a tested, value-engineered approach to provide quality deployable post-disaster housing for cities. Additionally, it sets a baseline for quality and outlines the key requirements for urban post-disaster housing in a way that can be easily customized for any city.

Local codes affect the cost, time and material requirements of a project. Vendors need to know where the greatest flexibility is so they can optimize the design. The specification helps cities communicate this in two ways: 1) by calling out where local codes have the biggest impact and 2) by requesting specific information not required in a typical project. In areas where local codes can have a big impact, specific NYC codes are used as examples: this shows where jurisdictions need to insert local requirements. To reduce the time it takes housing units to arrive after disasters, a locality should adapt this specification to a jurisdiction's requirements beforehand and identify preferred vendors in advance.

Background

An earlier version of this document, issued by the U.S. Army Corps of Engineers as part of a request for proposals, was created as the basis for the country's first Urban Post-Disaster Interim Housing prototype. This version incorporates best practices from the processes of designing, manufacturing, procuring, permitting, delivering, occupying and maintaining the prototype.

Design Principles

Overview

These Design Principles and Performance Specifications establish the minimum requirements for the design, construction and deployment of urban "Interim Housing Units" following disasters. The Interim Housing Unit (IHU) provides multi-family, multi-story housing that may extend beyond the twenty-four-month period specified by FEMA. Recognizing that interim housing is often in place longer than originally intended, these specifications call for construction quality equal to local building codes.

A city may need to maximize the number of temporary housing units deployed for displaced residents. In order to meet this need, government may procure the Interim Housing Units from multiple vendors depending on the capacity of each vendor to produce, deliver and deploy units. To accomplish this goal, the Interim Housing Units will incorporate standardized factory-manufactured modular housing units and construction specifications that are adaptable for both temporary and permanent use. The specifications will also identify certain urban considerations where it makes sense to depart from FEMA's requirements. The Interim Housing Unit must be rapidly deployable, transportable by truck, rail or cargo ship and must be able to be disassembled and stored off-site for future reassembly and re-use.

In order to achieve the production and rapid deployment of the Interim Housing Units, proposals should demonstrate a modular design and standardized manufacturing process. In order to accelerate the production schedule, the use and incorporation of pre-manufactured readily available components, such as modular bathrooms and kitchen pods is encouraged. Similarly, other factors such as innovative production that demonstrate the vendor's capability to quickly produce, transport and deploy a maximum number of units should also be defined.

This design concept focused on two proposed entries from NYCEM's "What if NYC…" design competition that used modified ISO shipping containers or shipping container technology and pre-manufactured modular construction methods. Other unit types including Factory Built Housing, Manufactured Housing (HUD-Code), Modular Housing, Panelized Housing and other alternative dwelling units that meet or exceed this NYCEM Design Standard and Performance Specification will also be considered.

Universal Design

In an effort to facilitate the development of a standard layout universally accessible to everyone, the vendor's proposal should incorporate the principles of Universal Design. Design layouts of all units should comply with the minimum requirements of the Americans with Disabilities Act (ADA) without the need for adaptation or specialization. Each unit should prioritize inclusive design that goes above and beyond stated codes. Universal Design Recommendations from the prototype study are called out throughout this document.

Factory Pre-Finished

The Interim Housing Unit should be factory pre-finished, transported, and installed with no or minimal field finishing work, including the interior walls and partitions. The Interim Housing Unit should be deployed to the selected site ready to be connected to existing municipal utilities or temporary services. The

unit should be transported and installed at the site fully furnished, with appliances, utility hook-ups, and accessories such as ramps and stair towers such that the unit is ready for habitation.

Permanency

The Interim Housing Unit should be designed as a "temporary-to-permanent" solution. The vendor should demonstrate and document design features that make it structurally feasible to install individual and/or stacked multiple dwelling units on permanent foundation systems, connect the unit to permanent municipal utilities, expand the living and common spaces, and to integrate the Interim Housing Unit into the permanent built community where appropriate. However, they should be able to be relocated and re-reused since, in most areas, the intent is that they remain for an interim period only.

Climate

The units should focus on passive heating and cooling, as appropriate to climate, and maximize natural light and air.

Performance Specifications

Design Concept

These specifications call for standard, but flexible, design elements and construction methods that can be combined to accommodate a range of family sizes. The design concept envisions a basic "Utility" dwelling unit module that is configured as a studio or one-bedroom apartment and includes all central requirements such as a kitchen, a bathroom, a living/dining/bedroom, electric power distribution, plumbing and mechanical distribution, and any necessary equipment. In addition to the core module, a standard "Bedroom" unit would incorporate additional living spaces (without plumbing service) to accommodate two additional bedrooms. The "Bedroom" unit would connect to the "Utility" unit in various configurations to form a larger family dwelling unit when needed. While the language in this document generally refers to a bedroom as being a space where two adults could share a queen-sized bed, this space can be furnished and customized to accommodate each household.

Alternate design concepts that can meet this specification will also be considered.

Utility Services Concept

Interim housing may use existing utility connections in areas designated by the city, or temporary connections that use "off-grid" systems with a self-contained power, water and waste supply. Preferred sources should be indicated at the time of the event. Units should use electrical power only, not gas, to standardize the utility design.

Each "Utility" module should be designed and engineered to incorporate a common utility chase(s) or riser(s) for electrical, sewer, water and other common services that might be required. The chase or riser should be arranged to align vertically and horizontally with other stacked "Utility" units, and also should be attached to "Bedroom" units, to permit the easy and quick connection of services in stacked, side-by-side or clustered complex arrangements.

In anticipation of labor shortages, as much interior plumbing should be assembled off-site as possible.

Unit Design

The overall exterior dimensions of the vendor's proposed standard modular should be within the maximum limits established for highway, rail

and cargo ship transport.

The typical exterior footprint ranges for a "Utility" dwelling unit, and a "Bedroom" unit, are below:

- Studio "Utility" Dwelling Unit: 260 – 300 square feet
- One-Bedroom "Utility" Dwelling Unit: 300 – 480 square feet
- Three-Bedroom Dwelling Unit ("Utility" + "Bedroom" module): 600 – 960 square feet

The minimum clear interior unit room width should be 8'-0" per NYC Building Code Section BC 1208.1.

The minimum interior finished ceiling height should be 8'-0" per NYC Building Code Section BC 1208.2.

Neighborhood Configurations

The Interim Housing Units should be stacked in clusters of multiple-dwelling complexes. Separate core units may be used to accommodate laundry units, secured storage, mail rooms, and mechanical equipment for servicing the clustered IHU arrangements.

Plan Layout and Features: Utility Unit

Floor space and clearances should comply with minimum requirements of the ADA for all units. Several aspects of Universal Design are critical to the plan layout.

Kitchen

Provide a complete all-electric adaptable kitchen (no gas or propane appliances) in compliance with the ADA, including all the following features:

- Kitchen Cabinets: Overhead and under-counter kitchen cabinets with countertops; kitchen cabinets and countertops should be constructed from metal or alternate acceptable durable materials resistant to moisture, mold, abuse, and delaminating. For purposes of efficient and rapid deployment, consider the readily available modular kitchen unit or the standard pre-manufactured "off the shelf" component. Custom designed units should be avoided.
- Universal Design Recommendations: Stainless steel sink with a water-saving, single-lever faucet with handheld spray is preferred. Prioritize multiple low cabinets for people with limited reach.
- Refrigerator: 14.4 cu. ft. minimum Energy Star-compliant frost-free with freezer. 100% of the refrigerator and 50% of the freezer must be at maximum, 54" above floor per the ADA.
- Microwave: Minimum 1.2 cu. ft. microwave or 2 cu. ft. convection microwave with child lock.
- Range & Oven: Minimum 24" electric cooking range. Also provided should be a one-piece construction range hood, lighted and power-vented.
- Dishwasher, Washer, and Dryer: not included.

Bathroom

One full bathroom must be provided in each "Utility" One Bedroom Dwelling Unit. Connecting a "Three-Bedroom" Unit does not require additional bathrooms.

Bathroom designs should be based on a Universal design layout. In compliance with the ADA Section 4.21, a roll-in type shower (no bathtub) with a shower curtain, curtain rod and curtain hooks, a drop down seat and grab bars should be provided. A wall-hung or floor-mounted lavatory with clear knee clearance and a wall hung or floor mounted 1.28 gallon water

saver closet should be included. The height of the water closet should comply with ADA Section 4.16. A removable under-lavatory vanity is acceptable.

Use recessed or surface wall mounted medicine cabinet with tilting shatterproof mirror. Wall mounted grab bars, locations and size compliant with the ADA.

In the event of a material shortage or as a cost-saving measure, all first floor units should have grab bars installed and the units above them should have blocking installed such that grab bars can be installed at a later time. The blocking location should be indicated on the architectural plan and match on all floors.

Bathroom floor space, clearances, and accessories should all comply with ADA requirements.

Bathrooms should include an adequately sized exhaust fan capable of exhausting a minimum 50 CFM (for an intermittent fan) or 20 CFM (for a continuous fan) of air, vented and ducted to the outside in compliance with the NYC Building Code. The exhaust fan should be 1.5 sones or quieter and Energy Star compliant.

For drainage, a positive pitch for the walk in shower drain should be provided to prevent water pooling within the bathroom area.

Storage

Storage opportunities are to be maximized.

Universal Design Recommendation: Ample storage and closet space with adjustable and removable storage shelving should be provided which is compliant with the ADA Section 4.25. Adjustable shelving should allow hung items to be accessed from a seated height.

Living/Dining Room

The dining area should include a surface and seating to accommodate 4-6 adults and provide circulation space for accessory furniture.

The living room area should include a sleeper sofa bed and sufficient circulation space to accommodate typical living room furniture. A Murphy-type bed may also be considered for a studio or a one-bedroom unit. A built-in or attached credenza and desk should also be provided.

Bedroom (also applies to "Bedroom" Unit)

Each bedroom should accommodate one full-sized bed or two twin-sized beds with adequate circulation and turning space, along with a closet or wardrobe with ADA compliant doors.

Universal Design Recommendation: An electrical plug for wheelchair charging or additional medical equipment should be easily reachable from the bed.

Building Design

Fire Safety

Egress Windows: Each dwelling unit should provide emergency and outside window openings in each sleeping room or occupied space (including living rooms with sofa beds), unless the space has an exit door, in compliance with NYC Building Code Article BC 1029 and with the NYC Fire Code.

Smoke Detectors: Each kitchen, living room and sleeping space should have combination smoke and carbon monoxide detectors, with built-in audible and visual alarms compliant with the National Fire Prevention Association Standard 72, and the NYC Building Code. Detectors should be hard wired to the electrical circuits with battery backup.

Fire Extinguishers: Each dwelling unit should

be equipped with one 5-lbs dry chemical A-B-C fire extinguisher that is compliant with or exceeding the requirements of the National Fire Prevention Association Standard 10, and is easily accessible in the kitchen area.

Doors and Windows

The building envelope should reflect the principles related to climate considerations, natural light, ventilation, and air quality.

All primary windows and sliding glass doors should be insulating and fully weather-sealed, and should comply with the latest edition of the AAMA 1701.2, "Voluntary Standard Primary Window and Sliding Glass Door for Utilization in Manufactured Housing."

The design and construction of all swinging exterior passage doors should also meet or exceed the requirements of the latest edition of AAMA 1702.2, "Voluntary Standard Swinging Exterior Passage Door for Utilization in Manufactured Housing."

Exterior doors should have two independent locks with separate keys and be capable of being opened from the inside without a tool or key. The height of locks, latches and other locking mechanisms on the inside of exterior and interior doors should comply with the ADA 4.2.5 and 4.2.6. Additionally, all exterior doors should have a vision peep-hole at a height compliant with the ADA.

All operable windows should have latches and locking mechanisms that prevent the windows from being opened from the outside. The latches and locking mechanisms should be able to be manually opened from the inside without the use of a tool or key.

Universal Design Recommendation: Handles should be able to be used with a closed fist.

All operable windows should be equipped with removable non-corrosive insect screens.

If windows and glass doors are to be equipped with blinds, these should first be approved as being safe for children.

Child-protective guards should be provided for all operable windows above the first floor in compliance with NYC Code, Rules and Ordinances.

Sound Attenuation

Each dwelling unit, including fenestration and exterior envelope assemblies, should achieve a composite building sound attenuation value equal to or greater than 30 OITC based on a maximum indoor noise level of 45 dBA.

Exterior Finishes and Weather Resistance

Exterior exposed surfaces: Materials should be designed to present a uniform and aesthetically pleasant appearance. Exterior material and/or cladding should be non-combustible, durable, moisture, mold and weather resistant, corrosion resistant and maintenance free. All fasteners should be corrosion resistant and designed to resist wind, snow and rain. The vendor should demonstrate a uniform aesthetic appearance for the Interim Housing Unit in multi-family building complexes and clustered arrangements.

Roof Surfaces: Roofs should be covered in appropriate roofing systems with durable material equivalent to a 10-15 year warranty type system, and secured to resist wind forces in compliance with the NYC Building Code. Roof surfaces should be pitched to provide positive drainage to an integral drainage system, gutters or other acceptable drainage methods. Refer to "Storm Water Disposal" elsewhere in this

document. “Cool roofs” preferred.

All exterior openings, such as windows, doors, drainpipes, etc., should be sealed and caulked to prevent air and moisture penetration and to resist the entrance of rodents.

Life Safety

Means of Egress

Required means of egress systems, including, but not limited to the number of exit stairs, the maximum travel distance, components such as doors, clear width and height; minimum illumination, signage, etc. should comply with NYC Building Code Chapter 10.

Fire Suppression

Fire Suppression System:

Article BC 903.2.8 of the NYC Building Code requires all residential type occupancies, with the exception of one- and two-family detached dwellings that are smaller than three stories in height, be provided with an automatic sprinkler system. In a post-disaster environment, a reliable municipal source of water may not be available or sufficient for sprinkler systems where the Interim Housing Unit is located. The fire suppression system should be designed to integrate all available site municipal utilities and /or temporary water sources. Based on the source water supply condition, availability for fire pumps should be provided, if needed.

Water-Based Fire Suppression System:

Water-based automatic fire sprinkler system should be designed and implemented in compliance with NYC Building Code Section BC 903 for R2 occupancy. The provision of a sprinkler system should not be considered for increase in permitted limits of building area, height, and egress and construction classification.

A visual/audible device should be located on the exterior of the Interim Housing Units, visible from a public way, providing alarm notification upon activation of the fire sprinkler system.

The vendor should submit system testing and independent listing agency documentation for approval and acceptance by the NYC Fire Department (FDNY) for this type of use.

Standpipe

For complex clustered site arrangements, a standpipe system should be designed and provided in compliance with NYC Building Code Section BC 905 as required for the proposed building complex height and total floor area as prescribed in Section BC 905.3.1.

Building Systems

Structural

Connections:

Each Interim Housing Unit module should be engineered and constructed to support vertical live and dead loads, wind and seismic forces, as prescribed by the NYC Building Code, for Interim Housing Unit modules stacked up to four stories maximum with pre-engineered connections. Individual, stacked and combined dwelling unit arrangements should be engineered to resist lateral forces including wind and seismic in addition to live and dead loads in compliance with the NYC Building Code.

Temporary Foundations:

Excavation and construction of permanent foundation systems may not be viable in a disaster recovery situation and in some cases will not be considered. Pre-engineered temporary foundation systems should be provided to support singular and stacked

Interim Housing Units Dwelling Units at various locations, terrain and surface conditions, such as asphalt paved parking fields, lawns, parkland, sidewalks, streets, etc. Temporary foundation systems may include, but not be limited to platforms, pre-cast or steel grade beams, piles, fiber concrete columns, anchors, or similar.

The Interim Housing Units should be designed and pre-engineered to provide appropriate anchorage to the temporary foundations including tie-down of the Interim Housing Units and temporary foundation required for securing to the ground.

The soil conditions encountered for the location of the Interim Housing Units may vary. The design for the pre-engineered temporary foundation systems should assume a conservative soil bearing capacity of < 1,000 pounds per square foot. Standard modular IHU units should accommodate various interchangeable foundation systems and the vendor may propose different types of systems appropriate for various soil and bearing conditions. The vendor should perform test borings as necessary at the selected site to confirm soil and bearing capacity and conditions.

Amenities:

Pre-engineered and modular amenities should be provided which are compliant with the ADA, such as stair towers, platforms and landings, ramps, decks, walkways, etc. Each should be pre-assembled and engineered for quick deployment and installation in the field. Public space amenities such as bicycle racks, benches and play equipment should be considered. For efficiency and economy, standard modular, readily available pre-manufactured systems should be used.

Structural Integrity:

Each pre-assembled Interim Housing Unit should be engineered and constructed to remain structurally sound during transport and installation.

Delivery, Installation and Demobilization

The Interim Housing Units shall be delivered and installed by the vendor's personnel or by a third-party contractor hired by the vendor. Proposals should include detailed installation plans and information regarding any required training. They should arrive ready for hook-up to permanent municipal electric, sewage and water or temporary utility services as further described in this document.

Interim Housing Units should not require more than two weeks of finish work on site. All interior finishes, partitions, doors and windows, and fixtures should be included with delivery; vendor should not assume these are available at the site.

The vendor should provide plans for removal. Installation methods and structural systems should allow the site to be restored to its original condition.

Mechanical, Electrical and Plumbing Systems

Heating, Ventilation and Air-Conditioning

Each Interim Housing Unit should be equipped with a Heating, Ventilation and Air Conditioning (HVAC) system (with warranty) capable of maintaining living space winter conditions of maximum 72F (22C) and summer conditions of minimum 75F (24C) with 50-55% relative humidity. All heating and cooling systems must meet Energy Star qualifications.

Interim Housing Units should have a minimum Air Exchange Rate per Hour (ACH) of .35 (35%) of outdoor air being introduced into the unit per hour. Ventilation should be in addition to any natural ventilation from windows and/or doors.

Documentation must be provided to show how all supply and return air is extracted, delivered and distributed.

Units should be designed to meet industry minimum standards for residential ventilation and acceptable indoor air quality per the American Society of Heating, Refrigeration, and Air-Conditioning Section 62 (ASHRAE 62).

Electric baseboard radiation, and through wall heat pumps with electric resistance supplement as required, or a combination of both are acceptable for HVAC services. Also acceptable are packaged HVAC units that require wall louvers for heat rejection.

In all cases, adequate zoning for individual spaces is preferred. Sound criteria shall be as recommended by ASHRAE or other recognized authority. See also Sound Attenuation.

Electrical

Electrical design should comply with Article 550 of the NYC Electrical Code. Utility service for Interim Housing Units dwelling units should be all-electric. (Gas service will not be available at the temporary housing sites. Use of propane is not allowed).

Metering the units: a master meter should be installed for each cluster of units, including accommodation for combined services such as lighting, and sub-meters for each unit. Utility bills are to be available for individual units.

Electric service entrance connection at each Interim Housing Unit should be located on the exterior in vandal-proof, locked and weather proof junction boxes. Alternately, a secure utility room or locked box for master connections to electrical service and utilities may be provided. The incorporation of concealed and vandal-proof modular troughs for quick-connect power and telecom distribution is acceptable and recommended.

All wiring should be concealed in flexible or rigid conduit. All wire should be copper with a ground conductor.

All interior and exterior lighting should use commercially available fluorescent, compact fluorescent or LED lamps. All outdoor lighting shall be controlled by photocell; if none are available, timers are acceptable and should be included. All interior lighting fixtures should be ceiling or wall mounted with shatterproof lenses. Use of custom or long lead lighting fixtures should be avoided. All electrical hardware should be vandal-proof. All receptacles and switches should be heavy-duty industrial type with ground-fault circuit interrupter (GFCI).

Lighting Control: the height of lighting controls should comply with the ADA 4.27.3. A means to control at least one source of bedroom light from one bedside location should be provided.

Universal Design Recommendation: Off-the-shelf large rocker switches preferred.

Access panels at the interior of each unit should be accessible to the resident, facilitating quick connection and maintenance of services.

Communications

Phone and Data: Each unit should be provided with at least one telephone, data and cable connection to be located in the living room. A service entrance connection should be located on the exterior in vandal-proof, locked and weather proof boxes. Alternatively, all-wireless internet service can be considered.

Water Heating

An independent supply of hot water should be provided to each Interim Housing Unit and

should be capable of delivering an adequate supply of hot water to all plumbing fixtures and equipment as required. Choices on heating and plumbing systems should weigh system cost versus availability of equipment and speed of production.

A self-contained hot water generation system using electric power for all plumbing fixtures and equipment requiring hot water should be provided.

In order to avoid the requirements of a re-circulation system to maintain the hot water temperature, a distance of twenty (20) feet from the hot water heater to the farthest fixture as per the NYC Plumbing Code should not be exceeded.

The hot water heater should be suitable for the type of building structure and should be capable of providing the minimum total demand including recovery/storage requirements.

Potable Water, Sanitary and Storm Water Disposal

In a post-disaster environment, municipal water, sanitary and storm water disposal may be adversely affected. Such services may not be available for a short or extended period, or available services may be limited. The vendor's proposal should demonstrate the ability of the Interim Housing Units to connect to permanent municipal services when available, including water, sanitary and storm water disposal. If services are not available the vendor should demonstrate how the system can connect to alternate water storage and purification systems, and wastewater collection and/or treatment systems.

Temporary and permanent services should incorporate the following:

Domestic Water Supply

An adequate potable water supply, acceptable and approved by the New York City Department of Health and Mental Hygiene and the New York City Department of Environmental Protection (DEP), should be provided to each Interim Housing Unit Dwelling Unit for drinking, cooking, and bathing purposes.

Domestic water may be supplied from a city water main, on site water storage, water trucks or a combination thereof. Supplied potable water should connect to a central, pre-assembled domestic water service for each building complex or series of complexes per site, with metering and backflow protection, for quick installation in the field in compliance with DEP Rules and Regulations.

Sanitary Drainage Disposal

Sanitary drainage should be disposed of in compliance with local code.

Sanitary drainage from plumbing fixtures for each Interim Housing Unit should be conveyed by gravity to a central point within each building housing complex, where it should then connect to the municipal sewer line when available. If no sewer line is available, sanitary disposal should be conveyed by an approved alternative method, including but not limited to:

- A central or localized holding tank that can be pumped out by a sewage disposal service and disposed of as permitted by federal, state or local authorities.
- Connection of sanitary system disposal from temporary systems to available permanent municipal disposal services should be subject to approval by the New York City Department of Environmental Protection. The vendor should provide technical sanitary system design information in their proposal,

including calculations. This information will be evaluated by the DEP at the time for switch over from temporary to permanent services in order to assure that the municipal system will not be overtaxed. If sanitary disposal from the Interim Housing Units cannot be conveyed by gravity, then a receiver tank with ejector pumps should be used to convey the discharge into a gravity line. The discharge should not be permitted to pressurize the street sewer.

Storm Water Disposal

Storm water drainage should be disposed of in an acceptable manner in compliance with local code. Drainage for the site should be based on the layout of the Interim Housing Units so that there will be no flooding within the area.

Storm water drainage from the site should be conveyed to the municipal storm or combination storm/sanitary sewer line when available. If a sewer line is not available, storm disposal should be conveyed to approved alternative methods provided by the vendor, including but not limited to:

- Drywells where feasible. Percolation tests should be performed at the site prior to design and installation of the drywells.
- A central or localized holding tank that can be pumped out by a disposal service and disposed of as permitted by federal, state or local Authorities.
- Storm water may discharge on unpaved areas such as lawns provided that storm water will flow away from buildings toward unpaved areas on the same site that will accommodate the rainfall.

Protection from Freezing

All system piping design and installation should be protected from freezing. Appropriate insulation and/or heat trace as necessary should be provided.

All above ground or shallow buried piping, water supply or sanitary disposal should be protected from freezing by appropriate methods including insulation, heat tracing, etc. as necessary. Any bends in above ground piping require cleanouts with adequate maintenance space for snaking.

All above-ground piping shall be protected from damage resulting from vehicles, pedestrians and vandalism as required.

Compliance with Codes and Regulations

Code Compliance

Building codes are one of the best ways to mitigate the effects of local hazards. Post-disaster housing should be as safe and well-designed as any other housing, and should comply with current local codes. The 2014 NYC Construction Code was in effect at the time the prototype was created and is referenced in this document. Subsequent code updates and revisions in NYC and elsewhere should govern when Interim Housing Units based on these specifications are commissioned. Where these NYC code references appear, local governments should insert their equivalent requirements.

Universal Design Recommendation: Where FEMA, HUD or local codes conflict, the strictest should govern.

The Interim Housing Units constructed to these design guidelines and performance specifications must comply with the following codes and standards in effect at time of contract award:

1. New York City Construction Codes consisting of:
    a. New York City Building Code (NYCBC)
    b. New York City Plumbing Code (NYCPC)
    c. New York City Mechanical Code (NYCMC)
2. New York City Electrical Code (NYCEC)
3. New York City Fire Code (NYCFC)
4. New York City Energy Conservation Code (NYCECC)
5. New York State Energy Conservation Construction Code (NYSECCC)
6. Americans with Disabilities Act (ADA) Standards for Accessible Design
7. New York City Department of Environmental Protection (DEP)
8. New York City Housing Maintenance Code (NYCHMC)
9. New York State Multiple Dwelling Law (NYSML)
10. National Fire Protection Association (NFPA)
11. National Sanitation Foundation (NSF)
12. American Architectural Manufacturers Association (AAMA)
13. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

Occupancy Classification

Based on the New York City Building Code, Section BC310.1.2, the Interim Housing Unit building complex is classified as Residential Occupancy R2, which includes apartment-type multiple dwellings and apartment hotels.

The Interim Housing Units are typically arranged as a multiple dwelling complexes, stacked four stories maximum, as buildings above four stories are required to have an elevator. The total number of dwelling units in each complex depends on the size and configuration of available sites and compliance with the NYC Building Code.

Construction Classification

Construction classification for all elements of Interim Housing Units should comply with NYC Building Code Table 601 and table 602 for Type IIA and Type IIIA construction.

Fire resistance ratings for Type IIA and Type IIIA construction should not be reduced as otherwise permitted by Table 601, footnote 'd' for automatic sprinkler systems.

Zoning Considerations

Fire District

The Interim Housing Units may be located at any site within the five boroughs of New York City. For IHU's all portions of the boroughs of Manhattan, Bronx, Brooklyn, Queens and Staten Island shall be deemed located in the Fire District, including areas in the Fire Limits Maps annotated on NYC Building Code Appendix D as outside the Fire District. Building construction limits noted in Table 503 and Table 603 for R2 occupancy should apply as prescribed for structures located in the Fire District.

Height and Area

The design of the Interim Housing Unit multiple dwelling complexes should comply with the height and area limits prescribed in NYC Building Code Chapter 5, Table 503 for R2 occupancy group and Type IIA and IIIA construction. Type V construction is excluded.

The building height increase permitted for automatic sprinkler systems per NYC Building Code Section BC 504.2 should not apply. The maximum stacked building complex height

in height are not required. (Refer to NYC Building Code Section BC 3002.4)

An area increase permitted for frontage per NYC Building Code Section BC 506.2 and for automatic sprinkler systems per Section BC 506.3 should not apply.

An unlimited area permitted for buildings of Type IIA and IIIA construction per NYC Building Code Section BC 507.13 should not apply.

Distance between Building Complexes

The distance between Interim Housing Unit building complexes on an individual site or between units and existing buildings on an adjoining site should comply with Table 602 for R2 occupancy and type of construction.

Zoning regulations regarding setback, yard and separation distances may be waived during a declared emergency and disaster recovery. A minimum separation of 20 feet should be provided between an Interim Housing Unit building complex frontage and other Interim Housing Unit building complexes located on a common site. This is necessary in order to provide access for adequate light and ventilation and building access for Fire Department and other emergency services.


NYC
Emergency
Management