A Typology of Very Small Dwellings: Lessons from 15 Years of Permanent Supportive Housing

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Recent building and zoning code changes in the United States and Canada have significantly reduced the minimum size of a dwelling: from 290 to 220 square feet in San Francisco and from 400 to 300 square feet in New York City. Market-rate developers can plan for these new opportunities by turning to examples of well-designed small dwellings from non-profit developers, who have been building such apartments in permanent supportive housing projects for people transitioning from chronic homelessness. This paper presents a typological study of very small studio apartments from North American permanent supportive housing (PSH), formulating a set of spatial descriptors within a typological framework. This paper is grounded in the scholarship on permanent supportive housing and the particular needs of the residents, as well as the emerging literature on very small dwellings.

The classifications understood by this study include: width and depth and width/depth ratio; entry sequence; kitchen type and kitchen location; storage size and allocation; bathroom fixture types and layout. Space syntax diagrams reveal that the overall layout is determined primarily by the entry sequence, has two primary diagrams, dependent on whether the resident walks directly into the kitchen or into a distinct entry hall. The placement of each additional component hinges on this first decision.

PSH units are a resource for all human-centered designers, whether developing market rate or subsidized housing units. The patterns noted in this study establish design guidelines which will allow teams to learn from existing unit designs. This research has increased benefits for the designers and developers of housing for formerly homeless individuals, as many new communities throughout the country are recognizing the benefit of PSH when addressing the pervasive spread of homelessness.

INTRODUCTION

As market-rate developers look to create small, autonomous dwellings for millennials and other urbanites, they would be well-served to look to an existing, similar project type. For the past two decades, non-profit housing developers have created thousands of very small dwellings for people transitioning from chronic homelessness. The primary question guiding this research is: what are the characteristics and patterns inherent in these very small dwellings? The premise is that by closely examining the typology of the unit plan and establishing the stylized facts of the unit type, this research will provide lessons for designers of all very small dwellings. Streamlining decisions about entry sequence, kitchen position and bath layout creates time for the architect to innovate in other areas of the design.

Very small dwellings were first introduced as experiments in Existenzminimum, or minimum subsistence level dwelling, in Frankfurt in the 1920s. In the United States and Canada, Single Room Occupancy (SRO) Hotels were built as a temporary living arrangement for single adults, especially recent arrivals to industrial cities. In the 1980s, after changes in psychiatric institutionalization policies, SROs were used again to help solve the homelessness crisis (Jones et al 1992). In some communities, new SROs were built with the same goal. Permanent supportive housing builds on this legacy.

Permanent supportive housing (PSH) refers to service-enriched projects with extensive common areas and offices on site to serve the residents directly. This research builds on previous and ongoing research on the common areas of PSH projects. Because up to 50% of the floor area of such buildings is dedicated to shared space (Bollo and Donofrio 2019), there is a strong incentive to design the units very efficiently while still maintaining autonomy for the residents. Each apartment has a private bathroom and kitchen en suite, unlike the traditional single-room occupancy hotels of the early twentieth century in which cooking and bathing facilities were shared and located down the hall.

There is a tension between supporting the autonomy of the individual and creating a place where residents can be involved in the community of the building (Johnson 2009). The perceived risk of autonomous apartments versus a congregate arrangement is loneliness. However, research shows that for most tenants living in independent apartments with supportive services, loneliness was not a serious problem or it was an issue they could overcome (Piat et al. 2018). Living in full apartments correlated with a sense of control, stability and security (Watson et al. 2019). Extensive common areas in these projects set the stage for interaction and provide a place for human connection (Huffman 2018). There is also evidence that an autonomous

apartment gives residents a chance to reconnect with family and friends in a normalized environment (Tsai 2010).

The chief societal concerns of very small dwellings relate to health and wellbeing for the residents. Dak Kopec notes that residents may feel they have to choose between the physical crowding of furniture and belongings in their unit and social crowding, caused by other residents, in the common areas of the building (Urist 2013). Gary Evans and his team find that "… floorplan configurations that afford greater opportunity for being alone also attenuate the negative impacts of residential density on psychological wellbeing" (Evans et al. 2002, 222).

METHODS

The foundation of this study is Kelbaugh's philosophy of typology as an architecture of limits (1996). Our initial tendency when designing this research project was to collect, list and categorize. But, as Moneo reminds us, typology "is neither a spatial diagram nor the average of a serial list. It is fundamentally based on the possibility of grouping objects by certain inherent structural similarities" (Moneo 1978, 23).

The data for this study are floor plans of 23 very small studio apartments in permanent supportive housing projects as noted in Table 1, below. Units were chosen from a set of purpose-built PSH projects in North America from the last 15 years. The criteria for inclusion in this study are unit size (less than 400 square

feet), apartment type (full studio apartments with kitchens and bathrooms en suite). Previous work on the common areas of PSH projects yielded eight exemplary projects which meet the other criteria (Bollo and Donofrio, 2019). The remaining projects are prioritized to create diversity in geography, architect, and sponsors. The criteria for unit selection from each project were: a typical accessibility level (i.e. an ANSI Type-B design rather than the more accessible Type-A, or fully accessible design); and a typical location in the middle of the building, not outliers on the corner, at the end of a corridor, or with extra space. For projects with two typical units, each representing half the total, we included both in the study.

The plans for the units came directly from architects and housing providers or from print sources such as Architectural Record. Occasionally, photographs are used to verify the unit features, such as the kitchen appliances or dropped ceilings. The quality and drawing style of the plans collected varies widely, so the they are scaled to 1⁄4" = 1'- 0" and then traced by hand so that the analysis would benefit from stylistic consistency. Though care to be consistent is taken between drawings, the measurements are intended as an accurate, but not precise, approximation of the unit size and dimensions. For the units that we were able to visit during the course of this research, the architects were extremely helpful in understanding the genesis of each design decision.

Table 1. *Selected Projects Sorted by Year*

Year	Building Name	Location	Architect	Sponsor
2006	Rainbow	Los Angeles	Michael Maltzan	Skid Row Housing Trust
2007	Schiff	Chicago	Helmut Jahn	Mercy Lakefront
2010	Zygmunt Arendt House	San Francisco	Solomon	Community Housing Partnership
2011	97 Crooke	New York	Dattner Architects	CAMBA
2011	Karis Place	Vancouver	NSDA	More Than A Roof
2011	Richardson	San Francisco	David Baker	Mercy Housing
2011	Dunbar	Vancouver	DYS	Coast Mental Health
2011	Bud Clark Commons	Portland	Holst	Central City/Home Forward
2012	Kingsbridge Terrace	New York	OCV Architects	Jericho Project
2012	First Place	Vancouver	GBL	Lookout
2012	Hegeman	New York	Cook + Fox	Breaking Ground
2013	Rene Cazenave	San Francisco	LMS	Community Housing Partnership
2013	Urness House	Seattle	Weinstein AU	Compass Center
2014	La Casa	Washington	Leo Daley & Studio 27	Friendship Place
2015	Interbay Place	Seattle	SMR Architects	DESC
2016	The Six	Los Angeles	Pugh + Scarpa	Skid Row Housing Trust
2016	Boston Road	New York	Alexander Gorlin	Breaking Ground
2016	Crest	Los Angeles	Michael Maltzan	Skid Row Housing Trust
2017	Plymouth First Hill	Seattle	SMR Architects	Plymouth Housing Group
2019	Greenway Flats	Colorado Springs	HB&A	Springs Rescue Mission
2019	Lincoln Park	Chicago	MKB	Lincoln Park Community Services

Five major components are represented in the sample units: bathroom, kitchen, storage, distinct entry, and main living area. In addition to absolute area calculations, we utilize an index system to understand the ratio of each component to the total unit area. The dimensions are taken to the inside surface of walls as they were drawn in the primary source document.

For kitchens set within the main living area, we measured the area of the cabinets and appliances plus a 36" clear maneuvering space. For the kitchens set in the entry area, the effective area is measured to the adjacent wall; in these projects, this space is used as both kitchen access and circulation. For projects with separate kitchens, galley or L-style configuration, the kitchen is defined by itself (*Figure 1*). A storage component is defined as a floor-to-ceiling, built-in, architectural feature. Both the number of discrete storage components and the net floor area of those components is catalogued.

During the typological analysis, we used space syntax analysis methods as prescribed by Hillier and Hanson (1989), Markus (2013), and Bafna (2003). The relationships between spaces in each dwelling are analyzed and compared through simple justified graphs for each unit starting at the entry door. This technique of abstraction resulted in the foregrounding of patterns and similarities between the units, rather than a focus on the exceptions. We calculate basic descriptive statistics to understand the range in a given component size for the group of units: the mean and median for each unit, and for each of the major components. Diagnostically, because the mean and median were similar, we know our range of sample units is appropriate. To understand the relationships between components in the unit plans, we calculated Pearson coefficients of correlation. This simple statistical technique served largely to support or refute theories based on the typological analyses.

RESULTS

The typological classifications revealed and examined by this study include: width and depth and width/depth ratio; entry sequence; kitchen type and kitchen location; storage size and allocation; bathroom fixture types and layout. The living area dimensions are often determined by building code requirements on habitable space. Additional components found in some projects include: defined entry area, bed nook, window seats, built in desks. The typology matrix includes this information for each project and categorizes the units (*Figure 2*).

Space syntax diagrams expose overall layout patterns. Across projects, the layout is determined primarily by the entry sequence, which has two categories, dependent on whether the resident walks directly into the kitchen or into a distinct entry hall. The placement of each additional component hinges on this first decision. In this section, the patterns we found for each component are described, as well as the relationship between them.

SIZE AND DIMENSION RESULTS AND PATTERNS

The net areas of the example units range from 236 to 345 square feet. The mean of the sample is 303 square feet and the median is 306 square feet; the nearness of these numbers reveals a cross-section that is biased neither to the lower nor the higher end of the size continuum. The typical unit is between 10'- 6" and 13'- 0" wide between 23'- 0" and 27'- 0" deep.

The depth-width ratio was calculated for each unit to understand its proportions and as a metric that can be studied later to understand the proportion's effect on the layout of the unit. Most of the projects are greater than a double-square; only nine of the units fall between 1.6 and 2.0. At the higher end

Figure 1. Kitchen Location Typology (l to r): Main room at Urness (with kitchen overlapping living area); Entry at Richardson; Separate galley at Dunbar; Separate L-style at The Six.

GREENWAY
311 sf
13'-3"
65% 18%

ZYGMUND ARENDT
319 sf
25'-0"
12'-9"
45% 17%

INTERBAY
306 sf
25'-6"
12'-0"
39% 17%

RENE CAZENAVE
333 sf
26'-4"
12'-10"
45% 20%

• DEFINED ENTRY
• PASS THROUGH KITCHEN
• BATHROOM OFF KITCHEN

URNESS
308 sf
26'-3"
11'-9"
57% 14%

PLYMOUTH FIRST HILL
252 sf
21'-0"
12'-0"
48% 22%

BOSTON ROAD
303 sf
24'-3"
12'-6"
49% 18%

• DEFINED ENTRY
• KITCHEN IN MAIN ROOM
• BATHROOM OFF ENTRY

CREST (A)
305 sf
13'-0"
52% 25%

• ENTER THROUGH KITCHEN
• BATHROOM OFF MAIN LIVING AREA

BUD CLARK
252 sf
26'-0"
11'-6"
53% 24%

SCHIFF
279 sf
21'-6"
13'-0"
57% 25%

• ENTER THROUGH KITCHEN
• BATHROOM OFF KITCHEN
• NO LARGE STORAGE

97 CROOKE
292 sf
24'-9"
10'-6"
43% 17%

KINGSBRIDGE
267 sf
24'-3"
11'-0"
52% 13%

FIRST PLACE
306 sf
25'-6"
12'-0"
49% 17%

RAINBOW
282 sf
24'-6"
11'-6"
52% 19%

HEGEMAN
236 sf
22'-6"
10'-6"
42% 17%

• DEFINED ENTRY
• PASS THROUGH KITCHEN
• BATHROOM OFF ENTRY

CREST B
344 sf
27'-6"
12'-6"
33% 19%

THE SIX
337 sf
27'-0"
12'-6"
49% 19%

LINCOLN PARK
324 sf
27'-0"
12'-0"
49% 11%

DUNBAR
319 sf
25'-0"
12'-9"
47% 20%

• DEFINED ENTRY
• SEPARATE KITCHEN OFF ENTRY
• BATHROOM OFF ENTRY

• DEFINED ENTRY
• SEPARATE KITCHEN OFF MAIN LIVING
• BATHROOM OFF ENTRY

KARIS
344
30'-0"
11'-6"
60% 22%

97 CROOKE
292 sf
24'-9"
10'-6"
47% 17%

RICHARDSON
312 sf
24'-0"
13'-0"
48% 21%

LA CASA
297 sf
19'-6"
15'-3"
46% 30%

• ENTER THROUGH KITCHEN
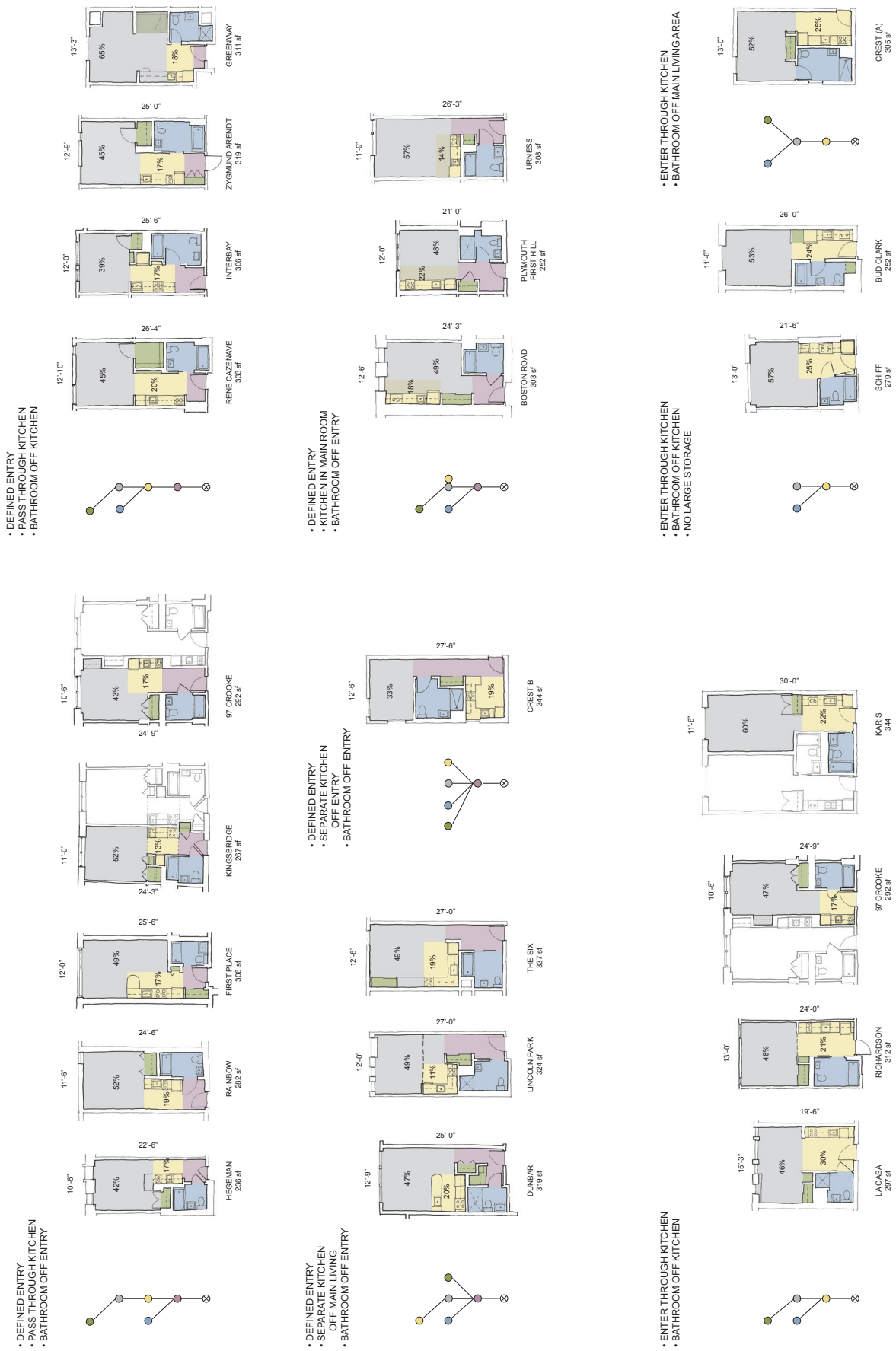• BATHROOM OFF KITCHEN

Figure 2. Typology Matrix with Space Syntax Analysis for Depth from Door.

of the unit proportion range are several units that employ an interlocking nesting design. At the lowest end of the unit proportion range (1.28) is the La Casa apartment, the only unit in the study that is close to square. Its depth and width, 19'-6" and 15-3", are well outside the typical range for their absolute dimensions.

COMPONENT RESULTS AND PATTERNS

Kitchens. In the unit examples, the absolute effective kitchen areas range from 36 to 77 square feet. The kitchen index is defined as kitchen space as a percentage of total unit area. The median and mean kitchen index is 19%, and all but three of the kitchens fall between 11% and 23%. The most space-efficient kitchen layout appears to be the separate kitchen space, though the maneuvering area of the entry kitchens does double duty as circulation, which makes the entry kitchens the most efficacious. The type of cooking appliance does not correlate with absolute effective size of the kitchen nor the kitchen index for these projects. Project stakeholders noted that the choice between a two-burner counter-affixed cooktop and a full range with stovetop and oven was determined by local building regulations, state funding requirements, and insurance company guidance.

Storage. Across the projects, the number of discrete storage areas and the net floor area has a greater range than any other unit component. The typical unit has between 10 and 12 square feet of storage across one, two or three components. This category includes half of the projects. The "abundant storage" category is defined by a range of 16 and 34 square feet within two or three storage components and the "very limited storage" units have between six and eight square feet in a single component. One project has a unique storage strategy as compared to the other projects. The Greenway Flats unit has a single, very large storage area that is intended to be flexible in its use as a separated bed nook for a twin bed. If the resident chooses to use this area for their bed, there is no place

for clothes storage. If they use it for abundant storage, there is sufficient space in the main living area for the bed.

Bathrooms. Within these representative plans, there are three major categories of bathroom layout: bathrooms with the fixtures anchored to one wall; to two walls; and to three walls (*Figure 3*). The one-wall plans come in two categories, which are reflective of accessibility requirements at the time of permitting: Bath 1A has the toilet on the wall to facilitate grab bar installation, while Bath 1B has the toilet in the middle of the three fixtures. Among the one-wall baths, the bathing fixture varies from a four- or five-foot tub, to a three- or five-foot shower. The two-wall bath layout typically has the toilet parallel to the long wall, away from the door for grab-bar adaptability. The three-wall baths were rare: only Lincoln Park and Crest utilized this layout. It results in ample maneuvering space in the center of the bathroom. The two-wall bath is the most space efficient while meeting the current International Building Code adaptability requirements for residential bathrooms. Some service providers express preferences for showers over tubs, wall mounted lavatories over vanities, or request additional grab bars for residents who might age in place.

Living Area. The living area index indicates the share of the living area in relationship to the unit as a whole. For these sample units, the mean and the median are 48%. Assuming the bathroom, kitchen, entry, and storage take up a reasonably steady amount of absolute floor area, we hypothesize the living area index to be higher for larger units. In fact, the correlation coefficient (-.004) between the overall floor area and the living area index shows nearly no relationship between the two. A larger unit is neither more nor less likely to have a larger share dedicated to the primary room.
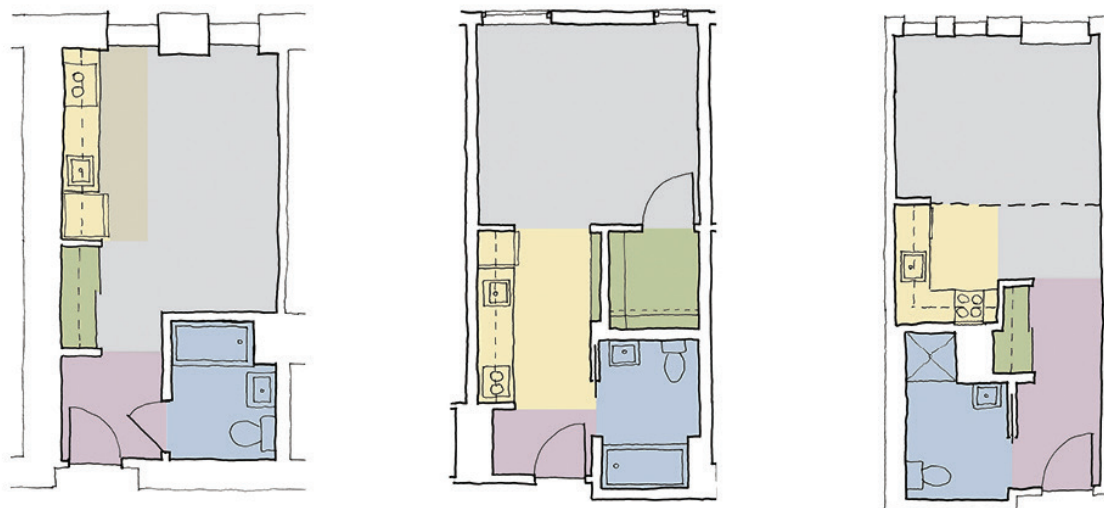

Figure 3. Bathroom Typology (l to r): One-wall at Hegeman; Two-wall at Rene Cazenave; Three wall (with shower stall) at Lincoln Park.

Also possible: a separate kitchen leads to a lower living area index. The living area index for the units with an entry kitchen was higher (52%) than it was for the main room kitchens and the separate kitchens (46% and 47%, respectfully). A large living area, or at least a high living area index, can indicate greater resident choice. Schiff, for example, has a high percentage of main living area. Spatially, there are several suitable locations for the bed (or "bedwalls"). There are no closets, so the resident can relocate the moveable clothes storage anywhere in the unit.

OVERALL LAYOUT RESULTS AND PATTERNS
The space syntax analysis leads to clear patterns in the layout of the major components of the units. As seen in the typology matrix, the highest-level categories were units with a distinct entry and units without. For units with a distinct entry, the next division is defined by the next room: kitchen or main living area. Further categorization results from the bathroom access (entry hall or kitchen) and kitchen position (separate or pass through). Within the group without distinct entries, the only further categorization is based on the presence of storage.

Descriptive statistics confirm several of the spatial observations made of the unit layouts and the share of each component in the overall unit area. There is a strong, negative correlation (-.689) between the existence of a defined entry and the kitchen index. In other words, the units with defined entries have a smaller percentage of the dwelling floor area taken up by the kitchen. There is also a moderate, negative correlation (-.332) between the existence of the defined entry and the living area index: the living areas in units with defined entries have a smaller main living area relative to the unit as a whole. These observations in tandem reveal that the entry "steals" from both the kitchen and the living area, but the effect is much greater on kitchen size.

A jogging party wall between units can create meaningful and useable space, such as a desk at 97 Crooke; more room for usable bathrooms at Karis; and a more accessible entry at Kingsbridge (*Figure 4*). All three projects have above average unit depth and below average unit width, resulting in an elongated design. Though nesting requires expensive fire-resistive construction with more corners and potentially more structure depending on construction type, the decision to nest allows for a narrow overall unit without sacrificing unit accessibility or livability. The 97 Crooke units are treated as two separate units in the typological analysis because their entry sequence and resultant space syntax diagrams are very different. The unit on the left has a defined entry space, while the resident of the unit on the right enters directly into their kitchen. The living area of the unit on the right is diminished by the kitchen intrusion, but the unit on the right has a "lost space" area that is neither in the kitchen nor living area and not particularly furnishable.

DISCUSSION
The results of this study show the large implications of small design decisions in small units. The range of projects helps to reveal the constraints created by site geometry and orientation, jurisdiction, geography, and provider priorities. Though there is no one perfect unit, there are patterns that can give designers a head-start in creating a high-quality very small dwelling. This section details the constraints and the opportunities, including accessibility requirements and goals, construction techniques, and innovative features revealed by the analysis.

ACCESSIBILITY
Accessibility requirements impact the layouts of small units, in particular the bathroom, kitchen, and entry designs. The examined units are all from elevator-served buildings and require adaptable design for mobility impairments in every unit within these elevator-served buildings. The accessibility standard, ANSI A117.1-2009, has significant impacts in these small dwelling units. At the unit entry, the door is required to have maneuvering clearances from both the exterior and interior of the unit entry. This is a significant change from the previous version (2003) in which the maneuvering clearance at a Type B unit was only required from the corridor side of the entry door. This requirement creates an approximately 25 SF zone that must remain clear at each unit entry door. There is a

Figure 4. Nested Units (l to r): Karis, Kingsbridge, 97 Crooke.

clear, positive correlation between the presence of a defined entry and a post- 2012 completion of the project. Thus, our hypothesis is that the pull-side clearance requirement in ANSI A117.1-2009 spurred the creation of the entry as a means to provide full access. Some of the projects take advantage of the regulation to create a strong sense of arrival at the space.

Accessibility requirements for the bathroom layouts impact even the smallest and most efficient unit design. In a Type B bathroom, the bathroom door is prohibited from swinging into the clear floor space required at any fixture unless an additional clear floor space (CFS) of 30" x 48" (10 SF) is provided beyond the door swing. The most efficient bathrooms find a way to overlap this required clear floor space with a fixture required CFS, but in many cases this does add square footage to a bathroom. The implication of ANSI A117.1-2009 on a kitchen with this requirement is that you rarely find an appliance or sink close to a kitchen end wall, which adds length to kitchens designed near the unit entry.

CONSTRUCTION TECHNIQUES
In addition to building codes influencing the design of these very small dwellings, there is evidence that recent uptake of modular, off-site construction may be influencing the size and proportions, at least in certain markets. The small scale, with widths around 12 or 13 feet is a good fit for off-site construction. Some recent PSH and Affordable Housing projects in California designed by architects in this study have been utilizing modular construction (WSP 2018). In many cases, the repeatability of these micro-units could lend itself to modular construction, but typical project financing methods for affordable housing provide a barrier. Thus, most of the unit plans studied are in site-built construction.

A project investigated in the previous common area research, Star Apartments, utilizes prefabricated construction (Michael Maltzan Architecture 2019). This building, by Skid Row Housing and Michael Maltzan Architecture (the project team for Crest and Rainbow) has a similar unit design to Rainbow, though slightly narrower. The team chose prefabrication because of the limited budget and tight schedule.

INNOVATIONS
The focus of this study was deriving patterns from existing, very small dwellings, but along the way we witnessed intriguing innovations. Many are discussed earlier in the paper, such as Greenway Flats bed nook and the effective nesting seen at Karis, Kingsbridge and 97 Crooke. Other examples include: Richardson breaks convention and swings the entry door into the hallway in order to provide more push-side clearance; the extra counter at Hegeman counts as an accessible, lowered work surface, but also serves the main living area as a desk or table; the extra counter at First Place is intended as a dining table and it also closes off the kitchen area to create separation from the main room; the lowered ceilings at the kitchens at Lincoln Park and

Kingsbridge are a subtle way to differentiate the kitchen from the adjacent spaces without losing floor area. Small moves like those listed above improve the quality of life for residents, making the most of the small space. As noted in the introduction, streamlining layout decisions allows the architect more time and energy to innovate.

CONCLUSION
In summary, this research study finds clear typological patterns amongst the built, very small dwellings located in permanent supportive housing projects. The most significant of these patterns are related to the entry to the unit, and the layout and procession of the rooms after the entry. Though our hypothesis was that the bathroom and kitchen location is the first design decision, we find instead that the entry decision governs the subsequent design.

One limitation is the issue of data inconsistency. The plans are of differing quality: for some projects we have full constructions sets with dimension strings; for others we have scans from magazines that we scale through assumptions about door and counter width. For this reason, our area and linear dimensions may differ from the architects' calculations and we welcome corrections (and higher resolution plans). The other inconsistency is in our ability to visit the apartments themselves: where there is no vacant unit, privacy prohibits our visceral understanding of the apartment and for these we rely on photos.

There are two paths for future research. The first is typological. Is this an architecture of minimums? Should the most efficient type of each component dominate and then the living area is maximized? We also wondered about the importance of alignment: Does it matter to anyone but architects? How does this aspect of unit design intersect with lost space? To answer these questions, the architects should be the informants, in a rigorous qualitative study.

The second path is related to livability and resident impressions. The question of kitchen location is especially apt for a resident survey or focus group, especially if a given provider had a variety of layouts across the portfolio that could be compared by residents. A less invasive study could involve visiting the units to understand more about furnish-ability by visually surveying the variation in the residents' choices using Gosling's personal living space cue inventory (Gosling et al. 2005). While the intent of the research is to establish the stylized facts of this increasingly common housing type and to provide a framework for designers, whomever their client or end user, validating the design decisions through feedback from the users will be a natural next step.

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