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WEATHERING THE STORM:
Mental Health and Resilient Design

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ABSTRACT

The goal of this research project was to evaluate the relationship between resilient design strategies and their impact on the mental health of building occupants during a crisis event. We hypothesized that certain resilient design strategies were better suited to mitigate the negative effects on mental health, and, through analysis of this potential, be ranked by efficacy.

The methodology for evaluating specific design strategies' potential was a formula that measured each strategy's potential to mitigate multiple contributing factors to victim stress in a crisis event. These factors were: the ability to address both acute and chronic events, the ability to address the five major categories of stressors, and finally the ability to address four major types of stress. After being scored against these factors, the strategies were then analyzed against cost of implementation to determine total efficacy.

The evaluation revealed that the majority of the fourteen strategies evaluated have a potential for mitigating negative mental health impacts on building occupants. While some strategies may prove cost prohibitive for many buildings, nine of the fourteen strategies were considered marginal to low cost solutions that are easily implemented in both new and existing buildings.

Once the vulnerability of a building or space is determined, priority can be given to implementation of the strategies best suited to address those factors.

It is recommended that further field testing and data collection through surveys and interviews are necessary to investigate the effects that the design strategies covered in this research have on occupants' stress..

KEYWORDS: mental health, stress, resilience, disaster, design

1.0 INTRODUCTION

The goal of this research project was to evaluate the relationship between resilient design strategies and their impact on the mental health of building occupants during a crisis event. The primary goal of most resiliency-focused design strategies falls under one of several areas: mitigating property damage, preventing disruption of basic utilities such as electricity and water, or minimizing physical threats to occupants. Crisis events affect the mental health of individuals by causing anxiety-related responses that can later evolve into chronic and severe mental health disorders. Studies have recorded elevated levels of stress induced mental health issues in populations who have experienced flooding, and during slow-developing events such as prolonged droughts that include anxiety, depression, post-traumatic stress disorder (PTSD) and increased incidence of suicide[1].

Despite these statistics, little research has been conducted to assess the impact of specific strategies on reducing stress and associated mental health disorders in populations during and after an event. This is likely

due, in part, to the difficulty in predicting the location of future events and in gathering first-hand accounts from occupants pinpointing the impact of specific strategies, however it is critical not to underestimate the potential impact. There has been research compiled and resources are available on the impacts of community-level planning for emergency preparedness and how mental health issues can be addressed at the neighborhood level. As such, the following research focuses primarily on strategies at the single building level. Some community-scale approaches are scalable to single buildings, especially for structures with multiple floors and tenants.

As an example, after Hurricane Katrina, 42 percent of the people who stayed behind said they did so because they could not evacuate with their companion animals[2]. Since then, in 2006, FEMA was directed to develop emergency preparedness plans to ensure that state and local emergency plans take into account the needs of individuals with pets and service animals during a major disaster or crisis[3]. This may illustrate the important role that companion animals often play in mitigating mental and emotional distress for victims, and how failing to acknowledge this undermined the efficacy of other emergency planning measures.

This article aims to establish criteria that predict the potential for different design strategies to impact the mental health of victims. It is intended to provide guidelines to design teams for evaluation of design strategies. Ultimately, the goal is to improve the mental health of victims before, during and after crisis events by helping people cope with stress through design solutions. The framework could also serve as a tool for assisting end users in the decision making process during project scope discussions and long-range planning.

The document assesses a series of design strategies selected for their potential to positively impact the mental health of occupants during a crisis event. It is not intended to be an exhaustive analysis of all strategies for resilience. Due to the limitations mentioned above, the article attempts to predict impacts through analytical criteria rather than analyzing evidence based research.

1.1 Defining Resilience in Design

According to the American Institute of Architects, resilience, in the context of architectural design, is defined as design that is able to "adapt to changing conditions and to maintain or regain functionality and vitality in the face of disturbance"[4]. The American Psychological Association defines resilience as "the process of adapting

well in the face of adversity, trauma, tragedy, threats or significant sources of stress – such as family and relationship problems, serious health problems or workplace and financial stressors."[5]. While both definitions refer to adaptability, does this refer to the potential for resisting acute hazards during a crisis, or does adaptation refer instead to the chronic hazards in the period after a crisis? How can resilience be achieved at a building or tenant fit-out level, where there is the most direct potential for occupant interaction? With certain building types, is it possible to separate maintaining functionality strategies from promotion of mental health strategies? Based on these questions, for the purposes of this article, we define resilient design as the following:

"Resilient design reduce negative impacts to the physical and mental health of occupants by allowing adaptation in the face of crisis, while providing basic requirements for mental and emotional well-being, thereby reducing stress and the long-term effects caused during and after a crisis event."

This definition addresses both the immediate physical and longer-term emotional needs of victims. Although many efforts assess resilient strategies for impact on reducing damage to property and eminent physical threats, few address the emotional and mental health aspects. More chronic events also have direct psychological impacts. In drought-affected rural Australia in 2007 and 2008, populations reported increased rates of stress, social isolation, domestic abuse, and suicide[6].

Findings like these lead to the question: which common resilient design strategies have the most potential to positively impact mental health of occupants? We hypothesized that certain design strategies would be better suited to meaningfully reduce negative impacts on mental health during an event, and that by analyzing the number of ways a strategy is best suited for acute or chronic stress events, we can predict which strategies will best reduce mental health issues related to stress during an event.

There are strategies that address the mental and emotional health of victims, but they are often only applicable at a community level, with good reason. Communities that are connected with strong social networks are able to better organize themselves and recover more quickly than communities lacking these characteristics. Community efforts following environmental threats often focus on civic impact, typically utilizing community centers and places of worship to facilitate communication between community members. This begs the question, for anything bigger than a single family dwelling, what

are buildings if not small communities, and can these same strategies be scaled down to a building level? Particularly in urban settings, many mixed use, multifamily and large office buildings already operate like small communities.

Resilient design strategies often focus on a few specific building types. Planning for resilience is an increasingly present goal for hospitals and residential buildings. Hospitals obviously provide critical support services before, during and after any crisis event, and with the personal investment we make in our homes, it is easy to understand why this is the case. According to the Bureau of Labor Statistics, Americans spend almost 60 percent of their waking day at work[7], making a business district or office building the most likely place many people will be when short-term events with little warning occur, such as earthquakes, or terrorist attacks. It is just as critical that these buildings be resilient as healthcare and residential facilities.

It is also important to understand the potential duration of a threat, and the impact this has on buildings, occupants and their mental health status. This is important because some strategies are better suited for addressing one type of threat than others. For instance, shelter facilities are intended to provide temporary shelter in the event of a short term event, such as an earthquake or a flood. However, they have very limited impact on resolving longer term threats, such as drought. Conversely, a water reclamation strategy in a building is intended to address long term loss of municipal water supply and has no direct benefit on a short term threat like storm or earthquake.

1.1.1 Acute and Chronic Events

In the climate adaptation and resiliency planning spheres, events are categorized as either being acute or chronic. While the definition of each term varies based on the source, it should be noted that in all conditions the definition of the term relative to a crisis event is also relative to the greater timeline of normal condition as described below.

An acute event is one that has a clearly defined beginning and ending in time. Acute events may or may not provide warning to an affected population to allow for preparations. The most straightforward examples of acute events include weather events, such as tornadoes, hurricanes, and blizzards. Occupants may have minutes or days of notice to prepare for safety. Earthquakes are considered acute events, though aftershocks and effects may occur over several days. Non-weather acute

events include terrorist attacks and outbreaks of illness. These events are abnormalities that may leave residual effects on the landscape, but the events themselves do not linger. A heat wave can also be considered an acute event. Even though a heat wave can last for days or weeks, it is generally identified with a beginning and ending, and in relation to the greater weather patterns of a location it is not a continual event. Acute events can also be caused by people. Fires and acts of terrorism may have lasting impacts, but generally have a defined beginning and ending.

Chronic events, on the other hand, may have an identifiable start date, but have a less discernable ending, or are not expected to end. Chronic events may have immediate impacts on a population, but also may have long-term effects that ultimately change the natural, geopolitical, and built landscape of a location permanently. Events such as long-term drought and sea-level rise have lasting effects physically, as well as psychologically. War may begin with a specific violent action, but may continue for months or years and have profound impacts on populations. People develop different coping mechanisms for chronic events than for acute, and they will need to learn to live differently in the longer term.

1.2 Mental Health: Setting the Stage

The predominant negative impact on mental health during an event crisis is stress. Stress can manifest as a host of other related health concerns. Symptoms vary from person-to-person based on physiological make-up, genetics, life experiences and emotional state before an event. Additionally, mental health needs vary according to the severity and scope of an event and individual victims are at risk according to their own severity of exposure[8]. Because of the variability in the extent and type of disaster, no consistent rates of psychiatric illness can be predicted for every situation. While more extreme illnesses like PTSD are easy to recognize, they are not the most prevalent. Common problems attributed to Hurricane Katrina included memory disturbance, anxiety, insomnia, psychosomatic illness and relapses of pre-existing psychiatric illness[9]. Stress can lead to physical, emotional and behavioral symptoms that eventually degrade an individual's mental health status. Stress can also impact the mental health of a community following a crisis event, exacerbating perceptions of insecurity in vulnerable communities and influencing aspects of cultural identity[10]. Other common mental health related symptoms can include anxiety, depression, solastalgia (distressing sense of loss), post-traumatic stress disorder and even suicide, persisting for years following an

event[1]. One year after Hurricane Katrina, mental health professionals were reporting that 6.4 percent of the effected population still had suicidal thoughts, and that serious mental illness had increased 89.2 percent from baseline levels in the population[9]. Despite this, it is still common for emergency responders and officials to view the assessment of the mental health needs of trauma victims as secondary, ignoring immediate post-incident interventions. The result is that mental health officials are required to respond to individuals emerging from traumatic events who are already severely impaired cognitively and emotionally[8].

Because the symptoms are so varied, and are based on a combination of personality, history of psychological and emotional response strategies, degree of the disaster's impact, breadth of loss and environmental status, an analysis of the socio-environmental factors causing the distress is the most effective way to eliminate stress and its impact on a survivor's mental health. Stress is linked to the social vulnerability of a community or individual, and is caused by feelings of vulnerability related

to access to information, power or control over a situation, access to resources, capacity to adapt to altered environment and means of communication.

In order to reduce or eliminate stress for victims during an incident, it is first important to understand the root causes of stress during the event. Once this is understood, design strategies can be evaluated on their ability to address these stressors. Previous literature suggests that there are seventeen social vulnerability indicators that can be used to predict the vulnerability of an individual, household or community[11].

The indicators range from household structure and housing status to level of education and language skills, and are grouped into the following five larger categories:
• Child care needs
• Elder care needs
• Transportation needs
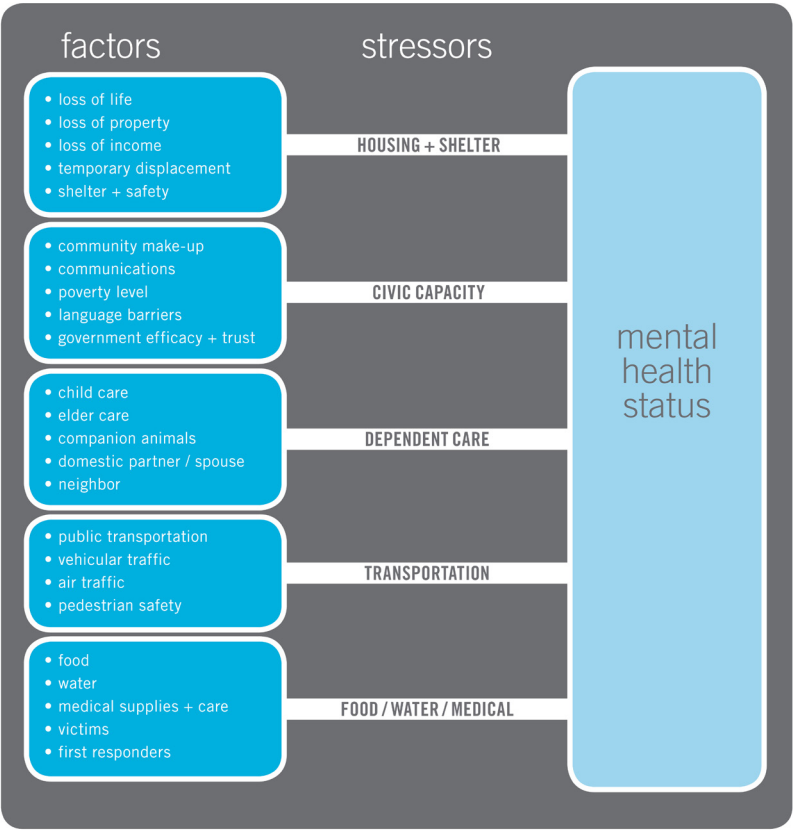• Housing and shelter needs
• Civic capacity needs.

Figure 1: Stressors impacting mental health.

The work hypothesizes that when these indicators exist in a geographic area, that region is less adaptable when faced with a crisis event, resulting in great vulnerability. It is this sense of vulnerability in the face of disaster that is the source of stress for victims, therefore, the same list of needs can be used as the basis of a framework to categorize stressors during a crisis. For the purposes of this study, we have modified the five categories slightly to include the following:
• Housing and shelter
• Civic capacity
• Dependent care
• Transportation
• Food / water / medical.

1.2.1 Stressors
Housing and shelter is often the most immediate cause of stress to disaster victims. The ability to provide for basic physical needs and safe shelter is perhaps the most basic drive for humans. Feeling that these conditions are not met, or that our ability to provide them is compromised, can result in elevated stress levels. The threat of short or long term displacement can begin contributing to elevated stress levels even leading up to an event, if, in the case of storms, the event is to some degree predictable, and can continue long after the event has passed. As many as 23,000 people sought temporary refuge in shelters following Hurricane Sandy, a storm that damaged up to 200,000 homes[12]. Research indicates that disaster-related displacement or relocation including loss of property are factors that contribute to mental health concerns, such as PTSD and depression[13].

Civic capacity, or the make-up of a community and its ability to effectively communicate during an event, is easy to overlook in planning, but can be a significant source of stress to residents when it is compromised. Lack of connectivity to other individuals and lack of access to current information during and after an event can result in elevated stress levels. This can be caused by different situations. Loss of power and cellular networks are common reasons communication from authorities and between individuals are cut off during an event. Socioeconomic status can also impact an individual's or community's access to information. Authorities often assume residents in an area all have access to the same information during planning and execution of disaster preparedness policies. However, studies show that certain communities are inherently distrustful of media and government communications, preferring to rely on social connections within the community. This limits the ability for effective communication[11]. Lan-

guage barriers are another reason many individuals do not receive current or accurate information during a crisis. The phenomenon known as "urban sprawl", a term referring to the expansion of development across large geographic areas outside major urban settings, also impacts the civic capacity of a community. Low residential and employment density, low connectivity between destinations and dispersed activity centers are common indicators of urban sprawl[14]. These attributes increase the vulnerability of neighborhoods by lowering their civic capacity. Civic capacity also gives rise to questions of social equity. Low-income and minority populations are more likely to inhabit vulnerable communities with the least resources to deal with stressors during a crisis[15].

Dependent care, or in other words, providing care for individuals that are dependent on certain individuals during a crisis, can be a major source of stress for those individuals. Children, seniors, chronically-ill family members and even companion animals impact a household's ability to adapt to environmental issues. Dependents often have limited mobility or communication abilities, impeding the ability to quickly respond to an event. Dependents may be remotely located at primary care locations, requiring additional travel and coordination. This can be physically dangerous when concerns over dependents drive primary caregivers away from sheltered locations during an event in order to provide care. The emotional impact from concern over dependent care can also contribute to trauma. For example, concern over childcare needs in the days following an event might elevate stress levels in individuals who must get back to work quickly after a disaster, before daycare centers have reopened. Additionally, the mental health impacts on children and older adults can manifest differently than average adults. In the wake of Katrina, certain mental health problems were prolific in elderly populations, including higher rates of depression and suicide, resulting from a sense of loss over their life work and savings. These issues can in turn impact the emotional state of those close to them[9]. Other research notes that more severe stress is exhibited in children than adults after disaster[6].

Transportation needs can also be a stressor, particularly in urban settings where residents depend heavily on mass transportation, or where larger percentages of households do not own vehicles. The ability to mobilize resources after an event is critical to treatment, but also to regaining a sense of normalcy. Transportation shut downs affected 8.5 million people following Hurricane Sandy due to the flooding of New York City's subway system and East River tunnels[12]. The impact that trans-

portation can have not only effects those relying on mass transportation. Bridges and tunnels in and out of both Manhattan and Washington DC were closed for at least a full day after the attack on 9/11, leaving many people stranded in the city. Restaurants and stores were unable to receive scheduled deliveries, impacting their ability to serve the numbers of people stranded in the two cities. Similarly, air traffic was suspended, stranding people across the country. Transportation provides critical access to employment, childcare, medical facilities and other resources in many communities, particularly in non-urban settings where services are dispersed. Many low income and minority neighborhoods may lack even basic infrastructure for pedestrian traffic, such as sidewalks, crosswalks and street lights, further impacting occupants' ability to travel when vehicular traffic is impeded[15].

Finally, the need for basic food, water and medical supplies can be an acute stressor in many crisis events, for not only the victims, but emergency responders as well. Challenges in locating food and access to fresh water is often the most immediate stress to impact victims following an event. Locating medical supplies and administering them to injured companions is another stressor that takes a toll on victims. While many care providers, such as police, fire, rescue and paramedics are afforded some degree of protection from mental health impacts during an event due to their formal training, they still often times suffer emotionally after a major event. Informal first responders, often times normal citizens without formal training who might be in proximity, are particularly vulnerable[8]. The stress of locating and administering very basic first aid while waiting for professional medical help can acutely impact an individual's mental health status.

1.2.2. Types of Stress
Categorizing stress can be challenging. The multitude of potential stressors attached to crisis events will affect individuals differently, based on their ability to cope with stress, make decisions, remain focused in pressure situations, and engage a positive outlook whenever possible. Other factors assist individuals in managing stress levels. These factors may include aspects of the built environment around them, but also individual means of coping. Examples may include meditation, exercise, hobbies, or interaction with children and animals.

Related to times of crisis and catastrophic events, it is helpful to see potential stressors as affecting individuals with respect to timing. In his book *From Crisis to Recovery: Strategic Planning for Response, Resilience, and Recovery,* George W. Doherty groups the effect of

incidents and events into four categories[16]:
- *Anticipatory* stress is that when individuals have concern for a future issue or event. If we take the example of a hurricane, a person may experience anticipatory stress in the days leading up to the storm hitting his or her location, after the individual becomes aware of the pending incident.
- *Situational* stress is experienced during a crisis situation. The newness, uniqueness, and magnitude of the situation become the concerns of the moment. In the hurricane example, this is the stress experienced while the individual rides out the storm.
- *Chronic* stress is worry over time. This is longer-term emotion that includes prolonged incidents and the immediate after-effects of short-term events. Chronic stress would be felt by those impacted by a long-term severe drought, or in the example of the hurricane would include prolonged weather and immediate effects such as flooding or loss of power. Similar to the definition of a chronic event, the timeframe for chronic stress is relative to the timeframe of the crisis event itself.
- *Residual* stress is that experienced after a crisis event has concluded. This category includes unresolved emotions an individual may feel related to experiencing a catastrophic event, as well as feelings of uncertainty about a repeat of the event. Some psychologists link this type of stress in severe cases to post-traumatic stress disorder (PTSD), often experienced by soldiers returning home from battle and victims of violent crimes[16].

It should be noted that PTSD is sometimes referred to as Delayed Stress, as symptoms or signs may not surface within an individual until well after the event has been experienced[16].

All four types of stress can be impacted by a variety of factors, and these in turn will influence the intensity of an individual's reaction to the stress. Key factors include duration, presence of multiple stressors at one time, the relative importance of a situation to a person, how an individual evaluates stress, experiencing reminders that trigger memories of past events, and an individual's ability to manage or tolerate stressors.

Other research uses different terminology to categorize the phases of stress, but the timeframes are similar to those outlined above. In the compilation "Interventions Following Mass Violence and Disasters" emotional and psychological responses are categorized as immediate, early adaptation, mid-phase, late-phase, and resolution[8].

1.2.3 Mental Health Summary
Many studies link elevated stress levels to degradation of mental health, both in individuals, and communities. Research has also shown that a range of mental illnesses can be found in the victims of climate related crisis events, brought on by the stress endured leading up to, during and after the event, which are classified as Anticipatory, Situational, Chronic and Residual stress. Both acute and chronic term events impact victims in varying ways, and individual symptoms depend on many factors. Low income and minority communities are particularly vulnerable, due to general lack of resources. Stressors during an event can be grouped into five categories, Housing and Shelter, Civic Capacity, Dependent Care, Transportation and Food/ Water/ Medical. It is by studying how resilient design strategies address the combination of the type of stress, and specific stressors, that we can begin to assess their overall ability to impact mental health.

2.0 RESILIENT DESIGN STRATEGIES
Designers have the ability to incorporate strategies into a structure and into the functionality of a space that can positively impact the mental health of occupants throughout the duration of a crisis event. While there are more strategies to consider than the constraints of this article will allow, we have selected a number that represent both design and operational tactics. We have also listed simple, low-cost options suitable for new construction as well as retrofits in addition to more complex solutions that most likely carry a higher installation or long-term cost.

Due to the wide range of potential threats resilient designs try to address, there are many facets to even the simplest strategies which have the potential to positively impact the mental health of victims in the right circumstances. Understanding scale, building type and event duration are all key to assessing the potential for any design strategy.

Many of the strategies presented in this article align with those associated with the concept of passive survivability - defined as a building's ability to maintain critical life-support conditions in the event of extended compromise[17]. While passive survivability focuses more on loss of life and basic physical necessities, minimizing occupant discomfort can be extended to acknowledge the positive mental health benefits of such planning.

Each strategy is briefly described, followed by an analysis of mental health benefits and a conceptual discussion of magnitude of cost.

2.1 Green Roof as Gathering Space
A green roof on a structure has long been considered a multi-faceted sustainable design strategy. When designed properly, it provides thermal insulation at the roof level. It provides for added wildlife habitat and reduces the urban heat island effect in certain settings. A green roof also assists in mitigating stormwater by retaining rain that falls on the surface and slowing the water that flows to storm systems, which is important during heavy precipitation events. A thoughtfully-designed green roof can also provide welcome outdoor amenity space to building occupants.

The roof of a building can be one of the safest places for occupants during or after a catastrophic event, especially if lower portions of the building are compromised. This is easily seen after weather events such as Hurricane Katrina in 2005, when residents took to their roofs in flooded neighborhoods. A green roof provides an added amenity to provide respite from indoor spaces when occupants cannot leave a building, and the green roof will have cooler ambient and surface temperatures than a typical membrane or gravel roof.

Green roofs do have limitations, though. They do not provide shelter from the sun, wind, or precipitation. Their use may be somewhat limited during certain types of crisis events.

Mental Health Benefits
If occupants are required to remain in a building for any length of time due to a catastrophic event, a green roof provides a connection back to nature that is often thought to relieve stress[14,18]. Incorporation of interactive elements, such as walking labyrinths, personal gardens, and space for lawn games provide for mental distraction, even if temporary. Having an alternate space to go to during and after a crisis event, especially one with connection to nature, may reduce situational and chronic stress in occupants, as well as residual stress after an event has passed. A habitable green roof provides an alternate approach to addressing the housing and shelter stressors associated with a crisis event by expanding the area available to occupants if not confined indoors for safety. Civic capacity is also addressed as the roof may be the largest safe gathering space available for all occupants of a building.

Cost
There is a premium to add a green roof to a building, whether as new construction or as a retrofit. Part of the cost is fixed in the type of green roof system selected and can be estimated based on the system's area. How-

ever, a building's roof structure may need fortification for added weight of the system and the water it will retain from rain. Added structure, along with any required roofing assembly repair, needs to be factored into the total installation cost.

2.2 Green Roof as Food Production

A green roof can be an amenity and sustainable strategy in many ways, as noted above. When designed correctly, it can also provide for cultivation of certain types of fruits and vegetables. Studies have called attention to the lack of resilience in many urban areas with respect to food supply, noting it may take a significant amount of time for supply levels to return to post-event levels[19]. Production of food can assist in easing the food needs of a small population directly after a crisis event.

The depth of the green roof system and the growing medium will determine what types of edible plants—if any—can be grown atop a building. Most green roofs tend to be extensive, meaning the depth of the system is usually six inches or less and it is most suitable for sedums, herbs, and other drought-tolerant plants. An intensive green roof system provides for a deeper growing medium and can accommodate a wider variety of plant types. Most green roof systems will not accommodate root vegetables and trees that bear fruit, but other types of edible plants can be cultivated.

Growing fruits and vegetables on a roof requires careful consideration of typical gardening variables – climate, growing season, whether or not irrigation is provided, and soil nutrition. Depending on a building's location, the growing season may be limited. Drought tolerant plants are always primarily recommended. Plants that require regular irrigation should be carefully planned.

Mental Health Benefits
In situational and chronic stress situations, access to fresh food can be severely limited. With power supplies available, perishable foods typically last three to seven days. Without power and refrigeration, perishable food will be inedible in 24-72 hours. Mental anguish can start to occur with the first signs of hunger. Growing fruits and vegetables on a building roof can respond to some of the food/water/medical stressors with occupants knowing there is a food supply available. It has been noted that when people have a problem to solve and focus on, they more easily move from despair to a sense of hope and empowerment[6]. Fruits and vegetables are also generally more nutritious than processed foods, contributing to physical health as well. Finally, cultivation of food on the roof allows for activity and

mental diversion from the chronic stressors at hand.

Cost
The same cost factors discussed above are applicable for green roofs that are used to grow food. However, if deeper soils are required to grow certain types of vegetables, the building structure must be adequately designed for the added load of the growing medium and additional amount of stormwater it will hold.

2.3 On-Site Renewable Energy

Renewable energy is not a new concept. The use of non-polluting sources to generate energy on a site has been in practice for years in passive methods and in recent history technology has allowed the sun's rays and changing winds to be converted to energy and stored for later use. Originally criticized for up-front cost on installation, use of renewable energy technologies have dramatically increased over the last twenty years. Buildings and sites can be designed for rooftop energy generation, as well as integrated strategies that allow for solar, wind, and geothermal energy sources within and applied to a structure.

During a catastrophic event, it is not uncommon for buildings to lose power for a variety of reasons. In addition to general building functionality, loss of power can significantly impact the communications systems as well as food preservation.

Mental Health Benefits
On-site energy generation may allow critical building systems to continue to function without significant downtime, addressing situational and chronic stresses. Emergency systems for a typical office building may include modified lighting levels, ventilation (with or without conditioning of the air), elevators, and communications systems.

If communications systems can be maintained and broader systems are not compromised, occupants can maintain contact with dependents and loved ones. As inability to contact dependents is one of the greatest stresses during a chronic event, allowing for power to communications systems—even limited—can alleviate stress.

While most on-site energy generation in urban settings does not completely meet the demand of the building, the renewable energy system can be sized for serving a stripped down capacity of critical needs. Building occupants may feel a sense of security knowing that critical building systems can be maintained during a

catastrophic event (combatting anticipatory stresses), a response to the housing and shelter stressors often associated with a catastrophic event.

Cost

The cost of photovoltaic panels continues to drop, with prices for solar energy systems costing 30 percent less than they did five years ago[20]. However, there is still an up-front cost for new construction to integrate a solar array into the building design. In addition to the system itself, the armature required to support panels tilted toward the sun must be designed to resist uplift from winds, which impacts the connections to building structure below. Other types of energy systems attached to a building also must be evaluated for impacts on the building's structure.

Cost benefit analysis should also be performed between rooftop energy systems and other options, such as green roofs. Systems may compete for space, limiting the building to one roof function.

Like any other building system, there is a cost to operation. This cost includes regular maintenance and general upkeep by building engineers, connections to building automation systems, and costs of repair over time. However, this strategy also has the ability to reduce long-term building energy costs as well. A life-cycle cost analysis can be performed to provide a truer indication of payback and total cost of ownership.

2.4 Building Elements above Flood Plain

It is not uncommon for major pieces of mechanical equipment to be located on a building's roof, especially in urban environments where space at grade is at a premium. If a building is located in a known flood plain, additional planning of building elements may be required to ensure occupant safety during a catastrophic event or natural disaster.

One of the greatest risks for buildings sited in low-lying areas and for building spaces at or below grade is flooding, which can occur as a result of a variety of types of events. Regularly occupied spaces located at or below grade in a flood plain provide for risk of loss of life, loss of property, and loss of function. It is common (especially in urban markets) for daycare facilities to be located in the lower levels of multi-tenant office buildings. This location is chosen for a variety of reasons: easier access for children, less disruption to business workers, and using less desirable space for service instead of tenants. However, the risk associated with ground level or below-grade daycare needs to be carefully considered in areas prone to flooding.

Moving occupants to higher floors also poses challenges. Evacuation plans should be thought through, and the existing building egress stairs analyzed to confirm they can accommodate larger numbers of users. Certain types of occupants - such as small children or the elderly - may also be more challenged in evacuating from higher floors.

Unoccupied regular uses may be more suitable for grade-level spaces in buildings within known flood plains. These uses may include lobbies and circulation, service spaces such as trash rooms and loading docks, bicycle storage, and tenant storage.

Mental Health Benefits

Occupants may feel a lessening of anticipatory stress knowing that their regularly occupied space has a lesser risk of flooding because of the building's interior spatial configuration, or that the entire building is not located within an area at risk of a 100- or 500-year flood. Planning for building elements such as daycare facilities also addresses dependent care, civic capacity, and shelter related stressors.

Having critical facilities and systems above a known flood plain also can relieve situational stress, as building components would not be compromised by flooding.

Cost

Cost for this strategy is difficult to pinpoint, as it relies heavily upon when the strategy is employed—during initial building design or as a retrofit—and what spaces are being located at a higher elevation. When taken into consideration during initial project design, this strategy could be low to no cost. For example, moving critical mechanical systems from at or below grade to a higher floor in a high-rise office building would nott greatly impact the total run of pipe and duct if considered in the design phase. Relocation of a system after the building is operational is a much costlier exercise.

2.5 Transportation for Building Occupants

When Hurricane Sandy hit the New York metropolitan area in 2012, many major transportation arteries were compromised due to significant flooding and lack of electricity. New York City was paralyzed with respect to transportation: rail and subway tunnels were flooded and unusable, and roads were flooded and buckled from soil saturation. During the days after the storm, more people moved through the city by bicycle or walking than by train, car, or bus[21].

A building can provide dedicated parking or storage for occupant-owned bicycles used for daily commuting.

An additional area can be reserved for bicycles owned by the building or landlord that could be used in crisis situations when other types of transportation become unavailable or unsafe.

Sustainability rating programs, such as LEED for Commercial Interior and LEED for New Construction, offer requirements for user-owned bicycle parking as well as space for visitors' bicycles. These designated areas may allow for building- or tenant-owned vehicle storage as well without adding more storage requirements[22].

In locations prone to flooding or within known flood plains, simple inflatable rafts and pumps may be a viable transportation option in crisis. When deflated, the rafts take up minimal space.

Mental Health Benefits
Occupants may feel a sense of relief from anticipatory stress knowing that there is transportation available in their building which could be utilized in a time of emergency. Safe transportation options also relieve residual stress by allowing occupants to move away from the facility after an event occurs. The ability to travel to dependents or loved ones, along with the ability for occupants to leave the building to obtain supplies, medicine, or food could be considered a critical building amenity for those in areas that can expect disruption in normal transportation options.

Cost
While any number of building-owned vehicles represents an up-front cost commitment on behalf of the owner (in addition to regular maintenance cost for upkeep), there could be multiple uses for building-owned bicycles during times of non-crisis in addition to providing a safe and non-fuel-intensive transportation option for occupants during crises.

Inflatable rafts and manual pumps are inexpensive in terms of up-front cost, and require no regular maintenance. If ever inflated and deployed, inspection for leaks and patching is the minimal maintenance time required.

Dedicated space for bicycles may or may not take rentable area away from the larger facility. With bicycle storage generally expected or mandated in most urban environments, and when compared to the area required for parking of one car, the cost for the bicycle storage space would be a minimal consideration. Building-owned alternative vehicles (bicycles and/or inflatable rafts) could be stored in unrentable space (such as under stairwells) to minimize impact on rental income.

2.6 On-Site Storage of Emergency Supplies: Food

Basic necessities of life can be the most critical elements of survival when it comes to crisis management and resilience. Multi-use buildings are typically not stocked with food to support the normal occupant population. Storage of food (and any other good, for that matter) requires dedicated space within a building. This storage space must be sized appropriately for the number of occupants and a pre-determined number of days' worth of nutrition per occupant. The U.S. Federal Emergency Management Agency recommends at least a three-day supply of food per person[23]. The RELi Resilience framework notes thresholds of two, four and ten days' worth of food for two times a building's occupancy[24]. The cost per area of storage space needs to be translated into rentable or non-rentable income as appropriate to the tenant or building owner. Food-storage space should also have the ability to be well-lit, but in general should be kept cool and dry. Canned and packaged foods need to be checked periodically for expiration dates, which requires maintenance time.

Mental Health Benefits
Occupants may experience reduced levels of anticipatory stress leasing up to an event just from knowing there is a supply of food available in their building in the event a crisis situation occurs. They may also experience reduced levels of situational and chronic stresses knowing there are necessities available to weather through an event. For building-wide food storage, this strategy could be considered as a building amenity for tenants.

Cost
There are two general costs related to storage of nutrition for occupants: the cost of the food itself and the cost of the space required for the storage. Generally non-perishable foods are not a high expense, but the cost will be determined by the number of occupants being accommodated and the number of meals allocated to each occupant.

The cost of space may be a greater financial concern, especially in regions that carry high rental costs for tenant space. For example, a lease for commercial office space in Washington, DC may be $55 per rentable square foot of space. If a storage closet is required for a floor of occupants that is roughly 6 feet by 3 feet, that equates to $990 per month in rent for that room on that floor, or $11,880 in rent per year.

2.7 On-Site Storage of Emergency Supplies: Water

Much like the storage of food described above, storage of water for building occupants requires calculation of storage space based on the number of occupants to be supplied and the desired timespan of service. Unlike estimating the number of required meals though, water can be estimated using health standards of gallons of fresh water required per person for survival. According to FEMA, one gallon of water per person per day is required for drinking and health, and a three-day supply of water is recommended per person. Nursing mothers, children, and sick individuals may require additional water per day[23].

Storage of water could be achieved through commercially-bottled products—to be considered a static supply—or could be more dynamic with collection of rain water on the building's roof and site and sent through on-site treatment and purification systems to achieve a drinkable quality. On-site retention and purification can be costly options as they require up-front design and construction as well as ongoing maintenance for operation. Water stored in tanks or cisterns needs to be checked regularly for bacteria and organisms deemed unhealthy to humans. Purified water needs to be proven drinkable to local health authorities on a regular basis. On-site water reuse, though, could be a building operation strategy year-round and in non-crisis times as well, serving the building as long as there is adequate rainfall to do so. Based on connections to local wastewater systems, reused water could be treated to a lesser standard and used for toilets, urinals, and outdoor irrigation. The system could be switched to a higher treatment standard when needed for drinking, bathing, or cooking. Water reclamation systems need to be evaluated by cost with respect to their return on investment, valuing the upfront cost of design and installation with the potential long-term reduction in utility-provided water supply needed.

Provisions for water supply are considered requisite in the RELi Resiliency Action List, and are noted to be sized appropriately for occupant load and a range of timeframes[24].

Mental Health Benefits

Knowing that there is a supply of drinkable water available in crisis situations may allow occupants to experience reduced levels of anticipatory stress leading up to an event. They may also experience reduced levels of situational and chronic stresses when necessities are available to weather through an event. The ability to relieve chronic stress will be directly proportional to the amount of water stored and how long it can last. When on-site water reclamation systems are employed, residual stresses may be relieved as well as the building can return to normal operation faster.

As mentioned earlier regarding food storage, building-wide water storage could also be regarded as a building amenity for tenants.

Cost

The same cost considerations should be studied for water storage that were raised for food storage when undertaking using commercially-available water products. For water reclamation systems the cost will be significantly higher, especially when considered as a building retrofit. There is cost associated with the system components that will clean the water for various levels of use as well as a cost to provide the energy required to pumps and filters on a regular basis. In times of emergency, back-up power would be required to keep the pumps operational. There is also cost associated with taking space in a building for water storage, and finally the cost for personnel to maintain the system.

If the system is planned for use during normal occupancy as well as times of crisis, there may be a cost savings realized in the reduction of utility charges for both potable water and removal of waste water.

Like any building system, a life-cycle cost analysis can be performed to determine total cost of ownership and potential return on investment. Due to the general long-term nature of return on investment with these systems, this strategy may be most applicable for owner-occupied buildings and long-term lease tenant spaces.

2.8 Emergency Communications

As already noted in this article, inability to communicate with loved ones is considered the top stressor in crisis situations. Modern technology may allow us to be in constant contact with others around the world, but if cellular towers are incapacitated during a storm, the devices can be rendered useless. Some events also spark above-average use of cellular service, overwhelming the service and again rendering cell phones useless.

Provision for emergency communications can be designed and constructed into a building or tenant space to allow for occupants to attempt contact with dependents, as well as allow for general communication with emergency services. Examples of emergency communications include traditional phone ("land") lines, NOAA weather-band radios, HAM radios, and limited-use cel-

lular phones ("track phones"). Dedicated wireless internet service may also be a reliable option provided power is available for modems and routers.

The recently-released RELi Resiliency Action List includes communications provisions as a requisite in the Hazard Preparedness category, with enhanced access to a wider variety of communications as a separate checklist item[24].

Mental Health Benefits
As previously mentioned, the inability to communicate with dependents can be one of the greatest stressors during and after a catastrophic event. The simple ability to speak with a loved one or arrange care for those who are remote and cannot care for themselves can ease anxiety when travel to that person or persons is not available. In addition, provisions for alternate communications can assist building maintenance and operators in connecting to municipal emergency personnel and coordinating needed repairs, rescue, transfer of occupants, and supplies (civic capacity).

Emergency communications means would be employed during a crisis situation as well as in the immediate after-effects, addressing both situational and chronic stresses.

Cost
Generally, provisions for communications are low compared to other strategies. Most types of communications do not take up significant rentable area, and service can usually be arranged as a part of overall telecommunications provisions. Some options— such as HAM and NOAA radios—do not need anything more than a supply of batteries and antenna access to the sky.

2.9 Shelter in Place
When designing a new building, certain elements of the structure can be designed with consideration to potential crisis events anticipated in a specific area. The opportunities to impact occupant safety can vary greatly, and may be larger than the purview of this article. However, a few examples that address rethinking building elements include:
- In geographic areas prone to earthquakes, the building structure can be designed for progressive failure. Anticipated compromise of the structure can be pinpointed in the design, allowing a portion of the building to fail (or collapse) without impacting the structural integrity of the rest of the building. Building occupants can be notified of this feature, knowing to retreat to areas designed for greater stability during an earthquake.

- Operable windows are sometimes considered anathema to mechanical systems, but in times of power failure these openings allow for natural ventilation as well as potential escape routes (depending upon height above ground level). They may also encourage the ability for residents to signal to emergency personnel on the ground.
- Buildings considered targets for terrorism often require blast-resistant windows. While this conflicts with the ability to achieve natural ventilation, it may protect building occupants in the event of an act of terrorism.
- An area on each floor of a building—particularly in a common space—can be identified as a safe area for occupants if the enclosure to the area has enhanced fire resistance, structural bracing, and communications methods. Not unlike areas of refuge within a fire stair, larger spaces can be used for emergency gatherings of all occupants when exiting a building is not possible. In regions prone to tornados, designated safe areas are not uncommon building components. This "safe area" may incorporate other strategies listed in this article, such as provisions for food, water, and communications. The design of the space may emphasize safety and calmness in the finishes and colors employed on the walls and floor.

A single tenant within a building can also prepare for safe shelter of occupants without the entire building providing the option. For example, creating a designated safe area as noted above can occur within a tenant space.

Mental Health Benefits
Shelter is considered a basic necessity of life, and providing for a basic necessity is a straightforward way to alleviate some types of individual stress. As society becomes increasingly mobile, traditional links to sense of place have been strained[14], and considering a physical space to be a safe haven may be less common. Notifying occupants that a specific location in a building is designed for specific safety needs may combat the current trend of constant mobility and fragility. Occupants may feel less anticipatory stress leading up to an event knowing there are provisions in the building or tenant suite designed to enhance safety. Situational stress may also be lessened because of the safety provided by the building itself. Other stressors such as dependent care and food/water/medical issues may also be addressed within the designated safe area within a building, but would be determined by individual building needs and spatial capacity.

For buildings designed with resilience aspects as noted above, certain elements may be considered attractive to tenants when looking for new space.

Cost

Cost for this strategy varies greatly based on the aspects of the building affected, and whether the work is planned as part of the initial design or as a retrofit. Designating a "safe area" on each floor of a building may not require more than the designation itself if the area was constructed with high levels of fire resistance, for example. Replacing windows may be a higher cost item, and obviously depends on the number of units being replaced and what qualities the new panes include. Progressive failure of a structure must be designed into the initial construction and can dramatically increase up-front construction cost, but then requires no ongoing operational or maintenance expenses.

2.10 Training for Personnel

When dealing with large groups of people, designated leaders or coordinators are invaluable in keeping the group on track, on task, or in motion. Many buildings rely on volunteer leaders for fire drills to ensure all occupants leave the building and are accounted for. These same volunteer leaders could be called on in crisis to provide key direction to occupants, ensuring safety in the short or long term. For a typical multi-tenant office building, the key personnel may include building engineers, building security, and designated administrative staff for each tenant.

For personnel to be effective in crisis, there are several fundamental elements in which they will need to be well-versed to effectively lead and guide other occupants. Depending upon the total building population and the types of tenants in a structure, these skills include:
- Understanding the crisis management elements designed into a space, such as emergency communications, safe haven areas, etc.
- The ability to give clear direction
- Knowledge of the building or tenant population, including whether transient guests are present and need to be accommodated
- Knowledge of key organizations and municipal departments appropriate for the building and how to get in contact with each (such as fire and rescue, police, the Red Cross, etc.)
- Basic first aid skills to treat common wounds and illnesses, and any training specifically required by a unique occupant group (children, the elderly, etc.)
- Certification in CPR

- The ability to delegate tasks as required, and to assess occupant situations to a decision point.

Training and certifications must be kept current. Key personnel should be required to take annual courses to refresh skills as required, and changes to building policies or elements need to be communicated to all designated personnel.

Mental Health Benefits

Proper training can assist in addressing many categories of stressors, including civic capacity and food/water/medical factors. Occupants may experience less anticipatory stress knowing that there are key personnel trained to assist them in the event of an emergency. Situational stress for occupants may also be decreased with individuals who are charged with maintaining some level of quality of life should they be unable to leave a building during an event. Longer term stress may or may not be alleviated with strong leadership as other elements of the event and environment may become more pronounced.

The designated personnel who act as leaders in crisis may experience elevated levels of stress when put into crisis situations. These individuals should be evaluated for the ability to handle stress when selected for these leader positions, but should also be provided additional mental health support when a situation has subsided as they may be prone to residual stresses. The Center for Disease Control and other organizations provide a framework of resources for first responders and emergency personnel that can be adapted or transposed to event-specific personnel[25].

Cost

General first aid and CPR training is minimal to no cost, and can often be arranged for groups directly through aid organizations, such as the American Red Cross. Annual or semi-annual meetings refreshing knowledge of building features take minimal paid staff time and can offer valuable information on a semi-regular basis.

2.11 Communications to Occupants

Emergency preparedness comes in many forms. Pre-event communication and preparedness training have been strongly encouraged in "disaster prone" areas and those that experience certain "disaster seasons" (such as "hurricane season" in the southeast United States)[6]. At its simplest, buildings notify occupants when there is a change in routine related to preparedness drills and systems testing (such as fire drills and alarms). That same strategy can be extended to communicat-

ing building-level resilience planning measures. Occupants can be informed or reminded on a regular basis of building features that may assist in a time of crisis. These communications can take a variety of forms including emails, posted flyers, permanent placards, and all-hands type meetings. Any communication should be handled prior to crisis, that is, on a regular basis in times of non-crisis to allow occupants to understand plans for dealing with specific types of crisis events. New occupants should be given the information during new employee orientation periods.

Depending on the resilience aspects of a building or space, management should determine the most effective means of communication for the specific group of occupants. Communications may also vary based on the type of event for which specific messaging is being planned. Some catastrophic events, such as hurricanes, allow for more time leading up to the event for communication. Plans can be tailored to specifics of the event. Other types of events, such as tornadoes and earthquakes, do not allow for anticipatory time for instruction. Planning for these events should be communicated ahead of the immediate need so that occupants have a level of preparedness before a crisis situation.

Mental Health Benefits
Occupants who understand the crisis management aspects of a building or tenant space may experience lower levels of anticipatory stress leading up to an event, and may react in calmer and more measured ways during an event (situational stress). Good communication and outreach also deal directly with elements of civic capacity, and depending on the content of communications can also deal with other stressors.

Cost
For many types of communication to building or suite occupants, the cost is virtually nothing as it only takes the time to draft or forward an email or make a general announcement. Communications can be presented in forums already in place, such as all-staff meetings and management updates. Permanent placards may be the most costly form of communication as they take time to design, order, and install, in addition to the material cost of the items. However, relative to other building-wide strategies this tactic is one of the lowest in cost.

2.12 Strategy Summary and Efficacy
The matrix presented in Table 1 summarizes the resilience planning strategies outlined in this research article and their potential impacts on mental health of the occupants. The chart does not rank the strategies in

any order, but does offer a snapshot as the variables each strategy represents. Specifically:
- The strategy is categorized as a design approach (D), or an operational approach (O), or impacting both design and operations (D, O)
- Stressor categories addressed: Housing & Shelter (H), Civic Capacity (C), Dependent Care (D), Transportation (T), and Food/Water/Medical (FW)
- Types of stress impacted by the strategy: Anticipatory (A), Situational (S), Chronic (C), and Residual (R)
- Whether the strategy addresses Acute (A) or Chronic (C) events
- A cost factor, relative among the discussed strategies.

Recognizing that stress, stressors, coping, and emotional health are all very much tied to the mental health of the individual, ranking strategies with respect to efficacy is extremely challenging. The variables of geographic location, type of building, climate, and local infrastructure make it almost impossible to say with certainty that one design strategy will be more effective in improving mental health than another.

For the purposes of this research, and to provide a starting point to design teams for decision making, the following explains the methodology of relative efficacy based on the factors previously discussed in this research. The equation below (Figure 2) scores each strategy based on the number of stressors addressed, the number of types of stresses addressed, and whether the strategy applies most to an acute event or both acute and chronic events.

The numeric score for each strategy was plotted on the graph against the relative cost established in the narrative and summarized in Table 2. The chart shows the efficacy of the strategy in relation to cost. This information may assist design teams in determining the value of a design strategy, particularly when budget is constrained. For buildings undergoing renovation, a strategy may carry a greater cost, but may also provide for greater impact on occupants.

The graph shows that the strategies selected to be part of this research are spread fairly evenly among relative cost. The numeric scores calculated with the formula above show that the selected strategies all have high efficacy levels with respect to metal health. There are many other strategies for design teams to employ that may have less effect on occupant psychological well-being, and those have not been considered in this study.
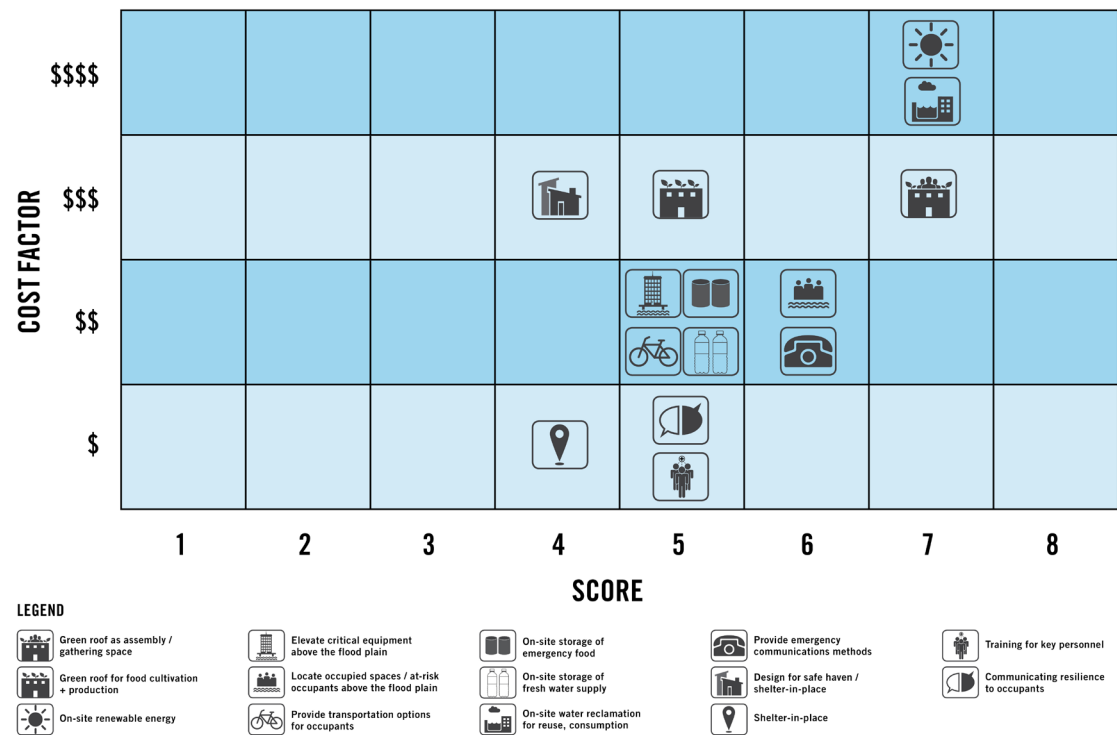
Table 1: Summary of design strategies and impacts on stresses, stressors, and relative cost.

RESILIENCY STRATEGY		DESIGN OR OPERATIONAL	STRESSOR CATEGORIES	STRESS TYPES AFFECTED	ADDRESSES ACUTE OR CHRONIC STRESS	COST FACTOR
	Green roof as assembly / gathering space provide for shade, cool roofing, and soft turf for occupants should use of the roof be required for safe haven during an event	D	H, C	S, C, R	A, C	$$$
	Green roof for food cultivation + production use a green roof system for growing fruits and vegetables when seasonally and geographically appropriate	D, O	FW	C, R	A, C	$$$
	On-site renewable energy incorporate passive energy generation into the structure; power key systems in crisis	D	H, C	S, C, R	A, C	$$$$
	Elevate critical equipment above the flood plain mechanical, life support	D	H	A, S	A, C	$$
	Locate occupied spaces / at-risk occupants above the flood plain this applies to existing buildings located in a flood plain	D, O	H, C, D	A, S	A	$$
	Provide transportation options for occupants bicycles located within a facility	O	T	R	A, C	$$
	On-site storage of emergency food stock nonperishable food for occupants	O	FW	S	A	$$
	On-site storage of fresh water supply stock water supply for occupants	O	FW	S	A	$$
	On-site water reclamation for reuse, consumption filtration of rainwater and / or stormwater for basic needs	D, O	H, FW	S, C, R	A, C	$$$$
	Provide emergency communications methods land line phones, HAM and NOAA radio	O	D, C	S, C	A, C	$$
	Design for safe haven / shelter-in-place upgraded design or building retrofit	D	H	A, S	A	$$$
	Shelter-in-place designate safe haven areas	D, O	H	A, S	A	$
	Training for key personnel first aid, CPR, emergency responsiveness	O	C	A	A	$
	Communicating resilience to occupants messaging methods	O	H, C	A	A, C	$
Stressor Categories: Housing + Shelter (**H**), Civic Capacity (**C**), Dependent Care (**D**), Transportation (**T**), and Food/Water/Medical (**FW**)						
Types of Stress: Anticipatory (**A**), Situational (**S**), Chronic (**C**), and Residual (**R**)						

$$\left(\begin{array}{c} \text{\# of stressors} \\ \text{addressed} \end{array} \right) + \left(\begin{array}{c} \text{\# of types} \\ \text{addressed} \end{array} \right) + \left(\begin{array}{c} \text{1 for acute impact, 2 for} \\ \text{acute \& chronic impact} \end{array} \right) = \begin{array}{c} \text{strategy efficacy} \\ \text{score} \end{array}$$

Figure 2: Design strategy efficacy equation.

Table 2: Relative cost plotted against efficacy.

LEGEND

Green roof as assembly / gathering space	Elevate critical equipment above the flood plain	On-site storage of emergency food	Provide emergency communications methods	Training for key personnel
Green roof for food cultivation + production	Locate occupied spaces / at-risk occupants above the flood plain	On-site storage of fresh water supply	Design for safe haven / shelter-in-place	Communicating resilience to occupants
On-site renewable energy	Provide transportation options for occupants	On-site water reclamation for reuse, consumption	Shelter-in-place	

3.0 CONCLUSION

As research clearly indicates, there are many ways that stress can take its toll on victims, and how it manifests may vary among individuals. Therefore, how can the best strategies be identified for a project? As with all design strategies, specific project and client goals must always be taken into account when determining the correct course. The first step is to start by determining the vulnerability points of a project site. Which of the five stressors are most likely to impact the occupants of a space? Tenants in an urban office building are much more likely to suffer from transportation related stress if an event forces mass transportation systems or tunnels and bridges to close than those in non-urban settings. Conversely, less densely populated areas typical have a higher ratio of families than urban settings, meaning that dependent care may be a more prominent stressor. The make-up of building occupants can also determine the stressors most likely to impact occupants. Race, gender, age and level of education all influence how an individual or community responds to a crisis.

Once the most eminent stressors are determined, the next step is to evaluate the threats most prevalent in the site's geographic and climatic region. Is the space in California, where earthquakes and drought are real threats, or is the project on the coast of Florida where hurricanes and flooding are of greater concern? Determining the nature of the threat will help to identify the kinds of stress occupants are most likely to suffer from. In the case of California and earthquakes, anticipatory and situational stress may be quite low because there is little warning, and the event itself happens very quickly. This means earthquake victims are much more likely to suffer from chronic and residual stress, as the aftermath of earthquakes may take years to resolve. Strategies that provide accessible food and water would mitigate some of the chronic stress caused by an earthquake. Looking at the coastal Florida example, anticipatory stress plays a greater role in the days leading up to a storm. With the regularity of hurricane season, residents may even experience anticipatory stress annually, whether a specific storm is threatening or not. Operational strategies communicating disaster planning protocol would reassure occupants that a plan is in place, helping to reduce anticipatory stress. Building use will also impact selection of specific strategies. Occupants in a hospital will experience very different stress than those in an office building.

By determining the stressors most likely to impact occupants and the types of stress, it is possible to understand the most vulnerable aspects of a building or space. Prioritizing strategies that address the specific needs of that population is necessary. Investment into resources for solutions with the most potential to mitigate stress on occupants is essential. However, this effort does not always require a large monetary investment. Operational strategies focusing on communication protocol and training require relatively little funding (compared to building retrofits) and can still be impactful if addressed as part of change management.

Any steps taken to eliminate the toll of stress on occupants during a crisis event have the potential to reduce longer term mental health issues. The positive effects can be tremendous. For the occupants, less stress means fewer thoughts and actions that may be risky or dangerous to the individual or others. Studies previously cited note that manifestations of stress often are visible depression as well as volatile actions, such as assault, abuse, and even suicide. For employers, lowering anticipatory and residual stress may result in generally happier and more confident employees as well as lower insurance costs. Finally, the building owner and manager may make a building more attractive to potential tenants showing there is resilience planning in place, and may even benefit from lower property insurance costs. Further research should focus on these various benefits and effects to quantify their value, as well as find ways of refining the strategies that relate to building design. Climate adaptation planning and resilience can quickly fall into negative and pessimistic dialogue as populations deal with issues such as rising sea level, extreme weather events, and terrorism. Providing design solutions that promote positive mental well-being is one method of turning that dialogue around.

Ideally, designers will begin to use tools and methods, such as those presented in this article, to challenge the notion of good design, adding the psychological dimension to discussions of form and function. The design community as a whole has the opportunity to make resilience and impacts on mental health integral components of a project solution, bringing these issues to the same realm as building aesthetics, structural integrity, and sustainability.

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