

Webinar: Envisioning In Situ Sea Level Rise Adaptation Strategies for a Densely Developed Coastal Community, Waikīkī



Photo credit: Ireland Castillo

Poll Results and Q&A

Presentation April 1, 2022,
via Online Webinar by the University of
Hawai'i at Mānoa

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I. ACKNOWLEDGEMENTS

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II. PROJECT BACKGROUND

One approach to manage sea level rise in densely urban Waikiki is to assume an in-place adaptation strategy which needs to be defined and envisioned. The University of Hawai'i Sea Grant College Program, SOEST, and the School of Architecture are working on a research project to create conceptual architectural and urban renderings to visualize preliminary flood adaptation strategies in Waikiki to compel discussion and contribute to future design guidance, pilot projects, and policies.

III. PRESENTATION GOALS

Sea Grant graduate research fellows from the School of Architecture presented example architectural renderings depicting potential sea level rise adaptation strategies for two sites in Waikiki for two timeframes: the years 2050 and 2100. Expert panelists discussed the advantages and disadvantages of the strategies as they apply to each site. The audience was polled for opinions. The feedback will inform future conceptual architectural renderings of flood adaptation measures in other locations.

IV. WEBINAR ORGANIZERS AND PARTICIPANTS

Presenters, organizers, and facilitators:

- Wendy Meguro, MS, AIA, LEED AP BD+C, Associate Professor, School of Architecture and Hawai'i Sea Grant
- Ireland Castillo, Doctorate of Architecture candidate and Hawai'i Sea Grant
- Josephine Briones, Doctorate of Architecture candidate and Hawai'i Sea Grant
- Eileen Peppard, MS, Project and Partnership Coordinator, Hawai'i Sea Grant
- Melanie Lander, MS, Community Planning and Design Extensions Specialist, Hawai'i Sea Grant
- Dolan Eversole, MS, Coastal Systems Extension Agent for Hawai'i Sea Grant and Waikiki Beach Coordinator, Hawai'i Sea Grant

Expert panelists:

- Lisa Raap, AIA, LEED AP, Principal, Architects Hawai'i
- Randall Wakumoto, PE, Civil Engineer, Program Administrator, City and County of Honolulu, Department of Facility Maintenance Storm Water Division

Attendees:

- 121 stakeholders participated in the webinar

V. POLL RESPONSES

The audience was polled after each set of site-specific potential flood adaptation strategies were presented for a year (2050 or 2100). Only one of the five to eight response options could be selected.

Site #1: High-rise example

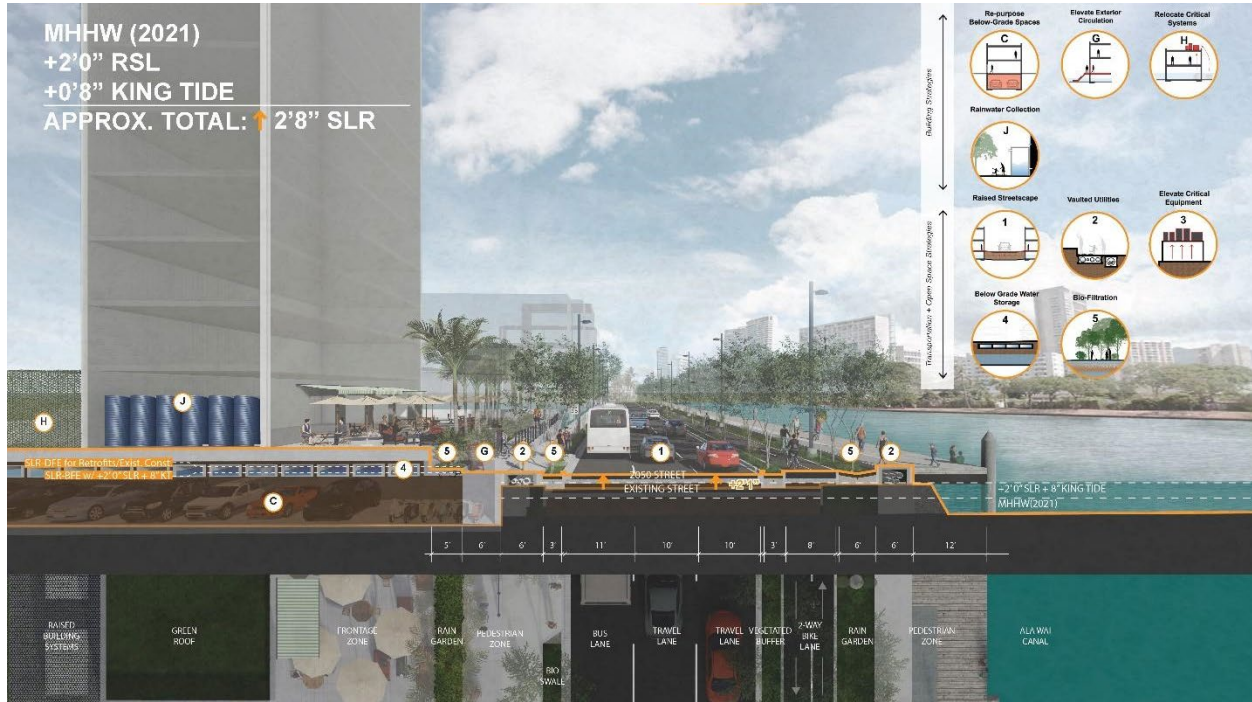


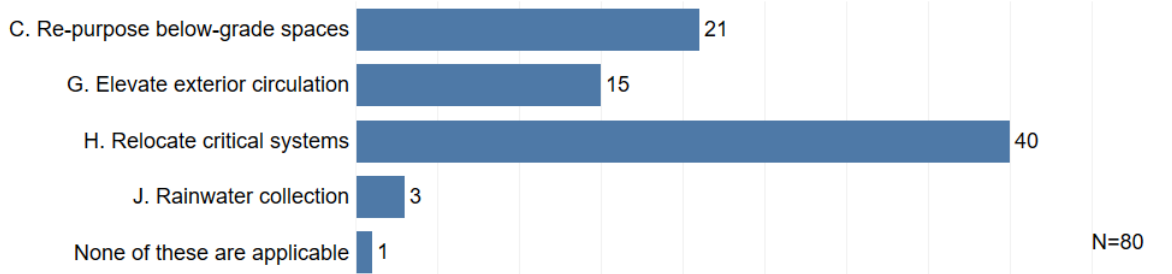
Figure 1. Site #1 depicted using adaptation strategies for sea level rise for the year 2050.



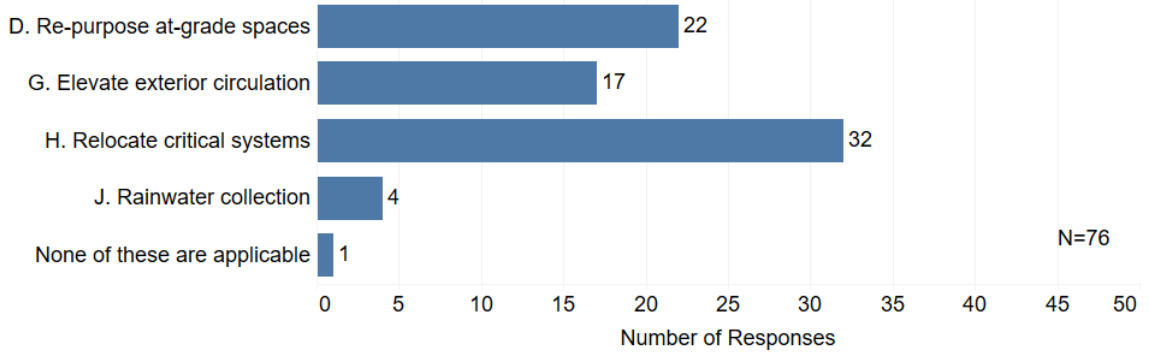
Figure 2. Site #1 depicted using adaptation strategies for sea level rise for the year 2100.

Site #1: Which building strategy is most applicable for this site?

By 2050:

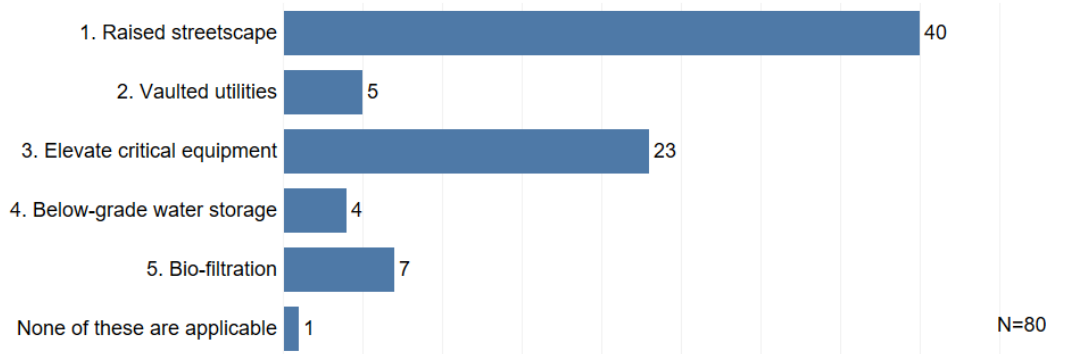


By 2100:

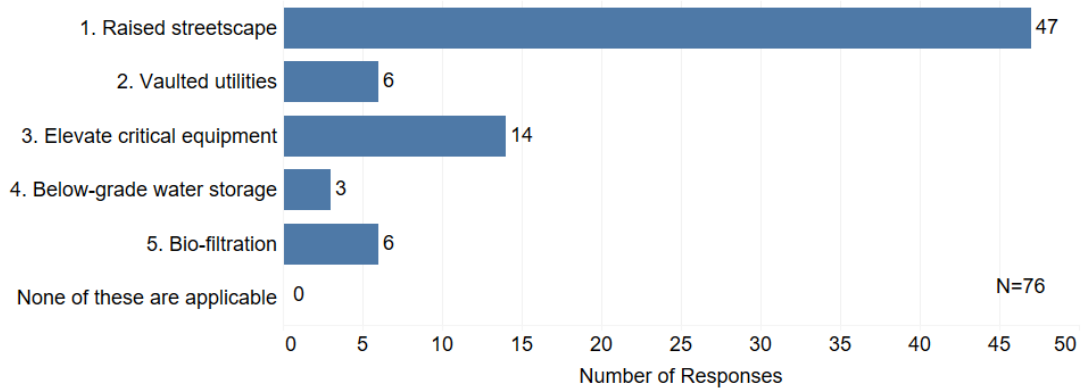


Site #1: Which transportation or open space strategy is most applicable for this site?

By 2050:



By 2100:



Site #2: Low-rise example

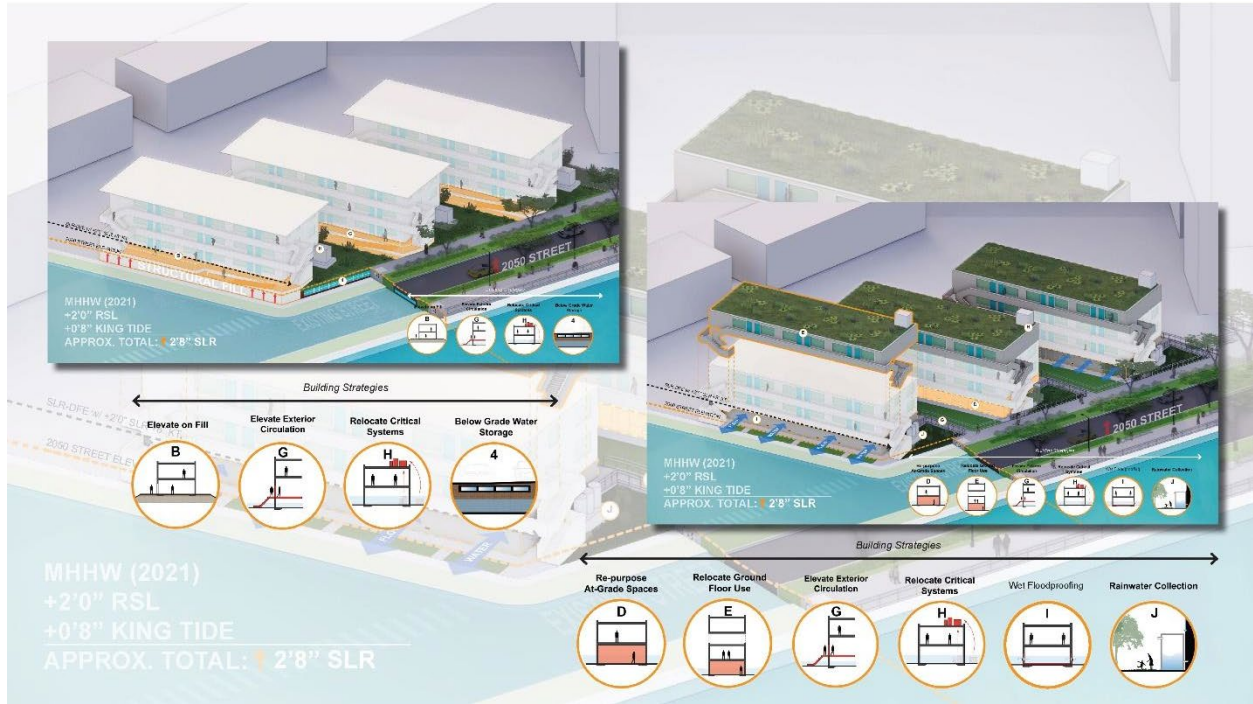


Figure 3. Site #2 depicted using adaptation strategies for sea level rise for the year 2050.

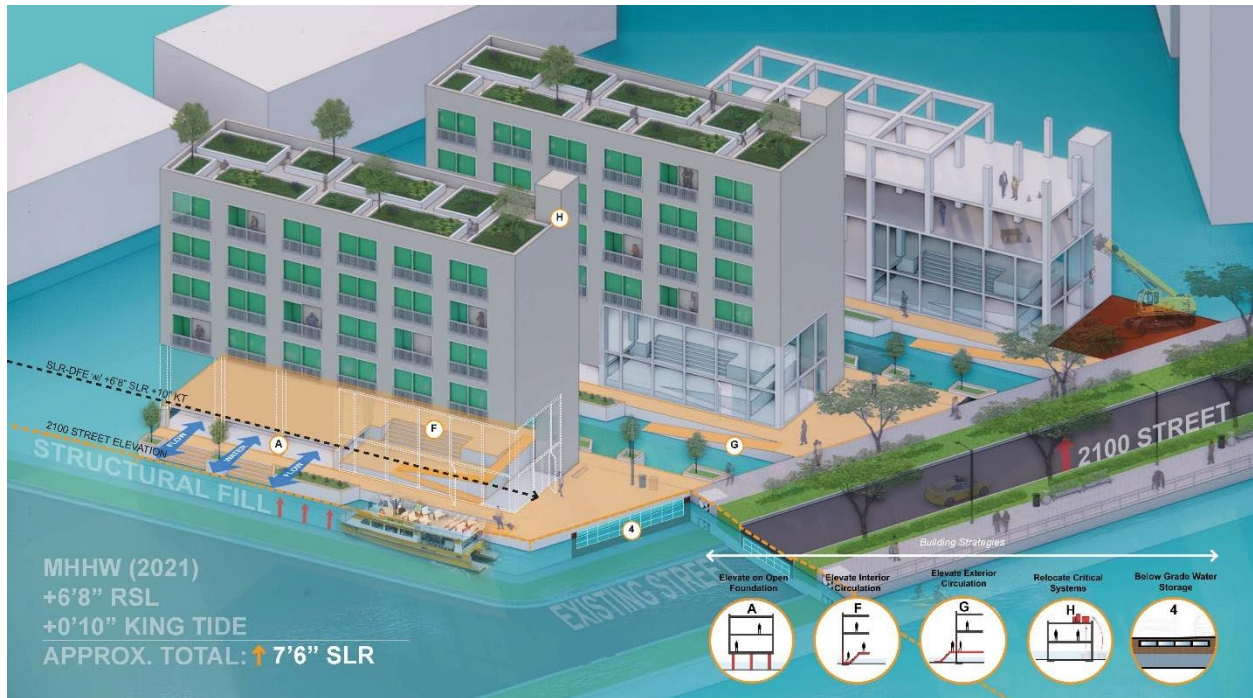
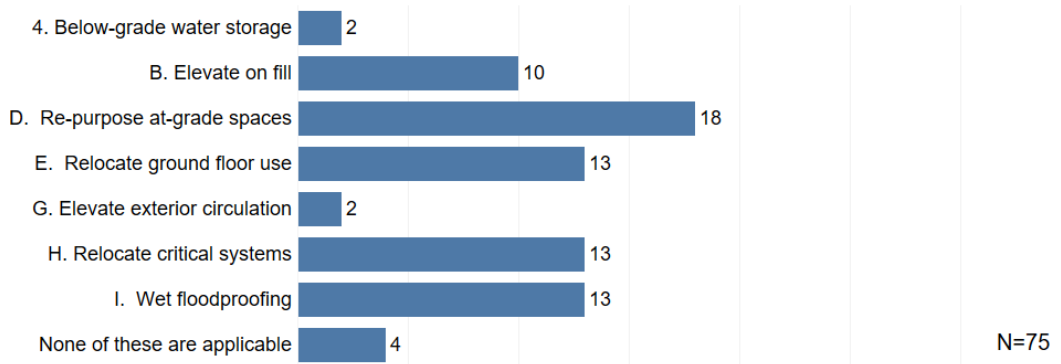


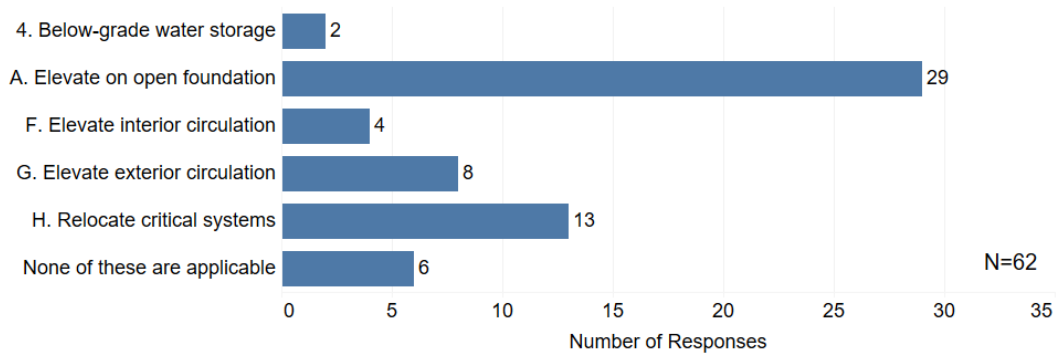
Figure 4. Site #2 depicted using adaptation strategies for sea level rise for the year 2100.

Site #2: Which building strategy is most applicable for this site?

By 2050:



By 2100:



By 2050, which transportation or open space strategy is most applicable for this site?

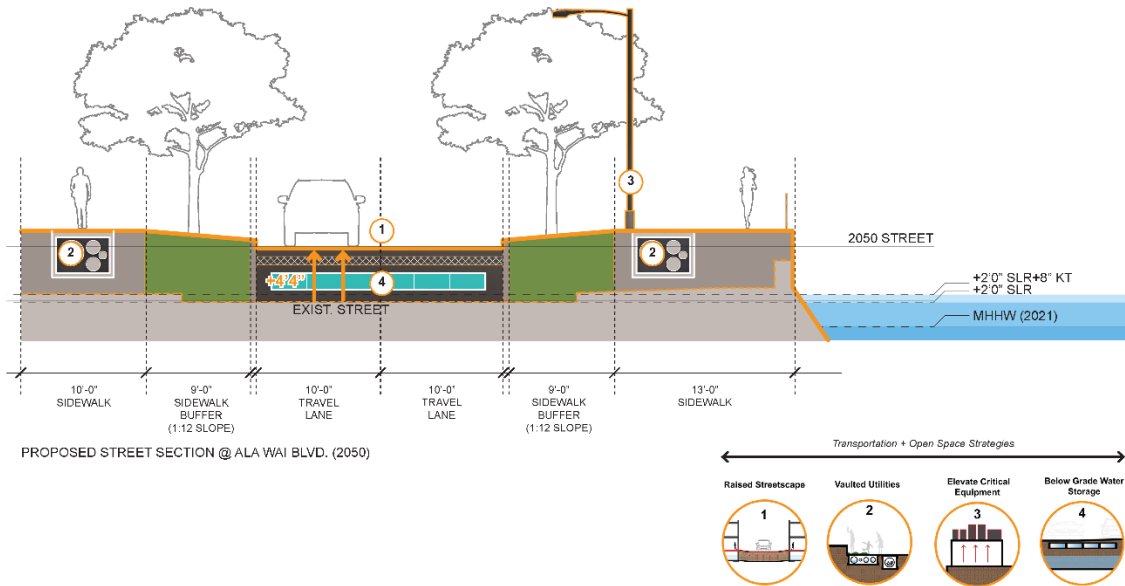


Figure 5. Site #2 depicted with transportation, utility, and open space strategies for 2050.

By 2100, which transportation or open space strategy is most applicable for this site?

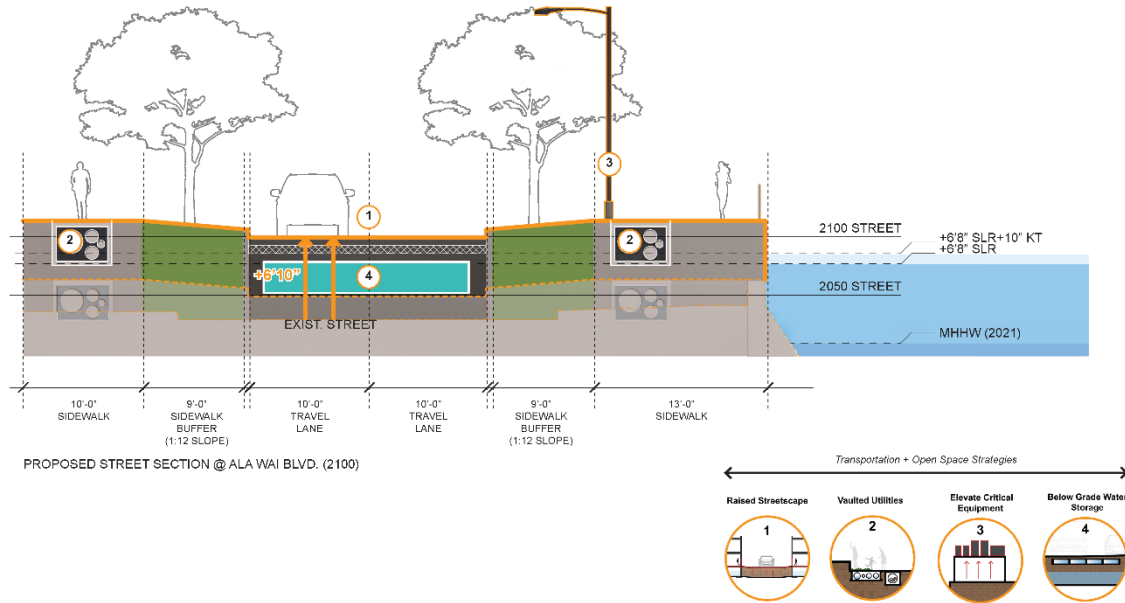
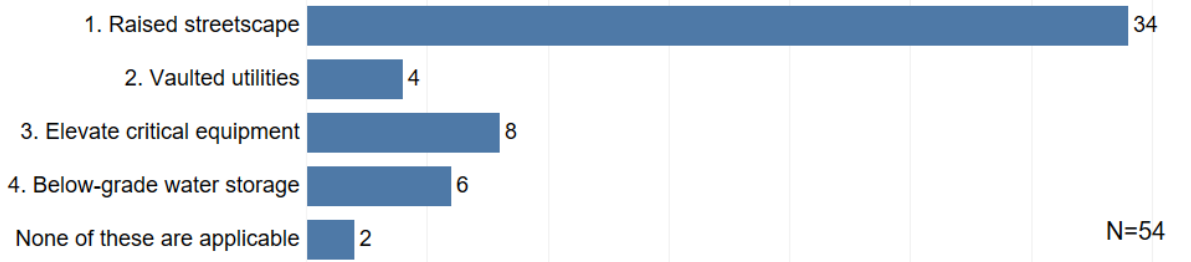


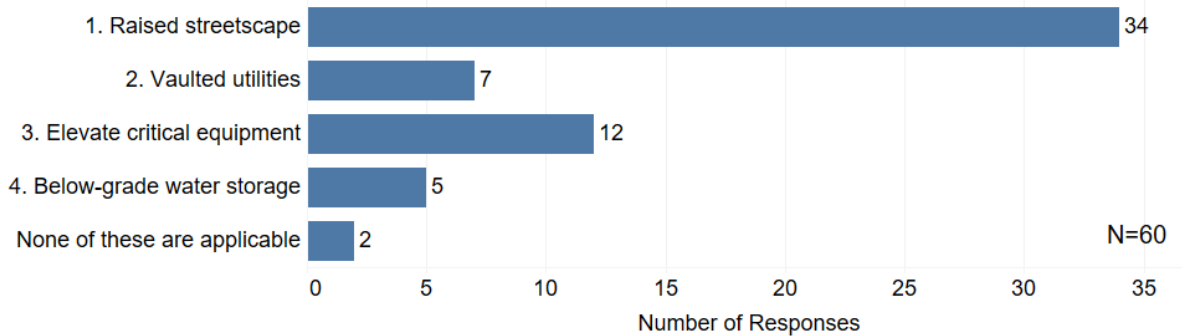
Figure 6. Site #2 depicted with transportation, utility, and open space strategies for 2100.

Site #2: Which transportation or open space strategy is most applicable for this site?

By 2050:



By 2100:



VI. COMMENTS FROM THE AUDIENCE

PRACTICAL CONSIDERATIONS

- Who is paying for this and how much will it cost?
- As a practical consideration, these low-rise buildings would be replaced going forward.
- Elevators to 4th Floor?

SEWER/WASTE

- I think we need to decentralize the sewer system.
- I agree, hopefully by 2100 water, sewer, waste, energy, and food systems will be decentralized and operate at a building/block/neighborhood level. (SLR/flood control adaptation can serve as a catalyst for this and many other much-needed changes in our approaches to regulating and operating climate-resilient, livable cities.)
- One option for buildings in flood areas due to climate change impacts, for sewer service, is to switch to a low-pressure sewer system (LPSS). An LPSS consists of a grinder pump that pumps the wastewater from the property directly to the gravity sewers in the road. This would reduce and/or eliminate additional flows from climate change impacts to the City sewer system from the impacted property.
- garbage?

TRANSPORTATION

- Thank you for doing these analyses and providing some options for the future of adaptation in Waikiki. It would be very nice if these designs would visualize an automobile minimized Waikiki, which would allow a much broader suite of adaptations. Sad reality is that once the beaches are eroded, Waikiki may become irrelevant.
- Your solutions all assume drastically reduced auto use. Is that realistic?
- Hopefully we won't have what we think of as "streets" any longer by 2100??
- Where will all this fill come from? Versus, say, elevated roadways?
- To purchase "A" parking space currently is \$85,000 in Waikiki
- I think by 2100 we can hope that there wouldn't be as many cars on the road as there is today. However, the true issue in the near-future will be parking! Especially in Waikiki.
- Issues around storage of personal cars dovetails with need for a circular economy in which (by 2050) cars are perhaps a service (think Uber) that are stored elsewhere.
- We so need land speeders

RESOURCES

- Might want to consider updating projections/timelines with the Sweet et al 2022 SLR Tech Report <https://oceanservice.noaa.gov/hazards/sealevelrise/sealevelrise-tech-report.html>
- Agreed! The 2022 Report shows slightly different amounts of SLR versus the 2017 Report which we referenced at the time of this project.
- Resources: NYC Climate Resiliency Design Guidance, Boston Coastal Flood Resilience Design Guidelines
- For more information: <https://seagrant.soest.hawaii.edu/meguro-adapting-waikiki/>

KUDOS

- I admire the wonderful work that you have done. This is a real concern.
- I agree, great job everyone.
- Great discussion, mahalo for your efforts!
- Excellent work all!
- thank you everyone! Amazing work and renderings!
- Outstanding job
- I second that, great amount of useful information Mahalo Nui!
- Excellent!
- Thank you for this session. Great work!
- Great work, looking forward to more
- Thank you!
- Mahalo nui!
- Super job! mahalo!
- mahalo

VII. WRITTEN CHAT QUESTIONS AND ANSWERS

The following are questions and comments received from the participants during the webinar on April 1, 2022. Some have been edited for spelling or clarity. The responses from the webinar hosts appear in italics. Some responses were developed by the team after the webinar with the intent of sharing them online.

Will this recording be available to the Waikīkī Neighborhood Board?

Yes, we will make the webinar recording available through the project website.

Thank you for doing these analyses and providing some options for the future of adaptation in Waikīkī. It would be very nice if these designs would visualize an automobile minimized Waikīkī, which would allow a much broader suite of adaptations. Sad reality is that once the beaches are eroded, Waikīkī may become irrelevant.

Waikīkī's adaptation to sea level rise will likely necessitate rethinking the role of vehicles in the community. In the near-to-midterm (2050), the project renderings include elevating primary roadway (Ala Wai Boulevard at mauka site) to allow vehicles and bicycles to continue to access the area. In the future, transportation planners may consider alternatives to single occupancy vehicles and restrict vehicle access to life safety and delivery purposes along secondary roadways (depicted in West Waikīkī's proposed expanded pedestrian area and reduced parking). In the longer term (2100), the renderings show tertiary roads replaced with mass transit or new alternatives like ferries. In both the near and long-term, adaptations should prioritize and enhance multi-modal access on streets and add vegetated buffers to retain and treat contaminated stormwater. Future design proposals will address how new spaces can attract people.

One option for buildings in flood areas due to climate change impacts, for sewer service, is to switch to a low-pressure sewer system (LPSS). An LPSS consists of a grinder pump that pumps the wastewater from the property directly to the gravity sewers in the road. This would reduce and/or eliminate additional flows from climate change impacts to the City sewer system from the impacted property.

Thank you for the helpful suggestion. We'll look into it for future renderings. The watertight design sounds relevant for Waikīkī to keep the rainwater and groundwater from entering the sanitary sewer lines.

As a practical consideration, these low-rise buildings would be replaced going forward.

It is likely that Waikīkī's slab-on-grade low-rise residential buildings will be replaced by the end of the century.

I think we need to decentralize the sewer system.

The decentralization of wastewater and other utility systems is a great option to enhance local resilience to both sea level rise and other forms of natural disasters, like hurricanes.

I agree, hopefully by 2100 water, sewer, waste, energy, and food systems will be decentralized and operate at a building/block/neighborhood level. (SLR/flood control adaptation can serve as a catalyst for this and many other much-needed changes in our approaches to regulating and operating climate-resilient, livable cities.)

Great suggestion!

Your solutions all assume drastically reduced auto use. Is that realistic?

Good point. This project visualized futures for two roads adjacent to the two building sites. One site is located adjacent to a primary road with three lanes of traffic and the second site was next to a less utilized road with two lanes of traffic. The proposed design gives more priority to pedestrian circulation, reduces parking, but still allows vehicles. By depicting convenient alternatives to single occupancy vehicles, the renderings are intended to envision a desirable destination.

Hopefully we won't have what we think of as "streets" any longer by 2100??

This project adopts best practices from the Honolulu Complete Streets Guide to reimagine how vehicular traffic operates. By 2100, roadways would require elevation and alternative modes of transportation (bicycle, pedestrian, mass transit, ferry) are envisioned.

Where will all this fill come from? Versus, say, elevated roadways?

The use of fill as an adaptation strategy has limitations in Hawai'i for environmental, cultural, and economic reasons. This project did not calculate the fill requirements for elevating roadways or filling below grade spaces. It will likely be necessary to prioritize some streets to raise and use material removed from other streets to elevate them. These secondary streets could detain or retain stormwater and include pedestrian and bicycle boardwalks. The use of fill is likely to require a planned and selective approach throughout Waikīkī.

Garbage?

All systems, including garbage collection and disposal, will require a form of adaptation as sea levels rise. Instead of garbage trucks, maybe one day we will have electric, amphibious garbage vehicles or boats!

Might want to consider updating projections/timelines with the Sweet et al 2022 SLR Tech Report <https://oceanservice.noaa.gov/hazards/sealevelrise/sealevelrise-tech-report.html>

Thank you. We agree. This project utilized 2017 projects, which were the best available science at the time of the team's calculations. As the project progresses and visualizes other sites in Waikīkī, those designs will be adjusted to reflect the 2022 projections.

Resources: NYC Climate Resiliency Design Guidance, Boston Coastal Flood Resilience Design Guidelines

Agreed! The 2022 Report shows slightly different amounts of SLR versus the 2017 Report which we referenced at the time of this project.

To purchase "A" parking space currently is \$85,000 in Waikīkī

Space is already at a premium in Waikīkī, and sea level rise is likely to increase the scarcity of dry, useable land. Surface parking and below grade parking may not be the best and highest use to create a vibrant community and may be phased out over time in favor of other modes of transit that are more affordable, environmentally conscious, and reliable.

Issues around storage of personal cars dovetails with need for a circular economy in which (by 2050) cars are perhaps a service (think Uber) that are stored elsewhere.

Based on the popularity of today's car services (Uber, Lyft), car-sharing, bike rentals, and e-scooters, the transition you reference likely to continue and evolve as sea levels change our roadways.

Who is paying for this work? Please answer the question.

This work was funded by a 2017 research grant from the University of Hawaii Sea Grant College Program and continues under funding from the U.S. Navy into 2022.

With the elimination of underground parking in the 2050 scenario, is there discussion or planning for interconnected above ground garages to replace it?

While this suggestion may be viable in some areas, roadways in the future are unlikely to accommodate the level of automobile-based transit we are used to today. Sea level rise and king tides will inundate the subsurface portion of roads, compromising their structure. With limited fill available to raise all roadways, along with the need to reduce fossil fuel-based transit for climate change mitigation, the strategic reimagining of roads and reduction of automobile traffic will be needed. The use of automobiles in Waikīkī is likely to dramatically decrease as sea levels rise and some roadways become impassible.

From an urban design and landscape architecture perspective (no landscape architect on your team??), it seems to me that by 2100 we should be able to reduce the travel lanes a lot further (you still have one 11'-ft bus lane and two 10'-travel lanes). Wouldn't you think that by then we won't have individual automobiles in Waikīkī any longer? Perhaps one shared travel lane would suffice in the future for access, delivery, drop off, some future electric, autonomous form of transit and autonomous, shared vehicles that might circle Waikīkī on a one-way loop; automation will make things much more efficient. That way, much more space would be available for nature-based adaptation solutions and placemaking strategies.

Our 2022 team has added a landscape architect! Regarding your suggestion for roadways adaptation, it may be necessary to limit automobiles to service vehicles in the future. Future project renderings will take this suggestion into account.

So are you attempting to gain more lanes by raising the street level? What happens to the building with underground parking?

These renderings suggest the elimination of sub-surface parking structures because they may experience groundwater inundation prior to 2050 or flooding from direct marine inundation in 2100. The raising of street levels will allow some vehicles to transit the Waikīkī area without being impacted by flood waters, however, no lanes would be added. In fact, the width and number of lanes open to automobiles is likely to be reduced to accommodate increased pedestrian and bicycle access, as well as the placement of green stormwater infrastructure.

Given the value of dense, in situ infrastructure, was any consideration given to Holland-style seawall strategies (keeping the water out versus trying to elevate everything within the area)?

Like Miami, Florida, Waikīkī's sub-surface geology, a combination of karst (limestone) and karst-based fill material, and its history as a wetland system will allow water to rise from below ground (groundwater inundation) as sea levels rise. Sea walls may have strategic applications to mitigate the impacts of wave-action on Waikīkī's seaward (makai) side, however they cannot prevent flooding from groundwater inundation.

Who is paying for this and how much will it cost?

This research effort did not include cost estimates for design proposals, however due to the density of Waikīkī's development sea level rise adaptation measures are likely to cost hundreds

of thousands to millions of dollars at the building-scale, and millions to billions of dollars at the community-scale.

Where do you think the current population will park?

With limited fill available to raise all roadways, along with the need to reduce fossil fuel-based transit for climate change mitigation, the strategic reimagining of roads and reduction of automobile traffic will be needed. The use of automobiles in Waikīkī may dramatically decrease as sea levels rise and many roadways become impassible.

AIA Hawai'i is working on building code for SLR. How do we set finish floor elevations to meet architect standard of care? Given that buildings have long service life.

This research team studied the SLR-adapted design flood elevations from other municipalities in order to propose potential design flood elevations for the study sites. The proposed SLR-adjusted Base Flood Elevation in a given year includes the 2022 Base Flood Elevation + depth of sea level rise for the useful life of the building + estimated king tide for the useful life of the building. The AIA may want to reference the 2022 Interagency Sea Level Rise Scenarios calculated for the Honolulu Tide Station. This research uses the "NOAA Intermediate-High Scenario" because of the low risk tolerance for the residential buildings.

Elevating the road first could increase flooding risk on adjacent private properties and vice versa. How do we adapt public and private lands at the same time, so we don't increase flood hazards on adjacent lands? Are there examples or good practices from elsewhere we can follow to avoid that?

Interdisciplinary collaboration was an important aspect of this project, and the necessary coordination of adaptation on public and private lands is a great example of the need for such partnership. "The Miami Beach Rising Above Elevation calculator" website (used to be public, but now requires a password) is an example of a good planning tool for Honolulu. The purpose is to "identify the current elevation of your home relative to the future elevation of the road in front of it. Armed with your home elevation certificate, you will be able to determine the actual elevation (in inches) of the public right-of-way adjacent to your property. You can then take a yard stick and easily see the actual future road elevation in comparison to your driveway and your home's finished floor elevation."

In Honolulu, if future street heights were posted years, even decades ahead of time, building owners could plan for them.

Are you suggesting a "dike" system for these building?

No, dikes are not recommended for Waikīkī by this project.

As a practical consideration, these low-rise buildings would be replaced going forward.

Agreed, please see related question, and answer above.

Will existing building foundations be able to survive a permanent salt/brackish water condition? What % of Waikīkī buildings were designed for this? I think we may need to start mapping/rating survivability of existing buildings. (a sort of long-term triage)

Saltwater and brackish water are likely to have negative impacts on existing buildings, particularly those constructed with concrete and rebar. Though a number or percentage is unknown by the project team, it is likely that very few buildings in Waikīkī, took sea level rise into account during construction. Though not part of this research effort, mapping building structure typology, condition, and assessing their structural risk to sea level rise is imperative and would make an excellent research project.

Does anyone think we may be at the start of a meltwater pulse? *No response*
Elevators to 4th Floor? *No response*

Where will all this fill come from? Versus, say, elevated roadways?
Please see related question and answer above.

Where existing buildings rise above open foundations and sacrifice ground floors to allow water to pass through, how well can the buildings withstand structurally? Do structural elements like columns need to be armored?

This very important question has yet to be answered. However, any material that can be penetrated by water and is likely to degrade (i.e., concrete, rebar) is likely to require redundancy, reinforcement, and regular assessment for stability and safety.

Did the design process begin with the assumption that we will have the resources to maintain these systems (roadways/central utilities/etc.) across the whole area? It would seem that variable might have the largest impact on possible adaptive designs. Some questions by others hinted at this: "Should we assume decentralized sewer?" "Should we assume far less auto dependence in the area?" This ties to the question of "who pays?"

This project is intended to visualize flood adaptation strategies at specific sites around which design guidance and policy may be discussed. It did not comprehensively assess the resources needed to adapt and maintain the entire community. Based on the research that informed the two sites presented today, we can deduce that dependence on automobiles is likely to reduce as roads become increasingly impassible. Decentralizing all systems will help to increase the viability and resilience of this community. The economic implications are likely tremendous and will likely determine how much of the community is adapted, and which areas become open space used to accommodate flood waters.

Do we need to start to design docks for our buildings for the watercraft which will be navigating Waikīkī in 2100? Venice of the Pacific :)

As roadways become flooded the increased role of boats, such as ferries in the Ala Wai Canal, and on minor roads, may be planned for as part of a comprehensive sea level rise strategy.

The architecture students did a great job. However, since SLR is supposed to continue for centuries even if we successfully mitigate Climate Change, how would they consider building future responses into the flexibility of their 2050 and 2100 designs?

Yes, sea level rise is anticipated far beyond 2100. As we learn more about how sea level rise will affect our communities, our plans for adaptation will need to evolve accordingly. Importantly, a fundamental rethinking of how our communities operate and who they serve will be necessary, the Waikīkī of today will not be possible in 2050, 2100, or beyond!

Again, who is paying for all this?

Funding adaptation strategies will likely occur from both the public and private sectors, phased over many decades in order to shoulder its enormous cost. Some currently developed areas may not be adapted based on their low economic viability, or their importance as restored ecosystems.

Should we be identifying buildings in certain corridors where we prohibit more than say 50% renovation, with the objective of seeing them torn down to create areas for detention basins or even cut canals?

As you recognize, current Special Management Area (SMA) regulations limit the redevelopment of many coastal properties to 50%. A Waikīkī-scale plan for managing the various sources of flooding would help identify the areas appropriate for structures to be deconstructed, demolished, or possibly elevated above new open space to detain flood water. The identification of such buildings, as well as willing landowners, would be a helpful adaptation measure.

VII. COMMENTS

The following comments were collected in the chat during the webinar.

- I think by 2100 we can hope that there wouldn't be as many cars on the road as there is today. However, the true issue in the near future will be parking! Especially in Waikīkī.
- I admire the wonderful work that you have done. This is a real concern.
- I agree with [name redacted], great job everyone.
- Great discussion, mahalo for your efforts!
- Excellent work all!
- We so need land speeders thank you everyone! Amazing work and renderings!
- Outstanding job
- I second that, [name redacted], Great amount of useful information Mahalo Nui!
- Excellent!
- Thank you for this session. Great work!
- Great work, looking forward to more
- Thank you!
- Mahalo nui!
- Super job! Mahalo!
- Thank you!
- Mahalo!