Appendix B: Methodology

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Expert Elicitation

Semi-structured Interview Process

We contacted 19 different individuals in a number of different local, state, and federal organizations. Each prospective interviewee was sent an email requesting a meeting either in person, by phone, or by email. An interview was conducted with one to two interviewers from our research team over a one hour period. All interviewees were asked a set of predetermined questions to begin the interview which was followed up with an informal discussion. Notes were recorded and saved in a shared Google Drive. The following email template was used to contact potential interview candidates.

Email template

Aloha _____,

My name is (David/Dain/Laura/Lesley/Aimee) and I am a graduate student at UH Manoa working with a small team of graduate students to conduct research for Mālma Maunalua. 9 of the 10 streams that reach Maunalua Bay have been channelized and create concentrated high volume and velocity streamflow which increases sediment and undesirable nutrient runoff into the bay resulting in degraded coral and ecosystem health. Our objective is to identify feasible retrofitting options for the channelized streams in the East Honolulu/Maunalua Bay watershed. We would love to set up a meeting with you to discuss your knowledge and ideas regarding retrofitting options, feasibility, or any other related concerns to our project. Plus let us know if and when you would be available to meet.

Mahalo nui loa,

(David/Dain/Laura/Lesley/Aimee)

Interview Questions

The following interview questions were used to introduce our topic and stimulate an informal discussion.

- What is your background knowledge of Maunalua Bay?
- What is your understanding of stream retrofitting?
- What do you think are some retrofitting ideas for reducing channelized/hardened streams?
- What problems do you foresee in the retrofitting and in Hawaii in general?

- The balance between sedimentation and flood prevention?
- What part of the stream system does your organization/research oversee?
- Are there permits, protocols, or applications in place to take actions, specifically construction/retrofitting, in the stream system?
- Do you work with any other organizations/researchers to monitor or modify the stream systems?
- Outside of channelizing for flood controls, have there been any prior attempts to retrofit or modify the streams?

Persons Contacted

At the beginning of this project, we built a systems map using the DiPSR framework in order to identify key leverage points and feedback loops. From there we evaluated relevant literature and reached out to a variety of different agencies that we thought might be able to provide insight into possible retrofitting options. Many of the experts we contacted were unable to participate in an interview but were willing to answer questions, and give guidance and feedback via email.. Due to the time constraints, multiple experts were not able to participate before project deadlines. .

Organization/Personnel	Contact
HDR, Civil Engineer	Contacted. No interview completed.
Hawaii Kai Resident	Interview Completed.
Sustainable Resource Group International (SRGII)	Interview Completed.
University of Hawaii Manoa - NREM Faculty	Interview Completed.
University of Hawaii Manoa - Geology Dept Faculty	Interview Completed.
Environmental Protection Agency	Interview Completed.
US Army Corps of Engineers	Contacted. No interview completed.
Ridge to Reefs	Interview Completed.
Mālama Maunalua	Interview Completed.
HI Dept of Facilities Maintenance	Contacted. No interview completed.
HI Dept of Planning and Permitting	Contacted. No interview completed.
Hi Department of Land and Natural Resources	Contacted. No interview completed.
Department of Environment and Education	Interview Completed.

Hirschman Water & Environment LLC	Contacted. No interview completed.

Our post-interview process consisted of compiling and synthesizing interview notes, debriefing team members that were absent during the interviews, and reviewing materials given or suggested to us by the interviewee. Many interviewees suggested other experts that we contact for further guidance or expertise. Multiple interviews were conducted with select individuals.

Literature Review

Our literature review comprised of searching through scholarly databases (Google Scholar, Web of Science, Malama Maunalua Resource Library), reviewing local, state, and federal policy documents, guidelines, and procedures, and examining materials suggested by experts. The resources listed below in an annotated bibliography format are the primary resources used to determine the decision making the process and potential retrofitting options.

Allen, H. H., & Leech, J. R. (1997). *Bioengineering for streambank erosion control*. US Army Corps of Engineer.

The authors of this report examined how bioengineering can be used to prevent erosion in streambanks when the use of hard structures, such as concrete-lined channels, is not an option. They defined bioengineering as the combination of biological, mechanical, and ecological concepts to control erosion and stabilize soil through the use of vegetation or a combination of it and construction materials.

Atkinson, A., (2007). A Natural and Cultural History of Maunalua Bay and its Watershed. Ph.D. Dissertation. San Francisco State University, Department of Geography.

This study looked at how Maunalua Bay area's history, geology, flora and fauna and hawaiian culture influenced its development. This information was used to illustrate the demographic and developmental changes that have occured in the last few decades in the Maunalua Bay area. These alterations were the driving force behind the installation of channelized streams.

Department of Environment and Swan River Trust (DESRT) 2006, *Retrofitting, Stormwater Management Manual for Western Australia*, Department of Environment and Swan River Trust, Perth, Western Australia.
http://www.water.wa.gov.au/__data/assets/pdf_file/0019/1657/84955.pdf

The aim of this chapter is to explain the issues to be addressed when retrofitting existing urban developments and individual stormwater management devices in urban areas throughout Western Australia. This chapter provides brief descriptions of several

best management practices provided with case studies and examples that demonstrate how to undertake retrofitting projects and achieve multiple objectives: reduce flood risk, improve public health and safety, improve water quality, restore and/or conserve environmental condition, create more attractive and livable neighborhoods, increase cost effectiveness, and enhance the cultural values of the urban water landscape.

Department of Natural Resources Maryland (2018) Regenerative Stream Conveyance (RSC): Construction Guidelines First Edition., *Chesapeake and Coastal Service* www.dnr.maryland.gov

The authors of this report give a comprehensive guide to Regenerative Stream Conveyance (RSC) including the guidance on construction teams, site preparation, methods and techniques. Our report emphasizes the need for upland and urban solutions. These guidelines could serve managers looking to implement RSC as a solution in low grade upland tributaries or urban parks.

Mālama Maunalua. 2009. *Maunalua Bay conservation action plan: a community's call to action*. Mālama Maunalua, Honolulu, HI. (Mālama Maunalua 2009)

The first three objectives outlined in Mālama Maunalua's Action Plan emphasize the need to reduce polluted runoff and sediment flow into Maunalua Bay. In addition, each objective outlines strategic plans and a projected timeline for completion of actions.

Oleson, K. L. L., Falinski, K. A., Lecky, J., Rowe, C., Kappel, C. V., Selkoe, K. A., & White, C. (2017). Upstream solutions to coral reef conservation: The payoffs of smart and cooperative decision-making. *Journal of Environmental Management*, *191*, 8–18. https://doi.org/10.1016/j.jenvman.2016.12.067

The authors of this study used sediment modeling software (InVEST-SDR) to predict where the the most sediment could be retained while minimizing costs on West Maui, Hawaii, USA. This article helped bring local context to our work as our report emphasizes bridging the gap between landowners and working together to reduce sediment flow into the Bay.

Richardson, C. M., Dulai, H., Whittier, R. B., (2017). Sources and spatial variability of groundwater-delivered nutrients in Maunalua Bay, O'ahu, Hawai'i, Journal of Hydrology: Regional Studies, Volume 11, 178-193. https://doi.org/10.1016/j.ejrh.2015.11.006

This study looked at the effects of submarine groundwater discharge at two points in the reef system of Maunalua Bay. The results found that areas with high groundwater discharge saw reduced net production and calcification rates in the nearby reef. This shed light on the importance of considering the effects of groundwater discharge on ecosystem

health. The impacts of impervious surfaces are felt in surface and groundwater that enter the Bay.

Flores, H., McMonigle, D., and Underwood, K. (2012, December 5). Regenerative Step Pool Storm Conveyance (SPSC). Retrieved April 22, 2019.

The authors wanted to create a design guidelines and procedural steps in Regenerative Step Pool Storm Conveyance (SPSC) system. SPSCs target solutions in steep slopes. These guidelines are aimed at best management practices (BMP). SPSCs can be implemented as a stormwater management device to manage water quality treatment as part of a treatment. See Appendix A for the full report.

California Stormwater Quality Association, Stormwater Best Management Practice Handbook (2003)https://www.casqa.org/sites/default/files/BMPHandbooks/BMP_NewDevRedev_Complete.pdf

The purpose of this handbook is to give general guidance on Best Management Practices (BMPs) for stormwater runoff in order to reduce pollutants. This guide provides a framework for developers to select what BMPs works best in their area, making it adaptable to Hawai'i's special circumstances. See Appendix A for the full report.

Sustainable Resources Group Intn'l, Inc. (SRGII), 2010 Watershed Based Plan for Reduction of Nonpoint Source Pollution in Wailupe Stream Watershed. Malama Maunalua resource library. http://www.malamamaunalua.org/resource-library/

This report is a comprehensive review of various retrofitting options available for the Wailupe stream system with the primary goal of reducing sediment entering the bay. The report includes retrofitting scale, associated costs and benefits, applicable locations, specifications, and additional information needed to feasibly implement each option. Each retrofitting option presented can by adjusted and applied to any of the channelized stream systems in the Maunalua/East Honolulu watershed. See Appendix A for the full report.

Schueler, T., Hirschman, D., Novotney, M., and Zielinksi, J. (2007, July). *Urban Subwatershed Restoration Manual No.3.* Urban Stormwater Retrofit Practices. Retrieved April 22, 2019.

The authors created a manual to develop and refine more appropriate methods in order to design and build different retrofit options faster and more cost-effectively. The focus was on retrofitting ideas to restore small watersheds in the urban land use. There is background information on stormwater retrofitting, where retrofitting options can be implemented, different types of stormwater treatment options for the retrofitting options, as well as a created retrofit inventory for the subwatershed. See appendix A for full report.

U.S. Department of Interior & USGS. Modeling of Watershed Systems (MOWS). (2017, July 21). Retrieved April 22, 2019, from https://wwwbrr.cr.usgs.gov/projects/SW_MoWS/

The Maunalua Bay watersheds have little to no actionable stream data or monitoring systems. This report provides guidelines on how to use similar watersheds as a proxy for watersheds that lack data or monitoring systems. We recommend these guidelines be used if necessary models or data collection methods are missing.

U.S. Census Bureau, 2010 Census Redistricting Data (Public Law 94-171) *Summary File (February 2011) calculations by the Hawaii State Department of Business, Economic*

This report contains summary statistics on population and housing subjects derived from questions on the 2010 Census questionnaire. Population and demographic information from this report was used in our study.