FROM REFUSE TO RESOURCE:
LAND-BASED STRATEGIES TO ADDRESS MARINE DEBRIS

Photo from NOAA 2019 Hawaii Marine Debris Action Plan Report

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Executive Summary

The volume of plastic marine pollution globally continues to accelerate at an alarming rate. This has become an international public health crisis and has led to extensive environmental damage. It is estimated that plastics represent up to 90% of the total marine debris found globally, with up to 12.7 million metric tons of consumer plastics ending up in the oceans annually (Agamuthu et al., 2019). Given its position as an island community, Oahu can serve as a global model for addressing this problem. This report proposes management strategies for plastic marine waste that are harmonious with the collective missions of our three clients: National Oceanic and Atmospheric Administration (NOAA), Ocean Voyages Institute (OVI), and the National Disaster Preparedness Training Center (NDPTC). Each organization possesses strengths that can be used to realize this report's recommendations. NOAA wields the greatest political influence and should lead efforts to amend or enact federal and state policies. OVI's primary mission is ocean restoration making it the natural lead for actions related to physical debris cleanup efforts. Although each client recognizes the need for effective training and education, NDPTC should be the primary organization to develop and administer training.

Source reduction has the greatest impact on reducing marine debris. The three recommendations to achieve this goal are to disincentivize the creation and use of single use plastics, develop product alternatives and redesign, and strengthen education and training initiatives. Greater emphasis should also be placed on **increasing plastic waste collection and diversion away from landfills and incineration**. Because higher bottle redemption fees result in increased bottle collection, this report recommends the State of Hawaii raise the bottle deposit fee to at least ten cents. Increasing the deposit fee captures the externality of plastic bottle waste from those using the products. The expansion of reverse vending machines in public areas boosts plastic bottle collection by making redemption convenient for the consumer. Enacting Extended Producer Responsibility (EPR) holds producers responsible for the recycling and handling of post-consumer plastics.

Given the logistical barriers posed by Oahu's geographic isolation, this report recognizes the need for **decentralized waste management and processing facilities**. Promoting community recycling facilities allows community members to exchange plastic waste for recycled goods, eliminating the logistical barriers associated with centralized collection. Pyrolysis, as an emerging technology, deserves consideration given its potential to convert carbon-based waste products into economically viable byproducts. Related technologies like the Thermal Conversion of Organic Material (TCOM) enable communities to turn previously un-recyclable waste into an economic resource.

The recommendations provided are not intended to be a full account of all potential solutions. Instead, this report identifies tangible goals and identifies potential means to accomplish them. These recommendations are in line with the mission of each client. They are designed to assist NOAA, OVI, and NDPTC in reducing the impacts of marine debris and plastic waste.

Introduction: Marine Debris is a Growing, Global Problem

Figure 1: Marine Litter, The Issue, UNEP

According to the National Oceanic and Atmospheric Administration (NOAA) Marine Debris Program Strategic Plan, marine debris is defined as "any persistent solid material that is manufactured or processed and directly or indirectly, intentionally or unintentionally, disposed of or abandoned into the marine environment or the Great Lakes". Marine debris is harmful to marine life, human health, and the economy (Agamuthu et al. 2019). In this report, the problem of marine debris is framed as an externality of society's modern consumption habits and the absence of systems that responsibly manage waste. The true cost of the materials that end up as marine debris is not factored into the price of the manufactured goods. Most marine debris is composed of plastic, paper, metal, textile, glass, and rubber; however, plastics represent between 50% to 90% of the total marine debris found globally with 4.8 to 12.7 million metric tons of consumer plastics ending up in the oceans each year (Agamuthu et al., 2019). For these reasons, this research focuses primarily on post-consumer plastic waste. Post-consumer waste refers to the waste produced at the end of a consumer-product lifecycle, and it has served its intended purpose, passed through the hands of a final consumer, and has been discarded for disposal or recovery (Taha, 2016).

Honolulu is not a major global producer of plastic waste or marine debris. However, it has the potential to become a world leader in marine debris management. Honolulu's geography contributes to its fragmented handling of used consumer plastics. High value recyclables are shipped overseas. Low-value waste and non-recyclables are either incinerated, landfilled, or uncollected. Lacking the required recycling infrastructure, Honolulu imports much more material than it can manage effectively on its own. There is a need for increased dialogue and collaboration between state agencies at all levels of government and environmental nonprofit organizations. The objective of this practicum is to identify policy changes and land-based strategies to improve the management of plastic waste on Oahu and reduce the problem of marine debris. There are three goals outlined in this report, each with a complimentary set of recommendations:

1. **Source Reduction**: reduce the island's consumption of plastic; reduce the volume of waste that needs to be incinerated, landfilled, or recycled.
2. **Increased Collection and Landfill/Incineration Diversion**: make consumer products recyclable and increase rates of recycling; reduce the amount of uncollected waste.
3. **Decentralization**: create a waste management and recycling system that is accessible and localized.

These goals correspond with the life cycle of plastic waste and are ordered from greatest to least impact (Exhibit A). Additionally, the specific recommendations for each goal are listed from easiest to most difficult to implement.

***Exhibit A**: Project Goals*

Clients and Stakeholders

The clients for this project include NOAA, the Ocean Voyages Institute, and the National Disaster Preparedness Training Center (NDPT). NOAA is a federal agency under the U.S. Department of Commerce. Their mission is “to understand and predict changes in climate, weather, oceans, and coasts, to share that knowledge and information with others, and to conserve and manage coastal and marine ecosystems and resources” (NOAA). The NOAA Marine Debris Program was established by Congress, which enacted the Marine Debris Act in 2006. It requires the program to “identify, determine sources of, assess, prevent, reduce, and remove marine debris and address the adverse impacts of marine debris on the economy of the United States, marine environment, and navigation safety” (NOAA Marine Debris Program). The Ocean Voyages Institute (OVI) is a nonprofit organization founded in 1979. OVI focuses on education in maritime arts and sciences and seeks to preserve the world’s oceans. One of their most notable programs is Project Kaisei which was launched in 2009. It aims to remove marine debris, document its presence, and raise awareness on this global issue. Last year, OVI recovered 170 tons of marine debris from the North Pacific Gyre during their open ocean recovery missions. NDPTC’s work focuses on disaster management and education. The center also specializes in identifying specific issues and opportunities that coastal and island communities encounter when addressing natural disasters. NDPTC is concerned about marine debris dispersal from disaster events.

Local stakeholders range from the average citizen to those at the top levels of government. Specifically, the organizations and companies who manage waste and prevent plastics from becoming marine debris are most affected by this project’s policy recommendations. The input and buy-in of the recycling industry are an important part of the

project's success. Three major industry stakeholders on Oahu are Honolulu Disposal Service, RRR Recycling Services (pictured below), and Reynolds Recycling. Elected officials are also important stakeholders as their power to create or amend public policy affects the success of the proposals outlined in this report. Several agencies within the executive branches of state and local governments are tasked with the oversight and administration of waste management and recycling systems. The City Department of Environmental Services is charged with the handling of the county's municipal solid waste and its H-Power waste-to-energy plant. The Hawaii Department of Health manages the State's bottle fee redemption program. Finally, those who operate alternative waste management facilities like pyrolysis play a role in the decentralization of waste management.

Figure 2: RRR Recycling Services Hawaii PET bottles, Honolulu Civil Beat

Literature Review: The Role of Planning in Addressing Marine Debris

Wicked Problems in Planning

The concept of 'wicked problems' describes social systems that interact with other systems (e.g., economic or environmental) and are characteristically complex (Rittel & Webber, 1973). They have numerous causes which are intertwined, difficult to describe, and lack a single, clearly defined solution. It was first theorized by urban planner Horst Rittel, who later clarified the term in his work with fellow planner Melvin Webber. Wicked problems also have "many clients and decision makers with conflicting values, and… the ramifications in the whole system are thoroughly confusing" (Churchman, 1967, p. 141).

The theory of 'wicked problems' distinguishes such issues from classical or 'tame' problems. Rittel and Webber (1973) provide a list of characteristics that are commonly associated with wicked problems. Landon-Lane condenses these into seven points pertinent to the problem of marine plastic pollution (2018):

1. They require management that constantly adapts to changing factors, meaning that the problem may not ever disappear.
2. Management is at best optimal, not "right" or "wrong", subject to managerial and external limitations.
3. The full effects of a chosen management pathway are only known post implementation and may serve to irreversibly worsen the problem.
4. Wicked problems do not have an exhaustible set of potential solutions.
5. Every wicked problem is unique and continues to change into the future.
6. They can be considered the symptoms of other problems.
7. Decision makers carry a heavy moral burden, as their decisions are not allowed to be wrong.

Given the complicated nature of a 'wicked problem' like marine debris, finding adequate solutions extends beyond the jurisdiction of government institutions. Effective management requires strong governance in conjunction with greater corporate social responsibility and changes to modern society's culture of consumerism.

The conceptualization of a wicked problem like marine debris and its various solutions are contingent upon one's underlying perspectives. For instance, businesses and the industrial sector may pose an opposition to further regulation due to their own economic interests. Opinions on the scope and severity of the problem can also vary drastically within civil society. What one considers an acceptable solution is often driven by their own priorities, be it economic growth or environmental sustainability. And just as wicked problems can grow in complexity over time, so too can the set of viable solutions. How society determines which options are most actionable or potentially the most impactful can change as new knowledge is established and practices shift accordingly. The unintended consequences of previous plans can sometimes exacerbate a wicked problem and other related issues. For instance, the recycling industry as it has been currently developed was meant to increase the reuse of plastics materials. However, not only has it not had much of a dramatic effect on the reduction in global plastics production, but it has also exacerbated the wicked problem of climate change through the huge carbon footprint it produces.

Marine Debris as a Wicked Problem

Marine debris is a wicked problem operating on a global scale. Even Hawaii, an isolated archipelago in the middle of the Pacific Ocean known for its scenic beauty suffers from the presence of waste in its waters and shorelines. This contributes to economic and public health problems in addition to the environmental problem itself. Population growth has led to an increase in human activities resulting in greater consumption and consequently, greater waste (Alimba, C., and Faggio, C., 2019; da Silva Videla, E and Vieira de Araujo, F., 2021). The lack of producer responsibility (Harris, L., et al, 2021) and the improper disposal by the population because of mismanaged government policy feeds into the problem of marine debris (Oliveria, A., and Turra, A., 2015).

In the late 1960's, Kenyon and Kridler (1969) wrote an article highlighting ingestion of plastic by the Laysan Albatross in the Northwestern Hawaiian Islands. In 1972, Edward and Smith (1972) published work on plastics on the Sargasso Sea surface. They found that eleven surface samples in the North Atlantic had plastic pellets present. In the late 1980's, roughly 30 years after plastic began being mass produced, marine plastic debris was identified as a potential impact to the marine environment worldwide (Pruter, T., 1987; Laist, D., 1987). Although plastic debris as a form of marine pollution was reported decades ago, it has only recently been recognized as a global issue (Geyer, R., et al., 2017).

In 2019, a plastic bag was discovered in the Mariana Trench, believed to be the deepest point of the ocean (Mitchell, A, 2019). The fact that plastic pollution reached, arguably, the most unattainable location on earth serves as a heartbreaking metaphor that not even the seemingly infinite depths of the ocean can escape the negative externalities of human consumption. As of 2017, there are approximately 348 million metric tons of plastic produced annually compared to just 2 million metric tons produced in 1950 (Targeted News Services, 2020). By 2040, it is

estimated that the world will be producing nearly 700 million tons of plastic annually, highlighting the fact that the problem of marine debris, specifically plastics, is getting worse not better.

A Planner's Role in Managing Marine Debris

A planner's role is to mediate the spaces where knowledge and action; science and praxis; and researchers and practitioners interface (Moroni, 2020; Campbell, 2012). These divergent worlds are often misaligned, and planners seek to create better place-based outcomes while navigating those relationships (Campbell, 2012). Many responsibilities accompany a planner's role as a mediator. One of them is conflict management. Kühn (2020) criticizes agnostic planning theory's tendency to view conflict as a positive and productive force and distinguishes between three ways to manage conflict in pluralistic democracies. Conflict can be avoided if it is too disruptive, it can present opportunities for participation and consensus building, or it can be accepted as a natural part of the planning process.

Uncertainty is inherent to planning. Planners must use the tools at their disposal to plan for and overcome the variable conditions uncertainty brings (Christensen, 1985). The issue of marine debris is beset with uncertainty. As a wicked problem, there is uncertainty over both the means and the ends. This requires planners to focus their attention on problem finding, defining, and articulation. Planners must frame the problem in a compelling and intelligible manner to motivate others to work at finding a resolution. In addition to managing uncertainty, planners also manage ethical concerns and social justice issues. Planning is both political and authoritative (Moroni, 2020). Planners help to distribute benefits and costs more equitably while reducing the harms for all (Woodruff, 2018). Due to the multidisciplinary nature of planning, planners must often collaborate with other fields to create and implement plans. Building the public's trust in governance is an important part of collaborative planning (Shmueli et al. 2020). Part of this includes creating safe spaces for communication and dialogue for community members, elected officials, and government agencies (Moroni, 2020).

These roles and responsibilities make planners ideally suited to address the issue of marine debris. Planners can use their skills and knowledge of land use for a targeted land-based approach to waste management. In their study examining the pathways of marine debris discharged from Mediterranean coastlines Portman & Brennan (2017) found that beaches used for bathing activities contained the most beach litter when compared to other landside activities. This led them to conclude that planners should emphasize influencing beach-goer behavior, prevention of plastic waste, and increased research and monitoring of local contexts to address non-plastic waste. These recommendations involve all the skills mentioned above. Planners help to gather and assimilate knowledge, and they also organize and mobilize others toward action.

Potential Solutions, Decentralized Waste Management Systems

In a decentralized waste management system, waste is sorted and processed within each neighborhood rather than by a centralized processing plant or, more often, a landfill. Decentralized waste management occurs in two main ways: it is treated at the point of generation or the waste is converted into a resource. The quicker that the waste can be

segregated and processed, the higher the resource recovery and the lower the storage and recycling costs. In a decentralized system, consumer behaviors shift, and individuals take on more responsibility for waste,

In developed countries, providing effective and inexpensive waste treatment systems especially in rural areas is a challenge. In these communities, the challenges and drawbacks of centralized waste treatment methods are apparent. Building and operating centralized waste collection and treatment systems is expensive in areas with low population densities and scattered households (Fehr, 2006). Developing nations lack the financial resources and technologies to construct and maintain consolidated facilities. Decentralization allows for diverse, redundant management systems, and implementation of existing and new technologies (Massoud, 2009). Although there are obstacles and difficulties in developed countries when it comes to waste management, these challenges can be addressed with planning and policy enforcement. Understanding the social and environmental context is critical for technology selection. Thorough site assessment is needed to identify opportunities and constraints to the implementation of improved systems. Decentralized waste treatment facilities could also be integrated with centralized supervision to ensure that systems have been inspected and managed to protect health and safety and appropriate disposal. Site-specific management plans can consider specific social, cultural, environmental, and economic factors related to waste management.

Sustainable Communities and Considerations of Social Equity

Although concerns about the impact of marine debris on the economy or environment are regularly discussed, social equity is often neglected. Feiock and Coutts (2013) found that most sustainability plans in US cities focus solely on combating long-term environmental problems. Residents of a city are all connected economically, ecologically, and socially. Lack of attention to equity can be detrimental to robust sustainability planning, particularly for more vulnerable groups.

Equitable societies do not necessarily equalize the conditions or successes of individuals. Rather, they can be defined as equitable if such differences are not the result of membership to groups defined by characteristics like one's race, ethnicity, gender, or where one lives (Johnson & Svara, 2011). In other words, access to income, education, health care, and other resources and services do not rely on membership to a dominant class. Social equity is an integral component to sustainability efforts as it can be determinative of how the benefits and burdens of policy decisions are distributed. It is clear from past research how externalities of industrial and waste management planning disproportionately affect poor and marginalized communities (Bullard, 1990; Bryant & Mohai, 1992).

Government action without proper consideration of the limitations faced by such communities can perpetuate and potentially exacerbate inequities that already exist. For instance, tax credits might be created to incentivize families to install at-home composting solutions. However, they might still need to have the income and good credit standing to take advantage of the opportunity. As such, it is important that poor/minority communities be able to participate in the policy- and plan-making process. According to Young, cities can achieve democratic and equitable ends when all who have a justice-based claim are allowed a voice in

the ultimate decision (2000). This inclusion of public input should sometimes also extend beyond normal jurisdictional boundaries. For example, government decisions about the location of a new landfill or incineration facility might still affect those who do not reside within the specific jurisdictional boundary of the proposed site.

Local governments alone should not be responsible for initiating policies that promote environmental sustainability. Ross (2011) points out how government action that neglects the equity component can lead to top-down approaches that do not cultivate inclusive democracy. Community groups and organizations can also participate and lead efforts to drive change that benefits and accounts for the needs of marginalized groups. Co-production, a process by which community groups are empowered to engage the state around urban development issues, can often improve final outcomes; state and citizens have different but complementary forms of knowledge (Watson, 2014). Mitlin also expands upon this idea, describing how grassroots movements and co-production efforts ultimately strengthen civil society; teaching groups new ways of behaving, which strengthens collective practice (2008).

Background

Honolulu's Waste Management and Recycling Systems

Figure 3: Honolulu's waste-to-energy plant, H-Power, run by Covanta, City & County of Honolulu

The waste management and recycling systems in Oahu are operated and managed by a consortium of government agencies and private companies. Most of the island's municipal solid waste (MSW) is handled by the City and County of Honolulu's Department of Environmental Services (ENV) via its curbside 'gray bin' pick-up program. Curbside pick-up of green waste ('green bin') and other recyclable waste ('blue bin') is also handled by ENV. Much if not all of Oahu's non-recyclable waste is incinerated via the City's H-Power facility (pictured above) in Kapolei which is operated by Covanta, a private business. The waste-to-energy plant accounts for roughly 10 percent of the island's energy production (PUC, 2018). Ash produced by the incineration process is landfilled at the Waimanalo Gulch Landfill.

The sorting of recyclable materials collected via the 'blue bins' occurs at a nearby processing facility in Campbell Industrial Park. The City contracts the sorting process out to RRR Recycling Services. Materials arrive mixed, which requires staff and various automated machinery to pull out anything non-recyclable or contaminated. Oahu lacks the necessary infrastructure to carry out the actual recycling of plastics into new products. Rather, what is called "recycling" is aggregating. Recyclable materials are separated, then compacted and bundled together into bales. International brokers who deal in recyclables then buy and sell these material bales over commodity markets (B. Iverson, practicum meeting, February 22,

2021). Most of Oahu's recyclable waste is shipped to California where it is in turn shipped to other recycling facilities, the majority of which are in Southeast Asia.

The State of Hawaii's Department of Health (DOH) also administers a recycling program in the form of the HI-5 Bottle Deposit Program. All consumers pay a 6-cent deposit fee at the point of purchase of any qualified recyclable bottle (plastic [PET, HDPE], metal [aluminum], bi-metal, and glass). Money collected from this fee is retained by DOH in the Beverage Container Deposit Special Fund. Consumers can then return their bottles at any HI-5 certified redemption center to receive a 5-cent refund; a 1-cent container fee is withheld paid to the redemption center. While Hawaii has an impressive recycling rate of 62.7 percent, especially when compared to the rest of the U.S., it is important to note that redemption centers and local recycling companies mainly deal in high-value plastics (OSWM, 2020). Other low-value plastics and single-use packaging continue to go unrecycled. This residual plastic waste is either incinerated or goes uncollected, polluting terrestrial ecosystems or falling into the island's waterways.

There is much to criticize about the waste management and recycling systems on Oahu as they currently exist. The incineration of MSW and export of only high-value recyclables result in a large carbon footprint, exacerbating the wicked problem of climate change. To instead landfill all of it would require much more land than is currently available, and it would still result in the release of methane emissions (EPA, 2011). And still, viable recycling solutions that are actionable locally at a large scale are few and far between. Economics is still the greatest obstacle to the development of alternatives. The cost to construct the required recycling and remanufacturing infrastructure make it near impossible while the industry itself is already notorious for its razor-thin profit-margins. Even if it had the needed processing facilities, Oahu may not even produce enough plastic waste to make local recycling a sustainable business model (Caufield, 2020). This leaves us only with alternatives that make waste management cheaper and are easily deployable or those that modify producer/consumer behavior. Potential solutions that fit these parameters are discussed later in this report.

Permitting and Land Use Considerations

The development and construction of new waste management and recycling infrastructure on Oahu requires the approval of various county, state, and potentially federal permitting agencies. Beginning at the county level, the construction of any facility must adhere to the City's zoning codes as found in the Land Use Ordinance (LUO). New MSW processing or recycling facilities would most likely be classified as having a 'waste disposal and processing' land use on the LUO Master Use Table. These facilities are only allowed on land zoned as P-2 (preservation), AG-2 (agricultural), I-2 (intensive manufacturing) or I-3 (waterfront industrial). The construction of such a facility on P-2 or AG-2 land requires the approval of a Major Conditional Use Permit (CUP) while I-2 or I-3 requires a Minor CUP. Both, however, require the applicant to notify adjoining property owners and present their plan to the appropriate Neighborhood Board(s).

The State of Hawaii also shares police power in determining land uses across Oahu. Hawaii's environmental review law (Hawaii Revised Statutes 343), patterned closely after the National Environmental Policy Act of 1969, is administered by the Department of Health (DOH)

Office of Environmental Quality Control. The preparation of an Environmental Assessment (EA) or an Environmental Impact Statement (EIS) is required if one or more criteria as set forth in HRS 343 is triggered. Both an EA and EIS provide the public and government agencies the opportunity to review a project proposal and provide comments regarding environmental concerns as well as economic and technical considerations. Many agencies do not process or issue permits until an EA or EIS process is completed.

The State's environmental review process also serves to clarify which other permitting requirements the applicant must adhere to. Depending on the facility's location, a traffic impact assessment may be required by the Department of Transportation, Highways Division, particularly if transport of a feedstock or source material is needed. The assessment is sometimes triggered as part of the review of other permits like a county zoning permit. Traffic impact assessments evaluate safety concerns from increased vehicle traffic, the inadvertent release of feedstocks during transport, and noise concerns. A Solid Waste Management Permit may also be required from the DOH Environmental Management Division, Solid and Hazardous Waste Management Branch (SHWB). If the facility handles, treats, or stores hazardous waste as defined by the Hawaii Administrative Rules 11-261-3, the operator would also need to apply for a Hazardous Waste Treatment, Storage and Disposal Permit with SHWB. Facilities that produce emissions during the pyrolysis or combustion process must also apply for a Clean Air Permit from the DOH Clean Air Branch.

Global to Local: Evaluation of Other Frameworks and Plans

For Hawaii, two main frameworks exist for addressing marine debris: NOAA's 2011 Honolulu Strategy and the 2018 Hawaii Marine Debris Action Plan. While these documents create a strong framework for managing marine debris both are lacking rigorous implementation and evaluation components that can lead to effective action.

The Honolulu Strategy is a global framework proceeding from the Fifth International Marine Debris Conference in Honolulu in 2011 through a collaboration between the UNEP and NOAA. The resulting document details goals to reduce land and sea-based sources of marine debris and remove already accumulated marine debris. However, being a global rather than local framework, the Honolulu Strategy acknowledges that establishing a time-sensitive target for reducing marine debris creation, Integrated Solid Waste Management (ISWM), and Extended Producer Responsibility were outside of its scope based on their complexity and local contextualization (UNEP and NOAA, 2011). These are important components for addressing marine debris and they should be emphasized and explained in future updates. While the Honolulu Strategy addresses new technologies, they mainly focus on the creation of biodegradable products instead of waste-to-resource advancements. It inexplicitly mentions product redesign and does not mention decentralization. The Honolulu Strategy claims to be: (1) a planning tool for developing marine debris programs and projects; (2) a reference for collaborative efforts common frame of reference for collaboration and sharing of best practices and lessons learned; (3) a monitoring tool; and (4) results oriented (UNEP and NOAA, 2011). While this may be true, it is so broad that it lacks the depth, detail, and metrics necessary for real and effective action. Supporting reports could strengthen the framework through the expansion of concrete plans, measurable goals and timelines, strong evaluation rubrics, and the

inclusion of planning and process technologies in addition to cutting edge waste management technologies. While the Honolulu Strategy supports this report's arguments regarding the need for market-based instruments to incentivize behavior such as waste taxes and rebates, legislation, education, and improved technology (see Table 1), it serves as a starting point. It is over 10 years old and should be revisited.

Honolulu Strategy Goal A Strategies	This Report's Recommendations
Strategy A1. Conduct education and outreach on marine debris impacts and the need for improved solid waste management	Support **training and education** provided by local non-profits; 2019 Hawaii Marine Action Plan
Strategy A2. Employ market-based instruments to support solid waste management, in particular waste minimization	**Economic benefits** of **pyrolysis** require research **New recycling technologies**
Strategy A4. Develop, strengthen, and enact legislation and policies to support solid waste minimization and management	Legislation changes: **HI-5** and **Extended Producer Responsibility**

***Table 1**: Honolulu Strategy Comparison Table*

NOAA's 2018 Hawaii Marine Debris Action Plan (MDAP) is the result of a multi-sector collaborative workshop of 36 organizations in Honolulu, Hawaii. Its main goals for managing marine debris are prevention; waste reduction; removal; addressing abandoned and derelict vessels; and research (National Oceanic and Atmospheric Administration Marine Debris Program, 2018). The HI-MDAP has several strengths. It is action oriented. It contains a list of current and future activities according to each goal, which creates a picture of the landscape of effort currently being directed at finding solutions for the issue of marine debris. It has a strong focus on marine-based marine debris but relies mainly on outreach, plastic bans, and consumer behavior changes to manage land-based sources. The HI-MDAP supports this report's recommendations for extended producer responsibility, education, and increased technology but it does not mention decentralization. It set a 2020 target date for the reduction of marine debris impacts. It also promised to monitor progress of action items and facilitate ongoing communication between workshop participants through an online portal. As a living document, it was designed to be updated every two years. It remains to be seen if the appropriate monitoring and evaluation tools have been successful or if the plan has achieved its goals. While the actions are good, evaluation is important to assess how close the results are to their intent.

Plan Quality Metrics

When examining the various strategies outlined above, it is important to consider the components of a good plan. Such plans begin with a clearly defined problem statement and a systematic evaluation to ensure successful implementation. To accomplish this, planners must ensure there is an appropriate level of non-biased criteria to grade the effectiveness of the plan

against the goals it aims to achieve (Baer, 1997; Brooks, 2002; Lowry unpublished; Weiss, 1998). It is also necessary to align the objectives of the plan with the values of the community for which it serves. The planner must carefully weigh the motivations of each stakeholder (Lowry, unpublished; Weiss, 1998) and try to make an unbiased determination of the plan's potential effectiveness. While no approach is perfect, it is the planner's responsibility and duty to provide fair critiques to ensure their plan or policy is appropriate and can deviate if necessary.

There must be consensus on what a program or plan is trying to achieve before it can be evaluated (Weiss, 1998). For this reason, it is recommended that goals be specific, measurable, attainable, relevant, and time-bound (SMART) to definitively conclude if progress, or completion has occurred (Cothran and Wysocki, 2005). The SMART framework reduces uncertainty and helps planners focus efforts on tangible outcomes. Once the goals and objectives of the plan have been clearly established and the plan has been created, there must be a recurring, iterative, and looping process for its evaluation and implementation (Baer, 1997; Brooks, 2002; Sabatier & Mazmanian, 1983; Stone, 2011) to achieve the intended results. The most important aspect to any plan is the evaluation criteria of its success. Evaluation questions are one set of tools used to measure a plan's success. This tool can be used to foster public trust. Alexander and Faludi (1989) state this rather bluntly, "…if planning is to have any credibility as a discipline or profession, evaluation criteria must enable a real judgement of planning effectiveness: good planning must be distinguishable from bad" (p. 127). Planners must be critical of the plan and evaluate it fairly. The credibility of the profession requires it, and the public expects it.

A systematic approach to evaluation is necessary and challenging. Evaluations can be used to ensure objectives are in alignment with community goals and values. An impartial evaluation serves as a midcourse correction (Weiss, 1998) like checking the map after driving for a long distance to ensure the route is correct. Evaluation models can be tailored to the problems their plans address. A good plan begins with a clear problem definition and continues to be improved through an iterative process based on feedback from stakeholders and a critical evaluation from the unbiased planner. The planner fulfills their obligation to the profession, their clients, and the public by ensuring plans are evaluated appropriately, and limited resources are being used effectively and fairly.

Goal No. 1: Source Reduction

Reduce overall plastic consumption. Reduce the total volume of waste that needs to be incinerated, landfilled, or recycled.

Recommendation No. 1: Disincentivize Consumers' Use of Single-Use Plastics

Honolulu's ban on single-use plastic bags has been a small, but important step in reducing the amount of non-recyclable waste generated on-island. The county went a step further in 2019 by phasing out the use of single-use plastic service ware items like utensils and polystyrene containers. There is more that can be done, however, to incentivize the use of reusable items and containers commercially. One suggestion from the 2020 Plastic Source Reduction Working Group's (PSRWG) Report to the Legislature included the enactment of a tax credit for businesses that invest in modern commercial reuse and washing equipment that

reduce the use of plastic. Another was the creation of a pilot program which would test the efficacy and expenses of making UV-C or other sanitizing technology widely available to consumers.

Recommendation No. 2: Changes to Manufacturing, Materials Used, and Product Design

Poor product design is an obstacle to recycling at the end of a product's life cycle. A plastic container may be composed of layers of different types of plastics. If it is identified and sorted as the wrong material in a recycling facility, it may end up contaminating the final recyclable bale, rendering it worthless. Although several large corporations have made efforts to redesign products to use less plastics or to increase the use of recycled materials in their products, legislation or government intervention may help to expedite this process. Regulation requiring consumer products to use similar materials or to only use materials that are highly valuable and recyclable are examples of policy changes that this project's clients may support.

Recommendation No. 3: Education and Public Awareness

Expanding public awareness of marine debris is a shared goal among this project's clients. Educating both the public and the industry about the externalities of marine debris is an important part of influencing consumer behavior and generating the political will necessary to effect change. Education and public awareness campaigns draw public attention towards the harm of current plastic consumption and have the potential to affect the greatest amount of change for the least amount of money. NOAA, NDPTC, and OVI can collaborate in a joint effort with the applicable state and local agencies to educate and inform local communities regarding the effects of un-recycled plastic waste and marine debris. The Hawaii Marine Debris Action Plan is part of many other regional action plans containing recommendations for raising awareness such as social media campaigns and events. Utilizing social media and other means, NDPTC can start a marine debris monitoring program that trains citizens who would like to track where debris tends to collect. The program can be ongoing and have a disaster-specific component where locations are photographed pre- and post-disaster. If a decentralized waste management system is implemented, the NDPTC can provide training on how to secure it in the event of a natural disaster. OVI can host public viewing exhibits of the marine debris they collect during their open ocean recovery missions. They can partner with other local nonprofits like the Kokua Hawaii Foundation. The NOAA Marine Debris Program can create a podcast talking about the impacts of marine debris and can provide training to organizations and offices looking to reduce their dependence on single-use plastics.

Goal No. 2: Increased Collection and Landfill/Incineration Diversion
Reduce the amount of waste that might otherwise go uncollected. Incentivize the collection of uncollected waste. Improve the profitability of recycling and waste diversion.

Recommendation No. 1: Increase the Bottle Deposit Redemption Fee

An increase of the State's 5-cent bottle deposit redemption fee will result in an increase in bottle collection. Bottle redemption programs are intended to minimize litter by reimbursing consumers who turn in used bottles, cans, and other beverage containers. Similar programs exist in ten other states and Guam. The program could also be expanded to include other kinds of plastic containers. There is evidence to suggest that areas with higher deposit fees also experience higher rates of recycling redemption. Norway, which instituted a 25-cent deposit fee, sees a bottle redemption rate upwards of 90 percent. It should be noted, however, that bottle redemption systems like Hawaii's HI-5 program only target high-value plastics like plastic bottles and not low-value plastics like plastic bags, packaging, or single-use service ware items. Critics of increasing the bottle deposit fee point to the social equity challenge that raising the price of goods disproportionately has on the poor. Raising the bottle deposit fee to ten cents results in consumers paying a total of $2.40 on a hypothetical 24-pack of single use plastic beverages. In families where every dollar is carefully counted and spent, this action certainly increases the financial strain on the most vulnerable households. However, Honolulu receives a high number of tourists each year and the bottle deposit fee increase is a means to capture the externality of plastic bottle waste and ensure the cost is borne by the user.

Bottle Deposit Laws in the United States

California, Connecticut, Delaware, Hawaii, Iowa, Maine, Massachusetts, Michigan, New York, Oregon, and Vermont are among the eleven states that have passed bottle bills. Oregon was the first to do so. Oregon established a fee of five cents in 1971, which was raised to ten cents in 2017. A deposit fee of five cents is required in nine of the eleven states, while a deposit fee of ten cents is required in two of them, Michigan, and Oregon. Connecticut has the lowest bottle return rate at 50.7 percent, according to the Bottle Bill Resource Guide (Container Recycling Institute, 2021). Conversely, residents in Michigan redeem 92.2 percent of the soda bottles they purchase at a cost of ten cents each. The redemption percentages in the other nine states are in the 60th and 70th percentiles. Higher deposits in other countries also affect the rate of return. The redemption rate of bottles and cans is 97 percent in Norway, where the deposit is equivalent to about 25 cents. This is also one of the many reasons why Oahu's deposit should be increased from five cents to ten cents.

Recommendation No. 2: Reverse Vending Machines

Figure 4: Tomra R-1 RVM, Tomra Collection Solutions

A reverse vending machine (RVM) functions as a small-scale recycling redemption center. These machines allow users to recycle empty beverage containers in exchange for a monetary refund of the bottle deposit fees. Greater public/private investment in RVMs and installation around highly trafficked or polluted areas would prevent a greater amount of recyclables from going uncollected or mixing with MSW. RVMs could support the proposed change in bottle deposit legislation by facilitating convenient decentralized collection. However, this decentralized collection method does present several challenges. To be effective, software must stay current with new beverage container products that are released to detect the container type. Additionally, the restaurant industry raised concerns about the footprint of these machines in narrow sidewalk areas. This recommended program must have supporting infrastructure to ensure machines are emptied and the bottles are collected in a timely manner. Finally, the machines themselves will pose an expense that will cut into the profits of whatever company is tasked with executing this recommendation.

Recommendation No. 3: Extended Producer Responsibility

Extended Producer Responsibility (EPR) policy requires plastics producers and manufacturers to accept responsibility (financial and/or physical) for the proper treatment and disposal/recycling of consumer products. EPR was first implemented by Sweden and Germany in the 1990s (Lifset et al. 2013). A manual produced by the Organization for Economic Co-operation and Development in 2001 describes how EPR can generally be implemented in two ways:

1. As an upstream shift in responsibility towards the producer and away from municipalities; and/or
2. Incentives for producers to design their products with the end of a product's life cycle and the environment in mind.

Planners can create successful EPR programs by keeping the following recommendations in mind (OECD, 2001):

- A good communication strategy to inform all actors of the program and gain their support.

- Stakeholder engagement early in the process to ensure that there is a good understanding of the costs and benefits to all parties.
- Local governments should be consulted regarding how they feel the program could operate given their political climate and capacity.
- Program developers should consider voluntary and mandatory approaches for participation.
- Routine evaluations should be conducted to identify inefficiencies and adjust the program accordingly.
- There should be a balance between environmental benefits and domestic economic impacts (try to avoid negative impacts as much as possible); and
- Transparency is paramount.

EPR's role in the marine debris issue is the creation of a circular economy that incentivizes changes needed throughout the product life cycle. It can also help to create and fund a more holistic approach to waste management (EBCD, 2018). EPR programs are designed to be fiscally self-sustaining. Harris et al. (2021) used citizen science to show that there was no reduction in shoreline debris in British Columbia after implementing a plastic waste EPR program in 2014. However, plastic waste recovery increased from 52% to 75% and their EPR program for plastic packaging is 100% industry funded. The report acknowledged that citizen science data may not have been the best research tool for that application, but still revealed how EPR can minimize the amount of plastic waste that can become marine debris.

In the United States, momentum is also building behind implementing EPR policy to tackle plastic waste. The Break Free from Plastic Pollution Act which included language to create a federal EPR program was recently introduced by Senator Jeff Merkley and Representative Alan Lowenthal in Congress. Their bill proposes that 80 percent of all covered products, except paper, should be reused or recycled; 90 percent of all beverage containers and paper covered products should be recycled; and 70 percent of all industrially compostable covered products should be composted (Eastwood et al. 2020).

As of February 2020, 30 of the 63 countries with EPR programs also regulate the manufacture of plastic products and packaging processes involving plastics (Eastwood et al. 2020). The United States has neither a federal EPR policy or manufacturing/packaging waste-reduction regulations. Some progress has been made at the state level, although efforts have been piecemeal at best (Hickle, 2014). According to the Nash and Bosso (2013) status report of EPR in the U.S., states like California, Maine, and Vermont have led the nation in EPR with laws for five or six product categories. Thirty-two states have at least 1 EPR law (Nash & Bosso 2013). California has a policy whereby retailers collect an advanced recycling fee to fund waste collection and recycling (Hickle. 2014).

There is research to suggest that EPR policies are most effective when programs capture significant percentages of post-consumer waste (Nash & Bossco, 2013). There is huge room for improvement as the U.S. only recycles about 8.7 percent of plastic waste (EPA, 2013). None of the state EPR systems incentivize the redesign of products to be less burdensome on the environment (Lifset et al. 2013). Instead, the primary achievement of EPR has been to fund, create, or expand infrastructure for post-consumer recycling (Lifset et al. 2013). Challenges to EPR policy development in the U.S. have been attributed to producer resistance. As a response

to stricter EPR laws, some manufacturers created voluntary EPR programs. These programs have been criticized for lobbying for weaker EPR laws as well as lacking proper accountability and monitoring (Nash & Bosso 2013). These efforts contribute to the slow progress being made on achieving the goals of EPR. Additionally, most state legislation has focused too heavily on high-value recyclables like rechargeable batteries, mercury thermostats, mercury auto switches, electronics, and leftover paints (Nash & Bosso, 2013). Given that most marine debris is plastic, these policies do little to solve this problem.

There are three main ways to address disjointed EPR regulations: legislation at the federal level; model state legislation; and an overall EPR policy framework that could guide individual states and stakeholders (Hickle, 2014). While each option is a step in the right direction, they each present unique challenges. A federal-level EPR policy would require the creation of a new environmental review body. Model state legislation may be politically challenging with some states unwilling to approve stipulations that they believe should not apply to them. A policy framework could lead to a patchwork of different laws that may leave some waste types unaccounted for. Despite these challenges, a national policy framework may be the best starting point (see Table 2 below). It would provide consistent definitions for terms and legal language; a consistent set of criteria and processes for deciding which products are included; clearly defined roles and responsibilities for players involved; appropriate financing mechanisms to ensure responsibility is shared; tools for industry collaboration; plans for the program works; performance metrics, standards, and goal setting; reporting and evaluation for program transparency; and recommended processes for engaging stakeholders (Hickle, 2014).

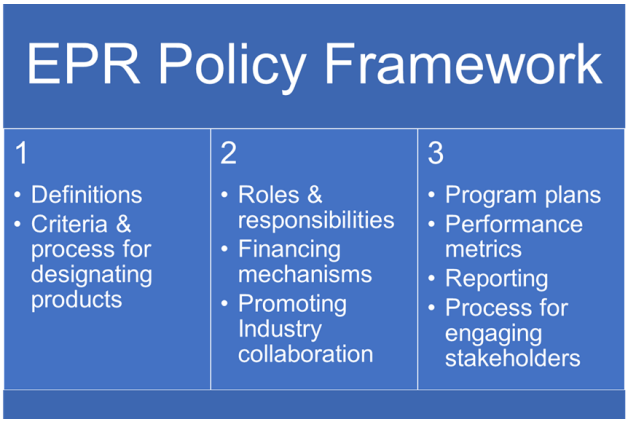

***Exhibit B**: A federal EPR policy framework would create unified understanding between states for potential laws.*

Extended Producer Responsibility in Japan

Japan is the second largest packaging waste generator per capita and the second largest plastic waste exporter (Greenpeace, 2019). In 2017, data from the Japanese Plastic Waste Management Institute revealed that the country generated 9.03 million tons of plastic waste. About 6% of their plastic waste was landfilled, 58% was sent to waste-to-energy facilities, and 8% was incinerated without energy recovery (Greenpeace, 2019; Ogushi and Kandlikar,

2007). About 23% was mechanically recycled (Greenpeace, 2019). Japan exported 61.1% of the 2.1 million tons of plastic waste collected for recycling (Greenpeace, 2019).

Japan's EPR program was first established in 1997 (Ogushi and Kandlikar, 2007). The Japan Packaging Recycling Act required producers and importers to bear the responsibility of recycling packaging waste after it was collected by municipalities. Producers can either collect and recycle the waste themselves or outsource it to a producer responsibility organization (PRO) (Yamakawa 1995). The Act was based on the principle that the state, the private sector, and the public share responsibility in the handling of post-consumer waste. Consumers are responsible for source sorting; municipalities are responsible for sorted collection and for educating the public; and producers are responsible for recycling. Japan revised the act in 2006 to include a packaging waste reduction component (Yamakawa 1995). Businesses using large amounts of packaging are required to report their packaging waste reduction strategies to the government. If the government finds these efforts to be insufficient, it can recommend or require retailers to reduce the number of bags used when selling their products (Yamakawa 1995).

One lesson to be learned from Japan's implementation of EPR policy is that different products are subject to differing after-market conditions. As such, EPR legislation cannot be "one-size-fits-all". Policy needs to adapt as markets change (Ogushi and Kandlikar, 2007). A positive outcome of Japan's EPR laws has been significant cost reductions to waste disposal countrywide. They have also helped some municipalities reduce the average costs of processing larger appliances like A/C units by as much as 64 percent (Ogushi and Kandlikar, 2007).

Goal No. 3: Decentralization
Increase the accessibility and localization of waste management and recycling systems

Recommendation No. 1: Community Recycling Facilities, Open-Source Designs

The creation of community recycling facilities reduces the need for plastics to be shipped internationally for recycling. For example, in Seoul, South Korea, a local recycling center called the Plastic Mill allows community members to turn in used plastic waste in exchange for upcycled goods. One of the center's recent campaigns was to collect bottle caps, which were recycled into 'tube-squeezers' for toothpaste (Park, 2020). Community recycling facilities can also take advantage of open-source plans for recycling machinery. Nonprofit organizations such as Precious Plastics have made publicly available the designs for prototypes of their plastic shredder, extruder, compactor, and compression machines. Precious Plastics also promotes several online retailers that sell a variety of components and parts for their designs. Communities can circumvent the permitting and land use restrictions that apply to larger commercial plants by localizing some of the materials recycling process. Open-source 3D printing technologies also offer a new opportunity to reuse recycled plastic waste and promote the growth of a circular economy (Santander, 2020). However, high-energy costs, the poor recycling rate of certain polymers, and other logistical issues must still be addressed if it is to gain widespread adoption (Cruz, 2017).

Figure 5: Precious Plastic semi-industrial open-source design recycling machines support decentralized waste management, Precious Plastic

Recommendation No. 2: Expand Composting as Preparation for Plastics Alternatives

Advocacy for the expansion of composting is important to preparing Honolulu for eventual changes to product design and manufacturing. As the technology surrounding plastics alternatives continues to advance, there will most likely be a greater need for composting facilities at both the industrial and residential/household scale to accommodate. Localizing composting at the community level can also reduce transportation burden and large infrastructure costs. The expansion and acceleration of composting was also recognized in the PSRWG's 2020 report. Some of their specific sub-recommendations included the revision of permit applications to encourage greater small-scale participation; providing tax incentives to residents and businesses who set up community compost systems; and the creation of composting pilot projects within community institutions like schools, farms, nonprofits, and businesses.

Recommendation No. 3: Pyrolysis of MSW and Low-Value Recyclables

Figure 6: Figure 6: Activated carbon from pyrolysis at Carbon Geo-Tek Consultants, photo courtesy of Tom Stock

Pyrolysis is the process by which carbon-based waste is heated and broken down into residual components or byproducts which can be used for other purposes. Examples of carbon-based waste might include medical waste, construction waste, green waste, tires, plastics, manure, or other MSW. Pyrolysis as an alternative to the landfilling or incineration of MSW has gained traction within the waste management industry and involved academics. However, the technology is not without its own drawbacks. The process of breaking down the feedstock can be energy intensive, and there are questions about whether this energy draw makes the technology economically suboptimal (Rhodes, 2018).

Pyrolysis in Honolulu, Carbon Geo-Tek Consultants

Carbon Geo-Tek Consultants, based on Oahu, is developing a new method of treating waste products. Thermal Conversion of Organic Material (TCOM) is a process by which carbon-based waste is used as a feedstock and then broken down into economically valuable byproducts. The TCOM process combines pressurized pyrolysis, carbonization, and gasification. The feedstock is combined with a catalysis (the specific catalysis depends on the initial feedstock) and is loaded into either a 3' or 6' diameter canister. The canister is then placed into a processor where waste products are exposed to an oscillating thermal layer (a 'hot wave'). Gas is bled off, scrubbed, and catalyzed into liquid fuel. In total, the process takes approximately 45 minutes. Once complete, the feedstock inside is considered activated carbon. The first canister is then removed, and a new canister can be loaded into the processor. The activated carbon is "post-processed" and can be packaged and sold for a variety of uses.

It is difficult to quantify a dollar-value of the output since it is highly reliant on the quality of the initial feedstock. For example, high quality feedstock such as compact macadamia nut shells will produce high-quality byproducts with little waste. Loosely packed refuse yields relatively low-quality byproducts. Anecdotally, an operations test of a dumpster of domestic refuse was successfully converted, leaving only a single bag of trash (non-carbon products). The TCOM technology offers an alternative to conventional approaches to waste management like landfilling or incineration. Landfill mining is the process of using landfilled waste as a feedstock for the TCOM process. It has the advantage of reducing the amount of waste that is landfilled as well as eliminating harmful pathogens and health hazards commonly found in piled refuse. A secondary benefit is the produced gas and activated carbon, which can be used for other purposes.

According to its creators, political and bureaucratic barriers present the biggest challenge to expanding the use of this technology. They argue that the size and political influence of key stakeholders in the refuse collection and disposal industries prevent society from moving past the status quo. The target consumer for TCOM is any small to midsize community looking for an alternative to dealing with refuse. However, the relatively high price point can make the technology cost prohibitive.

For politicians that claim to prioritize the environment, this seems like a no-brainer. The invention takes garbage, or any carbon-based waste product, and turns it into a usable and economically viable commodity. The return on investment will vary with the source of feedstock, which will depend heavily on the user. Again, the initial price of the equipment will likely deter most of the audience they are looking to capture, but the team has made it clear they are primarily focused on perfecting the tool (TCOM) rather than implementing its solutions. Regardless, the technology represents a fresh approach to an age-old problem of

refuse and basic sanitation. Should Hawaii support a test run in smaller communities, it may be the catalyst the company needs to attract serious investors to expand.

Pyrolysis as an alternative to landfilling or incineration has gained some support in academic literature. However, one of the larger drawbacks is the energy needed to produce the byproducts, which can make the process economically suboptimal (Rhodes, 2018). Agricultural waste presents a unique opportunity for pyrolysis because of its potential as a high-quality feedstock. The initial capital investment required for pyrolysis equipment combined with the high-energy costs may make it harder to implement in urban areas (Trninic, et al., 2016).

Conclusion

Marine debris is a wicked problem unfolding on a global scale. The set of recommendations offered in this report are not a full account of all potential solutions to marine debris. Rather, the report identifies tangible, land-based strategies that are clearly defined and attainable in Honolulu. Although the scope of this research might extend beyond the interests of any one organization, the far-reaching impacts and complexity of marine debris requires solutions driven by collaboration with other stakeholders operating in adjacent fields and industries.

As mentioned previously, Honolulu is not a major global producer of plastic marine debris. However, by rethinking how plastic waste is produced, consumed, and effectively managed, Honolulu can become an example to other coastal and island cities. The goals and recommendations in this report target the problem of marine debris along three leverage points of its lifecycle: source reduction, collection and diversion, and the decentralization of waste management. They are designed to help align the efforts of policy makers, industry leaders, and other key stakeholders towards proper mitigation of plastic waste, thereby reducing the impact of marine debris.

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Ginger Porter, Pacific International Training Desk
May 3rd and May 10th presentation participants

Appendix A: Addressing Client and Stakeholder Concerns

1. Updates on U.S. Congressional efforts to address plastic marine debris:

Efforts to implement and amend federal policy that could reduce plastic marine debris are nascent. Perhaps the most notable and comprehensive attempt thus far is the *Break Free from Plastic Pollution Act*, a bill introduced by the U.S. Senator Jeff Merkley (OR) and Representative Alan Lowenthal (CA) in early 2021. Among its many proposals, the bill would enact a federal EPR program by which American packaging manufacturers would carry the financial burden of collecting, recycling, and properly disposing of their products. It would also prohibit the conversion of used plastics into single-use plastics or energy. As of the writing of this report, the bill has not received a committee hearing or floor vote.

2. Importance of policy updates for NOAA related to microplastics and its impacts on human health:

Comments related to the growing concern of microplastics were heard during the final presentation to faculty and staff as well as during the final client presentation. Microplastics are the result of larger plastics that degrade and break down into smaller pieces. Of the three main clients, NOAA has the strongest political influence to make legislative changes to address the issue. There has been recent progress made in the fight against microbeads. In 2015, the *Microbead-Free Waters Act* of 2015 was signed into law by President Obama, which prohibited the sale of products like cosmetics from containing microplastics. Still, the breakdown of larger plastics entering the ocean remains the greater threat. This report's discussion on source reduction recommendations presents the most efficient way to combat the growing presence of microplastics in the oceans. NOAA is aware of this issue and their Marine Debris Program is working to quantify the amount of microplastics released into the environment, which is the first step in more accurately determining its impacts both globally and locally (NOAA, 2021).

3. Funding for ocean clean-up efforts (tracking, transportation, and disposal of marine debris):

Two potential opportunities for additional funding are the grants-in-aid awarded by the Hawaii State Legislature and City Council of Honolulu to nonprofit organizations applying for funding for operational and/or capital costs. Each award is made at the discretion of each legislative body along with approval from the corresponding executive branch. It is recommended that applicants contact and engage the appropriate subject matter committee chair for more information. By including volunteers in this process, they gained a better understanding of the effect their everyday lives have on their climate, which ties back to their primary objective of modifying habits to prevent marine debris from washing up on Hawaii's beautiful coastlines.

4. Financial management and auditing of bottle deposit proceeds:

The recommendation to raise the bottle deposit fee is not without its criticism. Manufacturers and distributors of beverage containers are responsible for depositing and paying fees into the DBC Fund when they sell, donate, or otherwise distribute beverages in applicable containers throughout the state. Manufacturers and distributors may pass on deposits and container fees to their clients (e.g., retailers), who may then pass the costs on to consumers. In addition to the equity concerns for the community discussed in the report, another question was raised regarding proper financial management related to the state's redemption program. In March 2019, a State Audit highlighted fraudulent charges made in Hawaii's HI-5 bottle deposit redemption program. Any discussion or action related to raising the bottle deposit program must include safeguards to protect taxpayers against businesses taking advantage of the system. Public trust plays an important role in consumer behavior. Strict penalties for illegal activity would provide sufficient deterrent for companies that intentionally act unethically. More frequent auditing of the State redemption program and the enactment of stiffer financial penalties for offending businesses are recommended.

5. Liability concerns and penalties imposed on counties and states from EPA and environmental groups because of shoreline debris:

Civil penalties and fines issued from the Environmental Protection Agency (EPA) or other organizations are to be avoided whenever possible. During the final presentation to clients, Representative Nicole Lowen cited the need to solve this issue locally to avoid outside influence. Should the problem of marine debris become too prevalent, the EPA could issue fines until the situation is resolved. It is understandable that any 'solutions' to address the problem of plastic waste and marine debris must be properly vetted to avoid potential liability issues. This comment is well received and there is little debate that any potential solution must provide more than a net positive in solving the issue. Solutions must act as intended and should be vetted through each implementing organization to ensure it is free from any unintended consequences.

6. Supporting innovation and helping local businesses involved in decentralized waste management to generate jobs and solutions:

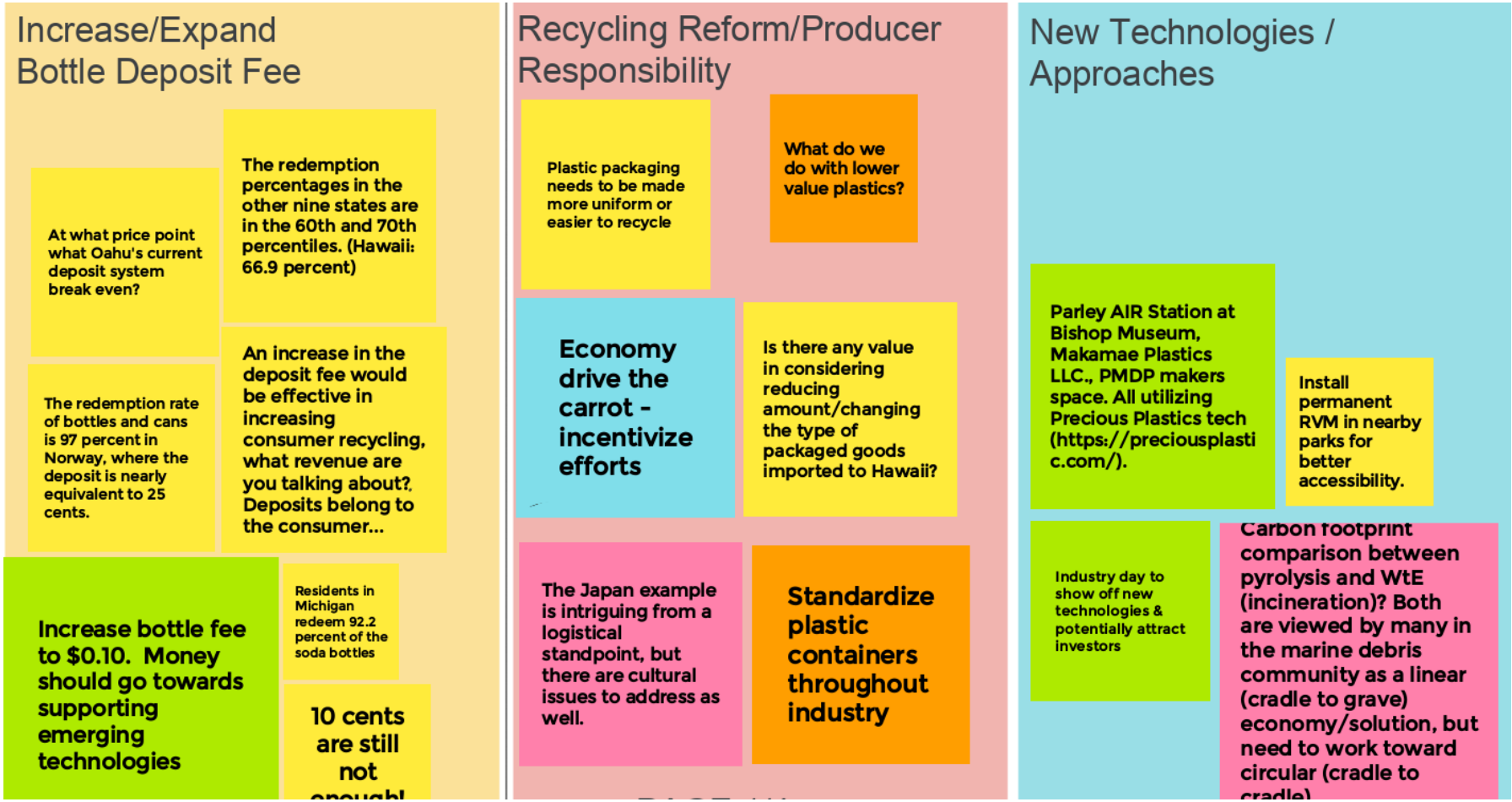
The cost of developing the infrastructure needed to operate a waste processing facility within a centralized waste management system is enormous, especially on Oahu. There are also strong financial incentives for government agencies to maintain the status quo (e.g., the City and County of Honolulu is fined for not incinerating enough MSW tonnage at H-Power according to its contract with Covanta, the plant operator). Potential difficulties in promoting and supporting local businesses interested in decentralized waste management could be side-stepped if such efforts originate at the state level. State decision makers have greater available capital and policy leeway when enacting tax credits, tax refunds, and other financial incentives for businesses. Local business advocacy groups and chambers of commerce should also be consulted to determine how such businesses could succeed in the current economic environment.

7. Importance of culturally based sustainable approaches:

During the presentation to faculty and staff, a comment was made regarding the importance of culturally based sustainable operations, specifically, decentralized approaches to waste management. Hawaii is unique compared to the rest of the continental United States in that the efficiencies of long logistical waste management chains are often unrealized and costly. This presents an opportunity for decentralization. By focusing on community-based solutions, Hawaii can turn its geographic isolation into a strength. The logistical barriers of waste management can be overcome by localized solutions and this report concurs with the idea that the rich history and community of Hawaiians can and should be leveraged to generate creative ways to manage waste. Solutions rooted in community allow its members to take ownership of the problem which results in a grassroots or bottom-up approach more powerful than any government mandated policy.

Appendix B: Project Milestones and Expert Engagement

February	March	April	May
5 - Initial Client Meeting & Stakeholder Engagement **12** - Meetings with Dr. James Richardson; Michael Lurvey of Carbon Geo-Tek Consultants (TCOM) **22** - Dr. Kitty Courtney, Tetra Tech; Bruce Iverson, Reynolds Recycling **24** - Site visit with Carbon Geo-Tek Consultants	**13** - Second Client Meeting & Facilitated Discussion **26** - Completed Literature Review	**14** - Draft report to faculty advisor for review and comment **21** - Draft report to clients, stakeholders & DURP **28** - Feedback received from interested parties	**3** - Presentation to DURP, additional feedback **10** - Final client presentation, final feedback **15** - Finished report sent to clients and stakeholders



Pictured above: Practicum group utilized Google Jamboard to facilitate client and stakeholder discussions.

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