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March 19, 2019

VIA HAND DELIVERY

Cord D. Anderson, Vice Chair
Planning Commission
c/o Department of Planning and Permitting
650 South King Street, 7th Floor
Honolulu, Hawaii 96813

Dear Vice Chair Anderson:

Re: Planning Commission Special Use Permit Application File No. 2008/SUP-2, Waimanalo Gulch Sanitary Landfill

Condition 1 of the Planning Commission's Findings of Fact, Conclusions of Law, and Decision and Order dated August 4, 2009, states in relevant part: "On or before November 1, 2008, the Applicant shall begin to identify and develop one or more new landfill sites that shall either replace or supplement the [Waimanalo Gulch Sanitary Landfill ("WGSL")].

As part of its work to prepare the City and County of Honolulu's Integrated Solid Waste Management Plan, funds were allotted in the Fiscal Year 2010 budget to conduct a site selection study for a secondary landfill on Oahu and the Mayor's Landfill Site Selection Committee was formed. The Committee was tasked with providing the City advisory recommendations concerning the selection of a future site for a landfill to replace or supplement WGSL. The Committee ranked numerous sites according to criteria that it determined most appropriate for landfill sites to accommodate municipal solid waste ("MSW"), ash and residue from facilities such as H-POWER, and construction and demolition debris. In the Committee's final report, eleven potential sites were identified and ranked based on community criteria.

The city retained a consultant to further review and analyze the sites based on the following technical and logistical criteria: landfill lifespan, site development cost, roadway improvement cost, access road requirements, location relative to H-POWER, and acquisition. The consultant evaluated the criteria and, in November 2017, published a report entitled *Assessment of Municipal Solid Waste Handling Requirements for the Island of O'ahu* ("Landfill Report").

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The Landfill Report states that based on MSW projections and the City's plan to maximize usage of MSW and ash air space at WGSL, the available capacity at WGSL is expected to be exhausted in approximately 2038. Further, the report states that based on the conservative timeline of ten years to develop a new landfill, it would be appropriate for the City to begin the development process in the year 2028. Between now and the date that a new landfill will be needed, there may be improvements in solid waste management technologies and changes in demographics, landfill engineering technologies, regulations, values and availability of land, land use, community sentiments, policies and other factors. Thus, the Landfill Report suggests that it may be more appropriate to undertake the landfill siting process closer to the date when a new landfill will be needed and when all conditions can be thoroughly assessed. See Landfill Report at pp. 30-31.

In response to a recent request from the Planning Commission, six copies of the Landfill Report are being transmitted with this letter. Because four commissioners are recused from matters relating to the WGSL, we are providing copies for each member who may be involved in the enforcement of conditions to the Planning Commission's approval of 2008/SUP-2 (SP09-403), plus one copy for the commission's files. The report is also available online at http://opala.org/solid_waste/pdfs/WGSL%20Assessment%202017.pdf.

Sincerely,

KAMILLA C. K. CHAN
Deputy Corporation Counsel

KCC:mw

Encs.

cc: Calvert G. Chipchase, Esq., Attorney for Intervenors Ko Olina Community Association and Maile Shimabukuro
Ian L. Sandison, Esq., Attorney for Intervenor Schnitzer Steel Hawaii Corporation
Richard N. Wurdeman, Esq., Attorney for Intervenor Colleen Hanabusa
✓Kathy K. Sokugawa, Acting Director, Department of Planning and Permitting (without enclosure)

16-09965/729803

Assessment of Municipal Solid Waste Handling Requirements for the Island of O‘ahu

Department of Environmental Services
City and County of Honolulu

November 2017

Preparers:
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EXECUTIVE SUMMARY

This report assesses the City and County of Honolulu's (City's) solid waste management system, materials requiring landfill disposal, the remaining lifespan of Waimanalo Gulch Sanitary Landfill (WGSL), and the year the City should begin development of a future municipal solid waste landfill (MSWLF). The report also reviews the sites identified by the 2012 Mayor's Advisory Committee on Landfill Site Selection (MACLSS) and examines them based on a technical and logistical review.

To determine the existing lifespan of WGSL, waste generation was projected through year 2040 using O'ahu's de facto population data from the State of Hawaii Department of Business, Economic Development and Tourism (DBEDT) along with expected recycling diversion rates. Conservative projections show that by year 2040, up to 860,000 tons of MSW may need to be handled by the City. The Honolulu Program of Waste Energy Recovery (H-POWER) facility would process the majority of this tonnage, approximately 820,000 tons, with approximately 253,000 tons of material (MSW and H-POWER ash and residue) requiring landfill disposal. Based on these projections and considering the planned landfill cell reconfiguration at WGSL to maximize existing air space, there is enough capacity for WGSL to accept waste to the year 2038.

Considerable effort has been put into siting a future landfill. The 2012 MACLSS report identified 11 potential landfill sites and ranked them based on a community perspective. In this report, those 11 sites were reanalyzed and scored against six criteria: landfill lifespan, site development cost, roadway improvement cost, access road requirement, location relative to H-POWER, and acquisition. These criteria were chosen because the location of a future landfill also needs to be based on technical and logistical concerns which factor heavily into ensuring any site is feasible, cost effective, and functional.

This technical and logistical analysis showed that five sites (Upland Nānākuli 1, Ameron Quarry and Kapa'a Quarry Road, Kāne'ohe by H-3, and Kea'au) could be considered for a future landfill location based on their higher scoring relative to the criteria. The remaining six sites (Upland Hawai'i Kai, Upland Pūpūkea 2, Upland Lā'ie, Upland Pūpūkea 1, Upland Kahuku 2, and Upland Kahuku 1) ranked lower and would be less viable sites. It should be noted that future conditions could change the technical and logistical factors for any of these 11 sites and this needs to be considered. While this report's technical and logistical ranking provides important information for the siting of a future landfill, the selection of any site needs to also carefully consider the community perspectives cited in the 2012 MACLSS report.

Despite these siting efforts, based on the current projection that WGSL will have capacity until 2038 and a conservative timeline of 10 years to develop a new landfill, it would be appropriate to begin the process to site a new landfill in year 2028. During the period between 2028 and 2037, the City should reanalyze the sites ranked in this report and investigate potential new landfill sites, conduct the site selection, undertake land acquisition (e.g., negotiation, condemnation or purchase), obtain environmental permits, land use permits and operating permits, and conduct site planning, design, engineering, and construction.

To maintain the accuracy of the projected 2028 date, anticipated waste generation and the remaining lifespan of WGSL should be annually reviewed based on current and planned landfill diversion efforts. This will update the appropriate year in which to begin development of a future site and it will also provide information to determine if new or altered criteria for a future site are required; in particular, if the annual tonnage of materials needing landfill disposal is significantly reduced, smaller landfill sites may become viable. If smaller sites are desirable, the list of potential new landfill sites that could be considered would increase.

Additionally, between now and year 2038, new and improved solid waste management technology could further extend the date when a future landfill will be required. The City may decide to further expand H-POWER or use other technology to process waste, recycle H-POWER ash and residue, and recycle other residues. There may also be changes in demographics, landfill engineering technology, regulations, values and availability of land, land use and zoning, community sentiments, policies, and other factors. To best account for these variables, it would be prudent to undertake the landfill siting process in the future, ten years prior to the date when one would be needed and when all conditions can be thoroughly assessed.

INTRODUCTION AND BACKGROUND

This report is prepared for the City and County of Honolulu (City) Department of Environmental Services (ENV) to determine the lifespan of the Waimānalo Gulch Sanitary Landfill (WGSL); to further define the future need for municipal solid waste landfill (MSWLF) capacity for the island of O'ahu based on recent improvements to the City's solid waste system that have significantly diverted waste from the WGSL; to establish a timetable when the development of a new landfill (LF) site can be correlated with its need; and, to reassess the 11 alternative LF sites identified by the 2012 Mayor's Advisory Committee on Landfill Site Selection (MACLSS). The reassessment is a technical review to reflect City and ENV requirements to provide municipal solid waste (MSW) disposal for solid waste that cannot be further reused, recycled, processed at H-POWER or processed in another practical, reasonable, and efficient manner for all island communities on O'ahu.

The solid waste handling capacity on the island of O'ahu is assessed for an existing and future planning timeframe of approximately 25 years (from Year 2015 to Year 2040). The selection of a 25-year planning horizon is expected to be accurate within plus or minus five years based on the following:

-- The management of solid waste has undergone major changes since the WGSL, O'ahu's sole MSWLF, started operations in the late 1980s. Significant effort by the City has since reduced the volume of MSW requiring landfilling primarily through improved waste handling brought about by the Honolulu Program on Waste Energy Recovery (H-POWER) facility. The City has also investigated and planned for additional projects to further reduce the amount of MSW requiring future landfilling; and,

-- Solid waste generation projections for the island of O'ahu along with current and future landfill diversion programs indicate there is significant remaining usable capacity at the WGSL. This study will update the projected remaining life of the WGSL to support future waste disposal requirements of the City.

This report is presented in two phases of work:

Phase 1 This phase examines the City's existing solid waste management system for the handling of MSW requiring landfill disposal. Recycling data is also examined and is summarized to show the potential effect over time on the WGSL lifespan, and when a future MSWLF is expected to be required. Construction and demolition (C&D) waste and emergency disaster debris (EDD) are also reviewed.

Phase 2 This phase describes the City's future plans to address the handling of MSW. Current projections demonstrate that over time there has been significant progress made in reducing O'ahu's MSW waste stream, but that a MSWLF will remain of vital importance as a backup for H-POWER and for certain types of MSW that cannot be further reused, recycled, or processed. Phase 2 will include:

- A technical review of the 2012 MACLSS, which identified 11 alternative landfill sites using citizen-based criteria developed by the committee;

- An examination of the technical and logistical requirements for a new MSWLF; and

- The overall effect of both a projected reduced rate of MSW generation, and the City's on-going efforts to reduce the MSW waste stream requiring landfill disposal through the use of the H-POWER facility and future projects to divert waste.

PHASE 1 – SOLID WASTE MANAGEMENT SYSTEM CAPACITY

O'ahu's existing solid waste management system has a direct effect on the amount of MSW that must be disposed of at the WGSL. Recycling data are also examined to gauge their effect over time. Waste generation projections are then developed and forecasts are used to estimate the remaining WGSL lifespan. Construction and demolition (C&D) waste and emergency disaster debris (EDD) are also examined.

1. MSW Waste Stream

The City MSW Management System processes waste in three ways: (1) Recycling; (2) Waste-to-Energy; and, (3) Landfilling.

Recycling: Commercial recycling companies gather, process, and recycle materials from businesses as mandated by various City Ordinances. Many of these programs have been in operation since the 1990s and are currently well-established in the private sector. The City encourages households to recycle green waste and mixed recyclables through its well-established automated green cart and blue cart collection programs. The City also provides for the recycling of automotive batteries, white goods, propane tanks, and metals at various convenience centers and transfer stations. These commercial and household recycling efforts result in the diversion of these materials from entering the waste stream and will continue as mandated by Ordinance.

Waste-to-Energy (H-POWER): MSW collected by City and commercial haulers is delivered to the H-POWER facility in Campbell Industrial Park, where it is processed and incinerated in one of two combustion processes – refuse derived fuel (RDF) or mass burn (MBN) incineration. In addition to normal household trash, sewage sludge, certain types of tires and medical waste, bulky waste, and other special waste are also taken to H-POWER. The combusted waste is converted to power providing as much as 10 percent of O'ahu's electricity, while reducing the volume of refuse requiring landfilling by up to 90 percent. By-products of the H-POWER process include ferrous and non-ferrous metals, which are recovered and recycled, and waste ash and residue. Currently, the waste ash and residue cannot be further recycled or reused and is disposed of at the WGSL.

Landfilling: Some materials that cannot otherwise be recycled or taken to H-POWER are received directly at WGSL. This includes sterilized medical waste (sharps), dead animals, sludge screenings and grit from O'ahu wastewater treatment plants, sandblast grit, etc. Other materials currently landfilled include auto shredder residue (ASR), non-combustible homeowner "drop-off" waste, and food and other products suitable for landfilling that have expired. H-POWER residue from the RDF process and ash are also delivered to WGSL. During periods of H-POWER maintenance, MSW that would normally be received at H-POWER is sometimes diverted to the WGSL, depending on the amount of storage available at the H-POWER facility.

Each waste stream contributes to the total MSW volume and is considered in the MSW forecast. Each waste stream also affects the capacity assessment of the City's MSW system to handle future waste streams generated on O'ahu. The MSW forecast provides an estimate of future waste generation that is independent of the waste treatment process, which will be further described in the next section of this report.

2. Construction and Demolition (C&D) Waste Stream

C&D waste is not accepted at the WGSL and is not factored into the waste generation or landfill life projection for the WGSL. C&D waste, however, is included as part of the overall solid waste management plan and therefore, a brief investigation of the C&D waste stream was conducted and included interviews with the operator of the PVT Landfill, O'ahu's primary construction and demolition debris landfill.

PVT Landfill accepts the following types of material for processing or disposal:

- Construction and demolition waste (up to 2,000 tons per day, which is the primary waste material accepted at the facility);
- Waste and other organic containing material that can be processed into feedstock for bioconversion;
- Scrap metal;
- Double-bagged asbestos containing material (up to 500 tons per day);
- Liquid wastes for solidification;
- Approved contaminated soil for disposal or use in solidification of liquid wastes and sludge; and
- In the event of a natural disaster, C&D materials will be taken to the PVT Landfill for processing and/or disposal.

In addition to C&D landfill operations, PVT Landfill operates a recycling and materials recovery center. Materials recovered from the facility are sold for recycling and other reuse purposes reducing the amount of material needing to be landfilled at PVT Landfill.

3. Emergency Disaster Debris (EDD)

The management of EDD waste on O'ahu is described in the City's Emergency Operations Plan and the Honolulu Disaster Debris Management Operations Plan. In the event of a natural disaster significant amounts of waste, EDD, could be created including green waste, debris from damaged buildings, material from within damaged buildings, etc. The City's plan calls for EDD to be sorted, screened, and separated at temporary debris storage and reduction (TDSR) sites across the island. The sorted and reduced materials would then be transferred from the TDSR sites for disposal and/or processing at various facilities (e.g., H-POWER, green waste recyclers, metal recyclers, PVT Landfill, etc.), or stored until such time they are able to accept materials. Air-curtain burning and the mulching and spreading of green waste into open areas may be used to further reduce green waste. Clean woody debris and other burnable materials (e.g., cardboard, newspaper, etc.) can also be disposed of by air-curtain burning.

During an emergency condition WGSL would primarily be used to dispose of putrescibles (e.g., trash that decomposes, causes odors, vectors, etc.), medical waste, sewage sludge, dead animals, other wastes deemed appropriate and household trash, in the event that H-POWER is inoperable. EDD generated during a disaster is not factored into the projections for waste generation or landfill life since it is planned to be diverted from WGSL.

A. Forecasts

Forecasts for MSW obtained in the course of this study projected the growth of MSW according to past solid waste generation patterns and the expected change in the *de facto* population on O'ahu. Data relevant to the City's capacity to handle existing and future solid waste streams were provided by ENV. Historical data are shown in Table 1: Municipal Solid Waste Volume, City and County of Honolulu, 2000 - 2015. Details are presented in Appendix A.

Table 1: Municipal Solid Waste Volume, City and County of Honolulu, 2000 - 2015

Year	De facto Population	Total MSW Generated (tons)	Recycled Material (tons)	Total Municipal Solid Waste Received (tons)
2000	926,192	1,207,081	327,710	879,371
2001	926,713	1,264,996	367,300	897,696
2002	934,070	1,249,674	352,699	896,975
2003	931,880	1,256,289	366,639	889,650
2004	949,262	1,337,090	386,338	950,752
2005	959,340	1,358,983	417,669	941,314
2006	967,400	1,351,104	421,072	930,032
2007	963,577	1,341,682	453,372	888,310
2008	962,908	1,310,093	456,876	853,217
2009	972,202	1,209,961	426,947	783,014
2010	988,106	1,208,542	448,639	759,903
2011	1,000,733	1,251,736	490,061	761,675
2012	1,019,530	1,230,565	487,157	743,408
2013	1,033,388	1,235,964	477,011	758,953
2014	1,041,721	1,242,190	475,953	766,237
2015	1,033,251	1,261,555	478,934	782,621

Source: City and County of Honolulu
Note: Totals may not add due to rounding.

The *de facto* population of the City was defined as the total population of the City on July 1 of each year between 2000 and 2015, plus the average daily visitor census in July of each year between 2000 and 2015, minus the estimated number of O'ahu residents absent from the County each day during the years 2000 through 2015, as taken from the State Department of Business, Economic Development, and Tourism (DBEDT) Population and Economic Projections for the State of Hawai'i, 2040 Series.

De Facto Population = Total Population + Average Daily Visitor Census
– O'ahu Residents Absent

Recycled material was defined as the tons of materials collected and recycled by the City and by private industry recycling companies, as reported to ENV in annual surveys. The total municipal solid waste received was defined as the tons of MSW received at H-POWER and WGSL. The total MSW generated was defined as the sum of waste received and total waste recycled annually from 2000 through 2015.

1. Forecasting Waste Generation on O'ahu

A model for forecasting future MSW was prepared that incorporated *de facto* population growth as a driver of the total MSW generated, and recycling, which governs the extent to which total MSW would be reduced, the remainder of which would be received at H-POWER and the landfill.

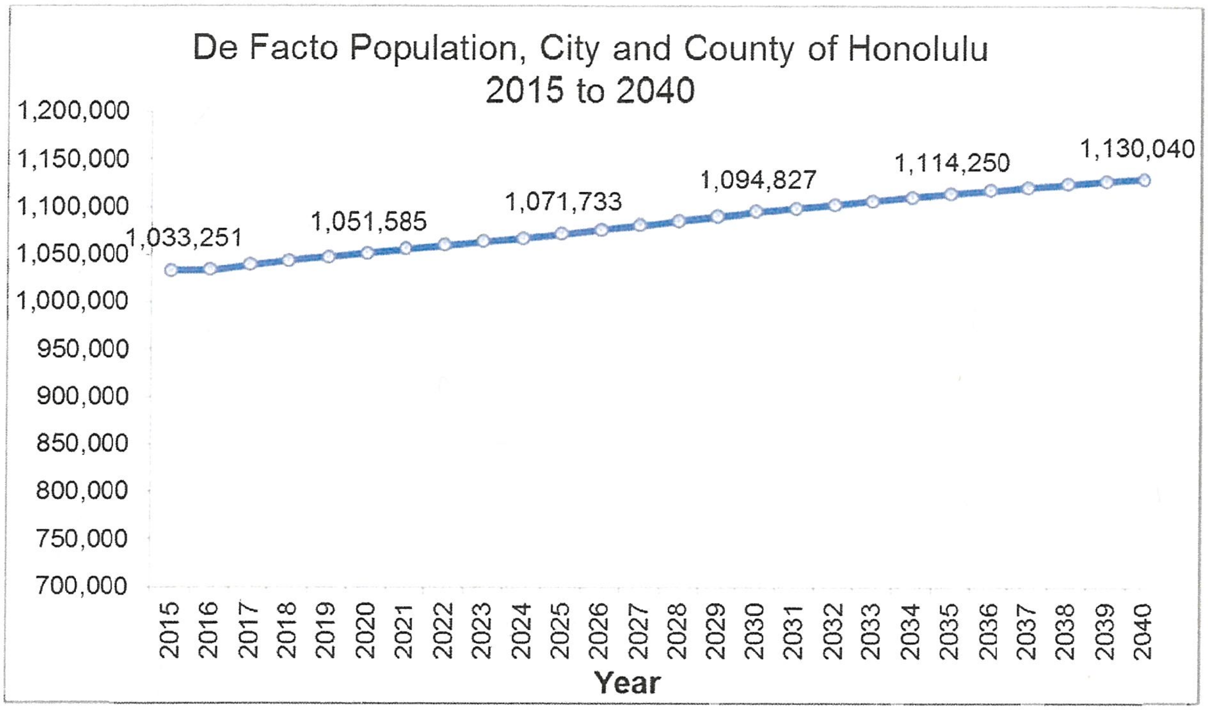
Population projections were a key element in developing forecasts for waste generation. The forecasts are based on the *de facto* population, which is particularly appropriate for Honolulu due to more than 5 million visitor arrivals each year. The future annual growth rate data was also derived from the DBEDT Population and Economic Projections for the State of Hawai'i, 2040 Series. See Figure 1: Population Forecast, 2015 to 2040.

The rate shown represents relatively slow growth of approximately 0.4 percent per annum. The major component of the City's *de facto* population is the resident population. Average daily visitor census is the second most important component and has been growing at record rates over the last four years. However, meaningful change in the rate of growth would require a more significant change in O'ahu's resident population.

Natural growth and net in-migration constitute two significant factors that affect change in the resident population. Natural growth, defined as the excess of births over deaths, has been relatively slow over the last decade and a major change in this pattern in the next 25 years is not anticipated. Improvements in medical care may be expected to continue to reduce death rates. However, a rise in birth rates is less likely due to competing demographic forces. For example, while a rising economy may increase births, demographic trends of the last two decades show that many out-migrants were women of childbearing age.

The larger and most volatile component of population growth is the excess of in-migration over out-migration. In the last decade or more, Honolulu has been distinguished by its relatively high rates of out-migration. While it is possible that a new wave of in-migration might arise, it is expected that demographic and economic conditions and especially O'ahu's inelastic housing supply will continue to support out-migration. These factors lead to greater confidence in the forecast, which may be further supported or moderated by the next series of population projections from the State.

Figure 1: Population Forecast 2015 to 2040



Source: Department of Business, Economic Development and Tourism, Population and Economic Projections for the State of Hawai'i to 2040 (March 2012); SMS Research Estimates

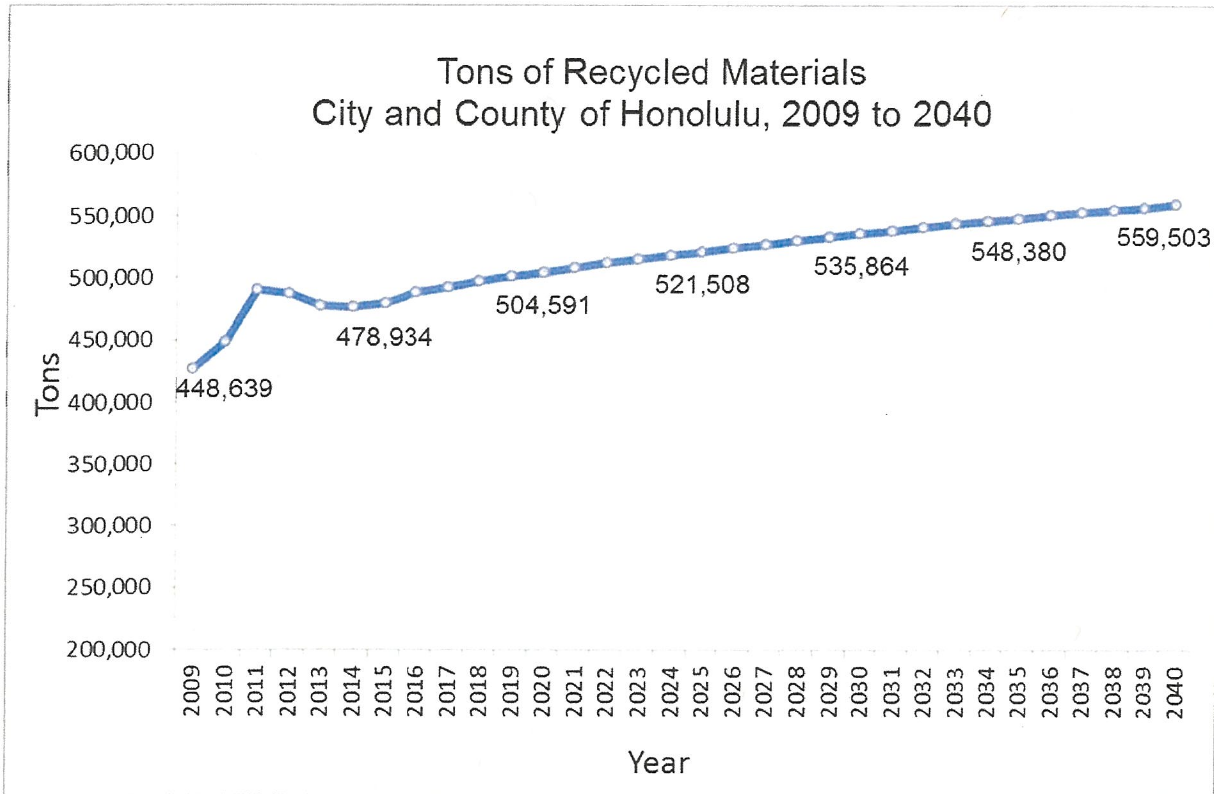
2. Forecasting Recycled Material

Recycled material, as defined by the City's curbside recycling program includes green waste, glass bottles and jars, metal and aluminum cans, newspaper, cardboard, office paper and plastic containers #1 and #2. It also includes materials collected by private sector recyclers. See Table 1, above, for annual recycled material tonnages.

Between 2000 and 2011, the volume of recycled material collected grew rapidly due to the implementation of recycling programs on O'ahu and the rising awareness and popularity of recycling. Growth during this period was about 15,000 tons in an average year, for a growth rate of 4.5 percent per annum. By 2011, 490,000 tons of recyclables were being processed per year. However, in recent years the recycling growth rate has significantly slowed to an average -0.7 percent per year which suggests a stabilization of the program.

The recycling forecast is shown in Figure 2: Tons of Recycled Materials, City and County of Honolulu, 2009 to 2040.

Figure 2: Tons of Recycled Materials, City and County of Honolulu, 2009 to 2040



Source: City & County of Honolulu's Department of Environmental Services, Recycling and Landfill Diversion; SMS Research Estimates

It should be noted that the future forecast for recycling based on data from 2000 through 2015 was heavily affected by strong growth rates prior to 2011 and produces a very large amount of recycled material when projected through 2040. Alternatively, a forecast based on the years between 2011 and 2015 would otherwise eliminate any projection for increased recycling before the year 2040, which does not accurately portray City efforts. In order to derive a more realistic forecast for the future years, a solution is to use a more reasonable time series, from 2008 through 2014. This method generated a lower and slower growth rate (about 0.9% per year) with the resulting forecast trend line showing an overall increase in tons of recycled materials, but at a decreasing rate over time.

3. Forecasting MSW

Forecasting MSW based on population and recycled material produced the results shown in Table 2: Municipal Solid Waste Volume Forecast, Honolulu, 2016 – 2040 below. A rising de facto population will reach 1,130,040 persons in 2040, generating about 1,377,157 tons of MSW. 559,503 tons would be recycled and the remaining 817,654 tons will enter the City's H-POWER or WGSL waste streams for processing or landfilling.

Table 2: Municipal Solid Waste Volume Forecast, Honolulu, 2016 - 2040

	De facto Population	Total MSW Generated (tons)	Recycled Material (tons)	Total Municipal Solid Waste Received (tons)
2010	988,106	1,208,542	448,639	759,903
2015	1,033,251	1,261,555	478,934	782,621
2020	1,051,585	1,288,340	504,591	783,749
2025	1,071,733	1,315,924	521,508	794,417
2030	1,094,827	1,339,175	535,864	803,311
2035	1,114,250	1,359,331	548,380	810,951
2040	1,130,040	1,377,157	559,503	817,654

Source: Department of Business, Economic Development and Tourism, Population and Economic Projections for the State of Hawai'i to 2040; City & County of Honolulu's Department of Environmental Services, Recycling and Landfill Diversion; SMS Research Estimates

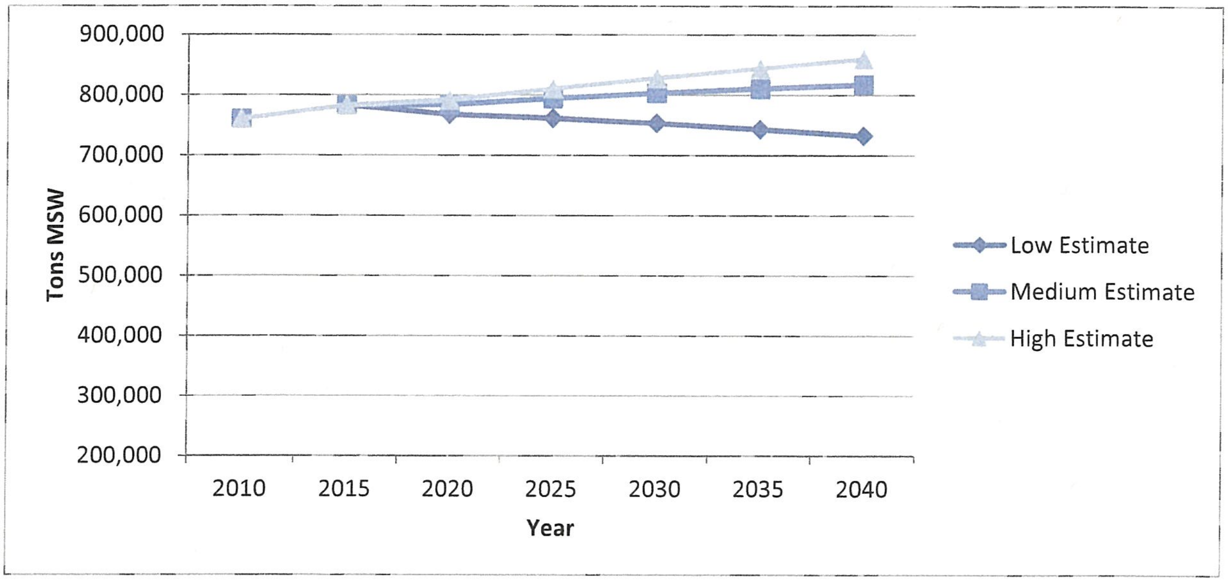
The assumptions underlying these forecasts for solid waste generation are that the *De facto* population growth rates will remain relatively stable over the long run and that recycling will continue to grow slowly, but at a decreasing rate through 2040. It should be noted that the forecasts are based on DBEDT's latest Population and Economic Projections for the State of Hawai'i, 2040 Series (March 2012) and that once DBEDT provides a new update, these forecasts may need to be adjusted.

Low, medium, and high forecasts were also developed as the last step in the forecasting procedure. See Table 3: Municipal Solid Waste Forecast, Three Alternatives, 2016 - 2040. The medium estimate is considered the forecast result. The low and high estimates include a component for statistical error in forecasting (approximately 5 percent) and the risk that the assumptions may differ over time. The high estimate increases the forecast by about 1 percent by 2020 and to 5.2 percent by 2040. This suggests that the statistical error is quite low, and that there is relatively little probability that the future will result in an MSW volume that is higher than forecasted. However, the condition for a high estimate may occur if O'ahu's *de facto* population grows at a higher rate than estimated or if the rate of recycling were lower than what is projected. The low estimate assumes that the population will increase slower than anticipated and/or the recycling rate will increase faster than anticipated.

Table 3: Municipal Solid Waste Forecast, Three Alternatives, 2016 - 2040

	Total Municipal Solid Waste Received (tons)		
	Low Estimate	Medium Estimate	High Estimate
2010	759,903	759,903	759,903
2015	782,621	782,621	782,621
2020	767,421	783,749	791,913
2025	761,316	794,417	810,967
2030	753,104	803,311	828,414
2035	743,372	810,951	844,740
2040	732,482	817,654	860,240

Figure 3: Municipal Solid Waste Forecast, Three Alternatives, 2016 - 2040



Source Table 3 & Figure 3: City & County of Honolulu's Department of Environmental Services, Recycling and Landfill Diversion; SMS Research Estimates

B. Handling MSW on O'ahu

From the time the MACLSS process was concluded, the methods of handling waste on O'ahu have changed, becoming increasingly efficient and effective since the addition of a new mass burn (MBN) 3rd boiler at H-POWER in 2012. Changes made to the handling of solid waste on O'ahu and its effect on estimating landfill lifespan were accomplished through the MSW handling model developed for this analysis.

Prior to the addition of the MBN 3rd boiler, H-POWER's refuse derived fuel (RDF) facility processed anywhere between 550,000 and 645,000 tons per year of MSW. The added MBN 3rd boiler can process at over 300,000 tons per year but for model purposes is conservatively set at 280,000 tons per year. The processing model assumes the MBN facility will produce at that level for the next 25 years while the RDF facility would take the remaining tonnage. The MBN process produces about 22 tons of ash per 100 tons of MSW. The RDF process produces about 12 tons of residue and 16 tons of ash per 100 tons of MSW processed. It should be noted that these percentages can vary depending on operations (e.g., if combustible residue from the RDF process is taken to the MBN facility for combustion; directing certain types of MSW to either the RDF or MBN portion of the facility, etc.). Both the ash and residue are transferred for disposal at WGSL. The model forecast results are shown in Table 4: Waste Handling Projections, O'ahu, 2005 to 2040 below and details are provided in the appendix as APPENDIX B: Municipal Solid Waste Handling Process Historical Data and Projections, O'ahu, 2001 to 2040.

Table 4: Waste Handling Projections, O'ahu, 2005 to 2040

Year	Total Municipal Solid Waste Received (tons)	MSW Received at H-POWER	MSW Received at WGSL	H-POWER Ash and Residue Received at WGSL	Total Waste Landfilled (Includes MSW, H-POWER Ash and Residue)
2005	941,314	553,138	388,176	164,262	552,438
2010	759,903	598,041	161,862	179,946	341,808
2015	782,621	718,518	64,103	203,698	267,801
2020	783,749	754,446	29,303	194,445	223,748
2025	794,417	759,639	34,778	195,899	230,677
2030	803,311	766,759	36,552	197,892	234,444
2035	810,951	772,534	38,416	199,510	237,926
2040	817,654	777,278	40,376	200,838	241,214

Source: Department of Business, Economic Development and Tourism, Population and Economic Projections for the State of Hawai'i to 2040; City and County of Honolulu's Department of Environmental Services, Recycling and Landfill Diversion; SMS Research Estimates

Note: Totals may not add due to rounding. The quantities shown in the chart above for H-POWER and WGSL are based on the tonnage processed in that particular year, see Appendix B for details.

Between 2005 and 2015, MSW generation decreased by approximately 17 percent from 941,314 tons to 782,621 tons, primarily due to the impact of increased recycling activity on O'ahu and the economic downturn in 2008. In future years, MSW generation is forecasted to increase to 817,654 tons by 2040 due to the increasing *de facto* population.

In 2005, H-POWER processed 553,138 tons of MSW, or 59 percent of total MSW generated. By 2015, that amount had increased to 718,518 tons, or 92 percent of total MSW generated, increasing the efficiency of the system largely due to the new MBN 3rd boiler. It is expected that H-POWER will continue to process the majority of the total MSW through the future years.

In 2010, before the MBN facility was constructed, WGSL received 161,862 tons of MSW. In 2015, that figure was down to 64,103 tons, a reduction of 60 percent. Through the future years, MSW delivered directly to WGSL is expected to vary between approximately 30,000 to 50,000 tons per year depending primarily on the amount of tonnage diverted from H-POWER during periods of maintenance. Should future landfill diversion efforts be implemented, these quantities may be further reduced.

MSW received at H-POWER is burned to produce electricity and in the process, residue and ash are also produced and transferred for disposal at WGSL. In the last column of Table 4 and the bottom row of Table 5, the ash and residue are combined with the MSW to calculate the total impact on the WGSL. In 2005, the City's solid waste processing system began with 941,314 tons of total MSW and 552,438 tons of MSW H-POWER and ash and residue was taken to the LF, 59 percent of the total MSW. In 2015, there were 782,621 tons of total MSW and 267,801 tons of MSW, ash and residue, or 34 percent, was delivered to the LF. In year

2040, it is estimated that 817,654 tons of MSW would be generated and about 30 percent, or 241,214 tons, will be sent to the landfill.

Based on these waste handling processes, low, medium and high MSW estimates were developed as shown in Table 5: Waste Received at H-POWER and WGSL, 2016 – 2040. These projections will be utilized in determining landfill lifespan.

Table 5: Waste Received at H-POWER and WGSL, 2016 - 2040

Items	Timeframe	Low Forecast	Medium Forecast	High Forecast
Total MSW Received (tons)*	2016	770,113	773,335	774,947
	2040	732,482	817,654	860,240
	Annual growth	-0.20%	0.23%	0.44%
Received at H-POWER (tons)*	2016	694,113	697,335	698,947
	2040	692,106	777,278	819,865
Received at WGSL (Including H-POWER Ash and Residue)*	2016	266,883	268,000	268,559
	2040	217,366	241,214	253,138

*Figures in table based on 2015 forecasting data. Annual growth reflects waste generation increasing at a decreasing rate.
Note: The quantities shown in the chart above for H-POWER and WGSL are based on the tonnage processed in that particular year, see Appendix B for details.

C. Estimating the Remaining Lifespan of WGSL

The pattern of waste management developed for the project used the waste generation forecast and current diversion and waste management practices at WGSL and H-POWER to estimate the remaining lifespan of the WGSL under the low, medium, and high waste generation scenarios. The conversion rates for landfill air space were taken from the existing LF operations. Estimates of MSW received at the LF, residue, and ash were converted from tons to cubic yards. Remaining capacity was calculated for each MSW forecast, and cubic yards of space were subtracted from the remaining capacity on a year-by-year basis factoring in the appropriate air space utilization factor.

Currently at the WGSL, the MSW portion of the LF is projected to reach capacity sooner than the ash portion since more of the existing LF air space is currently dedicated to ash. To adjust for this, the City has begun implementing plans to rebalance the WGSL so that both the MSW and ash areas reach capacity at approximately the same time. This reallocation will provide for more efficient use of the entire landfill air space and, for a landfill that will avoid steep slopes and provide safer access into the MSW and ash areas.

The results of the model for estimating the future life of the WGSL are shown in Table 6: WGSL Lifespan Estimates, and details are provided in Appendix C: Waimānalo Gulch Sanitary Landfill Lifespan Estimate (No-change Model), O‘ahu, 2016-2040 and Appendix D: Waimānalo Gulch Sanitary Landfill Lifespan Estimate (With Reconfiguration), O‘ahu, 2016-2040.

Table 6: WGSL Lifespan Estimates

Landfill Cell Allocation	Low Forecast	Medium Forecast	High Forecast
Current Cell Allocation Final Year of Operation at WGSL*	2031	2030	2030
With Cell Re-allocation Final Year of Operation at WGSL*	2039	2038	2038

Source: Source: City & County of Honolulu's Department of Environmental Services, Recycling and Landfill Diversion; SMS Research Estimates
Note: *Forecasts are based on rounding to establish the closest landfill lifespan year.

Under the current cell allocation processing model, and using the low-growth forecast for MSW, WGSL would reach its capacity during the year 2031. The medium forecast would end later in 2030, and the high MSW generation forecast would reduce the lifespan to earlier in 2030. These estimates are provided for information only and will not be applicable as the City has begun efforts to reallocate the landfill air space for maximum use. With the cell reallocation, the low-growth MSW forecast would find the WGSL reaching its capacity during the year 2039, the medium forecast would end later in 2038, and the high forecast would be earlier in 2038.

These results are based on the forecast and handling analyses conducted for this report and illustrate the updated landfill life assessment for the current landfill. The updated estimates will also serve as the basis for the selection of a future landfill site in Phase 2 of this investigation. It should be noted that these landfill life projections should be periodically updated as future landfill operations and related data (e.g., air space calculations, air space utilization factors, landfill fill sequences, cell allocations, compaction factors, etc.) may affect the forecasts.

D. Time Schedule for the Next O‘ahu Landfill

The foregoing discussion suggests that the WGSL will reach its capacity in approximately year 2038 and the result is that a new landfill would not be required until year 2037, in anticipation of the exhaustion of space a year later. The start of work will depend on the timetable developed to schedule all of the tasks associated with site identification, selection, land acquisition, environmental and land use permitting, design, and construction. The timetable will also depend on the specific characteristics of the site selected.

Improvements to roadways and intersections, along with the need for an access road and major land excavation to develop the landfill cells are likely to be required and would vary for each site. Additional infrastructure improvements such as drainage and utilities would also be required and accordingly, these costs will differ for each site.

Developing any new site will be a complex and technical process and can be expected to involve issues that cannot be fully anticipated or predicted such as the support or rejection of the host community, unwilling sellers, land use approvals, potential lawsuits, etc. Based on these complexities and unknowns, it is recommended that a minimum of 7 to 10 years be utilized as the time needed to develop a new landfill, with 10 years being more conservative.

Based on the current WGSL site becoming exhausted at approximately year 2038, it is suggested that the planning process begin 10 years before the site is needed, by year 2028. The anticipated major elements associated with the site selection and development process and the approximate timeframes would be as follows:

Year Time Required for Landfill Development	1 2028	2 2029	3 2030	4 2031	5 2032	6 2033	7 2034	8 2035	9 2036	10 2037
Site Selection										
Land Acquisition										
Environmental and Land Use Permitting										
Site Planning and Engineering Design										
Construction (First Cells Available for Use)										

Task Description:

- Site Selection: This is to reassess prior and potential new LF sites to reflect future community values and technical needs 10 years prior to when the WGSL is scheduled for closure. Time required: ~2 to 3 yrs.

- Land Acquisition: This is to consider land ownership, negotiations, purchase or condemnation, and budgeting. Time required: ~3 to 4 yrs.

- Environmental and Land Use Permitting: By Hawaii Administrative Rules, an EIS and associated special studies will be required. Depending on the site selected, land use permits may also be required. Time required: ~4 to 5 yrs.

- Site Planning and Engineering Design: This is to consider development requirements including site planning, costs, technical analyses, and the engineering design. Time required: ~2 to 3 yrs.

- Construction (First Cells Available for Use): Contract advertisement/bid/award. Grading, earthwork, cell lining, infrastructure, site facilities, access improvements, off-site improvements, etc., will be constructed. Time required: ~2 - 3 yrs.

PHASE 2 – TECHNICAL AND LOGISTICAL REVIEW OF LANDFILL SITES

The Phase 1 forecasts indicate that there has been significant progress in reducing O'ahu's MSW waste stream through development of the H-POWER facility and the City's recycling programs. As a result, there has been a significant reduction in the amount of refuse requiring landfilling. However, until such time that an alternative to the use of a MSWLF is developed for the treatment and handling of MSW that cannot be further reused, recycled, or otherwise combusted, a MSWLF will continue to be required as an integral part of the City's solid waste management system. The City notes that a MSWLF is a requirement of its H-POWER permit as it is of vital necessity for the disposal of H-POWER ash and residue, and for the disposal of MSW when H-POWER is not able to receive waste.

Work tasks in Phase 2 included a review of the prior work of the 2012 MACLSS which identified 11 alternative MSWLF sites according to citizen-based community criteria. This report will also examine the technical and logistical considerations that make the development of a new MSWLF site feasible, cost effective, and functional with operations. The factors considered include estimating the effect of the projected reduced rate of increase of MSW, and consideration of the City's on-going efforts to further reduce the MSW waste stream needing landfill disposal through the use of H-POWER and other similar projects.

This analysis is based on the following: (1) the rate of MSW generated will continue to increase, but at a decreasing rate; (2) the City will continue to increase its efforts at waste recovery and recycling to continue to reduce its dependency on the need for landfilling; and (3) a MSWLF would still be a necessity for certain wastes and should be sized to support projected needs.

A. Previous Site Evaluation

The 2012 MACLSS was a select committee of highly qualified citizens appointed by the Mayor to review the development of a system for identifying potential sites, then evaluating the chosen sites. The MACLSS identified properties that qualified as potential MSWLF sites using a set of criteria developed by the committee to represent the community-based interests of O'ahu. The objectives were to ensure that citizen participation was included in the formative stages of the MSWLF site selection process, to identify the interests of the community in locating the next landfill, and, to identify a number of sites that would be suitable according to community interests.

1. Process

The MACLSS met frequently to discuss the issues, review consultant materials, provide interim guidance, and to direct the work tasks of the consultant team assisting the committee. The committee met for approximately a year and oversaw the process of identifying potential new landfill sites. The committee developed a set of 19 criteria to evaluate potential sites and approved a set of measurements for each of the criteria. The consultants assisted the MACLSS in developing a rating system for combining the criteria scores to form a summary measure for each alternative site. Independent of consultant input, the committee also developed numerical weights for each of the criteria, reviewed the scoring system, and compiled its results. The committee concluded its task with the submittal of its final report to the Mayor.

2. Results

The results of the 2012 MACLSS selection process are shown below in Table 7: MACLSS Ratings of 11 Potential Landfill Sites.

Table 7: MACLSS Ratings of 11 Potential Landfill Sites

Site	Score*	Rank
Upland Kahuku 2	716	1
Upland Kahuku 1	697	2
Upland Pūpūkea 2	681	3
Upland Pūpūkea 1	616	4
Ameron Quarry	580	5
Upland Nānākuli 1**	568	6
Upland Lā‘ie	565	7
Kea‘au	533	8
Kāne‘ohe by H3	512	9
Upland Hawai‘i Kai	440	10
Kapa‘a Quarry Road	437	11

Notes:
* Scores were rounded to the nearest whole number.
** The site name "Upland Nānākuli 1" was used for various locations in the area over the initial period of site study by the MACLSS. Although the site is technically located in Wai‘anae, the use of the site name was retained.

The ranked list of sites fulfilled the MACLSS mission to select and evaluate potential alternative locations for O‘ahu's next LF site. The analysis of this report utilizes the work of the 2012 MACLSS and provides an examination of technical and logistical factors affecting each of the 11 sites.

B. Technical and Logistical Site Evaluation

This section examines the 11 sites identified in the 2012 MACLSS report against technical and logistical criteria developed to measure each site's feasibility, cost effectiveness, and functionality to serve as a future landfill location. This evaluation will provide a ranking based on a different focus from that of the previous community-based ranking of the MACLSS.

1. Criteria

Six criteria, landfill lifespan, site development cost, roadway improvement cost, access road requirement, location relative to H-POWER, and acquisition were developed. For each criterion, a score was assigned to each site that measured that site's suitability to meet that criterion when compared against the other sites. No criterion weights were assigned that would favor one criterion over another as all criteria were deemed of like importance. As there are six criteria, the highest possible score a site could obtain is 60. For an explanation on the scoring, see Appendix I: Explanation on Scaling Scores for Evaluation Criteria.

The following provides an explanation for each criterion:

a. Landfill Site Life

For this criterion, the potential lifespan for each site is calculated and ranked since having a larger site is preferred as it amortizes the total cost of developing the landfill over a larger site and hence a longer period of time, versus a smaller site. Updated waste generation, handling, and MSWLF lifespan estimates suggest it is necessary to re-evaluate the prior sites to reflect practical and operational considerations of the City. Cubic yards of capacity for each of the 11 sites were developed as part of the MACLSS site selection process. In this section, three estimates of landfill lifespan were calculated based on alternative fill rates. The fill rates are designed to represent three levels of cubic yards of MSW capacity, RDF residue, and ash deposited annually. The original landfill lifespan estimate used the cubic yards of material deposited at WGSL as calculated in the 2012 MACLSS report, which was approximately 400,000 cubic yards per year. An updated estimate based on the level of diversion that has been achieved on O'ahu in 2016 indicates this is about 225,000 cubic yards per year. A future estimate is also provided based on increasing landfill diversion that would result in a 20 percent improvement from the 2016 performance to approximately 179,000 cubic yards per year.

The 2012 MACLSS established a minimum capacity of 15 years to justify the cost of acquiring, permitting, and constructing a new MSWLF. This was based on the ability of the new site to accept about 400,000 cubic yards of MSW, ash, and residue each year. The volume estimate was also based on the then-current fill rates for the WGSL. This resulted in the elimination of all sites less than 90 acres in size. It should be noted that in the future, MSW technology and management techniques may further reduce the need for large-scale landfill operations. Should the City implement plans for further landfill diversion, this may allow for examination of smaller landfill sites compared to those considered in the 2012 MACLSS.

For results and further detail on this criterion see Appendix E, Exhibit 1: Landfill Lifespan.

b. Site Development and Operation Cost

This criterion is treated in a similar manner as in the 2012 MACLSS report. Site development costs includes the cost of acquisition, development (e.g., storm water control and treatment, drainage facilities, soil suitability for daily cover) and closure. Operations costs were calculated as standard MSWLF site operating costs based on existing landfill operating costs and would be similar for all sites. Development and operating costs were estimated for a starting year of 2037 and considers inflation which would affect all 11 alternative sites similarly.

For results and further detail on this criterion see Appendix E: Exhibit 2. Site Development Cost.

c. Roadway Improvement and Highway Intersection Costs

This criterion covers the cost of improvements to existing roadways used by solid waste transport vehicles between a numbered highway and the MSWLF site. Refuse truck traffic to and from the new landfill will travel along different types of roadways, some of which may require improvement to facilitate the traffic. This may require planning, developing, and constructing roadway interchanges; improving and widening existing roads; developing new gulch and stream crossings; and, widening bridges, as required. The cost of these activities is expected to differ from one site to another.

For each site, the following assumptions guided the development of cost estimates:

- A full 24-foot wide new access schematic layout was used. Final alignments and profiles of roadways must be designed with surveyed topography.
- New access road sections call for a 9-inch thick Portland cement concrete (PCC) Pavement, 6-inch base course, and a 12-inch subbase course.
- Length & width of existing roadways was determined from measurements using Google Earth.
- Any existing roadways to be reused will be reconstructed and widened to 24 feet.
- Existing roadway subbase course will remain and be widened to 24 feet.
- Intersections with major highways will require improvements to the highway.
- Major highways will be widened to have dedicated turn lanes (150 feet long).
- If there are overhead utilities at the intersection, then 400 feet of relocation was used for costs.

As this analysis was carried out using maps and other information available online, certain costs were excluded from the analysis. Those included:

- Traffic control costs
- Signalization of intersections
- Underground utility relocations
- Temporary erosion control, Best Management Practices (BMP) costs
- Roadway striping and reflective pavement marker costs
- Earthwork costs to access the site

Maps of each site were prepared, showing existing roadways affected as well as the access road to be discussed in the next section. See Appendix F: Access Road Evaluation (11 sites). The specific assumptions for each site are shown in Table 8: Site Specific Assumptions for Roadway Improvement Cost Estimates, 2016.

Table 8: Site Specific Assumptions for Roadway Improvement Cost Estimates, 2016

Ameron Quarry:	No intersection upgrades, no widening of Kapa'a Quarry Road, only new access road
Kapa'a Quarry Road:	No intersection upgrades, no widening of Ililani St, only new access road
Kāne'ohe by H3:	Access is only right in, right out off of scenic point lookout exit, minimal improvements to exit ramp
Upland Hawai'i Kai:	Intersection upgrade/widening for left turn lane in and right out merge lane
Kea'au:	Intersection upgrade/widening for right turn in lane, overhead utility line relocations, existing Kea'au Homestead Road requires widening from 20' to 24', 1 gulch/stream crossing
Upland Kahuku 2:	Intersection upgrade/widening for right turn in lane, overhead utility line relocations, existing Kawela Camp Road requires widening from 12' to 24', a single gulch crossing
Upland Lā'ie:	Intersection upgrade/widening for left turn lane in and right out merge lane, overhead utility line relocations, existing PCC access road is 24' wide and does not require widening
Upland Nānākuli 1:	No intersection upgrades, no widening of Wai'anae Valley Road & Piliuka Place, existing Kawiwi Way requires widening from 12' to 24'
Upland Kahuku 1:	Intersection upgrade/widening for right turn in lane, overhead utility line relocations, existing Charlie Road requires widening from 12' to 24', 1 gulch crossing
Upland Pūpūkea 1:	Intersection upgrade/widening for right turn in lane, bridge widening for right turn lane, existing Ashley Road requires widening from 20' to 24', 1 gulch crossing
Upland Pūpūkea 2:	Intersection upgrade/widening for right turn in lane, bridge widening for right turn lane, existing Ashley Road requires widening from 20' to 24', gulch crossing

Applying the general and specific assumptions, the estimated costs for each of the four roadway improvement categories and the access road were calculated. See Table 9: Site Specific Assumptions for Roadway Improvement Cost Estimates, 2016:

Table 9: Site Specific Assumptions for Roadway Improvement Cost Estimates, 2016

Sites	Roadway Improvement and Intersection Costs				
	Existing Road Improvements	Intersection Improvements	Stream/Gulch Crossings	Bridge Widening	Sub-Total
Ameron Quarry	$ -	$ -	$ -	$ -	$ -
Upland Lāʻie	$ 1,787,000	$ 180,000	$ -	$ -	$ 1,967,000
Upland Pūpūkea 1	$ 5,340,000	$ 50,000	$ 10,000,000	$ 3,000,000	$ 18,390,000
Upland Pūpūkea 2	$ 5,871,410	$ 50,000	$ 5,000,000	$ 3,000,000	$ 13,921,410
Keaʻau	$ 836,000	$ 130,000	$ 5,000,000	$ -	$ 5,966,000
Upland Nānākuli 1	$ 4,851,000	$ -	$ 5,000,000	$ -	$ 9,851,000
Upland Hawaiʻi Kai	$ -	$ 100,000	$ -	$ -	$ 100,000
Kapaʻa Quarry Road	$ -	$ -	$ -	$ -	$ -
Kāneʻohe by H3	$ -	$ 100,000	$ -	$ -	$ 100,000
Upland Kahuku 1	$ 5,046,000	$ 130,000	$ 5,000,000	$ -	$ 10,176,000
Upland Kahuku 2	$ 3,845,000	$ 130,000	$ 5,000,000	$ -	$ 8,975,000

For results and further detail on this criterion see Appendix E: Exhibit 3. Roadway Intersection Improvement Costs.

d. Access Road Costs

This criterion ranks access road costs based on the section of roadway between the last serviceable roadway and the location of the MSWLF operations facility. Typically, access roads do not traverse along existing roadways and must be constructed across undeveloped terrain. Some sites, such as Ameron Quarry and Kapaʻa Quarry, will require only an access driveway for access to the site from existing roadways. Other alternative sites will require access from a major highway over sometimes challenging terrain, such as gulches or along steep grades. These conditions can significantly affect costs.

The site maps in Appendix F: Access Road Evaluation (11 sites) show access roadways in yellow. All access roads were assumed to be 24 feet wide with road sections set with 9-inch thick PCC pavement, 6-inch base course, and a 12-inch subbase course. Access road development costs excluded temporary erosion control, BMP costs, roadway striping and reflective pavement marker costs, clearing, grubbing costs, and earthwork costs. The length of roadways was estimated using measurements in Google Earth.

Each site was examined to determine the need for an access road then estimates were made for the length of the access road, design of the road, and estimated costs. See Appendix G: Access Road / Intersection Improvement Cost Estimation (11 sites). The costs are shown in Table 10: Site Specific Assumptions for Roadway Improvement Cost Estimates, 2016 in current dollars.

Table 10: Site Specific Assumptions for Roadway Improvement Cost Estimates, 2016

Landfill Site	Access Road Cost
Ameron Quarry	$ 412,000
Upland Lāʻie	$ 3,684,000
Upland Pūpūkea 1	$ 1,530,000
Upland Pūpūkea 2	$ 1,927,235
Keaʻau	$ 2,267,000
Upland Nānākuli 1	$ 2,494,000
Upland Hawaiʻi Kai	$ 851,000
Kapaʻa Quarry Road	$ 659,000
Kāneʻohe by H3	$ 964,000
Upland Kahuku 1	$ 3,401,000
Upland Kahuku 2	$ 851,000

For results and further detail on this criteria see Appendix E: Exhibit 4. Access Road Requirement

e. Location Relative to H-POWER:

Traffic impacts identified by the 2012 MACLSS were largely related to traffic along roadways that affect Oʻahu residents near sites and/or along refuse transportation routes. This analysis of the sites included consideration of the following factors: cost to transport H-POWER ash and residue to various sites; the impact of refuse and ash trucks on roadway maintenance costs; cost of traffic engineering measures; cost of peak hour traffic on the economy; and, others. An initial investigation found that all of these factors differ across the potential sites primarily as a function of the distance the refuse trucks must travel on all road surfaces. For example, the cost of traffic congestion would be different for each site, but would principally be created due to the distances traveled by refuse trucks. If all sites were equidistant from H-POWER, the relevant impact on congestion would therefore be similar. Hence, for this criterion, ranking was based on the distance between the individual sites and H-POWER as a more reliable surrogate for total impact on cost, roadways and traffic. The range of estimates is shown in Technical Criterion 5.

For results and further detail on this criterion see Appendix E: Exhibit 5. Impact on Roadways: Location Relative to H-POWER.

f. Acquisition

The ability to acquire property for use as a MSWLF was discussed frequently and at length during the 2012 MACLSS site selection deliberations. It was widely accepted that "a willing seller" was a key element in land acquisition and in the successful development of a new LF site. However, acquisition was not previously used as a criterion for site selection.

For this criterion, the ranking was based on several aspects of land acquisition for each site including the following: (1) land use, (2) property ownership, and (3) the assessed tax value of the site. Each of the components of land acquisition was first assigned a raw score, a numerical score which measured the ease with which a property might be acquired. Details are provided in Appendix H: Raw Scores Assigned to Acquisition Component Variables, 2016 and Appendix H-2: Total CCE Site Scores. The values assigned were based on the data collected. In the case of assessed value, for example, the lowest-priced site was given the highest score because it would be the least expensive to acquire.

For land use, agricultural/commercial land was awarded the highest scaled score of 10 and agricultural only owned land was awarded a scaled score of 9. For fee ownership, State-owned land was awarded the highest scaled score of 10, and preservation trust land, considered to be the most difficult to acquire, was awarded a scaled score of 1.

The three component scaled scores were then summed and rescaled to a 10-point scale, with 10 representing the highest ranked score. See Table 11: Sub-scores and Scores for Site Acquisition, 2016, for site scores.

The Upland Nānākuli 1 site emerged as the site that would potentially encounter the least barriers to acquisition. This site is located on State-owned land and classified for agricultural activity. Its total acquisition cost is also relatively low compared to the rest of the potential sites. The most difficult site to acquire would be the Upland Hawai'i Kai property, primarily due to its placement in a preservation trust after many years of well documented community efforts to preserve the site from development.

It should be noted that land markets and owner interests may change significantly between now and the start of development for the next O'ahu landfill site. Changes to land values, land use designations, or ownership would affect the prospects for acquisition at any of the 11 sites. Depending on the community sentiments, even designating locations of potential landfill sites may cause enough community activism for acquisition profiles to be altered.

As noted previously, should the City implement plans for further diversion of materials from the landfill, this may allow for the examination of smaller landfill sites compared to those considered in the 2012 MACLSS. Smaller sites can be expected to be more numerous, less costly and could also have more favorable ownership and land use designations.

For results and further detail on this criterion see Appendix E: Exhibit 6. Acquisition.

Table 11: Sub-scores and Scores for Site Acquisition, 2016

Site Name	Acquisition-Relevant Information										
	Sub-score for Land Use			Sub-score for Fee Owner			Sub-score for Assessed Value			Summary	
	Class	Raw Score	Scaled Score	Class	Raw Score	Scaled Score	2015 dollars	Raw Score	Scaled Score	Sum of Scaled Scores	Scaled Score
Ameron Quarry	Industry, Preservation	6	5	Private	3	8	$ 2,082,500	2.1	10	22	7
Upland Lā'ie	Agriculture, Preservation	6	5	Church	4	7	$ 3,062,600	3.1	9	21	6
Upland Pūpūkea 1	Ag. Industry Preservation	6	5	Trust	4	7	$ 22,650,100	22.7	5	16	3
Upland Pūpūkea 2	Ag, Industry Preservation	6	5	Trust	4	7	$ 21,152,400	21.2	5	17	4
Kea'au	Agriculture, Preservation	6	5	Private	3	8	$ 4,318,300	4.3	9	22	6
Upland Nānākuli 1	Agriculture	3	9	State	2	10	$ 2,489,100	2.5	9	28	10
Upland Hawai'i Kai	Preservation	9	1	Preservation	9	1	$ 1,181,500	1.2	10	12	1
Kapa'a Quarry Road	Preservation	9	1	Trust	6	4	$ 370,000	0.4	10	15	3
Kāne'ohe by H3	Preservation	9	1	Trust	6	4	$ 232,700	0.2	10	15	3
Upland Kahuku 1	Agriculture	3	9	Military	8	2	$ 4,552,300	4.6	9	20	5
Upland Kahuku 2	Agriculture, Commerce	2	10	Military	8	2	$ 39,148,400	39.1	1	13	2

Note: Some scaled sub-scores may not add to the sum of scaled scores due to rounding.

2. Scores

The six criteria scores for each of the 11 sites are presented below in Table 12: Criterion Scores. An assessment and comparison was performed for each site according to criteria developed for this analysis. Higher scores indicate a site had more of the qualities of the particular criterion being reviewed compared to the other sites.

Other technical and backup information used in preparing the criterion scores, including data sources, and assumptions, are provided in the accompanying data sheets and other report appendices.

Table 12: Criterion Scores

Potential Landfill Sites Identified by MACLSS	Technical Criteria Scores					
	Landfill Life-span	Site Development Cost	Roadway Improvement Cost	Access Road Requirement	Location Relative to H-Power	Acquisition
Upland Kahuku 2	5	1	6	9	2	2
Upland Kahuku 1	2	8	5	2	2	5
Upland Pūpūkea 2	2	10	3	6	5	4
Upland Pūpūkea 1	2	9	1	7	5	3
Ameron Quarry	2	9	10	10	6	7
Upland Nānākuli 1	10	7	5	4	10	10
Upland Lā'ie	2	10	9	1	1	6
Kea'au	2	9	7	5	9	6
Kāne'ohe by H-3	1	10	10	8	6	3
Upland Hawai'i Kai	1	8	10	9	4	1
Kapa'a Quarry Road	1	10	10	9	6	3

Order of presentation is taken from the MACLSS scoring results.

Landfill Lifespan - Upland Nānākuli 1 was the highest ranked site with the next being Upland Kahuku 2. Those two sites are relatively large with large usable areas. The remaining sites were smaller in size or had less usable area and scored much lower compared to the larger sites.

Site Development Cost - Upland Kahuku 2 was ranked low due to very high development costs, primarily due to difficult site conditions. All other sites had relatively lower development costs and were ranked higher.

Roadway Improvement Cost - Ameron Quarry, Kāne'ohe by H-3, Upland Hawai'i Kai, and Kapa'a Quarry Road have significantly lower costs than the other sites and were ranked high. Both Pūpūkea sites, with their significant roadway, stream, and gulch improvements received low scores. The other sites were ranked in between.

Access Road Requirement - Ameron Quarry has existing roadways to bring heavy trucks into the site and ranked highest. Upland Hawai'i Kai, Upland Kahuku 2, and Kapa'a Quarry Road are also high ranking sites. Upland Lā'ie and Upland Kahuku 1 scored low due to difficult access. The remaining sites ranked in between.

Location Relative to H-POWER - Sites in closer proximity to H-POWER were preferred over those at a greater distance. Upland Nānākuli 1 and Kea'au were nearest to H-POWER and scored high. Upland Lā'ie and both Kahuku sites scored low due their location far on the other side of the island from H-POWER. The remaining sites ranked in between based on their distance from H-POWER.

Acquisition – The Upland Nānākuli 1 site received the highest score, as the site is State-owned, has an agriculture land use designation, and is relatively lower in assessed value. Ameron Quarry received the next highest score as the site is privately owned, has an industrial/preservation land use designation, and is also lower in assessed value. The remaining sites received relatively lower scores based on issues related to land use, ownership, or value.

3. Rankings: Scoring of a Future Landfill Site Based on a Technical and Logistical Analysis

The data from Table 12 was used to provide a final analysis of the 11 alternative landfill sites shown below in Table 13: Site Rankings. Scores for the six criteria were summed and ranked as shown in Appendix H-2: Total CCE Site Scores. For a map of the ranked sites, see Appendix J: Map – Technical and Logistical Review Future Landfill Site Rankings.

Table 13: Site Rankings

	Score	Rank
Upland Nānākuli 1	46	1
Ameron Quarry	44	2
Kapa'a Quarry Road	39	3
Kea'au	38	4 (tie)
Kāne'ohe by H-3	38	4 (tie)
Upland Hawai'i Kai	33	6
Upland Pūpūkea 2	30	7
Upland Lā'ie	29	8
Upland Pūpūkea 1	27	9
Upland Kahuku 2	25	10
Upland Kahuku 1	24	11

The highest scored site based on the technical and logistical analysis was Upland Nānākuli 1, with a score of 46. In 2012, the MACLSS analysis ranked the site 6th based on community input. The Upland Nānākuli 1 site ranked high in lifespan, distance from H-POWER, and acquisition. Upland Nānākuli 1 is also the only property owned by the State and could be less distressing to acquire than military, or private or trust property. From a community perspective, Upland Nānākuli 1 is located on the leeward coast and residents have continually expressed strong opposition to landfilling in the region (i.e., the WGSL).

Four other sites, Ameron Quarry, Kapa'a Quarry Road, Kea'au, and Kāne'ohe by H3, also scored high in many criteria and ranked 2nd, 3rd, and 4th (tied), respectively, placing these sites into consideration along with Upland Nānākuli 1. The Ameron Quarry site is currently an active quarry, however, that location could become potentially more attractive should quarrying operations ultimately end near a time in the future when a new landfill is required. For comparison, the 2012 MACLSS rated these sites relatively low at 5th, 11th, 8th, and 9th respectively. Similar to the Upland Nānākuli 1 site, there would be expected community sentiment against siting a landfill in these locations.

The remaining six sites, Upland Hawai'i Kai, Upland Pūpūkea 2, Upland Lā'ie, Upland Pūpūkea 1, Upland Kahuku 2, and Upland Kahuku 1 were ranked lower, 6th through 11th, respectively. These sites are located on relatively remote parcels at greater distances from numbered roadways and at greater distances from H-POWER and are harder to acquire. Noting the different focus of this report's technical and logistical review compared to that of the community in the 2012 MACLSS report, Upland Kahuku 2, Upland Kahuku 1, Upland Pūpūkea 2, and Upland Pūpūkea 1 were ranked 1st, 2nd, 3rd and 4th due to their locations in remote areas away from neighborhoods, schools, visitor accommodations, hospitals, etc.

It should be noted that both Kahuku sites are located on military property which would make those sites difficult to obtain. Upland Hawai'i Kai is located on preservation trust land which would also make that site difficult to obtain. Additionally, all 11 sites have existing land use classifications that will make siting a landfill complex and lengthy since all of the sites would require a conditional use permit, other land use and environmental documents and permits depending on location, and, approval by various government agencies, boards and commissions.

While this report's technical and logistical rankings provides valuable information important for the siting of a future landfill, the selection of any site needs to also carefully consider the community perspectives cited in the 2012 MACLSS report.

C. Impact of Changes in MSW Generation and Handling

This section considers the impact of the anticipated slower MSW growth rate in the latest forecast, and the City's continuing efforts to divert MSW from the LF by expanding and enhancing the H-POWER facility and implementing other projects to further divert materials from landfill.

1. Future Solid Waste Requirements

Between 2015 and 2040, the MSW generation on O'ahu will rise at a rate of about 0.2 percent per year from 782,621 tons in 2015 to 817,654 tons in 2040. Projections based on maximum growth show that by 2040, approximately 860,000 tons of MSW would need to be handled by the City. H-POWER would process approximately 820,000 tons with approximately 253,000 tons of material (MSW, H-POWER ash and residue) requiring landfill disposal. Based on those requirements and the remaining landfill capacity at WGSL, the last active year at the site would be 2038.

Changes in O'ahu's *de facto* population could affect the waste generation forecast. If the natural growth rate (excess of births over deaths) were to rise, or if the average daily visitor census were to increase significantly, then waste generation rates may be higher than the forecast as reflected in the maximum growth projections. The current ratio of birth to deaths is relatively low because the birth rate is low. Birth rates increase with improvement in the economy or the fecundity of the adult population. We do not foresee any major increase in GDP per capita above what has been predicted by DBEDT, and the population dynamics suggest that we have been experiencing a decrease in the population of women of childbearing age for some time.

The waste generation forecast may also be affected by changes in recycling. The City witnessed a notable increase in the public's willingness to separate their recyclable materials with the implementation of the City's green and blue bin recycling program which diverted green waste and mixed recyclables from the MSW waste stream. If public or private efforts were made to increase consumer recycling even further (e.g., reduce consumer packaging in goods purchased, implement new manufacturer take-back programs, etc.), the amount of waste needing to be handled would be less.

Should the population decrease, either due to lower birth rate or higher out-migration, or should recycling increase, then less waste would be generated in the future. Less solid waste generation would increase the lifespan of WGSL and extend the timetable for a future landfill site.

The City's waste management policies can also significantly affect the need for a new LF. Changes in MSW handling, for example, expanding and enhancing H-POWER, would increase the continuing trend toward MSW diversion resulting in decreased material sent to the LF. In the 20 or so years during which WGSL can still be utilized, other technologies may become available to reduce the need for landfilling H-POWER ash and residue, and other recycling residue and sludge.

2. Project Timeframe Requirements and Landfill Diversion

Based on existing projections and the City's plan to maximize the usage of MSW and ash air space, WGSL would be exhausted in approximately year 2038. If a lower growth forecast is experienced, or if the City increases the diversion of materials from the landfill, WGSL may be able to be used significantly longer.

Developing a new LF site requires approximately 7 to 10 years, time needed to properly reassess prior and investigate potential new LF sites, conduct a site selection, undertake land acquisition (e.g., negotiation, condemnation or purchase), environmental permitting, land use permitting, obtain operating permits, site planning, design, engineering, and construction. Assuming WGSL would be exhausted in approximately year 2038, the work of planning and developing the next LF site should conservatively begin on or about the year 2028.

Based on the above, it is prudent for the City to annually reassess the LF life model based on updated waste generation projections, current conditions and future plans. The updated data will inform whether the year 2028 is an acceptable date to begin development of the next landfill or whether that date needs to be sooner or may be deferred to later. The reassessment may also suggest new or altered requirements for a site, in particular, if the annual tonnage of materials needing landfill disposal is significantly reduced, the need for large-scale landfill operations may not be required. This would allow for an examination of smaller landfill sites compared to those previously considered and in turn, increase the amount of sites to be considered.

Between now and the time a new landfill would be required, new and improved solid waste management technology could further divert materials from WGSL. The City may decide to further expand H-POWER or use other technology to process waste, recycle H-POWER ash and residue, or recycle other residues, all of which would extend the time for when another landfill would be needed. There may also be changes in demographics, landfill engineering technology, regulations, values and availability of land, land use, community sentiments, policies, and other factors. Accordingly, it would be more appropriate to undertake the landfill siting process closer to the date when one would be needed and when all conditions can be thoroughly assessed.

SUMMARY AND CONCLUSIONS

Based on MSW generation projections and the City's plan to maximize usage of MSW and ash air space at WGSL, available capacity at WGSL is expected to be exhausted in approximately year 2038. The development of a new landfill site will require approximately 7 to 10 years and includes work to properly reassess previously considered landfill sites and investigate potential new landfill sites, conduct site selection, undertake land acquisition, obtain environmental permits, land use permits, and operating permits, and complete site planning, design, engineering, and construction. Based on the current projection that WGSL will have capacity until 2038 and the conservative timeline of 10 years to develop a new landfill, it would be appropriate for the City to begin the development process in the year 2028.

The technical and logistical evaluation undertaken in this report reviewed the 11 potential landfill sites identified in the 2012 MACLSS report and it showed that five sites – Upland Nānākuli 1, Ameron Quarry, Kapa'a Quarry Road, Kea'au, and Kāne'ohe by H3 – could be considered for a future landfill location. Future conditions and considerations could change the technical and logistical factors for any of these 11 sites. Further, the selection of any sites should consider both the technical and logistical factors, as well as the community perspectives cited in the 2012 MACLSS report.

The City should continue to annually reassess the anticipated waste generation and remaining lifespan of WGSL. The reassessment should include current and planned landfill diversion efforts. The approximate year in which a new landfill site will be needed may change as a result of this annual reassessment and in turn, the projected date to begin development of a future landfill site may change. Further, factors such as available solid waste management technology, changes in demographics, landfill engineering technology, regulations, values and availability of land, land use, community sentiments, and policies, could change over time. Accordingly, it would be prudent to undertake the landfill siting process closer in time to when one would be needed and when all conditions can be thoroughly assessed.

APPENDICES

Appendix A: Total Municipal Solid Waste Generated Historical Data and Forecasts, City and County of Honolulu, 2000 - 2040

Year	De Facto Population	Total MSW Generated (tons)	Recycled Materials (tons)	Total Municipal Solid Waste Received (tons)
2000	926,192	1,207,081	327,710	879,371
2001	926,713	1,264,996	367,300	897,696
2002	934,070	1,249,674	352,699	896,975
2003	931,880	1,256,289	366,639	889,650
2004	949,262	1,337,090	386,338	950,752
2005	959,340	1,358,983	417,669	941,314
2006	967,400	1,351,104	421,072	930,032
2007	963,577	1,341,682	453,372	888,310
2008	962,908	1,310,093	456,876	853,217
2009	972,202	1,209,961	426,947	783,014
2010	988,106	1,208,542	448,639	759,903
2011	1,000,733	1,251,736	490,061	761,675
2012	1,019,530	1,230,565	487,157	743,408
2013	1,033,388	1,235,964	477,011	758,953
2014	1,041,721	1,242,190	475,953	766,237
2015	1,033,251	1,261,555	478,934	782,621
2016[a]	1,033,421	1,261,729	488,394	773,335
2017	1,038,641	1,268,862	492,723	776,139
2018	1,043,379	1,275,653	496,853	778,799
2019	1,047,675	1,282,136	500,804	781,332
2020	1,051,585	1,288,340	504,591	783,749
2021	1,056,189	1,294,289	508,228	786,060
2022	1,059,580	1,300,004	511,728	788,275
2023	1,063,870	1,305,504	515,102	790,402
2024	1,067,179	1,310,806	518,359	792,447
2025	1,071,733	1,315,924	521,508	794,417
2026	1,076,356	1,320,872	524,555	796,317
2027	1,080,977	1,325,661	527,509	798,152
2028	1,085,595	1,330,302	530,375	799,927
2029	1,090,212	1,334,804	533,158	801,645
2030	1,094,827	1,339,175	535,864	803,311
2031	1,098,715	1,343,425	538,498	804,927
2032	1,102,601	1,347,559	541,062	806,496
2033	1,106,485	1,351,584	543,562	808,022
2034	1,110,369	1,355,506	546,000	809,506
2035	1,114,250	1,359,331	548,380	810,951
2036	1,117,411	1,363,063	550,705	812,358
2037	1,120,570	1,366,708	552,977	813,731
2038	1,123,728	1,370,270	555,200	815,070
2039	1,126,884	1,373,751	557,374	816,377
2040	1,130,040	1,377,157	559,503	817,654

Source: Department of Business, Economic Development and Tourism, Population and Economic Projections for the State of Hawai'i to 2040; City & County of Honolulu's Department of Environmental Services, Recycling and Landfill Diversion; SMS Research Estimates

Note: [a] Municipal Solid Waste forecast starts in the year of 2016

Appendix B: Municipal Solid Waste Handling Historical Data and Projections, O'ahu, 2001 to 2040

MSW HANDLING PROCESS	CY2001	CY2002	CY2003	CY2004	CY2005	CY2006	CY2007	CY2008
Total Tons Received at H-Power and LF (tons)	897,696	896,975	889,650	950,752	941,314	930,032	888,310	853,217
Tons Received at H-Power (tons):	554,209	568,202	627,602	636,450	553,138	645,868	585,569	623,312
Tons Received at LF without prior treatment at H-Power	343,487	328,773	262,048	314,303	388,176	286,842	306,691	233,065
Residue from H-Power RDF	N/A	N/A	N/A	N/A	85,257	99,550	107,420	104,308
Total Ash from H-Power (tons)	N/A	N/A	N/A	N/A	79,005	92,250	81,931	87,405
Total Waste Landfilled (tons)	N/A	N/A	N/A	N/A	552,438	478,642	496,042	424,778

MSW HANDLING PROCESS	CY2009	CY2010	CY2011	CY2012	CY2013	CY2014	CY2015	CY2016
Total Tons Received at H-Power and LF (tons)	783,014	759,903	761,675	743,408	758,953	766,237	782,621	773,335
Tons Received at H-Power (tons):	607,301	598,041	594,793	613,328	678,389	686,279	718,518	697,335
Tons Received at LF without prior treatment at H-Power	178,512	161,862	166,921	130,940	81,989	81,023	64,103	76,000
Residue from H-Power RDF	98,326	91,964	70,650	57,261	48,815	58,010	77,440	60,000
Total Ash from H-Power (tons)	90,357	87,982	92,968	104,404	131,554	130,389	126,258	132,000
Total Waste Landfilled (tons)	367,195	341,808	330,539	292,605	262,358	269,422	267,801	268,000

MSW HANDLING PROCESS	CY2017	CY2018	CY2019	CY2020	CY2021	CY2022	CY2023	CY2024
Total Tons Received at H-Power and LF (tons)	776,139	778,799	781,332	783,749	786,060	788,275	790,402	792,447
Tons Received at H-Power (tons):	738,139	750,689	753,121	754,446	755,664	746,285	757,817	758,766
Tons Received at LF without prior treatment at H-Power	38,000	28,110	28,211	29,303	30,396	41,990	32,585	33,681
Residue from H-Power RDF	64,139	56,483	56,775	56,933	57,080	55,954	57,338	57,452
Total Ash from H-Power (tons)	134,902	136,910	137,299	137,511	137,706	136,206	138,051	138,203
Total Waste Landfilled (tons)	237,042	221,503	222,285	223,748	225,182	234,150	227,974	229,335

MSW HANDLING PROCESS	CY2025	CY2026	CY2027	CY2028	CY2029	CY2030	CY2031	CY2032
Total Tons Received at H-Power and LF (tons)	794,417	796,317	798,152	799,927	801,645	803,311	804,927	806,496
Tons Received at H-Power (tons):	759,639	761,191	751,650	764,095	765,455	766,759	768,010	757,634
Tons Received at LF without prior treatment at H-Power	34,778	35,126	46,502	35,832	36,190	36,552	36,917	48,863
Residue from H-Power RDF	57,557	57,743	56,598	58,091	58,255	58,411	58,561	57,316
Total Ash from H-Power (tons)	138,342	138,591	137,064	139,055	139,273	139,481	139,682	138,021
Total Waste Landfilled (tons)	230,677	231,459	240,164	232,978	233,717	234,444	235,160	244,200

MSW HANDLING PROCESS	CY2033	CY2034	CY2035	CY2036	CY2037	CY2038	CY2039	CY2040
Total Tons Received at H-Power and LF (tons)	808,022	809,506	810,951	812,358	813,731	815,070	816,377	817,654
Tons Received at H-Power (tons):	770,363	771,470	772,534	773,558	762,387	775,490	776,401	777,278
Tons Received at LF without prior treatment at H-Power	37,659	38,036	38,416	38,800	51,344	39,580	39,976	40,376
Residue from H-Power RDF	58,844	58,976	59,104	59,227	57,886	59,459	59,568	59,673
Total Ash from H-Power (tons)	140,058	140,235	140,406	140,569	138,782	140,878	141,024	141,165
Total Waste Landfilled (tons)	236,561	237,248	237,926	238,597	248,012	239,917	240,568	241,214

Appendix C: Waimānalo Gulch Sanitary Landfill Lifespan Estimate (No-change Model), O'ahu, 2016-2040

WGSL MSW Cell	CY 2016	CY 2017	CY 2018	CY 2019	CY 2020	CY 2021	CY2022
Volume Needed at Landfill (tons)	136,000	102,139	84,593	84,986	86,237	87,476	97,944
Residue from H-POWER RDF	60,000	64,139	56,483	56,775	56,933	57,080	55,954
Landfill Only Materials[a]	9,500	10,000	9,100	8,191	8,273	8,356	8,439
ASR	16,500	17,000	18,000	19,000	20,000	21,000	22,000
H-Power Planned Maintenance Diversion	50,000	10,000	0	0	0	0	10,500
H-Power Unscheduled Maintenance Diversion	0	1,000	1,010	1,020	1,030	1,041	1,051
Capacity on Jan 1 (cubic yards)	1,732,963	1,568,314	1,444,659	1,342,246	1,239,358	1,134,955	1,029,052
Volume Needed at Landfill (cubic yards)	164,649	123,655	102,413	102,888	104,403	105,903	118,577
Capacity Remaining after Dec 31	1,568,314	1,444,659	1,342,246	1,239,358	1,134,955	1,029,052	910,475
Capacity Reached (date)	7/18/2026	9/3/2029	2/4/2032	1/13/2032	11/22/2031	9/16/2031	9/2/2030
Remaining Life (years)	9.5	11.7	13.1	12.0	10.9	9.7	7.7

WGSL MSW Cell	CY 2023	CY 2024	CY 2025	CY 2026	CY 2027	CY 2028	CY 2029
Volume Needed at Landfill (tons)	89,923	91,133	92,334	92,868	103,100	93,923	94,445
Residue from H-POWER RDF	57,338	57,452	57,557	57,743	56,598	58,091	58,255
Landfill Only Materials[a]	8,524	8,609	8,695	8,782	8,870	8,958	9,048
ASR	23,000	24,000	25,000	25,250	25,503	25,758	26,015
H-Power Planned Maintenance Diversion	0	0	0	0	11,025	0	0
H-Power Unscheduled Maintenance Diversion	1,062	1,072	1,083	1,094	1,105	1,116	1,127
Capacity on Jan 1 (cubic yards)	910,475	801,610	691,279	579,494	467,063	342,244	228,536
Volume Needed at Landfill (cubic yards)	108,866	110,330	111,785	112,432	124,818	113,708	114,340
Capacity Remaining after Dec 31	801,610	691,279	579,494	467,063	342,244	228,536	114,197
Capacity Reached (date)	5/10/2031	4/12/2031	3/7/2031	2/24/2031	9/26/2030	1/5/2031	12/30/2030
Remaining Life (years)	7.4	6.3	5.2	4.2	2.7	2.0	1.0

WGSL MSW Cell	CY 2030	CY 2031	CY 2032	CY 2033	CY 2034	CY 2035	CY 2036
Volume Needed at Landfill (tons)	94,963	95,478	106,179	96,503	97,012	97,393	97,777
Residue from H-POWER RDF	58,411	58,561	57,316	58,844	58,976	58,976	58,976
Landfill Only Materials[a]	9,138	9,230	9,322	9,415	9,509	9,605	9,701
ASR	26,275	26,538	26,803	27,071	27,342	27,616	27,892
H-Power Planned Maintenance Diversion	0	0	11,576	0	0	0	0
H-Power Unscheduled Maintenance Diversion	1,138	1,149	1,161	1,173	1,184	1,196	1,208
Capacity on Jan 1 (cubic yards)	114,197	-771	-116,362	-244,908	-361,739	-479,188	-597,096
Volume Needed at Landfill (cubic yards)	114,967	115,591	128,546	116,832	117,448	117,909	118,374
Capacity Remaining after Dec 31	-771	-116,362	-244,908	-361,739	-479,188	-597,096	-715,470
Capacity Reached (date)	12/28/2030	12/28/2030	2/2/2031	11/26/2030	12/2/2030	12/8/2030	12/10/2030
Remaining Life (years)	0.0	-1.0	-1.9	-3.1	-4.1	-5.1	-6.0

WGSL MSW Cell	CY 2037	CY 2038	CY 2039	CY 2040
Volume Needed at Landfill (tons)	110,320	98,557	98,953	100,049
Residue from H-POWER RDF	58,976	58,976	58,976	59,673
Landfill Only Materials[a]	9,798	9,896	9,995	10,095
ASR	28,171	28,452	28,737	29,024
H-Power Planned Maintenance Diversion	12,155	0	0	0
H-Power Unscheduled Maintenance Diversion	1,220	1,232	1,245	1,257
Capacity on Jan 1 (cubic yards)	-715,470	-849,030	-968,348	-1,088,145
Volume Needed at Landfill (cubic yards)	133,559	119,318	119,797	121,125
Capacity Remaining after Dec 31	-849,030	-968,348	-1,088,145	-1,209,270
Capacity Reached (date)	8/24/2031	11/20/2030	12/2/2030	12/29/2030
Remaining Life (years)	-6.4	-8.1	-9.1	-10.0

[a] Landfill Only Materials = Sharps, dead animals, WWTP Grit/Screening, other sludge, homeowner drop off, expired food, Synagro, etc.
Source: City & County of Honolulu's Department of Environmental Services, Recycling and Landfill Diversion; SMS Research Estimates

Appendix D: Waimānalo Gulch Sanitary Landfill Lifespan Estimate (With Reconfiguration), O'ahu, 2016-2040

WGSL MSW Cell*	CY 2016	CY 2017	CY 2018	CY 2019	CY 2020	CY 2021	CY 2022
Volume Needed at Landfill (tons)	136,000	102,139	84,593	84,986	86,237	87,476	97,944
Residue from H-POWER RDF	60,000	64,139	56,483	56,775	56,933	57,080	55,954
Landfill Only Materials[b]	9,500	10,000	9,100	8,191	8,273	8,356	8,439
ASR	16,500	17,000	18,000	19,000	20,000	21,000	22,000
H-POWER Planned Maintenance Diversion	50,000	10,000	0	0	0	0	10,500
H-POWER Unscheduled Maintenance Diversion	0	1,000	1,010	1,020	1,030	1,041	1,051
Capacity on Jan 1 (cubic yards)	2,650,000	2,485,351	2,361,696	2,259,283	2,156,395	2,051,992	1,946,089
Volume Needed at Landfill (cubic yards)	164,649	123,655	102,413	102,888	104,403	105,903	118,577
Capacity Remaining after Dec 31	2,485,351	2,361,696	2,259,283	2,156,395	2,051,992	1,946,089	1,827,512
Capacity Reached (date)	2/15/2032	1/31/2037	1/16/2041	12/9/2040	9/10/2040	5/12/2040	5/26/2038
Remaining Life (years)	15.1	19.1	22.1	21.0	19.7	18.4	15.4

WGSL MSW Cell*	CY 2023	CY 2024	CY 2025	CY 2026	CY 2027	CY 2028	CY 2029
Volume Needed at Landfill (tons)	89,923	91,133	92,334	92,868	103,100	93,923	94,445
Residue from H-POWER RDF	57,338	57,452	57,557	57,743	56,598	58,091	58,255
Landfill Only Materials[b]	8,524	8,609	8,695	8,782	8,870	8,958	9,048
ASR	23,000	24,000	25,000	25,250	25,503	25,758	26,015
H-POWER Planned Maintenance Diversion	0	0	0	0	11,025	0	0
H-POWER Unscheduled Maintenance Diversion	1,062	1,072	1,083	1,094	1,105	1,116	1,127
Capacity on Jan 1 (cubic yards)	1,827,512	1,718,647	1,608,316	1,496,531	1,384,100	1,259,281	1,145,573
Volume Needed at Landfill (cubic yards)	108,866	110,330	111,785	112,432	124,818	113,708	114,340
Capacity Remaining after Dec 31	1,718,647	1,608,316	1,496,531	1,384,100	1,259,281	1,145,573	1,031,234
Capacity Reached (date)	10/10/2039	8/10/2039	5/18/2039	4/20/2039	1/29/2038	2/4/2039	1/4/2039
Remaining Life (years)	15.8	14.6	13.4	12.3	10.1	10.1	9.0

WGSL MSW Cell*	CY 2030	CY 2031	CY 2032	CY 2033	CY 2034	CY 2035	CY 2036
Volume Needed at Landfill (tons)	94,963	95,478	106,179	96,503	97,012	97,393	97,777
Residue from H-POWER RDF	58,411	58,561	57,316	58,844	58,976	58,976	58,976
Landfill Only Materials[b]	9,138	9,230	9,322	9,415	9,509	9,605	9,701
ASR	26,275	26,538	26,803	27,071	27,342	27,616	27,892
H-Power Planned Maintenance Diversion	0	0	11,576	0	0	0	0
H-Power Unsched. Maintenance Diversion	1,138	1,149	1,161	1,173	1,184	1,196	1,208
Capacity on Jan 1 (cubic yards)	1,031,234	916,266	800,675	672,129	555,298	437,849	319,941
Volume Needed at Landfill (cubic yards)	114,967	115,591	128,546	116,832	117,448	117,909	118,374
Capacity Remaining after Dec 31	916,266	800,675	672,129	555,298	437,849	319,941	201,567
Capacity Reached (date)	12/17/2038	12/2/2038	3/28/2038	9/30/2038	9/21/2038	9/16/2038	9/15/2038
Remaining Life (years)	8.0	6.9	5.2	4.8	3.7	2.7	1.7

WGSL MSW Cell*	CY 2037	CY 2038	CY 2039	CY 2040
Volume Needed at Landfill (tons)	110,320	98,557	98,953	100,049
Residue from H-POWER RDF	58,976	58,976	58,976	59,673
Landfill Only Materials[b]	9,798	9,896	9,995	10,095
ASR	28,171	28,452	28,737	29,024
H-POWER Planned Maintenance Diversion	12,155	0	0	0
H-POWER Unsched. Maintenance Diversion	1,220	1,232	1,245	1,257
Capacity on Jan 1 (cubic yards)	201,567	68,007	-51,311	-171,108
Volume Needed at Landfill (cubic yards)	133,559	119,318	119,797	121,125
Capacity Remaining after Dec 31	68,007	-51,311	-171,108	-292,233
Capacity Reached (date)	7/4/2038	7/27/2038	7/27/2038	7/31/2038
Remaining Life (years)	0.5	-0.4	-1.4	-2.4

*ASH Cell has similar fill rate schedule based on cell reallocation which maximizes usage of WGSL air space
[b] Sharps, Dead Animals, WWTP Grit/Screening, Other Sludge, Homeowner Drop off, Expired Food, Synagro, etc.
Source: City & County of Honolulu's Department of Environmental Services, Recycling and Landfill Diversion; SMS Research Estimates

Appendix E, Exhibit 1: Landfill Life Span

Technical Criterion 1: Landfil Life Span

Criterion Definition

Landfill life span is the number of years a landfill site can serve as O'ahu's next landfill based on specific fill rates.

Rationale

A landfill site should have sufficient potential life span to accept at least 15 years of MSW and ash at specific fill rates for the community served. Its life span should not be greater than 30 years at current fill rates. The MACLSS initially established a minimum capacity of 15 years to justify the cost of acquiring, permitting, and constructing a new landfill. Sites between 4,866,210 and 9,726,420 cubic yards are optimum for this analysis.

Measurement

Measurement was carried out in five steps: (1) a temporary site footprint was established at each site; (2) the usable landfill area was calculated as the total area of the footprint minus the area needed for landfill support facilities and other solid-waste related activities; (3) the total volume in cubic yards was estimated from the area of the top and bottom surfaces of the landfill and the distance between the surfaces; (4) the volume of MSW that can be accommodated at the site was estimated as total volume minus the volume of soil and other materials needed for the liner, leachate, and gas controls, as well as for daily, intermediate, and final cover: and (5) the available volume was converted to tons of MSW and H-POWER ash using the same compacting factors as were used for the MACLSS site selection. Life span in years for the original estimate was based on the original MACLSS fill rate. For the current Life span estimate we used the most recent estimate of fill rate for 2015. Life span in years for the future estimate was based on the City's estimate for performance in 2037. The current life span estimate was then transformed to a ten-point scale with endpoints defined as shown below.

Point Value	Measure Assigned
1	The site with the shortest estimated life span
10	The site with the longest esimated life span

Data Source

Capacity in cubic yards was taken from the MACLSS report. Fill rates (annual estimated deposit of MSW, residue, and ash) for the original estimate were taken from calculatons for the MACLSS report (~400,000 cu. yd. per year). Fill rates for the updated estimate were taken from the Phase I forecasts (267,801 cu. yd. per year in 2015) (See Appendix B). Fill rates for the future estimates were taken as 80 percent of the fill rate estimates for the year 2037 (178,742 cu.yd. per year).

Data and Measurement Issues

In future years, the size of the property to be acquired may differ significantly from what is available in 2015. Therefore, the capacity in cubic yards will differ. In addition, periodic updates to ENV waste production and fill rates may change. All will have significant impact on lifespan estimates and scaled scores.

Calculation Detail

Site Num	Site Name	TMK	Capacity in cubic	Landfill Capacity Life Span in Years: Original	Current	Future	Scaled Score
1	Ameron Quarry	42015001	16,518,292	41	51	92	2
2	Upland Lā'ie	55007001	14,474,548	36	45	81	2
3	Upland Pūpūkea 1	61006001	14,094,080	35	43	79	2
4	Upland Pūpūkea 2	61007001	12,506,560	31	39	70	2
5	Kea'au	83001040, 83001041, 83001042	12,595,616	31	39	70	2
6	Upland Nānākuli 1	85006004	93,793,394	234	289	525	10
7	Upland Hawai'i Kai	39010047	6,033,507	15	19	34	1
8	Kapa'a Quarry Road	44011003	7,871,800	20	24	44	1
9	Kāne'ohe by H3	44012001	7,893,540	20	24	44	1
10	Upland Kahuku 1	56008002	14,623,695	37	45	82	2
11	Upland Kahuku 2	57002001	41,605,467	104	128	233	5
			Raw score data is measured in	Cubic yards	Range	271	
			Scale Direction: 1 = Normal; 0 = Inverted	1	Maximum	289	

Note: Normal scaled score is used when the raw data and the scaled score have the same direction, low to high. The higher score is preferred and thus the highest score is set at 10 and lowest score is set at 1. In cases where lower score is preferred, the scale is inverted, i.e. the highest raw score is set at 1 and the lowest raw score is set at 10.

Appendix E: Exhibit 2: Site Development Cost

Technical Criterion 2: Site Development Cost

Criterion Definition

The criterion is an estimated cost of landfill development and operations in 2037. the first year of operation for the next O'ahu landfill. Costs were expressed as the sum of the cost of acquisition, develoment, closure, and operations, including the cost of storm water control and treatment, drainage facilities to handle peak rain events, and soil suitability for daily cover. To adjust for different site capacities, final costs were also expressed as cost per cubic yard of capacity. The scaled score, however, was based on the adjusted development cost estimates.

Rationale

The cost of a new landfill is an important consideration and lower costs are preferred. Site-specific factors can make the cost of one site significantly different from other sites. This criterion measures that difference.

Measurement

The costs described above were summed. The estimate for each site was transformed to 2015 current dollars. The result was divided by the estimated cubic yards of capacity at the site. This development cost was entered as the raw score for the site. The raw scores were then transformed to a ten-point scale with the orientation noted below.

Point Value	Measure Assigned
1	The site with the highest development cost in 2037
10	The site with the lowest development cost in 2037

Data Source

MACLSS Report 2012; DBEDT State Databook 2015 Section 14 Table 14.06.

Data and Measurement Issues

A re-analysis of these sites in 2037 will differ significantly from todays' cost estimates. Some sites may not be available at that time, and other new sites may be identified. While the method of estimating site development costs will still be applicable, the results will change.

Calculation Detail

Site Num	Site Name	TMK	Capacity in cubic yards	Development Cost	$/cu yd.	Scaled Score
1	Ameron Quarry	42015001	16,518,292	$38,758,882	$ 2.35	9
2	Upland Lā'ie	55007001	14,474,548	$34,564,802	$ 2.39	10
3	Upland Pūpūkea 1	61006001	14,094,080	$37,921,020	$ 2.69	9
4	Upland Pūpūkea 2	61007001	12,506,560	$33,649,697	$ 2.69	10
5	Kea'au	83001040, 83001041, 83001042	12,595,616	$40,588,357	$ 3.22	9
6	Upland Nānākuli 1	85006004	93,793,394	$45,972,031	$ 0.49	7
7	Upland Hawai'i Kai	39010047	6,033,507	$44,107,396	$ 7.31	8
8	Kapa'a Quarry Road	44011003	7,871,800	$34,396,294	$ 4.37	10
9	Kāne'ohe by H3	44012001	7,893,540	$33,997,379	$ 4.31	10
10	Upland Kahuku 1	56008002	14,623,695	$42,243,556	$ 2.89	8
11	Upland Kahuku 2	57002001	41,605,467	$76,797,530	$ 1.85	1
			Raw score data is measured in	Dollars	Range 43,147,832	
			Scale Direction: 1 = Normal; 0 = Inverted	0	Maximum 76,797,530	

Note: Normal scaled score is used when the raw data and the scaled score have the same direction, low to high. The higher score is preferred and thus the highest score is set at 10 and lowest score is set at 1. In cases where lower score is preferred, the scale is inverted, i.e. the highest raw score is set at 1 and the lowest raw score is set at 10.

Appendix E: Exhibit 3: Roadway Intersection Improvement Cost

Technical Criterion 3: Roadway Intersection and Improvement Costs

Criterion Definition

This criterion describes the cost of roadway Intersections and improvements necessary for each potential site. It estimates the dollar costs of improvements needed to bring refuse truck traffic onto an existing highway or freeway. The impact was measured as the cost of upgrading or constructing the subject roadway(s) to a level consistent with MSW ash and residuals truck traffic. These costs were not included in the cost of development and operations.

Rationale

The cost of developing and installing roadway intersection improvements is a cost incurred by the City for most sites. A site that generates a lower cost for developing these improvements is preferred over a site that requires a higher roadway intersection improvement costs.

Measurement

Each site was examined to identify the need for development or improvement to existing roadways (reconstruction or widening, etc.), gulch or stream crossings, roadway intersection to meet minimum requirements, major intersection improvements, and possible bridge widening (See Figure 1 to Figure 11 in Appendix F). RMT civil engineering staff then designed the required improvements and estimated the cost, in 2015 dollars, to complete the improvements (See Table 1, Appendix G). Cost for each site were summarized as the total estimated cost, which was transformed to a 10-point scaled score with the orientation shown below.

Point Value	Measure Assigned
1	Site with the highest estimated cost for roadway and interesection improvements
10	Site with the lowest estimated cost for roadway and interesection improvements

Data Source

The length and width of existing roadways were determined from measurements determined in Google Earth.

Data and Measurement Issues

Cost estimates were based on desk research. Some estimates, particularly those for roadway widening, gulch and stream crossings, and bridge widening, may change as a result of more detailed field work, measurement, and engineering design. Re-analysis in 2037 may also change results significantly if the size of the acquired parcel changes or if footprints are moved. Inflation can be expected to affect all cost estimates. Roadway intersections may improve for other reasons between now and then, and some rural roadway conditions may deteriorate. All factors would affect estimates shown below.

Calculation Detail

Site Num.	Site Name	TMK	Roadway Intersection and Improvement Costs: Roadway Reconstruction /Widening (ft.)	(1) Gulch/ (2) Stream Crossing	Minimal Intersection Improvement	Major Intersection Improvements[a]	Bridge Widening	Total Estimated Cost	Scaled Score
1	Ameron Quarry	42015001	0	No	No	No	No	$ -	10
2	Upland Lā'ie	55007001	3,850	No	No	Yes	No	$ 1,967,000	9
3	Upland Pūpūkea 1	61006001	15,525	Yes (2)	No	Yes	Yes	$18,390,000	1
4	Upland Pūpūkea 2	61007001	16,800	Yes (1)	No	Yes	Yes	$13,921,410	3
5	Kea'au	83001040, 83001041, 83001042	2,000	Yes (1)	No	Yes	No	$ 5,966,000	7
6	Upland Nānākuli 1	85006004	26,050	Yes (1)	Yes	No	No	$ 9,851,000	5
7	Upland Hawai'i Kai	39010047	0	No	No	Yes	No	$ 100,000	10
8	Kapa'a Quarry Road	44011003	0	No	No	No	No	$ -	10
9	Kāne'ohe by H3	44012001	0	No	Yes	No	No	$ 100,000	10
10	Upland Kahuku 1	56008002	14,550	Yes (1)	No	Yes	No	$10,176,000	5
11	Upland Kahuku 2	57002001	16,000	Yes (1)	No	Yes	No	$ 8,975,000	6
		Raw score data is measured in	Dollars			Range		$18,390,000	
		Scale Direction: 1 = normal; 0 = Inverted	0			Maximum		$18,390,000	

Note. Normal scaled score is used when the raw data and the scaled score have the same direction, low to high. The higher score is preferred and thus the highest score is set at 10 and lowest score is set at 1. In cases where lower score is preferred, the scale is inverted, i.e., the highest raw score is set at 1 and the lowest raw score is set at 10.

[a] Major Intersection Improvements include widening for turn lanes, utility relocations, etc

Appendix E: Exhibit 4: Access Road Requirement

Technical Criterion 4: Access Road Requirements

Criterion Definition

This criterion considers the extent to which developing a landfill at a specific site requires development of a new access road. An access road was defined as that section of roadway between the last serviceable roadway and the location of the landfill operations facility.

Rationale

A potential site that results in lower expenditures for access road construction is preferred over a site that requires greater expenditures for access road construction. These costs were not included in the cost of development and operations, nor in the cost of existing roadway improvements.

Measurement

Each site was examined to identify the need for an access road (See Figure 1 to Figure 11 in Appendix F). The civil engineering staff then estimated the length of the access road, designed the road, and estimated its cost (See Table 1 in Appendix G). The costs are shown below in current 2015 dollars. Costs for each site were transformed to a 10-point scaled score.

Point Value	Measure Assigned
1	Highest roadway upgrade and construction cost
10	Lowest roadway upgrade and construction cost

Data Source

The length and width of existing roadways were determined from measurements taken from Google Earth.

Data and Measurement Issues

Cost estimates were based on desk research. The access road length and development costs may change as a result of more detailed field work, measurements, and engineering design. Site design, the size of the acquired parcel, or footprint size may change, causing further alterations in the estimates shown below. Inflation can be expected to affect all cost estimates. In the MACLSS, access road costs were included in the site development costs.

Calculation Detail

Site Num.	Site Name	TMK	Estimated Roadway Upgrade/Construction Cost: Linear Feet of Roadway (ft.)	Estimated Cost	Scaled Score
1	Ameron Quarry	42015001	1,200	$ 412,000	10
2	Upland Lā'ie	55007001	3,850	$ 3,684,000	1
3	Upland Pūpūkea 1	61006001	2,700	$ 1,530,000	7
4	Upland Pūpūkea 2	61007001	3,400	$ 1,927,235	6
5	Kea'au	83001040, 83001041, 83001042	4,000	$ 2,267,000	5
6	Upland Nānākuli 1	85006004	4,400	$ 2,494,000	4
7	Upland Hawai'i Kai	39010047	1,500	$ 851,000	9
8	Kapa'a Quarry Road	44011003	1,056	$ 659,000	9
9	Kāne"ohe by H3	44012001	1,700	$ 964,000	8
10	Upland Kahuku 1	56008002	6,000	$ 3,401,000	2
11	Upland Kahuku 2	57002001	4,000	$ 851,000	9
		Raw score data is measured in	Dollars — Range	$ 3,272,000	
		Scale Direction: 1 = Normal; 0 = Inverted	0 — Maximum	$ 3,684,000	

Note: Normal scaled score is used when the raw data and the scaled score have the same direction, low to high. The higher score is preferred and thus the highest score is set at 10 and lowest score is set at 1. In cases where the lower score is preferred, the scale is inverted, i.e. the highest raw score is set at 1 and the lowest raw score is set at 10.

Appendix E: Exhibit 5: Impacts on Roadways: Location Relative to H-POWER

Technical Criterion 5: Location Relative to H-POWER

Criterion Definition

Distance measured between the H-POWER facility and the landfill site. The measurement includes the distance along suitable truck-accessible roadways from the H-POWER facility to the landfill site. This criterion measures the additional cost of a site that is more than 12 miles from H-POWER.

Rationale

A set of impacts along roadways, other than those covered by the MACLSS, must be taken into consideration for each site. Some of those include the impact of refuse and ash trucks on roadway maintenance costs, cost of traffic engineering measures that might be required, cost of peak hour traffic, etc. An initial investigation found that all of these differ across potential sites largely as a function of the distance trucks must travel on all road surfaces. The major difference from site to site is the distance traveled by refuse trucks transporting ash and residue from the H-POWER site in West Oahu. Hence, the distance between the individual site and H-POWER is a reliable surrogate for total impact on roadways and traffic.

Measurement

The distance was measured in miles along suitable truck-accessible roadways from the H-POWER facility to each landfill site. The distance measurements were transformed to a ten-point scale with the orientation noted below.

Point Value	Measure Assigned
1	Greatest distance along suitable truck-accessible roadways from H-POWER facility to each LS.
10	Shortest distance along suitable truck-accessible roadways from H-POWER facility to each LS.

Data Source

Using Google Earth, the distance was measured from H-POWER to the point at which the landfill access road intersected the public road.

Data Issues and Measurement Discussion

None

Calculation Detail

Site Num.	Site Name	TMK	Location Relative to H-POWER		
			Detail	Raw Score	Scaled Score
1	Ameron Quarry	42015001	None	31.7	6
2	Upland Lā'ie	55007001	None	47.5	1
3	Upland Pūpūkea 1	61006001	None	32.2	5
4	Upland Pūpūkea 2	61007001	None	34	5
5	Kea'au	83001040, 83001041, 83001042	None	19.8	9
6	Upland Nānākuli 1	85006004	None	16	10
7	Upland Hawai'i Kai	39010047	None	37.6	4
8	Kapa'a Quarry Road	44011003	None	30.3	6
9	Kāne"ohe by H3	44012001	None	30.9	6
10	Upland Kahuku 1	56008002	None	44.7	2
11	Upland Kahuku 2	57002001	None	42.4	2
		Raw score data is measured in	Miles	Range 31.2	
		Scale Direction: 1 = Normal; 0 = Inverted	0	Maximum 47.5	

Note: Normal scaled score is used when the raw data and the scaled score have the same direction, low to high. The higher score is preferred and thus the highest score is set at 10 and lowest score is set at 1 In cases where lower score is preferred, the scale is inverted, i.e. the highest raw score is set at 1 and the lowest raw score is set at 10.

Appendix E: Exhibit 6: Acquisition

Technical Criterion 6: Acquisition

Criterion Definition

This criterion combines several aspects of land acquisition. In addition to the price of land, the acquisition score covers land use, ownership, size, value per square foot, and the possibility of acquiring only part of the subject land parcels.

Rationale

In addition to the estimated cost of the land parcel involved, there are other aspects of acquisition that will come into play. Considering land use, preservation land might be more difficult to acquire than agricultural or industrial land. Considering land owner type, it may be very difficult to acquire preservation trust land and less difficult to acquire government land. The value itself might be better treated as the cost per acre, and the City might consider acquiring only part of the parcel(s) on which the proposed site footprint has been drawn.

Measurement

Scores in known units (acres, dollars) were converted to scales from high to low and then transformed to a common scale from 1 to 10, where 10 represented the most preferred characteristic. The table shows the assigned values for reach of the land use, owner, and assessed value scales. Scores for non-numeric components were assigned numbers from 1 to 10 where the most preferred item was assigned 10 points. The three scores were summed and ranked. The ranked scores were then transformed to a ten-point scale with the orientation noted below.

Point Value	Measure Assigned
1	Land that was most difficult to acquire.
10	Land that was least difficult to acquire.

Data Source

Honolulu Tax Maps, property records

Data Issues and Measurement Discussion

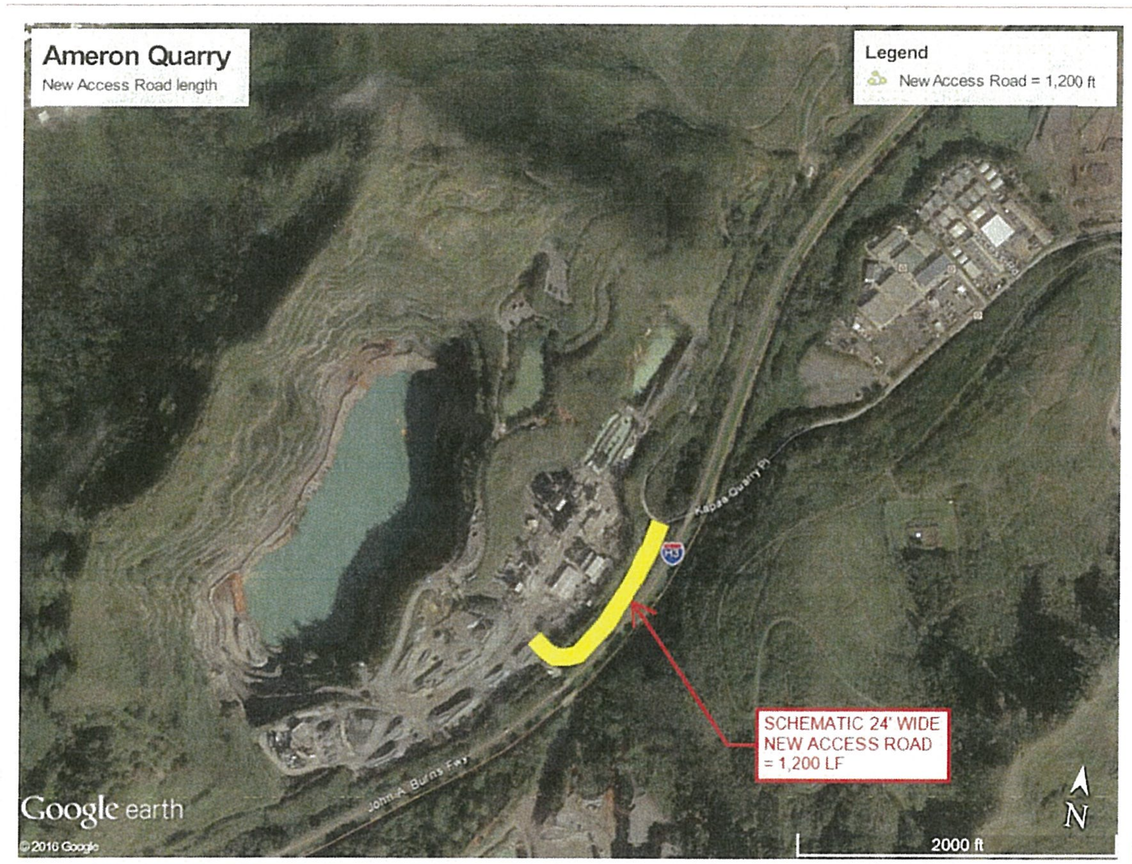
Components of the acquisition score were based on desk research and may change to some extent after more detailed field work and more extensive measurement. Assessed values will change according to market forces, ownership may change hands, and land use changes may occur between this report and the final planning stages for the next Honolulu landfill site. It is likely that this analysis will be updated before action is taken in the future.

Site Num	Site Name	TMK	Acquisition-Relevant Information								
			Land Use		Fee Owner		Assessed Value			Summary	
			Raw Score	Scaled Score	Raw Score	Scaled Score	2015 Dollars	Raw Score	Scaled Score	Sum of Scaled Scores	Scaled Score
1	Ameron Quarry	42015001	6	5	3	8	$ 2,082,500	2.1	10	22	7
2	Upland Lā'ie	55007001	6	5	4	7	$ 3,062,600	3.1	9	21	6
3	Upland Pūpūkea 1	61006001	6	5	4	7	$ 22,650,100	22.7	5	16	3
4	Upland Pūpūkea 2	61007001	6	5	4	7	$ 21,152,400	21.2	5	17	4
5	Kea'au	83001040, 83001041, 83001042	6	5	3	8	$ 4,318,300	4.3	9	22	6
6	Upland Nānākuli 1	85006004	3	9	2	10	$ 2,489,100	2.5	9	28	10
7	Upland Hawai'i Kai	39010047	9	1	9	1	$ 1,181,500	1.2	10	12	1
8	Kapa'a Quarry Road	44011003	9	1	6	4	$ 370,000	0.4	10	15	3
9	Kāne'ohe by H3	44012001	9	1	6	4	$ 232,700	0.2	10	15	3
10	Upland Kahuku 1	56008002	3	9	8	2	$ 4,552,300	4.6	9	20	5
11	Upland Kahuku 2	57002001	2	10	8	2	$ 39,148,400	39.1	1	13	2
	Index scores	Range	7		7			38.9		16	
		Max	9		9			39.1		28	
		Scale Direction: 1 = Normal; 0 = Inverted	0		0			0		1	

Note: Normal scaled score is used when the raw data and the scaled score have the same direction, low to high. The higher score is preferred and thus the highest score is set at 10 and lowest score is set at 1. In cases where lower score is preferred, the scale is inverted, i.e., the highest raw score is set at 1 and the lowest raw score is set at 10.

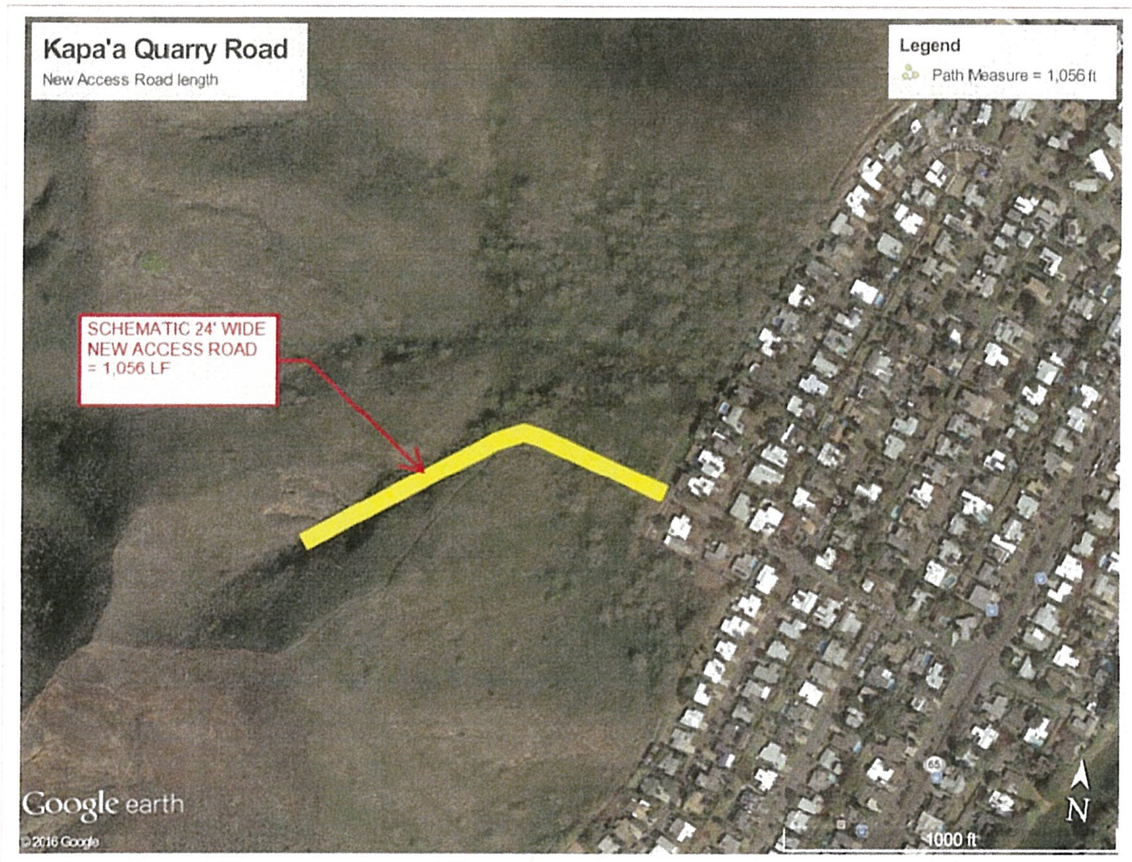
Note: Some scaled scores may not add to the sum of scaled scores due to rounding.

Appendix F: Access Road Evaluation for Ameron Quarry

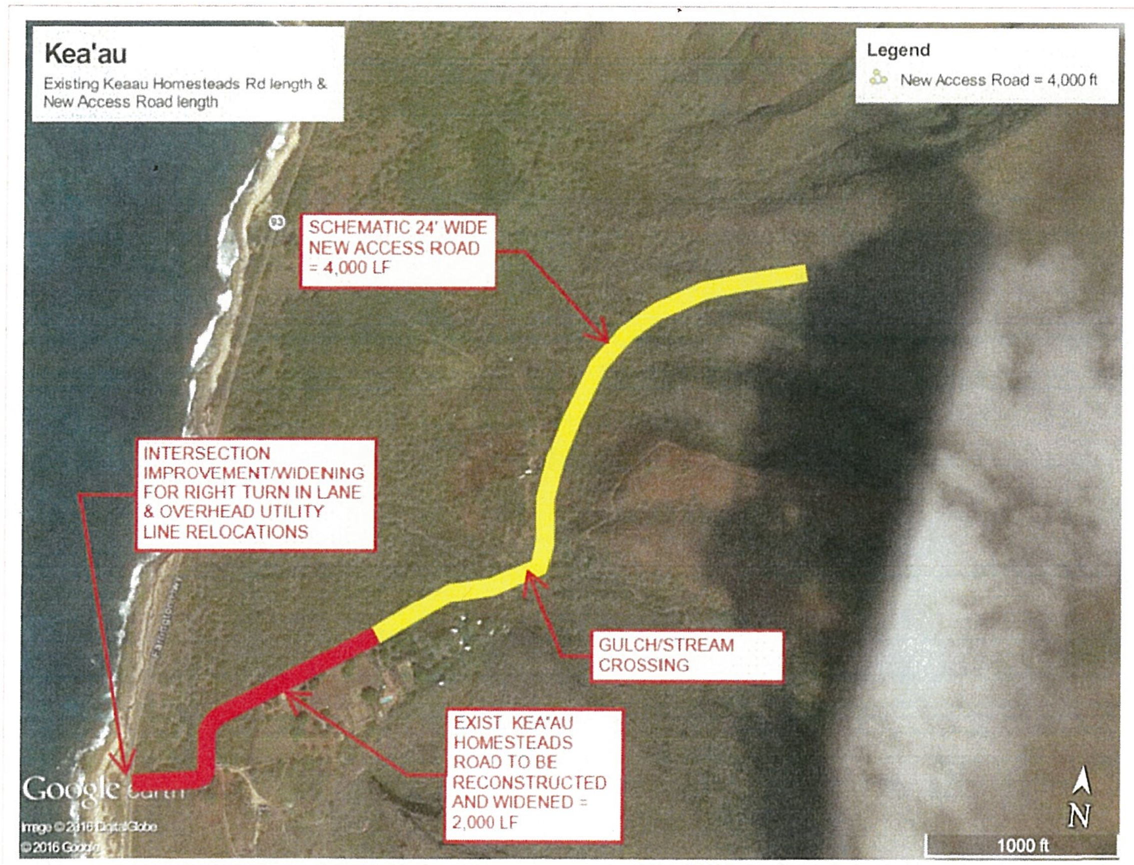


Appendix F: Access Road Evaluation for Kāne'ohe by H-3

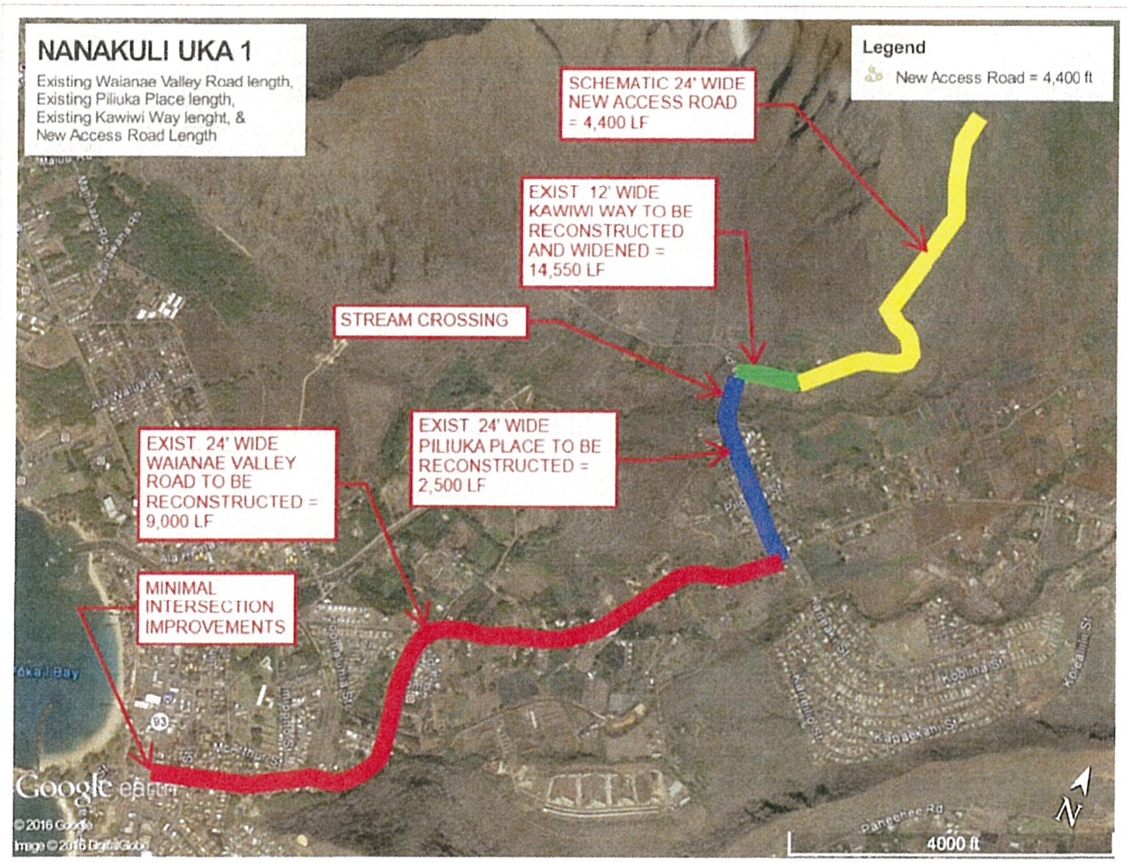
Appendix F: Access Road Evaluation for Kapa'a Quarry Road



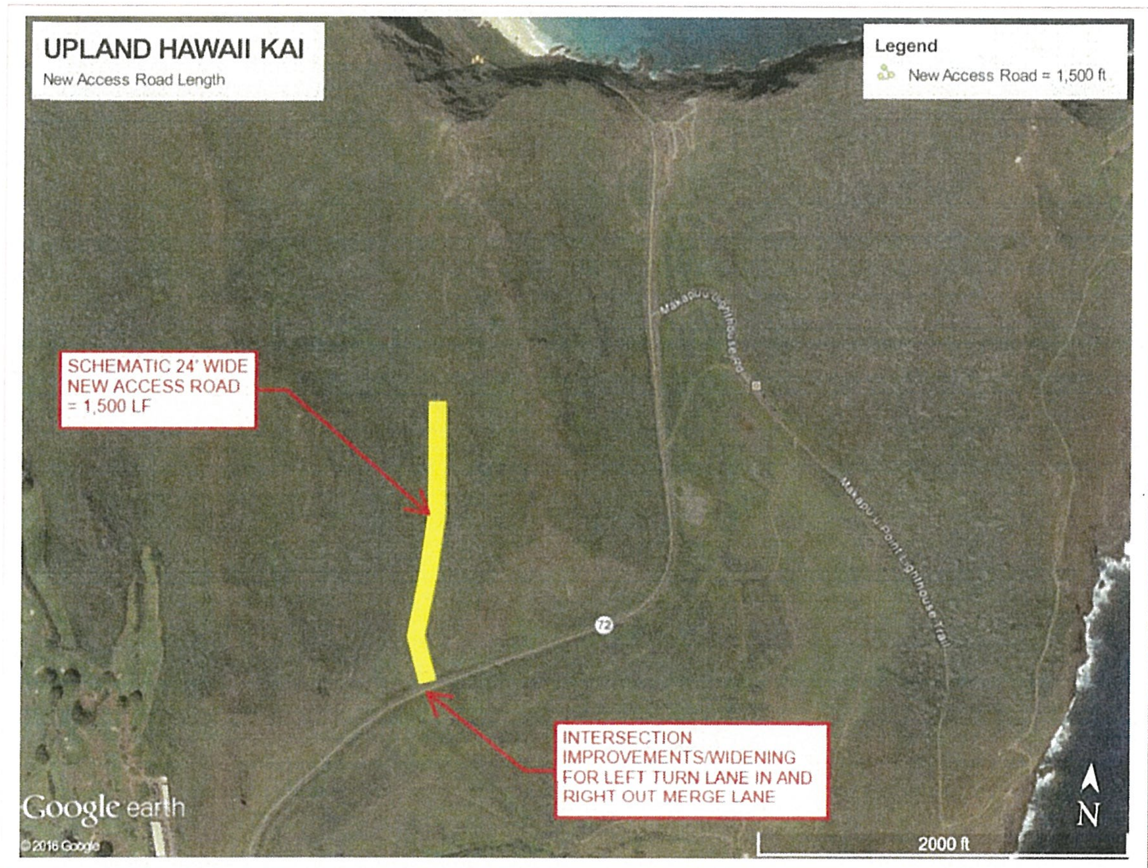
Appendix F: Access Road Evaluation for Kea'au



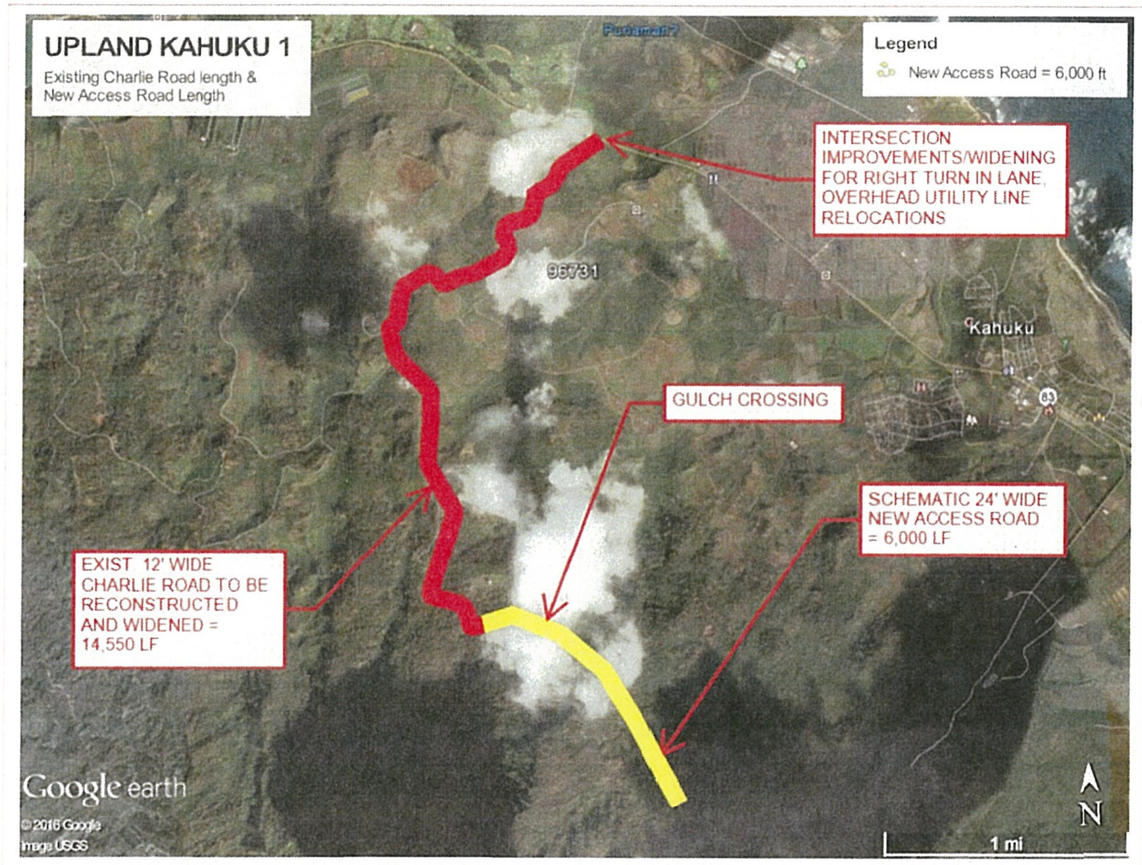
Appendix F: Access Road Evaluation for Nānākuli Uka 1



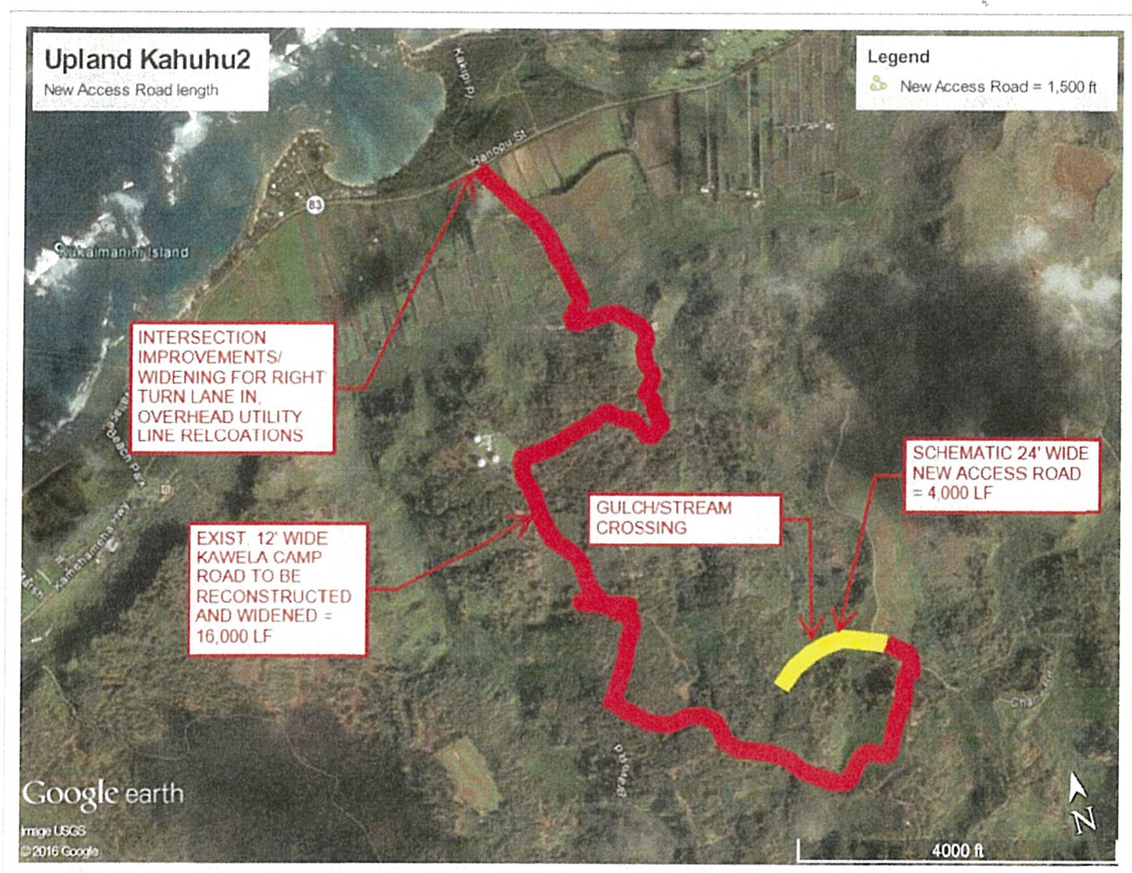
Appendix F: Access Road Evaluation for Upland Hawai'i Kai



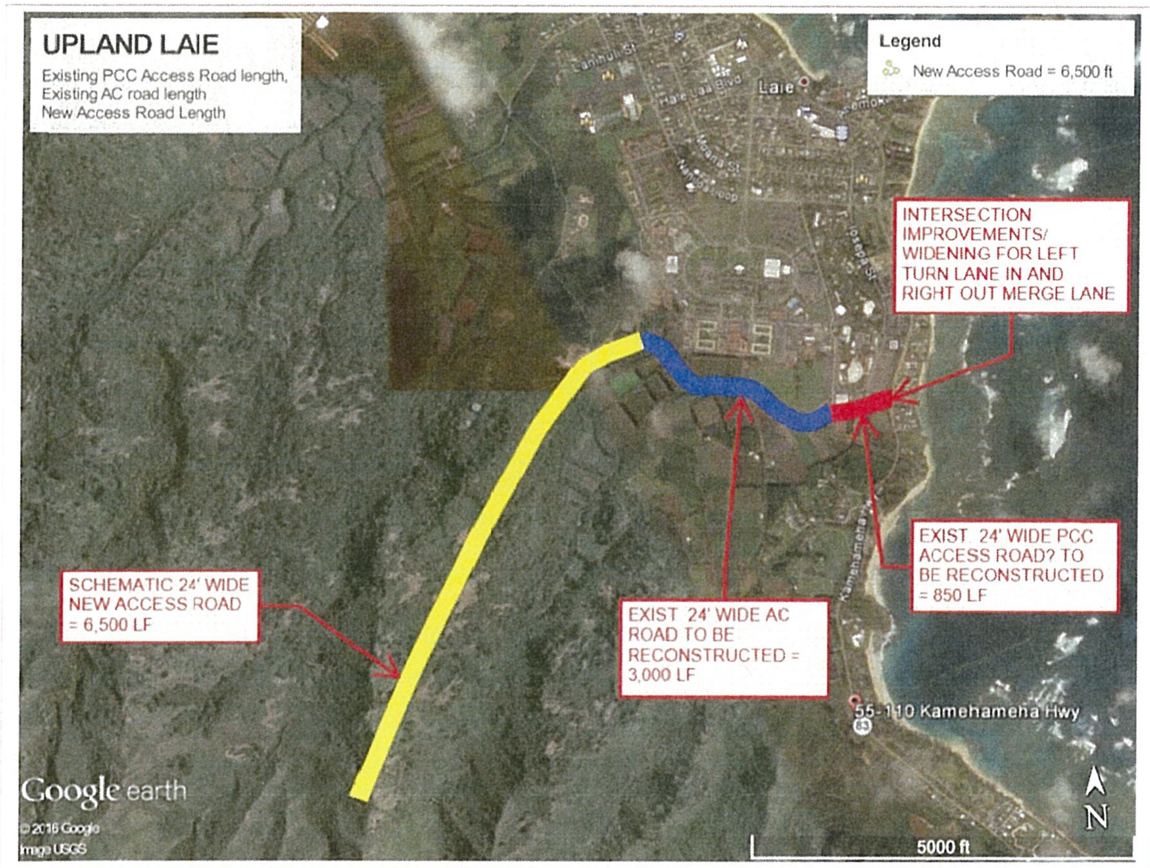
Appendix F: Access Road Evaluation for Upland Kahuku 1



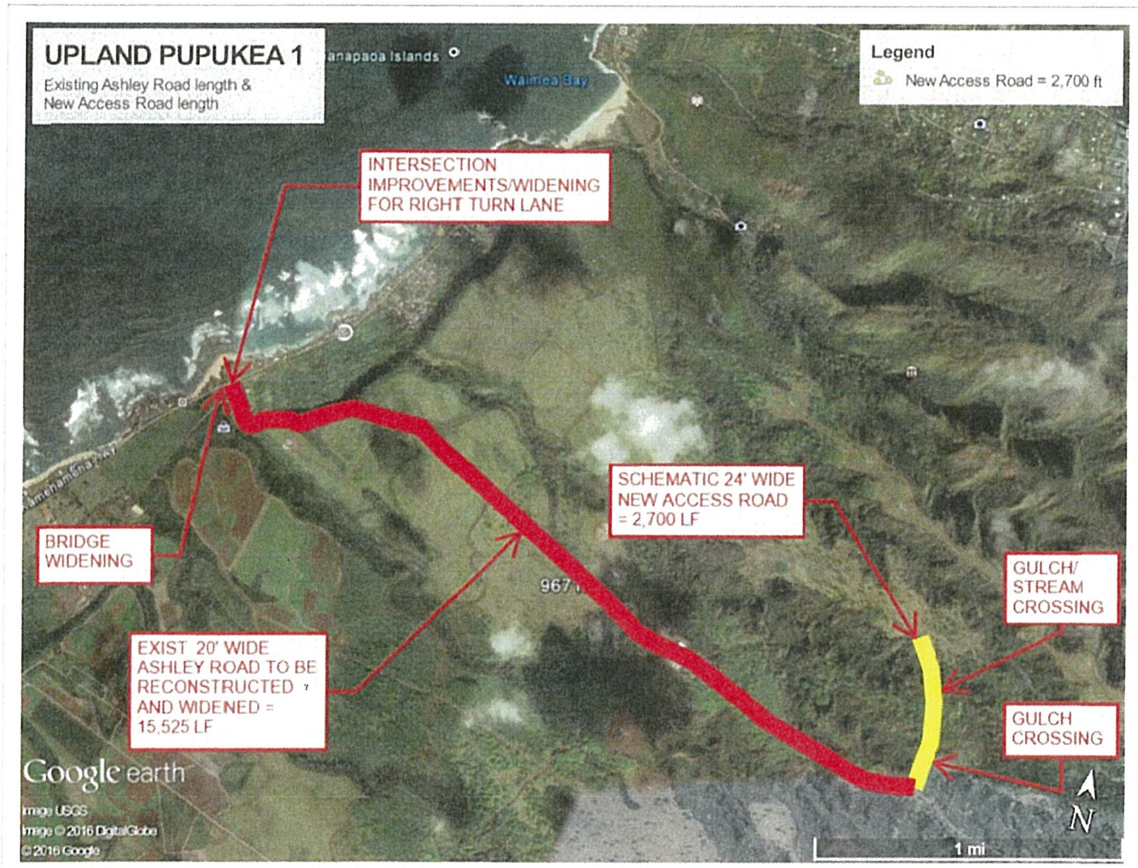
Appendix F: Access Road Evaluation for Upland Kahuku 2



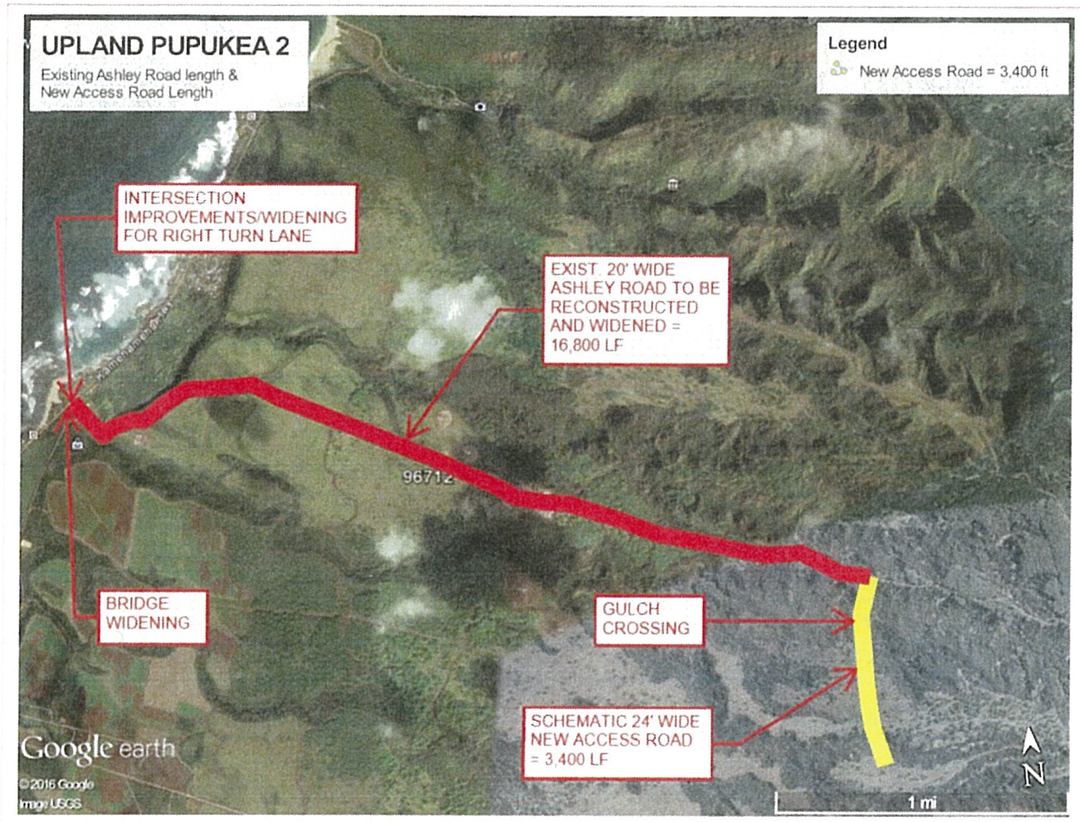
Appendix F: Access Road Evaluation for Upland Lā'ie



Appendix F: Access Road Evaluation for Upland Pūpūkea 1



Appendix F: Access Road Evaluation for Upland Pūpūkea 2



Appendix G: New / Existing Roadways Improvement Cost Estimation and Assumptions for 11 Sites

Oahu Landfill Road Study

0% Cost Estimate
December 19, 2016

	LOCATIONS:										
ASSUMPTIONS:	**AMERON QUARRY**	**KAPA'A QUARRY ROAD**	**UPLAND HAWAII KAI**	**KANEOHE BY H3**	**UPLAND LAIE**	**KEA'AU**	**UPLAND KAHUKU 2**	**NANAKULI UKA 1**	**UPLAND KAHUKU 1**	**UPLAND PUPUKEA 2**	**UPLAND PUPUKEA 1**
Linear feet of roadway reconstruction/widening	0	0	0	0	3,850	2,000	16,000	26,050	14,550	16,800	15,525
Linear feet of new roadway construction	1,200	1,056	1,500	1,700	6,500	4,000	4,000	4,400	6,000	3,400	2,700
Gulch/Stream crossing(s)	No	No	No	No	No	Yes, stream (1)	Yes, gulch (1)	Yes, stream (1)	Yes, gulch (1)	Yes, gulch (1)	Yes, gulch/ stream (2)
Minimal Intersection Improvements	No	No	No	YES	No	No	No	YES	No	No	No
Major Intersection Improvements (widening for turn lanes, utility relocations)	No	No	YES	No	YES	YES	YES	none	YES	YES	YES
Bridge widening	No	No	No	No	No	No	No	N	No	YES	YES
COSTS (ROM):											
Existing Road Improvements	$0	$0	$0	$0	$1,787,000	$836,000	$3,845,000	$4,851,000	$5,046,000	$5,871,410	$5,340,000
Access Road	$412,000	$659,000	$851,000	$964,000	$3,684,000	$2,267,000	$851,000	$2,494,000	$3,401,000	$1,927,235	$1,530,000
Intersection Improvements	$0	$0	$100,000	$100,000	$180,000	$130,000	$130,000	$0	$130,000	$50,000	$50,000
Stream/Gulch Crossings	$0	$0	$0	$0	$0	$5,000,000	$5,000,000	$5,000,000	$5,000,000	$5,000,000	$10,000,000
Bridge Widening	$0	$0	$0	$0	$0	$0	$0	$0	$0	$3,000,000	$3,000,000
TOTAL:	$412,000	$659,000	$951,000	$1,064,000.00	$5,651,000	$8,233,000	$9,826,000	$12,345,000	$13,577,000	$15,848,645	$19,920,000

Oahu Landfill Road Study

0% Cost Estimate

December 19, 2016

AMERON QUARRY				
TMK: 4-2-015:001				
DESCRIPTION	QTY	UNIT	UNIT PRICE	TOTAL
New Access Road				
A.C. Pavement 2 1/2" thick, in place complete.	484	CY	$250.00	$121,000.00
Base Course 6" thick, in place complete.	533	CY	$375.00	$199,875.00
Subbase Course, 12" thick, in place complete.	1067	CY	$85.00	$90,695.00
			TOTAL	$411,570.00
NOTE: Quantities are based on an approximation of paving ~1200 sf of roadway to add a 24' wide driveway connecting to Kapaa Quarry Road with a minimum turning radius of 45'.				

Appendix G: Access Road / Intersection Improvement Cost Estimation for Kapa'a Quarry Road

Oahu Landfill Road Study

0% Cost Estimate

December 19, 2016

KAPA'A QUARRY ROAD				
TMK: 4-4-11:003				
DESCRIPTION	**QTY**	**UNIT**	**UNIT PRICE**	**TOTAL**
New Access Road				
P.C.C. Pavement 9" thick, in place complete.	775	CY	$480.00	$372,000.00
Base Course 6" thick, in place complete.	517	CY	$385.00	$199,045.00
Subbase Course, 12" thick, in place complete.	1033	CY	$85.00	$87,805.00
			TOTAL	$658,850.00

Oahu Landfill Road Study

0% Cost Estimate

December 19, 2016

UPLAND HAWAII KAI				
TMK: 3-9-10: 047				
DESCRIPTION	**QTY**	**UNIT**	**UNIT PRICE**	**TOTAL**
New Access Road				
P.C.C. Pavement 9" thick, in place complete.	1000	CY	$480.00	$480,000.00
Base Course 6" thick, in place complete.	667	CY	$385.00	$256,795.00
Subbase Course, 12" thick, in place complete.	1334	CY	$85.00	$113,390.00
Intersection Improvements				
Widening for left turn lane				$100,000.00
Signalization?				
			TOTAL	$950,185.00

Oahu Landfill Road Study

0% Cost Estimate

December 19, 2016

KANEOHE BY H3				
TMK:				
DESCRIPTION	**QTY**	**UNIT**	**UNIT PRICE**	**TOTAL**
New Access Road				
P.C.C. Pavement 9" thick, in place complete.	1134	CY	$480.00	$544,320.00
Base Course 6" thick, in place complete.	756	CY	$385.00	$291,060.00
Subbase Course, 12" thick, in place complete.	1512	CY	$85.00	$128,520.00
Intersection Improvements				
Widening for right turn lane				$100,000.00
			TOTAL	$1,063,900.00

Oahu Landfill Road Study

0% Cost Estimate

December 19, 2016

UPLAND LAIE				
TMK: 5-5-7: 001				
DESCRIPTION	**QTY**	**UNIT**	**UNIT PRICE**	**TOTAL**
PCC Access Road? (24' wide A.C. Pav't.)				
Demolition and removal of existing A.C. pavement, including base course.	20400	SF	$8.00	$163,200.00
A.C. Pavement 2 1/2" thick, in place complete.	158	CY	$250.00	$39,500.00
Base Course 6" thick, in place complete.	378	CY	$375.00	$141,750.00
Exist. AC access Road (24' wide A.C. Pav't.)				
Demolition and removal of existing A.C. pavement, including base course.	72000	SF	$8.00	$576,000.00
A.C. Pavement 2 1/2" thick, in place complete.	556	CY	$250.00	$139,000.00
Base Course 6" thick, in place complete.	1334	CY	$375.00	$500,250.00
Subbase Course, 12" thick, in place complete.	2667	CY	$85.00	$226,695.00
New Access Road				
P.C.C. Pavement 9" thick, in place complete.	4334	CY	$480.00	$2,080,320.00
Base Course 6" thick, in place complete.	2889	CY	$385.00	$1,112,265.00
Subbase Course, 12" thick, in place complete.	5778	CY	$85.00	$491,130.00
Intersection Improvements				
Widening for left turn lane				$100,000.00
Relocation of overhead utility lines	400	LF	$200.00	$80,000.00
			TOTAL	$5,650,110.00

Appendix G: Access Road / Intersection Improvement Cost Estimation for Kea'au

Oahu Landfill Road Study

0% Cost Estimate

December 19, 2016

KEA'AU				
TMK: 8-3-1:006				
83-202 Farrington Highway				
DESCRIPTION	**QTY**	**UNIT**	**UNIT PRICE**	**TOTAL**
Keaau Homesteads Road (20' wide A.C. Pav't.)				
Demolition and removal of existing A.C. pavement, including base course.	48,000	SF	$8.00	$384,000.00
A.C. Pavement 2 1/2" thick, in place complete.	370	CY	$250.00	$92,592.59
Base Course 6" thick, in place complete.	889	CY	$375.00	$333,333.33
Subbase Course, 12" thick, in place complete.	300	CY	$85.00	$25,500.00
New Access Road				
P.C.C. Pavement 9" thick, in place complete.	2667	CY	$480.00	$1,280,160.00
Base Course 6" thick, in place complete.	1778	CY	$385.00	$684,530.00
Subbase Course, 12" thick, in place complete.	3556	CY	$85.00	$302,260.00
Intersection Improvements				
Widening for Right turn lane				$50,000.00
Signalization?				
Relocation of overhead utility lines	400	LF	$200.00	$80,000.00
Gulch/Stream crossing	1	EA		$5,000,000.00
			TOTAL	$8,232,375.93
NOTE: Quantities are based on an approximation of paving ~960000 sf of roadway to add a 24' wide driveway connecting to the end of Keaau Homesteads Road with a minimum turning radius of 45'.				

Oahu Landfill Road Study

0% Cost Estimate

December 19, 2016

UPLAND KAHUKU 2				
TMK: 5-7-2:001?				
DESCRIPTION	**QTY**	**UNIT**	**UNIT PRICE**	**TOTAL**
Kawela Camp Road (12' wide A.C. Pav't.)				
Demolition and removal of existing A.C. pavement, including base course.	192000	SF	$8.00	$1,536,000.00
A.C. Pavement 2 1/2" thick, in place complete.	1482	CY	$250.00	$370,500.00
Base Course 6" thick, in place complete.	3556	CY	$375.00	$1,333,500.00
Subbase Course, 12" thick, in place complete.	7112	CY	$85.00	$604,520.00
New Access Road				
P.C.C. Pavement 9" thick, in place complete.	1000	CY	$480.00	$480,000.00
Base Course 6" thick, in place complete.	667	CY	$385.00	$256,795.00
Subbase Course, 12" thick, in place complete.	1334	CY	$85.00	$113,390.00
Intersection Improvements				
Widening for Right turn lane				$50,000.00
Signalization?				
Relocation of overhead utility lines	400	LF	$200.00	$80,000.00
Gulch/Stream crossing	1	EA		$5,000,000.00
			TOTAL	$9,824,705.00

NOTE: Existing Kawela Camp Road is assumed to be 12' wide A.C. pavement of approx. 16,000'. Assuming widening of exist. subbase by 12 feet for two way traffic.

Oahu Landfill Road Study

0% Cost Estimate

December 19, 2016

NANAKULI UKA 1				
TMK: 8-5-006: 004?				
DESCRIPTION	**QTY**	**UNIT**	**UNIT PRICE**	**TOTAL**
Waianae Valley Road (24' wide A.C. Pav't.)				
Demolition and removal of existing A.C. pavement, including base course.	216000	SF	$8.00	$1,728,000.00
A.C. Pavement 2 1/2" thick, in place complete.	1667	CY	$250.00	$416,750.00
Base Course 6" thick, in place complete.	4000	CY	$375.00	$1,500,000.00
Piliuka Place (24' wide A.C. Pav't.)				
Demolition and removal of existing A.C. pavement, including base course.	60000	SF	$8.00	$480,000.00
A.C. Pavement 2 1/2" thick, in place complete.	463	CY	$250.00	$115,750.00
Base Course 6" thick, in place complete.	1112	CY	$375.00	$417,000.00
Kawiwi Way (12' wide A.C. Pav't.)				
Demolition and removal of existing A.C. pavement, including base course.	9600	SF	$8.00	$76,800.00
A.C. Pavement 2 1/2" thick, in place complete.	75	CY	$250.00	$18,750.00
Base Course 6" thick, in place complete.	178	CY	$375.00	$66,750.00
Subbase Course, 12" thick, in place complete.	356	CY	$85.00	$30,260.00
New Access Road				
P.C.C. Pavement 9" thick, in place complete.	2934	CY	$480.00	$1,408,320.00
Base Course 6" thick, in place complete.	1956	CY	$385.00	$753,060.00
Subbase Course, 12" thick, in place complete.	3912	CY	$85.00	$332,520.00
Gulch/Stream crossing	1	EA		$5,000,000.00
			TOTAL	$12,343,960.00

Oahu Landfill Road Study

0% Cost Estimate

December 19, 2016

UPLAND PUPUKEA 2				
TMK: 6-1-6:001?				
DESCRIPTION	**QTY**	**UNIT**	**UNIT PRICE**	**TOTAL**
Ashley Road (20' wide A.C. Pav't.)				
Demolition and removal of existing A.C. pavement, including base course.	336000	SF	$8.00	$2,688,000.00
A.C. Pavement 2 1/2" thick, in place complete.	2593	CY	$250.00	$648,250.00
Base Course 6" thick, in place complete.	6223	CY	$375.00	$2,333,625.00
Subbase Course, 12" thick, in place complete.	2371	CY	$85.00	$201,535.00
New Access Road				
P.C.C. Pavement 9" thick, in place complete.	2267	CY	$480.00	$1,088,160.00
Base Course 6" thick, in place complete.	1512	CY	$385.00	$582,120.00
Subbase Course, 12" thick, in place complete.	3023	CY	$85.00	$256,955.00
Intersection Improvements				
Widening for Right turn lane				$50,000.00
Bridge widening				$3,000,000.00
Signalization?				
Gulch/Stream crossing	1	EA		$5,000,000.00
			TOTAL	$15,848,645.00

Oahu Landfill Road Study

0% Cost Estimate

December 19, 2016

UPLAND PUPUKEA 1				
TMK: 6-1-6:001?				
DESCRIPTION	**QTY**	**UNIT**	**UNIT PRICE**	**TOTAL**
Ashley Road (20' wide A.C. Pav't.)				
Demolition and removal of existing A.C. pavement, including base course.	304500	SF	$8.00	$2,436,000.00
A.C. Pavement 2 1/2" thick, in place complete.	2350	CY	$250.00	$587,500.00
Base Course 6" thick, in place complete.	5639	CY	$375.00	$2,114,625.00
Subbase Course, 12" thick, in place complete.	2371	CY	$85.00	$201,535.00
New Access Road				
P.C.C. Pavement 9" thick, in place complete.	1800	CY	$480.00	$864,000.00
Base Course 6" thick, in place complete.	1200	CY	$385.00	$462,000.00
Subbase Course, 12" thick, in place complete.	2400	CY	$85.00	$204,000.00
Intersection Improvements				
Widening for Right turn lane				$50,000.00
Bridge widening				$3,000,000.00
Signalization?				
Gulch/Stream crossing	2	EA	$5,000,000.00	$10,000,000.00
			TOTAL	$19,919,660.00

Oahu Landfill Road Study

0% Cost Estimate

December 19, 2016

UPLAND KAHUKU 1				
TMK: 5-6-008: 002				
DESCRIPTION	**QTY**	**UNIT**	**UNIT PRICE**	**TOTAL**
Charlie Road (12' wide A.C. Pav't.)				
Demolition and removal of existing A.C. pavement, including base course.	174600	SF	$8.00	$1,396,800.00
A.C. Pavement 2 1/2" thick, in place complete.	2695	CY	$250.00	$673,750.00
Base Course 6" thick, in place complete.	6467	CY	$375.00	$2,425,125.00
Subbase Course, 12" thick, in place complete.	6467	CY	$85.00	$549,695.00
New Access Road				
P.C.C. Pavement 9" thick, in place complete.	4000	CY	$480.00	$1,920,000.00
Base Course 6" thick, in place complete.	2667	CY	$385.00	$1,026,795.00
Subbase Course, 12" thick, in place complete.	5334	CY	$85.00	$453,390.00
Intersection Improvements				
Widening for Right turn lane				$50,000.00
Signalization?				
Relocation of overhead utility lines	400	LF	$200.00	$80,000.00
Gulch/Stream crossing	1	EA		$5,000,000.00
			TOTAL	$13,575,555.00

Appendix H-2: Total CCE Site Scores

	Scaled Scores							
	Criterion #		1	2	3	4	5	6
Site #	Site Name	Total CCE Site Score	Landfill Lifespan	Site Development Cost	Roadway Intersection Improvement Cost	Access Road Requirement	Location Relative to H-POWER	Acquisition
1	Ameron Quarry	44	2	9	10	10	6	7
2	Upland Lā'ie	29	2	10	9	1	1	6
3	Upland Pūpūkea 1	27	2	9	1	7	5	3
4	Upland Pūpūkea 2	30	2	10	3	6	5	4
5	Kea'au	38	2	9	7	5	9	6
6	Upland Nānākuli 1	46	10	7	5	4	10	10
7	Upland Hawai'i Kai	33	1	8	10	9	4	1
8	Kapa'a Quarry Road	39	1	10	10	9	6	3
9	Kāne'ohe by H3	38	1	10	10	8	6	3
10	Upland Kahuku 1	24	2	8	5	2	2	5
11	Upland Kahuku 2	25	5	1	6	9	2	2

Appendix I: Explanation on Scaling Scores for Evaluation Criteria

O'ahu Landfill Project
SMS Research

August 22, 2017

The method used to scale scores for the landfill site evaluation was developed while working with the Mayor's Advisory Committee on Landfill Site Selection (MACLSS) in the 2012 timeframe.

Several meetings were held during which methods for data analysis were discussed and MACLSS members noted their preferred characteristics for scoring the site selection criteria, including:

1. The score should be an accurate representation of the data defined by the criteria.
2. Use linear scales from low to high; high represents desirability for use as a landfill.
3. Scores should have a similar or identical range for comparability.
4. The method of scoring must preserve the rank order of the raw data.
5. The resulting scores should have the same polarity; if a low raw score represents high desirability (low prices are preferred), then the polarity of the scaled score must be reversed to show that a higher score represents greater desirability for use as a landfill.

An equation was developed in two parts to arithmetically transform the raw data into whole number scales with a common range of 1 through 10. The two parts are shown below.

Standard case: $s = ((Max_c - X_c \setminus Max_c - Min_c) * 9) + 1$
Inverted case: $s = 9 - (((Max_c - X_c \setminus Max_c - Min_c) * 9) + 1)$

Where:

s	=	Score
Max_c	=	The maximum individual score received within the category
Min_c	=	The minimum individual score received within the category
X_c	=	The value of the item under measurement. For example, in Figure 1, below, the value of X_c is represented by the cubic yards of capacity for each of the six landfill sites evaluated. The methodology was consistently applied using the values obtained per landfill site for each of the six criteria.

The method preserves the rank orders of the raw data within the rounding error. The site with the lowest raw score (the least qualification for use as a landfill) received a score of 1. The site with the highest raw score (representing greatest qualification for use as a landfill) received a score of 10. Other scores were ranked between the endpoints according to their qualification as measured by the raw data score.

Appendix J: Map – Technical and Logistical Review Future Landfill Site Rankings