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SOCIO-ECONOMIC AND ENVIRONMENTAL IMPACTS OF LANDFILL SITES ON OAHU, HAWAII

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ABSTRACT

We assessed socio-economic and environmental impacts of five candidate sites for a landfill relocation on Oahu, Hawaii. The sites had been recommended for consideration by the Mayor's Blue Ribbon Advisory Committee (MBRAC) of the city and county of Honolulu. The sites are known as the Ameron Quarry on the windward side, Maili, Nanakuli B, Makaiwa, and Waimanalo Gulch New Expansion. Our study was made at the request of Wade Wakayama, President of Ameron Hawaii.

INTRODUCTION

A socio-economic impact assessment requires both quantitative and qualitative comparisons of the candidate sites for landfill relocation. Relevant factors include:

- Site acquisition costs:
  – The cost to the city to acquire the respective sites;
  – Business/residential dislocation costs due to any relocation.
- Site preparation and development costs.
- The estimated annual operation and maintenance costs of a landfill at each site.

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- Changes in employment in the community that creates additional demand for housing.
- Community perceptions related to whether the landfill development preserves the character of the community and is compatible with other developments planned in the community.
- Changes in community demographics, demand for housing and for retail and service businesses demand for public services, employment and income levels, and the aesthetic quality of the community.
- The environmental impact of a landfill on the community and surrounding areas.

It merits recognition that the impact of a landfill project could begin soon after it is proposed. There could be changes in social structure and patterns of community interaction. Once there is an announcement of likely landfill sites, attitudes form, interest groups coalesce and develop strategies, land speculation may occur and politicians maneuver for advantages. Such dynamics could change results of the impact analysis but unfortunately are difficult if not impossible to predict.

STUDY SCOPE

Our assessment of socio-economic and environmental impacts took the Ameron quarry site as a baseline relative to the other MBRAC sites assessed, following the accepted methods outlined in [1]. The study evaluated:

- Site acquisition costs
- Annual landfill operation cost differences
  - – Fuel cost differences
  - – Operation and maintenance cost differences
- Non-quantifiable impacts
  - – Population demographic impacts
  - – Potential development at sites
  - – Current land use
- Environmental impact differences between sites and potential impact mitigation cost differences.

However, some of the factors listed above were beyond the scope of the present analysis:

- Site preparation and development costs, which likely differ between the sites.
- Community perceptions related to a landfill development in their area.
- Changes to a community due to a landfill placement such as traffic pattern and flow changes.
- Detailed environmental impact and mitigation measures and their associated costs for each site.

SITE ACQUISITION COSTS

As noted, there are two components to site acquisition costs: the cost to the city to acquire a specific site and business/residential dislocation costs due to landfill relocation.

City Acquisition Costs

The City and County of Honolulu owns the Waimanalo Gulch site. Thus, there are no acquisition costs for this site. Each of the other sites would have an acquisition cost. Table 1 presents property value estimates of the different sites based on assessed valuations. These estimates do not accurately reflect actual site acquisition costs at the time of any acquisition due to the fact they do not represent expected market values at the time of acquisition. For example, a Kaneohe Ranch (property owner) valuation of the Ameron site equals $22-46 million (5/20/04 L. Goldstein (Ameron) to Loudat e-mail). This amount significantly exceeds the Ameron site assessed value of less than $1 million in Table 1. If equivalent market values were available for all the sites they could be used for this analysis and would provide a more accurate relative cost comparison than performed in this report. However, the data does allow a relative site value determination for the respective site alternatives assuming market valuations would have similar relative differences to assessed valuations.

Using the median site property value (i.e., Waimanalo Gulch New Expansion) site as the baseline value, Table 1 shows the acquisition cost relative to this baseline, its cost rank from least to most expensive and the cost difference from the baseline.

Combining this with data on site waste capacity, one can calculate the cost per capacity year. The results of Table 2 show the same relative cost ranking as above (cost rank from least to most, $ capacity cost/year).

Table 1. Site Acquisition Costs

Site	Relative acquisition cost ranking	Acquisition cost relative to baseline[a]	Cost difference from baseline[a] (in million $)
Makaiwa	1	–99%	–$2.1
Ameron	2	–89%	–$1.3
Waimanalo Gulch	3	0%	$0
Maili	4	27%	$6.6
Nanakuli	5	28%	$7.8

[a]Table uses median site property value (i.e., Waimanalo Gulch New Expansion) as baseline value.

Table 2. Relative Cost Ranking

Site	Rank	Cost per year capacity
Makaiwa	1	$ 832
Ameron	2	$ 55,000
Waimanalo Gulch	3	$107,000
Maili	4	$583,000
Nanakuli	5	$663,000

By an order of magnitude, Makaiwa has the lowest acquisition cost per year capacity. Nanakuli has the highest such cost.

Relocation Costs

There are no residential dislocation costs at the Ameron, Makaiwa, and Waimanalo Gulch sites. There would not appear to be any residential dislocation costs for the Maili and Nanakuli sites due to the landfill site itself. Depending on site access routes, there may or may not be residential dislocation costs for these sites. Whether there will be residential dislocation costs due to site access routes for the Maili and Nanakuli sites and estimation of any such potential costs is beyond the scope of this analysis.

Ameron is the only site where there would be a cost due to business dislocations. Currently, Ameron Hawaii, Grace Pacific, and three small trucking companies operate businesses at the Ameron site. Ameron Hawaii serves the commercial, governmental infrastructure, residential, and military markets providing ready-mix concrete, aggregates, concrete pipe, and related miscellaneous items. Grace Pacific operates an asphalt plant at the Ameron site. Each of these businesses would require relocation given location of the landfill at the Ameron site. Relocation costs are currently only available or can only be calculated for a relocation of Ameron's Kapa'a quarry operation. Thus, the total business dislocation cost estimated in this analysis understates what these costs will likely be.

Ameron Relocation Costs

Ameron relocation costs include lost sales and profit from the Phase I pit would not be garnered if this site becomes the landfill, as well as operation relocation costs and operational cost changes to any remaining Ameron, Kapa'a quarry operation. This analysis period is made for the sake of calculation simplicity. Ameron has indicated (5/20/04 Linda Goldstein to Tom Loudat e-mail) that at point of condemnation, they will start a six-month period when all

equipment at Kapa'a is down and transfer/construction in Phase II begins. At this time they will outsource all material (rock) requirements. After six months, they will continue construction with limited production, providing coarse aggregate but no fine aggregates for a year beyond the previous six months. After 1.5 years they expect to be at "full" production but not at current levels. Ameron expects that once attained, this reduced production level will persist indefinitely. From their point of view, this reduced production level will lead to reduced market share and sales, and ultimately profits.

Lost Sales and Profits — Ameron estimates that the Phase I quarry has 10 years of rock remaining. We use 2005 as a start year under the assumption that the Ameron site is selected for the landfill and Phase I operations cease with a simultaneous commencement of relocation to a Phase II operation site. We use 2015 as an end date, which implicitly assumes that the Phase I site has 10 years of rock remaining as expected. Mining began in Phase I (the Kaneohe side of H-3 at the Kapa'a quarry site) in the mid-1960s. Five million tons of rock in Phase I are scheduled to be mined over the next 10 years. Development in Phase II located on the opposite side of H-3 is just beginning, with an anticipated 50-year lifespan for that phase. Based on historic Ameron data to forecast future amounts from 2005 to 2015, Table 3 shows the present value amounts for sales and Ameron profits for the given period.

The sales present value of $78 million shown in Table 3 equals the value of the resource assuming 10 years of remaining life lost to society if the quarry becomes a landfill. If the same level of economic activity utilizing the resource is to continue, a substitute quarry site(s) must be found. The cost of materials from any such site(s) will be more than the same amount of resource at the Ameron site given the mere fact of its development and the fact that at the margin, one can assume that the least cost resource site (i.e., Ameron Phase I) was developed first.

Table 3 shows the present value of lost profit from the operation of Phase I to Ameron equals $19 million. This loss would be offset by substitute (for Phase I)

Table 3. Lost Ameron Sales and Profits if Site Chosen for Landfill

Value Steam	2005-2015
Present Value Phase I Sales	$77,845,131
Preset Value Phase I Profit	$19,254,822

Source: Forecast 2005-2015 sales are from Ameron income statement data for the period 1986-2003.

operations Ameron could establish to maintain its sales. However, according to Ameron, the company will lose market share due to its inability to fully substitute for this lost resource and thus will never fully recover this lost profit. Additionally, profit margins will be less at alternative sites and the life of any Ameron quarry operation will be reduced due to the loss of 10 years of resource life lost if the Phase I quarry becomes a landfill.

Operation Relocation Costs — J. Uno and Associates have estimated that the direct costs for Ameron to relocate its operation from its current Phase I site across H-3 to a Phase II site is $47.9 million [2]. This cost does not include clearing and grubbing, removal of overburden, and phase-in escalation costs of moving the business to this new site. Ameron estimates it will incur an additional $5 million to prepare the Phase II site for equipment location. Thus, the overall relocation costs to Ameron given a Phase I landfill site location equals $52.9 million.

A significant relocation issue and related costs not addressed is that no level area of sufficient size exists for Ameron operations much less the other current business operations at the Phase II area of the Ameron site. Resolving this issue could add significantly to the total relocation cost estimated in this analysis.

Operational Impacts — Ameron estimates that it will incur a net annual impact of –$978 thousand for 20 years (2005-2025) if the Phase I pit is unavailable to the operation due to its use as a landfill. Ameron expects to use the Phase I pit for control, management and disposal of site overburden, operation waste, and excess water from current and future operations at both Phase I and II areas. Without the Phase I pit, Ameron must expend capital and annual operating costs for water control and fill management systems. These costs are offset, but not totally, from revenues from assumed sales of fill material (overburden, residual concrete, and basalt fines). If this assumption proves untrue for any reason the net annual operational impact to Ameron will exceed the amount noted. The rate of overburden removal will accelerate with use of Phase I for a landfill. It is uncertain whether Ameron can dispose of this excess above what they have historically sold per year. If they cannot, it will require disposal thereby becoming a cost as opposed to a revenue item in operational impact calculations. The present value of the net annual operational impact for 20 years is ($10.7 million) (see Table 4).

ANNUAL LANDFILL OPERATION AND MAINTENANCE COSTS

Annual operation and maintenance costs are the costs of operating a landfill subsequent to the completion of site preparation and development costs making the site ready for use. At the margin, the most significant change from operation of a landfill at Waimanalo Gulch to one at the Ameron site is the ash transport

Table 4. Present Value of Increased Ameron Operating Costs

Year	Amount
2004	
2005	($978,333)
2006	($978,333)
2007	($978,333)
2008	($978,333)
2009	($978,333)
2010	($978,333)
2011	($978,333)
2012	($978,333)
2013	($978,333)
2014	($978,333)
2015	($978,333)
2016	($978,333)
2017	($978,333)
2018	($978,333)
2019	($978,333)
2020	($978,333)
2021	($978,333)
2022	($978,333)
2023	($978,333)
2024	($978,333)
Total	($19,566,660)
Present value	($10,721,522)

Interest rate used for discounting: 6.57%
Increase in annual costs with loss of Phase I pit: ($978,333)

distance from H-Power to the landfill. This is not to say that there are not other annual operation costs differences at the margin between these two sites. Rather: 1) they are insignificant in comparison to the marginal cost differences assessed, and 2) their detailed assessment is beyond the scope of this analysis.

Fuel Costs

Fuel costs equal the cost of diesel fuel to transport ash from H-Power to a landfill via 60-ton tractor-trailers. The increased distance from H-Power to the Ameron site as opposed to Waimanalo Gulch is 26.8 miles one way. Using this data, increases due to Oahu population projections estimated trips per capita, and estimated diesel usage and projected costs, one can estimate the annual, expected increase in fuel costs to transport H-Power ash to the Ameron site versus Waimanalo Gulch landfill. The present value of this cost stream using a 15-year estimated life for the Ameron site commencing in 2008 equals $965,000. In words, the expected future fuel cost increase to the City and County of Honolulu expressed in current dollar terms of transporting H-Power ash to an Ameron landfill site as opposed to a Waimanalo Gulch site equals $965,000.

Operation and Maintenance Costs

Operation and maintenance costs comprise all non-fuel costs to maintain and operate the refuse collection and distribution fleet. Table 5 shows the derivation of this per capita operation and maintenance cost. Using population and cost inflation projections, Table 6 shows the present value of this cost stream for the same period noted for fuel costs. This amount is $3.1 million. In words, the expected future refuse collection fleet operation and maintenance cost increase to the City and County of Honolulu expressed in current dollar terms of transporting

Table 5. Operation and Maintenance Costs per Mile per Capita

2003 Refuse Fleet O&M Cost[a]	5,000,000
Total Miles per Year[a]	3,052,140
Oahu 2003 Population[b]	902,704
O&M Cost per Mile per Capita	1.81476E-06

Source:
[a]Personal Communication: Robert Primiano, Automotive Equipment Services, City & County of Honolulu in a 4/12/04 e-mail.
[b]2003 Population estimates from Hawaii DBEDT data.

Table 6. Estimated H-Power Added Fuel Cost

Year	Population projections	Estimated H-Power Added Fuel Cost: Diesel cost projection	O&M inflation	H-power to landfill trips	Added miles	Added fuel cost	Added O&M cost
2004	908,124	$2.25	1.00			$0	$0
2005	913,576	$2.36	1.02			$0	$0
2006	919,061	$2.48	1.05			$0	$0
2007	924,579	$2.61	1.07			$0	$0
2008	930,130	$2.74	1.10	3,496	187,373	$93,450	$347,482
2009	935,714	$2.88	1.12	3,517	188,498	$98,791	$360,036
2010	941,332	$3.03	1.15	3,538	189,630	$104,438	$373,045
2011	946,984	$3.18	1.18	3,559	190,769	$110,408	$386,523
2012	952,669	$3.35	1.21	3,580	191,914	$116,718	$400,488
2013	958,389	$3.52	1.24	3,602	193,066	$123,390	$414,958
2014	964,143	$3.69	1.27	3,624	194,225	$130,443	$429,950
2015	969,932	$3.88	1.30	3,645	195,391	$137,898	$445,484
2016	975,755	$4.08	1.33	3,667	196,565	$145,780	$461,580
2017	981,613	$4.29	1.36	3,689	197,745	$154,113	$478,257
2018	987,507	$4.51	1.39	3,711	198,932	$162,922	$495,536
2019	993,436	$4.73	1.42	3,734	200,126	$172,234	$513,440
2020	999,400	$4.98	1.46	3,756	201,328	$182,079	$531,991
2021	1,005,400	$5.23	1.49	3,779	202,537	$192,486	$551,212
2022	1,011,437	$5.49	1.53	3,801	203,753	$203,488	$571,127
Present value						$964,661	$3,137,530

H-Power ash to an Ameron landfill site as opposed to a Waimanalo Gulch site equals $3.1 million.

It is important to note that this analysis does not forecast any increase in vehicle procurement costs that would likely occur due to increased use and thus wear and tear of the vehicles from transporting the ash an increased distance to Kapa'a quarry. The FY 2005 budget for major vehicle procurement for the City and County of Honolulu equals $13 million.

NON-QUANTIFIABLE IMPACTS

Non-quantifiable impacts include impacts for which it is either impossible to attach a dollar value to the impact or beyond the scope of this analysis. These impacts include: population demographics, potential development at the respective sites, and current land use. For these non-quantifiable impacts it is only possible to indicate the magnitude of the impact at the Ameron site relative to the others.

Population Demographics

Table 7 presents demographic information obtained from Census data for each of the respective sites. This data serves as the basis for the discussion and conclusions drawn related to population demographics for each different demographic variable assessed.

Total Population

Judging by the potential population that could be affected by the landfill, it would appear that this would be the greatest for the Ameron quarry site, as it would affect 88,179 people based on the 2000 U.S. Census in the communities of Kailua, Maunawili, Kaneohe, and Kaneohe station. It is beyond the scope of this analysis to *exactly* determine population impacts of a landfill for the respective sites. An analysis of population impacts would likely show that a landfill would only impact some portion of the regional site population. For the sake of this exposition, it is assumed that whatever the impacted proportion, it would be roughly the same per site resulting in the same relative impacts presented herein. The potential population that would be affected in Maili is about 7,769 including the residents of Maili and Lualualei homeland. Therefore this would be the area of least impact on people. The number affected at Nanakuli B is 15,913 including residents of Nanakuli and Nanakuli Homeland. Since the Makaiwa and Waimanalo Gulch New Expansion sites are situated fairly close to each other, they affect identical populations at Barbers Point Housing, Ewa Beach, Ewa Gentry, and Ewa Villages, which number 24,397 altogether. The population affected near the Kapa'a quarry site is roughly twice the number of all other sites combined.

Minority Populations

Environmental justice populations (a federal definition) exist at all sites, implying that landfill siting in any of those sites could possibly impact minority and low income population's health and/or environment. The minority population affected by the Ameron quarry site would be 23% Asian, 7% Native Hawaiian/Pacific Islanders, and 8% Hispanic/Latino. Corresponding figures for Maili, Nanakuli B and Waimanalo Gulch new expansion/Makaiwa areas would be 14%, 35%, and 12%; 8%, 45%, and 9%; and 45%, 6%, and 8%. In absolute, sheer number terms, the Ameron quarry site could affect the greatest number of minorities due to the much larger population base even though minority percentages are less.

Location of the landfill at the Ameron site could also disproportionately impact the elderly (%>65 years) as they account for 11% of the population in the affected communities relative to 8% in Maili, and 7% at all the other three remaining sites viz. Nanakuli B, Makaiwa, and Waimanalo Gulch New Expansion. The marginal impact on health is likely to be greater for this population category as a result of potential adverse changes in the quality of the environment such as air or water quality caused by the landfill siting.

Employment

The unemployment rate is relatively low (3%) in the communities affected by the Ameron quarry siting. However, unemployment rates have been relatively high at the Maili location (8%) and Nanakuli B (9%) sites. The figures for the unemployment rate in the 2000 U.S. Census for Waimanalo Gulch New Expansion/Makaiwa area was 4%. Although landfill operations typically are *not* major job creators, nonetheless retaining landfill operations within the higher poverty rate communities could help better distribute employment opportunities on Oahu. Much of future expected population growth on the island of Oahu is also expected in these high(er) poverty rate areas.

Income

The per capita income and median household income are highest among communities affected by the Ameron quarry site relative to all other landfill site locations. The median household income and per capita income were $63,924 and $24,077 respectively in the year 2000. In communities near the existing landfill site in Waimanalo Gulch and Makaiwa the corresponding figures were $58,903 and $17,652 for the same year. In Maili, the median household income and per capita income were $54,300 and $14,126. Nanakuli had the least median household income and per capita income with $47,687 and $11,911 respectively. These income differentials again also argue for maintaining the landfill operations near the existing Waimanalo site as the added incomes from the operation of a

Table 7. Population Demographic Information

Demographics	Total population	% Female	% Male	Median age	% >18 years	% >65 years	% White	% Asian	% Native Hawaiian/ Pacific Islanders	% Hispanic/ Latino	% Two or more races
SITES											
Ameron Quarry											
Kailua	36513	51%	50%	39	76%	14%	44%	21%	8%	6%	25%
Maunawili	4869	53%	47%	41	77%	16%	37%	29%	9%	6%	25%
Kaneohe	34970	51%	49%	38	75%	15%	21%	39%	11%	7%	28%
Kaneohe Station	11827	33%	67%	22	76%	0%	67%	5%	1%	15%	6%
***Totals/Averages**	**88179**	**47%**	**53%**	**35**	**76%**	**11%**	**42%**	**23%**	**7%**	**8%**	**21%**
Maili											
Maili	5943	49%	51%	28	65%	9%	11%	23%	24%	15%	40%
Lualualei Homeland	1826	50%	50%	33	67%	7%	6%	6%	45%	9%	42%
***Totals/Averages**	**7769**	**50%**	**50%**	**31**	**66%**	**8%**	**9%**	**14%**	**35%**	**12%**	**41%**
Nanakuli B											
Nanakuli	10814	50%	50%	27	64%	7%	6%	12%	40%	11%	41%
Nanakuli Home Land	5099	50%	50%	29	67%	7%	3%	5%	49%	7%	42%
***Totals/Averages**	**15913**	**50%**	**50%**	**28**	**66%**	**7%**	**5%**	**8%**	**45%**	**9%**	**41%**
Makaiwa											
Barbers Point Housing	67	52%	48%	18	49%	0%	91%	9%	3%	3%	3%
Ewa Beach	14650	50%	50%	33	71%	11%	11%	49%	11%	10%	27%
Ewa Gentry	4939	49%	51%	32	71%	4%	15%	51%	5%	9%	23%
Ewa Villages	4741	50%	51%	33	72%	14%	4%	70%	5%	9%	20%
***Totals/Averages**	**24397**	**50%**	**50%**	**29**	**66%**	**7%**	**30%**	**45%**	**6%**	**8%**	**18%**
Waimanalo Gulch New Exp.											
Barbers Point Housing	67	52%	48%	18	49%	0%	91%	9%	3%	3%	3%
Ewa Beach	14650	50%	50%	33	71%	11%	11%	49%	11%	10%	27%
Ewa Gentry	4939	49%	51%	32	71%	4%	15%	51%	5%	9%	23%
Ewa Villages	4741	50%	51%	33	72%	14%	4%	70%	5%	9%	20%
***Totals/Averages**	**24397**	**50%**	**50%**	**29**	**66%**	**7%**	**30%**	**45%**	**6%**	**8%**	**18%**

Demographics	Total housing units	Median value housing	# in labor force	% unemploy-ment	Median household income	Per capita income	Individual poverty rate	Individual poverty status
SITES								
Ameron Quarry								
Kailua	12770	$367,100	19681	3%	$72,784	$29,299	5%	1972
Maunawili	1501	$363,100	2486	2%	$82,148	$30,551	3%	114
Kaneohe	11475	$298,700	17890	4%	$66,006	$23,476	6%	2105
Kaneohe Station	2388	$202,500	7792	3%	$34,757	$12,983	7%	544
***Totals/Averages**	**28134**	**$307,850**	**47849**	**3%**	**$63,924**	**$24,077**	**5%**	**4735**
Maili								
Maili	1537	$173,100	2325	9%	$45,786	$13,185	22%	1291
Lualualei Homeland	520	$154,000	932	7%	$62,813	$15,066	7%	129
***Totals/Averages**	**2057**	**$163,550**	**3257**	**8%**	**$54,300**	**$14,126**	**14%**	**1420**
Nanakuli B								
Nanakuli	2497	$148,600	4168	9%	$45,352	$11,690	21%	2251
Nanakuli Home Land	986	$134,000	2171	9%	$50,022	$12,132	17%	837
***Totals/Averages**	**3483**	**$141,300**	**6339**	**9%**	**$47,687**	**$11,911**	**19%**	**3088**
Makaiwa								
Barbers Point Housing	131		24		$65,625	$21,083		
Ewa Beach	3515	$224,600	6877	4%	$57,073	$14,807	10%	1430
Ewa Gentry	1832	$230,700	2820	2%	$61,462	$21,833	3%	131
Ewa Villages	1258	$178,800	1988	4%	$51,451	$12,883	9%	403
***Totals/Averages**	**6736**	**$211,367**	**11709**	**4%**	**$58,903**	**$17,652**	**7%**	**1964**
Waimanalo Gulch New Exp.								
Barbers Point Housing	131		24		$65,625	$21,083		
Ewa Beach	3515	$224,600	6877	4%	$57,073	$14,807	10%	1430
Ewa Gentry	1832	$230,700	2820	2%	$61,462	$21,833	3%	131
Ewa Villages	1258	$178,800	1988	4%	$51,451	$12,883	9%	403
***Totals/Averages**	**6736**	**$211,367**	**11709**	**4%**	**$58,903**	**$17,652**	**7%**	**1964**

Source: U.S. Census Bureau, Census 2000; *Calculated from U.S. Census Bureau, Census 2000.

landfill boost community income through direct and indirect expenditures. This has a salutary impact on reducing inter community income differentials.

Poverty

The poverty rate is higher in the communities adjacent to or near the Waimanalo Gulch site than for the Ameron site. In communities around Waimanalo Gulch New Expansion and Makaiwa the poverty rate in 2000 was estimated to be 7%. Among residents of Maili and Nanakuli the poverty rate was 14% and 19%, respectively. Communities affected by the Ameron site had a poverty rate of only 5%, less than half of the national poverty rate. Thus, maintaining jobs in these higher poverty rate communities could to a small extent contribute to lessening the incidence of poverty in these areas.

Housing

The median value of housing was highest in communities affected by the Ameron quarry site valued at $307,850 in 2000. This was followed by Waimanalo Gulch new expansion/Makaiwa communities valued at $211,367. Median value of housing in Maili and Nanakuli were $163,550 and $141,300 respectively. The operation of a landfill at any of these sites could have an impact on air quality and noise pollution levels due to increased traffic. Research by Bertrand [3] and Smith and Huang [4] suggest that implicit price of both noise and air pollution will be higher in property markets where households are relatively wealthier and where the general level of pollution is relatively higher. Thus, there is capitalization of air quality and noise pollution levels into property values.

Chay and Greenstone [5] indicate that marginal reduction of one unit in suspended particulates results in a 0.7–1.5% increase in home valuation. On the other hand, in noise pollution studies due to increased traffic, the percentage decrease in housing prices following a 1 dB increase in noise pollution have been reported to range from .08% to 2.22%. The average lies in the lower part of the range. Bateman et al. [6] estimate it to be 0.20%. The noise level pollution due to traffic can be high for Maili and Nanakuli communities as the access roads would have to pass through residential areas. However, the monetary impact due to possible air quality changes and noise pollution levels would be highest in communities affected by the Ameron quarry due to higher capitalized value of housing property and the very large number of housing units compared to the total for all leeward communities combined. These communities may already suffer from air quality and noise pollution levels caused by the operation of the quarry itself. These would be exacerbated (an impact doubling) by operation of the quarry at a Phase II site and a landfill at the Phase I site.

Potential Development at Sites

There are plans to build a perimeter trail around the 830 acres of Kawainui Marsh wetland adjacent to the Ameron quarry. The project began to take form in 1999 (*Honolulu Advertiser,* June 5, 2002). The trail is to be developed in six phases. There are 22 archaeological sites on the marsh, which the trail would enable visitors to view. The marsh is also home to four endangered species of birds such as the Hawaiian duck, the Hawaiian coot, the common moorhen, and the black-necked stilt. Locating the landfill site at Kapa'a quarry, which is immediately adjacent to the Kawainui Marsh, would be incompatible with the future development of the Kawainui marsh trail, as well as pose an environmental threat to the marsh as a habitat for endangered species.

The landfill sites at Waimanalo Gulch's New Expansion and the Makaiwa site are adjacent to each other. The current location of the landfill at Waimanalo Gulch does not appear to have impacted resort and residential development in the surrounding area as this area has experienced the greatest development of all local Oahu areas in recent times.

The Estate of James Campbell owns the Makaiwa site property. The property is in the State Urban District and is an integral part of the overall Makaiwa Hills Residential Project. According to the Estate of James Campbell, this residential project is designated on the City and County Ewa Development Plan as residential and is actively being planned for near-term development. This planning and expected development has apparently progressed in coexistence with the landfill at Waimanalo Gulch.

A recent *Honolulu Advertisers* (6/17/04) reported that it only took 10 days for a luxury-home-builder to sell 148 mostly condominium villas at Ko Olina Resort & Marina for an average price of about $750,000. The article goes on to report the developer was "overwhelmed." Potential buyers could make $10,000 deposits to register for a June 1 lottery but the registration process was cut short. The developer noted "We just shut it off because we didn't want to set expectations for people when we knew we wouldn't have enough product. The response has been nothing short of incredible. . . . Essentially, we were selling new homes as fast as we could write the contracts." The homes sold for a total of $112 million.

The *Advertiser* also reported (4/2/04) that Ko Olina is planning additional development over the next decade worth $700 million. It is uncertain in any meaningful or measured way, what impact continuation of the landfill at Waimanalo Gulch would have on this development as the same *Honolulu Advertiser* article only noted that it "could be" jeopardized according to the resort.

No major development activity is planned at the Maili and Nanakuli sites although the only coral quarry on the island is located in proximity to the Maili site [7].

Current Land-Use

In terms of current land use, the Ameron quarry is still an active operation. It will be difficult and expensive (see above discussion) to re-site the quarry and to use it as a landfill. Additionally, there is considerable overburden at the Phase II site for the Ameron quarry the removal cost of which could go up considerably with a landfill relocation to this site. It is estimated that the disposal of this overburden at the Kapa'a quarry site could use up to 40% of its capacity as a landfill. Because of these factors, prices of products produced by Ameron and the industry in general could increase. Based on previous experience with supply reductions, this could be as much as 25% in the immediate term according to Linda Goldstein, Ameron Manager (March 18, 2004). Aside from negative impacts on the construction industry, other businesses that use its products as well as government projects involving roads and buildings, such price increases could lower the marginal efficiency of investment (MEI) of construction projects in Hawaii causing them to move outside of the State. This would result in exogenous, negative economic and fiscal impacts to the local economy.

OTHER COST ISSUES

There is one other issue, which results in cost differences between the alternative sites. This is site life.

Table 2 shows that the Makaiwa site has the greatest expected life (25 years) followed by Waimanalo Gulch New Expansion (20 years) followed by the other three sites each of which has an expected landfill life of 15 years. Choosing one of the 15-year sites means that at some point previous to the end of their expected landfill life, the City and County must commence a new landfill selection process. The closer in time this process occurs, the greater is the present value of its cost. The present value of a dollar 15 years in the future equals $0.385, 20 years in the future $0.282, and 25 years in the future $0.204. The five-year historic, average annual average prime rate is used for discounting. The present value cost of recommencing a new site selection process for a 15-year landfill is 37% and 89% greater than a 20- and 25-year landfill, respectively.

ENVIRONMENTAL CONSIDERATIONS

This section identifies some of the environmental impacts both on natural resources and human resources that could occur due to locating a new landfill site. It is beyond the scope of this report to do a detailed analysis for each site. This analysis only notes unique characteristics of the Ameron site that distinguish it from the others. The assessment also provides a preliminary estimate of environmental mitigation costs utilizing recent data available for landfill alternatives developed by Friesen and Associates for the new South Hilo landfill.

Natural Resources

Geology

Landfill development could alter existing site topography. The Ameron site is the only site having a current and expected future use that would be completely precluded if used as a landfill. The current use is as a rock quarry. Expected future use is to contain storm water runoff and clear the overburden for Phase II of the quarry operation.

Water Resources

The Kapa'a stream is located mauka (mountain side) of Kawainui Marsh and discharges into the marsh. The Kapa'a stream drains a small watershed, which includes the Ameron rock quarry (Kapa'a Quarry) and a closed county landfill in the vicinity. The former landfill already contributes large amounts of nitrogen, phosphorous, and sediments to the stream. The Ameron quarry operation contributes sediment into this waterway.

Data from monitoring of water quality shows it exceeds the water quality criteria for nitrogen and phosphorous. Visual assessments have also shown that large amounts of floating algae, water hyacinth, and oil film are to be found in the stream. Litter has also been found polluting the stream and the surrounding area in significant quantities [8]. No other site has a similar water resource situation much less water resources already compromised by an historic landfill and current use. A landfill at the Ameron quarry would exacerbate the already compromised water resources in and around the Ameron site.

Air Resources

Air resources at any of the sites could be impacted by emissions from trucks and heavy equipment that would be used for a landfill. Air quality could also be impacted if the landfill gas (methane) is flared. Emissions from flares and other energy recovery systems include CO_2, CO, NOx, SOx, and other components, which could have local effects. The major components of landfill gas, methane, and carbon dioxide are colorless and odorless. Although landfill gas emissions are typically, quickly, and harmlessly dissipated in the atmosphere, in confined spaces such as a quarry pit there may be risk of asphyxiation and/or toxic effects if landfill gas collects at high concentrations.

Wetlands

The Ameron Quarry is situated within the 20 square mile area of the Kailua watershed, which is part of the wider Koolaupoko watershed region. The Koolaupoko consists of the Kaneohe, Kailua, and Waimanalo watershed regions.

Koolaupoko is home to several wetlands listed by the U.S. Fish and Wildlife Service (USFWS).

The Kawainui Marsh is an important and protected wetland in the Koolaupoko watershed region. It abuts the Ameron quarry. The Kawainui Marsh is about 800 acres and serves multiple purposes as a flood storage basin, wetland filter, wildlife habitat, and cultural and scenic resource pursuant to a master plan prepared in 1994.

Situating a landfill at the Ameron Quarry next to protected wetlands poses numerous environmental threats to the disappearing Kawainui Marsh. Unabated leachate migration, storm water runoffs, sediment flows, and litter through the intermittent Kapa'a stream that enters the Kawainui Marsh near the landfill could compromise a resource currently compromised by the historic landfill at Kapa'a quarry and from truck traffic along Kapa'a quarry road.

Terrestrial and Aquatic Ecology

The Kawainui Marsh supports a wide variety of aquatic plants. It also provides a native habitat to an abundance of water birds such as the Hawaiian gallinule or moorhen ('alae), the closely related Hawaiian coot ('ula), the night heron (auku'u), Hawaiian duck (koloa), mallards, kolea, and the Hawaiian Stilt (ae,o). Some of the sightings maintained by the Audubon Society in recent years suggest a lessening of numbers for some of these species.

Lack of cropping has led to a series of ecological changes in the Marsh that is partly natural and partly a result of diversions of water by man. As mentioned earlier, the Kapa'a stream descends through the Ameron Quarry into the Kawainui Marsh bringing with it sediments, nutrient loadings, and pathogens. Establishing a landfill in the Quarry, could reverse the ameliorative steps taken in the past few years to restore the wetlands and preserve the terrestrial and aquatic ecology compounding the problems faced by the Marsh. No other site has a similar terrestrial and aquatic ecology, again, much less one that is already compromised due to past environmental degradation.

Marine Ecology

A landfill located in the Ameron Quarry would leave no room for storm water retention, an issue no other site faces due to past and current operations at this site. The runoffs descending from a landfill at the quarry into Kapa'a Stream would only exacerbate the situation as sediments, excess nutrients, and pathogens would course through the Kawainui Marsh and eventually affect the marine ecology of Kailua Bay. Kailua Bay already shows very little evidence of live coral even though there is a submerged coral reef 20 feet below the surface waters along Kailua Beach. Ameron Quarry currently works with the State Department of Health to establish a Total Maximum Daily Load (TMDL) to cease pollution

through discharge waters, again alluding to an already environmentally compromised system, a characteristic no other site possesses.

Environmental Impacts on Human Resources

Land Use

The distinguishing land use of the Ameron Quarry site are the existence of business operations on site and the retention of approximately 300 million gallons of water on site in the event of storms. According to Ameron personnel, this could be as high as 3 billion gallons if Ameron cannot dispose of the water. Resolving this issue could also cause significant cost increases to Ameron. The location of the new landfill would impact these uses. Kailua has a low groundwater table and thus is prone to flooding. Loss of the storm water retention capability could result in more serious flooding than already occurs.

Transportation

Only the Ameron site has other businesses currently operating on site. The Ameron Kapa'a quarry is the largest quarry in the State with its incumbent traffic. A landfill will not only generate truck traffic incumbent with a landfill operation but H-Power to landfill traffic as well. The cumulative total truck traffic that would occur at the Ameron site with a landfill would far exceed that for any other site. This could have significant traffic and transportation infrastructure impacts on roads and highways leading to/from a quarry landfill. It also merits mention that Kapa'a quarry road does not meet current county road specifications and frequently closes due to flooding.

Community Services

Because of Kailua's proneness to flooding (this has retarded urbanization of Kailua), losing storm water retention capacity at the quarry site increases the possibility of flooding thereby affecting homes in residential areas. Consequently additional money may have to be allocated for emergency preparedness, flood insurance, and the construction of levies to prepare against flooding contingencies. No other landfill site residential area faces similar issues due to a landfill in the area.

Archaeological and Historic Resources

This analysis does not inventory or address archaeological and historic resources of the respective sites and any relative differences.

Recreation

The only relative difference between the alternative landfill sites related to recreational resources is the plan to establish a Kawainui trail around the Marsh which would serve as an educational center, a nature park, walking paths, and bikeways [9]. A landfill may impact this plan and potential use. No other site has such a potential impact.

Visual and Aesthetic Resources

A landfill has the potential to change the visual and aesthetic character of the surroundings. A cursory assessment of the alternative sites suggests that the visual and aesthetic resources of the Ameron and Waimanalo Gulch sites are already significantly compromised due to existing and historic operations at these sites. This contrasts with all other sites whose visual and aesthetic resources would be significantly compromised due to the location of a landfill at the site.

Noise

The estimated level of noise at 50 feet for trash compaction and waste truck idling is 80 decibels, and 85 decibels for refuse unloading, truck entering, exiting, or underway to working face and for operating the landfill gas blower or flare unit. The projected level of noise for receptors some 800 feet away would still be some 56-60 decibels accounting for the decay over the distance. Thus, noise from a landfill will have an impact on surrounding areas and uses. To what extent this impact differs between sites is beyond the scope of this analysis relative to both noises created by a landfill operation itself and the interaction of this noise with noise created by existing operations and uses.

Dust and Liner

Depending on management practices, prevailing and exceptional winds may disperse dust and particulate matter over a wide area from a landfill. Residents on the Ewa side have complained of litter blowing out onto the roads, beaches, and the water from haul trucks carrying garbage to the present Waimanalo Gulch Sanitary landfill facility. They have even complained of litter getting into the rudders of boats in the water. Dust can also cause health problems. To what extent these impacts differ between sites is beyond the scope of this analysis.

Landfill Gas and Odors

Methane gas is produced at a landfill site as well as various unpleasant odors caused by the natural decomposition of solid wastes. Such gases and odors can cause negative aesthetic and nuisance impacts. An elderly resident of Kaneohe reported how odors blew into Kaneohe town from the old Kapa'a landfill due

to changes in wind direction (personal communication) suggesting that such problems have occurred in local neighborhoods near Oahu landfills. To what extent these impacts differ between sites is beyond the scope of this analysis.

Accounting Costs of Environmental Impact Mitigation

Environmental impact mitigation measures add to the cost of constructing and operating a landfill. A study by Friesen and Associates provided cost estimates for landfill alternatives on the Big Island of Hawaii in 2003, which serve as benchmarks for similar such costs on Oahu. Costs include landfill development, post-closure costs, and operating costs each of which includes environmental impact mitigation costs. When analyzed, the estimates show that the costs of environmental mitigation of a landfill facility are a significant percentage of a landfill's overall cost structure. Thus, higher environmental impact mitigation costs can dramatically increase the overall cost structure of a landfill, all other factors the same.

Environmental impact mitigation costs particularly for the post-closure period of the sites investigated in the Big Island showed these costs were least for East Hawaii County Dry Area landfill. This site received the lowest annual rainfall of the sites investigated. The Ameron quarry area has average annual precipitation of 60 inches compared to approximately 20 inches or less for each of the other Oahu sites. Based on this relative difference it seems reasonable to conclude that the Ameron quarry site is likely to incur higher costs to mitigate environmental impacts than any of the other sites. This conclusion comports with the consensus of the Mayor's Blue Ribbon Commission, which, according to newspaper sources, concluded that the Ameron quarry will have the highest operating costs of all five sites identified.

True Cost Pricing of a Landfill Site

There has been widespread belief that waste disposal is undervalued but is not supported by a review of relevant fees [10]. According to the authors, the Ontario Ministry of the Environment initiated studies to determine the relationship between existing and replacement costs of waste management services (including external social costs), actual and potential sources of revenues to cover these costs, and the nature of relationship between disposal costs and recycling costs.

Primary dis-amenity impacts are on housing values generally at 5% of costs in urban areas. Despite extensive mitigation measures undertaken by newer landfills, typical disposal costs were estimated at $50/ton in 1990 dollars.

The three main sources of revenues to cover the waste disposal costs are property taxes, grants, and tipping fees. Generally specific costs incurred for specific sites may not be considered in setting tipping fees.

The costs of recycling must be seen in relation to waste disposal costs. If the recycling programs cost more per ton than waste going for disposal then waste

disposal could be a more attractive alternative especially in the absence of significant markets for secondary recycled materials.

Having noted the above, it is important to consider if there is under-pricing of landfills as noted by NERA economists Berkman and Dunbar [11]. These economists contend that in most U.S. cities landfills may be priced artificially low because the full costs of the landfill are not reflected in the tipping fee. Three costs of running a landfill that may not be included in the tipping fees include: a) the opportunity cost of land; b) the depletion costs of older landfills; and c) environmental damages.

For the Ameron quarry landfill site the opportunity cost of land is fairly high. It has been noted that the Ameron quarry supplies significant amount of aggregates, rock, and gravel for Hawaii's construction industry. It has an active life of another 10 years with *in situ* resources having a market value of approximately $85 million. A secondary use of the quarry site is storm water retention capability, which prevents flooding of the surrounding areas and avoids environmental damages to the Kawainui Marsh. Also, an older landfill near the proposed site makes it difficult for this area to have another effective use for a period of 30-40 years.

The depletion cost of the Ameron quarry landfill site must be understood in terms of its relative (to other sites considered) limited capacity to take in wastes before it is full and must be replaced. The replacement is generally by a higher cost facility such as a resource recovery plant. Thus, when a site is selected with a smaller containment capacity, it hastens the day when a higher cost facility will be needed (see "Other Issues" section for an estimate of this cost).

The third costs are those associated with environmental externality or spillover costs. Previous sections have enumerated a number of environmental costs that are specific to the Ameron quarry site some of which can be quantified and some of which defy precise quantification.

In sum, this "true cost" picture suggests that the tipping fees at the Ameron quarry site may be a lot more than those currently used at the Waimanalo Gulch Sanitary Landfill facility which now is around $80 per ton. Based on figures generated in this report and other supplementary sources, the "true cost" pricing or tipping fees at the Ameron Quarry landfill site could be 120-$150 per ton.

CONCLUSIONS

The overall conclusion of this analysis is that the most costly site for a landfill is the Ameron site. This is true regardless of the assessment criterion: quantifiable cost factors, non-quantifiable impacts or environmental impacts, and their expected cost mitigation. Using the Waimanalo Gulch expansion site as a normative site for comparative purposes, it will cost the City and County $86 million present value dollars more to develop and use the Ameron site as a landfill as opposed to Waimanalo Gulch. The cost summary (Table 8) shows the cost factors used in the analysis.

Table 8. Cost Summary Table

Cost factor	Cost difference
Site acquisition	($1,308,058)
Ameron lost profit	$19,254,822
Ameron relocation costs	$52,900,000
Ameron increased operation costs	$10,721,522
C&C fuel costs	$964,661
C&C operation and maintenance costs	$3,137,530
Total	$85,670,477

The assessment of non-quantifiable impacts resulted in the following specific conclusions:

- Impacts on Demographics
  - The population affected by an Ameron quarry landfill is roughly twice the number from all other sites combined.
  - In absolute numbers the Ameron quarry site could affect the greatest number of minorities and/or elderly due to the much larger population base of surrounding areas.
  - Retaining landfill operations at Waimanalo Gulch would better distribute employment opportunities on Oahu.
  - Income and poverty level differentials argue for maintaining the landfill at Waimanalo Gulch or other regional sites as it would add income through direct and indirect expenditures to adjacent communities, which have relatively lower income levels than those near the Ameron site.
  - The monetary impact due to air quality changes and noise pollution levels would be highest to communities close to the Ameron site due to higher capitalized housing property values and the very large number of housing units compared to the total for all communities combined for the other sites.
- The value of Potential Development would seem greatest at the Waimanalo Gulch and Makaiwa sites followed by the Kapa'a quarry site. It is uncertain, however, to what extent this development would be impacted, if at all, by continuation of the landfill at Waimanalo Gulch.
- Current Land Use impacts are greatest at the Ameron site. No other site would require the relocation of a business with potential significant local and regional negative economic impacts due to a landfill siting.

In summary, the non-quantifiable factors analyzed indicate that exclusive of the indeterminate relative impact of a landfill site on potential development, each non-quantifiable factor indicates a relative higher cost (or lower benefit) of the Kapa'a quarry site location relative to all others.

Finally, environmental impacts appear greater at the Ameron site relative to the others with respect to natural resources including: the preclusion of multiple current and expected future land uses of economic value, the impact on water resources especially wetlands and related terrestrial and aquatic ecology which no other site possesses; and human resources including: traffic flows and transportation infrastructure and community services and/or the cost of their provision. Environmental impact mitigation cost estimates via comparative accounting estimates and "true" cost estimates suggest that they would be greatest for an Ameron landfill relative to the other sites.

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