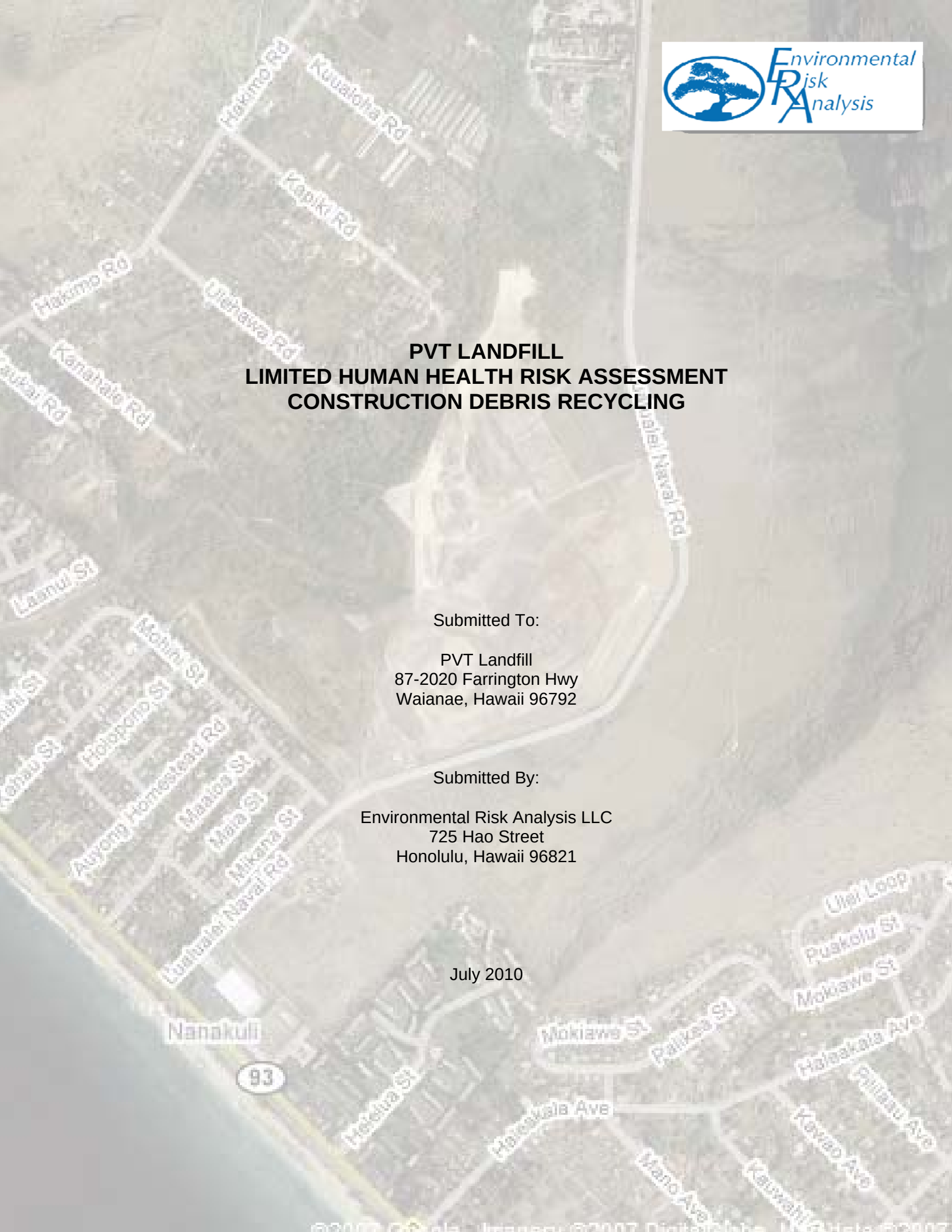

PVT LANDFILL
LIMITED HUMAN HEALTH RISK ASSESSMENT
CONSTRUCTION DEBRIS RECYCLING

Submitted To:

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EXECUTIVE SUMMARY

Environmental Risk Analysis (ERA) has evaluated the potential for human health impacts associated with the recycling of construction and demolition (C&D) materials for use as feedstock in a liquid gas manufacturing plant. The Limited Human Health Risk Assessment was prepared to address Hawaii Department of Health (HDOH) and anticipated community concerns regarding the safety of the proposed recycling operations, including the use of two separate processing/shredding plants at the PVT Landfill Site. The plants are part of a larger recycling initiative that, when implemented, will significantly reduce the volume of material going to landfill, provide the State with an additional renewable source of fuel gas and align PVT operations with the State's Clean Energy Initiative and Integrated Solid Waste Management Plan. Specifically, the assessment evaluates the following potential impacts associated with the proposed recycling program:

- Airborne dust impacts during delivery and stockpiling of feedstocks
- Airborne dust impacts during mining of closed portions of the landfill for feedstocks
- Airborne dust impacts during processing and shredding of feedstocks
- Airborne dust impacts from on-site storage of processed material

The current assessment was performed using similar methods and procedures used in a study performed by the HDOH which assessed human health risks from fugitive dust and surface soils assumed to contain specific concentrations of various metals (AMEC, 2005). In this assessment, respirable dust concentrations (PM10) were measured by Real-Time Personal DataRAM (pDR) or equivalent. Because it is not currently available, potential dust generation from the fine shredder (and subsequent stockpiling of fine shredded material) was estimated using health protective dust emission rates obtained from the USEPA (USEPA 1995b). The respirable dust fraction (PM10) from these activities was then modeled to nearby residential neighborhoods assumed to be located at the PVT Landfill fence line. The respirable particulate concentrations derived from each of the recycling processes was used in conjunction with chemical analytical data of bulk material samples to estimate chemical concentrations at resident locations in the adjacent community. All respirable dust measured in this study was assumed to be derived from process operations.

Potential health risks via the inhalation pathway were estimated for adults and children who live approximately ¼ mile downwind from dust generating activities. Potential estimated lifetime cancer risks were compared to the USEPA and HDOH regulatory level of concern for residential areas of one excess cancer in 1,000,000 people. Estimated noncarcinogenic risks are presented as total site Hazard Indices that sum the Hazard Quotients of each Chemical of Potential Concern at the site. A total Hazard Index of 1 was the regulatory level of concern. A total Hazard Index that does not exceed 1 indicates that no adverse noncarcinogenic health effects are expected to occur. In addition, this study also evaluated whether it is safe for PVT Landfill workers to be involved with the program. Dust concentrations and metals concentrations in dust during recycling operations were compared to OSHA Permissible Exposure Limits (PELs). OSHA PELS are time-weighted concentrations of dust or chemicals that should not be exceeded over an 8 hr period.

WORKER RESULTS

To ensure worker safety, active air sampling for total metals and total dust was performed and compared to OSHA Permissible Exposure Limits (PELs). No metals were detected in the air samples and Total Dust was detected at a concentration of 1.7mg/m^3, which is well below the OSHA PEL of 50 mg/m^3.

RESIDENT RESULTS

The residential scenario assumed fugitive dust is generated during delivery and stockpiling of feedstock; during mining of closed portions of the landfill; during processing, crushing and shredding of feedstock; and from wind erosion of on-site storage of processed material. The residential scenario assumed migration of fugitive dust (24 hrs/day) to residential areas located approximately ¼ mile away from dust generating activities. In reality, the majority of recycling activities (e.g., processing of material) will only occur during working hours. Carcinogenic Excess Lifetime Cancer Risk (ELCR) due to the inhalation pathway was 3E-07 or a 3 in 10,000,000 probability that a resident will develop cancer in his or her lifetime, over and above the background cancer rate, as a result of potential Site-related exposures to COPCs in the air. This was well below the residential regulatory level of concern of 1E-06 or 1 in 1,000,000. Noncarcinogenic health risks due to the inhalation

pathways were .0003 for the residential adult receptor and for the residential child receptor, both below the regulatory level of concern (Hazard Index of 1).

The maximum annual average PM10 concentration as determined by USEPA Model SCREEN3 was 0.41 ug/m^3. This is well below the National Ambient Air Quality Standard (NAAQS) of 50 ug/m^3 for PM10 (annual average). The NAAQS standards were developed to address chemicals considered harmful to public health and the environment. The Clean Air Act established two types of national air quality standards. Primary standards set limits to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards set limits to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings. The primary and secondary standards for PM10 are both 50 ug/m^3. The respirable dust concentrations determined in this study are therefore far less than concentrations that cause health effects in “sensitive” populations and are also far less than concentrations that result in nuisance concerns.

The recycling program does not pose a potentially significant threat to human health and the environment. The chemical driver responsible for the majority of the carcinogenic risk and non-carcinogenic hazard was arsenic measured in the bulk material “spiked” with Chromated Copper Arsenate (CCA) treated lumber. The inhalation of fugitive dust containing arsenic and chromium was responsible for nearly 100% of the assessment’s carcinogenic risks. It should be noted that bulk materials knows to contain arsenic were added to the bulk material samples collected at PVT and then evaluated by the laboratory. Actual concentrations of arsenic are anticipated to be much lower based on waste acceptance records provided by PVT. To provide an extra measure of safety, ERA performed a supplemental assessment (calculations not shown) assuming that bulk material contained up to 932 mg/kg arsenic and 47.8 mg/kg hexavalent chromium. This is 4 times the amount of arsenic and chromium present in the bulk samples containing additional arsenic-containing material. All other exposure assumptions being identical, cancer and noncancer risks were still below the HDOH regulatory levels of concern for residential scenarios.

1.0 INTRODUCTION

PVT Landfill has retained Environmental Risk Analysis LLC (ERA) to evaluate potential human health risks associated with the recycling of construction and demolition (C&D) materials for use as feed stock in a liquid gas manufacturing plant. The Human Health Risk Assessment (HHRA) is a companion document to the PVT Landfill Work Plan and Sampling Analysis Plan, Limited Human Health and Environmental Assessment of Construction Debris Recycling (ERA, March 2010). The HHRA was prepared to address Hawaii Department of Health (HDOH) concerns about the safety of the proposed recycling operations, including the use of a shredding/processing plant at the PVT Landfill Site (Figure 1). The proposed plant is part of a larger recycling initiative that when implemented will significantly reduce the volume of material going to landfill, provide the State with an additional renewable source of fuel gas and align PVT operations with the State's Clean Energy Initiative and Integrated Solid Waste Management Plan. Specifically, the HDOH is concerned with the following potential impacts associated with the proposed recycling program:

- Airborne dust impacts during delivery and stockpiling of feedstocks
- Airborne dust impacts during mining of closed portions of the landfill for feedstocks
- Airborne dust impacts during processing, crushing and shredding of feedstocks
- Airborne dust impacts from onsite storage of processed material

The study described herein was designed to conservatively address these concerns. ERA has estimated health impacts to nearby residents from potential air sources originating from the recycling program and determined if it is safe per OSHA regulations for PVT Landfill workers to be involved with the program.

1.1 Site and Sampling Area Location

The PVT Landfill Site is located at 87-2020 Farrington Highway on the western side of the island of O'ahu, in Nanakuli, Hawai'i (Figure 1). The PVT Landfill Site consists of an irregularly shaped 15.44-acre parcel of land (Latitude/Longitude: 21º 23' 50'' N/158º 09' 00''W). The Site is bounded by residential areas at its southern and western borders.

Figure 1 Site Location Map

1.2 General Study Approach

The PVT Landfill recycling program is a multi-phased, multifaceted program and involves implementation of the following tasks. Some of these tasks are currently ongoing; while others (i.e. mining of additional feedstocks, fine shredding and stockpiling of processed material) are proposed for future operations.

Currently Ongoing Operations

- Stockpiling of bulk material (feedstocks)
- Separation of metal recyclables
- Coarse shredding of bulk material to 6” to 8” pieces

Proposed Future Operations

- Mining of additional feedstocks from closed portions of the landfill
- Fine shredding of coarsely shredded material to 3/8” to 2.5”
- Handling and stockpiling of processed material (Risk associated with this task include fugitive dust emissions during handling of processed material and fugitive dust generated by wind erosion of open storage piles)

In this risk assessment, health risks from chemicals in fugitive dust from current operations have been added to risks from dust generated from future recycling operations (mining activities, fine shredding and stockpiling of processed material) to estimate a comprehensive operational risk. Evaluation of potential health risks due to these operations requires 1) an estimation of dust generation from these activities, 2) modeling of dust to receptor locations, 3) estimation of metals concentrations at receptor locations, and 4) estimation of cancer risks and noncancer hazards. Each of these steps is discussed in the sections below.

The technical approach of this study was developed in accordance with the following guidance documents including but not limited to:

- USEPA Risk Assessment Guidance for Superfund, Volume I Part A - Human Health Evaluation Manual (USEPA 1989)
- Sampling and Analysis Plan Guidance and Template (USEPA 2000).
- USEPA Office of Air Quality Planning and Standards: Compilation of Air Pollutant Emission Factors, AP-42 Fifth Edition, January 1995b. Updates provided in http://www.epa.gov/ttnchie1/ap42/.
- ASTM Standard D6051-96 (revised in 2001), Standard Guide for Composite Sampling and Field Subsampling for Environmental Waste Management Activities (ASTM 2001).
- Guidance for Obtaining Representative Laboratory Analytical Subsamples from Particulate Laboratory Samples EPA/600/R-03/027, November, 2003.

2.0 ESTIMATION OF DUST GENERATION

Estimation of dust from current operations was accomplished by field measuring dust from currently ongoing operations *in total* (i.e., measuring dust generated from all three current activities: stockpiling of bulk material, separation of recyclables, and coarse shredding). Estimation of total dust generation for future activities was accomplished by estimating dust levels generated from each individual task and summing the parts. The approach selected (summing of individual parts or obtaining a dust concentration *in total*) was dependent on ongoing operations at the landfill. For example, dust generation from current operations in its entirety could be estimated as these activities are ongoing. Individual emission rates for each subactivity are not necessary to evaluate risk from the operations as a whole and therefore were not estimated. However, for proposed future operations, it is not possible to obtain a total dust emission rate (operations are unable to be simulated). Dust emissions were therefore estimated for each individual subactivity. In this study, a demonstration project to collect real life data was performed to obtain relevant and applicable dust generating data for future mining operations. Because the fine shredding processor is not currently available, real-life dust generated from fine shredding and its subsequent stockpiling cannot be obtained. For these cases, conservative dust emission rates were obtained from USEPA AP-42 (USEPA 1995b).

2.1 Dust Associated with Current Operations

PVT currently stockpiles feedstock material, separates combustible material from metal recyclables and coarse shreds combustibles to 6” to 8” pieces. Other activities (proposed for future operations) will be implemented upon approval of the recycling program. Methods to estimate dust generation from these future activities are discussed in Section 2.2.

ERA collected air samples during current processing activities and analyzed samples for total RCRA 8 metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium and silver), total dust and respirable dust (PM10). Sampling methodology and results for each is described below. Photos and video of the sampling event is provided in Appendix A.

Air Monitoring for Total RCRA 8 Metals and Total Dust

Active air sampling for total metals and total dust employed two (2) sets of air pumps: The first set was used to measure total dust, while the second set was used to measure total metals. Individual pumps (1 for total dust and 1 for total metals) were situated upwind of processing activities, downwind of processing activities and within the recycling segregation chamber. Pumps were run for approximately 4 hours, the anticipated duration of general usage of the plant. Low-flow pumps were employed and set at an air collection rate appropriate for the chemicals of concern:

Total Dust – 1L/min – 120L total volume
Metals – 2.5L/min – 500L total volume

Analytical laboratory results are provided in Appendix B and are summarized in Table 2-1. Metals were not detected above laboratory reporting limits in any sample collected. All detection limits were below their applicable OSHA Permissible Exposure Limits (PELs). For this reason, USEPA style chronic and acute health risk assessment was not performed for the worker scenario. Total dust was detected in both the upwind and the downwind samples at 0.15 mg/m^3. In the segregation chamber (noted as “chipper” in the analytical laboratory reports) total dust measured 1.7 mg/m^3. At this time, OSHA regulates wood dust as a nuisance dust. The maximum permissible exposure for nuisance dust is 15 mg/m^3, total dust. Total dust from current operations *InTotal*, are below the OSHA PEL for worker safety.

Table 2-1: Analytical Results from Active Air Monitoring

Analyte	OSHA PEL (mg/m^3)	Maximum Concentration Detected (mg/m^3)
Total Dust	15	1.7
Arsenic	0.01	< 0.00006
Barium (sulfate)	15	< 0.04
Cadmium	0.005	< 0.0015
Chromium (VI)	0.005	< 0.0025
Lead (inorganic)	0.5	< 0.0041
Mercury (inorganic)	2	< 0.0015
Selenium	0.2	< 0.00017
Silver	0.01	< 0.0012

Air Monitoring for Respirable Dust

Active air sampling for respirable dust employed three (3) individual air pumps: Individual pumps (1 at each location) were situated upwind of processing activities, downwind of processing activities and within the recycling segregation chamber. Pumps were run for approximately 4 hours, the anticipated duration of general usage of the plant. Low-flow pumps were employed and set at 1.7 L/min for a total volume of 340L.

Respirable dust was also collected by a Real-time Personal DataRam with cyclone attachment to estimate PM10 emissions from current processing operations. Real-time PM10 dust concentrations in ambient air was monitored over a continuous 2-hr period during active processing activities that included bulk material delivery, segregation of recyclables, coarse shredding and stockpiling of processed material. DataRam data is provided in Appendix C. Data logging was performed at 1 minute intervals. ERA staff performed the sampling event by moving the DataRam continuously so that it was always in the downwind direction of processing activities. If wind was blowing from the northeast, the DataRam was moved to the southwest side of the processing activities. Additionally, the DataRam was located in the highest impact area as determined by the visual dust plume. Winds on the day of the sampling event were variable, but were predominantly

from the northeast which is the typical wind direction for the area approximately 80-90% of the time.

The arithmetic average of PM10 results was 0.036 mg/m^3. The maximum PM10 was 3.559 mg/m^3. 95% Upper Confidence Level of the Mean (UCL) was 0.046 mg/m^3. UCL calculations are also provided in Appendix C. OSHA currently regulates wood dust as a nuisance dust. The maximum permissible exposure 8-hr time weighted average limit (TWA) for nuisance dust (PM10 fraction) is 5 mg/m^3. Maximum PM10 dust concentration detected during monitoring activities was well below the 8hr TWA.

2.2 Dust Associated with Future Recycling Operations

Health risks from chemicals in fugitive dust from current operations will be added to risks from dust generated from future recycling operations (mining activities, fine shredding and stockpiling of processed material) to estimate a comprehensive operational risk.

1) Mining Activities:

Air Monitoring for Total Dust

Total dust generated from potential mining operations was measured via active air sampling as previously described. Active air sampling employed three (3) sets of air pumps: The first pump was situated in the presumed upwind direction of mining activities; the second and third pumps were located in the presumed downwind direction of mining activities. Pumps were run for approximately 2 hour at 1 L/min for a total volume of 120L. Results are summarized in Table 2-2. Laboratory results and COC are provided in Appendix B.

Table 2-2: Total Dust Results During Mining Operations

Location	Concentration Detected (mg/m^3)
UW-2 - Upwind	0.32
DW-1 - Downwind 1	< 0.25
DW-3 - Downwind 2	1.3

Total dust was detected in upwind sample UW-2 at 0.32 mg/m^3. The result from sample UW-1 was determined to be unusable because the tripod on which the cartridge was situated was blown over by the wind. Downwind samples DW-1 and DW-3 were situated in the southeast direction of mining activities. DW-1 was run for a total of 2 hr during demonstration mining activities. Dust for sample DW-1 was collected between 8:30 AM and 10:30 AM. At 10:30 AM, the sample collection cartridge was replaced. Total dust captured in sample DW-1 was below the laboratory detection limit of 0.25 mg/m^3. Sample DW-3 was run from 10:30 AM through 11:00 AM but was suspended early due to rain. Total volume of the sample was 30L. The DW-3 result for total dust was 1.3 mg/m^3. NIOSH Method 0500 requires a minimum volume of 7L to a maximum volume of 133L and these results were considered valid. The sample volume collected for DW-3 was well within method parameters. Sample DW-2 was situated in the southwest direction of mining activities. A total volume of 120L was captured and analyzed for total dust. Total dust at DW-2 was found to be 0.53 mg/m^3. Again, the maximum permissible exposure for nuisance dust is 15 mg/m^3, total dust. Total dust from potential mining operations are below the OSHA PEL for worker safety.

Air Monitoring for Respirable Dust

PM10 emission rates generated from future mining operations were determined via active real time monitoring of a pilot demonstration project conducted over a continuous 2 ½ hr period. Real-time data was collected *in lieu* of active air pump sampling data because monitoring with air pumps and filters is generally collected over an abbreviated period of time and in a fixed location. The pDR real time data may better represent the 8-hour TWA

as it can be collected over the course of the work day (or over the course of work activities), and therefore higher dust generation periods are offset by periods of lower dust generation.

Respirable dust was collected by a TSI DustTrak 8520 (equivalent to the pDR used in the previous study) to estimate PM10 emissions. DustTrak data is provided in Appendix C. Data logging was performed at 1 minute intervals. ERA staff performed the sampling event by moving the DustTrak continuously so that it was always in the downwind direction of processing activities as sampled for current operations. Additionally, the DustTrak was positioned in the highest impact area to the mining activities as determined by the visual dust plume. Winds on the day of the sampling event were variable, but were predominantly from the northeast which is the typical wind direction for the area approximately 80-90% of the time.

The arithmetic average of PM10 results was 0.05 mg/m^3. The maximum PM10 was 0.736 mg/m^3. 95% Upper Confidence Level of the Mean (UCL) was 0.0637 mg/m^3. UCL calculations are also provided in Appendix D. Again, the maximum permissible exposure 8-hr time weighted average limit (TWA) for nuisance dust (PM10 fraction) is 5 mg/m^3. Maximum PM10 dust concentration detected during monitoring activities was well below the OSHA 8hr TWA PEL for worker safety.

Table 2-3: PM10 Dust Results During Mining Operations

Location	Maximum Concentration (mg/m^3)	Average Concentration (mg/m^3)	95% UCL Concentration (mg/m^3)
PDR-1 – PM10 Concentration During Mining Activities	0.736	0.05	0.0637

PM10 dust was measured over a continuous 2 ½ hour period during a demonstration mining pilot test. 145 individual measurements were collected during the demonstration project.

2) Fine Shredding: PM10 emissions generated from fine shredding activities were estimated using equations provided in USEPA Office of Air Quality Planning and

Standards, AP-42 (USEPA 1995b). Per AP-42 Section 13.2.4, Heavy Construction Operations (Portable Plants: Crushing Operations), equations and factors provided in AP-42 Section 11.19.2, Crushed Stone Processing and Pulverized Mineral Processing should be used to estimate emissions from the fine shredding of wood products. The derivation of the emission rate for dust from Fine Shredding operations is further discussed in Section 3.

3) Stockpiling of Processed Materials: PM10 emissions from the handling and stockpiling of processed materials may be generated by actual handling of materials as well as by wind erosion of open aggregate storage piles. USEPA AP-42, Section 13.2.4 provides equations and standard factors for estimating emission rates for aggregate handling. The USEPA acknowledges and provides these standard equations because it is understood that fugitive dust may be generated by stockpile handling activities and that these piles are usually left uncovered because of the need for frequent material transfer into and out of storage. Dust emissions addressed by these equations include several points in the storage cycle such as material loading onto the pile, disturbances by strong wind currents, loadout from the pile and the movement of loading equipment in the storage pile area. Wind erosion of aggregate storage piles were addressed with standard USEPA AP-42 equations presented in Section 13.2.5, Industrial Wind Erosion. The emission rate for dust from the stockpiling of processed materials is further discussed in Section 3.

3.0 AIR DISPERSION MODELING OF DUST TO RESIDENT LOCATIONS

Air emission data were evaluated using SCREEN3. Respirable dust was modeled to the nearest residential community assumed located approximately 1/4 mile from processing or mining operations. No evaluation for deposited particulates was performed.

Results from both the active (available for current operations) and real-time sampling events were evaluated and the Reasonable Maximum Exposure (RME) point concentration from either of the data sets was used in the air dispersion model, SCREEN3. SCREEN3 is a single source Gaussian plume model which provides maximum ground-level concentrations for point, area, flare, and volume sources, as well as concentrations in the cavity zone, and concentrations due to inversion break-up and shoreline fumigation. SCREEN3 is a screening version of the ISC3 model. The SCREEN3 air dispersion model (Version 96043) (USEPA 1995) was used to predict off-site ambient PM10 concentrations for various scenarios based on the calculated emission rates for current and proposed future operations.

3.1 Dust Emission Rate Calculations

Emission rates were calculated for current operations and for future activities to estimate the amount of dust generated by each individual task at the point of production. These emission rates could then be used in the SCREEN3 air dispersion model to estimate the amount of respirable dust at the nearest residential community.

The approach selected (summing of individual parts or obtaining a dust concentration *in total*) was dependent on ongoing operations at the landfill. For example, dust generation from current operations in its entirety could be estimated as these activities are ongoing. Individual emission rates for each subactivity are not necessary to evaluate risk from the current operations as a whole and therefore were not estimated. However, for proposed future operations, it is not possible to obtain a total dust emission rate (operations are unable to be simulated). Dust emissions were therefore estimated for each individual subactivity. In this study, a demonstration project to collect real-life data was performed to obtain dust generating data for future mining operations. Because the fine shredding

processor is not currently available, real-life dust generated from fine shredding and its subsequent stockpiling cannot be obtained. For these cases, conservative dust emission rates were obtained from USEPA AP-42 (USEPA 1995b).

Emission Rate from Current Operations

Estimation of emission rates dust from current operations was accomplished by field measuring dust from currently ongoing operations *in total* (i.e., measuring dust generated from all three current activities: stockpiling of bulk material, separation of recyclables and coarse shredding). The PM10 emission rate (Q) during these activities was determined using the Box Model described by Stern (Stern, 1984). The 95% UCL of the real-time PM10 data (0.046 mg/m^3) was conservatively chosen as the PM10 concentration to estimate emission rates from current operations.

The Box Model is presented as below:

$$E_{10} = (L \times Q / (h \times u_{mean})) \times 10^6$$

or

$$Q = (E_{10} \times h \times u_{mean}) / (L \times 10^6)$$

where:

- Q: PM10 emission rate (g/s-m^2)
- E_{10}: PM10 concentration (ug/m^3)
- h: mixing height
- u_{mean}: mean wind speed (m/s), and
- L: landfill length.

The PM10 concentration (E_{10}) was derived from site-specific data obtained during the air monitoring sampling. The 95% UCL PM10 concentration for data collected via PDR was 0.046 mg/m^3. This assumption is a conservative estimate of the average dust generated by current operations as the data was collected entirely downwind of the activities and within dust plumes. The emission rate based on this value is 5.72E-06 g/s-m^2. Calculations are presented below.

$$Q = (E_{10} \times h \times u_{mean}) / (L \times 10^6)$$

Parameters		Value	Reference
Q:	PM10 emission rate (g/s-m^2)		calculated
E10:	PM10 concentrations (ug/m^3)	46	
h:	mixing height	2	
umean:	mean wind speed (m/s)	2.8	site-specific
L:	landfill length	45	site-specific

Q = 5.72E-06 g/s-m^2

Emission Rates from Future Recycling Activities

1) Mining Activities: The emission rate for future mining activities was also calculated using measured respirable dust generated via active air monitoring as previously described. Results of the active air monitor resulted in an arithmetic average PM10 concentration 0.05 mg/m^3. The maximum PM10 concentration was 3.559 mg/m^3. 95% Upper Confidence Level of the Mean (UCL) was 0.0637 mg/m^3. The PM10 emission rate (Q) during mining activities was again determined using a Box Model (Stern, 1984). The 95% UCL of the PM10 concentration (0.0637 mg/m^3) was conservatively chosen as the PM10 concentration for modeling purposes to estimate the average dust concentration from mining operations. The emission rate based on this value is 7.93E-06 g/s-m^2. Calculations are presented below.

$$Q = (E_{10} \times h \times u_{mean}) / (L \times 10^6)$$

Parameters		Value	Reference
Q:	PM10 emission rate (g/s-m^2)		calculated
E10:	PM10 concentrations (ug/m^3)	63.7	
h:	mixing height	2	
umean:	mean wind speed (m/s)	2.8	site-specific
L:	landfill length	45	site-specific

Q = 7.93E-0 6 g/s-m^2

2) Fine Shredding: PM10 emissions generated from fine shredding activities were estimated using equations provided in USEPA Office of Air Quality Planning and

Standards, AP-42. Per AP-42 Section 13.2.4, Heavy Construction Operations (Portable Plants: Crushing Operations), equations and factors provided in AP-42 Section 11.19.2, Crushed Stone Processing and Pulverized Mineral Processing should be used to estimate emissions from the fine shredding of wood products. Tertiary Crushing Emission Factor from 11.19.2 Crushed Stone Processing and Pulverized Mineral Processing estimates that 0.0012 kg of respirable dust is released per Megagram (Mg) of material processed. In this assessment, it is conservatively assumed that the processor will be running at its maximum capacity 24 hours a day. The maximum capacity of the processor is assumed to be 80 metric tons/hr.

$$EmissionRate = 80Mg/hr \times 0.0012kg/Mg = 0.096kg/hr$$

0.096kg PM10 released per hour is equivalent to an emission rate of **0.0267 g/s** of respirable dust released.

3) Stockpiling of Processed Materials: PM10 emission rate from the handling and stockpiling of processed materials was derived following USEPA AP-42, Section 13.2.4 which provides equations and standard factors for estimating emission rates for aggregate handling and storage. Dust emissions addressed by these equations include several points in the storage cycle such as material loading onto the pile, disturbances by strong wind currents, loadout from the pile and the movement of loading equipment in the storage pile area. Wind erosion of aggregate storage piles were also addressed with standard USEPA AP-42 equations presented in Section 13.2.5, Industrial Wind Erosion. These two emission rates were summed to conservatively estimate the dust emission rate from the stockpiling of processed materials.

Emission rate for Aggregate Handling and Storage Pile

Emission rate for Aggregate Handling and Storage Pile is estimated by the following equation:

$E = k(0.0016)\ ((U/2.2)^{1.3} / (m/2)^{1.4})$

Parameters		Value	Reference
E:	PM10 emission rate (kg/Mg)		calculated
U:	mean wind speed (m/s)	63.7	site-specific
M:	material moisture content (%)	15	site-specific
k:	particle size multiplier	.35	for PM10

E = 4.56E-05 kg/Mg

Again it is assumed that the material handled would be equal to the maximum processing rate of the fine processor (80 metric tons/hr). The area of the storage pile is assumed to be approximately 5,000 ft^2 or 464.515 m^2.

$$EmissionRate = \frac{80Mg/hr \times 0.0000456kg/Mg}{464.515m^2} = 0.00000785kg/hr - m^2$$

The area emission rate for Aggregate Storage and Handling of 7.85E-06 kg/hr-m^2 is equivalent to **2.17E-06 g/s-m^2**

Emission Rate for Industrial Wind Erosion

$$EF = k\sum_{i=1}^{N} P_i$$

$$P = 58(u* - u_t*)^2 + 25(u* - u_t*)$$

Parameters		Value	Reference
EF:	Emission Factor (g/m^2-yr)		calculated
u_t:	threshold friction velocity (m/s)	1.12	site-specific
u:	0.053 * fastest mile (m/s)	1.59	site-specific
P:	erosion potential (g/m^2)	24.6	site-specific
N:	disturbances	365	site-specific
k:	particle size multiplier	.5	for PM10

EF = 1.42E-04 g/s-m^2

The Emission Rates for Aggregate Storage and Handling and for Industrial Wind Erosion were summed to have to total Emission Rate for the Stockpiling of processed materials of 1.44E-04 g/s-m^2

3.2 Fugitive Dust Concentration

The SCREEN3 air dispersion model (Version 96043) (USEPA 1995) was used to predict off-site ambient PM10 concentrations for various scenarios based on the calculated emission rates for both current operations and future recycling operations as described in the previous section. SCREEN3 determines 1-hour maximum chemical concentrations under worst-case wind conditions. It assumes that fugitive dust blows in the direction of the receptor continuously, 100% of the time. The model does not allow for an adjustment to be made to the percentage of time wind blows in the direction of the residents over a longer averaging time. To account for this, U.S. EPA states that annual average PM10 concentrations should be calculated by multiplying the 1-hour maximum concentration by a factor of 0.08 (USEPA 1992). However, this assessment utilized a Hawaii-specific value of 0.2 (Personal Communication with Dr. Barbara Brooks, HEER Office). 0.2 is a factor which considers Hawaii-specific wind and meteorological conditions and is 2.5 times more health protective than the USEPA factor.

The source area for current operations (stockpiling of bulk material, separation of recyclables and coarse shredding of bulk material) were modeled as ground-level sources of 45 x 45 square meters (0.5 acre). 0.5 acres is a USEPA Region 9 default source size as well as the approximate area of current processing activities. Likewise, source areas for mining activities and stockpiling of fine shredded material were also conservatively assumed to be 45 x 45 square meters. Actual area for these operations would be much less. The source for the proposed fine shredder was assumed to be a point source rather than area source because dust emissions are limited to a finite and defined space.
SCREEN3 Areas Source calculations were based on the following assumptions:

Parameter	Value
Source type	area
Source release height	0.1 m
Length of larger side for area	45 m
Length of smaller side of area	45 m

Receptor height above ground	1.8 m
Urban or Rural Area	Rural
Meteorology	
Stability class	1 – Unstable/Turbulent
Anemometer height wind	2.8 m/s

SCREEN3 Point Source calculations were based on the following assumptions:

Parameter	Value
Source type	point
Source release height	1 m
Stack inside diameter	1 m
Exit velocity	0 m/s
Stack gas exit temperature	293K
Ambient air temperature	293K
Receptor height above ground	1.8 m
Urban or Rural Area	Rural
Meteorology	
Stability class	1 – Unstable/Turbulent
Anemometer height wind	2.8 m/s

As noted above, air dispersion modeling was conducted for both dust generated in current processing activities and from future recycling operations.

Fugitive Dust Concentrations from Current Operations

1. SCREEN3 air dispersion modeling results for current processing activities resulted in a maximum respirable dust concentration of 0.1953 ug/m^3 at a distance of 1/4 mile away from dust generating activities based on a calculated emission rate of 5.72E-06 g/s-m^2. After applying the 0.2 adjustment factor, the annual average respirable dust concentration is 0.039 ug/m^3 at a distance of 1/4 mile away from dust generating activities.

Fugitive Dust Concentrations from Future Recycling Activities

2. SCREEN3 air dispersion modeling results for mining operations result in a maximum respirable dust concentration of 0.2704 ug/m^3 at a distance of 1/4 mile away from dust generating activities. After applying the 0.2 adjustment factor, the annual average respirable dust concentration is 0.05408 ug/m^3 at a distance of 1/4 mile away from dust generating activities.
3. SCREEN3 air dispersion modeling results for the fine shredding of materials resulted in a maximum respirable dust concentration of 0.4540 ug/m^3 at a distance

of 1/4 mile away from dust generating activities. After applying the 0.2 adjustment factor, the annual average respirable dust concentration is 0.0908 ug/m^3 at a distance of 1/4 mile away from dust generating activities.

4. SCREEN3 air dispersion modeling results for the stockpiling of processed material resulted in a maximum respirable dust concentration of 1.135 ug/m^3 at a distance of 1/4 mile away from dust generating activities. After applying the 0.2 adjustment factor, the annual average respirable dust concentration is 0.227 ug/m^3 at a distance of 1/4 mile away from dust generating activities.

The sum of all the modeled annual average dust concentrations a 1/4 mile away from the site is 0.41088 ug/m^3. This potential annual average is significantly lower than the National Ambient Air Quality Standards (NAAQS) PM10 annual average limit of 50 ug/m^3. The SCREEN3 air dispersion model calculations are presented in Appendix E. Table 3-1 lists the measured PM10 concentration (if applicable) at the site, the calculated emission rate, and SCREEN3 results at 1/4 mile after the 0.2 adjustment factor is applied.

TABLE 3-1: PM10 Respirable Dust Concentrations

	Measured Concentration (ug/m^3)	Calculated Emission Rate	Estimated PM10 Concentration at 1/4 mile (ug/m^3)
Current Operations			
All Current Operations	46	5.72E-06 g/s-m^2	0.039
Future Recycling Operations			
Mining Activities	63.7	7.93E-06 g/s-m^2	0.05408
Fine Shredding	*NA*	2.67E-02 g/s	0.0908
Stockpiling	*NA*	1.44E-04 g/s-m^2	0.227
Total			**0.41088**

4.0 ESTIMATION OF CHEMICAL CONCENTRATIONS IN BULK MATERIAL AND AT RECEPTOR LOCATIONS

In order to estimate the concentration of chemicals transported by fugitive dust to resident locations it was first necessary to estimate the respirable dust concentration at receptor locations. This process required the derivation of emission rates for the current operations and each of the activities to take place during future recycling operations (described in Section 3 above). Estimated dust concentrations as determined by the SCREEN3 are then multiplied by the estimated chemical concentrations in bulk material to estimate the concentration of Chemicals of Potential Concern in the fugitive dust.

4.1 Estimation of chemical concentration in bulk material

Exposure point concentrations for constituents derived from recycling operations were estimated using all relevant analytical data collected during the investigation. ERA collected three (3), five (5) – gallon buckets of bulk C&D material representative of material accepted by the landfill. Representative material included but was not limited to, painted and unpainted wood, untreated wood, Copper/Chrome/Arsenic (CCA) treated wood, drywall, insulation, and small amounts of metal (e.g. nails), concrete, glass, plastics, etc. In an effort to ensure that the sample submitted to the laboratory included representative quantities of CCA treated wood, known samples of CCA treated wood were included in the samples and submitted to the laboratory. Multiple waste stream analyses have been performed by third parties at PVT Landfill. A waste stream analysis was performed by Cascadia Consulting Group for the State of Hawaii Department of Business, Economic Development, & Tourism in 2007 through 2009 that included two summer and two winter sampling events. A separate study conducted by Element Environmental evaluated two sets of waste streams in 2010. Appendix G provides the results of the independent 3rd party studies. Based on these studies, this risk assessment assumes that CCA treated wood comprises 2.5% of the PVT Landfill waste stream. In an effort to ensure that the representative fraction of CCA treated wood was included in the bulk sample analyzed by the laboratory, PVT Landfill required the laboratory to spike the bulk sample with known quantities of CCA treated wood.

Samples were sent to a certified laboratory for total RCRA 8 metals analyses as well as RCRA 8 and pentachlorophenol TCLP and SPLP analyses. Results are provided in Table 4-1. TCLP and SPLP results are used to determination of the leachable potential of stockpiled processed material. All TCLP and SPLP results were below applicable detection limits or below hazardous waste determination limits. No further discussion of TCLP and SPLP results is required.

Table 4-1: Analytical Results

	Results (mg/kg)							
	Arsenic	**Barium**	Cadmium	**Chromium**	**Lead**	**Mercury**	Selenium	Silver
HTB0121-01	233	*11*	*5.5*	299	31.6	0.0477	*11*	*5.5*
HTB0121-02	111	20.4	*4.955*	148	*9.9*	0.0385	*9.9*	*4.955*
HTB0121-03	122	*10.15*	*5.05*	161	*10.15*	0.0613	*10.15*	*5.05*
Max	233	20.4	*5.5*	299	31.6	0.0613	*11*	*5.5*

Italics indicate samples that were below detection limits. A value of ½ the detection limit is used as a surrogate.

Reasonable Maximum Exposure (RME) values were derived in accordance with USEPA guidance (USEPA, 2002a). Due to limited sampling, the maximum value detected was conservatively used to represent concentrations in bulk material. Laboratory data sheets are presented in Appendix B. In calculating exposure point concentrations, a value equal to one-half the limit of detection reported by the laboratory was used as a surrogate concentration for those constituents that were not detected in a particular sample as specified by U.S. EPA (1989a).

As there is no USEPA-verified Reference Concentration for lead, it was evaluated separately from the other COPCs. The maximum concentration of lead detected in the samples was 31.6 mg/kg. This is below all applicable regulatory levels including the HDOH EAL of 200 mg/kg for residential soil. In addition there were no detectable concentrations of leachable lead in the TCLP analysis; therefore, lead was not carried forward for additional analysis.

4.2 Estimation of Chemical Concentrations at Receptor Locations

Estimation of COPC Concentrations in Dust at Offsite Locations

This assessment utilized a similar approach used in a study conducted by the HDOH to assess human health risks from soil derived fugitive dust from PVT Landfill (AMEC, 2005). Respirable particulate data was used in conjunction with bulk material analytical data to estimate COPC concentrations at specific receptor locations in the adjacent community. Estimated dust concentrations as determined by the SCREEN3 were multiplied by the COPC concentrations assumed present in the bulk material to estimate the concentration of COPCs in fugitive dust. Current operations as well as each future recycling activity were modeled independently and a separate exposure point concentration was calculated from each operation. All dust generated was assumed to be operation-derived. Table 4-2 summarizes the calculated COPC Exposure Point Concentrations at potentially affected residential communities approximately 1/4 mile away from dust generating activities.

TABLE 4-2: Fugitive Dust COPC Exposure Point Concentrations from On-site Activities

Constituent	Current Operations Concentration (mg/m^3)	Mining Activities (mg/m^3)	Fine Processing (mg/m^3)	Stockpile Storage (mg/m^3)
METALS				
Arsenic	9.09E-09	1.26E-08	2.12E-08	5.29E-08
Barium	7.96E-10	1.10E-09	1.85E-09	4.63E-09
Cadmium	2.15E-10	2.97E-10	4.99E-10	1.25E-09
Chromium VI*	4.66E-10	6.47E-10	1.09E-09	2.71E-09
Lead	1.23E-09	1.71E-09	2.87E-09	7.17E-09
Mercury, Divalent	2.39E-12	3.32E-12	5.57E-12	1.39E-11
Selenium	4.29E-10	5.95E-10	9.99E-10	2.50E-09
Silver	2.15E-10	2.97E-10	4.99E-10	1.25E-09

* This assessment assumed that hexavalent chromium exists at 4% of the total chromium detected, which is the upper end value of speciation studies which detected hexavalent chromium from disposed CCA treated wood samples in concentrations of approximately 0.7 to 4% of the total chromium. Additional details provided in Section 5.1

5.0 ESTIMATION OF CANCER RISKS AND NON-CANCER HAZARDS

A human health risk assessment was conducted to quantify potential risks to adult and children residents who might breathe site-related chemicals associated with current and future recycling activities. Chemicals of Potential Concern (COPCs) included RCRA 8 metals. Residential receptors were evaluated assuming they would be exposed to recycling derived dust via the inhalation pathway only.

As described in Section 4 above, respirable dust was modeled to specific receptor locations assumed 1/4 mile away from recycling operations using emission rates estimated from active and real-time air monitoring or via use of USEPA AP-42 default emission rates for industrial processes. The air dispersion model, SCREEN3 conservatively estimates maximum ground-level concentrations of respirable dust at specific set residential receptor points. Respirable particulate data is used in conjunction with analytical data (of bulk material) to estimate COPC concentrations at specific receptor locations (in this case 1/4 mile away from current and future recycling activities). Potential health risks via the inhalation pathway are then estimated for adult and child residents who reside approximately 1/4 mile from dust generating activities.

The phases of the risk process are described herein. The protocol adopted is consistent with the approach recommended by the National Research Council (NRC). The NRC, established by the National Academy of Sciences (NAS) to further scientific knowledge and to advise the federal government, has established a four-step paradigm for conducting health-based risk assessments (NAS 1983). This paradigm has been adopted by USEPA as well as many federal and state regulatory agencies. In accordance with the NRC recommendations, this risk assessment is organized into the following four steps:

- Hazard Identification;
- Toxicity Assessment;
- Exposure Assessment; and
- Risk Characterization.

Each of these steps is detailed in the sections below.

5.1 Hazard Identification

In this step, compounds assumed to be of concern are selected for inclusion in the quantitative risk assessment. These compounds are designated as COPCs. COPCs for this investigation include arsenic, barium, cadmium, chromium, lead, mercury, selenium and silver. Site-specific valence state of chromium in CCA treated wood was not available. Based on historic speciation studies, the majority of hexavalent chromium present in CCA treatment products is reduced to trivalent chromium during the fixation process (Dahlgren and Hartford 1972). The chemicals within CCA treatment products react with the wood fibers which affixes the products to the wood. During this process hexavalent chromium is reduced to low toxicity trivalent chromium (Ung 2004). Speciation studies indicate that both new and weathered CCA treated wood contain hexavalent chromium in concentrations of approximately 0.7 to 4% of the total chromium. Shredding of CCA treated wood is not anticipated to alter the valence state of chromium. To be conservative, this assessment assumed that hexavalent chromium exists at 4% of the total chromium detected, which is the upper end value of detected hexavalent chromium from CCA treated wood samples (Song 2005).

5.2 Toxicity Assessment

The USEPA states that the purpose of the Toxicity Assessment is to "weigh available evidence regarding the potential for particular contaminants to cause adverse effects in exposed individuals and to provide, where possible, an estimate of the relationship between the extent of exposure to a contaminant and the increased likelihood and/or severity of adverse effects" (USEPA 1989a)." In essence, the Toxicity Assessment can also be described as a Dose-Response Assessment. A Dose-Response Assessment is used to identify both the types of adverse health effects a COPC may potentially cause, as well as the relationship between the amount of COPCs to which receptors may be exposed (dose) and the likelihood of an adverse health effect (response). The USEPA characterizes adverse health effects as either carcinogenic or noncarcinogenic and dose-response relationships are defined for oral and inhalation routes of exposure. Dermal exposure toxicity criteria are estimated based on oral criteria. The results of the toxicity assessment, when combined with the results of the exposure assessment provide an estimate of potential risk.

The most current USEPA-verified dose-response criteria were used in this assessment. Dose-response information was obtained from the following sources, in order of priority:

- Hawaii Department of Health; Evaluation of Environmental Hazards at Sites with Contaminated Soil and Groundwater; EHE Guidance (HDOH, 2009)
- U.S. EPA's Integrated Risk Information System (IRIS) (USEPA, 2010a);
- U.S. EPA's Regional Screening Level Tables (USEPA, 2010b)

In the case of lead, there is no U.S. EPA-verified Reference Dose. However, because lead was detected at concentrations well below the Hawaii Department of Health Environmental Action Level (EAL), and U.S. EPA Regional Residential Screening Levels (RSLs), it was not considered for further quantitative analysis.

Noncarcinogenic dose-response information for both oral and dermal routes of exposure were not used as this assessment as this assessment only characterizes inhalation risks to offsite receptors. To evaluate inhalation exposure, U.S. EPA has derived reference concentrations (RfCs) for certain compounds. For use in estimating noncarcinogenic, these RfCs (in units of mg/m^3) are compared to an Exposure Concentration (EC) calculated based on the estimated Exposure Point Concentration. This conversion allows the risk assessment to consider receptor-specific exposure duration described in the exposure assessment.

To evaluate carcinogenic risks from oral exposures, carcinogenic dose-response values for inhalation exposures are generally provided as inhalation unit risk (IUR) values expressed in terms of $(\mu g/m^3)^{-1}$. Carcinogenic Risk is estimated by multiplying this IUR value by the Exposure Concentration. Dose-Response information used in this assessment is listed in Table 5-1.

TABLE 5-1: Dose-Response Information

Constituent	Inhalation Unit Risk Factor $(ug/m^3)^{-1}$		Inhalation RfC (ug/m^3)	
METALS				
Arsenic	4.30E-03	a b	3.00E-02	a
Barium	NA		5.00E-01	a c
Cadmium	1.80E-03	a b	1.00E-02	c
Chromium VI	8.40E-02	a c	1.00E-01	a b
Lead	NA		NA	
Mercury, Divalent	NA		3.00E-01	b
Selenium	NA		2.00E+01	c
Silver	NA		NA	

NA - Not Applicable
(a) Hawaii Department of Health EALs (2009)
(b) U.S. EPA (2010). IRIS
(c) RSL Table (2010)

5.3 Exposure Assessment

In the Exposure Assessment, the magnitude and frequency of a receptors' potential exposure to COPCs is quantified. Exposure factors including length and duration of exposure and potential absorption adjustment factors are designated during this phase of work. Other receptor specific factors such as ingestion, inhalation, and body weight are usually quantified in this section but not required for this assessment. Based on the results of above-described tasks, the final phase of the exposure assessment is the derivation of exposure point concentrations and the calculation of the Inhalation Exposure Concentration. The results of the exposure assessment are described in the following subsections.

5.3.1 Identification of Receptors

Potential human receptors for this investigation are adult and children residents who may breathe fugitive dust containing COPCs. Adult and child residents were identified based on characteristics of the site and surrounding area and the specific concerns of the neighboring community.

5.3.2 Identification of Potential Exposure Pathways

Potential exposure pathways are the mechanisms by which the receptors in the study area may be exposed to compounds emitted current operations and future mining and recycling activities. According to U.S. EPA (1989), four elements must be present in order for a potential human exposure pathway to be complete:

- a source and mechanism of compound release to the environment ;
- an environmental transport medium;
- an exposure point, or point of potential contact with the potentially impacted medium; and
- a receptor with a route of exposure at the point of contact.

The exposure pathways examined in this risk assessment include the inhalation of fugitive dust generated from current operations and future mining and recycling operations.

5.3.3 Identification of Exposure Scenarios

Exposure scenarios describe the frequency and magnitude of exposure to chemicals as they relate to specific receptors and exposure pathways. The exposure scenarios evaluated in this risk assessment include the following:

- Resident Adults presumed to be exposed to contaminants via fugitive dust generation. Recycling Operations are assumed to occur 24 hrs/day for a 24 year period;
- Resident Children presumed to be exposed to contaminants via fugitive dust generation. Recycling Operations are assumed to occur 24 hrs/day for a 6 year period;

The two residential scenarios are summed to create a total 30 year residential scenario including 6 years as a child and 24 years as an adult.

5.3.4 Exposure Concentration Calculations

This section describes the equations and assumptions used to evaluate the concentration of contaminants to which a receptor may be exposed. The equation used to calculate the

Exposure Concentration (EC) adjusts the Exposure Point Concentration by receptor specific exposure time factors and averaging over the period of time for which the receptor is assumed to be exposed. The Exposure Concentration for each compound is compared to the noncarcinogenic reference concentration for that compound in order to estimate the potential noncarcinogenic hazard index due to exposure to that compound via inhalation.
For compounds with potential carcinogenic effects, the Exposure Concentration is calculated by averaging the assumed chemical concentration over the receptor's entire lifetime (assumed to be 70 years). The Exposure Concentration for each compound is combined with the cancer Inhalation Unit Risk for that compound in order to estimate the potential carcinogenic risk due to exposure to that compound via inhalation.

The equations for estimating the Exposure Concentration (both lifetime and chronic) are presented in the following subsections. The exposure parameters used in each potential exposure pathway are also discussed in the following subsections.

Estimation of Potential Exposure via Inhalation

Calculations of potential risk resulting from the inhalation of the respirable fraction of particulates in air (i.e., particles < 10 pm in diameter) are presented in Appendix F. The equation used to calculate the Exposure Concentration due to inhalation exposure is as follows:

$$A = \frac{B \times C \times D \times E \times F \times G}{H}$$

where:

A = Exposure Concentration (mg/m^3)
B = Compound Concentration in Bulk Material (mg/kg)
C = Concentration of Respirable Particulates in Air (mg/m^3)
D = Exposure Time (hr/day)
E = Exposure Frequency (days/year)
F = Exposure duration (years)
G = Inhalation Absorption Adjustment Factor (unitless)
H = Averaging Time (hours).

Chemical Concentration in Bulk Material

The data used in this risk assessment are provided in Appendix B. Concentration in the processed material were assumed to be equal to the maximum value detected in the bulk material samples (Table 4-1).

Concentration of Respirable Particulates in Air

Respirable particulate concentrations in air at offsite locations for the residential scenarios were calculated in the SCREEN3 analysis as detailed in Section 3. It was assumed that 100% of the respirable particles were derived from onsite operations.

Exposure Time and Frequency

Assuming that dust is generated only during onsite operations, offsite residents would be exposed to contaminants only for the duration of these operations. However, for this assessment it was assumed that Recycling Operations are occurring 24 hrs/day for the entire exposure duration period. Accordingly, offsite adult and children residents were also assumed to be continuously exposed to fugitive dust generated from the site 24 hours/day, 350 days/year.

Exposure Duration

As previously described, the risk assessment assumes that potential offsite residential receptors are exposed for a 30 year period. This 30 year duration is split between 6 years as a child and 24 years as an adult.

Absorption Adjustment Factors

Absorption Adjustment Factors were assumed to be 100% via the inhalation route of exposure for all COPCs.

Averaging Time

The Exposure Concentration of COPCs used to calculate noncarcinogenic risks must be averaged over the duration which the receptor is assumed to be exposed (USEPA 1989). Therefore, the averaging time for noncarcinogenic Exposure Concentration is equal to the Exposure Duration X 365 days/year X 24 hours/day.

The Exposure Concentration used to determine potential carcinogenic effects, however, must be averaged over the entire lifetime (70 years), regardless of the length of time which the receptor is assumed to be exposed (USEPA 1989). Therefore, the averaging time for carcinogenic Exposure Concentration is equal to the 70 years X 365 days/year X 24 hours/day.

TABLE 5-2: Exposure Assumptions

Receptor	**Parameter (units)**	**Value**
Adult Resident	Exposure Duration (hr/d)	24
	Exposure Frequency (d/y)	350
	Exposure Period (y)	24
	Averaging Period - Lifetime (hr)	613,200
	Averaging Period - Chronic Noncancer (hr)	210,240
	Fraction from Site (unitless)	1
Child Resident	Exposure Duration (hr/d)	24
	Exposure Frequency (d/y)	350
	Exposure Period (y)	6
	Averaging Period - Lifetime (hr)	613,200
	Averaging Period - Noncancer (hr)	52,560
	Fraction from Site (unitless)	1

5.4 Risk Characterization

The Risk Characterization combines the results of the Exposure Assessment with the results of the Toxicity Assessment to derive quantitative estimates of the potential for adverse health effects to occur as a result of potential exposure to processed material derived dust. The potential for both noncarcinogenic and carcinogenic effects are estimated for each receptor for each potential exposure pathway identified in the Exposure Assessment.

The risk characterization is the step in the risk assessment process that combines the results of the exposure assessment and the toxicity assessment for each compound of concern in order to estimate the potential for carcinogenic and noncarcinogenic human

health effects from chronic exposure to that compound. This section summarizes the results of the risk characterization for each receptor evaluated in the risk assessment.

5.4.1 Noncarcinogenic Risk Characterization

The potential for exposures to COPCs to result in adverse noncarcinogenic health effects is estimated for each receptor by comparing the Exposure Concentration for each compound with the Reference Concentration for that compound. The resulting ratio, which is unitless, is known as the Hazard Quotient (HQ) for that compound. The HQ is calculated using the following formula:

$$A = \frac{B}{C}$$

where:

A = Hazard Quotient (unitless);

B = Exposure Concentration (ug/m^3); and

C = Reference Concentration (ug/m^3).

When the Hazard Quotient for a given compound does not exceed 1, the Reference Concentration has not been exceeded, and no adverse noncarcinogenic health effects are expected to occur as a result of exposure to that compound via that route. The HQs for each compound are summed to yield the Hazard Index (HI) for that pathway. An HI is calculated for each receptor for each pathway by which the receptor is assumed to be exposed. A Total Hazard Index for a chemical is then calculated for each receptor by summing the pathway-specific HIs. A Total HI for a chemical that does not exceed 1 for a given receptor indicates that no adverse noncarcinogenic health effects are expected to occur as a result of that receptor's potential exposure to a chemical in the environmental media. TheHIs calculated for this assessment are presented in Table 5-3. All HIs were lower than the U.S. EPA and HDOH criterion goal of 1, and therefore all were below the regulatory level of concern.

TABLE 5-3: Noncarcinogenic Risk

RECEPTOR	HAZARD QUOTIENTS				
	Current Operations	**Mining Activities**	**Fine Processing**	**Stockpile Storage**	**Total**
Adult Resident, inhalation exposure	6.E-04	9.E-04	1.E-03	4.E-03	**7.E-03**
Child Resident, inhalation exposure	6.E-04	9.E-04	1.E-03	4.E-03	**7.E-03**

5.4.2 Carcinogenic Risk Characterization

The purpose of carcinogenic risk characterization is to estimate the likelihood, over and above the background cancer rate, that a receptor will develop cancer in his or her lifetime as a result of facility-related exposures to COPCs in various environmental media. This likelihood is a function of the Exposure Concentration and the Inhalation Unit Risk (IUR) Factor for that compound. The relationship between the Excess Lifetime Cancer Risk (ELCR) and the Exposure Concentration of a compound may be expressed by the equation:

$$A = B \times C$$

where:

A = Excess Lifetime Cancer Risk (unitless);

B = Inhalation Unit Risk ($(ug/m^3)^{-1}$); and

C = Exposure Concentration (ug/m^3).

The product of the IUR and the EC is unitless, and provides an estimate of the potential carcinogenic risk associated with a receptor's exposure to that compound via that pathway. ELCRs are calculated for each potentially carcinogenic compound. For each receptor, the ELCRs for each pathway by which the receptor is assumed to be exposed are calculated by summing the potential risks derived for each compound. A Total Excess Lifetime Cancer Risk is then calculated by summing the pathway-specific ELCRs. The ELCRs calculated for this assessment are presented in Table 5-4. All risks to the offsite residential receptors were substantially lower than the USEPA and HDOH regulatory point of departure level of concern of 1 E-06.

TABLE 5-4: Carcinogenic Risk

RECEPTOR	**Excess Lifetime Cancer Risk**				
	Current Operations	**Mining Activities**	**Fine Processing**	**Stockpile Storage**	**Total**
Adult Resident, inhalation exposure	2.E-08	3.E-08	4.E-08	1.E-07	2.E-07
Child Resident, inhalation exposure	5.E-09	7.E-09	1.E-08	3.E-08	5.E-08
Total Residential Scenario	2.E-08	3.E-08	6.E-08	1.E-07	**3.E-07**

TABLE 5-5: Final Risk Results

	Hazard Index		**Lifetime Cancer Risk**	
	Child	**Adult**	**Child**	**Adult**
Current Process	3.E-04	3.E-04	6.E-09	3.E-08
Mining	4.E-04	4.E-04	9.E-09	4.E-08
Fine Shredding	7.E-04	7.E-04	2.E-08	6.E-08
Stockpiling	2.E-03	2.E-03	4.E-08	2.E-07
TOTAL	**3.E-03**	**3.E-03**	**7.E-08**	**3.E-07**
Total Residential Cancer Risk			**3.E-07**	

6.0 CONCLUSIONS

This risk assessment was performed to assess the human health impacts associated with the proposed modification to the PVT Landfill permit to include segregation and processing of C&D material for recycling initiatives. Impacts assessed included the following:

- potential for airborne dust impacts to residential communities due to the recycling program
- potential for health impacts to PVT Landfill recycling program workers
- potential leaching impacts of processed materials

In total, potential human health risk was assessed for dust generated by bulk material mining and delivery, segregation of combustibles and recyclables, coarse and fine shredding of combustibles and handling and storage of processed materials. ERA considers this a reasonable "cradle to grave" approach to assess cumulative risk from current landfill and future recycling operations. To evaluate worker risks, dust and metal concentrations were compared to OSHA PELS. Potential leaching impacts of processed materials was conducted via SPLP and TCLP sampling of the bulk material to determine leaching characteristics of the materials in question. Results of the Human Health Risk Assessment for offsite residential receptors resulted in Human Health Risks well below all applicable regulatory levels of concern. Both residential scenarios resulted in a noncancer hazard index of 0.003, well below the regulatory level of concern of 1. The total residential Excess Lifetime Cancer Risk (including 6 years as a child, and 24 years as an adult) was determined to be 3E-07 or a 3 in 10,000,000 probability that a resident will develop cancer in his or her lifetime, over and above the background cancer rate, as a result of potential Site-related exposures to COPCs in the air. This is well below the point-of-departure regulatory level of concern for residential receptors of 1E-06 or 1 in 1,000,000. The residential scenario assumed migration of fugitive dust (24 hrs/day) to residential areas located approximately ¼ mile away from dust generating activities. In reality, the majority of recycling activities (e.g., processing of material) will only occur during working hours.

The recycling program does not pose a potentially significant threat to human health and the environment. The chemical driver responsible for the majority of the carcinogenic risk

and non-carcinogenic hazard was arsenic potentially present in the bulk material. The inhalation of fugitive dust containing arsenic was responsible for nearly 100% of the assessment's carcinogenic risks. It should be noted that known quantities of arsenic were added to the bulk material samples evaluated by the laboratory. Actual concentrations of arsenic are anticipated to be much lower based on waste acceptance records performed by 3rd parties and provided by PVT. To provide an extra measure of safety, ERA performed the assessment assuming that bulk material contained up to 932 mg/kg arsenic and 47.8 mg/kg hexavalent chromium. This is 4 times the amount of arsenic and chromium detected in the samples with added arsenic. All other exposure assumptions being identical, cancer and noncancer risks were still below the HDOH regulatory levels of concern for residential scenarios.

7.0 UNCERTAINTY ANALYSIS

Within any of the four steps of the risk assessment process, assumptions must be made due to a lack of absolute scientific knowledge. Some of the assumptions are supported by considerable scientific evidence, while others have less support. Every assumption introduces some degree of uncertainty into the risk assessment process. Conservative assumptions are made throughout the risk assessment to ensure that the health of workers and local residents are protected. Therefore, when all of the assumptions are combined, it is much more likely that actual risks, if any, are overestimated rather than underestimated.

7.1 Hazard Identification

During the Hazard Identification step, compounds are selected for inclusion in the quantitative risk assessment. Eight metals known to be present in processed material were selected as COPCs. This assessment was not exhaustive and did not include all chemicals and compounds (e.g., pentachlorophenol, dioxins, etc.) that may be disposed of at the landfill and subsequently processed for recycling. Conversely, this assessment was extremely health protective in determining the magnitude of chemical concentrations present in PVT bulk material. Specifically, the evaluation assumed that a specific proportion of waste processed for recycling would be CCA treated wood. To ensure that the correct ratio of arsenic, chrome and copper were accounted for, known samples of CCA treated wood was added (spiked) to the samples analyzed by the laboratory. Actual concentrations of CCA treated wood are anticipated to be less.

ERA did not perform specific analysis on different types of treated wood per HDOH recommendation. As noted, ERA prepared a representative composite sample of mixed wood types and performed analysis on these samples. ERA understands performing analytical tests on specific types of treated wood, would allow for calculations to determine maximum amount of specific wood types allowed in the feedstock material. This method however was deemed inappropriate. Analysis of a single treated wood type is not appropriate when a mixture of wood types constitutes the feedstock as may be present in PVT materials. Such an analysis would not take into consideration cumulative health effects of chemicals in mixed feedstock. To provide an extra measure of safety, ERA performed the assessment assuming that bulk material contained up to 932 mg/kg arsenic and 49.8 mg/kg hexavalent chromium, 4 times the amount of arsenic and chromium

detected in the spiked samples. Estimated risks were still below applicable regulatory levels of concern.

Although a Batch Test Leaching Model evaluation was not performed, this assessment did evaluate the leaching potential of bulk material stored in stockpiles prior to processing. TCLP and SPLP results were below HDOH leaching and hazardous waste determination criteria.

7.2 Toxicity Assessment

Dose-response values are usually based on limited toxicological data. For this reason, a margin of safety is built into estimates of both carcinogenic and noncarcinogenic risk, and actual risks are lower than those estimated. The two major areas of uncertainty introduced in the dose-response assessment are: (1) animal to human extrapolation; and (2) high to low dose extrapolation.

Human dose-response values are often extrapolated, or estimated, using the results of animal studies. Extrapolation from animals to humans introduces a great deal of uncertainty in the risk assessment because in most instances, it is not known how differently a human may react to the chemical compared to the animal species used to test the compound. The procedures used to extrapolate from animals to humans involve conservative assumptions and incorporate several uncertainty factors that overestimate the adverse effects associated with a specific dose. As a result, overestimation of the potential for adverse effects to humans is more likely than underestimation.

Predicting potential health effects from the facility emissions requires the use of models to extrapolate the observed health effects from the high doses used in laboratory studies to the anticipated human health effects from low doses experienced in the environment. The models contain conservative assumptions to account for the large degree of uncertainty associated with this extrapolation (especially for potential carcinogens) and therefore, tend to be more likely to overestimate than underestimate the risks.

Additional uncertainty could be introduced with regards to the toxicity of chromium in the bulk material sampled. Valence state of chromium was not available and based upon historical information regarding the valence proportion present in discarded CCA treated wood. Speciation studies indicate that both new and weathered CCA treated wood contain

hexavalent chromium in concentrations of approximately 0.7 to 4% of the total chromium. To be conservative, this assessment assumed that hexavalent chromium exists at 4% of the total chromium detected, which is the upper end value of detected hexavalent chromium from CCA treated wood samples (Song 2005).

This risk assessment also took a very conservative approach regarding the bioaccessible fraction of COPCs available to be absorbed by the body. These relative absorption factors (RAFs) estimate the amount a chemical that is absorbed by the body through different routes of exposure. Hawaii Department of Health EAL Table and U.S. EPA RSL Table have recommended dermal and gastro-intestinal absorption fractions for different compounds. For the inhalation pathway the most conservative default value of 1 was assumed for these fractions meaning the entire concentration of chemicals would be available for absorption by the body. More realistic bioaccessible fractions for this pathway could be derived and would most likely reduce the portrayed risk in this assessment.

7.3 Exposure Assessment

During the exposure assessment, exposure point concentrations are estimated, and exposure doses are calculated. Exposure point concentrations are the estimated concentrations of compounds to which humans may be exposed. Because ambient air chemical concentrations do not exist at the remote receptor locations at levels which would most likely exceed analytical detection limits, and direct measurement would be confounded by non-relevant sources, exposure point concentrations were estimated using models containing numerous assumptions, such as the amount of compound released from the site, the dispersion of the compound in air and its fate and transport in the environment, and the location of people potentially exposed to released compounds. Once the concentrations in air have been predicted, the calculation of human exposure and dose involves making additional assumptions. The major sources of uncertainty associated with these assumptions are discussed below.

7.3.1 Estimation of Particulate Emission Factors

Offsite concentrations of COPCs for this risk assessment were either derived from ambient air-monitoring events or by emission studies via USEPA Office of Air Quality Planning and Standards, AP-42. During active dust monitoring, real-time dust concentrations were taken

periodically over a continuous period during which operations were taking place. A 95% UCL was calculated all the data collected while dust generating activities were ongoing to determine a conservative average of processing derived dust concentrations. This 95% UCL of dust monitored during this event was used to model fugitive dust concentration to offsite receptors. Implementation of the 95% UCL estimates that the value calculated is greater than or equal to the true mean 95% of the time when calculated for a random data set. This assumption is health-protective because in the majority of cases overestimates the amount of dust that could result from processing operations occurring on site. During this sampling event, dust concentrations were monitored downwind as close as reasonably possible to dust generating activities and in areas where large amounts of dust appeared to be generated. In efforts to be conservative, sampling was performed in worst case scenario locations as to not underestimate that amount of dust generated during processing activities. This assessment also assumed that the sampling performed was representative of conditions that exist onsite 24 hours a day, 7 days a week.

7.3.2 Estimation of Airborne Dust Concentrations Offsite

There is some uncertainty in the estimation of airborne dust concentrations, because the risk assessment does not separately consider dust concentrations on days when winds are high. This uncertainty is minimal, however, as described below. The current risk assessment utilizes an EPA screening air dispersion model that assumes winds are blowing towards residential receptors 24 hours a day, 365 days a year at 2.8 m/s for either a 1-year or 30-year period. The USEPA states that a 0.08 times multiplication factor should be used to convert the 1-hr maximum average to an annual average. This was not done in this evaluation. Instead, an adjustment factor of 0.2 was applied to estimate the annual average (personal communication with Dr. Barbara Brooks, HEER Office). Had a more realistic air dispersion model been used, the ambient dust concentrations at remote receptor locations would have been lower.

This Risk Assessment also only modeled airborne dust concentrations at an assumed ¼ mile distance from dust generating activities. If dust generating activities were moved closer to neighboring residences or in the future new residences are built closer to dust generating activities, the concentration of airborne dust would likely be higher. Likewise, ¼ mile was

chosen as a conservative assumption and all residents which live further than ¼ mile from dust generating activities would likely be exposed to lower ambient dust concentrations.

7.3.3 Estimation of Exposure Dose

Exposure point concentrations are estimated values of what is a Reasonable Maximum Exposure across the entire site. Given that these are estimates, a significant amount of uncertainty can be introduced into the assessment. In this assessment, the maximum detected concentration of contaminants was used as the exposure point concentration in dust that would potentially be released off site. Uncertainty was introduced in analytical results from the bulk samples as known quantities of arsenic was added to the bulk material samples evaluated by the laboratory. Actual concentrations of arsenic are anticipated to be much lower based on waste acceptance records noted by PVT. The concentration in bulk material was multiplied by the modeled concentration of fugitive dust to determine an exposure point concentration of respirable contaminants offsite. This assumption therefore introduces significant uncertainty as it relates to the true risk and almost certainly overestimates both offsite concentrations and risk.

Additional uncertainty is also introduced by assuming non-detect laboratory results as present at ½ the sample reporting limit. In reality this may over or under estimate the actual concentration of the contaminant in the sample. As analytical methods have a limit to their accuracy at very low concentrations, this introduces uncertainty in the assessment.

Once the concentrations of the potentially released compounds in air have been predicted through modeling, the extent of human exposure must be estimated. This requires making assumptions about the frequency and duration of human exposure. Uncertainty may be associated with some of the assumptions used to estimate how often exposure occurs. Such assumptions include location, accessibility, and use of an area. With this in mind, the receptor, or person who may potentially be exposed, and the location of exposure were defined for this risk assessment. The locations where certain activities were assumed to take place have been purposely selected because chemical concentrations and frequency of exposure are expected to be high (i.e., use of the maximally affected areas). In this assessment, residential receptors were assumed to live in the neighboring communities for 30 years and be present 24 hours per day, 350 days per year. However, actual frequencies and durations of exposure are likely to be much lower than assumed, because residents are

not likely to stay in one place and may, for instance, work far away or move to another location. Additionally, the majority of recycling activities (e.g., processing of material) will only occur during working hours, not continuously 24 hours per day. Furthermore the remaining lifetime of the landfill will probably not approach the estimated duration of lifetime, residence, or employment. In these cases, the person's potential exposure would be reduced, and the health risks discussed in this assessment would be overestimated.

7.4 Risk Characterization

The risk of adverse human health effects depends on estimated levels of exposure and dose-response relationships. Once exposure to and risk from each of the selected compounds is calculated, the total risk posed by recycling operations is determined by combining the health risk contributed by each compound. For virtually all combinations of compounds present in chemicals evaluated in this assessment, there is little or no evidence of interaction. However, in order not to understate the risk, it is assumed that the effects of different compounds may be added together.

The current assessment evaluates risk from dust generated from various recycling operations. The risk estimates derived herein do so in a deterministic manner. Doing so ensures that risks determined are from facility operations. It does not derive screening levels for PM10 or COPCs at the fence line. Evaluation of fence line data may be problematic as sources of dust and COPCs may not be 100% PVT operation derived.

8.0 REFERENCES

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APPENDIX **A**
Ambient Air Monitoring Photographs

Current Processing Facility
Ambient Air Monitoring

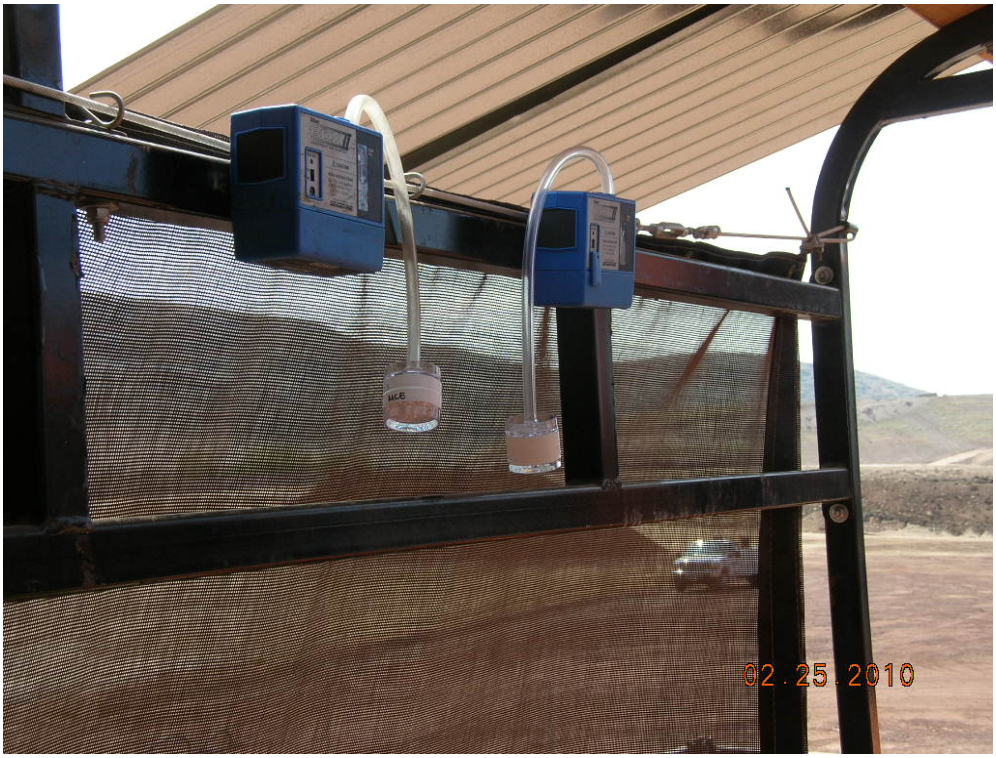
Chipper Collection at Rolloff Bin

Chipper to Rolloff Bin

Conveyor Belt to Chipper

Debris Pile to be Separated

Downwind Air Sampling



Air Sampling at Conveyor Belt

Current Processing Area and Downwind Sampling Location

Upwind Sampling Location

Future Mining Demonstration Project
Ambient Air Monitoring

PHOTOGRAPHIC DOCUMENTATION

Mining Demonstration and Upwind Sampling Location

Downwind Sampling Location

Mining of C&D Waste


Dust Plume during Mining Operations

Upwind Sampling Location

C&D Waste

Downwind Sampling

Downwind Sampling