PVT LANDFILL
HUMAN HEALTH RISK ASSESSMENT OF AES CONDITIONED ASH LIMITED DEMONSTRATION PROJECT

Submitted To:

PVT Landfill
87-2020 Farrington Hwy
Waianae, Hawaii 96792

Submitted By:

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EXECUTIVE SUMMARY

The Hawaii Department of Health (DOH) has requested that a demonstration project and human health risk assessment be performed to evaluate the safety of using AES conditioned coal ash for various soil replacement operational uses at PVT Landfill. According to the DOH the demonstration project and assessment should include all uses for which ash is being considered for beneficial reuse. Beneficial reuses evaluated in this assessment include:

- Daily cover,
- Void space fill,
- Interim daily cover and;
- Liquid adsorption

The demonstration project consisted of ambient air monitoring for respirable dust during actual operational use of AES ash for void space fill and daily cover. Respirable dust concentrations (PM10) were measured by Active Air Monitoring and Real-Time Personal DataRAM (pDR). The respirable particulate data measured in the demonstration project was used in conjunction with chemical analytical data of AES ash samples collected from 2008 to 2009 to estimate chemical concentrations at specific receptor locations at the work site and in the adjacent community. Forty-two (42) composite conditioned ash samples (analyzed for antimony, arsenic, barium, beryllium, boron, cadmium, chromium, copper, iron, lead, mercury, molybdenum, nickel, selenium, silver, thallium, and zinc) were included in the analysis. The UCL 95 percentile mean concentration was assumed to be representative of future conditioned ash chemical concentrations to be used at PVT for operational uses. Utilization of such a robust historical dataset ensured that inter- and intra-batch variability was not a significant contributor to uncertainty. All respirable dust measured in this study was assumed to be ash-derived.

Potential health risks were estimated for landfill workers directly working with ash who may inhale ash-derived dust and ingest and dermally absorb metals in ash. Potential health risks via the inhalation pathway were also estimated for hypothetical adult and child

residents who live approximately 1/4 mile downwind from the demonstration project site. Potential estimated lifetime cancer risks were compared to the USEPA and DOH regulatory level of concern of 1 X 10^{-5} for commercial and industrial workers and 1 x 10^{-6} for residential receptors. 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 considered to be the regulatory level of concern.

Although not specifically evaluated in the demonstration project and risk assessment, the use of AES conditioned ash for other operational uses such as interim cover and liquid adsorption is qualitatively addressed below and is also considered acceptable practice. The use of AES ash as interim cover was considered for analysis but was deemed *Not Required* because PVT standard operating procedures require that any ash used as soil replacement be covered by a minimum of 6 inches of soil within 1 month of application (i.e., there are no true interim cover scenarios anticipated). Quantitative risk evaluation of AES ash for liquid adsorption was also deemed *Not Required.* The addition of any liquids to coal ash was presumed to increase percent moisture and for all practical purposes reduce dust and airborne particulate generation. Any risk associated with ash further wetted for the purposes of liquid adsorption was assumed to be lower than uses evaluated in the current assessment.

WORKER RESULTS

Two worker scenarios were evaluated. The first scenario assumed a worker is in the immediate vicinity of ash dumping and ash use, 8 hours per day, 250 days a year, for 25 years and contacts ash and inhales chemicals in ash-derived dust. The second worker scenario assumed a worker is in the immediate vicinity of ash use during final daily end cap activities 1 hour per day, 250 days a year, for 25 years. Cumulative carcinogenic and noncarcinogenic risks to both worker scenarios were below regulatory levels of concern. For the 8 hour worker, the total cumulative carcinogenic risk and noncarcinogenic hazard index was 1E-05 and 0.8 respectively. Cumulative carcinogenic risk and noncarcinogenic hazards for the 1 hour daily end cap worker were 1E-05 and 0.3, respectively.

HYPOTHETICAL RESIDENT RESULTS

The residential scenario assumed fugitive dust is generated during ash dumping, ash handling activities and wind erosion. The residential scenario assumed migration of fugitive dust (24 hrs/day) to residential areas located approximately ¼ mile away from the site. Residents were assumed to inhale site-derived dust 24 hrs/day, 350 days/year for 30 years. Carcinogenic and noncarcinogenic risks due to inhalation pathways only were 5E-08 and .01, respectively.

SECTION 1
INTRODUCTION

PVT Landfill has retained AMEC Earth and Environmental (AMEC) to quantify potential human health risks associated with various operational uses of AES conditioned ash at PVT Landfill. This document presents the results of the beneficial ash reuse demonstration project and corresponding human health risk assessment (HHRA). The methodology and approach to this study have been previously described in the Sampling and Analysis Plan (AMEC, 2009) and are discussed herein. Deviations from the sampling plan are noted in this report.

According to the DOH the demonstration project and assessment should include all uses for which ash is being considered for beneficial reuse. Beneficial reuses evaluated in this assessment include:

- Daily cover,
- Void space fill,
- Interim daily cover and;
- Liquid adsorption

The HHRA evaluated the impact to workers at the Site during delivery, movement and handling of coal ash. The risk assessment assumed workers would directly contact coal ash as well as inhale airborne particulates containing heavy metals present in ash generated from movement and use of AES ash. The HHRA also evaluated risks to nearby residents (in a residential scenario). Residents were assumed to be exposed to metals in fugitive dust generated by operational uses of ash.

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: 21° 23' 50" N/158° 09' 00"W). The Site is bounded by residential areas at its southern and western borders.

1.2 Approach

This investigation was performed in 2 phases:

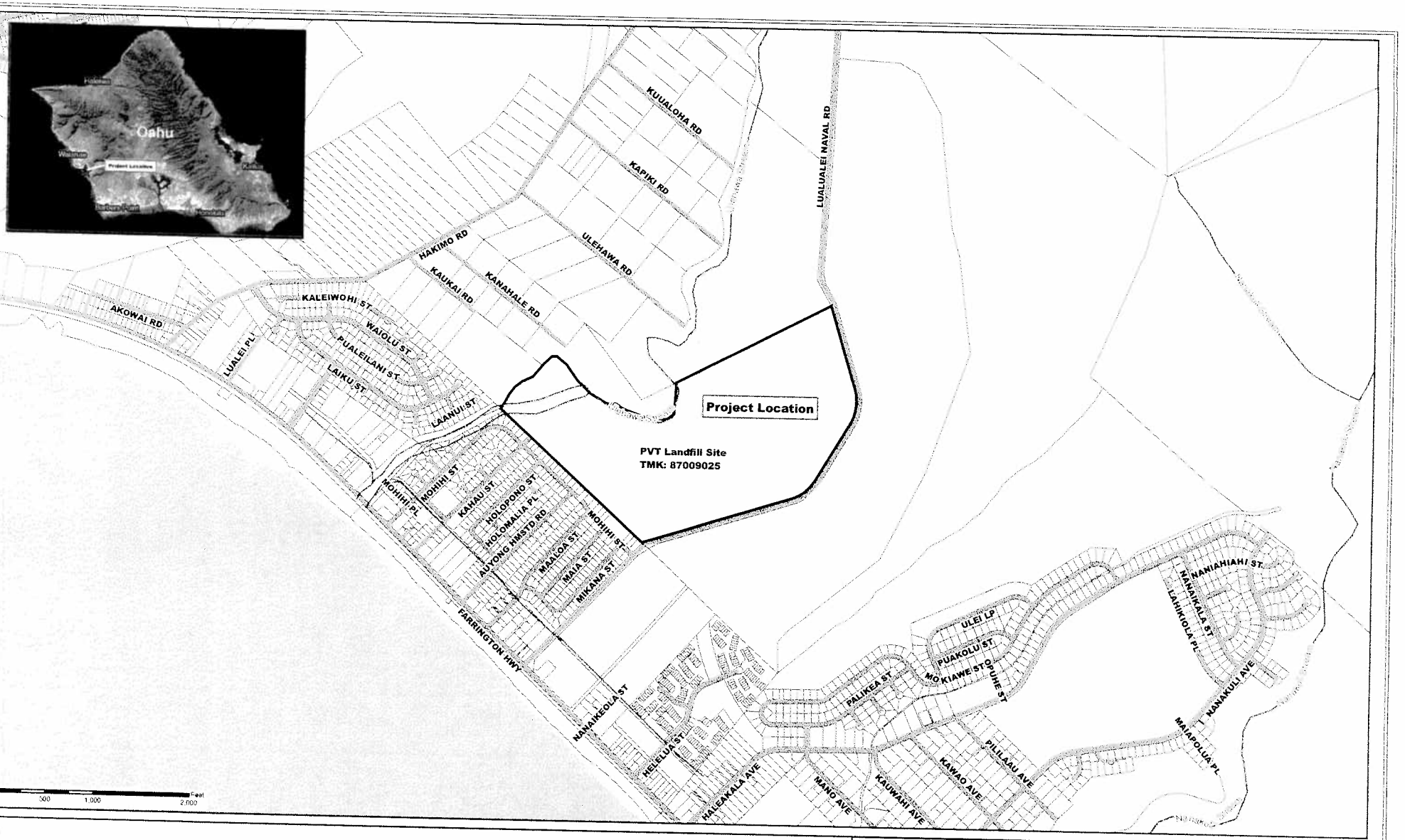
Phase 1: Ambient Air Monitoring (Section 2)

- Respirable dust concentrations (PM10) were measured by Active Air Monitoring and Real-Time Personal Data Rams (PDR)

Phase 2: Human Health Risk Assessment (Section 3)

- Conditioned ash analytical lab data for metals were combined with fugitive dust data measured in Phase 1 to assess the potential for human health risks to workers and nearby residents.

Respirable particulate data was used in conjunction with ash analytical data (provided by PVT Landfill) to estimate COPC concentrations at specific receptor locations at the site and in the adjacent community. Ash analytical data (from AES Hawaii through PVT Landfill) provided historical metals data for AES Coal Ash. Mean historic metals concentrations were assumed to represent future ash concentrations. All dust generated was assumed to be ash-derived.



PVT Landfill: Project Location

Source: Base GIS Data from State of Hawaii, Hawaii GIS Program

amec

W.O.	325190008
DESIGN	LRK
DRAWN	LRK
DATE	06/23/2005

FIGURE 1
PVT LANDFILL
87-2020 FARRINGTON HWY
WAIANAE, HAWAII 96792

SECTION 2
AIR MONITORING

Air monitoring was performed in order to determine the respiratory risk associated with the delivery, movement and handling of ash. AMEC utilized two monitoring methods, active air sampling and real-time air monitoring, to determine the amount of respirable particulates (PM10) generated during operational use of AES ash. Air monitoring for respirable dust was conducted at the landfill on October 26, 2009. Air sampling locations are shown on Figure 2 and in Appendix B, photos. Following is a description of the two air monitoring methods used:

Active Air Sampling

Active air sampling was utilized to collect air particulates during different landfill activities. Five (5) sets of low-flow air pumps were positioned at different areas of the landfill face. The pumps were placed at the following locations: 1) by the ash pile, 2) at the road above the ash pile, 3) high area above the ash pile, 4) east of the ash pile, and 5) during end cap activities. Pumps ran for the duration of ash handling activities during delivery and use of fresh AES coal ash. The pumps were set at an air collection rate appropriate for total dust and PM10 particulates. Air samples were submitted to the laboratory for total dust and PM10 analysis.

Real-Time Air Monitoring

Real-time air monitoring, via Personal DataRAM (pDR), was the second method used to determine if nuisance dust was being generated during specific landfill activities (delivery of ash, movement of ash in between delivery of waste, movement of ash at the end of the day). PM10 data was collected using a pDR with cyclone to determine respirable dust concentrations associated with the above listed specific activities.

Results from both the active and real-time sampling events were evaluated and the maximum 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.

As previously mentioned, the active sampling data provides dust concentrations from a specific landfill activity (ash handling activities during delivery and use of fresh AES coal ash). This concentration is collected over an abbreviated period of time and does not represent an 8-hour time weighted average (TWA). The pDR real time data better represents the 8-hour TWA as it was collected over the course of the work day and therefore higher dust generation periods are offset by periods of lower dust generation. A summary of dust data for the active sampling event and pDR readings are presented in Tables 2-1 and 2-2. Again, in an effort to be health protective, this assessment has utilized the highest dust concentrations in evaluating potential risk.

TABLE 2-1

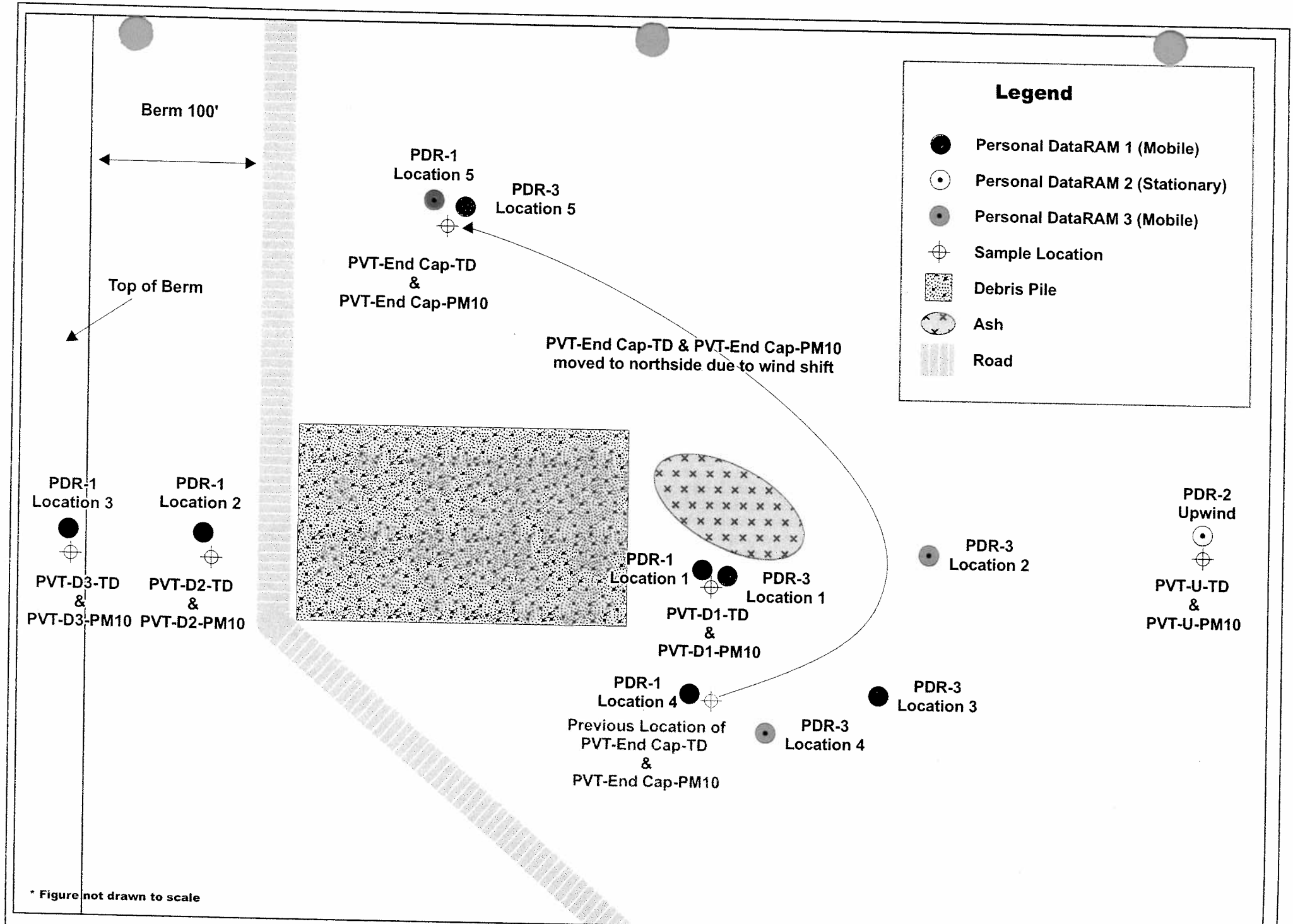
PM10 Active Air Monitoring Results

Sample ID - Location	Concentration (mg/m^3)
PVT-D1 PM10 – Ash Pile	0.3
PVT-D2 PM10 – Road Above Ash Pile	0.59
PVT-D3 PM10 – High Area Above Ash Pile	0.34
PVT-U PM10 – East of Ash Pile	0.05
PVT-End Cap PM10 – Ash Pile	1.1

TABLE 2-2

Personal DataRAM (PDR) PM10 Ambient Air Monitoring Results

Location	Maximum Concentration (mg/m^3)	Average Concentration (mg/m^3)
PDR-1 – Followed Active Samples D1-2-3-End Cap	1.67	0.044
PDR-2 – Upwind Location by PVT-U	2.88	0.055
PDR-3 - Rover	3.584	0.051



amec

PVT Landfill

Sample Locations

FIGURE 2

SECTION 3
HUMAN HEALTH RISK ASSESSMENT

A human health risk assessment was conducted to quantify potential risks to workers at the facility and for adult and children residents who might breathe site-related chemicals associated with ash handling activities. Chemicals of Potential Concern (COPCs) included all metals analyzed by AES. Workers were assumed to directly contact ash and inhale dust generated during operational activities, specifically, during the application of ash as daily cover and void space fill. Residential receptors were evaluated assuming they would inhale fugitive dust only.

As described in Section 2 above, AMEC collected fugitive dust data to determine realistic emission rates for specific operational uses. Emission rates were then used as inputs into SCREEN3 to conservatively estimate maximum ground-level concentrations of respirable dust at the nearest residential receptor point. Respirable particulate data was used in conjunction with ash analytical data (provided by PVT Landfill) to estimate COPC concentrations at specific receptor locations at the site and in the adjacent community. Potential health risks via the inhalation pathway were estimated for adult and child residents who reside approximately 1/4 mile from disposal site. Potential health risks were also estimated for workers at the facility which may inhale ash derived dust and directly contact the ash.

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 section below.

3.1 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. The selection of COPCs for this investigation is based upon historical information regarding the chemical composition of AES conditioned ash.

Analytical data for metals were provided for ash samples collected bi-monthly at AES for the years 2008 and 2009. A total of forty-two (42) composite conditioned ash samples were included in this risk assessment. Metals analyzed include antimony, arsenic, barium, beryllium, boron, cadmium, chromium, copper, iron, lead, mercury, molybdenum, nickel, selenium, silver, thallium, and zinc. Valence state of chromium was not available and was assumed present in a 1:6 chromium VI to chromium III ratio. All chemicals listed above were included as COPCs for evaluation in the human health risk assessment.

3.2. 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:

U.S. EPA's Integrated Risk Information System (IRIS) (USEPA, 2009a);
U.S. EPA's Provisional Peer Reviewed Toxicity Values (PPRTV) (USEPA, 2009b);
Agency for Toxicity Substances and Disease Registry (ASTDR, 2009)
U.S. EPA's Health Effects Assessment Summary Tables (HEAST) (USEPA, 1997);

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

Noncarcinogenic dose-response information for both oral and inhalation routes of exposure were used when available. To evaluate inhalation exposure, U.S. EPA has derived reference concentrations (RfCs) for certain compounds. For use in estimating intake, these RfCs (in units of mg/m^3) are converted to reference doses (RfDs) (in units of mg/kg-day) by multiplying by a 20 m^3/day inhalation rate and dividing by the adult body weight of 70 kg (USEPA 1997b). This conversion allows the risk assessment to consider activity-specific inhalation rates described in the exposure assessment.

To evaluate carcinogenic risks from oral exposures, the U.S. EPA has derived cancer slope factors expressed in terms of $(mg/kg\text{-}day)^{-1}$. Carcinogenic dose-response values for inhalation exposures are generally provided as inhalation unit risk (IUR) values expressed in terms of $(\mu g/m^3)^{-1}$. For this assessment, IUR values are converted to an inhalation CSF correcting for body weight, inhalation rates, and units using the following equation:

$$CSF_{inh} = \frac{IUR \times 70kg}{20m^3 / day} \times 1000\mu g / mg$$

where:

CSF_{inh}	=	inhalation cancer slope factor (mg/kg-day)-1
IUR	=	inhalation unit risk ($\mu g/m^3$)
70 kg	=	body weight

1000 µg/mg	=	conversion factor; and
20 m^3/day	=	inhalation rate.

3.3 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, inhalation and ingestion rates, body weights, and absorption adjustment factors are designated during this phase of work. 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 average daily doses. The results of the exposure assessment are described in the following subsections.

3.3.1 Identification of Receptors

Potential human receptors for this investigation are adult workers at the facility and 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.

3.3.2 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 from the landfill during disposal events. 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 pathways examined in this risk assessment include:

- Direct contact for the workers on site;
- Inhalation for the workers to dust onsite; and,
- Inhalation of fugitive dust offsite to neighboring communities.

3.3.3 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:

- Industrial Workers presumed to be exposed to contaminants in ash via direct contact and onsite dust generation during ash handling operations 8 hours/day, 250 days/year for a 25 year period;
- Industrial (daily endcap) workers presumed to be exposed to contaminants in ash via direct contact and onsite dust generation during daily end capping operations 1 hour/day, 250 days/year for a 25 year period;
- Resident Adults presumed to be exposed to contaminants in ash via fugitive dust generation. Ash handling operations are assumed to occur 24 hrs/day for a 24 year period;
- Resident Children presumed to be exposed to contaminants in ash via fugitive dust generation. Ash handling 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.

3.3.4 Estimation of Exposure Point Concentrations in Ash

Exposure point concentrations for constituents detected in the ash were estimated using all relevant analytical data provided to AMEC from AES Hawaii. Exposure point concentrations (UCL 95th percentile on the mean) were derived in accordance with USEPA guidance (USEPA, 2002a) using USEPA's ProUCL software (USEPA, 2004c). Results are presented in Appendix E. 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). Table 2-3 presents the EPCs calculated in this assessment.

TABLE 2-3

Exposure Point Concentrations in Ash

Constituent	EPC Concentration in Ash (mg/kg)
METALS	
Antimony	0.719
Arsenic	18.17
Barium	645.2
Beryllium	3.121
Boron	769.7
Cadmium	0.606
Chromium VI (1:6 VI:III Ratio)*	8.232
Copper	35.39
Iron	25350
Lead	21.64
Mercury, Divalent	0.404
Molybdenum	6.741
Nickel	95.72
Selenium	1.931
Silver	0.772
Thallium	0.651
Zinc	596.7

3.3.5 Estimation of Exposure Point Concentrations in Fugitive Dust

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 two scenario-specific PM10 emission rates (Q). The first emission rate (hereafter called Ash Handling Activities Emission Rate) estimated via the Box Model (Stern 1984) describes the dust generating potential caused by various human activities at the landfill (i.e., dumping, pushing, compacting). The second emission rate is based on the unlimited erosion model (hereafter called the Unlimited Erosion Model Emission Rate) and estimates the PM10 emission rate due to atmospheric dispersion generated from wind erosion of site ash (assuming contaminated ash is left uncovered).

Ash Handling Activities Emission Rate

PM10 emissions would be generated by several landfill ash handling activities. The PM10 emission rate (Q) during these activities was determined using a Box Model (Stern, 1984).

Estimation of the ash handling activities PM10 emission rate could either be based on the maximum PM10 concentration at any monitoring location during active air sampling or on the maximum average PM10 concentration collected from the PDR data sets. The maximum PM10 concentration from any monitoring location (1100 ug/m^3) which occurred during the final end cap activities was significantly higher than the average PDR data (55 ug/m^3) and was conservatively chosen as the PM10 concentration for modeling purposes. Health risks estimated using the average PM10 concentration from the PDR would be significantly lower than estimated in this assessment for inhalation pathways.

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 maximum onsite PM10 concentration for any of the five monitoring locations was 1100 ug/m^3. This occurred during the end cap activities and was used for emission rate calculations for the fugitive dust emission rates. The emission rate based on this value is 1.4E-04 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)	1100	
h:	mixing height	2	
umean:	mean wind speed (m/s)	2.8	site-specific
L:	landfill length	45	site-specific

Q = 1.4E-0 4

Unlimited Erosion Model Emission Rate

The second emission rate was derived using the unlimited erosion factor. The unlimited erosion factor equation is used to determine the emission rate due to atmospheric dispersion generated from wind erosion of soil (assumes ash erosion is equivalent and left uncovered). Site-specific PM10 data are not required. The equation used to estimate the emission rate assuming wind dispersion of uncovered ash is provided below.

$$Q = 0.036 \times (1 - V) \times (u_{mean} / u_{t)}^{3} \times F(y) \times (1/3600)$$

where:

Q: PM10 emission factor (g/s-m^2)
V: fraction of surface vegetative cover, V = 0 (assumption)
u_{mean}: mean annual wind speed (m/s), u_{mean} = 2.8 m/s (site-specific data)
ut: threshold value of wind speed at 7m (m/s)
y: y = 0.886 u_t / u_{mean} (dimensionless ratio), and
F(y): function of y (USEPA 1985).

For this equation, the fraction of surface vegetative cover was assumed to be zero. As mentioned above, the site-specific wind speed is 2.8 m/s (6.2 mph). Parameters for u_t and F(y) were obtained from USEPA (2004a) and are equal to 11.32 and 0.194 m/s, respectively. Using these variables and the above equation, the emission factor for PM10 (PM10 emission rate, or Q) was calculated as 2.9E-08 g/s-m^2. Calculations are presented below.

$$Q = 0.036 \times (1 - V) \times (u_{mean} / u_{t)}^{3} \times F(y) \times (1/3600)$$

Parameters		Value	Reference
Q:	PM10 emission factor (g/s-m^2)		calculated
V:	fraction of surface vegetative cover	0	
umean:	mean annual wind speed (m/s)	2.8	site-specific
F(y):	function of y [0.886 ut / umean (dimensionless ratio)]	0.194	default (USEPA 2004a)
ut:	threshold value of wind speed at 7 m (m/s)	11.32	default (USEPA 2004a)

Q = 2.9E-08

SCREEN3 PM10 Concentrations

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 ash handling operations and wind erosion of the landfill surface. 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 health protective adjustment factor which considers Hawaii-specific wind and meteorological conditions.

The source areas at the ash disposal area of the landfill site were modeled as ground-level sources of 45 x 45 square meters (0.5 acre). 0.5 acres is the USEPA Region 9 default source size as well as the approximate area of ash handling at PVT Landfill. The receptors were deployed using the SCREEN3 receptor distance array ranging from 402 meters (1/4 mile) out to 8,047 meters with a receptor height of 1 .8 m. It was assumed that the entire area was an emission source.

SCREEN3 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

As noted above, air dispersion modeling was conducted for both dust generated in ash handling activities and due to wind erosion, in order to conservatively estimate the amount of wind blown dust to nearby residential areas.

1. SCREEN3 air dispersion modeling results for ash handling activities resulted in a maximum respirable dust concentration of 4.669 ug/m^3 at a distance of 1/4 mile away for dust generating activities. After applying the 0.2 adjustment factor, the annual average respirable dust concentration is 0.934 ug/m^3 at a distance of 1/4 mile away for dust generating activities. This annual average is significantly lower than the National Ambient Air Quality Standards (NAAQS) PM10 annual limit of 50 ug/m^3.
2. SCREEN3 air dispersion modeling results for the wind erosion data set result in a maximum respirable dust concentration of 0.00099 ug/m^3 at a distance of 1/4 mile away for dust generating activities. After applying the 0.2 adjustment factor, the annual average respirable dust concentration is 0.0002 ug/m^3 at a distance of 1/4 mile away from the demonstration project site. This annual average is significantly lower than the National Ambient Air Quality Standards (NAAQS) PM10 annual limit of 50 ug/m^3.

The SCREEN3 air dispersion model calculations are presented in Appendix F. Table 2-4 lists the measured $_{PM10}$ concentration at the site and SCREEN3 results at 1/4 mile.

TABLE 2-4

PM10 Respirable Dust Concentrations

	Measured Concentration (ug/m^3)	Estimated Concentration at 1/4 mile* (ug/m^3)
Ash Handling Activities		
PVT- End CapPM10	1100	0.934
Unlimited Erosion Model		
	NA	*0.00099*

Estimation of COPC Concentrations in Dust at Offsite Locations

Estimated dust concentrations, both via ash handling activities as well as the unlimited erosion model, as determined by the SCREEN3 were multiplied by the exposure point concentration of the COPCs in the ash (Table 2-3) to estimate the concentration of COPCs in the fugitive dust which migrates to neighborhoods approximately ¼ mile offsite to the potential residential receptors.

Estimation of COPC Concentrations in Dust at Onsite Locations

Measured PM10 concentrations, the maximum measured during the course of the day and during end cap activities, were multiplied by the exposure point concentration of the COPCs in ash (Table 2-3) to estimate the concentration of COPCs in the dust for inhalation pathway to the workers onsite. Maximum PM10 concentration measured during the course of the day was 590 ug/m^3. Maximum PM10 concentration measured during end cap activities was 1100 ug/m^3, which was also conservatively used in the SCREEN3 analysis for modeling dust migration off site.

3.3.6 Exposure Dose Calculations

This section describes the equations and assumptions used to evaluate a receptor's potential exposure to compounds. The equation used to calculate Chronic Average Daily Dose (CADD) estimates a receptor's potential daily intake from exposure to compounds with potential noncarcinogenic effects. According to USEPA (1989), the exposure dose is calculated by averaging over the period of time for which the receptor is assumed to be exposed. The CADD for each compound via each route of exposure is compared to the noncarcinogenic reference dose for that compound in order to estimate the potential noncarcinogenic hazard index due to exposure to that compound via that route of exposure.

For compounds with potential carcinogenic effects, the equation for Lifetime Average Daily Dose (LADD) is employed to estimate potential exposures. In accordance with USEPA (1989), the LADD is calculated by averaging the assumed exposure over the receptor's entire lifetime (assumed to be 70 years). The LADD for each compound via each route of exposure is combined with the cancer slope factor for that compound in order to estimate the potential carcinogenic risk due to exposure to that compound via that route of exposure.

The equations for estimating a receptor's average daily dose (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 G. The equation used to calculate the CADD and LADD due to inhalation exposure is as follows:

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

where:

A = Average Daily Dose following Inhalation (mg/kg-day)
B = Compound Concentration in Ash(mg/kg)
C = Concentration of Respirable Particulates in Air (mg/m^3)
D = Inhalation Rate (m^3/hr)
E = Exposure Time (hr/day)
F = Exposure Frequency (days/year)
G = Exposure duration (years)
H = Inhalation Absorption Adjustment Factor (unitless)
I = Body Weight (kg)
J = Averaging Time (days)

Estimation of Potential Exposure via Direct Contact

Ash Ingestion

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

where:

A = Average Daily Dose Due to Ash Ingestion (mg/kg-day)

B = Constituent Concentration in Ash (mg/kg)

C = Unit Conversion Factor ($1x10^{-6}$ kg/mg)

D = Ingestion Rate (mg/day)

E = Exposure Frequency (days/year)

F = Exposure Duration (years)

G = Oral-Soil Absorption Adjustment Factor (unitless)

H = Area Use Factor (unitless)

I = Body Weight (kg)

J = Averaging Time (days)

Dermal Contact with Ash

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

where:

A = Average Daily Dose Due to Dermal Contact (mg/kg-day)

B = Constituent Concentration in Ash (mg/kg)

C = Unit Conversion Factor ($1x10^{-6}$ kg/mg)

D = Skin Adherence Factor (mg/cm^2)

E = Skin Surface Area Exposed (cm^2/day)

F = Exposure Frequency (days/year)

G = Exposure Duration (years)

H = Dermal-Soil Absorption Adjustment Factor (unitless)

I = Area Use Factor (unitless)

J = Body Weight (kg)

K = Averaging Time (days)

Each of the parameters in these equations is described below.

Chemical Concentration in Ash

The data used in this risk assessment are provided in Appendix D. EPCs were calculated using the 95% UCL of the analytical data (Table 2-3).

Concentration of Respirable Particulates in Air

Respirable particulate concentrations in air at offsite locations for the residential scenarios were calculated in the SCREEN3 analysis. Respirable particulate concentrations in air onsite for the worker scenarios were the measured PM10 concentrations. It was assumed that 100% of the respirable particles are ash-derived.

Inhalation Rate

Inhalation of particulate matter is a function of the ambient concentration of particulate matter, inhalation rate, relative bioavailability, and human body weight.

It is assumed that the average inhalation rate is age and activity dependent. The average daily inhalation rate for children was assumed to be 10 m^3/day. The average daily inhalation rate for adults was assumed to be 20 m^3/day.

Exposure Time and Frequency

Assuming that dust is generated only during ash handling activities, offsite residents would be exposed to contaminants only for the duration of these operations. However, for this assessment it was assumed that ash handling 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. Workers were assumed to be on site for an 8 hours/day, 250 days/year. End cap workers were assumed to be exposed for only 1 hour/day, 250 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. The worker receptor assumes a 25 year employment tenure.

Absorption Adjustment Factors

Absorption is assumed to be 100% via the inhalation route of exposure for all COPCs. The oral and dermal absorption adjustment factors were taken from the Hawaii Department of Health EALs, U.S. EPA RSLs, or derived by AMEC. In cases where no absorption factor was found, a default of 1 was used.

Body Weight

The body weights assumed in this risk assessment are 15 kg for the child and 70 kg for the adult receptors (USEPA 2001c).

Averaging Time

The average daily dose of COPCs used to calculate noncarcinogenic risks must be averaged over the duration which the receptor is assumed to be exposed (USEPA 1989). Therefore, in the CADD calculations, the averaging time is equal to the exposure duration (above).

The average daily dose 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).

TABLE 2-5

Exposure Assumptions

Receptor	Parameter (units)	Value
Adult Resident	Exposure Duration (hr/d)	24
	Exposure Frequency (d/y)	350
	Exposure Period (y)	24
	Body Weight (kg)	70
	Averaging Period - Lifetime (d)	25550
	Averaging Period - Chronic Noncancer (d)	8760
	Inhalation Rate	0.833 m^3/hr
	Respirable particulate concentration in air (mg/m^3)	9.34E-04 mg/m^3
	Fraction from Site (unitless)	1
Child Resident	Exposure Duration (hr/d)	24
	Exposure Frequency (d/y)	365
	Exposure Period (y)	6
	Body Weight (kg)	15
	Averaging Period - Lifetime (d)	25550
	Averaging Period - Noncancer (d)	2190
	Inhalation Rate	0.417 m^3/hr
	Respirable particulate concentration in air (mg/m3)	9.34E-04 mg/m^3
	Fraction from Site (unitless)	1
Worker	Exposure Duration (hr/d)	8
	Exposure Frequency (d/y)	250
	Exposure Period (y)	25
	Body Weight (kg)	70
	Averaging Period - Lifetime (d)	25550
	Averaging Period - Noncancer (d)	9125
	Inhalation Rate	0.833 m^3/hr
	Ingestion Rate	100 mg/day
	Skin Surface Area	3300 cm^2
	Adherence Factor	0.29 mg/cm^2/event
	Respirable particulate concentration in air (mg/m3)	5.90E-01 mg/m^3
	Fraction from Site (unitless)	1

End Cap Worker	Exposure Duration (hr/d)	1
	Exposure Frequency (d/y)	250
	Exposure Period (y)	25
	Body Weight (kg)	70
	Averaging Period - Lifetime (d)	25550
	Averaging Period - Noncancer (d)	9125
	Inhalation Rate	0.833 m^3/hr
	Ingestion Rate	100 mg/day
	Skin Surface Area	3300 cm^2
	Adherence Factor	0.29 mg/cm^2/event
	Respirable particulate concentration in air (mg/m3)	1.10E+00 mg/m^3
	Fraction from Site (unitless)	1

3.4 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 AES coal ash. The potential for both noncarcinogenic and carcinogenic effects are estimated for each receptor for each potential exposure pathway identified in the Exposure Assessment. The risks from each exposure pathway are summed to obtain an estimate of total risk for each receptor.

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.

3.4.1 Noncarcinogenic Risk Characterization

The potential for exposures to COPCs to result in adverse noncarcinogenic health effects is estimated for each receptor by comparing the Chronic Average Daily Dose (CADD) for each compound with the Reference Dose 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 = Chronic Average Daily Dose (mg/kg-day); and
C = Reference Dose (mg/kg-day).

When the Hazard Quotient for a given compound does not exceed 1, the Reference Dose 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. The HIs calculated for this assessment are presented in Table 2-7. All HIs were lower than the U.S. EPA and HDOH criterion goal of 1.

TABLE 2-7

Noncarcinogenic Risk

RECEPTOR	HAZARD QUOTIENT
Worker, 8-hour inhalation exposure	6E-01
Worker, 1-hour end cap inhalation exposure	1E-01
Worker, dermal and ingestion exposure	2E-01
Adult Resident, inhalation exposure	4E-03
Child Resident, inhalation exposure	9E-03

3.4.2 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 dose of a compound and the Cancer Slope Factor (CSF) for that compound. The relationship between the Excess Lifetime Cancer Risk (ELCR) and the estimated Lifetime Average Daily Dose (LADD) of a compound may be expressed by the exponential equation:

$$A = 1 - e^{-BC}$$

where:

A = Excess Lifetime Cancer Risk (unitless);
B = Cancer Slope Factor (1/(mg/kg-day)); and
C = Lifetime Average Daily Dose (mg/kg-day).

When the product of the CSF and the LADD is much greater than 1, the ELCR approaches 1 (i.e., 100% probability). When the product is less than 0.01 (10^{-2}), the equation can be closely approximated by the linear equation:

$$A = B \times C$$

where:

A = Excess Lifetime Cancer Risk (unitless);
B = Cancer Slope Factor (1/(mg/kg-day)); and
C = Lifetime Average Daily Dose (mg/kg-day).

The product of the CSF and the LADD 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 2-8. All risks to the offsite residential receptors were substantially lower than the USEPA and HDOH point of departure value of 1 E-06. Risks to the two worker scenarios

exceeded the point of departure value of 1E-06, but were below the USEPA and DOH regulatory level of concern of 1E-05 for commercial and industrial workers.

TABLE 2-8

Carcinogenic Risk

RECEPTOR	CANCER RISK
Worker, 8-hour inhalation exposure	5E-06
Worker, 1-hour end cap inhalation exposure	1E-06
Worker, dermal and ingestion exposure	5E-06
Adult Resident, inhalation exposure	3E-08
Child Resident, inhalation exposure	2E-08

TABLE 2-9

Final Risk Results

Human Health Risk Assessment

RECEPTOR	Hazard Index	Cancer Risk
End Cap Worker Total (End Cap Inhalation + Direct Contact)	**3E-01**	**6E-06**
Worker Total (Worker Inhalation + Direct Contact)	**8E-01**	**1E-05**
Residential Total (Child Inhalation + Adult Inhalation)	**1E-02**	**5E-08**

SECTION 4
UNCERTAINTY ANALYSIS

The risk assessment for the beneficial reuse of AES coal ash at PVT Landfill contains many assumptions that lead to significant uncertainty. The assumptions that introduce the greatest amount of uncertainty in this risk assessment are discussed in this section. They are discussed in general terms, because for most of the assumptions there is not enough information to assign a numerical value that can be factored into the calculation of risk.

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 local residents is protected. Therefore, when all of the assumptions are combined, it is much more likely that actual risks, if any, are overestimated rather than underestimated.

4.1 Hazard Identification

During the Hazard Identification step, compounds are selected for inclusion in the quantitative risk assessment. For this assessment all 17 metals analyzed for in AES coal ash were selected as COPCs. As such the level of uncertainty in selecting COPCs is also assumed low. Accordingly, little uncertainty is introduced by the Hazard Identification step.

4.2 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.

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. This risk assessment utilized these fractions for the direct contact oral and dermal pathways. 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.

4.3 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 of 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 an environmental medium such as 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.

4.3.1 Estimation of Particulate Emission Factors

Offsite concentrations of COPCs for this risk assessment were either derived from a single ambient air-monitoring event. Maximum dust monitored during this event was used to model fugitive dust concentration to offsite receptors. This assumption is extremely health-protective because it most certainly would overestimate the amount of dust that could result from ash handling operations to occur on site. For example, the particulate emission factor was derived from the PM10 concentration from the location with the maximum particulate reading. Had the average at all monitoring locations been used, PM10 concentrations would have been significantly lower. Similarly, the PM10 concentration was also monitored using real time personal data rams (PDR). The average PM10 concentration over the course of the day from the PDR was significantly lower than the measured PM10 concentration from the air pumps. To be health protective, the cassette data from the active air sampling was carried forward in the human health risk assessment. Use of the PDR data would significantly lower the quantified human health risks.

4.3.2 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.

4.3.3 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. A 95% UCL was used as the exposure point concentration in AES coal ash. 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 therefore introduces significant uncertainty as it relates to the true risk and almost certainly overestimates both site 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. The workers were assumed to be present at the site 8 hours per day, 250 days per year, and have a employment tenure of 25 years. 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. 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.

4.4 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 disposal 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.

SECTION 5
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APPENDIX A

Ambient Air Monitoring Field Notes

PVT Dust Monitoring

1050- Up wind location cassettes (PVT-U-PM10, PVT-U-TD) and dataRam set up and activated to run until EOD.
1110- Sampling cassettes PVT-D1-PM10 and PVT- D1-TD set up about 20-25 feet SE from ash pile and activated near beginning of ash dump.
1115- Rover (Amec dataRam) activated about 35 feet SE of ash pile.
1135- Ash Dump. Wind strong to east.
1145- D1 off.
1150- Moved Rover 20' east and 10' north.
1158- D2 (PVT-D2-PM10 and PVT- D2-TD) set up and awaiting ash dump.
1203- Dozer piling ash pile.
1208- Dozer pau.
****- dataRam at D2 had pump turned off after D1 sampling.
1230- dataRam at D2 pump turned on.
1245- Moved Rover ~25' south (wind direction a steady SE). Checked on upwind pumps-OK.
****- Debris trucks deliver and dump debris all day. Water truck waters various areas of road and debris pile all day.
1312- ash truck onsite. Samplers at D2 turned on.
1315- ash dump. Could not get attention of spotter. Other vehicles onsite continue to work while ash is dumped. Wind still towards SE.
1325- D2 samplers off.
1330- D3 (PVT-D2-PM10 and PVT- D2-TD) samplers set up. Solid SE winds.
1349- Moved Rover 20' south.
1350- ash truck onsite.
1351- pumps at D3 on.
1405- pumps off. dataRam left on. Debris trucks continue to dump and the water truck continues to make its rounds.
1428- ash truck dumps.
1431- debris pile capping begins.
1435- Debris pile capping samplers (PVT-End Cap-PM10 and PVT- End Cap-TD) turned on.
1542- Moved samplers to north side due to steady north wind.
1545- Upwind samplers uprighted.
1547- Rover to north side
1555- capping is pau. Samplers off. MB de-mobs and offsite.

On October 26, 2009, Amec performed air monitoring and sampling for Total Dust and Respirable Dust (PM10) at the PVT Land Company Landfill, Nanakuli, Hawaii. Inalab Laboratory of Honolulu provided Amec with pre-weighed 37mm PVC cassettes installed with 0.8um MCE filters. Sampling consisted of two (2) pre-weighed cassettes, each attached by tubing to a personal pump. One of the two cassettes was fitted into a Gilian Cyclone cassette holder that separates respirable dust from particulate matter of 10 microns or more and the other cassette drew unfiltered air to collect total dust. Both samples were collected at a rate of 1.7 L/min. Monitoring of respirable dust consisted of a personal pump attached to a Thermo Electro Corporation personal DataRam 1200 (pDR 1200) with cyclone attachment. Air was pumped through the pDR 1200 at the rate of 1.2L/min. per manufacturer's instructions for PM10 monitoring. Sampling and monitoring coincided with 3 ash deliveries and the capping of the debris pile at EOD. Samples and air monitoring data were collected at five (5) pre-determined locations:

1. Upwind of the ash pile, approximately 500' E side. (Samples PVT-U-TD, PVT-U-PM10)
2. Adjacent to the ash pile, SE side. (Samples PVT-D1-TD, PVT-D1-PM10)
3. Approximately 20' above the debris pile, W side. (Samples PVT-D2-TD, PVT-D2-PM10)
4. Approximately 100' above the debris pile on upper soil plateau, W side. (Samples PVT-D3-TD, PVT-D3-PM10)
5. Adjacent to the ash pile during EOD capping of the debris pile, SE and N side. (Samples PVT-End Cap-TD, PVT-End Cap-PM10)

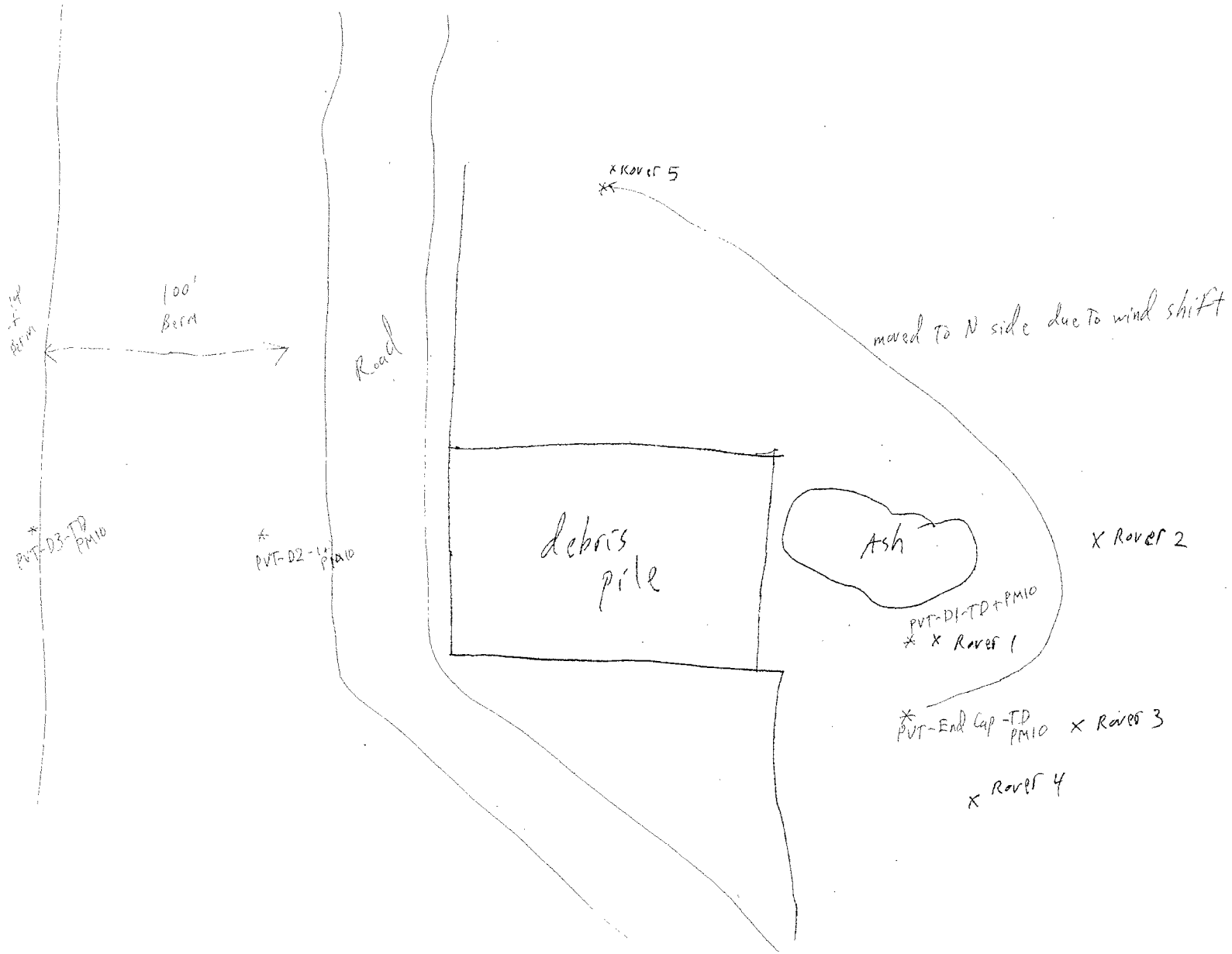
In addition to the 5 pre-determined locations, a pDR 1200 monitor measured the concentration of respirable dust from various downwind locations onsite.

Sample collection times are as follows:

1. Upwind: 1050-1555
2. D1: 1110-1145
3. D2: 1158-1208
4. D3: 1351-1405
5. End Cap: 1435-1555

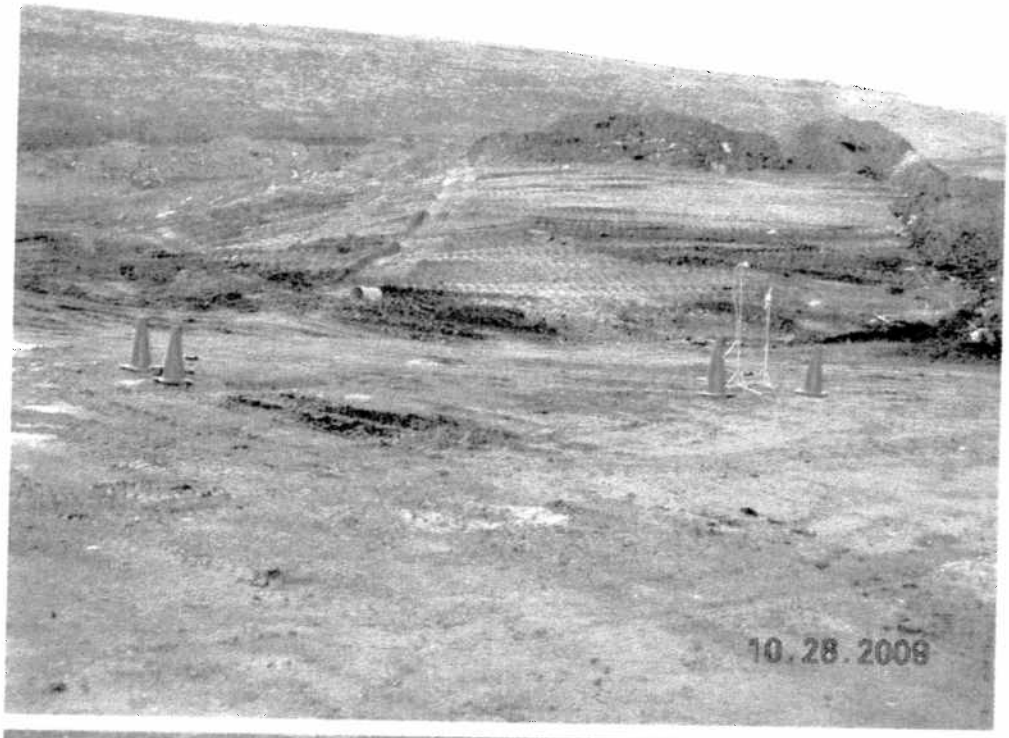
The End Cap sample was collected from two locations according to the wind direction.

The pictures are provided and show sampling locations


100'
Berm
Road
Rover 5
moved to N side due to wind shift
debris pile
Ash
Rover 2
PVT-D1-TD+PM10
Rover 1
PVT-End Cap-TD PM10
Rover 3
Rover 4
PVT-U-TD PM10
plus one Data Ram until EOD

APPENDIX B

Ambient Air Monitoring Photographs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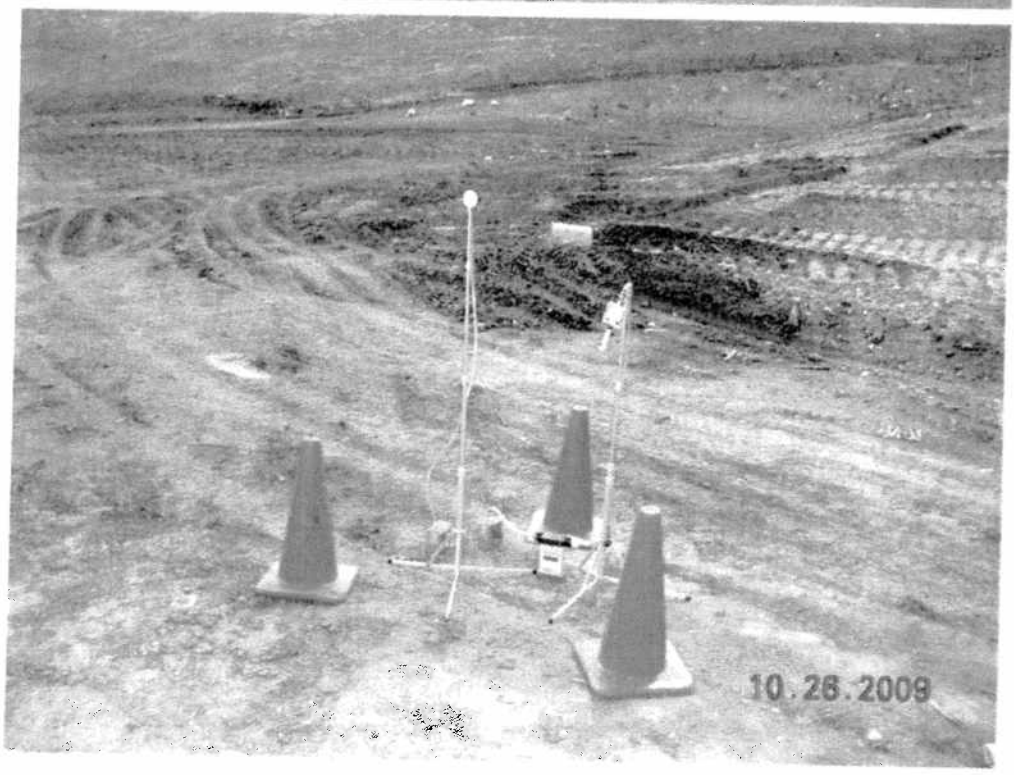
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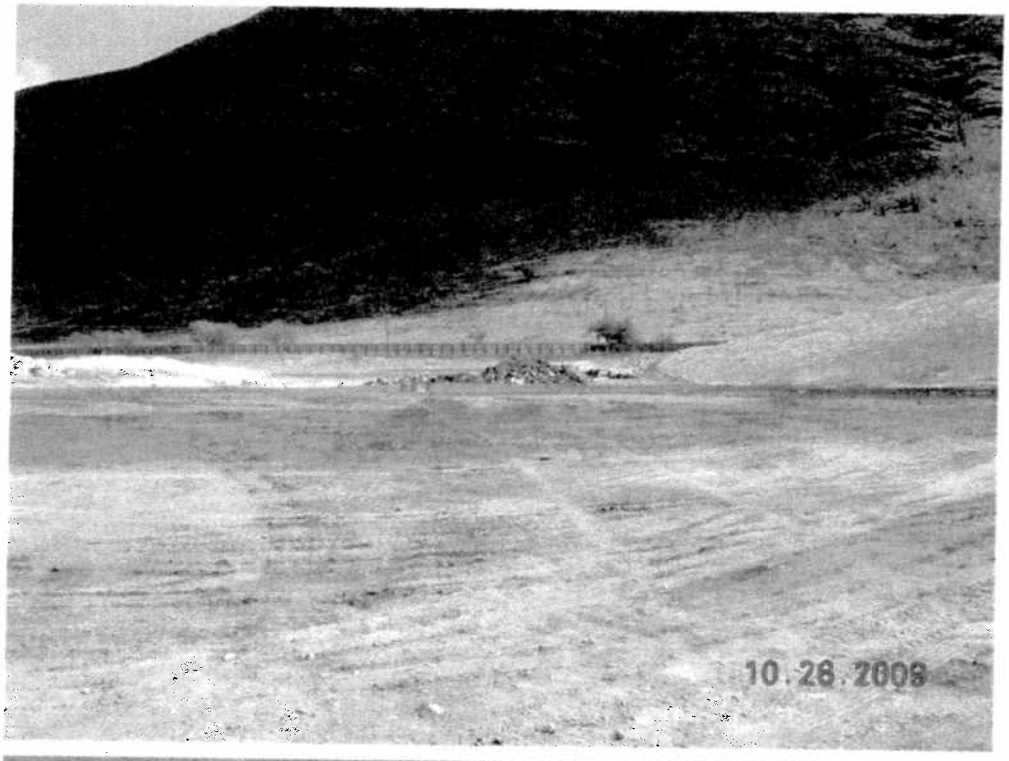
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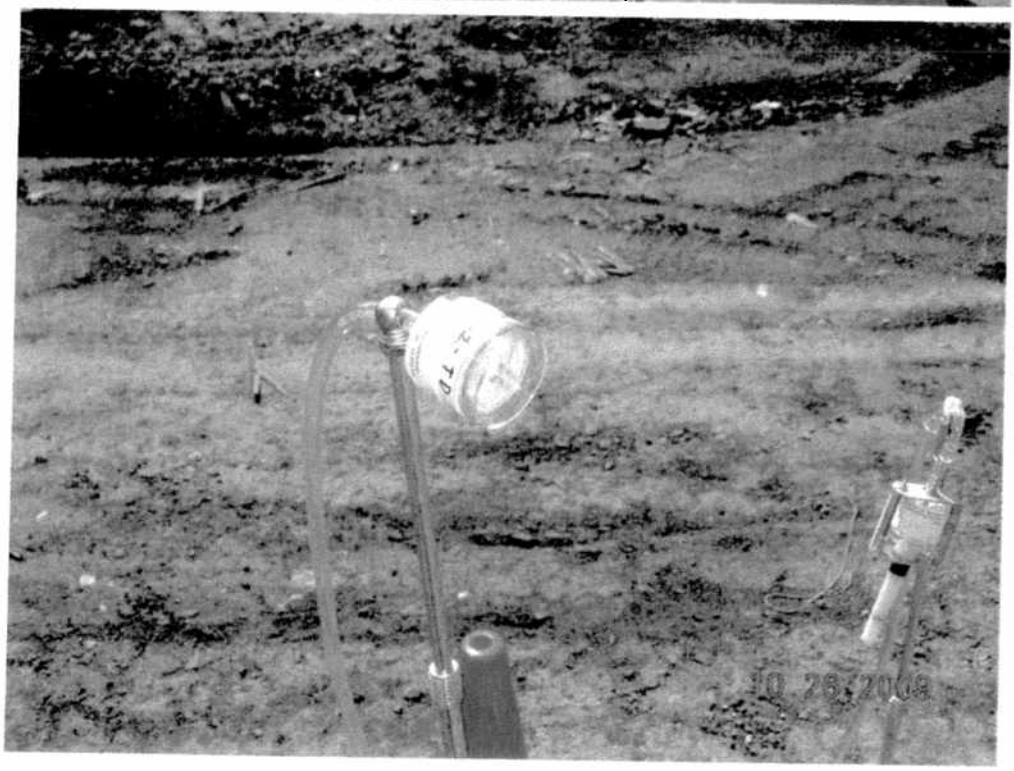

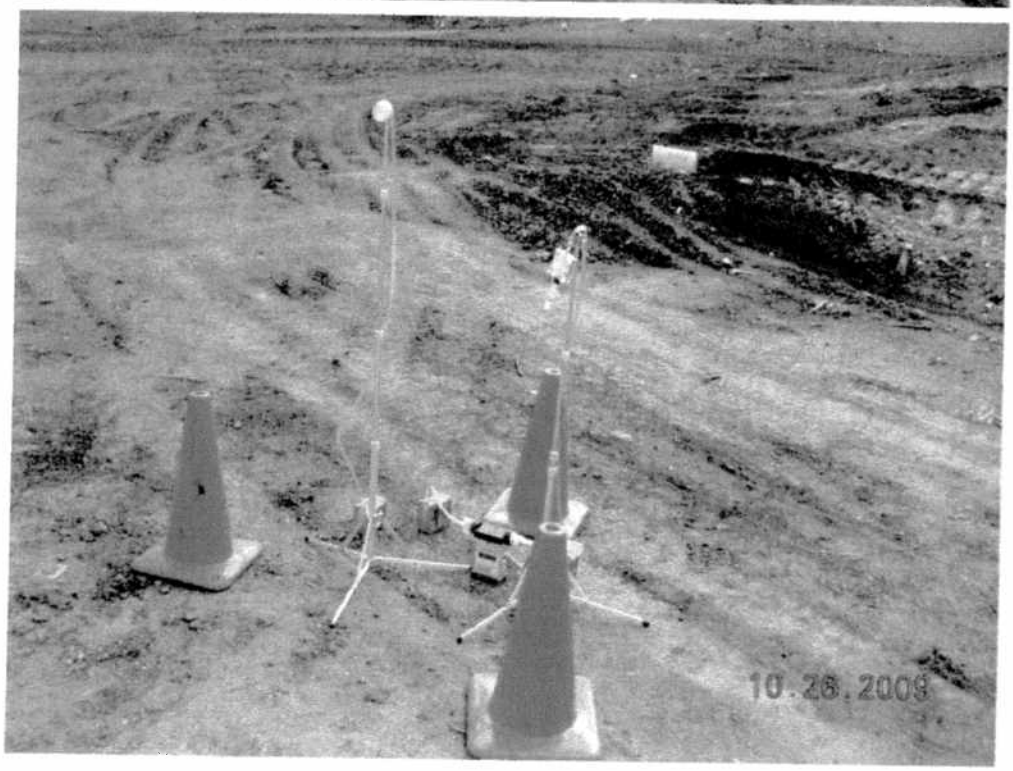
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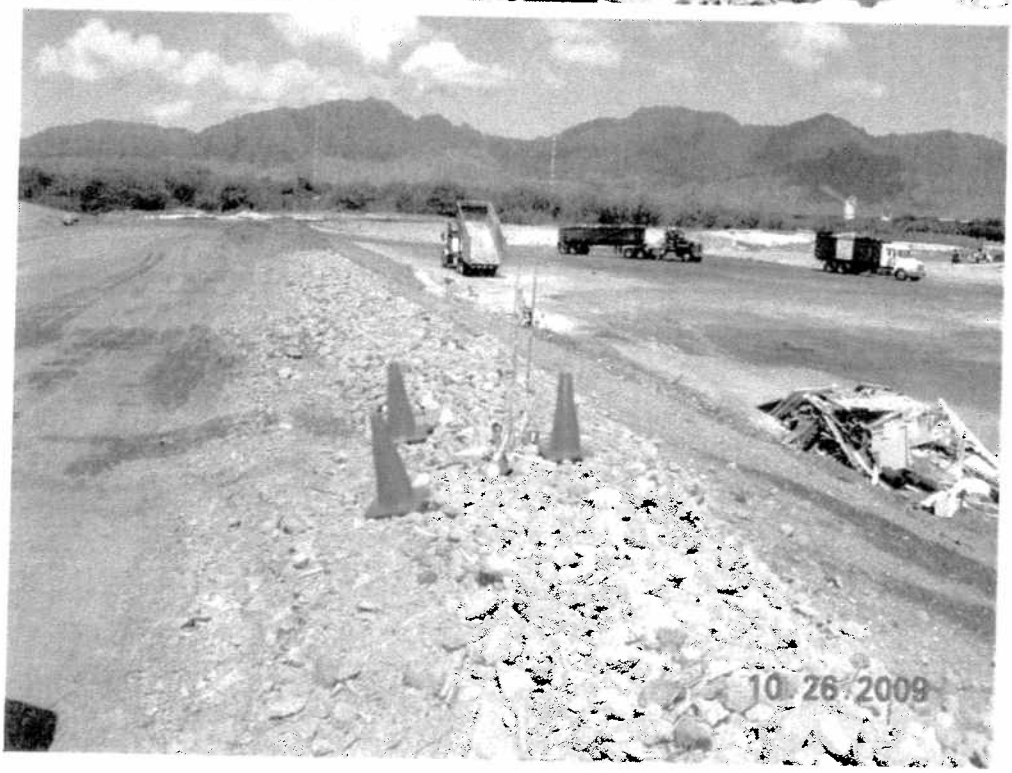
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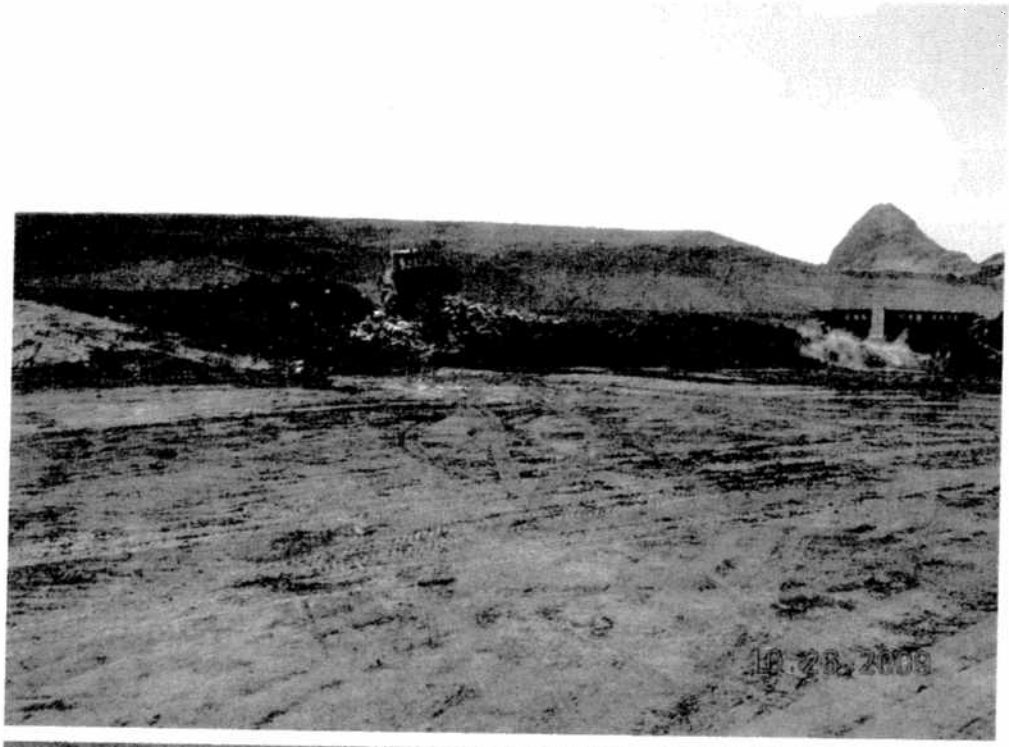
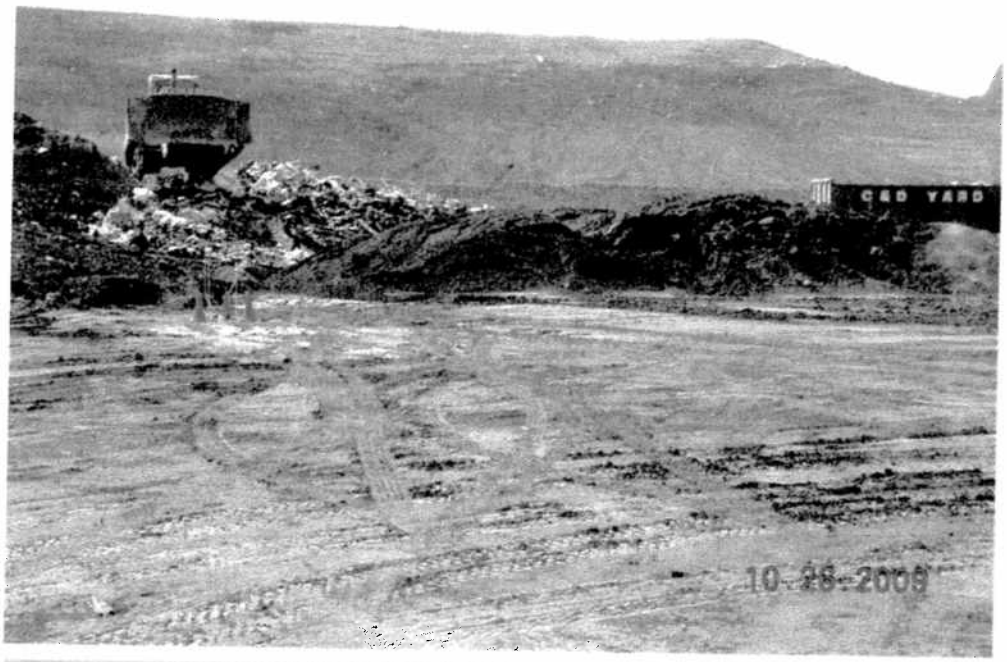
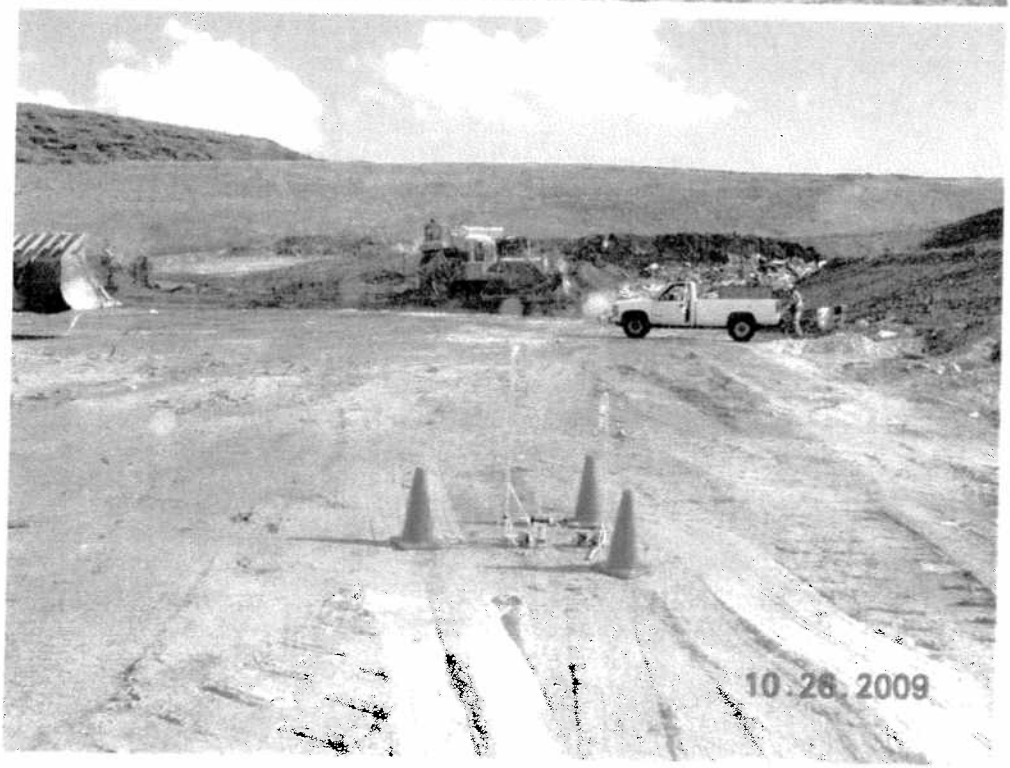



C&D YARD
10.28.2009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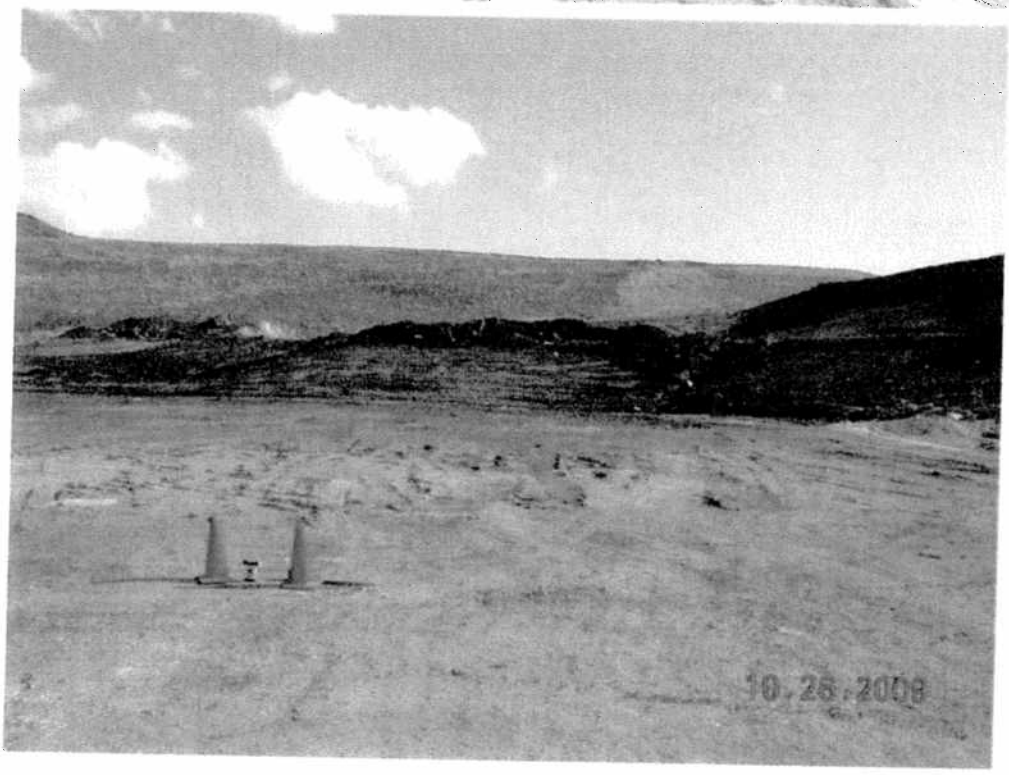
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