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Title: Comparison of Two Surface Contamination Sampling Techniques Conducted for the Characterization of Two Pajarito Site Manhattan Project National Historic Park Properties

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Comparison of Two Surface Contamination Sampling Techniques Conducted for the Characterization of Two Pajarito Site Manhattan Project National Historic Park Properties

by

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The Manhattan Project National Historic Park

- The United States (U.S.) National Park Service (NPS) is developing a National Historic Park dedicated to the Manhattan Project.
  - A research and development project that developed the world's first atomic bomb which ended World War II.
- It will include three areas involved in the "dawn of the atomic age":
  - the Oak Ridge Reservation in Oak Ridge, Tennessee (OPEN);
  - Hanford Engineer Works in Hanford, Washington (OPEN);
  - Los Alamos National Laboratory (LANL) in Los Alamos, New Mexico (IN PROCESS)
- NPS requested that LANL begin characterization of the buildings that will be part of the park so that eventually public access can be granted.

Technical Area-18 (TA-18 aka Pajarito Site)

- One of three areas at LANL that is to be included in the park.
- Located at the intersection of two canyons, Pajarito Canyon and Three Mile Canyon (“Manhattan Project,” n.d.; McGehee et al., 2009).
- Has buildings on the National Register of Historic Landmarks that will be included in the park due to:
  - historical contribution to nuclear weapons and critical assembly R&D conducted during the World War II and Cold War eras (McGehee et al., 2009).

History of Pajarito Site

- Originally a dude ranch established in 1914 by Ashley Pond.
- A few log cabins were built on the property for a Pajarito Club, including TA-18-0029 Pond Cabin, but was abandoned in 1916 (McGehee et al., 2009).
- Pond founded a boy's private ranch school in Los Alamos in 1917, later chosen for the Manhattan Project location by Dr. Robert Oppenheimer (McGehee et al., 2009).
- Manhattan Project began in 1943 but scientists needed an area to study the rates of spontaneous fission reactions with radioactive materials (McGehee et al., 2009).
  - Main technical area was in the present day town site of Los Alamos.
  - Geographical segregation was critical due to extreme instrument sensitivity (McGehee et al., 2009).
- Pajarito Site was perfect!
  - Secluded from, but had proximity to, Los Alamos.
  - Also had a few log buildings that could be utilized (McGehee et al., 2009).

Figure 1:

Pajarito Club established by Ashley Pond

Photo courtesy of Los Alamos Historical Society (McGehee et al. 2009)

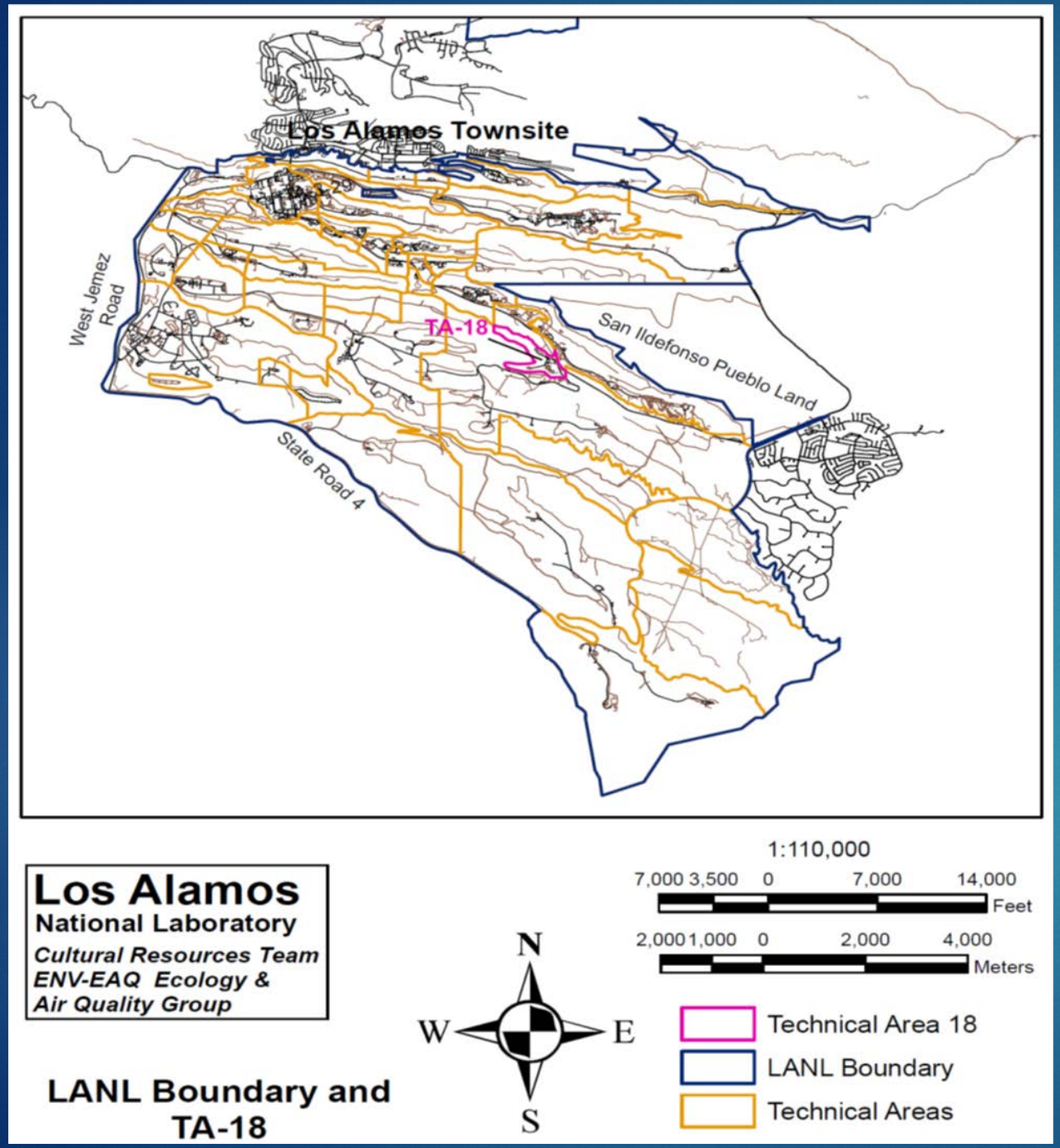


Figure 2:

TA-18 location within LANL boundaries and in relation to Los Alamos town site

(McGehee et al., 2009)

Historical Contributions of Pajarito Site

- August 1943 – P-5 Radioactivity scientists began work in the area (McGehee et al., 2009).
  - Pond cabin used for administrative functions as well as occasional overnight sleeping quarters;
  - Another cabin used for experimental work, which contributed to the overall atomic bomb design, and was later torn down (McGehee et al., 2009).
- 1944 - 1945– G-3 group took over to study the magnetic method of implosions and conduct high explosive assembly testing with charges up to two tons (McGehee et al., 2009).
  - 2 of 3 firing sites were at Pajarito Site; each had at least one (or more) firing locations and “battleship” bunkers (ex. TA-18-0002 battleship bunker) (McGehee et al., 2009).
- April 1946 - Pajarito site became the area where LANL’s critical assembly work was conducted (McGehee et al., 2009; “RFI Work,” 1993).
  - A few criticality accidents had occurred; structures were constructed so that criticality experiments could be assembled by machines which were controlled remotely and a safe distance away (McGehee et al., 2009).
- Early Cold War era (1946-1956) - criticality experiments continued, providing data needed to improve and confirm calculations critical for weapons design (McGehee et al., 2009).
- 1970s and 1980s – Facility capabilities and expertise in critical assembly work caused it to become the nation’s leading site for critical assembly safety training for the Department of Energy (DOE) as well as other institutions (McGehee et al., 2009; “RFI Work,” 1993).

Current Status of Pajarito Site

- Operations have ceased.
- Many of the facilities have been, or are in the process of being, decontaminated, decommissioned, and demolished.
- 4 buildings at the site, including one of the battleship bunkers (TA-18-0002) and the historic Pond cabin (TA-18-0029), are being proposed as part of the Manhattan Project National Historic Park and need to be released for public access.
- Since both rad materials as well as several chemicals and metals were used for the nuclear work that was conducted in the area, the 4 buildings need to be characterized by LANL's Associate Directorate for Environmental Safety and Health (ADESH) for:
  - radiological contamination,
  - metals (especially Be, Pb, and Cd),
  - organics, and
  - asbestos.

Beryllium (Be)

- Naturally-occurring, light-weight alkaline metal with high tensile strength
- Used in: alloy production, computers, aeronautical brakes, electronics, dental bridges, aerospace, x-ray machines, nuclear weapons, nuclear reactors, etc. (Klaasen, 2013).
- 1° route of exposure = inhalation.
  - Dermal and ocular absorption as well as ingestion can also occur (Klaasen, 2013).
- Biological half-life of > 1 year (450 days) (Klaasen, 2013; “Beryllium (EHC 106, 1990),” n.d.).
- Can also cause a sensitization immune response.
  - Identified via a beryllium lymphocyte proliferation test (BeLPT) (CDC, 2011).
  - Can progress to CBD (combination of granulomas on the lungs coupled with fibrosis cause lung expansion difficulties and blood oxygenation problems) (CDC, 2011).
  - No cure.
- 1999 - DOE implemented the Chronic Beryllium Disease Prevention Program (aka the Beryllium Rule 10 CFR 850) at all DOE facilities which imposed the following Be action levels:
  - 1) 0.2 ug/m^3 airborne limit,
  - 2) a housekeeping limit for Be work area surfaces of 3.0 ug/100cm^2,
  - 3) a housekeeping limit for non-Be work area surfaces of 0.2 ug/100cm^2, as well as for any equipment release (United States Department of Energy [DOE], 1999; Brisson & Ekechukwu, 2009).

10 CFR 850

- Chronic Beryllium Disease Program aka the Beryllium Rule 10 CFR 850
  - Wet wipe sampling listed as a housekeeping requirement of the U.S. Code of Federal Regulations Chronic Beryllium Disease Prevention Program 10 CFR 850; micro-vacuum sampling not mentioned (DOE, 1999).
  - Now wet wipe sampling and micro-vacuuming being proposed to be included in the exposure monitoring requirements in amended version of 10 CFR 850 via the 2016 DOE Notice of Proposed Rulemaking (DOE, 2016).

Cadmium

- Naturally-occurring transition metal (Klaasen, 2013).
- Used in: alloys, batteries, as a color pigment in paints and plastics, nuclear reactors, electroplating coatings, as well as many other applications (United States Department of Labor [USDOL], n.d.).
- Exposures occur primarily via inhalation but also ingestion via contaminated food intake (USDOL, n.d.; Klaasen, 2013).
  - Soil contamination can cause plants to accumulate Cd and cause food and tobacco products to have high Cd content (Klaasen, 2013).
- highly toxic
- Can cause cancer or target many of the body's different systems including cardiovascular, renal (nephrotoxin), gastrointestinal, neurological, reproductive and respiratory (USDOL, n.d.).
  - Can cause chronic obstructive pulmonary disease, cardiovascular disease, and osteoporosis (Klaasen, 2013).
- At present, there is no surface housekeeping limit.

Lead

- Naturally-occurring heavy metal (USDOL, n.d.).
- Most of environmental lead is due to anthropogenic activities (Klaasen, 2013).
- Used in: batteries, radiation shields, ammunition and water pipes, automobile lead-acid storage batteries, ceramic glazes, ammunition, radiation shielding, plastics, jewelry and pottery making, glass polishing, stained glass crafting, and gun smithing (Klaasen, 2013; USDOL, n.d.).
- Used to be added to interior and exterior household paints, gasoline, solder and water supply pipes but has been removed; lead in household paints was banned in 1977 due to it toxicity (USDOL, n.d.; Klaasen, 2013).
- Exposure routes are via inhalation and ingestion (USDOL, n.d.).
  - Ingestion can accidentally occur through contact with contaminated surfaces via hands and clothing and shoes (USDOL, n.d.).
    - big concern with infants/children due to hand to mouth contact from household dusts and paints (Klaasen, 2013).
- Can cause gastrointestinal, neurological, renal, hematologic, immunotoxicity, bone, and cardiovascular effects, as well as cancer; it also demonstrates a teratogenic effect to a pregnant woman's fetus (USDOL, n.d.; Klaasen, 2013).
- Surface housekeeping limit for lead that LANL uses follow the Housing of Urban Development (HUD) guidelines of 21.5 ug/100cm^2.

Battleship Bunker (TA-18-0002) and Pond Cabin (TA-18-0029)

- LANL's Industrial Hygiene database had no records of past sampling characterization data here.
- Characterization was needed prior to entry by the public in order to provide safe entry requirements in regards to Be, Cd, Pb, and other metals
  - Dermal or inhalation exposures can occur from contaminated surface dust containing toxic metals.
- Not thought to be contaminated but past H&S controls were more flexible so there may have been contamination brought into either building.
  - Workers slept in the Pond cabin on occasion. Evidence that a gentleman lived in the cabin for approximately 3 years while working at the site.
  - Also possible, but unknown if, work materials may have been brought into the cabin by those living/sleeping there.

Figure 3:
Battleship Bunker (TA-18-0002)

ADC reviewed and approved by Audrey Martinez Z#181899.

- One of three earth-covered “battleship bunkers”
- 69 square foot building - partially underground
- Accessed by a concrete stairwell on the east side where the blast resistant steel door exists (McGehee et al., 2003).
- Shielded inside with steel.
- Characterization concerns: encased in concrete and shielded in steel and has been exposed to the weather elements

Figure 4: Pond Cabin (TA-18-0029)

ADC reviewed and approved by Audrey Martinez Z#181899.

- 384 square foot (16 x 24 ft) building with an 8 foot high metal panel roof and log walls (McGehee et al., 2003).
- Characterization concerns: 102 years old and has been exposed to the weather elements. It is of wood composition.

American Society for Testing and Materials (ASTM) D6966 vs. ASTM D7144

Method	ASTM D6966 – "Standard Practice for Collection of Settled Dust Samples Using Wipe Sampling Methods for Subsequent Determination of Metals" protocol	ASTM D7144 – "Standard Practice for Collection of Surface Dust by Micro-Vacuum Sampling for Subsequent Metals Determination" protocol
Description	Ghost wipes are used to wipe a 100 cm^2 surface area (ASTM, 2013).	An air sampling pump is connected to a cassette with a small collection hose attached and samples are "vacuumed" through the hose for a 100 cm^2 surface area (ASTM, 2011).
Recommended for	Recommended for smooth, nonporous surfaces (ASTM, 2013).	Recommended for rough or porous surfaces such as wood and concrete (ASTM, 2011).
Limitations	Possible tears in the wipe from rough surfaces or mis-collection of dust in porous surfaces	Biases towards particles that are smaller in size and less dense in weight and, therefore, will not reflect the total dust of the surface area (ASTM, 2011).

Project Objectives

- Two objectives:

1) Compare wet wipe and micro-vacuum sampling data to help form a technical basis for choosing between the two sampling methods;

2) Study the analytical results to determine if elemental soil constituents can be used to distinguish between natural levels and contamination from past operations.

-Both buildings have weathered for decades and have layers of dirt, which could effect the results.

-Results will help improve the technical basis for interpreting surface contamination sampling results and determining protective actions including:

-access control

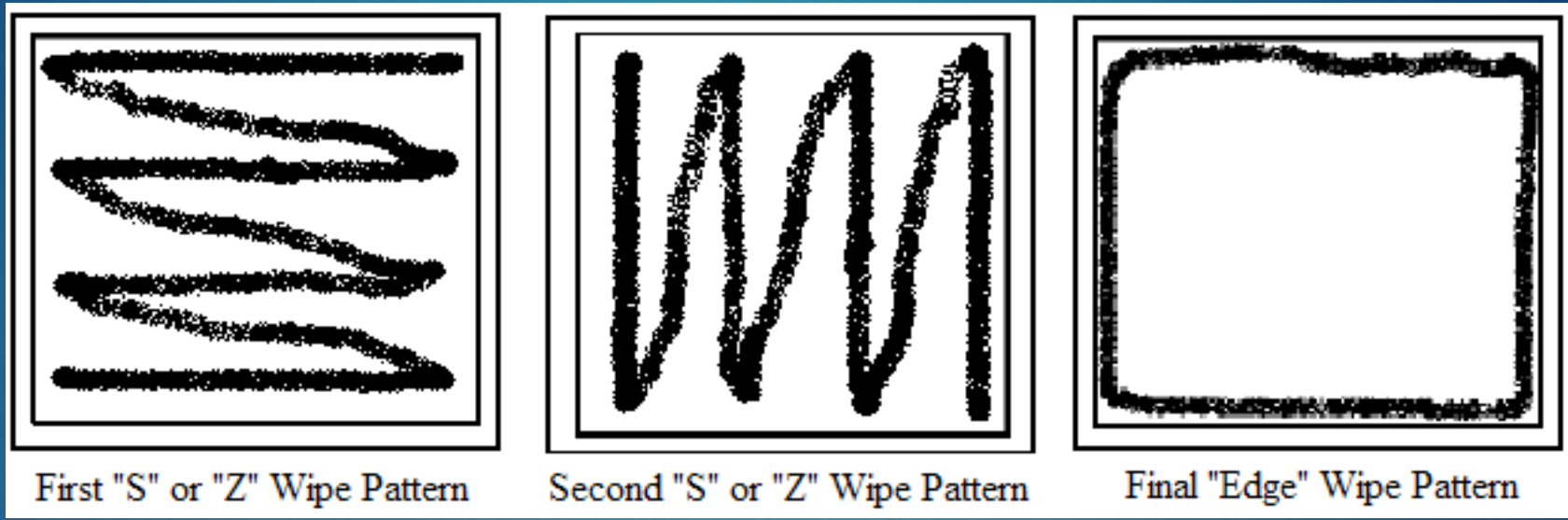
-PPE requirements

-housekeeping/decon efforts.

Surface wet wipe sampling procedure (ASTM D6966)

- Experimental Express ghost wipes that are pre-moistened with deionized water were used due to their durability.
- Clean, disposable nitrile gloves were donned.
- A ghost wipe was removed from its package, unfolded, and then folded in half.
- A 10cm x 10cm area was wiped with firm pressure using a $100cm^2$ template; horizontal s-strokes were done side-to-side, then without allowing the ghost wipe to touch anything else and folding the contaminant side in, s-strokes were done vertically, and then lastly, on the third fold, the edges of the sampled area were wiped.
- The wipe was then transferred into a pre-labeled Fisher 50 ml centrifuge tube and wrapped with a chain of custody seal.
- Gloves were changed after every surface wipe sample.

Diagram of Wipe Sampling Pattern from the LANL Laboratory Industrial Hygiene and Safety Manual



Micro-vacuum sampling procedures (ASTM D7144)

- An Airchek Sampler pump was pre-calibrated with a Defender 510/520 calibrator to a flow rate of 2.5 LPM, per the ASTM D7144 procedure (ASTM, 2011).
- Small collection nozzles of Fisher polyvinyl (PVC) tygon tubing with an inside diameter of 0.60 cm were cut with a prior to sampling to a length of 5.5 cm, with a 45° angle cut at the inlet end (ASTM, 2011).
- The outlet end was fitted to a SKC pre-loaded, Mixed Cellulose Ester (MCE), matched weight filter cassette (0.8um pore size, 37 mm diameter, 3 piece, pre-banded – lot #15651-7DF-014 Exp. 8/17) (ASTM, 2011).
- Each cassette was pre-labeled with a unique ID and had a collection nozzle pre-fit in advance of sampling.
- PVC tygon tubing was used to connect the sampling pump to each cassette.
- A 10cm x 10cm area was “vacuumed” in the same sampling manner as the wipe sampling, with the exception that each sample was timed one minute as per protocol (ASTM, 2011).
- The cassette was removed from the sampling pump apparatus and changed for each sample; the collection nozzle was thrown away and the nibs were placed back onto the end of the cassettes.
- A chain of custody seal was placed around the cassettes and each was placed into its own small plastic bag. The field blanks were treated the same way as the sample but no surface wiping or micro-vacuuming was conducted.

Field Methods and Procedures

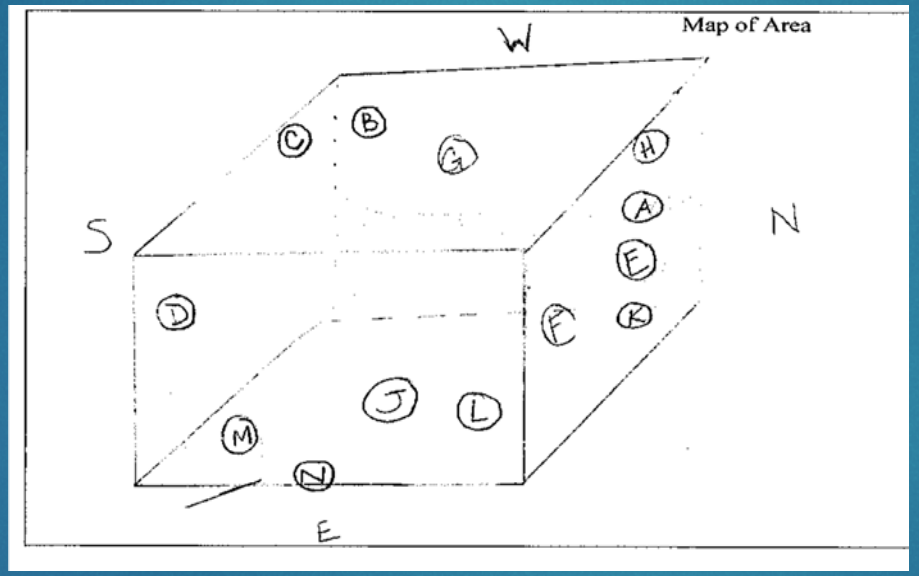
- Sampling was conducted for 2 days in the TA-18 area:
  - Team of 3 Industrial Hygiene Professionals at the battleship bunker on Day 1
  - Team of 4 Industrial Hygiene Professionals and Technicians at the Pond cabin on Day 2
- All samples collected were labeled with a pre-assigned, unique ID prior to sampling.
  - Micro-vacuum samples had an “MV” designation
  - Wipe samples had a “W” designation.
  - Followed by the TA number 18 and building number (either 0002 or 0029)
  - Lastly, alphabetical letters were used starting with A to designate each different sample.
- Wipe and micro-vacuum samples taken side-by-side following 100cm^2 disposable templates.
- Field notes were taken and a sketch of the sampled areas were logged into a logbook.

Sampling at Battleship Bunker Day One

- PPE: Tyvek lab coats, booties, safety glasses, and nitrile gloves.

- 15 wipe samples (including two blanks)
- 15 micro-vacuum samples (including two blanks)
- Total of 30 samples

Figure 5: Sketch of the Battleship Bunkers Sampled Locations



Battleship Bunker sketch

Figure 7:
Battleship Bunker Sampled Locations

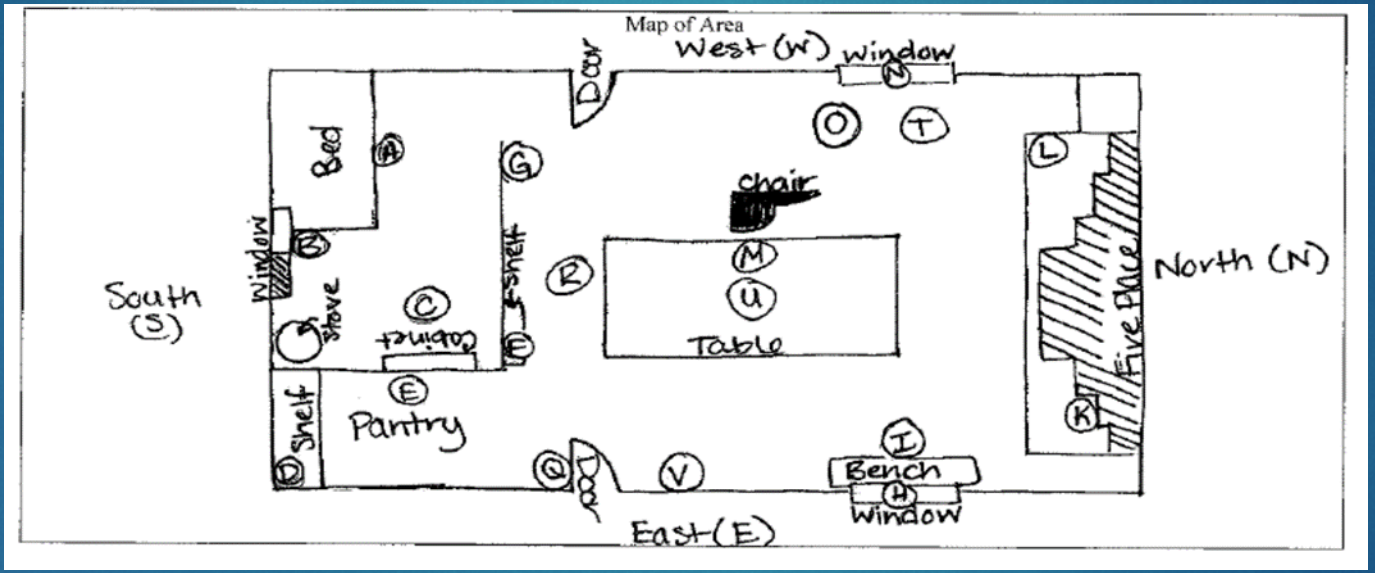
Top left: view of west wall. Top middle: view of south wall. Top right: view of ceiling. Bottom left: view of east wall. Bottom right: view of inside of east door.

Sampling at Pond Cabin Day Two

- PPE: Tyvek suits, knee length booties with rubber soles, safety glasses, nitrile gloves, and an optional respirator with P100 cartridges
  - respirator optional due to the presence of mice droppings in the cabin and their possible disturbance, with the concern being Hantavirus.

- 21 wipe samples (including two blanks)
- 21 micro-vacuum samples (including two blanks)
- Total of 42 samples

Figure 6:
Sketch of the Pond Cabin Sampled Locations



Pond Cabin sketch

Figure 8A:
Pond Cabin Main Room Sampled Locations

Top left: view of the west entrance. Top middle: view of the west side of the cabin. Top right: view of the east side of the cabin. Bottom left: view of the main room and west and north side of the cabin. Bottom right: view of the east entrance.

Figure 8B:
Bedroom and Pantry Sampled Locations

Top left: bedroom window and bed. Top right: bedroom stove and dresser cabinet. Bottom left: bed in the bedroom. Bottom right: pantry area.

Sampling Details continued…

- Used PPE and disposable equipment was bagged and placed in the buildings until the results were analyzed, after which coordination of proper disposal was conducted with a LANL waste management coordinator.
- A Chain-of-Custody form and a total of 72 samples were submitted for analysis to ALS Environmental Laboratory in Salt Lake City, UT.
- A National Institute for Occupational Safety and Health (NIOSH) 7300 Panel B metal sampling analysis was requested.
  - Includes 27 metals: aluminum, arsenic, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, lithium, magnesium, manganese, molybdenum, nickel, phosphorus, platinum, selenium, silver, sodium, tellurium, thallium, titanium, vanadium, yttrium, zinc, and zirconium.
  - Key metals of interest are beryllium, cadmium, lead, aluminum, iron, and yttrium due to history of area.

Results: Comparison Statistics of Micro-vacuum vs. Wet Wipe Sampling

- To compare the micro-vacuum and wet wipe techniques statistically, beryllium (Be) and lead (Pb) values for both techniques were used because these were the only two metals out of the Panel B metal scan that had LANL internal housekeeping limits to compare the values to.

- As previously mentioned:
  - Be internal housekeeping limit = 0.2 ug/100cm^2 for Be surface contamination
  - Pb internal housekeeping limit = 21.5 ug/100cm^2 for Pb surface contamination.

Table I: Bunker Building Micro-vacuum vs. Wet Wipe Comparison

Be	Analysis	N*	Minimum	Maximum	N < LOD (N/%)	LOD < N < RL (N/%)	N > RL (N/%)	N ≥ 0.2 ug/100cm² (N/%)
	Micro-vacuum	13	LOD	0.0074	9 (69.2%)	4 (30.8%)	0 (0%)	0 (0%)
	Wipes	13	LOD	0.016	5 (38.5%)	2 (15.4%)	6 (46.2%)	0 (0%)
Pb	**Analysis**	**N***	**Minimum**	**Maximum**	**N < LOD (N/%)**	**LOD<N<RL**	**N > RL (N/%)**	**N ≥ 21.5 ug/100cm² (N/%)**
	Micro-vacuum	13	LOD	5.7	8 (61.5%)	3 (23.1%)	2 (15.4%)	0 (0%)
	Wipes	13	LOD	510	0 (0%)	1 (7.7%)	12 (92.3%)	6 (46.2%)

*excludes field blanks

Note: The LOD for Be was 0.0038 ug/sample for the micro-vacuum samples and 0.0021 ug/sample for the wipe samples. The LOD for Pb for the micro-vacuum and wipe samples was 0.38 ug/sample. The RL for Be for the micro-vacuum samples was 0.013 ug/sample and 0.0071 ug/sample for the wipes. The RL for Pb for the micro-vacuum and wipe samples was 1.3 ug/sample.

Table II: Paired, Two-tailed t-test for Bunker Building Micro-vacuum and Wet Wipe Comparison

Be	N*	Mean (ug/100cm^2)	Standard deviation	Probability for Paired 2 tail t-test
Micro-vacuum	13	0.0017	0.0028	0.0209
Wipes	13	0.0070	0.0067	
Al	**N***	**Mean (ug/100cm^2)**	**Standard deviation**	**Probability for Paired 2 tail t-test**
Micro-vacuum	13	9.4	16.29	0.0230
Wipes	13	706.92	980.96	
Fe	**N***	**Mean (ug/100cm^2)**	**Standard deviation**	**Probability for Paired 2 tail t-test**
Micro-vacuum	13	218.03	422.25	0.0985
Wipes	13	7396.15	14845.04	

*excludes field blanks

Table III: Pond Cabin Micro-vacuum vs. Wet Wipe Comparison

Be	Analysis	N*	Minimum	Maximum	N < LOD (N/%)	LOD < N < RL (N/%)	N > RL (N/%)	N ≥ 0.2 ug/100cm² (N/%)
	Micro-vacuum	19	LOD	0.039	13 (68.4%)	5 (26.3%)	1 (5.3%)	0 (0%)
	Wipes	19	LOD	0.31	0 (0%)	0 (0%)	19 (100%)	7 (36.8%)
Pb	**Analysis**	**N***	**Minimum**	**Maximum**	**N < LOD (N/%)**	**LOD<N<RL**	**N > RL (N/%)**	**N ≥ 21.5 ug/100cm² (N/%)**
	Micro-vacuum	19	LOD	3	17 (89.4%)	1 (5.3%)	1 (5.3%)	0 (0%)
	Wipes	19	LOD	150	0 (0%)	1 (5.3%)	18 (94.7%)	10 (52.6%)

*excludes field blanks

Note: The LOD for Be was 0.0038 ug/sample for the micro-vacuum samples and 0.0021 ug/sample for the wipe samples. The LOD for Pb for the micro-vacuum and wipe samples was 0.38 ug/sample. The RL for Be for the micro-vacuum samples was 0.013 ug/sample and 0.0071 ug/sample for the wipes. The RL for Pb for the micro-vacuum and wipe samples was 1.3 ug/sample.

Table IV: Paired, Two-tailed t-test for Bunker Building Micro-vacuum and Wet Wipe Comparison

Be	N*	Mean ($ug/100cm^2$)	Standard deviation	Probability for Paired 2 tail t-test
Micro-vacuum	19	0.0037	0.0090	4.226×10^{-8}
Wipes	19	0.1535	0.0758	
Al	**N***	**Mean ($ug/100cm^2$)**	**Standard deviation**	**Probability for Paired 2 tail t-test**
Micro-vacuum	19	27.832	83.210	8.867×10^{-9}
Wipes	19	1590	713.92	
Fe	**N***	**Mean ($ug/100cm^2$)**	**Standard deviation**	**Probability for Paired 2 tail t-test**
Micro-vacuum	19	31.668	101.57	1.595×10^{-7}
Wipes	19	1732.1	813.73	

*excludes field blanks

Discussion: Comparison Statistics of Micro-vacuum vs. Wet Wipe Sampling

- Data indicates that the two techniques are statistically different for both buildings.
- Via a comparison of the percentages on Be and Pb values alone, the data indicates that the wet wipes were a more efficient method of sampling than the micro-vacuum.
- However, in bunker building comparative statistics data, the Fe probability indicated that the two methods are not statistically different because the micro-vacuum technique was able to detect a sufficient amount of Fe as compared to the wet wipe technique.
  - Fe is a heavier metal in density than Al and Be therefore, this is probably not attributed to weight but may be attributed to the bunker building surface composition.
    - Bunker building has steel inside and iron is one of the elements that composes steel.
    - There are several areas where there is obvious rust on the steel walls.

Results: Determination of Background Be Levels Due to Soil vs. Operational Contamination

Table III

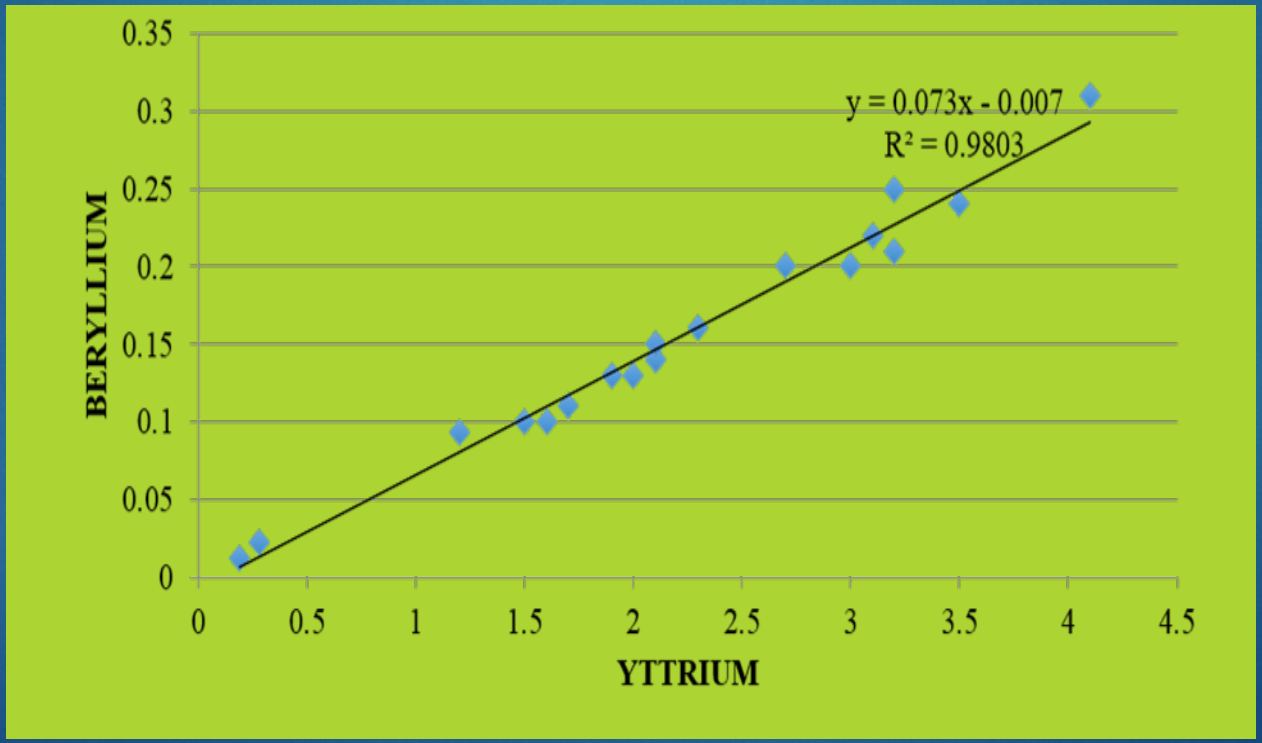
Be	Analysis	N*	Minimum	Maximum	N < LOD (N/%)	LOD < N < RL (N/%)	N > RL (N/%)	N ≥ 0.2 ug/100cm² (N/%)
	Micro-vacuum	19	LOD	0.039	13 (68.4%)	5 (26.3%)	1 (5.3%)	0 (0%)
	Wipes	19	LOD	0.31	0 (0%)	0 (0%)	19 (100%)	7 (36.8%)
Pb	**Analysis**	**N***	**Minimum**	**Maximum**	**N < LOD (N/%)**	**LOD<N<RL**	**N > RL (N/%)**	**N ≥ 21.5 ug/100cm² (N/%)**
	Micro-vacuum	19	LOD	3	17 (89.4%)	1 (5.3%)	1 (5.3%)	0 (0%)
	Wipes	19	LOD	150	0 (0%)	1 (5.3%)	18 (94.7%)	10 (52.6%)

- 7 samples taken at the Pond Cabin had Be levels above internal housekeeping limit of 0.2 ug/100cm^2. Values ranged from 0.2 to 0.31 ug/100cm^2.
- Operational contamination or background levels?
  - Background Be soil levels can be subtracted if known but unknown for area.
  - Could not use background soil data from other sites since may vary due to operational history.

Yttrium Normalization Method

- Prokisch, Kovacs, Palencscar, Szegvari, and Gyori (2000) used an “yttrium normalization method” to determine if high concentrations of elements like chromium that occur naturally in the soil are due to background levels or contamination; since both exist in the soil naturally, a non-contaminated area should have a strong concentration correlation (Prokisch, Kovacs, Palencscar, Szegvari, & Gyori, 2000).
  - Y and Cr concentrations were compared through linear regression and they were strongly correlated; this yttrium normalization technique can be applied to other common elements of the soil as well (Prokisch et al., 2000).
- At other DOE sites, Y and Be concentrations have been compared to determine whether or not Be concentrations were due to background or operational contamination.
- Y and Be concentrations from the Pond cabin were plotted in a scatter plot with yttrium on the x axis and beryllium on the y axis (Figure 9). A linear regression line was run through the values and the equation and the r-squared values were determined.
- The r-squared value for these data was 0.98, indicating a strong correlation between the Y and Be concentrations found at the Pond cabin.
- Therefore, it was determined that the Be levels are due to background soil.

Figure 9: Yttrium vs. Beryllium Linear Regression plot



Results: Presence of Pb and Cd

- Both the bunker building and Pond cabin had wipe samples with Pb concentrations above the HUD limit of 21.5 ug/100cm^2. These levels ranged from 28-150 ug/100cm^2 for 6 samples at the bunker and 22-150 ug/100cm^2 for the 10 samples at the Pond cabin.
  - These concentrations were high enough that it was unlikely that they were due to background concentrations.

- For the wipe samples, 12 of the 13 samples taken (92.3%) at the Bunker building had concentrations above the Reporting Limit (RL); 17 of the 19 samples taken (89.5%) at the Pond cabin had concentrations above the RL.
  - Therefore, cadmium is present in both buildings.

Conclusions

- It was determined from this sampling project that the wet wipe surface sampling technique is more efficient in its ability to collect metal concentrations from surface dust and had results in statistically significant higher concentrations than the micro-vacuum sampling technique.
  - Note: Both buildings had weathered and sat with basically no activity for several decades; there may have been layers of grime or oil on the surfaces that the micro-vacuum technique had difficulty penetrating.
  - As indicated by Brisson and Ekechukwu (2009), surface characteristics of the areas to be sampled (ie. porosity and roughness) as well as the surface dust characteristics (thickness, oiliness) must be considered as these play a role in selection of the proper surface sampling technique (Brisson & Ekechukwu, 2009).

Conclusions continued…

- Currently, DOE is amending 10 CFR 850 guidelines and they suggest micro-vacuum sampling as a method that can be used for exposure monitoring. This data suggests that the sampling methods are not strongly correlated and that results may not be comparable.
  - Until more is known about the efficiency of the micro-vacuum technique in different scenarios, it should not be recommended as a solo method to determine possible surface dust contamination levels.
- The Pond Cabin Be data has compelled LANL Industrial Hygenists to gathering information from other sources and compile a “white paper” on how to statistically determine whether or not Be levels are due to operational or background contamination.
  - Yttrium normalization method has been used at other DOE sites to determine operational vs background contamination. However, there is no official document to support this.
  - This project has propelled LANL to propose new industrial hygiene and statistically-proven methods for determination of background versus operational contamination.

Conclusions continued…

- Due to the Pb contamination and presence of Cd at both buildings, PPE and administrative controls have been put in place for incoming DOE and NPS tourists.
  - Pond Cabin and Bunker Building PPE for entry: booties and gloves.
  - Currently the Pond cabin is lined from the east to the west entrance with plastic so that tourists can visually tour, but not touch, the inside of the Pond cabin; this allows LANL to minimize the waste generated from these tours.
  - In addition, signage about the lead contamination has been posted at both buildings.
  - Future decontamination efforts will have to be implemented before public entry without PPE can be granted.

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Dedication

- First and foremost, I wish to thank God for all the blessings and opportunities He has given me in my life.
- Thank you to my co-workers and supervisors, past and present, who assisted and supported me in the pursuit of my degree.
- Thank you to my husband, and all my family, for being patient with me and supporting me always.
- I dedicate this to my son, Gilbert. May you always know you are the light of my life, the twinkle in my eye, the beat in my heart, and the answer to my prayers. Always reach for the stars, my beautiful baby boy!

QUESTIONS?