

An Assessment of the Potential Presence of Carcinogenic Materials at Non-Military Industrial Sites in Vieques, Puerto Rico

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A. Scope of Work

The purpose of this site assessment was to identify chemically contaminated industrial and non-industrial sites within the non-military areas of the island of Vieques, Puerto Rico and describe environmental exposure pathways for carcinogenic substances.

B. Introduction and Background

United States' involvement with the Island of Vieques began in 1941 when the US Navy purchased large areas of the island for military operations. Essentially the entire eastern and western portions of the island were dedicated and restricted US Naval Property (see Figure 1). The extensive use of these sites for military exercises and ammunitions testing has generated much controversy over the past 35 years and culminated in the Naval withdrawal from the island in 2003. Presently, the eastern and western areas are

designated a National Wildlife Refuge and supervised by the appropriate US agency. However, large select areas are still restricted and legally off-limits to residents and visitors.

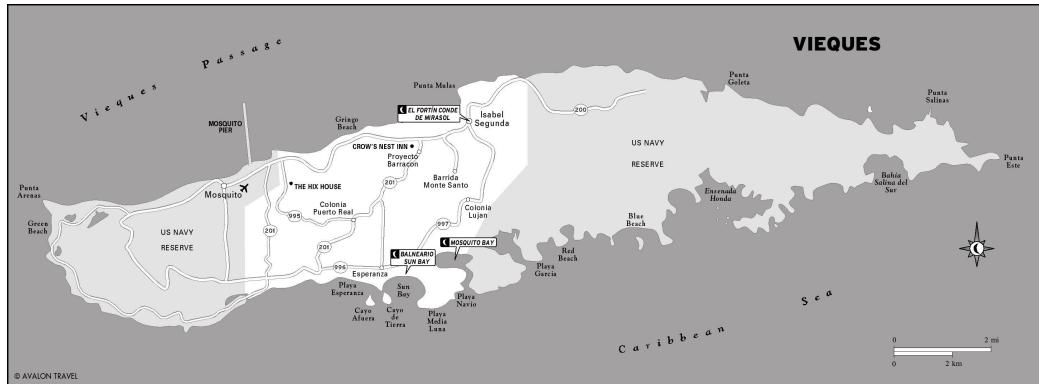


Figure 1: Island of Vieques with former US Navy Jurisdictions

As background, the island is roughly 21 miles long and 4 miles wide and inhabited by approximately 10,000 permanent residents with a substantial population increases during the tourist season (December - June). While beaches are open in the former eastern Naval area, most residential housing is centered on the middle of the island in the northern villages of Isabella and Florida and southern village of Puerto Real. The geography of Vieques consists of rolling hills with no appreciable mountainous areas (maximum elevation 987 feet) and is listed as having a tropical climate with little temperature variation during the year (24° - 30°C).

Water supply for the island is provided by a submerged underwater pipeline across the 18-mile span between mainland Puerto Rico and Vieques. However, numerous private homes have rainwater collect system with storage cisterns. It was not clear if rainwater was used as potable water or simply for washing or gardening. Island electricity is provided by PREPA (Puerto Rico Electric Power Authority) from mainland PR via underwater cables.

Primary transportation on Vieques is by private automobile using single and double lane paved roads. Access to the island is either by commercial small propeller plane from San Juan or by ferryboat. Given the high cost of air travel and the nominal cost of ferry travel, residents almost exclusively travel to and from the main island using the ferry.

At the request of Green Cross Switzerland, a team visited the island in September 2015 to explore potential past or present waste sites that may produce a carcinogenic risk to residents of the island. The team consisted of Jack Caravanos (author) and an environmental health graduate student, Jon Carrelli. Dr. Caravanos spent 5 days on the island and Mr. Carrelli 4 days.

C. Methods

The site investigation for the identification of properties or sites capable of producing a carcinogenic risk to humans through either air, soil or water exposure pathways was addressed using the following methods:

1. Visual Identification and Assessment (25-29 September 2015)

Using a rented vehicle, the team traveled extensively to all villages within the inclusion zone (villages and areas having no history of US Naval activity or authority). When suspect sites were identified, the team left the vehicle and walked the property looking for evidence of past or present contamination (i.e. stained soil, stressed vegetation, metallic objects, industrial equipment and building foundations). If a site contained any of these items, surface soil sampling using a portable X-ray Fluorescence metals detector was conducted and well as ionizing radiation readings. GPS coordinates were also collected and stored.

2. Environmental Screening / Sampling

Carcinogenic materials fall under a number of chemical and physical forms including metals such as arsenic and hexavalent chromium and volatile or semi-volatile organic compounds such as pesticides, polycyclic aromatic hydrocarbons and formaldehyde. In addition, various chemical dusts such as asbestos and silica are confirmed IARC Group 1 (human) carcinogens. In short, there are 481 agents listed by IARC as either carcinogenic or probably/possibly carcinogenic to humans. There is no single portable instrument available to quantify the 400+ chemical or agents that may cancer in humans.¹

Given the scope of the assignment, the team chose to conduct heavy metal screening as a surrogate to chemical contamination. The idea being, if a site was contaminated with industrial compounds (several of which may be carcinogenic), then residual heavy metals would likely still be present in the soil. While organics and semi-volatiles are easily mobilized and degrade more rapidly than metals, the presence or absence of heavy metals would be an appropriate alternate chemical surrogate of contamination. An *Innov-X* portable hand-held X-ray fluorescence heavy metals detector (model Alpha-4000) was used to test surface soil for metals. This unit reports in-situ results within the top 3 centimeters of soil for 34 elements including Arsenic, Cadmium, Chromium, Cobalt, Lead, Manganese and Mercury. The reporting unit for this instrument is milligrams per kilogram soil (aka ppm). A pre and post calibration check using standard reference material was conducted throughout the equipment's usage.

The team also took a *Jerome 405J* mercury in air direct reading instrument. While mercury is not a suspect human carcinogen in any form, the presence of airborne mercury was used as a surrogate for other industrial contamination.

¹ International Agency for Research on Cancer, <http://monographs.iarc.fr/ENG/Classification/>

Finally, continuous ionizing radiation readings were taken during the entire site visit using a *Gamma-Scout Standard* radiation detector / Geiger counter. Readings for total ionizing radiation (α , β , γ) were reported in micro-Sieverts per hour (uSv/hr).

3. Interviews (residents, business owners/operator and local regulatory agency)

During the teams 5 days on Vieques, we repeatedly asked local residents, shop owners and hotel proprietors for information regarding industries on Vieques or other clues to environmental contamination not associated with US Naval activities. At least 20 individual "informal interviews" were conducted discretely and anonymously.

The US Environmental Protection Agency maintains a field office in Vieques and is staffed by a single individual. An appointment was made to discuss past and present US EPA activities on the island as well as industrial activity. The meeting took place at US EPA offices during the middle of the assessment period (i.e. 28 September).

4. Record Review (internet based)

The team searched publically available records from a variety of Internet sources for publications, reports, datasets and general information regarding industries, waste sites, chemical contamination and spills, and other environmental information applicable to the scope of the project. Specific attention was focused on documents and records from the US Environmental Protection Agency (including Toxic Release Inventory database), Center's for Disease Control (ATSDR report) and the US Navy.

D. RESULTS

1. Results from Visual Identification and Assessment:

The following sites were discovered/investigated.

PETROLEUM / GASOLINE STATIONS: Vieques has 2 operating petrol (gasoline) service stations. A third station has been closed for some time. In discussion with the local US EPA environmental office for Vieques, it was reported that the stations are in compliance with underground storage testing requirements as per 40 CFR 280. Given the lack of evidence of contamination and human exposure pathways, it is very unlikely any petroleum products have substantially impacted air, water or soil in Vieques.

INDUSTRIAL FACILITIES: The islands only major industrial facility is General Electric (GE) Industrial of Puerto Rico LLC (property owned by Puerto Rico Industrial Development Corporation) on the north side of the island near the main population center (Lat/Long 18.14004, -65.45798). This small, approximately 4-acre site, manufactures various small electrical components such as fuses, relays and switches. Given the discovery of the industrial solvent and cleaner, trichloroethylene, a dense

non-aqueous phase liquid (DNAPL) in groundwater below the property, the site is under a voluntary cleanup and ground water monitoring order as per US EPA ². According to US EPA records, the site has undergone “clean closure certification” as of March 2005. A Human Exposure report detailing the events at the site with monitoring results claims the site did not and does not pose any credible adverse public health risk ³. The final US EPA order for closure is anticipated in 2016. Given the lack of a clear human exposure pathway, it is very unlikely any organic materials (DNAPLs) have substantially impacted air, water or soil in Vieques. See photos

AGRICULTURE / CANE INDUSTRY: Presently, there is no major agricultural or farming industry on Vieques. Residents practice subsistence farming with low pesticide and herbicide usage; as reported by several residents and shop owners. Historically the island had extensive cane sugar operations with production facilities throughout the northern portion of the island. However, during the 1920’s operations were suspended and went into steady decline. Remnants of the cane industry can be found throughout the island in the form of foundations and piers. Given the lack of any contamination source as well as the length of time that has transpired, it is very unlikely any material from these past activities or buildings impacted air, water or soil in Vieques.

PETROLEUM OPERATIONS: At the time of the assessment, there did not appear to be any past or present petroleum or fossil fuel delivery or storage operations on Vieques. Fossil fuels are delivered by lorry (truck) on the main ferryboat from Puerto Rico. Given the lack of any contamination source it is very unlikely any material from fuel delivery or storage has impacted air, water or soil in Vieques.

SOLID WASTE MANAGEMENT FACILITIES: The team identified one solid waste management facilities (sanitary landfill) due east of the main village of Isabella (Lat/Long 18.14929, -66.41660). This facility is the sole solid waste handling site for Vieques and consists of several distinct disposal sites; namely an e-waste site, a putrescible garbage site, an organic/yard waste site and an automotive/metals disposal site. Each site was visited and visually assessed as well as tested for heavy metals in soil, mercury vapors in air and radiological materials. Our assessment yielded no apparent source of organic or inorganic materials of environmental consequence as well as no radiological materials. Given the lack of any contamination source as well as the distance from any appreciable population receptor, it is very unlikely any material from these waste management sites has impacted air, water or soil in Vieques.

AUTOMOTIVE REPAIR FACILITIES: Several residents and officials of Vieques informed us of the presence of several private and unlicensed auto repair shops in the surrounding villages. These shops are dispersed somewhat randomly throughout the

² GE Industrial of Puerto Rico LLC, Vieques Plant, <http://www3.epa.gov/region02/waste/fsgeviequ.htm>

³ US EPA Human Exposure Report <http://www3.epa.gov/region02/waste/gevequ725.pdf>

center region of the island and range from small (2-4 cars in the “shop”) to large (6+ automobiles) on an acre of more of land. Approximately 6 auto repair sites were discovered with others possible. No noticeable odors were present during our investigation of these sites. Given the private nature of these businesses, sampling was limited to the public portion of the road outside these sites. While the shops likely created occupational health risks and chemical exposures to the operators and residents living at the site, general population exposures were unlikely. Given the lack of any significant contamination source and the limited population at risk, it is very unlikely any material from these repair shops significantly impacted air, water or soil in Vieques. See photos

WATER PUMPING STATIONS: While all potable water is delivered to the island via underwater pipeline from Puerto Rico, the distribution of water to villages necessitates the use of local pumping stations and storage tanks. There are numerous small pumping stations on the islands with many using diesel powered engines for backup pumps. These sites were all fenced off and appeared well manicured and maintained. Fuel storage tanks were well labeled and surrounded by secondary leakage containment. Given the lack of any significant contamination source and the limited population at risk, it is very unlikely any material from these drinking water pumping stations significantly impacted air, water or soil. See photo

GENERAL FIELD OBSERVATIONS: Lastly, the team travelled extensively to all regions of Vieques focusing special attention on residential and populated neighborhoods. Where there was a site with large vacant land, or a site with evidence of past buildings (i.e. old foundations) or a current industrial buildings the team conducted a careful and thorough visual inspection with periodic soil sampling. Given the lack of any significant contamination source and the limited population at risk, it is very unlikely any material from these properties significantly impacted air, water or soil in Vieques. See photos

2. Results from Environmental Screening (Sampling)

SOIL METALS CONTENT: Thirty-one XRF readings were taken from the various sites listed above. For Arsenic, Cadmium, Chromium and Mercury all soil samples were non-detects (i.e. <LOD). The lead in soil content varied from non-detectable (16 readings) to 105 ppm (US EPA guideline – 400 ppm). Lead is not a cancer causing substance.

MERCURY IN AIR READINGS: In short, all mercury air levels taken during the visual assessment were at the non-detect level (i.e. 0.00 ug/m³). The Jerome mercury was used extensively at the solid waste facility and the GE Plant in the continuous mode setting. No positive mercury in air readings were observed.

RADIATION READINGS: The Gamma Scout Ionizing Radiation Meter is also a continuous direct reading instrument. Radiation readings fluctuated along background levels from 0.08 to 0.13 uSv/hr. At no time during the visual inspection of any site did readings go beyond 0.13 uSv/hr.

3. Results from On-Site Interviews:

During the almost two-dozen interviews and contacts with local residents and business owners there was complete unanimity regarding the absence of any industries (other than the GE facility) on Vieques. Whether past or present, no individual reported any facility with chemical storages, use or noteworthy news items.

During the 1-hour interview with the local US EPA official, he was quite open and accommodating on all the activities on Vieques. Having been stationed on Vieques for many years, he consistently assured us of the lack of “toxic” waste sites, chemical storage tanks, pesticide storage sites or other potential exposures to hazardous materials. When asked about the infamous radioactive metal/ammunitions assertion at Vieques, he stated that “this was extensively investigated by numerous people” and no such radiation source has ever been uncovered. In short, given the lack of any reported contamination source from a cross section of residents living and knowledgeable of Vieques, it is unlikely any as of yet undiscovered site poses an environmental health threat to air, water or soil.

4. Results from Record Review (internet based)

US Environmental Protection Agency

The US EPA Toxic Release Inventory (TRI) system has several searchable databases that collect and report on storage of chemicals and releases to air, water or land ⁴. All applicable databases have been searched during multiple time periods. Results indicate that, with the exception of copper released from the GE Facility in the mid-2000, no reportable releases or storage of hazardous materials is present on Vieques (zip code: 00765).

US Centers for Disease Control (CDC)

In 2013, the CDC produced an extensive environmental health risk assessment report with the following conclusions (verbatim).⁵

Local Produce and Livestock Pathway

ATSDR evaluated the available data and information on contaminants detected in locally raised garden produce and in livestock.

- The overall data are insufficient to quantify human exposures or draw health conclusions.
Limited sampling data suggest cadmium toxicity may be a concern for excessive consumption*

⁴ Toxic Release Inventory Program, US EPA, <http://www2.epa.gov/toxics-release-inventory-tri-program/tri-data-and-tools>

of pigeon peas, but not for typical consumption rates of pigeon peas.

- *A preliminary data evaluation completed for this report has concluded that the level of cadmium reported in a few samples of locally grown pigeon peas would not contribute excess dietary cadmium to preschool children who eat less than five of the largest (6 ounces) servings per week of locally grown pigeon peas. Adults who eat the largest serving sizes (12 ounces) should limit intake to 11 servings per week. Typical serving sizes for preschool children (1.5 ounces) do not contribute excess cadmium below 20 meals per week and adults who eat a typical serving (3 ounces) may eat up to 44 meals per week without exceeding recommended cadmium intake levels.*
- *The significant uncertainty in the evaluation of cadmium in pigeon peas stresses the need for further sampling. Preliminary evaluation suggests a potential for uptake of metals from soil into food crops. These results warrant further investigation.*

Air

- *We reviewed the data on airborne contaminants from military exercises at the former Vieques Naval Training Facility. This review confirmed our previous findings and indicated that airborne contaminants from past military operations were very unlikely to have had health effects on Viequenses.*

Soil

- *Sufficient data are available to conclude that people who lived on the LIA during the 1999-2000 protests were not exposed to soil contaminants at levels high enough to cause adverse health effects.*
- *Recent data, and the presence of unexploded ordnance at the LIA, support the need for continued, restricted access to the LIA and to other potentially contaminated former military exercise areas. Environmental assessment and remediation activities should continue.*
- *In the island's residential areas, no soil data are adequate to characterize potential exposures fully. To address remaining uncertainties about residential soil contamination issues, ATSDR recommends surface-soil sampling in the island's residential areas.*

Drinking Water

- *With the possible exception of one private well found to contain harmful nitrate-nitrite levels, all drinking water supplies in Vieques are acceptable for their current uses. ATSDR recommends no one drink from the one private well until further testing confirms its water is safe.*
- *Ongoing monitoring of the current pipeline-source water is required to ensure the supply meets drinking water standards. Repeating previous sampling of storage tanks, residential taps, and wells still in use would address any remaining uncertainty.*

5. Naval Reports (Radiation Activities on Vieques):

a. Depleted Uranium Munitions:

There have been numerous claims of radiation. During the US Navy's military presence on the island, it has been reported that depleted uranium penetrators have been used in the restricted areas⁵. Ammunitions made from depleted uranium are much harder and denser than existing materials and offer enhanced penetration of the target. The shells contain approximately 60% of the radioactivity of natural uranium. DU shells are coated with thin metal to prevent radiation exposure while handling.

⁵ http://www.atsdr.cdc.gov/hac/pha/vieques/Vieques_Summary_Final_Report_English_2013.pdf

The depleted munitions shells are likely concentrated on portions of the island used by the military. However it's reasonable to assume that some shells fell into surrounding waters. Given the location of use, density, low solubility and the encasement of these shells in protective metal, the risk to humans from environmental mobility and aquatic contamination is likely very low.

b. USS Killen - Navy Destroyer used and scuttled at Vieques

This ship was launched in 1941 and used in the Pacific during World War II. It was decommissioned in 1946 and later used during atomic bomb testing in the US Marshall Islands. During this testing the ship was contaminated with nuclear fallout and subsequently cleaned. In 1962 it was taken through the Panama Canal to the east coast and used in high explosive testing in Chesapeake Bay. It was subsequently towed to Vieques (in 1975) and used as a bombing range target, and later scuttled within the restricted zone (i.e. Bahia Salina del Sur).

The most extensive and up to date radiation study of the USS Killen at Vieques was prepared by Underwater Ordnance Recovery, Inc. under the direction of James Barton and Professor James Porter entitled "Radiological, Chemical and Environmental Health Assessment of the Marine Resources of the Isla de Vieques Bombing Range, Bahia Salina del Sur, Puerto Rico.⁶ This comprehensive assessment addressed many aspects of environmental exposures with the following conclusions (verbatim).

A. *Given the history of the USS Killen's use as an atom bomb test ship in 1958:*

1) What is the radiological signature of the site today?

ANSWER: We recorded normal ambient readings.

2) What threat do these readings present?

ANSWER: None whatsoever.

3) What action needs to be taken?

ANSWER: None; the wreck of the USS Killen should be left undisturbed to provide marine habitat.

B. *Noting the presence of hundreds of 55 gallon drums in and around the wreck of the USS Killen:*

1) What is the radiological signature in and around the barrels?

ANSWER: We recorded normal ambient readings.

2) What are the physical contents of the barrels?

ANSWER: Most barrels have less than 20% levels of sediment, containing soil remnants, cut up electrical cable, empty cartridge cases, sand, mud, and seashells.

3) What do laboratory analyses of samples collected from the barrels and nearby sediment show?

ANSWER: The barrels contain no detectable explosive residues or hazardous levels of heavy metals listed in the Resource Conservation Recovery Act (RCRA).

4) What action needs to be taken?

ANSWER: None; the barrels should be left undisturbed to provide marine habitat.

C. *Noting the presence of underwater unexploded ordnance (UWUXO) in the vicinity of the USS Killen:*

1) What physical impact do UWUXO have on the marine environment?

⁶ http://www.delphinschutz.org/informationsmaterial/gefahren/munitionsaltlasten/vieques_island_pr_study.pdf

ANSWER: In addition to damage caused by initial contact with the sea floor, some items including 16-inch projectiles weighing in excess of 2000 lbs move during each storm surge, damaging fragile marine life in their path.

2) What toxicological impact does decaying ordnance have on this marine environment?

ANSWER: Laboratory analysis of marine life, water and sediment samples collected in and around a decaying bomb found TNT residue and nitrates consistent with those of bomb explosives.

ANSWER: Measurable readings of explosive residues were detected in biota from the vicinity of the bomb, with concentrations decreasing with increasing distance from the source.

3) What threat do decaying ordnance items pose?

ANSWER: From a toxicological viewpoint, these readings are localized, and pose a minimal threat to humans.

ANSWER: From an environmental viewpoint, evidence shows that toxic materials are leaking from UWUXO and are suffusing into the environment and the biota.

ANSWER: As an explosive hazard, unexploded munitions are unlikely to detonate when left undisturbed.

ANSWER: The risk of detonation increases as more people have access to unexploded munitions, particularly those ordnance items found at the shoreline or in shallow water.

4) What action needs to be taken?

ANSWER: Due to the risk of detonation with increased human access and the patterns of environmental leaching, spread and bioaccumulation in their immediate vicinity, UWUXO and related debris located from the high water mark on shore to the bottom of Bahia Salina del Sur should be removed.

ANSWER: Non-destructive removal of UWUXO is recommended, and should be employed on exposed munitions only.

ANSWER: UWUXO buried beneath the reef, or located beneath the sea floor should be left in place.

ANSWER: Since the adverse impact UWUXO's have on the marine ecosystem is related to the number of UWUXO's present, we recommend a detailed survey be conducted to determine the total number of ordnance in the waters surrounding the live impact area.

ANSWER: Bahia Salina Del Sur should be designated as a marine sanctuary to ensure that further damage does not occur, and to promote the restoration of the Vieques coral reef ecosystem.

ANSWER: Permanent boat anchorages should be established in Bahia Salina del Sur to minimize interaction of boat anchors with benthic organisms and buried ordnance.

D. Noting the presence of small amounts of explosive compounds in the vicinity of the USS Killen:

1) Is it safe to eat the fish and lobster collected there?

ANSWER: Yes; concentrations of explosive chemicals found in fish and lobster collected in the vicinity of the USS Killen are below the EPA's Risk-Based Concentrations for commercially edible seafood.

ANSWER: It must be noted that there is a lower concentration of UWUXO in the vicinity of the wreck of the USS Killen than other areas within Bahia Salina del Sur, and that fish and lobster collected from those areas may contain higher amounts of toxic chemicals.

Given these conclusions from a March 2004 report, the likelihood that this source has contaminated non-military aquatic regions of Vieques remains low.

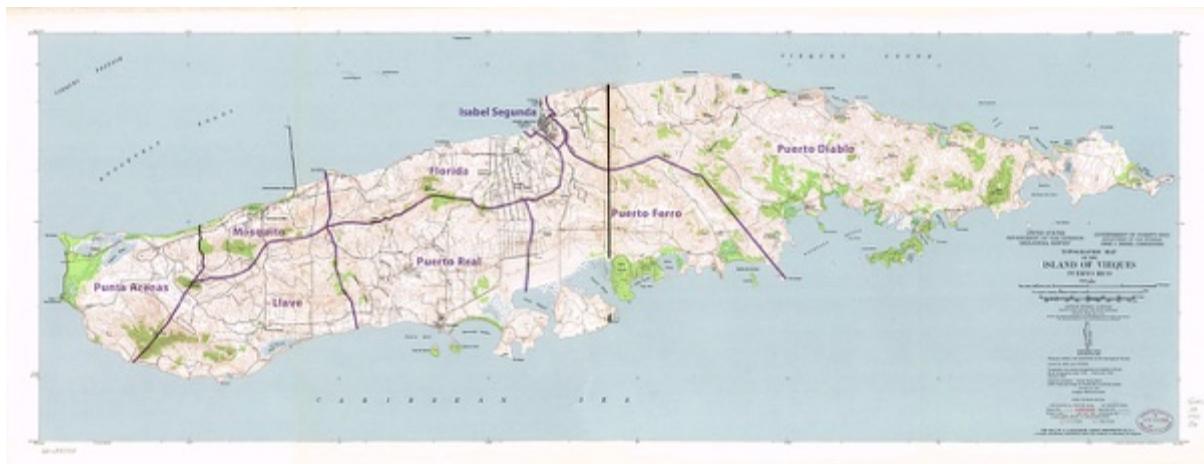
E. Conclusion

All environmental site assessments have limitations and uncertainties. The total land area of Vieques is 135 square km (52 sq. miles) and even though $\frac{1}{3}$ is residential (non-military) land, it is possible that a very remote jungle area may have environmental chemical contamination. However, given that residents did not and do not consumer local groundwater together with the remoteness of such a source, it's highly unlikely

that a significant carcinogenic exposure would be present; and clearly no one has reported such a source.

In this particular assessment, every effort was made to arrive at a scientifically defensible conclusion. Using a combination of visual inspection, personal interviews, environmental sampling and review of published records, the team feels very confident in its methodology and determination that the residential (i.e. non US Navy occupied) areas of Vieques does not appear to have any facility that presently is releasing or has the potential to release carcinogenic agents to either air, water or land (soil). Additionally, no evidence of past chemical releases of significance has been identified. Finally, while claims of radiological materials, wastes or ammunitions are periodically made, there does not appear to be any credible objective data that substantiates such a claim.

Therefore, we conclude that the Island of Vieques is free of any identifiable environmental sources of cancer causing materials arising from anthropomorphic activities including industrial waste sites or soil contamination.



Photos from Site Visit

| | |
|-------------|-------------|
| GE Facility | GE Facility |
|-------------|-------------|



GE Facility



Solid Waste Facility



XRF Soil Testing for Metals



Solid Waste Facility



Photos from Site Visit

Automotive Repair Shop (informal)



Automotive Repair Shop (informal)



Drinking Water Pumping Station



Abandoned US Navy Warehouse

