

# Health Consultation

---

MATAGORDA ISLAND

ZACHARY, CALHOUN COUNTY, TEXAS

MARCH 31, 2009

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES  
Public Health Service  
Agency for Toxic Substances and Disease Registry  
Division of Health Assessment and Consultation  
Atlanta, Georgia 30333

## **Health Consultation: A Note of Explanation**

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

You May Contact ATSDR Toll Free at  
1-800-CDC-INFO

or

Visit our Home Page at: <http://www.atsdr.cdc.gov>

HEALTH CONSULTATION

MATAGORDA ISLAND  
ZACHARY, CALHOUN COUNTY, TEXAS

Prepared by:

Division of Health Assessment and Consultation  
Site and Radiological Assessment Branch  
Agency for Toxic Substances and Disease Registry

## **Summary and Statement of Issues**

In May 2008, the US Environmental Protection Administration (USEPA) Region VI office in Dallas, Texas requested that the Agency for Toxic Substances and Disease Registry (ATSDR) review radiologic data collected on Matagorda Island, southwest of Galveston, TX. Elevated levels of radioactivity had been detected during a survey by Texas Conservation of Environmental Quality (TCEQ) personnel who identified areas along the beach that had radiation levels 10-40 times background. In response, the US Fish and Wildlife Service requested that USEPA conduct an assessment of specific areas on Matagorda Island, TX. This surveying activity was considered a Phase 1 assessment.

ATSDR prepared a technical assistance for the USEPA and recommended that additional exposure readings be taken to determine if the readings are elevated in other beach areas. ATSDR also recommended that environmental samples be collected at those areas in which the exposure readings exceed 10 times background.

In February 2009, USEPA Region VI requested a second evaluation by ATSDR on new data that had been collected following the recommended sampling. The request included determining if the radioactivity was naturally occurring and to make health recommendations based on the detected concentrations.

## **Background**

### **Site Description and History**

Matagorda Island is 38 miles long and varies in width from less than a mile to about four and a half miles. The island includes is a wildlife management area (WMA) and a Texas state park. The Matagorda Island WMA consists of 56,688 acres of offshore barrier island and bayside marshes jointly owned by the Texas General Land Office and the U.S. Fish and Wildlife Service. The island is jointly managed as the Matagorda Island National Wildlife Refuge and State Natural Area. Texas Parks and Wildlife manages the area for public use and the US Fish and Wildlife Service has the main responsibility for managing the wildlife and habitat on the island.

Wildlife on the island is varied and includes a wide variety of migratory birds, almost 20 state or federally listed threatened or endangered species, a large herd of white-tailed deer, alligators and other wildlife. Recreational activities on the island include salt-water fishing, hunting (in season), birding, picnicking and interpretation of island history. A lighthouse dating from 1852 still stands at the north end of the island. During the 1950s, the island housed a US Air Force Base and an associated bombing area.

Because the island is in the Gulf of Mexico, the state annually collects waste containers that wash up on the shores of the island. The wastes are evaluated for the presence of hazardous and radioactive materials. During the 2008 collection effort, the Texas Department of Environmental Quality detected elevated levels of radioactivity along portions of the island. As a result the US Fish and Wildlife requested assistance from the USEPA.

---

---

## **Demographics**

No permanent residents reside on the island. Access is only by boat and no motorized vehicles are allowed on the island. Furthermore, there is no electricity or drinking water on the island and camping is limited. The state estimated that 5,000 individuals visit the island annually.

## **Community Health Concerns**

There is no community on the island.

## **Discussion**

On August 20, 2008, USEPA, TCEQ, USFW and USEPA START collected approximately six soil samples in areas where elevated radiation readings were found. The six soil samples were collected near the Phase 1 assessment locations. Some sand from the previously determined areas of concern had moved. USEPA assumes that the sand was displaced due to the changing tides. The six soil samples were submitted to the USEPA National Air and Radiation Environmental Laboratory (NAREL) in Montgomery, Alabama for radionuclide analysis. Additional soil samples were collected and will be sent to a laboratory for mineralogy identification.

Sample analysis by NAREL included isotope separation by column chromatography followed by radioisotopic identification. The laboratory also performed quality control evaluation on their procedures including reagent blanks. All samples including a duplicate field sample passed the quality control procedures.

The results supplied to ATSDR included the laboratory data sheets which included not only the sample measurement but the 2 sigma error representative of a 95% confidence level but also included the minimum detectable activity of each isotope identified. This allowed for more detailed analysis by ATSDR than would have been possible if the results alone had been supplied.

For the uranium analysis, the isotopes identified included uranium 238 (U 238), U 235, and U 234. The analysis of thorium included the isotopes thorium 232 (Th 232), Th 230, Th 228, and Th 227. Only Th 232 is considered naturally occurring, the remainder is considered natural and decay products of U 238 (Th 230), U 235 (Th 227), and Th 232 (Th 228). U 234 is also produced by the decay of U 238.

To determine if the radioisotopes detected were indicative of natural radioactivity, one can evaluate several ratios of these isotopes. In undisturbed soils, the activity of U 238 and U 234 should be about equal; whereas, the activity of U 238 should be about 22 times that of U 235. Furthermore, the activity of U 238 should be about equal to Th 230 and the activity of U 235 should be about equal to Th 227. In the case of Th 232, its activity should be about equal to the activity of Th 228. These equalities are determined by the decay chain and the process of secular equilibrium. Simply, secular equilibrium defines the activity of decay products as compared to the parent, in this case, U 238, U 235, or Th 232. These data evaluations are shown in Table 1

---

and indicated that the calculated ratios of the radioactive constituents were found at the expected value of about 1.0. Although the ratio of U 238/U 235 was not at the expected value of 22, the standard deviation indicates that the range of the values was large. This can be explained by the difficulties in detecting U 235 because of its naturally low concentration and activity in the environment. The lower the activity, more difficult it is to detect. This can be easily seen by the variability of the sample A8.06258F and the duplicate analysis of this same sample, A8.06258-DUP.

Of the 6 samples supplied to ATSDR, one sample was designated as a background sample. The measured value of this sample was subtracted from the other samples to determine the degree to which those samples exceeded background levels. These results are shown in Table 2 for the uranium radionuclides and Table 3 for the thorium radionuclide Th 232 and its decay product Th 228.

**Table 1. Isotopic ratio of Matagorda Island soils**

Isotopic Ratio					
Sample Number	U238/234	U238/235	U235/Th227	U238/Th230	Th 232/228
A8.06257E	8.70E-01	1.89E+01	1.13E-01	8.56E-01	8.53E-01
A8.06258F	1.05E+00	9.92E+00	1.97E+00	9.29E-01	1.07E+00
A8.06259G	7.80E-01	6.68E+00	2.52E-01	9.52E-01	9.15E-01
A8.06260Z	8.73E-01	1.16E+01	6.84E-01	9.44E-01	1.14E+00
A8.06261A	8.74E-01	1.78E+01	4.94E-01	8.22E-01	1.02E+00
A8.06262B	9.67E-01	2.01E+01	2.97E-01	8.97E-01	9.85E-01
A8.06258F – DUP	1.24E+00	2.43E+01	4.80E-01	1.19E+00	1.03E+00
Average	9.03E-01	1.42E+01	6.35E-01	9.00E-01	9.98E-01
Std. Dev.	9.46E-02	5.49E+00	6.84E-01	5.19E-02	1.04E-01

**Table 2. Activity in Matagorda Island soil samples.\***

Sample	U 234	U 235	U 238
A8.06257E†	0.00E+00	0.00E+00	0.00E+00
A8.06258F	1.09E+01	1.17E+00	1.15E+01
A8.06259G	5.58E-01	7.82E-02	4.19E-01
A8.06260Z	5.82E+00	4.43E-01	5.08E+00
A8.06261A	1.41E+00	6.95E-02	1.23E+00
A8.06262B	3.14E+00	1.52E-01	3.05E+00
A8.06258F – DUP	9.51E+00	4.86E-01	1.18E+01

\*Results are expressed in picocuries per gram of soil after subtraction of background.

† Sample A.06257E was listed as the background.

When evaluating both the concentrations of uranium and thorium, the results indicate that two samples, A8.06259G and A8.06261A, are within the variability of background. The remaining

three soil samples ending in 58F, 60Z, and 62B, are significantly elevated above the background location. The USEPA believes the elevated levels are derived from a monazite sand formation in the Colorado River (Texas) that empties into the Matagorda Bay.

*Dose Assessment Estimate:* To determine if the residual radioactive poses a health hazard, ATSDR used the RESRAD computer code to determine the combined dose from the uranium and thorium. The RESRAD code is designed for estimating radiologic issues associated with residual radioactivity; however, the program cannot evaluate short term exposures of less than one year. The radiation dose received after one year exposure were calculated and compared to the ATSDR Minimal Risk Level (MRL).

The values used were the highest concentrations measured, sample A8.06258F. The pathways analyzed included external gamma radiation, inhalation, and soil ingestion. Other pathways were not evaluated because of the island characteristics. Two exposure scenarios were considered. Scenario 1 is an individual who only visits the island one time and spends less than 8 hours in the contaminated area. They are exposed to both external radiation and internal via incidental ingestion. Scenario B is similar; however, the individual camps overnight on the island in the contaminated area for 1 complete year.

**Table 3. Thorium concentrations in Matagorda Island soil samples.\***

Sample	Th 232	Th 228
A8.06257E†	0.00E+00	0.00E+00
A8.06258F	2.72E+01	2.52E+01
A8.06259G	9.64E-01	1.04E+00
A8.06260Z	1.69E+01	1.47E+01
A8.06261A	2.58E+00	2.50E+00
A8.06262B	9.07E+00	9.18E+00
A8.06258F – DUP	2.14E+01	2.07E+01

\*Results are expressed in picocuries per gram of soil after subtraction of background.

† Sample A.06257E was listed as the background.

The estimated radiation dose to a one time visitor to the island, Scenario A, was estimated to be less than 5 millirem above background. This value was obtained by estimating the soil screening value for Th 228 using USEPA soil screening guidance<sup>1</sup>. The soil guidance value calculated by this method was about 1600 pCi/g which yields an estimated lifetime cancer risk of 1 in a million.

The dose assessment for Scenario B, a one year continuous exposure, is given in Figure 1. For this assessment the total dose from all sources (ingestion, inhalation, and external) and the dose arising from only external exposure were evaluated. The computer modeling indicates the majority of the dose arises from external exposure to the thorium decay chain radionuclides. Comparing these values to the ATSDR MRL, as discussed in the ATSDR Toxicological Profile

<sup>1</sup> Environmental Protection Agency web site <http://rais.ornl.gov/rad-ssg/radssl1.shtml> accessed on March 9, 2009.

for Ionizing Radiation<sup>2</sup>, shows that, in this scenario, a continuous one year exposure easily exceeds the ATSDR screening level. The dose also exceeds other federal guidelines and regulations used to protect the public from ionization radiation<sup>3</sup>.

The data in the figure also indicates that even during a short time period, approximately 3 months, the radiation dose arising from the thorium decay products will still exceed the ATSDR MRL for ionizing radiation. Using the soil screening guidelines of the USEPA, the soil guideline for this period of exposure suggests the clean up value for Th 228 and its decay products would be on the order of 4.5 pCi/g of soil. This value is less than the current concentrations of radionuclides found on the island.

## **Child Health Considerations**

In communities faced with air, water, or food contamination, the many physical differences between children and adults demand special emphasis. Children could be at greater risk than are adults from certain kinds of exposure to hazardous substances. Children play outdoors and sometimes engage in hand-to-mouth behaviors that increase their exposure potential. Children are shorter than are adults; this means they breathe dust, soil, and vapors close to the ground. A child's lower body weight and higher intake rate results in a greater dose of hazardous substance per unit of body weight. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. Finally, children are dependent on adults for access to housing, for access to medical care, and for risk identification. Thus adults need as much information as possible to make informed decisions regarding their children's health.

The radiological doses discussed in this public health consultation address the doses received by an adult. A more detailed review of the age adjusted dose coefficients indicates that children would receive a higher dose to the bone surfaces than adults following the intake of Th 232<sup>4</sup>. The bone surface is considered the critical organ for this radionuclide as it is the organ that receives the highest radiation dose.

Matagorda Island is a recreational setting and ATSDR believes that children would be at a higher risk based on their greater incidental ingestion of soils and sands over an extended period of time.

---

<sup>2</sup> Agency for Toxic Substances and Disease Registry (ATSDR). 1999. Toxicological profile for ionizing radiation. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

<sup>3</sup> For example, see 10 CFR 20 entitled Standards for Protection against radiation.

<sup>4</sup> International Commission on Radiological Protection (2001). ICRP database of dose coefficients: Workers and members of the public. Version 2.01.

---



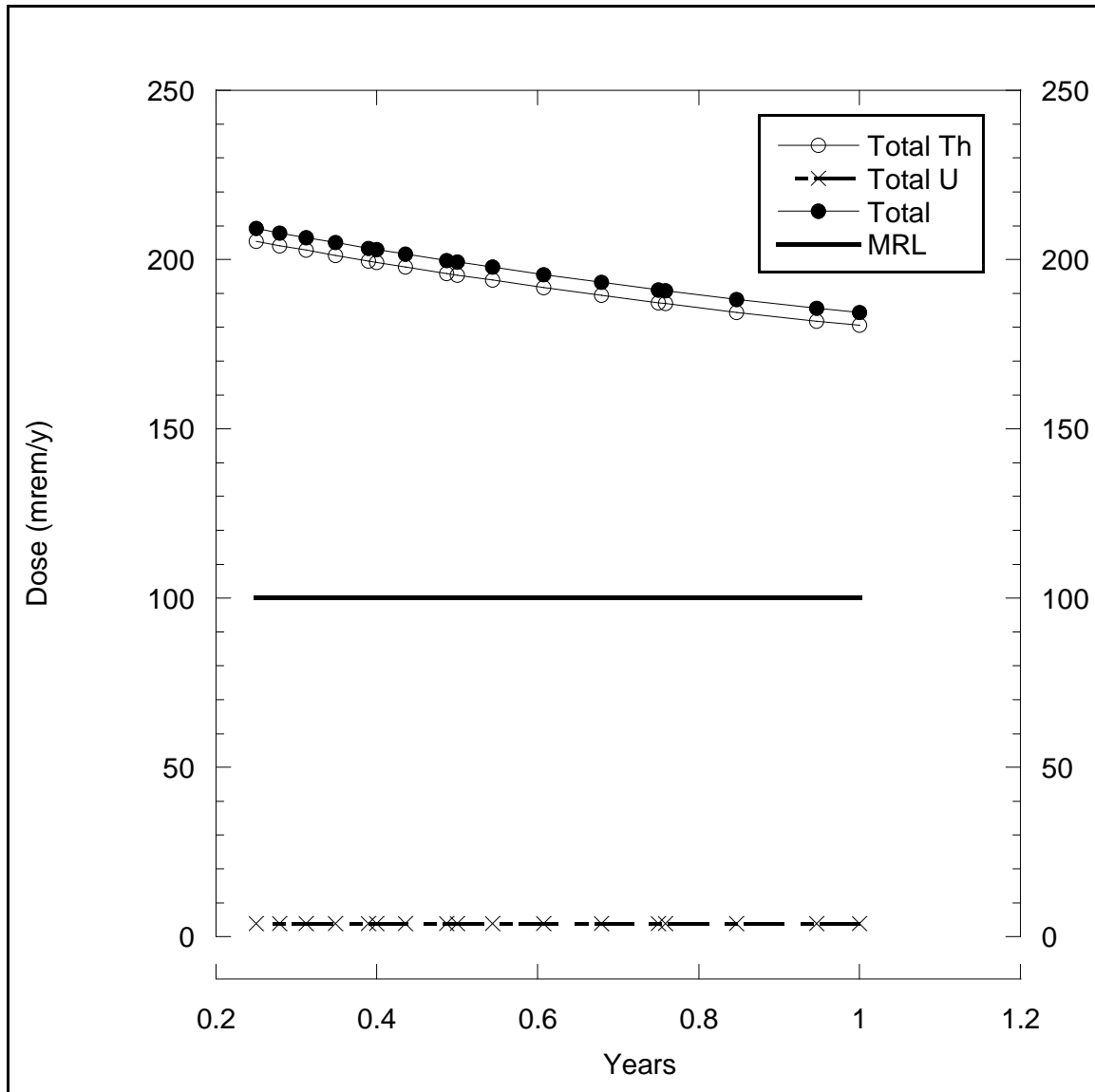


Figure 1. Matagorda Island 1-year Radiation Dose Assessment

## Conclusions

ATSDR has reviewed environmental radiation data supplied to the agency by the USEPA. These data included soil concentrations of uranium and thorium as well as their respective decay products. The data met the quality control and quality assurance protocols in place at the laboratory performing the analysis.

Based on this review, ATSDR believes the uranium and thorium isotopes present on the island are representative of natural radioactivity concentrations as isotopic analysis is present at the expected ratios similar to what is found in nature. This ratio, known as secular equilibrium,

defines the activity of decay products in relation to the activity of the parent radionuclide, in this case, either the uranium or the thorium.

ATSDR received analysis of 6 samples, one of which was defined as a background sample. Of the 5 remaining samples, 3 samples identified with the letters B, F, and Z were significantly elevated over the background for thorium (see Table 3). In the case of uranium, the samples with significantly elevated concentrations were designated with the letters F and Z (see Table 2).

A radiological dose assessment using a model for residual radioactivity (RESRAD) and using extremely conservative parameters, generated values that exceed the ATSDR Minimal Risk Level (MRL) of 100 millrems per year for any individual who spends a significant amount of time on those contaminated portions of the island.

Exceeding the MRL does not indicate that an adverse health problem will develop. When ATSDR develops MRL values, several safety factors, also known as conservative factors, are included in the derivation of the MRL. In the case of Matagorda Island exposures, since there are no permanent populations and that the contamination is not wide-spread, the exposures and doses that ATSDR derived would not represent a typical exposure. Short term exposures to these levels of radiation have not been associated with any adverse health problems. Because radiation doses can vary in the environment in relation to altitude, season, or geological formations, the doses received on Matagorda Island are equivalent of an individual living at high elevations, such as Denver. Also, the radiation doses received here are less than many of the typical medical procedures commonly used today.

Public health conclusion categories help ensure a consistent approach regarding the level of public health hazard present at a site or following a release of hazardous materials. ATSDR has assigned a public health conclusion category to the Matagorda Island Radiation site based on the conclusions presented in this document.

ATSDR assigns the radiological contamination on Matagorda Island as a Category 4, No Apparent Public Health Hazard for the following reasons:

1. The radiological contamination is localized on a small part of the island.
  2. An individual locating the area of highest concentration may be difficult
  3. The radiological dose assessment is based on extremely conservative assumptions. ATSDR calculations for long-term exposure were based on a permanent population on the island or an individual staying in constant contact with the contamination for several months.
  4. There are no utilities on the island nor is there potable water so an individual would not be able to remain onsite for a year.
-

---

## **Recommendations**

In response to the requests made by USEPA to ATSDR, the following recommendations are made to assist the USEPA in determining the proper actions to take for protecting the public.

1. The USEPA or the appropriate state regulatory agency should continue to monitor the island on an annual basis to determine if additional contamination appears. The monitoring would not necessarily consist of soil analysis; however, ambient gamma radiation monitoring should be sufficient.
2. USEPA and island management officials should discuss the options for ensuring long-term occupation of the contaminated areas by campers does not occur.

## **Authors, Technical Advisors**

Paul A. Charp, Ph.D.  
Senior Health Physicist  
Site and Radiological Assessment Branch

---