

# Health Consultation

---

ORDNANCE REEF

WAI'ANAE, HONOLULU COUNTY, HAWAII

OCTOBER 16, 2007

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

ORDNANCE REEF

WAI'ANAE, HONOLULU COUNTY, HAWAII

Prepared By:

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

## Summary and Statement of Issues

The Agency for Toxic Substances and Disease Registry (ATSDR) prepared this health consultation in response to a request by the United States Army (Army) to review the sampling and methodology of the study performed by the National Oceanic and Atmospheric Administration (NOAA) to determine

- 1) the potential public health impact related to the chemicals present in fish and sediments from materials disposed at Ordnance Reef, Hawaii and
- 2) data gaps in sampling, analyses, or methodology.

ATSDR reviewed two documents: *NOAA Ordnance Reef, Wai'anae, Hawai'i: Remote Sensing Survey and Sampling at Disposed Military Munitions Site Final March 2007* and the U.S. Army Center for Health Promotion and Preventive Medicine, *Health Risk Evaluation No. 39-EJ-06UY-07, Ordnance Reef Disposed Military Munitions Site Wai'anae, O'ahu, Hawai'i May 2007*.

As requested by the Army, ATSDR did not address any potential physical hazard posed by the material disposed at Ordnance Reef. ATSDR's health evaluation differs significantly from classical risk assessment in purpose and methodology. As a public health agency, and not an environmental regulatory or clean up authority, ATSDR acts as advisors to citizens, groups, and agencies regarding the body of scientific knowledge of human exposures to chemicals in the environment and whether such exposures would likely result in adverse health effects. ATSDR makes recommendations to stop, reduce, or prevent exposures and for additional public health actions if needed.

## Findings

### *Public Health Impact*

ATSDR reviewed the reports to determine the public health implications of the chemicals present in fish and sediment from disposed materials at the Ordnance Reef site. ATSDR considers ingestion of biota within the area the most significant way in which people could contact chemicals from Ordnance Reef. Contact with chemicals in sediments would not be of sufficient frequency to present a hazard by ingestion or dermal contact.

- 1) The explosive compounds cyclotrimethylenetrinitramine (RDX), trinitrotoluene (TNT), and 2,4,6-trinitrophenyl-N-methylnitramine (teteryl) were not detected in fish.
- 2) As reported in the NOAA study, chemical levels of inorganic chemicals including arsenic, cadmium, lead, mercury, and zinc detected in fish collected from the Ordnance Reef area are below levels shown to cause adverse health effects. Therefore, the detected inorganic chemicals do not pose a public health hazard.
- 3) Although explosive compounds were not detected and the inorganic chemicals detected in fish are not a public health hazard, sufficient information does not exist in the NOAA report for ATSDR to determine the public health implications of consuming fish caught

near the Ordnance Reef site. The following chemicals were reported as non-detected: antimony, cobalt, chromium, copper, selenium, thallium, and vanadium. ATSDR estimated exposure doses using the detection limits reported in Appendix G of the NOAA report. Although based on these estimates, antimony, cobalt, copper, selenium, thallium, and vanadium exceed ATSDR's health screening values, only estimated exposure doses for antimony, thallium and vanadium are close to levels at which health effects have been reported in the scientific literature. Specifically, if the concentrations of antimony, thallium, and vanadium are close to their detection limit, then consuming fish could be a public health hazard.

### ***Limitations of the Reports***

In addition, the Army requested that ATSDR identify any limitations of the study. ATSDR has identified the following limitations.

- 1) Although fish tissue analyses of some inorganic compounds appear as non-detected values, detection limits reported in Appendix G of the NOAA report are higher than the health based comparison values we use to determine adverse health effects. Therefore, no public health determination can be made regarding antimony, thallium, and vanadium in fish tissue.
- 2) The NOAA report does not state the likelihood of military munitions to exist beyond the investigated area. Extent of the investigated area was due to the limitations of the side sonar scanner equipment, yet the report states that clusters of military munitions were also discovered south of the sewage outfall, outside the noted Ordnance Reef site "boundary". Therefore, the criteria for determining the site boundary is unclear.

## **Background**

### ***Site Description***

The site is known by locals as "Ordnance Reef," and appears in NOAA's nautical chart 19340 as "Unexploded Ordnance". The NOAA chart designates the area as 1 nautical mile (nm) by 0.5nm. The area survey was approximately 3nm (3.45 statute miles) in length by 1.5nm (1.7 statute miles) in width on the western, (leeward) side of O'ahu roughly one mile from shore. The survey was conducted at depths of approximately 24 feet to 300 feet (based on the depth limitations of the sonar equipment).

Ordnance Reef is a known munitions disposal area in Pokai Bay, near the island of O'ahu, Hawaii in Honolulu County. The nearest Hawaiian cities are Wai'anae, about 3 miles to the northeast, and Maili, about 5 miles to the east. Honolulu is about a 32 mile drive from Wai'anae.

### ***Local Land Use***

The Wai'anae Wastewater Treatment Plant (WWTP) outfall diffuser pipe, installed in 1986, is reported to be approximately 600 yards southeast of the Ordnance Reef disposal site. Military munitions were also discovered south of the sewage outfall. The outfall pipe at Wai'anae extends 1.1 miles offshore into 108 feet (deep) water. Benthic and fish communities have been

quantitatively monitored at sampling stations every year since 1990 for possible effects of treated sewage effluent inshore of the outfall diffuser discharge (NOAA 2007). In 1996, the WWTP was converted from a primary to a secondary WWTP. Primary treatment removes solids. Secondary treatment is designed to degrade the biological content of the sewage reducing the concentration of the effluent entering the ocean. A noticeable decline in the number of fish around the diffuser was attributed to this conversion (NOAA 2007). The WWTP discharges 3.4 million gallons per day.

The Wai'anae coast is designated Class A waters from Barbers Point at the southern end to Makua Beach near the northern end. Water quality studies along the Wai'anae coast describe a "pristine, unperturbed coastal region". Temperature and salinity values indicate that the region is well flushed and minimally affected by surface runoff of terrestrial sediments (Bienfang 1980, Koch 2004).

Coral reefs are abundant on the Wai'anae coast, in part due to the more protected leeward side of O'ahu. Storms are infrequent but can be severe. Storms during February and March 2006 carried sediment into the study area.

Off-shore activities include fishing, surfing, snorkeling, spear fishing, canoe paddling, swimming, and other boating activities. Additionally, pelagic troll fishing from small vessels between 16 and 30 feet long is popular. Skipjack tuna or aku (*Katsuwonus pelamis*), Yellowfin (*Thunnus albacares*) and bigeye ahi (*Thunnus obesus*), akule (*Selar crumenophthalmus*) and blue marlin (*Makaira mazara*), goatfish or weke (*Mulloidichthys* spp.) and the blue-lined snapper or taape (*Lutjanus kasmira*) are also caught in greater numbers than at most places in the state (HDLNR 2007).

Pokai Bay is a regulated fishing area maintained by the Hawaiian Department of Natural Resources (HDNR 2007). It is legal to take goatfish of a minimum size of 7 inches with a fishing license within the area including the Pokai Boat Harbor and the Wai'anae Small Boat Harbor, the seaward boundary - a straight line from Kaneilio Point to Lahilahi Point, and the northwestern boundary - a straight line extending southwest from the point immediately seaward of Wai'anae High School. Commercial and private fishing licenses are issued for goatfish fishing. Goatfish are extremely popular reef fish to catch and eat. They are typically cooked as whole fish (Glaser 2007, Guzman 2007).

The Makua Military Reservation is roughly 6 nautical miles northeast of Ordnance Reef, 3 statute miles north of Wai'anae. It has been used for military training since World War II. The Makua Valley drains from the Makua Military Reservation to the Wai'anae Coast of Oahu.

### **Demographics**

Wai'anae, which is about 3 miles from Ordnance Reef, covers approximately 3.5 square miles and is considered within the metropolitan area of Honolulu. From the United States 2000 Census, the Wai'anae population totaled 10,506 with an even distribution of males and females. The majority of people consider themselves in the Native Hawaiian, other Pacific

Islander, and/or Asian category. The homeownership rate was about 60 percent, somewhat lower than the national average of 68 percent. The median household income was \$46,717, slightly above the national average (\$41,994) (US Census 2000). These demographic data show that most people maintain a moderately comfortable lifestyle and suggest that subsistence consumption of resources for most people would be by choice and not based on financial necessity.

## Review of Environmental Investigations

ATSDR reviewed the environmental investigation document: *NOAA Ordnance Reef, Wai'anae, Hawai'i: Remote Sensing Survey and Sampling at Disposed Military Munitions Site Final March 2007*. Below, we present a summary of the information relevant to our review.

*Ordnance, Reef, Wai'anae, Hawai'i: Remote Sensing Survey and Sampling at Discarded Military Munitions Site, National Oceanic and Atmospheric Administration (NOAA 2007)*

NOAA independently collected biological, sediment and water sampling data to define the extent of a discarded military munitions sea disposal site off O'ahu Hawai'i. The area is locally referred to as Ordnance Reef. NOAA used a side scan sonar to survey an "81.7 linear mile" area to determine the extent of the munitions area (NOAA 2007).

NOAA analyzed 49 fish and 96 sediment samples for the following inorganic metals: antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, molybdenum, nickel, selenium, silver, thallium, vanadium, and zinc. All of the fish and a portion of the sediment samples were also analyzed for the following explosive-related compounds: HMX, RDX, 1,3,5-trinitrobenzene, 1,3-dinitrobenzene, tetryl, nitrobenzene, 2,4,6-trinitrotoluene, 4-amino-2,6-dinitrotoluene, 2-amino-4,6-dinitrotoluene, 2,6-dinitrotoluene, 2,4-dinitrotoluene, 2-nitrotoluene, 4-nitrotoluene, and 3-nitrotoluene. Water samples were collected and processed for salinity, dissolved oxygen, pH and temperature.

Military munitions were found at a depth of 24 feet to the maximum depth the equipment could detect, approximately 300 feet. Clusters of military munitions not previously identified were found near shore. Discarded military munitions present within the study area range from small arms ammunitions to large caliber projectiles and naval gun ammunition. Identification of the specific munitions was difficult due to the growth of marine life such as coral on the items.



A total of 49 individual representative reef fish were collected throughout the designated survey area. Fish species were selected based on long term residence time within the survey area, represent a variety of trophic levels and feeding niches, and importance as local food fish to the resident population of the Wai'anae Coast of Oahu. Most of the samples (38 of 49) were from the goatfish family (*Parapeneus multifasciatus* (32 fish), *P. pleurostigma* (4 fish), *P. porphyreus* (1 fish) and *Mulloidichthys flavolineatus* (1 fish) these goatfish are called Moano, Weke, 'Oama, and Kumu by local Hawaiians (HDNR 2007). The goatfish feed on worms, crustaceans, small mollusks and heart urchins living in rubble and sand habitats. Other species sampled include *Gymnothorax flavomarginatus*, *Lutjanus kasmira*, *Coris ballieui*, *Parapercis schauinslandii*, *Sufflamen fraenatus*, *Malacanthus brevirostris*, and *Melichthys vidua*, which are carnivorous species, that feed on a variety of invertebrate and vertebrate prey, and were selected for their potential to show biomagnifications of contaminants.

The fish were collected using spears or hook and line. Of the 49 samples, 13 came from the Fish Haven south of the known military munitions disposal area (Control Area), 8 were collected at 2 locations adjacent to the Wai'anae WWTP Outfall (Outfall Area), and 28 came from 11 locations within the military munitions disposal area where military munitions were known or suspected present (Munitions Area). Based on input from DLNR regarding fish consumption in Hawai'i, whole fish were homogenized, and tissue samples were analyzed for heavy metals and explosives. All results were reported on a wet weight basis.

No explosive related compounds were detected in fish tissue. Ninety-eight percent (48 of 49) fish sampled had detectable levels of zinc and 93% (46 of 49) had detectable levels of arsenic. Perchlorate was not included in the analyte list.

ATSDR noted that polychlorinated biphenyls were not included in the analyte list of compounds. The rationale was provided by the Army Assistant for Munitions and Chemical Matters and is included as Appendix A. Based on this response, ATSDR does not believe that PCBs is essential for this study.

Although reported as non-detected, laboratory detection limits for antimony, thallium, and vanadium were not low enough to make a public health determination. ATSDR estimated exposure doses for adults and children based on the detection limit levels. Detection limit levels for antimony, thallium, and vanadium are close to levels at which health effects have been reported in the scientific literature. The assumptions used to estimate exposure doses are provided in Appendix B.

ATSDR agrees with the type of fish selected as being prone to spending their time feeding in this area and would be representative of contamination release from the munitions. While sampling whole fish would not be representative of what most people actually eat, it would give an indication of the highest contaminant levels. This "worst case scenario" is typically used in risk assessments to over estimate exposures to achieve a large margin of safety.



### *Chemicals in Sediments*

Divers sampled areas where munitions had been identified. The explosives RDX, trinitrotoluene (TNT), and tetryl were not detected during the sampling effort, however, a related munitions compound, dinitrotoluene (DNT) was detected in four of the 47 sediment samples (three near munitions, and one not associated with munitions). The distribution of samples exhibiting DNT is largely restricted to this relatively small area, except for one sample, which was collected much closer to shore in only about 20 feet of water depth.

Five sediment samples analyzed displayed a quantifiable amount of explosive type compound and two of the 14 compounds determined by this EPA method were detected above the reporting limit of 0.2 ppm. The two compounds found in these samples are 2,4-DNT and 2,6-DNT. Concentrations of 2,4-DNT ranged from 3.1 ppm to 21 ppm with an average of 8.4 ppm. Concentrations of 2,6-DNT were in two samples at a maximum of 1.4 ppm.

Copper was found at elevated concentrations, the maximum concentration detected was 2100 ppm copper, in the locations close to visually identified munitions. Except for copper, elevated concentrations of metals were not detected in sediments near the munitions located in the Ordnance Reef area, but elevated metal concentrations were detected at the outfall from the on-shore Wai'anae Wastewater Treatment Plant (WWTP).

## **Public Health Implications and Conclusions**

### **Sediment**

Even though it appears that some munitions constituents may have been released to the adjacent sediment, levels of DNT, copper, and lead are too low to present a health hazard to persons who would infrequently contact the sediments directly. Additionally, the contamination does not appear to be widespread, but localized in areas at or adjacent to munitions locations presenting less opportunity for uptake in fish.

### **Fish - Explosive Compounds**

Explosive compounds were found in sediments, but no explosives or related compounds were detected in the fish.

### **Fish – Inorganic Chemicals Detected**

ATSDR estimated exposure doses for the chemicals detected in the NOAA study. The chemicals arsenic, cadmium, lead, and zinc exceed health-based screening values which are daily lifetime dose levels of a substance that is unlikely to cause harm in humans. ATSDR determined that although some chemicals were higher than screening values, levels were lower than those shown in the scientific literature to result in adverse health effects. Therefore, they do not present a public health hazard to adults and children who may consume large subsistence amounts of these species.

### **Fish – Inorganic Chemicals Not Detected**

Although antimony, thallium, and vanadium are not known to be associated with Ordnance Reef, the analysis was not sensitive enough to determine if those chemicals are at safe levels

for subsistence fish eaters. Therefore, ATSDR categorizes Ordnance Reef as presenting an indeterminate public health hazard. Exposure doses at the detection limit levels on those inorganic chemicals are close to levels at which health effects have been reported in the scientific literature.

## **Recommendations**

ATSDR needs additional data and information to evaluate the public health implications of eating fish caught near the Ordnance Reef site.

- 1) Future samples should be analyzed with laboratory detection limits that are lower than the health screening values.
- 2) If seaweed samples are analyzed, seaweed species should be determined and arsenic analysis should include speciation.
- 3) ATSDR also needs additional information about the potentially affected community including their eating and customary uses of seafood, health issues, and customary fishing practices.

## Material Cited and Reviewed

Bienfang, P.K., and R.E. Brock. 1980. Predevelopment Reconnaissance of the Water Quality and Macrobiota Conditions Affronting the West Beach Coastline, O'ahu, Hawai'i. Technical Report Submitted to Environmental Communications, Inc.

Cox, E., De Carlo, E., Overfield, M., 2007. Ordnance, Reef, Wai'anae, Hawai'i: Remote Sensing Survey and Sampling at Discarded Military Munitions Site, Marine Sanctuaries Conservation Series NMSP-07-01. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Sanctuary Program, Silver Spring, MD. March 2007. [www.sanctuaries.nos.noaa.gov](http://www.sanctuaries.nos.noaa.gov)

Glaser, Walter. Glaser, Cherie. Fine Dining in Honolulu, Menu. [http://www.sallys-place.com/food/dining\\_directory/oceania/honolulu.htm](http://www.sallys-place.com/food/dining_directory/oceania/honolulu.htm) Accessed August 2007.

Guzman, Elmer. 2006. Recipes. <http://www.elmerguzman.com> Accessed August 2007.

Hawaii Department of Land and Natural Resources (HDLNR), Division of Aquatic Resources August 2007. [http://www.hawaii.gov/dlnr/dar/fish\\_regs/oahu.htm](http://www.hawaii.gov/dlnr/dar/fish_regs/oahu.htm)

Koch, L., J. Harrigan-Lum, and K. Henderson. 2004. Final 2004 List of Impaired Waters in Hawai'i Prepared under Clean Water Act §303(d). Hawai'i State Department of Health, Environmental Planning Office. <http://www.hawaii.gov/health/environmental/envplanning/wqm/wqm.html#303pcd>

Tetra Tech, Incorporated. 2007. Marine Resources Study, Field Sampling Results and Risk Assessment, Makua Military Reservation O'ahu, Hawai'i. Volume I, Prepared for the U.S. Army Corps of Engineers, Draft January 2007.

U.S. Army Center for Health Promotion and Preventative Medicine 2007. Health Risk Evaluation No. 39-EJ-06UY-07 Ordnance Reef Disposed Military Munitions Site, Wai'anae, O'ahu, Hawaii, May 2007.

U.S. Census Bureau, U.S. Census 2000. Available online at <http://www.census.gov/>.

## **Appendix A PCB Presence in Munitions**

Information provide by J.C. King, Assistant for Munitions and Chemical Matters  
ODASA(ESOH), Pentagon  
September 5, 2007

“ The Defense Ammunition Center maintains the MIDAS database which identifies a number of details including the weights of compounds used in 8,900 munitions (of an estimated 12,000 munitions in the stockpile). While MIDAS does not have all munitions loaded into the system, the ones in the database are primarily the older munitions and ones that found in the demilitarization account—such as those munitions that would have been sea-disposed. Only one item in the database is identified as containing PCBs (the MK90 Proximity Fuze). The data base also identifies two Navy projectiles (PROJ 5IN/38 CAL HE-IR MK51 MOD0 and PROJ 5IN/38 CAL IR MK35/47/49 MODS) with the MK90 fuze attached. The material is a component/material of the Anti Reflection Coated Window Assembly in the fuze that weighs 1.05 oz. The fuze weighs 5 lbs. The material is called Sapphire Synthetic and would be much less than the 1.05 oz. for the assembly. It appears that PCBs are used in small amounts on munitions, in internal components. PCBs were used routinely on electrical wires in the general public, so again may have been used for some electrical components or circuit boards of munitions. There is no indication that PCBs were found in any paints, primers, lacquers, enamels, solders or welds. It should be noted that extremely small components and/or materials, e.g., circuit boards, fuze components, wire coatings, platings or coatings are not estimated in MIDAS.”

## Appendix B Exposure Dose Calculations

The parameters used to determine the exposure dose, given

$$ED = \frac{C \times IR \times EF}{BW}$$

Where

ED = Estimated Dose;

C = Contaminant Concentration;

IR = Ingestion Rate: 0.170 kg/day for adults and 0.056 kg/day for children.

EF = Exposure Factor, the frequency and duration of exposure assumed 1 (daily)

BW = Body Weight in kilograms (kg), using ATSDR defaults of 70 kg for adult and 16 kg for children.

| Compound | Detection Limit Range (mg/kg) | Estimated Dose Range Adult (mg/kg/d) | Estimated Dose Range Child (mg/kg/d) | RfD (mg/kg/d) | LOAEL (mg/kg/d) | Exceeds                   |
|----------|-------------------------------|--------------------------------------|--------------------------------------|---------------|-----------------|---------------------------|
| Antimony | 5 - 50                        | 0.0121 - 0.1214                      | 0.0175 - 1.4000                      | 0.0004        | 0.0075          | Yes Exceeds RfD and LOAEL |
| Thallium | 5 - 50                        | 0.0121 - 0.1214                      | 0.0175 - 1.4000                      | 0.00007       | 0.0700          | Yes Exceeds RfD and LOAEL |
| Vanadium | 5 - 50                        | 0.0121 - 0.1214                      | 0.0175 - 1.4000                      | 0.0010        | 0.0500          | Yes Exceeds RfD and LOAEL |

mg/kg - milligram per kilogram (contaminant concentration or detection limit)

mg/kg/day - milligram per kilogram per day (dose)

RfD – USEPA's Reference Dose – Health screening value. Daily lifetime dose levels unlikely to cause harm in humans.

LOAEL - Lowest Observed Adverse Health Effect Level – from rat studies (factor of 10 applied to account for animal to human variability)

When evaluating potential for adverse health effects, human data if typically used, if not available in the scientific literature, then animal data is used. Typically, estimated doses less than 100 times LOAELs are considered safe.