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EPIDEMIOLOGICAL RESEARCH STUDY OF THE CONTAMINATION OF GUAM'S WATER, SOIL, AIR, & FOOD WITH TOXIC CHEMICALS KNOWN TO REPRESENT A SERIOUS HEALTH RISK FOR CANCER AND OTHER CHRONIC DISEASES TO THE HUMAN POPULATION.

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CHAPTER: I

THE EPIDEMIOLOGICAL STUDY

I. INTRODUCTION

The results of this study shows that the incidence and mortality rates of Chronic Diseases in Guam have epidemic proportions. These figures go from Deaths Rates up to 2,000 % higher in Guam than in Continental US, to Incidence Rates 10,000 % higher in Guam than in the rest of the world.

- Guam lacks registries for the majority of the diseases known to have a very high incidence in Guam. Despite that, the comparison of the health data that is available, to that of continental United States, shows that many chronic diseases in Guam have epidemic proportions. Examples of death rates that are ***higher in Guam than in Continental U.S., include:***

A. CANCER

1. Nasopharyngeal cancer…….***1,999 % higher in Guam than in Continental US***
2. Cervical Cancer……65 % higher in Guam than in Continental US
3. Uterine Cancer……55 % higher in Guam than in Continental US
4. Liver Cancer……41 % higher in Guam than in Continental US

B. NEUROLOGICAL/LYTICO BODIG

Lytico-bodig is a disease that presents itself in two ways: (a). Lytico: a progressive paralysis that resembles ALS (amyotrophic lateral sclerosis) which is a disease of the neuron; (b) Bodig: a condition resembling parkinsonism with occasional dementia. Since the early 1950's, the population of Guam began to be affected by a group of severe, progressive, and fatal neurological disorders including:

a. Amiotrophic Lateral Sclerosis .....***10,000 % higher than the rest of the world***
b. Parkinson-Dementia Complex.....25-50 fold higher than in the rest of the world

- Though the listed diseases are Neurodegenerative Diseases of Aging, the majority have the onset between the ages of 25 and 40.

- Without any scientific evidence, teams of several universities sustain that the cause of ALS and PD are: Fruit Bats and Cycad Seeds, despite the fact that they have not been used as food by the natives (Chamorros) for many decades.

- Conducted studies, including serial studies of the brains of deceased people from Guam, collected by several universities, and presently stored at the Mt. Sinai Medical Center in Manhattan, NY. The results showed the presence of "Heavy Metals" in the brains (i.e. Aluminum, Manganese). The critical question is which are the sources of the Heavy Metals that were contaminating Guam's environment.

- It is important to take into account that many of the Toxic Substances in the air, food, and drinking water of Guam, are Volatile Organic Compounds (VOCs), which are Lipophilic. Though, the human brain is 60 % Lipids.

C. DIABETES, CARDIOVASCULAR, KIDNEY

1. Diabetes……..150 % higher in Guam than in Continental US
2. Ischemic Heart Disease……15 % higher in Guam than in Continental US
3. Kidney Failure……12 % higher in Guam than in Continental US

D. INFANT MORTALITY RATE
   1. In Guam…… 25.2/1000 live births
   2. In Continental US……4.3/1000 live births

E. POPULATION 65+ YEARS IN:
   1. US-Continental……12.43 %
   2. US-Guam……5.30% (250 % lower than in continental US).

II. RATIONALE, HYPTHESIS, AND OBJECTIVE OF THE STUDY

The study is based in the identification of the needed data, the collection of information, and the analysis, critical epidemiological review, and presentation the results.

The present study is aimed at determining if there is an association between source/s of environmental contamination associated the epidemic of chronic diseases in the population of Guam, based in the following facts:

It is a basic epidemiological concept that diseases in general, and the excess in the number of cases documented in Guam, may be due to:

1. Host Factors (i.e. genetic makeup, nutrition, immunological status of the population),
2. Environmental Factors (i.e. contamination of the environment of a given population with physical, chemical, or biological agents),
3. A combination of Host and Environmental Factors.

❒ Host Factors- Unlikely, because:

a. All the mentioned diseases are not only common, but in many cases fatal. It is obvious that such a severe genetic disorder would have exterminated the affected population in a relativily short period of time.

b. As the epidemics of chronic diseases are very different in nature, from cancers to ischemic heart diseases), it is very unlikely that so many people have so many and different genetic abnormalities, and/or abnormal immunological status, and/or a dietary habits.

❒ Environmental Factors, likely, because:

a) It is the only viable scientific explanation for so many people with so many diseases of very different in nature.
b) Presence of toxic chemicals in the organs of the population of Guam, like heavy metals in the brain of community members with severe neurological disorders. Knowing that the environment of Guam is contaminated with Toxic Chemicals, the next obvious step trying to identify the sources of the chemicals.

c) Millions of tons of hazardous wastes have been produced in the United States since World War II and have been dispersed into the air, into water, and on and under the

ground. Much of this waste has accumulated in uncontrolled hazardous waste sites, and these sites are widespread across the nation.

d) The U.S. Environmental Protection Agency (EPA) has identified more than 15,000 such sites; 1,371 are proposed for listing or are listed already on the National Priorities List (NPL). Assessment and remediation of these sites is proceeding under the direction of the U.S. EPA, with support of the national Superfund Trust

e) The majority (65-70%) of uncontrolled waste sites in the United States and its territories, are waste storage and treatment facilities (including landfills). Many of these properties have been abandoned, and most have more than one major chemical contaminant.

f) The National Research Council has identified 17,482 contaminated sites at 1,855 military installations.

g) Some of these sites cover large geographic areas and are contaminated with very complex mixtures of wastes.

h) The substances most commonly released into environmental media from uncontrolled hazardous waste sites are ***heavy metals*** and ***organic solvents***:
   - ⇨ Lead (59% of sites)
   - ⇨ Trichlorethylene (53%)
   - ⇨ Chromium (47%),
   - ⇨ Benzene (46%)
   - ⇨ Arsenic (45%).

i) Request by Congressman Underwood for an Epidemiological Research Study of Chemical Dumps:
   - ➲ His call came on the heels of the discovery of chemical weapons. Drums containing unknown liquids, in light of recent discoveries of chemical weapons testing kits containing toxic chemicals on Guam

   - ➲ Congressman Underwood made reference to the evidence that several tons of chemicals weapons, were brought into Guam in the late 1940s, but found no evidence that they were ever removed

III. SOURCES OF INFORMATION AND METHODOLOGY OF THE STUDY:

1. Type of information targeted to evaluate the characteristics of the contamination of Guam with Toxic Chemicals:

   - **Sources of Contamination**: type of toxic chemicals, history, locations, and concentrations.

   - **Contamination of the Environment**: with emphasis in food, water, and air.

   - **Dispersion trough out Guam:** areas (villages), and extent of the contamination.

- **Exposure of the Population**: mechanisms by which the Toxic Chemicals enter the human body.

- **Health effects in humans, plants, and animals:** diseases associated with the contamination of toxic chemicals.

- **Diagnosis of contamination in humans***:* specimens, techniques, reliability, and interpretation.

- **Regulations:** mandatory measures established by the Federal government, to protect the community

- **Treatment:** which toxic chemicals can be treated in humans, type of treatments, and side effects.

2. The study is based in the critical epidemiological review of information gathered trough:

   - Systematic computerized search of the worldwide scientific literature.

   - Research studies conducted by Universities from Guam, and off-island.

   - Research studies and surveys conducted by specialized organizations from Guam, and off-island.

   - Exchange of information on this subject, with members of the medical community of Guam.

   - Interviews with residents of Guam, that for different circumstances have personal knowledge about different aspects of the contamination problem.

CHAPTER: II

FINDINGS:
TOXIC SUBSTANCES IN THE ENVIRONMENT OF GUAM:
LIST, CHARACTERISTICS, AND THEIR EFFECT
IN THE HEALTH OF THE HUMAN POPULATION

A. LIST OF TOXIC CHEMICALS IN GUAM

1. DIOXINS
2. ALUMINUM
3. BARIUM
4. ANTIMONY
5. ARSENIC
6. CADMIUM
7. COPPER
8. CHROMIUM
9. LEAD
10. MANGANESE
11. METALS: NOT SPECIFIED
12. NICKEL
13. PESTICIDES: NOT SPECIFIED
14. POLYCHLORINATED BIPHENYLS (PCBs)
15. POLYCYCLIC AROMATIC HYDROCARBONS (PAHs)
16. SELENIUM
17. SILVER
18. THALLIUM
19. TETRACLHORO DIBENZENO DIOXINS (TCDD)
20. TOTAL PETROLEUM HYDROCARBONS (TPH)
21. VANADIUM
22. VOLATILE ORGANIC COMPOUNDS (VOC)-A-TRICHLOROETHYLENE (TCE)
23. VOLATILE ORGANIC COMPOUNDS (VOC)-B-
    BENZENE, TOLUENE, ETHYLBENZENE, XYLENES (BTEX)
    VOC AND SVOC (SEMI-VOLTILE ORGANIC COMPOUNDS NOT SPECIFIED.
24. ZINC
25. CYANIDE

B. CHARACTERISTICS OF THE TOXIC CHEMICALS IN GUAM

1. MOST TOXIC NATURAL ELEMENTS:

In cooperation with the U.S. Environmental Protection Agency (EPA), the ATSDR has compiled a Priority List of natural elements called the ***"Top 7 Most Hazardous Substances". All of them are in Guam, in very high concentrations***

Ranking of Hazardous Substances

The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) Priority List of Hazardous Substances contains the names of 275 substances found at NPL sites and believed to pose the most significant potential threat to human health. This list helps form ATSDR priorities on many issues. The Superfund Amendments and Reauthorization Act of 1986 (SARA) requires ATSDR, in cooperation with EPA, to compile this priority list, which is drawn from all hazardous substances known to exist at NPL sites. The ranking of substances on the priority list is based on three criteria: (1) frequency of occurrence at NPL sites, (2) toxicity, and (3) potential for human exposure.

Table 1.
Top 7 Substances on the 2001 Priority List
All of them in Guam

Rank	Name
1	ARSENIC
2	LEAD
3	MERCURY
4	VINIL CHLORIDE
5	PCBs
6	BENZENE
7	CADMIUM

2. MOST TOXIC MAN MADE TOXIC CHEMICAL*:*

Between the non-metal toxic chemicals, ***the most deadly are the Dioxins (or TCDD, or Agent Orange*****.....**ALSO PRESENT IN GUAM, AT EXTREMELY HIGH CONCENTRATIONS.

C. BRIEF LIST OF DISEASES ASSOCIATED WITH THE TOXIC CHEMICALS IN GUAM

Health Effects: the toxic chemicals enter the person's bloodstream and may affect any organ or system in the body, some examples of the most common diseases produced by the chemicals include:

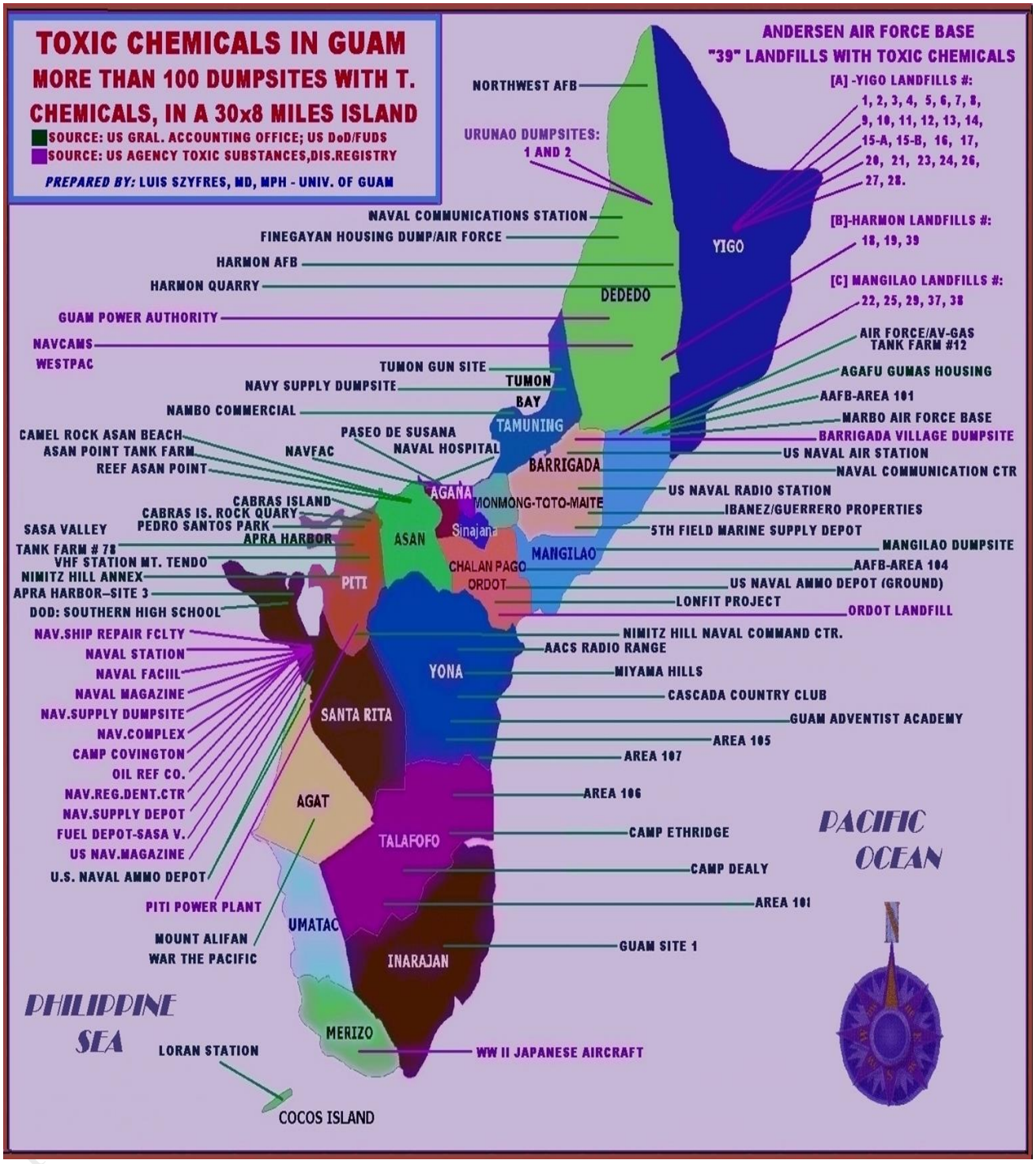
1. **Cancer**
2. **Encephalitis**
3. **Renal Dysfunction**
4. **Cardiovascular Disease**
5. **Liver Dysfunction**
6. **Deafness**
7. **Blindness**
8. **Parkinson's Disease**
9. **Multiple Sclerosis**
10. **Alzheimer's disease**
11. **Amyotrophic Lateral Sclerosis**
12. **Postencephalitic Parkinsonism**
13. **Progressive Bulbar Paralysis**
14. **Progressive Lenticular Degeneration**
15. **Myelopathy**
16. **Epilepsy**
17. **Peripheral Neuropathies**
18. **Seizures**
19. **Memory Loss (long term)**
20. **Attention Deficit Disorder**
21. **Autism**
22. **Schizophrenia**
23. **Concentration Loss**
24. **Emotional Instability**
25. **Hallucinations**

26. **Depression**
27. **Dyslexia**
28. **Behavioral Disorders**
29. **Hyperactivity**
30. **Learning Disability**
31. **Arthritis**
32. **Gout**
33. **Muscular Dystrophy**
34. **Joint Pain**
35. **Cartilage Destruction**
36. **Nephritis**
37. **Anemia**
38. **Hypertension**
39. **Adrenal Insufficiency**
40. **Hypothyroidism**
41. **Stillbirths**
42. **Sterility**
43. **Infertility**
44. **Sudden Infant Death Syndrome**
45. **Damage to the central nervous system**
46. **Loss of memory**
47. **Listlessness**
48. **Severe trembling**
49. **Immune Suppression**
50. **Dementia**

CHAPTER: III

FINDINGS:
SOURCES OF CONTAMINATION WITH TOXIC CHEMICALS

Map No: 104 Dumpsites with Toxic Chemicals

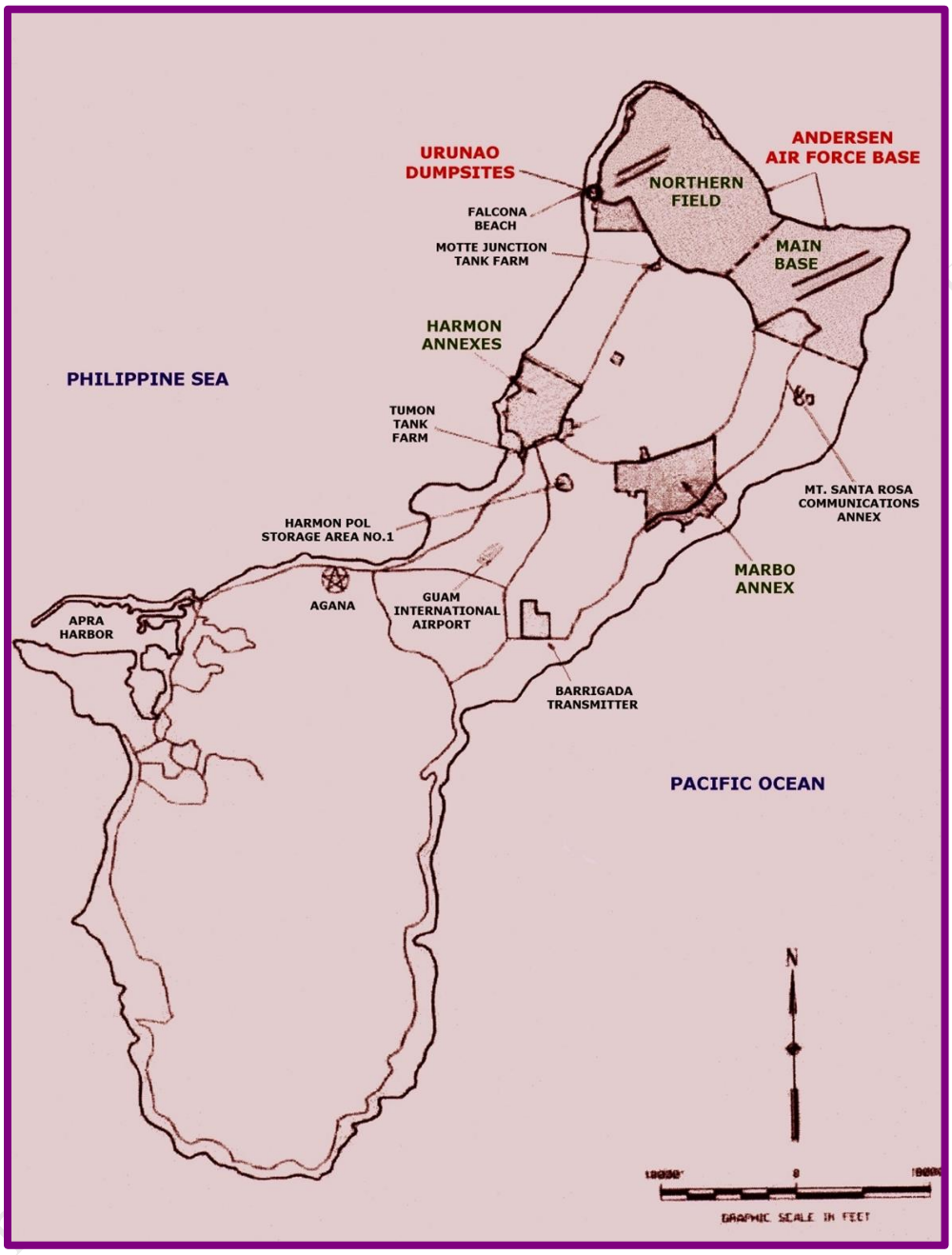


CHAPTER: IV

FINDINGS:
DETAILED DESCRIPTION OF SOME OF THE TOXIC CHEMICAL LANDFILLS: HISTORY, CHEMICALS, & CONCENTRATIONS

Two Toxic Chemical Landfills were chosen for a very detailed description, one in Federal land, and the other in Private Properties.

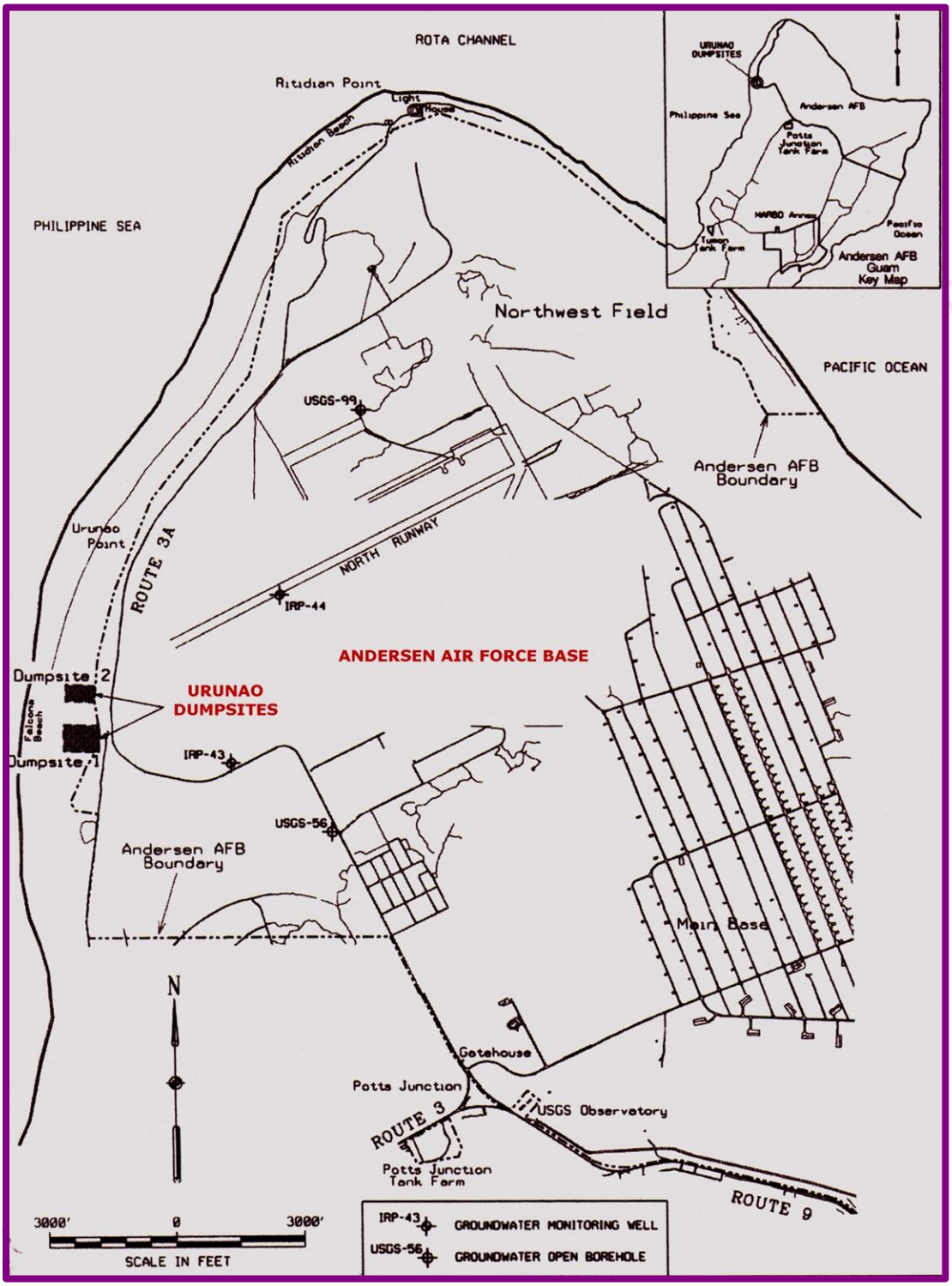
MAP No.



- **TOXIC CHEMICAL LANDFILLS IN FEDERAL PROPERTY-ANDERSEN AIR FORCE BASE: THIRTY-NINE LANDFILLS IN YIGO, HARMON, AND MARBO ANNEX.**

  Toxic Chemicals: sources, locations, concentrations, exposure, and effects in the health of the human population, animals, and vegetation.

MAP No.



1. DIOXINS (TETRACHLORODIBENZODIOXIN, TCDD, AGENT ORANGE)

The most toxic manmade substances known.
Three ounces of dioxin can kill in excess of one million people.
The toxicity of TCDD is 1,000 times more lethal than potassium cyanide.

CLARIFICATION OF THE DIFFERENT TYPES OF AGENTS/TCDD IN GUAM

- Tetrachlorodibenzo-p-dioxin or TCDD, is commonly known as Dioxin, or Agent Orange. TCDD is in reality a family of dioxins that contain four chlorine atoms each. Therefore, is classified as a chlorinated organic chemical.

- 2, 4-D an herbicide, that is a component of the **Agent Orange** defoliant stored in Guam, and used during the Vietnam War, contains **TCDD/Dioxin** in very high concentrations, which is ***the most toxic manmade substances known***.

- Agent Orange, Agent Purple, Agent Pink, etc, is the name to which all herbicides are referred in error. The name, Agent Orange, has become synonymous for, and collective of, all herbicides used during the Vietnam War. Agent Orange, is also the term for the harmful effects of herbicides (again, in error). People do not have Agent Orange disease, rather, a disease, or cancer caused directly or indirectly from exposure to an herbicide containing TCDD or Dioxins.

- The Dioxins used during the Viet Nam war, were manufactured in different concentrations. To recognize the concentrations of Dioxins in the drums, the military were placing color stripes in them. When the concentration of Dioxins were up to 40 ppm, *orange stripes were placed on drums, and it became known as Agent Orange*. If the concentration of Dioxins were up to 45 ppm, a Purple Strip was placed in the drum, and called Agent Purple. All this Agents/TCDD at different concentrations, were stored in Guam, and released to the environment. (See table below No...)

Table No.4: List of the herbicides (Agents) stored in Guam, and used during the Vietnam War, & the amount of TCDD present in the agents:

Description	TCDD (Dioxin) Amounts
Acceptable Amount	1.1 **ppm or less**
Agent Blue (Purple)	45 ppm
Agent Red (Pink)	65 ppm
Agent White (Green)	65 ppm
Silvex	70 ppm

***Accepted Concentration of Dioxins in Herbicides*:**
Less than 0.1 ppm (less than 10% *of* 1 ppm)

Shallow Subsurface Soil

❒ **GUAM, YIGO –** (SITE NO. 26)
Fire Training Area No.2-Operable Unit. Main Base: used between 1958 and 1988.

TCDD: concentrations *"above"* CVs ---- up to 19,000 ppm

❒ **GUAM, YIGO –** (SITE NO. 35)
Waste Pile No.1-Operable Unit. Main Base:

Several thousand deteriorated drums of asphaltic tar ***from unknown dates*** are at this site.

TCDD: concentrations *"above"* CVs ---- up to 87 ppm

❒ **GUAM, MARBO –** (SITE NO. 37)
War Dog Borrow Pit-Operable Unit. MARBO Annex.

Its contents and dates of operation are unknown.

TCDD: concentrations *"above"* CVs ---- up to 94 ppm

❒ **GUAM, NORTHWEST FIELD –** (SITE NO. 31)
Chemical Storage Area No. 4. Operable Unit. Northwest Field: waste oils and solvents were stored at this site.

TCDD: concentrations *"above"* CVs ---- up to 130 ppm

❒ **GUAM, YIGO –** (SITE NO. 2)
Landfills No.2/Landfill No.4/Landfill No.5 (4 & 5 are contained within 2)-Operable Units. Main Base: used from 1947 to 1975, with a small area remaining active until 1982.. Materials disposed of at this site include, petroleum, oil, lubricants, solvents**,** pesticides, ferrous metal, construction debris, and unexploded ordinance.

TCDD: present/concentration not-specified

❒ **GUAM, HARMON -** (SITE NO. 19)
Landfill No.24-Operable Unit. Harmon: holds sanitary trash and possibly other types of debris from the 1950s.

TCDD: present/concentration not-specified

❒ **GUAM, NORTHWEST FIELD –** (SITE NO. 21)
Landfill No.26-Operable Unit. Northwest Field: is filled with sanitary trash and construction debris from 1966.

TCDD: present/concentration not-specified

❒ **GUAM, YIGO –** (SITE NO. 5)
Landfill No.7-Operable Unit. Main Base.
TCDD: concentrations *"above"* CVs

DISPERSION TROUGHOUT GUAM

⇨ Since the 1940's, TCDD (Dioxines, Agent Orange) were stored in drums in Guam, in large quantities. As the time passed, the dioxins were released to the environment from the rusted, leaking drums.

⇨ The Dioxines were disseminated troughout all Guam, by winds, infiltration, evaporation, rains, and typhoons.

⇨ The military not only sprayed Agent Orange in Vietnam, but in Guam as well.

⇨ Dioxin released into the atmosphere contaminates the rivers and soil. Because dioxin compounds do not break down easily, they eventually find their way into the food chain in fish, crops, and other produce.

EXPOSURE OF THE RESIDENTS OF GUAM

1. Once the Dioxins are released, they are found throughout the environment and most people are exposed to them in contaminated air, soil, water, and food.

2. A major route of current and past exposures is from the movement of dioxin from soil into water sediment, then into fish, and from fish consumption...into people.

3. In the case of lactating women, the dioxins are in their milk, which are passed to the babies during breastfeeding.

4. Half Life; The length of time required for half a quantity of drug, or other substance residing in a living organism to be metabolized, or eliminated by normal biological processes. It is also called biological half-life. The half-life of dioxin is 9 years in humans. ***Its effects will be with the Guamanians for many generations.***

5. After entering the bloodstream of humans and animals, and disperse throughout many organs and systems were Dioxines are associated with severe/deadly diseases, they are stored in the fat tissue, they get stored/bioaccumulation in the fat tissue.

6. Dioxines accumulate in people: as it is lipophilic, which means that when it is assimilated into the human body, the heaviest depositsof dioxins are to be found in body fat. The level in a person's body is called the dioxin body burden.

7. Many people think that fat is only what you have in the wait and hips**,** but **60 %** of the human **BRAIN** and the nerves that run every system in the body, **is FAT**.

8. When the person does any type of exercise/fat burning, they are released again to the bloodstream

HEALTH EFFECTS IN THE POPULATION

Human Studies: evaluation of evidence

1. Objective:
   To fulfill its charge of assessing whether specific human health effects are associated with exposure to at least one of the herbicides or TCDD, the committee concentrated its review on epidemiologic studies.

2. Methodology:
   The studies of cohorts of populations that resided near sites of environmental contamination, or areas used to dispose of toxic waste. More than 3,000 relevant studies were identified in those searches, and more than 550 were reviewed.

3. Evaluation of the health effects of Agent Orange:
   Was studied in individuals, general population, or groups of veterans were evaluated in terms of disease or medical outcome. Pathologists, clinicians, and epidemiologists

use several classification systems. For a patient to be correctly diagnosed, careful staging of the extent of disease is necessary and a biopsy of the tissue must be analyzed by microscopy, often with special immunohistochemical stains, to confirm a clinical impression.

4. Committee's Conclusions about Health Outcomes

The present committee weighed the strengths and limitations of the epidemiological evidence reviewed in this report and in previous Agent Orange studies. Its conclusions were drawn from the new evidence in the context of the entire body of literature. It assigned each health outcome to one of four categories based on the evidence. Table 1 defines these categories and gives criteria for assigning a health outcome to each of them. Based on the committee's evaluation of occupational, environmental, and veteran's studies, this table also lists the relative weight of evidence for association between particular health outcomes and exposure to the herbicides. The conclusions are related to associations between exposure to Agent Orange and outcomes in human populations, not to the likelihood that any individual's health problem is associated with or caused by the herbicides in question.

TABLE-1
Summary of Findings of the association between Exposure of the Population to Agent Orange and Specific Diseases.

Sufficient evidence of an association

1. Hodgkin's disease
2. Non-Hodgkin's lymphoma
3. Soft-tissue sarcoma
4. Chronic lymphocytic leukemia (CLL)
5. Chloracne

Suggestive evidence of an association

6. Respiratory cancer (lung and bronchus, larynx, and trachea)
7. Prostate cancer
8. Multiple myeloma
9. Type 2 diabetes (mellitus)
10. Early-onset transient peripheral neuropathy
11. Spina bifida in offspring of exposed individuals
12. Porphyria cutanea tarda

More evidence needed to determine whether an association exists

13. Hepatobiliary cancer
14. Oral, nasal, and pharyngeal cancer
15. Bone and joint cancer
16. Skin cancers (melanoma, basal cell, and squamous cell)
17. Breast cancer
18. Female reproductive cancer (cervix, uterus, ovary)
19. Testicular cancer
20. Urinary bladder cancer
21. Renal cancer
22. Leukemia (other than CLL)
23. Abnormal sperm characteristics and infertility
24. Spontaneous abortion

25. Neonatal or infant death and stillbirth in offspring of exposed individuals
26. Low birth weight in offspring of exposed individuals
27. Birth defects (other than spina bifida) in offspring of exposed individuals
28. Childhood cancer (including acute myelogenous leukemia) in offspring of exposed individuals
29. Neurobehavioral disorders (cognitive and neuropsychiatric)
30. Movement disorders, including Parkinson's disease and amyotrophic lateral sclerosis (ALS)
31. Chronic peripheral nervous system disorders
32. Respiratory disorders
33. Gastrointestinal, metabolic, and digestive disorders (changes in liver enzymes, lipid abnormalities, ulcers)
34. Immune system disorders (immune suppression, autoimmunity)
35. Circulatory disorders
36. Amyloidosis
37. Endometriosis
38. Effects on thyroid homeostasis

TERATOGENESIS

Agent Orange (as well as Agents Purple, Pink, Blue and Green) contained dioxins, which caused serious harm to the health to those exposed, as well as their children and grandchildren. Dioxins are recognized as strong carcinogens and teratogens, very persistent in the environment and in the human body. The containers in which they are stored in Guam, have been leaking for a long time.

Photo-01: Teratogenic effects of TCDD

Photo-02= Teratogenic effects of TCDD

Photo-03= Teratogenic effects of TCDD

Photo-04: Teratogenic effects of TCDD

AGENT ORANGE: MANAGEMENT OF THE ENVIRONMENTAL CONTAMINATION

EXAMPLE: US-CONTINENTAL Vs US-GUAM

A. US, STATE OF MISSOURI, CITY OF TIMES BEACH

➢ SITUATION:

- Times Beach, Missouri was a small town of 2,240 residents.
- Unknown to the residents of Times Beach, for several years in the mid 1970s, dioxin laced oil had been sprayed on the town's roads to keep down the dust.
- Times Beach, -had- levels of dioxin contamination as high as **33 parts per million ---- *- 33 times more toxic than the U.S Environmental Protection Agency (EPA) level of acceptance***

➢ACTION TAKEN:

- **The government took immediate action**, and ***decided that as the contamination was so bad***, the only way to save the town's residents from further damage from dioxin was to buy them out and move them out.
- In early 1983, the U.S. government spent $33 million buying the 801 homes and businesses in Times Beach and relocating its 2,200 residents. The entire town was fenced in and guards were brought in to keep out the curious. "Caution, Hazardous Waste Site, Dioxin Contamination," read the signs leading into Times Beach.

B. US, GUAM

➢SITUATION:

- Guam is a US territory with a population of 154,805 (2000 U.S. Census).
- Unknown to the residents of Guam, their environment has been contaminated with toxic chemicals, including Agent Orange, for more that *four decades.*
- Guam, -has- levels of dioxin contamination as high as **19,000 parts per *million* --- 19, 000 times more toxic than EPA's levels of acceptance**

➢ACTION TAKEN:

- ***After more than 50 years, no action was taken by the Federal or local government governments.***

2. ALUMINUM

Federal Agency for Toxic Substances & Disease Registry (ATSDR)
Aluminum: sites, dates, & concentrations/comparison values (CVs).

Shallow Subsurface Soil

❒ **GUAM, NORTHWEST FIELD -** (SITE NO. 17)
Landfill No. 22. Northwest Field: during the 1950s, sanitary trash and unknown quantities of unexploded ordinance and black powder were discarded at this site.

Sixteen surface soil samples were analyzed. Results--**Aluminum: concentrations *"above"* CVs for a child.**

- **GUAM, YIGO –** (SITE NO. 25)
  Fire Training Area No.1. Main Base: waste solvents and contaminated fuels were used.

  Aluminum: concentrations *"above"* CVs for a child.

- **GUAM, YIGO –** (SITE NO. 4)
  Landfill No. 6. Main Base: operated from 1953 to 1954.

Twenty surface soil samples were analyzed. Results--**Aluminum: concentrations "above" CVs for a child.**

DISPERSION TROUGHOUT GUAM

1. Aluminum cannot be destroyed in the environment. It can only change its form or become attached or separated from particles.

2. Aluminum contained in wind-borne soil is generally found in larger particles. These particles settle to the ground or are washed out of the air by rain.

3. Aluminum that is attached to very small particles may stay in the air for many days.

4. Most aluminum will ultimately end up in the soil or sediment.

5. When acid rain falls, aluminum compounds in the soil may dissolve and enter lakes and streams. Since the affected bodies of water are often acidic themselves from the acid rain, the dissolved aluminum does not combine with other elements in the water and settle out as it would under normal (i.e., non-acidic) conditions. In this situation, abnormally high concentrations of aluminum may occur.

EXPOSURE OF THE RESIDENTS OF GUAM

A. Humans:
People are always exposed to some aluminum compounds by ***eating food***, ***drinking water***, ***breathing air***, or by ***skin contact with soil ,and water,*** causing serious diseases.

B. Animals & plants:

- Aluminum may accumulate in plants and cause health problems for animals that consume these plants.

- In contaminated waters, the number of fish and amphibians is declining due to reactions of aluminum ions with proteins in the gills of fish and the embryo's of frogs.

- High aluminum concentrations do not only cause effects upon fish, but also upon birds and other animals that consume contaminated fish and insects and upon animals that breathe in aluminum through air. The consequences for birds that consume contaminated fish are eggshell thinning and chicks with low birth-weights.

- The consequences for animals that breathe in aluminum through air may be lung problems, weight loss, and a decline in activity.

- Another negative environmental effect of aluminum is that its ions can react with phosphates, which causes phosphates to be less available to water organisms.

- High concentrations of aluminum may not only be found in acidified lakes and air, but also in the groundwater of acidified soils. There are strong indications that aluminum can damage the roots of trees when it is located in groundwater

HEALTH EFFECTS IN THE POPULATION

Long lasting uptakes of significant concentrations of aluminum can lead to serious health effects, such as**:**

1. CNS: aluminum is associated with serious damage to the Central Nervous System (CNS), including:
   - Alzheimer's Disease.
   - Severe trembling
   - Loss of memory
   - Listlessness
   - Dementia

2. LUNGS: produces Pulmonary Fibrosis/Shaver's Disease. Inhalation of finely divided aluminum and aluminum oxide powder has been reported as a cause of pulmonary fibrosis and lung damage. This effect, know as Shaver's Disease, is complicated by the presence in the inhaled air of silica and oxides of iron.

3. KIDNEYS: Aluminum can cause problems for kidney patients when it enters the body during kidney dialyses.

4. DISEASES IN CHILDREN:
   - Brain and bone disease caused by high levels of aluminum in the body have been seen in children with kidney disease.

   - Aluminum from the mother can enter her unborn baby through the placenta, also Aluminum is found in breast milk.

DIAGNOSIS

- Aluminum can be measured in the blood, bones, feces, or urine.

- Urine and blood aluminum measurements show whether a person has been exposed to larger-than-normal amounts of aluminum.

- Measuring bone aluminum can also indicate exposure to high levels of aluminum, but this requires a bone biopsy.

Regulations of the Federal Government to protect human Health

EPA has recommended a Secondary Maximum Contaminant Level (SMCL) of 0.05–0.2 milligrams per liter (mg/L) for aluminum in drinking water.

3. ANTIMONY

Federal Agency for Toxic Substances & Disease Registry (ATSDR)
Antimony: sites, dates, & concentrations/comparison values (CVs).

Shallow Subsurface Soil:

❒ **GUAM, MARBO –** (SITE NO. 24)
Landfill No.29-Operable Unit. MARBO Annex: is littered with household debris and garbage.

Dates of operation are unknown.

Antimony: concentration *"above"* CVs.

DISPERSION TROUGHOUT GUAM
EXPOSURE OF THE RESIDENTS OF GUAM
HEALTH EFFECTS IN THE POPULATION

EXPOSURE

- When Antimony is released in the air, it is attached to very small particles that may stay in the air for many days. Most antimony ends up in soil, where it attaches strongly to particles that contain iron, manganese, or aluminum. In polluted areas containing high levels of antimony, it may be found in the air, water, and soil.

- The general population is exposed to Antimony primarily in food, drinking water, and air.

Regulations of the federal government to protect the health of the community:
● The EPA allows 0.006 parts of antimony per million parts of drinking water (0.006 ppm). The EPA requires that discharges or spills into the environment of antimony be reported.

● The Occupational Safety and Health Administration (OSHA) has set an occupational exposure limit of 0.5 milligrams of antimony per cubic meter of air (0.5 mg/m^3) for an 8-hour workday, 40-hour workweek.

HEALTH EFFECTS

- **RESPIRATORY SYSTEM:** the primary effects from chronic exposure to antimony in humans are respiratory effects that include:
  1. Pneumoconiosis
  2. Alterations in pulmonary function
  3. Chronic Bronchitis
  4. Chronic emphysema
  5. Inactive tuberculosis
  6. Pleural adhesions

- **CARDIOVASCULAR SYSTEM:** humans chronically exposed to antimony by inhalation show:
  a) Heart muscle damage.
  b) Increased blood pressure
  c) Altered EKG readings

Regulations of the federal government to protect the health of the community:
The United States Environmental Protection Agency (EPA) has set a limit of 145 ppb in lakes and streams to protect human health from the harmful effects of antimony taken in through water and contaminated fish and shellfish. EPA has also set limits on the amount of antimony that industry can release.

4. ARSENIC

Studies on the spring waters that discharged from the northern lens aquifer in Guam, reported unusually high levels of Arsenic.

There are more than 100 Ground Water Wells in this part of the island (North). Some of these wells are connected trough conduits that flow out as springs or seeps along Tumon Bay (South)

Shallow Subsurface Soil:
Average level of Arsenic in surface and groundwater: 0.001 ppm
Average level of Arsenic in soil: 3-4 ppm.

- **GUAM, YIGO –** (SITE NO. 27)
  Hazardous Waste Storage Area No.1. Main Base: beginning in 1950 and continuing through the 1970s, petroleum, oil, lubricants, and solvents were stored. From the late 1970s to 1983 was used to store hazardous wastes.

  Arsenic: concentration *"above"* CVs----up to 201 ppm

- **GUAM, YIGO –** (SITE NO. 28)
  Chemical Storage Area No.1. Main Base: in the early 1970s, the site may have been used for the disposal of waste petroleum, oils, lubricants, and chlorinated solvents. About 70% of the site is filled material covered with vegetative cover.

  Arsenic: concentrations *"above"* CVs----up to 15 ppm

- **GUAM, YIGO –** (SITE NO. 4)
  Landfill No.6. Main Base: operated from 1953 to 1954.

***Twenty surface soil samples were analyzed. Results*--Arsenic: concentrations "above" CVs for a child**

DISPERSION TROUGHOUT GUAM

1. Arsenic enters the air, water, and land from wind-blown dust and may get into water from runoff and leaching.

2. Arsenic cannot be destroyed in the environment. It can only change its form, or become attached to or separated from particles. It may change its form by reacting with oxygen or

other molecules present in air, water, or soil, or by the action of bacteria that live in soil or sediment.

3. Arsenic contained in wind-borne soil is generally found in large particles. These particles settle to the ground or are washed out of the air by rain.

4. Arsenic that is attached to very small particles may stay in the air for many days and travel long distances.

5. Many common arsenic compounds can dissolve in water. Thus, arsenic can get into lakes, rivers, or underground water by dissolving in rain or snow or through the discharge of industrial wastes. Some of the arsenic will stick to particles in the water or sediment on the bottom of lakes or rivers, and some will be carried along by the water.

6. Ultimately, most arsenic ends up in the soil or sediment. Fish and shellfish take in arsenic, which may build up in tissues, most of this arsenic is in an organic form called arsenobetaine (commonly called "fish arsenic").

EXPOSURE OF THE RESIDENTS OF GUAM

Maximum exposureto Arsenic, occurs in people that are near a waste site/landfill.

a. People are exposed to Arsenic by ***eating food, drinking water, or breathing air***.

b. People may also be exposed by ***skin contact*** with soil or water that contains arsenic, and children may be exposed to arsenic by eating dirt.

c. Food is usually the largest source of arsenic. Seafood contains the greatest amounts of arsenic. Some seaweeds may contain arsenic in inorganic forms that is more harmful.

d. If people swallow arsenic in water, soil, or food, most of the arsenic quickly enters in the body.

e. If people breath the air that contains arsenic dusts, many of the dust particles settle onto the lining of the lungs. Most of the arsenic in these particles is then taken up from the lungs into the body.

f. Near waste sites, where arsenic-contaminated soils are allowed to blow into the air, or working with arsenic-containing soil.

HEALTH EFFECTS IN THE POPULATION

The scientific literature about the toxicity of arsenic is extensive, containing a large number of studies of exposed human populations, in whom the main route of exposure is oral. These studies have identified effects on virtually every organ or tissue evaluated.

Inorganic arsenic has been recognized as a human poison since ancient times, and oral doses above 60 ppm, in food or water, can result in death.

A. CANCER

The Department of Health and Human Services (DHHS): concluded that inorganic arsenic is a human carcinogen.
*The Environmental Protection Agency (EPA)**:*** determined that inorganic arsenic is a human carcinogen by the inhalation and oral routes, and has assigned it the cancer classification, Group A.
*The International Agency for Research on Cancer (IARC)***:** cites sufficient evidence of a relationship between exposure to arsenic and human cancer. The IARC classification of arsenic is Group 1.

Main types of cancer related to arsenic exposure:

- **Lung Cancer**: there is clear evidence from studies in humans that exposure to inorganic arsenic by either the inhalation or oral routes increases the risk of cancer. Numerous studies have reported an increased risk of lung cancer.

- **Skin Cancer**: there is convincing evidence from a large number of epidemiological studies and case reports that ingestion of inorganic arsenic increases the risk of developing skin cancer. The most common tumors seen are squamous cell carcinomas, which may develop from the hyperkeratotic warts or corns commonly seen as a dermal effect of oral inorganic arsenic exposure.

- **Bladder Cancer**: there is increasing evidence that long-term exposure to arsenic can result in the development of bladder cancer, with transitional cell cancers being the most prevalent.

- **Transplacental Cancer**: a recent study in mice reported that arsenic could function as a complete transplacental carcinogen, resulting in tumors in the offspring of exposed animals.

B. CARDIOVASCULAR

A large number of studies in humans have reported cardiovascular effects following oral exposure to inorganic arsenic compounds. The cardiac effects of arsenic exposure are numerous, and include:

a. ***Altered Myocardial Depolarization***

b. ***Cardiac Arrhythmias***

c. ***Ischemic Heart Disease***.

These effects have been seen after acute and long-term exposure to inorganic arsenic in the environment. Chronic exposure to inorganic arsenic has also been shown to lead to effects on the vascular system. The most dramatic of these effects is "Blackfoot Disease", a disease characterized by a progressive loss of circulation in the hands and feet, leading ultimately to necrosis and gangrene. Arsenic exposure has also been associated with an increased incidence of cerebrovascular and microvascular diseases and ischemic heart disease. Other vascular effects are common in areas with arsenic exposures, include such severe effects as increases in the incidences of Raynaud's disease and of cyanosis of fingers and toes as well as hypertension, thickening and vascular occlusion of blood vessels, and other unspecified cardiovascular conditions.

C. *Neurological*

1. Encephalopathy.

2. Peripheral Neuropathy.

3. Children: decreases in intelligence scores.

D. *Skin*

a. Hyperkeratinization

b. Hyperpigmentation.

E. *Children*

1. Children are exposed to arsenic in many of the same ways that adults are. Since arsenic is found in the soil, water, food, and air, children may take in arsenic in the air they breathe, the water they drink, and the food they eat.

2. Since children tend to eat or drink less of a variety of foods and beverages than do adults, ingestion of contaminated food or juice or infant formula made with arsenic-contaminated water may represent a significant source of exposure.

3. As children often play in the dirt and put their hands in their mouths and sometimes intentionally eat dirt, ingestion of contaminated soil may be a more important source of arsenic exposure for children than for adults.

4. In areas around contaminated waste sites, exposure of children to arsenic through ingestion of soil and water may be very hight.

5. Children who are exposed to arsenic may have many of the same effects as adults, including irritation of the stomach and intestines, blood vessel damage, skin changes, and reduced nerve function. There is also evidence that suggests that long-term exposure to arsenic in children may result in lower IQ scores.

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Regulations of the Federal Government to protect human Health

- Regulations and recommendations can be expressed as "not-to-exceed" levels, that is, levels of a toxic substance in air, water, soil, or food that do not exceed a critical value that is usually based on levels that affect animals; they are then adjusted to levels that will help protect humans.

- The federal government has taken several steps to protect humans from arsenic. First, EPA has set limits on the amount of arsenic that industrial sources can release into the environment. Second, EPA has restricted or canceled many of the uses of arsenic in pesticides and is considering further restrictions. Third, in January 2001, the EPA lowered the limit for arsenic in drinking water from 50 to 10 ppb.

5.BARIUM

Screening of Soil at Urunao Dumpsite

SCREENING VALUE mg/Kg: 62.0

In 27 of 27 samples: Barium levels "above screening value" --- up to: 7,750

DISPERSION TROUGHOUT GUAM

1. Barium gets into the air during the mining, refining, and production of barium compounds, and from the burning of coal and oil.

2. The length of time that barium will last in air, land, water, or sediments depends on the form of barium released.

3. Barium compounds, such as barium sulfate and barium carbonate, which do not dissolve well in water, can last a long time in the environment.

4. Barium compounds, such as barium chloride, barium nitrate, or barium hydroxide, that dissolve easily in water usually do not last in these forms for a long time in the environment. The barium in these compounds that is dissolved in water quickly combines with sulfate or carbonate that are naturally found in water and become the longer lasting forms (barium sulfate and barium carbonate).

5. Fish and aquatic organisms can accumulate barium.

EXPOSURE OF THE RESIDENTS OF GUAM

a. Exposure to barium occurs mostly from drinking contaminated water.

b. Ingesting small amounts present in your food and water or breathing air containing very low levels of barium.

HEALTH EFFECTS IN THE POPULATION

- Ingesting drinking water containing levels of barium above the EPA drinking water guidelines, can: ***damage the kidneys***

- Eating or drinking very large amounts of barium compounds that easily dissolve can cause changes in ***heart rhythm or paralysis and possibly death*.**

Animals that drank barium had damage to the ***kidneys,*** decreases in body weight, and some died.

Regulations of the Federal Government to protect human Health

The EPA has set a limit of 2.0 milligrams barium per liter of drinking water (2.0 mg/L), which is the same as 2 ppm.

6. CADMIUM

Federal Agency for Toxic Substances & Disease Registry (ATSDR)
Cadmium: sites, dates, & concentrations/comparison values (CVs).

Shallow Subsurface Soil

❒ **NORTHWEST FIELD, GUAM -** (SITE NO. 16)
Landfill No.21. Northwest Field: operated as a sanitary trash disposal site.

Cadmium: concentrations *"above"* CVs----up to 240 ppm

❒ **GUAM, NORTHWEST FIELD -** (SITE NO. 17)
Landfill No. 22. Northwest Field. During the 1950s, sanitary trash and unknown quantities of unexploded ordinance and black powder were discarded at this site.

***Sixteen surface soil samples were analyzed. Results*-- Cadmium: concentrations *"above"* CVs for a child.**

EXPOSURE

Cadmium exposure occurs mainly through **Cereals and Vegetables** grown on contaminated soils. **Shellfish and Animal Organs** also contain high levels. Cadmium accumulates in the kidneys and is implicated in a range *of kidney diseases*.

HEALTH EFFECTS

A. Kidneys

The kidney is considered the critical target organ for the general population. Within the kidney, the cortex is the site where the first adverse effect occurs.

1. **Renal Tubular Dysfunction:**
   Long-term exposure to cadmium causes renal tubular dysfunction with proteinuria, glucosuria, and aminoaciduria, as well as histopathological changes, in both experimental animals and humans. These are usually the first effects to occur after ingestion or inhalation exposure. In environments with high cadmium exposure levels, people have also developed hypercalciuria, phosphaturia , and polyuria.
2. **Renal Failure**:
   As the renal dysfunction progresses in severity, the glomeruli may also be affected and, in a few cases, the cadmium-induced damage leads to renal failure.

B. Cancer

Lung Cancer: several studies in humans have reported an excess risk of lung cancer in exposed cohorts.

C. Bone

a) Calcium Deficiency
b) Osteoporosis
c) Osteomalacia
d) Bone Lesions accompanied by Renal Damage

E. Respiratory System

1. Emphysema and Dyspnea

2. Chronic inflammation of the pharynx and larynx.

E. Reproductive System

- Decreased birth weight

G. **Genetics**

- Studies indicate that cadmium is genotoxic**.**

7. CHROMIUM

Chromium: sites, dates, & concentrations/comparison values (CVs).

A. Shallow Subsurface Soil

❒ **GUAM, YIGO –** (SITE NO. 35)
Waste Pile No.1. Main Base.

Several thousand deteriorated drums of asphaltic tar ***from unknown dates*** located here.

Chromium: concentrations *"above"* CVs ---- up to 1,550 ppm

❒ **GUAM, YIGO –** (SITE NO. 29)
Chemical Storage Area 2 (now called waste pile No.2). Main Base: Dates of operation are unknown.

Deteriorating drums of asphaltic tar are stored in this site

Chromium: concentrations *"above"* CVs ---- up to 950 ppm

❒ **GUAM, MARBO –** (SITE NO. 24)
Landfill No.29. MARBO Annex: is littered garbage.

Dates of operation are unknown.

Chromium: concentrations *"above"* CVs ---- up to 860 ppm

❒ **GUAM, YIGO –** (SITE NO. 27)
Hazardous Waste Storage Area No.1. Main Base: beginning in 1950 and continuing through the 1970s, petroleum, oil, lubricants, and solvents were stored. From the late 1970s to 1983 was used to store hazardous wastes.

Chromium : concentration *"above"* CVs ---- up to 1,300 ppm

❒ **NORTHWEST FIELD, GUAM -** (SITE NO. 16)
Landfill No.21. Northwest Field: operated as a sanitary trash disposal site.

Chromium: concentrations *"above"* CVs ---- up to 6,500 ppm

❒ **GUAM, NORTHWEST FIELD –** (SITE NO. 30)

Chemical Storage Area 3 (now called waste pile no.4). Northwest Field: operated from 1950 to 1970. Unexploded ordinance, waste oils, and solvents were disposed at this site.

Chromium: concentrations *"above"* CVs ---- up to 2,200 ppm

B. Groundwater from Downgradient Wells of Each Site

❒ **GUAM, YIGO –** (SITE NO. 35)
Waste Pile No.1. Main Base

Several thousand deteriorated drums of asphaltic tar ***from unknown dates*** are in this site.

Chromium: concentratons *"above"* EPA's Maximum Contaminant Levels (MCLs)
MCLs: are legal drinking water quality standards defined by the Safe Drinking Water Act. MCLs represent contaminant concentrations in drinking water that do not produce diseases. Any concentration above this standard represents a health risk for the community.

EXPOSURE

- In air, chromium compounds are present mostly as fine dust particles, which eventually settle over land and water.

- People are exposed to the toxic effects of Chromium by:
  1. Eating contaminated food
  2. Breathing contaminated air.
  3. Drinking contaminated well water.
  4. Skin contact during use in the workplace.
  5. Living near hazardous waste sites containing chromium.

HEALTH EFFECTS

a. *Eating:*
   ⇨ Stomach ulcers.
   ⇨ Convulsions.
   ⇨ Kidney damage.
   ⇨ Liver damage.
   ⇨ Death.

b. *Breathing*: nosebleeds, and ulcers and holes in the nasal septum.

c. *Skin contact*: skin ulcers.

d. *Cancer:* increase the risk of lung cancer
   ★ *The EPA:* has determined that chromium in air is a human carcinogen.
   ★ *The DHHS*: has determined that chromium is known to cause cancer in humans.
   ★ *The WHO*: has determined that chromium is a human carcinogen.

8.COPPER

Cadmium: sites, dates, & concentrations/comparison values (CVs).

Screening/Conservative Value	Values found in this site
URUNAO DUMPSITE I	
72 mg/kg	**5.120 mg/kg**
URUNAO DUMPSITE II	
72 mg/kg	**2.460 mg/kg**

DISPERSION TROUGHOUT GUAM

1. Copper enters the environment through waste dumpsites, and windblown dust. Therefore, copper is widespread in the environment. Copper is often found near landfills, and waste disposal sites.

2. When copper is released into soil, it can become strongly attached to the organic material and other components (e.g., clay, sand, etc.) in the top layers of soil and may not move very far when it is released.

3. When copper and copper compounds are released into water, the copper that dissolves can be carried in surface waters either in the form of copper compounds or as free copper or, more likely, copper bound to particles suspended in the water.

4. Even though copper binds strongly to suspended particles and sediments, there is evidence to suggest that some water-soluble copper compounds do enter groundwater. Copper that enters water eventually collects in the sediments of rivers, lakes, and estuaries.

5. Copper is carried on particles, and carried back to earth through gravity or in rain.

COPPER IN THE ENVIRONMENT

a. Copper can be found in plants and animals, and at high concentrations in filter feeders such as mussels and oysters. Copper is also found in a range of concentrations in many foods and beverages that we eat and drink, including drinking water.

b. People are exposed to copper by breathing air, drinking water, eating food, and by skin contact with soil, water and other copper-containing substances.

c. Most copper compounds found in air, water, sediment, soil, and rock are strongly attached to dust and dirt or imbedded in minerals. Thus, people can take copper into your body upon ingestion of water or soil that contains copper or by inhalation of copper-containing dust.

d. Some copper in the environment is less tightly bound to soil or particles in water and may be soluble enough in water to be taken up by plants and animals.

e. In the general population, soluble copper compounds (those that dissolve in water), which are most commonly used in agriculture, are more likely to threaten your health. When soluble copper compounds are released into lakes and rivers, they generally become attached to particles in the water within approximately 1 day.

f. Exposure to copper in water, depends on how strongly the copper is bound to the particles and how much of the particles settle into lake and river sediments. However, fine particles have an enormous surface area and can remain suspended for prolonged periods of time. Therefore, at high fine particle concentrations, both exposure and uptake can be considerable even under conditions of tight copper binding to the suspended particulates.

g. People may be exposed to levels of soluble copper in the ***drinking water*** that are above the acceptable drinking water standard of 1,300 parts copper per billion parts of water (ppb), especially if the water is corrosive and you have copper plumbing and brass water fixtures. The average concentration of copper in tap water ranges from 20 to 75 ppb.

h. Once in natural water, much of this copper soon attaches to particles or convert to other forms that can settle into sediments. If the sediments are stirred; for example, by the resuspension and swallowing of sediments by swimmers in recreational waters.

i. People may be exposed to this copper by skin contact. Children may also be exposed to this copper by hand to mouth contact and eating the contaminated dirt and dust.

HUMAN EXPOSURE

- Copper can enter your body when you drink water or eat food, soil, or other substances that contain copper. Copper can also enter your body if you breathe air or dust containing copper. Copper may enter the lungs of workers exposed to copper dust or fumes.

- Copper rapidly enters the bloodstream and is distributed throughout the body after you eat or drink it. Certain substances in foods eaten with copper can affect the amount of copper that enters the bloodstream from the gastrointestinal tract. Your body is very good at blocking high levels of copper from entering the bloodstream. We do not know how much copper enters the body through the lungs or skin. Copper then leaves your body in feces and urine, mostly in feces. It takes several days for copper to leave your body. Generally, the amount of copper in your body remains constant (the amount that enters your body equals the amount that leaves).

HEALTH EFFECTS

Nausea, vomiting, stomach cramps, diarrhea, liver and kidney damage, and death.

Regulations from the Federal Government:
The federal government develops regulations and recommendations to protect public health. Regulations can be enforced by law. The EPA, the Occupational Safety and Health Administration (OSHA), and the Food and Drug Administration (FDA) are some federal agencies that develop regulations for toxic substances. Regulations provide valuable guidelines to protect public health, and are enforced by law.

⇨ EPA has determined that drinking water should not contain more than 1.3 mg copper per liter of water (1.3 mg/L).

9. **LEAD**

Federal Agency for Toxic Substances & Disease Registry (ATSDR)
Lead: sites, dates, and concentrations/comparison values (CVs).

A. ***Shallow Subsurface Soil***

EPA: Uncontaminated soil-concentrations of less than 50 ppm. Soil cleanup level-400 ppm

❒ **GUAM, YIGO** – (SITE NO. 10).
Landfill No.14. Main base: contains concrete debris and construction debris.

Lead: concentrations *"above"* CVs----up to 40,000 ppm

❒ **GUAM, MARBO** – (SITE NO. 22)
Waste Pile No. 6 (formerly known as Landfill No. 27). MARBO Annex: contains construction debris.

Dates of operation are unknown.

Lead : concentrations "*above*" CVs ---- up to 6,500 ppm

❒ **GUAM, MARBO** – (SITE NO. 24)
Landfill No.29. MARBO Annex: is littered with household debris and garbage.

Lead: concentrations "above" CVs ---- up to 1,100 ppm

❒ **GUAM, YIGO** – (SITE NO. 28)
Chemical Storage Area No. 1. Main Base: in the early 1970s, the site was used for the disposal of waste petroleum, oils, lubricants, and chlorinated solvents.

About 70% of the site is filled material covered with vegetative cover.

Lead: concentrations "*above*" CVs ---- up to 770 ppm

❒ **GUAM, NORTHWEST FIELD** – (SITE NO. 31).
Chemical Storage Area No. 4. Northwest Field: waste oils and solvents were stored at this site.

Lead: concentrations "*above*" CVs --- up to 3,100 ppm

❒ **GUAM, YIGO** – (SITE NO. 27).
Hazardous Waste Storage Area No. 1. Main Base: beginning in 1950 and continuing through the 1970s, petroleum, oil, lubricants, and solvents were stored. From the late 1970s to 1983 was used to store hazardous wastes.

Lead : concentration *"above"* CVs----up to 8,600 ppm

❒ **GUAM: NORTHWEST FIELD** - (SITE NO. 16).
Landfill No. 21. Northwest Field: operated as a sanitary trash disposal site.

Lead: concentrations *"above"* CVs----up to 16,000 ppm

❒ **GUAM, YIGO** – (SITE NO. 5).
Landfill No. 7. Main Base.

Lead: concentrations "*above"* CVs

❒ **GUAM, MARBO** – (SITE NO. 38)
MARBO Laundry Facility. MARBO Annex.

Lead: concentrations *"above"* CVs ---- up to 15,700 ppm

B. Groundwater from Downgradient Wells of Each Site

❒ **GUAM, YIGO –** (SITE NO. 1)
Landfill No. 1. Operable Unit. Main Base: opened in 1945 and continues to be used today. Materials disposed of include waste petroleum, oil, lubricants (POL), solvents, ferrous metal, construction debris, and pesticides

Lead: concentration"*above" drinking water* comparison values (CVs)

❒ **GUAM, MARBO –** (SITE NO. 24)
Landfill No. 29 (LF-29). OU: MARBO Annex. LF-29 is littered with household debris and garbage.

Dates of operation are unknown.

Lead: present/concentration not-specified

EXPOSURE

A common source of lead contamination are landfills that contain waste of lead-containing products (i.e. ammunition and waste from military bases)

A. Contamination of the Environment

1. Once lead falls onto soil, it sticks strongly to soil particles and remains in the upper layer of soil, and part of it may enter rivers, lakes, and streams when soil particles are moved by rainwater.

2. Sources of lead in dust, soil, and groundwater include lead that falls to the ground from the air. Once lead that gets into the atmosphere, may travel long distances if the lead particles are very small

3. Lead may remain stuck to soil particles or sediment in water for many years.

4. The levels of lead may build up in plants and animals from areas where air, water, or soil are contaminated with lead.

5. If animals eat contaminated plants or animals, most of the lead that they eat will pass through their bodies.

B. Exposure of the population to lead

a) People living near hazardous waste sites are exposed to lead and chemicals that contain lead by breathing air, drinking water, eating foods, or swallowing dust or dirt that contain lead.

b) People may be exposed to lead by eating food, drinking water, or breathing in or swallowing airborne dust and dirt.

c) Leafy fresh vegetables may have lead-containing dust on them. Children may be exposed to lead by hand-to-mouth contact after exposure to lead-containing soil or dust.

d) Some of the lead that enters the human body comes from breathing in dust or chemicals that contain lead. Once this lead gets into the lungs, it goes quickly to other parts of the body in the blood.

e) Lead can also enter the body by swallowing food or drinking liquids that contain it.

f) Dust and soil that contain lead may get on the skin.

g) Shortly after lead gets into the body, it travels in the blood to the "soft tissues" and organs (such as the liver, kidneys, lungs, brain, spleen, muscles, and heart).

h) After several weeks, most of the lead moves into the bones and teeth. Some of the lead can stay in the bones for decades; however, some lead can leave the bones and reenter the blood and organs under certain circumstances (e.g., during pregnancy and periods of breast-feeding, after a bone is broken, and during advancing age).

HEALTH EFFECTS

- An enormous amount of information is available on the health effects of lead on human health. In fact, the toxic effects of lead have been known for centuries, but the discovery in the past few decades that levels of exposure resulting in relatively low levels of lead in blood associated with adverse effects in the developing organism is a matter of great concern.

- The most sensitive targets for lead toxicity are the developing nervous system, the hematological and cardiovascular systems, and the kidney. However, due to the multi-modes of action of lead in biological systems may affect any organ in the body, including:

    1. Encephalitis, Parkinson's Disease, Multiple Sclerosis, Myelopathy (spinal cord pathology), Epilepsy, Peripheral Neuropathies, Seizures.

    2. Memory Loss (long term), Attention Deficit Disorder, Autism, Schizophrenia, Concentration Loss, Emotional Instability, Hallucinations, Depression, Dyslexia, Behavioral Disorders, Hyperactivity, Learning Disability.

3. Arthritis (rheumatoid and osteo), Gout, Muscular Dystrophy, Joint Pain, Cartilage Destruction.
4. Nephritis, Renal Dysfunction
5. Cardiovascular Disease, Anemia, Hypertension.
6. Adrenal Insufficiency, Hypothyroidism.
7. Stillbirths, Sterility, Infertility, Sudden Infant Death Syndrome.
8. Liver Dysfunction.
9. Deafness, Blindness.
10. Immune Suppression.

10. MANGANESE

Federal Agency for Toxic Substances and Disease Registry (ATSDR)
Manganese: sites, dates, & concentrations/comparison values (CVs).

Shallow Subsurface Soil:

❒ **GUAM, NORTHWEST FIELD -** (SITE NO. 17)
Landfill No.22-Operable Unit. Northwest Field: during the 1950s, sanitary trash and unknown quantities of unexploded ordinance and black powder were discarded at this site.

Sixteen surface soil samples were analyzed. Results--**Manganese: concentrations *"above"*CVs for a child**

❒ **GUAM, YIGO –** (SITE NO. 4)
Landfill No.6. Main Base: operated from 1953 to 1954.

Twenty surface soil samples were analyzed. Results—**Manganese: concentrations *"above* CVs for a child**

EXPOSURE

The major route of entry is inhalation of dust or fume of manganese. In addition, inhaled large particles are ingested after mucociliary clearance from the lungs.

HEALTH EFFECTS

A. Chronic intoxication :

Central Nervous System (CNS): the primary target organ of manganese toxicity is the **central nervous system**, particularly the **extra-pyramidal system**; the lungs may also be injured in the case of chronic exposure to manganese.

Central Nervous System:

- Amyotrophic Lateral Sclerosis,
- Postencephalitic Parkinsonism,
- Progressive Bulbar Paralysis
- Multiple Sclerosis
- Progressive Lenticular Degeneration (Wilson's disease)

The best way to diagnose, at an early stage, manganese intoxication is neurological examination. Some symptoms, among others, to be looked for in chronic manganese intoxication :

- nervousness
- irritability
- memory loss
- tiredness
- insomnia
- muscle weakness
- muscle pain
- trembling fingers
- stiffness of limbs
- difficulty with fine movements
- stuttering
- hoarse voice
- urinary problems
- impotence.

B. Acute intoxication :

- Metal fume fever :
  Inhalation of manganese oxide fumes may cause a flu-like syndrome similar to "metal fume fever ", treatment is symptomatic.
- Chemical pneumonia :
  In the case of severe exposure to fumes or dust of various manganese salts, a severe chemical pneumonia may occur.
- Acute intoxication by ingestion :
  Acute intoxication by ingestion rarely occurs and is caused by accidental or voluntary ingestion of a manganese salt (as the ingestion of tablets of potassium permanganate), this chemical causes massive burns of the digestive tract, edema of the upper respiratory tract and circulatory collapse.

Recommendations of the federal government to protect the health of the community:
The U.S. Environmental Protection Agency (EPA) has set a guideline for the level of manganese in drinking water at 0.05 milligrams per liter.

11. METALS: NOT SPECIFIED

Metals: sites, dates, and concentrations/comparison values (CVs).

Shallow Subsurface Soil:

❒ **GUAM, YIGO –** (SITE NO. 35)
Waste Pile No.1-Operable Unit. Main Base:

Several thousand deteriorated drums of asphaltic tar ***from unknown dates*** are located here.

Metals-Not Specified: concentrations *"above"* CVs

❒ **GUAM, YIGO –** (SITE NO. 26)
Fire Training Area No.2. Main Base: operated between 1958 and 1988.

Metals-Not Specified: concentrations *"above"* CVs

❒ **GUAM, MARBO –** (SITE NO. 37)
War Dog Borrow Pit. MARBO Annex: dates of operation and contents are unknown.

Metals-Not Specified: concentrations *"above"* CVs

❒ **GUAM, HARMON -** (SITE NO. 19)
Landfill No.24. Harmon: holds sanitary trash and possibly other types of debris from the 1950s.

Metals-Not Specified: present-concentrations not specified

❒ **GUAM, NORTHWEST FIELD –** (SITE NO. 21)
Landfill No.26. Northwest Field: is filled with sanitary trash and construction debris from 1966.

Metals-Not Specified: present-concentrations not specified

❒ **GUAM, YIGO –** (SITE NO. 1)
Landfill No.1-Operable Unit. Main Base: opened in 1945 and continues to be used today. Materials disposed of include waste petroleum, oil, lubricants, solvents, ferrous metal, construction debris, and pesticides.

Metals-Not Specified: present-concentrations not specified

❒ **GUAM, NORTHWEST FIELD –** (SITE NO. 21)
Landfill No.26-Operable Unit. Northwest Field: is filled with sanitary trash and construction debris from 1966.

Metals-Not Specified: present-concentrations not specified

❒ **GUAM, MARBO –** (SITE NO. 38)
MARBO Laundry Facility. MARBO Annex.

Metals-Not Specified: concentrations *"above"* CVs.

❒ **GUAM, MARBO –** (SITE NO. 22)
Waste Pile No.6 (formerly Landfill No.27)-Operable Unit. MARBO Annex: contains construction debris.

Dates of operation are unknown.

Metals-Not Specified: concentrations "*above*" CVs.

Note: virtually all metals are toxic if the people are exposed to them to concentrations "above" CVs. Many metals *are always toxic* if they are ingested, for example arsenic, cadmium, lead, and mercury. Once emitted, metals can reside in the environment for hundreds of years or more.

EXPOSURE

1. Toxic heavy metals accumulate in the soft tissues. Heavy metals may enter the human body through food, water, air, or absorption through the skin.

2. ATSDR: has classified the exposure to toxic heavy metals as acute, 14 days or less; intermediate, 15-354 days; and chronic, more than 365 days. Additionally, acute toxicity is usually from a sudden or unexpected exposure to a high level of the heavy metal.

3. Chronic toxicity: results from repeated or continuous exposure, leading to an accumulation of the toxic substance in the body. Chronic exposure may result from contaminated food, air, water, or dust; living near a hazardous waste site; spending time in areas with landfills that store compounds with lead; or maternal transfer in the womb.

4. Chronic exposure: may occur in either the home or workplace. Symptoms of chronic toxicity are often similar to many common conditions and may not be readily recognized.

5. Routes of exposure: include inhalation, skin or eye contact, and ingestion (ATSDR MMGs and ToxFAQs; Anon. 1993; WHO 1998; International Occupational Safety and Health Information Centre 1999; Roberts 1999; Dupler 2001; Ferner 2001).

6. Exposure is the amount of the metal or compound to which the individual is exposed. This is distinct from the biological effects of exposure, which are the symptoms suffered because of the exposure. These are difficult to assess, as individuals often differ in their response to similar exposure. Some of the factors affecting exposure of individuals to particular metals are:

- *Food chains*: plant uptake, agriculture, fishing
- *Route of entry*: oral, inhalation, skin
- *Geography*: wind direction, water run-off, and distance from source.
- *Physical form*: dust, fume, solubility
- *Concentration*: high, low
- *Duration*: acute, chronic, variable

HEALTH EFFECTS

Introduction

1. *Heavy Metals*: There are 35 metals that concern us because of occupational or residential exposure; 23 of these are the "heavy metals", which include:
   - Antimony, Arsenic, Cadmium, Chromium, Lead, Manganese, Mercury, Nickel, Uranium, and Vanadium (Glanze 1996).

2. *Health Effects*, heavy metal toxicity can result in:
   - Cancer
   - Damaged or reduced mental and central nervous function
   - Damage to blood composition, lungs, kidneys, liver, and other organs.
   - Muscular and neurological degenerative processes

- Alzheimer's disease
- Parkinson's disease
- Muscular dystrophy
- Multiple sclerosis.

3. Exposure to heavy metals at concentrations "above" CVs, may cause acute or chronic toxicity (poisoning).

    a) *The symptoms of acute toxicity*: is not difficult to recognize because the symptoms are usually severe, rapid in onset, and associated with a known exposure or ingestion (Ferner 2001): cramping, nausea, and vomiting; pain; sweating; headaches; difficulty breathing; impaired cognitive, motor, and language skills; mania; and convulsions.

    b) *The symptoms of chronic toxicity* : i.e. impaired cognitive, motor, and language skills; learning difficulties; nervousness and emotional instability; and insomnia, nausea, lethargy, and feeling ill, are also easily recognized; however, they are much more difficult to associate with their cause. Symptoms of chronic exposure are very similar to symptoms of other health conditions and often develop slowly over months or even years. Sometimes the symptoms of chronic exposure actually abate from time to time, leading the person to postpone seeking treatment, thinking the symptoms are related to something else. Long-term contact with some metals or their compounds may cause cancer (International Occupational Safety and Health Information Centre 1999).

4. Heavy metals' toxic levels can be just above the CVs. Therefore, it is important for us to inform ourselves about the heavy metals and to take protective measures against excessive exposure.

5. If unrecognized or inappropriately treated, toxicity can result in significant illness and reduced quality of life. For persons who suspect that they or someone in their household might have heavy metal toxicity, testing is essential. Appropriate conventional and natural medical procedures may need to be pursued.

6. Birds: a study on the possible effects of heavy metal exposure on the health of songbirds (great tit or Parus major) showed that their excrements contained very high concentrations of heavy metals (arsenic, cadmium, and mercury, lead) if they were exposed to contaminated areas. Their body mass and condition were significantly reduced and presented growth abnormalities of the legs.

Priority List of Toxic Chemicals: "The Top 20 Hazardous Substances".
Developed by: US Agency for Toxic Substances & Disease Registry (ATSDR), and the U.S. Environmental Protection Agency (EPA).

The Top 20 Hazardous Substances in the world, include:
Arsenic (1), Lead (2), and Cadmium (7).

Arsenic
Number 1 on ATSDR's "Top 20 List."

- Arsenic is the most common cause of acute heavy metal poisoning in adults.
- Arsine gas is a common byproduct produced by the manufacturing of pesticides that contain arsenic.

×Arsenic in water supplies leads to exposure of shellfish, cod, and haddock.
×Target organs are the blood, kidneys, and central nervous, digestive, and skin systems

Lead

Number 2 on ATSDR's "Top 20 List."

▪Lead accounts for most of the cases of pediatric heavy metal poisoning.
▪Present in many elements, including: ammunition, fuel additives, PVC plastics, pesticides.
▪Target organs are the bones, brain, blood, kidneys, and thyroid gland

Cadmium

Number 7 on ATSDR's "Top 20 List".

▪Inhalation accounts for up to 50% of absorption through the respiratory system; up to 7% of ingested cadmium is absorbed in the gastrointestinal system.
▪Cadmium may be found in reservoirs containing shellfish.
▪Target organs are the liver, placenta, kidneys, lungs, brain, and bones.

Aluminum

×Studies began to emerge about 20 years ago suggesting that aluminum might have a possible connection with developing Alzheimer's disease when researchers found what they considered to be ***significant amounts of aluminum in the brain tissue of Alzheimer's patients***. At the present, most researchers agree that Aluminum is an important factor in the development of dementia.
×The World Health Organization concluded that the studies demonstrate a positive relationship between aluminum in drinking water and Alzheimer's disease
×Target organs for the toxicity of aluminum are the central nervous system, kidney, and digestive system.

Mechanisms of toxicity

Metals generally produce their toxicity by forming complexes with organic compounds. The modified molecules loose their ability to function properly, which leads to the malfunction or death of the affected cells. Metals commonly bind to biological compounds, which inactivate certain enzyme systems or affect protein structure.

12. NICKEL

Nickel: sites, dates, and concentrations/comparison values (CVs).

Groundwater from Downgradient Wells of Each Site

❒ **GUAM, NORTHWEST FIELD –** (SITE NO. 30)
Waste Pile No. 4 (formerly known as Chemical Storage Area 3). Northwest Field: from 1950 to 1970. Used to dispose unexploded ordinance, waste oils, and solvents.

Nickel: concentrations "above" EPA's Maximum Contaminant Levels (MCLs)

EXPOSURE

The general population can be exposed to nickel via inhalation, oral, and dermal routes of exposure.
Based on occupational exposure studies, reports of allergic contact dermatitis, and animal exposure studies, the primary targets of toxicity appear to be the respiratory tract following inhalation exposure, the immune system following inhalation, oral, or dermal exposure, and possibly the reproductive system and the developing organism following oral exposure.

HEALTH EFFECTS

A. CANCER

Human and animal data provide strong evidence that inhalation exposure to some nickel compounds induce **lung cancer**. Carcinogenic responses have been observed following inhalation exposure to nickel subsulfide and nickel oxide; in the absence of exposure to other carcinogenic agents.

B. RESPIRATORY SYSTEM

Evidence of lung inflammation has been observed following acute-, intermediate-, and chronic-duration exposure to nickel sulfate, nickel subsulfide, or nickel oxide.

C. SKIN

The most commonly reported adverse health effect associated with nickel exposure is contact dermatitis. Contact dermatitis is the result of an allergic reaction to nickel that has been reported in the general population via dermal contact with airborne nickel. After an individual becomes sensitized to nickel, dermal contact with a small amount of nickel or oral exposure to low doses of nickel can result in dermatitis.

13. PESTICIDES: NOT SPECIFIED

Pesticides: sites, dates, & concentrations/comparison values (CVs).

❒ **GUAM, MARBO –** (SITE NO. 24)
Landfill No.29-Operable Unit. MARBO Annex: is littered with household debris and garbage.

Dates of operation are unknown.

Pesticides: present/concentrations not-specified

❒ **GUAM, YIGO –** (SITE NO. 26)
Fire Training Area No.2-Operable Unit. Main Base: used between 1958 and 1988.

Pesticides: present at levels *"above"* CVs

❒ **GUAM, YIGO –** (SITE NO. 8)
Landfills No.10/Landfill No.11/Landfill No.12-Operable Units. Main Base. LF-10: used from the early to mid-1950s to dispose of asphalt wastes, scrap metals, empty 55-gallon drums, sanitary wastes, construction debris, petroleum, oil, lubricants, and solvents. LF-11: was used in the early 1950s as a disposal area for asphaltic material, empty 55-gallon drums, and construction debris. LF-12: was used in the late 1950s to dispose of sanitary trash and small quantities of asphaltic wastes.

Pesticides: present/concentrations not-specified

There are more than 865 active ingredients registered as pesticides, which are formulated into thousands of pesticide products that are available in the marketplace. About 350 pesticides are used on the foods we eat, and to protect our homes and pets.

EXPOSURE

- Studies show that only 5% of pesticides reach target weeds. The rest, (95 % of the pesticides) runs off into water or dissipates in the air. Drift from landscaping can range from 12 feet **to 14.5 miles.** Guam is 30 miles x 10 miles.
- Pesticides can be absorbed through the skin, swallowed, or inhaled. Pesticides often stray from their point of application to settle on neighbors' properties, clotheslines, pools, toys, and furniture.
- Children and pets often track pesticide residues into the house.
- Effects that are more serious appear to be produced by direct inhalation of pesticide sprays than by absorption or ingestion of toxins.
- Because safety testing has not been adequate, current pesticide applications are essentially a giant experiment using the general public.
- In the US, it is a violation of federal law to state that the use of pesticides is safe, because pesticides are toxic by definition.

HEALTH EFFECTS

A. **Short/Single and Intermediate Exposure**

● Neurotoxicity

B. **Long-term exposure**

● Cancer

● Birth Defects

● Genotoxicity

● Hormone Disruption (development, growth, reproduction, and behavior)

Human Health Risk Assessment and the Law:
Federal law requires detailed evaluation of pesticides to protect human health and the environment. In 1996, Congress made significant changes to strengthen pesticide laws through the Food Quality Protection Act (FQPA). Many of these changes are key elements of the current risk assessment process. FQPA required that EPA consider:

- A New Safety Standard: FQPA strengthened the safety standard that pesticides must meet before being approved for use. EPA must ensure with a reasonable certainty that no harm will result from the legal uses of the pesticide.

- Exposure from All Sources: In evaluating a pesticide, EPA must estimate the combined risk from that pesticide from all non-occupational sources, such as:

  Food Sources
  Drinking Water Sources
  Residential Sources

- Cumulative Risk: EPA is required to evaluate pesticides in light of similar toxic effects that different pesticides may share, or "a common mechanism of toxicity". At this time, EPA is developing a methodology for this type of assessment.

- Special Sensitivity of Children to Pesticides: EPA must ascertain whether there is an increased susceptibility from exposure to the pesticide to infants and children. EPA must build an additional 10-fold safety factor into risk assessments to ensure the protection of infants and children, unless it is determined that a lesser margin of safety will be safe for infants and children.

14. Polychlorinated Biphenyls (PCBs)

PCBs: sites, dates, and concentrations/comparison values (CVs).

Shallow Subsurface Soil:

❒ **GUAM, YIGO –** (SITE NO. 34)
PCB Storage Area-Operable Unit. Main Base.

Dates of operation are unknown.

PCBs: concentrations *"above"* CVs ---- up to 19 ppm

EXPOSURE

1. PCBs are a group of synthetic organic chemicals that can cause a number of different harmful effects. There are no known natural sources of PCBs in the environment, they are either oily liquids or solids. Some PCBs are volatile and may exist as a vapor in air.

2. PCBs may enter the air, water, and soil from wastes placed in landfills, or from poorly maintained hazardous waste sites. Once in the environment, PCBs do not readily break down and therefore may remain for very long periods of time. They can easily cycle between air, water, and soil. For example, PCBs can enter the air by evaporation from both soil and water.

3. In air, PCBs can be carried long distances and have been found in seawater far away, from where they were released. They will eventually return to land and water by settling as dust or in rain.

4. In water, PCBs may be transported by currents, attach to bottom sediment or particles in the water, and evaporate into air.

5. Sediments that contain PCBs can also release the PCBs into the surrounding water. They do not readily break down in soil and may stay in the soil for years. Evaporation appears to be an important way by which the PCBs leave soil.

6. As a gas, PCBs can accumulate in the leaves and aboveground parts of plants and food crops.

7. PCBs are taken up into the bodies of small organisms and fish in water. They are also taken up by other animals that eat these aquatic animals as food. PCBs especially accumulate in fish and marine mammals, reaching levels that may be many thousands of times higher than in water.

8. If people breathe air that contains PCBs, they can enter the body through the lungs and pass into the bloodstream.

9. PCBs can also enter the body by eating meat or fish products or other foods

10. PCBs remain in the body and are stored for years mainly in the fat .

11. PCBs collect in milk fat and can enter the bodies of infants through breast-feeding.

HEALTH EFFECTS

Many studies have looked at how PCBs can affect human health. Most of the studies of health effects of PCBs in the general population examined children of mothers who were exposed to PCBs

- ☐ **Health effects from exposures from conception to maturity at 18 years of age:**

- Children are exposed to PCBs both prenatally and from breast milk. PCBs are stored in the mother's body and can be released during pregnancy, cross the placenta, and enter fetal tissues. Because PCBs dissolve readily in fat, they can accumulate in breast milk fat and be transferred to babies and young children. PCBs have been measured in umbilical cord blood and in breast milk.

- Children are exposed to PCBs in the same way, as are adults, by eating contaminated food, and drinking contaminated water.

- Because the brain, nervous system, immune system, thyroid, and reproductive organs are still developing in the fetus and child, the effects of PCBs on these target systems may be more profound after exposure during the prenatal and neonatal periods, making fetuses and children more susceptible to PCBs than adults.

1. Low Weight Babies:

Studies of women who consumed high amounts of fish contaminated with PCBs had babies that weighed less than babies from women who did not eat fish.

2. Abnormal Infant Behavior:

Studies of babies born to women who ate fish contaminated with PCBs before and during pregnancy showed abnormal responses to tests of infant behavior. Some of these behaviors, such as problems with motor skills and a decrease in short-term memory, persisted for several years.

3. Immunological Defects in Children:

Studies suggest that the immune system may be affected in children born to and nursed by mothers exposed to increased levels of PCBs.

☐ **Cancer**

Studies of workers provide evidence that PCBs were associated with certain types of cancer in humans, such as cancer of the liver and biliary tract. The Department of Health and Human Services (DHHS) has stated that PCBs may reasonably be anticipated to be carcinogens. Both EPA and the International Agency for Research on Cancer (IARC) have determined that PCBs are probably carcinogenic to humans.

Regulations of the Federal Government to protect human Health:

- EPA:

For the protection of human health from the possible effects of drinking the water or eating the fish or shellfish from lakes and streams that are contaminated with PCBs, the EPA regulates that the level of PCBs in these waters be no greater than 0.17 parts of PCBs per trillion parts (ppt) of water. The EPA requires that companies that transport, store, or dispose of PCBs follow the rules and regulations of the federal hazardous waste management program. EPA also limits the amount of PCBs put into publicly owned wastewater treatment plants.

- FDA:

Has set residue limits for PCBs in various foods to protect from harmful health effects. FDA required limits include 0.2 parts of PCBs per million parts (ppm) in infant and junior foods, 0.3 ppm in eggs, 1.5 ppm in milk and other dairy products (fat basis), 2 ppm in fish and shellfish (edible portions), and 3 ppm in poultry and red meat (fat basis).

15. Polycyclic Aromatic Hydrocarbons (PAHs)
Examples: Benzo-pyrene, Benzo-fluoranthene, Benzanthracene, Fluoranthene, Naphthalene.

PAHs: sites, dates, and concentrations/comparison values (CVs).

Shallow Subsurface Soil:

❒ **GUAM, NORTHWEST FIELD –** (SITE NO. 30)
Chemical Storage Area-3 (now known as Waste Pile No.4). Operable Unit. Northwest Field: used from 1950 to 1970 to dispose of unexploded ordinance, waste oils and solvents.

PAHs: concentrations up to CVs.

EXPOSURE

1. PAHs are a group of chemicals that are formed during the incomplete burning of coal, oil, gas, wood, garbage, or other organic substances. They are found in the air, water, and soil. PAHs

can enter groundwater from ash, tar, or creosote that is improperly disposed in landfills. They can occur in the air, either attached to dust particles or as solids in soil or sediment.

2. Exposure to polycyclic aromatic hydrocarbons usually occurs by breathing contaminated air. In the home, PAHs are present in smoke from wood fires, creosote-treated wood products, cereals, grains, flour, bread, vegetables, fruits, meat, processed or pickled foods, and contaminated cow's milk or human breast milk.

3. Food grown in contaminated soil or air may also contain PAHs. Cooking meat or other food at high temperatures, which happens during grilling or charring, increases the amount of PAHs in the food. Shellfish living in contaminated water may be another major source of exposure. PAHs may be in groundwater near disposal sites where wastes or ash are buried; people may be exposed by drinking this water.

4. PAHs can be absorbed through skin. Exposure can come from handling contaminated soil or bathing in contaminated water. People living near waste sites containing PAHs may be exposed through contact with contaminated air, water, and soil.

5. PAHs enter all the tissues of the body that contain fat. They tend to be stored mostly in your kidneys, liver, and fat. Smaller amounts are stored in the spleen, adrenal glands, and ovaries.

HEALTH EFFECTS

A. **CANCER**

Studies of peoples how that individuals exposed by breathing or skin contact for long periods to mixtures that contain PAHs and other compounds can also develop cancer.

a. The International Agency for Research on Cancer (IARC):
Has determined the following: benz[a]anthracene and benzo[a]pyrene are probably carcinogenic to humans; benzo[b]fluoranthene, benzo[j]fluoranthene, benzo[k]fluoranthene, and indeno[1,2,3-c,d]pyrene are possibly carcinogenic to humans.

b. EPA:
Has determined that benz[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, chrysene, dibenz[a,h]anthracene, and indeno[1,2,3-c,d]pyrene are probable human carcinogens.

B. **ORGAN SYSTEMS**

PAHS can produce damage to several organs, including:

- Lungs.
- Liver.
- Kidneys.
- Skin.

Regulations of the Federal Government to protect human Health:
The federal government has set regulations to protect people from the possible health effects of eating, drinking, or breathing PAHs. The EPA has provided estimates of levels of total cancer-causing PAHs in lakes and streams associated with a risk of human cancer development.

16. Selenium

Selenium: sites, dates, & concentrations/comparison values (CVs).

Screening/Conservative Value	Values found in this site
URUNAO DUMPSITE I	
3.30 mg/kg	**16.60 mg/kg**

DISPERSION TROUGHOUT GUAM

⇨ Airborne particles of selenium can settle on soil or surface water.

⇨ Selenium compounds that can dissolve in water are very mobile. Thus, there is an increased chance of exposure to these compounds. Evidence indicates that selenium can be taken up in tissues of aquatic organisms and possibly increase in concentration as the selenium is passed up through the food chain.

EXPOSURE

Hazardous waste sites at which selenium is present, represent a major source of exposure.

1. Selenium is harmful when regularly taken in amounts higher than those needed by the body.

2. People may be exposed to higher-than-normal levels of selenium at hazardous waste sites by swallowing soil or water, or by breathing dust.

   ➢FOOD: Some plants can build up selenium to levels that harm livestock feeding on them. People are exposed to too much selenium if they eat locally grown grains and vegetables or animal products that have built up high levels of selenium.

   ➢DRINKING WATER: The selenium in drinking water is usually in the form of sodium selenite; which is easily absorbed from the digestive tract.

   ➢AIR: Selenium in the air may also enter the human body when people breathe it.

3. The way that selenium enters the body from a particular site depends on such factors as whether vegetables are grown in soil in which selenium from the site has been deposited, whether water at the site contains selenium and is able to flow into drinking water supplies, and whether selenium dust blows into the air.

4. Children living near selenium waste sites are likely to be exposed to higher environmental levels of selenium through breathing, touching soil, and eating contaminated soil.

5. The primary route of human exposure to selenium is through eating food. People who irrigate their home gardens with groundwater containing high levels of selenium may grow and eat plants that contain high levels of selenium because this element is taken up by plants.

6. People, who regularly eat fish and game, may also consume above average levels of selenium.

➢ Specific tests of locally grown food, drinking water, and air must be done to find out whether exposure is occurring.

➢ Selenium builds up in the human body. It builds up mostly in the liver and kidneys but also in the blood, lungs, heart, and testes.

HEALTH EFFECTS

- Dizziness, fatigue, and irritation of mucous membranes.
- Brittle hair and deformed nails.
- Skin rashes, redness, heat, swelling, and pain.
- Loss of feeling and control in arms and legs.
- Severe bronchitis.
- Collection of fluid in the lungs (pulmonary edema).
- Cancer (EPA has determined that selenium sulfide, is a probable human carcinogen).

DIAGNOSIS

1. Selenium can be measured in the blood, urine, and fingernails or toenails of exposed individuals.
2. Samples of blood, urine, or nails can be properly collected in a physician's office and sent to a laboratory that has the special equipment needed to measure selenium.
3. Urine can be used to determine short-term exposure.
4. Because red blood cells last about 120 days before they are replaced by newly made red blood cells, the presence of selenium in red blood cells can show whether a person was exposed to selenium during the 120 days before testing, but not if exposed more than 120 days before testing.
5. Toenail clippings can be used to determine longer-term exposure.

CHILDREN: If your doctor finds that you have been exposed to significant amounts of selenium, ask whether your children might also be exposed. Your doctor might need to ask your state health department to investigate.

Some children eat a lot of dirt. You should discourage your children from eating dirt. Make sure they wash their hands frequently and before eating. Discourage your children from putting their hands in their mouths or from other hand-to-mouth activity.

Regulations of the Federal Government to protect human Health:

- The EPA Office of Drinking Water regulates the amount of selenium allowed in drinking water: public water supplies are not allowed to exceed 50 ppb total selenium.

- The FDA regulations allow a level of 50 ppb of selenium in bottled water.

17. Silver

Silver: sites, dates, & concentrations/comparison values (CVs).

Normal Value: 0.20-0.30 parts silver per million parts soil (ppm) in soils

Screening/Conservative Value	Values found in this site
URUNAO DUMPSITE I (Soil)	
21 mg/kg	**262 mg/kg**

DISPERSION TROUGHOUT GUAM

●The Environmental Protection Agency (EPA) has identified 1,177 sites on its National Priorities List (NPL). Silver has been found at 27 of these sites.
●The information is important for you because silver may cause harmful health effects and because these sites are potential or actual sources of human exposure to silver.

⇨ Silver is rare but occurs naturally in the environment as a soft, "silver" colored metal. It also occurs in powdery white (silver nitrate and silver chloride) or dark-gray to black compounds (silver sulfide and silver oxide). Silver could be found at hazardous waste sites in the form of these compounds mixed with soil and/or water.

⇨ Silver is stable and remains in the environment in one form or another. Because silver is an element, it does not break down, but it can change its form by combining with other substances.

⇨ Over time, it may change from the form first released, to metallic silver, and then back to the same or other compounds. The form it is found in depends on environmental conditions.

⇨ When a Toxic Chemical like Silver is released from a large area, such as a landfill, it enters the environment as a chemical emission.

⇨ The emission of Silver, which is also called a release, people may be exposed to it in the environment by breathing, eating, or drinking substances containing the chemical or from skin contact with it.

⇨ Silver that is released into the environment *may be carried long distances in air and wate*r.

⇨ *Rain washes silver compounds out of many soils* so that it eventually *moves into the groundwater.*

EXPOSURE OF THE RESIDENTS OF GUAM

1. If are exposed to a hazardous substance such as silver, several factors will determine whether harmful health effects will occur and what the type and severity of those health effects will be. These factors include the dose (how much), the duration (how long), the route or pathway by which you are exposed (breathing, eating, drinking, or skin contact), the other chemicals to which you are exposed, and your individual characteristics such as age sex, nutritional status, family traits, life style, and state of health.

2. Most people are exposed to silver mainly in food and drinking water, and less in air. In addition, people may also be exposed through skin contact with silver compounds.

3. Silver may enter people's body through the mouth, throat, or digestive tract after eating food or drinking water that contains silver, or through your lungs after breathing air containing silver.

4. Because many silver compounds dissolve in water and do not evaporate, the most common way that silver may enter the body of a person near a hazardous waste site is by drinking water that contains silver or eating food grown near the site in soil that contains silver.

5. Part of the silver that is eaten, inhaled, or passes through the skin may build up in many places in the body.

HEALTH EFFECTS IN THE POPULATION

a. Since at least the early part of this century, doctors have known that silver compounds can cause some areas of the skin and other body tissues to turn gray or blue-gray. Doctors call this condition ***"argyria".*** Argyria occurs in people who eat or breathe in silver compounds over a long period (several months to many years).

b. Once people get argyria, it is permanent.

c. Exposure to dust containing relatively high levels of silver compounds such as silver nitrate or silver oxide may cause ***breathing problems, lung and throat irritation*** and *stomach pain*.

d. Skin contact with silver compounds has been found to cause ***allergic reactions***, such as rash, swelling, and inflammation, in some people.

e. One animal study suggests that long-term exposure (125 days) to moderately high levels of silver nitrate in drinking water ***may affect the brain*** because exposed animals were less active than animals drinking water without silver.

f. Another study found that some of the animals that drank water containing moderately high levels of silver had ***hearts that were larger than normal***.

g. There have been suggestions in some occupational studies in humans that silver can cause ***kidney problems***.

h. Another study found that ***reproductive tissues were damaged*** in animals after they received injections of silver nitrate.

Regulations of the Federal Government to protect human Health

- ⇨ EPA: recommends that the concentration of silver in drinking water not exceed 0.10 milligrams per liter of water (0.10 mg/L) because of the skin discoloration that may occur.
- ⇨ EPA: requires that spills or accidental releases of 1,000 pounds or more of silver be reported to the EPA.

18. Thallium

Federal Agency for Toxic Substances & Disease Registry (ATSDR)
Thalium: sites, dates, & concentrations/comparison values (CVs).

Up until 1972 thallium was ***used as a rat poison***, but was then banned because of its potential harm to man. *Thallium is* ***no longer produced in the U.S***. All the thallium used in the United States since 1984 has been obtained from imports and thallium reserves

Hazardous waste sites/Landfills, are sources of exposure to thallium.

Thallium can be fatal from a dose as low as 1 gram.

People are exposed by eating food, drinking water, or breathing air, contaminated with Thalium.

Screening/Conservative Value	Values found in this site
URUNAO DUMPSITE I	
1.40 mg/kg	**2.30 mg/kg**
URUNAO DUMPSITE II	
1.40 mg/kg	**2.70 mg/kg**

DISPERSION TROUGHOUT GUAM

Hazardous waste sites/Landfills, are sources of exposure to thallium.

➢*Water:*

1. An average of 23 ppb of thallium in surface water and 11 ppb in groundwater have been found at hazardous waste sites.

2. Since thallium compounds mix easily in water, you are exposed if you live near a chemical waste site where thallium emissions have contaminated the water.

➢*Soil*:

1. An average of 1.7 parts of thallium per million parts (ppm) of soil was found at hazardous waste sites.

2. Since thallium sticks to soil, you are exposed at hazardous waste sites if you swallow or touch contaminated soil.

➢*Air:*

1. Thalliumcontaminated dust in the air can also be swallowed after it is cleared from the lungs.

EXPOSURE OF THE RESIDENTS OF GUAM

A. People are exposed to thallium in air, water, and food.

B. The greatest exposure occurs when people eat food.

C. Thallium enters the human body when people eat food or drink water contaminated with thallium, breathe thallium in the air, and when their skin comes in contact with it.

D. When thallium is swallowed most of it is absorbed and rapidly goes to various parts of your body, especially the kidney and liver.

A. FOOD:

◆Fruits and Green Vegetables:

a. The greatest exposure occurs ***when people eat food, mostly homegrown fruits, and green vegetables*** contaminated by thallium.

b. Thallium is released into the air, and falls out of the air onto nearby fruit and vegetable gardens. Thallium enters food because it is easily taken up by plants through the roots.

◆Fish:

a. Although fish take up thallium from water, there are no sufficient studies to know the correlation between eating fish and the amount of thallium levels in the human body.

B. WATER, DUST, SKIN

The significant routes of exposure near hazardous waste sites are through swallowing thallium-contaminated soil or dust, drinking contaminated water, and skin contact with contaminated soil.

HEALTH EFFECTS IN THE POPULATION

➔ Damage to the:

1. Nervous System.
2. Lungs.
3. Heart.
4. Liver.
5. Kidneys.

➔ May cause:

1. Temporary hair loss, vomiting, and diarrhea can also occur and death may result after large exposure to thallium.

Regulations of the Federal Government to protect human Health

EPA has determined a water quality criteria level of 13 ppb in surrounding waters to protect humans from the harmful effects of drinking water and eating food containing thallium.

19. TOTAL PETROLEUM HYDROCARBONS (TPH)

TPH: sites, dates, and concentrations/comparison values (CVs).

Petrochemicals are chemical products made from raw materials of petroleum (hydrocarbon) origin.

The two main classes of raw materials are olefins (including ***ethylene*** and *propylene*) and aromatics (including ***benzene and xylene*** isomers), both of which are produced in very large quantities, mainly by the steam cracking and catalytic reforming of refinery hydrocarbons. From these basic building blocks are made a very wide range of raw materials used in industry - plastics, resins, fibres, ***solvents***, detergents, etc.

Shallow Subsurface Soil

❒ **GUAM, YIGO –** (SITE NO. 35)
Waste Pile No.1. Main Base.

Several thousand deteriorated drums of asphaltic tar ***from unknown dates*** are located at this site.

TPH: concentrations *"above"* CVs.

❒ **GUAM, MARBO –** (SITE NO. 37)
War Dog Borrow Pit-Operable Unit. MARBO Annex.

Its contents and dates of operation are unknown.

TPH: concentrations *"above"* CVs.

❒ **GUAM, YIGO –** (SITE NO. 26)
Fire Training Area No. 2-Operable Unit. Main Base: used between 1958 and 1988.

TPH: concentrations *"above"* CVs.

❒ **GUAM, NORTHWEST FIELD –** (SITE NO. 31)
Chemical Storage Area No.4-Operable Unit. Northwest Field: waste oils & solvents were stored at this site.

TPH: concentrations *"above"* CVs.

❒ **GUAM, MARBO –** (SITE NO. 22)
Waste Pile No.6 (formerly known as Landfill No. 27)-Operable Unit. MARBO Annex: contains construction debris. Dates of operation are unknown.

TPH: concentrations "*above*" CVs.

❒ **GUAM, MARBO –** (SITE NO. 38)

MARBO Laundry Facility-Operable Unit.MARBO Annex.

TPH: concentrations *"above"* CVs.

❒ **GUAM, YIGO –** (SITE NO. 1)
Landfill No.1-Operable Unit. Main Base: opened in 1945 and continues to be used today. Materials disposed of include waste petroleum, oil, lubricants, solvents, ferrous metal, construction debris, and pesticides.

TPH: present/concentrations not-specified

20. VANADIUM

Vanadium: sites, dates,& concentrations/comparison values (CVs).

Shallow Subsurface Soil:

❒ **GUAM, YIGO –** (SITE NO. 4)
Landfill No.6-Operable Unit. Main Base: used from 1953 to 1954.

Twenty surface soil samples were analyzed. Results: **Vanadium: concentrations *"above"* CVs for a child**

EXPOSURE & HEALTH EFFECTS

Vanadium is a metallic element that occurs in numerous inorganic compounds.

A. ORAL EXPOSURE:

Numerous studies indicate that for sub chronic and chronic oral exposures the primary targets are the:

1. Digestive system.
2. Kidneys.
3. Blood.

B. INHALATION EXPOSURE:

a) Respiratory system:
Bronchospasm, Pulmonary congestion, Bronchitis.

b) Other:
Conjunctivitis, Dermatitis

21. VOLATILE ORGANIC COMPOUND (VOC):

A. Trichloroethylene (TCE) or Perchloroethylene (PCE)

TCE: sites, dates, and concentrations/comparison values (CVs).

Groundwater from Downgradient Wells of Each Site

❒ **GUAM, YIGO –** (SITE NO. 33)
Drum Storage Area. No.2-Operable Unit. Main Base:

Active drum storage area for asphalt, paints, oil, tar, & contaminated soil from underground storage tank removals.

PCE: concentrations *"above"* the ATSDR *drinking water* CV.

❒ **GUAM, MARBO –** (SITE NO. 37)
War Dog Borrow Pit-Operable Unit. MARBO Annex: is an abandoned quarry.

Its contents and dates of operation are unknown.

TCE : concentrations *"above"* the ATSDR *drinking water* CV

❒ **GUAM, MARBO –** (SITE NO. 22)
Waste Pile No.6 (formerly Landfill No. 27)-Operable Unit.MARBO Annex: contains construction debris.

Dates of operation are unknown.

PCE: concentration *"above"* the ATSDR *"drinking water"* CV.

❒ **GUAM, YIGO –** (SITE NO. 2)
Landfill No.2/Landfill No.4/Landfill No.5 (4 & 5 are contained within 2)-Operable Units. Main Base: was used from 1947 to 1975, with a small area active until 1982. Materials disposed of at this site include petroleum, oil, lubricants, solvents**,** pesticides, ferrous metal, construction debris, and unexploded ordinance.

TCE: concentrations *"above"* the ATSDR *drinking water* CV

❒ **GUAM, YIGO –** (SITE NO. 8)
Landfill No. 10/Landfill No. 11/Landfill No. 12. Operable Units. Main Base. LF-10: used from the early to mid-1950 to dispose of asphalt wastes, scrap metals, empty 55-gallon drums, sanitary wastes, construction debris, occasional waste POL, and solvents. LF-11: used in the early 1950s as a disposal area for asphaltic material, empty 55-gallon drums, and construction debris. LF-12: used in the late 1950s to dispose of sanitary trash and asphaltic wastes.

PCE: concentrations *"above"* the ATSDR *drinking water* CV.

❒ **GUAM, MARBO –** (SITE NO. 38)
MARBO Laundry Facility-Operable Unit. MARBO Annex

PCE: concentrations *"above"* the ATSDR *drinking water* CV.

EXPOSURE

The US Air Force began uses TCE, an industrial solvent, to degrease airplane parts.

1. Tetrachloroethylene (TCE) is a synthetic chemical that is widely used for metal-degreasing operations. Other names for tetrachloroethylene include perchloroethylene, PCE, pert, tetrachloroethene, perclene, and perchlor.

2. TCE enters the environment mostly by evaporating into the air during use. It can also get into surface water supplies and the soil during disposal of sewage sludge and when leaking from underground storage tanks.

3. Tetrachloroethylene may also get into the air, soil, or water by leaking or evaporating from storage and waste sites.

4. TCE can stay in the air for several months before is brought back down to the soil and water by rain.

5. Much of the tetrachloroethylene that gets into water and soil will evaporate into the air. However, because tetrachloroethylene can travel through soils quite easily, it can get into underground drinking water supplies. If it gets into underground water, it may stay there for many months.

6. TCE may stick to the soil and stay there.

7. Vapor intrusion through walls and floors can be a source of indoor exposure in buildings near contaminated groundwater.

8. TCE can enter the body when people breathe air containing it, or when they drink water or eat food containing the chemical. Tetrachloroethylene can also be found in the breast milk of mothers who have been exposed to the chemical.

HEALTH EFFECTS

A. Statements by Federal Authorities:

- **US Senators--Hillary Rodham Clinton, Barbara Boxer, Christopher J. Dodd, Frank Lautenberg, Joseph I. Lieberman, Gordon Smith,** and **Ron Wyden** in written appeal to EPA for better public protection against TCE:
  "TCE...is known to cause cancer and damage the nervous and immune systems. Children and seniors are especially vulnerable to TCE's toxic effects... Today, thousands of Americans may be exposed to unhealthful levels of TCE."

- **Walter Mugdan, Director,** Division of Environmental Planning and Protection, US EPA in Vapor Intrusion, The Next Big Thing, August, 2006**:**
  "The major implication of the new findings is, of course, that human exposures at potentially dangerous levels may have occurred for years or decades, even after a site was recognized and (as we thought), satisfactorily addressed. We may presume that our relative ignorance in this arena will unfortunately have contributed to some number of additional cancers or other illnesses that could have been prevented."

B. Studies

Studies by the National Research Council, sponsored by the U.S. Department of Defense, the U.S. Department of Energy, the U.S. Environmental Protection Agency, and the National Aeronautics and Space Administration, shows that TCE (Trichloroethylene) is:

1. Nephrotoxic

2. Nephrocarcinogenic
3. Cardiac teratogenesis
4. Cause of infertility in males and females
5. Cause of impaired fetal growth.

22. VOLATILE ORGANIC COMPOUND (VOC): B. BTEX (benzene, toluene, ethylbenzene, and xylenes)

BTEX: sites, dates, and concentrations/comparison values (CVs).

Groundwater from Downgradient Wells of Each Site

❒ **GUAM, YIGO –** (SITE NO. 26)
Fire Training Area No.2. Main Base: used between 1958 and 1988

BTEX: concentrations "above" CVs---- up to: 7,200 ppb

EXPOSURE

a) Benzene, toluene, ethylbenzene, and xylenes (BTEX) frequently occur together at hazardous waste sites. The four chemicals are volatile and have solvent properties.

b) BTEX compounds are among the most acutely toxic and the most mobile in soil and groundwater, with the potential to move through soil and contaminate ground water, and their vapors are highly flammable and explosive.

c) BTEX compounds can pose a drinking water hazard when they accumulate in ground water.

HEALTH EFFECTS

BTEX compounds are well absorbed, distribute to lipid-rich and vascular tissues such as the brain, bone marrow, and body fat due to their lipophilicity.

A. Chronic potential hazards include harmful effects to the:

- Liver
- Kidneys
- Heart
- Lungs
- Nervous System, including neurological impairment
- Anemia, with subsequent manifestation of Acute Myelogenous Leukemia.

B. Acute hazards include:

Potential acute toxicity to aquatic life in the water column, as well as potential inhalation hazards.

23. Volatile Organic Compounds(VOCs) & Semi Volatile Organic Compounds (SVOCs): C. Not Specified

Substances containing carbon and different proportions of other elements such chlorine, bromine or sulfur; these substances easily become vapors or gases. A significant number of the VOCs are commonly used as solvents (e.g., paint thinners, lacquer thinner, degreasers, dry cleaning fluids).

SVOCs: sites, dates, and concentrations/comparison values (CVs).

A. *Shallow Subsurface Soil*

GUAM, YIGO – (SITE NO. 35)
Waste Pile No.1-Operable Unit. Main Base.

Several thousand deteriorated drums of asphaltic tar ***from unknown dates*** in this site.

SVOCs: concentrations *"above"* CVs ---- up to 0.27 ppm

GUAM, YIGO – (SITE NO. 29)
Waste Pile No. 2 (formerly known as Chemical Storage Area 2)-Operable Unit. Main Base:

Deteriorating drums of asphaltic tar .Dates of operation unknown.

❒ **GUAM, MARBO –** (SITE NO. 22)
Waste Pile No.6 (formerly Landfill No. 27)-Operable Unit. MARBO Annex: contains construction debris.

Dates of operation are unknown for this site

VOCs: concentrations "*above*" CVs.

SVOCs: concentrations *"above"* CVs ---- up to 0.26 ppm

❒ **GUAM, NORTHWEST FIELD –** (SITE NO. 31)
Chemical Storage Area No.4. Operable Unit. Northwest Field: waste oils and solvents stored at this site.

VOCs: concentrations "*above*" CVs ---- up to 1 ppm

❒ **GUAM, YIGO –** (SITE NO. 26)
Fire Training Area No.2. Main Base: used between 1958 and 1988.

VOCs: concentrations *"above"* CVs ---- up to 109 ppm

❒ **GUAM, YIGO –** (SITE NO. 26)
Fire Training Area No.2-Operble Unit. Main Base: used between 1958 and 1988.

SVOCs: concentrations *"above"* CVs ---- up to 6.8 ppm

❒ **GUAM, HARMON -** (SITE NO. 19)
Landfill No.24-Operable Unit. Harmon: holds sanitary trash and other types of debris from the 1950s.

SVOCs: concentrations *"above"* CVs ---- up to 230 ppm

❒ **GUAM, NORTHWEST FIELD –** (SITE NO. 21)
Landfill No.26-Operable Unit. Northwest Field: filled with sanitary trash & construction debris from 1966.

SVOCs: concentrations "*above"* CVs ---- up to 42 ppm

❒ **GUAM, YIGO –** (SITE NO. 8)
Landfill No.10/Landfill No.11/Landfill No.12-Operable Units. Main Base.LF-10: was used from the early to mid-1950s, to dispose of asphalt wastes, scrap metals, empty 55-gallon drums, sanitary wastes, construction debris, occasional waste POL, and solvents. LF-11: was used in the early 1950s as a disposal area for asphaltic material, empty 55-gallon drums, and construction debris. LF-12: was used in the late 1950s to dispose of sanitary trash and small quantities of asphaltic wastes.

SVOCs: concentrations "above" CVs ---- up to 50 ppm

B. Groundwater from Downgradient Wells of Each Site:

❒ **GUAM, NORTHWEST FIELD –** (SITE NO. 30)
Chemical Storage Area 3 (now known as Waste Pile No.4)-Operable Unit. Northwest Field: used from 1950 to 1970 to dispose of unexploded ordinance, waste oils and solvents.

VOCs: concentrations *"above"* EPA's Maximum Contaminant Levels (MCLs)

24. Zinc

Zinc: sites, dates, & concentrations/comparison values (CVs).

Screening/Conservative Value	Values found in this site
URUNAO DUMPSITE I	
130 mg/kg	**8,630 mg/kg**
URUNAO DUMPSITE II	
130 mg/kg	**2,040 mg/kg**

DISPERSION TROUGHOUT GUAM

1. Zinc is released into the environment by several mechanisms, like burning of waste, from dumpsites/landfills.

2. It attaches to soil, sediments, and dust particles in the air.

3. Rain and snow remove zinc dust particles from the air.

4. Depending on the type of soil, some zinc compounds can move into the groundwater and into lakes, streams, and rivers.

5. Most of the zinc in soil stays bound to soil particles and does not dissolve in water.

6. It builds up in fish and other organisms, but it does not build up in plants.

EXPOSURE OF THE RESIDENTS OF GUAM

a. Ingesting small amounts present in your food and water.

b. Children living near waste sites that contain zinc are exposed to higher levels of zinc through breathing contaminated air, drinking contaminated drinking water, touching or eating contaminated soil.

HEALTH EFFECTS IN THE POPULATION

1. Stomach cramps, nausea, and vomiting.

2. Skin irritation

3. Anemia and decrease the levels of good cholesterol.

4. Inhaling Zinc can cause a disease called metal fume fever.

Regulations of the Federal Government to protect human Health

- U.S. EPA: recommends that drinking water should contain no more than 5 milligrams per liter of water (5 mg/L) because of taste. The EPA requires that any release of 1,000 pounds (or in some cases 5,000 pounds) into the environment be reported to the agency.

◆ **TWO TOXIC CHEMICAL LANDFILLS IN PRIVATE PROPERTY-YIGO: URUNAO I AND II.**

Soil Screening Levels (SSLs) of Toxic Chemicals, and Health Risk/Hazard Quotient

RESULTS:

A. ALL THE TOXIC CHEMICALS AT URUNAO 1 & 2, HAVE VALUES AVOBE EPA's SOIL SCREENING LEVELS.

URUNAO DUMPSITE 1

CHEMICAL	SCREENING VALUE mg/Kg	VALUES IN URUNAO 1 mg/Kg	PRESENT IN:
1. Antimony	63.0	"above screening value" --- up to: 8,520	21 of 22 samples
2. Arsenic	62.0	"above screening value" --- up to: 173	22 of 22 samples
3. Barium	335	"above screening value" --- up to: 7,750	27 of 27 samples
4. Copper	72.0	"above screening value" --- up to: 5,120	22 of 22 samples
5. Lead	166	"above screening value" --- up to: 5,200	22 of 22 samples
6. Manganese	5500	"above screening value" --- up to: 8,010	26 of 26 samples
7. Nickel	243	"above screening value" --- up to: 325	22 of 22 samples
8. Selenium	3.30	"above screening value" --- up to: 16.6	17 of 22 samples
9. Silver	21.0	"above screening value" --- up to: 262	11 of 22 samples
10. Thallium	1.40	"above screening value" --- up to: 2.30	19 of 22 samples
11. Zinc	130	"above screening value" --- up to: 8,630	22 of 22 samples
URUNAO DUMPSITE 2			
CHEMICAL	CONSERVATIVE VALUE mg/Kg	VALUES IN URUNAO 1 Mg/Kg	PRESENT IN:

1. Antimony	63.0	"above screening value" --- up to: 186	2 of 14 samples
2. Copper	72.0	"above screening value" --- up to: 2,460	7 of 14 samples
3. Lead	166	"above screening value" --- up to: 53,400	8 of 14 samples
4. Manganese	7100	"above screening value" --- up to: 10,100	8 of 25 samples
5. Thallium	1.40	"above screening value" --- up to: 2.70	8 of 14 samples
6. Zinc	130	"above screening value" --- up to: 2,040	11 of 14 samples

CHAPTER: V

FINDINGS:
CONTAMINATION OF GROUNDWATER & DRINKING WATER WITH TOXIC CHEMICALS

GROUNDWATER AND DRINKING WATER

Yigo is located on the northern end of the island of Guam, and occupies approximately 20,000 acres, located in a karst limestone terrain. Inadequately contained sources of hazardous substances are located in sinkholes that provide a direct route for contamination to reach ground water.

40,200 civilians live within 4 miles of the dumpsites in Dededo, Tamuning, & Yigo, and obtain drinking water from wells in this site

Sources of hazardous substances include:
Chemical storage areas

Unlined landfills,
Drum storage
Disposal areas
Waste storage areas
Industrial and flight line operations.

Substances known to be involved in AAFB's operations include:

Solvents such as TRICHLOROETHENE (TCE)
Paint thinners
Dry cleaning fluids and laundry products
Fuels such as JP-4 and gasoline
Pesticides
Antifreeze
Aircraft cleaning compounds
PCBs

Sources of Contamination:

Landfills
Storage - drums/containers of waste
Explosive disposal/detonation
Waste pile

THREATS AND CONTAMINATION

1. Some of the areas where hazardous wastes are stored are inadequately contained and located near sinkholes; therefore, ***they constitute a threat to groundwater***.

2. ***Groundwater*** **sampling indicates the presence of**:
   ⇨ HEAVY METALS, including: LEAD and CHROMIUM,
   ⇨TOLUENE
   ⇨ Tetrachloroethane.
   ⇨ TCE

Assessing the Human Health Risks of Trichloroethylene (TCE)

THE NATIONAL ACADEMIES: NATIONAL ACADEMY OF SCIENCES; NATIONAL ACADEMY OF ENGINEERING; U.S. INSTITUTE OF MEDICINE; U.S. NATIONAL RESEARCH COUNCIL.

Study sponsored by the Department of Defense, Department of Energy, and the Environmental Protection Agency. July 2006

- Trichloroethylene, a solvent widely used as a degreasing agent, is a common contaminant of air, soil, and ***water at military installations, and dumpsites.***

- TCE is released into the air during degreasing operations and is found in soils and ***surface water*** as a result of direct discharges, and ***in groundwater from disposal operations***.

- TCE is released in indoor air ***if tap water is contaminated***, or if ***vapors enter from contaminated groundwater nearby.***

3. Surface areas, including unlined landfills and chemical storage areas, are contaminated with VOCs, PCBs, fuels, and Pesticides.

4. ***Civilians are at risk by ingesting or coming into direct contact with contaminated groundwater.***

GUAM: GROUNDWATER AND DRINKING WATER	
Were drinking water wells shut down due to contamination?	**No data**
Are drinking water wells potentially threatened?	**Yes**
Population served by the threatened wells:	**10,001 - 100,000**
Aquifer discharges into:	A sensitive ecological environment Surface water
Population served by water wells in the aquifer:	**10,001 - 100,000**

GUAM, MONGMONG AREA
GROUNDWATER PATHWAYS ANALYSIS
The following bullets list of chemical contamination sources in this area:

1. Trichloroethylene (TCE) and other chlorinated hydrocarbons, fuels, and cleaning solvents are in the groundwater, potentially moving toward Mongmong.

2. TCE have been found in nearby community production wells. The TCE's source is still unknown. GEPA is collecting additional information on potential sources in the area.

GUAM'S WATERS

GROUNDWATER QUALITY

1. Four chemicals, trichloroethylene (TCE), trichlorathane(TCA), perchloroethylene (PCE) and ethylene dibromide (EDB), have caused production wells to *Violate Safe Drinking Water Standards.*

2. *One Air Force well, one Navy well and two of Guam Waterworks Authority wells have been closed in recent years due to toxic contamination,.*

3. *12 Wells have increasing chloride levels from saltwater intrusion*.

SURFACE WATER QUALITY

- Due to extenuating circumstances, monitoring data of Toxic Chemicals was slim at the time Guam's most recent water quality assessment report (1998 305(b) report) was published.

- Monitoring was essentially restricted to evaluating bacteria, in order to protect and evaluate Guam's primary contact recreational designated use (swimming and wading).

CHAPTER: VI

FINDINGS:
TOXIC CHEMICALS IN THE SEA WATER AND SEAFOOD

A. GUAM: CONTAMINATION OF THE SEA WATER SEDIMENT

- Agana Boat Basin had high levels of COPPER, LEAD, and ZINC. The shallow waters close to shore at the Merizo Pier had HEAVY COPPER, LEAD, TIN, and ZINC concentrations**.** The highest levels of contaminants were at Apra Harbor, where moderate to heavy enrichment of COPPER, LEAD, MERCURY, TIN, ZINC, PCB'S and PAH'S were identified in sediments collected near Hotel Wharf, Commercial Port and Dry Dock Island. The recently constructed Agat Marina had lowest contaminant levels, showing CHROMIUM contamination.

- Inner Apra Harbor may have the highest levels of sediment contamination on Guam, based on limited sampling for the Navy which showed, for example, elevated levels of TIN. *These tin levels rank among the highest concentrations ever recorded in harbor sediments world-wide.*

B. GUAM: CONTAMINATION OF THE SEAFOOD
Contaminant Bio-Uptake Study

- Increases in ARSENIC, COPPER, LEAD, MERCURY, TIN, and PCB'S recorded in certain biota (the combined flora and fauna of a region), at localized sites, mostly in Apra Harbor. Levels of contaminants in edible parts of consumed organisms were significant or indicative of real health risks for COPPER and ZINC in *OYSTERS* in Apra Harbor and Agana Boat Basin and ARSENIC in the Apra Harbor ***OCTOPUS*.** MERCURY was found in muscle tissue at a level above Canadian and Australian standards in three out of seventy-five ***FISH*** sampled; two edible fishes and one lizardfish from Apra Harbor.

C. EFFECTS OF THE CONTAMINATION OF SEA WATER & SEAFOOD IN HUMAN HEALTH

1. Physical contact with sediment contaminants found in Guam harbors, at the levels observed (University of Guam,1997), would not pose a notable health risk. Ingestion of measurable amounts of the contaminated sediments would not reasonably be expected. However, sources of health risk may arise through uptake of contaminated sediments or their pollutants by harbor organisms and passage through food chains to human consumers. Bio-accumulation of heavy metals and PCB's from sediments potentially can make marine organisms unacceptable for human consumption.

2. PCB's are linked to increased cancer risks, disruption of women's reproductive function and to neurobehavioral and developmental problems in children born to women exposed to PCB's and are also associated with other systemic effects (e.g., liver disease and diabetes, compromised immune function, and thyroid effects). A comparative analysis of PCB levels in organisms in Guam harbors with levels in related species elsewhere**,** indicates mild enrichment extending to moderate levels in certain species at localized sites in Apra Harbor.

3. The levels of COPPER and ZINC in filter feeding ***OYSTERS*** from Agana Boat Basin and parts of Apra Harbor exceed standards applied in Australia for fishery products.
4. The ***OCTOPUS*** from Apra Harbor had arsenic concentrations comparable to those found in related species in other countries, but could cause deleterious health effects to a person consuming in excess of 60 grams of this per day (University of Guam, 1999).

5. Some heavy metals found in Guam, such as MERCURY, LEAD, and CADMIUM**,** are excreted very inefficiently by the human body and even if exposure to these metals is extremely minute, their levels may still exceed the quantity that the body can excrete and, consequently, toxic levels may be achieved after several years of chronic exposure.In addition to lead poisoning, effects of these metals include chronic fatigue syndrome, fibromyalgia and multiple chemical sensitivity syndrome.

6. MERCURY has been recognized as the most significant metal contaminant derived from ***FISH*** consumption. Even minute quantities of mercury are extremely toxic. When mercury from contaminated ***SEAFOOD*** accumulates, the immune system becomes weakened, the detoxification capacity of the liver and kidneys is diminished, hormones become poorly regulated, and the NERVOUS SYSTEM becomes impaired. Allergies, chemical sensitivities, gastrointestinal disturbances, depression, anxiety, headaches, muscle and joint pains, chronic fatigue, frequent infections, abnormal gastrointestinal flora and hormonal disturbances are just a few of the many symptoms which have been linked with chronic mercury toxicity.

7. Although PCB'S bioaccumulate and concentrate through food chains leading to humans being exposed when they consume contaminated ***FISH.*** *Cancer* risks can arise from PCB intake and maternal consumption of PCB contaminated fish is associated with adverse health of children Certain polycyclic aromatic hydrocarbons (PAH'S) are potentially carcinogenic. They are also released from sediments through dredging activities.

D. EFFECTS OF THE CONTAMINATION OF THE SEA WATER ON NATURAL RESOURCES

a. COPPER and TIN are undoubtedly toxic to marine invertebrates. University of Guam's, Professor Heslinga (1976) research showed COPPER impacts on larvae of a common species of ***SEA URCHIN*** from Guam's reefs. Copper can be acutely or chronically toxic to aquatic organisms through exposure in water or in sediments.

b. PCB'S and PAH'S also may be released to food chains, and that PCB'S of sufficient doses can produce an immunosuppressive effect and induce hepatic microsomal enzyme systems. They have the ability to bioactivate relatively nontoxic compounds in cells to become *cytotoxic or genotoxic metabolites*. Some PAH'S are carcinogenic to animals (University of Guam, 1997)

c. Based on Guam studies by the University of Guam,1997), accumulation of finer sized sediment fractions has a greater inhibiting effect on the recruitment and growth of corals than does the larger sized fractions. It is not known whether the severity of impacts from pollutants in Guam harbor sediments would be distributed differentially with the size of sediment fractions. ➢But sediment particle sizes in Guam harbors tend to be predominantly sand sized (greater than 0.063mm diameter) with less than 10% being smaller silt particles.

CHAPTER: VII

FINDINGS:
LIST OF ACTIVE AND ABANDONED LANDFILLS IN GUAM WITH TOXIC CHEMICALS, THAT REPRESENR A SERIOUS THREAT TO THE HEALTH OF THE POPULATION.

GUAM, A SMALL ISLAND 30 MILES LONGE-8 MILES WIDE, HAS...
ONE HUNDRED-FOURTEEN (107) TOXIC CHEMICAL DUMPSITES.

\- -

N0.	EPA SITE #, or PROPERTY #	GUAM- VILLAGE:	NAME OF DUMPSITES WITH TOXIC CHEMICALS
1	GU6170090017	**HAGATNA**	AGANA RIVER AND PASEO SITE

2	GU0170027320	**BARRIGADA/TIYAN**	NAVAL AIR STA AGANA
3	GU4170027334	**SANTA RITA**	NAVAL SHIP REPAIR FACILITY
4	GU7170027323	**SANTA RITA**	NAVAL STA GUAM
5	GUD984366328	**HAGATNA**	NAVFAC
6	GU4170090001	**PITI**	PITI POWER PLT
7	GU5170090018	**BARRIGADA**	BARRIGADA VILLAGE DUMPSITE
8	GUD980497093	**DEDEDO**	GUAM POWER AUTHORITY
9	GU1170090012	**MERIZO**	WW II JAPANESE AIRCRAFT
10	GU2170090011	**SANTA RITA**	NAVAL FACIL GUAM
11	GU9170090006	**SANTA RITA**	NAVAL HOSP GUAM
12	GU9170090006	**SANTA RITA**	NAVAL MAGAZINE GUAM
13	GU6170090009	**DEDEDO**	NAVAL COMM AREA
14	GU0170090005	**PITI**	NIMITZ HILL ANNEX
15	GU9170090014	**SANTA RITA**	NAVY SUPPLY DUMP SITE
16	GUD980637649	**ORDOT**	ORDOT LANDFILL

17	GU7170090008	**SANTA RITA/PITI**	APRA HARBOR NAVAL COMPLEX
18	GU6170090025	**SANTA RITA**	CAMP COVINGTON
19	GUT000010009	**SANTA RITA**	GUAM OIL REF CO (GORCO)
20	GU7170090024	**SANTA RITA**	NAVAL REG. DENTAL CTR
21	GU8170090023	**SANTA RITA**	NAVAL SUPPLY DEPOT
22	GU1170090004	**SANTA RITA**	SASA VALLEY FUEL DEPOT
23	GU7170090016	**PITI**	TENJO VISTA OILY WASTE DSPL
24	GU8170090015	**DEDEDO**	FINEGAYAN HOUSING DUMP
25	GU0170090013	**SANTA RITA**	US NAVAL MAGAZINE
26	GU6571999519	**YIGO**	LANDFILL No.1 ANDERSEN AFB: MAIN BASE
27	GU6571999519	**YIGO**	LANDFILL No.2 ANDERSEN AFB: MAIN BASE
28	GU6571999519	**YIGO**	LANDFILL No.3 ANDERSEN AFB: MAIN BASE
29	GU6571999519	**YIGO**	LANDFILL No.4 ANDERSEN AFB: MAIN BASE
30	GU6571999519	**YIGO**	LANDFILL No.5 ANDERSEN AFB: MAIN BASE

31	GU6571999519	**YIGO**	LANDFILL No.6 ANDERSEN AFB: MAIN BASE
32	GU6571999519	**YIGO**	LANDFILL No.7 ANDERSEN AFB: NORTHWEST FIELD
33	GU6571999519	**YIGO**	LANDFILL No.8 ANDERSEN AFB: MAIN BASE
34	GU6571999519	**YIGO**	LANDFILL No.9: ANDERSEN AFB: MAIN BASE
35	GU6571999519	**YIGO**	LANDFILL No.10: ANDERSEN AFB: MAIN BASE
36	GU6571999519	**YIGO**	LANDFILL No.11: ANDERSEN AFB: MAIN BASE
37	GU6571999519	**YIGO**	LANDFILL No.12: ANDERSEN AFB: MAIN BASE
38	GU6571999519	**YIGO**	LANDFILL No.13: ANDERSEN AFB: MAIN BASE
39	GU6571999519	**YIGO**	LANDFILL No.14: ANDERSEN AFB: MAIN BASE
40	GU6571999519	**YIGO**	LANDFILL No.15-A ANDERSEN AFB: MAIN BASE
41	GU6571999519	**YIGO**	LANDFILL No.15-B: ANDERSEN AFB: MAIN BASE

42	GU6571999519	**YIGO**	LANDFILL No.16: ANDERSEN AFB: MAIN BASE
43	GU6571999519	**YIGO**	LANDFILL No.17: PATI POINT DUMP
44	GU6571999519	**YIGO**	LANDFILL No.18: ANDERSEN AFB: HARMON ANNEX
45	GU6571999519	**YIGO**	LANDFILL No.19: ANDERSEN AFB: HARMON ANNEX
46	GU6571999519	**YIGO**	LANDFILL No.20: ANDERSEN AFB: MAIN BASE
47	GU6571999519	**YIGO**	LANDFILL No.21: ANDERSEN AFB: NORTHWEST FIELD
48	GU6571999519	**MANGILAO**	Site 22: *WASTE PILE No.6* MARBO ANNEX
49	GU6571999519	**YIGO**	LANDFILL No.23: ANDERSEN AFB: NORTHWEST FIELD
50	GU6571999519	**YIGO**	LANDFILL No.24: ANDERSEN AFB: MAIN BASE
51	GU6571999519	**MANGILAO**	LANDFILL No.25: ANDERSEN AFB: MARBO ANNEX
52	GU6571999519	**YIGO**	LANDFILL No.26: ANDERSEN AFB: MAIN BASE
53	GU6571999519	**YIGO**	Site 27: <u>HAZARDOUS WASTE STORAGE #.1</u> ANDERSEN AFB: NORTHWEST FIELD

54	GU6571999519	**YIGO**	Site # 28: CHEMICAL STORAGE AREA No.1 ANDERSEN AFB: MAIN BASE
55	GU6571999519	**MANGILAO**	Site 29: *WASTE PILE No. 2* ANDERSEN AFB: MARBO ANNEX
56	GU6571999519	**YIGO**	Site.30: CHEMICAL STORAGE AREA No. 4 ANDERSEN AFB: NORTHWEST FIELD
57	GU6571999519	**YIGO**	Site 31: CHEMICAL STORAGE No. 4 ANDERSEN AFB: NORTHWEST FIELD
58	GU6571999519	**YIGO**	Site 32: DRUM STORAGE AREA No.2 ANDERSEN AFB: MAIN BASE
59	GU6571999519	**YIGO**	LANDFILL No.33: ANDERSEN AFB: MAIN BASE
60	GU6571999519	**YIGO**	Site 34: PCB STORAGE AREA ANDERSEN AFB: MAIN BASE
61	GU6571999519	**YIGO**	Site 35: WASTE PILE No. 1 ANDERSEN AFB: MAIN BASE
62	GU6571999519	**YIGO**	Site.36*: RITIDIAN WASTE PILE* ANDERSEN AFB: NORTHWEST FIELD
63	GU6571999519	**MANGILAO**	Site 37: WAR DOG BORROW PIT ANDERSEN AFB: MARBO ANNEX
64	GU6571999519	**MANGILAO**	Site.38: ANDERSEN AFB: MARBO ANNEX
65	GU6571999519	**HARMON**	LANDFILL No.39

			ANDERSEN AFB: HARMON
66	GU 6571999519	**YIGO**	PRIVATE PROPERTY. West of Andersen AFB
67	GU6571999519	**YIGO**	PRIVATE PROPERTY. WEST OF ANDERSEN AFB
68	H09GM 0280	**YIGO**	NORTHWEST AFB
69	H09GM 0281	**DEDEDO**	NAVAL COMMUNICATIONS STATION
70	H09GM 0017	**DEDEDO**	FINEGAYAN HOUSING DUMP
71	H09GM 0280	**DEDEDO**	DEDEDO AFB
72	H09GM 0004	**DEDEDO**	HARMON QUARRY
73	H09GM 0006	**TUMON**	TUMON GUN SITE
74	H09GM 0291	**TIYAN (BARRIGADA)**	NAVAL AIR STATION
75	H09GM 0019	**TUMON**	NAVY SUPPLY DUMPSITE
76	H09GM 0018	**TAMUNING**	NAMBO COMMERCIAL
77	H09GM 0302	**MAITE**	5TH FIELD MARINE SUPPLY DEPOT
78	H09GM 0005	**HAGATNA**	PASEO DE SUSANA
79	H09GM 0298	**TALAFOFO**	AREA 108

80	H09GM 0016	**INAJERAN**	GUAM SITE 1
81	H09GM 0003	**ASAN**	CAMEL ROCK BEACH
82	H09GM 0285	**ASAN**	ASAN POINT TANK FARM
83	H09GM 0002	**ASAN**	REEF ASAN POINT
84	H09GM 0011	**PITI**	CABRAS ISLAND
85	H09GM 0013	**PITI**	CABRAS IS. ROCK QUARY
86	H09GM 0000	**PITI**	PEDRO SANTOS PARK
87	H09GM 0007	**PITI**	APRA HARBOR, SITE 2
88	H09GM 0300	**ORDOT**	LONFIT PROJECT
89	H09GM 0282	**PITI**	MT. TENJO VHF STATION
90	H09GM 0275	**SANTA RITA**	DoD: SOUTHERN HIGH SCHOOL
91	H09GM 0009	**SANTA RITA**	APRA HARBOR: SITE 3
92	H09GM 0001	**AGAT**	MT.ALIFAN/WAR THE PACIFIC
93	H09GM 0278	**AGAT & SANTA RITA**	US NAVAL AMMO DEPOT
94	H09GM 0301	**Off- MERIZO**	COCOS ISLAND - LORAN STATION

95	H09GM 0276	**YIGO**	AIR FORCE: AV-GAS TANK FARM 12
96	H09GM 0292	**YIGO**	AGAFU GUMAS HOUSING
97	H09GM 0295	**YIGO**	A.AFB: AREA 101
98	H09GM 0012	**MANGILAO**	MARBO AIR FORCE BASE
99	H09GM 0091	**BARRIGADA**	US NAVAL AIR STATION
100	H09GM 0281	**BARRIGADA**	NAVAL COMMUNICATION CTR.
101	H09GM 0269	**MAITE/MONMONG**	IBANEZ/GUERRERO PROPERTIES
102	H09GM 0288	**PITI**	NIMITZ HILL NAVAL COMMAND CTR
103	H09GM 0271	**BARRIGADA**	US NAVAL RADIO STATION
104	H09GM 0278	**ORDOT**	US NAV. AMMO DEPOT (GROUND)
105	H09GM 0296	**CHALAN PAGO**	AREA 104
106	H09GM 0289	**YONA**	AACS RADIO RANGE
107	H09GM 0284	**YONA**	MIYAMA HILLS
108	H09GM 0008	**MANGILAO**	MANGILAO DUMPSITE

109	H09GM 0299	**YONA**	CASACADA COUNTRY CLUB
110	H09GM 079	**PITI**	SASA VALLEY: TANK FARM # 78
111	H09GM 0014	**YONA**	ADVENTIST ACADEMY
112	H09GM 0297	**TALAFOFO**	AREA 106
113	H09GM 0293	**TALAFOFO**	CAMP DEALY
114	H09GM 0273	**TALAFOFO**	CAMP ETHRIDGE RECREATIONAL BEACH

CHAPTER: VIII

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