FACT SHEET ON OCEAN DUMPING OF RADIOACTIVE WASTE MATERIALS

Prepared For
House of Representatives
Subcommitte on Oceanography
of the
Committee on Merchant Marine and Fisheries

Environmental Protection Agency
Office of Radiation Programs
Washington D.C.

November 20, 1980

INTRODUCTION

Low-level radioactive wastes are routinely generated by a wide range of military and non-military operations, including nuclear powerplant operations, commercial manufacturing processes, and research and medical institutions. When we say low-level radioactive wastes, we generally mean all those materials not directly resulting from the processing of spent reactor fuel. Low-level wastes defined in this way may be hazardous, depending upon their concentration and their proximity to man or other organisms. The bulk of these low-level wastes are by-product materials, especially materials such as equipment, tools, and lab clothes which have become contaminated by exposure to or contact with radioactive materials. Some examples of by-products materials are radioactive cobalt, strontium, americium, and cesium. At times, they also may include small quantities of "source materials", such as uranium and thorium, or traces of "special nuclear materials" such as plutonium or enriched uranium.

From 1946 through 1970 the United States disposed of these radioactive waste materials either by shallow land-burial at government-owned sites, or by ocean dumping at AEC-approved sites. Because the materials were potentially hazardous, they were given special attention in transport and handling. But because they were regarded primarily as garbage, precise records apparently were not kept of the disposal operations. Materials for land burial were packaged in a wide variety of containers, while materials for ocean disposal were encased primarily in concrete-filled steel drums.

Today, the records of the ocean dumping activities consist primarily of licenses issued by the Atomic Energy Commission to private contractors and of logs indicating the approximate locations of disposal sites. In most of the cases the records do indicate the nature of the materials, the quantities, the estimated radioactivity, and the approximate coordinates of the dumping location; unfortunately, they do not indicate the specific isotopic content, and neither the content of the containers nor the precise dumping locations can be verified. Records of military operations and government contractors (such as the national laboratories) may also still exist, but are not currently available.

The environmental survey work of the ocean nuclear waste dumpsites by EPA was initiated under the mandate of the Marine Protection, Research and Sanctuaries Act (PL 92-532) in order to provide a technical basis for both the development of regulations and criteria and the consideration of future disposal alternatives. In 1974 EPA sent an initial survey team to the Farallon Islands dumpsites to confirm the feasibility of locating the containerized waste packages, and to determine if any measurable amounts of radioactivity could been released into the dumpsites. Using an unmanned submersible vehicle several cannisters were successfully located, underwater photographs were taken to assess the condition of the drums, and sediment samples were collected in proximity to both intact and imploded drums. Low levels of plutonium 238, 239, and 240 were detected.

In 1977, two additional surveys of the Farallon Island Sites were undertaken; the first to provide estimates of biologic activity and diversity, and to take samples of the water column and the ocean bottom, and the second to measure ocean currents and attempt the recovery of one of the waste cannisters.

In the Atlantic Ocean a similar series of investigations was undertaken at the 2800 and 3800 meter sites. A preliminary sampling team went out to the 2800 meter site in May, 1974; in 1975 three dives in a submersible vehicle were made at the 2800 meter site to locate and document the condition of drums and take a variety of sediment, water, and biological samples. In 1976 similar data and a waste canister were recovered from the 2800 meter site for detailed laboratory analysis of canister corrosion and physical integrity, and in 1978, similar samples were obtained from the 3800 meter site and a waste drum was recovered for analysis.

This Fact Sheet is a summary of information currently available to EPA about these waste dumping activities. It includes:

1) A history of dumping operations.

2) A tabular summary identifying all known sites, the types of materials dumped, the licensed dumping agents, and indicating whether or not EPA has surveyed the sites;

3) Summaries of the survey work which has been done under contract to EPA and in conjunction with EPA scientists;

4) A list of the principal statutory authorities relating to the ocean dumping of low-level radioactive materials;

HISTORY OF DUMPING OPERATIONS

On the basis of the information EPA has gathered to date, the following are salient points in the history of U.S. ocean dumping of radioactive materials. A tabular summary of the designated dump sites follows this list

- Between 1946 and 1970 the ocean dumping of radioactive wastes was conducted under the licensing authority and direction of the Atomic Energy Commission;

- In 1960, the AEC imposed a moratorium on the issuance of new dumping licenses, allowing existing licenses to remain in orce and to be renewed;

- By 1963 most ocean dumping activities had been phased out, and, in 1970, the U.S. terminated all ocean dumping of radioactive waste materials;

- In 1973, the U.S. ratified the 1972 London Dumping Convention, prohibiting, among other things, the ocean disposal of high level nuclear wastes and allowing for the future dumping of low-level radioactive wastes only under controlled conditions stipulated by the Convention;

- From 1946 thru 1962 (two years after the license moratorium), the U.S. dumped a total of approximately 89,400 containers with an estimated inventory of 94,400 curies (Ci) of radioactivity;

- Between 1963 and 1970 (when all dumping was terminated) the U.S. dumped only about 350 containers with an estimated total activity of about 230 curies.

- The Farallon Island Sites (collectively) received approximately 99 percent of the radioactivity dumped in the Pacific Ocean;

- The Atlantic 2800 Meter Sites received approximately 96 percent of all radioactivity dumped in the Atlantic.

TABLE OF U.S. OCEAN DUMPING OF RADIOACTIVE MATERIALS

PACIFIC OCEAN SITES

Recorded Site Designation(s)[1/ 8/]	Depth (meters)	Central Coordinates[2/]	Relation to Land[3/]	Material[4/]	Activity[5/]	Containers[6/]	Agents[7/]	Years Used	EPA Reports
P1 Farallon Islands (8)	896 - 1700	37°38'N 123°08'W	25-60 miles WSW of San Francisco	B, S, SNM	14,500	47,500	NEC, OTC, CR USNRDC AEC	1946-1970	YES
P2 Hawaiian Island (1) 9/	3500	21°28'N 157°25'W	70 miles NE of Honolulu*	B	00.9	39	UH	1959-1960	NO
P3 Midway Island (1)	5490	34°58'N 174°52'W	300 miles N of Midway Islands*	B	14	7	MSTS	1959-1960	NO
P4 Santa Cruz (3)	1830 - 1940	33°40'N 119°35'W	35 miles SW of Port Hueneme	B, S	108	3,114	PN, AEC	1946-1962	NO 11/
P5 (1)	3294	42°12'N 129°31'W	230 miles W of Or/Ca border*	B	0.95	26	CR	1955-1958	NO
P6 (1)	2928	43°52'N 127°44'W	190 miles NW of Or/Ca border*	B	0.08	4	CR	1960	NO
P7 (1)	4099	42°04'N 125°01'W	35 miles W of Or/Ca border*	B	0.08	4	CR	1960	NO
P8 Los Angeles (2)	3660 - 4570	30°43'N 139°05'W	1000 miles WSW of Los Angeles*	B	0.95	26	CR	1955-1958	NO
P9 (1)	3477	28°47'N 135°00'W	800 miles SW of San Francisco*	B	1.1	29	CR	1955-1960	NO
P10 San Diego (1)	2210 - 3660	32°00'N 121°30'W	225 miles SW of San Diego	B, S, SNM	34	4,415	CMDC, ISC	1959-1962	NO
P11 Cape Mendocino (1)	1830 - 1990	40°07'N 135°24'W	800 miles WNW of San Francisco*	B, S	0.22	29	AML	1960	NO

TABLE OF U.S. OCEAN DUMPING OF RADIOACTIVE MATERIALS

PACIFIC OCEAN SITES

Recorded Site Designation(s)[1/ 8/]	Depth (meters)	Central Coordinates[2/]	Relation to Land[3/]	Material[4/]	Activity[5/]	Containers[6/]	Agents[7/]	Years Used	EPA Reports
PI2 Cape Scot 1 (1)	3294	50°56'N 136°03'W	350 miles NW of Cape Flattery*	B, S	96	197	AML10/	1958-1966	NO
PI3 Cape Scott 2 (1)	3294	52°25'N 140°12'W	350 miles NW of Cape Flattery*	B, S	28	163	AML10/	1962-1969	NO
North Pacific (1)		51°30'N 136°31'W			0.54	38		1946-1962	NO
North Pacific (1)		52°05'N 140°00'W			0.54	41		1946-1962	NO
North Pacific (Unk.)		47°00'N 138°54'W			97.4	361		1946-1966	NO
(1)	1830				1.2	37		1946-1962	NO
(1)					96.5	231		1963-1966	NO

TABLE OF U.S. OCEAN DUMPING OF RADIOACTIVE MATERIALS

ATLANTIC OCEAN DISPOSAL SITES

Recorded Site Designation(s)[1/] [8/]	Depth (meters)	Central Coordinates[2/]	Relation to Land[3/]	Material[4/]	Activity[5/]	Containers[6/]	Agents[7/]	Years Used	EPA Reports
A1 Massachusetts Bay (1)	92	42°25'N 70°35'W	Massachusetts Bay	B, S	2,440	4,008	CMDS	1952-1959	NO
A2 Cape Henry (5)	1830 - 1967	36°56'N 74°23'W	80 miles E of Cape Henry*	B	87	843	NIH	1949-1967	NO
A3 Sandy Hook 1 (1)	1830 - 2800	38°30'N 72°06'W	140 miles SE of Sandy Hook*	B	74,400	14,301	AEC	1951-1956 1959-1962	YES
A4 Sandy Hook 2 (1)	1830 - 3800	37°50'N 70°35'W	220 miles SE of Sandy Hook*	B	2,100	14,500	AEC	1957-1959	YES
A5 Charleston (13)	915 - 3660	31°32'N 76°30'W	220 miles E of Charleston*	B	0.66	119	SMO, ARC	1955-1962	NO
A6 Morehead City (1)	18	34°32'N 76°40'W	15 miles S of Morehead City*	B	0.3	unpackaged	FWS	1955-1961	NO
A7 thru A11 Central Atlantic	3660 - 5289	36°20'N - 43°49'N 45°00'W		B	480	432	MSTS	1959-1960	NO
A12 Sapelo Islands	11		Off coast of Sapelo Islands	B	0.005	liquid	UG	1955-1960	NO

GULF OF MEXICO DISPOSAL SITES

Recorded Site Designation(s)[1]/	8/ Depth (meters)	Central Coordinates[2]/	Relation to Land[3]/	Material[4]/	Activity[5]/	Containers[6]/	Agents[7]/	Years Used	EPA Reports
GM1	1930	27°14'N 89°33'W	170 miles S of New Orleans, LA.*	B	10	1	MP	1958	NO
GM2	3111	25°40'N 85°17'W	250 miles SE of Appalachicola, Fla.*	B	0.002	78	SMO	1955-1957	NO

Notes to Table

1/ In contracting and licensing the ocean dumping of radioactive wastes, the AEC designated general areas for approved dumping. In some instances these areas were identified by single coordinates and the wastes were concentrated in relatively specific areas, while in other instances the AEC designated much broader areas and allowed those dumping to proceed according to general guidelines. Dumping under these designations resulted in much less concentrated dumping activities and a multitude of individual "dumpsites". The number of such individual dumpsites under a particular heading in this column is indicated in parentheses. The designation A1 through A12, GM1 and GM2, and P1 through P13 refer to the NRC site numbering system.

2/ Central coordinates designate dumping areas thought to have received concentrations of waste materials. Actual coordinates may have varied over wider distances.

3/ Approximations for land references: an asterisk means that EPA has not plotted the coordinates on nautical charts to confirm the stated distance from land; blanks mean we haven't found the information yet.

4/ Three types of materials were dumped under AEC licenses or by AEC contractors: by-product materials (B), source materials (S), and special nuclear materials (SNM). By-product materials refer to a wide variety of substances which were exposed to incidental radiation. Source materials include uranium and thorium. Special nuclear materials include plutonium, uranium-233, enriched uranium-233 or 235, and any other materials which the AEC may have determined to be special nuclear materials.

5/ Radioactivity is given in estimated curies at the time of packaging.

6/ Waste materials were generally either packaged in special containers which were then placed in concrete-filled steel drums, or mixed directly in concrete which was in turn placed in the steel drums.

7/

AEC	U.S. Atomic Energy Commission
AML	American Mail Lines
ARC	Atlantic Refining Company
CMDC	Coastwise Marine Disposal Corporation
CR	Chevron Research
FWS	U.S. Fish and Wildlife Service
ISC	Isotope Specialty Company
MP	Magnolia Petroleum
MSTS	Military Sea Transport Service
NEC	Nuclear Engineering Company
NIH	U.S. National Institute of Health
NRDL	U.S. Naval Radiation Development Laboratory
OTC	Ocean Transport Company
PN	Pneumodynamics
SMO	Socono-Mobil Oil
UG	University of Georgia
UH	University of Hawaii

8/ There were some AEC approved ocean dumping sites for which EPA has no records of dumping activities. They are as follows.

Pacific Ocean	Atlantic Ocean
39°30'N; 125°40'W	41°33'N; 65°30'W
37°40'N; 124°50'W	41°33'N; 65°33'W
36°00'N; 124°00'W	41°28-38'N; 65°28-45'W
34°30'N; 122°50'W	38°30'N; 72°00'W
	36°30'N; 74°13'W
	36°15'N; 76°35'W
	34°15'N; 76°35'W

9/ Based on NRC memorandum of 8/14/80 additional dumpings appear to have taken place in the 1960's and are being characterized in ongoing records research.

10/ Under the terms of the AML license, AML was authorized to dump along the path of its shipping route beyond depths of 1,000 fathoms (1830 meters).

11/ Report published by NOAA in April 1973, "Submersible Inspection of Deep Ocean Waste Disposal Sites Off Southern California" describes survey of Santa Cruz Basin.

*/ See note number 3/, above.

SUMMARY OF EPA SURVEYS OF PAST DISPOSAL SITES FOR RADIOACTIVE WASTES

A number of reports have been prepared for the Office of Radiation Programs (ORP) of the EPA to describe surveys of the old ocean disposal sites for radioactive materials. These surveys have been generally described in EPA Annual Reports to Congress, ORP Radiological Quality of the Environment Reports, the EPA Journal and elsewhere.

In 1974, an initial survey term was sent to the Farallon Islands sites. These teams used an unmanned submersible vehicle to locate waste drums. The Atlantic 2800 meter depth site was similarly investigated in conjunction with NOAA studies at Deep Water Dumpsite (DWD) 106. This was followed in 1976 by an EPA survey of the Atlantic site using the manned submersible ALVIN. In 1977 two additional surveys of the Farallon Islands were undertaken to provide estimates of the biological activity and diversity or the area, and to obtain a wide range of samples. In 1978, the ALVIN was again employed to investigate conditions at the 3800 meter depth Atlantic radioactive waste disposal site.

Geologists, biologists, radiochemists, physical oceanographers and oceanographic engineers from many universities and oceanographic institutions participated in shipboard and onshore laboratory tasks in connection with the EPA surveys. Reports of this work have been submitted to the Office of Radiation Programs in various stages of completion and about 30 are currently on file with EPA. All of these reports have been provided to the House Government Operations Committee Subcommittee on Environment, Energy, and Natural Resources, and to other interested government officials.

The reports are summarized below in two sets: those prepared in conjunction with the Pacific Ocean site investigations, and those prepared in conjunction with the Atlantic Ocean site investigations. Five of the Atlantic reports and three of the Pacific (Farallon Islands) reports are final and have been published; and the remaining reports are in varying stages of completion by contractors or are undergoing scientific review within and outside EPA. The reader should be aware that both data and interpretations presented by the contractor for the reports still undergoing review may be either incomplete or subject to misunderstanding, and do not necessarily represent conclusions of EPA at this time.

Atlantic Ocean

The following is a summary of seventeen research reports prepared for EPA/ORP on the 1974, 1975, 1976, and 1978 surveys of the 2800 meter and 3800 meter Atlantic dumpsites. In some instances where researchers were involved in investigations at both the Atlantic and Pacific Ocean sites, there may be overlap between information reported in Atlantic and Pacific Ocean reports.

(1) Dyer, Robert S., "Investigation of Radioactive Waste Disposal at Deepwater Dumpsite 106", in May 1974 Baseline Investigation of Deepwater Dumpsite 106, NOAA Dumpsite Evaluation Report 75-1, December 1975.

This published report describes the purposes of sediment and biological sample collection at the site and the manner in which shipboard operations were conducted. Recommendations for future work are also included.

(2) EPA Eastern Environmental Radiation Facility (EERF) radioanalytical data, found in: Dyer, Robert S., "Environmental Surveys of Two Deepsea Radioactive Waste Disposal Sites Using Submersibles", Management of Radioactive Wastes from the Nuclear Fuel Cycle, IAEA, Vienna, March 1976.

This published paper describes the early survey work at the 900 meter and 1700 meter sites in the Pacific and the 2800 meter site in the Atlantic. Radioactive waste containers were located for the first time, with the use of submersibles. Radioanalytical results by EERF for the 2800 meter site in the Atlantic are presented in Table IV. Cesium-137 contamination was found in three sediment cores taken from near waste containers. It is believed to be the result of leaching from the concrete matrix of the containers. At the Farallon Islands, values for Pu-239, 240 found in sediment samples taken from near some waste containers exceeded expected values for this latitude and depth, as did the ratio of Pu-238 to Pu-239, 240. The plutonium distribution in the sediment near some containers indicates that the release from the containers could have occurred many years ago.

(3) Neiheisel, James, "Sediment Characteristics of the 2800 Meter Atlantic Nuclear Waste Disposal Site: Radionuclide Retention Potential", EPA Technical Note ORP/TAD-79-10, September 1979.

This EPA published report characterizes the sediments from the 1974 2800 meter radioactive waste disposal site survey. The chemical analyses were performed on sediments which had been in storage.

This geochemical work, particularly the effort on cation exchange capacity, will contribute to understanding of the potential for migration of radionuclides released into the deep marine environment, where radionuclide retention by the sediments is anticipated. The origin of sediments at the site and characteristics of sediment deposition are also of interest; the report indicates the source as the continental shelf and the Hudson Canyon adjacent to the dumpsite.

(4) Bowen, Vaughan T., and Linda Graham, "1976 Site-Specific Survey of the Atlantic 2800 Meter Deepwater Radioactive Waste Dumpsite: Radiochemistry", May 1979.

This report presents the data on levels of radioactivity found in sediment cores obtained at the 2800 meter site adjacent to a radioactive waste container and in various areas of the disposal site. Cesium-137, plutonium-239,240, and americium-241 in some sediment cores were found to be above the expected range for weapons testing fallout in sediment for this latitude and depth. In addition, iron-55 and cobalt-60 were also found in sediment cores and are believed to have originated from the waste containers.

(5) Colombo, P., R.M. Nelson, Jr., and M.W. Kendig, "Analysis and Evaluation of a Radioactive Waste Package Retrieved from the Atlantic 2800 Meter Disposal Site," September 1978.

This published report presents the results of analyses performed by Brookhaven National Laboratory on the first radioactive waste container recovered from a waste disposal site. It was retrieved by EPA for the purpose of container corrosion and matrix degradation analysis for the 2800 meter depth Atlantic radioactive waste disposal site.

Analyses in the report indicate that the container had withstood the rigors of the deep ocean environment. The authors estimate that a minimum of 100 years in the deep ocean environment would be required before the concrete waste form would lose its integrity.

(6) Dayal, R., S.A. Oakely, and I.W. Duedall, "Sediment Geochemical Studies of the 2800 Meter Atlantic Nuclear Waste Disposal Site", June 30, 1978.

This report analyzes and discusses the physical and chemical properties of the sediments collected at the 2800 meter site. These parameters influence the amount of binding of radionuclides to the sediment. Cs-137 and Cs-134 were found to have been released from a radioactive waste container, but the sediments were determined to be an effective barrier to migration. It was found in this study that bioturbation (the reworking of sediments by organisms) can actively redistribute radionuclides vertically in the sediment column. Pore water migration, in comparision, was negligible.

(7) Dexter, Stephen C., "Cruise Report on R.V. Cape Henlopen 12/76, 1976 Atlantic Radioactive Waste Dumpsite Survey".

This report presents the various scientific operations which were ongoing during the 1976 radioactive waste disposal site survey, where the various sampling stations were located, and the manner in which operations were undertaken.

(8) Dexter, Stephen C., "Materials for Containment of Low-Level Nuclear Waste in the Deep Ocean", August 1978.

This generic report of deep ocean corrosion processes for steels and concrete explains in easily understandable terms the mechanisms and expected rates of corrosion. The report concludes with recommendations regarding improvement of the reliability of the containers potentially used for future ocean disposal practices.

(9) Polloni, Pamela T., and Isabelle P. Williams, "Characterization of the Atlantic 2800 Meter Deepwater Radioactive Waste Dumpsite-Macro-Infaunal Analysis", August 1977.

This report summarizes the findings of an investigation into abundance, biomass and species composition of the benthic infaunal community at the 2800 meter depth site. Age structure was also investigated. The samples were collected as a part of the sediment sampling program with the use of a Soutar box core.

High species diversity was found. Polychaetes, followed by crustaceans, were the most abundant organisms. No extraordinary organisms or distribution of organisms were discovered.

(10) Rawson, Martine Dreyfus, and William 8.F. Ryan, "Geologic Observation of Deepwater Radioactive Waste Dumpsite-106", EPA-520/9-78-001, June 1978.

The bottom terrain of the 2800 meter radioactive waste disposal site was investigated by direct visual observation using the manned submersible ALVIN. It was found to be characterized by meandering channels, with some boulders and rock outcroppings. The report attempts to interpret the geological history of the site, where major natural disturbances appear to have occurred in the past. The rate of sedimentation at the site is estimated to be 5 cm per 1000 years. Sediment deposition in addition to this, with potential to further bury radioactive waste containers, could occur through future downslope sediment slumping.

(11) Reish, Donald J., "Survey of the Benthic Invertebrates Collected from the United States Radioactive Waste Disposal Site in the Atlantic and Pacific Oceans", June 1977.

Taxonomic identification was made of the benthic infaunal organisms at both the 1975 Farallon Islands west coast radioactive waste disposal site and in 1976 at the 2800 meter Atlantic site. This report describes the infaunal populations collected from both coasts, and provides a comparative analysis.

The West coast typically constitutes a more productive infaunal regime. Polychaeates were the most abundant constituent on both coasts, but the number and size of the east coast populations were much smaller than the west coast, as expected. The author concludes that a greater opportunity for biological movement of radionuclides exists at the west coast site location.

(12) Carney, Robert S., "Report on the Invertebrate Megafauna Sampled by Trawling in the Atlantic 4000 meter Low-Level Radioactive Waste Disposal Site 1978", September 1979.

Examination of the benthic population via ottertrawl showed that the predominant megafaunal organisms at the 3800-meter radioactive waste disposal site were brittle stars (ophiuroids) and hermit crabs (pagurids). This information is in accord with sampling data from other regions of the N.W. Atlantic from similar depths. It is believed that the ophiuroids, as well as sea cucumbers (holothuroids) could contribute to vertical bioturbation. Pagurids and ophiuroids could transport adsorbed nuclides laterally.

Characterization of bottom fauna will assist in assessing potential pathways for radionuclide transport from the deep ocean to man.

(13) Dexter, Stephen C., "On Board Corrosion Analysis of a Recovered Nuclear Waste Container," Technical Note ORP/TAD-79-2, August 1979.

This published EPA report discusses a short-term corrosion analysis of the exterior of the radioactive waste container retrieved from the Atlantic 3800-meter radioactive waste disposal site. The container surface is described prior to subsequent detailed laboratory analysis. Some suggestions for improvement of package design are also incorporated.

Such information will be useful to EPA in determining packaging criteria for sea disposal of low-level nuclear wastes.

(14) Hanselman, David H., and William B. F. Ryan, "1978 Atantic 3800 Meter Radioactive Waste Disposal Site Survey-Sedimentary, Micromorphologic and Geophysical Analyses", June 1979.

This report describes the geological and topographical regime at the 3800 meter radioactive waste disposal site. The area was observed directly through use of the manned submersible ALVIN, and was found to be unstable, due to sediment slumping or avalanche activity. The containers might be buried by these activities in the future. They also might be moved around and thus be subject to damage mechanisms other than corrosion.

Such geological information is important in developing future site selection criteria for the ocean disposal option for low-level radioactive materials.

(15) Musick, John A., and Kenneth J. Sulak, "Characterization of the Demersal Fish Community of a Deep-Sea Radioactive Dump Site (Results of Cruise, EPA-7801, R. V. ADVANCE II, 21-27 June 1978), May 1978.

Bottom fish were collected through deep water trawling operations. No differences were found between the fish assemblage at the radioactive waste disposal site and other regions of similar depth. The dominant fish species was Coryphaenoides armatus, the rattail, a large mobile species capable of long-distance migrations.

This information on fish population abundance, biomass, diversity and migratory patterns assists in evaluating potential transport of nuclides from the site to man.

(16) Reish, Donald J., "Survey of the Benthic Invertebrates Collected from the United States Radioactive Waste Disposal Site-Atlantic Ocean 3800-Meter Location", November 1979.

Infaunal populations were taxonomically identified. As was the case at the 2800 meter site, polychaetes were the most abundant group at the 3800 meter site. Since they actively rework the sediment, the potential for slow radionuclide movement through the sediment exists. The organisms collected at this site were also similar in their small size to those obtained at the 2800 meter site; Atlantic specimens are typically smaller than Pacific infauna. Some mention is made in this report of feeding patterns and potential food chain links.

While some new species and genera of polychaetes may have been collected, no unusual or aberrant forms were noticed.

(17) Schell, W.R., and A. Nevissi, "Radionuclides at the U.S. Radioactive Waste Disposal Site in the Hudson Canyon, 350 Km Off New York City", January 1980.

This report, in first submission format by the contractor, provides radioanalytical data for the nuclides cesium-137, lead-210, plutonium-238, plutonium-239 and 240, americium-241, and strontium-90 in biological and sediment samples taken from the 3800 meter Atlantic dumpsite in 1978. The sediments tested did not show significant levels of radioactivity. Americium-241 was recorded in very high levels (significant concentrations) in the rattail fish, Nezumia bairdi, although not in other biological samples or in sediments obtained adjacent to radioactive waste containers. The americium in the fish was in lower concentrations in the muscle, or edible, fraction of the fish. The rattail is not a commercially harvested species in the United States, and no commercial fishing occurs in the immediate vicinity of the dumpsite. No other nuclides were found in elevated concentration in this or other biological samples. The author concludes that the observed americium-241 in the rattail fish came from the radioactive wastes. In EPA's judgement this is a speculative conclusion, and it cannot be verified at this time. Other possible explanations are measurement error or bioconcentration by the rattail fish of fallout from atmospheric weapons tests. Study of this data is continuing, and it appears that resolution of the open questions will have to come from further baseline and dumpsite sampling.

Independently Published Reports by Survey Participant

(1) Ito, Akihiko, "Surveys of Deepsea Radioactive Waste Disposal Sites by USEPA.

This report, in Japanese, describes the participation of this Japanese scientist in the EPA surveys of the Atlantic Ocean 2800 meter disposal site.

(2) Schell, William R., "Radionuclides at the Deep Water Disposal Sites Located Near the Farallon Islands in the Pacific and at the Mouth of the Hudson Canyon in our Atlantic", Presented at the Second International Ocean Dumping Symposium, Woods Hole, Ma., 15-19 April 1980.

In this report, Schell summarizes his work for EPA at the Atlantic and the Pacific dumpsites (number 10 in the Pacific summary and number 17 in the Atlantic summary).

(3) Schell, W.R., and S. Sugai, "Radionuclides at the U.S. Radioactive Waste Disposal Site Near the Farallon Islands", Health Physics, Vol. 39., No. 3, pp 475-496.

This report is a formal publication of the work conducted for EPA by these researchers at the Farallon Islands dumpsites (number 10 in the Pacific summary).

Pacific Ocean

The following is a summary of eleven research reports prepared for EPA/ORP on the 1974, 1975, and 1977 surveys of the Farallon Islands radioactive waste disposal sites.

(1) Dayal, R., I. W. Duedall, M. Fuhrmann, and M. G. Heaton, "Sediment and Water Column Properties of the Farallon Islands Radioactive Waste Dumpsites," September 1979.

Dayal et al have analyzed the sediments collected at the site for geochemical properties which might affect the behavior of radionuclides in the marine environment. Dayal found that the nuclides tend to adsorb to the sediment rather than remaining suspended in the water column.

This report is important in understanding the role of such parameters as pore water diffusion and also bioturbation for nuclide mobilization. The sediments at the site are being characterized in order to evaluate chemical interactions of radionuclides with the sediments and to predict potential transport pathways for radioactivity in the oceans.

(2) Interstate Electronics Corporation," Operations Report - A Summary of the Farallon Islands 500 Fathom Radioactive Waste Disposal Site," U.S. Environmental Protection Agency, Technical Note ORP-75-1, December 1975.

This previously published report has been circulated extensively; it summarizes the operational aspects of EPA's early survey work at the Farallon Islands.

(3) Interstate Electronics Corporation, "Operational Plan, Phase I, 1977 Farallon Island Survey," IEC 446SP 550.

This operational plan describes the logistics involved in the first phase of our 1977 survey, during which we performed surface ship trawling and coring operations for geochemical, radiochemical, and biological analyses. Participants are listed.

(4) Interstate Electronics Corporation, "Operational Plan, Phase II, 1977 Farallon Island Survey," IEC 446SP 551.

The plan presents the logistical plans for the second phase of the 1977 Farallon Islands survey. EPA used the Canadian manned submersible PISCES VI to make bottom observations and to obtain sediment cores in close proximity to radionuclide containers for subsequent radiochemical and geochemical analyses. Participants are listed.

(5) LFE Environmental Analysis Laboratories, "Radiochemical Analysis of Samples from the 900 Meter Pacific Dumpsite," September 1979.

This report presents raw data, without interpretation, of radioanalysis of sediment and biological samples. It has undergone only preliminary EPA review at present.

The conclusions which we have drawn from the report are that the radiation measured in the biota is in the range expected from fallout and that the concentrations present do not represent a source of harm to either man or the marine environment. Concentrations of radioactivity in fish collected in the vicinity of the Farallon Islands are within the ranges occurring from atmospheric fallout. Human consumption of such fish would yield an annual estimated dose that is approximately 1,000 times lower than the dose from radioactive materials occurring normally within the human body.

(6) Reish, Donald J., "Survey of the Benthic Invertebrates Collected from the United States Radioactive Waste Disposal Site Off the Farallon Islands, California," August 1978.

The contractor taxonomically identifies infaunal and benthic organisms collected at the site. He reports no unusual findings in terms of biomass or species present. No aberrant forms were found.

EPA is attempting to characterize the biological populations in the site area. We are interested in studying the role of benthic and infaunal organisms in terms of the potential for bioturbation (reworking of sediments which might enhance mobilization of radionuclides), and for biological uptake for potential transport through marine food chains.

(7) Robison, Bruce H., "Cruise Report: Farallon Islands Disposal Site Survey; Phase I - 25 August to 2 September 1977.

Dr. Robison's report summarizes the operations of the 1977 site survey and also provides useful suggestions for future survey work.

(8) Robison, Bruce H., "Midwater Trawling Summary: Farallon Islands Disposal Site Survey, 1977."

Midwater organisms, many of which may be highly migratory, could provide a go-between food chain transfer mechanism between deep ocean and near-surface waters. This report identifies and describes the mid-water populations found at the Farallons site. As in Reish's report (06), there were no unusual findings in terms of biomass or species present, and no aberrant forms. The sample size was insufficient to provide an understanding of actual food chain pathways between bottom and mid-water regions.

(9) Rego, Jennifer A., "Deep-Sea Echinoids and Asteroids of the Northeastern Pacific: An Aid in Selecting Candidate Species for Chromosomal Analysis-And-Observations Concerning Three Species of Sea Stars Collected by the Velero II," March 1980.

A literature search was performed by Rego to predict which benthic invertebrates were most likely to be found in the vicinity of the Farallon Islands and which ones might prove suitable for future chromosome study. The second section of the report describes deep-sea starfish collected at the site in 1977. Although a baseline study to determine capability of visualizing size and number of chromosomes was not possible from Rego's technique, interesting information concerning life history was obtained by laboratory examination.

Our office has an interest in determining whether a marine organism's response to radiation can be detected via cytogenetic laboratory procedures.

(10) Schell, W. R., and S. Sugai, "Radionuclides in Water, Sediment and Biological Samples Collected in August-October 1977 at the Radioactive Waste Disposal Site Near the Farallon Islands," July 1978.

Dr. Schell reports on his measurements of very low levels of radioactivity in sediments obtained at varying distances from radioactive waste containers and in sediments and biota from the surrounding vicinity. Although his radiological technique for plutonium is less sensitive than that of other researchers, his estimation of the upper limit of plutonium that could be present is apparently consistent with the conclusion of no radioactivity in excess of background. There was no detection of plutonuim in the edible portion of any fish. In the case of cesium, his results were easier to compare with existing literature and they are comparable to background radiation.

(11) Silver, Gary R., "A Taxonomic Review of the Farallon Island Sponge Fragments," February 1979.

Dr. Silver, an hexactinellid sponge specialist, analyzed samples of the large hexactinellid for taxonomic purposes. EPA first observed these sponges growing on the radioactive waste containers at the site His report confirms that this sponge, a new species, is indeed a typical hexactinellid which is growing to a normal hexactinellid sponge size. It is not an aberrant organism.

EPA's interest in the sponge stems from curiosity concerning the sponge's large holdfast and the potential impact it might have on acceleration or deceleration of container corrosion.

STATUTORY AUTHORITIES

There are seven principal authorities relevant to the ocean disposal of radioactive materials, to oceans research, and to monitoring and surveillance of dumpsites:

- The Atomic Energy Act of 1946

  Under this Act the Atomic Energy Commission, (AEC) was given exclusive authority for all matters pertaining to atomic energy. Subsequent executive actions and Acts of Congress transferred those authorities to other Executive Agencies.

- Energy Reorganization Plan No. 3 of 1970

  Under the Energy Reorganization Plan of 1970, the Environmental Protection Agency (EPA) was established, and the authority to "establish generally applicable environmental standards for protection of the general environment from radioactive materials..." was transferred from the AEC to EPA.

- The Marine Protection, Research, and Sanctuaries Act of 1972

  This Act (PL 92-532), commonly referred to as the Oceans Dumping Act, authorized EPA to regulate ocean dumping. Furthermore, the Secretary of Commerce, in conjunction with the Administrator of EPA, was directed to "initiate a comprehensive and continuing program of monitoring and research regarding the effects of the dumping of material into ocean waters..."

- The Energy Reorganization Act of 1974

  Under the Energy Reorganization Act of 1974 the AEC was abolished and its regulatory authorities were conveyed to the newly created Nuclear Regulatory Commission (NRC) while its other responsibilities were transferred to the Department of Energy.

o EPA Regulations and Criteria for Ocean Dumping

On January 11, 1977, EPA issued regulations and criteria for ocean dumping pursuant to PL 92-532 (40 CFR Parts 220 - 229). These regulations specify that:

1) radioactive materials must be contained to prevent their dispersion into ocean waters, and

2) the containment system must be designed to remain intact until the radioactive materials decay to innocuous levels.

o The National Ocean Pollution Research and Development and Monitoring Planning Act of 1978

Under this Act (PL 95-273), the National Oceanic and Atmospheric Adminsitration (NOAA) is directed to: 1) establish a comprehensive 5-year plan for federal ocean pollution research and development and monitoring programs; 2) carry out a comprehensive program of ocean pollution monitoring, including radiation; and 3) provide necessary data to support and provide for the conservation, utilization, and development of ocean resources.

o The London Dumping Convention

The Convention on the Prevention of Marine Pollution by dumping of Wastes and Other Matter (London Dumping Convention) was convened in 1972 to prevent pollution of the marine environment. The Convention was signed by the United States in December, 1972 and ratified by the U.S. Senate in August, 1973. The Convention became effective in August, 1975, and has since been ratified by about 40 nations.