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Eastern Environmental
Radiation Facility
1890 Federal Drive
Montgomery, AL 36109

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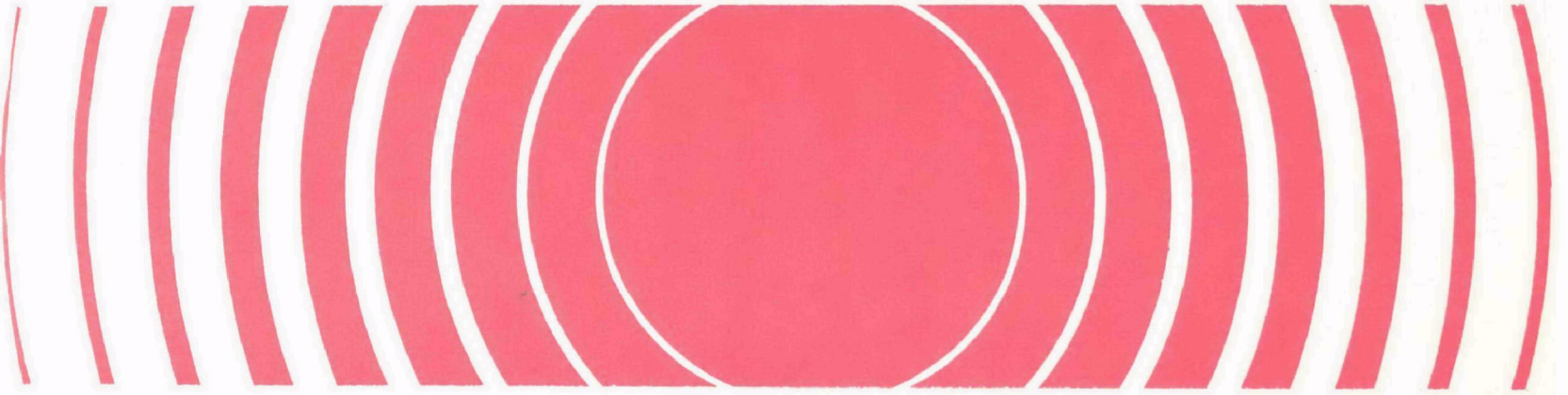
Radiological Survey of Charleston Naval Base and Shipyard and the Charleston Naval Weapons Station



Radiological Survey of the Charleston Naval Base and Shipyard and the Charleston Naval Weapons Station

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Preface

The Office of Radiation Programs identifies and evaluates environmental public health impacts of both natural and man-made radiation sources. The Eastern Environmental Radiation Facility (EERF) is a fully integrated participant with other components of the Office in these efforts. The Facility provides comprehensive capability for evaluating radiation sources through planning and conducting environmental studies, nationwide surveillance, and laboratory analysis. The EERF also provides special analytical support for Environmental Protection Agency Regional Offices and other Federal government agencies, as requested, as well as technical assistance to the radiological health programs of State and local health departments.

This report presents results of the survey conducted by EERF personnel to assess levels of environmental radioactivity resulting from maintenance and operation of nuclear-powered warships at the Charleston Naval Base and Shipyard and the Charleston Naval Weapons Station, near Charleston, South Carolina. The purpose of the survey was to determine if operations related to nuclear powered warship activities resulted in release of radionuclides which may contribute to significant population exposure or contamination of the environment.

Readers of our reports are encouraged to bring comments, omissions or errors to our attention.

Charles R. Porter, Director
Eastern Environmental Radiation Facility

Introduction

Since 1963, the Eastern Environmental Radiation Facility (EERF), U.S. Environmental Protection Agency (USEPA), in cooperation with the U.S. Naval Sea Systems Command (NAVSEA) has surveyed facilities serving nuclear powered warships on the Atlantic and Pacific coasts and the Gulf of Mexico. These surveys assess whether the operation of nuclear powered warships, during construction, maintenance, overhaul, or refueling, have created elevated levels of radioactivity and whether any elevated levels that are found constitute a significant hazard to the public health and safety or the environment. The surveys emphasize sampling those areas and pathways that could expose the public.

In 1984, NAVSEA requested that all active facilities servicing nuclear powered warships be resurveyed over the next three years. Charleston Naval Base and Shipyard and the Naval Weapons Station, Charleston, SC, which were surveyed by EERF personnel in August 1985, are the second group of facilities to be completed under this agreement. The Harbor was last surveyed by the EERF (then the U.S. Public Health Service) in January, 1966 (1). The 1985 survey was similar to that in 1966 except that more detailed sampling was performed around the piers and near the dry docks than in 1966 and the newer equipment used is generally more sensitive, which results in lower levels of detectability.

Characteristics of Charleston Naval Base and Shipyard and Weapons Station

Charleston Harbor is formed by the confluence of the Ashley, Cooper and Wando Rivers and lies seven miles inland of the Atlantic Ocean. It serves the city of Charleston, South Carolina, which is the closest population center. The Charleston Naval Base and Shipyard and the Naval Weapons Station are located on the Cooper River, immediately north of the City of Charleston. The Shipyard contains the submarine base, berthing areas and repair basins while the Weapons Station is the weapons loading location for the submarines.

Of the three rivers forming the harbor, the Cooper has the most influence. The Ashley and Wando are tidal throughout their lengths and contribute no fresh water in-flow except for local run-off. The Cooper is tidal to the Pinopolis Dam, a part of the Santee-Cooper Power Project of the State of South Carolina. As a result of the hydroelectric power plant, which operates on a demand basis, the mean discharge prior to 1985 was approximately 15,000 cfs (2, 3). In 1985, a rediversion canal forming a new outlet for Lake Moultrie was completed which carries most of the Santee River water diverted into Lake Moultrie back to the Santee River. The purpose of the rediversion canal is to reduce the requirements for maintenance dredging of Charleston Harbor. Since completion of the rediversion canal in 1985, the mean discharge is approximately 3,000 cfs (3, 4).

Survey and Analytical Methods

The basic purposes of the survey were to document the radioactivity levels in the harbor and environs, ascertain whether there is any public health significance of these levels and, if possible, determine their origin. Specifically, the survey was designed to determine:

(a) The radionuclides and levels of radioactivity currently present in and adjacent to the harbor,

(b) The location of radioactivity in the harbor area,

(c) The distribution of radioactivity between the various components of the environment, i.e., harbor bottom sediment, water, fish, and shellfish.

To achieve these goals, samples of harbor and drinking water, harbor bottom sediment, shellfish, and fin fish were collected and returned to the EERF for radioanalysis. In addition, a gamma scintillation probe designed to measure activities *in situ* was utilized in an attempt to determine the relative geographic distribution of activity on the harbor bottom.

Sampling sites were selected to represent the most probable locations where radioactivity could be deposited and which are accessible to the public. Extensive sampling was done in the vicinity of all dry docks, berthing areas, and repair facilities where nuclear powered warships are or have been serviced. Discussions were held with Navy personnel to aid in selecting sampling locations. Sampling locations are shown in Figure 1 for the general area surrounding the Charleston Naval Base and Shipyard and the Charleston Naval Weapons Station. Figures 2 and 3 show sampling locations for the Naval Base and Shipyard and the Naval Weapons Station, respectively.

Since cobalt-60 is the predominant radioisotope associated with Naval nuclear propulsion plants, environmental sampling focused on detecting this radioisotope. In the 1966 survey of Charleston, low levels of cobalt-60 were found in harbor bottom sediment. Some manganese-54 was also detected in the harbor sediment.

An underwater gamma scintillation probe with a 10 centimeter by 10 centimeter sodium iodide detector was used with a portable multichannel pulse height analyzer to help locate areas of radioactivity. A background was taken at Site 1 and stored in the memory for subtraction from each measurement to yield net activity. All probe measurements were made for 10 minutes. The underwater probe has been useful in past surveys to select areas for dredge sampling of bottom sediment and to delineate areas of radioactivity. However, due to the relatively low sensitivity (as compared to laboratory measurements) of the probe, sediment samples were collected at all locations of probe measurement where sediment was available. Probe measurements were duplicated for quality assurance purposes at approximately 10% of the sites.

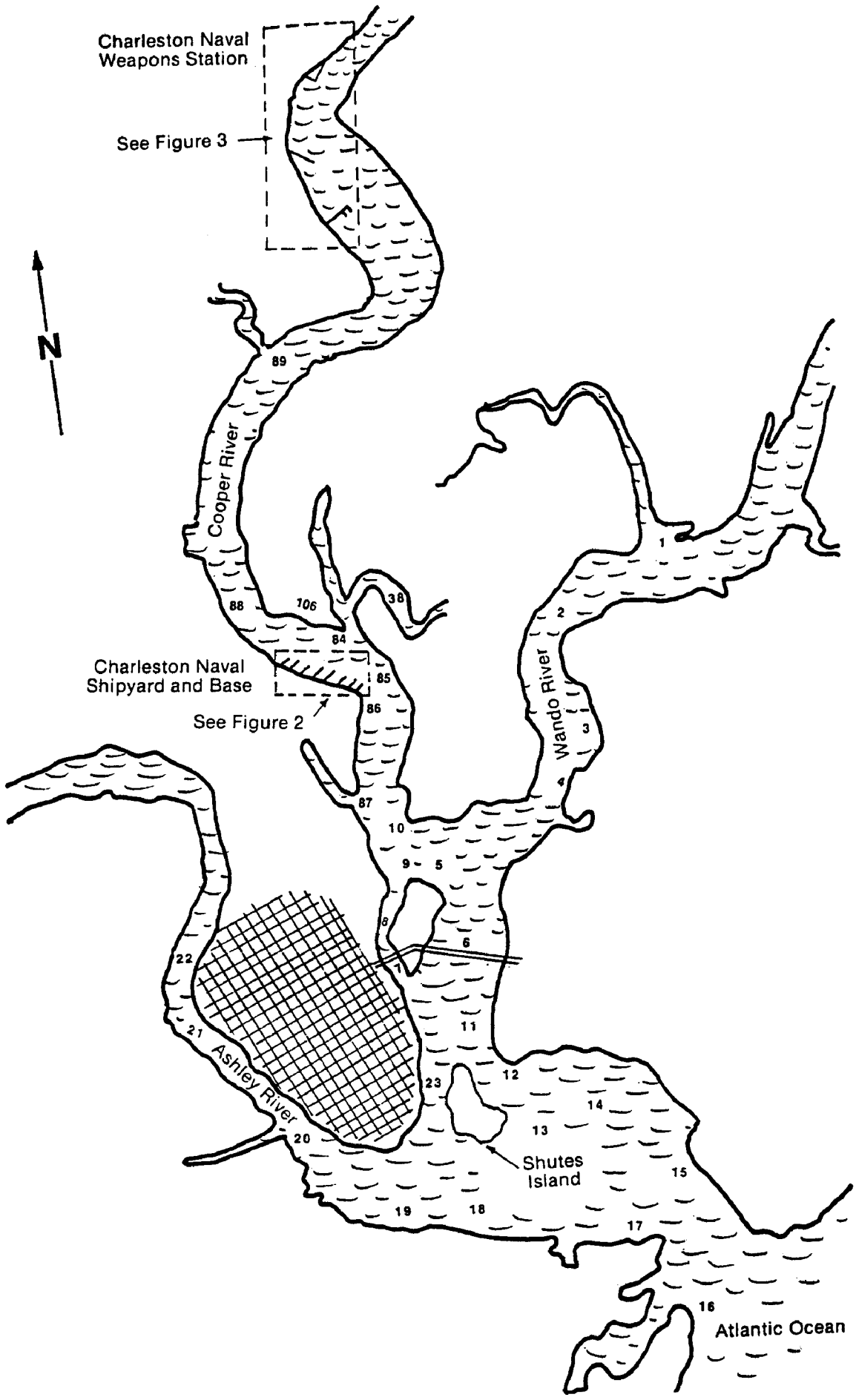

Figure 1: General Site Sampling Locations, Charleston Harbor, South Carolina

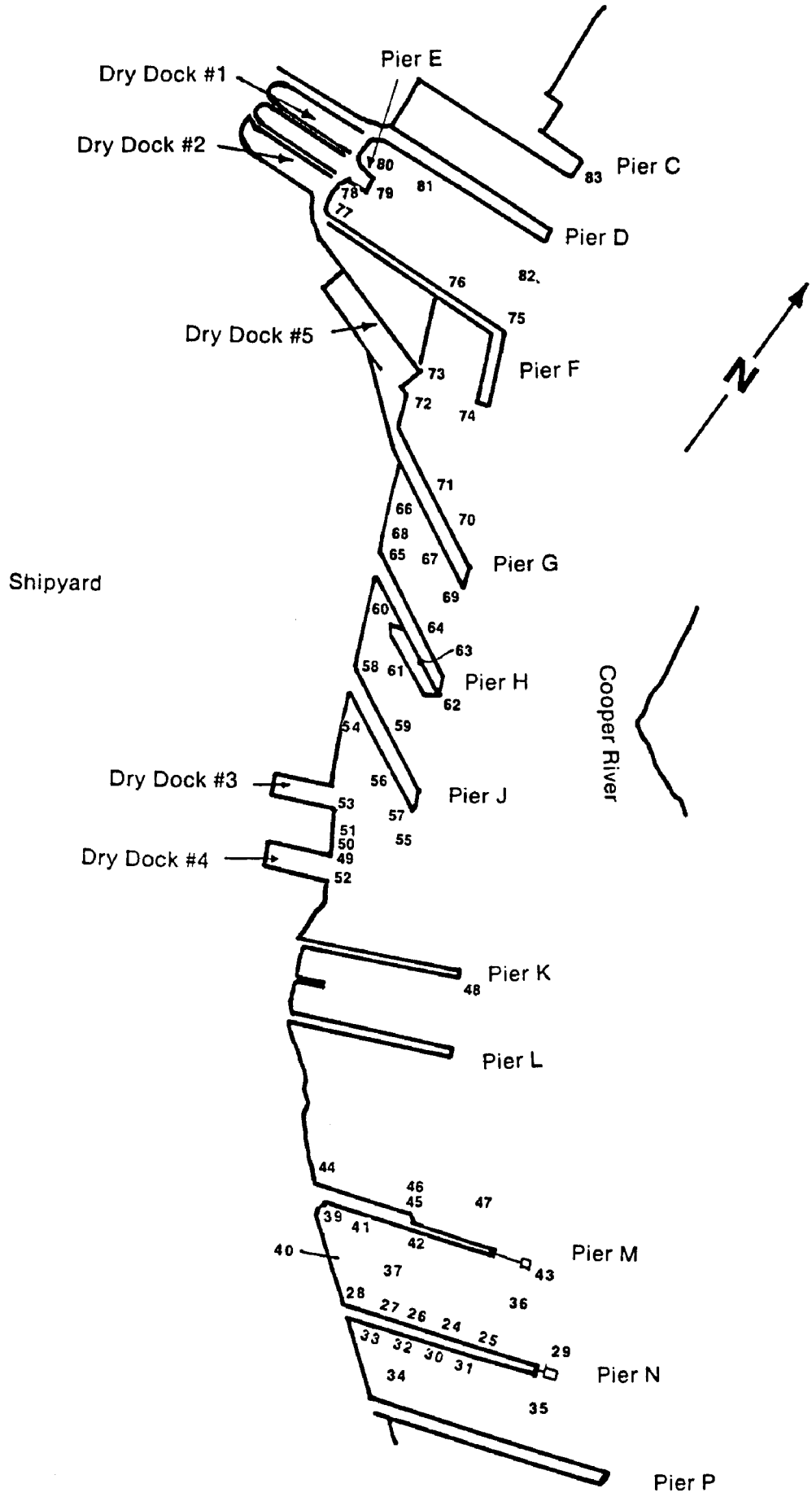

Figure 2: Sampling Locations Along the Charleston Shipyard Piers

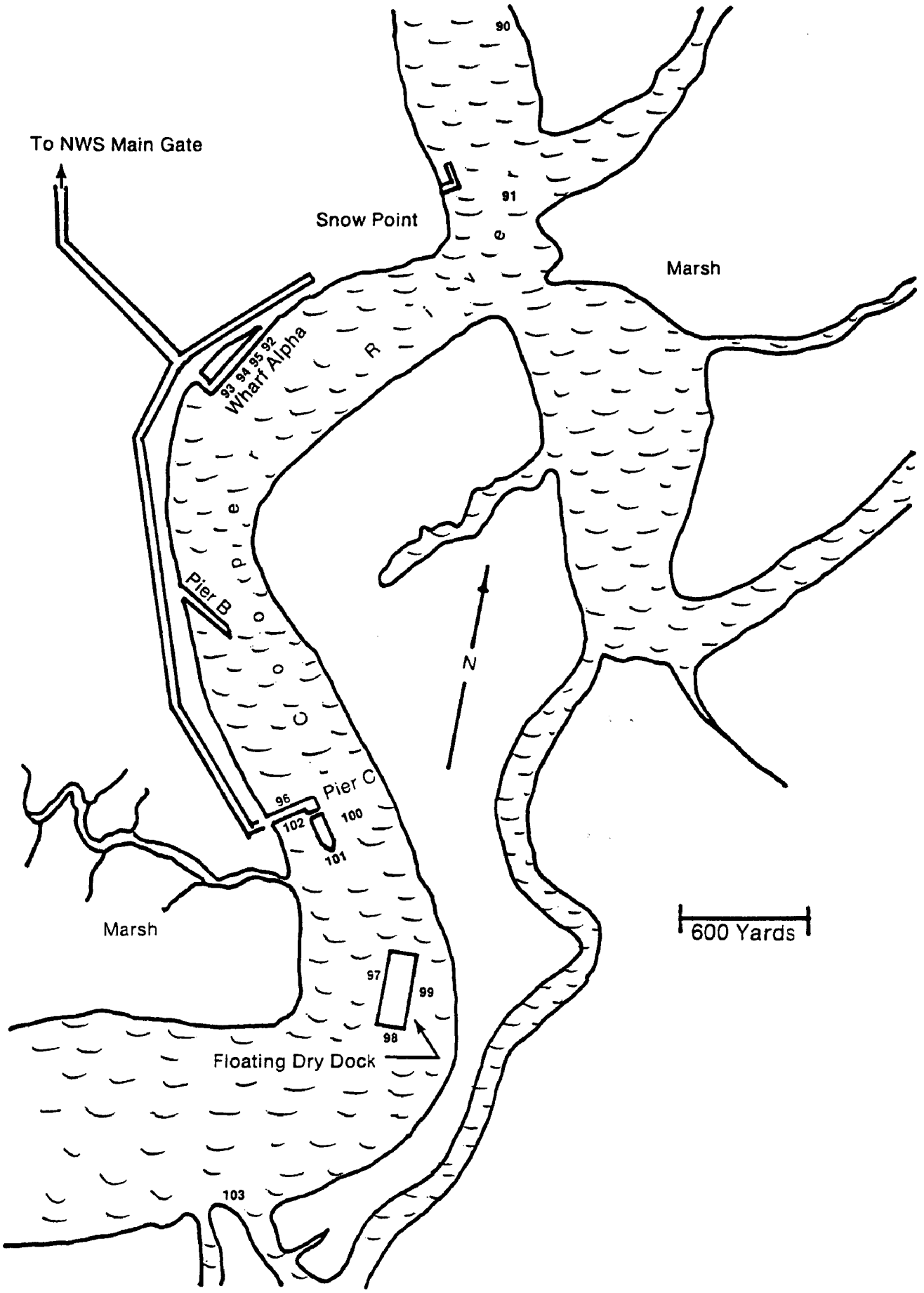

Figure 3: Sampling Locations, Charleston Naval Weapons (NWS) Station

A standard Peterson dredge was used to sample approximately the top 10 centimeters of harbor bottom sediment. These sediment samples were collected at 105 sampling locations. At approximately 5% of the sampling sites, duplicate sediment samples were collected. At the laboratory the samples were dried, ground to a fine powder, placed in 400 cm^3 containers, and counted on a Ge(Li) or intrinsic germanium detector for 1,000 minutes.

Sediment core samples have been useful in determining the vertical distribution of radioactivity in past surveys. Radioactive materials from past operations which were subsequently covered with sediment might be observed in the core samples. Core samples were taken with a 3.8 centimeter diameter by 61 centimeter long plastic tube. The tube was pushed into the sediment as far as possible, capped on each end, and carefully removed. At the laboratory the cores were frozen and cut into 2.5 cm sections. Sections were dried, weighed and counted on a Ge(Li) or intrinsic germanium detector for 1,000 minutes to determine gamma emitting radioisotopes. The activity is reported per gram dry weight.

Water samples were collected at 10 locations in the harbor and from 2 public drinking water supplies. These samples were placed in 1 liter containers and counted on a Ge(Li) or intrinsic germanium detector for 1,000 minutes to detect gamma emitting radioisotopes, especially Co-60.

Seventeen aquatic life samples (shellfish and fish) were collected at various locations in the harbor by the South Carolina Fish and Game Division. These samples were shipped to EERF where they were prepared by cutting and packing in 400 cm^3 containers and counted wet on a Ge(Li) or intrinsic germanium detector for 1,000 minutes to determine levels of gamma emitting radioiostopes.

Direct gamma radiation exposure was monitored and recorded continuously each day using a pressurized ionization chamber (PIC) mounted on the survey boat. The average surface exposure rate at each sampling location was identified on the continuous record.

An overland survey was also conducted, along the shoreline areas and the perimeter fences that are accessible to the public, in both the shipyard and the weapons station. A few other areas within these facilities were also monitored. These measurements were made with a scintillation survey meter that was periodically calibrated with a PIC.

Results and Discussion

Harbor bottom sediment sampling was the most extensive, since past surveys have shown that if radioactivity had been released, it would usually be detectable in the sediment. Samples were collected at 105 locations. Only naturally occurring radionuclides and trace amounts of Cs-137 (typically fallout from previous worldwide nuclear weapons testing) were found in these sediment samples. The EERF minimum detectable activity for cobalt-60 in sediment is approximately 0.01 pCi/gram and we did not detect cobalt-60 in any of these sediment samples.

Core samples were collected at 7 locations and analyzed for gamma emitting radionuclides. None of these cores contained other than naturally occurring radionuclides and trace amounts of Cs-137.

Harbor water samples were collected at eight locations. The radionuclide content of these samples determined by gamma analysis is shown in Table 1. Only naturally occurring K-40 was found in these water samples. Sample 91 was collected at the Weapons Station near Snow Point and showed no detectable radioactivity. It is believed that a sample this far upstream would be fresh water and that this is the reason that no K-40 was detected in the sample. All other harbor water samples collected in this study were collected downstream from location 91.

Drinking water samples were collected at the shipyard diving locker room and from the Charleston municipal drinking water supply. The samples were gamma analyzed and no detectable radioactivity was found in these samples.

During the overland survey of the Naval Base and Shipyard perimeters, external gamma exposures were observed between 6 and 46 μR/hr (see Figure 4). All radiation levels above general background (which is 8-15 μR/hr in the Charleston area) were due to natural radioactivity included in stone, asphalt or concrete used in shoreline riprap, roadbeds, and other construction, or due to natural radioactivity in sand used for sandblasting operations. For the Naval Weapons Station, external radiation levels were observed between 5 and 50 μR/hr (see Figure 5). All radiation levels above background are associated with the asphalt road beds on the site or with the asphalt and stone riprap used along parts of the shoreline near Wharf Alpha and Piers B and C. For both the Naval Base and Shipyard and the Weapons Station, the occasional slightly elevated radiation levels detected in the overland survey are not associated with any nuclear operations at the facilities but result from sandblasting sand, asphalt, stone and concrete, which are slightly higher in natural radioactivity content than the silt and soil along the shoreline.

Table 1

Results of Harbor Water Analysis

Location	Radionuclide	Activity (pCi/l) ± 2 sigma error
1	K-40	200 ± 24%
5	K-40	140 ± 31%
6	K-40	220 ± 23%
24	K-40	65 ± 88%
42	K-40	190 ± 27%
63	K-40	120 ± 34%
91		ND
100A	K-40	145 ± 33%
100B	K-40	100 ± 45%

ND-No detectable radioactivity.

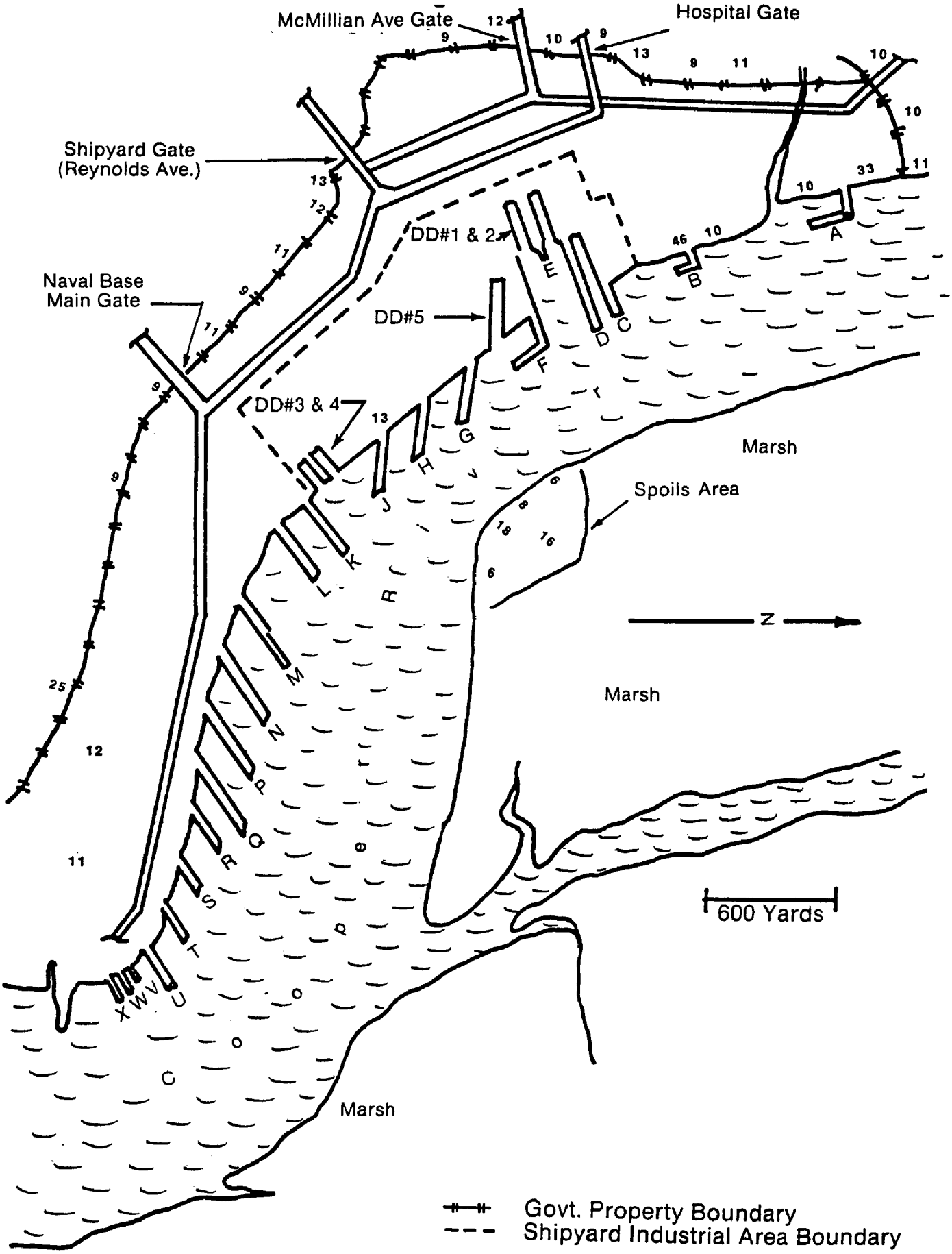

Figure 4: External Gamma Readings (μR/hr) Measured at the Charleston Naval Station and Naval Shipyard, August 1985.

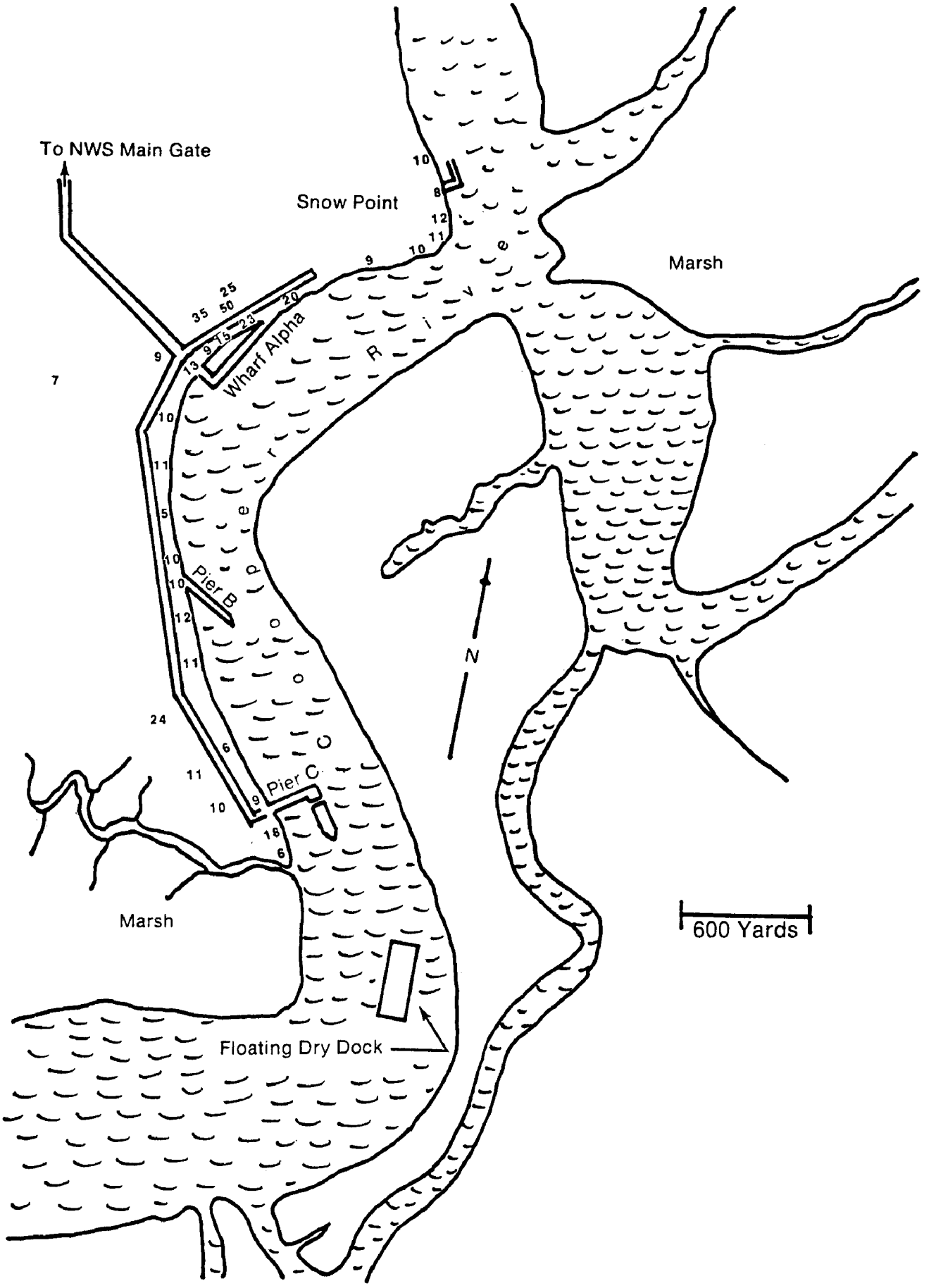

Figure 5: External Gamma Readings (μR/hr) Measured at the Naval Weapons Station, August 1985.

Aquatic life samples (fish and shellfish) were collected by the South Carolina Fish and Game Division and shipped to EERF for analysis. The results are presented in Table 2. All radioactivity detected in these samples is of natural origin with no contribution based on shipyard or weapons station operations. The absence of detectable Co-60 activity in seafood is important from the public health standpoint since many seafood organisms tend to concentrate this isotope to levels greatly in excess of its concentration in the surrounding water and bottom sediment.

Pressurized ionization chamber (PIC) readings were taken at most sediment sampling locations and the external gamma radiation levels measured are listed in Table 3. Measurements made over water were with the PIC approximately fifteen feet above the water surface. Measurements made over land were with the PIC approximately 3 feet above the land surface. Background levels were measured at all locations where data were recorded.

Table 2

Results of Aquatic Life Sample Gamma Analysis*

Sample Type	Location	Radionuclide Concentration (pCi/gm wet) + 2 sigma error (%) K-40	Pb-214	Bi-214	Th-232
Flounder	Charleston Harbor	2.7+ 7%			
Crabs	Shipyard, Piers H & X	1.4±13%			
Shrimp	Rebellion Reach	2.8±17%			
Trout	Rebellion Reach Harbor	2.7±16%			
Spot	Rebellion Reach	2.6± 8%			
Shrimp	Shipyard, Piers A-J	2.0±12%			
Trout	Shipyard, Piers J-A	3.1±16%			
Shrimp	Ft. Johnson	1.6±24%			
Shrimp	Ft. Johnson	2.5±11%			
Shrimp	Miscellaneous Locations	2.2± 9%			
Crabs	Shipyard, Pier M	1.9±13%	0.083±51%	0.086±34%	
Crabs	Shipyard, Pier M	1.8± 9%	0.028±52%	0.023±58%	0.048±47%
Crabs	Shipyard	1.8±11%	0.10 ±25%	0.12 ±20%	0.074±41%
Crabs	Weapons Station, Pier A	1.4±13%	0.049±61%	0.055±40%	0.076±37%
Crabs	Weapons Station, Pier B	2.0±13%	0.16 ±19%	0.17 ±22%	0.18 ±29%
Crabs	Weapons Station, Pier C	1.5±11%	0.11 ±20%	0.092±22%	
Shrimp	Weapons Station Locations	2.1± 8%			

* Note: Samples were collected by the South Carolina Fish and Game Division. The EPA sample location numbering system did not include location numbers for these samples. Blanks in the table indicate that no detectable levels of the radionuclide appeared in that sample.

Table 3
Exposure Measurements Observed at Sampling Sites
with Pressurized Ionization Chamber

Site	Exposure (μR/hr)	Site	Exposure (μR/hr)	Site	Exposure (μR/hr)
1	4.0	45	4.0	82	4.0
2	4.0	46	4.6	83	4.6
3	5.0	47	4.5	84	3.5
4	4.0	48	4.5	85	4.0
5	4.3	49	4.5	86	4.0
6	4.0	53	4.4	87	4.8
7	4.0	54	4.2	88	4.6
8	4.2	55	4.2	89	4.1
9	4.2	56	4.0	90	4.0
10	3.9	57	4.5	91	4.8
11	4.1	58	4.1	92	4.0
12	4.0	59	4.2	93	3.8
13	4.1	60	5.2	94	4.7
14	4.2	61	4.5	95	5.0
15	4.5	62	4.5	96	4.4
16	4.5	64	5.0	97	4.0
17	3.7	65	5.0	98	4.5
18	4.0	66	4.7	99	4.2
19	4.3	67	4.5	100	6.0
24	4.7	68	4.0	101	4.0
28	5.0	69	5.2	102	4.0
29	4.8	70	4.7	103	4.4
30	3.8	71	5.2		
34	4.0	72	4.3		
35	4.5	73	4.0		
36	4.2	74	4.5		
37	4.5	75	4.2		
39	6.5	76	4.2		
40	5.1	77	5.2		
41	4.4	78	5.1		
42	4.5	79	5.6		
43	4.0	80	5.4		
44	4.8	81	4.3		

Conclusions

The radiological survey of the Charleston Naval Base and Shipyard and the Naval Weapons Station provided the basis for the following conclusions:

1. All samples collected during this survey contained only low levels of natural radioactivity and cesium-137 from fallout. There was no detectable radioactivity in any of the samples due to nuclear operations at the shipyard or weapons station.

2. The low levels of cobalt-60 in harbor sediment have decreased to non-detectable levels since the 1966 survey.

3. Drinking water from the shipyard and from the Charleston municipal water supply did not contain any detectable radioactivity.

4. In the overland survey of the base and shipyard and the weapons station, no elevated readings from nuclear powered warship operations at these facilities were detected.

5. Navy practices to restrict the release of radioactive material to the minimum practical into the harbor have been effective.

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