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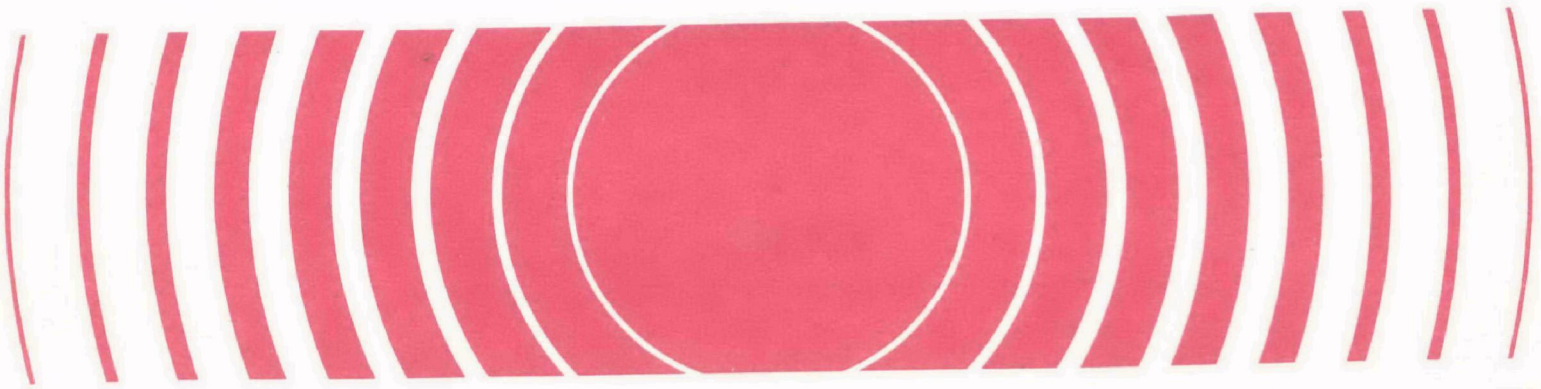
Radiological Survey of Portsmouth Naval Shipyard, Kittery, Maine, and Environs



EPA-520/5-79-003

RADIOLOGICAL SURVEY

OF

PORTSMOUTH NAVAL SHIPYARD, KITTERY, MAINE,

AND ENVIRONS

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FOREWORD

The Eastern Environmental Radiation Facility (EERF) provides environmental surveillance and analytical capability in support of the Office of Radiation Programs (ORP) activities.

This report presents results of a harbor survey conducted by EERF personnel which was designed to assess environmental radioactivity resulting from normal operations of nuclear-powered vessels.

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

Charles R. Porter
Director
Eastern Environmental Radiation Facility

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I. Introduction

The Eastern Environmental Radiation Facility (EERF), U.S. Environmental Protection Agency (USEPA), in cooperation with the U.S. Naval Sea System Command (NAVSEA) has conducted several radiological surveys of ports which serve nuclear powered vessels. The first of these surveys was completed in 1963. Subsequently, surveys have been conducted at ports on the Atlantic, Gulf, and Pacific coasts including Pearl Harbor. The following references are examples of two surveys conducted at ports which serve nuclear powered vessels (1,2).

These studies were undertaken to determine if nuclear powered vessel operations, including berthing, repair, and servicing have created environmental radioactivity levels which could result in significant radiation exposure to the public. These surveys are conducted with emphasis on sampling those areas and pathways which would indicate exposure to the public. This survey of Portsmouth Naval Shipyard (PNS) was conducted July 1977. Representatives from the States of Maine and New Hampshire participated in the survey.

II. Characteristics of Portsmouth Naval Shipyard

The facility is located in Portsmouth Harbor on Seavey Island. The shipyard is accessible via bridge from Kittery, Maine, and occupies all of the island (figure 1). The facility is approximately 1981 meters (east-west) by 1158 meters (north-south), an area of 277.8 acres. The Piscataqua River empties into the harbor on the west-northwest side. The deepest part of the harbor is approximately 23 meters in the channel at low tide. The shipyard is a major repair facility for the Navy's nuclear submarine fleet.

Observations made during the survey indicated that the harbor bottom surface is rock at several locations. The bottom at other areas is mud. Tidal action supplemented by the river flow results in a swift current around the shipyard. This current results in the lack of sediment on the bottom surface at several locations.

Discussions with shipyard personnel indicated that most of the water is accessible to the public by boat with the exception of certain areas which are restricted for security reasons. There are extensive commercial fishing and recreational activities in the area, the most significant being lobster fishing. There are many lobster traps (commercial and private) in the immediate vicinity of the shipyard.

The shoreline of the harbor is utilized primarily for residential, recreational, and some commercial activity.

III. Survey and Analytical Methods

The sampling locations covered a large area extending from Great Bay to Wallis Sands Beach off Rye, New Hampshire, (figure 1). Concentrated sampling was performed in close proximity of the PNS and primarily in locations where, based on shipyard operations, radioactivity most likely could be found (figure 2). Discussions were held at the shipyard with representatives of NAVSEA and local shipyard personnel to assist in determining the sampling locations.

Figure 1. Sampling locations in the general survey area.

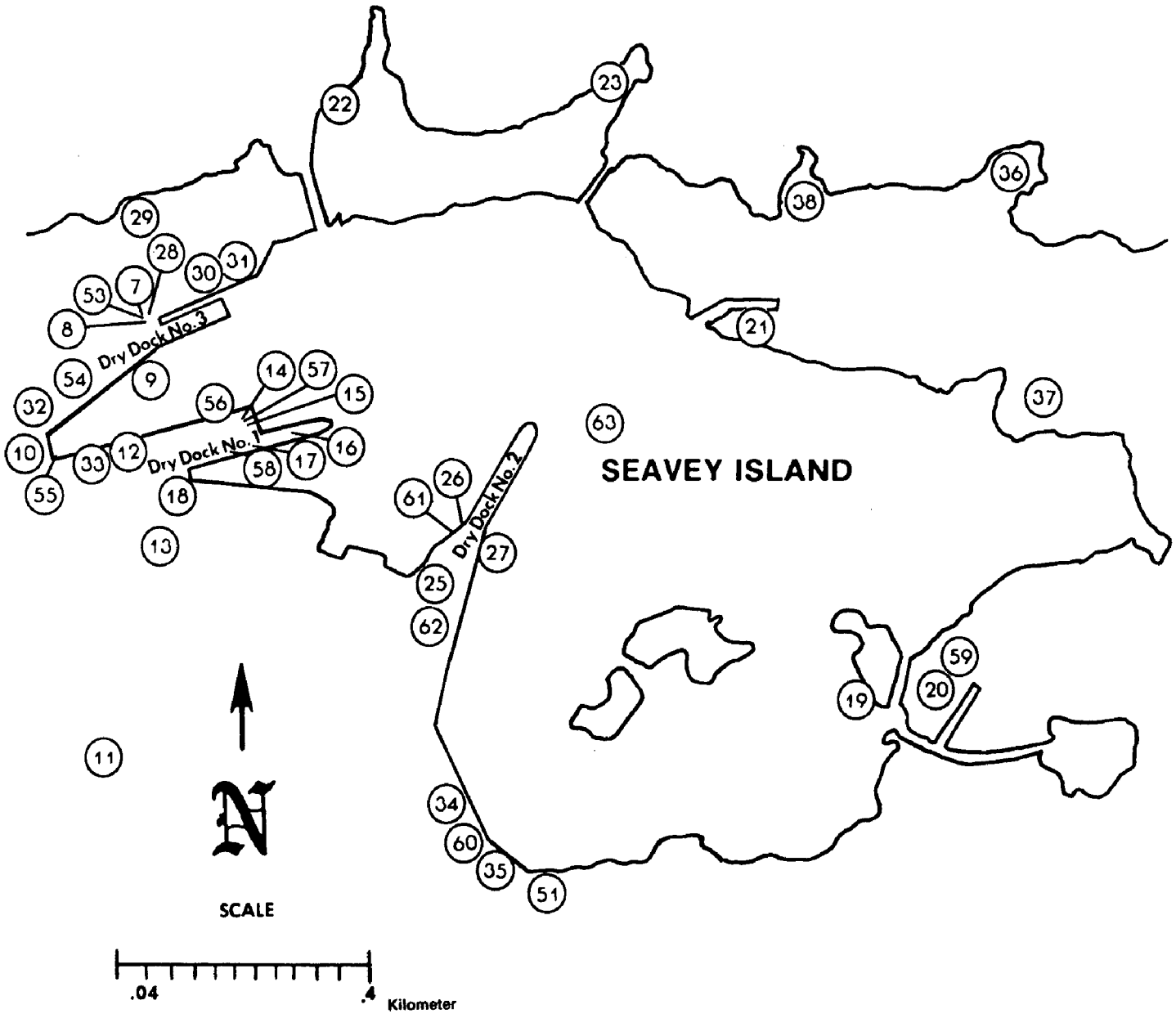

Figure 2. Sampling locations in the Portsmouth Naval Shipyard (PNS) area.

An underwater scintillation probe utilizing a 10-centimeter by 10-centimeter sodium iodide detector was used with a 1024 channel pulse height analyzer to assist in locating and delineating areas of radioactivity. Some problems were encountered in being able to position the probe on the harbor bottom due to the swift current. However, readings were taken at most desired locations. A 15-minute background spectrum was taken in Great Bay for subtracting from counts taken at other sampling locations. All probe counts were made for 15 minutes. Locations of probe measurements are shown in figure 3.

The underwater scintillation probe has been useful in past surveys to delineate areas for dredge sampling of bottom sediment. No radioactivity above background could be found by the underwater probe. Dredge samples were taken at locations where radioactivity seemed most probable, based on shipyard operations both current and past.

Extensive sampling was performed at all dry docks, berthing areas, and repair facilities.

A Peterson dredge was used to sample approximately the top 10 centimeters of sediment. The samples were dried at 110° C, ground to a fine powder, placed in a 400-cm^3 container and counted on a 10-centimeter by 10-centimeter NaI (Tl) detector or a 40-cm^3 Ge(Li) detector.

Core samples in past surveys have been useful in defining the vertical distribution of radioactivity. Also, radioactive materials from past operations which were subsequently covered with silt might be observed in the deep core samples. These samples were taken by divers at several locations. A 2.4-centimeter diameter by 61-centimeter tube is used for sample collection. The tube is pushed into the bottom as far as possible and then the ends are capped. When the core samples arrive at the laboratory they are frozen, cut into 2.5-centimeter sections and counted in the wet state.

Vegetation samples were collected where available in the vicinity of the PNS. Vegetation was the most abundant on pier pilings and on rock near the shoreline. These samples were dried at 110° C, ground to a fine powder, and analyzed for gamma emitting radionuclides. Several water samples were also collected and analyzed for gamma emitting nuclides and tritium.

Divers were used for collection of most of the aquatic life samples consisting of lobster, crab, flounder, mussel, and starfish. These samples were analyzed for gamma emitting radionuclides. Sample preparation for counting consisted of cutting and packing the material in a 400-cm^3 container.

Air samples were collected specifically for determining the presence of airborne gamma emitters. Also, a moisture sample was collected to determine if tritium was present. A high volume air sampler with an MSA Dust Filter was used for collecting particulate gamma emitters, and a low volume air pump was used with a Drierite column for the collection of moisture in the air to be analyzed for tritium.

Direct radiation exposure measurements were made using a pressurized ionization chamber (PIC) (3). Those areas accessible to the public were of particular interest.

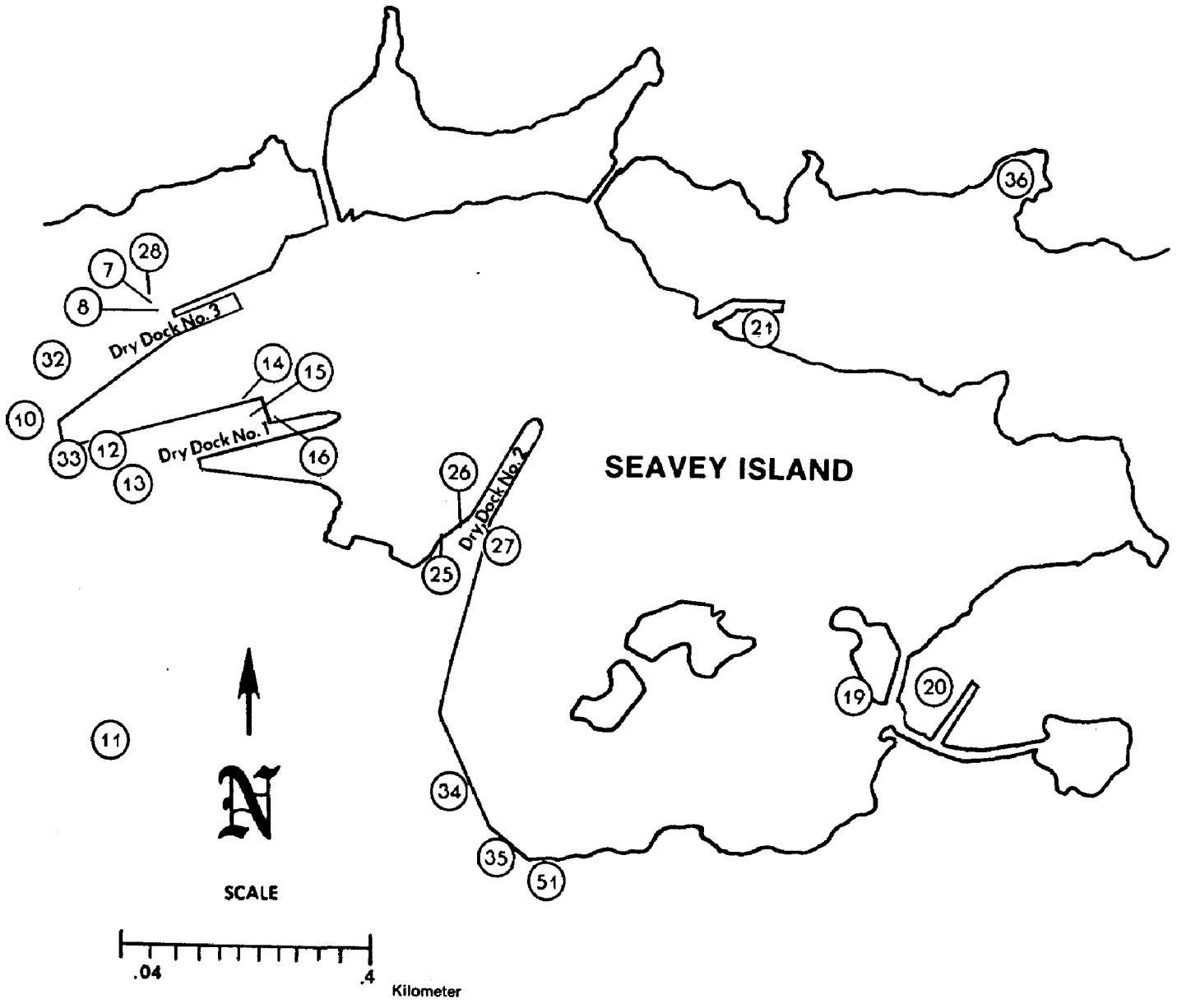

Figure 3. Gamma probe measurement locations.

IV. Results and Discussion

Cobalt-60 is the only isotope that could be attributed to nuclear ship operation that has been found during the survey conducted several years ago (4). All samples during this survey were analyzed for gamma emitting radionuclides with particular emphasis on cobalt-60. In addition to the gamma analysis, air and water samples were analyzed for tritium.

There is considerable fishing in the area, both commercial and sport, with some in very close proximity to the shipyard. Aquatic life samples were collected in the waters of the shipyard which are most accessible to the public. No radioactivity (other than natural ^{40}K) above minimum detectable levels was found in any of the aquatic life samples other than a trace amount of ^{95}Zr-^{95}Nb which is attributable to fallout. This was verified by the presence of larger amounts of ^{95}Zr-^{95}Nb detected in the silt background sample (0.11 $\pm$ 70% pCi/g) as shown in table 5. Results of these analyses are shown in table 1.

Air samples were collected and analyzed for tritium and gamma emitters (table 2). No gamma emitters other than background and those which are attributed to fallout were detected. Results of the tritium analyses were within the range detected routinely in the northeast part of the United States by the Environmental Radiation Ambient Monitoring System (ERAMS). Results from the (ERAMS) station in Buffalo, New York, for the same date is included in the table for reference purposes.

Water samples were collected and analyzed for gamma emitters and tritium. No gamma emitting radionuclides above our detection limit were found. The trace quantity of tritium detected is very close to the limit of detectability (0.2 nCi/l) and is within the range of tritium activity commonly found in water. Data from the background surface water stations collected during the same time period are included in the results for reference purposes. Results of the water analysis are shown in table 3.

Aquatic vegetation was collected in several harbor areas and analyzed for gamma emitting radionuclides. No activity found in the vegetation could be attributed to shipyard operation. Radionuclides detected were either naturally occurring or a result of fallout. Data from the vegetation analysis are shown in table 4.

The silt sampling was the most extensive of all the sampling activities. Any recent releases of radioactivity will usually be detectable in the silt. Silt samples were collected at 47 locations and no cobalt-60 was detected in any of the samples (figure 4). The only radionuclides detected were those attributed to fallout and those which are naturally occurring as shown by the analyses of the background sample (table 5).

Core samples were collected at eleven locations (see figure 5) to determine the vertical distribution of radioactivity in the sediment. The only detectable radionuclides were naturally occurring and those which are attributed to fallout. Results of the core sample analyses indicated no significant difference in any of the samples. Results for the core sample taken at Dry Dock #1 are shown in table 6.

The external gamma exposure rate was measured at several locations using a PIC. The areas of interest were those which are readily accessible to the public. A series of measurements was made over water at the site boundary. These measurements were made approximately every 500 feet around the perimeter of the shipyard for a total of 104 measurements (figure 6). All readings were considered to be within the range of natural background except those which were adjacent to the radiological repair barge. Readings at W20, W21, and W22 were slightly above background presumably due to material in the barge. These readings would result in a small annual exposure above the natural

Table 1

Results of Aquatic Life Sample Gamma Analysis

Sample Type	Collection Location	Specific Gamma Activity (pCi/g wet weight)	
Lobster (composite)	End of Dry Dock 3 (Site 7) Berth 12 (Site 10) Sound Pier (Site 20)	^{95}Zr-^{95}Nb ^{40}K	$0.02 \pm 60\%$ $1.70 \pm 12\%$
Flounder (composite)	Discharge at Dry Dock 1 (Site 15) End of Dry Dock 3 (Site 7) Berth 1 (Site 58)	^{95}Zr-^{95}Nb ^{40}K	$0.02 \pm 66\%$ $2.48 \pm 8\%$
Muscle	Berth 11-Rad Barge (Site 56)	^{95}Zr-^{95}Nb ^{40}K	$0.05 \pm 73\%$ $1.30 \pm 37\%$
Crab	Berth 12 (Site 10)	^{95}Zr-^{95}Nb ^{40}K	$0.10 \pm 77\%$ $1.87 \pm 54\%$

Site locations are approximate since these are aquatic life samples collected underwater.

Table 2

Results of Air Sample Analysis

Location	Radionuclide	Activity (pCi/l)
Building H.2 (Site 63)	^{3}H	0.02 ± 8.7%
	^{144}Ce	$6.85 \times 10^{-5} \pm 11\%$
	^{7}Be	Trace
	^{95}Zr-^{95}Nb	$8.17 \times 10^{-5} \pm 2\%$
	^{214}Bi	$1.58 \times 10^{-5} \pm 56\%$
Niagara Falls (ERAMS station) (for reference purpose)	^{144}Ce	$7.05 \times 10^{-5} \pm 10\%$
	^{7}Be	Trace
	^{95}Zr-^{95}Nb	$7.86 \times 10^{-5} \pm 2\%$
	^{214}Bi	$7.85 \times 10^{-6} \pm 97\%$

Table 3

Results of Tritium Analysis

Location	Radionuclide	Activity nCi/l
Little Bay (Site 1)	^{3}H	0.2 ± .2
Berth 13 (Site 9)	^{3}H	0.2 ± .2
Berth 11 (Site 12)	^{3}H	0.2 ± .2
Berth 5 (Site 25)	^{3}H	0.3 ± .2
Poughkeepsie, NY (Background station for ERAMS surface water network)	^{3}H	0.4 ± .2

Table 4

Results of Vegetation Sample Analysis

Location	Specific Gamma Activity Radionuclide	(pCi/g)
Pier by bridge to Spruce Creek (Site 4)	^{95}Zr-^{95}Nb	0.76 ± 6%
	^{232}Th	0.22 ± 48%
	^{40}K	13.73 ± 5%
End of Dry Dock 3 (Site 8)	^{95}Zr-^{95}Nb	1.29 ± 5%
	^{40}K	18.21 ± 5%
Southeast of yard in Piscataqua River (Site 11)	^{95}Zr-^{95}Nb	1.09 ± 6%
	^{232}Th	0.20 ± 74%
	^{40}K	18.40 ± 5%
	^{214}Bi	0.53 ± 95%
Outboard of Rad. Barge (Site 13)	^{95}Zr-^{95}Nb	1.59 ± 5%
	^{232}Th	0.26 ± 68%
	^{40}K	53.30 ± 2%
Discharge of Dry Dock 2 (Site 26)	^{95}Zr-^{95}Nb	2.23 ± 4%
	^{232}Th	0.27 ± 60%
	^{40}K	29.29 ± 4%
Berth 6 (Site 27)	^{95}Zr-^{95}Nb	0.65 ± 9%
	^{232}Th	0.17 ± 82%
	^{40}K	21.29 ± 4%
Southwest of Building 233 (Site 34)	^{95}Zr-^{95}Nb	0.98 ± 7%
	^{232}Th	ND
	^{40}K	21.46 ± 4%
South of Building 233 (Site 35)	^{95}Zr-^{95}Nb	0.91 ± 7%
	^{232}Th	ND
	^{40}K	19.17 ± 5%
Pier on Gerrish Island (Site 49)	^{95}Zr-^{95}Nb	1.95 ± 6%
	^{232}Th	ND
	^{40}K	24.09 ± 6%

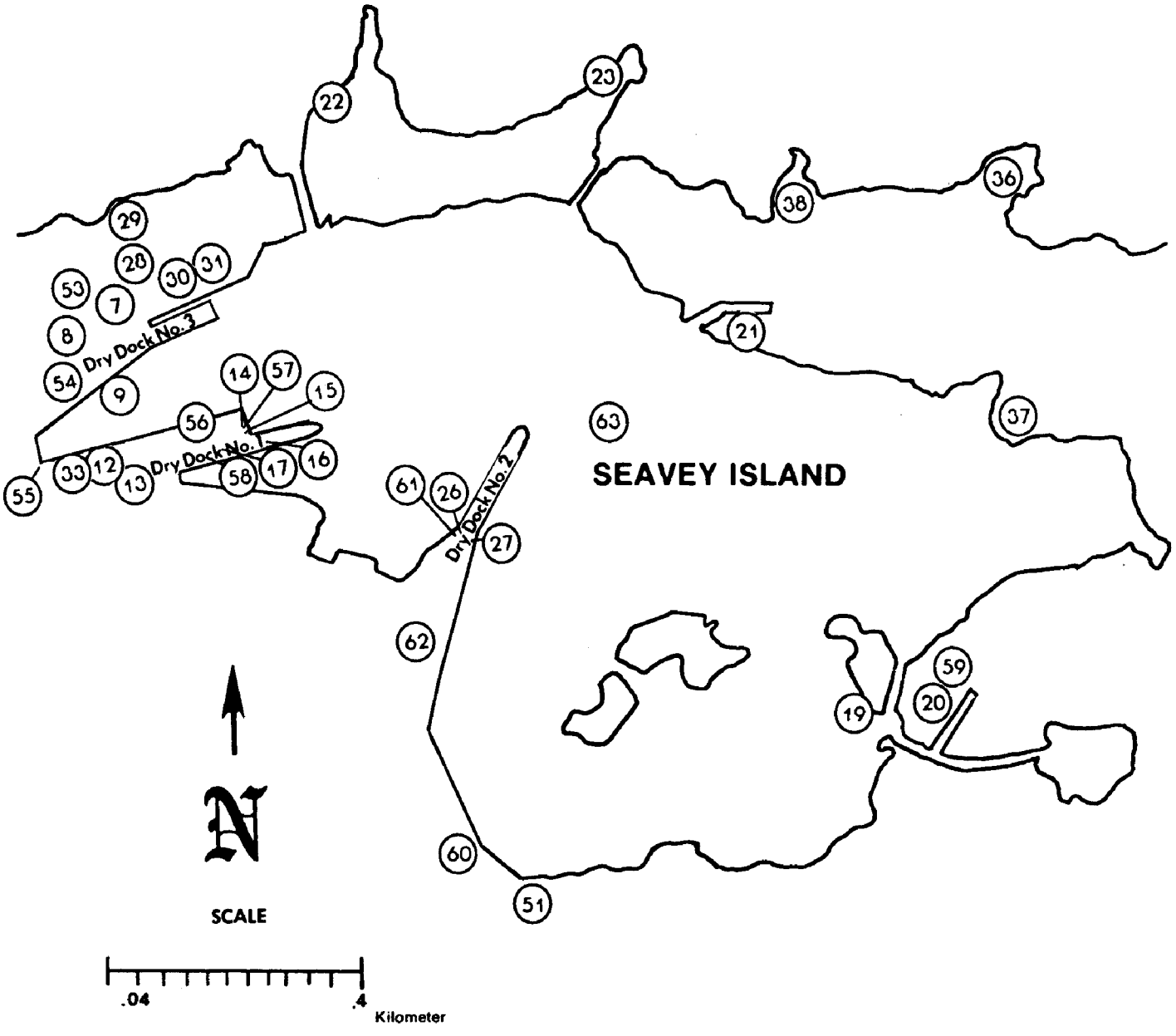

Figure 4. Silt sampling locations.

Table 5

Results of Silt Sample Analysis

(Partial Listing - These results are typical of all samples analyzed)

Location		Activity pCi/g Dry Weight
Site 09 (Berth 13)	^{137}Cs	0.29 ± 21%
	^{40}K	19.99 ± 9%
	^{214}Bi	0.75 ± 18%
Site 13 (Berth 1)	^{137}Cs	0.21 ± 22%
	^{40}K	17.06 ± 10%
	^{214}Bi	0.82 ± 15%
Site 15 (Dry Dock 1)	^{137}Cs	0.14 ± 25%
	^{40}K	12.43 ± 9%
	^{214}Bi	1.01 ± 12%
Site 17* (Berth 1)	^{137}Cs	0.25 ± 30%
	^{40}K	17.60 ± 5%
	^{214}Bi	1.98 ± 26%
Site 25 (Berth 5)	^{137}Cs	0.47 ± 17%
	^{40}K	23.99 ± 9%
	^{214}Bi	0.85 ± 17%
Site 26 (Discharge Point of Dry Dock 2)	^{137}Cs	0.29 ± 21%
	^{40}K	20.43 ± 10%
	^{214}Bi	0.83 ± 19%
Site 38 (Back channel by Public Works Pier)	^{137}Cs	0.20 ± 33%
	^{40}K	16.33 ± 5%
	^{214}Bi	1.45 ± 32%
Site 45 (Entrance to Little Harbor)	^{137}Cs	0.08 ± 33%
	^{40}K	14.88 ± 9%
	^{214}Bi	0.37 ± 21%
Site 1 (Background)	^{137}Cs	0.08 ± 30%
	^{40}K	14.79 ± 9%
	^{214}Bi	0.57 ± 16%
	^{95}Zr-^{95}Nb	0.11 ± 70%
	^{232}Th	0.68 ± 8%

All samples counted by a GeLi except those with an * which were counted by a NaI (Tl) detector. Locations are all shown in figure 4 except for site 1 which is shown in figure 1.

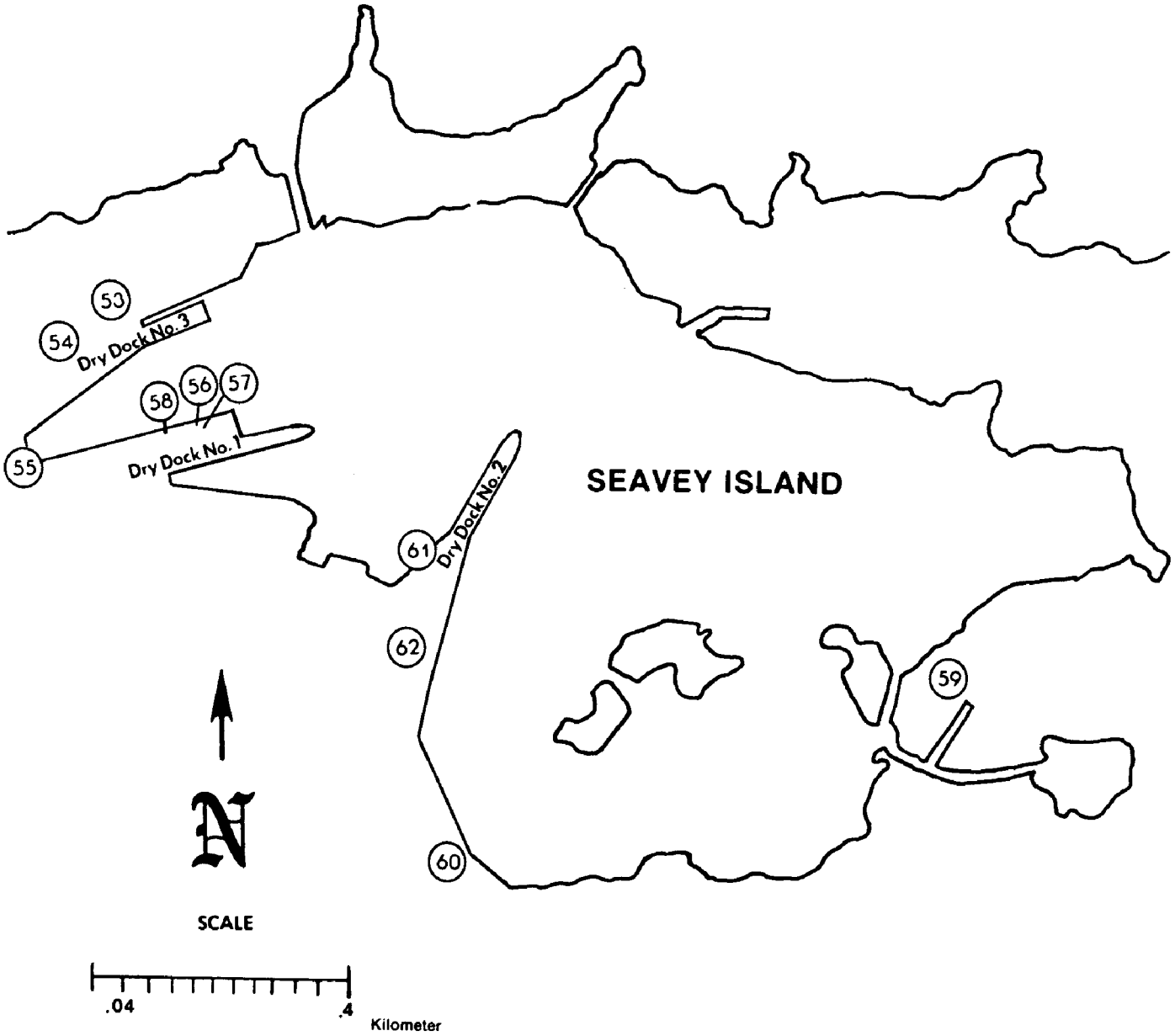

Figure 5. Core sampling locations.

Table 6

Results of Core Sample Analysis

(All samples counted by an NaI (Tl)

Location	Depth Below Sediment Water Interface (cm)		Activity (pCi/g) Dry Weight
Dry Dock #1 Site 15	3	^{95}Zr-^{95}Nb	1.34 ± 29%
		^{232}Th	1.90 ± 53%
		^{40}K	25.50 ± 21%
	5	^{137}Cs	0.71 ± 63%
		^{95}Zr-^{95}Nb	1.20 ± 29%
		^{232}Th	1.50 ± 60%
		^{40}K	20.77 ± 23%
	8	^{95}Zr-^{95}Nb	0.90 ± 37%
		^{232}Th	1.77 ± 50%
		^{40}K	18.98 ± 25%
	10	^{95}Zr-^{95}Nb	0.33 ± 90%
		^{232}Th	1.50 ± 54%
		^{40}K	21.37 ± 20%
	13	^{232}Th	1.75 ± 51%
		^{40}K	18.82 ± 25%
	15	^{232}Th	1.14 ± 70%
		^{40}K	18.30 ± 23%
	18	^{144}Ce	1.51 ± 83%
		^{137}Cs	0.44 ± 90%
		^{95}Zr-^{95}Nb	0.34 ± 88%
		^{232}Th	0.98 ± 82%
		^{40}K	20.96 ± 20%
	20	^{232}Th	1.40 ± 57%
		^{40}K	18.40 ± 23%
	23	^{95}Zr-^{95}Nb	0.33 ± 91%
		^{232}Th	1.50 ± 54%
		^{40}K	20.0 ± 21%

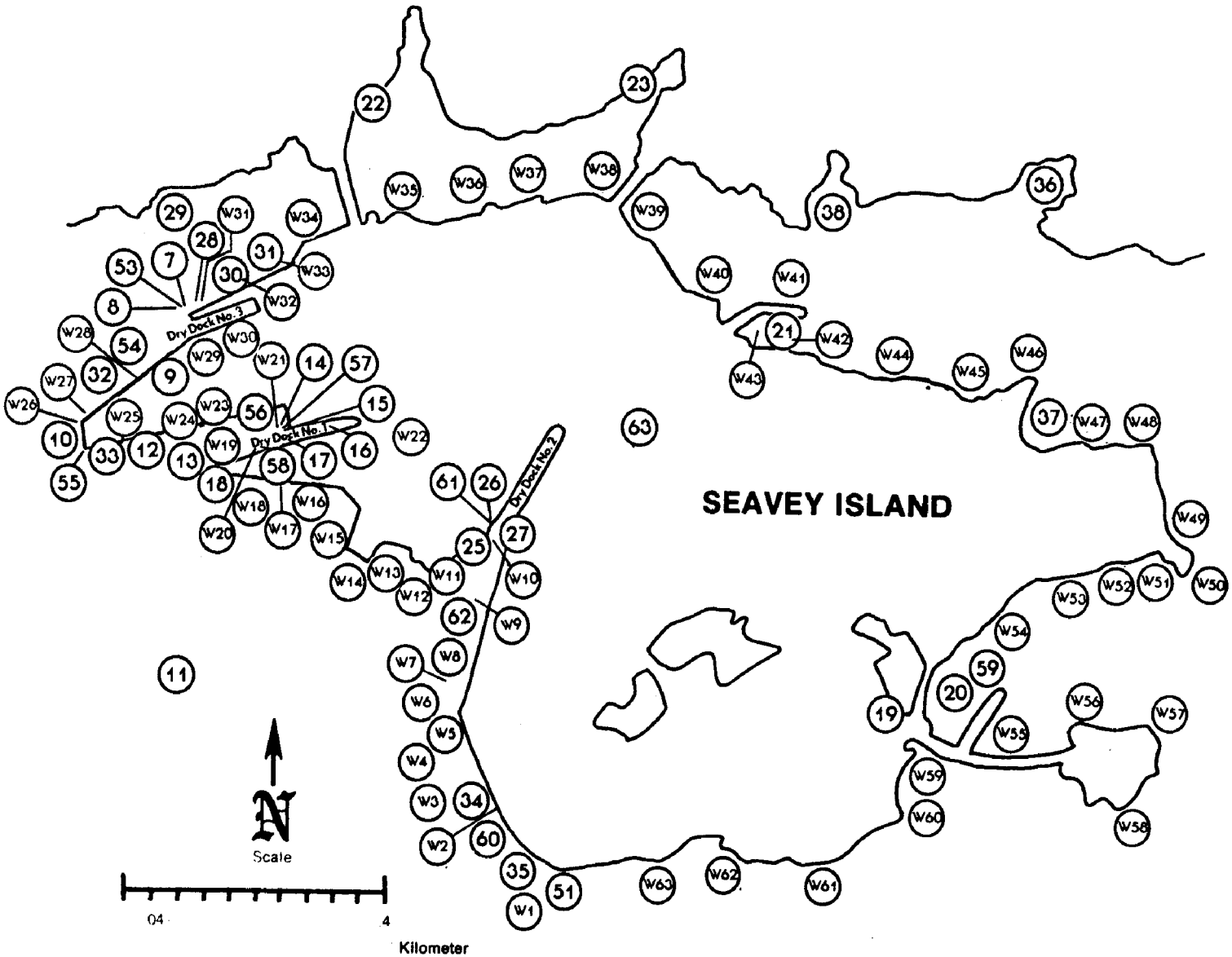

Figure 6. Locations of external gamma radiation measurements.

background if one was in this area continuously. In actuality, because of the location of the barge, it is highly unlikely that a member of the general population would spend any significant time adjacent to this radiological repair barge. Thus, no significant exposure to the general public should result. These readings are shown in tables 7 and 8. Since some of the sampling points were of very close proximity to each other, some of the PIC readings would include more than one sampling location.

V. Conclusions

The radiological survey of the Portsmouth Naval Shipyard provided the basis for the following conclusions.

1. The survey demonstrated that the procedures which are being utilized by the Navy to control the releases of radioactive materials into the harbor are effective. Also, controls of direct gamma radiation around the shipyard are effective.

2. Levels of activity measured are close to the minimum detection limit for most equipment. Radionuclides detected were either naturally occurring or attributed to fallout. Survey results indicate that nuclear operations at the Portsmouth Naval Shipyard are not contributing a significant radiation exposure to the public.

3. External gamma measurements indicate that shipyard operations do not significantly raise radiation exposure to the public above natural background levels.

4. The continuation of the various controls by the Navy should be adequate to insure continued absence of significant public exposure resulting from shipyard operations.

Table 7

Exposure Measurements at Sampling Sites

PIC Data (μ R/hr)

Location	Exposure Rate	Location	Exposure Rate
1	4.9	27	6.9
2	4.9	28	4.2
3	5.0	29	4.5
4	5.0	32	4.5
7	5.0	33	4.5
8	5.0	34	6.2
9	4.5	35	6.2
10	4.0	36	4.5
11	5.0	37	4.5
12	5.0	38	4.5
13	5.0	39	4.5
14	4.9	40	5.0
17	5.5	41	4.5
18	6.5	42	4.5
19	5.0	43	4.5
20	4.5	44	4.5
21	4.5	47	4.5
24	4.5	48	4.5
25	6.2	49	4.5
26	6.9	50	4.5
		51	4.7

Table 8

Exposure Measurements at Locations

Other than Sampling Sites

PIC Data (μ R/hr)

Location	Exposure Rate	Location	Exposure Rate
W1	4.5	W33	4.0
W2	4.5	W34	4.5
W3	5.0	W35	5.2
W4	5.0	W36	4.9
W5	4.9	W37	4.5
W6	5.0	W38	4.9
W7	5.0	W39	5.0
W8	4.9	W40	4.5
W9	4.9	W41	4.5
W10	4.9	W42	4.5
W11	5.0	W43	4.5
W12	4.9	W44	4.5
W13	4.9	W45	4.0
W14	4.5	W46	4.5
W15	4.5	W47	4.9
W16	5.0	W48	5.0
W17	4.9	W49	4.5
W18	4.5	W50	4.5
W19	6.0	W51	4.9
W20	8.5	W52	4.0
W21	6.0	W53	4.5
W22	7.5	W54	5.0
W23	5.0	W55	4.5
W24	5.0	W56	4.9
W25	5.0	W57	4.5
W26	4.5	W58	4.5
W27	4.3	W59	4.0
W28	4.5	W60	4.2
W29	4.5	W61	4.0
W30	4.5	W62	4.5
W31	4.5	W63	4.0
W32	4.5		

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