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**Results of the Independent
Radiological Verification
Survey of the B Ditch
at
DuPont Chambers Works,
Deepwater, New Jersey
(DNJ001V)**

**M. E. Murray
C. A. Johnson**

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LIFE SCIENCES DIVISION

Department of the Army- Corps of Engineers
(Activity No. 43WM11202; DAG)

**Results of the Independent Radiological Verification
Survey of the B Ditch at DuPont Chambers Works,
Deepwater, New Jersey (DNJ001V)**

M. E. Murray and C. A. Johnson

Date Issued -December 1998

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U. S. DEPARTMENT OF ENERGY
under contract DE-AC05-96OR22464

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ACKNOWLEDGMENTS

This project was sponsored by the Office of Environmental Restoration, U.S. Department of Energy, under contract DE-AC05-96OR22464 with Lockheed Martin Energy Research Corp. The writing and publication of this report was sponsored by the U. S. Army Corps of Engineers under contract 43WM11202. The authors wish to acknowledge the essential contributions of R. L. Coleman, V. P. Patania, D. A. Roberts, D. A. Rose and W. Winton of the Measurement Applications and Development Group, Life Sciences Division, Oak Ridge National Laboratory, for their participation in collecting, reporting, and analyzing the data for this effort.

ABSTRACT

This report documents the results of a radiological verification survey conducted at the Chambers Works of the E. I. DuPont Company in Deepwater, New Jersey by a team from the Oak Ridge National Laboratory (ORNL) in response to the Department of Energy's (DOE) Environmental Restoration Program requirements. The survey was to confirm that radioactive residuals previously identified in a portion of a central drainage ditch (the B Ditch) had been remediated to bring that portion of the property into compliance with current U.S. Department of Energy guidelines.

The survey was conducted in the spring of 1997 in conjunction with DuPont's remediation and stabilization of the B Ditch to remove elevated levels of 2,4-dinitrotoluene and organic lead compounds. Portions of this ditch were located in an area where former Manhattan Engineering District of the Atomic Energy Commission work was conducted, and an independent verification survey was taken to ensure that this area had been remediated to radionuclide concentrations and activity levels below the applicable guideline limits.

The survey included directly measured radiation levels and soil analysis to determine concentrations of uranium, and to compare these data to applicable guidelines.

The results of the independent verification survey on this property demonstrate that the remediated and surveyed section of the B Ditch at the DuPont Chambers Works, Deepwater, New Jersey, successfully meets remedial action objectives, and radiological measurements in that portion of the property fall below the limits prescribed by radiological guidelines established for this site.

Results of the Independent Radiological Verification Survey of the B Ditch at DuPont Chambers Works, Deepwater, New Jersey (DNJ001V)*

INTRODUCTION

This report documents the results of an independent radiological verification survey conducted at the Chambers Works of the E. I. DuPont Company in Deepwater, New Jersey. The DuPont Chambers Works site is located on the southeast shore of the Delaware River, extending northward from the Delaware bridge for approximately one mile (Fig. 1). This 700-acre complex is adjacent to the residential community of Deepwater, New Jersey. The background information in this report concerning operations and sources of contamination at the Chambers Works is based on a variety of secondary sources. The accuracy of this information was not validated as part of this project because the information has no impact on the results of the independent verification of current contamination levels that are reported here.

The survey was conducted to confirm that radioactive residuals previously identified in a portion of the Historic Process Water Ditch System, a central drainage ditch also called the "B Ditch", had been remediated to bring that portion of the property into compliance with current U. S. Department of Energy (DOE) guidelines.

During the 1940s, the Dupont Chemical Company performed chemical and radioactive material production at the Chambers Works, (formerly called Dye Works) for the Manhattan Engineering District (MED) of the Atomic Energy Commission (AEC). Only a small portion of the site was affected by the MED activities. The locations at which these uranium products were handled included what is now the F Corral parking area and Building 845. Building 845 is a four-story structure which still stands and is currently used as a warehouse (Fig. 2). It is located approximately 100 ft southeast of the F parking facility. Residual wastes from Building 845 were discharged into a wooden trough located east of the building. The trough dumped into the central drainage ditch approx 150 ft north of Building 845. The ditch, whose primary function was to carry residual wastes from chemical operations, then drained into the eastern corner of Lagoon A, located further north on the site. Composites from Lagoon A were then pumped into the on-site water treatment facility for chemical processing of the waste.

DuPont continued its research activities for the AEC until late 1947. In 1948 the AEC conducted radiological surveys and decontamination activities at the site and, following a radiological survey based on then-existing criteria, AEC released the buildings back to DuPont in 1949.

The central drainage ditch, or B Ditch, is approximately 3.5 miles long. The ditch, which received process water prior to 1980, passes in the vicinity of a radiologically impacted area resulting from the MED activities. Sections of this ditch were being remediated to remove

*The survey was performed by members of the Measurement Applications and Development Group of the Life Sciences Division at Oak Ridge National Laboratory under DOE contract DE-AC05-96OR22464.

elevated levels of 2,4-dinitrotoluene and organic lead. At the request of the New Jersey Department of Environmental Protection and the DOE, the DuPont company agreed to perform additional work as remediation of the B Ditch moved into the radiologically impacted area. DuPont agreed to monitor and collect samples of the treated ditch material for radionuclide analysis.

In March 1977, at the request of DOE, the Oak Ridge National Laboratory (ORNL) conducted a radiological survey of areas of the Chambers Works that were used during MED/AEC activities.¹ This survey focused on Building 845, the surrounding area, and the F Corral parking area.

The survey results indicated that elevated concentrations of uranium were present in building material from the operations building (Building 845) and in some surface and subsurface soil samples. Based on the 1977 ORNL survey results, the DOE Assistant Secretary for the Environment determined in 1980 that the DuPont site warranted remedial action under the Formerly Utilized sites Remedial Action Program (FUSRAP), and the site was then designated for inclusion into the program.

Additional characterization activities were performed in 1983 by Bechtel National, Inc. (BNI), the Project Management Contractor for FUSRAP, to determine if the property contained radioactive contamination in six areas potentially impacted by the uranium production process, and to further define the boundary and depth of the contamination.² Three of these areas were: Building 845, the Central Drainage Ditch (now called the B Ditch), and the F Corral parking area (see Fig. 2). Results of this survey showed radiological contamination in excess of site guidelines (150 pCi/g ²³⁸U) in all but the B Ditch.

In 1997, Dupont began remediation and stabilization of the B Ditch to remove elevated levels of 2,4-DNT and organic lead compounds. Because portions of this ditch were located in an area where former MED work was conducted, DOE requested an independent verification survey to ensure that this area had been remediated to radionuclide concentrations and activity levels below the applicable guideline limits set for this site.

GUIDELINE DEVELOPMENT

A site-wide authorized limit of 100 pCi/g for total uranium above background levels was approved for use in the cleanup of the DuPont Site, pursuant to DOE Order 5400.5, Chapter IV, Section 5a. A separate authorized limit of 500 pCi/g was approved for the central drainage ditch.³ The authorized limits are stated in terms of the average residual concentration per 100 m² area.

A request for approval of uranium guidelines for the DuPont Site of the Formerly Utilized Sites Remedial Action Program was made based on a report by Argonne National Laboratory (ANL). Based on ANL's supporting analysis, the recommended value of 100 pCi/g of total uranium is within DOE's dose guideline of 100 millirem per year which must be met under all worst case, plausible scenarios, including the assumed subsistence residential use. The recommended level of 100 pCi/g also meets the constraint of 30 millirem per year for current or

likely land use, as proposed in 10 CFR 834.

The authorized level of 500 pCi/g meets the basic dose limit of both DOE order 5400.5, Chapter IV and proposed 10 CFR 834. The separate, higher limit for the central drainage ditch is justified because it will not result in impermissible exposures to uranium. The nature and extent of residual chemical contamination that will remain in this location after remediation is completed will require the use of institutional controls. In view of these controls, the limit of 500 pCi/g of uranium is adequate to ensure protection of health and the environment. Use of this limit also reduces worker exposure to the chemical contamination that is present.

Several factors are considered for "Hot spot" determination. In previous radiological surveys on this property by ORNL and Bechtel, all contamination greater than the guideline of 500 pCi/g was at a depth of less than 2 feet. Typically, DuPont excavated 6 to 8 ft below grade as necessary to remove the lead contamination and to allow for the new piping. Therefore as the systematic analysis indicated, very little uranium was found. In addition, the grid spacing used provides a 90% confidence that an elliptical spot of 22 m² would be found. An assumed contamination level of 1000 pCi/g would still meet the average guideline value of 500 pCi/g and all related hot spot criteria.

Applicable guidelines are summarized in Table 1. Photos of the central drainage ditch and the movable enclosure are shown in Figs. 3 and 4.

SCOPE OF THE SURVEY

Objectives

The objective of the verification activities was to confirm that the remedial action reduced contamination levels to within authorized limits. Applicable DOE guidelines for protection against radiation and radionuclides are summarized in Table 1. Typical background levels for the southern New Jersey area are shown in Table 2.

Survey Methods

A comprehensive description of the survey methods and instrumentation used in this survey is given in *Procedures Manual for the ORNL Radiological Survey Activities (RSA) Program*, ORNL/TM-8600 (April 1987)⁴ and *Measurement Applications and Development Group Guidelines*, ORNL-6782 (January 1995).⁵

The radiological verification survey of the B Ditch on this property included (1) surface radiation measurements along the ditchline from markers 6+00 to 11+00 with a NaI detector connected to a Victoreen 190 meter, (2) systematic FIDLER (Field Instrument for Detection of Low-Energy Radiation) measurements at 2-meter intervals over the suspected radiologically impacted area, and (3) the collection of soil samples taken from the bottom center of the excavation and analysis by gamma spectroscopy for total uranium content.

Surface radiation measurements were taken along the length of the section of the ditch in the radiologically impacted area to define the subsurface contamination and to help define the post-remediation sampling requirements. After the excavation of the contaminated soil and before filling with clean fill material, samples were taken from the bottom center of the ditch and analyzed for total uranium. The results of soil radionuclide analysis for ^{238}U and ^{235}U indicated that all radionuclide concentrations were well below limits prescribed for this site for protection against human radiation exposure.

Results of the independent radiological verification survey by ORNL of a section of the central drainage ditch on this property confirm that the remedial action has reduced radiological contamination levels to within authorized limits.

Based on the review of the verification survey data, all radiological measurements fall below the limits prescribed by the radiological guidelines established for this site, and the remediated and surveyed section of the B Ditch at the DuPont Chambers Works, Deepwater New Jersey, successfully meets the remedial action objectives.

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Fig. 1. General location of the DuPont Chambers Works Facility, Deepwater, New Jersey, and part of the radiation impacted area on the site.

ORNL DWG. 98-128219

Fig. 2. Drawing showing the section of the B Ditch between the F Parking Area and Building 845 where soil samples were taken. Samples were taken every 50 ft beginning at marker 6+10 for 200 ft, and every 25 ft for the remaining 300 ft.

Fig. 3. View of the B Ditch looking north along the ditch from the 6+10 marker.

Fig. 4. View of the B Ditch looking south into the containment tent in the process of being built.

Fig. 5. Drawing of the B Ditch showing systematic FIDLER measurements at 2-meter intervals. Sampling locations are shown along the B Ditch centerline.

Fig. 6. Cross-sectional drawing of the B Ditch showing the excavated area that was subsequently filled with clean fill material after remediation was complete. A soil sample was taken at the center of the excavation prior to filling.

Table 1. Applicable guidelines for protection against radiation
(Limits for uncontrolled areas)

Mode of exposure	Exposure conditions	Guideline value
Gamma radiation	Indoor gamma radiation level (above background)	20 $\mu\text{R}/\text{h}^a$
Radionuclide concentrations in soil (generic)	Maximum permissible concentration of the following radionuclides in soil above background levels, averaged over a 100-m ² area ^{226}Ra ^{232}Th ^{230}Th	5 pCi/g averaged over the first 15 cm of soil below the surface; 15 pCi/g when averaged over 15 cm-thick soil layers > 15 cm below the surface
Derived concentrations	Total uranium	500 pCi/g ^b
Guideline for non-homogeneous contamination (used in addition to the 100-m ² guideline) ^c	Applicable to locations with an area ≤ 25 m ² , with significantly elevated concentrations of radionuclides ("hot spots")	$G_A = G_i(100/A)^{1/2}$, where G_A = guideline for "hot spot" of area (A) G_i = guideline averaged over a 100-m ² area

^aThe 20 $\mu\text{R}/\text{h}$ shall comply with the basic dose limit (100 mrem/yr) when an appropriate-use scenario is considered.

^bDOE guidelines for uranium are derived on a site-specific basis. The guideline of 500 pCi/g total uranium has been applied to the B Ditch at this FUSRAP site. Sources: Albert S. Johnson, Office of Eastern Area Programs, U.S. DOE, *Uranium Authorized Limits for the DuPont Site, Deepwater, New Jersey*, memorandum to W. A. Williams, Designation and Certification Manager, Office of Environmental Restoration, U.S. DOE, March 27, 1997 (Ref. 3).

^cDOE guidelines specify that every reasonable effort shall be made to identify and to remove any source that has a concentration exceeding 30 times the guideline value, irrespective of area (adapted from *Revised Guidelines for Residual Radioactive Material at FUSRAP and Remote SFMP Sites*, April 1987).

Sources: Adapted from U.S. Department of Energy, *Radiation Protection of the Public and the Environment*, DOE Order 5400.5, April 1990, and U.S. Department of Energy, *Guidelines for Residual Radioactive Material at Formerly Utilized Sites Remedial Action Program and Remote Surplus Facilities Management Program Sites*, Rev. 2, March 1987; and U. S. Department of Energy Radiological Control Manual, DOE N 5480.6 (DOE/EH-256T), June 1992.

Table 2. Average background radiation levels and concentrations of ^{238}U at six locations in the southern New Jersey area^a

Location number	Gamma radiation measurements at 1 meter ($\mu\text{R/h}$)	Radionuclide concentrations of ^{238}U in soil (pCi/g)
1	4	1.5
2	4	1.9
3	6	4.0
4	6	1.6
5	3	0.3
6	4	1.8

^aThese values represent a range of normal radionuclide concentrations found in six areas in this part of the state. Actual values may fluctuate.

Source: U. S. Department of Energy, *Formerly Utilized MED/AEC Sites Remedial Action Program, Radiological Survey of the E.I. DuPont DeNemours and Co., Deepwater, New Jersey*, DOE/EV-0005/8, December 1978. Values were obtained from six locations in the vicinity of the Chambers Works site. (Ref. 1).

Table 3. Concentrations of selected radionuclides in soil samples collected from B Ditch at DuPont Chambers Works, Deepwater, New Jersey (DNJ001V)

Sample ID ^b	Location	Radionuclide concentration (pCi/g) ^a		
		²³⁸ U	²³⁵ U ^c	Total U
VS1	6+10	0.8	ND	1.5
VS2	6+60	0.8	ND	1.7
VS3	7+10	1.1	ND	2.3
VS4	7+60	0.6	ND	1.1
VS5	8+10	0.7	ND	1.5
VS6	8+35	0.6	ND	1.1
VS7	8+60	0.6	ND	1.2
VS8	8+85	1.0	ND	2.0
VS9	9+10	1.4	ND	2.9
VS10	9+35	2.4	0.2	5.0
VS11	9+45	0.8	ND	1.6
VS12	9+70	1.5	ND	3.1
VS13	9+95	3.8	ND	7.8
VS14	10+20	7.0	0.4	14
VS15	10+45	4.0	0.2	8.2
VS16	10+70	2.6	0.2	5.4
VS17	10+95	19.0	0.8	39
VS18	11+20	8.0	0.4	16

^aIndicated counting error is at the 95% confidence levels ($\pm 2\sigma$). Background concentrations (see Table 2) have not been subtracted.

^bSample locations are shown on Fig. 2.

^cND = Not Detected. Minimum detectable for ²³⁵U for the method used is 0.1 pCi/g.

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