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ENVIRONMENTAL SCIENCES DIVISION

CHARACTERIZATION OF THE OLD HYDROFRACTURE FACILITY (OHF) IMPOUNDMENT

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ABSTRACT

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Oak Ridge, Tennessee. 130 pp.

A characterization study was conducted on a radioactive-waste impoundment, known as the Old Hydrofracture Facility (OHF) Pond, at Oak Ridge National Laboratory to provide information necessary for its proper disposition. The impoundment was constructed in 1963 to provide a containment basin for radioactive grout in the event of an emergency spill from the Hydrofracture Facility. The impoundment is rectangular and measures approximately 30 by 6 m (100 by 20 ft) at the bottom. Water in the impoundment overlies approximately 0.3 m (0.9 ft) of sediment waste.

The pond sediment was sampled and analyzed to determine whether it would classify as a hazardous waste under regulatory definitions promulgated in accordance with the Resource Conservation and Recovery Act (RCRA). The impoundment is not regulated under RCRA, because it was a land disposal unit and ceased receiving waste prior to November 19, 1980. However, if the sediment contained RCRA-defined hazardous waste, it would be subject to the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). Chemical analyses indicate that the sediment/waste does not contain hazardous chemical constituents above levels permitted by RCRA regulations. The sediment was found to contain an estimated radioactivity inventory of approximately 9500 GBq (260 Ci), consisting primarily of ^{137}Cs

(2400 GBq or 60 Ci), ^{90}Sr (7000 GBq or 190 Ci), ^{60}Co (12 GBq or 0.3 Ci), and ^{238}U (12 GBq or 0.3 Ci).

The impoundment is excavated in clay soil and weathered sedimentary rock of the Conasauga Group. Four wells for monitoring the groundwater were constructed around the perimeter of the impoundment to depths ranging from 5.8 to 7.9 m (19 to 26 ft). Sampling and analyses of the groundwater have been completed for the winter and spring seasons (1985) and will be continued for at least two more quarters to account for possible natural seasonal variation in groundwater quality. At the end of that time, a determination as to the effect of the impoundment on the groundwater quality will be made. Analyses from the first two quarters indicate that radioactivity (gross beta resulting from ^{90}Sr and tritium) of the groundwater exceeds limits allowed by RCRA regulations. Low levels (0.0001 mg/L) of polychlorinated biphenyls (PCBs) were also detected in the groundwater.

1. INTRODUCTION

A characterization study of the Old Hydrofracture Facility (OHF) impoundment at Oak Ridge National Laboratory (ORNL) has been conducted under the Surplus Facilities Management Program (SFMP) to provide information necessary for proper disposition of the facility. The SFMP at ORNL is part of the Department of Energy's (DOE) National SFMP, administered by the Richland Operations Office. This program provides for the management of radioactively contaminated DOE facilities from the end of their operating life until final disposition is completed. The work has been performed with a view towards obtaining the information in a format such that it would also be useful in assisting ORNL in fulfilling any obligation that may develop under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA).

1.1 Comprehensive Environmental Response, Compensation and Liability Act

Disposal impoundments that contain hazardous wastes but that stopped receiving such wastes prior to November 19, 1980, are regulated under CERCLA rather than the Resource Conservation and Recovery Act (RCRA). The Old Hydrofracture Facility ceased operation by 1980, and it has been listed as a possible hazardous waste facility with the Environmental Protection Agency (EPA) and the Tennessee Division of Solid Waste Management (TDSWM). Under CERCLA regulations, this original listing of the site did not require sampling and analysis of the waste, but could be based on "the respondent's belief, recollection and examination of available records" [EPA Notices, Fed. Regist. 46(77):22144 (April 15, 1981)]. Primarily, CERCLA hazardous waste sites are regulated by EPA under the National Oil and Hazardous Substances Contingency Plan of 40 CFR 300 (USEPA 1983a). Unlike RCRA regulations, the National Oil and Hazardous Substances Contingency Plan does not provide specific procedures for determining whether a waste is hazardous, or for determining any potential effect on the groundwater at a site. Therefore, RCRA procedures and requirements generally have been employed as guidelines for the current characterization study.

1.2 Scope of the Characterization

A previous unpublished study (by S. F. Huang, W. F. Ohnesorge, B. F. Kelly, R. K. Owenby, J. S. Eldridge, K. L. Daniels, and T. W. Oakes of the ORNL Environmental and Occupational Safety Division) sampled, analyzed, and calculated inventories of radionuclides, polychlorinated biphenyls (PCBs), and certain heavy metals in the impoundment's sediment. This study will be referred to throughout this report as S. F. Huang (personal communication). The current study commenced in November 1984 and extended through July 1985. The sediment waste in the bottom of the pond was sampled and analyzed to determine whether it would classify as a hazardous waste as defined by RCRA regulations, and to determine the chemical elements that comprise the major portion of the sediment. The groundwater hydrology at the site was investigated by a review of its geology and by the construction and sampling of four groundwater-monitoring wells.

2. DESCRIPTION OF THE IMPOUNDMENT

The OHF impoundment is located in Melton Valley, slightly more than one mile south of the main ORNL complex (Fig. 1). The facility is situated on the west edge of Solid Waste Storage Area 5 (SWSA 5), where low-level radioactive wastes were buried during the 1960s. The impoundment is situated at the base of a north-trending valley wall at an elevation below the OHF main plant facilities (see Fig. 2). White Oak Creek flows southward through this valley, approximately 120 m (400 ft) west of the impoundment, and westward-flowing Melton Branch lies approximately the same distance to the south. Three partially buried concrete waste vaults lie less than 15 m (50 ft) to the east of the south end of the impoundment at a slightly higher elevation. In addition, five steel tanks are buried approximately 20 m (70 ft) south of the impoundment. The vaults and tanks contain radioactive wastes from the hydrofracture operation.

2.1 Impoundment Construction

The impoundment was constructed as part of the hydrofracture operation in 1963, essentially by excavating a rectangular basin in the base of the valley wall. According to W. R. Reed (Engineering Division, ORNL, personal communication), construction dimensions of the bottom of the basin are 6 m (20 ft) in width by 30 m (100 ft) in length, with sides sloping at 1 vertical on 1.5 horizontal. The depth of the pond is slightly greater than 1.5 m (5 ft) at the low (west) side. The sides are lined with limestone rip-rap. Design capacity was 379,000 L (100,000 gal). Inflow was to the south end of the impoundment

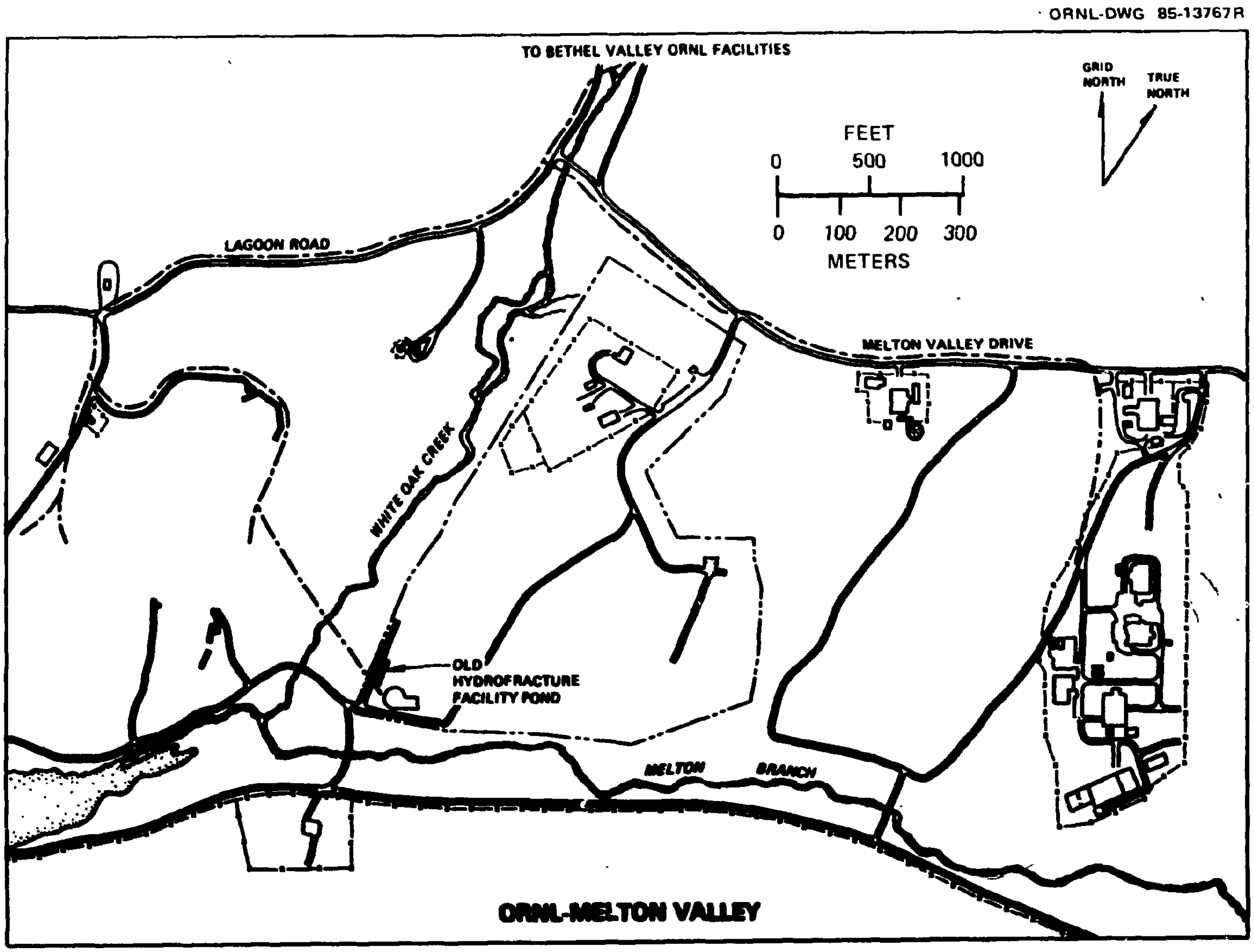

Fig. 1. Location of Old Hydrofracture Facility impoundment within ORNL.

ORNL PHOTO-8052-84

Fig. 2. Aerial photograph of the Old Hydrofracture Facility with the impoundment visible at lower right.

via a buried 46-cm (18-in.) line from the injection well cell. A 20.3-cm (8 in.) line from a waste pit, which was part of the injection operation, is also shown on drawings as entering the impoundment at the same location W. R. Reed (personal communication). Construction drawings specified that the pond bottom be sprayed with liquid asphalt to control erosion; and a plastic liner was placed in the pond prior to experimental injections W. R. Reed (personal communication). However, no evidence of either of these treatments was observed while sampling the sediment for this study. A concrete standpipe, 1.5 m (5 ft) high, was provided as an emergency outflow at the north end of the impoundment. ORNL drawing S-10,916 EA 001 D shows this vertical standpipe connected to a 20-cm (8 in.) vitrified clay pipeline. The drawing shows this line extending to the west approximately 15 m (50 ft.), where it empties into a shallow natural swale at approximate elevation 233 m (763 ft). Probings made during the current study indicate that the bottom of the impoundment is at an approximate elevation of 233.1 m (764.6 ft.).

2.2 Impoundment Operation

The impoundment was constructed to serve as an emergency containment basin in the event of a spill from the radioactive grout injections, for example, caused by backflow of grout. Due to malfunction of pumping equipment or piping, the impoundment did receive radioactive grout from injections made in 1965 (de Laguna et al. 1971) and 1977 (Lasher 1985). Prior to a grout injection at the facility, the water level in the pond was required to be low enough that there would be sufficient freeboard capacity in the impoundment to hold the radioactive grout should an emergency arise that required such action during the operation. Prior to some injections, depending on the water level, this necessitated decanting the water from the pond. Before contamination of the impoundment by radioactive waste, the pond water was syphoned to the White Oak Creek flood plain. Subsequent to contamination of the impoundment, the water was pumped to the low-level waste system for processing (Lasher 1985).

Operation of the OHF ceased by 1980 (Myrick 1984). In the winter of 1984-85, the pond received drilling fluid and drill cuttings from an exploratory core boring (5.7-cm core diam. and 8.6-cm hole diam.) through the radioactive grout sheets underlying the OHF site.

Probings made during the current study indicate that the thickness of the sediment in the impoundment averages 27-cm (0.9 ft). This amounts to approximately 55,000 L (14,500 gal) of sediment. From the size and length (165 m or 542 ft) of the exploratory core, approximately 900 L (230 gal), or less than 2% of the total sediment volume, is sediment from the 1985 core-drilling operation.

3. IMPOUNDMENT SEDIMENT WASTE

3.1 Sediment and Pond Water Sampling Procedures

To determine the constituents of the waste sediment, samples were taken from the north, center, and south sections of the impoundment (Fig. 3). Two sets of samples were obtained: the first in November 1984 and the second in February 1985.

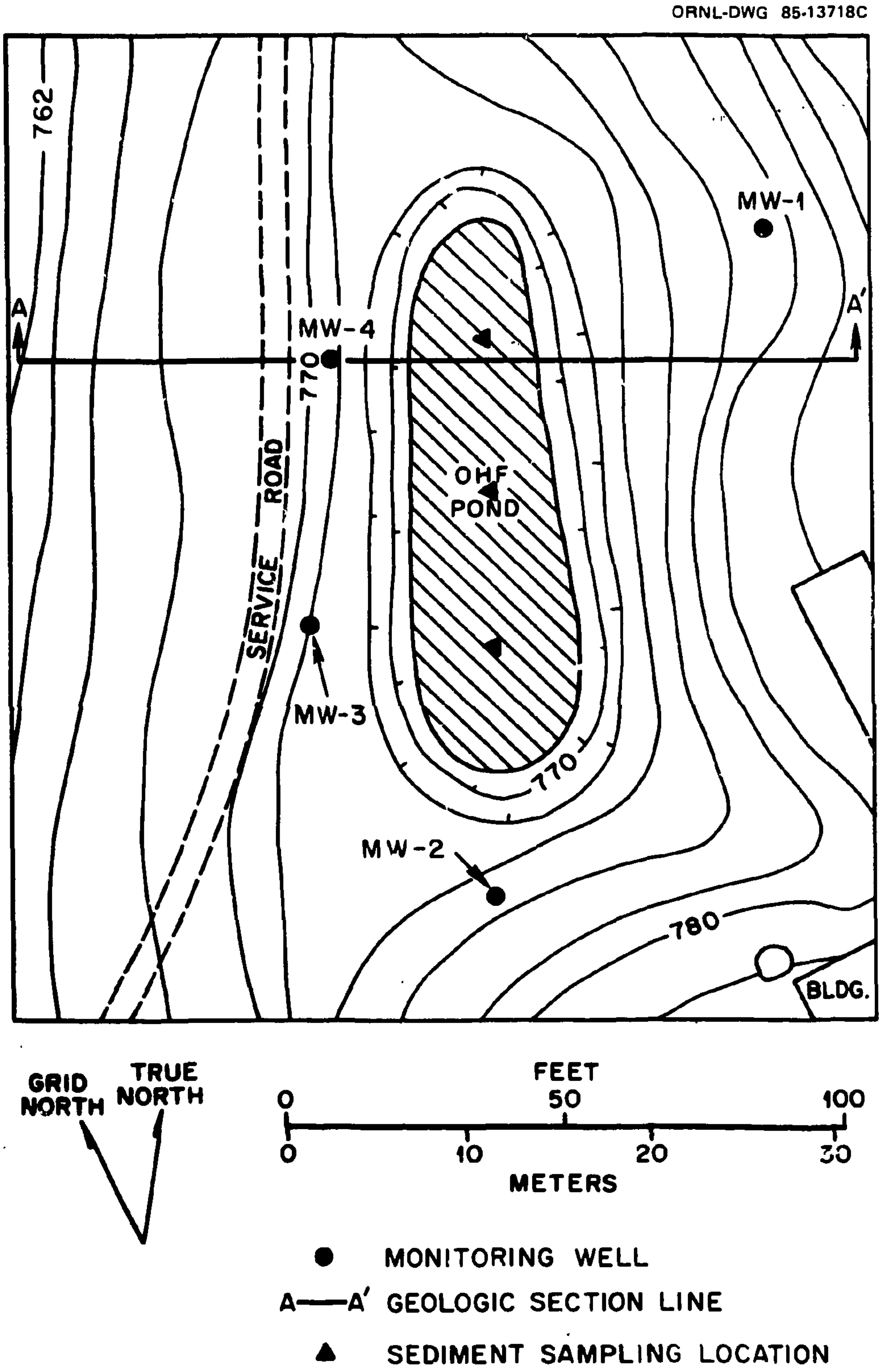

Fig. 3. Location of sediment sampling sites and groundwater monitoring wells.

The procedure for sampling the first set consisted of pushing an aluminum tube, 7.62-cm (3.0 in.) diameter, through the sediment into the underlying clay bottom to a depth of 2.54 to 7.62 cm (1 to 3 in.). The clay acted as a plug at the bottom of the sampling tube to retain the loose, low-density sediment. The top of the tube protruded above the water level and was plugged with a rubber stopper prior to retrieving the sample tube from the sediment. The second set of samples were grab samples collected by the use of a wood scoop, and the clay bottom was not retrieved in the sample.

For ease of handling, sediment samples were emptied from the sampling devices into wide-mouth plastic containers, from which they were transferred to 1.9-L (1/2-gal) glass containers at the sampling site. More than one core, or grab sample, was taken at each site for each of the two sets of samples. During the first sampling, two containers of sediment were collected at each location. For the second sampling, only one container was collected at each location.

Pond water was sampled in May 1985 from a location in the center of the impoundment using a glass container. At the time the sample was obtained, the water depth was approximately 1 m (3 ft).

3.2 Selection of Constituents for Analysis in Sediment and Pond Water

The purpose of the sampling was to determine whether the sediment waste in the bottom of the OHF pond would be classified as a hazardous waste under CERCLA or RCRA regulations. Federal regulation 40 CFR 261, promulgated under RCRA, specifies that a solid waste is a hazardous waste if it exhibits any of the defined characteristics of ignitability, corrosivity, reactivity, or extraction procedure (EP) toxicity. The EP toxicity is of primary concern, as the inherent physical and chemical characteristics of the sediment rule out classification as a hazardous waste based on ignitability, or reactivity. The EP toxicity characteristic is based on measured concentrations of eight elements of the National Interim Primary Drinking Water Standard (NIPDWS) and six herbicides and pesticides in the filtrate of a 24-h solid waste extraction test (USEPA 1980). These contaminants and their maximum permissible concentrations are listed in Table 1. If the level of any one of these constituents exceeds its established maximum permissible concentration shown in Table 1, then that waste is considered a hazardous waste. As supplementary information, concentrations of nonregulatory elements were also reported for EP extracts. These concentrations resulted from analysis of the EP extracts by the multi-elemental analysis technique, inductively coupled plasma (ICP) spectroscopy. These elements, such as Fe, Ca, Na, P, Cu, and Ni, although not regulated by CERCLA or RCRA, are significant in determining the overall leaching characteristic of the sediment.

An estimate of total elemental composition of the sediment was conducted, as well as a determination of polychlorinated biphenyls (PCBs) in the sediment. Analyses of this nature are useful in evaluating remedial action alternatives and are necessary to determine inventories of chemical constituents in the sediment waste.

The concentrations of certain radionuclides were also determined in the sediment of the OHF pond. These included gross alpha and beta

Table 1. Contaminants that determine EP toxicity[a]

EPA hazardous waste[b] number	Contaminant	Maximum concentration (mg/L)
D004	Arsenic	5.0
D005	Barium	100.0
D006	Cadmium	1.0
D007	Chromium	5.0
D008	Lead	5.0
D009	Mercury	0.2
D010	Selenium	1.0
D011	Silver	5.0
D012	Endrin (1,2,3,4,10,10-hexochloro-1,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-endo, endo-5,8-dimethano naphthalene)	0.02
D013	Lindane (1,2,3,4,5,6-hexachlorocyclohexane gamma isomer)	0.4
D014	Methoxychlor (1,1,1-trichloro-2,2-bis [P-methoxyphenyl]ethane)	10.0
D015	Toxaphene ($C_{10}H_{10}Cl_8$, technical chlorinated camphene, 67--69 % chlorine)	0.5
D016	2,4-D,(2,4-Dichlorophenoxyacetic acid)	10.0
D017	2,4,5-TP Silvex (2,4,5-trichlorophenoxy-propionic acid)	1.0

[a] From Fed. Reg. 45:98 (May 1980), p. 33122.

[b] Waste is classified as hazardous if concentration of any listed constituent equals or exceeds these maximum concentrations.

analyses, as well as analyses of specific alpha-, beta-, and gamma-emitting isotopes. Low-level alpha measurements were precluded by the relatively high levels of beta and gamma radiation, as low-level radiochemical analysis facilities cannot accept samples with much activity. Of major concern were ^{90}Sr, ^{137}Cs, ^{60}Co, ^{241}Am, and the uranium isotopes. A recent internal report S. F. Huang (personal communication) also reported measurements for these radionuclides.

The pond water in the impoundment was analyzed for the parameters defined by the NIPDWS and for those established to determine groundwater quality and as indicators of groundwater contamination. In addition, radiological analyses of the pond water were made. These analyses included gross alpha and beta determinations, as required by the NIPDWS regulations, in addition to separate analyses of specific alpha-, beta-, and gamma-emitting isotopes. Data of this type have also been previously reported by S. F. Huang (personal communication).

3.3 Chemical Methods Used for Analysis of Sediment and Pond Water

Chemical analyses used to characterize the sediment and pond water were performed by the ORNL Analytical Chemistry Division. The methods used are predominately those described in Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, second edition, published July 1982 by the USEPA Office of Solid Waste and Emergency Response, Washington, D.C. (USEPA 1982) and Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, revised March 1983, published by the USEPA Environmental Monitoring and Support Laboratory, Office of Research and Development, Cincinnati, Ohio (USEPA 1983b).

For the sediment, the (EP) toxicity test was conducted as outlined by EPA method 1310 (USEPA 1982). The elemental concentrations in the EP extract were determined by EPA methods 7061, 7081, 7131, 7191, 7421, 7470, 7741, and 7761 (USEPA 1982) and by inductively coupled plasma (ICP) spectroscopy, method 200.7 (USEPA 1983b). The concentrations of pesticides and herbicides in the EP extracts were determined by method 8080 (USEPA 1982), except that the analyses were by liquid chromatography instead of gas chromatography.

Total elemental concentrations in the sediment from the OHF pond were determined by fusion of a 2- to 3-g sample (dry weight at 110°C overnight) with lithium metaborate. The residue melt was taken up in 3% nitric acid, and elemental concentrations were determined by ICP spectroscopy. This procedure precludes the analysis of mercury, as the element is lost on volatilization. The total concentrations of PCBs in sediment were determined using method 8080 (USEPA 1982).

Elemental concentrations in pond water at the OHF site were determined by ICP spectroscopy, (method 200.7 (USEPA 1983b). The methods used to determine concentrations of pesticides, herbicides, and PCBs were the same as those used to determine their concentrations in the EP extracts. Coliform bacteria were determined by method 405.1 (USEPA 1983b). Concentrations of fluoride, chloride, nitrate, and sulfate were determined in pond water using methods 340.2 and 300.0 (USEPA 1983b). Phenol concentration was determined by method 420.1 (USEPA 1983b). Total organic carbon (TOC) and total organic halides (TOX) were determined in pond water using methods 9060 and 9020, respectively (USEPA 1982).

3.4 Results and Discussion of Chemical Analyses of Sediment and Pond Water

As stated earlier, the primary interest in the chemical characterization of sediment and pond water at the OHF is the classification of the sediment as a hazardous or nonhazardous waste as defined by RCRA. The pH of the sediment slurry was found to be 5.2; thus the waste does not have the characteristic of corrosivity as defined by EPA. The controlling test for classification is the EP toxicity characteristic. Concentrations of RCRA regulatory constituents in EP extracts from sediment taken at various locations within the OHF pond are presented in Table 1A of Appendix III. Eachconcentration in Table 1A prefixed by a minus sign is the detection limit for the element or compound for that analysis. These measurements are summarized in Table 2, where the mean, minimum, and maximum values and the coefficient of variation (CV in percent) are presented across each of the three locations in the pond and, for the elements, the two sampling dates. This represents six measurements for each RCRA metal and three measurements for each herbicide and pesticide.

Where detection limits were low enough, the concentrations of RCRA regulated constituents measured in the EP extracts were well below RCRA maximum allowable concentrations. Selenium concentrations of the sediment samples collected in November 1984 (see Table 1A) are a possible exception because of the high detection level. For these samples, the ICP detection limit was 1.4 mg/L greater than the RCRA limit. The detection limit for ICP analyses is often dictated by the dilution factor used in the analysis. Samples are routinely diluted to

Table 2. Concentrations (mg/L) of RCRA Regulated Constituents in EP Extracts from OHF Pond Sediment

Constituent	Maximum allowable concentration	Mean	N	Measured concentration Min	Max	CV
Arsenic	5.0	0.6002	6	0.0005	1.2000	109.5
Barium	100.0	0.3067	6	0.0600	0.7200	101.2
Cadmium	1.0	0.0092	6	0.0001	0.0430	105.5
Chromium	5.0	0.0492	6	0.0010	0.1100	108.9
Lead	5.0	0.0232	6	0.0001	0.1300	225.6
Mercury	0.2	0.0650	6	0.0001	0.2000	124.3
Selenium	1.0	1.2050	6	0.0100	2.4000	108.6
Silver	5.0	0.2102[a]	6	0.0005	0.4200	109.3
Endrin	0.02	0.0001[a]	3	0.0001	0.0001	0.0
Lindane	0.04	0.0001[a]	3	0.0001	0.0001	0.0
Methoxychlor	10.0	0.0002[a]	3	0.0002	0.0002	0.0
Toxaphene	0.5	0.0020[a]	3	0.0020	0.0020	0.0
2,4-D	10.0	0.0050[a]	3	0.0050	0.0050	0.0
2,4,5-TP	1.0	0.0050[a]	3	0.0050	0.0050	0.0

[a] Measurements include analytical detection levels (see Table 1A).

include as many elements as possible in the analysis. This dilution step often results in higher detection limits than desired for elements such as selenium. In further analysis of selenium, in the EP extracts of the sediments sampled in February 1985, the selenium levels were 100 times lower than maximum allowable RCRA concentrations, indicating that selenium concentrations in the OHF sediment are well below RCRA limits. The data for selenium in Table 2 were determined using the higher detection limits for selenium (i.e., those from the November sampling); thus, mean selenium concentrations are suspect.

Concentrations of Cu, Ni, and Zn in EP extracts (see Table 2A of Appendix III) are significantly below 100 times the maximum limit for water in the recently issued "Hazardous Substance Guidelines" (see Table 3) by the State of Tennessee [L. W. Gregory, Tennessee Department of Health and Environmental, (personal communication)]. The concentrations listed in Table 3 are not a regulation, but rather are guidelines currently used by the State of Tennessee. As such, they are subject to modification. Activities of radionuclides were not determined on the EP extracts.

Results of total elemental analyses of the sediment (in milligrams per kilogram of dry sediment) are provided in Table 3A of Appendix III. Also included in this table are concentrations of PCBs, which ranged from 0.4 to a maximum of 7.3 mg/kg. Regulatory levels do not presently exist governing total concentrations of inorganic or organic constituents in sediments. However, comparison with the previously mentioned Tennessee "Hazardous Substance Guidelines" indicates that the sediment exceeds maximum soil limits for Cu, Ni, Cr, Pb, PCBs, and

Table 3. Hazardous substance guidelines from Tennessee Division of Solid Waste Management-Superfund

Compound	Maximum limit, water (ppm or mg/l)	Maximum limit, soil (ppm or mg/kg)	Water reference
Benzene	0.025	2.5	6
Ethylbenzene	1.4	140	1
Toluene	14.3	1430	1
Carbon tetrachloride	0.025	2.5	6
Chloroform	0.002	0.2	1
1,2-Dichloroethane	0.26	26	6
1,1-Dichloroethylene	0.35	35	6
Methylene chloride	0.15	15	2
Tetrachloroethylene	0.085	8.5	6
Trichloroethylene	0.26	26.0	6
1,1,1-Trichlorethane	1.0	100	6
Acetone	20	2,000	7
Ethylacetate	400	40,000	4
Xylenes	0.62	62	2
Methylethyl ketone	0.75	75	5
Methylisobutyl ketone	100	10,000	4
Vinyl chloride	0.06	6.0	6
Naphthalene	0.025	2.0	1
Di-n-butyl phthalate	0.034	3.4	1
Pentachlorophenol	1.01	101	1
Cyanide	0.2	10	3,8
Phenol	0.3	30	1,8
Copper	1	100	3
Zinc	5	500	3,8
Nickel	0.2	20	3,8
Mercury	0.002	0.2	3,8
Arsenic	0.05	5	3,8
Cadmium	0.01	1.0	3,8
Chromium	0.05	5	3,8
Silver	0.05	5	3,8
Lead	0.05	5	3,8
PAHs	0.000028	0.0028	1
PCBs	0.00000079	0.000079	

Water limits, clarified by MED 8/28/84
Nitrates(N)--10 ppm
Sulfates--250 ppm
Phosphate--should be set below 50 ppm in water (gives renal damage in rats and is 10 times dietary, adequate nutritional level for rats)

References:
1. *Fed. Reg.* 45:231 (Nov. 1980).
2. Long-term SNARL.
3. Interim Drinking Water Standard.
4. Dangerous Properties of Industrial Materials, N. Irving Sax.
5. 10-d SNARL.
6. *Fed. Reg.* 49:114 (June 1984), p. 24338.
7. Flash point concentration.
8. EP toxicity limit or suggested level (phenol, cyanide, nickel).

possibly Ag and Cd (detection limits were in excess of the maximum limits). The chromium concentration in the sediments (mean concentration 341.9 mg/kg) was over 50 times the guideline maximum for soil (5 mg/kg). The measured chromium concentrations in this study were considerably higher than those reported by S. F. Huang (personal communication) (from 17 to 27 mg/kg on a wet-weight basis). Even correcting the concentrations determined in this study to a wet-weight basis (mean concentrations determined in this study, approximately 100 mg/kg) the chromium concentration in the sediment is approximately 4 times that determined by S. F. Huang (personal communication).

An inventory of metals and other constituents in the sediments of the OHF impoundment, derived from the total elemental analyses, is presented in Table 4A of Appendix III. The inventory was calculated based on 55,000 L of sediment having a bulk wet density of 1.2 g/cm3 and 71% water, as determined in this study. The sediment inventory of these metals and PCBs, in kilograms, was determined by using the mean concentration across the three locations (center, north, and south sections of the pond) sampled in February 1985. For those measurements below detection, the detection limit was used as an estimated concentration (e.g., the absolute value of the 'less-than' concentration reported in Table 3A). Thus, for those measurements below detection, the quantities reported in Table 4A represent upper limits. As discussed earlier, the total elemental concentration of mercury was not determined in analyses for this report (mercury was determined for the EP toxicity test only). However, S. F. Huang (personal communication) reported an average mercury concentration for the sediment of <2.3 mg/kg and an inventory in the sediment of <180 g.

The inventory in the OHF sediment (Table 4A) is slightly higher for metals and lower for PCBs than that estimated by S. F. Huang (personal communication). The inventory of Pb, Cu, Zn, and Cr ranged from approximately 2 to 6 times that estimated by S. F. Huang (personal communication). In reality, these measurements compare quite well, taking into consideration the sampling and analytical error involved. S. F. Huang (personal communication) estimated an inventory of 280 g of PCBs, while this study estimated an inventory of 50 g.

Chemical analysis of the OHF pond water is presented in Table 5A of Appendix III. The analyses indicated that As, Ba, Cd, Cr, Hg, Pb, fluorine, and nitrate and the pesticides and herbicides were below the maximum allowable NIPDWS. The measured concentration of selenium (0.016 mg/L), slightly over the NIPDWS level (0.01 mg/L), and the detection limit of silver (0.07 mg/L) determined in the May sampling were the only indications that chemical constituents in the pond water exceeded the allowable NIPDWS levels. Detectable concentrations of PCBs were observed in the pond water (0.0001 mg/L), and counts of coliform bacteria (8 counts/mL) were in excess of the NIPDWS. The concentration of total organic halides (TOX) was 0.13 mg/L. The total organic carbon content (TOC) content, however, was relatively low (16 mg/L). Other than the radionuclide concentrations, which are discussed below, the water quality of the OHF pond water (based on these chemical analyses) is surprisingly high.

3.5 Radionuclide Analytical Methods

Concentration of radionuclides in pond water at the OHF impoundment were determined using solid state alpha and beta detectors. Gross alpha and gross beta measurements were performed by counting on Tennelec LB5100 series II equipment. This automated system is programmed to convert raw data to activity units and will also utilize material weights or volume to produce activity per unit weight or volume. Analyses of gamma-emitting radionuclides were conducted using high-resolution germanium detectors. The detectors were shielded from extraneous background and were calibrated for the respective sample geometries using certified mixtures of gamma-emitting radionuclide standard solutions from the National Bureau of Standards (NBS). Calibration procedures and assessment have been described elsewhere (Larsen and Cutshall 1981).

Concentrations of gamma-emitting radionuclides in the sediments were counted directly (without chemical dissolution) using the techniques described above. Gross alpha and gross beta were determined following fusion of the sediment with lithium metaborate and subsequent dissolution of the melt with 3% nitric acid. Aliquots of the acid solution were counted for gross alpha and gross beta by a technique similar to that described above. Strontium-90 was also determined after fusion with lithium metaborate. The strontium was separated from other cations by precipitation as the oxalate salt and then counted on a beta proportional counting system.

3.6 Results and Discussion of Radionuclide Analyses of Sediment and Pond Water

The measured concentrations of radionuclides in the OHF sediment are presented in Table 6A of Appendix III. The major radionuclides measured in the sediment are ^{137}Cs and ^{90}Sr. Their concentrations (approximately 1.25×10^5 and 3.9×10^4 Bq/g or 3.4×10^6 and 1.1×10^6 pCi/g, respectively, for ^{137}Cs and ^{90}Sr) are similar to those determined by S. F. Huang (personal communication). The inventory of radionuclides in the OHF sediment, presented in Table 4, indicates an activity of approximately 2 GBq (0.05 Ci) of gross alpha and slightly under 2000 GBq (50 Ci) of gross beta (which is largely a result of the ^{90}Sr and ^{90}Y decay). The radionuclide measured in greatest quantity was ^{137}Cs (approximately 2400 GBq or 60 Ci), followed by ^{90}Sr (approximately 750 GBq or 20 Ci) (see Table 4).

Major contaminants in the pond water, as expected, are the radionuclides, as shown in Table 7A of Appendix III. The bulk of the activity is from ^{137}Cs and ^{90}Sr, 3900 and 4400 Bq/L (1.1×10^5 and 1.2×10^5 pCi/L), respectively. Average values reported in the OHF pond water by S. F. Huang (personal communication) were 29,000 and 7100 Bq/L (0.78 and 0.9 mCi/L), respectively for Cs-137 and Sr-90. Gross beta activity appears to be predominately from ^{90}Sr and ^{90}Y decay; i.e., gross beta (9400 Bq/L or 2.5×10^5 pCi/L) is slightly more than twice the ^{90}Sr activity. Gross alpha activity in the pond water is less than 0.1% of the gross beta and ^{137}Cs activity combined.

The inventory of radionuclides in the pond water, presented in Table 8A, was determined by multiplying the volume of pond water

Table 4. Inventory of radionuclides in OHF pond sediment

Constituent[a]	Total inventory mean
alpha	1.95
beta	1774.28
^{134}Cs	0.38
^{137}CS	2391.86
^{154}Eu	0.43
^{234}U	0.64
^{238}U	11.72
^{241}Am	0.38
^{60}Co	11.64
^{90}Sr	741.93

[a] Measured in giga becquerels.

(2.45×10^5 L) by the radionuclide concentration (Table 7A). Total inventory of ^{90}Sr and ^{137}Cs (approximately 1 GBq or 0.03 Ci for each radionuclide) was reasonably close to the estimate by S. F. Huang (personal communication) of 2.1 and 0.5 Bq/L, for ^{137}Cs and ^{90}Sr, respectively.

4. SUBSURFACE EXPLORATION AND MONITORING WELLS

4.1 Drilling and Sampling

A total of four borings ranging in depth from 7.3 to 10.4 m (24 to 34 ft) were drilled with a Mobile model B-33 drilling machine using hollow-stem augers, 20.3 cm (8 in.) in diameter. The augers were after between the drilling of each hole; and the sampling tools were washed and rinsed with dilute nitric acid followed by distilled water between each sampling event.

At depths of 1.5 m (5 ft) and greater, samples of subsurface materials were obtained from the auger. A 1.5-m 5-ft) depth provided sufficient length of drill tools to allow a sampler, manufactured by Central Mining Equipment, Inc., to be inserted within the hollow-stem auger. Continuous sampling of soil and highly weathered bedrock was possible with this device during penetration by the auger. Every 1.5 m (5 ft) of drilling depth, the sampler was retrieved and the sample, which was 5.7 cm (2.25 in.) in diameter, was removed. When the drill could no longer advance the auger employing the sampling device, the sampler was removed and replaced by the center section of the auger bit; this allowed the drilling to continue in firm rock. All soil samples and drill cuttings were monitored with a Geiger-Mueller (G/M) meter, and no radioactivity above background was detected. Descriptive records of all borings are provided in the boring logs in Appendix I. Locations of the borings (as monitoring wells) are shown in Fig. 3.

4.2 Monitoring Well Construction

A groundwater monitoring well was constructed in each of the borings using fiberglass well screen and casing, 7.6 cm (3 in.) in diameter. Prior to installation of the well screen, drill cuttings from the shale and limestone bedrock encountered in the borings were flushed from the bottom of the hole by pressure washing with potable water. The coarse cuttings, 0.6 cm (1/4 in.) and larger, were allowed to remain in the bottom of the boring, as the pump used for washing did not have sufficient flow to wash the heavier cuttings from the hole. These cuttings will not cause the well to produce turbid water, as the fine particles that could enter the well through the screen have been washed from the well. To ensure that the potable wash water did not interfere with sampling of the groundwater, a volume of water was removed from each of these wells equal to or greater than 5 times the drilled-diameter volume of the well.

The entrance areas of the well screens consisted of two rows of slots with openings, 0.25 mm (0.01 in.) wide. The screens were 3 m (10 ft) in length. Each screen was surrounded by a sand pack of medium-grained quartz sand, which extended a minimum height of 30.5 cm (1 ft) above the top of the well screen. A bentonite (clay) seal at least 30.5 m (1 ft) thick was placed at the top of the sand pack. The remainder of the boring was backfilled with portland cement concrete from the top of the seal to the top of the boring. A protective casing, 10.16 cm (4 in.) in diameter and 1.52 m (5 ft) in length, was installed around the well-riser pipe with both the pipe and casing extending approximately 0.91 m (3 ft) above the ground surface. The top of the riser pipe is closed by a removable plastic cap. Construction details of each of the wells are provided in Appendix II. A summary of construction details, measured groundwater elevations, and surveyed locations and elevations is provided in Table 5.

4.3 Monitoring Well Location

Locations available for the construction of monitoring wells at the OHF site are restricted by topography, roads, an overhead powerline, and two underground pipelines. In addition, SWSA 5 trenches containing low-level radioactive waste are located within 46 m (150 ft) of the impoundment on the upgradient side.

The location for monitoring well 1 (MW-1) was selected to attempt to provide a groundwater sampling point located upgradient (i.e., in the direction of increasing static head of the groundwater table) of the impoundment, from which representative samples of the groundwater that would move through the impoundment site could be obtained. Also, the upgradient well should not be affected by potential contamination from the monitored facility. Monitoring well No. 1 is located approximately 27 m (95 ft) downgradient of the nearest waste trench in SWSA 5 which is a potential source of contamination for the upgradient well.

Table 5. Summary of monitoring well location, construction data, and water levels at the OHF impoundment

Parameter	MW-1	MW-2	MW-3	MW-4
North grid coordinate, ft	17325.24	17236.06	17298.86	17339.13
East grid coordinate, ft	28600.38	28504.80	28496.78	28519.01
Top of well casing (elevation ft)	782.11	776.89	773.46	773.50
Height of casing above ground, ft	2.8	2.7	2.9	2.9
Ground surface elevation, ft	779.3	774.2	770.6	770.6
Top of well screen, ft	760.1	761.2	760.4	760.5
Bottom of well screen, ft	750.1	751.9	750.4	750.5
Top of sand pack, ft	769.8	768.2	764.6	762.6
Bottom of well hole, ft	744.3	750.2	746.6	746.6
Diameter of well pipe/screen, in.	3.0	3.0	3.0	3.0
Type material of pipe/screen	Fiber-glass	Fiber-glass	Fiber-glass	Fiber-glass
Width of screen opening, in.	0.01	0.01	0.01	0.01
Water level (4-8-85), ft	770.92	756.58	757.38	760.87
Water level (5-23-85), ft	769.41	755.86	756.79	759.82
Water level (6-4-85), ft	768.92	755.37	756.14	759.36
Water level (7-1-85), ft	768.23	755.34	756.30	759.46
Water level (7-30-85), ft	768.04	755.47	756.50	759.66

The locations of the other three monitoring wells were selected to determine whether contaminants from the impoundment are migrating into the groundwater. As CERCLA does not provide specific requirements for monitoring well locations, these wells (Table 5) comply with regulations promulgated in accordance with RCRA, which specify that there be at least three hydraulically downgradient (i.e., in the direction of decreasing static head of the groundwater table) wells. These downgradient wells are required to be at the boundary of the impoundment facility, which, as described in the RCRA Permit Writer's Guidance Manual for Groundwater Protection, 40 CFR, 264, Subpart E, draft (USEPA 1983c), EPA interprets to be no more distant than the outside toe of any containment dike that may exist, plus 9.14 m (30 ft) for physically selecting an appropriate drill site.

Monitoring well 2 is at the south end of the impoundment, and water-level measurements show it to be the extreme downgradient well. This well is approximately 6.1 m (20 ft) from the two influent pipelines coming from the pumping cell and waste pits to the southeast end of the impoundment.

Monitoring wells 3 and 4 are on the topographically low (west) side of the impoundment. It is estimated that the geologic strike of the bedrock strata makes an angle of approximately 55° with the long axis of the pond (based on reports cited in Sect. 5.2, Site Geology). Therefore, both of these wells, which are downgradient relative to the pond, are also in strata that strike under the impoundment.

4.4 Surface Geophysical Survey

An electromagnetic (EM) conductivity survey, using a model EM-34 instrument manufactured by Geonics Ltd., was conducted around the perimeter of the OHF impoundment. This geophysical method provides a rapid site reconnaissance that can detect contaminant plumes of high ionic strength. The technique measures the apparent electrical conductivity of the subsurface using self-contained dipole transmitter and receiver coils held in the horizontal dipole configuration and separated by a horizontal distance of 6.1 m (20 ft). When in this configuration, the instrument senses to approximately 0.75 of the intercoil spacing (Geonics 1983). Therefore, the apparent conductivity was measured to an approximate depth of 4.6 m (15 ft) at each station. Readings in millimhos per meter (mmhos/m) at each measurement station around the OHF impoundment are shown in Fig. 4. The magnitudes of variations do not indicate major conductivity anomalies that would seem to be attributable to contamination plumes from the impoundment. These variations may be due to interferences caused by surrounding overhead and underground power lines and pipelines.

5. GEOLOGY

5.1. Regional Geology

Oak Ridge National Laboratory lies in the Ridge and Valley Physiographic Province. In Tennessee, the province consists of northeast-southwest striking rock strata of limestone, sandstone, and shale extending from the Georgia-Alabama border on the south to the

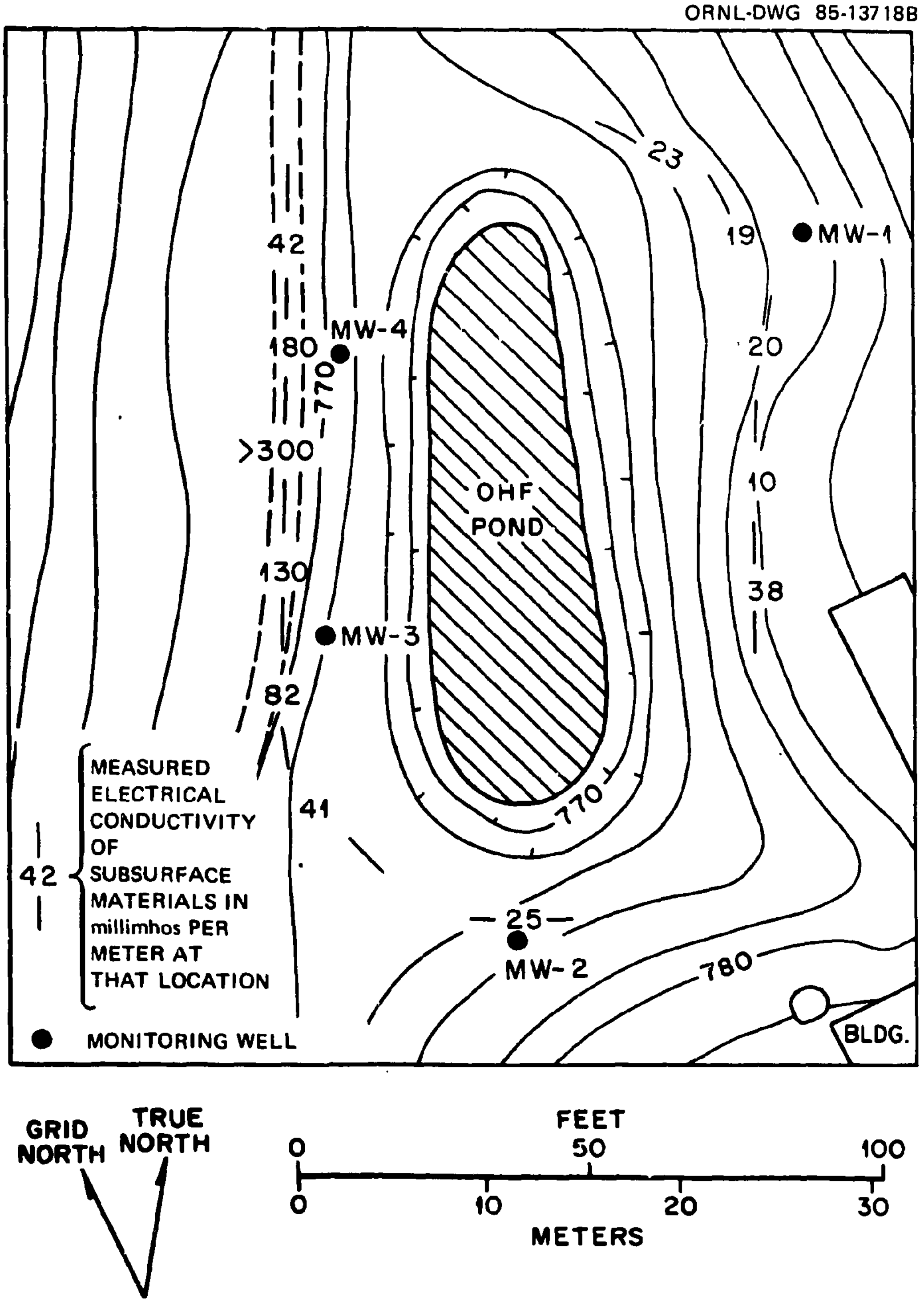

Fig. 4. Locations and measurements of electromagnetic conductivity survey.

Virginia border on the north. The strata are tilted to angles of 30° and greater throughout their length, resulting in the formation of parallel ridges by erosion-resistant beds and the formation of intervening valley floors in less resistant beds.

5.2 Site Geology

5.2.1 Bedrock

The OHF impoundment lies in Melton Valley, approximately 1200 m (4000 ft) southeast of the Copper Creek fault. As shown in Fig. 5, a geologic map, the site is underlain by unit "Ccb" of the Conasauga Group. The lithology of this unit is described by McMaster and Waller (1965) as follows:

> "Variable lithology, ranging from shale and siltstone to limestone. Limestone is characteristically pebble conglomerate or edgewise conglomerate having irregular bedding surfaces coated with thin film of dark grey clay and marked by abundant ropy 'worm trails'.
>
> "Limestone occurs in zones of shale and siltstone. Siltstone in this unit is commonly calcareous and white or light grey when fresh. Shale is thinly bedded, colored brown, olive, and tan, and locally maroon. In places the unit is deformed by very small, sharp folds and faults of small displacement."

They described the residual material as follows:

> "Unit weathers to a bedded shale appearance, leaving little or no indication of original calcareous nature. Limestone weathers to porous brown siltstone or to a light orange-yellow illitic clay. Residuum is generally light tan to yellow-brown but local variations include maroon and green bands. Black manganese oxide stains common on joint surfaces."

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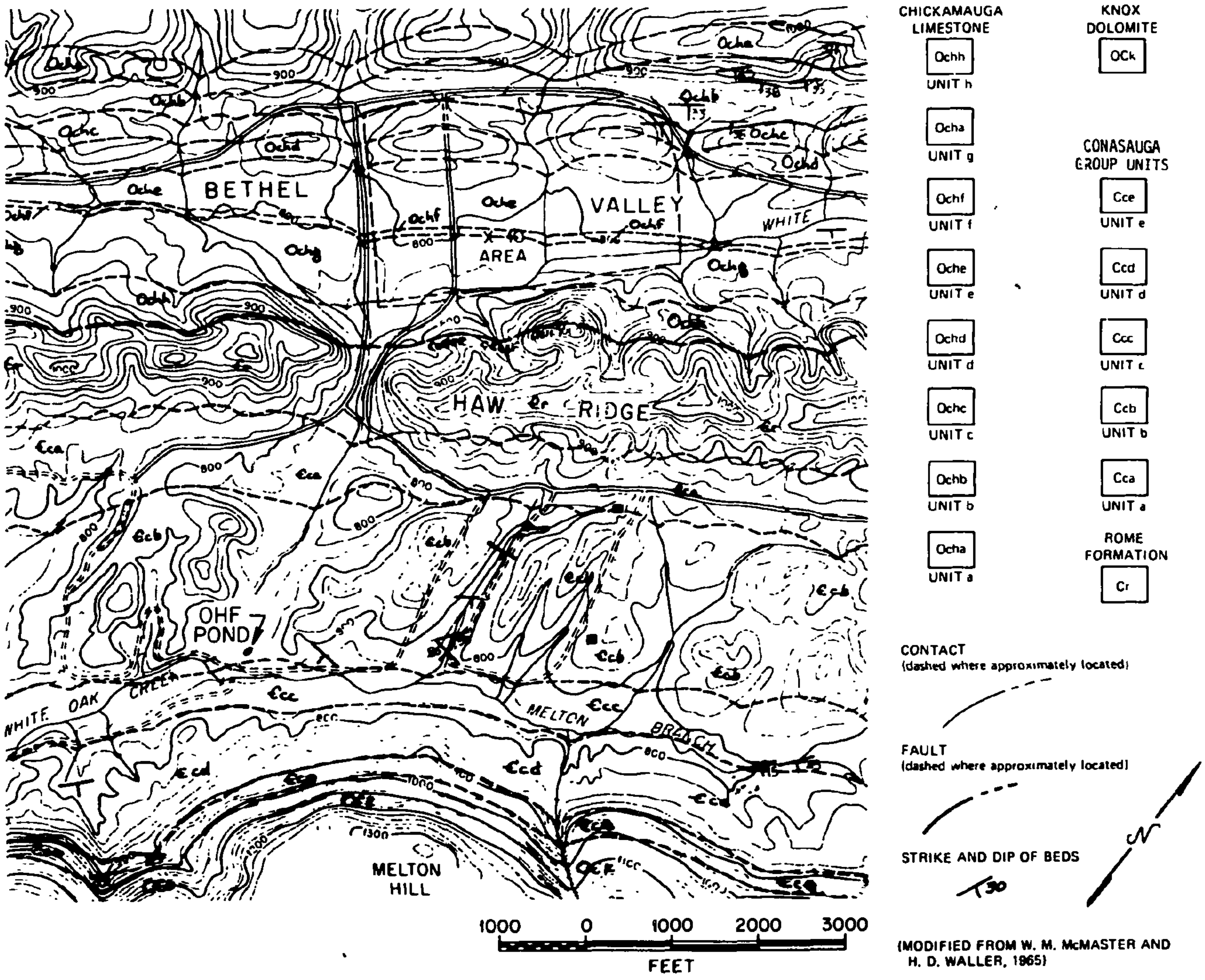

(MODIFIED FROM W. M. McMASTER AND H. D. WALLER, 1965)

Fig. 5. Geologic map of the ORNL area, including the Old Hydrofracture Facility impoundment.

The log records of the borings (Appendix I) for the monitoring wells indicate that the subsurface materials encountered are encompassed by the above descriptions.

The OHF impoundment was constructed in the upper beds of the Ccb unit as mapped by McMaster and Waller (1965). From later work in the area by others (Haase, Zucker, and Stow 1985; Davis et al. 1984; and Rothschild et al. 1984), the upper beds of this mapped unit can be correlated with the upper portion of the Maryville Limestone Formation of the Conasauga Group. Davis and Stansfield (1984) reported on the excavation and construction for a French drain in the Maryville Formation at Solid Waste Storage Area (SWSA) 6, approximately 1200 m (4000 ft) southwest of the OHF site and along the same geologic strike. They found that the attitudes of the beds vary locally from horizontal to dipping to the southeast as steep as 60° due to folding of the strata. They also found two near-vertical joint sets in the weathered rock. Slides into that excavation, along bedding planes, indicate that either a third joint system or bedding plane faults existed along those surfaces. Both vertical joint systems were very closely spaced (approximately 1 cm) in the weathered rock. At the location that was subsequently the site of the OHF facility, Cowser et al. (1961) mapped the bedrock strata as striking approximately north 43° east, and dipping 15° to the southeast.

A geologic section through the impoundment is shown in Fig. 6. The elevations of the sediment and bottom of the impoundment, as shown in the figure, are based on probings obtained for this study.

5.2.2 Soil

The soil depth [illegible]d the impoundment ranges from approximately 1.5 to 2.7 m (5 to 9 ft). As indicated by the boring records in Appendix I, the soil consists of material that would classify as clay under the Unified Soil Classification System. This clay soil overburden is the residuum of the underlying bedrock. Soils derived from the Conasauga Group contain illite and vermiculite as the predominate clay minerals.

6. HYDROLOGY

From 1948 through 1983, the mean annual precipitation at Oak Ridge was 138.71 cm (54.61 in.). In this region, the heaviest precipitation normally occurs during winter and early spring, with the monthly maximum normally occurring during the period January to March. However, during some years the monthly maximum has occurred in July, because of thunderstorms. September and October are usually the driest months. Mean annual lake evaporation in the Oak Ridge area is 88.9 cm (33 in.).

From the above data, it can be estimated that the net annual precipitation input to the OHF pond is 56 cm (22 in.). Multiplying this amount by the surface area of the impoundment yields an average yearly retained precipitation contribution of approximately 140,000 L (37,000 gal). In late summer of 1985, the water surface of the pond was measured at elevation 234.2 m (768.4 ft) above msl. At this elevation, the capacity of the pond is approximately 300,000 L (77,000 gal). Therefore, the average net annual precipitation input

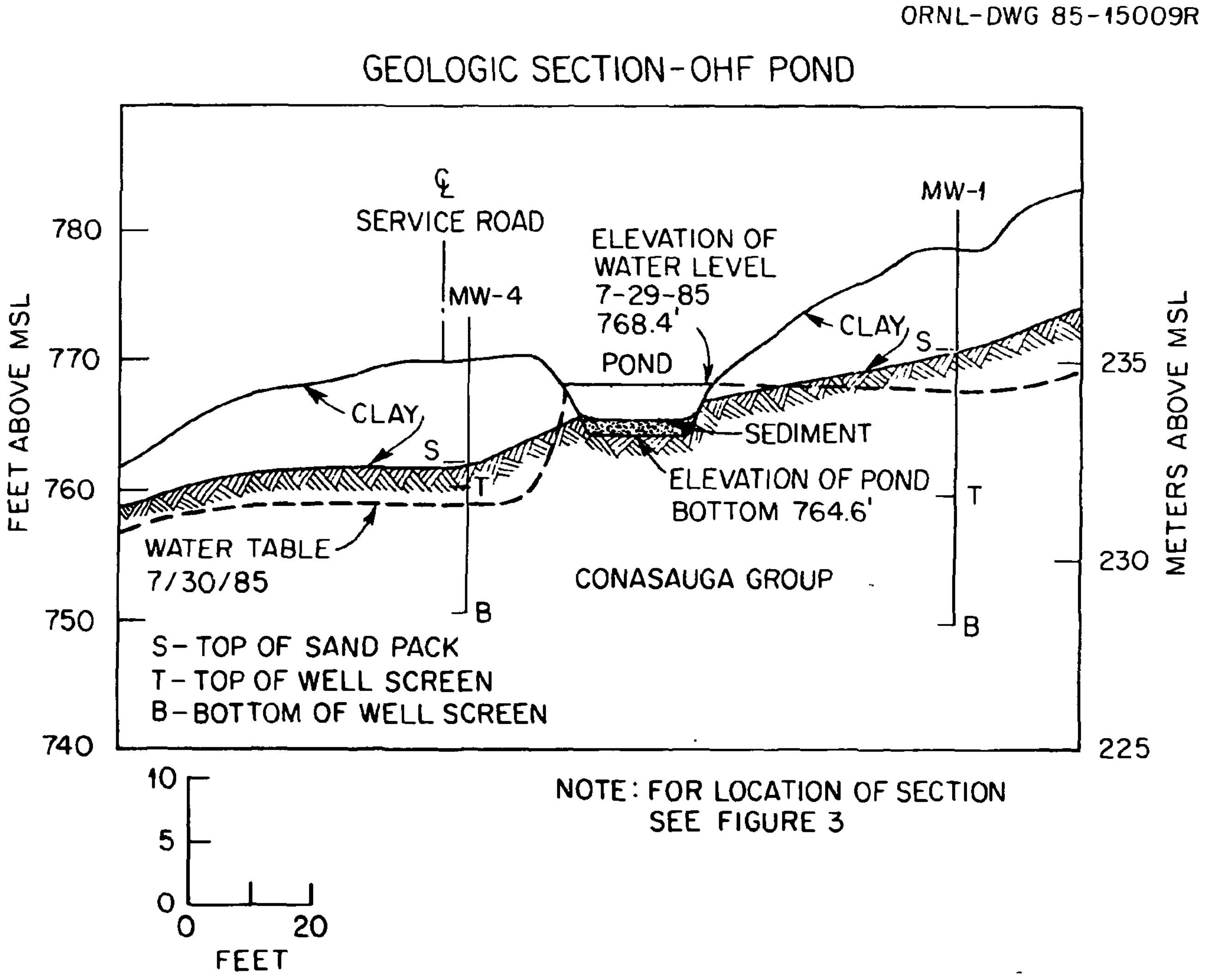

Fig. 6. Geologic section through the Old Hydrofracture Facility impoundment.

amounts to slightly less than one-half the capacity of the pond at this level. The only design outflow system appears to be by the vertical standpipe, and this overflow system would not come into operation until slightly below the elevation at which overflow of the west wall of the impoundment would occur. As there have been no withdrawals of water from the pond since operation of the facility ceased, it therefore appears that the net annual precipitation of approximately 140,00 L (37,000 gal) (minus water evaporated from the pond surface) is leaking from the pond and entering the groundwater.

6.1 Groundwater Movement

Two water-table maps are shown in Figs. 7 and 8. The map in Fig. 7 is from a report by Cowser et al. (1961) and depicts the water table for SWSA 5 prior to the construction of the OHF impoundment on the western border of the area. Figure 8 is based on water level observations from the four monitoring wells constructed during this study and is limited to the immediate site of the OHF impoundment. Water level observations upon which Fig. 8 is based are provided in Table 5. Both Figs. 7 and 8 show the hydraulic gradient at the impoundment to be generally towards White Oak Creek, which is also the general direction of geologic strike of the bedrock strata. At the impoundment, as shown in Fig. 8, the gradient also has a component in the direction of Melton Branch which is in the general direction of the geologic dip of the bedrock strata.

As shown in the geologic section (Fig. 6) through the pond and the site water-table map (Fig. 8), the water table is below the bottom of

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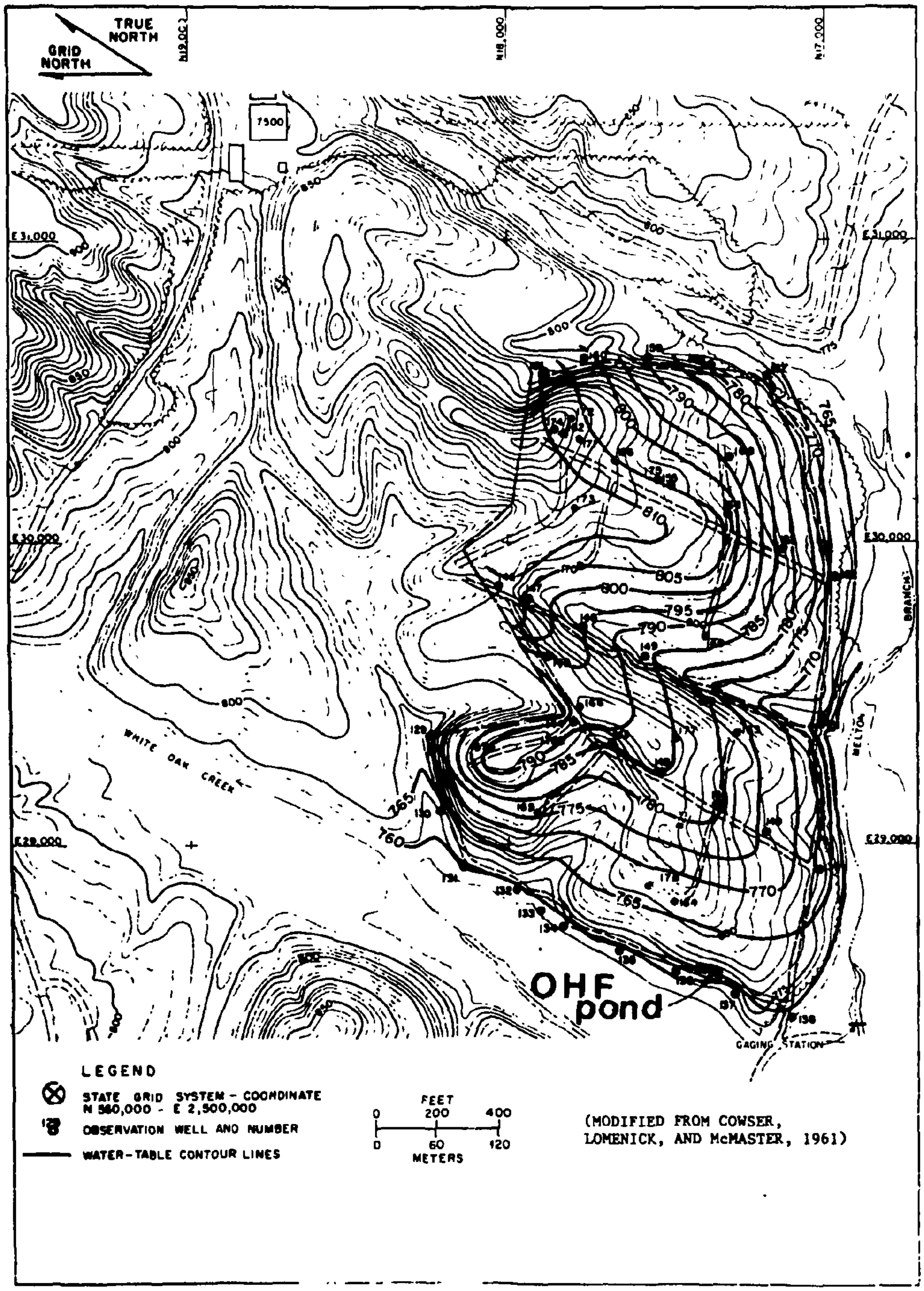

Fig. 7. Water-table map of SWSA 5, including the Old Hydrofracture Facility site.

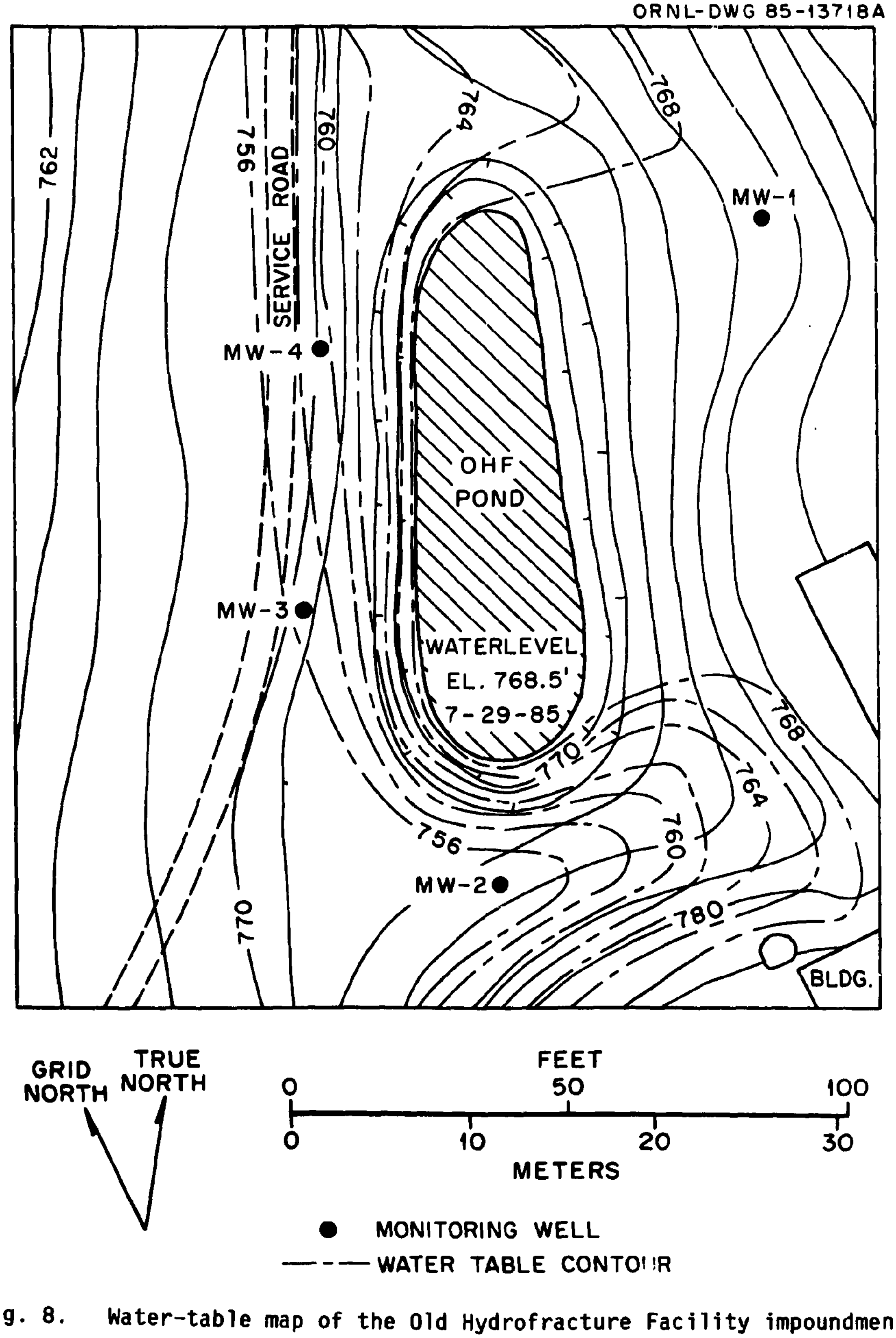

Fig. 8. Water-table map of the Old Hydrofracture Facility impoundment.

the impoundment on the downgradient (west and south) sides. The water level on the upgradient side is several feet above the bottom of the pond. In the summer of 1985, the water surface of the pond was approximately at the same elevation as the upgradient monitoring well.

Studies on the ORNL reservation (Webster 1976; Davis et al. 1984) result in the observation that in the bedrock, the direction of groundwater movement is greatly affected by the directional permeability of the strata. Therefore, the overall groundwater movement through the bedrock is often in a direction at some acute angle to the groundwater contours. Such movement would not normally be expected to be in a straight line of flow, but rather would follow irregular pathways, such as along joints and bedding planes, because the bedrock strata has insignificant primary permeability. Therefore, a particular groundwater pathway could extend a distance southwestward (direction of geologic strike) in the form of a bedding plane joint before intersecting another fracture heading in a steeper downgradient direction.

6.2 Uppermost Aquifer

The soil at the impoundment consists of material that has been visually classified as clay (according to the Unified Soils Classification System), which categorically has low hydraulic conductivities. However, as shown in Fig. 6, the water table is below the soil, except at the edge of the pond. Therefore, the uppermost aquifer at the site is the "Ccb" unit (probably the Maryville Limestone Formation). Davis et al. (1984) conducted hydraulic conductivity tests in 36 monitoring wells in the Maryville Limestone. Conductivities ranged from 1×10^{-5} to 238×10^{-5} cm/s with a geometrical mean of 6.31×10^{-5} cm/s, and the effective porosity was estimated to be 0.03. These aquifer characteristics are believed to be representative of the OHF site.

6.3 Groundwater Sampling Methods

Water levels were measured with an electric tape prior to purging and sampling each well, and the immersed portion of the tape was rinsed with distilled water between wells. The wells were purged and sampled with bottom-loading stainless steel bailers that were disassembled for thorough cleaning before use. The bailers were washed with hot water and detergent, and rinsed with distilled water. In addition, during the first round of sampling, the bailers were also rinsed with dilute nitric acid followed by distilled water. During the second round, to avoid rusting of the steel, the dilute acid rinse was replaced with alcohol. A new nylon line was attached to the bailer for each well.

Prior to taking a sample, the well was purged by removing a volume of water equal to three times the volume contained within the well screen and casing. This amounted to a volume of 13.7 L/m (1.1 gal/ft) of water depth in the well. The water removed for purging purposes was measured in 19-L (5-gal) containers and discarded into the impoundment.

Specific conductivity and pH were measured at the well site at the time of sampling.

6.4. Sample Collection and Preservation

Groundwater samples to be analyzed by the Analytical Chemistry Division (ACD) were poured directly from the stainless-steel bailer into new 0.95-L (1-qt) glass, containers (previously rinsed with distilled water) having caps with Teflon liners. Four such samples were collected from each well during March and May, and two of the samples from each were acidified with nitric acid to a pH of 2. These samples were either delivered to the Analytical Chemistry Division within an hour after collection, where they were refrigerated, or were stored overnight in a refrigerator for next-day delivery to Analytical Chemistry. In addition, in March and May, 1-L samples were collected from each well and placed in plastic containers for gamma radiation analysis by the Environmental Sciences Division's Low-Level Gamma-Ray Spectrometry Laboratory, using a high-resolution lithium-drifted germanium [Ge(Li)] detector. These samples required no preservation.

6.5 Chain of Custody

A record that was completed for all samples collected contains the following information: name of collector, identifying list of samples, date and location where collected, inclusive dates during which samples were in the collector's custody, and the date that samples were transferred to the laboratory for analyses. A copy of this record accompanied the samples to the laboratory.

6.6 Selection of Constituents for Analysis in Groundwater

The principal goal in analyzing the groundwater was to determine whether it had been contaminated. To do this, the groundwater was analyzed for those 30 constituents promulgated under RCRA regulations as shown in Table 6. For active hazardous waste facilities (those that receive hazardous waste after November 19, 1980), RCRA regulations require that each groundwater monitoring well be sampled and analyzed for these constituents at least four times during the first year to ascertain any seasonal variations in groundwater quality. Sampling for this report was conducted in March and May 1985.

In addition to those 30 constituents listed in Table 6, groundwater samples were analyzed by ICP spectroscopy. This technique provides general information on concentrations of nearly 30 elements in one analysis. Many of these are not RCRA regulatory elements, but their concentrations in groundwater are useful in evaluating general groundwater quality. For instance, the concentrations of Cu, Ni, and Zn were determined in groundwater samples using this technique. These elements are included in the list of compounds and elements listed in the recently issued "Hazardous Substance Guidelines" by the State of Tennessee (Gregory 1985). Groundwater samples were also analyzed for PCBs and the radioisotopes ^{90}Sr, ^{137}Cs, and tritium.

6.7 Chemical Methods Used for Analysis of Groundwater

The methods used to analyze groundwater are those described in USEPA (1982 and 1983b). For elemental concentrations of the NIPDWS, it was necessary to use atomic absorption methods to reach the required

Table 6. RCRA-40 CFR 265.92-groundwater monitoring parameters

EPA Interim Primary Drinking Water Standards	
Parameter	Maximum level (mg/L)
Arsenic	0.05
Barium	1.0
Cadmium	0.01
Chromium	0.05
Fluoride	1.4--2.4
Lead	0.05
Mercury	0.002
Nitrate (as N)	10.0
Selenium	0.01
Silver	0.05
Endrin	0.0002
Lindane	0.004
Methoxychlor	0.1
Toxaphene	0.005
2,4-D	0.1
2,4,5-TP Silvex	0.01
Radium	5 pci/L
Gross alpha	15 pci/L
Gross beta	4 millirem/year
Coliform bacteria	1/100 mL
Parameters establishing groundwater quality	
Chloride	
Iron	
Manganese	
Phenols	
sodium	
Sulfate	
Parameters used as indicators of groundwater contamination	
pH	
Specific conductance	
Total organic carbon	
Total organic halogen	

detection levels. The recommended USEPA methods are 7061, 7081, 7131, 7191, 7421, 7470, 7741, and 7761 (USEPA 1982) for As, Ba, Cd, Cr, Pb, Hg, Se, and Ag, respectively. As mentioned above, ICP spectroscopy, method 200.7 (USEPA 1983b) was also used to determine concentrations of nonregulatory elements. The concentrations of pesticides, herbicides, and PCBs in the groundwater, were determined by method 8080 (USEPA 1982), except that the analyses were by liquid chromatography instead of gas chromatography. The total toxic organics (TTO) were determined using method 624 (USEPA 1983b) or pentane extraction for the volatile organic compounds and method 1625 (USEPA 1982) for the semi-volatile compounds. Coliform bacteria were determined by method 405.1 (USEPA 1983b). Concentrations of fluoride, chloride, nitrate, and sulfate were determined in pond water using methods 340.2 and 300.0 (USEPA 1983b). Phenol concentration was determined by method 420.1 (USEPA 1983b). Total organic carbon (TOC) and total organic halides (TOX) were determined in the pond water using methods 9060 and 9020, respectively (USEPA 1982). The radionuclide concentrations were determined as described for the radionuclide analyses of the pond water.

6.8 Results and Discussion of Chemical and Radioactivity Analyses of Groundwater

Groundwater concentrations measured in the four monitoring wells in March and May are presented in Tables 9A and 10A of Appendix III. Those constituents presented in Table 9A are those regulated by RCRA (principally those listed in the NIPDWS), those that have been determined to be parameters establishing groundwater quality, (Fe, Mn, Na, chloride, phenols, and sulfate), and those which USEPA has determined to be indicators of groundwater contamination (pH, specific conductance, total organic carbon, and total organic halogens). Also included in Table 9A are the concentrations of PCBs, the beta-emitting radionuclides tritium and ^{90}Sr, and the gamma-emitters ^{137}Cs and ^{60}Co. Listed in Table 10A are the concentrations of elements determined in groundwater samples by ICP spectroscopy.

Table 7 is a summary of measured concentrations of constituents of all analyses from all downgradient wells listed in Table 9A. As can be seen in Tables 7 and 9A, the maximum permitted level for beta-emitting radionuclides is presented as a dose rate of 4 millirems per year. However, the gross beta concentrations in Table 7 and 9A are presented in the commonly accepted manner as activity units (Bq/L). EPA specifies that the dose rate for drinking water be calculated as the total body or organ dose that a person would receive by drinking 1-L of the water daily for 1 year (USEPA 1976). According to EPA (1976), the activities, in water, of the beta emitters tritium and ^{90}Sr that result in a dose rate of 4 millirems/yr are 740 Bq/L (20,000 pCi/L) and 0.3 Bq/L (8 pCi/L), respectively.

Major contaminants in groundwater at the OHF impoundment appear to be radionuclides, e.g., gross alpha and gross beta concentrations exceed NIPDWS concentrations in upgradient as well as downgradient wells. Other than the concentrations of Ba, Cr, and Pb in monitoring well 3 sampled in March, all other samplings, in both the upgradient and downgradient wells, revealed that the concentrations of metals, herbicides, and pesticides were below NIPDWS maximum allowable limits.

Table 7. Concentration of selected groundwater parameters[a]

Constituent	Unit	Maximum allowable concentration	Mean	Measured concentration			CV
				N	Min	Max	
Silver	mg/l	0.05	0.0700	6	0.0700	0.0700	0.0
Aresenic	mg/l	0.05	0.0017	6	0.0010	0.0020	31.0
Barium	mg/l	1.0	0.3907	6	0.0660	1.0900	94.7
Cadmium	mg/l	0.01	0.0037	6	0.0010	0.0100	98.6
Chloride	mg/l	ND[b]	14.6667	3	8.0000	19.0000	40.0
Coliform	Co/100/ml	1/100/mL	12.7000	6	0.0000	48.0000	147.7
Chromium	mg/l	0.05	0.0456	6	0.0200	0.0797	47.3
Endrin	mg/l	0.0002	0.0001	5	0.0001	0.0001	0.0
Fluoride	mg/l	1.4 --2.4	1.0000	6	1.0000	1.0000	0.0
Iron	mg/l	ND	12.1117	6	0.2900	57.9000	185.5
Gross[a]	Bq/L	0.556	3.00783	6	0.3100	11.0000	129.6
Gross[b]	Bq/L	4mrem/year	381.9667	6	1.7000	1300.0000	134.5
Mercury	mg/l	0.002	0.0001	6	0.0000	0.0001	7.9
Lindane	mg/l	0.004	0.0001	6	0.0001	0.0001	0.0
Methoxychlorf	mg/l	0.1	0.0002	6	0.0002	0.0002	0.0
Manganese	mg/l	ND	2.3755	6	0.5630	8.8500	134.2
Nitrate-N	mg/l	10.0	3.8333	6	1.0000	8.0000	68.9
sodium	mg/l	ND	22.8667	6	13.8000	37.3000	48.7
Lead	mg/l	0.05	0.0267	6	0.0020	0.0800	102.2
PCB	mg/l	ND	0.0001	3	0.0001	0.0002	26.4
pH	pH	ND	6.4933	15	6.1700	6.9000	4.4

Table 7. (continued)

Constituent	Unit	Maximum allowable concentration	Mean	Measured concentration N	Min	Max	CV
Phenol	mg/l	ND	0.0010	6	0.0010	0.0010	0.0
^{226}Ra	B/L	0.19	0.1042	6	0.0070	0.2000	100.8
Selenium	mg/l	0.01	0.0023	6	0.0010	0.0050	70.0
Sulfate	mg/l	ND	17.0000	6	12.0000	24.0000	29.5
Sp. Cond.[c]	µMHOS/M	ND	376.4667	15	158.0000	755.0000	58.9
TOC[d]	mg/l	ND	6.3747	15	2.1800	8.4000	28.1
TOX[e]	mg/l	ND	0.0308	6	0.0090	0.0490	42.6
Toxaphene	mg/l	ND	0.0020	6	0.0020	0.0020	0.0
Tritium	Bq/L	ND	94333.3333	3	33000.0000	190000.0000	89.0
^{137}Cs	Bq/Filter Bq/L	ND ND	0.2615 1.7091	3 5	0.0000 0.7180	0.5848 3.6269	113.6 72.3
2,4-D	mg/l	0.1	0.0050	6	0.0050	0.0050	0.0
2,4,5-TP	mg/l	0.01	0.0050	6	0.0050	0.0050	0.0
^{60}Co	Bq/L	ND	2.9541	5	0.5736	6.5877	76.9
^{90}Sr	Bq/L	ND	223.4033	3	0.2100	420.0000	94.5

[a] From downgradient wells at the OHF pond; summary across all sampling sites.
[b] Not defined.
[c] Specific conductance.
[d] Total organic carbon.
[e] Total organic halogen.

The concentrations of 1.09, 0.0797, and 0.080 for Ba, Cr, and Pb, respectively, in monitoring well 3 in May, possibly represent a contaminated sample. This seems to be likely, as the mean concentrations across all sampling dates in the downgradient wells are 0.3907, 0.0456, and 0.0267, respectively, for Ba, Cr, and Pb (see Table 7), which are all below NIPDWS maximum allowable limits. Counts of coliform bacteria in groundwater, upgradient as well as downgradient, were in excess of the NIPDWS. These counts may result from wildlife inhabitants such as waterfowl and terrestrial animals known to be in the area. These also may represent sampling and analytical variations. Additional monitoring will indicate a trend over time. The concentrations of total organic carbon (TOC), total organic halides (TOX), and PCBs in groundwater samples appear to be relatively constant regardless of the monitoring well sampled, upgradient or downgradient from the CHF impoundment. To date, it appears that the groundwater is contaminated by radionuclides and PCBs, as both are detected in the upgradient well; however, greater concentrations have been measured in downgradient wells, particularly in monitoring well 4.

7. IMPOUNDMENT CLOSURE

7.1 Current Concept for Pond Closure

The current technical plan for closure of the impoundment is summarized by Myrick (1984) as follows: "...The pond would be stabilized in place by solidifying the residual sediment and sludge on the pond bottom and consolidating the remaining pond structures (riprap and equipment) into a fixed form. The overall site grade around the entombed structures would be made consistent with the lay of the land and the burial ground requirements. Any underground piping would be left in place, but grouted to restrict water transfer."

7.2 Characterization Results to be Considered

As previously discussed, analyses of the sediment have determined that, in addition to being radioactive, the sediment has concentrations of PCBs ranging from 1 to 7 mg/kg. Therefore, any closure concept may be required to comply with regulations of the EPA in addition to those of the Nuclear Regulatory Commission (10 CFR 20 or 10 CFR 61). The impoundment closure date has not yet been scheduled. However, EPA requirements at the time of closure may be adverse to in situ solidification for final disposition of PCBs.

The vertical overflow pipe at the north end of the pond may not to be rigidly founded at its base. This observation is based on the fact that, during the sampling of the pond sediment, the operator of the boat felt movement in the standpipe under moderate hand pressure. As discussed earlier in this report, the construction drawings indicate that the standpipe is attached to a horizontal drainpipe that exits about 50 ft (15 m) west of the north end of the pond. The exit end of this pipeline, as shown in the drawings, is no longer visible in the field. However, a Geiger-Mueller (G/M) survey of that area measured an activity of up to 7000 counts per minute within 10 cm (4 in) of the ground surface. It would seem that the most likely cause of this activity would be leakage of pond water either through the pipeline or through the material backfilled around the pipeline.

The elevation of the bottom of the pond is below the elevation of the groundwater table on the east (upgradient side) and above it on the west (downgradient side). Therefore, it will be hydrologically possible to isolate the solidified waste from contact with the groundwater by the construction of either a French drain or a slurry trench. Both of these techniques require that a trench be excavated to an elevation below the depth of the impoundment on the upgradient side and extend around the pond to the downgradient side. A review of the logs of borings for the monitoring wells (Appendix I) indicates that interbedded shale and limestone would be encountered at depth. If the trench could not be excavated to the proper depth, due to hard rock, curtain grouting would be necessary to reduce the hydraulic conductivity in the rock below a slurry trench or French drain. Additional exploratory corings in the rock will be necessary to determine whether an excavation can be made to an elevation below the bottom of the pond.

The current closure concept indicates that the impoundment site may be graded to the surrounding topography during the closure operation. This would require that soil fill be placed over the present site of the pond, and it is anticipated that this fill placement may cause the groundwater table to rise above its current position at the site (as described earlier and can be seen in Fig. 3, the impoundment was excavated in a valley wall). Therefore, of the two groundwater isolation methods, the French drain would seem to have the greatest isolation potential. The reason for this is that the drain would not allow the groundwater table on its downgradient side to rise above the bottom of the drain (due to the long, narrow geometry of the site to be isolated).

In the current closure plan, underground pipelines are to be grouted and left in place. Portions of the two influent lines to the OHF impoundment are below the groundwater table. Therefore, it would be appropriate to test or inspect the lines to determine that they are open so that they can accept the grout for their full length.

8. ADDITIONAL DATA NEEDS

8.1 Groundwater Sampling of Existing Wells

Monitoring wells at the OHF impoundment will be sampled at least twice more, so that four quarters of data on RCRA-regulated constituents (see Table 6) will be available. For impoundments active after November 19, 1980, RCRA regulations require that, at the end of the first year of sampling, statistical analyses be performed on the data from the four quarters to determine whether the groundwater is polluted by the impoundment. Pollution is assumed if the analysis (Cochran's Approximation to the Behrens-Fisher Student's t test) indicates a significant increase (decrease in the case of pH) in the water quality parameters listed in Table 6 between the upgradient and downgradient wells. This procedure for determining pollution will be considered for the OHF impoundment after four quarters of sampling and analyses have been completed.

8.2 Potential Subsurface Exploration

The possibility of seepage from the pond having occurred in the subsurface, along the 20-cm (8-in.) drain line, needs to be investigated. The investigation, or remedial action if found necessary, should assure that uncontrolled outflow from the pond through the drain cannot occur.

In addition, if the results of continued sampling confirm that the OHF impoundment has significantly contaminated the groundwater, additional monitoring wells will be considered for construction in the appropriate areas to determine the extent and contaminant concentrations of the plume.

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APPENDIX I

Drilling Logs of Borings, MW-1 through MW-4

Hole No. MW-1

DRILLING LOG	DIVISION Environmental Sciences	INSTALLATION Oak Ridge National Laboratory	SHEET 1 OF 2 SHEETS

1. PROJECT SFMP-OHF Pond	10. SIZE AND TYPE OF BIT 8" Auger
2. LOCATION *(Coordinates or Station)* N17325.24; E28600.30	11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)* MSL
3. DRILLING AGENCY Plant & Equipment Division	12. MANUFACTURER'S DESIGNATION OF DRILL Mobile B-33
4. HOLE NO. *(As shown on drawing title and file number)* MW-1	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED 4 Jars — UNDISTURBED
5. NAME OF DRILLER P. E. Moore	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.	15. ELEVATION GROUND WATER
	16. DATE HOLE — STARTED 3/7/85 — COMPLETED 3/8/85
7. THICKNESS OF OVERBURDEN 8.5'	17. ELEVATION TOP OF HOLE 779.3'
8. DEPTH DRILLED INTO ROCK 25.5'	18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE 34.0'	19. SIGNATURE OF INSPECTOR R. G. Stansfield

ELEVATION (ft)	DEPTH (ft)	LEGEND	CLASSIFICATION OF MATERIALS *(Description)* Visual classification only	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS *(Drilling time, water loss, depth of weathering, etc., if significant)*
779.3	0		CLAY (CL) medium, moist, brown with shale fragments	A U G E R E D		Installed CME sampler at 5.0' depth. Samples and drill cuttings checked with G/M meter; no measurement above background. CME sampler removed at 11.7' as unable to advance through limestone bed. Note: Classification of rock type encountered below depth of 11.7' is based on action of drill machine and drill cuttings brought to surface by augers.
	1					
	2				2.5' Jar 1	
	3					
	4				5.0'	
	5			5.0'	Jar 2	
	6					
	7			100%	Jar 3	
	8		8.5'			
770.8	9		SHALE weathered, brown, structure, visible, plat			
	10			10.0' 100%	10.0' Jar 4	
	11		11.7'	11.7'	11.7'	
767.6	12		LIMESTONE, hard 12.0'			
	13					
	14					
	15				N O S A M P L E	
	16					
762.3	17		17.0' LIMESTONE			
	18					
	19					
	20					

PROJECT | HOLE NO. MW-1

Hole No. MW-1

DRILLING LOG	DIVISION Environmental Sciences	INSTALLATION Oak Ridge National Laboratory	SHEET 2 OF 2 SHEETS

1. PROJECT SFMP-OHF Pond	10. SIZE AND TYPE OF BIT
2. LOCATION *(Coordinates or Station)*	11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)*
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. *(As shown on drawing title and file number)* MW-1	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.	15. ELEVATION GROUND WATER
	16. DATE HOLE — STARTED — COMPLETED
7. THICKNESS OF OVERBURDEN	17. ELEVATION TOP OF HOLE
8. DEPTH DRILLED INTO ROCK	18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE	19. SIGNATURE OF INSPECTOR

ELEVATION (ft)	DEPTH (ft)	LEGEND	CLASSIFICATION OF MATERIALS *(Description)* Visual classification only	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS *(Drilling time, water loss, depth of weathering, etc., if significant)*
758.8	20		LIMESTONE 20.5'			
	21		SHALE 21.0' LIMESTONE 21.2' SHALE			
	22				NO SAMPLE	
756.3	23		23.0' LIMESTONE			
	24					
754.8	25		24.5' SHALE			
753.3	26		26.0' LIMESTONE			
	27					
	28					
750.7	29		28.6' SHALE			
	30					
	31		LIMESTONE 30.4' SHALE 30.6'			
	32					
	33		33.6' LIMESTONE 34.0'			Upon removal of augers from hole at completion, drill cuttings were found to fill the hole to a depth of 18.0'. Cuttings were washed from hole with clear water prior to installation of well screen.
745.3	34		Bottom of hole			

PROJECT

HOLE NO. MW-1

Hole No. MW-2

DRILLING LOG	DIVISION Environmental Sciences	INSTALLATION Oak Ridge National Laboratory	SHEET 1 OF 2 SHEETS
1. PROJECT SEMP-OHF Pond		10. SIZE AND TYPE OF BIT	8" Auger
2. LOCATION (Coordinates or Station) N17236.06; E28504.80		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY Plant & Equipment Division		12. MANUFACTURER'S DESIGNATION OF DRILL Mobile B-24	
4. HOLE NO. (As shown on drawing title and file number)	MW-2	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 6 Jars UNDISTURBED
5. NAME OF DRILLER P. E. Moore		14. TOTAL NUMBER CORE BOXES	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ________ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
		16. DATE HOLE	STARTED 3/8/85 COMPLETED 3/11/85
7. THICKNESS OF OVERBURDEN	5.4'	17. ELEVATION TOP OF HOLE	774.2'
8. DEPTH DRILLED INTO ROCK	19.6'	18. TOTAL CORE RECOVERY FOR BORING	%
9. TOTAL DEPTH OF HOLE	25.0'	19. SIGNATURE OF INSPECTOR R. G. Stansfield	

ELEVATION (ft) a	DEPTH (ft) b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) Visual classification only d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
774.2	0		CLAY medium, moist, brown			Samples and drill cuttings checked with G/M meter; no measurement above background.
	1					
	2				2.5' Jar 1	CME sampler installed at depth of 5.0'.
	3					
	4					
	5		5.4'	5.0'	5.0' Jar 2	
768.8	6		SHALE AND SILTSTONE highly weathered, platy very soft, tan, brown with black staining			
	7			90%	Jar 3	
	8					
	9					
	10			10.0'	10.0'	
	11					
	12			90%	Jar 4	
	13					
	14		Purple and gray siltstone lenses at 14.0' to 15.0' depth to 1/2" thick	15.0'	15.0'	
	15					
	16			90%	Jar 5	
	17					
	18					
	19		Purple and gray siltstone beds to 1" thick from 18.5' to 20.0'			
754.2	20			20.0'	20.0'	

PROJECT

HOLE NO. MW-2

Hole No. MW-2

DRILLING LOG	DIVISION Environmental Sciences	INSTALLATION Oak Ridge National Laboratory	SHEET 2 OF 2 SHEETS

1. PROJECT SFMP-OHF Pond	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number) MW-2	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN | DISTURBED | UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.	15. ELEVATION GROUND WATER
	16. DATE HOLE | STARTED | COMPLETED
7. THICKNESS OF OVERBURDEN	17. ELEVATION TOP OF HOLE
8. DEPTH DRILLED INTO ROCK	18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE	19. SIGNATURE OF INSPECTOR

ELEVATION (ft) a	DEPTH (ft) b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) Visual classification only d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
754.2	20					
	21		Purple and gray siltstone from 21.8' to 22.4'		Jar 6	
	22					
751.4			22.8'	23.0'	23.0'	CME sampler removed from auger at 23.0' as unable to advance further in shale.
	23		SHALE calcareous, gray-green, moderately hard		NO SAMPLE	
	24					Upon removal of auger, drill cuttings filled hole to 19.0' depth. Drill cuttings were washed from hole with clear water prior to installing well screen.
			25.0'			
749.2	25		Bottom of hole			

PROJECT HOLE NO. MW-2

Hole No. MW-3

DRILLING LOG	DIVISION Environmental Sciences	INSTALLATION Oak Ridge National Laboratory	SHEET 1 OF 2 SHEETS

1. PROJECT SFMP-OHF Pond
2. LOCATION (Coordinates or Station) N17298.86; E28496.78
3. DRILLING AGENCY Plant & Equipment Division
4. HOLE NO. (As shown on drawing title and file number) MW-3
5. NAME OF DRILLER P. E. Moore
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN 4.0'
8. DEPTH DRILLED INTO ROCK 20.0'
9. TOTAL DEPTH OF HOLE 24.0'
10. SIZE AND TYPE OF BIT 8" Auger
11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL
12. MANUFACTURER'S DESIGNATION OF DRILL Mobile B-33
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN DISTURBED 5 Jars UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE STARTED 3/12/85 COMPLETED 3/12/85
17. ELEVATION TOP OF HOLE 770.6'
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR R. G. Stansfield

ELEVATION (ft)	DEPTH (ft)	LEGEND	CLASSIFICATION OF MATERIALS (Description) Visual classification only	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
770.6			LIMESTONE pieces to 6" size (Rip rap) 0.6'		0.6'	Samples and drill cuttings checked with G/M meter; no measurement above background. CME sampler installed in auger at depth of 5.0'.
	1 2 3		CLAY medium, moist, brown	A U G E R E D	Jar 1 1.0'	
766.6	4 5 6		4.0' SHALE intensely weathered, soft, greenish-gray to 8.5' depth then changes to brown color - root at 6.5'-	5.0'	5.0' Jar 2	
	7 8 9			80%	Jar 3	
	10 11		Changes from intensely weathered to highly weathered at approximately 11.0'		10.0'	
	12 13			80%	Jar 4	
	14 15 16 17 18 19				14.5'	CME sampler removed at 14.5' unable to advance in shale.
750.6	20					

Hole No. MW-3

DRILLING LOG	DIVISION Environmental Sciences	INSTALLATION Oak Ridge National Laboratory	SHEET 2 OF 2 SHEETS

1. PROJECT SFMP - OHF Pond	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number) MW-3	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN | DISTURBED | UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.	15. ELEVATION GROUND WATER
	16. DATE HOLE | STARTED | COMPLETED
7. THICKNESS OF OVERBURDEN	17. ELEVATION TOP OF HOLE
8. DEPTH DRILLED INTO ROCK	18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE	19. SIGNATURE OF INSPECTOR

ELEVATION (ft)	DEPTH (ft)	LEGEND c	CLASSIFICATION OF MATERIALS (Description) Visual classification only	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	20		SHALE weathered			Water encountered below 20.0'.
	21					
752.2	22		22.0' SHALE, CALCAREOUS gray, medium hardness			
	23				24.0	
750.2	24		24.0' Bottom of hole		Jar 5	Sample #5 from auger bit.
						Upon removal of augers, drill cuttings filled hole to 16.0' depth. Cuttings were washed from hole with clear water prior to installation of well screen.

PROJECT HOLE NO. MW-3

Hole No. MW-4

DRILLING LOG	DIVISION Environmental Sciences	INSTALLATION Oak Ridge National Laboratory	SHEET 1 OF 2 SHEETS

1. PROJECT SFMP-OHF Pond
2. LOCATION (Coordinates or Station) N17339.13; E28519.01
3. DRILLING AGENCY Plant & Equipment Division
4. HOLE NO. (As shown on drawing title and file number) MW-4
5. NAME OF DRILLER P. E. Moore
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN 9.0'
8. DEPTH DRILLED INTO ROCK 15.0'
9. TOTAL DEPTH OF HOLE 24.0'
10. SIZE AND TYPE OF BIT 8" Auger
11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL
12. MANUFACTURER'S DESIGNATION OF DRILL Mobile B-33
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN DISTURBED 7 Jars UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE STARTED 3/13/85 COMPLETED 3/13/85
17. ELEVATION TOP OF HOLE 770.6'
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR R. G. Stansfield

ELEVATION (ft)	DEPTH (ft)	LEGEND	CLASSIFICATION OF MATERIALS (Description) Visual classification only	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
770.6			CLAY (CL) medium, damp, brown		Jar 1 0.5'	Samples and drill cuttings checked with G/M meter; no measurement above background.
	1					
	2				Jar 2 2.5'	
	3					
	4					
	5		CLAY changes color to gray at 5.0'	5.0'	Jar 3 5.0'	CME sampler installed in auger at 5.0' depth.
	6					
	7		7.8'	76%	Jar 4	
761.6	8		CLAY (CL) medium, damp, light red, with weathered fragments of shale			
	9		9.0'		9.0' Jar 5	
	10		SHALE highly weathered, platy closely fractured, brown with black staining	10.0'	10.0'	
	11					
	12			85%	Jar 6	
	13					
	14					
	15			15.0'	15.0'	
	16		17.0' SHALE Platy , soft, olive gray, slightly weathered, 3/4" hard limestone lense at 17.7'	100%	Jar 7	CME sampler removed from auger at 18.1' depth as firmness of material prevented advancing it further.
753.7	17					
752.4	18		18.2' LIMESTONE	18.1'	18.1'	Note: Rock type below 18.1' classified based on action of drill and [illegible] cuttings.
	19					
	20					

PROJECT

HOLE NO. MW-4

Hole No. MW-4

DRILLING LOG	DIVISION Environmental Sciences	INSTALLATION Oak Ridge National Laboratory	SHEET 2 OF 2 SHEETS

1. PROJECT SFMP - OHF Pond	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number) MW-4	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN DISTURBED UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
	15. ELEVATION GROUND WATER
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.	16. DATE HOLE STARTED COMPLETED
7. THICKNESS OF OVERBURDEN	17. ELEVATION TOP OF HOLE
8. DEPTH DRILLED INTO ROCK	18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE	19. SIGNATURE OF INSPECTOR

ELEVATION (ft) a	DEPTH (ft) b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d Visual classification only	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
750.2	20		LIMESTONE 20.4' SHALE		N O	
	21				S A	
	22				M P	
	23				L E	
746.6	24		24.0' Bottom of hole			Upon removal of augers, drill cuttings were found to fill hole to a depth of 17.0'. Cuttings were washed from hole with clear water prior to well screen installation.

PROJECT | HOLE NO. MW-4

APPENDIX II

Groundwater Monitoring Well Reports, MW-1 through MW-4

GROUND WATER OBSERVATION WELL REPORT

PROJECT SFMP Ponds

LOCATION OHE Pond: N17325.24; E28600.38

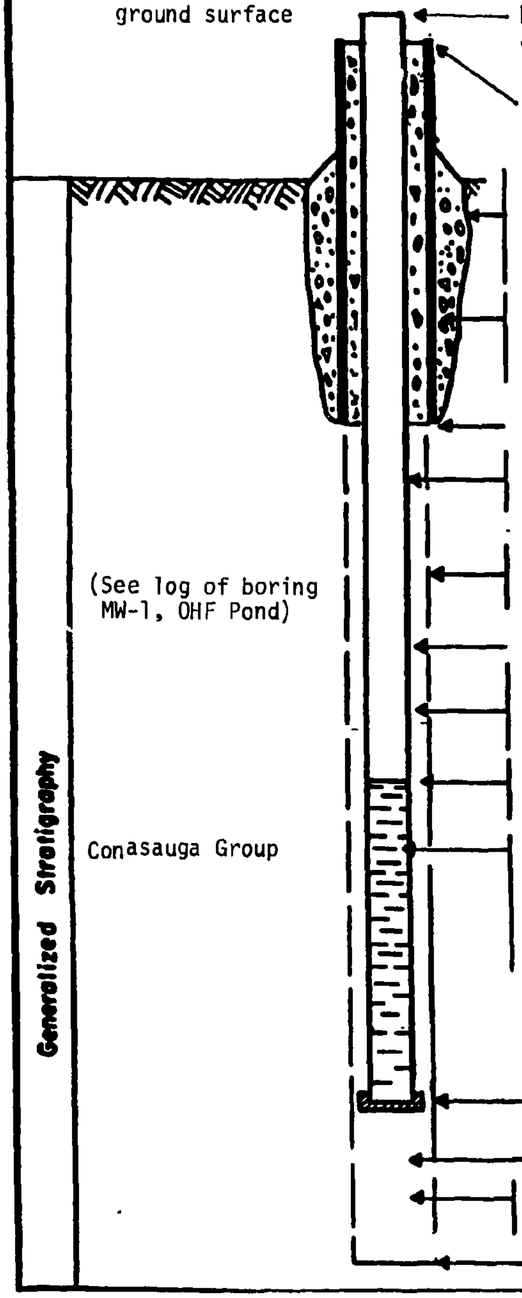
Date Completed 3/15/85 **Original Depth** 29.2' below ground surface

Elevation top of well riser pipe = 782.11'

Well No. MW-1

Aquifer Uppermost (Water table)

Note: All depths and heights are referenced to ground surface



Height of riser pipe above ground surface 2.8'

Height of top of surface casing. pipe above ground surface 2.3'

Depth of surface seal below ground surface 2.7'

Type of surface seal: Concrete

I.D. of surface casing. 4.0"

Type of surface casing: Steel

Depth of surface casing below ground 2.7'

I.D. of riser pipe. 3.0"

Type of riser pipe: Fiberglass

Diameter of borehole 8.0"

Depth of borehole 35.0'

Type of backfill: Concrete

depth top of seal. 8.0'

Type of seal: Bentonite

depth bottom of seal. 9.5'

Type of sand pack. Medium-grain silica sand & sand size drill cuttings

Depth of top of sand pack. 9.5'

depth top of screened section. 19.2'

Type of screened section: Fiberglass

Discribe openings Slotted 2 sides; 0.01" at 1" intervals

I.D. of screened section. 3.0"

depth bottom of screened section 29.2'

depth bottom of sand column. 27.0'

Type of backfill below observation pipe. In-place, sand size drill cuttings

depth of hole. 35.0'

GROUND WATER OBSERVATION WELL REPORT

PROJECT SFMP Ponds

LOCATION OHF Pond; N17236.06; E28504.80

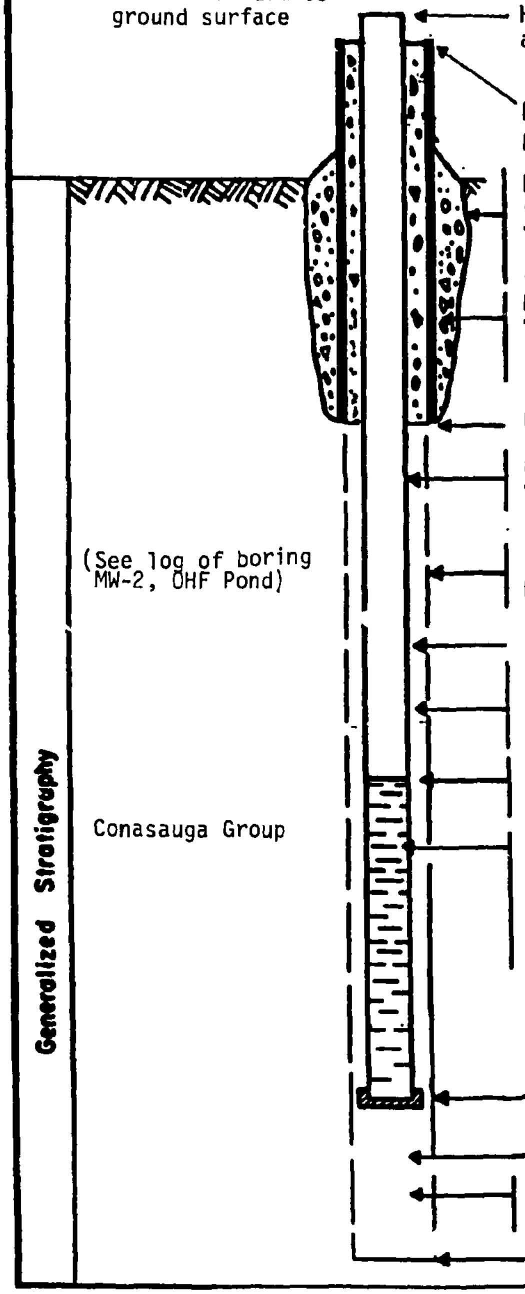
Date Completed 3/11/85 **Original Depth** 22.3' below ground surface

Elevation top of well riser pipe = 776.89'

Well No. MW-2

Aquifer Uppermost (Water table)

Note: All depths and heights are referended to ground surface



Height of riser pipe above ground surface 2.7'

Height of top of surface casing. pipe above ground surface. 2.4'

Depth of surface seal below ground surface 2.6'

Type of surface seal: Concrete

I.D. of surface casing. 4.0"

Type of surface casing: Steel

Depth of surface casing below ground 2.6'

I. D. of riser pipe: 3.0"

Type of riser pipe: Fiberglass

Diameter of borehole 8.0"

Depth of borehole 25.0'

Type of backfill: Concrete

depth top of seal. 8.0'

Type of seal: Bentonite

depth bottom of seal. 6.0'

Type of sand pack. Medium grain silica sand

Depth of top of sand pack. 6.0'

depth top of screened section. 12.3'

Type of screened section: Fiberglass

Discribe openings Slotted 2 sides; 0.01" slots at 1" intervals

I.D. of screened section. 3.0"

depth bottom of screened section 22.3'

depth bottom of sand column. 22.3'

Type of backfill below observation pipe. In-place; sand size drill cuttings

depth of hole. 25.0'

GROUND WATER OBSERVATION WELL REPORT

PROJECT SFMP Ponds

LOCATION OHF Pond: N17298.86; E28496.78

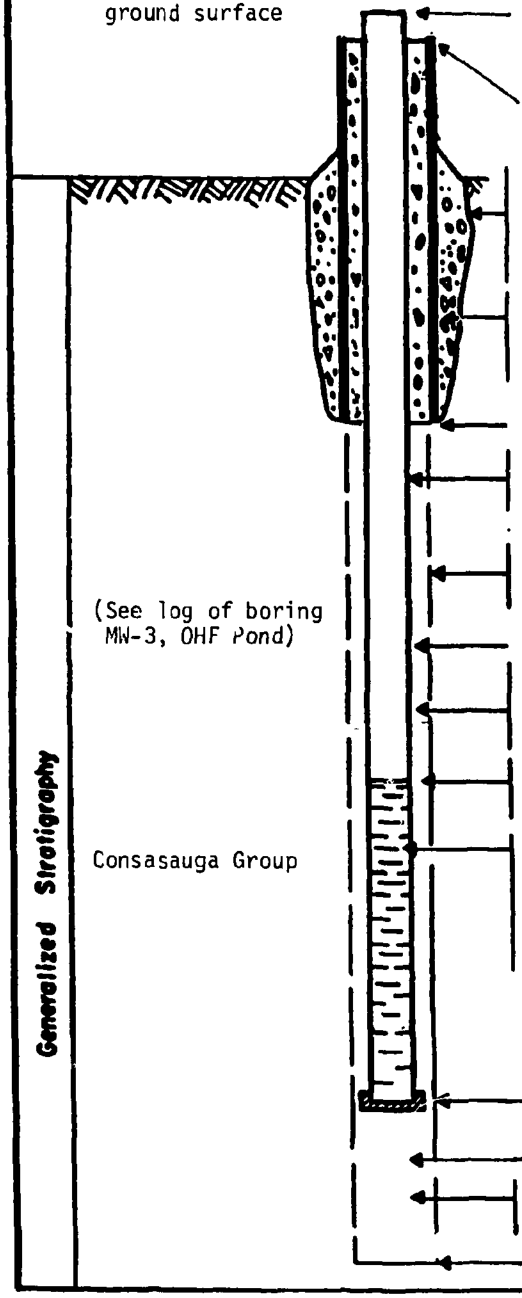
Date Completed 3/15/85 **Original Depth** 20.2' below ground surface

Elevation top of well riser pipe = 773.46'

Well No. MW-3

Aquifer Uppermost (Water table)

Note: All depths and heights are referenced to ground surface



Height of riser pipe above ground surface 2.9'

Height of top of surface casing. pipe above ground surface. 2.7'

Depth of surface seal below ground surface 4.0'

Type of surface seal: Concrete

I.D. of surface casing. 4.0"

Type of surface casing: Steel

Depth of surface casing below ground 2.3'

I.D. of riser pipe: 3.0"

Type of riser pipe: Fiberglass

Diameter of borehole 8.0"

Depth of borehole 24.0'

Type of backfill: Concrete

depth top of seal. 4.0'

Type of seal: Bentonite

depth bottom of seal. 6.0'

Type of sand pack. Medium grain silica sand

Depth of top of sand pack. 6.0'

depth top of screened section. 10.2'

Type of screened section: Fiberglass

Discribe openings Slotted 2 sides; 0.01" at 1" intervals

I.D. of screened section. 3.0'

depth bottom of screened section 20.2'

depth bottom of sand column. 19.0'

Type of backfill below observation pipe. In-place; sand size drill cuttings

depth of hole. 24.0'

GROUND WATER OBSERVATION WELL REPORT

PROJECT SFMP Ponds

LOCATION OHF Pond: N17334.13; E28519.01

Date Completed 3/15/85 **Original Depth** 20.1' below ground surface

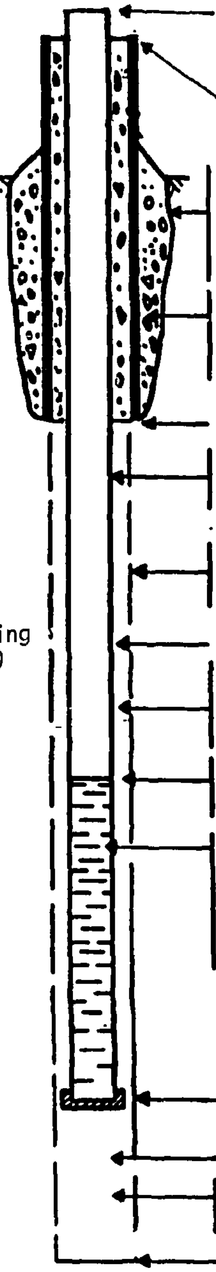
Elevation top of well riser pipe = 773.50'

Well No. MW-4

Aquifer Uppermost

(Water table)

Note: All depths and heights are referenced to ground surface



Generalized Stratigraphy

(See log of boring MW-4, OHF Pond)

Conasauga Group

Height of riser pipe above ground surface 2.9'

Height of top of surface casing pipe above ground surface 2.7'

Depth of surface seal below ground surface 6.9'

Type of surface seal: Concrete

I.D. of surface casing. 4.0"

Type of surface casing: Steel

Depth of surface casing below ground 2.3'

I.D. of riser pipe: 3.0"

Type of riser pipe: Fiberglass

Diameter of borehole 8.0"

Depth of borehole 24.0'

Type of backfill: Concrete

depth top of seal. 6.0'

Type of seal: Bentonite

depth bottom of seal. 8.0'

Type of sand pack. Medium grain silica sand

Depth of top of sand pack.

depth top of screened section. 10.1'

Type of screened section: Fiberglass

Discribe openings Slotted 2 sides, 0.01" at 1" intervals

I.D. of screened section. 3.0"

depth bottom of screened section 20.1'

depth bottom of sand column. 19.0'

Type of backfill below observation pipe. In-place; sand size drill cuttings

depth of hole. 24.0'

APPENDIX III

Analytical Tables, 1A through 10A

Notes for all tables:

1. The "-" (minus) symbol is used to represent the detection limit
2. Detection limit for the same constituent varied among the analyses due to sample dilution and matrix effects.

TABLE 1A. CONCENTRATIONS OF RCRA REGULATED CONSTITUENTS IN EP EXTRACTS FROM OHF POND SEDIMENT.

					MEASURED CONCENTRATION
					MEAN
CONSTITUENT	UNIT	MAXIMUM ALLOWABLE CONCENTRATION	LOCATION	SAMPLE DATE	
AS	MG/L	5.0	CENTER	02/20/85	-0.0005
				11/15/84	-1.2000
			NORTH	02/20/85	-0.0005
				11/15/84	-1.2000
			SOUTH	02/20/85	-0.0005
				11/15/84	-1.2000
BA	MG/L	100.0	CENTER	02/20/85	0.0800
				11/15/84	0.6800
			NORTH	02/20/85	0.0600
				11/15/84	0.2200
			SOUTH	02/20/85	0.0800
				11/15/84	0.7200
CD	MG/L	1.0	CENTER	02/20/85	0.0001
				11/15/84	0.0110
			NORTH	02/20/85	-0.0001
				11/15/84	0.0010
			SOUTH	02/20/85	0.0001
				11/15/84	0.0430
CR	MG/L	5.0	CENTER	02/20/85	0.0010
				11/15/84	0.0820
			NORTH	02/20/85	0.0010

(CONTINUED)

TABLE 1A. CONCENTRATIONS OF RCRA REGULATED CONSTITUENTS IN EP EXTRACTS FROM OHF POND SEDIMENT.

					MEASURED CONCENTRATION
					MEAN
CONSTITUENT	UNIT	MAXIMUM ALLOWABLE CONCENTRATION	LOCATION	SAMPLE DATE	
CR	MG/L	5.0	NORTH	11/15/84	0.1000
			SOUTH	02/20/85	0.0010
				11/15/84	0.1100
PB	MG/L	5.0	CENTER	02/20/85	-0.0001
				11/15/84	0.0060
			NORTH	02/20/85	-0.0001
				11/15/84	-0.0030
			SOUTH	02/20/85	-0.0001
				11/15/84	0.1300
HG	MG/L	0.2	CENTER	02/20/85	0.0001
				11/15/84	0.1000
			NORTH	02/20/85	-0.0001
				11/15/84	0.2000
			SOUTH	02/20/85	0.0001
				11/15/84	0.0900
SE	MG/L	1.0	CENTER	02/20/85	-0.0100
				11/15/84	-2.4000
			NORTH	02/20/85	-0.0100
				11/15/84	-2.4000
			SOUTH	02/20/85	-0.0100
				11/15/84	-2.4000

(CONTINUED)

TABLE 1A. CONCENTRATIONS OF RCRA REGULATED CONSTITUENTS IN EP EXTRACTS FROM OHF POND SEDIMENT.

					MEASURED CONCENTRATION
CONSTITUENT	UNIT	MAXIMUM ALLOWABLE CONCENTRATION	LOCATION	SAMPLE DATE	MEAN
AG	MG/L	5.0	CENTER	02/20/85	-0.0005
				11/15/84	-0.4200
			NORTH	02/20/85	-0.0005
				11/15/84	-0.4200
			SOUTH	02/20/85	-0.0005
				11/15/84	-0.4200
ENDRIN	MG/L	0.02	CENTER	02/20/85	-0.0001
			NORTH	02/20/85	-0.0001
			SOUTH	02/20/85	-0.0001
LINDANE	MG/L	0.04	CENTER	02/20/85	-0.0001
			NORTH	02/20/85	-0.0001
			SOUTH	02/20/85	-0.0001
METHOXYCHLOR	MG/L	10.0	CENTER	02/20/85	-0.0002
			NORTH	02/20/85	-0.0002
			SOUTH	02/20/85	-0.0002
TOXAPHENE	MG/L	0.5	CENTER	02/20/85	-0.0020
			NORTH	02/20/85	-0.0020
			SOUTH	02/20/85	-0.0020
2,4-D	MG/L	10.0	CENTER	02/20/85	-0.0050
			NORTH	02/20/85	-0.0050
			SOUTH	02/20/85	-0.0050

(CONTINUED)

TABLE 1A. CONCENTRATIONS OF RCRA REGULATED CONSTITUENTS IN EP EXTRACTS FROM OHF POND SEDIMENT.

					MEASURED CONCENTRATION
					MEAN
CONSTITUENT	UNIT	MAXIMUM ALLOWABLE CONCENTRATION	LOCATION	SAMPLE DATE	
2,4,5-TP	MG/L	1.0	CENTER	02/20/85	-0.0050
			NORTH	02/20/85	-0.0050
			SOUTH	02/20/85	-0.0050

TABLE 2A. CONCENTRATIONS OF RCRA NONREGULATED CONSTITUENTS IN EP EXTRACTS FROM OHF POND SEDIMENT

				MEASURED CONCENTRATION
				MEAN
CONSTITUENT	UNIT	LOCATION	SAMPLE DATE	
AL	MG/L	CENTER	11/15/84	5.2000
		NORTH	11/15/84	-1.2000
		SOUTH	11/15/84	8.6000
B	MG/L	CENTER	11/15/84	-0.6000
		NORTH	11/15/84	1.1000
		SOUTH	11/15/84	0.7800
BE	MG/L	CENTER	11/15/84	-0.0060
		NORTH	11/15/84	-0.0060
		SOUTH	11/15/84	-0.0060
CA	MG/L	CENTER	11/15/84	1100.0000
		NORTH	11/15/84	1500.0000
		SOUTH	11/15/84	1100.0000
CO	MG/L	CENTER	11/15/84	-0.1200
		NORTH	11/15/84	-0.1200
		SOUTH	11/15/84	-0.1200
CU	MG/L	CENTER	11/15/84	-0.1200
		NORTH	11/15/84	-0.1200
		SOUTH	11/15/84	-0.1200
DIS SOLIDS	MG/ML	CENTER	11/15/84	0.7300
		NORTH	11/15/84	0.6100
		SOUTH	11/15/84	0.4600
FE	MG/L	CENTER	11/15/84	1.1000
		NORTH	11/15/84	0.1900

(CONTINUED)

TABLE 2A. CONCENTRATIONS OF RCRA NONREGULATED CONSTITUENTS IN EP EXTRACTS FROM OHF POND SEDIMENT

				MEASURED CONCENTRATION
				MEAN
CONSTITUENT	UNIT	LOCATION	SAMPLE DATE	
FE	MG/L	SOUTH	11/15/84	1.2000
GA	MG/L	CENTER	11/15/84	-3.0000
		NORTH	11/15/84	-3.0000
		SOUTH	11/15/84	-3.0000
HF	MG/L	CENTER	11/15/84	-0.3600
		NORTH	11/15/84	-0.3600
		SOUTH	11/15/84	-0.3600
K	MG/L	CENTER	11/15/84	13.0000
		NORTH	11/15/84	8.4000
		SOUTH	11/15/84	13.0000
LI	MG/L	CENTER	11/15/84	-1.2000
		NORTH	11/15/84	-1.2000
		SOUTH	11/15/84	-1.2000
MG	MG/L	CENTER	11/15/84	30.0000
		NORTH	11/15/84	14.0000
		SOUTH	11/15/84	26.0000
MN	MG/L	CENTER	11/15/84	3.6000
		NORTH	11/15/84	2.7000
		SOUTH	11/15/84	5.5000
MO	MG/L	CENTER	11/15/84	-0.1200
		NORTH	11/15/84	-0.1200
		SOUTH	11/15/84	-0.1200
NA	MG/L	CENTER	11/15/84	120.0000

(CONTINUED)

TABLE 2A. CONCENTRATIONS OF RCRA NONREGULATED CONSTITUENTS IN EP EXTRACTS FROM OHF POND SEDIMENT

CONSTITUENT	UNIT	LOCATION	SAMPLE DATE	MEASURED CONCENTRATION MEAN
NA	MG/L	NORTH	11/15/84	100.0000
		SOUTH	11/15/84	250.0000
NI	MG/L	CENTER	11/15/84	-0.3600
		NORTH	11/15/84	-0.3600
		SOUTH	11/15/84	-0.3600
P	MG/L	CENTER	11/15/84	-1.8000
		NORTH	11/15/84	-1.8000
		SOUTH	11/15/84	-1.8000
SB	MG/L	CENTER	11/15/84	-1.8000
		NORTH	11/15/84	-1.8000
		SOUTH	11/15/84	-1.8000
SI	MG/L	CENTER	11/15/84	62.0000
		NORTH	11/15/84	28.0000
		SOUTH	11/15/84	72.0000
SR	MG/L	CENTER	11/15/84	7.0000
		NORTH	11/15/84	3.9000
		SOUTH	11/15/84	5.8000
TI	MG/L	CENTER	11/15/84	-0.1200
		NORTH	11/15/84	-0.1200
		SOUTH	11/15/84	-0.1200
V	MG/L	CENTER	11/15/84	-0.1800
		NORTH	11/15/84	-0.1800
		SOUTH	11/15/84	-0.1800

(CONTINUED)

TABLE 2A. CONCENTRATIONS OF RCRA NONREGULATED CONSTITUENTS IN EP EXTRACTS FROM OHF POND SEDIMENT

				MEASURED CONCENTRATION
CONSTITUENT	UNIT	LOCATION	SAMPLE DATE	MEAN
ZN	MG/L	CENTER	11/15/84	0.1400
		NORTH	11/15/84	-0.1200
		SOUTH	11/15/84	0.1600
ZR	MG/L	CENTER	11/15/84	-0.3600
		NORTH	11/15/84	-0.3600
		SOUTH	11/15/84	-0.3600

TABLE 3A. TOTAL ANALYSIS OF OHF POND SEDIMENT.

CONSTITUENT	UNIT	LOCATION	SAMPLE DATE	MEASURED CONCENTRATION MEAN
AG	MG/KG	CENTER	02/20/85	-48.3150
		NORTH	02/20/85	-42.1500
		SOUTH	02/20/85	-32.1000
AL	MG/KG	CENTER	02/20/85	64420.0000
		NORTH	02/20/85	50580.0000
		SOUTH	02/20/85	70620.0000
AS	MG/KG	CENTER	02/20/85	-141.7240
		NORTH	02/20/85	-123.6400
		SOUTH	02/20/85	-94.1600
B	MG/KG	CENTER	02/20/85	1513.8700
		NORTH	02/20/85	98.3500
		SOUTH	02/20/85	23540.0000
BA	MG/KG	CENTER	02/20/85	386.5200
		NORTH	02/20/85	165.7900
		SOUTH	02/20/85	406.6000
BE	MG/KG	CENTER	02/20/85	3.8652
		NORTH	02/20/85	2.7819
		SOUTH	02/20/85	3.4240
CA	MG/KG	CENTER	02/20/85	70862.0000
		NORTH	02/20/85	15736.0000
		SOUTH	02/20/85	34240.0000
CD	MG/KG	CENTER	02/20/85	-6.4420
		NORTH	02/20/85	-5.6200

(CONTINUED)

TABLE 3A. TOTAL ANALYSIS OF OHF POND SEDIMENT.

CONSTITUENT	UNIT	LOCATION	SAMPLE DATE	MEASURED CONCENTRATION MEAN
CD	MG/KG	SOUTH	02/20/85	6.2060
CO	MG/KG	CENTER	02/20/85	23.1912
		NORTH	02/20/85	18.2650
		SOUTH	02/20/85	25.6800
CR	MG/KG	CENTER	02/20/85	450.9400
		NORTH	02/20/85	365.3000
		SOUTH	02/20/85	209.7200
CU	MG/KG	CENTER	02/20/85	141.7240
		NORTH	02/20/85	134.8800
		SOUTH	02/20/85	143.3800
FE	MG/KG	CENTER	02/20/85	31887.9000
		NORTH	02/20/85	3934.0000
	MG/L	SOUTH	02/20/85	27820.0000
GA	MG/KG	CENTER	02/20/85	-354.3100
		NORTH	02/20/85	-309.1000
		SOUTH	02/20/85	-235.4000
HF	MG/KG	CENTER	02/20/85	67.6410
		NORTH	02/20/85	39.3400
		SOUTH	02/20/85	74.9000
K	MG/KG	CENTER	02/20/85	[illegible]
		NORTH	02/20/85	[illegible]
		SOUTH	02/20/85	[illegible]
LI	MG/KG	CENTER	02/20/85	[illegible]

(CONTINUED)

TABLE 3A. TOTAL ANALYSIS OF OHF POND SEDIMENT.

CONSTITUENT	UNIT	LOCATION	SAMPLE DATE	MEASURED CONCENTRATION MEAN
LI	MG/KG	NORTH	02/20/85	258.5200
		SOUTH	02/20/85	385.2000
MG	MG/KG	CENTER	02/20/85	12884.0000
		NORTH	02/20/85	8149.0000
		SOUTH	02/20/85	104860.0000
MN	MG/KG	CENTER	02/20/85	483.1500
		NORTH	02/20/85	199.5100
		SOUTH	02/20/85	428.0000
MO	MG/KG	CENTER	02/20/85	-14.1724
		NORTH	02/20/85	-12.3640
		SOUTH	02/20/85	19.9020
NA	MG/KG	CENTER	02/20/85	-354.3100
		NORTH	02/20/85	730.6000
		SOUTH	02/20/85	-235.4000
NI	MG/KG	CENTER	02/20/85	215.8070
		NORTH	02/20/85	174.2200
		SOUTH	02/20/85	57.7800
P	MG/KG	CENTER	02/20/85	1449.4500
		NORTH	02/20/85	786.8000
		SOUTH	02/20/85	1647.8000
PB	MG/KG	CENTER	02/20/85	-141.7240
		NORTH	02/20/85	134.8800
		SOUTH	02/20/85	192.6000

(CONTINUED)

TABLE 3A. TOTAL ANALYSIS OF OHF POND SEDIMENT.

CONSTITUENT	UNIT	LOCATION	SAMPLE DATE	MEASURED CONCENTRATION MEAN
PCB	MG/KG	CENTER	02/20/85	1.1500
		NORTH	02/20/85	0.7150
		SOUTH	02/20/85	6.7000
SB	MG/KG	CENTER	02/20/85	-212.5860
		NORTH	02/20/85	-185.4600
		SOUTH	02/20/85	184.0400
SE	MG/KG	CENTER	02/20/85	-283.4480
		NORTH	02/20/85	-247.2800
		SOUTH	02/20/85	-188.3200
SI	MG/KG	CENTER	02/20/85	4509.4100
		NORTH	02/20/85	137.6900
		SOUTH	02/20/85	2011.6000
SR	MG/KG	CENTER	02/20/85	386.5200
		NORTH	02/20/85	56.2000
		SOUTH	02/20/85	109.1400
TI	MG/KG	CENTER	02/20/85	4831.5000
		NORTH	02/20/85	1461.2000
		SOUTH	02/20/85	38520.0000
V	MG/KG	CENTER	02/20/85	93.4090
		NORTH	02/20/85	56.2000
		SOUTH	02/20/85	87.7400
ZN	MG/KG	CENTER	02/20/85	173.9340
		NORTH	02/20/85	98.3500

(CONTINUED)

TABLE 3A. TOTAL ANALYSIS OF OHF POND SEDIMENT.

CONSTITUENT	UNIT	LOCATION	SAMPLE DATE	MEASURED CONCENTRATION MEAN
ZN	MG/KG	SOUTH	02/20/85	211.8600
ZR	MG/KG	CENTER	02/20/85	199.7020
		NORTH	02/20/85	146.1200
		SOUTH	02/20/85	620.6000

TABLE 4A. INVENTORY OF CONSTITUENTS IN OHF POND SEDIMENT

CONSTITUENT	UNIT	TOTAL INVENTORY MEAN
AG	KG	0.78
AL	KG	1184.26
AS	KG	2.29
B	KG	160.47
BA	KG	6.12
BE	KG	0.06
CA	KG	770.95
CD	KG	0.12
CO	KG	0.43
CR	KG	6.55
CU	KG	2.68
FE	KG	406.04
GA	KG	5.73
HF	KG	1.16
K	KG	644.38
LI	KG	6.37
MG	KG	803.20
MN	KG	7.09
MO	KG	0.30
NA	KG	8.42
NI	KG	2.86
P	KG	24.78
PB	KG	2.99
PCB	KG	0.05

(CONTINUED)

TABLE 4A. INVENTORY OF CONSTITUENTS IN OHF POND SEDIMENT

		TOTAL INVENTORY
		MEAN
CONSTITUENT	UNIT	
SB	KG	3.71
SE	KG	4.59
SI	KG	42.48
SR	KG	3.52
TI	KG	285.91
V	KG	1.51
ZN	KG	3.09
ZR	KG	6.17

TABLE 5A. CHEMICAL CONSTITUENTS MEASURED IN OHF POND WATER.

			MEASURED CONCENTRATION
			MEAN
CONSTITUENT	UNIT	SAMPLE DATE	
AG	MG/L	05/08/85	-0.0700
AL	MG/L	05/08/85	4.8100
AS	MG/L	05/08/85	-0.0010
B	MG/L	05/08/85	-0.1000
BA	MG/L	05/08/85	0.5390
BE	MG/L	05/08/85	0.0021
CA	MG/L	05/08/85	26.3000
CD	MG/L	05/08/85	0.0015
CL	MG/L	05/08/85	64.0000
CO	MG/L	05/08/85	-0.0200
COLIFORM	CO/100ML	05/08/85	8.0000
CR	MG/L	05/08/85	0.0219
CU	MG/L	05/08/85	-0.0200
ENDRIN	MG/L	05/08/85	-0.0001
F	MG/L	05/08/85	1.0000
FE	MG/L	05/08/85	9.2500
GA	MG/L	05/08/85	-0.5000
HF	MG/L	05/08/85	-0.0600
HG	MG/L	05/08/85	0.0001
K	MG/L	05/08/85	6.5000
LI	MG/L	05/08/85	-0.2000
LINDANE	MG/L	05/08/85	-0.0001
METHOXYCHLOR	MG/L	05/08/85	-0.0002

(CONTINUED)

TABLE 5A. CHEMICAL CONSTITUENTS MEASURED IN OHF POND WATER.

			MEASURED CONCENTRATION
			MEAN
CONSTITUENT	UNIT	SAMPLE DATE	
MG	MG/L	05/08/85	8.9900
MN	MG/L	05/08/85	0.2000
MO	MG/L	05/08/85	-0.0200
NITRATE-N	MG/L	05/08/85	-1.0000
NA	MG/L	05/08/85	-0.5000
NI	MG/L	05/08/85	-0.0600
P	MG/L	05/08/85	-0.3000
PB	MG/L	05/08/85	-0.0010
PCB	MG/L	06/27/85	0.0001
PH	PH	01/26/85	7.0500
PHENOL	MG/L	05/08/85	-0.0010
SB	MG/L	05/08/85	-0.3000
SE	MG/L	05/08/85	0.0160
SI	MG/L	05/08/85	7.8100
SULFATE	MG/L	05/08/85	19.0000
SP.COND.	UMHOS/CC	01/26/85	223.7500
SR	MG/L	05/08/85	0.3160
TI	MG/L	05/08/85	-0.0200
TOC	MG/L	05/08/85	16.5000
TOX	MG/L	05/08/85	0.1320
TOXAPHENE	MG/L	05/08/85	-0.0020
V	MG/L	05/08/85	-0.0300
ZN	MG/L	05/08/85	0.1340

(CONTINUED)

TABLE 5A. CHEMICAL CONSTITUENTS MEASURED IN OHF POND WATER.

			MEASURED CONCENTRATION
			MEAN
CONSTITUENT	UNIT	SAMPLE DATE	
ZR	MG/L	05/08/85	-0.0600
2,4-D	MG/L	05/08/85	-0.0050
2,4,5-TP	MG/L	05/08/85	-0.0001

TABLE 6A. RADIONULCIDES MEASURED IN OHF POND SEDIMENT

				MEASURED CONCENTRATION
				MEAN
CONSTITUENT	UNIT	LOCATION	SAMPLE DATE	
GROSS-A	BQ/G	CENTER	02/20/85	34.0000
		N-END	02/20/85	42.0000
		S-END	02/20/85	229.0000
GROSS-B	BQ/G	CENTER	02/20/85	53400.0000
		N-END	02/20/85	73700.0000
		S-END	02/20/85	151000.0000
134CS	BQ/G	CENTER	02/20/85	-20.0000
		N-END	02/20/85	-20.0000
		S-END	02/20/85	-20.0000
137CS	BQ/G	CENTER	02/20/85	59400.0000
		N-END	02/20/85	99500.0000
		S-END	02/20/85	216000.0000
154EU	BQ/G	CENTER	02/20/85	-20.0000
		N-END	02/20/85	-28.0000
		S-END	02/20/85	-20.0000
234U	BQ/G	CENTER	02/20/85	-40.0000
		N-END	02/20/85	-40.0000
		S-END	02/20/85	-20.0000
238U	BQ/G	CENTER	02/20/85	-280.0000
		N-END	02/20/85	-1200.0000
		S-END	02/20/85	-357.0000
241AM	BQ/G	CENTER	02/20/85	-20.0000
		N-END	02/20/85	-20.0000

(CONTINUED)

TABLE 6A. RADIONULCIDES MEASURED IN OHF POND SEDIMENT

				MEASURED CONCENTRATION
				MEAN
CONSTITIUENT	UNIT	LOCATION	SAMPLE DATE	
241AM	BQ/G	S-END	02/20/85	-20.0000
60CO	BQ/G	CENTER	02/20/85	348.0000
		N-END	02/20/85	417.0000
		S-END	02/20/85	1060.0000
90SR	BQ/G	CENTER	02/20/85	2630.0000
		N-END	02/20/85	1660.0000
		S-END	02/20/85	112000.0000

TABLE 7A. RADIONUCLIDES MEASURED IN OHF POND WATER

			MEASURED CONCENTRATION
			MEAN
CONSTITUENT	UNIT	SAMPLE DATE	
GROSS-A	BQ/L	05/08/85	11.0000
GROSS-B	BQ/L	05/08/85	9400.0000
137CS	BQ/L	05/08/85	3900.0000
226RA	BQ/L	05/08/85	0.0150
234U	BQ/L	05/08/85	1.5000
238PU	BQ/L	05/08/85	0.1700
238U	BQ/L	05/08/85	0.3750
239PU	BQ/L	05/08/85	0.0520
241AM	BQ/L	05/08/85	0.2400
244CM	BQ/L	05/08/85	6.8000
60CO	BQ/L	05/08/85	27.0000
90SR	BQ/L	05/08/85	4400.0000

TABLE 8A. INVENTORY OF RADIONUCLIDES IN OHF POND WATER

CONSTITUENT	UNIT	TOTAL INVENTORY MEAN
GROSS-A	GBQ	0.00
GROSS-B	GBQ	2.30
137CS	GBQ	0.96
226RA	GBQ	0.00
234U	GBQ	0.00
238PU	GBQ	0.00
238U	GBQ	0.00
239PU	GBQ	0.00
241AM	GBQ	0.00
244CM	GBQ	0.00
60CO	GBQ	0.01
90SR	GBQ	1.08

TABLE 9A. INDEX OF GROUNDWATER QUALITY FOR THE OHF SITE

					MEASURED CONCENTRATION
CONSTITUENT	UNIT	MAXIMUM ALLOWABLE CONCENTRATION	WELL NUMBER	SAMPLE DATE	MEAN
AG	MG/L	0.05	1	03/11/85	-0.0700
				03/27/85	-0.0700
				05/24/85	-0.0700
			2	03/26/85	-0.0700
				05/24/85	-0.0700
			3	03/27/85	-0.0700
				05/24/85	-0.0700
			4	03/27/85	-0.0700
				05/24/85	-0.0700
AS	MG/L	0.05	1	03/11/85	-0.0010
				03/27/85	-0.0020
				05/24/85	-0.1005
			2	03/26/85	-0.0020
				05/24/85	-0.1005
			3	03/27/85	-0.0020
				05/24/85	-0.0990
			4	03/27/85	-0.0020
				05/24/85	-0.1005
BA	MG/L	1.0	1	03/11/85	0.2540
				03/27/85	0.2500
				05/24/85	0.2570
			2	03/26/85	0.4200

(CONTINUED)

TABLE 9A. INDEX OF GROUNDWATER QUALITY FOR THE OHF SITE

					MEASURED CONCENTRATION
CONSTITUENT	UNIT	MAXIMUM ALLOWABLE CONCENTRATION	WELL NUMBER	SAMPLE DATE	MEAN
BA	MG/L	1.0	2	05/24/85	0.2530
			3	03/27/85	0.3900
				05/24/85	1.0900
			4	03/27/85	0.0660
				05/24/85	0.1250
CD	MG/L	0.01	1	03/11/85	-0.0010
				03/27/85	-0.0010
				05/24/85	-0.0030
			2	03/26/85	-0.0010
				05/24/85	-0.0055
			3	03/27/85	0.0060
				05/24/85	0.0005
			4	03/27/85	-0.0010
				05/24/85	-0.0055
CHLORIDE	MG/L	NOT DEF	1	03/11/85	12.0000
				03/27/85	12.0000
				05/24/85	12.0000
			2	03/26/85	19.0000
				05/24/85	20.0000
			3	03/27/85	17.0000
				05/24/85	40.0000
			4	03/27/85	8.0000

(CONTINUED)

TABLE 9A. INDEX OF GROUNDWATER QUALITY FOR THE OHF SITE

					MEASURED CONCENTRATION
CONSTITUENT	UNIT	MAXIMUM ALLOWABLE CONCENTRATION	WELL NUMBER	SAMPLE DATE	MEAN
CHLORIDE	MG/L	NOT DEF	4	05/24/85	17.0000
COLIFORM	CO/100ML	1/100ML	1	03/11/85	2.0000
				03/27/85	8.0000
				05/24/85	16.0000
			2	03/26/85	0.0000
				05/24/85	10.0000
			3	03/27/85	48.0000
				05/24/85	-0.1000
			4	03/27/85	18.0000
				05/24/85	-0.1000
CR	MG/L	0.05	1	03/11/85	-0.0500
				03/27/85	-0.0500
				05/24/85	-0.0200
			2	03/26/85	-0.0500
				05/24/85	0.0242
			3	03/27/85	-0.0500
				05/24/85	0.0797
			4	03/27/85	-0.0500
				05/24/85	-0.0200
ENDRIN	MG/L	0.0002	1	03/11/85	-0.0001
				03/27/85	-0.0001
				05/24/85	-0.0001

(CONTINUED)

TABLE 9A. INDEX OF GROUNDWATER QUALITY FOR THE OHF SITE

					MEASURED CONCENTRATION
CONSTITUENT	UNIT	MAXIMUM ALLOWABLE CONCENTRATION	WELL NUMBER	SAMPLE DATE	MEAN
ENDRIN	MG/L	0.0002	2	03/26/85	-0.0001
				05/24/85	-0.0001
			3	03/27/85	-0.0001
				05/24/85	-0.0001
			4	05/24/85	-0.0001
F	MG/L	1.4-2.4	1	03/11/85	-1.0000
				03/27/85	-1.0000
				05/24/85	-1.0000
			2	03/26/85	-1.0000
				05/24/85	-1.0000
			3	03/27/85	-1.0000
				05/24/85	-1.0000
			4	03/27/85	-1.0000
				05/24/85	-1.0000
FE	MG/L	NOT DEF	1	03/11/85	1.1700
				03/27/85	0.6100
				05/24/85	0.5870
			2	03/26/85	3.8000
				05/24/85	4.0000
			3	03/27/85	3.2000
				05/24/85	57.9000
			4	03/27/85	0.2900

(CONTINUED)

TABLE 9A. INDEX OF GROUNDWATER QUALITY FOR THE OHF SITE

CONSTITUENT	UNIT	MAXIMUM ALLOWABLE CONCENTRATION	WELL NUMBER	SAMPLE DATE	MEASURED CONCENTRATION MEAN
FE	MG/L	NOT DEF	4	05/24/85	3.4800
GROSS-A	BQ/L	0.556	1	03/11/85	0.4600
				03/27/85	-0.4000
				05/24/85	1.8000
			2	03/26/85	0.3100
				05/24/85	-2.0000
			3	03/27/85	0.9600
				05/24/85	1.2000
			4	03/27/85	11.0000
				05/24/85	-3.0000
GROSS-B	BQ/L	4MREM/YR	1	03/11/85	4.2000
				03/27/85	3.5000
				05/24/85	4.6000
			2	03/26/85	2.1000
				05/24/85	1.7000
			3	03/27/85	8.0000
				05/24/85	380.0000
			4	03/27/85	600.0000
				05/24/85	1300.0000
HG	MG/L	0.002	1	03/11/85	-0.0000
				03/27/85	-0.0000
				05/24/85	-0.0000

(CONTINUED)

TABLE 9A. INDEX OF GROUNDWATER QUALITY FOR THE OHF SITE

					MEASURED CONCENTRATION
CONSTITUENT	UNIT	MAXIMUM ALLOWABLE CONCENTRATION	WELL NUMBER	SAMPLE DATE	MEAN
HG	MG/L	0.002	2	03/26/85	-0.0000
				05/24/85	-0.0300
			3	03/27/85	-0.0001
				05/24/85	-0.0000
			4	03/27/85	-0.0000
				05/24/85	-0.0000
LINDANE	MG/L	0.004	1	03/11/85	-0.0001
				03/27/85	-0.0001
				05/24/85	-0.0001
			2	03/26/85	-0.0001
				05/24/85	-0.0001
			3	03/27/85	-0.0001
				05/24/85	-0.0001
			4	03/27/85	-0.0001
				05/24/85	-0.0001
METHOXYCHLOR	MG/L	0.1	1	03/11/85	-0.0002
				03/27/85	-0.0002
				05/24/85	-0.0002
			2	03/26/85	-0.0002
				05/24/85	-0.0002
			3	03/27/85	-0.0002
				05/24/85	-0.0002

(CONTINUED)

TABLE 9A. INDEX OF GROUNDWATER QUALITY FOR THE OHF SITE

					MEASURED CONCENTRATION
CONSTITUENT	UNIT	MAXIMUM ALLOWABLE CONCENTRATION	WELL NUMBER	SAMPLE DATE	MEAN
METHOXYCHLOR	MG/L	0.1	4	03/27/85	-0.0002
				05/24/85	-0.0002
MN	MG/L	NOT DEF	1	03/11/85	0.2930
				03/27/85	0.2000
				05/24/85	0.0334
			2	03/26/85	1.3000
				05/24/85	0.5630
			3	03/27/85	1.5000
				05/24/85	8.8500
			4	03/27/85	1.1000
				05/24/85	0.9400

TABLE 9A. INDEX OF GROUNDWATER QUALITY FOR THE OHF SITE

CONSTITUENT	UNIT	MAXIMUM ALLOWABLE CONCENTRATION	WELL NUMBER	SAMPLE DATE	MEASURED CONCENTRATION MEAN
NITRATE-N	MG/L	10.0	1	03/11/85	1.0000
				03/27/85	1.0000
				05/24/85	6.0000
			2	03/26/85	2.0000
				05/24/85	8.0000
			3	03/27/85	2.0000
				05/24/85	-5.0000
			4	03/27/85	-1.0000
				05/24/85	-5.0000
NA	MG/L	NOT DEF	1	03/11/85	17.0000
				03/27/85	11.0000
			2	03/26/85	17.0000
				05/24/85	13.8000
			3	03/27/85	37.0000
				05/24/85	37.3000
			4	03/27/85	17.0000
				05/24/85	15.1000
PB	MG/L	0.05	1	03/11/85	-0.0010
				03/27/85	0.0020
				05/24/85	-0.0960
			2	03/26/85	0.0200
				05/24/85	-0.0925

(CONTINUED)

TABLE 9A. INDEX OF GROUNDWATER QUALITY FOR THE CHF SITE

CONSTITUENT	UNIT	MAXIMUM ALLOWABLE CONCENTRATION	WELL NUMBER	SAMPLE DATE	MEASURED CONCENTRATION MEAN
PB	MG/L	0.05	3	03/27/85	0.0250
				05/24/85	-0.0600
			4	03/27/85	0.0020
				05/24/85	-0.0910
PCB	MG/L	NOT DEF	1	05/24/85	0.0001
			2	05/24/85	0.0001
			3	05/24/85	0.0001
			4	05/24/85	0.0002
PH	PH	NOT DEF	1	03/27/85	6.2000
				05/24/85	6.8400
			2	03/26/85	6.3000
				05/24/85	6.9000
			3	03/27/85	6.5000
				05/24/85	6.5125
			4	03/27/85	6.2000
				05/24/85	6.1875
PHENOL	MG/L	NOT DEF	1	03/11/85	-0.0010
				03/27/85	-0.0010
				05/24/85	0.0020
			2	03/26/85	-0.0010
				05/24/85	-0.0010
			3	03/27/85	-0.0010

(CONTINUED)

TABLE 9A. INDEX OF GROUNDWATER QUALITY FOR THE OHF SITE

CONSTITUENT	UNIT	MAXIMUM ALLOWABLE CONCENTRATION	WELL NUMBER	SAMPLE DATE	MEASURED CONCENTRATION MEAN
PHENOL	MG/L	NOT DEF	3	05/24/85	-0.0010
			4	03/27/85	-0.0010
				05/24/85	-0.0010
226RA	BQ/L	0.19	1	03/11/85	-0.0200
				03/27/85	-0.0300
				05/24/85	-0.0050
			2	03/26/85	-0.2000
				05/24/85	-0.0080
			3	03/27/85	-0.2000
				05/24/85	-0.0070
			4	03/27/85	-0.2000
				05/24/85	0.0100
SE	MG/L	0.01	1	03/11/85	-0.0050
				03/27/85	-0.0030
				05/24/85	-0.2005
			2	03/26/85	0.0050
				05/24/85	-0.2005
			3	03/27/85	-0.0030
				05/24/85	-0.2005
			4	03/27/85	-0.0030
				05/24/85	-0.2005
SULFATE	MG/L	NOT DEF	1	03/11/85	19.0000

(CONTINUED)

TABLE 9A. INDEX OF GROUNDWATER QUALITY FOR THE OHF SITE

					MEASURED CONCENTRATION
CONSTITUENT	UNIT	MAXIMUM ALLOWABLE CONCENTRATION	WELL NUMBER	SAMPLE DATE	MEAN
SULFATE	MG/L	NOT DEF	1	03/27/85	19.0000
				05/24/85	20.0000
			2	03/26/85	13.0000
				05/24/85	12.0000
			3	03/27/85	24.0000
				05/24/85	13.0000
			4	03/27/85	21.0000
				05/24/85	19.0000
SP.COND.	UMHOS/CC	NOT DEF	1	03/27/85	817.0000
				05/24/85	609.7500
			2	03/26/85	755.0000
				05/24/85	576.7500
			3	03/27/85	711.0000
				05/24/85	242.7500
			4	03/27/85	259.0000
				05/24/85	161.0000
TOC	MG/L	NOT DEF	1	03/11/85	4.0000
				03/27/85	2.7000
				05/24/85	6.9750
			2	03/26/85	6.3300
				05/24/85	8.2500
			3	03/27/85	3.2100

(CONTINUED)

TABLE 9A. INDEX OF GROUNDWATER QUALITY FOR THE OHF SITE

CONSTITUENT	UNIT	MAXIMUM ALLOWABLE CONCENTRATION	WELL NUMBER	SAMPLE DATE	MEASURED CONCENTRATION MEAN
TOC	MG/L	NOT DEF	3	05/24/85	7.0000
			4	03/27/85	2.1800
				05/24/85	5.7250
TOX	MG/L	NOT DEF	1	03/11/85	0.0130
				03/27/85	0.0270
				05/24/85	0.0110
			2	03/26/85	0.0280
				05/24/85	0.0090
			3	03/27/85	0.0330
				05/24/85	0.0290
			4	03/27/85	0.0490
				05/24/85	0.0370
TOXAPHENE	MG/L	NOT DEF	1	03/11/85	-0.0020
				03/27/85	-0.0020
				05/24/85	-0.0020
			2	03/26/85	-0.0020
				05/24/85	-0.0020
			3	03/27/85	-0.0020
				05/24/85	-0.0020
			4	03/27/85	-0.0020
				05/24/85	-0.0020
TRITIUM	BQ/L	NOT DEF	1	05/24/85	79000.0000

(CONTINUED)

TABLE 9A. INDEX OF GROUNDWATER QUALITY FOR THE CHF SITE

CONSTITUENT	UNIT	MAXIMUM ALLOWABLE CONCENTRATION	WELL NUMBER	SAMPLE DATE	MEASURED CONCENTRATION MEAN
TRITIUM	BQ/L	NOT DEF	2	05/24/85	190000.0000
			3	05/24/85	60000.0000
			4	05/24/85	33000.0000
137CS	BQ/L	NOT DEF	1	03/11/85	0.7217
				03/27/85	2.0688
				05/24/85	0.7772
			2	05/24/85	0.9993
			3	03/27/85	0.7180
				05/24/85	0.9252
			4	03/27/85	2.2761
				05/24/85	3.6269
2,4-D	MG/L	0.1	1	03/11/85	-0.0050
				03/27/85	-0.0050
				05/24/85	-0.0050
			2	03/26/85	-0.0050
				05/24/85	-0.0050
			3	03/27/85	-0.0050
				05/24/85	-0.0050
			4	03/27/85	-0.0050
				05/24/85	-0.0050
2,4,5-TP	MG/L	0.01	1	03/11/85	-0.0050
				03/27/85	-0.0050

(CONTINUED)

TABLE 9A. INDEX OF GROUNDWATER QUALITY FOR THE OHF SITE

CONSTITUENT	UNIT	MAXIMUM ALLOWABLE CONCENTRATION	WELL NUMBER	SAMPLE DATE	MEASURED CONCENTRATION MEAN
2,4,5-TP	MG/L	0.01	1	05/24/85	-0.0050
			2	03/26/85	-0.0050
				05/24/85	-0.0050
			3	03/27/85	-0.0050
				05/24/85	-0.0050
			4	03/27/85	-0.0050
				05/24/85	-0.0050
60CO	BQ/L	NOT DEF	2	05/24/85	0.5736
			3	03/27/85	2.0540
				05/24/85	6.5877
			4	03/27/85	2.1132
				05/24/85	3.4419
90SR	BQ/L	NOT DEF	1	05/24/85	1.8000
			2	05/24/85	0.2100
			3	05/24/85	250.0000
			4	05/24/85	420.0000

TABLE 10A. SUPPLEMENTARY GROUNDWATER QUALITY MEASUREMENTS FOR THE OHF SITE.

					MEASURED CONCENTRATION
					MEAN
CONSTITUENT	UNIT	MAXIMUM ALLOWABLE CONCENTRATION	WELL NUMBER	SAMPLE DATE	
AL	MG/L	NOT DEF	1	03/11/85	0.6420
				03/27/85	0.5700
				05/24/85	0.3890
			2	03/26/85	3.4000
				05/24/85	2.4900
			3	03/27/85	3.0000
				05/24/85	29.3000
			4	03/27/85	0.3900
				05/24/85	2.6300
B	MG/L	NOT DEF	1	03/11/85	-0.1000
				03/27/85	-0.1000
				05/24/85	-0.1000
			2	03/26/85	-0.1000
				05/24/85	0.1530
			3	03/27/85	-0.1000
				05/24/85	-0.1000
			4	03/27/85	-0.1000
				05/24/85	-0.1000
BE	MG/L	NOT DEF	1	03/11/85	-0.0010
				03/27/85	-0.0010
				05/24/85	-0.0020

(CONTINUED)

TABLE 10A. SUPPLEMENTARY GROUNDWATER QUALITY MEASUREMENTS FOR THE OHF SITE.

CONSTITUENT	UNIT	MAXIMUM ALLOWABLE CONCENTRATION	WELL NUMBER	SAMPLE DATE	MEASURED CONCENTRATION MEAN
BE	MG/L	NOT DEF	2	03/26/85	-0.0010
				05/24/85	-0.0020
			3	03/27/85	-0.0010
				05/24/85	0.0035
			4	03/27/85	-0.0010
				05/24/85	0.0023
CA	MG/L	NOT DEF	1	03/11/85	124.0000
				03/27/85	140.0000
				05/24/85	173.0000
			2	03/26/85	110.0000
				05/24/85	160.0000
			3	03/27/85	110.0000
				05/24/85	36.3000
			4	03/27/85	39.0000
				05/24/85	17.8000
CL	MG/L	NOT DEF	1	05/24/85	12.0000
			2	05/24/85	20.0000
			3	05/24/85	40.0000
			4	05/24/85	17.0000
CD	MG/L	NOT DEF	1	03/11/85	-0.0200
				03/27/85	-0.0200

(CONTINUED)

TABLE 10A. SUPPLEMENTARY GROUNDWATER QUALITY MEASUREMENTS FOR THE OHF SITE.

					MEASURED CONCENTRATION
					MEAN
CONSTITUENT	UNIT	MAXIMUM ALLOWABLE CONCENTRATION	WELL NUMBER	SAMPLE DATE	
CO	MG/L	NOT DEF	1	05/24/85	-0.0200
			2	03/26/85	-0.0200
				05/24/85	-0.0200
			3	03/27/85	-0.0200
				05/24/85	0.0669
			4	03/27/85	-0.0200
				05/24/85	-0.0200
CU	MG/L	NOT DEF	1	03/11/85	-0.0200
				03/27/85	-0.[illegible]
				05/24/85	-0.0200
			2	03/26/85	-0.0200
				05/24/85	-0.0200
			3	03/27/85	-0.0200
				05/24/85	0.0567
			4	03/27/85	-0.0200
				05/24/85	-0.0200
GA	MG/L	NOT DEF	1	03/11/85	-0.5000
				03/27/85	-0.5000
				05/24/85	-0.5000
			2	03/26/85	-0.5000
				05/24/85	-0.5000

(CONTINUED)

TABLE 10A. SUPPLEMENTARY GROUNDWATER QUALITY MEASUREMENTS FOR THE OHF SITE.

					MEASURED CONCENTRATION
CONSTITUENT	UNIT	MAXIMUM ALLOWABLE CONCENTRATION	WELL NUMBER	SAMPLE DATE	MEAN
GA	MG/L	NOT DEF	3	03/27/85	-0.5000
				05/24/85	-0.5000
			4	03/27/85	-0.5000
				05/24/85	-0.5000
HF	MG/L	NOT DEF	1	03/11/85	-0.0600
				03/27/85	-0.0600
				05/24/85	-0.0600
			2	03/26/85	-0.0600
			3	03/27/85	-0.0600
				05/24/85	0.0624
			4	03/27/85	-0.0600
				05/24/85	-0.0600
K	MG/L	NOT DEF	1	03/11/85	2.4000
				03/27/85	1.6000
				05/24/85	1.3000
			2	03/26/85	3.7000
				05/24/85	1.6000
			3	03/27/85	2.4000
				05/24/85	3.6000
			4	03/27/85	1.9000
				05/24/85	1.8000

(CONTINUED)

TABLE 10A. SUPPLEMENTARY GROUNDWATER QUALITY MEASUREMENTS FOR THE OHF SITE.

					MEASURED CONCENTRATION
CONSTITUENT	UNIT	MAXIMUM ALLOWABLE CONCENTRATION	WELL NUMBER	SAMPLE DATE	MEAN
LI	MG/L	NOT DEF	1	03/11/85	-0.2000
				03/27/85	-0.2000
				05/24/85	-0.2000
			2	03/26/85	-0.2000
				05/24/85	-0.2000
			3	03/27/85	-0.2000
				05/24/85	-0.2000
			4	03/27/85	-0.2000
				05/24/85	-0.2000
MG	MG/L	NOT DEF	1	03/11/85	14.0000
				03/27/85	15.0000
				05/24/85	16.3000
			2	03/26/85	17.0000
				05/24/85	12.8000
			3	03/27/85	14.0000
				05/24/85	21.7000
			4	03/27/85	7.5000
				05/24/85	5.5400
MO	MG/L	NOT DEF	1	03/11/85	-0.0200
				03/27/85	0.0240
			2	03/26/85	0.0350

(CONTINUED)

TABLE 10A. SUPPLEMENTARY GROUNDWATER QUALITY MEASUREMENTS FOR THE OHF SITE.

					MEASURED CONCENTRATION
					MEAN
CONSTITUENT	UNIT	MAXIMUM ALLOWABLE CONCENTRATION	WELL NUMBER	SAMPLE DATE	
MO	MG/L	NOT DEF	2	05/24/85	-0.0200
			3	03/27/85	0.0250
				05/24/85	-0.0200
			4	03/27/85	0.0240
				05/24/85	-0.0200
NI	MG/L	NOT DEF	1	03/11/85	-0.0600
				03/27/85	-0.0600
				05/24/85	-0.0600
			2	03/26/85	-0.0600
				05/24/85	-0.0600
			3	03/27/85	-0.0600
				05/24/85	0.0735
			4	03/27/85	-0.0600
				05/24/85	-0.0600
P	MG/L	NOT DEF	1	03/11/85	-0.3000
				03/27/85	-0.3000
				05/24/85	-0.3000
			2	03/26/85	1.1000
				05/24/85	0.3280
			3	03/27/85	0.5500
				05/24/85	3.2700

(CONTINUED)

TABLE 10A. SUPPLEMENTARY GROUNDWATER QUALITY MEASUREMENTS FOR THE OHF SITE.

					MEASURED CONCENTRATION
CONSTITUENT	UNIT	MAXIMUM ALLOWABLE CONCENTRATION	WELL NUMBER	SAMPLE DATE	MEAN
P	MG/L	NOT DEF	4	03/27/85	-0.3000
				05/24/85	-0.3000
SB	MG/L	NOT DEF	1	03/11/85	-0.3000
				03/27/85	-0.3000
				05/24/85	-0.3000
			2	03/26/85	-0.3000
				05/24/85	-0.3000
			3	03/27/85	-0.3000
				05/24/85	-0.3000
			4	03/27/85	-0.3000
				05/24/85	-0.3000
SI	MG/L	NOT DEF	1	03/11/85	7.0400
				03/27/85	6.2000
				05/24/85	9.6700
			2	03/26/85	7.5000
				05/24/85	12.0000
			3	03/27/85	7.9000
				05/24/85	36.3000
			4	03/27/85	3.6000
				05/24/85	6.2400
SR	MG/L	NOT DEF	1	03/11/85	0.1260

(CONTINUED)

TABLE 10A. SUPPLEMENTARY GROUNDWATER QUALITY MEASUREMENTS FOR THE OHF SITE.

CONSTITUENT	UNIT	MAXIMUM ALLOWABLE CONCENTRATION	WELL NUMBER	SAMPLE DATE	MEASURED CONCENTRATION
					MEAN
SR	MG/L	NOT DEF	1	03/27/85	0.1400
				05/24/85	0.1420
			2	03/26/85	0.1800
				05/24/85	0.1210
			3	03/27/85	0.1100
				05/24/85	0.0895
			4	03/27/85	0.0650
				05/24/85	0.0498
TI	MG/L	NOT DEF	1	03/11/85	-0.0200
				03/27/85	0.0240
				05/24/85	-0.0200
			2	03/26/85	0.0260
				05/24/85	0.0537
			3	03/27/85	0.0270
				05/24/85	0.1030
			4	03/27/85	-0.0200
				05/24/85	-0.0200
V	MG/L	NOT DEF	1	03/11/85	-0.0300
				03/27/85	-0.0300
				05/24/85	-0.0300
			2	03/26/85	-0.0300

(CONTINUED)

TABLE 10A. SUPPLEMENTARY GROUNDWATER QUALITY MEASUREMENTS FOR THE OHF SITE.

					MEASURED CONCENTRATION
CONSTITUENT	UNIT	MAXIMUM ALLOWABLE CONCENTRATION	WELL NUMBER	SAMPLE DATE	MEAN
V	MG/L	NOT DEF	2	05/24/85	-0.0300
			3	03/27/85	-0.0300
				05/24/85	0.0962
			4	03/27/85	-0.0300
				05/24/85	-0.0300
ZN	MG/L	NOT DEF	1	03/11/85	0.0781
				03/27/85	0.0900
				05/24/85	-0.0200
			2	03/26/85	0.2100
				05/24/85	-0.0200
			3	03/27/85	0.1200
				05/24/85	0.1930
			4	03/27/85	0.3200
				05/24/85	0.0228
ZR	MG/L	NOT DEF	1	03/11/85	-0.0600
				03/27/85	-0.0600
				05/24/85	-0.0600
			2	03/26/85	-0.0600
				05/24/85	-0.0600
			3	03/27/85	-0.0600
				05/24/85	-0.0600

(CONTINUED)

TABLE 10A. SUPPLEMENTARY GROUNDWATER QUALITY MEASUREMENTS FOR THE OHF SITE.

					MEASURED CONCENTRATION
					MEAN
CONSTITUENT	UNIT	MAXIMUM ALLOWABLE CONCENTRATION	WELL NUMBER	SAMPLE DATE	
ZR	MG/L	NOT DEF	4	03/27/85	-0.0600
				05/24/85	-0.0600

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