1 of 1

ANNUAL REPORT OF 1991 GROUNDWATER
MONITORING DATA FOR THE KERR HOLLOW QUARRY
AND CHESTNUT RIDGE SEDIMENT DISPOSAL BASIN
AT THE Y-12 PLANT

Ground Water Surface Elevations

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MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
U. S. DEPARTMENT OF ENERGY
Under Contract no. DE-AC05-84OR21400

MASTER

February 1992

Y/TS-833/P1

Annual Report of 1991 Groundwater
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PURPOSE

The purpose of this document is to provide a summary and interpretation of hydraulic head measurements obtained from wells surrounding the Kerr Hollow Quarry and Chestnut Ridge Sediment Disposal Basin sites at the U.S. Department of Energy Y-12 Plant in Oak Ridge, Tennessee. Periodic water level observations are presented using hydrographs and water table contour maps based on data obtained from quarterly sampling during calendar year 1991. Generalized, preliminary interpretation of results are presented.

The two sites covered by this report have interim status under the provisions of the Resource Conservation and Recovery Act (RCRA). A subset of the wells at each site are used for groundwater monitoring purposes under the requirements of RCRA. A discussion of the up-gradient and down-gradient directions for each of the sites is included.

1.0 KERR HOLLOW QUARRY

Introduction

This document provides a summary and interpretation of hydraulic head data obtained from groundwater investigation wells surrounding the Kerr Hollow Quarry site at the Oak Ridge Y-12 Plant in Oak Ridge, Tennessee (Fig. 1-1). Water level data for calendar year (CY) 1991 are presented using hydrographs and water table elevation maps. Kerr Hollow Quarry is currently in the process of clean closure activities, and drums are being removed from the quarry. Analyses of hydrologic data at the site for CY 1987, 1988, 1989, and 1990 have been presented elsewhere (Haase, Gillis, and King 1988; and Early and Switek 1989, 1990, 1991 respectively).

Data Sources and Methods

Hydrologic data used in this report were obtained from the Y-12 Plant Groundwater Protection Program. The data were collected as part of that program's CY 1991 environmental monitoring activities. All data used in the preparation of this report are on file in the program's central data base, which is maintained and periodically updated by H & R Technical Associates (H&R), Oak Ridge, Tennessee.

Precipitation data for CY 1991 at site RG1 at Walker Branch Creek in Bethel Valley, located approximately 3.5 miles southwest of Kerr Hollow Quarry (Fig. 1-1), are illustrated in Fig. 1-2. Precipitation data were accumulated on a daily basis by Environmental Consulting Engineers, Knoxville, TN, on contract to Oak Ridge National Laboratory (ORNL), Environmental Sciences Division (ESD). The precipitation data which is illustrated in this figure is preliminary and has not yet been validated. The data will be validated and become part of the data set included in the Annual Hydrologic Data Summary for the White Oak Creek Watershed, Water Year 1991, which was being prepared by ESD staff at the time this document was being completed. The data will also be entered on the ORNL SAS database (Hook, et al., 1990). Note that precipitation data for October, November and December, 1991 was not available at the time of preparation of this document.

Water level measurements in groundwater investigation wells were taken on a quarterly basis by K-25 personnel. Water levels are routinely measured just prior to the quarterly groundwater sampling at each well (Fig 1-3). Measurements were made with an electronic-

Figure 1-1. Index Map of the Kerr Hollow Quarry Site

Daily Total Precipitation for 1991
Site = Rain Gauge RG1

Figure 1-2. Graph of 1991 Y-12 Plant Precipitation Data from Rain Gauge RG1.

Figure 1-3. Well location map for the Kerr Hollow Quarry Site.
Elevation Values are Given in Feet.

tape device. Quarry water level measurements were not obtained during 1991.

Because the water table at the site may be locally influenced by purging activities associated with quarterly groundwater sampling, the water table contour map (Fig. 1-8) is based on water levels measured on December 5, 1991. Both true north and Y-12 grid north are shown on all maps. Observations and conclusions presented in this report are referenced to Y-12 grid north.

Site Background

Kerr Hollow Quarry is located on a low ridge running along the north side of Bethel Valley (Fig. 1-1). The quarry was active in the 1940s and was abandoned sometime in the late 1940s. Since the early 1950s the quarry has been used for the disposal of reactive materials from the Y-12 Plant and from Oak Ridge National Laboratory (Haase et al. 1987).

Kerr Hollow Quarry is located at the contact between the Newala Formation of the Knox Group and Unit A of the Chickamauga Group. At the site, the contact is an unconformity and exhibits approximately 50 to 100 ft of topographic relief. The uppermost Knox Group at this site consists of medium-bedded to massive dolostone with locally abundant nodular-to-bedded chert occurring throughout. The basal portion of the Chickamauga Group consists of abundant thin-to-medium bedded maroon and gray siltstones, thin-bedded limestones, and less-abundant-to-rare, nodular-to-bedded chert. As with other strata in the Oak Ridge vicinity, both the upper Knox Group and the basal Chickamauga Group are pervasively jointed, with predominant joint directions being parallel and perpendicular to geological strike, which is approximately parallel to the ridge crests. In the vicinity of Kerr Hollow Quarry, an additional joint set trends approximately north-south (Haase et al. 1987; Law Engineering 1983).

Evaluation of geophysical logs and drill core obtained from boreholes at this site suggest that there are thin (<1 to 3 ft), relatively permeable, fractured zones occurring within bedrock to depths of at least 600 ft (Haase and King 1987). Data indicate that groundwater movement within the bedrock occurs principally within fractures and fracture systems and not dominantly within any one stratigraphic unit.

Hydrologic Data

Well Network

Seven groundwater investigation wells (GW-142, GW-143, GW-144, GW-

145, GW-146, GW-147, and GW-231) were installed surrounding the Kerr Hollow Quarry site in 1985 (Fig. 1-3). An eighth boring at the site (CH-143) is an exploratory corehole used for subsurface characterization. The corehole was not completed as a well and was plugged during casing and grouting operations at adjacent groundwater investigation wells. Construction details for the wells are presented by Haase, Gillis, and King (1987).

Wells GW-147 and GW-231 form a piezometer cluster at the northwestern edge of the site that penetrates unconsolidated material and the top of bedrock zone. The remaining wells monitor various fractures and fracture zones identified in the exploratory corehole. Wells GW-143 and GW-144 form a piezometer cluster south of the site to investigate several small fracture zones occurring in two 50 ft long intervals in the upper bedrock. Wells GW-145 and GW-146 form a piezometer cluster southwest of the site to investigate fracture zones within shallow and deep bedrock intervals. Well GW-142 also investigates several fracture zones within the upper bedrock.

Water Levels and Hydrographs

During CY 1991 water level data collection for wells at the Kerr Hollow Quarry site continued on a quarterly basis. Hydrographs for the water table wells are illustrated in Fig. 1-4 and those for the northwestern, southwestern, and southern piezometer clusters are illustrated in Figs. 1-5 through 1-7, respectively. Elevations for surface water in Kerr Hollow Quarry itself were not measured during 1991 due to closure activities at the site.

Throughout most of CY 1991 the water levels in the water table wells exhibited similar variations. In contrast to earlier studies at Kerr Hollow Quarry in which water level fluctuations could be correlated to precipitation patterns (Haase, Gillis, and King 1988 and Early and Switek 1989), the low frequency of these measurements during 1989, 1990, and 1991 prohibits this type of analysis (Early and Switek 1990). The 1991 water level data generally exhibit variations in the water table through time similar to those observed in previous years. In 1990, water levels measured in wells GW-142, GW-145 and GW-231 had the highest water table elevations, while well GW-144 had lower head levels, except during September when the water level in GW-142 was slightly lower (Early and Switek, 1991). This general pattern of water levels seen in 1990 is consistent with earlier studies.

Hydrographs for wells GW-147 and GW-231, the northwestern piezometer cluster (Fig. 1-5), suggest that the hydrologic systems monitored by these two wells are closely linked. The same results were obtained in 1990. Neither well consistently exhibited the higher hydraulic head so that no conclusion regarding vertical head gradients during 1990 or 1991 can be made. However, water level

Figure 1-4. Hydrographs for Water Table Wells in 1991 at the Kerr Hollow Quarry Site. Vertical Axis Represents Hydraulic Head Measured in Feet above Mean Sea Level.

Figure 1-5. Hydrographs for the Northwestern Piezometer Cluster in 1991 at the Kerr Hollow Quarry Site. Vertical Axis Represents Hydraulic Head Measured in Feet Above Mean Sea Level. Values in Parentheses Following Well Numbers are Total Depths of Wells Below Ground Surface.

Figure 1-6. Hydrographs for the Southwestern Piezometer Cluster in 1991 at the Kerr Hollow Quarry Site. Vertical Axis Represents Hydraulic Head Measured in Feet Above Mean Sea Level. Values in Parentheses Following Well Numbers are Total Depths of Wells Below Ground Surface.

Figure 1-7. Hydrographs for the Southern Piezometer Cluster in 1991 at the Kerr Hollow Quarry Site. Vertical Axis Represents Hydraulic Head Measured in Feet Above Mean Sea Level. Values in Parentheses Following Well Numbers are Total Depths of Wells Below Ground Surface.

data for 1988 for these two wells suggest the existence of a downward gradient (Early and Switek, 1989). One possible source of uncertainty in the present study is limitations imposed by quarterly measurements, such that fluctuations in water levels corresponding to increased precipitation or to well purging activities associated with water quality sampling may not be recognized, or may mask the true vertical gradient.

Water levels in all wells were measured December 5, 1991, one full month after GW-147 and GW-231 were sampled. Assuming the wells had fully recovered from the previous sampling event by December 5, these water level data are a more reliable indicator of local, vertical gradients than those plotted on the hydrographs. The measured water level in GW-147 (total depth of 69 feet) was 838.62 feet AMSL (above mean sea level) while that in GW-231 (total depth of 35 feet) was 838.97 feet. These December 5 data suggest only a very slight downward gradient between GW-231 and GW-147. Hence, 1991 data mimic those obtained in 1990, both of which indicate that the hydrologic systems monitored by these wells are closely linked.

Hydrographs for wells GW-145 and GW-146, the southwestern piezometer cluster (Fig. 1-6), are in sharp contrast to those observed in Fig. 1-5 for wells GW-147 and GW-231 in both 1990 and 1991. Previous studies of more detailed water level data for these wells demonstrate that the response of well GW-146 is characteristic of low permeability conditions and exhibits a very slow recovery to pumping events associated with groundwater sampling activities (Haase, Gillis, and King 1988 and Early and Switek 1989). The hydrographs in Fig. 1-6 suggest that there may be a downward hydraulic head gradient at the site of the cluster. However, the existence and magnitude of the gradient may be uncertain if well GW-146 did not recover to steady state conditions during the period of observation.

Hydrographs for wells GW-143 and GW-144, the southern piezometer cluster appear in Fig. 1-7. The wells in the southern cluster exhibit generally similar response characteristics, suggesting that the two bedrock intervals investigated by these piezometers are linked. During 1991, as in previous years, GW-143 generally exhibited slightly higher hydraulic head, indicating a small upward vertical gradient at this part of the site.

Water Table Map

A water table elevation map (Fig. 1-8) is presented for conditions on December 5, 1991. Water table elevations for the wells at Kerr Hollow Quarry are given, and water table elevation contours are illustrated. Because of the very shallow gradient of the water table, such contours are generalized and subject to significant uncertainty. Water level data from other studies suggest that the

Figure 1-8. Water Table Elevation Contour Map from water levels measured on December 5, 1991 at the Kerr Hollow Quarry Site.

groundwater table is closely linked to the water level of the quarry (Haase, King, Gillis, Kimbrough, and Mercier 1987; Haase, Gillis and King 1988; and Early and Switek 1989). Although no water level data for the quarry are available for 1991, the configuration of the water table illustrated in Fig. 1-8 appears to be consistent with local control by the quarry reservoir and a similar configuration was observed in 1990. The water table map suggests that there is groundwater flow in a southerly, and locally southwesterly direction, dominantly directed toward well GW-144.

Summary

Hydrologic data for the Kerr Hollow Quarry locality suggest that the shallow groundwater system is seasonably variable and closely associated with the water level of the quarry reservoir. The water table in the vicinity of the quarry is relatively flat, with only small, lateral hydraulic head gradients observed across the entire site.

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2.0 CHESTNUT RIDGE SEDIMENT DISPOSAL BASIN

Introduction

This document provides a summary and interpretation of hydraulic head data obtained from groundwater investigation wells surrounding the Chestnut Ridge Sediment Disposal Basin (CRSDB) site at the Oak Ridge Y-12 Plant in Oak Ridge, Tennessee (Fig. 2-1). Water level observations for calendar year (CY) 1990 are presented using hydrographs and water table elevation maps. A preliminary interpretation of results is presented to satisfy the annual reporting requirement specified in section 1200-1-11-.05 (6)(e)(1)(ii)(lll) of the State of Tennessee Rule 1200-1-11-.05 Interim Status Standards for Owners and Operators of Existing Hazardous Waste Treatment, Storage, and Disposal Facilities. The CRSDB has been closed in place as a RCRA Interim Status Facility. Analyses of hydrologic data at the site for CY 1987, 1988, 1989, and 1990 have been presented elsewhere (Haase, Gillis, and King 1988; and Early and Switek 1989, 1990, 1991, respectively).

Data Sources and Methods

Hydrologic data used in this report were obtained from the Y-12 Plant Groundwater Protection Program. The data were collected as part of that program's CY 1991 environmental monitoring activities. All data used in the preparation of this report are on file in the Program's central data base, which is maintained and periodically updated by H & R Technical Associates (H&R).

Precipitation data for CY 1991 at site RG1 at Walker Branch Creek in Bethel Valley, located approximately 3.5 miles southwest of the CRSDB (Fig. 2-1), are illustrated in Fig. 2-2. Precipitation data were accumulated on a daily basis by Environmental Consulting Engineers, Knoxville, TN, on contract to Oak Ridge National Laboratory (ORNL), Environmental Sciences Division (ESD). The precipitation data which is illustrated in this figure is preliminary and has not yet been validated. The data will be validated and become part of the data set included in the Annual Hydrologic Data Summary for the White Oak Creek Watershed, Water Year 1991, which was being prepared by ESD staff at the time this document was being completed. The data will also be entered on the ORNL SAS database (Hook, et al., 1990). Note that precipitation data for October, November and December, 1991 was not available at the time of preparation of this document.

Water level measurements in groundwater investigation wells were taken on a quarterly basis by K-25 personnel. Water levels are routinely measured just prior to the time of quarterly groundwater sampling at these wells (Fig. 2-3). Measurements were made with an electronic-tape device.

Figure 2-1. Index Map of the Chestnut Ridge Sediment Disposal Basin Site.

Figure 2-2. Graph of 1991 Precipitation Data from Rain Gauge RG1.

Figure 2-3. Well Location Map for the Chestnut Ridge Sediment Disposal Basin Site. Elevations Values are Given in Feet Above Mean Sea Level. The triangles mark the locations of the destroyed, and plugged and abandoned wells. GW-155 is replaced by GW-732, and GW-157 is replaced by GW-731.

The water table contour map was based on data collected on December 5, 1991. Both true north and Y-12 grid north are shown on all maps, yet observations and conclusions presented in this report are referenced to Y-12 grid north.

Site Background

The Chestnut Ridge Sediment Disposal Basin (CRSDB) is located on Chestnut Ridge, immediately southeast of the eastern end of the Y-12 Plant (Fig. 2-1). It is approximately 900 ft southeast of New Hope Pond. The site is located in soils and residuum developed on strata of the Copper Ridge Dolomite, which is the lowermost formation in the Knox Group. Depth to bedrock at the site ranges from 50 to 100 ft (Haase et al. 1987; Haase et al. 1988).

The Copper Ridge Dolomite is a massive to thinly-bedded dolostone with locally abundant horizons of nodular-to-bedded chert. It strikes northeast to southwest, relative to true north, and dips 40 to 50 degrees to the southeast (King and Haase 1987). Throughout the Oak Ridge area, the Copper Ridge Dolomite is pervasively jointed and fractured; the orientations of these features are principally parallel to and perpendicular to strike, although some variability is noted (Law Engineering 1983; Ketelle and Huff 1984). The Copper Ridge Dolomite also exhibits solutional widening of fractures and other karst features, and it is believed that such features strongly influence groundwater flow at sites underlain by Knox Group strata (Ketelle and Huff 1984).

Hydrologic Data

Well Network

Ten groundwater investigation wells have been installed at the CRSDB site (Fig. 2-3). Wells 1095 and 1096 were installed in 1983 and six additional wells (GW-155, GW-156, GW-157, GW-158, GW-159, and GW-241) were installed in 1985. Wells GW-303 and GW-304 were completed in 1987 and 1988, respectively. During routine monitoring well inspections in 1991, wells GW-155 and GW-157 were found to be deteriorated beyond rehabilitation and were, therefore, subsequently plugged and abandoned. Replacement wells GW-732 and GW-731 were installed during September, 1991 (SAIC 1991a and 1991b). GW-732 is located slightly to the west of the GW-155 location, while GW-731 was drilled just to the west of the GW-157 location. Details of well constructions are summarized elsewhere (Haase, Gillis, and King 1987a,b; Geraghty and Miller 1988; EDGE 1989; SAIC 1991b). An eleventh boring at the site is an exploratory corehole (C-157) drilled for subsurface characterization (Haase, Gillis, and King, 1987a).

All of the groundwater investigation wells, except GW-158 and GW-303, are finished within a zone at the top of bedrock characterized

by weathered dolostone and chert and by pervasive solutionally widened fractures and solution cavities (Haase, Gillis, and King 1987a). Well GW-158 is finished in bedrock within a fractured interval at a depth of 440 feet and forms a piezometer cluster with well GW-241 south of the site. Well GW-303 is completed within bedrock over a depth interval of 300 to 321 ft and forms a piezometer cluster with well to the north of the site 1095.

Water Levels and Hydrographs

During 1991 water level data collection continued on a quarterly basis. Hydrographs for the shallow water table wells surrounding the CRSDB site are illustrated in Fig. 2-4. Hydrographs for the southern piezometer cluster (GW-158 and GW-241) are illustrated in Fig. 2-5.

With the exception of observations made at the end of October, the southernmost well at the CRSDB site, GW-241, had the highest head during 1991. This finding is consistent with water level measurement results reported by Early and Switek (1990, 1991) for 1989 and 1990. However, during 1988 well GW-159 had the highest water level at the site (Early and Switek 1989). These observations may be a reflection of the unusually high amount of precipitation recorded during 1989 and 1990, which followed an anomalously dry year in 1988.

Hydrographs for wells GW-158 and GW-241, which constitute a piezometer cluster approximately 400 ft south of the CRSDB site, are illustrated in Fig. 2-5. In contrast to observations made during 1989 (Early and Switek, 1990) the hydrographs suggest that there was a downward hydraulic gradient at the site during the first half of 1990 and 1991 that reversed during the latter half of these years. Haase, Gillis, and King (1988) noted that during periods of increased precipitation in CY 1987 a reversal in vertical gradient occurred, with well GW-241 exhibiting the higher head. Consequently, it is concluded that the high water level observed in well GW-241 and the downward head gradient in this cluster for the first 6 to 7 months of 1991 is related to the high precipitation recorded for that part of the year. The head gradient reversal that occurs at this well cluster later in the year may be related to a reduction in the amount of precipitation recorded during the second half of the year. This apparent relationship with precipitation suggests that well GW-241 may be more responsive than other wells at the site to variations in precipitation. It is possible that the existence of localized fractures or solution channels in shallow bedrock in the vicinity of well GW-241 facilitates recharge.

Water Table Map

Water table elevation contour maps are presented in Fig. 2-6 for

Figure 2-4. Hydrographs for Water Table wells in 1991 at the Chestnut Ridge Sediment Disposal Basin Site. Vertical Axis Represents Hydraulic Head Measured in Feet Above Mean Sea Level.

Figure 2-5. Hydrographs for the Southern Piezometer Cluster in 1991 at the Chestnut Ridge Sediment Disposal Basin Site. Vertical Axis Represents Hydraulic Head Measured in Feet Above Mean Sea Level. Values in Parentheses Following Well Numbers are Total Depths of Wells Below Ground Surface.

Figure 2-6. Water Table Elevation Contour Map from water levels measured December 5, 1991 at the Chestnut Ridge Sediment Disposal Basin Site.

Figure 2-7 Water Table Elevation Contour Map from water Levels measured in 1990 at the Chestnut Ridge Sediment Disposal Basin.

data obtained at the CRSDB site on December 5, 1991, and in Fig. 2-7 for data obtained in early March, 1990.

Water levels were not measured in well 1095 in 1990, yet they were measured in December, 1991. The additional data in 1991 allows for a slightly different interpretation of the water level contours. In 1990, it was unclear how the water level in well GW-241 (south of the site) was related to the rest of the site (see Fig. 2-7). It was interpreted that the high water table elevation in this area is "localized and subject to significant fluctuations related to the amount of precipitation and local recharge conditions" (Early and Switek 1991). The 1990 data indicated that the total hydraulic head generally decreased across the site toward the east. With the exception of the apparent outlier (ie. well GW-241), well GW-159 exhibited the highest hydraulic head and was the up-gradient well for the CRSDB site. Wells GW-155 (replaced in 1991 by GW-732) and GW-156, the easternmost wells, had the lowest hydraulic heads while wells GW-157 and GW-304 had heads intermediate between heads measured in the upgradient and downgradient wells in 1990.

The same general flow direction and relationship between monitoring wells is observed in the 1991 data. However, inclusion of well 1095 in the 1991 data set allows an interpretation of well GW-241 which is more consistent with the data obtained in the other CRSDB monitoring wells (Fig. 2-6). The alternative interpretation presented in Fig. 2-6 indicates that local groundwater flow is generally parallel to sub-parallel to geologic strike, and likely to be controlled by strike-parallel fractures and solutionally enlarged joints and fractures. Both fractures and cavities (up to six feet in height) were intersected while drilling wells GW-155, -156, -157, -159, -731, and -732 (SAIC 1991b; King et al. 1991), indicating the likelihood of karst behavior in solutionally enlarged, strike-parallel, or nearly strike parallel fractures (Ketelle and Huff, 1984; Law Engineering, 1983). In addition, the water level contours (Fig. 2-6) suggest that groundwater flow from the west and south may be directed toward the location of the disposal basin which was possibly constructed in a sinkhole. It is noted that interpretation of water level data in karst aquifers can be difficult, and unambiguous interpretations are difficult to obtain. Nevertheless, the 1991 water level data suggest that the presence of a sinkhole at the CRSDB may locally affect the groundwater flow at the site and may act as a local drain. However, the overall trend of the contours illustrated in Fig. 2-6 is generally consistent with that reported by Early and Switek (1989, 1990, 1991) for 1988, 1989, and 1990, (see Fig. 2-7) in that well GW-159 is up-gradient of the basin and GW-156 and GW-732 are down-gradient of the site. In general, the configuration of the water table in Fig. 2-6 is believed to be representative of hydrologic conditions at the site throughout CY 1991.

Summary

Hydrologic data for the CRSDB site indicate that groundwater flow directions within the shallow system are generally to the east. Data from the piezometer cluster at the southern edge of the site indicate that there is the potential for downward flow during the first six months of the year. Based on water level observations made at this cluster over the past several years, it is apparent that periodic reversals in the vertical hydraulic head gradient have occurred in response to changes in the amount of precipitation.

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