UNITED STATES
NUCLEAR REGULATORY COMMISSION
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January 26, 2007

MEMORANDUM TO: Jamnes L. Cameron, Branch Chief
Decommissioning Branch
Division of Nuclear Material Safety
Region III

FROM: B. Jennifer Davis, Acting Branch Chief
Performance Assessment Branch
Division of Waste Management
and Environmental Protection
Office of Federal and State Materials
and Environmental Programs

SUBJECT: ENVIRONMENTAL PROTECTION AND PERFORMANCE ASSESSMENT DIRECTORATE'S TECHNICAL EVALUATION REPORT ON BATTELLE'S GROUNDWATER MONITORING PLAN AND THE RADIOLOGICAL IMPACT OF SITE ACTIVITIES ON THE GROUNDWATER AT THE WEST JEFFERSON NORTH SITE, WEST JEFFERSON, OHIO

The Environmental Protection and Performance Assessment Directorate (EPPAD) has conducted a technical evaluation of Battelle's groundwater monitoring plan and the radiological impact of site activities on the groundwater at the West Jefferson North site near West Jefferson, Ohio that was requested by Region III's Decommissioning Branch.

It is the EPPAD staff's assessment that the original and supplemental groundwater monitoring plans are adequate to address the potential site-generated radionuclides in the groundwater at this site. The EPPAD staff has also concluded that site-generated radionuclides have not impacted any drinking water aquifers or water-bearing units at this site or nearby areas.

The enclosed Technical Evaluation Report completes the Decommissioning Branch's Technical Assistance Request to EPPAD dated March 11, 2006.

License No.: SNM-00007
Docket No.: 070-00008

Enclosure: Technical Evaluation Report
Attachment 1: Tables
Attachment 2: Figures

CONTACT: Jon Peckenpaugh, FSME/DWMEP
301-415-6753

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TECHNICAL EVALUATION REPORT ON BATTELLE'S GROUNDWATER MONITORING PLAN AND THE RADIOLOGICAL IMPACT OF SITE ACTIVITIES ON THE GROUNDWATER AT THE WEST JEFFERSON NORTH SITE, WEST JEFFERSON, OHIO

DATE: January 26, 2007

FACILITY: West Jefferson North Site, West Jefferson, Ohio

License No.: SNM-7

TECHNICAL REVIEWER: Jon Peckenpaugh, EPPAD

PROJECT MANAGER: George M. McCann, Region III

SUMMARY AND CONCLUSIONS

The Environmental Protection and Performance Assessment Directorate (EPPAD) has conducted a technical evaluation of Battelle's groundwater monitoring plan and the radiological impact of site activities on the groundwater at the West Jefferson North site near West Jefferson, Ohio that was requested by Region III's Decommissioning Branch.

It is the EPPAD staff's assessment that the original and supplemental groundwater monitoring plans are adequate to address the potential site-generated radionuclides in the groundwater at this site.

The radiological results since 1970 indicate that water supply well JN-W in the West Jefferson Nuclear Sciences Area and the other two water supply wells outside this area are not impacted by site-generated radionuclides. The shallow groundwater units (surface till unit, alluvial unit, and the 885 sand layer) have been impacted by site-generated radionuclides. However, the low yield and shallow depth to the groundwater in these units precludes their use as a source of drinking water. Also, the State of Ohio requires that drinking water wells be screened at depths of 25 feet or more below the land surface. The radiological results for the 855-sand layer and the basal sand unit indicate that they are not impacted by site-generated radionuclides.

Therefore, the EPPAD staff has concluded that site-generated radionuclides have not impacted any drinking water aquifers or water-bearing units at this site or nearby areas.

BACKGROUND

Region III on March 11, 2005, submitted a Technical Assistance Request (TAR) to the Environmental Protection and Performance Assessment Directorate (EPPAD) that requested a review of Battelle Memorial Institute's (Battelle) groundwater sampling plan for the West Jefferson Nuclear Sciences Area and nearby areas (West Jefferson North site). The specific purpose of the review was to determine whether this plan adequately addressed the procedures

to identify and sample the site-generated radionuclides in the groundwater. The scope of this TAR was expanded to include an evaluation of the occurrence and concentration of the site-generated radionuclides present in the groundwater.

The West Jefferson Nuclear Sciences Area is located in the northern portion of Battelle's West Jefferson facility which is approximately 17 miles west of Columbus, Ohio. Figure 1 (Figure 2 from ECC & E2 Closure Services, LLC, 2004a) shows the relationship of the 10-acre Nuclear Sciences Area (NSA) with respect to the entire West Jefferson site and the nearby streams, roads, and county boundaries. The NSA is bounded on the east by the terrace and flood plain of Big Darby Creek and on the south and southwest by Silver Creek Reservoir.

Battelle used the NSA to perform research and development (R&D) activities for the Manhattan Engineering District and its successor agencies -- the Atomic Energy Commission, the Energy Research and Development Agency, and the U.S. Department of Energy (DOE). The R&D activities at the NSA started with the Hot Cell Building (JN-1) in 1955. Work conducted in JN-1 included the evaluations of power and research reactor fuels until 1988. The two other building at NSA are the former Critical Assembly Laboratory (JN-2) and the former Research Reactor Building (JN-3). Both of these buildings are significantly less contaminated than the Hot Cell Building. The licensee has completed decommissioning of these three buildings and adjacent soils, including the filter beds that were used for the sanitary and laboratory disposal systems. The primary radioactive contaminants in the NSA are transuranic wastes, mixed fission products, and activation products. The licensee has already decommissioned and terminated the license for the former Plutonium Building (JN-4) in this area.

PHYSIOGRAPHY AND GEOLOGY

The NSA is a flat bluff that is gently sloping except for the V-shaped valley of Silver Creek, which is now dammed forming Silver Creek Reservoir, sometimes referred to as Battelle Lake. The elevation of the land surface of the NSA ranges from about 900 to 910 feet mean sea level (MSL). The eastern edge of the bluff drops sharply to approximately 870 feet MSL on a terrace of Big Darby Creek and to 860 feet MSL within the flood plain of Big Darby Creek. The terrace and flood plain are heavily vegetated with deciduous trees, shrubs, and grasses (ECC & E2 Closure Services, LLC, 2004a).

The NSA is underlain by Quaternary age (Pleistocene) glacial till and outwash deposits. The glacial till thickness is estimated to be 40 to 160 feet in this area. Construction fill materials are also present within the NSA. Three soils types have developed on the NSA with a thickness of a few feet up to 6 feet. In the terrace and flood plain of Big Darby Creek, the surficial material is alluvium between 10 to 15 feet deep. A fourth soil has formed on the alluvium in this area from the parent alluvial materials.

The glacial till consists of a heterogeneous mixture of clay, silt, and sand with variable amounts of gravel. Borings for the dam (Silver Creek Reservoir) and the well logs indicate that at least two outwash deposits of sand and gravel with variable thicknesses are present within the till at the site. One of these outwash deposits separates the upper brown till from a lower grey till. The alluvium is stratified deposits of silt, fine to medium sand, and clay. The sand layers within the alluvium are generally thin (Beard and Gupta, 1990).

Devonian and Silurian age bedrock units of limestone and dolomite rocks are beneath the lower grey till, and in some areas a basal sand underlies the grey till. These bedrock units are approximately 500 feet thick in this area. The upper limestone unit is the drinking water aquifer for the site and nearby areas.

The major geologic materials present at this site are soil, alluvial deposits, fill materials, glacial till and outwash deposits, and limestone bedrock.

SURFACE WATER

Big Darby Creek and Silver Creek Reservoir are the principal surface water features impacting this site. Big Darby Creek is a perennial stream approximately 800 feet east of NSA. Big Darby Creek's average annual stream flow (over a 75 year period) is 472 cubic feet/second (CFS) at the U.S. Geological Survey Darbyville gaging station (USGS 03230500) approximately 20 miles south and downstream from this site (ECC & E2 Closure Services, LCC, 2004a). The elevation of the surface water in Big Darby Creek is slightly below 860 feet MSL (Beard and Gupta, 1990).

Silver Creek, a tributary to Big Darby Creek, has been dammed forming Silver Creek Reservoir. The outflow from this reservoir is discharged into Big Darby Creek. Silver Creek Reservoir has a surface water elevation of approximately 888 feet MSL.

HYDROGEOLOGY

The hydrogeologic system at the NSA consists of approximately 100 feet of unconsolidated glacial deposits that overlie the limestone bedrock. Big Darby Creek has eroded several feet of the glacial deposits and deposited a few feet of alluvial materials along the eastern edge of the site. The hydrogeologic system, potentially impacted by site operations, contains six water-bearing units. Two shallow unconfined water-bearing units that contain the uppermost groundwater surface, a surface till unit and an alluvial unit, have low water yield capacity. Both of these water-bearing units are less than 25 feet below the land surface. Therefore, these units should not be used for human drinking water because the State of Ohio will not issue permits for any public or private water supply wells that are screened at depths less than 25 feet below the land surface.

The third water-bearing unit is the 885 sand layer, which is either confined or unconfined in this area. It is a very thin glacial deposit composed of sandy till approximately 30 feet below the land surface at about 885 feet MSL within the clay-rich till. In a few locations, this unit has the ability to slowly seep groundwater into wells. The sandy horizon outcrops along embankments, the sloping areas near Silver Creek Reservoir, and the bluff or upland adjacent to the Big Darby Creek terrace and flood plain. This material likely represents a period of high energy glacial melt water depositing outwash sand between long periods of till deposition. This unit has been detected in about half the borings throughout the site, and its areal extent has been recently delineated by the August -September 2006 drilling program where nested monitoring wells were installed within the NSA and within the area between the NSA and Big Darby Creek. The lateral extent of this unit beyond the site is unknown, and its vertical thickness is not well defined under the site. Well logs from domestic water supply wells in the region have not identified the 885 sand layer.

Another thin water-bearing unit, the 855 sand layer, is located approximately 60 feet below the NSA land surface at approximately 855 feet MSL within the unconsolidated glacial deposits. The medium to coarse sand unit varies from about 0.5 to 10.0 feet in thickness. This material also likely represents a period of high energy glacial melt water depositing outwash sand between long periods of till deposition. This confined unit has been detected in several borings throughout the site and in the nested monitoring wells that were installed during the August-September 2006 drilling program. However, the lateral extent beyond the site is unknown. Well logs from domestic water supply wells in the region have not identified the 855 sand layer. The licensee has estimated from slug tests that the hydraulic conductivity of this unit is approximately 1.0×10^{-4} cm/sec. This unit is unsuitable for domestic water supply because of its low sustainable yields, ranging from 0.5 to 2 gallons per minute.

The fifth water-bearing unit is the basal sand unit or the 805 sand layer. It is near the base of the till above the weathered limestone bedrock. It is most likely an outwash sand that was deposited between till deposition. This confined unit was present in 5 of the 8 monitoring wells installed during the August-September 2006 drilling program with a sand thickness ranging from 1 to 9 feet. The licensee believes that this unit is hydraulically connected to the underlying limestone bedrock aquifer; however, some well logs indicate a thin layer of till lies beneath this unit and above the bedrock.

The deepest water-bearing unit at the West Jefferson site that could potentially be impacted by site activities is the confined limestone bedrock aquifer. Three water supply wells in the limestone bedrock aquifer are used for the site's drinking water, and the north water supply well with a depth of 130 feet below the land surface is located within the NSA. Since 1970, the licensee has monitored and analyzed these wells for radiological and drinking water parameters every six months.

The groundwater discharge areas of the surface till unit, alluvial unit, 885 sand layer, and 855 sand layer are either Big Darby Creek or Silver Creek Reservoir. The groundwater flow in the basal sand unit is toward Big Darby Creek.

The references for this section are Beard and Gupta (1990); (ECC & E2 Closure Services, LLC, 2004b); Battelle (1990, 2006a, 2006b, 2006c); and Bowser Morner (2006).

GROUNDWATER MONITORING PLAN

As previously mentioned, the original purpose of this TAR was to address whether the groundwater sampling plan (that is, the groundwater monitoring plan) adequately addressed the procedures to identify and sample the site-generated radionuclides in the groundwater. The licensee documented its groundwater monitoring plan in its Environmental Monitoring Plan (EMP), which contains several monitoring issues besides groundwater (ECC & E2 Closure Services, LLC, 2004b). Because the initial plan addressed only the potential site-generated radionuclides in the surface till unit, the alluvial unit, and the 885 sand layer, the groundwater monitoring plan as presented in the EMP was not adequate. The impact of potential radionuclides in the 855 sand layer and basal sand unit should have also been addressed.

However, before the licensee expanded its monitoring program with the monitoring wells installed during the August-September 2006 drilling program, it supplemented the original

groundwater monitoring plan with a groundwater monitoring plan for these new monitoring wells (Battelle, 2006a). It is EPPAD staff's assessment that the original and supplemental groundwater monitoring plans are adequate to address the potential site-generated radionuclides in the groundwater at this site.

GROUNDWATER MONITORING

The groundwater monitoring at the West Jefferson North site has evolved over time to serve different purposes. The earliest groundwater monitoring pertained to the three water supply wells. Later, wells were installed to monitor the radiological and chemical parameters dissolved in the shallow groundwater. During site characterization for decommissioning the facility, wells and piezometers were installed to monitor groundwater levels. Recently, nested wells were installed to monitor potential migration of radionuclides into the deeper sand layers.

Groundwater monitoring at the West Jefferson North site began with sampling and analysis of the north water supply well, JN-W, in the NSA. This well and the other two water supply wells that are located south of the NSA have been sampled and analyzed for radionuclides and drinking water parameters semi-annually since 1970 (ECC & E2 Closure Services, LLC, 2004b).

Twelve shallow radiological and three shallow chemical monitoring wells were installed in the summer and fall of 1989. The bottom five feet of these wells were screened in either the surface till unit or the 885 sand layer. Figure 2 shows the location of these wells, and Table 1 lists the monitoring wells at the West Jefferson North site during the 2000 to 2003 monitoring periods. This table delineates the well depth, land surface elevation in feet MSL, and the depth to water during June and November 2000. The groundwater flow directions for the potentiometric surfaces of the water-bearing surface till unit and the 885 sand layer are toward the Silver Creek Reservoir and toward Big Darby Creek along the northeast area of the NSA. Only some of these wells are still used because remediation has required the removal of several monitoring wells.

Six shallow piezometers were installed within and near the retired filter beds area within the terrace and flood plain of Big Darby Creek in September 1995. Additional shallow piezometers have been installed in or near the retired filter beds since 1995. Several of these piezometers are delineated on Figure 2. The retired filter beds have been remediated.

Piezometers and monitoring wells were installed in the early 2000's to characterize the groundwater flow patterns in the NSA and to provide support for site remediation. Six piezometers were installed near buildings JN-1, JN-2, and JN-3 to depths of 22 feet to obtain information on the hydrology of the fill near these buildings. See Figure 5 from Battelle (2006a) for the location of these piezometers. Water levels for these piezometers were measured from October 2001 to August 2002 (Battelle Environmental Restoration Department, 2002). Twenty-two monitoring wells were installed in the 885 sand layer, 855 sand layer, and basal sand unit during 2002 and 2003 to determine the groundwater flow directions in these units. See Figures 4 and 6 from Battelle (2006a) for the location of these wells. The licensee's report, *West Jefferson North Facility: Monitoring Well Cluster Location Plan* (Battelle, 2006a) contains more details on this groundwater characterization program. These monitoring wells were abandoned in 2004.

During the August-September 2006 drilling program, 22 monitoring wells were installed in either the 885 sand layer, 855 sand layer, or the basal sand unit to evaluate the potential radionuclide contamination of these water-bearing units. Nine wells were installed in the NSA area, and 13 wells were installed in the area between NSA and Big Darby Creek, that is down gradient from the NSA. Figure 3 [from Battelle (2006a)] shows the location of these 22 monitoring wells. This drilling program, which is discussed in the *West Jefferson North Facility: Monitoring Well Cluster Location Plan* (Battelle, 2006a), was developed because the licensee's December 2005 sampling event indicated that the two caisson wells near the JN-1B Facility contained elevated Sr-90 values. These caisson wells were installed in the 885 sand layer. Therefore, there was a likelihood that radionuclides were present in the 885 sand layer and the water-bearing units below the 885 sand layer.

RADIOLOGICAL ANALYSIS

The radiological evaluation of the groundwater at this site has expanded as the licensee became aware of potential site-generated radionuclides in the groundwater. Since 1970, the three water supply wells at this site have been sampled and analyzed for radionuclides in the groundwater semi-annually. Well JN-W and the two other water supply wells have never tested positive for any radionuclide above background levels. Groundwater samples from twelve shallow radiological and three chemical wells (installed in 1989), six shallow piezometers within and near the retired filter beds (installed in 1995), and additional piezometers within and near the retired filter beds have been annually collected and analyzed for site-generated radionuclides. Other wells and piezometers have been sampled and analyzed for radionuclides on a less frequent and regular basis or on a one-time only basis (for example, the two caisson wells near the JN-1B Facility and the monitoring wells installed in 2002 and 2003 to characterize the groundwater flow patterns). Finally, 22 monitoring wells, which were installed during the August-September 2006 drilling program to resolve the potential radionuclide contamination of the 855 sand layer and the basal sand unit, were sampled and analyzed for radionuclides in August and September of 2006.

The radiological results for the three water supply wells and the surface unit and alluvial unit wells (installed in 1989, 1995, and later) have been included in Battelle's annual reports on radiological and nonradiological parameters. Battelle (ECC & E2 Closure Services, LCC, 2004a) is one example of these reports. Tables 2 and 3, which were reworked by Region III from Battelle's annual reports, show that some samples from the shallow wells have exceeded the U.S. Environmental Protection Agency's (EPA's) maximum concentration limits (MCLs) for Sr-90, gross alpha, and gross beta during the 2000 to 2005 time period. Several of these shallow wells have been abandoned because of remediation that has occurred, some in late 2005. However, the licensee sampled 10 of these shallow wells (wells 100, 118, 168, 206, 300, 306, 506, C03, C09, and C16) in April 2006 Battelle (2006d). Wells 118, 168, and C09 had Sr-90 concentrations above the minimum detectable activity (MDA). For wells 118, 168, and C09, the Sr-90 and gross beta concentrations were (4.9, 2.8, and 22.6 pCi/L) and (8, 10, and 64 pCi/L), respectively. The licensee refers to this southeast area of the NSA where wells 168 and C09 are located as the "Bog Area" because the groundwater in this area is perched and it contains elevated areas of Sr-90 even though the soils and unsaturated materials above have been remediated.

The licensee performed a sampling event in December 2005, which included several of the shallow wells delineated on Figure 2 and listed in Table 3. Analytical results were similar to those listed in Table 3. However, the licensee also sampled and analyzed the two 36-inch diameter caisson wells, which were installed when the JN-1B Facility was built in 1970 to assist with water pressure removal during the construction of the deep fuel pool. The grab samples collected during this sampling event had average Sr-90 and gross beta concentrations of 57.4 pCi/L and183 pCi/L, respectively.

Some of the 22 monitoring wells that were installed in the 885 sand layer, 855 sand layer, or basal sand unit during 2002 and 2003 to determine the groundwater flow directions were sampled and analyzed for gamma spectroscopy and/or gross alpha and beta activity measurements. The licensee has indicated that the field sampling procedures were not based upon the procedures listed in its groundwater monitoring plan (ECC & E2 Closure Services, LCC, 2004b) and that the analytical results may be questionable. Nevertheless, the radiological results ranged as follows: gamma spectroscopy - less than the MDA, gross alpha - less than 3 to 13 pCi/L, and gross beta - 92 to 446 pCi/L. These well were sampled only once, and then all the wells were abandoned in 2004 using State well closure rules.

The licensee collected groundwater samples from 22 monitoring wells (that were installed during the August-September 2006 drilling program) during an extended sampling event in August and September 2006. The following wells were sampled: 5 wells in the 885 sand layer, 9 wells in the 855 sand layer, and 8 wells in the basal sand unit. The licensee's laboratory performed analyses for the following radionuclides: gamma spectroscopy (Co-60, Cs-137, Sb-125, Eu-152, Eu-154, and Am-241), gross alpha and beta, Sr-90, and alpha spectroscopy (Pu-238, Pu-239, U-234, U-235, and U-238). The licensee's radiological results are presented in Table 4 from Battelle (2006c). The analytical results for well #4-885 should not be used because the groundwater sample contained excessive amounts of sediment, and the sample was not filtered before preserved with acid. Therefore, the results represents radionuclides that were both initially dissolved and attached to the sediments. The radiological results for the other wells are below the EPA's MLCs.

SPLIT SAMPLING EVENTS

In June 2005, the licensee and the NRC performed a split sampling event. The NRC collected groundwater from 9 shallow monitoring wells (with two duplicate samples) and 1 surface water site along Big Darby Creek. NRC's contract laboratory, Oak Ridge Institute for Science and Education (ORISE), ran gamma spectroscopy (Co-60, Cs-137, and Am-241), gross alpha and beta, Sr-90, and alpha spectroscopy (Am-241, Pu-238, Pu-239, U-234, U-235, U-238, and total U) analyses (ORISE, 2005). Table 3 delineates the analytical results for ORISE and the licensee's laboratory. The analytical results compared favorably between the two laboratories. From this split sampling event, the EPPAD staff has concluded that the licensee's field sampling procedures and its radiological analyses are adequate.

However, the licensee changed laboratories for its 2006 sampling events. Therefore, the NRC performed another split-sampling event with the licensee in August 2006, where the sand layer wells in the NSA were sampled (2 wells from 885 sand layer, 4 wells from 855 sand layer, and 3 wells from the basal sand unit). Again, ORISE was the NRC's contract laboratory, and ORISE's radiological analyses included gamma spectroscopy (Co-60, Cs-137, Eu-152, Eu-154, and Am-

241), gross alpha and beta, Sr-90, and alpha spectroscopy (Pu-238, Pu-238/239, U-234, and U-238) [ORISE, 2006]. The licensee's analytical results are listed in Table 4. The analytical results compared favorably between the two laboratories. The EPPAD staff has concluded that the licensee's field sampling procedures and its radiological analyses are adequate.

RADIOLOGICAL IMPACT OF SITE-GENERATED ACTIVITIES ON GROUNDWATER

The radiological results since 1970 indicate that water supply well JN-W in the NSA and the other two water supply wells outside the West Jefferson North site are not impacted by site-generated radionuclides. The depth and thickness of the till units above this aquifer provides additional assurance that this aquifer has not and will not be impacted by site activities.

The shallow groundwater units (surface till unit, alluvial unit, and the 885 sand layer) have been impacted by site-generated radionuclides. Even though the site soils have been remediated to the decommissioning plan's criteria, groundwater from well C09 [April 2006 sampling event (Battelle, 2006d)] exceeds the Sr-90 and gross beta EPA's MCLs. The licensee believed that the detection of the elevated strontium-90 levels in this perched groundwater area is caused by past discharges of its facility's radiologically contaminated storm water drainage to the "Bog Area". Therefore, Sr-90 will likely be detected in the groundwater until sufficient time allows for decay and dilution by precipitation percolating through the overlying soils. However, the low yield and shallow depth to the groundwater in these units precludes their use as a source of drinking water. The State of Ohio requires that drinking water wells be screened at depths of 25 feet or more below the land surface. Therefore, groundwater from these units would be considered a non-potable water supply.

The radiological results for the 855-sand layer and the basal sand unit indicate that they are not impacted by site-generated radionuclides. Also, the licensee has indicated that the two caisson wells will be pumped and remediated.

CONCLUSIONS

It is the EPPAD staff's assessment that the original and supplemented groundwater monitoring plans are adequate to address the potential site-generated radionuclides in the groundwater at this site.

Furthermore, the EPPAD staff has concluded that site-generated radionuclides have not impacted any drinking water aquifers or water-bearing units at this site or nearby areas.

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