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GROUND WATER AND ENVIRONMENTAL CONSULTANTS
ST. MICHAELS, MARYLAND AND EXTON, PENNSYLVANIA

June 12, 1998

Mr. Orlando Monaco
Naval Facilities Engineering Command
Northern Division
Environmental Restoration Branch
10 Industrial Highway
Lester, Pennsylvania 19113

Subject: Review and Comment on Summary Report for Areas A and D Groundwater Monitoring
Former NAWC Warminster, Pennsylvania

Dear Mr. Monaco:

Earth Data Incorporated (Earth Data) has reviewed the Summary Report for Areas A and D Groundwater Monitoring prepared by Brown and Root Environmental, dated February 1998. Provided below are comments concerning the report.

Comments

1) What are the expected start and completion dates for the remainder of the OU-1 interim remedy components?

2) The USGS should be referenced with respect to the base supply well study.

3) What are the expected start and completion dates for the OU-4 interim remedy components?

4) Preparation of final RI and FS reports for Areas A and D groundwater on an as needed basis suggests the interim remedies could become final remedies?

5) What determined placement of the dashed Areas A and D separation line? Water quality results for wells HN-17, HN-82 and HN-83?

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6) The use of clustered, variable depthed wells is appropriate for the Stockton Formation. Intermediate and deep well open intervals are two to three times too long and have most likely lead to mixing of multiple water bearing (and losing) zones, which resulted in diluted chemical concentration data and average hydraulic head data, especially in the deep wells where open intervals are longest and hydraulic pressures are highest. Though the wells provide useable aquifer data to infer contaminant fate and transport, well construction biases well data.

7) With respect to Area A and D water levels, the report indicated bedrock dip was considered along with monitored intervals for potentiometric map construction. In addition, the report indicated the potential hydraulic control induced by pumping effects of a nearby municipal water-supply well. Potentiometric maps (Figures 2-1, 2-2, 2-3 and 2-4) in the report indicate only monitored intervals (shallow, intermediate etc.) were ultimately used to map and infer groundwater flow.

Review of the investigation data indicate three regional controls on groundwater flow: structure, topography and well WMA26, with possible local influences from the base supply wells. The coincident alignment of the direction of dip of the leaky, multi-bed strata of the Stockton Formation (and associated bedding plane partings and interbed fracturing), the direction of topographic slope and the location of well WMA 26, all in a northward trend relative to Areas A and D, promote down dip recharge and offsite flow of groundwater out of Areas A and D towards the north.

Under natural conditions, the combined effect of the topographic slope essentially parallel to the direction of the dipping multi-layered units, promotes infiltrated recharge to be driven down dip, resulting in the confinement of groundwater at depth under successively deeper layers of beds. As a result, groundwater at depth will appear "confined" from more shallow overlying groundwater, however shallow groundwater anywhere in the area will eventually "recharge" deeper, more laterally distant down dip fracture zones. Superimposed on this natural system is the continuous pumping effects of WMA26. The deep, open rock construction and high yield of the well act to significantly lower hydraulic heads in the surrounding strata, including fractures that dip towards the well from the south (Areas A and D), steepening gradients and further promoting down dip flow from south to north.

Though cross bed leakage does occur, up or down, depicting horizontal groundwater flow through shallow, intermediate and deep "zones" of the aquifer implies groundwater in any one zone traverses the entire zone, as currently mapped from south to north, as though each zone were isolated from another.

Shallow groundwater occurring at any one time in the vicinity of HN-32(S) most likely does not entirely flow to HN-52(S), but rather recharges deeper fractures down dip, especially under exaggerated pumping gradients.

8) In light of the above, evaluation and discussion of Area A and D groundwater levels and contaminant distribution should be refined to conform with aquifer hydrogeology and the known controls on groundwater flow and not arbitrary, categorical "levels" or "zones" like shallow, intermediate and deep. Discussion of these levels is appropriate at a given well cluster, in light of the monitored intervals relative to the supposed depth of the viable aquifer, but not in the context of regional groundwater flow.

- The average yield and pumping water level within WMA 26 for the period of monitoring well water level measurement should be included in the aquifer water level discussion.

- Cross sections or fence diagrams, at least one per area, oriented parallel to dip through the principal axis of TCE or Total VOC contamination and well WMA 26, should be constructed showing both topographic slope and underlying structure to better visualize the aquifer and determine stratigraphic zones to map groundwater through. Local strike and dip measurements should be used. The middle member of the Stockton Formation is known for thick sandstone units relative to thinner shale/siltstone units. Well density in the areas is sufficient to attempt to correlate and trace the coarser grained units for depiction on the cross sections/fence diagrams, again in an attempt to identify area specific hydrostratigraphic zones suitable for potentiometric surface mapping. The sandstone unit correlation would be useful to at least establish an aquifer framework for both understanding contaminant flow and more importantly, for the adequate design and implementation of interim or long-term contaminant recovery systems.

An attempt should be made to construct water level maps from combinations of shallow, intermediate and deep wells that are open and therefore potentially monitor the same bedding plane/hydrostratigraphic zones between Area D, Area A and WMA 26. At least two potentiometric maps, one originating at well HN-32(S) for Area D and one originating at well HN-11(I) for Area A (or more specifically a shallow well located up dip from HN-11(I) coincident to the same bedding plane/stratigraphic zone monitored by HN-11(I), maybe HN-12(S)?) should be constructed in this manner to show the relationship between horizontal groundwater flow and structure.

9) The discussion of "positive hydraulic head differentials" at individual well clusters would have more meaning in the context of structure and stratigraphy than from "deep to shallow water-bearing zones," and may be irrelevant to regional groundwater flow other than to demonstrate the degree of confinement or really the degree of hydraulic disconnection of shallow groundwater from immediately deeper underlying groundwater.

Groundwater flows from shallower to deeper zones down dip and may leak across and around beds at depth as a result of higher hydraulic pressure and the known inability of the lenticular beds that make up the formation to completely confine or disconnect water bearing zones.

10) Discussion of groundwater quality relative to shallow, intermediate and deep zones in Area A (and Area D) does not correlate with actual groundwater flow through Area A and offsite. Area A contaminant fate and transport would be better described in the context of structure and stratigraphy, with or without the influence of well WMA 26, beginning with where contaminants are most prevalent and proceeding off site, down gradient and down dip to the north. Discussion of the entire plume as it has dispersed down through the aquifer makes more sense than discussion within out-of-context categories. The cross sections/fence diagrams would greatly improve groundwater quality discussion. This same comment applies to Area D.

11) Characterization of Area A (and Area D) contaminant impact to off site groundwater appears incomplete. The most down gradient well clusters installed for the study have not delineated the extent of the plume. The only inference that can be made is that all of the contaminants are drawn to WMA 26. This comment applies to Area D.

12) The report summary and conclusions should be revised as needed following revision of the approach to characterize groundwater flow and contaminant dispersion consistent with aquifer geology and hydraulics.

13) An additional well cluster, appropriately constructed, should be installed in the vicinity of Building 70 in Area D where the wastewater lines were found to be badly damaged. Three additional well clusters, appropriately constructed, should be installed down dip from existing clusters HN-50, HN-16 and HN-52, but up dip from WMA 26.

14) Area A and D groundwater quality discussion should incorporate the results of the USGS testing at the base supply wells in the area.

15) Lastly, groundwater quality discussions should incorporate discussion on chlorinated hydrocarbon transformation, both current and potential future transformation, as this will impact groundwater recovery in the future.

In summary, investigation of Area A and D groundwater contamination, where investigated, has been extensive. Based on other hydrogeologic investigations in this formation, considerable data exist to develop a very detailed understanding of groundwater flow and contaminant dispersion in the area and for the formation in general. The Area A impact to off site groundwater quality characterization should be finished through additional well installation, or it should be acknowledged with existing data that the contamination detected in well clusters HN-50, HN-16 and HN-52 is ultimately drawn towards WMA 26.

Abandon use of the shallow, intermediate and deep "categorization" of the Area A and D aquifers and replace categorization with "hydrostratigraphic characterization" based on the voluminous amount of data on actual topography, geology, structure, groundwater flow and contaminant dispersion. This will improve interim and long-term groundwater recovery efforts by providing for more accurate recovery well location, construction and operation.

Sincerely,

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