5. Potentiometric Surface Map

Discussion: Only generalized information on the ground-water flow system at the site has been provided (see references). The flow pathways and the potential receptors associated with those pathways are needed to evaluate the human health and environmental exposures from a potential release from the licensed site operations.

Request: Provide a potentiometric surface map of the shallowest monitored ground-water system for the entire site, depicting ground-water flow direction(s) and the elevation of the potentiometric surface. This map should include the well locations used to measure the ground-water elevations and the locations where licensed materials are processed and stored, along with the proposed background and monitoring well locations for the bulk storage area.

Comment 5 Potentiometric Surface Map

Three figures (Figures 1, 2 and 3) that illustrate groundwater flow elevations and interpreted groundwater flow directions for the Cabot Facility are enclosed with these responses. These figures, which illustrate groundwater flow in September 2000, September 2001, and September 2002, show that groundwater consistently flows to the southwest towards a local discharge point at West Swamp Creek.

Environmental Standards has groundwater elevation contour maps for more than 30 sampling events. Although absolute elevations fluctuate depending on water supply conditions (drought *vs.* normal or high groundwater events), the overall flow direction is consistently to the southwest as shown in the attached figures.

6. Well Construction Information

Discussion: The licensee proposes to change the monitoring locations for the NRC licensed activities. There may have also been some changes in other monitoring programs at the site since the previous license renewal. Current information is needed to complete the Environmental Assessment for the license renewal.

Request: Provide the following data for all wells at the facility. These wells should also be depicted on the potentiometric map.

Summary of Wells at the Cabot Facility

Well Number	Date Constructed	Total Depth (feet)	Well Material[1]	Screened Interval (feet)[2]	Purpose[3]

[1] Material used to construct the well casing (e.g. Carbon Steel, PVC)
[2] Indicate whether well is screened or open hole intervals.
[3] Water supply, quality monitoring PADEP, quality monitoring NRC, water level only

Comment 6 Well Construction Information

The attached table (Table 1) provides the requested information. Please note that those wells proposed for inclusion in the NRC permit renewal are highlighted.

7. Travel Time

Discussion: The licensee indicated a desire to change the monitoring locations for the bulk storage area from those currently in the license. The potential travel time to the new monitoring locations is needed to determine the appropriateness of the proposed locations.

Request: Provide a calculation of potential travel time from the bulk storage area to each monitoring well, based on the flow gradients from the potentiometric map and the measured or estimated hydraulic conductivity of the Brunswick formation.

Comment 7 Travel Time

In order to calculate potential groundwater travel times (seepage velocities) from the bulk storage area to the proposed new monitoring well locations, Environmental Standards reviewed Cabot Supermetal's hydrogeologic setting and the currently accepted site conceptual model as presented in the Environmental Standards document titled *Supplemental Assessment of March 2000 Water Sampling Program, Cabot Performance Materials, Boyertown, Pennsylvania Plant* (Environmental Standards, 2000).

As presented in the conceptual model, the Cabot facility is located in the Triassic Basin of the Piedmont Physiographic Province. The shales of the Brunswick Formation, the youngest lithologic unit of the Late Triassic Stage Newark Group, underlie the area. The Newark Group is contained in a southwest trending basin that reaches from Rockland County, New York, through Adams County, Pennsylvania. The Newark Basin is the largest of three basins included in one of six major Triassic rift valleys that run in a sinuous belt for more than 1,000 miles from Nova Scotia to South Carolina. These rift valleys formed as a result of tensional stress along the Atlantic coast that caused downward normal faulting.

The Newark Group consists of 16,000 to 20,000 feet of non-marine sedimentary rocks (and associated intrusive and extrusive igneous rocks) deposited in the Triassic rift valley from Paleozoic source rocks to the northwest. The lowest member of the Newark Group is the Stockton Formation, which consists primarily of light yellowish gray to pale reddish brown well-sorted arkose and subordinate conglomerate and mudstone. In the vicinity of the project site, weathered arkosic and sand zones within the Stockton Formation are the sources for most of the potable water withdrawn from the Stockton Formation.

The Stockton Formation is conformably overlain by the Lockatong Formation, a large lacustrine lens that ranges from 3,750 feet thick in the center of the basin to 500 to 750 feet thick in the subsurface west of Staten Island. The Lockatong Formation, as an aquifer, is reportedly the poorest groundwater producing unit in the Newark Group (Hall, 1974). The Lockatong Formation grades conformably upward into the reddish brown shales of the Brunswick Formation.

The Brunswick Formation consists of a thick sequence of interbedded brown, reddish brown, and gray shale, sandy shale, sandstone, and some conglomerate. The thickness of the Brunswick Formation is estimated to range from greater than 16,000 feet in the southwest portion of the basin to several thousand feet in the vicinity of the Cabot facility. Regional bedding generally strikes in a northeast direction, with the dip between 10° and 30° northwest, but this can vary significantly on a local scale.

It is Environmental Standards' experience that the Brunswick Formation, over which the site is located, can be locally characterized by complicated hydrogeology, with groundwater flow controlled by a combination of local and regional topography, formation bedding, fracturing, and regional groundwater usage. Secondary permeability developed in discrete bedding planes and fractures normally control groundwater flow.

The number and width of secondary openings and, consequently, formation hydraulic conductivity controls (to some degree) the seepage velocity of the Brunswick Formation. Impermeable bedding surfaces in the Brunswick Formation often limit the potential degree of vertical compound migration, particularly in local areas where groundwater pumping is limited.

In the Brunswick Formation, local and regional topography significantly influences groundwater conditions. For example, in high ridgetop areas, a localized perched water zone in the upper bedrock (approximately 10-20 feet below ground surface [bgs]) overlies a deeper regional groundwater flow system. By contrast, in low-lying areas such as valleys and well-developed flood plains, the entire sequence may be saturated.

Locally, the Cabot facility is located in a north-south trending drainage sub-basin that discharges groundwater and overland flow to West Swamp Creek. Drainage patterns and the conceptual flow model developed for the local area suggest that water flow in this sub-basin, as expected, is relatively separate and distinct from the surrounding sub-basins that also discharge to West Swamp Creek (Figure 4).

The diabase dike intrusives, northeast of the facility, have caused additional fracturing of the Brunswick Formation in the area, and thus, secondary porosity is more abundant in the vicinity of these diabase dikes than when relatively distant from these igneous intrusive rocks.

An interpretation of historical groundwater elevation contour data indicates that groundwater beneath the Cabot facility consistently flows in a south-southwest direction and discharges to West Swamp Creek (see prior response to Comment 5). The hydrogeologic flow model developed for the local groundwater system suggests that the area upgradient (north and northeast) of the facility property is an upland zone of relatively significant groundwater recharge and high groundwater gradients. This area is characterized by a strong downward vertical hydraulic gradient and a rapid groundwater seepage velocity to the south and southwest.

Environmental Standards performed a search of available hydrogeologic data and studies on the Brunswick Formation in order to calculate the potential travel time from the bulk storage area to the newly proposed monitoring well locations (these monitoring wells include wells MW 95-03, MW 95-04, and MW 97-06; see Figures 1, 2, and 3). Our review included evaluating publicly available literature, Cabot Facility site-specific studies, and Environmental Standards hydrogeologic reports prepared for other client projects in the Brunswick Formation. We specifically focused on projects located in the general vicinity of the Cabot facility.

Based on our review, Environmental Standards selected to use both site-specific data and the results from a bromide tracer study conducted on the Brunswick Formation aquifer from another local industrial facility located in Perkasie, Pennsylvania (less than 19 miles east of the Cabot facility). The Perkasie site which is located in the same relative geologic position in the Newark

Basin, is in southeast Pennsylvania, is underlain by the Brunswick Formation, and is proximal to the same local diabase intrusive complex (Figure 5).

The bromide tracer study results were used for this travel time estimation because Environmental Standards considers the results to more accurately reflect the influence of both primary and secondary porosity on groundwater seepage velocity rather than standard pump test or slug test results.

For example, in the original Rogers, Golden and Halpern groundwater engineering report completed on behalf of Cabot in December 1985, slug test results suggested that formation hydraulic conductivities were very low (averaged 0.3 ft/day) (RGH, 1985). In addition, porosity values used in the RGH calculations reflected primary porosities and neglected to account for secondary porosities (a porosity value of 5 percent was assumed by RGH).

Much has been learned regarding fractured bedrock flow since the RGH report was prepared. It is Environmental Standards' opinion that calculating groundwater (and subsequently radionuclide) travel times using only primary porosity hydraulic conductivities in fractured bedrock may well lead to erroneous (perhaps even dangerous) assumptions regarding licensee response times to react to an inadvertent release of radionuclides into groundwater (if such a release were to occur). Environmental Standards' experience in the Brunswick Formation in this area suggests that the RGH-reported hydraulic conductivities are reflective of primary porosity conductivities but are not reflective of not secondary (fracture, weathered bedding plane) conductivities. Thus, a revision of the original RGH travel time calculation is appropriate.

Environmental Standards hydrogeologists generally model the Brunswick Formation using a dual porosity-modeling paradigm. The dual porosity paradigm emerges from considering both primary porosity (matrix porosity) and secondary porosity (fracture and weathered bedding plane). While modeling is a simulative exercise, the bromide tracer study referenced above relied on direct empirical observation of groundwater transport behavior. We have selected to use the groundwater seepage velocity developed from the nearby bromide tracer study because this velocity accounts for both primary and secondary porosity and relies on the results of direct observation. In addition, the extrapolation of these data seems appropriate given the previously enumerated similarities between the two sites.

In order to calculate travel times, Environmental Standards used the following equations in our analysis.

Potential travel time = Seepage velocity in groundwater × distance from the bulk storage area to the potential new monitoring well.

Seepage velocity in groundwater = Hydraulic gradient × ratio of hydraulic conductivity to effective porosity.

A groundwater seepage velocity of 27 feet per day was used in the calculations. This value was derived from the sodium bromide tracer study conducted in the Brunswick Formation at the manufacturing facility near Perkasie, Pennsylvania (Environmental Standards, 1999). The seepage velocity of 27 feet per day was determined at the Perkasie site when the hydraulic gradient was measured to be 0.026 at the site.

Using these two input variables for the site near Perkasie, the ratio of hydraulic conductivity to effective porosity was calculated to be 1038.5 ft/day for the site.

The distance from the bulk storage area to the proposed new monitoring wells was measured using an Autocad map and the Pennsylvania-licensed surveyor data for each well. The distances from the bulk storage area to the proposed monitoring wells are as follows.

- MW 95-03 – 745 feet
- MW 95-04 – 700 feet
- MW 97-06 – 810 feet

Using the site-specific hydraulic gradient from the bulk storage area to the proposed new monitoring wells (0.025) and the ratio of hydraulic conductivity to effective porosity (1038.5 ft/day) derived from the sodium bromide tracer study, we then solved the travel time equations for each monitoring well and obtained the following results.

- MW 95-03 – 29 days
- MW 95-04 – 27 days
- MW 97-06 – 31 days

Further, the travel time from the bulk storage area to West Swamp Creek (the nearest surface water discharge point and radionuclide receptor, 1900 feet downgradient of the bulk storage area) is 268 days. This estimate is based on assuming a hydraulic gradient from the bulk storage area to the monitoring wells of 0.025 and a hydraulic gradient from these wells to the creek of 0.0048. As shown on the attached groundwater elevation contour maps, the gradient in the aquifer beneath the Cabot facility is substantially reduced in the Swamp Creek flood plain.

It should be noted that the preceding values represent minimum radionuclide travel times from the bulk storage area to the proposed new monitoring wells and West Swamp Creek. Other physical-chemical processes that would inhibit travel of radiological accidentally released from the bulk storage bins to the proposed new downgradient monitoring wells have not been considered. Some of these processes include ion-exchange phenomenon (cation adsorption, for example), complex formation, anion adsorption and exclusion mechanisms, and equilibrium/kinetic adsorption considerations. Other processes that retard the radionuclide and elemental mobility in soils have also not been considered, thus, the travel times presented represent travel time minimums.

25. Water Use

Discussion: The staff must consider current and future water uses in the area for the evaluation of potential health and environmental impacts. The land use survey provided by CPM as response 4 on October 11, 2002, indicated that a subdivision was under construction 2 miles southeast of the facility, but there was no mention of potential impacts.

Request: Provide an update for the current and future water uses (surface and ground water) in the area that are relevant to the evaluation of potential impacts of continued facility operation, including any significant changes that were not addressed since the last license renewal.

Comment 25 Water Use

The current subdivision under construction as identified in the October 4, 2002, evaluation is supplied with potable water by a public water purveyor. The source of this water is several miles from the Cabot plant and the plant is not considered to be a realistic source of impact to this system's supply.

Further, there have been no increases in water use adjacent to or downgradient of the plant. Cabot purchased real estate downgradient of the plant to improve site-lines at the Swamp Creek Road/County Line Road intersection. Two residences were purchased as part of this transaction. Both residences relied on groundwater for potable supply. The residences have been razed, and these potential groundwater receptors no longer exist, further reducing the potential exposure of nearby properties to accidental Cabot releases (if such releases were to occur).