

**Table 2.1-2 Hydrogeologic Properties of the Chesapeake Basin**

| AQUIFER   | Columbia (Unconfined)   |   |   | Chesapeake Group  |  |  |  |  |  | Piney Point  | Ranococas  | Mount Laurel   | Englishtown   | Magothy  | Potomac   |   |   |
|---|---|---|---|---|--|--|--|--|--|--|--|--|---|--|---|---|---|
|   | FORMATION   | Beaverdam   | Bethany   | Manokin   | Choptank   | Federica   | Calvert  | Federsburg   | Cheswold   |  |  |  |   |  |   |   |   |
| <b>AQUIFER TYPE</b>                               | Columbia  | Beaverdam   | Bethany   | Manokin   | Choptank   | Federica   | Federsburg   | Cheswold   | Piney Point  | Ranococas  | Mount Laurel   | Englishtown  | Magothy   | Potomac  |   |   |   |
| <b>FORMATION</b>                                  | Columbia  | Beaverdam   | Bethany   | Manokin   | Choptank   | Federica   | Federsburg   | Cheswold   | Piney Point  | Ranococas  | Mount Laurel   | Englishtown  | Magothy   | Potomac  |   |   |   |
| <b>AQUIFER TYPE</b>                               | A major unconfined aquifer which blankets the upper 239' of the basin.  | A major surficial unconfined aquifer.   | Forms the lower portion of the unconfined (water table) aquifer and acts as one hydrologic unit with the Beaverdam where Frm is sandy enough. | Unconfined where the Frm outcrops the Beaverdam Frm. It then becomes confined by the Bethany Frm south of a northeast trending line through Laurel. | Confined aquifer.  | Confined except in subcrop areas which runs through Dover.   | Confined.  | Confined except in subcrop areas just south of Smyrna where it forms the bottom sands of the unconfined aquifer.   | Major confined aquifer.  | Consists of the Honesstown and Vintonville Frms. It is a confined aquifer in the Middletown area and acts as one hydrologic unit with Columbia in Middletown to Townsend area. Becomes confined by the Calvert Frm. south of Townsend.   | An unconfined aquifer in subcrop areas with overlying Columbia sands. May become confined by Honesstown Frm. in the Middletown area.   | Generally confined except possibly north of the canal where near out crop and form one hydrologic unit with Columbia.  | Generally confined except around the C & D canal where may be one hydrologic unit with Columbia.  | Generally confined around the C & D canal where may be one hydrologic unit with Columbia. Useful as an aquifer from the subcrop area south to southern New Castle County. Is too deep and salty to be used as an aquifer in Kent and Sussex counties.  | Generally unconfined. May be one hydro unit with Columbia in upper portion of basin in and around the canal area. May contain as many as three separate hydrologic units (sand beds).                               |   |   |
| <b>AREA OF RESOURCE VALUE</b>                     | Generally become usable as an aquifer (for domestic use) where Columbia sediments or a combination of Columbia sediments and subsurface sandy units have a thickness of 30' to 40'. These conditions sporadically occur from Dover north to US Rt. 40. The Columbia is consistently 40' - 50' thick and greater south of Dover to about Bridgewater. Is sealed in Kent County by the Dover and Dover area. Is used for recharging rain water and releasing it as baseflow to streams. | Used as an aquifer and provides baseflow to streams from the Bridgewater area to the southern boundary of the basin. As much as 75% of total flow in Nanticoke River is derived from ground-water discharge.  | Used as an aquifer in southernmost portion of basin, generally south of Laurel.   | Used as an aquifer in the Seaford, Bethel, and Laurel area.   | Becomes a usable aquifer between Teton and Harrington, remains usable to approximately Laurel.   | A primary aquifer in Dover area and south to about Greenwood.  | Utilized as a minor aquifer in the Dover area.   | A primary aquifer between Smyrna and Greenwood.  | Utilized most often in the Cheswold to Camden Wyoming area. Potentially usable as far south as about the Sussex County line.   | Townsend area. Potentially usable as far south as about the Sussex County line.  | A minor aquifer used for domestic purposes in the Middletown area and to form in subcrop areas.  | Minor aquifer in Chesapeake & Delaware Canal area.   | Useful as an aquifer from the subcrop area south to southern New Castle County. Is too deep and salty to be used as an aquifer in Kent and Sussex counties.   | Major aquifer in Middletown area and north.  | Major aquifer in Middletown area and north.   |   |   |
| <b>THICKNESS (ft)</b>                             | Highly variable ranging from 0' to 100' (in patches). Thickest units occur along an east-west trend from Dover north to US Rt. 40. A north-south boundary (approximately located west of Frilton (in the easternmost portion of basin). Excluding thicknesses in the Paltochannels - 10' to 30' thick north of canal, 10' to 50' thick from canal to the northern Kent County line, 10' to 30' thick from Smyrna to Dover area, and from 20' to 100' thick from Dover to Bridgeville. | Maximum thickness of approximately 90' to 100' between Seaford and Laurel and near Delmar. Underlying Bethany Frm is often in hydraulic connection, with the total saturated thickness approaching 200' near Delmar.  | Maximum thickness of approximately 200' (if overlying Beaverdam sands included).  | Up to approximately 50' thick in the Seaford area.  | DGS well NC-13 in Greenwood indicates a thickness of approximately 50' dating at a depth of about 120' Below Ground Surface (BGS).   | Approximately 20' to 30' thick in Dover area.  | Very limited data exist for the portion of this formation in the Chesapeake Basin.   | Approximately 100' thick at Greenwood, DE.   | The formation is approximately 180' thick in the Dover area.   | Approximately 120' thick in the Middletown area, DE.   | Yields range from 10 gpm to over 200 gpm. From pump test data taken from wells 2 miles north of Smyrna. T ranges from 1872 to 2587 ft/d. In southern part of county, the Ranococas is highly correlated with Stivalies ranging from 0.0019 to 0.0028. Where unconfined, T ranges from 0.9 to 1.5. In the Middletown area, a T value of 584 ft/d. | May yield up to 70 gpm in the Middletown area. Fair to poor water yielding properties. Pump test in Middletown area indicates a T value of 1871 ft/d for Mount Laurel and Englishtown aquifers. An S value of 2 x 10 <sup>-4</sup> has been recorded in the Middletown area. | May yield enough water for domestic well use. Fair to poor yielding characteristics. Pump test in Middletown area indicates a T value of 1871 1204 for Mount Laurel and Englishtown aquifer(s).   | Approximately 20' thick in the Middletown area.  | Ranges from approximately 40' to 70' thick from south of canal to Town of Middletown.   | Yield up to 75 gpm. From a pump test in Middletown T = 534 ft/d and S = 6 x 10 <sup>-4</sup> .  | May yield up to several hundred gpm. Drawdown data from 11 wells in the upper Potomac area in the canal area indicate that T averages 789 ft/d. In the upper hydrologic unit in the Middletown area values of 600 ft/d and 6 x 10 <sup>-4</sup> for T and S respectively were recorded. |
| <b>HYDROGEOLOGIC PROPERTIES</b>                   | Yield ranges from a few gpm up to 1300 gpm for large diameter wells. Average yield 718 gpm. T values range from 280 to 2200. Average T = 897.5 S.C. range from 5 to 86. Average S.C. = 24. Strata range from < 1 to 21 mol. Average NO <sub>3</sub> = 3 mol. range .05 - .17. Average S = 0.1. K <sub>v</sub> ranges from 50 to 250. K <sub>h</sub> , K <sub>v</sub> = Hyd. Conductivity (ft/day)   | T values of 13,589 and S <sub>v</sub> = 40.15 are representative. T values range from 3000 to 21,000. Y values range from 1220 to 1400. S <sub>v</sub> values range from 7 to 107. Average T = 6228. Average yield = 0.77. Average S <sub>v</sub> = 50.   | Very limited data exist for the portion of this formation in the Chesapeake Basin.  | Very limited data exist for the portion of this formation in the Chesapeake Basin.  | Based on drawdown data for two wells in the Bridgewater area the following ranges were recorded: T = 100-505; S.C. = 1-95.   | In Harrington, a T value estimated at 1644. Has poor yield characteristics downward. S = 403.  | Very limited data exist for the portion of this formation in the Chesapeake Basin.   | From 6 wells in Dover area T averaged 2946 S. S values range from 0.062 to 0.0031. Yields from about Kenton and north generally only suitable for domestic use. T ranges from 141' south of Dover to 44' 12' near middle of Dover.   | Aquifer is thick and overlies in Dover. In Dover area and to south may yield up to 600 gpm. Yields less north of Dover. T ranges from 5481 just south of Dover to 802 north of Dover. In 5 wells from Port Nelson to southwest of Dover, T averaged 4251. Most productive area of aquifer is along a northeast trending line through DAFB. Poor yield along tanks of aquifer. Is fully developed in Dover. | Yields range from 10 gpm to over 200 gpm. From pump test data taken from wells 2 miles north of Smyrna. T ranges from 1872 to 2587 ft/d. In southern part of county, the Ranococas is highly correlated with Stivalies ranging from 0.0019 to 0.0028. Where unconfined, T ranges from 0.9 to 1.5. In the Middletown area, a T value of 584 ft/d. | May yield up to 70 gpm in the Middletown area. Fair to poor water yielding properties. Pump test in Middletown area indicates a T value of 1871 ft/d for Mount Laurel and Englishtown aquifers. An S value of 2 x 10 <sup>-4</sup> has been recorded in the Middletown area.   | May yield enough water for domestic well use. Fair to poor yielding characteristics. Pump test in Middletown area indicates a T value of 1871 1204 for Mount Laurel and Englishtown aquifer(s).  | Approximately 20' thick in the Middletown area.   | Ranges from approximately 40' to 70' thick from south of canal to Town of Middletown.  | Yield up to 75 gpm. From a pump test in Middletown T = 534 ft/d and S = 6 x 10 <sup>-4</sup> .  | May yield up to several hundred gpm. Drawdown data from 11 wells in the upper Potomac area in the canal area indicate that T averages 789 ft/d. In the upper hydrologic unit in the Middletown area values of 600 ft/d and 6 x 10 <sup>-4</sup> for T and S respectively were recorded. |   |
| <b>GROUND-WATER QUALITY</b>                       | Water is generally acidic with an average pH of approximately 5.6. Iron (Fe) concentrations highly variable depending on oxygen content. From Dover to Bridgewater dissolved oxygen content is 0.03 to 0.3 mg/l. Average Fe is 0.1 mg/l. Average Mn is 0.1 mg/l. Average NO <sub>3</sub> = 3 mol. range .05 - .17. Average S = 0.1. K <sub>v</sub> ranges from 50 to 250. K <sub>h</sub> , K <sub>v</sub> = Hyd. Conductivity (ft/day)  | Acidic water with an average pH of approximately 5.6. Consistently the lowest Fe concentrations occur northwest of Seaford. In surface confined region the generally 2 mg/l and NO <sub>3</sub> range from < 1 to 21 mol. Average NO <sub>3</sub> = 3 mol. range .05 - .17. Average S = 0.1. K <sub>v</sub> ranges from 50 to 250. K <sub>h</sub> , K <sub>v</sub> = Hyd. Conductivity (ft/day) | Very limited data exist for the portion of this formation in the Chesapeake Basin.  | Very limited data exist for the portion of this formation in the Chesapeake Basin.  | Elevated pH is consistently above 7.0 and can be as high as 8.5. Calcium (Ca) and Magnesium (Mg) may also be elevated. Elevated HCO <sub>3</sub> and silica due to shell material and salt water dilutions in Frm. Chesapeake Group Aquifers have the highest average TDS in state. Relatively low total dissolved iron content. | Elevated pH is consistently above 7.0 and can be as high as 8.5. Calcium (Ca) and Magnesium (Mg) may also be elevated. Elevated HCO <sub>3</sub> and silica due to shell material and salt water dilutions in Frm. Chesapeake Group Aquifers have the highest average TDS in state. Relatively low total dissolved iron content. | Elevated pH is consistently above 7.0 and can be as high as 8.5. Calcium (Ca) and Magnesium (Mg) may also be elevated. Elevated HCO <sub>3</sub> and silica due to shell material and salt water dilutions in Frm. Chesapeake Group Aquifers have the highest average TDS in state. Relatively low total dissolved iron content. | Elevated pH is consistently above 7.0 and can be as high as 8.5. Calcium (Ca) and Magnesium (Mg) may also be elevated. Elevated HCO <sub>3</sub> and silica due to shell material and salt water dilutions in Frm. Chesapeake Group Aquifers have the highest average TDS in state. Relatively low total dissolved iron content. | Generally C <sub>v</sub> exceed 250 mg/L. Below the Piney Point. Piney Point is generally too salty for use in Sussex. High HCO <sub>3</sub> content. Iron has not been analyzed. Elevated Silica. With an exception of Ca order ions are relatively low. pHs range from 5.9 - 6.1.  | Ground-water ration often exceeds 300 picograms per liter. Due to gluconate, total dissolved from may be locally high.   | Reason in ground water often exceeds 300 picograms per liter. The Mt. Laurel Frm is fresh to about Dover. Cap rock and cement ions. pH is relatively high and Fe is usually not a problem.   | Reason in ground water often exceeds 300 picograms per liter. Similar quality to Mount Laurel Frm.   | Analytical test indicate that reason is not a problem. Potential salt-water problems around canal area. Relatively low TDS concentrations around canal. Sulfur and iron concentrations are relatively high.   | Highly variable in thickness and not generally continuous from C & D canal to 5 miles south. Note: Ground-water divide occurs from 2 to 5 miles south of center of north side of canal. The divide of Magothy intersected upper Potomac sands in canal area and in this area, the two units can be considered one. Is a leaky aquifer up dip and becomes more confined down dip. (429.26.40) | Due to salty water is not utilized as an aquifer in Kent and Sussex Counties. Of all aquifers has the highest average iron concentration. Has relatively low TDS solid concentration. Average pH approximately 6.9. |   |   |
| <b>GROUND WATER-SURFACE WATER INTERACTIONS</b>    | Interactions occur and degraded ground-water quality can degrade surface-water quality.   | Likely has considerable influence on the quality of receiving streams due to volume of water the Frm contributes.   | Depth of Frm prevents significant interactions.   | Likely limited due to the Frm. depth but possibly contribute a small percentage of baseflow to the Nanticoke River.                                 | None due to depth.   | Contributes to baseflow of streams in subcrop areas.   | None due to depth.   | Contributes to baseflow in subcrop areas.  | None   | Likely contributes to stream baseflow in the Middletown to Townsend area where the Columbia Frm. is thin.  | Likely interacts with streams in subcrop area where Columbia is thin.  | Limited interaction possible in areas just north and around the canal.   | Possible in area around canal.  | Possible in area north of Chesapeake and Delaware Canal.   |   |   |   |
| <b>PROPERTIES OR FACTS (References - see key)</b> | Average annual fluctuation of water = 5'. East of Middletown water table up to 35' BGS. Sit in Columbia Frm has an estimated K <sub>v</sub> of 1 ft/d. (6.9, 14, 15, 16, 17, 24, 25, 32, 34, 36, 37, 42)  | (1.9, 14, 17, 29, 40)   | Roughly occurs from -100 to -154 BGS near Delmar, DE. A Chesapeake Group Aquifer. (28)  | A Chesapeake Group Aquifer. (28)  | In the Laurel area, the top of the Choptank Frm occurs at a depth of approximately 300 BGS. Portions are composed of alternating sandstone and shale strata generally 15' to 20' thick. A Chesapeake Group Aquifer. (1, 6, 40)   | A Chesapeake Group Aquifer. (28, 40)   | A Chesapeake Group Aquifer. (29)   | Original pressure (head) use to be 12' above sea level. A good aquifer and may yield up to 500 gpm in Dover area where it overlaps to capacity. No water in the west. Northern characteristics. A Chesapeake Group Aquifer. (24, 28, 41)   | Based on a pump test conducted in the Piney Point in Dover area where it overlaps to capacity. No water in the west. Northern characteristics. A Chesapeake Group Aquifer. (1, 6, 54, 55, 56, 57, 61)  | Supplies up to 25% of the ground water used in New Castle County south of the Chesapeake and Delaware canal. (4, 23, 26, 29, 36)   | Other considered as one hydrologic unit with the underlying. (6, 29, 36, 40)   | Generally considered as one hydrologic unit with the overlying. (4, 29, 36, 40)  | Note: Ground-water divide occurs from 2 to 5 miles south of center of north side of canal. The divide of Magothy intersected upper Potomac sands in canal area and in this area, the two units can be considered one. Is a leaky aquifer up dip and becomes more confined down dip. (429.26.40) | (29, 36, 40)   |   |   |   |

Reference Key: -1) Andrus, 1984; -4) Bachman and others, 1995; -6) Benson and others, 1977; -9) Berner, 1986; -14) Hamilton and others, 1993; -19) Johnston, 1977; -18) Johnston, 1978; -17) Johnston, 1973; -18) Jordan and Taylor, 1979; -24) Pickett and Benson, 1983; -28) Pickett and Benson, 1983; -29) Pickett and Spojack, 1971; -20) Ramsey and Schneck, 1990; -29) Staudium and others, 1975; -32) Spojack, 1987; -34) Spojack and Woodruff, 1970; -30) Woodruff, 1990; -37) Woodruff, 1986; -40) Woodruff, 1970; -41) Woodruff, 1972; -42) Woodruff and Thompson, 1972.