Source Water Protection Citizen Technical Advisory Committee (CTAC)
Source Water Assessment Plan Update - Subcommittee Meeting

July 24, 2019
Final Meeting Minutes
Meeting Location: Tidewater Utilities Conference Room

WELCOME & INTRODUCTIONS – Douglas Rambo, P.G., DNREC, Division of Water

Mr. Rambo called the meeting to order at 10:03 a.m. and welcomed everyone. He asked for introductions around the table. The attendance list is included at the end of the meeting minutes.

REVIEW AND APPROVAL OF THE JUNE 27, 2019 DRAFT MEETING MINUTES

Mr. Rambo asked if anyone had any edits to the June draft meeting minutes. Mrs. Laura Mensch and Mr. Ashley Kunder commented on the last bullet point on Page 1 regarding a discussion Mr. Rambo had verbally with Mr. Keith Mensch and not at the meeting. Mr. Kunder stated that he spoke with Mr. Mensch and Mr. Mensch does not recall the details of this conversation with Mr. Rambo and Mr. Rambo stated that he will look into it and have it clarified.

No additional edits were suggested.

Final meeting minutes are posted online at https://publicmeetings.delaware.gov/Meeting/63062 .

FOLLOW-UP DISCUSSIONS FROM THE JUNE 27, 2019 MEETING – Douglas Rambo, P.G., DNREC, Division of Water

Table 4-1 - Updated
Mr. Rambo updated Table 4-1 from comments and suggestions made at the June 27th meeting. He stated the subcommittee is getting closer to the list that will be included in the Source Water Action Plan as what routinely gets tested through various Programs such as Underground Storage Tanks (now known as "Corrective Action Group") and the Office of Drinking Water (ODW) (updated Table 4-1 attached).

Information from DHSS on Water System Security
Mr. Rambo stated that he spoke with Mr. Keith Harrison at ODW and Mr. Harrison told Mr. Rambo they have a "Water System Security Threat and Emergency Response Guidance Manual" (these were distributed to the subcommittee). Mr. Rambo discussed the manual with the subcommittee and mentioned the typo in the green bar that should say "Green" and not "Orange" and "Low" not "High".

FOLLOW-UP DISCUSSION FROM THE SOURCE WATER CTAC COMMITTEE MEETING OF JULY 18, 2019 – Douglas Rambo, P.G., DNREC, Division of Water

Mr. Rambo said, "One of the outcomes of that meeting is for this subcommittee to discuss consideration of inclusion of susceptibility to saltwater intrusion, flooding, sea level rise, and storm water." Mr. Rambo asked for discussion from the subcommittee.

Mr. Ross Elliott said, "For specifically the sea level rise and saltwater intrusion, will we incorporate those models into the CCR or will they just be projected into the story map?" Mr. Rambo replied, "It would be an awareness of where you are related to the projections for sea level rise. There's nothing that mandates water systems have to account for sea level rise unless they are getting federal funding." Mr. Elliott suggested incorporating the flood maps. Mr. Rambo and Mr. Elliott continued to discuss.

It was asked if the EPA had any requirements but they were not present at the meeting and Mr. Rambo said he would reach out to some colleagues in other states with their Source Water Program that are approaching sea level rise.

Mr. Elliott stated that the storm water systems are lots of times private. He continued to discuss. Mr. Rambo said, "The problem with storm water is that the management of storm water is spread out across DNREC, DelDOT, the City of Wilmington, counties, and Conservation Districts. So trying to get a master list is going to be difficult and we may only be able to go off of what we can get from DelDOT and potentially the counties." Mr. Elliott stated that would be a good start. Mr. Rambo continued, "A partial thing could also be us having someone go through in GIS and mark the locations of visible storm water management ponds in aerial photography." Mr. Andrew Homsey said, "DelDOT has a very good database but it's not complete. New Castle County is okay but they're not complete either." Mr. Homsey continued to discuss.

Ms. Samantha Smith added, "It goes back to that discussion we had that if we don't have the most up to date and accurate information should it even be included rather than providing just partial information that's not accurate?" Mr. Matt Grabowski said, "Having worked in the Storm Water Program for a number of years, there is no complete GIS data and there's just so much construction happening at such a rapid rate it's almost immediately outdated. I think we would be best to add a step in our review where we reach out to whoever has delegated agency control in that particular area." He continued to discuss with the subcommittee and stated that without talking to that particular jurisdiction we may miss something because, particularly in coastal Sussex, a lot of these storm water BMP's are underground because of the value of the property and will not appear on aerial.

Mrs. Amber Bataille stated, "In terms of sea level rise, we have the maps from Coastal Programs. In terms of saltwater intrusion, that's a whole other beast." Mrs. Bataille discussed further. Mr. Homsey brought up the presentation and discussion that Mr. Scott Andres had at the May 8, 2019, Water Supply Coordinating Council meeting regarding saltwater intrusion. Mrs. Bataille and Mr. Homsey continued to discuss. Mr. Rambo stated that our coastal communities have been dealing with saltwater intrusion for decades.

Mr. Elliott stated how the DGS is beginning to work on establishing a Groundwater Monitoring Network. Mrs. Bataille said they are starting the infrastructure and DNREC has a network that's established but right now they're production wells. She continued to discuss and also stated that the Water Supply Section is in the process of establishing an Ambient Groundwater Quality Network statewide. She continued to discuss further with the subcommittee and also discussed how she is contacting smaller systems to see if they would be willing to join the network but at that point it would be voluntary or if they will give us access to their wells. Mr. Homsey stated it seems it would be in their best interest and Mrs. Bataille agreed but stated cost could possibly be an issue. The subcommittee continued to discuss.

Mr. Homsey asked if getting a sample is difficult and Mrs. Bataille said that taking the sample is simple but getting the sample is difficult. Mrs. Sheila Shannon asked if ODW could carry a conductivity meter with them when getting their sample for the smaller systems? Mrs. Bataille said that is a possibility but we would have to make a partnership with ODW. Mr. Kunder added that it's not just ODW but also the Department of Public Health. The subcommittee continued to discuss. Mr. Elliott said it sounds like we need more resources to adopt the chlorides under the SWAPP to make it more of a requirement. Mr. Rambo stated that technically SWAPP is non-regulatory but can use the data found to make recommendations that can assist other Programs.

Mr. Homsey asked Mr. Rambo if DNREC has a position on sea level rise. Mr. Rambo replied, "Right now the operation is that the Department is looking at half meter to one and a half meters of sea level rise by 2100." He continued to discuss and said the potential is pretty good for saltwater intrusion in the next 50-80 years. Mr. Elliott stated it's already a mission. The subcommittee continued to discuss.

Mrs. Bataille continued to discuss the Ambient Groundwater Monitoring Network. Mr. Elliott stated that there needs to be an early warning system and asked if we can recommend that. Mr. Elliott and Mr. Homsey discussed.

Mrs. Mensch discussed with Mrs. Bataille the data that can be used from the Department of Agriculture.

Mrs. Bataille stated that we are in early stages of developing this network. She said she believes they are going to start with the Columbia aquifer but eventually go to the other aquifers that are producing drinking water. She stated that in the coastal areas maybe we don't need to monitor the Columbia as heavily because most of the water purveyors are not using the Columbia but it's important to monitor it so we'll have an idea if we're moving salt down into the other aquifers. Mrs. Mensch stated that the Department of Agriculture's are all outside the municipalities. Mrs. Smith added that this is a work in progress. Mr. Rambo said, "Technically the CTAC is a sounding board to provide information to the Secretary of DNREC so if the subcommittee deems it necessary or important we can take that issue to the Cabinet Secretary and see if there is the possibility for looking at funding for progressive years and go towards this."

Mrs. Bataille said another place to get resources is the Water Supply Coordinating Council (WSCC) who meet three times a year at the Kent County building. She stated that the Council

consists of many of the providers and the Council has been good about getting project funds. Mrs. Mensch stated how this has been a topic of discussion lately at the WSCC meetings.

Mrs. Shannon stated how salt is tough to treat and very expensive to treat.

Mrs. Mensch said, "Say you're irrigating saline water and now you're introducing saline into the soil. That can be an issue. Maybe different than the drinking water side."

Mrs. Smith said, "So as far as the Plan, I know we're working on saltwater intrusion and getting data so is it worth putting that into our Plan currently. The one that we're working on now." Mrs. Mensch said, "It would make sense. I think the issue is how do you incorporate it into the mapping?" Mrs. Mensch and Mr. Elliott discussed incorporating the models and Mrs. Bataille agreed with incorporating the sea level rise models and also suggested if the wellhead protection area intersects a saltwater body then your susceptibility has now increased or even take a buffer approach. She continued to discuss.

Mr. Rambo asked Mr. Hassan Mirsajadi if Watershed Assessment has any mapping that shows the extent of the saltwater push and Mr. Mirsajadi replied, "We have no maps but we have tide boundaries, extent of tide excursion, and steam depths." Mr. Rambo said the extent of tide could be a good estimate for monitoring. The subcommittee continued their discussion.

Mr. Rambo said for the next meeting he can put together a few maps that look at the flood mapping with relation to source water areas, the sea level rise maps related to source water areas, and have examples to show. He also stated there will be a follow up discussion on this topic at the next meeting.

COMMENTS ON CHAPTER 1: BACKGROUND AND PUBLIC PARTICIPATION – Douglas Rambo, P.G., DNREC, Division of Water

Mr. Rambo said a draft Chapter 1 is on the Group.io page and is also attached to the meeting minutes. He also stated that he is almost finished Chapter 2 (Delineation) and it is broken into two sections for Surface Water and Groundwater. Mr. Rambo continued to discuss with the subcommittee what is currently being updated and he added that if anyone has any questions or suggestions on updates to the draft to email him at Douglas.Rambo@delaware.gov.

OPEN DISCUSSION / PUBLIC COMMENT

There were no additional comments.

The next subcommittee meeting is scheduled for August 29, 2019, at 10:00 a.m. in the Tidewater Conference Room.

ADJOURN – Douglas Rambo, P.G., DNREC, Division of Water

Meeting adjourned at 11:16 a.m.

These minutes are not intended to be a detailed record. They are for the use of the Source Water Assessment and Protection Program, Source Water Assessment Plan Subcommittee members in supplementing their personal notes and recall of Committee discussions and presentations and to provide information to Committee members unable to attend. Minutes recorded and submitted by Kimberly Burris.

Attendees are listed below alphabetically, last name first:
Bataille, Amber – DNREC, Source Water Protection Program
Brown, Patrick – Sussex County Engineering
Burris, Kimberly – DNREC, Division of Water, Administration
Elliott, Ross – DNREC, Tanks
Grabowski, Matthew – DNREC, Division of Water
Haggerty, Kenneth – Artesian Water Company
Homsey, Andrew – DGS, Water Resources Agency
Mensch, Laura – Department of Agriculture
Mirsajadi, Hassan – DNREC, Watershed Assessment
ONeill, Gyllian – DNREC, Division of Water
Peterson, Steve – DNREC, Waste & Hazardous Substances
Rambo, Douglas – DNREC, Division of Water, Source Water Protection Program
Shannon, Sheila – Tidewater Utilities
Smith, Samantha – DNREC, Division of Water, Source Water Protection Program

Table 4-1 Contaminants of Interest

Substance	Standard (mg/L unless otherwise indicated)	Standard Classification	Substance Origin
TIER 1			
Regulated Inorganic Contaminants			
Antimony (Sb)	0.006	MCL[1]	
Arsenic (As)	0.010	MCL[1]	Natural
Asbestos	7 MF/L [6]	MCL[1]	
Barium (Ba)	2	MCL[1]	Natural
Beryllium (Be)	0.004	MCL[1]	
Cadmium (Cd)	0.005	MCL[1]	Natural
Chromium (Cr)	0.1	MCL[1]	Natural
Cyanide (Cn)	0.2	MCL[1]	
Fluoride (F)	2.0	MCL[1]	Natural
Lead (Pb)	0.015	AL[2][3]	Natural
Mercury (Hg)	0.002	MCL[1]	Natural
Nickel (Ni)	0.1 mg/L	MCL[1]	
Nitrate Nitrogen (NO_3-N)	10	MCL[1]	Natural
Nitrite Nitrogen (NO_2-N)	1	MCL[1]	
Total Nitrate-Nitrogen and Nitrite-Nitrogen (NO3-N) + (NO2-N)	10	MCL[1]	
Selenium (Se)	0.05	MCL[1]	Natural
Turbidity	See regulations [2]		Combined Natural/Synthetic
Regulated Microbiological Contaminants			
Total Coliform Bacteria	See regulations [2]		Combined Natural/Synthetic
E. coli	Negative	MCL[1]	Combined Natural/Synthetic
Cryptosporidium	See regulations [2]		Combined Natural/Synthetic
Giardia lamblia	See regulations [2]		Combined Natural/Synthetic
Regulated Radionuclides			
Radium 226 and 228 (combined)	5 pci/l	MCL[1]	Combined Natural/Synthetic
Alpha Particles	15 pci/l	MCL[1]	Combined Natural/Synthetic
Beta Particles and Photon Emitters	4 mRem/yr	MCL[1]	Combined Natural/Synthetic
Uranium	30 pci/l	MCL[1]	
Regulated Disinfection Byproducts			
Haloacetic Acids (HAA5) [dibromoacetic acid, dichloroacetic acid, monobromoacetic acid, monochloroacetic acid, trichloroacetic acid]	0.060	MCL[1]	Synthetic
Total Trihalomethanes (TTHM) [Chloroform, Bromoform, Bromodichloromethane, Dibromochloromethane]	0.080	MCL[1]	Synthetic
Regulated Volatile Organic Compounds (VOCs)			
Benzene	0.005	MCL[1]	Synthetic
Carbon tetrachloride	0.005	MCL[1]	Synthetic
Ortho-dichlorobenzene	0.6	MCL[1]	Synthetic
Para-dichlorobenzene	0.075	MCL[1]	Synthetic
1,2-dichloroethane	0.005	MCL[1]	Synthetic
1,1-dichloroethene	0.007	MCL[1]	Synthetic
Cis-1,2-dichloroethene	0.07	MCL[1]	Synthetic
Trans-1,2-dichloroethene	0.1	MCL[1]	Synthetic
Dichloromethane	0.005	MCL[1]	Synthetic
1,2-dichloropropane	0.005	MCL[1]	Synthetic
Ethylbenzene	0.7	MCL[1]	Synthetic
Monochlorobenzene	0.1	MCL[1]	Synthetic
Methyl Tertiary Butyl Ether (MTBE)	0.01	MCL[1]	Synthetic
Styrene	0.1	MCL[1]	Synthetic
Tetrachloroethene	0.001	MCL[1]	Synthetic
Toluene	1	MCL[1]	Synthetic
1,2,4-trichlorobenzene	0.07	MCL[1]	Synthetic
1,1,1-trichloroethane	0.2	MCL[1]	Synthetic
1,1,2-trichloroethane	0.005	MCL[1]	Synthetic
Trichloroethene	0.001	MCL[1]	Synthetic
Vinyl Chloride	0.001	MCL[1]	Synthetic
Total Xylene	10	MCL[1]	Synthetic
Regulated Pesticides, PCBs and Other Organics			
Alachlor	0.002	MCL[1]	Synthetic
Aldicarb	0.003	MCL[1]	Synthetic
Aldicarb Sulfone	0.003	MCL[1]	Synthetic
Aldicarb Sulfoxide	0.003	MCL[1]	Synthetic
Atrazine	0.003	MCL[1]	Synthetic
Benzo(a)pyrene	0.0002	MCL[1]	Synthetic
Carbofuran	0.04	MCL[1]	Synthetic
Chlorodane	0.002	MCL[1]	Synthetic
Dalapon	0.2	MCL[1]	Synthetic
Di(2-ethylhexyl) adipate	0.4	MCL[1]	Synthetic
Di(2-ethylhexyl)phthalate	0.006	MCL[1]	Synthetic
Dibromochloropropane	0.0002	MCL[1]	Synthetic
Dinoseb	0.007	MCL[1]	Synthetic
Diquat	0.02	MCL[1]	Synthetic
2,4-D	0.07	MCL[1]	Synthetic
Endothall	0.1	MCL[1]	Synthetic
Endrin	0.002	MCL[1]	Synthetic
Ethylenedibromide (EDB)	0.00005	MCL[1]	Synthetic
Glyphosphate	0.7	MCL[1]	Synthetic
Heptachlor	0.0004	MCL[1]	Synthetic

Hepachlor epoxide	0.0002	MCL[1]	Synthetic
Hexachlorobenzene	0.001	MCL[1]	Synthetic
Hexachlorocyclopentadiene	0.05	MCL[1]	Synthetic
Lindane	0.0002	MCL[1]	Synthetic
Methoxychlor	0.04	MCL[1]	Synthetic
Oxamyl (Vydate)	0.2	MCL[1]	Synthetic
Pentachlorophenol	0.001	MCL[1]	Synthetic
Picloram	0.5	MCL[1]	Synthetic
Polychlorinated biphenyls (PCBs)	0.0005	MCL[1]	Synthetic
Simazine	0.004	MCL[1]	Synthetic
2,3,7,8-TCDD (Dioxin)	$3x10^{-8}$	MCL[1]	Synthetic
Toxaphene	0.003	MCL[1]	Synthetic
2,4,5-TP (Silvex)	0.05	MCL[1]	Synthetic

Substance	Standard (mg/L unless otherwise indicated)	Standard Classification	Substance Origin
TIER 2			
Regulated Secondary Contaminants			
Aluminum	0.05-0.2 mg/L	SMCL[4]	
Chloride (Cl)	250	SMCL[4]	Natural
Color	15 color units	SMCL[4]	Combined Natural/Synthetic
Copper (Cu)	1.0	SMCL[4]	Natural
Corrosivity	Non-corrosive	SMCL[4]	Combined Natural/Synthetic
Foaming Agents	0.5	SMCL[4]	Synthetic
Iron (Fe)	0.3	SMCL[4]	Natural
Manganese (Mn)	0.05	SMCL[4]	Natural
Odor	3 threshold odor number	SMCL[4]	Combined Natural/Synthetic
pH	6.5 - 8.5	SMCL[4]	Natural
Silver (Ag)	0.1	SMCL[4]	Natural
Sulfate (SO_4)	250	SMCL[4]	Natural
Total Dissolved Solids (TDS)	500	SMCL[4]	Natural
Zinc (Zinc)	5	SMCL[4]	Natural
Sodium (Na)	See regulations [2]		Natural
Perfluorooctanoic Acid / Perfluorooctane Sulfonate (individual or combined)	70 ng/L[5]	LHA[5]	Synthetic

Substance	Standard (mg/L unless otherwise indicated)	Standard Classification	Substance Origin
TIER 3			
Unregulated Contaminants			
bis(2-chloroethyl)ether (BCEE)	N/A	N/A	Synthetic
Bromobenzene	N/A	N/A	Synthetic
Bromochloromethane	N/A	N/A	Synthetic
Bromomethane	N/A	N/A	Synthetic
n-butylbenzane	N/A	N/A	Synthetic
sec-butylbenzene	N/A	N/A	Synthetic
Tert-butylbenzene	N/A	N/A	Synthetic
Cesium	N/A	N/A	Natural
Chloroethane	N/A	N/A	Synthetic
Chloromethane	N/A	N/A	Synthetic
2-chlorotoluene	N/A	N/A	Synthetic
4-chlorotoluene	N/A	N/A	Synthetic
1,2-dibromo-3-chloropropane	N/A	N/A	Synthetic
1,2-dibromoethane	N/A	N/A	Synthetic
Dibromomethane	N/A	N/A	Synthetic
1,3-dichlorobenzene	N/A	N/A	Synthetic
Dichlorodifloromethane	N/A	N/A	Synthetic
1,1-dichloroethane	N/A	N/A	Synthetic
1,2-dichloropropane	N/A	N/A	Synthetic
2,2-dichloropropane	N/A	N/A	Synthetic
1,1-dichloropropene	N/A	N/A	Synthetic
Cis-1,3-dichloropropene	N/A	N/A	Synthetic
Trans-1,3dichloropropene	N/A	N/A	Synthetic
1,4-Dioxane	N/A	N/A	Synthetic
Hexachlorobutadiene	N/A	N/A	Synthetic
Isopropylbenzene	N/A	N/A	Synthetic
4-isopropyltolulene	N/A	N/A	Synthetic
Naphthalene	N/A	N/A	Synthetic
Tert-amyl-methyl ether (TAME)	N/A	N/A	Synthetic
tert-butyl alcohol (TBA)	N/A	N/A	Synthetic
Propylbenzene	N/A	N/A	Synthetic
1,1,1,2-tetrachloroethane	N/A	N/A	Synthetic
1,1,2,2-tetrachloroethane	N/A	N/A	Synthetic
1,2,3-trichlorobenzene	N/A	N/A	Synthetic
Trichloropropane	N/A	N/A	Synthetic
1,2,4-trimethylbenzene	N/A	N/A	Synthetic
1,3,5-trimethylbenzene	N/A	N/A	Synthetic
o-xylene	N/A	N/A	Synthetic
m-xylene	N/A	N/A	Synthetic
p-xylene	N/A	N/A	Synthetic

[1] Maximum Contaminant Level
[2] Substance regulated by the Delaware Division of Public Health in the State of Delaware Regulations Governing Public Drinking Water Systems, Revised January 1, 2016
[3] Action Level
[4] Secondary Maximum Contaminant Level
(5) Lifetime Health Advisory
(6) million fibers per liter, with fiber length > 10 microns

CHAPTER 1: OVERVIEW OF THE PROGRAM

1.1 Introduction and Background of Source Water Assessment and Protection Program

For many years the primary mechanism for ensuring that our public drinking water supplies were safe was to construct water treatment systems that could remove materials that were harmful to our health. To this end, water suppliers have invested millions of dollars in treatment and distribution facilities that ensure that the water delivered to your tap is clean and healthy.

In 1996 the United States congress amended the Safe Drinking Water Act (SDWA). One of the amendments to the SDWA was to establish a Source Water Assessment and Protection Program (SWAPP) requiring the States to evaluate the sources of drinking water (wells, streams, reservoirs, etc.) used to supply public drinking water systems. The goal of the SWAPP is to promote and facilitate the assessment and protection of these public drinking water sources in an effort to complement the traditional water treatment approach. Instead of completely relying on treatment to deliver a safe product, the SWAPP offers an approach to manage, control, and/or eliminate some of the potential contaminants before they reach the treatment system.

To assist the states in implementing their SWAPP and provide some direction to this nationwide effort, the U.S. Environmental Protection Agency (USEPA) published the document "State Source Water Assessment and Protection Programs Guidance" (August 1997). This guidance requires states to develop an assessment plan – termed the Source Water Assessment Plan (SWAP) – which explains how states will assess the susceptibility of public water systems to existing or potential contamination. The preparation of Delaware's SWAP relies on both the EPA's guidance and on the unique programs already in place in Delaware.

The DNREC, Division of Water, Water supply Section, Source Water Assessment and Protection Program has the lead in the continued development and implementation of the SWAP. The DNREC is directly assisted in the efforts to implement the program by the Delaware Department of Health and Social Services, Division of Public Health, Office of Drinking Water (ODW) and the University of Delaware, Water Resources Center (WRC).

1.2 Statutory Requirements

The SDWA Amendments of 1996 (Public Law 104-182) established a national requirement for the states to place a greater emphasis on ensuring the quality of public drinking water supplies through the "prevention" of contamination. According to the guidelines provided by the USEPA, this prevention approach has two key components:

- A clear state lead, with flexibility and resources to achieve results:
- A strong ethic of public information and involvement within the states' decision-making processes.

The USEPA wanted the states to have flexibility in developing their individual program because prevention activities often involve decisions about land use which are generally controlled at the local (or state) level. Additionally, Congress provided resources (funding) to the states to develop and implement this federally mandated program. The 1996 Amendments also placed a great deal of emphasis on involving the public in both the design of the state SWAP and in having ready access to the individual system assessments. The USEPA's intention is that by involving the public in the entire process the public will be able to make more informed decisions regarding the protection of its drinking water sources.

As required by the USEPA guidance, state SWAPs must include the following elements:

- Methodology and approach to delineate the boundaries of source water assessment areas from which each public water system draws water;

- Methodology for the inventory of significant potential sources of contamination;

- Approach to determining the susceptibility of these source waters to contamination; and

- Adequate public involvement in developing the state's source water assessment plan.

1.3 The Citizens and Technical Advisory Committee

In October 1997 the Delaware DNREC held three public workshops to inform the public of the new program and to solicit public participation on the committee being formed to develop Delaware's SWAP document. The USEPA Guidance suggested that states form separate Citizen Workgroups and Technical Workgroups to aid in the development of their SWAPs. Based upon the interest expressed by the public, water suppliers, and State/Federal agencies, Delaware chose to form a single Citizen and Technical Advisory Committee (CTAC) to develop its Plan. Over the next 15 months the CTAC met to develop Delaware's original SWAP (**Appendix A**).

The members of the CTAC met throughout 1998 and early 199 to develop Delaware's Plan. While most States disbanded their citizen and technical committees after the acceptance of their SWAPs, Delaware chose to keep their CTAC active. In 2001, then Governor Ruth Ann Minner signed the Delaware Source Water Protection Law (7 Del. C §6081-6084) establishing the CTAC as an advisory board to the Secretary of DNREC on matters related to the implementation of the SWAP and the requirements of the State Source Water Protection Law.

The CTAC meets twice a year to keep the members updated about the status of the program. All CTAC meetings are advertised and open to the public.

A list of current members serving on the CTAC can be found at: http://delawaresourcewater.org/advisorycommittee/

1.4 Components of Delaware's Source Water Assessment Plan

The following chapters describe the components of Delaware's SWAP which consists of the following five major elements:

- Public Participation: A Citizen and Technical Advisory Committee (CTAC) was assembled in 1998 to facilitate input to the program from both the general public and those with technical expertise and continues to this day. Meetings are held at least twice a year to discuss Source Water Program related issues. A web site was established to provide greater public access to the SWAP (http://delawaresourcewater.org/).

- Delineation of Source Water Assessment Areas: The areas contributing source water to each of the public water systems will be determined and mapped.

- Existing or Potential Contaminant Source Inventory: All known existing or potential point and non-point sources of contamination will be inventoried within the source water assessment area. Field inspections will be conducted as necessary.

- Susceptibility Determination: Using information about the ground water or surface water system and the contaminant inventory, a determination will be made as to the potential for the source water system to become contaminated (even though it may be able to remove these contaminants through treatment).

- Source Water Assessment Implementation: The work of conducting assessments for new public water systems and those requiring reassessment due to major changes to the water system or within the delineated source water protection area. The priority of conducting assessments and/or reassessments considers factors such as population, water quality, vulnerability, and public requests.

1.5 Public Availability of Source Water Assessments

The Delaware Department of Natural Resources and Environmental Control is the lead agency in conducting source water assessments. At this time, there are approximately 483 PWSs in the State of Delaware, as summarized by county in Table 1-1:

Table 1-1: Summary of Public Water Supply (PWS) Systems in Delaware (July 2019)

	Community PWS		Non-Transient Non-Community PWS		Transient PWS		TOTAL	
	Systems	Wells / Surface Intakes	Systems	Wells / Surface Intakes	Systems	Wells / Surface Intakes	Systems	Wells / Surface Intakes
Kent County	72	301 / 0	21	28 / 0	51	47 / 0	144	376 / 0
New Castle County	23	190 / 6	19	38 / 0	27	24 / 0	69	252 / 6
Sussex County	115	547 / 0	50	90 / 0	105	88 / 0	270	725 / 0
Total	**210**	**1038 / 6**	**90**	**156 / 0**	**183**	**159 / 0**	**483**	**1353 / 6**

When the source water assessments are completed, they will be made available to the public. DNREC, with the assistance of the WRC, has established a web site where information on State's Source Water Assessment and Protection Program can be found (http://delawaresourcewater.org). The Source Water Program web site will be continually updated to provide the public with current information on the status and availability of these assessments, as well as the earlier versions of assessments as they are updated. Also, the public water suppliers are required to notify their customers of the availability of these assessments and provide a summary of its findings in their Consumer Confidence Reports (CCRs).

The extent to which individual assessments are made available will depend on the level of public interest. At a minimum, the assessments will be available at the DNREC offices, the Office of Drinking Water, and with the public water supplier. Additional locations for distribution will be made on a case-by-case basis. This may include the public libraries in each county, the libraries of colleges and universities, and at city and county offices if the demand arises. Phone numbers for people to contact to explain the assessments is available from the Source Water Program website.

1.6 Funding for the Source Water Assessment and Protection Program

Financial support for the development of the Delaware SWAPP comes from set-asides in the State's Drinking Water State Revolving Fund (DWSRF). In addition, the wellhead protection program will also be partly funded for the duration of the DWSRF. In addition to the DWSRF set-aside funds, staff resources supporting the Delaware SWAPP include those from the Clean Water Act Section 106 grant, and from state general funded positions. Delaware continues to

utilize the 15% set-aside from the DWSRF to delineate and assess sources of public drinking water.

CHAPTER 2: SOURCE WATER ASSESSMENT AREA DELINEATION

The USEPA has provided the states with guidance (EPA, August 1997) on the items that must be included in a state's SWAP submittal. The guidance, however, allowed for a large degree of flexibility between the states. The initial step in developing the program is the delineation of areas that contribute to and could impact public drinking water surface intakes, raw water storage facilities (reservoirs), and public water supply wells. These source water assessment areas are the geographic extent for conducting the contaminant inventory and lastly, determining the susceptibility of each public water source. For surface water source water assessment areas, the delineations will utilize existing information maintained in the geographic information systems (GIS) of the State of Delaware and the Water Resources Agency/University of Delaware (WRA). For others, particularly the groundwater systems, the modeling and delineation of the boundaries of these areas will need to be accomplished through the source water assessment activities. Groundwater delineations will be provided by the DNREC SWAPP utilizing simple GIS related methods or more complex computer simulations.

Each State is required to identify the locations of the sources of public drinking water supplies and delineate a source water area based upon those locations. The Delaware DNREC has been working since the 1990's to capture the locations of public water supplies (surface water intake, well, or reservoir) using high-accuracy global positioning system (GPS) units with a horizontal accuracy of one-meter (or less) after post-processing.

Part A of this chapter will detail the methods and techniques employed by the State of Delaware for the delineation of surface water sources of drinking water, meanwhile Part B of this chapter will go into detail regarding the delineation of wellhead protection areas for groundwater derived sources of drinking water.

PART A:

SOURCE WATER PROTECTION AREA DELINEATION OF SURFACE WATER SYSTEMS

2.A.1 Surface Water Supply Sources in Delaware

There are only three public water suppliers in the State of Delaware that have surface water intakes for their source of drinking water, and all are located in New Castle County (Figure 2.A.1). These are the City of Wilmington, the City of Newark, and SUEZ Water Delaware. The surface waters used by these three suppliers are Brandywine Creek, White Clay Creek, Red Clay Creek, and the Christina River. Although these streams vary in size, they all share a common trait - the headwaters of these waterways are in another state, Pennsylvania (Figure 2.A.2). In addition, much of the drainage basin for three of the four waterways are also within Pennsylvania. A small portion of the Christina River watershed is in the State of Maryland. This major drainage basin, called the Christina River Basin, ultimately flows into the Delaware River.

<INSERT FIGURE 2.A.1>

<INSERT FIGURE 2.A.2>

Additionally, there are two large surface water impoundment facilities in Delaware, the Edgar M. Hoopes Reservoir, which is owned and operated by the City of Wilmington, and the Newark Reservoir which is owned and operated by the City of Newark (Figure 2.A.3). Hoopes Reservoir is a two billion gallon off-stream pumped storage facility located on a tributary of the Red Clay Creek, although the water stored in the Hoopes Reservoir is pumped from the Brandywine Creek. The entire 2 square mile watershed for Hoopes Reservoir is within Delaware. Hoopes Reservoir is principally an emergency storage facility utilized by Wilmington when conditions on the Brandywine Creek are impaired by quality or quantity. Hoopes Reservoir is also used by SUEZ Water Delaware, the Artesian Water Company, and the City of Newark through an agreement with the City of Wilmington to release raw water from the reservoir into the Red Clay Creek to be withdrawn, treated, and distributed by SUEZ Water when needed. The Newark Reservoir is a 340 Million Gallon off-stream pumped storage facility located adjacent to the White Clay Creek which serves as its source of supply. The total watershed area for the Newark Reservoir consists of 349 acres (0.54 square miles). The Newark Reservoir is principally an emergency storage facility utilized by the City of Newark when conditions on the White Clay Creek are impaired by degraded quality or low flows.

<INSERT FIGURE 2.A.3>

One other surface water source that is used daily in Delaware is the Octoraro Creek in the Susquehanna River Basin of Pennsylvania. Water from this out-of-state source enters Delaware as finished water through pipelines from the Chester Water Authority (CWA) in Pennsylvania. One of the pipelines connects the CWA to the Artesian Water Company and another pipeline connects the CWA to SUEZ Water Delaware. The following table summarizes the public water suppliers that utilize surface water for public supplies in Delaware and shows the percentage of each watershed that is within Delaware's state boundaries.

Table 2.A-1 Summary of Watersheds Used for Public Drinking Water in Delaware

Water Supplier	Source Water/ Watershed	Maximum Withdrawal	Total Watershed Area	% of Watershed in Delaware
City of Wilmington	Brandywine Creek	44 MGD	320 Sq. Miles	10%
City of Wilmington	Hoopes Reservoir	24 MGD	2 Sq. Miles	100%
City of Newark	White Clay Creek (above Newark)	Up to 5 MGD	69 Sq. Miles	14%
City of Newark	Newark Reservoir	18 MGD	0.54 Sq. Miles	100%
SUEZ Water Delaware	Red Clay/ White Clay Creek	30 MGD	155 Sq. Miles	40%
SUEZ Water Delaware	Christina River at Smalley's Pond	6 MGD	56 Sq. Miles	81%
Chester Water Authority, Pennsylvania	Octorora Creek	8 MGD	140 Sq. Miles	0%

2.A.2 Delineation of Source Water Assessment Areas for Surface Water Systems

According to US EPA's document "State Methods for Delineating Source Water Protection Areas for Surface Water Supplied Sources of Drinking Water" (August 1997) there are three main methods states utilize to delineate surface water assessment areas upstream of a public supply intake:

- Topographic boundary delineation,
- Setback/buffer zone delineation,
- Time-of-travel calculation.

Topographic boundaries are determined by the contour of the land. These boundaries are commonly referred to as the watershed or drainage basin for the stream. A setback/buffer zone is an area along the banks of a stream established by a policy decision considering such factors as the slope of the land adjoining a stream, size of stream, and local land uses along the stream. According to US EPA, a typical buffer zone is a strip of land up to about 200 feet wide. The third method for delineating a surface water assessment area is by developing time-of-travel calculations. This approach is used to determine how long it would take for a contaminant moving at the same speed of the stream water to reach the supply intake(s). This method is very useful for emergency response activities and most important for places where there are sources of contamination located directly adjacent to the stream or its tributaries with little overland flow needed to enter the watercourse.

The State of Delaware's approach to delineating surface source water assessment areas will utilize topographic boundaries, physical land characteristics (soils), and setback/buffer zones in a hierarchical arrangement. Initially, all lands upstream of the public surface water supply intakes will be divided into watersheds based on the topography of the land. The US EPA's Final Guidance document requires states to delineate the source water assessment area for surface water sources based on the watershed upstream of the suppliers' intakes up to the state's

borders. For Delaware, the watersheds of the four streams used for water supply - the Brandywine Creek, the White Clay Creek, the Red Clay Creek, and the Christina River, have been delineated (Figure 2.A.1). However, since such a large portion of the watersheds for these surface water sources for Delaware are in Pennsylvania, the watershed delineations have been extended into Pennsylvania (Figure 2.A.2) up to the next drinking water intake. It is the intention of Delaware to work closely through existing interstate relationships with the Commonwealth of Pennsylvania and Chester County, Pennsylvania personnel to implement elements involved in Delaware's source water assessment activities, including the delineation, potential contaminant inventory, and susceptibility determinations.

Delaware has been working with Pennsylvania agencies on a project called the Christina Basin Clean Water Partnership (CWP). The CWP is a regional management committee that has been established consisting of representatives from Pennsylvania, Delaware, USEPA, the Delaware River Basin Commission, as well as water utilities and environmental organizations. The goal of this program is to address water quality problems through a regional, watershed-based approach. Ultimately, TMDLs, as required by Section 303 (d) of the Clean Water Act, have been or will be established for these four streams in the Christina River Basin through the development of a watershed water quality model. The TMDLs will be limits established on discharges that will result in improving the quality of these surface water sources including those used for public drinking water. Through this program and the work of various DNREC programs, the basic delineation of the entire watershed and the sub-basins for each of these streams has been completed and is maintained in a Geographic Information System (GIS) database at the WRA and at DNREC. A base map has been developed that shows the hydrology, road network, major/minor watersheds, and the state/county/municipal boundaries of the 565 square mile Christina River Basin. The SWAPP will utilize the most up-to-date data from the following sources to maintain the base map:

<u>Roadway and Stream Network</u>

Delaware Department of Transportation (DELDOT)
Pennsylvania Department of Transportation (PENNDOT)
Maryland Department of Transportation (MDOT)

<u>State/County/Municipal Boundaries</u>

DELDOT
PENNDOT
MDOT

<u>Watershed Boundaries</u>

Delaware - Water Resources Agency
Pennsylvania - Chester County Planning Commission watershed maps by WRA
Maryland - Digitized from the USGS Newark West Quadrangle by WRA

Additionally, a variety of GIS data layers have been developed to characterize the watershed and provide a foundation for assessing these source waters. This data includes impervious cover,

land use, zoning, topography, and soil classifications. This program and information will be utilized for surface water delineation in the Delaware SWAP and to coordinate interstate source water assessment and protection efforts within the Christina River Basin area.

Although the entire watershed area is important, and will be considered, for source water assessment, different land areas have varying impacts to surface water quality, usually related to relative distance from the stream. To delineate the areas of most value to surface water quality, the State will use an approach based on natural land characteristics and a buffer area of 200 feet. The methodology using floodplains, adjacent steep slopes, and soil characteristics used by the Water Resources Agency in developing the Water Resource Protection Area (WRPA) Program in New Castle County will be employed. The WRPAs are areas that were determined by the Delaware Geologic Survey, DNREC, and WRA to be most important to maintaining the quality and quantity of the sources of public drinking water - both ground and surface water supplies. These areas were delineated, mapped and adopted into the land development code for New Castle County in 1991 and were subsequently updated.

Delaware's surface water assessment areas are lands upstream of public water supply intakes that are in the 100-year floodplain, erosion prone slopes contiguous to and draining towards a floodplain, and areas that drain directly to public water supply reservoirs (Figure 2.A.4). The erosion prone slope areas consist of lands with soils that easily erode as mapped in the United States Department Agriculture Soil Survey for New Castle County. These areas, used for the WRPA program in New Castle County, will be utilized for delineating surface water source water assessment areas. In areas along tributaries where there are no delineated erosion-prone slope areas or 100 year floodplain on the New Castle County WRPA maps, a fixed distance of 200 feet from both edges of the stream will be established.

<Insert Figure 2.A.4>

Lastly, consideration will be given to some of the area downstream of the surface water intake for United Water Delaware at Stanton in the delineated assessment area. The stream used for source water, the White Clay Creek, is influenced by tidal action up to the intake. The contaminant inventory and vulnerability analysis may need to consider some portion of this downstream area since contaminants could migrate upstream by tidal movement under certain flow conditions. A likely point downstream is the tidal control structure.

It is recommended that a similar stream buffer approach be used in Pennsylvania to target areas of higher importance to surface water quality. It should be noted that there will be gaps between the last downstream intake in Pennsylvania and the Delaware state line for the Brandywine Creek. Also, there are no public water system intakes in Pennsylvania on the Red Clay, White Clay, and the Christina River. Data from the Christina River Basin Clean Water Partnership will be used for these assessments.

2.A.3 Surface Water Delineation Classification Hierarchy

A two-zone delineation classification approach will be used for source water assessment areas for all surface supply sources in Delaware (Figure 2.A.4). Each delineation level (1A, 1B,

2) will have an impact on the contaminant source inventory and the susceptibility determination to be described in the remaining chapters.

CATEGORY	DELINEATED AREA
Level 1A	100-year floodplains, and/or erosion-prone slopes;
Level 1B	Buffer areas 200 feet from each side of streams;
Level 2	All watershed areas above public drinking water supply intakes

See Appendix I, page I-3 for an example of this approach

PART B:

SOURCE WATER PROTECTION AREA DELINEATION OF GROUNDWATER SYSTEMS

2.B.1 Groundwater Supply Sources in Delaware

With the exception of the six (6) surface water intakes and the associated three systems, all of the rest of Delaware's public water systems rely on groundwater as the only source of public drinking water. Table 2.B.1 summarizes the approximately 1050 public supply wells in Delaware by county and by system type.

These public water supply wells have been drilled to a wide range of depths and draw water from various aquifers. For source water assessment purposes, a key factor need to delineate the source water area is whether a well is screened in an unconfined, semi-confined, or confined aquifer. Semi-confined and confined aquifers are generally, but not always, deeper than the unconfined aquifer and are separated from the overlying geologic formation by a layer of clay-like materials. These materials, termed confining layers, impede the vertical movement of water making confined aquifers less susceptible to contamination than unconfined aquifers. A listing of all current public water supply systems is provided in Appendix D. Additionally, the wells currently within the DNREC database for Kent, Sussex, and New Castle Counties are illustrated in Figures 2.B.1, 2.B.2 and 2.B.3, respectively. DNREC began locating all public supply wells using global positioning system (GPS) units. The Delaware SWAP will delineate the source waters of the following groundwater-based public water supply systems:

- Community Public Water Systems
  - Municipalities
  - Investor-owned purveyors
  - Privately-owned purveyors

- Non-Transient Non-Community Public Water Systems
  - Schools/Day Care Centers
  - Offices/Factories

- Transient Non-Community Public Water Systems
  - Restaurants and Stores
  - Hotels/Recreation Areas

Table 2.B.1 Summary of Public Water Supply Wells in Delaware (August 1999)

	Community PWS Wells	**Non-Transient / Non-Community PWS Wells**	**Transient PWS Wells**	**TOTAL Wells**
Kent County	158	47	34	239
New Castle County	123	59	11	193
Sussex County	337	76	74	487
Total	618	182	119	919

<INSERT Figure 2.B.1 New Castle County>

<INSERT Figure 2.B.2 Kent County>

<INSERT Figure 2.B.3 Sussex County>

2.B.2 Delineation of Source Water Assessment Areas for Groundwater Systems

As with surface water sources, the delineation of areas critical to protecting the quality and quantity of groundwater sources has been underway for several years. In 1990, Delaware's Wellhead Protection Program was approved by the USEPA. This program established the methodology used in Delaware for delineating wellhead protection areas in the SWAP. The areas that will be delineated are divided into two categories: wellhead protection areas (the surface or sub-surface area surrounding a water well or wellfield through which contaminants are likely to move toward and reach such well or wellfield) and recharge-potential areas (areas where the soil and rock characteristics are favorable for water on the land surface to pass into an aquifer). A July 1994 draft report written by the Delaware DNREC entitled *"Wellhead Protection Area Delineation Manual*" provides additional detail on the following explanation of the State's approach to wellhead protection area delineation.

The DNREC policy for delineating wellhead protection areas provides the guidance for delineating the source water assessment areas around public water supply wells. This policy applies to all of the categories of wells listed previously. All public supply wells pumping at or less than 50,000 gallons per day (gpd) are assigned a circular wellhead area of 150 feet radius centered on the well. For most low pumping-rate wells the 150-foot radius would include the 5-year time of travel. Also more detailed wellhead protection area (WHPA) delineations at low system-wide water use are not credible due to their sensitivity to varying groundwater flow direction. On the other hand, all public water system wells withdrawing more than 50,000 gpd would have a wellhead protection area delineated using various modeling techniques such as, but not limited to, USEPA's Wellhead Analytical Element Model (WhAEM) and the United States Geological Survey's MODFLOW computer models.

Another important factor in delineating the wellhead protection area is the determination of whether the well is drawing water from a confined, unconfined, or semi-confined aquifer. Many aquifers in Delaware are considered confined if the aquifer has an impermeable layer over the top of it that significantly reduces the lateral flow of water from above. In most cases, a well screened in one of these aquifers may be considered confined by DNREC and the wellhead area would be a 150 foot radius circle centered to the well. The exception to this is where these otherwise confined aquifers subcrop (i.e. are in limited, but direct hydraulic connection with) beneath the unconfined aquifer, and thus they will be considered semi-confined in these locations. The aquifers that have subcrop areas include the Rancocas, Magothy, Potomac, Pocomoke, Ocean City, Manokin, Cheswold, and Frederica aquifer units of the Chesapeake Group. Semi-confined wells will be evaluated on a case-by-case basis through their location, water use, well construction, and water quality to determine if they should be delineated using a fixed radius or a more complex groundwater model.

The unconfined aquifer covers the surface of much of Delaware and consists mainly of a sand layer of varied depth that generally thickens from 0 to 130 feet as you move from north to south. This aquifer is usually referred to as the Columbia or water table aquifer. Wells screened in an unconfined or semi-confined aquifer are treated the same when considering wellhead protection delineation. If the pumping rate is at or less than 50,000 gpd, the wellhead is again the 150-foot radius circle centered on the well. If the pumping rate exceeds 50,000 gpd, hydrogeologic modeling is required to determine the wellhead protection area. Water use reports required by the DNREC Water Allocation Program will be used to determine the pumping rate for existing wells.

The Delaware DNREC is using groundwater models to delineate wellhead protection areas for wells pumping greater than 50,000 gpd. As described in Delaware's Wellhead Protection Plan, DNREC uses a 5-year time of travel in the modeling, meaning that it would take 5 years for a drop of water to travel from the outer boundary of the resulting wellhead protection area boundary to the well. These models vary in complexity, detail, and cost and the one selected for a well will depend on the individual conditions related to the underlying geology. Necessary inputs to the models include transmissivity, saturated thickness, effective porosity, groundwater flow direction, and hydraulic gradient.

DNREC will also be using the groundwater recharge-potential mapping project to provide additional information needed to better define the local conditions for input into the wellhead models. This project characterizes the ease with which recharging water (or other liquids) can move through the subsurface and into the unconfined aquifer. The Delaware Geological Survey (DGS) utilizes a "stack-unit" methodology to rank areas as either poor, fair, good, or excellent (Andres, 1991). This method is basically a detailed lithologic characterization of the top 25 feet of soils and sediments from which an inference can be made about the intrinsic permeability of the material.

In New Castle County, the wellhead protection areas to be used for the SWAP include delineations through work by the Delaware Geological Survey, DNREC, the Water Resources Agency, and New Castle County Council. Wellhead protection areas were delineated and adopted into law by New Castle County Council as part of the New Castle County WRPA program. The State DNREC included the wellhead protection program provisions of the NCC WRPA Program in its USEPA approved Wellhead Protection Program. The areas (Figure 2.B.4) are defined as:

- Class A Wellhead Areas - - The area within a 300 foot radius circle around all public water supply wells which are classified as water systems, as defined by Section 22.146 (Public Water Systems) in the State of Delaware Regulations Governing Public Drinking Water Systems. Class A wells are community, transient non-community, and non-transient non-community.;

- Class B Wellhead Areas - The Glendale and Eastern States Wellfields. These Wellhead Protection Areas have been delineated through the use of hydrogeologic mapping, analytical methods, and application of U.S. EPA modular semi-analytical models using a five year time-of travel by the Delaware Geological

Survey as discussed in a report prepared by the Delaware Geological Survey entitled "Application of the EPA WHPA Models for Delineation of Wellhead Protection Areas in the Glendale and Eastern States Wellfields, New Castle County, Delaware" dated January 1993.;

- Class C Wellhead Areas - Wellhead Protection Areas delineated by the Delaware Geological Survey and the Delaware Department of Natural Resources and Environmental Control through the interpretation of geologic and hydrologic reports and maps, water-table maps, and professional judgment. Such areas are considered preliminary designations;

- The Cockeysville Formation Water Resource Protection Areas consist of: (1) areas that are directly underlain (outcrop) by the Cockeysville Formation, and (2) land surface areas which drain to the areas underlain by the Cockeysville Formation (Cockeysville Formation Drainage Area). The locations of the Cockeysville Formation were obtained from Plate 1 of a report prepared by the Delaware Geological Survey in 1991 titled "Summary Report, Geology and Hydrology of the Cockeysville Formation, New Castle County, Delaware." Areas draining to and across the Cockeysville Formation were derived from the U. S. Geological Survey 7.5 minute topographic quadrangle maps

These areas will be included in the Delaware SWAP for the delineation of community public water supply wells in New Castle County. They are consistent with the DNREC approach for the State with the exception of the wellhead area surrounding a well, which can be up to a 300 foot radius in New Castle County. Additionally, the Class C wellhead areas may be included in the State wellhead delineation work using ground water models. The State will also add the NTNC PWS wells and the TNCPWS wells to the mapped wellhead areas in New Castle County for inclusion in the SWAPP. A 150-foot radius wellhead area will be assigned to them unless the system-wide water use exceeds 50,000 gpd.

<INSERT Figure 2.B.4 New Castle County Groundwater WRPAs>

2.B.3 Delineation of Wells where Little Information is Known

There may be instances in the records of wells housed at the DNREC that the only known information about a well is its location and a total depth based upon word-of-mouth conversations with the well owner/operator. It is not uncommon for the SWAPP to run across these wells in the process of inspecting a water system since the DNREC did not begin formally issuing well permits until approximately 1971. Prior to then the Department has relied upon the records of the Delaware Geological Survey (DGS) or the Unites States Geological Survey (USGS) for information on wells – if such information exists.

In the case where little information is known about the well, the Department may use the Calculated Fixed Radius (CFR) method to determine the WHPA for a well or wells on a water system screened in the unconfined aquifer. The CFR method draws a circular protection area for

a specified time-of-travel threshold (5-years). A simple volumetric flow equation is used to calculate the radius (Figure 2). Data required are 1) well pumping rate, 2) porosity of aquifer and 3) open or screened interval of the well. (If the actual screened interval is unknown, or if the well is constructed with an open interval at its base, a minimum value of 10 feet should be used.)

$$r = \sqrt{\frac{Q \cdot t}{\pi \cdot n \cdot H}}$$

where: r = calculated fixed wellhead radius

Q = pumping rate of well in ft^3/yr (provided well is pumping greater than 50,000 GPD)

n = aquifer porosity: typically 30% in Delaware (dimensionless)

H = *length of well screen/ thickness of unsaturated aquifer in ft*

t = time of travel in years (5 per DE SWAP)

This delineation method is easy to apply and relatively inexpensive, it requires a minimum level of technical expertise. Because of its simplicity it can be used as a delineation method for moderate and smaller systems. It could be used by many systems as a first cut method for identifying immediate threats to the water quality. The one drawback to the CFR method is that rarely does groundwater behave as simply as this method predicts.

2.B.4 Conjunctive Delineations (needs further discussion)

USEPA has described the need to consider situations where surface water is closely tied to ground water. Delineations that consider this situation have been termed "conjunctive delineations." This concept is particularly useful in instances where ground water is under the direct influence of surface water (GWUDI). **At this time, no GWUDI conditions have been recognized in Delaware for any public water supply systems**; hence, no conjunctive delineations are warranted. However, DNREC will take steps as part of its susceptibility determination to include surface water drainage areas as part of wellhead delineation areas and contaminant source identification.