



# DUPONT TELOMER MANUFACTURING SITES: ENVIRONMENTAL ASSESSMENT OF PFOA LEVELS IN AIR AND WATER

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## EXECUTIVE SUMMARY

A voluntary Letter of Intent (LOI) was submitted by the Telomer Research Program (TRP) to the United States Environmental Protection Agency (EPA) on March 14, 2003 to address questions raised by the EPA about the possible association of perfluorooctanoic acid (PFOA) with telomer-based products. One component of the LOI was to characterize potential release of PFOA from telomer-based product manufacturing operations.

As the only fully integrated U.S. producer/manufacturer of telomer products, DuPont volunteered to conduct a series of environmental assessments at its telomer manufacturing operations located at Chambers Works in Deepwater, New Jersey and Washington Works in Parkersburg, West Virginia (TRP LOI Appendix 1). Both sites are multi-purpose manufacturing operations. Chambers Works alone manufactures over 400 products and has around eight major chemistries. At Washington Works, the telomer operation is one of twelve different manufacturing operations.

The specific assessments are as follows:

- ❑ Develop site specific plans to assess levels of PFOA in air and water from manufacturing operations around each site; development of plans will begin no later than April 14, 2003.
- ❑ Conduct site-specific air dispersion modeling for applicable manufacturing operations, using the EPA-approved Industrial Source Complex Short Term 3 (ISC3) model, as described in EPA's *Guideline on Air Quality Models* (40 C.F.R. Part 51, Appendix W), and assess the results using the air screening levels established in West Virginia.
- ❑ Conduct groundwater and surface water analyses at each site and assess the results using the water screening levels established in West Virginia.
- ❑ Use the West Virginia screening levels to determine what additional actions, if any, may need to be taken.

This report summarizes the results of this work using the West Virginia Screening Levels as established by the C8 Assessment of Toxicity Team (CATT) (WVDEP, 2002a and 2002b). PFOA levels in surface water were compared to CATT-established human health protective screening criteria for water of 150 ppb ( $\mu\text{g/l}$ ) PFOA and the CATT-established aquatic life advisory of 1,360 ppb PFOA (Table 1). PFOA levels in air were compared to the CATT-established inhalation reference concentration screening level of  $1.0 \mu\text{g}/\text{m}^3$  air (Table 1).

## **Chambers Works**

Air dispersion modeling for PFOA was conducted for the telomers manufacturing facilities (Table 2). The Chambers Works site air dispersion modeling results show a maximum average annual off-site concentration of approximately  $0.0036 \mu\text{g}/\text{m}^3$  which is nearly three orders of magnitude below the CATT established screening levels. The model using only the telomers operations resulted in a maximum average annual off-site concentration of  $0.00004 \mu\text{g}/\text{m}^3$ . This is five orders of magnitude below the CATT-established inhalation screening level of  $1.0 \mu\text{g}/\text{m}^3$  (Table 2).

Groundwater at Chambers Works is contained by a groundwater collection system consisting of six interceptor wells that withdraw over 1.5 million gallons per day beneath the site to maintain an inward hydraulic gradient around the site. At the interceptor wells, located in the central portions of the site, the highest concentration (46.6 ppb) of PFOA was measured (Table 3). At the perimeter wells, located at the southeast and southwest site borders, concentrations of PFOA were at very low part per billion levels. Groundwater in the vicinity of Chambers Works is not removed from the ground for drinking water or other use, with the exception of the IWS; therefore, it is not appropriate to compare these results with the CATT-established screening levels for drinking water. Nevertheless, numbers are well below these levels.

At Chambers Works, PFOA measurements in surface water were well below the CATT-established screening levels. Table 4 compares Chambers Works analytical results from surface water to the CATT-established screening levels. To be conservative, the highest concentrations of PFOA in the far-field surface water samples are used for comparison. Because the Delaware River near Chambers Works is not designated as a drinking water source, the aquatic life advisory (1,360 ppb) was used for comparison. Results from Salem Canal, designated a drinking water source by New Jersey Department of Environmental Protection (NJDEP), were non-detect upstream of Chambers Works and a maximum of 0.089 ppb at the Chambers Works Salem Canal water intake. These results are below the CATT-established screening level of 150 ppb.

## **Washington Works**

At Washington Works, PFOA in groundwater and surface water has been thoroughly assessed for the site (DuPont, 2003) so no further work was needed to characterize groundwater and surface water. Air dispersion modeling has also been conducted for the site using the ISC3 model. However, potential PFOA emissions from telomer manufacturing were not included in the model. The EPA Screen3 dispersion modeling tool was used to evaluate whether estimated emissions from telomer operations would have a significant affect on the previous modeling results. The Screen3 model for telomers manufacturing at Washington Works predicts a maximum average annual fence line concentration of  $0.00012 \mu\text{g}/\text{m}^3$ —significantly below the CATT-established inhalation reference concentration screening level of  $1.0 \mu\text{g}/\text{m}^3$  (Table 2). These data would not significantly affect the current models for the Washington Works site.

## **Summary**

Overall the data show that telomers manufacturing is not a significant source of PFOA to the environment.

**Table 1**  
**CATT Established Screening Levels**

|                                                    |                       |
|----------------------------------------------------|-----------------------|
| Aquatic Life Advisory Concentration (water)        | 1,360 µg/l (ppb)      |
| Human Health Protective Screening Criteria (water) | 150 µg/l (ppb)        |
| Inhalation Reference Concentration (air)           | 1.0 µg/m <sup>3</sup> |

**Table 2**  
**Summary of Air Dispersion Modeling Results**

| Air                             | Maximum Calculated Off-site Concentrations | CATT Established Screening Levels |
|---------------------------------|--------------------------------------------|-----------------------------------|
| Chambers Works Site             | 0.0036 µg/m <sup>3</sup>                   | 1.0 µg/m <sup>3</sup>             |
| Chambers Works Telomers Only    | 0.00004 µg/m <sup>3</sup>                  | 1.0 µg/m <sup>3</sup>             |
| Washington Works Telomers Only* | 0.00012 µg/m <sup>3</sup>                  | 1.0 µg/m <sup>3</sup>             |

\*Screen3 model used

**Table 3**  
**Summary of Groundwater Sampling Results—Chambers Works**

| Groundwater                        | Maximum Analytical Results |
|------------------------------------|----------------------------|
| Interceptor Wells – Plant Interior | 46.6 ppb                   |
| Perimeter Monitoring Well          | 5.0 ppb                    |

**Table 4**  
**Summary of Surface Water Sampling Results—Chambers Works**

| Surface Water              | Maximum Analytical Results | CATT Established Screening Levels |
|----------------------------|----------------------------|-----------------------------------|
| Delaware River – Far Field | 0.566 ppb                  | 1,360.0 ppb                       |
| Salem Canal                | 0.089 ppb                  | 150.0 ppb                         |

## 1.0 INTRODUCTION

A voluntary Letter of Intent (LOI) was submitted by the Telomer Research Program (TRP) to the United States Environmental Protection Agency (EPA) on March 14, 2003 to address questions raised by the EPA about the possible association of perfluorooctanoic acid (PFOA) with telomer-based products. One component of the LOI was to characterize potential release of PFOA from telomer-based product manufacturing operations.

As the only fully integrated U.S. producer/manufacturer of telomer products, DuPont volunteered to conduct a series of environmental assessments at its telomer manufacturing operations at Chambers Works in Deepwater, New Jersey and Washington Works in Parkersburg, West Virginia (TRP LOI Appendix 1). Neither of these sites is a pure telomer manufacturing site. Both sites are multi-purpose manufacturing operations. Chambers Works alone manufactures over 400 products and has around eight major chemistries. At Washington Works, the telomer operation is one of twelve different manufacturing operations.

The specific assessments are as follows:

- ❑ Develop site specific plans to assess levels of PFOA in air and water from manufacturing operations around each site; development of plans will begin no later than April 14, 2003.
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- ❑ Conduct groundwater and surface water analyses at each site and assess the results using the water screening levels established in West Virginia.
- ❑ Use the West Virginia screening levels to determine what additional actions, if any, may need to be taken.

This report summarizes the results of this work using the West Virginia Screening Levels as established by the C-8 Assessment of Toxicity Team (CATT) (WVDEP, 2002a and 2002b). PFOA levels in surface water were compared to CATT-established human health protective screening criteria for water of 150 ppb PFOA and the CATT-established aquatic life advisory of 1,360 ppb PFOA. PFOA levels in air were compared to the CATT-established inhalation reference concentration screening level of  $1.0 \mu\text{g}/\text{m}^3$ .

### 1.1 Chambers Works

The DuPont Chambers Works, located in Deepwater, New Jersey near the Delaware Memorial Bridge, has manufactured a variety of industrial compounds over the past 86 years (Figure 1). Today, the site produces approximately 400 different products. Telomer production is only a portion of the manufacturing process and chemistries

present. The manufacturing site is approximately 600 acres, bounded by a non-manufacturing area, which includes a DuPont owned and maintained wildlife habitat to the north, the Delaware River to the west, Salem Canal to the south, and the Deepwater, New Jersey community to the east.

Since the 1970s the site has had a groundwater containment system. The most significant containment program is the Interceptor Well System (IWS) that withdraws over 1.5 million gallons of groundwater a day from the underlying aquifers and pumps the water to the site wastewater treatment plant (WWTP) for treatment. The interceptor well systems maintain an inward hydraulic gradient on the site to prevent off site migration of groundwater.

The study team identified four operations on-site with the potential for handling PFOA. These were a tenant manufacturing operation, the site WWTP, the site groundwater collection system, and telomers operations. For purposes of this study, each operation was evaluated for its potential contribution to air for input to the air dispersion model.

Surface water was evaluated by collecting surface water samples from the Delaware River and Salem Canal and at control locations upstream of the potential influence from Chambers Works emissions. Groundwater was evaluated by sampling the IWS and perimeter wells along prevailing wind directions. The specific contribution from telomers to water was not evaluated although it is anticipated that the contribution is very low.

## 1.2 Washington Works

DuPont manufactures telomer intermediates at its Washington Works Site located in Parkersburg, West Virginia. Washington Works manufacturing operations cover about 170 acres, with the telomer facility covering about one acre (Figure 2). Telomer manufacturing is one of 12 different manufacturing processes at Washington Works. The telomer facility manufactures a variety of telomer intermediates that are shipped to the DuPont Chambers Works Site for further processing.

PFOA emissions from the Washington Works site have been thoroughly characterized through a series of studies on air dispersion, surface water and groundwater (DuPont, 2003b). Because of the extensive work on surface water and groundwater emissions from the site, no further evaluation was needed for this study. Previous air dispersion modeling did not include potential air emissions from telomers operations. To evaluate whether estimated telomer PFOA emissions had any appreciable effect on fence line concentration of PFOA, the EPA's Screen3 air dispersion model screening tool was used. The results of this assessment are expected to be more conservative than the ISC3 dispersion model.

## 2.0 DATA ANALYSIS AND ANALYTICAL REPORTING

Analysis of PFOA in water was performed by Exygen Research, Inc. according to a laboratory Standard Operating Procedure (SOP) developed by Exygen. The analytical method utilizes Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS). Exygen reports PFOA results for the laboratory replicate of each field sample. These results are evaluated for precision by comparing the field sample result to the corresponding laboratory replicate result:

- ❑ If both results are less than the practical quantitation limit (PQL), the replicate sample for that analyte is considered to have passed the precision criteria.
- ❑ If one or both results are between one and five times the PQL, the replicate is considered to have met the precision criteria if the two results differ by less than the PQL.
- ❑ If one result is less than the PQL and the other is not, and if the two results differed by a value less than the PQL, the replicate is said to have met the acceptance criteria.
- ❑ If both results are at least five times the PQL, the replicate is considered to have met the criteria if the relative percent difference (RPD) between the two results is less than or equal to 20%. The RPD is the absolute value of the difference of two measurements divided by their average.

When the precision criteria outlined above are met, Exygen reports the average of the field sample and lab replicate results reported by the laboratory. If criteria for precision are exceeded, Exygen reports the higher of the sample and lab replicate results. Finally, when one result (from the sample/lab replicate pair) is above the PQL and one below, the result that is above the PQL is reported. Final PFOA results are recorded in the Corporate Environmental Database (CED) and are reported as FC-143 for consistency with historical results.

An aliquot of each field sample is also analyzed as a matrix spike (MS). Results of the MS analysis are used to assess accuracy. The MS recovery value must fall between 70 to 130%, unless the sample concentration is at least four times the amount spiked. The maximum amount used to spike field samples is 500 ppb.

All data packages generated by Exygen are reviewed in-house for compliance with the laboratory SOP and data usability, using the checklist provided in Appendix A of the *Quality Assurance Project Plan* (DuPont CRG, 2003). Results of the in-house review indicate that data reported by Exygen have been generated in compliance with the laboratory SOP, with few exceptions as noted in the individual review summaries. All data reported by Exygen have been judged usable for the purposes of the project.

## 3.0 AIR DISPERSION MODELING

### 3.1 Chambers Works – ISC3 Modeling Methodology and Results

#### 3.1.1 Emission Source Information

The ISC3 model was used to calculate ambient ground-level air concentrations for emissions of PFOA from both the Chambers Works site and from the telomers operations. Table 5 shows the stack parameters and emission rates used in the model for each emission point. Appendix A contains the basis for the emission estimates of PFOA for the site.

#### 3.1.2 Modeling Methodology

Dispersion modeling was performed using the EPA's Industrial Source Complex 3 Model (ISC3), version 00101, provided by Trinity Consultants. All modeling was done in accordance with the procedures in EPA's *Guideline on Air Quality Models* (40 CFR Part 51, Appendix W). The EPA regulatory default options and rural dispersion coefficients were used in the model.

The PFOA emission sources were evaluated for downwash effects from surrounding buildings. The Building Profile and Input Program (BPIP) provided by Trinity Consultants was used to provide wind direction specific building parameters. All buildings on the site were evaluated to determine if they could potentially impact the stack by causing building downwash effects. Table 6 lists the buildings included in the model and their heights.

A 100-meter receptor grid extending out 600 meters from the plant fenceline was used. In addition, discrete receptors with 50-meter spacing were placed on the plant property line. Because the area surrounding the plant site is flat, no terrain elevations were used.

Per standard protocol, five years of meteorological data were analyzed. The surface data is from New Castle County Airport (Wilmington, DE), and the upper air data is from Washington Dulles Airport (Sterling, VA). An anemometer height of 6.1 meters was used for the modeling. For this study, readily available data from years 1989 through 1993 were used. These data are viewed to be representative of meteorological conditions at Chambers Works and are sufficient for providing screening values for this study.

#### 3.1.3 Modeling Results

An averaging time of one year was used to determine the annual average ground-level concentrations over the entire receptor grid. For Chambers Works site emissions the modeling results for each year are shown in Table 7. The maximum average annual off-site value predicted by the model was  $0.00364 \mu\text{g}/\text{m}^3$ . This value was located at a receptor on the plant property line along highway NJ State Route 130.

The model was rerun using only estimated emission sources from Chambers Works telomers operations (Table 5). For telomers operations estimated average annual emissions, the modeling results are shown for each year in Table 8. The maximum average annual off-site value predicted by the model is  $0.00004 \mu\text{g}/\text{m}^3$ . This value was located at a receptor on the plant property line along Salem Canal. These results are well below the CATT-established inhalation reference concentration screening level of  $1.0 \mu\text{g}/\text{m}^3$ .

**Table 5**  
**Chambers Works Stack Parameters and Emission Rates**

| Process Area        | Source                | Average Annual Emission Rate (lb/hr) | Stack Height | Stack Diameter | Flowrate or Velocity | Temperature |
|---------------------|-----------------------|--------------------------------------|--------------|----------------|----------------------|-------------|
| Tenant Operation    | Building 1163 Stack   | 0.033                                | 25 ft        | 31"            | 92 ft/s              | 194°F       |
| Telomer A*          | DMA Roof #1           | 6.06E-06                             | 70 ft        | 2"             | 17 acfm              | 150°F       |
| ZFAN Crude*         | 1156 Building Hotwell | 4.45E-05                             | 12 ft        | 2"             | 0.033 acfm           | 65°C        |
| 185 Alcohol Drying* | 185 Building Hotwell  | 2.94E-06                             | 0 ft         | 6"             | 0 acfm**             | 40°C        |
| 185 Alcohol Drying* | TS-45 Tank Vent       | 1.62E-06                             | 25 ft        | 3"             | 10 ft/s              | 70°C        |
| D Building*         | D Building Roof       | 1.87E-05                             | 55 ft        | 2"             | 1 acfm               | ambient     |
| D Building*         | D Building Jets       | 2.04E-06                             | 88 ft        | 36"            | 10,000 acfm          | ambient     |
| EO Center*          | Hotwell and Stack     | 2.19E-05                             | 85 ft        | 4"             | 80 acfm              | ambient     |

\* telomers operations

\*\*185 building hotwell stack points at the ground

**Table 6**  
**Chambers Works Building Heights**

| Building Name | Height (ft) | Building Name | Height (ft) |
|---------------|-------------|---------------|-------------|
| 1             | 60          | 43            | 16          |
| J26           | 38          | 1050          | 22          |
| 1089          | 15.5        | 1163          | 13.5        |
| 1094          | 30          | 115 East      | 45          |
| T3            | 45          | 115 West      | 30          |
| 589           | 15          | 656           | 30          |
| 745           | 50          | 1402          | 25          |
| 888           | 60          | 185           | 68          |
| 1183          | 60          | 1156          | 45          |
| 1182          | 60          | 234           | 30          |
| 669           | 40          | 788           | 40          |
| 1205          | 31          |               |             |

**Table 7**  
**Chambers Works Site Air Dispersion Modeling Results**

| Year | Annual Average Concentration<br>( $\mu\text{g}/\text{m}^3$ ) | Location                       |
|------|--------------------------------------------------------------|--------------------------------|
| 1989 | 0.00309                                                      | plant fenceline along US130    |
| 1990 | 0.00364                                                      | plant fenceline along US130    |
| 1991 | 0.00305                                                      | plant fenceline along US130    |
| 1992 | 0.00267                                                      | plant fenceline along US130    |
| 1993 | 0.00300                                                      | plant fenceline along DE River |

**Table 8**  
**Chambers Works Telomers Operations Air Dispersion Modeling Results**

| Year | Annual Average Concentration<br>( $\mu\text{g}/\text{m}^3$ ) | Location                          |
|------|--------------------------------------------------------------|-----------------------------------|
| 1989 | 0.00003                                                      | plant fenceline along Salem Canal |
| 1990 | 0.00003                                                      | plant fenceline along Salem Canal |
| 1991 | 0.00004                                                      | plant fenceline along Salem Canal |
| 1992 | 0.00004                                                      | plant fenceline along Salem Canal |
| 1993 | 0.00004                                                      | plant fenceline along Salem Canal |

## 3.2 Washington Works – Screen3 Modeling Methodology and Results

### 3.2.1 Data and Modeling Procedures

Air emissions for Washington Works have been characterized using the EPA's ISC3 dispersion model (Bradley, 2002). However, the model input did not include potential emissions from the telomers operations at the site. Because the estimated emissions from telomers operations are so small, the EPA's Screen3 model was used to see if there was any appreciable affect from telomers to the modeled Washington Works site emissions. The Screen3 model is a screening tool that gives predictions of ambient ground-level concentrations for a single stack. Due to the assumptions made in the model, particularly those regarding meteorological conditions and combining all emissions into a single source point, these predictions will always be more conservative (higher concentrations) than predictions made by the ISC3 model. The advantage of using this tool is that one can look at the contribution from telomers manufacturing only, independent of other site contributions.

Although there are several different potential point sources of PFOA emissions in the telomers area at the Washington Works site, these emission points are combined together into a common stack. The following parameters for this stack were used in the model:

Stack Height: 85 feet

Diameter: 1.5 feet

Temperature: 68°F

Velocity: 47 ft/s

PFOA Emission Rate: 0.16 lb/yr ( $1.83 \times 10^{-5}$  lb/hr)

The PFOA emission rate is based on the maximum production rate for the telomers area. The basis for the emission calculations is shown generically in Appendix A, section entitled Telomers Processes.

To determine the impacts of building downwash on dispersion from the stack, the Screen3 model uses only the dominant downwash structure as an input to the model. The dominant downwash structure can be found by first locating all buildings that have an area of influence encompassing the stack. The EPA defines the area of influence as a distance of five times the lesser of the height or the maximum projected width of the building. Once all of the potential downwash structures are located, the dominant downwash structure is determined by calculating the GEP (Good Engineering Practice) stack height for each building. The building with the greatest GEP stack height is the building that should be included in the Screen3 model. The GEP stack height is calculated according to the following formula:

$$H = h + 1.5L,$$

where H = GEP stack height

h = building height

L = lesser of the building height or maximum projected width

The following table shows the buildings that were included in the downwash analysis and their respective GEPs (Table 9):

**Table 9**  
**Washington Works GEP Stack Heights**

| Building | Height (ft) | Length (ft) | Width (ft) | Max Projected Width (ft) | GEP (ft) |
|----------|-------------|-------------|------------|--------------------------|----------|
| 164      | 44          | 90          | 90         | 125                      | 110      |
| 180      | 64          | 70          | 25         | 75                       | 160      |
| 184*     | 96          | 195         | 120        | 230                      | 240      |

\*This building has the highest GEP and was used in the model.

### 3.2.2 Modeling Results

Using the above data the Screen3 model predicted a maximum off-site ground-level concentration of  $0.0023 \mu\text{g}/\text{m}^3$  at a distance of 289 feet from the source. This concentration is based on a one-hour averaging time. To convert a Screen3 model result to an annual average, EPA guidance directs the user to multiply the predicted Screen3 concentration by a value of 0.05. This gives an annual average concentration of  $1.15 \times 10^{-4} \mu\text{g}/\text{m}^3$ . This concentration is four orders of magnitude below the CATT-established inhalation reference concentration screening level of  $1.0 \mu\text{g}/\text{m}^3$ . These data would not significantly affect the current models for the Washington Works site.

A copy of the Screen3 model output is located in Appendix B.

## **4.0 CHAMBERS WORKS GROUNDWATER SAMPLING**

### **4.1 Background**

DuPont operates and manages a groundwater containment program for the Chambers Works site. This program comprises of several different systems and programs, the most significant of which is the site Interceptor Well System (IWS). The IWS consists of six pumping wells (in five locations) that contain and capture groundwater beneath the site. Chambers Works has been pumping groundwater beneath the site since the early 1970s. Each day, over 1.5 million gallons is withdrawn from aquifers beneath the site and is treated at the WWTP.

Groundwater at Chambers Works is routinely monitored and evaluated as part of a site-wide program that satisfies the conditions of the site's Discharge to Groundwater (DGW) Permit requirements. There are about 400 monitoring wells located on site. The semi-annual groundwater monitoring report is issued to the NJDEP and USEPA and covers the sampling of many of these wells. The semi-annual report also includes rigorous statistical analysis of the well data so that any significant groundwater quality trends can be identified. Through these reports, the physical and chemical properties of site groundwater have been characterized and are well understood. Information from these reports was used to assist in identifying the wells and locations sampled for this study.

### **4.2 Regional Geology**

The DuPont Chambers Works manufacturing facility covers approximately 600 acres in Salem County, New Jersey. The site is located in the Delaware River Basin, near the northwestern edge of the Atlantic Coastal Plain. In general, the site is underlain by approximately 500 feet of unconsolidated Coastal Plain sediment. This sediment was deposited during the Holocene, Pleistocene, and Cretaceous periods. These geologic units thicken and dip regionally to the southeast and are characteristic of fluvial, estuarine, and marine origins.

### **4.3 Site Geology**

The geology beneath the site is typical of the geologic setting, with alternating layers of coarse and fine sediments. Periods of erosion between depositional cycles have generally caused discontinuous units across the site. In the shallow zones, this has been exacerbated by building and construction activity over the years.

There are five water-bearing units and four confining units beneath the site that make up the geologic model of the site. They are:

- ❑ **A Zone:** This zone consists mainly of fill material, and varies in thickness from 0 to 17 feet. Because the site has been excavated and filled over the decades of operation, the unit is discontinuous, and the depth to groundwater varies greatly. In some portions of the site, the A Zone is partially to fully saturated; while in others, a saturated zone is not present.

- ❑ **A/B Confining Unit:** This unit is the first clay horizon encountered beneath the ground surface and varies in thickness from 0 to 12 feet. This unit is not continuous across the site.
- ❑ **B Aquifer:** This unit consists of interbedded clay, silt, and sand and ranges from 0 to 30 feet thick. There is an extensive network of monitoring wells in the B aquifer, because it is the shallow-most aquifer that is mostly continuous.
- ❑ **B/C Confining Unit:** This unit is the second clay horizon encountered beneath the surface, and varies in thickness from 0 to 25 feet. The confining unit is not continuous across the site, and there is drawdown in the B aquifer in certain areas from the ongoing operation of the IWS.
- ❑ **C Aquifer:** This unit is made of coarser sediment than the B aquifer and varies in thickness from 5 to 40 feet. The C aquifer is the first water-bearing unit that contains the site's high-yielding interceptor wells.
- ❑ **C/D Confining Unit:** This unit is the third clay horizon encountered beneath the surface and varies in thickness from 5 to 35 feet. The confining unit is continuous across the site.
- ❑ **D Aquifer:** This unit is the deepest water-bearing unit associated with the Pleistocene sediment. It comprises poorly graded sands with occasional cobbles and varies in thickness from 5 to more than 35 feet. The D aquifer also contains some of the site's high-yielding interceptor wells.
- ❑ **D/E Confining Unit:** This unit is the fourth clay horizon and the second mapped unit of the Cretaceous Age. The clay is continuous across the site. It is easily identified by its red or variegated color and varies from 10 to 50 feet thick.
- ❑ **E Aquifer:** This unit is mostly coarse-grained sands, and is similar in lithology to the shallower units. It comprises multiple units with varying degrees of hydraulic connectivity and could range up to 100 feet thick.

#### **4.4 Site Hydrogeology**

The IWS wells are located in the C and D aquifers, strategically located across the site to maximize their influence on the groundwater flow. DuPont maintains an inward hydraulic gradient across the B, C, and D aquifers through the continued operation of the IWS. There are a few perimeter areas where an inward gradient has not been confirmed in the B aquifer (only).

In addition to the IWS, there are several other systems that deal with localized groundwater containment. These other systems include the groundwater recovery system at the site's hazardous waste landfill, the shallow recovery trench near a perimeter Solid Waste Management Unit (SWMU), and the E aquifer pumping well. All of these systems create inward (towards the site) gradients in the areas that they operate.

## **4.5 Sample Location Selection**

The groundwater monitoring program for PFOA was based on the knowledge of the site-wide groundwater and the existing network of wells. Since the IWS creates a significant inward hydraulic gradient and influences multiple aquifers, sampling the IWS was the first step of a PFOA-focused evaluation. A complete round of groundwater sampling from all five interceptor well locations was conducted. In Figure 2, the interceptor wells are shown as:

- ☐ H-11
- ☐ R-09
- ☐ K-06
- ☐ M-14
- ☐ Q-13 (two wells)

A total of six samples were collected from interceptor wells since Q-13 is actually two separate wells, screened in different aquifers.

The B aquifer monitoring wells along the fenceline at the southeastern edge of the site were selected based on an evaluation of predominant wind direction to evaluate if groundwater was affected by any potential air deposition of PFOA. Local weather station data were evaluated to create a windrose for the site. A windrose maps wind speed and duration for the purpose of identifying the prevailing seasonal wind direction. Perimeter wells were identified for sampling by super-imposing the windrose over the site well map (Figure 3).

Two B aquifer wells were selected in an area of the site adjacent to the Delaware River where the hydraulic gradient was not as well defined. (Figure 2).

## **4.6 Sampling Activities and Results**

On May 1 and 2 and June 20, 2003, groundwater was sampled from a total of seven monitoring wells and five interceptor wells. The sampling was conducted in accordance with the "Site Assessment Plan" (Appendix C). The sampling was conducted by experienced personnel to ensure the data quality objectives were achieved.

All of the monitoring wells selected are screened in the B aquifer. One interceptor well is screened in the C aquifer, one is screened in the D aquifer, and the other four interceptor wells are screened across both the C and D aquifers. A total of fourteen groundwater samples, including three duplicates, were analyzed for PFOA. Figure 3 shows the location of the wells sampled for PFOA.

Table 10 presents the PFOA analytical results for all of the samples. For wells screened in the B aquifer, the range in PFOA concentration is 0.2 ppb to 5.2 ppb.

The PFOA concentration measured in the C aquifer interceptor well at location Q-13 is 3.3 ppb. The concentration measured for the interceptor well in the D aquifer at Q-13 is 0.4 ppb. This significant concentration drop-off with depth is consistent with other water

**Table 10**  
**Chambers Works Groundwater Analytical Results**

| Sample Location | Aquifer | Well Type        | Sample Date | PFOA (ppb) |
|-----------------|---------|------------------|-------------|------------|
| C08-M01B1       | B       | Monitoring Well  | 5/02/2003   | 5.3        |
| C10-M01B1       | B       | Monitoring Well  | 5/02/2003   | 1.4        |
| C10-M01B1-2     | B       | Monitoring Well  | 5/02/2003   | 1.5        |
| N04-M01B        | B       | Monitoring Well  | 6/20/2003   | 0.2        |
| O05-M01B        | B       | Monitoring Well  | 6/20/2003   | 0.8        |
| P06-M01B        | B       | Monitoring Well  | 6/20/2003   | 1.1        |
| P06-M01B-2      | B       | Monitoring Well  | 6/20/2003   | 1.2        |
| R08-M01B        | B       | Monitoring Well  | 6/20/2003   | 0.9        |
| Q13-R01C        | C       | Interceptor Well | 5/01/2003   | 3.3        |
| H11-R01C/D      | C and D | Interceptor Well | 5/01/2003   | 8.5        |
| H11-2           | C and D | Interceptor Well | 5/01/2003   | 8.4        |
| K06-R01C/D      | C and D | Interceptor Well | 5/01/2003   | 3.1        |
| M14-R01C/D      | C and D | Interceptor Well | 5/01/2003   | 46.6       |
| Q13-R01D        | D       | Interceptor Well | 5/01/2003   | 0.4        |

quality parameters at the site. The PFOA concentration range observed for interceptor wells screened in the C and D aquifers is from 3.1 ppb to 46.6 ppb.

Groundwater elevation contour maps for the B, C, and D aquifers are provided in Figures 4, 5, and 6, respectively.

Figure 4 shows that a small groundwater mound exists in the B aquifer in the southwestern corner of the site. Groundwater on the western side of the mound, including groundwater in monitoring wells C08-M01B and C10-M01B, may flow towards the Delaware River; while groundwater on the eastern side flows towards the interceptor well system. Groundwater in the B aquifer in the southeastern corner of the site, including monitoring wells N04-M01B, O05-M01B, P06-M01B, and R08-M01B, generally flows towards the northwest towards Interceptor Wells M-14 and Q-13.

Figures 5 and 6 show the same general patterns of groundwater flow with flow towards the pumping interceptor wells, indicating communication between the C and D aquifers.

## 4.7 Summary of Results

The results of the sampling program show the existence of PFOA in the groundwater at the site at very low levels. The results show that PFOA is being contained on-site by the site groundwater containment system. Groundwater in the vicinity of Chambers Works is not removed from the ground for drinking water or other use, with the exception of the

IWS; therefore, it is not appropriate to compare these results with the CATT-established screening levels for drinking water. Nevertheless, numbers are well below these levels.

The PFOA concentration data clearly show a decrease outwards from the IWS and a decrease in PFOA concentration with depth. This is consistent with the characterization of site-wide groundwater. The site-wide groundwater containment system maintains a hydraulic gradient inwards towards the interceptor wells. At the southeastern site perimeter, all four monitoring wells sampled were 1 ppb or less. This area has a strong inward hydraulic gradient towards the plant preventing off-site migration of groundwater.

At the southwestern perimeter of the site, adjacent to the Delaware River, the levels in the B aquifer monitoring wells were also very low at 1.3 ppb and 5.3 ppb.

## **5.0 CHAMBERS WORKS SURFACE WATER SAMPLING**

DuPont Chambers Works is located in Deepwater, New Jersey at approximately Delaware River mile 69. The Delaware River at river mile 69 is a tidal estuary, with the salinity of the tidal river being a function of the freshwater flows from the Schuylkill and Delaware River north of Trenton, New Jersey (Figure 7).

Chambers Works has a primary discharge identified as outfall DSN001 (NJPDES Permit #NJD0005100), discharging treated process wastewater at a rate of approximately 10 to 12 million gallons per day (mgd) and non-contact cooling water and stormwater at a rate of approximately 15 to 25 mgd.

The site has two water intakes. One intake is on non-tidal Salem Canal (freshwater source) and one intake is on the tidal Delaware River Zone 5 (fresh to brackish water source) downstream of the primary Chambers Works Discharge Outfall. The Salem Canal intake is approximately 5 to 10 mgd and the Delaware River water intake is approximately 20 to 30 mgd. Zones 4 through 6 of the Delaware River are not classified as drinking water sources per the Delaware River Basin Commission Water Quality Standard Regulations (Figure 7). The Salem Canal is classified as a drinking water source per NJDEP regulations.

DuPont Chambers Works operations that have the potential to be a source of PFOA to the WWTP are batch operations, with the exception of continuous flow from groundwater sources. Therefore, outfall concentrations are only estimates at a point in time and cannot be used to estimate average loadings from Chambers Works.

### **5.1 Site Effluent Sample Results**

The primary Chambers Works outfall to the Delaware River is DSN001. A total of five composite samples were collected from DSN001 in April, May, and June. The results are presented in Table 11.

**Table 11**  
**Chambers Works Outfall DSN001 Results**

| <b>Date</b> | <b>Conc. (ppb)</b> | <b>Sample Type</b> |
|-------------|--------------------|--------------------|
| April 18    | 194                | 48 hr Comp         |
| May 16      | 102                | 48 hr Comp         |
| June 2-8    | 139                | 6 day Comp         |
| June 9      | 97                 | 24 hr Comp         |
| June 10     | 80                 | 24 hr Comp         |

### **5.2 Chambers Works and Upstream Surface Water Intake Results**

There are two surface water intakes to the Chambers Works site, the non-tidal Salem Canal Intake and the tidal Delaware River Water intake. Another Delaware River intake

located approximately 14 miles north of Chambers Works and outside the influences of Chambers Works discharges, was used as the upstream sample. Composite samples were taken from the upstream site's tidal Delaware River intake and are considered representative of background PFOA concentration. A total of two samples were taken from each intake. The results are presented below.

**Table 12**  
**Chambers Works Surface Water Intake Results**

| Date     | Intake               | Conc (ppb) | Sample Type |
|----------|----------------------|------------|-------------|
| April 16 | Salem Canal          | 0.064      | 24 hr Comp  |
| May 14   | Salem Canal          | 0.089      | 24 hr Comp  |
| May 15   | Salem Canal RR*      | ND         | Grab        |
| April 16 | CW – Del River       | 3.20       | 24 hr Comp  |
| May 14   | CW – Del River       | 0.853      | 24 hr Comp  |
| April 18 | Upstream – Del River | NQ         | 24 hr Comp  |
| May 14   | Upstream – Del River | NQ         | 24 hr Comp  |

\* A grab sample was taken approximately ¼ mile upstream of the DuPont Salem Canal Water intake on May 15, 2003.

The Chambers Works Delaware River intake is located downstream of the site's primary outfall. These samples are within the outfall's mixing zone and are not representative of Delaware River surface water conditions.

### 5.3 Delaware River Surface Water Sampling

Tidal flow on the Delaware River can reach up to 8 to 12 miles upstream of the Chambers Works facility depending on the freshwater flows from the Schuylkill and northern Delaware River (non-tidal). DuPont performed a low-flow and high-flow dye dispersion study and a hydrographic survey of the Delaware Estuary in the late 1980s. These studies showed that the Delaware Estuary is well mixed vertically, and that there is no significant salinity gradient within the water column. It also appeared to show elevated dye concentrations near the eastern shore when compared to the western side of the estuary, which indicates incomplete mixing horizontally (i.e., the effluent tends to "hug" the eastern shore).

Surface water samples were not taken at different depths in the river because the estuary is well mixed vertically. However, samples were taken over the width of the river to take into account the possibility of varying concentrations across the river.

The Delaware River was sampled downstream of DSN001 on June 9 during the outgoing tide (DRO1 to DRO12) and on June 10 during the incoming tide (DRI19 to DRI24). The downstream samples taken during the outgoing tide were taken at points approximately ½ mile, 1 mile, 4 miles, and 12 miles downstream of Chambers Works effluent discharge to the river (DSN001). For the incoming tide, the samples were taken at points approximately 1 mile and 4 mile downstream. The downstream results of the surface water samples are presented in Tables 13 and 14 and Figures 8 and 10.

The tidal Delaware River was sampled upstream of DSN001 during the incoming tide on June 9 (DRI13 to DRI18) and during the outgoing tide on June 10 (DRO25 to DRO30). The samples for the incoming and outgoing tides were taken at points approximately 4 miles and 13+ miles upstream of the Chambers Works outfall. The 13+ mile sample is outside the influence of the Chambers Works effluent and is considered a background sample. The upstream results of the surface water samples are presented in Tables 13 and 14 and Figures 9 and 11.

The Chamber Works DSN001 effluent was sampled each day (24-hour composite) from June 2 through 8 prior to the surface water sampling events. These samples were combined to form a single 6-day composite sample for analysis. Daily composite samples were also taken at DSN001 on June 9 and 10 when sampling of the Delaware River was being performed. The results of the outfall samples collected are presented above in Table 11.

### **5.3.1 Delaware River – Discussion of Results**

#### **Background Concentrations**

The upstream sampling results and the Delaware River surface water results, identified as samples DRO 28 through 30, are indicative of the background concentration of PFOA, outside the influence of any PFOA present in the Chambers Works outfall DSN001. The results indicate that the background concentration of PFOA is non-detectable (ND) or not quantifiable (NQ). ND is less than 10 ppt and NQ is less the 50 ppt.

#### **Effluent Concentrations**

The Chambers Works outfall DSN001 average PFOA concentration during the sampling period was approximately 133 ppb. The range of the data set was 80 ppb to 194 ppb. The batch nature of PFOA loading into the WWTP is the reason for the variability in effluent concentrations, and makes it difficult to extrapolate the data set to an average concentration.

#### **Near Field Concentrations of Outfall 001**

A preliminary assessment of near-field dilution of Chambers Works discharge in the Delaware River was performed by the consulting firm Lawler, Matusky, & Skelly Engineers in September 1990. The results of the near-field assessment indicated an average dilution of 6:1 river/effluent within 100 ft of the discharge. This equates to an estimated PFOA average concentration of approximately 20 ppb at the edge of the 100-foot mixing zone.

#### **Far Field Concentrations Downstream of Outfall 001**

Two sets of surface water samples were taken downstream of the Chambers Works outfall 001, one set during an outgoing tide, samples DRO1 through DRO12 (Figure 2) and the other set during an incoming tide, samples DRI19 through DRI24 (Figure 4). The surface water concentrations ranged from NQ to 0.566 ppb during an outgoing tide and from NQ to 0.233 ppb during an incoming tide at the locations where samples were collected. The data indicate that concentrations on the eastern side of the river were higher than western side of the river, and the concentrations decreased downstream.

These results are consistent with the previous dye studies conducted by Lawler, Matusky & Skelly Engineers for DuPont. These results are well below the aquatic life advisory concentration for PFOA (1,360 ppb). Because of its high salinity the Delaware River, Zone 5 is not designated for use as a drinking water source.

#### **Far Field Concentrations Upstream of Outfall 001**

Two sets of surface water samples were taken upstream of the Chambers Works outfall DSN001, one set during an incoming tide, samples DRI13 through DRO18 (Figure 3) and the other set during an outgoing tide, samples DRO25 through DRO30 (Figure 5). The surface water concentrations were either ND or NQ during the incoming and outgoing tides. The DRO25 through DRO30 samples represent at or near background concentrations since the samples were taken several miles upstream of outfall DSN001. Samples DRI13 through DRI18 were taken several miles upstream of outfall DSN001 several hours after high tide (outgoing); during an incoming tide; however, these samples were taken only an hour after the change of tide. Therefore, it is not clear whether they were influenced by the discharge from DSN001; the results were either ND or NQ.

### **5.4 Salem Canal**

The Salem Canal is a fresh water canal that connects to the Delaware River via Munson Dam at approximate river mile 68. It is separated from the Delaware River by the dam, and flow to the river is controlled by DuPont to maintain water level in the canal. Chambers Work withdraws approximately 8 to 10 mgd of water at Munson Dam. Two Salem Canal intake samples were collected in April and May (Table 12). The results of these two samples were 0.064 and 0.089 ppb, respectively (average of 0.077). An additional sample was taken approximately  $\frac{3}{4}$  mile upstream of the Salem Canal intake at the railroad bridge that crosses the canal (Figure 12). This location is outside the DuPont Chambers Works boundary. The PFOA result was ND. This indicates no off-site presence of PFOA in Salem Canal.

### **5.5 Summary of Results**

Measured concentrations of PFOA in the Salem Canal and Delaware River are well below CATT-established human health protective screening criteria for water of 150 ppb and CATT-established aquatic life advisory of 1,360 ppb, respectively.

## 6.0 CONCLUSIONS

The Environmental Assessment laid out in the TRP LOI, Appendix 1 has been completed. Air emissions have been evaluated for Chambers Works and Washington Works. Surface water and groundwater concentrations of PFOA have been assessed for Chambers Works. Washington Works surface water and groundwater have already been assessed (DuPont, 2002b) and were not included in this study.

All findings from these assessments are well below the CATT-established screening levels, indicating telomer manufacturing operations are not a significant source of PFOA to the environment. At Chambers Works and Washington Works, the telomers manufacturing potential contribution to air is very low, with the maximum calculated off-site concentration in air between  $0.00004 \mu\text{g}/\text{m}^3$  and  $0.00012 \mu\text{g}/\text{m}^3$ .

PFOA concentrations in groundwater and surface water around Chambers Works are all well below CATT-established screening levels.

In summary, all PFOA concentrations measured or modeled in the environment were well below the CATT-established screening levels.

## 7.0 REFERENCES

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- Lawler, Matusky & Skelly Engineers. 1990b. Low-Flow Dispersion and Hydrographic Survey in the Delaware River Near Deepwater Point, New Jersey, February 1990
- Delaware Department of Environmental Protection. 1999. State of Delaware Surface Water Quality Standards, As Amended, August 11, 1999.
- West Virginia Department of Environmental Protection. 2002a. C8 Assessment of Toxicity Team (CATT) Aquatic Life Advisory Concentration for C8, October 2002
- \_\_\_\_\_. 2002b. Final Ammonium Perfluorooctanoate (C8) Assessment of Toxicity (CATT) Report, August 2002

## **TABLES**

Table 13

## Chambers Works Delaware River Sampling

Date: June 9, 2003

High Tide: 0835

Low Tide: 1546

| Sample ID | Coordinates |           | DTB<br>(ft) | Sample Depth<br>(ft) | Sample Time | pH   | Temp C<br>(C) | Spec. Cond. | D.O.<br>(mg/L) | Redox | PFOA<br>(ug/L) |
|-----------|-------------|-----------|-------------|----------------------|-------------|------|---------------|-------------|----------------|-------|----------------|
|           | Northing    | Westing   |             |                      |             |      |               |             |                |       |                |
| DRO 01    | 39-41-974   | 75-31-091 | 40'         | 13'                  | 0915        | 6.83 | 17.3          | 269         | 5.34           | 516   | NQ             |
| DRO 02    | 39-41-954   | 75-30-742 | 62'         | 20'                  | 0932        | 7.13 | 17.2          | 192.5       | 4.45           | 463.3 | 0.378          |
| DRO 03    | 39-41-827   | 75-30-580 | 25'         | 9'                   | 0941        | 6.87 | 17.1          | 194.5       | 4.49           | 458   | 0.566          |
| DRO 04    | 39-41-005   | 75-31-667 | 22'         | 7'                   | 0956        | 7.42 | 17.2          | 212         | 4.56           | 438.2 | NQ             |
| DRO 05    | 39-40-737   | 75-31-390 | 53'         | 18'                  | 1008        | 7.52 | 17.5          | 202         | 4.96           | 424.7 | 0.134          |
| DRO 06    | 39-40-561   | 75-31-009 | 18'         | 6'                   | 1023        | 7.26 | 17.6          | 201         | 5.17           | 419.7 | 0.301          |
| DRO 07    | 39-39-503   | 75-33-202 | 27'         | 9'                   | 1235        | 7.72 | 18.3          | 232         | 5.31           | 391.8 | NQ             |
| DRO 08    | 39-39-167   | 75-32-824 | 38'         | 13'                  | 1246        | 7.25 | 17.9          | 193.2       | 5.09           | 388.4 | 0.101          |
| DRO 09    | 39-38-990   | 75-32-447 | 24'         | 8'                   | 1414        | 7.67 | 18.8          | 204         | 6.01           | 357   | 0.287          |
| DRO 10    | 39-36-798   | 75-36-201 | 24'         | 8'                   | 1449        | 7.10 | 19.0          | 215         | 6.53           | 350.9 | 0.051          |
| DRO 11    | 39-36-754   | 75-34-823 | 35'         | 12'                  | 1516        | 7.09 | 17.7          | 185.7       | 5.70           | 365.5 | 0.051          |
| DRO 12    | 39-36-716   | 75-34-403 | 25'         | 8'                   | 1526        | 6.73 | 17.8          | 193.1       | 5.17           | 372.2 | 0.202          |
| DRI 13    | 39-46-182   | 75-28-746 | 9'          | 3'                   | 1640        | 7.39 | 17.5          | 180.8       | 6.28           | 332.4 | NQ             |
| DRI 14    | 39-46-055   | 75-28-351 | 50'         | 16'                  | 1649        | 6.85 | 16.8          | 151.8       | 6.30           | 335.4 | NQ             |
| DRI 15    | 39-46-006   | 75-27-882 | 30'         | 10'                  | 1700        | 6.73 | 17.3          | 167.9       | 6.03           | 344.2 | NQ             |
| DRI 16    | 39-49-525   | 75-22-981 | 38'         | 13'                  | 1715        | 7.44 | 17.3          | 179.1       | 5.92           | 332.8 | ND             |
| DRI 17    | 39-49-391   | 75-22-696 | 50'         | 16'                  | 1724        | 6.95 | 17.1          | 156.8       | 5.85           | 349.8 | NQ             |
| DRI 18    | 39-49-214   | 75-22-563 | 23'         | 8'                   | 1735        | 6.75 | 17.2          | 149.4       | 4.06           | 332.1 | NQ             |

DTB - Depth to Bottom

Limit of Detection (LOD) for the procedure is approximately 0.010 ug/L

Limit of Quantification (LOQ) for the procedure is 0.050 ug/L

ND - Compound not detected

NQ - Compound detected at a level between LOD and LOQ. Result not quantifiable.

Table 14

## Chambers Works Delaware River Sampling

Date: June 10, 2003

High Tide: 0939

Low Tide: 0424

| Sample ID | Coordinates |           | DTB<br>(ft) | Sample Depth<br>(ft) | Sample Time | pH   | Temp C<br>(C) | Spec. Cond. | D.O.<br>(mg/L) | Redox | PFOA<br>(ug/L) |
|-----------|-------------|-----------|-------------|----------------------|-------------|------|---------------|-------------|----------------|-------|----------------|
|           | Northing    | Westing   |             |                      |             |      |               |             |                |       |                |
| DRI 19    | 39-41-949   | 75-31-204 | 31'         | 11'                  | 0740        | 6.94 | 17.9          | 137.2       | 5.08           | 553.2 | NQ             |
| DRI 20    | 39-42-001   | 75-30-770 | 63'         | 21'                  | 0755        | 6.69 | 17.3          | 128.8       | 4.57           | 519   | NQ             |
| DRI 21    | 39-41-764   | 75-30-655 | 46'         | 15'                  | 0811        | 7.07 | 17.5          | 116.4       | 5.2            | 474.1 | 0.154          |
| DRI 22    | 39-39-531   | 75-33-287 | 30'         | 10'                  | 0914        | 7.24 | 17.9          | 123.8       | 4.35           | 397.5 | 0.057          |
| DRI 23    | 39-39-290   | 75-32-712 | 51'         | 17'                  | 0925        | 7.13 | 17.9          | 133.1       | 4.95           | 387.5 | 0.140          |
| DRI 24    | 39-39-059   | 75-32-165 | 8'          | 3'                   | 0940        | 7.09 | 18.5          | 141.3       | 5.22           | 382.1 | 0.233          |
| DRO 25    | 39-45-604   | 75-29-017 | 42'         | 14'                  | 1220        | 7.5  | 18.8          | 236         | 6.21           | 327.5 | ND             |
| DRO 26    | 39-45-429   | 75-28-750 | 31'         | 10'                  | 1230        | 7.39 | 18.0          | 147.4       | 9.57           | 355.8 | NQ             |
| DRO 27    | 39-45-314   | 75-28-362 | 30'         | 10'                  | 1245        | 6.69 | 18.2          | 126.9       | 7.21           | 355.9 | ND             |
| DRO 28    | 39-49-470   | 75-23-057 | 34'         | 11'                  | 1305        | 7.09 | 17.8          | 157.5       | 5.78           | 358.2 | ND             |
| DRO 29    | 39-49-307   | 75-22-852 | 50'         | 17'                  | 1325        | 7.25 | 17.2          | 101.2       | 6.46           | 343.1 | ND             |
| DRO 30    | 39-49-167   | 75-22-650 | 32'         | 11'                  | 1335        | 7.18 | 18.3          | 99.2        | 6.42           | 337.9 | NQ             |

DTB - Depth to Bottom

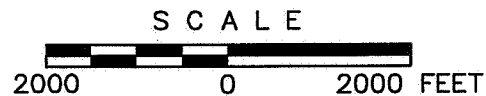
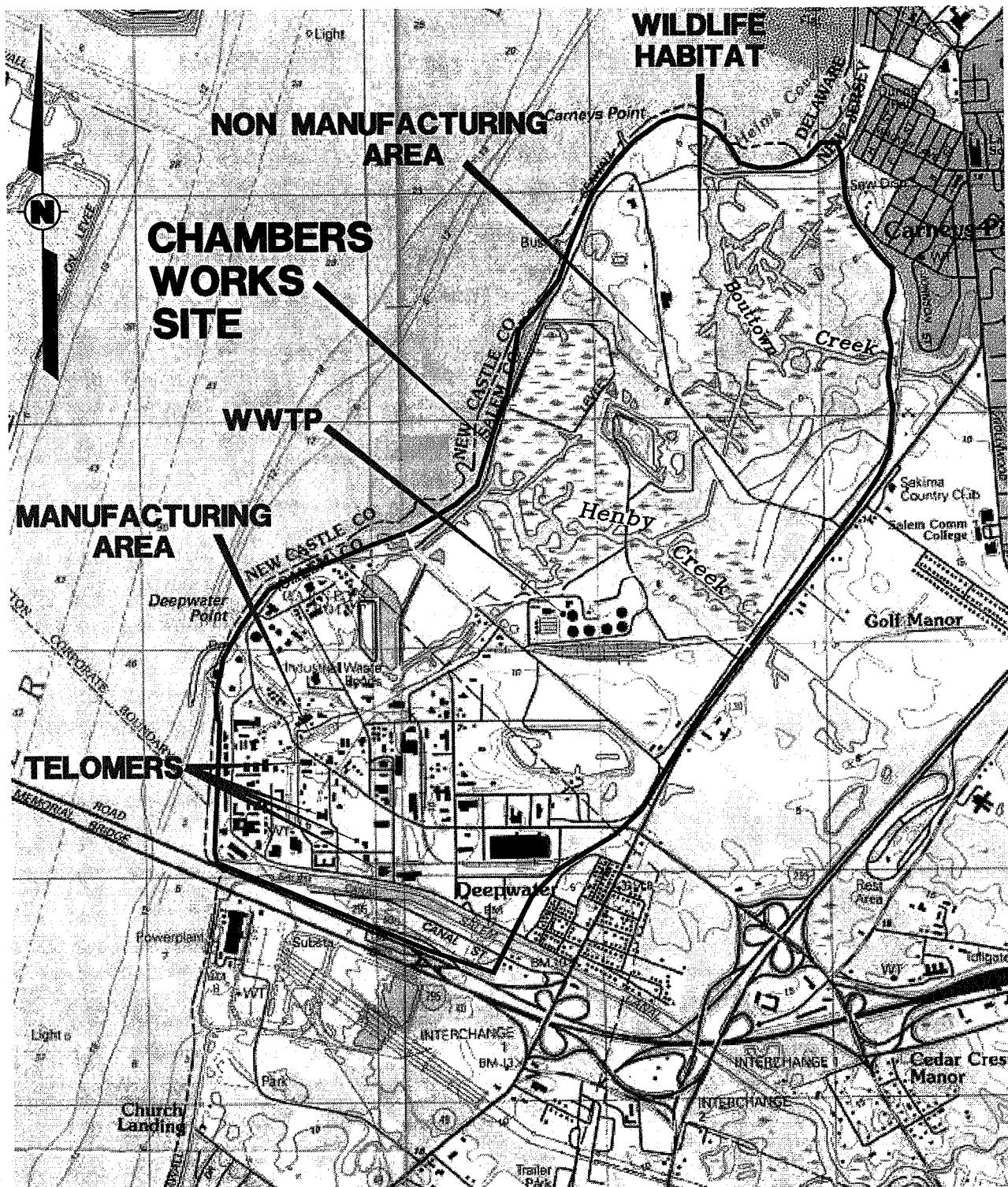
Limit of Detection (LOD) for the procedure is approximately 0.010 ug/L

Limit of Quantification (LOQ) for the procedure is 0.050 ug/L

ND - Compound not detected

NQ - Compound detected at a level between LOD and LOQ. Result not quantifiable.

## FIGURES



SOURCE: USGS QUADRANGLE: WILMINGTON (SOUTH), DE-NJ (1993)  
 SOURCE: USGS QUADRANGLE: PENNS GROVE, NJ-DE (1993)



**Corporate Remediation Group**

*An Alliance between  
 DuPont and URS Diamond*

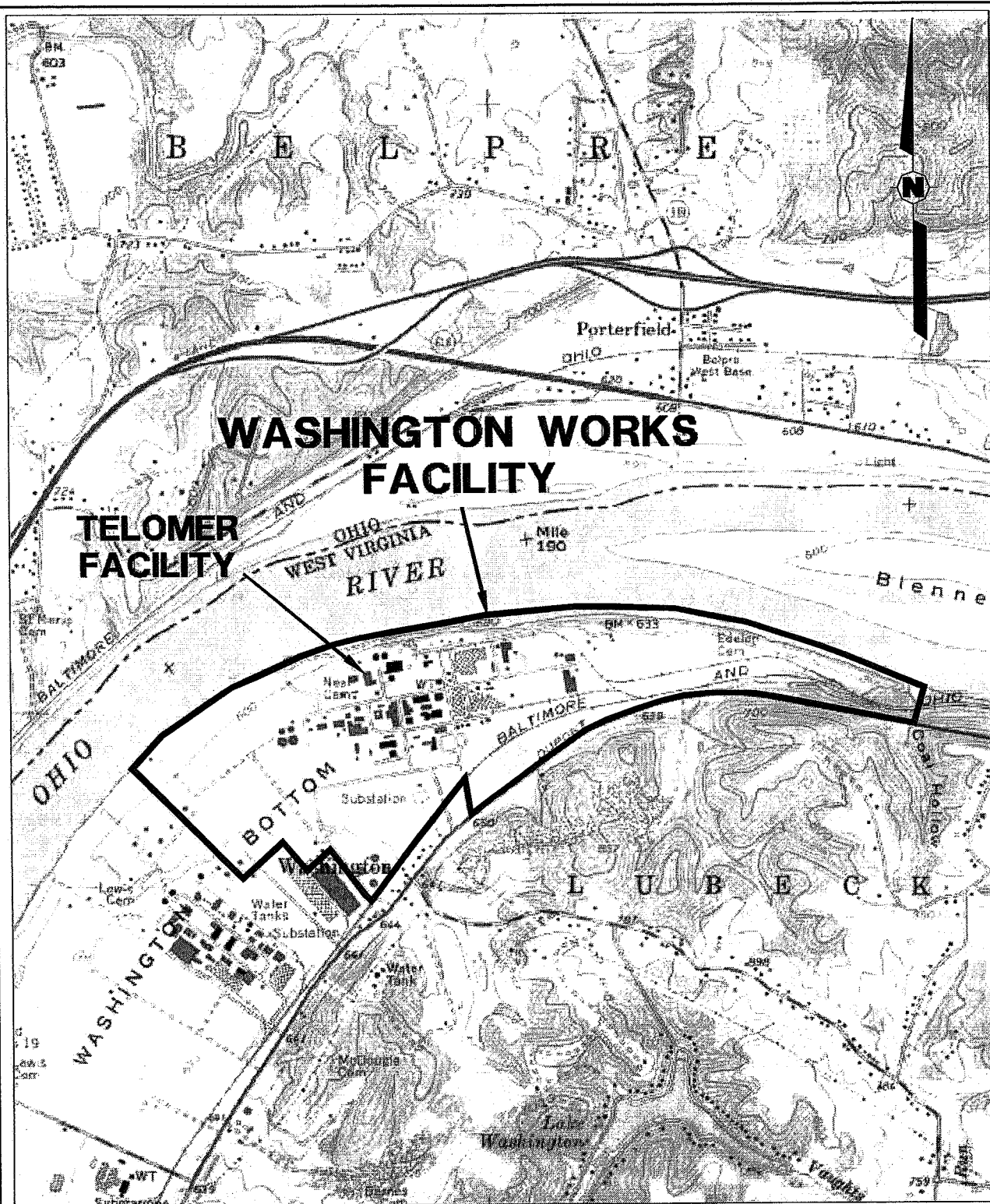
Barley Mill Plaza, Building 27  
 Wilmington, Delaware 19805



### SITE LOCATION MAP

CHAMBERS WORKS  
 DEEPWATER, NEW JERSEY

|                   |          |          |     |                          |
|-------------------|----------|----------|-----|--------------------------|
| SCALE<br>1"=2000' | DESIGNED | DRAWN    | DEL | CAD FILE NO.<br>7141A051 |
| DATE<br>8/28/03   | CHECKED  | APPROVED |     | FIGURE<br>1              |



Source: MAP TAKEN FROM THE LUBECK, WV  
USGS QUADRANGLE



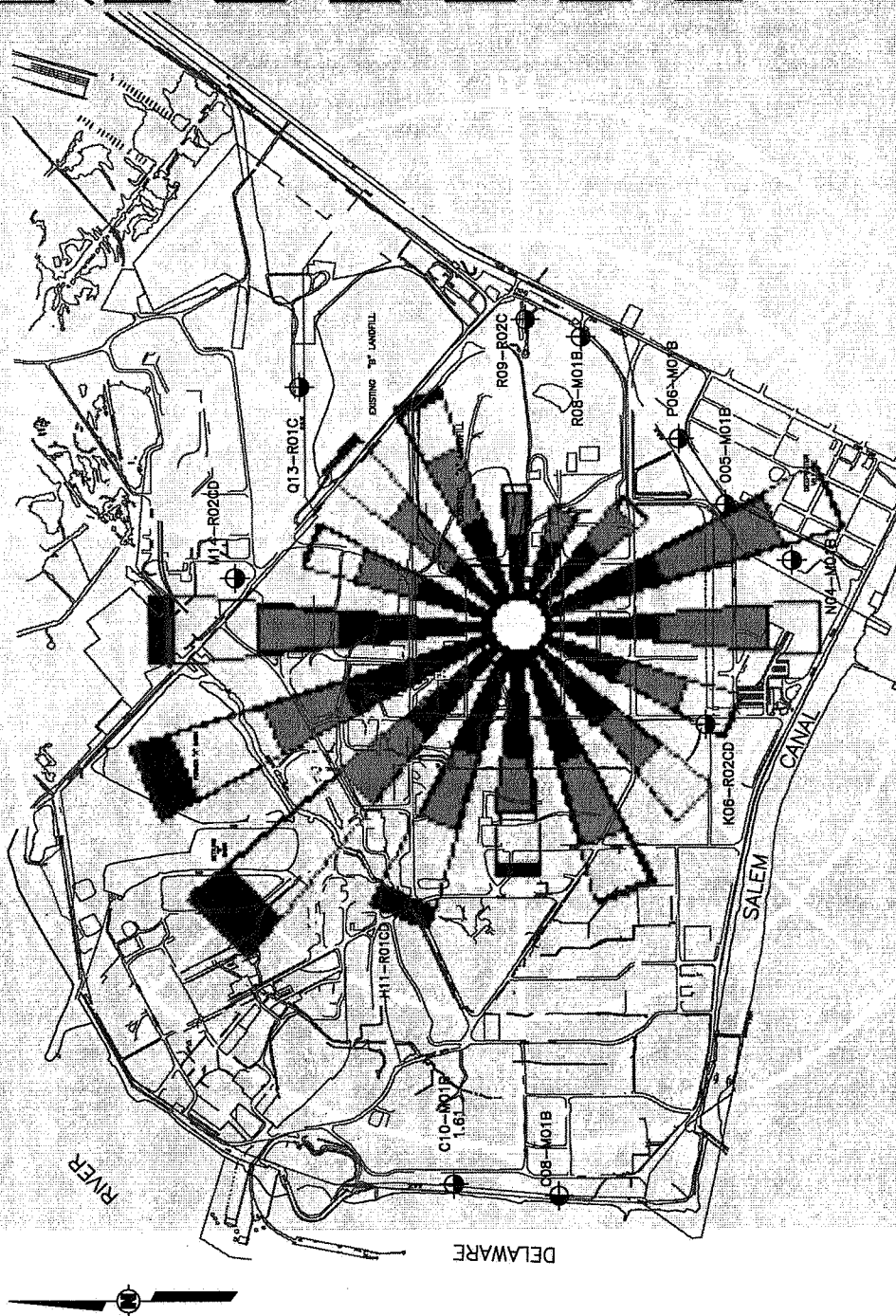
**Corporate Remediation Group**  
*An alliance between  
DuPont and ERS Diamond*

Saley Mill Plaza, Building 27  
Wilmington, Delaware 19805

### SITE LOCATION MAP

DuPont Washington Works Facility  
and Local Landfill Facility  
Washington, West Virginia

|                       |                |               |                          |
|-----------------------|----------------|---------------|--------------------------|
| SCALE<br>Not to scale | DESIGNED       | DRAWN<br>DEL. | CAD FILE NO.<br>7422AD07 |
| DATE<br>9/23/03       | CHECKED<br>YES | APPROVED      | FIGURE<br>2              |



RIVER

## REFERENCED ELEVATIONS TO N.G.V.D.

| INITIALS | COMMENTS                |
|----------|-------------------------|
|          | DEL                     |
|          | SYN                     |
|          | TTS                     |
|          | APPROVED (CONSTRUCTION) |



**Corporate Remediation Group**

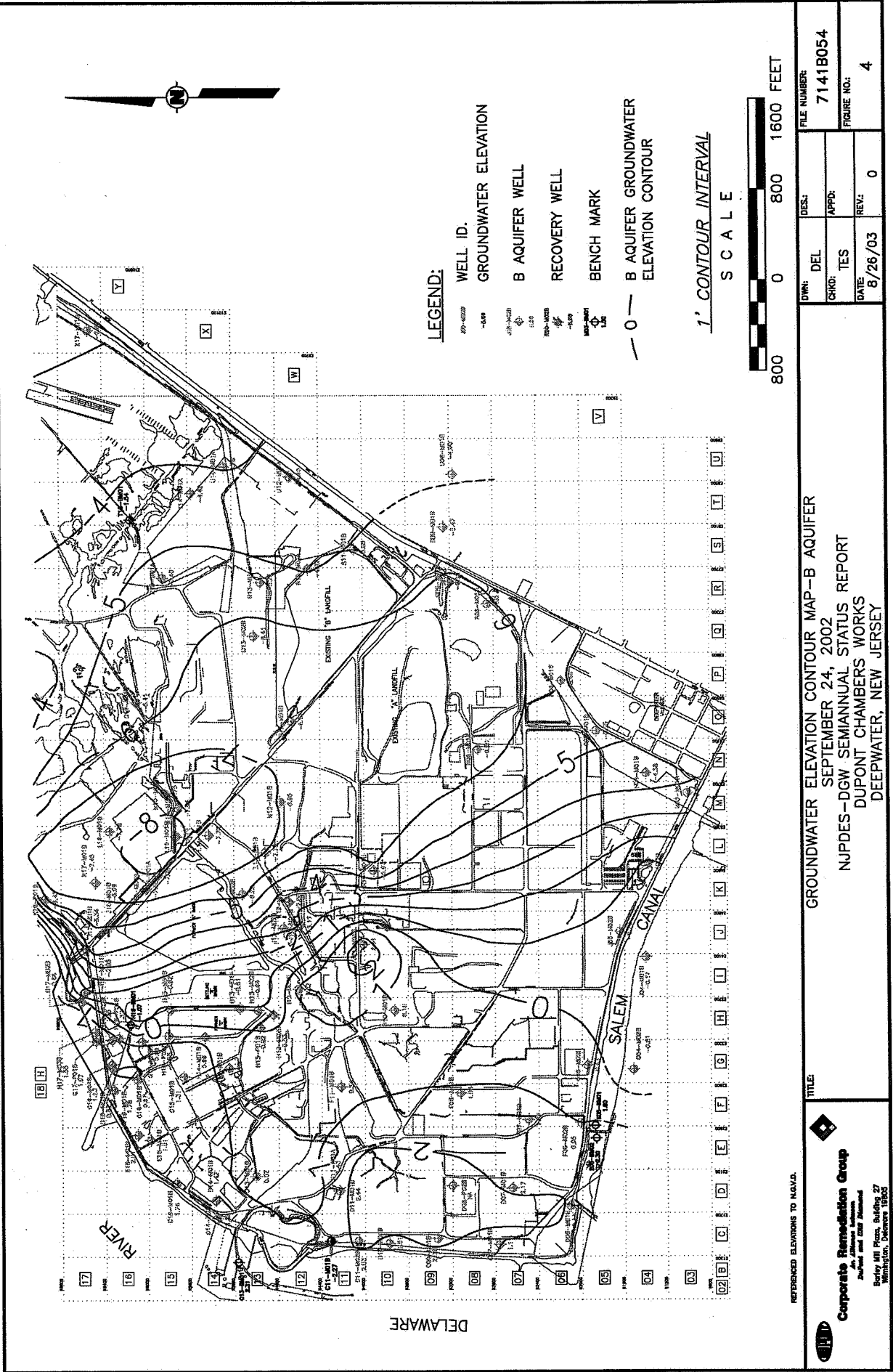
## An Alliance between DuPont and URS Diamond

Barley Mill Plaza, Building 27  
Wilmington, Delaware 19805

GROUNDWATER SAMPLE LOCATION MAP &  
WILMINGTON 1993 WINDROSE DIAGRAM

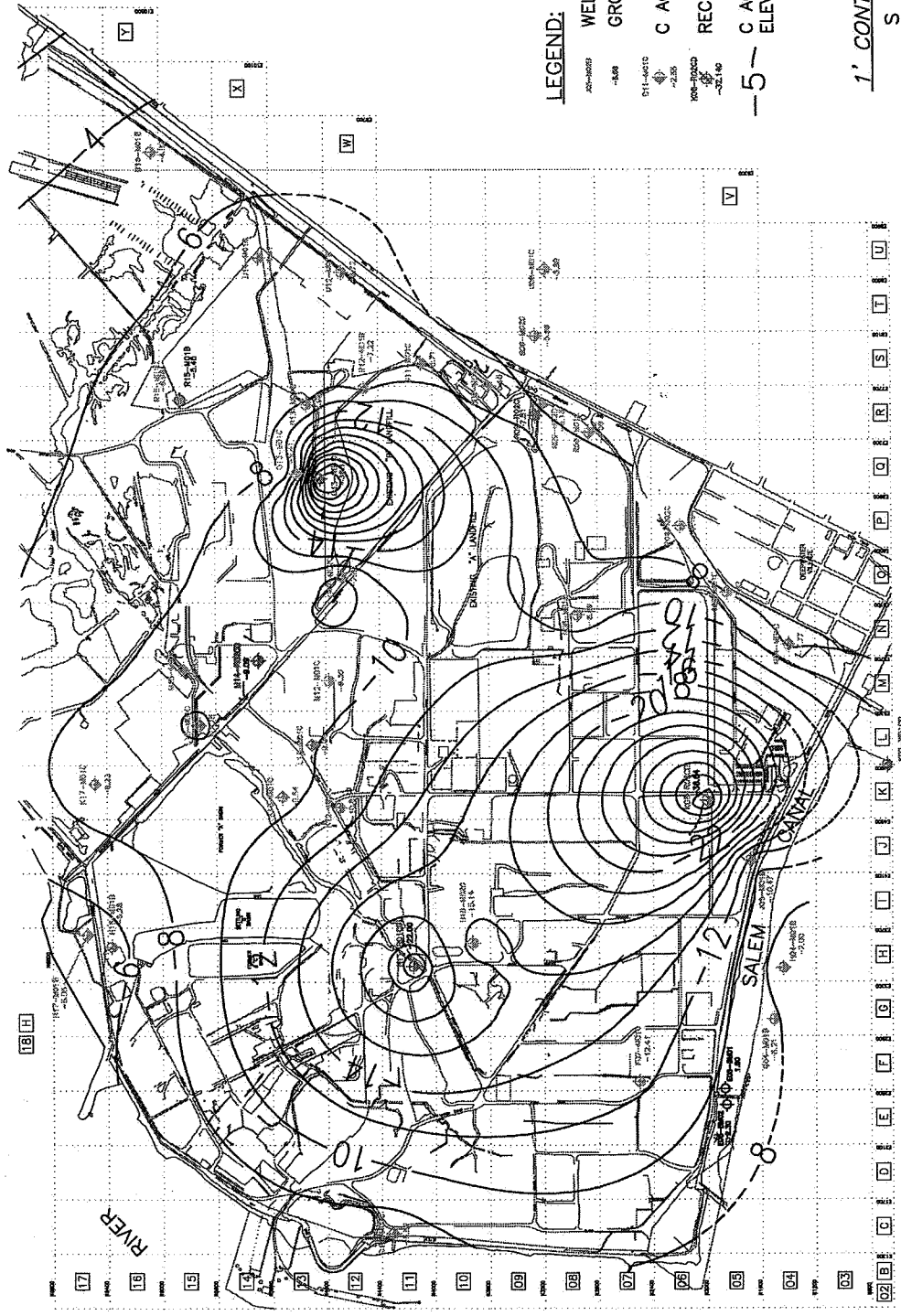
**DuPont Chambers Works  
Deepwater, New Jersey**

|          |         |          |   |
|----------|---------|----------|---|
| As shown | 7/30/33 | 71450077 | 3 |
|----------|---------|----------|---|



REFERENCED ELEVATIONS TO NAVD.

|                                                                                                                                                               |       |         |       |                                             |          |  |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|---------|-------|---------------------------------------------|----------|--|
| <p><b>Corporate Remediation Group</b><br/>An Alliance between<br/>Zachry and CDR Federal<br/>Baker Hill Plaza, Building 27<br/>Wilmington, Delaware 19805</p> | TITLE |         |       | GROUNDWATER ELEVATION CONTOUR MAP-B AQUIFER |          |  |
|                                                                                                                                                               | DWN:  | DEL     | DES:  | FILE NUMBER:                                | 7141B054 |  |
|                                                                                                                                                               | CHKD: | TES     | APPD: | FIGURE NO.:                                 | 4        |  |
|                                                                                                                                                               | DATE  | 8/26/03 | REV:  | 0                                           |          |  |



**LEGEND:**

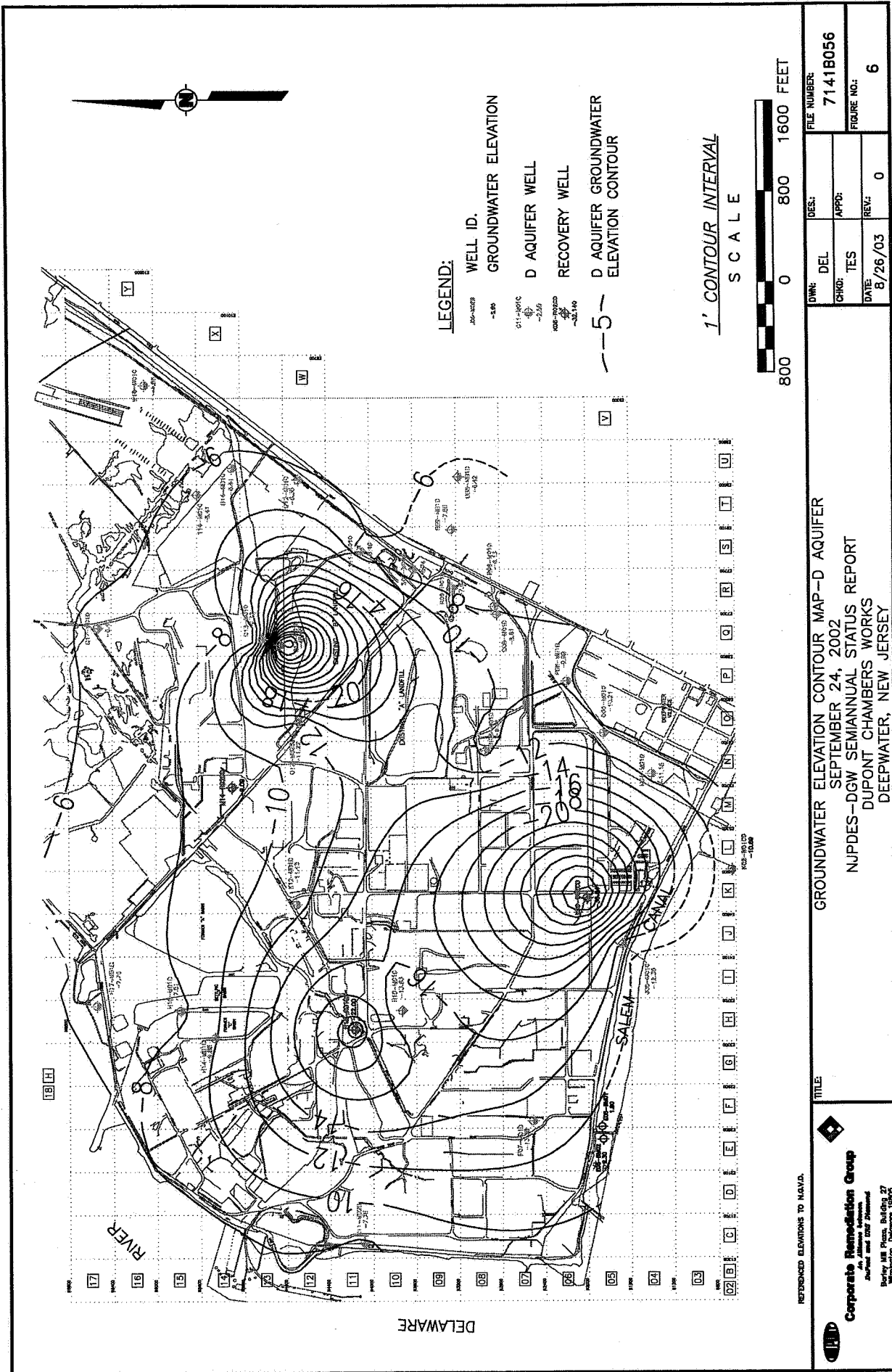
- WELL ID.
- GROUNDWATER ELEVATION
- C AQUIFER WELL
- RECOVERY WELL
- C AQUIFER GROUNDWATER ELEVATION CONTOUR

1' CONTOUR INTERVAL  
SCALE

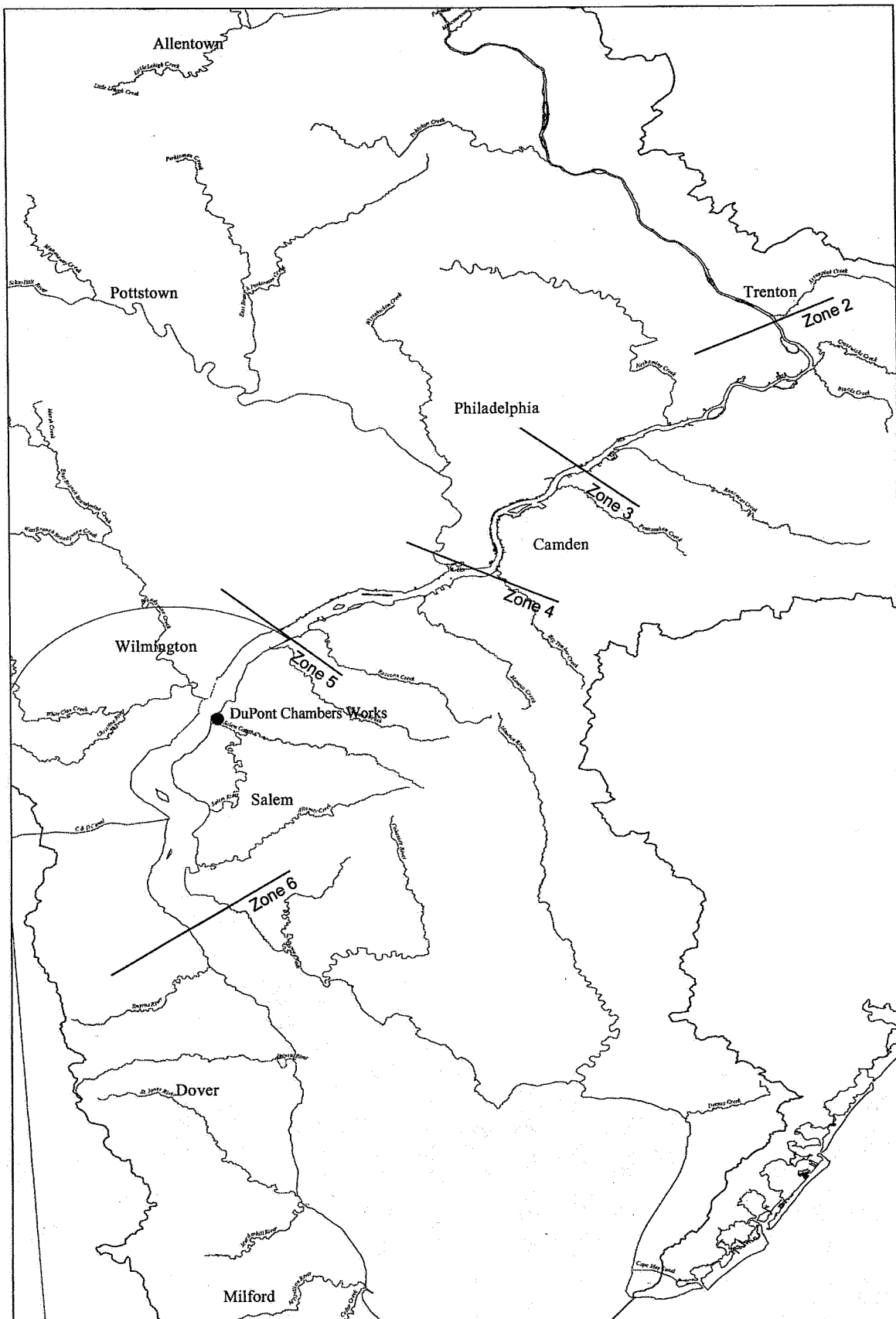


|                                                                                                                                                                      |                                                    |         |       |         |              |          |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|---------|-------|---------|--------------|----------|
| <p><b>Corporate Remediation Group</b><br/>An Alliance between<br/>DuPont and C&amp;D Placemat<br/>Berkley Hill Plaza, Building 27<br/>Wilmington, Delaware 19805</p> | <p>GROUNDWATER ELEVATION CONTOUR MAP-C AQUIFER</p> |         |       |         | FILE NUMBER: | 7141B055 |
|                                                                                                                                                                      | DATE:                                              | 8/26/03 | REV:  | 0       | DES:         |          |
|                                                                                                                                                                      | CHKD:                                              | TES     | APPR: |         | FILE NO.:    | 5        |
|                                                                                                                                                                      | DWN:                                               | DEL     | DATE: | 8/26/03 |              |          |

SEPTEMBER 24, 2002  
NJPDDES-DGW SEMIANNUAL STATUS REPORT  
DUPONT CHAMBERS WORKS  
DEEPPWATER, NEW JERSEY



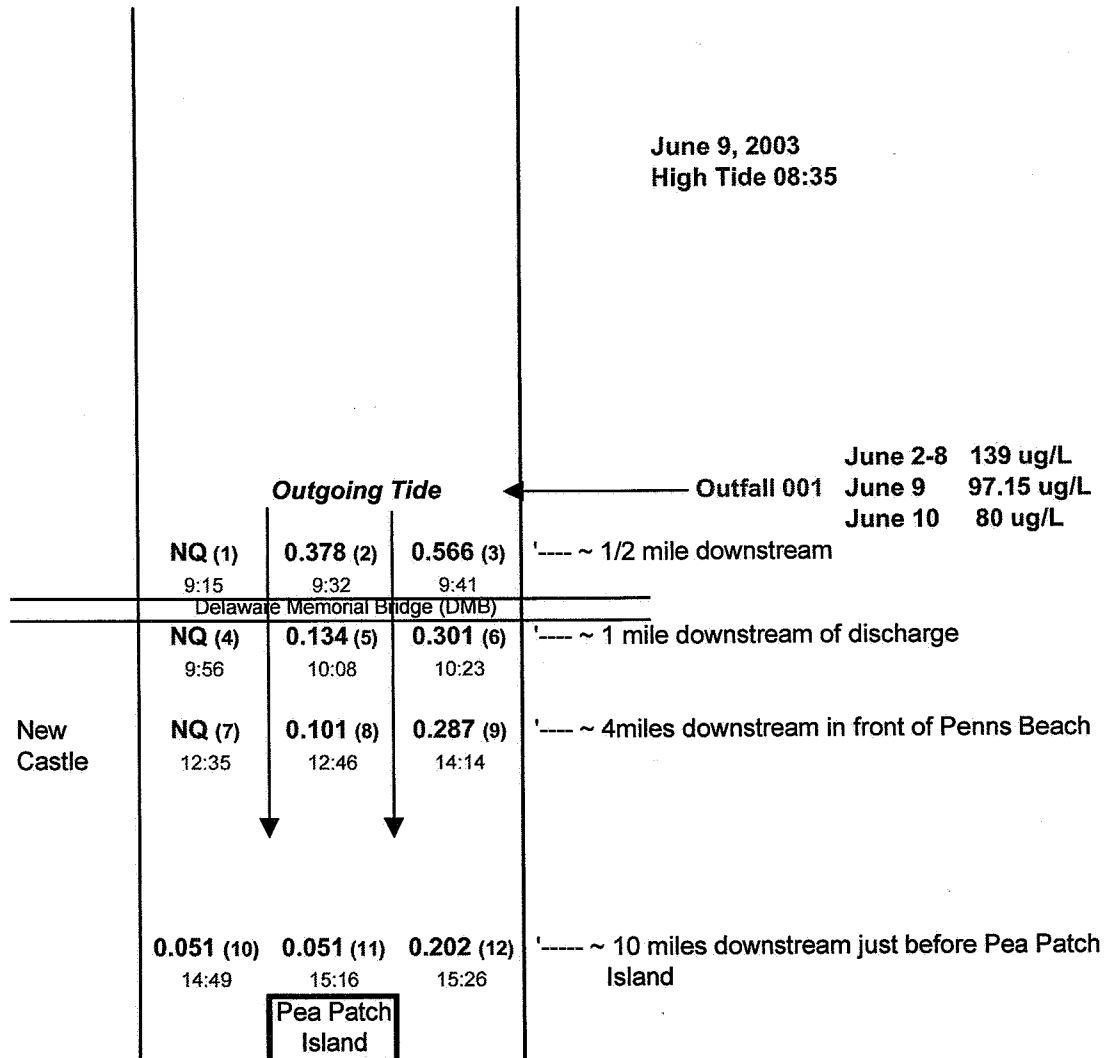
# Delaware River Zone Designations



**Figure 8**

**Delaware River Surface Water Sampling June 9th Sampling Results**

Outgoing-Tide (High Tide going to Low Tide)

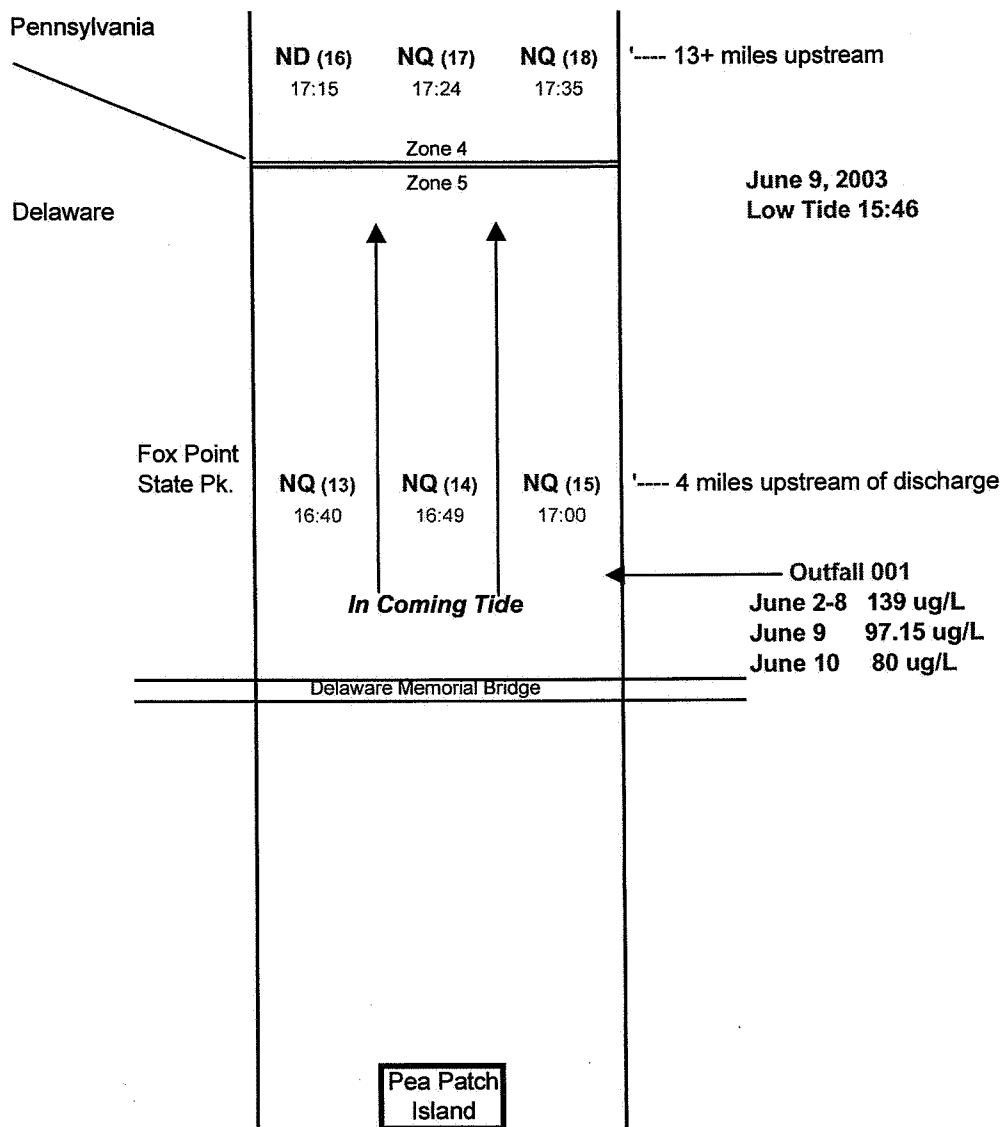


Units are ug/L (ppb)

Data is presented as **RESULT** (sample ID#)  
Time of sample

**Figure 9**

**Delaware River Surface Water Sampling June 9th Sampling Results**  
 Incoming-Tide (Low Tide going to High Tide)



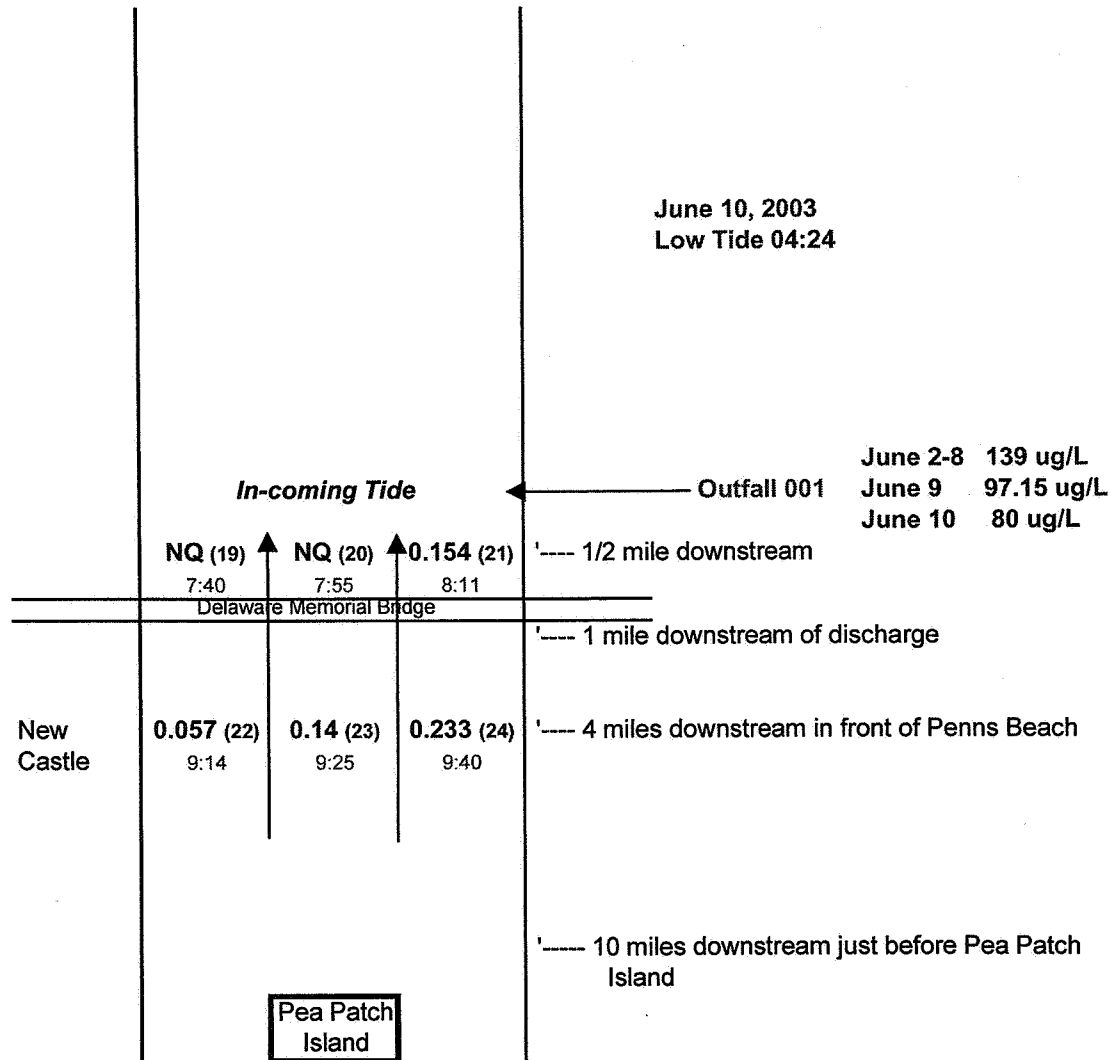
Units are ug/L (ppb)

Data is presented as **RESULT** (sample ID#)  
 Time of sample

Figure 10

**Delaware River Surface Water Sampling June 10th Sampling Results**

Incoming-Tide (Low Tide going to High Tide)

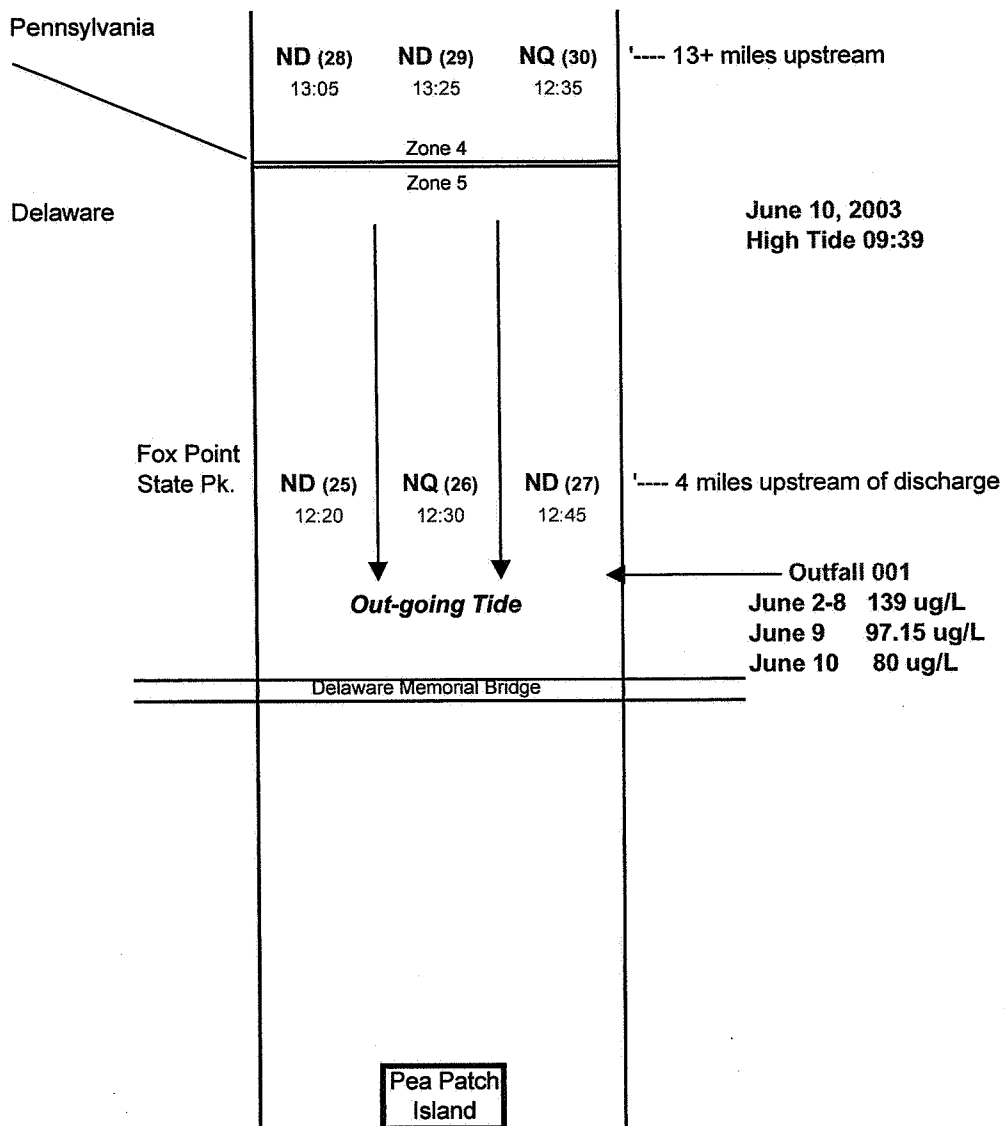


Units are ug/L (ppb)

Data is presented as **RESULT** (sample ID#)  
Time of sample

**Figure 11**

**Delaware River Surface Water Sampling June 10th Sampling Results**  
 Outgoing-Tide (High Tide going to Low Tide)

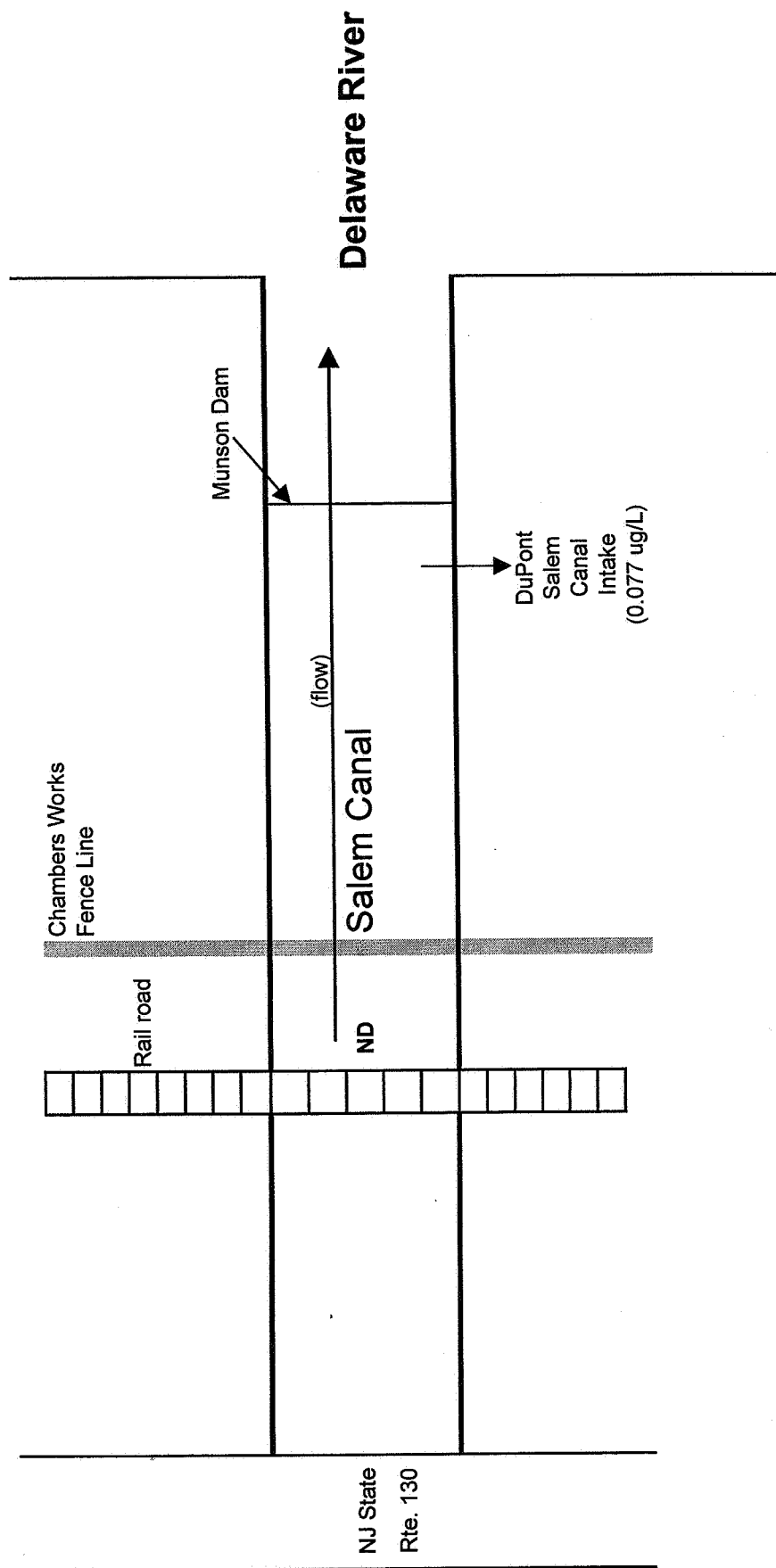


Units are ug/L (ppb)

Data is presented as **RESULT** (sample ID#)  
 Time of sample

Figure 12

Salem Canal Surface Water Sampling Results



## **APPENDICES**

---

**APPENDIX A**

**CALCULATION OF AIR EMISSIONS**

## **APPENDIX A**

### **Calculation of Air Emissions**

#### **Tenant Operation**

The site has a tenant operation running a small batch manufacturing process using PFOA as a processing aid. A simple mass balance using conservative estimates of air emissions was used. Air emission estimates were based on a 96-hour campaign, with PFOA released over a 10-hour drying cycle. The drying cycles occurred after hours 34, 58, 82 and 106 into the cycle. Estimated emission varied from 0.3 to 0.8 pounds of PFOA released over the 10-hour cycle. Model input took the maximum emissions over 110 days per year campaign schedule.

#### **Wastewater Treatment Plant (WWTP)**

Emissions characterization for the site WWTP was based on a combination of engineering analysis, mass balancing, and modeling. For wastewater treatment operations, the TOXCHEM+ model, Version 3.0 from Enviromega in Canada was used to predict how much of the material would be emitted to air from treating wastewater at the site. For this study, TOXCHEM+ was run to simulate maximum expected PFOA loading conditions from the site, i.e., all batch operations running at the same time. Twenty-two separate modeling runs were conducted to understand how potential air emissions might vary with changing physical/chemical properties of PFOA. In every case, results showed that virtually none (less than 0.04 lb/yr) of the material was transferred to the air phase. Therefore, these data were not used in the air dispersion modeling study.

#### **Telomers Processes**

This assessment required the development of a method for estimating PFOA concentration that could potentially be emitted from telomer manufacturing operations. This method is not validated. The resulting estimated values are not of sufficient accuracy and certainty to be used for any purpose other than for comparison to a screening level, as set forth in the LOI. PFOA emissions from telomers operations were calculated based on the estimated analytical data, which suggests that this compound is present in the process at trace levels. One data sample was collected and analyzed at each of various points in the process following a batch run. This was repeated for different product chemistries, and the data were used to estimate vapor phase emissions from a variety of vessels during process steps that include filling, evacuating, distilling, reacting, homogenizing, and packing out. These data provide a reasonable estimated concentration in the process to be used for this screening level study.

### Basic Physical Property Data

The primary property determining vapor phase composition above a mixture containing PFOA is the vapor pressure. Recent measurements of the vapor pressure (2003) were used in emission calculations and is best described by the following equation:

$$\ln (\text{VP}) \text{ in psia} = 12.7965 - 3388.046 / (T \text{ oK} - 130.441)$$

The vapor pressure of PFOA is quite low; when combined with the low levels of PFOA in the operations evaluated, it is anticipated that air emission rates will be also be very low.

### Vapor Phase Composition Calculations

The composition of the vapor phase during all processing steps was determined by calculating the partial pressure of the PFOA above the organic solution using Raoult's law and the ideal gas law.

The use of Raoult's law implies that the liquid solution is ideal and that the activity coefficient of PFOA out of telomers is 1.0. For similar compounds this would normally be a reasonable first pass assumption; however, there is no measured vapor-liquid equilibrium data to verify that this is indeed the case. As a result, the partial pressure could be greater (positive deviation systems) or less (negative deviation systems) than calculated by Raoult's law.

The use of the ideal gas law implies that all processing steps are at low to medium pressures (below 100 psig). This is indeed the case, as the highest pressure encountered in processing is 55 psig.

The calculation of vapor composition also assumes that the vapor is primarily nitrogen such that the molecular weight of the vapor is approximately 28 lb/lbmole. Based on processing temperatures and available vapor pressure data, this is a reasonable assumption.

The mole fraction of PFOA in the vapor is, therefore, calculated as follows:

$$y = x (\text{VP}) / P_{\text{tot}}$$

where y and x represent mole fractions of PFOA in the vapor and liquid phases respectively. Total pressure of the system is represented as  $P_{\text{tot}}$  and VP represents the vapor pressure of PFOA at the liquid temperature.

### Liquid Phase Composition Calculations

The liquid phase composition was determined by analysis and is altered only when additions are made to the vessel contents. To be conservative, during a distillation or evacuation step (low boiler removal), it was assumed that the composition of any vapor leaving the condenser was based on the partial pressure above the vessel contents at the condenser temperature. Since the PFOA content in the condenser liquid will be lower than in the vessel, this assumption may be quite conservative in estimating the emissions.

During processing steps in which other materials are added to the vessel, the vapor displaced is assumed to be at the partial pressure prior to dilution. Subsequent process

steps take credit for any dilution effects provided by addition of other materials. When two liquid phases are present (water additions), there is no credit taken for dilution, and the liquid phase composition is assumed to remain unchanged. This results in a conservative estimate for the emissions estimates.

During processing steps if there was analytical data for PFOA content at that step, it was this value that was provided as input to the calculations.

### **Vapor Flow Rate Calculations**

During any filling step, it was assumed that the vapor displaced was equal in volume to the liquid charged to the vessel and in equilibrium with the liquid. During steps in which the vessel pressure was changed, such as in pressurization and venting or evacuation, the mass of vapor discharged was calculated using the ideal gas law and the vapor space of the particular vessel as follows:

$$\text{Total Mass of Vapor Discharged} = V \Delta P MW / (RT)$$

The mole fraction of PFOA in the vapor was determined at the initial pressure and instantaneous equilibrium assumed. Pressure let-downs were assumed to occur much faster than the mass transfer rate to the vapor during venting and/or evacuations.

### **Total Annual Emission Calculations**

Emissions were calculated based on the operating procedures for each step of the typical area processes. These total emissions were then divided by the total batch time to arrive at an hourly rate of emission and multiplied by 8,760 hours/year to arrive at an annual rate. For those processes that operated on a continuous basis, the emission rate calculated was multiplied by 8,760 hours/year to arrive at the annual emission rate. The following represents the total emissions calculated for the telomers area of Chambers Works and Washington Works:

|                  |             |
|------------------|-------------|
| Chambers Works   | 0.9 lbs/yr  |
| Washington Works | 0.16 lbs/yr |

## **APPENDIX B**

### **SCREEN3 MODEL RUN**

# Appendix B SCREEN3 MODEL OUTPUT

08/01/03

13:17:07

\*\*\*SCREEN3r MODEL RUN\*\*\*

\*\*\*VERSION DATED 96043\*\*\*

\*\*WASHINGTON WORKS TELOMERS EMISSIONS \*\* 0

## SIMPLE TERRAIN INPUTS:

|                         |   |             |
|-------------------------|---|-------------|
| SOURCE TYPE             | = | POINT       |
| EMISSION RATE (G/S)     | = | .230576E-05 |
| STACK HEIGHT (M)        | = | 25.9080     |
| STK INSIDE DIAM (M)     | = | .4572       |
| STK EXIT VELOCITY (M/S) | = | 14.3256     |
| STK GAS EXIT TEMP (K)   | = | 293.1500    |
| AMBIENT AIR TEMP (K)    | = | 293.0000    |
| RECEPTOR HEIGHT (M)     | = | .0000       |
| URBAN/RURAL OPTION      | = | RURAL       |
| BUILDING HEIGHT (M)     | = | 29.2608     |
| MIN HORIZ BLDG DIM (M)  | = | 36.5760     |
| MAX HORIZ BLDG DIM (M)  | = | 59.4360     |

THE REGULATORY (DEFAULT) MIXING HEIGHT OPTION WAS SELECTED.  
THE REGULATORY (DEFAULT) ANEMOMETER HEIGHT OF 10.0 METERS WAS ENTERED.

BUOY. FLUX = .004 M\*\*4/S\*\*3; MOM. FLUX = 10.719 M\*\*4/S\*\*2.

## \*\*\* FULL METEOROLOGY \*\*\*

\*\*\*\*\*

## \*\*\* SCREEN AUTOMATED DISTANCES \*\*\*

\*\*\*\*\*

## \*\*\* TERRAIN HEIGHT OF 0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES \*\*\*

|       | DIST<br>(M) | CONC<br>(UG/M**3) | STAB | U10M<br>(M/S) | USTK<br>(M/S) | MIX HT<br>(M) | PLUME<br>HT (M) | SIGMA<br>Y (M) | SIGMA<br>Z (M) |
|-------|-------------|-------------------|------|---------------|---------------|---------------|-----------------|----------------|----------------|
| DWASH | 10.         | .0000             | 0    | .0            | .0            | .0            | .00             | .00            | .00            |
| NA    | 100.        | .2091E-02         | 6    | 1.0           | 1.7           | 10000.0       | 26.21           | 4.07           | 18.28          |
| SS    | 200.        | .1291E-02         | 6    | 1.0           | 1.7           | 10000.0       | 26.21           | 7.73           | 24.04          |
| SS    | 300.        | .8797E-03         | 6    | 1.0           | 1.7           | 10000.0       | 26.21           | 11.23          | 30.17          |
| SS    | 400.        | .6730E-03         | 6    | 1.0           | 1.7           | 10000.0       | 26.21           | 14.64          | 30.53          |
| SS    | 500.        | .5466E-03         | 6    | 1.0           | 1.7           | 10000.0       | 26.21           | 17.97          | 30.89          |
| SS    | 600.        | .4609E-03         | 6    | 1.0           | 1.7           | 10000.0       | 26.21           | 21.24          | 31.25          |
| SS    | 700.        | .3988E-03         | 6    | 1.0           | 1.7           | 10000.0       | 26.21           | 24.46          | 31.60          |
| SS    | 800.        | .3517E-03         | 6    | 1.0           | 1.7           | 10000.0       | 26.21           | 27.63          | 31.95          |
| SS    | 900.        | .3147E-03         | 6    | 1.0           | 1.7           | 10000.0       | 26.21           | 30.78          | 32.29          |
| SS    | 1000        | .2848E-03         | 6    | 1.0           | 1.7           | 10000.0       | 26.21           | 33.88          | 32.63          |
| SS    | 1100        | .2601E-03         | 6    | 1.0           | 1.7           | 10000.0       | 26.21           | 36.96          | 32.96          |

|                                         |      |           |   |     |     |         |        |       |       |
|-----------------------------------------|------|-----------|---|-----|-----|---------|--------|-------|-------|
| SS                                      | 1200 | .2394E-03 | 6 | 1.0 | 1.7 | 1000.0  | 26.21  | 40.01 | 33.29 |
| SS                                      | 1300 | .2217E-03 | 6 | 1.0 | 1.7 | 10000.0 | 26.21  | 43.04 | 33.62 |
| SS                                      | 1400 | .2065E-03 | 6 | 1.0 | 1.7 | 10000.0 | 26.21  | 46.05 | 33.94 |
| SS                                      | 1500 | .1932E-03 | 6 | 1.0 | 1.7 | 10000.0 | 26.21  | 49.03 | 34.26 |
| SS                                      | 1600 | .1815E-03 | 6 | 1.0 | 1.7 | 10000.0 | 26.21  | 51.99 | 34.57 |
| SS                                      | 1700 | .1711E-03 | 6 | 1.0 | 1.7 | 10000.0 | 26.21  | 54.94 | 34.89 |
| SS                                      | 1800 | .1618E-03 | 6 | 1.0 | 1.7 | 10000.0 | 26.21  | 57.87 | 35.20 |
| SS                                      | 1900 | .1534E-03 | 6 | 1.0 | 1.7 | 10000.0 | 26.21  | 60.78 | 35.50 |
| SS                                      | 2000 | .1459E-03 | 6 | 1.0 | 1.7 | 10000.0 | 26.21  | 63.68 | 35.80 |
| MAXIMUM 1-HR CONCENTRATION AT OR BEYOND |      |           |   |     |     |         | 10. M: |       |       |
| SS                                      | 88.  | .2254E-02 | 6 | 1.0 | 1.7 | 10000.0 | 26.21  | 3.65  | 17.65 |

DWASH= MEANS NO CALC MADE (CONC = 0.0)  
 DWASH=NO MEANS NO BUILDING DOWNWASH USED  
 DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED  
 DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED  
 DWASH=NA MEANS DOWNWASH NOT APPLICABLE,  $X < 3 * LB$

\*\*\*\*\*  
 \*\*\*\*\* REGULATORY (Default) \*\*\*\*\*  
 PERFORMING CAVITY CALCULATIONS  
 WITH ORIGINAL SCREEN CAVITY MODEL  
 (BRODE, 1988)  
 \*\*\*\*\*

| ***CAVITY CALCULATION - 1*** |   |           | ***CAVITY CALCULATION - 2*** |   |           |
|------------------------------|---|-----------|------------------------------|---|-----------|
| CONC (UG/M**3)               | = | .8839E-03 | CONC (UG/M**3)               | = | .1001E-02 |
| CRIT WS @10M (M/S)           | = | 1.27      | CRIT WS @10M (M/S)           | = | 2.37      |
| CRIT WS @ HS (M/S)           | = | 1.54      | CRIT WS @ HS (M/S)           | = | 2.87      |
| DILUTION WS (M/S)            | = | 1.00      | DILUTION WS (M/S)            | = | 1.44      |
| CAVITY HT (M)                | = | 38.48     | CAVITY HT (M)                | = | 32.60     |
| CAVITY LENGTH (M)            | = | 67.12     | CAVITY LENGTH (M)            | = | 48.77     |
| ALONGWIND DIM (M)            | = | 36.58     | ALONGWIND DIM (M)            | = | 59.44     |

\*\*\*\*\*  
 END OF CAVITY CALCULATIONS  
 \*\*\*\*\*

\*\*\*\*\*  
 \*\*\* SUMMARY OF SCREEN MODEL RESULTS \*\*\*  
 \*\*\*\*\*

| CALCULATION<br>PROCEDURE | MAX CONC<br>(UG/M**3) | DIST TO<br>MAX (M) | TERRIAN<br>HT (M) |                        |
|--------------------------|-----------------------|--------------------|-------------------|------------------------|
| SIMPLE TERRAIN           | .2254E-02             | 88.                | 0.                |                        |
| BLDG. CAVITY-1           | .8839E-03             | 67.                | —                 | (DIST = CAVITY LENGTH) |
| BLDG. CAVITY-2           | .1001E-02             | 49.                | —                 | (DIST = CAVITY LENGTH) |

\*\*\*\*\*  
 \*\* REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS \*\*  
 \*\*\*\*\*

*Note: The off-site concentration referenced in the report is the concentration shown for simple terrain. This concentration is valid for receptor locations near the fenceline since this area is relatively flat. Although the model predicted a building cavity concentration which is higher than the predicted value for simple terrain, this concentration will occur on site and is not applicable for this analysis .*

## **APPENDIX C**

**SITE ASSESSMENT PLAN (SAP) TO ASSESS PFOA LEVELS IN  
AIR AND WATER FROM DUPONT TELOMER MANUFACTURING  
OPERATIONS AT CHAMBERS WORKS, DEEPWATER, NJ AND  
WASHINGTON WORKS, PARKERSBURG, WV**

APPENDIX C  
SITE ASSESSMENT PLAN (SAP) TO  
ASSESS PFOA LEVELS IN AIR AND  
WATER  
FROM DUPONT TELOMER  
MANUFACTURING OPERATIONS AT  
CHAMBERS WORKS, DEEPWATER, NJ  
AND WASHINGTON WORKS,  
PARKERSBURG, WV

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## 1.0 INTRODUCTION

A Letter of Intent (LOI) was entered into between Telomers Research Program (TRP) and the United States Environmental Protection Agency (EPA) on March 14, 2003. Appendix 1 of the LOI committed DuPont Telomer Manufacturing Operations at Chambers Works in Deepwater, New Jersey and Washington Works in Parkersburg, West Virginia to complete the following:

- ☐ Develop site specific plans to assess levels of PFOA in air and water from manufacturing operations around each site; development of plans will begin no later than April 14, 2003.
- ☐ Conduct site-specific air dispersion modeling for applicable manufacturing operations, using the EPA-approved Industrial Source Complex Short Term 3 (ISC3) model, as described in EPA's *Guideline on Air Quality Models* (40 C.F.R. Part 51, Appendix W), and assess the results using the air screening levels established in West Virginia.
- ☐ Conduct groundwater and surface water analyses at each site and assess the results using the water screening levels established in West Virginia.
- ☐ Use the West Virginia screening levels to determine what additional actions, if any, may need to be taken.

The purpose of the Site Assessment Plan (SAP) is to meet the requirements in Appendix 1 of the LOI and to provide a description of the activities to be conducted and the procedures that will be followed for modeling and sampling.

## 2.0 CHAMBERS WORKS

### 2.1 Air Quality Modeling Protocol

The following sections describe the dispersion modeling methodology to be employed in order to assess the locations of maximum ambient air concentrations resulting from PFOA emissions at the DuPont Chambers Works facility located in Deepwater, New Jersey.

#### 2.1.1 Emissions Inventory

The following emission inventory information will be assembled in order to conduct the air quality modeling:

- ☐ Stack locations
- ☐ Stack base elevations
- ☐ Stack heights
- ☐ Stack diameters
- ☐ Stack gas exit temperatures
- ☐ Stack gas flow rate or exit velocities
- ☐ Detailed plant layout, including all building dimensions (provided in a scaled plot plan)
- ☐ PFOA emission rate

The detailed plant layout is necessary to evaluate the building dimensions in the vicinity of each stack and to identify the plant perimeter for defining the starting point of the receptor grid.

The following emission sources will be evaluated by the dispersion model:

- ☐ **Tenant operation:** Emission rates have been estimated for model.
- ☐ **Telomer operations:** There is considerable uncertainty around PFOA Telomers operations. A parallel program as part of the overall LOI is evaluating presence of PFOA and whether there would be any air emission sources from the operations. This information is required for the model.

The following sources are not believed to have air emissions of PFOA:

- ☐ **WWTP operations:** TOXCHEM modeling analysis conducted indicates that PFOA is not present in significant quantities ( $<1 \times 10^{-5}$  lbs/hr) in air emissions from the facility.

### 2.1.2 Model Selection

The area surrounding Chambers Works is primarily non-urban as previously determined by recommended EPA classification procedures. The EPA procedures classify land use within 3 kilometers of the site by the Auer method (Auer, 1978). Previous review of U. S. Geological Survey (USGS) maps, aerial photographs, and site visits clearly indicated that the area is over 50% non-urban. The terrain immediately surrounding the plant is primarily flat.

The Industrial Source Complex Short Term Model (ISC3) will be used as the primary model to estimate pollutant concentrations. ISC3 is a steady-state Gaussian model recommended by the EPA, included in the *Guidelines on Air Quality Models* (40 CFR 51, Appendix W) for modeling of pollutant emissions from industrial-type sources subject to significant building downwash. Refined ISC3 modeling will be conducted using five years of sequential hourly meteorology from the Greater Wilmington New Castle County (NCC) Airport, located in Wilmington, DE as described below.

### 2.1.3 Receptor Selection

A Cartesian grid of receptors will be utilized in this modeling analysis. This grid will consist of receptors placed at 200 meter (m) intervals on a grid extending a minimum distance of 6 km from any plant boundary. The nearest residences to the Chambers Works site will be covered by this receptor grid. All receptors will be located outside the plant boundary.

A Cartesian receptor grid such as the one described above is considerably more dense than recommended by the EPA in the *Guidelines on Air Quality Models* (EPA, 1998) for modeling a facility of this type. Additional discrete receptors will be placed at 100 meter intervals along the plant boundary. Although the topography in the immediate vicinity of Chambers Works is primarily flat, there is some elevated terrain to the Northwest of the site. Additional modeling will be conducted at a dense grid of receptors in the vicinity of the highest predicted concentration. This dense grid will consist of a 1 km by 1 km Cartesian grid of receptors with 100 meter spacing between each receptor.

### 2.1.4 Meteorological Data

The Chambers Works facility is located approximately 9 km from the New Castle County (NCC) Airport. Meteorological observations at the airport are considered representative of the site and of conditions affecting transport and dispersion of stack emissions. Therefore, five years of hourly surface observations from the National Weather Service (NWS) station at NCC Airport will be used in the refined air quality dispersion analysis.

Hourly meteorological data for the period 1989-1993 will be used in this study. Concurrent twice daily upper air data from the Dulles International Airport NWS station located in Sterling, VA will be used along with NCC surface temperatures to obtain hourly mixing depths.

### 2.1.5 Modeling Procedures

The most recent version of ISC3 will be used in the air quality dispersion modeling of all receptors. All model options will be set to the EPA regulatory default version of ISC3. The model will be run in the rural mode since the land area in the immediate vicinity of Chambers Works is more than 50% rural. Any effects of aerodynamic downwash caused by structures adjacent to the modeled stack will be included in the ISC3 modeling analysis, along with a summary of the building downwash input files (BPIP). Air quality dispersion modeling will be conducted on an hour-by-hour basis using the five years of meteorological data described above. The results will be summarized for annual averaging periods.

## 2.2 Surface Water Sampling

DuPont Chambers Works is located in Deepwater, New Jersey at approximate Delaware River mile 69. The Delaware River at river mile 69 is tidal, with the salinity of the tidal river being a function of the freshwater flows from the Schuylkill and Delaware Rivers north of Trenton, New Jersey.

The site has one primary wastewater outfall (DSN001) and two water intakes. One intake is on Salem Canal (freshwater source) and one intake is on the Delaware River (brackish water source). The Salem Canal intake is approximately 5-10 mgd and the Delaware River water intake is approximately 20-30 mgd.

The surface water sampling program is designed to assess PFOA concentrations in Salem Canal and the Delaware River adjacent to the plant using previous hydrology studies to assist with the sample location planning.

### 2.2.1 Effluent and Intake Sampling Plan

| Sampling Location                    | Description                                                      |
|--------------------------------------|------------------------------------------------------------------|
| Outfall to Delaware River DSN001     | Stormwater run-off, WWTP effluent and non-contact cooling water. |
| Delaware River Upstream Sample       | Approx. 15 miles upstream                                        |
| Chambers Works Salem Canal Intake    | Raw Water Intake                                                 |
| Chambers Works Delaware River Intake | Water Intake-non contact cooling and fire water                  |

#### Sample Type

- ☐ Outfall samples 48-hour composite samples (two 24-hr composites combined)
- ☐ DuPont Chambers Works Delaware River Intake, Salem Canal Intake and Upstream Sample 24-hour composite samples

**Parameters to be Sampled**

Each sample collected will be analyzed for PFOA , total organic carbon, and total suspended solids.

Upstream Delaware River and Salem Canal samples will only be taken during the first sampling event. Based on results additional samples may be taken, as appropriate.

**2.2.2 Delaware River Sampling Plan****Sampling Locations**

DuPont Chambers Works is located in Deepwater, New Jersey approximately at Delaware River mile 69. The Delaware River at river mile 69 is tidal with the salinity of the tidal river being a function of the freshwater flows from the Schuylkill and the Delaware River north of Trenton, New Jersey.

The tidal flow can reach up to 8 to 12 miles upstream of the facility depending on the freshwater flows from the Schuylkill and northern Delaware River (non-tidal). DuPont performed a low-flow and high-flow dye dispersion study and a hydrographic survey of the Delaware Estuary in the late 1980s. These studies showed that the Delaware Estuary is well mixed vertically, and that there is no significant salinity gradient within the water column. It also appeared to show elevated dye concentrations near the eastern shore when compared to the western side of the estuary.

Thus, surface water sampling does not need to be taken at different depths since the estuary is well mixed vertically; however, samples will need to be taken over the width of the river to take into account the possibility of varying concentrations.

The Delaware Estuary will be sampled upstream and downstream of DuPont Chambers Works on an incoming and outgoing tide. The downstream samples on an outgoing tide will be ½ mile, 1 mile, 4 miles and 12 miles downstream of Chambers Works outfall. For the incoming tide the samples will be taken at the 1 mile and 4 mile downstream points.

The upstream samples taken on an incoming tide will be 4 miles and 13+ miles upstream of the Chambers Works outfall. The 13+ mile sample will be outside the influence of the Chambers Works wastewater and will be considered a background sample. Figures 9 to 11 provide a general description of the sampling locations.

The Chamber Works outfall 001 effluent will be sampled each day (24-hr composite) for a week prior to the surface water sampling. These samples will be combined to form a single composite sample for analysis.

**Sample Types**

All samples in the estuary will be grabs and taken at approximately 0.6 to 0.75 of the depth from the bottom of the river. Effluent samples will be 24-hour composite samples.

**Parameters to be Sampled**

Surface water samples will be analyzed for PFOA, specific conductivity, and total suspended solids. The location of each sample must be recorded by GPS. The effluent samples will be analyzed for PFOA.

### Collection of Samples

Prior to collection of the samples the sampling team must first divide the estuary width by three for each sampling location. The sampling team will then determine the center of each section for sampling location. All samples will be grabs and taken at approximately 0.6 to 0.75 of the depth from the bottom of the river as shown in Figure 1 below. (The symbol "o" represents the sampling location.)

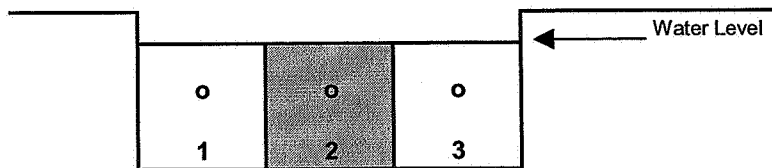


Figure 1

## 2.3 Groundwater Sampling

Groundwater samples will be collected at the five interceptor well locations.. The data will be used to determine if PFOA is present in groundwater at Chambers Works. The interceptor wells have been chosen as the sampling location since the interceptor wells hydraulically contain the groundwater beneath the site.

A complete round of groundwater sampling from all five interceptor well locations will be conducted. The interceptor wells are known as:

- ☐ H-11
- ☐ R-09
- ☐ K-06
- ☐ M-14
- ☐ Q-13 (two wells)

A total of six samples will be collected from interceptor wells since Q-13 is actually two separate wells, screened in different aquifers. Samples will be collected from sample ports from the discharge piping at each location. Interceptor well sampling ports (taps) will be changed out to eliminate PTFE-tape, prior to groundwater sampling.

In addition, samples will be collected from two existing B Aquifer monitoring wells located near the telomers area. The wells to be sampled are identified as:

- ☐ C10-M01B
- ☐ C08-M01B

Prior to groundwater sampling of the B Aquifer monitoring wells, the depth to water will be measured with an electronic water-level probe. The probe will be decontaminated between wells by rinsing with methanol and distilled water.

A low-flow (minimum drawdown) groundwater sampling procedure will be used to purge monitoring wells and collect groundwater samples. The groundwater sampling procedures are summarized in Section 2.4.5, General Instructions for Water Sampling. Samples will be submitted to the laboratory for analysis. Quality assurance/quality control procedures, described in Section 2.5, will be followed to ensure that the data collected in the field is both valid and representative of the site conditions.

## 2.4 Field Procedures

### 2.4.1 Field Sampling Preparation Procedures

To ensure that sampling activities are conducted correctly and safely, the following six steps will be followed prior to commencing field activities:

- ☐ The project's quality assurance officer will notify the laboratory of the upcoming sampling event so that the laboratory can prepare the appropriate type and number of sample containers. The anticipated number of samples, replicate requirements, and the number of extra bottles needed for quality control testing will be specified to the laboratory manager.
- ☐ The field team will inspect all equipment to be used during the sampling event.
- ☐ Field meters to be used during sampling (i.e., pH, temperature probe, water level specific conductance, and dissolved oxygen meters) will be checked to ensure proper calibration and precision response.
- ☐ The field sampling team and/or the project's quality assurance office will assemble all forms to be used in the field [including the field logbook, chain-of-custody (COC) sheets and seals, and sample analysis request forms].
- ☐ Bottles will be "prelabeled" during the mobilization phase of the sampling event to reduce confusion in the field. Certain information (e.g., well number, sample point, sample identification number, preservative, and type of parameters) will be affixed to the label with permanent ink during pre-field activities. Other information (e.g., sample time and date, sampler's name) will be added to the label only after the sample is collected. A cross-reference to information contained on the label will be documented in the field notebook and will correspond with the well number
- ☐ Prior to sampling, sampling personnel will review proper sampling protocols. In addition, proper health and safety protocols and the site-specific Health and Safety Plan will be reviewed prior to sampling.

Scheduling and coordination of the sampling team will be completed prior to field mobilization and then will be reviewed periodically. Equipment calibration and inspection will be completed at least once per day (when the equipment is used). Review of procedures and protocols will be completed as required.

### 2.4.2 Calibration Procedures

Calibration is the process of establishing a relationship of a measured output to a known input and provides a point of reference to which other sample analyses can be correlated. Each field instrument will be calibrated prior to its first use each day. More frequent calibration will be conducted as necessary, based on instrument performance checks and operator judgment. All calibrations will be performed using standard industry practices or equipment manufacturer recommendations.

### 2.4.3 Field Procedures

Field meters used during sampling (i.e., PID, pH, conductivity, temperature, dissolved oxygen, turbidity, redox, and water level) will be checked for calibration consistent with manufacturer-recommended procedures. Field instrument and equipment calibration should be conducted daily. Where the manufacturer has not specified a calibration interval for an instrument, it will be established based on industry practice or by the sampling team. Field equipment will be supplied and maintained by the sampling team.

The pH meter calibration will be checked by using at least two different buffer solutions that bracket the expected range of pH in the wells to be sampled. The probe of the meter and sampling cups will be thoroughly rinsed with deionized water before and after use. Additional calibration procedure details are described in the manufacturer's guidelines for this instrument.

The specific conductivity meter will be checked daily against a laboratory-prepared potassium chloride (KCl) standard solution. When the meter exhibits unacceptable error (greater than five percent), it will be recalibrated according to the procedure defined in the manufacturer's guidelines for this instrument. The probe of the meter and the sampling cups will be thoroughly rinsed with deionized water before and after use.

The static water level in a well will be measured using an electric water-level indicator. The water level will be measured from a scribed mark at the top of the steel or PVC well casing.

A PID will be used for screening soil samples for health and safety monitoring in accordance with the project HASP. The calibration will be in accordance with manufacturer's specifications. The PID will be calibrated using a zero air gas and appropriate calibration indicator gas.

### 2.4.4 Standards

For the pH meter, buffers will be at pH 4, pH 7, and pH 10. Two of the three buffers will be used to calibrate the meter. The third buffer will be used for periodic calibration checks. The pH 7 buffer will always be one of the calibration buffers. The buffers will be purchased from a laboratory chemical supply manufacturer, and the exact pH will be noted on a calibration form.

For the conductivity meter, reference solutions will be in the range of 500  $\mu\text{mhos/cm}$ . Three known reference solutions will be used for each calibration. The median standard will be used for calibration checks. For the PID, span gases will be purchased from

chemical suppliers. These gases will be in the 10 to 100 parts per million (ppm) range. Calibration procedures for all health and safety related equipment are specified in the HASP.

## 2.4.5 Sampling Procedures

Samples collected during this investigation will be analyzed for PFOA and will include groundwater and surface water samples taken from the WWTP.

### General Decontamination Procedures

All equipment in direct contact with the material to be sampled will be decontaminated prior to sampling to prevent cross-contamination of samples collected. In addition, care will be taken so as not to allow anything to come into contact with a sample or sample area, which may affect its composition.

Sampling equipment will include bailers, tubing, and pumps. All of these items will come in direct contact with the sample and have potential to impact analytical results. Therefore, care will be taken to ensure the cleanliness of all sampling equipment. When possible, pre-cleaned or disposable sampling equipment will be used (e.g., bailers for sampling wells). Field decontamination will be permitted for bailers and pumps, provided the following method is applied:

- 1 Wipe off any residual sludge or water with a Chem-wipe.
- 2 Rinse the equipment with deionized water.
- 3 Rinse the equipment with methanol.
- 4 Place in zip-sealed bag until the next use.

In addition to the decontamination procedures outlined above, the person collecting the sample will wear clean latex or nitrile disposable lab or exam gloves and will limit his/her contact with the samples. Sample bottles and containers will be prepared by the contracted laboratory and will be sealed to ensure cleanliness. Sample bottles will not be cleaned in the field.

A personnel decontamination area will be set up at each sample location prior to starting sampling activities. Procedures for the decontamination of protective equipment and the removal of respiratory and personal protection clothing to avoid transfer of constituents from clothing to the body are discussed in the HASP. To the extent that it is economically feasible and technically acceptable, disposable personal protective equipment (PPE) will be used. Where the work scope restricts use of disposable PPE, decontamination facilities will be provided.

### General Instructions for Water Sampling

Water sample bottles will not be pre-rinsed with site water prior to sample collection. Gloves will be worn during sampling activities and replaced between samples. All samples will be held chilled to approximately 4°C (not frozen to 6°C) with wet ice from collection to shipping.

In order to minimize the possibility of introducing PFOA- contamination into samples, the following protocol will be followed:

- ☐ Avoid polytetrafluoroethylene (PTFE).
- ☐ Avoid aluminum foil.
- ☐ Do not use self-stick memo notes.
- ☐ Avoid blue ice.
- ☐ Avoid pre-wrapped foods or snacks.
- ☐ Wear clothing that has been washed at least six times
- ☐ Use only containers supplied by contract laboratory.

The field team leader or a senior member of the field team will be responsible for water sampling and laboratory coordination. The laboratory will provide necessary sample containers with the shipping containers (i.e., shuttles). Containers and any preservative added to the containers will be in accordance with EPA document SW-846 protocol. All samples requiring refrigeration will be shipped at approximately 4°C (not frozen to 6°C).

Field equipment will consist of some or all of the following:

- ☐ Polyethylene collection bottles (laboratory provided)
- ☐ Field sampling record
- ☐ Sufficient ice to maintain the samples at approximately 4°C (not frozen to 6°C)
- ☐ Methanol and deionized/distilled water
- ☐ Conductivity meter, pH meter, temperature probe, redox probe, dissolved oxygen probe, and turbidity meter
- ☐ Glass beakers
- ☐ PID and/or FID for organic vapor analysis
- ☐ Pumps and/or bailers for purging
- ☐ Rope
- ☐ Stainless-steel or polypropylene leader to attach rope to sampling device
- ☐ Bailers or other sampling devices (preferably dedicated or pre-cleaned)

Preparing for sampling includes acquiring all of the necessary monitoring equipment listed above and site-specific information to perform the required monitoring.

### **Groundwater Sampling**

Groundwater will be sampled from monitoring wells and interceptor (pumping) wells at the facility. Prior to initiating sampling activities at a given location a complete round of depth to water levels will be measured to the nearest one hundredth of a foot.

Prior to sample acquisition, monitoring wells will be purged using a low flow protocol. The low-flow pump will be lowered gently and set at approximately the middle of the screen. If the static water level is below the top of the screen, then the pump will be lowered to the middle of the water column. In either case, the pump intake will be placed a sufficient distance above the bottom of the well to avoid mobilization of any

accumulated sediment. Well purging will begin at a rate of 0.2 to 0.5 L/min. Water level in the well will be monitored during purging, and the purge rate will be lowered, if possible, if well drawdown is noted.

During low flow purging, pH, specific conductance, dissolved oxygen (DO), oxidation-reduction potential (Eh), temperature, and turbidity will be monitored using a flow through cell. Purging is complete when all field parameters have stabilized (variations in values are within 10 percent of each other for three consecutive readings taken 3 to 5 minutes apart). Once field parameters have stabilized, samples will be collected directly from the end of the discharge tube.

Alternatively, if low flow purging is not practical due to field conditions, monitoring wells will be evacuated to a minimum of 3 volumes of water standing in the well casing. The depth of the purge pump intake will depend on well yields. The ideal intake will be at the static water level in the well. The pump intake will be adjusted as the water level responds to pumping. Shallow wells, where the screened interval extends above the water table and cannot be purged of three well volumes due to slow recovery rates, will be pumped dry and allowed to recover before sampling. The water level in deeper wells will be pumped to just above the screened interval and will be allowed to recover before sampling. If standard purge protocols are to be used, measurements of pH and specific conductance will be collected during well purging, and well evacuation will stop when at least 3 volumes are evacuated and three consecutive readings of pH and specific conductance have stabilized within 10 percent.

Pre-cleaned or dedicated, 1¼-inch-diameter bottom-loading bailers will be used to collect grab groundwater samples for transfer into the proper sample containers if standard purge protocols are used. Monofilament polypropylene or stainless steel wire leaders attached to nylon or polypropylene rope will be used to raise and lower the bailer. The bailer will be lowered to the screened interval for sample collection. If well yields are low at the site, the samples will be collected at or near the screen as the well recovers and provides a sufficient volume for sample collection. Each of the wells exhibiting suitable recovery will be sampled within two hours of evacuation.

Sample containers will be filled to at least the container shoulder. After the sample containers are filled, they will be labeled appropriately and placed in a sample shuttle containing ice or ice packs. Samples requiring refrigeration for preservation will be stored at approximately 4°C (not frozen to 6°C) during storage and shipment.

The following procedure will be followed during groundwater sampling:

- 1 Wipe the exterior of the sampling bottle using a Chem-wipe moistened with methanol.
- 2 Remove the bottle cap, wipe the bottle lip using a Chem-wipe moistened with methanol, and fill from the bailer or hose. Do not use a secondary container to fill the bottle.
- 3 Recap the sample bottle.
- 4 Wipe the bottle using a Chem-wipe moistened with methanol and affix a sample label.

- 5 Place the sample in a cooler of ice.
- 6 Complete the chain-of custody form.

### **WWTP/Surface Water Sampling**

The following procedure will be followed during surface water sampling:

- 1 Wipe the exterior of the sampling bottle using a Chem-wipe moistened with methanol.
- 2 Submerge the sample bottle below the water surface and unscrew the bottle cap.
- 3 Fill the water bottle by turning the bottle parallel to the water surface and slowly rotating so that the mouth of the bottle is up right. This procedure will ensure that water from the surface microlayer is not pulled into the sample bottle.
- 4 Recap the sample bottle under water.
- 5 Wipe the bottle using a Chem-wipe moistened with methanol and affix a sample label.
- 6 Place the sample in a cooler of ice.
- 7 Complete the chain-of custody form.

#### **Disposable Equipment**

All disposable equipment and other materials that are not decontaminated for reuse will be disposed of in an acceptable manner.

## **2.5 Quality Assurance/Quality Control**

Quality assurance/quality control (QA/QC) procedures will be performed to ensure that the data collected is both valid and representative of the site conditions. Quality assurance/quality control (QA/QC) procedures are summarized below.

### **2.5.1 Field Checks**

Selected field activities that are performed that incorporate QA/QC checks include the following:

- ☐ Using standardized data collection formats
- ☐ Calibrating field equipment
- ☐ Collecting duplicate samples and field blanks
- ☐ Conducting field audits

Field equipment will be calibrated prior to use in accordance with the standardized procedures contained in the equipment manual.

Field and laboratory audits may be performed by the QA officer (or his/her designee) to confirm that proper protocols and procedures are being employed.

## 2.6 Quality Control Sample Collection

Duplicate groundwater and/or surface water samples will be collected by alternately filling sample containers from the same sampling device for each parameter. Field duplicates will be collected at a minimum rate of 1 per 20 field samples. A greater frequency can be selected in order to verify laboratory and field performance. Blind duplicate samples will be collected at one or more well locations and coded so that only the sampling team knows the exact location of the sample collection.

Equipment blanks (also called rinsate blanks) will be used to evaluate equipment cleaning or decontamination procedures. At the sample location, analyte-free water or deionized water will be poured over or through the sample collection device, collected in a sample container, and preserved as appropriate. A minimum of one equipment blank per day will be collected.

All blanks will be handled, transported, and analyzed in the same manner as actual field samples. Blanks will be held on-site for the minimum number of days. The temperature of the blanks will be maintained at approximately 4°C while on-site and during shipment.

### 2.6.1 Laboratory Checks

Periodic audits of the analytical laboratory may be performed by the project QA officer (or his/her designee) to confirm that proper analytical protocols are being followed concerning sample analysis and laboratory QC checks.

## 2.7 Waste Handling

Waste management procedures are summarized below. Each waste produced during the sampling program will be characterized and classified so that disposal options can be determined. The typical wastes that will be generated and managed during investigation activities include the following:

- ☐ Water from purging and development of monitoring wells
- ☐ Water from decontaminating sampling equipment
- ☐ Disposable sampling equipment
- ☐ Disposable PPE

Classification of the wastes generated during the program will be dependant on the source of the waste and, when applicable, the classification of the wastes contained in the nearest land disposal unit. All waste not classified at the time of the field investigation will be placed in containers labeled and managed in accordance with state and federal regulation.

PPE and disposable sampling equipment wastes that do not come into contact with materials contained within SWMUs will be classified as nonhazardous wastes. All groundwater and decontamination cleaning waters will be containerized.

Once characterized, wastes will be classified as uncontaminated, nonhazardous, or hazardous. Waste containers will be labeled to indicate classification. Wastes will be disposed of according to applicable federal and state regulations.

### **3.0 WASHINGTON WORKS**

Washington Works has completed thorough assessments of surface water and groundwater around the site. Air modeling was conducted for areas that are known sources of PFOA. However, there is considerable uncertainty around the presence of PFOA in telomer manufacturing operations. The LOI includes a commitment to assess whether PFOA is in the telomer process, and if found, at what levels and what are the emission rates.

Once this information is determined, the data will be compared with existing surface water and groundwater sampling results and using the West Virginia Screening levels, determine if additional sampling is needed. The data will also be compared to inputs for the Washington Works air dispersion assessments for PFOA and the West Virginia Screening levels. If the data indicate that further evaluation is needed, the models will be rerun to include telomers operations at Washington Works.



**PLEASE REPLACE THE TEXT – “REVISED AUGUST 15,  
2003” WITH THE ATTACHED TEXT – “REVISED NOVEMBER  
9, 2004”**

**PLEASE INSERT ATTACHED ITEMS IN THE BACK OF  
APPENDIX A**

**PLEASE INSERT ATTACHED ITEMS IN THE BACK OF  
APPENDIX G**



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