

**AMMONIUM
PERFLUOROOCCTANOATE
(C-8)
GROUNDWATER
INVESTIGATION STEERING
TEAM REPORT**

AUGUST 2003

CONSENT ORDER No. GW- 2001-019

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AMMONIUM PERFLUOROCTANOATE (C-8) GROUNDWATER INVESTIGATION STEERING TEAM REPORT

EXECUTIVE SUMMARY

A multi-media Consent Order (GWR-2001-019) was entered into between the West Virginia Department of Environmental Protection (WVDEP), the West Virginia Department of Health and Human Resources-Bureau for Public Health (WVDHHR-BPH) and DuPont on November 14th, 2001.

The Consent Order identified a series of requirements to be performed by the Parties (WVDEP, WVDHHR-BPH, and DuPont) in order to determine whether there has been any impact on human health and the environment as a result of releases of ammonium perfluorooctanoate (C-8), CAS Number 3815-26-1, to the environment from DuPont operations at the Washington Works main plant and three associated landfills (Local, Dry Run, and Letart). C-8 is a material used by DuPont in its fluoroproducts manufacturing process at its Washington Works Facility's located in Washington, Wood County, West Virginia. C-8 has not been identified as a hazardous substance, hazardous waste, or otherwise specifically regulated under West Virginia or federal statute or regulation.

In accordance with Attachment A of the Consent Order, three tasks were to be performed by DuPont and evaluated by the Groundwater Investigation Steering Team (GIST). The GIST used a phased approach towards meeting these requirements.

TASK A:

Task A required Dupont to conduct a distance-phased public water supply service survey along the Ohio River on both the West Virginia and Ohio sides of the river. Subsequent to the Task A requirement, a one-mile (and possibly a two- and three-mile) radial distance of the Washington Works Facility and the Local, Letart, and Dry Run Landfills. The phased approach to the water and groundwater well use survey and sampling was intended to allow the GIST to focus efforts along potential C-8 impact transport pathways and eventually cease activities in directions where impacts were not present or where there were low concentrations.

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WEST VIRGINIA PRIVATE WATER SUPPLY SOURCES:*Conclusions:*

- Initial sampling within a one-mile radius of the Washington Works Facility and each of the three landfills resulted in varying levels of C-8 being found in private water sources.
- Private water sources within a one- to two-mile radius were sampled around the Washington Works Facility and the Local Landfill based on C-8 concentrations detected greater than 1.0 µg/l in the one-mile radius. No further private water sources sampling beyond the two-mile radius is necessary based on the lower concentrations detected in the one- to two-mile radius sampling area.
- No private water sources in West Virginia were found to exceed the C-8 drinking water screening level of 150 µg/l. The highest concentration detected was 10.4 µg/l.

Recommendations:

- Continued quarterly sampling of selected private water sources around the Washington Works Facility and Local and Dry Run Landfills for one year is recommended by the GIST. Annual sampling of the private water sources at the Letart Landfill is also recommended. Subsequently, the frequency of the sampling should then be re-evaluated.

OHIO PRIVATE WATER SUPPLY SOURCES:*Conclusions:*

- Initial sampling within a one-mile radius of the Washington Works Facility resulting in varying levels of C-8 being found in approximately 94% of the water sources sampled.
- Private water sources within a one- to two-mile radius from the Washington Works Facility were sampled based on the levels of C-8 detected at the outer limits of the one-mile radius.
- No private water sources in Ohio were found to exceed the C-8 drinking water screening level of 150 µg/l. The highest concentration detected was 23.6 µg/l.

Recommendations:

- Continued quarterly sampling of selected water sources around the Washington Works Facility for one year is recommended by the Ohio EPA. Subsequently, the frequency of the sampling should then be re-evaluated.

WEST VIRGINIA PUBLIC WATER SUPPLY SYSTEMS:*Conclusions:*

Ten public water supply systems along the Ohio River at various points up and downstream from the Washington Works Facility and Letart Landfill were sampled for C-8.

- No public water supply production wells in West Virginia were found to exceed the drinking water screening level of 150 µg/l. The highest concentration detected was 1.87 µg/l.
- The widespread distribution and low concentrations of C-8 indicate that the primary migration pathways to the public water supplies are air emissions from the Washington Works Facility and pumping-induced infiltration from the Ohio River, which receives C-8 from the National Pollutant Discharge Elimination System (NPDES) outfalls at the Washington Works Facility and the Letart Landfill.

Recommendations:

- Continued quarterly sampling at the Lubeck Public Service District (PSD), DuPont Washington Works Facility, and General Electric public water systems for two years is recommended by the GIST. Also, annual sampling of the Blennerhassett Island, Mason County PSD, and the Racine Lock and Dam Public Water System for two years is advised. Subsequently, the frequency of the sampling should then be re-evaluated.

OHIO PUBLIC WATER SUPPLY SYSTEMS:*Conclusions:*

Six public water supply production wells along the Ohio River at various points up and downstream from the Washington Works Facility and the Letart Landfill were sampled for C-8.

- No public water supply production wells in Ohio were found to exceed the C-8 drinking water screening level of 150 µg/l. The highest concentration detected was 8.58 µg/l.
- The widespread distribution and the low concentrations of C-8 indicate that the primary migration pathways to the public water supplies are air emissions from the Washington Works Facility and pumping-induced infiltration from the Ohio River, which receives C-8 from NPDES outfalls at the Washington Works Facility and Letart Landfill.

Recommendations:

- Continued quarterly sampling of the Little Hocking Water Association Public Water System for two years is recommended by the GIST. Also, annual sampling of the Tappers Plains-Chester Water District Public Water System for two years is advised. Subsequently, the frequency of the sampling should then be re-evaluated.

TASK B:

Task B required the development and implementation of a monitoring plan that would determine the extent and presence of C-8 in drinking water, groundwater, and surface water in and around the Washington Works Facility and the three landfills, and to provide a compilation of all available groundwater/surface water monitoring and hydrogeologic characterization data for each facility.

OHIO RIVER SURFACE WATER SAMPLING:*Conclusions:*

- Twelve sampling locations in the Ohio River at points up to 28.6 miles upstream of the Washington Works Facility and downstream to the Letart Landfill were sampled for C-8.
- No samples collected from the Ohio River were found to exceed the C-8 drinking water screening level of 150 µg/l. The highest concentration detected was 1.04 µg/l.

Recommendations:

- No additional river sampling is recommended.

SURFACE WATER AND GROUNDWATER MONITORING:

This task included monitoring of the surface water and groundwater at the Washington Works Facility and the three landfills for four consecutive monthly events, followed by quarterly sampling thereafter.

DRY RUN LANDFILL:*Conclusions:*

- C-8 is believed to be migrating, via groundwater and surface water, from the C-8-containing waste that has been disposed of within the landfill.

- Groundwater flow is toward the west and toward the Dry Run valley at this site.
- C-8 concentrations measured within the one-mile radius of the site show that some off-site migration of C-8 may have occurred.
- The Dry Run Landfill is located within eight miles of the Washington Works Facility. The transport of C-8 via air emissions from the plant could potentially be the source of the very low concentrations of C-8 detected within the one-mile radius sampling area.
- There are no known complete exposure pathways for human receptors that exceed the C-8 drinking water screening level of 150 µg/l.

Recommendations:

- Surface water and groundwater monitoring should continue at this site. The groundwater sampling should continue to be quarterly, while the outfall sampling can be either monthly or quarterly, as required by the site's NPDES permit.
- The C-8 concentrations in wells DRMW-13A and DRMW-13A should be monitored, as these wells appear to be the most vulnerable (down-gradient portion of the C-8 plume).
- The C-8 concentrations at the Dry Run leachate discharge location should be monitored.

LETART LANDFILL:

Conclusions:

- C-8 is believed to be migrating via surface water transport from the C-8 containing waste that has been disposed of within the landfill.
- Groundwater flow in the A Zone, D-E Zones, C Zone, and F Zone at the Letart Landfill is towards the Ohio River, and is away from the private water supplies in this area. Groundwater flow in the F Zone (the deepest zone) is generally believed to be towards the Ohio River and away from the private water supplies in this area; however, there may be a groundwater flow divide on the upper and northwestern side of the landfill.
- The annual C-8 loading from groundwater to the Ohio River indicates a very low concentration in the river from the landfill, and this is supported by the very low concentrations of C-8 in the Ohio River downstream of the landfill. It is possible, however, that this loading is contributing to the presence of low C-8 concentrations in some of the down river community water systems.
- Air emissions are not a viable migration pathway from the landfill because there

are no air emissions at the Letart Landfill.

- There are three complete exposure pathways for human receptors that exceed the CATT-established C-8 drinking water screening level of 150 µg/l. These are: contact with either surface water runoff (at the Cap Runoff location), leachate discharged to surface water at the toe of the Letart Landfill, and the resulting wet-weather stream that discharges into the Ohio River. However, these exposure routes are limited because of the remote location of the landfill, the very steep terrain, and the wet-weather nature of the stream. In addition, the fencing around the site limits trespasser access to the area, and the use of health and safety plans, standing operating procedures, and personal protective equipment also limits C-8 exposure for the on-site workers.

Recommendations:

- Surface water and groundwater monitoring should continue at this site. The groundwater sampling should continue to be quarterly, while the outfall sampling can be either monthly or quarterly, as required by the site's NPDES permit.
- All three of the Zone A groundwater monitoring wells (LMW-1, LMW-7, and LMW-8) should be monitored for C-8 concentrations and groundwater flow direction.
- Zone F groundwater wells LMW-2A and LMW-12 should be monitored for C-8 concentrations and groundwater flow direction.

LOCAL LANDFILL:

Conclusions:

- C-8 is believed to be migrating via surface water transport from the C-8 containing waste that has been disposed of within the landfill.
- Groundwater flow from the Local Landfill is toward the northwest at this site and toward the Ohio River valley. Flow is also towards the Washington Works Facility.
- C-8 detected within the one- and two-mile radius sampling areas near the Washington Works Facility and Local Landfill is likely to have been transported from the plant via air emissions.
- There are no known complete exposure pathways for human receptors that exceed the C-8 Assessment of Toxicity Team (CATT)-established C-8 drinking water screening level of 150 µg/l.

Recommendations:

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- Surface water and groundwater monitoring should continue at this site. The groundwater sampling should continue to be semi-annually, while the outfall sampling can be either monthly or quarterly, as required by the site's NPDES permit.
- Three locations at the Local Landfill should be monitored: Outlet 101, Outlet LM1, and well LLMW-4.

WASHINGTON WORKS FACILITY:*Conclusions:*

- The on-site Solid Waste Management Units (SWMUs) are believed to be the primary source of C-8 migration into the groundwater.
- Air deposition of C-8 onto the ground surface and its subsequent migration into the groundwater may also have occurred.
- No off-site migration of the groundwater is occurring, as long as DuPont's Western Well Field continues pumping.
- Some limited groundwater may migrate off-site in the northwest corner of the DuPont facility in response to the GE plant pumping their wells #3 and #4.
- Air emissions are believed to be the primary migration pathway of C-8 from the Washington Works Facility to adjacent areas in Ohio.
- Air emissions of C-8 from the Washington Works Facility are believed to be the source of C-8 detected in areas of West Virginia located adjacent to the facility and the Local Landfill.
- Air emissions of C-8 and the discharge of C-8 through the outfalls are believed to be the migration pathways of C-8 from the facility to the Ohio River, and—most likely—from the river to the public water supplies located downstream.
- Air emissions of C-8 from the plant are believed to be the source for C-8 along the Ohio River upstream of the plant.
- There are no known complete exposure pathways for human receptors that exceed the CATT-established C-8 drinking water screening level of 150 µg/l at the Washington Works Facility.

Recommendations:

- Surface water and groundwater monitoring should continue at this site. The groundwater sampling should continue to be quarterly, while the outfall sampling can be either monthly or quarterly, as required by the site's NPDES permit.

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- The following groundwater monitoring wells and outfalls require further monitoring at the Washington Works Facility: RO4-MW02, PO4-MW-2, QO4-MW02, VO5-PW01, NO4-MW-01, and Outfall 005.

It is important that DuPont further investigates the high concentrations of C-8 in these wells, which are located at the Washington Works Facility adjacent to the Ohio River. DuPont has stated (in their February 2003 *Summary Report*) that C-8 is confined to a perched aquifer and that the deeper aquifer contains no C-8.

TASK C:

Task C required the determination of the vertical and horizontal extent of any and all C-8 impacted groundwater exceeding 1 µg/l. This task also included an assessment of C-8 impacted surface water and/or groundwater at the Letart Landfill and its impact on the Ohio River and nearby public water systems along the river.

GROUNDWATER MODELING:

Groundwater modeling of the Washington Works Facility and surrounding area was conducted to evaluate the groundwater flow pathways and determine the potential of C-8 migration to off-site receptors.

Conclusions:

- The Ohio River creates a groundwater divide in the Pleistocene alluvium under the river. As a result of production-well pumping at the Dupont Washington Works Facility and the neighboring GE facility, the C-8-impacted groundwater from the Washington Works Facility is not being drawn into either the Lubeck PSD municipal well field in West Virginia or the Little Hocking Water Association well field in Ohio. Some limited groundwater may migrate off-site in the northwest corner of the DuPont facility in response to GE pumping wells #3 and #4. Sources of C-8, for the Lubeck PSD and the Little Hocking Water Association, are coming from the Ohio River and dispersion by air.

Recommendation:

- The URS Diamond model should be accepted as representing real-world conditions in determining groundwater flow and contaminant transport.

WEST VIRGINIA PUBLIC WATER SUPPLY SOURCES

Public Water Supply Sources (PWSSs) in West Virginia along the Ohio River were sampled at various points upstream and downstream of the DuPont Washington Works Facility pursuant to the Consent Order. Initial sampling of PWSSs within a one-mile upstream and ten miles downstream of the facility began in December 2001. Based on the C-8 concentrations measured, the sample area was expanded to include PWSs located as far as seven miles upstream of the facility and 54 miles downstream. Sampling efforts between January 2002 to March 2003 resulted in the following findings:

Public Water System	River Miles from Washington Works	Sampling Dates	Well Field Results (C-8 $\mu\text{g/l}$)	Distribution System Results (C-8 $\mu\text{g/l}$)
Parkersburg Water Department	-7	Mar and Apr 2002	Well #1: 0.0686 to 0.0746 Well #2: ND Well #3: ND Well #4: ND Well #5: ND	NQ
Blennerhassett Island State Park	-1	Jan 2002	Well #1: 0.165	Not tested
DuPont Washington Works Facility	0	Jan 2002 Mar 2003	AM07-PW01: NQ to 0.335 AO08-PW01: 0.308 to 0.499 AX13-PW01: 0.721 to 1.42	Not tested
General Electric	1.5	Jan, Feb, and Apr 2002	Well #3: 1.75 to 1.87	Not tested
Lubeck PSD	4.5	Jan 2002 to Feb 2003	Well A: 0.683 to 0.938 Well B: 0.443 to 0.61 Well C: 0.398 to 0.592 Well D: 0.397 to 0.758 Well E: 0.332 to 1.21 Well F: 0.283 to 1.04	0.6 to 0.69
Bellville Hydro Electric Recreation	14	Jan 2002	Not tested	ND
Ravenswood Municipal Water Works	31	Mar 2002	Well #1: ND Well #2: ND Well #3: ND Well #4: ND Well #5: ND	NQ
Mason County PSD—Letart	45	Jan, Mar, and Apr 2002	Well #1: NQ Well #2: 0.0618 to 0.0838 Well #3: 0.063 to 0.102	Not tested

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Racine Locks and Dam	48	Jan 2002	Not tested	0.518
New Haven Water Department	54	Apr 2002	Well #1: NQ	ND

- * A negative stream mile value refers to a location upstream from the Washington Works Facility. A positive number refers to a location downstream from that facility.
- ** ND refers to a "Non Detect" concentration that is at or below the laboratory's minimum detection limit. The listed concentration can vary by instrument and time; however, the Non Detect concentration for C-8 for this period of time is 0.01 µg/l.
- *** NQ refers to "Not Quantifiable." It is a concentration that is below the laboratory's minimum detection limit and is therefore below the level of quantification. The Not Quantifiable concentration for C-8 for this period of time is 0.05 µg/l.

Upon completion of the C-8 Assessment of Toxicity Team (CATT) study establishing a drinking water screening level of 150 µg/l for C-8, sampling efforts were discontinued for General Electric, Parkersburg Water Department, Blennerhassett Island State Park, Bellville Hydro Electric Recreation Plant, Ravenswood Municipal, Mason County PSD—Letart, Racine Locks and Dam, and New Haven Water Department based on the measured low concentrations. Sampling was continued at the DuPont Washington Works Facility and Lubeck PSD on a quarterly basis to continue to evaluate trends in C-8 concentrations.

CONCLUSIONS:

The completion of the groundwater studies and sampling efforts performed as a part of the C-8 GIST study have resulted in the following conclusions regarding the source of C-8 in the West Virginia PWSSs:

- *Parkersburg Water Department and Blennerhassett Island State Park:* It is believed that the C-8 levels are transported from the DuPont Washington Works Facility via air emissions. Please note that C-8 transported in air emissions and deposited on surfaces is likely to be mobilized by precipitation and migrate via water transport to surface and/or groundwater.
- *DuPont Washington PSD:* It is believed that the C-8 levels are transported via air emissions, and from groundwater migration from C-8-containing materials in the on-site Solid Waste Management Units at the Washington Works Facility.
- *General Electric:* It is believed that the C-8 levels are transported from the DuPont Washington Works Facility via air emissions associated with the infiltration of precipitation or from production-well-induced recharge from the Ohio River impacted with wastewater discharges from the DuPont Washington Works Facility.
- *Lubeck PSD:* It is believed that the C-8 levels are associated with pumping-induced recharge of surface water from the DuPont Washington Works Facility's wastewater discharges to the Ohio River and possibly via air deposition.

- *Mason County PSD—Letart*: It is believed that the C-8 levels are derived from pumping-induced recharge of surface water from DuPont Washington Works Facility's wastewater discharges to the Ohio River.
- *Racine Locks and Dam*: It is believed that the C-8 levels are derived by pumping-induced recharge of surface water from the DuPont Washington Works Facility and/or the Letart Landfill leachate discharges to the Ohio River.

RECOMMENDATIONS:

Considering this data, it is the GIST's recommendation that DuPont continue the following for the PWSSs:

- *Lubeck PSD, DuPont Washington Works Facility, and General Electric*: Quarterly sampling of wells for two years to ensure that C-8 levels are being maintained or reduced. Conduct a limited field investigation to determine the extent and concentration of C-8 in soil at the Lubeck PSD in the vicinity of their production wells. When the soil sample results are available and the data is evaluated, the GIST will determine what additional sampling activities are necessary to complete the investigation. DuPont will submit a report documenting the sampling investigation and the C-8 results to the GIST when the results are finalized. After two years, the sampling program will be re-evaluated.
- *Blennerhassett Island State Park and Mason County PSD—Letart*: Annual sampling for a two-year period to ensure C-8 levels are being maintained or reduced. After two years, the sampling program will be re-evaluated.
- *Racine Lock and Dam*: Annual sampling for a two-year period to evaluate levels of C-8 due to the upstream proximity of the Letart Landfill, and to ensure that C-8 levels are being maintained or reduced. After two years, the sampling program will be re-evaluated.
- *Parkersburg Water Department, Bellville Hydro Electric Recreation Plant, Ravenswood Municipal Water Works, and New Haven Water Department*: No further action is deemed necessary at this time.