

**RESULTS OF 1997-1998 SITE-WIDE
GROUNDWATER MONITORING AT THE FORMER
PLUM BROOK ORDNANCE WORKS**

**AS REPORTED IN THE DRAFT SUMMARY REPORT
SITE-WIDE GROUNDWATER INVESTIGATION**

Presented to the Restoration Advisory Board

May 12, 1999



Purpose and Objectives

- Determine if hazardous substances are present in groundwater at concentrations that may constitute unacceptable risk to human health and the environment
- Refine Site Conceptual Model
- Determine current and future routes of exposure as part of a site conceptual exposure model

NOTE: Summary Report Site-Wide Groundwater Monitoring (1997-1998) issued as Draft in February 1999. Therefore, findings, recommendations, and conclusions presented herein are subject to revision.



Scope of the Site-Wide GW Investigation

■ Monitoring Well Installation

- Install 3 overburden and 8 bedrock monitoring wells
- One proposed overburden well was dry

■ Groundwater Level Measurements

- Quarterly measurements of 58 overburden wells and 19 bedrock wells

■ Groundwater Sampling

- Semi-annual sampling of 38 overburden and 17 bedrock monitoring wells (November 1997 & May 1998)



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Groundwater Level Measurements

■ Four Quarterly Measurement Events Completed

- August & November 1997
- February & May 1998

→ Two Water-Bearing Zones Monitored

- Overburden Water-Bearing Zone
- Bedrock Water-Bearing Zone
 - Ohio Shale
 - Olentangy Shale
 - Delaware Limestone



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Groundwater Level Measurements

■ Bedrock Water Level Measurements

- Groundwater flow is generally to the north-northeast with flow on the west side of the site toward a groundwater trough trending west to northeast
- Groundwater fluctuations between wells completed in the Ohio Shale and Olentangy Shale are very similar; greater water level fluctuations were observed in wells completed in the Delaware Limestone
 - Fluctuations in the Delaware Limestone possibly attributed to groundwater extraction from sump wells in the Reactor Building and formation heterogeneity
- Hydraulic conductivity ranges from 0.03 ft/day to 22.2 ft/day with a geometric mean of 0.35 ft/day in eight bedrock wells



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Bedrock Groundwater Elevation Contour Map



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Groundwater Level Measurements

■ Overburden Water-Bearing Zone

- Groundwater flow in the overburden generally mirrors surface topography with the predominant flow direction to the north-northeast
- Groundwater fluctuations in the overburden wells are very similar possibly implying a certain degree of connectivity between site wells.



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Groundwater Level Measurements

■ Overburden Water-Bearing Zone (continued)

- Hydraulic conductivity ranges from 0.74 ft/day to 212 ft/day with a geometric mean of 8.75 ft/day.
- Similar groundwater elevations in the overburden and bedrock water bearing zones were observed in the eastern and southern portions PBOW indicating a higher degree of connectivity between overburden and bedrock water bearing zones.



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Overburden Groundwater Elevation Contour Map



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Risk-Based Screening Concentrations (RBC)

- RBCs are a screening tool
 - Determine need for additional investigation/assessment
 - Identify Chemicals of Potential Concern for Risk Assessment
- PBOW RBCs adapted from published EPA Region 3 RBCs using lifetime excess cancer risk of 10^{-6} and hazard index (HI) of 0.1 (published RBCs use cancer risk of 10^{-6} and HI of 1.0)
- RBCs do not replace human health or ecological risk assessments
- Risk Based Screening Criteria derived from EPA Region IX Preliminary Remediation Goals currently proposed to replace RBCs.



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Groundwater Sampling Results

■ Sampled Areas

- West Area Red Water Ponds Area (5 overburden / 1 bedrock)
- Pentolite Road Red Water Ponds Area (4 / 1)
- TNT Area A (5 / 2), TNT Area B (2 / 2), TNT Area C (6 / 1)
- Acid Area 1 (2 / 2), Acid Area 2 (3 / 2), Acid Area 3 (1 / 1)
- Burning Grounds (5 / 2)
- Upper Toluene Tank Area (1 / 1)
- Lower Toluene Tank Area (2/0)
- Reactor Facility (1 / 1)
- PB-BED-GW020 (0 / 1)
- IT-MW01 (1/0)



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Site-Wide RBC Exceedances

| Site | Water Bearing Zone | Number of Wells Exceeding RBCs/Total Number of Wells | | | | | |
|--------------------------------|--------------------|--|------------|---------------|------------------|---------|---------|
| | | VOCs | SVOCs | Nitroaromatic | Dissolved Metals | Cyanide | Nitrate |
| West Area Redwater Ponds | Overburden | 0/5 | 3/5 | 2/5 | 5/5 | 1/5 | 1/5 |
| | Bedrock | 1/1 | 1/1 | 0/1 | 0/1 | 1/1 | 1/1 |
| Pentolite Road Red Water Ponds | Overburden | 2/4 | 3/4 | 3/4 | 4/4 | 3/4 | 3/4 |
| | Bedrock | 1/1 | 1/1 | 0/1 | 1/1 | 0/1 | 0/1 |
| TNT Area A | Overburden | 0/5 | 1/5 | 1/5 | 5/5 | 0/5 | 0/5 |
| | Bedrock | 2/2 | 0/2 | 1/2 | 2/2 | 0/2 | 0/2 |
| TNT Area B | Overburden | 0/2 | 0/2 | 1/2 | 2/2 | 0/2 | 0/2 |
| | Bedrock | 1/2 | 0/2 | 0/2 | 2/2 | 0/2 | 0/2 |
| TNT Area C | Overburden | 0/6 | 2/6 | 0/6 | 6/6 | 0/6 | 2/6 |
| | Bedrock | 1/1 | 1/1 | 0/1 | 1/1 | 0/1 | 0/1 |
| Acid Areas | Overburden | 2/6 | 1/6 | 0/6 | 2/6 | 0/6 | 0/6 |
| | Bedrock | 3/5 | 3/5 | 3/5 | 5/5 | 0/5 | 0/5 |
| Burning Grounds Areas | Overburden | 1/5 | 1/5 | 0/5 | 5/5 | 0/5 | 0/5 |
| | Bedrock | 0/2 | 0/2 | 0/2 | 2/2 | 0/2 | 1/2 |
| Lower Toluene Tank Area | Overburden | 0/2 | 1/2 | 0/2 | 2/2 | 0/1 | 0/1 |
| | Bedrock | 1/1 | 1/1 | 0/1 | 1/1 | 0/1 | 0/1 |
| Upper Toluene Tank Area | Overburden | 1/1 | 1/1 | 0/1 | 1/1 | 0/1 | 0/1 |
| | Bedrock | 1/1 | 1/1 | 0/1 | 1/1 | 0/1 | 0/1 |
| Reactor Facility | Overburden | 0/1 | 0/1 | 0/1 | 0/1 | 0/1 | 0/1 |
| | Bedrock | 1/1 | 1/1 | 0/1 | 1/1 | 0/1 | 0/1 |
| IT-MW01 | Overburden | 0/1 | 0/1 | 0/1 | 1/1 | 0/1 | 0/1 |
| Southeast Bedrock Well | Bedrock | 1/1 | 0/1 | 0/1 | 1/1 | 0/1 | 0/1 |



RBC exceedances indicated by bold/red



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Map of Site-Wide Groundwater Analytical Results



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Conclusions

■ Overburden Water Bearing Zone

→ Organic Contaminants (VOCs, SVOCs)

- Acid Area 1, Acid Area 3, and the Reactor Building do not exhibit impacts of organic compounds from past site activities
- TNT B, TNT C, Burning Grounds Areas, and Lower Toluene Area exhibited sporadic exceedances of organics; however, these detections are not necessarily site related.
- TNT A exhibited one SVOC that warrants further evaluation to determine if it is site related.
- The Maintenance Area and Upper Toluene Area have been impacted by VOCs from past site activities.



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Conclusions

■ Overburden Water-Bearing Zone (continued)

→ Nitroaromatic Contaminants

- TNT A and TNT B have been impacted by low levels of nitroaromatics
- Pentolite Road and Red Water Ponds Areas exhibited the highest concentrations of nitroaromatics from previous site activities.



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Conclusions

■ Overburden Water Bearing Zone (continued)

→ Metals

- Acid Area 2, the Maintenance Area, and the Reactor Facility did not exhibit dissolved metals at concentrations above RBCs.
- TNT C, Acid Area 3, the Additional Burning Ground, the Snake Road Burning Ground and the Upper Toluene Area exhibited dissolved iron, manganese, and/or nickel at concentrations exceeding RBCs.
- Acid Area 1 and the Lower Toluene Area exhibited dissolved iron and manganese at concentrations exceeding RBCs
- TNT A, TNT B, the West Area Red Water Ponds and Pentolite Road Red Water Ponds exhibited larger suites of metals than other sites
- Detected metals concentrations are believed to be naturally occurring but require additional study to confirm



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Conclusions

■ Bedrock Water-Bearing Zone

→ Organic Contaminants (VOCs, SVOCs)

- Natural petroleum and corresponding low levels of BTEX constituents are prevalent in bedrock across much of the site
- The Additional Burning Ground and G-8 Burning Grounds do not exhibit organics at levels exceeding RBCs
- The Pentolite Road Red Water Pond, TNTA, TNTC, Acid Area 2 and the Upper Toluene Tanks Area exhibited benzene and/or toluene at concentrations exceeding RBCs
- West Area Red Water Pond and the Upper Toluene Tank Area exhibited two or more SVOCs at concentrations exceeding RBCs.
- Sporadic detections of bis(2-ethylhexyl)phthalate require additional study to determine if it is site related or a sampling artifact



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Conclusions

■ Bedrock Water-Bearing Zone

→ Nitroaromatic Contaminants

- TNT A, Acid Areas 1 and 2, the Maintenance Area, and the West Area Red Water Ponds exceeded RBCs

→ Metals

- Dissolved barium and manganese exceeded RBCs in most areas of PBOW.
- Arsenic, iron, thallium, and vanadium were detected at concentrations exceeding RBCs

→ Cyanide

- Cyanide exceeded RBCs at the West Area Red Water Ponds



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