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.

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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
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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