Battlefield Golf Club Hydrogeological Investigation

CDM

March 16, 2011

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Overview

- **2002 to 2007** - Construction of Battlefield Golf Club
- **7/2008** - City Requests Assistance from US EPA
- **8/2008 & 9/2008 -** City Hires Consultants For Water Supply Feasibility Study and Groundwater Modeling
- **7/2009 to 11/2009** - Field Investigations
- **9/2009 -** Bids Received for Construction of Centerville Water Main
- **12/2009 -** Dominion Post-Construction Ash Fill, Soil Cover and Groundwater Evaluation Report Issued

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Overview

- **3/2010** - Bids Received for Construction of Murray/Whittamore WM
- **4/2010 –** EPA Final Site Inspection Report Issued
- **7/2010** - City Water Available along Centerville Turnpike/Fentress
- **11/2010** - City Water Available along Murray Drive
- **1/2011** - City Water Available along Whittamore Road
- **3/2011 -** 22 Hook-Ups to City Water made to date

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CDM's Role

- Assess groundwater quality
- Develop a groundwater model
- Assess the potential migration of constituents leached from fly ash
- Study involved many scientific disciplines
- Study does not address Health Impacts

Study focused on groundwater -
Will contaminants leach into the groundwater and, if so, could they migrate off site?

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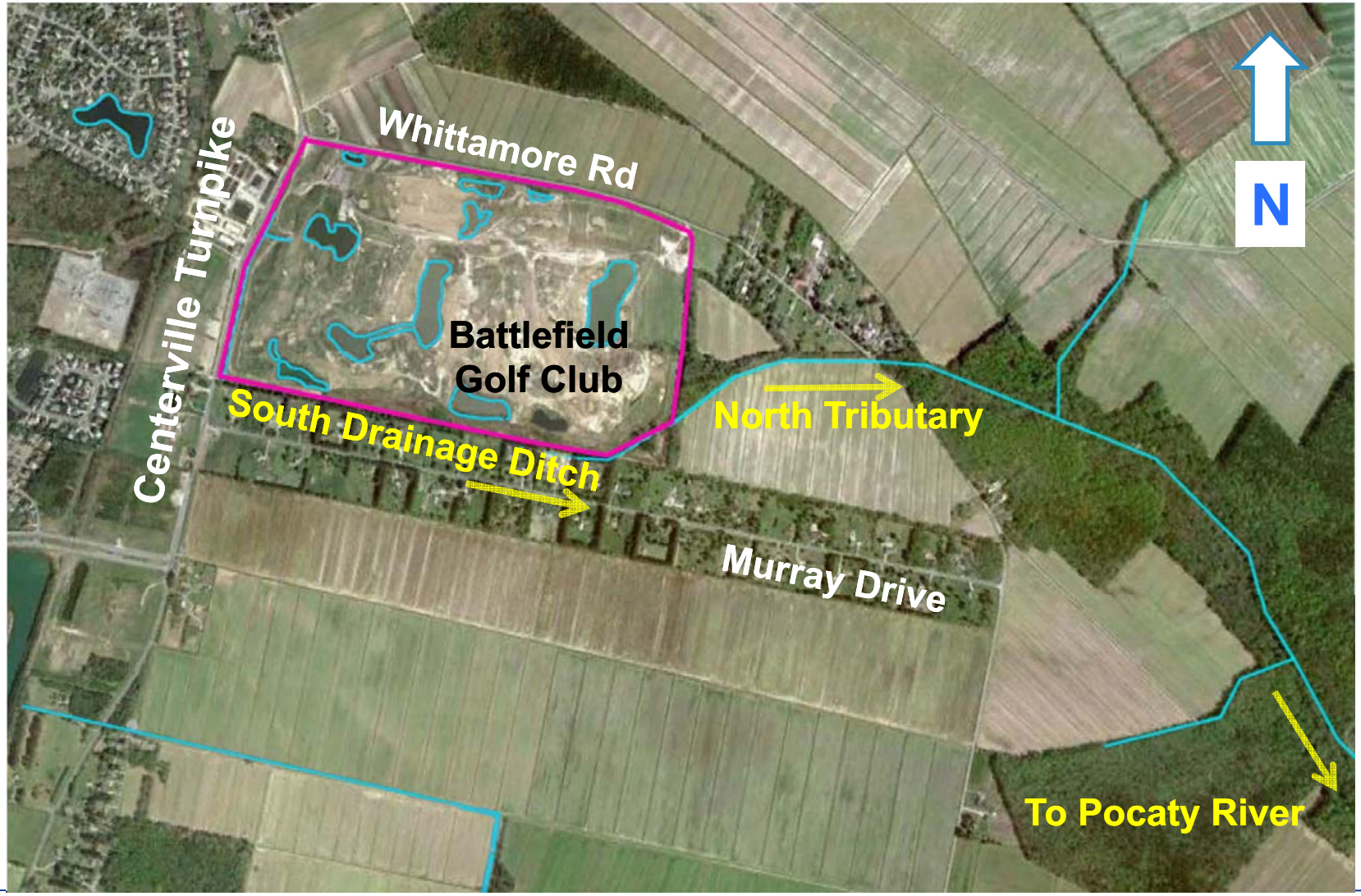
Site Map/Surface Drainage



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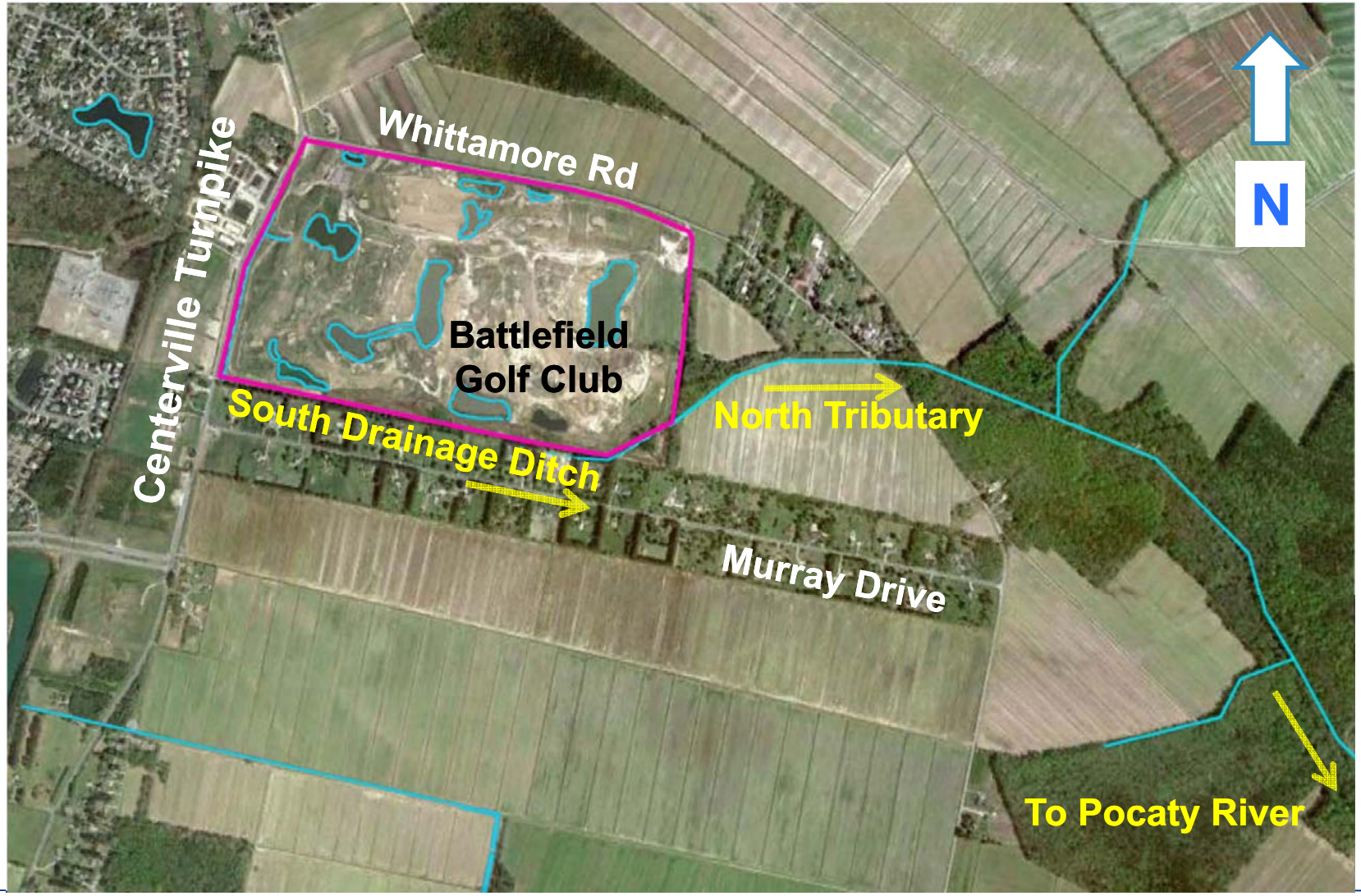
Site Map/Surface Drainage



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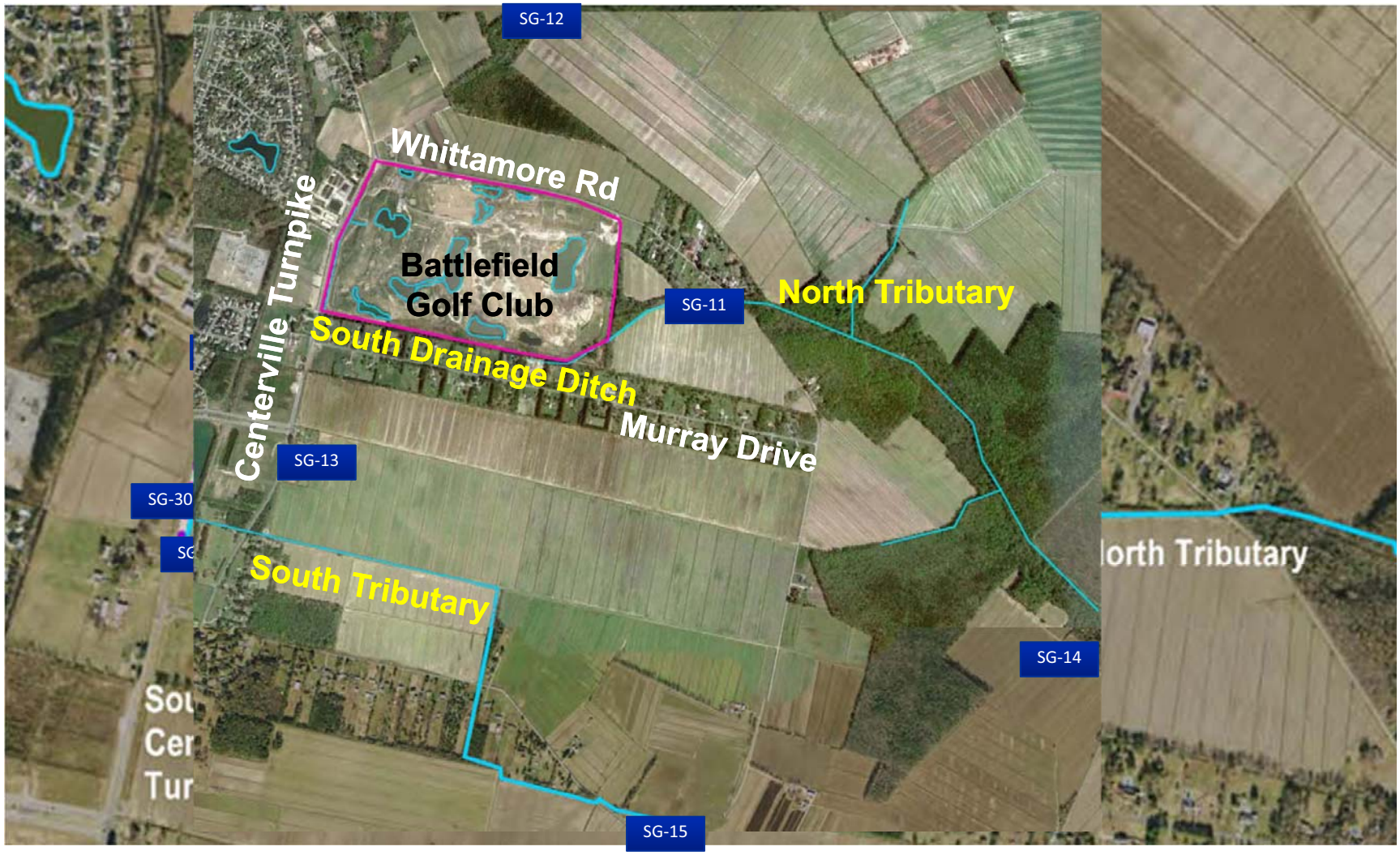
Surface Water Monitoring



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Surface Water Quality Sampling

- 33 Surface Water Sampling Locations
  - On Site
  - Nearby Site
  - USGS Regional Network
- >1,300 Analytical Results

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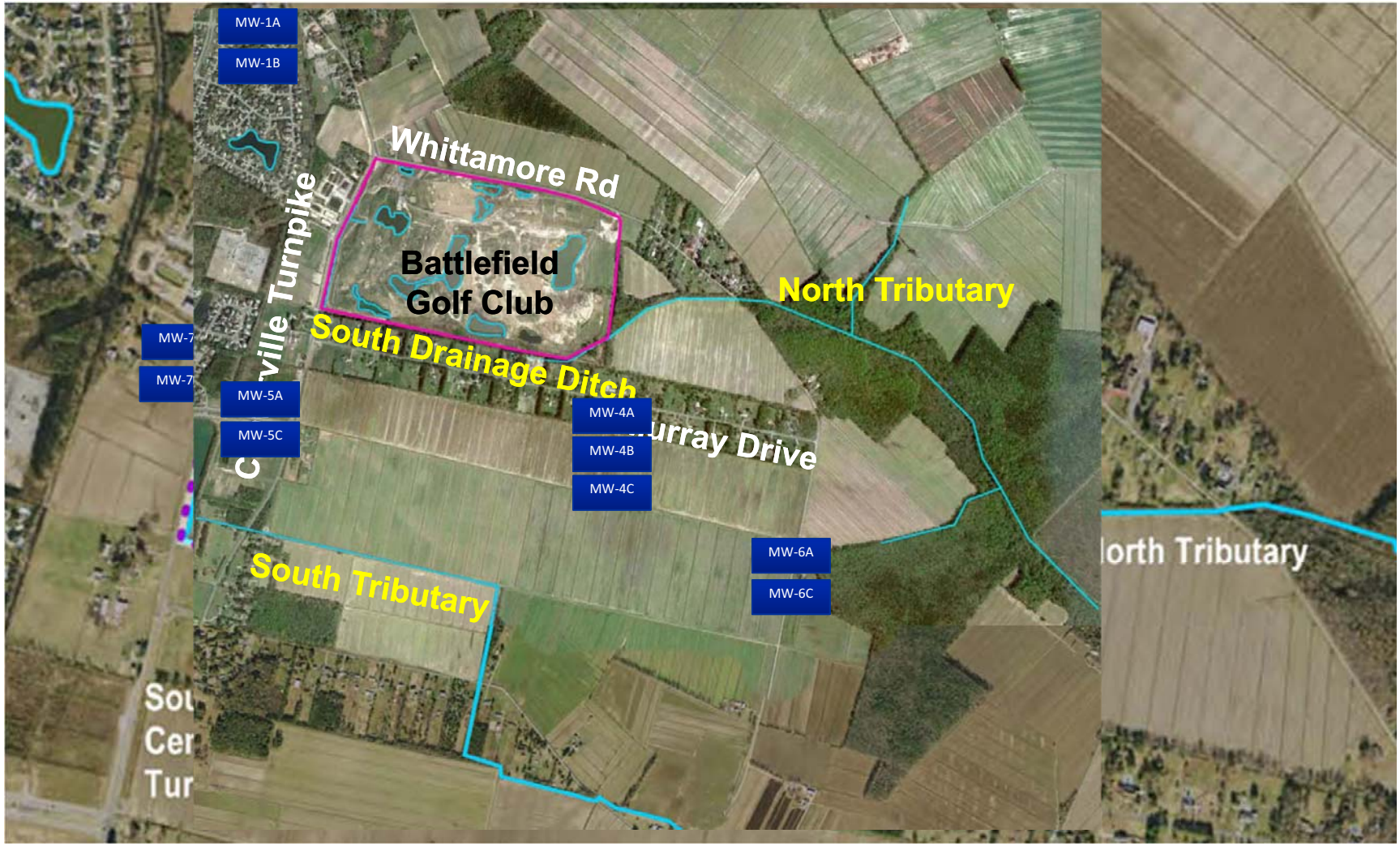
Ground Water Monitoring



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Groundwater Water Quality Database

- 128 Groundwater Sample Locations
  - 48 Monitoring Wells
  - 80 Residential Wells
  - >4,100 Analytical Results

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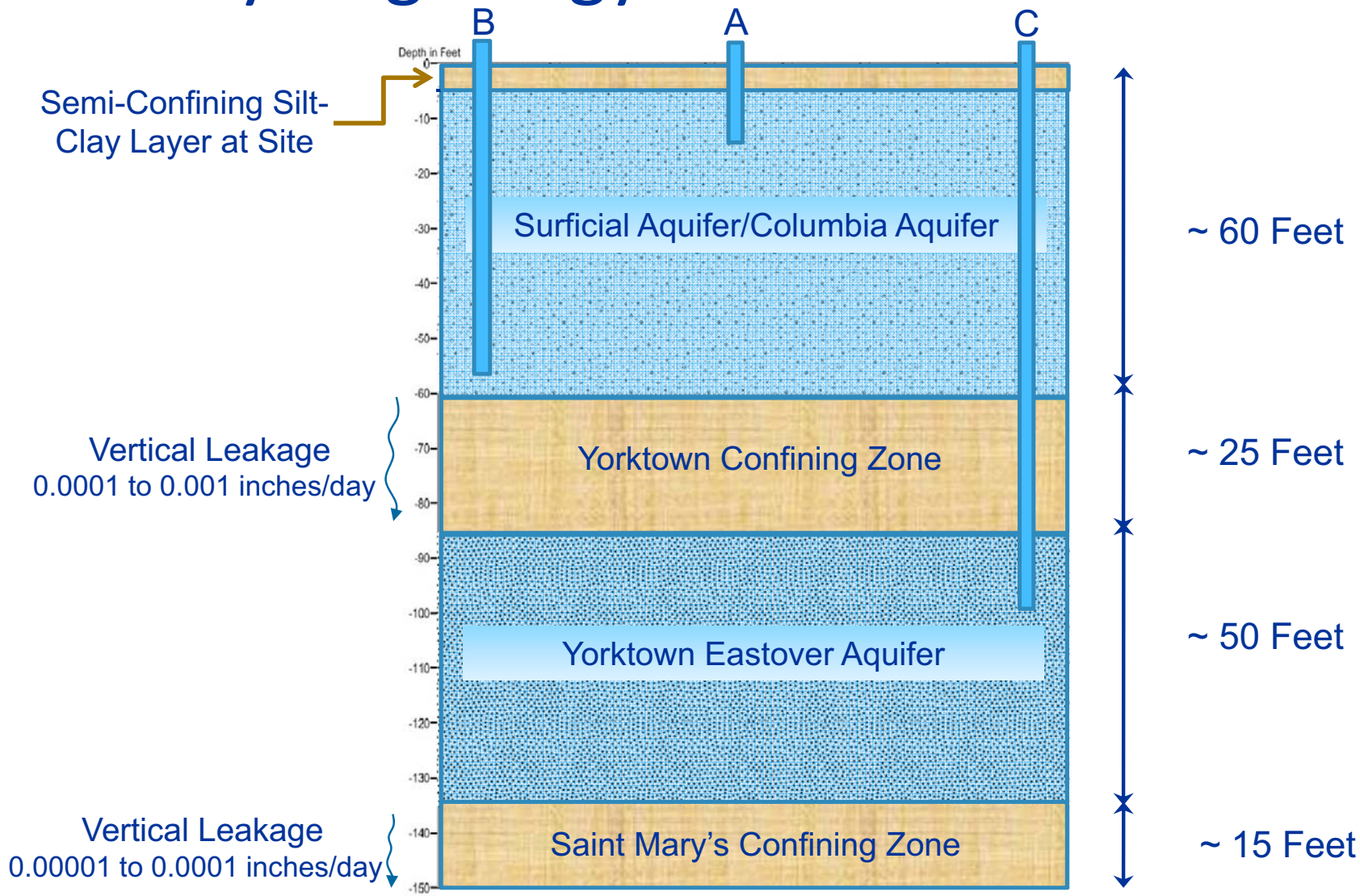
Site Hydrogeology



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Fly Ash Locations

Fly Ash

- 92.4 acres
- 1.5 million tons
- Locations taken from Construction Plans

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Fly Ash Leachate Constituents

COMPARED

Baseline Levels	On-site Shallow Wells & Ponds Levels
• Residential Wells • Off-site Monitoring Wells • Upgradient Monitoring Wells • On-site Monitoring Wells (At the Base of the surficial aquifer) • Off-site Surface Water Samples	

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Fly Ash Leachate Constituents

- 27 Initially Analyzed
- 12 Not found at levels above baseline levels
- 5 Showed no influence on groundwater
- 10 Showed possible influence on groundwater

Aluminum	*Nickel*
Ammonia	*Nitrate*
Iron	*Nitrite*
Magnesium	*Sulfate*
Manganese	*Zinc*

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Hydraulic Model

- DYNFLOW/DYNTRACK
  - Developed over the past 20 years
  - Applied to >200 groundwater modeling studies in the US
  - Reviewed and tested by the International Groundwater Modeling Center
  - EPA-Accepted Model
- Site Specific Model
  - Applied USGS Regional Model Data
  - Predictions based on scientific assumptions and data collected to date

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Groundwater Withdrawals

- 63 known residential wells in the site vicinity
- 17 known well depths
- 46 remaining wells conservatively assumed to pump from the surficial aquifer
- Assumed continuous pumping at typical City of Chesapeake residential water use rate (0.45 gpm or 650 gpd)

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Modeling Parameters

- Migration of Fly Ash Constituents Examined for 200 Years in the Future
- Two Constituents Picked to Represent the Range of Effects Expected from the Fly Ash
  - Arsenic
  - Nitrate

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Modeling Parameters

- Arsenic
  - *Although high background levels can be found in ambient groundwater*
  - *Low Federal Maximum Contaminant Level (0.01 mg/l)*
  - *Moderate mobility in groundwater*
  - *Will leach from the fly ash for a longer period of time*

Modeling Parameters

- Nitrate
  - *Potential for elevated levels (10 mg/l)*
  - *High mobility in groundwater*
  - *Will leach relatively quickly compared to other constituents*

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Hydraulic Findings

- Regional Groundwater Flow in the surficial aquifer is to the southeast
- Continuous water table exists between monitoring wells and South Drainage Ditch
- Continuous water table exists between some on-site Golf Course ponds and the South Drainage Ditch

Modeling Results

- Arsenic
  - Typically it could take ~20 years to migrate into the upper surficial aquifer,
  - Could take up to 100 years to exceed drinking water MCL
  - Once in the surficial aquifer, flow is influenced by the South Drainage Ditch,
  - Little or no arsenic migrates to the deeper portions of the surficial aquifer or to off-site locations
  - Source likely to continue for 200 or more years

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Modeling Results

- Nitrate
  - Represents the maximum distance constituents would travel from the site,
  - Maximum concentration likely to appear in ~ 5 years in the upper surficial aquifer,
  - Depletes much more rapidly than arsenic or other metals – a few decades,
  - Similar results as Arsenic –
    - Slightly deeper migration into the surficial aquifer
    - Ultimately discharges to the South Drainage Ditch

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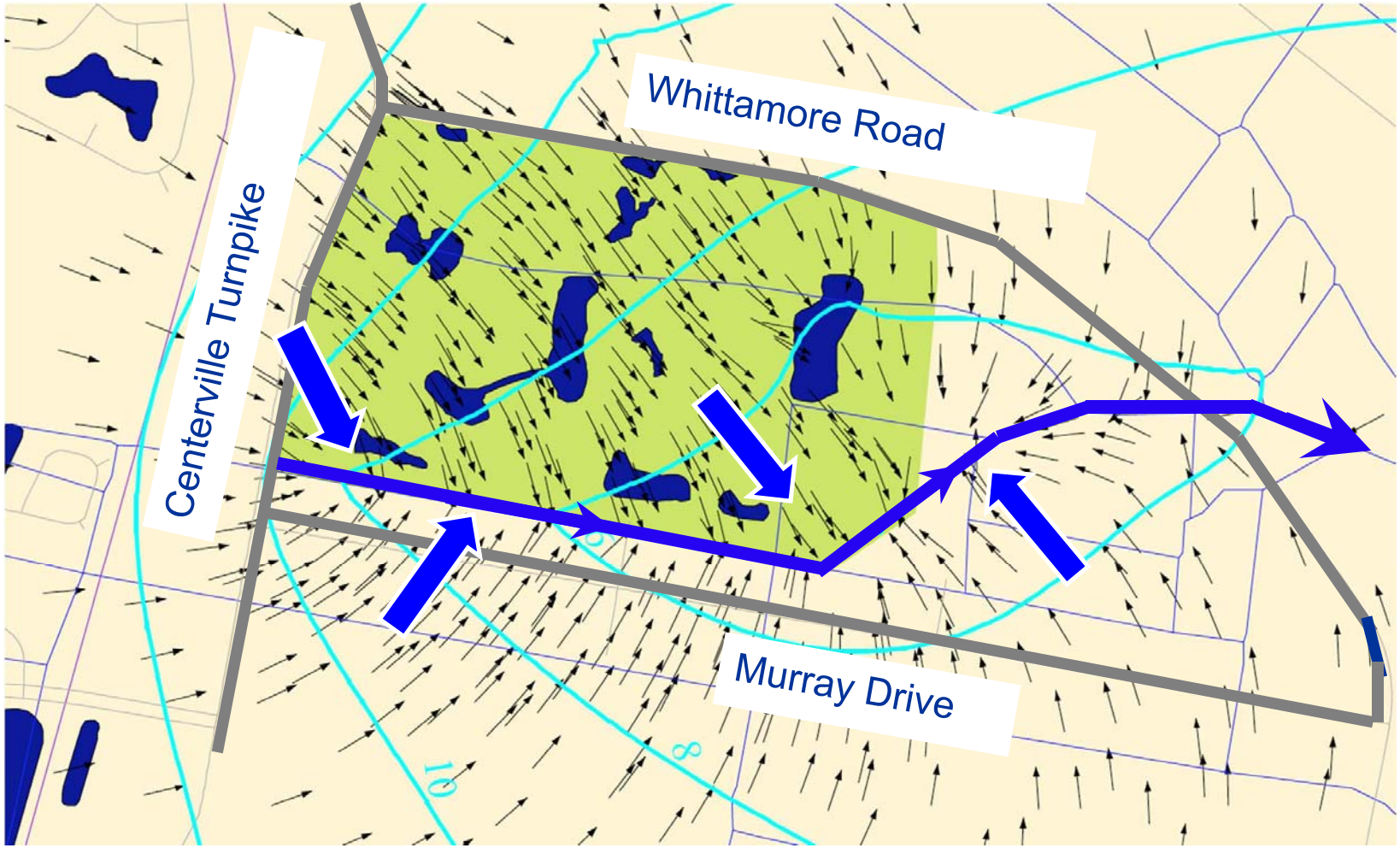
Groundwater Flow – Surficial Aquifer



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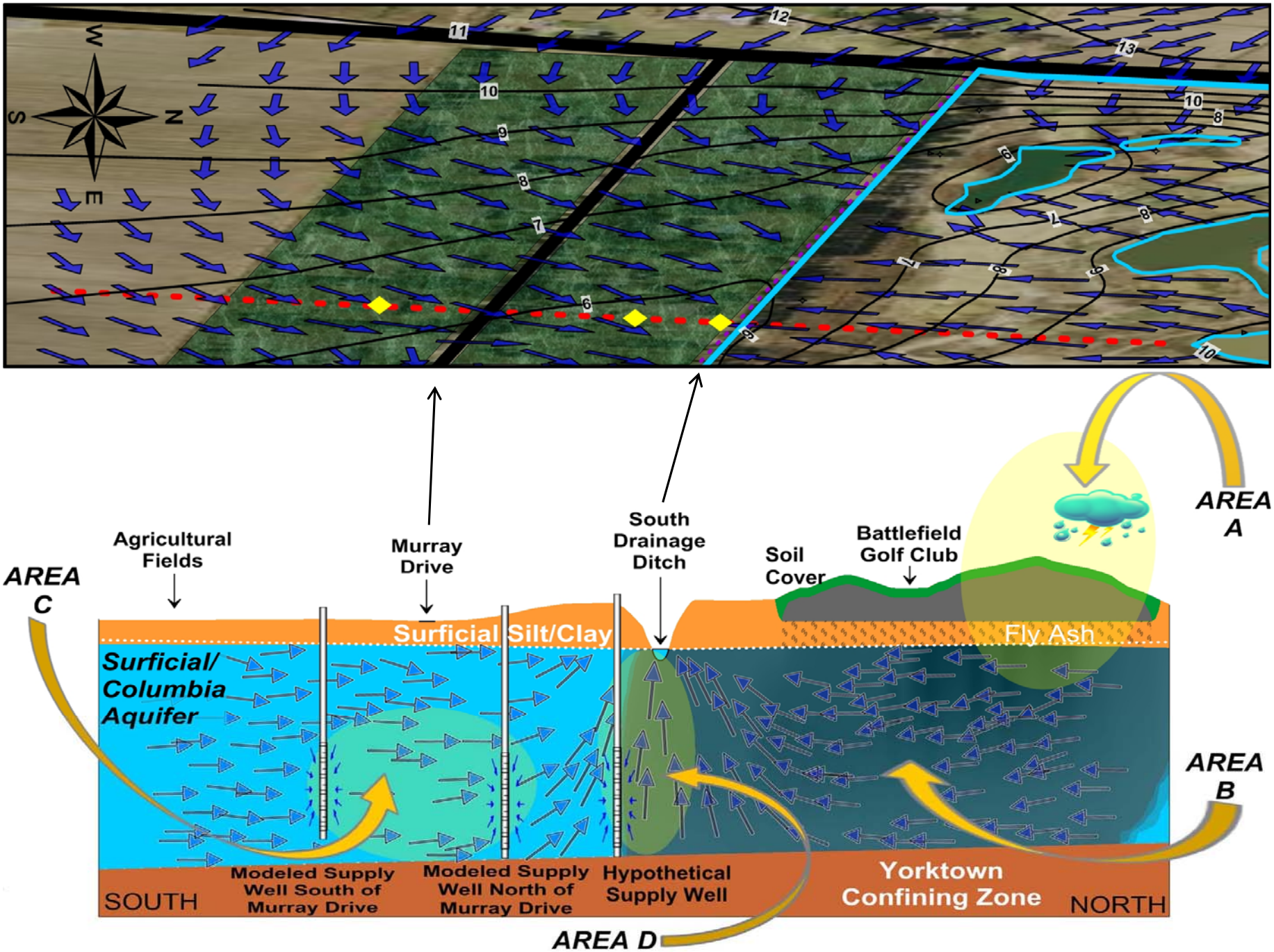
W
S
N
E
11
12
13
10
9
8
7
6
AREA A
AREA B
AREA C
AREA D
Agricultural Fields
Murray Drive
South Drainage Ditch
Soil Cover
Battlefield Golf Club
Surficial Silt/Clay
Fly Ash
Surficial/ Columbia Aquifer
Modeled Supply Well South of Murray Drive
Modeled Supply Well North of Murray Drive
Hypothetical Supply Well
Yorktown Confining Zone
SOUTH
NORTH

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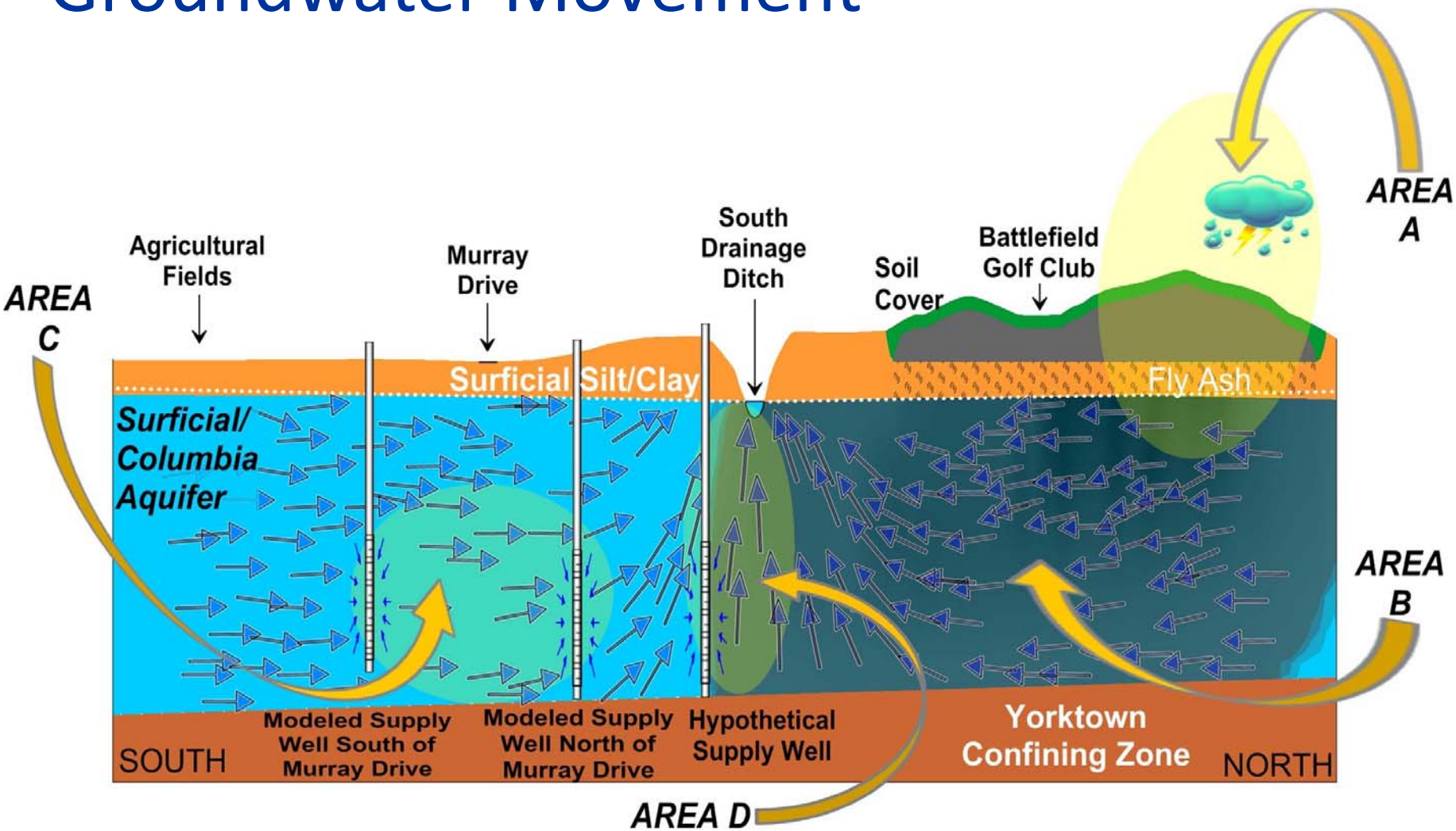
Groundwater Movement



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Conclusions

- Higher concentrations of constituents were found on-site in the upper surficial aquifer than offsite
- Plumes are expected develop under the site
- Groundwater flow from the site is primarily discharged to the South Drainage Ditch
- Local residential well pumping does not appear to have an appreciable impact on groundwater flow
- If a residential well(s) is actually located close to the ditch, it could be influenced by fly ash leachate in the future

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Conclusions (Continued)

- Maintenance of ditch is critical. Lack of ditch maintenance, prolonged drought, and/or lowering of the water table, may have future impact on hydraulics and constituent transport (contamination of the surficial water aquifer)
- Should soil cover above the fly ash erode in the future - higher infiltration rates would be expected
- Constituent concentrations found in the southwestern corner of the site should be further evaluated

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Action Items

- Evaluate human health and ecological impacts to surface water in the South Drainage Ditch and downstream
- Ensure long term maintenance of the South Drainage Ditch and fly ash cover
- Conduct site mitigation study (e.g. deepen/widen ditch)
- Review historical drought data

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Action Items

- Develop and implement a monitoring program to include:
  - Monitoring wells on south side of South Drainage Ditch
  - Surface water in South Drainage Ditch
  - Groundwater along golf course south boundary
  - Action levels for implementing contingency plans
- Further study of southwest corner of the site
- Evaluate potential land use restrictions

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