MRN/SWANA-MA 2019 CONFERENCE

THE CHANGING CLIMATE OF SOLID WASTE & RECYCLING

A Practical Approach for the 21st Century

BWI Marriott

Tuesday, June 11, 2019

Landfill Design Incorporating Resilience to Climate Change

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Principal Engineer

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Agenda

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We're familiar with discussing the impacts of waste management on climate change … but much less familiar with discussing the impacts of climate change on waste management!

This presentation will focus on:

- How climate change could impact landfill performance over the long term
- How to assess potential vulnerabilities
- How to adapt designs to make landfills more resilient

Simple case study example from the Eastern Shore

EPA Guidance (8pp. Factsheet)

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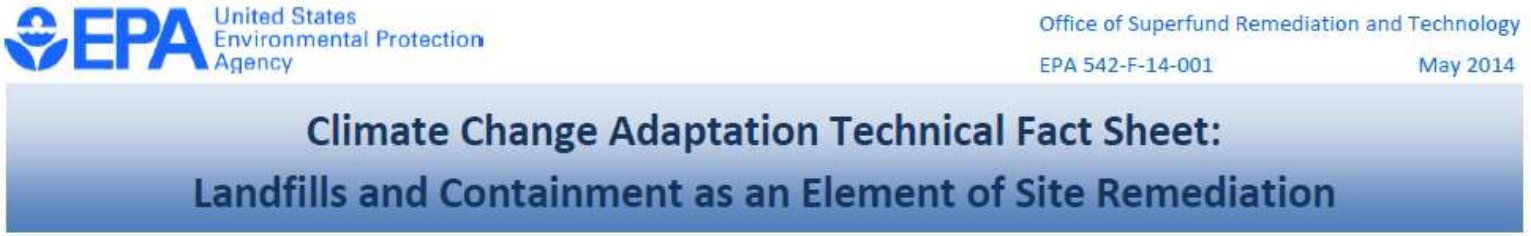

- Climate change adaptation for an existing or planned containment system should focus on:
  - Evaluating the system's vulnerability to climate change
  - Implementing adaptation measures, when warranted, to ensure the remedy continues to protect HHE
- The adaptation strategy should include monitoring of implemented measures, periodic re-evaluation of the system's vulnerability, and incorporating any needed changes.

https://semspub.epa.gov/work/11/175853.pdf

Climate Change Vulnerability Assessment

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EPA 542-F-14-001

Climate Change Impacts

Temperature:
- *Increased occurrence of extreme temperatures*
- *Sustained changes in average temperatures*
- *Decreased permafrost*

Precipitation:
- *Increased heavy precipitation events*
- *Increased flood risk*
- *Decreased precipitation & increasing drought*
- *Increased landslides*

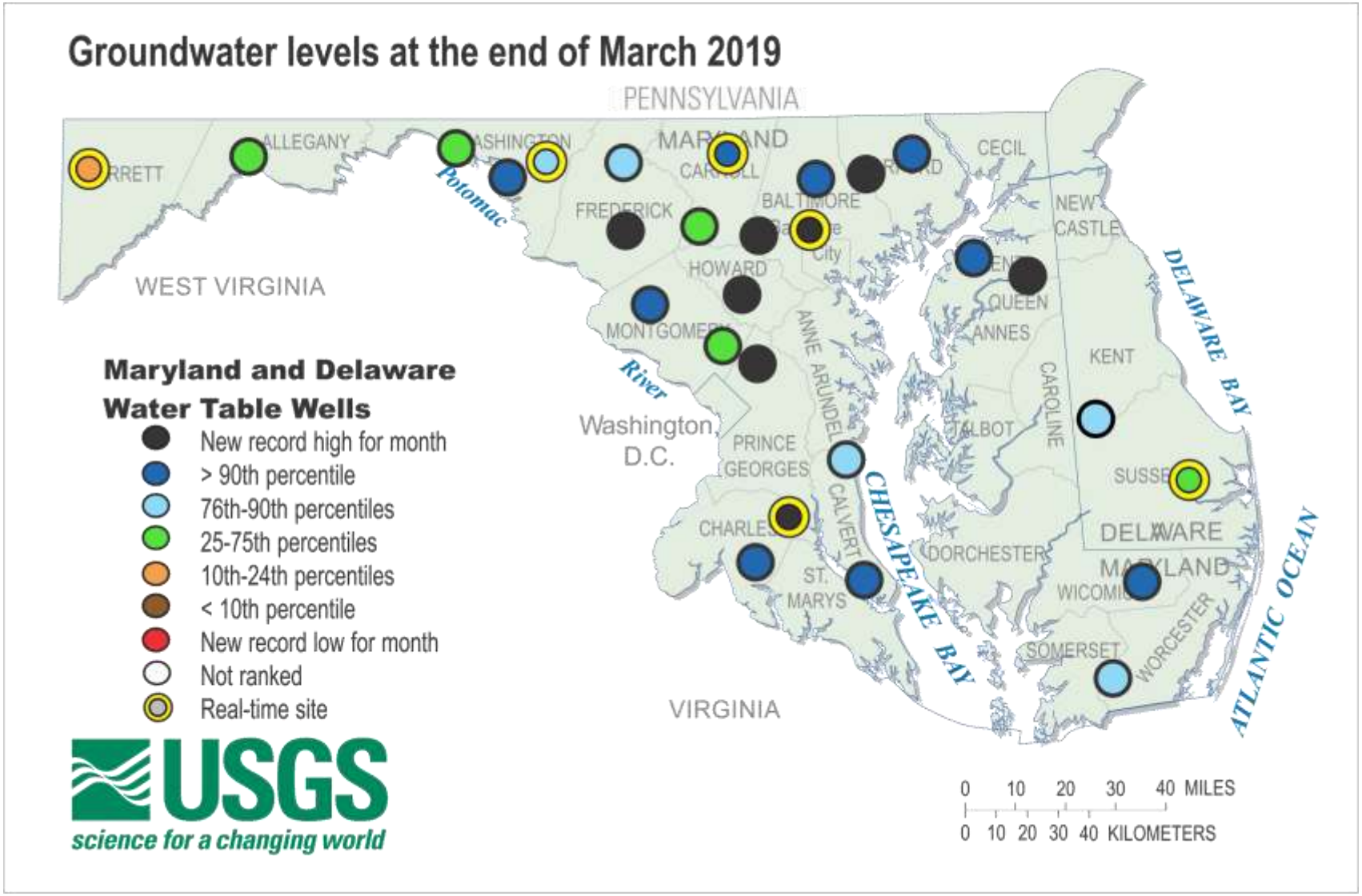
Wind:
- *Increased intensity of hurricanes*
- *Increased intensity of tornados*
- *Increased storm surge intensity*

Wildfires:
- *Increased frequency & intensity*

Sea level rise

Office of Solid Waste and Emergency Response Climate Change Adaptation Plan (draft),[5] Appendix A (adaptation)

Groundwater Rise



https://waterdata.usgs.gov/md/nwis/rt

Vulnerability Considerations

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- System Components
  - Underground and at-grade components
    - **Liner system**; Leachate collection/transmission system; LFG transmission system; **Stormwater management system**
  - Aboveground components
    - Leachate storage/treatment system; LFG collection system; Flare/gas-to-energy plant; Electric controls
  - Site operations and infrastructure
    - Utilities; Buildings; Tanks; Immobile equipment; Fences
- Potential Vulnerabilities
  - Power interruption
  - Physical damage
  - Water damage
  - Reduced access

State Guidance (150pp. Report)

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DEPARTMENT OF ECOLOGY
State of Washington

Adaptation Strategies for Resilient Cleanup Remedies

A Guide for Cleanup Project Managers to Increase the Resilience of Toxic Cleanup Sites to the Impacts from Climate Change

https://fortress.wa.gov/ecy/publications/documents/1709052.pdf

Case Study Site Layout

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Design Needs Based on Potential Climate Change Impacts

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- **Sea Level Rise (Flooding)**
  - Site is above projected zones of expanded FEMA 100-year flood plain
  - Flood protection controls (levees, berms) may need to be placed along creek to protect the landfill site from higher-than-expected flooding
- **Elevated Groundwater (Inundation)**
  - Options for addressing this challenge include:
    - Raise base of landfill liner
    - Revise base grade slopes, cell sizes, and/or drainage patterns
    - Design leachate collection system to handle potential future groundwater infiltration
- **Storm Intensity and Frequency (Physical Damage)**
  - Design stormwater management system and ponds to handle higher rainfall intensity storm events

Climate Change Considerations

- **Sea Level Rise**: Mean sea level is predicted to rise an average of ~3 feet above current levels in Dorchester County by 2100
  - Extends limits of flood plains along creeks near landfill site
- **Groundwater Impacts**: Groundwater levels are predicted to mirror sea level rise

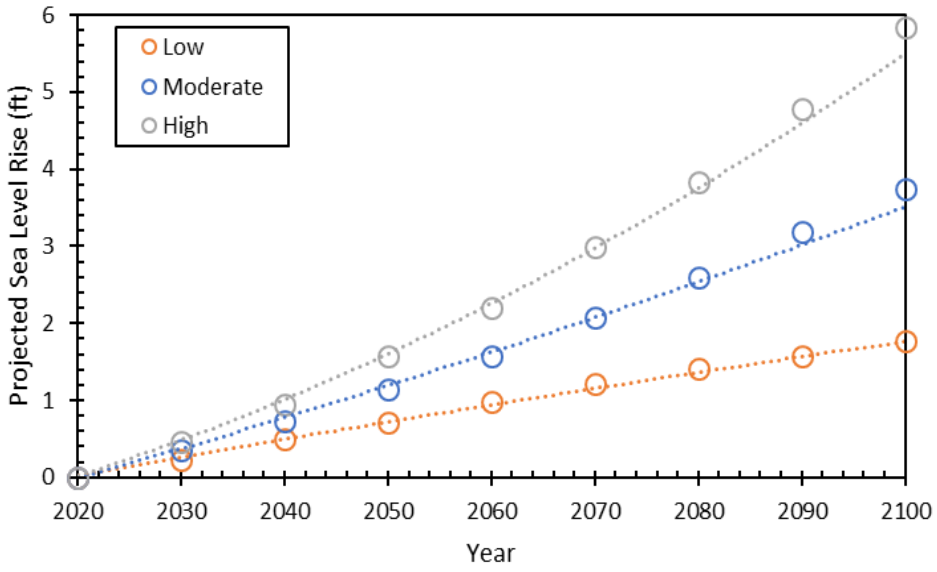

SEA LEVEL RISE: TECHNICAL GUIDANCE for DORCHESTER COUNTY

Wanda Diane Cole
Maryland Eastern Shore
Resource Conservation & Development Council

for

Maryland Department of Natural Resources
Chesapeake and Coastal Management Program

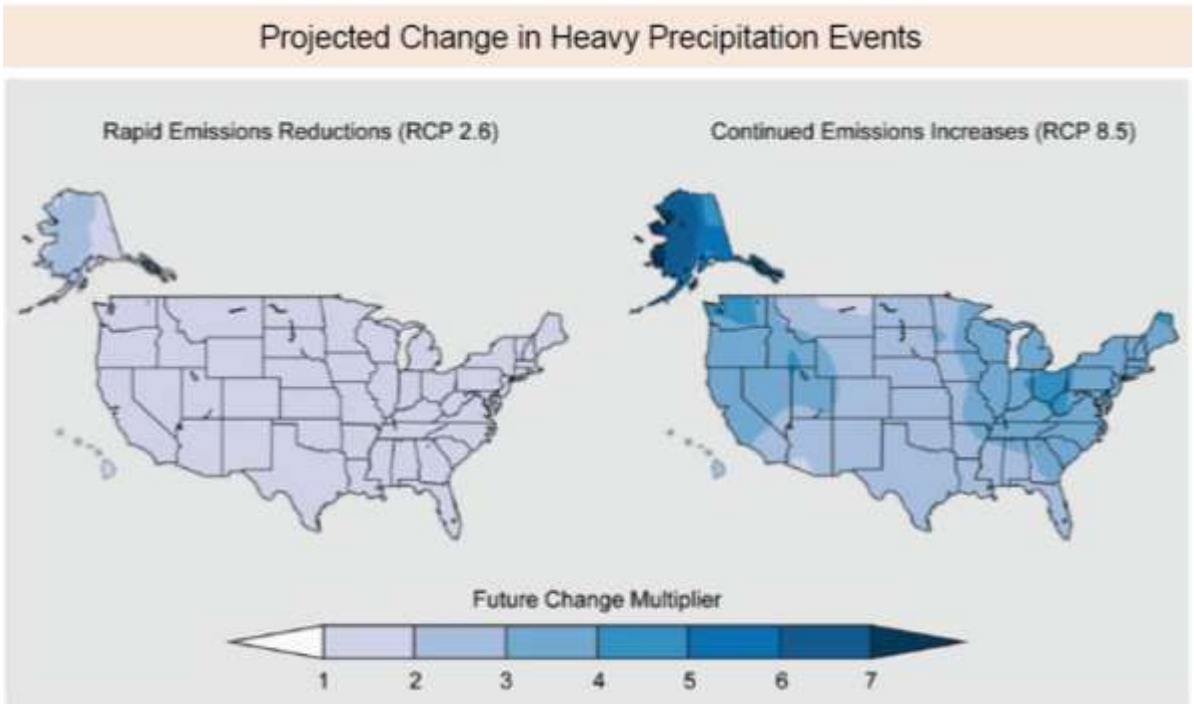
Fall 2008



Sea Level Rise Projections from NOAA (2017)

Climate Change Considerations

- **Storm Intensity**: Heavy precipitation events are expected to increase in frequency by 2-3 times by 2100



The Third National Climate Assessment. U.S. Global Change Research Program (2014)

Resilience of the Design to Potential Climate Change Impacts

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- **Sea Level Rise (Flooding)**
  - Site is entirely above the FEMA 500-year flood plain, rather than just the 100-year flood plain as required under current regulation
  - Landfill is designed with a perimeter berm to protect the landfill site from higher-than-expected flooding (top of berm is 15-ft above creek)
- **Elevated Groundwater (Inundation)**
  - Liner subgrades are always >4.5-ft above highest observed GW, rather than 1.5-ft as required under current regulation
    - Geomembrane liner (and overlying LCS and waste deposits) at least 6.5-ft above highest observed GW
  - Leachate transmission system designed as “inward gradient” system
    - GW would leak into the pipes/manholes, rather than leachate leaking out
- **Increased Storm Intensity and Frequency (Physical Damage)**
  - Stormwater management system and ponds are designed to handle higher rainfall intensity (100-year storm events rather than 25-year storm events as required under current regulation)
  - Ponds designed with 2x the freeboard required under current regulation (2-ft freeboard under a 100-year storm event)

Thank you

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engineers | scientists | innovators