SOUTH CAROLINA DHEC

DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL

Engineered Barrier Workshop

Barnwell Low-Level Radioactive Waste Disposal Facility

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SC DHEC Radioactive Waste Management Program

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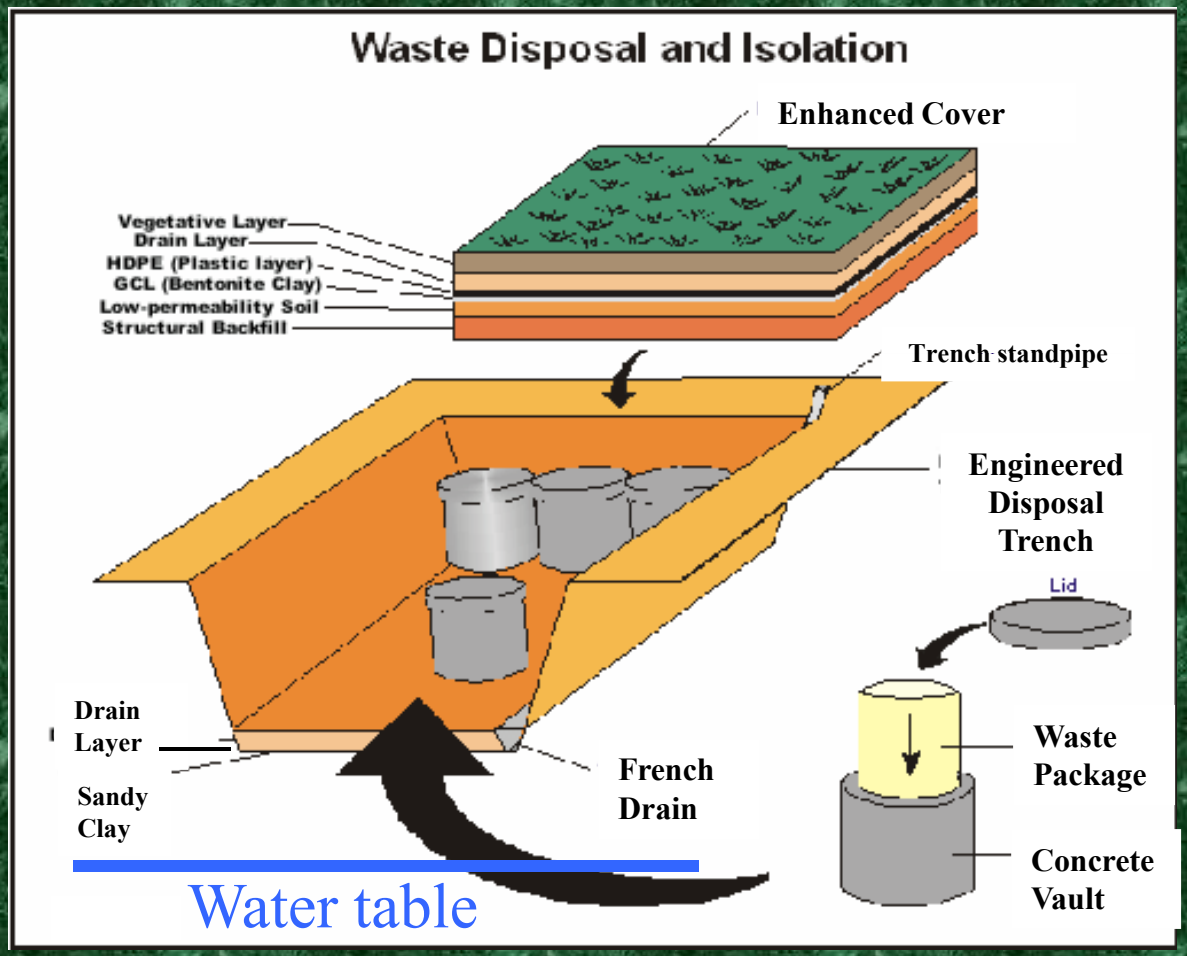
Barnwell Site

Started operating in 1971

Disposal Site for Low-Level Radioactive Waste

235 acres used for waste disposal and for site buildings

Three Types of Engineered Barriers



Trenches

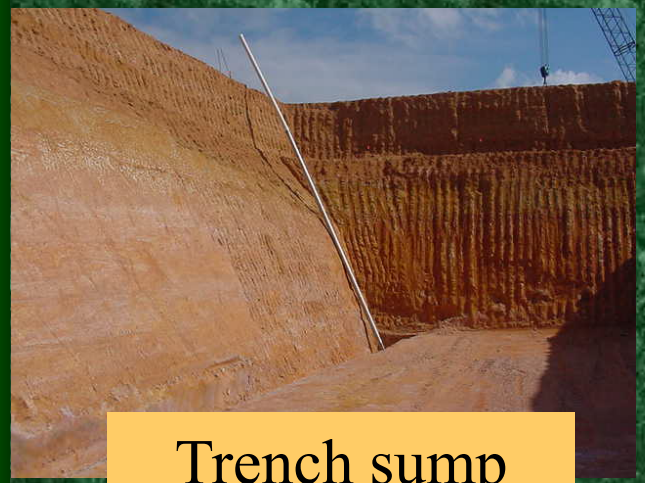
Vaults

Caps

Low-level waste disposed of in shallow trenches

Trench Design

- Designed to prevent water from accumulating in the waste zone
- Virgin clay bottom retards percolation
- Bottom elevation at least 5 feet from highest historical water table elevation



Trench sump with standpipe

Virgin Clay

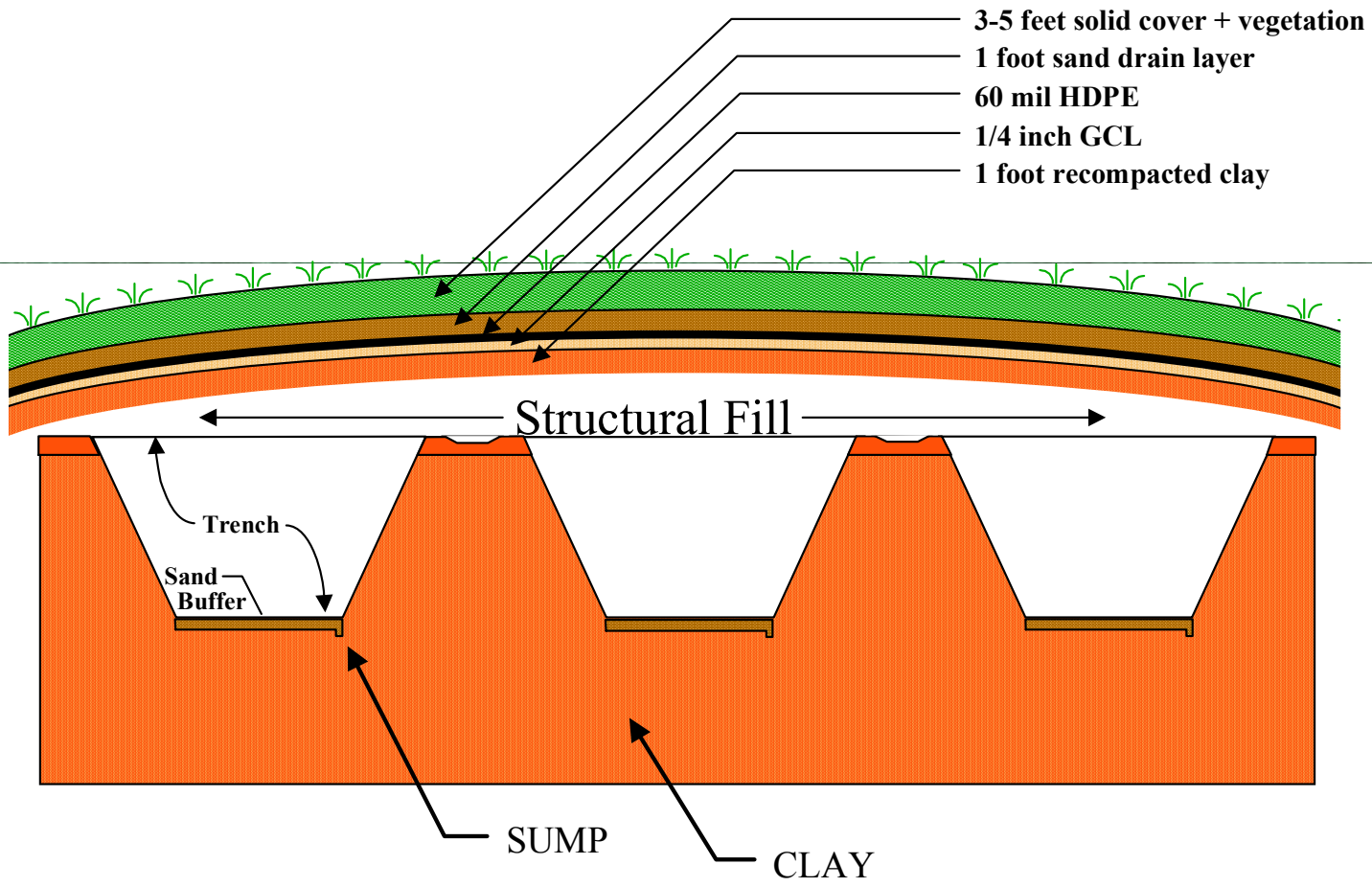
Sand Layer

Engineered trench with vaults in place

Intruder barrier and Engineered barrier

State requirement for all classes of waste since 1995

Enhanced Cap Construction Details



NOTE: Drawing not to scale

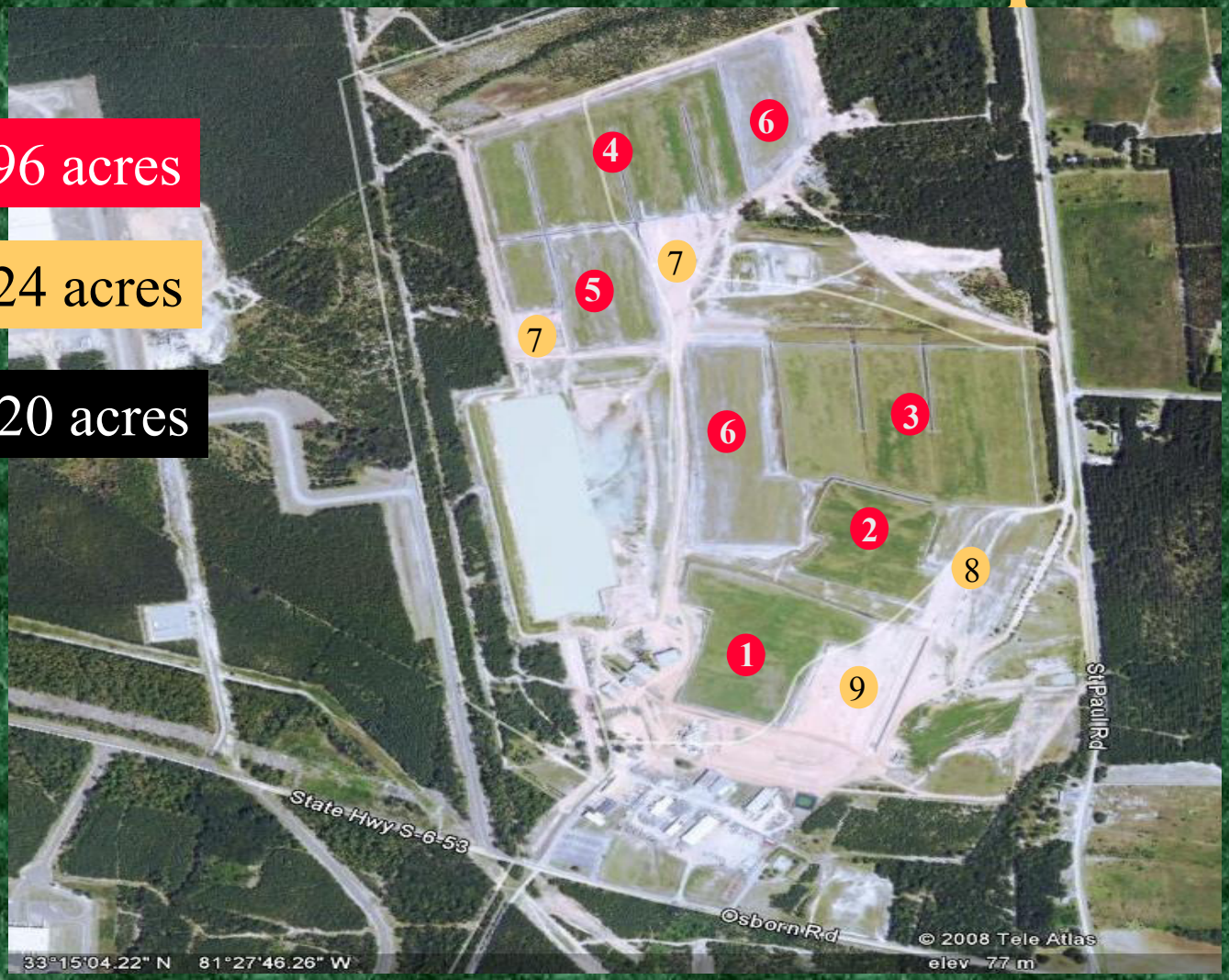
Enhanced Cap/Cover

Aerial View of Caps

96 acres

+ 24 acres

~ 120 acres



Monitoring Devices and Systems

- Sump monitoring
- Rain event/Routine inspections
- Extensive Groundwater Monitoring
- 182 monitoring locations
  - On-site wells
  - Off-site wells
  - Creek
- Quarterly Sampling
- Tritium, Gross alpha/beta, Gamma spec, VOCs

Tritium Concentrations in Zone 2 Wells

Highest Concentration

WM-0110

21,400,000 pCi/L

Headwaters of Creek

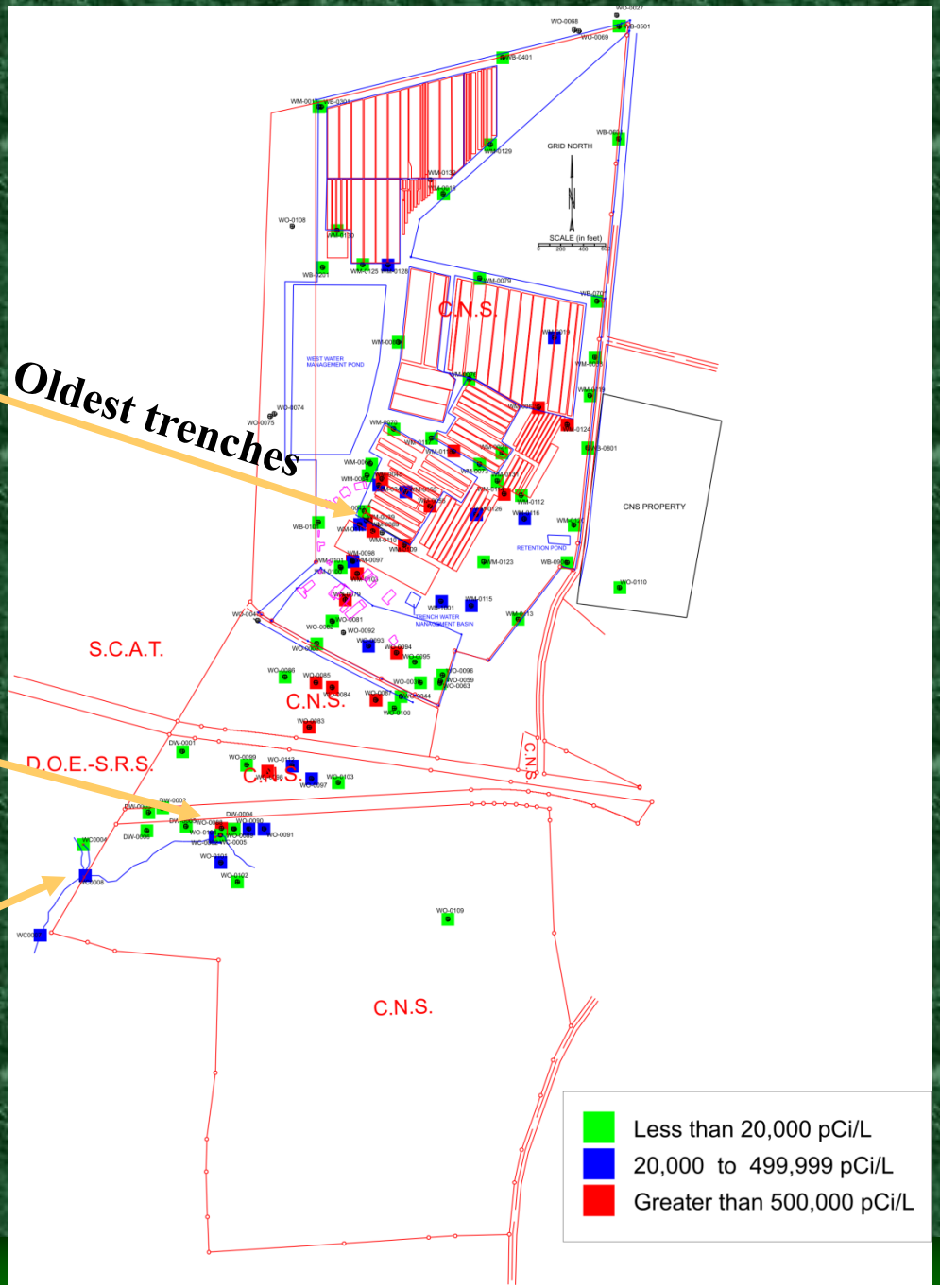
WC-0002

445,000 pCi/L

Compliance Point

WC-0008

105,000 pCi/L



Are engineered barriers performing short-term?

- Trenches are assumed to be intact
  - If vaults were failing would see evidence through cap
- Most trench sumps are dry
- Tritium levels in sumps are background since 2007
- Enhanced caps – 4 incidences from 1998 to 2007
  - In the process of repair, able to inspect the condition of cover – observed no breaches to cover – no significant failures – pre-vault trenches beneath
- Current data shows site meets performance objectives and dose limit at compliance point
- No known receptors at the compliance point

Will engineered barriers perform long-term?

- Use modelling and annual trending reports to predict future compliance
- Current model predicts continued compliance
- DHEC evaluating all performance objectives as Site has completed Phase I closure activities

Annual Trending Report

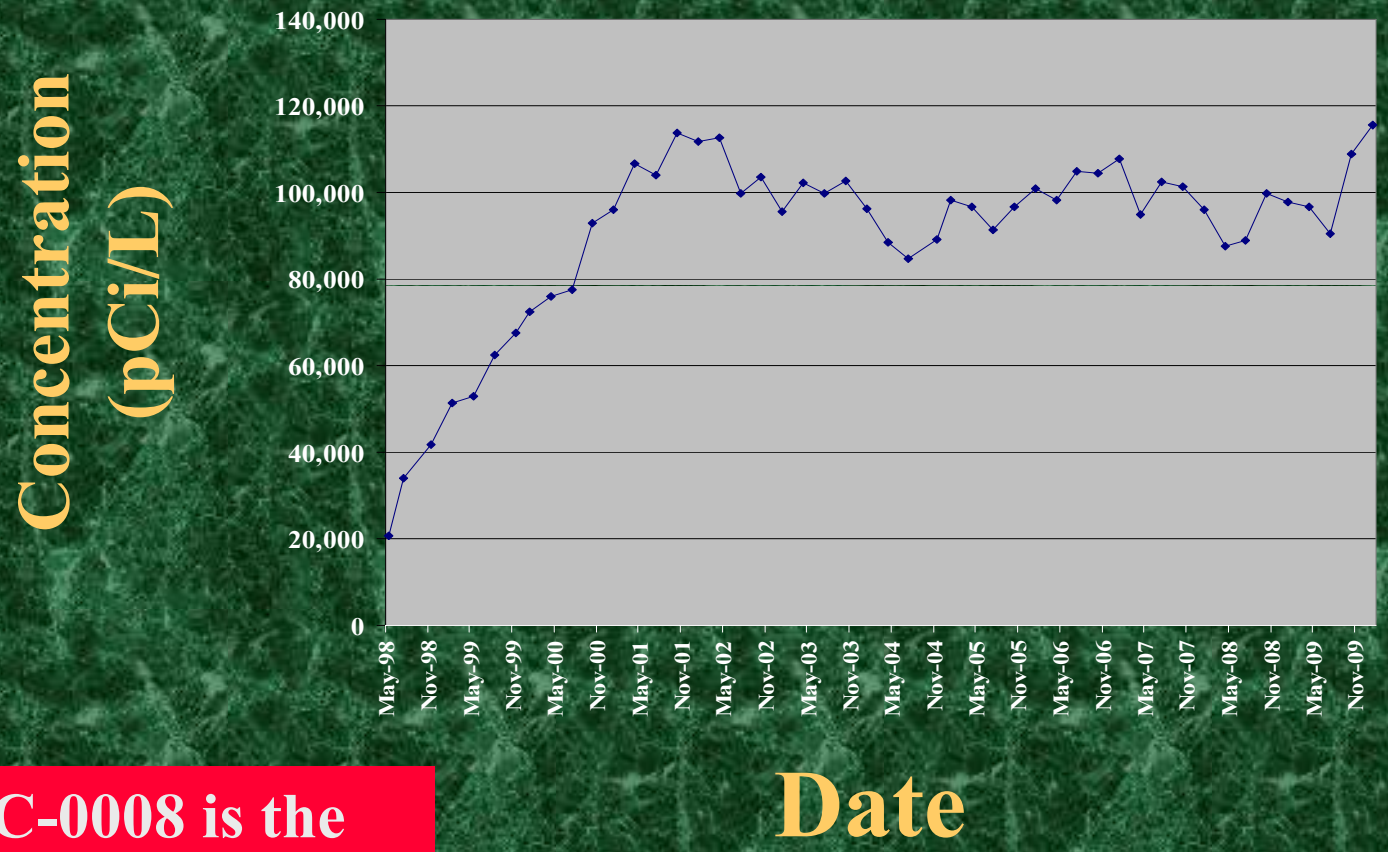
- Monitors plume movement
- Looks at data for last 5 years
- 27 locations
- Statistical analysis
- 10 - upward
- 8 - downward
- 9 - no trend

TABLE 2-1
LIST OF MONITORING LOCATIONS AND TRENDS

SAMPLE POINT	TYPE	TREND FOR	5 YEAR TREND	COMMENTS
WB-0401	Boundary well	Water Elevation	Downward	Zone 2
WB-0502	Boundary well	Water Elevation	Downward	Zone 1
WB-0801	Boundary well	Water Elevation	Downward	Zone 2
WB-1001	Boundary well	Water Elevation Tritium	Downward Upward	Zone 2
WB-1003	Boundary well	Water Elevation	Downward	Zone 1
WC-0002	Creek/Spring	Tritium	Upward	
WC-0008	Creek/Spring	Tritium	No evidence of upward trend. No evidence of downward trend.	
WM-0039	On-site well	Tritium	No evidence of upward trend. No evidence of downward trend.	
WM-0049	On-site well	Tritium	Upward	
WM-0055	On-site well	Tritium	No evidence of upward trend. No evidence of downward trend.	
WM-0056	On-site well	Tritium	Upward	
WM-0073	On-site well	Tritium	Upward	
WM-0089	On-site well	Tritium	Downward	
WM-0098	On-site well	Tritium	Downward	
WM-0103	On-site well	Tritium	No evidence of upward trend. No evidence of downward trend.	
WM-0110	On-site well	Tritium	No evidence of upward trend. No evidence of downward trend.	
WM-0113	On-site well	Tritium	Downward	
WM-0114	On-site well	Tritium	No evidence of upward trend. No evidence of downward trend.	
WM-0115	On-site well	Tritium	Upward	
WM-0118*	On-site well	Tritium	No evidence of upward trend. No evidence of downward trend.	
WM-0124*	On-site well	Tritium	Upward	See Note 1.
WM-0128*	On-site well	Tritium	Upward	See Note 2.
WO-0084*	Off-site well	Tritium	Downward	
WO-0085*	Off-site well	Tritium	Downward	
WO-0086	Off-site well	Tritium	Downward	Background
[illegible]	[illegible]	[illegible]ritium	Upward	
[illegible]	[illegible]	[illegible]ritium	Upward	
[illegible]	[illegible]	[illegible]ritium	No evidence of upward trend. No evidence of downward trend.	See Note 3.
[illegible]	[illegible]	[illegible]ritium	Downward	
[illegible]	[illegible]	[illegible]ritium	Downward	Background
[illegible]	[illegible]	[illegible]ritium	No evidence of upward trend. No evidence of downward trend.	Replaces WO-0012

Tritium levels are closely monitored at the compliance point to be sure they do not exceed regulatory limits

Tritium Concentration Compliance Point 1998-2010



WC-0008 is the Compliance Point

Practical Insights on Monitoring

- Challenges in addressing the issue of settlement
  - Vaults and free flowing material to improve stability in waste zone
- Frequent routine maintenance and inspections key
  - Visually inspect entire site weekly including open trenches ; “Walk the caps” monthly
- Allow time for monitoring between discovery and repair of enhanced caps
  - Time yields understanding of extent and cause of damage
- Balance need for standpipes and their effect on cap performance
  - Minimize penetrations before placing cap

Practical Insights on Modeling

- Groundwater models are evolving
- Earlier models did not pinpoint correct pathway or flow times
  - Original 1970 model did not consider tritium, however tritium is primary migrating radionuclide
  - 1970 model did not take into account fluctuating water table elevation and overestimated transport time
  - 1982 USGS study – overestimated the transport time
- Estimating source term - complex

Codes and Modeling Experiences: Groundwater Flow

- Currently use multiple one-dimensional stream tube model
  - 3D MODFLOW/MODPATH
  - Current model predicts 13 mrem while current calculated hypothetical annual dose is 5 mrem
- New model being developed using 3D transport
  - MODFLOW/MODPATH and MT3DMS

Summary

- Multiple engineered barriers work together to enhance performance
- Expected to mitigate but not eliminate tritium plume
- Not directly modelling engineered barrier performance
  - Using sump monitoring, current data from environmental monitoring, and annual trending
- Current groundwater model shows performance objectives will continue to be met