CBU-PIT-2006-00106
June 6, 2006

SRS savannah river site

SRS Approach to NRC Request for Additional Information

Draft 3116 Waste Determination for Closure of Tank 19 and Tank 18

For DOE-NRC Discussions Related to Performance Assessment

APPROVED for Release for Unlimited (Release to Public)

June 8, 2006

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE

Objective

- To provide information to NRC staff on SRS plans for resolving NRC's 3/31/06 Request for Additional Information on the draft waste determination
  - To provide an opportunity for NRC to ask questions and offer comments or suggestions, as appropriate
  - To facilitate resolution of the NRC comments and completion of the waste determination

Note that all information provided is predecisional and subject to change.

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comments to be discussed

Comment categories

1) Removal of highly-radioactive radionuclides (4, 11, 12)
2) Inventory and sampling (14-17)
3) Receptor description (21-26, 28, 29)
4) Near field release (30-31, 33, 34, 36-40, 42, 44-48)
5) Far field transport (49-50)
6) Model implementation (51-58)
7) Sensitivity analyses (59-61)

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 3

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Framework for discussions

The following information is provided for each comment:

Basic path forward recommended by NRC: A condensed version of the path forward included with the comment to indicate NRC's expectations

Proposed DOE approach: A brief statement of the proposed general approach to resolve the comment

Key points:

- The key factors related to the proposed response

Additional information:

- In some cases additional information such as figures are provided to help explain DOE's proposed approach

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 4

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 4 (radionuclide removal)

Basic path forward recommended by NRC: Provide additional information on 6 matters related to waste removal technology selection.

Proposed DOE approach: Provide the requested information with supporting details.

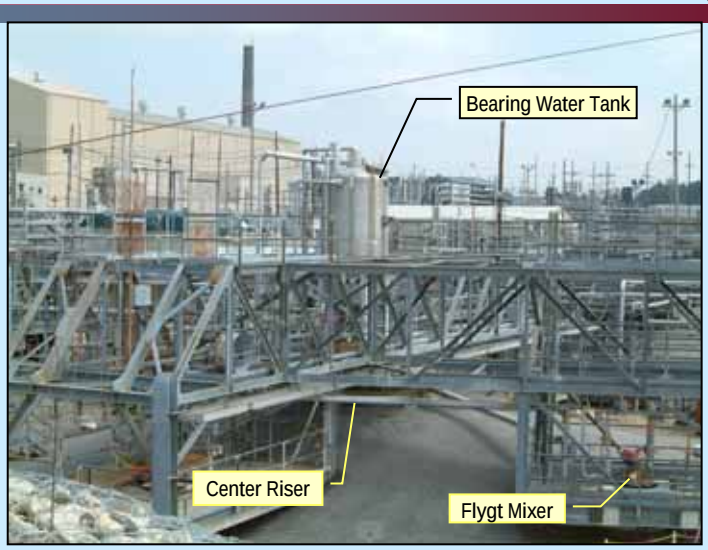
Key points:

- Available tank risers were used to the best advantage in waste retrieval
- *Line of sight* refers to area of tank interior visible from opening without camera
- Creating new tank openings entails risk to tank structural integrity
- Tank 19 center riser plugs could not be removed due to interferences
  - However, structural evaluation was performed and it was determined to be acceptable to drill small holes in center riser plug
- Substantial personnel radiation exposure (total person-rem) would be involved with removal of equipment presently installed in Tanks 19 and 18

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 5

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 4 – Tank 19 structural steel (1)



PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 6

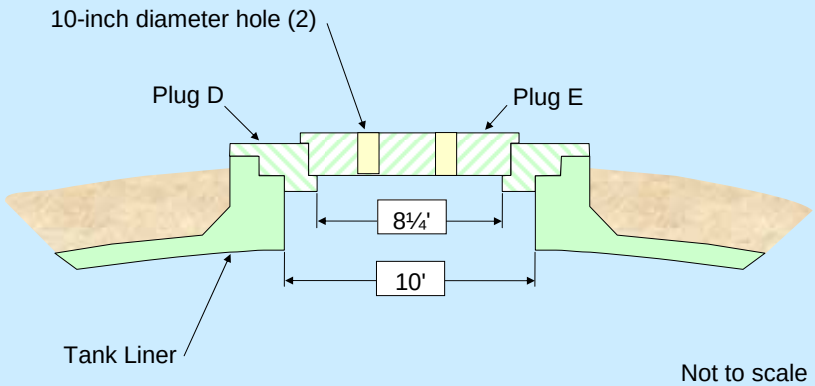
SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 4 – Tank 19 structural steel (2)

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 7

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

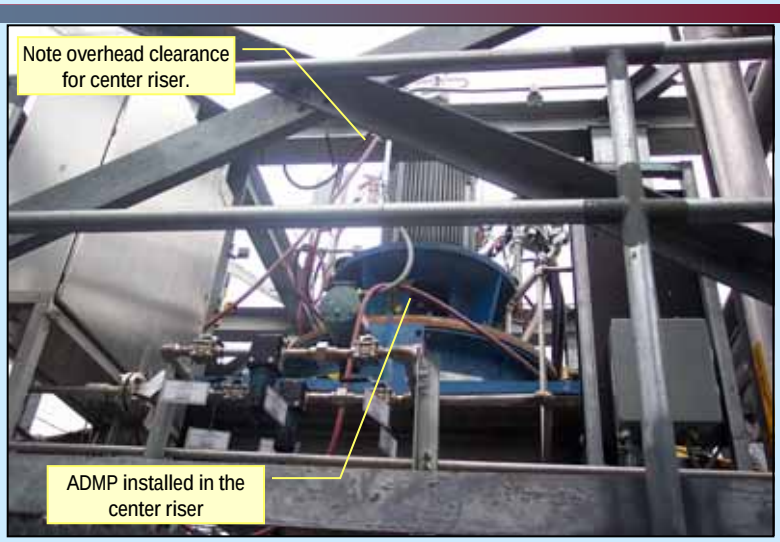
Comment 4 – Tank 19 center riser nested plugs



PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 8

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 4 – Tank 18 center riser



PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 9

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 11 (radionuclide removal)

Basic path forward recommended by NRC: Provide more information on viability of using oxalic acid for cleaning Tanks 18 and 19

Proposed DOE approach: Provide the requested information.

Key points:

- *Heel Removal and Annual Cleaning Technology Development Suspension Plan* provides details of DOE team's development of optimal chemical cleaning method:
  - 31 completed technology development products
  - Work remaining includes evaluation of (1) trapped hydrogen in sodium oxalate layer, (2) tank corrosion, and (3) carbon steel corrosion rates and free hydrogen generation rate
  - After completion of evaluations, accident analyses could be completed
- To address issue, DOE evaluated cost-benefits of possible oxalic acid use on 12 tanks scheduled for closure by 2016
  - Comparison expected to show Tank 19 actual residual heel removal costs in $/gal to be slightly less than estimated cost of oxalic acid use on the other tanks

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 10

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 12 (radionuclide removal)

Basic path forward recommended by NRC: Provide information on PITBULL™ pump, especially impact of aerosolization and costs to limit impacts

Proposed DOE approach: Provide the requested information, explaining that the pump is usable with certain operating limitations.

Key points:

- Pump was authorized for use with limitations reflected in authorization basis
  - Limitations include: (1) transfer time ≤ 24 hr, (2) Tank 19 ventilation ≤ 1040 scfm, (3) pumping operating < 10 cycles per minute
- SRNL testing evaluated risk related to entraining and aerosolizing waste and potential airborne radioactivity release accidents
  - Testing was completed before the pump was installed
  - Response will summarize test results, with reference to detailed report
- The pump, which was to be used in a desludging program in connection with a crawler, was not used because of concerns over water volume addition at a time when tank space was very limited

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 11

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 14 (inventory and sampling)

Basic path forward recommended by NRC: Provide solid sample details, including samples taken in residual hardened material in both tanks, or increase tank inventories to account for uncertainty

Proposed DOE approach: Provide information to demonstrate there are no hidden zeolite slabs in Tank 19 and that contents of both tanks are well mixed.

Key points:

- Tank 19
  - (1) All zeolite discharged directly under NE riser; (2) hydrolance broke up zeolite slabs under this riser, with 11 detailed inspections showing no zeolite slabs elsewhere in tank (see next slide); (3) heel maps show significant redistribution of residual solids; (4) simulant testing showed mixer effectively cleaned tank bottom; and (5) velocity profile test results
- Tank 18
  - (1) South mound sample results were carefully considered in inventory development and (2) alternative method separately characterizing south mound material produced only negligibly different inventory (see figures)

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 12

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 14 (new figure)

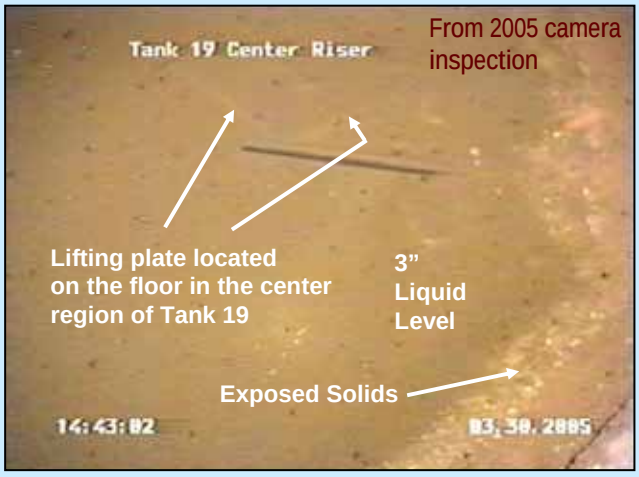
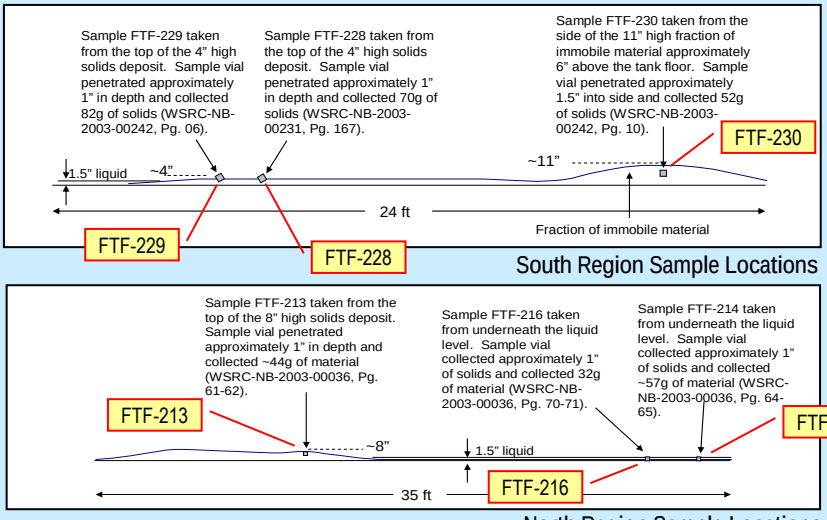


Photo of Tank 19 Floor Lifting Plate

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 13

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

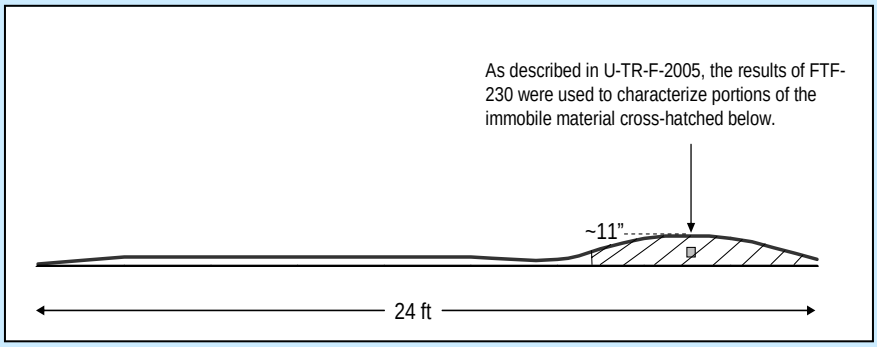
Comment 14 (new Tank 18 sample figures)



PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 14

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 14 (Tank 18, south region)



Tank 18 Bottom Cross Section – South Region Material Characterization Method

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 15

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 15 (inventory and sampling)

Basic path forward recommended by NRC: Describe any studies assessing reliability of WCS-based inventories, explain differences in WCS and sampled values, etc.

Proposed DOE approach: Compare WCS tank heel predictions to sample-based inventories.

Key points:

- No previous studies comparing WCS predictions to sample results are available
- Comparison shows that
  - (1) Cs-137 and Ba-137m are underestimated using fission yields, as previously explained, and (2) all other fission products are underestimated by fission yields
- Cs-134 and Cs-135 inventories likely underestimated like Cs-137 also, but their effect on dose is negligible

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 16

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 16 (inventory and sampling)

Basic path forward recommended by NRC: Describe development of upper confidence limits (UCLs) in Tank 18 and 19 data, provide assessment of Tank 18 unsampled volume, revise inventory based on uncertainty or more sampling

Proposed DOE approach: Provide the requested information, but not revise inventory.

Key points:

- WSRC-TR-2002-00052, Rev 3 provides details of UCL development for Tank 19
  - UCLs for 4 radionuclides with limited data were developed using different process
- U-TR-00005, Rev 2 provides details of UCL development for Tank 18
  - Tank 18 SE mound (with single sample results) was characterized differently

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 17

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 17 (inventory and sampling)

Basic path forward recommended by NRC: Provide equipment void volume and characterization info for failed or abandoned equipment in tanks, discuss equipment openings and hydraulic isolation, provide basis for associated waste quantity.

Proposed DOE approach: Provide the requested information.

Key points:

- It was not necessary to assign a separate waste inventory to the equipment because
  - No volume reduction was assumed to account for submerged equipment
  - Very little potential for significant waste hold-up in the equipment existed
- Equipment descriptions and drawings are being provided

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 18

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 21 (receptor description)

Basic path forward recommended by NRC: Provide data to support conclusion on 4% flow to Congaree aquifer, with uncertainties, address consistency with green clay layer vertical hydraulic conductivity.

Proposed DOE approach: Provide information, including PORFLOW analysis results.

Key points:

- The 4% is based on flow model calibrated using site tritium groundwater travel data
  - 4% value is for the location closest to flow path from F-Tank Farm to Fourmile Branch
- DOE has performed a side-by-side modeling comparison using PORFLOW
  - PORFLOW is SRNL groundwater flow and transport program
  - PORFLOW results are expected to be consistent with lower water budget to Congaree than to upper aquifers
- Additional sensitivity analyses are being performed to evaluate 4% model input
  - Congaree with 100% flow
  - Results will be provided

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 19

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 22 (receptor description)

Basic path forward recommended by NRC: Provide data showing all aquifer flow discharges to the streams or demonstrate that the seepline receptor receives higher dose than would a receptor using groundwater at an offsite location, assuming underflow.

Proposed DOE approach: Provide information demonstrating that all aquifer flow discharges to the streams.

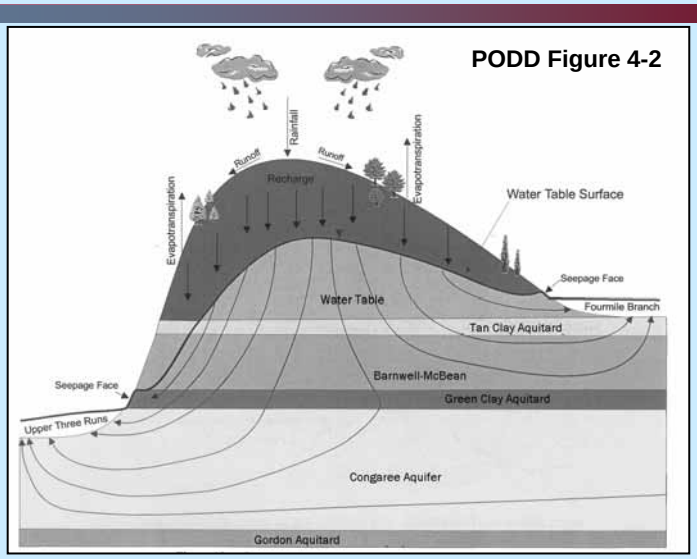
Key points:

- The water table is higher on either side of Fourmile Branch, confirming no underflow
- Potentiometric data for Barnwell-McBean aquifer on both sides of stream indicate flow toward Fourmile Branch
- Groundwater flow maps from semiannual Corrective Action Reports show that Upper Three Runs and Fourmile Branch bound GSA groundwater flow (see figures)
- Large scale integrated groundwater modeling of the GSA confirms this conclusion

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 20

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 22 – GSA groundwater flow

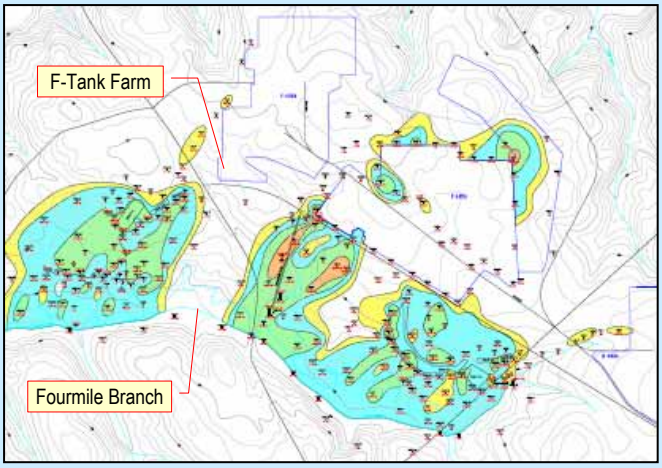


PREDECISIONAL INFORMATION – SUBJECT TO CHANGE

21

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 22 – GSA groundwater (1)



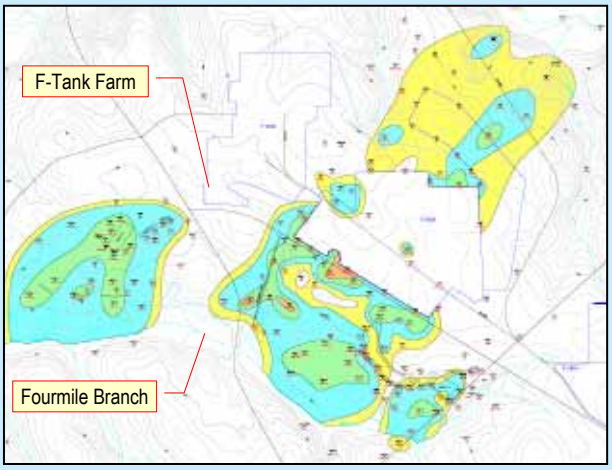
Tritium Concentration in Upper Aquifer Zone of Upper Three Runs Aquifer at the GSA, First Quarter 2005

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE

22

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 22 – GSA groundwater (2)

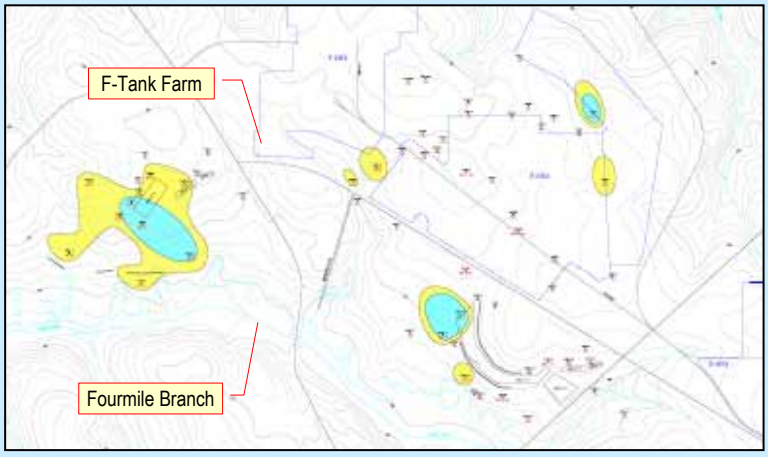


Tritium Concentration in Lower Aquifer Zone of Upper Three Runs Aquifer at the GSA, First Quarter 2005

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 23

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 22 – GSA groundwater (3)



Tritium Concentration in the Gordon Aquifer at the GSA, First Quarter 2005

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 24

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 23 (receptor description)

Basic path forward recommended by NRC: Clarify receptor locations, put all on a single map, provide additional details.

Proposed DOE approach: Provide requested information, including revised PODD Figures 4-3 and 4-7; provide new figure showing all receptor locations; and a new table with pathway details.

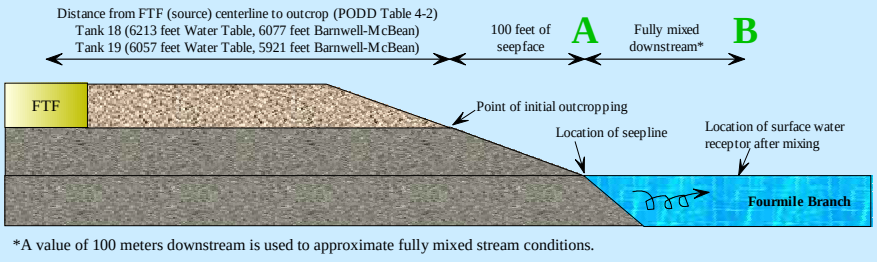
Key points:

- The public receptor for soil ingestion is located at the shoreline at the downstream point of maximum surface water exposure, rather than at the seepline
- The public receptor for direct radiation is located at the shoreline at the downstream point of maximum surface water exposure

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 25

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 23 – new figure



*A value of 100 meters downstream is used to approximate fully mixed stream conditions.

Not to Scale

MEPAS Receptor Locations

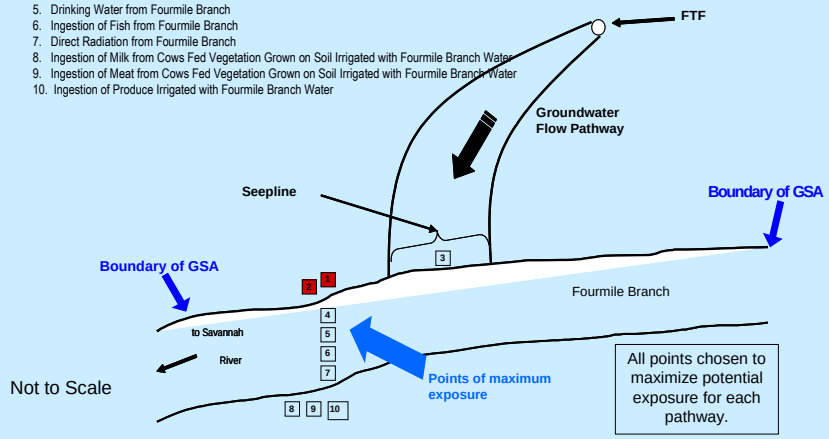
PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 26

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 23 – revised PODD Figure 4-3

EXPOSURE PATHWAYS FOR MEMBER OF PUBLIC

1. Incidental Ingestion Of Soil From Shoreline Deposits (During Recreational Activities)
2. Direct Radiation from Shoreline
3. Air Inhalation (I-129 Volatilization) At Seepline
4. Dermal Contact with Fourmile Branch
5. Drinking Water from Fourmile Branch
6. Ingestion of Fish from Fourmile Branch
7. Direct Radiation from Fourmile Branch
8. Ingestion of Milk from Cows Fed Vegetation Grown on Soil Irrigated with Fourmile Branch Water
9. Ingestion of Meat from Cows Fed Vegetation Grown on Soil Irrigated with Fourmile Branch Water
10. Ingestion of Produce Irrigated with Fourmile Branch Water



PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 27

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 24 (receptor description)

Basic path forward recommended by NRC: Clarify whether Congaree aquifer was modeled as flowing to Upper Three runs or Fourmile Branch. Calculate dose to public receptor using water from well in Congaree aquifer on edge of buffer zone (100 m).

Proposed DOE approach: Clarify Congaree aquifer modeling, explain basis for dose to Congaree aquifer, provide additional analysis.

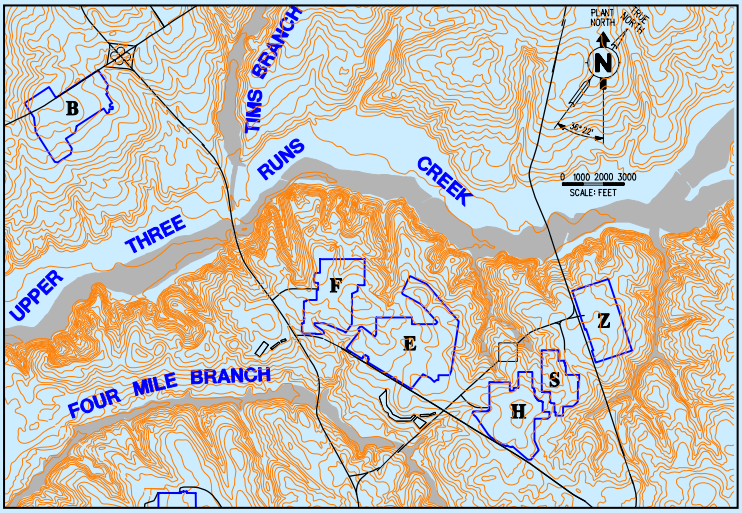
Key points:

- Congaree aquifer was modeled as flowing north towards Upper Three Runs
- 100 m well data for Congaree aquifer is located at flow point towards Fourmile Branch
- Sensitivity analysis is being performed using 100 m well in Congaree aquifer on side toward Upper Three Runs

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 28

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 24 –stream location



PODD Figure 2-7

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE

29

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 25 (receptor description)

Basic path forward recommended by NRC: Provide information about relative amounts of contaminated infiltration water that flow toward Fourmile Branch and Upper Three runs for each aquifer.

Proposed DOE approach: Provide requested information (see also Comment 21).

Key points:

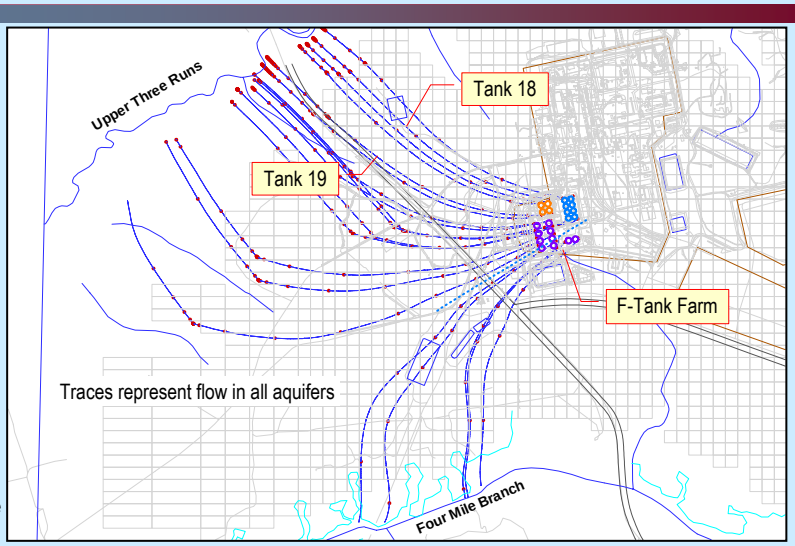
- Stream tracer runs based on GSA groundwater flow model (see figure) show that leakage from Tanks 19 and 18 will move toward Upper Three Runs
- 31%/65%/4% balance in Q-CLC-H-00005 based on calibrated model and area closest to the groundwater flow path to Fourmile Branch
- Modeling groundwater flow toward Fourmile Branch is conservative
  - Modeling flow toward Fourmile Branch effectively concentrates contaminants in the upper aquifers, making higher concentrations available for seepline exposures
  - Lower Fourmile Branch flow rate (<10% of Upper Three Runs) means less dilution (and more conservatism) in Fourmile Branch model
  - Permits modeling all 22 FTF tanks on single centerline to Fourmile Branch

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE

30

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 25 – stream traces



Not to Scale

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 31

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 26 (receptor description)

Basic path forward recommended by NRC: Provide map showing wells that generated data for green and tan clay layers near tanks. If data do not support assumed continuity of layers, update base case PA results for potential fast pathways.

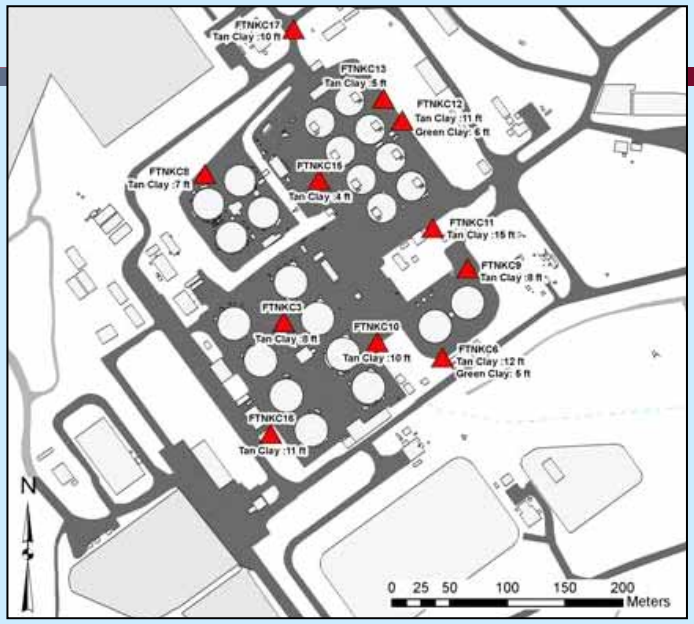
Proposed DOE approach: Provide map, discuss data, run additional sensitivity analyses.

Key points:

- Data support 3-foot tan layer and 5-foot green layer used in modeling (see figure)
- Thickness of tan clay confining unit is based on data in SRS geologic/hydrologic database

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 32

New map



Comment 28 (receptor description)

Basic path forward recommended by NRC: Compare estimated mechanical forces on closure system components to design values, demonstrate how PA incorporates impacts, if necessary, and provide plans for verifying intruder barrier compressive strength.

Proposed DOE approach: Provide requested information on mechanical forces and plans for verifying intruder barrier compressive strength.

Key points:

- Calculations show that
  - Compressive forces from the closed tanks and the overlying materials will be well below compressive strengths of the intruder grout, reducing grout, and basemat, and well below the design bearing capacity of soil under the basemat
  - The total (up to 10,000 psf) force from the closed tanks with their overburden will result in slight settling (calculated at ~1.8 inch in 10,000 years)
  - The system will be structurally sound
- SRS will verify intruder barrier compressive strength by periodic tests in accordance with ASTM standards during grout installation

Comment 29 (receptor description)

Basic path forward recommended by NRC: Provide support for assumptions on (1) 1000 m^2 garden size and (2) contaminated water not used for garden irrigation, or revise base-case agricultural intruder scenario with well at maximum dose point, e.g., 1 m from tanks.

Proposed DOE approach: Provide requested information.

Key points:

- Garden size is appropriately based on 2-adult household, regional survey, NUREG-0782 guidance, and other factors
  - PODD sensitivity analysis evaluated 500 m^2 and 2200 m^2 gardens
- Irrigation pathway was omitted because of insignificant contribution to dose at peak year
  - Peak dose comes from exhumed transfer line inventory at 100 years, when it is assumed that institutional controls are lost
  - Peak dose from groundwater pathway comes much later

Comment 30 (near field release)

Basic path forward recommended by NRC: Explain whether pouring grout through center riser would move waste to edge of tank bottom and, if so, how to prevent waste concentrating there, or estimate waste at bottom edge and revise PA to account for oxidation at that location. Describe options for mixing tank heel waste with grout.

Proposed DOE approach: Provide requested information.

Key points:

- New grout to be used will not move residual waste to the edges of the tank bottom
  - Based on SRS Tank 17 and 20 experience and Hanford tests and waste similarities
- Additional sensitivity analyses being performed will provide bounding case for oxidation at bottom edge
  - Include changing Tc-99 K_d to represent a fully oxidized state
- No readily available, proven methods for mixing tank heel and grout are available

Comment 31 (near field release)

Basic path forward recommended by NRC: Provide information on grout thickness, on an assessment of grout shrinkage, and on aluminum and zinc present, and provide an assessment of release rates when discrete system features result in higher flow, etc.

Proposed DOE approach: Provide requested information as available.

Key points:

- Selected model input parameters assume flow through the basemat will not change in first 500 years, even with cracks and fast flow paths through grouted tank
  - Preliminary results indicate that fast flow would change peak year, but not peak dose
  - Simulation bounds possible fast flow paths
- Model assumptions about initial infiltration (e.g., not accounting for clay cap, tank dome, and steel liner) are conservative
- 700 year tank liner integrity assumption based on analyses in WSRC-TR-2005-00369
- Additional sensitivity analyses are being performed on grout failure at 100 years considering shorter-lived radionuclides
- No long-term test data are available regarding grout shrinkage

Comment 33 (near field release)

Basic path forward recommended by NRC: Provide all F-Tank Farm water level data and other information on water table depth at tanks. Assess impacts with tank bottoms in water table to inadvertent intruder and member of the public.

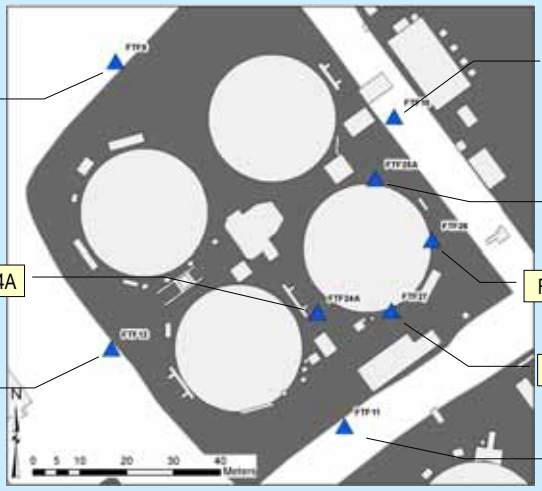
Proposed DOE approach: Provide requested information.

Key points:

- New map shows wells close to tanks (see figure)
- Well data being provided includes up to year 2000
- Historical data show long-term average below base case of 224 feet above mean seal level
- NUREG-1573 indicates that long-term climate changes not to be considered
- Additional sensitivity analyses are being performed
  - Results are to be provided
- Statistical projection was not developed because sensitivity analyses will bound potential conditions

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 33 – new figure

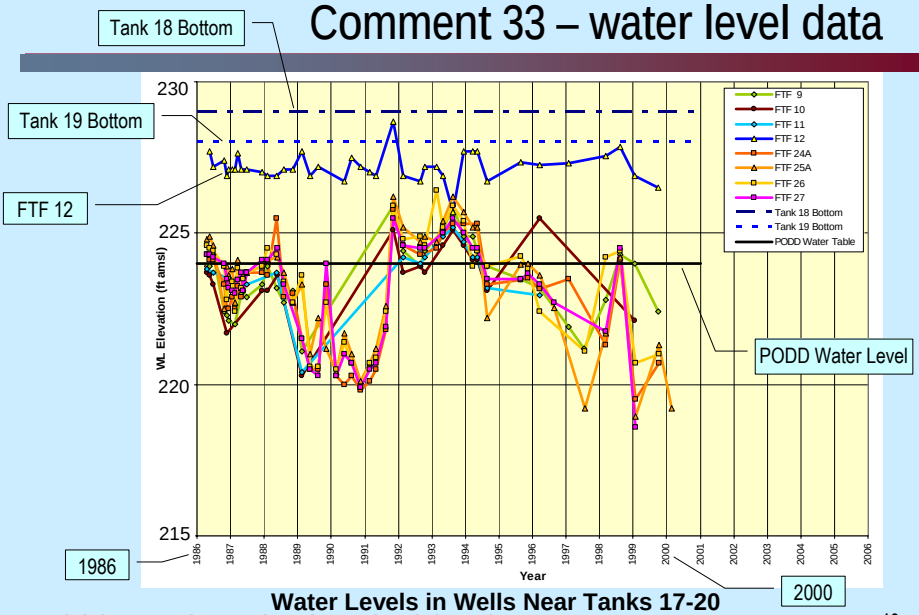


Map Showing Wells Close to Tanks

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 39

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 33 – water level data



Water Levels in Wells Near Tanks 17-20

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 40

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 34 (near field release)

Basic path forward recommended by NRC: Provide basis for conclusion that radiological and thermal properties of the waste will not enhance degradation of grouted waste or assess predicted effects on grout integrity and radionuclide release.

Proposed DOE approach: Provide basis for conclusion about no enhanced degradation.

Key points:

- Evaluation shows that radiological effects on degradation of the grouted waste will be negligible, based on
  - Data from SRS study of effect of 10^{10} rad gamma on simulated cement waste form
  - Study dose of 10^{10} rad would correspond to approximately 700 years exposure of grouted residual waste in Tanks 19 and 18
  - Effects of alpha radiation expected to be less than gamma due to lower alpha dose rates
- Thermal transients/profiles from radiation energy also are insignificant, based on
  - Calculated temperature differentials for tanks (2°F) << American Concrete Institute recommended maximum to prevent concrete cracking (35°F)

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 41

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 35 (near field release)

Basic path forward recommended by NRC: Correct or clarify Table 7-4 and provide source for 700-year estimate for tanks remaining intact.

Proposed DOE approach: Correct Table 7-4, provide source for estimate.

Key points:

- The table erroneously stated that the reducing grout would fail chemically at 500 years
  - SRNL simulations show 95% of grout remaining reduced with no cracks at 10,000 years
  - Modeling assumption of grout retaining reducing properties is appropriate
- Basis for 700 year estimate is analysis in WSRC-TR-2005-00369 report
  - Analysis considered general corrosion and pitting
  - Data from NBS corrosion studies were used
  - Predicted disintegration after concrete failure was 770 years by general corrosion and 675 years by pitting
- Note that model takes no credit for steel liner and its capability to retain waste after concrete failure

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 42

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 36 (near field release)

Basic path forward recommended by NRC: Provide basis for assumed immobilization of free liquid fraction, such as by leaching test results. Alternatively, compare fractional release rates used in PA with potential rates from free liquid fraction.

Proposed DOE approach: Provide information on basis for assumed immobilization.

Key points:

- Experience in grouting Tanks 17 and 20 showed free liquid minimal, with this small amount bound to grout mass by application of dry cement
  - This technique has also been demonstrated in field tests (WSRC-TR-2002-00052)
- All free liquid in Tanks 19 and 18 will be incorporated into grout mass
  - This liquid is expected to be sorbed into grout, which is designed for minimal bleed water, with dry cement used as necessary to fix any liquid near bottom of tank
- Because all free liquid will be incorporated into the grout mass, radionuclides associated with free liquid are modeled like radionuclides in the residual solid heel

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 43

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 37 (near field release)

Basic path forward recommended by NRC: Provide basis for using concrete K_d values for grouted tank, addressing formulation differences, effects of additives, etc. Provide available studies related to pore water pH and radionuclide leaching from waste solids.

Proposed DOE approach: Provide technical basis for using concrete K_d values.

Key points:

- Selected concrete K_d values were used to conservatively approximate K_d values in contaminated zone in absence of measured K_d values for waste
- Comparison of nuclide travel in contaminated zone to travel time in soil shows Tc and Np will spend a relatively large time fraction in contaminated zone, with a corresponding delay in time to reach dose peak

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 44

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 38 (near field release)

Basic path forward recommended by NRC: Provide additional basis for chemical performance of reducing grout over time, addressing pore water chemistry and potential for oxidizing conditions in the lowermost portions of the tanks.

Proposed DOE approach: Address by showing that contaminated zone K_d values are appropriate or conservative under the expected oxidizing conditions.

Key points:

- Grout aging rate to Region III is not controlled solely by cement content
  - Slag and fly ash also produce high pH conditions in contact with water, slow aging
- As indicated in response to Comment 37, Tc and Np will spend a relatively large time fraction in contaminated zone, although this factor has little impact on dose
- U, Pu, Np, and Tc are expected to occur as solid reduced phases
- A rising water table or exposure to soil gas will not mobilize Pu or Np due to low solubility, though they could enhance Tc and U mobility after reducing slag exhausted

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 45

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 39 (near field release)

Basic path forward recommended by NRC: Explain why site-specific clay K_d values were not used for Tc-99, Am, and Cm, or, for Tc-99, demonstrate that the clay unit K_d value has a negligible effect on dose.

Proposed DOE approach: Explain basis for values used and show lack of dose effects of K_d variation.

Key points:

- K_d values used were based on the most current and relevant sources
  - Shepard and Thibault study is primary source for recommended values for clay
  - Saltstone values were based on different soil type
- Additional sensitivity analysis evaluated effects of changing Tc-99 clay aquitard K_d
  - Reduced from 1 to 0.1 cm^3/g
- Site-specific observations for Am and Cm mobility in surface aquifer are not applicable
  - Associated with acidic plume below seepage basins; tank environment alkaline

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 46

Comment 40 (near field release)

Basic path forward recommended by NRC: Evaluate potential importance of alkaline plume migration on radionuclide transport through unsaturated zone, or explain why this is not important.

Proposed DOE approach: Address both matters.

Key points:

- Seepage basin experience and lab observations show soil permeability can decrease greatly in contact with high-pH, high-nitrate solutions
  - Study reported in DPST-81-935 describes seepage basin experience
  - Phenomenon is addressed in Salt Waste Disposal RAI response
- No credit was taken for permeability decrease that is likely below the tanks
  - Neglecting this effect is conservative because alkaline plume would reduce contaminant movement

Comment 42 (near field release)

Basic path forward recommended by NRC: Provide support for conclusion that release of colloid-associated radionuclides from tanks will be negligible, or provide technical basis for bounding colloid-associated Pu and U release over 10,000 year period.

Proposed DOE approach: Provide support for the conclusion about negligibility.

Key points:

- No conclusive information is available to indicate that colloids significantly effect contaminant transport at the site
- K_d values provide recognized means of evaluating radionuclide migration in groundwater
- Indeterminate effects of colloids on radionuclide transport are not expected to have a significant influence on the modeling results

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 44 (near field release)

Basic path forward recommended by NRC: Provide basis for assumption that infiltrating waters will continue to be reduced, or discuss bounding sensitivity analyses for effect of oxidizing infiltrating waters on Tc-99 transport.

Proposed DOE approach: Describe sensitivity study results for Tc-99 in Tank 19 and provide information to explain results.

Key points:

- Additional Tank 19 sensitivity study presently being performed with 1-year time increments
  - With contaminated zone K_d for reducing (1000 mL/g) and oxidizing conditions (1 mL/g)
  - Expected to show that complete oxidation results in modest increase in maximum seepline dose
- Results driven by a combination of factors, such as
  - Hydraulic characteristics of contaminated zone and basemat, contaminated zone K_d, basemat and soil K_d, dispersion

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 49

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 45 (near field release)

Basic path forward recommended by NRC: Provide evaluation of potential impact of different daughter mobility on dose, with bounding calculations on dose impact, or adjust inventory of K_d values. Provide K_d values used for Pb-210.

Proposed DOE approach: Perform evaluation, provide information as indicated.

Key points:

- Evaluation of MEPAS runs identified higher mobility progeny that could impact dose
  - Considering progeny with lower basemat K_d and relative parent-progeny dose conversion factors
- Values for U and Pu and their progeny in basemat are not a concern
  - High solubility in contaminated zone restricts movement into basemat
  - Analysis with parent K_d at minimum progeny K_d value supports this conclusion
- Overall conclusion – assigning parent K_d to progeny has no effect on dose
- In response to question, MEPAS used parent (U-238) K_d for Pb-210 K_d

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 50

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 46 (near field release)

Basic path forward recommended by NRC: Provide basis for assumption that cracks in grout would remain saturated or update extent of oxidation. Provide basis for estimating or bounding impact of grout oxidation on Tc-99 release during 10,000 year period.

Proposed DOE approach: Provide requested information.

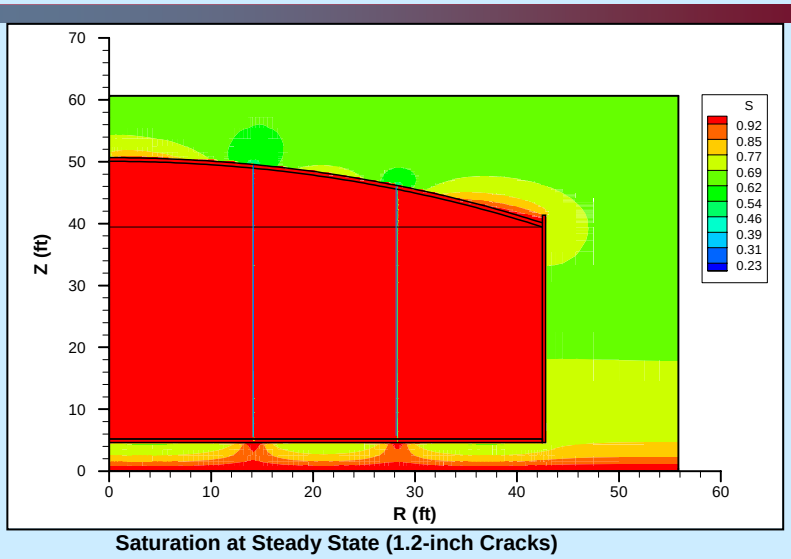
Key points:

- In model associated with PODD Figure 2-35, simulated annular cracks were actually unsaturated (note blue lines in figure)
- Transport model considered only liquid-phase oxygen transport, under-predicting oxygen concentrations, but this model is appropriate because oxygen concentration at grout boundaries would be at saturation for practical purposes
  - Liquid phase diffusion within grout dominates, so including gas phase would not significantly alter slag reduction capacity
- Over time, grout will become saturated by drawing water from surrounding soil

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 51

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

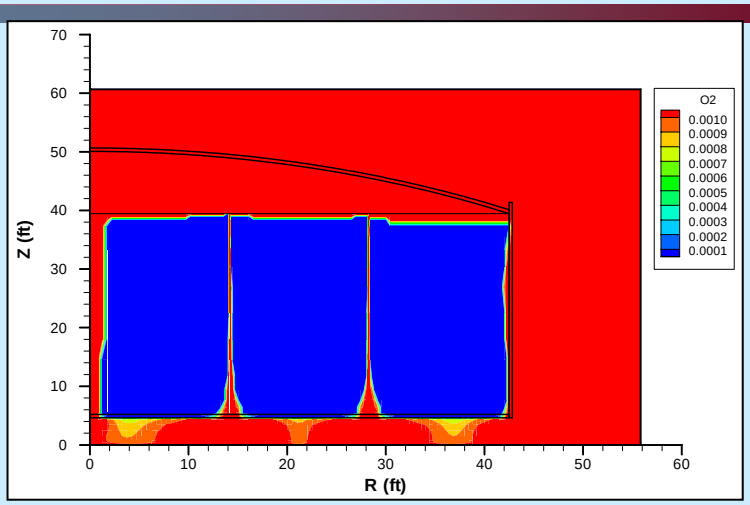
Comment 46 – new figure (1)



Saturation at Steady State (1.2-inch Cracks)

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 52

Comment 46 – new figure (2)



Predicted Oxygen Concentrations in Pore Water After 10,000 Years for Annular Crack Scenario

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE

Comment 47 (near field release)

Basic path forward recommended by NRC: Provide basis for modeling cracked basemat as sand with concrete K_d values, or provide alternative model.

Proposed DOE approach: Provide basis for approach and sensitivity analysis results.

Key points:

- Model assumes substantial degradation via higher basemat vertical hydraulic conductivity:
  - 9.6E-09 to 6.6E-03 cm/sec
- Using constant K_d values consistent with Saltstone and INL tank modeling
- Sensitivity analyses presently being performed to evaluate varying basemat thickness and K_d

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 48 (near field release)

Basic path forward recommended by NRC: Provide data to show basemats are intact, or assess impact of current cracks on public and intruder doses. Provide basemat design details, describing expected effects of drainage slots on basemats.

Proposed DOE approach: Provide requested information.

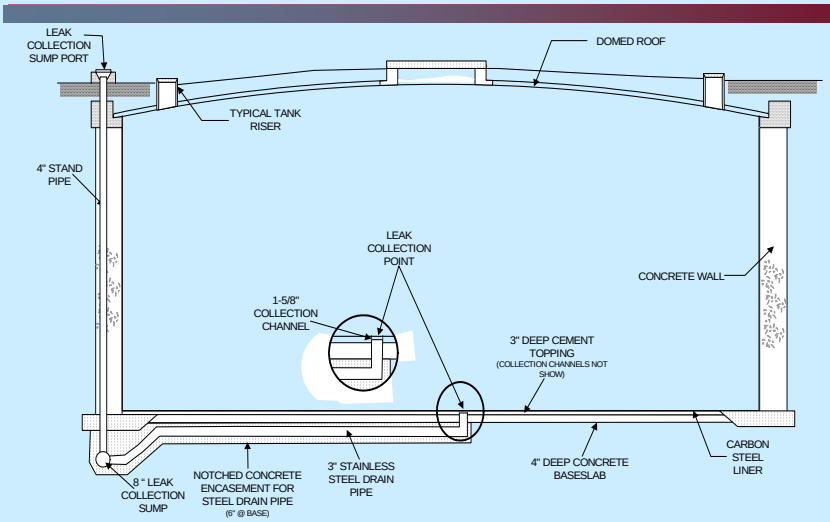
Key points:

- Sensitivity study to evaluate impacts of 4-inch basemat and no basemat in progress
  - Results bound drainage channel condition and potential fast flow paths
- Basemat foundation and floor were constructed of Class C concrete poured without construction joints (all other design details being provided)
- Concrete testing was performed in accordance with DuPont specification (information being provided)
- Settlement survey data from 1991-2001 showed <1/4-inch settlement/heave for tanks
  - Survey report notes results "do not indicate any significant trends or distress"

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 55

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 48 – new figure



Typical Type IV Waste Tank

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 56

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 49 (far field release)

Basic path forward recommended by NRC: Explain how fluxes in various layers are calculated, addressing pore water velocity and flow through basemat.

Proposed DOE approach: Explain how MEPAS treats the 3.7 cm/yr water that flows through source layer when it reaches the basemat with 0.3 cm/yr hydraulic conductivity, explain how Darcy velocities are used with respect to MEPAS input values.

Key points:

- Unsaturated layer travel time depends on both infiltrating water incident rate and layer water transmission rate:
  - Incident Darcy velocity < permeability, then layer will transmit only incident water
  - Incident Darcy velocity >permeability, then layer will only transmit water based on permeability
  - Basis examples for basemat and underlying vadose zone exhibit this relationship
- Entire source term is accounted for in combined early and later releases
- MEPAS model with early phase water and mass flux flowing around basemat was evaluated to bound faster pathway of radionuclide release (no dose increase resulted)

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 57

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 50 (far field release)

Basic path forward recommended by NRC: Provide basis for (1) hydraulic conductivity of disturbed soil being the same as for undisturbed soil and (2) that riprap layers will not result in high long-term infiltration to the tanks.

Proposed DOE approach: Provide the requested information.

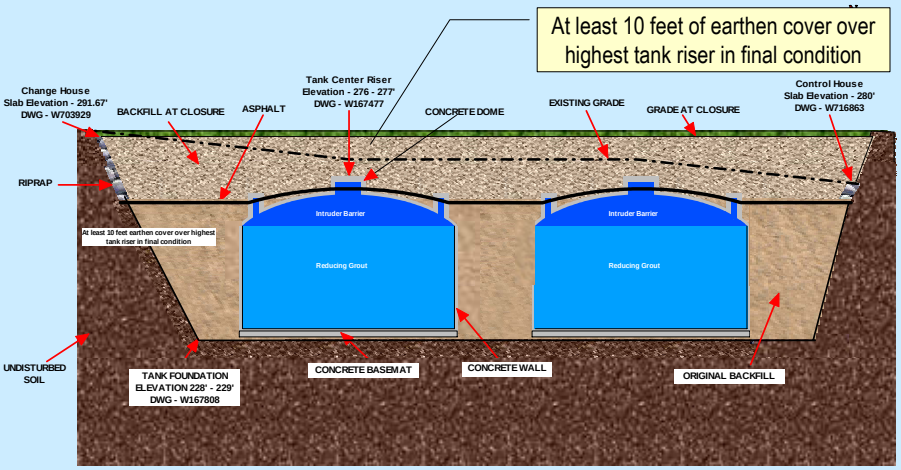
Key points:

- Soil of interest under tank was undisturbed until basemat and wall foundation were poured; therefore, use of undisturbed values is reasonable
- The riprap and disturbed soil around and above the tank are not associated with MEPAS soil input parameters
  - Significant conservatism comes from ignoring the effect of the earthen cover and low-permeability barrier on infiltration rate
- The sensitivity study on the 40 cm/yr infiltration rate will show the effect of doubling the infiltration rate on peak Tc-99 dose for both tanks
  - Bounds possible effect of riprap channeling flow toward tanks

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 58

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 50 – new figure



Not to scale

Concept for Soil Cover and Cap

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 59

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 51 (model implementation)

Basic path forward recommended by NRC: Provide detailed information to clarify the overall computational approach, provide MEPAS files for dose conversion factor calculations, and provide a map with all receptor locations and other details.

Proposed DOE approach: Provide requested information.

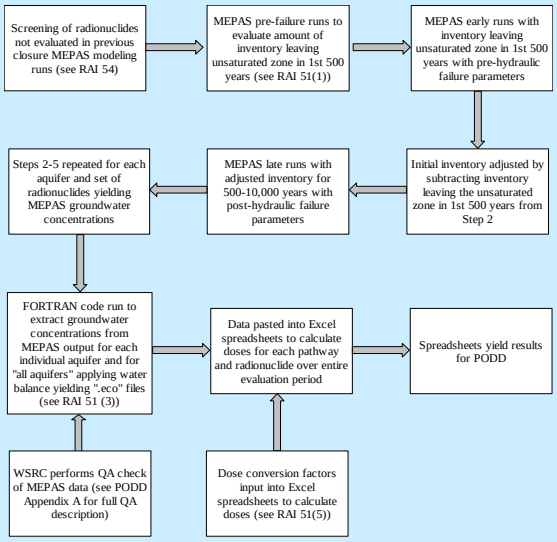
Key points:

- All of the requested information is being provided, including addressing each of the 7 areas listed in the Comment BASIS:
  1) MEPAS calculation mechanics, including why code was run 3 times
  2) Algorithm used in early MEPAS runs
  3) FORTRAN program functions
  4) How aquifer water balance percentages were included
  5) How pathway dose conversion factors were calculated
  6) Pathways included in and excluded from Table 4-15 thru 4-35 calculations
  7) Distances used from tanks to seepline receptor

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 60

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

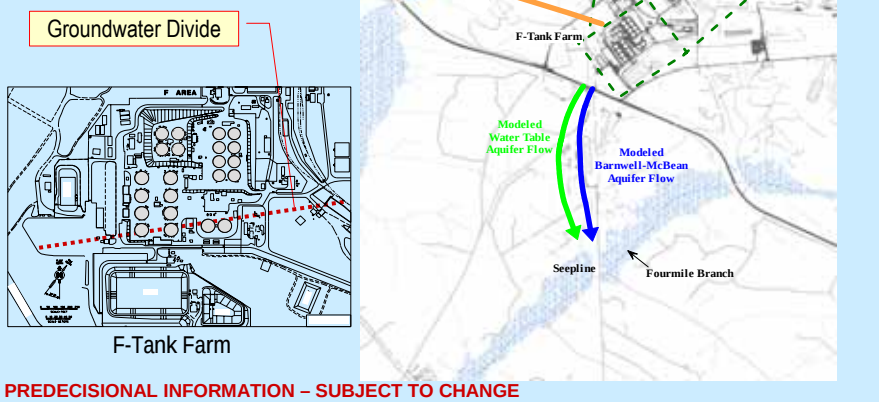
Comment 51 – flowsheet



PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 61

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determina

Comment 51 –new map



PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 62

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 52 (model implementation)

Basic path forward recommended by NRC: Provide sensitivity to time-stepping [use of MEPAS 70-year interval averages] in the analysis, with a comparison to a separate calculation to demonstrate that MEPAS results are reasonable.

Proposed DOE approach: Provide requested information, including PORFLOW comparison.

Key points:

- Additional MEPAS base case and sensitivity runs are being performed with 1-year intervals
- PORFLOW is being used for side-by-side comparison
  - Results expected to show MEPAS results to be reasonable and generally conservative

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 63

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 53 (model implementation)

Basic path forward recommended by NRC: Explain procedure used to transform Pa-233 and Ra-225 concentrations in .eco files to those used in dose calculation.

Proposed DOE approach: Provide requested information.

Key points:

- Pa-233 and Ra-225 are included because they are alpha emitter progeny or appear in a decay chain where successive progeny are alpha emitters
- They must be removed after MEPAS evaluation because MEPAS cannot evaluate decay chains without including non-alpha emitting radionuclides
  - They are eliminated in alpha concentration and dose spreadsheets because inclusion would be erroneous
- This is the only transformation of radionuclides listed in the .eco files

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 64

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 54 (model implementation)

Basic path forward recommended by NRC: Describe procedure used to screen radionuclides out of the groundwater analysis for Tanks 18 and 19.

Proposed DOE approach: Provide requested information, including addressing effect of thick basemats in Tank Group 3 tanks used in screening.

Key points:

- Several radionuclides not included in previous FTF MEPAS models were identified in tanks
- Screening performed using dose conversion factors, half-life, and K_d values
- Conservative approach was taken in which new radionuclides were modeled using MEPAS assuming that their FTF inventory released at tank group closest to receptor location
- Because several radionuclides did not appear in MEPAS database, suitable surrogates were used
- Results of MEPAS modeling appear in .eco files (Appendix C and on data CD)
- Significance of new radionuclides to all-pathway dose was evaluated through comparison with Tc-99 and Np-237 dose estimates
  - Results indicated either 0 due to short half-life or << than Tc-99 and Np-237 doses, therefore new radionuclides were screened from groundwater analyses
  - Effects of thick Group 3 basemats were taken into account

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 65

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 55 (model implementation)

Basic path forward recommended by NRC: Provide more detailed explanation for Tc-99 sensitivity analysis results. If MEPAS analysis is not changed, provide justification that PA provides supportable dose prediction

Proposed DOE approach: Provide requested information, changing MEPAS analysis protocol to produce annual peak doses rather than 70-year averages.

Key points:

- All Tank 19 and 18 base case and sensitivity studies are being reanalyzed based on annual dose, rather than the average dose over 70-year intervals used initially
- Preliminary results indicate that the use of 70-year averages masked actual sensitivities to parameter variations in one case

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 66

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 56 (model implementation)

Basic path forward recommended by NRC: Provide animal uptake factors as part of exposure calculations in the PODD, with references to source documents.

Proposed DOE approach: Provide requested information and a sensitivity analysis using the latest uptake factors.

Key points:

- The source for the bioaccumulation factors used (in MEPAS database) is primarily NUREG/CR-5512
- A 2003 PNL report (PNNL-13421) compiles agricultural and animal product transfer factor data from various sources
  - IAEA Handbook is primary source
- Comparison of MEPAS factors to PNNL-13421 values showed some differences
  - MEPAS values are more conservative in many cases, same in others, less conservative for beef uptake of Np-237 (5.5E-05 vs. 1.0E-03 IAEA)
- Sensitivity analysis using later PNL report is being performed – results to be provided

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 67

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 57 (model implementation)

Basic path forward recommended by NRC: Explain the basis for the water content and density values used in the MEPAS modeling (with respect to grout parameters, which appear inconsistent).

Proposed DOE approach: Provide requested information.

Key points:

- Grout itself was not modeled; the upper layer modeled was the waste itself
- Densities and water vapor contents for the upper layer are based on actual waste density and water vapor content
  - 77.5 volume % moisture content comes from the tank characterization reports, which show waste sludge solids moisture content of 70 to 85 Volume %
  - Bulk density value of 1.0 g/mL, also based on waste characterization data, is more conservative than use of higher grout density

.

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 68

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 58 (model implementation)

Basic path forward recommended by NRC: Clarify whether code validation or analyses were performed to provide confidence in MEPAS model, describing activities to verify that the calculations were performed correctly.

Proposed DOE approach: Provide available analyses performed for validation of release, transport, and dose calculations, and information on MEPAS ver. 4.1 validation.

Key points:

- Benchmarking and comparisons indicate model functions as designed
  - Examples of applications, model evaluation, comparison, and benchmarking appear on MEPAS website
  - MEPAS has been studied by USEPA and reviewed by NAS
- Recent SRS comparison to PORFLOW produced results of same general magnitude
- Modeling results are being compared with analytical solution for Tc-99 K_d change (Comment 44)

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 69

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 59 (sensitivity analyses)

Basic path forward recommended by NRC: Perform sensitivity analyses to evaluate the potential for faster release of Np from the waste form, combining them with other uncertainty analyses. Assess effects of uncertainty in literature-based soil Np K_d values.

Proposed DOE approach: Perform requested analyses.

Key points:

- An additional sensitivity analysis being performed involves decreasing Np K_d values for contaminated zone and basemat
- No sensitivity analysis was performed for soil or clay Np K_d values because the values used tended to be the lowest seen in the literature
- Sources of base case Np K_d value for the contaminated zone and basemat (5000 mg/L) were Bradbury and Sarott and Kaplan
- Sensitivity analysis results will be provided

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 70

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 60 (sensitivity analyses)

Basic path forward recommended by NRC: Compare the range of uncertainty values considered in Section 5 to the expected variability range for dispersivity, inventory, water balance, and infiltration rate.

Proposed DOE approach: Provide requested information, addressing basis for estimated uncertainty.

Key points:

- Dispersivity: Data on expected range are provided, 0.025 value used in sensitivity analysis for longitudinal dispersivity bounds expected variations on low side (maximum dose)
- Inventory: Inventory uncertainty is being addressed (Tc-99 and Np-237 concentrations based on 95% UCL on sample average), 2X inventory used in sensitivity analysis is expected to bound upper limit
- Aquifer water balance: Expected variations on 31/65/4 assumed balance in MEPAS model are addressed, 80/20/0 balance in original sensitivity study and Congaree variations in additional sensitivity analyses bound potential variations
  - PORFLOW modeling also supports MEPAS base case with 31/65/4 balance
- Infiltration rate: Expected variations of 22-45 cm/yr based on historical data are bounded by sensitivity study 20 and 80 cm/yr values

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 71

SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination

Comment 61 (sensitivity analyses)

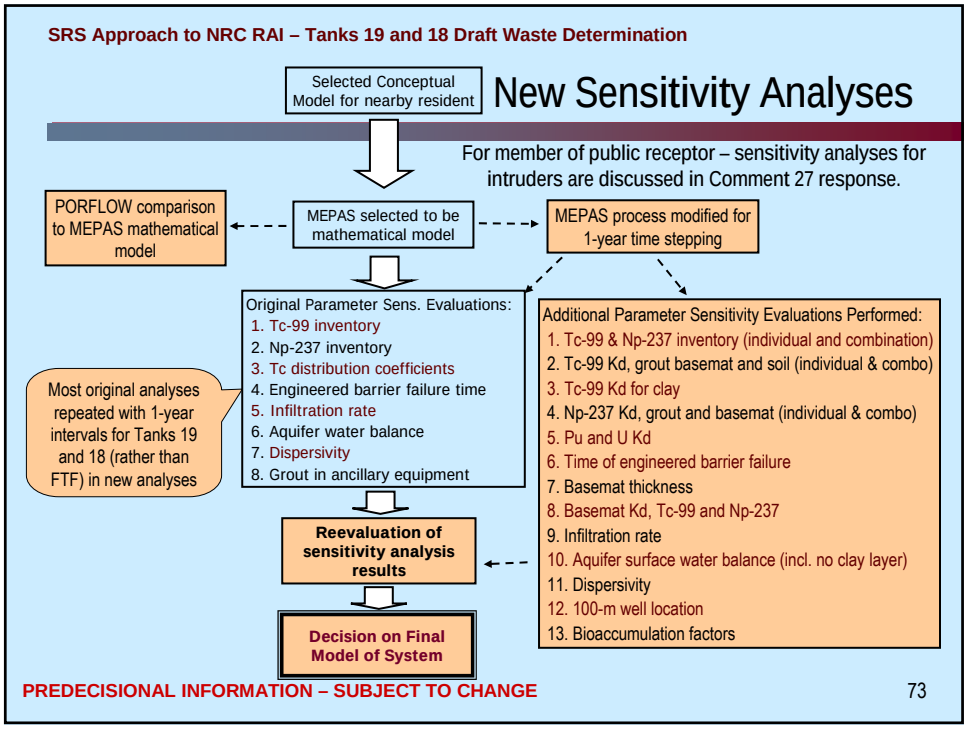
Basic path forward recommended by NRC: Perform expanded sensitivity analysis to address 7 issues in the BASIS and any additional ones that DOE does not have adequate information to resolve at this time.

Proposed DOE approach: Perform additional sensitivity analyses.

Key points:

- Variety of additional sensitivity analyses are being performed for member of the public receptor, all with 1-year time increments (see figure)
  - Focused on key radionuclides (Tc-99 and Np-237) and Tanks 19 and 18
- Additional combination sensitivity analyses being performed for both tanks
- Results to be provided and placed into context with regard to the base cases
- Separate summary report also to be provided

PREDECISIONAL INFORMATION – SUBJECT TO CHANGE 72


SRS Approach to NRC RAI – Tanks 19 and 18 Draft Waste Determination
Selected Conceptual Model for nearby resident
New Sensitivity Analyses
For member of public receptor – sensitivity analyses for intruders are discussed in Comment 27 response.
PORFLOW comparison to MEPAS mathematical model
MEPAS selected to be mathematical model
MEPAS process modified for 1-year time stepping
Original Parameter Sens. Evaluations:
1. Tc-99 inventory
2. Np-237 inventory
3. Tc distribution coefficients
4. Engineered barrier failure time
5. Infiltration rate
6. Aquifer water balance
7. Dispersivity
8. Grout in ancillary equipment
Most original analyses repeated with 1-year intervals for Tanks 19 and 18 (rather than FTF) in new analyses
Additional Parameter Sensitivity Evaluations Performed:
1. Tc-99 & Np-237 inventory (individual and combination)
2. Tc-99 Kd, grout basemat and soil (individual & combo)
3. Tc-99 Kd for clay
4. Np-237 Kd, grout and basemat (individual & combo)
5. Pu and U Kd
6. Time of engineered barrier failure
7. Basemat thickness
8. Basemat Kd, Tc-99 and Np-237
9. Infiltration rate
10. Aquifer surface water balance (incl. no clay layer)
11. Dispersivity
12. 100-m well location
13. Bioaccumulation factors
Reevaluation of sensitivity analysis results
Decision on Final Model of System
PREDECISIONAL INFORMATION – SUBJECT TO CHANGE
73