Savannah River Remediation

We do the right thing.

Proposal to Cease Waste Removal Activities in Tanks 18 and 19 and Enter Sampling and Analysis Phase

October 1, 2009

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Manager, Closure & Waste Disposal Authority

Meeting with DOE-SR and SCDHEC

SRR-CWDA-2009-00030

Presentation Outline

- Meeting Objective
- Background
- Waste Removal History
- Results of Waste Removal Efforts
- Evolution of the Sand Mantis™
- Sand Mantis™ Operations
- Practicality Considerations
- Review Against Performance Objectives
- Conclusion
- Request for DOE/DHEC/EPA Concurrence

Purpose of Meeting

Obtain mutual agreement among South Carolina Department of Health and Environmental Control, the U.S. Environmental Protection Agency and the U.S. Department of Energy to:

1. Discontinue waste removal activities in Tank 18 and Tank 19; and
2. Proceed with sampling and analysis activities in Tank 18 and Tank 19

Common Goals & Values

1. **Reduce operational risk and the risk of leaks to the environment by removing waste from tanks, and closing the tanks.**
2. Remove actinides from waste expeditiously since they impact on the environment most significantly if a leak occurs.
3. Maximize amount of waste ready for disposal in deep geologic repository. Make significant effort to ensure maximum amount of long lived radionuclides are disposed in a deep geologic repository.
4. Remove as much cesium as practical from salt waste and dispose in parallel with vitrified sludge.
5. Dispose of cesium as soon as practical to avoid having cesium only waste when sludge vitrification is complete.
6. Limit disposal of radioactive waste onsite at SRS so that residual radioactivity is as low as reasonably achievable.
7. Ensure DOE's strategy and plans are subject to public involvement and acceptance.

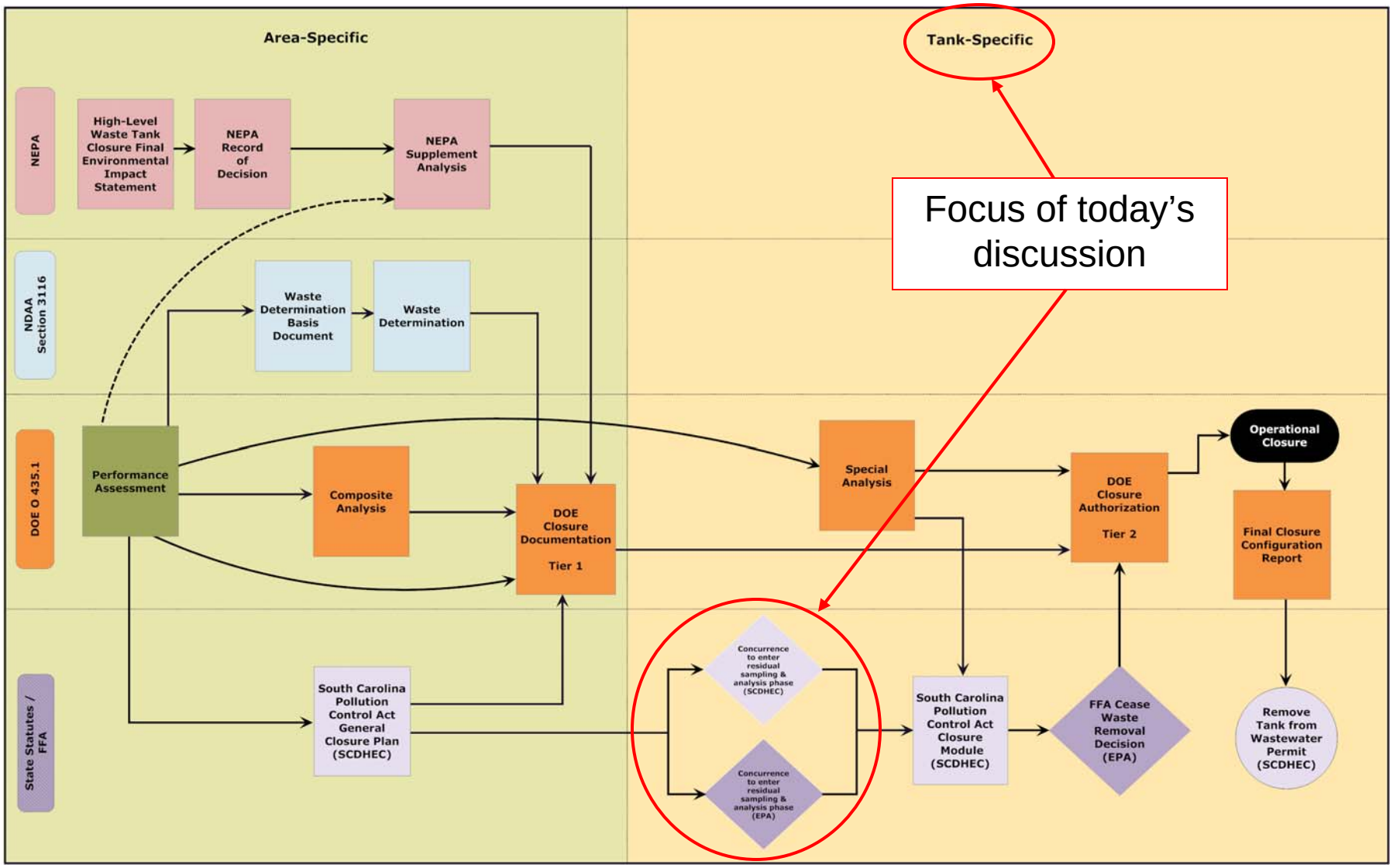
Meeting Drivers

The *Statement of Resolution of Dispute Concerning Extension of Closure Dates for Savannah River Site High-Level Radioactive Waste Tanks 19 and 18 states:*

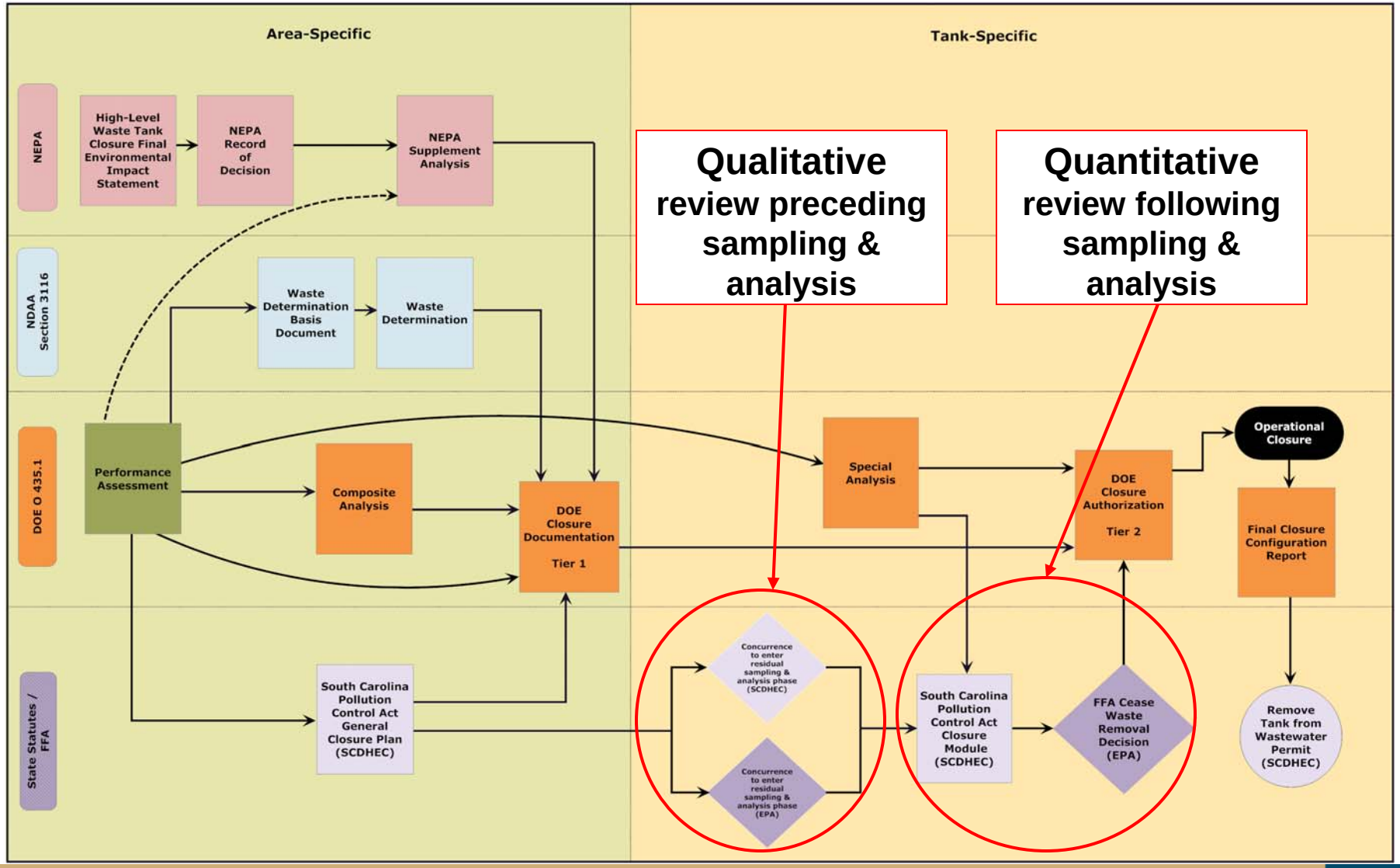
1. *DOE has initiated additional waste removal efforts from Tanks 19 and 18 and will continue waste removal efforts until DOE, SCDHEC and Environmental Protection Agency (EPA) agree that waste removal may cease. DOE expects to remove up to 75% of the current waste volume by 12/31/08.*

9b. *… When DOE considers waste removal to be complete, DOE shall notify EPA and SCDHEC and provide any supporting documentation to SCDHEC and EPA for review. DOE, SCDHEC and EPA shall mutually agree that waste removal activities may cease.*

Pathway to Closure



Pathway to Closure

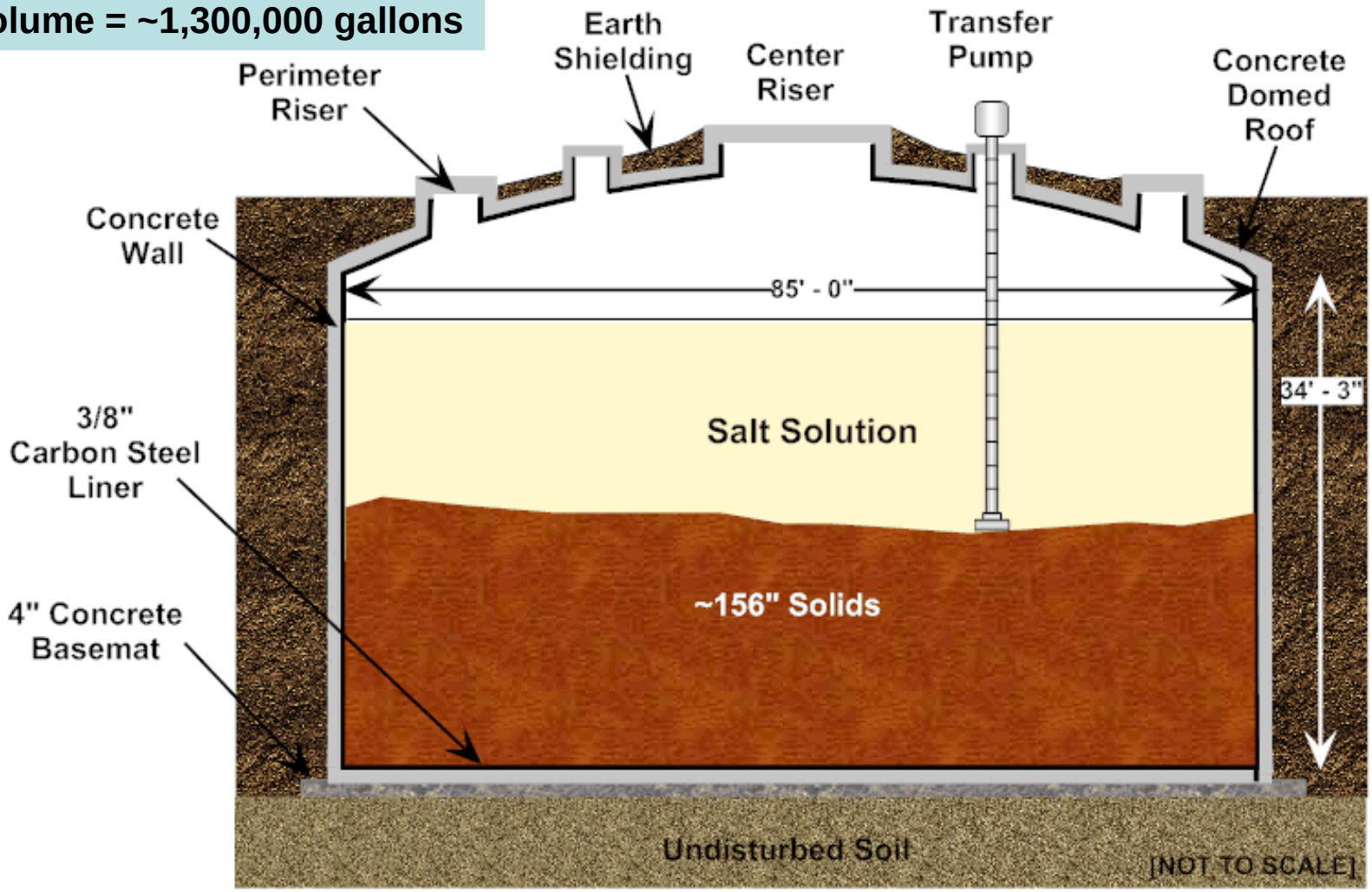


Executing the Agreement

- Initial conference call with agencies held in 5/09
- Assessment of results was pending evaporation of liquid in tanks
- Liquid Waste contract transition completed with SRR assuming responsibility on 7/1/09
- A series of high resolution photographs taken in tanks to determine status of evaporation / support volume estimation
- Residual surfaces now dry enough for residual volume estimation to support qualitative assessment
- Meeting today to seek three-agency agreement

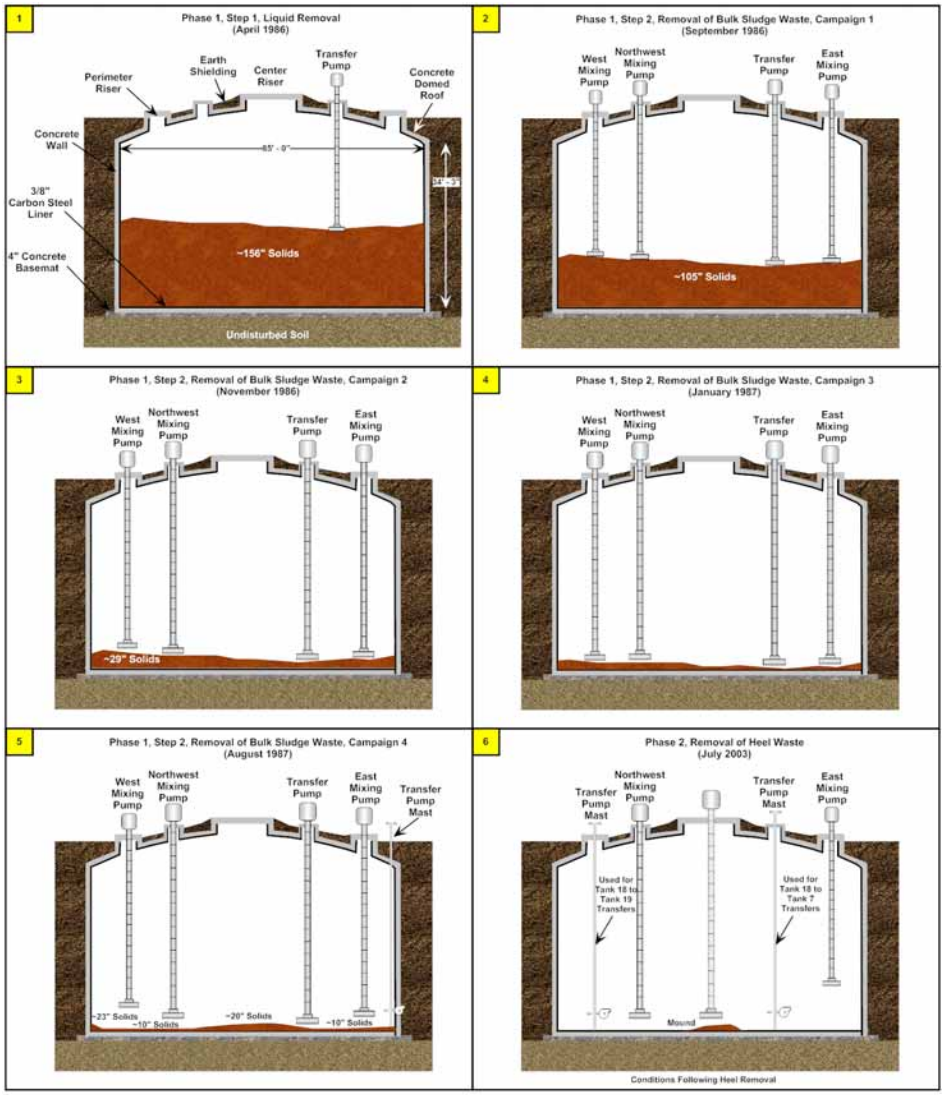
Tank 18 Waste Removal History

Initial Volume = ~1,300,000 gallons



Initial Condition at Liquid Removal Initiation

Tank 18 Waste Removal History



The numbers related to saltcake height represent approximate average height, except for panels 5 and 6, where the numbers represent maximum height.

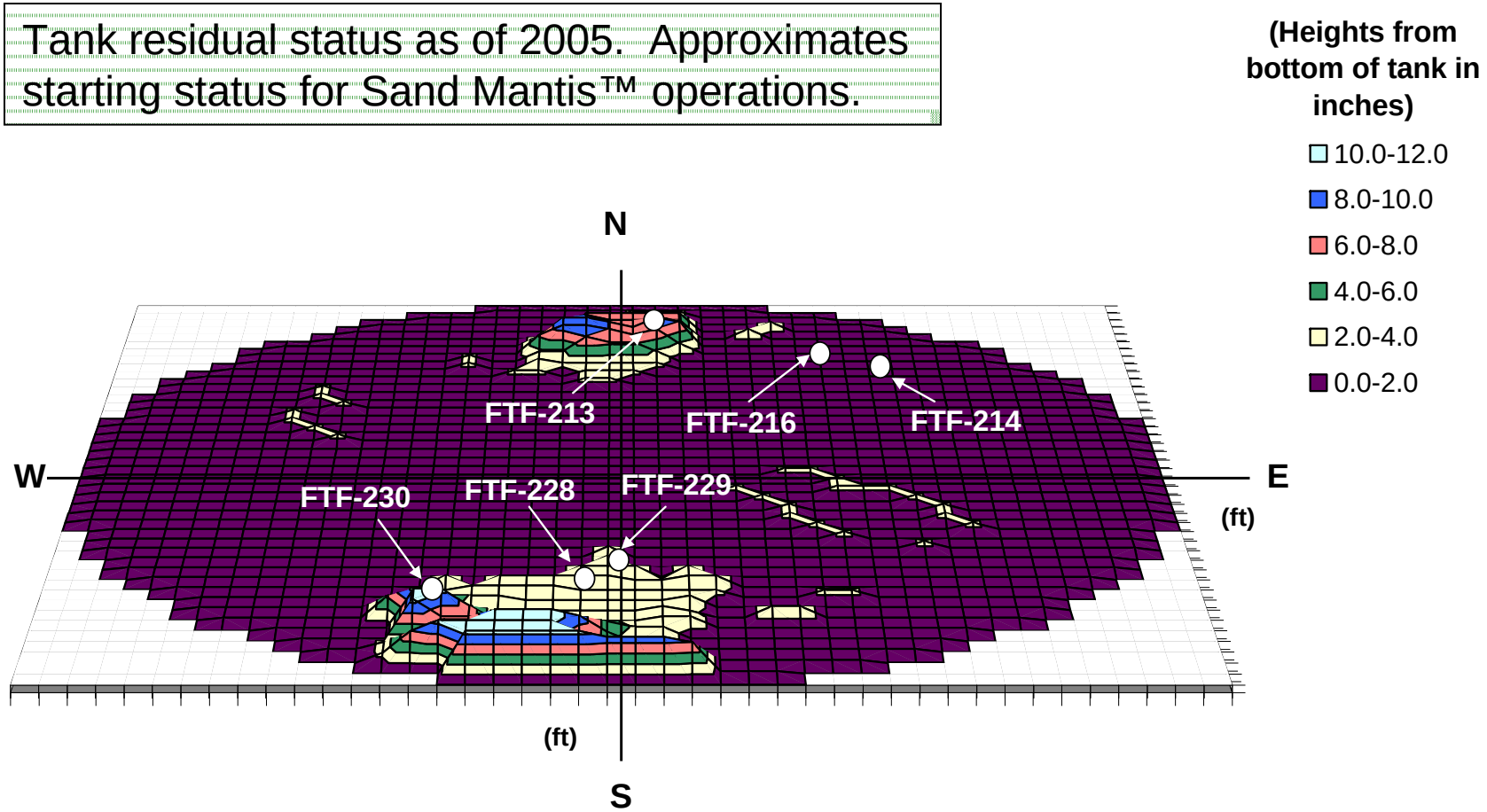
View of ADMP showing discharge nozzle.

View of ADMP showing suction screen (39 inch diameter).

Installation of the ADMP in the center riser of Tank 18

Tank 18 Waste Removal History

Tank residual status as of 2005. Approximates starting status for Sand Mantis™ operations.

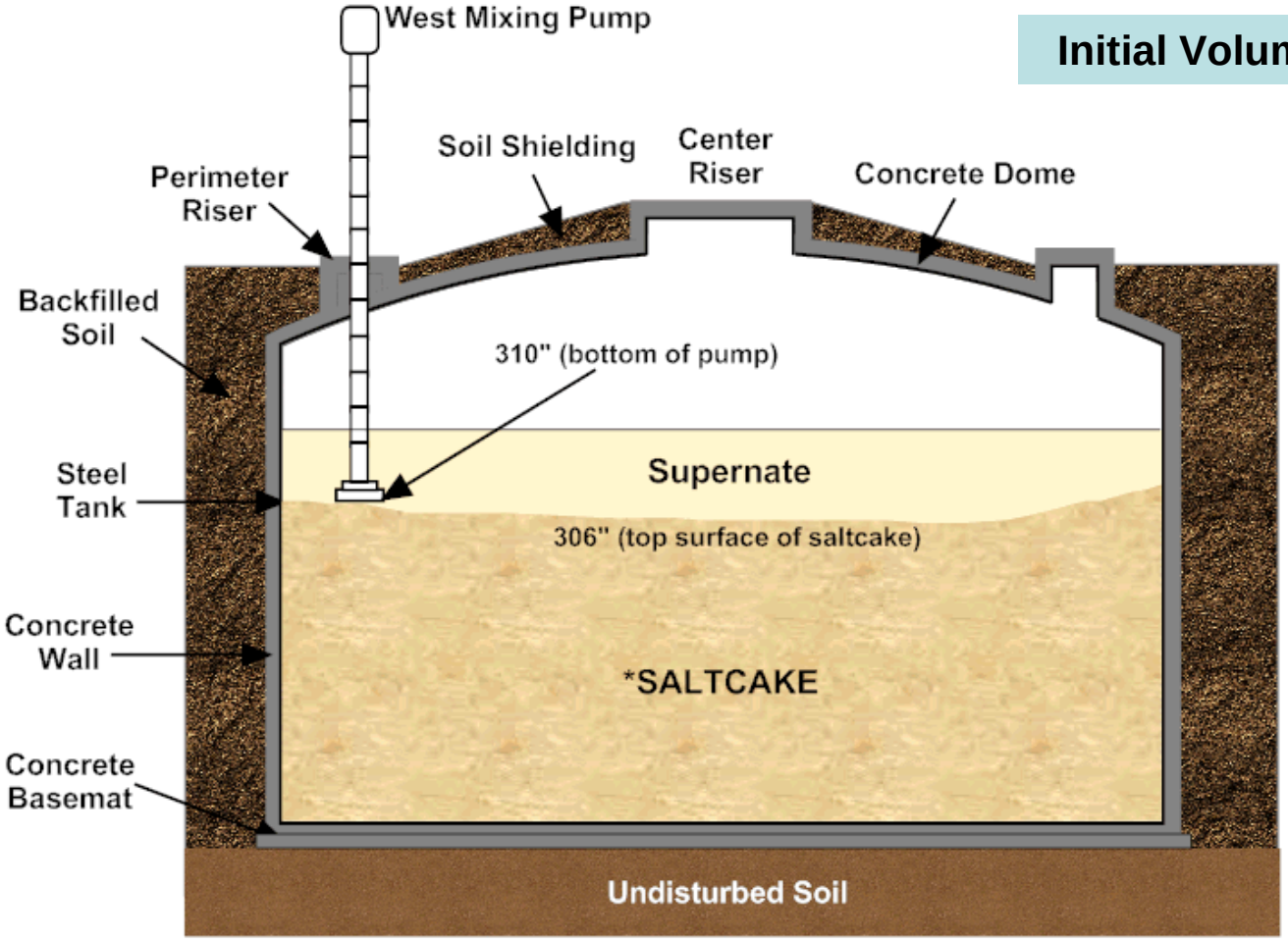


Note: Each square in the grid represents a 2 foot x 2 foot area of the tank bottom

There are a total of 1419 squares for Tank 18

Tank 19 Waste Removal History

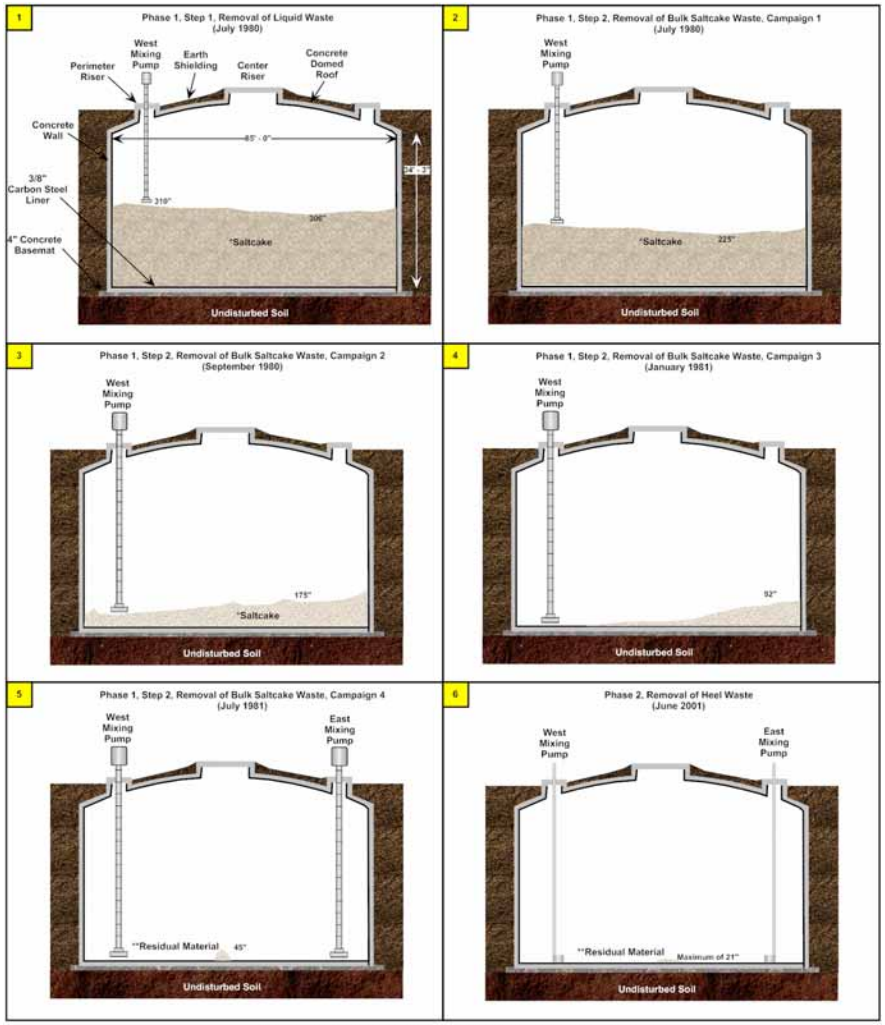
Initial Volume = ~1,300,000 gallons



*Saltcake includes crystallized salts, interstitial liquid, insoluble solids and zeolite solids.
**Numbers in inches indicate distance above the tank bottom.

[NOT TO SCALE] (January 1980)

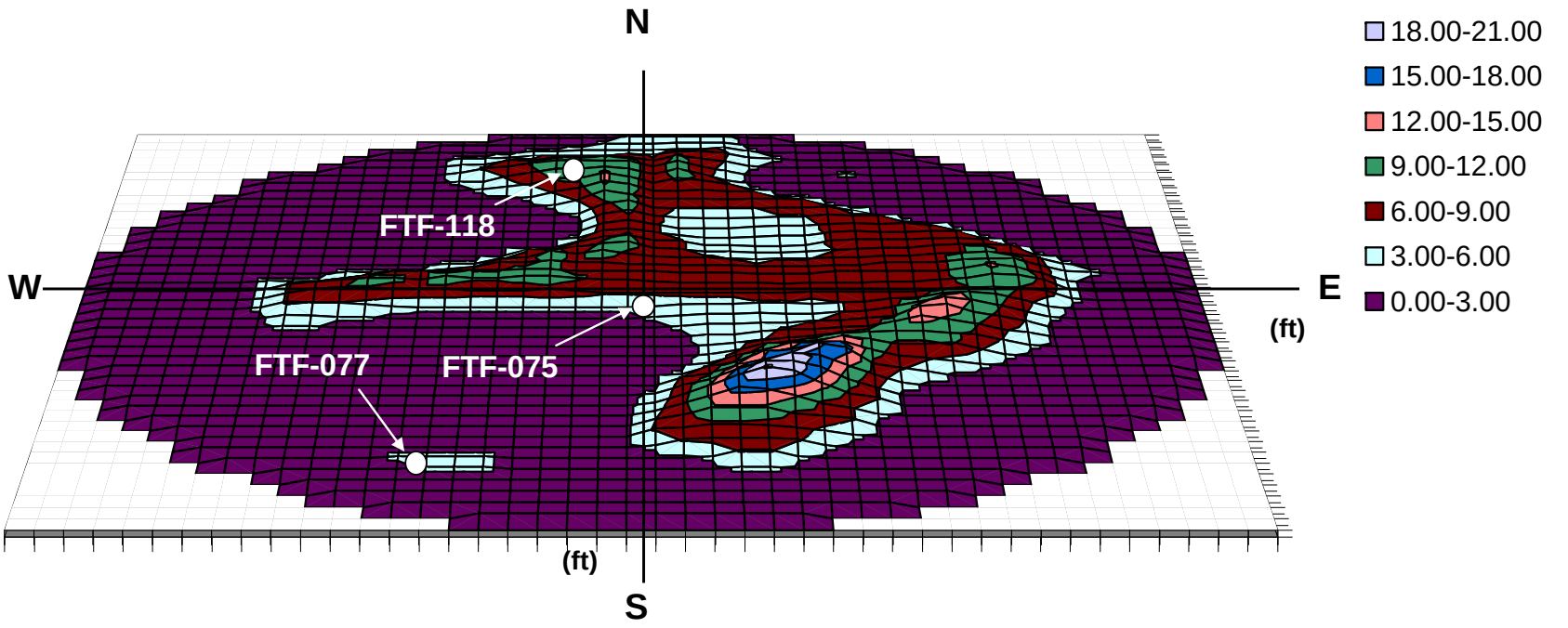
Tank 19 Waste Removal History



*Saltcake includes crystallized salts, interstitial liquid, insoluble solids, and zeolite solids.
**Residual material includes free liquid, interstitial liquid, insoluble solids, and zeolite solids.
The numbers related to saltcake height represent approximate average height, except for panels 5 and 6, where the numbers represent maximum height.
Note: Each panel represents condition at the end of each step.

Tank 19 Waste Removal History

Tank residual status as of 2005. Approximates starting status for Sand Mantis™ operations.



Note: Each square in the grid represents a 2 foot x 2 foot area of the tank bottom

There are a total of 1419 squares for Tank 19

Type IV Tank Status - 2005

	Tank 17	Tank 18	Tank 19	Tank 20
Total Additions to Tank (gal)	1,900,000	2,200,000	2,600,000	1,700,000
Total Residual Solids Volume (gal)	2,400	4,300**	15,100	1,000
Percent Zeolite	0%	46%	66%	0%
Total Residual Curies (Ci)*	2,260	19,000	63,400	540
Cs-137/Ba-137m Curies*	112	16,500	63,200	80
Percent Cs-137/Ba-137m	5%	**87%**	**99.7%**	15%

- Total curies includes Ba-137m and Y-90, and all radionuclides are decayed to Year 2020.

** This volume was estimated based on observations through standing liquid and considerably underestimated the actual volume of solids present in Tank 18 at the completion of that phase of heel removal.

Waste Removal History

- In 2001 and 2003, DOE completed bulk waste and initial heel removal activities on Tank 19 and Tank 18, respectively, following a formal technology selection process.
- In 2005, DOE submitted a draft NDAA Section 3116 Waste Determination for the closure of Tanks 18/19 to the NRC for consultation
- In March 2006, DOE sponsored a tank cleaning workshop to explore new, improved options
  - The technology that would become the Sand Mantis™ was identified
- Decision made to suspend closure activities pending exploration of this emergent technology
  - Had potential application for SRS Type IV tanks and Hanford tanks

Technology Selection

- Technology discovered at a SRS-sponsored exchange
- Utilized 32,000 psi water jets to create an aspirator
- Prototype easily collected and transported wet solids during the relatively short initial test periods
- Appeared to uniquely overcome the obstacle of fast settling of zeolite particles
- Changes to design required to go from concept to deployment in an 85-ft diameter waste tank

Technology Selection

Prototype "Aardvark" device

Conclusion of initial vendor visit:

"The device demonstrated by TMR has possibilities for further waste removal in Tanks 18 and 19. It has the capability of removing most, if not all, of the particulates from a surface, much in the same way a shop vacuum cleaner is used to clean a floor. The Mantis prototype (nicknamed the "Aardvark"), however, was operated under ideal shop conditions with short runs of hose, and short durations. A more involved demonstration is needed to prove efficacy of this technology."

Technology Deployment

- During extensive testing at SRNL, high pressure water sprays eroded equipment
- Determined to be undeployable without modifications
- Evaluated other mechanical options

- Pressure reduced from 32,000 psi to 17,500 psi
- Screen added to collection area to prevent damage due to tank debris

Grinder Installation

- Following equipment development, downstream issue identified
- Testing identified that the Sand Mantis™ negatively altered the physical characteristics of waste
- Grinder in receipt tank required to enable subsequent waste removal

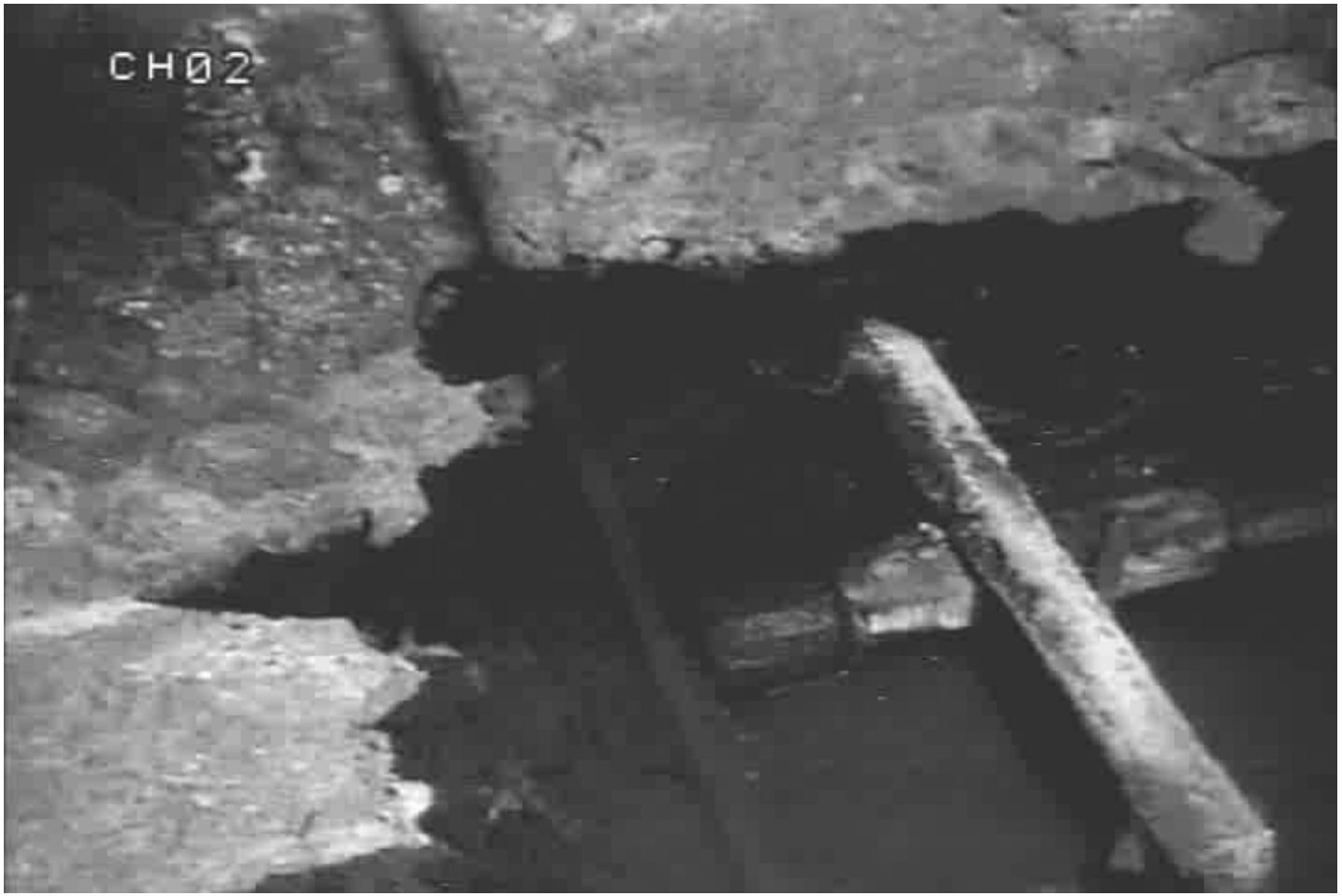
Final Sand Mantis™ Device

Performance Baseline

- Initial solids volumes were:
  - Tank 19 = 15,100 gallons
  - Tank 18 = 4,300 gallons

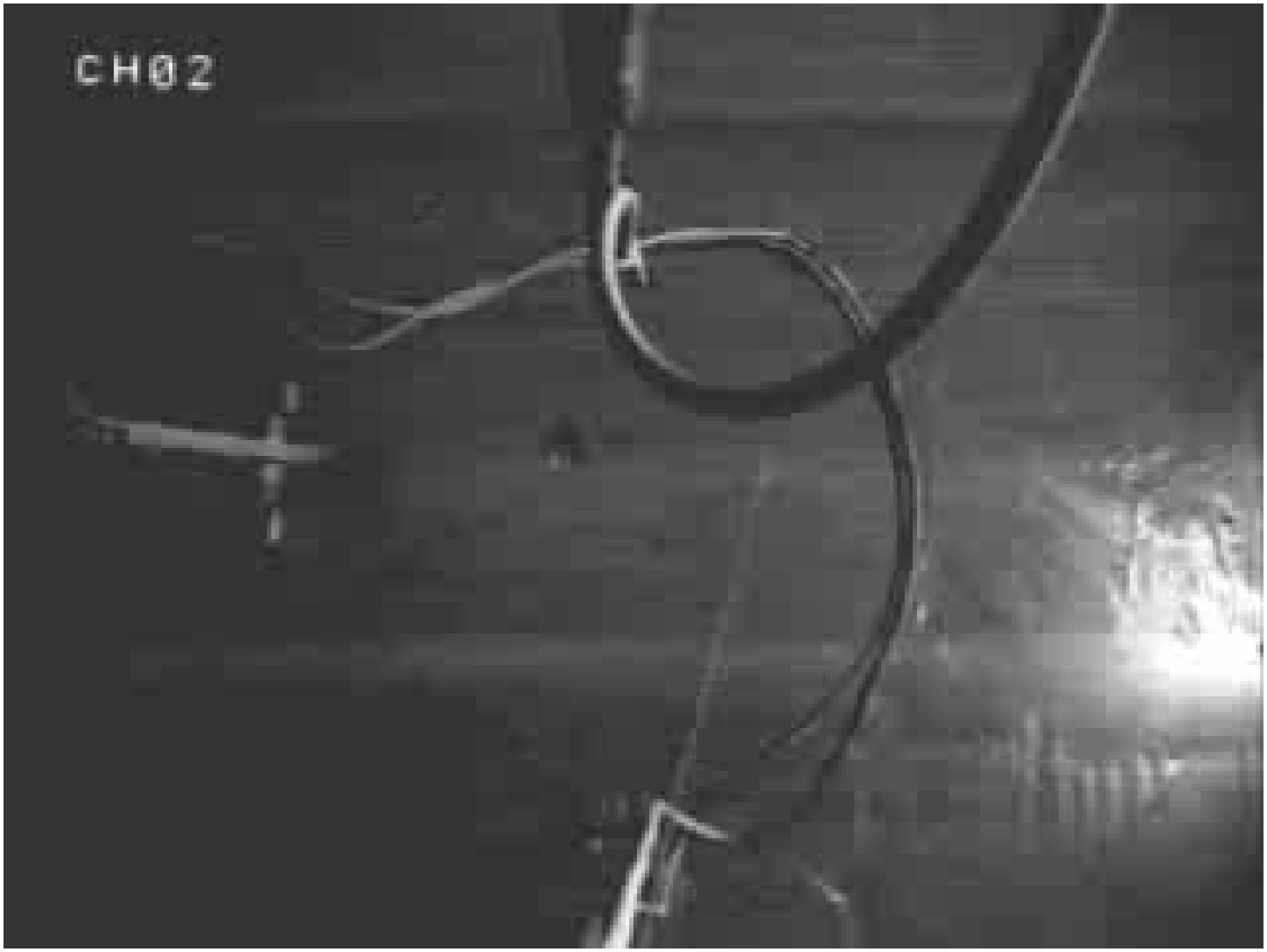
  } ~19,400 gallons
- Factory Acceptance Testing demonstrated that the device could remove material at ratio of 4:1 liquid added to tank solids removed
- Based on testing, predicted time to clean solids:
  - Tank 19 = 125 hours
  - Tank 18 = 36 hours
- The total "tank space budget" for cleaning Tanks 18 and 19 was 168,000 gallons
- Projected design life of 250 hours total operation of mantis
- Cost/schedule for development, design, & deployment of mantis: $15M / 2 years

Sand Mantis™ Operations

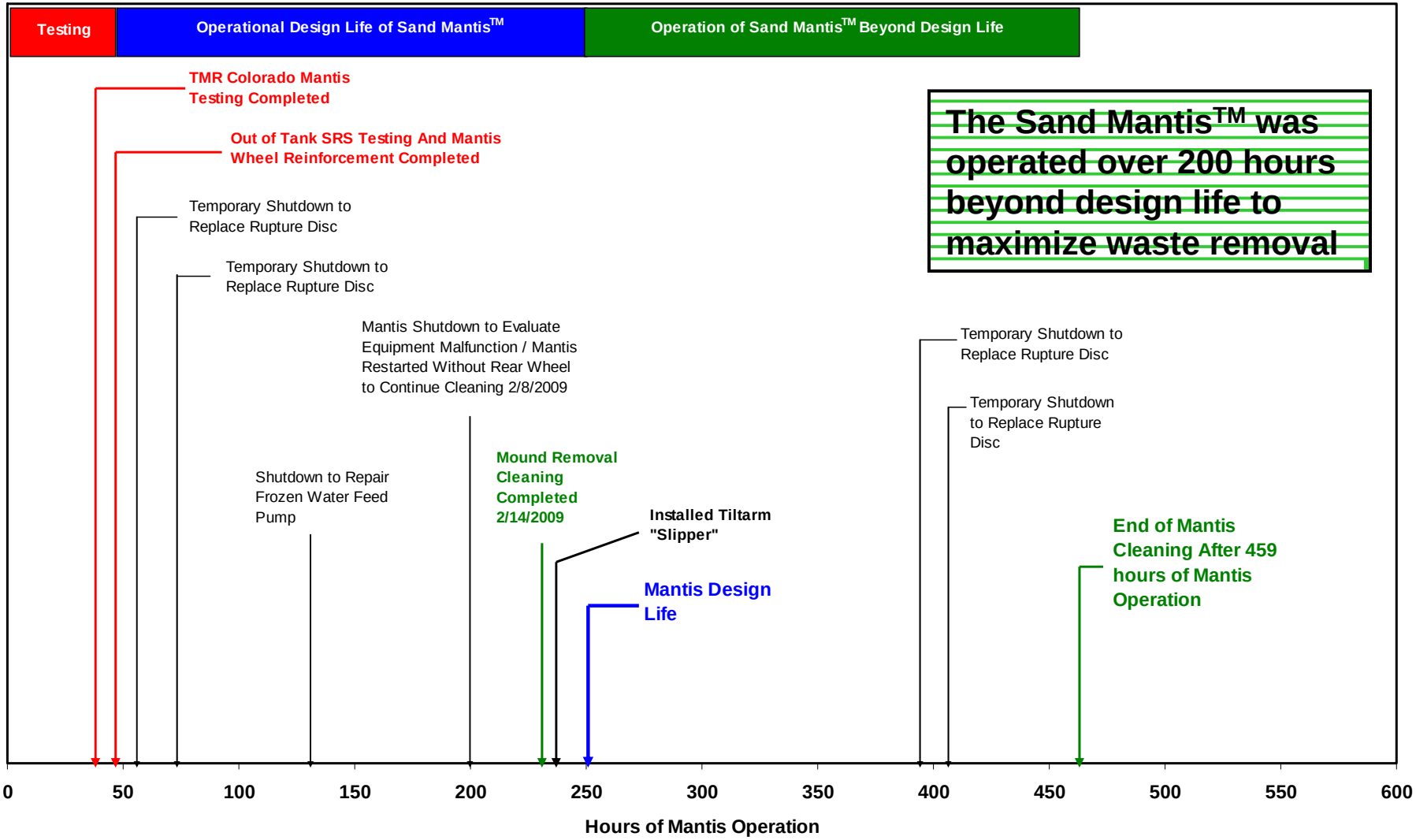


Sand Mantis™ Operations

Sand Mantis™ Operations

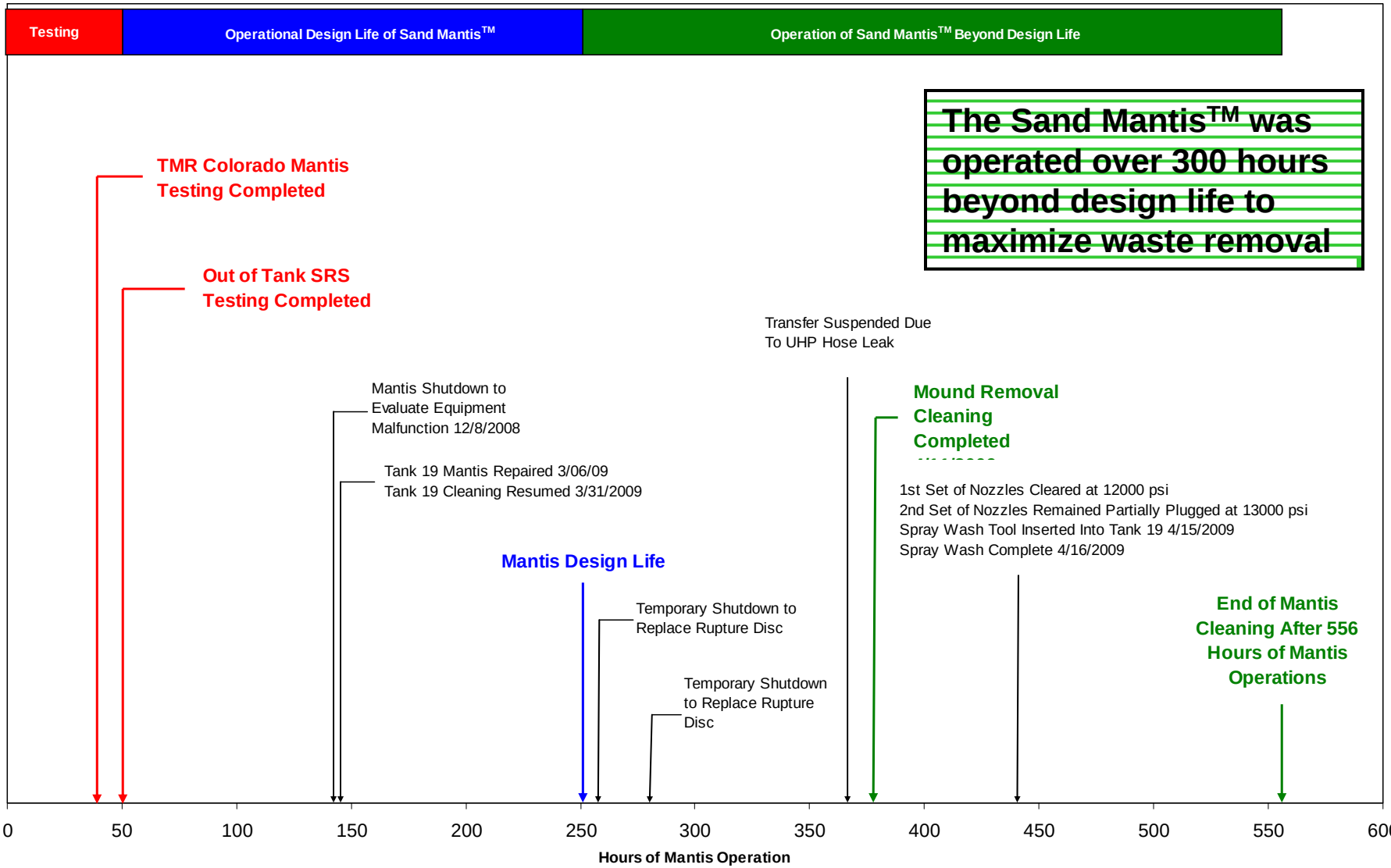


Tank 18 Timeline



The Sand Mantis™ was operated over 200 hours beyond design life to maximize waste removal

Tank 19 Timeline



Factors for Suspension of SandMantis™ Operation

- Visual observation of the tank floor
- Transfer line radiation reading trends indicated diminished removal of radioactivity
- No longer capable of corralling solids for the SandMantis™ to remove
- Significant increase in water addition to solids removal ratio
- Confirmatory operation over final ten 10’ x 10’ squares validated diminished removal capability
- Above factors indicate extent of technology reached

Sand Mantis™ Results

- After drying, initial inspection indicates:
  - Significant reduction in volume and curies of residual material
  - More solids remaining than initially estimated and discussed in May conference call
- Enhanced video equipment inspection indicates some residual on Tank 18 walls that could not previously be seen

In-Tank Performance

- Estimated removal of **~68%*** of solids on the floor of Tanks 18 and 19
  - Equates to additional removal of ~68%* of the curies from these tanks
  - Estimated solids volume remaining is ~6,200* gallons
    - Tank 18 - ~ 4,200* gallons (3,900 on floor; 300 in wall scale)
    - Tank 19 - ~ 2,000* gallons
- Actual in-tank run times significantly exceeded planning basis
  - Tank 18 = 415 hours of cleaning operation
  - Tank 19 = 474 hours of cleaning operation
- Total volume of waste created = ~250,000 gals

***Note: All values for Tanks 18 and 19 are estimates at this time pending final residual characterization.**

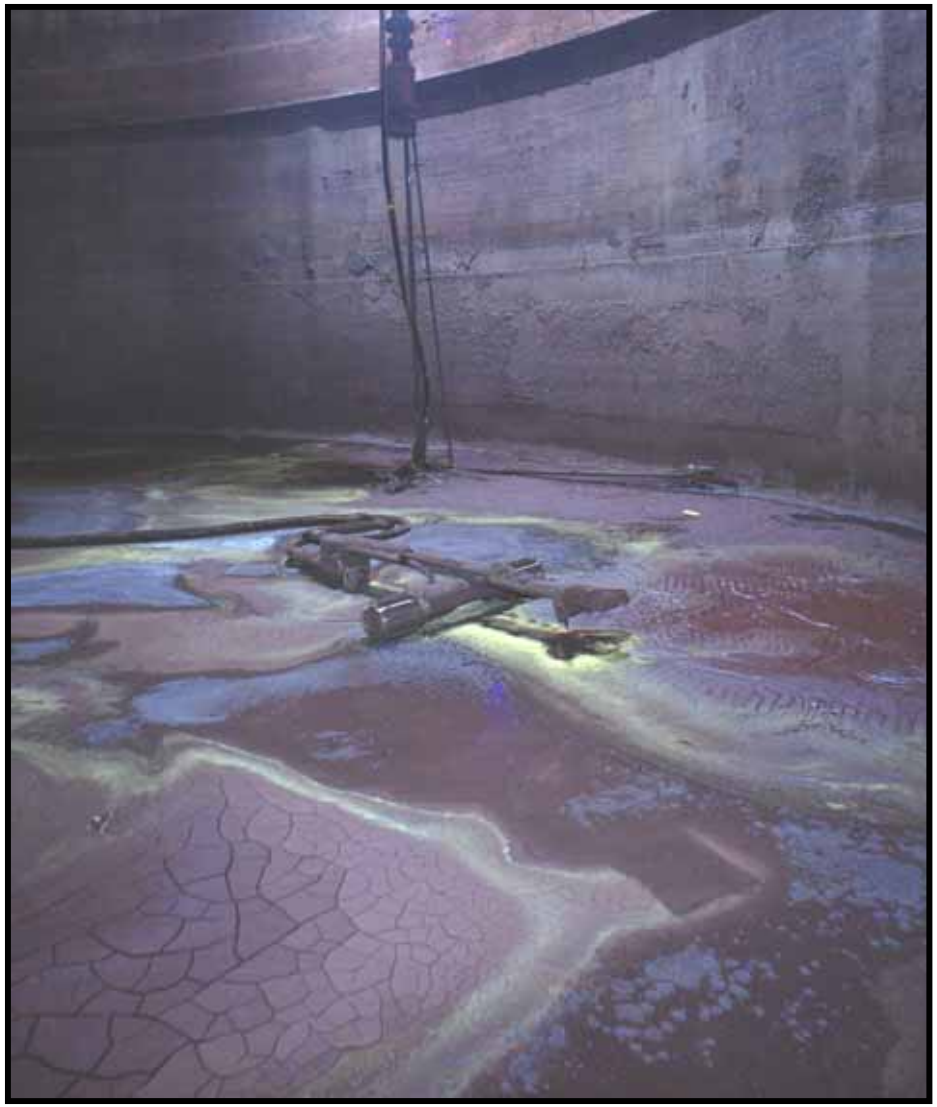
Type IV Tank Status - Current

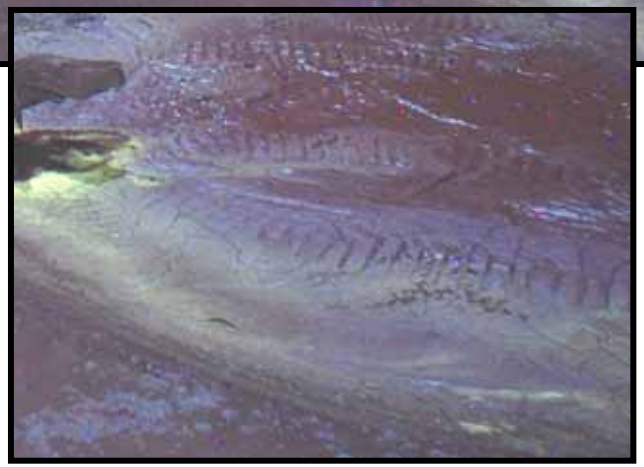
***Note: All values for Tanks 18 and 19 are estimates at this time pending final residual characterization.**

	Tank 18	Tank 19
Total Additions to Tank During Waste Removal (gal)	**2,310,000**	**2,740,000**
Total Residual Solids Volume (gal)	4,200	2,000
Percent Zeolite	46%	66%
Total Residual Curies Prior to Waste Removal (Ci)	~2,500,000	~2,200,000
Estimated Residual Curies At Closure (Ci)*	~18,600	~8,400
Cs-137/Ba-137m Curies*	~16,000	~8,300
Percent Cs-137/Ba-137m	**86%**	**>99%**
Percent Curies Removed At Closure (Ci)*	**99.3%**	**99.6%**

* Total curies includes Ba-137m and Y-90, and all radionuclides have been decayed to Year 2020.

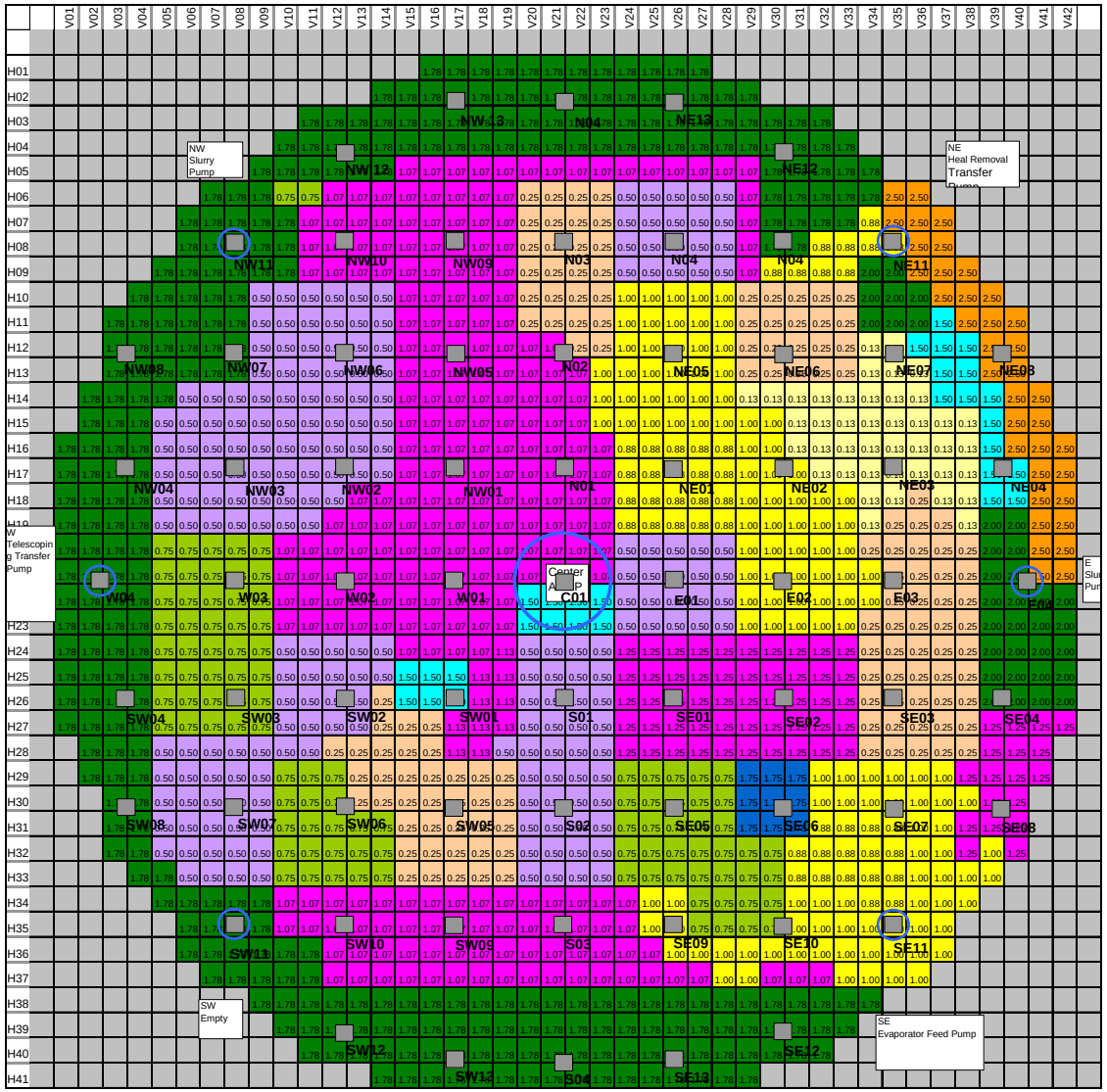
Tank 18 Today





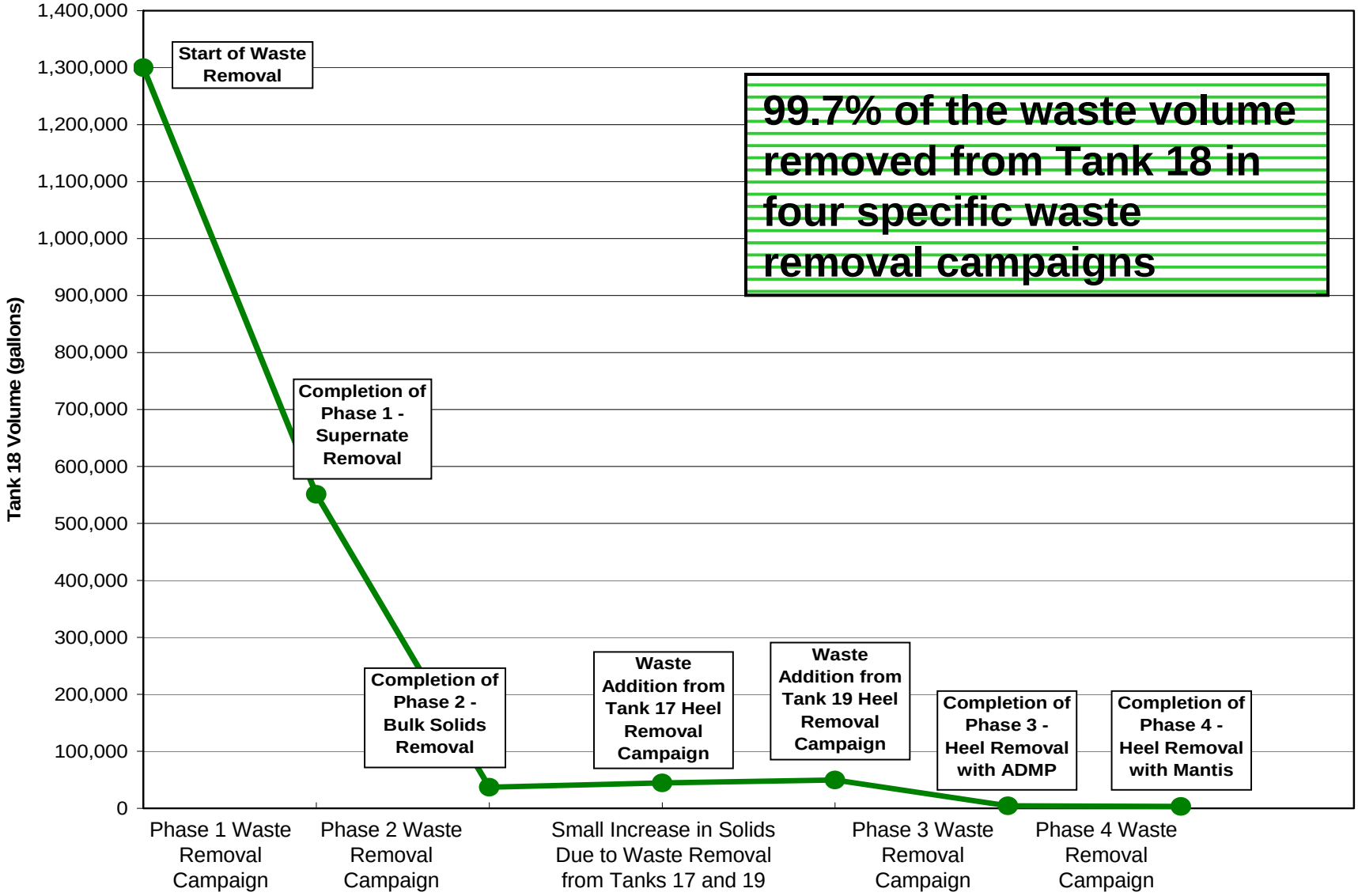
Tank 18 Today - Scale

Tank 18 Today



LEGEND	
inches	
2.50	
2.25	
2.00	
1.75	
1.50	
1.25	
1.00	
0.75	
0.50	
0.25	
0.125	

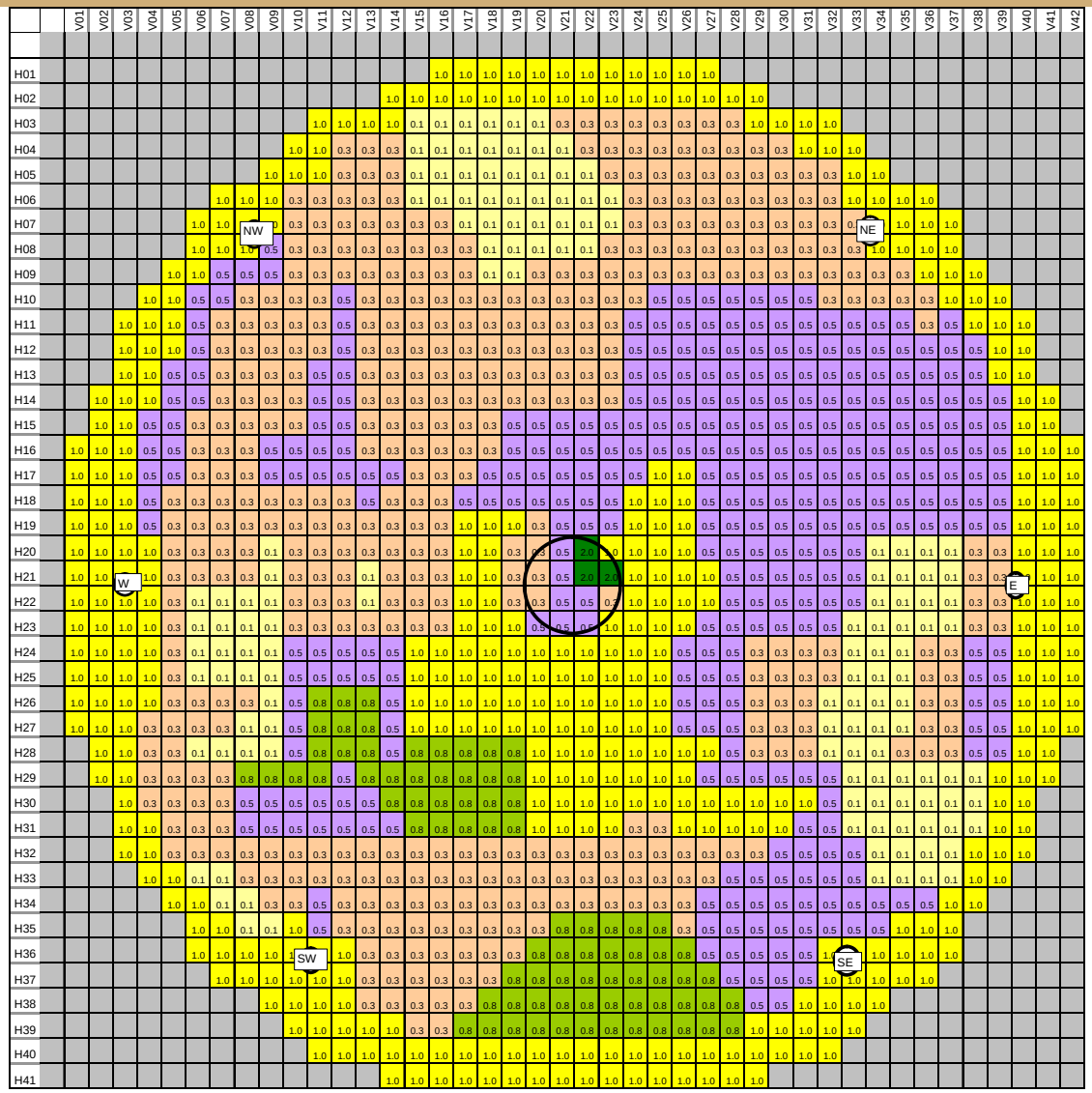
Tank 18 Waste Removal



99.7% of the waste volume removed from Tank 18 in four specific waste removal campaigns

Tank 19 Today

Tank 19 Today



LEGEND	
inches	
2.50	
2.25	
2.00	
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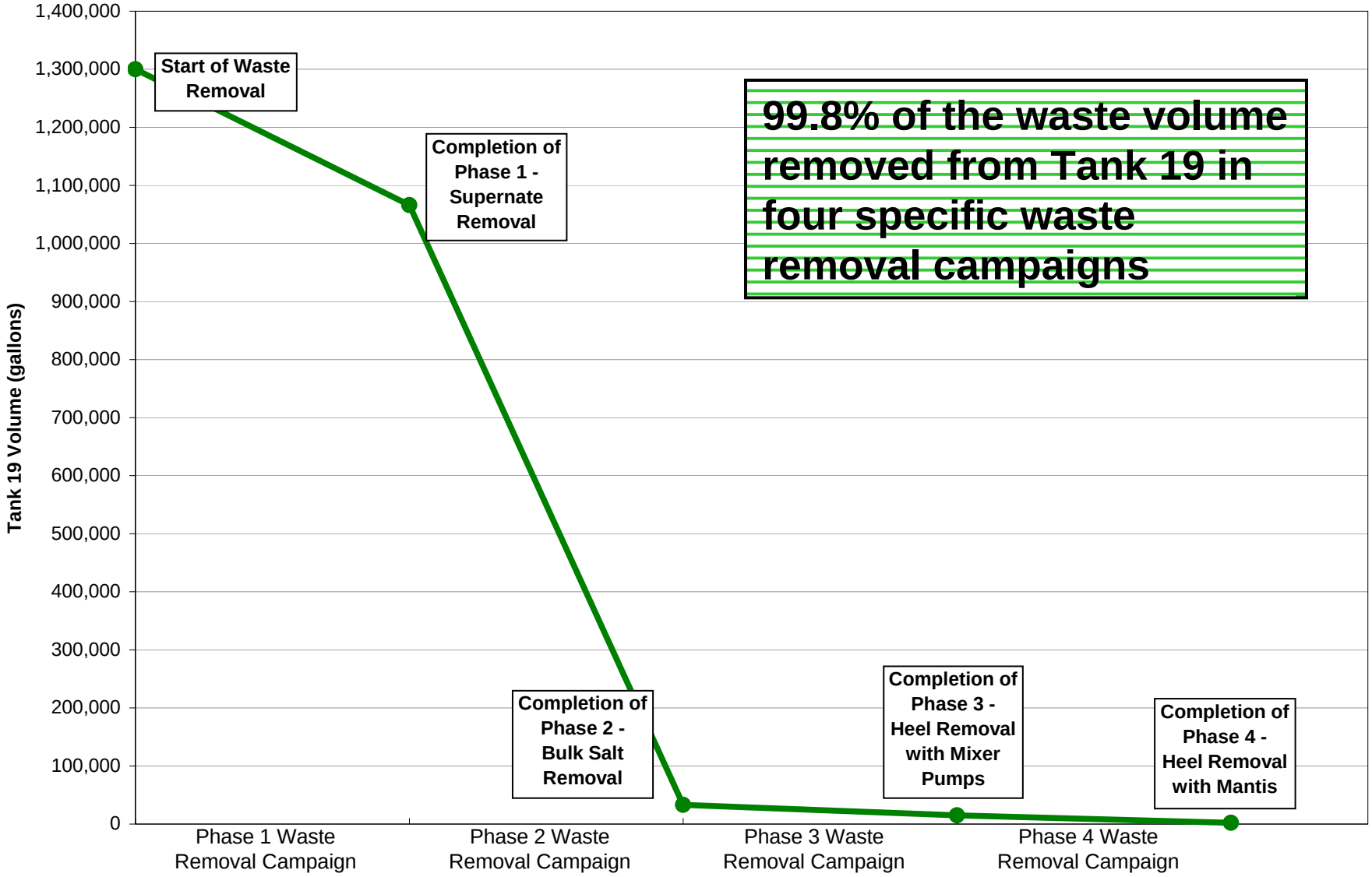
Tank 19 Waste Removal



99.8% of the waste volume removed from Tank 19 in four specific waste removal campaigns

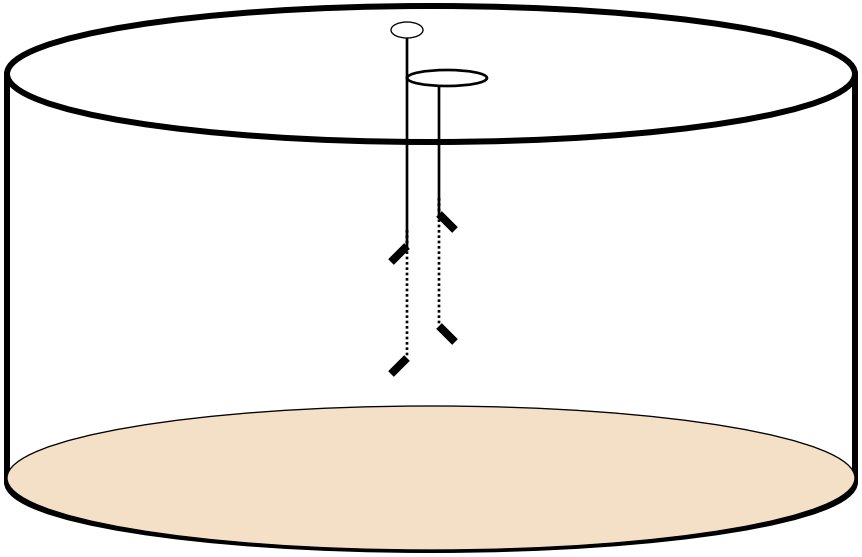
Residual Mapping Process

- Obtain digital photographs of residuals
- Establish 2’ x 2’ grid across tank bottom
- Identify lifting plates and other landmarks
- Determine solids height
- Map solids configuration
- Calculate residual volume

Digital Photography

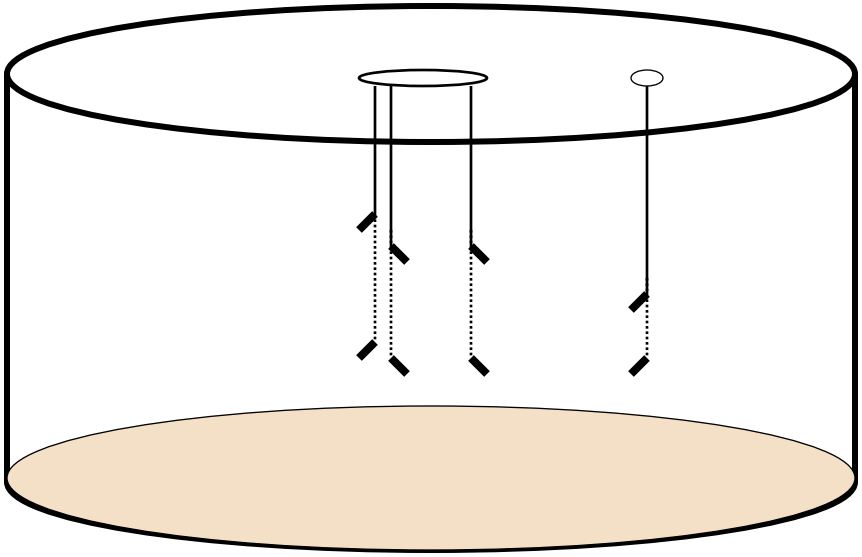
Tank 19 Camera Locations

- C Riser – 5/6/09
- N Sample Riser – 8/8/09
- Total Photographs: 140



Tank 18 Camera Locations

- C Riser – East and West ports – 4/28/09
- Toadstool Riser – 7/21/09
- C Riser – West – 7/22/09
- Total photographs: 150

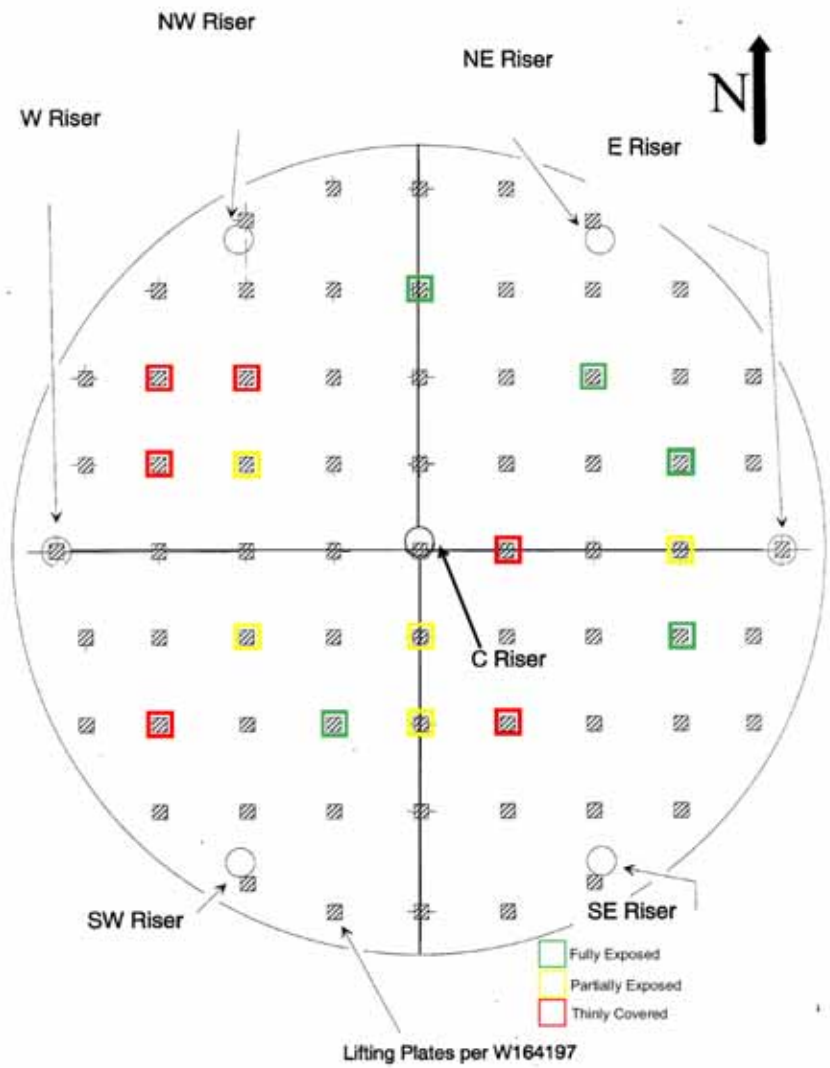


Identify Lifting Plates

Tank 18: 16 plates

Tank 19: 35 plates

Tank 17: 41 plates



69 plates total

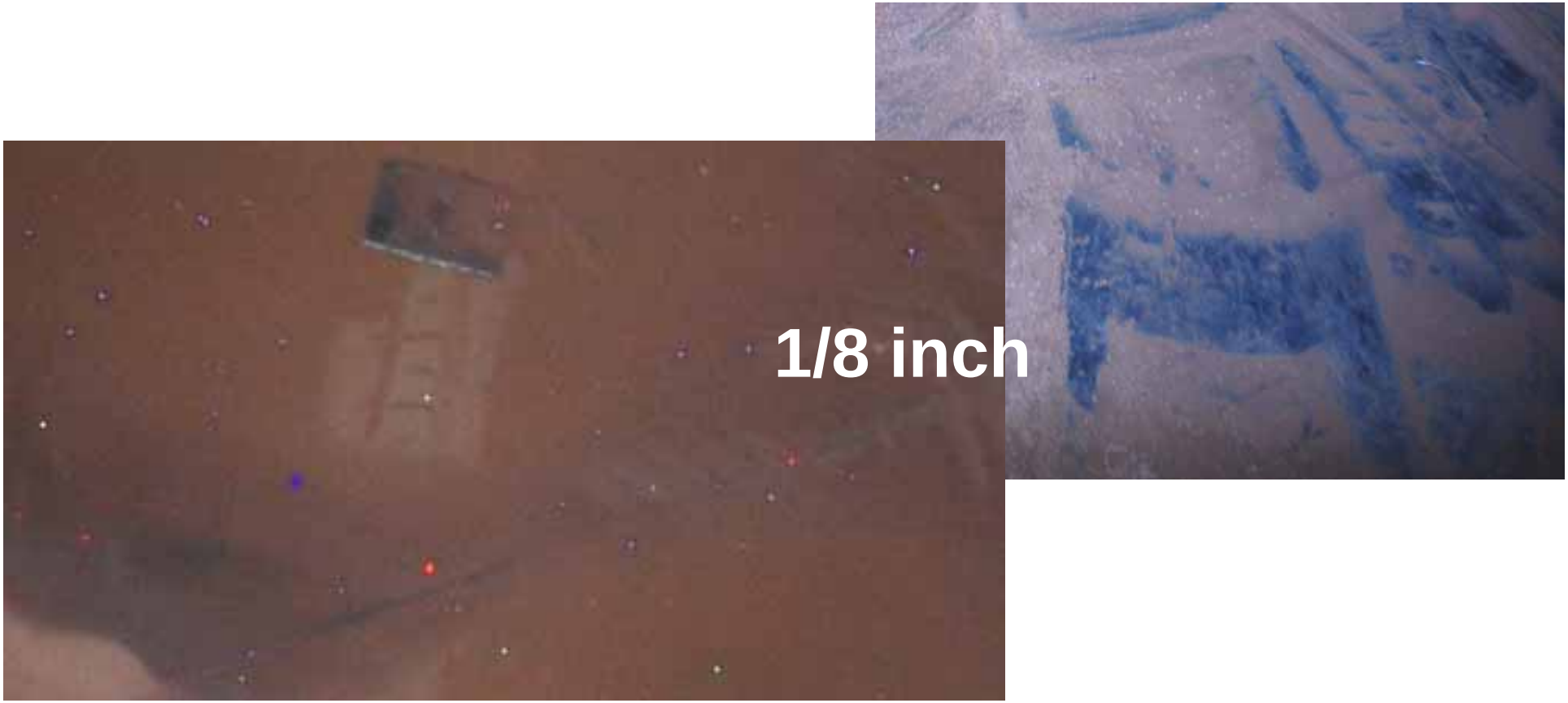
Determine Solids Height

CRITERIA

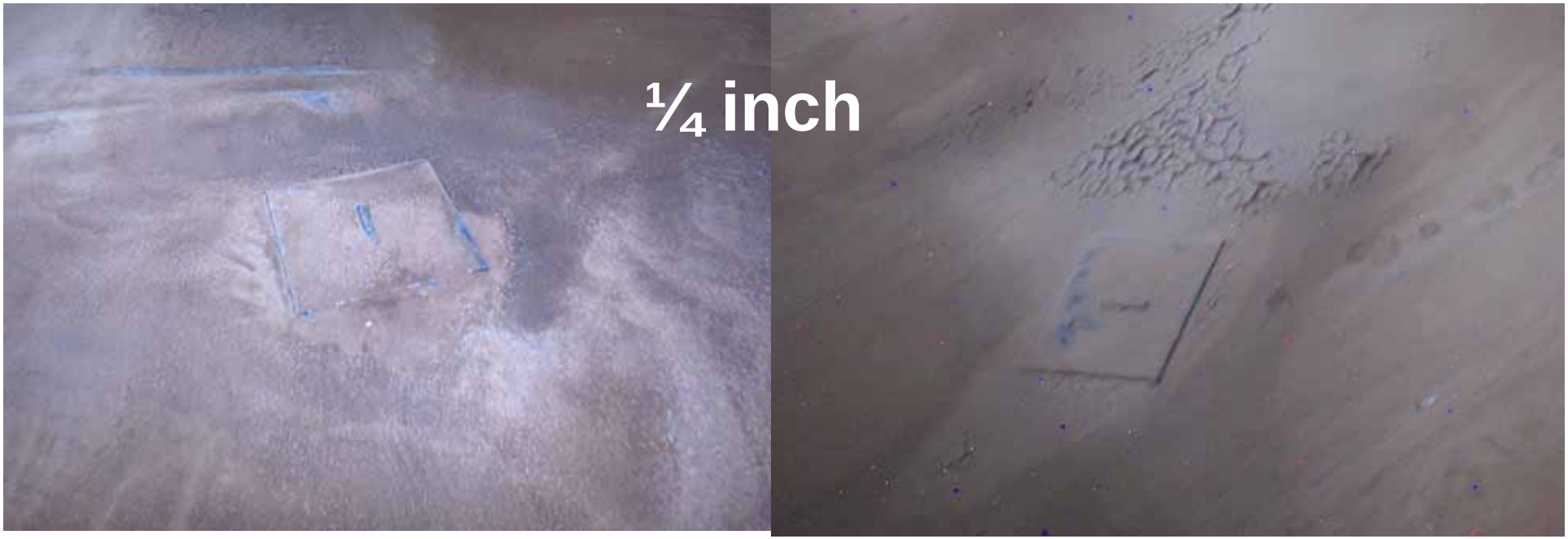
Solids Height (in.)	Tanks 18 and 19	Tank 17*
0	Not used	See entire weld bead. No visible sludge around plate with clean or mostly clean tank floor.
1/8	Dusting of solids evident with some clean steel floor visible.	Dusting of sludge evident. Weld bead mostly visible. Portions of weld bead covered.
1/4	Sides of lifting plate visible. Solids are mostly well below the top of lifting plate.	Weld bead is mostly covered, but portions of bead are still visible.
1/2	Square shape of lifting plate visible. Solids appear to be sample depth as top of lifting plate.	Same
3/4	Shape of lifting plate can be discerned through solids.	Only remnant of lifting rod is visible. Shape of lifting plate can be discerned through solids.

* Tank 17 mapping used video camera.

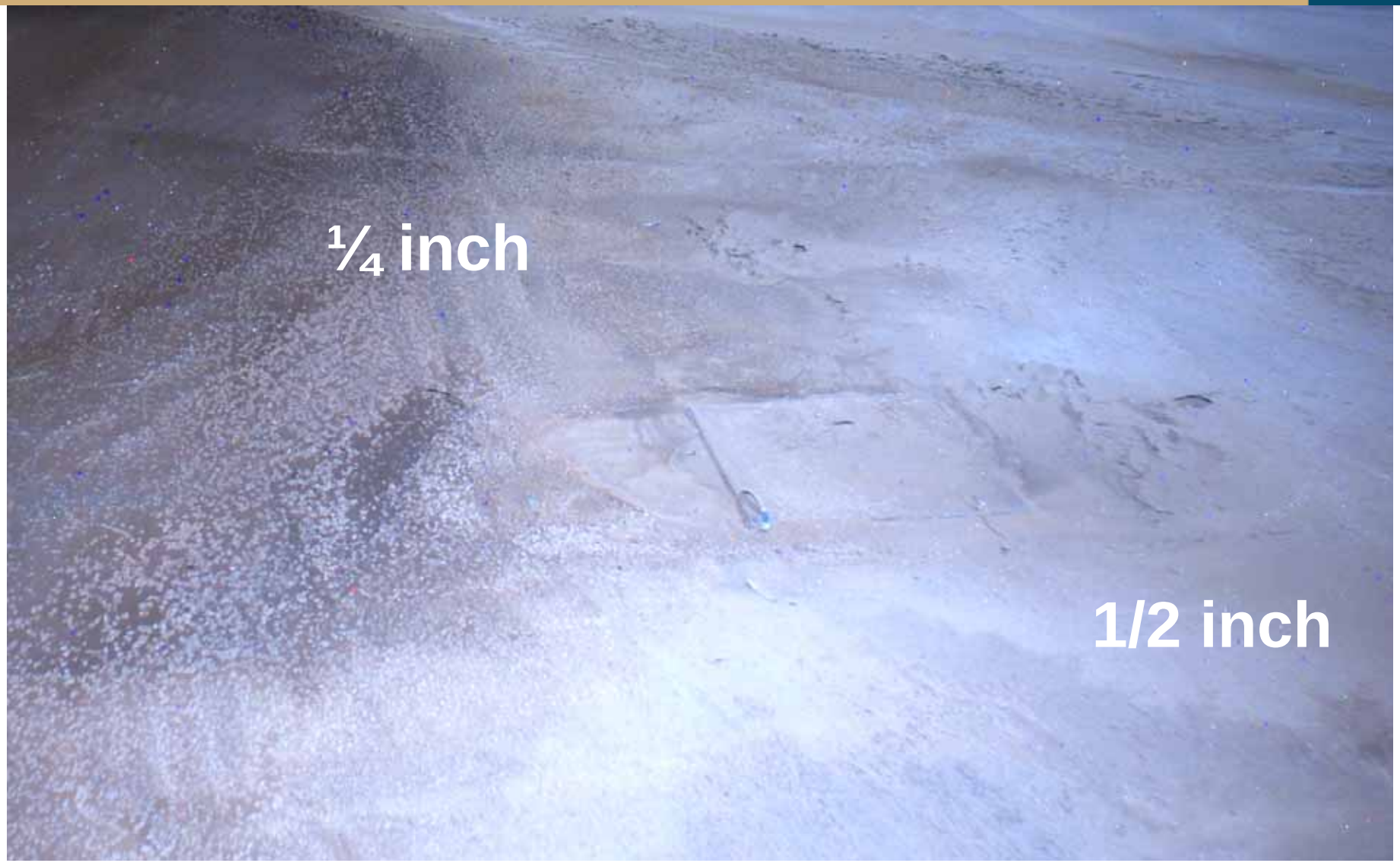
Tank 19 Photographs



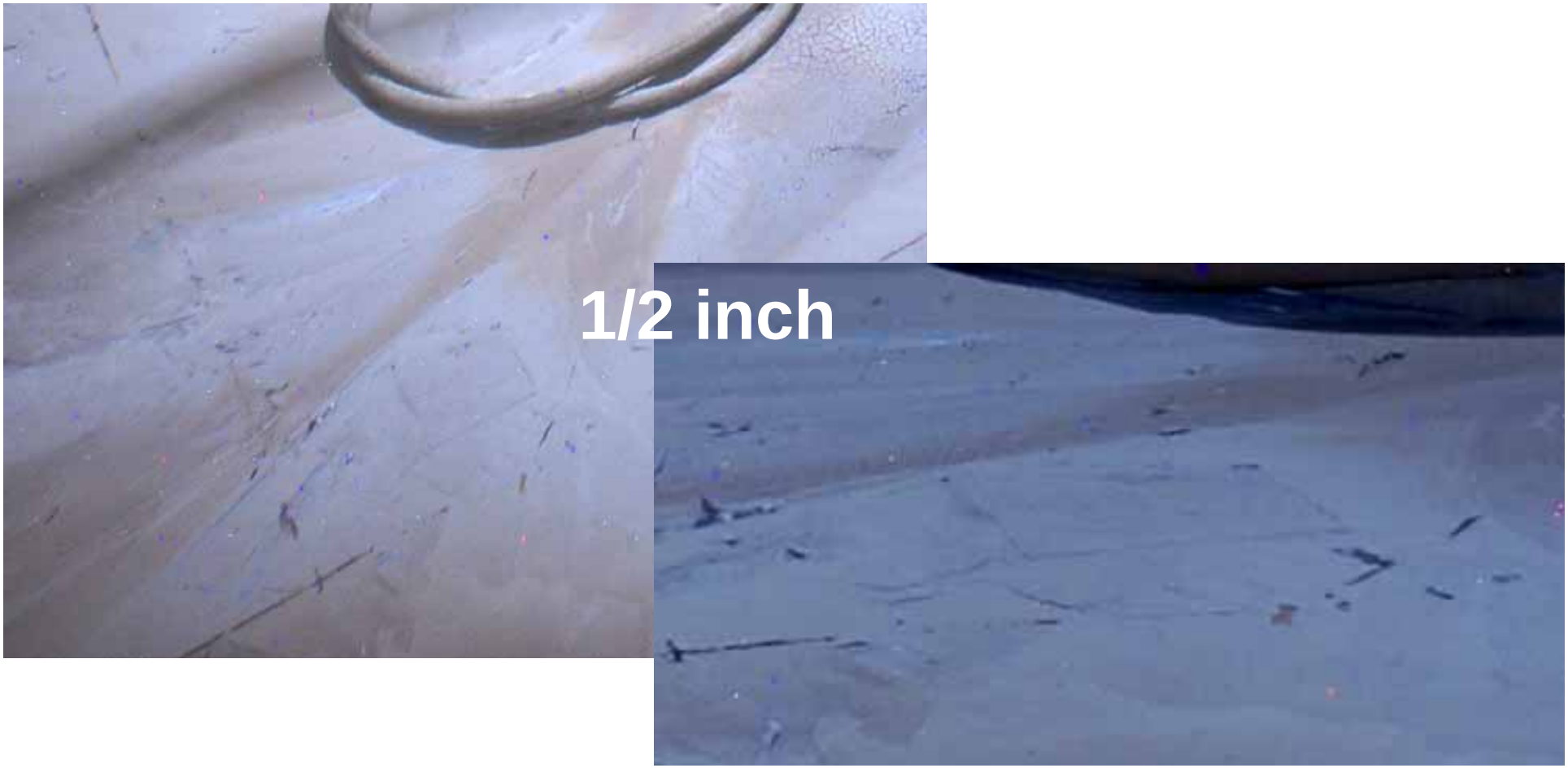
Tank 19 Photographs



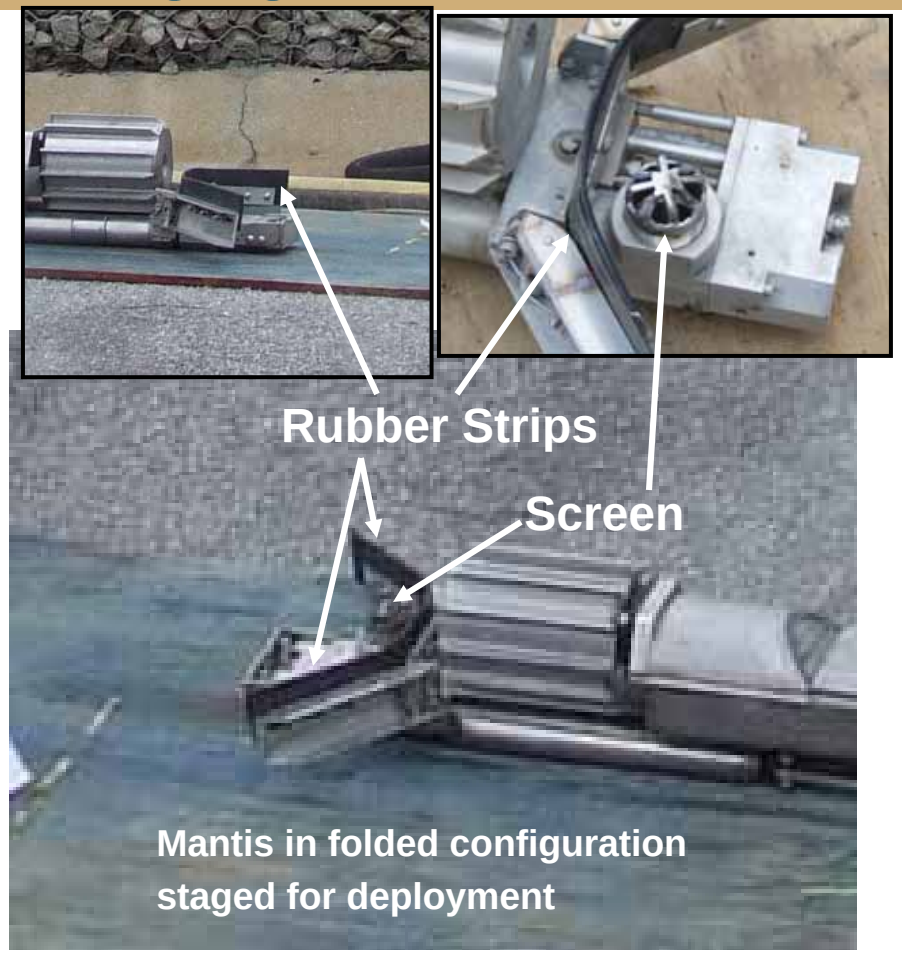
Tank 19 Photographs



Tank 19 Photographs



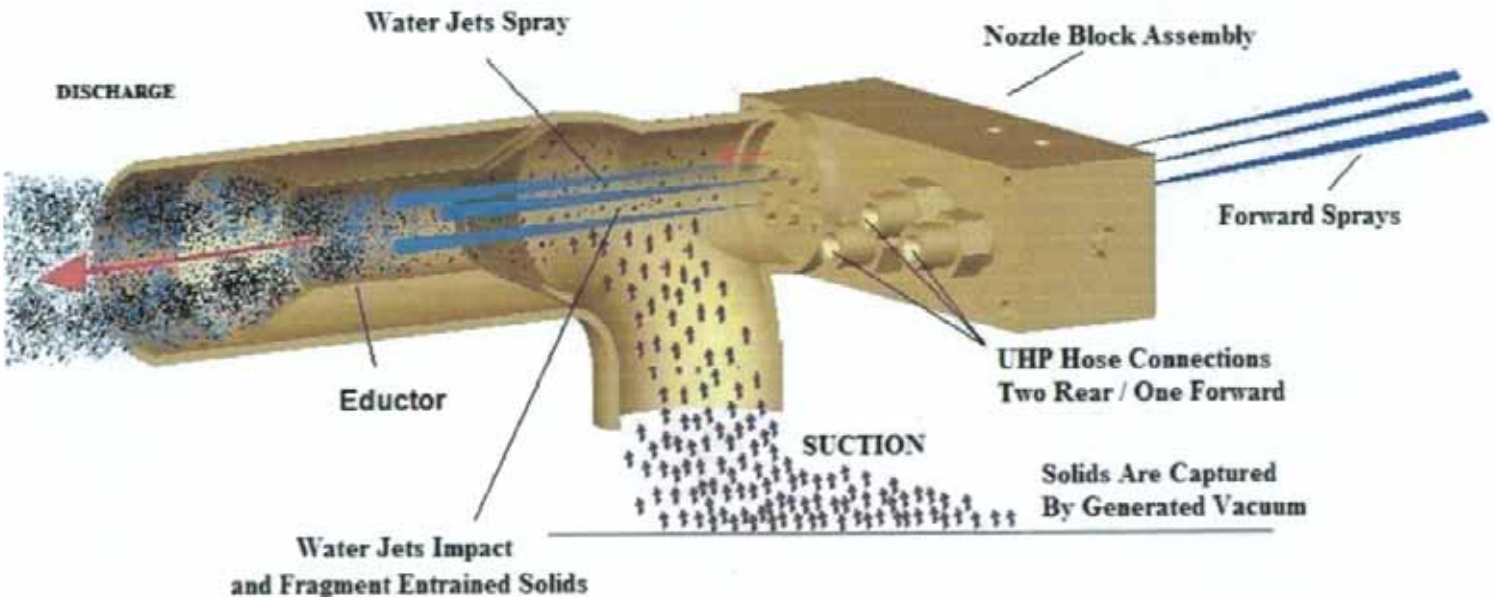
Extent of Mantis Operation



Bottom view of the Sand Mantis™ device

- The rubber strips used to funnel waste to the collection area were worn off over time
- The screen to protect against debris entering and damaging the device limits ability to remove solids at 1/4” to 1/2” from tank bottom
- Over time the vacuum created by the device degrades due to erosion of the key components

Schematic of Device



- As solids move into nozzle, zeolite, an abrasive material like sand, wears the tips of the jets. This affects the vacuum. A spare set of jets were used in Tank 18 resulting in very little improvement.
- Two prototype Mantis' deployed in Tanks 18 and 19 were first devices built with this configuration of spray nozzles and vacuum system. Built by hand in a machine shop to defined tolerances, but some variability expected. Variability and degradation during operation are believed to be the reasons for variation in performance between the two devices.

Additional Removal Options

Deployment of a new Sand Mantis™?

- Minimal additional removal anticipated due to design limitations realized
- Estimated cost of deployment is > $4,000,000
- Greater than one year to deploy and operate
  - Vendor procurement action required
- Total additional worker radiation exposure estimated to range from 250 to 1,250 mrem
- Additional waste created that must be stored, treated and ultimately disposed of

Additional Removal Options

Deployment of a new mixing and transfer capability?

- Minimal additional removal anticipated due to fast settling material
  - Significant experience in mechanical waste removal efforts in Tanks 18 and 19
- Cost estimated to exceed $5,000,000
- Greater than two years to deploy and operate
- Total additional worker radiation exposure estimated to be > 1,000 mrem
- Additional waste created that must be stored, treated and ultimately disposed of

Additional Removal Options

Use of a chemical cleaning flowsheet?

- Experience in Tank 24 demonstrates that oxalic acid would not be effective due to the quantity of zeolite remaining in Tank 18
  - Other acids have been previously evaluated at SRS and other DOE sites and found not to be viable (Ref.:WSRC-TR-2003-00401, September 9, 2003)
  - Acids are not effective in removing zeolite nor in breaking the associated bounds with cesium (Ref.:
- Chemical cleaning requires vigorous agitation
  - Infrastructure and equipment would have to designed, procured and deployed
- Cost estimated to significantly exceed $5,000,000
- Additional waste created that must be stored, treated and ultimately disposed of

Zeolite & Oxalic Acid

Oxalic Acid cleaning was performed in Tank 24 in the ’80’s. The oxalic acid interacted with the zeolite in this tank and formed agglomerated masses of solid material.

Additional Considerations

- The Type IV tanks only drive the peak dose because the Type I and III tanks are projected to “fail” outside the 10,000-year compliance period
  - Peak doses from the Type I and III tanks are seen between year 13,000 and 14,000
  - Significant factor is not which Type IV tank drives dose, but rather how much is the peak dose

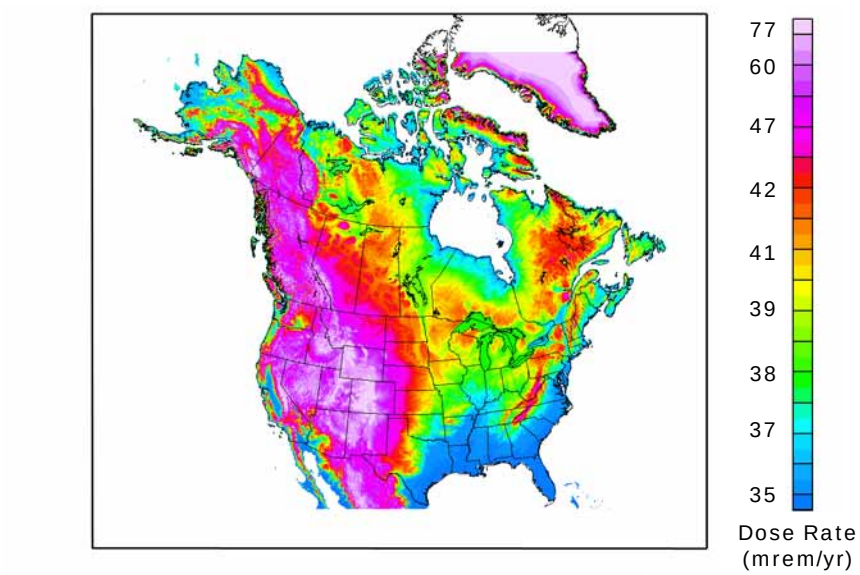
- Scoping calculations using the current estimated residual inventories in Tanks 18 and 19 provide confidence that the compliance period peak dose remains well below the 25 mrem per year performance objective for all-pathways dose

- Scoping calculations also provide reasonable assurance that the residual inventories in Tanks 18 and 19, when combined with the assumed inventories for the remainder of the FTF tanks, will not challenge the EPA Primary Drinking Water Standard

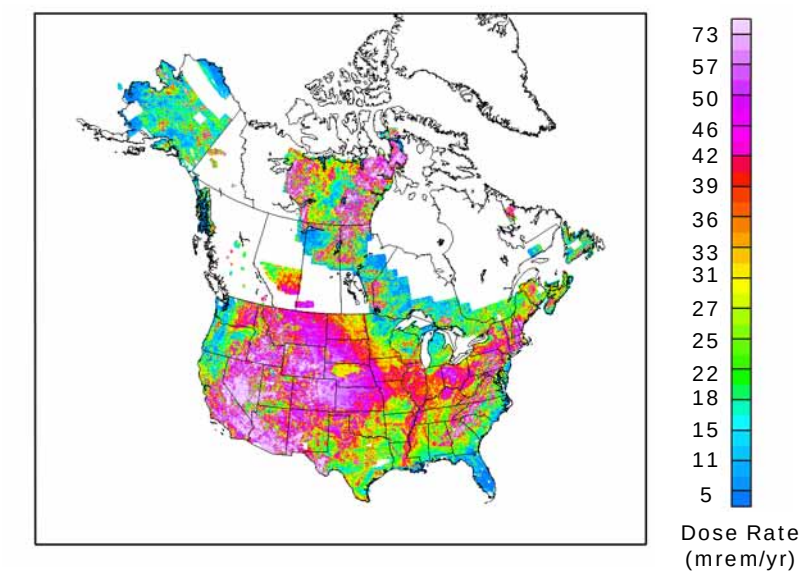
Radiation Dose Perspective

- It is anticipated that the peak annual dose from FTF closure operations will be **< 5 mrem** during the 10,000-year Compliance Period
- Per NCRP-160, the average dose to a person in the United States in 2006 was **620 mrem**
  - Approximately 310 mrem from naturally occurring background
  - Approximately 300 mrem from medical procedures
  - Up from 360 mrem in the 1980's due mainly to increases in medical procedures
- A person receives approximately 0.5 mrem/hr for a jet airliner flight
  - Roundtrip flight to the West Coast results in ~5 mrem dose
  - Dream vacation to Europe yields a dose of ~ 10 mrem
- If a person lived in a wood house in Columbia, South Carolina and moved to brick house in Denver, Colorado, his annual dose from background radiation would increase by ~80 mrem.

North America Radiation Levels



Cosmic



Terrestrial

Annual doses from background radiation varies significantly across the United States. Would you decide not to visit or move to the western states knowing that your annual exposure increases by tens of mrem per year?

DOE On-going Actions

- DOE is preparing a revised sample plan for Tanks 18 and 19
- DOE is revising the FTF PA to incorporate lessons learned from Tanks 5, 6, 18 and 19
- DOE is currently preparing a General Closure Plan for review and concurrence
- DOE is also preparing a NDAA §3116 waste determination for F-Tank Farm tank closures
- Once the General Closure Plan and the WD are approved, DOE will prepare a Closure Module for Tanks 18 and 19

Summary

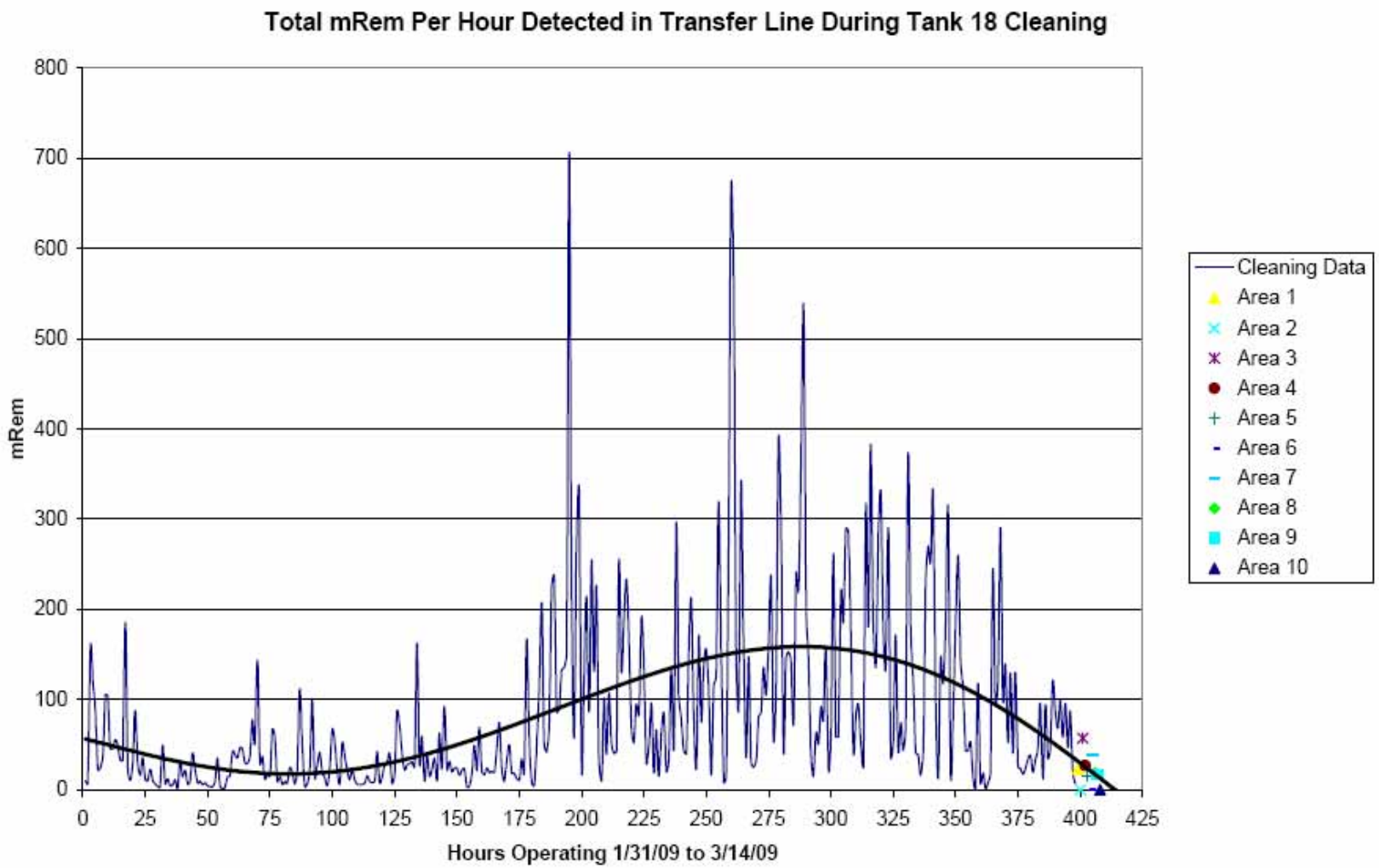
- The Sand Mantis™ technology has been effective in Tanks 18 and 19 and has reached the extent of this technology to remove significant additional waste
- Over 99% of the waste and the associated radionuclides in these tanks have been removed
- A qualitative assessment of additional options indicate that additional waste removal is not practical
- A qualitative assessment indicates that 10 CFR 61 performance objectives will be met
- A formal practicality discussion will be included in the Tanks 18 and 19 Closure Module
  - Approval of the Closure Module must be received before DOE can operational close these tanks

Requested Action

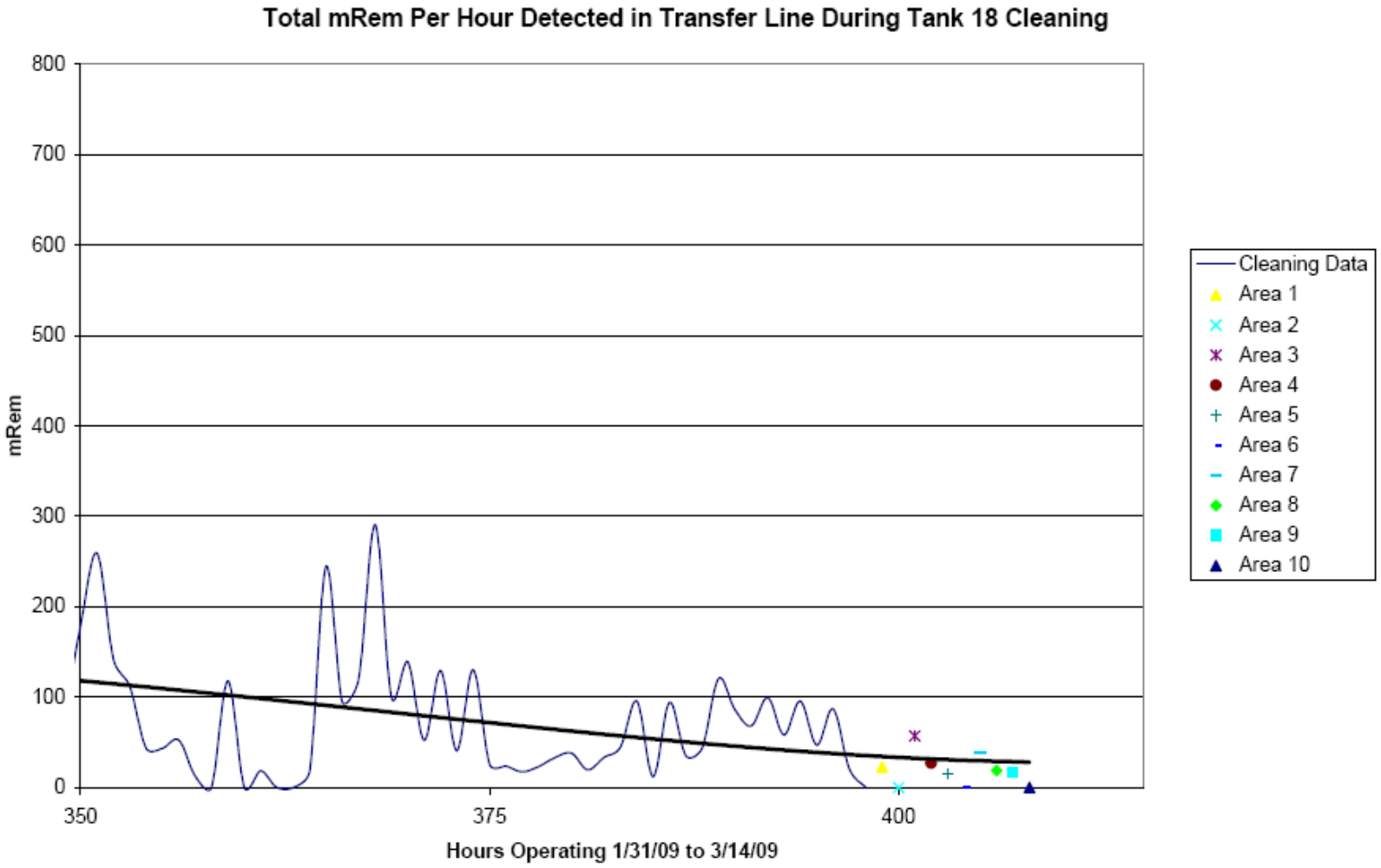
The three agencies agree that, based upon the described qualitative assessment, there is reasonable assurance that it is appropriate to discontinue waste removal activities and enter the sampling and analysis phase of the closure process for Tank 18 and Tank 19.

Back-up Slides

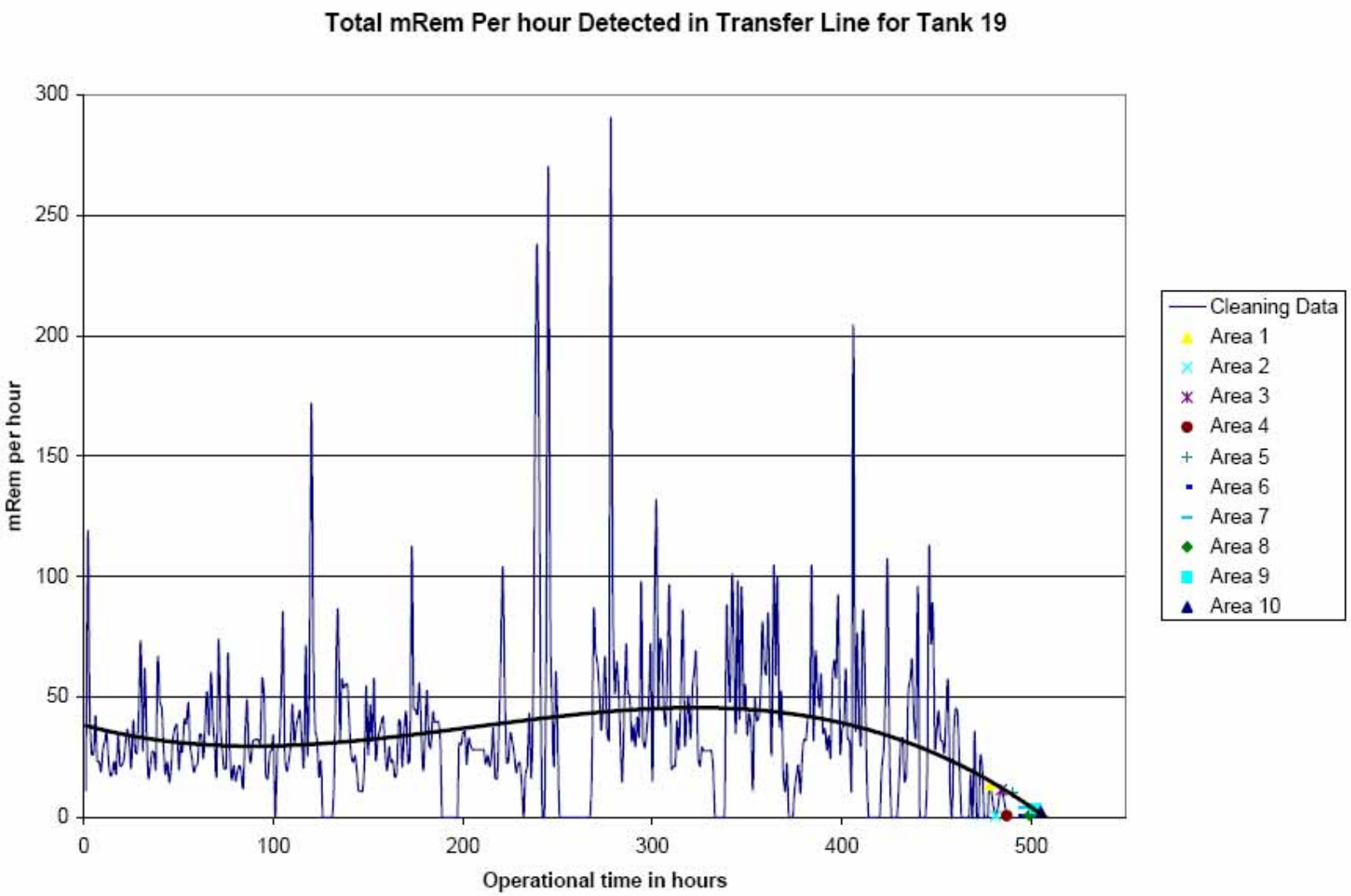
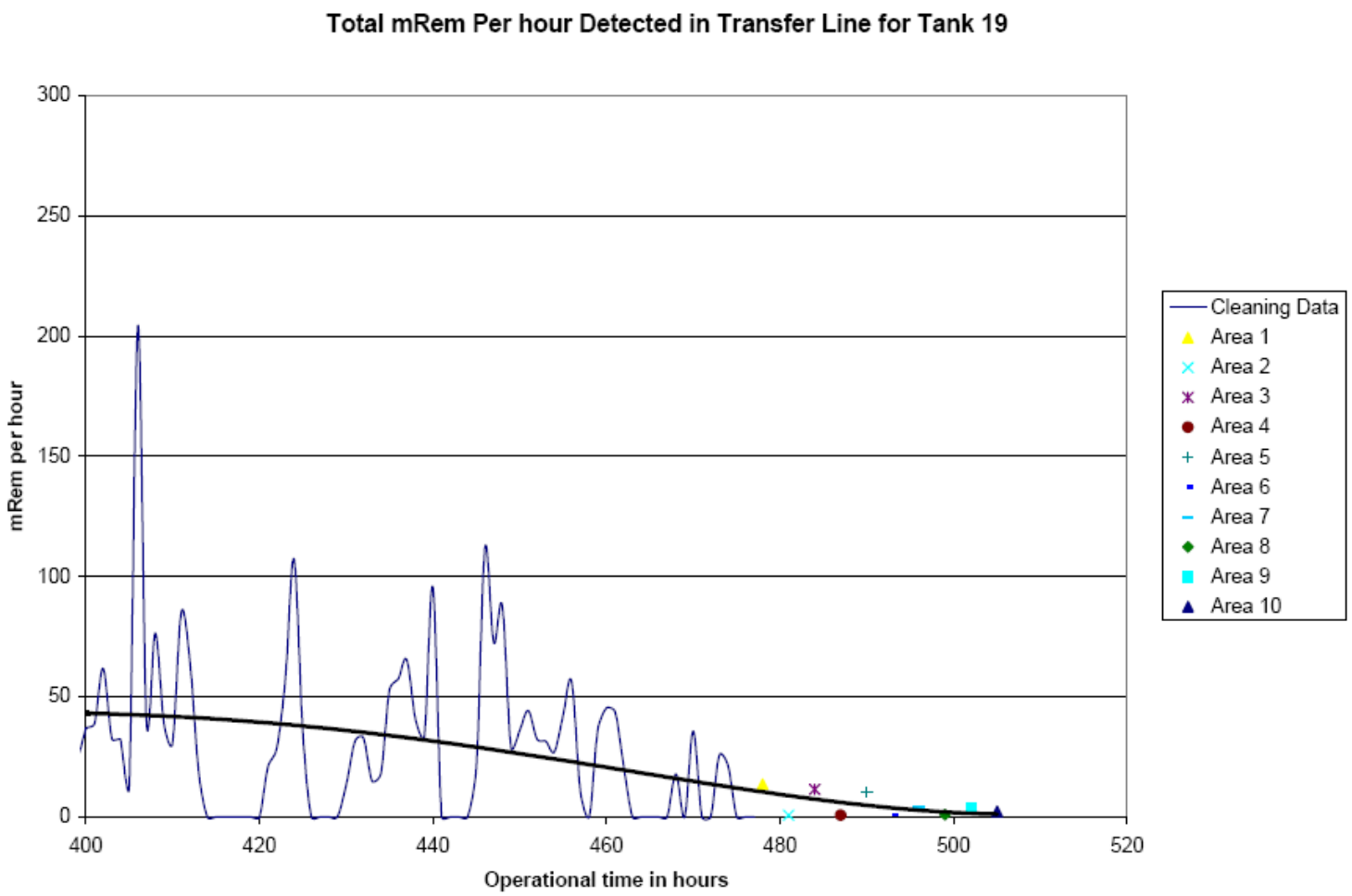
Tank 18 Radiation Data Collected



Tank 18 Radiation Data Collected



Tank 19 Radiation Data Collected



Tank 19 Radiation Data Collected