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Tank 18 Volume Estimation Following Mantis™ Cleaning Operations

Author: Wm. Clifton Ludwig — W. C. Ludwig — 12/15/09 — Date

Verifier: B. A. Martin — 12/16/09 — Date

Approver: W. L. Isom — 12/16/09 — Date

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Purpose

The purpose of this report is to document the estimated volume of material left in Waste Tank 18 after Mantis™ Cleaning Operations. Characterization of the remaining material will be discussed in a later report after sample analysis.

Background

Prior to Mantis™ operations an ADMP (Advanced Design Mixer Pump) cleaning operation was used to remove waste from Tank 18 in July of 2003. The summary report of that cleaning operation (U-TR-F-00005, *Characterization of Tank 18 Residual Waste),* states that after the ADMP cleaning, Tank 18 contained 4334 gallons of sludge material in addition to 2410 gallons of free liquid for a total waste volume of 6744 gallons.

On November 19, 2003, 3035 gallons of 12.2 wt% sodium hydroxide were added to Tank 18 to meet corrosion control program requirements. Since that time, Tank 18 was undisturbed until preparations for Mantis™ cleaning operations began. During the five-year interim, most of the free liquid inside of Tank 18 evaporated.

Mantis™ operation in Tank 18 began on January 29, 2009 and was completed on March 14, 2009. During operation, the Mantis™ experienced several shutdowns (see Attachment A) which contributed to a longer than anticipated cleaning operation.

Material Mapping

Material mapping is a method for determining the volume of materials inside of a waste tank. This method relies on video and still images to capture the relative depth of material across a tank in relation to known landmarks. These depths can then be plotted over an area to give an estimate of the volume. Following Mantis™ operations over 140 photographs were taken of the interior of Tank 18 using a high quality digital camera at various locations and elevations inside the tank. The pictures were inspected by a team consisting of William Ludwig (Closure Engineering), Bruce Martin (Closure & Waste Determination Authority) and Billy West (Camera Inspection Group) for evidence of the lifting plates and other known depth measurements.

The floor of a Type IV waste tank has 69 1 foot by 1 foot by 1/2 inch lifting plates arrayed in a grid pattern across the floor (Attachment B). Each plate has a 1/4 inch weld bead affixing it to the floor and the remnant of where the lifting rod attached to the top of the plate during tank construction (Figure 1). These lifting plates were used as landmarks for material mapping.

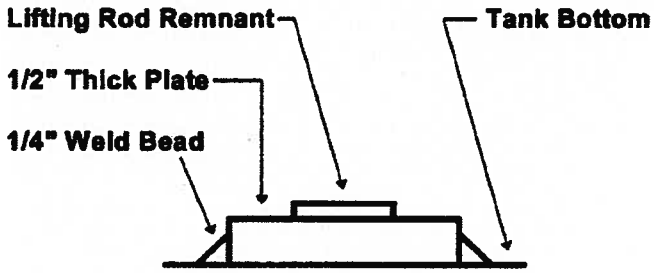


Figure 1: Lifting Plate Elevation View. (Not to Scale)

The evaluation team used a widescreen high definition monitor and picture enhancement software to adjust color, contrast and brightness to provide the best views possible. Twenty lifting plates were identified and the criteria in Table 1 was used to assign depths of residual solids. Identified lifting plates are listed in Attachment C. Photographic examples of material depths are shown in Attachment D. The regions surrounding the identified lifting plates were plotted onto an Excel map to generate a volume estimate.

Depth (Inches)	Criteria
1/8	Dusting of Solids evident with some clean steel floor visible.
1/4	Sides of lifting plate visible. Solids are mostly well below the top of lifting plate.
1/2	The shape of the lifting plate is clearly visible but the material appears to be the same depth as the top of the lifting plate.
3/4	Shape of lifting plate can be discerned through solids.

Table 1: Material Depth Criteria

As the majority of the lifting plates were not visible it was determined additional data would be required to fully map Tank 18 for a volume estimation. It was deemed necessary to restore driving functions to the Tank 18 Mantis™ in order to collect additional material depth measurements using known dimensions of the Mantis™ wheels (Attachment E). In early September 2009, the Mantis™ was used to survey the unmeasured portions of Tank 18. The Mantis™ successfully surveyed the previously indeterminate Central, North Eastern, Eastern and South Eastern regions. For each depth measurement in these regions the Mantis™ was made to dig its' wheels down to bare tank floor to ensure that the measurement was accurate. However, due to a loss in traction caused by material building up inside the Mantis™' wheels and drag weight of hose and tether system the Mantis™ was unable to reach the other regions inside of Tank 18. The travel limitations of the Mantis™ are shown in Attachment F.

The material depths in the unreachable regions of Tank 18 appeared similar to the areas surveyed by the Mantis™. The unsurveyed areas are distinguishable into two general sections, a lower flat plain around the center of the tank, and a ring of material around the perimeter. To approximate the material depths in these regions the corresponding depths

in the surveyed areas were analyzed and their weighted mean values where applied the unreachable regions.

In addition to material resting on the floor of Tank 18 there is also material deposited on the tanks stiffening bands and on the tank wall surfaces. The stiffening band is 5 inches wide and in areas where material was visible the depth was conservatively estimated at a full inch thick from the wall to the edge of the band. The volume of the material resting on the stiffening bands was estimated to be about 8 gallons based on analysis of digital photographs between each of the risers (Attachment G).

The depths and areas covered by the material on the vertical surfaces of the walls was also estimated using digital photographs. The material on the lower regions of the wall (above the lower weld 27 inches above the floor) was estimated to be 3/16 inch thick. For volume estimation purposes, the tank wall surface area covered by this material is represented by a 3 foot wide band around the entire circumference of the tank. Material on the wall was estimated to be ¼ inch thick at other various elevations of the tank wall as shown in Attachments H.

Material Mapping Findings

The material depths derived from lifting plates in the digital still photos and the regions reached by the Mantis™ during the September survey are listed in Attachment C. The weighted mean averages used for the indeterminate portions of Tank 18 were 1.07 inches for the central plain area and 1.78 inches for the ring along the perimeter. The measured and calculated material depth values were then entered into an Excel sheet (Attachment I). Each cell in the sheet represents a 2 foot by 2 foot section of tank floor. The material volumes for each cell were summed giving a final value of 3900 gallons of material remaining in Tank 18.

The evaluation of the material located on the stiffening bands showed there to be approximately 8 gallons. The value generated by the spreadsheet for the volume of material on the vertical surface of the wall is estimated to be 110 gallons.

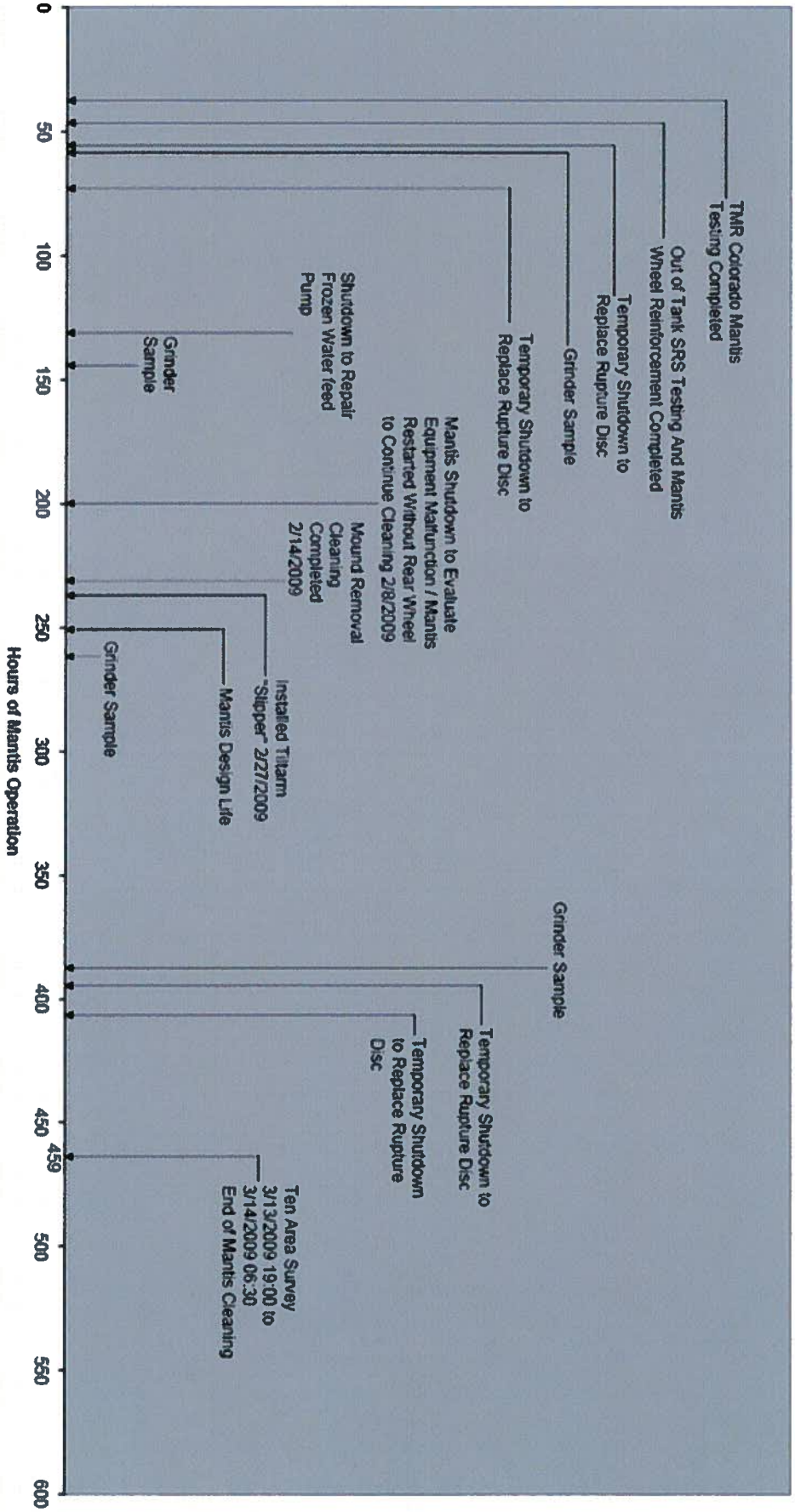
Summary

The Mantis™' activities have successfully removed the two remaining mounds inside of Tank 18. Using a combination of still pictures and live video of the Mantis™ surveying the Tank and the use of statistical analyses the depth of the remaining material in the tank was estimated to be approximately 4000 gallons.

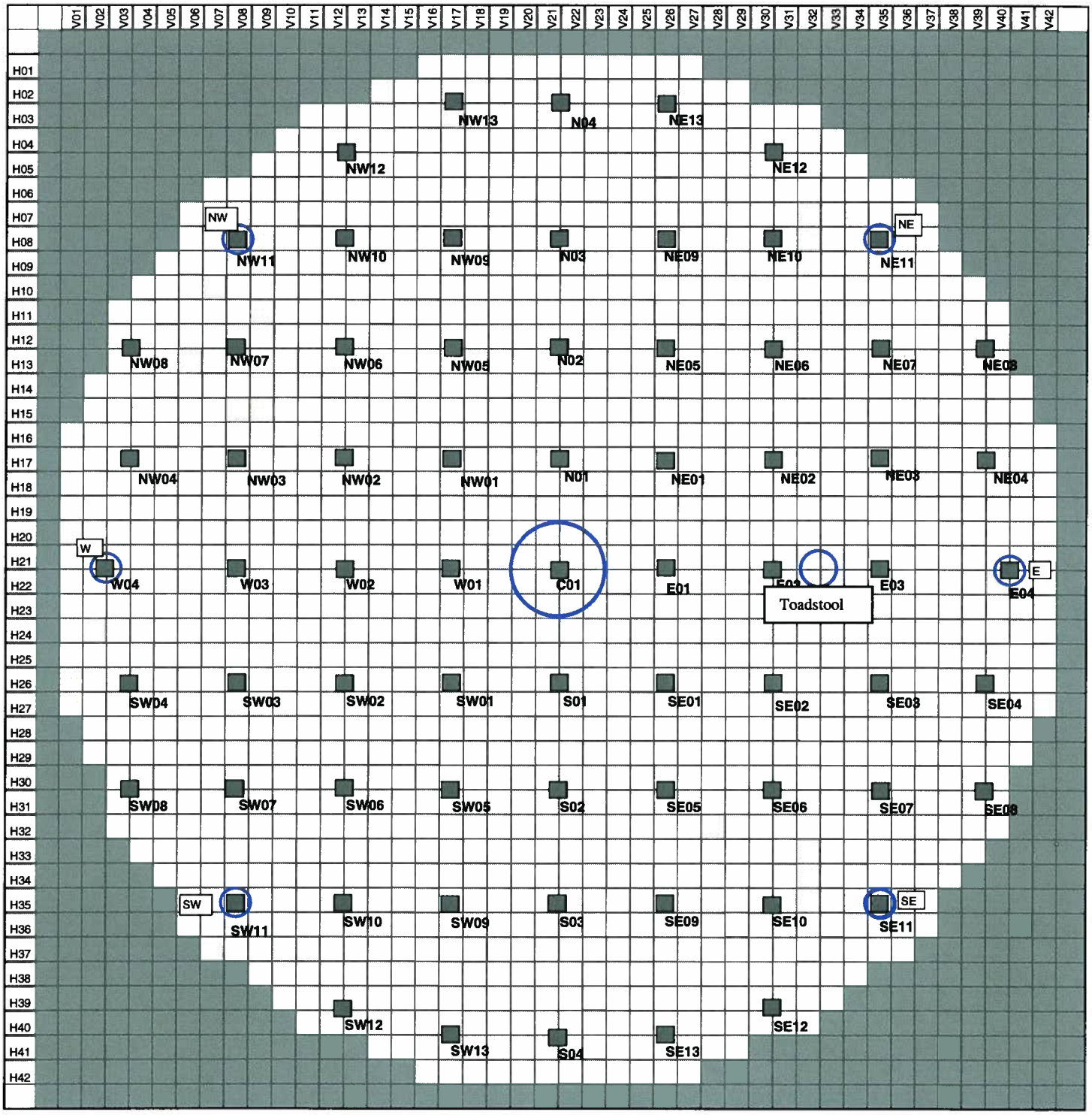
Reference

1. U-TR-F-00005 Rev. 2, Characterization of Tank 18 Residual Waste
2. Pictures are stored with Site I&SE Group. Digital Pictures used for this report include P0911201 though P0911246 and P0911301 through P0911327

Attachment A
Tank 18 Mantis™ Operation Timeline



Attachment B
Tank 18 Lifting Plate Layout



Attachment C
Observed Material Depths

Point	Depth	Location	Quadrant	Depth Method	Nearest Lifting Plate	Picture Identified In
P01	1.5	H15-V37	NE	Crawler	NE04	N/A
P02	1.5	H18-V41	NE	Crawler	NE04	N/A
P03	2	H24-V39	SE	Crawler	SE04	N/A
P04	1.25	H30-V38	SE	Crawler	SE08	N/A
P05	1	H36-V34	SE	Crawler	SE11	N/A
P06	1	H36-V33	SE	Crawler	SE11	N/A
P07	1	H30-V36	SE	Crawler	SE07	N/A
P08	0.875	H31-V33	SE	Crawler	SE06	N/A
P09	1.25	H30-V31	SE	Crawler	SE06	N/A
P10	1.75	H30-V30	SE	Crawler	SE06	N/A
P11	1.25	H26-V32	SE	Crawler	SE02	N/A
P12	1.25	H26-V27	SE	Crawler	SE01	N/A
P13	1	H23-V30	SE	Crawler	E02	N/A
P14	1	H22-V29	SE	Crawler	E02	N/A
P15	1	H18-V29	NE	Crawler	NE02	N/A
P16	0.875	H18-V27	NE	Crawler	NE01	N/A
P17	0.875	H17-V25	NE	Crawler	NE01	N/A
P18	1	H14-V26	NE	Crawler	NE05	N/A
P19	1.5	H13-V38	NE	Crawler	NE08	N/A
P20	2	H10-V36	NE	Crawler	NE11	N/A
P21	0.875	H08-V33	NE	Crawler	NE10	N/A
P22	1	H36-V27	SE	Crawler	SE09	N/A
P23	1.5	H26-V19	SW	Crawler	SW01	N/A

Attachment C
Observed Material Depths (Continued)

Point	Depth	Location	Quadrant	Depth Method	Nearest Lifting Plate	Picture Identified In
P24	1.5	H26-V16	SW	Crawler	SW01	N/A
P25	1.5	H23-V21	SW	Crawler	C01	N/A
P26	0.5	H12-V13	NW	Lifting Plate	NW06	P0911324
P27	0.5	H17-V13	NW	Lifting Plate	NW03	P0911324
P28	0.5	H17-V08	NW	Lifting Plate	NW02	P0911323
P29	0.75	H22-V08	NW	Lifting Plate	W03	P0911322
P30	0.75	H26-V08	SW	Lifting Plate	SW03	P0911322
P31	0.5	H26-V12	SW	Lifting Plate	SW02	P0911321
P32	0.5	H31-V08	SW	Lifting Plate	SW07	P0911321
P33	0.75	H31-V12	SW	Lifting Plate	SW06	P0911320
P34	0.25	H31-V17	SW	Lifting Plate	SW05	P0911320
P35	0.5	H31-V21	SW	Lifting Plate	S02	P0911319
P36	0.25	H25-V35	SE	Lifting Plate	SE03	P0911213
P37	0.75	H31-V26	SE	Lifting Plate	SE05	P0911230
P38	0.75	H35-V31	SE	Lifting Plate	SE10	P0911318
P39	0.5	H22-V36	SE	Lifting Plate	E01	P0911220
P40	0.25	H22-V35	SE	Lifting Plate	E03	P0911314
P41	0.125	H17-V35	NE	Lifting Plate	NE03	P0911223
P42	0.125	H13-V35	NE	Lifting Plate	NE07	P0911223
P43	0.25	H13-V31	NE	Lifting Plate	NE06	P0911222
P44	0.5	H08-V26	NE	Lifting Plate	NE09	P0911326
P45	0.25	H08-V22	NE	Lifting Plate	N03	P0911326

Attachment D
Examples of Lifting Plate Depths

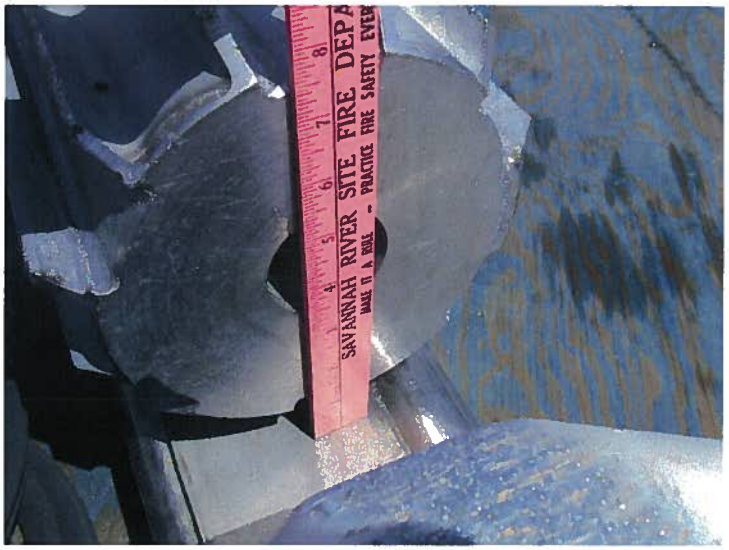
1/8 Inch

1/4 Inch

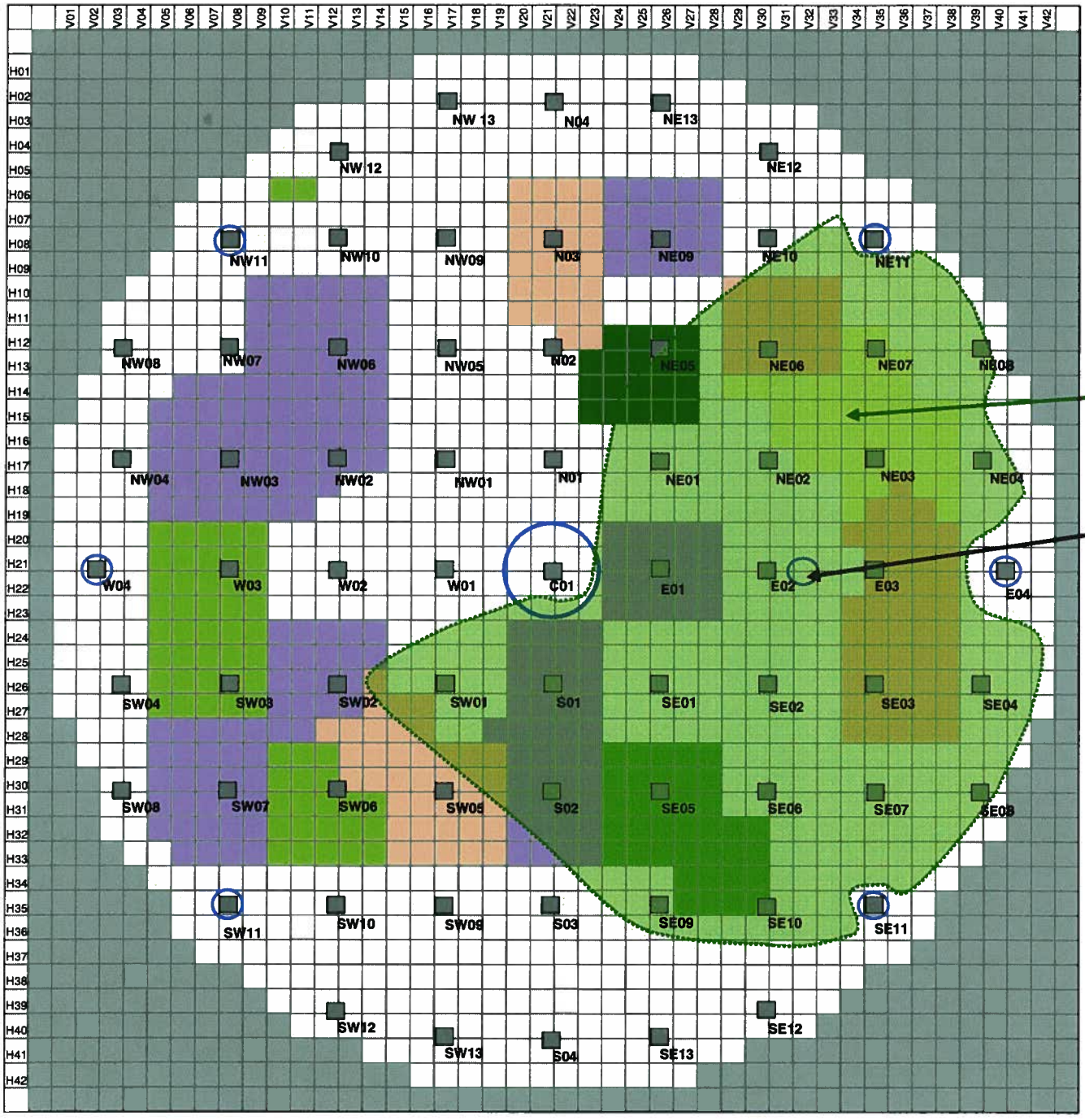
1/2 Inch

3/4 Inch

Attachment E
Reference Pictures For Mantis™ Mapping



Attachment F
Crawler Travel Limitations



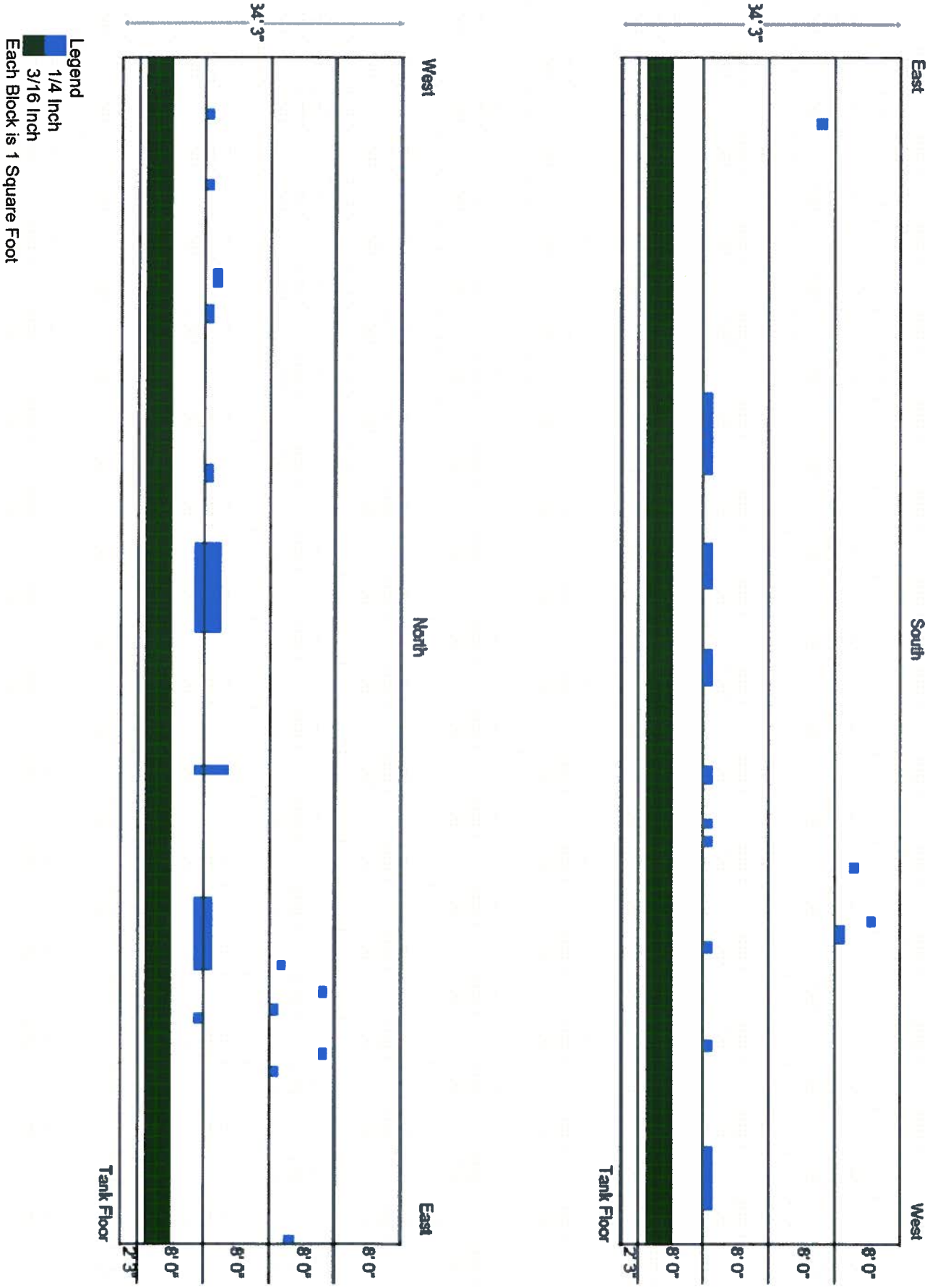
Attachment G
Tank 18 Stiffening Bands Material Estimation

268' Tank Circumference
Stiffening Band is 5" Deep

East	South East	South West	West	North West	North East
P0906207 0 Gal	P0906104 0 Gal	P0906106 0 Gal	P0906108 0 Gal	P0906110 0 Gal	P0906205 1.2 Gal
P0911239 P0911241 0 Gal	P0911243 P0911244 0 Gal	Upper Stiffening Band P0911233 0 Gal	P0911234 0 Gal	P0911235 0.6 Gal	P0911237 5.8 Gal
		Lower Stiffening Band			

P-series numbers are photograph database reference numbers

Attachment H
Tank 18 Wall Map



Attachment I
Tank 18 Mapping After Mantis™ Operation