The Dow Chemical Company
Midland, MI 48667

Michigan Operations
April 13, 2005

Mr. David Nelson
U.S. Nuclear Regulatory Commission
11545 Rockville Pike
Rockville, MD 20852

SUBJECT: Revised RAIs and Revision 2 of Supplement to the Decommissioning Plan for the TDCC Bay City, MI, Site

Dear Mr. Nelson,

The purpose of this letter is to provide revisions to RAIs #3, #8, and #9, and the revision to the FSS plan for the rail loading area and support zone. The original versions of these documents were submitted in The Dow Chemical Company's (TDCC) December 31, 2004, response to NRC's August 30, 2004, *Request for Additional Information on Revision 1 of the Revised Supplement to the Decommissioning Plan for the TDCC Bay City, MI, Site*. These revisions were made in response to NRC concerns expressed during teleconferences conducted in February and March 2005.

To simplify the review, Enclosure 1 contains only the RAIs that were revised, i.e., #3, #8, and #9, and the revised FSS plan, with additions and deletions indicated by change bars. Enclosure 2 contains a complete version of the all RAI responses with change bars indicating revised sections. Enclosure 3 contains Revision 2 of the Supplement, which was revised to include additional text to reflect commitments made in the RAI responses. The additional text is indicated by change bars.

The RAI response contained in Enclosure 2 is intended to supercede in its entirety the RAI response that was provided in TDCC's December 31, 2004, letter. Revision 2 of the Supplement (contained in Enclosure 3) is intended to supercede in its entirety Revision 1 of the Supplement.

Because the Supplement to the Decommissioning Plan has been under NRC review and TDCC revision for over 3 years, a brief review of the licensing submittal history is provided here to ensure clarity of the Docket.

- August 17, 2001 – Initial Submittal of Supplement
- January 31, 2002 – Revised Supplement to the Decommissioning Plan (Revision 0) was submitted to NRC. (Superceded Initial Submittal)

- December 26, 2002 - NRC provided comments on Revision 0 of the Supplement.
- December 8, 2003 - TDCC provided responses to the NRC December 26, 2002, RAIs and also submitted Revision 1 of the Supplement. Revision 1 superceded Revision 0 in its entirety.
- August 30, 2004 – NRC provided comments on the Supplement Revision 1.
- December 31, 2004 - TDCC provided responses to the August 30, 2004, RAIs and a markup version of the Supplement Revision 1 for review.

Following the December 31, 2004, submittal, TDCC and NRC staff had several discussions. In response to NRC concerns and comments expressed during the discussions the RAIs responses were modified and Revision 2 of the Supplement was developed. As stated above, the modified RAI responses (Enclosure 2) and Revision 2 of the Supplement (Enclosure 3) supercede in their entirety all of the TDCC documents and submittals listed above.

Please contact me or David Fauver if you have any questions.

Sincerely,

Ben Baker
Project Manager
The Dow Chemical Company
47 Bldg
Midland, MI 48667

ENCLOSURE 1

To

Ben Baker, TDCC, Letter to David Nelson, NRC, dated April 13, 2005

NRC Comment #3

Enclosure 2 of Revision 1, page 13, paragraph 2 - In paragraph 2 you state, in part, that "the water table is at ground surface elevation over the entire site at certain times of the year." During those times there would not be an unsaturated zone, since the 9.1 acres would be under water. Given this condition, surveys could not be conducted during this time and unsaturated zone samples could not be collected in those areas of the site that are inundated. This would invalidate the AAR Method for determining subsurface residual radioactivity within the 9.1 acres. At other times of the year the water table is below ground, and there exists definable unsaturated and saturated subsurface zones. Depending on the depth of the unsaturated zone during the dry times, surveys could be conducted and sufficient samples could be collected to validate the AAR Method. Since the depth of the unsaturated zone is critical during surveying and sampling, please describe the schedule that you will follow to ensure that surveying and sampling are conducted to properly characterize the surface and subsurface distribution of the thorium contamination within the 9.1 acres. Since the depth of the unsaturated zone is also critical to the proposed remediation approach, please describe the method(s) you will use to ensure that sufficient remediation (i.e., excavation) will be performed. Please include consideration of how the proposed additional surveying, sampling, and excavation will be consistent with the characterization data obtained to date.

Revised TDCC Response to Comment #3

TDCC understands Comment #3 to have two major parts; 1) how does site flooding affect the proposed methods and 2) does the variability in GW table depth affect the proposed methods.

Regarding site flooding, the TDCC statement that "*the water table is at ground surface elevation over the entire site at certain times of the year*," requires clarification. The water is essentially at the ground surface over the entire site for short periods of time up to about a week in length after major rainfall events and possibly snow melt depending on the seasonal snowfall. The standing water recedes fairly quickly after a given event to equilibrate with the normal water table depth. No sampling or excavation will be performed when the site is covered with standing water. The general question of variable water table depths is addressed below.

The variability of the water table depth was evaluated using the static water level measurements in the15 onsite GW monitoring wells that have been sampled periodically since December 2000 (see Table 1). The average minimum water table depth (as measured from the ground surface) was 0.41 m. The average maximum depth was 1.30 m. The overall average depth was 0.83 m. In general, the water table was lower from September through February and higher April through June.

TDCC believes that the variability in GW depth does not significantly affect the applicability of the sampling and excavation methods proposed in the Revised Supplement and that the methods remain conservative. Several reasons for this position are provided below.

1. Fundamentally, the range of GW depth over the year is small. The maximum and minimum GW depths are only 0.47 m higher and 0.42 m lower, respectively, than the average depth of 0.83m.

2. TDCC has agreed to excavate the unsaturated zone soil that exceeds the criteria down to the saturated zone regardless of the depth. This excavation will occur despite the fact that in many cases some of the unsaturated soil to be removed will be saturated at some other time of the year. This is a conservative approach since there is no credible future land use scenario where significant onsite excavation would occur at depths where the soil is saturated at some time during the year. A more realistic approach, which would be consistent with the Commission's direction to use more realistic scenarios, would be to limit unsaturated zone excavation to the 0.41 minimum GW depth, regardless of the actual GW depth encountered. Notwithstanding the possibility that limiting the depth of unsaturated zone excavation would be more realistic, TDCC continues to conservatively commit to excavate all unsaturated soil exceeding the criteria that is present at the time of excavation, regardless of whether the soil is expected to be saturated at some other time of the year.

Table 1 – GW Depth Over Time in 15 Onsite Monitoring Wells

Sample Date	Well ID and GW Depth Below Ground Surface (ft)																Average (ft)	Average (m)
	B5-3	**D4-7**	**D6-8**	**E10-7**	**E4-1**	**E6-1**	**F4-2**	**F5-5**	**F5-6**	**F7-3**	**F7-4**	**F7-7**	**G5-8**	**G6-9**	**I5-5**	**I6-8**		
12/27/2000		2.58																
1/2/2001	2.57		2.24	3.63	3.3		2.65						2					
1/3/2001						2.7								2.74				
1/10/2001	2.62	2.76	2.27	2.27	3.3	2.8	2.65						1.53	2.78				
2/8/2001								1.3	1.5	1.3	1.7	2.8						
9/16/2002		3.74																
9/17/2002																		
9/18/2002	3.69		3.6	3.04	4.5	4.2	3.83	4.06	4.2	2.7								
9/19/2002											3.29	3.6	3.22	4.09				
2/24/2003				3.3						3.24	3.98							
2/25/2003							4.5	4.64	4.78				3.97	4.74				
2/26/2003		4.45			5.2	4.8												
2/27/2003	4.16		3.99															
6/3/2003				2.33									1.74	2.83				
6/4/2003								2.53	2.79	1.62	2.31	2.87						
6/5/2003	1.71						2.36											
6/9/2003		1.67	0.59		2.6	1.2												
6/10/2003																		
9/9/2003				3.27						3.08				4.63				
9/10/2003	4.19				4.9	4.7	4.2	4.77	4.78		3.72		3.91					
9/11/2003		4.23	4.13															
9/15/2003																		
9/16/2003																		
12/8/2003					2.9		2.81	2.24	2.38	1.66	2.13							
12/9/2003	2.24	2.32	1.66	2.88		2.3							1.83	2.41				
12/10/2003																		
4/6/2004								0.92	1.14		1.39			1.69				
4/7/2004	1.75	1.7	0.99	1.59	2.2	1.4	1.65			1.06			0.63					
4/20/2004																		
4/21/2004																		
6/29/2004						1.9		1.77	1.92	0.41	1.61							
6/30/2004	2.07	2.13	1.4	1.09	2.6		1.9						1.09	2.07				
MIN	1.71	1.67	0.59	1.09	2.20	1.19	1.65	0.92	1.14	0.41	1.39	2.80	0.63	1.69			**1.36**	**0.41**
MAX	4.19	4.45	4.13	3.63	5.21	4.76	4.50	4.77	4.78	3.24	3.98	3.60	3.97	4.74			**4.28**	**1.30**
AVG	2.78	2.84	2.32	2.60	3.50	2.89	2.95	2.78	2.94	1.88	2.52	3.09	2.21	3.11			**2.74**	**0.83**

3. The AAR method assumes that future excavation will occur at the site. Regardless of GW depth, this is a conservative assumption for the Thorad site since it is more likely that significant excavation will not occur. Future industrial (or residential) use would predominantly involve onsite backfill, not excavation.

4. If unsaturated zone excavation were to occur at some time in the future, it would likely be conducted during the spring and summer construction season when the GW level is generally higher. This supports statement #2 above that it would be more realistic to excavate the unsaturated zone only to the 0.41 m minimum depth and that TDCC's approach is conservative.

5. Regardless of whether excavation occurs, TDCC has proposed to conduct 4 times as many exposure rate measurements as recommended in NUREG/CR-5849. These measurements specifically address direct exposure, which is the most likely future exposure pathway. The ~0.45 m variability in GW depth does not affect this direct exposure result.

6. The dike surrounding the site will be removed at the end of the project which will allow additional water to enter the site and result in a larger fraction of the site being flooded at some time during the year. The dike was specifically constructed to decrease flooding on the site during decommissioning. The purpose of removing the dike is to facilitate the area reverting back to a wetlands ecosystem, which further reduces the probability of future excavation.

In summary, the proposed sampling and excavation methods continue to be conservative and ALARA when the small variability in GW levels are considered. However, TDCC proposes the following additional actions to ensure that all saturated soil, including both soil that is saturated during part of the year and soil saturated for the entire year, is fully addressed.

- If a borehole sample collected as a part of the ~750 additional unsaturated zone samples that TDCC has committed to collect exceeds 30 pCi/g Th-232, the entire soil column represented by the borehole sample will be excavated, regardless of whether part of the soil column is saturated at the time of excavation. Also, if a given unsaturated zone sample collected as a part of the ~750 additional samples exceeds 30 pCi/g, a borehole sample of the saturated zone will also be collected from the same location (or as close as practicable). The 30 pCi/g saturated zone criteria will apply to any saturated zone borehole sample. Regardless of the depth of the saturated zone at the time of sampling, all of the additional 750 unsaturated zone samples will be a minimum of 1.4 feet deep. If unsaturated zone excavation is required, the excavation will be a minimum of 1.4 feet, regardless of the unsaturated zone depth at the time of excavation.

RAI #3 requests a description of the schedule to ensure proper characterization of the site. Based on the reasons discussed above, TDCC believes that the risk from the future use of the site, after compliance with the proposed sampling and excavation methods, is not strongly dependent on the implementation schedule, and that therefore characterization can be conducted at any time of the year. However, it should be noted that the ~1500 borehole samples collected to date were collected from August through December, when the GW is generally at lower levels. For consistency, efforts will be made to perform the additional ~750 unsaturated zone borehole samples in February and March 2005, when the water table is also generally lower. However, depending on the NRC review schedule, TDCC's implementation schedule, and weather conditions, some of the ~750 characterization samples may be collected in other months.

RAI #3 also requests a description of the methods to ensure sufficient excavation will be performed. TDCC believes that the methods described in the Revised Supplement will ensure sufficient excavation. However, the additional actions proposed above are intended to further strengthen the approach and ensure that areas saturated at some time during the year are fully addressed.

NRC Comment #8

<u>Section 3.3, Unrestricted Use Criteria for Groundwater in Saturated Zone</u> - In the first paragraph of this section you state, "compliance will be demonstrated using the spatial average from the wells designed in the TDCC groundwater monitoring plan (to be submitted at a later date)." Submit the monitoring plan with your responses to the RAIs

TDCC Response to Comment #8

A groundwater (GW) monitoring plan is provided in Attachment 1. This monitoring plan supplements the detailed report, "Hydrological Assessment, Dow Thorium Site, Bay City, MI," April 2000, URS Corporation, that was submitted to NRC on December 8, 2003. The GW monitoring plan concludes the 15 onsite wells that have sampled periodically since December 2000 provide a sufficient, and likely conservatively, representation of the radiological conditions of the site GW.

~~TDCC proposes to use the results of the last four quarters of sampling in the 15 onsite wells to demonstrate compliance with the MCLs in accordance with the NRC approved method described in Section 3.3 of the Supplement, Revision 1. The use of data collected prior to beginning excavation is necessary because many of these wells must be removed to complete site decommissioning. In addition, this is a conservative approach because remediation of the site will decrease the potential source term for GW contamination.~~

~~The GW sampling results for gross alpha and Total Radium (Ra-226 + Ra-228) for the 4th Qtr 2003, 1st Qtr 2004, 2nd Qtr 2004, and 3rd Qtr 2004 (covering a one year period) are provided in Tables 2 and 3. During the same period, the average~~

~~background concentration of Total Radium was 2.7 pCi/g (the individual sample background ranged from 0.7 pCi/g to 6.0 pCi/g).~~

A summary of the last four quarters of groundwater sampling results is provided in Tables 2 and 3 for information. As seen in the tables, the average concentrations of Total Radium and gross alpha in each quarter are well below their respective limits of 5 pCi/L and 15 pCi/L. The upper 95% confidence levels (mean + 1.761 σ_{mean}) for the full year of results are also well below the limits. The low average concentrations in the GW sampled from the 15 monitoring wells over the one year period provides high confidence that any future sampling will also be in compliance with the criteria. This result was expected because of the very low solubility of the slag material.

Table 2 – Summary of Total Radium (Ra-226 + Ra-228) Concentration in Monitoring Well Samples

Well ID	Ra-226 + Ra-228 (pCi/L)				
	3rd 04	2nd 04	1st 04	4th 03	1 Year Average
B5-3	2.47	2.31	1.57	1.70	2.01
D4-7	2.16	1.77	0.80	1.11	1.46
D6-8	0.83	1.61	0.81	0.62	0.97
E10-7	0.82	1.53	1.07	0.70	1.03
E4-1	0.78	1.51	0.54	1.21	1.01
E6-1	0.76	2.43	0.77	0.70	1.17
F4-2	1.64	1.35	1.33	0.80	1.28
F5-5D	1.03	0.84	0.34	0.35	0.64
F5-6D	1.48	0.81	1.55	1.21	1.26
F7-3A	1.63	1.57	0.27	0.25	0.93
F7-4A	DRY	2.81	1.90	1.32	2.01
G5-8	3.16	2.47	1.64	2.00	2.32
G6-9	3.60	4.26	2.72	3.82	3.60
I5-5	6.30	7.86	4.87	5.08	6.03
I6-8	5.93	6.00	3.41	4.37	4.93
Mean	2.33	2.61	1.57	1.68	2.04
Std Dev					0.42
Mean + 1.761σ					2.78

Table 3 – Summary of Gross Alpha Concentration in Monitoring Well Samples

Well ID	**Gross Alpha (pCi/L)**				
	3rd 04	2nd 04	1st 04	4th 03	1 Year Average
B5-3	0.79	0.56	10.20	2.28	3.46
D4-7	3.43	1.96	0.16	3.75	2.32
D6-8	1.26	2.16	-3.59	10.50	2.58
E10-7	0.81	1.44	3.40	-1.28	1.09
E4-1	0.21	6.48	-0.98	0.21	1.48
E6-1	0.75	-0.08	2.54	11.10	3.58
F4-2	-1.20	1.06	22.30	2.24	6.10
F5-5D	2.69	2.24	-8.29	0.00	-0.84
F5-6D	0.50	-0.32	-0.49	1.74	0.36
F7-3A	4.92	3.86	-5.64	-3.79	-0.16
F7-4A	DRY	0.95	3.31	-1.43	0.94
G5-8	-0.12	1.01	1.37	7.77	2.51
G6-9	5.75	6.39	12.20	2.14	6.62
I5-5	5.84	5.11	17.30	4.58	8.21
I6-8	11.50	9.43	10.40	28.00	14.83
Mean	2.65	2.82	4.28	4.52	3.54
Std Dev					1.04
Mean + 1.761σ					5.38

NRC Comment #9

Incomplete Sampling - Revision 1 of the Supplement indicates that the ~750 boreholes will provide sufficient characterization and final status survey (FSS) sampling for the saturated zone. However, we note that some of the subgrids (100 m^2 areas) have not yet been sampled. For example, samples apparently have not been taken in subgrids E8-7, E8-8, E8-9, E9-7, E9-8, and E9-9. This situation also may be applicable to the unsaturated zone characterization. Describe how the characterization and FSS surveys will be completed for these and all subgrids of the 9.1 acre area (for both the unsaturated and saturated zones).

Revised TDCC Response to Comment #9

No data was reported for the subgrids listed in Comment #8 because the geoprobe sampling equipment could not penetrate the subsurface material in these subgrids. Field personnel that were present when the sampling was being performed reported that refusal was met due to the presence of large quantities of a plastic sheeting material. Attempts were made to sample at various locations within a given quadrant if refusal was encountered during the initial effort at the center of the quadrant. These areas are not believed to contain significant quantities of contaminated slag since it is evident by inspection that waste material from a production process other than Mg-Th alloy was used as fill in these areas.

~~If refusal was met over an entire quadrant during the saturated zone sampling conducted to date, attempts will be made to sample in adjacent quadrants in the same subgrid. If refusal is met in all quadrants of a subgrid no data will be reported for the saturated zone in the given subgrid~~.

~~For the unsaturated zone, TDCC proposes to collect geoprobe borehole samples in each quadrant. Therefore, if refusal is met over an entire quadrant, no sample will be reported for the quadrant. However, it is expected that some depth of soil cover will be present in every quadrant that can be used to represent the unsaturated zone even if refusal is met before groundwater is encountered.~~

All quadrants that were not sampled due to geoprobe refusal will be re-sampled using a larger geoprobe, a drill, or excavation, as necessary.

ATTACHMENT 1

GROUNDWATER MONITORING PLAN FOR TDCC BAY CITY SITE

Ground Water Monitoring Plan for Thorad Site
The DOW Chemical Company
Bay City, Michigan

Introduction

The Groundwater Monitoring Plan was developed to monitor the possible contamination of groundwater from magnesium-thorium slag at the Bay City Thorad site. Specifically the plan will monitor for the presence of gross alpha, radium 226, and radium 228.

Background Information

Beginning in the early 1940's and continuing into the early 1960's, The Dow Chemical Company (TDCC) produced a metallic magnesium alloy used in aircraft applications. The alloy was a lightweight material with improved high temperature strength. Production took place at two locations – in Bay City, Michigan, and in Midland, Michigan.

The production process yielded slag material as a by-product. The magnesium-thorium slag material, which is regulated as a radioactive material, has been stored on TDCC property at Bay City, Michigan under a license from the Nuclear Regulatory commission (NRC)

The Site is located adjacent to the Saginaw River near the mouth where the river discharges into Saginaw Bay. Most of the topography can be characterized as generally low lying land with an average surface elevation around 585 feet relative to the USGS datum. The geology of the site consists of 6-12 feet of river sediments and fill overlying a hard dense till clay.

Previous hydrogeological assessments (URS, April 2001) indicate that groundwater is found within the river sediments, glacial till sands, if present, and the Saginaw formation. Due to the proximity of the Saginaw River shallow groundwater is in hydraulic communication with the river. The assessment also indicated that the Saginaw formation is the most significant source of groundwater in the area. Till sands may provide a source of groundwater, however their occurrence is too sporadic and it is highly unlikely that till sand is in communication with the river sediment. River sediments, which are significantly thinning away from the Saginaw River and are essentially contiguous with the surface water in the Saginaw River, contain groundwater sporadically or on a seasonal basis. The most likely pathway for thorium migration would be the groundwater in these river sediments. Due to the thickness of the dense glacial till clays below the river sediments vertical migration would be very unlikely.

Current conditions

Fifteen wells have been installed at the Thorad site in "hotspots" - areas of highest thorium levels, and are screened within the shallow river sediments. In addition seven upgradient wells located to the west of the Thorad site are currently being monitored for background conditions. Given the known hydrogeological conditions discussed above, all wells were reviewed for adequacy for this groundwater monitoring plan. It was determined that the given location of the wells represent site as well as up and downgradient conditions.

1. Sampling Plan

Due to the occurrence of groundwater in the river sediments at the Thorad site, wells must monitor the down gradient flow of the river sediment formation in addition to monitoring conditions at the established hotspots. Wells should also monitor background conditions and need to be placed up gradient from the site.

1.1.1 The general groundwater flow at the site is to the east. Wells E10-7 and D6-8 will serve as down gradient wells. These two wells are located at the eastern edge of the monitoring area and are therefore sufficient in represent the downgradient conditions. Wells listed separately in Section 1.4 will act as the background wells for this monitoring plan. As river sediments are discontinuous in nature, monitoring the hotspots at the site provides the highest likelihood of determining the worst case site groundwater concentrations.

1.1.2 The potentially impacted water bearing zone is the shallow ground water within the river sediments and is found between 3-5 feet below ground level. All monitored wells are screened in this zone.

1.2 Frequency of Water level measurements

Site specific groundwater gradient to the east northeast, has been determined during the Hydrological Assessments conducted at the site.

1.2.1 Water levels will be obtained prior to purging the wells

1.2.3 Water levels will be obtained within as short a time period of each other as is practicable.

1.3 Sampling Method

Sample tubing is lowered into the well using designated tubing when available. If tubing has not already been designated for a specific well, new tubing will be used. The tubing is placed into the wells such that the bottom of the tubing is at approximately mid-screen. A table of well screen intervals is available to determine the mid-screen depth. For wells that are poor producers the tubing may have to be lowered closer to the bottom, trying not to get closer than 6-inches.

After well pumping is initiated, a "hydrolab' is used to monitor for pH, conductivity, oxidation/reduction potential, dissolved oxygen and turbidity. An initial reading is taken when the hydrolab cell is filled. The static water level is checked to ensure that the well level is stable and will remain so at the pumping rate. The static water level is maintained within about 1 foot of the initial reading. If that is not possible and the well purges dry, the sample is not collected and another attempt is made within 24 hours.

Readings are taken for temperature, static water level, rate of purging, dissolved oxygen, turbidity, oxidation/reduction potential, conductivity, and pH. Readings are recorded every three minutes after a sufficient volume has been purged. When the parameters reach equilibrium for three consecutive readings, samples are collected. Parameter equilibrium is defined as + 0.1 for pH, + 3% for conductivity, + 10mV for oxidation/reduction potential (ORP), and + 10% for turbidity and dissolved oxygen.

Samples are filtered using a 0.45 µm filter and collected in 1 liter sample containers provided and certified clean by the laboratory. All sample containers are acidified with HNO_3 in the field prior to shipment to the laboratory.

A duplicate is collected for every 10 samples and a matrix spike/matrix spike duplicate (MS/MSD) sample is collected for every 20 samples. At least one duplicate and one MS/MSD must be collected per day.

1.4 Constituents analyzed

1.4.1 The constituents of concern at this site are:

Gross Alpha
Radium 226
Radium 228

For Analytical methods and detection limits see table below.

Analytes	Analytical Method	Detection Limit
Radium 266	EPA 903.1	5 picoCuries/L combined
Radium 228	EPA 904.0	
Gross Alpha	EPA 900.0	15 pCi/L

1.5 Sampling Frequency

1.5.1 The sampling frequency will be quarterly over a twelve month period. The following wells will be sampled quarterly to monitor the shallow groundwater zone after all saturated zone remediation is completed. The results from the wells listed as downgradient will be treated the same as all other wells in the calculations to demonstrate compliance.

The construction designs for wells I5-5 and I6-8 are provided below. The construction designs for all other wells were previously submitted to NRC. The construction of wells I5-5 and I6-8 was different from the remaining wells. Therefore, wells I5-5 and I6-8 will be removed before remediation and reconstructed in the same location after remediation in the area is completed. The new I5-5 and I6-8 wells will have a 5 ft screen depth and a 2 in screen diameter to match the design of the remaining wells. The depth of the new wells will be approximately the same as the depth shown in the attached diagrams.

B5-3
D4-7
E6-1
I5-5
I6-8
E4-1
F5-5D
G5-8
G6-9
F5-6D
F4-2
F7-3A
F7-4A

The following wells will serve as background wells:

5487
5849
5851
5852
5855
5858
5860

The following wells will serve as downgradient wells:

E10-7
D6-8

1.6 Inspection and well maintenance

The condition of each well shall be inspected at each sampling event. These conditions are as follows:

- Surface Seal
- Casing Integrity
- Total depth of well

Any necessary repair will be made prior to the next sampling event. If a well can not be properly repaired it will be replaced or abandoned.

1.7 Sampling Schedule

Sampling will be completed during each quarter over a twelve month period.

FSS PLAN FOR
RAIL CAR LOADING AREA AND SUPPORT ZONE SOIL,
TEMPORARY OFFICE/LABORATORY BUILDING,
PERSONNEL DECONTAMINATION FACILITY BUILDING, AND
RAIL LOADING AREA SUPPORT TRAILER

Final Status Survey of the Rail Loading Area and the Support Zone Soil

Two soil areas require final status survey (FSS) that are not discussed in the Supplement, Revision 1; the Rail Car Loading Area and the Support Zone (see attached Figures). The Rail Car Loading area serves as the staging and rail car loading area for excavated soil for shipment to an offsite disposal site. The Support Zone is the location of the support facilities including the onsite laboratory, office trailer, sample storage, and operations and radiation protection support.

The FSS of these soil areas will be conducted in accordance with NUREG/CR-5849 guidance for affected areas. The FSS will apply to surface soil only. The presence of subsurface soil is very unlikely in these areas. The two areas will be divided into 100 m^2 grids. The FSS will consist of a scan survey of 100% of the two areas, four surface soil samples (6 in. depth) in each 100 m^2 grid, and four exposure rate measurements in each 100 m^2 grid. The soil samples and exposure rate measurements will be collected using the sampling pattern shown in Figure 4-4 of NUREG/CR-5849.

The site specific soil concentration limit of 3.2 pCi/g Th-232 (including background) will be applied along with the $(100/A)^{1/2}$ averaging criteria from NUREG/CR-5849. The exposure rate limit will be 10 uR/hr, above background, with a 20 uR/hr, above background, maximum. Compliance with the soil and exposure rate limits will be demonstrated for each area (i.e., Rail Car Loading and Support Zone) at a 95% confidence level using Equation 8-13 from NUREG/CR-5849. The $(100/A)^{1/2}$ soil averaging criteria and the 20 uR/hr maximum exposure rate criteria will apply to each 100 m^2 grid with the limitation that the average in each 100 m^2 area must be less than the 3.2 and 10 uR/hr limit.

Final Status Survey of Temporary Office/Laboratory Buildings, Personnel Decontamination Facility Building, and Rail Loading Area Support Trailer

There are three structures in the Support Zone and one structure in the Rail Loading Area. Current plans call for the Temporary Office Building, Temporary Laboratory Building, and Rail Loading Area Support Trailer to be removed from the site and the Personnel Decontamination Facility Building to remain. An FSS will be performed in the Decontamination Building. For the Office Building, Laboratory Buildings, and Support Trailer, either an FSS or free release survey will be performed at the discretion of TDCC. The FSS will be performed in accordance with the guidance in NUREG/CR-5849 as described below.

The unrestricted use criteria applied to building surfaces are listed in "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material," Policy and Guidance Directive FC 83-23. The FC-83-23 criteria for Th-230 and Natural Thorium (Th-Nat), the radionuclides present at the Thorad site, are provided below.

Th-Nat

- Surface contamination (fixed plus removable): 1,000 dpm/100 cm^2, averaged over 1 m^2, and 3,000 dpm/100 cm^2 maximum.

- Removable contamination: 200 dpm/100 cm^2.

Th-230

- Surface contamination (fixed plus removable): 100 dpm/100 cm^2, averaged over 1 m^2, and 300 dpm/100 cm^2 maximum.

- Removable contamination: 20 dpm/100 cm^2.

The criteria for exposure rate is 5 uR/hr above background, at 1 m from building surfaces, averaged over 10 m^2 of contiguous surface area. Individual measurements may not exceed a maximum of 10 uR/hr above background, at 1 m.

Because the radionuclide mixture consists of alpha emitters with different criteria, a gross activity criterion was calculated using Equation A-2 of NUREG/CR-5849. The ratio of Th-230:Th-232 was assumed to be 3:1 at the Thorad site. However, for each Th-232 alpha, there are 6.33 total alpha emissions in the Th-Nat series. Therefore, the effective Th-230:Th-Nat alpha ratio applicable to the calculation of the gross activity criteria is 3:6.33. To calculate the gross activity criteria, the radionuclide fraction is required. For the Thorad site, the alpha fraction is used in place of the radionuclide fraction. Assuming the 3:6.33 ratio of alpha emissions, the alpha fractions would 0.33 and 0.67, for Th-230 and Th-Nat, respectively. Using these fractions, the gross activity criterion is calculated below.

$$\text{Alpha Gross Activity Criterion} = \frac{1}{\frac{.33}{100} + \frac{.67}{1000}} = 250 \text{ dpm/100 cm}^2 \text{ alpha}$$

The maximum gross activity criterion is 750 dpm/100 cm^2 (3x250) and the removable gross activity criterion is 50 dpm/100 cm^2 (250/5).

All four structures are designated as affected. The floors and lower walls (up to 2m) will be scan surveyed over 100% of the surface using an alpha detector such as a gas proportional counter. Elevated areas will be investigated and remediated as necessary. Direct alpha measurements and smear samples will be performed at a frequency of 1 per m^2. Exposure rate measurements will be performed at a frequency of 1 per 4 m^2. The maximum survey unit size for floors and lower walls will be 100 m^2 of floor area.

A minimum of 30 direct measurements and 30 smear samples will be collected in the upper walls and ceilings. Scan surveys will be performed in the immediate vicinity of each direct measurement. If a significant number of areas in the upper walls and ceilings are found to exceed 25% of the guideline level, the frequency of the direct measurements will be increased to 1 per m^2. There is no limit to the survey unit size for upper walls and ceilings. However, to ensure reasonable coverage, the measurement frequency will not be less than 1 per 20 m^2.

All instruments will be calibrated with NIST traceable sources. Background and source checks will be performed before and after each use.

The direct measurement MDC will be calculated using the following equation. The source efficiency (e_s) used in the MDC calculation will be the ISO-7503-1 default value for alpha of 0.25. The instrument efficiency (e_i) is the 2π efficiency, which will be determined by calibration to a NIST source. The parameters in the equation below will be set to ensure that the MDC is less than the 250 dpm/100 cm^2 criteria.

$$MDC_{direct} = \frac{3 + 3.29\sqrt{B_R \cdot t_s \cdot (1 + \frac{t_s}{t_b})}}{t_s \cdot ei \cdot es \cdot \frac{A}{100}}$$

Where:

MDC_{direct}	=	minimum detectable concentration (dpm/100 cm^2)
B_R	=	background count rate (cpm)
t_b	=	background count time (cpm)
t_s	=	sample count time (min)
A	=	detector area (cm^2)
e_i	=	instrument efficiency
e_s	=	source efficiency

The alpha scan survey MDC will be calculated using the following two equations (MARSSIM Equations 6-12 and 6-13). The first equation calculates the probability of observing a single count when the contamination level equals the criteria. If a single count is observed during the scan survey, the technician will stop and perform a stationary count for the time calculated using the second equation. The scan survey parameters are selected to ensure that the probability of observing a single count when contamination is present at levels ≥ the criteria is ≥ 95%. The follow up stationary count time is set to ensure that the probability of observing a second count is 90% when contamination is present at levels ≥ the criteria. If no count is recorded during the stationary count, then the count detected during scanning does not represent contamination above the criteria and scanning is continued.

$$P(n \geq 1) = 1 - e^{\frac{-GEd}{60v}}$$

Where:

P(n≥1)	=	probability of observing a single count
G	=	contamination activity (dpm)
E	=	detector efficiency (4π)
d	=	width of detector in direction of scan (cm)
v	=	scan speed (cm/s)

$$t = \frac{13{,}800}{CAE}$$

Where:

t	=	time period of stationary count (s)
C	=	contamination criteria (dpm/100 cm^2)
A	=	physical probe area (cm^2)
E	=	detector efficiency (4π)

The following parameters are used to calculate a nominal scan MDC and stationary follow up count time.

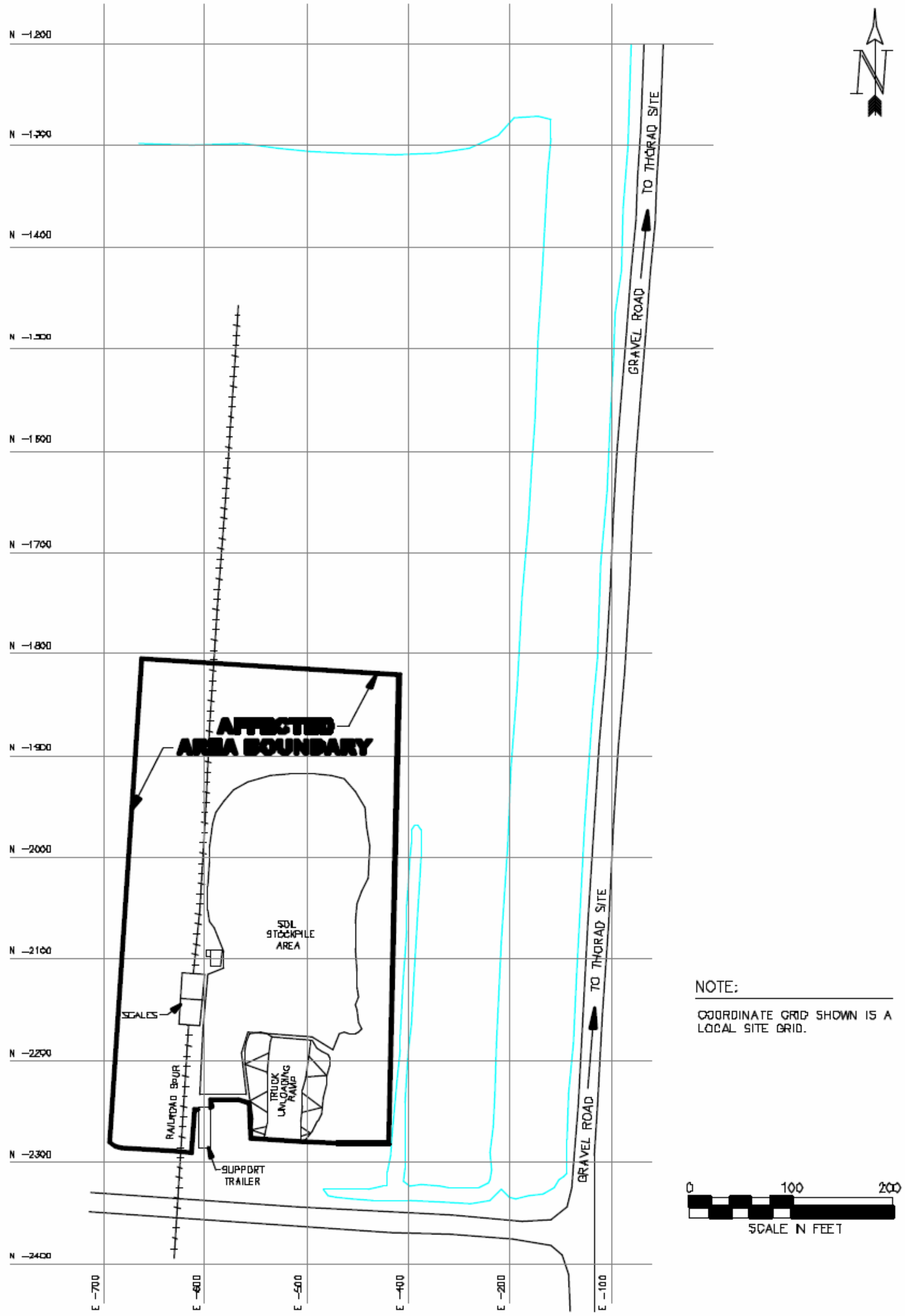
G	=	250 dpm
E	=	0.15
d	=	12 cm
v	=	2 cm/s
C	=	250 dpm/100 cm^2
A	=	100 cm^2

Using the values listed above, the scan detection probability and stationary count time are calculated as follows:

$$P(n \geq 1) = 1 - e^{\frac{-(250)(0.15)(12)}{60(2)}} \quad = \quad 97\%$$

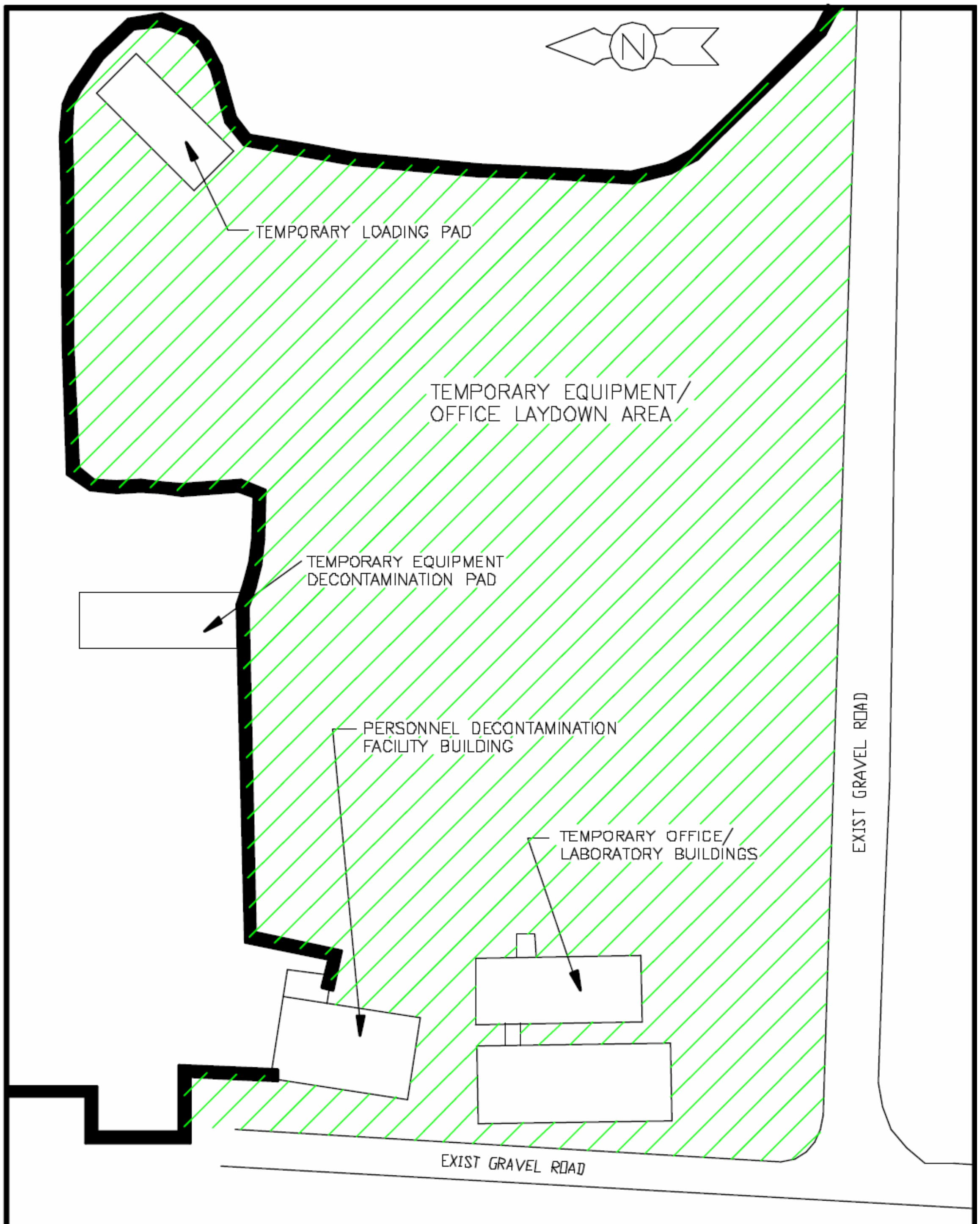
$$t = \frac{13{,}800}{(250)(100)(0.15)} \quad = \quad 4 \text{ seconds}$$

Compliance will be demonstrated for each survey unit at the 95% confidence level using Equation 8-13 in NUREG/CR-5849. An FSS report will be submitted for NRC review and approval.



THORAD SITE – RAIL LOADING AREA
THE DOW CHEMICAL COMPANY
BAY CITY, MI

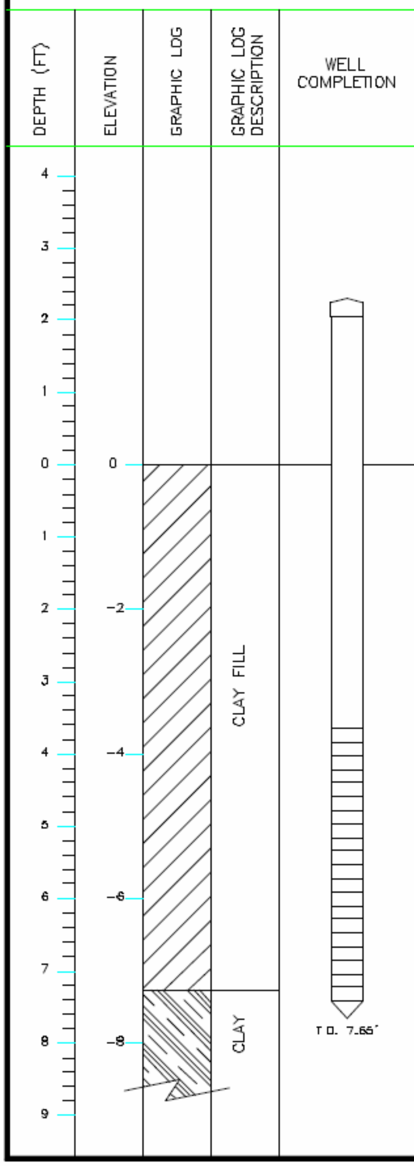
SCALE:	DATE:	DRAWING NO.
AS SHOWN	JUNE 2004	?????



THORAD TEMPORARY EQUIPMENT AND OFFICE LAYDOWN AREA

THE DOW CHEMICAL COMPANY
BAY CITY, MI

URS CORPORATION		WELL NUMBER I5-5C(R)
CLIENT: *Dow Chemical*	PROJECT: *Thorod*	LOCATION: *Bay City, MI*
DATE STARTED: *9/12/02*	DATE FINISHED. *9/12/02*	BOREHOLE DIA.: *1 7/8 inch*
SUPERVISED BY: *G. A. Sgro*	DRILLER: *URS Corp.*	WATER LEVEL:
DRILL METHOD: *Geoprobe*	PROJECT NUMBER: *007133*	
DRILL COMPANY: *URS Corp.*		
COORDINATES: *E 440 N 840*	SURFACE ELEVATION:	T.O.C. ELEVATION:



WELL COMPLETION MATERIALS AND DEPTHS

SURFACE COMPLETION: *STICK-UP 2.21ft.*

RISER

RISER TYPE: *PVC*
RISER DIA.: *1 inch*
RISER LENGTH: *STICK-UP 2.21ft.*

ANNULAR SEAL

GROUT TYPE:
AMOUNT OF CEMENT:
AMOUNT OF WATER:
AMOUNT OF BENTONITE:
SEAL TYPE: *GRANULAR*
AMOUNT OF SEAL: *5#*
DEPTH TO SEAL: *6 inches*

FILTER PACK

FILTER PACK TOP:
FILTER PACK BOTTOM.
FILTER PACK TYPE:
GRAIN SIZE:
AMOUNT:

WELL SCREEN

SCREEN TOP: *3.65*
SCREEN BOTTOM: *7.65*
SCREEN TYPE: *PVC*
SCREEN DIA *1 inch*

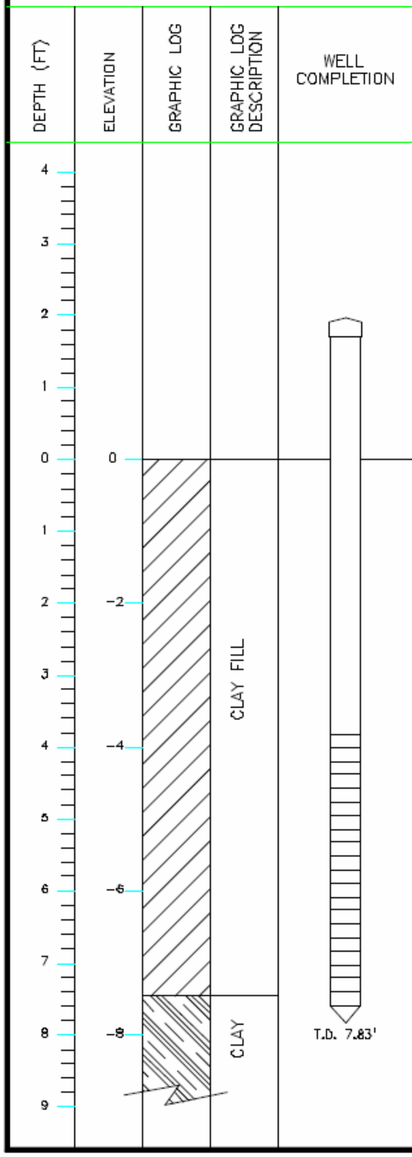
WELL DEVELOPMENT

DEVELOPMENT DATE:
VOLUME REMOVED:
TURBIDITY:
pH:
TEMPERATURE:
CONDUCTIVITY:
METHOD:

URS CORPORATION

WELL NUMBER I6-8C(R)

CLIENT: *Dow Chemical*	PROJECT: *Thorad*	LOCATION: *Bay City, MI*
DATE STARTED: *9/12/02*	DATE FINISHED: *9/12/02*	BOREHOLE DIA.: *1 7/8 inch*
SUPERVISED BY: *G. A. Sgro*	DRILLER: *URS Corp.*	WATER LEVEL:
DRILL METHOD: *Geoprobe*	PROJECT NUMBER: *007133*	
DRILL COMPANY: *URS Corp.*		
COORDINATES: *E 540 N 806*	SURFACE ELEVATION:	T.O.C. ELEVATION:



WELL COMPLETION MATERIALS AND DEPTHS

SURFACE COMPLETION: *STICK-UP 1.96ft.*

RISER

RISER TYPE: *PVC*
RISER DIA.: *1 inch*
RISER LENGTH: *STICK-UP 1.96ft.*

ANNULAR SEAL

GROUT TYPE:
AMOUNT OF CEMENT:
AMOUNT OF WATER:
AMOUNT OF BENTONITE:
SEAL TYPE: *GRANULAR*
AMOUNT OF SEAL: *5#*
DEPTH TO SEAL: *6 inches*

FILTER PACK

FILTER PACK TOP:
FILTER PACK BOTTOM:
FILTER PACK TYPE:
GRAIN SIZE:
AMOUNT:

WELL SCREEN

SCREEN TOP: *3.83*
SCREEN BOTTOM: *7.83*
SCREEN TYPE: *PVC*
SCREEN DIA. *1 inch*

WELL DEVELOPMENT

DEVELOPMENT DATE:
VOLUME REMOVED:
TURBIDITY:
pH:
TEMPERATURE:
CONDUCTIVITY:
METHOD:

ENCLOSURE 2

To

Ben Baker, TDCC, Letter to David Nelson, NRC, dated April 13, 2005

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION ON REVISION 1 OF THE SUPPLEMENT DATED AUGUST 30, 2004

The Dow Chemical Company
Midland, MI 48667

NRC Comment #1

<u>Section 3, Unrestricted Use Criteria, and Section 4, Final Status Survey</u> - The cover letter to Revision 1 of the Supplement states, in part, that the Supplement "contains a survey and averaging approach that appears to be consistent with NRC approved guidance (the AAR Method) that was specifically developed to address sites with random subsurface contamination." In Sections 3 and 4 of Revision 1, you describe, in detail, how the AAR Method would be applied to the Dow Chemical Company (TDCC) site. Specifically, you describe a survey and sample collection methodology to be used and include acceptance criteria used to evaluate the data collected. The NRC staff agrees that the statistical approach used by the AAR Method appears to be valid.

We note, however, that the release criteria in Revision 1 appear to be 5 pCi/g for Th-232 and 10 pCi/g for total thorium (Th-232 and Th-228). You have not requested that the thorium concentration criteria be changed for the 9.1 acres remaining to be remediated. Therefore, compliance with the criteria for the 9.1 acres (2.9 pCi/g for Th-232 (average) or 3.2 pCi/g including background), which was previously approved under License Amendment No. 7, must be demonstrated.

Please address this apparent conflict. Either derive site-specific criteria for addressing surface and subsurface (unsaturated and saturated zone) residual radioactivity that are consistent with the 2.9 pCi/g criterion, or describe in detail why the criteria listed in Revision 1 on pages 20, 21, and 22 are appropriate.

TDCC Response to Comment #1

TDCC agrees to modify the averaging criteria on pages 20, 21, and 22 of Revision 1 to be consistent with the Bay City site-specific unrestricted use limit of 2.9 pCi/g Th-232. The modified averaging criteria for the unsaturated zone (including 0.3 pCi/g background) are listed below:

- Maximum individual sample < 14.8 pCi/g Th-232
- Average of any two samples in a given $100m^2$ subgrid from 0-1 meter depth < 6.1 pCi/g Th-232
- Average of the four samples from the 0-1 m depth in a given 100 m^2 subgrid < 3.2 pCi/g Th-232.
- Average of the eight samples from the 0-2 m depth in a given 100 m^2 subgrid < 3.2 pCi/g Th-232 (if applicable).
- Average of the two samples from 0-2 meters in the same borehole < 4.3 pCi/g Th-232 (if applicable).

NRC Comment #2

<u>Section 4.2, Unsaturated Zone</u> - On page 22 you state, in part, that "investigation will be conducted and remediation completed, as necessary, if exposure rate measurements cause a subgrid to fail or if a borehole sample causes a subgrid to fail." You did not, however, describe the kind of investigations that will be conducted, circumstances for which remediation would be necessary, or the methods used to remediate the subgrid. Please provide a more comprehensive description of the investigation that would be conducted and describe how those failures would affect other decisions or remediation activities if failures are identified.

TDCC Response to Comment #2

The exposure rate and borehole measurements proposed for the locations of the maximum NaI cpm reading in each 100 m^2 subgrid are not required by the AAR method and are considered to be conservative additions. An investigation will be conducted if any of these additional exposure rate or borehole measurements cause the 100 m^2 averaging criterion or the individual sample maximum criterion to be exceeded. The investigation and remediation methods will be the same as those applied to the ~ 1500 systematic unsaturated zone borehole samples and the ~ 6,000 systematic exposure rate measurements performed to determine compliance.

NRC Comment #3

<u>Enclosure 2 of Revision 1, page 13, paragraph 2</u> - In paragraph 2 you state, in part, that "the water table is at ground surface elevation over the entire site at certain times of the year." During those times there would not be an unsaturated zone, since the 9.1 acres would be under water. Given this condition, surveys could not be conducted during this time and unsaturated zone samples could not be collected in those areas of the site that are inundated. This would invalidate the AAR Method for determining subsurface residual radioactivity within the 9.1 acres. At other times of the year the water table is below ground, and there exists definable unsaturated and saturated subsurface zones. Depending on the depth of the unsaturated zone during the dry times, surveys could be conducted and sufficient samples could be collected to validate the AAR Method. Since the depth of the unsaturated zone is critical during surveying and sampling, please describe the schedule that you will follow to ensure that surveying and sampling are conducted to properly characterize the surface and subsurface distribution of the thorium contamination within the 9.1 acres. Since the depth of the unsaturated zone is also critical to the proposed remediation approach, please describe the method(s) you will use to ensure that sufficient remediation (i.e., excavation) will be performed. Please include consideration of how the proposed additional surveying, sampling, and excavation will be consistent with the characterization data obtained to date.

TDCC Response to Comment #3

TDCC understands Comment #3 to have two major parts; 1) how does site flooding affect the proposed methods and 2) does the variability in GW table depth affect the proposed methods.

Regarding site flooding, the TDCC statement that "*the water table is at ground surface elevation over the entire site at certain times of the year*," requires clarification. The water is essentially at the ground surface over the entire site for short periods of time up to about a week in length after major rainfall events and possibly snow melt depending on the seasonal snowfall. The standing water recedes fairly quickly after a given event to equilibrate with the normal water table depth. No sampling or excavation will be performed when the site is covered with standing water. The general question of variable water table depths is addressed below.

The variability of the water table depth was evaluated using the static water level measurements in the15 onsite GW monitoring wells that have been sampled periodically since December 2000 (see Table 1). The average minimum water table depth (as measured from the ground surface) was 0.41 m. The average maximum depth was 1.30 m. The overall average depth was 0.83 m. In general, the water table was lower from September through February and higher April through June.

TDCC believes that the variability in GW depth does not significantly affect the applicability of the sampling and excavation methods proposed in the Revised Supplement and that the methods remain conservative. Several reasons for this position are provided below.

1. Fundamentally, the range of GW depth over the year is small. The maximum and minimum GW depths are only 0.47 m higher and 0.42 m lower, respectively, than the average depth of 0.83m.

2. TDCC has agreed to excavate the unsaturated zone soil that exceeds the criteria down to the saturated zone regardless of the depth. This excavation will occur despite the fact that in many cases some of the unsaturated soil to be removed will be saturated at some other time of the year. This is a conservative approach since there is no credible future land use scenario where significant onsite excavation would occur at depths where the soil is saturated at some time during the year. A more realistic approach, which would be consistent with the Commission's direction to use more realistic scenarios, would be to limit unsaturated zone excavation to the 0.41 minimum GW depth, regardless of the actual GW depth encountered. Notwithstanding the possibility that limiting the depth of unsaturated zone excavation would be more realistic, TDCC continues to conservatively commit to excavate all unsaturated soil exceeding the criteria that is present at the time of excavation, regardless of whether the soil is expected to be saturated at some other time of the year.

Table 1 – GW Depth Over Time in 15 Onsite Monitoring Wells

Sample Date	Well ID and GW Depth Below Ground Surface (ft)																Average (ft)	Average (m)
	B5-3	**D4-7**	**D6-8**	**E10-7**	**E4-1**	**E6-1**	**F4-2**	**F5-5**	**F5-6**	**F7-3**	**F7-4**	**F7-7**	**G5-8**	**G6-9**	**I5-5**	**I6-8**		
12/27/2000		2.58																
1/2/2001	2.57		2.24	3.63	3.3		2.65						2					
1/3/2001						2.7								2.74				
1/10/2001	2.62	2.76	2.27	2.27	3.3	2.8	2.65						1.53	2.78				
2/8/2001								1.3	1.5	1.3	1.7	2.8						
9/16/2002		3.74																
9/17/2002																		
9/18/2002	3.69		3.6	3.04	4.5	4.2	3.83	4.06	4.2	2.7								
9/19/2002											3.29	3.6	3.22	4.09				
2/24/2003				3.3						3.24	3.98							
2/25/2003							4.5	4.64	4.78				3.97	4.74				
2/26/2003		4.45			5.2	4.8												
2/27/2003	4.16		3.99															
6/3/2003				2.33									1.74	2.83				
6/4/2003								2.53	2.79	1.62	2.31	2.87						
6/5/2003	1.71						2.36											
6/9/2003		1.67	0.59		2.6	1.2												
6/10/2003																		
9/9/2003				3.27						3.08				4.63				
9/10/2003	4.19				4.9	4.7	4.2	4.77	4.78		3.72		3.91					
9/11/2003		4.23	4.13															
9/15/2003																		
9/16/2003																		
12/8/2003					2.9		2.81	2.24	2.38	1.66	2.13							
12/9/2003	2.24	2.32	1.66	2.88		2.3							1.83	2.41				
12/10/2003																		
4/6/2004								0.92	1.14		1.39			1.69				
4/7/2004	1.75	1.7	0.99	1.59	2.2	1.4	1.65			1.06			0.63					
4/20/2004																		
4/21/2004																		
6/29/2004						1.9		1.77	1.92	0.41	1.61							
6/30/2004	2.07	2.13	1.4	1.09	2.6		1.9						1.09	2.07				
MIN	1.71	1.67	0.59	1.09	2.20	1.19	1.65	0.92	1.14	0.41	1.39	2.80	0.63	1.69			**1.36**	**0.41**
MAX	4.19	4.45	4.13	3.63	5.21	4.76	4.50	4.77	4.78	3.24	3.98	3.60	3.97	4.74			**4.28**	**1.30**
AVG	2.78	2.84	2.32	2.60	3.50	2.89	2.95	2.78	2.94	1.88	2.52	3.09	2.21	3.11			**2.74**	**0.83**

3. The AAR method assumes that future excavation will occur at the site. Regardless of GW depth, this is a conservative assumption for the Thorad site since it is more likely that significant excavation will not occur. Future industrial (or residential) use would predominantly involve onsite backfill, not excavation.

4. If unsaturated zone excavation were to occur at some time in the future, it would likely be conducted during the spring and summer construction season when the GW level is generally higher. This supports statement #2 above that it would be more realistic to excavate the unsaturated zone only to the 0.41 m minimum depth and that TDCC's approach is conservative.

5. Regardless of whether excavation occurs, TDCC has proposed to conduct 4 times as many exposure rate measurements as recommended in NUREG/CR-5849. These measurements specifically address direct exposure, which is the most likely future exposure pathway. The ~0.45 m variability in GW depth does not affect this direct exposure result.

6. The dike surrounding the site will be removed at the end of the project which will allow additional water to enter the site and result in a larger fraction of the site being flooded at some time during the year. The dike was specifically constructed to decrease flooding on the site during decommissioning. The purpose of removing the dike is to facilitate the area reverting back to a wetlands ecosystem, which further reduces the probability of future excavation.

In summary, the proposed sampling and excavation methods continue to be conservative and ALARA when the small variability in GW levels are considered. However, TDCC proposes the following additional actions to ensure that all saturated soil, including both soil that is saturated during part of the year and soil saturated for the entire year, is fully addressed.

- If a borehole sample collected as a part of the ~750 additional unsaturated zone samples that TDCC has committed to collect exceeds 30 pCi/g Th-232, the entire soil column represented by the borehole sample will be excavated, regardless of whether part of the soil column is saturated at the time of excavation. Also, if a given unsaturated zone sample collected as a part of the ~750 additional samples exceeds 30 pCi/g, a borehole sample of the saturated zone will also be collected from the same location (or as close as practicable). The 30 pCi/g saturated zone criteria will apply to any saturated zone borehole sample. Regardless of the depth of the saturated zone at the time of sampling, all of the additional 750 unsaturated zone samples will be a minimum of 1.4 feet deep. If unsaturated zone excavation is required, the excavation will be a minimum of 1.4 feet, regardless of the unsaturated zone depth at the time of excavation.

RAI #3 requests a description of the schedule to ensure proper characterization of the site. Based on the reasons discussed above, TDCC believes that the risk from the future use of the site, after compliance with the proposed sampling and excavation methods, is not strongly dependent on the implementation schedule, and that therefore characterization can be conducted at any time of the year. However, it should be noted that the ~1500 borehole samples collected to date were collected from August through December, when the GW is generally at lower levels. For consistency, efforts will be made to perform the additional ~750 unsaturated zone borehole samples in February and March 2005, when the water table is also generally lower. However, depending on the NRC review schedule, TDCC's implementation schedule, and weather conditions, some of the ~750 characterization samples may be collected in other months.

RAI #3 also requests a description of the methods to ensure sufficient excavation will be performed. TDCC believes that the methods described in the Revised Supplement will ensure sufficient excavation. However, the additional actions proposed above are intended to further strengthen the approach and ensure that areas saturated at some time during the year are fully addressed.

NRC Comment #4

<u>Section 1.1.3, Current Site Condition, page 5</u> - *In this section you state, in part, that "under the conditions of the permits (MDEQ and Corps of Engineers) excavated areas shall be graded and allowed to revert back into wetlands and will be left undisturbed." In Section 4, however, you indicate that excavated unsaturated zone overburden will be used as backfill to fill saturation zone excavations. There appears to be potential inconsistencies between your plans for excavation and the provisions of the permits. Please clarify your intent with regard to complying with the permits, as well as Revision 1 of the Supplement.*

TDCC Response to Comment #4

In a letter to the USACE dated December 21, 2004, TDCC requested a revision to the permit to allow the backfill of areas excavated as a part of future decommissioning activities. USACE staff have indicated that approval of this request is likely. The MDEQ permit will be modified to reflect the revised USACE permit

NRC Comment #5

<u>Section 4, Saturated Zone</u> - *In this section you state, "the affected area will be defined a priori by borehole samples collected in a square and circular pattern around the elevated location before the excavation begins. The linear distance between samples will vary depending on the size of the affected area but in no case will exceed 5 meters." Without further information, this statement implies that only one borehole sample collected adjacent to the original borehole would be sufficient to determine the size of the affected area's excavation. This does not appear to be the intent of TDCC. Provide clarification with regard to locations and numbers of samples collected.*

TDCC Response to Comment #5

A minimum of three *apriori* borehole samples will be collected to define an affected saturated area.

NRC Comment #6

<u>Section 3.1, Unrestricted Use Criteria for Material in Saturated Zone</u> *- In this section you state, "after the presumed remediation of all identified areas exceeding 30 pCi/g Th-232 to 3.2 pCi/g, the average concentration of licensed material in the saturated zone would be 1.6 pCi/g Th-232." The meaning of this sentence is unclear. Specifically, is 30 pCi/g to 3.2 pCi/g the distribution of the Th-232 activity within the excavated material or, will the areas containing 30 pCi/g be remediated to 3.2 pCi/g and that value added to the other sample results to derive an overall saturated zone average of 1.6 pCi/g? Please clarify what is meant in the above statement or provide an alternate explanation for the use of 3.2 pCi/g*

TDCC Response to Comment #6

The saturated zone borehole samples exceeding 30 pCi/g were assumed to be remediated to 3.2 pCi/g to produce the 1.6 pCi/g Th-232 estimate of the average concentration that may remain in the 9.1 acre area after remediation. Assuming remediation to 3.2 pCi/g is a reasonable assumption since the Supplement Rev 1 proposes to excavate the saturated areas with borehole samples exceeding 30 pCi/g down to the underlying clean clay layer. This would result in the removal of all potentially contaminated saturated material in the vicinity of the elevated borehole leaving a concentration of essentially background (0.3 pCi/g) in the given affected area versus the assumed 3.2 pCi/g.

Another way to estimate the post-remediation Th-232 concentration is to assume that the areas exceeding 30 pCi/g are excavated to the 30 pCi/g maximum limit. This would result in a post-remediation average of 3.1 pCi/g Th-232.

Regardless of the method used to estimate post-remediation concentration, the Supplement Rev. 1 proposes to continue remediation until the actual post-remediation average is less than 3.2 pCi/g (including background) at a 95% confidence level.

NRC Comment #7

<u>Section 4.2, Unsaturated Zone</u> *- The second paragraph on page 21 states, "If a more realistic method is needed, additional, equally spaced, FSS borehole samples may be collected to determine a more representative concentration for the excavated sidewalls and floor at the discretion of TDCC. These additional samples would be random start, systematic samples at a frequency determined on a case-by-case basis." This paragraph implies that the AAR Method may not be sufficient to quantify the thorium activity levels in the saturated zone. Provide additional information that indicates when additional samples would be needed and/or how*

those samples would be collected. The purpose for including this paragraph in Revision 1 of the Supplemental needs to be clarified or the paragraph needs to be modified or deleted. If more samples are needed, provide the reason for collecting more samples in the context of using the AAR Method. Clearly identify the regimen that will be used for collecting the samples, and describe how the data will be used.

TDCC Response to Comment #7

The paragraph on page 21 referred to in RAI #7 pertains to sampling after remediation in accordance with the limits set by the AAR method. The most conservative method for assessing the residual radioactivity remaining after remediation is to collect a bias sample at the location with the highest NaI reading as discussed in the last paragraph on page 20. However, if this sample is less than the maximum limit of 14.8 pCi/g Th-232 but still causes the weighted average calculation described in the first paragraph on page 21 to fail, additional samples could be collected around the excavation area and the average of these samples used to demonstrate compliance as opposed to the single biased sample. As stated in the text, the samples will be composites of the excavation sidewall (using the "1.5 m rule") collected either directly from the exposed sidewall surface or by collecting a geoprobe borehole sample outside of the excavated area but as close to the sidewall as practicable. A description of how the data will be used is provided in the first paragraph on page 21.

NRC Comment #8

Section 3.3, Unrestricted Use Criteria for Groundwater in Saturated Zone - In the first paragraph of this section you state, "compliance will be demonstrated using the spatial average from the wells designed in the TDCC groundwater monitoring plan (to be submitted at a later date)." Submit the monitoring plan with your responses to the RAIs

TDCC Response to Comment #8

A groundwater (GW) monitoring plan is provided in Attachment 1. This monitoring plan supplements the detailed report, "Hydrological Assessment, Dow Thorium Site, Bay City, MI," April 2000, URS Corporation, that was submitted to NRC on December 8, 2003. The GW monitoring plan concludes the 15 onsite wells that have sampled periodically since December 2000 provide a sufficient, and likely conservatively, representation of the radiological conditions of the site GW.

A summary of the last four quarters of groundwater sampling results is provided in Tables 2 and 3 for information. As seen in the tables, the average concentrations of Total Radium and gross alpha in each quarter are well below their respective limits of 5 pCi/L and 15 pCi/L. The upper 95% confidence levels (mean + 1.761 σ_{mean}) for the full year of results are also well below the limits. The low average concentrations in the GW sampled from the 15 monitoring wells over the one year period provides high confidence that any future sampling will also be in compliance with the criteria. This result was expected because of the very low solubility of the slag material.

Table 2 – Summary of Total Radium (Ra-226 + Ra-228) Concentration in Monitoring Well Samples

Well ID	**Ra-226 + Ra-228 (pCi/L)**				
	3rd 04	2nd 04	1st 04	4th 03	1 Year Average
B5-3	2.47	2.31	1.57	1.70	2.01
D4-7	2.16	1.77	0.80	1.11	1.46
D6-8	0.83	1.61	0.81	0.62	0.97
E10-7	0.82	1.53	1.07	0.70	1.03
E4-1	0.78	1.51	0.54	1.21	1.01
E6-1	0.76	2.43	0.77	0.70	1.17
F4-2	1.64	1.35	1.33	0.80	1.28
F5-5D	1.03	0.84	0.34	0.35	0.64
F5-6D	1.48	0.81	1.55	1.21	1.26
F7-3A	1.63	1.57	0.27	0.25	0.93
F7-4A	DRY	2.81	1.90	1.32	2.01
G5-8	3.16	2.47	1.64	2.00	2.32
G6-9	3.60	4.26	2.72	3.82	3.60
I5-5	6.30	7.86	4.87	5.08	6.03
I6-8	5.93	6.00	3.41	4.37	4.93
Mean	2.33	2.61	1.57	1.68	2.04
Std Dev					0.42
Mean + 1.761σ					2.78

Table 3 – Summary of Gross Alpha Concentration in Monitoring Well Samples

Well ID	Gross Alpha (pCi/L)				
	3rd 04	2nd 04	1st 04	4th 03	1 Year Average
B5-3	0.79	0.56	10.20	2.28	3.46
D4-7	3.43	1.96	0.16	3.75	2.32
D6-8	1.26	2.16	-3.59	10.50	2.58
E10-7	0.81	1.44	3.40	-1.28	1.09
E4-1	0.21	6.48	-0.98	0.21	1.48
E6-1	0.75	-0.08	2.54	11.10	3.58
F4-2	-1.20	1.06	22.30	2.24	6.10
F5-5D	2.69	2.24	-8.29	0.00	-0.84
F5-6D	0.50	-0.32	-0.49	1.74	0.36
F7-3A	4.92	3.86	-5.64	-3.79	-0.16
F7-4A	DRY	0.95	3.31	-1.43	0.94
G5-8	-0.12	1.01	1.37	7.77	2.51
G6-9	5.75	6.39	12.20	2.14	6.62
I5-5	5.84	5.11	17.30	4.58	8.21
I6-8	11.50	9.43	10.40	28.00	14.83
Mean	2.65	2.82	4.28	4.52	3.54
Std Dev					1.04
Mean + 1.761σ					5.38

NRC Comment #9

<u>Incomplete Sampling</u> - Revision 1 of the Supplement indicates that the ~750 boreholes will provide sufficient characterization and final status survey (FSS) sampling for the saturated zone. However, we note that some of the subgrids (100 m^2 areas) have not yet been sampled. For example, samples apparently have not been taken in subgrids E8-7, E8-8, E8-9, E9-7, E9-8, and E9-9. This situation also may be applicable to the unsaturated zone characterization. Describe how the characterization and FSS surveys will be completed for these and all subgrids of the 9.1 acre area (for both the unsaturated and saturated zones).

TDCC Response to Comment #9

<u>All quadrants that were not sampled due to geoprobe refusal will be re-sampled using a larger geoprobe, a drill, or excavation, as necessary.</u>

ATTACHMENT 1

GROUNDWATER MONITORING PLAN FOR TDCC BAY CITY SITE

Ground Water Monitoring Plan for Thorad Site
The DOW Chemical Company
Bay City, Michigan

Introduction

The Groundwater Monitoring Plan was developed to monitor the possible contamination of groundwater from magnesium-thorium slag at the Bay City Thorad site. Specifically the plan will monitor for the presence of gross alpha, radium 226, and radium 228.

Background Information

Beginning in the early 1940's and continuing into the early 1960's, The Dow Chemical Company (TDCC) produced a metallic magnesium alloy used in aircraft applications. The alloy was a lightweight material with improved high temperature strength. Production took place at two locations – in Bay City, Michigan, and in Midland, Michigan.

The production process yielded slag material as a by-product. The magnesium-thorium slag material, which is regulated as a radioactive material, has been stored on TDCC property at Bay City, Michigan under a license from the Nuclear Regulatory commission (NRC)

The Site is located adjacent to the Saginaw River near the mouth where the river discharges into Saginaw Bay. Most of the topography can be characterized as generally low lying land with an average surface elevation around 585 feet relative to the USGS datum. The geology of the site consists of 6-12 feet of river sediments and fill overlying a hard dense till clay.

Previous hydrogeological assessments (URS, April 2001) indicate that groundwater is found within the river sediments, glacial till sands, if present, and the Saginaw formation. Due to the proximity of the Saginaw River shallow groundwater is in hydraulic communication with the river. The assessment also indicated that the Saginaw formation is the most significant source of groundwater in the area. Till sands may provide a source of groundwater, however their occurrence is too sporadic and it is highly unlikely that till sand is in communication with the river sediment. River sediments, which are significantly thinning away from the Saginaw River and are essentially contiguous with the surface water in the Saginaw River, contain groundwater sporadically or on a seasonal basis. The most likely pathway for thorium migration would be the groundwater in these river sediments. Due to the thickness of the dense glacial till clays below the river sediments vertical migration would be very unlikely.

Current conditions

Fifteen wells have been installed at the Thorad site in "hotspots" - areas of highest thorium levels, and are screened within the shallow river sediments. In addition seven upgradient wells located to the west of the Thorad site are currently being monitored for background conditions. Given the known hydrogeological conditions discussed above, all wells were reviewed for adequacy for this groundwater monitoring plan. It was determined that the given location of the wells represent site as well as up and downgradient conditions.

1. Sampling Plan

Due to the occurrence of groundwater in the river sediments at the Thorad site, wells must monitor the down gradient flow of the river sediment formation in addition to monitoring conditions at the established hotspots. Wells should also monitor background conditions and need to be placed up gradient from the site.

1.1.1 The general groundwater flow at the site is to the east. Wells E10-7 and D6-8 will serve as down gradient wells. These two wells are located at the eastern edge of the monitoring area and are therefore sufficient in represent the downgradient conditions. Wells listed separately in Section 1.4 will act as the background wells for this monitoring plan. As river sediments are discontinuous in nature, monitoring the hotspots at the site provides the highest likelihood of determining the worst case site groundwater concentrations.

1.1.2 The potentially impacted water bearing zone is the shallow ground water within the river sediments and is found between 3-5 feet below ground level. All monitored wells are screened in this zone.

1.2 Frequency of Water level measurements

Site specific groundwater gradient to the east northeast, has been determined during the Hydrological Assessments conducted at the site.

1.2.1 Water levels will be obtained prior to purging the wells

1.2.3 Water levels will be obtained within as short a time period of each other as is practicable.

1.3 Sampling Method

Sample tubing is lowered into the well using designated tubing when available. If tubing has not already been designated for a specific well, new tubing will be used. The tubing is placed into the wells such that the bottom of the tubing is at approximately mid-screen. A table of well screen intervals is available to determine the mid-screen depth. For wells that are poor producers the tubing may have to be lowered closer to the bottom, trying not to get closer than 6-inches.

After well pumping is initiated, a "hydrolab' is used to monitor for pH, conductivity, oxidation/reduction potential, dissolved oxygen and turbidity. An initial reading is taken when the hydrolab cell is filled. The static water level is checked to ensure that the well level is stable and will remain so at the pumping rate. The static water level is maintained within about 1 foot of the initial reading. If that is not possible and the well purges dry, the sample is not collected and another attempt is made within 24 hours.

Readings are taken for temperature, static water level, rate of purging, dissolved oxygen, turbidity, oxidation/reduction potential, conductivity, and pH. Readings are recorded every three minutes after a sufficient volume has been purged.

When the parameters reach equilibrium for three consecutive readings, samples are collected. Parameter equilibrium is defined as + 0.1 for pH, + 3% for conductivity, + 10mV for oxidation/reduction potential (ORP), and + 10% for turbidity and dissolved oxygen.

Samples are filtered using a 0.45 µm filter and collected in 1 liter sample containers provided and certified clean by the laboratory. All sample containers are acidified with HNO_3 in the field prior to shipment to the laboratory.

A duplicate is collected for every 10 samples and a matrix spike/matrix spike duplicate (MS/MSD) sample is collected for every 20 samples. At least one duplicate and one MS/MSD must be collected per day.

1.4 Constituents analyzed

1.4.1 The constituents of concern at this site are:

Gross Alpha
Radium 226
Radium 228

For Analytical methods and detection limits see table below.

Analytes	Analytical Method	Detection Limit
Radium 266	EPA 903.1	5 picoCuries/L combined
Radium 228	EPA 904.0	
Gross Alpha	EPA 900.0	15 pCi/L

1.5 Sampling Frequency

1.5.1 The sampling frequency will be quarterly over a twelve month period. The following wells will be sampled quarterly to monitor the shallow groundwater zone after all saturated zone remediation is completed. The results from the wells listed as downgradient will be treated the same as all other wells in the calculations to demonstrate compliance.

The construction designs for wells I5-5 and I6-8 are provided below. The construction designs for all other wells were previously submitted to NRC. The construction of wells I5-5 and I6-8 was different from the remaining wells. Therefore, wells I5-5 and I6-8 will be removed before remediation and reconstructed in the same location after remediation in the area is completed. The new I5-5 and I6-8 wells will have a 5 ft screen depth and a 2 in screen diameter to match the design of the remaining wells. The depth of the new wells will be approximately the same as the depth shown in the attached diagrams.

B5-3
D4-7
E6-1
I5-5
I6-8
E4-1
F5-5D
G5-8
G6-9
F5-6D
F4-2
F7-3A
F7-4A

The following wells will serve as background wells:

5487
5849
5851
5852
5855
5858
5860

The following wells will serve as downgradient wells:

E10-7
D6-8

1.6 Inspection and well maintenance

The condition of each well shall be inspected at each sampling event. These conditions are as follows:

- Surface Seal
- Casing Integrity
- Total depth of well

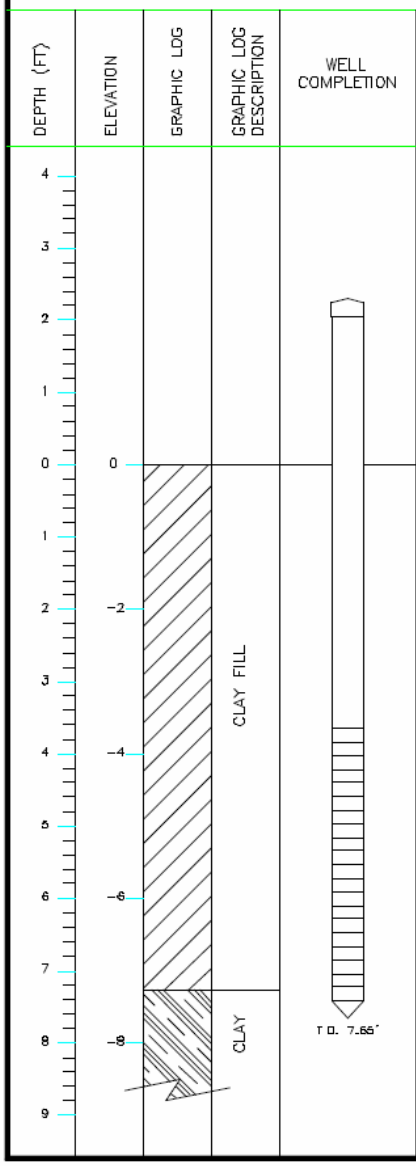
Any necessary repair will be made prior to the next sampling event.
If a well can not be properly repaired it will be replaced or abandoned.

1.7 Sampling Schedule

Sampling will be completed during each quarter over a twelve month period.

URS CORPORATION **WELL NUMBER I5-5C(R)**

CLIENT: *Dow Chemical*	PROJECT: *Thorad*	LOCATION: *Bay City, MI*
DATE STARTED: *9/12/02*	DATE FINISHED. *9/12/02*	BOREHOLE DIA.: *1 7/8 inch*
SUPERVISED BY: *G. A. Sgro*	DRILLER: *URS Corp.*	WATER LEVEL:
DRILL METHOD: *Geoprobe*	PROJECT NUMBER: *007133*	
DRILL COMPANY: *URS Corp.*		
COORDINATES: *E 440 N 840*	SURFACE ELEVATION:	T.O.C. ELEVATION:



WELL COMPLETION MATERIALS AND DEPTHS

SURFACE COMPLETION: *STICK-UP 2.21ft.*

RISER

RISER TYPE: *PVC*
RISER DIA.: *1 inch*
RISER LENGTH: *STICK-UP 2.21ft.*

ANNULAR SEAL

GROUT TYPE:
AMOUNT OF CEMENT:
AMOUNT OF WATER:
AMOUNT OF BENTONITE:
SEAL TYPE: *GRANULAR*
AMOUNT OF SEAL: *5#*
DEPTH TO SEAL: *6 inches*

FILTER PACK

FILTER PACK TOP:
FILTER PACK BOTTOM.
FILTER PACK TYPE:
GRAIN SIZE:
AMOUNT:

WELL SCREEN

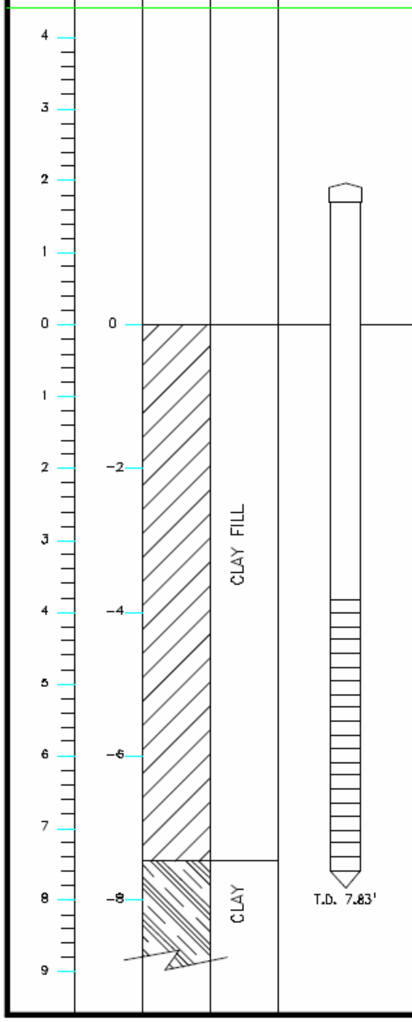
SCREEN TOP: *3.65*
SCREEN BOTTOM: *7.65*
SCREEN TYPE: *PVC*
SCREEN DIA *1 inch*

WELL DEVELOPMENT

DEVELOPMENT DATE:
VOLUME REMOVED:
TURBIDITY:
pH:
TEMPERATURE:
CONDUCTIVITY:
METHOD:

URS CORPORATION		**WELL NUMBER I6-8C(R)**
CLIENT: *Dow Chemical*	PROJECT: *Thorad*	LOCATION: *Bay City, MI*
DATE STARTED: *9/12/02*	DATE FINISHED: *9/12/02*	BOREHOLE DIA.. *1 7/8 inch*
SUPERVISED BY: *G. A. Sgro*	DRILLER: *URS Corp.*	WATER LEVEL:
DRILL METHOD: *Geoprobe*	PROJECT NUMBER: *007133*	
DRILL COMPANY: *URS Corp.*		
COORDINATES: *E 540 N 806*	SURFACE ELEVATION:	T.O.C. ELEVATION:

DEPTH (FT)	ELEVATION	GRAPHIC LOG	GRAPHIC LOG DESCRIPTION	WELL COMPLETION



WELL COMPLETION MATERIALS AND DEPTHS

SURFACE COMPLETION: *STICK—UP 1.96ft.*

RISER

RISER TYPE: *PVC*
RISER DIA.: *1 inch*
RISER LENGTH: *STICK—UP 1.96ft.*

ANNULAR SEAL

GROUT TYPE:
AMOUNT OF CEMENT:
AMOUNT OF WATER:
AMOUNT OF BENTONITE:
SEAL TYPE: *GRANULAR*
AMOUNT OF SEAL: *5#*
DEPTH TO SEAL: *6 inches*

FILTER PACK

FILTER PACK TOP:
FILTER PACK BOTTOM:
FILTER PACK TYPE:
GRAIN SIZE:
AMOUNT:

WELL SCREEN

SCREEN TOP: *3.83*
SCREEN BOTTOM: *7.83*
SCREEN TYPE: *PVC*
SCREEN DIA. *1 inch*

WELL DEVELOPMENT

DEVELOPMENT DATE:
VOLUME REMOVED:
TURBIDITY:
pH:
TEMPERATURE:
CONDUCTIVITY:
METHOD:

ENCLOSURE 3

To

Ben Baker, TDCC, Letter to David Nelson, NRC, dated April 13, 2005

SUPPLEMENT TO THE DECOMMISSIONING PLAN

FOR REMOVAL OF MAGNESIUM-THORIUM SLAG FROM

THE DOW CHEMICAL COMPANY'S BAY CITY, MICHIGAN SITE

The Dow Chemical Company
Midland, MI 48674

Revision 2
April 13, 2005

CONTENTS OF SUPPLEMENTAL DECOMMISSIONING PLAN

1. GENERAL INFORMATION

The Decommissioning Plan ("DP") developed by the Dow Chemical Company ("TDCC") in October 1993 was based on removal of surface contaminated soils from the Midland and Bay City slag piles and disposal at Dow's Salzburg Landfill. The DP was supplemented in December 1995 to transport the material from the piles by rail to the Envirocare facility in Clive, Utah for disposal. The current supplement to the DP describes the decommissioning approach for achieving ALARA contamination levels in the subsurface of the Bay City site. Whenever possible, reference is made to the relevant information provided in the original DP, as supplemented.

The statements and commitments made in this supplement to the DP supercede any conflicting statements and comments made in the original DP or subsequent supplements.

The activities described in this submittal do not pose additional occupational radiation protection risks or generate additional pathways for release of radioactive material to the environmental beyond those previously described in License Amendments No. 6 and No.7. The DOW Thorad Project "Radiological Health and Safety Plan," approved June 2001, provides the necessary organization, procedures, etc., to ensure that the activities described in this submittal are completed in accordance with applicable NRC regulations and guidance. In addition, the decommissioning cost estimate and Financial Assurance mechanism currently in place are sufficient for the activities proposed in this supplement.

1.1 Background

On July 19, 1996, the Nuclear Regulatory Commission (NRC) issued a license amendment to The Dow Chemical Company (TDCC) authorizing the remediation and offsite disposal of thorium contaminated material from storage piles at the Dow Midland and Bay City Sites (License No. STB-527, Amendment No. 6). On July 21, 1997, NRC in License Amendment No. 7 approved the unrestricted use criteria and final survey methods for the remediated areas.

After the remediation of the majority of the stockpiled surface material at the Bay City site was completed, Dow discovered that there was a significant volume of contaminated material at the Bay City site below the water table, i.e., in the saturated zone. The material in the saturated zone was not specifically addressed in License Amendments 6 and 7. TDCC is submitting this supplemental decommissioning plan to NRC to address this subsurface saturated zone material. This supplement proposes unrestricted use criteria, remediation methods, and final survey methods specifically applicable to the contamination within the saturated zone.

The development of effective final survey methods for material in the saturated zone required consideration of final survey methods for unsaturated subsurface soil/slag (hereafter referred to as "soil"), as well as surface soil. This supplement provides a comprehensive final survey approach for surface soil, unsaturated zone subsurface soil, and saturated zone subsurface soil that ensures compliance with all unrestricted use criteria. The final survey methods provided in this supplement are intended to address areas of the site that have not been verified by NRC as of the date of this submittal and supercede any previous described final survey methods. The site areas that have been final surveyed and verified by NRC as of the date of this submittal (Verification Areas VA I-VI, see "Decommissioning Status" below) are considered suitable for unrestricted release and are not included in this supplement.

1.1.1 Site History

Beginning in the early 1940's and continuing into the early 1970's, TDCC produced a metallic magnesium alloy used in aircraft applications. The alloy was a lightweight material with improved high temperature strength. Production took place at two locations - in Bay City, Michigan, and in Midland, Michigan.

The production process yielded slag material as a by-product. The magnesium-thorium slag material, which is regulated as a radioactive material, has been stored on TDCC property at Bay City, Michigan under a license from the Nuclear Regulatory Commission (NRC).

1.1.2 Licensing History

A single license (STB-527) was granted by the Nuclear Regulatory Commission (NRC) in 1973 for the Bay City and Midland sites to store up to 200,000 pounds of Thorium as slag. This license expired in 1978, but has remained in effect under timely renewal. The Thorium-contaminated material was removed from the Midland site and this area was surveyed by the NRC in May 1997 and removed from the license.

The initial decommissioning plan for the Bay City site, approved on July 7, 1996, was for the removal of approximately 40,000 cubic yards of thorium-magnesium contaminated material located over an area of less than one acre. During the initial phase of material removal, new information regarding residual surface and subsurface contamination extending beyond the immediate slag pile area was discovered. Based on this information, it was determined that a new plan needed to be developed for the removal of the contaminated material. Subsequently, with communications with the NRC, the license was extended through June 2003.

1.1.3 Current Site Condition

The site is located adjacent to the Saginaw River near the mouth of the river where it discharges to the Saginaw Bay. The site is surrounded by a series of industrial service water ditches located to the north, west, and south. The only access to the site is through gated and fenced TDCC property via a gravel road and the only permanent structures near the site include the old Coast Guard Lighthouse to the north and a water pump house adjacent to the southern service water ditch near the Saginaw River. Other facilities on site include temporary offices, laboratory, and decontamination facilities. Most of the topography can be characterized as generally flat, low lying land with an average surface elevation around 585 feet relative to the USGS datum. Most of the variation in the surface topography is a result of excavated areas or due to the temporary flood control earthen berm located along the eastern and northern sides of the site.

The geology at the site is simple, and consists of 6-12 feet of river sediment and fill overlying a hard, dense till clay. The river sediments consist predominantly of sand, silty sand, and clayey sand with occasional lenses of clay and silt. Organic material is common throughout the river sediment, and occasional lenses of peat are also present.

Some areas of the site contain up to 6 feet of fill. This fill consists primarily of rubble and soil, with pockets of magnesium/thorium slag. It appears that the fill was likely placed directly into low-lying areas and graded to match surrounding topography at the time they were placed or shortly thereafter. These low areas were once wetlands contiguous to the Saginaw River.

The glacial till consists of very hard, very dense gray silty clay with a trace of gravel. Information from other sites in the area also indicates that sand lenses are sometimes present within the glacial till, although these bodies tend to be widely dispersed and often discontinuous. Information from surrounding sites indicates that bedrock is encountered at between 80 and 90 feet below ground level in this area. Bedrock consists of sandstone and shale of the Saginaw Formation.

Groundwater is found within the river sediments, glacial till sands, if present, and Saginaw Formation. Groundwater in the river sediment is found between 3 and 5 feet below ground level at the site, and is essentially continuous with the surface water in the Saginaw River.

Groundwater levels indicate a very shallow east-northeast gradient (0.004 ft/ft) toward the Saginaw River. This gradient likely remains very low throughout the years and it is possible that there are occasional fluctuations in the flow direction based on the rise and fall of the Saginaw River.

The entire Bay City storage site is located within a wetland / floodplain adjacent to the Saginaw River. Decommissioning activities within the wetland area are being performed under Michigan Department of Environmental Quality, Natural Resources and Environmental Protection Act 451, PA 1994 Permit No. 00-09-0017-P and Department of the Army, Corps of Engineers Discharge and Dredge Materials Permit File No. 90-020-020-3. Under the conditions of the permits, excavated areas shall be graded and allowed to revert back into wetlands and will be left undisturbed.

Five water well records within a mile of the site were obtained from the Department of Health. Three of the wells within a mile of the site were water supply wells, four were monitoring wells (contained on one water well record), and one was a cathodic protection well. Water supply well #1 appears to be screened in a glacial till sand, and is located across the Saginaw River to the east of the site. Water supply wells 2 and 3 appear to be screened in the Saginaw Formation, and are located to the northwest and southwest of the site, respectively.

Based on these logs and an evaluation of the local groundwater use for other sites in the area, it appears that the Saginaw Formation is the most significant source of groundwater in the area. Till sands may periodically be tapped for groundwater when present, but widespread use is unlikely given their sporadic and wide dispersal. It is unlikely that anything other than monitoring or cathodic protection wells are screened in the river sediment. Investigations at other sites in the area indicate that the river sediments thin significantly away from the Saginaw River, and may contain groundwater only on a sporadic or seasonal basis. Only those sediments adjacent to the Saginaw River provide a reliable groundwater source and the installation of wells within the shallow sediments in this area is unlikely, as it would be easier to pump directly from the river.

1.1.4 Decommissioning Status

Pre-decommissioning activities were initiated in November 1995 and included contractor procurement, health and safety planning, and transportation and disposal negotiations. During January – June 1996 the following major items were designed and installed in support of the decommissioning effort:

- On-site office and laboratory facilities (7,200 square feet)
- 4.2 miles of exclusion fencing and a perimeter air monitoring system
- 2.8 miles of road upgrade
- Personnel and equipment decontamination facilities
- Two on /off loading ramps and three acres of lined storage pads
- 1,200 gpm raw water system
- Environmental control systems (dust and water)
- Rail facility including spurs, weigh station, and covered loading station

Major excavations of waste materials were initiated in late June 1996 at both the Midland and Bay City sites. Waste shipping by rail to Envirocare of Utah was initiated in August 1996. The U. S. Nuclear Regulatory Commission (NRC) in May 1997 performed a final confirmatory survey of the Midland site and a determination was made in June 1997 that the site met unrestricted release guidelines.

With the exception of winter months, waste excavation activities at the Bay City site have continued to date. Five confirmatory surveys of six areas of the site have been completed by NRC Region III staff. Inspection reports received from the staff indicate that 31.33 acres (Table 1) meet unrestricted release guidelines.

Table 1 Decommissioning Status

U.S. NRC REGION III REPORT DATE	VERIFICATION AREA DESIGNATION	NO. OF SUBGRIDS (10m x 10m) MEETING UNRESTICTED CRITERIA	CORRESPONDING AREA IN ACRES
August 13, 1997	VA-I	430	10.750
January 7, 1998	VA-II	107	2.675
January 7, 1998	VA-III	335	8.375
October 20, 1998	VA-IV	163	4.075
December 17, 1998	VA-V	150	3.750
August 5, 1999	VA-VI	68	1.700
TOTALS		1253	31.33
REMAINING AREA		364	9.100
TOTAL SITE AREA		1617	40.425

1.1.5 Source Term Estimation

The saturated zone source term is estimated as follows:

Assumptions:

- 364-100 m^2 subgrids
- Saturated zone fill material average 2 meters deep
- Fill material density approximated as 1.6 g/cm^3
- Average current radionuclide concentrations are 3.7 pCi/g Th-232, 3.5 pCi/g Th-228, and 10.8 pCi/g Th-230. These concentrations are the average results from over 750 soil sample collected from the site saturated zone
- Background radionuclide concentrations are assumed to be a nominal 0.3 pCi/g for all radionuclides

Estimation:

- Total mass = (364 grids)($100m^2$/grid)(2m depth)($1E+06cm^3/m^3$)(1.6 g/cm^3) = 1.2E+11 g
- Th-232 source term = (1.2E+11g)(3.7-0.3 pCi/g) = 0.4 Ci
- Th-228 source term = (1.2E+11 g)(3.5-0.3 pCi/g) = 0.4 Ci
- Th-230 source term = (1.2E+11g)(10.8-0.3 pCi/g) = 1.3 Ci

If the thorium were present at concentrations equal to the Unimportant Quantity limit in 10 CFR 40.13 where persons are exempt from licensing, the thorium source term would be 13.0 Ci.

2. FUTURE LAND AND GROUNDWATER USE

This discussion is provided in three parts. The first part provides the justification for the assumption that the site shallow groundwater will not be used as a domestic water source. The second part describes the deed restrictions and restrictive covenants that will be placed on the site for RCRA compliance. The third part provides the bases for assuming that the most likely future land use at the site will be recreational use. The text provided below is a verbatim copy of TDCC's response to NRC's RAI#2 that was submitted to NRC in a letter dated March 17, 2003.

2.1 Justification For Conclusion That Site Shallow Groundwater Is Not Drinking Water Source

2.1.1 Summary/Conclusion

In order for shallow ground water to be realistically considered for use at the TDCC Thorium Site (Site) located in Bangor Township, Bay County, Michigan (Figure 1), a well penetrating the aquifer must be able to provide water of sufficient quantity and quality for potable use. The installation of a drinking water well must also be allowed under current and future regulations. In addition, the availability of other sources of drinking water must be considered when evaluating potential sources of drinking water.

The conclusion of this analysis is that it is highly unlikely that shallow ground water at the Site would be used as a potable or domestic source of water. The reasons for this conclusion are:

1. Michigan State regulations (R325.1622(1)) prohibit the installation of a water well in the shallow groundwater at the Site because shallow ground water occurs at a depth of no more than approximately 12 ft bgs.
2. Ground water at the Site is of poor quality and exceeds the aesthetic standard for TDS (R299.5744 Table 1) making the water undesirable for drinking water purposes
3. Alternative higher quality sources of drinking water are available including access to a treated municipal water and ground water in deeper aquifers that are hydraulically isolated from the shallow aquifer.
4. Ground water use as a drinking water resource at the Site will be prohibited by a deed restriction filed with Bay County as a part of the ongoing Resource Conservation and Recovery Act (RCRA) corrective action for Bay City sites.
5. No credible land use scenarios would involve the use the shallow aquifer as drinking water regardless of the water's potability.

2.1.2 Background Information

Information on the hydrogeologic conditions is presented in several reports, including:

- "Hydrogeological Assessment, Dow Thorium Site, Bay City, MI", April 2001 by URS Corporation;

- “Hydrogeologic Assessment of The Dow Chemical Company Thorium Contamination Site in Bay City Michigan”, September 2000 by URS Corporation; and
- “Ground Water Elevation and Flow Study, Industrial Waste Site Perimeter, Dow Chemical Company USA”, December 1977 by SAMTEST, Inc.

In addition, information on the hydrogeologic conditions in the area is described in “Dow Bay City Sites, Environmental Assessment of Groundwater and Soil”, September 1990 by TDCC. Figure 2 shows the locations of the sites for which subsurface data were available[1].

These reports along with available water well records, City of Bay City water line maps, 1998 aerial photographs, and Dow well and boring records from the Dow Bay City Sites were reviewed in preparing this assessment.

The Site consists of low-lying, essentially flat, terrain along the Saginaw River and is surrounded by water on all sides (Figure 3). The elevation of the site ranges from 580 - 586 ft relative to the USGS datum. Several wetland areas currently exist at the Site and are projected to remain in the future. The subsurface materials consist primarily of fine silty sand and silt up to 12 ft thick overlying dense glacial till. The surface soils also contain various amounts of clay, peat, gravel, and industrial fill. The glacial till consists primarily of silty clay and extends to approximately 80 to 90 feet below ground surface (bgs) where it overlies bedrock of the Saginaw Formation. Figures 3 and 4 in the April 2001 Hydrogeologic Assessment are geologic cross sections constructed at the Site showing these relationships.

Ground water at the Site is encountered at a depth of 1 to 5 ft bgs under unconfined conditions. A limited amount of information is available on ground water levels at the Site; however available data indicate that ground water flow is generally to the east ultimately discharging to the Saginaw River. It is likely the flow directions and gradients fluctuate seasonally and are affected by long-term trends in the water levels of the Great Lakes (average water levels in the Saginaw River at the Site are essentially the same as in Lake Huron). Due to the proximity of the Site to the Saginaw River, it is likely that shallow ground water is in hydraulic communication with the river and that ground water levels will fluctuate along with the river levels. It is expected that the shallow ground water is recharged by the river and service water ditches during periods of rising water levels and dewaters to some degree during periods of falling water levels. Although Site specific data are not available demonstrating this relationship, Dow has conducted detailed hydrogeologic studies at the nearby Dow Bay City Terminal and former ITI sites (Figure 2) located on the Saginaw River and observed these relationships between the river and shallow ground water system.

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[1] These represent the sites with readily available subsurface data. There may be other sites in MDEQ files that also have available data. The possible existence of additional data is not anticipated to affect interpretations of conditions at the Thorad site.

The geometric mean hydraulic conductivity of the saturated zone has been calculated to be 9.4 x 10^{-4} feet per minute (ft/min) from aquifer slug tests conducted at the Site (see Table 2, in April 2001 Hydrogeologic Assessment). Variable hydraulic gradients ranging from 0.00032 to 0.0072 ft/ft of have been measured at the site resulting in estimated ground water flow velocities ranging from 0.022 to 0.049 ft per day.

2.1.3 Evaluation

The following sections provide Site-specific information on:

- Ground water quality;
- Ground water quantity;
- Availability of drinking water; and
- Restrictions on ground water use.

Ground Water Quality
Shallow ground water is generally discouraged for use as a drinking water source by public health officials due to generally poor water quality and the potential to be impacted by various types of contamination. General water quality parameters that are routinely considered by the State of Michigan relative to the suitability of ground water as a drinking water source include:

- Nitrate and nitrites;
- Total dissolved solids (TDS);
- Bacteriological contaminants; and
- Other sources of contamination.

Monitoring wells at the site have not been sampled for nitrate, nitrite, or bacteriological contaminants; however, samples have been analyzed for TDS. Samples were collected and analyzed for TDS from 10 onsite wells and 2 background wells in May 2002. Concentrations ranged from 590 to 7,100 milligrams per liter (mg/L) with an average of 2,800 mg/L with onsite and offsite wells at similar concentrations (Table 1). These concentrations all exceed the MDEQ generic drinking water criteria of 500 mg/L (an aesthetic standard).

Although long-term hydrogeologic data are not available for the Site, it is likely that the shallow ground water is primarily recharged by precipitation. Under certain climactic conditions the ground water is also likely to be recharged from surface water as noted previously in the section Background Information. The Site is surrounded by surface water, including service water ditches located along the southern and western edges of the Site and the Saginaw River located along the remainder of the Site boundary. The Saginaw River contains elevated concentrations of nitrate (USGS water quality data for Saginaw River) and is it possible that this would negatively impact ground water at the Site during periods of recharge from the surrounding surface water (the service water ditches primarily obtain water from the Saginaw River).

Ground Water Quantity
Ground water must be present in sufficient quantity to make installation of a water well practical. No ground water supply wells exist at the Site and no wells have been installed to test the production rate of shallow ground water. There are also no permitted or other wells known to have been installed to produce or test shallow ground water in similar hydrogeological conditions within a 3 mile radius of the site.

The saturated thickness of shallow ground water is variable across the site and is typically on the order of 2 to 5 ft. In-situ aquifer slug tests were conducted in 10 monitoring wells and indicated that hydraulic conductivity ranged between 5×10^{-3} and 1×10^{-4} ft/min with a geometric mean of 9.4×10^{-4} ft/min. Ground water sampling records at the Site indicate that most of the monitoring wells can be produced at a low rate (0.007 to 0.07 gallons per minute (gpm)) without dewatering for the purpose of collecting ground water samples. The quantity of water that could be produced from a shallow water supply well at the Site is likely to be limited due to the relatively thin saturated thickness within an unconfined aquifer. The heterogeneous nature of the deposits suggests that ground water may be isolated and that sustained production from a well may not be possible.

Availability of Drinking Water
Due to its relatively poor quality and the estimated marginal yield to a well, it is realistic to expect that shallow ground water at the Site would only be considered for drinking water use if other higher quality and more reliable sources were not available. Other sources of drinking water are available at the Site now, and will be available in the future. These include:

1. Bay City Municipal Water Supply system; and
2. Deeper aquifers at the Site.

Municipal Water Supplies

Potable water is provided to the Site area by Bay City from intakes in Lake Huron. Water mains currently run along Wilder Road approximately 2,900 ft south of the Site and along Shady Shores Road approximately 3,800 ft north of the Site. The SC Johnson manufacturing facilities located approximately 1,500 ft west of the Site are also supplied with potable water by Bay City as well as the other businesses and industrial users in the area. Water lines were extended in 2002 to the new Port Fisher/Bay Aggregate development located approximately 1 mile south of the Site (Figure 2).

Deeper Aquifers

Ground water has been demonstrated to be present in the Saginaw Formation in the area at a depth of approximately 90 ft bgs. One water supply well was installed in this formation approximately 4,000 feet southwest of the Site and registered to the Straits Corporation for irrigation (see Figure 4 in April 2001 Hydrogeological Assessment[2]). The depth to the Saginaw Formation at the Site is estimated to be 80 to 90 ft. Saginaw

[2] Note that well #2 shown on Figure 4 is shown in error. The well record indicates it is located in another township than shown on the Figure 4.

Formation aquifers are isolated from the shallow ground water by approximately 70 ft of glacial till.

Water is also occasionally obtained from till sands found within the glacial till. One registered well was located in the area that was completed in a till sand. The well was completed at a depth of 32 ft bgs and was located across the Saginaw River approximately 6,500 ft northeast of the Site (see Figure 4 in April 2001 Hydrogeological Assessment). If a till sand aquifer is present at the Site, it would likely provide higher quantity and better quality water than the shallow ground water. The presence of till sands is hard to predict and it is uncertain whether or not any till sands are present beneath the Site because no borings have been drilled that fully penetrate the glacial till. As part of other activities in the area, Dow drilled 7 exploratory borings through the glacial till to the underlying Saginaw Formation at the Bay City Terminal located approximately 4,400 ft south of the Site. Of these, only 1 boring encountered a till sand at a depth of 68 bgs. The till sand was approximately 9 ft thick and appeared to be hydraulically isolated from the shallow ground water.

Restrictions on Ground Water Use

The State of Michigan regulates the permitting and use of ground water through the Well Construction Code Administrative Rules (R 325). These rules are implemented and water wells are permitted through the local health departments. The Bay County Department of Public Health has jurisdiction over the Dow Thorium Site. Rules pertaining to shallow ground water at the site include the following:

- **R325.1621(3)(b):** This rule requires that wells be constructed to exclude known sources of contamination from the well.

- **R325.1622(1):** This rule specifies that a water well for any beneficial use shall be located where it is not subject to contamination.

- **R325.1632(3):** This rule requires that well casings extend not less than 25 ft bgs. Exceptions to the rule must be obtained in writing from the health officer pursuant to the provisions of R325.1613.

- **R325.1613(2)(d) & (e):** These rules discuss allowable deviations from the requirement that well casings extend greater that 25 ft bgs. An exception is allowed under subpart (d) if the well water is not used for human consumption and certain other conditions are met. An exception is allowed under subpart (e) if it is shown that potable water does not exist at depths of greater the 25 ft and if the distance between the well and contamination is increased or a confining layer is present above the aquifer.

These rules clearly prohibit the installation of a water well at the Dow Thorium Site because shallow ground water occurs at a depth of no more than approximately 12 ft bgs. Exceptions under R325.1613 do not apply to the Site because potable water in suitable quantities has been shown to exist in the area from aquifers at depths ranging from approximately 80 to 90 feet bgs.

2.2 Restrictive Covenants (Deed Restrictions) for the Bay City Site

To further restrict use of ground water at the site, TDCC will be placing a deed restriction on the Site as a part of the ongoing RCRA corrective action for Bay City sites. The deed restriction will be transferred to all future owners of the Site.

Region 5 of the U.S. Environmental Protection Agency (EPA) has identified The Dow Chemical Company Bay City Sites as a RCRA site that will require corrective action (EPA identification number MID 005 380 258). The Bay City sites include the Thorium Site as well as other significant facilities, including: the former Petrochemical Facility, former West Tank Farm, former Bay Refinery, and the Bay City Terminal. Seventeen (17) Solid Waste Management Units (SWMUs) and 13 Areas of Concern (AOCs) were identified by EPA in 1993. The Thorium Site was identified as SWMU #2, "Thorium Slag Pile". In 1996, the Michigan Department of Environmental Quality (MDEQ) identified a portion of the Bay City Sites as a facility subject to corrective actions. In 2002, EPA proposed the implementation of a Voluntary Agreement between EPA, MDEQ and Dow to address the implementation of corrective actions at the Bay City Sites. As proposed, the Voluntary Agreement would allow corrective actions to be implemented following MDEQ regulations and guidance documents

Over the years Dow has initiated numerous corrective actions at the Bay City Sites and is presently working with the MDEQ under Part 201 of the Natural Resources and Environmental Protection Act 451 on the development of a Remedial Action Plan (RAP) for the Bay City Terminal. A key component of the RAP will be the implementation of land and resource use restrictions on all the affected and potentially affected properties that are part of the Bay City Sites. Under part 20120b of Part 201, it is permissible to rely upon land or resource use restrictions as long as the restrictions meet the requirements defined in the Act. The restrictive covenant must be recorded with the registrar of deeds for the county in which the property is located. The restrictions shall run with the land and be binding on the owner's successor, assigns, and lessees and shall include provisions to accomplish, among other things, the following:

- Restrict activities that may interfere with remedial action, operation and maintenance, monitoring, or other activities necessary to assure the effectiveness of the remedy;
- Restrict activities that may result in exposures above levels in the RAP;
- Require notice to the MDEQ to convey any interest in the facility;
- Grant the MDEQ the right to enter the property; and
- Allow the state to enforce the restriction by legal action.

Restrictive covenants have been recorded with Bay County for 17-acre and 32-acre portions of the Bay City Sites (see Figure 4). These restrictive covenants meet the strict provisions of 20120b and were approved by MDEQ. Both restrictions prohibit the use of ground water. Restrictive covenants will be prepared prohibiting ground water use on the remainder of the Bay City Sites as part of Dow's plan for meeting its Part 201 obligations and preparing a RAP for approval by the MDEQ.

2.3 Bases For Selection Of Recreational Scenario For Future Land Use At The TDCC Bay City Site

2.3.1 Land Use History

The general area around the Thorium Site has a long history of industrial development due to its location along a major transportation corridor near the mouth of the Saginaw River. The following paragraphs briefly describe some of the significant industrial operations in the area. The locations of significant facilities discussed below are shown on Figure 5.

Some of the earliest industrial development in the site area occurred by 1919[3] with the construction of a marine terminal on the Saginaw River with railroad access. The marine terminal, located approximately ½ mile south of the Thorium Site, later became a terminal and petroleum tank farm operated by the Standard Oil Company (currently Bay Aggregate). In 1937, the Bay Refining Company opened a petroleum refinery on the banks of the Saginaw River approximately 1 ½ miles south of the Site. By 1950, other industrial concerns were present in the area including the current Marathon Ashland Petroleum LLC terminal (formerly Unocal) located on the corner of Wilder and Tiernan roads[4]. The late 1950's saw significant industrial expansion in the area with the purchase of the Bay Refining Company by The Dow Chemical Company (Dow). Beginning in about 1957, Dow began construction of the Petrochemical, Polyethylene, and Handiwrap plants. In the early 1970's the Polyethylene plant was closed and a Ziplock plant was constructed on the same site. The Straits Wood Treating facility was constructed on Wilder Road south of the Dow plants in the early 1980's. Other significant facilities constructed in the area include the coal-fired electric power plant operated by Consumers Energy across the river from the site and the West Bay County Wastewater Treatment Plant located approximately 1-mile southwest of the site.

Recent industrial development includes the construction of an asphalt terminal in 2002, by Bit-Mat Corporation on a previously undeveloped portion of the Dow Bay City Terminal. In 2002, the Bay Aggregate Company also began moving its operations from downtown Bay City to the former Standard Oil Company terminal site. Proposed additional development in the area also includes construction of a preformed concrete facility on former Dow property on Wilder and Tiernan roads.

Although there have been many changes in the industries located in the area over the past 50 years, the developed properties have remained industrial. The following facilities noted above are still in operation:

- Handiwrap Plant, current owner SC Johnson;
- Ziplock Plant, current owner SC Johnson;
- Straits Wood Treating Plant, current owner Straits Corporation; and

[3] USGS Bay City Quadrangle, 1919 Edition.
[4] 1950 aerial photograph

- Marathon Ashland Petroleum LLC.

The following properties have changed operations, but remain industrial:
- Bay Refinery, current owner Dow, part of Bay City Terminal, refinery has been demolished, operations currently include calcium chloride and liquid fertilizer storage and shipment; and
- Standard Oil Company Terminal, current owner Port Fisher, for Bay Aggregate Company operations for shipment and storage of aggregate.

It is expected that future development of the general area will remain industrial in nature for a number of reasons. The location near the mouth of the Saginaw River ensures that the area will be of interest to industries that rely on the transfer of goods by water. Both Bangor Township and Bay City have zoned the Thorium Site as well as all adjacent parcels General Industrial to encourage additional industrial development in this area. In addition, the presence of industry in the area is a deterrent to residential and commercial development because of heavy truck traffic, noise, emissions, and aesthetics. Figure 6 shows the location of Industrial Zoning in the site area. However, there are impediments to the development of the wetlands area that is subject to NRC license. These are discussed below.

2.3.2 Impediments to Future Development of Site

Site Physical Limitations

Based on an aerial topography, the Site elevations were determined to range from 580 to 586. This data is consistent with the United States Geological Survey (USGS) Topographic Map (1973), which indicates the site elevation ranges from 580 to 585 ft (USGS datum).

The FEMA flood zone map indicates that the Site is located in Zone AE (100 yr floodplain). The 100-yr floodplain elevation for the Site is 586. In addition to flooding, the elevation of Lake Huron and the Saginaw River naturally fluctuate from 582 to 576 (data from NOAA Great Lakes Environmental Laboratory for period 1918 to 2000). When short term fluctuations of 1 to 2 ft (due primarily to storm conditions over hours or several days) are superimposed on the long-term levels, the maximum lake elevation can be as high as 584. These data indicate that, in addition to flood conditions, the site is periodically inundated as water levels in Lake Huron and the Saginaw River naturally fluctuate.

Based on the evaluations of the site, the Saginaw River, and the 100-yr floodplain, large volumes of fill material, ranging from one to six feet, would be needed to prevent the site from periodic flooding. For each acre of fill, one (1) foot deep the cost of the material, grading and compaction would be approximately $32,000.

Restriction on Wetland Development

Any alteration of a wetlands area will require a Wetlands Permit including dredging, filling crossing, and draining surface water. Wetlands mitigation is a requirement of most Wetlands Permits. This is accomplished by creating new wetlands onsite from an upland area, creating new wetlands at an offsite location or through the purchase of property currently available in "Wetlands Mitigation Banking." Wetlands mitigation is done at one and a half times the area of wetlands disturbed. The cost of wetlands mitigation to replace floodplain volume lost due to filling would be approximately $48,000 per acre.

Poor Soil Quality

According to the United States Soil Conservation Service (USCS) Soil Survey, the Site soils are composed of sandy and loamy aquents. Aquents are described as highly variable borrow/fill/altered. The Soil Survey indicates that "major hazards or management problems" may need to be overcome to utilize areas comprised of this soil type for either development or agriculture. Groundwater is seasonally variable and is historically encountered between six inches (6") to two feet (2') below ground surface.

2.3.3 Future Land Use

The most probable future land use for the site is the Recreational Intruder. It is most likely that any future industrial development in the general area would occur at other locations that do not pose the engineering and wetlands challenges of the Site. It is reasonable to assume that this land would be maintained in a natural state. The recreational intruder is an individual that enters the site for hunting and or fishing. In the past, this type of activity has been observed at the site. The dose pathways for the Recreational Intruder would include direct exposure, particulate inhalation, meat ingestion, aquatic food ingestion, and direct ingestion.

It is possible, although less likely, that the future land use would be Industrial. The Industrial scenario would not include the use of the shallow groundwater for drinking water or any other purpose for the reasons described above. The physical limitations of the site result in significant cost and engineering impediments and challenges to the implementation of the industrial scenario. For example, the filling and mitigation of a five acre site (assuming 6 feet of fill) could cost as much as $2.4M. This is before consideration of any other site permitting or engineering issues such as the presence of loamy aquents soils. These challenges limit the types and scope of future land use that could reasonably be envisioned to occur at the Site

It is also possible based on a review of past development records in other wetlands areas in Michigan that a wetlands site could be developed for a marina (with no use of the shallow groundwater). Because of the long history of industrial use in the area and the impediments to successful development, the Marina scenario has a lower probability of occurrence than the Industrial scenario. The economic and engineering impediments for a marina development would be similar to that described above for industrial development.

A Resident Farmer scenario is the least likely scenario with an exceedingly low probability of ever occurring at the site due to physical limitations, wetlands, unsuitability of shallow groundwater for use as drinking water or irrigation, soil type, cost, environmental liability, deed restrictions, zoning, and past land use. The resident farmer scenario does not meet the definition of prudently conservative and does not apply to the Bay City Site.

3. UNRESTRICTED USE CRITERIA

3.1 Unrestricted Use Criteria for Material in Saturated Zone

The unrestricted use criteria for the material in the 9.1 acres of the saturated zone remaining to be remediated will be the same as that currently approved for the storage piles, i.e., 2.9 pCi/g Th-232 average (3.2 pCi/g including background). This limit is based on the assumptions that Th-232 is in secular equilibrium with Th-228 and that the Th-230:Th-232 ratio is 3:1.

The maximum concentration limit for any individual composited borehole sample from the saturated zone is 30 pCi/g Th-232. To demonstrate that the risk from the 30 pCi/g Th-232 maximum is sufficiently low, a simple dose assessment was performed using the "single bucket" excavation scenario from the NRC guidance provided in "Method for Surveying and Averaging Concentrations of Thorium in Contaminated Subsurface Soil," February 13, 1997, letter from John T. Buckley, NRC, to Howard A. Pulsifer, AAR Corporation (AAR Method). An occupancy time of 2000 hrs per year outdoors was assumed. The resulting dose was 23 mrem/yr.

The single bucket scenario is the most applicable excavation scenario for the saturated zone material. Since the most credible mechanism for saturated zone excavation is inadvertent intrusion during some type of land preparation work being done in the unsaturated zone for the construction of some type of building. Such a building could be envisioned in the recreational or industrial scenario. If there were inadvertent intrusion into the saturated zone as evidenced by a single "wet" excavator bucket load, the equipment operator would adjust to prevent a second occurrence. There is no credible scenario for continuous large scale excavation of the site saturated zone.

The marina land use scenario was evaluated for applicability to the site. It was determined that the 9.1 acres of land remaining to be remediated are not near the river, and would not be affected by presumed saturated zone excavation for docks. If a marina were to be built in the vicinity, the land in the remaining 9.1 acre area could possibly be used for storage or for an onsite support building of some type. The "single bucket" excavation scenario described above would be the most applicable in this case as well.

To provide insight into the levels of residual contamination currently contained in the saturated zone, the existing 750 borehole sample results were evaluated. After the presumed remediation of all identified areas exceeding 30 pCi/g Th-232 to 3.2 pCi/g, the average concentration of licensed material in the saturated zone would be 1.6 pCi/g Th-232. This demonstrates that the overall risk from the saturated zone material is low.

3.2 Unrestricted Use Criteria for Material in Unsaturated Zone

The unrestricted use criteria for the material in the 9.1 acres of the unsaturated zone remaining to be remediated will be the same as that currently approved for the storage piles, i.e., 2.9 pCi/g Th-232 average (3.2 pCi/g including background). This limit is based on the assumptions that Th-232 is in secular equilibrium with Th-228 and that the Th-230:Th-232 ratio is 3:1. Averaging criteria will be applied as described in the Section 4.0 below.

3.3 Unrestricted Use Criteria for Groundwater in Saturated Zone

The MCL's listed in the EPA Drinking Water Standards will be used as the unrestricted use criteria for the saturated zone in accordance with the SDMP Action Plan. The MCL's applicable to the site include gross alpha and total radium, i.e., 15 pCi/l and 5 pCi/l, respectively. Compliance will be demonstrated using the spatial average from the wells designated in the TDCC groundwater monitoring plan (to be submitted at a later date), where the concentration assigned to each well will be the annual average from four quarterly samples. The groundwater monitoring will occur after saturated zone remediation is completed. Compliance with this spatial average will be demonstrated at the 95% confidence level using Equation 8-13 from NUREG/CR-5849. In addition, the spatial average of the monitoring well results from each round of quarterly sampling will be less than the MCL's. This method for demonstrating compliance with the MCLs was approved by NRC in a letter dated June 6, 2003.

4. FINAL STATUS SURVEY

4.1 Saturated Zone

The final status survey (FSS) of the saturated zone in the remaining 9.1 acres of the site to be remediated (see Figure 7) will be performed using composite borehole samples collected from the top of the saturated zone to the underlying clay layer. The existing ~750 saturated zone samples will be used for FSS (Figure 8 shows the location and summarized results of the ~750 samples). Additional samples are not justified because of the low probability of future saturated zone excavation and the low percentage of site fill material that was originally contaminated (estimated to be about 2%). Compliance will be demonstrated at the 95% confidence level using Equation 8-13 from NUREG/CR-5849 and the ~750 borehole sample results.

The affected area around any location with a borehole sample exceeding 30 pCi/g Th-232 will be excavated and shipped for offsite disposal. The affected area will be defined *apriori* by borehole samples collected in a square or circular pattern around the elevated location before excavation begins. The linear distance between samples will vary depending on the size of the affected area but in no case will exceed 5m. The boundary defined by the square or circular pattern will be projected downward to the clay layer. The entire resulting projected volume of saturated zone material will be remediated to the underlying clay layer. No additional samples will be collected after excavation since the contaminated volume will be well defined by the *apriori* boreholes.

The average Th-232 concentration in the *apriori* borehole samples will replace the original (i.e., pre-remediation) elevated value in the 750 sample saturated zone FSS database and be used in the 95% confidence compliance demonstration.

The thorium concentration in the excavated unsaturated zone overburden that will be used as backfill after the saturated zone excavation is completed will be assessed by collecting a grab sample from each excavator bucket load and compositing the grab samples. Each composite will represent a volume of approximately 25 m^3 or less. The results of the composite will be evaluated using the methods described n Section 4.2 below assuming that the composite represents an individual borehole sample.

4.2 Unsaturated Zone

Borehole Samples

The current 2.9 pCi/g Th-232 limit (3.2 pCi/g including background) will be applied to the average of all borehole composite samples collected in the unsaturated zone of the remaining 9.1 acre area. Compliance will be demonstrated at the 95% confidence level using Equation 8-13 from NUREG/CR-5849.

In addition, the surveying and averaging criteria defined in the AAR method will be applied to the unsaturated zone. The AAR method ensures "…that the number and location of samples are sufficient to 1) demonstrate, with reasonable confidence, that a significant volume of subsurface contamination is identified by one of the samples, and 2) demonstrate that the average contamination level in the identified volume would not result in a significant dose after excavation."

TDCC will follow the sampling and averaging recommendations in the AAR method as described below:

- One borehole sample per 25 m^2 (resulting in ~1500 samples) consisting of approximately 1m composite samples. The existing borehole sample data (~750 samples) will be used and supplemented by an additional ~750 samples to meet the 25 m^2 sample frequency. The additional borehole samples will be a minimum 1.4 ft deep.

  NOTE: Due to inconsistent depth of the unsaturated zone, the depth of borehole composite samples will vary. If the sample depth is greater than

1.5 m it will be split into two equal length composite samples. If the sample depth is less than 1.5 m it will be composited into one sample. If the composite sample depth exceeds 2 m, the first composite will be 1.0 m and the "1.5m rule" will apply to the depth from 1-3 m. Any composite sample between 0 (1.4 ft minimum for ~750 additional samples to be collected) and 1.5 meters in length using the rules described above is considered to represent a 1 m composite in the AAR method. For example, if the unsaturated zone in a given area is 1.2 m deep, the entire 1.2 m will be composited and entered into the database as a sample from the "0-1m depth" discussed in the AAR method. Likewise, if the unsaturated zone depth is, for example, 0.6 m the result will also be entered as a sample from the "0-1m depth."

- If a borehole sample collected as a part of the ~750 additional unsaturated zone samples that TDCC has committed to collect exceeds 30 pCi/g Th-232, the entire soil column represented by the borehole sample will be excavated, regardless of whether part of the soil column is saturated at the time of excavation. Also, if a given unsaturated zone sample collected as a part of the ~750 additional samples exceeds 30 pCi/g, a borehole sample of the saturated zone will also be collected from the same location (or as close as practicable). The 30 pCi/g saturated zone criteria will apply to any saturated zone borehole sample. Regardless of the depth of the saturated zone at the time of sampling, all of the additional 750 unsaturated zone samples will be a minimum of 1.4 feet deep. If unsaturated zone excavation is required, the excavation will be a minimum of 1.4 feet, regardless of the unsaturated zone depth at the time of excavation.

- The acceptance criteria for the 1500 borehole sample results as provided in the AAR method corrected for the Thorad site-specific criteria of 2.9 pCi/g Th-232, including the 0.3 pCi/g background, are:

  - Maximum individual sample < 14.8 pCi/g Th-232
  - Average of any two samples in a given 100m^2 subgrid from 0-1 meter depth < 6.1 pCi/g Th-232
  - Average of the four samples from the 0-1 m depth in a given 100 m^2 subgrid < 3.2 pCi/g Th-232.
  - Average of the eight samples from the 0-2 m depth in a given 100 m^2 subgrid < 3.2 pCi/g Th-232 (if applicable).
  - Average of the two samples from 0-2 meters in the same borehole < 4.3 pCi/g Th-232 (if applicable).

Excavation of unsaturated zone areas will stop when the saturated zone is encountered. No additional samples or measurements of the saturated zone are required if the saturated zone FSS sampling plan described above has been satisfied. If the unsaturated zone excavation is not deep enough to encounter the saturated zone, FSS will be conducted on the unsaturated zone excavation floor.

FSS sampling of excavated area floors will consist of a borehole composite sample(s) using the “1.5 m rule” at a frequency of at least 1 sample per 25 m^2, consistent with the AAR method. Compositing is appropriate since these surfaces will be part of a subsurface volume after backfill. The borehole sample will be collected at the location of the highest scan survey result, as documented by the cpm reading of a NaI detector in contact with the floor surface. In addition, a borehole sample of the excavation sidewall (or equivalent composite sample collected from the sidewall surface) will be collected at the location of the highest scan result, as documented by the cpm reading of a NaI detector in contact with the sidewall surface. The borehole sample will be collected as close as possible to the sidewall given structural limitations and safety considerations. If borehole or hand compositing is not possible, standard grab samples will be collected to conservatively demonstrate compliance. The FSS excavation sample result will replace the original (i.e., pre-remediation) elevated value in the unsaturated zone FSS database and be used in the 95% confidence compliance demonstration.

The AAR 100 m^2 averaging criteria will be used as the acceptance criteria for the excavation FSS samples. The average of the floor sample (if required) and the biased sidewall sample will be evaluated on a weighted-average basis in accordance with the projected surface area of the excavation. Compliance with the 3.2 pCi/g 100 m^2 averaging criteria will be demonstrated using the weighted average of the excavated area and the remaining area in a given subgrid. For example, assume a 16 m^2 area is excavated down to the saturated zone (no floor sample required) and the bias sidewall sample was 5.7 pCi/g Th-232. Also assume that the average of the remaining 3 borehole sample results in the given 100 m^2 grid is 2.4 pCi/g. The weighted average would be 2.9 pCi/g [(16/100)(5.7) + (84/100)(2.4) = 2.9)] and the 100 m^2 subgrid would be meet the 3.2 pCi/g AAR compliance criteria (and the 14.8 pCi/g maximum criteria). This method is conservative since the average sidewall concentration will be lower than the biased concentration and clean fill will be used.

If a more realistic method is needed, additional, equally spaced, FSS borehole samples may be collected to determine a more representative concentration for the excavated sidewalls and floor at the discretion of TDCC. These additional samples would be random start, systematic samples at a frequency determined on a case-by-case basis.

Exposure Rate Measurements

Four FSS exposure rate measurements will be collected in each 25 m^2 quadrant. This exceeds the one measurement per 25 m^2 frequency recommended in NUREG/CR-5849. Additional emphasis is placed on exposure rate measurements because 1) the vast majority of projected dose is from direct gamma, 2) exposure rate measurements best augment the 1 m composite borehole samples, and 3) the SDMP Action plan limit for thorium is fundamentally based on a 10 uR/hr exposure rate as described in the 1981 Branch Technical Position “Disposal or Onsite Storage of Thorium or Uranium Wastes from Past Operation.”

The exposure rate criterion is 10 uR/hr, above background at 1 meter, averaged over each 100 m^2 subgrid. Consistent with NUREG/CR-5849, the maximum individual exposure rate will not exceed 2 times the criteria, i.e., 20 uR/hr. All FSS exposure rate measurements will be conducted after backfill in areas where excavation is required.

Scan Survey

All land areas (post-backfill if excavation required) will undergo 100% surface scan as a part of FSS.

- An additional exposure rate measurement will be collected in each 100 m^2 sub-grid at the location of the highest FSS surface scan result (as documented by the cpm reading from a NaI detector in contact with the ground surface).

- A composite borehole sample will be collected in each 100 m^2 sub-grid at the location of the highest FSS scan result (as documented by the cpm reading from a NaI detector in contact with the ground surface). The "1.5 m rule" will apply to the borehole composite.

- If the borehole sample and exposure rate both meet the limit using the assessment methods described above, then the survey is complete.

- If the exposure rate measurement causes a subgrid to fail using the assessment methods described above, then an investigation will be conducted and remediation completed as necessary. To demonstrate compliance, the biased exposure rate measurement will be added to the existing 16 measurement FSS data set and the average of the 17 will be less than 10 uR/hr. The 20 uR/hr maximum will apply.

- If the borehole sample causes a subgrid to fail using the 100 m^2 averaging criteria described above, then an investigation will be conducted and remediation completed as necessary. To demonstrate compliance, the borehole sample will be added to the existing four sample FSS borehole data set in a given sub-grid and the average of the five will be less than 3.2 pCi/g Th-232. The 14.8 pCi/g maximum will apply.

4.3 Final Status Survey of Rail Car Loading Area and Support Zone

Attachment 1 contains the FSS plan for the soil and buildings in the Rail Car Loading Area and Support Zone

5. SCHEDULE

A two year effort, from site mobilization through submittal of final status survey reports, is anticipated. If site work can start by April 2005, decommissioning could be completed in 2006. This schedule supercedes all previously approved DP schedules.

FIGURE 7 - REMAINING SUBGRIDS TO BE REMEDIATED

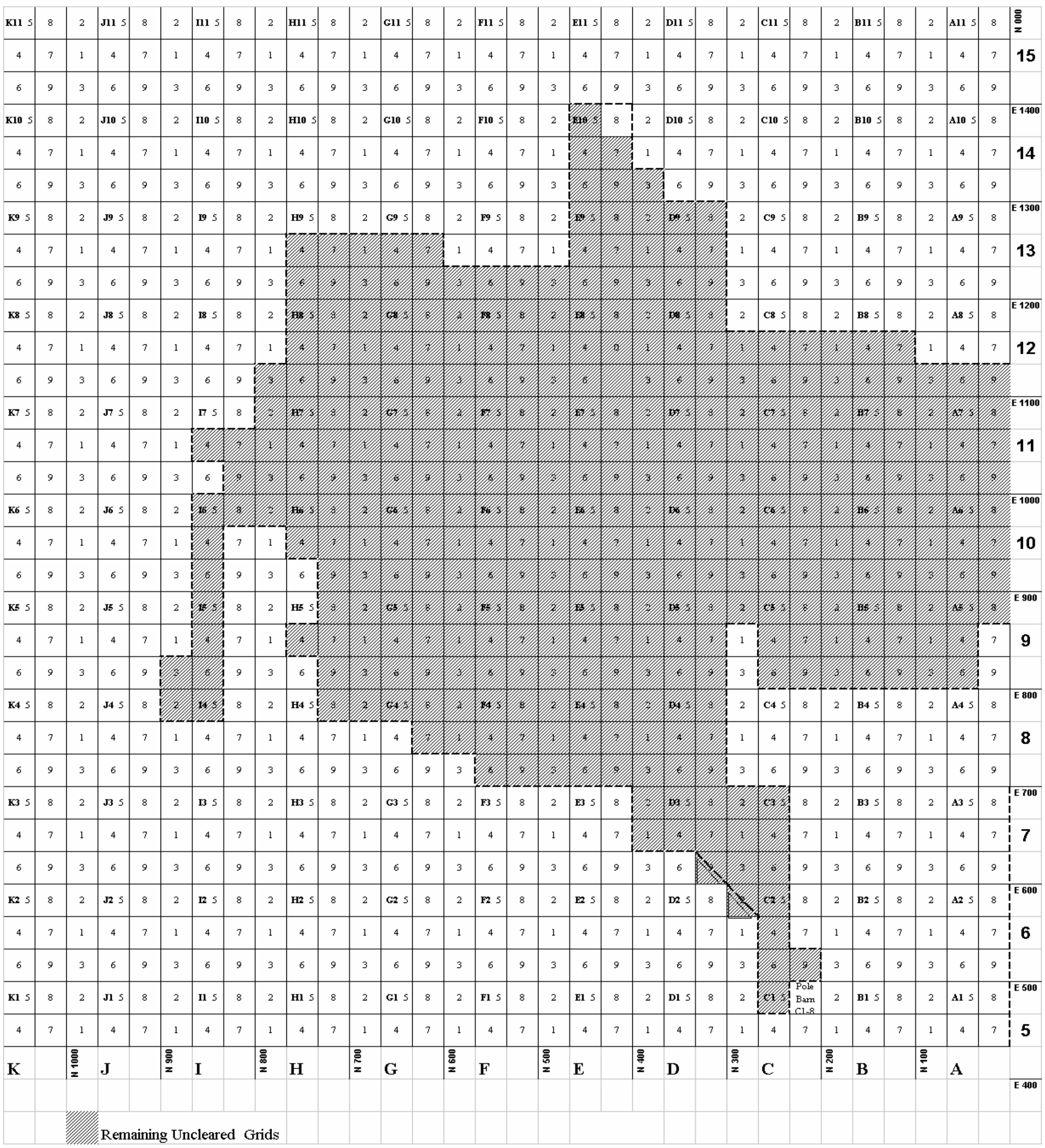
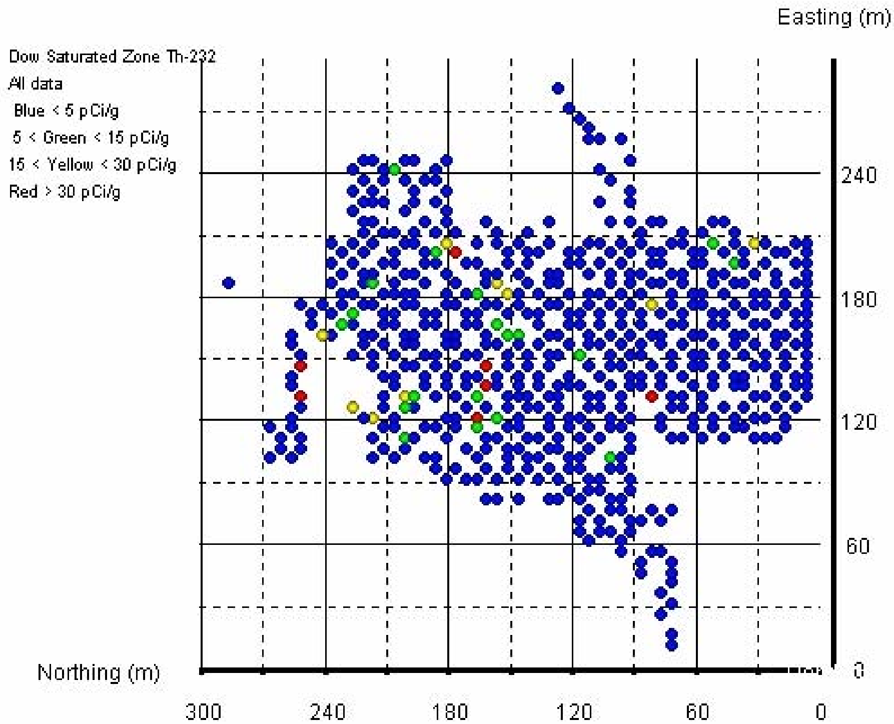


FIGURE 8 - LOCATION AND RESULTS OF 750 BOREHOLE SAMPLES COLLECTED FROM THE SATURATED ZONE



ATTACHMENT 1

To

Supplement to The Decommissioning Plan
For Removal of Magnesium-Thorium Slag From
The Dow Chemical Company's Bay City, Michigan Site

Revision 2 April 2005

FSS PLAN FOR RAIL CAR LOADING AREA AND SUPPORT ZONE SOIL, TEMPORARY OFFICE/LABORATORY BUILDING, PERSONNEL DECONTAMINATION FACILITY BUILDING, AND RAIL LOADING AREA SUPPORT TRAILER

Final Status Survey of the Rail Loading Area and the Support Zone Soil

Two soil areas require final status survey (FSS) that are not discussed in the Supplement, Revision 1; the Rail Car Loading Area and the Support Zone (see attached Figures). The Rail Car Loading area serves as the staging and rail car loading area for excavated soil for shipment to an offsite disposal site. The Support Zone is the location of the support facilities including the onsite laboratory, office trailer, sample storage, and operations and radiation protection support.

The FSS of these soil areas will be conducted in accordance with NUREG/CR-5849 guidance for affected areas. The FSS will apply to surface soil only. The presence of subsurface soil is very unlikely in these areas. The two areas will be divided into 100 m^2 grids. The FSS will consist of a scan survey of 100% of the two areas, four surface soil samples (6 in. depth) in each 100 m^2 grid, and four exposure rate measurements in each 100 m^2 grid. The soil samples and exposure rate measurements will be collected using the sampling pattern shown in Figure 4-4 of NUREG/CR-5849.

The site specific soil concentration limit of 3.2 pCi/g Th-232 (including background) will be applied along with the $(100/A)^{1/2}$ averaging criteria from NUREG/CR-5849. The exposure rate limit will be 10 uR/hr, above background, with a 20 uR/hr, above background, maximum. Compliance with the soil and exposure rate limits will be demonstrated for each area (i.e., Rail Car Loading and Support Zone) at a 95% confidence level using Equation 8-13 from NUREG/CR-5849. The $(100/A)^{1/2}$ soil averaging criteria and the 20 uR/hr maximum exposure rate criteria will apply to each 100 m^2 grid with the limitation that the average in each 100 m^2 area must be less than the 3.2 and 10 uR/hr limit.

Final Status Survey of Temporary Office/Laboratory Buildings, Personnel Decontamination Facility Building, and Rail Loading Area Support Trailer

There are three structures in the Support Zone and one structure in the Rail Loading Area. Current plans call for the Temporary Office Building, Temporary Laboratory Building, and Rail Loading Area Support Trailer to be removed from the site and the Personnel Decontamination Facility Building to remain. An FSS will be performed in the Decontamination Building. For the Office Building, Laboratory Buildings, and Support Trailer, either an FSS or free release survey will be performed at the discretion of TDCC. The FSS will be performed in accordance with the guidance in NUREG/CR-5849 as described below.

The unrestricted use criteria applied to building surfaces are listed in "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material," Policy and Guidance Directive FC **83-23.** The FC-83-23 criteria for Th-230 and Natural Thorium (Th-Nat), the radionuclides present at the Thorad site, are provided below.

Th-Nat

- Surface contamination (fixed plus removable): 1,000 dpm/100 cm^2, averaged over 1 m^2, and 3,000 dpm/100 cm^2 maximum.

- Removable contamination: 200 dpm/100 cm^2.

Th-230

- Surface contamination (fixed plus removable): 100 dpm/100 cm^2, averaged over 1 m^2, and 300 dpm/100 cm^2 maximum.

- Removable contamination: 20 dpm/100 cm^2.

The criteria for exposure rate is 5 uR/hr above background, at 1 m from building surfaces, averaged over 10 m^2 of contiguous surface area. Individual measurements may not exceed a maximum of 10 uR/hr above background, at 1 m.

Because the radionuclide mixture consists of alpha emitters with different criteria, a gross activity criterion was calculated using Equation A-2 of NUREG/CR-5849. The ratio of Th-230:Th-232 was assumed to be 3:1 at the Thorad site. However, for each Th-232 alpha, there are 6.33 total alpha emissions in the Th-Nat series. Therefore, the effective Th-230:Th-Nat alpha ratio applicable to the calculation of the gross activity criteria is 3:6.33. To calculate the gross activity criteria, the radionuclide fraction is required. For the Thorad site, the alpha fraction is used in place of the radionuclide fraction. Assuming the 3:6.33 ratio of alpha emissions, the alpha fractions would 0.33 and 0.67, for Th-230 and Th-Nat, respectively. Using these fractions, the gross activity criterion is calculated below.

$$\text{Alpha Gross Activity Criterion} = \frac{1}{\frac{.33}{100} + \frac{.67}{1000}} = 250 \text{ dpm/100 cm}^2 \text{ alpha}$$

The maximum gross activity criterion is 750 dpm/100 cm^2 (3x250) and the removable gross activity criterion is 50 dpm/100 cm^2 (250/5).

All four structures are designated as affected. The floors and lower walls (up to 2m) will be scan surveyed over 100% of the surface using an alpha detector such as a gas proportional counter. Elevated areas will be investigated and remediated as necessary. Direct alpha measurements and smear samples will be performed at a frequency of 1 per m^2. Exposure rate measurements will be performed at a frequency of 1 per 4 m^2. The maximum survey unit size for floors and lower walls will be 100 m^2 of floor area.

A minimum of 30 direct measurements and 30 smear samples will be collected in the upper walls and ceilings. Scan surveys will be performed in the immediate vicinity of each direct measurement. If a significant number of areas in the upper walls and ceilings are found to exceed 25% of the guideline level, the frequency of the direct measurements will be increased to 1 per m^2. There is no limit to the survey unit size for upper walls and ceilings. However, to ensure reasonable coverage, the measurement frequency will not be less than 1 per 20 m^2.

All instruments will be calibrated with NIST traceable sources. Background and source checks will be performed before and after each use.

The direct measurement MDC will be calculated using the following equation. The source efficiency (e_s) used in the MDC calculation will be the ISO-7503-1 default value for alpha of 0.25. The instrument efficiency (e_i) is the 2π efficiency, which will be determined by calibration to a NIST source. The parameters in the equation below will be set to ensure that the MDC is less than the 250 dpm/100 cm^2 criteria.

$$MDC_{direct} = \frac{3 + 3.29\sqrt{B_R \cdot t_s \cdot (1 + \frac{t_s}{t_b})}}{t_s \cdot ei \cdot es \cdot \frac{A}{100}}$$

Where:

MDC_{direct}	=	minimum detectable concentration (dpm/100 cm^2)
B_R	=	background count rate (cpm)
t_b	=	background count time (cpm)
t_s	=	sample count time (min)
A	=	detector area (cm^2)
e_i	=	instrument efficiency
e_s	=	source efficiency

The alpha scan survey MDC will be calculated using the following two equations (MARSSIM Equations 6-12 and 6-13). The first equation calculates the probability of observing a single count when the contamination level equals the criteria. If a single count is observed during the scan survey, the technician will stop and perform a stationary count for the time calculated using the second equation. The scan survey parameters are selected to ensure that the probability of observing a single count when contamination is present at levels ≥ the criteria is ≥ 95%. The follow up stationary count time is set to ensure that the probability of observing a second count is 90% when contamination is present at levels ≥ the criteria. If no count is recorded during the stationary count, then the count detected during scanning does not represent contamination above the criteria and scanning is continued.

$$P(n \geq 1) = 1 - e^{\frac{-GEd}{60v}}$$

Where:

P(n≥1)	=	probability of observing a single count
G	=	contamination activity (dpm)
E	=	detector efficiency (4π)
d	=	width of detector in direction of scan (cm)
v	=	scan speed (cm/s)

$$t = \frac{13{,}800}{CAE}$$

Where:

t	=	time period of stationary count (s)
C	=	contamination criteria (dpm/100 cm^2)
A	=	physical probe area (cm^2)
E	=	detector efficiency (4π)

The following parameters are used to calculate a nominal scan MDC and stationary follow up count time.

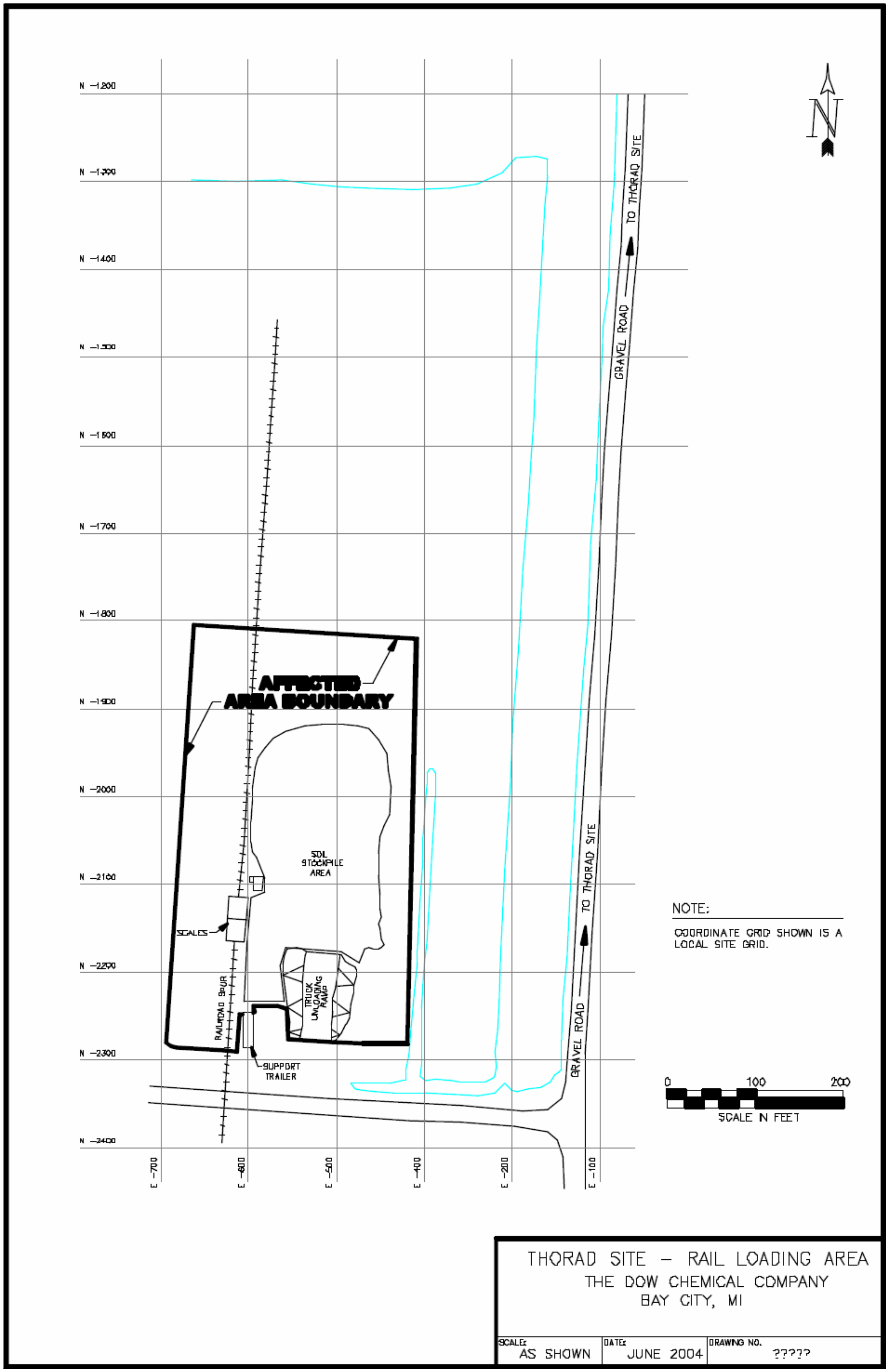
G	=	250 dpm
E	=	0.15
d	=	12 cm
v	=	2 cm/s
C	=	250 dpm/100 cm^2
A	=	100 cm^2

Using the values listed above, the scan detection probability and stationary count time are calculated as follows:

$$P(n \geq 1) = 1 - e^{\frac{-(250)(0.15)(12)}{60(2)}} = 97\%$$

$$t = \frac{13{,}800}{(250)(100)(0.15)} = 4 \text{ seconds}$$

Compliance will be demonstrated for each survey unit at the 95% confidence level using Equation 8-13 in NUREG/CR-5849. An FSS report will be submitted for NRC review and approval.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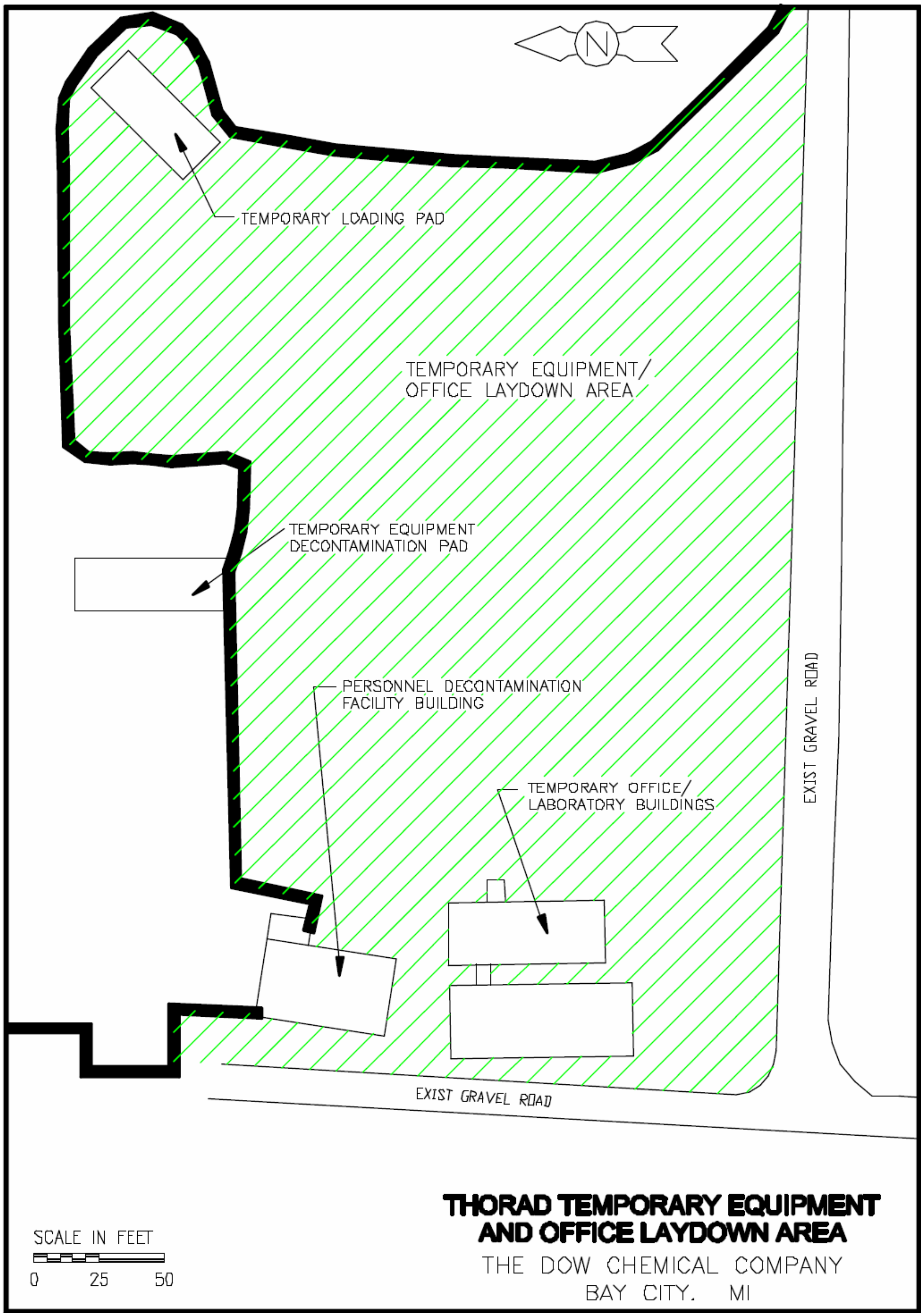
N -2300
N -2400
E -700
E -600
E -500
E -400
E -200
E -100
TO THORAD SITE
GRAVEL ROAD
AFFECTED AREA BOUNDARY
SOIL STOCKPILE AREA
SCALES
RAILROAD SPUR
TRUCK UNLOADING RAMP
SUPPORT TRAILER
NOTE:
COORDINATE GRID SHOWN IS A LOCAL SITE GRID.
0
100
200
SCALE IN FEET
THORAD SITE – RAIL LOADING AREA
THE DOW CHEMICAL COMPANY
BAY CITY, MI
SCALE: AS SHOWN
DATE: JUNE 2004
DRAWING NO. ?????


N
TEMPORARY LOADING PAD
TEMPORARY EQUIPMENT/
OFFICE LAYDOWN AREA
TEMPORARY EQUIPMENT
DECONTAMINATION PAD
PERSONNEL DECONTAMINATION
FACILITY BUILDING
TEMPORARY OFFICE/
LABORATORY BUILDINGS
EXIST GRAVEL ROAD
EXIST GRAVEL ROAD
SCALE IN FEET
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THORAD TEMPORARY EQUIPMENT
AND OFFICE LAYDOWN AREA
THE DOW CHEMICAL COMPANY
BAY CITY, MI