REPORT

Test Results, Statistical Analysis and Proposed Testing Program for Release of Equipment/Materials for Unrestricted Use at the Bluewater SX Dismantlement Project.

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Submitted to
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TABLE OF CONTENTS

I. Introduction

II. Statistical Analysis of Radiological Surface Contamination on the Interior Surfaces of SX Tanks

Method
Analysis
Results
Conclusions

III. Test Sections to Determine Adequacy of Cleaning Methods

Method
Analysis
Results
Conclusions

IV. Recommended Sampling Program for the Dismantlement Project

Appendix A

Statistical Analysis Summary

Appendix B

Photographs

I. Introduction

Landmark Reclamation was directed by Cyprus Metals to perform a testing program to determine radiological contamination levels within the ARCO Bluewater 3X building. The work was performed in accordance with ARCO Radiation Work Permit (RWP) 89-015 and applicable Nuclear Regulatory Commission (NRC) regulations.

The purpose of the testing program was three fold.

- Establish a quantitative basis for determining the necessary sample size to adequate characterize materials for release for unrestricted use or rejection.
- Determine the adequacy of various cleaning methods available for decontamination of equipment/materials.
- Perform a general survey to determine radiological contamination associated with siding and recycle lines.

II. Statistical Analysis of Radiological Surface Contamination on the Interior of SX Tanks.

Landmark Reclamation measured radiological contamination levels associated with selected tanks and materials associated with the SX circuit at the ARCO Bluewater Mill. The purpose of the testing was to establish a quantitative basis for determining the necessary sample size to adequately characterize materials/equipment to be released for unrestricted use.

Materials/equipment to be released are governed by "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use" issued by the Nuclear Regulatory Commission. This guideline specifies that equipment/materials must not exceed 15,000 disintegrations per minute (dpm) per 100 cm^2 total alpha radiation at a maximum 5000 dpm per 100 cm^2 total alpha radiation on average, or 1000 dpm per 100 cm^2 removable alpha radiation.

METHOD

A review of the flow sheet associated with the SX circuit was made to determine the areas most likely to have the highest levels of surface contamination. Extraction Settler Tank #1 and Strip Settler Tank #1 were selected for the following reasons:

- Highest concentrations of soluble uranium of any other location within the circuit.
- Extraction Tank #1 received solutions directly from the leach circuit.
- Strip Settler Tank #1 received pregnant organic solutions with the highest concentrations of entrained uranium.

Refer to Appendix A for photographs of the test area procedures.

Tanks were first cleaned using high pressure water only. Tanks were swept wet and then allowed to dry. No special cleaning procedures, other than those described, were employed. Then a grid for sampling purposes was established in each tank. The grids were established by using a chalk line and tape to mark one square meter increments. Grid corners and identification numbers were marked using indelible paint. Grid #1 was established in Extraction Settler Tank #1. Grid cells were established both on the floor and sides of the tank. A total of 71 grid squares were established as part of Grid #1.

Grid #2 was established in Strip Settler Tank #1. The tank was cleaned and a grid established just as for Extraction Tank #1. No grid squares were established on the side of the Strip Settler Tank #1, however. A total of 50 grid squares were established in Grid #2.

A grid square one square meter in dimension was selected for a "nested" sampling as well. Eighty four (84) grid locations were established within this m^2 grid cell.

Measurements of total and removable alpha radiation were then made using an Eberline ESP-1 programmable equipped with an AC 3-7 alpha scintillation probe. Alpha swipes were collected for those grid locations indicating total alpha radiation of 500 dpm/cm^2 and read later in the day.

Also, spot checks of various materials within the SX building were made to determine the spacial and numeric variability of surface contamination on these selected materials. No grid or statistical analysis was applied to these materials.

ANALYSIS

Statistical analysis was applied to determine the significance of differences between the means of the entire sample population and subsets of the entire population selected randomly. Two statistical tests were utilized for this purpose; the Mann-Whitney U Test and the Students T Test. All data was input into a computer and the program STATPAK was utilized for analysis.

A summary of all statistical data is provided in Appendix B.

Three separate populations were compared statistically: Grid #1 Floor Samples (Extraction Tank #1), Grid #1, Side Samples (Extraction Tank #1) and Grid #2 (Strip Tank #1).

Also, basic statistical parameters were determined for the "nested" grid, cell 34, contained within Grid #2.

Test data was corrected by using the following factors and formulas to give a true representation of alpha radiation in dpm per $100/cm^2$.

Corrected Value = 0.89 x (Reading 1 + Reading 2) - 1.2.4.

The calibration constant for the AC 3-7 probe was set at 0.19 which represents 100% efficiency for two readings assuming 2 π probe geometry.

The probe face of the AC 3-7 has an effective sensing area of 56 cm^2. Therefore, two side by side measurements using the AC 3-7 probe actually senses 112 cm^2 instead of 100 cm^2. Therefore, a correction factor of .89 was applied to data.

Background for the probe was determined to be 52.2 dpm which was multiplied by 2 for the two readings taken and subtracted from gross dpm after correction for probe geometry.

The Mann Whitney U Test is a comparative test which assumes non-normal distribution of sample data. The null hypothesis (Ho) was that the mean of the entire sample population and the mean of a subset are the same. Since test data for the two grid surfaces

tested appear to be log normally distributed and not normally distributed, the Mann Whitney U Test probably gives a better estimate than the Students T Test.

The Students T Test assumes normal distribution of the data and posed the same null hypothesis.

RESULTS

The first test to be run on TEST #1 (Extraction Tank #1) data set was a Mann-Whitney U test statistic, a comparison of the means of the side and floor samples. This test was used to evaluate whether there was a significant difference between the samples from the floor and sides of the container. The full data set was used for this test statistic. A confidence level of 95% ($z = 1.96$) was chosen.

The results indicate a z of 3.98, a result well beyond the 99% confidence level for indicating a difference between the means. This would strongly suggest that the sides and floor of the container must be treated as different populations for sampling purposes.

The next test to be run on the floor samples from TEST #1 data set was to select subsets from the total data set for comparison of statistical validity of smaller sample sets for sampling purposes. The floor data set had 51 samples in total. Sub-sets containing five samples each (10% of the total population) were selected by random number from the 51 sample data set. The means of the sub-sets were compared to the mean of the main data set by the Mann Whitney U test statistic to determine whether the sub-sets had significantly different means from the total set. The results were as follows: A 95% confidence level was chosen ($z = 1.96$).

Subset	z Statistic
1	.71
2	-.44
3	.79
4	-.22
5	-.24

These results are well within the acceptable confidence level for indicating a lack of significant difference between the means of the sub-sets and the main data set.

The same procedure was run with the side wall samples except the sub-sets had 25% of the population in them. A level of 10% would have included only 2 samples in each sub-set, a number inadequate to evaluate a means difference.

Subset	z Statistic
1	.37
2	-.99
3	1.12
4	-.51
5	-.85

These results are well within the acceptable range for stating that the means of the sub-sets and the main data set have no significant difference

In TEST #2 data set the original sub-setting of the test data set was at a 10% level. The data was evaluated using the Mann-Whitney U test. The results indicate that one of the five original sub-sets had a significant difference in the mean with the original data at a significance level of 95% The data was as follows

Subset	z Statistic
1	.28
2	- .32
3	.84
4	- .88
5	-2.55

The z of -2.55 would indicate that this sub-set from the main population would not be considered to be from the same population by a comparison of the means.

A resampling of the data with a 25% sub-setting of the sample sizes gave the following results.

Subset	z Statistic
1	.67
2	1.27
3	-.65
4	-.81
5	-.85

This would be acceptable at the 95% confidence level for no difference between the means.

The Students T test was also performed on log transformed sample data for Test Grid #1-Floor Samples, Test Grid #1-Side Samples and Test Grid #2 data. The Students T test results confirm Mann Whitney Test data. Data is included in Appendix B.

The question was also posed whether a sample of 5,000 dpm or greater would be probable, given the test data sets. The total data available, i.e. TEST #1 and TEST #2, but not the resampling tests, was used. The data statistics are displayed below.

THERE ARE 121 OBSERVATIONS

MEAN	597.06
STD.DEV.	439.13
VARIANCE	192835.00
MEDIAN	468.67
MODE	376.11 *
MAXIMUM	2648.28
MINIMUM	31.68
STD ERR OF MEAN	39.92
SKEWNESS	1.45
COEF. OF VAR.	73.55

* MORE THAN 1 MODE EXISTS - ONLY THE FIRST IS SHOWN

A number greater than or equal to 5,000 dpm would have a probability computed as follows.

$$\frac{5000 - 597.06}{439.13} = 10.03$$ standard deviations above the mean

This is well beyond the tabled confidence levels of a normal distribution table. Given this data set, a value of $\geq$ 5,000 dpm would be very unlikely.

CONCLUSION OF STATISTICAL COMPARISON PROGRAM

Test results have demonstrated the following items through statistical testing of the SX data.

- The floor and side samples taken as part of Grid #1 (Extraction Tank #1) have different means and are therefore, distinct populations as determined by both the Mann Whitney U Test and Students T Test.

- The mean of the total sample population and the means of five (5) separate subsets composed of 10% of the total population are the same for Test Grid #1 floor samples and Test Grid #2, except for one subset comparison. The mean of the total sample population and the means of five subsets composed of 25% of the total population are the same for Test Grid #1 side samples. Therefore, since only one subset sample population showed a significant difference between means at a 95% confidence interval and the overall sample population mean is well below 5000 dpm, it can be said with reasonable certainty that random sampling of 10% of the surface materials/equipment within the SX building adequately characterizes material/equipment.

- The probability of a value exceeding 5000 dpm/cm^2 alpha radiation, given the test data, is well in excess of a 0.01 confidence interval.

III. Test Sections to Determine Adequacy of Cleaning Methods

The purpose of the test program was to determine the adequacy and effectiveness of various cleaning methods for removal of surface radiological contamination existing on equipment/materials associated with the SX circuit at the ARCO Bluewater Mill. A secondary goal was to get an indication of the maximum and average radiological contamination levels found on interior and exterior surfaces of the SX building. Testing was not intended to be exhaustive in nature.

METHOD

Based upon knowledge of the SX circuit, areas within the SX building, thought to have potential for greatest radiological contamination, were selected for testing.

These areas are listed in Table I, along with the types of measurements taken for each surface. Test locations are located on Figure 1. Most measurements were taken with an ESP-1 Smart Portable or PRS-2 with an AC 3-7 alpha scintillation probe. Calibration records are attached to RWP 89-018 on file with ARCO.

Test results are shown on Tables 2 through 4. Approximate locations of test readings are found on Figure 1.

RESULTS

Total alpha contamination on tested areas on external surfaces of Extraction Tank #1 are well below Annex A limitations prior to high pressure water wash. Removal of contamination is less than minimum detectable (MDA) for three out of five test locations after high pressure water wash only.

Internal surfaces of the organic weir overflow within Extraction Settler Tank #1 were measured for total alpha radiation after steam cleaning only and for steam cleaning after two applications of Radiac soap at a 10% dilution. Removable alpha radiation was measured only for those areas which indicated alpha radiation of 1000 dpm/100 cm^2 or greater. The organic weir overflow for Extraction Settler Tank #1 is expected to have the highest average levels of alpha contamination of anywhere in the building. This is because pregnant aqueous solutions were highest in concentration of soluble uranium as anywhere within the SX circuit. Also, the organic amine and kerosene carrier tends to coat the sides and walls of the tank which makes cleaning surfaces more difficult.

Total net dpm ranged from less than background to 1748 dpm/100 cm^2 for sections cleaned with high pressure steam. Removable alpha radiation was negligable in all cases after steam cleaning.

TEST SECTION LOCATIONS
FOR RADIOLOGICAL CHARACTERIZATION
Bluewater SX Dismantlement Project

Figure 1

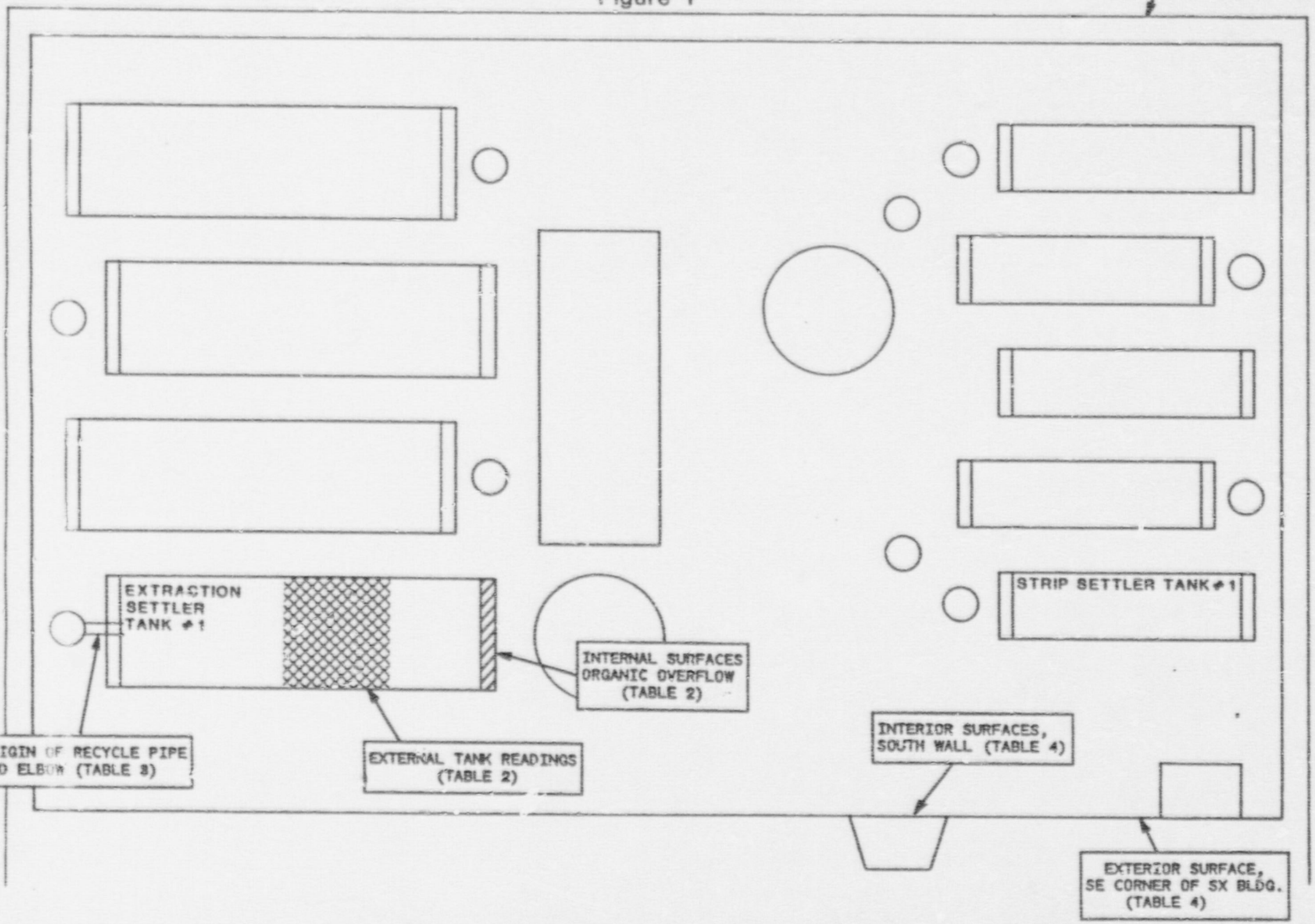

TABLE 1

Wash Test Section Methods

Location	Wash Technique	Information Collected	Instrument, and Date Testing Took Place (3)
Extraction Settler #1; External Tank Surface	Before cleaning	Total alpha (1)	PRS-2 with AC 3-7 Probe, 4-18-89
	High pressure water only	Removable alpha (2)	PRS-2 with AC 3-7 Probe, 4-18-89
Extraction Settler #1; Organic Overflow	Before cleaning	Total alpha (1)	ESP-1 with AC 3-7 Probe, 4-8-89
	High pressure steam only	Total alpha (1) Removable alpha (2)	ESP-1 with AC 3-7 Probe, 4-8-89
	Radiac wash and steam	Total alpha (1) Removable alpha (2)	ESP-1 with AC 3-7 Probe, 4-8-89
Extraction Settler #1; Recycle	Before cleaning	Total alpha	ESP-1 with AC 3-7 Probe, 4-8-89
	High pressure water only	Total alpha Removable alpha	ESP-1 with AC 3-7 Probe, 4-8-89
SX Building; Interior Surfaces, South Wall, Man Height	After high pressure only	Total alpha	PRS-2; AC 3-7 Probe, 4-18-89
SX Building; Exterior Surfaces NE Wall, Man Height	Before wash	Total alpha Removable alpha	PRS-2 AC 3-7 Probe, 4-18-89

(1) Alpha radiation reported in dpm/100 cm^2 corrected for background.
(2) Removable alpha in dpm/100 cm^2 measured by swipe testing.
(3) ESP-1 serial number 2286, AC 3-7 Probe serial number 706606
PRS-2 serial number 89743; AC 3-7 Probe serial number 706605

TABLE 1

Wash Test Section Methods

Location	Wash Technique	Information Collected	Instrument, and Date Testing Took Place (3)
Extraction Settler #1; External Tank Surface	Before cleaning	Total alpha (1)	PRS-2 with AC 3-7 Probe, 4-18-89
	High pressure water only	Removable alpha (2)	PRS-2 with9 AC 3-7 Probe, 4-18-89
Extraction Settler #1; Organic Overflow	Before cleaning	Total alpha (1)	ESP-1 with AC 3-7 Probe, 4-8-89
	High pressure steam only	Total alpha (1) Removable alpha (2)	ESP-1 with AC 3-7 Probe, 4-8-89
	Radiac wash and steam	Total alpha (1) Removable alpha (2)	ESP-1 with AC 3-7 Probe, 4-8-89
Extraction Settler #1; Recycle	Before cleaning	Total alpha	ESP-1 with AC 3-7 Probe, 4-8-89
	High pressure water only	Total alpha Removable alpha	ESP-1 with AC 3-7 Probe, 4-8-89
SX Building; Interior Surfaces, South Wall, Man Height	After high pressure only	Total alpha	PRS-2; AC 3-7 Probe, 4-18-89
SX Building; Exterior Surfaces NE Wall, Man Height	Before wash	Total alpha Removable alpha	PRS-2 AC 3-7 Probe, 4-18-89

(1) Alpha radiation reported in dpm/100 cm^2 corrected for background.
(2) Removable alpha in dpm/100 cm^2 measured by swipe testing.
(3) ESP-1 serial number 2286, AC 3-7 Probe serial number 706606
PRS-2 serial number 89743; AC 3-7 Probe serial number 706605

TABLE 2

Test Results - Extraction Settler #1

Location	Treatment	Total Alpha Net dpm/100 cm^2	Removable Alpha Net dpm/100 cm^2	Instrument
External Tank Surface	Before Wash	1) 200 2) 133 3) 166 4) 168 5) 160		PRS-2 with AC 3-7 Probe
	After Wash with High Pressure Wash		1) 54 2) <MDA 3) 54 4) <MDA 5) <MDA	PRS-2 with AC 3-7 Probe

TABLE 2 (con't)

Location	Treatment	Section ID	Total Alpha Net dpm/100 cm^2	Removable Alpha Net dpm/100 cm (1)	Instrument
Internal Surfaces; Organic Overflow Weir	Steam clean only	1	<BGR		ESP-1 with AC 3-7 Probe
		2	94		
		3	103		
		4	85		
		5	76		
		6	-		
		7	1391	≤ BKG	
		8	875	≤ BKG	
		9	1092	≤ BKG	
		10	117		
		11	75		
		12	1748	7.4	
		13	57		
		14	25		
		15	44		
	Radiac Soap (10% solution and steam clean	16	48		
		17	91		
		18	284		
		19	1432	88.7	
		20	1256	73.0	
		21	127		
		22	1125	57.4	
		23	276	57.4	

(1) Removable alpha taken only when total alpha was over 1000 dpm/100 cm^2.

TABLE 3

Test Results - Recycle Line - Extraction Settler #1

Location	Treatment	ID	Total Alpha Net dpm/100 cm^2	Removable Alpha Net dpm/100 cm^2	Instrument
External Surface	Before Cleaning	1	892	-	ESP-1 with AC 3-7
		2	704	-	
Interior Surface; Elbow	Before Cleaning	3	7,988	Visible Cake	ESP-1 with AC 3-7
		4	12,776	"	
Interior Surface; Straight Pipe	Before Cleaning	5	2,560		ESP-1 with AC 3-7
		6	16,708	"	
		7	23,372	"	
Interior Surface; Elbow	After high pressure water only	3	681.	-	ESP-1 with AC 3-7
		4	1691.	673.	ESP-1 with AC 3-7

TABLE 4

Test Results - SX Building Surfaces

Location	Treatment	Net dpm/100 cm^2	Net dpm/100 cm^2	Instrument
Exterior Surface; NE corner of building; man height	Before Wash	180	-	PRS-2 with AC 3-7 Probe
		97	-	
		323	-	
		442	-	
		298	-	
Exterior Surface; SE corner of building; man height	Before Wash	442	-	PRS-2 with AC 3-7 Probe
		817	-	
		712	-	
		500	-	
		123	-	
Interior Surface; South Wall; man height	High Pressure Wash	2000 (1)	-	PRS-2 with AC 3-7 Probe
		112	11	
		319	23	
		402		
		435		
Interior Surface; SE corner, man height		612	-	PRS-2 with AC 3-7 Probe
		701	-	
		450	-	
		189	-	
		210	-	

(1) Visual evidence of yellow crust from spill.

For areas cleaned with Radiac soap (10% solution) and steam cleaning, total alpha radiation ranged from 48 to 1432 dpm/100 cm^2. Removable contamination was less than 100 dpm/100 cm^2 in the three cases tested.

Fiberglass pipes and elbows which were part of the barren aqueous recycle line were tested for total alpha contamination before and after cleaning with high pressure water only. Visible caked slimes were visible on internal surfaces prior to cleaning and total alpha readings were not surprisingly high ranging from 704 to 23,372 dpm/100 cm^2 prior to cleaning. After cleaning with high pressure water only, interior surface contamination was greatly reduced, but still relatively high (681 to 1691 total alpha dpm/100 cm^2).

Exterior and interior surfaces of the SX building siding were spot tested for total alpha contamination. Interior surfaces were tested after an initial wash to reduce potential airborne contamination in the SX building. All readings were well below 1000 dpm/100 cm^2 total alpha except for one test on the interior south well of the SX building. In this case, visible yellow crust was identified. The spot was probably a result of a spill of pregnant aqueous or organic.

CONCLUSIONS

Based upon the limited testing performed during the test period, it appears that external and internal surfaces of extraction and strip tanks can easily be decontaminated to levels specified in Annex A for release of equipment/material for unrestricted use. Cleaning with high pressure water only should be adequate for most tank surfaces. In areas where monitoring indicates consistently high (over 3000 dpm/100 cm^2) or highly variable readings high pressure steam, soap and high pressure steam, wet sand blasting or acid wash will be employed as cleaning techniques.

Recycle lines associated with extraction and strip tanks exhibit relatively high levels of total and removable alpha contamination. Recycle lines will probably require special cleaning using one of the more intensive methods if recycle lines are to be released for unrestricted use. An economic decision will be made as to the feasibility of cleaning these materials if they are contaminated. If the cost of decontamination outweighs salvage value, materials will be disposed of on site.

Both external and internal surfaces of siding appear to be well within acceptable contamination limits, except in those rare locations where visible contamination can be seen.

Landmark feels strongly when visual indications of contamination are evident, that sampling in addition to grid sampling be performed to assure compliance with Annex A criteria.

IV. Proposed Sample Program

On the basis of information generated, Landmark Reclamation recommends a sample program which is based on the following criteria.

1) Testing will be performed on 10% of the surface of a particular piece of equipment or material. Test locations will be selected randomly using random numbers and a griding system.

2) When visual inspection or readings from the sampling indicate readings approaching action levels (500 dpm/100 cm^2 removable alpha or 4000 dpm/100m^2 total alpha) more intensive sampling will be performed to confirm adequate decontamination.

3) More frequent measurements will be taken in areas suspected of potential radiological levels approaching action levels. Such areas will include irregularly shaped portions of tanks or pipes which tend to trap contaminants, areas with heavy scale, staining or organic film and any materials with more open porous structures such as rubber or wood.

4) Beta radiation measurements will be made only on that equipment/material which has a tendency to absorb ^{226}Ra and daughters. Past testing by ARCO has demonstrated a one-to-one correspondence of beta to alpha dpm in most circumstances. Examples of materials which absorb or selectively attracts radium and radium decay products are rubber materials or oxidized metal surfaces. Spot checks of beta radiation will be made periodically throughout the project on representative equipment.

5) All information generated during the testing process will then be recorded for each individual piece of material/equipment using an appropriate numeric code.

APPENDIX A

Statistical Analysis Reports

OBS	CODE	NUM	READ1	READ2	FINAL
1	1.000000	1.000000	172.0000	203.0000	240.8340
2	1.000000	2.000000	157.0000	167.0000	195.4440
3	1.000000	3.000000	110.0000	99.00000	93.09400
4	1.000000	4.000000	104.0000	156.0000	138.4840
5	1.000000	5.000000	136.0000	99.00000	116.2340
6	1.000000	6.000000	297.0000	219.0000	368.3240
7	1.000000	7.000000	250.0000	303.0000	399.2540
8	1.000000	8.000000	308.0000	323.0000	468.6740
9	1.000000	9.000000	381.0000	277.0000	492.7040
10	1.000000	10.00000	454.0000	125.0000	422.3940
11	1.000000	11.00000	438.0000	277.0000	543.4340
12	2.000000	12.00000	485.0000	668.0000	933.2540
13	2.000000	13.00000	618.0000	626.0000	1012.464
14	2.000000	14.00000	563.0000	475.0000	830.9040
15	2.000000	15.00000	584.0000	574.0000	937.7040
16	2.000000	16.00000	809.0000	751.0000	1295.484
17	2.000000	17.00000	850.0000	726.0000	1308.834
18	2.000000	18.00000	694.0000	590.0000	1049.844
19	2.000000	19.00000	584.0000	537.0000	904.7740
20	2.000000	20.00000	772.0000	652.0000	1174.444
21	2.000000	21.00000	647.0000	678.0000	1088.334
22	2.000000	22.00000	370.0000	292.0000	496.2640
23	2.000000	23.00000	167.0000	443.0000	449.9840
24	2.000000	24.00000	699.0000	689.0000	1142.404
25	2.000000	25.00000	944.0000	949.0000	1591.854
26	2.000000	26.00000	788.0000	903.0000	1412.074
27	2.000000	27.00000	777.0000	824.0000	1331.974
28	2.000000	28.00000	548.0000	590.0000	919.9040
29	2.000000	29.00000	548.0000	417.0000	761.4840
30	2.000000	30.00000	511.0000	532.0000	835.3540
31	2.000000	31.00000	548.0000	511.0000	849.5940
32	2.000000	32.00000	376.0000	454.0000	645.7840
33	1.000000	33.00000	313.0000	224.0000	385.0140
34	2.000000	34.00000	297.0000	230.0000	376.1140
35	2.000000	35.00000	358.0000	378.0000	582.1240
36	2.000000	36.00000	277.0000	287.0000	409.0440
37	2.000000	37.00000	283.0000	261.0000	391.2440
38	2.000000	38.00000	219.0000	329.0000	394.8040
39	2.000000	39.00000	203.0000	224.0000	287.1140
40	2.000000	40.00000	350.0000	376.0000	553.2240
41	2.000000	41.00000	402.0000	365.0000	599.7140
42	2.000000	42.00000	454.0000	459.0000	719.6540
43	2.000000	43.00000	490.0000	470.0000	761.4840
44	2.000000	44.00000	433.0000	506.0000	742.7940
45	2.000000	45.00000	396.0000	471.0000	678.7140
46	2.000000	46.00000	402.0000	360.0000	585.2640
47	2.000000	47.00000	261.0000	318.0000	422.3940
48	2.000000	48.00000	104.0000	323.0000	287.1140
49	2.000000	49.00000	104.0000	277.0000	246.1740
50	2.000000	50.00000	162.0000	365.0000	376.1140
51	2.000000	51.00000	213.0000	141.0000	222.1440
52	2.000000	52.00000	334.0000	297.0000	468.6740

OBS	CODE	NUM	READ1	READ2	FINAL
53	2.000000	53.00000	417.0000	454.0000	682.2740
54	2.000000	54.00000	203.0000	323.0000	375.2240
55	2.000000	55.00000	209.0000	365.0000	417.9440
56	2.000000	56.00000	271.0000	230.0000	352.6740
57	2.000000	57.00000	183.0000	240.0000	283.5540
58	2.000000	58.00000	261.0000	266.0000	376.1140
59	2.000000	59.00000	313.0000	209.0000	371.6640
60	2.000000	60.00000	292.0000	339.0000	468.6740
61	2.000000	61.00000	470.0000	323.0000	612.8540

Test Grid #1
(Extraction Settler Tank #1)
Adjusted Data
#1-#71

Landmark Reclamation
Bluewater SX Dismantlement Project

64	1.000000	64.00000	344.0000	242.0000	428.6240
65	1.000000	65.00000	334.0000	318.0000	487.3640
66	1.000000	66.00000	203.0000	157.0000	227.4840
67	1.000000	67.00000	136.0000	242.0000	243.6040
68	1.000000	68.00000	116.0000	266.0000	246.1740
69	1.000000	69.00000	62.00000	78.00000	31.68400
70	1.000000	70.00000	277.0000	355.0000	469.5640
71	1.000000	71.00000	313.0000	713.0000	820.2240

VAR

OBS	NUM	READ1	READ2	FINAL
1	1.000000	452.0000	543.0000	792.6340
2	2.000000	595.0000	563.0000	937.7040
3	3.000000	537.0000	642.0000	956.3940
4	4.000000	1060.000	986.0000	1719.124
5	5.000000	1150.000	589.0000	1436.994
6	6.000000	894.0000	809.0000	1244.754
7	7.000000	810.0000	590.0000	975.0840
8	8.000000	475.0000	642.0000	901.2140
9	9.000000	323.0000	313.0000	473.1240
10	10.00000	543.0000	830.0000	1129.054
11	11.00000	1360.000	1720.000	2648.284
12	12.00000	177.0000	198.0000	240.8340
13	13.00000	657.0000	805.0000	1030.264
14	14.00000	370.0000	488.0000	670.7040
15	15.00000	78.30000	120.0000	83.57100
16	16.00000	407.0000	355.0000	585.2640
17	17.00000	245.0000	219.0000	320.0440
18	18.00000	689.0000	381.0000	859.3840
19	19.00000	209.0000	188.0000	260.4140
20	20.00000	268.0000	287.0000	399.2540
21	21.00000	303.0000	151.0000	311.1440
22	22.00000	115.0000	157.0000	149.1640
23	23.00000	403.0000	756.0000	938.5940
24	24.00000	271.0000	339.0000	449.9840
25	25.00000	63.00000	125.0000	74.40400
26	26.00000	177.0000	157.0000	204.3440
27	27.00000	125.0000	172.0000	171.4140
28	28.00000	350.0000	579.0000	733.8940
29	29.00000	167.0000	193.0000	227.4840
30	30.00000	125.0000	188.0000	185.6540
31	31.00000	798.0000	563.0000	1118.374
32	32.00000	788.0000	740.0000	1267.004
33	33.00000	861.0000	1130.000	1679.074
34	34.00000	167.0000	192.0000	226.5940
35	35.00000	271.0000	172.0000	301.3540
36	36.00000	136.0000	172.0000	181.2040
37	37.00000	89.00000	177.0000	143.8240
38	38.00000	876.0000	1020.000	1594.524
39	39.00000	120.0000	130.0000	129.5840
40	40.00000	151.0000	89.00000	120.6840
41	41.00000	198.0000	151.0000	217.6940
42	42.00000	247.0000	157.0000	266.6440
43	43.00000	303.0000	182.0000	320.9340
44	44.00000	339.0000	286.0000	463.3340
45	45.00000	177.0000	318.0000	347.6340
46	46.00000	344.0000	245.0000	431.2940
47	47.00000	177.0000	136.0000	185.6540
48	48.00000	108.0000	103.0000	93.09400
49	49.00000	125.0000	138.0000	141.1540
50	50.00000	97.00000	151.0000	127.8040

Test Grid #2
(Strip Settler #1)
Adjusted Data
#1-#50

Landmark Reclamation
Bluewater SX Dismantlement Project

***** BAR GRAPH FOR VARIABLE: FINAL *****

RANGE OF VALUES	FREQ	PCENT	
31.68 - 162.5	13	10.7	IXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
162.5 - 293.3	21	17.4	IXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
293.3 - 424.2	21	17.4	IXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
424.2 - 555.0	17	14.0	IXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
555.0 - 685.8	9	7.4	IXXXXXXXXXXXXXXXXXXXXXXXXXXXX
685.8 - 816.7	6	5.0	IXXXXXXXXXXXXXXXXXX
816.7 - 947.5	12	9.9	IXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
947.5 - 1078.	5	4.1	IXXXXXXXXXXXXXXXX
1078. - 1209.	5	4.1	IXXXXXXXXXXXXXXXX
1209. - 1340.	5	4.1	IXXXXXXXXXXXXXXXX
1340. - 1471.	2	1.7	IXXXXXXX
1471. - 1602.	2	1.7	IXXXXXXX
1602. - 1732.	2	1.7	IXXXXXXX
1732. - 1863.	0	0.0	I
1863. - 1994.	0	0.0	I
1994. - 2125.	0	0.0	I
2125. - 2256.	0	0.0	I
2256. - 2387.	0	0.0	I
2387. - 2517.	0	0.0	I
2517. - 2648.	1	0.8	IXXX
	121		

5.0 10.0 15.0 20.0
PERCENTAGE

Frequency Graph
for Test Grid #1
and #2 Data

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Bluewater SX Dismantlement Project

```
        ***** BAR GRAPH FOR VARIABLE: LOGF  *****

 RANGE OF VALUES        FREQ  PCENT +--------------------+--------------------+--------------------+--------------------+
1.501   -  1.597          1    0.8 IXXX
1.597   -  1.693          0    0.0 I
1.693   -  1.789          0    0.0 I
1.789   -  1.885          1    0.8 IXXX
1.885   -  1.981          3    2.5 IXXXXXXXXXX
1.981   -  2.077          1    0.8 IXXX
2.077   -  2.174          6    5.0 IXXXXXXXXXXXXXXXXXXXXX
2.174   -  2.270          5    4.1 IXXXXXXXXXXXXXXXXXX
2.270   -  2.366          7    5.8 IXXXXXXXXXXXXXXXXXXXXXXXX
2.366   -  2.462         10    8.3 IXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
2.462   -  2.558          6    5.0 IXXXXXXXXXXXXXXXXXXXXX
2.558   -  2.654         19   15.7 IXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
2.654   -  2.750         14   11.6 IXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
2.750   -  2.846          8    6.6 IXXXXXXXXXXXXXXXXXXXXXXXXXXXX
2.846   -  2.942         11    9.1 IXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
2.942   -  3.039         13   10.7 IXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
3.039   -  3.135          9    7.4 IXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
3.135   -  3.231          5    4.1 IXXXXXXXXXXXXXXXXXX
3.231   -  3.327          1    0.8 IXXX
3.327   -  3.423          1    0.8 IXXX
                        ----       +--------------------+--------------------+--------------------+--------------------+
                         121                            ^                    ^                    ^                    ^
                                                       5.0                 10.0                 15.0                 20.0
                                                    PERCENTAGE
```

Frequency Graph
for log adjusted

Test Grid #1 and
#2 data

Note that data
appears to be log
normally distributed.

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THERE ARE 1 VARIABLES AND 121 OBSERVATIONS

VAR.	MEANS	STD.DEV.	VARIANCE
	597.0569	439.1298	192835.0

VAR.	MEDIAN	MODE		MAXIMUM	MINIMUM
	468.6740	378.1140	*	2648.284	31.68400

* MORE THAN 1 MODE EXISTS - ONLY THE FIRST IS SHOWN

VAR.	STD ERR OF MEAN	SKEWNESS	COEF. OF VAR.
	39.92089	1.451274	73.54908

Basic statistical
parameters for
Grid #1 and #2
data grouped together.

***** MANN-WHITNEY U-TEST *****
ANALYSIS ON VARIABLE: FINAL WITH INDEPENDENT SAMPLES DETERMINED
BY A BREAKDOWN ON VARIABLE: CODE

VAR.	VS VAR.	MEAN	STANDARD DEVIATION	Z	N1	N2	U1	U2
1	2	510.0000	78.23043	3.975435	20	51	821.0000	199.0000

Variable 1 consists of
Grid #1 sidewall samples.
Variable 2 consists of
Grid #1 floor samples.
The high Z score indicates
a significant difference
between the means at a
significant level of .01 (99%)

***** MANN-WHITNEY U-TEST *****
ANALYSIS ON VARIABLE: FINAL WITH INDEPENDENT SAMPLES DETERMINED
BY A BREAKDOWN ON VARIABLE: CODE

VAR.	VS VAR.	MEAN	STANDARD DEVIATION	Z	N1	N2	U1	U2
2	3	127.5000	34.80302	0.7183285	51	5	152.5000	102.5000
2	4	127.5000	34.80302	-0.4453637	51	5	112.0000	143.0000
2	5	127.5000	34.80302	0.7901614	51	5	155.0000	100.0000
2	6	127.5000	34.80302	-0.2298651	51	5	119.5000	135.5000
2	7	127.5000	34.80302	-0.2442317	51	5	119.0000	136.0000

Mann Whitney U Test performed on Grid #1 Floor Sample data. Each Subset represents 10% of the population randomly selected. Z scores indicate no significant difference between menas at the 95% confidence level.

***** T TESTS *****
ANALYSIS ON VARIABLE: LF WITH TREATMENTS DETERMINED
BY A BREAKDOWN ON VARIABLE: CODE

VAR.	SIZE	MEAN	STD. DEV.
1	20	2.443	0.3284
2	5	2.503	0.2349
3	5	2.332	0.2956
4	5	2.603	0.1348
5	5	2.386	0.3398
6	5	2.289	0.4512

1.000P					
0.705P	1.000P				
0.497P	0.339P	1.000P			
0.304P	0.435P	0.099P	1.000P		
0.734P	0.544P	0.793P	0.222P	1.000P	
0.390P	0.373P	0.863P	0.174P	0.709P	1.000P
1	2	3	4	5	6

Students T test using
log transformed data
for Grid #1 Side Samples
Data indicates that
using random subsets of
25% of the side sample
that means are the same
at the 95% confidence interval.

***** T TESTS *****
ANALYSIS ON VARIABLE: LF WITH TREATMENTS DETERMINED
BY A BREAKDOWN ON VARIABLE: CODE

VAR.	SIZE	MEAN	STD. DEV.
1	51	2.783	0.2175
2	5	2.862	0.1570
3	5	2.732	0.2286
4	5	2.859	0.1728
5	5	2.761	0.1934
6	5	2.762	0.2986

1.000P					
0.495P	1.000P				
0.615P	0.359P	1.000P			
0.453P	0.947P	0.348P	1.000P		
0.825P	0.436P	0.832P	0.421P	1.000P	
0.840P	0.566P	0.861P	0.548P	0.995P	1.000P
1	2	3	4	5	6

Students T test using
log transformed data for
Grid #1 Floor Samples.
Data indicates that using
random subsets of 10% of the
total population means are
the same at the 95%
confidence interval.

Landmark Reclamation
Bluewater SX Dismantlement Project

***** MANN-WHITNEY U-TEST *****
ANALYSIS ON VARIABLE: FINAL WITH INDEPENDENT SAMPLES DETERMINED
BY A BREAKDOWN ON VARIABLE: CODE

VAR.	VS VAR.	MEAN	STANDARD DEVIATION	Z	N1	N2	U1	U2
1	2	125.0000	34.15650	0.2781315	50	5	134.5000	115.5000
1	3	125.0000	34.15650	-0.2220470	50	5	114.0000	136.0000
1	4	125.0000	34.15650	0.8343946	50	5	153.5000	96.50000
1	5	125.0000	34.15650	-0.8783101	50	5	95.00000	155.0000
1	6	125.0000	34.15650	-2.547099	50	5	38.00000	212.0000

Mann Whitney U Test comparing sample Grid #2 data to 5 randomly selected subsets of 5 each (10% of population), Z scores indicate no significant difference (except for subset 6) between the means of subsets and Test Grid #2 data.

***** T TESTS *****
ANALYSIS ON VARIABLE: LF WITH TREATMENTS DETERMINED
BY A BREAKDOWN ON VARIABLE: CODE

VAR.	SIZE	MEAN	STD. DEV.
1	50	2.613	0.4014
2	5	2.656	0.3638
3	5	2.535	0.2485
4	5	2.779	0.5982
5	5	2.461	0.2825
6	5	2.141	0.1748

1.000P					
0.819P	1.000P				
0.676P	0.557P	1.000P			
0.403P	0.704P	0.424P	1.000P		
0.416P	0.373P	0.670P	0.313P	1.000P	
0.013P	0.021P	0.019P	0.061P	0.063P	1.000P
1	2	3	4	5	6

Students T test using log transformed data for Grid #2 (Strip Settler Tank #1). Data indicates that using random subsets of 10% of the total population, means are the same at the 95% confidence interval, except for comparison of variable 6 to 5, which is significantly different.

ERE ARE 1 IABLES AND 84 OBSERVATIONS

?.	MEANS	STD.DEV.	VARIANCE	
AL	99.23712	47.44602	2261.125	
?.	MEDIAN	MODE	MAXIMUM	MINIMUM
AL	102.1720	120.8620	322.0020	14.95900
?.	STD ERR OF MEAN	SKEWNESS	COEF. OF VAR.	
AL	5.176785	1.258495	47.81076	

Basic statistics
for Grid #3
(cell 34 nested data)

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Bluewater SX Dismantlement Project

APPENDIX B

- Photographs -

Bluewater SX Dismantlement Project

- PHOTOGRAPH LOCATIONS -