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LERF Basin 44 Process Test Plan

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LIQUID EFFLUENT RETENTION FACILITY
BASIN 44 PROCESS TEST PLAN

January 1999

By:

Waste Management Federal Services Hanford, Inc.

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CONTENTS

APPENDIX

FIGURE

TABLES

GLOSSARY

ALARA	as low as reasonable achievable
AFF	auxiliary fine filter
ARF	auxiliary rough filter
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CWC	Central Waste Complex
CT	concentrate tank
DOE	U. S. Department of Energy
ERDF	Environmental Restoration Disposal Facility
ETF	Effluent Treatment Facility
LERF	Liquid Effluent Retention Facility
LDR	land disposal restriction
LWPF	Liquid Waste Processing Facilities
MTT	main treatment train
PDM	peroxide destruction module
STT	secondary treatment train
SWRT	secondary waste receiving tank
RO	reverse osmosis
TCLP	toxicity characteristic leaching procedure
UV/OX	ultraviolet oxidation

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LIQUID EFFLUENT RETENTION FACILITY BASIN 44 PROCESS TEST PLAN

This document presents a plan to process a portion of the Liquid Effluent Retention Facility (LERF) Basin 44 wastewater through the 200 Area Effluent Treatment Facility (ETF). The objective of this process test is to determine the most effective/efficient method to treat the wastewater currently stored in LERF Basin 44. The process test will determine the operational parameters necessary to comply with facility effluent discharge permit limits (Ecology 1995) and the Environmental Restoration Disposal Facility (ERDF) acceptance criteria (BHI-00139), while achieving ALARA goals and maintaining the integrity of facility equipment.

A major focus of the test plan centers on control of contamination due to leaks and/or facility maintenance. As a pre-startup item, all known leaks will be fixed before the start of the test. During the course of the test, a variety of contamination control measures will be evaluated for implementation during the treatment of the remaining Basin 44 inventory. Of special interest will be techniques and tools used to prevent contamination spread during sampling and when opening contaminated facility equipment/piping. At the conclusion of the test, a post ALARA review will be performed to identify lessons learned from the test run which can be applied to the treatment of the remaining Basin 44 inventory.

The volume of wastewater to be treated during this test run is 500,000 gallons. This volume limit is necessary to maintain the ETF radiological inventory limits per the approved authorization basis. The duration of the process test is approximately 30 days.

1.0 INTRODUCTION

Majority of the wastewater inventories in Basin 44 fall under regulatory requirements of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 wastewaters from several sources in the 100 Areas and 200 Areas (100-C, 100-N, 100-D, ERDF leachate). The treatment of these wastewaters represents unique challenges for the ETF. Compared to wastewaters previously treated by the facility, Basin 44 wastewater has elevated levels of radionuclides and chloride. The difference in the feed stream will require an evaluation of system configuration and treatment parameters, enhanced contamination control techniques, and constant evaluation of ALARA considerations during plant maintenance evolutions. The focus of this process test is the establishment of operational parameters and protocols that will support the successful treatment of the remaining Basin 44 inventory.

2.0 OBJECTIVE

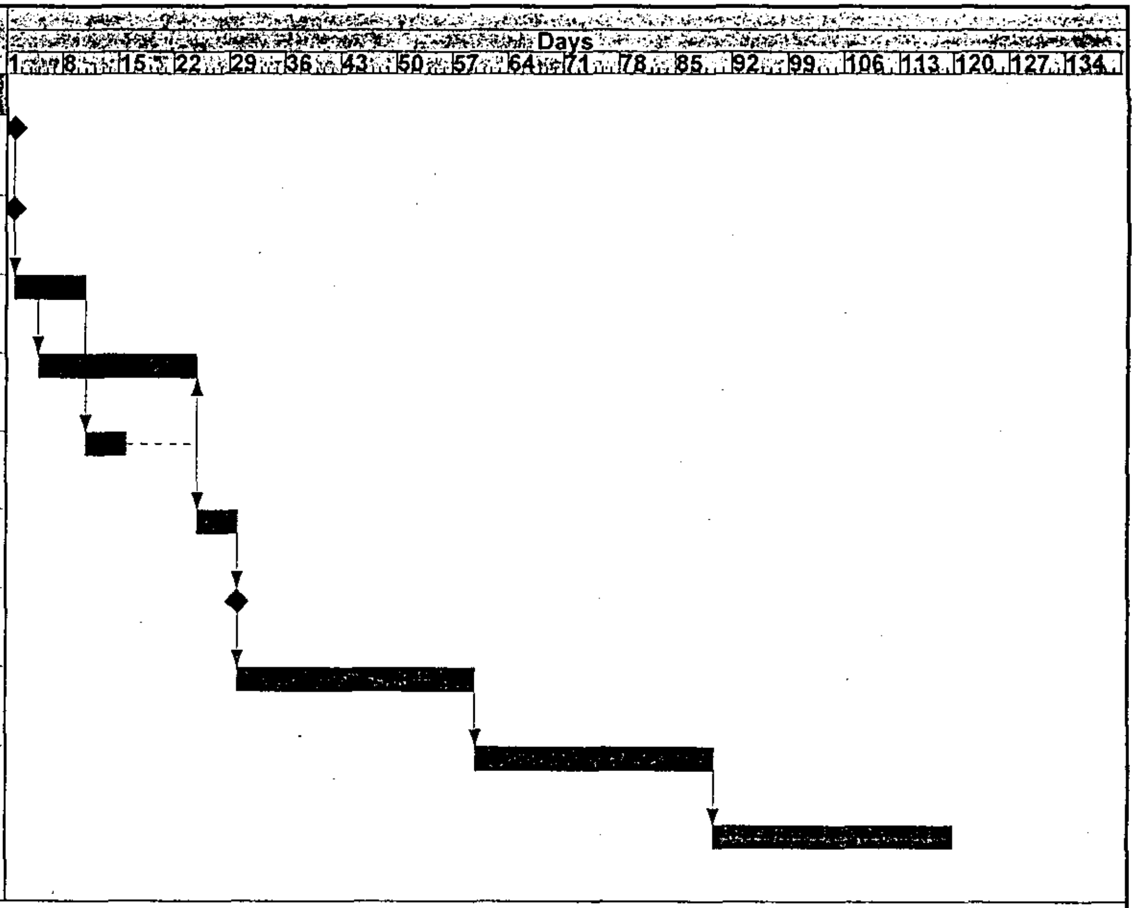
The objective of this Basin 44 process test is to make the following determinations.

- Confirm the process test flowsheet (Appendix A) based on an evaluation of sampling data collect during the test run.
- Determine the operating parameters necessary to effectively/efficiently treat Basin 44 wastewater to below regulatory discharge requirements (Ecology 1995) and ERDF acceptance criteria (BHI-00139) while achieving ALARA goals and maintaining the integrity of the facility equipment.
- Determine the turnaround time from which a drum of powder is generated, to the time the drum is transferred to ERDF for disposal.
- Identify flushing techniques, which will minimize the residual radiological dose rates and contamination levels in the ETF.

Figure 1 provides key element durations.

LERF BASIN 44 PROCESS TEST

Activity Description	Orig Dur
RL CONCURRENCE FOR PROCESS TEST	0
PRE-START ITEMS COMPLETE	0
MTT OPERATION ON LERF FEED	9
STT OPERATION	20
MTT POST CLEANOUT	5
STT POST CLEANOUT	5
END OF PROCESS TEST	0
RECEIVE ANALYTICAL DATA	30
REVIEW ANALYTICAL DATA	30
PREPARE POST RUN DOCUMENT	30



Assumptions:

- Liquid Effluent Retention Facility (LERF) feed rate at 45 gallons per minute
- Main treatment train (MTT) 8 days of processing LERF feed with 24 hours for filter change-out
- Post cleanout activities to include reverse osmosis cleaning, fine filter chemical cleaning, polisher regeneration, and MTT bio-sanitizing
- Evaporator brine at 7 weight percent (dry basis)
- Dryer feed bulked to 20 weight percent calcium sulfate (dry basis)
- One dryer batch takes 4 days to fill a concentrate waste receiving tank and 3 days to process through the dryer

Run Date 11JAN99 © Primavera Systems, Inc.	Early Bar Progress Bar Critical Activity	Sheet 1 of 1 LERF Basin 44 Process Test Plan January 5, 1999 Waste Management Hanford	WASTE MANAGEMENT HANFORD

3.0 FACILTIY DESCRIPTION

The LERF is used to store and treat aqueous waste generated on the Hanford Site from a variety of remediation and waste management activities. The LERF consists of three lined and covered surface impoundments with a nominal capacity of 7.8 million gallons in each basin. This test addresses the wastewater inventories stored in one of the LERF basins (i.e., Basin 44).

The ETF consists of a series of process units that are configured to provide treatment for contaminants that might be present in aqueous wastes generated on the Hanford Site. The main treatment train (MTT), includes those process units that remove or destroy dangerous and radioactive constituents from the aqueous waste. These constituents are concentrated and dried into a powder in the secondary treatment train (STT).

The treated effluent is contained in verification tanks where the effluent is sampled, analyzed, and verified to be below release limits (Ecology 1995) prior to discharge. The treated effluent is discharged under a state waste discharge permit and final delisting petition to the State Approved Land Disposal Site (SALDS), located in the 600 Area, north of the 200 West Area. The treated effluent is discharged as a nondangerous, delisted waste.

4.0 PRE-STARTUP ITEMS

Provided below is a list of pre-start items. From this list punchlist was developed and incorporated into the 200 Area Liquid Waste Processing Facilities (LWPF) integrated schedule.

- Repair all known LERF/ETF process leaks
- Setup contamination control and monitoring stations as required
- Isolate equipment not needed during this process test to minimize contaminated areas
- Modify procedures, radiation work permits, etc., as necessary
- Issue operational process memos
- Complete ETF radiological inventory calculation
- Notify ERDF of drums with potentially higher radiological level than ETF has previously transferred
- Transfer waste to ERDF that was generated during the December 1998 filtration test
- Setup proper shielding around sensitive instrumentation equipment
- Setup sampling events and notify laboratories to ensure support for fast turnaround times.

5.0 OPERATING PARAMETERS

Table 1 provides a summary of the operating parameters for this test run. The following sections provide a discussion of these operating parameters. The significant operating difference between Basin 44 wastewater and UP-1 groundwater are those parameters effected by elevated levels of radionuclides and chloride. Operating conditions will be prescribed in a process memo.

Table 1: Operating Parameters.

Parameter	Targeted values	Comment
Maximum allowable batch volume	500,000 gallons	Section 5.2
Flowrate (Nominal)	▪ LERF feed rate: 45 gpm ▪ MTT: 60 gpm	Section 5.2
Type of filters for ARF, AFF, and PDM	▪ ARF: 10 micron (abs) depth-filters in series with 1 micron (abs) depth-filters ▪ AFF: 5 micron (abs) depth-filters ▪ PDM: 7,4,1-micron, size #2 if decomposers are on line (if required)	Section 5.4
Surge tank	Target pH : 6.0 - 7.0	
pH Adjustment Tank	Target pH: 4.5 – 5.0	
Hydrogen peroxide addition	None	Peroxide could be added at the UV/OX if the desired levels of TOC are not met, Section 5.5.
Peroxide decomposers	Not on-line	Section 5.5
Reverse osmosis (RO)	25% reject	Section 5.6
Secondary Waste Receiving Tanks (SWRTs)	Target pH : 6.0 – 8.0	▪ Wastewater to be recirculating as necessary. Stagnant conditions will be minimized, Section 5.8. ▪ It is estimated that approximately 40,000 gallons of wastewater will be produced during MTT cleanout activities, Section 5.9.
Evaporator	Set point 213 F Brine weight percent: 7	▪ It is estimated that approximately 9500 gallons of brine (including bulking chemicals) will be generated from the processing of the 500,000 gallons of Basin 44 wastewater, Section 5.9.
Concentrate Tanks (CTs)	Target pH: 10 – 11	▪ Wastewater to be recirculating as necessary. Stagnant conditions will be minimized, Section 5.8.
Estimated number of drums produced	Bulking/mixing capability to 20 weight percent (dry basis) calcium sulfate: ▪ 35 powder drums Post-cleanout activities: ▪ 3 powder drums	Section 5.9

Abs = absolute
AFF = auxiliary fine filter
ARF = auxiliary rough filter
gpm = gallons per minute
LERF = Liquid Effluent Treatment Facility
MTT = main treatment train
PDMF = peroxide destruction module filters
TOC = total organic carbon
UV/OX = ultraviolet oxidation

5.1 Characterization of Basin 44 Inventory and Process Flowsheet

Four samples of Basin 44 wastewater were taken in mid-September of 1998. These samples were taken at four different risers and at four different levels. From this sampling data, a process flowsheet was developed that includes the projected constituent concentrations at different unit operations in the facility. The analytical data and process flowsheet is provided in Appendix A. The appendix also provides a description of the different columns of the spreadsheet and the parameters used during the development of the process flowsheet.

Basin 44 wastewater contains higher levels of total dissolved solids, radionuclides, potassium, chloride, and sulfate, and contains lower levels of nitrates, silica, and sodium than the UP-1 groundwater. Calcium and magnesium levels are about the same in both wastewaters.

5.2 Allowable Process Batch Volume and Process Flowrates

The ETF is a radiological facility in accordance with DOE Orders (HNF-SD-ETF-ASA-001). To maintain this designation, the authorization basis for ETF requires that the radionuclide inventory will not exceed the DOE Standard 1027-92 Hazard Category 3 sum of fractions threshold of 1.0. Characterizing feed streams for radionuclide inventory and calculating a maximum allowable feed batch not to exceed a Category 3 sum of fractions of 0.8 accomplishes radionuclide inventory at the ETF. The 20 percent margin is derived from the precision/accuracy specified for the ETF sample analyses.

Based on the sum of fractions, the maximum allowable batch volume for the test run is 517,000 gallons. Considering this small batch volume, it is assumed that there is not enough time to characterize and transfer any powder drums required to increase the LERF feed volume for this test. One objective of this test plan will be to determine the turnaround time to transfer a drum of powder waste to ERDF once generated. This turnaround time will be a key factor in the determination of the processing duration for the remaining Basin 44 inventory.

From the concentrate tank (CT) data collected during this test run, a determination of the constituent variability in the different dryer batches will be made. If the variability is negligible, the waste profile developed during this test run will be used for waste generated during the treatment of the remaining Basin 44 wastewater. Using the same waste profile will allow quicker transfer of powder/waste drums to ERDF.

Based on a batch volume of 500,000 gallons Basin 44 inventory, the LERF feed rate will be approximately 45 gallons per minute and the MTT flowrate 60 gallons per minute. The processing duration of LERF feed through the MTT is 8 days (assuming no downtime). These flowrates were chosen based on dryer loading capacity of 375 pounds per hour distillate. These flowrates also were chosen to provide a long enough processing duration to support laboratory turnaround time, thus allowing for process changes in the event that the desired system efficiencies are not achieved.

5.3 Bacteria Control

The total organic carbon level appears to increase as the liquid level in Basin 44 decreases. This could mean an increase in bacteria (living or dead) level towards the bottom of Basin 44. Bioscan readings of 140 at the 6 foot level and 500 at the 2 foot level also supports this. Dip slide tests showed no anaerobic (require no oxygen to survive) bacteria. However, anaerobic type bacteria usually is found under bacterial film and not expected to be found in samples from LERF.

Because of the short processing duration of Basin 44 wastewater, the effect of bacteria on the operating efficiency might not be able to be determined during this test run. However, the following is strategy to be used in determining a bacteria control plan for future processing of Basin 44 wastewater.

- Analyze for total organic carbon at different locations along the MTT, and correlate these results to dipslide results taken at the same locations
- Trend filter loading
- Trend reverse osmosis (RO) membrane fouling by collecting pressure drop data across the membranes

As part of the post-cleanout activities, a MTT sanitizing with peroxide will be performed. Details of this sanitizing will be provided in a process memo.

5.4 Filtration

A filtration test of 80,000 gallons of Basin 44 inventory was successfully completed in December of 1998. This filtration test was performed to test the efficiency of different filter types with the objective to effectively reduce radiological contamination levels in the downstream process components while minimizing the dose rates of the filter housings and without causing undue downtime for filter change outs. Additionally, the filtration test provided a means to collect actual radiological dose levels that are being used to determine the radiological controls necessary during the test of the 500,000 gallons. During the filtration test, Basin 44 feed was brought in through the auxiliary rough filters (ARF), to the surge tank and back to LERF. Because of the flowpath, the test was performed as a batch, based on surge tank capacity. The test filtered a single batch at 80,000 gallons of Basin 44 wastewater at a feed flowrate of 60 gallons per minute through a 10-micron depth-type filter in series with 2 micron pleated type filters.

Based on results of the December 1998 filtration test, this test run will begin with 10-micron depth-type filters in series with 1-micron depth-type filters in the ARF and 10-micron depth-type filters in the auxiliary fine filters (AFF). The filter change out depends on differential pressure (dp) across the filters and radiological dose rate of the filters housing. The dp change out limit will vary depending on the type of filter used. The filter dose rate change out limit will be at 10 mrem/hr at 1 foot, which corresponds to the ERDF waste acceptance criteria. Based on the results of the December 1998 filtration test, it is assumed that the solids loading will dictate filter removal rather than radiological dose limits. For this reason, a depth-type filter will be tested because these filters have higher solid loading capacity than the pleated-type surface filters. A process memo will be issued detailing the filter test parameters and duration times.

5.5 Organic Removal

Of the organics analyzed in the Basin 44 wastewater, only chloroform and methylene chloride were detected, at very low levels. Chloroform has a 216 permit early warning value of 5 parts per billion and methylene chloride requires monitoring only. The maximum concentration of chloroform in Basin 44 inventory is 46 parts per billion. Chloroform should have a removal efficiency of about 90 percent at 80°F in the degas column. Because Henry's constant for methylene chloride is slightly higher (0.13 versus 0.12) than chloroform, the removal of methylene chloride should be at least as good.

Maximum concentration of total organic carbon is 10,300 parts per billion in the Basin 44 wastewater. Total organic carbon has a discharge permit (Ecology 1995) early warning value of 1,100 parts per billion. It is predicted that the total organic carbon level will be reduced to below discharge permit requirements by filtration and/or degassification. During the test, total organic carbon will be sampled for at different locations along the MTT once a shift (i.e., twice a day). If based on the sample results, the total organic carbon is not effectively removed and exceeds the requirement, then hydrogen peroxide will be added at the ultraviolet oxidation (UV/OX) unit. A hydrogen peroxide concentration of 50 parts per million will be added to UV/OX unit in the beginning and thereafter incrementally increased until the total organic carbon levels meet the discharge permit requirement. During the addition of peroxide, its destruction efficiency by the UV/OX unit will be determined. If the peroxide level can be effectively destroyed by the UV/OX unit without compromising the integrity of the reverse osmosis (RO) membranes then the peroxide decomposer modules (PDMs) will be brought online. The peroxide concentration for the RO membranes should be maintained below 5 parts per million.

The approach of this test is to see if the ETF process can effectively reduce the total organic carbon to below discharge permit level without bringing the PDMs on-line. Bringing the PDM on-line is being avoided because radionuclides will absorb onto the activated carbon and it will be difficult to reduce radiological dose rates and contamination levels in these modules once the test has been completed.

5.6 Reverse Osmosis

The levels of barium and sulfate in the Basin 44 wastewater, dictates a RO unit recovery (based on MTT flow) of 80% (75% water recovery based on LERF feed). A conservative approach by increasing the RO rejection rate to 25% will be used during this test run to ensure that the saturation level of barium sulfate is not exceeded. Because sulfates tend to be difficult to remove with conventional cleaning methods and the RO membranes are showing signs of irreversible fouling on the first RO unit Ist array, the conservative approach is being used during this test. Based on an evaluation of the data from this test run, the RO rejection it will be determined whether the RO rejection rate can be decreased during the processing of the remaining Basin 44 inventory. Decreasing the RO rejection rate decreasing the loading on the STT.

5.7 Polisher Column

Based on operating experience, approximately 1.2 million gallons of Basin 44 wastewater can be processed through the MTT before regeneration is required of the polisher columns. The projected radiological dose rate of the polisher column after the processing of the 500,000 gallons of Basin 44 inventory is less than 0.5 mrem/hr. Therefore, a regeneration of the polisher columns will not be required during this test run; however, a regeneration of the used polisher columns will be performed after the test and before the re-startup of the next campaign.

5.8 Corrosion Control

Corrosion control within the ETF will be one of the major concerns during the processing of Basin 44 inventory. Based on a corrosion analysis, a maximum chloride level of 10,000 parts per billion in the CTs was established that would allow processing Basin 44 wastewater within the current configuration and would not cause undue risk to the integrity of components. This established chloride limit results in a weight percent of the evaporator brine that normally has been at 25 weight percent to be reduced down to 7 weight percent. The concentration of chloride in the STT systems depends on the concentration of dissolved solids in the wastewater. A high dissolved solids concentration, relative to the chloride concentration, will produce more bulk in the STT brine, and will lower concentration factors, thereby reducing the STT chloride concentration.

Due to operating the ETF at elevated chloride levels, the following strategy will be used to reduce the risk of corrosion attack in the STT during this test run. This strategy will be reflected in a process memo.

- Maintain chloride levels to 10,000 parts per million in the CTs, which will result in a maximum evaporator brine weight percent of 7 on a dry basis
- Keep the SWRT and CT solutions recirculating, as necessary. Stagnant conditions will be minimized
- Maintain the pH in the SWRTs between 6 - 8 and in the CTs between 10 – 11
- Minimize any solids buildup
- Dilute the heel with verification water during campaigns or flush tanks
- Monitor chloride levels.

5.9 Evaporator and Dryer

With an evaporator brine total weight percent of 7, about 2 weight percent is expected to be anhydrous calcium sulfate, assuming all calcium precipitates as the insoluble salt. Because the anhydrous calcium sulfate will hydrate fully to gypsum, the resulting weight percent will be 2.5 on a dry basis. The weight percent of gypsum in the evaporator brine becomes 36 weight percent. This is slightly lower than the proportions in the groundwater where, in the evaporator brine, the gypsum makes up about 60 weight percent of the total solids on a dry basis.

Based on dissolved solids loading of 7 weight percent in the evaporator brine, a set point of 213°F will be appropriate for running the evaporator. This will be verified via laboratory determination of total solids and total dissolved solids from a sample of evaporator brine taken when this boiling point is reached. Preliminary monitoring will be accomplished with daily samples using a hydrometer.

Based on historical data of the ETF dryer capability, bulking is required for any dryer feed with an excess of 20 weight percent (dry basis) calcium sulfate. The term bulking is used to describe the use of sulfuric acid and caustic (sodium hydroxide) to create sodium sulfate in the dryer feed, which can be dried easily. Feeds that contain calcium sulfate at a high weight percent (dry basis) are difficult to dry and will compromise the integrity of the equipment. Recently, agitators have been installed in the two CTs to keep the insoluble salts suspended in solution. The agitators provide improved mixing action in the tank allowing a consistent dryer feed composition.

Calcium sulfate at 40 weight percent in the Basin 44 dryer feed, will require bulking to reduce the brine to 20 weight percent. The amount of bulking chemical per 1,000 gallons of brine will be approximately 30 gallons of 93 weight percent acid and 60 gallons of 50 weight percent caustic. These amounts will change based on the targeted calcium sulfate weight percent in the dryer feed. It is estimated that approximately 9,500 gallons of evaporator brine will be generated during this test, which correlates to a total of 35 powder drums. Approximately three powder drums will be generated from post-cleanout activities.

Analytical results of the CTs will be used to characterize the powder. Sampling of the powder will be avoided unless it is projected that the land disposal restrictions (LDR) metals in the powder cannot be met. Then, if necessary, the powder will be sampled and analyzed for the LDR metals using the toxicity characteristic leaching procedure (TCLP).

6.0 RADIOLOGICAL PARAMETERS

Radiological parameters are provided in Table 2.

Table 2: Radiological Parameters.

Parameter	Result	Comment
Projected maximum radiological dose rates	Dose rates are at 1 foot from source ▪ Powder drum: 36 mrem/hr ▪ Polisher column: <0.5 mrem/hr ▪ SWRT at 100 percent level: <1 mrem/hr ▪ CT at 50 percent level : 5 mrem/hr 100 percent level: 11 mrem/hr	The powder drum dose rates are based on zero bulking of the dryer feed.
ALARA targeted control points	▪ Filter housings : 10 mrem/hr ▪ Process area: <70 mrem/hr	
mrem/hr = milliroentgen equivalent man per hour		

Radiological exposure and contamination will be one of the major concerns during the Basin 44 wastewater test run. An ALARA evaluation is being performed that will identify radiological control parameters for the test. Some items have already been identified and have been incorporated into the LWPF integrated schedule. These items include the activation of the area radiation monitors located in the evaporator and drum handling areas, providing continuous air monitors at the thin film dryer and drum handling areas, identifying technical basis for dosimetry needs, modification of sampling lines, and review of radiation routine survey program. The in-line radiation monitors located near the ARF and AFF skids that are currently in place but not in service will not be required. The feed from LERF is homogeneous and these in-line radiation monitors will not add any value.

Projected dose rates for powder drums, CWRT, SWRT, and polisher column, along with targeted radiological dose limits on the filter skids are provided in Table 2. The dose rate for a pallet of four powder drums is 55 mrem/hr and the dose rate for two pallets of eight drums stack (one on top the other) is 67 mrem/hr. The projected radiological dose rates are based on the flowsheet provided in Appendix A.

7.0 ENVIRONMENTAL PARAMETERS

The following sections discuss issues associated with DOE Order 5400.5, the State Waste Discharge Permit requirements (Ecology 1995) that allow discharge to the state approved land disposal site (SALDS) and the ERDF acceptance criteria (BHI-00139) for disposal of the solid waste. Table 3 provides a summary of the discussion.

Table 3: Environmental Parameters.

Criteria	Constituents of concern	Comment
DOE Order 5400.5 and State Waste Discharge Permit limit	▪ Strontium-90 ▪ Gross beta	Constituents of concern that are approaching discharge requirements, Section 7.1
ERDF acceptance criteria	▪ LDR metals (arsenic, barium, chromium, selenium) ▪ Radionuclides (curium-242, ▪ cesium-137, technesium-99) ▪ Powder drums exceeding ERDF acceptance criteria of 50 mR/hr measured at 1 foot from surface	Constituents/parameters of concern that are approaching ERDF acceptance criteria, Section 7.2.

7.1 State Waste Discharge Permit Limits

A major objective of the process test plan is to identify the operational parameters necessary to treat the Basin 44 wastewater to below the DOE Order 5400.5 and the State Waste Discharge Permit ST 4500 limits. The DOE Order 5400.5 discharge limits for radionuclides is 4 percent of the derived concentration guideline. A decontamination factor of 100,000 is needed for strontium-90 and gross beta.

The other constituent that will require treatment is total organic carbon. A decontamination factor of 10 is required to reduce the level of total organic carbon to below discharge limits. A sampling schedule has been developed to monitor key constituents that will be used in the determination of removal efficiencies of the different unit operations in the facility.

Because of the nature of this test it is possible that the treated effluent may not meet the discharge criteria. If this occurs the wastewater will be returned to LERF Basin 44 and alternatives (e.g., blending, facility modifications) will be evaluated before treatment of the remaining Basin 44 inventory.

7.2 ERDF Acceptance Criteria

Projected powder constituent concentrations were compared against the ERDF acceptance criteria (BHI-00139). It appears that selenium might exceed the ERDF acceptance criteria. Based on analytical results from the 1998 filtration test, it appears that 50 percent of the selenium is filterable, thus reducing its concentration in the powder. Arsenic, barium, chromium, and zinc also approach the limits of the ERDF acceptance criteria. However, if necessary the powder will be sampled per the TCLP method because historical data has shown that normally the calculated TCLP values are higher than the actual TCLP values.

As for the radionulcide values, it appears that technesium-99 is the only radionuclide in jeopardy of exceeding the ERDF acceptance criteria. Using the sum of fraction method, the powder has a sum of fraction of 0.60 compared the ERDF acceptance criteria of a value of 1. If based on actual analytical data, it appears that the powder will not meet the ERDF acceptance criteria, the following contingency plan has been developed.

1. Fill the drums partially full (e.g., 1/3, ½) with powder and add an inert material (e.g., kitty litter) until the drum is full. Add the prescribed amount of water (22 gallons) as with the UP-1 groundwater powder drums. Mix ratios will be adjusted as needed, and/or,

2. Reduce the purity of the powder by bulking the batches, thus generating more volume with much lower constituent concentrations.

8.0 POST-CLEANOUT ACTIVITIES

After the MTT has processed 500,0000 gallons of Basin 44 wastewater, a RO unit and fine filter chemical cleaning will be performed along with regeneration of the polisher columns. A MTT biological sanitizing with peroxide will be performed that will provide adequate flushing of the MTT systems. Waste produced during these cleaning activities will be process through the STT and the system flushed/purged with verification water before resuming the groundwater campaign. In an attempt to reduce the systems that require flushing, only required equipment and process piping lines will be used. Specifics of the cleaning/flush activities will be covered in a process memo.

9.0 SAMPLING

Table 4 contains the projected sampling schedule.

Table 4: Sampling Schedule.

Location	Frequency	Analyses	Comment
ARF inlet/outlet	3 times during run	ICP/ICP-MS metals, radionuclides, dip slides	• Metals will be analyzed to determine removal efficiencies by filtration and RO reject optimization. • The metal and radionuclide results will be used to characterize the filters for disposal. • Record radiological dose rates of filter housings and of filters during change-out. • A portion of a spent filter will be obtained and analyzed for TCLP metal for disposal.
AFF inlet/outlet	3 times during run	ICP/ICP-MS metals, radionuclides	• Metals will be analyzed to determine removal efficiencies by filtration and RO reject optimization. • The metal and radionuclide results will be used to characterize the filters for disposal. • Record radiological dose rates of filter housings and of filters during change-out. • A portion of a spent filter will be obtained and analyzed for TCLP metal for disposal.
	Once/shift	TOC	• TOC will be analyzed to determine if the filters will provide sufficient efficiency to meet discharge permit requirements.
UV/OX unit outlet	Once/shift	TOC, peroxide*	• TOC is being analyzed to determine if the TOC is biological and if the discharge permit limit can be meet without the addition of peroxide at the UV/OX. • Peroxide will be analyzed only if added to the system to reduce the TOC level. Peroxide results will be used to determine the UV/OX destruction efficiency of the peroxide.
Decomposer outlet*	3 times during run	Alkalinity	• Alkalinity will be analyzed to determine carbonate removal efficiency. • The decomposers will be put on-line only if peroxide is added at the UV/OX to destroy the TOC. Peroxide will be analyzed before and after the decomposers. If the decomposers are not on-line, no peroxide analyzes will be performed.
	TBD	Peroxide*	
Degas Outlet	3 times during run	Alkalinity	• Alkalinity will be analyzed to determine carbonate removal efficiency.
RO unit permeate	3 times during run	Gross alpha, gross beta, GEA, Sr-90	• Radionuclides will be analyzed to determine removal efficiencies. Sr-90 and Cs-137 are approaching discharge limits.
Polisher unit outlet	Daily	TOC	• TOC will be analyzed to determine if the discharge limits is being met or if peroxide needs to be added at the UV/OX.
	3 times during run	Gross alpha, gross beta, GEA, Sr-90	• Radionuclides will be analyzed to determine removal efficiencies. Sr-90 and Cs-137 are approaching discharge limits.
1st RO feed Tank	Daily	TOC	• TOC will be analyzed to determine if the discharge limits are being met or if peroxide needs to be added at the UV/OX.
	3 times during run	Gross alpha, gross beta, GEA, Sr-90, anions, ICP/ICP-MS metals	• Radionuclides will be analyzed to determine removal efficiency for the RO and polisher individually.
RO unit/fine filter cleaning solutions	Once for each solution	ICP-ICP-MS metals, gross alpha, gross beta, anions	• The cleaning waste of each type of cleansers used will be sampled to determine the RO and Fine filter fouling constituents.
Evaporator brine	Daily	pH, specific gravity (SpG)	• pH and SpG is performed daily to optimize the operation of the evaporator
	Once per Batch	Anions, cations, TS, TSS	• Once the desired evaporator boiling point has been reached, the brine will be sampled for additional parameters to provide direction for operation of the dryer.
Evaporator distillate	Daily	PH	• Process monitoring
CTs	For first 3 dryer feed batches (VOA ; semi-VOA only for first batch)	ICP/ICP-MS metals, anions, TDS, TSS, TS, VOA, Semi-VOA, GEA, gross alpha, Gross beta, radionuclides	• The powder will be characterized by estimating the concentrations from evaporator brine analysis. • CWRTs will be analyzed for chlorides to control corrosion in these tanks. • Record tank volumes corresponding to each sampling event and number of powder drums produced per each dryer batch.

GEA = gamma energy analysis	TBD = to be determined	TSS = total suspended solids
Cs = cesium	TDS = total dissolved solids	SpG = specific gravity
ICP = ion coupled plasma	TOC = total organic carbon	Sr – strontium
MS = mass spectroscopy	TS = total solids	VOA = volatile organic analysis

10.0 POST RUN REPORT

A post-run report will summarize the results of the Basin 44 test run. This report will focus on the final determination of the objectives presented in Section 2.0 and provide a method to treat the wastewater currently stored in LERF Basin 44. The post-run document will follow closely the same outline as this test plan.

11.0 REFERENCES

BHI-00139, *Environmental Restoration Facility Waste Acceptance Criteria*, Revision 3, Bechtel Hanford, Inc., Richland, Washington

DOE Order 5400.5, Radiation Protection of the Public and the Environment

Ecology, 1995, *State Waste Discharge Permit No. ST 4500, amended for 200 Area Effluent Treatment Facility, Hanford Facility*, Washington State Department of Ecology, Olympia, Washington

HNF-2154, *200 Area Effluent Treatment Facility Process Control Plan 98-02*, Revision 0, Fluor Daniel Hanford, Inc., R ichland, Washington

HNF-SD-ETF-ASA-001, *200 Area Effluent Treatment Facility Auditable Safety Analysis*, Revision 1, Waste Management Federal Service of Hanford, Inc., Richland, Washington

APPENDIX A

LERF BASIN 44 PROCESS FLOWSHEET

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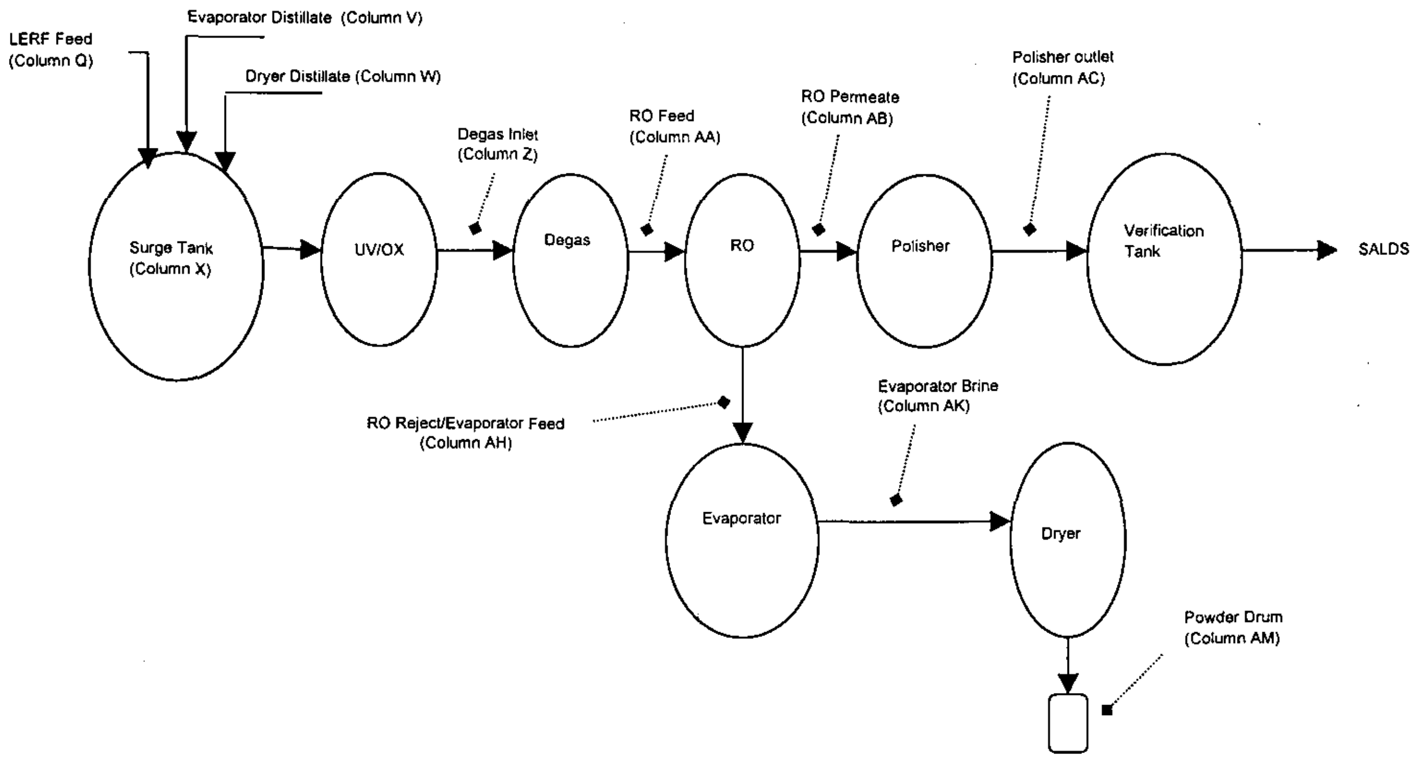
DESCRIPTION OF FLOWSHEET



Columns C, E, G, I:

Four samples of LERF Basin 44 wastewater were taken in mid-September of 1998. These samples were taken at four different risers and at four different levels. The sample results are given in columns C, E, G, and I of the spreadsheet. Indicated in row 2 in each column is the riser number and level at which the sample was taken. The levels represent the distance from the bottom of the basin; for example, the 2 foot level is towards the bottom of the basin and the 14 foot level is towards the top.

Columns D, F, H, J:

To determine the validity of the data, a charge balance was completed as indicated in columns D, F, H, and J, with the percent deviation given in row 49 of the column. Based on the percent deviation of the charge balance, it was concluded that the cation and anion sample results from risers 2, 4, and 6 are suspect. The calcium, magnesium, potassium, and sodium levels are low. A negative percent deviation indicates an excess of anions compared to cations. The radionuclide data of the four samples seem reasonable based on generator characterization data for the individual wastewaters that makeup the Basin 44 inventory.

Column Q – LERF Feed:

In characterizing the LERF feed, only the data from the 2 foot level (Column C) were used for the anions and cations. These data only showed a 5 percent deviation in the charge balance, and the constituent levels are close to those that were expected from the generator characterization data. The radionuclide, total organic carbon, chloroform, and methylene chloride levels appear to be reasonable for all four samples and therefore, for these constituents/radionuclides, the maximum values were used in the development of the flowsheet.

Column X – Surge Tank:

Provided in Column X is projected characterization of the surge tank inventory that will feed the MTT. The surge tank inventory consists of LERF feed (Column Q), evaporator distillate (Column V), and dryer distillate (Column W). The surge tank inventory was characterized by performing a material balance of the three different streams makeup the tank inventory. The projected concentrations of the two distillate streams is based on historical data.

Column Y – Acid Addition in MTT:

A titration curve for the Basin 44 wastewater was developed and was used to determine the sulfuric acid addition in the MTT.

Column Z – Degas Column Inlet:

Calculations were used to determine the bicarbonate and carbon dioxide concentration at a pH of 5.0. It is predicted that the organics will be reduced to below discharge requirements by filtration and/or degassification.

Column AA – RO Feed:

The RO feed stream represent the removal of bicarbonate, carbon dioxide, and organics by the degas column. All other constituent remained the same.

Column AB – RO Permeate:

Based on operating experience, a RO removal efficiency of 99 percent was used for nitrate, bicarbonate, and carbon dioxide and a removal efficiency of 99.9 percent was used for all other constituents.

Column AC – Polisher Outlet:

Based on operating experience, a polisher removal efficiency of 99 percent was used for all constituents except radionuclides in which a removal efficiency of 99.9 percent was used.

Column AH - RO Reject/Evaporator Feed:

Based on operating experience, the concentration of the RO reject/evaporator feed was determined by multiplying the RO feed concentrations by four. The pH adjustment in the evaporator feed stream is considered negligible and was not included in the flowsheet.

Column AK – Evaporator Brine:

In determining the evaporator brine concentration, a maximum chloride level of 10,000 parts per million in the concentrate tanks was used which correlates to a maximum weight percent of total solid in the brine to be 7.0 (on a dry basis). It is assumed that the solids are dissolved. The weight percent (dry basis) of the evaporator brine was determined based on the maximum allowable chloride level in the concentrate tanks. The concentrations were determined by the following calculation:

$$[X]_{BRINE} = ([X]_{EVAPORATOR\ FEED} / [TDS]_{EVAPORATOR\ FEED}) * [TDS]_{Brine})$$

Where:

[X] = the concentration of constituent X in the brine
$[TDS]_{Evaporator\ Feed}$ = the total dissolved solids concentration in the evaporator feed
$[TDS]_{Brine}$ = total dissolved solids concentration in the brine which equal 70,000 parts per million

Column AM – Powder:

In determining the projected powder concentration, it was assumed that the weight percent (dry basis) of the powder is 99 percent. The projected concentrations are considered worst case because the acid and caustic used for bulking is not included. The concentrations were determined by the following calculation:

$$[X]_{POWDER} = ([X]_{BRINE} / [TDS]_{BRINE}) * \text{(990,000 parts per million)}$$

Where:

[X] = the concentration of constituent X in the powder
[TDS] = the total dissolved solids concentration in the evaporator brine
Total weight percent (dry basis) of powder = 99 percent or 999,000 parts per million

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Basin 44 Process Flowsheet

	A	B	C	D	E	F	G	H	I	J	Q
2	STREAM	Units	LERF Riser 2 14 foot level	Charge Balance	LERF Riser 4 10 foot level	Charge Balance	LERF Riser 6 6 foot level	Charge Balance	LERF Riser 7 2 foot level	Charge Balance	LERF Feed
4	Volume	gallons									5.00E+05
5	Flowrate	gpm									44
7	pH		7.74		8.73		8.67		8.56		8.56
8	Antimony	ug/l	0	0.00E+00	0	0.00E+00	0	0.00E+00	40	9.86E-07	4.00E+01
10	Arsenic	ug/l	9.10E+01	3.64E-06	9.40E+01	3.76E-06	8.30E+01	3.32E-06	1.24E+01	4.97E-07	1.24E+01
12	Barium	ug/l	0	0.00E+00	5.31E+00	7.73E-08	5.41E+00	7.88E-08	5.34E+01	7.78E-07	5.34E+01
14	Cadmium	ug/l	0	0.00E+00	0	0.00E+00	0	0.00E+00	6.00E-01	1.07E-08	6.00E-01
15	Calcium	ug/l	8.52E+03	4.25E-04	1.27E+04	6.34E-04	1.37E+04	6.84E-04	1.23E+05	6.14E-03	1.23E+05
17	Chromium	ug/l	0	0.00E+00	0	0.00E+00	0	0.00E+00	3.50E+00	2.02E-07	3.50E+00
18	Cobalt	ug/l	0	0.00E+00	0	0.00E+00	0	0.00E+00	1.60E+01	5.43E-07	1.60E+01
19	Copper	ug/l	0	0.00E+00	0	0.00E+00	0	0.00E+00	1.63E+01	5.13E-07	1.63E+01
21	Iron	ug/l	0	0.00E+00	0	0.00E+00	0	0.00E+00	3.91E+01	2.10E-06	3.91E+01
23	Lead	ug/l	0	0.00E+00	0	0.00E+00	0	0.00E+00	5.00E-01	4.83E-09	5.00E-01
24	Magnesium	ug/l	2.22E+03	1.83E-04	1.82E+03	1.50E-04	1.74E+03	1.43E-04	1.74E+04	1.43E-03	1.74E+04
26	Manganese	ug/l	0	0.00E+00	0	0.00E+00	0	0.00E+00	2.48E+01	9.03E-07	2.48E+01
28	Mercury	ug/l	0	0.00E+00	0	0.00E+00	0	0.00E+00	2.00E-01	1.99E-09	2.00E-01
29	Potassium	ug/l	0	0.00E+00	1.48E+04	3.79E-04	1.57E+04	4.02E-04	1.83E+05	4.68E-03	1.83E+05
31	Selenium	ug/l	1.74E+02	6.61E-06	1.79E+02	6.80E-06	2.32E+02	8.81E-06	7.60E+00	2.89E-07	7.60E+00
33	Silicon	ug/l	9.11E+02	1.52E-05	8.90E+02	1.48E-05	8.62E+02	1.43E-05	9.04E+03	1.50E-04	9.04E+03
35	Sodium	ug/l	1.46E+04	6.35E-04	1.74E+04	7.57E-04	1.75E+04	7.61E-04	1.87E+05	8.13E-03	1.87E+05
37	Strontium	ug/l	3.36E+02	7.67E-06	5.03E+02	1.15E-05	5.46E+02	1.25E-05	5.46E+02	1.25E-05	5.46E+02
38	Uranium	ug/l	7.60E+01	6.39E-07	7.50E+02	6.30E-06	8.78E+02	7.38E-06	9.16E+02	7.70E-06	9.16E+02
40	Zinc	ug/l	5.64E+00	1.73E-07	6.79E+00	2.08E-07	8.16E+00	2.50E-07	5.03E+01	1.54E-06	5.03E+01
42	Total Alkalinity (CaCO3)	ug/l	1.30E+05	0.00E+00	2.50E+05	0.00E+00	2.70E+05	0.00E+00	2.60E+05	0.00E+00	2.60E+05
43	Bicarbonate (HCO3-)	ug/l	1.50E+05	-2.46E-03	3.05E+05	-5.00E-03	3.29E+05	-5.39E-03	3.17E+05	-5.20E-03	3.17E+05
44	Carbon Dioxide (CO2)	ug/l	3.00E+03		6.00E+03		7.00E+03		6.00E+03		6.00E+03
45	Chloride	ug/l	1.56E+05	-4.40E-03	1.78E+05	-5.02E-03	1.78E+05	-5.02E-03	1.80E+05	-5.08E-03	1.80E+05
46	Fluoride	ug/l	1.00E+03	-5.26E-05	0	0.00E+00	1.00E+03	-5.26E-05	1.00E+03	-5.26E-05	1.00E+03
47	Nitrate (as N)	ug/l	6.76E+03	-4.83E-04	3.70E+03	-2.64E-04	3.00E+03	-2.14E-04	3.20E+03	-2.28E-04	3.20E+03
48	Sulfate	ug/l	1.85E+05	-3.85E-03	3.61E+05	-7.52E-03	3.94E+05	-8.20E-03	3.95E+05	-8.22E-03	3.95E+05
49	% Charge Deviation	%		-80		-80		-81		5	
50	Total dissolved solids	mg/l	7.80E+02		1.20E+03		1.23E+03		1.26E+03		1.26E+03
51	Total organic carbon	ug/l	7.32E+03		9.74E+03		1.03E+04		1.06E+04		1.06E+04
52	Chloroform	ug/l	2.00E+00		3.90E+01		4.60E+01		ND		4.60E+01
53	Methylene Chloride	ug/l	ND		1.20E+01		1.10E+01		1.00E+01		1.20E+01
54	Amercium-241	pCi/L	5.60E+01		7.30E+01		1.10E+02		5.00E+01		1.10E+02
55	Cobalt-60	pCi/L	ND		5.60E+02		7.18E+02		6.89E+02		7.18E+02
56	Curium-242	pCi/L	ND		ND		2.07E+03		1.55E+03		2.07E+03
57	Cesium-134	pCi/L	ND		4.64E+02		5.06E+02		4.06E+02		5.06E+02
58	Cesium-137	pCi/L	8.44E+04		9.80E+05		1.07E+06		1.03E+06		1.07E+06
59	Tritium	pCi/L	1.30E+06		9.90E+06		1.20E+07		1.20E+07		1.20E+07
60	Neptunium-237	pCi/L	ND		2.60E+01		4.00E+00		4.90E+01		4.90E+01
61	Plutonium-238	pCi/L	1.10E+02		ND		ND		2.10E+02		2.10E+02
62	Plutonium-239/240	pCi/L	1.70E+02		8.10E+02		8.60E+02		6.50E+02		8.60E+02
63	Plutonium-241	pCi/L	6.96E+03		3.32E+04		3.52E+04		2.66E+04		3.52E+04
64	Radium-226	pCi/L	ND		ND		ND		0.00E+00		0.00E+00
65	Antimony-125	pCi/L	ND		ND		2.07E+03		1.55E+03		2.07E+03
66	Strontium-90	pCi/L	4.00E+05		5.20E+06		5.50E+06		6.00E+06		6.00E+06
67	Technesium-99	pCi/L	2.80E+04		3.40E+05		4.80E+05		7.60E+05		7.60E+05
68	Total Alpha	pCi/L	ND		ND		3.50E+03		3.50E+03		3.50E+03
69	Gross Beta	pCi/L	6.40E+05		8.50E+06		9.90E+06		9.10E+06		9.90E+06
70											
71	gpm = gallons per minute		mg/l = milligrams per liter			pCi/l = picocuries per liter			ug/l = microgram per liter		

Basin 44 Process Flowsheet

	A	B	V	W	X	Y	Z	AA	AB	AC	AH	AK	AM
2	STREAM	Units	Evaporator Distillate Feed to Surge Tank	Dryer Distillate Feed to Surge Tank	Surge Tank	Acid addition in MTT	Degas Inlet	RO Feed	RO Permeate	Polisher Outlet	RO Reject/ Evaporator Feed	Evaporator Brine	Powder
4	Volume	gallons	1.20E+05	1.00E+04	6.30E+05								
5	Flowrate	gpm	14	0.71	58						15	0.73	0.08
7	pH					5	5						
8	Antimony	ug/l		9.85E+05	3.22E+01		3.22E+01	3.22E+01	1.61E-01	1.61E-03	1.28E+02	2.43E+03	3.59E+04
10	Arsenic	ug/l		3.05E+05	9.97E+00		9.97E+00	9.97E+00	4.98E-02	4.98E-04	3.97E+01	7.52E+02	1.11E+04
12	Barium	ug/l		1.32E+06	4.29E+01		4.29E+01	4.29E+01	2.15E-01	2.15E-03	1.71E+02	3.24E+03	4.79E+04
14	Cadmium	ug/l		1.48E+04	4.82E-01		4.82E-01	4.82E-01	2.41E-03	2.41E-05	1.92E+00	3.64E+01	5.38E+02
15	Calcium	ug/l		3.03E+09	9.89E+04		9.89E+04	9.89E+04	4.94E+02	4.94E+00	3.94E+05	7.46E+06	1.10E+08
17	Chromium	ug/l		8.62E+04	2.81E+00		2.81E+00	2.81E+00	1.41E-02	1.41E-04	1.12E+01	2.12E+02	3.14E+03
18	Cobalt	ug/l		3.94E+05	1.29E+01		1.29E+01	1.29E+01	6.43E-02	6.43E-04	5.12E+01	9.71E+02	1.43E+04
19	Copper	ug/l		4.02E+05	1.31E+01		1.31E+01	1.31E+01	6.55E-02	6.55E-04	5.22E+01	9.89E+02	1.46E+04
21	Iron	ug/l		9.63E+05	3.14E+01		3.14E+01	3.14E+01	1.57E-01	1.57E-03	1.25E+02	2.37E+03	3.50E+04
23	Lead	ug/l		1.23E+04	4.02E-01		4.02E-01	4.02E-01	2.01E-03	2.01E-05	1.60E+00	3.03E+01	4.48E+02
24	Magnesium	ug/l		4.29E+08	1.40E+04		1.40E+04	1.40E+04	6.99E+01	6.99E-01	5.57E+04	1.06E+06	1.56E+07
26	Manganese	ug/l		6.11E+05	1.99E+01		1.99E+01	1.99E+01	9.97E-02	9.97E-04	7.94E+01	1.50E+03	2.22E+04
28	Mercury	ug/l		4.93E+03	1.61E-01		1.61E-01	1.61E-01	8.04E-04	8.04E-06	6.40E-01	1.21E+01	1.79E+02
29	Potassium	ug/l		4.51E+09	1.47E+05		1.47E+05	1.47E+05	7.36E+02	7.36E+00	5.86E+05	1.11E+07	1.64E+08
31	Selenium	ug/l		1.87E+05	6.11E+00		6.11E+00	6.11E+00	3.06E-02	3.06E-04	2.43E+01	4.61E+02	6.81E+03
33	Silicon	ug/l		2.23E+08	7.27E+03		7.27E+03	7.27E+03	3.63E+01	3.63E-01	2.89E+04	5.48E+05	8.10E+06
35	Sodium	ug/l	8.50E+08	4.61E+09	1.51E+05		1.51E+05	1.51E+05	7.53E+02	7.53E+00	6.00E+05	1.14E+07	1.68E+08
37	Strontium	ug/l		1.35E+07	4.39E+02		4.39E+02	4.39E+02	2.19E+00	2.19E-02	1.75E+03	3.31E+04	4.89E+05
38	Uranium	ug/l		2.26E+07	7.36E+02		7.36E+02	7.36E+02	3.68E+00	3.68E-02	2.93E+03	5.56E+04	8.21E+05
40	Zinc	ug/l		1.24E+06	4.04E+01		4.04E+01	4.04E+01	2.02E-01	2.02E-03	1.61E+02	3.05E+03	4.51E+04
42	Total Alkalinity (CaCO3)	ug/l		6.41E+09	2.09E+05		2.09E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
43	Bicarbonate (HCO3-)	ug/l					4.20E+04	6.22E+02	6.22E+00	6.22E-02	2.46E+03	0.00E+00	
44	Carbon Dioxide (CO2)	ug/l					2.81E+05	3.00E+03	3.00E+01	3.00E-01	1.19E+04	0.00E+00	
45	Chloride	ug/l		4.43E+09	1.45E+05		1.45E+05	1.45E+05	7.24E+02	7.24E+00	5.76E+05	1.09E+07	1.61E+08
46	Fluoride	ug/l		2.46E+07	8.04E+02		8.04E+02	8.04E+02	4.02E+00	4.02E-02	3.20E+03	6.07E+04	8.96E+05
47	Nitrate (as N)	ug/l	1.46E+07	7.88E+07	2.58E+03		2.58E+03	2.58E+03	2.58E+01	2.58E-01	1.02E+04	1.94E+05	2.86E+06
48	Sulfate	ug/l		9.73E+09	3.18E+05	1.90E+05	5.08E+05	5.08E+05	2.54E+03	2.54E+01	2.02E+06	3.83E+07	5.66E+08
49	% Charge Deviation	%										1.10E+00	
50	Total dissolved solids	mg/l	5.74E+06	3.11E+07	1.02E+03	1.90E+02	1.21E+03	8.88E+02	4.44E+00	4.44E-02	3.53E+03	6.70E+04	9.90E+05
51	Total organic carbon	ug/l	0.00E+00	0.00E+00	8.41E+03		8.41E+03	8.41E+03	4.21E+01	4.21E-01	3.35E+04	0.00E+00	0.00E+00
52	Chloroform	ug/l	0.00E+00	0.00E+00	3.65E+01		3.65E+01			0.00E+00			
53	Methylene Chloride	ug/l	0.00E+00	0.00E+00	9.52E+00		9.52E+00			0.00E+00			
54	Amercium-241	pCi/L		2.71E+06	8.84E+01		8.84E+01	8.84E+01	4.42E-01	4.42E-04	3.52E+02	6.67E+03	9.86E+04
55	Cobalt-60	pCi/L		1.77E+07	5.77E+02		5.77E+02	5.77E+02	2.89E+00	2.89E-03	2.30E+03	4.36E+04	6.44E+05
56	Curium-242	pCi/L		5.10E+07	1.66E+03		1.66E+03	1.66E+03	8.32E+00	8.32E-03	6.62E+03	1.26E+05	1.86E+06
57	Cesium-134	pCi/L		1.25E+07	4.07E+02		4.07E+02	4.07E+02	2.03E+00	2.03E-03	1.62E+03	3.07E+04	4.54E+05
58	Cesium-137	pCi/L		2.64E+10	8.60E+05		8.60E+05	8.60E+05	4.30E+03	4.30E+00	3.42E+06	6.49E+07	9.59E+08
59	Tritium	pCi/L		2.96E+11	9.65E+06		9.65E+06	9.65E+06	9.65E+06	9.65E+06	0.00E+00	0.00E+00	0.00E+00
60	Neptunium-237	pCi/L		1.21E+06	3.94E+01		3.94E+01	3.94E+01	1.97E-01	1.97E-04	1.57E+02	2.97E+03	4.39E+04
61	Plutonium-238	pCi/L		5.17E+06	1.69E+02		1.69E+02	1.69E+02	8.44E-01	8.44E-04	6.72E+02	1.27E+04	1.88E+05
62	Plutonium-239/240	pCi/L		2.12E+07	6.91E+02		6.91E+02	6.91E+02	3.46E+00	3.46E-03	2.75E+03	5.22E+04	7.71E+05
63	Plutonium-241	pCi/L		8.68E+08	2.83E+04		2.83E+04	2.83E+04	1.42E+02	1.42E-01	1.13E+05	2.14E+06	3.16E+07
64	Radium-226	pCi/L		0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
65	Antimony-125	pCi/L		5.10E+07	1.66E+03		1.66E+03	1.66E+03	8.32E+00	8.32E-03	6.62E+03	1.26E+05	1.86E+06
66	Strontium-90	pCi/L		1.48E+11	4.82E+06		4.82E+06	4.82E+06	2.41E+04	2.41E+01	1.92E+07	3.64E+08	5.38E+09
67	Technesium-99	pCi/L		1.87E+10	6.11E+05		6.11E+05	6.11E+05	3.06E+03	3.06E+00	2.43E+06	4.61E+07	6.81E+08
68	Total Alpha	pCi/L		8.62E+07	2.81E+03		2.81E+03	2.81E+03	1.41E+01	1.41E-02	1.12E+04	2.12E+05	3.14E+06
69	Gross Beta	pCi/L		2.44E+11	7.96E+06		7.96E+06	7.96E+06	3.98E+04	3.98E+01	3.17E+07	6.01E+08	8.87E+09
70													
71	gpm = gallons per minute		mg/l = milligrams per liter				pCi/l = picocuries per liter				ug/l = microgram per liter		