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INEEL Radioactive Liquid Waste Reduction Program

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ABSTRACT

Reduction of radioactive liquid waste, much of which is Resource Conservation and Recovery Act (RCRA) listed, is a high priority at the Idaho National Technology and Engineering Center (INTEC). Major strides in the past five years have lead to significant decreases in generation and subsequent reduction in the overall cost of treatment of these wastes.

In 1992, the INTEC, which is part of the Idaho National Environmental and Engineering Laboratory (INEEL), began a program to reduce the generation of radioactive liquid waste (both hazardous and non-hazardous). As part of this program, a Waste Minimization Plan was developed that detailed the various contributing waste streams, and identified methods to eliminate or reduce these waste streams. Reduction goals, which will reduce expected waste generation by 43%, were set for five years as part of this plan. The approval of the plan led to a Waste Minimization Incentive being put in place between the Department of Energy – Idaho Office (DOE-ID) and the INEEL operating contractor, Lockheed Martin Idaho Technologies Company (LMITCO). This incentive is worth $5 million dollars from FY-98 through FY-02 if the waste reduction goals are met.

In addition, a second plan was prepared to show a path forward to either totally eliminate all radioactive liquid waste generation at INTEC by 2005 or find alternative waste treatment paths. Historically, this waste has been sent to an evaporator system with the bottoms sent to the INTEC Tank Farm. However, this Tank Farm is not RCRA permitted for mixed wastes and a Notice of Non-compliance Consent Order gives dates of 2003 and 2012 for removal of this waste from these tanks. Therefore, alternative treatments are needed for the waste streams. This plan investigated waste elimination opportunities as well as treatment alternatives. The alternatives, and the criteria for ranking these alternatives, were identified through Value Engineering meetings with all of the waste generators. The most promising alternatives were compared by applying weighting factors to each based on how well the alternative met the established criteria. From this information, an overall ranking of the various alternatives was obtained and a path forward recommended.

INTRODUCTION

Past nuclear fuel reprocessing activities and current waste processing activities at the Idaho National Technology and Engineering Center (INTEC) generate hazardous radioactive liquid waste that is stored in underground stainless steel tanks (i.e. the Tank Farm) which do not meet current RCRA regulatory requirements. Aqueous low-activity radioactive wastes from water runoff, fuel storage and other operations are generally concentrated in the Process Equipment Waste Evaporator (PEWE) prior to storage in this Tank Farm. Acid in the PEWE overheads is separated for recycle by acid fractionators. In the New Waste Calcining Facility (NWCF), the Tank Farm liquid wastes are converted to a solid granular form (calcine) which is then stored in the calcine bin sets.

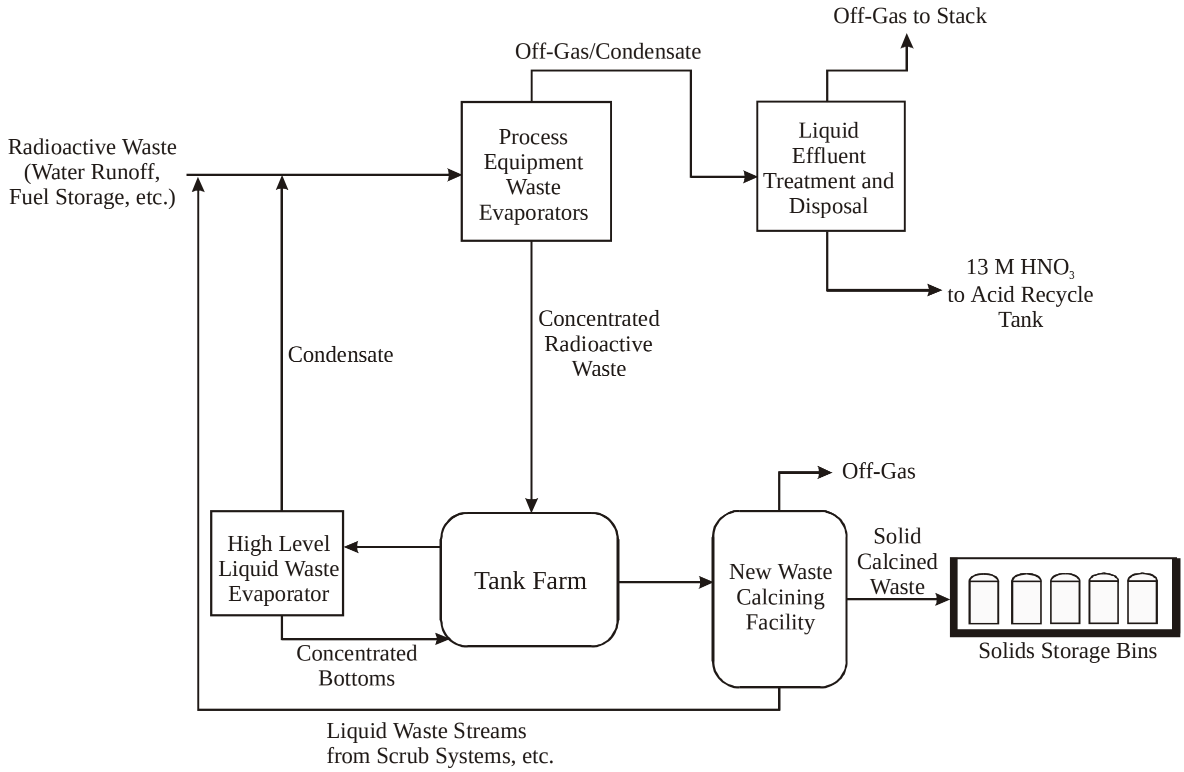


Figure 1. Waste System Schematic

Waste system.cdr

A Notice of Noncompliance was received on the use of the Tank Farm tanks for storing RCRA waste in non-RCRA permitted storage. This led to a Settlement Agreement between the Department of Energy (DOE), the Navy and the State of Idaho that requires that all waste in the Tank Farm must be calcined by the end of 2012. The Noncompliance Consent Order also requires cease use of a portion of the tanks by 2003 and of all tanks by 2012. Therefore, each gallon added to the Tank Farm is one more gallon needing processed prior to meeting these commitments and a need for a waste generation reduction program was established.

WASTE MINIMIZATION PROGRAM

Waste generation projections for processes operating at INTEC were first established in 1994. These estimates projected waste generation based on the best knowledge available from plant operators and engineers at that time. A Radioactive Liquid Waste Management Plan was also issued in 1994. This report proposed an integrated plan to manage generation of radioactive liquid waste at the INTEC based on a budgeting type of approach. This report also established waste minimization goals as annual targets or ceiling limits and recommended that they be incorporated into the contractor performance indicators. It was also recommended that a special team annually reviews and approves generation of all waste streams. This plan was never implemented.

In July 1996, the INTEC waste generation projections were updated. These projections were determined through a series of facilitated meetings with waste generator input. In the fall of 1996, this information was used to establish a new waste generation baseline representing the current waste generation activities without additional waste minimization. In addition, new goals were set to reduce waste generation by 35%. Meeting these goals became part of the cost plus award fee (CPAF) criteria for FY-97. These goals were met through a combination of waste avoidance, alternative decontamination processes, more effective process operations, and more effective chemicals. The waste generated during FY-97 was decreased by more than 35% below the FY-97 baseline.

A 1997 agreement signed by A. L. Alm, Assistant Secretary for Environmental Management, DOE-HQ and J. M. Wilcynski, Manager, DOE Idaho Operations Office, resulted in the development of a continuing waste minimization plan detailing how to further reduce the baseline waste going to the INTEC Tank Farm by 35% between FY-98 and FY-02. The waste generation projections from 1996 were used as a starting point to determine a new waste generation baseline and set new waste minimization goals for FY-98 through FY-02. A facilitated meeting was held in July 1997 with the personnel responsible for the majority of the waste generation to obtain the required input. The resulting minimization plan provides background information on the various waste streams, shows the current waste generation status (baseline), details improvements which can be made, sets certain milestones to meet the improvements, and shows the waste generation goals which will enable the INTEC to meet a 43% reduction over the five-year period. Table I shows the waste streams, the baseline volumes and the goals.

WASTE MINIMIZATION INCENTIVE

From the recent waste minimization plan, a liquid waste minimization incentive plan was prepared to promote and incentivize the reduction of liquid waste generation discharged to the Tank Farm. Incentivizing the waste minimization program is intended to effect the desired results of reducing the volume of waste going to the Tank Farm, benefit the contractor (LMITCO) and assist DOE in meeting the agreed-to milestones in the Consent Order with the State of Idaho. DOE-ID has set aside \$5 million over the 5-year period for this incentive. The baseline and goal waste projections in the previously established waste minimization plan are the basis for this incentive. Performance is measured by the following formula:

$$\frac{\text{Cumulative baseline waste generation (for FY-98 through the current time)} \; - \; \text{Cumulative actual volume generated (from FY-98 through the current time)}}{\text{5-year cumulative baseline volume} \; - \; \text{5-year cumulative goal volume.}}$$

To calculate the percentage of the 5-year goal (and thus as a percentage of the \$5 million), this ratio is multiplied by 100. During the first year of this incentive, FY-98, only 46,106 gallons of waste was sent to the INTEC Tank Farm. This was due to tightening of process controls, increased operator attention, equipment repairs made, use of more effective chemicals for cleaning, and a variety of other reasons. This is 44.3% of the adjusted 5-year cumulative reduction goal, which resulted in a calculated fee earned of \$2.2 million.

LIQUID WASTE MANAGEMENT PLAN

In addition to minimizing the waste being generated, alternative treatment (and further minimization) of waste streams destined for the tank farm was investigated. The objective of the INEEL Liquid Waste Management Plan was to define a path-forward to eliminate all “non-calcination” related waste from going to the unpermitted Tank Farm by 2005. It was assumed that the “calcination-related” waste, which is essentially a recycle of solutions taken out of the Tank Farm for processing, would be allowed to return to the Tank Farm. (The current focus is changing to include all newly generated waste must not be sent to the unpermitted Tank Farm by 2005.) This was to be accomplished by waste minimization, waste elimination and alternative treatment methods. These “non-calcination” related waste streams come from the fuel storage basins, water runoff, evaporation and off-gas cleanup operations, analytical laboratories, decontamination facilities and other INEEL locations.

Identifying the waste streams destined for the Tank Farm was the initial step in completing this approach. Most of the INTEC waste streams had already been identified and quantified in the previously written plans (see Table I), however the waste streams from other INEEL locations had not. This identification phase resulted in a total of 34 waste streams. Next, again building on the previous plans, a list of waste elimination or minimization possibilities was developed. This resulted in ideas for elimination or minimization on 14 of the waste streams, since the other 20 waste streams were either already generated (such as basin water) or were not fully defined (such as future decontamination flushes in support of facility closures). Figure II shows a typical flow diagram created with the elimination/minimization ideas.

The waste streams were then grouped based on their composition in four areas: acid; radioactivity; total dissolved solids (TDS); and RCRA components. This resulted in 7 groupings varying from a non-RCRA, Low TDS, Low

Table I. Waste generation baseline and goals.

Waste Stream	Waste Generation Baseline (gal to Tank Farm)	Waste Generation Goals (gal to Tank Farm)
NWCF Bed Dissolutions	35,000 gal per dissolution, 1 dissolution every 6 months of operation.	17,500 gal per dissolution, 1 dissolution every 6 months of operation.
NWCF Operations	a. Deep Recycle – 5000 gal/operating mo b. Adsorber Washes - 10,000 gal/turnaround	a: 3000 gal/operating mo b: 8,000 gal/turnaround
NWCF Decon/ Turnaround	15,050 gal / 6 months operation	9783 gal / 6 months operation
Deep Tanks Direct	3000 gal/yr.	100 gal/yr
PEWE Descale	2000 gal/yr.	1000 gal/yr in FY-98 & -99. 400 gal/yr in FY-00 thru 02.
Tank Farm Line Flushes	1000 gal/yr.	500 gal/yr
NWCF Operations	125 gal/operating mo.	83 gal/operating mo.
FAST	1630 gal/yr for FY-98 &-99. 967 gal/yr for FY-00 thru –02.	994 gal/yr for FY-98 & -99. 358 gal/yr for FY-00 thru -02.
601/Lab Drains	2100 gal/yr	1386 gal/yr
WCF Sumps	133 gal in FY-98.	133 gal in FY-98.
NWCF Decon Room	2500 gal/yr	1625 gal/yr
LET&D	200 gal/yr	130 gal/yr
CPP-603	1200 gal/yr in FY-98 & -99. 167 gal/yr in FY-00 thru -02.	720 gal/yr in FY-98 &-99. 100 gal/yr in FY-00 thru -02.
Tank Farm Sumps	2000 gal/yr	1200 gal/yr
Pilot Plants	100 gal/yr	50 gal/yr
RCRA Wells	100 gal/yr	75 gal/yr
Misc. Balance of Plant (BOP)	967 gal/yr	828 gal/yr
NWCF Utility Tunnels	333 gal/yr	50 gal/yr
CPP-604 Sumps	200 gal/yr	100 gal/yr
603 Basin Removal	50,000 gal in FY-00	30,000 gal in FY-00
Filter Leach	3300 gal/yr in FY-98 and –99. 3750 gal/yr in FY-00 thru -02	Same as baseline.
CPP-603 D&D	2500 gal/yr in FY-01 & -02.	1500 gal/yr in FY-01 & -02.
601/627/640 D&D	2000 gal in FY-99 750 gal in FY-00.	867 gal in FY-99 325 gal in FY-00
ROVER D&D	3,666 gal in FY-98	1009 gal in FY-98
Discretionary	12,000 gal/yr	5000 gal/yr

Rad, and non-Acid group to a RCRA listed, High TDS, High Rad, High Acid group as shown in Table II. The Group 1 wastes were essentially slightly contaminated water, and because there were no RCRA components or difficult to treat toxic or acidic wastes had many feasible treatment alternatives. However, these waste streams do not add significantly to the final waste volume going to the Tank Farm since they evaporate almost completely in the existing PEWE. Therefore, it was not considered important to use alternative treatments to eliminate these streams from the process flow to the Tank Farm. The Group 3 and 4 waste streams are those that are expected to contribute the largest volume to the Tank Farm, after the maximum amount of evaporation has occurred in the PEWE. These remaining waste streams, after evaporation, would result in combined tank farm feeds of essentially the same composition as the waste currently in the Tank Farm.

Various alternatives were then investigated for treatment of the waste groups. Over 25 different waste treatment alternatives (such as drum evaporation, ion exchange, etc.) were evaluated for treatment of the waste streams remaining after the elimination and minimization efforts. Criteria were established for use in a subjective ranking to narrow down the choice of the various treatment options. The seven criteria used were cost, difficulty of meeting regulatory requirements, difficulty of obtaining stakeholder approval, acceptability of the final waste form, logistics for putting the option in place (schedule, space requirements, etc.), the difficulty of completing all necessary safety aspects, and the technical maturity of the option. A Kepner-Trego paired analysis technique was used to determine the relative weighting factors for the criteria. These criteria (and their weighting factors) were used to narrow the main treatment alternatives for the waste streams that exist after 2005 to those shown in Table III. A rough order of magnitude cost analysis was then completed on four different scenarios (Figure IV). These indicated that the most cost-effective and technically feasibly approach would be to treat all of the waste streams going to the Tank Farm together instead of establishing a different treatment for each of the groups.

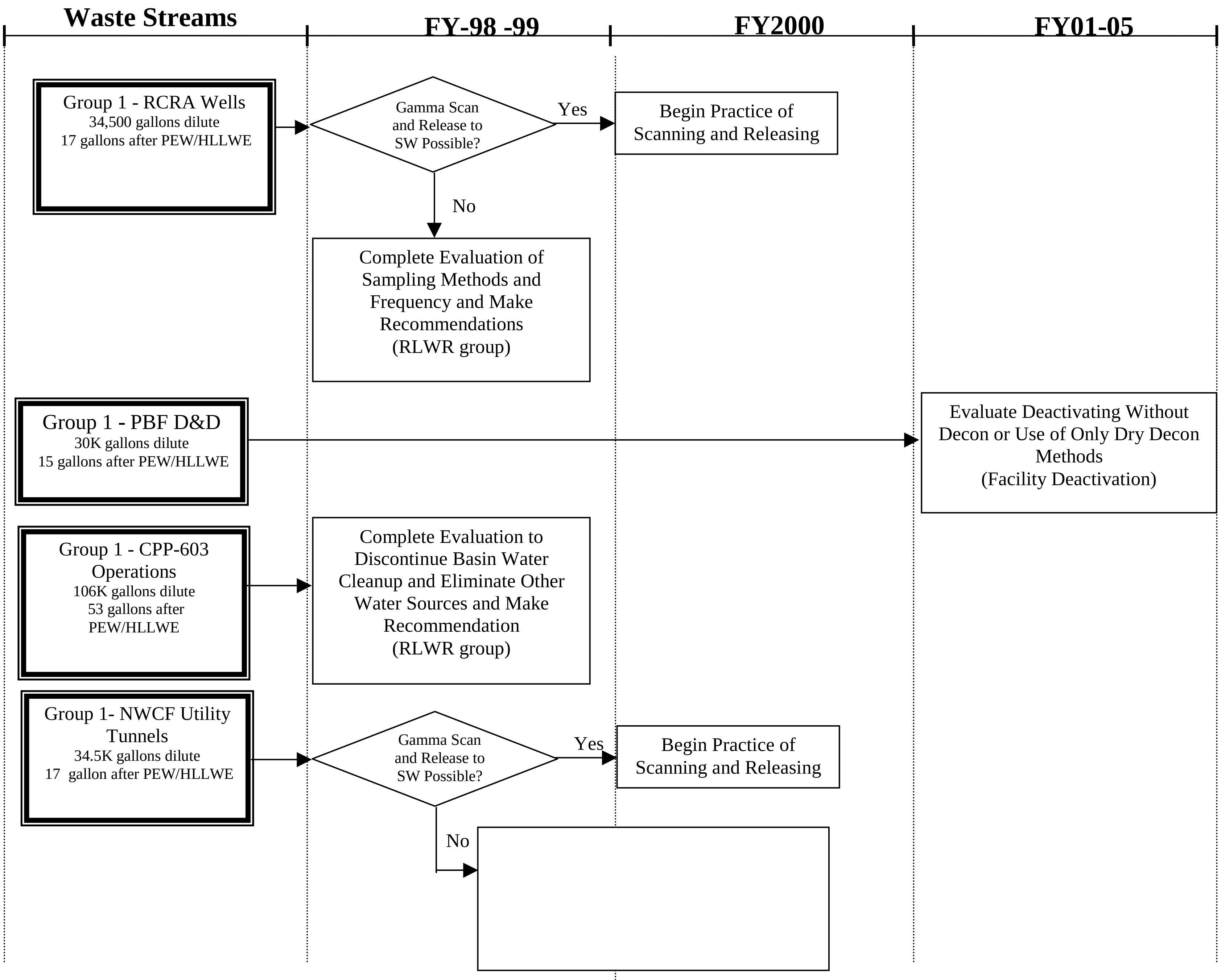


Figure 2. Example waste elimination/minimization flow diagram.

Table II. Waste stream groupings.

Group #	Waste Stream Group	Waste Stream	Streams Existing After 2005
1	Non RCRA	**PBF 10K Tank**	
	Low TDS	**PBF Canal**	
	Low/Rad	**PBF Reactor Vessel**	
	Non Acid	**PBF Sump**	
		PBF HDW	
		PBF D&D	
		PBF Knockout Drum	
		PBF 1,000 gal tank	
		FAST Operations	X
		FAST Basin Water	X
		CPP-603 Basin Water	
		CPP-603 Operations	*
		RCRA Sample Wells (except Well #18)	X
		NWCF Utility Tunnel	X
2	RCRA	CPP-604 Sumps	X
	Low TDS	Tank Farm Sumps	X
	Low/Rad	RCRA Sample Well #18	X
	Non Acid		
3	RCRA	LET&D	*
	Low TDS		
	Low Rad		
	High Acid		
4	RCRA	CPP 601/Labs & Deep Tanks Direct	X
	High TDS	NWCF Decon Facility	X
	High Rad	CPP-601/627/640 Deactivation	
	High Acid	CPP-603 Deactivation	
		Calciner Closure Flush 3	
5	RCRA	**TRA 605**	
	High TDS	**TRA 713-C**	
	Low/High Rad	**TRA 713-D**	
	Non Acid	**TRA 730 Catch Tanks**	
		TRA 689 Decon solution	X
		PEWE Descale	*
6	RCRA	**SMC**	
	High TDS	Pilot Plants	*
	Low Rad		
	High Acid		
7	Unclassified	Misc. Balance of Plant	X
		Facility Closures, Undefined	X
		Chemical Vulnerability Flushes, Undefined	

* May possibly be eliminated.

BOLD = Type 2 waste streams that are already generated.

Table III. Alternative Treatments.

Group #	Waste Stream	Permitted Evap & Tank, Vendor Grout	Permitted Evap Pond	Vendor Clean & Release TRA Pond or Evap & Grout	Clean and Release to Service	Collect and Use for Tank Farm Flushes	Vendor Clean and Release to SW or Evap	Analytical Work to Outside Lab or Grout Waste	No Debris Treatment or Grout NWCF Decon Waste	Dry Facility Closures or Grout	Treat With SBW	IX and Recycle to Basin
1	FAST Operations	X	X		X	X					X	X
1	FAST Basin Water	X	X		X		X				X	
1	NWCF Utility Tunnel	X	X		X	X					X	
1	RCRA Sample Wells	X	X		X	X					X	
2	CPP-604 Sumps	X	X			X					X	
2	Tank Farm Sumps	X	X			X					X	
2	RCRA Sample Well	X	X			X					X	
4	CPP-601/Labs & Deep	X						X			X	
4	NWCF Decon Facility	X							X		X	
5	TRA 689 Decon	X		X							X	
7	Misc. BOP	X									X	
7	Facility Closures/Deact.	X								X	X	

Figure 3. Possible Disposal Options for Waste Streams Existing After 2005

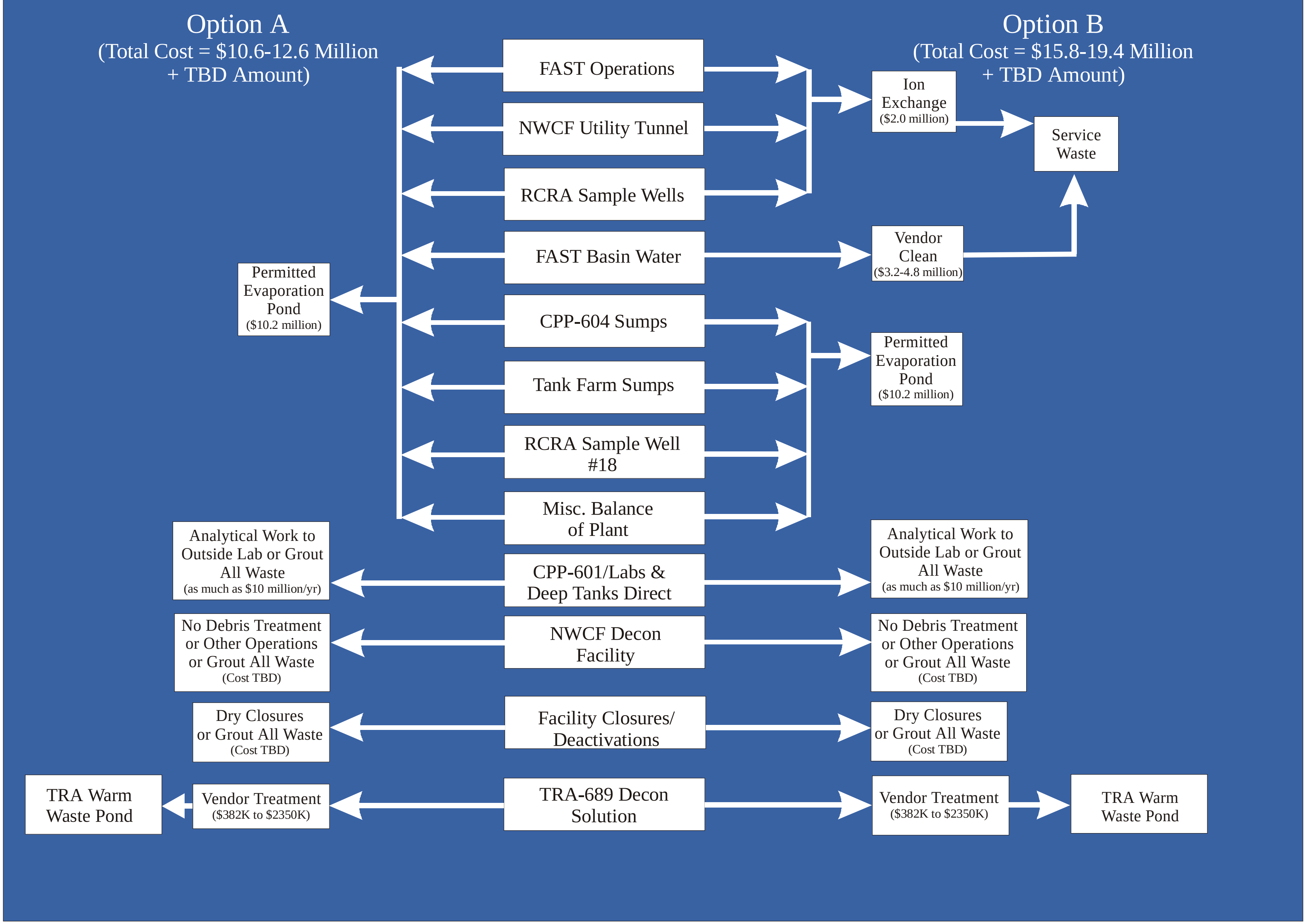
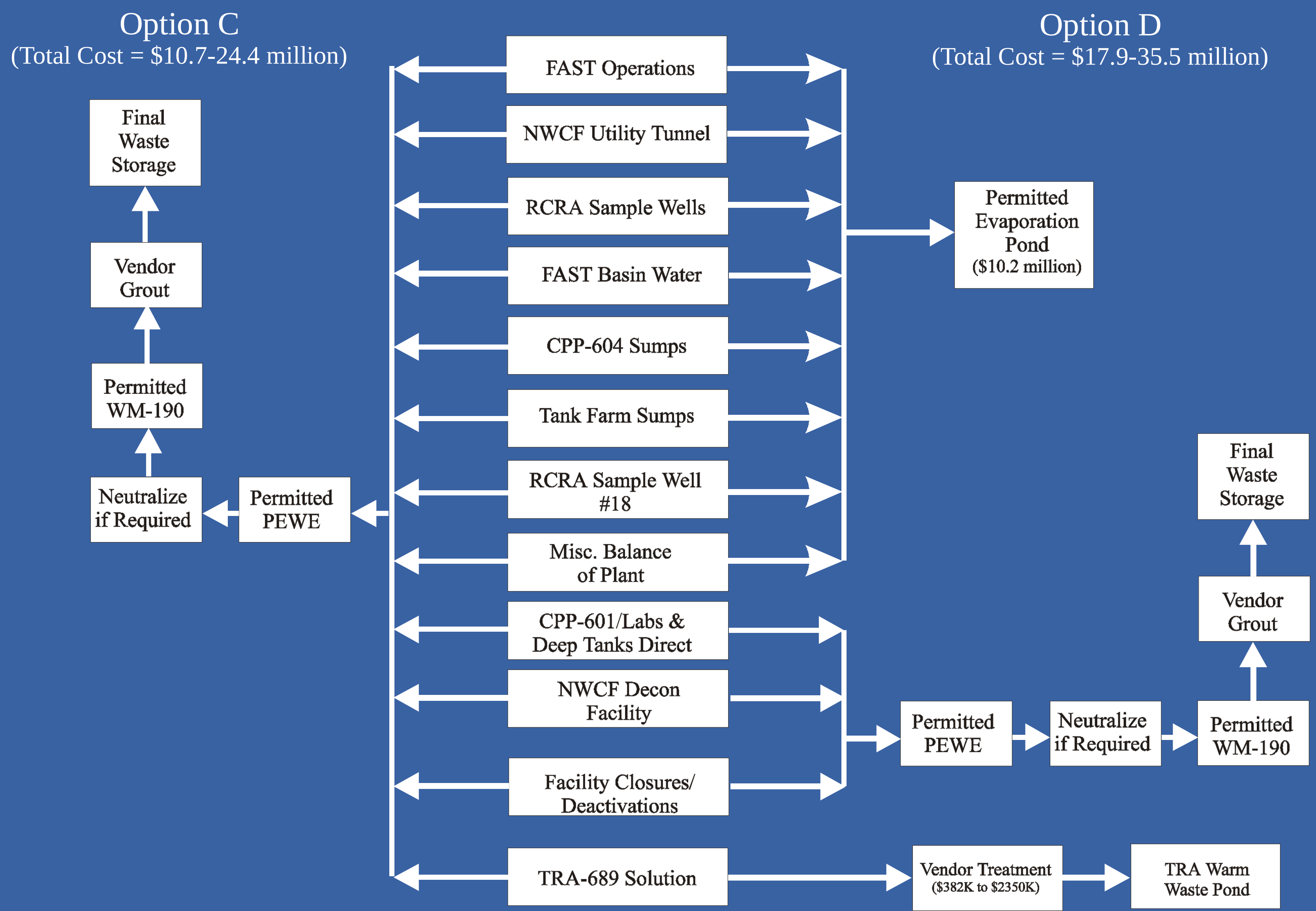


Figure 3. Possible Disposal Options for Waste Streams Existing After 2005



The result of this alternatives analysis resulted in the recommended path forward of continuing to evaporate the newly generated waste with the existing equipment (i.e. the PEWE) and segregate the bottoms from the evaporator into a separate RCRA permitted tank. This evaporated waste would be stored in a permitted tank until the final treatment path is established. Additional, in-depth studies are being completed in FY-99 to determine the feasibility of this approach and establish the actual project costs.

WASTE MINIMIZATION EFFORTS

Waste minimization efforts have already significantly decreased the amount of waste destined for the INTEC Tank Farm. For instance, Decontamination & Decommissioning plans in 1993 included the generation of 200,000 gallons of waste from the closure of the Waste Calcining Facility (WCF). This facility is now being grouted in place with the generation of less than one-fourth the formerly planned amount. Closure of several other facilities is being approached in the same way. Another successful waste minimization effort was the installation of an acid recycle tank which collects the high molarity acid bottoms from the acid fractionator for the evaporator condensate to allow reuse of this acid in the plant. Storm runoff collection in radioactive areas has also been decreased through grading and other efforts.

The waste evaporators were built in the 1950's. Their primary objective is to minimize waste going to the Tank Farm. However, the personnel operating the evaporators must balance between less waste to the Tank Farm and causing increased corrosion of the evaporator components by very aggressive evaporation. Historical PEWE performance shows an overall average reduction of 30:1. The last evaporator upgrade installed a recycle line from the bottoms tank to the feed tank. This now allows the bottoms to be mixed with dilute waste and re-evaporated so more acid can be stripped from the solution. Addition of this recycle and a shift in operational objectives to achieving maximum waste minimization has enabled the achievement of a 97:1 reduction overall in the evaporator during FY-98 compared to the historical 30:1 average.

In addition, the Radioactive Liquid Waste Reduction group, a small group of engineers and scientists, was established to focus on finding ways to minimize the amount of waste going to the Tank Farm. Past efforts have centered around reducing decontamination waste by using low waste generating methods. Current responsibilities include tracking the waste generated and comparing it to established goals, championing plant waste minimization efforts, researching waste streams and possible alternative handling methods, and conducting testing to evaluate alternative waste minimization methods in a controlled manner for effectiveness, waste generation, compatibility with plant systems, and applicability to specific needs.

CONCLUSIONS

In the first year of a monetary waste minimization incentive, 44.3% of the adjusted 5-year cumulative reduction incentive goal was achieved, which resulted in a calculated fee earned of $2.2 million. This indicates that waste minimization has become a part of the normal INTEC operations. The combination of external drivers, such as the Consent Order, and monetary awards, from the incentive, will ensure that the reduction of waste to the Tank Farm is always a high priority.

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