Cesium Management and Disposition Alternatives for the Low Activity Waste Pretreatment System (LAWPS)

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Summary

The Hanford Advisory Board, following lengthy discussions and reviews conducted by the Board's Tank Waste Committee with the U.S. Department of Energy (DOE) Office of River Protection (ORP), has completed a review of the proposed Direct Feed Low Activity Waste (DFLAW) process and the Low Activity Waste Pretreatment System (LAWPS). Specifically, the Committee's discussions centered on the proposed management and potential disposal paths of the High Level Cesium Waste resulting from the LAWPS process. This review was performed at the request of DOE-ORP Federal Project Director, Low Activity Waste Pretreatment System, as described in the Hanford Advisory Board 2015 and 2016 Work Plans. Specific areas to be discussed in this work plan item included:

- Are there alternate cesium removal, storage, and disposition technologies that should be considered under Direct Feed Low Activity Waste scenarios?

- What would be the implications for long term cleanup planning on the Central Plateau?

The goal of this paper is to identify and review alternatives to the current baseline of removing the High Level Cesium Waste and returning it back to the double shell tanks. The table below summarizes the options developed during presentations, discussions and on-site tours with DOE, and in-depth dialogue and analysis by members of the Board.

Cesium Disposition Option		Cs Removal Process	DFLAW Cs Deposition	Regulatory Requirements	Comments
1	Return Cesium back to DST	Elutable Resin	DST	Acceptable	DFLAW Baseline
1A	Return Cesium to DST and Expedite Direct Feed HLW	Elutable Resin	DST	Acceptable	WTP Redesign Required for Direct Feed HLW
2	Dispose of Cesium in Deep Geologic Bore Holes	Either, $CsNO_3$ from elutable or CST	Bole Hole	Regulatory Pathway Unknown, Requires WIR	Feasibility Undefined

Cesium Disposition Option		Cs Removal Process	DFLAW Cs Deposition	Regulatory Requirements	Comments
3	Place Dry Media/Cesium in HICs and Dispose of in Licensed Commercial Disposal Facility	Non-Elutable, Zeolite	WCS	Requires WIR, Class C Waste Due to Cs-137	Limited Curie Count, Requires More Frequent Media Change Out
4	Store Cesium in HICs on Dry Ion Specific Media for Future Federal Disposal	Non-Elutable, CST	On-Site Storage Awaiting Geological Repository	On-site Storage Until After Repository Opens or 150-200 years then Class C	No Current Path for Permanent Disposal as HLW; No Destination. Long Time Until Class C Waste
4A	Store Cesium in Dry HICs or Wet in New Underground Tank. Media to be Ground Up and Incorporated into HLW Glass.	Non-Elutable, CST	On-Site Storage Awaiting HLW Operations	On-site Storage Until HLW After Operational	HLW Has No Current Destination. Very Slight Increase in HLW Canister Count, 1-2%

Note: 4 and 4A can be combined for maximum flexibility. This would require non-elutable media in 4A to be stored in HICs (High Integrity Containers) and either shipped off site to geological repository as HLW, allowed to decay for 150 to 200 years then disposed as Class C Low Level Waste, or removed from HICs, ground up and incorporated into HLW glass.

<u>Preferred options are 1A, 3, or 4/4A</u>. Expedited Direct Feed HLW should be done regardless of option selected since it will decrease time to Pretreatment Facility and HLW operation due to less need for solids processing.

<u>Option 1A</u> is a modified ORP baseline. It uses DFHLW to reduce DFLAW cesium disposition path from 17 years estimated time to 10 years estimated time. 2032 startup of DFHLW instead of 2039. Total cost is significant less (billions $) than ORP DFLAW baseline. It does require business case analysis (in progress), changes in WTP operations, and supplemental ROD analysis for DFHLW.

<u>Option 3</u> requires a WIR, Waste Acceptance Criteria for WCS, RCRA permitted storage, and HIC containers. Total estimated cost of $340 million more than baseline (RPP-RPT-57115). Use of all WCS Federally reserved Curie content and a revised list to minimize curies of cesium-137 process will free up about 4 million gallons of DST space. It is likely the Curie restrictions could be increased. Cost benefits of not returning cesium to tanks are not included.

<u>Option 4/4A</u> is the most flexible from baseline and has a cost range of estimated ~$120 million to $546 million over baseline. Since it uses non-elutable media it is more efficient at creating new DST space. This will probably create 1 more free DST (1 million gallons more free space) in the life of DFLAW which

is worth about $80 million. Cost benefits of not returning cesium to tanks are not included. For shipment dry cesium media to geological repository as HLW the Repository Waste Acceptance Criteria would have to be evaluated, RCRA permitted interim storage, additional containers, transportation, and repository cost would be incurred; these are estimated at $546 million (RPP-RPT-57115, $626 million minus $80 million, value of space= $546 M). Cost of grinding cesium media up and incorporating to HLW glass as illustrated in RPP-47630 is estimated at $200M. Subtracting cost benefits of additional DST space over baseline would give a cost of ~$120 million over baseline. This would require WTP operations change and supplemental ROD analysis.

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Background

Current DFLAW plans call for using an ion exchange process in the LAWPS to strip high level waste constituents, primarily highly radioactive cesium, from a waste stream from the tank farms creating a low activity waste feed for vitrification in the Low Activity Waste (LAW) facility. The cesium or high level waste would be returned to the existing waste tanks in the tank farms for later processing when the capability to process High Level Waste (HLW) in the Waste Treatment and Immobilization Plant (WTP) is available.

On September 24, 2013, the U.S. Department of Energy (DOE) released the Hanford Tank Waste Retrieval, Treatment, and Disposition Framework (Framework) document. This document describes a strategic framework for addressing the risks and challenges to completing the DOE Office of River Protection (ORP) mission by implementing a phased approach that would:

- Begin immobilization of the tank waste as soon as practicable through the Direct Feed Low Activity Waste (DFLAW) process.
- Process transuranic (TRU) tank wastes for disposal at the Waste Isolation Pilot Plant (WIPP).
- Resolve technical issues for the Pretreatment (PT) and High-Level Waste (HLW) Facilities, including determining how to adequately mix and sample the waste prior to processing, to enable design completion, and the safe completion of construction, startup and operations of these facilities.

Immobilization of the approximately 56 million gallons of radioactive and chemical wastes stored in 177 underground tanks located on Hanford's Central Plateau will occur in the Waste Treatment and Immobilization Plant (WTP). The complexity of both the waste itself as well as the WTP facilities has led to difficult, and to date, unresolved technical issues for the portions of the facility (PT Facility and to a much lesser extent the HLW Facility) that will process the solid portions of the waste. Because the current design of WTP anticipates that all waste will be processed through the PT Facility, immobilization of any waste could not occur per the current plan until the many technical issues involving the PT Facility are resolved. Therefore, an alternative approach for immobilizing waste as soon as practicable, while simultaneously resolving the remaining technical challenges, was identified. By adopting a DFLAW option in which the waste bypasses the PT Facility, waste immobilization could begin significantly earlier than if treatment of the waste is delayed until all technical issues are resolved and the PT and HLW Facilities are completed.

The Framework document divided the 56 million gallons of tank waste into three major categories for treatment:

(1) Low-activity waste;
(2) Potential contact-handled transuranic waste (CH-TRU); and
(3) High-level waste, which is further subdivided into waste not requiring special handling (easier to process) and waste requiring special handling (harder to process).

The low-activity waste consists primarily of the supernate (liquid) portion of the tank waste with most of the solids and radioactivity removed before vitrification, low-activity waste will be the largest tank waste stream by volume (approximately 90% of the volume), but the lowest in radioactivity content (approximately 10% of the curies). Since the low-activity waste makes up approximately 90% of the total volume of waste to be treated, and has the greatest influence on the total duration of the Hanford tank waste mission. The liquid form of this waste makes it susceptible to leakage. The low activity waste is also the tank waste most easily processed through the WTP. In particular, at the present time it is felt that there are no significant technical risks associated with vitrifying this waste stream in the LAW Facility.

Beginning LAW Facility operations before the PT Facility is operational would require a capability to remove the cesium and small amounts of transuranic and strontium-90 solids from the liquid supernatant waste stream so that low-activity waste could be directly fed to the LAW Facility for glass immobilization.

ORP's analyses of this approach indicates that a standalone Interim Pretreatment System Facility would best address this need. It would be located between the tank farms and the LAW Facility and would remove the solids and cesium from the liquid waste stream. In addition, some space has been set aside to possibly remove other radioactive elements or test improvements in currently planned separation techniques. This facility would provide the processing capability to support a DFLAW operation prior to the completion of PT. As this option uses mature technologies, DOE felt that the technical risks associated with this alternative were low.

Disadvantages of Returning Radioactive Cesium to the Waste Tanks

The current baseline for the DFLAW process is to return the high level cesium waste that is removed from the waste stream back to the double shell tanks. The focus of this paper is to identify and discuss potential alternate cesium removal, storage, and disposition technologies to this baseline approach.

Cesium is present in HLW mostly in salt cake and supernatant as stable Cs-133 and radioactive Cs-134, Cs-135, and Cs-137. Cs-134 has mostly decayed away, leaving Cs-135 and Cs-137. Cs-137 decays to Ba-137m which decays to Ba-137. This is the principle gamma source in tanks. There is ~3 to 4 times more total cesium verses Cs-137 radioactivity.

The return of radioactive cesium to the tanks has numerous disadvantages. These include:

- Cesium gamma emissions are the principle radiation hazard to the work force.
- Cesium makes up about 50% of hydrogen generated in tanks/Pretreatment. 7 of 12 tanks scheduled for DFLAW have high hydrogen generation rates.
- Cesium places more radiation/heat stress on tanks; some nearing their design life.

- Cesium return to the DSTs is more expensive and creates more waste. It is cheaper in the short run and costlier in the long run.
- Returning cesium takes up tank space; less free DST space created.

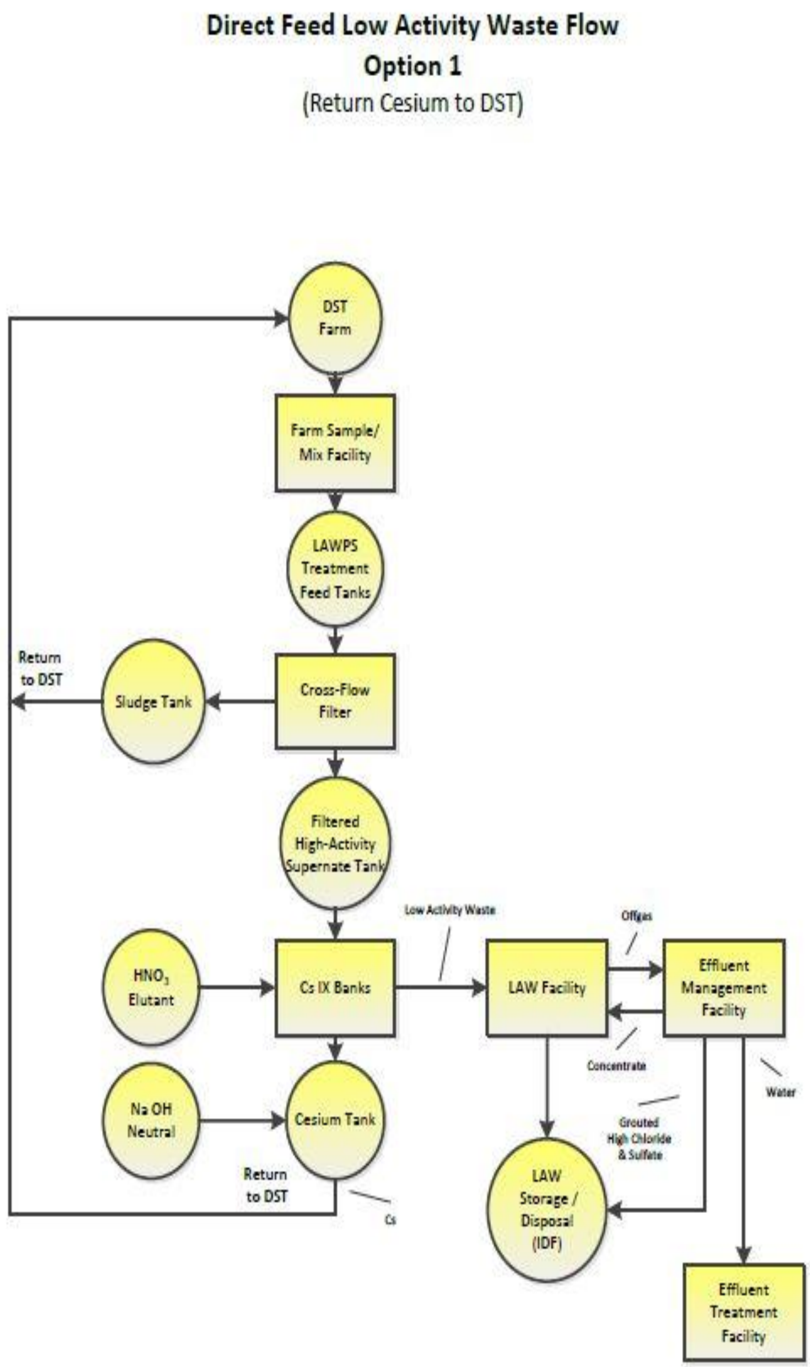
Cesium Disposition Alternatives

As requested by ORP in the Hanford Advisory Board (Board) 2015 and 2016 Work Plan, the Board has conducted an in-depth review of the preliminary design associated with the DFLAW and the possible alternate cesium removal, storage, and disposition technologies that might be considered for use in the DFLAW.

The alternatives were developed and considered for the disposition of the Cesium removed from the waste steam as part of the DFLAW process.

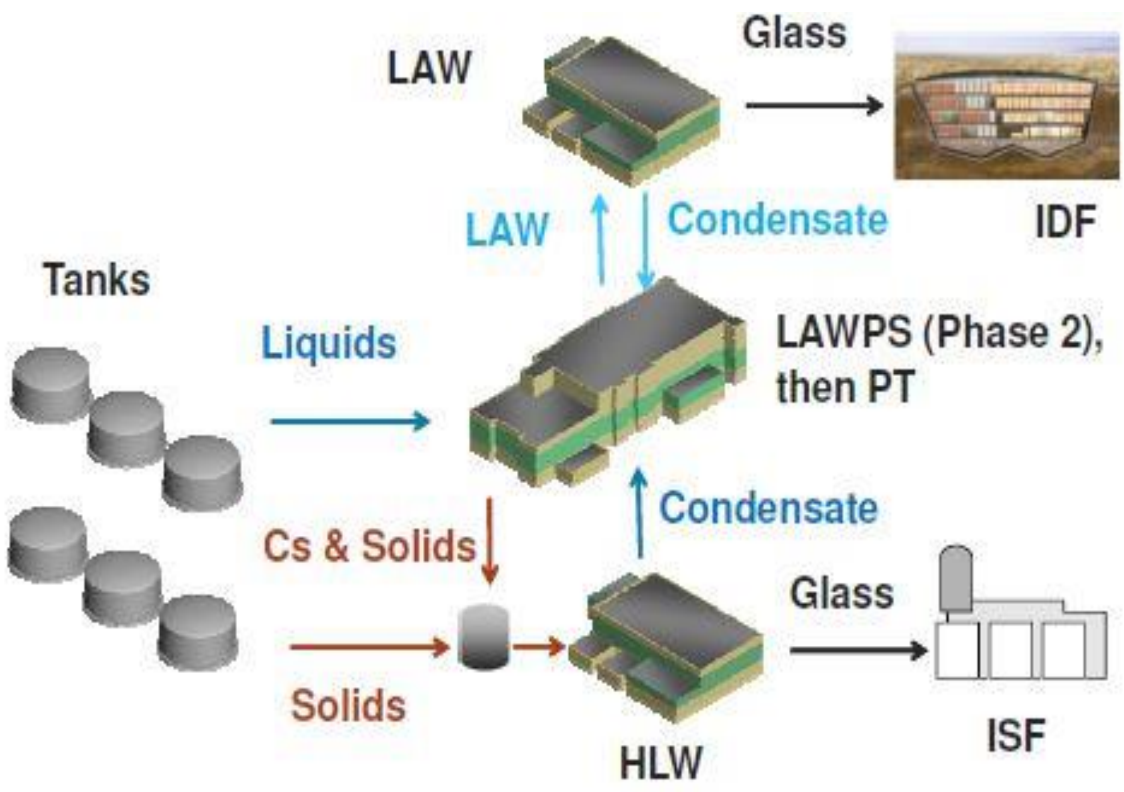
Option 1 - Return Cesium back to the DST (current DOE baseline alternative)

The solids and cesium and possibly other radioactive elements will be removed from the liquid waste stream from the tank waste prior to vitrification in the LAW Facility. The Cesium is captured using Ion Exchange Resin media, then eluated with nitic acid, neutralized and returned to the DST. Secondary liquid wastes generated from the LAW Facility offgas system would then be treated and volume-reduced through evaporation activities using the new Effluent Management Facility and existing Effluent Treatment Facility and 242-A Evaporator in the tank farms.



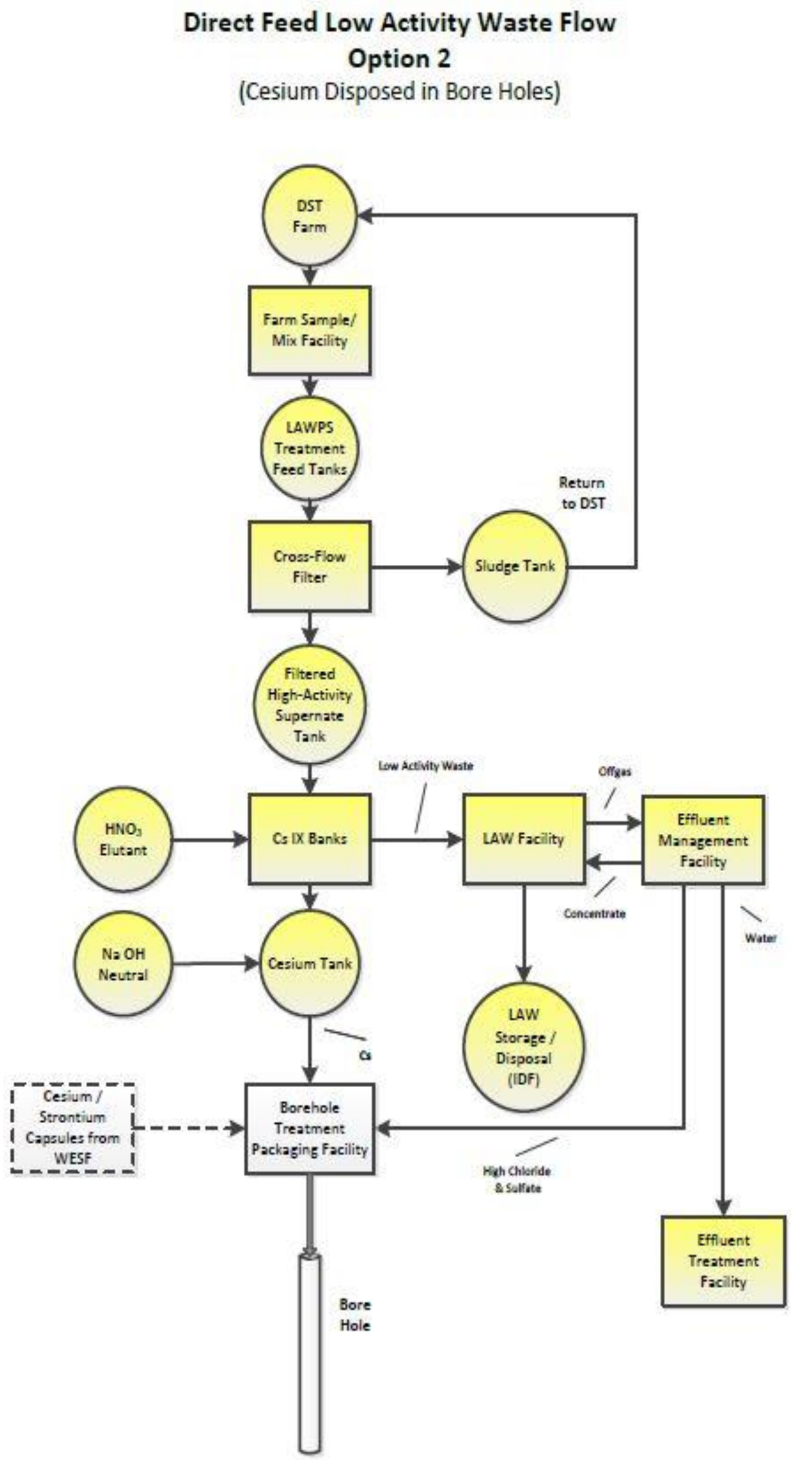
Option 1A – Return Cesium to DST and Expedite Direct Feed HLW

Process DFLAW baseline with cesium returned back to DSTs and expedite Direct Feed HLW. For DFLAW initial runs process low concentration cesium supernatant only (no saltcake in initial runs). Initial process sequence for DFLAW tanks is: 1st tank AP-104, 2nd tank AP-106, 3rd tank AP-103, and 4th tank AP-108, and 5th tank AP-102). Total supernatant processed is 3 million gallons. Expedite Direct Feed HLW process by installing a 100,000 gallon below ground DST tank with some solids/liquid separation capability, large single (replaceable) mixing impeller, hard installed sampling ports, small sampling and ventilation support building, and related underground piping. All tank sludge solids and some related saltcake retain in sludge transfers are to be process by Direct Feed HLW without any pretreatment extraction of any kind for the life of the mission. Once Direct Feed HLW is operational direct all cesium from LAWPS process to HLW glass. Once Pretreatment Facility is complete integrate off gas of all glass plants and processes. Expose Pretreatment Facility to minimal entrained solids; only if absolutely necessary for some select HLW glass batches use Pretreatment Facility to process sludge solids.



Option 2 - Dispose of Cesium in Deep Geologic Bore Holes

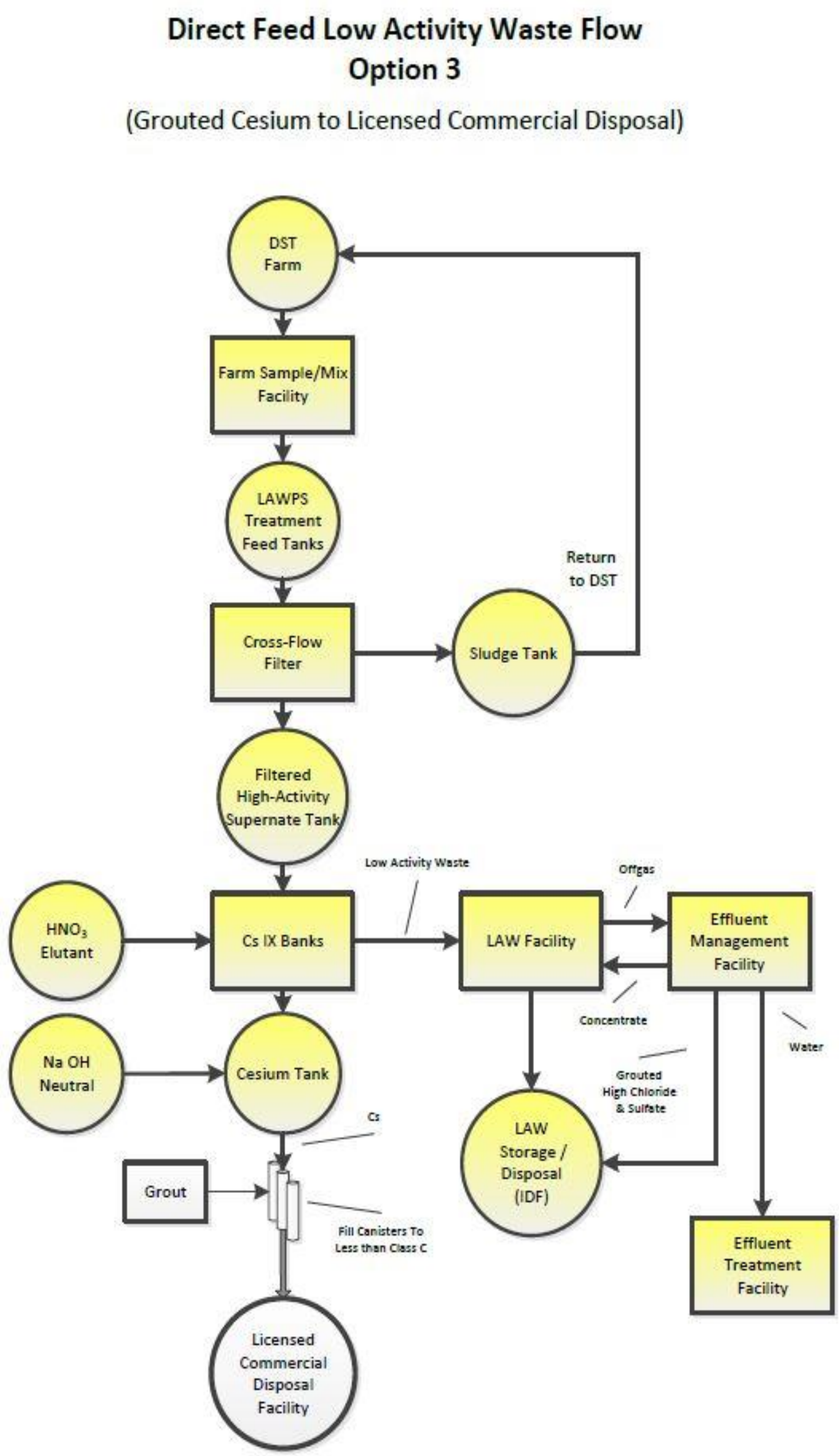
The solids and cesium and possibly other radioactive elements will be removed from the liquid waste stream from the tank waste prior to vitrification in the LAW Facility. The Cesium is captured using Ion Exchange Resin media, then eluated with nitic acid, neutralized, and treated and packaged for disposition in a deep geologic Bore Hole. Alternatively the media could be high retention non-elutable media such as CST which would be dried and packaged for bore holes. Secondary liquid wastes generated from the LAW Facility offgas system would then be treated and volume-reduced through evaporation activities using the new Effluent Management Facility and existing Effluent Treatment Facility and the existing 242-A Evaporator in the tank farms.



Option 3 - Place Dry Media/Cesium in HICs and Dispose of at in Licensed Commercial Disposal Facility

The solids and cesium and possibly other radioactive elements will be removed from the liquid waste stream from the tank waste prior to vitrification in the LAW Facility. The Cesium is captured in LAWPS using zeolite ion specific media and dried and packaged in a High Integrity Container for disposition in a Licensed Commercial Waste Disposal facility. The Zeolite media is low cesium retention to produce Class C LLW. Secondary liquid wastes generated from the LAW Facility offgas system would then be treated and volume-reduced through the new Effluent Management Facility and existing Effluent Treatment Facility and 242-A Evaporator in the tank farms.

The Federal LLRW site at Texas WCS has a current maximum Curie limit of 5.6 MCi. WCS can currently accept ~2.8 MCi of cesium-137 due to barium-137m progeny. This equates to 608 cubic meters of Class C waste at maximum cesium-137 concentration LLW Class C.



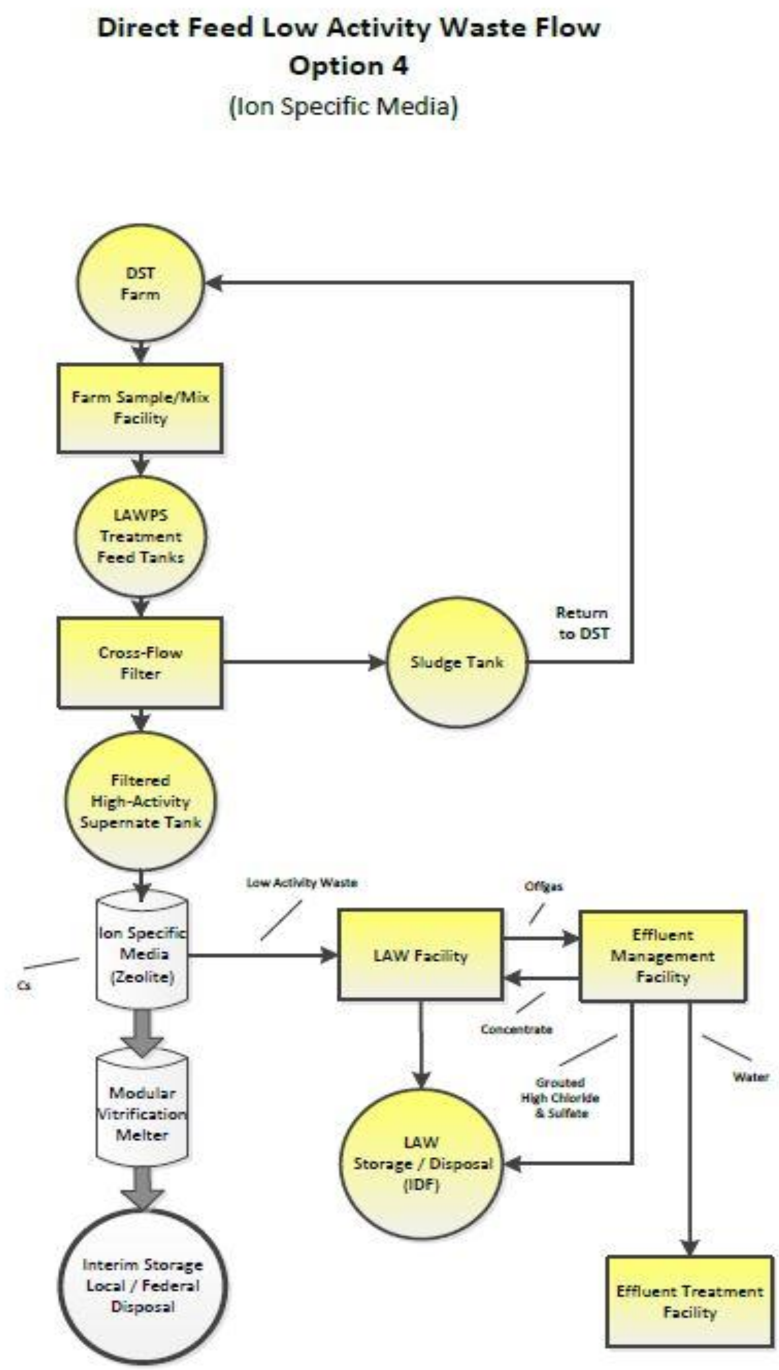
Option 4 - Store Cesium in HICs on Dry Ion Specific Media for Future Federal Disposal

The solids and cesium and possibly other radioactive elements will be removed from the liquid waste stream from the tank waste prior to vitrification in the LAW Facility. The Cesium is captured using a non-elutable Ion Specific media such as crystalline silicotitanate, CST. The cesium could be stored in a high integrity container, HIC or could vitrified in a modular vitrification melter and stored for future disposal in federal repository.

Alternatively cesium in HIC media could decay for 150-200 years and become Class C LLW.

Secondary liquid wastes generated from the LAW Facility offgas system would then be treated and volume-reduced through evaporation activities using new Effluent Management Facility and existing Effluent Treatment Facility and the existing 242-A Evaporator in the tank farms.

The non-elutable media have potentially better cesium selectivity than resorcinol formaldehyde resin, are high pH compatible, and there is no resin regeneration waste sent to tanks.



Option 4A – Store Cesium in Dry HICs or Wet in New Underground Tank. Media to be Ground Up and Incorporated into HLW Glass

Bind Cesium from LAWPS using non-elutable media such as easier to transfer large, spherical (3-5 mm), crystalline silicotitanate. Place media in dry form in HIC containers. Alternatively media can be transferred in slurry form to new underground storage tanks. Media would be ground up and incorporated into HLW glass. If all 56 million gallons of tank waste were extracted of Cesium by CST and CST was ground up and incorporated into HLW glass the HLW canister could would increase by 2-4%. It is expected the DFLAW mission to increase HLW canister count by 0.8-1.6%.

Analysis

The following discusses each of the options that the Board considered and the potential impacts of each option on the path forward toward the DFLAW approach.

The table below summarizes the options developed during presentations, discussions and on-site tours with DOE, and in-depth dialogue and analysis by members of the Board.

Cesium Disposition Option		Cs Removal Process	DFLAW Cs Deposition	Regulatory Requirements	Comments
1	Return Cesium back to DST	Elutable Resin	DST	Acceptable	DFLAW Baseline
1A	Return Cesium to DST and Expedite Direct Feed HLW	Elutable Resin	DST	Acceptable	WTP Redesign Required for Direct Feed HLW
2	Dispose of Cesium in deep geologic Bore Holes	Either, $CsNO_3$ from elutable or CST	Bole Hole	Regulatory Pathway Unknown, Requires WIR	Feasibility Undefined
3	Place dry media/Cesium in HICs and dispose of in Licensed Commercial Disposal Facility	Non-Elutable, Zeolite	WCS	Requires WIR, Class C Waste Due to Cs-137	Limited Curie Count, Requires More Frequent Media Change Out
4	Store Cesium in HICs on Dry Ion Specific Media for Future Federal Disposal	Non-Elutable, CST	On-Site Storage Awaiting Geological Repository	On-site Storage Until After Repository Opens or 150-200 years then Class C	No Current Path for Permanent Disposal as HLW; No Destination. Long Time Until Class C Waste
4A	Store Cesium in Dry HICs or Wet in New Underground Tank. Media to be ground up and incorporated into HLW Glass.	Non-Elutable, CST	On-Site Storage Awaiting HLW Operations	On-site Storage Until HLW After Operational	HLW Has No Current Destination. Very Slight Increase in HLW Canister Count, 1-2%

Discussion

DFLAW impacts on DST Capacity

The actual space taken up by returning neutralized cesium eluded off the LAWPS cesium resin back into the DSTs is ~9% of the supernatant volume removed. This does not include concentration by evaporation which is probably not the choice operation for many reasons. The approximate remaining 24% volume returned to the DSTs (remember 3 parts volume removed from DST, 1 part volume retuned to DSTs) is from LAWPS resin pretreatment, LAWPS resin post cesium elution reactivation, and from LAW off gas processes, and ETF brine volume from all sources. This 24% of volume returned to the tanks includes significant reduction by evaporation by a factor of ~2.5 or slightly more. The large majority of this is form LAW off gas.

Disposition Alternatives:

Option 1A (DFHLW) is the best from an economic, regulatory, and stakeholder perspective. It is support by ORP management, but is lacking a full economic analysis. Potential savings could range be in the billions of dollars since Pretreatment and HLW could be active much earlier than 2039.

Some combination of Options 1A and 3, or 1A and 4, or 1A and 4A are also possible. The option 1A and 4 or 1and 4A combination is the best from the tank space perspective considering the least goes back into the tanks and all high level waste goes to a high level waste repository.

Option 3 is only a temporary solution since this option selected with the lowest cesium level DST tanks considered for DFLAW would only do the supernatant in the 4 listed lowest supernatant tanks in ~1.2 years, but it would process 3 million gallons. This is at 8 gpm at 60% output time from LAWPS.

Even with optimum processing lowest supernatant cesium in DST approximately 5.6 million gallons could be processed before WCS is full in ~2-3 years. This could be done by processing supernatant only as in the table listed below. This would create at most 4 million gallons of space in the DSTs.

Option 3 for a long term DFLAW run would require WCS to be able to accept a higher Curie count. This is quite likely since WCS's political clout is very high in Texas and it is likely the Curie limit can be increased. The increase in Curie limit will not increase costs above the projected $340 million over baseline as the Curie limit issue was not considered in the cost estimate found in RPP-RPT-57115.

Option 3 does require a WIR which we need to have a discussion with NRC about as far as environmental acceptance.

		Cesium DST Supernatant, Lowest to Highest						
Tank		Ci Cs-134 137 per kl		kl		Cesium Ci	Cesium Ci sum	Gallons
241-AN-106		7.53		926		6.97E+03	6.97E+03	2.45E+05
241-AW-105		10.14		580		5.88E+03	1.29E+04	3.98E+05
241-SY-101		23.20		3246		7.53E+04		
241-SY-102		27.86		1382		3.85E+04		
241-AN-101		30.24		863		2.61E+04	3.90E+04	6.27E+05
241-AP-104		38.41		755		2.90E+04	6.80E+04	8.26E+05
241-AY-101		55.90		2124		1.19E+05	1.87E+05	1.39E+06
241-AW-103		105.41		2884		3.04E+05	4.91E+05	2.15E+06
241-AY-102		140.11		2291		3.21E+05	8.12E+05	2.76E+06
241-AP-106		170.65		4272		7.29E+05	1.54E+06	3.89E+06
241-AP-103		175.28		2168		3.80E+05	1.92E+06	4.46E+06
241-AP-108		189.28		4290		8.12E+05	2.73E+06	5.60E+06

The 1A and 4A options looks the best. The option of 1A and 4/4A gives the most flexibility. Option 4A gives the lost estimated additional cost because it used high storage CST media and uses the accepted path of disposition in HLW glass. This does require DOE and WTP contractor to be open to changes in HLW processes, but the additional cost is in the 120 to 200 million dollar range with more DST space being created.

Several Possibilities for Cesium Pathway Using Non-Elutable Resin, Package, and Disposal; RPP-RPT-57115

- Alternative 1: Use non-elutable CST resin and ship to deep geological repository as HLW. Not likely a solution since repository is not operational. This could change hopefully by time HLW glass is being made.
- Alternative 2: Use low loading zeolite exchange media, ship to WCS Texas, requires WIR. Class C waste because of Cs-137. Nevada National Security Site is the other option but more DOE red tape (paperwork) is required.
- Alternative 3: IDF disposal as in Alternative 2, not in TC&WM EIS/ROD so amendment required and WIR required. 2-4 of 12 DFLAW tanks spent resin is likely TRU, but don't tell Texas.

Cost for 5 years operations with resin disposal, $Million

Item	Description	Alt. 1	Alt. 2	Alt. 3
1	Manage Spent IX Resin Disposition	8.7	8.7	8.7
2	ISF Permitting	12.4	13.8	9.7
3	Spent IX Resin ISF	11.9	33.3	25.4
4	Spent IX Resin Disposition	590.7	277.1	8.1
5	ISF Demolition & Remediation	2.4	7.2	5.1
	Total	626.1	340.1	67.1

Cesium Pathway in Processes Using Non-Elutable Resin with Glass Stabilization and Elutable Resin with Less Waste

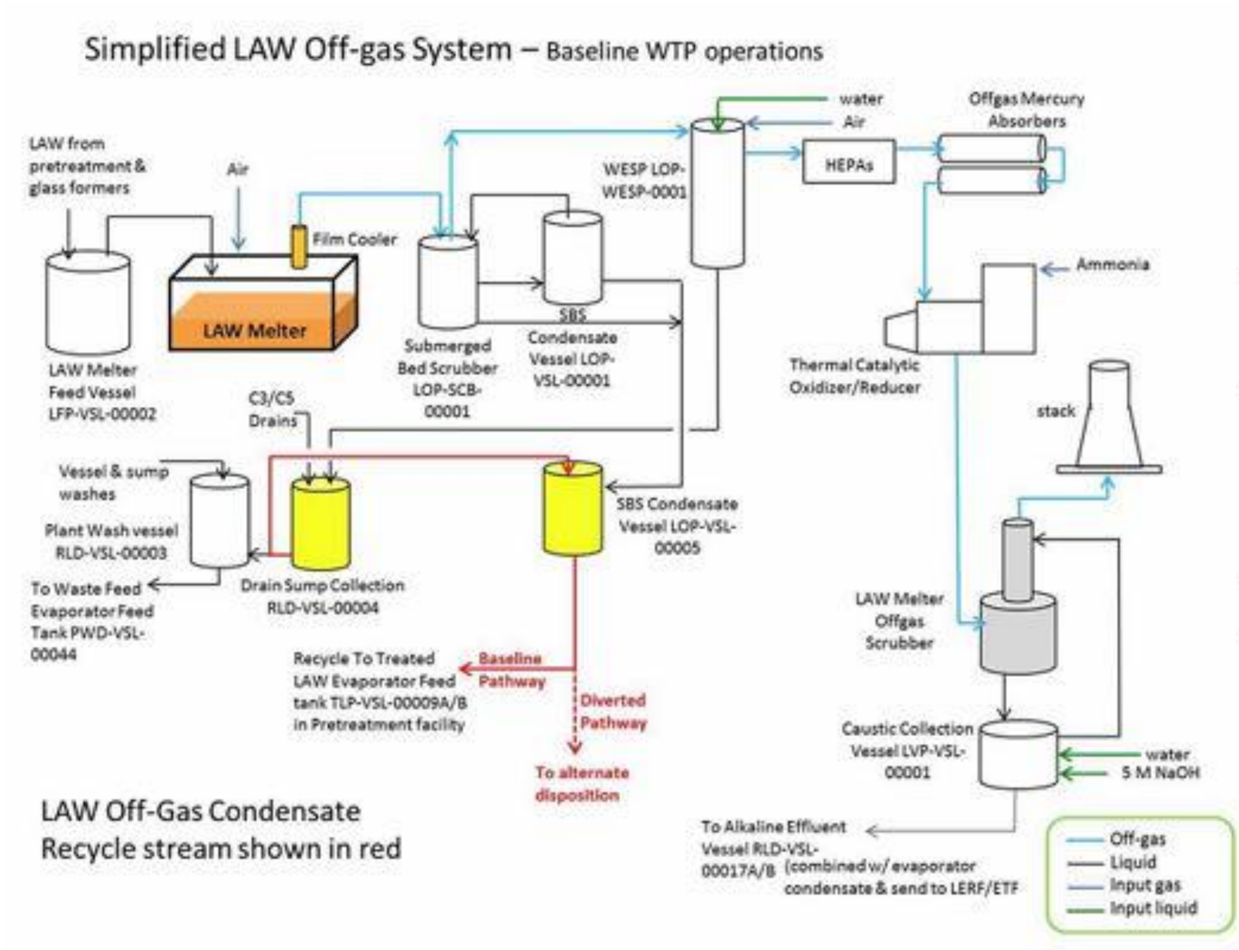
- Another alternative: Kurion and SRNL are proposing a modified Kurion system for cesium removal and interim storage in support of direct feed LAW. Details to be discussed. Likely a crystalline silicotitanate exchange media that is easily incorporated into glass, Geo Melter.
- Even another alternative: proposal to use Electro-active ion exchange by the Nez Perce Tribe. Used conductive ion exchange media of similar structure and selectivity to current resin. Does not require nitric acid and sodium hydroxide for regeneration and you get a counter-ion for free, technetium-99. Resin unloading in accomplished by switching electrical voltage opposite loading voltage. Waste cones off very concentrated giving small storage volume or borehole-able package sizes (grout). This is not electro-deionization (EDI). Electro-active ion exchange has not been evaluated much for nuclear waste, 1 or 2 minor examples. Could not be a mainstream proposal without proof of concept on Hanford waste types.

Off Gas System Impacts

The DFLAW will require the supernate stream to be transferred to the LAW Facility for vitrification following interim pretreatment. Very low activity secondary liquid wastes generated from the LAW facility off gas system (caustic scrubber), LAWPS facility effluent, 242-A Evaporator process condensate, MLLW, IDF, and miscellaneous waste water would be transferred to a new Effluent Treatment Facility, ETF, for volume reduction evaporation and conversion to solid waste, IDF, with liquids going back to tanks (or PT), and LEFT. The input volumes to the ETF are substantial. The system will likely work if the assumptions made in the off gas of the LAW is correct for the later removal trains of the off gas flow. At least a portion ETF was scheduled to be in the Pretreatment Facility, but since PT is not functional a portion of the Pretreatment Facility will be removed and placed in the ETF along with additional separation equipment needed to manage WTP output to go to Liquid Retention Facility, LERT, and then to SALDS. The flow train of the ETF is: pH adjustment, organic destruction, reverse osmosis, evaporator, vacuum spray dryer, and thin film dryer. Volumes are as follows:

DFLAW, 242-A, IDF/MLLW Brine and Powder Quantities, HNF-58821 Rev 0 , July 2015							
Source	Source Rate	Mission Average	Feed Vol	Powder Production	Total Drums*	Brine Volume	Brine Density
	(gal/min)	(gal)	(gal/yr)	(kg/yr)	Powder (per yr)	(gal/yr)	(kg/L)
242-A PC	75		3.50E+06	4.90E+03	24	8.11E+03	1.10
DFLAW EMF/CS	75	3.38E+07	3.38E+06	4.28E+04	209	3.13E+04	1.20
MWT/IDF/Misc	56		2.00E+06	1.99E+03	10	7.79E+03	1.04
WTP	75						
Total Per year			8.88E+06	4.96E+04	242	4.72E+04	
Mission average							
* An average drum loading of 205 kg powder is used to determine drum count. This drum loading is based on operation experience							

The big hitter from DFLAW is 2.9 MT mercury in powder over a 10 year period.



The hotter output of LAW off gas is the submerged bed scrubber condensate vessel. This is rich in technetium-99, iodine-129, strontium-90, samarium-151, cesium-137, plutonium-241, and americium-241. This would usually go to the PT facility, but it is assumed it would go back to the tanks or some other deposition path (SRNL-STI-2014-00602 Revision 0 December 2014). The current technetium-99 incorporation rate is maximum 70% in LAW, but varies from 16 to 80%. Iodine-129 LAW incorporation is ~30%. It is expected that the most mobile radionuclide incorporation will increase by the time LAW is operation but it is not expected to exceed 90% of input. These submerged bed scrubbers off gas would go back to the tank farms along with LAWPS cesium effluent under the current baseline. These would be transferred to the tank farms and volume-reduced through evaporation activities using the existing 242-A Evaporator.

Waste streams from LAWPS would be primarily from resorcinol formaldehyde cesium eluent (which would be neutralized and likely sent directly back to DST), and water solutions of : 0.4% sodium hydroxide, 4% sodium hydroxide, 2.8% nitric acid, deionized water, and rinses of spent resin before disposal.

These total transactions for every 1 million gallons of DST supernatant removed from the tanks and processed is approximately 0.33 million gallons returned to DSTs after evaporation. So for every 3 parts of supernatant removed and process 1 part of waste is returned to the DSTs.

Recommendations

(Add statement of recommendation – What option are we recommending)

References

(add references to presentations and other documents used)

Next steps, Considerations - To be resolved and removed)

- *Waste from ion exchange and spent elutable or spent non-elutable resin will be Class C, GTCC, CH-TRU, RH-TRU, and/or HLW.*
- *Need to determine approximate fraction of expected waste destinations and types for proposals.*
- *Need to determine basic short term and long term costs for the above disposition destinations. On a cost basis the results currently are: HLW deep geological repository = 2 X WCS = 10-72 X IDF. IDF looks unrealistically cheap.*
- *Look at site impacts and see what pathways can minimize impacts. Rank depositions: HLW ≈ RH-TRU ≈ Deep Borehole > GTCC > Class C*