

US Air Force

Environmental Restoration Program – Optimization and Sustainable Remediation

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Air Force Center for Engineering and the Environment
E2S2
May 6, 2009

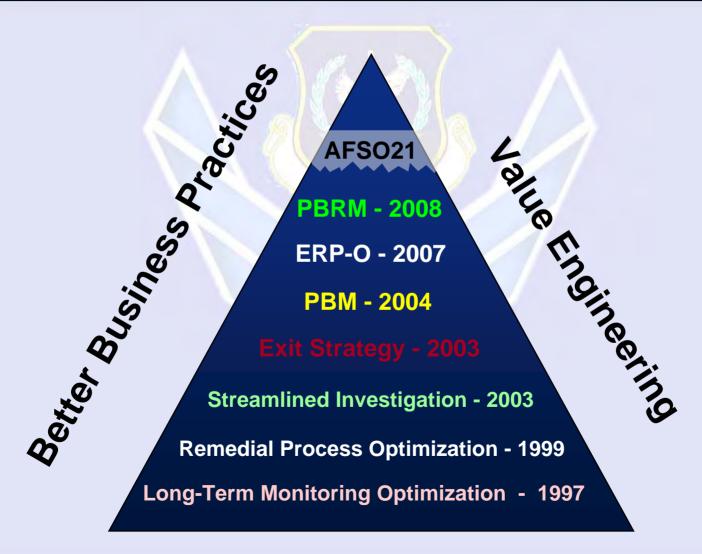
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Foundation for ERP-O





ERP-O Definition

Definition:

Environmental Restoration Program Optimization (ERP-O) is a comprehensive and systematic review of an installation's past, current and planned cleanup activities whose goal is to ensure protection of human health and the environment over the entire restoration life-cycle at minimal risk and optimal costs

ERP-O provides all the needed tools to manage risk and complies with AFSO21



ERP-O Flow Chart

Environmental Restoration Program Optimization Remedy Selection, Proposed Plan, and Record of No Further Action Response Complete Decision (ROD) Cleanup Confirmed Remedy Site Closure **NFRA** Site Closure in Place NFAP Preliminary Site Remedial Post-Closure Remedial Design Assessment/Site Remedial Action Long-Term Investigation/ (RD)/Remedial Action Care Investigation Feasibility Operations (RA-O) Monitoring Construction (RA-C) (Site Closed) (PA/SI) Study (RI/FS) **Investigation Process Remedial Process Optimization** Optimization

Technical Assistance Visits



Investigation Process Optimization (IPO)

Definition:

An Iterative/Systematic Planning Approach for Evaluating Remedial Study Programs with the Goal of Improving Overall:

- ✓ Study Program Effectiveness
- ✓ Time and Cost to Achieve Site RIP Milestone
- ✓ Timely Feedback to Decision Makers

A component of the overall AFCEE ERP-O



Remedial Process Optimization (RPO)

Definition:

An Iterative/Systematic Planning Approach for Evaluating Existing/Proposed Remediation Processes with the Goal of Improving Overall:

- ✓ Control Effectiveness
- ✓ Site Cleanup Time and Costs
- ✓ Timely Feedback to Decision Makers

A component of the overall AFCEE ERP-O



Technical Assistance

Definition:

A Systematic Analytical Approach for resolution of regulatory, technical, contractual, programmatic issues

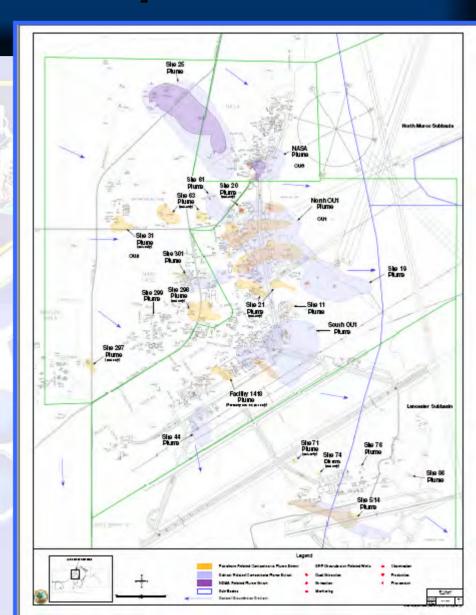
- ✓ Conceptual Site Models and Exit Strategies
- Decision Documents
- ✓ Contractual Strategies
- ✓ Decision Logic
- ✓ Background Studies

A component of the overall AFCEE ERP-O



Example Site: EAFB

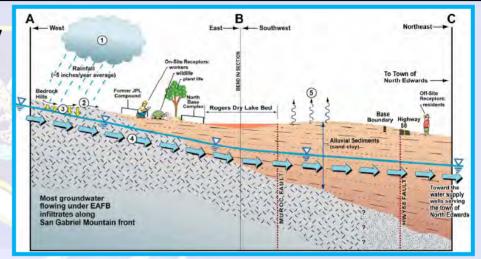
- Edwards Air Force Base
- Technical Impracticability waivers
- Base-related practices for over 50 years
- Several large plumes in complex geology including fractured bedrock
- > A variety of cleanup technologies
- Chemicals of Concern:
 - ✓ TCE, BTEX, MTBE, Perchlorate, NDMA, etc.

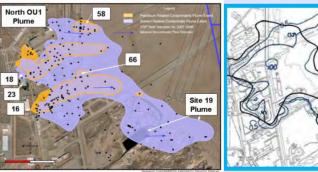




EAFB : ERP-O Team Recommendations

- Continue Technical Impracticability waivers where applicable
- Establish a base-wide LTMO process, build an LTMO decision tree (based on a DQOs), and share with the RPMs
- Prepare a detailed performance monitoring plan to ensure that remedy maintains effectiveness and efficiency
- Consider an overall strategy that does not require perpetual extraction well network to contain the down-gradient migration of the plume





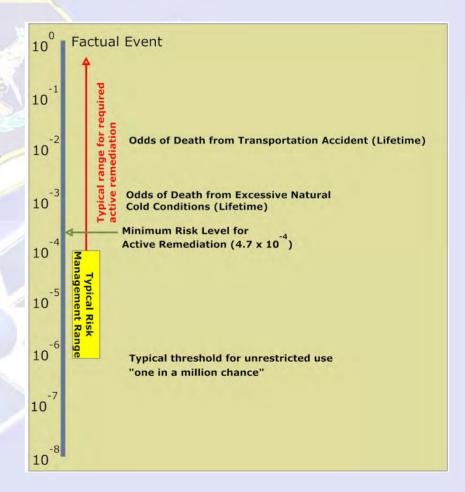




Example: Risk to Workers

Which site at which facility

- ➤ By operating the groundwater treatment system:
 - √ Risk to workers 1 X10⁻³
 - √ Risk to community 1 X10⁻⁴
- ➤ Risk to HH & Eco from ground water 1 X10⁻⁶
- ➤ Is active remediation really justified?
 - ✓ Alternative to remediation





Resources Utilized vs. Resources Protected

- Evaluation of resources being protected
- > Technology vs. Energy Use
- ➤ Is active remediation really justified?
 - ✓ Alternative to remediation

Groundwater restoration

California installation

Consuming 1.5M KWH/yr

Removing < 50 grams of TCE

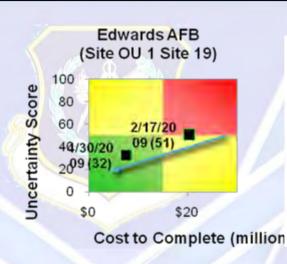
\$3.6M/lb removed

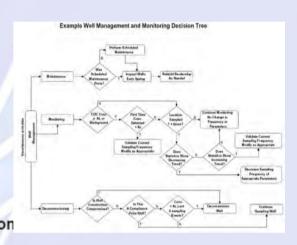


ERP-O Tools

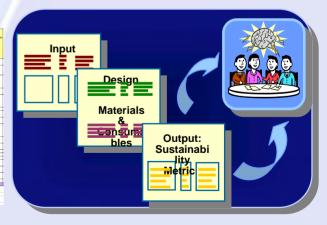
Support Tools

- ✓ Uncertainty Tool
- ✓ Sustainability Tool
- ✓ Performance Tracking
- ✓ Recommendation Tracking
- **✓LTMO**





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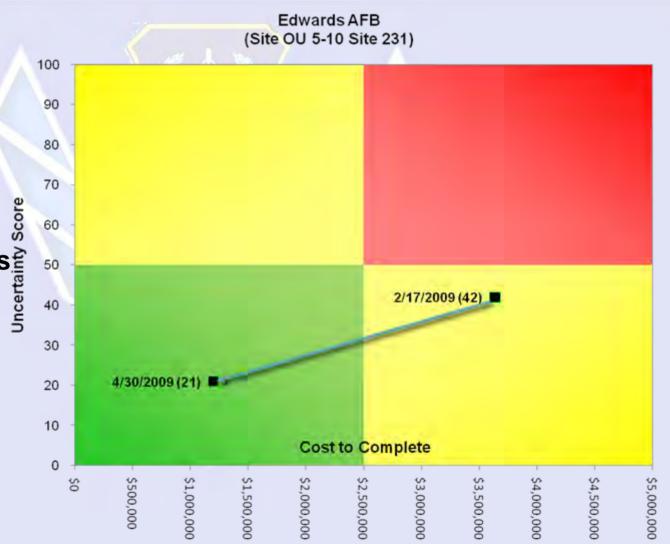




Uncertainty Analysis Tool



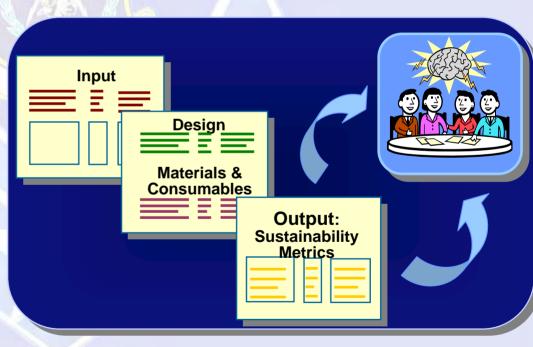
- Site-specific information
- Estimates based on ERP-O team recommendations
- recommendations







- ➤ SRT estimates sustainable metrics for specific technologies
 - ✓ Excavation
 - **✓** SVE
 - ✓ P&T
 - ✓ Enhanced Bioremed
- Sustainable metrics developed
 - √ CO₂
 - √ Energy Consumed
 - √ Technology Cost
 - √ Safety/Accident Risk

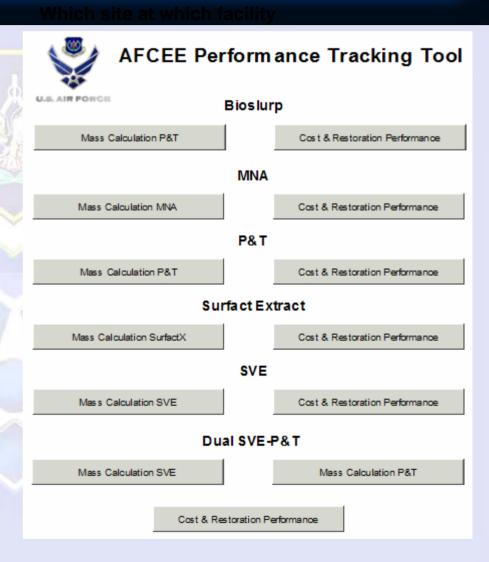




Performance Tracking Tool

➤ Track Remedy's Performance and Cost

- ✓ Projected vs. actual for contaminant reduction
- ✓ Projected cost vs. actual
- Normalized output for easy comparisons
- Six Technologies
 - ✓ Bioslurping
 - ✓ MNA
 - **√** P&T
 - ✓ Surfactant Extraction
 - **✓** SVE
 - ✓ Dual SVE & P&T



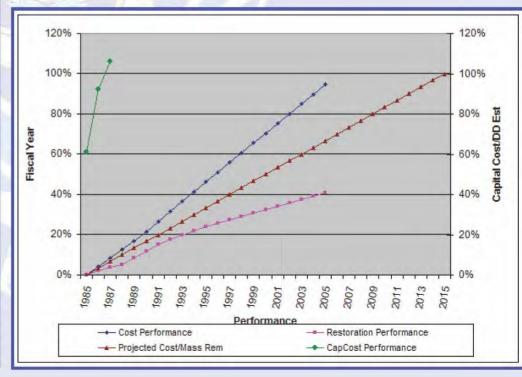




by	ital Cost Fiscal Year	Ma	eration & intenance t by Fiscal Year	Projected Costs/Mass Removed (from DD)	Capital Cost as Percent DD Est.	O&M as Percent of CTC	Total Pecent Mass Removed	
\$	195,000	\$ -		0%	61%	0%	0%	
\$	100,000	\$	290,000	3%	92%	4%	2%	
\$	45,000	\$	290,000	7%	106%	8%	4%	
		\$	300,000	10%		13%	5%	
		\$	310,000	13%		17%	8%	
		\$	305,000	17%		21%	12%	
		\$	375,000	20%		27%	15%	
		\$	340,000	23%		32%	18%	
		\$	340,000	27%		36%	20%	
		\$	340,000	30%		41%	22%	
		\$	340,000	33%		46%	24%	
		\$	340,000	37%		51%	26%	
		\$	340,000	40%		56%	27%	
		\$	340,000	43%		61%	29%	
		\$	340,000	47%		66%	31%	
		\$	340,000	50%		70%	32%	
		\$	340,000	53%		75%	34%	
		\$	340,000	57%		80%	36%	
		\$	340,000	60%		85%	37%	
		\$	340,000	63%		90%	39%	
		\$	340,000	67%		95%	41%	
				70%				
				73%				
				77%				
				80%				
				83%				
				87%				
				90%				
				93%				
				97%				
				100%				

Total Mass at RA-O Start-Up (II	30000
Cost-To-Complete (CTC) (\$)	\$ 7,000,000
DD Capital Cost Est	\$ 320,000
Impacted Acres	23
Acre-ft of groundwater impacted	265
RA-O Start Year (from DD)	1985
RA-O Completion Year	2015

		To Date		stimated otal cost
Cost/Acre	\$	288,261	\$	117,832
Cost/Acre feet	5	25,019	- 5	10,227
Cost/lb removed	\$	541		
Total O&M Costs	\$	6,630,000		
Total Mass Removed		12,263 lbs		
Portion of DD Mass Rem		40.9%		







Which site at which facility

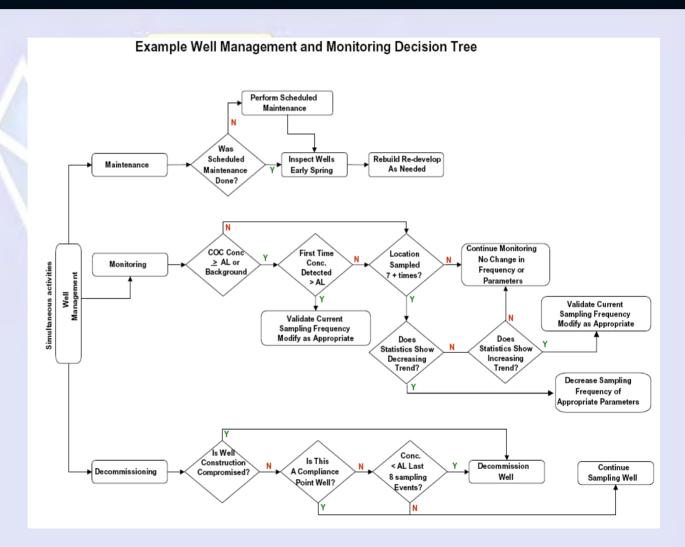
- Track Recommendations (ERP-O Phase IV)
- ➤ Phase II, III
- > Track
 - ✓ Implementation
 - ✓ Risk reduction
 - ✓ RC Acceleration
 - ✓ Total Investment
 - ✓ Cost avoidance
 - ✓ ROI

н	M ART AL AK									N.		l li	
	2008 Phase I Wrigh-Patterson AFB RPO Report Recommendations	Site	Recommendati on Author	Status of Recommenda tion	OPR	Estimated Implementation Date	Impact on Risk to Human Health and the Environme nt	Impact on Time to Site Closure	Estimated Cost Avoidance Annual/Life Cycle	Cost to Implement Recommendations	Documented Cost Avoidance Annual/Life Cycle	Recommendations Presented and Approved by Regulators Y/N = 1/0 N/A	Implementat Contract Awarded Y/N = 1/0 N/A
FY08WPAFB01	Prepare Basewide CSM (consolidated, concise, current) for use as a management tool	Basewide/Pr ogram Wide	JGibbs	Planning	RPO Phase II	3009	None	Shorten				0	0
FY08WPAFB02	Record decision inputs, technical approaches, and exit strategies to document institutional knowledge in a management summary	Basewide/Pr ogram Wide	JGibbs	Planning	RPO Phase II	3009	None	Shorten				0	0
FY08WPAFB03	For future optimization efforts, perform LTM Optimization (LTMO) on monitoring wells according to the criteria described in the data quality objectives (DQOs) in QAPP	Basewide/Pr ogram Wide	SMadabhushi	Planning	PMO and Base	10:10	Lower Risk	Shorten				0	0
FY08WPAFB04	Develop Exit Strategies for all sites (including a clear definition of the endpoint)	Basewide/Pr ogram Wide	SMadabhushi	Planning	PMO and Base	4003	None	Shorten				0	0
FY08WPAFB05	Prepare CSM for each site exceeding VIP screening criteria (BS 5; Bldg 53; FAA-B; LF 8, residential area; OU 2; MW20-2S and SV08 areas; OU 4, MW-12B; OU 10 MW-11S)	Basewide/Pr ogram Wide	RKutaman	Planning	RPO Phase II	4009	None	Shorten				0	0
FY08WPAFB06	Develop site-specific CSM for GWOU	GW0U	JSpencer	Planning	PMO and Base	4003	None	Shorten				0	0
FY08WPAFB07	OU1: Validate need for leachate extraction wells and optimize if needed	001	SBrock	Planning	PMO and Base	4003	None	None				0	0
FY08WPAFB08	Perform further optimization to reduce groundwater monitoring	001	SBrock	Planning	PMO and Base	1010	None	None				0	0
FY08WPAFB9	OU1: Complete a stand alone OU1 CSM to document current conditions and focus additional optimization until the site is closed (use as a template for other site-specific CSMs)	001	SBrock	Planning	PMO and Base	4903	None	None				0	0
FY08WPAFB10	OU2: Build a 3-D CSM to explain the anomalies	002	SMadabhushi	Planning	PMO and Base	4009	Lower Risk	Shorten				0	0
FY08WPAFB11	OU2: Negotiate RB cleanup levels as applicable and appropriate	002	SMadabhushi	Planning	PMO and Base	1010	Lower Risk	Shorten				0	0
FY08WPAFB12	OU2: Monitoring for NA parameters less	002	SMadabhushi	Planning	PMO and Base	NA	None	None				0	0
FY08WPAFB13	Develop Site-Specific Exit Strategy	005	JGibbs	Planning	PMO and Base	10:10	None	None				0	0
FY08WPAFB14	Develop program summary for risk	0U5	JGibbs	Planning	PMO and Base	4003	None	Shorten				0	0
FY08WPAFB15	Document transition of objectives to life cycle minimization (risk, duration, cost)	005	JGibbs	Planning	PMO and Base	3009	None	None				0	0
FY08WPAFB16	Consider low energy treatment alternatives in remedy selection/alternative analysis for GWTP	005	JGibbs	Planning	PMO and Base	1010	None	Shorten				0	0
FY08WPAFB17	Document management rationale, decisions, logic to preserve institutional knowledge	005	JGibbs	Planning	PMO and Base	4003	None	None				0	0
									0		<u> </u>		
	In a l						0	0	0	0	0		
Blue Shading =	Phase 2 general conceptual recommendations.												-
an Shading =	Phase 2 field work items.												-
Green Shading =	Phase 2 technical studies or tasks (may include a		collection].										-
Grey Shading =	Canceled, postponed, or completed recommends	ition											-
Jo Shading =	No shading indicates base/PMO OPR			ı									



Monitoring Decision Logic

- Purpose of each well?
- > CoC trends
- Statistical analysis
- Rational recommenda tions





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Monitoring Decision Logic

Wellio	5.	orreal mpling rgareag	learliady, hashyround, sompliance modificing, scaleguell, plane modificing, close	Targel Analgles/Melb ad Je.g., 82685, MHA, field parameters, els.[# Sample results in biologic record and must record result my/L #, TCE, PCA	Qualitation Connecteding Teendo HealWella Deureaning in Plane	Petrolialiq opalialiq redundanl or osororosarq	Resourced etalistical temporal tered analysis?	for folier modificing [e.q., forgonoug, analyte fiel, nampling mothed, command]	Ralineale for economycelaline	Commed
AP-374	somi	-annual	rontry	VOCrby 8260B	21, ND, ND	Decrearing/Stabl e	Unnocossary	No	NO (Abandan)	Dawn gradient of sentry well AP4019	All non datactes incoincaption (21 sampling rounds)
AP-401	romi	-annual	PM.		19, 17, 1.3	٥	AP4017 % AP4525	No		Plumostability is confirmed	Only TCE romains above MCLs after 19 rounds of sampling
				90Crby		Decrearing/Stabl			YES (5 yr, TCE		And the second s
AP-401	somi	rannual	PM	8260B VOCaby	18,1200,280	o Docroaring/Stabl		No		Main plume manitaring well To manitar plume stability and	Principal indicator of progress towards RAOs
AF-4019	romi	-annual	rontry	\$260B	18, ND, ND	o personning (2446)		No		behavior	Sentry well to ensure the plume stability
THE TAY I	2.11			VOCa by		Docroaring/Stabl			ariamy,		
AP-434	romi	-annual	rontry	\$260B	7, 15, nd		Unnocorrary	No	NO (Abandan)	Plumo ir stablo	Sontry well has a well upgradient to monitor AP4525
			A	VOCa by		Decrearing/Stabl	60				
AP-434	romi	-annual	sontry	8260B VOCrby	7,nd,nd	o Docroaring/Stabl	Unnocossary	No	NO (Abandan)	Plumostability is confirmed	No dotections of CoCs for over five years of sampling
AP-435	ram:	annual	rantry	8260B	7, nd, nd	necrearings 25 and	Unnecersary	No	NO (Abandes)	Plumostability is confirmed	TCE, PCEND for ton yours
A 400	2011	annia al	2051/	VOCarby		Decreasing/Stabl	**************************************		YES (5 yr, TCE	rames sacins) a sportrings	A SOLD SOLD TRANSPORT
AP-452	romi	-annual	PM	8260B	5,600,120			No	Management of the Committee of the Commi	Plume manitaring	Principal indicator of progress towards RAOs
100.00			sof .	VOCa by	CO. Track	Docroaring/Stabl	Spatially rodundant with	20	deres	E SUPE - I	The Carlo and Ca
AP-455	somi	-annual	PM	8260B	3, 19, 120	D 1 10 11	AP4017 & AP4525	No	NO (Abandon)	Plumo ir stablo	TCE can be manitared from the wells AP4017 & AP4525
Apiesa		2000	Cotto	VOCaby 8260B	Charles Control of the Control	Docroaring/Stabl	11	No	NO CALLED A	Plumostability is confirmed	No detections of CoCs
HF-524	rom)	-annual	sentry	VOCrby	1, nd, nd	o Docroarina/Stabl	Unnocorrary Spatially rodundant with	110	ITO (Mbanaan)	Up gradient of sentry manitoring well	ing detections or odes
AP-374	romi	-annual	PM	8260B	14,56,9	0	AP4017 % AP4525	No	NO (Abandan)		All COCr bolow action lovely except for TCE & PCA
1			ridogradion	VOCs by		Decrearing/Stabl			Tree and	Up gradient of sentry monitoring well	
AP-374	romi	-annual	ŧ	8260B	17, 29, 25	0	Unnocorrary	No	NO (Abandan)	AP3748	All COCr bolou action lovelrexcept for TCE & PCA
				VOCarby		Decreasing/Stabl			YES (5 yr, TCE		
MP-37	remi	rannual	rentry May	8260B VOCrby	16,250,2.5	o Docroaring/Stabl		No	&PCA enly)	Manitaring/Sentry well	Sentry well to ensure the plume stability
AP-374	som!	-annual		8260B	18, ND, ND	o commence and	Unnecorrary	No	NO (Abandes)	Upgradient clean well	
	1		-y de a witchet	VOCr by		Docroaring/Stabl			YES (5 yr, TCE	The second second second	Management of the second of th
AP-398	somi	-annual	Upgradient	8260B	14, 9.8, 2.5		Unnecessary	No	&PCA only)	Plumostability is confirmed	Naflau detectionssince 2000
120 120				VOCr by	a transfer of the con-	Decrearing/Stabl		La Terra	Water de la Maria		
AP-398	romi	-annual	sontry	8260B	18, ND, ND	6 1 (C. 10)	Unnocorrary	No	NO (Abandon)	Plumoztability is confirmed	Na dotoctions sinco 2000
Ap. 200		-annual	БМ	VOCrby 8260B	17,2100,720	Docroaring/Stabl	Spatially rodundant with AP4017 & AP4525	No	NOTAL I	Plume ir stable	Waltran aithorsida AP3989 and AP4519 will suffice
ME -230	120mi	annual	ret	VOCarby		Docroaring/Stabl	Spatially rodundant with	110	IIO (Mbanadh)	r iume u Stable	TO BE AN OIS NOT 2190 MF 2797 GING MF 4217 MINISUFFICE
AP-398	romi	-annual	PM		17,350,53	0	AP4017 % AP4525	No	NO (Abandon)	Plumostability is confirmed	Other wells in the main plume area will continue to monitor
Date of the Control				VOCa by		Decreasing/Stabl	Spatially rodundant with				
AP-398	romi	-annual	PM	8260B	16,250,27		AP4017 % AP4525	No		Plume ir stable	Other wells in the main plume area will continue to monitor
			BU	VOCarby COCCAR		Docroaring/Stabl				Tomonitor plumostability and	TCE and PCA can be munitured in this well to make future cleanup complete
AP-35	romi	-annual	rm	\$260B VOCaby	18,920,200	e Decrearing/Stabl		No	⊗PCA enly)	behavior	decirion
AP-435	som!	-annual	rontry	8260B	7, nd, nd	enertemindiscasi	Unnecessary	No	NO (Abandes)	Down gradient clean well	Na dotoctionssince 2000
			Upgradient			Docroaring/Stabl		No		Plumostability is confirmed	Upgradientwell
			Upgradient			Decreasing/Stabl		No		Upgradient clean well	Na detections ever
AP-451:	somi	-annual	ridogradion		15, ND, ND	Decrearing/Stabl	Unnecessary	No		Sidegradient clean well	No dotoctions over
Lund)						Docroaring/Stabl			YES (5 yr, TCE	The second second	TCE and PCA can be manitared in thir well to make future cleanup complete
AP-45	somi	-annual	PM		6,1000,350	6 1 to 12	e	No	@PCA anly)	Main plume manitaring well	docirion
AP-455	zomi	-annual	РМ		3,1000,330	DocroarinqfStabl o	Spatially radundant with AP4017 & AP4525	No	NO (Abandan)	Plumostability is confirmed	Other wells in the main plume area will continue to many or



ERP-O Supporting Agencies

- >ITRC Interstate Technology Regulatory Council
 - ✓ ITRC Team Members become Advocates for the Process
- **➤ USGS US Geological Survey**
 - ✓ Support CSM and fate and transport model oversight
- **➤ USACE US Army Corp of Engineers**
 - ✓ Additional DoD Technical Expertise



ITRC RRM and GSR Teams

- >ITRC Interstate Technology Regulatory Council
- ➤ AFCEE is providing in-kind support to several ITRC teams including Remediation Risk Management (RRM) and Green & Sustainable Remediation (GSR) Teams
- ➤ AFCEE Funds and Supports ITRC RPO Team Members to Participate on ERP-O Reviews



ITRC RRM & GSR Team Products

- > RPO Products on www.itrcweb.org
 - ✓ RPO and PBEM Technical Guidance Documents
 - ✓ RPO related Fact Sheets
 - ✓ RPO and PBEM Internet-based Trainings
- > ITRC RRM Team Products
 - ✓ Technical & Regulatory Guidance Document (Fall '09)
 - ✓ Internet-based Training on RRM (Early 2010)
- > ITRC GSR Team Products
 - ✓ Status summary of GSR practices
 - ✓ State survey of GSR practices
 - ✓ Technical and Regulatory Guidance Document (2010)
 - ✓ Internet-based Training on GSR (2011)



Incorporating Sustainable and Green Practices into ERP-O

- ➤ AFCEE PBM Guidance document is being developed to reflect ERP-O Strategies and sustainable remediation
 - ✓ PBRM a green/sustainable process is also being revised
 - ✓ PBM, ERP-O, IPO, RPO, PBRM all have a common goal
 - Sustainable, green, & cost effective RIP by 2012
 - Accelerate clean closure
- > Investigation Processes
 - ✓ Use more sustainable approaches for characterization
 - ✓ Use Triad with a green perspective
- Land Use and Institutional Controls
 - ✓ Developing sustainable strategies with the active participation from stakeholders



Integrity-Service-Excellence