DOE-Sponsored

Pollution Prevention Opportunity Assessment Training

May 2, 2005

Las Vegas, Nevada

Welcome and Introductions

> Introduce Trainers
  - Lisa Burns (Shaw Environmental)
  - Martha Gitt (Shaw Environmental)
  - Lee Bishop (Office of Repository Development - Yucca Mountain Project)

Billboard you will NEVER see

Outline of Today's Training Schedule

Welcome/Introductions (8:00-8:15AM)

Integrating Pollution Prevention and Environmental Management Systems (EMS) (8:15 – 9:15)

> Drivers for P2 and EMS
> Benefits of P2 and Opportunity Assessments
> Integration of P2 into EMS
> Identifying Significant Environmental Aspects and Environmental Impacts
> Setting Objectives and Targets

BREAK (9:15 – 9:30)

Aspect/Impact Analysis (P2 Opportunity Assessment) Methodology (9:30 – 11:30)

> Select and Define Scope of Assessment
> Team Selection
> Collect Information (Develop Baseline Flow Diagram) LEVEL 1
> Brainstorm Opportunities/Draw Alternative Flow Diagram/Decision on Level of Assessment Needed - LEVEL 2

LUNCH – 11:30 – 12:30 - On Your Own

> Life Cycle Analysis – Martha Gitt (12:30 – 1:30) – LEVEL 3
> Recommendations/Selling to Management (1:30 – 1:45)
> WAKE UP!

DOE-Specific, Practical Examples

Energy Management Discussion(1:45 – 2:30)

BREAK 2:30 – 2:45

> Green Teaming (Lee Bishop) (2:45 – 3:30)
> Environmental Restoration Example (3:30 – 4:00)

Wrap-up/Summary (4:00)

RECEPTION – 5:00 – 7:00

Training for what?

P2 and Environmental Management Systems (EMS)

Management Commitment

"By building sound P2 measures into our EMS, we can attain "beyond compliance" results that help reduce the environmental footprint as well as the life-cycle costs of our facilities and operations."

John Spitaleri Shaw

DOE Assistant Secretary for
Environment, Safety and Health
2005 Earth Day Message

Do we have to?
P2/WMin Regulatory Matrix/Drivers

Federal Drivers

- Pollution Prevention Act of 1990
- Resource Conservation & Recovery Act (RCRA)
- Comprehensive Environmental Response, Compensation, Liability Act (CERCLA) 1980
- Clean Air Act/Clean Water Act
- Emergency Planning and Community Right-to-Know Act
- Energy Policy Act of 1992

Executive Orders

- E.O. 13123 – GTG Efficient Energy Management
- E.O. 13148 – GTG Leadership in Environmental Management
- E.O. 13101 - GTG Waste Prevention, Recycling and Federal Acquisition
- E.O. 13221 – Energy-Efficient Stand-by Power Devices
- E.O. 13134 – Developing and Promoting Bio-Based Products and Bio-energy
- E.O 13327 – Federal Real Property Asset Management
- E.O. 13149 – GTG Federal Fleet and Transportation Efficiency

DOE Orders

- DOE Order 450.1 – Environmental Protection Program
- DOE Order 430.2A – Departmental Energy and Utility Management
- DOE Order 430.1B – Real Property Asset Management

Another good reason -
New IG Audit Report on DOE's P2 Program - IG-0680

Issued March 17, 2005

Results

- > No comprehensive, consistent complex-wide program to identify, evaluate, and implement cost-effective proposals to minimize future waste generation
- > Not systematically researching new opportunities to prevent and recycle waste
- > Not implementing P2 strategies that were deemed feasible and cost effective

Recommendations:

- > Conduct operational assessments to identify opportunities for P2 projects and implement those deemed cost-effective using life-cycle assessment concepts
- > Employ innovative strategies, such as waste generator's fees, to fund pollution prevention programs
- > Develop and implement performance measures for P2 activities that re-emphasize the program and hold managers accountable for implementation.

- > ***The entire report can be found on the web at:*** **http://www.ig.doe.gov/igreports.htm#cal2005**

Why incorporate P2 into EMS?

> GOTTA do it

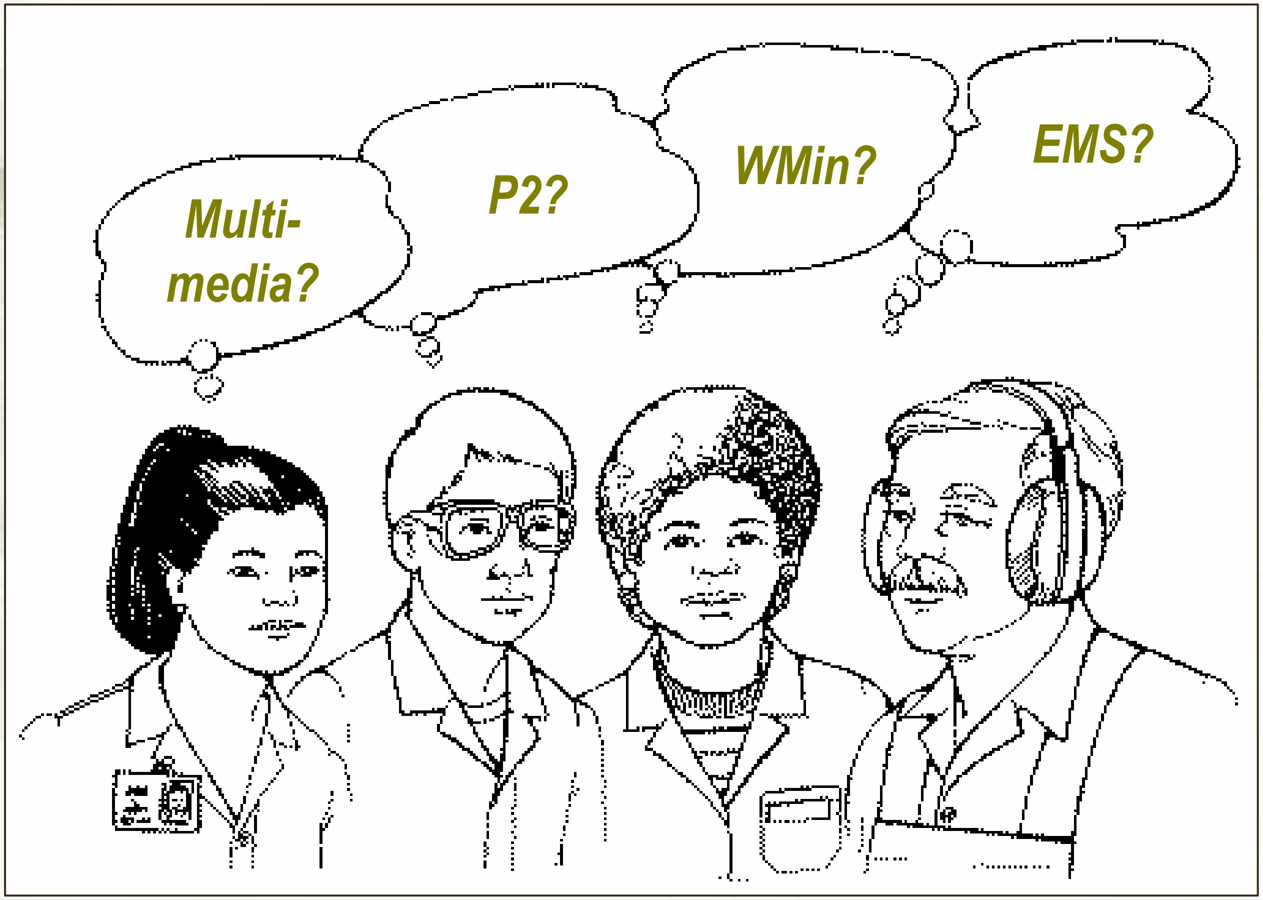
> OUGHTA do it

- Relevant, Significant, Helpful
- **Compliance is an outcome of a well-functioning EMS**

Both are Helpful - How?

- > Minimize wastes, energy, and water usage
- > Reduce overall process and project costs
- > Increase efficiencies – SMART business!
- > Reduce risks and liabilities (hazards)
- > Reduces DOE's long-term mortgage
- > Reduces reporting and permitting
- > Reduces resource usage/increases conservation efforts
- > Improves public image – good environmental stewards

Definitions



Pollution Prevention/Waste Minimization Defined

- P2 - Optimizes resources and reduces or eliminates material releases to the air, water, and/or land (multi-media). **A better definition** "Activities that have the potential to transform industry from material intensive, high through-put processes to systems that use fuel and raw materials in a highly efficient manner and rely on inputs with low environmental costs, generate little or no waste, recycle residuals, and release only benign effluents"
- Waste Minimization - If you have to generate wastes, MINIMIZE THEM - economically avoids or reduces the generation of waste by source reduction, reducing toxicity, improving energy usage, or recycling and reuse.

P2 is a Multi-Media Discipline

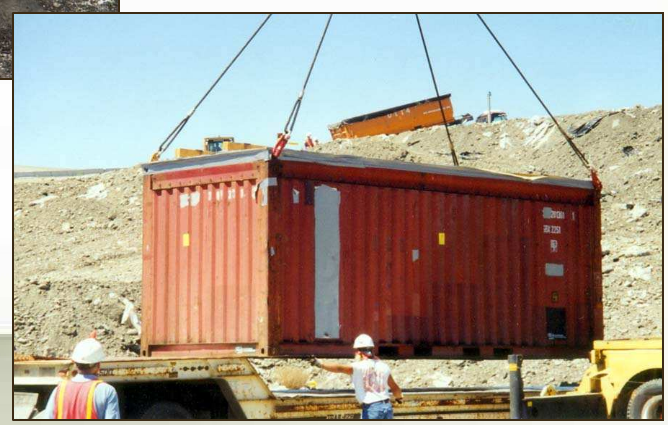
W ater
A ir
S olids
T ime
E nergy

Waste Disposal Adds Up!

Legacy Waste Adds Up!


GROVE
HO-64-6063
TRAIL-EZE

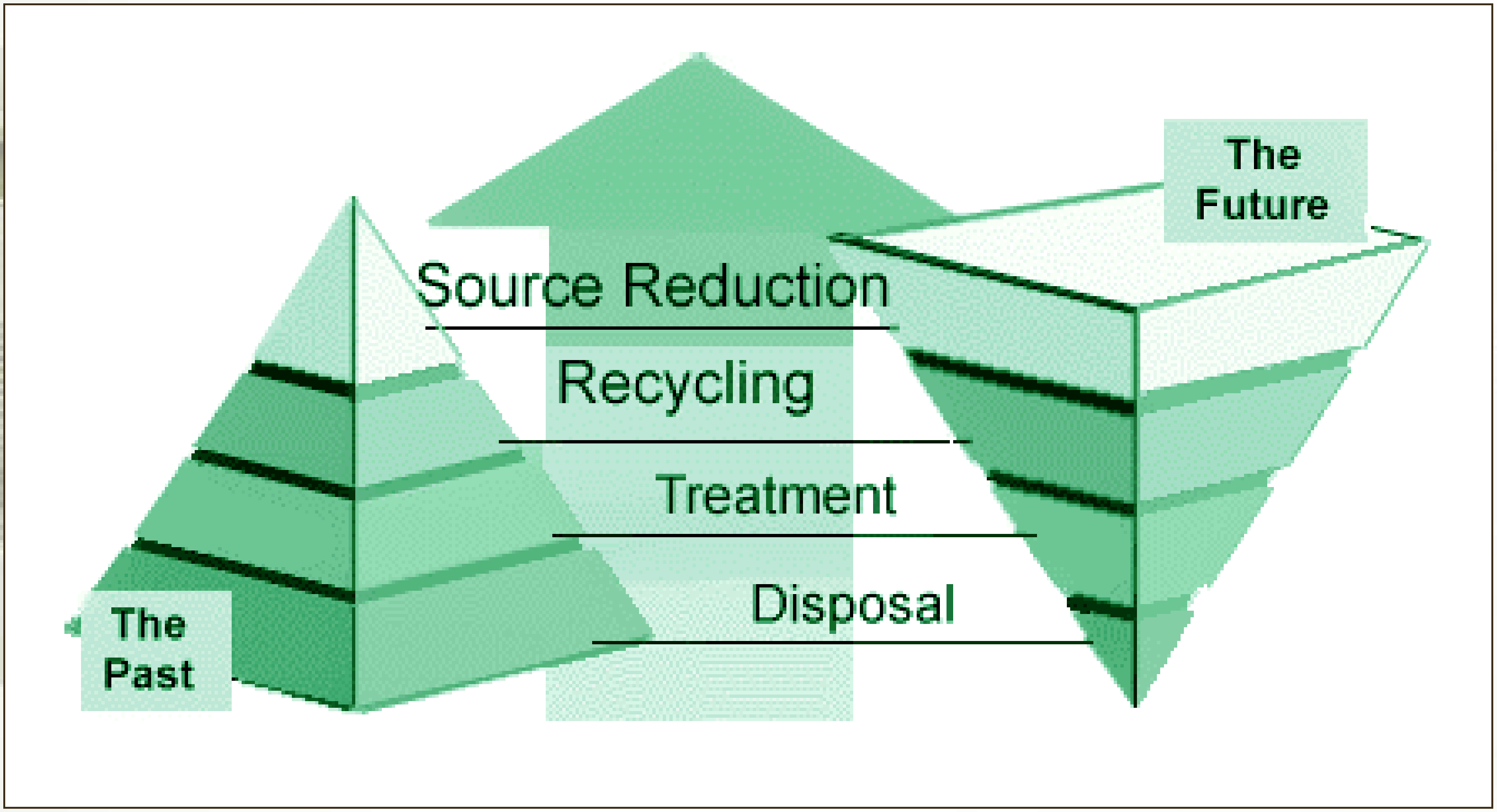

GROVE



Waste Management Costs are Directly Effected by P2/WMin Implementation

> Reduced manpower and equipment requirements
> Less waste storage space resulting in less monitoring and surveillance requirements
> Less packaging prior to disposal
> Less need to transport for disposal (reduced emissions)
> Smaller quantities treated, resulting in shift to less costly non-rad, non-haz status
> Reduced paperwork and record-keeping requirements (waste tracking system usage lessened, fewer waste manifests, etc.)

Old and New Environmental Management



What is an EMS?

> Management approach to determine, prioritize, implement, and improve on environmental issues that will lead to sustainable environmental stewardship

Integration of P2 into EMS


I WANT YOU TO PERFORM A GAP ANALYSIS FOR OUR DEPARTMENT.
BE COMPLETELY HONEST.
THE GAP IS LOCATED BETWEEN TWO POINTY TUFTS OF HAIR THAT MOVE ABOUT THE OFFICE.
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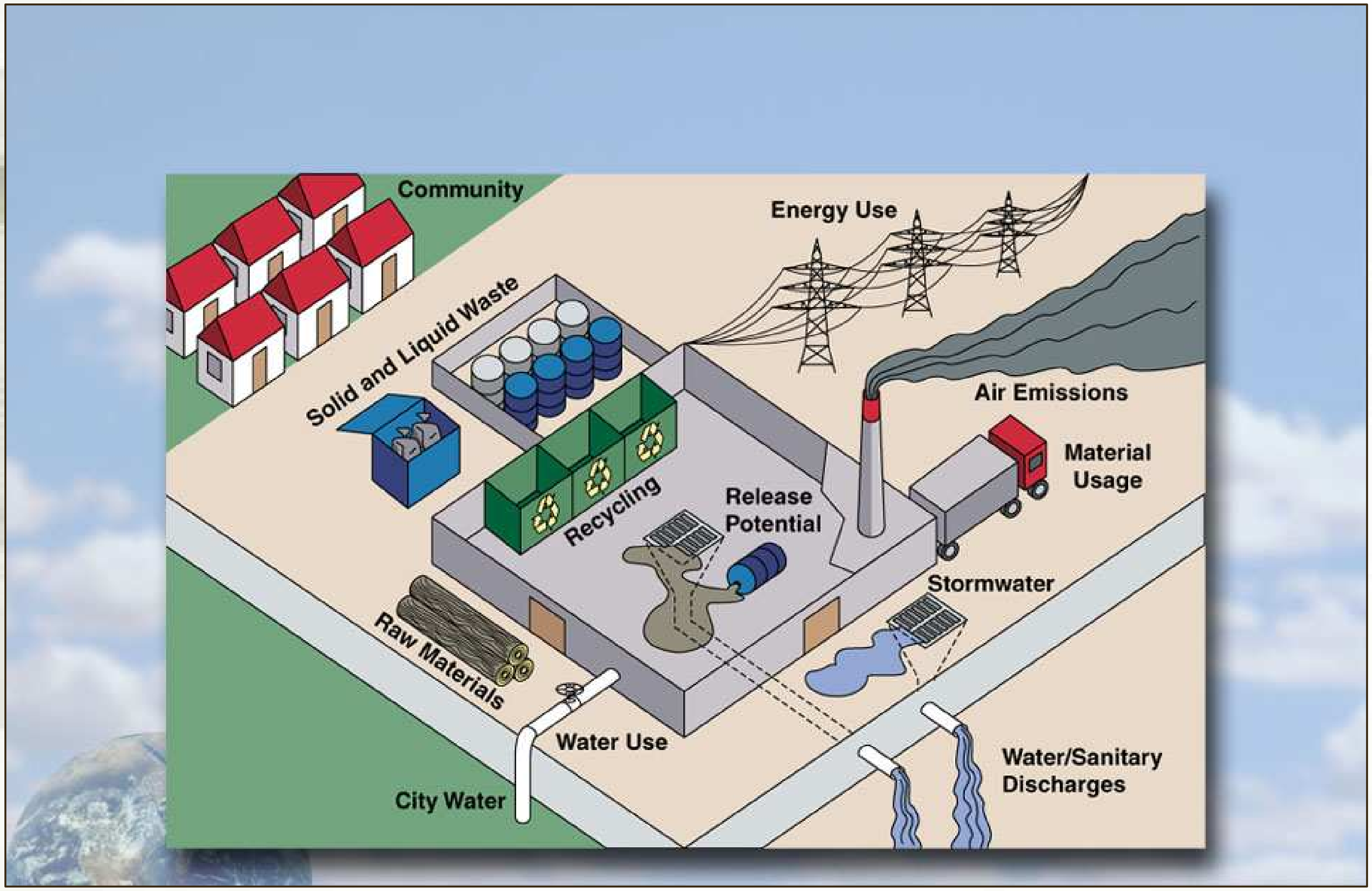
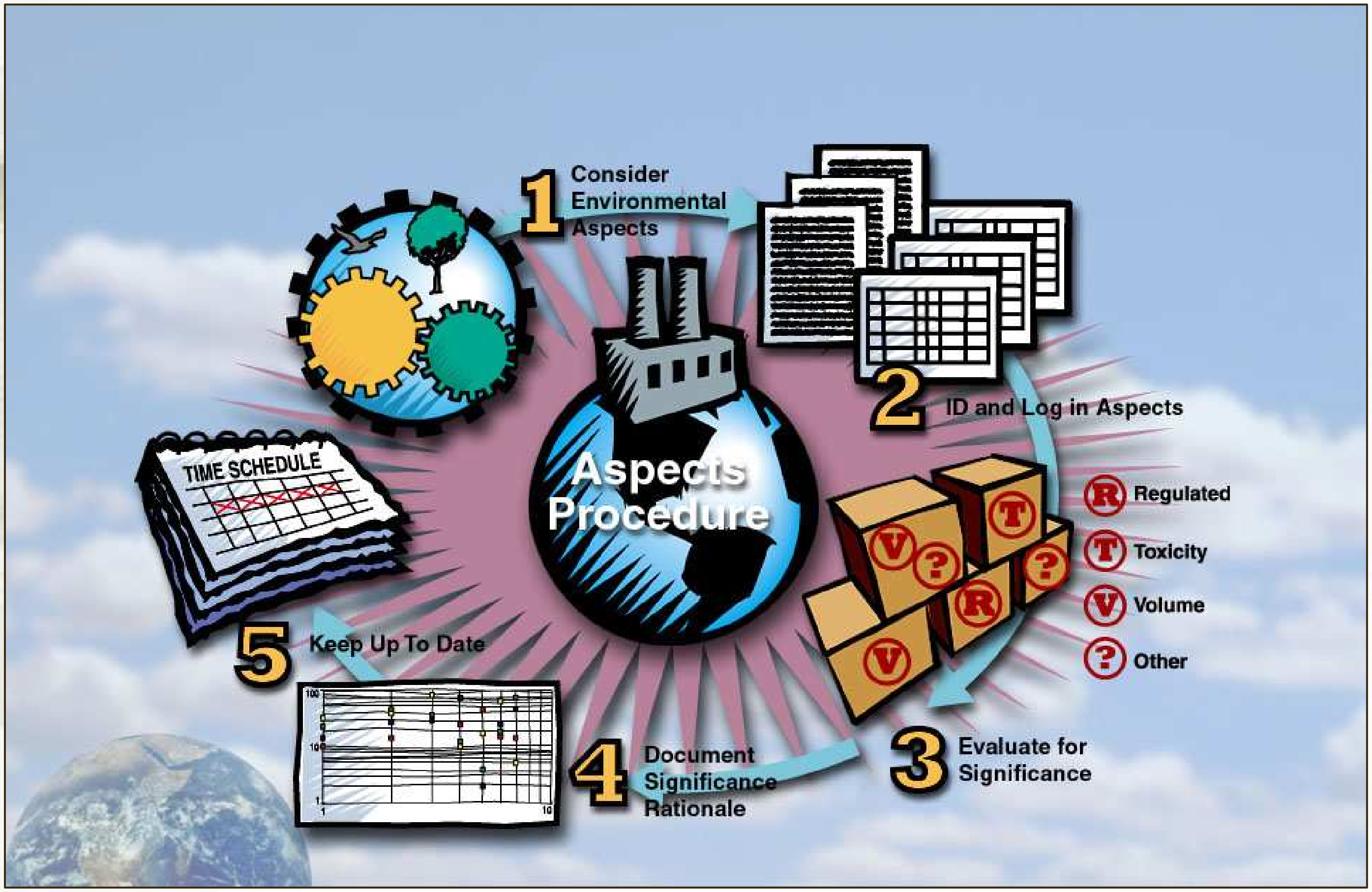
Sites Continually Interact With the Environment



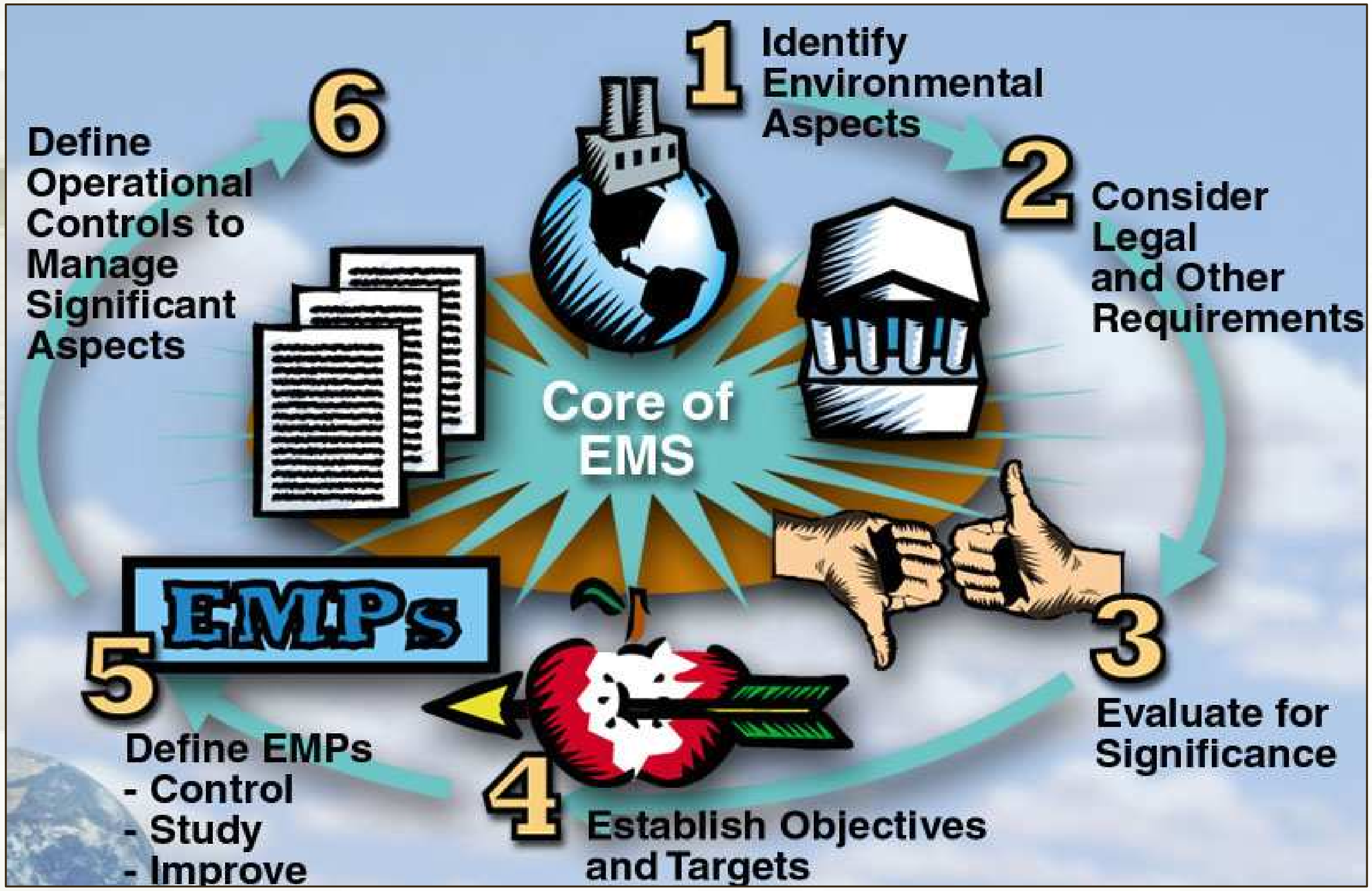
Identify YOUR Environmental Aspects



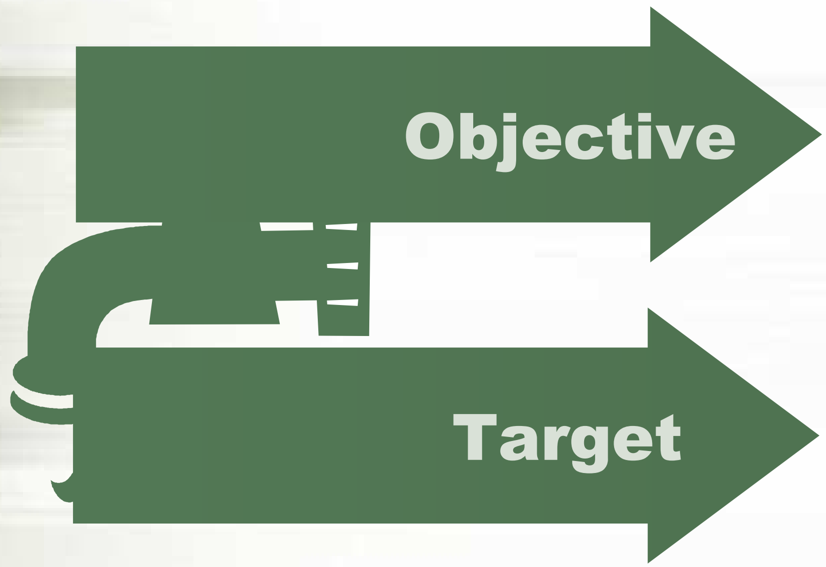
Examples of Aspects and Impacts

Aspect	*Impact*
Air Emissions	Degraded effect on air quality
Industrial Wastewater Treatment Facility Operations/Discharges	Waste generation – sludges and sediments
Energy and Fuel Usage	GHG

Determine Significant Environmental Aspects



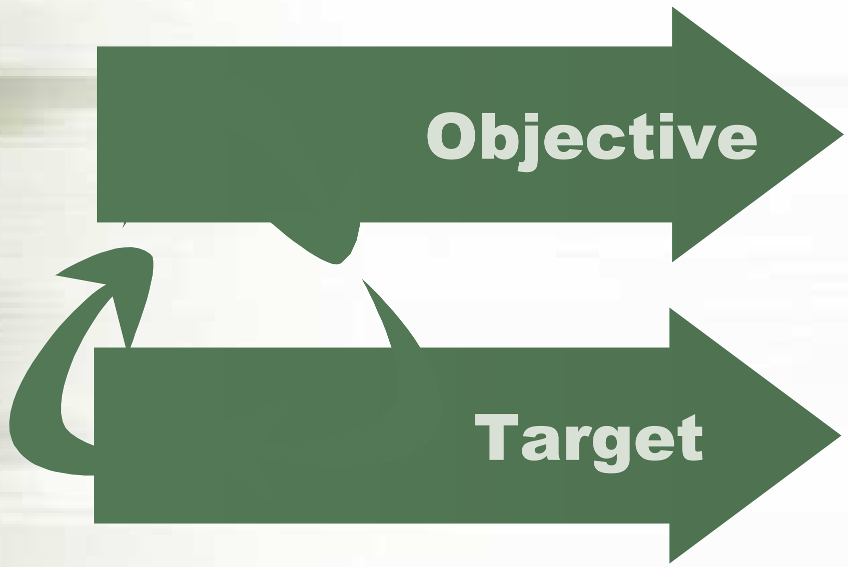
Set Objectives and Targets



Reduce water usage

Reduce water usage by 5% this year

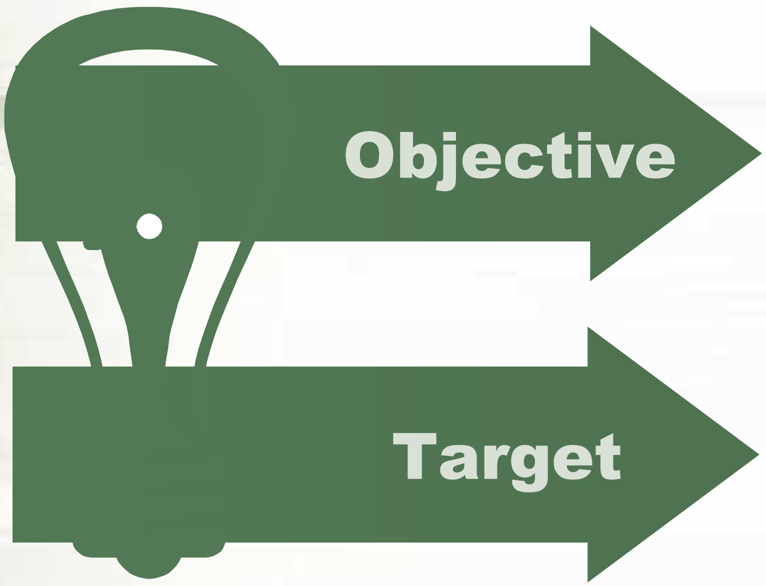
Objectives and Targets



Study waste management practice

Reduce solid waste by 5% per year

Objectives and Targets



Reduce energy consumption

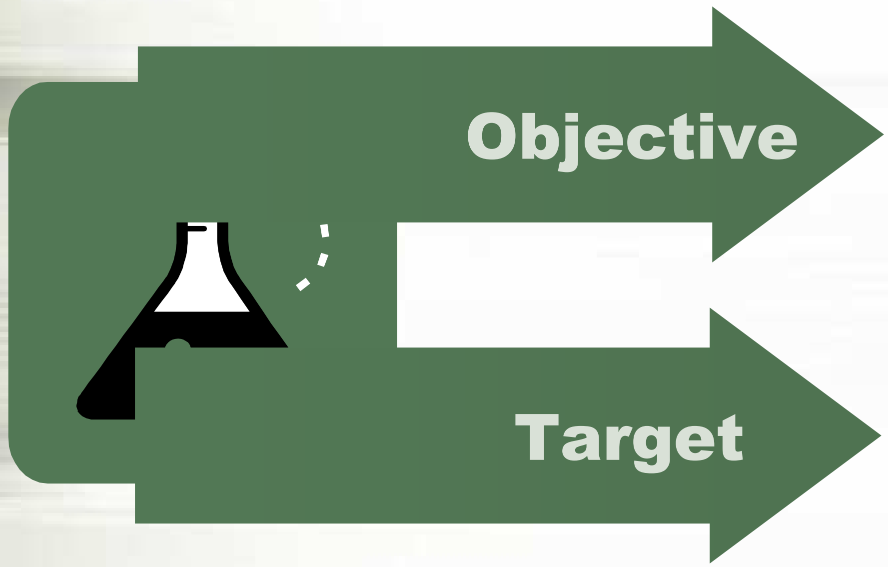
Reduce energy consumption by 10% in office buildings

Objectives and Targets

Objective → ***Maximize purchase and use of environmentally preferable products***

Target → ***Purchase and use 10% more bio-based and recycled-content products than previous year***

Objectives and Targets - Laboratory



Reduce or eliminate the use and/or generation of hazardous substances in laboratory operations

Develop and utilize environmentally benign solvents or solvent-less systems in 90% of laboratory operations

Okay –
Now, how do we meet the targets?

Aspect/Impact Analysis – Violá!

> Perform PPOA/AIA on targeted activities:

- Water usage
- Solid waste generating activities
- Energy usage in office buildings
- Purchasing department
- Laboratory operations

Aspect/Impact Analysis (PPOA) Methodology

Pollution Prevention Opportunity Assessment (PPOA) Approach

What IS it??

- > PSOA?
- > PPOA?
- > P2OA?
- > P2DA?
- > LCDA?
- > AIA?

A methodology used to solve a problem and to make a good decision

It IS……

> A systematic, structured analysis of a process or activity/project to identify opportunities to:

- Eliminate or reduce wastes
- Conserve natural resources
- Reduce toxic chemical or hazardous material use, and
- Recycle materials


I CANCELLED OUR DUMPSTER SERVICE TO SAVE MONEY.
I DISCOVERED AN ALTERNATIVE THAT COSTS NOTHING.
EVERYONE TEAR OFF A PIECE AND PUT IT IN YOUR POCKET.
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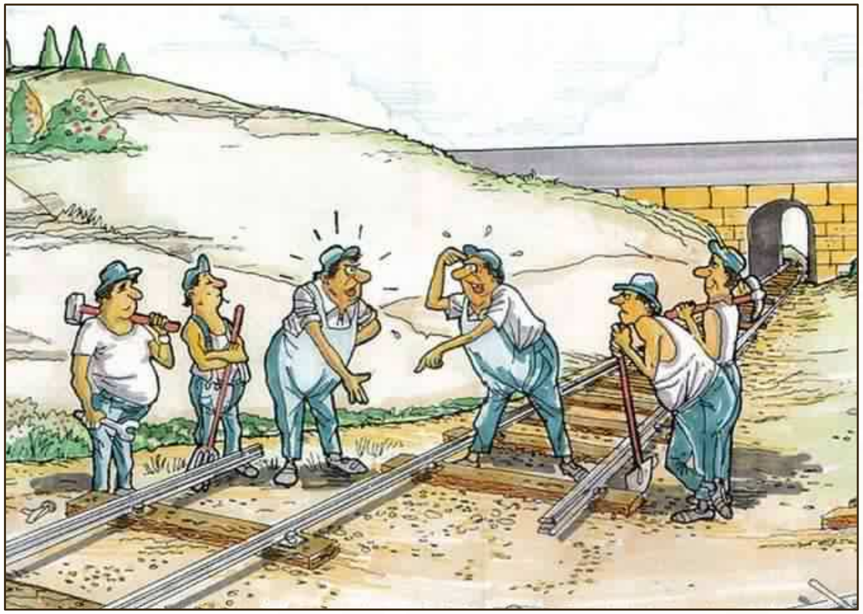
Use PPOAs to...

> Impact change in the workplace by gaining insights and buy-in from the individuals and groups most affected by the issue or the objective/target

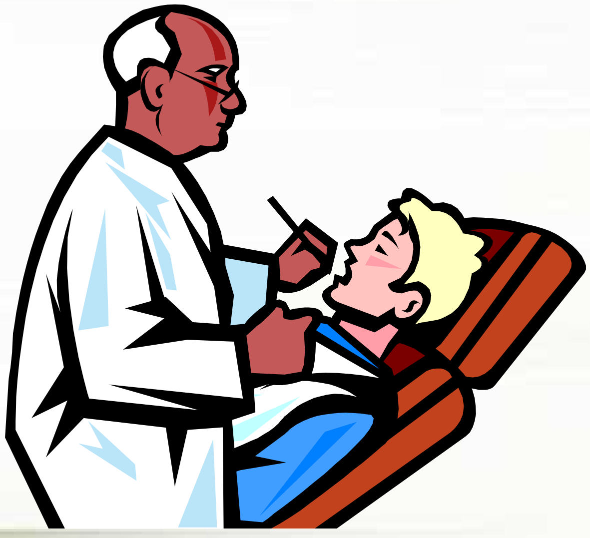


What it is NOT!

> a way to solve management issues!

The goal of a PPOA:

"An ounce of prevention is worth a pound of cure"



Standard
Environmental Management Hierarchy

Examples of Environmental Practices

Priority	Method	Example	Applications
1	Pollution Prevention and Waste Minimization	• Process and technology changes • Environmentally friendly product design • Source elimination • Energy and water conservation • Toxic material reduction substitution	• Use dissolvable rags • Modify product to extend life, such as high-efficiency bypass oil filters or use of rechargeable batteries • Packaging controls • Preventing clean materials from entering contaminated areas
2	Recycling	• Reuse • Reclamation	• Solvent or mineral spirit recycling • Metal recovery from spent waste • Scrap metal recycling
3	Treatment	• Stabilization • Neutralization • Precipitation • Evaporation • Incineration • Compaction	• Use of gravity sand filter at WWTP to remove solids • Precipitation of heavy metals from a spent plating bath • Compaction (volume reduction)
4	Disposal	• Disposal at a permitted facility	• Offsite landfill

Where can PPOAs be used?

> ROUTINE PROCESSES

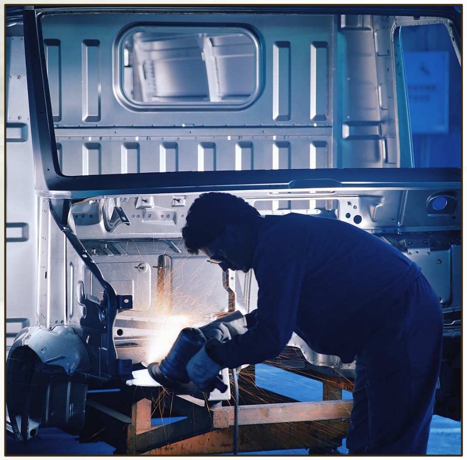
- Manufacturing
- Sampling and analysis
- Laboratory operations
- Procurement operations

> NONROUTINE PROJECTS

- New facility design and construction
- Demolition projects
- Environmental Restoration Activities
  - Decommissioning projects
  - Remediation activities

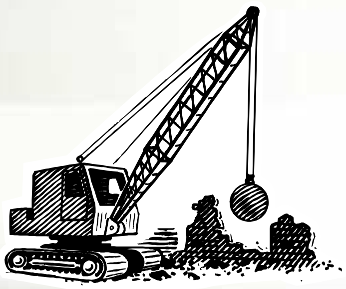
Routine Operations

- Identifiable inputs and outputs
- Material balance
- Ongoing, repeated processes



Non-Routine (project-oriented) Activities

- Perform PPOAs on common waste streams (IDW, concrete, PPE)
- Include P2/WMin principles in the planning stage of a project, perform assessment on PLANNED activity (ER project plans, new building/facility designs)
- Decide on macro-level view – perform assessment on repeated, general activities that occur from project to project (sampling, drilling, decontamination, soil segregation, decommissioning, material procurement)



Non-Routine Focal Areas

Deactivation

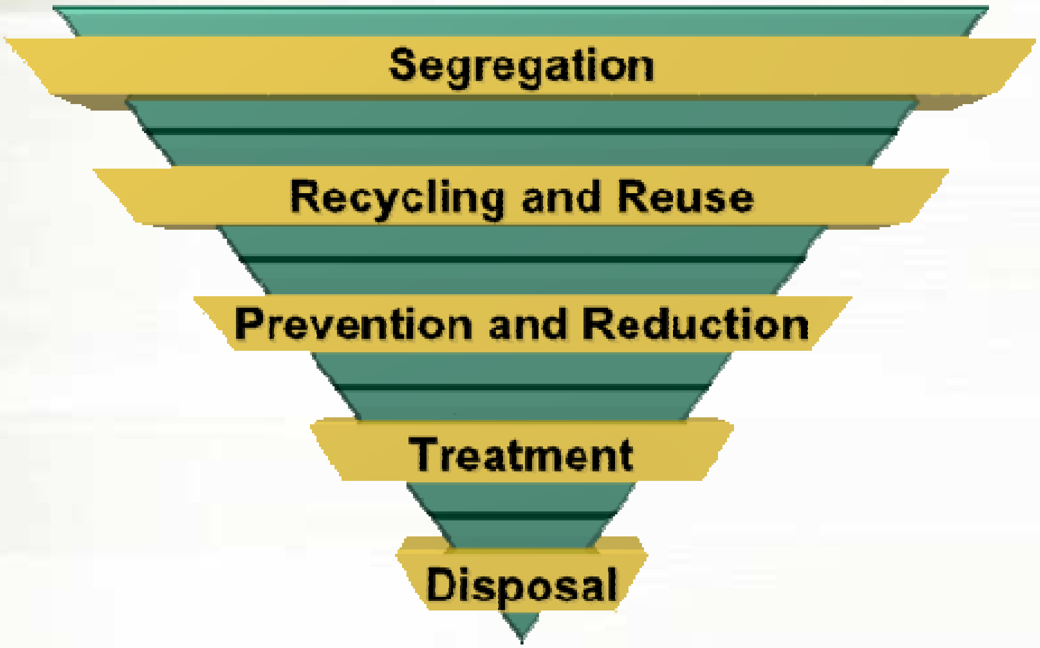
Construction and Design

Stabilization

Decommissioning Remediation

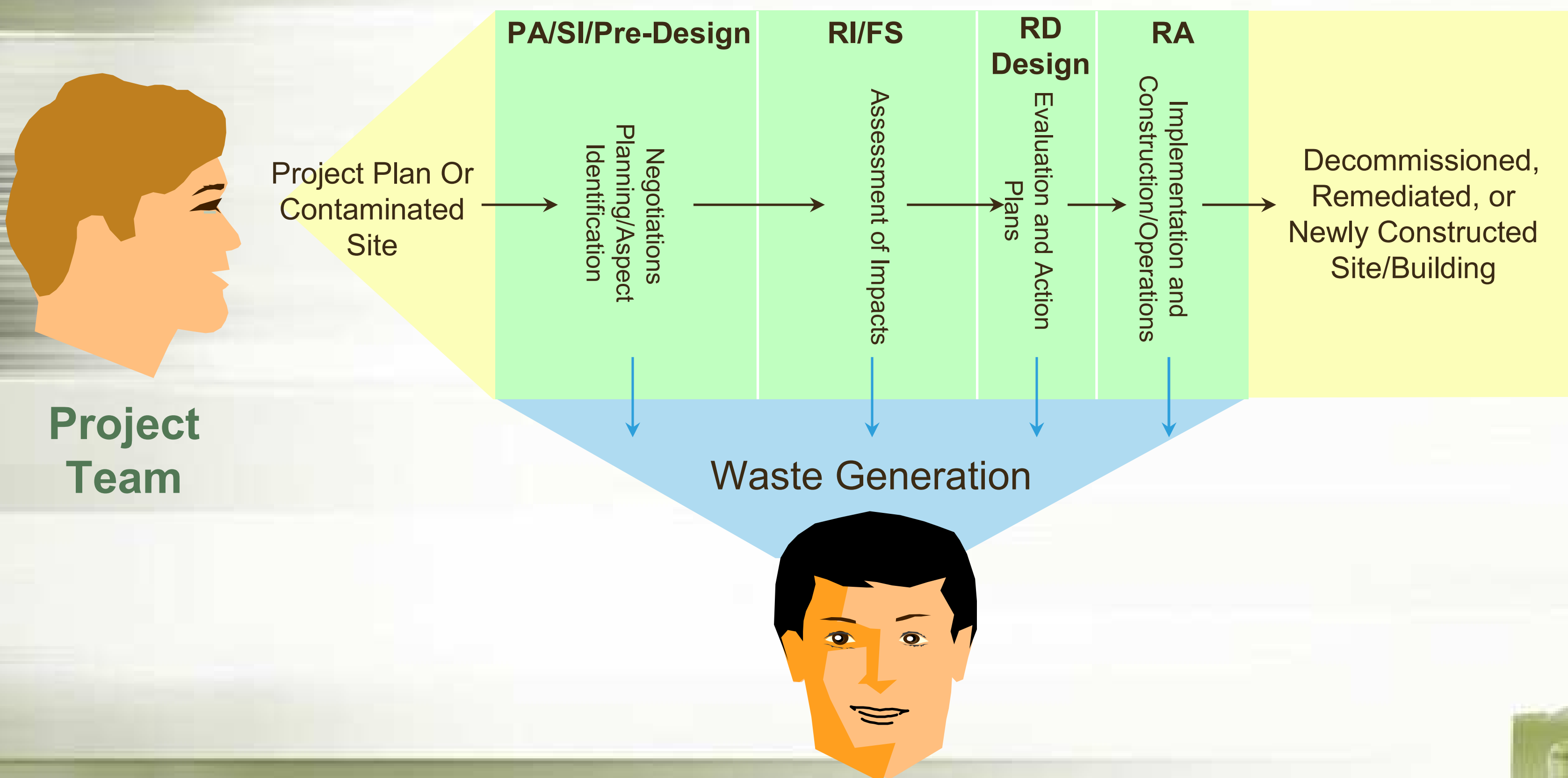
Remedial Action Projects

P2/WMin Approach for Non-Routine Activities – Most Effective Techniques



Performing a PPOA on Non-Routine Operations

> Looking at the Life-cycle of a Project from the Aspect of the Waste and Energy/Water Use



Project Team

P2 Awareness

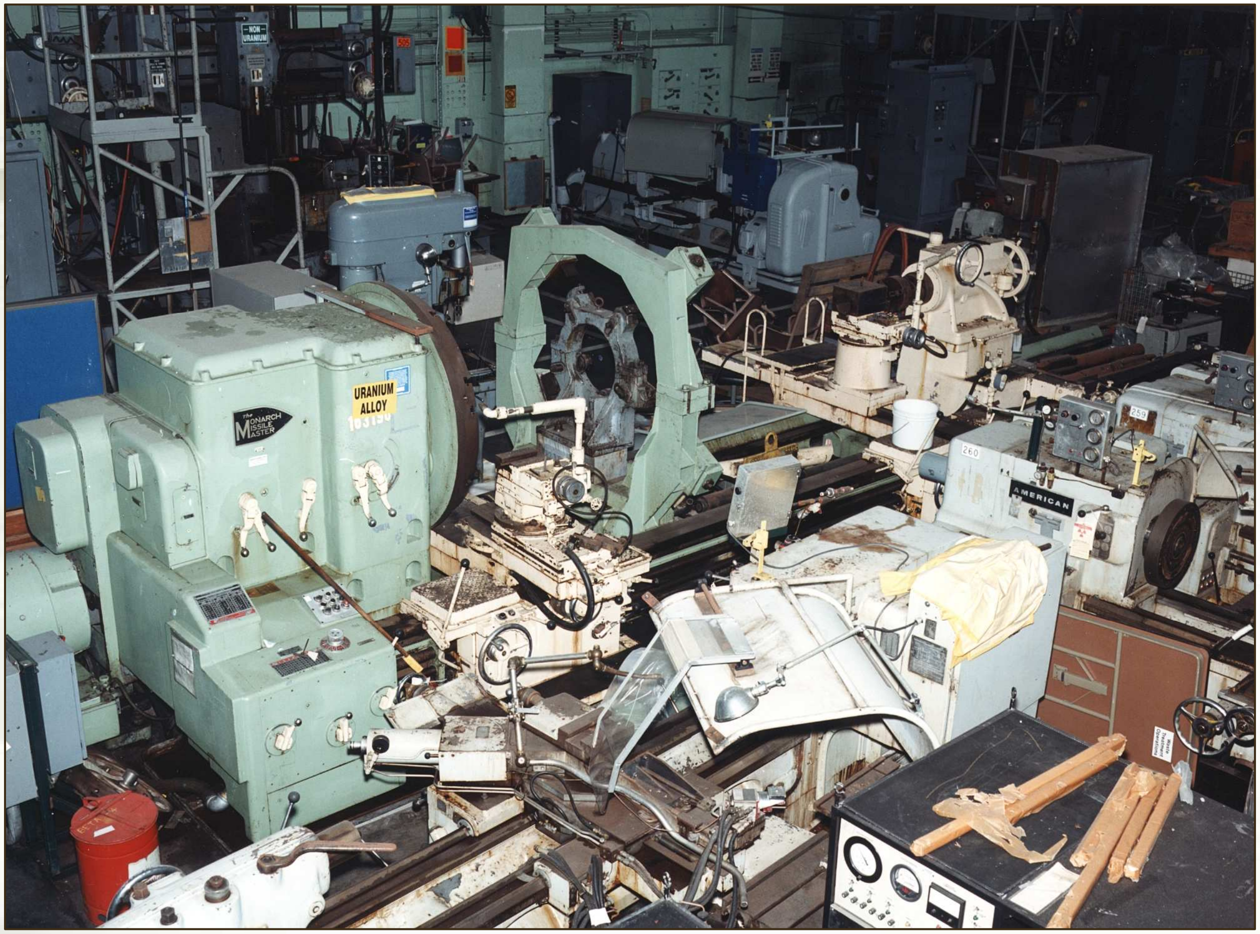
Planning

> Discuss and negotiate regulatory issues
> Forecast and characterize significant primary and secondary waste stream volumes
> Determine waste disposition alternatives
> Assess P2/Wmin opportunities for each waste stream
> Document P2 activities/alternatives chosen for future comparison

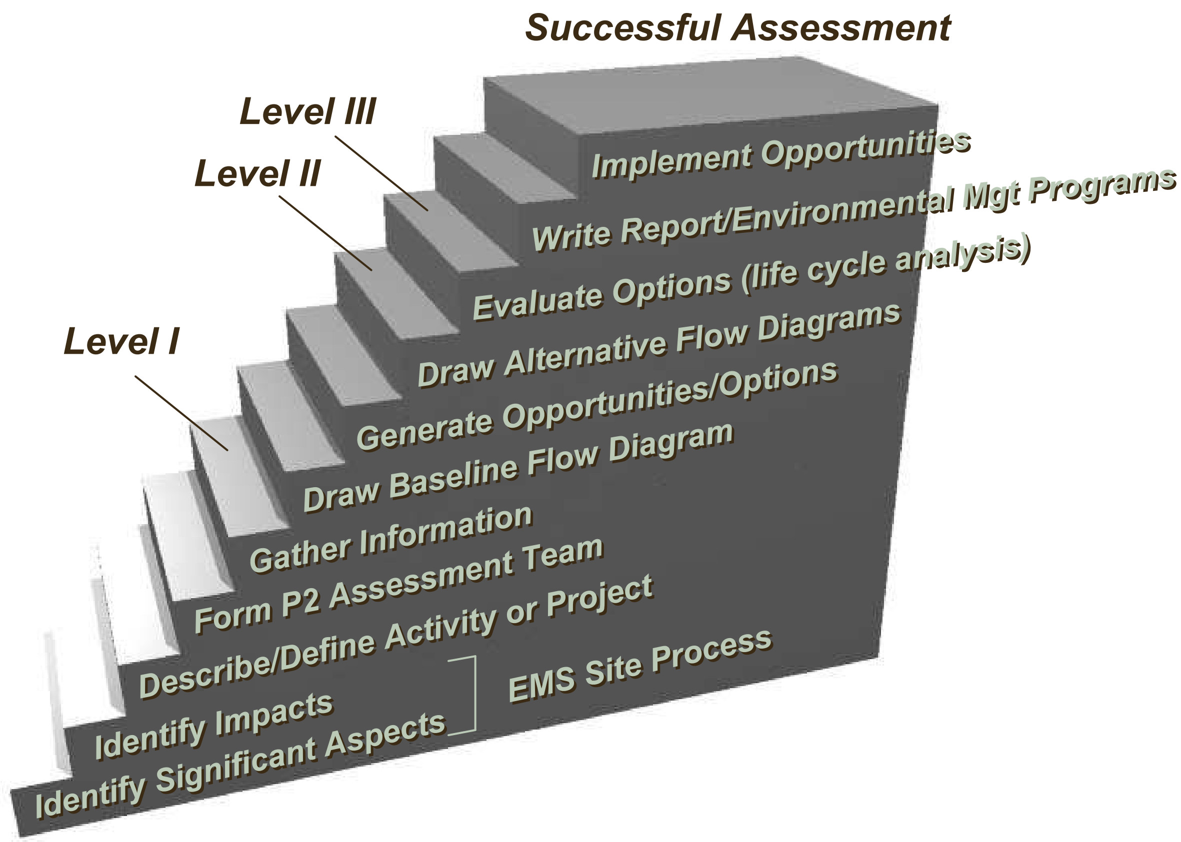
Evaluate Waste Generation

- Conduct PPOAs on all significant forecasted project waste streams
- Perform PPOAs on repeated, general activities that occur from project to project - a series of routine activities
- Complete PPOAs to increase technology efficiencies
- Evaluate P2 potential at each project phase
- Document lessons learned from project to project

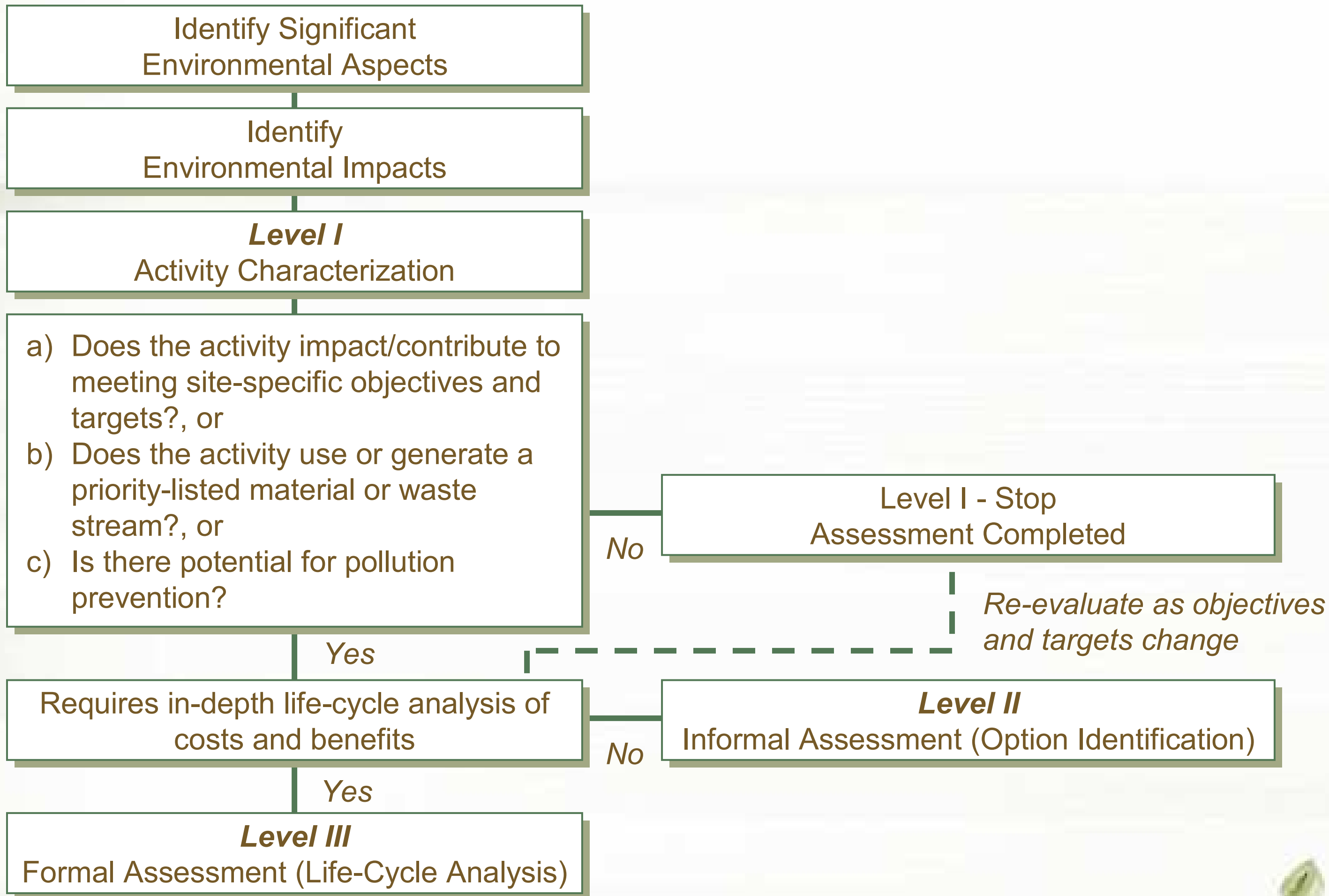
Old, Outdated Equipment



Steps to a Successful Assessment



P2 Opportunity Assessment Approach Logic Diagram



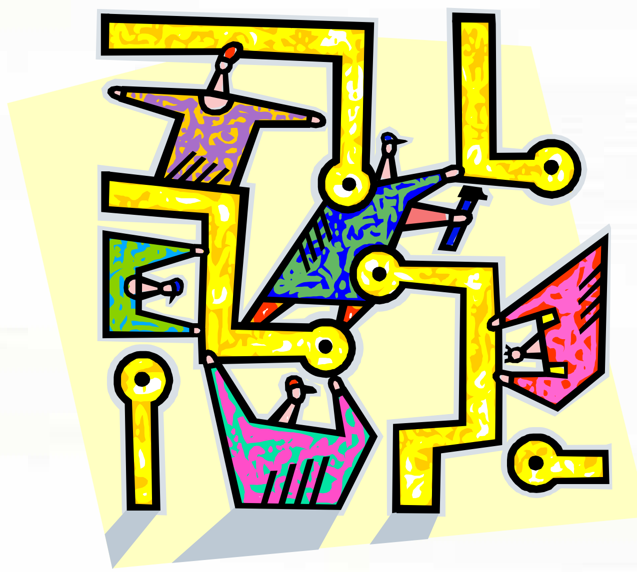
Get Started

Select Activity or Project for Assessment

- Decision to perform PPOA done by P2 program or project staff based on EMS objectives (goals) or targets, P2/E2 goals, or Executive and DOE Orders
- Identified as a significant or regulated environmental aspect
- Consider priority listed material or waste streams (EPA target chemical, ODC, no approved disposal, TRI chemical, SARA Title III, equal to 5% of facility total waste volume)
- High profile project/construction activity
- Large costs associated with waste management
- Management commitment (including funding)
- Project/process personnel available and committed
- Identify and document previous or current P2/E2 activities

Activity or Project Description

> Any existing or planned project element or task which uses energy and/or generates waste or pollution to the air, water, and/or land



Establish Assessment Scope

> Distinct start and end point of activity/project – get team acceptance
> Input materials, energy usage, project size must be capable of being accounted for
> Time frame must be considered
> Level of effort (including costs) established and understood
> Manageable/Achievable? (does it makes sense and can it be done?)

Activity or Project Description

Pollution Prevention Opportunity Assessment

Activity or Project Description

PPOA Title: ______________________________

PPOA Number: ______________________________

Contributes to what EMS Objective or Target (if applicable): ______________________________

	Site: ________	Area: ________	Bldg: ________
Project or Activity Location:	Floor: ________	Dept: ________	Room: ________

Project or Activity Description:

____
____
____
____
____
____
____
____

Description of Major Product(s) of Activity or Project Purpose:

____
____
____
____
____

NETL – Pittsburg Campus

Example Process Selected: NETL Laboratory Process Industrial Wastewater Treatment Facility

- Two of NETL’s Top 10 Environmental Aspects – Industrial Wastewater Treatment Facility Operations and Discharge; Waste Generation, Management, Disposal
- Quantity and cost of waste/sludge disposal and the cost of discharge of the treated effluent to the POTW
- Management commitment to stakeholders to reduce impact of operations
- Management provided funding and labor to perform assessment over 3 month period; requested briefing of results

Team Selection Methods

- Site Core P2 Team/P2 Advisory Council – determines PPOA priority, schedule, and scope and forms process-specific PPOA Teams
- Site P2 Coordinator - performs functions of the Core P2 Team and acts as Team Leader for assessments

The make-up of the PPOA team will vary depending on the size, complexity, and resources available for the assessment. Most importantly, include line/project staff as part of the team.

Team Selection

Consider the following personnel for participation in the PPOA Team:

- Operations
- Engineering
- Maintenance
- Scheduling
- Procurement/EPP
- Accounting/Estimators
- Health and Safety
- Legal
- Design
- Facilities
- Materials Control
- Environmental
- Quality
- Management
- Waste Management
- Regulatory/Compliance
- Energy Conservation
- Recycle Coordinator

PPOA Team Members

Pollution Prevention Opportunity Assessment

Team Identification

PPOA Title: ____________________

Assigned PPOA Number: ____________________

Team Members

Dept	Name	phone	fax	email

Nobody's Perfect – But A Team Can Be

What is needed is not well balanced individuals; but individuals who balance well with each other."

Dr. Merideth Belbin

Team Dynamics

- Differing priorities and missions
- Personality styles
- Negativism – can't do that!
- Commitment

Potential Areas of Conflict Within Groups

- Asch effect – 80% of group members will yield to incorrect group opinion
- Groupthink – cohesive team failing to realistically view alternatives
- Social loafing – decrease in individual effort as the group size increases
- Four Ways Not to Listen (Non-listening, Listening to Ignore, Listening Selectively, Listening for the Ego)
- Trust and Criticism Styles
- Formal or Informal Team

Team Member Roles

> LEADER	Guides the team and sets the agenda, ensures total team participation
> SCRIBE	Captures ideas an flip chart/worksheets, maintains and distributes minutes
> SPOKESPERSON	Gives verbal briefings to management

NETL PPOA Team

Construction

Wastewater Treatment

Field Ops

P2

EMS Mgr

ES&H

Engineering

Compliance

Information Collection

> Material purchases and usage
> Energy usage
> Waste generation data
> Tour area/process/activity
> Draw baseline activity flow diagram

Sources of Information

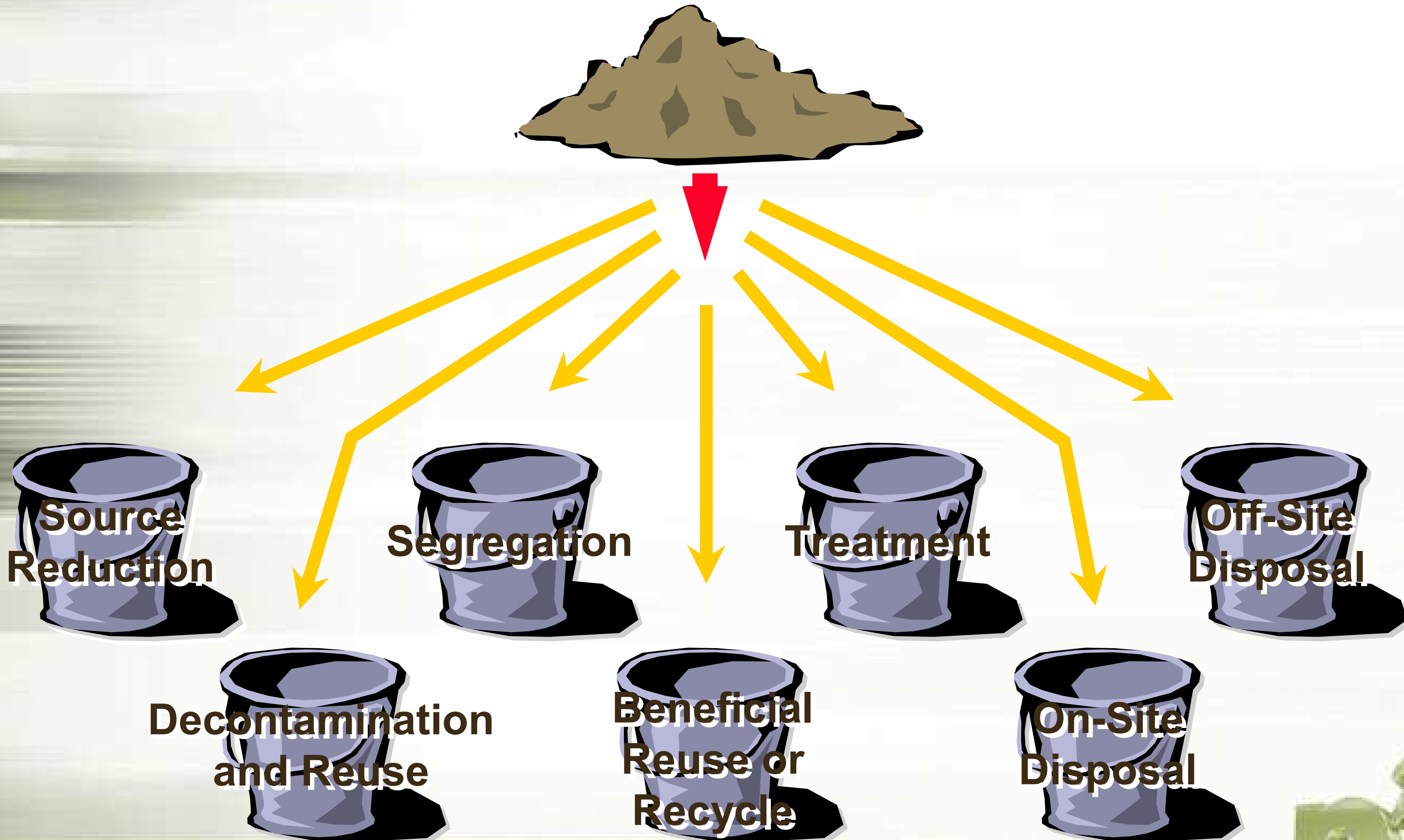
- Hazard or Safety Analysis/Risk Assessment documents
- Legal requirements/agreements/compliance documents
- EMS Action Plans for achieving objectives and targets
- Training manuals
- ISMS documents
- Past P2/Wmin projects or PPOAs
- Procurement records
- Material inventories
- Specifications
- Work instructions/procedures
- Material Safety Data Sheets
- Operating logs
- Laboratory analysis
- Waste manifests
- Reports and permits
- Waste tracking system
- Emissions data
- Energy audits/reports/statements
- Purchase requisitions
- Vendor data
- Design documents
- Other DOE sites/contacts
- Lessons Learned database
- Interviews
- Tour

NETL Tour of Wastewater Treatment Facility

Waste Data Needed

- Quantity
- Types (LLW, Mixed LLW, sanitary, hazardous, TRU, HLW)
- Matrices (soil, metal, sludge, liquid)
- Primary or secondary
- Disposition pathway
- Unit cost of current waste disposition
- How is the waste generated?

Waste Disposition Pathways



Level I Assessment

- > Characterize/define activity of project
- > Formulate team
- > Gather necessary information
- > Decision on if the activity:
  - Contributes to meeting objectives and targets
  - Generates a priority waste stream
  - Potential for P2/WMin
- > Answer NO – document as a Level I Assessment
- > YES – continue to a Level II Assessment
- > Re-evaluate as objectives and targets change

Baseline Activity Flow Diagram

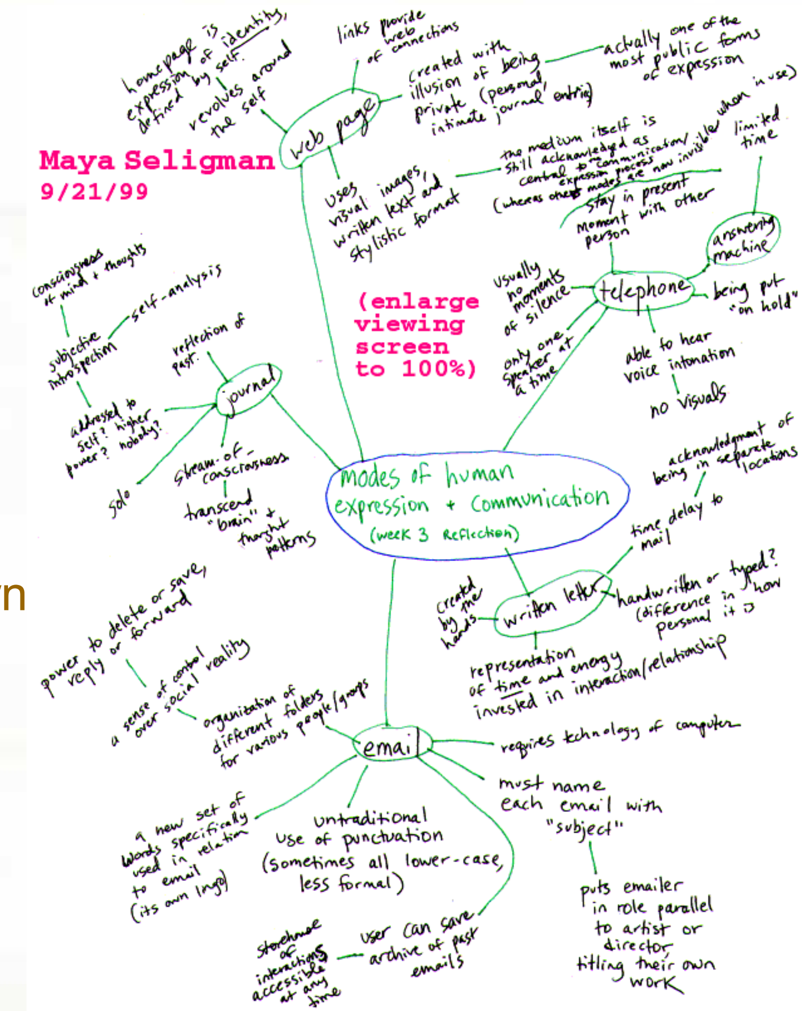
- A picture is worth 1,000 words
- Identifies major process or project steps
- Indicates the flow of materials and/or energy into and out of the process or project (material balance)
- Characterizes the waste streams or releases

NETL Baseline Flow Diagram

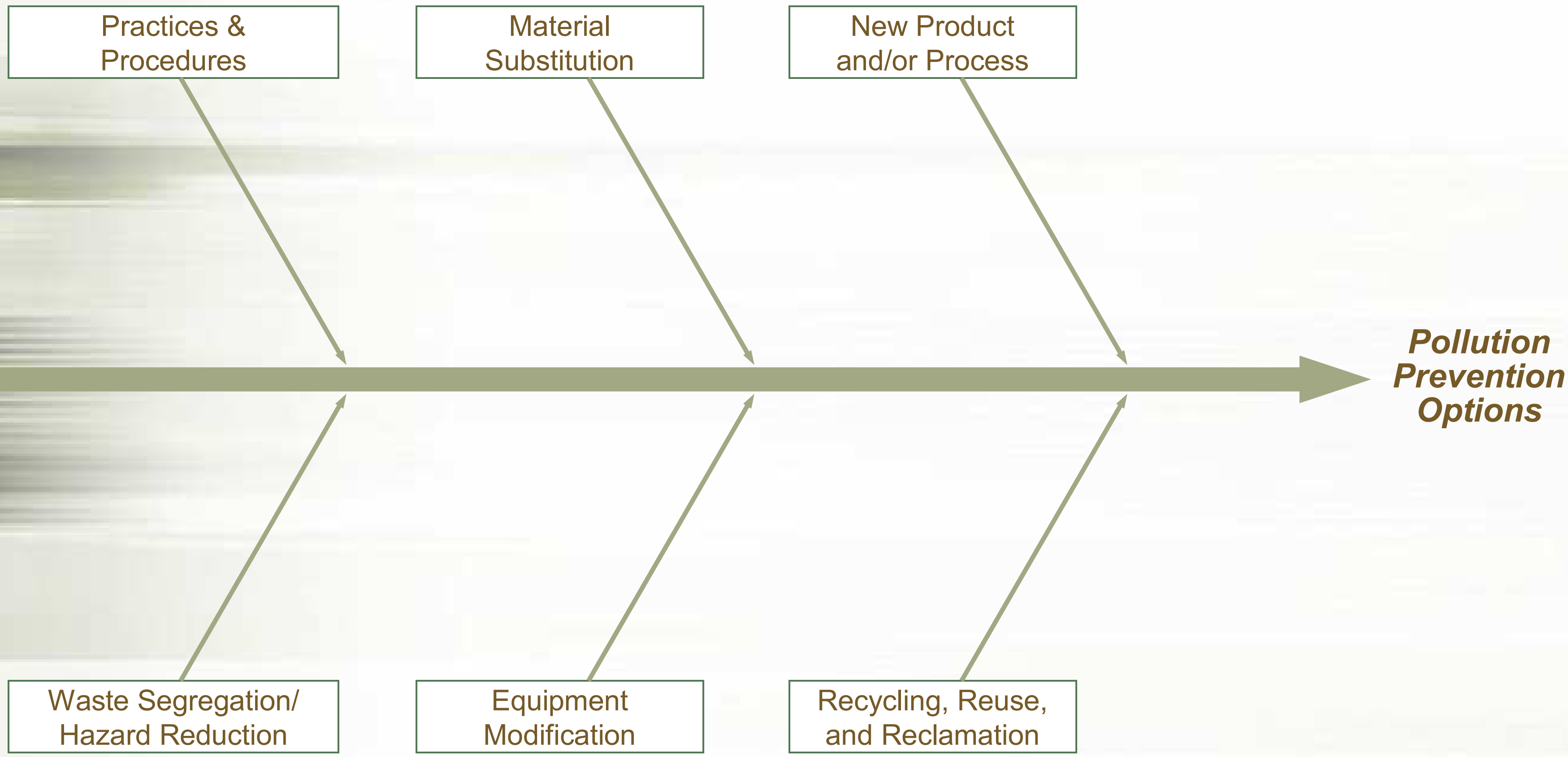
Get Creative!

Brainstorm!

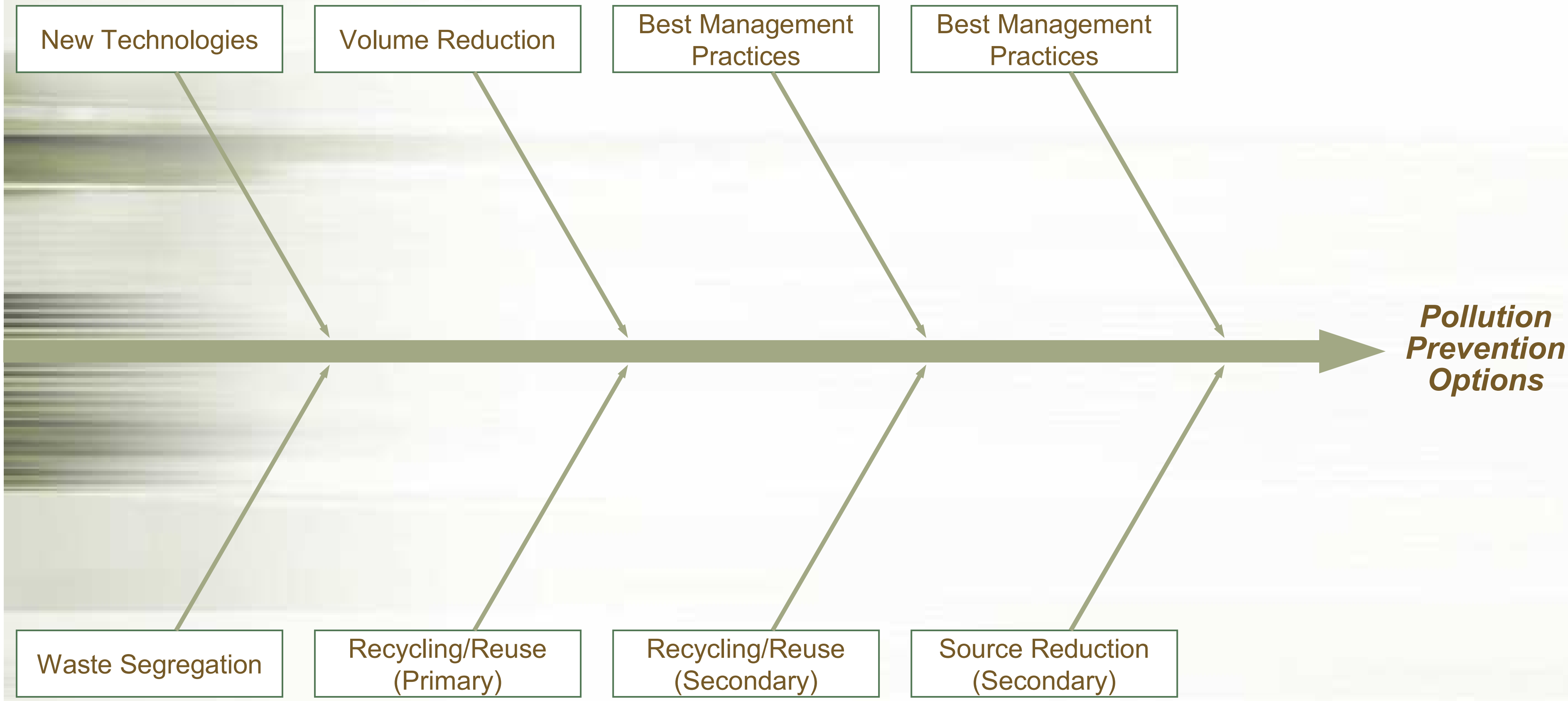
- Leader insures involvement
- No insults or criticism
- Everyone contributes
- Free flow of ideas
- No judging
- No answer is wrong
- Do not laugh, groan, or frown



Fishbone Diagram – Routine Operations



Fishbone Diagram – Non-routine Operations



NETL Brainstorming Session

Screen Alternatives and Recommend Viable Options - LEVEL 2 Assessment

- Review and sort the brainstorming list
- Eliminate impractical ideas
- Combine similar options
- Focus on real reductions to wastes/energy/water
- Pin-point ideas benefiting objectives and targets
- Narrow to 3-8 workable opportunities
- Assign actions for further investigation
- Document eliminated ideas and why they were eliminated from consideration

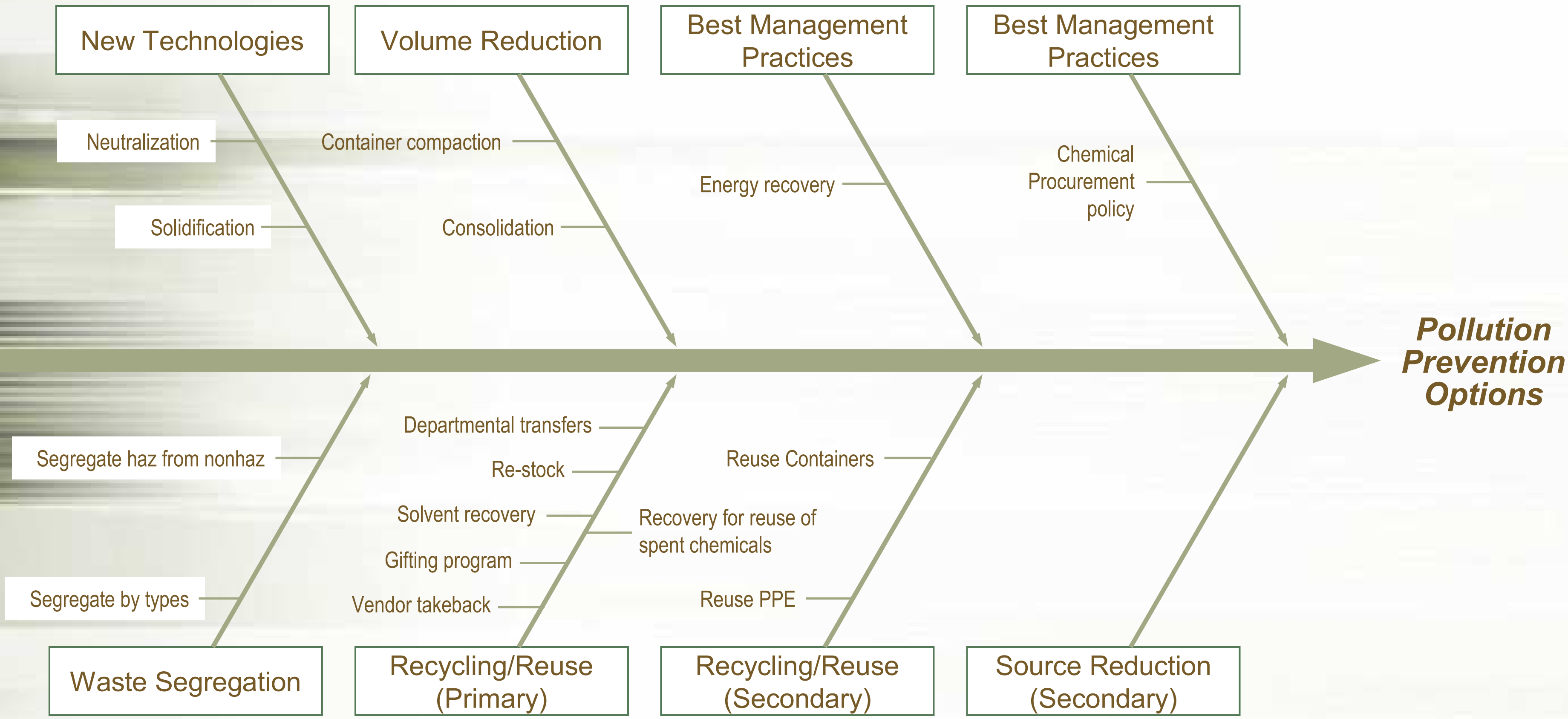
Hands-On Exercise

- Plant 2 Wastewater Treatment Laboratory Dismantlement
- BRAINSTORM ALTERNATIVES

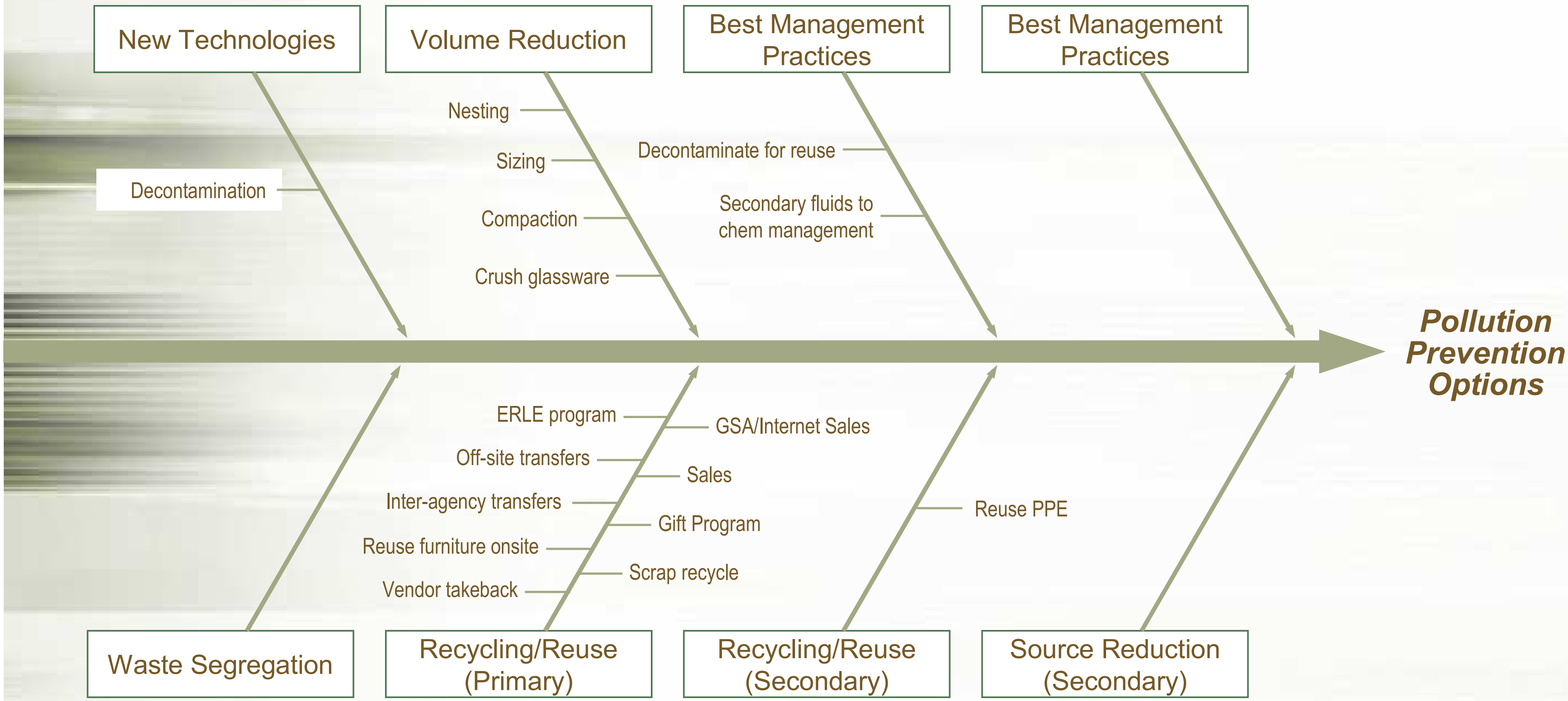
Waste Water Treatment Laboratory – Plant 2 Building Dismantlement Project

Inputs	Baseline Approach	Outputs
	Radiological and Mercury Survey of Building	PPE, lab samples
Packaging, Waste Containers	Remove Excess Chemicals	Opened & unopened chemicals, PPE
Packaging, Waste Containers	Remove Equipment	Furniture, glassware, lab equipment, instruments
	Dismantle Structure	Transite panels, asbestos bricks, above-ground concrete, concrete block, structural steel, piping/insulation (lead-based paint), ductwork, electrical materials, packaging materials, roofing materials (rubber, metal), tools
	Size Reduction	
	Segregation	
Containers	Package	
	Certify	
	Ship for Disposal	

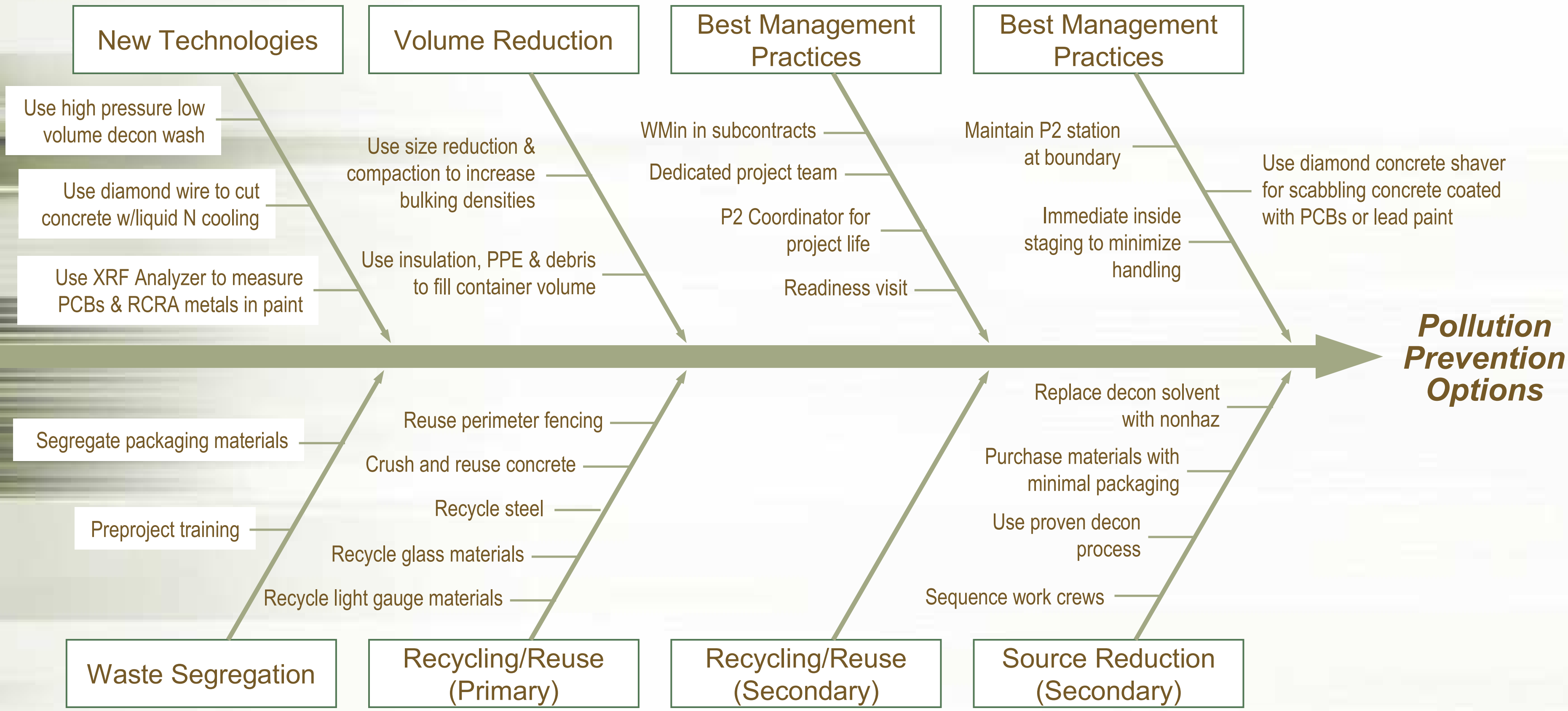
Brainstorm – Excess Chemical Options



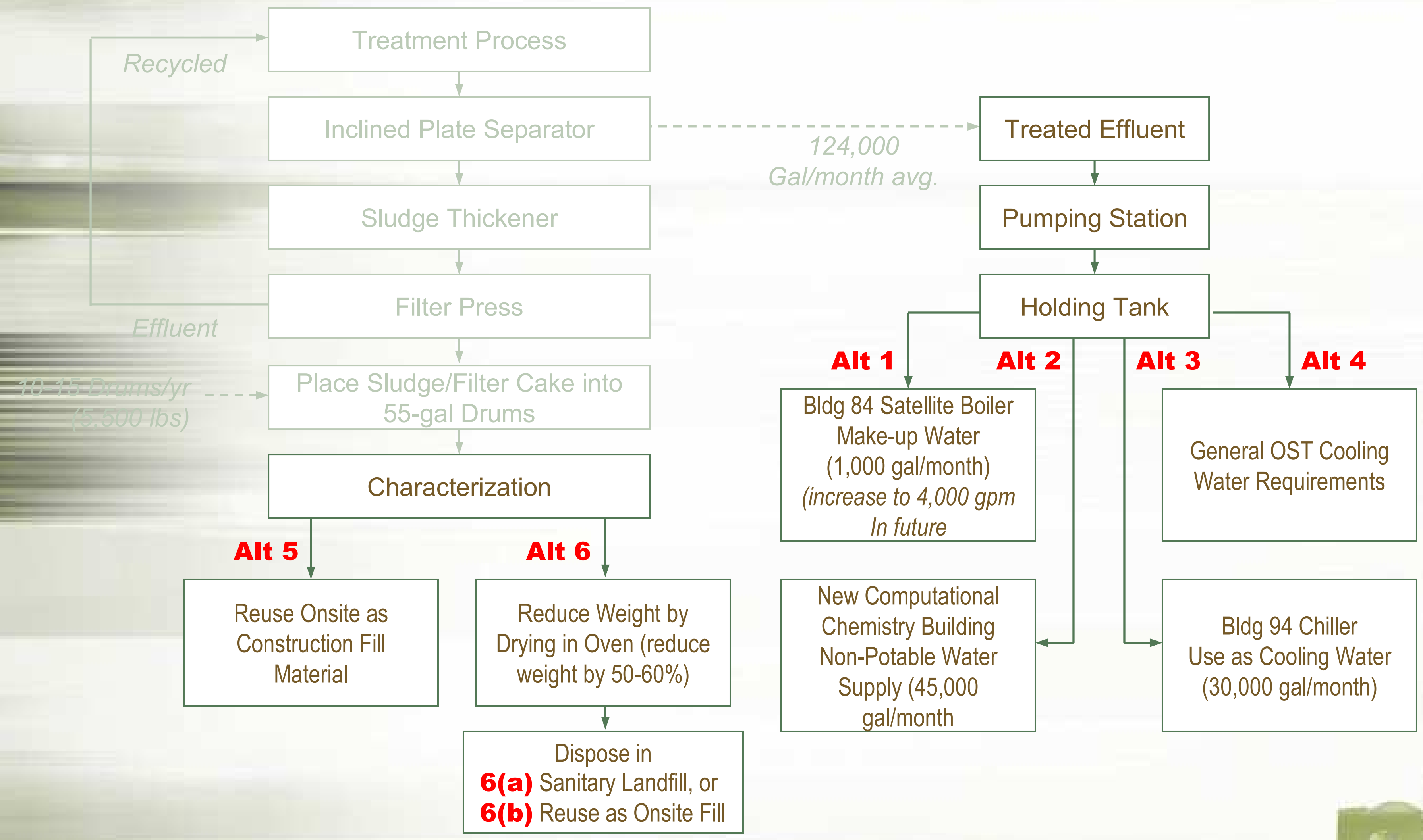
Brainstorm – Equipment Options



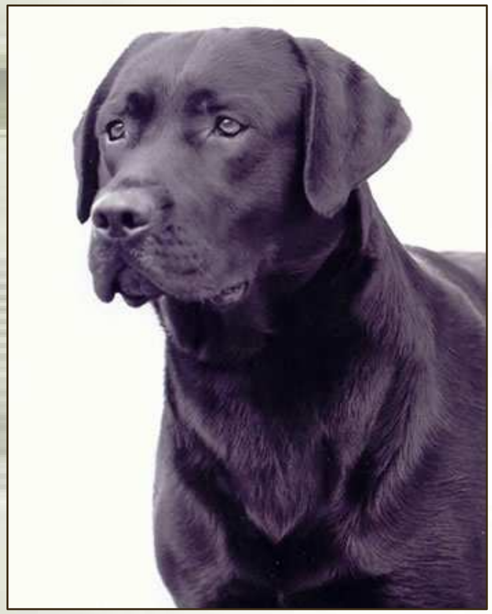
Brainstorm – Dismantlement Options

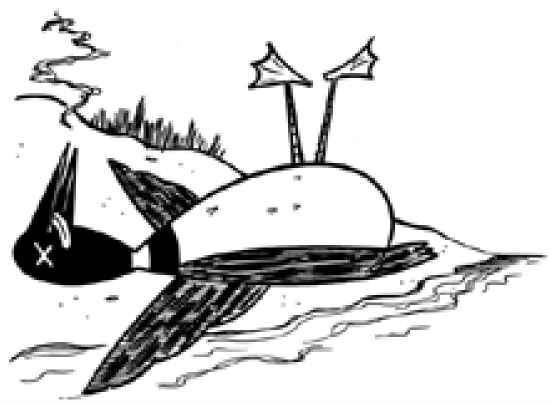


NETL Alternative Flow Diagram



Everything Costs Something!





Life Cycle Analysis

> Calculate Waste Reduced or Energy Saved
> Calculate Annual Cost Savings
> Calculate Implementation Cost and Payback
> Develop Set of Site-specific Attributes
> Perform Life Cycle Analysis
> Identify Barriers to Implementation

NETL Sludge/Filter Cake Costs

	Current Disposal	Reuse as Construction Fill	Dry and Dispose	Dry and Reuse
Sludge Generation (lbs)	6,000	6,000	6,000	6,000
Estimated Water Loss (lbs)	0	0	-3,000	-3,000
Sludge Reuse	0	-6,000	0	-3000
Sludge Disposal (lbs)	6,000	0	3,000	0
Number of Drums Required (400 lbs/drum)	15	0	8	0
Drum Purchase Cost ($65/drum)	$975	$0	$520	$0
Drum Disposal Cost ($70/Drum)	$1,050	$0	$560	$0
Total Disposal Cost	**$2,025**	**$0**	**$1,080**	**$0**

NETL Treated Effluent Costs

	Current Discharge to POTW	Reuse as Boiler Water	Reuse as New Bldg Non-potable Water	Reuse as Cooling Tower Water	Combined Reuse
Treated Water Generation (gal/yr)	1,488,000	1,488,000	1,488,000	1,488,000	1,488,000
Treated Water Reuse (gal/yr)	0	-12,000	-72,000	-360,000	-444,000
Water Discharge to POTW	1,488,000	1,476,000	1,416,000	1,128,000	1,044,000
Avoided Water Purchase Cost ($0.01/gal)	$0	-$120	-$720	-$3,600	-$4,440
Avoided Water Discharge Cost ($0.0033/gal)	$0	-$40	-$238	-$1,188	-$1,465
Annual Avoided Costs	**$0**	**-$160**	**-$958**	**-$4,788**	**-$5,905**
One-Time Alternative Construction Costs (Trench, Pump, and Tank)	$0	$98,270	$131,150	$78,500	$308,040
Simple Payback Period (yrs)		616	137	16	52

Economic Analysis

Economic Evaluations are not created Equal

- $ Simple Payback
- $ Return on Investment
- $ Life-Cycle Cost Analysis

Simple Payback Period (SPP)

> How quickly the investment can be recovered

> A 5 year project with a $100 investment reduced annual costs from $75 to $25 ($50 per year in savings)

$$SPP = \frac{\text{Investment}}{\text{Annual Return}}$$

$$SPP = \frac{\$100}{\$50 \text{ per year}}$$

SPP = 2 years

Return-on-Investment (ROI)

- Percent expected gain
- A 5 year project with a $100 investment reduced annual costs from $75 to $25

$$\text{ROI} = \frac{\Sigma\ \text{Costs}_{before} - \Sigma\ \text{Costs}_{after}}{\Sigma\ \text{Investment Costs}} \times 100$$

$$\text{ROI} = \frac{(5\text{yrs})(\$75/\text{yr}) - (5\text{yrs})(\$25/\text{yr})}{\$100} \times 100$$

$$\text{ROI} = 250\ \%$$

Life-Cycle Cost Analysis (LCCA)

LCCA considers project costs of

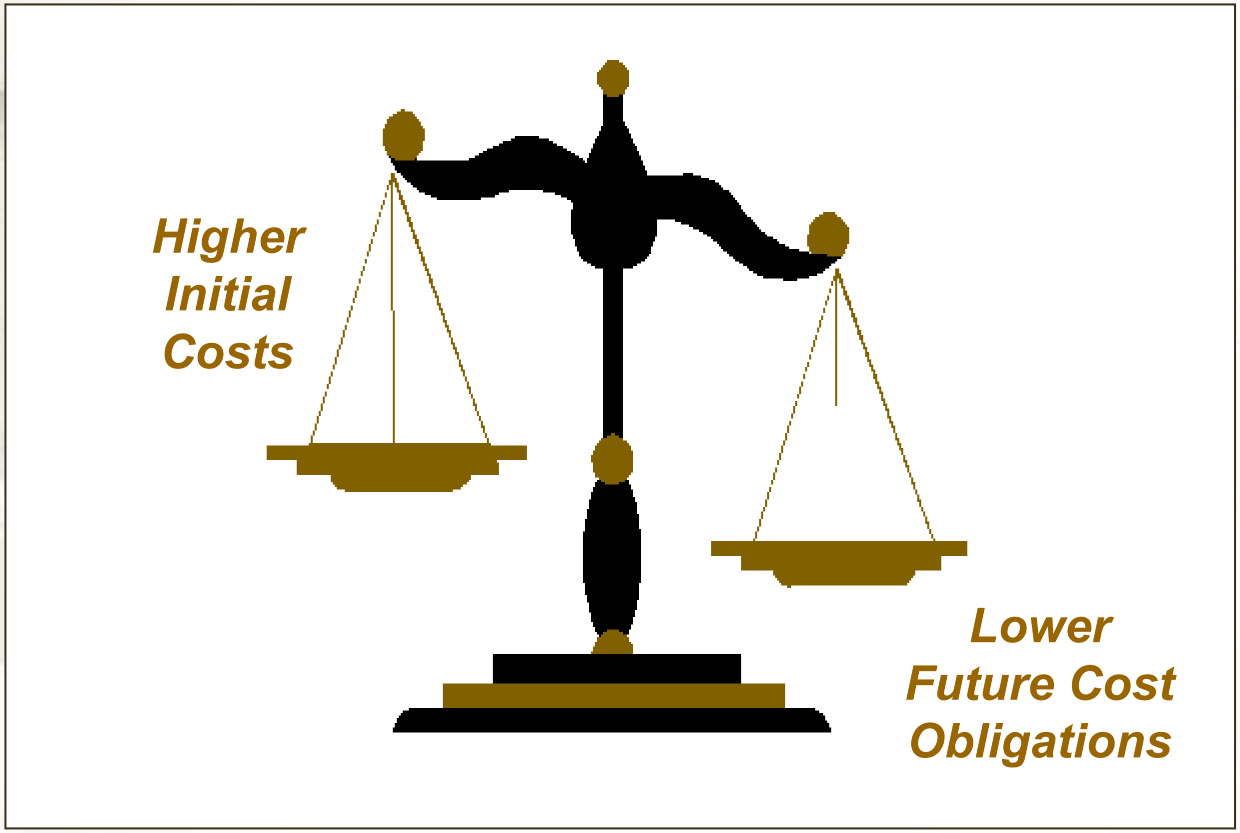
Construction

Operation

Maintenance

Disposition

Pay Me Now or Pay Me Later



Why LCCA?

- Economic justification from the investor's point of view
- Based on ***reduced*** future costs due to ***lower resource demand*** and other cost implications
- Concerned with the project life or the investor's time horizon
- ***Long-term*** economic performance or profitability versus how quickly the ***initial investment*** can be recovered

Time Value of Money

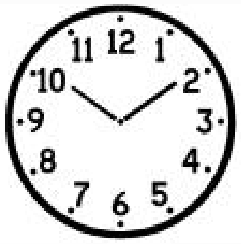
> A dollar today is worth . . .   in the future

> Should be considered in LCCA

> Federal discount rate is 3 %

> Commercial expected rate of return is much higher (10 to 30 + %)

> Engineering economics can get very complicated



Uniform Series Present Worth Factor

> Present Worth Factor = $P/A_{i,n} = \dfrac{(1 + i)^n - 1}{i(1 + i)^n}$

i = interest rate

n = number of years

Present Worth of Cash Flow

- A $100,000 retrofit will save $25,000 per year for 5 years.
- Interest rate is 10 %. Is the retrofit cost effective?

$$P/A_{10,5} = \frac{(1 + 0.1)^5 - 1}{.1(1 + 0.1)^5} = 3.7908$$

PW = - $100,000 + 3.7908($25,000)

PW = - $100,000 + $94,770

PW = - $5,230

Life Cycle Decision Analysis (LCDA)

> It's about more than the $

> Multi-attribute decision analysis

> Takes into consideration factors important to stakeholders like:

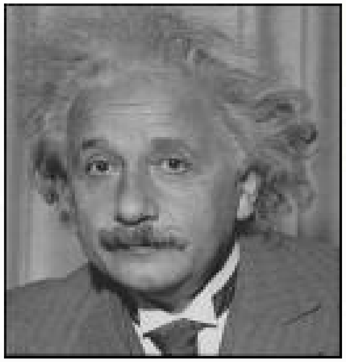
- Health and Safety impacts
- Environmental impacts
- Schedule impacts
- Program crosscutting impacts

> Makes decision making process more transparent

Environmental Accounting

"Not everything that can be counted counts,
and not everything that counts can be counted."

Albert Einstein (1879-1955)

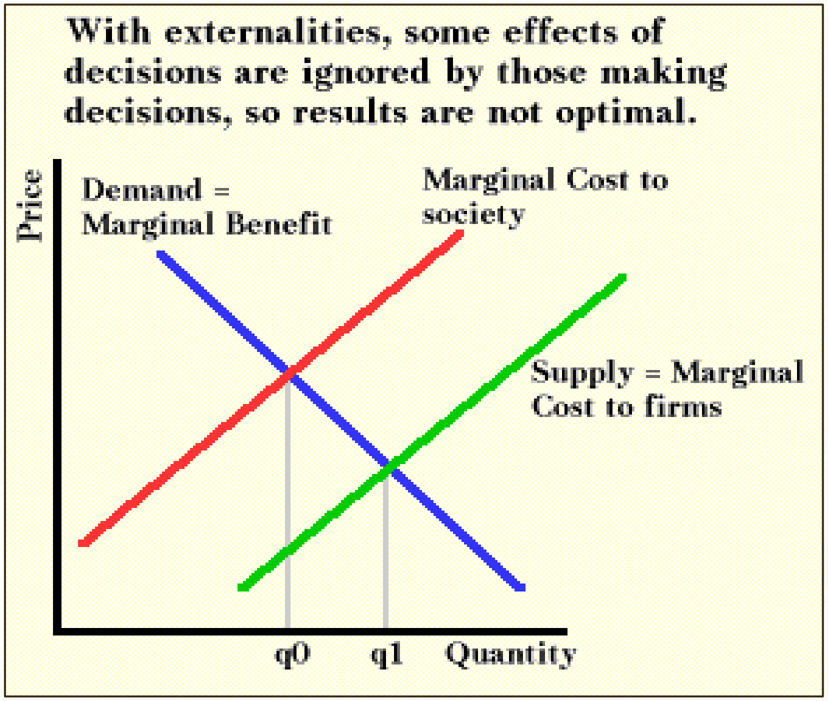


Why Perform LCDA?

- Includes qualitative analysis
- Internalizes “Externalities”
- Involves site-specific criteria/attributes to judge decision alternatives
- Helps management better understand the complexity of the problem
- Used to consider tradeoffs among alternatives

Externality

> An effect of a purchase or use decision by one set of parties on others who did not have a choice and whose interests were not taken into account.



Elements of NETL LCDA

- Cost Estimate ($)
- Risk (Health and Safety)
- Waste Reduction/Pollution Prevention
- Regulatory Issues
- Community Relations

NETL Wastewater Treatment Sludge/Filter Cake Decision Matrix

	Baseline	Alternative 1	Alternative 2A	Alternative 2B
	Dispose in Sanitary Landfill	Reuse Onsite as Construction Fill	Reduce Weight by Drying – Offsite Disposal	Reduce Weight by Drying – Reuse as Fill Onsite
Cost	$2025/yr	No Cost	$1080/yr (+ minimal energy costs)	No Cost (minimal energy costs
Risk (Health and Safety)	◓	○	○	○
Waste Reduction/ Pollution Prevention	●	◓	◓	◓
Regulatory Issues	◓	○	○	○
Community Relations	○	◒	○	◒

◉ ◓ ○ ◒ ●

Best → *Worst*

NETL Wastewater Treatment Treated Effluent Decision Matrix

	Baseline	Alternative 1	Alternative 2	Alternative 3	Alternative 4
	Discharge to POTW	Route/Reuse as Boiler Makeup	Route/Reuse in New Building	Route/Reuse as Cooling Water	Route/Reuse for Generagl OST Requirements
Cost	$5,000/yr	$4,960/yr	$4,758/yr	$3,790/yr	$3,508/yr
One-Time Only Construction Cost	None	$98,270	$131,150	$78,500	$308,040
Risk (Health and Safety)					
Waste Reduction/ Pollution Prevention					
Regulatory Issues					
Community Relations					

Report Development and Selling to Management

- Discuss what the project is and what it will provide (results and recommendations)
- What will the project cost?
- Is it profitable?
- What are the next steps?
- Justify the funding required
- Incorporate recommendations into EMS Environmental Management Plans

More Billboards You will NEVER see

Practical Examples

Energy Management

Nine Major Systems to Consider:

1. Building Envelop
2. HVAC System
3. Electrical Supply System
4. Lighting
5. Boiler and Steam System
6. Hot Water System – domestic
7. Compressed Air System
8. Motors (that you can see)
9. Special Purpose Equipment

Energy Audit Elements

> Facility Description
> Energy Bill Analysis
> Energy Management Opportunities
> Energy Action Plan

Facility Description

> Function (office, laboratory, etc.)
> Size (ft^2)
> Construction layout (shape, floors)
> Hours of operation
> Occupancy
> Equipment list with specifications

Energy Bill Analysis

> Utility rate structures
> Energy consumption data by fuel type
> Energy costs by fuel type

Energy Management Opportunities (EMOs)

> List of potential opportunities
> Energy reduction quantities
> Implementation costs
> Energy savings
> Return-on-Investment

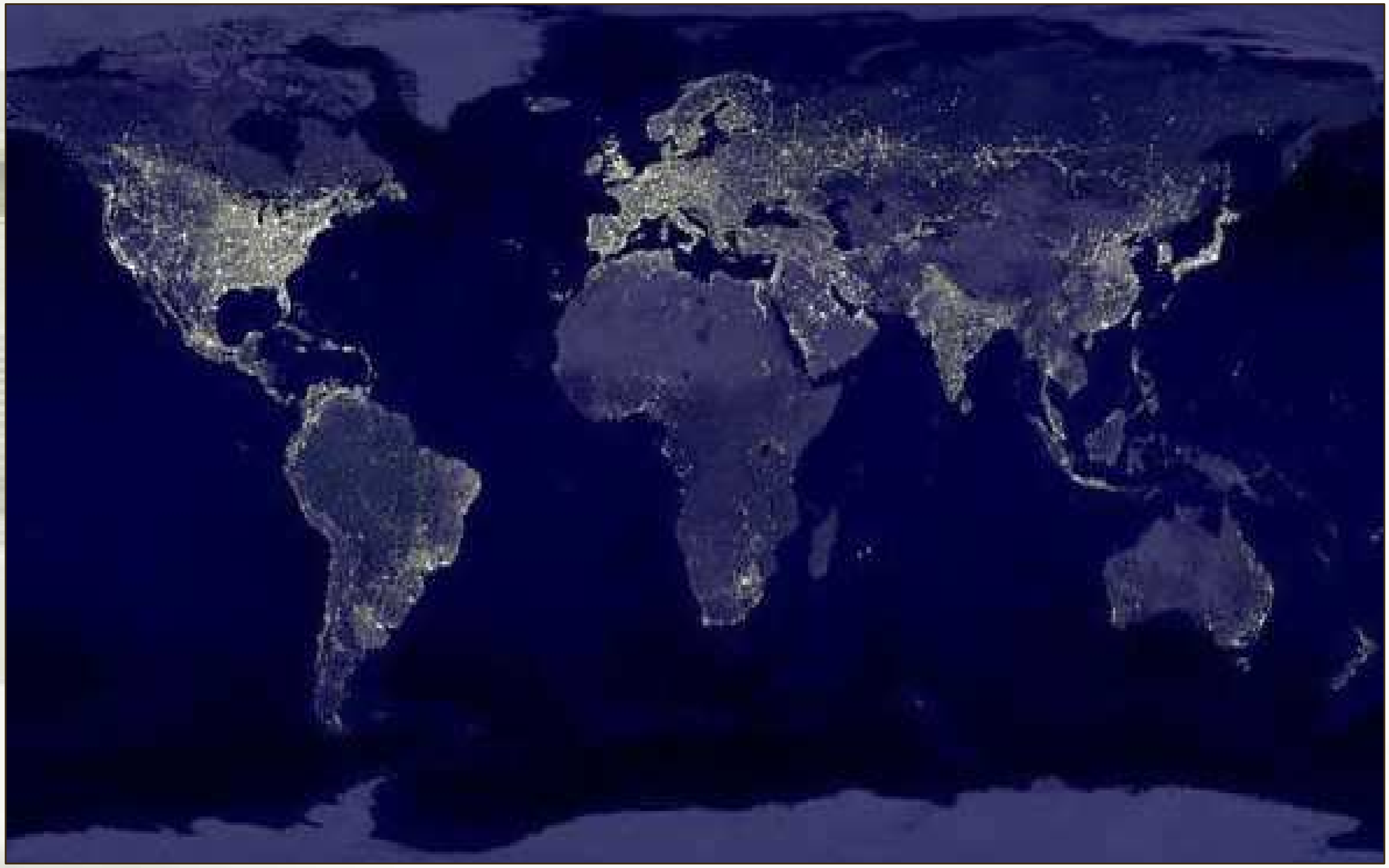
Energy Action Plan

> Recommendations
> Schedules
> Payback periods
> Monitoring and maintenance

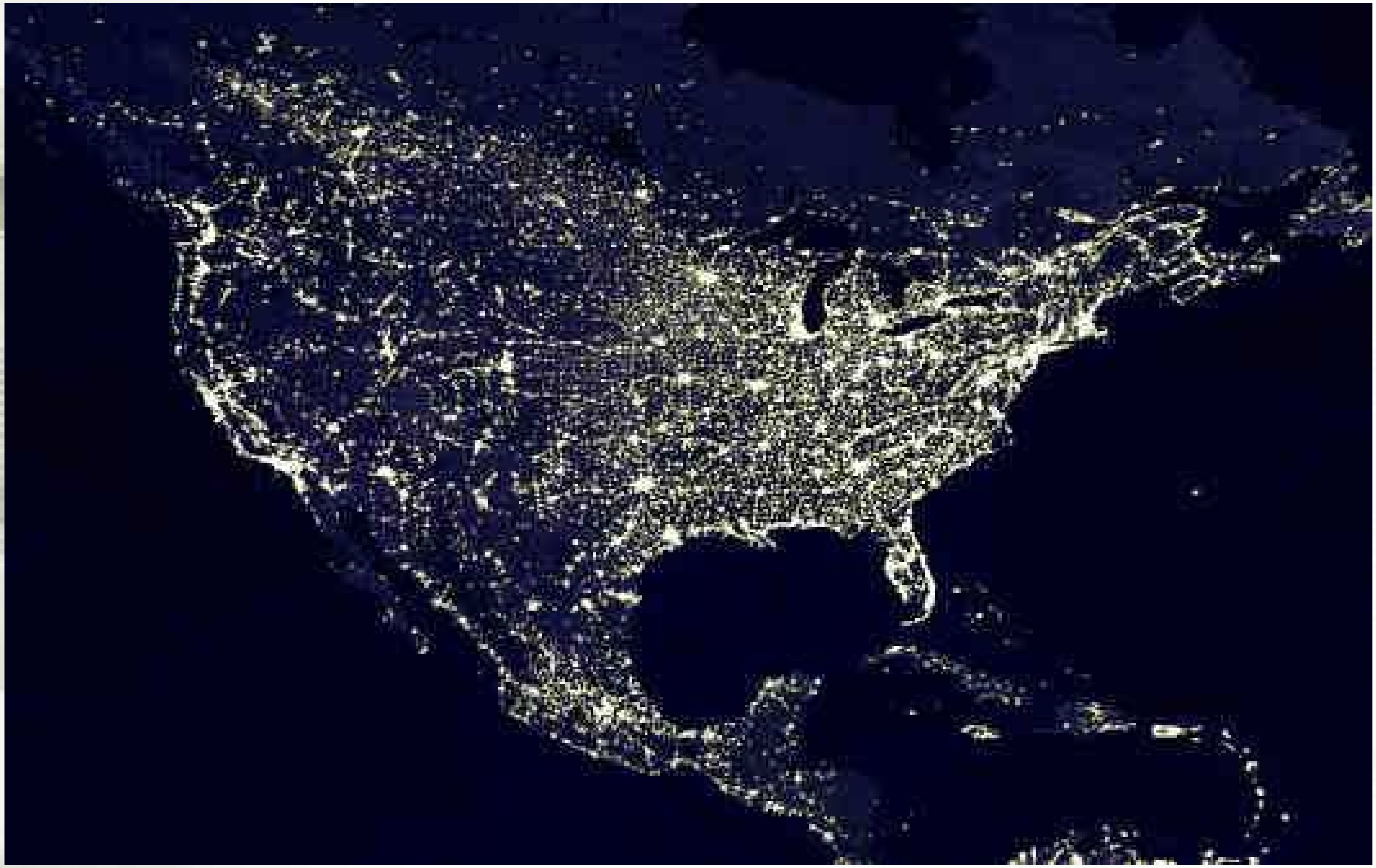
Common EMOs

> Lighting
> Insulation
> Comfort
> Equipment
> Boilers
> Compressors

Lighting



Lighting



Lighting

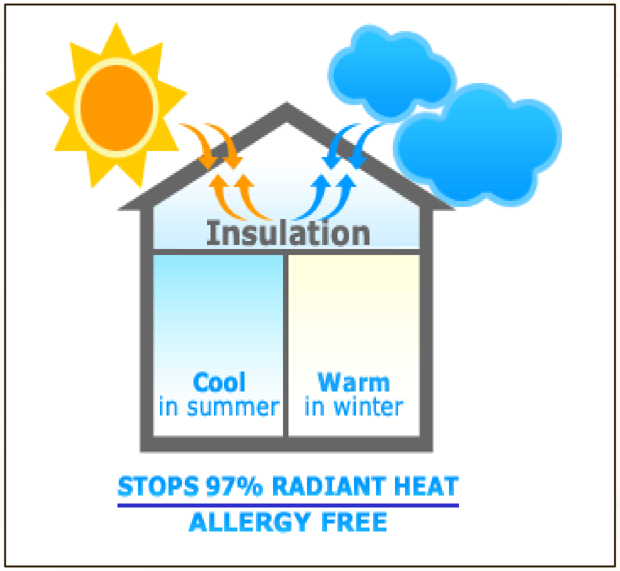
> Switch to energy-efficient lamps and light sources
> Use day-lighting
> Use night setback-setup
> Use occupancy sensors
> Install an automated Energy Management System

Emergency Lighting Example

	Incandescent	Compact Flourescent
Watts	60	15
Annual Use hrs	8,736	8,736
Annual kWh	524	131
Elect cost @ $0.05kWh	$26.21	$6.55
Bulb Cost	$1	$20
Bulb Life (hr)	1,000	10,000
# Changeouts/yr	9	1
Annual Bulb Cost	$9	$20
Total Cost (w/o labor)	$35.21	$26.55
Est. Labor/yr *($45/hr, 1/2hr, 2 people)*	$393	$45
Est. Total Costs	**$428**	**$72**

Insulation

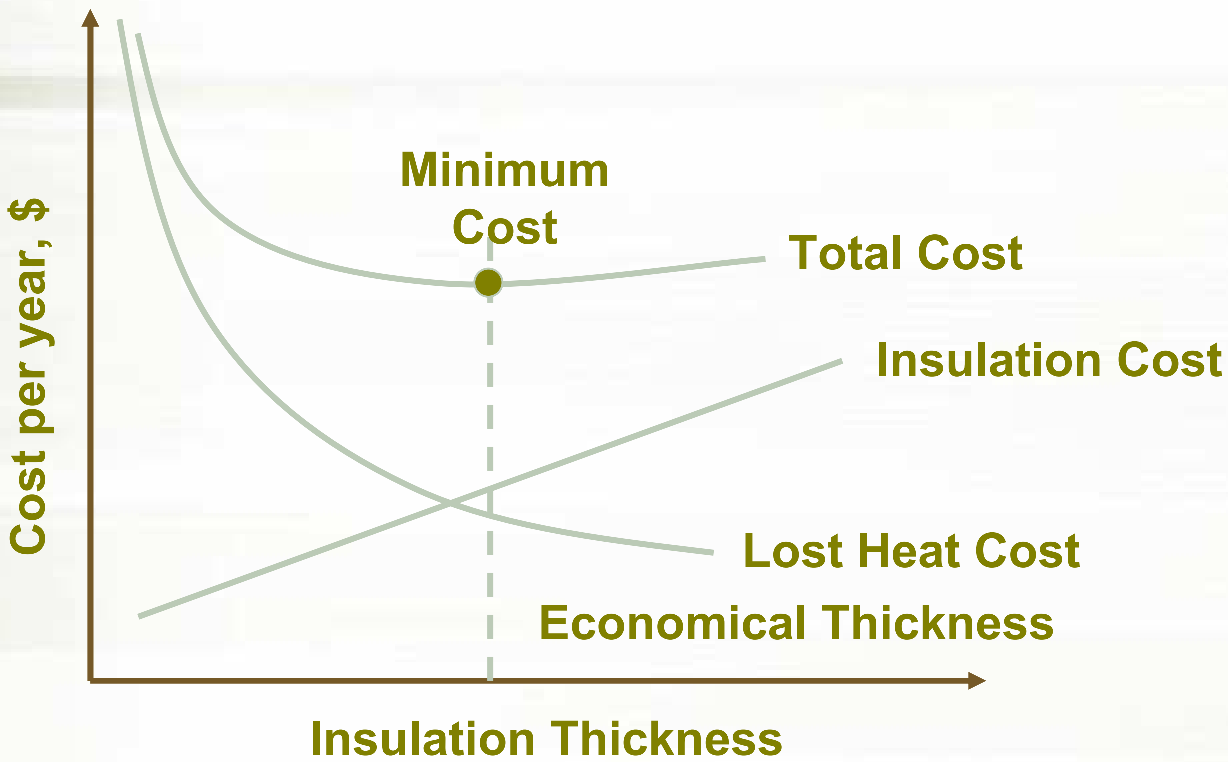
> Insulate walls, ceilings, roofs, and doors
> Install storm windows, doors, and weather stripping
> Insulate bare tanks, vessels, lines, and process equipment
> Insulate dock doors
> Cover open heated tanks



Insulation Example

Insulation Thickness (in)	Installed Cost ($/ft²)	Annual Energy Loss (kWh/ft²)	Energy Cost ($/kWh)	Cost of Energy Loss ($/ft²)	Total First Year Cost ($)	Cost over 10 years
0	$0.00	45.80	$0.05	$2.29	$2.29	$22.90
1	$1.31	**15.54**	$0.05	$0.78	$2.09	$9.08
2	$1.53	9.36	$0.05	$0.47	$2.00	$6.21
3	$1.65	6.70	$0.05	$0.33	**$1.98**	$5.00
4	$1.84	5.21	$0.05	$0.26	$2.10	$4.45
5	$2.01	4.27	$0.05	$0.21	$2.22	$4.14
6	$2.15	3.61	$0.05	$0.18	$2.33	**$3.96**
7	$3.27	3.13	$0.05	$0.16	$3.43	$4.84
8	$3.43	2.76	$0.05	$0.14	$3.57	$4.81
9	$3.57	2.47	$0.05	$0.12	$3.69	$4.81

Economic Thickness

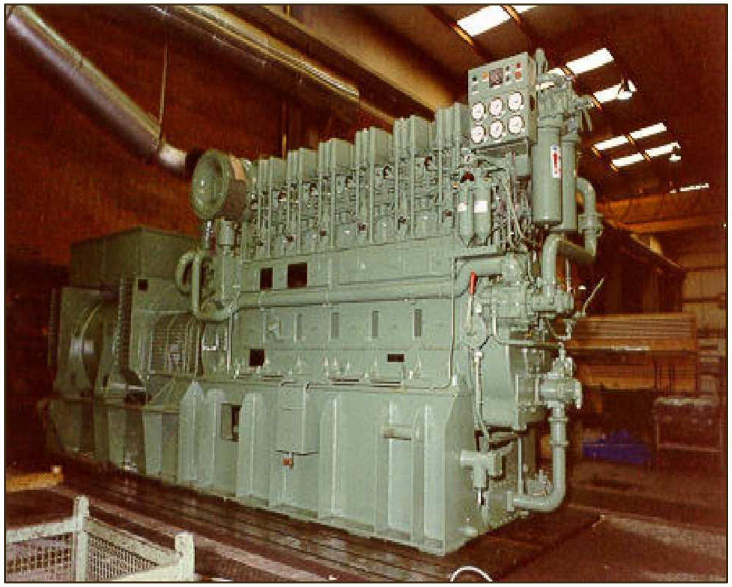


HVAC

- Explore waste heat recovery for space exhaust systems
- Spot-ventilate or use air filters
- Use radiant heat (warms objects not space)
- Install economizers on air conditioners (use outside air when cooler)
- Install an automated Energy Management System

Equipment

- Turn off equipment
- Use energy-efficient electric motors
- Reschedule operations to reduce peak demand



Boilers

- Control excess air for combustion
- Preheat combustion air
- Return steam condensate to the boiler
- Use recycled water as boiler feedstock

Compressors

- Move air compressor intake to cooler locations
- Eliminate leaks in steam and compressed air systems
- Reduce the pressure of compressed air and steam
- Recover heat from air compressors

Energy Efficiency Vocabulary

- Energy Units
- Energy Equivalents
- Electric Power Rate Structure

Energy Units

> kilowatt hours
> cubic feet
> therms
> barrels
> tons
> gallons
> horsepower
> cords

Energy Equivalents

> 1 horsepower (HP)	=	2,545 BTU
> 1 kWh electricity	=	3,412 BTU
> 1 ft3 natural gas	=	1,000 BTU
> 1 therm nat gas	=	100,000 BTU
> 1 gallon gasoline	=	125,000 BTU
> 1 gallon #2 fuel oil	=	140,000 BTU
> 1 barrel crude oil	=	5,100,000 BTU
> 1 ton coal	=	25,000,000 BTU
> 1 cord wood	=	30,000,000 BTU

Electric Power Rate Structure

1. **Customer Cost** - fixed monthly cost
2. **Energy Cost** - proportional factor based on energy used ($/kWh)
3. **Demand Cost** - proportional factor based on power delivered ($/kW)
4. **Demand Ratchet** – used to determine minimum demand charge. Customer pays a large percentage of the highest demand experienced over the previous 11 months even if that peak was reached only one time. Typically ranges from 60 to 100 percent.

Utility Bill Example

> Customer cost	$100 / month
> Energy cost	$0.05 / kWh
> Demand cost	$10 / kW / month
> Demand ratchet	75 percent
> Previous high demand	500 kW

Utility Bill Example Calculation 1

Consumption	50,000 kWh
Actual Demand	250 kW
Customer cost	$ 100
Consumption ($0.05/kWh)*(50,000 kWh)	$ 2,500
Demand ($10/kW)*(250kW)	$ 2,500
	$ 5,100

Utility Bill Example Calculation 2

Demand Ratchet of 75 % means you have to pay for at least 375 kW per month, so

Customer cost	$ 100
Consumption ($0.05/kWh)*(50,000 kWh)	$ 2,500
Demand ($10/kW)*(.75)(500kW)	$ 3,750
	$ 6,350

$5,100 per month without ratchet

Difference is $1,250 per month

Facility Energy Decision System

Developed by:
Pacific Northwest National Laboratory

FEDS - What is it?

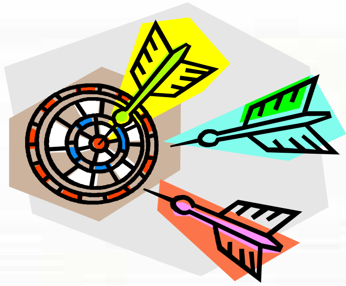
- FEDS is a fuel-neutral,
- technology independent,
- comprehensive method for
- quickly and objectively identifying building energy efficiency improvements
- that offer maximum savings

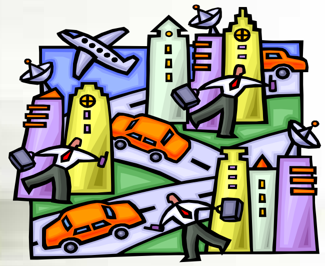
FEDS Design Goals

Designed for two major purposes:

> Estimate current energy consumption for all energy systems under consideration

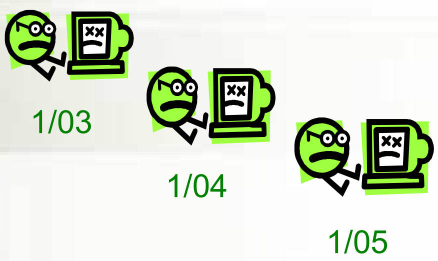
> Determine the minimum life-cycle cost retrofits to systems within a facility and across an installation





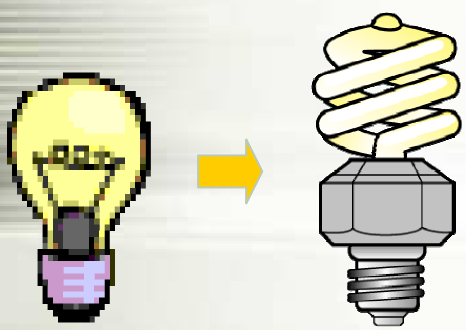
> Assess and analyze energy efficiency in multiple buildings and at multiple sites

> Identify retrofits, determine payback, and enable users to prioritize options



> Provide a consistent basis for decision-making on retrofit options

- Calculate lowest life-cycle and cost-effective energy systems for all building types
- Accept generic or very detailed inputs
- Determine the optimal set of retrofits to the current system - considering interactive effects



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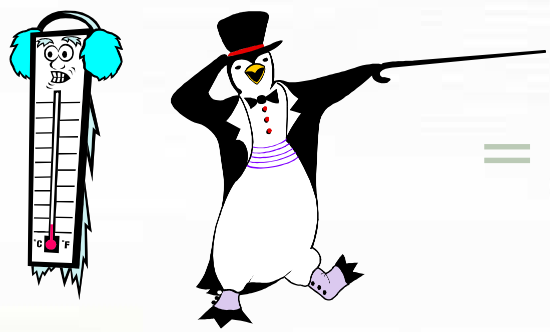

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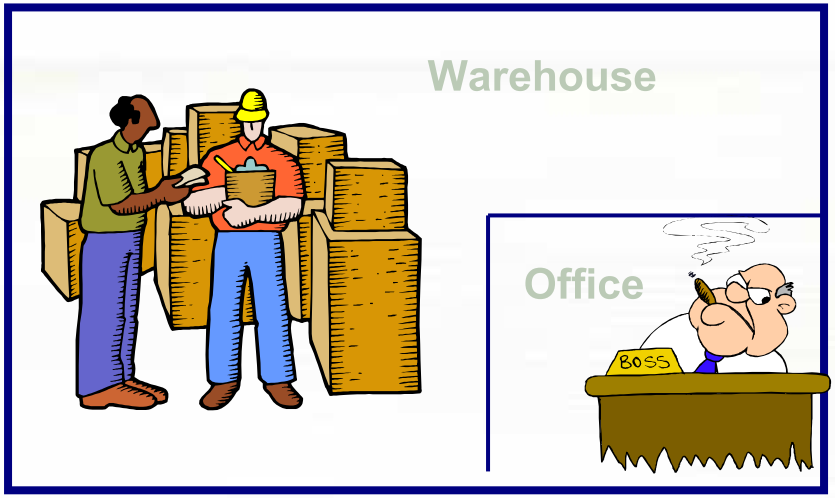
Replace inefficient lights with efficient lights

Less heat into the space, and people begin to feel like penguins

Therefore, heating system must make up the difference

- Provide very detailed efficiency recommendations, including technology selection
- Model use areas



- Model buildings with seasonal occupancy

- Track emissions impacts

How to Obtain the Software

- Visit *www.pnl.gov/FEDS*
- Attend free 2-3 day training given by PNL
- Submit a software request on-line
- View latest software news and update information
- Once you're listed on the official distribution list, you will be notified of all upgrades & updates

Okay – these are STILL pretty funny!

GREEN TEAMING

Taking Advantage of the System

M. Lee Bishop

USDOE Office of Repository Development

May 2005

What Is Green Teaming?

- Green Teaming
- Cross over organizational boundaries and partner to develop solutions that are not limited to environmental issues
- Formal or informal, focus on one or multiple aspects and impacts at a site

Green Teaming Benefits

- Produces positive impacts, beyond environmental
- P2 managers move from an advisory to a participatory role
- Provides real-world EMS training that results in meeting near-term Objectives and Targets with long-term positive programmatic environmental impacts

Traditional Site Waste Process

1. Materials, supplies, wastes are expended or no longer needed; they become waste or declared "excess"
2. Property Department screens the excess materials, picks the high dollar items for sale, the rest is considered waste
3. Waste Management prepares, packages, ships, and dispositions

P2 programs are typically not part of the process or only manage the traditional recycling programs

Problem: *Integration*

- Each department (Operations, Purchasing, Property, Waste Management) has it's own specific mission, focus, and budget
- In many cases, the process is so automated no one even talks to their counterparts
- Aspects and Impacts tend to be managed departmentally, not "Life Cycle"

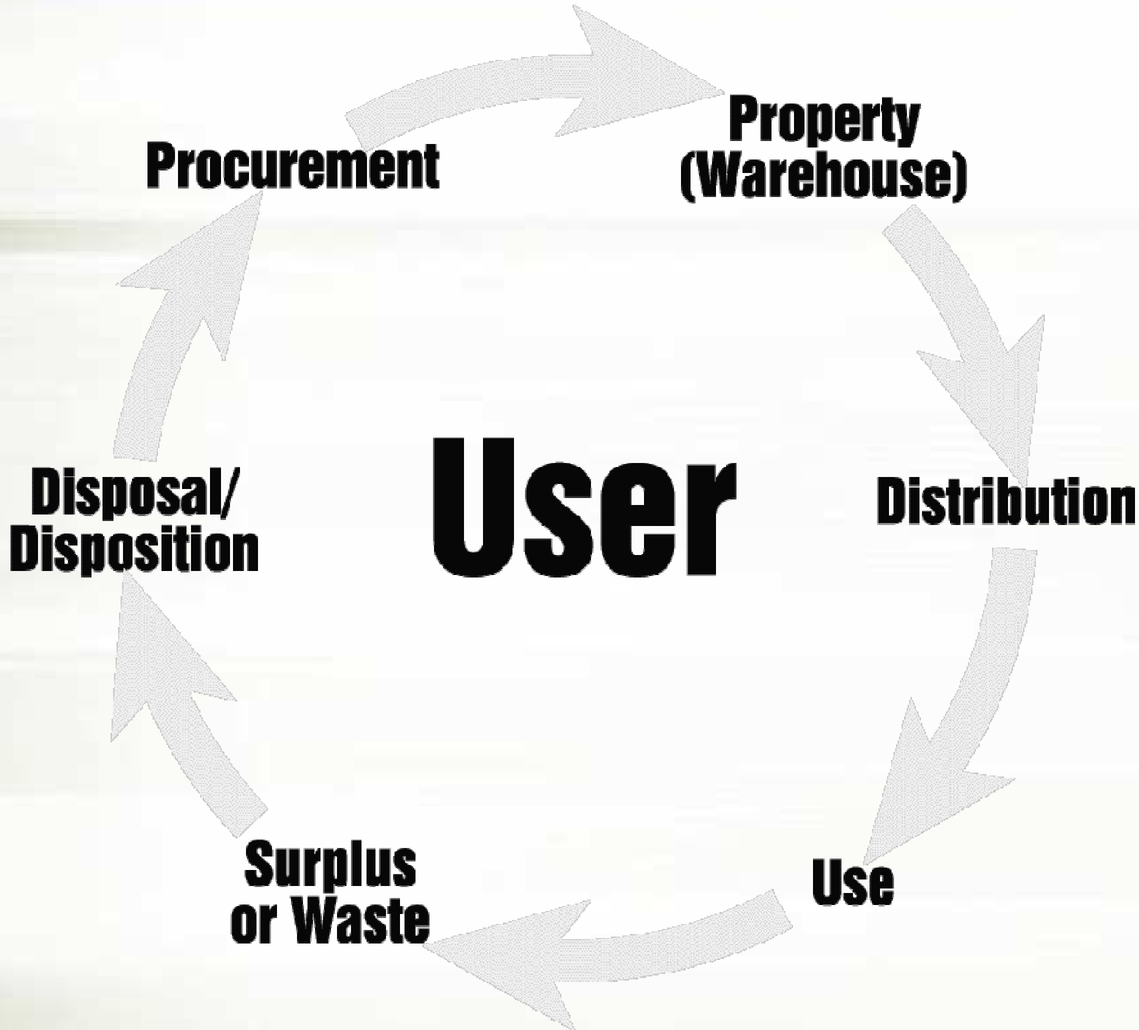
"their intimate knowledge of our systems and our business and their partnership approach have meant that they have added value in a number of ways."

Jim Swinden
Chief Executive Office
Freemasons Hospital

One Solution, Multiple Goals

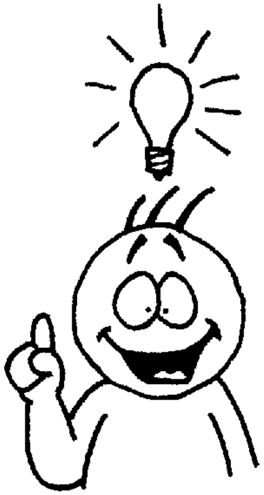
- Green Teaming recognizes that “Recycle, Reuse, and Reduce” is a great goal, but in most cases is not a primary mission in other departments
- Other Departments will partner if the environmental solution supports their programmatic goals (money, time, scope)
- Achieves immediate solutions to environmental impacts, but in the long-term, creates environmental/EMS advocates

Life Cycle Asset Management Flow Diagram



Before You Start - Understand P2 Goals

1. *What do you want to accomplish?*
2. *Which is most important?*
3. *Write it down!*



- > P2 / Waste Min
- > Zero Cost
- > Savings
- > Revenue Generation
- > Footprint Reduction
- > Milestones & Schedule
- > Community
- > Others?

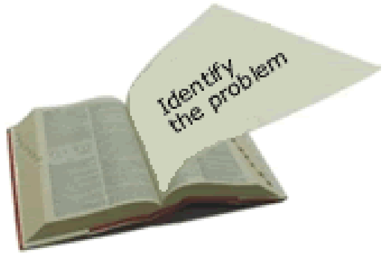
Seven Simple Steps To Green Teaming

1. Scope - Define the environmental aspect and impacts
2. Partner - Determine which organizations have potential associated interests or goals
3. Approach - Baseline vs. Alternative(s)
4. Negotiate - Choose the best common alternative
5. Plan - Who, What, When, and How
6. Execute - Ownership and management by the team
7. Review - Lessons Learned, re-enforce relationships

Scope - Know Your Challenges!

Define aspects and impacts

- > Understand current management approach
- > Gather historical data and process knowledge
- > Collect field data and analytical results
- > Investigate regulatory burdens and issues
- > Examine property issues (real & personal)
- > Capture costs (overall and time commitment)



Partners – What do they want?

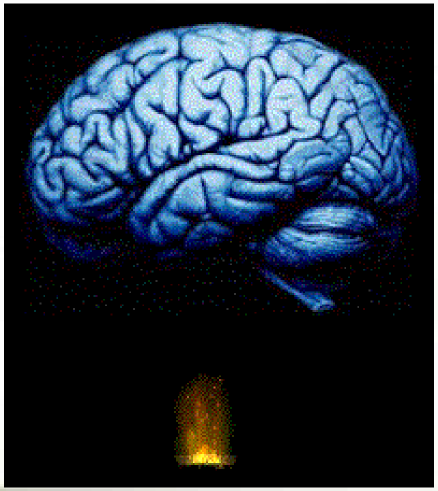
Money or Savings? More or Less Work? Fame? Less Liability?

- Waste Management
- Property
- Facilities
- Maintenance
- Public Affairs
- Community Reuse Organizations
- Security

- Health Physics
- Quality Assurance
- Legal
- Document Control
- IT Support
- Safety
- Admin Services
- Special Programs

Define Common Alternatives

- > Start with the current baseline
- > Outline everyone's goals
- > Brainstorm possible and reasonable common alternatives
- > Develop Targets and Objectives based on missions, organizations, politics, operations, perceptions, and barriers



Negotiate

- Rank the alternatives considering the Partners' goals
- Negotiation is an evolutionary process
- The best environmental approach may not satisfy your partners' goal
- Keep in mind what the Partners provide (money, resources, influence, outlets)
- In the end, all the Partners need to be Winners!

The Plan

The Partners may have very different business processes, training, and even their own language

Even for simple projects make sure everyone understands:

- **Who**: Delegate responsibilities
- **What**: Clear Objectives and Targets
- **When**: Schedule, including budget cycles
- **How**: Defined actions
- **Money**: Who's paying and receiving

Execute

Manage the Green Team beyond mitigating just the impacts

"Real-World EMS Training results in meeting near-term Objectives and Targets with long-term positive programmatic impacts."

The Partners must:

> play an active role

> function as a "Team"

> take individual ownership

Review

Formally closeout the Green Teaming effort:

> Lessons Learned (Next Time)
> Validate efforts (Awards, Celebrations)
> Empower Partners
> Re-enforce relationships (Green Network)
> *Long Term EMS Results – Continuous Improvement!*

Who are the Partners?
Who Teams with Who?

> Has Anybody Every Really Done This?

Partner: Waste Management

Approach: *"It's not a waste, It's not a cost"*

> Green Products (bio-based, non-haz)

> Challenges during D&D (labs, support facilities, building rubble)

> Intra- and Inter-site transfers (paint, chemicals)

> New recycle streams (batteries, lead)

> Reuse of contaminated materials transferred for government and commercial (B-25, drums, equipment)

> **Teams well with Property, Operations, and Buyers**

green products alliance

Partner: Property

Approach: *"Help! I can't sell it"*

> Recycling contracts (metal, electronics, batteries)

> Transfers - new owners

> Shelf-life re-certifications

> New uses (materials, chemicals)

> Focus on the small items with large volumes

> School gift programs

> Used Energy-Related Laboratory Equipment (ERLE) Grant Program

> **Teams well with Waste Management, Grants, & Contracts**

Public Affairs

Approach: *"Looking Good in the Press"*

> School gifts and grants
> Community Reuse Organizations
> Award programs
> Small businesses with e-products and services
> Interactions with other program offices and agencies
> **Teams well Grant and Gift programs**

“P2 Star” – DOE Award program

Security/Legal

Approach: *"OPSEC - Official Use Only"*

- Paper Recycle and Shredding
- Hard Drives and Data Systems
- Classified Destruction and Melts
- De-Militarization of Equipment
- Export Controls
- **Teams well with IT, Facilities, and Operations**

IT Department

Approach: *"Less is More"*

> Centralized printers
> Paper use reductions
> Energy Star equipment
> "Turn-Key" lease programs
> UPS and nickel battery recycle
> School Gift Program
> Electronics recycle
> **Teams well with Property and Facilities**

Facilities & Maintenance

Approach: *"Make It Easier"*

- Supports DOE O 430.1B – Real Property Asset Management and DOE O 430.2A – Energy Management
- Used fluids and by-product recycling
- Scrap programs
- Green alternatives
- Material exchange
- Building LEED certification
- **Teams well with Operations, Buyers, and Contracts**

Who are Your Partners?

ER/D&D Example – West Valley Decontamination Project

SELECT ACTIVITY: Fuel Receiving and Storage Pool (FSP) Decontamination Project

PROJECT SCOPE:

1. Cleaning sludge and debris from pool
2. Remove and package equipment and debris
3. Treat and drain pool water
4. Decontaminate FSP to ALARA

Team Selection

Collect Information

Reviewed the Project Plan to determine baseline approach and waste estimates

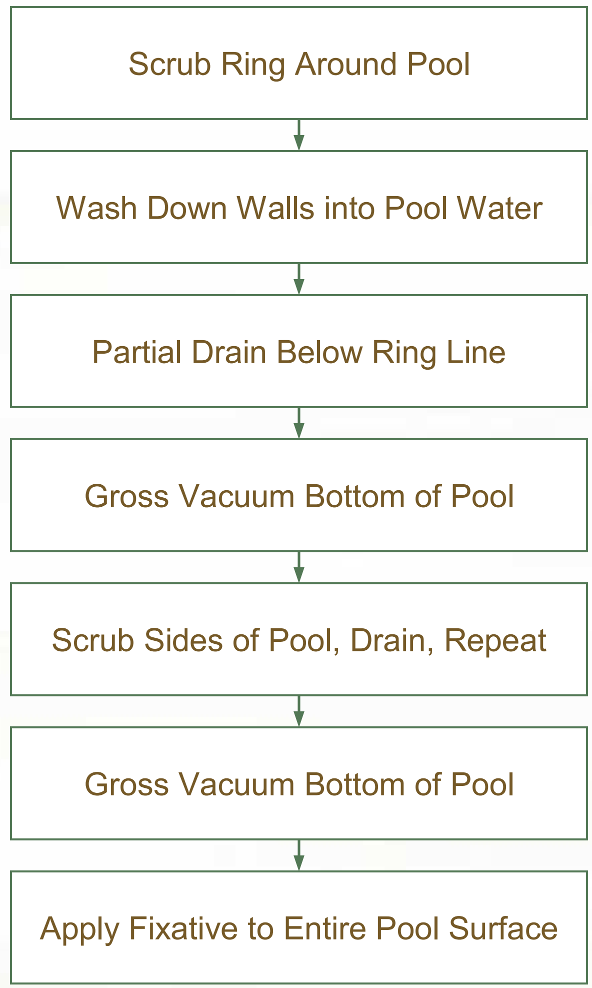
Primary wastes:

> 12,300 cubic feet of LLW – Class A
> 1,000 cubic feet of LLW – Class C
> 250 cubic feet of TRU waste

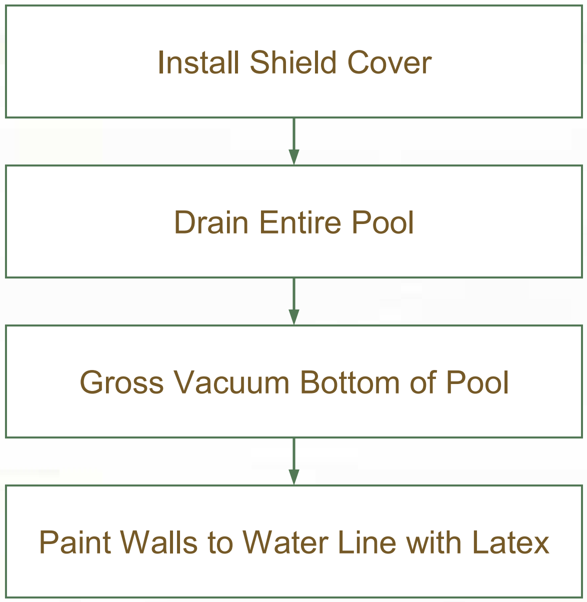
Secondary Wastes:

> PPE
> Decontamination and packaging materials

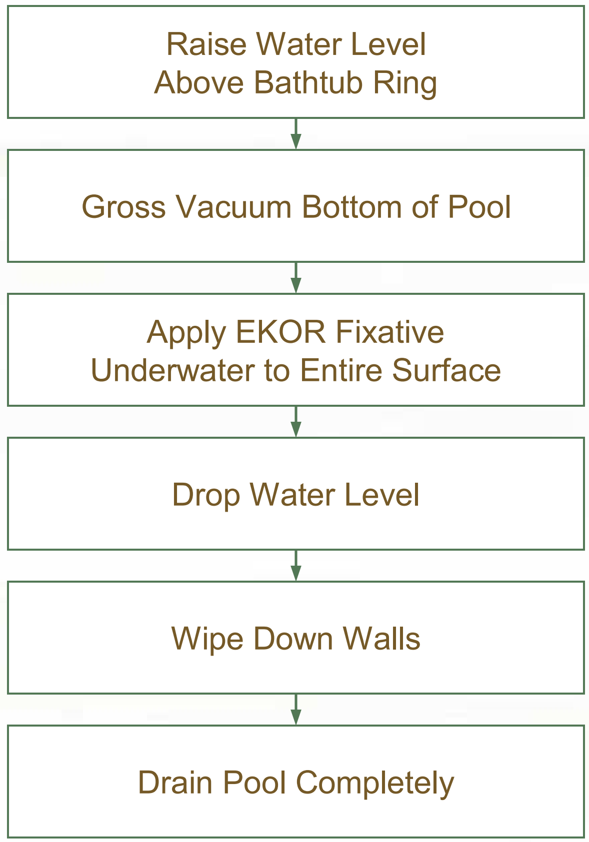
WVDP Fuel Storage Pool
Baseline Flow Diagram



WVDP Fuel Storage Pool
Alternative Flow Diagram 1



WVDP Fuel Storage Pool
Alternative Flow Diagram 2



WVDP Fuel Storage Pool
Alternative Flow Diagram 3

Scrub/Vacuum Entire Pool at the Same Time in Small Areas

↓

Gross Vacuum Pool Bottom Periodically

↓

Apply Epoxy-Based Coating Underwater to Entire Surface

↓

Drop Water Level

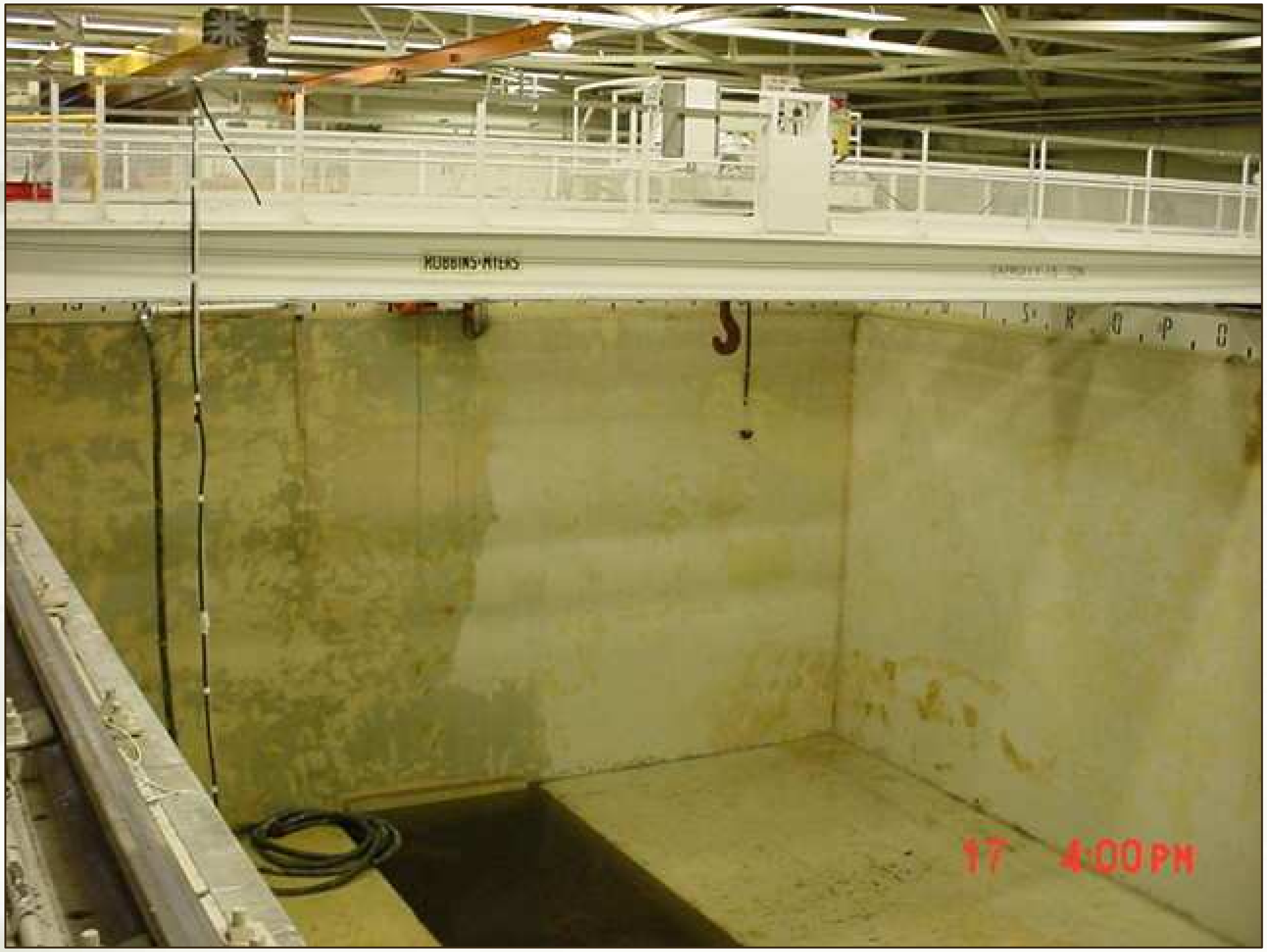
↓

Wipe Down Walls

↓

Drain Pool Completely


U T S R Q P O N M L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WVDP Pool Decontamination Cost Table

	Baseline Alternative	Alternative 1	Alternative 2	Alternative 3
Raise Water Level	Not Required	Not Required	11200	Not Required
Pool Cleaning	$ 738,338	Not Required	Not Required	Combined Below
Pool Draining	$ 291,200	$ 254,800	$ 336,000	$ 252,000
Painting or Fixative Application	$ 214,824	$ 425,777	$ 325,750	$ 171,115
Gross Vacuuming	$ 134,400	$ 134,400	$ 33,600	Combined Below
Scrub & Vacuuming	See Above	See Above	See Above	$ 158,215
Capital Equipment Purchase	Not Required	$ 15,000	Not Required	$ 50,000
Total Costs	**$ 1,378,761**	**$ 829,977**	**$ 706,550**	**$ 631,330**
Time to Completion - Weeks	**93**	**80**	**71**	**57**

WVDP Life Cycle Decision Analysis

	Baseline	Alternative 1	Alternative 2	Alternative 3	Alternative 4
	Scrub/Drain/ Latex	No Scrub/Drain/ Latex	EKOR Fixative	Epoxy Fixative	Offsite Vendor
Cost	$1.4M	$830K	$707K	$631K	$550K
Risk (Health and Safety)	◒	○	◒	◎	◎
Waste Reduction/ Pollution Prevention	◒	○	○	◒	◎
Schedule Impact	◎	◓	◓	◒	●
Compatibility & Maturity	◎	○	◎	◒	●
Recontamination Potential	●	●	○	◓	◎

◎ ◓ ○ ◒ ●

Best → *Worst*

WVDP LCA Description Chart

Criterion	Baseline Scrub/Drain/ Latex	Alternative 1 No Scrub/Drain/ Latex	Alternative 2 No Scrub/EKOR	Alternative 3 Combine/ Epoxy	Alternative 4 Offsite Vendor
Cost	$1.4 M	$830 K	$707 K	$631 K	$550 K
Health and Safety	High worker exposure	High worker exposure	Work underwater, less exposure	Work under-water, less exposure	High worker exposure
P2 (secondary wastes)	PPE generation	PPE generation	Less PPE, some tools, equipment	Epoxy waste may present disposal issues	Generation of higher volume of secondary waste
Schedule Impact	Estimated longer schedule	No scrubbing, shortens schedule	No scrubbing, less manpower, short-ens schedule	Shortens schedule	Unknown
Compatibility and Maturity	Compatible with existing WVDP equipment	Application to unscrubbed, unclean surface needs tested	Application of EKOR on vertical walls needs tested	Application of epoxy under-water needs tested	Proven method
Recontamination Potential	Minimal	Minimal	Likely	Likely	Very unlikely

P2/WMin Techniques and Technologies

Aqueous-based parts washers

> Reduce VOC emissions and worker exposure

> Self-cleaning/filtering aqueous parts washers reduce generation of waste cleaning solution

Powder Coating

> Powder coating of metal parts provides a more durable surface (reducing the need to repaint) while generating less VOC emissions

Cutting Fluid Recycler

> reduces waste generation during machining operations

Reusable Containers

> reduce container waste and provides a more organized means of managing hazardous materials

Personal Ice Cooling System

> PICS with Level C Clothing
  - 5.4 hours of field work per 10-hour shift

> Level C Clothing with no cooling
  - 2.3 hours of field work per 10-hour shift

> PICS improves productivity by 130%

Personal Ice Cooling System

- For a D&D job requiring 1,000 hours of field work based on ten-hour shifts with two changes of PPE per day:
  - PICS used 370 sets of Level C clothing
  - No cooling used 870 sets of Level C clothing
- Saved 500 sets of Level C clothing for 1,000 hours of field work

Soft-Sided Waste Containers

Containers at NTS

Soft-Side Waste Container

> Volume of container only
  - 19 cu ft for soft-sided waste container
  - 40 cu ft for three 12-ga. 4x4x6 ft metal boxes

> Soft-sided waste container also conforms to shape of waste to reduce voids within container and disposal cell

Concrete Dust Suppression

Concrete Dust Suppression System

> Demolition of high wall of concrete used:
  - 1.7 gal of water per cu ft of concrete using automated spray system
  - 14 gal/cu ft using manned fire hoses

> Eight times less water consumed and treated using automated spray system

Liquid Nitrogen-Cooled Diamond Wire

Liquid Nitrogen - Cooled Diamond Wire

> Demonstration at C-Reactor on three-foot thick concrete:
  - 3 gal wastewater per sq ft of face cut for water-cooled diamond wire
  - No wastewater for liquid nitrogen-cooled diamond wire

> Typical recycled water requiring treatment at conclusion of diamond wire cut is 100-150 gallons

Diamond Concrete Shaver

- Infinitely variable shaving depths controls the degree of removal to tight tolerances
- Leaves a smooth surface
- Avoids removal of entire concrete slab for disposal as LLW

TechXtract Chemical Decontamination

TechXtract Chemical Decontamination

> Demonstration on lead bricks at C-Reactor

- 78 out of one ton of 80 lead bricks were decontaminated to free release limits
- Avoided disposal of lead bricks as a mixed waste

Long-Range Alpha Detector

Long-Range Alpha Detector

> Demonstration at SRS 321-M Fuel Fabrication Facility

- Free released materials that were not able to be free released by hand probe or smear samples
- Good for monitoring alpha contamination:
  - Items with complex shapes
  - Large items
  - Multiple items

Strippable Coatings

> Demonstration in SRS LSDDP

- Only generated six gallons of liquid waste per 2,300 sq ft
- Liquid waste was generated during cleaning of spray equipment

Cooling Towers Demolition Project: Innovative Approach During Planning

> Up-front planning resulted in project success

- Approved release protocol allowed for the maximization of recycle during this project
- 850 tons of non-radioactive scrap metal recycled - netted $2.5M cost savings
- 5,500 yd3 concrete rubble used as fill material - cost savings of $148K over traditional LLW disposal
- 900,000 gallons free-standing water utilized to irrigate fields rather than being treated - saved $870K in treatment costs

Sandia Segregation Methods

Hypothesis: Dig and haul techniques are generally expensive and very inefficient

- SNL utilized the segmented gate system to screen soils and separate LLW from clean waste.
- Reduced waste soil volume by 70% with a cost savings of $684,000
- Combined the use of the Containerized Vat Leaching Process to increase reductions

Segmented Gate System

Hanford Reduces LLW Soil Using Real-Time Estimates

Hypothesis: "If it clicks, dig it up" is NOT efficient

- Utilized hand-held gamma ray spectrometer to screen soils during pipeline remediation
- Identifies and Measures Exposure Rates for Specific Nuclides in the Field
- Reduced sampling costs, time and 14,000 m3 of soil from being disposed as LLW

SRS IDW Management

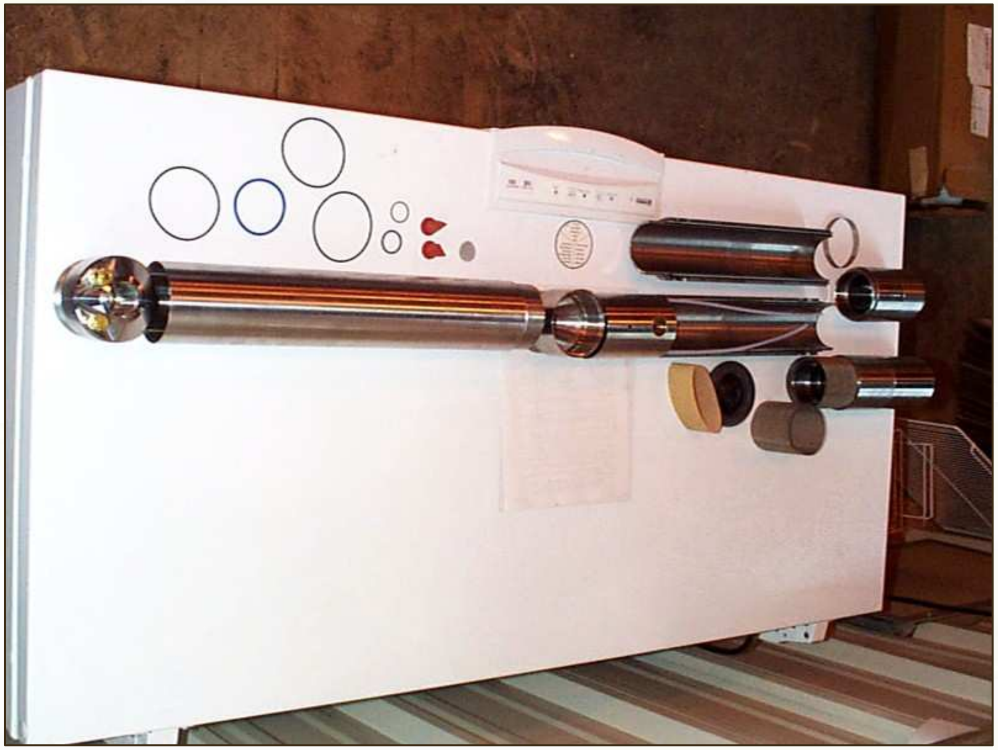
Hypothesis: The less you handle and treat wastes the lower the costs of waste management

- Negotiated with regulators to allow IDW wastes to remain at sample site
- 100% waste avoidance achieved

SRS Enclosures

Simulprobe - In situ site characterization tool

- Takes simultaneous sample collections of soil, gas, and groundwater



Examples of P2 in ER – Implementation Phase

- Segregate "like" materials to avoid mixed waste
- Reuse PPE whenever possible
- Minimize material, equipment, and personnel in controlled areas
- Fill void spaces of containers with compactible material such as soil, PPE, insulation if allowed in waste acceptance criteria
- Reduce packaging inefficiencies by using appropriate containers
- Utilize volume reduction whenever feasible
- Scabble localized hot spots from concrete to enable reuse
- Mechanically remove localized contamination from equipment
- Specify non-hazardous decontamination solutions
- Use HEPA ventilated units and wetting agents to prevent spread of contamination

Contracting

> Increased Number of Firm-Fixed Price Contracts

> Inclusion of P2 as a Performance-based Incentive

> Requirement by DOE that Contractors Pay Secondary Waste Costs

> Requirement by DOE that Contractors Plan to Deconstruct Treatment Facilities

Procurement Initiatives

- Develop standard P2 language early for insertion into all project contracts
- Discuss P2 language/requirements thoroughly with contractors and subcontractors during contract negotiations
- Focus performance measures in contracts to maximize recycle/reuse and reducing secondary waste generation.

Procurement Initiatives

- Include the development of a P2/WMin Plan by contractors as a performance measure
- Provide contract incentives to seek out and utilize waste reduction technologies
- Utilize language from other successful contracts; "EM Guidance on Incorporating P2 Principles into the Contracting Process"

Wrap Up/Summary

References and THANKS

- National Energy Technology Laboratory (NETL)– PITTS campus (Bruce Webster)
- West Valley Demonstration Project (Ahmad Aldaouk)
- Kim Fowler and Jill Engle-Cox – PNNL
- Kansas City Plant – PPOA Training (Susan Pemberton)
- Battelle EMS Workshop Presenters
- Kathy Yuracko – (YAHSGS LLC) – LCDA
- DOE’s PPOA Guidance
- EPA’s PPOA Guidance