U.S. NUCLEAR REGULATORY COMMISSION
AND
NATIONAL MINING ASSOCIATION

Uranium Recovery Workshop

UNITED STATES NUCLEAR REGULATORY COMMISSION

NMA™
THE AMERICAN RESOURCE

May 24 & 25, 2005

Denver, Colorado

AGENDA FOR THE 2005 NATIONAL MINING ASSOCIATION (NMA) /NUCLEAR REGULATORY COMMISSION (NRC) URANIUM RECOVERY WORKSHOP
Executive Tower Hotel, Denver, Colorado
May 25, 2005

8:30 a.m.	Continental Breakfast	
9:00 a.m.	NAS Report on Waste Disposal	– John Wiley, NAS
9:30 a.m.	Innovative Radiological Soil Survey at Dawn Mining's Facility	– Jan Johnson, MFG
10:00 a.m.	Health Physics Society Legislative and Regulatory LLRW Initiatives	– Scott Kirk, Health Physics Society
10:30 a.m.	**BREAK**	
10:45 a.m.	Land Reuse of Reclaimed Sites	– Tish O'Connor, DOE (Panel Discussion) – Craig Cox, Inter West Energy Alliance – Doug Dahle, National Renewable Energy Laboratory (NREL) –Jeff Dominick - NREL
11:30 a.m.	**LUNCH (ON YOUR OWN)**	
1:00 p.m.	Economic Forecast for Uranium	– Fletcher Newton, Power Resources
1:30 p.m.	EPA Uranium Mining TENORM Report and More	– Loren Setlow, EPA
2:00 p.m.	Overview UR Inspections Activities	– Jack Whitten, NRC
2:30 p.m.	Use of Spatial Analysis and Decision Assistance System for Cleanup Analysis	– George Powers, NRC
3:30 p.m.	Wrap Up	

AGENDA FOR THE 2005 NATIONAL MINING ASSOCIATION (NMA) /NUCLEAR REGULATORY COMMISSION (NRC) URANIUM RECOVERY WORKSHOP
Executive Tower Hotel, Denver, Colorado

May24, 2005

8:30 a.m.	Registration/Continental Breakfast	
8:50 a.m.	Welcome/Opening Remarks	– John Lusher, NRC – Katie Sweeney, NMA – Robert Pierson, NRC
9:00 a.m.	NRC Overview	– Robert Nelson, NRC
9:30 a.m.	Commission Decision in HRI Litigation	– Anthony J. Thompson, Law Office of Anthony J. Thompson
10:00 a.m.	License Termination at a Superfund Site ... A Joint Partnership	–Rahe Junge, UMETCO
10:30 a.m.	**BREAK**	
10:45 a.m.	New ISL Regulations in Wyoming	– Rick Chancellor (or Roberta Hoy), State of Wyoming
11:15 a.m.	NRC Activities for Controlling the Disposition of Solid Materials	– John Lusher, NRC
11:45 a.m.	**LUNCH (ON YOUR OWN)**	
1:15 p.m.	Successful Land Transfer at Sohio L-Bar	– Kevin Myers, State of New Mexico – Mark Plessinger, Stoller
2:15 p.m.	**BREAK**	
2:30 p.m.	DOE Title II Site Annual Update	– Ray Plieness, DOE
3:00 p.m.	Update on MOU to Deferring Groundwater Regulation at ISL Facilities	– Robert Nelson, NRC
3:30 p.m.	Wrap up Day 1	

OVERVIEW OF URANIUM RECOVERY ACTIVITIES

NMA/NRC Uranium Recovery Workshop

Robert A. Nelson, Chief
Uranium Processing Section, NRC

May 24, 2005

SIGNIFICANT ACCOMPLISHMENTS SINCE LAST WORKSHOP

- Issued Regulatory Issues Summary (RIS) 2004-09
- Completed on-site reviews of NE & WY ground water programs
- Approved Rio Algom-Lisbon ACL & Erosion Protection Plan
- Transferred four licenses to UT
- Terminated specific license for L-Bar; transferred to DOE
- Published draft of Pore Volume study

SIGNIFICANT ACCOMPLISHMENTS SINCE LAST WORKSHOP Contd.

- Closed approximately 60 licensing actions & decreased backlog
- Renewed Kennecott-Sweetwater license
- Revised UR Non-Common Performance Indicators for IMPEP
- Conducted 7 inspections (FY 04)
- Reviewed and responded to NMA/FCFF White Paper

ONGOING/PLANNED ACTIVITIES

- Analysis of results of ground water program reviews
- Hearing regarding HRI license
- Licensing reviews
- Title I reviews
- New applications
- Finalize Pore Volume study

CHALLENGES

- Attrition & recruitment
- Maintaining adequate technical expertise
- Need for institutional controls

May 2005

5

NRC STAFF CHANGES & RESPONSIBILITIES

Robert A. Nelson
Chief, Uranium Processing Section
U.S. Nuclear Regulatory Commission

May 2005 1

STAFF CHANGES

- Losses
  - Elaine Brummett - Retirement
  - Jill Caverly - Promotion to another Division
- Gains
  - Stephen Cohen - Hydrogeologist
  - Paul Michalak - Hydrogeologist
- Rotational Assignment
  - Bill von Till - May through August

May 2005 2

HIRING PLANS

- One Hydrogeologist
- One Geotechnical Engineer
- Both are nationwide postings
- Hope to fill by November

STAFF ASSIGNMENTS

- S. Cohen Kennecott
- M. Fliegel Sequoyah Fuels
- J. Lusher Rio Algom; Pathfinder; Cogema; ANC; ExxonMobil; Power Resources; Crow Butte
- D. Martin Dam Safety

STAFF ASSIGNMENTS (Contd.)

- M. Raddatz — Water Remediation Technology
- B. Von Till — Western Nuclear; UNC; Homestake
- R. Weller — Bear Creek; Hydro Resources; Petrotomics; Umetco

May 2005 5

New Developments in ISL Uranium Recovery Regulation:

Hydro Resources, Inc.'s Crownpoint Uranium Project

Presented By:
Anthony J. Thompson, Esq.
Christopher S. Pugsley, Esq.
Thompson & Simmons, PLLC

Thompson & Simmons, PLLC 1

PRESENTATION OUTLINE

- Hydro Resources, Inc.'s (HRI) Nuclear Regulatory Commission (NRC) Licensing Proceeding
  - Background and Procedural History
  - Licensing Board Determinations
  - Issues Appealed
  - Argument
  - Commission Decisions

Thompson & Simmons, PLLC 2

BACKGROUND AND PROCEDURAL HISTORY

- 1987: HRI Submits License Application for the Crownpoint Uranium Project (CUP)
  - Four Proposed Uranium Recovery Sites:
    - Church Rock Section 8
    - Church Rock Section 17
    - Unit One
    - Crownpoint

Thompson & Simmons, PLLC 3

BACKGROUND AND PROCEDURAL HISTORY

- 1994: NRC Staff Issues Draft Environmental Impact Statement (DEIS)
- 1996: Eastern Navajo Dine Against Uranium Mining, Southwest Research and Information Center and Others (Intervenors) Request NRC Hearing
- 1997: NRC Staff Issues Final Environmental Impact Statement (FEIS) and Determines No Significant Impacts Posed by HRI's Proposed CUP

BACKGROUND AND PROCEDURAL HISTORY

- 1997: Intervenors Granted NRC Subpart L "Informal" Hearing on CUP
- Hearing Request Areas of Concern for All Proposed Uranium Recovery Sites:
  - Groundwater Protection and Restoration
  - Financial Assurance
  - Historic Preservation
  - Air Emissions
  - Environmental Justice
  - FEIS Adequacy
  - Financial and Technical Qualifications

BACKGROUND AND PROCEDURAL HISTORY

- NRC Hearing Bifurcated to Be Litigated By Site
- 1998-1999: Church Rock Section 8 Litigation Commences
- Licensing Board Determines That HRI License Application is Adequate

BACKGROUND AND PROCEDURAL HISTORY

- Intervenors Appeal to Commission
- 5/2000: Commission Determines that HRI Must Submit Groundwater Restoration Action Plans (RAPs) and Financial Assurance Cost Estimates Prior to Commencing Uranium Recovery (CLI-00-08)
- 2000-2001: HRI Submits RAPs for All Sites and Receives NRC Staff Approval
- 2001: Intervenors Challenge RAP for Church Rock Section 8
- 11/01: Oral Hearing At NRC With Licensing Board Regarding RAPs

LICENSING BOARD DETERMINATIONS

- 1/04: Licensing Board Issues Decision Upholding HRI Church Rock Section 8 RAP With Three Exceptions (LBP-04-03):
  - RAP Cannot Assume Availability of *Major* Site Equipment During Restoration
  - RAP Cannot Assume the Performance of Multiple, Unrelated Tasks (i.e., Wearing Multiple Hats) by Site Employees During Groundwater Restoration
  - RAP Must Account for Use of "Tremie Line" Method of Well-Plugging

ISSUES APPEALED

- 2/04: HRI Appeals LBP-04-03 to the Commission and Requests Review
- 5/04: Commission Grants HRI's Request for Review
- 7/04: HRI Submits Initial Brief to Commission
- Issues for Review:
  - RAP Cannot Assume Availability of *Major* Site Equipment During Restoration
  - RAP Cannot Assume the Performance of Multiple, Unrelated Tasks (i.e., Wearing Multiple Hats) by Site Employees During Restoration

ARGUMENT

- ISSUE #1: RAP Cannot Assume Availability of *Major* Site Equipment During Restoration
- SUMMARY OF ARGUMENT:
  - Standard Industry Practice and NRC ISL Standard Review Plan Allows for the Availability of *Major* Site Equipment
  - Licensing Board Decision Does Not Define What is *Major* Site Equipment (i.e., All Pumps, All Pipes, RO's, IX Columns, Brine Concentrators, etc.)
  - NRC Regulations Requiring Mandatory Annual Surety Updates Allow for Adjustment of Financial Assurance to Reflect Maintenance, Repair or Replacement of Site Equipment

Thompson & Simmons, PLLC 10

ARGUMENT

- ARGUMENT #1: Standard Industry Practice and NRC ISL Standard Review Plan Addresses for the Availability of *Major* Site Equipment
  - Standard Industry Life-Cycle Cost Estimates on Site Equipment Provides for Adequate Assessments and Repair or Replacement of *Major* Site Equipment as Necessary
  - Mandatory Fifteen Percent (15%) Contingency Included in Cost Estimates Provides Additional Safeguard

Thompson & Simmons, PLLC 11

ARGUMENT

- ARGUMENT #2: Licensing Board Decision Does Not Define What is *Major* Site Equipment
  - ISL Uranium Recovery Facilities Have Numerous *Types* of Equipment That Could Be Deemed Major:
    - Well-Field Pipes
    - Brine Concentrators
    - Reverse Osmosis Mechanisms
    - Front-End Loaders
    - IX Columns

Thompson & Simmons, PLLC 12

ARGUMENT

- ISL Uranium Recovery Licensees Do Not Account for Dismantling Entire Well-Field and Reconstructing for Decommissioning
  - Cost-Prohibitive to Force Licensees to Re-Purchase All Site Equipment for Decommissioning
  - Not All Site Equipment Requires Replacement, Only Maintenance and Repair

ARGUMENT

- ARGUMENT #3: NRC Regulations Requiring Mandatory Annual Surety Updates Allow for Adjustment of Financial Assurance to Reflect Maintenance, Repair or Replacement of Site Equipment
  - NRC Regulations at 10 CFR Part 40, Appendix A, Criterion 9 Require Mandatory Surety Updates on an Annual Basis
  - Surety Updates Require Cost Adjustments (Up or Down) in the Event of:
    - *Change in Technology or Processes*
    - *Change in Engineering Practices*
    - *Change in Total Costs for Licensed/Approved Actions*
    - *Change in Environmental Parameters for Restoration*
    - *Inflation*
  - Following NRC Regulations for Surety Updates As An Adequate Safeguard for Decommissioning is Standard Industry Practice and Generally Approved by NRC Staff

ARGUMENT

- ISSUE #2: RAP Cannot Assume the Performance of Multiple, Unrelated Tasks (i.e., Wearing Multiple Hats) by Site Employees During Restoration
- SUMMARY OF ARGUMENT:
  - Standard Industry Practice Assumes the Performance of Multiple, Unrelated Tasks by Site Employees
  - URI's Proposed Labor Categories and Cost Estimates Are Sufficient to Perform Groundwater Restoration
  - NRC Regulations Requiring Mandatory Annual Surety Updates Provide Adequate Safeguards for Potential Increases in Labor Requirements

ARGUMENT

- <u>ARGUMENT #1:</u> Standard Industry Practice Assumes the Performance of Multiple, Unrelated Tasks by Site Employees
  - ISL Uranium Recovery is Largely Automated and Few Site Employees Are Required
  - Multiple Tasks Can Be Performed by Experienced Qualified Professionals

ARGUMENT

- <u>ARGUMENT #2:</u> HRI's Proposed Labor Categories and Cost Estimates Are Sufficient to Perform Groundwater Restoration
  - HRI Modeled Its Proposed Labor Categories and Costs on Existing or Completed, NRC/Agreement State-Approved Projects
  - HRI Included Required Fifteen Percent Contingency for An Additional Safeguard

17

ARGUMENT

- <u>ARGUMENT #3:</u> NRC Regulations Requiring Mandatory Annual Surety Updates Provide Adequate Safeguards for Potential Increases in Labor Requirements
  - Appendix A, Criterion 9 Mandatory Annual Surety Updates Allow for Assessment of Labor Costs and Potential Need for More or Less Manpower at the Site
  - Surety Updates Require Cost Adjustments in the Event of:
    - Change in Technology or Processes
    - Change in Engineering Practices
    - Change in Total Costs for Licensed/Approved Actions
    - Change in Environmental Parameters for Restoration
    - Inflation

COMMISSION DECISION

- 12/04: Commission Issues CLI-04-33 and Finds For HRI On Both Appealed Issues As Follows:
- ISSUE #1: RAP Cannot Assume Availability of *Major* Site Equipment During Restoration
  - Commission Determines:
    - That HRI RAP Properly Presents Financial Assurance Cost Estimates for Availability of Site Equipment
    - That Site Equipment Must Be Assessed Based on Whether Maintenance, Repair or Replacement is Required
    - That NRC Annual Surety Updates and Fifteen Percent Contingency Are An Adequate Safeguard to Ensure Funds Are Available for This Assessment

COMMISSION DECISION

- ISSUE #2: RAP Cannot Assume the Performance of Multiple, Unrelated Tasks (i.e., Wearing Multiple Hats) by Site Employees During Restoration
  - Commission Determines:
    - That Standard Industry Practice of Assuming the Performance of Multiple, Unrelated Tasks by Site Employees is Appropriate
    - That HRI's RAP Presents the Proper Approach
    - That NRC Annual Surety Updates Are An Adequate Safeguard for Assessing the Potential Need for Increases in Labor Costs for Financial Assurance Cost Estimates

OUTSTANDING ISSUES

- Three Remaining Uranium Recovery Sites Must Be Litigated:
  - Church Rock Section 17
  - Unit One
  - Crownpoint

OUTSTANDING ISSUES

- Scope of Issues Have Been Refined:
  - Groundwater
    - SDWA/AEA Regarding Operating in Drinking Water Sources
    - Fluvial Aquifer Characteristics in ISL Mining
    - Performance-Based Licensing Approach for ISL Mining
    - Excursion Controls
    - Restoration Costs Estimates
  - Cultural and Historic Resources
    - Phased Approach to Section 106 Resource Identification Per Performance-Based License Approach
  - Air Emissions
    - Only Church Rock Section 17 to Be Litigated
  - Environmental Impact Statement Adequacy
    - Same Arguments for Church Rock Section 8 to Preserve Appeal

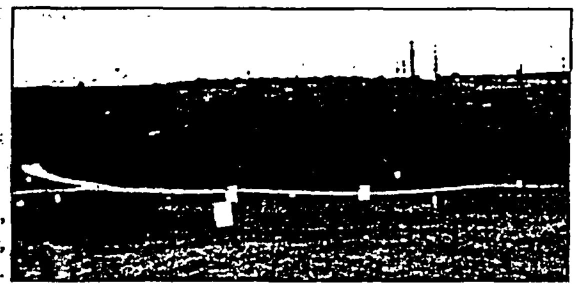
Thompson & Simmons, PLLC

Recent Changes to WDEQ In Situ Rules

LQD & WQD Rules

WQD - Chapter 8, Section 4 - In Situ Restoration

LQD - Chapters 7 and 11- Noncoal In Situ Mining



Power Resources, Inc. (PRI) - Highlands, Erosion Fabric in F-Wellfield Drainage, 6/98, Quarterly Inspection.

Recent Changes to WDEQ In Situ Rules

Regulatory Framework - Overview

Purposes of the LQD & WQD Rule Packages

Hot Topics in the Rule Packages

PRI - Smith Ranch, Wellfield 4 Pilot Holes, 12/98, Quarterly Inspection.

Regulatory Framework - Overview

Federal

EPA - Safe Drinking Water Act
- Underground Injection Control Program
- Code of Federal Regulations
- EPA Delegation of Primacy to WDEQ

NRC - Atomic Energy Act
- NRC Draft Memorandum of Understanding (MOU) with WDEQ

State

WDEQ
- 'As stringent as' federal requirements
- Wyoming Environmental Quality Act (WEQA)
- WQD Memorandum of Understanding with LQD
- Policies

Regulatory Framework - Overview

EPA - Safe Drinking Water Act (SDWA, 1974)

- 1974 - Underground Injection Control (UIC) Program established as part of SDWA.
- 1980 - 1st UIC Regulations
  Class III wells - wells associated with solution mining.
- 1983 - EPA Delegation of Primacy to WDEQ.

Regulatory Framework - Overview

NRC - Atomic Energy Act (1954)

- NRC has a process similar to EPA 'primacy', through which a State is deemed an 'Agreement State'. However, Wyoming has never sought Agreement State status for a variety of technical, regulatory, and monetary reasons.
- Prior to 2000, the NRC exercised jurisdiction over surface activities only (e.g., ore processing through ion exchange). However, in 2000, the NRC decided that NRC jurisdiction extends to the subsurface activities in the wellfields. (SECY-99-0013).
- In 2003, to help reduce or avoid dual regulation as a result of this decision, the NRC approved work on MOUs with the non-Agreement States - Wyoming, Nebraska, & New Mexico (SECY-03-0186).

Regulatory Framework - Overview

Wyoming Environmental Quality Act

- Created in 1973, specific in situ mining provisions (similar to current provisions) added in 1979.
- Associated WDEQ rules promulgated in 1980. Few changes until 2005.
- LQD Guideline 4 also developed in 1980. Periodically updated.

WQD/LQD Memorandum of Agreement

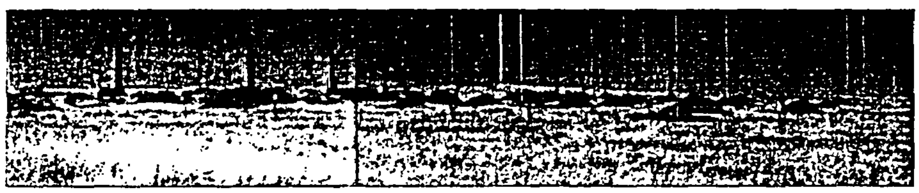
- Developed in 1996 to identify the "respective responsibilities of the divisions regarding the permitting and enforcement actions relation to mining operations."
- LQD responsible for in situ mining permits.
- Groundwater classification responsibilities remain with WQD for consistency among all users.

Regulatory Framework - Overview

WDEQ Policies

Three policies which impact in situ mining have been developed in the last few years:

- Wellfield Averaging (WDEQ 1996)
- Treatability Criteria (WDEQ 2000)
- Monitored Natural Attenuation
  (EPA 1980s-1990s /WDEQ 2000)



PRI - Highlands, Well Installation in Wellfield H, 3/00, Quarterly Inspection.

Regulatory Framework - Overview

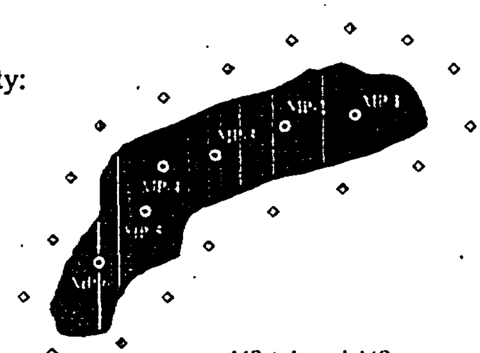
Wellfield Averaging

To characterize baseline water quality:

- Water quality data from inside the ore zone is averaged.
- Water quality data at the monitor well ring is on an individual well basis.

Primary reason:

- Extent of mixing in ore zone during mining.



MP-1 through MP-6.
Average data from all the wells.

through
Use individual well data.

Regulatory Framework - Overview

Radium Treatability Criteria:

- Chapter 8, Section 5(a) provides WQD authority to set "treatability limits" for Class I (Domestic) groundwater which "shall be classified by ambient water quality and the technical practicability and economic reasonableness of treating ambient water quality to meet use suitability standards."
- The Class I standard for radium is 5 picoCuries per liter (pCi/l), and the treatability limit was 100 pCi/l.
- In 2000, at a joint meeting of LQD's and WQD's respective Advisory Boards, the decision was made to rescind the radium treatability limit.
- Primary reason: Concern was that, despite the ready treatability of radium (e.g., the Hanna water supply), an individual treatment unit could result in a radioactive source.

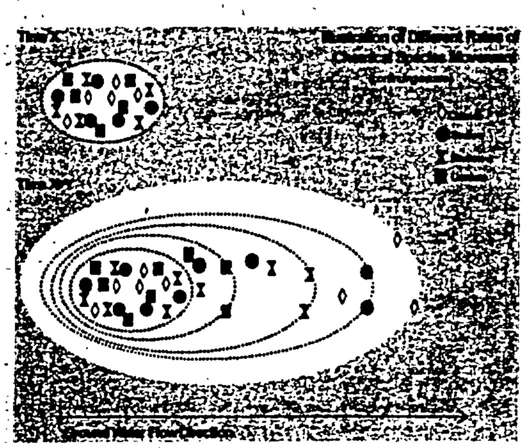
Regulatory Framework - Overview

Monitored Natural Attenuation

- To ensure water is still suitable for the uses for which it was suitable prior to mining.

Primary reasons:

- Uncertainty about effectiveness of MNA for in-situ, particularly given change in oxidation-reduction conditions.
- Potential impacts if not effective.



Changes to WDEQ In Situ Rules

✓ ***Regulatory Framework***

→ ***Purposes of the LQD & WQD Rule Packages***

Hot Topics in the Rule Packages

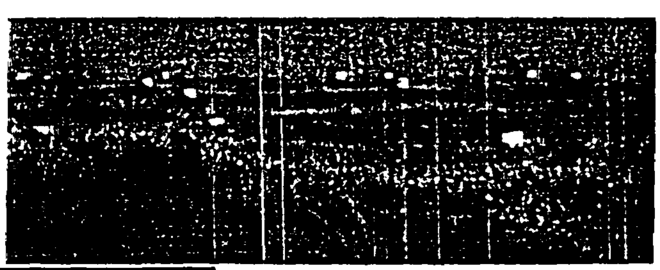
PRI - Smith Ranch, Drilling activity in Wellfield 3, 12/98, Quarterly Inspection.

Changes to WDEQ In Situ Rules

Purposes of the LQD & WQD Rule Packages

- *Wyoming Program 'Maintenance';*
- *'Harmonize' Federal & State requirements;*
- *Clarify & coordinate language; and*
- *Address technical issues/improvements.*

Some of these are also hot topics.



PRI - Highlands, F-Wellfield, 2nd year in operation. 7/98, Quarterly Inspection.

Purposes of the LQD & WQD Rule Packages

Wyoming Program 'Maintenance'

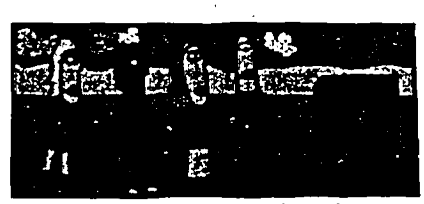
- Some of the decisions made by WDEQ and EPA when primacy was granted are not clear because documentation may not have been maintained and personnel involved in the decisions are no longer with the agencies.
- Need to update for EPA revisions since primacy was granted.

Purposes of the LQD & WQD Rule Packages

'Harmonize' Federal and State Requirements

2 Examples

- Permitting Process; and
- Applicability.



'Harmonize' Federal and State Requirements

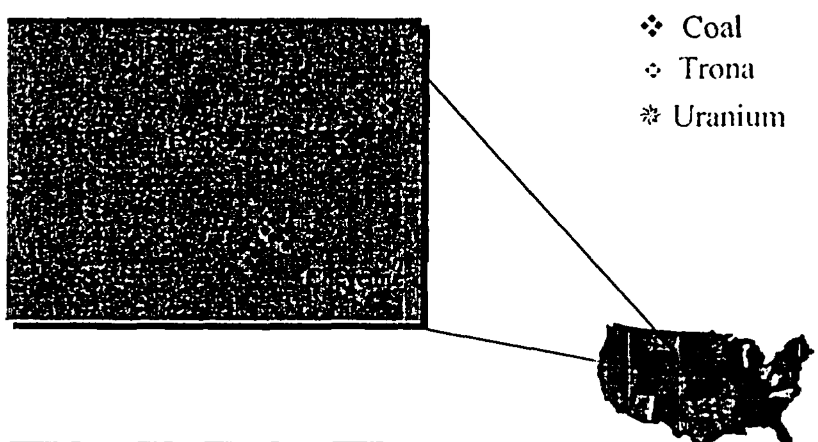
The Permitting Process

- EPA process designed for a small operation (e.g., only a few wells) with minimal changes.
- Wyoming process designed for a multiple well operation with wellfields coming on line and being taken off line.

Proposed rules retain the ***existing*** Wyoming permitting process with minimal changes, and differences from the EPA process are documented.

'Harmonize' Federal and State Requirements

Applicability - Minerals other than uranium.



- Coal
- Trona
- Uranium

Changes to WDEQ In Situ Rules

✓ *Regulatory Framework*

✓ *Purposes of the LQD & WQD Rule Packages*

→ *Hot Topics in the Rule Packages*

PRI - Highlands, Mechanical Integrity Testing, 11/99, Quarterly Inspection.

Changes to WDEQ In Situ Rules

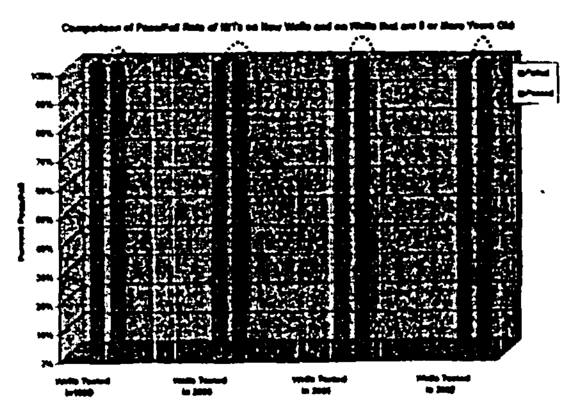
'Hot Topics' in the Rule Packages

- *Well Construction & MIT Testing Frequency*
- *Reporting Requirements*
- *EPA Aquifer Exemption/WQD Ground Water Classification*
- *Restoration Requirements*
- *Uranium Classification Standard*

Well Construction & MIT Testing Frequency

Underlying Technical Issue

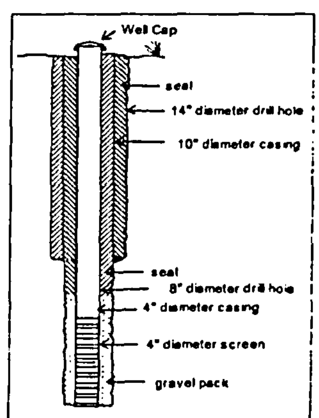
Number of Wells (7,000+) & Increasing MIT Failure Rate



Well Construction & MIT Testing Frequency

Changes to Specific Sections in Chapter 11 *(examples)*

Section 6(c)(i) - The drill hole shall be of sufficient diameter for adequate sealing and, at any given depth, at least ***three inches*** greater in nominal diameter than the diameter of the outer casing at that depth. [Note: *Proposed State Engineer rules require 4 inches.*]



Section 7(a)(iii) - Maintenance of the mechanical integrity of each Class III well, which has not been plugged or converted as required by Section 8 of this Chapter, shall be demonstrated at least ***once every five years, or on a schedule determined by the Administrator.***

Reporting Requirements

Underlying Regulatory Issue

As noted earlier, overall intent was to change the overall permitting process as little as possible, but a few changes had to be made to ensure consistency with federal language. For example, federal rule is specific that the notification from the Administrator to an operator that reinjection into a repaired well can resume must be provided on a well-by-well basis. However, operators requested an alternative that the notification could be provided on a wellfield basis.

Change to Specific Sections in Chapter 11 (Example)

Chapter 11, Section 7(a)(v) If the Administrator determines that *a* Class III well lacks mechanical integrity, he or she shall give written notice of this determination to the operator of the well....The operator may resume injection upon ***written notification*** from the Administrator that the operator has demonstrated mechanical integrity.

EPA Aquifer Exemptions/WQD Ground Water Classification

Underlying Regulatory & Technical Issues

Differences in EPA & WQD Approaches
Ore Distribution
Water Quality Distribution
Water Testing Requirements
Selection of Exemption Boundaries

PRI - Smith Ranch, Pilot Hole drilling in Wellfield 4, 12/98, Quarterly Inspection.

EPA Aquifer Exemptions/WQD Ground Water Classification

Underlying Regulatory Issue - Differences in EPA & WQD Approaches

The Safe Drinking Water Act ***prohibits*** injection into an aquifer that could serve as an "Underground Source of Drinking Water" ***unless*** one of the following aquifer exemption criteria is applicable...

PRI - Gas Hills, Cameron Spring & Associated Reservoir, 7/98, Pre-Operation Inspection.

EPA Aquifer Exemptions/WQD Ground Water Classification

...An aquifer (or portion of an aquifer) may be determined to be 'exempt' if:

(a) It ***does not currently serve as a source of drinking water***; and

(b) It cannot and will not be a source of drinking water because:

(1) It is ***mineral, hydrocarbon or geothermal energy producing***, or can be demonstrated to be commercially producible;

(2) It is situated at a ***depth or location*** which makes recovery of water for drinking water purposes economically or technologically impractical;

(3) It is ***so contaminated*** that it would be economically or technologically impractical to render that water fit for human consumption; ***or***

(4) It is located over a Class III well mining area subject to ***subsidence or catastrophic collapse***; or

(c) Total Dissolved Solids (TDS) are ***more than 3,000 and less than 10,000*** milligrams per liter (mg/l). (40 CFR 146.4)

EPA Aquifer Exemptions/WQD Ground Water Classification

In EPA's Aquifer Exemption process:

- The EPA can identify an aquifer as an exempted aquifer when the State Program is approved; or
- After the State Program is approved, the State can submit the request for an exemption to the EPA, and if the EPA approves the exemption, then the exemption becomes a program revision.

In discussing application of the aquifer exemption process in Wyoming, four items to keep in mind...

EPA Aquifer Exemptions/WQD Ground Water Classification

Wyoming-Specific Considerations (cont'd)

- The area to be exempted must meet one of EPA's exemption criteria. The exemptions EPA has granted in Wyoming have been based on ***'commercially producible'*** e.g., the wellfield boundary (with an allowance to the monitor well ring), due to overall good quality of the water (generally ≤ 500 mg/l TDS).
- When Wyoming was granted primacy for the UIC program by EPA, the State did not directly adopt the EPA aquifer exemption process, at least in part because of concerns about creating 'sacrifice areas.' Instead, ***WQD retained their ground water classification process***, which includes Class V (Hydrocarbon Commercial, Mineral Commercial, or Geothermal). Therefore, none of the other EPA exemption criteria have direct counterparts in the WQD rules.

EPA Aquifer Exemptions/WQD Ground Water Classification

Wyoming-Specific Considerations (cont'd)

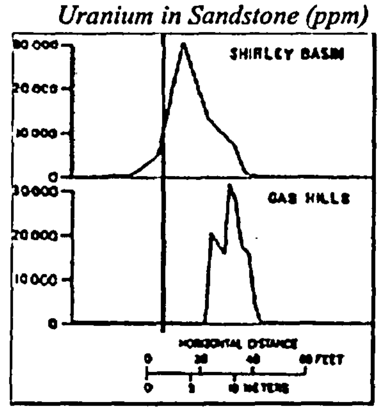
- Once WDEQ determines that an area can be reclassified as Class V, then WDEQ submits a request to EPA for an aquifer exemption. If EPA grants the aquifer exemption, then WDEQ reclassifies the ground water as Class V (public notice is required & generally occurs through the LQD permitting process).
- Although EPA exemption is permanent, ***the WQD classification is not considered permanent.*** W.S. § 35-11-103(f) includes ***restoration requirements*** specifically for in situ mining, and WQD rules (Chapter 8, Section 3(c)) require ***protection of ground waters for all uses for which the water is suitable.***

EPA Aquifer Exemptions/WQD Ground Water Classification

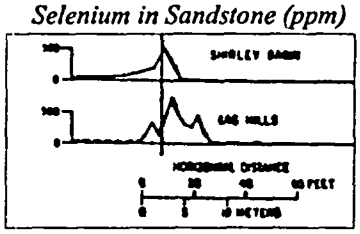
Underlying Technical Issue - Ore Distribution

In Wyoming, the distribution of uranium and associated minerals (e.g., selenium) is due to oxidation and reduction conditions in the subsurface formations when the minerals were deposited. At most sites, the concentration gradient from 'inside' to 'outside' the ore zone is quite steep.

Uranium in Sandstone (ppm)



Selenium in Sandstone (ppm)

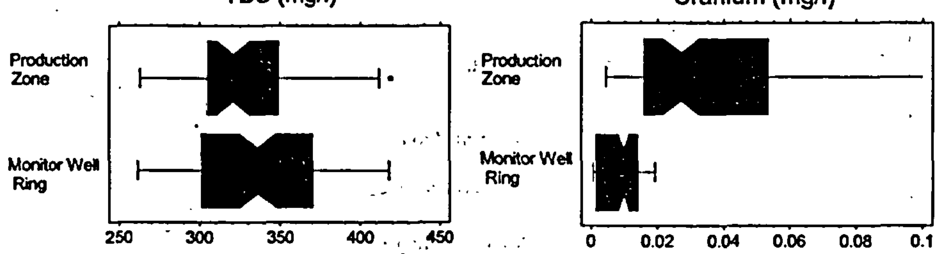


Adapted from E.N. Harshman, 1974, Distribution of elements in some roll-type uranium deposits, in Formation of Uranium Ore Deposits, IAEA, pp.169-183.

EPA Aquifer Exemptions/WQD Ground Water Classification

Underlying Technical Issue - Water Quality Distribution

In addition, significant water quality differences inside and outside most ore zones are generally limited to a very specific set of parameters - radionuclides...



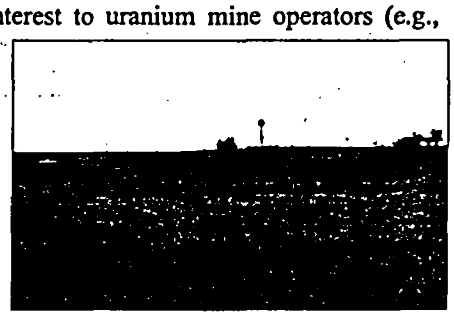
Baseline data from PRI Smith Ranch Wellfield 4. Note that the scale on the uranium 'box & whisker' plot does not show highest uranium concentrations. Vertical line on uranium plot illustrates EPA standard.

EPA Aquifer Exemptions/WQD Ground Water Classification

Underlying Regulatory Issue - Water Testing Requirements

The parameters which distinguish the ore zone water quality are not parameters for which wells are commonly tested. In fact, there is no requirement that owners of 'individual' wells, who may use wells for domestic and/or stock purposes, test their wells for any parameters. There may often be a suggested list of parameters, but it may or may not include parameters of interest to uranium mine operators (e.g., uranium, radium, and radon).

These 'individual' wells provide essential water sources on many of the more than 9,000 farms and ranches (not to mention ranchettes) in Wyoming, including those in the areas where uranium mines are located. Plus new water users (e.g., CBM) are arriving.



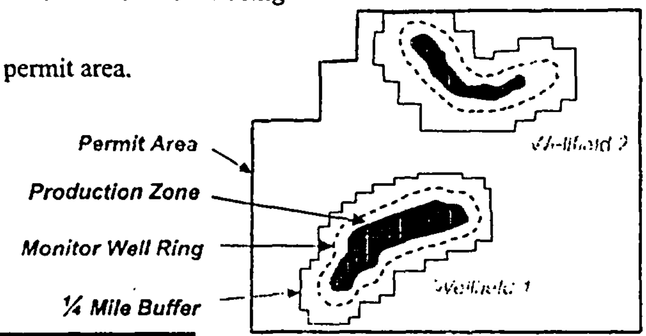
PRI - Highlands (south of Satellite No.2), Windmill used for livestock supply, 2/99, Quarterly Inspection.

EPA Aquifer Exemptions/WQD Ground Water Classification

Underlying Regulatory Issue - Selection of Exemption Boundaries

If exemption boundaries for in situ uranium mining in Wyoming, Nebraska, and Texas are compared, three approaches have been used:

- Exemption of the area inside the monitor well ring;
- Exemption of the area inside the monitor well ring + ¼ mile 'buffer';
- Exemption of the entire permit area.



EPA Aquifer Exemptions/WQD Ground Water Classification

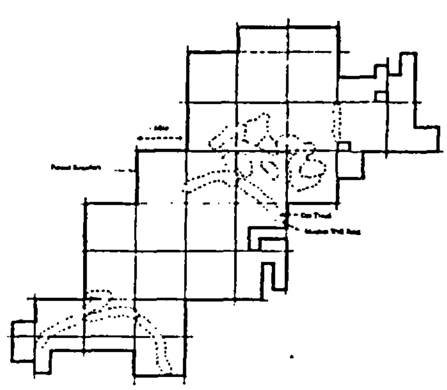
Underlying Regulatory Issue - Selection of Exemption Boundaries

The differences are apparently due to three factors:

Water Quality - In an area where the TDS concentrations exceed 8,000 mg/l both inside and outside the production zone, the overall water quality limits the uses for which the water would be suitable. Conversely in an area where the TDS concentrations inside and outside the production zone are less than 5,000 mg/l, more uses are possible;

Best Professional Judgment - What is considered a limiting factor in one area may not be so considered in other areas; and

Lack of Historical Records - Resulting in unintended changes from previous boundary selection approaches.



EPA Aquifer Exemptions/WQD Ground Water Classification

Changes to Chapter 11

Added Section 10 (*paraphrased below*)

(a) Injection restricted to production zones that:

(i) & (ii) Have been classified by WDEQ as Class V and exempted by EPA;

(iii) In a hydrologic setting in which ***fluid movement into unauthorized zones can be prevented.***

(b) An aquifer, or a portion thereof may be exempted if:

(i) It meets criteria similar to ***EPA criteria***;

(ii) As demonstrated by information in application, including:

(A) Map and general description;

(B) Information that exemption area is ***commercially producible***, including:

(I) The permit boundary;

(II) The ***right to mine***; but ***no more than*** the area w/i the ***monitor well ring plus a distance to the next quarter quarter (¼ ¼) section boundary that is at least one quarter (¼) mile from the monitor well ring***;

(III) & (IV) Information on mineralogy, geochemistry and mining technology; and

(C) Amenability of production zone to proposed mining method; and a mining schedule.

(c) Process for obtaining an exemption (i.e., the EPA Program Amendment).

EPA Aquifer Exemptions/WQD Ground Water Classification

Other Efforts

- Continue to work with EPA to develop a consistent aquifer exemption process.
- Continue compilation of available baseline water quality data to help ensure the exemption area is representative of ore distribution and protective of ground water resources.

PRI Gas Hills, 7/98,
Pre-permitting Inspection in
area of previous exploration.

Restoration Requirements

NRC

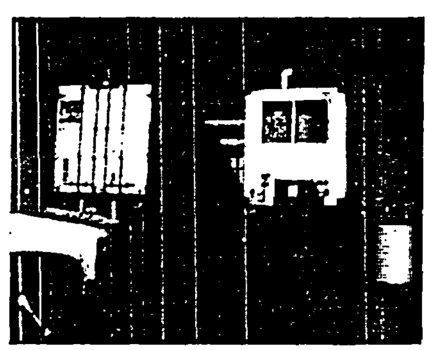
- Restoration language in the NRC Guidance Document 1569 mirrors what is now the old LQD rule language.
- Per letter of 11/2/2004 from NMA to NRC, NRC restoration requirements may be of concern to NMA.

  (Note: *Per the information in the previous slides, WDEQ does not consider the letter to be an accurate reflection of aquifer exemption and restoration requirements and concerns in Wyoming.*)

Restoration Requirements

EPA

While EPA can require restoration of exempted area if it is deemed "necessary and feasible to insure adequate protection of USDWs" (40 CFR 146.11), and does require restoration of exempted areas on Indian Lands, more stringent restoration requirements within the exempted area are generally left up to the individual states. However, ...



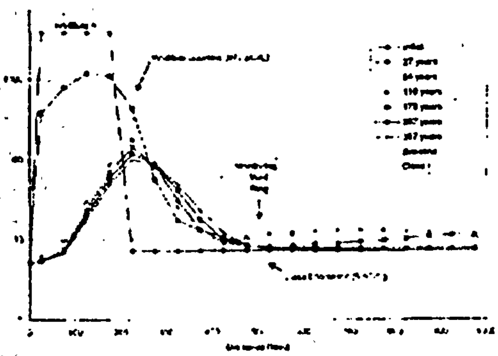
PRI - Highlands, Reverse Osmosis Units, 11/00, Quarterly Inspection.

Restoration Requirements

EPA (cont'd)

...EPA does require that USDWs next to the exempted portion of the aquifer not be adversely impacted by residual water quality in the exempted portion.

If natural attenuation processes (e.g., adsorption, precipitation, and dilution), are relied on to reduce concentrations migrating out of the wellfield, then monitoring to confirm the effectiveness of the attenuation may be necessary. (EPA & WDEQ Policies)



PRI - Highlands, 2004, Evaluation of Natural Attenuation of Radium.

Restoration Requirements

Wyoming

W.S. § 35-11-103(f):

(iii) "Groundwater restoration" means the condition achieved when the quality of all groundwater affected by the injection of recovery fluids is returned to a ***quality of use equal to or better than, and consistent with the uses for which the water was suitable prior to the operation*** by employing the best practicable technology; (emphasis added)

where "best practicable technology" is defined as:

(i) .... [A] technology based process justifiable in terms of existing performance and achievability in relation to health and safety which minimizes, to the extent safe and practicable, disturbances and adverse impacts of the operation on human or animal life, fish, wildlife, plant life and related environmental values.

Restoration Requirements

Wyoming (cont'd)

- LQD relies on WQD's Class of Use in Chapter 8 to determine "quality of use", and classification responsibilities remain with WQD for consistency among all Wyoming water users.

- The rule changes are intended to: bring language more in line with the statute; better define the factors that go into an evaluation of whether BPT has been applied; and serve as a reminder of the statutory provision for changing restoration requirements (Director referral to the EQC).

Restoration Requirements

Wyoming (cont'd)

Old Rule

Chapter 11, Section 3(d)(i)

The information necessary to demonstrate that the operation will return all affected groundwater, including affected groundwater within the production zone, receiving strata, and any other areas, to a condition such that its quality of use is equal to or better than, and consistent with, the uses for which the water was suitable prior to the operation by employing the best practicable technology. Such a demonstration shall be made by showing that, through the employment of the best practicable technology, as defined in W.S. § 35-11-103(f)(i):

(A) To background or better, or:

(B) Quality of use equal to and consistent with uses for which thee water was suitable prior to the commencement of the operation.

New Rule

Chapter 11, Section 5(a)(ii) *(paraphrased)*

The information necessary to demonstrate that the operation will achieve the standard of returning all affected groundwater to the pre-mining class of use or better using Best Practicable Technology, in accordance with the following provisions:

(A) List of BPT factors;

(B) Use wellfield averaging;

(C) Parameter by parameter basis; and

(D) Protection of adjacent aquifers

(E) If unable to achieve the pre-mining class of use:

(I) Request Director recommend to EQC to modify restoration criteria (W.S. 35-11-429(iii));

(II) Provided Section 5(a)(ii)(D) can still be met.

Uranium Classification Standard

Groundwaters of the state are classified by:

Use
Groundwater that is a known source of supply and appropriated for uses identified in W.S.§ 35-11-102 and 103(c)(i) is classified by use: domestic water (Class I); water for fish and aquatic life (Special A); water for agriculture (Class II); water for livestock (Class III); and water for industry (Class IVA&B); ***or by***

Ambient Water Quality
Table 1 of Chapter 8 (first promulgated in 1980) establishes the type of use that groundwater is suitable for, based upon the concentrations of minerals in the water. Recognizing that the natural, or ambient, quality of groundwater varies and is dependent upon the concentrations of specific constituents that naturally exist in groundwater, Chapter 8 established a system to classify groundwater according to its suitability for various purposes.

Uranium Classification Standard

The concentration values (mg/L) in Table I are also used by WDEQ to:

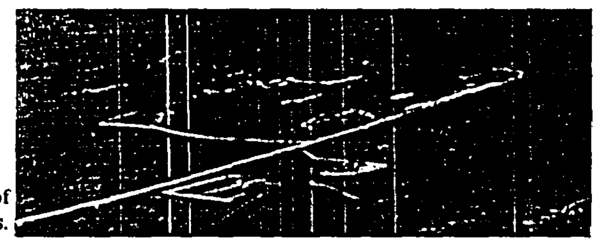
- Establish the permissible limits to which a regulated discharge to groundwater can legally impair groundwater quality beyond ambient conditions (but with no change in the use suitability of the water); &
- Establish the limits to which impacted groundwater must be restored in the event a discharge or release results in an exceedance of that limit.

The values in Table I are ***not*** drinking water standards.

Uranium Classification Standard

- The concentration values in Table I had not been updated in several years, and WQD considered it necessary to update the table based on more recent information about safety and aesthetic considerations for some of the parameters, one of which was uranium.

- The change made by EPA to uranium drinking water standard was for new safety (health) considerations, and the change was to reduce the uranium standard for drinking water supplies from 5 mg/l to 0.03 mg/l.



'Negley' Subdivision near area of LQD Permit 522, 1980s.

Uranium Classification Standard

- However, because Table I is for classification only, WQD decided not to adopt the new standard, because it could result in much of the water in the state not being eligible for Class I protections, even though the water quality was good in all other respects. WQD also did not want to leave the old standard in Table I because of concerns that it could lead to false sense of security if Table I were misapplied, i.e., if values in the table were thought to be drinking water standards. In addition, a concentration of 5 mg/l is high, even in the baseline data from wells in production zones in the Wyoming in situ uranium mines.

Range in Wellfield Concentrations:	<0.003 to 18.600	mg/l
Range in Wellfield Means:	0.013 to 1.067	mg/l
Range in Wellfield Medians:	0.008 to 0.073	mg/l

(Note: *Reported ranges should be considered draft.*)

Rulemaking on Controlling the Disposition of Solid Materials

May 2005

1

Background

- Current approach
  - Existing guidelines include consideration of survey instrument capabilities
- Rulemaking reconsiders current approach
  - Current approach protects public health
  - Consideration to make more efficient and consistent

2

Information gathering

- Stakeholder input
- National Academies Study
- Technical studies: NUREG-1640; NUREG-1761
- Input from scientific organizations: NCRP, IAEA

3

Current Status

- March 31, 2005, staff draft proposed rule package to Commission in SECY-05-0054.
- April 18, 2005, Draft rule package made publicly available
- Commission reviewing draft rule package

4

Rulemaking Website Address

- Website:

[illegible]

(under "Key Topics," link to "Controlling the Disposition of Solid Materials")

5

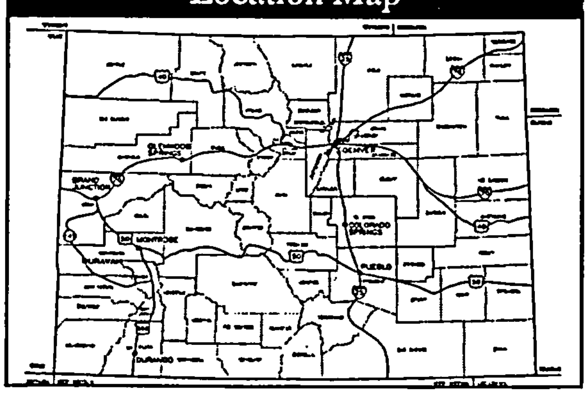
License Termination at a Superfund Site A Joint Partnership

Rahe Junge Umetco Minerals
Phil Stoffey Colorado Department of Health and Environment
Rebecca Thomas U.S. Environmental Protection Agency
Mike Tucker U.S. Department of Energy
Teresa Pfifer U.S. Bureau of Land Management

Partnership Advantages

- Increase effective communication between industry and governmental agencies
- Understand agency processes and agency needs
- Determine the involvement and interrelationship of various agencies
- Identify possible road blocks for delisting of the site and termination of the radioactive materials license
- Meet community needs by interaction with community leaders

Location Map



Uravan Superfund Site

History

- 1914 Radium Production
- 1929 Vanadium Production
- 1940-1945 Uranium Production for Manhattan Project
- 1948-1984 Uranium Production for AEC's Weapons Program and Power Plants : 10.5 MM tons
- 1983 State of Colorado filed suit against Union Carbide for Natural Resource Damages
- 1987 Remedial Action Plan Implemented
  - Negotiated Settlement Reached
  - Remedial Construction Began

Project Scope

- Evaluation of over 1600 acres of potentially affected land.
- Removal and disposal of 3,000,000 cubic yards of radioactive waste from over 400 acres.
- Collection and evaporation of over 250,000,000 gallons of contaminated seepage and groundwater.
- Construction of 4 repositories designed to isolate over 13,000,000 cubic yards of radioactive waste for 1,000 years.
- Total reclamation cost: $120,000,000

Delisting and License Termination Process

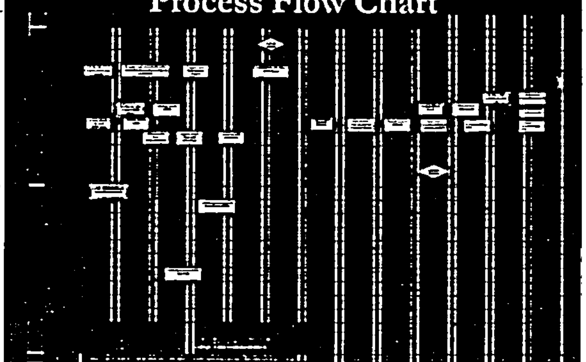
- Form Site Closure Committee
  - Identify Participating Regulatory Agencies
  - Prepare Committee Charter
- Prepare Process Flow Chart
  - Determine Regulatory Needs
  - Assess Project Activities
  - Define and Establish Regulatory Interrelationships
  - Determine Key Site Closure Activities
- Develop Committee Work Activities and Set Action Items

Uravan Site Closure Committee

- Partners: Umetco, EPA, BLM, DOE, CDPHE, Judge Dana (Special Master) and Leo Large (County Commissioner). NRC is an ad hoc participant.
- Charter:

  The Committee exists to close the Uravan site in a timely and efficient manner consistent with the Uravan Consent Decree and applicable regulations by:
  - *Clarify understanding each organization's internal processes and needs for Uravan deletion, license termination, and land transfer.*
  - *Minimizing delays to deletion, termination, and land transfer process by identifying agency requirements for the Uravan site.*
  - *Providing a vehicle for ongoing discussions and clarification throughout the deletion, termination, and land transfer process.*

Process Flow Chart



Key Committee Activities

- Established communications between all stakeholders
- Assess de-listing process and license termination time frame
- Review and approve site closure process
- Streamline closure process by identifying key issues
- Approve site closure documents

N&B Committee Activities

- Quarterly Meetings
- Round Table Discussions
- Presentations on Specific Issues (e.g. Alternate Soil Standards)
- NRC Advisement on Specific Topics
- Action Items – Committee Homework

Future Site Closure Activities

- Complete Remedial Actions
- Umetco Certification Report
  - Key to timely delisting and license termination
  - Objective : To have all necessary technical and legal information in one report so that final CDPHE, EPA, DOE and NRC documents can be efficiently prepared from the same data base.
  - Certification Report will incorporate three guidance documents: PCOR, LTSP and CRR
- Preliminary Close-Out and Completion Review Report
  - Prepared by CDPHE
  - Reviewed by EPA and NRC
- Resolve Land Transfer Areas (BLM, DOE, County)

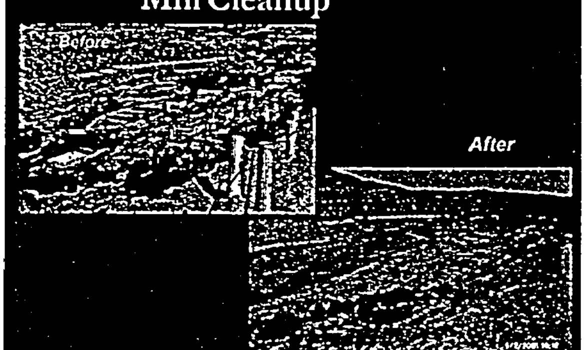
Schedule of Closure Activities

- 2007 Complete Construction
- 2007 Submit Closure Documents to CDPHE, EPA, NRC, DOE, and BLM
- 2008 CDPHE Prepares PCOR and CRR
- 2008 EPA Deletes Site from NPL
- 2008 NRC Terminates License
- 2008 Site Transferred to DOE

What makes it work ?

- Committee members interested in the outcome of the project
- Well defined goals/objectives
- Frank and open discussions (No meeting minutes)
- Action Items drive the process

Mill Cleanup



State and Federal Regulatory Processes for Transfer of the L-Bar Site

May 24, 2005 Denver, CO

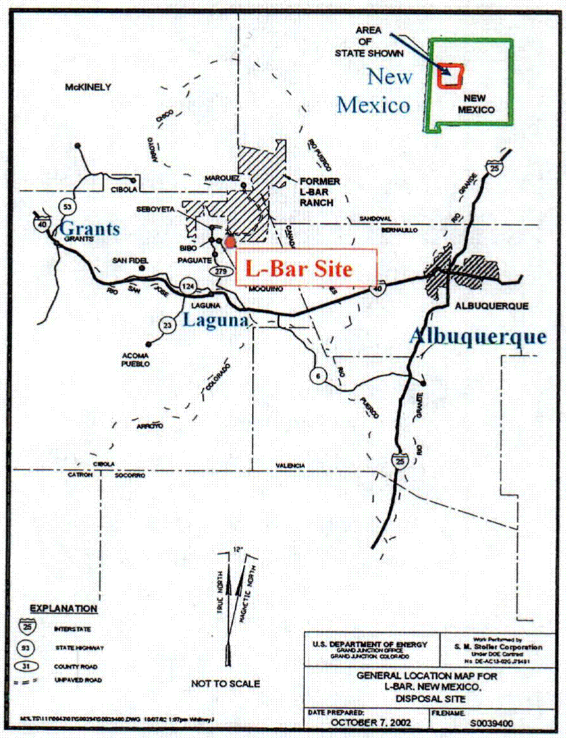
By Kevin Myers, NMED Ground Water Quality Bureau;
Mark Plessinger, SM Stoller for U.S. DOE; and
John Trummel, SOHIO Western Mining Co.

Acknowledgements And Introduction

- Thanks to SOHIO, DOE, NMED and NRC/NMA
- Presentation Overview:
  - Site Background,
  - Federal/State Processes Prior to Transfer,
  - DOE Issues for Site Transfer
  - Questions or Comments

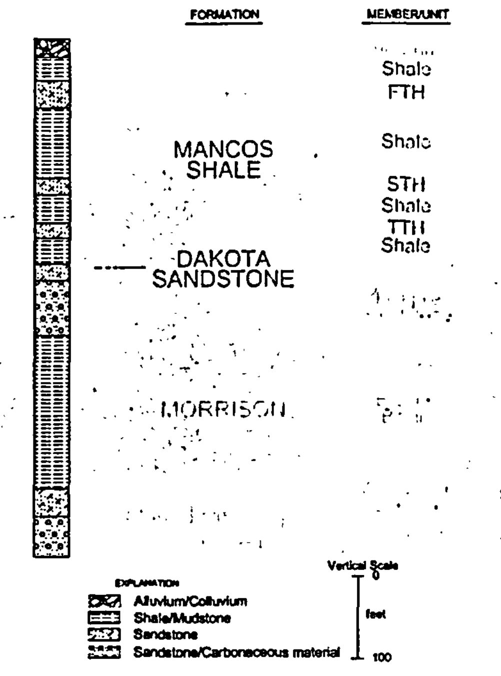
L-Bar Site

- Near Moquino, Bibo & Seboyeta
- West of Albuquerque
- Laguna Mining District



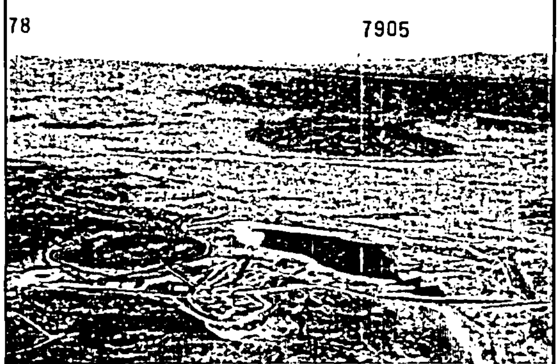
C01

L-BAR SITE STRATIGRAPHY



Operational History L-Bar Facility

- Mill and Tailings 1977 to 1981
- Tailing pond 140 acres; 1 to 45 feet in height; 2 M tons
- State Permit DP-150 from 1982 thru October 2004
- NM Water Quality Act 1978
- NRC License SUA #1472 thru October 2004
- UMTRCA 1978



1978 Oblique Aerial Photo, EPA
Looking Southwest

1978 L-Bar Site Mill and Tailings

1978 Aerial Photo, EPA

Partial Reclamation History

- Initial CAP 1986, Pump & Evap
- Cover placed 1990, radon barrier
- Settling of Tailings and Cover
- Cease Pump & Evap 1999
- Added Cover 2000,
  - minimum 4.1 feet thick
- Revised rip rap, sediment basin design
- Final CAP complete by 2000

L-Bar Site 1997

Areal Photograph October 5. 1997.
Courtesy USGS TerraServer

Jurisdictional Issue

- NRC/NMED regulation of non radiological contaminants and off-site contamination.
- Sohio/DOE/NMED met in Santa Fe with NRC included telephonically
- Rights reserved, State process continues with DOE incorporating results into LTSP for NRC review

NRC Requirements

- License Amendments Fulfilled
- ACL Petition 1998
- ACL Approval 1999
- Cover and Storm Water Design Revised
- Reclamation complete 2000
- Radon Barrier Survey and Final Inspection 2001

NMED Requirements I

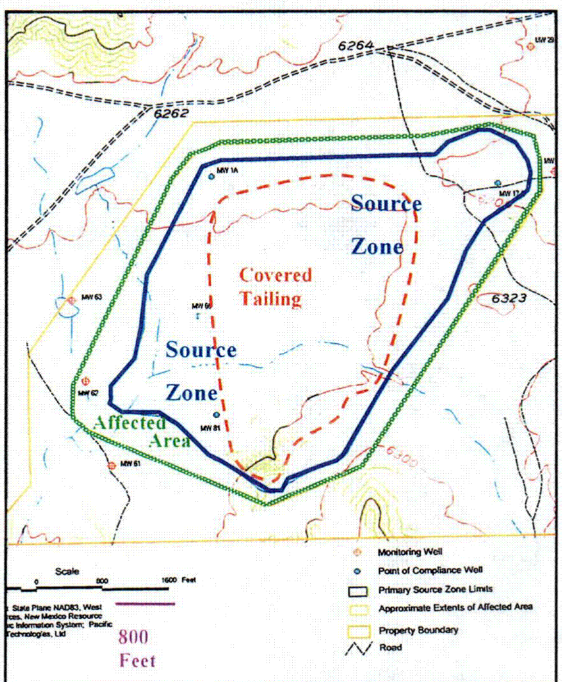
- Abatement Process
- Public Meetings 2001 and 2003
- SOHIO Petitions for AAS 2002
- NMED Supports Petition

NMED Requirements II

- WQCC
- WQCC Public Hearing and Approval for AAS 2003
- Completion Report Jan 2004
- Compliance with WQCC Regulations and Permit DP-150

Analyte	New Mexico Standard	ACL	AAS Source Zone	AAS Affected Area
U	0.030 (2004/07)	13	13	NA
Se	0.05	2.0	2.0	NA
Cl	250	NA	1,127	NA
SO_4	4,000 background	NA	13,110	5,185
NO_3	10.0	NA	1,180	NA
TDS	5,880 background	NA	20,165	7,846

ALL VALUES IN mg/L



Source Zone and Affected Area Map

C02

DOE Issues Site Transfer

- Work with NRC, SOHIO and NMED
- DOE Requirements
- WQCC Hearing – Testimony
- Draft and Final LTSP (SMP)

DOE Requirements I

- Site reclamation approved by NRC
- Clear title to site property
- Unimpeded access to site and off site features (e.g., monitor wells)

DOE Requirements II

- Site must be free of unnecessary infrastructure (e.g., buildings and equipment)
- Site cannot have outstanding federal, state, or local permits
  - DOE will not accept responsibility for closing out existing permits
  - Lesson learned the hard way

WQCC Hearing Outcome

- AAS Petition Approved
  - Adequate Source Control, Abatement, and Monitoring Plan
  - Institutional Controls accepted
- Draft LTSP Additions
  - Map of source zone/affected area
  - AAS numerical values
  - Sample Moquino supply wells
  - Erosion monitoring program

LTSP Finalized

- LTSP Revised and Reviewed
- Final Draft Submitted to NRC
- NRC Reviews and Approves

L-Bar Site Transferred October 2004

- New Mexico Approves Termination of Permit DP-150
- NRC License SUA #1472 terminates
- DOE General License In Place
- LTSP active
- Financial Assurance Transfer
- DOE begins inspections

L-Bar Site, July 2004

L-Bar Site, July 2004

Conclusions and Questions

- Cooperation between Federal and State Agencies facilitated the L-Bar site transfer for SOHIO.

- QUESTIONS or COMMENTS?

DOE Title II Sites Annual Update

Ray Plieness, Acting Director
Office of Land and Site Management

2005 U.S. Nuclear Regulatory Commission/
National Mining Association Workshop

May 24–25, 2005
Denver, Colorado

Status of Title II Site Transfers to DOE

- L-Bar, New Mexico
  - Site transferred to DOE October 21, 2004
- Shirley Basin South (Petrotomics), Wyoming
  - Real property transferred to DOE March 25, 2005
  - Site transfer to DOE license pending receipt of recorded deed and subsequent submittal of LTSP to NRC
  - Final transfer imminent

2

Status of Title II Site Transfers to DOE (continued)

- Bear Creek Wyoming
  - Licensee has resolved mineral rights issue
  - DOE has addressed NRC comments on LTSP
  - Real property transfer activities will start when licensee receives mineral deed from state
  - Site transfer anticipated in late 2005
- Durita, Colorado
  - DOE submitted LTSP to NRC February 1, 2005
  - Corps of Engineers ready to transfer real estate at DOE's direction
  - Site transfer anticipated in late 2005

Status of Title II Site Transfers to DOE (continued)

- Gas Hills North (Lucky Mc), Wyoming
  - DOE submitted LTSP to NRC on March 30, 2005
  - Pathfinder working closely with DOE Real Property Specialist
  - Site transfer anticipated in late 2005
- Gas Hills East (Umetco), Wyoming
  - DOE internal draft LTSP complete
  - LTSP submittal to NRC planned for FY 2005

Status of Title II Site Transfers to DOE (continued)

- Lisbon Valley, Utah
  - DOE internal draft LTSP complete
  - LTSP submittal to NRC planned for FY 2005
- Highland, Wyoming
  - DOE internal draft LTSP complete; however, licensee's ACL application still pending
  - LTSP submittal to NRC after ACL approval

5

Status of Title II Site Transfers to DOE (continued)

- Panna Maria, Texas
  - DOE internal draft LTSP complete; however, licensee's ACL application still pending
  - LTSP submittal to NRC will occur after agreement state (Texas) approves final site reclamation, including ACL
- Maybell West (Umetco), Colorado
  - DOE internal draft LTSP initiated; completion scheduled for FY 2005

6

Status of Title II Site Transfers to DOE (continued)

- Shootaring Canyon, Utah
  - DOE internal draft LTSP complete
  - Further site transfer efforts suspended per licensee's request

7

Institutional Controls

- Ideally, all land used for disposal of 11e.(2) by-product material is transferred to DOE
- If DOE will be responsible for potential human or environmental exposures outside boundary of transferred land, then an enforceable institutional control must be provided to DOE for effective management
- Example: If the point of exposure under an alternate concentration limit groundwater compliance strategy falls outside the site boundary, then institutional controls may be necessary to prevent exposure (NUREG-1620, Rev. 1, p. 4-32)

8

DOE Points of Contact for Title II Sites

Site Name and State	Company Name (former site name)	Projected Transfer Date	DOE Point of Contact	POC Phone	POC Email
Durita, CO	Hecla	2005	Michael K. Tucker	970-248-6004	michael.tucker@gjo.doe.gov
Gas Hills North, WY	Pathfinder (Lucky Mc)	2005	Tom Pauling	970-248-6048	tom.pauling@gjo.doe.gov
Bear Creek, WY	Anadarko	2005	Tom Pauling	970-248-6048	tom.pauling@gjo.doe.gov
Panna Maria, TX	Rio Grande Resources	2006	Louis L. McGee	304-285-4116	lmcgee@netl.doe.gov
Maybell West, CO	UMETCO	2006	Michael K. Tucker	970-248-6004	michael.tucker@gjo.doe.gov
Lisbon Valley, UT	Rio Algom	2006	Michael K. Tucker	970-248-6004	michael.tucker@gjo.doe.gov
Highland, WY	Exxon	2006	Tom Pauling	970-248-6048	tom.pauling@gjo.doe.gov
Gas Hills East, WY	UMETCO	2006/2007	Tom Pauling	970-248-6048	tom.pauling@gjo.doe.gov
Split Rock, WY	Western Nuclear	2007	Tom Pauling	970-248-6048	tom.pauling@gjo.doe.gov
Ambrosia Lake West, NM	Rio Algom/Quivira	2007	Jonathan F. Sink	970-248-6016	jon.sink@gjo.doe.gov
Shirley Basin North, WY	Pathfinder	2007	Tom Pauling	970-248-6048	tom.pauling@gjo.doe.gov
Ray Point, TX	Exxon	2007/2008	Jane Powell	304-285-4687	powell@netl.doe.gov
ANC Gas Hills West, WY	ANC	2007 or later	Tom Pauling	970-248-6048	tom.pauling@gjo.doe.gov
Uravan, CO	UMETCO	2008	Michael K. Tucker	970-248-6004	michael.tucker@gjo.doe.gov
Ford, WA	Dawn	2010	Richard P. Bush	970-248-6073	bushr@gjo.doe.gov
Conquista, TX	Conoco	2010	Jane Powell	304-285-4687	powell@netl.doe.gov
Church Rock, NM	UNC	2010	Jonathan F. Sink	970-248-6016	jon.sink@gjo.doe.gov
Sequoyah, OK	Sequoyah Fuels	2011	Ronald K. Staubly	304-285-4991	rstaub@netl.doe.gov
Grants, NM	Homestake Grants	2014	Jonathan F. Sink	970-248-6016	jon.sink@gjo.doe.gov
Cañon City, CO	Cotter	Indefinite	Tom Pauling	970-248-6048	tom.pauling@gjo.doe.gov
Sweetwater, WY	Kennecott	Indefinite	Tom Pauling	970-248-6048	tom.pauling@gjo.doe.gov
Shootaring Canyon, UT	Plateau	Indefinite	Michael K. Tucker	970-248-6004	michael.tucker@gjo.doe.gov
White Mesa, UT	International Uranium	Indefinite	Richard P. Bush	970-248-6073	bushr@gjo.doe.gov

9

Deferring Active Regulation of Groundwater Protection at *In Situ* Leach Uranium Extraction Facilities

Robert A. Nelson, Chief
Uranium Processing Section
U. S. Nuclear Regulatory Commission

BACKGROUND

- July 26, 2000
  - Staff Requirements Memorandum (SRM) SECY 99-0013)
  - Commission reaffirmed NRC's authority to regulate all waste waters from ISL facilities as 11e.(2) byproduct material
  - Commission recognized that dual regulation of ground-water protection at ISL facilities would exist between the NRC and the EPA or EPA-authorized States

BACKGROUND Contd. (July 26, 2000)

- Commission approved that the staff continue discussions with EPA and the appropriate EPA-authorized States to:

"determine the extent the NRC can rely on the EPA Underground Injection Control (UIC) program for ground-water protection issues, thereby potentially minimizing NRC review of ground-water protection issues at ISL facilities"

May 2005 3

BACKGROUND Contd. (July 26, 2000)

- Commission directed the staff to include in those discussions appropriate methods for implementing any agreements, including Memoranda of Understanding (MOUs) or language, in a new 10 CFR Part 41.

May 2005 4

BACKGROUND Contd.

- October 10 & November 29, 2000
  - Staff held meetings with EPA at NRC Headquarters
- May 29, 2001
  - SRM SECY 01-0026 - Staff discontinued development of a new Part 41

BACKGROUND Contd.

- June 2001
  - The NRC staff held closed meetings with non-Agreement State regulators and other Federal regulators during the annual Uranium Recovery Workshop.

BACKGROUND Contd.

- February 5, 2002
  - Standard Review Plan for ISL Uranium Extraction License Applications, NUREG-1569
  - issued for public comment by Notice in the Federal Register

May 2005 7

BACKGROUND Contd.

- June 2002
  - The NRC staff held closed meetings with non-Agreement State regulators and other Federal regulators during the annual Uranium Recovery Workshop

May 2005 8

BACKGROUND Contd. (June 2002)

NRC staff proposed that:

1. NRC would retain its authority provided by the Atomic Energy Act of 1954, as amended, to regulate ground-water protection at ISLs.

May 2005 9

BACKGROUND Contd. (June 2002)

2. NRC would defer active regulation of ground-water protection at ISL operations to a non-Agreement State authorized to administer the EPA's UIC program at ISL facilities, if the State entered into an MOU with the NRC.

May 2005 10

BACKGROUND Contd. (June 2002)

3a. ISL facilities in Agreement States authorized to administer EPA's UIC Program would not be impacted by this proposal (ex. Texas)

3b. Agreement States not authorized to administer EPA's UIC program could choose to pursue an individual agreement with EPA for reducing or eliminating dual regulation of ground-water protection (ex. Colorado)

(At present, no ISL uranium facilities are licensed in an Agreement State that is not a UIC EPA authorized State.)

May 2005 11

BACKGROUND Contd.

- June 2003
  - The NRC staff held closed meetings with non-Agreement State regulators and other Federal regulators during the annual Uranium Recovery Workshop and provided a copy of the strawman MOU to the States.
  - ISL Standard Review Plan, NUREG-1569, was issued in final form

May 2005 12

BACKGROUND Contd.

- July 24, August 9, & October 18, 2003
  - The staff received letters from Nebraska, Wyoming, and the National Mining Association supporting the pursuit of this proposal.

May 2005 13

BACKGROUND Contd.

- October 29, 2003
  - SECY-03-0186, OPTIONS AND RECOMMENDATIONS FOR NRC DEFERRING ACTIVE REGULATION OF GROUND-WATER PROTECTION AT *IN SITU* LEACH URANIUM EXTRACTION FACILITIES
  - Sent to the commission ML031210874

May 2005 14

BACKGROUND Contd.

- November 19, 2003
  - SRM SECY-03-0186 - Commission approved Option 2a.
    1. Develop a Regulatory Issue Summary (RIS) to inform the public about this proposal
    2. Develop a MOU with each appropriate State
    3. Management to ensure the development of MOUs involves minimum resource expenditures by the States and the NRC.

May 2005 15

RECENT ACTIONS

- January 2004 - Met with States of Nebraska and Wyoming and US EPA to derive dates for completing necessary actions
- February 2004 - Issued RIS 2004-02 for comment

May 2005 16

RECENT ACTIONS (Contd.)

- June 2004:
  - Issued RIS 2004-09
  - Developed program assessment procedures
  - Visited Nebraska for program assessment
- August 2004 - Visited Wyoming for program assessment

Improving the Regulation and Management of Low-Activity Radioactive Wastes

John R. Wiley
NMA/NRC Workshop
Denver, Colorado
May 25, 2005

THE NATIONAL ACADEMIES
Advisers to the Nation on Science, Engineering, and Medicine

Outline of Talk

- Who we are
- Approach
- Results of Phase I
- Outlook for Phase II
- Your input requested

The National Academies

- National Academy of Sciences (NAS)
- National Academy of Engineering (NAE)
- Institute of Medicine (IOM)
- National Research Council (NRC)
  Nuclear and Radiation Studies Board

- Private, nonprofit, Congressionally chartered (1863) to provide scientific and technological advice to the nation
- Our experts serve *pro bono*
- Information gathering meetings are open to the public

Reasons for the Study

This project was initiated by the National Academies' Board on Radioactive Waste Management, which observed that statutes and regulations controlling low-activity radioactive wastes (LAW) have evolved as a patchwork over the past 60 years.

- **Wastes from some origins may be over-regulated relative to their radiological hazards, increasing costs and other burdens on the generators and potentially increasing worker risks.**
- **Radiological hazards of other LAW may be greater than generally perceived.**

Statement of Task

1) Using available information from public domain sources, provide a summary of the sources, forms, quantities, and hazards of low-activity waste in the United States;

2) Review and summarize current policies and practices for regulating and managing low-activity waste, including treatment and disposal practices; and

3) Provide an assessment of technical and policy options for improving practices for regulating and managing this waste to enhance technical soundness, ensure continued protection of public and environmental health, and increase cost effectiveness.

Committee Members and Expertise

David H. Leroy, Chairman
Leroy Law Office

Michael T. Ryan, Vice-Chair
Charleston Southern University

Waste Management

Edward L. Albenesius
Savannah River Site (retired)

Wm. Howard Arnold
Westinghouse Electric (retired)

Maurice C. Fuerstenau
University of Nevada

Kimberly W. Thomas
Los Alamos National Laboratory

Economics

James Hamilton
Duke University

Health Risk

Gail Charnley
Health Risk Strategies

Sharon M. Friedman
Lehigh University

Michael T. Ryan, Vice-Chair

Law and Regulation

François Besnus
Institute de Radioprotection et de Sûreté Nucléaire

David H. Leroy, Chair

Environmental Policy

Perry H. Charley
Diné College

Ann Rappaport
Tufts University

Geoscience

D. Kip Solomon
University of Utah

BRWM Liaison
Robert M. Bernero
Nuclear Regulatory Commission (retired)

Phase I

The committee developed five waste groups that we believe are inclusive of LAW from all sources (DOE, nuclear utilities, other industries, medicine, research, mineral recovery).

The groups emphasize the physical and radiological characteristics of the wastes, rather than their origins. We chose this approach to emphasize inconsistencies, gaps, and suggest ways to improve the current LAW regulatory/ management system. Not a proposal for a new categorization scheme.

Low-activity Waste Groups 1-3

Three groups include wastes that are defined and regulated as low-level wastes. They are subject to the same statutory definition and controls (AEA, NWPA, LLWPA), but have different physical and radiological characteristics.

1. **Wastes that fit comfortably in USNRC classes A, B, C.**
    - Typical "Barnwell" commercial waste
    - DOE "burial ground" waste
2. **Slightly radioactive solid materials from decommissioning and cleanup.** These push the low end of USNRC class A. They produce very low or essentially non-detectable levels of radiation and arise in large volumes.
3. **Discrete sources (sealed sources).** These can push the upper end of USNRC class C (GTCC). Some produce high levels of radiation but their volumes are small.

Groups 4-5

Two groups include wastes that have similar physical and radiological properties (large volumes; U or Th series isotopes) but subject to different regulations.

4. **Uranium and thorium mining and processing wastes (AEA)**
   Post Uranium Mill Tailings Radiation Control Act (UMTRCA) 1978 wastes require disposal in a licensed radwaste facility.
   Pre-UMTRCA wastes (mostly AEC "FUSRAP" wastes) have other disposal options.

5. **NORM AND TENORM wastes (non-AEA)**
- Uneven control by state agencies
- Little public perception of radiation hazard
- Conference of Radiation Control Program Directors (CRCPD) model regulation.

Phase I Findings

FINDING 1:

Current statutes and regulations for low-activity radioactive wastes provide adequate authority for protection of workers and the public.

- **The current system is working; no crisis**
- **Uneven application of authority**
- **The patchwork approach may become less workable in the future.**

Phase I Findings

FINDING 2:

The current system of managing and regulating low-activity waste is complex. It was developed under a patchwork system that has evolved based on the origins of the waste.

- **Clear message from information-gathering meetings: A more consistent, simpler, performance-based, risk-informed approach is needed.**
- **Same message from studies by other organizations (NCRP-139).**

Phase I Findings

FINDINGS 3 AND 4:

Certain categories of low-activity wastes have not received consistent regulatory oversight and management.

Current regulations for low-activity wastes are not based on a systematic consideration of risks.

- **NORM/TENORM state regulation**
- **Uranium/thorium wastes pre- and post-UMTRCA**
- **Decommissioning waste (SRSM) Versus NORM/TENORM**
- **Waste shipments versus local disposal**

Phase II Task

(3) provide an assessment of technical and policy options for improving practices for regulating and managing LAW to enhance technical soundness, ensure continued protection of public and environmental health, and increase cost effectiveness.

This assessment should include an examination of options for utilizing risk-informed practices for regulating and managing low-activity waste irrespective of its classification.

Phase II Schedule

- Kick-off public information gathering meeting, Washington, DC, November 30.
- Ten-month study period to produce peer-reviewed National Academies' report in Fall 2005.

NMA Issues

- Disposal of non-11e.(2) wastes in U mill tailing impoundments (NMA-FCFF white paper).
- TENORM wastes from mining (e.g., rare earths, phosphate).

Written input welcome!
John Wiley (jwiley@nas.edu)

Project Sponsors

- **Army Corps of Engineers**
- **Department of Energy**
- **Environmental Protection Agency**
- **Nuclear Regulatory Commission**
- **Southeast Compact Commission**
- **California EPA**
- **DOD Executive Agent for LLW**
- **Institute of Applied Energy—Japan**
- **Institute for Radiation Protection and Nuclear Safety—France**
- **Midwest Interstate Compact Commission**

GPS-BASED SCANNING FOR SITE SOIL CHARACTERIZATION AND VERIFICATION

NMA/NRC Uranium Recovery Workshop

May 24-25, 2005

consulting scientists and engineers

Millsite Soil Characterization Summer - 2004

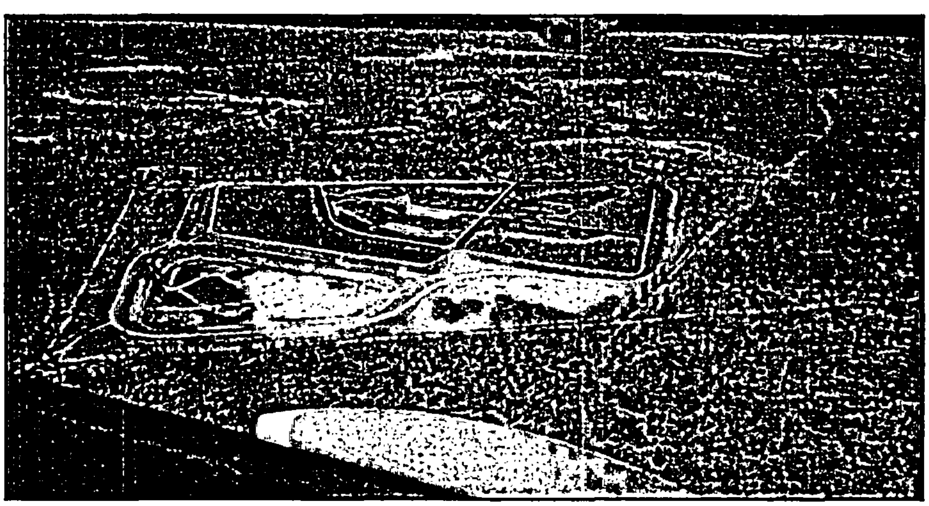
- Dawn Mining Company – Stevens County, Washington
- Washington Department of Health
- MFG, Inc.

consulting scientists and engineers

Dawn Mining Company Background Information

- DMC operated a uranium mill from 1957 to 1982 to process ore from the Midnite Mine
- The mill processed water treatment sludge from the mine to recover uranium from 1992 to 2001
- The mill was permanently shut down in 2001
- The mill building was demolished in 2003
- Site soil characterization took place in 2004
- Soil cleanup is scheduled for summer 2005
- Water treatment plant sludge will continue to be direct disposed to TDA4 for several more years.

Dawn Mining Company Millsite



Elements of the Soil Characterization Plan

- Perform a gamma scan of the entire millsite using a shielded NaI detector.
- Select correlation grid locations.
- Sample soils in correlation grids.
- Select, sample, and scan background (reference locations).
- Develop a correlation between the shielded exposure rate and Ra-226 activity concentration and identify a shielded exposure rate that represents 5 pCi/g Ra-226 above background.
- Dig backhoe trenches to sample sub-surface soils.

consulting scientists and engineers

Gamma Scan

- The gamma scan was intended to provide 100 percent coverage of the millsite and adequate coverage of potentially impacted areas within the millsite boundary excluding the evaporation ponds and tailings disposal areas.
- The millsite covers approximately 460 acres of which 175 acres are evaporation ponds, disposal areas, and borrow areas that were not scanned for the characterization survey.
- Survey of the roadsides leading into the mill
- The total area scanned on the millsite was approximately 285 acres.

consulting scientists and engineers

Gamma Scan Equipment

- ATV –mounted systems
  - Two Ludlum Model 44-10 detectors (2x2 inch NaI) shielded with approximately ¾ inch of lead
  - Two Ludlum Model 2350 Data Loggers
  - Pen top computer
  - Two Garmin GPS Legends
- Backpack-mounted system – approximately 40 lbs
  - Shielded Ludlum Model 44-10 detector (2 x 2 inch NaI crystal)
  - Ludlum Model 2350 Data Logger
  - Garmin iQue
    - Calculator size device functions as GPS and pen top computer

Gamma Scan Equipment

- The 2 inch NaI detector was mounted in a capped PVC pipe housing
- Lead donuts were fitted around the detector to a height of approximately 2 inches.
- The detectors were padded to prevent damage and keep them rigid in the housing
- For the ATV-mounted system
  - the data loggers and pen top computer were held in a single pack on the ATV.
  - A GPS was mounted on top of each detector housing
- For the backpack-mounted system
  - the data logger was placed in the pack
  - The iQue was carried by the surveyor

ATV- Scanning System

Backpack Scan system

Data Management

- Detector system measures exposure rate every second
- GPS collects time and location coordinates every second.
- The exposure rate, time, and location were simultaneously recorded and stored in the computer or iQue.
  - Note: The lap top and iQue were programed to "say" OhOh! If any of the connections were lost
- The data were downloaded to a laptop computer at least once a day.
- The output files were emailed to the MFG, Inc. office in Fort Collins daily for processing and graphic representation.

Typical Data File

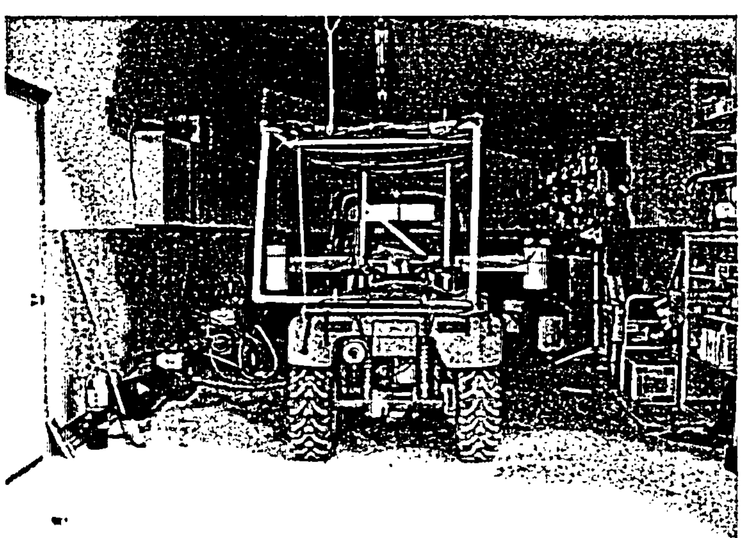
N 35 28.0501	W115 31.0668	3/9/05 8:48 41	3.05E-05	3D GPS Location
N 35 28.0501	W115 31.0668	3/9/05 8:48:42	3.05E-05	3D GPS Location
N 35 28.0500	W115 31.0668	3/9/05 8:48.43	3.31E-05	3D GPS Location
N 35 28.0500	W115 31.0667	3/9/05 8:48:44	3.36E-05	3D GPS Location
N 35 28.0500	W115 31.0667	3/9/05 8:48:45	3.41E-05	3D GPS Location
N 35 28.0499	W115 31.0667	3/9/05 8.48:46	3.15E-05	3D GPS Location
N 35 28.0499	W115 31.0667	3/9/05 8 48:47	3.24E-05	3D GPS Location
N 35 28.0499	W115 31.0667	3/9/05 8.48:48	3.24E-05	3D GPS Location
N 35 28.0499	W115 31.0666	3/9/05 8.48:49	3.40E-05	3D GPS Location
N 35 28.0498	W115 31.0666	3/9/05 8.48:50	3.68E-05	3D GPS Location
N 35 28.0498	W115 31.0666	3/9/05 8 48:51	3.52E-05	3D GPS Location
N 35 28.0498	W115 31.0666	3/9/05 8.48:52	3.52E-05	3D GPS Location
N 35 28.0498	W115 31.0665	3/9/05 8 48:53	3.31E-05	3D GPS Location
N 35 28.0497	W115 31.0665	3/9/05 8 48:54	3.55E-05	3D GPS Location
N 35 28.0497	W115 31.0665	3/9/05 8.48.55	3.35E-05	3D GPS Location
N 35 28.0497	W115 31.0665	3/9/05 8.48.56	3.35E-05	3D GPS Location
N 35 28.0497	W115 31.0664	3/9/05 8.48.57	3.27E-05	3D GPS Location
N 35 28.0497	W115 31.0664	3/9/05 8.48.58	3.36E-05	3D GPS Location
N 35 28.0498	W115 31.0664	3/9/05 8.48:59	3.56E-05	3D GPS Location

QA/QC

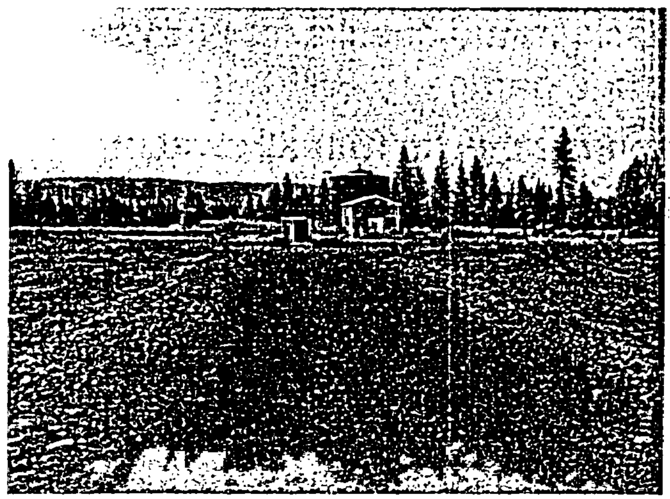
- Daily background checks for all systems in the storage garage
- Daily source checks with all systems
- Daily field checks

consulting scientists and engineers

ATV Garage



Field Check Strip



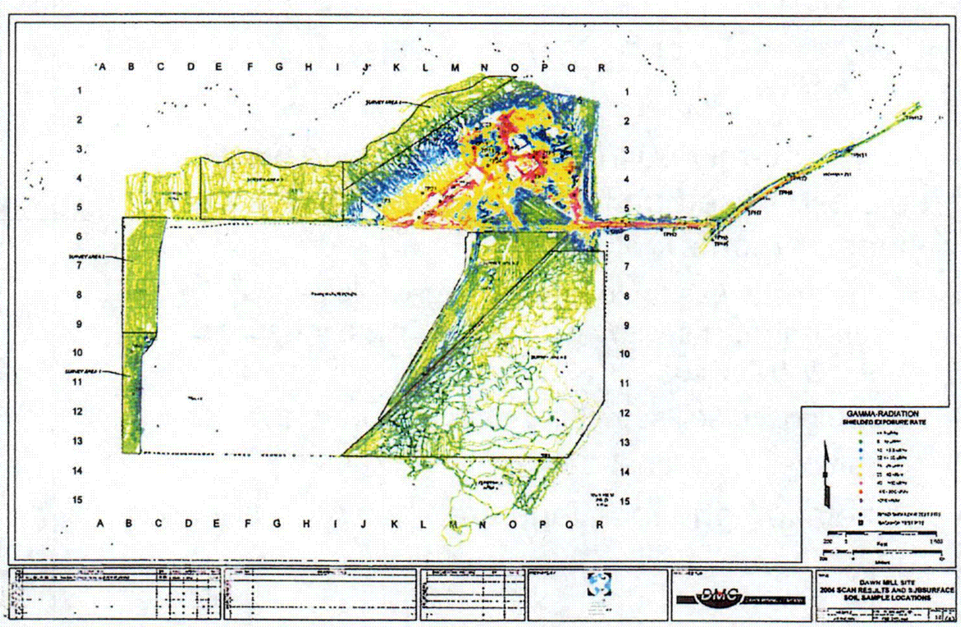
Background (Reference) Areas

- Two reference areas were selected
- Reference areas were scanned using the ATV
  - Average shielded exposure rates
    - Reference area 1 (NW) – 5.38 uR/hr
    - Reference area 2 (SE) – 7.56 uR/hr
- Twenty soil samples were taken from each reference area
  - Average Ra-226 concentrations
    - Reference area 1 - 0.95 pCi/g =
    - Reference area 2 - 1.35 pCi/g =

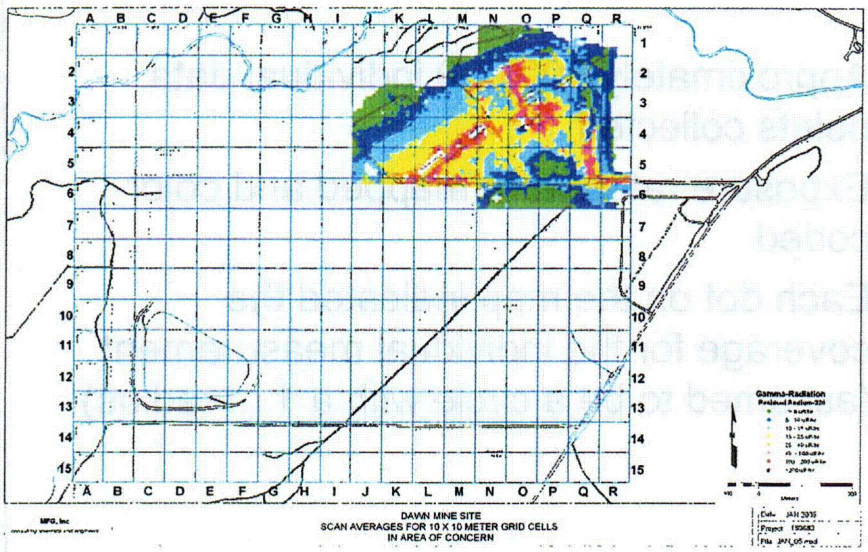
consulting scientists and engineers

Gamma Scan Results

- Approximately 600,000 individual data points collected
- Exposure rates were mapped and color-coded
- Each dot on the map indicated the coverage for the individual measurement (assumed to be a circle with a 1 m radius)



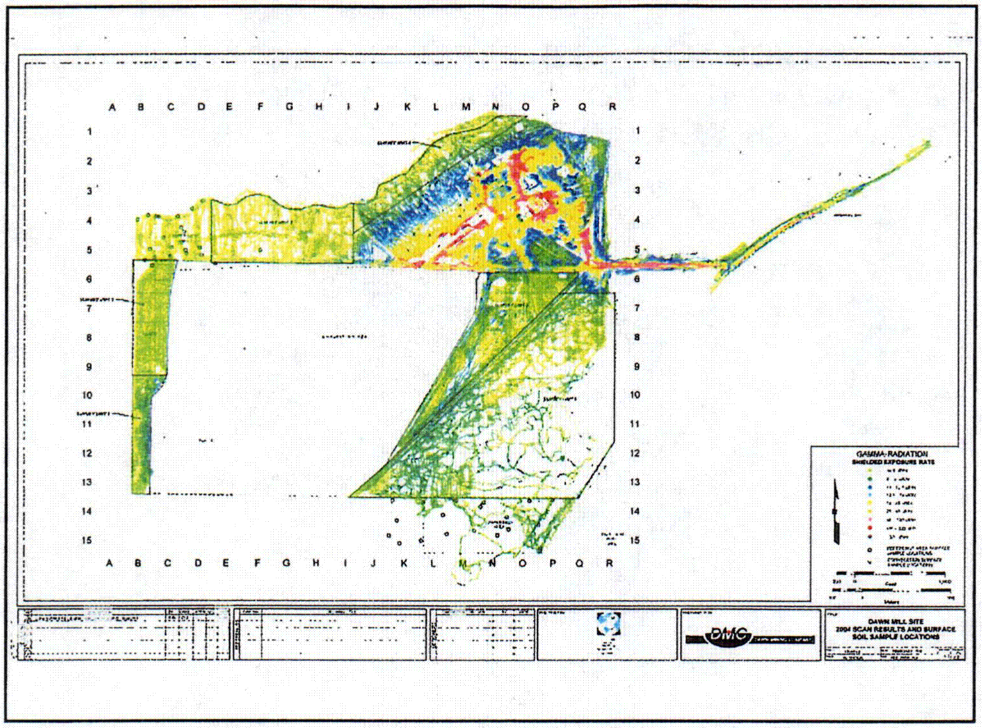
C03



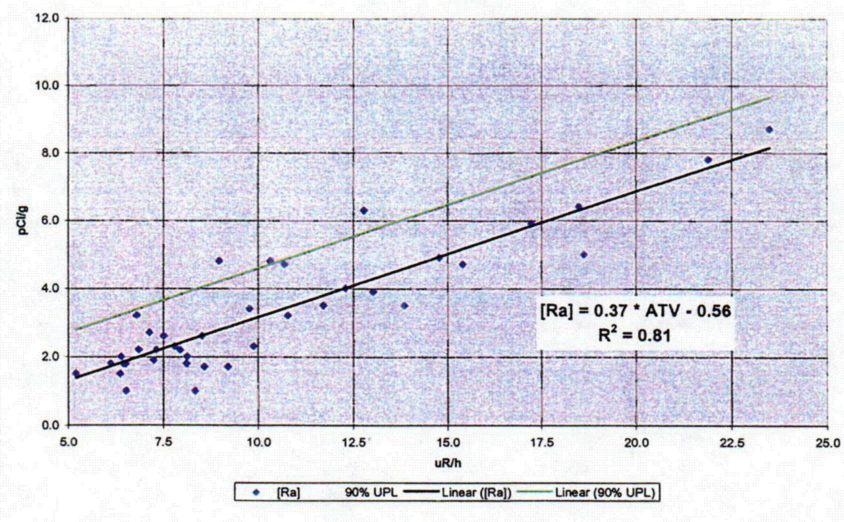
Correlation Grids

- Approximately 50 10 x 10 meter grids were selected based on initial gamma exposure rate measurements.
  - The intent was to cover the range of expected Ra-226 concentrations with emphasis on concentrations below 10 pCi/g.
  - Composite soil samples were taken from each grid.
  - Samples were analyzed at ELI for Ra-226.
- Correlation grid locations are shown on the scan map

C04

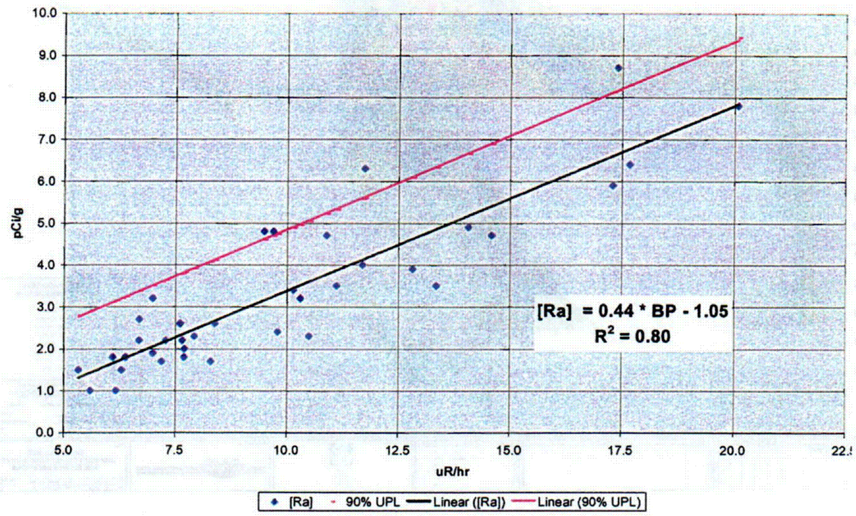


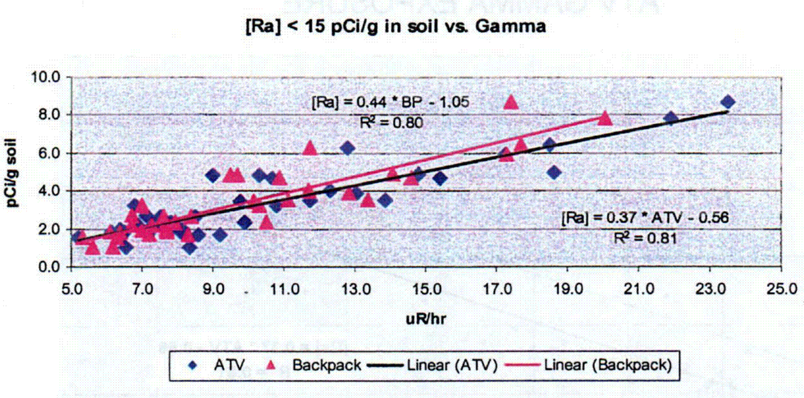
REGRESSION AND UPPER PREDICTION LIMIT FOR RA-226 CONCENTRATION IN SOIL AS A FUNCTION OF ATV GAMMA EXPOSURE



C05

REGRESSION AND UPPER PREDICTION LIMIT FOR RA-226 CONCENTRATION IN SOIL AS A FUNCTION OF BACKPACK (BP) GAMMA EXPOSURE

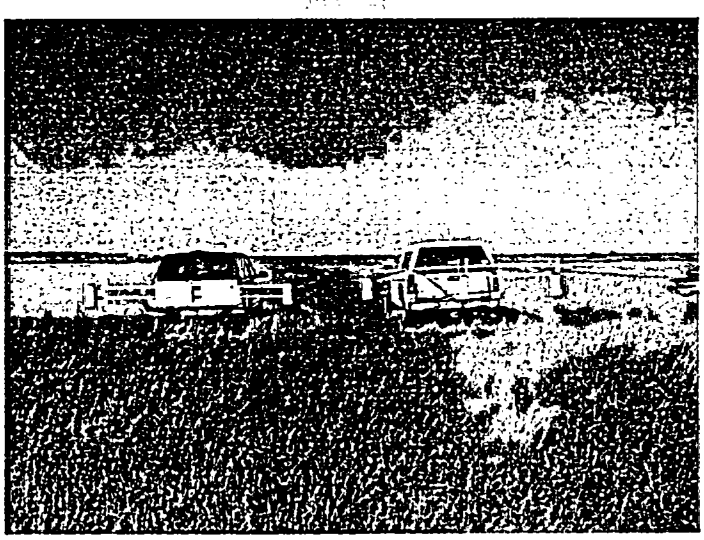




System Improvements

- The iQue is the size of a standard GPS so greatly improves the backpack capability
- The pen top computer can be programmed to record and store data from multiple detector/GPS units
  - Truck-mounted systems can carry up to three detectors
- The system is now programmed so that the data can be downloaded to a laptop and displayed on a base map immediately.
  - This allows the surveyor to make sure all areas have been covered.

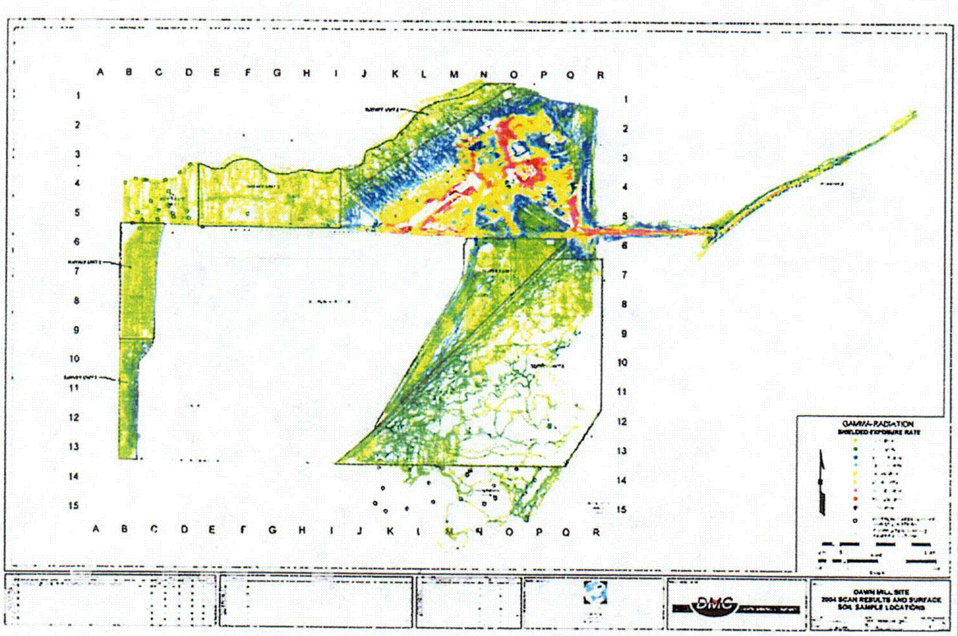
Truck Mounted Systems



Where do we go from here at DMC?

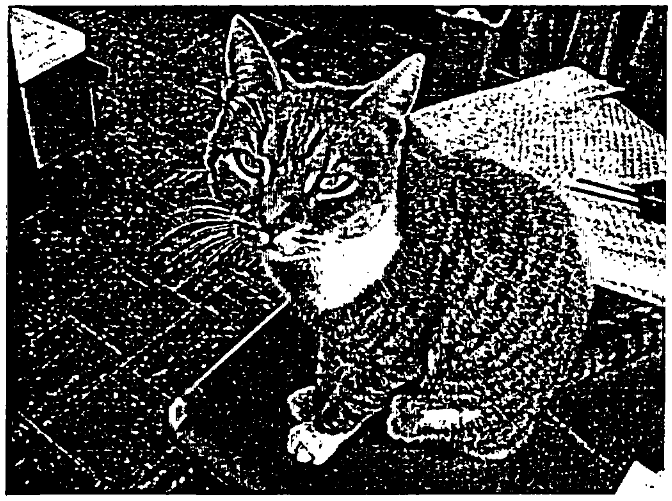
- Verification of areas that need no further cleanup based on the gamma scan.
- Site soil cleanup driven by the gamma scan and backhoe trench results.
- Final Status Survey at the time of site closure:
  - Gamma scan
  - Soil Sampling

consulting scientists and engineers



C07

Project Manager



12th Annual National Mining Association and Nuclear Regulatory Commission Workshop, Denver, Colorado

Health Physics Society's Legislative and Regulatory Initiatives on LLW

J. Scott Kirk, CHP

Chair, Health Physics Society's Legislation & Regulation Committee

May 25, 2005

1

Health Physics Society Mission

- The Health Physics Society (HPS) is a nonprofit scientific professional organization whose mission is to promote the practice of radiation safety. Since its formation in 1956, the Society has grown to approximately 6,000 scientists, physicians, engineers, lawyers, and other professionals representing academia, industry, government, national laboratories, the Department of Defense, and other organizations.
- Society activities include encouraging research in radiation science, developing standards, and disseminating radiation safety information. Society members are involved in understanding, evaluating, and controlling the potential risks from radiation relative to the benefits. (see http://www.hps.org/)

2

Recent Legislative and Regulatory Initiatives

- Senate Energy & Natural Resources Committee Hearing on LLW Oversight Testimony
- General Accountability Office Follow-up Report on LLW
- Organization of Agreement States (OAS) and HPS Joint Position Statement and Legislation Regarding Discrete Sources of NARM

3

Senate Testimony

- Senate Energy & Natural Resources Committee Holds Hearing on LLW Oversight on September 30, 2004
  - In response to GAO Report titled, *Low-Level Radioactive Waste, Disposal Availability Adequate in Short Term, but Oversight Needed to Identify any Future Shortfalls* (GAO-04-604), June 2004
  - GAO emphasis on Class C LLW should Barnwell prohibit access to non-compact member states in CY 2008
  - HPS presented written public witness testimony
  - Cal Rad Forum, DOE EM, NNSA, and GAO presented written and oral testimony

4

Senate Testimony

Changes to LLWPA?

- Nation Needs Predictable Long-Term Disposal Options for Class B/C LLW after CY 2008
  - LLWPA unnecessarily restricted access to available disposal sites and impeded open development of additional sites
  - Suggested Committee seek out ways to more effectively implement, amend or replace the LLWPA

5

Senate Testimony

Safeguarding Orphan Sources

- Lack of Disposal Options May Impact Existing Federal Programs to Safeguard Sealed Sources
  - Orphaned sealed sources generated by high disposal cost and lack of disposal options
  - Prohibition for disposal of sealed sources at EOU
  - Increase in orphan sources expected in 36 states not belonging to Atlantic Compact after 2008

6

Senate Testimony

Lack of Competition

- Beneficial Uses of Nuclear Technologies Must Be Balanced Against Health Risk Posed by Waste Streams
  - High cost of disposal caused by limited disposal options impede beneficial uses of nuclear technologies
  - GAO addressed disposal availability but did not address cost due to limited competition
- Despite Long-Term Disposal Options for Class A LLW, Lack of Competition Results in Excessive Costs for Many Licensees
  - Suggested reexamination of waste classification based on risk, not origins or statutory definitions
  - NCRP Report 139, *Risk-Based Classification of Radioactive and Hazardous Chemical Wastes*, December 2002

7

Senate Testimony

Rulemakings

- Testimony Called Out Current Rulemaking Initiatives by EPA and NRC to Increase Disposal Options and Competition on Market Place
  - Commensurate with risk posed by waste stream
- Informed Committee of Non-regulatory Alternative for Disposals of Non-11e.(2) By-product Materials
  - Candidate wastes must be radiologically, chemically, and physically similar to 11e.(2) by-product material
  - Provisions of long-term custodial care in perpetuity, more protective than RCRA Subtitle C and Part 61 sites
  - Referenced NMA/FCFF "White Paper" suggesting liberalization of NRC current policy for disposal of non-11e.(2) by-product materials

8

GAO Report

Preparation of Next Report

- Committee Chartered GAO to Prepare Follow-up Report
- GAO Requests Support Needed for Next Report on LLW
  - HPS President Ray Guilmette discussed responses to GAO questions on January 19, 2005
  - HPS provided written responses on March 1, 2005
  - NMA/FCFF "White Paper" and documentation on high cost of waste disposal provided to GAO
- HPS Recommended Additional Actions to Safeguard High-Risk Sources and Ease Burden for Disposal of LLW

9

GAO Report

Preparation of Next Report (Continued)

- GAO Follow-up Report Scheduled to Be Issued in September 2005
  - National Academy of Science report on reclassification of LLW also expected to be issued in September 2005
- Senate Hearings Expected to Be Held in Late 2005

10

Discrete Sources of NARM: Joint Position Statement and Legislation

Background Information

- Legislation Proposed in 108th Congress (S. 1043) to Reclassify Certain Sources of NARM Under the Atomic Energy Act of 1954 (AEA)
  - Legislation intended to fulfill international commitments to safeguard "high-risk" sources of ^{226}Ra
  - Legislation excluded disposal options thus potentially generating new "orphan sources"
- Senator Clinton Prepares Stand-alone Legislation (S. 2763) in the 108th Congress to Reclassify Discrete Source of NARM Under AEA

11

Joint Position Statement and Legislation (Background Information)

- September 16, 2004, NRC Issues Proposed Import/Export Rulemaking to Safeguard High-Risk Sources (10 CFR Part 110)
  - Intended to implement IAEA Code of Conduct
  - Includes both bulk materials shipment, as well as sealed sources
  - Rulemaking notes that Commission's limitations to regulating sources of ^{226}Ra

12

Joint Position Statement and Legislation

- Joint Position Statement and Draft Legislation for Discrete Sources of NARM Approved by HPS and OAS in January 2005
  - Position Statement and legislation proposed specific safety, security and disposal provisions
  - Fulfills international obligations and institutes uniform regulations needed to address transboundary issues across all 50 states
  - Submitted to key Congressional stakeholders, Commissioners, EPA, DOE, State Radiation Control Program Directors on January 14, 2005

13

HPS/OAS Joint Mission

Provisions of Proposed Legislation

- Empowers Federal Governmental Agencies With the Necessary Authority to Protect Public Health
  - Removes statutory impediments preventing agencies from fulfilling their delegated authority
- Uniform Regulations Common Mission by HPS, OAS and CRCPD to Remedy Transboundary Issues
- Discrete Sources of NARM Defined in Rulemaking, Not Legislation
  - Anticipate varying thresholds to include high-risk sealed sources, those posing public health concerns, and levels allowing exclusion consistent with international recommendations
  - Allows stakeholder involvement

14

HPS/OAS Joint Mission

Provisions of Proposed Legislation (Continued)

- Intended to Remove Statutory Impediment Currently Curtailing a Wide Variety of Disposal Options
  - Waste not defined as LLW under the LLWPA
  - Allows disposals at RCRA Subtitle C facilities
  - Equivalent to 11e.(2) By-product materials to allow disposal of uranium mill tailings
    - Consistent with CRCPD Part N Suggested State Regulations
  - Consistent with regulating LLW based on risk, not origin or statutory definition

15

HPS/OAS Joint Mission

NRC Proposed NARM Legislation

- HPS and OAS Discuss Provision of Proposed Legislation NRC
  - Teleconference with State and Tribal Programs, Office of General Counsel, and Decommissioning/Waste Management in February 2005
  - Teleconference with Commissioners' staff in March 2005
- NRC Proposes Draft Legislation to Regulate Discrete Sources of NARM Under the AEA on March 30, 2005
  - See NRC Letter to Congress that would amend the AEA, dated March 30, 2005 (ADAMS Accession No. ML050900405)

16

HPS/OAS Joint Mission

Comparison of Proposed Legislation

HPS/OAS Legislation

- Addresses security, safety and waste disposal options
- Applicable to discrete sources of Radium, NORM and accelerator-produced radioactive materials
- Specifically requires defining discrete sources in rulemaking
- Allows disposal at sites regulated by NRC
- Waste not defined as LLW under LLWPA
- Allows disposal at RCRA Subtitle C facilities
- Equivalent to 11e.(2) By-product materials
- Proposed one-year transition period

NRC Legislation

- Addresses security, safety and waste disposal options
- Applicable to discrete sources of ^{226}Ra, NORM and accelerator-produced radioactive materials
- Silent on rulemakings, but implies exemptions based on categories, not risk
- Allows disposal at sites regulated by NRC
- Waste not defined as LLW under LLWPA
- Allows disposal at RCRA Subtitle C facilities
- Silent on disposals as 11e.(2) By-product materials
- Proposed four-year transition period

17

HPS/OAS Joint Mission

What Happens Next?

- Senator Clinton and Congressman Markey Currently Drafting Legislation That Would Amend the AEA to Include NARM
  - Legislation proposed by NRC and HPS/OAS serve to promote uniform safety and security regulations for discrete sources of NARM
  - Both proposals go a long way to fill a longstanding hole in the AEA

18

Legacy Management Land Prospecting for Wind and Solar Power Production

Letitia O'Conor and Tracy Plessinger

U.S. Department of Energy, Office of Legacy Management, LM-30, 1000 Independence Ave., SW, Washington, D.C. 20585 letitia.o'conor@hq.doe.gov and tplessinger@gjo.doe.gov

Abstract – The Department of Energy (DOE) is *Energizing America for a New Century.*[1] DOE's Office of Legacy Management (LM), the Office of Energy Efficiency and Renewable Energy (EERE), and the National Renewable Energy Laboratory (NREL) offer land use and incentives to wind and solar power industries to meet the President's agenda goals to "Increase the supply of dependable energy by strengthening efforts to develop alternative energy, such as wind and solar power, and to fully utilize federal real properties."

I. INTRODUCTION

LM is custodian of radioactive ore-processing and mining sites with legacy wastes disposal systems requiring long-term surveillance and maintenance (LTSM). Large sites with suitable land buffer zones, surrounding low-level radioactive waste disposal cells and monitoring systems, can offer safe usage for renewable energy power production companies.

NREL and LM analyzed 80 properties for wind and solar energy resources. So far, LM has identified seven candidate wind power sites in Wyoming and two solar power sites in New Mexico as shown on the attached maps. Several more sites will be screening for their renewable energy power production reuse potential on a case-by-case basis. Overtime, LM expects more sites to be eligible for renewable energy reuse, as technologies advance to harvest lower wind and solar resources.

II. PROSPECTING SITES

Although some sites are undergoing reclamation, portions of sites that meet wind or solar power sector acceptance criteria can incorporate future energy production usage into cleanup and LTSM plans. For example, the NREL utilizes 275 acres of the Rocky Flats, Colorado site for wind turbine research while the DOE is conducting cleanup and planning LTSM.

As a land reuse strategy, renewable energy power production can meet LM's strategic plan goal to "...make excess lands available for private use consistent with the tenets of sustainability and good land management practices." As a reuse alternative, renewable energy sector use of LM sites for power generation, offers the following characteristics:

- industrial site use without hazardous waste generation or chemical usage;
- on-site energy workers to augment LM's LTSM annual site inspection with continuous monitoring and reporting unusual occurrences that could affect in-place disposal systems and land controls (e.g., fire, storms, trespassing);
- jobs and alternative energy for communities; and
- limit residential population encroachment adjacent to sites used for alternative energy production (e.g., large-scale wind farms).

LM and environmental regulators will ensure renewable energy site construction and usage will be protective of workers, human health, the integrity of disposal cells, and the environment.

LM and NREL will offer their assistance to renewable energy companies for prospecting suitable lands and providing technical support for safe construction. Private site owners conducting cleanup could chose to lease or sell a portion of their land not needed for LTSM, to an energy company. For some sites, a State government may decide to exercise its rights to acquire and manage a portion of a property destine to transfer to LM and then would work with a renewable energy company to permit or lease land usage. During remediation, land reuse options should be incorporated into the public participation process and approved by the Nuclear Regulatory Commission or other environmental regulators depending on the cleanup authority for the site.

II a. Sites with Solar Power Resources

LM and NREL are working together to determine the feasibility of building concentrated solar power production facilities on LM properties. NREL used their priority *Climatologically Solar Radiation Model* to obtain each site's average annual direct normal solar value. Sites with solar values of 7 or greater, using criteria developed by the DOE and BLM[2] to determine candidate sites for solar power production. Land criteria to site concentrating solar power facilities include: a relatively flat terrain; low winds; at least 200 to 500 acres suitable for construction; a water source; and close proximity to natural gas and electric power lines, roads, and population centers. Also, State incentives for renewable energy are crucial.[3] To date, LM has screened two high candidate solar sites located near Bluewater and Grants, New Mexico.

Concentrated solar power facilities are similar to steam power plants. A dry tower system may also be considered for locations with limited water sources and high drought frequencies. The type of solar power plant that could be sited on DOE property would produce 50 to 100 megawatts of power and require approximately 200 to 500 acres for construction of the plant and auxiliary buildings. Plant construction is estimated to employ 350 to 700 workers over a one to two year timeframe. Approximately 50 workers are needed full time for plant operation over a 20 to 30 year period.

New Mexico is working with the Western Governor's Association (WGA) and EERE to provide financial incentives to solar sector interests. Governor Richardson's goal is to have a large-scale solar plant generating power by 2006.[4] The State is currently conducting a feasibility study of candidate sites and solar power technologies. LM's Bluewater site is one of several candidate sites. If Bluewater is selected by the State for further solar facility siting analyses, LM will team with NREL, the solar energy company, the State of New Mexico, stakeholders, and environmental regulators to ensure site acceptability.

II.b Sites with Wind Power Resources

For wind power production, 80 geo-referenced sites were compared to wind resource maps, transmission line power maps, and site-specific wind industry screening criteria.[5] So far, NREL and LM have identified seven high potential wind power sites screened against compatibility criteria and site information provided to LM from uranium mill owners.

Table I. Candidate Wind Power Production Sites

Wyoming Sites	Acres	Wind Density	Site Owner Transfer to LM
Bear Creek	1,000	496	Union Pacific, 05
Spook	80	513	LM/State, 1996
Highlands	400	485	Exxon, 06
Gas Hill West	600	398	ANC, 07
Gas Hill East	2,000	438	UMETCO, 07
Gas Hill North	Large	466	Pathfinder, 05
Split Rock	5,200	500+	WNI, 07

The wind power density estimates are based on 50 m (watts/m2) resource potential: Fair (300-400), Good (400-500); and Excellent (500-600).

A candidate wind power production site must undergo site-specific wind sector screening criteria. Rules of thumb used by the industry in prospecting suitable large-scale wind farm sites may include:

- Transmission line access < 20 miles (69-345 kV) with transmission capacity
- Federal and state policies support wind energy (www.dsireusa.org)
- No specific energy development impediments: scenic areas, bird flyways, non-development or air traffic zones
- Access roads on and adjacent to sites
- Slope of the lands less than 14% grade
- Sites below 7,000 feet elevation
- Large contiguous parcels 1 square mile

Construction of a large-scale wind farm typically employs 150 construction workers for nine months. Once installed, a wind farm operates for 20 years on average and employs one to five wind smiths who maintain turbines and conduct land management on a daily basis. Typically the turbines occupy less than five percent of the land. The number of wind turbines for a large-scale wind farm always depends on the site-specific design. The number of turbines will define the number of on-site wind smiths and maintenance frequencies. Wind farm usage is compatible with cattle grazing practices.

Wyoming sites have a 150 to 250 acre uranium mill tailing containment cell and monitoring systems requiring LTSM. Most candidate sites for large-scale wind farm potential use are privately owned and undergoing reclamation with oversight by the Nuclear Regulatory Commission and in accordance with the Atomic Energy Act and associated provisions for LTSM. If a wind power company is interested in a property before the site is transferred to LM or a State for LTSM, the private land owner will need to work with the NRC to ensure wind turbine installations are compatible with uranium mill tailing containment systems, cleanup decisions and public participation, LTSM plans, and local requirements. DOE's NREL and LM programs will assist in planning efforts. A wind vendor will need to discuss site use and real estate options with LM if the site is federally owned.

ACKNOWLEDGMENTS

Steve Haymes, Donna Heimiller, Jim Johnson, Brian Parsons, Brian Smith and Mark Mehos, NREL
Phil Dougherty and Tex Wilkins, EERE

Dan Collette, Dick Johnson and Mark Plessinger, Stoller
Diane Nemeth, SAIC
Art Kleinrath and John Stewart, LM

REFERENCES

1. DOE, "Energizing America for a New Century" http://www.energy.gov/engine/content.do?PUBLIC_ID=14135&BT_CODE=DOEHOME&TT_CODE=GENERICDOCUMENT, 2004.

2. DOI's Bureau of Land Management and DOE's Office of Energy Efficiency and Renewable Energy, "Assessing the Potential for Renewable Energy on Public Lands", DOE/60-102003-1704, February 2003.

3. http://www.dsireusa.org

4. DOE, "DOE Supports Regional Effort to Use Solar Power", This Month, December 2004, p. 16.

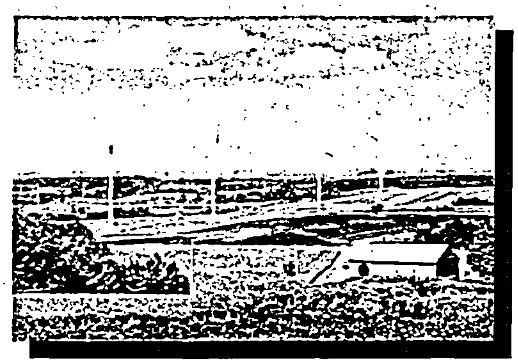
5. DOE NREL "Wind Resource Maps to geo-referenced LM custodian sites longitude and latitude", "Electric Transmission Lines Powermap" (Platts 2003).

A Breath of Fresh Air for America's Abandoned Mine Lands: Alternative Energy Provides a Second Wind

This report provides information about the development of wind energy at former mining sites for communities, including local governments, residents, and organizations, interested in creating renewable energy resources and new economic opportunities at these sites. The report describes the mechanics of wind energy, explores wind energy's environmental, economic, and social impacts at former mining sites, and provides case studies and next steps to get you started.

Introduction

Atop Buffalo Mountain, a former mining site twenty-five miles west of Knoxville, Tennessee, stand three 200-foot tall wind turbines. The white rotor-topped towers, with blades that weigh 14,000 pounds each, convert wind into electricity. The turbines at the Buffalo Mountain wind farm generate 4,000 megawatt hours of electricity annually, enough to supply approximately 400 homes.



Wind Turbines at the Somerset Wind Farm

Five hundred miles north, in Somerset County, Pennsylvania, six 1.5-megawatt wind turbines have been placed on a former mining site adjacent to the Pennsylvania Turnpike. The turbines at the Somerset wind farm generate 25,000 megawatt hours of electricity annually, enough to supply approximately 2,500 homes.

The Buffalo Mountain and Somerset wind farms are not simply examples of new wind power projects; they are examples of innovative reuse opportunities for former mining sites. Many communities across the United States are located in areas that once supported active mining operations. While mining has been an important economic engine and part of these communities' history and heritage, many mines have closed, leaving communities with vacant properties. According to the U.S. General Accounting Office, there are between 80,000 and 250,000 abandoned mine lands (AMLs) across the United States. AMLs include abandoned mines and the areas adjacent to or affected by the mines. Because of safety or environmental concerns, the majority of these sites have never been considered for any type of reuse and have long lain idle.

Wind energy may provide a significant opportunity to change this situation. Wind power, which is a renewable energy resource that does not generate pollution, has made wind energy an increasingly attractive way to diversify the nation's energy options. Spurred by technological advances and falling costs, wind is the world's fastest growing energy source.[1]

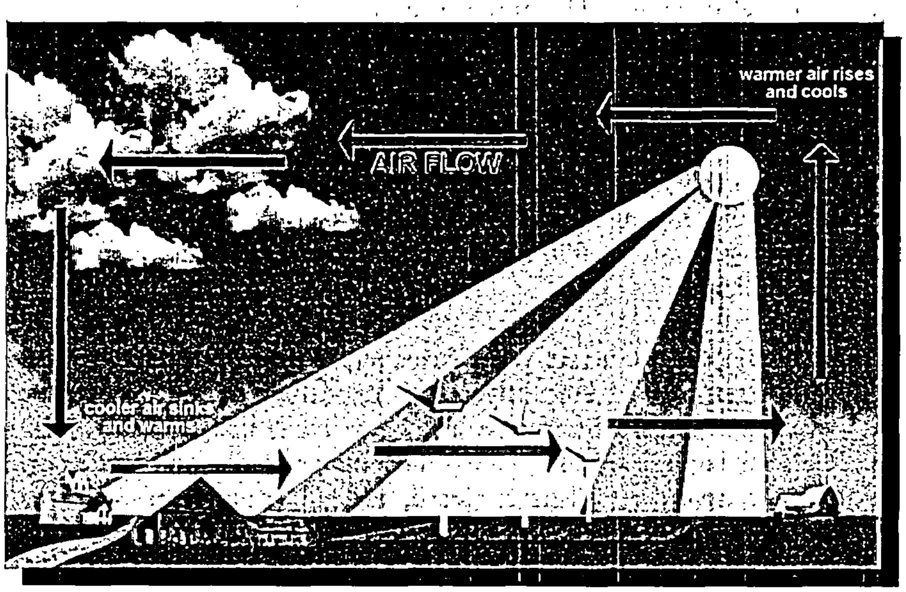
---

[1] Worldwide, there are an estimated 50,000 wind turbines in operation. While wind power currently makes up less than one percent of energy generated annually in the United States, about $3 billion worth of wind power projects are being proposed or planned for the next several years.

AMLs may serve as excellent locations for wind farms, as the requirements for a suitably-placed wind farm and the characteristics of abandoned mine lands may be well-suited to each other. First, wind farms require one critical element: a consistent and sufficient supply of wind. AMLs are often located in mountainous areas that receive consistent wind flows. Second, wind energy projects require access to large, open sites. The size of many AMLs means that large-scale wind turbines can be accommodated in one location. Third, many AMLs are located near existing infrastructure, including roads and power transmission lines, due to prior mining activities. In turn, the availability of existing infrastructure can reduce project costs.

What is an AML?

Abandoned Mine Lands (AMLs) are those lands, waters, and surrounding watersheds where extraction, beneficiation, or processing of ores and minerals has occurred. These also include sites where mining and mineral processing waste were disposed of or deposited.



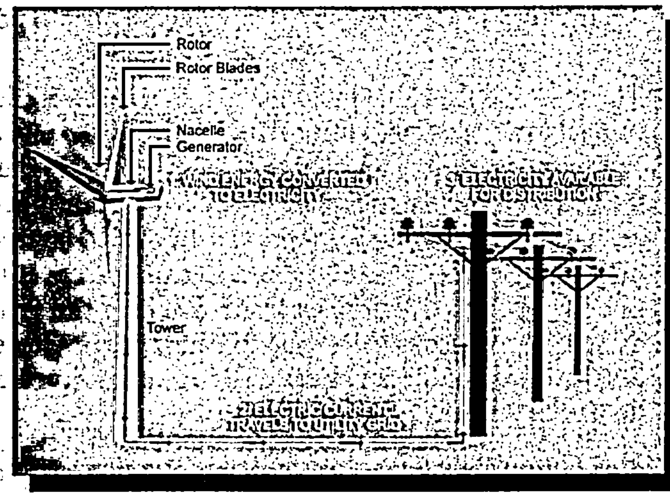
Wind Flow Diagram: The Creation of a Renewable Energy Resource

As a result, while AMLs may be located in areas that are ill-suited for other commercial or industrial reuses, wind farms can be built and operated in these areas. Wind farms can provide a local renewable energy source, enhancing economic growth, generating tax revenue, and returning lands to productive reuse, providing communities across the United States with reuse opportunities for former mining lands.

Wind Energy: What is It and How Does It Work?

Wind is created by the unequal heating of the earth's surface by the sun. Wind's kinetic energy can turn the rotor blades of wind turbines, generating electricity.

Wind turbines have four primary parts: a tower, a rotor, a generator, and a nacelle. The turbine's tower extends from its base on the ground into the air and supports the turbine's rotor. Towers can range in height from 120 feet to 400 feet – a tower's height dictates the maximum possible length of the turbine blades. Generally speaking, the taller the turbine, the greater the amount of electricity it will produce, due to the turbine's longer rotor blades and potential exposure to uninterrupted, higher-velocity winds at higher altitudes.



Wind Turbine Components & Energy Transmission

At the top of a turbine's tower, a rotor is connected by a shaft to a generator. The rotor's glass- and carbon fiber-reinforced plastic blades can be more than 100 feet long and are designed like airplane wings, producing lift that causes their rotation at 16-30 revolutions per minute. As the rotor is turned by the wind, the rotor's shaft turns the generator, producing electricity. The amount of energy that a wind turbine will produce is a function of two factors: the diameter of the rotor's blades, which determines its "swept area," and the amount of wind intercepted by the rotor blades. Cables carry the electricity generated by the turbine's rotor down the turbine tower to the ground, where equipment connects the turbine to the utility grid. The nacelle, the fourth primary part of a wind turbine, is the streamlined casing that encloses the rotor and generator.

While there are small-scale wind turbines designed to meet the needs of individual homes and businesses, utility-scale (750-kilowatt to two-megawatt) wind turbines are required to support commercially viable wind farms. A wind farm is a collection of large wind turbines used to produce electricity. A wind farm can include a handful – or more than 100 – wind turbines. According to the American Wind Energy Association, one 1.5-megawatt wind turbine can produce 4,600 megawatt hours of energy per year, enough to provide electricity for approximately 460 American homes.

Wind farms need to be located in areas with adequate wind resources, as a stronger wind means more power. Wind resources are characterized by wind-power density classes, ranging from class 1 (the lowest) to class 7 (the highest). In the United States, good wind resources (class 3 and above), which have an average annual wind speed of 11-13 miles per hour when the wind is blowing, are found across the country. Areas of the United States with wind resources that can support wind farms include the Pacific coast, the Great Plains, and the Appalachian Mountains. These areas are home to significant numbers of former mining sites. Colorado, for example, a state with an extensive coal and hard rock mining history, has more than 1,500 AMLs. The state receives enough energy from class 4 and higher winds to supply 14% of the electricity required by the lower 48 states.

Making the Connection: Wind Farms on Abandoned Mine Lands

The reuse of abandoned mine lands as wind farms is not a new idea. There are several of these projects in operation, both in the United States and around the world. Wind farms on AMLs in European countries, for example, have been providing electricity for several years. A wind farm located on a former coal mine in Kilronan, Ireland generates 14,000 megawatt hours of electricity annually, enough to supply approximately 2,300 homes. The Klettwitz wind farm, located on the site of a former open-cast coal pit in eastern Germany, is the largest wind farm in Europe. In operation since June 2000, 38 turbines at the 680-acre site generate 100,000 megawatt hours of electricity annually, enough to supply approximately 16,400 homes. Plans for an abandoned coal mine in Forth, Scotland, call for the construction of 67 turbines on the 2,400-acre site that could provide electricity to 80,000 homes.

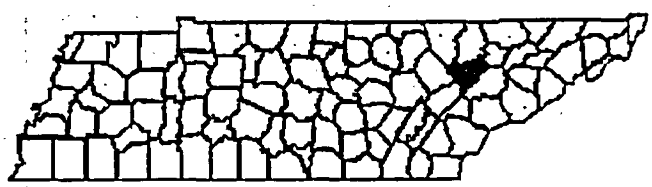
> "You could not pick a more disturbed area," said Tom Matthews, President of U.S. Wind Force, referring to the company's proposed wind farm site in West Virginia. "It is primarily made up of reclaimed and active strip mines, as well as abandoned deep mines. It is an area of West Virginia from which many of the natural resources have already been extracted."
>
> – *Charleston Gazette*, December 28, 2001

In the United States, plans for the largest wind farm in the eastern half of the country are being developed. Mount Storm Wind Force, a subsidiary of the U.S. Wind Force company, is planning to locate a 166-turbine farm on a site honeycombed by former coal and hard rock mining activities. Located on 10,000 acres of land between the Potomac River, Mount Storm Lake, and the Town of Mount Storm in West Virginia's Tucker and Grant counties, the farm will have the capacity to provide power for 65,000 homes. In addition, 99 percent of the land would continue to be usable for other activities, including farming.

There are also wind farms located on abandoned mine lands in the United States that have already moved beyond the planning stages, including the Buffalo Mountain wind farm, located in Tennessee, and the Somerset wind farm, located in Pennsylvania.

These two wind farms illustrate that the reuse of AMLs requires sustained dedication, community outreach and involvement, and strong working relationships. The wind farms also illustrate that the benefits provided by the reuse of these former mining lands can be substantial. Benefits include local job creation and economic growth, increased tax revenues from project-related spending, the development of a local renewable energy resource, and the return of previously vacant mining lands to productive reuse. Below, the project highlights and lessons learned at the Buffalo Mountain and Somerset wind farms are described in greater detail.

Buffalo Mountain Wind Farm



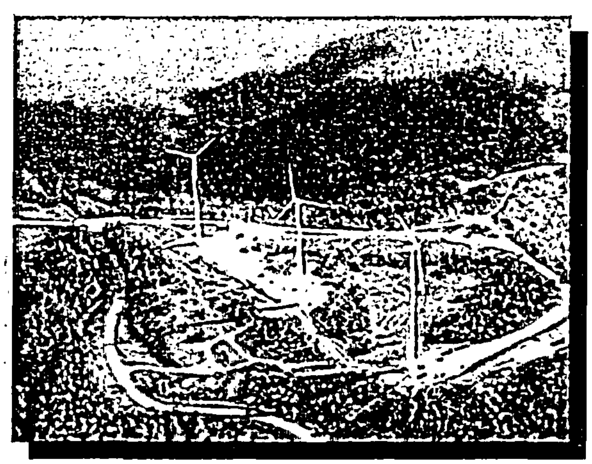
Anderson County, Tennessee

In October 2000, Anderson County, Tennessee became home to the first commercial wind generation facility in the southeastern United States. The Tennessee Valley Authority (TVA), a federal corporation and the nation's largest public power company, built a three-turbine wind farm on a former strip mine site on Buffalo Mountain, a high ridge located just outside the municipality of Oak Ridge. The 660-kilowatt capacity turbines generate 4,000 megawatt hours of electricity annually, enough to supply approximately 400 homes.

The two-acre Buffalo Mountain wind farm is located on a former strip mine operated during the 1980s by the Coal Creek Mining and Manufacturing Company. When the mine ceased operations in 1990, the company completed reclamation activities, including backfilling and revegetating the strip-mined areas. When TVA approached the Coal Creek Mining company about the possibility of siting wind turbines on the property, the company was provided an opportunity to explore an innovative reuse and generate revenue from an idle property.

The development of the Buffalo Mountain wind farm by TVA relied on extensive site research and community involvement, effective corporate and community partnerships and working relationships, and an emphasis on the importance of renewable energy. The following project highlights illustrate some of the lessons learned during the development of the wind farm.

- ***The importance of effective community outreach and communication.***



Wind Turbines at the Buffalo Mountain Wind Farm

The local community, as well as other agencies and organizations, was significantly involved throughout the project's development. A steering committee composed of TVA staff, community representatives, environmental organizations, and participating power distributors oversaw the project's development, providing input on site design and technical issues, and held a series of public meetings to incorporate community input and share project information. According to Rick Carson, TVA's Renewable Energy Program Manager, community involvement in the project's development led to community support for the Buffalo Mountain wind farm. "The community," he said, "including local residents who had worked in the coal-mining industry, was enthusiastic about the reuse of the property."

- ***The importance of strong working relationships that can provide the funding and technical expertise necessary for wind projects.***

Before TVA could build the wind park, the agency first had to work in close coordination with several public and private entities. TVA negotiated with the Coal Creek Mining and Manufacturing Company to be able to lease and site the wind farm on their property, while the energy consulting company, AWS Scientific, was hired to assess potential turbine sites. Lowe Excavating, a construction company, provided road improvement and site clearance services, while Tennessee Communications, a communications company, installed two miles of power lines connecting the wind turbines to the local power grid. Enxco, Inc., an energy company specializing in renewable energy, was hired to develop the wind farm and provide ongoing operations and maintenance services. Clinton Utility Board, the local power distributor, agreed to maintain the wind farm's connection to the local power distribution network.

Site History

- 1980s Buffalo Mountain wind farm site mined by Coal Creek Mining and Manufacturing Company
- 1990 Mining operations at the site cease
- 1990 Reclamation of land from mining activities at the site begins
- 1999 TVA conducts wind resource and environmental assessments of the mine site
- 1999 Site prepared for wind turbines: gravel roads upgraded for site access, vegetation cleared, power lines upgraded
- 2000 Turbines installed at the site; turbines tested and connected to distribution system.
- 2000 Buffalo Mountain wind farm in operation

- ***The financial and timing benefits provided by the site's remediation and the site's proximity to existing infrastructure.***

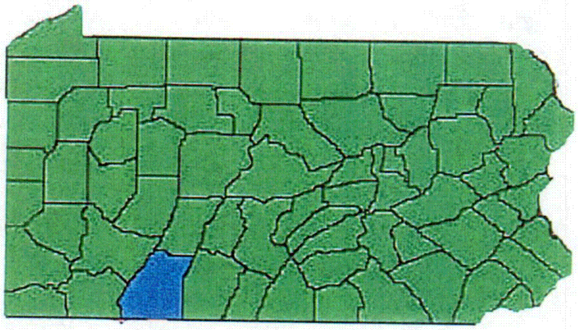
TVA was able to move rapidly from design to implementation of the wind farm in little more than a year for two reasons. Prior remediation work completed by the Coal Creek Mining and Manufacturing Company, which included capping open mine shafts and using vegetation to reduce soil erosion, meant that TVA did not need to pursue additional cleanup activities. Second, the site's close, two-mile proximity to existing infrastructure, including roads and power transmission lines, meant that site preparation costs for the Buffalo Mountain wind farm were reduced.

Results

Three wind turbines were installed on Buffalo Mountain in 2000. Today, as part of TVA's Green

Switch Program, developed to provide customers with access to renewable energy resources, the turbines are part of a renewable energy network that provides power to 5,800 residential customers and 300 business customers. As of April 2003, the three turbines had produced 9,500 megawatt hours of electricity. The wind farm's success has resulted in plans for additional turbines to expand the wind farm's capacity from two to 29 megawatts. In January 2003, TVA signed a 20-year purchase agreement with Invenergy, a Chicago-based energy development company, to add 18 1.5-megawatt wind turbines to the wind farm. The turbines will be in place by November 2003.

Somerset Wind Farm



Somerset County, PA

Somerset County, Pennsylvania is located in southwestern Pennsylvania's Laurel Highlands. The county's wind resources and high elevations mean that the county is a potential candidate for the location of wind farms. While the county's traditional manufacturing, coal mining, and agriculture base continues to sustain the area's economy, wind energy has provided a new opportunity for economic diversification and the reclamation and reuse of an AML. In October 2001, Somerset Windpower LLC, a joint venture between power companies Zilka Renewable Energy and Atlantic Renewable Energy, began operating six 1.5-megawatt wind turbines on farmland adjacent to the Pennsylvania Turnpike. The turbines at the Somerset wind farm generate 25,000 megawatt hours of electricity annually, enough to supply approximately 2,500 homes.

The 400-acre Somerset wind farm is located on farmland that was previously used by two different mining operations. In the early 1960s, the land was strip-mined for coal by Svonavec Inc., removing much of the land's surface soil. In the 1980s, PBS Coal Company deep-mined the same area for coal, creating underground shafts. The former coal mines on the wind farm were cleaned up between 1987 and 1990, using funds set aside by the two mining companies. The mined areas were backfilled with soil to recreate the land's original contours.

Students Visiting Somerset Wind Farm

The development of the Somerset wind farm by Somerset Windpower LLC relied on extensive site research, innovative construction approaches, and effective corporate and community partnerships and working relationships. The following project highlights illustrate some of the lessons learned during the development of the wind farm.

c08

- ***The selection of an AML site within an existing community with access to infrastructure.***

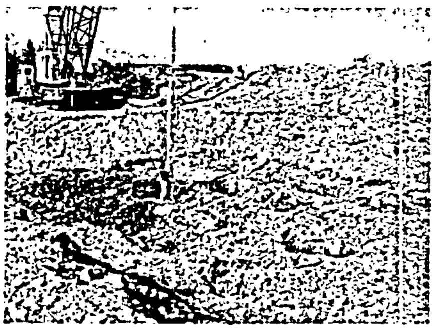
The Somerset wind farm illustrates that wind farms can be located on AMLs within existing communities. The site was selected for two reasons: sufficient wind power and the availability of infrastructure. Prior mining activities meant that roads and power transmission lines were already in place, reducing project costs.

- ***The importance of strong working relationships that can provide the funding and technical expertise necessary for wind energy projects.***

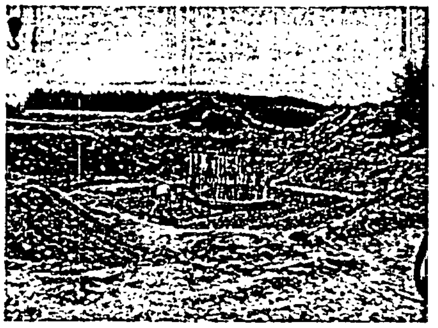
Once the site for the Somerset wind farm had been selected, several corporations, including Zilka Renewable Energy, Atlantic Renewable Energy, General Electric, Exelon Powerteam, and Community Energy, Inc., formed working relationships to turn the site into a successful, functioning wind farm. Two power companies, Zilkha Renewable Energy and Atlantic Renewable Energy, entered into a joint venture called Somerset Windpower LLC to design and build the wind farm. General Electric signed on to provide routine operations and maintenance services. Exelon Powerteam, a wholesale power marketing company, signed a 20-year agreement to buy the power produced by the Somerset wind farm. Exelon Powerteam worked with Community Energy, Inc., an energy-sector consulting company, to market the power to universities, corporations and residences under the name "New Wind Energy."

- ***Innovative construction approaches can allow for the presence of wind farms in areas that may be inaccessible or otherwise cost-prohibitive.***

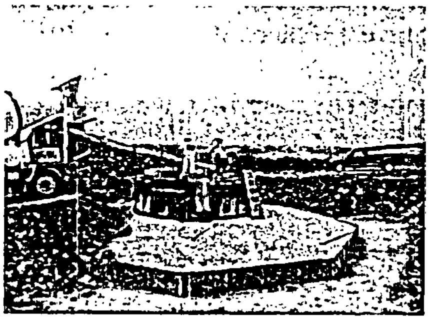
Somerset Wind Farm: Turbine Siting Preparation



Step 1: Checking the stability of each proposed turbine location



Step 2: Building each turbine's steel-reinforced concrete foundation



Step 3: Checking the stability of each turbine's foundation

Because of the prior mining activities at the Somerset wind farm site, additional analysis and remediation was required to ensure that the site's surface was structurally strong enough to support the weight of the six wind turbines. Sixteen-foot perimeter holes were drilled under each of the turbine sites and 15-ton weights (approximating the weight of the turbines) were then inserted into the holes to identify any structural weaknesses. Steel-reinforced concrete foundations were poured for each of the turbines – each foundation contains 180-200 cubic yards of concrete and 23,000-26,000 pounds of reinforced steel.

Somerset Windpower LLC also developed strategies to address unique on-site situations. One wind turbine, for example, was sited on a tract of land that was formerly deep-mined, potentially compromising the stability of the wind turbine's foundation. The turbine was centered over the mine's stable main heading corridor and concrete was poured into the shaft to stabilize the structure before pouring the turbine's foundation. In addition, a tilt sensor was installed on the turbine to detect subsidence that could compromise the turbine's foundation.

Results

The Somerset wind farm has shown that with careful planning, the use of turbines to harness the power of wind can successfully create clean, usable energy. Penn State University has purchased the output from five of the six turbines at the wind farm for the next five years, the largest retail purchase of wind energy in the United States. As a result, more wind farms are under development. Somerset County is already home to more wind turbines than any other county in Pennsylvania, and two new wind farm projects are under development in the county. One of the projects, a 20-turbine site, is being developed on a former mining area and landfill located adjacent to Somerset wind farm. Across Pennsylvania, construction of up to 50 new turbines is anticipated in 2003.

Impact Assessment: Environmental, Economic, and Social Impacts Associated with the Reuse of Abandoned Mine Lands as Wind Farms

The Buffalo Mountain and Somerset County wind farm examples illustrate how wind energy projects at AMLs can generate successful renewable energy resources *and* provide opportunities for communities to return former mining sites to productive reuse. However, while wind farms located at AMLs have proven successful for these localities in Tennessee and Pennsylvania, do they represent a reuse option that might make sense for former mining sites in your community?

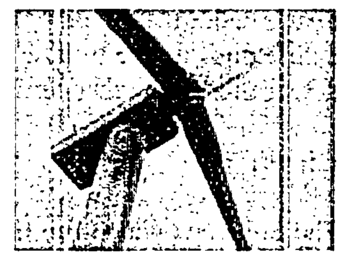
To help your community answer this question, this section reviews the range of environmental, economic, and social impacts created by the reuse of abandoned mine lands as wind farms. The section also provides anecdotal evidence describing how other communities have addressed these impacts and determined the degree to which wind energy represented a significant opportunity to reuse local AMLs.

Environmental Impacts

The reuse of abandoned mine lands as wind farms provides two primary environmental benefits. First, the location of wind farms on former mining sites has the potential to provide a market-based incentive to remediate hazardous waste sites and brownfield sites that may be contaminating local streams, groundwater, soils, or even entire watersheds. Without the existence of potential economic returns, many of these properties may otherwise remain vacant or continue to contaminate the local environment until a state or federal cleanup program addresses contamination issues. The location of wind farms on abandoned mine lands can potentially result in remediated properties, restored ecosystems and wildlife habitat, and improved water quality.

The Case for Wind Power

Wind energy is a free, inexhaustible natural resource and a source of clean, non-polluting electricity. The U.S. Department of Energy estimates that using one utility-scale wind turbine prevents the annual emission of 5,000 tons of carbon dioxide, a greenhouse gas that contributes to global warming.



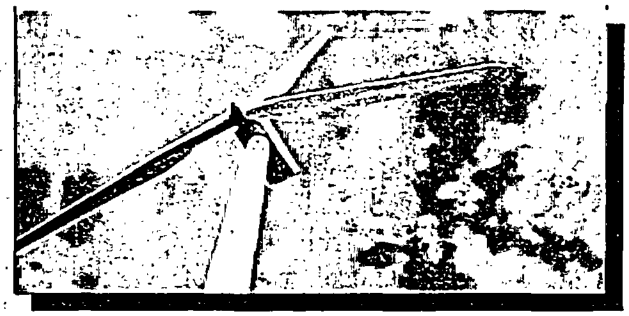
Traditional energy sources like coal and oil, in contrast, generate byproducts at each stage of the generation process. Mining depletes natural resources, degrades the environment, and destroys wildlife habitat. Acid mine drainage destroys stream and river ecosystems and threatens the health of people and wildlife. Power plants that generate electricity from oil and coal produce heavy metals and greenhouse gases as byproducts.

Second, wind farms represent a renewable energy resource that can provide an inexhaustible source of clean, non-polluting electricity. Unlike conventional power plants, wind plants emit no air pollutants or greenhouse gases. In 1990, according to the U.S. Department of Energy, California's wind farms – which generate approximately two percent of the state's total energy output – offset the emission of more than 2.5 billion pounds of carbon dioxide, and 15 million pounds of other pollutants that would have otherwise been produced. It would take a forest of 90 million to 175 million trees to provide the same air quality. The Department of Energy estimates that using one utility-scale wind turbine prevents the annual emission of 5,000 tons of carbon dioxide, a greenhouse gas that contributes to global warming. Energy produced from traditional sources like coal and oil, in contrast, generates byproducts at each stage of the generation process, leading to increased air pollution, and, in the case of coal mining, acid mine drainage.[2]

The environmental limitations associated with wind farms – at abandoned mine lands and in general – revolve around the turbines' potential threat to wildlife, primarily bats and local and migratory bird

[2] Recognizing these benefits, the Department of Energy has developed grant- and incentive-based programs to promote the development of wind energy resources. The *Resources* section of this report and Attachment A provide additional information.

populations. These concerns have arisen largely in response to the high number of bird kills at one wind farm located in Altamont Pass in California, where 183 birds, including five bald eagles, were killed by turbine rotor blades between 1990 and 1992. Changes in turbine technology – including additional lighting, the redesign of turbine nacelles to eliminate bird nesting opportunities, and slower blade rotations, which make the turbines easier for birds to see and avoid – have reduced their potential threat to wildlife. A 2001 National Wind Coordinating Committee (NWCC) study, indicated that, on average, approximately two birds are killed per turbine per year.



In some states, companies considering new locations for wind farms must also submit environmental impact statements before proceeding with projects. At the Buffalo Mountain Wind Farm, an environmental assessment was conducted to ensure that the wind farm would not negatively impact the natural environment.

Economic Impacts

The potential economic benefits provided by wind energy at AMLs include local job creation, economic growth and diversification, and increased tax revenues.[3] Wind energy can help revitalize economies by creating new businesses and jobs, and by keeping energy dollars circulating within local economies. Several recent studies have analyzed wind energy data to quantify these benefits. A nationwide 2001 study by the Center for Renewable Energy and Sustainable Technology concluded that wind farms create 40 percent more jobs per dollar invested than coal plants. The European Wind Energy Association estimates that every megawatt of wind capacity creates about 15-19 jobs, or about five times more jobs per dollar invested than coal or nuclear power.

Locating a wind farm at an AML can also benefit the local economy through the purchase of local goods and services. During the construction of the wind farm, companies and contractors require equipment and support services, while their employees require services like food and lodging. Following construction of a wind farm, companies and contractors and their employees continue to require local goods and services as the farms are maintained, repaired, and upgraded over time. Studies that have assessed the scale of local economic benefits provided by wind farms have reached different conclusions. One study for a wind developer cited by the NWCC concluded that the operation of a 100-megawatt wind farm would generate approximately $500,000 in annual local purchases. A 1995 report from California's Kern County Wind Energy Association, in contrast, concluded that the county's local economy gains $11 million annually from the purchase of goods and

[3] Additional tax revenues are generated from increased local spending on goods and services during the construction and operation of a wind farm.

services for wind energy projects. The county's total economic gain includes new tax revenues generated by the purchases. Kern County, which contains 4,600 wind turbines with a total generation capacity of 1,400 megawatts, is home to the largest cluster of wind farms in the United States.

The local revenue derived from a parcel of land can be significantly increased by the addition of wind turbines. Wind turbines provide an additional source of revenue, particularly at sites like AMLs where the land is either not in use or is in agricultural use. Wind farms can be integrated with existing agricultural uses. For example, at the Somerset wind farm, property owner Robert Will receives two percent of the turbines' production revenue as payment for allowing the turbines to be sited on his land. In total, each turbine generates $3,000 to $3,500 each year in revenue for the property owner, while Mr. Will retains the ability to farm most of his property.

> "We're the only family in Pennsylvania milking cows next to windmills. It's a way to make a little extra money, and it doesn't take much of your land. It does not disrupt your way of farming."
>
> - Property Owner Robert Will in the *Patriot News*, February 2nd, 2002

Even though the cost of generating wind energy has decreased dramatically in the past ten years, the technology does require a higher initial investment than fossil-fueled generators. Roughly 80 percent of a wind farm's startup cost is its machinery, with the balance being the site's preparation and installation. However, if wind farm systems are compared with fossil-fueled systems on a "life-cycle" cost basis (counting fuel and operating expenses for the life of the generator), wind costs are much more competitive with other generating technologies because there is no fuel to purchase and minimal operating expenses. The construction and operating costs associated with wind energy will also continue to decrease over time. New, utility-scale wind projects are being built in the United States today with energy generation costs ranging from 3.9 cents per kilowatt-hour (at windy sites in Texas) to five cents or more (in the Pacific Northwest), costs that are competitive with the direct operating costs of conventional forms of electricity generation.

Wind energy's remaining major economic limitation is its status as an intermittent power supply. While the wind is an inexhaustible, renewable natural resource, it does not blow all of the time, and cannot be guaranteed to come online during periods of high energy demand. Organizations like the Tennessee Valley Authority at the Buffalo Mountain wind farm are working to develop energy storage facilities for wind farms that would enable the power generated by wind turbines to be stored and released at times of high energy demand.

Social Impacts

Wind farms located on AMLs can provide several social benefits, serving as local landmarks and a source of community pride. At the Somerset wind farm, for example, the striking silhouette of the wind turbines has provided a new local point of reference, and even attracted tourists passing by on the nearby Pennsylvania Turnpike. Robert Will, the property's landowner, has come to expect a regular flow of visitors on weekends, drawn to look at the turbines.

Wind farms can also generate community concerns about the potential noise levels and aesthetics associated with wind turbines. Turbine noise levels have decreased substantially – a single modern wind turbine is barely audible. The American Wind Energy Association estimates that a wind turbine located 250 meters from a residence generates about as much noise as a kitchen refrigerator. A wind farm with multiple turbines, however, will generate more sound and the appropriate siting of the proposed wind farm in relation to surrounding land uses may need to be considered during the planning and siting process.

Community aesthetic concerns can center around the size, design, and visual prominence of the wind turbines, which may significantly alter a community's skyline. Turbines' shadow patterns and night-lighting can also create a visual nuisance if sited near residences and businesses. Turbines' shadow patterns and night-lighting can be addressed by planting trees or installing screens. Aesthetic concerns, however, can be more difficult to address, as people's preferences can vary. Some people like the profile of wind turbines, for example, while others find them visually disruptive. Community outreach and education efforts can help ensure that all community members are included in the planning process from the outset. During community meetings, community members can express their concerns, learn about wind energy, and work with other community members and interested parties, including local officials, residents, organizations, and energy providers, to ensure that proposed wind farm projects are appropriately designed, well-sited, and ultimately successful.

Getting Started

As your community evaluates its interest in pursuing wind power as a reuse option for local abandoned mine lands, there are several important factors to consider. These factors include:

- *Sustained Community Involvement*

Active, **sustained community involvement** is critically important from the outset of any community planning process, and can help determine the extent to which wind power may be able to meet local environmental, economic, and social needs. Discussion of community priorities can also help to identify potential community concerns, like noise levels or aesthetics, associated with the location of wind turbines on local AMLs.

Community discussions about potential reuse opportunities at local AMLs need to include a diverse range of stakeholders, reflecting the local and regional impact of former mining sites on economies, communities, and ecosystems. Stakeholders in an effective, inclusive process may include local government officials, citizens, and local organizations, previous site landowners and operators, current or future landowners, potential developers, Tribal interests, and state and federal agencies with potential oversight responsibilities at a site. Additional interested parties may include wind energy corporations and power companies, wildlife organizations, and renewable energy organizations. These organizations may be able to provide key technical support and funding resources.

- *Understanding of Land Ownership Issues*

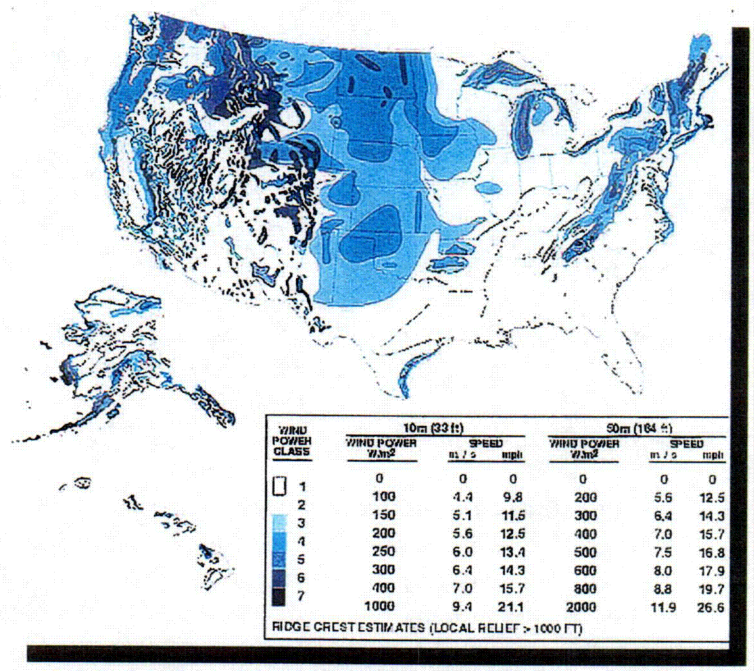
The community's efforts to evaluate local AMLs as potential locations for wind farms will require close coordination with the owners of these former mining sites. Landowners may be aware of the potential benefits provided by wind energy, or may need to work with the community to determine whether a wind farm represents an opportunity to return their property to successful reuse.

The community may also need to clarify and resolve several **land ownership issues**. Former mining sites often have multiple owners, including individuals and mining companies. Outstanding mining claims may need to be resolved. Properties may have separate surface and mining rights that are owned by different entities. In each case, the community will need to contact and develop working relationships with the owners of the properties or mining rights at each AML as early as possible in the planning process.

- *Site Feasibility*

As your community establishes an inclusive community involvement process and addresses site ownership issues, the community can begin to effectively evaluate the feasibility of wind power as a reuse option for local AMLs.

The **technical feasibility** of locating a wind farm on a local AML depends on the availability of sufficient wind resources, suitable location characteristics, and existing infrastructure. Energy resource maps can help the community determine if the site is located in an area that receives sufficient wind resources.



U.S. Wind Energy Resource Map ***(U.S. Department of Energy)***

Potential wind farm sites at AMLs must also include adequate space for large-scale turbines and open areas located away from buildings, which obstruct wind flow. Finally, the community will need to determine, using local electric power system maps and general area maps, whether AMLs are located in close proximity (typically within two miles) of existing infrastructure. Sites located adjacent to

c09

existing roads and power transmission lines mean that wind turbines can be installed and connected to the power grid with reduced cost.

Community Considerations: Evaluating the Potential Reuse of a Local AML

Communities considering the potential reuse of a local AML as a wind farm can work through the following evaluative steps. For information about wind energy consultants that can provide the services described below, please refer to the American Wind Energy Association (AWEA)'s web site at www.awea.org/directory.

- *Identify AML sites and their wind energy potential,* based on the availability of wind resources, site location, and the availability of existing infrastructure like roads and power transmission lines, which can reduce costs. Wind resource maps such as the Pacific Northwest Laboratory's *Wind Energy Resource Atlas* (online at rredc.nrel.gov/wind/pubs/atlas) and data from the National Climatic Data Center (online at www.ncdc.noaa.gov) can be used to assess local wind resources. Maps of local electric power systems and general area maps can help determine the availability of existing infrastructure.

- *Secure access to the site.* Work with AML property owners to explore the potential benefits provided by wind energy at each site and determine their level of interest.

- *Explore and address the social and environmental factors* that may affect the project, including raptor activity, endangered species in the area, the site's geology, community concerns about noise and aesthetics, cultural and historical factors, and local air traffic issues.

- *Arrange for a professional appraisal* of the site's wind resources. A professional appraisal of the site's wind resources involves the construction of meteorological towers equipped with anemometers, instruments that measure wind force and speed. Based on one-year's worth of data from these instruments, a meteorologist can prepare a site report that describes the area's wind resources. Companies that provide these services can be found on AWEA's website, listed above.

- *Obtain the services of a professional familiar with the regulatory environment* surrounding wind power development. These services can help ensure that relevant state and federal regulations like environmental impact statements are identified and addressed early in the planning process.

- *Identify a wind energy developer* that would be interested in discussing the possibility of locating a wind farm on the site. Attachment B at the end of this report provides a list of wind energy developers.

- *Identify a reliable power purchaser* and secure tentative commitments from one or more buyers for the wind farm's output. Local, regional, and national utilities, as well as other entities, including universities and businesses, are potential purchasers of a wind farm's output. Local utilities will also need to be contacted to ensure access to the area's existing power transmission network.

- *Establish access to sufficient capital* to support the cost of constructing a wind farm – approximately $1 million per megawatt. National and international lenders, including investment banks, insurance companies, and foreign investors, typically supply 50-90 percent of wind projects' capital costs, with project sponsors providing the remainder of the project's funding.

- *Secure an agreement with a company* to provide operations and maintenance services for the wind turbines. Companies that provide these services can be found on AWEA's website, listed above.

Community Resources

For communities interested in pursuing wind energy as a reuse opportunity for a local abandoned mine land, there are a wide range of existing programs and incentives that are available. Types of assistance that are available include grant funding, technical assistance, and tax credits. Some of these incentives, such as tax credits, target the private sector, spurring companies to develop wind farms. However, communities can access most of the resources that are available and receive financial assistance, information, and technical advice from organizations and agencies that specialize in the development of wind energy resources at AMLs.

Two federal agencies, the Department of Energy (DOE) and the Environmental Protection Agency (EPA), have developed programs that can assist communities as they explore wind energy reuse opportunities for AMLs. DOE has programs that provide financial incentive payments to public and non-profit renewable energy producers for the development of renewable energy resources, funding for community-based education, training, and information dissemination activities, and cost-sharing funding for state and industry renewable energy partnerships.

In particular, DOE's Rebuild America program can serve as a valuable resource for communities pursuing reuse opportunities at AMLs. The Rebuild America program is a network of hundreds of community-based partnerships across the nation that are dedicated to improving the quality of life in communities through energy efficiency solutions. The program provides financing and technical assistance to help communities identify, prioritize, and solve energy-related problems.

EPA's AML Team is also an important resource that can provide communities with technical support and resources as they explore reuse opportunities available at AMLs. EPA's AML Team can work in partnership with communities to clarify EPA's interests at former mining sites and address potential obstacles to reuse planning at these sites. In the future, the Team will also be developing databases, case studies, and other tools and resources to help communities pursue wind energy as a dynamic reuse opportunity for local AMLs.

Attachment A provides additional information about available federal and state-level programs and incentives, including the programs described above, as well as a list of additional wind energy resources. Because of the large number of state-level programs, the section provides links to two listings with information about these programs. Each of these programs have been highlighted because they can provide your community with helpful services and funding as it considers wind energy reuse options for local abandoned mine lands. Attachment B provides contact information for wind energy developers and consultants that are members of the American Wind Energy Association (AWEA). Attachment C lists the sources used during the development of this report.

Conclusions

Wind energy provides a significant opportunity for communities to reuse abandoned mine lands. By returning AMLs to productive reuse as wind farms, communities can benefit from the potential cleanup of these vacant, idle properties, as well as from economic benefits that include local job creation, economic growth and diversification, and increased tax revenues. To pursue these benefits, communities will need to evaluate local wind resources and establish strong working relationships with site landowners and wind energy providers. As the Buffalo Mountain and Somerset wind farms illustrate, these projects will also require sustained community interest and innovative financing and design approaches. The end result: AMLs reclaimed as wind farms that can help communities find new answers to long-standing economic and environmental questions. The opportunities await.

Contact Information

Interested in pursuing potential wind energy opportunities for a local AML site? For additional information, there are several federal resources that are available.

- For information about the Department of Energy's Rebuild America Program, please contact Elizabeth Freed at 202-564-5117 or Martha Otto at 703-603-8853.
- For information about EPA's AML Team, please contact Joan Fisk at 703-603-8791 or Shahid Mahmud at 703-603-8789.
- For additional information about the Buffalo Mountain wind farm, contact Rick Carson, TVA's Renewable Energy Program Manager, at 423-751-7461.
- For additional information about the Somerset wind farm, contact Jim Webb, Project Administrator at the Florida Power & Light Company, at (304) 463-3339.

The EPA Superfund Redevelopment Initiative website, at www.epa.gov/superfund/programs/recycle, also provides tools, case studies, and resource information addressing the reuse of Superfund sites, including AMLs.

Attachment A: Federal and State Resources

Program Name	Agency	Program Description	Contact Information
Renewable Energy Prod. Incentive	DOE and IRS	Financial payments for public and non-profit sector renewable energy producers	www.eren.doe.gov www.nrel.gov
Wind Biomass Renewable Electricity Production Credit	IRS	Tax incentives for private sector renewable energy producers	www.irs.gov
Solar, Wind, and Geothermal Modified Accelerated Cost Recovery System	IRS	Corporate depreciation tax deduction for investments in renewable energy technologies	www.irs.gov
Competitive Financial Assistance	DOE, Office of Energy Efficiency Renewable Energy	Grant funding for public outreach, training, and technical assistance related to energy efficiency and renewable energy	www.eren.doe.gov e-center.doe.gov
National Industrial Competitiveness through Energy, Environment, and Economics (NICE^3)	DOE, Golden Field Office	Grant funding for state and industry partnerships that emphasize energy efficiency and clean production technologies	www.golden.doe.gov
Native American Anemometer Loan Program	DOE, National Renewable Energy Laboratory	Provision of anemometers and installation equipment for measurement of wind resources on tribal lands	www.eren.doe.gov/windpoweringamerica/na_anemometer_loan.html
Green Power Partnership	EPA	Technical assistance for institutions that use renewable energy resources	www.epa.gov/greenpower/join/join.htm
Database of State Incentives for Renewable Energy	State programs	Tax credits, loans, and grants for renewable energy resources	www.dsireusa.org
Inventory of State Incentives for Wind Energy in the U.S.	State programs	Wind resource information and wind energy-related financial, economic, and regulatory incentives	www.awea.org/pubs/inventory.html

Program Name	Agency	Program Description	Contact Information
Illinois Renewable Energy Resources Program	Illinois Department of Commerce and Community Affairs	Grant funding for projects focused on the use of renewable energy resources in Illinois	www.commerce.state.il.us/com/pdf/RENEWABLE%20ENERGY%20RESOURCES%20Grant.pdf

Additional Wind Energy Resources

The American Wind Energy Association (AWEA) is a national trade association that promotes wind power as a renewable energy resource.	www.awea.org
The National Renewable Energy Laboratory (NREL) is DOE's premier laboratory for renewable energy research and development.	www.nrel.gov
The National Wind Technology Center is the subgroup of NREL that focuses on wind energy.	www.nrel.gov/wind
The National Wind Coordinating Committee (NWCC) supports the development of sustainable commercial markets for wind power.	www.nationalwind.org
The Golden Field Office manages many of DOE's renewable energy programs.	www.golden.doe.gov
AWEA policy document that describes wind energy development efforts around the world.	www.awea.org/policy/incentives.html

Attachment B: Contact Information for Wind Energy Companies and Consultants

The list below provides contact information for wind energy developers and consultants that are members of the American Wind Energy Association (AWEA). For a comprehensive listing of wind energy developers, operators, consultants, and turbine manufacturers, please refer to AWEA's online directory at www.awea.org/directory.

- ABB Power: www.abb.com
- AEP Energy Services, Inc.: www.aep.com
- Atlantic Renewable Energy Corp.: www.atlantic-renewable.com
- Black & Veatch Corp.: www2.bv.com/energy/index.htm
- CalWind Resources, Inc.: www.calwind.com
- Catamount Energy Corp.: www.catenergy.com
- CHI Energy, Inc.: www.chienergy.com
- Cielo Wind Power LLC: www.cielowind.com
- Clipper Windpower LLC: www.clipperwind.com
- Distributed Generation Systems, Inc.: www.disgenonline.com
- DP Energy Ltd.: www.dpenergy.com
- EAPC Architects & Engineers: www.eapc.net
- Endless Energy Corp.: www.endlessenergy.com
- Energy Unlimited, Inc.: www.eui-windfarm.com
- enXco: www.enXco.com
- Eurus Energy America Corp.: www.eurusenergy.com
- FPL Energy, Inc.: www.fplenergy.com
- Foresight Energy Company: www.foresightenergy.com
- GE Wind Energy: www.gewindenergy.com
- Generation Resources Holding Co.: www.grhc.biz
- Global EnerCom Management: www.gemengr.com
- Global Winds Harvest, Inc.: www.globalwinds.com
- Green Mountain Energy Company: www.greenmountain.com
- Greenlight Energy, Inc.: www.glnrg.com
- Guascor North America: www.guascor.com
- International Applied Engineering: www.iaeinc.com
- LG&E Power, Inc.: www.lgeenergy.com
- M.A. Mortenson: www.mortenson.com
- Midwest Renewable Energy Corp.: www.midwest-renewable.com
- National Wind Power, Ltd.: www.natwindpower.com
- NedPower US LLC: www.nedpower.com
- Northern Alternative Energy, Inc.: www.windpower.com
- North American Renewables Corp.: www.narenewables.com
- Oak Creek Energy Systems, Inc.: www.oakcreekenergy.com
- Orion Energy, LLC: www.orion-energy.com
- PB Power, Inc.: www.pbworld.com/power
- Pacific Winds, Inc.: www.powerworksinc.com
- Renewable Energy Systems (USA), Inc.: www.res-ltd.com
- SeaWest WindPower, Inc.: www.seawestwindpower.com
- Specialized Power Systems, Inc.: www.spswind.net
- Superior Renewable Energy: www.superiorrenewable.com
- Tenderland Power Company: www.tenderland.com
- Tennessee Valley Infrastructure Group: www.tvigroup.com
- United American Energy Corp.: www.uaecorp.com
- US Wind Force, LLC: uswindforce.com
- Wintec Energy, Ltd.: www.wintecenergy.com
- Zilkha Renewable Energy: www.zilkha.com

Attachment C: Acknowledgments

Information for this report was gathered from various reports, papers and online sources, categorized below:

General Wind Energy Information

- the U.S. Department of Energy's Wind Energy Program website, at www.eren.doe.gov/wind/homeowner.html.
- the 1995 book *Wind Energy Comes of Age* by Paul Gipe.
- the 1995 book *Renewables Are Ready* by Nancy Cole and P.J. Skerret.
- the Appalachian Mountain Club's 1996 *General Policy on Windpower*, at www.nationalwind.org.
- the U.S. Department of Energy's 2000 fact sheet *Wind Powering America: Clean Energy for the 21st Century.*
- the March 2000 *Smithsonian* article "A Second Wind."
- the August 2002 *Time* article "The Winds of Change."
- the August 16, 2002 *USA Today* article "Wind Energy Generates Income."
- the August 20, 2002 *Washington Post* article "Windmills on the Water Create Storm on Cape Cod."
- the American Wind Energy Association's website, at www.awea.org.
- the National Wind Coordinating Committee's wind energy fact sheets, at www.nationalwind.org.

AML-Related Information and the Buffalo Mountain and Somerset Wind Farms

- the December 4, 2001 *Elizabethton Star* article "Windmills on the Mountain? TVA Project Could Boost Tourism," at www.starhq.com/html/localnews/1201/120401Windmills.html.
- the December 28, 2001 *Charleston Gazette* article "Grant Wind Farm will be Largest in East."
- the Oak Ridge Nuclear Laboratory's website, at www.ornl.gov.
- the Tennessee Valley Authority's Green Power Switch and Public Power Institute programs websites, at www.tva.gov/greenpowerswitch/index.htm.
- the Powering the South organization's website, at www.poweringthesouth.org.
- the Community Energy, Inc.'s New Wind Energy program website, at www.newwindenergy.com.
- the August 2002 *Progressive Engineer* article "A New Crop Takes Root," at www.progressiveengineer.com/frm_back.htm.
- October 2002 and January 2003 interviews with Gary Verkleeren, Zilkha Renewable Energy.
- October 2002 interview with Robert Will, Somerset wind farm landowner.
- the Pennsylvania Department of Environmental Protection website, at www.dep.state.pa.us.

- the Fall 1995 *Land and Progress* article "Wind Energy Creates Jobs, Power in East Kern."
- the 1997 European Wind Energy Association report *Wind Energy in Europe - The Facts*, at www.ewea.org/doc/ewea.pdf.
- the U.S. Department of Energy's 2000 fact sheet *Wind Powering America: Clean Energy for the 21st Century.*
- the August 2001 National Wind Coordinating Committee report *Avian Collisions with Wind Turbines: A Summary of Existing Studies and Comparisons to Other Sources of Avian Collision Mortality in the United States*, at www.nationalwind.org.
- the October 2001 *AgJournal* article "Wind Energy Investment Benefits Landowners," at www.agjournal.com.
- the October 2001 *Penn Almanac* article "Wind Energy to Power Penn," at www.upenn.edu/almanac/v48/n10/WindPower.html.
- the November 2001 Renewable Energy Policy Project report *The Work That Goes Into Renewable Energy*, at www.repp.org/repp.
- the December 2002 *Grist* article "Tilting at Windmills: Activists Are Split on Proposed Project Off Cape Cod," at www.gristmagazine.com.
- February 2, 2002 *Patriot News* article, at www.pennlive.com/patriotnews.
- the American Wind Energy Association's website, at www.awea.org.
- the U.S. Department of Energy's Wind Energy Program website, at www.eren.doe.gov/wind/homeowner.html.
- the Pennsylvania Department of Environmental Protection's *Wind Farming* fact sheet, at www.dep.state.pa.us.
- the Office of Surface Mining, Reclamation, and Enforcement website, at www.doi.gov/pfin/ar4osm.html.

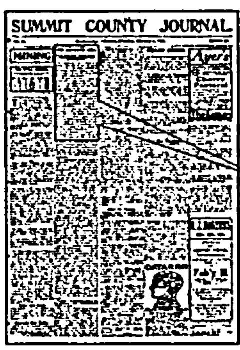
Wind Energy Development on Reclaimed Mining Sites

Craig Cox

Interwest Energy Alliance

NMA/NRC Uranium Recovery Workshop
Denver, Colorado
25 May 2005

Mine redevelopment is not a *new* idea...



THE ABANDONED MINE

One of Colorado's Richest Assets — Some Old Properties that Have Been Reworked.

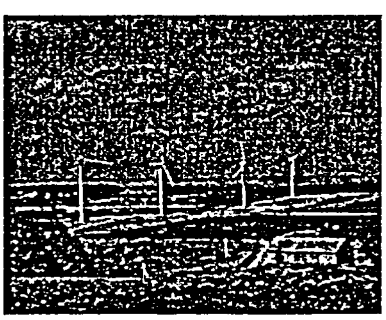
The abandoned mine! What more speaking illustration of ruin can be conceived? The dismantled shaft-house, with broken windows, sagging roof and flapping sheets of iron, the caving shaft and mouldy, rotten timbers!

Yet the abandoned mine is today one of Colorado's richest assets, and is attracting more attention than even the bonanza new strikes, says the Idaho Springs Mining Gazette.

The abandoned mines are the positive incentive for the huge development projects that are now being carried forward, in all parts of the state, particularly where the ore deposits are in fissure veins. The tunnels have the additional

Summit County Journal, Breckenridge, Colo., 4 February [illegible]

...but an *excellent* idea for today.



Somerset Windfarm, Pennsylvania

Advantages of mine redevelopment with wind energy

- Good transmission often in place
- Reduced environmental sensitivity
- Mines often located near good wind resources
- Strip and deep mines both good for wind redevelopment

Buffalo Mountain windfarm, Tennessee

Challenges in redeveloping mine sites with wind

- Biggest obstacle: foundation system
  - Wind turbine foundations are designed to handle enormous foundation loads
    - Wind turbine foundation systems are not capable of tolerating differential settlements induced from mine subsidence
    - Need to work on conditioning of soil and improving foundations
    - Sites often require a ground improvement technique such as deep dynamic compaction (DDC)
- Estimated added cost: 10% of foundation costs

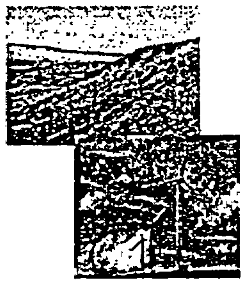
Other matters relating to mine redevelopment

Somerset windfarm, Pennsylvania

- Mines located at depths of 200 or more feet are generally considered deep mines.
- Wind turbine foundations have little or no impact over mines greater than 200' below the surface

Other matters relating to mine redevelopment, con't.

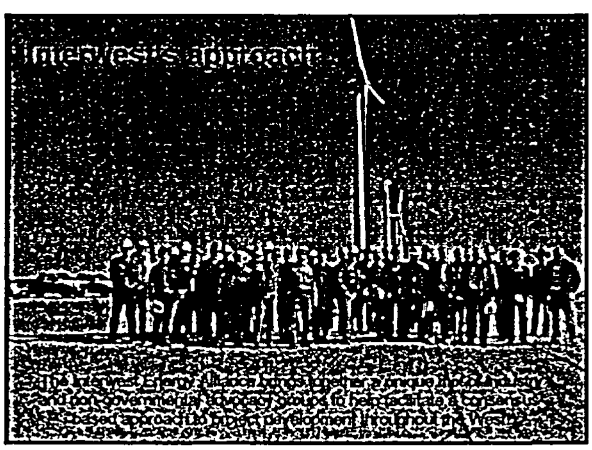
- Biggest concern with wind turbines over mines (surface or deep) is due to the potential influence of the mine (i.e. subsidence) on the wind turbine
- Records kept by mining companies of subsurface activities often prove to be valuable development tools



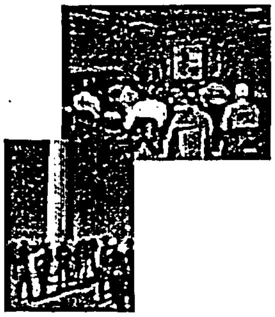
Kilronan windfarm, Ireland

Who is the Interwest Energy Alliance?

- American Wind Energy Association
- Coalition for Clean, Affordable Energy
- Colorado Farm Bureau
- Environment Colorado
- enXco
- Foresight Energy
- FPL Energy
- GE Wind Energy
- Grand Canyon Trust
- PPM Energy
- SeaWest Windpower
- Stoel Rives LLP
- Utah Clean Energy
- Vestas-American Wind Technology
- Western Resource Advocates

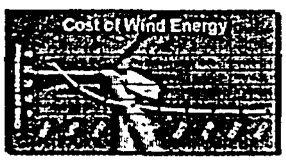


Good communications



- Involve local communities, stakeholder groups, advocacy organizations, utilities, governmental bodies and other players
  - Identify champions
- Try to resolve issues of concern before they make headlines
- Learn from success of other redevelopment projects

Wind energy is cost-competitive and market-ready



- In a 2001 decision, the Colorado Public Utilities Commission declared that the 162MW Lamar windpower facility will "likely lower the cost of electricity for Colorado's ratepayers."
  - Ancillary services deemed not to be a major cost; wind received fair capacity value; new wind energy predicted to cost less than natural gas when gas is above >$3.50 MMBTu

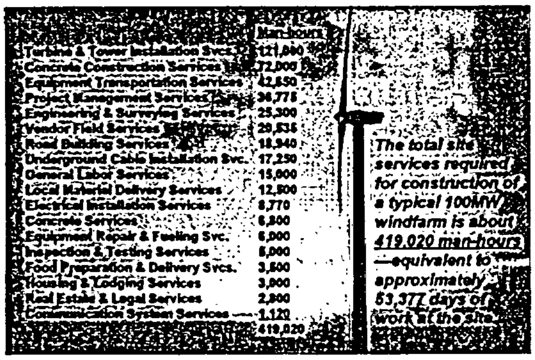
From NREL/CP-500-30551, "Colorado Public Utility Commission's Xcel Wind Decision

Xcel Energy Says Wind Energy Will <u>Save</u> Consumers $4.6 Million

- The new wind farm that Xcel Energy is building near Lamar will <u>save consumers $4.6 million</u> in their power bills.

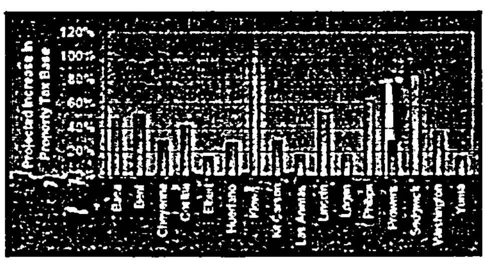
–From Xcel Energy testimony by Ronald Darnell to FERC, 16 June 2003

Site Services for a Typical 100MW Windfarm

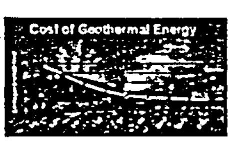


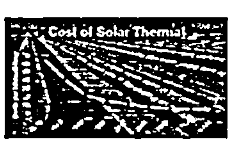
	Man-hours
Turbine & Tower Installation Svcs.	121,000
Concrete Construction Services	72,000
Equipment Transportation Services	42,850
Project Management Services	36,775
Engineering & Surveying Services	25,300
Vendor Field Services	20,535
Road Building Services	18,940
Underground Cable Installation Svc.	17,250
General Labor Services	15,000
Local Material Delivery Services	12,800
Electrical Installation Services	8,770
Concrete Services	6,800
Equipment Repair & Fueling Svc.	6,000
Inspection & Testing Services	5,000
Food Preparation & Delivery Svcs.	3,600
Housing & Lodging Services	3,000
Real Estate & Legal Services	2,800
Communication System Services	1,120
	419,020

Projected Tax-base Increases of a 162MW Windfarm in Some Colorado Counties



Other renewable technologies also experiencing plunges in cost






Thank you!

THE 2005 NATIONAL MINING ASSOCIATION (NMA)
NUCLEAR REGULATORY COMMISSION (NRC)
URANIUM RECOVERY WORKSHOP

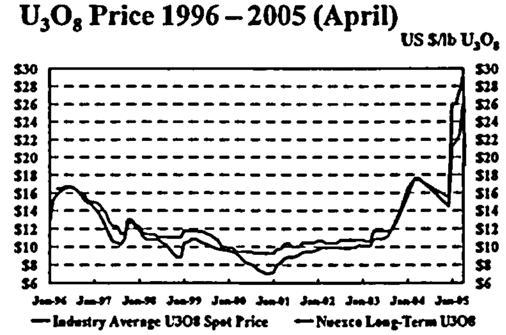
May 24-25, 2005
Executive Tower Hotel, Denver, Colorado

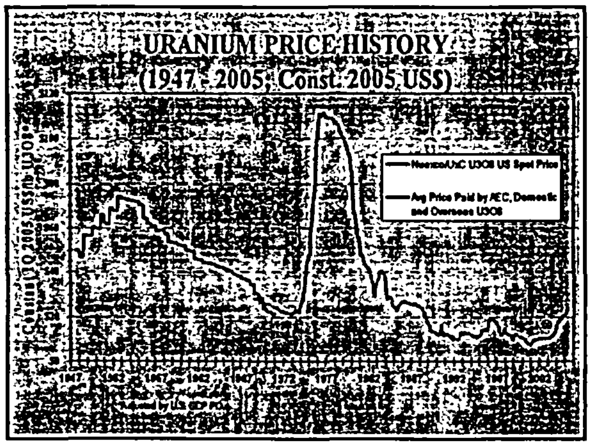
POWER RESOURCES

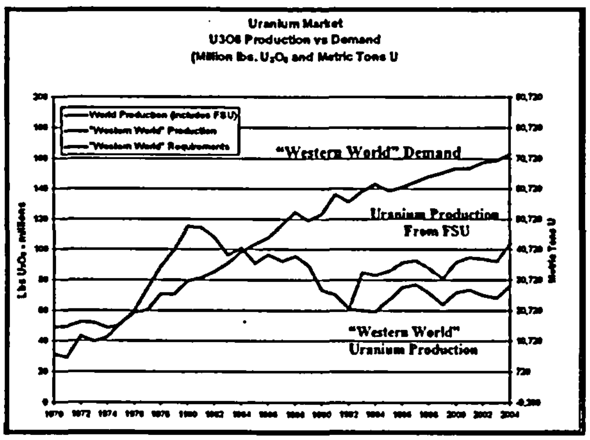
Uranium Market Update

Fletcher T. Newton
Chief Executive Officer
Power Resources, Inc.

U_3O_8 Price 1996 – 2005 (April)







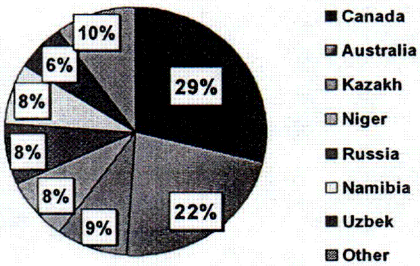
WORLD URANIUM REQUIREMENTS
&
WORLD URANIUM PRODUCTION
(POUNDS U_3O_8 equivalent)

Year	WESTERN WORLD DEMAND	WESTERN WORLD PRODUCTION	FORMER SOVIET UNION (FSU) PRODUCTION	DIFFERENCE
1970 - 1984	720.5	1,159.7	0.0	439.2
1985 - 2004	2,624.1	1,501.6	183.5	-938.9
TOTALS	3,344.6	2,661.3	183.5	-499.8

Uranium Market

104 million lbs U_3O_8

2004 World Uranium Production Estimate



U_3O_8 Supply/Demand: 2005-2014

Million lbs U_3O_8

> 100 million lbs

Total US Electricity Net Generation (2004)

	2004 Total Utility Generation	*(bkWhrs)*	*(Percent %)*
	Coal	1976.3	50.0
	Petroleum	117.6	3.0
	Natural Gas	699.6	17.7
	Nuclear		788.6
19.9	Hydroelectric	261.5	6.6
	Renewables	109.8	2.8
	Total	***3,953.4***	***100.0***

2004 Total Generation 3,953.4 bkWhrs

Source: EIA
Last Updated: 3/05

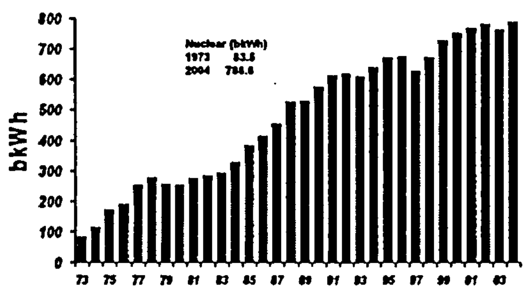
C10

US Electricity Generation Fuel Shares (1973 vs 2004[1])

Fuel Type	1973	2004
Nuclear	4.5%	19.9%
Coal	45.6%	50.0%
Oil	16.9%	3.0%
Gas	18.3%	17.7%
Hydro	14.6%	6.6%
Other	0.1%	2.8%

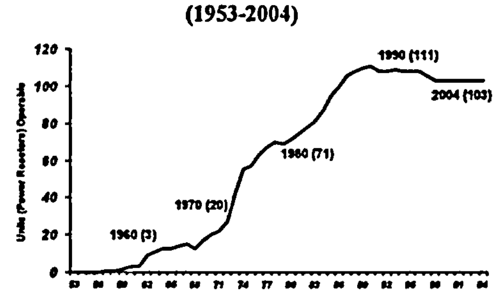
Source: EIA - Updated 3/05

US Nuclear Industry Net Electricity Generation (1973-2004)



Source: EIA - Updated: 3/05

Operable US Nuclear Power Plants (Units) (1953-2004)

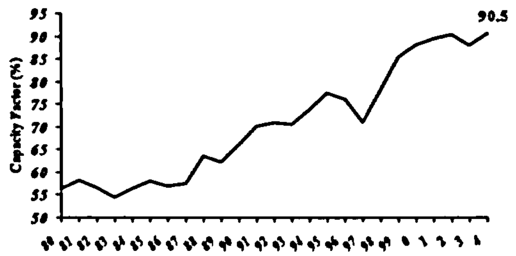


U.S. Capacity Factors by Fuel Type

Fuel Type	Average Capacity Factors (2004)
Nuclear	90.5%
Coal	70.8%
Gas (Combined Cycle)	38.2%
Gas (Steam Turbine)	16.6%
Oil (Steam Turbine)	26.2%
Solar	22.4%
Hydro	29.6%
Wind	32.1%

Source: Energy Information Agency (EIA) 4/05

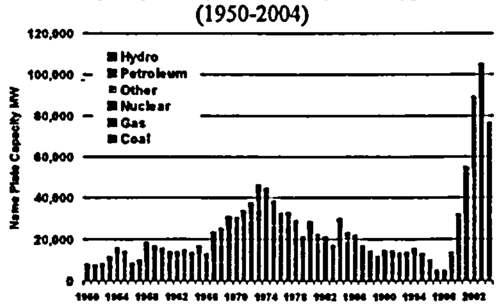
US Nuclear Industry Is Achieving Record Levels of Performance (1980-2004)



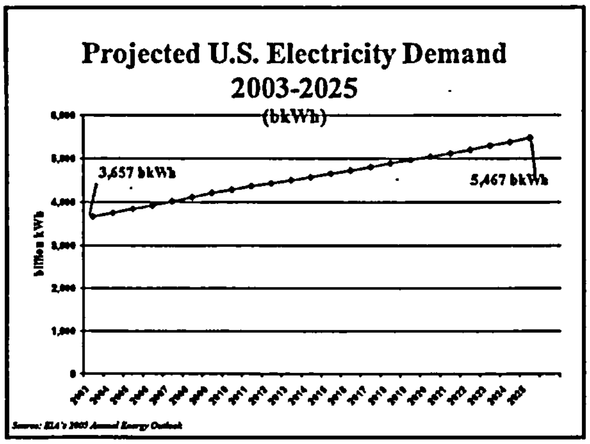
Source: EIA – Updated 4/05

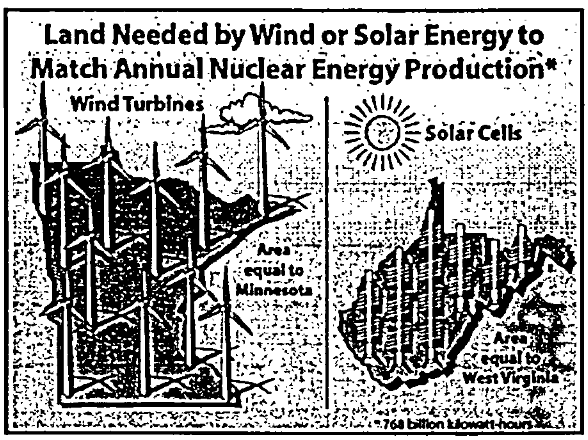
NEI

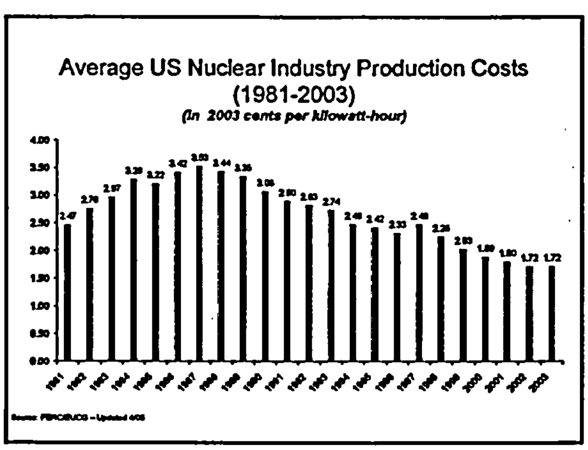
Capacity Brought on Line by Fuel Type (1950-2004)



Source: Energy Velocity Last updated 3/05.

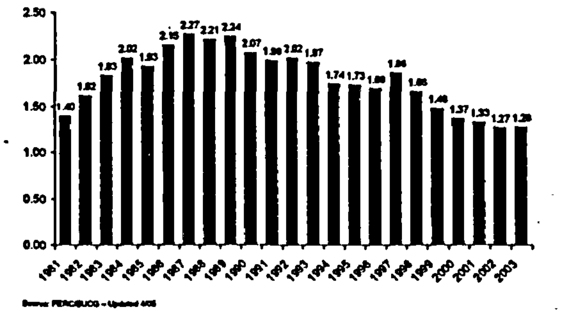

Projected U.S. Electricity Demand
2003-2025
(bkWh)
3,657 bkWh
5,467 bkWh
billion kWh


Land Needed by Wind or Solar Energy to Match Annual Nuclear Energy Production*
Wind Turbines
Solar Cells
Area equal to Minnesota
Area equal to West Virginia
*768 billion kilowatt-hours


Average US Nuclear Industry Production Costs
(1981-2003)
(in 2003 cents per kilowatt-hour)

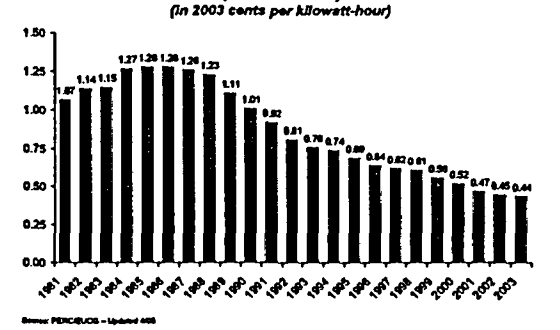
Average US Nuclear Industry Non-Fuel O&M Costs (1981-2003)

(In 2003 cents per kilowatt-hour)

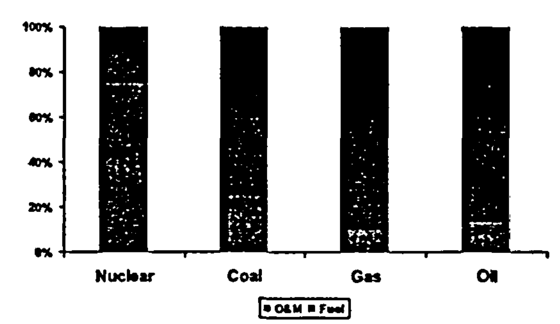


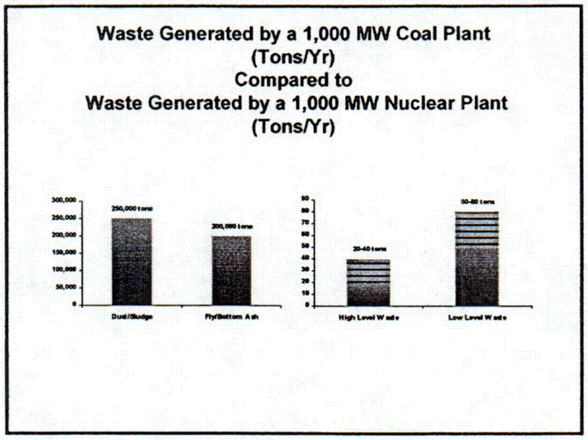
Average US Nuclear Industry Fuel Costs (1981-2003)

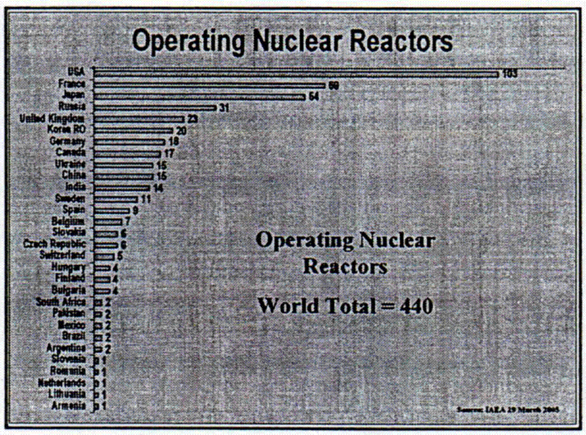
(In 2003 cents per kilowatt-hour)

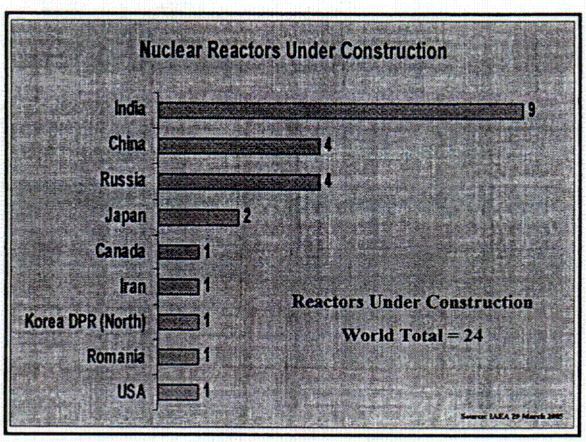


Fuel as a Percentage of Electric Power Industry Production Costs (2003)

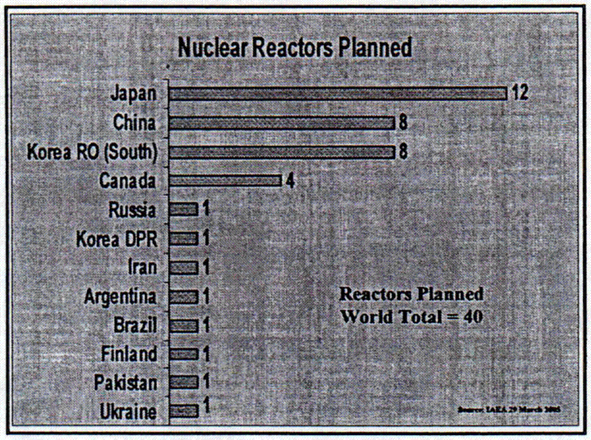



Waste Generated by a 1,000 MW Coal Plant
(Tons/Yr)
Compared to
Waste Generated by a 1,000 MW Nuclear Plant
(Tons/Yr)
300,000
250,000
200,000
150,000
100,000
50,000
0
250,000 tons
200,000 tons
Dust/Sludge
Fly/Bottom Ash
90
80
70
60
50
40
30
20
10
0
20-40 tons
50-80 tons
High Level Waste
Low Level Waste


Operating Nuclear Reactors
USA 103
France 59
Japan 54
Russia 31
United Kingdom 23
Korea RO 20
Germany 18
Canada 17
Ukraine 15
China 15
India 14
Sweden 11
Spain 9
Belgium 7
Slovakia 6
Czech Republic 6
Switzerland 5
Hungary 4
Finland 4
Bulgaria 4
South Africa 2
Pakistan 2
Mexico 2
Brazil 2
Argentina 2
Slovenia 1
Romania 1
Netherlands 1
Lithuania 1
Armenia 1
Operating Nuclear Reactors
World Total = 440
Source: IAEA 29 March 2005


Nuclear Reactors Under Construction
India 9
China 4
Russia 4
Japan 2
Canada 1
Iran 1
Korea DPR (North) 1
Romania 1
USA 1
Reactors Under Construction
World Total = 24
Source: IAEA 29 March 2005

C11



POWER RESOURCES

Credits & Sources:

Nuclear Energy Institute (NEI)
U.S. Department of Energy (DOE)
Energy Information Administration (EIA)
World Nuclear Association (WNA)
The Ux Consulting Company, LLC (UxC)
International Atomic Energy Agency (IAEA)

A member of the Cameco group of companies

C12

Uranium Mining TENORM Report and More

Loren Setlow

U.S. EPA

Office of Radiation and Indoor Air (6608J)

Washington, DC 20460

2005 NMA/NRC Uranium Recovery Workshop

Uranium Mining TENORM Report

- Report is follow-up and update to previous EPA reports on uranium mining, and uranium mining wastes but focusing on TENORM wastes and risks
- EPA meetings with its Science Advisory Board in 2001 affirmed general content of new report, SAB recommended coverage of all industry sector activities regardless of agency authorities

Previous EPA Reports

- **1983 (ORIA) – Report to Congress on the Potential Health and Environmental Hazards of Uranium Mine Wastes**
- **1985 (OSW) – Report to Congress on Wastes from the Extraction and Beneficiation of Metallic Ores, Phosphate Rock, Asbestos, Overburden from Uranium Mining, and Oil Shale**
- **1993/1994 (ORIA) – Draft Diffuse NORM Risk Assessment and Waste Characterization. SAB review**
- **1995 (OSW)–Extraction and Beneficiation of Ores and Minerals: Uranium**

Volume I

- Provides overview of U.S. uranium mining history, mining methods, wastes generated including physical and chemical characteristics, waste volumes, reclamation methods
- Peer and outside reviews of draft report, fall 2004
- Final release planned soon – Volume I
  - Will include statutory and regulatory responsibility appendix-clarifications on agency oversights
  - Plus other revisions based on comments received

EPA United States Environmental Protection Agency

Volume I

- **Overburden radium-226 ranges:**
  - **58 samples from 17 mines,**
  - **69% > 5 pCi/g and**
  - **50% > 20 pCi/g (EPA 1985)**
- **Values >20 pCi/g unusual, protore 30–600 pCi/g (Otton-USGS 1998)**
- **White King 53 pCi/g in near surface overburden while Lucky Lass sample had only 2 pCi/g (Weston 1997)**

EPA United States Environmental Protection Agency

Volume I

- **Estimated overburden produced by surface and underground mining ~4000 producers (Otton – USGS 1998 for EPA)**
- **These estimates may be low considering the numbers of sites identified by the EPA GIS effort**
- **Surface mining produced 45 times more overburden than underground mines**

Mining Method	Estimated Overburden Produced (MT)		
	Low Estimate	High Estimate	Average
Surface Mining	1,000,000,000	8,000,000,000	3,000,000,000
Underground Mining	5,000,000	100,000,000	67,000,000

EPA United States Environmental Protection Agency

Volume I

- DOE 2000 study of costs of remediating 21 uranium mines
  - Reclamation costs ranged from $0.24/MT of ore produced and $2,337/hectare of disturbance, to $33.33/MT of ore and $269,531/hectare of disturbance
  - Average total estimated reclamation cost was $13.9 million per mine – Differences based on mine size, accounting methods

Volume I

- DOE 21 mine sites studied:
  - 96.9 million MT ore, 114,803 MT of uranium
  - Lowest cost of closure, $/lb uranium yellowcake: $0.18
  - Highest cost of closure, $/lb uranium yellowcake: $23.74
  - Cost data developed for 2002 IAEA/NEA report

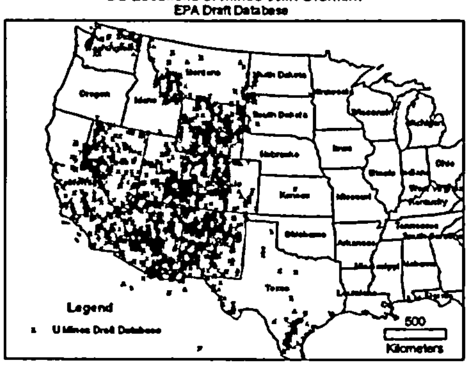
Volume II

- Results and analyses derived from EPA's uranium mining geographic information system (GIS) database
- Generalized risk assessments (cancer risk) from exposures to TENORM wastes from abandoned uranium mines
- Review of cancer risks associated with other aspects of uranium mines as reported in previous EPA and other studies

Volume II

- Regional GIS co-operation project, covers 14 western states; approximately 15,000 mines with uranium records in combined data bases
- Provides spatial co-location information for use in evaluating most likely stakeholder populations and exposure situations to uranium mining TENORM
- EPA field studies, GIS analyses, EPA SAB recommendations determined most likely exposure situations for modeling general exposure risk

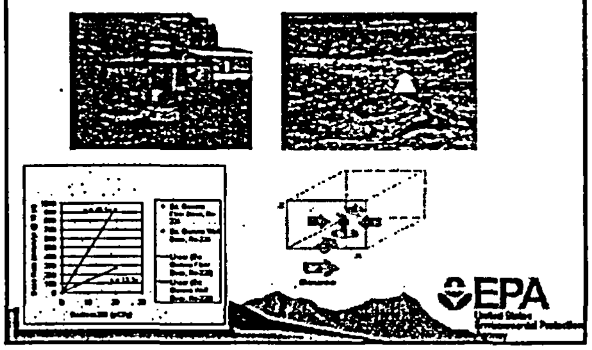
US Locations of Mines With Uranium
EPA Draft Database



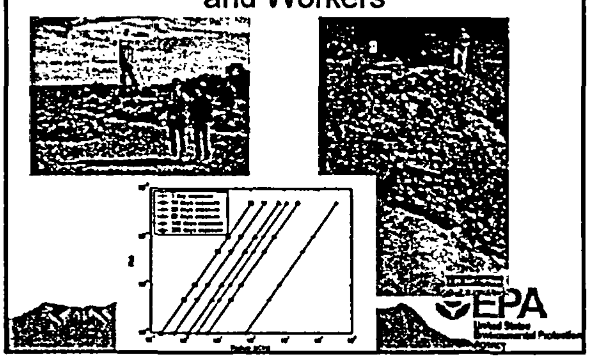
Risk Modeling -- Approaches

- Per EPA SAB recommendations, variety of computer models examined. Used for analyses:
  - Soil Screening Guidance for Radionuclides (U.S. EPA 2000)
  - RESRAD BUILD
- Most likely exposure situations:
  - Individuals building with, on, or adjacent to uranium mine waste, recreation situations, worker exposures
  - Exposures on Federal and Tribal lands

Modeling Scenarios – Building Materials

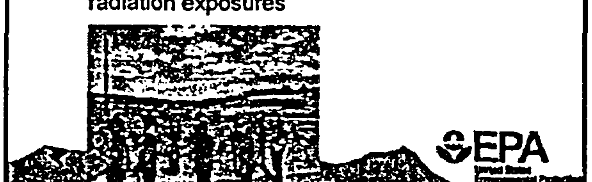


Modeling Scenarios – Recreational and Workers



Stakeholder Involvement

- A part of EPA's TENORM program strategy
  - Will be designed to determine interest and need for EPA technical, education, other assistance
  - Intended to find ways to partner to reduce radiation exposures



And More – Assistance to Tribes

- Assistance to EPA Regions 9 and 10 in uranium issues on Tribal lands
- Navajo contaminated homes grant
  - Identify locations of homes potentially constructed with uranium mine waste rock
  - Development of radiation protection standards
  - Development of survey methods and action levels

EPA United States Environmental Protection Agency

And More -- Radionuclide MCLs

- **Final Drinking Water Rule Promulgated in late 2000**
  - **Retained the maximum contaminant levels (MCLs) for combined Radium-226/228, gross alpha particle activity, and beta particle and photon radioactivity in drinking water**
  - **Set a new MCL for uranium**
  - **Established separate monitoring requirements for Radium-228; and**
  - **Required systems to monitor at each entry point to the distribution system.**
- **Compliance Activities Required Starting in 2003**
  - **By December 31, 2007, all drinking water systems must complete initial monitoring**

EPA United States Environmental Protection Agency

And More -- Radionuclide MCLs

- Standards

Radionuclide	Level
Combined radium-226 and 228	5 pCi/L
Gross alpha particle activity (excluding radon and uranium	15 pCi/L
Beta particle and photon radioactivity	4 mrem/year
Uranium	30 ug/L

EPA United States Environmental Protection Agency

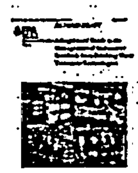
And More -- Radionuclide MCLs

- Draft EPA Regulator's Guide
- Estimation Tool (SPARRC)
  - Spreadsheet Program to Ascertain Radionuclides Residuals Concentration
- Technical and Regulatory Assistance
  - Waste Disposal
  - Worker Exposure and Safety Issues

EPA

And More -- Radionuclide MCLs

- **Draft EPA Regulator's Guide provides information on:**
  - **Treatment technologies**
  - **Applicable statutes and regulations**
  - **Radiation fundamentals**
  - **Waste disposal options**
  - **Worker exposure and safety**
  - **State and regional contacts**



EPA

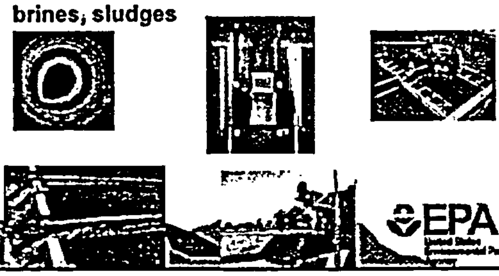
And More -- Radionuclide MCLs

- Treatment technologies discussed:
  - **Ion Exchange and Point of Use Ion Exchange**
  - **Reverse Osmosis and Point of Use Reverse Osmosis**
  - **Lime Softening**
  - **Green Sand Filtering**
  - **Co-precipitation with Barium Sulfate**
  - **Electrodialysis/ Electrodialysis Reversal**
  - **Pre-formed Hydrous Manganese Oxide Filtration**
  - **Activated Alumina**
  - **Coagulation/ Filtration**

EPA

And More -- Radionuclide MCLs

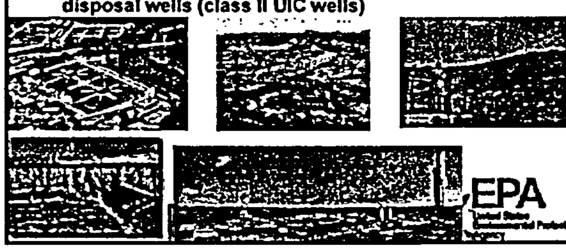
- Treatment Residuals -- **Solids and liquid wastes : pipe scale, filters, residuals, backwash, brines, sludges**



EPA

And More -- Radionuclide MCLs

- **Disposal Options -- Sanitary sewer, lagoons, industrial or hazardous waste landfills, radioactive waste disposal sites, enhanced recovery or deep disposal wells (class II UIC wells)**



EPA

And More -- Radionuclide MCLs

- **ANPR for low-activity radioactive waste disposal:**
  - **Potentially includes a large universe of low activity waste including naturally occurring radionuclides**
  - **Focus on disposal in RCRA hazardous waste landfills**
  - **Analysis could provide insight towards management decisions for water treatment residuals**

EPA

Summary

- EPA is completing technical reports on uranium mining TENORM in preparation for determining its next assistance steps with stakeholders
- EPA is developing waste management guidance for states and public water systems on implementation of the recent radionuclide MCL rule

EPA United States Environmental Protection Agency

Spatial Analysis and Decision Assistance (SADA) Version 4

Presented by
George E. Powers
Office of Nuclear Regulatory Research
Nuclear Regulatory Commission

Environmental Assessment Methods in SADA
Denver, CO
May 25, 2005

SADA™
Spatial Analysis and Decision Assistance

SADA General Information

Windows--based freeware designed to integrate scientific models with decision and cost analysis frameworks in a seamless, easy to use environment.

- Visualization/GIS
- Statistical Analysis
- Geospatial Interpolation
- Geospatial Uncertainty Analysis
- Human Health Risk Assessment
- Ecological Risk Assessment
- Custom Analysis
- MARSSIM Module
- Area of Concern Frameworks
- Cost Benefit Analysis
- Sampling Designs
- Export to Arcview/Earthvision

SADA has been supported by both the DOE, EPA, and the NRC. SADA Version 3.0 had about 11000 downloads. Version 4.0 has had 800+ since December, 2004.

SADA™
Spatial Analysis and Decision Assistance

SADA General Information (cont.)

Free stand-alone package for Windows 98, 98SE, NT SP4 or higher, 2000, ME, and XP.

Contact information, updates, documentation, and downloads are available on-line at http://www.tiem.utk.edu/~sada/

A SADA user's group, email, annual conferences, and on-site training.

A substantial help file is included.

Conduct "black and white box" testing internally as well as an external beta release period.

Publish verification document on the website.

SADA™

Spatial Analysis and Decision Assistance

Data Formats

- SADA can accept data in two formats: comma delimited files (csv) and Microsoft Access.
- SADA requires the presence of certain fields in the data set.
  - Easting
  - Northing
  - Depth
  - Value
  - Name
- SADA can use other forms of information as well
  - Media
  - Detection
  - Date
  - CAS Number
- Any other form of meta data can be imported as well. User can plot and retrieve this meta data during an analysis.
- SADA recognizes soil, sediment, surfacewater, groundwater, air, biota, and background, and the "basic" media type. Basic is assigned to data that have no media type.

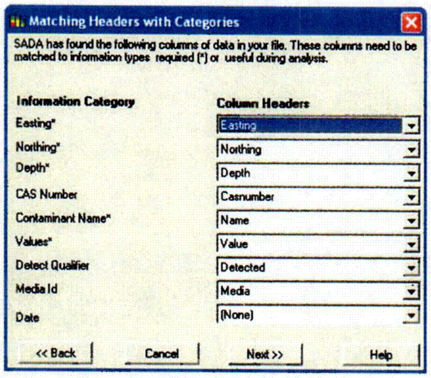
SADA™

Spatial Analysis and Decision Assistance

Importing Data Into SADA

The next step is to match the columns of information in the ascii data file to information categories that are required or may be useful in SADA.

Required information categories are followed by an (*) and must be assigned to a column in the ascii data file. A category is not assigned if the (none) option is selected in the drop down box. The Depth category is required only when data exist at varying depths. If the Detect Qualifier is not assigned, the data are assumed to be all detects.



If Media ID, which denotes the type of media the contaminants are sampled in (e.g. soil or groundwater) is not assigned, SADA adds an artificial media column titled 'Basic' and the human health risk and/or ecological risk modules cannot be setup later.

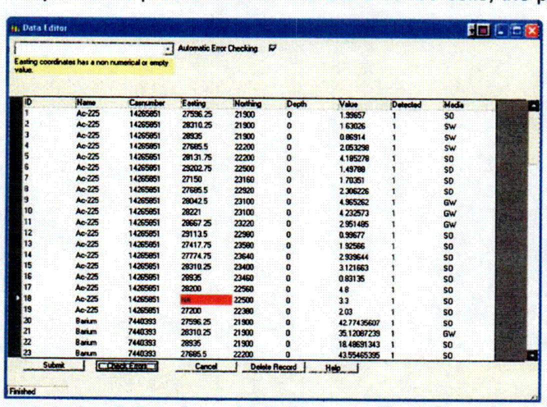
After the columns have been set, press **Next>>**. SADA begins the conversion process and presents the data as it will be imported into the Data Editor.

SADA™
Spatial Analysis and Decision Assistance

Data Editor

The Data Editor provides a chance to identify errors in the data set and correct them during the import process. It may also be accessed from the **Tools Menu** at any time later for data corrections or additions.

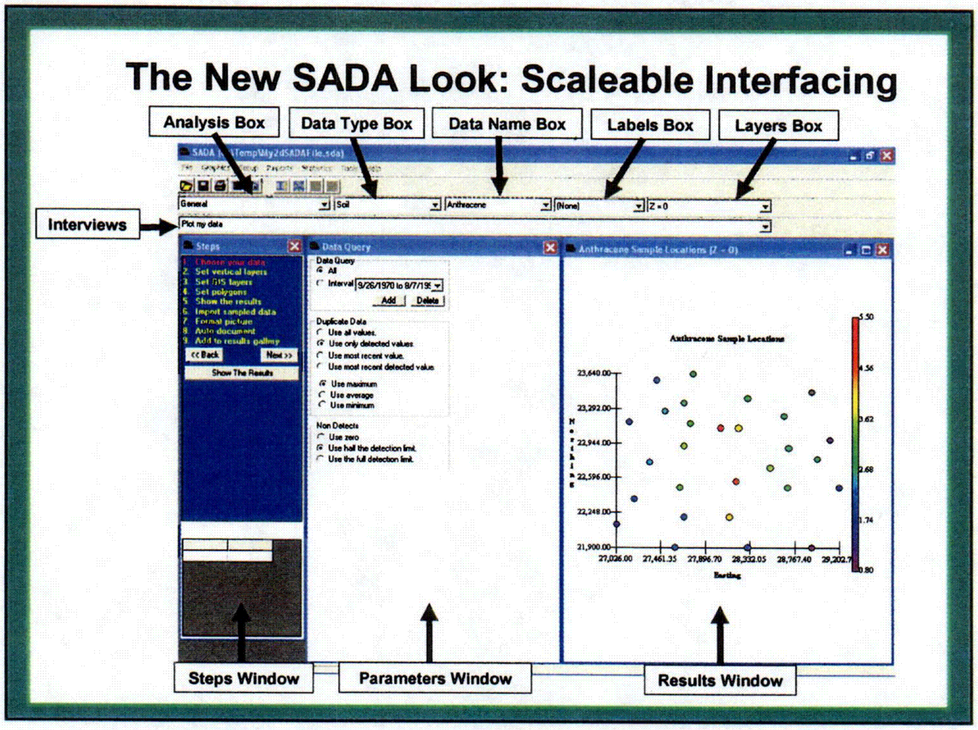
SADA highlights cells with red if they contain an unacceptable value. To determine the exact error, place the mouse over the red cell and the yellow text box near the top explains the problem. Once there are no red cells, the process continues.

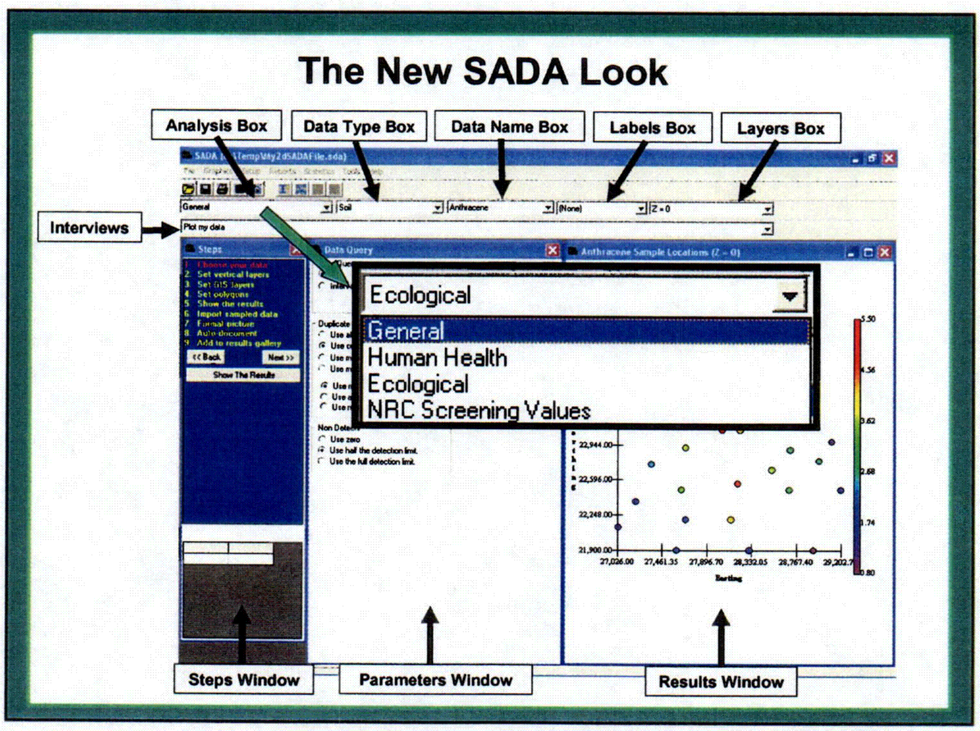


It is recommended that the **Automatic Error Checking** box remain checked so SADA looks for mistakes as you type. When the user is entering or pasting large amounts of data and does not wish the process to be slowed, however, it may be preferable to uncheck the **Automatic Error Checking** box and check errors later with the **Check Errors** button.

SADA™
Spatial Analysis and Decision Assistance

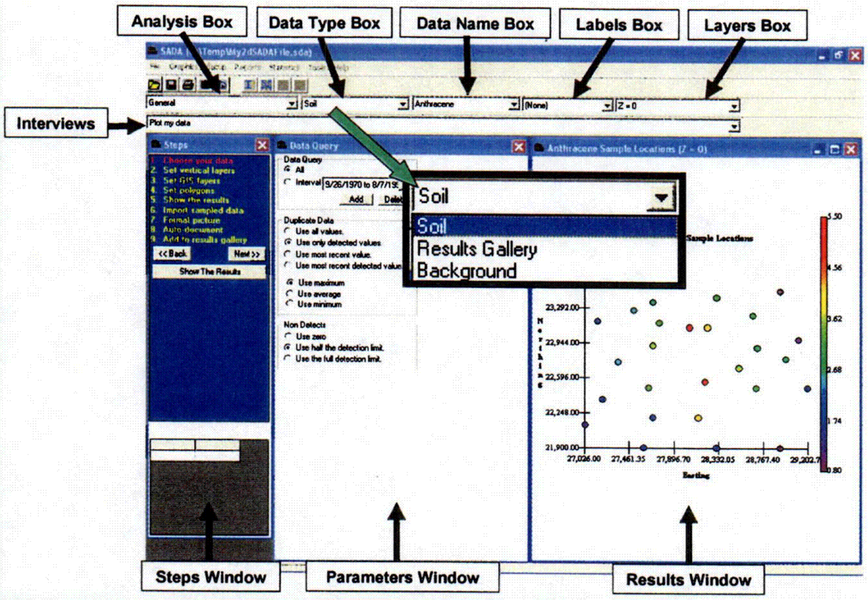
C13


The New SADA Look: Scaleable Interfacing
Analysis Box
Data Type Box
Data Name Box
Labels Box
Layers Box
Interviews
Steps Window
Parameters Window
Results Window

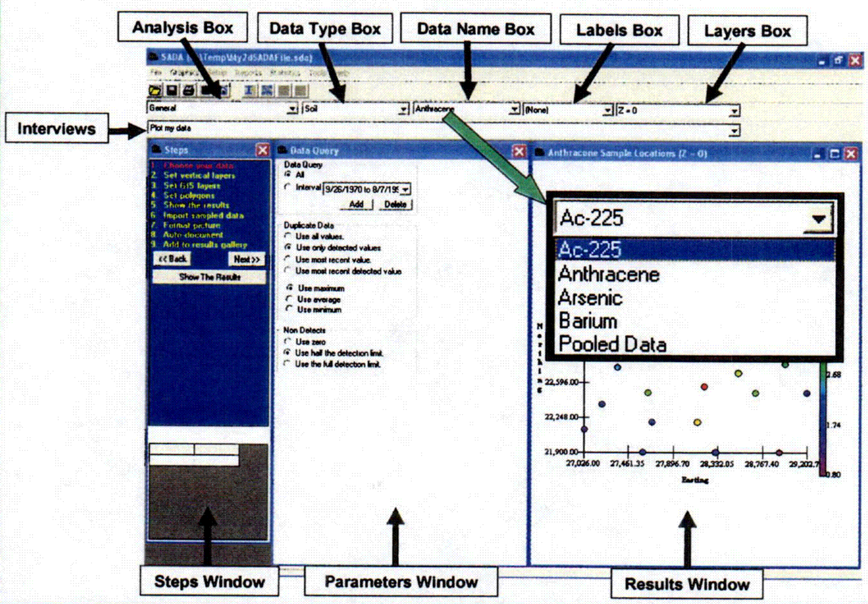

The New SADA Look
Analysis Box
Data Type Box
Data Name Box
Labels Box
Layers Box
Interviews
Ecological
General
Human Health
Ecological
NRC Screening Values
Steps Window
Parameters Window
Results Window

C14

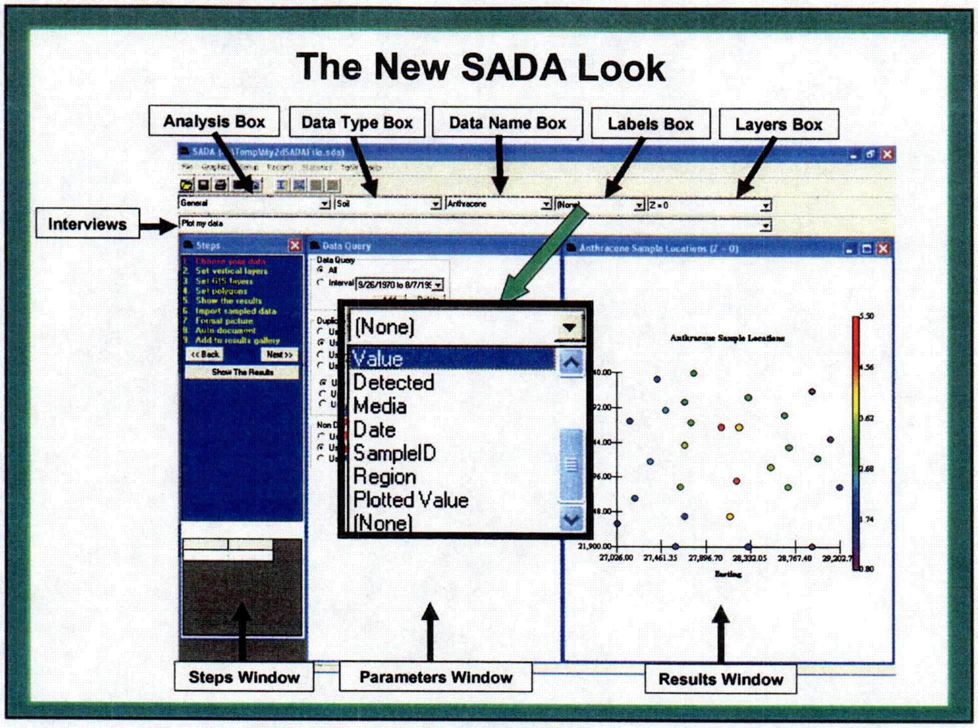
The New SADA Look

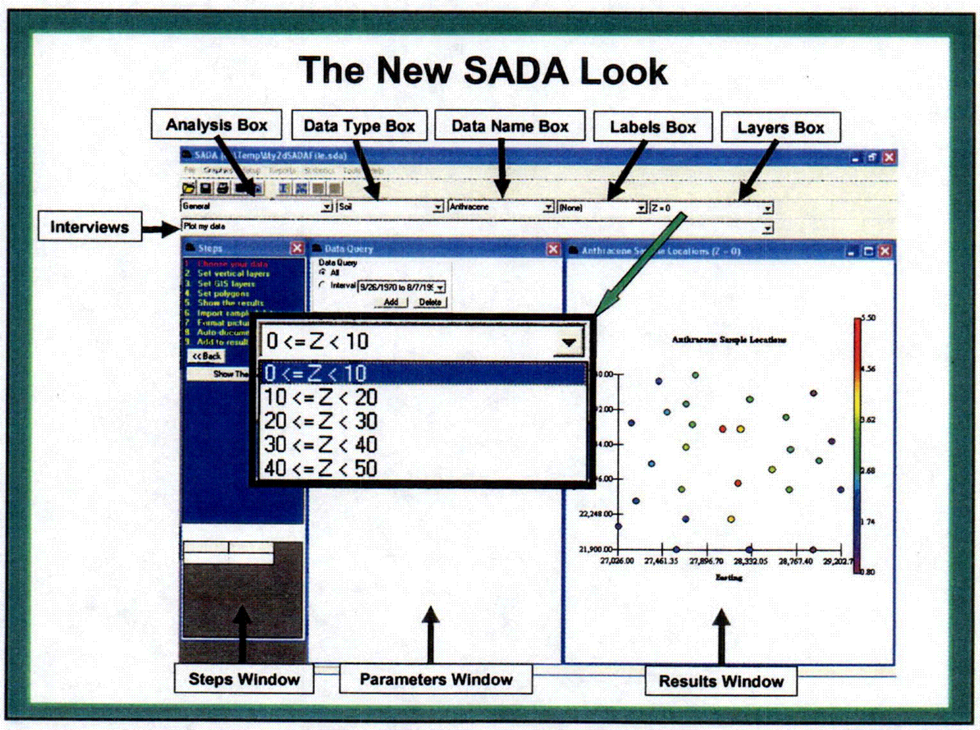


The New SADA Look

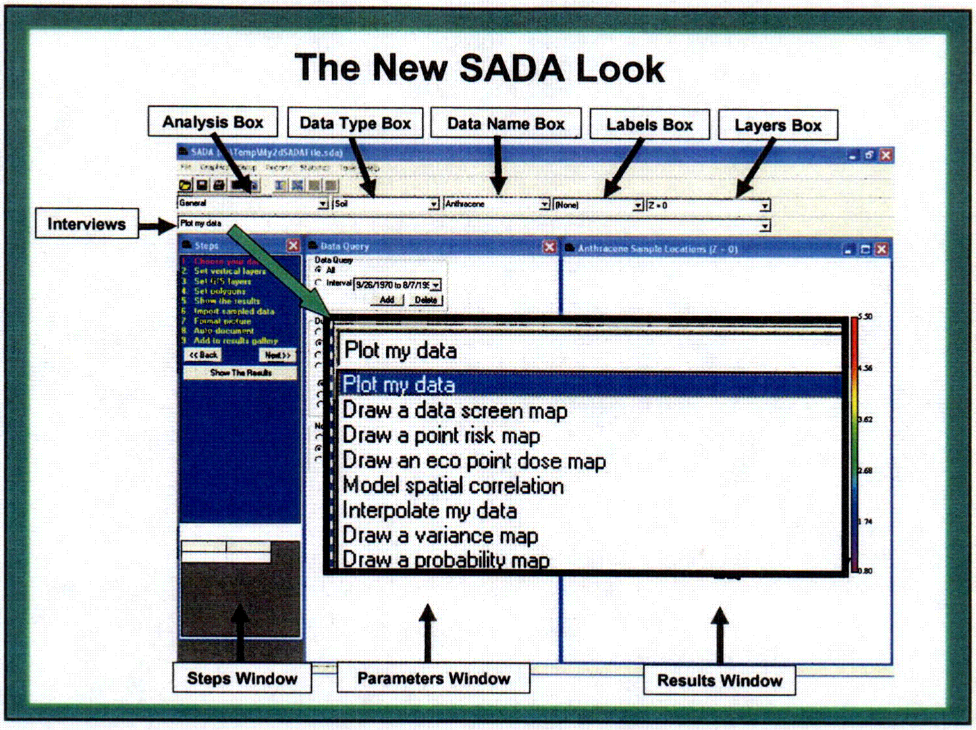


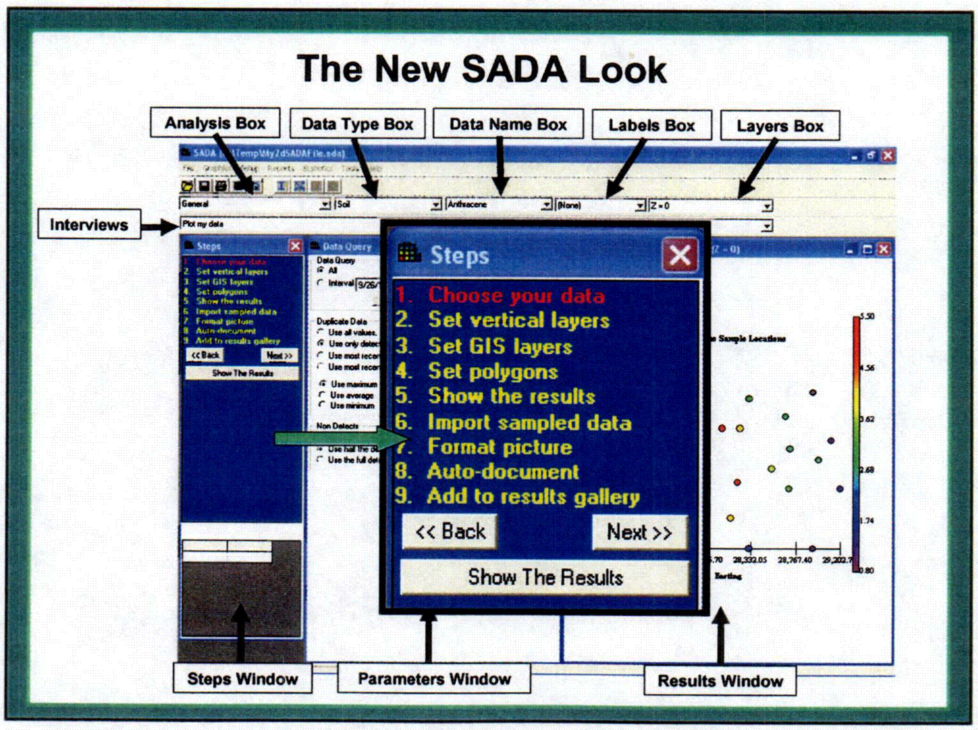
C15


The New SADA Look
Analysis Box
Data Type Box
Data Name Box
Labels Box
Layers Box
Interviews
(None)
Value
Detected
Media
Date
SampleID
Region
Plotted Value
(None)
Steps Window
Parameters Window
Results Window

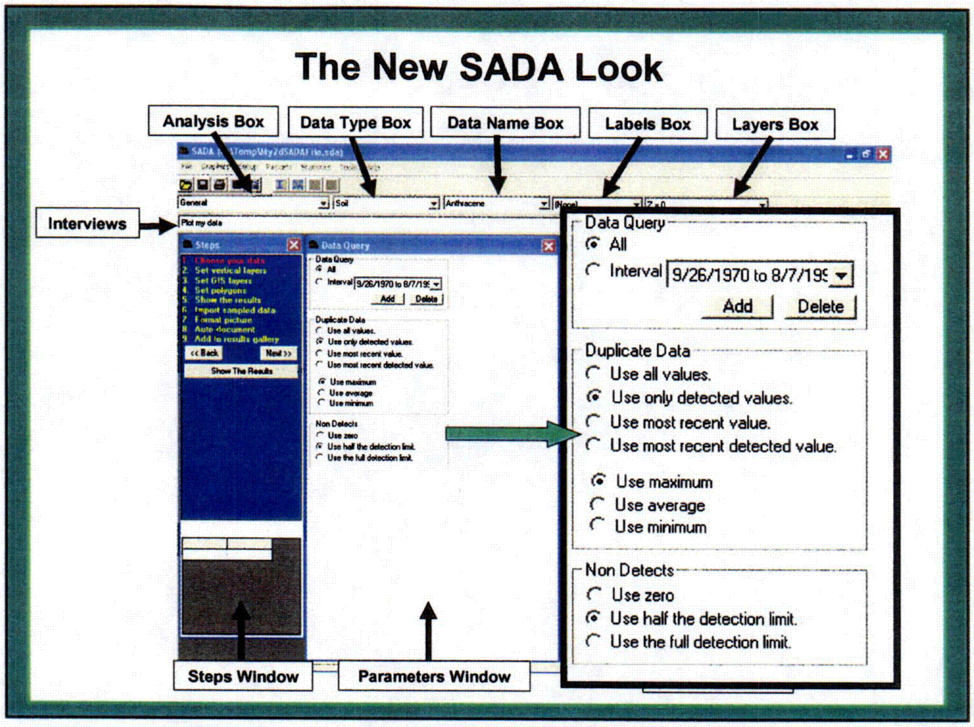

The New SADA Look
Analysis Box
Data Type Box
Data Name Box
Labels Box
Layers Box
Interviews
0 <= Z < 10
0 <= Z < 10
10 <= Z < 20
20 <= Z < 30
30 <= Z < 40
40 <= Z < 50
Steps Window
Parameters Window
Results Window

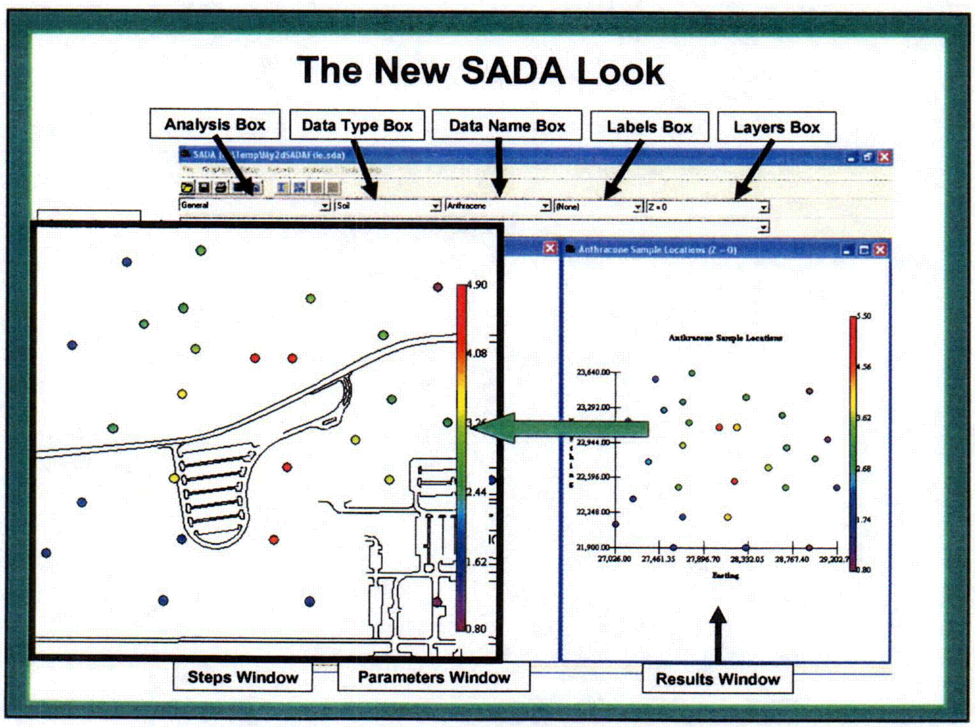
C16


The New SADA Look
Analysis Box
Data Type Box
Data Name Box
Labels Box
Layers Box
Interviews
Plot my data
Plot my data
Draw a data screen map
Draw a point risk map
Draw an eco point dose map
Model spatial correlation
Interpolate my data
Draw a variance map
Draw a probability map
Steps Window
Parameters Window
Results Window


The New SADA Look
Analysis Box
Data Type Box
Data Name Box
Labels Box
Layers Box
Interviews
Steps
1. Choose your data
2. Set vertical layers
3. Set GIS layers
4. Set polygons
5. Show the results
6. Import sampled data
7. Format picture
8. Auto-document
9. Add to results gallery
<< Back
Next >>
Show The Results
Steps Window
Parameters Window
Results Window

C17


The New SADA Look
Analysis Box
Data Type Box
Data Name Box
Labels Box
Layers Box
Interviews
Data Query
All
Interval
Add
Delete
Duplicate Data
Use all values.
Use only detected values.
Use most recent value.
Use most recent detected value.
Use maximum
Use average
Use minimum
Non Detects
Use zero
Use half the detection limit.
Use the full detection limit.
Steps Window
Parameters Window

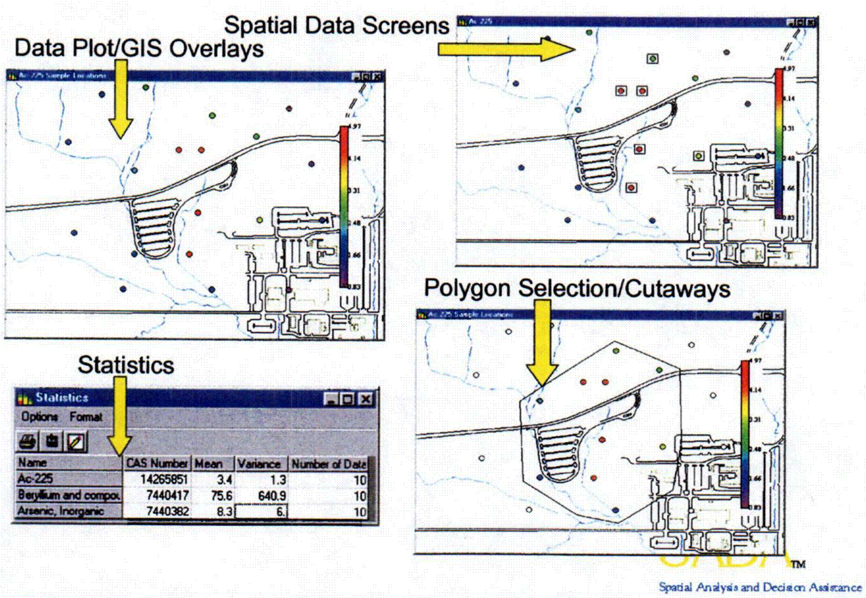

The New SADA Look
Analysis Box
Data Type Box
Data Name Box
Labels Box
Layers Box
4.90
4.08
2.44
1.62
0.80
Steps Window
Parameters Window
Results Window

C18

What exactly can you do in SADA?

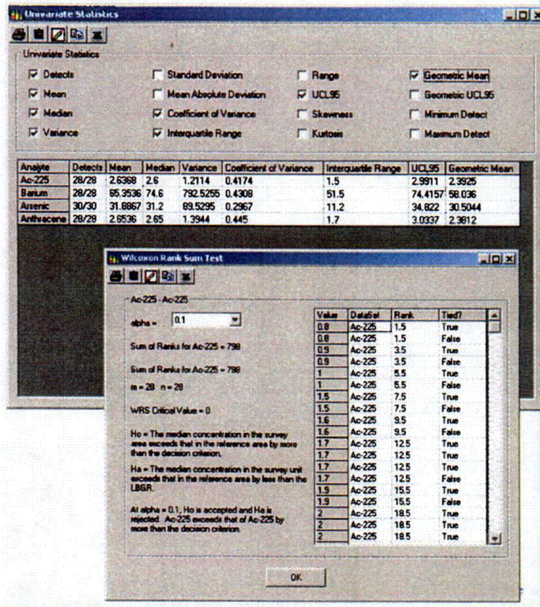
- Create initial sample designs
- Import data
- Plot data
- Import GIS layers
- Aggregate sections of the site
- Calculate statistics (univariate, bivariate)
- Model spatial correlation
- Create contour maps
- Create a kriging variance map
- Perform traditional HH and Eco risk assessments (tabular risk, screens, prgs, benchmarks)
- Create a HH or Eco contoured risk map
- Create a HH or Eco point risk map
- Create a data screen map for HH, Eco, Custom
- Create an eco point dose map
- Create an contoured eco dose map
- Create probability maps
- Define areas of concern
- Calculate cost vs cleanup
- Draw a LISA Map
- Develop secondary sample designs
- Perform a MARSSIM data analysis
- Detect and Define MARSSIM elevated area
- Visualize results in 3d
- Autodocument results
- Create a geobayesian site conceptual model
- Draw area of concern maps based on conceptual model
- Calculate cost vs cleanup based on conceptual model
- Update the site conceptual model
- Export to ESRI or Earthvision or common window applications

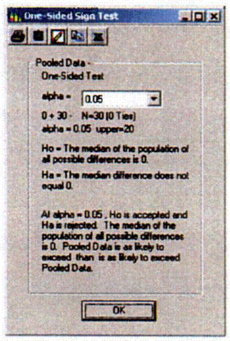
Data Exploration



Statistics

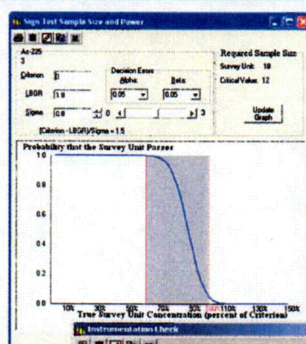
- Additional univariate statistics
- Non-parametric hypothesis testing

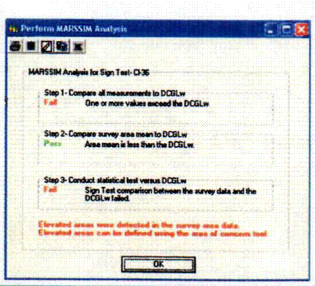


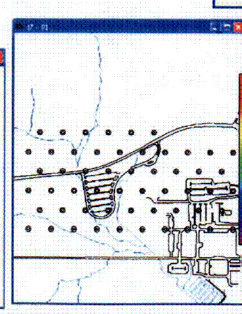


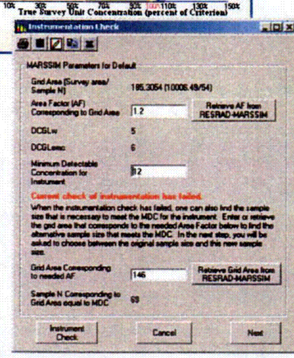
MARSSIM Functionality

- Calculate sample size based on Sign Test and WRS Test
- Develop initial sample design incorporating DCGLS, Area Factors, Instrument sensitivity
- Post sampling analysis (A site passes or fails)
- Detecting and Defining Elevated Areas

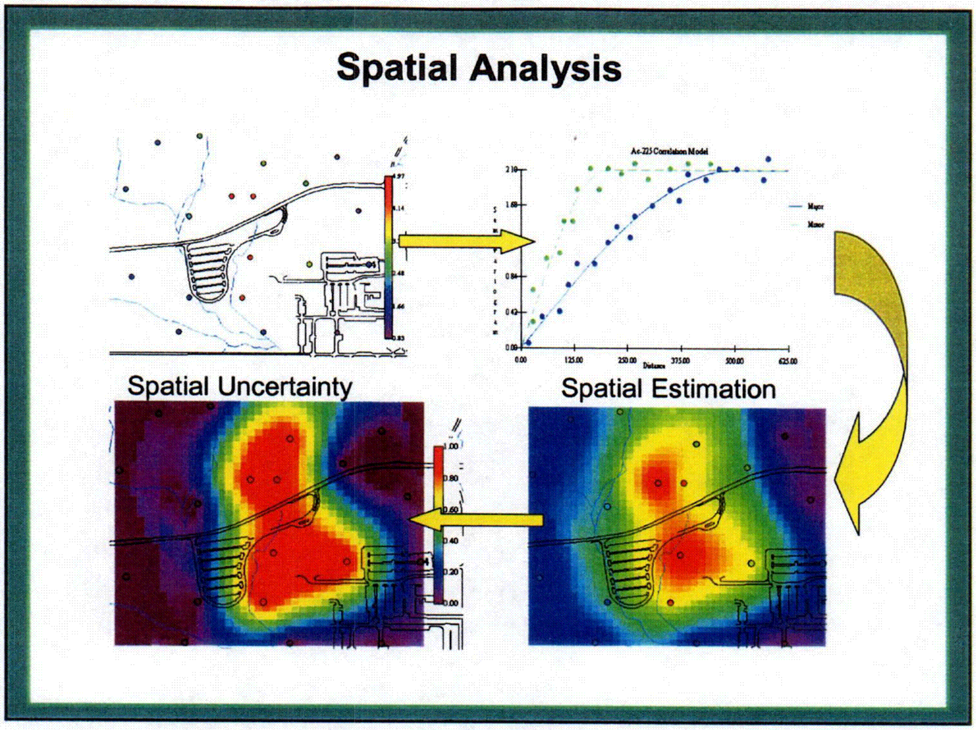


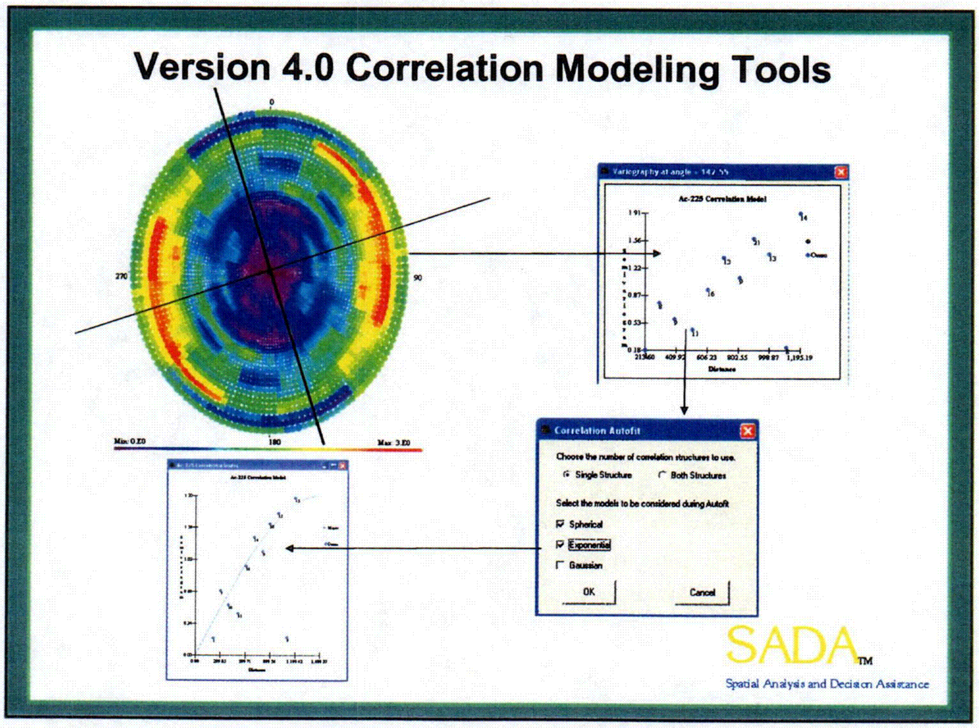






C20


Spatial Analysis
Spatial Uncertainty
Spatial Estimation


Version 4.0 Correlation Modeling Tools
Correlation Autofit
Choose the number of correlation structures to use.
Single Structure
Both Structures
Select the models to be considered during Autofit
Spherical
Exponential
Gaussian
OK
Cancel
SADA™
Spatial Analysis and Decision Assistance

C21

Geostatistics

SADA provides two kriging (geostatistical) models: Ordinary and Indicator kriging. Ordinary kriging assumes a normal or lognormal distribution for the data. Indicator kriging is a non parametric approach that does not assume any distribution.

Like the methods discussed in Basic Spatial Analysis Tools, both methods are based on a weighted combination of nearby samples. However, the development and expression of these weights is quite complex and beyond the scope of this training guide.

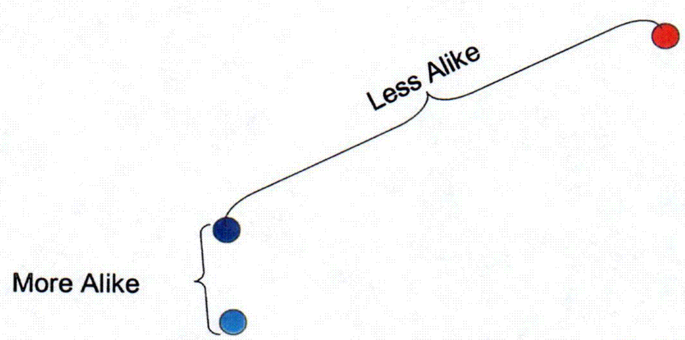
It may be helpful to think of kriging as an advanced form of the inverse distance method. Recall that the inverse distance method weights sampled values by their distance from the unsampled location.

Kriging approaches the problem in much the same way. However, rather than distance (d), the weights are based on the amount *of spatial correlation* or *spatial covariance* that samples exhibit at varying distances C(d).

SADA™
Spatial Analysis and Decision Assistance

Spatial Correlation

If data are spatially correlated, then on average, sample points that are close to each other are more alike than sample points further away. (More complex spatial correlations exist but this type is the most common).



SADA™
Spatial Analysis and Decision Assistance

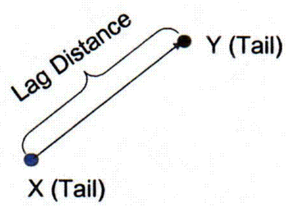
C22

Spatial Correlation

The degree to which data are more or less "alike" for any given distance can be calculated. SADA uses the *semi-variogram* method, which returns a measure of variance for any given distance of separation. This measure is defined as half of the average squared difference between values separated by distance **h**. The term **h** is referred to as the *lag* or *lag distance*.

$$\gamma(\mathbf{h}) = \frac{1}{2N(\mathbf{h})}\sum_{i=1}^{N(\mathbf{h})}(x_i - y_i)^2$$

where N(**h**) is the number of pairs separated by distance **h**, x_i is the starting sample point (tail), and y_i is the ending sample point (head).

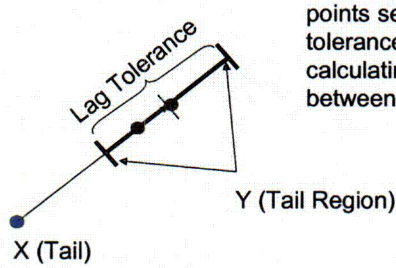


SADA™
Spatial Analysis and Decision Assistance

Spatial Correlation

Rarely in practice, will you ever have any sample points separated by exactly a lag distance **h.** Therefore, a lag tolerance centered about the lag distance will permit a capture of more data points in the calculation of $\gamma(\mathbf{h})$. In the figure below, all data points within the blue shaded area will be used.

So if we are interested in the variance of all data points separated by 10 feet and we permit a lag tolerance of 2 feet. We will actually be calculating the variance of all pairs of data between 9 and 11 feet apart.

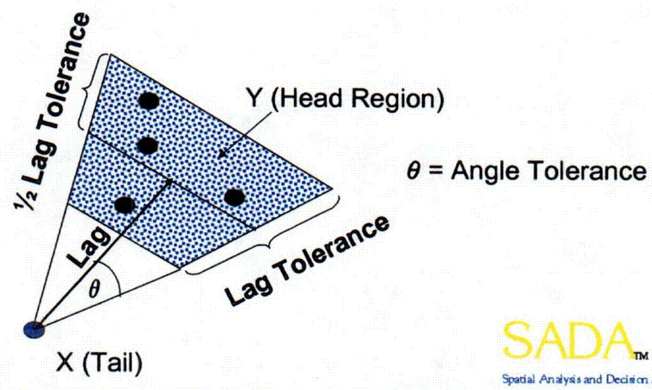


SADA™
Spatial Analysis and Decision Assistance

C23

Spatial Correlation

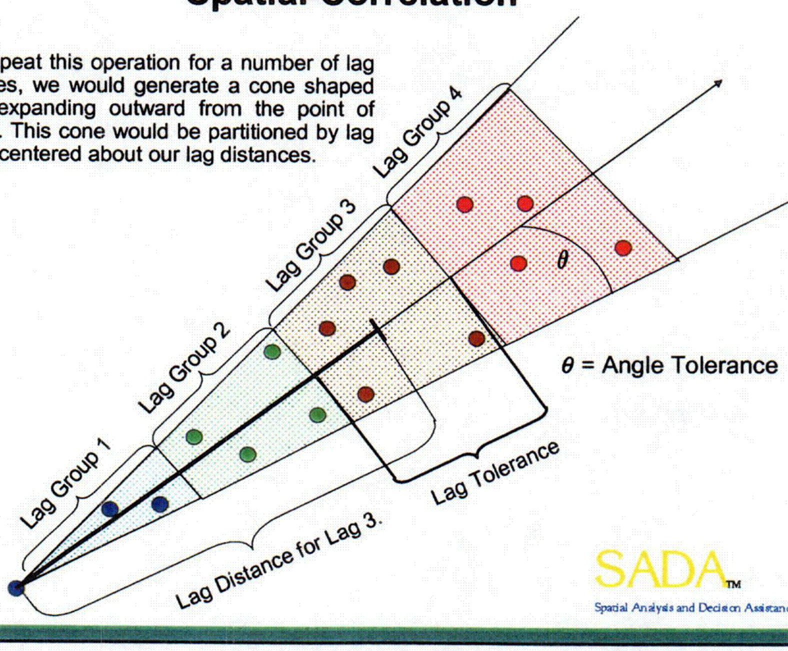
Although assigning a lag tolerance helps, most cases will never have enough samples separated by a lag - tol/2 to lag + tol/2 along a straight line to calculate the semivariogram value. Therefore, an angle tolerance, θ, is also introduced to expand the region and to include more points in the calculation of the semivariogram value for the specified lag distance. In the figure below, all data points within the blue shaded area will be used.



SADA™
Spatial Analysis and Decision Assistance

Spatial Correlation

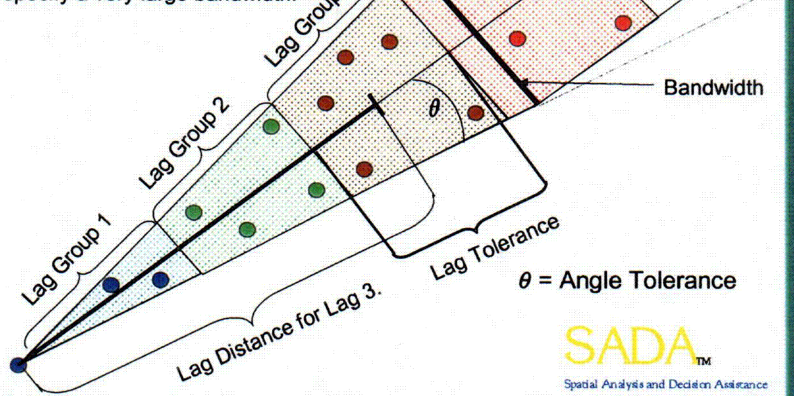
If we repeat this operation for a number of lag distances, we would generate a cone shaped object expanding outward from the point of interest. This cone would be partitioned by lag groups centered about our lag distances.



SADA™
Spatial Analysis and Decision Assistance

Spatial Correlation

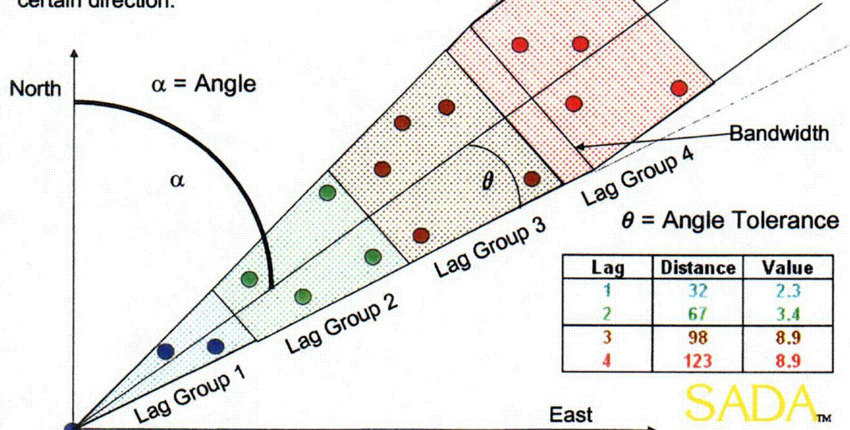
As the cone stretches farther out, it opens up increasingly wide, capturing more and more data points as it moves away. In practice, geostatisticians will often apply a constraint called the *bandwidth*. This bandwidth limits the expansion of the cone to a certain width. If you do not wish to constrain the cone's expansion, specify a very large bandwidth.



SADA™
Spatial Analysis and Decision Assistance

Spatial Correlation

Our final parameter is the angle. The angle specifies in what direction you will be calculating the semi-variogram values. This is sometimes referred to as the angle of anisotropy. Now we are constraining our semi-variogram values to a certain direction.

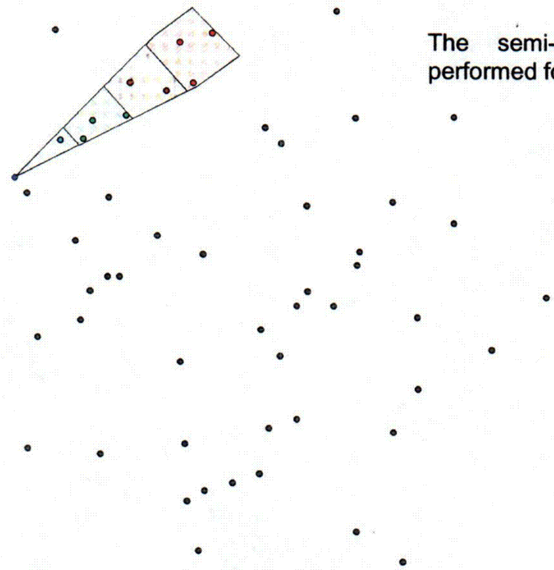


Lag	Distance	Value
1	32	2.3
2	67	3.4
3	98	8.9
4	123	8.9

SADA™
Spatial Analysis and Decision Assistance

C25

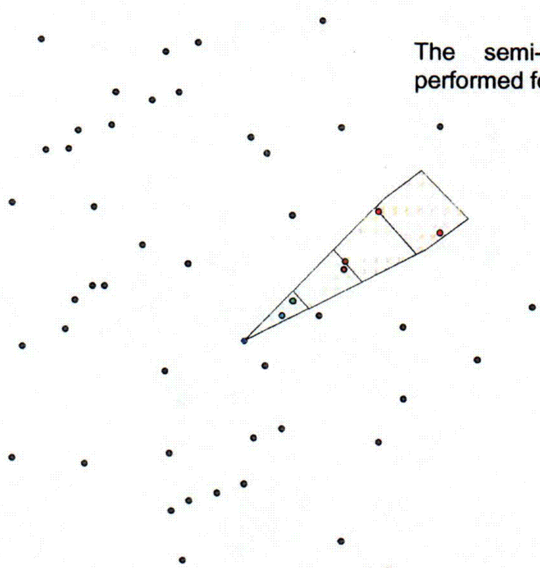
Spatial Correlation



The semi-variogram calculation is performed for every sampled point.

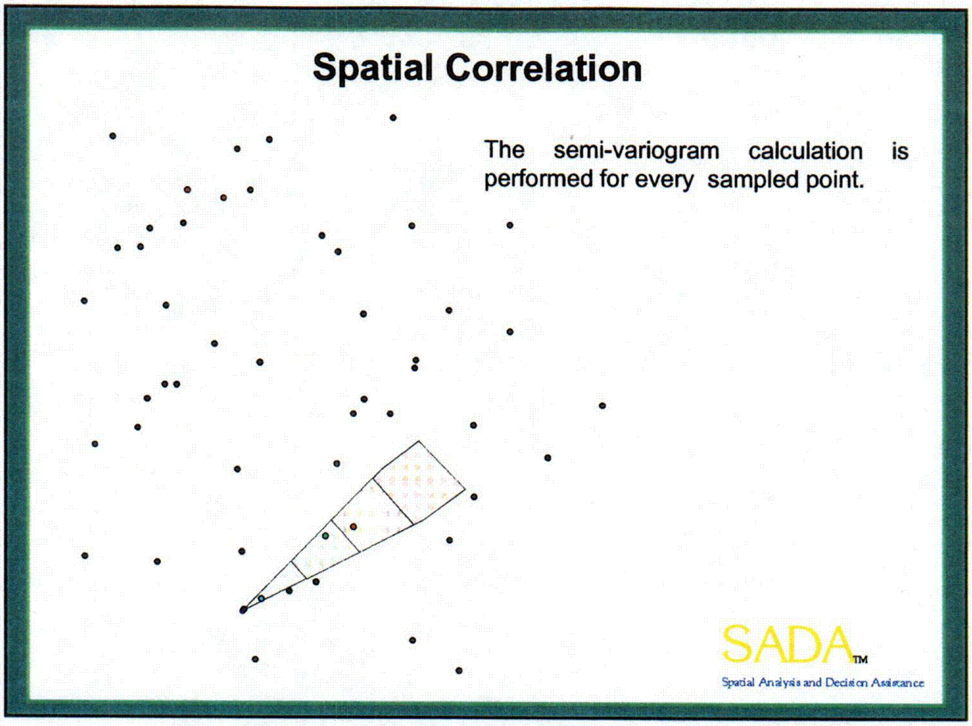
SADA™
Spatial Analysis and Decision Assistance

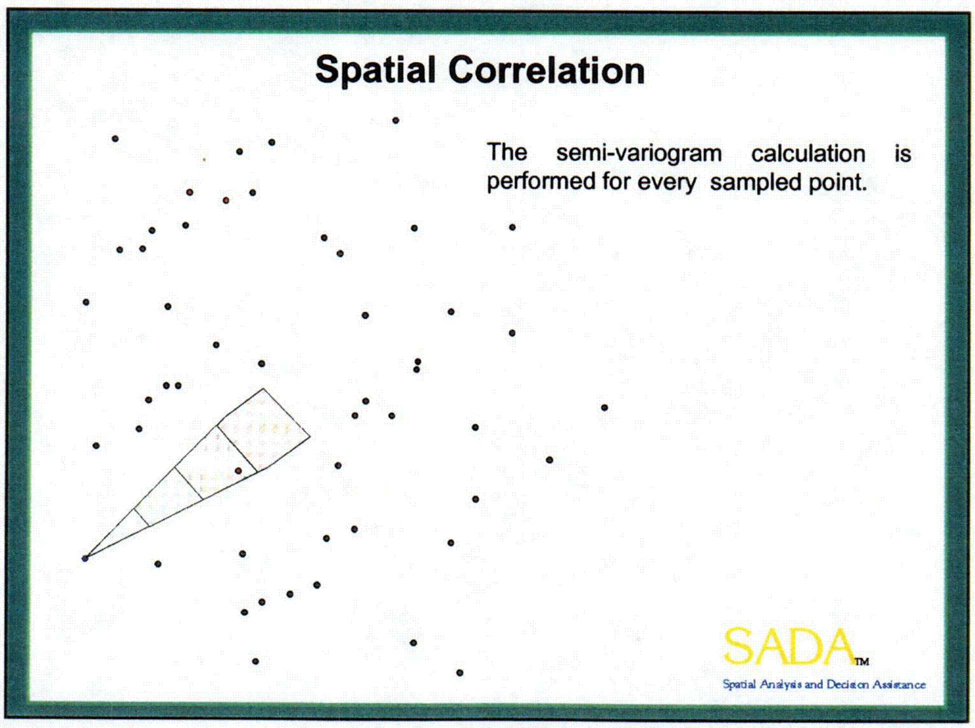
Spatial Correlation



The semi-variogram calculation is performed for every sampled point.

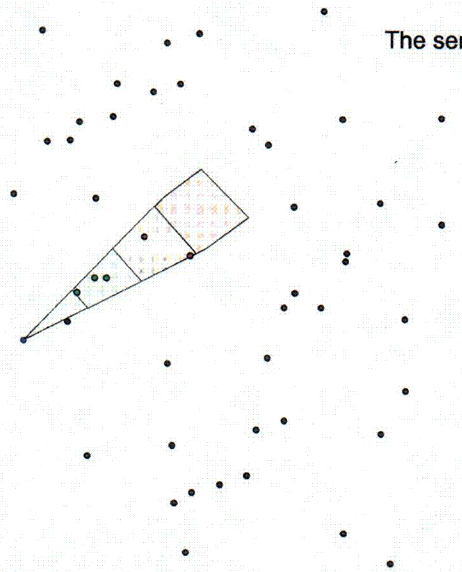
SADA™
Spatial Analysis and Decision Assistance


Spatial Correlation
The semi-variogram calculation is performed for every sampled point.
SADA™
Spatial Analysis and Decision Assistance


Spatial Correlation
The semi-variogram calculation is performed for every sampled point.
SADA™
Spatial Analysis and Decision Assistance

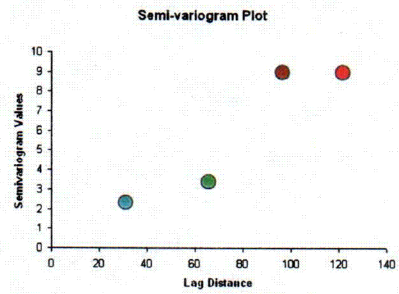
C27

Spatial Correlation



The semi-variogram values are then plotted.

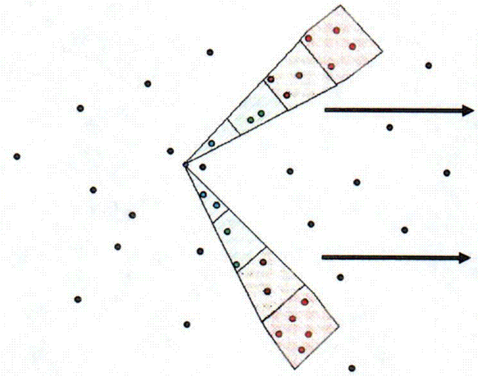
Lag	Distance	Value
1	32	2.3
2	67	3.4
3	98	8.9
4	123	8.9



SADA™
Spatial Analysis and Decision Assistance

Spatial Correlation

Note though, by specifying an angle α, we are excluding all those data points located outside of the cone from $\alpha - \theta$ degrees to $\alpha + \theta$ degrees. In other words, we are exploring how data are correlated in a particular direction. If we find that data are more correlated in one direction than another, the data are said to be *anisotropic*. This means that data in the direction α are more alike than in other directions.



Lag	Distance	Value
1	32	2.3
2	67	3.4
3	98	8.9
4	123	8.9

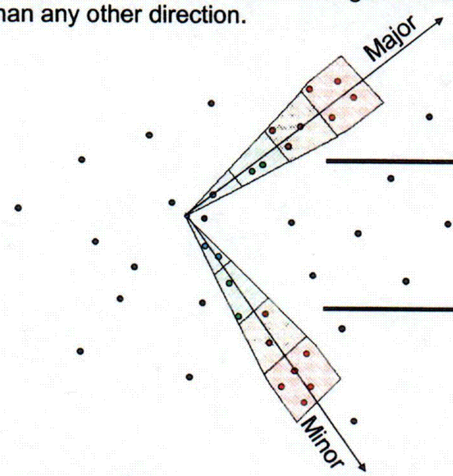
Lag	Distance	Value
1	32	4.3
2	67	5.2
3	98	9.4
4	123	9.6

SADA™
Spatial Analysis and Decision Assistance

C28

Spatial Correlation

In fact, if anisotropic conditions exist, the direction of highest correlation is considered the *major direction* of anisotropy. The perpendicular direction is referred to as the *minor direction* of anisotropy. The *major direction* of correlation will exhibit semi-variogram values that increase at a slower rate than any other direction.



Major

Lag	Distance	Value
1	32	2.3
2	67	3.4
3	98	8.9
4	123	8.9

Minor

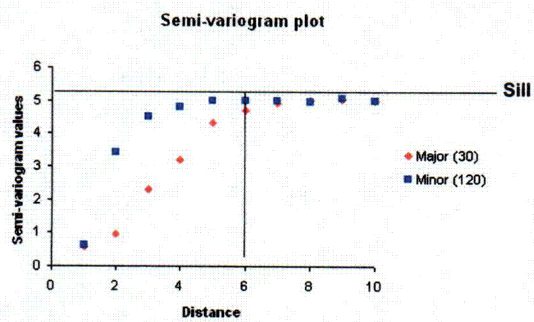
Lag	Distance	Value
1	32	4.3
2	67	5.2
3	98	9.4
4	123	9.6

SADA™
Spatial Analysis and Decision Assistance

Spatial Correlation

Theoretically, the semi-variogram values will continue to rise until they reach the *sill* value. The sill is the point at which the data are now far enough apart to be independent. The sill value should be roughly equivalent to the variance of the data set. A *semi-variogram plot* is useful in detecting the sill value and location.

Lag	Major (30)	Minor (120)
1	0.56	0.6
2	0.95	3.4
3	2.3	4.5
4	3.2	4.8
5	4.3	5
6	4.7	5
7	4.9	5
8	5	4.95
9	5.01	5.05
10	4.99	5

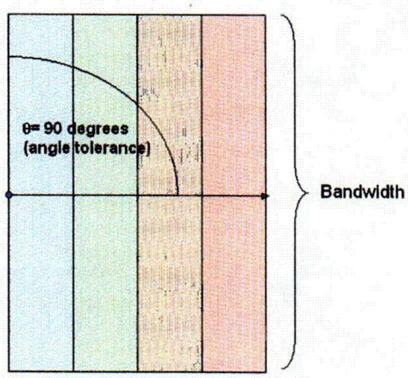


In the above example, we see a major direction at 30 degrees and the corresponding minor direction at 120 degrees. A sill value of approximately 5 is detected around 6 feet of separation.

SADA™
Spatial Analysis and Decision Assistance

Isotropic Variograms

In order to calculate an isotropic or *omni-directional* variogram, simply set the angle tolerance to 90 degrees and make the bandwidth significantly larger than the site. This will force the cone to consider the entire spectrum of data points.



SADA™
Spatial Analysis and Decision Assistance

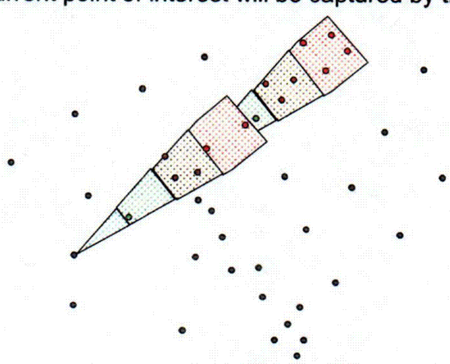
Spatial Correlation

What about in the opposite direction?

It is assumed that correlation is symmetrical. If data are varying a certain amount at 30 degrees, then they are varying the same amount at 120 degrees.

Why don't we include those sample points in the 120 degrees direction to improve our semi-variogram calculation?

We do. Our current point of interest will be captured by the cone of those points behind it.



SADA™
Spatial Analysis and Decision Assistance

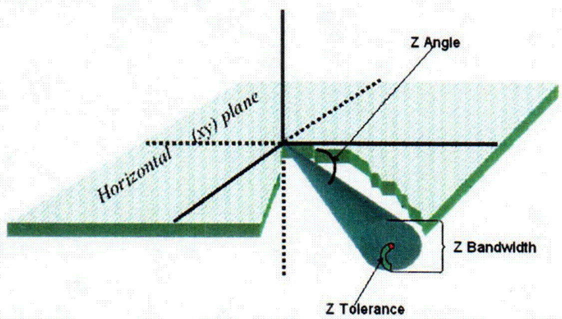
Three-Dimensional Variography

Three-dimensional semi-variogram calculation is the same approach as in the two-dimensional case. In addition to the previously defined parameters, a z angle (dip), z tolerance, and z bandwidth must be specified.

Z Angle (Dip) – The angle below the horizontal plane that the cone should dip.

Z Tolerance – The tolerance on this dip angle.

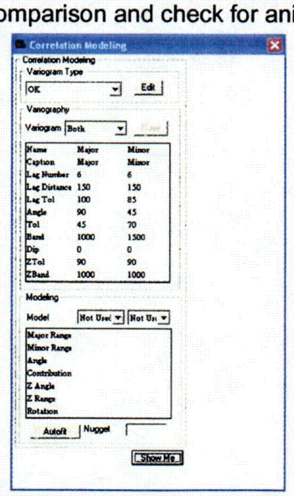
Z Bandwidth – The maximum distance the vertical component of the cone is permitted to go.

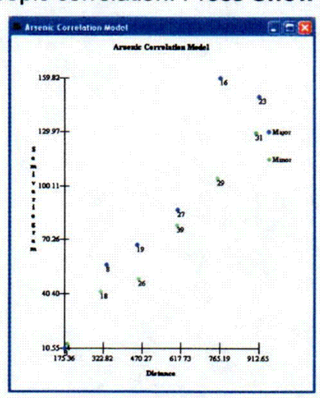


SADA™
Spatial Analysis and Decision Assistance

Setting Variography Model

To calculate semivariogram values, select **Correlation Modeling** from the **Steps Window** and enter the appropriate information on the **Parameters Window**. The results of two separate cones are viewed at once to provide visual comparison and check for anisotropic correlation. Press **Show Me**.



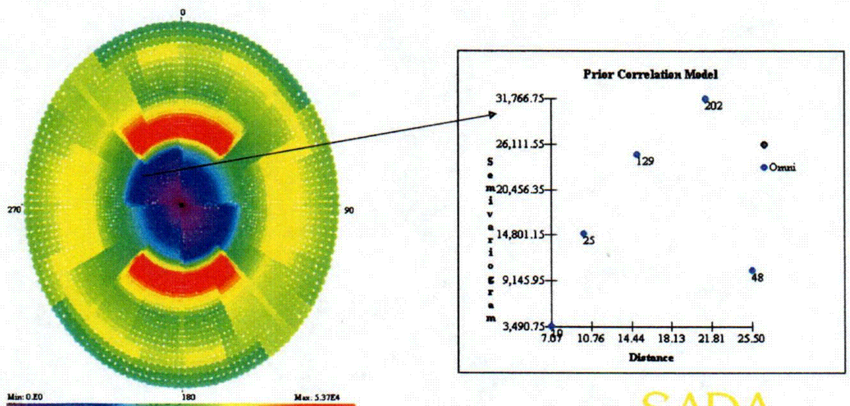


SADA™
Spatial Analysis and Decision Assistance

C31

Rose Diagrams

Rather than viewing only on angle at a time, users can view semivariogram values in all directions at once. They can then choose an angle of interest by clicking on the rose diagram map. SADA will show the semivariogram values for that direction.



SADA™
Spatial Analysis and Decision Assistance

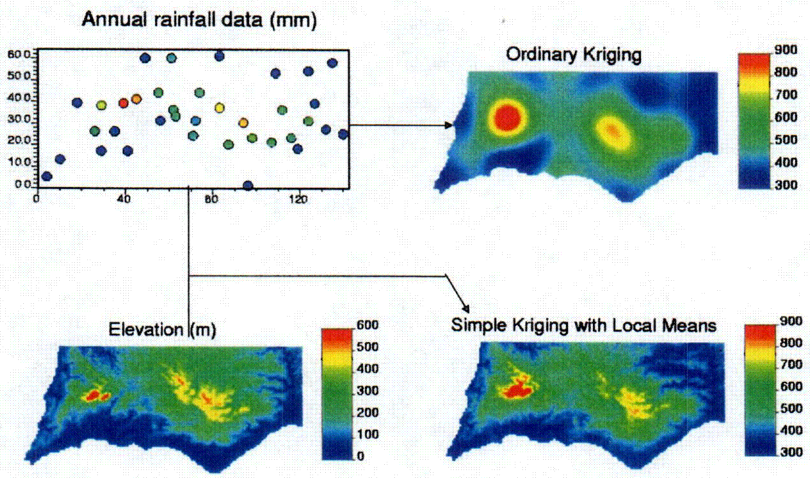
Secondary Information

- The term secondary information describes a collection of information that may be either quantitative or qualitative in nature. This collection of information is not the direct subject of interest. It is however related and may assist in characterization of the primary subject, particularly within a spatial context.
- Direct measurements of the subject may be costly or perhaps dangerous to obtain. This results in only a few explicit samples.
- If secondary information is available in great quantities, it may improve heterogeneity in the final results.

SADA™
Spatial Analysis and Decision Assistance

C32

Impact of Secondary Information



*Taken from Pierre Goovaerts' Presentation "Performance comparison of geostatistical algorithms for incorporating elevation into the mapping of precipitation"

SADA™
Spatial Analysis and Decision Assistance

Geobayesian History

- The U.S. Nuclear Regulatory Commission is interested in explicitly using all relevant information about a contaminated site to create a better design strategy for subsurface (3d) sampling.
- The interest originates from final status decommissioning surveys conducted by NRC.
- Issues in two-dimensional applications have been worked out in the MARSSIM guidance developed by NRC, EPA, and DOE.
- MARSSIM guidance is best suited for 2d applications because of the role that walk over radiological scans play in the process.
- The goal is to identify an analogous approach to MARSSIM for 3d, particularly when faced with sparse data sets.

SADA™
Spatial Analysis and Decision Assistance

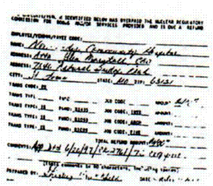
Geobayesian History

- In many cases, potentially useful information is known about the site that can drive sampling and characterization strategies. These may include site history, geology, and previous sampling.
- An approach is needed to explicitly use these varying sources of information in a formal geospatial framework to drive the location of final survey samples, to characterize the radiological risk, and to support closure decisions.
- A number of approaches are being evaluated. The first is a method originally formalized as the Adaptive Sampling and Analysis Program (ASAP) at Argonne National Laboratory. This method integrates a standard bayesian approach with indicator kriging.
- This approach was the basis for the SADA geobayesian module, created by NRC and the University of Tennessee in the freeware program SADA.
- Other models under consideration include Co-kriging, and Markov Bayes.

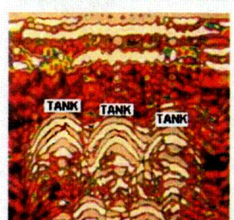
SADA™
Spatial Analysis and Decision Assistance

The Geobayesian Model

Historical Documents

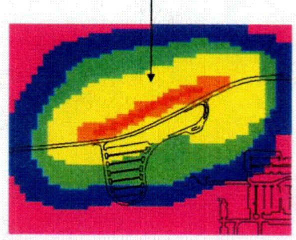


Geotechnical data



Previous data (secondary or direct)

X	Y	Z	CAS	Names	Values	Detect
27273.89	23261.16	2.6	1234123	Chlordane	0.00015	
27273.89	23261.16	5.2	1234123	Chlordane	0.00027	
27273.89	23261.16	7.8	1234123	Chlordane	0.00046	
27273.89	23261.16	10.4	1234123	Chlordane	0.00045	
27273.89	23261.16	13	1234123	Chlordane	0.00028	
27273.89	23261.16	15.6	1234123	Chlordane	0.00012	
27273.89	23261.16	18.2	1234123	Chlordane	0.00004	
27273.89	23261.16	20.8	1234123	Chlordane	0	
27273.89	23261.16	23.4	1234123	Chlordane	0	
27273.89	23261.16	26	1234123	Chlordane	0	
27512.91	23260.99	2.6	1234123	Chlordane	0.46147	
27512.91	23260.99	5.2	1234123	Chlordane	0.69144	
27512.91	23260.99	7.8	1234123	Chlordane	0.73024	
27512.91	23260.99	10.4	1234123	Chlordane	0.38323	



Probability of Exceedance

SADA™
Spatial Analysis and Decision Assistance

C34

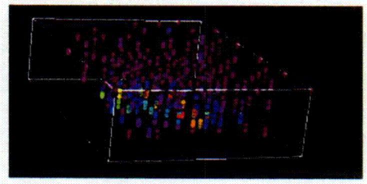
Case Study: Site Description

The KISKI Data Set

•Used as an example data set to test Geobayesian modeling.

•1261 samples in shallow sediment.

•~90 boreholes.

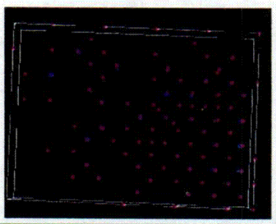


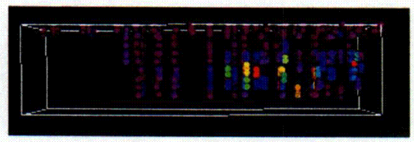
•Values range from near zero to 900 pCi/g.

•Contaminant name was changed.

•Large number of data, but typical spatial distribution.

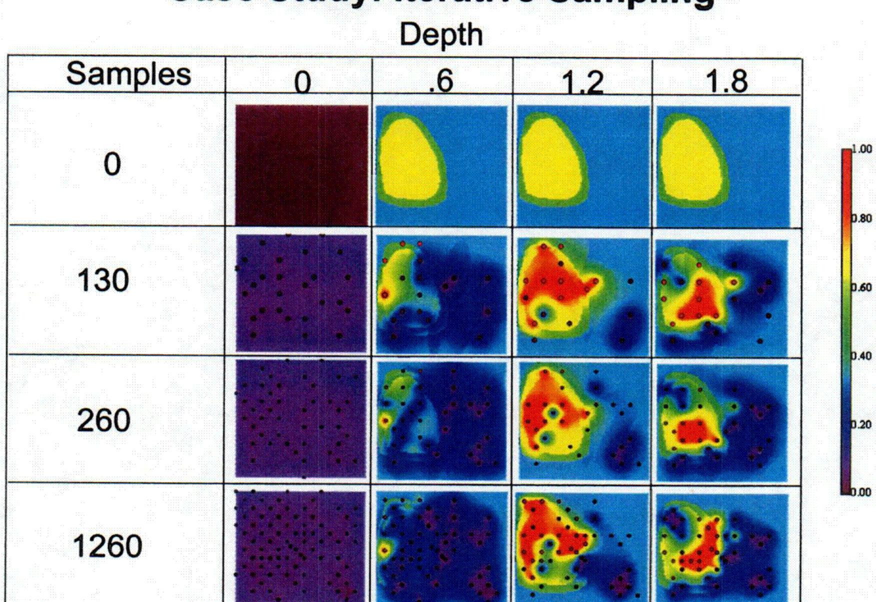
•Good starting point for evaluating the new Geobayesian approach.





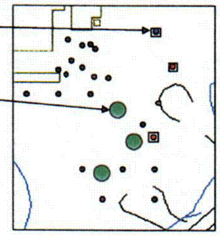
SADA™
Spatial Analysis and Decision Assistance

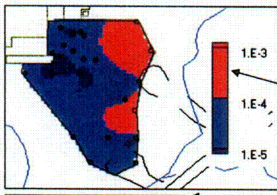
Case Study: Iterative Sampling



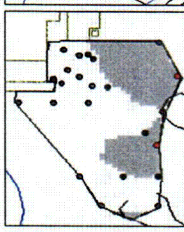
Decision Analysis

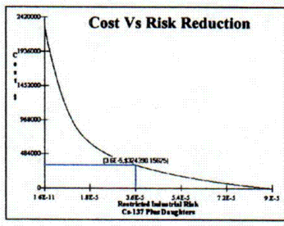
- Spatial Screens
- Sampling Strategies





- Spatial Risk
- Area of Concern
- Cost Benefit

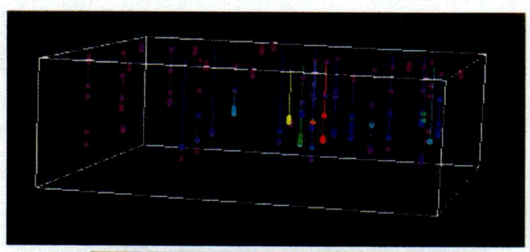


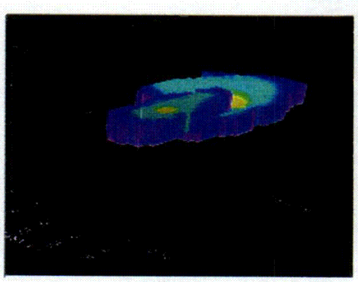


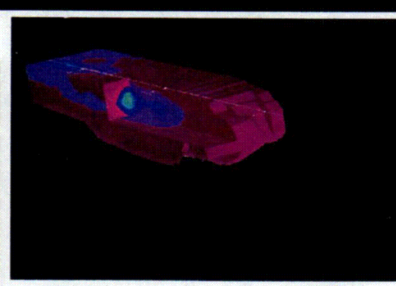
SADA™
Spatial Analysis and Decision Assistance

3D Visualization

True 3d Views: Points, Blocks, and Isosurfaces







SADA™
Spatial Analysis and Decision Assistance

Sample Designs

SADA has a number of sample design strategies in Version 4.0. These strategies include initial and secondary designs. Some are based on data alone while others are based on modeling results. With the exception of a couple of exclusively 2d designs all are available in 3d dimensions.

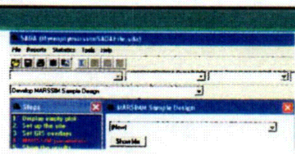
Initial Sample Designs

- Judgmental
- Simple Random
- Simple Grid
- Simple Unaligned Grid
- Standard Grid
- Standard Unaligned Grid
- ***MARSSIM Design***
- 2d and 3d Hot Spot search designs

Secondary Sample Designs

- Threshold Radial
- Adaptive Fill
- High Value
  - (soft, simulated & unsimulated)
- High Variance
  - (soft, simulated & unsimulated)
- Extreme Value
  - (soft, simulated & unsimulated)
- Area of Concern Boundary Design
  - (soft, simulated & unsimulated)
- Minimize/Maximize Area of Concern
- LISA Designs
  - (Ripley's K,Moran's I,Geary's C)

I want to create a MARSSIM sample design



(1) Identify the survey area
(2) Set Class I, II, or III based on extent of contamination suspected/known
(3) Set WRS or Sign (background or not)
(4) View/edit DCGL and associated values (DCGLw, LBGR, alpha, beta, sigma)
(5) Show power curve, return N, alpha, beta
(6) Get grid area (survey area/N)
(7) Get grid area-area factor curve
(8) Update AF for new grid area, calculate DCGLemc, get MDC
(9) Instrument sensitivity check
    (1) If pass
        (1) Show 2D Elipgrid results for circular hot spot of size grid area
    (2) If fail
        (1) Query for area factor based on updated grid area of (needed scan factor/DCGL)
        (2) Recalculate N based on updated grid area and survey area
        (3) Show elipgrid probabilities for both Ns and update grid area
        (4) Accept original N and higher risk of missing circular hotspot or new N and lower risk of missing same hotspot size
(10) Show MARSSIM grid or simple random sample design based on Class type

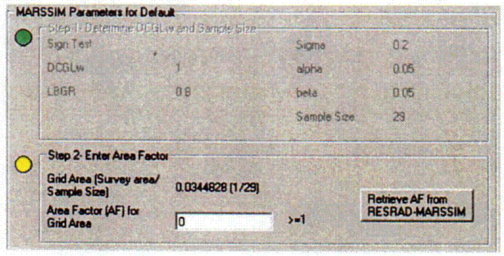
SADA™
Spatial Analysis and Decision Assistance

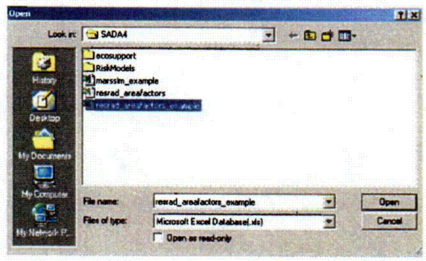
Calculate Grid Area and Enter Area Factor

Grid area is calculated based on the number of samples and the area of the site

Area Factor can be entered or retrieved from an excel file generated in RESRAD-MARSSIM

Click on Retrieve AF from RESRAD-MARSSIM

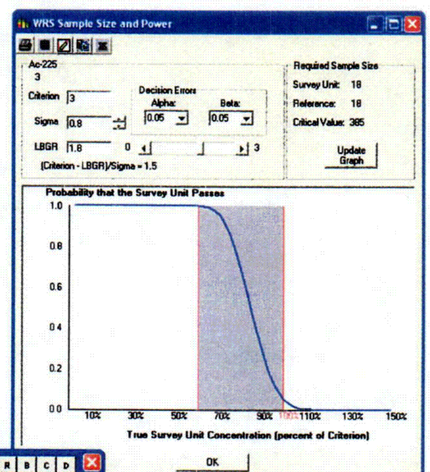


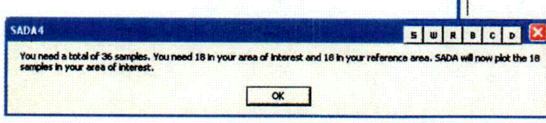


SADA™
Spatial Analysis and Decision Assistance

Determining Number of Samples – Wilcoxon Rank Sum

- User inputs DCGL, LBGR, and acceptable Type I and II error rates
- Appropriate for grid designs and simple random sampling
- Used when no background is available

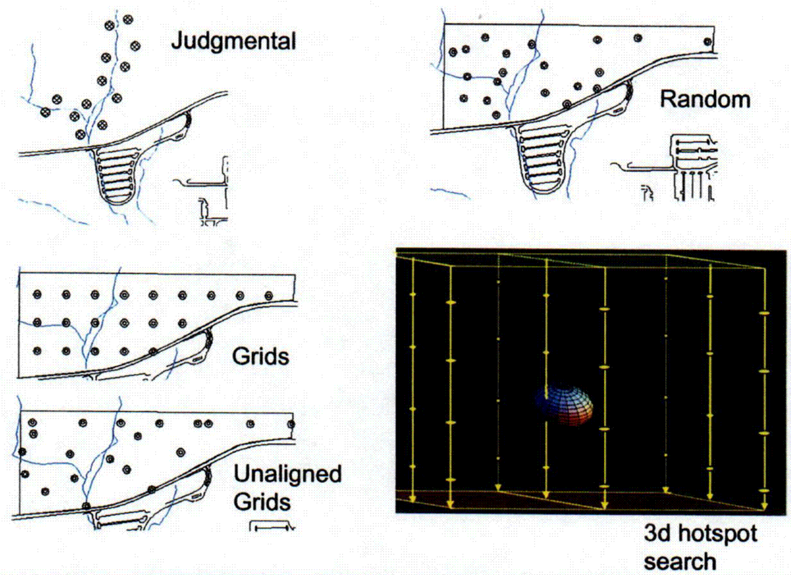




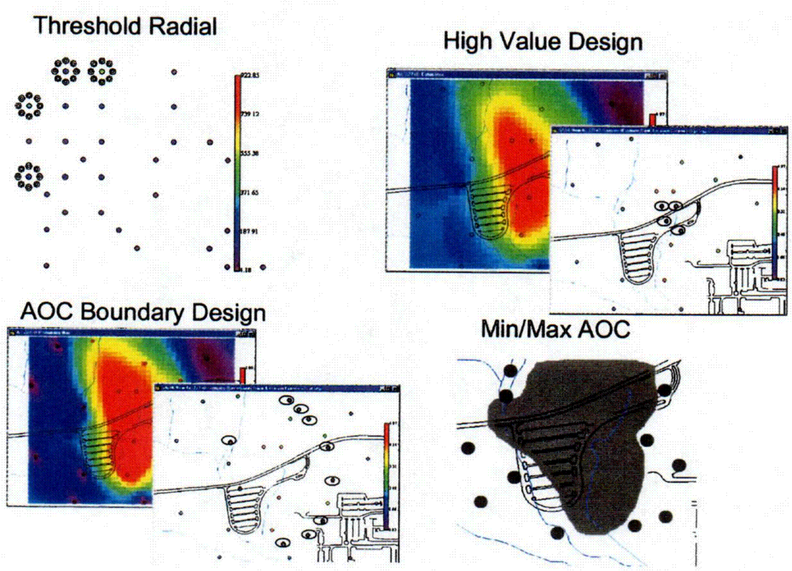
SADA™
Spatial Analysis and Decision Assistance

C38

Some Example Initial Designs



Some Example Secondary Designs



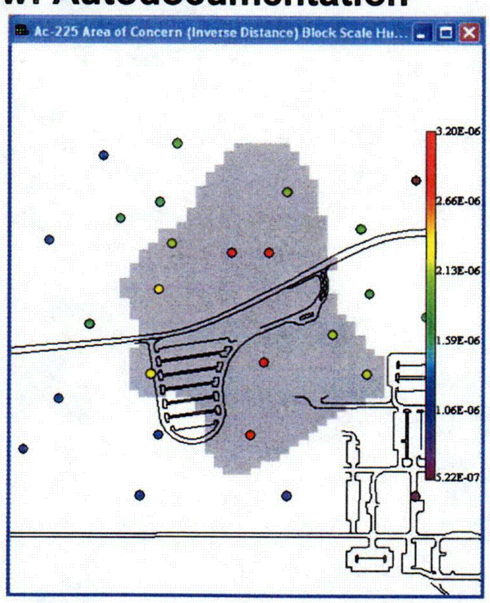
SADA Overview: Autodocumentation

- Provides transparency in the modeling process and facilitates reproducibility of results.
- SADA automatically analyzes any current result and determines what the “ingredients” of that result are. These ingredients are presented to the user, who can choose the level of documentation to create.
- Self-documentation of all parameters, models, and other relevant information.
  - Exposure concentrations
  - Risk models
  - Exposure variables
  - Geospatial parameters
  - Toxicity data
  - Images as bitmaps
- HTML format, can be exported to popular word processors

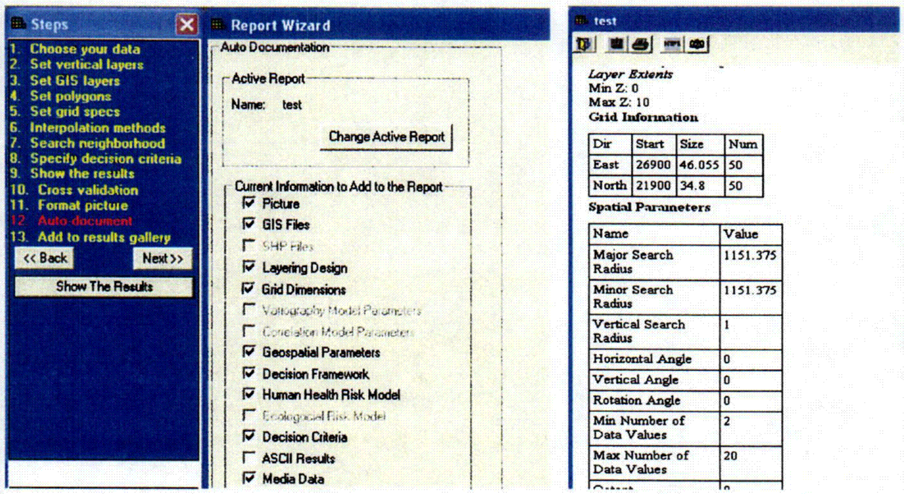
SADA™
Spatial Analysis and Decision Assistance

SADA Overview: Autodocumentation

- Area of concern map
- Based on HH Risk
- Utilized inverse distance as geospatial model
- Block based area of concern framework.



SADA Overview: Autodocumentation



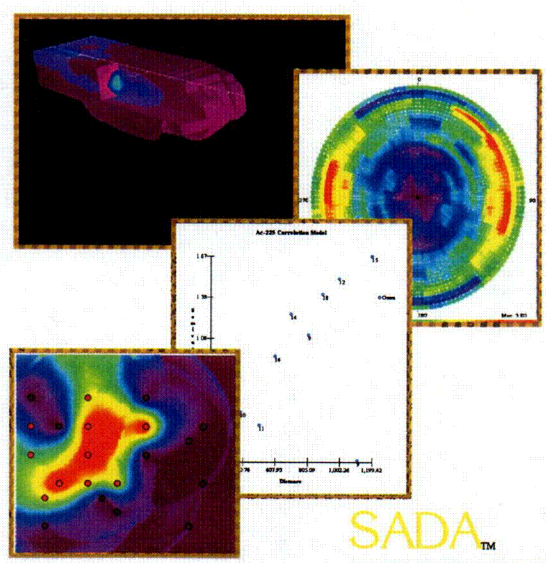
Step

Analysis of Model Elements

Documenation Output

Results Gallery

- Users can now save "static" results to the results gallery
- Users can view them, format them, and change various viewing properties
- Prevents users from having to regenerate a picture each time they want to see it
- Version 5.0 will allow dynamic results to be saved for further modeling



SADA™

Spatial Analysis and Decision Assistance

C41

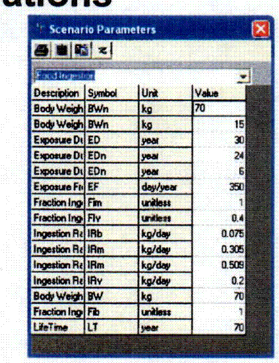
Human Health and Ecological Risk

- SADA implements EPA methods for conducting ecological and human health risk assessments
- Calculation of site-specific preliminary remediation goals
- Benchmark database for contaminant effects on ecological receptors
- Exposure modeling for humans and over 20 other terrestrial species
- Contains IRIS/HEAST toxicity databases for calculating risk from exposure
- Contains EPA default exposure parameters for the risk models
- Tabular screening and risk results
- Point screens
- Risk and dose mapping

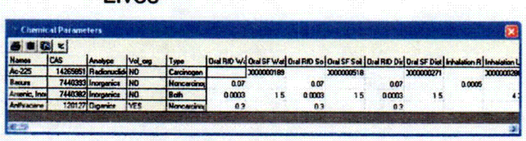
SADA™
Spatial Analysis and Decision Assistance

Human Health Risk Calculations

- For each media
  - Soil, Sediment, Surface Water, Groundwater
- Exposure Scenarios
  - Residential, Industrial, Recreational, Agricultural, Excavation
- Exposure Pathways
  - Ingestion, Inhalation, Dermal Contact, Food Chain (Beef, Milk, and Vegetable Ingestion)
- IRIS and HEAST Toxicity Databases for Carcinogenic and Noncarcinogenic Effects
- Physical Parameters for Modeling
  - Bioaccumulation Factors
  - Volatilization, Particulate Emission Factors
  - Permeability Constants, Absorption Factors
  - Saturation Coefficients, Radionuclide Half-Lives


Scenario Parameters

Description	Symbol	Unit	Value
Body Weigh	BWn	kg	70
Body Weigh	BWn	kg	15
Exposure Du	ED	year	30
Exposure Du	EDn	year	24
Exposure Du	EDn	year	6
Exposure Fr	EF	day/year	350
Fraction Ing	Fim	unitless	1
Fraction Ing	FIv	unitless	0.4
Ingestion Ra	IRb	kg/day	0.075
Ingestion Ra	IRm	kg/day	0.305
Ingestion Ra	IRm	kg/day	0.509
Ingestion Ra	IRv	kg/day	0.2
Body Weigh	BW	kg	70
Fraction Ing	Fib	unitless	1
LifeTime	LT	year	70


Chemical Parameters

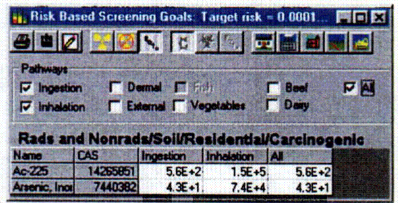
Names	CAS	Analyte	Vol_org	Type	Oral RfD W	Oral SF Wat	Oral RfD So	Oral SF Soil	Oral RfD Die	Oral SF Diet	Inhalation R	Inhalation L
Ac-225	14265851	Radionuclide	NO	Carcinogen		000000189		000000518		000000271		00000028
Barium	7440393	Inorganics	NO	Noncarcino	0.07		0.07		0.07		0.0005	
Arsenic, Ino	7440382	Inorganics	NO	Both	0.0003	1.5	0.0003	1.5	0.0003	1.5		4
Anthracene	120127	Organics	YES	Noncarcino	0.3		0.3		0.3			

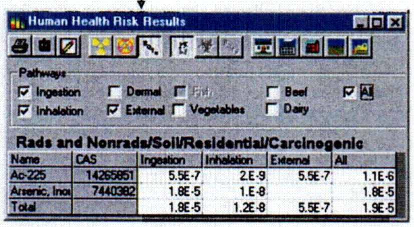
SADA™
Spatial Analysis and Decision Assistance

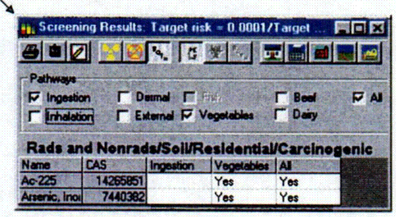
C42

Human Health Risk

- PRG Calculation
- PRG Screens
- Human Health Risk







SADA™
Spatial Analysis and Decision Assistance

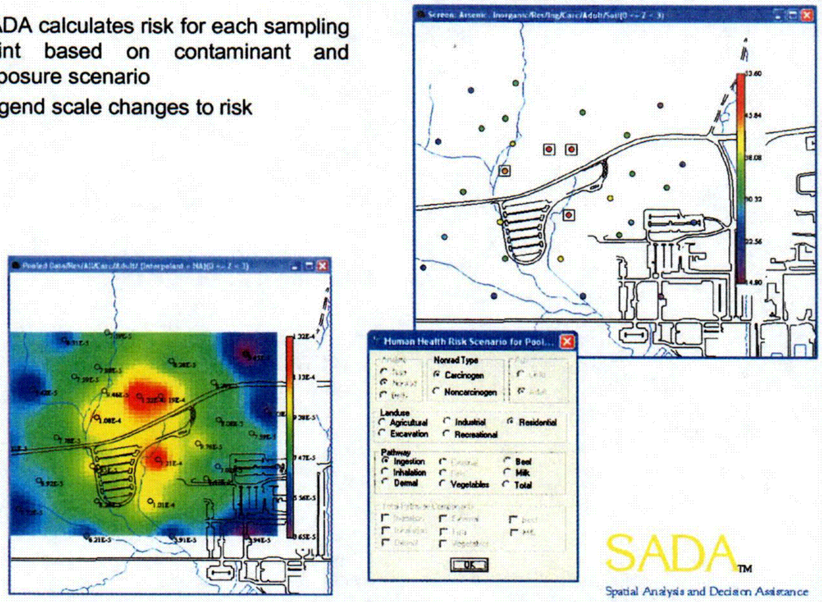
Spatial Implementation of Risk Assessment

- Conventional Risk Assessment Limitations
  - Typically regulatory exposure assessment guidance recommends a summary statistic for the exposure concentration
  - Spatial information is lost when a summary statistic is used in the RA- exposure is assumed to be continuous in space and time
  - Often this lost info not recovered in the rest of the remediation process
- Reasons for incorporating spatial statistics into risk assessment
  - Maximize the use of limited resources
    - Efficiently collect data
    - Retain collected spatial info in the risk assessment
    - Use all types of available data, including expert judgment
  - To more adequately characterize the exposure distribution
    - Extrapolate from known data to cover data gaps
    - Account for spatial processes related to exposure
    - Better understand uncertainties in the exposure assessment

C43

Human Health Spatial Risk Maps

- SADA calculates risk for each sampling point based on contaminant and exposure scenario
- Legend scale changes to risk

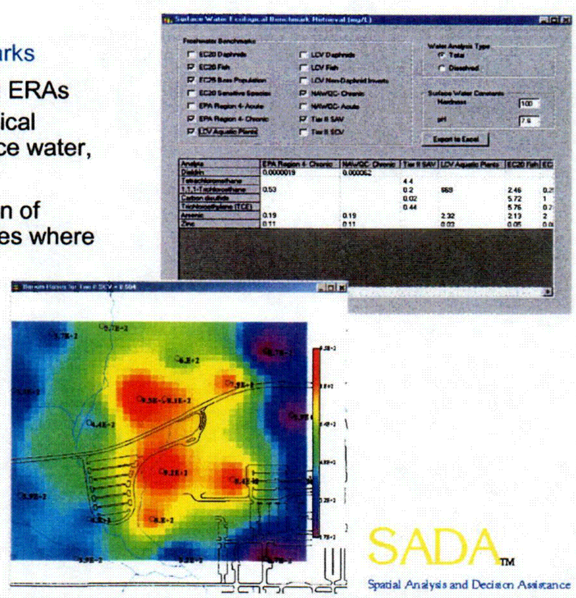


SADA™
Spatial Analysis and Decision Assistance

Ecological Risk

Ecological Risk Benchmarks

- Suitable for screening ERAs
- Compilation of ecological benchmarks for surface water, soil, and sediment
- Benchmarks a function of environmental variables where appropriate

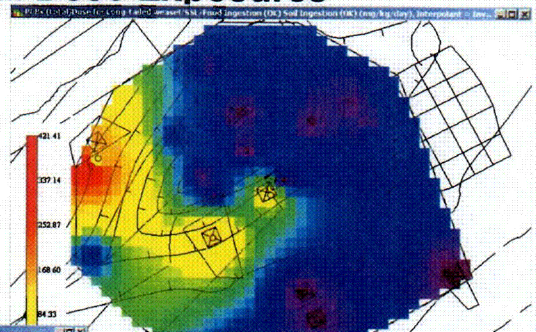


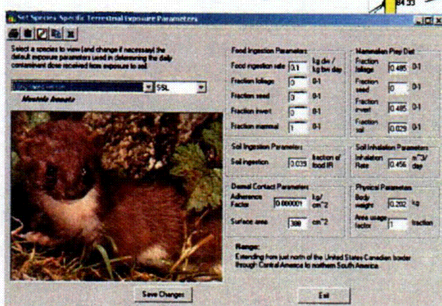
SADA™
Spatial Analysis and Decision Assistance

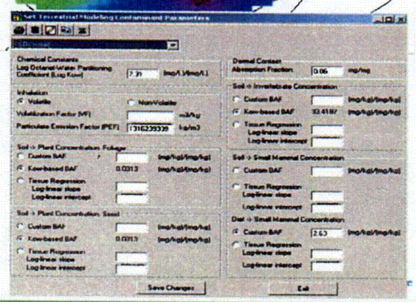
C44

Ecological Dose Exposures

- SADA calculates dose (mg/kg BW d) from food ingestion, soil ingestion, dermal contact, and inhalation for terrestrial exposures
- SSL, Female, Male, or Juvenile
- Over 20 different species







C45