W a s t e I s o l a t i o n P i l o t P l a n t

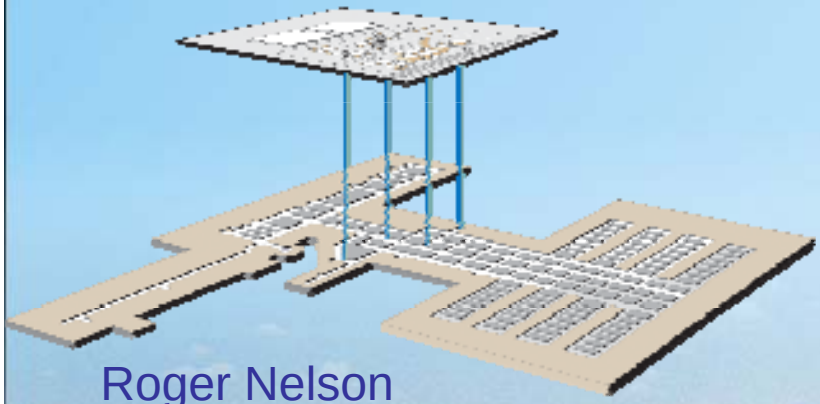
WIPP Status
(and PA Intro)

Presented to:

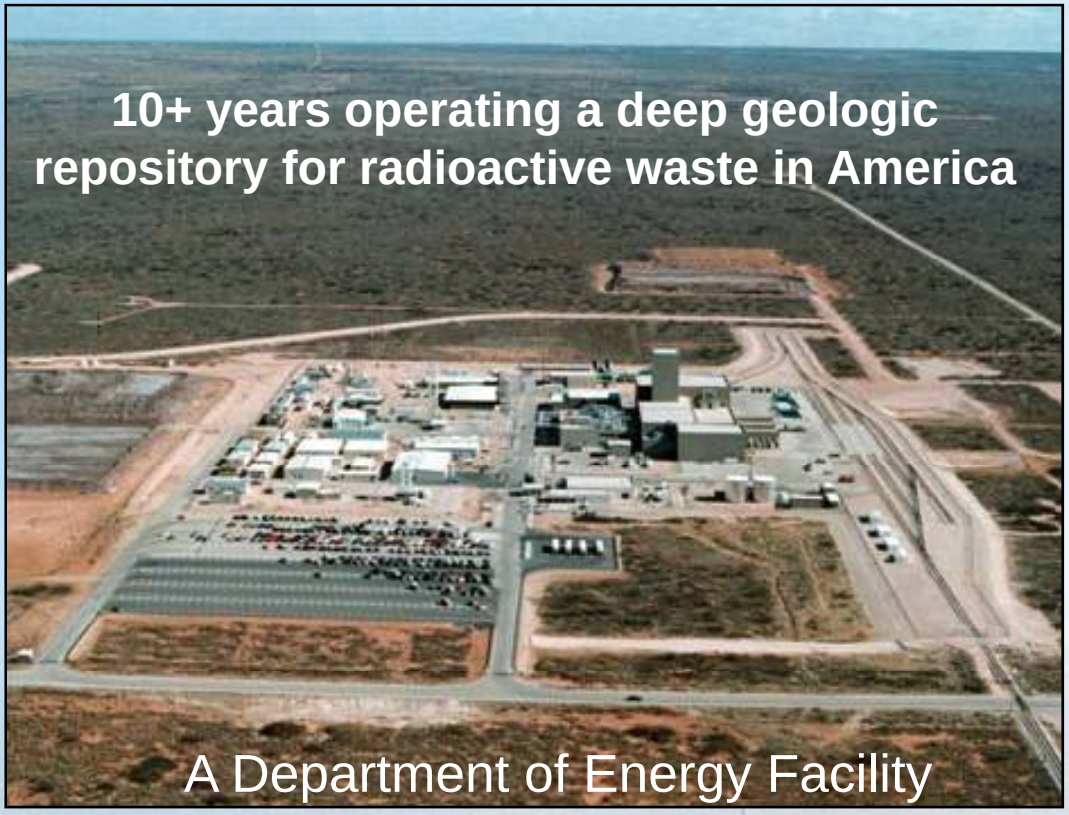
DOE-EM
Performance Assessment
Community of Practice

Technical Exchange Meeting

Salt Lake City
July 13-14, 2009



Roger Nelson
Carlsbad Field Office, USDOE



Safety ❖ *performance* ❖ *cleanup* ❖ *closure*

www.wipp.energy.gov

Environmental Management

Salt is the reason for WIPP's location

"Salt at great depth 'flows.' It will encapsulate waste and isolate it from the surface for eons."

- **Salt is its own indicator of hydrologic stability**
- **Stable geology (~250 million years)**
- **Lack of water**
- **Easy to mine**
- **Self-healing fractures**
- **5 x thermal conductivity of typical crustal rocks**
- **Salt "creep" will encapsulate the waste**

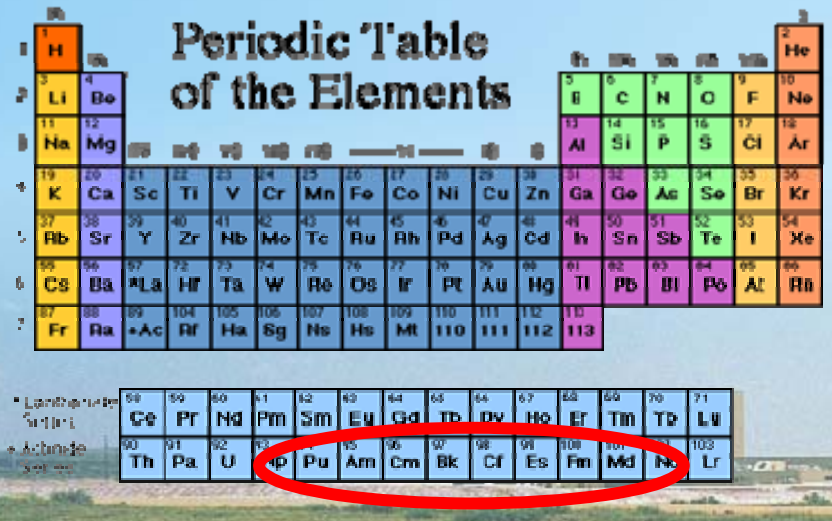
"The great advantage is that no water can pass through salt. Fractures are self healing…."

National Academy of Sciences, 1957

Salado Evaporite Formation

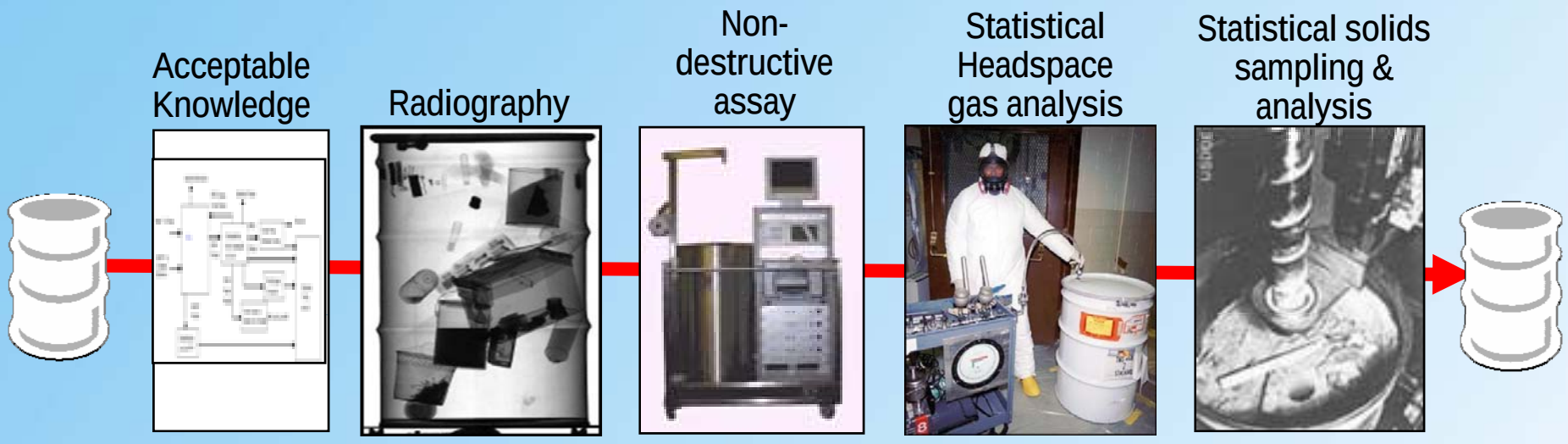
The deepest and thickest salt sequences suitable for deep geologic isolation are in the northern half of the Delaware Basin

WIPP is Limited to TRU waste



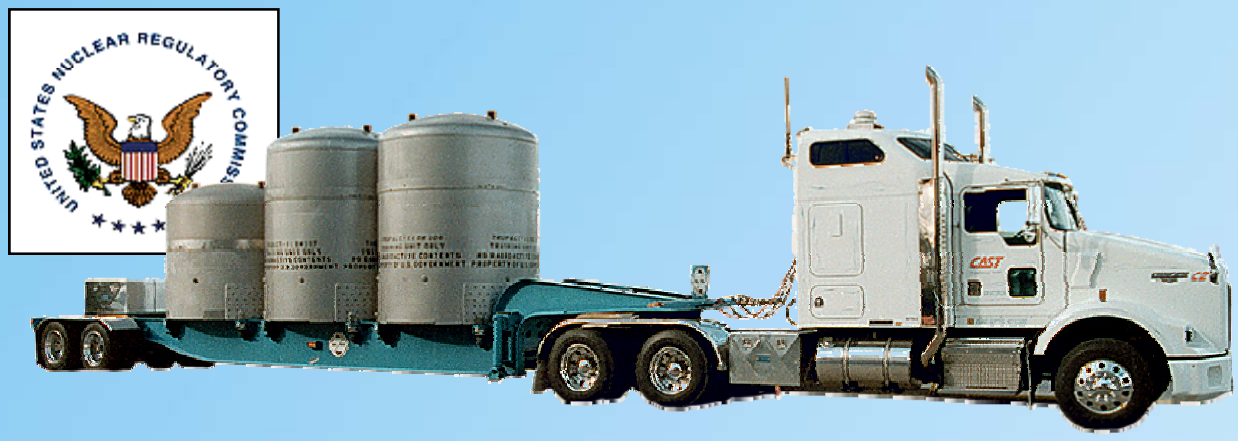
- **HLW and SNF legislatively prohibited**
- **>100 nCi/g (>3700 Bq/g ~1ppm):**
  - **alpha emitting isotopes**
  - **$t_{1/2}$ > 20 years**
  - **TRU ~ Greater Than Class C**
- **Two types of TRU waste**
  - **Contact-handled**
    - **<200 mrem/hr (<2mSv/hr)**
  - **Remote-handled**
    - **0.2 – 1000 rem/hr (.002 – 10 Sv/hr)**
- **Legacy inventory ~700,000 drum equivalents**

The Dance of the Drums
Packaging and Characterization

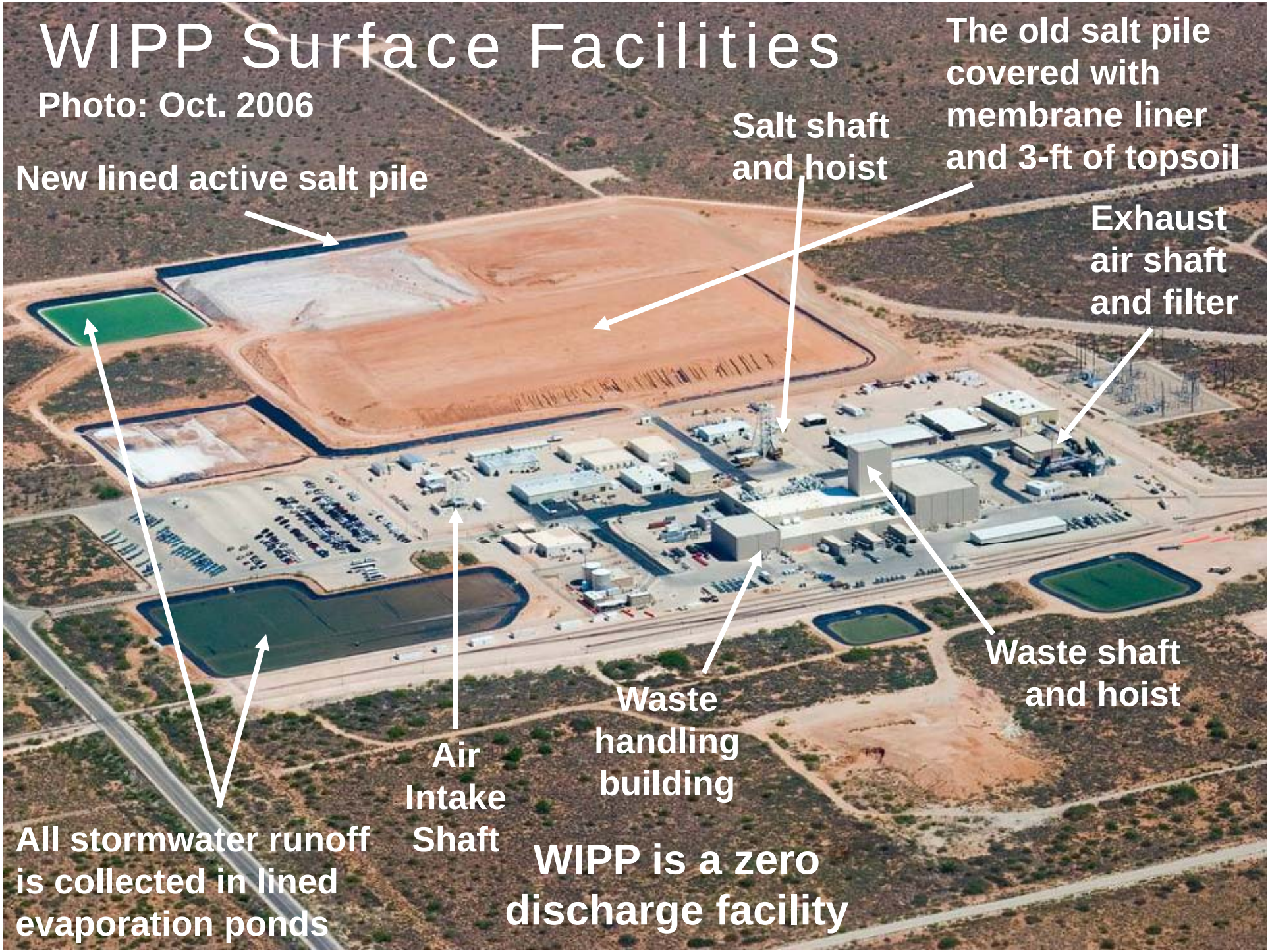


- **Payload containers nominally move 10 - 20 times before assembly into packages for final shipment to WIPP**
- **$2,000-$10,000 per container depending on waste type and AK pedigree**
- **All operations audited annually by CBFO with regulatory scrutiny**
- **Mistakes here result in regulatory compliance orders and penalties**

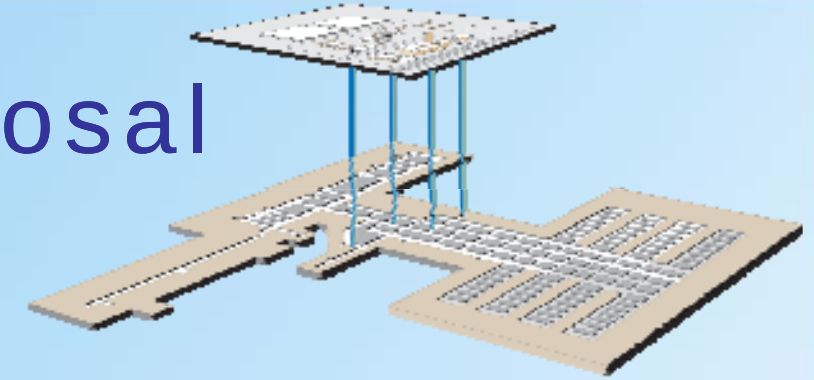
NRC Licensed Shipping Packages




Shipping Corridors
Hanford
432
Framatome
Idaho National Laboratory (INL)
3480
Argonne (ANL-W)
Lawrence Berkeley National Laboratory (LBNL)
Lawrence Livermore National Laboratory (LLNL)
General Electric Vallecitos Nuclear Center
18
Nevada Test Site (NTS)
48
Rocky Flats Environmental Technology Site (RFETS)
2,045
Los Alamos National Laboratory (LANL)
489
Energy Technology Engineering Center
Sandia National Laboratories
Lovelace Respiratory Research Institute
Waste Isolation Pilot Plant (WIPP)
US Army Materiel Command
Argonne (ANL)
25
Battelle Columbus Laboratories
Mound
University of Missouri Research Reactor
Paducah Gaseous Diffusion Plant
KAPL Nuclear Fuel Services
Oak Ridge National Laboratory (ORNL)
7
Savannah River Site (SRS)
1011
Knolls Atomic Power Laboratory
Separation Process Research Unit
Teledyne Brown
Bettis Atomic Power Laboratory
ARCO
Babcock & Wilcox NES, VA
Total shipments thru June, 2009
7,555
~9 million loaded miles
14 sites completed


WIPP Surface Facilities
Photo: Oct. 2006
New lined active salt pile
Salt shaft and hoist
The old salt pile covered with membrane liner and 3-ft of topsoil
Exhaust air shaft and filter
Waste shaft and hoist
Waste handling building
Air Intake Shaft
All stormwater runoff is collected in lined evaporation ponds
WIPP is a zero discharge facility

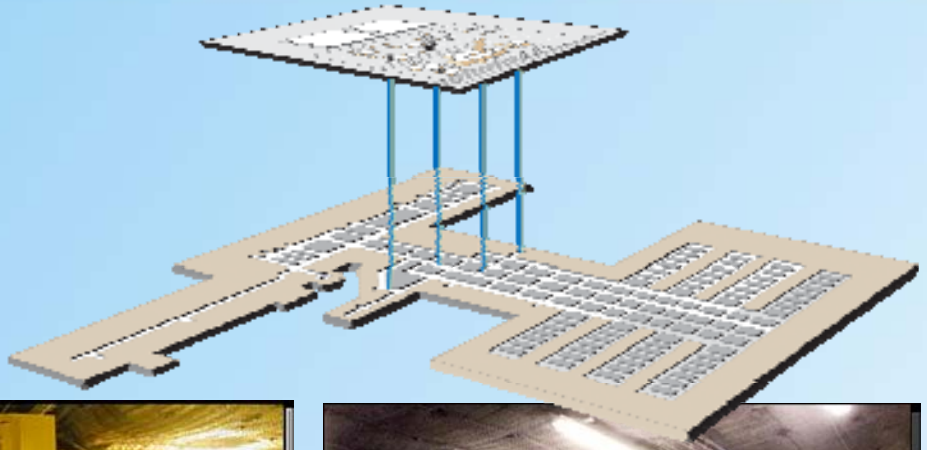
CH Disposal



Waste containers are unloaded and lowered 2,150 feet underground for final emplacement

Waste is emplaced in rooms mined out of ancient saltbeds. Magnesium oxide is placed on waste stack to limit solubility of radionuclides (engineered {chemical} barrier)

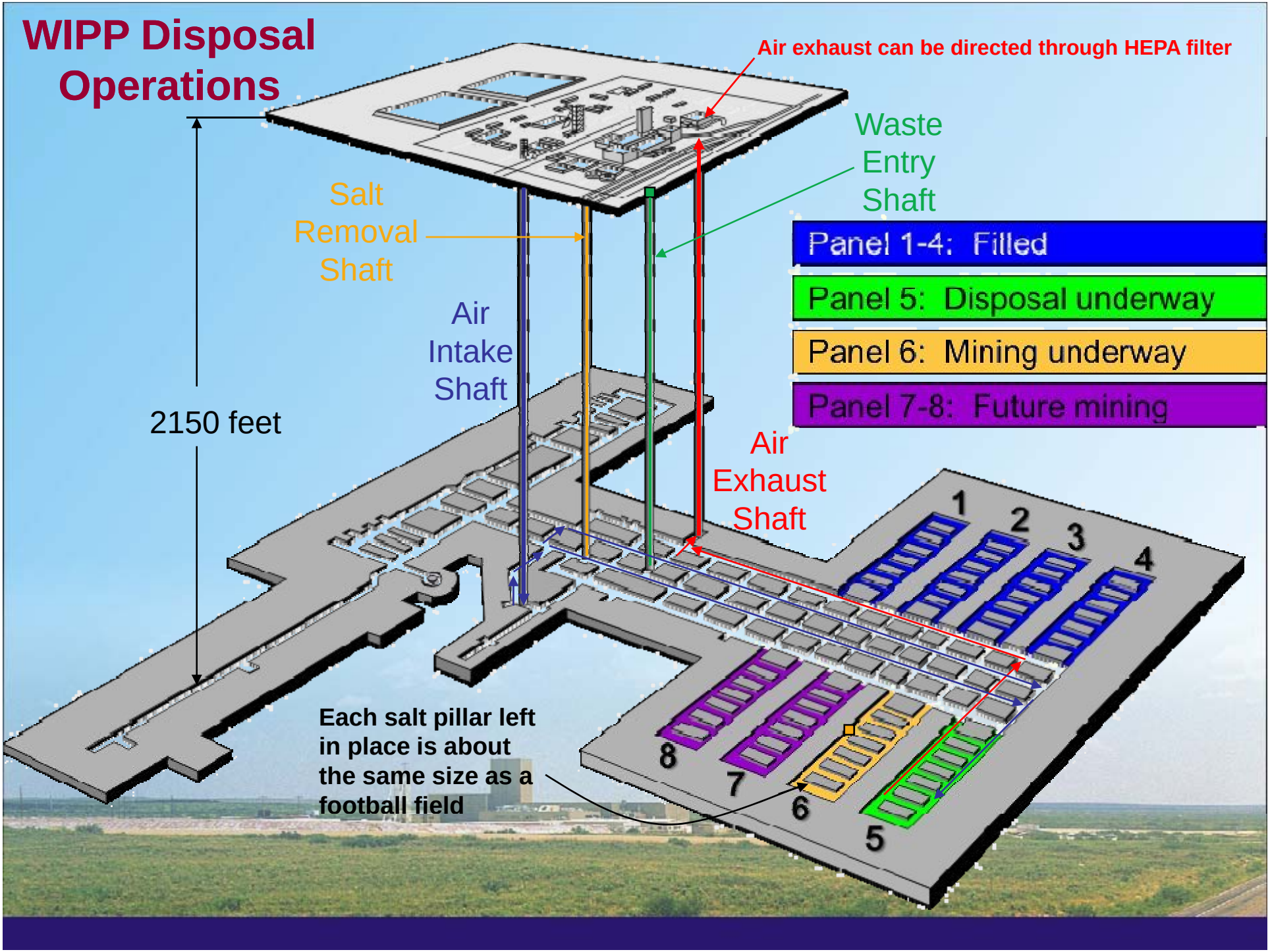
RH Disposal



Remote Handled waste canisters are pulled from the shipping cask behind shield doors and placed into a shielded facility cask for handling at WIPP

In the underground, the facility cask is removed from the hoist and transported to a disposal room by a 41-ton fork lift

RH waste in the canister is emplaced in boreholes pre-drilled into the walls of disposal rooms, and a concrete shield plug is inserted afterwards


WIPP Disposal Operations
Air exhaust can be directed through HEPA filter
Waste Entry Shaft
Salt Removal Shaft
Air Intake Shaft
Air Exhaust Shaft
2150 feet
Panel 1-4: Filled
Panel 5: Disposal underway
Panel 6: Mining underway
Panel 7-8: Future mining
1
2
3
4
5
6
7
8
Each salt pillar left in place is about the same size as a football field

People and Equipment

- **40 tractor trucking fleet (2 private carriers)**
- **112 shipping containers (84+15+12+1)**
- **5 mobile characterization lines deployed at TRU sites**
- **1000-employee workforce:**
  - **50 Carlsbad Field Office of DOE (CBFO)**
  - **45 Carlsbad Field Office Technical Assistance Contractor (CTAC)**
  - **38 Los Alamos National Laboratory-Carlsbad (LANL-CO)**
  - **75 Sandia National Laboratories-Carlsbad (SNL-C)**
  - **630 Washington TRU Solutions (WTS) – M&O Contractor**
  - **162 WTS subcontractors (records, security, environmental, information systems)**

Snapshot (Through June, 2009)

10 +	years of operation
7,555	shipments received
~300,000	loaded drum equivalent containers disposed
>60,000	cubic meters of TRU waste disposed
~9,000,000	loaded miles
~4	waste panels filled and closed
14	storage sites cleaned of legacy TRU waste
0	releases to the environment
0	contaminated WIPP personnel

22 consecutive years as NM "Mine Operator of the Year"

TITLE 40 - PROTECTION OF ENVIRONMENT

Part 191 - Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes

Subpart A - Environmental Standards for Management and Storage

Subpart B - Environmental Standards for Disposal

191.13. Containment requirements

a) Disposal systems … shall be designed to provide a reasonable expectation, based upon **performance assessments**, that the cumulative releases of radionuclides to the accessible environment for 10,000 years after disposal from **all significant processes and events** that **may affect the disposal system** shall be **less than specified releases limits**

191.14. Assurance requirements

191.15. Individual protection requirements

Subpart C - Environmental Standards for Ground-Water Protection

40CFR191.13.a Disposal systems … shall be designed to provide a reasonable expectation, based upon performance assessments, that the cumulative releases of radionuclides to the accessible environment for 10,000 years after disposal from **all significant processes** and events that may affect the disposal system shall be less than specified releases limits

Features, events, and processes (FEPs) FEPs are screened according to:

Probability: If probability of FEP $<10^{-4}$ in 10,000 years it is not included in PA (e.g., meteorite impact)

Consequence: if FEP is beneficial to performance or is not relevant to WIPP it is not included in PA (e.g., sorption, ocean rise).

Regulation: Certain FEPs are either screened in or out by regulation (e.g., mining, resource extraction following drilling).

Expected FEPs are included in all scenarios, e.g.,

- Creep closure
- Brine flow
- Gas generation

Disruptive FEPs only included in disturbed scenarios, e.g.,

- Drilling
- Mining
- Brine pocket

40CFR191.13.a Disposal systems … shall be designed to provide a reasonable expectation, based upon performance assessments, that the cumulative releases of radionuclides to the accessible environment for 10,000 years after disposal from all significant processes and events that **may affect the disposal system** shall be less than specified releases limits

24 Conceptual Models Used in WIPP PA

1. Disposal system geometry
2. Culebra hydrogeology
3. Repository fluid flow
4. Salado
5. Impure halite
6. Salado interbeds
7. Disturbed rock zone
8. Actinide transport in Salado
9. Units above the Salado
10. Dissolved transport in Culebra
11. Colloidal transport in Culebra
12. Exploration boreholes
13. Cuttings & Cavings
14. Spallings
15. Direct brine release
16. Castile and brine reservoir
17. Multiple intrusions
18. Climate change
19. Creep closure
20. Shafts and shaft seals
21. Gas generation
22. Chemical conditions
23. Dissolved actinide source term
24. Colloidal actinide source term

40CFR191.13.a Disposal systems … shall be designed to provide a reasonable expectation, based upon performance assessments, that the cumulative releases of radionuclides to the accessible environment for 10,000 years after disposal from all significant processes and events that may affect the disposal system shall be **less than specified releases limits**

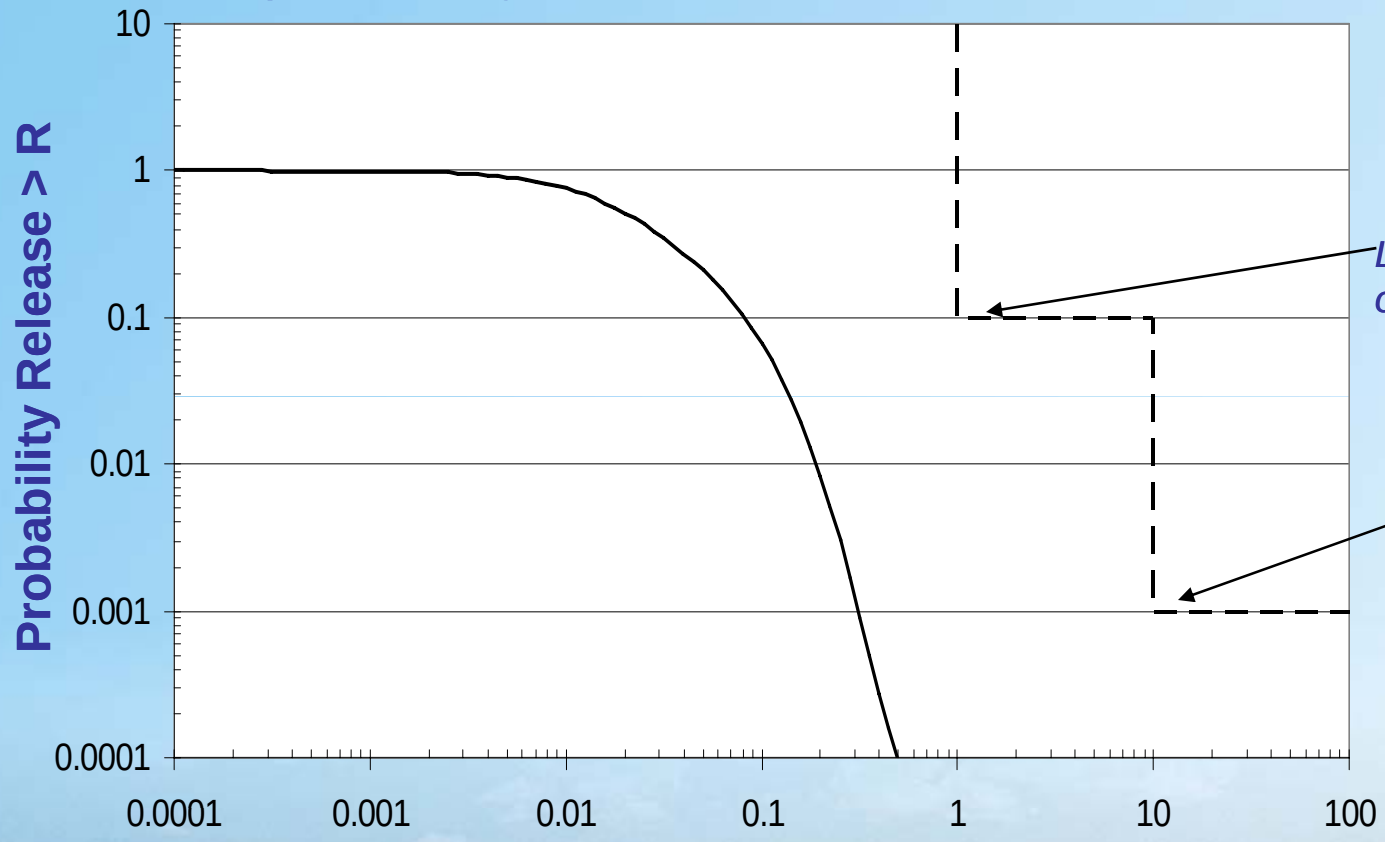
Release limits normalized by radionuclide and by total inventory

$$R = \sum \frac{Q_i}{L_i}\left(\frac{1\times10^{6}\,curies}{C}\right)$$

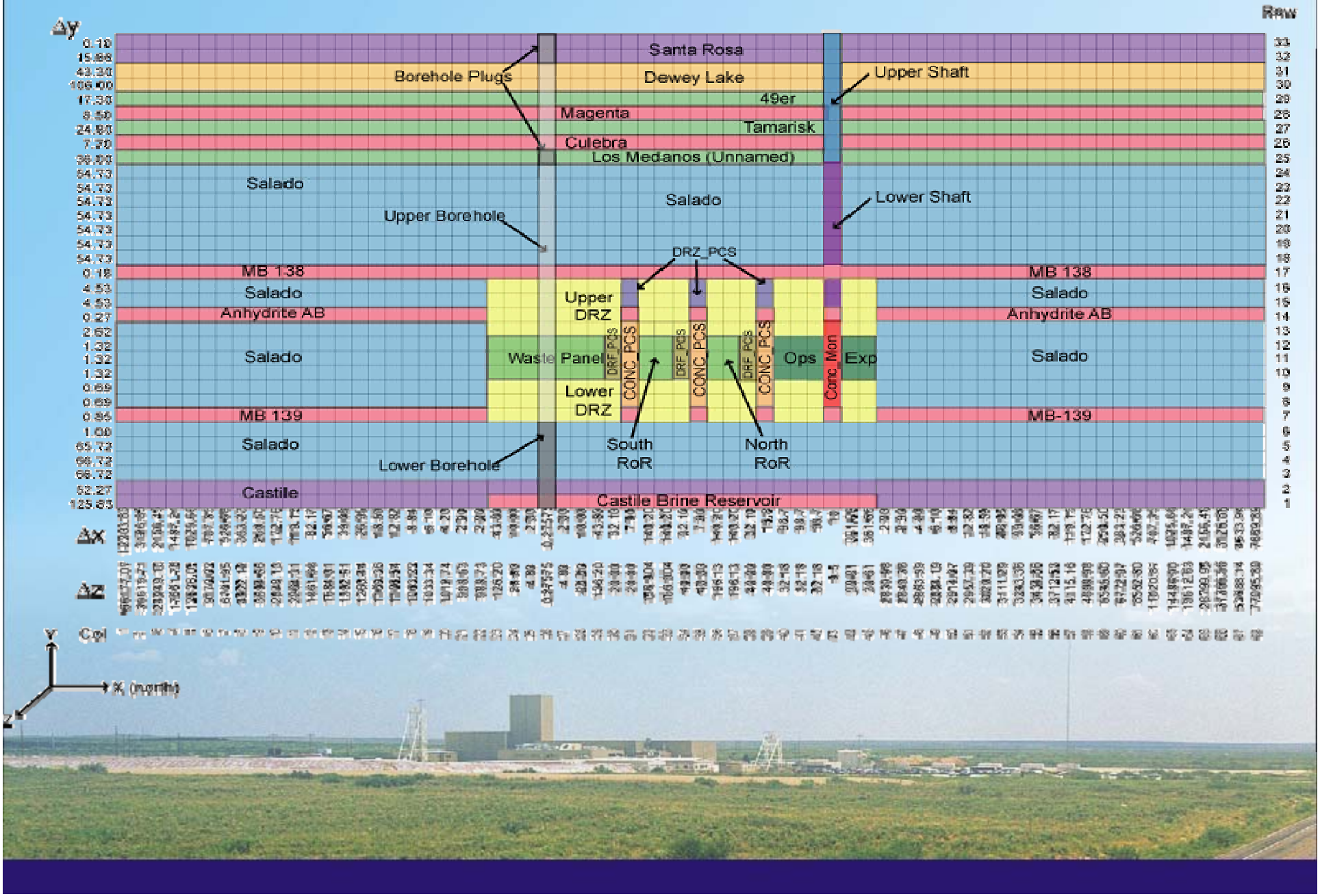
R = Normalized release in "EPA units"
Q_i = 10,000-year cumulative release (in curies) of radionuclide *i*
L_i = Release Limit for radionuclide *i*
C = total transuranic inventory (curies of α emitters $t_{1/2}$ > 20 years)

Release Limits: CCDF is a Measure of Compliance

Complementary Cumulative Distribution Function

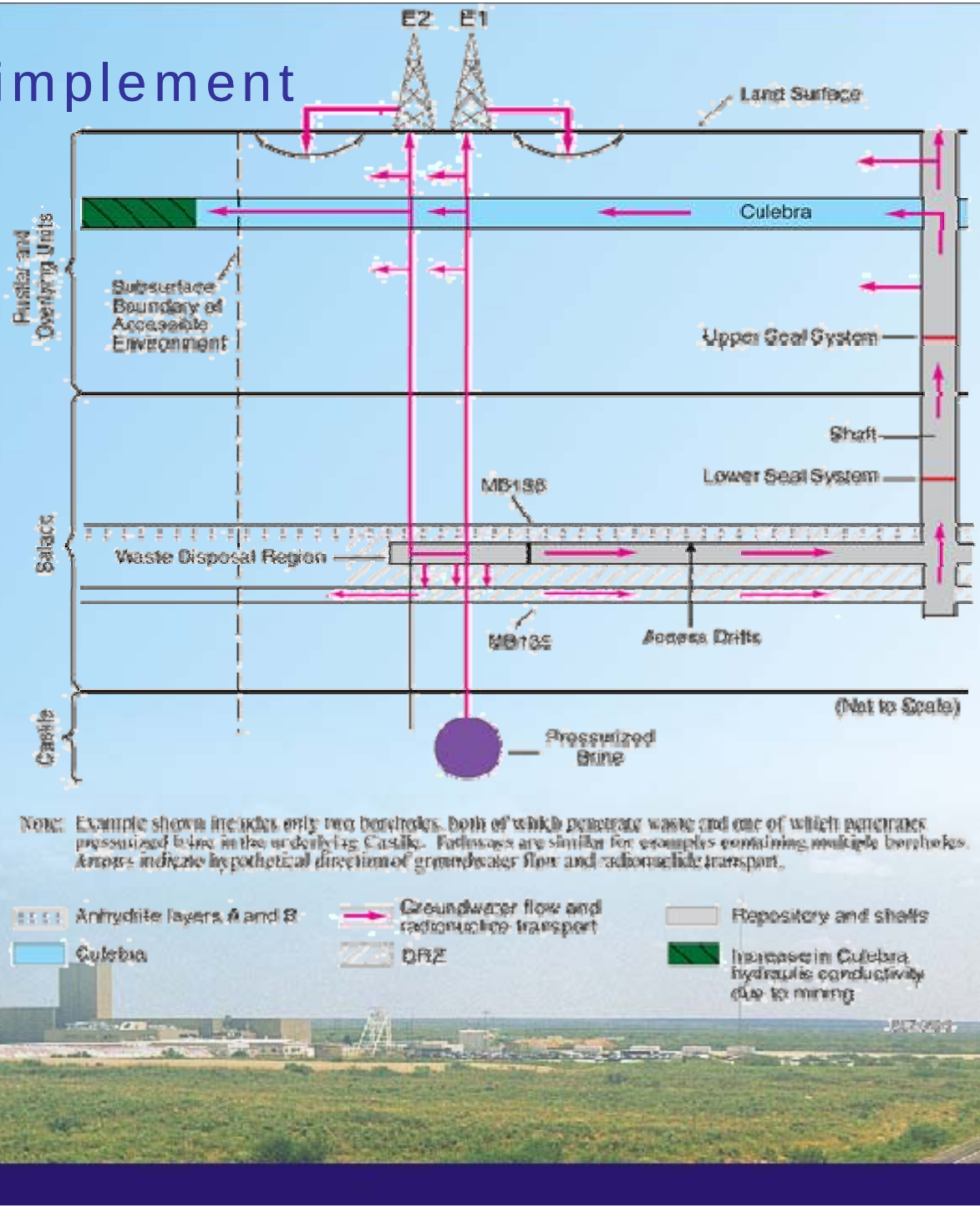


WIPP Performance Assessment Grid



Process models implement and combine conceptual models

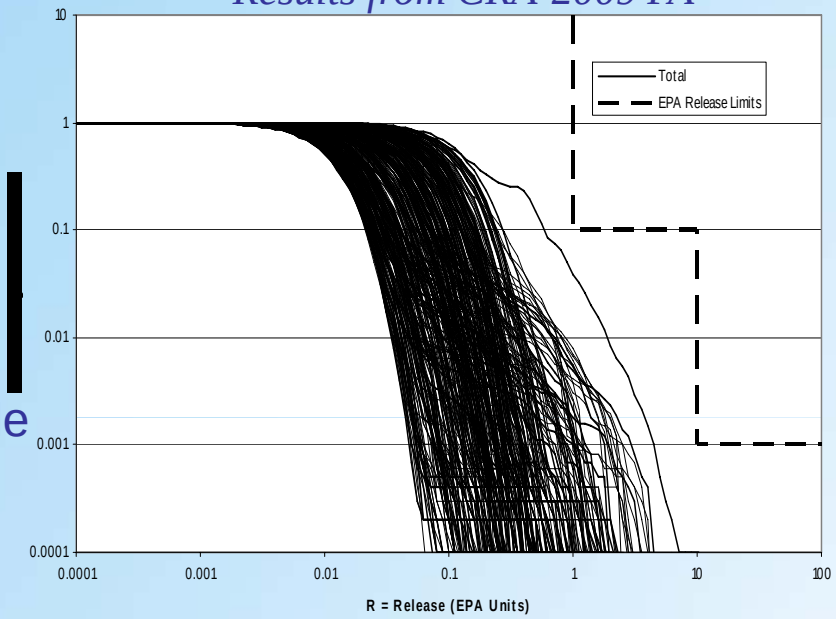
- Subsurface brine and gas flow
- Radionuclide transport in the subsurface
- Gas generation
- Brine and solids flow up a borehole
- Permeability enhancement due to fracturing
- Room closure
- Solid extraction by drilling

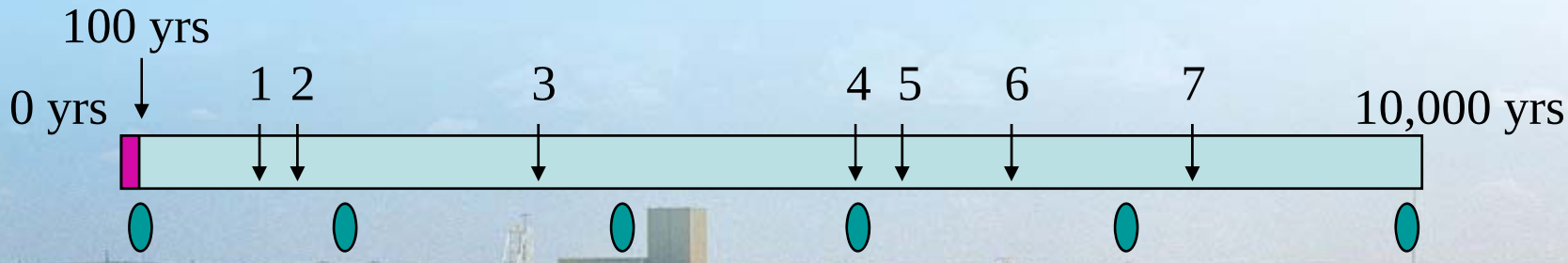


10,000 possible futures are generated for each vector.

- Each future consists of a series of randomly occurring drilling intrusions.
- The consequences of drilling intrusions are calculated by interpolating between consequences at discrete times.
- The cumulative release from one possible sequence of events from 0 to 10,000 years is called a future

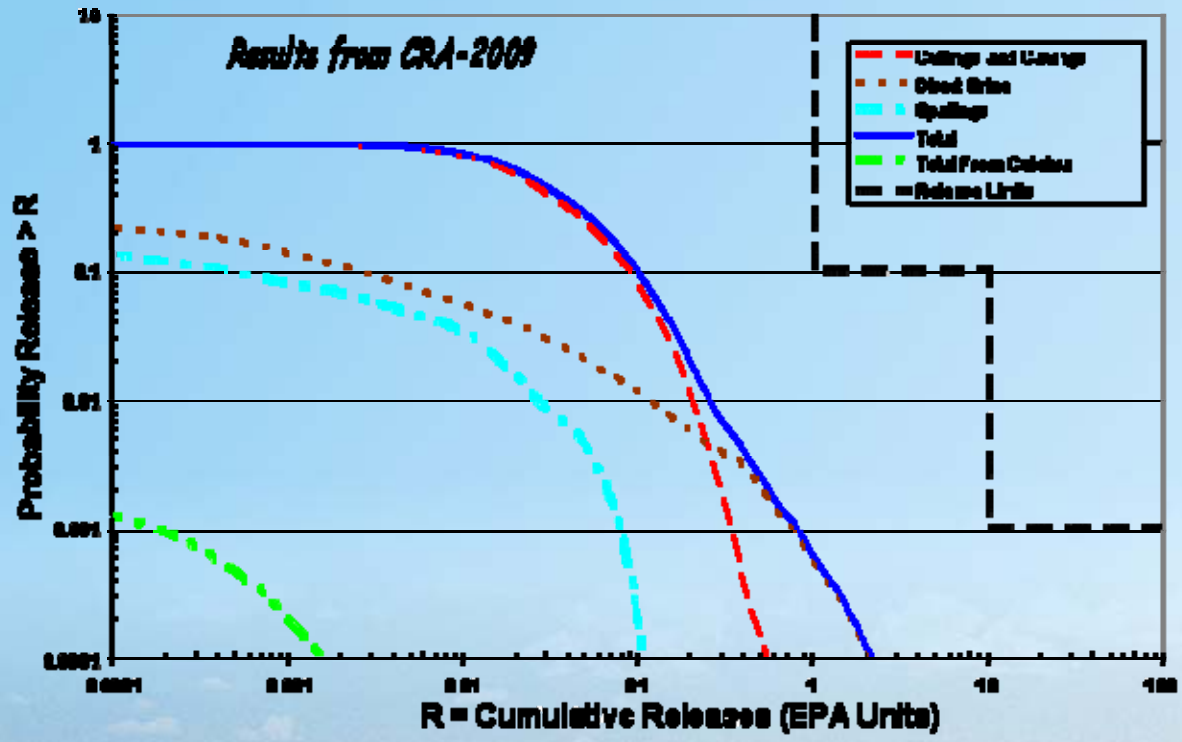
Results from CRA-2009 PA





WIPP Compliance Posture

Disturbed Performance (human intrusion)



Undisturbed Performance

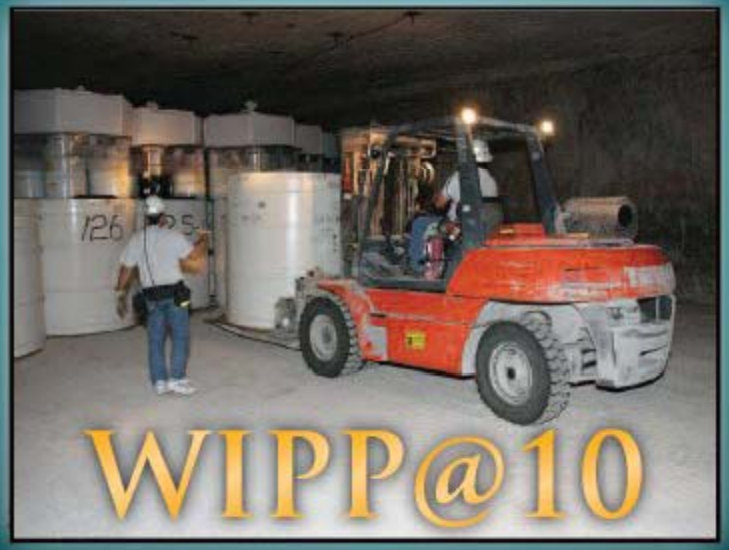
Release = 0

Closure animation showing salt creep crushing waste in the WIPP underground, healing fractures and reconsolidating

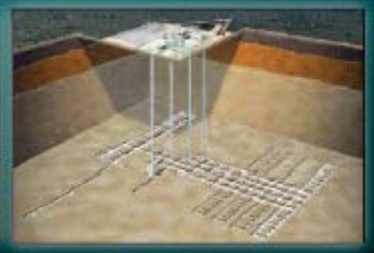
A PUBLICATION OF THE AMERICAN NUCLEAR SOCIETY

Radwaste Solutions

THE MAGAZINE OF RADIOACTIVE WASTE MANAGEMENT AND FACILITY REMEDIATION
MAY/JUNE 2009



WIPP@10



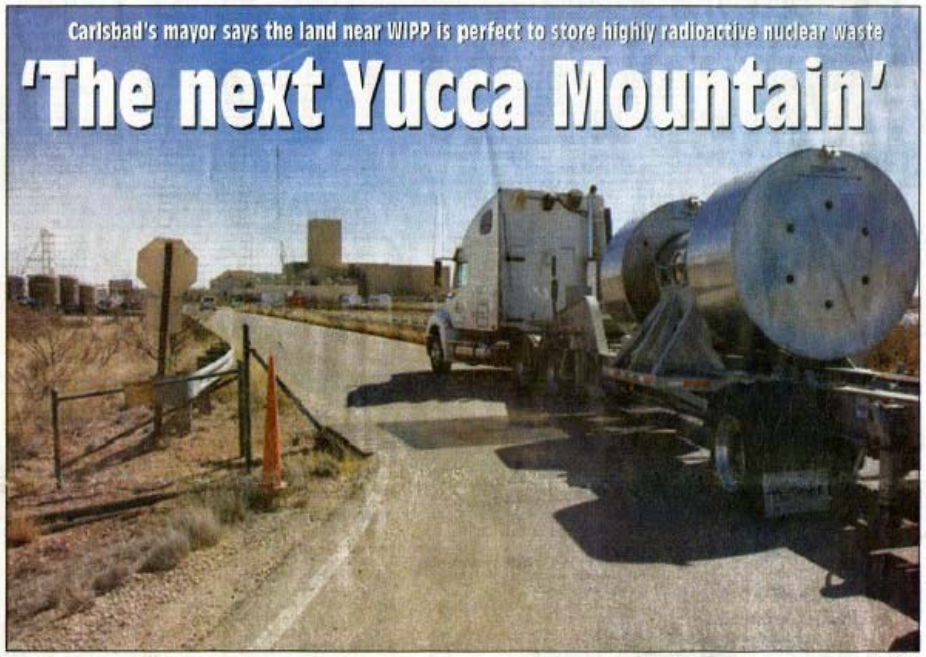
FRIDAY
March 27, 2009 50 cents

News-Sun

JAL EUNICE HOBBS LOVINGTON TATUM SEMINOLE DENVER CITY

Carlsbad's mayor says the land near WIPP is perfect to store highly radioactive nuclear waste

'The next Yucca Mountain'



AP PHOTO

This Feb. 27 photo courtesy of the U.S. Department of Energy's Carlsbad Field Office shows the arrival of remote-handled transuranic waste at the Waste Isolation Pilot Plant near Carlsbad.

'The community's ready, the timing couldn't be better'

ALBUQUERQUE (AP) — Longtime Carlsbad Mayor Bob Forrest recalls the days when no one wanted to take the federal government's radioactive waste except his southern New Mexico community.

Ten years after it opened, the Waste Isolation Pilot Plant, commonly known as WIPP, remains the government's only radioactive waste dump.

But now, Forrest says, the climate for all things nuclear has changed, and communities across the nation are fighting for projects.

Forrest himself believes the vast, 250 million-year-old salt beds that house WIPP east of his community of about 25,000 could store high-level nuclear waste such as that once destined for the Yucca Mountain project the Obama administration is apparently abandoning.

Such a repository would be separate from WIPP, he said.

WIPP, excavated 2,150 feet below the surface of the desert, is designed for so-called transuranic waste generated by the nation's defense work — such

SEE YUCCA, Page 3

An historic marker is seen as the cooling towers of Three Mile Island's Unit 1 Nuclear Power Plant pour steam into the sky in Middletown, Pa.

Global warming giving nuclear power new support

MIDDLETOWN, Pa. (AP) — The nation's worst nuclear power plant accident was unfolding on Pennsylvania's Three Mile Island when an industry economist took the rostrum at a nearby business luncheon.

It did not go well.

Those in the standing-room-only crowd listened to economist Doug Biden's thoughts about cheap, reliable nuclear power, but Biden could not calm their nerves or answer their pointed questions: Should they join the tens of thousands of people fleeing south-central Pennsylvania? Should they let their children drink local milk?

Three decades later, fears of an atomic

SEE NUCLEAR, Page 3

WIPP pilots safe and environmentally responsible waste management and energy solutions