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Concepts in Designing a Disposal System

John R. Cochran
(jrcochr@sandia.gov)
Sandia National Laboratories
Albuquerque, New Mexico

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Topics

- Design by Objective
- Designers Tools
- Specific Topics
- Example Designs

- For disposal of VLLW, LLW and ILW

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Design by Objective

- Design must be for specific set of objectives !
- If you don't know the objectives, you can't design and evaluate the design

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Typical Design Objectives

- Keep people from accidentally contacting wastes
- Keep wastes from migrating to people
- Long-term stability without active human controls
- Cost effective

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Design Tools

- Site characteristics
- Waste form
- Waste package
- Engineered barriers

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Keep people from accidentally contacting wastes

- **Site characteristics –** avoid population centers, avoid resource rich areas (future minerals extraction), avoid future farming areas
- **Waste form –** set limits on what is buried (part of the Waste Acceptance Criteria or WAC), keep specific activities of each packages low
- **Waste package –** make package and hazard recognizable for long time frames
- **Engineered barriers –** use depth of burial, deeper is better, use intruder barriers, warning markers (some people believe markers may *attract* future intruders looking for treasure)

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Keep wastes from migrating to people

- **Site characteristics – arid site is better, because water dissolves waste and moves it, deep water table is better – if there is no water, there is ~ no movement of radionuclides (except by intrusion)**
- **Waste form – insoluble waste form, no liquids!, set limits on what is buried using the WAC**
- **Waste package – use long-lived water-tight packages to keep water from dissolving and carrying waste**
- **Engineered barriers – use impermeable caps to keep water off wastes**

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Long-term stability without active human controls

- **Site characteristics –** avoid: tectonically active areas, volcanically-active areas, landslide areas, floodplains
- **Waste form –** use stable waste forms
- **Waste package –** do not bury voids, compressible wastes and wastes that will decay (like wood and cardboard)
- **Engineered barriers –** should be in harmony with geo-environment, avoid “leachate-collection systems” requires active human control

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Cost-effective

- **Site characteristics – pick "simple" sites that are easy to characterize and easy model, pick sites near population centers to reduce travel time**
- **Waste form – for ALARA and cost, limit the amount of conditioning before disposal**
- **Waste package – do not use packages or use inexpensive packages**
- **Engineered barriers – do not use engineered barriers or use inexpensive natural materials**

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Special Topics: Multiple Barriers

- Use multiple barriers
- If one barrier fails, the other barrier can still work
  (for example; arid site + insoluble waste form)

- A barrier is any material or structure that prevents or substantially delays movement of water or radionuclides:
  - a geologic structure
  - a waste form that significantly decreases the mobility of radionuclides,
  - a canister/container that significantly decreases the mobility of radionuclides, and
  - a material placed over and around waste that substantially delays movement of water or radionuclides.

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Special Topics: Impermeable Base

- Use free draining base
- Impermeable liners will cause moisture to collect in waste and are only good so long a humans can pump leachate

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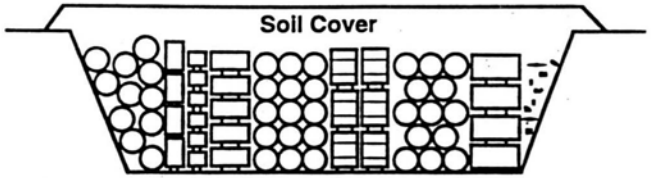
Special Topics: Prevent Future Subsidence

- Several early US radioactive waste landfills failed in < 10 years,
- Cap was destroyed by subsidence of landfill contents (also wet climate and impermeable liner contributed to the failure)
- Do not bury voids and wastes that will decay and rot
- Subsidence can destroy cap and focus precipitation



As Constructed

Differential Subsidence
During Active Subsidence

Differential Subsidence
in the Long Term

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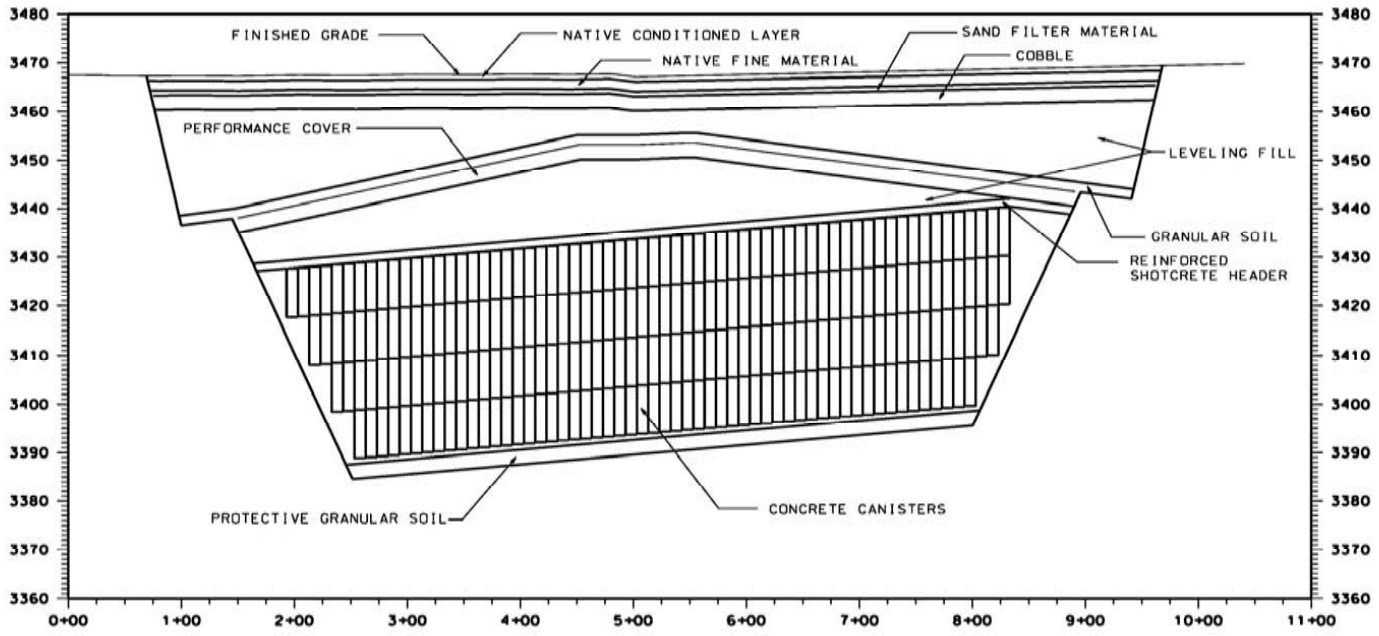
Balancing

- Must balance different design elements – for example, it is less expensive to characterize and use a disposal site near a population center, but more protective of human health to move disposal facility far from populations centers
- Look for lowest-cost option that still meets performance objectives

Example Designs

- Proposed design by Waste Control Specialists, Andrews Texas
- Actual design EnergySolutions, Clive Utah
- Conceptual Design

Waste Control Specialist, USA



C / CO.12 CWF CROSS SECTION POST CLOSURE

NOTE: VERTICAL SCALE EXPANDED (5:1)

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WASTE CONTROL SPECIALISTS LLRW LICENSE APPLICATION

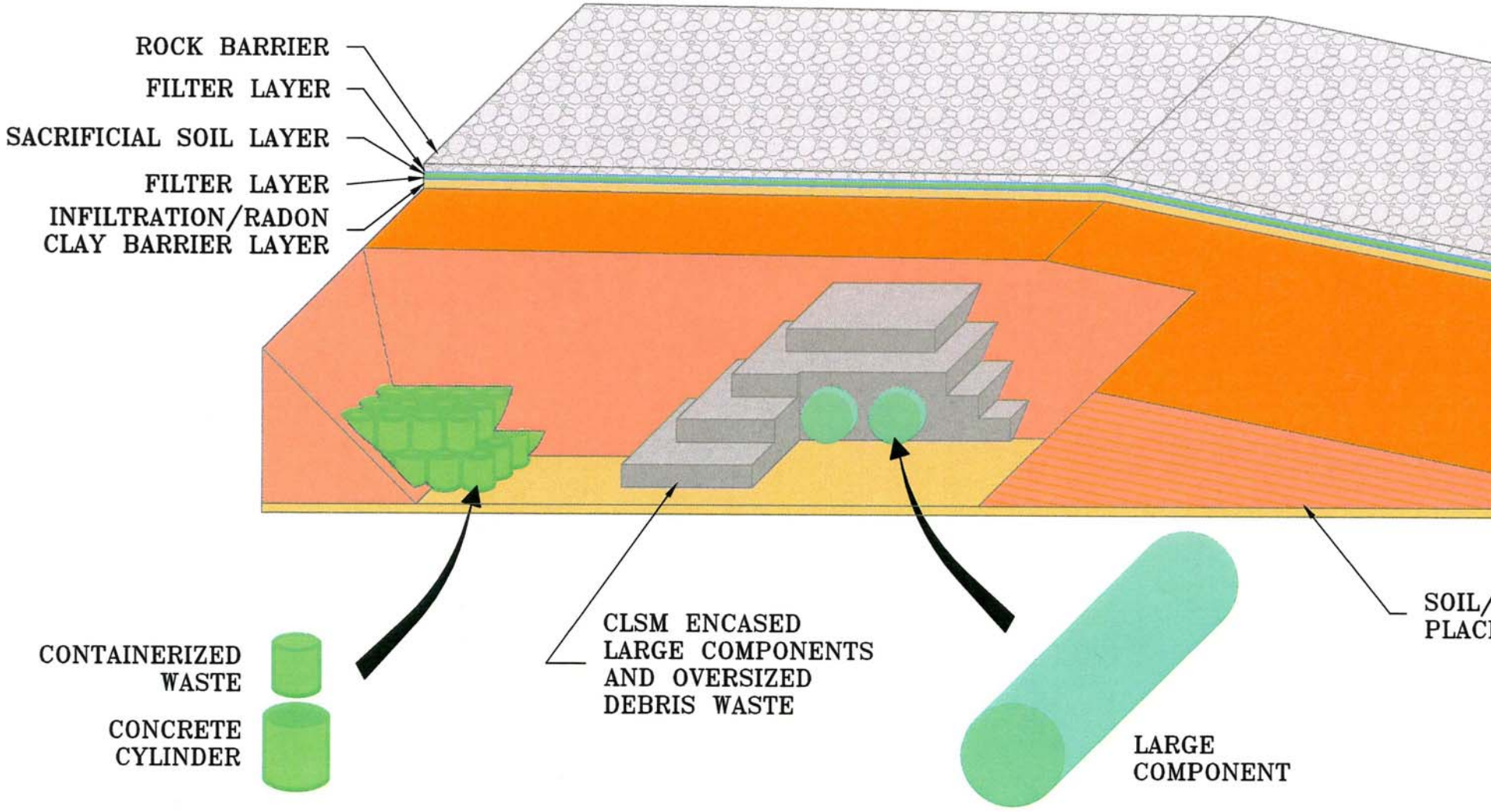
CWF - WASTE DISPOSAL SECTIONS

SHEET REFERENCE NUMBER C1.6

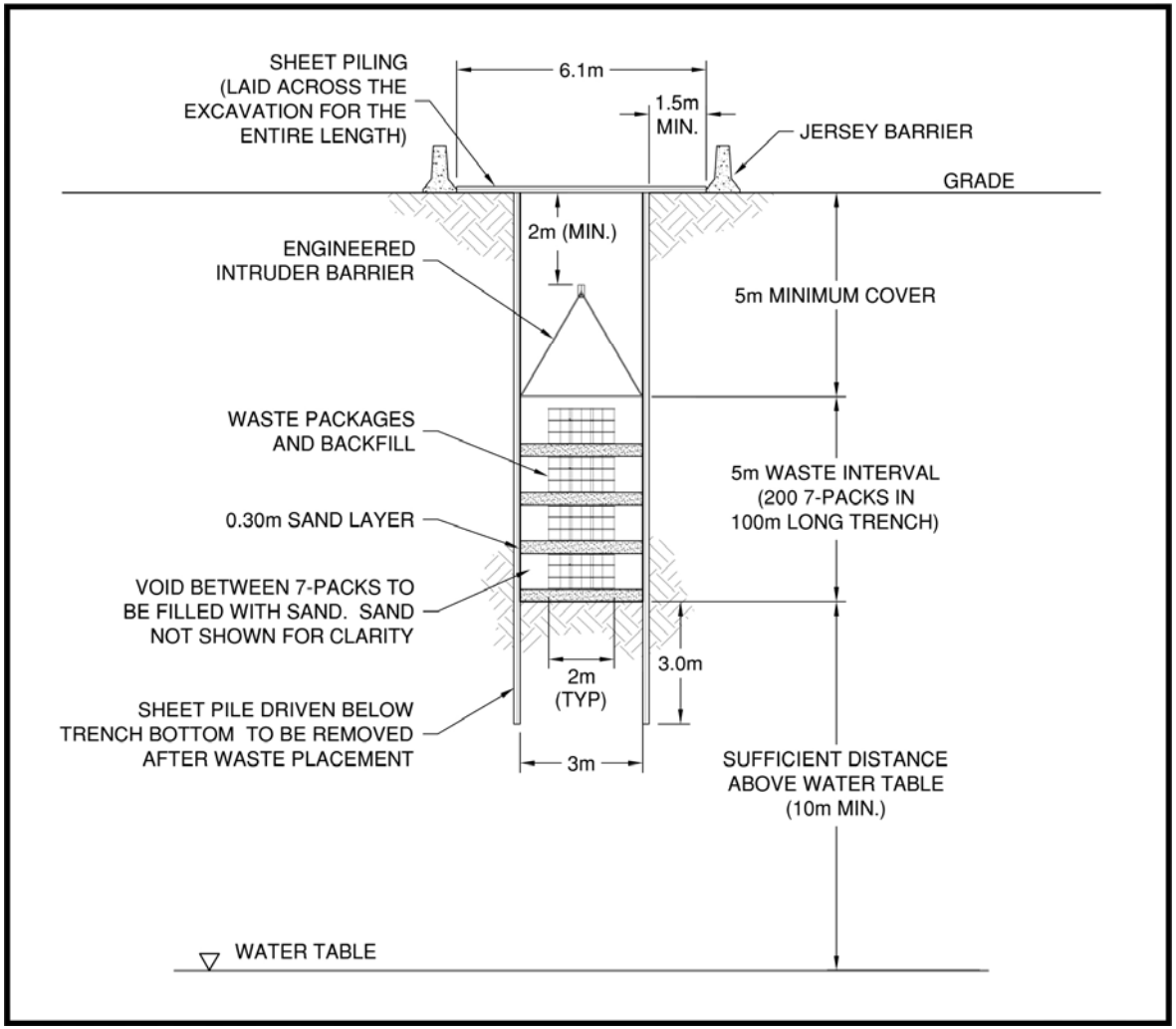
PROJECT NO. 39400004

WASTECONTROL SpecialistsLLC

URS


ROCK BARRIER
FILTER LAYER
SACRIFICIAL SOIL LAYER
FILTER LAYER
INFILTRATION/RADON
CLAY BARRIER LAYER
CONTAINERIZED
WASTE
CONCRETE
CYLINDER
CLSM ENCASED
LARGE COMPONENTS
AND OVERSIZED
DEBRIS WASTE
LARGE
COMPONENT
SOIL/
PLAC

Conceptual 3 m x 5 m deep trench



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Summary

- Design by Objective
- Designers Tools
  - Site characteristics
  - Waste form
  - Waste package
  - Engineered barriers
- Specific Topics
  - Multiple barriers
  - Impermeable base
  - Prevent subsidence
- Example Designs