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Consulting Group, Inc.

15 April 1986

Dr. Jerome Pearring
U.S. Nuclear Regulatory Commission
Division of Waste Management
Washington, D.C. 20555

"NRC Technical Assistance
for Design Reviews"
Contract No. NRC-02-85-002
FIN D1016

Dear Jerry:

Jaak asked that I forward the enclosed note, which is an updated outline on decommissioning sealing. He specifically addressed your request for data need identification.

I hope our letter to you was a correct assessment of NRC needs for the salt review effort. Please let me know if you need any further information.

Sincerely,

Roger

Roger D. Hart
Program Manager

Encl.
rdh/ks

P.O. Box 14806 • Minneapolis, Minnesota 55414 • (612) 623-9599

DRAFT

Salt Repository Decommissioning and Sealing Issues

J. Daemen
April 7, 1986

Preliminary problems:

1. Delays in DOE information transfer (i.e., is NRC reviewing current or outdated information?)

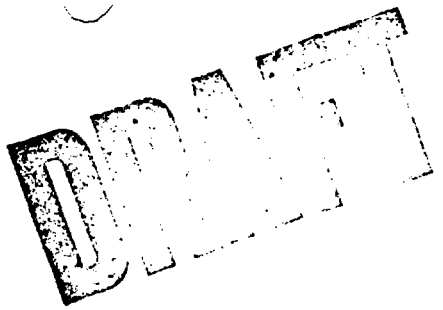
   SUGGESTION: All documents should include date when work was performed, as well as publication date.

2. NRC information needs: How much is needed, and when is it needed?

Sealing

- Shafts and boreholes
  - Materials:
    - cementitious; earthen; salt
    - information needs:
      - material performance characteristics, e.g.
        - hydraulic conductivity, strength, creep, as functions of time, temperature, pressure
        - longevity, durability, geochemical stability, e.g. interactions with groundwater, brine, surrounding rock
    - controversial:
      - organics (e.g. bitumen, chemical grouting, Chemseal)
      - casing; liners (to be removed?); concrete reinforcement
      - issues: durability - consequences of deterioration?
    - installation procedures and their effect on performance (particularly for boreholes, e.g. how does one compact crushed salt, bentonite in a borehole? and for grout/cement behind shaft liners)
- Shaft seal design:
  - geometry: shape - dimensions
  - damaged zone: - preventing/minimization
    - remedial action
  - caprock, aquitard penetration sealing
  - salt creep (walls)
  - salt creep and reconsolidation (crushed salt)

- Shaft construction and maintenance
  - construction method
    - drilling/blasting: damage?
    - boring: - grouting - is initial grout permanent?
      - interface: cleaning?
      - overbreak control - backfill
    - freezing: hole sealing - thawing damage?
    - liner: - part of permanent "sealing" system?
      - longevity
  - maintenance
    - grouting
    - liner replacement/additions
- Shaft surface protection - permanent closure
  - human intrusion
  - water inflow prevention?
  - institutional controls
- Borehole drilling, treatment, sealing
  - casing/cementing: permanent? if so, what are consequences of deterioration?
  - cementing: • products
    - methods, procedures
    - installation controls?
  - sealing: products, methods, procedures
  - location of old holes
  - treatment of old holes
  - risk of future holes
- Failure scenarios, performance assessment
  - past failure statistics?
  - failure mechanism identification; scenarios
    e.g. dissolutioning; material disintegration
  - consequence analysis
- Licensing applicability of "generic" tests and information
  - WIPP, ONWI, Asse
  - salt mine history
  - storage cavern history



- Sealing of anomalies
  - Types:
    - brine, gas caverns
    - clastic zones
    - faults
  - Detection?
  - Effects of waste emplacement?
    - thermal pressurization
    - migration
  - Remedial/preventive action
    - e.g. draining; grouting (backfilling)
- Backfill: rooms, drifts, (shafts)
  - timing
  - materials: salt; earthen; cementitious
  - emplacement in horizontal excavations: interface closure, sealing
  - damaged zone treatment:
    - preventive (excavation method; reinforcement)
    - remedial (grouting?)
- Primary post-closure issues
  - thermal effects:
    - caprock, aquitard deformation (fracturing?)
    - water circulation: re-activated dissolutioning?
    - inclusion pressurization - hydraulic fracturing?
    - inclusion heating - migration
    - seal-rock mechanical and chemical interactions
  - geochemical effects
  - room, drift, shaft creep closure
  - backfill consolidation
  - seal effectiveness, durability
- Primary pre-closure issues
  - risk of repository flooding
  - shaft sealing
  - accidental aquitard penetration
  - anomalies
  - inclusion migration/pressurization

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DECOMMISSIONING AND SEALING

Site Characterization Data Needs

This section is a tentative and preliminary discussion of the type of data that might be required during site characterization and of the types of issues that might have to be addressed in site characterization plans.

The primary objective is to ascertain that the site characterization will provide for the acquisition of all data necessary to demonstrate compliance with 10 CFR 60, in the present context especially §60.134, Design of seals for shafts and boreholes. A second and equally important objective is to preclude that site characterization activities induce irreversible effects that could significantly complicate permanent closure sealing or that could significantly reduce permanent closure sealing performance or reliability. A third objective, particularly in light of the long extensive history of flooding of mines in evaporite deposits, is the need to assure that site characterization activities, in particular deep holes and shafts, will not cause a substantial risk of repository flooding during operations, i.e. prior to permanent closure.

Most of the fundamental data necessary for sealing and permanent closure assessments will be gathered during site characterization as part of the overall site investigations, i.e. it is unlikely and unnecessary that a separate data gathering effort be implemented aimed exclusively at obtaining in situ geological data needed for seal design. Conversely, it is necessary that a survey of the site characterization plan be made to assure that all necessary data indeed is collected. Similarly, it is essential that all relevant data be accumulated and integrated within the seal design effort. Finally, it is essential that all data are collected that will document the impact of site characterization on sealing

and permanent closure, as well as the technical and contractual arrangements implemented to assure that site characterization will not permanently preclude acceptable permanent closure and sealing.

In situ parameters particularly necessary with regard to seal design, especially for the critical aquitards directly adjacent (above, below - if penetrated, to the side - e.g. dome flanks, if penetrated) to the soluble (halite) host formations:

- geology: mineralogy, stratigraphy, structure
- ground water: chemistry, pressure, flowrates
- mechanical rock properties: strength, in situ stress, deformability
- fractured zones, depths of anomalous water, brine, or gas pressures, inflows

Essential (QA'd) engineering data will include all drilling logs, with particular attention paid to maintaining depth records, brine/mud losses, water/gas inflows, mud composition, hole collapses, casing installed and cementing procedures used (including hole cleaning and flushing, cement mixes, volumes, and grouting procedures and logging). Probably more important than record keeping is the need to institute appropriate contractual procedures and field supervision methods, particularly with regard to dealing with drilling mud losses, with hole collapses, and with casing cementing. All three of these, whether for holes (e.g. characterization holes, freezing holes, principal ES holes) or for bored shafts, could have a permanent or difficult to remedy impact on permanent closure sealing closure sealing. In conventional practice remedial actions during mud losses or hole collapses, as well as casing cementing, focus on rapid recovery and progress. It is to be clear that similar procedures during repository-related operations must consider the impact of all such methods, and in particular of the durability of any products used, on permanent repository sealing.

Exploratory shaft construction and characterization data gathering needs include all parameters listed for drilling. Beyond that come parameters related to construction, which would depend greatly on the selected construction method (e.g. boring vs. conventional - freezing). Even more so than for drilling, it is essential that contractor, designer, and owner, explicitly recognize permanent closure sealing performance needs. ES construction will provide a unique opportunity to evaluate in situ the performance of various sealing components, to determine the damaged zone, the influence of freezing holes, of thawing of a freeze wall, of grout distribution behind steel liners, etc.

Summarizing Remarks

Preliminary and tentative guidelines are suggested for decommissioning sealing data needs during site characterization. Two broad classes of data needs are recognized: natural, in situ, geological conditions need to be identified, and manmade changes need to be identified (and their detrimental impact minimized). Data acquisition for the former should be an integral part of site characterization, while the latter will need to be addressed explicitly.

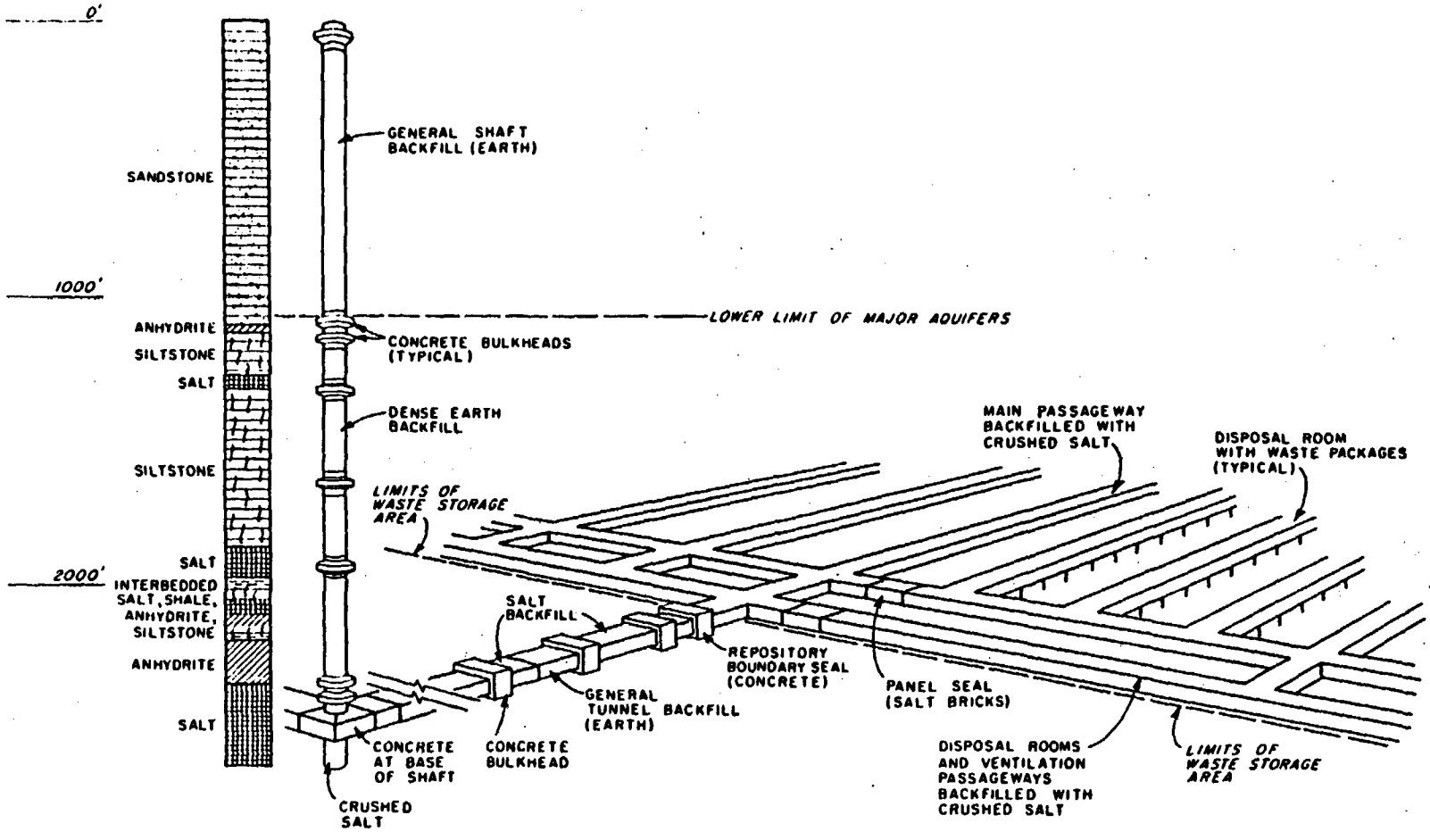
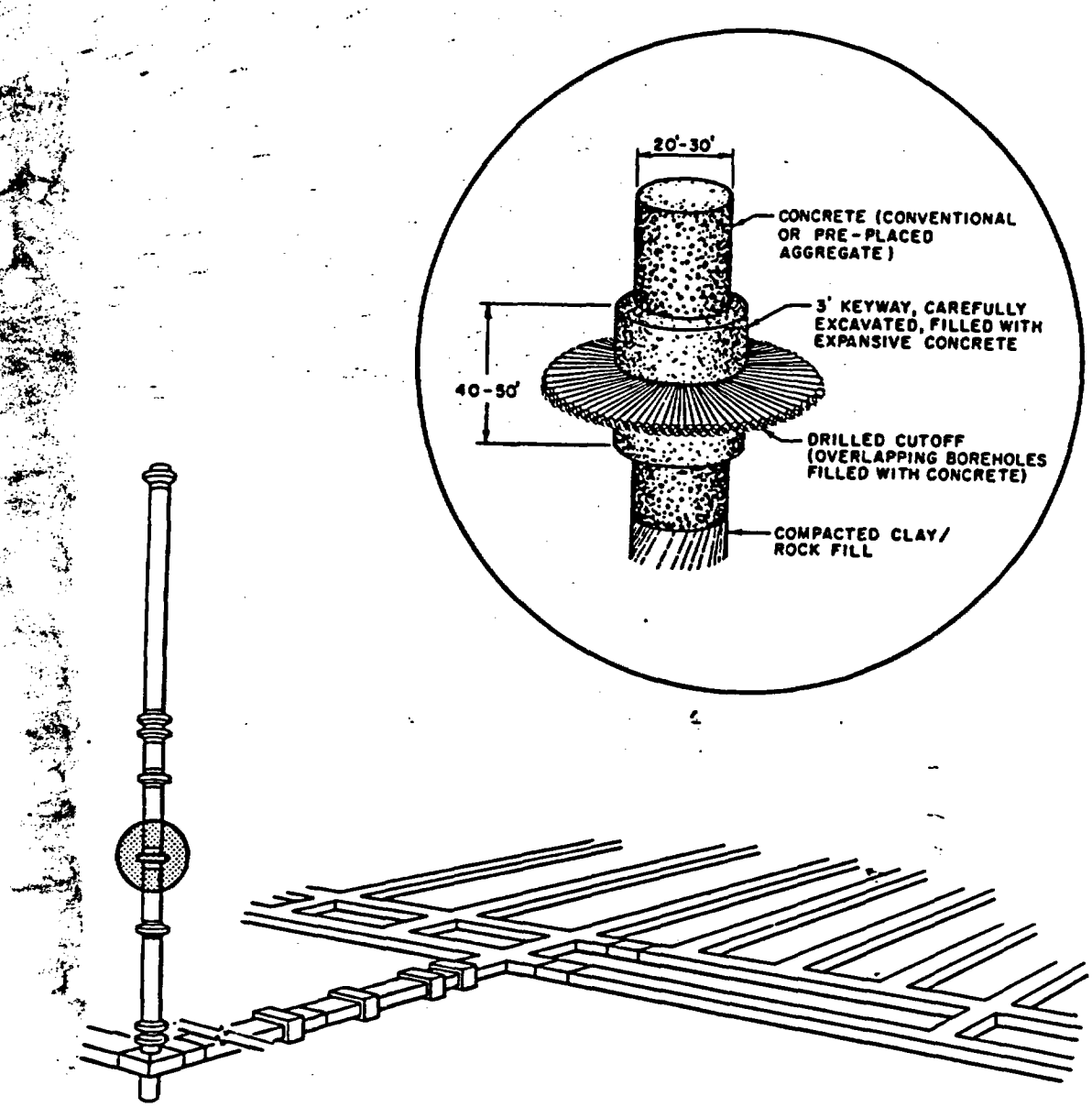


Figure 3-4. Tunnel-Shaft Seal System Schematic - Permian Basin Repository

From BMI/ONWI-564: Schematic Designs for Penetration Seals for a Repository in the Permian Basin. Prepared by P.C. Kelsall, J.B. Case, W.E. Coons, J.G. Franzone, and D. Meyer of IT Corporation for Office of Nuclear Waste Isolation, Battelle Memorial Institute, Columbus, Ohio, December 1985.



NOTES

SIMILAR CONCEPT WITHOUT DRILLED CUTOFF USED FOR SALT

BULKHEAD WITH DOUBLE DRILLED CUTOFF MAY BE USED IF COMPETENT ANHYDRITE IS SUFFICIENTLY THICK

Figure 3-8. Concept for Shaft Bulkhead in Anhydrite

From BMI/ONWI-564: Schematic Designs for Penetration Seals for a Repository in the Permian Basin. Prepared by P.C. Kelsall, J.B. Case, W.E. Coons, J.C. Franzone, and D. Meyer of IT Corporation for Office of Nuclear Waste Isolation, Battelle Memorial Institute, Columbus, Ohio, December 1985.

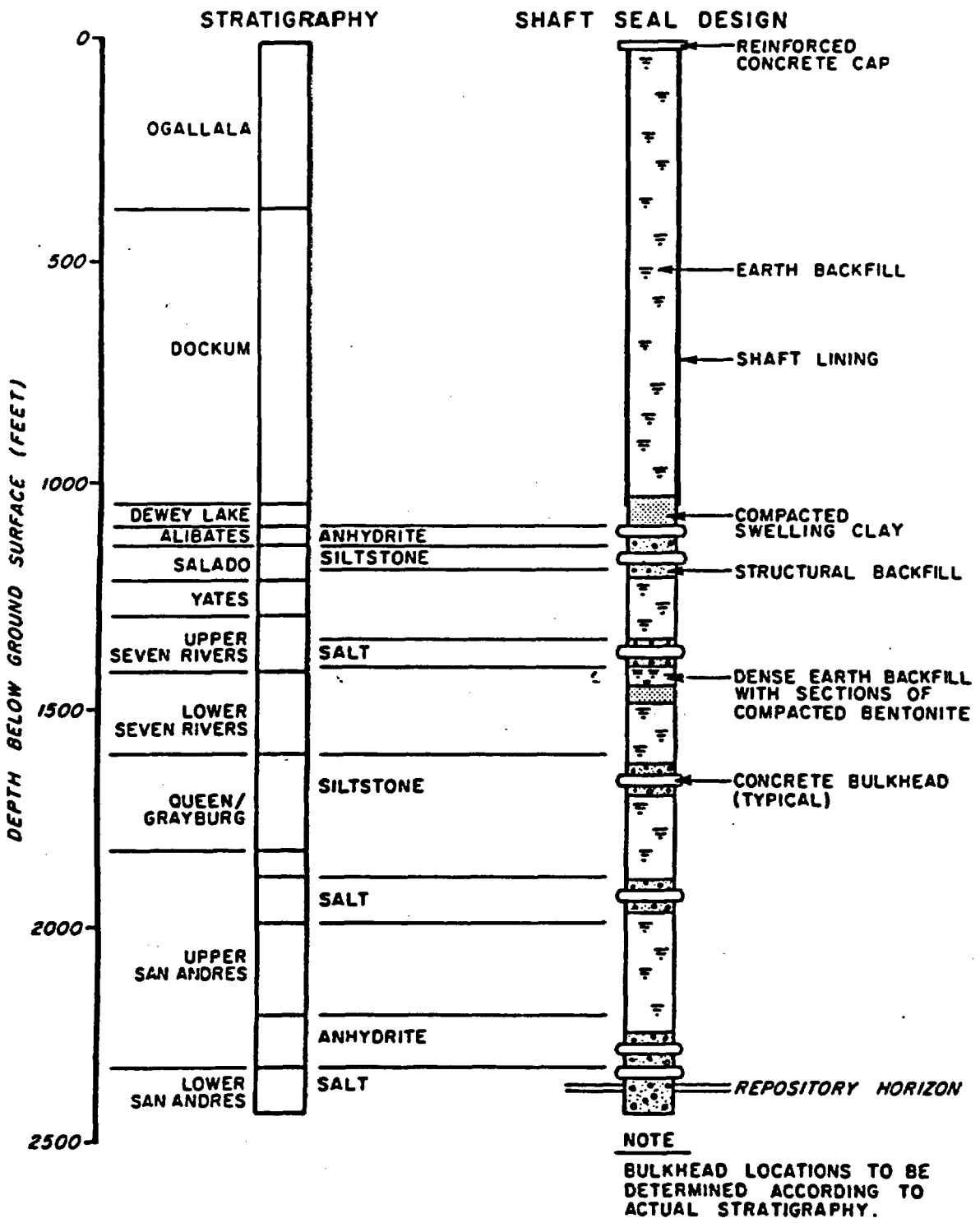


Figure 3-7. Schematic Layout for Shaft Seals - Permian Basin Repository

From BMI/ONWI-564: Schematic Designs for Penetration Seals for a Repository in the Permian Basin. Prepared by P.C. Kelsall, J.B. Case, W.E. Coons, J.C. Franzone, and D. Meyer of IT Corporation for Office of Nuclear Waste Isolation, Battelle Memorial Institute, Columbus, Ohio, December 1985.

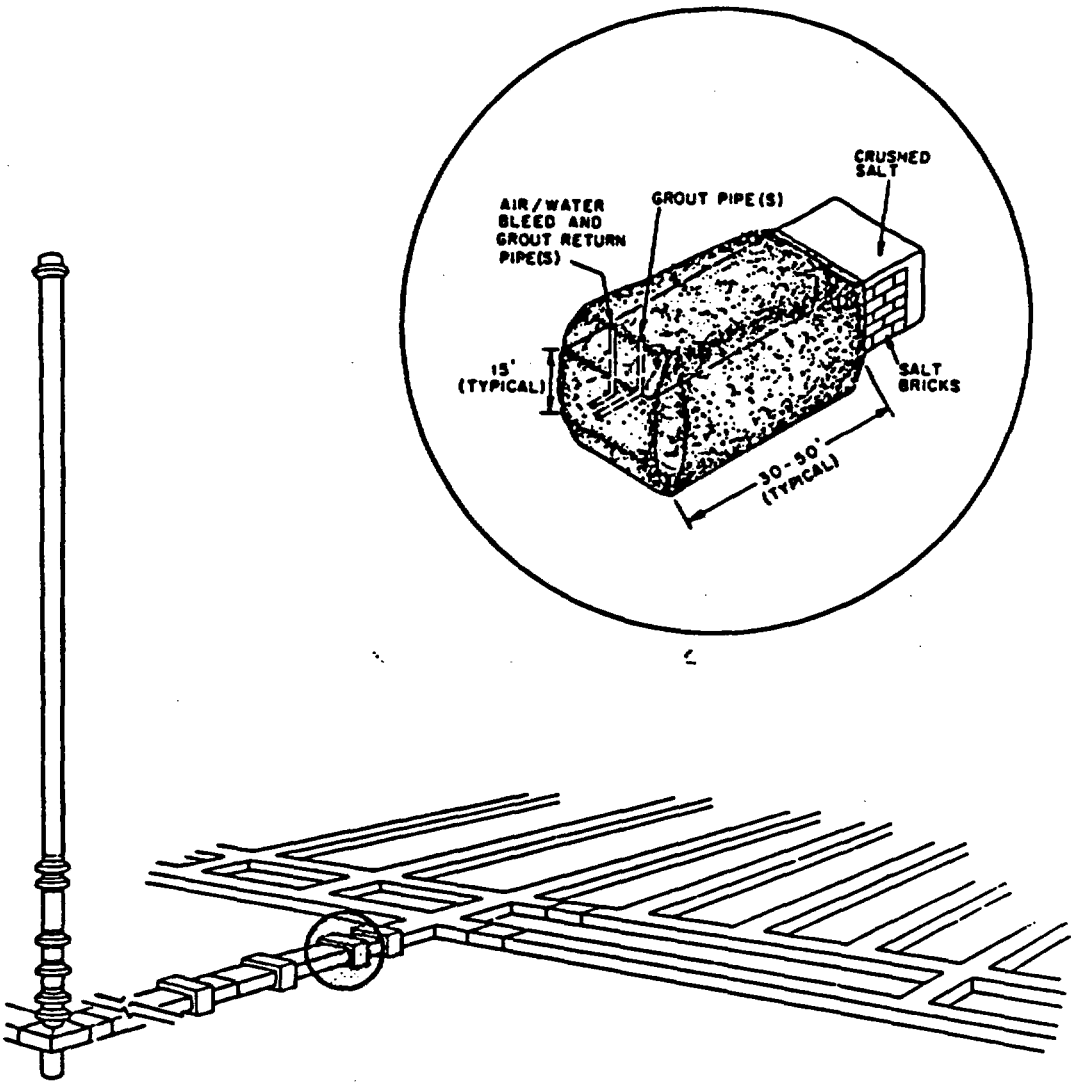


Figure 3-6. Concept for Concrete Tunnel Bulkheads

From BMI/ONWI-564: Schematic Designs for Penetration Seals for a Repository in the Permian Basin. Prepared by P.C. Kelsall, J.B. Case, W.E. Coons, J.G. Franzone, and D. Meyer of IT Corporation for Office of Nuclear Waste Isolation, Battelle Memorial Institute, Columbus, Ohio, December 1985.

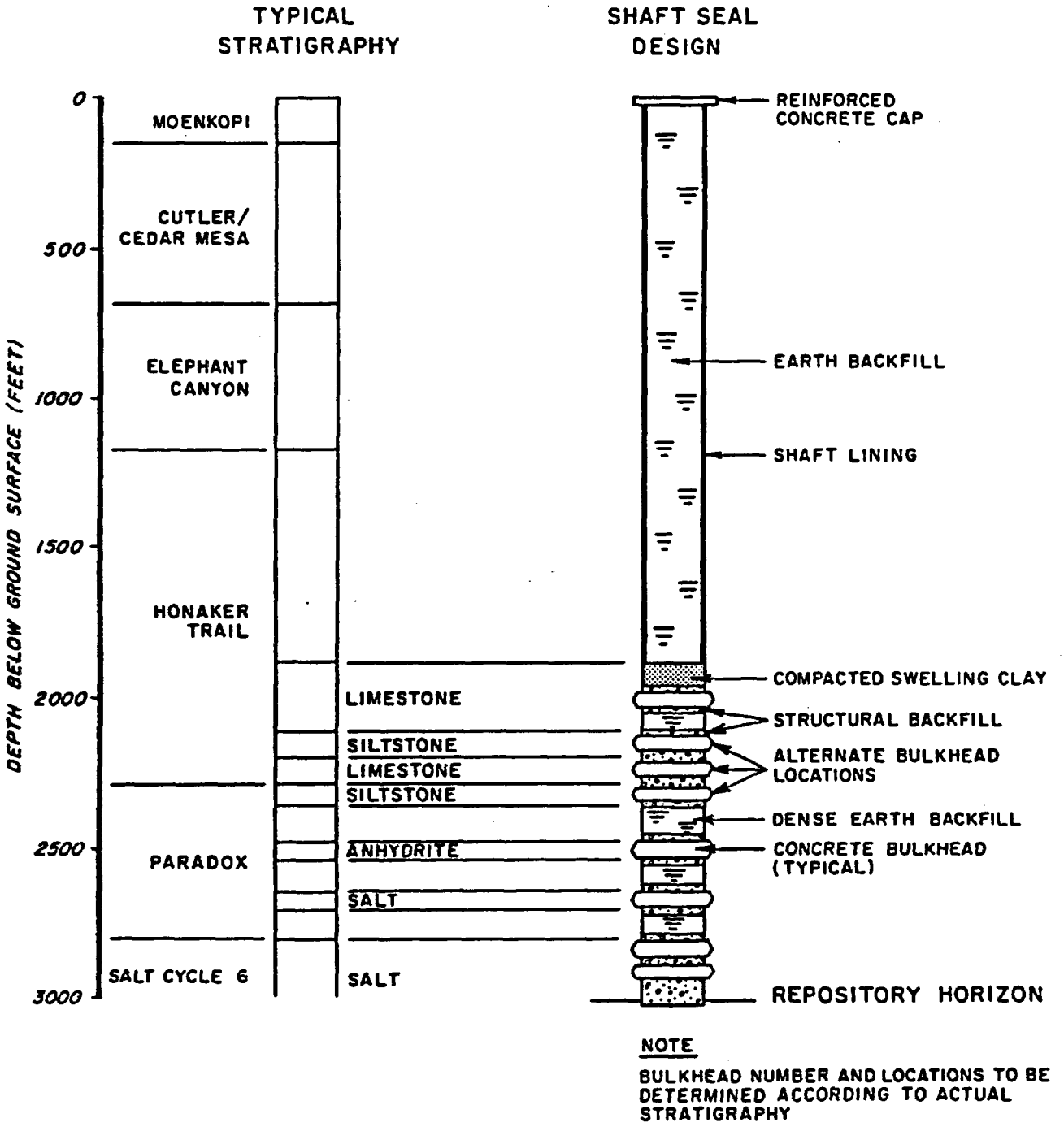
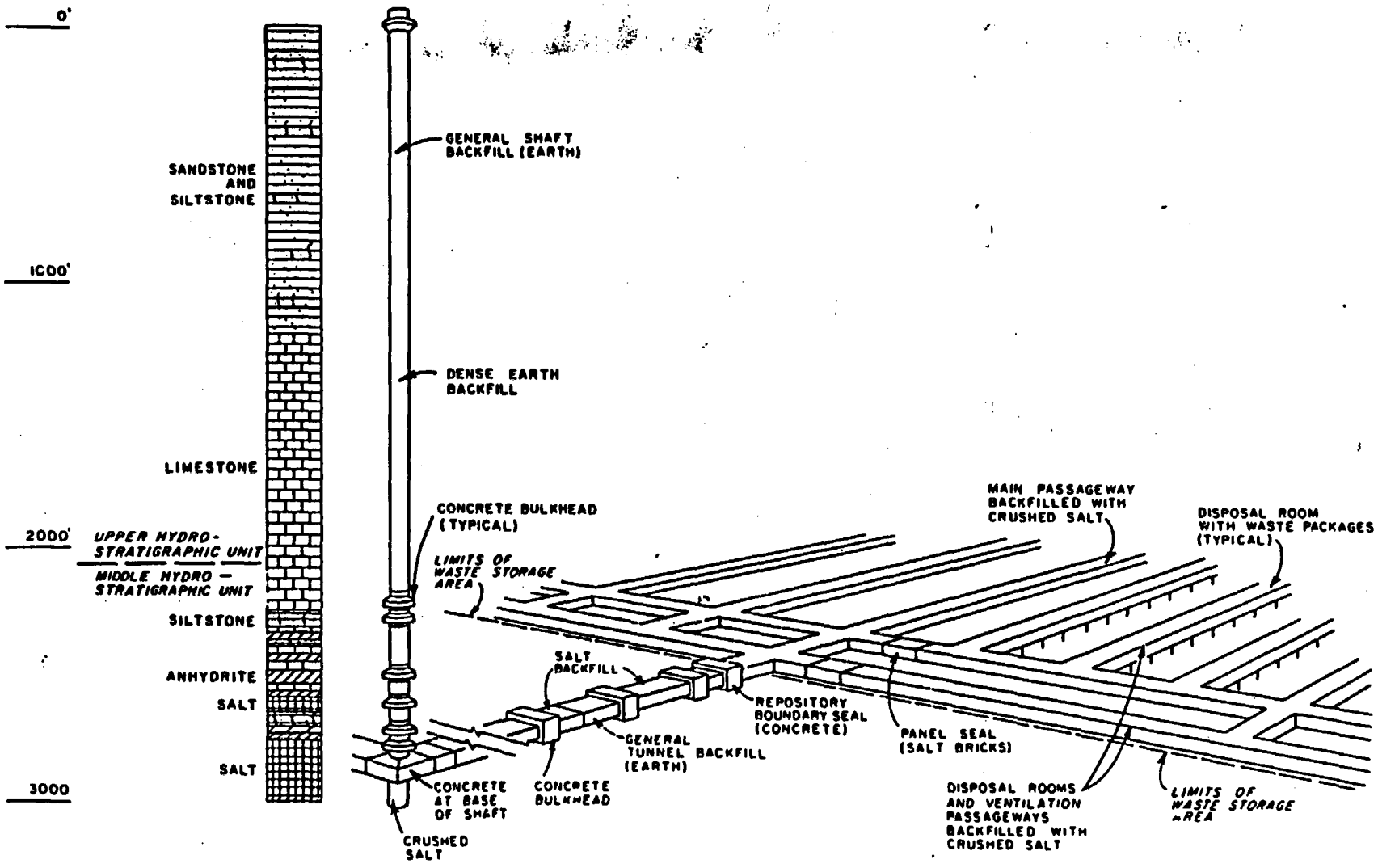


Figure 3-7. Schematic Layout for Shaft Seals - Paradox Basin Repository

From BMI/ONWI-563: Schematic Designs for Penetration Seals for a Repository in the Paradox Basin. Prepared by P.C. Kelsall, D. Meyer, J.B. Case, and W.E. Coons of IT Corporation for Office of Nuclear Waste Isolation, Battelle Memorial Institute, Columbus, Ohio, December 1985.



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