

**U.S. DEPARTMENT OF ENERGY
OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT**

**PRESENTATION TO
THE NUCLEAR WASTE TECHNICAL REVIEW BOARD**

**SUBJECT: CONTROL OF FLUIDS: THE ROLE
OF PERFORMANCE
ASSESSMENT**

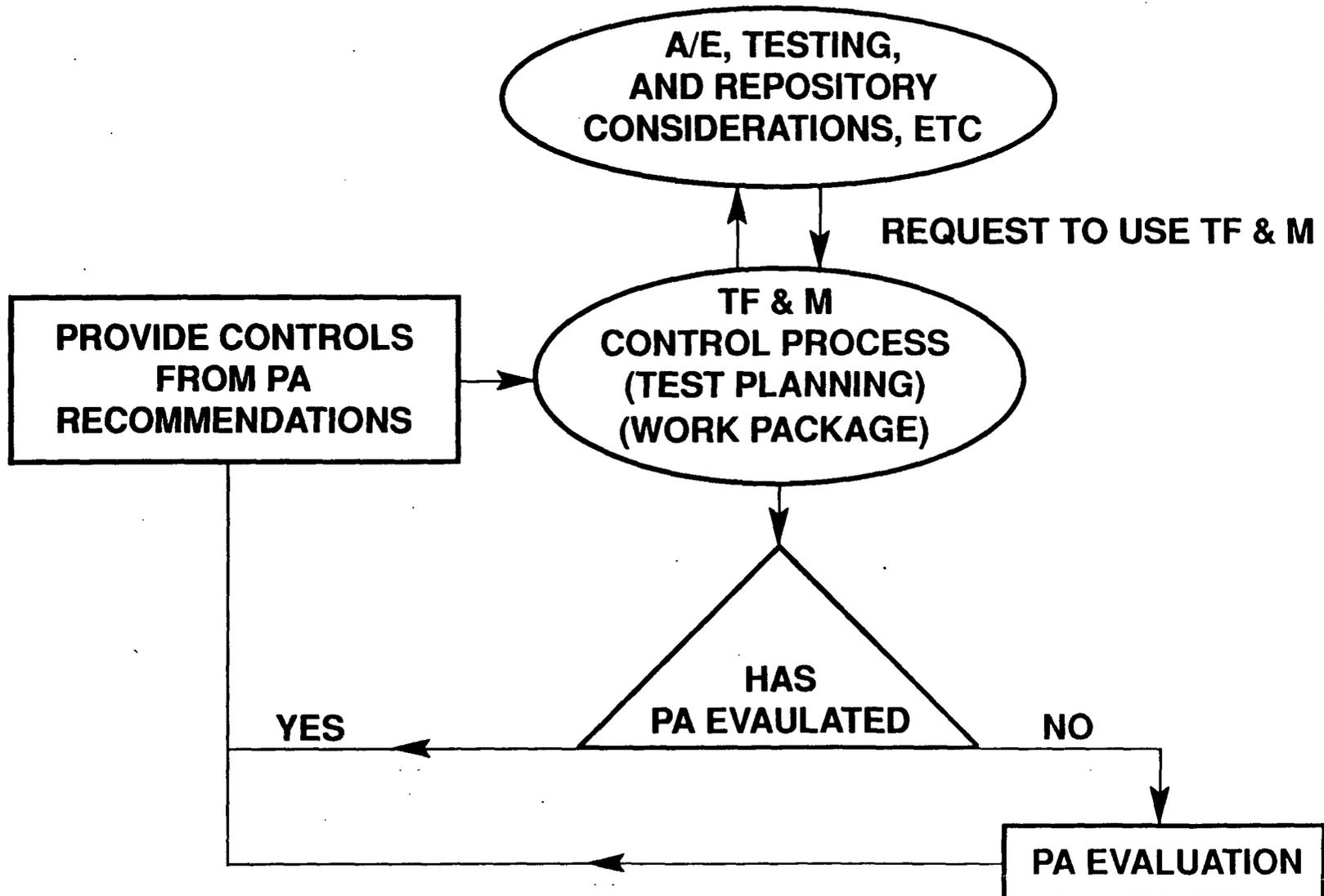
PRESENTER: MERTON. E. FEWELL

**PRESENTER'S TITLE
AND ORGANIZATION: SENIOR MEMBER, TECHNICAL STAFF
SANDIA NATIONAL LABORATORIES
ALBUQUERQUE, NEW MEXICO**

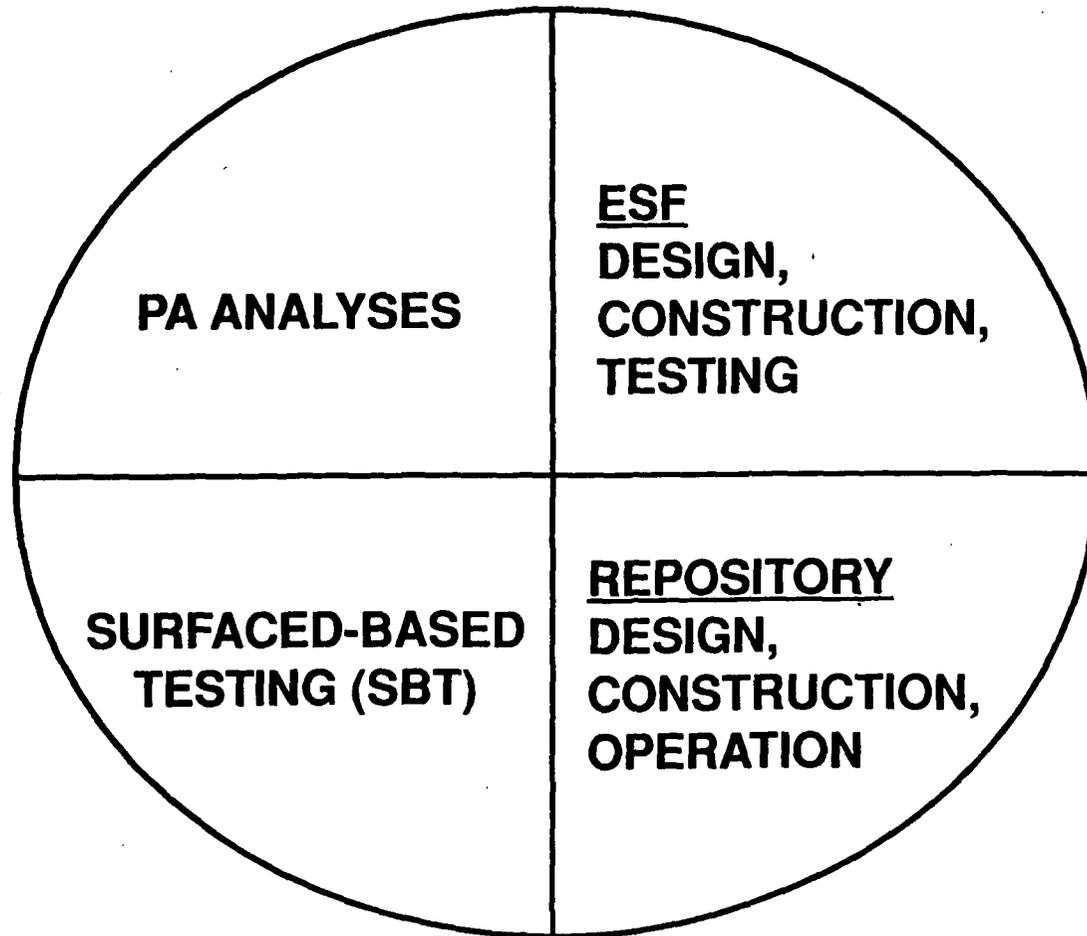
**PRESENTER'S
TELEPHONE NUMBER: (505) 844-7120**

SEPTEMBER 18 - 19, 1991

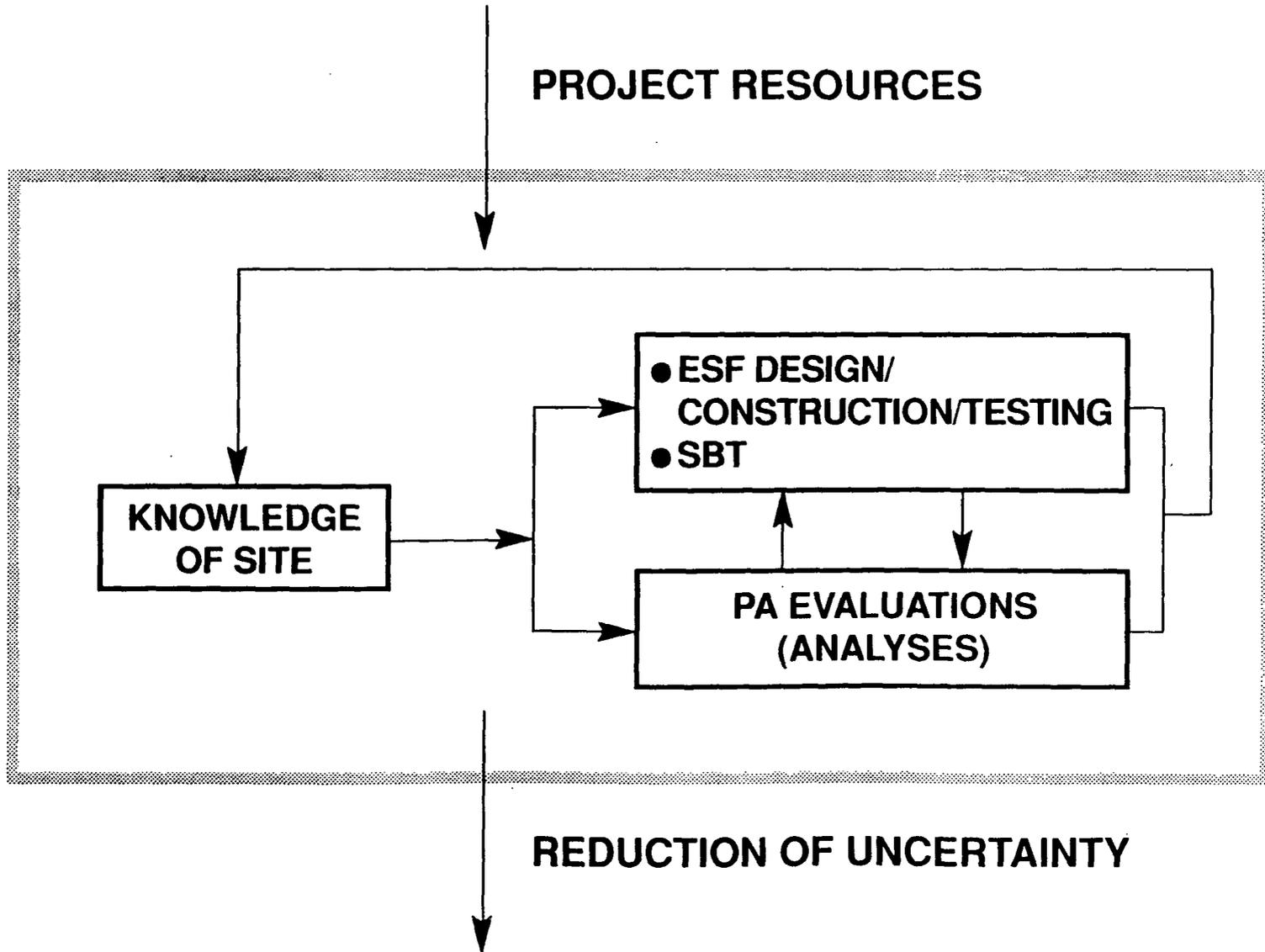
CONTROL OF FLUIDS



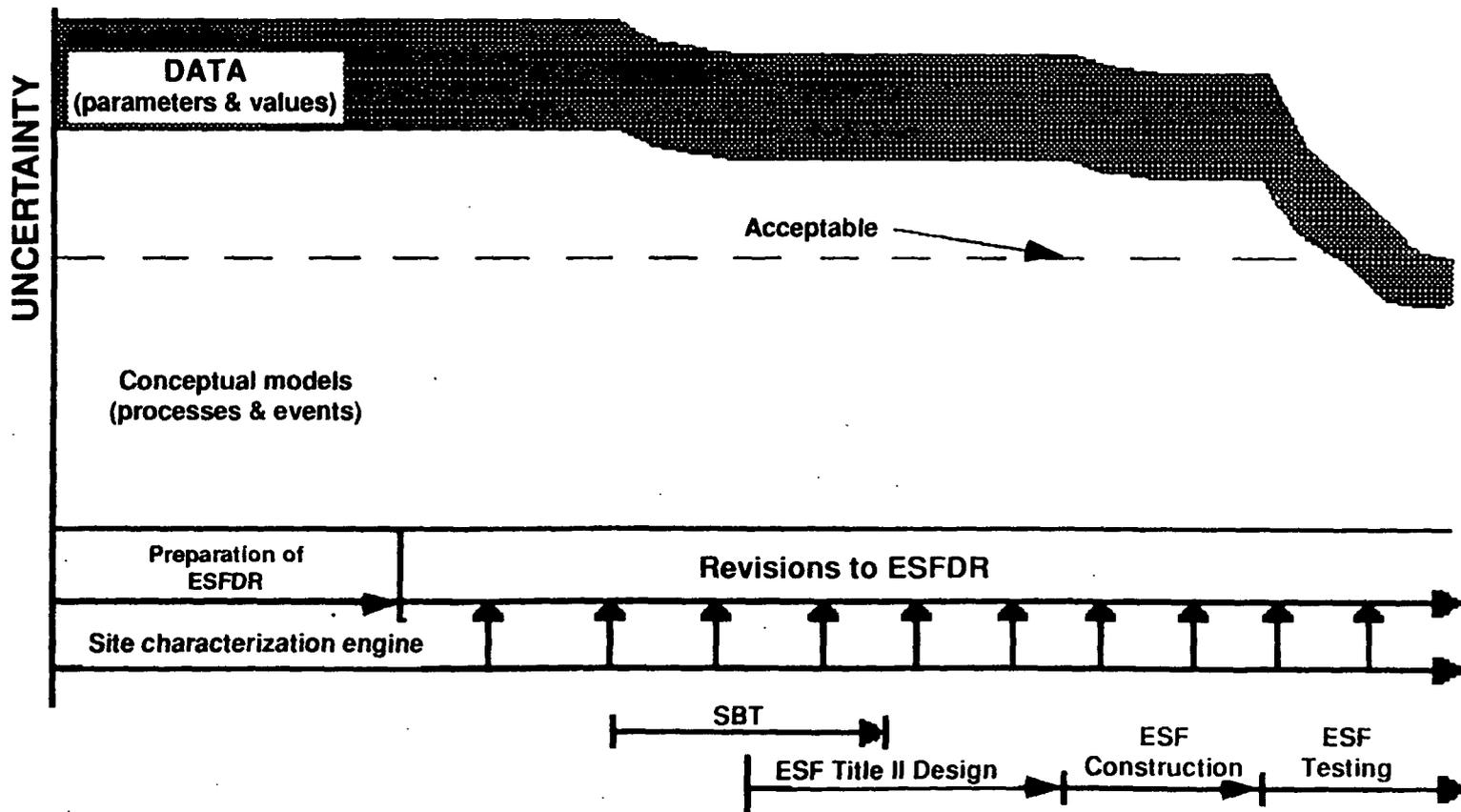
PA EVALUATION/CONTROLS



SITE CHARACTERIZATION ENGINE



SITE CHARACTERIZATION



OUTLINE

- **PA PLAN FOR SUPPORT OF THE ESF TITLE II DESIGN**
- **ANALYSIS REQUIRED FOR PA EVALUATIONS IN SUPPORT OF CONTROL OF FLUIDS**
- **DISCUSSION OF SPECIFIC ANALYSES AND RECOMMENDATIONS THAT SUPPORT CONTROL OF FLUIDS**

MOTIVATION/PURPOSE

● DESIGN CONTROL (NRC OBJECTION #1)

- MUST CONSIDER 10 CFR PART 60 REQUIREMENTS**
- MUST RECOGNIZE THE NEED FOR FEEDBACK AND INTERACTION AMONG PARTICIPANTS RESPONSIBLE FOR DESIGN, SCIENTIFIC TESTS, PERFORMANCE ASSESSMENT, CONSTRUCTION, AND OPERATIONS**
- DOE SHOULD DEMONSTRATE THAT THE ESF DESIGN CONTROL PROCESS HAS PROVIDED FOR SYSTEMATIC REVIEW REQUIREMENTS AND CONSIDERTIONS OF 10 CFR PART 60 REQUIREMENTS, IN THE DEVELOPMENT OF THE ESF DESIGN, AND FOR VERIFICATION THAT THOSE REQUIREMENTS HAVE IN FACT BEEN INCORPORATED INTO THE DESIGN**

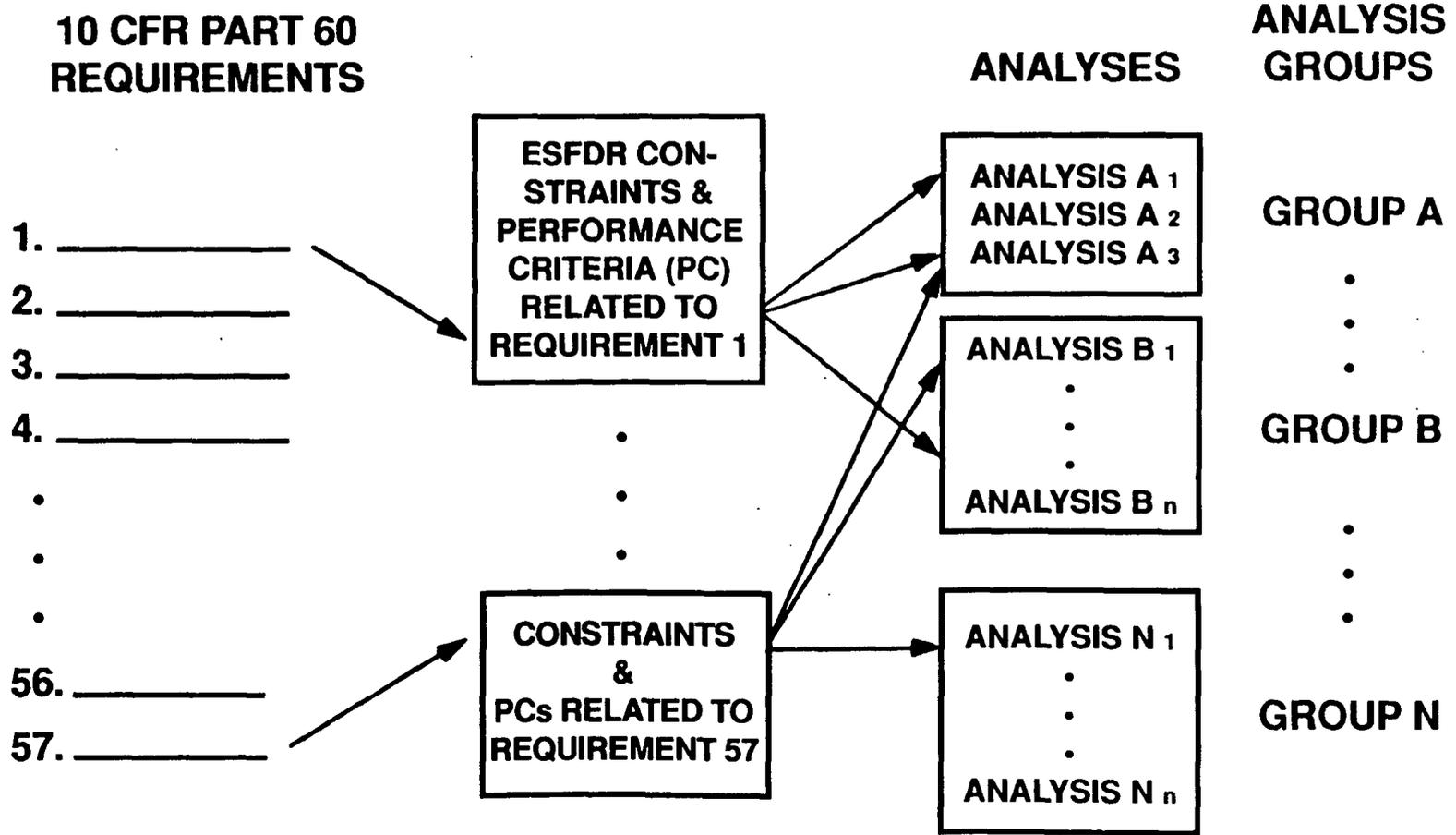
● LONG RANGE PLANNING/UTILIZATION OF RESOURCES

ELEMENTS OF PLAN

- IDENTIFICATION OF 10 CFR PART 60 REQUIREMENTS
- LINKAGE BETWEEN 10 CFR PART 60 REQUIREMENTS AND THE ESFDR
- LINKAGE BETWEEN ESFDR REQUIREMENTS AND ANALYSES*
- INTEGRATION WITH DESIGN SCHEDULE
- PRODUCTS/METHODS OF EVALUATION
- IDENTIFICATION OF RESOURCES
- APPLICATION OF ANALYSES AND RESULTS TO THE FINAL COMPLIANCE REVIEW
- IMPLEMENTATION/INTEGRATION OF PA

* IN THIS PLAN, THE WORD ANALYSES IS NOT LIMITED TO CALCULATIONS. THE WORDS ANALYSES AND EVALUATIONS ARE USED INTERCHANGEABLY. THUS, AN ANALYSIS MAY BE AN EVALUATION BASED ON EXPERT OPINION, A REVIEW OF EXISTING INFORMATION, NUMERICAL CRITERIA PROVIDED BY CALCULATIONS OR EXPERIMENTS, OR SOME MEANS OF EVALUATION.

PA PLAN FOR ESF TITLE II DESIGN



SAMPLE ESF REQUIREMENTS RELATED TO THE CONTROL OF FLUIDS

| 10 CFR | | ESFDR 7/29/91 | | |
|--------|-----------------|----------------|--|--------|
| Lbl | Requirement | Requirement | ESFDR or 10 CFR PART 60 Description | System |
| 15 | 60.15(c)(1) | 1.2.6.6 PC 2a | Review materials for substance effects on EBS & waste isolation | UGE |
| 16 | 60.15(c)(1) | 1.2.6.4 PC 2a. | Assess impacts of materials & support components on waste isolation | Shaft |
| 44 | 60.15(c)(4) | 1.2.6.0 C C(4) | Control all substances & tracers added to water & compressed air | Gen. |
| 45 | 60.15(c)(4) | 1.2.6.0 C C(4) | Use of hydrocarbons and solvents comply with criteria determined by PA | Gen. |
| 171 | 60.133(d) | 1.2.6.1 C F | Limit use of water | Site |
| 301 | 60.134(a) & (b) | 1.2.6.0 C H | Seals shall not compromise ability of site to meet performance goals | Gen. |

SAMPLE ESF REQUIREMENTS RELATED TO THE CONTROL OF FLUIDS

| | Category 1 | Category 2 | Category 3 | Category |
|------------|------------------|--------------------------------------|------------|-------------|
| Lbl | FF | G&M | T/S | TSYS |
| 15 | | 2.R(i) | | 4 |
| 16 | | 2.R(i) | | 4 |
| 44 | | 2.R(ii) | | |
| 45 | | 2.R(ii) | | |
| 171 | 1.I(j.ii) | | | 4 |
| 301 | | 2.R(iv) 3.C(i,x-xi),O,T(i-ii) | | 4 |

ESFDR REQUIREMENTS

337 REQUIREMENTS RELATED TO APPLICABLE 10 CFR PART 60 REQUIREMENTS

GROUPS:

- **NO PA ANALYSIS REQUIRED**
- **PA ANALYSIS REQUIRED**
- **ROLL-UP OF LOWER LEVEL REQUIREMENTS**

ANALYSIS CATEGORIES

- **FLUID FLOW**
- **GEOCHEMISTRY & MATERIALS**
- **THERMAL/STRUCTURAL**
- **TOTAL SYSTEMS**

SUMMARY OF TITLE II DESIGN SUPPORT

- **FLOW DOWN FROM 10 CFR PART 60 REQUIREMENTS TO ESF-DR REQUIREMENTS TO PERFORMANCE BASED ANALYSES**
- **PROVIDES PA INTEGRATION WITH TEST PLANNING AND WORK AUTHORIZATION PROCESS**
- **DYNAMIC**
- **PA ANALYSES ARE ONGOING AND ITERATIVE**

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PA ANALYSES/CONTROL OF FLUID IN ESF

FLUID FLOW

● ISOTHERMAL SUBSURFACE FLOW

- **ESF RELATED ALTERATION OF DIFFUSE SURFACE INFILTRATION**
- **LOCALIZED INFILTRATION SOURCES OF INFILTRATION IDENTIFIED WITH ESF ACTIVITIES**
- **ALTERATION OF NEAR SURFACE HYDROLOGIC PROPERTIES BY ESF ACTIVITIES**
- **EFFECTS OF WATER USAGE DURING ESF UNDERGROUND CONSTRUCTION AND OPERATIONS**
- **EVALUATION OF WATER AND GAS INTRUSION CONTROL MEASURES**
- **EVALUATION OF PREFERENTIAL PATHWAYS FOR GAS FLOW AS ESTABLISHED BY SURFACE BOREHOLES**
- **EVALUATION OF UNDERGROUND SUMP ON POSTCLOSURE PERFORMANCE**

● NONISOTHERMAL FLOW

- **UNCOUPLED NON-ISOTHERMAL FLOW**
- **NEAR-FIELD**

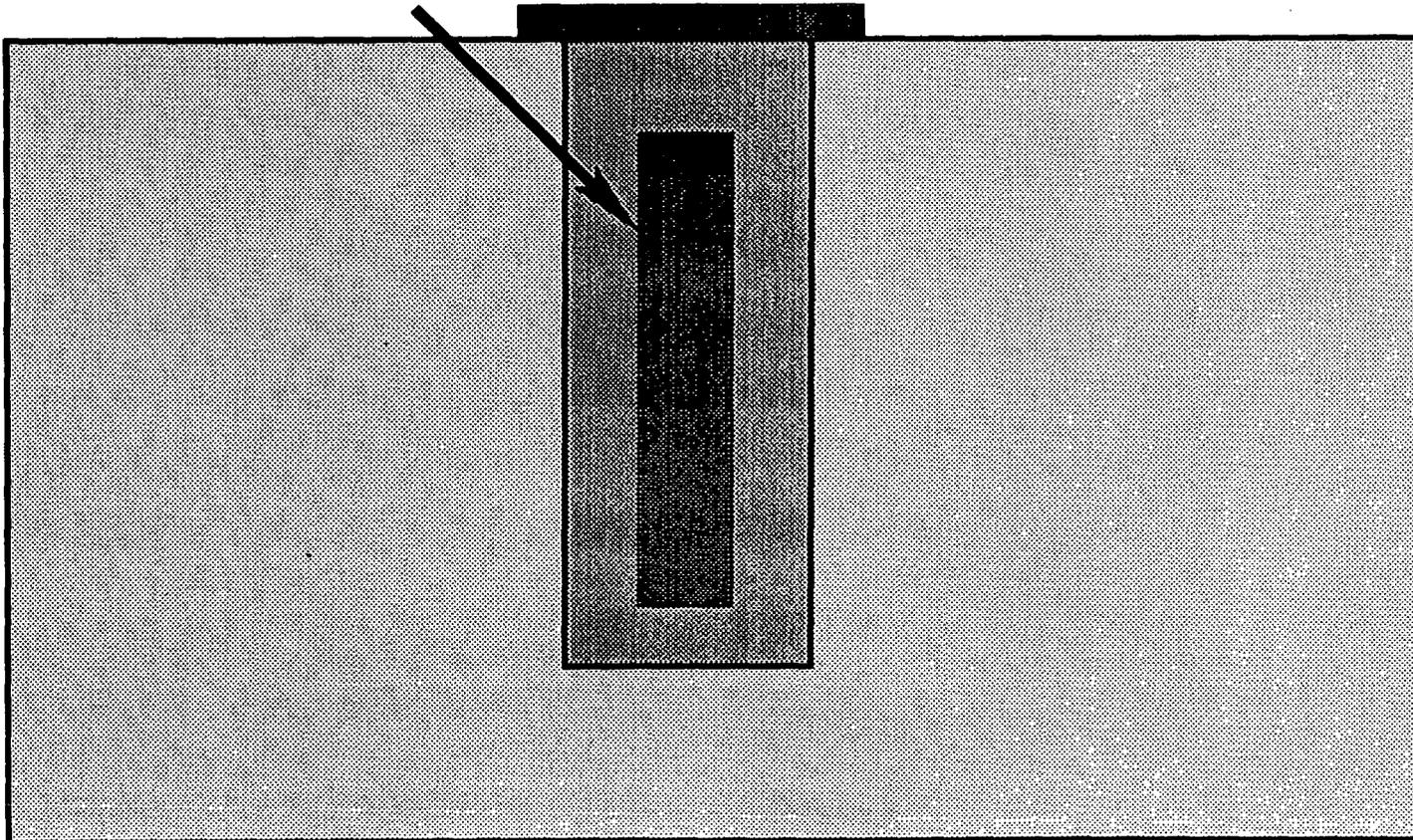
● FLOODS AND RUNOFF ON SURFACE

GEOCHEMISTRY AND MATERIALS

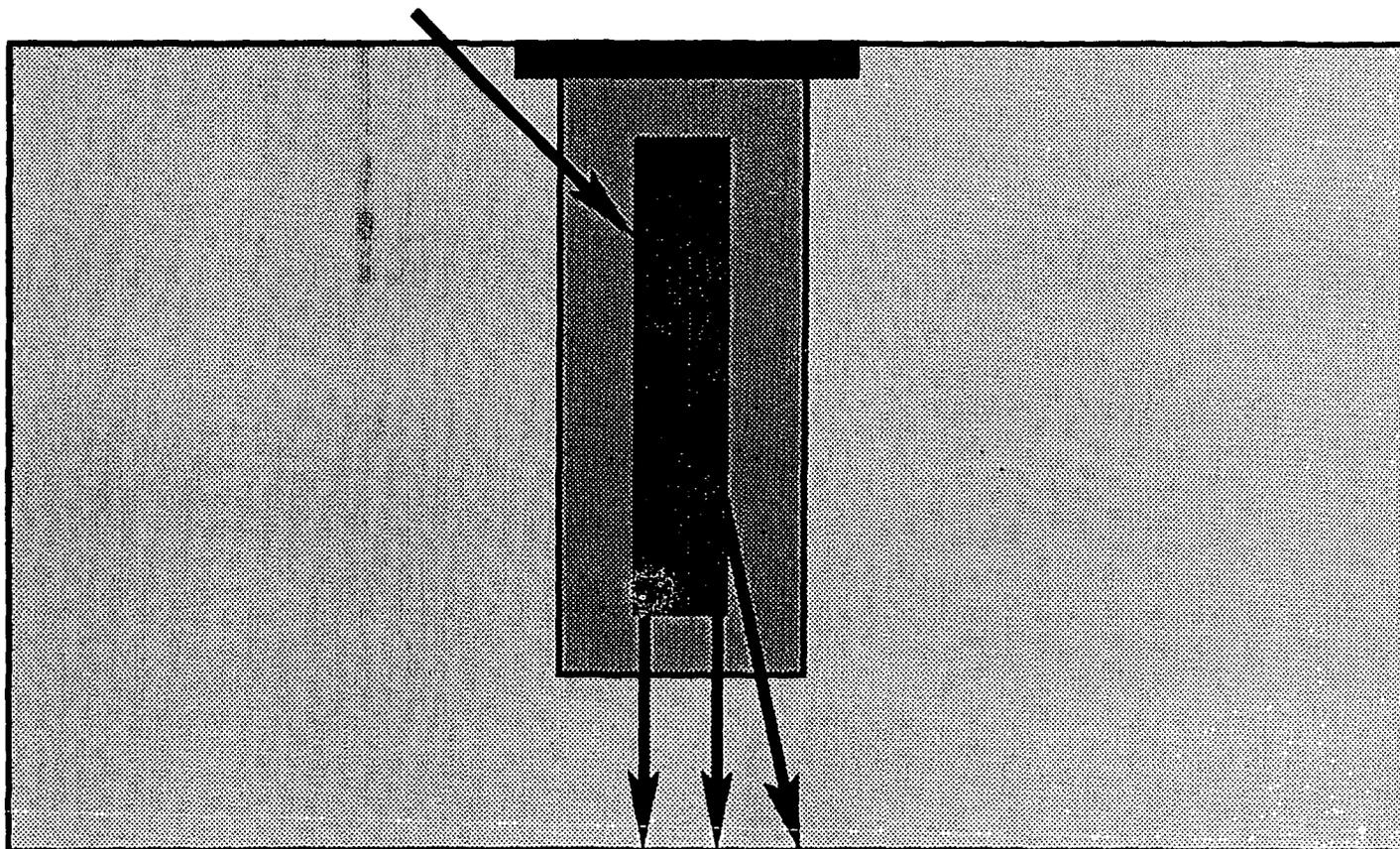
● REACTIVE CONTAMINANT FLOW AND TRANSPORT

- **CANISTER**
- **CHEMICAL REACTIONS WITH THE SOURCE**
- **ZONE OF ISOLATION**
- **FAR-FIELD**
- **UNDEFINED PERFORMANCE CONFIRMATION ANALYSES**

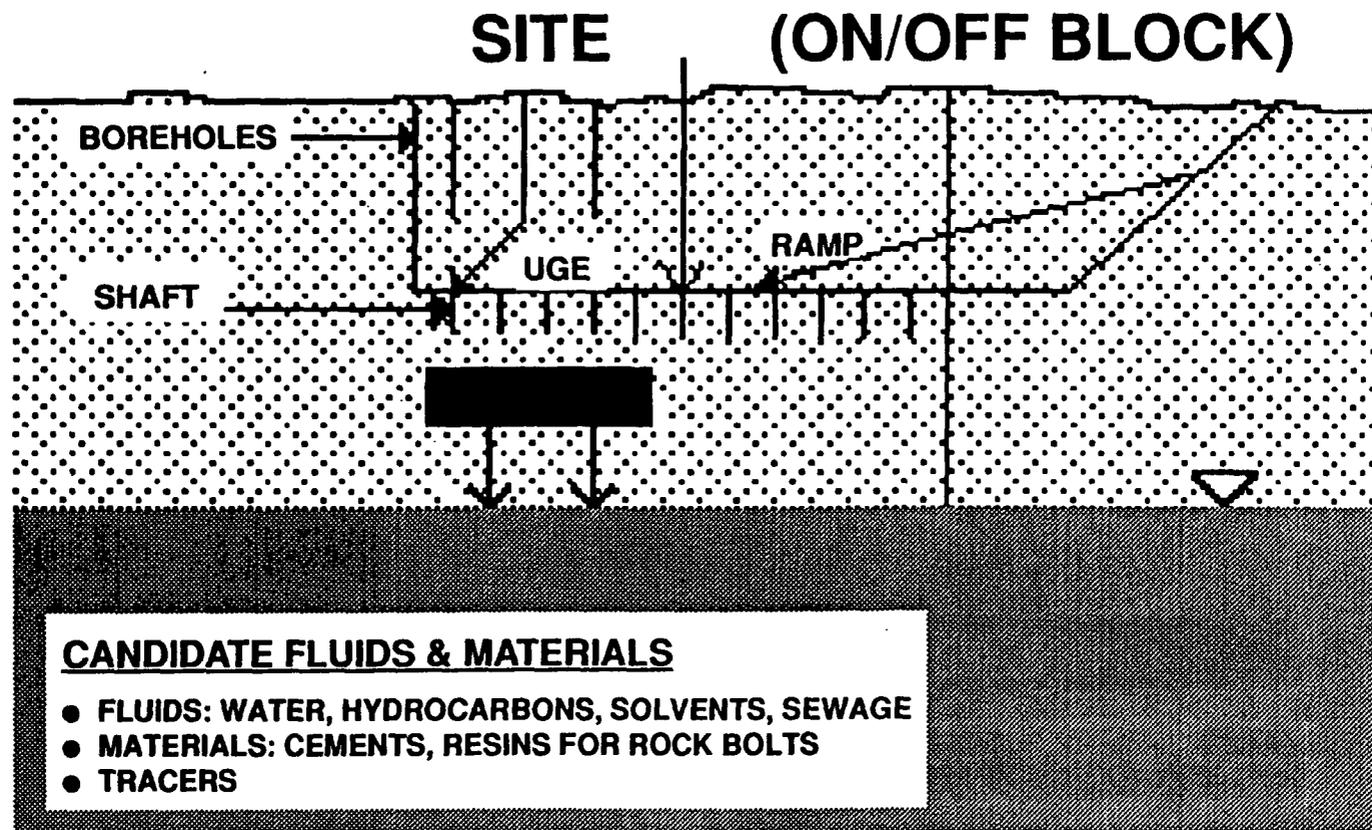
G & M ANALYSES: CANISTER CORROSION



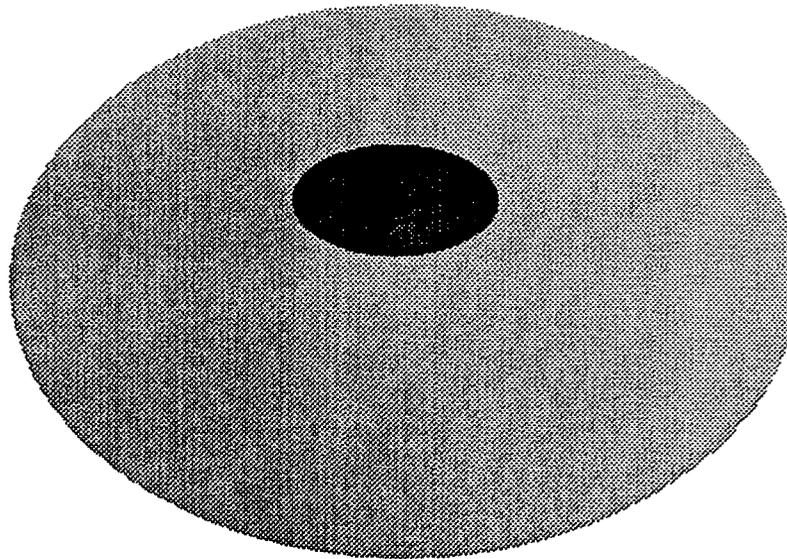
G & M ANALYSES: CHEMICAL REACTIONS WITH THE SOURCE



G & M ANALYSES: FAR-FIELD



G & M ANALYSES: TEST INTERFERENCE



COMPONENTS IN ZONE OF INFLUENCE

- **COMBUSTION PRODUCTS**
- **CONSTRUCTION, DRILLING, EXCAVATION EFFECTS**
- **NEIGHBORING TESTS**
- **DUST CONTROL ADDITIVES**
- **WALL CLEANING**

OUTLINE

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ATTRIBUTES

- **VALIDITY**

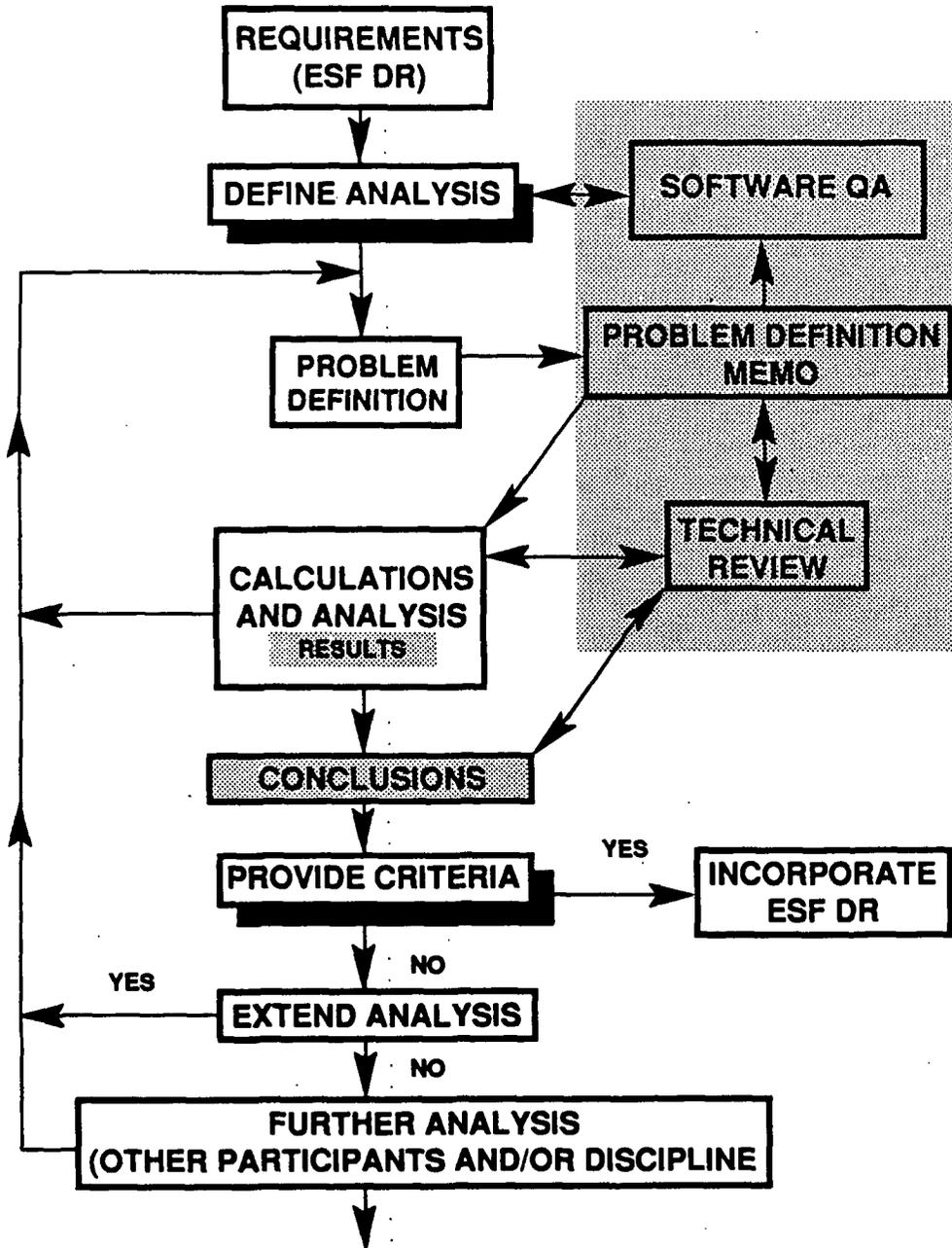
- **PHYSICAL PROCESSES AND MECHANISMS**
- **CONCEPTUAL MODELS**
- **SITE CHARACTERIZATION DATA**

- **QUALITY ASSURANCE**

- **ONGOING**

- **CONFIGURATION CHANGES**
- **ADDITIONAL DATA**
- **INTEGRAL PART OF DESIGN PROCESS**
- **TESTING**

ANALYSIS PROCESS



ANALYSIS #1 ESFDR REQUIREMENT

10 CFR 60.133(d) - CONTROL OF WATER AND GAS

THE DESIGN OF THE UNDERGROUND FACILITY SHALL PROVIDE FOR CONTROL OF WATER OR GAS INTRUSION

1.2.6.1 C F.i

THE AMOUNT OF WATER USED IN SITE PREPARATION AND OPERATIONS SHOULD BE LIMITED TO THAT REQUIRED FOR SANITATION, DUST CONTROL, COMPACTION OF ENGINEERED FILL MATERIAL, AND PROPER EQUIPMENT OPERATION SO AS TO LIMIT THE EFFECTS ON THE CONTAINMENT AND ISOLATION CAPABILITY OF THE SITE

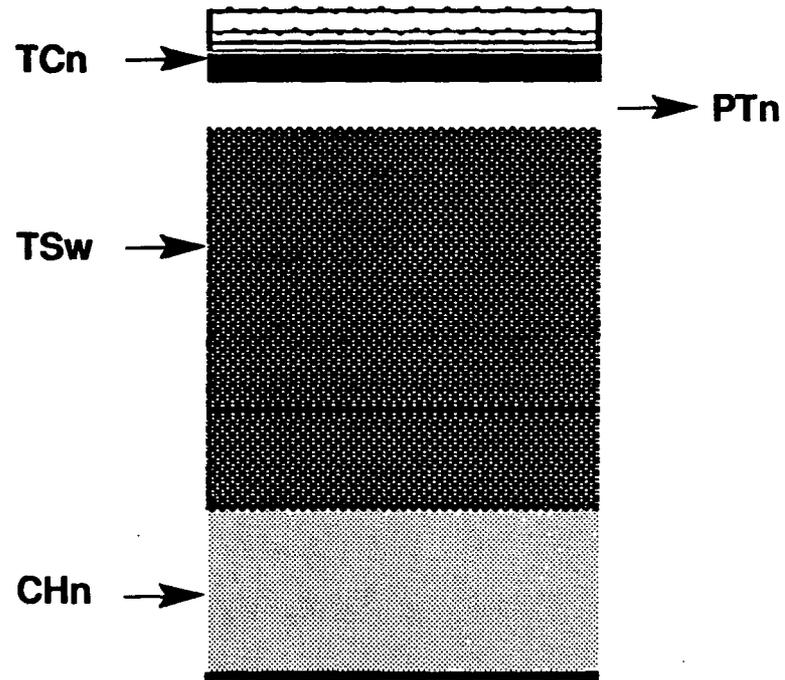
ANALYSIS #1

SURFACE CONSTRUCTION WATER MOVEMENT

PURPOSE:

TO PROVIDE NUMERICAL CRITERIA FOR LIMITING THE AMOUNT OF WATER THAT CAN BE PLACED ON THE SURFACE ABOVE THE REPOSITORY AND FOR DETERMINING THE LATERAL EXTENT OF WATER AS IT FLOWS WITHIN THE MOUNTAIN DUE TO THE APPLICATION OF WATER AT THE SURFACE

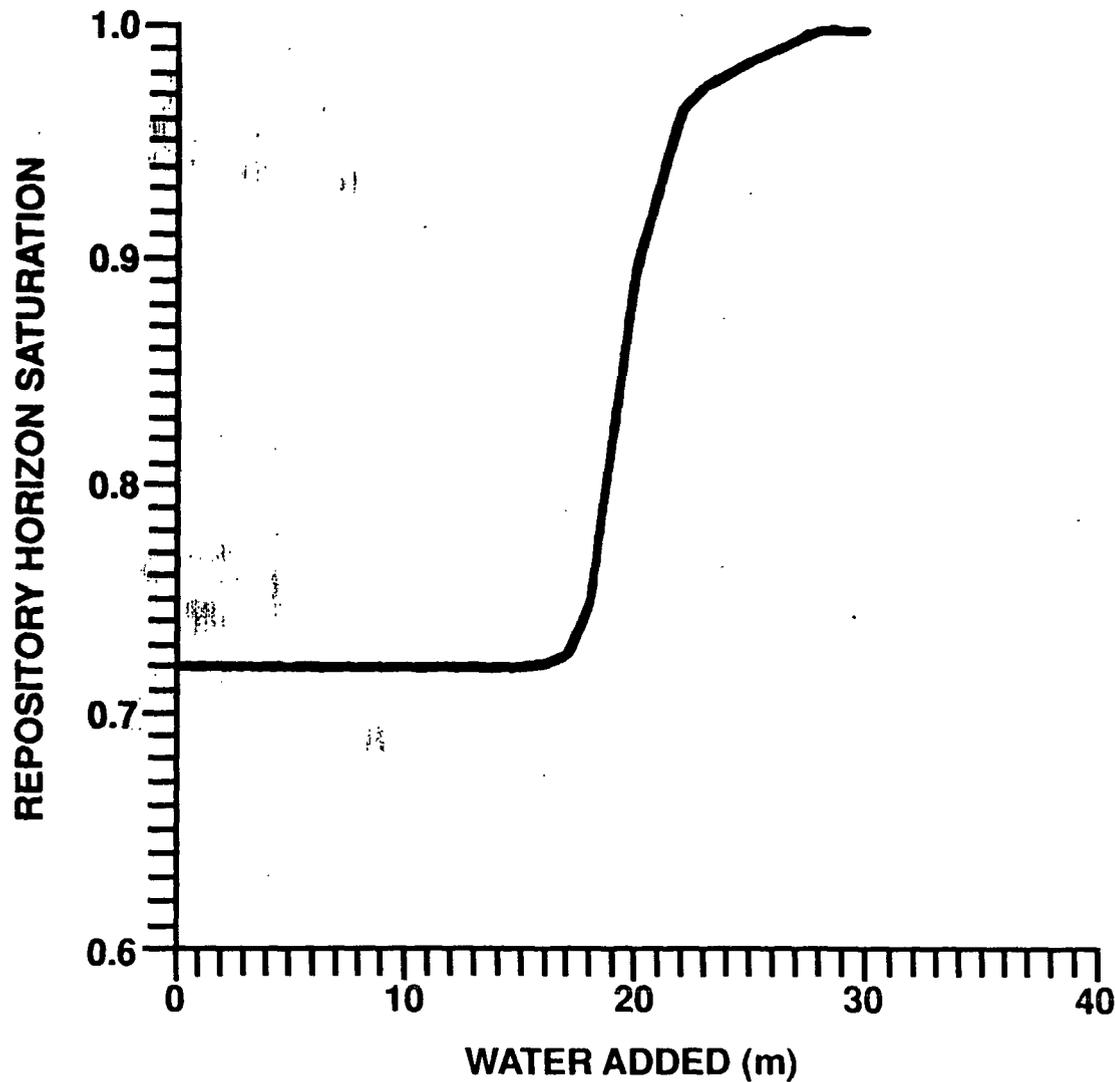
ANALYSIS #1



CRITERIA FOR MEASURING PERFORMANCE

- **GROUNDWATER TRAVEL TIME < 1,000 YEARS**
- **LIMITATION TO THE RADIONUCLIDE THAT CAN REACH THE ACCESSIBLE ENVIRONMENT IN 10,000 YEARS**

CHANGES IN RESPOSITORY HORIZON SATURATION RESULTING FROM SURFACE WATER ADDITION



ANALYSIS #1

CONCLUSION/RECOMMENDATION

CONCLUSION:

SIXTEEN CUBIC METERS OF WATER PER SQUARE METER OF DISTURBED AREA CAN INFILTRATE THE MOUNTAIN WITHOUT INCREASING THE SATURATION AT THE REPOSITORY HORIZON WITHIN 10,000 YEARS

RECOMMENDATION:

LIMIT PLACEMENT OF WATER ON THE TOP SURFACE OF YUCCA MOUNTAIN ABOVE THE REPOSITORY BLOCK TO 2 GAL/YD²/DAY CONTINUOUSLY APPLIED OVER A FIVE YEAR PERIOD

CONSERVATISM AND UNKNOWNNS

- **SURFACE WATER BALANCE**
 - **EVAPOTRANSPIRATION**
 - **RUNOFF**
 - **DOWNDIP**
 - **CLIMATIC CHANGE**
- **RELATIONSHIP BETWEEN REPOSITORY PERFORMANCE AND SATURATION CHANGE AT REPOSITORY HORIZON**
- **ONE-DIMENSIONAL SUBSTANTIATED BY TWO-DIMENSIONAL CALCULATIONS**

ANALYSIS #3

EXAMPLE OF ESFDR REQUIREMENTS

10 CFR 60.133(D)

ADDITIONAL DESIGN CRITERIA FOR THE UNDERGROUND FACILITY. CONTROL OF WATER AND GAS. THE DESIGN OF THE UNDERGROUND FACILITY SHALL PROVIDE FOR CONTROL OF WATER OR GAS INTRUSION.

ESF DR SECTION(S) REQUIRING ANALYSIS SUPPORT:

FLUIDS RECOVERED DURING _____ * OPERATIONS SHALL BE DISPOSED OF IN SUCH A WAY AS TO AVOID POTENTIAL FOR PERFORMANCE IMPACTS.

1.2.6.7.6 PC 1e. *CONSTRUCTION

1.2.6.8 C Ev *TESTING

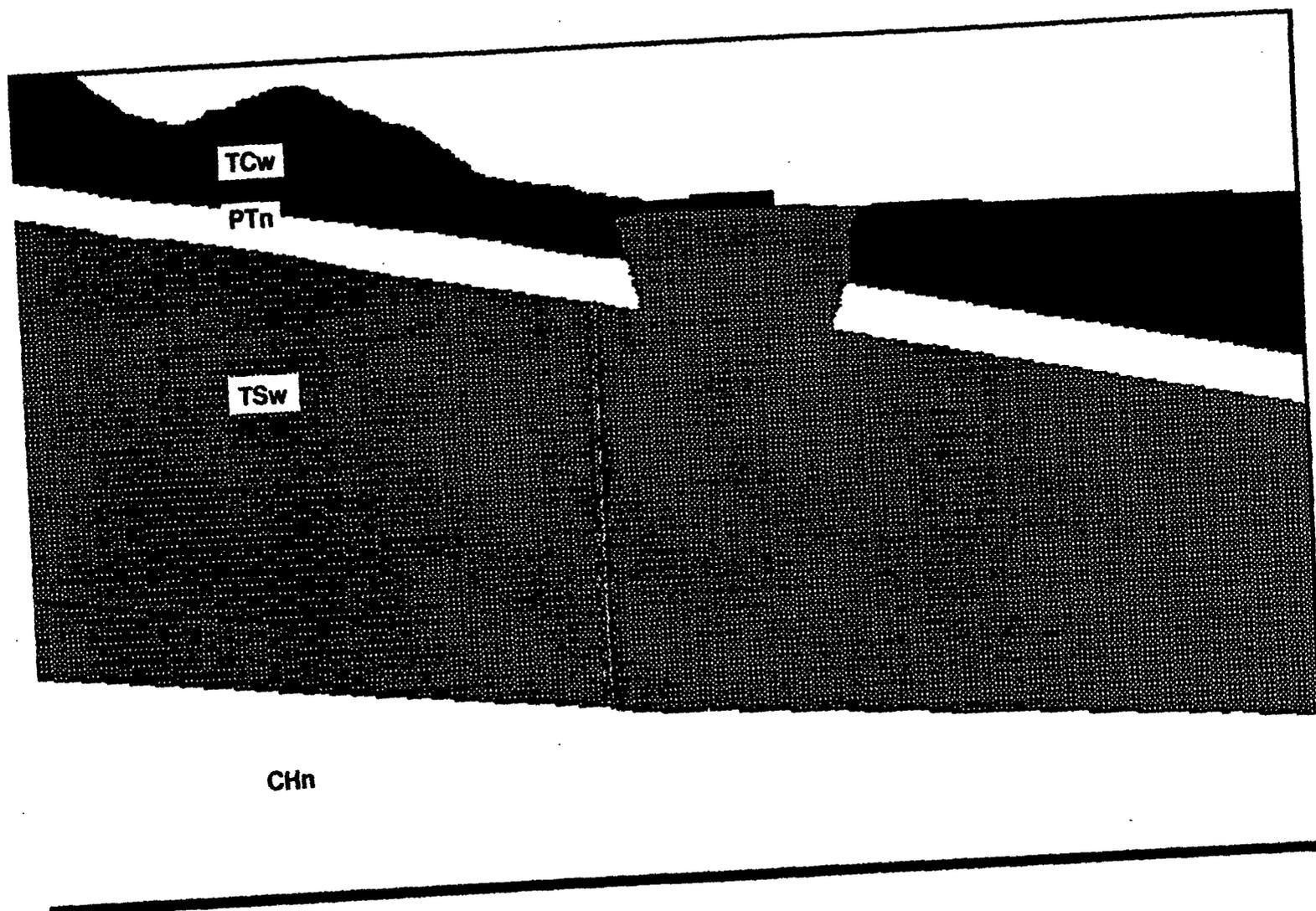
1.2.6.2.3 C B SANITARY WASTES SHALL BE DISPOSED OF BY MEANS OF COLLECTION PIPING FROM ALL BUILDINGS AND TRAILERS TO A SANITARY WASTE DISPOSAL SYSTEM LOCATED BEYOND THE PERIMETER OF THE PROPOSED REPOSITORY SUBSURFACE FACILITY AT A DISTANCE TO BE DETERMINED BY PERFORMANCE ASSESSMENT. THE SANITARY SYSTEM SHALL BE DESIGNED TO PREVENT INTERFERENCE WITH SITE CHARACTERIZATION ACTIVITIES

ANALYSIS #3

SEWAGE AND SETTLING PONDS

PURPOSE: TO ESTIMATE THE POTENTIAL FOR WATER LEAKAGE FROM SETTLING PONDS IN THE MUCK STORAGE AREA AND DISCHARGED FROM THE SEWAGE POND SYSTEM TO INTERFERE WITH EXPERIMENTS CONDUCTED IN THE ESF

SEWAGE AND SETTLING POND LOCATIONS



ANALYSIS #3

CONCLUSION/RECOMMENDATION

CONCLUSION:

WATER LEAKAGE FROM PONDS ON THE TITLE I MUCK STORAGE AREA AND DISCHARGED FROM THE SEWAGE POND SYSTEM HAVE NO EFFECT ON THE SATURATION AT THE REPOSITORY HORIZON AND WILL NOT INTERFERE WITH EXPERIMENTS CONDUCTED ON THE ESF

RECOMMENDATION:

LOCATE MUCK AND SEWAGE POINTS OFF REPOSITORY BLOCK

SUMMARY

- **ROLE OF PA IN FLUID CONTROL IN THE ESF IS ONGOING, INTEGRAL, ITERATIVE, AND WILL RESULT IN REFINED PA CAPABILITIES FOR PERFORMING PA CALCULATIONS IN SUPPORT OF REPOSITORY LICENSE APPLICATION**
- **A PLAN FOR IMPLEMENTING PA SUPPORT OF THE CONTROL OF FLUIDS IN THE ESF WAS DISCUSSED. THIS PLAN IS THE MECHANISM FOR SHOWING COMPLIANCE WITH 10 CFR PART 60 OF THE TITLE II DESIGN**
- **PA ANALYSES NECESSARY FOR PA SUPPORT FOR THE CONTROL OF FLUIDS WERE DESCRIBED**
- **ILLUSTRATIVE EXAMPLES OF PA ANALYSIS WERE PRESENTED**

RECOMMENDATION

BUILD ON THE TEST AND EVALUATION PLAN TO DEVELOP A BUDGET AND ALLOCATION PROCESS FOR FLUIDS AND MATERIALS TO INCLUDE ALL USAGE DURING SITE CHARACTERIZATION AND TO THE EXTENT NECESSARY FOR POTENTIAL REPOSITORY CONSTRUCTION AND OPERATION