

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

**NUCLEAR WASTE TECHNICAL REVIEW BOARD
ENVIRONMENT AND PUBLIC HEALTH PANEL MEETING**

**SUBJECT: ANTICIPATED REPOSITORY
EFFECTS**

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**LAS VEGAS, NEVADA
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PRESENTATION OUTLINE

- **Delineation of Impact**
- **Anticipated Effects**
- **State Of Knowledge On Possible Effects**
- **Uncertainties**
- **Plans To Address Uncertainties**
- **Conclusions**

DELINEATION OF IMPACT

- **Increased soil temperature**
 - **Most probable increase is 1.0 - 1.5° C**
 - **Maximum temperature increase expected at <6° C**
 - **Increased surface temperature to be seen on 2.3-3.0 sq mi**
 - **Temperature increase to begin about 1000 yrs after initial emplacement**
 - **Temperature maximum obtained 2000-3000 yrs after initial emplacement**
 - **Temperature to gradually reduce 2000-3000 yrs after initial emplacement**

WHAT POSSIBLE EFFECTS COULD BE ANTICIPATED

- **Altered water mass balance**
- **Altered timing of biological processes**
- **Change in the ecosystem structure & function**

POSSIBLE EFFECTS THAT COULD BE ANTICIPATED

(CONTINUED)

- **Altered water mass balance**
 - **Increased evaporation**
 - **Increased transpiration/respiration**
 - **Less available water for biological processes**

POSSIBLE EFFECTS THAT COULD BE ANTICIPATED

(CONTINUED)

- **Altered timing of biological processes**
 - **Species use environmental cues to initiate phases**
 - **Asynchrony of processes**
 - **Breaking seed dormancy**
 - **Emergence from hibernation**
 - **Pollination**
 - **Insufficient time to complete processes**
 - **Reduced growing season/activity period**
 - **Reduced resources**

POSSIBLE EFFECTS THAT COULD BE ANTICIPATED

(CONTINUED)

- **Change in ecosystem structure and function**
 - **Limiting factors/threshold limits**
 - **Species loss & change in composition/diversity**
 - **Reduction in primary productivity of system**
 - **Altered sex ratios**
 - **Enhancement of detrimental processes**
 - **Decomposition of organic matter**
 - **Enhance pathogens/pests**
 - **Localized impacts along fissures**
 - **Change in timing of biomass production**

STATE OF KNOWLEDGE ON POSSIBLE REPOSITORY EFFECTS

- **Literature review**
 - **Effects of increased soil temperature**
 - **Effects of reduced soil moisture**
 - **Effects of interaction between increased soil temperature and reduced in soil moisture**
- **Current environment**
 - **Geothermal**
 - **Site-specific: seasonal, annual and spacial variability**

IMPACT OF GEOTHERMAL HEATING ON LODGEPOLE PINE IN YELLOWSTONE N.P. (WHITE, 1978)

Investigated Three Zones - Normal, Mixed, Stunted

| Zone | Near Surface Heat Flow (W/M²) |
|----------------|---|
| Normal | 1.9 - 8.4 |
| Mixed | 9.6 - 13.8 |
| Stunted | >20.9 |

“The actual upper limit of tolerance is probably not set by heat flow as such but by the seasonal maximum soil temperature at the root depths preferred by each form of vegetation”

NATURAL VARIABILITY IN SOIL TEMPERATURE AT YUCCA MOUNTAIN

| Soil Temperature (C°) at 45 cm | Vegetation Associations | | | |
|--------------------------------------|-----------------------------|---------------------------------------|------------------|---------------------------|
| | <i>Larrea- Ambrosia</i> | <i>Larrea- Lycium- Grayia</i> | <i>Coleogyne</i> | <i>Lycium- Grayia</i> |
| January temp 1991 | 8.9 | 8.6 | 7.3 | 7.8 |
| August temp 1991 | 30.9 | 30.3 | 28.7 | 28.0 |
| Range of January temps | 8-10 | 7-10 | 6-9 | 6-10 |
| Range of August temps | 30-33 | 29-31 | 26-31 | 26-31 |

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| January temp | | | | |
| 1991 | 8.9 | 8.6 | 7.3 | 7.8 |
| 1992 | 6.2 | 5.3 | 5.2 | 4.4 |
| 1993 | 7.7 | 6.1 | 6.5 | 5.0 |
| August temp | | | | |
| 1991 | 30.9 | 30.3 | 28.7 | 28.0 |
| 1992 | 31.6 | 31.5 | 29.0 | 29.4 |
| Difference of August 1991-1992 temps | .7 | 1.2 | 0.3 | 1.4 |
| Difference of Jan 1991-1992 temps | 2.7 | 3.3 | 2.1 | 3.4 |

UNCERTAINTIES IN STATE OF KNOWLEDGE

- **The environmental conditions that will exist in 2,000 - 3,000 years**
- **Species responses to anticipated impact**
 - **Change in phenology/activity periods**
 - **Change in biomass production/food resource**
 - **Available water for biological processes**
- **Ecosystem responses to anticipated impact**
 - **Loss of species from ecosystem**
 - **Interaction of remaining species**
 - **Impact on trophic levels**
- **Evolutionary scale effects - genetic drift**

PLANS FOR DEVELOPMENT OF STUDY DESIGNS FOR REPOSITORY EFFECTS

- **Thorough literature review/interactions with other scientists**
- **Develop study designs which may include:**
 - **Measuring existing ecosystem components along latitudinal/elevational gradients**
 - **Measuring natural analogs - local/regional geothermal areas**
 - **Simulating effects through glasshouse/small field trials**
 - **Development of models/improving existing models**

CONCLUSIONS

- **Thermal loading should have an effect on biological resources**
- **The significance of that effect is dependent on actual level of surface temperature increase**
- **Biological systems have tolerance for change**
- **Uncertainties exist on:**
 - **Actual temperature increases**
 - **Environmental conditions in 2,000 - 3,000 years when temperature increases are anticipated**
 - **The resulting effect on the specific biological resources at Yucca Mountain**
- **Some of these uncertainties could be addressed through a research program**