CIVILIAN RADIOACTIVE WASTE MANAGEMENT SYSTEM

Management and Operating Contractor

Contract #: DE-AC01-91-RW00134
Document #: LV.PA.CEB.2/93-006

WASTE ISOLATION EVALUATION

DRILLING OF UZ-14

by

Carl E. Bruch

February 24, 1993

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Prepared by:

Carl E. Bruch — 24 Feb 1993
Project Consultant, Performance and Modeling Department — Date

Verified by:

Albin Brandstetter — 2/24/1993
Senior Staff Consultant, Systems Engineering Department — Date

Verification method: Comparison with source documents.

Reviewed by:

Abraham E. Van Luik — 2/25/1993
Manager, Performance Assessment and Modeling Department — Date

Approved by:

Jean L. Younker — 2/25/93
Systems Manager — Date

This waste isolation evaluation was prepared in accordance with M&O QAP-3-5.

Waste Isolation Evaluation

Drilling of USW UZ-14

SUMMARY

This waste isolation evaluation addresses the planned drilling of borehole USW UZ-14 on the same drillpad as the existing borehole UZ-1. No impacts on waste isolation are expected for the conceptual repository. The only potential impacts would be on the underlying repository expansion areas, should they be used in the future. No new controls beyond those already existing for surface-based testing and related activities are required, except to preserve the ability for effective sealing of the borehole should this be necessary on the basis of future ground-water flow and aqueous and gaseous radionuclide transport evaluations.

1. INTRODUCTION

1.1 Purpose

This evaluation was performed in response to a request from the Yucca Mountain Site Characterization Project Office (YMPO) to assess the potential waste isolation impacts of drilling borehole USW UZ-14 (Dyer, 1992b). This evaluation does not address the planned testing.

1.2 Location

The borehole USW UZ-1/UZ-14 drillpad is located in Drill Hole Wash. The existing borehole UZ-1 is located at Nevada State Central coordinates N771,276 ft and E560,221 ft (Whitfield et al., 1990) and the planned borehole UZ-14 will be located at N771,321 ft and E560,144 ft (verbal communication from RSN, September 2, 1992); thus UZ-14 will be about 14 m (45 ft) north and 23 m (77 ft) east of UZ-1 and the two boreholes will be about 27 m (89 ft) apart. The drillpad is about 560 m (1850 ft) in a north-by-northwest direction from the northernmost corner of the conceptual perimeter drift boundary (CPDB), inside the conceptual controlled area boundary (CCAB) (EG&G, 1992a and 1992b), and on the boundary between two potential repository expansion areas (DOE, 1990; EG&G, 1992c).

1.3 Relevant Elevations

Relevant elevations (rounded to nearest meter or foot) above mean sea level (m.s.l.) are listed in Table 1. The anticipated stratigraphy at USW UZ-14 is (Hayes, 1992) is listed in Table 2.

Table 1. Elevations of Boreholes and Exploratory Studies Facility

Location	Meters	Feet	Reference
USW UZ-14 drillpad	1348	4424	Hayes, 1992
USW UZ-14 borehole bottom, projected	756-786	2480-2578	Hayes, 1992
USW UZ-1 top of Topopah Spring tuff	1271	4170	Whitfield et al., 1990
USW UZ-1 bottom of Topopah Spring tuff	969 (est.)	3178 (est.)	Hayes, 1992
USW UZ-1 borehole bottom	961	3154	Whitfield et al., 1990
USW G-1 drillpad	1325	4348	USGS, 1993
USW G-1 water table (approx. ave.)	758	2489	Hayes, 1992
USW G-1 borehole bottom	-503	-1651	USGS, 1993
USW H-1 water table (approx. ave.)	730	2395	DOE, 1988a, Robison et al., 1988
North ramp at surface	1124	3687	YMP, 1991a
North ramp at Topopah Spring level	988	3240	YMP, 1991a
South ramp at surface	1198	3980	YMP, 1991a
South ramp at Topopah Spring level	1140	3741	YMP, 1991a
Calico Hills drift north end	824	2702	YMP, 1991a
Calico Hills drift south end	955	3134	YMP, 1991a

1.4 Existing Conditions and Planned Activities

The pad that will be used to drill borehole UZ-14 is the same as the one used for USW UZ-1. Remediation is currently underway for past hydrocarbon spills on the drillpad. The effects of the corrective actions are addressed in Test Interference and Waste Isolation Evaluations now in preparation. The contaminated materials have been excavated and are now stockpiled on the southern corner and along the northwest perimeter of the drillpad in several large piles on plastic sheeting and covered with plastic (Dyer, 1992a). The excavated materials will be removed and the excavation will be backfilled and compacted before UZ-14 will be drilled. The remediation is not expected to impact the drilling of UZ-14: the excavation is not close to the proposed UZ-14 location, and the excavation did not penetrate into the underlying bedrock.

USW UZ-14 will be continuously dry cored and drilled (reamed) to a diameter of 12.25 in and to a depth of approximately 40 feet below the water table, a total depth of approximately 591 to 622 m (1940 to 2040 ft). The drilling fluid will be gaseous tracer-tagged air. The gaseous tracer to be selected, e.g., sulphur hexafluoride, Freon-12, Freon-13B1, Freon-11, Freon-113,

tetrafluoroethane ("Suva" Cold-MP) or another gas, will be inserted into the compressor air line with a concentration of about 1.5 ppm. Surface casing will be installed to a depth of 50 ft, or 5 ft below the alluvial/colluvial-tuff contact, whichever is greater. Following completion of the drilling, tests will be undertaken to characterize percolation in the unsaturated zone, study geochemical and isotopic signatures of various lithologic units in the unsaturated zone, geophysically log the unsaturated zone, hydrochemically characterize the saturated and unsaturated zones, test air permeability, and measure matrix hydrologic properties (Hayes, 1992). This evaluation does not address the planned testing and future borehole sealing.

Table 2. Anticipated Stratigraphy in Borehole USW UZ-14

Stratigraphic Unit	Depth to top of unit (meters)	Depth to top of unit (feet)
Alluvium	0	0
Yucca Mountain Member		
Moderately Welded Tuff	17.4	57
Partially Welded Tuff	20.7	68
Bedded Tuff	25.6	84
Pah Canyon Member		
Nonwelded Tuff	32.0	105
Bedded Tuff	71.6	235
Topopah Spring Member		
Nonwelded Tuff	77.7	255
Moderately Welded Tuff	83.8	275
Densely Welded Tuff	86.3	283
Moderately Welded Tuff	100.6	330
Moderately to Densely Welded Tuff	132.6	435
Densely Welded Tuff	222.5	730
Calico Hills Member		
Nonwelded Tuff	380.0	1247

1.5 Quality Assurance

The described conditions may affect natural barriers of a potential repository at Yucca Mountain; these natural barriers are listed in Appendix A of the Q-List (YMP, 1990). For this reason, this report was prepared as a quality-affecting activity according to CRWMS M&O Quality Administrative Procedure QAP-3-5 Development of Technical Documents. Guidance for the format and content of waste isolation evaluation reports, in lieu of a document development preparation plan, was provided by Younker (1992). Some of the referenced data may not have been approved for quality-affecting activities and the referenced analyses may not have been performed as quality-affecting activities or under software quality assurance (QA) requirements. Some of the quoted water-level data were collected under YMP QA procedures by the U.S. Geological Survey (USGS) (Robison et al., 1988). The extent and possible effect of non-qualified data and analyses on the evaluations, conclusions and recommendations of this report were not determined.

2. EVALUATION

2.1 Evaluation Approach

This is a qualitative evaluation based on information in the referenced documents and supplemented by personal communications with YMP and participant staff. No new quantitative analyses were performed with the exception of quantitative comparisons of available data. A checklist (see last page) was used as guidance to ensure no activities and potential waste isolation impacts were overlooked.

2.2 Relative Locations and Elevations

USW UZ-14 is located about 560 m (1850 ft) outside the CPDB. The borehole is inside the CCAB and on the boundary of two potential repository expansion areas. The ground level of the borehole will be at an elevation of approximately 1348 m (4424 ft) above m.s.l., which is about 250 m (800 ft) higher than the planned Exploratory Studies Facility (ESF) north ramp entrance and 361 m (1184 ft) higher than the Topopah Spring level at the north ramp.

2.3 Relevant Hydrology and Hydrogeology

The drillpad for borehole USW UZ-14 straddles the western side of Drill Hole Wash. The hills on either side are quite steep. The drainage channel of the wash itself runs along the eastern side of the drillpad. A berm around the uphill sides of the drillpad, including between the pad and the wash's drainage channel, is expected to protect the pad and the borehole from runoff in the wash for a 100-year flood (Bullock, 1992).

The geologic formations, including the Topopah Spring tuff, dip downward in a northeasterly direction under the conceptual repository block, but then the downward dip swings toward a southeasterly direction approximately under Drill Hole Wash (Scott and Bonk, 1984). Scott and Bonk's vertical cross-section D-D', which intersects Drill Hole Wash about 150 m (500 ft) upstream of UZ-1, shows a roughly horizontal surface for the top of the Topopah Spring tuff

from the CPDB to Drill Hole Wash; their vertical cross-section E-E' shows a definite downward dip from borehole USW H-5 on the crest of Yucca Mountain to borehole USW G-1 in Drill Hole Wash about 335 m (110 ft) downstream of UZ-1, and from G-1 an upward dip in a northerly direction. This seems to indicate that the Topopah Spring tuff under UZ-1 is at about the same elevation or lower than along the northern CPDB. The USGS criteria letter (Hayes, 1992, p. 27) for the planned drilling of UZ-14 estimates the top of the Topopah Spring nonwelded tuff to be at an elevation of about 1271 m (4170 ft). The top of the same unit at H-5 is at an elevation of about 1330 m (4360 ft) (Scott and Bonk, 1984), which would indicate a downdip trend from the conceptual repository to UZ-1.

No faults are shown directly underneath borehole UZ-1, but existing and inferred faults are about 100 m (330 ft) to the north (Scott and Bonk, 1984). More north-trending faults are located about 330 m (1100 ft) to the west and 550 m (1800 ft) to the east.

Borehole UZ-1 was air-drilled in 1983; drilling was stopped when fluids were found at the bottom of the borehole; these fluids were later determined to contain drilling fluids originating from borehole G-1, which had been drilled in 1980 (WWL, 1986; DOE, 1988b; Whitfield et al., 1990). Borehole G-1 is 1829 m (6000 ft) deep; its bottom is in the upper vitrophyre of the Topopah Spring welded unit. Approximately 8,700 m^3 (2,300,000 gallons) of polymer drilling fluids were lost in the hole. It should be noted that the high hydrostatic head of the fluid in G-1 may have been a contributing factor in forcing the fluid into the rock, including toward the vicinity of UZ-1. Based on the time of drilling of the two holes and the distance between them, the minimum fluid velocity was calculated to be 3.2×10^{-6} m/s (100 m/yr = 330 ft/yr) which cannot be explained with known or expected porous-rock porosities and hydraulic conductivities. Consequently, a fracture pathway must exist for relatively fast fluid flow from G-1 to UZ-1 (WWL, 1986).

Borehole UZ-1 is 387 m (1270 ft) deep and it is doubtful that it penetrates the water table (DOE, 1988b; Hayes, 1992). Borehole UZ-14 is planned to be drilled to not more than 12 m (40 ft) below the water table (Hayes, 1992). The water table elevation at UZ-1/UZ-14 was estimated from observed water table elevations at the nearby boreholes USW G-1 and USW H-1. At G-1, the observed water table elevation is between about 754 m to 762 m (2473 to 2500 ft) and at H-1 it is at an elevation of about 730 m (2395 ft) (Hayes, 1992, p. 9; Robison et al., 1988). Both boreholes are southeast and downstream of UZ-1: G-1 is in Drill Hole Wash channel, about 335 m (1100 ft) downstream of UZ-1, and H-1 is at the junction of Drill Hole Wash and Teacup Wash, about 730 m (2400 ft) downstream of UZ-1.

Based on these two boreholes, Hayes (1992) estimated the water table at UZ-1/UZ-14 to be about 580 to 610 m (1900 to 2000 ft) below the surface. With the surface elevation at 1348 m (4424 ft), this would give a water table elevation from about 739 to 769 m (2425 to 2523 ft). A straight line projection would give a water table elevation between about 774 and 788 m (2540 to 2585 ft), or 561 to 575 m (1840 to 1885 ft) below the surface. Uncertainties exist, however, due to the steeper water table gradient north of these boreholes (Robison, 1984; DOE, 1988a).

In the vicinity of the drillpad, saturated-zone flow is expected to be first in a southeasterly direction to an area where the water table is fairly flat, and from there in a southerly direction, all

away from the conceptual repository block and potential repository expansion areas (Robison, 1984; DOE, 1988a). Due to the flatness of the water table farther south, however, uncertainties exist on the actual direction of flow.

2.4 Specific Evaluations and Conclusions

2.4.1 Water Flowing from Borehole to Conceptual Repository. USW UZ-14 will be dry-drilled, so no liquid drilling fluid will be used. In addition to the berm around the drillpad, many controls are in place to protect the borehole from surface water inflow (Hayes, 1992). Consequently, it is extremely unlikely that any significant quantity of surface water will enter the borehole. Thus, surface water flowing from UZ-14 to the conceptual repository is considered insignificant to waste isolation.

2.4.2 Unsaturated and Saturated Zone Ground-Water Travel Time. USW UZ-14 will be dry-drilled, so no liquid drilling fluid will be used. In addition to the berm around the drillpad, many controls are in place to protect the borehole from surface water inflow (Hayes, 1992). Consequently, it is extremely unlikely that any significant quantity of surface water will enter the borehole or reach the water table via the borehole while it is being drilled. Thus, surface water flowing from UZ-14 to the saturated zone and its effect on the ground-water travel time is considered an insignificant concern to waste isolation.

Because of its proximity to the repository, water could flow from the conceptual repository to the borehole, affecting ground-water travel time through the unsaturated zone while the borehole is open. Because the borehole will be sealed before waste would be placed in a repository, the sealed borehole is not expected to affect unsaturated-zone ground-water flow and travel time. Further analyses which address potential effects of borehole sealing on unsaturated ground-water flow may be necessary at this point.

2.4.3 Aqueous Radionuclide Transport. UZ-14 will extend to a depth which is 220 to 250 m (720-820 ft) lower than the Topopah Spring level at the north ramp and 367 to 397 m (1200-1300 ft) lower than the Topopah Spring level at the south ramp. Because the borehole may be stratigraphically downdip from the conceptual repository, the borehole could act as a pathway for aqueous radionuclide transport. However, the borehole will be sealed before waste would be placed in a repository. Thus, the drilling phase of UZ-14 is not expected to affect aqueous radionuclide transport. The borehole will be sealed before it is abandoned, and further analyses that address transport of aqueous radionuclides may be necessary at this point.

2.4.4 Gaseous Radionuclide Transport. The base of UZ-14 is 361 m (1184 ft) higher than the Topopah Spring level at the north ramp and 208 m (683 ft) higher than the Topopah Spring level at the south ramp. Because of its proximity to the repository, the borehole could act as a pathway for gaseous radionuclide transport. However, the borehole will be sealed before waste would be placed in a repository. Thus, the drilling phase of UZ-14 is not expected to affect gaseous radionuclide transport. The borehole will be sealed before it is abandoned, and further analyses that address transport of gaseous radionuclides may be necessary at this point.

2.4.5 Thermo-Mechanical Effects. Because no blasting will occur and because drilling has very short-range effects, no significant thermo-mechanical effects on the conceptual repository or potential repository expansion areas are expected as a result of drilling UZ-14.

2.4.6 Fluids, Tracers and Materials. No unusual fluids, tracers, and materials are expected to be used during drilling. Potential future spills of engine fuels, hydraulic fluids, and lubricants will not affect waste isolation provided normal precautions are taken to prevent spills and potential spills are cleaned up promptly.

2.4.7 Other Considerations. The drilling of UZ-14 may involve the pumping and disposal of perched and saturated-zone water, water used during fishing operations, and the management of leaching from wet drilling cuttings. Because drilling fluids from G-1 were encountered during the drilling of UZ-1, they may also be encountered during the drilling of UZ-14. However, it is unlikely that any of these fluids and their disposal in Drill Hole Wash or other environmentally acceptable locations off the conceptual repository block will impact waste isolation. Depending on the disposal locations and the volumes involved, the only potential impact would be on repository expansion areas, should they be used in the future.

3. CONCLUSIONS AND RECOMMENDATIONS

Assuming existing controls (YMP, 1991b; YMP, 1992a; YMP, 1992b) and those listed in the USGS criteria letter (Hayes, 1992) are followed, the drilling of borehole USW UZ-14 is not expected to impact waste isolation at the conceptual repository at Yucca Mountain.

Perched and saturated-zone water will be handled according to the procedures outlined in the USGS Scientific Notebook Plan NWM-USGS-HP-231T, R0 (USGS, 1992). The disposal of G-1 drilling fluids and fishing water and the management of leaching from wet drilling cuttings should be conducted in accordance with the appropriate Technical Procedures. Disposal locations should be outside the conceptual repository block and away from potential fracture zones within 600 m (200 ft) of the CPDB, based on SNL analyses (Blejwas, 1992).

No new controls beyond those already defined for surface-based testing and related activities and those mentioned above are necessary. The following actions are recommended, however, to assure adequate sealing and to prevent the borehole from becoming a pathway for aqueous and gaseous radionuclide transport:

1. No actions should be taken which would preclude the effective sealing of the borehole. The identification of necessary controls should consider recommendations by SNL's sealing program.

2. Evaluations should be performed in the future, prior to permanent sealing, to determine the needed effectiveness of seals with respect to potential effects on ground-water flow and on aqueous and gaseous radionuclide transport through the borehole, and to select appropriate seal locations and grout compositions. These evaluations cannot be performed until borehole-specific data have been collected.

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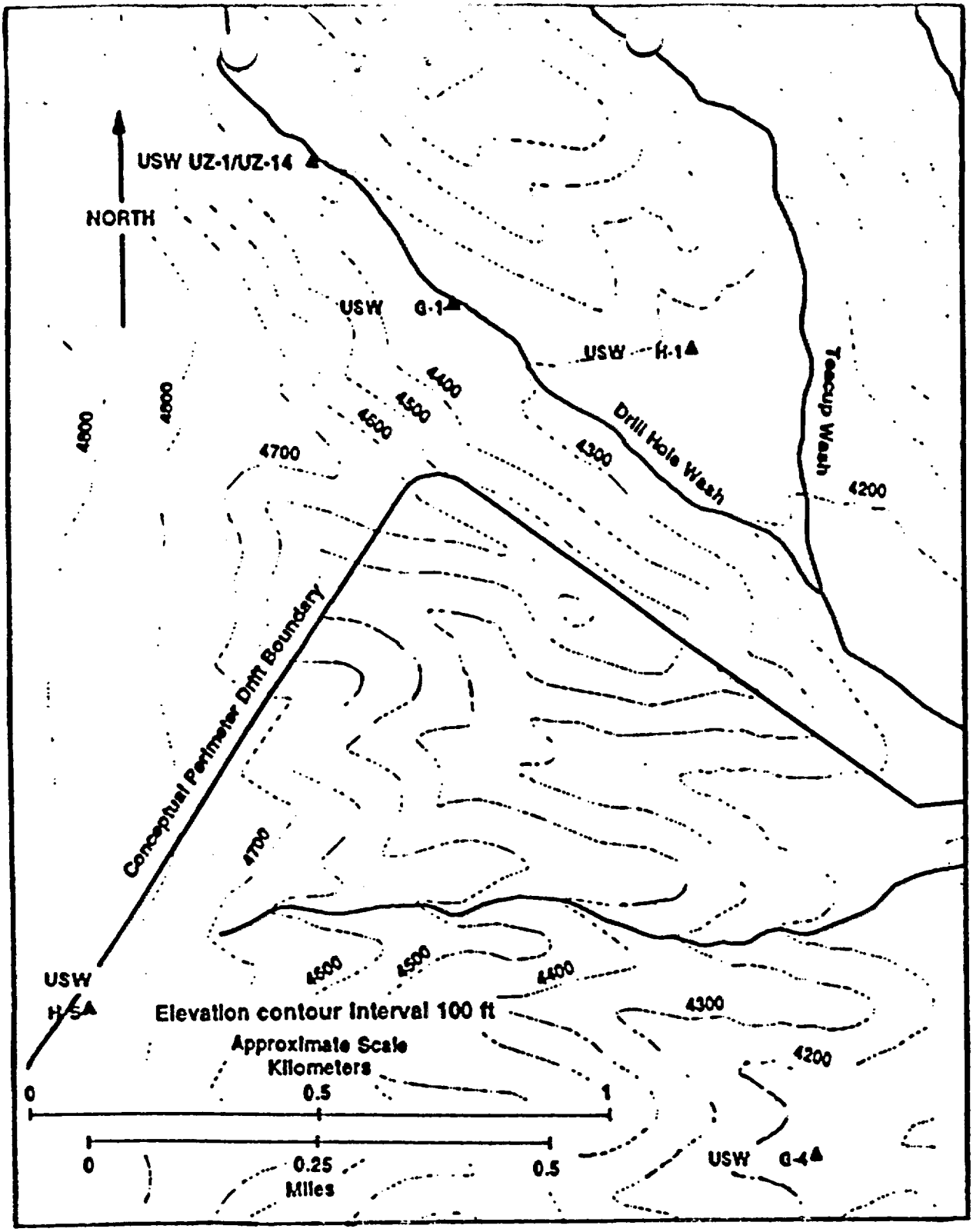

Figure 1. Vicinity map for boreholes USW UZ-1 and UZ-14.
(Adapted from EG&G GENISES/ArcView database January 28, 1993, plot)

CHECKLIST OF GENERAL CONCERNS REGARDING IMPACTS ON WASTE ISOLATION

CONCERNS	COMMENTS
I. Water	
A. Surface Sources	
1. Road watering for dust control	See recommendations
2. Drillpad dust control	See recommendations
3. Equipment washdown	See recommendations
4. Natural surface runoff	See sections 2.4.1 and 2.4.2 and recommendations
5. Accidental water spillage	See sections 2.4.1 and 2.4.2 and rec.
6. Used in testing	Not applicable
B. Underground	
1. Water loss during drilling	
a) Normal	Not applicable
b) Fishing	See section 2.4.7
c) Unexpected	Not applicable
2. Recovered or produced during drilling	
a) Perched water	See section 2.4.7
b) Water table	See section 2.4.7
3. Used in testing	Not applicable
II. Tracers, Fluids and Materials (other than water)	
A. Used in surface construction	
1. Building materials	Not applicable
2. Leachates from rock & muck piles	Not applicable
B. Used in borehole construction and/or sealing	
1. Grout for surface casings	See section 2.4.6
2. Drilling fluids	See sections 1.4 and 2.4.6
3. Other materials left in boreholes	Not applicable
C. Used in testing	Not applicable
III. Other considerations	
A. Physical and chemical characteristics of seals	Not applicable
B. Seals may not achieve design objectives	Not applicable
C. Cut-and-fill for roads, pads, trenches & pits	Not applicable
D. Blasting	See section 2.4.5