CORRECTIVE ACTION PROGRAM AND ALTERNATE CONCENTRATION LIMITS PETITION FOR UPPER MOST BEDROCK UNITS AMBROSIA LAKE URANIUM MILL FACILITY NEAR GRANTS, NEW MEXICO

Prepared for:
Quivira Mining Company
USNRC License No. SUA-1473, Docket No. 40-8905

Submitted to:
U. S. Nuclear Regulatory Commission

February 15, 2000

Prepared by:

AVM Environmental Services, Inc.
Grants, New Mexico

and

Applied Hydrology Associates, Inc.
Denver, Colorado

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EXECUTIVE SUMMARY

This Alternate Concentration Limits (ACLs) Petition is prepared to request approval of ACLs and termination of the groundwater Corrective Action Program (CAP) for the uppermost bedrock units (Dakota and Tres Hermanos Sandstone hydrogeologic units) at the Quivira Mining Company's (QMC) Ambrosia Lake Uranium Mill Facility (Facility) near Grants, New Mexico.

Following the review of groundwater detection monitoring program results for the Facility in 1988, the U. S. Nuclear Regulatory Commission (NRC) set Groundwater Protection Standards (GPSs) for 14 hazardous constituents in the Dakota Sandstone (Dakota), and nine constituents in Tres Hermanos A Sandstone (TRA) and Tres Hermanos B Sandstone (TRB) points of compliance (POCs). Since the groundwater concentrations for the hazardous constituents at the POCs exceeded the corresponding GPSs, the NRC required QMC to implement a groundwater CAP with the objective of returning hazardous constituents concentrations at the POCs to GPSs.

The approved groundwater CAP involves continuation of mine water pumping from the Westwater Canyon Member of the Morrison Formation at the Section 30 and Section 30 West mines so that any groundwater in the uppermost bedrock units (Dakota, TRB and TRA) down gradient of the tailings impoundments and evaporation ponds will be intercepted by the mine shaft, ventilation holes, and mine subsidence fractures that drain into the mine. The pumped mine water is treated at the Facility and discharged pursuant to the National Pollution Discharge Elimination System (NPDES) permit for mine water discharge. A dewatering trench was also installed between evaporation pond #7 and Tailings Impoundment #2 to intercept seepage from Tailings Impoundment #2 and pond #7. This dewatering trench is pumped and flow is routed to the seepage interceptor trench southeast of Tailings Impound #1, which is the corrective action for the Alluvial aquifer at the Site. This CAP evaluation and ACLs petition addresses only the uppermost bedrock units

Recent groundwater compliance monitoring results indicate that all of the hazardous constituents in the uppermost bedrock units groundwater at the POC wells are below the GPSs, except U-nat, Pb-210, Th-230, combined radium (Ra-226 and -228), gross alpha and nickel. Past corrective actions, including minimizing the amount of free water, use of lined evaporation ponds, removal of standing tailings solution, construction and operation of the dewatering trench, and placement of tailings cover have reduced seepage impacts significantly, and thereby, have reduced the concentration of hazardous constituents in groundwater at the POC.

Continuation of mine water pumping is not necessary to accomplish the interception of groundwater from the uppermost bedrock units. Regional groundwater modeling studies have shown that it will take hundreds of years for the dewatering centers to recover following termination of mine pumping in order for resaturation to occur at potential point of exposure (POE) locations in the Dakota, TRB and TRA units. However, pumping of mine water has not dewatered the Dakota unit at the potential POE location downgradient of ponds #7 and #8. Nevertheless, removal of tailing fluids and byproduct material from ponds #7 and #8 has been effective in reducing concentrations at the POC in the Dakota sufficiently to protect groundwater in the Dakota at all potential POE locations.

With final mill tailings reclamation at the Facility nearing completion, the range of other practical groundwater corrective action alternatives for the bedrock units is limited. Several potential alternative technologies were re-examined for potential feasibility and effectiveness as corrective action measures for the shallow bedrock units at the Facility. CAP alternatives, such as enhanced tailings dewatering and groundwater interception and treatment, will not be practicable or cost effective for removing the very low quantities and concentrations of constituents that currently remain in the groundwater in the uppermost bedrock units.

Alternative corrective actions evaluated will not significantly improve groundwater concentrations in the Dakota and TRA, and very optimistically, may reduce the current constituent concentrations in the TRB by less than 50%. Even though the TRB at potential POE locations down gradient of the Facility will not resaturate for hundreds of years, a cost-effectiveness evaluation of CAP alternatives was performed. This evaluation assumed that a family obtains its water from the TRB and the groundwater concentrations are equivalent to the highest of the recent POC concentrations in the TRB. Assuming that the CAP is effective in reducing these concentrations by 50%, either alternative costs about $1.7 million for averting one person-rem. This $1.7 million per person-rem averted exceeds by far the NRC's As Low As Reasonably Achievable (ALARA) guidance of $2,000 to $20,000 per averted person-rem specified in NRC's draft regulatory guide DG-4006. Thus, groundwater concentrations are ALARA.

A hazard evaluation was performed in support of this ACL Petition to demonstrate that the proposed ACLs for the uppermost bedrock units at the Facility will not pose substantial present or potential hazard to human health or the environment. A health risk-based concentration limit that will limit the lifetime risk to less than 1.0E-04 for groundwater consumption at potential POE locations was calculated for each constituent using the U. S. Environmental Protection Agency's (EPA) most recent federal guidance report for health risk from environmental exposure to radionuclides. The health risk-based concentrations were determined for all potential pathways for hazardous constituents in the groundwater in the vicinity of the Facility.

An ACL may replace the groundwater protection standard at the POC, when meeting the standard may not be practical or achievable, and the groundwater concentration does not pose a substantial present or potential hazard. In order for an ACL to be protective of human health and the environment, the contaminant attenuation between the POC and the POE must be sufficient to insure that the health risk-based concentration limit is attained at the POE. The proposed health risk-based concentrations and ACLs for the bedrock units are summarized in the following table:

Constituent	Health Risk-Based Concentrations	Proposed Alternate Concentration Limits		
		Dakota Sandstone	Tres Hermanos A Sandstone	Tres Hermanos B Sandstone
U-nat, mg/l	0.25	0.81	None	0.25
Th-230, pCi/l	139	869	139	139
Ra-226 and -228 pCi/l	41	41	41	41
Pb-210, pCi/l	13	57	13	13
Nickel, mg/l	0.10	0.12	None	0.37

QMC has limited the proposed ACLs for most of the constituents to the health-based concentrations. The ACLs requested for hazardous constituents at POC wells in the TRA have been set at the health risk-based concentrations. The proposed ACLs for the TRB and Dakota were set at either the health risk- based concentration, or the value of the mean plus two standard deviations determined from monitoring results from 1994 to present at the POC wells. However, in no case is an ACL proposed at a concentration higher than the estimated protective concentration at the POC based on contaminant attenuation between the POC and the POE.

The current groundwater concentrations at the POE wells at the Facility in all uppermost bedrock units (Dakota, TRA and TRB) are below the proposed health risk-based concentration, and are near the background levels. The incremental mortality risk from ingestion of hazardous constituents in groundwater at the potential POE in all three bedrock units is negligible, and significantly less than the 1.0E-04. The calculated health risk associated with groundwater use at the potential POE locations down gradient of the Facility is acceptable, especially considering that domestic use of groundwater near the potential POEs in the bedrock units is highly unlikely. There has been a large reduction in water use and groundwater withdrawals in the area over the past 10 to 15 years due to the poor economic conditions associated with the decline of the uranium industry. Projecting into the future, with site reclamation nearing completion, any increased use of groundwater in the Ambrosia Lake area in the vicinity of the tailings pile is highly unlikely. In fact, groundwater use at the potential POE locations in the TRA and TRB units will not even be possible for several hundred years because they are dewatered and will be the last units to resaturate during groundwater recovery following termination of mine water pumping. Therefore, the proposed ACLs are ALARA, and do not pose a substantial hazard to the human health or the environment.

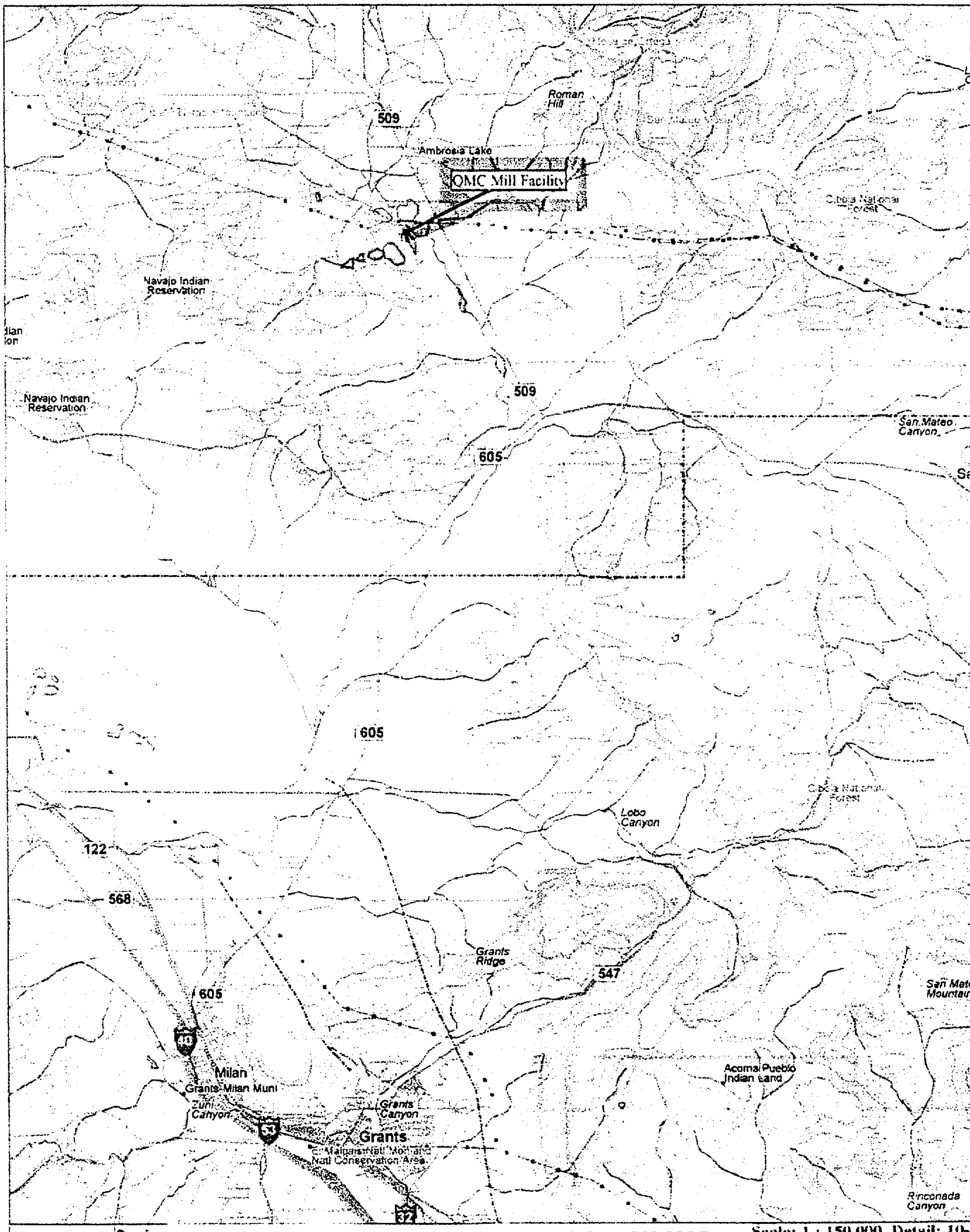
1.0 GENERAL INFORMATION

This groundwater Corrective Action Program (CAP) Review and Alternate Concentration Limits (ACL) Petition is prepared for the uppermost bedrock units (Tres Hermanos and Dakota Sandstone Hydrogeologic Units) at Quivira Mining Company's (QMC) Ambrosia Lake Uranium Mill Facility (Facility) near Grants, New Mexico. QMC requests termination of the groundwater CAP consisting of mine dewatering program for the uppermost bedrock units, and approval of ACLs in form of the License (SUA-1473) amendment. This CAP review and ACLs petition only addresses the uppermost bedrock units. The groundwater CAP review for Alluvial Aquifer unit is not included in this Petition. This ACL Petition is prepared consistent with the NRC's Staff Technical Position, Alternate Concentration Limits for Title II Uranium Mills (NRC 1996) and Draft Standard Review Plan, NUREG 1620 (NRC, 1998a). Section 1 of this Petition includes general information. The groundwater hazard assessment, including extent of groundwater contamination and exposure assessment is provided in Section 2. Section 3 contains the groundwater corrective action assessment and demonstrates that the groundwater concentrations are As Low As Reasonably Achievable (ALARA). Proposed ACLs and demonstration of ACLs being ALARA is included in Section 4.0

1.1 Facility Description

The Facility is located approximately 20 miles due north of Grants, New Mexico, in the heart of the Ambrosia Lake valley as shown in Drawing 1-1. Uranium mining and milling operations, which began in the Ambrosia Lake area in the mid-1950's, have created significant changes in the groundwater system in the area. Dewatering from several mines and discharge of mine water and disposal of mill tailings and effluents at several facilities in the area have combined to alter the quantity, quality, and pattern of flow of groundwater in the area.

Activities at the Facility started in 1957. A water storage reservoir was constructed to contain mine water for mill use and unlined evaporation ponds #4, #5, and #6 were constructed for evaporative treatment of mine water and mill effluents as shown in Map 1-1. Tailing Impoundments #1 and #2 were built in late 1958 along with pond #3 located at the eastern toe of the Tailings Impoundment #1 for decant of the tailings impoundments. The tailings were first produced at the Facility in November 1958. The solid portions of the process were disposed through a slurry transfer system to the tailings impoundments, while the liquid fraction was transferred to evaporation ponds. Evaporation pond residues from ponds #3, #4, #5, #6, #7, and #8 were placed in Tailings Impoundments #1 and #2 prior to final reclamation.



DRAWING 1-1. QMC MILL FACILITY LOCATION MAP

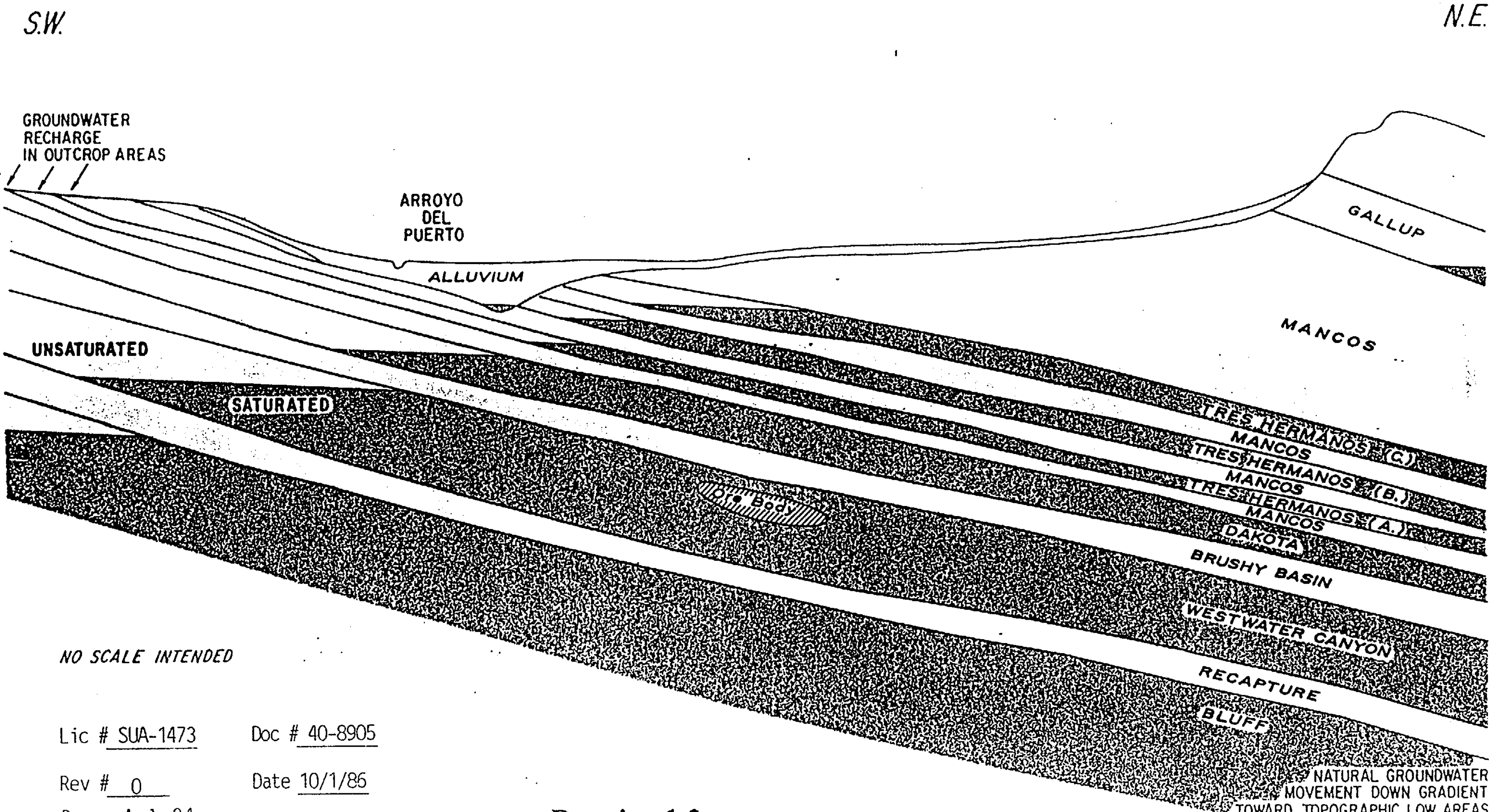
Scale: 1 : 150,000 Detail: 10-0

A map showing the location of the mill facilities and associated ponds is provided in the map pocket as Map 1-1.

Seepage from the tailings impoundments and from evaporation ponds #3 through #6 and discharge of treated mine water from the Facility and seepage and discharges at other uranium mining and milling operations in the vicinity have recharged the previously dry portions of the alluvium of Arroyo del Puerto. Seepage from the tailings impoundments and from evaporation ponds #7 and #8 have also recharged the shallow sedimentary bedrock units that outcrop at the Facility, including the Tres Hermanos sandstones occurring within the Mancos Formation and the Dakota Sandstone which underlies the Mancos Formation. These sedimentary rocks dip gently to the northeast. The bedrock units located stratigraphically below the Dakota Sandstone are the Brushy Basin and the Westwater Canyon members of the Morrison Formation, the latter being the uranium ore bearing unit in the Ambrosia Lake area. Drawing 1-2 shows a generalized cross section through the Ambrosia Lake area. The Westwater Canyon member in the vicinity of the Facility has been dewatered by historic and on going mine dewatering operations. Furthermore, the bedrock formations above the Westwater Canyon Member have been drained in the locations north and northeast of the Facility by the numerous ventilation holes, mine shafts and fractures induced by subsidence into the underground mine workings.

Tailings Impoundments #1 and #2 and the unlined evaporation ponds #7 and #8 overly bedrock while unlined ponds #3, #4, #5, and #6 were located within the alluvium of Arroyo del Puerto. Only a small fraction of the seepage from Tailings Impoundments #1 and #2 is thought to have migrated down dip into the sandstone units. Most of the tailings seepage has migrated down gradient through the shallow weathered bedrock (saprolite) underlying the tailings impoundments to the alluvium.

The unlined evaporation ponds #4, #5, and #6 were not used during the years 1960 to 1975. Instead, the water was diverted to ponds atop Tailings Impoundments #1 and #2 and to the unlined evaporation ponds #7 and #8 which were built in 1961. During this fifteen (15) year time span when unlined evaporation ponds #4, #5, and #6 were not used, the channel and alluvium of Arroyo del Puerto continued to receive water from solutions seeping from Tailings Impoundments #1 and #2 and pond #3 and from the continued discharge of treated mine water. The infiltration and percolation of this water created an area of saturation along the stream channel, slowly saturating the alluvium.



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Drawing 1-2

NE-SW CROSS-SECTION THROUGH AMBROSIA LAKE AREA - GENERALIZED PRE-MINING CONDITIONS

KERR-McGEE NUCLEAR CORPORATION Dec. 1980

In 1976, the natural stream course of the Arroyo del Puerto, which carried National Pollution Discharge Elimination System (NPDES) permit mine water discharge, was diverted from its natural course just east of pond #3 to its current location along the northern and eastern restricted area boundary. This placed the Arroyo del Puerto channel to the east of the unlined ponds #4, #5, and #6, and also east of the lined ponds #9 and #10 which were constructed in 1976. Following the channel relocation, unlined ponds #4, #5, and #6 were placed back into service to hold and evaporate excess process solutions. The locations of the natural and current Arroyo del Puerto channels are indicated on Map 1-1

In 1983, QMC entered into an Assurance of Discontinuance (AOD) with the State of New Mexico to minimize the future impact of mill tailings solutions seeping into the alluvium (KM83). The approved AOD remedial action plan required the construction and maintenance of an "Interceptor Trench" and discontinuing the use of all unlined evaporation ponds, including ponds #4, #5, #6, #7, and #8. These ponds were taken out of service in 1983 with all solutions removed.

The purpose of the interceptor trench was to prevent tailings seepage from entering the alluvium and to create a local hydrologic gradient towards the trench. This gradient caused the solutions in the alluvium located to the east of the interceptor trench, to flow towards the trench for recovery and removal from the unit. Construction of the trench was initiated in 1984. Alluvium material was removed down to the underlying Mancos shale or sandstone contact. The completed trench extends approximately 6,200 feet on the down dip gradient side of tailings impoundment #1 along the northern, eastern, and southern toe of pile. The location of the interceptor trench is presented on Map 1-1.

Completed to a maximum excavation depth of 36 feet, the trench has effectively captured seepage from the tailings impoundment and thereby preventing further migration of seepage to the alluvium. Due to the depth of excavation, the hydrologic gradient in the down dip area or east of the interceptor trench, has been reversed from its normal easterly direction, to a westerly gradient. This reversed gradient created by the interceptor trench combined with the recharge of the fresh water from the re-aligned channel of the Arroyo del Puerto has been effective in flushing the alluvium in the vicinity of the former ponds #4, #5 and #6.

1.2 Groundwater Protection Program

On June 1, 1986, the State of New Mexico relinquished its licensing authority over uranium milling activities. U. S. Nuclear Regulatory Commission (NRC) reasserted its regulatory jurisdiction over New

Mexico uranium processing facilities. As a result of the new regulatory jurisdiction, QMC submitted a "Detection Monitoring Plan" to the NRC on January 29, 1988, for the hydrogeologic units that could potentially be impacted by processing of uranium ore and disposal of by-product material at the Facility. The hydrogeologic units addressed by the Groundwater Protection Program were the Tres Hermanos A Sandstone Unit (TRA), The Tres Hermanos B Sandstone Unit (TRB), the Dakota Sandstone Unit (Dakota) and the alluvium of Arroyo del Puerto (Alluvium). The Detection Monitoring Plan was submitted pursuant to the Commission's newly adopted 10 CFR 40, Appendix A, Criteria 7 regulations that had became effective on December 14, 1987 (NRC, 1987). Upon plan approval, the Commission established its groundwater protection program for the Facility.

Following the review of data from the groundwater detection monitoring program sampling events, the NRC established Groundwater Protection Standards (GPSs) for hazardous constituents in groundwater at the point of compliance (POC) wells. The current GPSs for all hazardous constituents in the Dakota, the TRA, and the TRB are listed in Table 1-1.

Table 1-1 Groundwater Protection Standards for QMC

Constituents	Dakota Sandstone Unit	Tres Hermanos A Unit	Tres Hermanos B Unit
U-nat, mg/l	0.02	0.01	0.02
Selenium, mg/l	0.04	0.03	0.04
Molybdenum, mg/l	0.06	0.03	0.08
Gross Alpha, pCi/l	56.0	18.0	21.0
Ra-226 and -228, pCi/l	5.0	5.0	7.4
Th-230, pCi/l	2.3	4.3	2.2
Pb-210, pCi/l	1.9	4.1	0.9
Nickel, mg/l	0.03	0.05	0.06
Cyanide, mg/l	0.04	0.01	0.01
Antimony, mg/l	0.05	-	-
Beryllium, mg/l	0.01	-	-
Arsenic, mg/l	0.10	-	-
Cadmium, mg/l	0.01	-	-
Lead, mg/l	0.14	-	-

Under 10 CFR Part 40, Appendix A, Criterion 5B(2), a constituent must be listed under Criterion 13, reasonably expected to be in or derived from by-product material, and detected in the groundwater of the uppermost aquifer at the Facility in order to be considered hazardous. For all hazardous constituents listed in Table 5(C) of 10 CFR Part 40, Appendix A, the GPS is set at either the background concentration or at the value listed in the table if the background level of the constituent was below the listed value. For hazardous constituents not listed in Table 5(C) of 10 CFR Part 40, Appendix A, the GPS is set at the background concentration determined from sampling results of appropriate background well(s) in the specific aquifer.

The GPS for all hazardous constituents, except combined radium (Ra-226 and -228), were set at "background" concentrations determined from sampling events in October 1988 from one background well in each of the aquifers. The Ra-226 and -228 GPSs for the Dakota, the TRA were set at the Table 5(C) concentration in 10 CFR Part 40, Appendix A. The Ra-226 and -228 GPS for the TRB was set at the background concentration since the concentrations in the background well exceeded the specified value in the Table 5(C) concentration in 10 CFR Part 40, Appendix A. Map 1-1 shows the locations of the background monitoring wells, POC wells and other wells in the vicinity.

1.3 Scope of Corrective Action Program Review and ACL Petition

Since GPSs were exceeded at POC wells, NRC required QMC to prepare and implement a Groundwater Corrective Action Program and to establish and implement a corrective action monitoring program. The plan for Corrective Action was developed in accordance with Criterion 5D, Appendix A, 10 CFR Part 40 and submitted on September 12, 1989, to the NRC for review and approval. (Qu89). The CAP was approved by the NRC on December 29, 1989. (NRC, 1989)

This CAP evaluation and ACLs petition addresses only the uppermost bedrock units (Dakota, TRA, and TRB) for which the CAP consists of continued pumping of the Section 30 and 30 West mines which intercepts groundwater in these bedrock units downgradient of the Facility. The CAP for the Alluvium unit, which requires the continued operation and maintenance of the interceptor trench, is not addressed in this Petition.

1.4 Groundwater Compliance Monitoring Review and Assessment

This section provides a review of the compliance monitoring program data for each bedrock unit and lists the hazardous constituents within each unit for which ACLs are requested. Compliance monitoring for the bedrock units consists of semi-annual monitoring for GPS parameters within all POC and background monitoring wells located within the uppermost bedrock units. Groundwater corrective action measures are required until compliance with the GPSs has been attained. Under 10 CFR Part 40, Appendix A, Criterion 5B(5), the Groundwater Protection Standards for hazardous constituent at the point of compliance are:

a) The Commission approved background concentration of that constituent in groundwater;
b) The respective value given in the table in paragraph 5C if the constituent is listed in the table and if the background value is below the value listed; or
c) An ACL established by the Commission.

Compliance monitoring results from 1997 through first half of 1999 were reviewed to identify constituents that exceeded the corresponding GPS at POC wells.

1.4.1 Tres Hermanos B Unit

Compliance monitoring results from the last three years at each POC well within the TRB are compared with the corresponding GPSs in Table 1-2. The values which exceed the corresponding GPS are highlighted in bold in this table. These results show that the mean concentration for nickel, Pb-210, total radium, Th-230, U-nat, and gross alpha exceed the GPS at one or more of the POC wells.

Table 1-2 Compliance Monitoring Results from POC Wells in Tres Hermanos B Unit

Constituent	CN mg/l	Mo mg/l	Ni mg/l	Se mg/l	Pb-210 pCi/l	Ra-226 and -228 pCi/l	Th-230 pCi/l	U-nat mg/l	Gross Alpha pCi/l
GPS	0.01	0.08	0.06	0.04	0.9	7.4	2.2	0.0200	21
POC Well 31-66 (1)	<0.01	<0.05	**0.17**	0.006	**6.25**	**17.6**	**4.9**	**0.167**	**65**
POC Well 31-67 (1)	<0.01	0.02	<0.04	<0.001	**3.3**	**8.08**	**5.52**	0.0043	**41.6**
POC Well 36-01trb (1)	<0.01	0.01	0.03	0.003	**8.0**	3.66	**3.85**	0.0022	17
POC Well 36-02trb (1)	<0.01	0.065	**<0.08**	0.010	**3.06**	3.96	**4.7**	0.0048	17.4

Note (1) average concentrations of 1997, 1998 and first half 1999 sampling results

Since the analysis results for most of these constituents were below detection limit, the following protocol was used to treat less than detection limit values when calculating the mean value for analysis:

- When all values for a hazardous constituent at a given well are below the detected limit, the lowest detection limit value is used for the mean concentration for the constituent.
- When a hazardous constituent at a given POC well is detected at concentrations in some samples that are below the detection limit in other samples, only the detected values are used to calculate the mean.
- When a hazardous constituent at a POC well is detected at concentrations in some samples that are above the detection limit in other samples, the detected concentrations and the detection limit values (detection limit results above as well as below the detected value) are used to calculate the mean.

Although the detection limit for nickel is above the GPS in the 1997-1999 compliance monitoring data at POC well 36-02trb, nickel is not believed to be above the 0.02 mg/l GPS in this well because nickel has not been detected in this well since 1992 with detection limits occasionally as low as 0.02 mg/l. Since the mean concentrations for nickel, Pb-210, Th-230, U-nat, and Ra-226 and -228 based on the concentrations from the last three years (1997 and 1999) of compliance monitoring are above the corresponding GPS at one or more of the POC wells in the Tres Hermanos B, ACLs are requested for these hazardous constituents.

Gross alpha measurement has also been above the corresponding GPS at several of the POC wells in the Tres Hermanos B. However, the regulatory limit in 10 CFR 40, Appendix A, Table 5C for gross alpha activity in groundwater excludes uranium and radon alpha activities. The laboratory, who performed the groundwater analyses, has stated that the gross alpha concentration results reported by the laboratory includes alpha activity from U-nat and all other alpha emitters. Normally, alpha activity from uranium will contribute most of the gross alpha activity in neutralized groundwater impacted with uranium mill tailings liquids from sulfuric acid leach process. Furthermore, all the potential alpha emitters in neutralized groundwater impacted with uranium mill tailings liquids (U-nat, Th-230, Ra-226, and Po-210, which is a decay product of Pb-210) are being addressed in the Hazard Assessment and in the proposed ACLs. Therefore, the health hazard and ACL evaluation for gross alpha activity would be duplicative and unnecessary. QMC requests that the GPS for gross alpha be deleted from the licence as a hazardous constituent because the alpha activity hazard is addressed by the proposed ACLs for U-nat, Ra-226 and -228, Pb-210, and Th-230.

1.4.2 Tres Hermanos A

Compliance monitoring results from the last three years at POC well 31-01tra within the TRA are compared with the corresponding GPSs in Table 1-3. These show that the mean concentrations for cyanide, molybdenum, nickel, selenium, Pb-210, Th-230 and U-nat are at or below the corresponding GPS. Only the mean concentrations for Ra-226 and -228, and gross alpha at POC well 33-01tra exceed the corresponding GPS. However, the concentration of Pb-210 in the April 1997 sample and the concentration of Th-230 in the December 1998 sample from POC well 31-01tra also exceeded the GPS. Furthermore, the concentration of Pb-210 and Th-230 have exceeded the GPS in several samples from the background well during this period as summarized in Section 2, Table 2-4.

Table 1-3 Compliance Monitoring Results from the POC Well in Tres Hermanos A Aquifer

Constituent	CN mg/l	Mo mg/l	Ni mg/l	Se mg/l	Pb-210 pCi/l	Ra-226 and -228 pCi/l	Th-230 pCi/l	U-nat mg/l	Gross Alpha pCi/l
GPS	0.01	0.03	0.05	0.03	4.1	5.0	4.3	0.0100	18
POC Well 31-01tra (1)	<0.01	<0.01	<0.01	<0.001	3.7	**8.0**	1.54	0.0057	**50**

Note (1) average concentrations of 1997, 1998 and first half 1999 sampling results

Therefore, ACLs are requested for Pb-210, Th-230, and Ra-226 and -228. Gross alpha has also been above the corresponding GPS at the POC well. The GPS for gross alpha should be deleted from the licence as a hazardous constituent since the alpha activity hazard is addressed by the proposed ACLs for Ra-226 and -228, Th-230 and Pb-210 (which decays to Po-210).

<u>Dakota Sandstone</u>

Compliance monitoring results from the last two years at POC wells within the Dakota aquifer are compared with the corresponding GPSs in Table 1-4. These results show that the mean concentrations for arsenic, beryllium, cadmium, cyanide, molybdenum, lead, and selenium are at or below the corresponding GPS at all POC wells. Only the mean concentrations for nickel, antimony, Pb-210, total radium, Th-230,

Table 1-4 Compliance Monitoring Results from POC Wells in Dakota Sandstone Aquifer

Constituent	As mg/l	Be mg/l	Cd mg/l	CN mg/l	Mo mg/l	Ni mg/l	Pb mg/l	Sb mg/l	Se mg/l	Pb-210 pCi/l	Ra-226 and -228 pCi/l	Th-230 pCi/l	U-nat mg/l	Gross Alpha pCi/l
GPS	0.1	0.01	0.01	0.04	0.06	0.03	0.14	0.05	0.04	1.9	5.0	2.3	0.0200	56
POC Well 30-02KD (1)	0.006	<0.002	<0.003	<0.01	<0.01	**0.038**	<0.001	<0.002	<0.001	**3.64**	3.84	0.36	0.0087	10.2
POC Well 30-48KD (1)	<0.001	<0.002	<0.005	<0.01	<0.01	0.025	<0.001	<0.002	0.004	**8.72**	**8.07**	**3.07**	**0.236**	**180**
POC Well 32-45KD (1)	0.0025	<0.002	<0.003	<0.01	0.03	0.02	<0.001	<0.002	<0.001	**3.54**	4.98	**3.72**	0.0066	15.0
POC Well 36-06KD (1)	0.004	<0.004	.008	<0.01	.003	**0.055**	0.006	0.035	0.01	**13.4**	**21.44**	**420**	**0.55**	**591**

Note (1) average concentrations of 1997,1998 and first half of 1999 sampling results

U-nat and gross alpha exceeds the corresponding GPS at one or more of the POC wells. The antimony concentration of 0.13 mg/l detected in April 1997 exceeded the GPS. Since the antimony concentrations observed before and subsequent to the April 1997 sample at POC well 36-06KD were below the detection limit, the April 1997 antimony value appears to be spurious. Actual concentrations are believed to be below 0.01 mg/l based on the latest sample results.

ACLs are requested for nickel, Pb-210, Ra-226 and -228, Th-230, and U-nat because the concentrations for these constituents are above the corresponding GPS at one or more of the POC wells in the Dakota Sandstone.

As discussed previously, QMC requests that the GPS for gross alpha be deleted from the license as a hazardous constituent since the alpha activity hazard is addressed by the proposed ACLs for U-nat, Th-230, Ra-226 and -228, and Pb-210 (which decays to Po-210) to address the health hazard for the alpha activity associated with the gross alpha screening parameter.

1.5 Proposed Alternate Concentration Limits

The following ACLs are proposed for U-nat, Th-230, Ra-226 and -228, Pb-210 and nickel at the POCs in the Dakota and TRB units and proposed for Th-230, Ra-226 and -228, and Pb-210 at the POC well in the TRA unit. These proposed ACLs, summarized in Table 1-5, are based upon both the potential human health and environmental concerns at the potential Point of Exposures (POEs) and the requirement to maintain concentrations ALARA.

Table 1-5 Proposed Alternate Concentration Limits

Constituent	Proposed Health Risk-Based Limits	Proposed Alternate Concentration Limits		
		Dakota Sandstone Unit (POC Wells 30-48KD, 32-45KD, 30-02KD and 36-06KD)	Tres Hermanos A Unit (POC Well 31-01tra)	Tres Hermanos B Unit (POC Wells 36-01trb, 36-02trb, 31-66trb and 31-67trb)
U-nat, mg/l	0.25	0.81	--	0.25
Th-230, pCi/l	139	869	139	139
Ra-226 and -228, pCi/l	41	41	41	41
Pb-210, pCi/l	13	57	13	13
Nickel, mg/l	0.1	0.12	--	0.37

QMC has limited the proposed ACLs to the health risk-based concentrations for all constituents in TRA Unit, all but nickel in TRB Unit, and all constituents except U-nat, Th-230, Pb-210, and nickel in Dakota. These limits have been attained at the POC in the aquifer following implementation of corrective action and are expected to be attained in the future. The proposed ACLs for nickel in TRB Unit has been set at a concentration based on a statistical evaluation of recent concentrations in groundwater at the POC even though higher limits could be justified based upon attenuation between the POC and POE. The proposed ACLs for U-nat, Pb-210, and nickel in Dakota has also been set at a concentration based on a statistical evaluation of recent concentrations in groundwater at the POC even though higher limits could be justified. The proposed ACL for Th-230 in Dakota is set based on the protective concentration based on attenuation between POC and POE. Although the value of the mean plus two standard deviations for Th-230 exceeds the protective concentrations, the exceedence is due to a total analysis performed on several samples from well 36-06KD that contained suspended solids.

QMC has demonstrated that the proposed ACLs will not pose a substantial present or potential future hazard to human health or the environment at existing and foreseeable points of exposure. As discussed above, most of the proposed ACLs are set at the health risk-based concentrations.

Although higher limits could be justified based upon attenuation of contamination between the POC and the POE, the proposed ACLs have been set at the lowest concentration which can be expected to be maintained given the corrective actions which have been implemented at the Facility. QMC has previously implemented corrective action, including elimination of unlined evaporation pond use, timely removal of standing surface water on the tailings impoundments and tailings impoundment reclamation which included cover placement. These actions were taken to reduce the seepage of hazardous constituents to the groundwater and to maintain concentrations that are ALARA. As required by the NRC, QMC implemented groundwater CAP consisting of mine dewatering program, and expanding the interceptor trench and dewatering trench with the objective of returning hazardous constituents concentrations to GPSs. The proposed ACLs represent the concentrations that have been achieved through implementation of all practicable corrective action measurers at the Facility and are thus determined to meet the ALARA provision of the regulations. Rationale for the development of the proposed ACLs are developed in the subsequent sections.

2.0 HAZARD ASSESSMENT

2.1 Source and Contaminant Characterization

Quivira Mining Company's (QMC) mill used a sulfuric acid process to extract uranium from the arkosic sand ores. The tailings were first produced at the Facility in November 1958. The solid portions of the process were disposed through a slurry transfer system to Tailings Impoundments #1 and #2 (see Map 1-1). Tailings impoundment #1 encompasses 260 acres and contains approximately 30 million tons of uranium mill tailings. The placement of tailings in impoundment #1 ceased in January 1985. Tailings impoundment #2 encompasses 90 acres and contains approximately 3 million tons of uranium mill tailings. Both impoundments have been reclaimed with the exception of a portion of Tailings Impoundment #2 reserved for 11(e)(2) byproduct material pursuant to License Condition 41.

Tailings effluents were also previously placed in unlined evaporation ponds (ponds #3, #4, #5, #6, #7, and #8) as shown on Map 1-1. Pond #3 located at the eastern toe of Tailings Impoundment #1 was used for decanting of Tailings Impoundment #1 with excess water pumped to ponds #4, #5 and #6 for evaporative treatment. Pond #7, located west of Tailings Impoundment #2, was used for decant of Tailings Impoundment #2 with excess water pumped to pond #8 for evaporative treatment. The use of the unlined ponds #4, #5, #6, #7, and #8 was discontinued in 1983 and the residues from these ponds were subsequently removed and placed in the Tailings Impoundment #1 in accordance with the NRC-approved reclamation plan. Use of unlined pond #3 was discontinued in 1984 and the decant of tailings liquid was transferred to lined pond #9. Lined pond #9 is still active and is currently used in conjunction with the lined ponds in Section 4 for evaporative treatment of process solutions and water recovered by the groundwater corrective action. However, pond #9 is scheduled for closure in accordance with QMC's New Mexico Environment Department (NMED) Discharge Plan requirements.

Hazardous constituent remaining in neutralized tailings solution seepage from the tailings impoundments and ponds is the source of hazardous constituent concentrations in groundwater. An understanding of the changes in seepage rates over time and under various corrective action alternatives is needed to predict future trends in hazardous constituent concentrations in the groundwater and changes that may result from various corrective action alternatives.

McWhorter and Nelson (1979) describe three distinct stages of seepage from tailings impoundments and provide calculations for estimating seepage rates during each stage. In Stage 1, a wetting front advances downward through the partially saturated foundation material to the water table. Seepage to groundwater during this stage is lower than during subsequent stages. In Stage 2, after the wetting front contacts the water table a groundwater mound develops and seepage rates increase as the mound rises. After the groundwater mound rises to the elevation of the impoundment, a saturated seepage occurs during Stage 3 at approximately a constant rate assuming that the fluid elevation in the tailings impoundment remains constant. After reclamation, including stabilization and capping of the tailings impoundment, the seepage rate declines as the fluid elevation in the tailings impoundment drops. The rate of decline will vary with the rate of drainage from the tailings sands and with the rate of tailings solution released during consolidation of tailings slimes after placement of the tailing cover. Seepage from the reclaimed impoundments will eventually decline to a rate approximately the same as the rate of recharge through the tailings cover.

A water balance prepared by QMC for the year 1979 indicated a total seepage rate of 203 gpm from the unlined ponds into groundwater units at the Facility. Although this evaluation did not provide estimates of relative rates of seepage from each pond, it can be assumed that most of the seepage was from Tailings Impoundments #1 and #2 based on the relative area for each pond. As discussed, the seepage to groundwater from Tailings Impoundments #1 and #2 would be at a much lower rate after reclamation than during active tailings disposal. Since the unlined ponds were used intermittently and were not used after 1984, these pond locations are no longer a source of hazardous constituents in groundwater. Hazardous constituents in the soil and groundwater along the pathways of water migration from these ponds are the only remaining source associated with these unlined ponds.

Several sources of data exist concerning the concentrations of potentially hazardous constituents and geochemical conditions within the tailings and evaporation pond solutions. The concentrations of various constituents in process solutions placed in the ponds are shown in Table 2-1. These results show tailings solutions to have low pH, and high concentrations of TDS, sulfate, aluminum, chloride, copper, iron, manganese, and zinc. The potentially hazardous constituents; arsenic, cadmium, chromium, molybdenum, nickel, selenium, vanadium, lead, U-nat, and total radium were also found to be present. The concentrations of silver, barium, and mercury in these liquids were below the groundwater protection standards listed in Table 5(C) of 10 CFR Part 40, Appendix A, and fluoride was below the detection limit of 1 mg/l.

Table 2-1 Typical Concentrations in Process Liquids

Ag	0.02 mg/l	Hg	<0.0002 mg/l	F	< 1.0 mg/l
Al	1,380 mg/l	Mn	120 mg/l	Cl	1,540 mg/l
As	1.6 mg/l	Mo	14 mg/l	SO4	34,600 mg/l
Ba	<0.1 mg/l	Ni	1.0 mg/l	TDS	40,800 mg/l
Cd	0.3 mg/l	Pb	1.0 mg/l	pH	1.1 units
Cr	0.7 mg/l	Se	6 mg/l	Ra 226/228	336 pCi/l
Cu	2.2 mg/l	V	46 mg/l	U_{nat}	11.2 mg/l
Fe	2,990 mg/l	Zn	8.4 mg/l		

Analytical results from tailing liquid samples collected at the face of Tailings Impoundment #1 by the U. S. Nuclear Regulatory Commission (NRC) in 1987 at the beginning of the groundwater protection program are shown in Table 2-2. These results show the presence of the following potentially hazardous constituents in tailings solution: antimony, beryllium, cadmium, cyanide, molybdenum, nickel, U-nat, vanadium, Pb-210, Th-230, and total radium. Silver, chromium, lead, mercury, and selenium were below the detection limit in these samples but the detection limits were above the groundwater protection standards for these constituents, apparently due to either the selected method or analytical interferences in these complex matrix solutions. No volatile or semivolatile organic constituents were detected in the tailings solution samples analyzed by NRC.

Comparison of results in Tables 2-1 and 2-2 indicates a higher pH and lower concentrations of many of the constituents in the NRC sample collected at the face of Tailings Impoundment #1, apparently due to geochemical precipitation during seepage from the impoundment. Evaluation of both sets of data indicates the likely presence of the following potentially hazardous constituents in tailings solution: antimony, arsenic, beryllium, cadmium, chromium, cyanide, molybdenum, nickel, selenium, vanadium, lead, U-nat, Pb-210, Th-230, and total radium.

Table 2-2 Concentrations in Tailings Liquids from Face of Tailings Impoundment #1 by NRC, April 1987

Ag	< 0.3 mg/l	Mn^{+2}	160 mg/l	Tl	0.05 mg/L
Al	722 mg/l	Mo	0.46 mg/l	V	8.4 mg/l
As	< 0.6 mg/l	NH_3	357 mg/l	Zn	7.4 mg/l
Ba	0.13 mg/l	Ni	1.0 mg/l	Zr	< 0.12 mg/l
Be	0.1 mg/l	NO_3	< 50 mg/l	F	< 10 mg/l
Cd	0.14 mg/l	NO_2	< 50 mg/l	Cl	2,300 mg/l
Co	1.2 mg/l	P	6.7 mg/l	Sulfide	0.5 mg/l
Cr	< 0.24 mg/l	Pb	< 1.2 mg/l	SO4	16,000 mg/l
Cu	0.47 mg/L	PO_4	< 50 mg/l	TDS	28,090 mg/l
CN_{tot}	0.025 mg/l	Sb	< 1.2 mg/l	pH	3.95 units
F	< 10 mg/L	Se	< 1.2 mg/l	Ra 226/228	62 pCi/l
Fe^{+2}	1,400 mg/l	Si	19 mg/L	U_{nat}	8.4 mg/l
Ga	< 1.8 mg/l	Sn	< 0.3 mg/l	Pb-210	4.5 pCi/l
Hg	< 0.001 mg/l	Sr	8.8 mg/l	Th-230	11 pCi/l
Li	6.7 mg/l	Ti	< 0.12 mg/l		

Geochemical reactions between the tailings solution seeping from the impoundment and the geologic medium beneath the tailings impoundment significantly reduces the concentrations of hazardous constituents in tailings seepage. Precipitation of metals, sulfate, molybdenum, U-nat and isotopes of radium and thorium occurs in response to neutralization of tailings seepage. Neutralization of the solution is due to the buffering capacity of the aquifer matrix and the groundwater. Thus, when acidic solutions containing soluble metals comes in contact with the natural aquifer materials and groundwater, the rapid rise of pH causes the formation of insoluble metal hydroxides and carbonates.

Sulfate concentrations are reduced primarily by precipitation with calcium and magnesium. Trace constituents are also removed from solution by co-precipitation and by adsorption of trace components on the precipitate. A process that usually occurs beneath tailings impoundments is the co-precipitation of radium as radium sulfate with gypsum (calcium sulfate). Also, many radionuclides and heavy metals co-precipitate with the precipitation of iron and manganese and become entrapped in the amorphous structure of the iron and manganese precipitates.

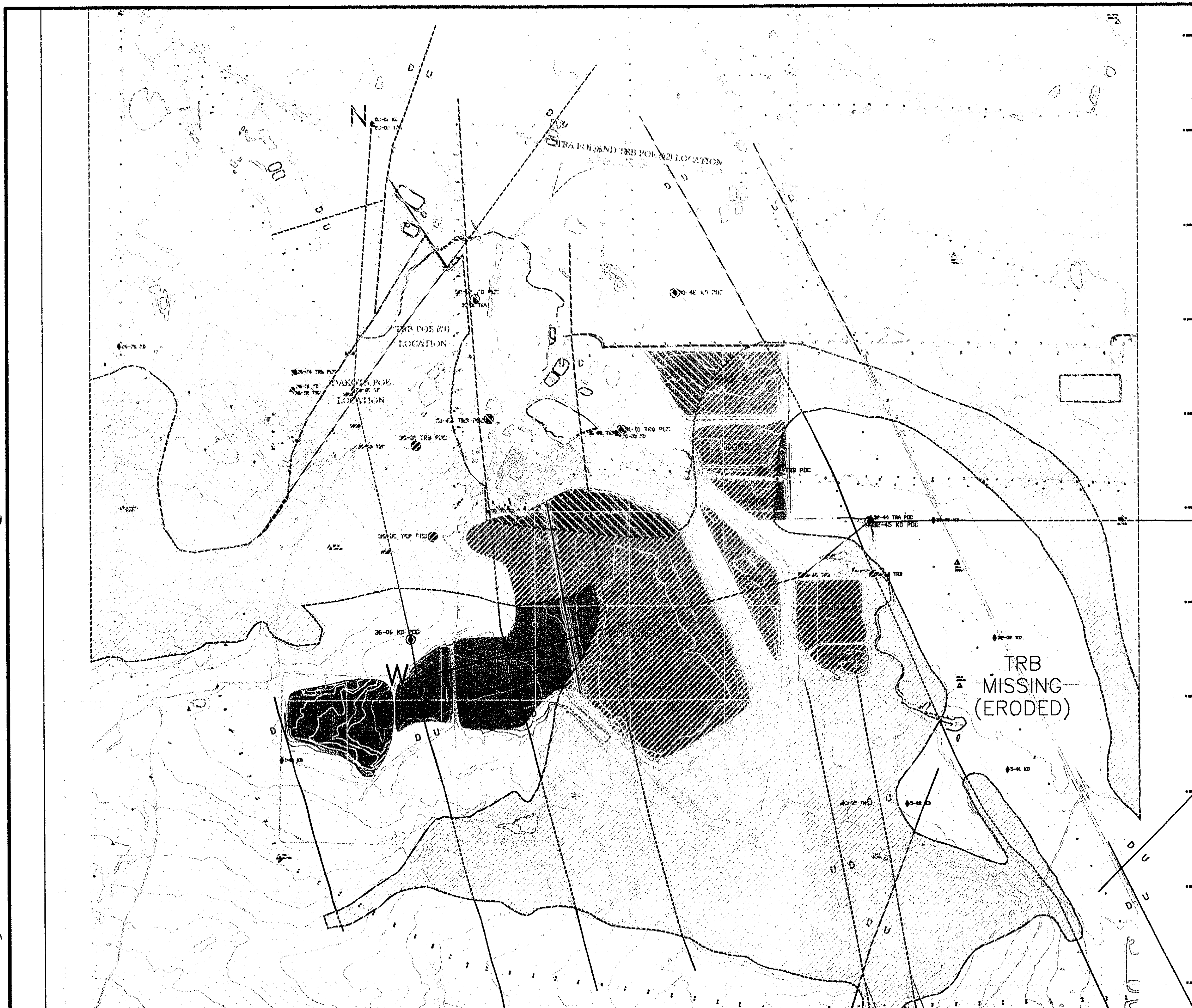
Once the ambient pH exceeds about 6.0, further precipitation of most metals, sulfate, molybdenum U-nat, radium, and thorium is negligible. Chloride and selenium are not subject to pH induced precipitation. Chloride is relatively high in tailings solution and relatively low in background groundwater and is not affected by adsorption. Thus it serves as an excellent tracer.

2.2 Extent of Bedrock Groundwater Contamination and Trends

2.2.1 Hydrogeologic Setting

The stratigraphic sequence of sedimentary rocks in the vicinity of QMC's mill tailings facility are well defined from regional studies, (see Cooper and John, 1968 and Craven and Hammock, 1958), information from nearby mining operations, and information generated from drilling and well completions associated with QMC's milling operation. The bedrock units that outcrop or subcrop in the vicinity of the Facility are the Mancos Formation and the Dakota Sandstone (Dakota), which underlies the Mancos Formation. The basal portion of the Mancos Formation contains several sandstone units, which are referred to as the Tres Hermanos A Sandstone (TRA), the Tres Hermanos B Sandstone (TRB), and the Tres Hermanos C Sandstone (TRC) units, in order from the stratigraphically lowest to highest.

The mill site and Tailings Impoundments #1 and #2 are located on the weathered Mancos Formation (saprolite) or on alluvium overlying the Mancos Formation. The bedrock units that have been impacted by tailings seepage include the Dakota Sandstone (the first unit below the Mancos Formation) which outcrops at pond #7 and #8, and the TRB which underlies the saprolite throughout most of the location of Tailings Impoundments #1 and #2 as shown on Drawing 2-1. Most of the seepage from Tailings Impoundment #1 and #2 migrates laterally through the alluvium and shallow saprolite in the direction of the surface slope to the alluvium of Arroyo del Puerto where it enters the interception trench as depicted in Drawing 2-2. The seepage that enters the unweathered bedrock beneath Tailings Impoundment #1 and #2 slowly migrates through the TRB to the north and northeast of the Facility in the general direction of the dip. The dewatering trench located between pond #7 and pond #2 has minimized any tailings seepage to the TRA, which underlies the saprolite and alluvium in the general vicinity of pond #7.



HORIZONTAL & VERTICAL CONTROL POINT
INDEX CONTOUR
INTERMEDIATE CONTOUR
DEPRESSION CONTOUR
DRAIN
POND
LONG TERM INSTALLATION CONTROL BOUNDARY

PAVED ROAD
DIRT ROAD
CULVERT
FENCE
BUILDING
POWER POLE

MONITORING WELLS
- TRES HERMANOS A (TRA)
- TRES HERMANOS B (TRB)
- TRES HERMANOS C (TRC)
- DAKOTA (KD)
- BY-PRODUCT MATERIAL DISPOSAL POND
- INTERCEPTION TRENCH

POC AND BACKGROUND WELLS
- TRES HERMANOS A (TRA)
- TRES HERMANOS B (TRB)
- DAKOTA (KD)
- DEWATERING TRENCH
- FAULT TRACE (TAKEN FROM USGS MAP)
- TRB OUTCROP / SUBCROP
- TRB OVERLAIN BY MANCOS SHALE

W—E EAST-WEST CROSS SECTION IN DRAWING 2-2
N—S NORTH-SOUTH CROSS SECTION IN DRAWING 2-3

1600' 0 1600'
SCALE IN FEET

QUIVIRA MINING COMPANY
AMBROSIA LAKE FACILITY
NEW MEXICO

GROUND WATER CAP AND ACL PETITIONS

DRAWING 2-1
BEDROCK FAULT AND TRB OUTCROP / SUBCROP MAP

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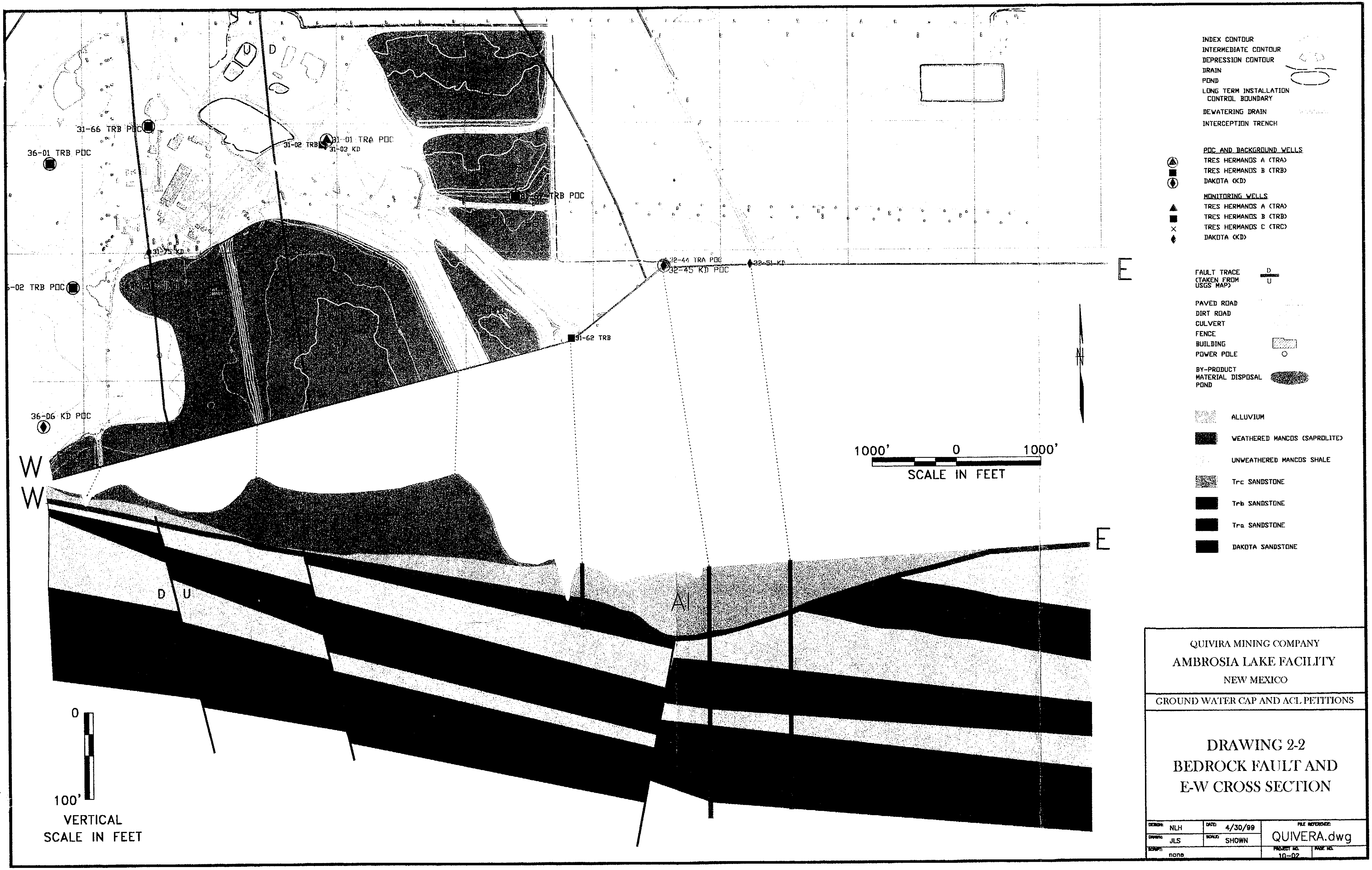
SCRIPT: OUT-SUB_CROPS	PROJECT NO. 10-02	PAGE NO.



QUIVIRA MINING COMPANY
AMBROSIA LAKE FACILITY
NEW MEXICO

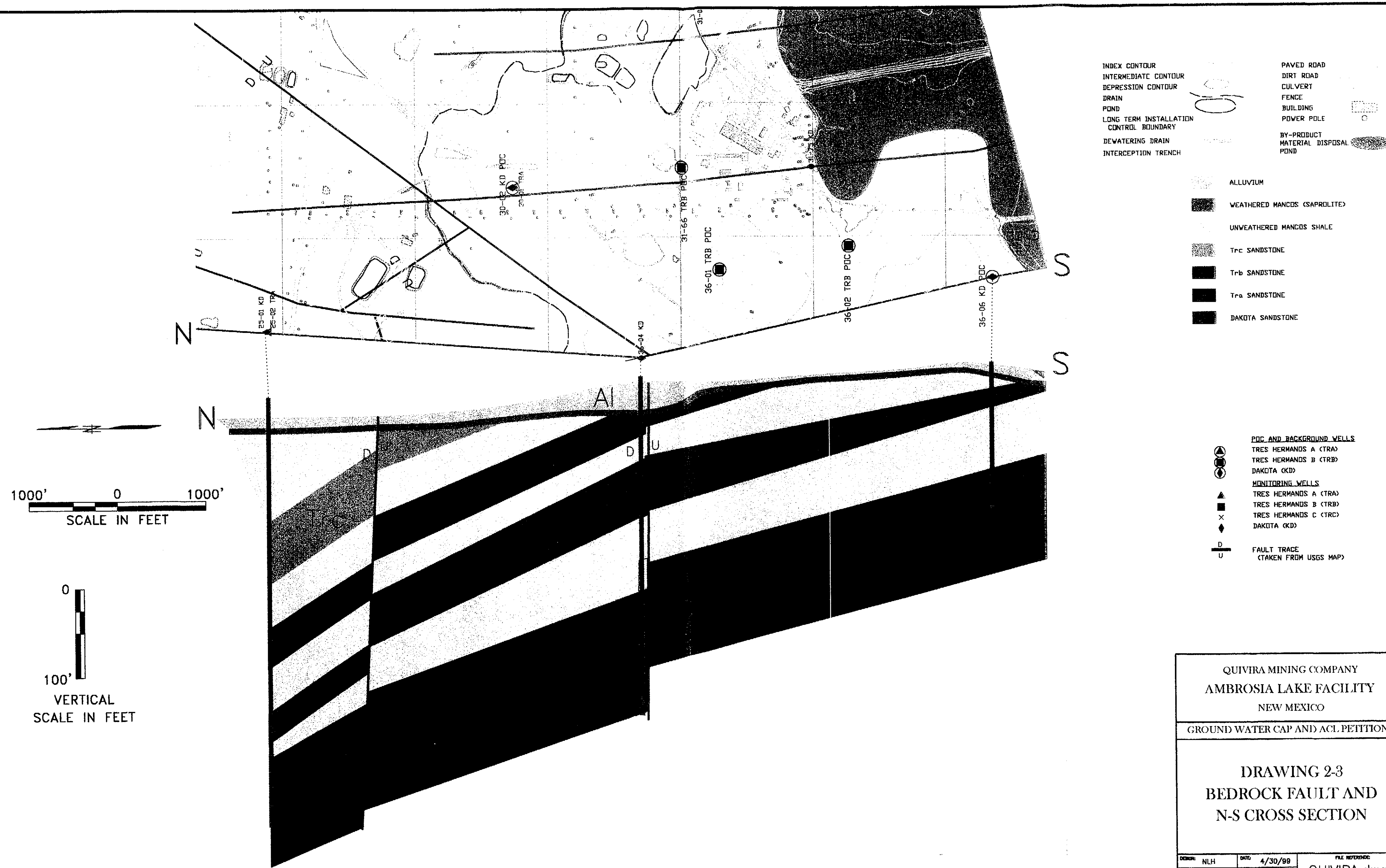
GROUND WATER CAP AND ACL PETITIONS

DRAWING 2-2
BEDROCK FAULT AND
E-W CROSS SECTION

The sedimentary rocks, in the vicinity, dip at an angle of about 2 degrees in a direction of north 15 degrees east. The local dip and direction varies somewhat due to faulting and rotational effects as shown in the cross sections provided in Drawings 2-2 and 2-3. The location for these cross sections are shown on Drawing 2-1. Drawings 2-2 and 2-3 depict the relationships of the water bearing zones and the surface features that affect groundwater movement in an east-west cross section through Tailings Impoundment #1 and #2 and in a north-south cross sections down gradient of pond #7. This conceptual model of the Facility hydrogeology was developed from cross sections provided in (Qu87) together with well logs and mapped faults. Faults in the area have been mapped by Broad and Stone (1981) and are shown on Drawing 2-1. Faults and fractures associated with the faults have a northerly trend. The degree of fracturing is much greater in the sandstones especially where they are shallow. Most of the faults are normal dip-slip faults with less than 40 feet of displacement.

Potentiometric information from the Tres Hemanos and the Dakota units show a general north-northeast potentiometric gradient in the general direction of the dip. The northerly trending faults and fractures are in the general direction of the potentiometric gradient are thought to enhance the rate of groundwater movement and the degree of longitudinal dispersion. Several east-west trending faults may serve to restrict groundwater movement, depending upon the degree of displacement and the extent of alteration of matrix in the vicinity of these faults. Chloride concentration data provides the best indication of the influence of the structural features on groundwater flow in the bedrock units downgradient of the Facility.

To determine the aerial extent of groundwater contamination in the bedrock units, QMC has extensively monitored for hazardous constituents in 27 bedrock monitoring wells. Also, in 1983 QMC performed downhole investigations to determine flow and water quality draining from each of the bedrock units to 30 ventilation holes and mine shafts in the area north and northeast of the Facility. The downhole investigation was repeated in 1989. No measurable fluid was observed in the TRC Sandstone in the downhole investigations. Two monitoring wells completed in the TRC Sandstone in Section 36 were also dry. Based on these results, the TRC Sandstone does not appear to be impacted by tailings seepage from the Facility. The extent of groundwater contamination identified from these surveys have been documented in various regulatory submittals previously forwarded to the NRC. (KM80; KM83; Qu86; Qu87; Qu89; Qu89a; Qu90) Due to the voluminous and extensive nature of these documents, QMC wishes to incorporate these submittals by reference. However, a summary of the extent of groundwater contamination and concentration trends in the Dakota and TRA and TRB units is presented below.



QUIVIRA MINING COMPANY

AMBROSIA LAKE FACILITY

NEW MEXICO

GROUND WATER CAP AND ACL PETITIONS

DRAWING 2-3
BEDROCK FAULT AND N-S CROSS SECTION

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2.2.2 Tres Hermanos B Sandstone

Tailings Impoundments #1 and #2 overlie the weathered Mancos Formation (saprolite) or the alluvium overlying the Mancos Formation. Seepage from Tailings Impoundment #1 and #2 that does not migrate through the shallow saprolite and alluvium to the alluvium of Arroyo del Puerto enters the unweathered Mancos Formation and TRB sandstone unit and migrates through the TRB unit down dip to the north and northeast of the Facility.

Time series plots of hazardous constituent concentrations detected during compliance monitoring of Point of Compliance (POC) wells and the background well in the TRB are provided in Figures 2-1 through 2-9 at the end of this section. The less than detection results are plotted at the detection limit value. Monitoring results summary tables are provided in Appendix A. Although each of the hazardous constituents included in the compliance monitoring program at one time exceeded its corresponding GPS at one time in one or more of the POC wells, these results show that Pb-210, radium 226 and -228, Th-230, U-nat, nickel, and gross alpha have been consistently above the corresponding GPS at one or more POC wells in the past three years. On the other hand, the concentrations of Pb-210, radium 226 and 228, Th-230, U-nat, and gross alpha have also been above the corresponding GPS at the background wells 19-VH2 and 19-77 for many of the monitoring events since the background was established in 1988.

Background was initially established by monitoring the seepage from the TRB into vent hole 19-VH2. This vent hole is located downgradient of the vent holes and shafts that intercepts flow within the bedrock units from the Facility. As discussed previously, the groundwater flow intercepted by the numerous vent holes and shafts drains to the mine workings in the Westwater Canyon member of the Morrison Formation. While this monitoring location (19-VH2) downgradient of the groundwater interception is suitable to represent background water quality, the groundwater levels and flow in the TRB has diminished over time as a result of the up-gradient groundwater interception such that it became more and more difficult to obtain sufficient water for analysis when sampling the TRB at 19-VH2. A replacement background well, 19-77, was completed in the TRB nearby in 1996 and semiannual samples were obtained at both locations in 1996. Although the TRB has been essentially dewatered in this background monitoring location, the well was completed with a large sump at the base that allows groundwater in the TRB to accumulate between the semiannual sampling events such that sufficient water can be obtained for analysis.

As shown in Figures 2-1 through 2-9, the hazardous constituent concentrations in the background samples from these two locations are very similar and exhibit significantly greater variation than reflected in the 1988 background results from 19-VH2. The chloride concentrations at the two locations are also similar and appear to fluctuate between 15 and 50 mg/l. The low concentrations of chloride observed in groundwater in the TRB at these location lends further support for the suitability of these locations for characterization of background concentrations of constituents in TRB groundwater.

Only the concentrations of Pb-210, gross alpha, and radium 226 and 228 in the last sample taken from 19-VH2 appear anomalous. Seepage rates from the TRB were so low when this sample was taken, the water sample contained a significant amount of sediment from the sides of the vent hole. Since this analysis was performed for total concentrations, dissolution of Pb-210 and total radium from these sediment accounts for the significant increase in concentrations observed in this sample. It is expected that some degree of cross contamination has occurred between the uranium ore in the Westwater Canyon member and the sides of borehole with during drilling of the vent hole and during the movement of the cage up and down within the vent hole. This cross contamination appears to have measurably influenced only the samples that contained sediments from the sides of the borehole. The potential for cross contamination influences has been eliminated with the completion of the replacement well, 19-77.

As shown in Figures 2-6 through 2-9, the concentrations of Pb-210, Th-230, U-nat, and Ra-226 and -228 in all the POC wells has consistently been below the proposed health risk-based concentration limits that are developed in Section 2.5 of this Petition. Results in Figures 2-7, 2-8 and 2-9 show that the concentrations of the alpha emitters (Th-230, U-nat and Ra-226) are below the proposed health risk-based concentrations.

The time series results for the POC wells presented in these figures also show a general decline in the concentration of hazardous constituents since 1990 with the exception of U-nat in POC well 31-66. The concentrations of U-nat in this well initially declined but appear to have increased in the 1998 and 1999 samples, although there is considerable variation in the analytical results. This apparent increase in U-nat and chloride in well 31-66 may be due to seepage of water from the nearby fresh water pond, which contains elevated concentrations of U-nat and chloride. Nevertheless, the concentrations of hazardous constituents, except nickel, at POC well 31-66 have remained below the proposed health-based level.

Hazardous constituent concentrations measured at TRB monitoring wells during the period 1997 through the first half of 1999 are presented in Table 2-3. Isopleth plots for 1998 results are provided in Appendix A. While the concentrations of several of the hazardous constituents exceed the GPS at a number of the wells, most are the result of variation in concentrations due to sampling and analysis that are not adequately represented in the GPS set by NRC based on 1988 sampling results from one background well in the TRB. For instance, the concentrations of a Pb-210, radium 226 and 228, U-nat, and gross alpha exceeded the GPS in well MW19-77 in the 1997 monitoring even though this is the background well for the TRB. Furthermore, the highest concentration for Pb-210 and the only concentration to exceed the Pb-210 health risk-based concentration were obtained from the December 1997 sample from this background well.

The only hazardous constituent observed above health-based limits in the TRB during 1997-1999 was U-nat in wells 31-02 and 32-64, and nickel in well 31-66. Well 31-02 is located immediately north of Tailings Impoundments #1 and #2 and immediately adjacent to the fresh water pond. The elevated chloride and U-nat in this well is thought to be due to seepage of water from the nearby fresh water pond which contains elevated concentrations of U-nat and chloride. Well 32-64 is located northeast of Tailings Impoundments #1 and immediately adjacent to former unlined pond #6 and lined pond #9. The elevated U-nat observed within the TRB in the vicinity of well 32-64 is thought to be due either to residual influences of seepage from unlined pond #6 or to seepage from the alluvium which immediately overlies the TRB at this well location.

2.2.3 Tres Hermanos A Sandstone

The TRA unit outcrops and subcrops in the general vicinity of ponds #7 and #8. Seepage from ponds #7 and #8 may have migrated through the shallow saprolite and alluvium into the TRA. However, given the minimal tailings seepage impact observed in the TRA, it is expected that tailings seepage to this bedrock unit has been minimized by the dewatering trench located between pond #7 and pond #2. Any seepage that entered the unweathered TRA and bypassed the dewatering trench would migrate down dip through the TRA to the north and northeast of the Facility.

Time series plots of hazardous constituent concentrations detected during compliance monitoring at POC well 31-01tra and the background well 33-01tra are provided in Figures 2-10 through 2-18 at the end of

Table 2-3 Concentrations of Hazardous Constituents in TRB Monitoring Wells – Year 1997 to 1999

TRB Monitor Well	Date	CN (mg/l)	Mo (mg/l)	Ni (mg/l)	Pb-210 (pCi/l)	Ra 226 and 228 (pCi/l)	Se (mg/l)	Th-230 (pCi/l)	U-nat (mg/l)	Gross Alpha (pCi/l)
31-02	5/8/97	<0.01	<0.01	<0.02	1.4	6	<0.005	0.9	0.49	411
31-02	5/4/98	<0.01	<0.05	<0.05	-3.2	4.25	0.006	2.7	0.61	305
31-02	3/23/99	<0.01	0.006	.008	17	5.2	0.002	1.1	0.662	445
31-62trb	5/8/97	<0.01	<0.01	<0.02	1.5	14	<0.005	0.3	0.0049	28
31-62trb	5/4/98	<0.01	<0.05	<0.05	.04	4.87	0.008	5.04	0.0013	19
31-62trb	3/19/99	<0.01	<0.05	<0.05	5.7	5.67	<0.001	0.8	0.008	3.6
31-66	4/3/97	<0.01	<0.05	<0.2	7.7	11.6	<0.025	3.1	0.13	38
31-66	12/3/97	<0.01	<0.05	0.2	6.2	16.4	<0.05	6.1	0.12	180
31-66	4/26/98	<0.01	<0.2	<0.2	7.8	7.72	.005	3.68	0.164	74
31-66	12/18/98	<0.01	<0.2	<0.2	4.8	29.2	.007	4	0.179	0
31-66	2/9/99	<0.01	<0.2	<0.2	4.7	21.54	.006	8.8	0.194	220
31-66	5/24/99	<0.01	0.002	0.167	5.2	28.6	0.01	0.2	0.214	110
31-66	7/26/99	<0.01	<0.01	0.18	1.8	17.6		0.3	0.212	180
31-67	4/2/97	<0.01	0.02	<0.04	6.8	9.1	<0.005	10	0.0051	17
31-67	12/2/97	<0.01	<0.01	<0.04	2.5	6	<0.005	2.8	0.0049	125
31-67	4/25/98	<0.01	<0.05	<0.05	6.5	7.2	<0.001	6.81	0.0035	51
31-67	12/7/98	<0.01	<0.05	<0.05	<1.1	11.61	<0.001	6.2	0.0043	1
31-67	2/9/99	<0.01	<0.05	<0.05	1.8	6.51	<0.001	1.8	0.004	16
32-64	5/8/97	0.02	0.12	<0.01	1.4	1.9	0.028	0.7	0.76	321
32-64	5/4/98	<0.01	0.12	<0.05	<1.4	1.79	0.037		0.55	443
32-64	3/23/99	<0.01	0.13	<0.002	2.6	1.59	0.019	0.32	0.613	393
36-01	4/3/97	<0.01	<0.01	<0.04	6	2.7	<0.005	0	0.0017	10
36-01	12/8/98	<0.01	<0.02	<0.02	9.9	4.63	<0.001	7.7	0.0027	24

Table 2-3 Concentrations of Hazardous Constituents in TRB Monitoring Wells – Year 1997 to 1999 (Continued)

TRB Monitor Well	Date	CN (mg/l)	Mo (mg/l)	Ni (mg/l)	Pb-210 (pCi/l)	Ra 226 and 228 (pCi/l)	Se (mg/l)	Th-230 (pCi/l)	U-nat (mg/l)	Gross Alpha (pCi/l)
36-02	4/3/97	<0.01	0.03	<0.08	4.8	2.6	<0.025	1.5	0.0044	0
36-02	12/2/97	<0.01	<0.02	<0.08	2	1.8	<0.025	1.3	0.0066	25
36-02	4/25/98	<0.01	<0.1	<0.1	5.6	5.87	0.007	19.48	0.003	0
36-02	12/8/98	<0.01	<0.1	<0.1	<3.1	4.57	0.013	1.2	0.004	30
36-02	2/9/99	<0.01	0.1	<0.1	6	4.94	0.011	0	0.006	32
36-74	6/2/97	<0.01	<0.01	<0.01	13	4.7	<0.005	1.8	0.0055	46
36-74	5/28/98	<0.01	<0.01	<0.01			<0.001		0.0018	
36-74	3/18/99	<0.01	<0.01	<0.01	5.4	5.81	<0.001	0.19	0.005	9
MW19-77	5/21/97	<0.01	0.02	<0.01	7.5	13.7	<0.005	1.2	0.02	45
MW19-77	12/28/97	<0.01	0.02	<0.04	23	10.5	<0.005	2.2	0.068	149
MW19-77	6/8/98	<0.01	0.03	<0.01	4.3	8.11	0.006	4.11	0.0568	151
MW19-77	12/18/98	<0.01	0.04	<0.02	12	7.6	<0.001	5.5	0.04	92
MW19-77	12/28/98	<0.01	0.02	<0.04	23	10.5	<0.005	2.2	0.82	149
MW19-77	3/8/99	<0.01	<0.02	<0.02	9.6	5.9	0.002	0.82	0.027	36
Groundwater Protection Standard		0.01	0.08	0.06	0.9	7.4	0.04	2.2	0.02	21
Health Risk Based Concentration				0.1	13	41		139	0.25	

Exceeds Groundwater Protection Standard
Exceed Health Risk Based Concentration Limit

this section. Less than detection results are plotted at the detection limit value. Monitoring results summary tables are provided in Appendix B. Although each of the hazardous constituents included in the compliance monitoring program exceeded its corresponding GPS at one time in this POC well, the monitoring results show that only gross alpha, and radium 226 and -228 have been consistently above the corresponding GPS at the POC well during the past three years. As shown in Figures 2-14 and 2-18, the GPS established from the 1988 sample results from background well 33-01tra does not adequately represent the variation in Th-230, Pb-210, U-nat, radium 226 and -228, and gross alpha concentrations observed in this background well. Characterization of background from limited sampling at one well is insufficient given the sampling and analytical variability in the concentrations of these constituents in the background samples from bedrock groundwater units in the vicinity of the Facility.

The results in Figures 2-14 through 2-17 show that the concentrations of hazardous constituents detected in the POC well in the TRA have not exceeded the proposed health risk-based concentration except for one Pb-210 analysis in 1988. However, as shown in Figure 2-15, the Pb-210 concentrations in the POC well are typically lower than the Pb-210 concentrations in the background well. Hazardous constituent concentrations measured at TRA monitoring wells during the period 1997 through first half of 1999 are presented in Table 2-4. While the concentrations of Pb-210, total radium, U-nat, and gross alpha occasionally exceed the GPS at a number of the wells, most are the result of variation in concentrations due to sampling and analysis that are not adequately represented in the GPS set by NRC based on 1988 sampling results from one background well in the TRB. For example, the concentrations of Pb-210 and gross alpha exceeded the GPS in well 33-01tra in the recent monitoring events even though the GPSs for the TRA were derived from this background well.

No hazardous constituents were observed at concentrations above the health risk-based limits in the TRA during 1997-1999 monitoring. The hazardous constituent concentrations in groundwater within the TRA are essentially the same as background as indicated in Figures 2-10 through 2-18 and in Table 2-4. The time series results for the POC and background well presented in these figures show considerable variation but no trend in the concentration of hazardous constituents.

Table 2-4 Concentrations of Hazardous Constituents in TRA Monitoring Wells – Year 1997 to 1999

TRA Monitor Well	Date	CN (mg/l)	Mo (mg/l)	Ni (mg/l)	Pb-210 (pCi/l)	Ra 226 and -228 (pCi/l)	Se (mg/l)	Th-230 (pCi/l)	U-nat (mg/l)	Gross Alpha (pCi/l)
25-02	6/2/97	<0.04	0.03	<0.01	13	4.2	<0.005	2.1	0.0081	33
25-02	5/29/98	0.03	0.03	<0.01			<0.001		0.0017	
25-02	3/15/99	0.03	0.03	<0.01	6	2.27	<0.001	0.71	0.003	4.6
30-01	5/12/97	0.29	<0.01	0.02	3.3	6.1	<0.005	4.3	0.011	33
30-01	5/29/98	0.31	<0.01	<0.02	<1.66	3.24	<0.001	1.24	0.0028	8.4
30-01	3/19/99	0.22	<0.02	0.02	4.6	3.45	<0.001	1.0	0.003	4.8
31-01	4/7/97	<0.01	<0.01	<0.01	5.4	3.3	<0.005	0.1	0.0099	16
31-01	12/4/97	<0.01	<0.01	<0.04	3.4	11.2	<0.005	0.6	0.006	135
31-01	4/26/98	<0.01	<0.01	<0.01	2.1	9.57	<0.001	1.48	0.0043	28
31-01	12/18/98	<0.01	<0.01	<0.01	3.8	16.8	<0.001	5.1	0.0041	62
31-01	3/8/99	<0.01	<0.01	<0.01	3.8	5.44	<0.001	0.41	0.004	14.4
32-44	5/12/97	<0.01	<0.01	<0.01	3.7	4.5	<0.005	3.7	0.0067	41
32-44	4/30/98	<0.01	<0.01	<0.01	<0.86	1.02	<0.001	0.54	0.0023	12
32-44	3/23/99	<0.01	0.002	<0.001	5.5	4.04	<0.001	1.0	0.004	8.8

Table 2-4 Concentrations of Hazardous Constituents in TRA Monitoring Wells – Year 1997 to 1999 (Continued)

TRA Monitor Well	Date	CN (mg/l)	Mo (mg/l)	Ni (mg/l)	Pb-210 (pCi/l)	Ra 226 and -228 (pCi/l)	Se (mg/l)	Th-230 (pCi/l)	U-nat (mg/l)	Gross Alpha (pCi/l)
33-01TRA	4/7/97	0.01	0.01	<0.01	10.1	4.1	<0.005	2.6	0.0083	23
33-01TRA	12/4/97	<0.01	<0.01	<0.04	7.2	4.2	<0.005	1.4	0.0055	86
33-01TRA	4/28/98	<0.01	<0.02	<0.02	4.1	2.09	<0.005	0	0.0024	19
33-01TRA	12/18/98	<0.01	<0.02	<0.02	8.1	4.97	<0.001	8.3	0.006	47
33-01TRA	2/9/99	<0.01	<0.02	<0.02	9.6	5.07	<0.001	2.7	0.058	53
5-05	5/12/97	<0.01	<0.01	<0.01	3.5	6.3	<0.005	2.5	0.0053	21
5-05	5/29/98	<0.01	<0.01	<0.02	<0.69	3.33	<0.001	3.41	0.0031	13
5-05	3/23/99	<0.01	<0.02	<0.02	4.6	3.62	0.003	6.4	0.008	6.1
Groundwater Protection Standard		0.01	0.03	0.05	4.1	5	0.03	4.3	0.01	18
Health Risk Based Concentration				0.1	13	41		139	0.25	

Exceeds Groundwater Protection Standard
Exceed Health Risk Based Concentration Limit

Table 2-6 Concentrations of Hazardous Constituents in Dakota Sandstone Monitoring Wells – Year 1997 to 1999

Dakota Monitor Well	Date	As (mg/l)	Be (mg/l)	Cd (mg/l)	CN (mg/l)	Mo (mg/l)	Ni (mg/l)	Pb (mg/l)	Pb-210 (pCi/l)	Total Radium (pCi/l)	Sb (mg/l)	Se (mg/l)	Th-230 (pCi/l)	U-nat (mg/l)	Gross Alpha (pCi/l)
17-01KD	4/10/97	<0.005	<0.004	<0.005	0.02	0.01	<0.01	<0.005	3.4	2.6	<0.02	<0.005	0.1	0.0059	11
17-01KD	11/3/97	<0.003	<0.002	<0.005	<0.01	<0.01	<0.04	<0.002	5.8	3	<0.05	<0.005	0.1	0.011	13
17-01KD	5/2/98	0.003	<0.002	<0.003	<0.01	0.02	0.02	<0.001	0.1	1.02	<0.02	<0.001	0.5	0.0047	15.8
17-01KD	12/27/98	<0.001	<0.002	<0.003	<0.01	0.01	0.03	0.003	3.4	3.6	<0.004	<0.001	0.41	0.007	11.2
17-01KD	2/19/99	<0.001	<0.002	<0.003	0.01	0.02	0.01	<0.001	16	7.0	<0.002	<0.001	0.88	.0009	11
25-01KD	5/21/97	0.009	<0.004	<0.005	0.15	<0.01	0.01	<0.005		3.2	0.03	<0.005	0.4	0.0031	39
25-01KD	5/22/98	0.001	<0.01	<0.02	0.14	<0.05	<0.05	<0.001	39.6	1.67	<0.002	0.002	18.4	0.009	89
25-01KD	3/15/99	0.002	<0.01	<0.02	0.13	<0.05	<0.05	<0.001	28	5.57	<0.002	<0.001	0.8	0.004	28
26-76KD	5/27/97	0.009	<0.004	<0.005	<0.01	<0.01	<0.01	<0.005	15	2.9	0.02	<0.005	1.8	0.024	40
26-76KD	5/22/98	<0.001	<0.002	<0.003	<0.01	<0.01	<0.01	<0.001	8.44	4.39	<0.002	<0.001	1.49	0.0099	35
26-76KD	3/15/99	0.003	<0.002	<0.003	<0.01	<0.01	<0.01	<0.001	9.7	4.63	<0.002	0.001	.47	0.004	14.6
30-02KD	4/8/97	0.006	<0.004	<0.005	<0.01	<0.01	0.05	<0.005	2.3	2.1	<0.02	<0.005	0.1	<0.0009	1
30-02KD	12/8/97	<0.005	<0.004	<0.005	<0.01	<0.01	<0.02	<0.025	3.1	0	<0.03	<0.005	0	0.0071	10
30-02KD	5/2/98	<0.001	<0.002	<0.003	<0.01	<0.01	<0.01	<0.001	<0.6	3.24	<0.002	<0.001	0.3	0.0022	9.3
30-02KD	12/26/98	<0.001	<0.002	<0.003	<0.01	<0.01	0.06	<0.001	8	4.35	<0.002	<0.001	0.83	0.019	15
30-02KD	3/8/99	<0.001	<0.005	0.001	<0.01	0.003	0.051	<0.001	5.4	9.46	<0.002	<0.001	0.58	0.016	17
30-48KD	4/8/97	<0.005	<0.004	<0.005	<0.01	<0.01	<0.01	<0.005	5	8.6	<0.02	<0.005	0.4	0.027	34
30-48KD	11/4/97	<0.003	<0.002	<0.005	<0.01	<0.01	0.04	<0.01	5.5	4.4	<0.05	<0.005	0.6	0.02	41
30-48KD	5/3/98	<0.001	<0.01	<0.02	<0.01	<0.05	<0.05	<0.001	14.8	10.35	<0.002	0.003	8.35	0.0146	90
30-48KD	12/27/98	<0.001	<0.002	<0.02	<0.01	<0.01	<0.01	<0.001	7.9	8.8	<0.002	0.002	7.8	0.861	526
30-48KD	2/16/99	<0.001	<0.004	<0.006	<0.01	<0.02	<0.02	<0.001	16	16.23	<0.002	<0.001	1.2	0.484	390
30-48KD	6/22/99	<0.005	<0.005	<0.005	<0.01	0.005	0.004	<0.001	8.1	8.4	<0.002	0.001	0.12	0.221	220
30-48KD	7/26/99				<0.01	0.002	0.003		8.3	7.0		<0.001	0.2	0.103	98

Water levels in the Dakota at the 36-06KD well location also declined following the removal of liquids from Ponds #7 and #8. As a result of the water level decline, well yields during sampling at well 36-06KD in 1998 and 1999 have been so low that a significant amount of well sediments/soil (suspended solids) has been collected with the water sample. Since the isotope analysis of water samples was performed for total concentrations with the sample preserved with nitric acid, leaching of constituents adsorbed and precipitated with these suspended solids in the samples accounted for the recent increases in the concentrations of several hazardous constituents observed at well 36-06KD. Therefore, in December 1998, sample splits were collected from well 36-06KD for analysis of both dissolved and total radiological constituents to examine the impact of suspended solids in the samples.

The comparison of dissolved and total radiological constituents in the December 14, 1998 samples from well 36-06KD provided in Table 2-5 shows that the concentrations of Pb-210, Th-230, and gross alpha were significantly higher in the total analyses than in the dissolved analysis. Recent results based on dissolved analysis show Th-230 and Pb-210 concentrations well below the health risk-based concentration. On the other hand, the results in Table 2-5 show little difference between the total and dissolved concentrations for U-nat, Ra-226, and -228. Since the U-nat values at well 36-06KD remain above the above the health risk-based concentration at this POC well, an ACL for U-nat will be determined from the transport and attenuation assessment in Section 2.3 of this Petition.

Table 2-5 Dissolved and Total Concentrations in Well 36-06KD

Constituent	Dissolved Analysis	Total Analysis
U-nat, mg/l	0.509	0.426
Gross Alpha, pCi/l	194	1065
Ra-226, pCi/l	16	13.55
Ra-228, pCi/l	14.7	15.3
Th-230, pCi/l	0	400
Pb-210, pCi/l	0.42	8.5

These results show that constituents may re-dissolve or leach from suspended solids (well soil/sediments) particles in samples. Generally the quantity of well soil/sediments would be negligible in groundwater samples from wells with a sufficient water column and yield. In this case, the difference between the dissolved and total constituent concentrations would be insignificant. However, in a sample from a well with limited water column and yield, especially where the sample is obtained by bailing, a significant amount of suspended solids could be present in the water sample. If the suspended solids contain constituents of concern, the analytical result will provide the total constituent concentrations, which exceeds the constituent concentration associated with groundwater transport. Therefore, beginning from second half of 1999, the sampling procedure for radionuclides was revised to filter the groundwater samples prior to adding nitric acid for preservation.

Well 30-48KD is the only other POC well where results of recent samples have exceeded the proposed health risk-based limits. The concentrations of U-nat and Pb-210 have exceeded the proposed health risk-based limits in 1998. The increase in U-nat and Pb-210 observed in this well was due to a damaged well casing that allowed surface water or shallow soil water containing elevated U-nat concentrations to migrate into the well down around the damaged casing. The damaged casing was repaired on April 30, 1999. The U-nat concentrations declined in the recent results of groundwater monitoring performed following repair of the damaged casing, as shown in Figure 2-29, indicating that the repairs have been effective in preventing cross contamination from surface water. The concentrations of hazardous constituents in the well are representative of groundwater, and are below the corresponding GPS or health risk-based concentrations in the Dakota at this POC well.

Hazardous constituent concentrations measured at Dakota monitoring wells from 1997 through first half of 1999 are presented in Table 2-6. Isopleth plots for 1998 results are provided in Appendix C. The concentrations of nickel, Pb-210, Ra-226 and -228, Th-230, U-nat and gross alpha exceeds the GPS at a number of the wells. However, the GPSs for nickel and Pb-210 established from the 1988 samples from background well 17-01KD does not appear to account for the variation in concentrations of these constituents in this background well as indicated in Figures 2-27 and 2-28. Also, an elevated concentration of cyanide has consistently been observed in well 25-01KD. The cyanide at this location is clearly not from the Facility as other hazardous constituents from tailings fluids are much lower than the concentrations in samples from this well. Also, the less than detection limit cyanide concentrations in the Dakota monitoring wells 36-06KDand 36-04KD located between ponds #7 and #8 and well 25-01KD do not indicate transport in groundwater from the Facility toward this well.

Table 2-6 Concentrations of Hazardous Constituents in Dakota Sandstone Monitoring Wells – Year 1997 to 1999

Dakota Monitor Well	Date	As (mg/l)	Be (mg/l)	Cd (mg/l)	CN (mg/l)	Mo (mg/l)	Ni (mg/l)	Pb (mg/l)	Pb-210 (pCi/l)	Total Radium (pCi/l)	Sb (mg/l)	Se (mg/l)	Th-230 (pCi/l)	U-nat (mg/l)	Gross Alpha (pCi/l)
17-01KD	4/10/97	<0.005	<0.004	<0.005	0.02	0.01	<0.01	<0.005	3.4	2.6	<0.02	<0.005	0.1	0.0059	11
17-01KD	11/3/97	<0.003	<0.002	<0.005	<0.01	<0.01	<0.04	<0.002	5.8	3	<0.05	<0.005	0.1	0.011	13
17-01KD	5/2/98	0.003	<0.002	<0.003	<0.01	0.02	0.02	<0.001	0.1	1.02	<0.02	<0.001	0.5	0.0047	15.8
17-01KD	12/27/98	<0.001	<0.002	<0.003	<0.01	0.01	0.03	0.003	3.4	3.6	<0.004	<0.001	0.41	0.007	11.2
17-01KD	2/19/99	<0.001	<0.002	<0.003	0.01	0.02	0.01	<0.001	16	7.0	<0.002	<0.001	0.88	.0009	11
25-01KD	5/21/97	0.009	<0.004	<0.005	0.15	<0.01	0.01	<0.005		3.2	0.03	<0.005	0.4	0.0031	39
25-01KD	5/22/98	0.001	<0.01	<0.02	0.14	<0.05	<0.05	<0.001	39.6	1.67	<0.002	0.002	18.4	0.009	89
25-01KD	3/15/99	0.002	<0.01	<0.02	0.13	<0.05	<0.05	<0.001	28	5.57	<0.002	<0.001	0.8	0.004	28
26-76KD	5/27/97	0.009	<0.004	<0.005	<0.01	<0.01	<0.01	<0.005	15	2.9	0.02	<0.005	1.8	0.024	40
26-76KD	5/22/98	<0.001	<0.002	<0.003	<0.01	<0.01	<0.01	<0.001	8.44	4.39	<0.002	<0.001	1.49	0.0099	35
26-76KD	3/15/99	0.003	<0.002	<0.003	<0.01	<0.01	<0.01	<0.001	9.7	4.63	<0.002	0.001	.47	0.004	14.6
30-02KD	4/8/97	0.006	<0.004	<0.005	<0.01	<0.01	0.05	<0.005	2.3	2.1	<0.02	<0.005	0.1	<0.0009	1
30-02KD	12/8/97	<0.005	<0.004	<0.005	<0.01	<0.01	<0.02	<0.025	3.1	0	<0.03	<0.005	0	0.0071	10
30-02KD	5/2/98	<0.001	<0.002	<0.003	<0.01	<0.01	<0.01	<0.001	<0.6	3.24	<0.002	<0.001	0.3	0.0022	9.3
30-02KD	12/26/98	<0.001	<0.002	<0.003	<0.01	<0.01	0.06	<0.001	8	4.35	<0.002	<0.001	0.83	0.019	15
30-02KD	3/8/99	<0.001	<0.005	0.001	<0.01	0.003	0.051	<0.001	5.4	9.46	<0.002	<0.001	0.58	0.016	17
30-48KD	4/8/97	<0.005	<0.004	<0.005	<0.01	<0.01	<0.01	<0.005	5	8.6	<0.02	<0.005	0.4	0.027	34
30-48KD	11/4/97	<0.003	<0.002	<0.005	<0.01	<0.01	0.04	<0.01	5.5	4.4	<0.05	<0.005	0.6	0.02	41
30-48KD	5/3/98	<0.001	<0.01	<0.02	<0.01	<0.05	<0.05	<0.001	14.8	10.35	<0.002	0.003	8.35	0.0146	90
30-48KD	12/27/98	<0.001	<0.002	<0.02	<0.01	<0.01	<0.01	<0.001	7.9	8.8	<0.002	0.002	7.8	0.861	526
30-48KD	2/16/99	<0.001	<0.004	<0.006	<0.01	<0.02	<0.02	<0.001	16	16.23	<0.002	<0.001	1.2	0.484	390
30-48KD	6/22/99	<0.005	<0.005	<0.005	<0.01	0.005	0.004	<0.001	8.1	8.4	<0.002	0.001	0.12	0.221	220
30-48KD	7/26/99				<0.01	0.002	0.003		8.3	7.0		<0.001	0.2	0.103	98

Table 2-6 Concentrations of Hazardous Constituents in Dakota Sandstone Monitoring Wells – Year 1997 to 1999 (Continued)

Dakota Monitor Well	Date	As (mg/l)	Be (mg/l)	Cd (mg/l)	CN (mg/l)	Mo (mg/l)	Ni (mg/l)	Pb (mg/l)	Pb-210 (pCi/l)	Total Radium (pCi/l)	Sb (mg/l)	Se (mg/l)	Th-230 (pCi/l)	U-nat (mg/l)	Gross Alpha (pCi/l)
31-03KD	5/29/97	<0.005	<0.004	<0.005	<0.01	0.01	<0.01	0.008	0.1	5.7	<0.02	<0.005	0	0.0075	27
31-03KD	5/28/98	<0.001	<0.002	<0.003	<0.01	0.01	<0.01	<0.001			<0.002	<0.001		<0.0002	
31-03KD	3/19/99	<0.001	<0.002	<0.003	<0.01	<0.01	<0.01	<0.001	3.8	5.25	<0.002	<0.001	1.1	0.013	18.5
32-45KD	4/8/97	0.005	<0.004	<0.005	<0.01	<0.01	<0.02	<0.005	2	4.1	<0.02	<0.005	0.4	0.0022	12
32-45KD	11/4/97	0.003	<0.002	<0.005	<0.01	0.03	<0.04	<0.002	2.7	4.4	<0.05	<0.005	0.4	0.0059	6
32-45KD	5/3/98	<0.001	<0.002	<0.003	<0.01	0.05	0.02	<0.001	0.3	4.48	<0.002	<0.001	10.76	0.0087	22.8
32-45KD	12/26/98	<0.001	<0.002	<0.003	<0.01	0.03	<0.01	<0.001	12	9.2	<0.002	<0.001	6.6	0.012	30
32-45KD	3/8/99	<0.001	<0.002	<0.003	<0.01	0.03	<0.01	<0.001	0.69	2.67	<0.002	<0.001	0.41	0.004	9.9
32-51KD	5/27/97	<0.005	<0.004	<0.005	<0.01	0.01	<0.01	<0.005	1.4	3.2	<0.02	<0.005	1.2	0.0012	13
32-51KD	5/3/98	<0.001	<0.002	<0.003	<0.01	<0.01	<0.01	<0.001	<0.6	3.24	<0.002	<0.001	230	0.002	72
32-51KD	3/16/99	<0.001	<0.002	<0.003	<0.01	<0.01	<0.01	<0.001	81	89.9	<0.002	<0.001	80	0.005	337
32-52KD	5/27/97	<0.005	<0.004	<0.005	<0.01	<0.01	<0.01	<0.005	5.3	5.8	<0.02	<0.005	2.6	0.018	37
32-52KD	5/28/98	<0.001	<0.002	<0.003	<0.01	0.01	<0.01	<0.001			<0.002	<0.001		<0.0002	
32-52KD	3/16/99	<0.001	<0.002	<0.003	<0.01	<0.01	<0.01	<0.001	5.3	7.72	<0.002	<0.001	0.97	0.002	7.3
36-01KD	5/29/97	0.005	<0.004	<0.005	<0.01	<0.01	<0.01	<0.005	1.2	4.7	<0.02	<0.025	0.2	0.0051	0
36-01KD	5/28/98	0.009	<0.01	0.02	<0.01	<0.05	<0.05	<0.001	1.66	0.83	<0.002	0.003		0.005	60
36-01KD	3/18/99	<0.002	<0.005	<0.03	<0.01	0.003	0.013	<0.002	15	9.54	<0.002	0.005	2.5	0.005	26
36-04KD	5/29/97	<0.005	<0.004	<0.005	<0.01	<0.01	<0.01	<0.005	2.5	13.7	<0.02	<0.025	0.6	0.0051	24
36-04KD	5/29/98	<0.001	<0.02	<0.03	<0.01	<0.1	<0.1	<0.001			<0.002	0.002		0.003	
36-04KD	3/18/99	0.017	<0.01	<0.005	<0.01	0.024	0.026	<0.002	9.1	8.53	<0.002	0.011	1.2	0.052	22

Table 2-6 Concentrations of Hazardous Constituents in Dakota Sandstone Monitoring Wells - Year 1997 to 1999 (Continued)

Dakota Monitor Well	Date	As (mg/l)	Be (mg/l)	Cd (mg/l)	CN (mg/l)	Mo (mg/l)	Ni (mg/l)	Pb (mg/l)	Pb-210 (pCi/l)	Total Radium (pCi/l)	Sb (mg/l)	Se (mg/l)	Th-230 (pCi/l)	U-nat (mg/l)	Gross Alpha (pCi/l)
36-06KD	4/7/97	0.005	<0.004	<0.005	<0.01	<0.01	0.05	<0.005	6.1	13.2	0.13	<0.005	16	0.23	133
36-06KD	12/8/97	<0.005	<0.004	<0.005	<0.01	<0.01	0.05	<0.025	14	5.8	<0.03	<0.025	0.3	0.65	686
36-06KD	5/3/98	0.003	<0.001	<0.02	<0.01	<0.05	0.06	<0.001	25.6	30.23	<0.01	0.011	1311.5	0.803	1159
36-06KD	12/4/98	<0.002	<0.01	<0.02	<0.01	<0.05	<0.05	<0.001	0.42	30.7	<0.002	0.005	0	0.509	194
36-06KD	3/8/99	<0.004	<0.01	0.008	<0.01	0.003	0.065	0.001	21	27.3	<0.002	0.003	370	0.545	456
36-06KD	5/10/99								3.6	20.3			0.05		110
36-06KD	5/26/99	<0.001	<0.005	0.005	<0.01	0.003	0.016	<0.001	0.83	18.3	<0.002	0.002	0.15	0.128	98
36-06KD	7/26/99	<0.001	0.003	0.003	<0.01	0.002	0.078	0.001	1.6	21.2	<0.002	<0.001	3	0.213	170
5-01KD	6/2/97	<0.005	<0.004	<0.005	<0.01	<0.01	<0.01	<0.005	3.9	2.8	<0.02	<0.005	3.9	0.0026	19
5-01KD	5/28/98	<0.001	<0.002	<0.003	<0.01	<0.01	0.04	<0.001			<0.002	<0.001		0.0009	
5-01KD	3/16/99	<0.001	<0.002	<0.003	<0.01	<0.01	<0.01	<0.001	4.1	2.49	<0.002	<0.001	0.71	0.0005	2.6
Groundwater Protection Standard		0.1	0.01	0.01	0.04	0.06	0.03	0.14	1.9	5.0	0.05	0.04	2.3	0.02	56
Health Risk Based Concentration							0.1		13	41			139	0.25	

Exceeds Groundwater Protection Standard
Exceeds Health Risk Based Concentration Limit

The only hazardous constituents observed above health-based limits in the Dakota during the period 1997 through first half of 1999 were U-nat and Pb-210 in POC wells 36-06KD and 30-48KD; Pb-210 in well 25-01KD; and Pb-210, Ra-226 and -228, and Th-230 in well 32-51KD. As discussed, the Pb-210 and Th-230 concentrations are elevated in some of the samples due to total analysis of samples containing sediment. The 1999 results from well 32-51KD based on total analysis appear spurious as previous sampling results of Ra-226 and -228, and Th-230 in this well were low. The elevated concentrations of Pb-210 and U-nat observed at the POC well 30-48 was found to be due to cross contamination from the surface through the damaged well casing. Although the hazardous constituent concentrations still exceed the health-based limits in the Dakota POC well 36-06KD, concentrations were substantially higher in 1988 and 1989 as indicated in Figures 2-28 through 2-32. Well 36-06KD is located immediately north of pond #7 and #8 and groundwater in the Dakota at this well location has clearly been impacted by seepage from these ponds. The elevated concentrations of hazardous constituents observed at this POC location within the Dakota will be evaluated in the transport and attenuation assessment in Section 2.3 of this Petition.

2.3 Groundwater Transport Assessment

A groundwater transport assessment has been developed to determine the rate and direction of groundwater flow in the TRA, the TRB, and the Dakota units downgradient of the byproduct disposal facilities and to assess the attenuation of hazardous constituents in groundwater transport in these units.

2.3.1 Hydrogeologic Characteristics, Flow Directions and Rates

The hydrogeologic and water quality conditions in the vicinity of the Facility have been studied in a number of previous investigations (see Qu86; Qu87; Hydro-Engineering, 1992; Cooper and John, 1968; and Craven and Hammock, 1958) that have been submitted to the NRC. Geologic strata at the Facility dip gently, usually about two degrees to the north and northeast, from the Zuni uplift to the southwest into the San Juan Basin to the north. The geology in the vicinity of the Facility is relatively complex due to displacement of the pre-Quaternary formations along several geologic faults and the presence of Quaternary alluvium. Faults and associated fractures have a predominantly north-south trend. Alluvium has been deposited along the course of Arroyo del Puerto filling the narrow valley incised within the erosional surface of the Mancos shale and Tres Hermanos Sandstones with up to 100 feet of sediment.

Tailings impoundments #1 and #2 overlie the Mancos Shale adjacent to the alluvium as shown in Drawing 2-2. The highly weathered portion of the Mancos Shale located within about 10 feet of the surface is represented as saprolite on geologic maps of the area. Most of the seepage from the Tailings Impoundments #1 and #2 flowed laterally through the saprolite following the surface slope and into the alluvium of Arroyo del Puerto. This seepage is collected by the interception trench installed as part of the groundwater corrective action program for the alluvium. A minor portion of seepage from the tailings impoundments flows vertically through the saprolite and into the underlying bedrock formations.

Groundwater Flow in the TRB Sandstone

The TRB subcrops beneath most of Tailings Impoundments #1 and #2 as shown in Drawing 2-1. Erosion of the Mancos Shale beneath the narrow alluvial valley east of Tailings Impoundment #1 has removed the TRB. The erosion was not sufficiently deep to remove the TRB in the portion of the valley north and northeast of Tailings Impoundment #1. Seepage from the Tailings Impoundments that reaches the TRB migrates down dip to the north and northeast. While the general direction of groundwater flow is well characterized by regional groundwater information, chloride concentrations, and groundwater levels, the groundwater levels and constituent concentrations at individual TRB wells downgradient of the Facility varies depending upon the structural features within the bedrock units, including fault displacements and fracture patterns.

Based on the results of the 1983 and 1989 downhole survey of shafts and ventilation holes conducted by QMC and a study performed by Hydro-Engineering (1992), the affected groundwater in the TRB downgradient of the Facility is intercepted by the numerous vent holes and shafts associated with the underground mines and by the vertical fractures induced by collapse of mine stopes. Total flow to the vent holes and shafts from the TRB measured in 1983 was 6 gpm. By 1989, the total flow had declined to 1.9 gpm with the associated decline in groundwater levels in the TRB.

An estimate of the groundwater flow of 6 gpm in the TRB downgradient of the Facility was developed by Hydro-Engineering (1992). The impacted groundwater plume was determined to have a width (W) of less than 6000 feet perpendicular to the direction of flow in the TRB at a location downgradient of the Tailings Impoundments but upgradient of the mine ventilation holes and shafts. The average transmissivity (T) of the TRB at this cross section was estimated to be 35 gpd/ft based on saturated thickness in nearby TRB wells and estimates of the hydraulic conductivity of the TRB. The average potentiometric gradient of the TRB at this location was determined to be 0.042 ft/ft. Thus, the total groundwater flow Q in the TRB is:

$$Q(gpd) = W(ft) * T(gpd/ft) * Gradient(ft/ft) = 6000 * 35 * 0.042 = 8{,}820 \text{ gpd } (6.1 \text{ gpm})$$

From the 1983 vent hole monitoring we know that elevated chloride occurs in the TRB at vent hole 30-10 located approximately 5600 feet downgradient of Tailings Impoundment #1. Elevated chloride was first observed at vent hole 30-10 in May of 1983 but was undoubtedly present at this location prior to 1983. Given the start of initial tailings disposal in impoundment #1 in late 1958, a transport velocity in the TRB of at least 0.63 ft/day would be required for chloride in tailings seepage to be observed at this well. However, this is a velocity for initial breakthrough of chloride at this well. The average groundwater velocity would be lower than this estimate due to longitudinal dispersion within the TRB. The average groundwater velocity in the TRB downgradient of the Facility is determined to average about 0.67 ft./day based on an effective porosity of 0.05 and a hydraulic conductivity averaging about 0.8 ft./day determined from packer tests conducted within the TRB by Woodward Clyde Consultants in 1983 (Bostick, 1985). As indicated, the actual velocities inferred from chloride transport are lower than 0.67 ft/day. This suggests that either the hydraulic conductivity is less than 0.8 ft./day or the effective porosity is greater than 0.05.

Groundwater Flow in the TRA Sandstone

The TRA unit outcrops and subcrops in the general vicinity of ponds #7 and #8. As indicated previously, most of the seepage from the ponds #7 and #8 that may have migrated through the shallow saprolite into the TRA unit has been minimized by the dewatering trench located between pond #7 and impound #2. The TRA downgradient of the Facility does not appear to have been measurably impacted by tailings seepage. As discussed in Section 2.2, the hazardous constituent concentrations in groundwater within the TRA are at or near background concentrations and do not exceed health-based limits.

The general direction of groundwater flow in the TRA is determined to be toward the north-northeast, comparable to the groundwater flow directions in the overlying TRB and underlying Dakota units. A potentiometric surface could not be constructed due to groundwater level measurements at only three wells (TRA wells 31-01tra, 30-01, and 32-44) located along the north and northeast side of the Facility. On the other hand, the TRA was found to be dry or damp in the 1989 vent hole survey indicating an overall potentiometric gradient down dip from TRA wells 31-01tra, 30-01, and 32-44 to the vent holes and shafts in Sections 30. Groundwater flow in the TRA is much less than the flow in the TRB.

Groundwater Flow in the Dakota Sandstone

Prior to uranium mining in the Ambrosia Lake area, the Dakota formation was unsaturated along the outcrop. Based on regional information prior to mining and a steady state groundwater model of the Dakota prior to mining, saturated conditions in the Dakota were found at an elevation of about 6,740 feet MSL in the northern portion of Section 36 and below the current location of Tailings Impoundment #1 in Section 31 (Snow, 1983). Groundwater monitoring within the Dakota indicates that the groundwater in the Dakota has been impacted within a narrow plume downgradient of ponds #7 and #8.

The affected groundwater in the Dakota downgradient of the Facility is intercepted by the numerous vent holes and shafts associated with the underground mines and by the vertical fractures induced by collapse of mine stopes as was shown previously for the TRB. Total flow to the vent holes and shafts from the Dakota measured in 1983 was 129 gpm. By 1989, the total flow had declined to 12.5 gpm with the decline in groundwater levels in the Dakota.

An estimate of the groundwater flow of 26 gpm in the Dakota downgradient of the Facility was developed by Hydro-Engineering (1992). The impacted groundwater plume was determined to have a width (W) of less than 10,000 feet perpendicular to the direction of flow in the Dakota at a location downgradient of the Tailings Impoundments but upgradient of the mine ventilation holes and shafts. The average transmissivity (T) of the Dakota at this cross section was estimated to be 100 gpd/ft based on saturated thickness in nearby Dakota wells and estimates of the hydraulic conductivity of the Dakota. The average potentiometric gradient of the Dakota at this location was determined to be 0.037 ft/ft. Thus, the total groundwater flow Q in the Dakota is:

$$Q(\text{gpd}) = W(\text{ft})*T(\text{gpd/ft})*\text{Gradient}(\text{ft/ft}) = 10{,}000*100*0.037 = 37{,}000 \text{ gpd } (25.7 \text{ gpm})$$

The average groundwater velocity in the Dakota downgradient of the Facility is determined to average about 0.5 feet per day based on an effective porosity of 0.03 and a hydraulic conductivity of about 0.4 ft/day determined from a pumping test at Dakota POC well 36-06KD. A one dimensional groundwater transport model was calibrated using chloride concentration data from Dakota POC well 36-06KD and downgradient POE well 36-04KD. The groundwater transport model is described in detail in Section 2.3.2.

Elevated chloride was present in the Dakota at vent hole 30W-6 prior to May of 1983. Vent hole 30W-6 is located approximately 7200 feet downgradient of pond #7. Given the start of initial liquid disposal in pond #7 in late 1961, the minimum chloride transport velocity in the Dakota of 0.92 ft/day would be required for chloride in tailings seepage to be observed at this well by May 1983. However, this is a velocity for initial breakthrough of chloride and the average groundwater velocity would be lower. As indicated, the flow velocities inferred from chloride transport modeling are approximately 0.5 ft/day. Also, the transport model shows initial chloride breakthrough beginning in the late 1970s at a location 9100 feet downgradient of pond #7. Thus the model results are consistent with the 1983 vent hole monitoring which found elevated chloride in the Dakota at vent hole 30W-6 located approximately 7200 feet downgradient of pond #7.

2.3.2 Transport and Attenuation of Hazardous Constituents

In Section 1.3, groundwater monitoring results for POC wells were reviewed for each of the bedrock aquifer units to determine which constituents exceeded the GPS in the compliance monitoring results from 1997 through first half of 1999. Based on these results, transport and attenuation evaluations are performed for the following constituents in the uppermost bedrock aquifer units:

- nickel
- Pb-210
- Th-230
- U-nat,
- Ra-226 and -228

The transport and attenuation of these constituents between the POC and the Point of Exposure (POE) in the respective bedrock aquifer units is addressed in sufficient detail to insure that the proposed ACLs are adequate to maintain health risk-based concentrations at the POE. Natural processes which influence attenuation of contaminant transport in groundwater include: (1) dilution and dispersion, (2) buffering of pH, (3) chemical precipitation either by reaction with dissolved species or by reaction with the geologic medium, (4) hydrolysis and precipitation of insoluble hydroxides, (5) precipitation resulting from oxidation-reduction reactions, (6) mechanical filtration, (7) volatilization and loss as a gas, (8) biological degradation or assimilation, (9) cation exchange reactions, (10) radioactive decay, and (11) matrix diffusion. These chemical interactions are very complex and affect different species to greatly varying degrees.

Most trace metals present in the acidic tailings water are, for the most part, removed from solution by precipitation as these liquids are neutralized as they move through the unsaturated zone. Monitoring data show that the neutralization of tailings water has resulted in nearly complete removal of heavy metals from the groundwater. Once the tailings fluid is neutralized, attenuation of remaining constituents is governed by dilution, dispersion, matrix diffusion, and by complex geochemical controls including Eh (redox potential), temperature, complexation, and interaction with aquifer solids.

U-nat, Th-230, and radium concentrations present in the acidic tailings liquid are substantially reduced by neutralization under the Tailings Impoundment. Geochemical testing performed for NRC (Serne and others, 1983) has shown that U-nat concentrations are greatly reduced and remain relatively low at pH levels above about 4.0. A pH of less than 3.7 "appeared to be critical for the mobilization of significant concentrations of U-nat". At more neutral pH levels, decreasing U-nat concentration measured in the column tests "is possibly attributable to adsorption or some other mechanism besides pH dependent solubility". U-nat, Th-230 and total radium concentrations in pH 3.9 seepage near the toe of Tailings Impoundment #1 were listed in Table 2-2 as 8.4 mg/l, 11 pCi/l and 62 pCi/l, respectively. Substantial declines in concentrations occur, as the pH in the groundwater becomes more neutral.

U-nat is composed of several isotopes of which uranium-238 is predominant. Th-230, Ra-226, and Pb-210 are daughter products of uranium-238. The pH-Eh and solubility diagrams published by Garrels and Christ (1965, p. 254-256) show that reduced uranium species are relatively insoluble, but that more highly oxidized forms such as the Uranyl ion, UO_2^{+2}, or anionic species present at high pH are more soluble. As long as oxidizing conditions exist in the aquifer, U-nat is usually moderately attenuated by adsorption on clay particles and precipitation with carbonate or sulfate complexes. Other mechanisms, which would tend to further attenuate uranium transport in groundwater, include dilution and dispersion, matrix diffusion, and precipitation resulting from oxidation state changes.

With adsorption mechanism, uranium is partitioned between the liquid (groundwater) and solid (aquifer matrix) in a reversible reaction on a mass-action basis. When the concentration of a contaminant in the liquid increases (such as by an increase in the seepage from a source), the contaminant will be bound to the solid phase; when the concentration decreases, the contaminant moves back into the solution. Adsorption phenomena result in slowing the velocity of the contaminant front and delaying the arrival of peak concentrations (retardation). These effects result in reduced variability of concentrations with time in response to changes in seepage (peak concentrations tend to be lowered by adsorption and valleys filled in due to desorption), and a greater persistence of the contaminant but at lower concentrations. Rancon (1973) has measured adsorption coefficients (Kd) values of 300 and 2000 mg/g for uranyl ion in clay soils at pH levels of 5.5 and 10, respectively.

Thorium is even more strongly adsorbed. Kd values of greater than 100,000 ml/g have been reported for silty loam and clay soils at pH levels greater than 6. Krishnaswami et al (1982) measured retardation values for isotopes of thorium, radium and lead in natural groundwaters in Connecticut. Retardation values for thorium were determined to be greater than 1.4×10^4. Radium isotopes were found to have retardation values ranging from 4.8×10^3 to 1.2×10^5. Retardation for Pb-210 could not be determined due to data limitations but retardation values for lead isotopes of 10^4 and higher were determined in previous investigations by Hussain and Krishnaswami (1980). Gee et al (1980) found Pb-210 to be strongly adsorbed, more so than other nuclides.

The ratio of Ra/U in groundwater is often lower than the equilibrium ratio because of radium adsorption onto clays and other ion exchanges (Matthess, 1982). The relative immobility of radium in natural groundwaters restricts the use of radium monitoring as a prospecting tool for uranium ore (Levinson and Coetzee, 1978). Radium mobility in natural water is controlled by the low solubility of radium sulfate (Hem, 1970). Adsorption and coprecipitation with amorphous Al-Si also serve to further attenuate radium transport (Bush and Markos, 1984).

Nickel is also strongly adsorbed by iron and manganese oxides (Hem, 1972). Nickel mobility in groundwater is limited by its low solubility in water. Retardation values ranging from 420 to 960 can be expected for sedimentary bedrock shales and sandstones (MFDS).

The literature provides a good understanding of the nature and mechanisms of attenuation in concentrations of U-nat, Th-230, total radium, Pb-210, and nickel in groundwater flow. However, site specific information from the relationship between concentrations at the POC to the concentrations in the aquifer downgradient of the POC provides the surest way to assess the likely magnitude of attenuation in hazardous constituents in groundwater at the Facility. The Dakota is the only bedrock unit for which monitoring of hazardous concentrations at a location downgradient of the POC can be used to assess the degree of attenuation between the POC and the nearest potential POE. In the TRB and TRA bedrock units, the aquifer has been dewatered in by the vent holes, mine shafts, and mine subsidence fracture in locations downgradient of the POC wells. Although some samples from the TRB and TRA were obtained from the vent hole survey, the time series of results needed to compare with POC concentrations could not be obtained because of the difficulty and safety concerns in obtaining these samples and the fact that most of the weep holes in the TRB and TRA were dry during the 1989 survey. Fortunately, site specific attenuation factors are not necessary for the TRB and TRA units because:

- Concentrations of hazardous constituents in POC wells have been below the health risk-based concentration limits, and
- Saturated conditions will not develop for several hundreds of years in the TRB and TRA units downgradient of the Facility at the closest POE location (See section 2.4).

2.3.2.1 Calculation of Attenuation Factors and Protective Concentrations in the Dakota Unit

As discussed in Section 2.2, the Dakota POC well showing the greatest impact due to tailings seepage is well 36-06KD located immediately downgradient of ponds #7 and #8. Monitoring results do not extend back far enough in time to indicate when hazardous constituent concentrations reached their peak at POC well 36-06KD. Liquids were not disposed in ponds #7 and #8 after 1983 and concentrations of hazardous constituents were declining in this well when it was first monitored in 1988. Extrapolation of trends in chloride concentrations in this well along with chloride measurements in downgradient well 36-04KD as shown in Figure 2-33 indicate that chloride concentrations prior to 1983 were likely at concentrations above 5500 mg/l at well 36-06KD. Source concentrations were probably at slightly higher levels as chloride concentrations between the ponds and Dakota at well 36-06KD is reduced by matrix diffusion and dilution and dilution would be minor since seepage from ponds #7 and #8 was the source of most of the groundwater observed at well 36-06KD.

These results are consistent with the conceptual model of groundwater flow in the Dakota. Prior to start of uranium mill tailings operation, the Dakota was unsaturated near the outcrop. Steady state modeling of baseline conditions by Snow (1983) indicates that the southern extent of saturation was in the northern portion of Section 36 in the general vicinity of Well 36-04KD. With the onset of disposal of byproduct liquids in ponds #7 and #8 in 1961, a wetting front advanced downward through the partially saturated

Dakota. With the advance of the wetting front, the water table in the Dakota began to rise. Eventually, saturated conditions developed in the Dakota near the ponds #7 and #8.

With removal of liquids from ponds #7 and #8, seepage rates declined substantially as indicated by the decline in saturated conditions in the Dakota as shown in Figure 2-34. The saturated thickness in wells 36-06KD has dropped from about 34 feet in 1988 to about 20 feet in 1999. Based on the declining trend, saturated thickness at this well location was undoubtedly greater than 34 feet when the liquids were removed from pond #7 in 1983. Saturated thickness has also declined in the downgradient well 36-04KD, although the rate of decline has been much slower as would be expected.

Based on the estimated groundwater velocity in the Dakota of 0.5 ft/day in the vicinity of well 36-04KD, it would take approximately 24 years for a conservative substance such as chloride to travel the 4,400 feet distance between the edge of pond #7 and well 36-04KD. Since the Dakota in this area was originally unsaturated, additional time would have been required for saturated conditions to develop. On the other hand, the gradients would have to be greater closer to the ponds, which would have increased groundwater velocities in this area. Furthermore, due to longitudinal dispersion, a conservative constituent such as chloride would reach well 36-04KD sooner than would be predicted based on average groundwater velocities. This conclusion is supported by both the chloride transport modeling presented below and the 1983 vent hole survey, which found elevated chloride in 7 of the 15 vent holes that showed seepage from the Dakota at much greater distances from the source than well 36-04KD.

The transport of the Pb-210, Th-230, U-nat, Ra-226 and Ra-228, and nickel in the Dakota would be retarded and attenuated relative to a conservative constituent such as chloride. The relationships between the concentrations of Pb-210, Th-230, U-nat, Ra-226 and -228, and nickel at the POC to their concentrations at the nearest potential POE can be used to set ACLs for the POC that would insure that health risk-based concentrations are maintained at the POE. Of course, if the ACLs at the POC are set at the health risk-based concentrations and then the need for the assessment of attenuation is unnecessary unless the ACLs are exceeded.

The concentrations of U-nat, Ra-226, Pb-210, Th-230 and Ra-228 at POC well 36-06KD and POE well 36-04KD are shown in Figures 2-35, 2-36, 2-37, 2-38, and 2-39, respectively. These results show no increasing trend in the concentrations of these constituents in POE well 36-04KD that indicates dispersive transport of these constituents in the groundwater. Variations in the concentrations of U-nat, Ra-226 and

-228, Pb-210, Th-230, and nickel at well 36-04KD are random and thought to be due mainly to the analysis for total concentrations, which could lead to wide variations in the concentrations due to variations in sediments in the samples. Recent concentrations of Pb-210, Ra-226 and -228, Th-230 and nickel are also below the health risk-based concentrations at the POC well 36-06KD except for occasional values that exceed the limits due to the analysis for total concentrations. The health risk-based concentration for U-nat continues to be exceeded at the POC well 36-06KD in the Dakota.

The evaluation of attenuation between the POC and POE in the Dakota was performed for uranium because it is the most mobile of the hazardous constituents of concern. The relationships of the concentrations of U-nat measured at the POC and at potential POE must be estimated based on modeling results since U-nat is at background concentrations at the POE. Therefore, U-nat transport in the Dakota Sandstone downgradient of POC well 36-06KD and ponds #7 and #8 was modeled to determine the degree of attenuation in U-nat concentrations between the POC wells and the potential POE. A one-dimensional analytical transport model (SOLUTE) was calibrated using existing monitoring data for U-nat and chloride from wells 36-06KD, 36-04KD, and 25-01KD. Calibration of the model with both chloride and U-nat data was necessary because U-nat remained at background level at the POE. The model runs are included in Appendix D.

The SOLUTE model assumes a uniform flow field with a constant groundwater velocity. Thus, it does not account for any increase in velocity and flow rates in the aquifer during the time period of high seepage from the Tailings Impoundment. Longitudinal dispersion and adsorption are the two mechanisms for attenuation that are included in the model. The source concentrations for the model need to reflect the influence of neutralization of tailings fluid in the groundwater near the tailings impoundments.

Inputs and parameters used in the model which were assumed or developed in model calibration are the source concentrations, the source duration, and the groundwater transport parameters listed in Table 2-7. Calibrated parameters were the longitudinal dispersivity and the retardation factor. The estimated source concentrations for U-nat from ponds #7 and #8 were determined from source measurements adjusted during model calibration to represent neutralized seepage. Chloride concentrations in source waters appear to range from about 2000 mg/l to 8800 mg/l. The chloride source concentration of 5870 mg/l was near the middle of this range and was validated by model calibration.

Only the source concentrations and the retardation factor were allowed to vary between the modeled transport assessment for chloride and the modeled transport assessment for U-nat. Modeled and observed results for chloride and U-nat are provided in Figures 2-40 and 2-41, respectively. Good comparisons between observed and predicted chloride concentrations were obtained at POC and the POE wells in the Dakota. The comparisons between observed and predicted U-nat concentrations at the POC well 36-06KD were not as good. Much higher U-nat concentrations were observed at well 36-06KD in 1988 than the modeled peak U-nat peak concentration 0.85 mg/l. However, the higher concentrations were observed at very low pH levels in this well and, after the pH rose with neutralization, measured U-nat concentrations at this well were less than the modeled concentrations. Thus, the modeled U-nat concentration in the Dakota is expected to be higher than the actual concentrations of U-nat in near neutral groundwater.

Table 2-7 Dakota Sandstone Transport Modeling Parameters

Parameter	Chloride Transport	U-nat Transport
Groundwater Seepage Velocity	182 ft/yr.	182 ft/yr.
Longitudinal Dispersivity	1200 feet	1200 feet
Concentration in Aquifer at Source	5870 mg/L	2.0 mg/l
Duration of Solute Source	22 yrs (1961-1983)	22 yrs (1961-1983)
Retardation Factor	1.4*	10

*Chloride retardation factor >1 due to matrix diffusion influences

The model predicts a peak U-nat concentration at the POE well 36-04KD of 0.133 mg/l. This peak concentration was predicted to occur in 2100 and reflects the influence of adsorption and matrix diffusion on attenuation of U-nat concentrations. Using the estimated peak U-nat concentration of 0.85 mg/l for the POC [well 36-06KD] and the estimated peak U-nat concentration of 0.133 mg/l for well 36-04KD at the potential POE, the estimated reduction factor for U-nat between the POC and potential POE in the Dakota aquifer is approximately 0.16. The actual reduction or attenuation factor is expected to be much lower as the transport model appears to overestimate the U-nat concentrations in near neutral (pH>5) groundwater.

U-nat is the most mobile of the hazardous constituents of concern and the attenuation factors for other constituents would be much lower. Also, a much lower U-nat attenuation factor of 0.017 is obtained if the highest observed U-nat concentration of 7.87 mg/l in well 36-06KD is compared to the modeled peak U-nat concentration of 0.133 mg/l for well 36-04KD at the potential POE. This attenuation factor includes the affects of neutralization as well as the influence of adsorption and dispersion.

Table 2-8 lists the maximum concentrations at the POC in the Dakota that would be protective given the estimated attenuation factor between the POC and the POE and the proposed health risk-based limits. The estimated attenuation factor of 0.16 was determined from the attenuation factor for U-nat based on dispersion and retardation alone. The calculated attenuation factor for U-nat without the influence of neutralization provides a very conservative estimate of the minimum attenuation for other hazardous constituents in the Dakota unit. The estimated concentrations would be protective are the maximum values that can occur at the POC with assurance that health risk-based concentrations would be attained at the POE. It should be noted that some constituents have previously exceeded the protective limits at the POC, but these exceedences occurred when the pH was very low or for the total analysis of the samples from well 36-06KD that contained high sediment levels.

Table 2-8 Calculation of POC Concentrations Needed to Maintain Health Risk-Based Limits at the POE in the Dakota Sandstone

Hazardous Constituent	Health Risk-Based Concentration	Estimated Attenuation Factor	Protective Concentration @ 36-06KD
U-nat (mg/l)	0.25	0.16	1.56
Pb-210 (pCi/l)	13	0.16	81
Total Ra (pCi/l)	41	0.16	256
Th-230 (pCi/l)	139	0.16	869
Nickel (mg/l)	0.1	0.16	0.6

2.3.2.2 Calculation of Protective Concentrations in the TRB and TRA Units

As discussed previously, recent concentrations of hazardous constituents in POC wells in the TRB and TRA have been below the health based concentration limits except for nickel in well 31-66. The use of health risk based concentration limits as ACLs for the POC insures that the health risk based limits will be met at the POE in both units.

The transport and attenuation of nickel between the POC well 31-66 and the Point of Exposure (POE) in the TRB unit is addressed in sufficient detail to insure that the proposed ACL for nickel adequate to maintain health based concentrations at the POE. Based on the potentiometric information, groundwater flow in the TRB is toward the north-north east. The average travel time for groundwater flow between the tailings impoundment #2 and well 31-66 located 1500 feet to the north is about 6.5 years based on the estimated groundwater velocity in the TRB. The average travel time for nickel will be longer due to adsorption.

A review of nickel analyses for well 31-66 in Appendix A indicates that nickel concentrations reached a peak of about 0.37 mg/l in the late 1980's and has declined to a concentration levels slightly less than 0.2 mg/l in the 1990's. Analysis of source fluids and tailings seepage has shown consistent nickel concentrations of 1 mg/l. If the source of nickel in well 31-66 is from tailings impoundment #2 located at a distance of 1500 feet south of this well, then the empirical attenuation factor for nickel is 0.37. By inference, the attenuation factor between POC well 31-66 and location 3000 feet north of this well would be approximately 0.37*0.37 or 0.137. The attenuation factor for nickel in the TRB at well 31-66 is less than 0.137, as the distance between TRB well 31-66 and potential POE locations is about 4200 feet. This is approximately the same as the distance between POC well 36-06KD and the POE in the Dakota. By inference from the Dakota well 36-06KD, an attenuation factor of 0.16 or lower would be reasonable for nickel in the in the TRB.

Given an attenuation factor for nickel of 0.16 or lower, the protective concentration for nickel in well 31-66 is determined as:

$$\begin{aligned}\text{Protective Conc. (mg/l)} &= \text{Health Risk Based Conc.(mg/l)/attenuation factor}\\ &= 0.1\ \text{(mg/l)}/0.16\\ &=0.625\ \text{mg/l}\end{aligned}$$

Thus, the degree of nickel attenuation in the TRB is sufficient that health based concentrations will not be exceeded at potential POE locations at the institutional control boundary.

U-nat concentrations at the TRB wells 32-64 and 31-02 have also exceeded health risk based concentrations as concentrations have ranged from about 0.5 to 0.75 in recent (1997-1999) monitoring events. Although these wells are not POC locations, the potential transport of U-nat from these well locations is addressed below.

As discussed previously, the elevated U-nat in well 31-02, which is located immediately adjacent to the fresh water pond, is thought to be due to seepage of water from the nearby fresh water pond. Thus the uranium in this well does not appear to be associated with by-product material. The elevated U-nat observed within the TRB in the vicinity of well 32-64 is thought to be due either to residual influences of seepage from unlined pond #6 or from seepage from the alluvium which overlies the TRB in the vicinity of this well as shown on Drawing 2-2. The U-nat concentrations at potential POE locations at the institutional control boundary will not be exceeded due to the elevated U-nat observed at wells 32-64 and 31-02. This conclusion is based on evaluations of groundwater flow in the TRB and inferences of attenuation factors for U-nat determined from the Dakota. This inference is believed to be valid because:

- the distance between TRB well 31-02 and potential POE locations is about the same as the distance between the POC and POE in the Dakota, and
- the attenuation of U-nat in the TRB due to dispersion and adsorption appears to be greater in the TRB than in the Dakota based on the higher percentage of fine grained sediments in the TRB and the site monitoring data which indicates limited extent of U-nat transport in the TRB.

The elevated U-nat observed at well 31-02 poses no long term risk. With the removal of fluids from the fresh water pond, U-nat concentrations will begin to decline in the vicinity of this well. If a peak U-nat concentration of 0.75 mg/l occurs at this well, the predicted peak U-nat concentration at a potential POE location 3000 to 5000 feet downgradient would be:

$$\text{U-nat @POE} = 0.75 \text{ mg/l} * 0.16 = 0.12 \text{ mg/l}$$

Based on the transport modeling results for the Dakota, this peak concentration would occur at the nearest POE location after about 100 years. However, the TRB at these locations are projected to remain dewatered in these potential POE locations for at least the next 200 years (See section 2.4). Therefore, U-nat concentrations would be further attenuated by the time that saturated conditions sufficient to sustain pumping are present in the TRB and TRA units downgradient of the QMC Facility at the closest POE locations.

The elevated U-nat observed at well 32-64 also poses no long term risk. The TRB subcrops within the alluvium of Arroyo del Puerto immediately east of this well location as shown in Drawing 2-2. The U-nat concentrations in this well are similar to the concentrations in the alluvium, indicating that the source of U-nat could be seepage from the alluvium. Based on water elevations in well 32-64 and in nearby TRB wells, the groundwater flow in the vicinity of this well is usually toward the alluvium, although reverse gradients may occur during high stream flows. The other source for U-nat in this well could be residual effects of seepage from pond #6. Any residual effects will diminish with time since fluids and byproduct material have been removed from this pond. It is unlikely that the source of U-nat in this well is from Tailings Impoundments #1 and #2 because the interception trench captures shallow seepage in the weathered bedrock and the U-nat concentrations are much lower in well 31-62 located between the interception trench and well 32-64.

2.4 Land Transfer for Long Term Institutional Control and POE Locations

As discussed in Section 2.5.1, the groundwater from the upper most bedrock units is not currently being used for industrial, municipal, domestic or livestock watering purposes in the vicinity of the tailings impoundment. Nevertheless, the proposed POE locations were established in accordance with the NRC's ACL guidance. The potential POE locations were designated along the down gradient edge of the land that will be transferred to the government agency for long term institutional control after the Facility license is terminated. The long term institutional control land boundary is shown on Map 1-1. As discussed below, this boundary is modified in some locations beyond the current restricted area boundary to include the POC wells and tailings reclamation designed erosion control features. The rationale for proposed POE locations is provided below for each bedrock unit.

<u>Dakota Unit POE Location</u>

There are four POC wells established for the Dakota Unit at the Facility as shown on Map 1-1. The Dakota Unit POE location, well 36-04KD, is approximately 4,000 feet down gradient of the POC well 36-06KD located west of the tailings impoundment in Section 36. The State of New Mexico owns Section 36. The Dakota Unit POE location is monitoring well 36-04KD, approximately 200 feet from the edge of the proposed land that will be transferred for long term institutional control. The other Dakota Unit POC wells, 30-48KD, 30-02KD and 32-45KD, are located north and northeast of the tailings impoundment. No POE locations are proposed down gradient of these wells for the following reasons:

1. The Dakota Unit has been dewatered beyond the boundary of the area to be transferred for long-term institutional control downgradient of these POC wells due to continuous draining of residual groundwater from the unit through vent holes into the deeper Westwater Canyon member of the Morrison Formation.

2. As discussed below, groundwater level recovery sufficient to support use in the location downgradient of the institutional control boundary is not likely to occur in the Dakota for hundreds of years due to the slow rate of groundwater recovery within the bedrock formations after mine dewatering is terminated.
3. The groundwater concentrations in these POC wells have been below the proposed health risk-based concentrations.
4. The ACLs established for the Dakota based on POC well 36-06KD will insure that health risk-based concentrations will be maintained at the institutional control boundary downgradient of the other POC wells because transport distances between these POC wells and the boundary are comparable to the transport distance between wells 36-06KD and 36-04KD.

Tres Hermanos A Sandstone Unit POE Location

There is only one POC well, 31-01tra, established for the TRA at the Facility. This well is located north of the tailings impoundment in Section 31. The proposed POE location, shown on Map 1-1, is not a well, rather it is a location at the edge of the land to be transferred for long term institutional control down gradient of the POC well 31-01tra. Currently, the TRA has been dewatered beyond the boundary of the land to be transferred for long-term institutional control due to continuous draining of residual groundwater from the unit through vent holes into the deeper Westwater Canyon member of the Morrison Formation. Groundwater level recovery sufficient to support use in the TRA downgradient of the institutional control boundary is not likely to occur for hundreds of years due to the slow rate of groundwater recovery within the bedrock formations after mine dewatering is terminated.

According to Bostic (1985), the Dakota, the TRA and the TRB " have been almost completely dewatered at the Facility. They therefore cannot be considered to be aquifers of foreseeable future use until they are allowed to repressurize, which would probably occur several hundred years from the present." These conclusions are based on venthole monitoring, numerical groundwater modeling conducted by Snow (1983), and several basin-wide numerical models of groundwater drawdown and recovery due to underground mines in the Ambrosia Lake area as reported in Bostic (1985). The recovery simulations for the basin-wide numerical groundwater models all show that hundreds of years will be required before any of the major mine dewatering centers fully recovery, even if all pumping is stopped.

Use of the health risk-based groundwater concentrations from the health hazard assessment for the proposed ACLs at the POC well provides a conservative approach to insure that groundwater in the TRA is protected regardless of the possible future potential exposure locations.

Tres Hermanos B Unit POE Locations

There are four POC wells established for the TRB at the Facility, which are shown on Map 1-1. The proposed TRB Unit POE locations, shown on Map 1-1, are not wells, rather they are locations at the edge of the land to be transferred for long term institutional control down gradient of the POC wells 36-01trb, 36-02trb, 31-66trb and 31-67trb.

Well 36-01trb is the POC well nearest the boundary for a potential POE location as shown on Map 1-1. Because the designated POE location-1 is relatively close to well 36-01trb and no monitoring well exists downgradient of this POC well, the groundwater concentrations in POC well 36-01trb will be used in the health hazard assessment and the development of ACLs for this well. Since well 36-01trb is downgradient of well 36-02trb, ACLs developed for well 36-01trb will also be protective at POC well 36-02trb.

The other TRB unit POC wells, 31-66trb and 31-67trb, are located north of the tailings impoundment. The proposed POE location-2, down gradient of these POC wells, as shown on Map 1-1, is not a well, rather it is a location at the edge of the land to be transferred for long term institutional control down gradient. Currently, the TRB unit has been dewatered beyond the boundary of the land to be transferred for long-term institutional control due to continuous draining of residual groundwater from the unit through vent holes into the deeper Westwater Canyon member of the Morrison Formation. As explained above, groundwater level recovery sufficient to support use in the TRB downgradient of the institutional control boundary is not likely to occur for hundreds of years due to the slow rate of groundwater recovery within the bedrock formations after mine dewatering is terminated. Use of ACLs that would insure maintenance of health-based groundwater concentrations at the boundary of the land to be transferred for long term institutional control provides a conservative approach for protecting the TRB for the long term after groundwater levels recover downgradient of the Facility.

The proposed long term institutional control area for the Facility, as shown on Map 1-1, includes some land beyond the current operational restricted area land. This additional land is essential for long term surveillance and control for the Facility because several of the POC wells and tailings reclamation designed erosion control features are located within these areas.

The proposed long-term control area boundary is extended west of the current operational restricted area into Section 36 a maximum distance of 2,800 feet. The boundary is extended beyond the current operational restricted area boundary in this portion of Section 36 to include the Dakota Unit POC well 36-06KD, and two TRB Unit POC wells, 36-01trb and 36-02trb. The State of New Mexico owns Section 36. The proposed long-term control area boundary is extended north of the current operational restricted area approximately 3,100 feet in Section 30. Two Dakota Unit POC wells, 30-02KD and 30-48KD, are located in this portion of Section 30 beyond the current operational restricted area. In addition, the designed PMF floodway required for stability of reclaimed tailings impoundments is located in this portion of Section 30 beyond the current operational restricted area. QMC owns Section 30. The proposed long-term control area boundary is extended east of the current operational restricted area into Section 32 a maximum distance of 3,500 feet. The boundary is extended beyond the current operational restricted area boundary in this portion of Section 32 to include the Dakota Unit POC well 32-45KD and designed PMF drainage area are located in this portion of Section 32, beyond the current operational restricted area boundary. The State of New Mexico owns majority of Section 32.

A meeting between QMC staff and the U.S. Department of Energy's (DOE) Grand Junction, Colorado office staff, potential long term custodian for the facility, was held on February 2, 2000 to discuss the proposed long term institutional control and surveillance area. The DOE staff agreed that it essential that the POC wells and any Facility reclamation designed features be located within the boundary of the land subject to institutional control and long-term surveillance, as proposed, because these wells and reclamation designed features for tailings piles stability need to be under the control of the long-term custodian. The DOE staff indicated that, at a minimum, the proposed long-term institutional control and surveillance area, which includes areas outside the current operational restricted area as shown on Map 1-1 is acceptable. The additional land would also provide a buffer zone for protection of human health and the environment from any surface hazard and to prevent encroachment within the drainage within Arroyo del Puerto to maintain the stability of the Facility disposal area features.

2.5 Exposure Assessment

2.5.1 Resource Classification and Water Uses

The Facility lies within the Bluewater Underground Water Basin. The New Mexico State Engineer is responsible for administering the groundwater and surface water rights in the basin. All water users must file and obtain an approval before diverting waters to beneficial use; permits are required before drilling a well. The basin is considered fully appropriated and any major new water rights must be purchased from existing rights-holders.

New Mexico Water Quality Control Commission regulations control discharges onto or below the surface of the ground for the protection of groundwater quality. The regulations also set numerical standards for groundwater quality. Other than for Ra-226 and -228 in well 36-06KD and one anomalous result for Ra-226 in the March 1999 sample from well 32-51KD, recent results (1997-1999) in all bedrock unit monitoring wells meet New Mexico Environment Department (NMED) human health groundwater quality standards for hazardous constituents.

Utilization of groundwater in the Ambrosia Lake area can be divided into two categories: (1) Irrigation, and (2) Domestic/stock watering. Neither irrigation, nor domestic/stock watering wells in the vicinity of the tailings impoundments are completed in the uppermost bedrock units (TRA, TRB and Dakota Sandstone units). The uppermost bedrock units in the vicinity of the tailings impoundment vicinity are not capable of providing sufficient water for use because these bedrock units have been essentially dewatered downgradient of the Facility due to drainage by the numerous vent holes and mine shafts, and reduced seepage from tailings following reclamation. Historically, groundwater supply wells were not completed in the uppermost bedrock hydrogeologic units in the vicinity of the Facility because these units were only partially saturated in this location near the outcrop.

A listing provided by the U.S. Geological Survey (USGS, 1998), as provided in Appendix E, shows approximately 65 groundwater wells within a 25 mile radius of the tailings impoundment. The closest groundwater supply well is completed in the Westwater Canyon Sandstone Member of the Morrison formation at a location approximately 1.5 miles west of the tailings impoundment (Location 14N.10W.35. 221). This well location is perpendicular to the potentiometric gradients in the bedrock hydrogeologic units in the vicinity of the Facility. No groundwater supply wells are known to be completed in the TRA or TRB units within a 25 mile radius of the tailings impoundment. The closest groundwater supply completed in the Dakota unit is located approximately 15 miles north of the tailings impoundment (Location 16N.10W.18.133B). This well is located generally down gradient of the Facility although the Dakota Sandstone is drained to the underground mines in the Westwater Canyon Sandstone member of the Morrison formation by the numerous vent holes and mine shafts located immediately downgradient of the Facility.

There has been a large reduction in water use and groundwater withdrawals in the area over the past 10 to 15 years because of poor economic conditions associated with the decline of the uranium industry. The current economic base in the Ambrosia Lake area is reclamation at the Facility and ranching. The area is very sparsely populated and the population is declining. Projecting into the future, with Facility reclamation nearing completion, any increased use of groundwater in the Ambrosia Lake area in the vicinity of the tailings impoundment is highly unlikely.

A socioeconomic study (Dames & Moore, 1989) of the Grants-Milan area was performed by ARCO to support their ACLs petition for the Bluewater Uranium Mill Site. The study area consisted of approximately 50 square miles around the Bluewater Mill Site. The objective of the study was to characterize current land uses and project future land and water use within the study area around the Bluewater Mill Site. The study found that most of the area is undeveloped range land and industrial property and that the sparse population in the area is declining. The study concluded that, given the poor economy and high vacancy rates in Grants and Milan, future development is not expected within the study area. Similar conclusions can be drawn for the Facility, which is approximately 20 miles from the Bluewater Mill Site at a more remote location.

2.5.2 Evaluation of Human Health Hazards

2.5.2.1 General

The potential pathways for human exposure to hazardous constituents in the groundwater in the vicinity of the Facility are: consumption of drinking water from impacted groundwater sources, eating beef from cattle consuming impacted groundwater and forage irrigated with impacted groundwater, ingestion of vegetables and soil irrigated with impacted groundwater. The milk ingestion pathway was not included in the risk analysis. There are no existing dairy herds within 50 miles of the Facility nor are there likely to be any dairy farms in the future. In any case, milk from individual dairy herds is generally co-mingled with milk from other herds. Therefore, in the unlikely event that dairy cows were to be raised near the

Facility, the potential impact of groundwater from at the POE would be small due to dilution with other sources of milk during processing for distribution.

The potential for contamination of surface water in the vicinity is negligible. Groundwater in the uppermost bedrock units does not appear to discharge to surface water within 100 miles of the tailings area. Therefore, surface water pathways, including ingestion of fish, were not included in the risk assessment.

Public water supplies would not be affected by groundwater from the Facility since groundwater in the uppermost bedrock units is not being used by any municipal water system within 100 miles of the tailings area. The nearest three municipal water systems located approximately 20 miles from the Facility are: (1) City of Grants, (2) Village of Milan, and (3) Village of Bluewater. Wells supplying water to these systems are completed either in the San Andres aquifer or the alluvial aquifer of the Rio San Jose and Rio San Mateo.

As discussed in Section 1.4, all of the hazardous constituents in the uppermost bedrock units groundwater at the POC wells are below the GPSs, except the constituents listed in the Table 2-9 below:

Table 2-9 Hazardous Constituents of Concern

Dakota Unit	TRA Unit	TRB Unit
U-nat	-	U-nat
Pb-210	Pb-210	Pb-210
Th-230	Th-230	Th-230
Ra-226 and -228	Ra-226 and –228	Ra-226 and -228
Gross alpha	Gross alpha	Gross alpha
Nickel	-	Nickel

Consistent with discussion in Section 1.4, the hazard evaluation for gross alpha activity is not being performed because gross alpha activity at uranium mill site primarily comprises of uranium isotopes, Th-230, Ra-226, -228, and Pb-210. Polonium-210 (Po-210) is a relatively short-lived decay product of Pb-210. However, it has not been measured at the Facility. The concentration of Po-210 in groundwater from other sites, where it has been included in the radiochemical analyses, is a small fraction of the Pb-210 concentration. Therefore, it is not included in the calculation of the health risk-based concentration for Pb-210. The hazard evaluation was performed for U-nat, Th-230, Ra-226 and -228, and Pb-210 to demonstrate that the proposed ACLs for the Facility uppermost bedrock units will not pose substantial risk to the human health and the environment.

A health risk-based concentration that will limit the lifetime risk to 1.0E-04 for groundwater consumption at potential POE location was calculated for each constituent. ACLs were established for the POC wells based on either the health risk-based concentration or a higher concentration which would insure that the health risk-based concentrations are maintained at the POE locations due to attenuation in the concentrations of hazardous constituents in groundwater transport between the POC wells and the POE locations. In addition, the lifetime risk was calculated for potential exposure to groundwater for each constituent in each uppermost bedrock unit at potential POE wells using the most recent (First quarter 1999) groundwater concentrations. The calculated risks are within acceptable limits and demonstrate that the uppermost bedrock aquifer units groundwater concentrations do not pose a substantial risk to the human health or the environment.

The hazard evaluation from exposure to radionuclides in groundwater was performed primarily using risk coefficients from Federal Guidance Report No. 13 (FGR 13), Part 1, (EPA 402-R-97-014) "Health Risk From Low Level Environmental Exposure to Radionuclides", published by the U. S. Environmental Protection Agency (EPA, 1998a), the Final Generic Environmental Impact Statement on uranium milling (FGEIS) NUREG-0706 (NRC, 1980), and the National Council on Radiation Protection and Measurements (NCRP), Report 123I, Screening Models for Releases of Radionuclides to Atmosphere, Surface Water, and Ground (NCRP, 1996). Federal Guidance Report #13 lists risk coefficients for cancer attributable to exposure to radionuclides through various environmental media; NUREG-0706 and NCRP Report 123I provide environmental transfer coefficients for food chains and human usage factors.

2.5.2.2 Health Risk-Based Concentrations

Health risk-based concentrations are determined for the unlikely scenario of use of groundwater as domestic tap water at the proposed POE wells. The health risk-based concentration are the concentrations for each constituent which limit the lifetime risk to less than 1.0E-04 and are determined as follows:

1. An acceptable lifetime intake that will limit the lifetime cancer mortality risk to 1.0E-04 from ingestion of radionuclide in tap water, is calculated using risk coefficient from EPA (1998a). The lifetime acceptable intake I is calculated as:

$$I\ (Bq) = R/r$$

where R = acceptable lifetime risk, 1.0E-04

r = risk coefficient from EPA (1998a), expressed as probability of radiogenic cancer mortality rate per unit (Bq) intake of a particular radionuclide in tap water averaged over all ages and both genders.

I = lifetime radionuclide intake (Bq)

Next, the health risk-based concentration (C_{hb}) which limits the lifetime risk to 1.0E-04 was calculated from the acceptable intake as:

$$C_{hb} = [(I)(CF)]/[(y)(d)(Q)]$$

where CF = is unit conversion factor, 27 pCi/Bq

y = groundwater exposure duration of 30 years based on EPA standard assumptions with regard to exposure duration (EPA, 1998b). The 30 years of exposure to potential POE is very conservative for this Facility because of the very low probability that any individual would move near the Facility and derive domestic tap water from the uppermost bedrock units (see Section 2.5.1).

d = days per year, 350 (EPA, 1998b)

Q = 1.11 liters per day lifetime combined average intake of tap water specified in FGR13 (EPA, 1998a)

2.5.2.2.1 Health Risk-Based Concentration for U-nat

The toxicology of uranium has been extensively studied in both humans and animal models. The literature contains as much, if not more, information with regard to the toxicity of uranium than exists for any other metal (Wrenn, M.E., and others, 1985). The results of these studies with regard to metabolism, kinetics, and toxic effects have been summarized in journal articles and proceedings as well as in government documents (Wrenn, M.E., and others, 1985; Durbin, P.W., 1984; EPA, 1985).

Chemotoxic Effects

Chemotoxic effects of uranium have been observed in humans exposed under both accidental and experimental conditions and quantified using animal models. Soluble uranium oxide ions complex with serum proteins and bicarbonate. The bicarbonate complex is filterable at the renal glomerulus. The uranium oxide ion dissociates within the tubular filtrate and recombines with cell surface ligands (Durbin, P.W., 1984). At low doses, renal injury is indicated by urinary biochemical changes rather than overt illness. The association between the biochemical indicators and clinically observable injury is not well defined.

Currently, the New Mexico Water Quality Control Commission (NMWQCC) has established a 5.0 mg/l (equivalent to 3385 pCi/l) groundwater protection standard for U-nat based on its chemotoxicity. Recently, a 0.43 mg/l U-nat concentration limit based on chemotoxicity for drinking water was established in the Alternate Concentration Limits Petition for Bluewater Uranium Mill Site, Grants, New Mexico (ARCO, 1995). This 0.43 mg/l health risk-based concentration is derived for threshold for human kidney injury, and is significantly more restrictive than the NMWQCC's 5.0 mg/l groundwater protection standard. The NRC agreed with this chemotoxicity health risk-based concentration of 0.43 ug/l (300 pCi/l), as it approved the groundwater ACLs based on this limit for the Bluewater Uranium Mill Site.

Radiotoxic Effects

Natural uranium has not been shown to be a human carcinogen. There is no direct evidence that ingested uranium induces cancer in humans (Mays, C. W., and others, 1985). High specific activity uranium isotopes, U-232 and U-233, have induced bone sarcomas in mice (National Research Council, 1988). However, ingested natural uranium (U-nat) has not been shown to produce cancer or bone marrow damage in laboratory animals (EPA, 1985). Therefore, the designation of U-nat as a Class A carcinogen is based on the qualitative and quantitative similarity in the results of animal studies involving U-232 and U-233 and Ra-226, and the fact that EPA considers all radionuclides to be Class A carcinogens.

The NRC effluent limit for U-nat in water specified in 10CFR20, Appendix B to control dose to an individual member of the general public is 300 pCi/l. This effluent limit in water is established based on drinking water that will limit radiation dose to the NRC's 0.1 rem acceptable dose limit for individual members of the general public. A health risk-based concentration limit for U-nat due to its radiotoxicity for this petition was derived based risk due to environmental exposure using risk coefficients for ingestion of tap water from FGR13 (EPA, 1998a).

Federal Guidance Report #13 specifies risk coefficients for ingestion of uranium isotopes in tap water, expressed as the probability of radiogenic cancer mortality per unit intake, where the intake is averaged over all ages and both genders. Federal Guidance Report #13 does not specify a risk coefficient for U-nat. The FGR13 mortality risk coefficients for U-234, U-235 and U-238 are 1.24E-09 Bq^{-1}, 1.21E-09 Bq^{-1} and 1.13E-09 Bq^{-1}, respectively. For the purpose of deriving a health risk-based concentration for intake of U-nat in tap water, a risk coefficient for U-nat of 1.19E-09 Bq^{-1} was calculated based on activity fractions of U-234, U-235 and U-238 in U-nat at 0.4889, 0.02218 and 0.4889, respectively. The risk coefficient for the short-lived decay product of U-238, Th-234, was added to the U-238 risk coefficient since Th-234 activity will build in to equilibrium within a few months. The total risk coefficient for U-nat, used in this analysis, is 1.36 E-09 Bq^{-1}.

Using the risk coefficient, a health-risk based concentration due to radiotoxic hazard from intake of U-nat in tap water to limit the risk to an acceptable level of 1.0E-04 was calculated as follows:

$I(Bq) = R/r$

where:

$R = 1\ E\text{-}04$

$r = 1.36\ E\text{-}09\ Bq^{-1}$

$I = 1.0\ E\text{-}04/1.36\ E\text{-}09 = 7.4E{+}04\ Bq$

The U-nat health-risk based concentration that will limit the lifetime risk to 1.0E-04 is:

$C_{hb} = I/(ED)(EF)(IW)$

where:

C_{hb} = health risk-based concentration

ED = exposure duration = 30 years (EPA 1998b)

EF = exposure frequency =350 days per year (EPA 1998b)

IW = average daily water intake = 1.11liters per day (EPA 1998b)

$$C_{hb} = [(7.4\ E{+}04\ Bq)(27\ pCi/Bq)]/[(30\ y)\ (350\ d/y)\ (1.11\ l/d)] = 171\ pCi/l$$

The 164 pCi/l (0.24 mg/l) limiting concentration due to radiotoxicity calculated for this petition is more restrictive than the NMWQCC 5.0 mg/l (3300 pCi/l), the 0.43 mg/l (300 pCi/l) limit established in ARCO's 1995 ACLs petition, and the NRC's 300 pCi/l effluent limit for licensed facilities. An ACL established for U-nat at the POC well based on the 164 pCi/l (0.24 mg/l) groundwater concentration at the POE well would be protective of human health and the environment, and would assure a lifetime risk below the 1.0E-04 acceptable level.

2.5.2.2.2 Health Risk-Based Concentration for Pb-210

As discussed in Section 1.4, the Pb-210 concentrations slightly exceeds GPS in groundwater at all three bedrock unit POC wells. The hazard assessment is performed using the 1.75E-08 mortality risk coefficient specified in FGR13 for ingestion of Pb-210 tap water.

The health risk-based concentration due to radiotoxic hazard from intake of Pb-210 in tap water to limit the risk at 1.0E-04 was calculated in the same manner as for U-nat:

$$I = (1.0E\text{-}04)/(1.75E\text{-}08\ Bq^{-1})$$
$$= 5.7E\text{+}03\ Bq$$

The Pb-210 health risk-based concentration that will limit the lifetime risk to 1.0E-04 is:

$$C_{hb} = [(5.7E\text{+}03\ Bq)(27\ pCi/Bq)]/[(30\ y)\ (350\ d/y)\ (1.11\ l/d)]$$
$$= 13\ pCi/l$$

2.5.2.2.3 Health Risk-Based Concentration for Thorium-230

Concentrations of Th-230 slightly exceed the GPS in the uppermost bedrock POC wells. The hazard assessment was performed using the mortality risk coefficient specified in FGR13 for ingestion of Th-230 in tap water, 1.67 E-09:

The health risk-based concentration for Th-230 in tap water was calculated as follows:

$$I = (1.0E\text{-}04)/(1.67E\text{-}09\ Bq^{-1})$$
$$= 6.0E\text{+}04\ Bq$$
$$C_{hb} = [(6.0E\text{+}04\ Bq)(27\ pCi/Bq)]/[(30\ y)\ (350\ d/y)\ (1.11\ l/d)]$$
$$= 139\ pCi/l$$

2.5.2.2.4 Health Risk-Based Concentration for Radium-226 and -228

The total of Ra-226 and -228 groundwater concentrations at the POC wells slightly exceed the 5.0 pCi/l combined Ra-226/228 GPS. The current Ra-226/228 combined standards are: EPA's 5.0 pCi/l drinking water Maximum Contaminant Limit (MCL) (40 CFR 141.15), NRC's 5.0 pCi/l groundwater protection standard (10CFR40, Appendix A), and the NMED 30.0 pCi/l GPS (New Mexico Water Quality Control Commission Regulations, subpart III). These standards were established for large, diverse populations and include an ample margin of safety. Where an ACL is proposed for a remote area with a very low probability of potential domestic use of groundwater, a health risk-based concentration that would ensure that the lifetime risk of mortality due to use of groundwater would not exceed 1.0E-04, is appropriate.

The GPS of 5.0 pCi/l is for combined Ra-226 and Ra-228. However, the risk coefficients for Ra-226 and Ra-228 are different due to their unique hazards. Based on the risk coefficients, Ra-228 poses a 3.8 times higher cancer mortality risk than Ra-226 per unit intake. Nevertheless, the NRC specifies a 60 pCi/l effluent concentration limit in 10CFR20, Appendix B for both Ra-226 and Ra-228. The NRC effluent limits are based on ALIs of 5.0 μCi and 4.0 μCi for members of the general public for Ra-226 and Ra-228, respectively.

Because of unique radiological characteristic and hazard of radium isotopes, Ra-226 being alpha emitter and Ra-228 beta emitter, first, a separate health risk based concentration to limit the lifetime risks to 1.0E-04 for each radium isotope was calculated using the risk coefficients specified in FGR13 for ingestion of tap water. Then, a combined health risk based concentration for Ra-226/228 was determined based on the fractions of Ra-226 and Ra-228 in the mill tailings liquid, the groundwater contamination source.

<u>Ra-226 Health Risk-Based Concentration</u>

$r = 5.32\text{ E-09}$

$I = 1.0\text{ E-04}/5.32\text{ E-09Bq}^{-1}$

$I \quad = 1.9\text{E+04 Bq}$

$C_{hb} = [1.9\text{E+04 Bq})(27\text{ pCi/Bq})]/[(30\text{ y})(350\text{ d/y})(1.11\text{ l/day})]$
$= 44\text{ pCi/l}$

Ra-228 Health Risk-Based Concentration

$r = 2.00\ E\text{-}08$

$I = 1.0E\text{-}04 / (2.00E\text{-}08\ Bq^{-1})$

$I = 5.0E03\ Bq$

$C_{hb} = [5.0E03\ Bq)(27\ pCi/Bq)]/[(30\ y)\ (350\ d/y)\ (1.11\ l/d)]$
$= 12\ pCi/l$

The Ra-226 and Ra-228 data from the June 1991 sampling of tailings interceptor and dewatering trenches. which are representative of the groundwater contamination source. are summarized in the following Table 2-10:

Table 2-10 Ra-226 and Ra-228 Content in Seepage Source

Source Description	June 1991 Sampling Data			
	Ra-226 pCi/l	Ra-228 pCi/l	Ra-226 %	Ra-228 %
Pond 2 Dewatering Trench	210	1.9	99.1	0.9
Interceptor Trench, South	400	14	96.6	3.4
Interceptor Trench, East	100	2	98.0	2.0
Interceptor Trench, North	13	4.3	75.2	24.8
Mean	**181**	**5.6**	**97.0**	**3.0**

The data indicate that the source does not contain significant concentrations of Ra-228, probably because Ra-228 is a thorium (Th-232) series radionuclide, and the facility processed uranium ore, which contains uranium (U-238) and actinium (U-235) series radionuclides. Ra-228 is not part of either of these decay series. Nevertheless, since Ra-228 poses a higher cancer mortality risk than Ra-226 per unit intake, and it was detected above the background level during the detection monitoring program, it is included in the health hazard assessment. The bedrock formation contamination source at the Facility is primarily the Pond 2 area, showing a radium composition of 99% Ra-226 and only 1% Ra-228. Nevertheless, for the purpose of this analysis, the average Ra-228 fraction of 3.0% is assumed for health hazard assessment because this is a conservative approach.

Based on health risk based concentration of 44 pCi/l for Ra-226 and 12 pCi/l for Ra-228 as determined above, and 97% Ra-226 and 3% Ra-228, the combined Ra-226 and -228 health risk based concentration to limit the lifetime mortality risk to 1.0E-04 is calculated as follow:

$$[C_{Ra\text{-}228}/C_{hb,Ra\text{-}228}] + [C_{Ra\text{-}226}/C_{hb,\,Ra\text{-}226}] = 1.0$$

Where:

$C_{Ra\text{-}228}$ = limiting Ra-228 concentration in pCi/l, which also would be 3.1% of the Ra-226 limiting concentration ($0.031{*}C_{Ra\text{-}226}$) based on fraction in the source.

$C_{hb,Ra\text{-}228}$ = Ra-228 health risk based Concentration, 12 pCi/l

$C_{Ra\text{-}226}$ = limiting Ra-226 concentration in pCi/l

$C_{hb,Ra\text{-}226}$ = Ra-226 health risk based concentration, 44 pCi/l

$$[(C_{Ra\text{-}226}{*}0.031)/12] + [C_{Ra\text{-}226}/44] = 1.0$$

$$C_{Ra\text{-}226} = 39.5 \text{ pCi/l}$$

$$C_{Ra\text{-}228} = .031{*}\ 39.5 \text{ pCi/l}$$

$$C_{Ra\text{-}228} = 1.2 \text{ pCi/l}$$

The combined Ra-226 and -228 health risk based concentration = 39.5pCi/l + 1.2 pCi/l
41 pCi/l

2.5.2.2.5 Health Risk-Based Concentration for Nickel

The reference dose (RFD) for nickel (Ni) is 0.02 mg per kg per day. The proposed MCL for Ni, which has been remanded, is 0.1 mg per liter. Therefore, there is no enforceable MCL for Ni at this time. The chronic effects of nickel ingestion following long-term exposures at concentrations above 0.1 mg per liter include heart and liver damage, dermatitis, and decreased body weight. Nickel is not considered to be a carcinogen when ingested.

The proposed MCL, 0.1 mg per liter, is also the proposed health risk-based concentration limit.

2.5.2.3 Human Health Risks Associated With Agricultural Use of Groundwater

The potential risks associated with agricultural use of groundwater at the health risk-based concentration limits calculated above were calculated assuming the applicable exposure pathways are ingestion of beef from cattle consuming the groundwater and forage irrigated with groundwater, ingestion of vegetables irrigated with groundwater, and direct ingestion of irrigated soil. As noted earlier, the milk ingestion pathway is not applicable for the area around the Facility.

2.5.2.3.1 Health Hazard Evaluation Due to Ingestion of Beef from Cattle Drinking Water and at Health Risk-Based Concentration

Beef cattle drink approximately 50 liters of water per day (NCRP, 1996). The daily intake of U-nat, Pb-210, Th-230, Ra-226 and Ra-228 by a cattle drinking groundwater at the above health risk-based concentrations would be as follows:

U-nat	171 pCi/l x 50 l/d = 8.6 E+03 pCi/day
Pb-210	13 pCi/l x 50 l/d = 6.5 E+02 pCi/day
Th-230	139 pCi/l x 50 l/d = 7.0 E03 pCi/d
Ra-226	44 pCi/l x 50 l/d = 2.2 E03 pCi/day
Ra-228	11 pCi/l x 50 l/d = 5.5 E+02 pCi/day

Using the environmental transfer coefficients from the Final Generic Environmental Impact Statement for Uranium Mills (NRC, 1980), the equilibrium concentration in beef would then be:

U-nat	(8.6 E03 pCi/d)(3.4E-04 pCi/kg/pCi/d) = 2.9 pCi/kg
Pb-210	(6.5 E02 pCi/d)(7.1E-04 pCi/kg/pCi/d) = 0.46 pCi/kg
Th-230	(7.0E+03 pCi/d)(2.00E-04 pCi/kg/pCi/d) = 1.4 pCi/kg
Ra-226	(2.2E+03 pCi/d)(5.1E-04 pCi/kg/pCi/d) = 1.1 pCi/kg
Ra-228	(5.5E+02 pCi/d)(5.1E-04 pCi/kg/pCi/d) = 0.28 pCi/kg

2.5.2.3.2 Annual Intake Due to Ingestion of Beef from Livestock Grazing on Pasture Grass Irrigated with Groundwater

Uptake by pasture grass irrigated with groundwater would be dependent on the soil concentration of radionuclides. If it assumed that the concentrations of radionuclides in soil are due only to irrigation with groundwater with elevated radionuclide concentrations, the equilibrium concentration in soil can be calculated using the following assumptions:

Irrigation (IR) is equivalent to 750 l per m^2 per year (NCRP, 1996)
Mass density of the plow layer (ρ) = 225 kg m^{-2} (NCRP, 1996)
Assumes the plow layer is 0.15 m and the soil density, 1.5 E03 kg m^{-3}
Removal half-time (leaching and harvesting) = 70 years
Effective decay constant (λ = 0.693/70 y = 9.9 E-03 y^{-1})
Exposure time (t) = 1 - 30 years

The radionuclide concentration in soil at time t would be as follows:

$$Cs = [(Cw)(IR)/\lambda\ \rho][1 - e^{-\lambda t}]$$

At the end of the first year of irrigation, the concentration in soil would be as follows:

$$Cs(1) = [(Cw)(750\ l/y\text{-}m^2)/(9.9\ E\text{-}03\ /y)(225\ kg/m^2)][1 - e^{-(9.9\ E\text{-}03/y)(1\ y)}]$$

$$Cs(1) = [(Cw)(3.37\ E2\ l\text{-}kg)][9.85\ E\text{-}03] = (Cw)(3.32\ l/kg)$$

The concentration at the end of each year for 30 years was calculated and the average value for the 30 year period determined.

$$\text{Mean } Cs = \Sigma Cs(t)/30$$

$$\text{Mean } Cs = (Cw)(45.0\ l/kg)$$

The mean estimated radionuclide concentrations in soil for the 30 year period were calculated for each of the nuclides as follows:

U-nat	(171 pCi/l)(45.0 l/kg) = 7695 pCi/kg
Pb-210	(13 pCi/l)(45.0 l/kg) = 585 pCi/kg
Th-230	(139 pCi/l)(45.0 l/kg) = 6255 pCi/kg
Ra-226	(44 pCi/l)(45.0 l/kg) = 1980 pCi/kg
Ra-228	(11 pCi/l)(45.0 l/kg) = 495 pCi/kg

The concentration ratios for soil to dry forage, specified in NCRP Report #123I, are as follows:

U	0.1
Pb	0.1
Th	0.1
Ra	0.2

Therefore, the radionuclide concentrations in dry forage would be as follows:

U-nat	(7695 pCi/kg)(0.1) = 770 pCi/kg dry forage
Pb-210	(585 pCi/kg)(0.1) = 59 pCi/kg dry forage
Th-230	(6255 pCi/kg)(0.1) = 626 pCi/kg dry forage
Ra-226	(1980 pCi/kg)(0.2) = 396 pCi/kg dry forage
Ra-228	(495 pCi/kg)(0.2) = 99 pCi/kg dry forage

Based on the NCRP Report #123I screening level value for consumption of dry forage by beef cattle, 12 kg/day (NCRP, 1996) the daily intake of U-nat, Pb-210, Th-230, Ra-226 and Ra-228 by the livestock would be as follows:

U-nat	(770 pCi/kg)(12 kg/d) = 9240 pCi/d
Pb-210	(59 pCi/kg)(12 kg/d) = 708 pCi/d
Th-230	(626 pCi/kg)(12 kg/d) = 7512 pCi/d
Ra-226	(396 pCi/kg)(12 kg/d) = 4752 pCi/d
Ra-228	(99 pCi/kg)(12 kg/d) = 1188 pCi/d

Using the environmental transfer coefficients from the NUREG-0706, the mean concentration in beef from ingestion of irrigated forage for the 30 year period would be as follows:

U-nat	(9240 pCi/d)(3.4 E-04 d/kg) = 3.1 pCi/kg
Pb-210	(708 pCi/d)(7.1 E-4 k/kg) = 0.50 pCi/kg
Th-230	(7512 pCi/d)(2.00 E-4 d/kg) = 1.5 pCi/kg
Ra-226	(4752 pCi/d)(5.1 E-4 d/kg) = 2.4 pCi/kg
Ra-228	(1188 pCi/d)(5.1 E-4 d/kg) = 0.61 pCi/kg

The total concentration of each radionuclide in beef is the sum of the concentration due to cattle consumption of groundwater and forage. These values are given in Table 2-11.

Table 2-11 Concentrations of Radionuclides in Beef

Nuclide	Daily Intake (pCi)			Transfer Coeff.	Conc. in Beef
	Water	Forage	Total	(d/kg)	(pCi/kg)
U-nat	8.6×10^{3}	9.2×10^{3}	1.7×10^{4}	3.4×10^{4}	6.0
Pb-210	6.5×10^{2}	7.1×10^{2}	1.4×10^{3}	7.1×10^{4}	0.96
Th-230	7.0×10^{3}	7.5×10^{3}	1.4×10^{4}	2.0×10^{4}	2.9
Ra-226	2.2×10^{3}	4.7×10^{3}	6.7×10^{3}	5.1×10^{4}	3.5
Ra-228	5.5×10^{2}	1.0×10^{3}	1.6×10^{3}	5.1×10^{4}	0.89

The average person consumes 78 kg of meat per year (NRC, 1980). Therefore, the annual intake by an individual from consumption of the meat would be:

U-nat	(78 kg/y)(6.0 pCi/kg)= 468 pCi/y
Pb-210	(78 kg/y)(0.96 pCi/kg) = 75 pCi/y
Th-230	(78 kg/d)(2.9 pCi/kg) = 226 pCi/y
Ra-226	(78 kg/y)(3.5 pCi/kg) = 273 pCi/y
Ra-228	(78 kg/y)(0.89 pCi/kg) = 69 pCi/y

The estimated annual intake of radionuclides from ingestion of vegetables irrigated with groundwater was calculated using the average soil concentrations estimated above and the concentration ratios given in NCRP Report #123I which are as follows:

U-nat	0.002
Pb-210	0.004
Th-230	0.001
Ra-226	0.04
Ra-228	0.04

The annual ingestion of locally grown vegetables was assumed to be 50 percent of the total annual ingestion of 100 kg, or 50 kg per year. The annual intake was calculated as follows:

Iveg = (Cs)(CR)(50 kg/y)

where: CR = concentration ratio
Cs = radionuclide concentration in soil

U-nat	(7695 pCi/kg)(0.002)(50kg/y) = 770 pCi/y
Pb-210	(585 pCi/kg)(0.004)(50 kg/y) = 117 pCi/y
Th-230	(6255 pCi/kg)(0.001)(50 kg/y) = 312 pCi/y
Ra-226	(1980 pCi/kg)(0.04)(50 kg/y) = 3960 pCi/y
Ra-228	(495 pCi/kg)(0.04)(50 kg/y) = 990 pCi/y

The total annual intakes of radionuclides from all food sources potentially impacted by groundwater are as follows:

Itot = Ibeef + Iveg

where:

Itot = total intake from food

Ibeef = intake from ingestion of beef

Iveg = intake from ingestion of locally grown vegetables

U-nat	468 pCi/y + 770 pCi/y = 1238 pCi/y
Pb-210	75 pCi/y + 117 pCi/y = 192 pCi/y
Th-230	226 pCi/y + 312 pCi/y = 538 pCi/y
Ra-226	273 pCi/y + 3960 pCi/y = 4233 pCi/y
Ra-228	69 pCi/y + 990 pCi/y = 1059 pCi/y

The risk coefficients for cancer mortality due to ingestion of radionuclides in food, given in FGR13 are as follows:

U-nat (+Th-234)	1.83 E-09 Bq^{-1}
Pb-210	2.31 E-08 Bq^{-1}
Th-230	2.16 E-09 Bq^{-1}
Ra-226	7.15 E-09 Bq^{-1}
Ra-228	2.74 E-08 Bq^{-1}

The lifetime risk from ingestion of radionuclides in food was calculated assuming a 30 year exposure duration as follows:

U-nat	(1238 pCi/y)(30 y)(0.037 Bq/pCi)(1.83 E-09/Bq) = 2.5E-06
Pb-210	(192 pCi/y)(30 y)(0.037 Bq/pCi)(2.31 E-08/Bq) = 4.9E-06
Th-230	(538 pCi/y)(30 y)(0.037 Bq/pCi)(2.16 E-09/Bq) = 1.3E-06
Ra-226	(4233 pCi/y)(30 y)(0.037 Bq/pCi)(7.15 E-09/Bq) = 3.4E-05
Ra-228	(1059 pci/y)(30 y)(0.037 Bq/pCi)(2.74 E-08/Bq) = 3.2E-05

Direct ingestion of soil can be an important exposure pathway in some instances. Using the soil concentrations calculated above and assuming a daily soil ingestion rate of 0.1 g per day or 37 g per year, the total annual intake of radionuclides in soil would be as follows:

U-nat	(7.7 pCi/g)(37 g/y) = 284 pCi/y
Pb-210	(0.58 pCi/g)(37 g/y) = 21 pCi/y
Th-230	(6.3 pCi/g)(37 g/y) = 245 pCi/y
Ra-226	(2.0 pCi/g)(37 g/y) = 74 pCi/y
Ra-228	(0.50 pCi/g)(37 g/y) = 19 pCi/y

These annual intakes are small compared to the intakes from beef and vegetables. In addition, the risk factors for ingestion of soil are not given in FGR13 (EPA, 1998a). Due to the fact that the radionuclides in soil would be likely to be absorbed in the body to a lesser degree than radionuclides in food and water, the risks from soil ingestion are likely to be negligible relative to the risks from food and water ingestion. Therefore, the risks of soil ingestion were not calculated.

As demonstrated above, the lifetime risks from ingestion of beef from livestock drinking water at above health risk-based concentration and grazing pasture irrigated with groundwater at health risk-based concentrations, and consumption of vegetables from gardens irrigated with groundwater at health risk-based concentrations are small and would not affect the health-risk based concentrations calculated based on ingestion of groundwater.

2.5.2.3.3 Effects of Health Risk-Based Concentrations in Groundwater on Livestock and the Environment

No significant environmental and agricultural impacts can be postulated due to groundwater with concentrations at the levels proposed in this report. The impacted aquifers do not discharge to surface water sources in the vicinity of the Facility. In any case, the health risk-based concentrations adequate to protect human health also insure that the health of livestock and indigenous wildlife is sufficiently protected.

There are no physical structures in the vicinity of the Facility, which would be adversely affected by proposed levels of radionuclides in groundwater.

2.5.2.4 Risk Assessment for Current Groundwater Concentrations at Proposed POE Locations

The lifetime risk from usage of groundwater at above health risk-based concentrations would be limited to 1E-04 for each hazardous constituent. However, the current groundwater concentrations at the POE wells at the QMCs Facility in all three uppermost bedrock units are near the background level, well below the proposed health risk-based concentration. Therefore, the health risks from ingestion of these radionuclides in groundwater at the potential POE in all three bedrock units will be significantly less than the 1.0E-04 risk at the proposed health risk-based concentrations.

Using the FGR13 risk coefficient, the current measured groundwater concentrations in POE wells at the Facility, combined average intake rate of 1.11 l/d for tap water specified in FGR13, and an average exposure period of 30 years, the potential lifetime risks from consumption groundwater for each radionuclide in each of the uppermost bedrock units are calculated as follows:

- First, the total lifetime intake, I, in Bq is calculated based the 1.11 liters per day lifetime combined average intake of tap water specified in FGR13 (EPA, 1998a) and the current concentration of radionuclide in groundwater at POE well.

  $I = (Cw)(0.037\ Bq/pCi)(Iw)(EF)(ED)$

  where:

  I = radionuclide intake
  Cw = radionuclide concentration in water
  Iw = daily water intake = 1.11 liters per day (EPA, 1998a)
  EF = exposure frequency = 350 days per year (EPA, 1998b)
  ED = exposure duration = 30 years (EPA, 1998b)

- Then, the lifetime risk is calculated using the FGR13 risk coefficient (r), for unit (Bq) of radionuclide ingested in tap water.

  $R = (I)(r)$

  where:
  R = lifetime risk
  r = mortality risk coefficient

Dakota Bedrock Unit

The risks for ingestion of U-nat, Th-230, Ra-226 and Pb-210 at current concentrations (first quarter 1999) measured at the potential POE well 36-04KD and the background well 17-01KD are in the following Table 2-12:

Table 2-12 Health Risk Calculation for Dakota Sandstone Unit

Constituent	Lifetime Mortality Risk Coefficient per bq. Ingested in Tap water	Groundwater Concentration @ POE Well pCi/l	Lifetime Mortality Risk @ POE Concentrations	Groundwater Concentration @ BKG Well pCi/l	Lifetime Mortality Risk @ BKG Concentrations	Incremental Lifetime Mortality Risk
U-nat	1.36E-09	35.20	2.1E-05	6.09	3.6E-06	1.7E-05
Pb-210	1.75E-08	9.10	6.9E-05	16.00	1.2E-04	<1.0E-06
Th-230	1.67E-09	1.20	8.6E-07	0.88	6.3E-07	2.3E-07
Ra-226	5.32E-09	2.33	5.3E-06	3.20	7.3E-06	<1.0E-06
Ra-228	2.00E-08	6.20	5.3E-05	3.80	3.3E-05	2.1E-05

Tres Hermanos A Bedrock Unit

Because there is no monitoring well at the proposed potential POE location in the TRA, the risks for ingestion of U-nat, Th-230, Ra-226 and Pb-210 were calculated using the March 1999 groundwater concentrations in POC well 30-01tra. Concentrations from background well 33-01tra were used for the background risk calculations. The risk calculation is summarized in the following Table 2-13:

Table 2-13 Health Risk Calculation for Tres Hermanos A Sandstone Unit

Constituent	Lifetime Mortality Risk Coefficient per bq. Ingested in Tap water	Groundwater Concentration @ POE Well pCi/l	Lifetime Mortality Risk @ POE Concentrations	Groundwater Concentration @ BKG Well pCi/l	Lifetime Mortality Risk @ BKG Concentrations	Incremental Lifetime Mortality Risk
U-nat	1.36E-09	2.71	1.6E-06	39.27	2.3E-05	<1.0E-06
Pb-210	1.75E-08	3.80	2.9E-05	9.60	7.2E-05	<1.0E-06
Th-230	1.67E-09	0.41	3.0E-07	2.70	1.9E-06	<1.0E-06
Ra-226	5.32E-09	1.14	2.6E-06	3.37	7.7E-06	<1.0E-06
Ra-228	2.00E-08	4.30	3.7E-05	1.70	1.5E-05	2.2E-05

Tres Hermanos B Bedrock Unit

As with the TRA, there is no monitoring well at the proposed potential POE location in the TRB. The risks for ingestion of U-nat, Th-230, Ra-226 and Pb-210 in tap water were calculated using the groundwater concentrations in the POC 36-01tba. The December 1998 sampling results were used because the well did not have sufficient water to sample in first quarter of 1999. March 1999 concentrations from background well 19-77trb were used for the background risk calculations. The risk calculation is summarized in the following Table 2-14:

Table 2-14 Health Risk Calculation for Tres Hermanos B Sandstone Unit

Constituent	Lifetime Mortality Risk Coefficient per bq. Ingested in Tap water	Groundwater Concentration @ POE Well pCi/l	Lifetime Mortality Risk @ POE Concentrations	Groundwater Concentration @ BKG Well pCi/l	Lifetime Mortality Risk @ BKG Concentrations	Incremental Lifetime Mortality Risk
U-nat	1.36E-09	1.83	1.1E-06	18.28	1.1E-05	<1.0E-06
Pb-210	1.75E-08	9.90	7.5E-05	9.60	7.2E-05	2.3E-06
Th-230	1.67E-09	7.70	5.5E-06	0.82	5.9E-07	5.0E-06
Ra-226	5.32E-09	3.22	7.4E-06	2.69	6.2E-06	1.2E-06
Ra-228	2.00E-08	1.41	1.2E-05	3.20	2.8E-05	<1.0E-06

As demonstrated above, the risks from potential consumption of groundwater at current concentrations are negligible. The groundwater concentrations in the Facility will continue to decline, presenting even lower potential health risk. These risk calculations assume the unlikely scenario that an individual moves on to the Facility immediately and obtains tap water from the uppermost bedrock units for thirty years. The health risks for ingestion of radionuclides for TRA and TRB Units were calculated based on domestic use of un-attenuated groundwater as tap water at POC well concentrations. This calculation overestimates the potential risks. Since the POE groundwater concentrations are near the background levels, the incremental risk from the Facility would be truly negligible. Therefore, the radiological risks associated with the potential POE for the Ambrosia Lake Facility are acceptable, since domestic use of groundwater near the potential POE is highly unlikely.

2.6 Hazard Assessment Summary

Ore milling operations at the QMC Ambrosia Lake facility and placement of mill tailings ceased in January 1985. The mill tailings reclamation activities were implemented in 1987 and tailings reclamation is scheduled for completion in 2000. Cessation of milling operations and implementation of a groundwater corrective action program have resulted in rapidly declining contaminant levels. Corrective action activities have included dewatering trenches and groundwater pumping through the mine dewatering program.

U-nat, Pb-210, Th-230, Ra-226 and -228, and nickel have been identified at the Facility as hazardous constituents which exceed GPSs. Groundwater at the Facility and in the vicinity meets the NMED groundwater standards for these constituents, except for combined Ra-226 and -228 at Dakota well 36-06KD and one anomalous result for Ra-226 and -228 at well 32-51KD. Health risk-based concentration exposure limits are proposed based upon human health criteria at present and foreseeable future POE. Human health risk-based concentration limits for these constituents are more restrictive than concentrations which would be of concern for the area for wildlife, irrigation, etc., and will therefore be protective of the environment.

The proposed health risk-based concentrations for U-nat, Pb-210, Th-230, Ra-226 and -228, and nickel in groundwater at the POE are summarized in the following Table 2-15:

Table 2-15 Proposed Health Risk-Based Concentrations

Constituent	QMC's Proposed Health Risk-Based POE Concentration Limit
U-nat	171 pCi/l (0.25 mg/l)
Pb-210	13 pCi/l
Th-230	139 pCi/l
Ra-226 and –228	41 pCi/l
Nickel	0.1 mg/l

These proposed health risk-based concentrations are based on the acceptable risk of 1.0E-04. This risk level is appropriate for use in determining Alternate Concentration Limit (ACL) for the Facility for the following reasons:

- The health risk-based concentration used to set the ACLs is not intended to be a drinking water standard for the general public. Rather it is a site-specific value which can be shown to present no substantial health risk. Drinking water standards for the general public are derived assuming that a large, diverse population will be ingesting the water. The health risk-based concentrations used to derive the ACLs is site-specific and take into account the very low probability of exposure, the limited population potentially exposed, and reasonable estimates of health risk. The probability that any individual would use the water in the uppermost bedrock aquifer units near the potential POE within the next 30 years is very low. Therefore, the probability of exposure is very small.

- The ACLs proposed for U-nat, Pb-210, Th-230, Ra-226 and -228 at the POC would result in concentrations at the POE no greater than the health risk-based concentrations, and in an estimated lifetime risk of cancer mortality due to ingestion of groundwater of no greater than 1.0E-04. According to published guidance, the ACL must be limited such that the concentration at the point of exposure presents no substantial health risk.

Although groundwater from the uppermost bedrock units in the vicinity of the tailings impoundment is not currently being used for industrial, municipal, domestic or livestock watering purposes, potential POEs have been established based on the occurrence of sufficient groundwater to support use and the boundary of the area that will be subject to institutional control after the Facility license is terminated. However, as discussed in Section 2.5.1, the future domestic use of groundwater from the Tres Hermanos Sandstones or the Dakota Sandstone in the vicinity of the Facility is extremely unlikely.

The nearest potential POE in the Dakota unit is in the vicinity of monitoring well 36-04KD in Section 36, located approximately 330 yards north of well 36-06KD and the current restricted area boundary. The highest concentrations of hazardous constituents in the Dakota were observed at POC well 36-06KD located adjacent to pond #8. Nevertheless, the Dakota unit between wells 36-06KD and 36-04KD was historically only partially saturated. Water levels have declined in this area since reclamation of nearby ponds #7 and #8. Over the long term saturated conditions would be expected to occur in the Dakota unit only in locations north (downgradient) of well 36-04KD. Therefore, well 36-04KD is considered to be the nearest location where groundwater supply could be obtained the Dakota. Although the State of New Mexico owns Section 36, QMC will seek to include the portion of this Section between 36-06KD and 36-04KD within the land area subject to long term institutional control as other POC wells also exist within this area. Potential POE locations have not been established down gradient of the other Dakota POC wells, 30-48KD, 30-02KD and 32-45KD, because the Dakota is dewatered downgradient of the area to be transferred for long term institutional control due to drainage to the Westwater Canyon member units of the Morrison Formation through numerous vent holes and shafts. Furthermore, the groundwater concentrations in these Dakota POC wells are below the proposed health risk-based concentration.

The nearest potential POE in the TRB is established near the section corner of Sections 36 and 25 of T14N, R10W and Sections 30 and 31 of T14N, R9W. However, due to lack of a monitoring well in this area, groundwater concentrations in the nearby TRB POC well 36-01trb were used for hazard assessment. Assumption of the POC well groundwater concentrations for hazard assessment for point of exposure provides an additional margin of safety and conservatism in the hazard assessment. POC well 36-01trb is located downgradient of TRB POC well 36-02trb. Potential POE locations have not been not established down gradient of the other TRB POC wells, 31-66 and 31-67, because the TRB is dewatered downgradient of the area to transferred for long term institutional control due to drainage to the Westwater Canyon member units of the Morrison Formation through numerous vent holes and shafts.

There is only one POC well, 31-01tra, established for the TRA at the Facility. This well is located north of the tailings impoundment in Section 31. The nearest potential POE location downgradient of this well is at the edge of the land to be transferred for long term institutional control. Currently, the TRA is dewatered downgradient of the area to transferred for long term institutional control due to drainage to the Westwater Canyon member units of the Morrison Formation through numerous vent holes and shafts de-hydrated from the mine dewatering program. Resaturation of the TRA is not expected for hundreds of years because of the extremely slow rate groundwater recovery in the deeper units following cessation of mine water pumping. For the purpose of health hazard assessment, un-attenuated groundwater concentrations at the POC well in the TRA is used, which provides a conservative approach for establishing ACLs.

Figure 2-1

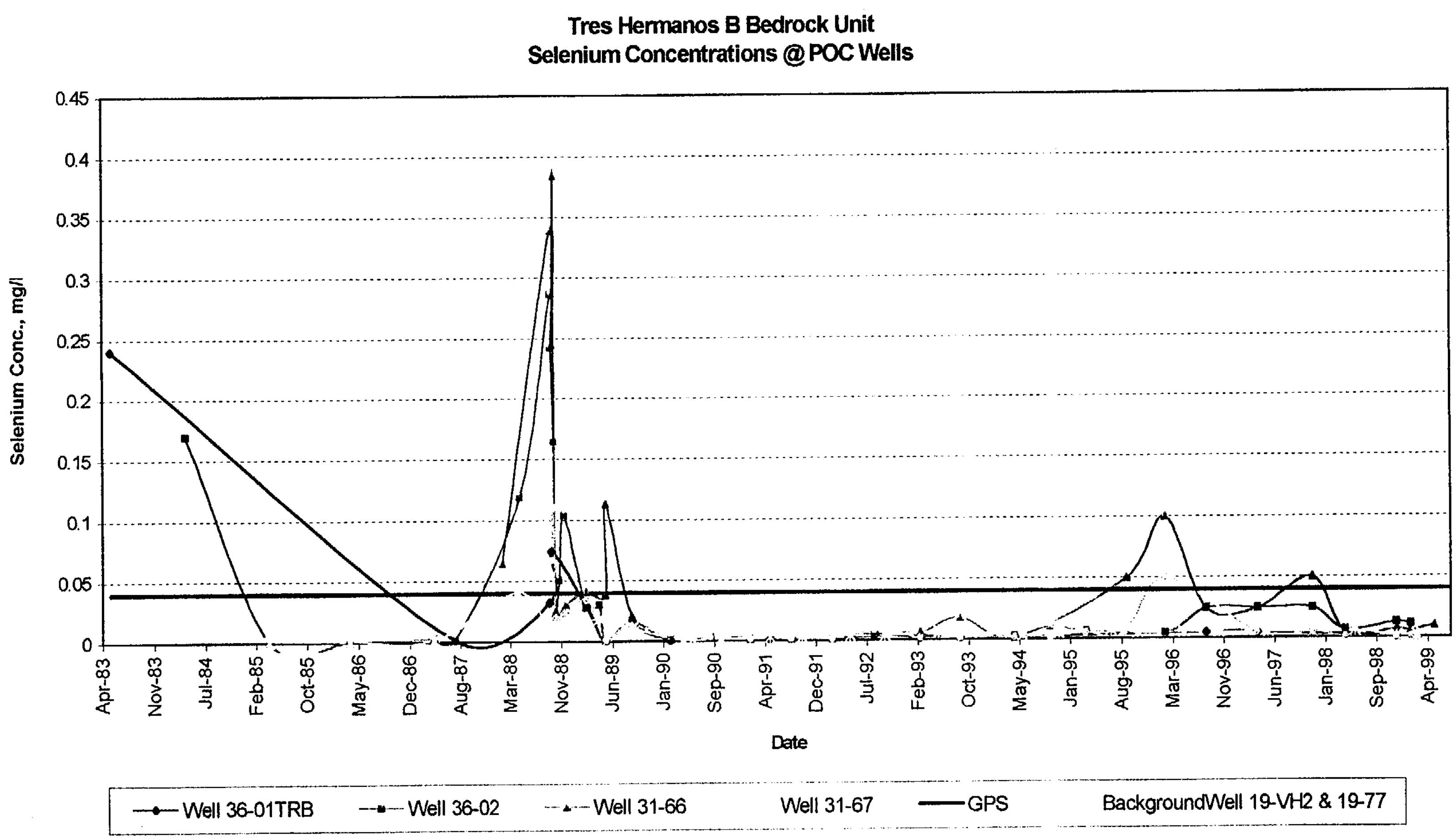

Tres Hermanos B Bedrock Unit
Selenium Concentrations @ POC Wells
Selenium Conc., mg/l
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Apr-83
Nov-83
Jul-84
Feb-85
Oct-85
May-86
Dec-86
Aug-87
Mar-88
Nov-88
Jun-89
Jan-90
Sep-90
Apr-91
Dec-91
Jul-92
Feb-93
Oct-93
May-94
Jan-95
Aug-95
Mar-96
Nov-96
Jun-97
Jan-98
Sep-98
Apr-99
Date
Well 36-01TRB
Well 36-02
Well 31-66
Well 31-67
GPS
BackgroundWell 19-VH2 & 19-77

Figure 2-2

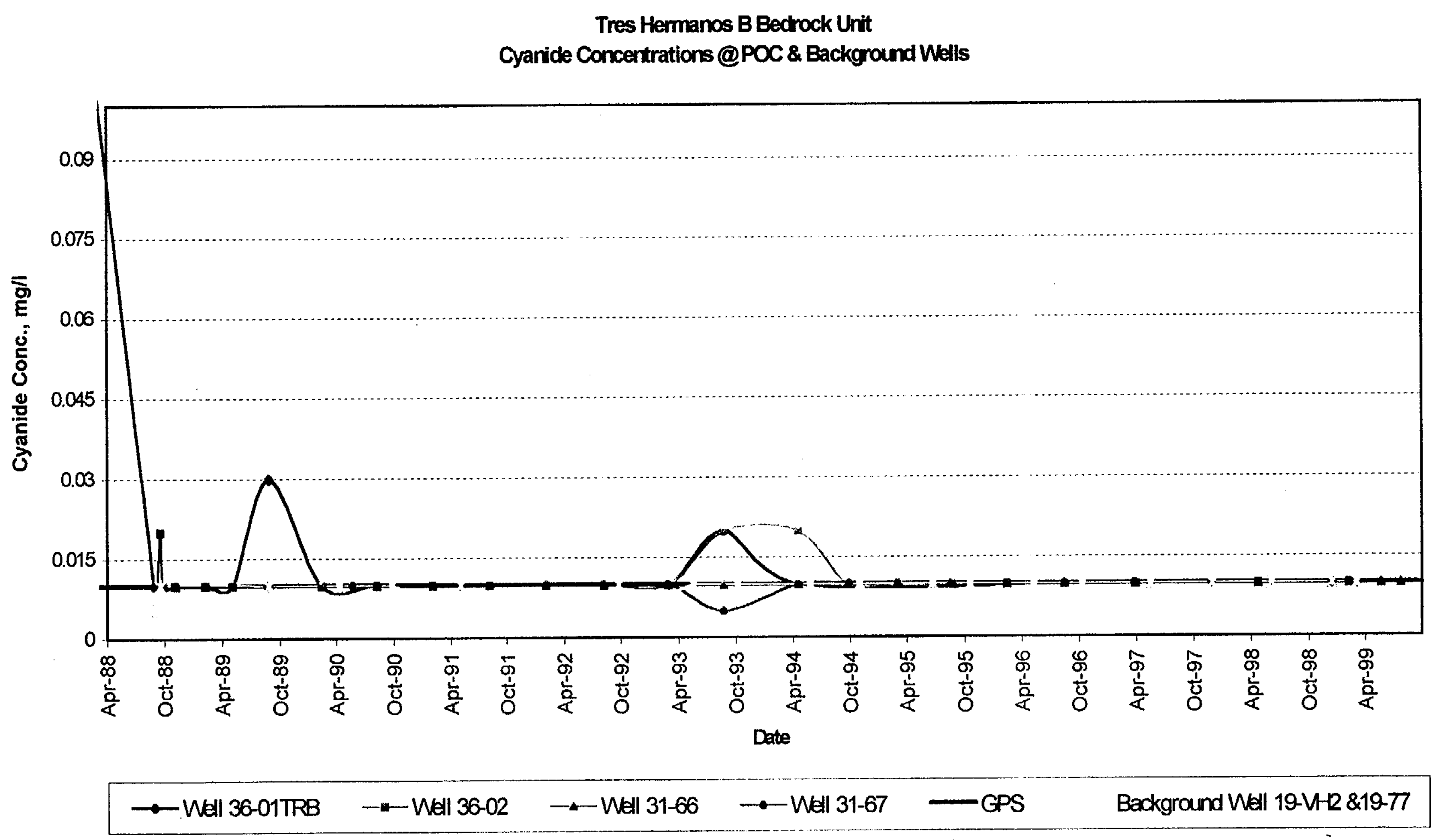

Tres Hermanos B Bedrock Unit
Cyanide Concentrations @ POC & Background Wells
Cyanide Conc., mg/l
0.09
0.075
0.06
0.045
0.03
0.015
0
Apr-88
Oct-88
Apr-89
Oct-89
Apr-90
Oct-90
Apr-91
Oct-91
Apr-92
Oct-92
Apr-93
Oct-93
Apr-94
Oct-94
Apr-95
Oct-95
Apr-96
Oct-96
Apr-97
Oct-97
Apr-98
Oct-98
Apr-99
Date
Well 36-01TRB
Well 36-02
Well 31-66
Well 31-67
GPS
Background Well 19-VH2 &19-77

Figure 2-3

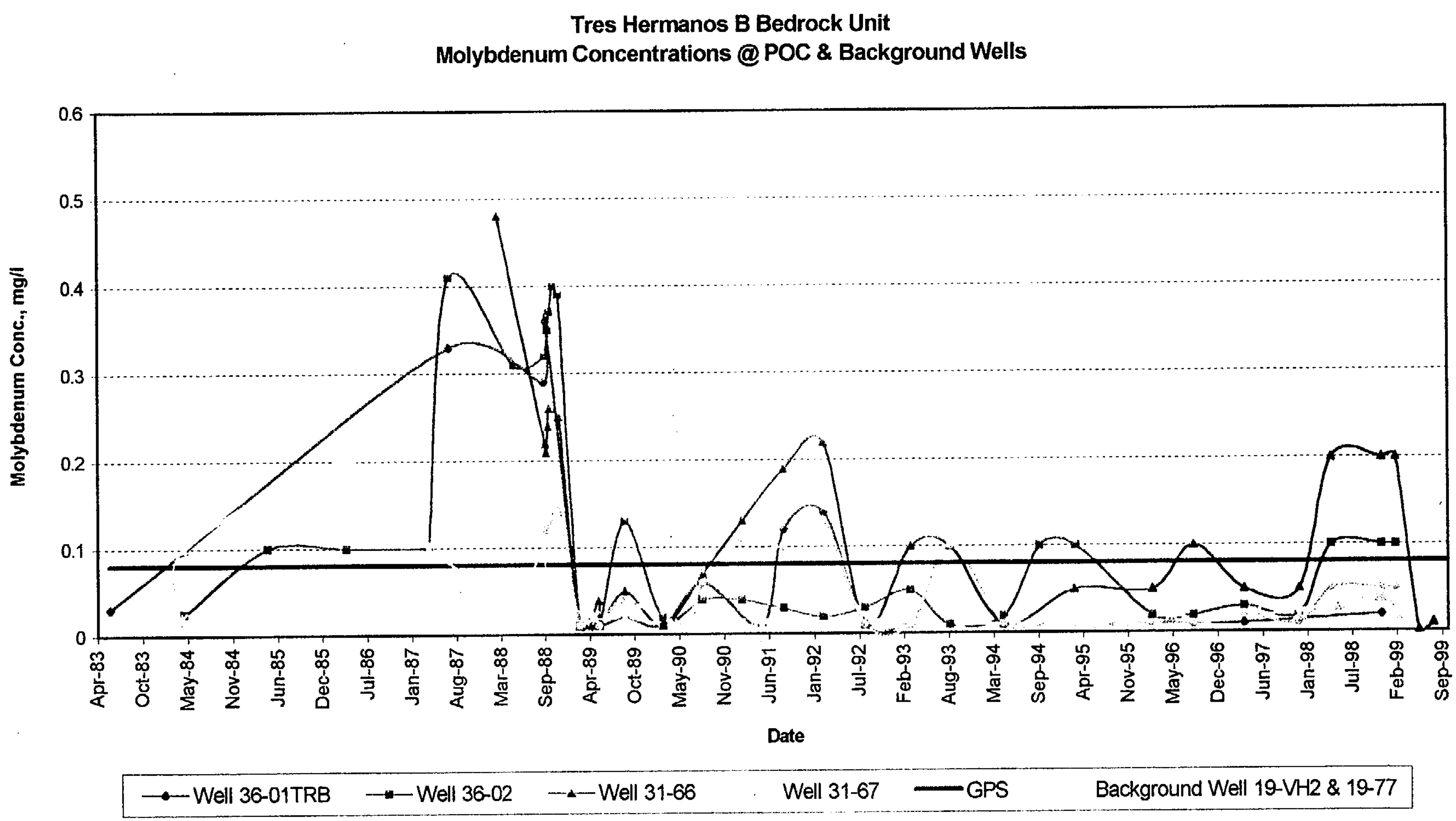

Tres Hermanos B Bedrock Unit
Molybdenum Concentrations @ POC & Background Wells
Molybdenum Conc., mg/l
0.6
0.5
0.4
0.3
0.2
0.1
0
Apr-83
Oct-83
May-84
Nov-84
Jun-85
Dec-85
Jul-86
Jan-87
Aug-87
Mar-88
Sep-88
Apr-89
Oct-89
May-90
Nov-90
Jun-91
Jan-92
Jul-92
Feb-93
Aug-93
Mar-94
Sep-94
Apr-95
Nov-95
May-96
Dec-96
Jun-97
Jan-98
Jul-98
Feb-99
Sep-99
Date
Well 36-01TRB
Well 36-02
Well 31-66
Well 31-67
GPS
Background Well 19-VH2 & 19-77

Figure 2-4

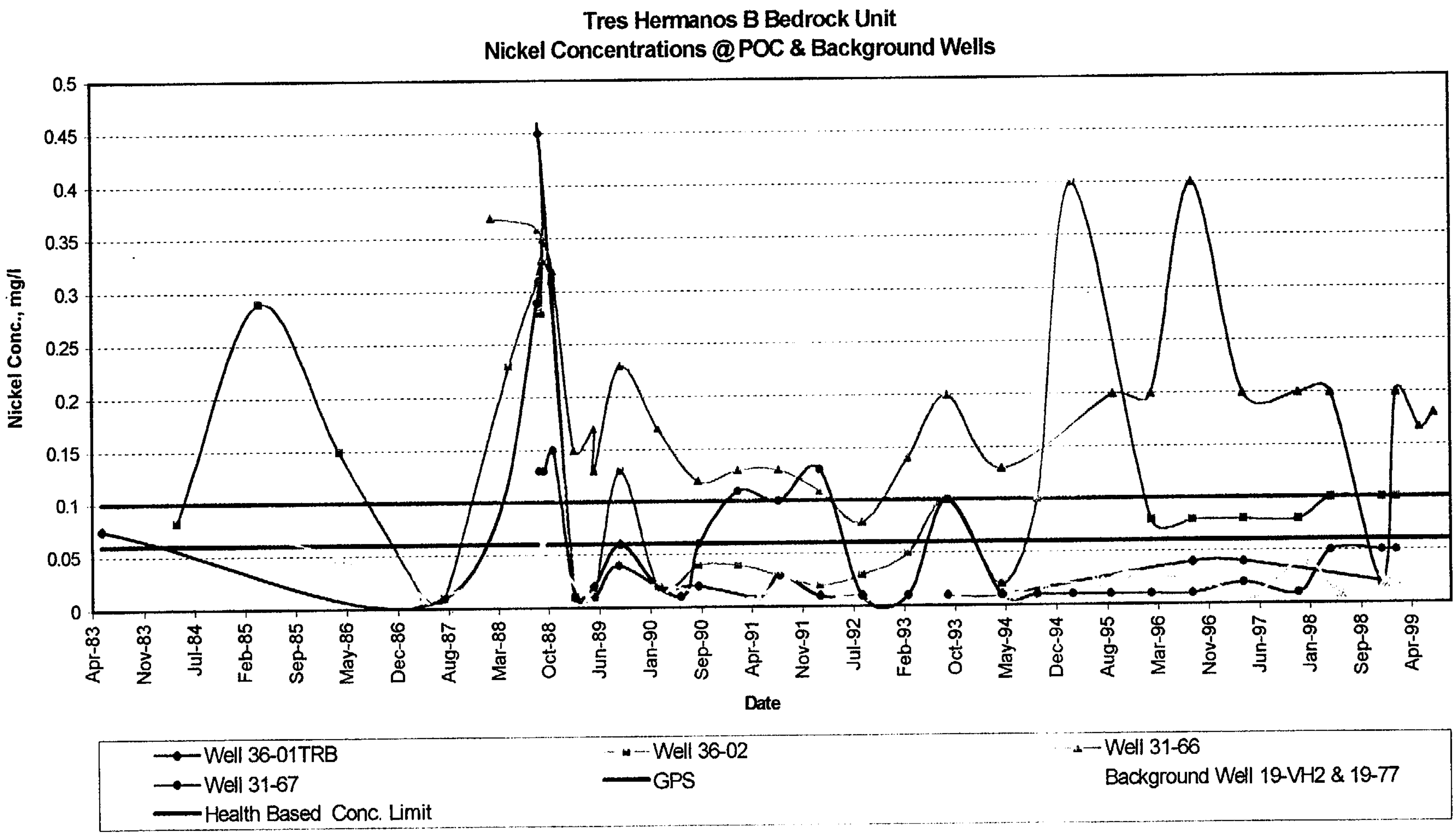

Tres Hermanos B Bedrock Unit
Nickel Concentrations @ POC & Background Wells
Nickel Conc., mg/l
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Apr-83
Nov-83
Jul-84
Feb-85
Sep-85
May-86
Dec-86
Aug-87
Mar-88
Oct-88
Jun-89
Jan-90
Sep-90
Apr-91
Nov-91
Jul-92
Feb-93
Oct-93
May-94
Dec-94
Aug-95
Mar-96
Nov-96
Jun-97
Jan-98
Sep-98
Apr-99
Date
Well 36-01TRB
Well 36-02
Well 31-66
Well 31-67
GPS
Background Well 19-VH2 & 19-77
Health Based Conc. Limit

Figure 2-5

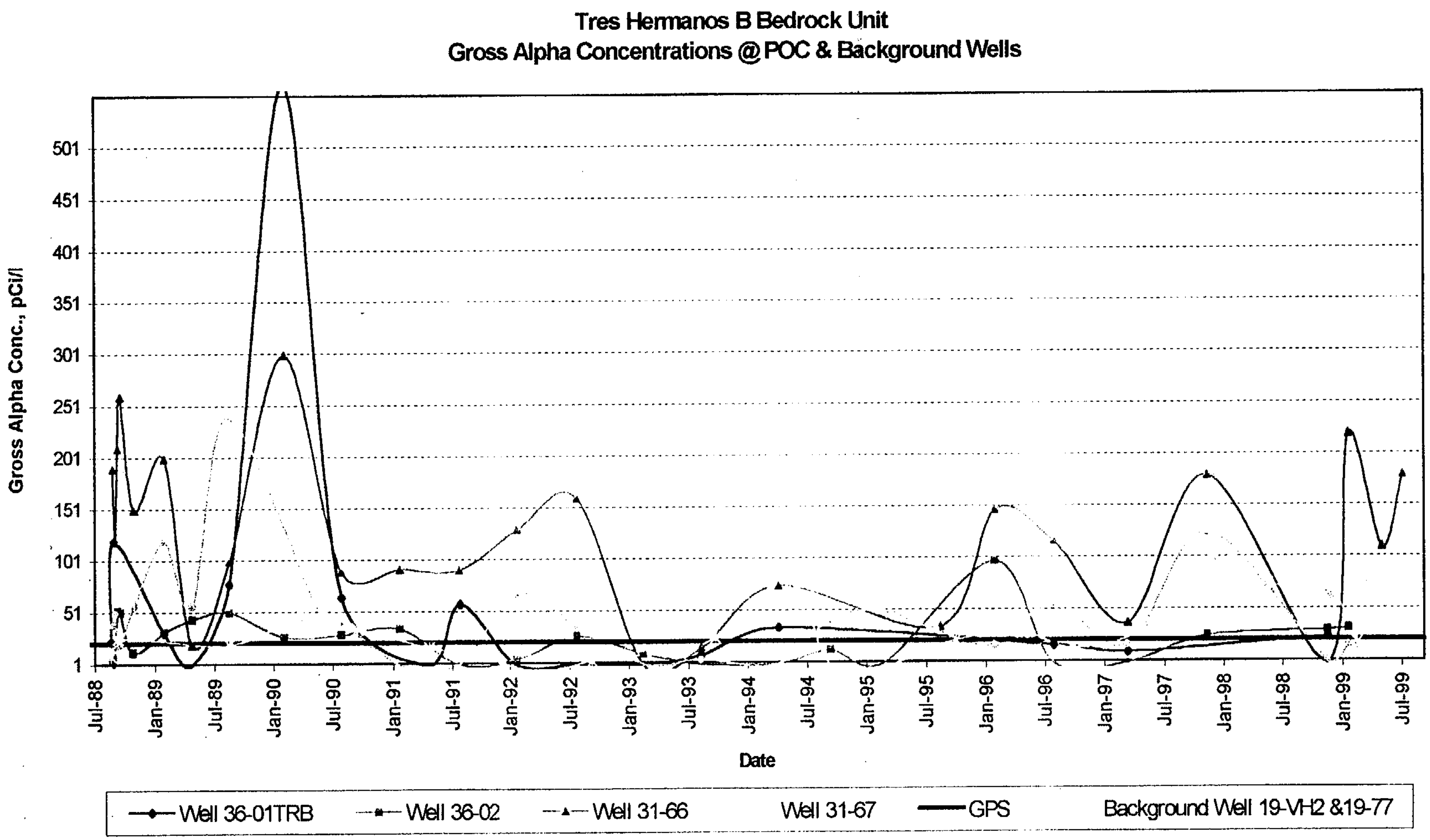

Tres Hermanos B Bedrock Unit
Gross Alpha Concentrations @ POC & Background Wells
Gross Alpha Conc., pCi/l
501
451
401
351
301
251
201
151
101
51
1
Jul-88
Jan-89
Jul-89
Jan-90
Jul-90
Jan-91
Jul-91
Jan-92
Jul-92
Jan-93
Jul-93
Jan-94
Jul-94
Jan-95
Jul-95
Jan-96
Jul-96
Jan-97
Jul-97
Jan-98
Jul-98
Jan-99
Jul-99
Date
Well 36-01TRB
Well 36-02
Well 31-66
Well 31-67
GPS
Background Well 19-VH2 &19-77

Figure 2-6

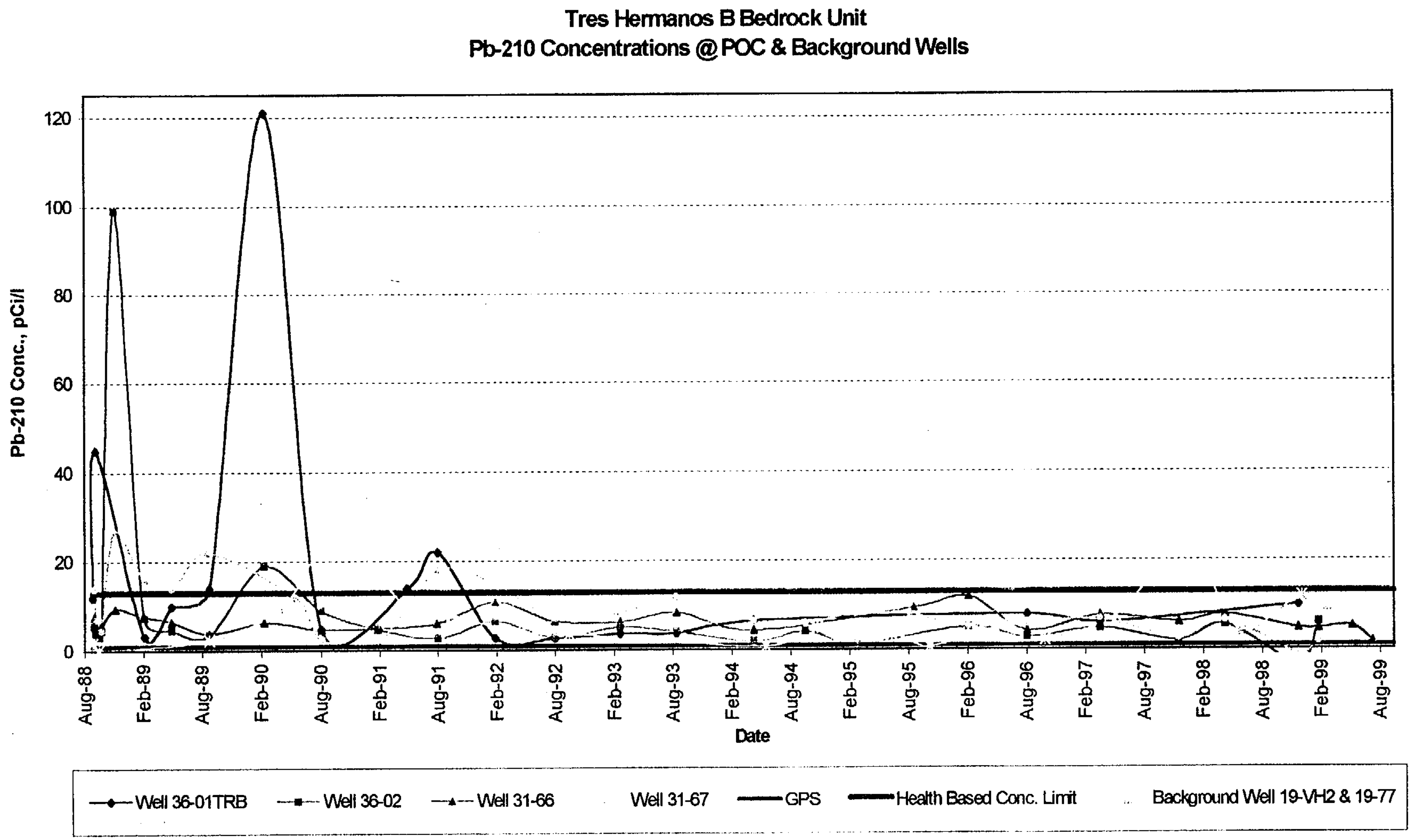

Tres Hermanos B Bedrock Unit
Pb-210 Concentrations @ POC & Background Wells
Pb-210 Conc., pCi/l
120
100
80
60
40
20
0
Aug-88
Feb-89
Aug-89
Feb-90
Aug-90
Feb-91
Aug-91
Feb-92
Aug-92
Feb-93
Aug-93
Feb-94
Aug-94
Feb-95
Aug-95
Feb-96
Aug-96
Feb-97
Aug-97
Feb-98
Aug-98
Feb-99
Aug-99
Date
Well 36-01TRB
Well 36-02
Well 31-66
Well 31-67
GPS
Health Based Conc. Limit
Background Well 19-VH2 & 19-77

Figure 2-7

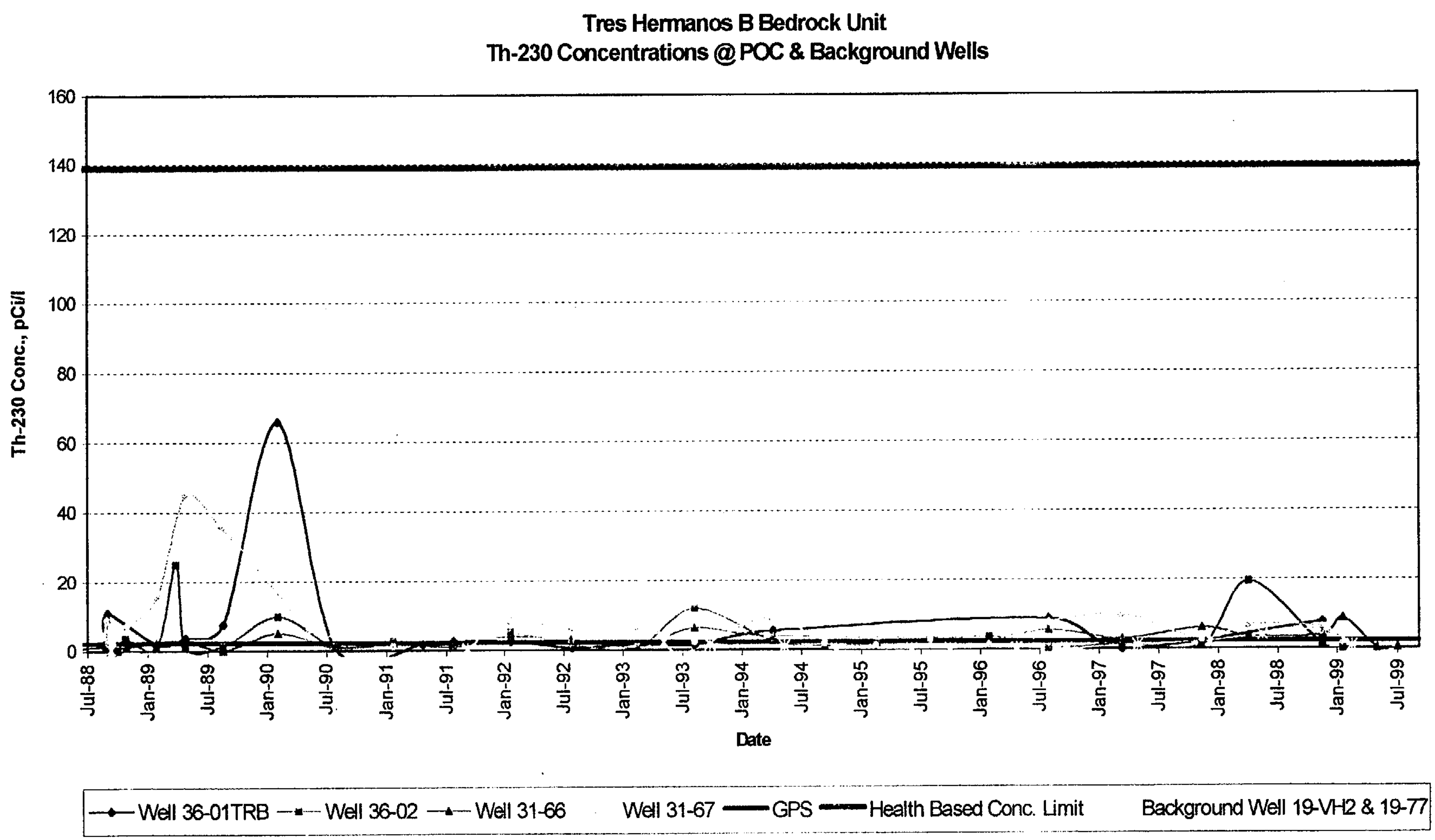

Tres Hermanos B Bedrock Unit
Th-230 Concentrations @ POC & Background Wells
Th-230 Conc., pCi/l
160
140
120
100
80
60
40
20
0
Jul-88
Jan-89
Jul-89
Jan-90
Jul-90
Jan-91
Jul-91
Jan-92
Jul-92
Jan-93
Jul-93
Jan-94
Jul-94
Jan-95
Jul-95
Jan-96
Jul-96
Jan-97
Jul-97
Jan-98
Jul-98
Jan-99
Jul-99
Date
Well 36-01TRB
Well 36-02
Well 31-66
Well 31-67
GPS
Health Based Conc. Limit
Background Well 19-VH2 & 19-77

Figure 2-8

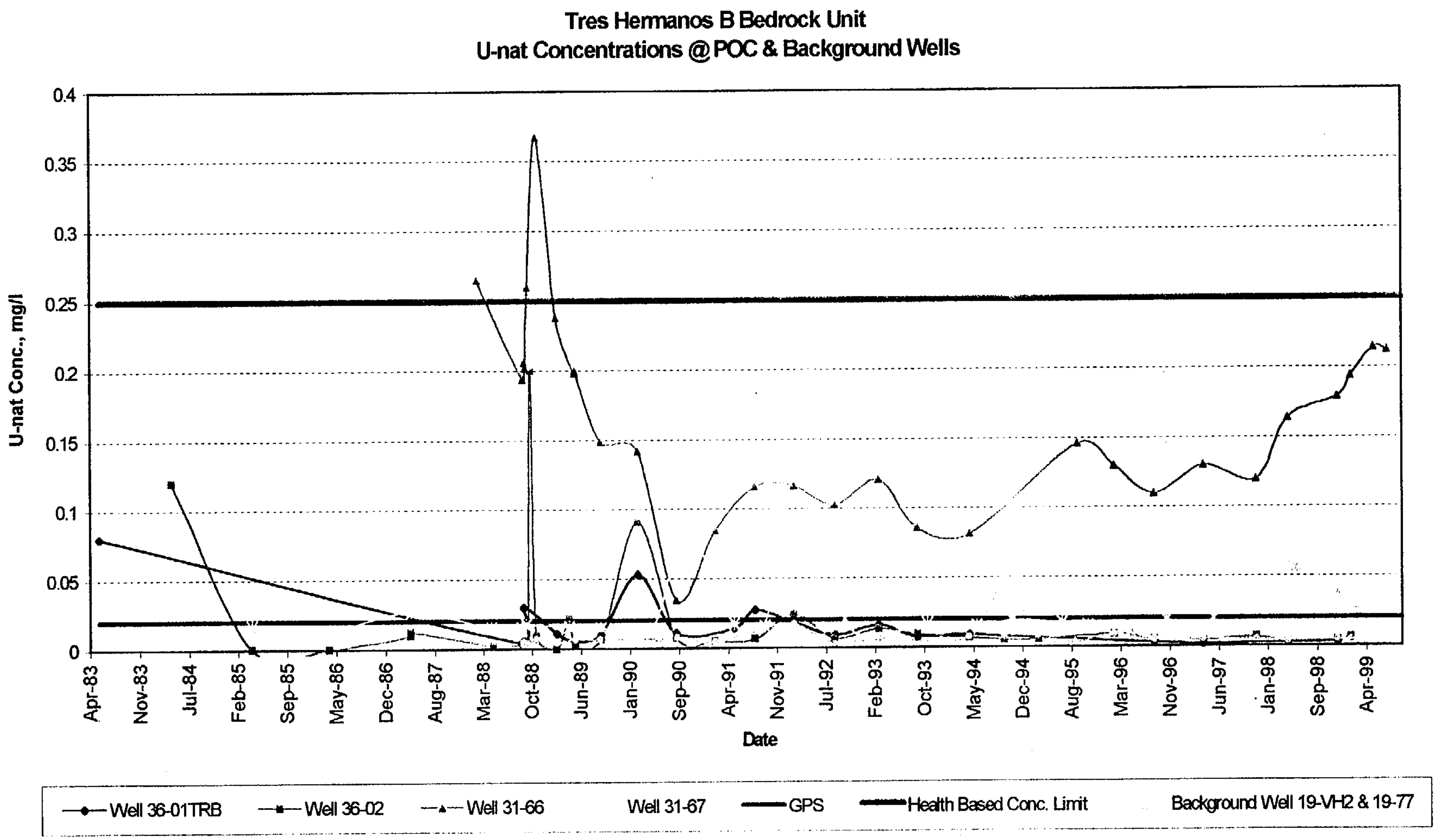

Tres Hermanos B Bedrock Unit
U-nat Concentrations @ POC & Background Wells
U-nat Conc., mg/l
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Apr-83
Nov-83
Jul-84
Feb-85
Sep-85
May-86
Dec-86
Aug-87
Mar-88
Oct-88
Jun-89
Jan-90
Sep-90
Apr-91
Nov-91
Jul-92
Feb-93
Oct-93
May-94
Dec-94
Aug-95
Mar-96
Nov-96
Jun-97
Jan-98
Sep-98
Apr-99
Date
Well 36-01TRB
Well 36-02
Well 31-66
Well 31-67
GPS
Health Based Conc. Limit
Background Well 19-VH2 & 19-77

Figure 2-9

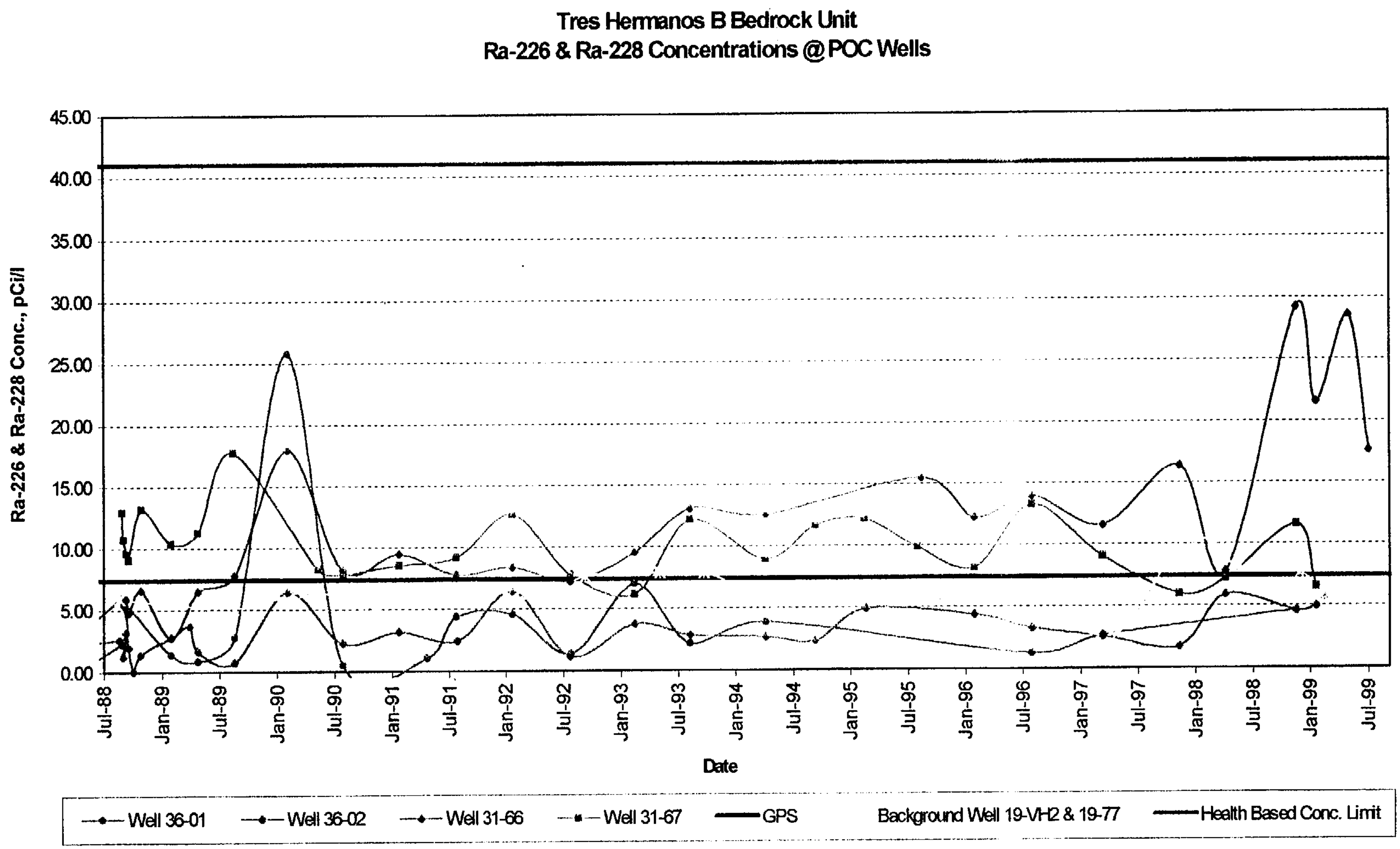

Tres Hermanos B Bedrock Unit
Ra-226 & Ra-228 Concentrations @ POC Wells
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Ra-226 & Ra-228 Conc., pCi/l
Jul-88
Jan-89
Jul-89
Jan-90
Jul-90
Jan-91
Jul-91
Jan-92
Jul-92
Jan-93
Jul-93
Jan-94
Jul-94
Jan-95
Jul-95
Jan-96
Jul-96
Jan-97
Jul-97
Jan-98
Jul-98
Jan-99
Jul-99
Date
Well 36-01
Well 36-02
Well 31-66
Well 31-67
GPS
Background Well 19-VH2 & 19-77
Health Based Conc. Limit

Figure 2-10

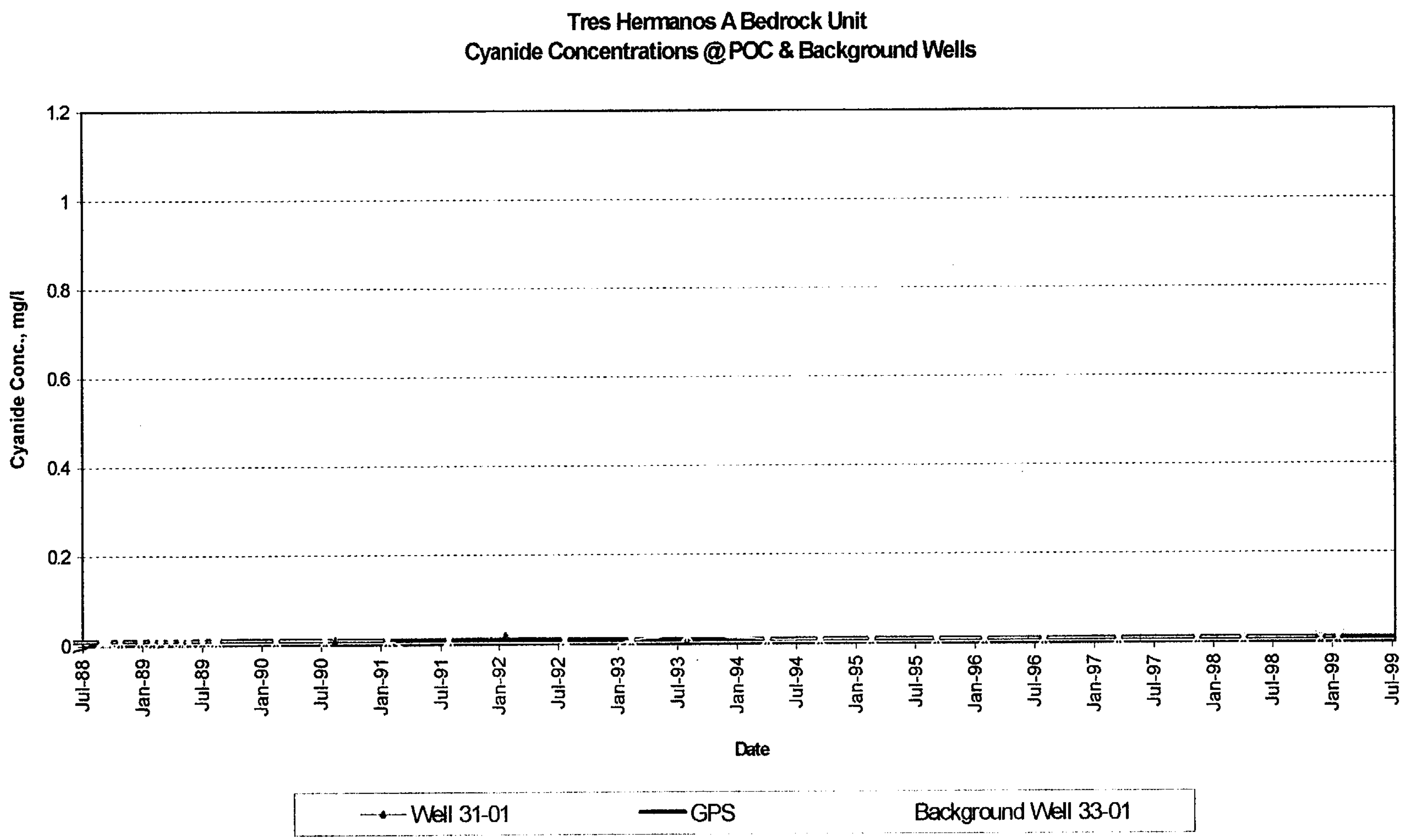

Tres Hermanos A Bedrock Unit
Cyanide Concentrations @ POC & Background Wells
Cyanide Conc., mg/l
1.2
1
0.8
0.6
0.4
0.2
0
Jul-88
Jan-89
Jul-89
Jan-90
Jul-90
Jan-91
Jul-91
Jan-92
Jul-92
Jan-93
Jul-93
Jan-94
Jul-94
Jan-95
Jul-95
Jan-96
Jul-96
Jan-97
Jul-97
Jan-98
Jul-98
Jan-99
Jul-99
Date
Well 31-01
GPS
Background Well 33-01

Figure 2-11

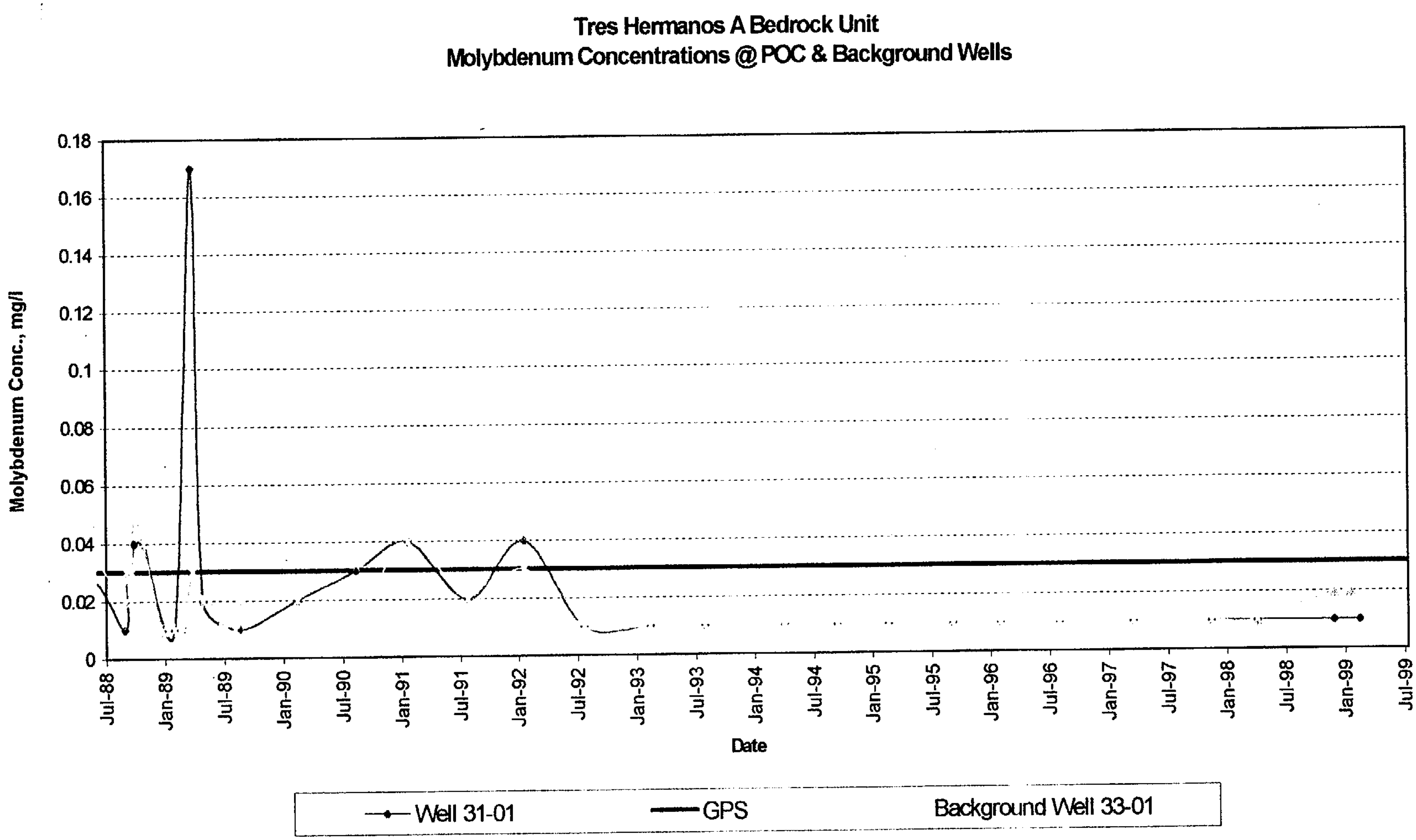

Tres Hermanos A Bedrock Unit
Molybdenum Concentrations @ POC & Background Wells
Molybdenum Conc., mg/l
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Jul-88
Jan-89
Jul-89
Jan-90
Jul-90
Jan-91
Jul-91
Jan-92
Jul-92
Jan-93
Jul-93
Jan-94
Jul-94
Jan-95
Jul-95
Jan-96
Jul-96
Jan-97
Jul-97
Jan-98
Jul-98
Jan-99
Jul-99
Date
Well 31-01
GPS
Background Well 33-01

Figure 2-12

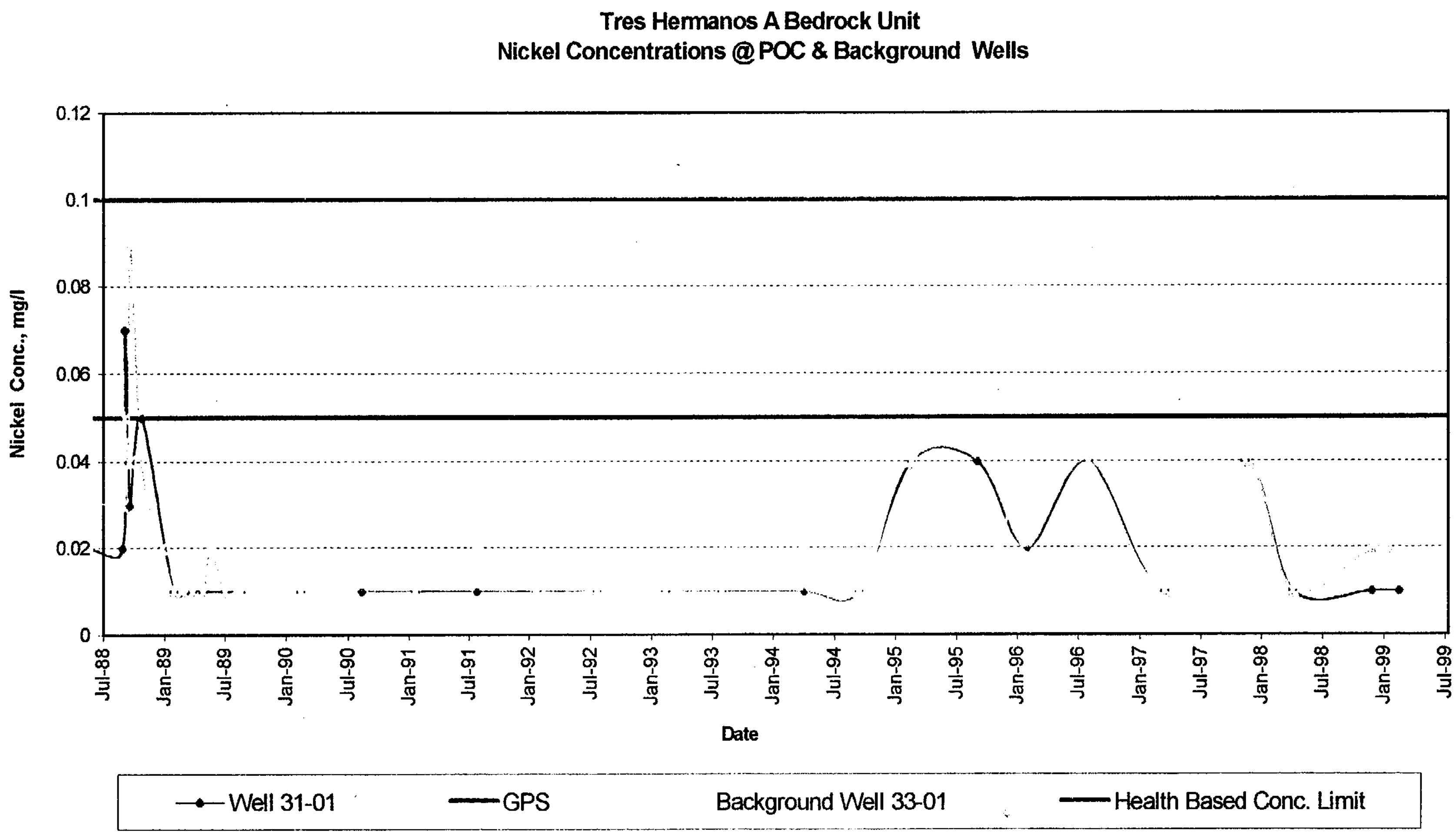

Tres Hermanos A Bedrock Unit
Nickel Concentrations @ POC & Background Wells
Nickel Conc., mg/l
0.12
0.1
0.08
0.06
0.04
0.02
0
Jul-88
Jan-89
Jul-89
Jan-90
Jul-90
Jan-91
Jul-91
Jan-92
Jul-92
Jan-93
Jul-93
Jan-94
Jul-94
Jan-95
Jul-95
Jan-96
Jul-96
Jan-97
Jul-97
Jan-98
Jul-98
Jan-99
Jul-99
Date
Well 31-01
GPS
Background Well 33-01
Health Based Conc. Limit

Figure 2-13

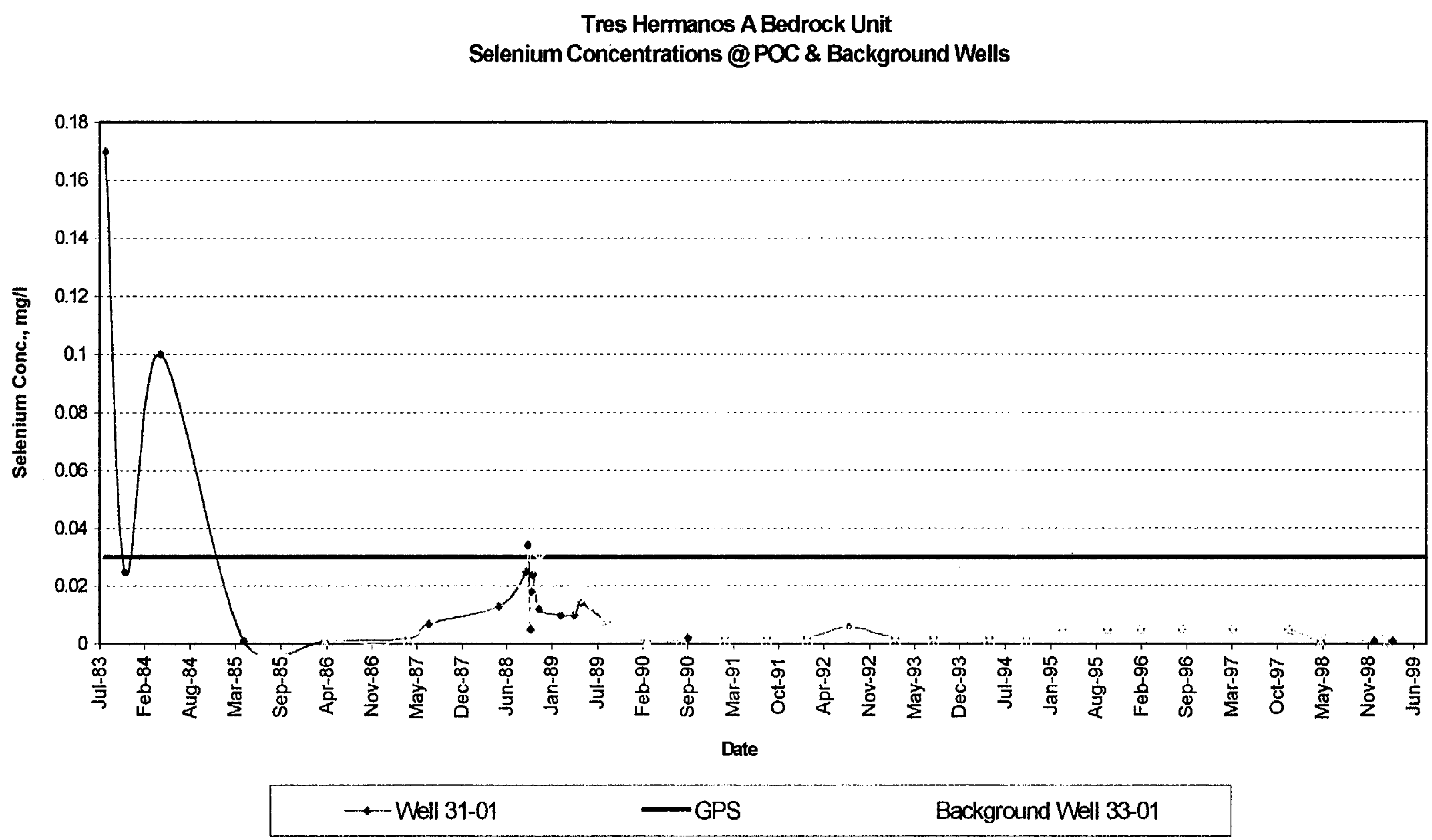

Tres Hermanos A Bedrock Unit
Selenium Concentrations @ POC & Background Wells
Selenium Conc., mg/l
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Jul-83
Feb-84
Aug-84
Mar-85
Sep-85
Apr-86
Nov-86
May-87
Dec-87
Jun-88
Jan-89
Jul-89
Feb-90
Sep-90
Mar-91
Oct-91
Apr-92
Nov-92
May-93
Dec-93
Jul-94
Jan-95
Aug-95
Feb-96
Sep-96
Mar-97
Oct-97
May-98
Nov-98
Jun-99
Date
Well 31-01
GPS
Background Well 33-01

Figure 2-14

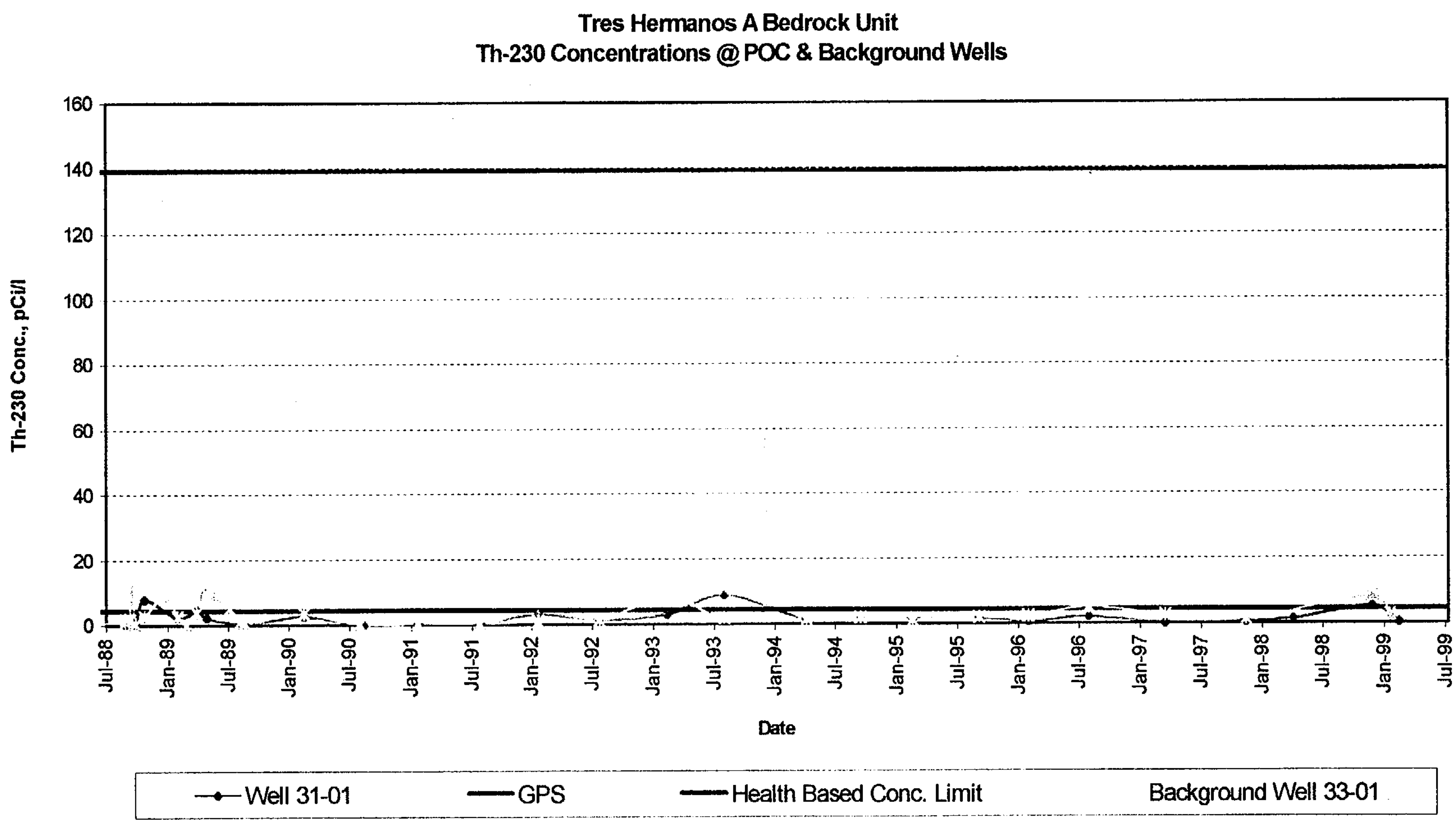

Tres Hermanos A Bedrock Unit
Th-230 Concentrations @ POC & Background Wells
Th-230 Conc., pCi/l
160
140
120
100
80
60
40
20
0
Jul-88
Jan-89
Jul-89
Jan-90
Jul-90
Jan-91
Jul-91
Jan-92
Jul-92
Jan-93
Jul-93
Jan-94
Jul-94
Jan-95
Jul-95
Jan-96
Jul-96
Jan-97
Jul-97
Jan-98
Jul-98
Jan-99
Jul-99
Date
Well 31-01
GPS
Health Based Conc. Limit
Background Well 33-01

Figure 2-15

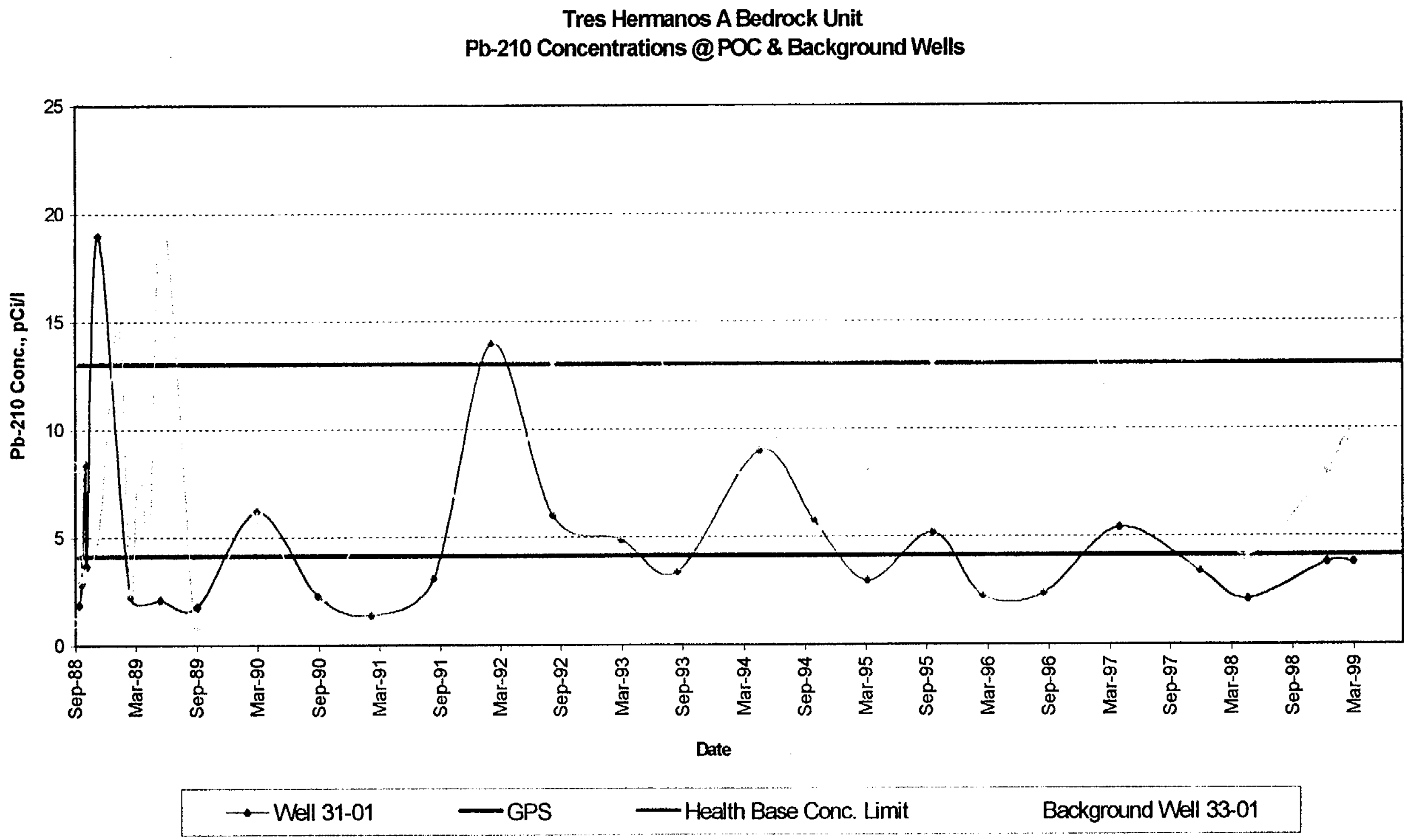

Tres Hermanos A Bedrock Unit
Pb-210 Concentrations @ POC & Background Wells
Pb-210 Conc., pCi/l
25
20
15
10
5
0
Sep-88
Mar-89
Sep-89
Mar-90
Sep-90
Mar-91
Sep-91
Mar-92
Sep-92
Mar-93
Sep-93
Mar-94
Sep-94
Mar-95
Sep-95
Mar-96
Sep-96
Mar-97
Sep-97
Mar-98
Sep-98
Mar-99
Date
Well 31-01
GPS
Health Base Conc. Limit
Background Well 33-01

Figure 2-16

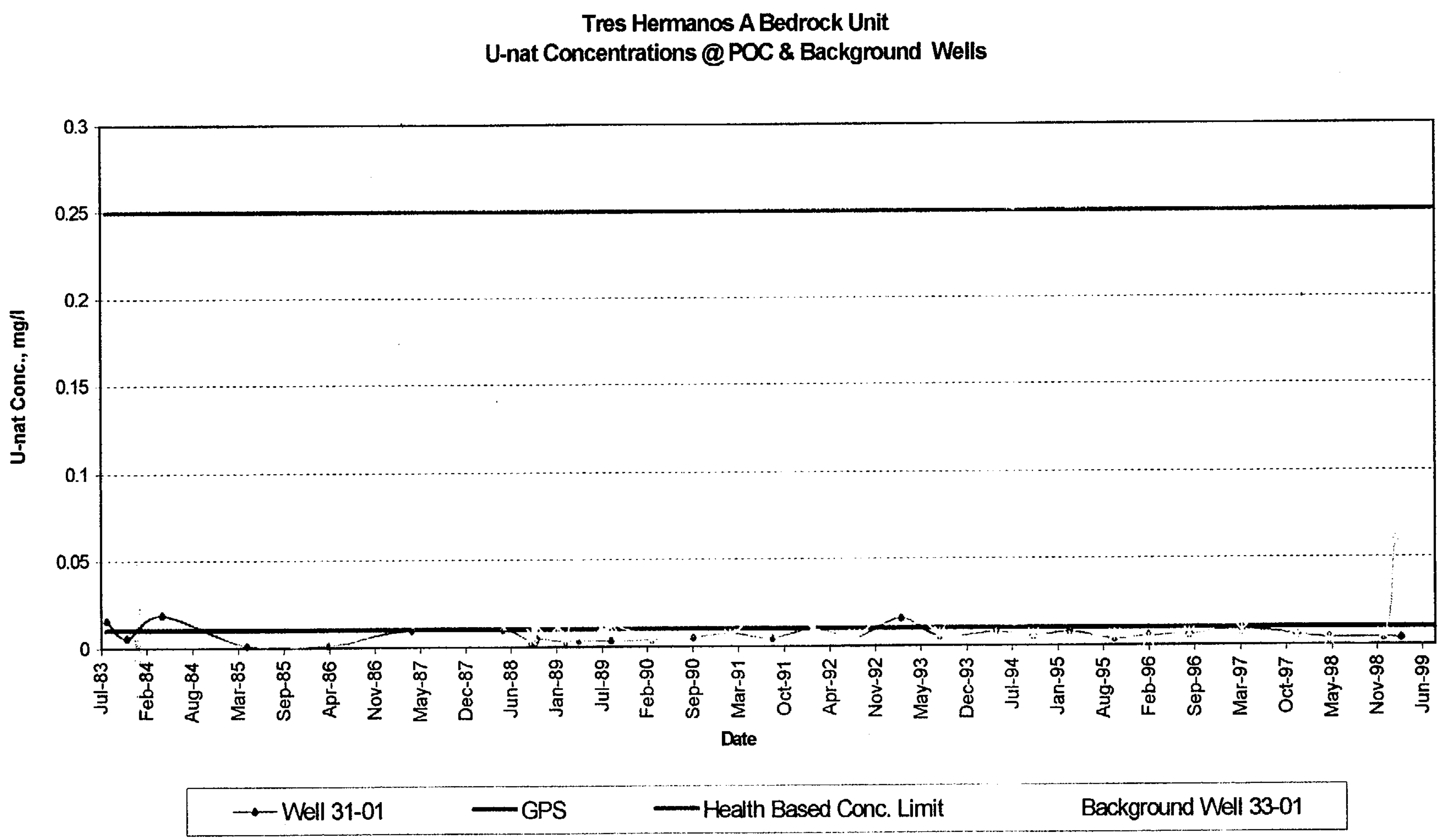

Tres Hermanos A Bedrock Unit
U-nat Concentrations @ POC & Background Wells
U-nat Conc., mg/l
0.3
0.25
0.2
0.15
0.1
0.05
0
Jul-83
Feb-84
Aug-84
Mar-85
Sep-85
Apr-86
Nov-86
May-87
Dec-87
Jun-88
Jan-89
Jul-89
Feb-90
Sep-90
Mar-91
Oct-91
Apr-92
Nov-92
May-93
Dec-93
Jul-94
Jan-95
Aug-95
Feb-96
Sep-96
Mar-97
Oct-97
May-98
Nov-98
Jun-99
Date
Well 31-01
GPS
Health Based Conc. Limit
Background Well 33-01

Figure 2-17

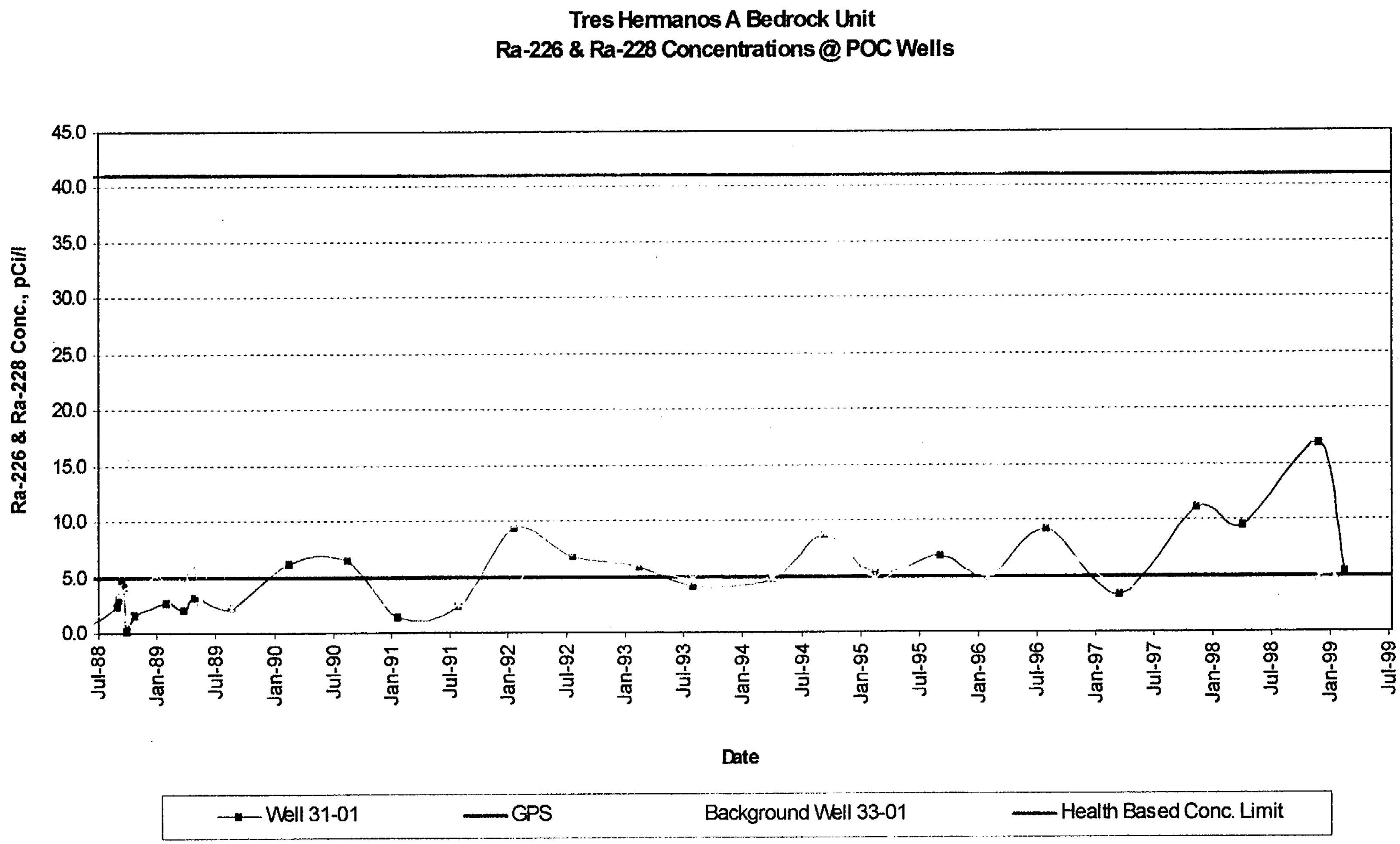

Tres Hermanos A Bedrock Unit
Ra-226 & Ra-228 Concentrations @ POC Wells
Ra-226 & Ra-228 Conc., pCi/l
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Jul-88
Jan-89
Jul-89
Jan-90
Jul-90
Jan-91
Jul-91
Jan-92
Jul-92
Jan-93
Jul-93
Jan-94
Jul-94
Jan-95
Jul-95
Jan-96
Jul-96
Jan-97
Jul-97
Jan-98
Jul-98
Jan-99
Jul-99
Date
Well 31-01
GPS
Background Well 33-01
Health Based Conc. Limit

Figure 2-18

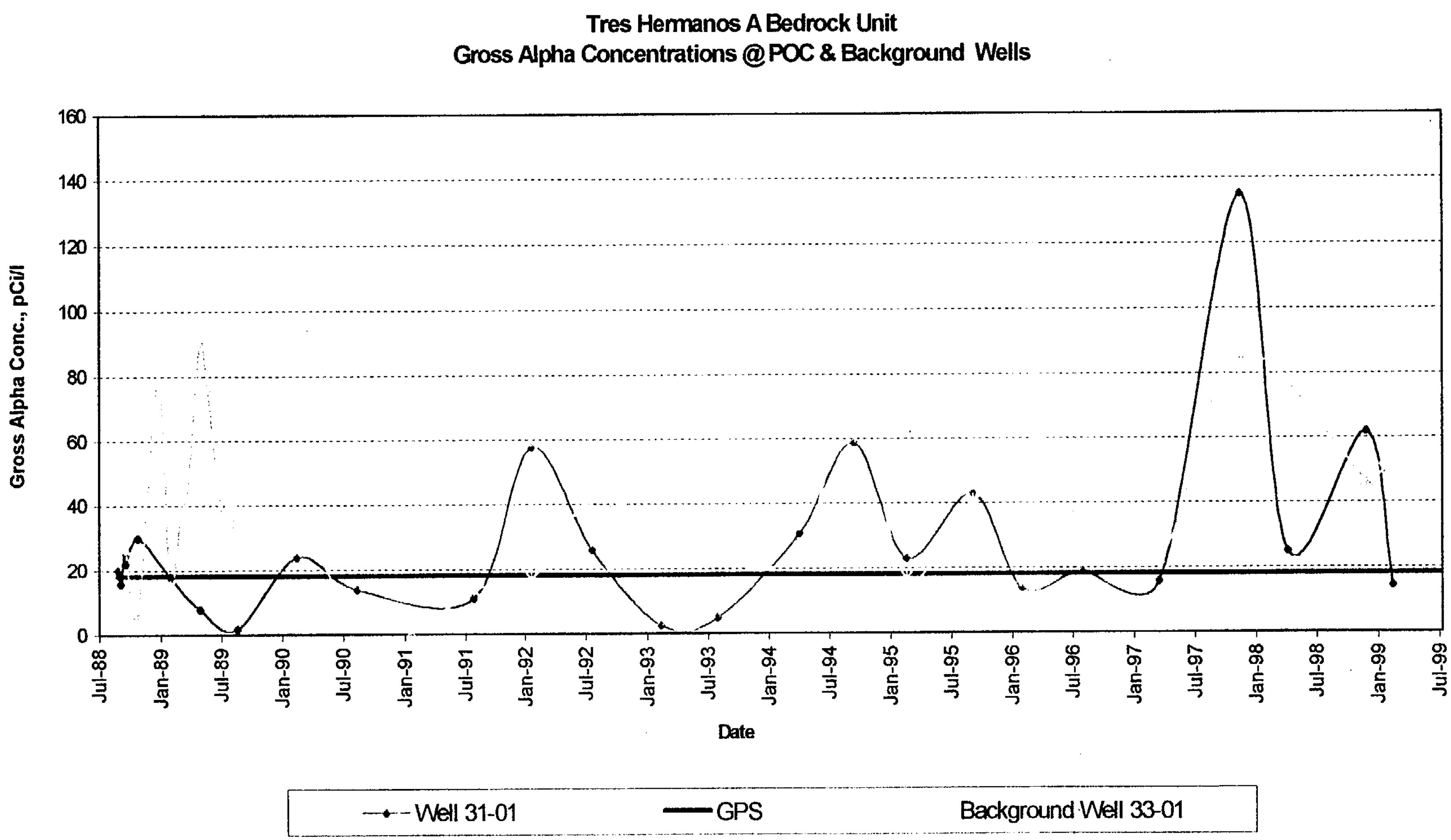

Tres Hermanos A Bedrock Unit
Gross Alpha Concentrations @ POC & Background Wells
Gross Alpha Conc., pCi/l
160
140
120
100
80
60
40
20
0
Jul-88
Jan-89
Jul-89
Jan-90
Jul-90
Jan-91
Jul-91
Jan-92
Jul-92
Jan-93
Jul-93
Jan-94
Jul-94
Jan-95
Jul-95
Jan-96
Jul-96
Jan-97
Jul-97
Jan-98
Jul-98
Jan-99
Jul-99
Date
Well 31-01
GPS
Background Well 33-01

Figure 2-19

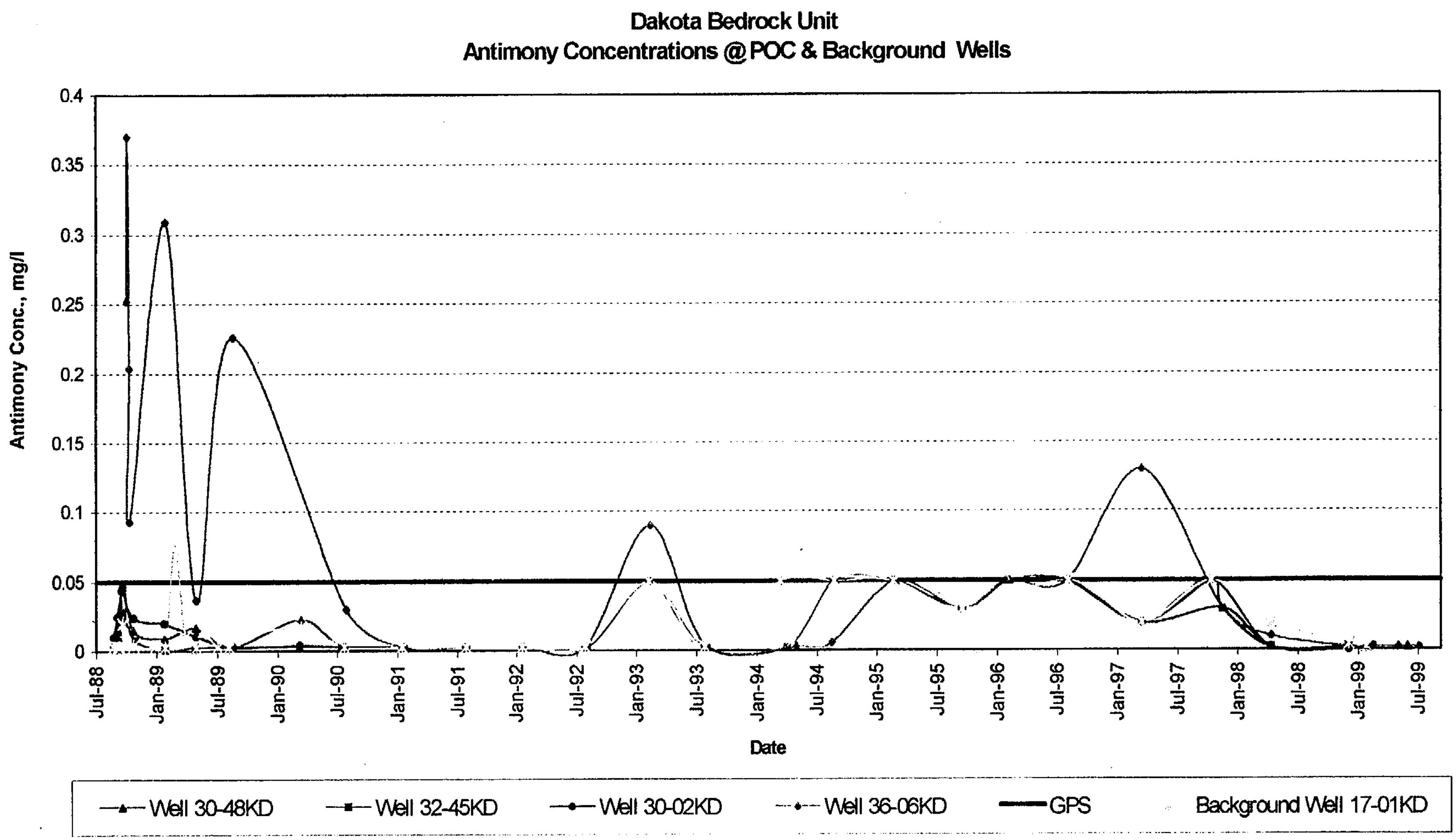

Dakota Bedrock Unit
Antimony Concentrations @ POC & Background Wells
Antimony Conc., mg/l
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Jul-88
Jan-89
Jul-89
Jan-90
Jul-90
Jan-91
Jul-91
Jan-92
Jul-92
Jan-93
Jul-93
Jan-94
Jul-94
Jan-95
Jul-95
Jan-96
Jul-96
Jan-97
Jul-97
Jan-98
Jul-98
Jan-99
Jul-99
Date
Well 30-48KD
Well 32-45KD
Well 30-02KD
Well 36-06KD
GPS
Background Well 17-01KD

Figure 2-20

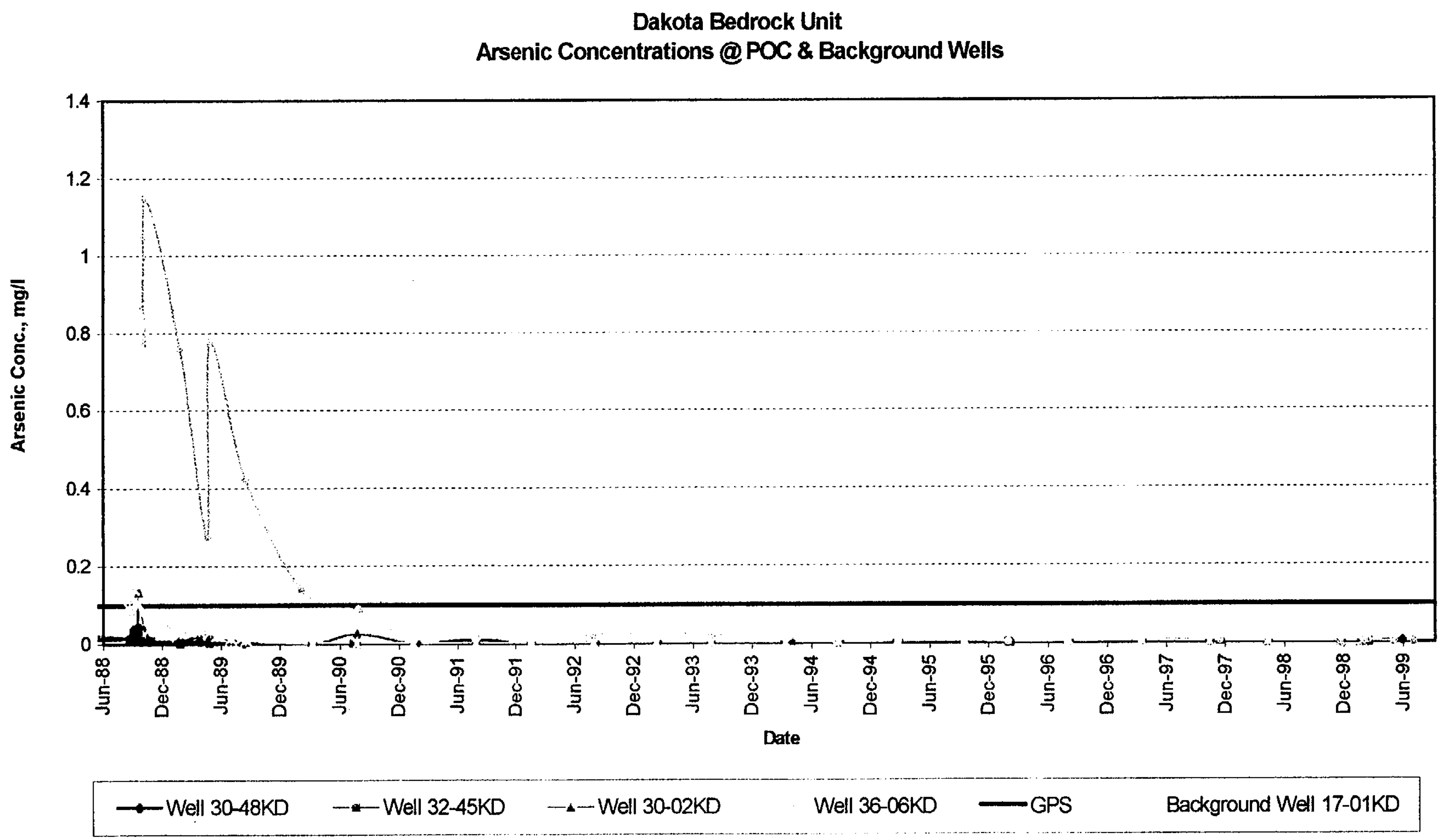

Dakota Bedrock Unit
Arsenic Concentrations @ POC & Background Wells
Arsenic Conc., mg/l
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Jun-88
Dec-88
Jun-89
Dec-89
Jun-90
Dec-90
Jun-91
Dec-91
Jun-92
Dec-92
Jun-93
Dec-93
Jun-94
Dec-94
Jun-95
Dec-95
Jun-96
Dec-96
Jun-97
Dec-97
Jun-98
Dec-98
Jun-99
Date
Well 30-48KD
Well 32-45KD
Well 30-02KD
Well 36-06KD
GPS
Background Well 17-01KD

Figure 2-21

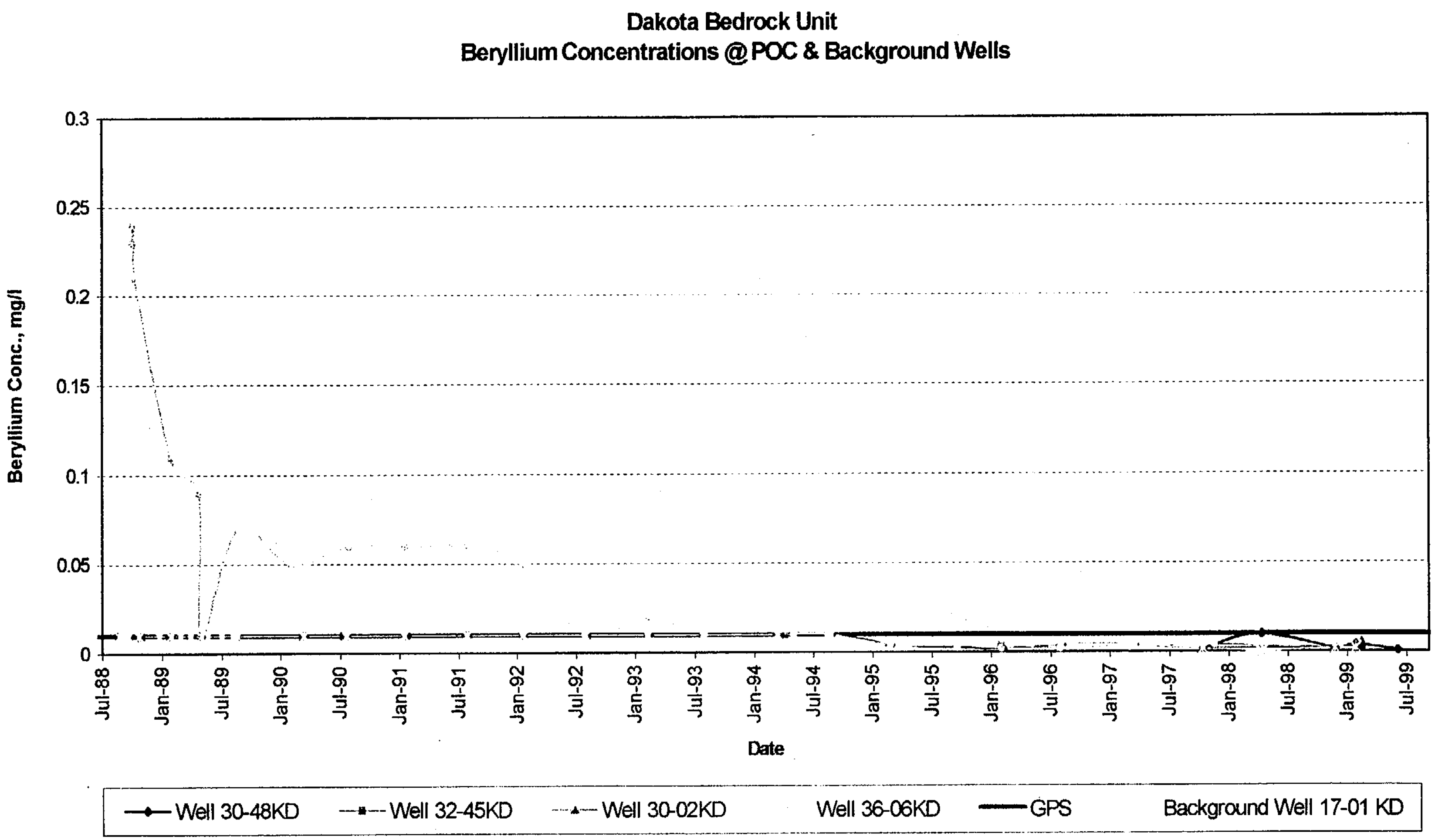

Dakota Bedrock Unit
Beryllium Concentrations @ POC & Background Wells
Beryllium Conc., mg/l
0.3
0.25
0.2
0.15
0.1
0.05
0
Jul-88
Jan-89
Jul-89
Jan-90
Jul-90
Jan-91
Jul-91
Jan-92
Jul-92
Jan-93
Jul-93
Jan-94
Jul-94
Jan-95
Jul-95
Jan-96
Jul-96
Jan-97
Jul-97
Jan-98
Jul-98
Jan-99
Jul-99
Date
Well 30-48KD
Well 32-45KD
Well 30-02KD
Well 36-06KD
GPS
Background Well 17-01 KD

Figure 2-22

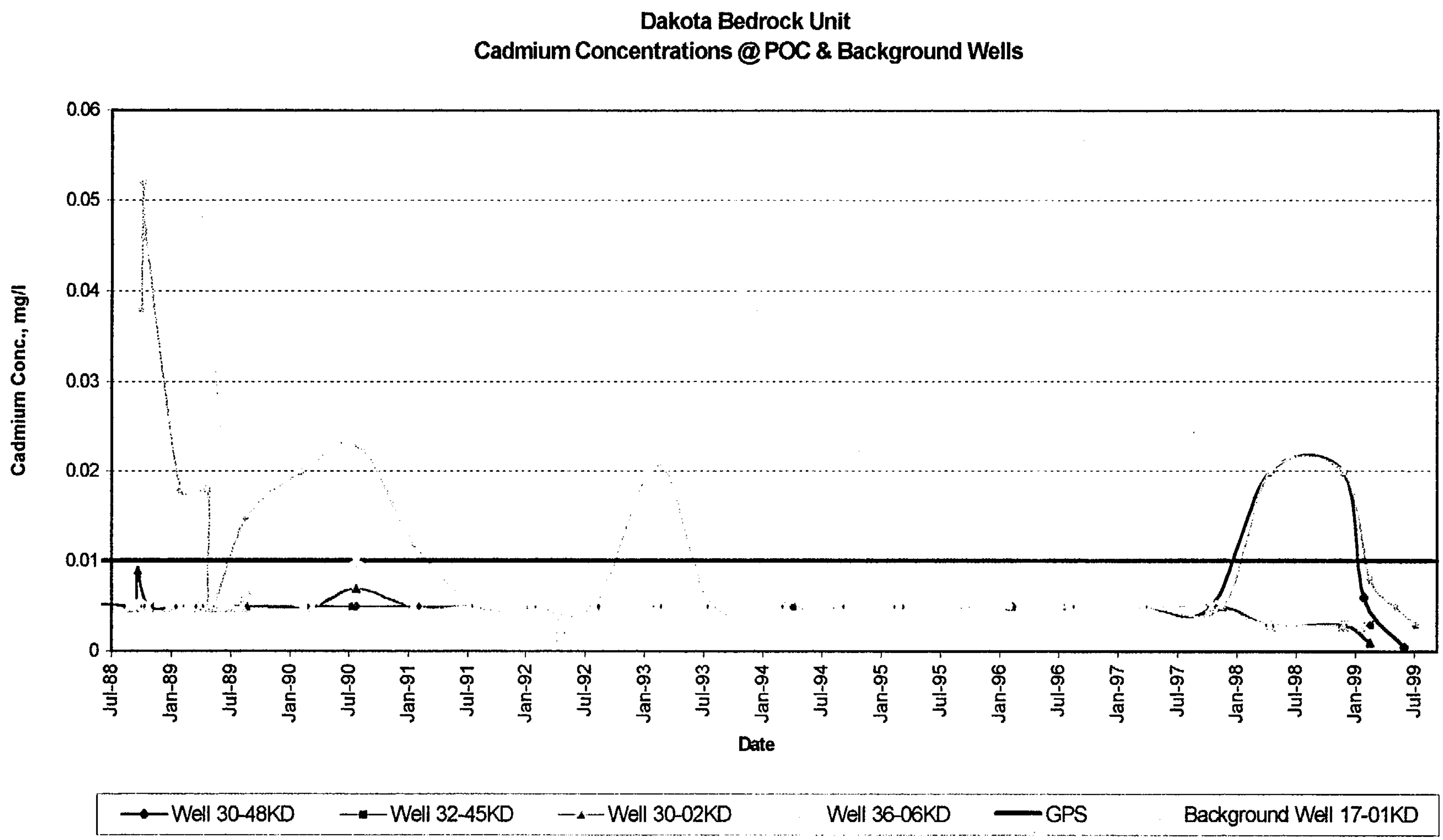

Dakota Bedrock Unit
Cadmium Concentrations @ POC & Background Wells
Cadmium Conc., mg/l
0.06
0.05
0.04
0.03
0.02
0.01
0
Jul-88
Jan-89
Jul-89
Jan-90
Jul-90
Jan-91
Jul-91
Jan-92
Jul-92
Jan-93
Jul-93
Jan-94
Jul-94
Jan-95
Jul-95
Jan-96
Jul-96
Jan-97
Jul-97
Jan-98
Jul-98
Jan-99
Jul-99
Date
Well 30-48KD
Well 32-45KD
Well 30-02KD
Well 36-06KD
GPS
Background Well 17-01KD

Figure 2-23

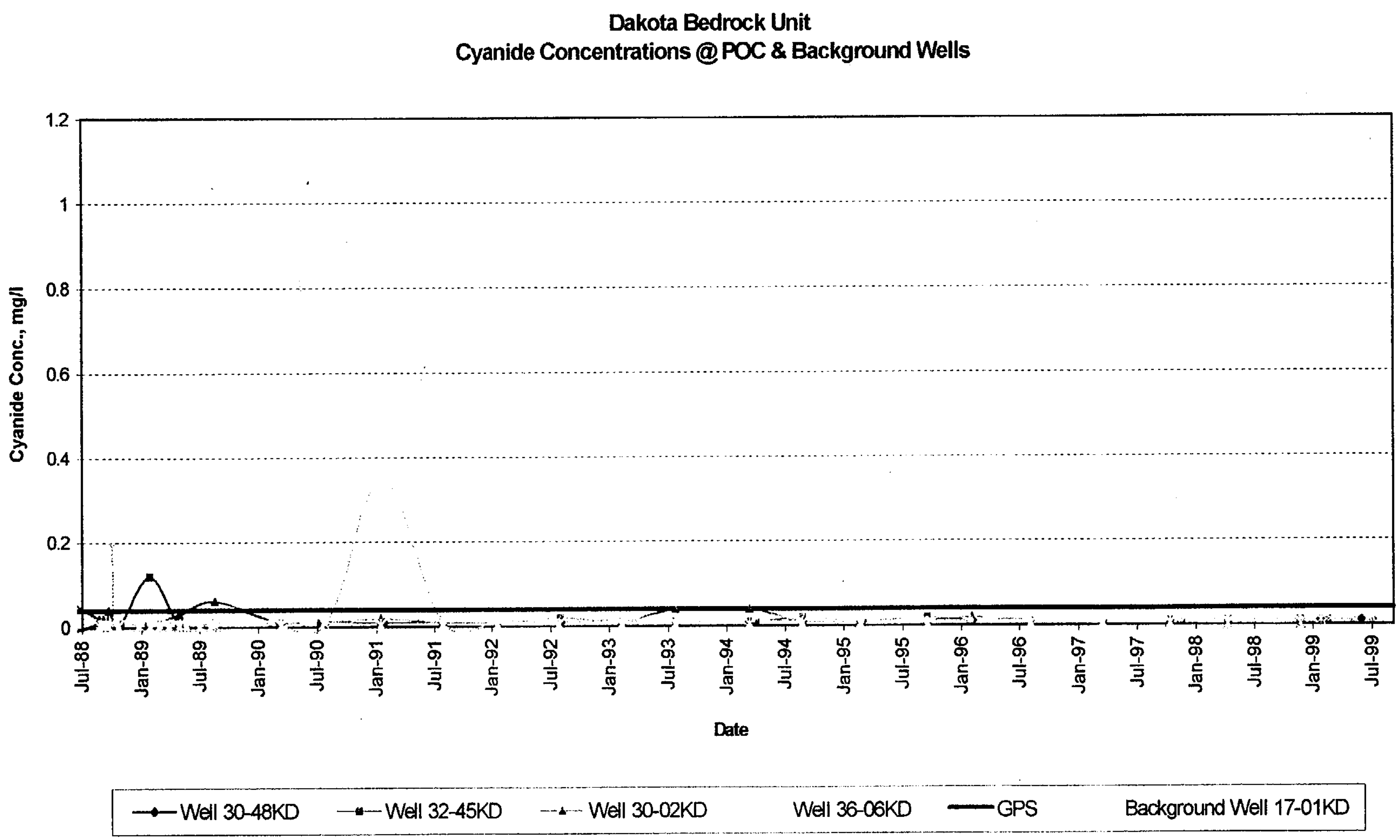

Dakota Bedrock Unit
Cyanide Concentrations @ POC & Background Wells
Cyanide Conc., mg/l
1.2
1
0.8
0.6
0.4
0.2
0
Jul-88
Jan-89
Jul-89
Jan-90
Jul-90
Jan-91
Jul-91
Jan-92
Jul-92
Jan-93
Jul-93
Jan-94
Jul-94
Jan-95
Jul-95
Jan-96
Jul-96
Jan-97
Jul-97
Jan-98
Jul-98
Jan-99
Jul-99
Date
Well 30-48KD
Well 32-45KD
Well 30-02KD
Well 36-06KD
GPS
Background Well 17-01KD

Figure 2-24

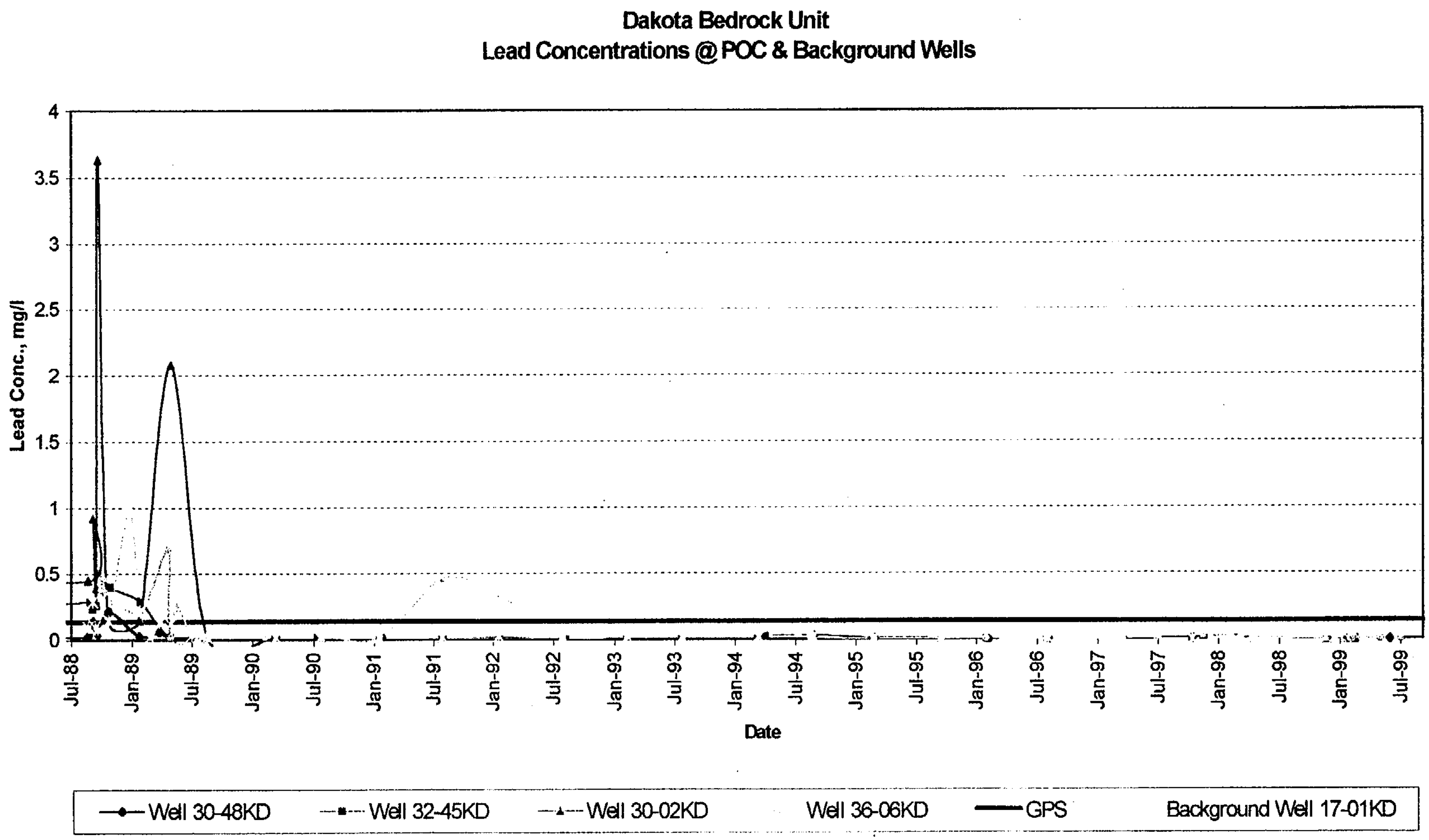

Dakota Bedrock Unit
Lead Concentrations @ POC & Background Wells
Lead Conc., mg/l
0
0.5
1
1.5
2
2.5
3
3.5
4
Jul-88
Jan-89
Jul-89
Jan-90
Jul-90
Jan-91
Jul-91
Jan-92
Jul-92
Jan-93
Jul-93
Jan-94
Jul-94
Jan-95
Jul-95
Jan-96
Jul-96
Jan-97
Jul-97
Jan-98
Jul-98
Jan-99
Jul-99
Date
Well 30-48KD
Well 32-45KD
Well 30-02KD
Well 36-06KD
GPS
Background Well 17-01KD

Figure 2-25

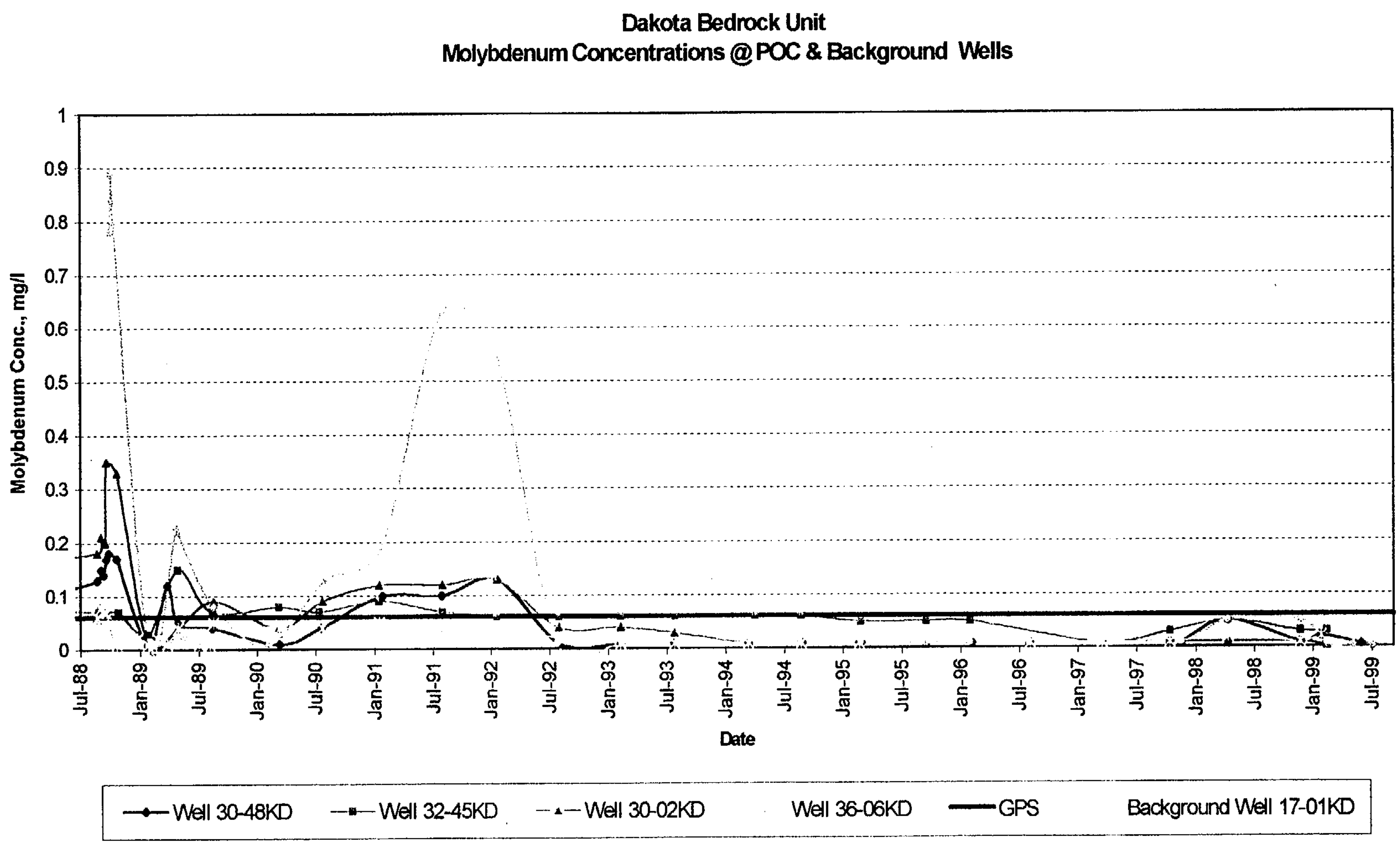

Dakota Bedrock Unit
Molybdenum Concentrations @ POC & Background Wells
Molybdenum Conc., mg/l
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Jul-88
Jan-89
Jul-89
Jan-90
Jul-90
Jan-91
Jul-91
Jan-92
Jul-92
Jan-93
Jul-93
Jan-94
Jul-94
Jan-95
Jul-95
Jan-96
Jul-96
Jan-97
Jul-97
Jan-98
Jul-98
Jan-99
Jul-99
Date
Well 30-48KD
Well 32-45KD
Well 30-02KD
Well 36-06KD
GPS
Background Well 17-01KD

Figure 2-26

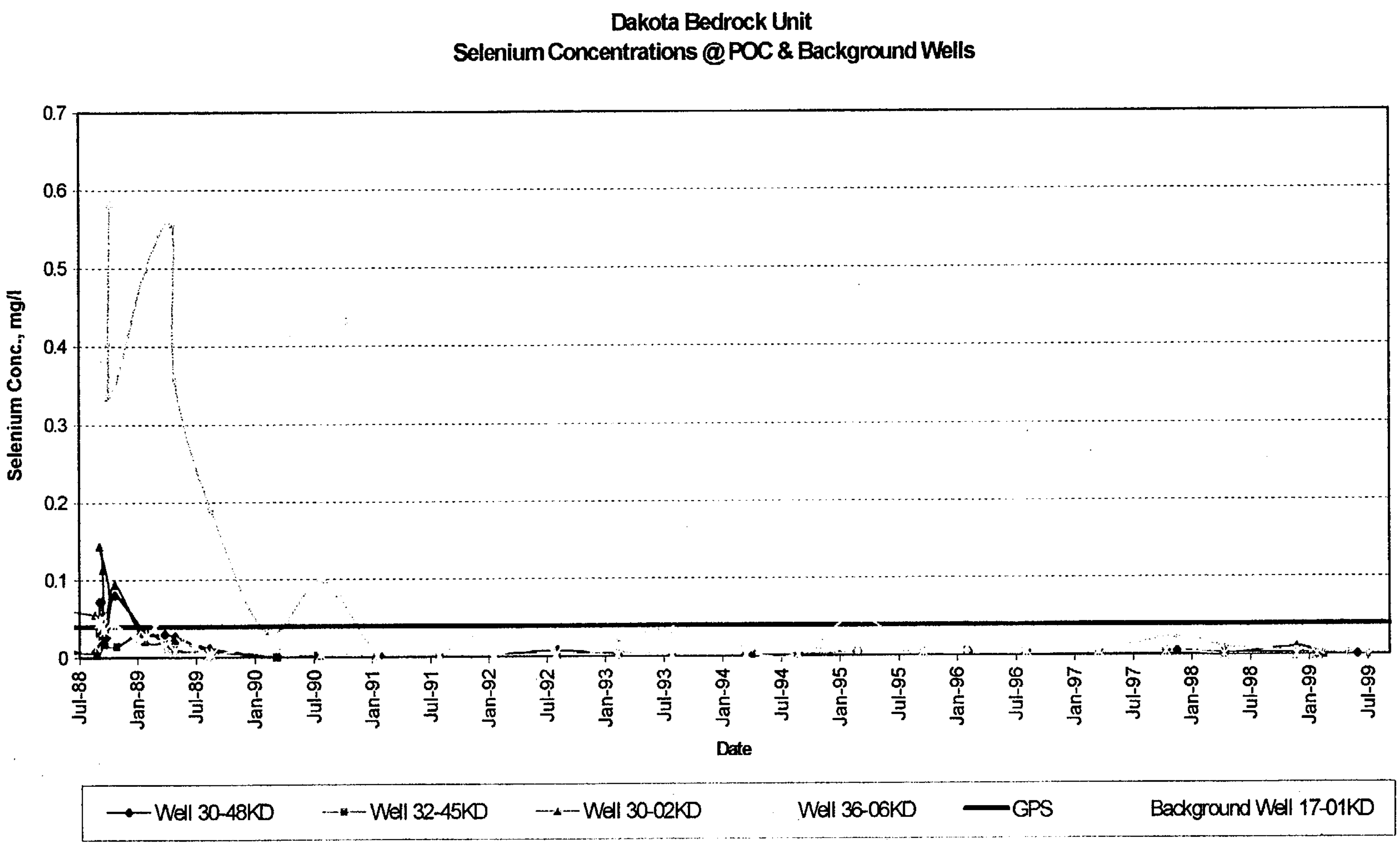
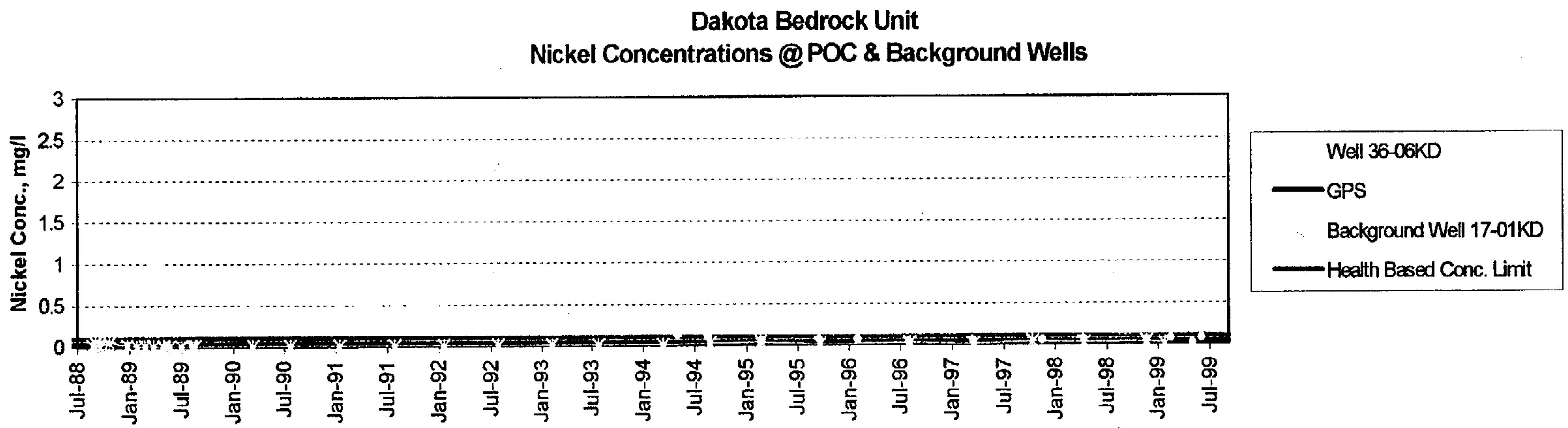

Dakota Bedrock Unit
Selenium Concentrations @ POC & Background Wells
Selenium Conc., mg/l
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Jul-88
Jan-89
Jul-89
Jan-90
Jul-90
Jan-91
Jul-91
Jan-92
Jul-92
Jan-93
Jul-93
Jan-94
Jul-94
Jan-95
Jul-95
Jan-96
Jul-96
Jan-97
Jul-97
Jan-98
Jul-98
Jan-99
Jul-99
Date
Well 30-48KD
Well 32-45KD
Well 30-02KD
Well 36-06KD
GPS
Background Well 17-01KD

Figure 2-27


Dakota Bedrock Unit
Nickel Concentrations @ POC & Background Wells
Nickel Conc., mg/l
3
2.5
2
1.5
1
0.5
0
Jul-88
Jan-89
Jul-89
Jan-90
Jul-90
Jan-91
Jul-91
Jan-92
Jul-92
Jan-93
Jul-93
Jan-94
Jul-94
Jan-95
Jul-95
Jan-96
Jul-96
Jan-97
Jul-97
Jan-98
Jul-98
Jan-99
Jul-99
Well 36-06KD
GPS
Background Well 17-01KD
Health Based Conc. Limit

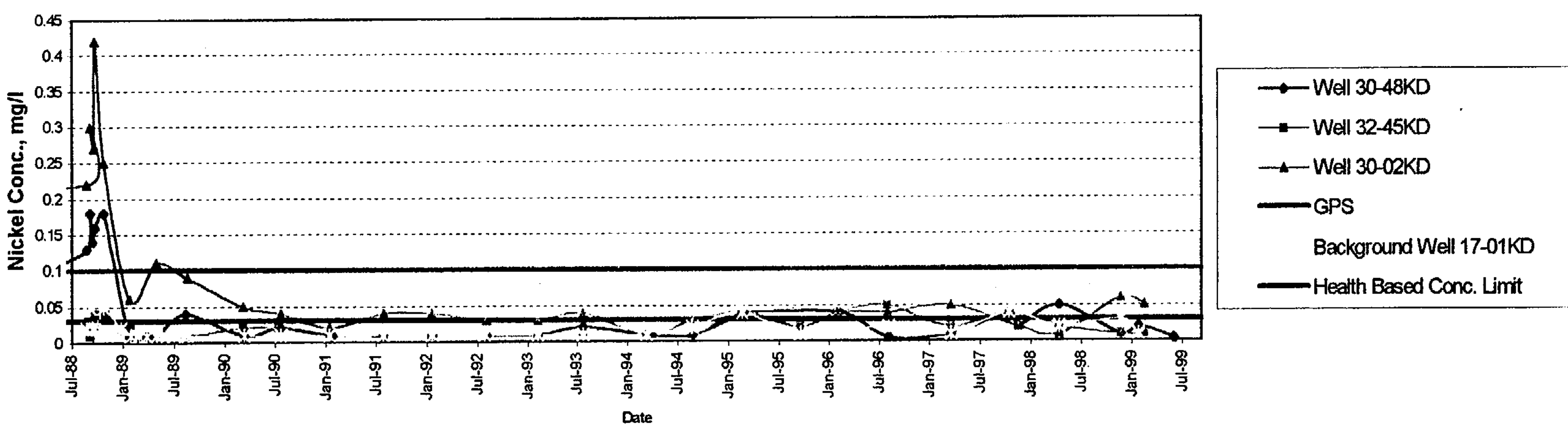

Nickel Conc., mg/l
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Jul-88
Jan-89
Jul-89
Jan-90
Jul-90
Jan-91
Jul-91
Jan-92
Jul-92
Jan-93
Jul-93
Jan-94
Jul-94
Jan-95
Jul-95
Jan-96
Jul-96
Jan-97
Jul-97
Jan-98
Jul-98
Jan-99
Jul-99
Date
Well 30-48KD
Well 32-45KD
Well 30-02KD
GPS
Background Well 17-01KD
Health Based Conc. Limit

Figure 2-28

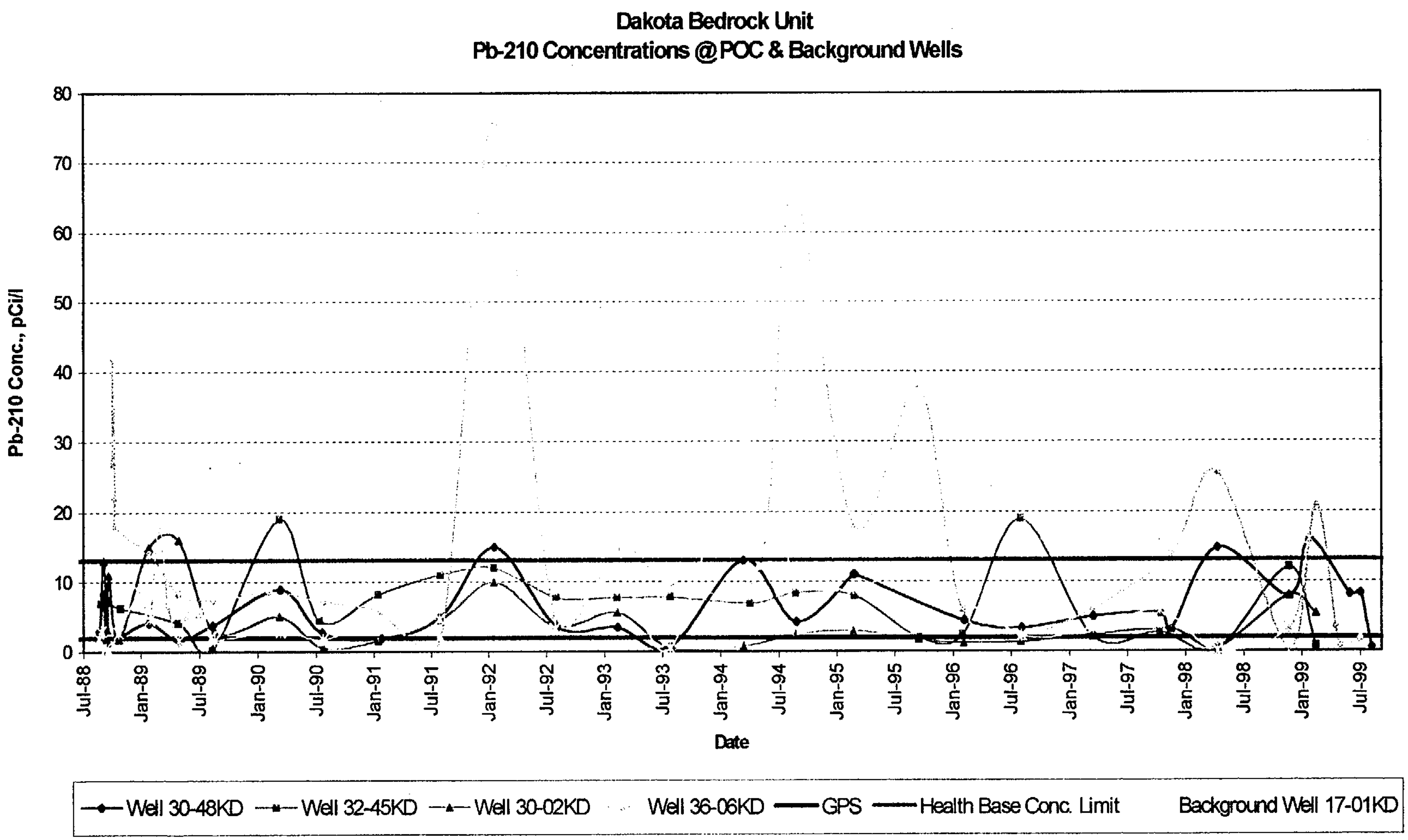

Dakota Bedrock Unit
Pb-210 Concentrations @ POC & Background Wells
Pb-210 Conc., pCi/l
80
70
60
50
40
30
20
10
0
Jul-88
Jan-89
Jul-89
Jan-90
Jul-90
Jan-91
Jul-91
Jan-92
Jul-92
Jan-93
Jul-93
Jan-94
Jul-94
Jan-95
Jul-95
Jan-96
Jul-96
Jan-97
Jul-97
Jan-98
Jul-98
Jan-99
Jul-99
Date
Well 30-48KD
Well 32-45KD
Well 30-02KD
Well 36-06KD
GPS
Health Base Conc. Limit
Background Well 17-01KD

Figure 2-29

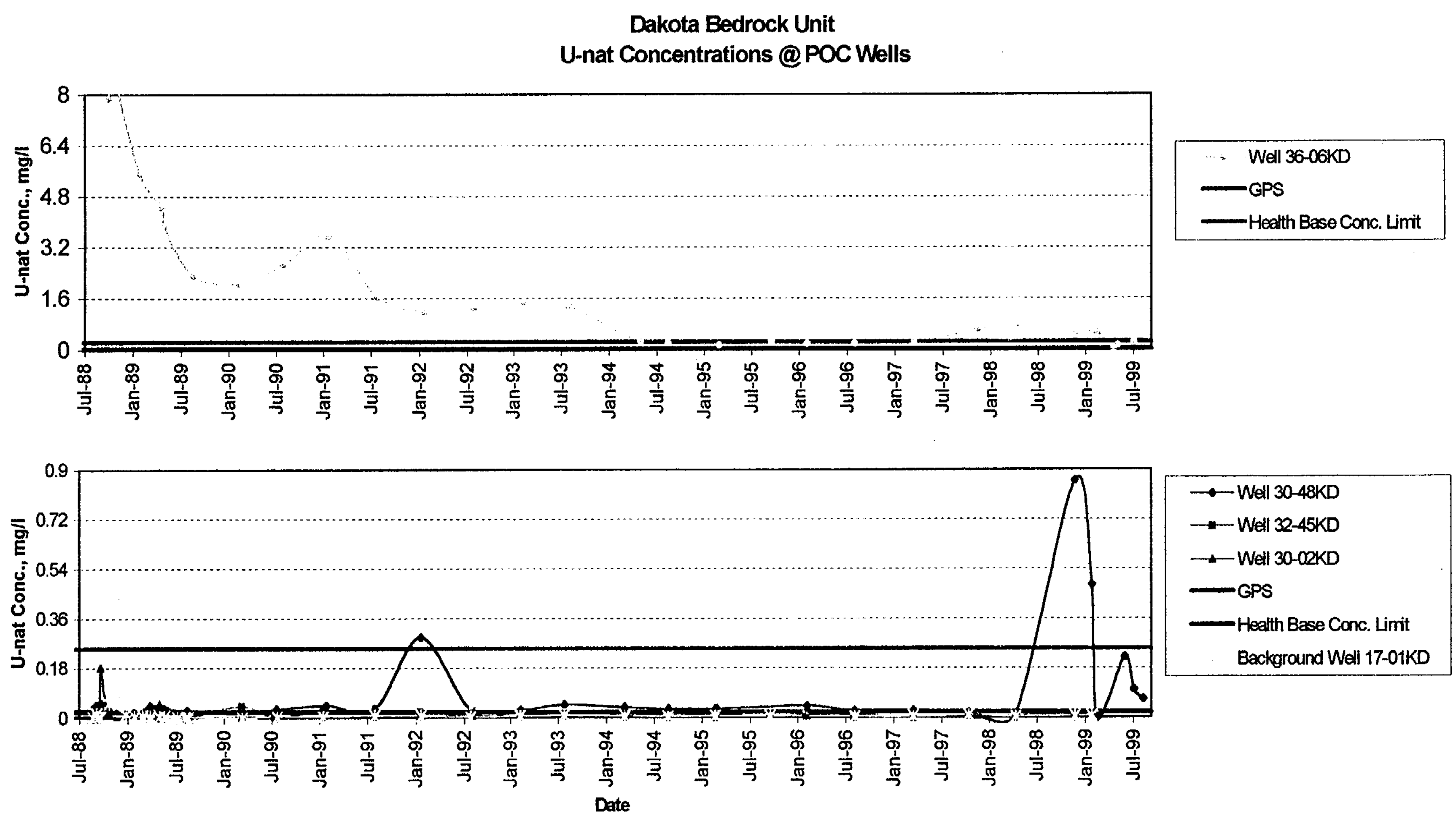

Dakota Bedrock Unit
U-nat Concentrations @ POC Wells
U-nat Conc., mg/l
8
6.4
4.8
3.2
1.6
0
Well 36-06KD
GPS
Health Base Conc. Limit
Jul-88
Jan-89
Jul-89
Jan-90
Jul-90
Jan-91
Jul-91
Jan-92
Jul-92
Jan-93
Jul-93
Jan-94
Jul-94
Jan-95
Jul-95
Jan-96
Jul-96
Jan-97
Jul-97
Jan-98
Jul-98
Jan-99
Jul-99
0.9
0.72
0.54
0.36
0.18
Well 30-48KD
Well 32-45KD
Well 30-02KD
Background Well 17-01KD
Date

Figure 2-30

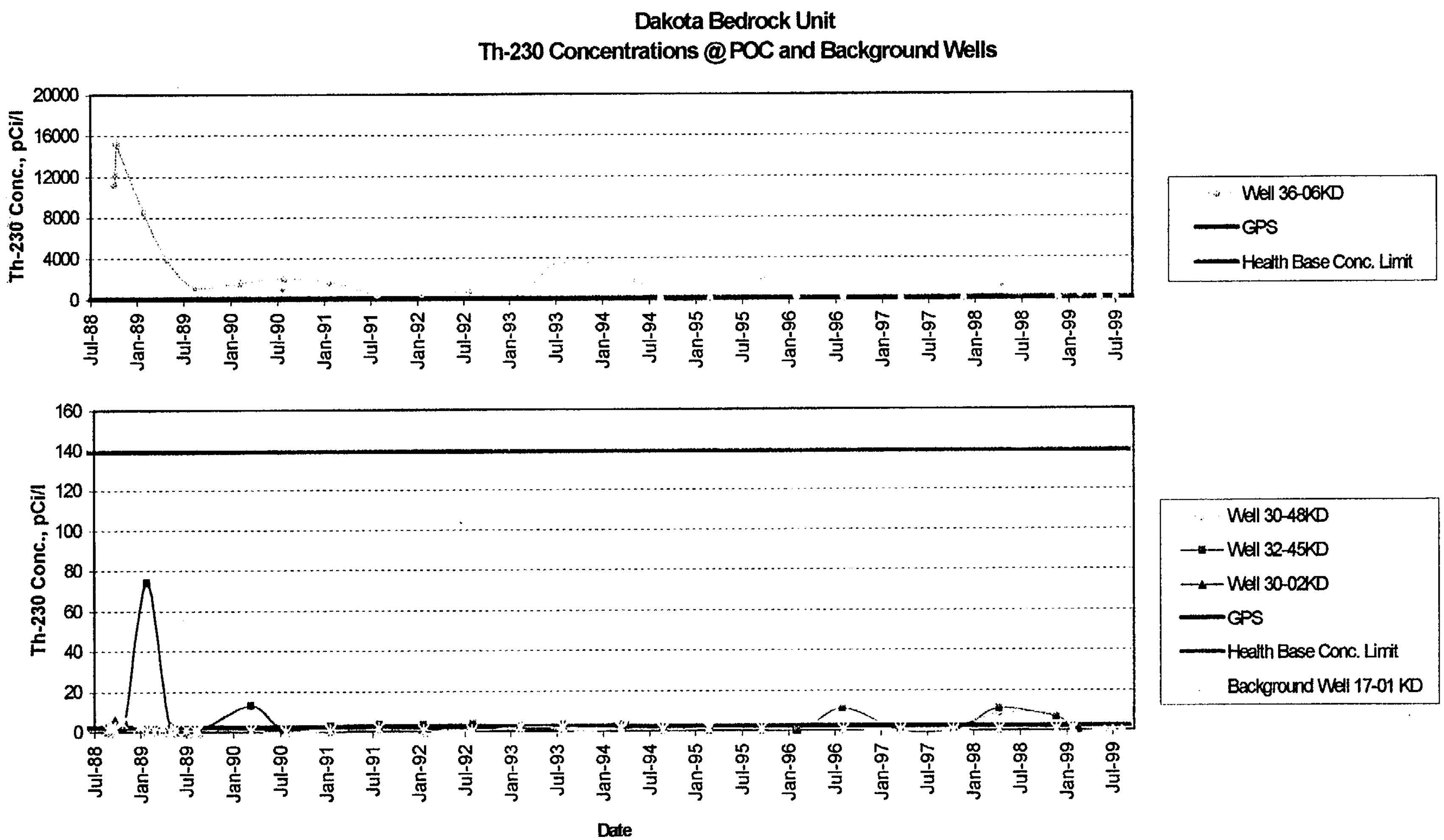

Dakota Bedrock Unit
Th-230 Concentrations @ POC and Background Wells
Th-230 Conc., pCi/l
20000
16000
12000
8000
4000
0
Jul-88
Jan-89
Jul-89
Jan-90
Jul-90
Jan-91
Jul-91
Jan-92
Jul-92
Jan-93
Jul-93
Jan-94
Jul-94
Jan-95
Jul-95
Jan-96
Jul-96
Jan-97
Jul-97
Jan-98
Jul-98
Jan-99
Jul-99
Well 36-06KD
GPS
Health Base Conc. Limit
160
140
120
100
80
60
40
20
Well 30-48KD
Well 32-45KD
Well 30-02KD
Background Well 17-01 KD
Date

Figure 2-31

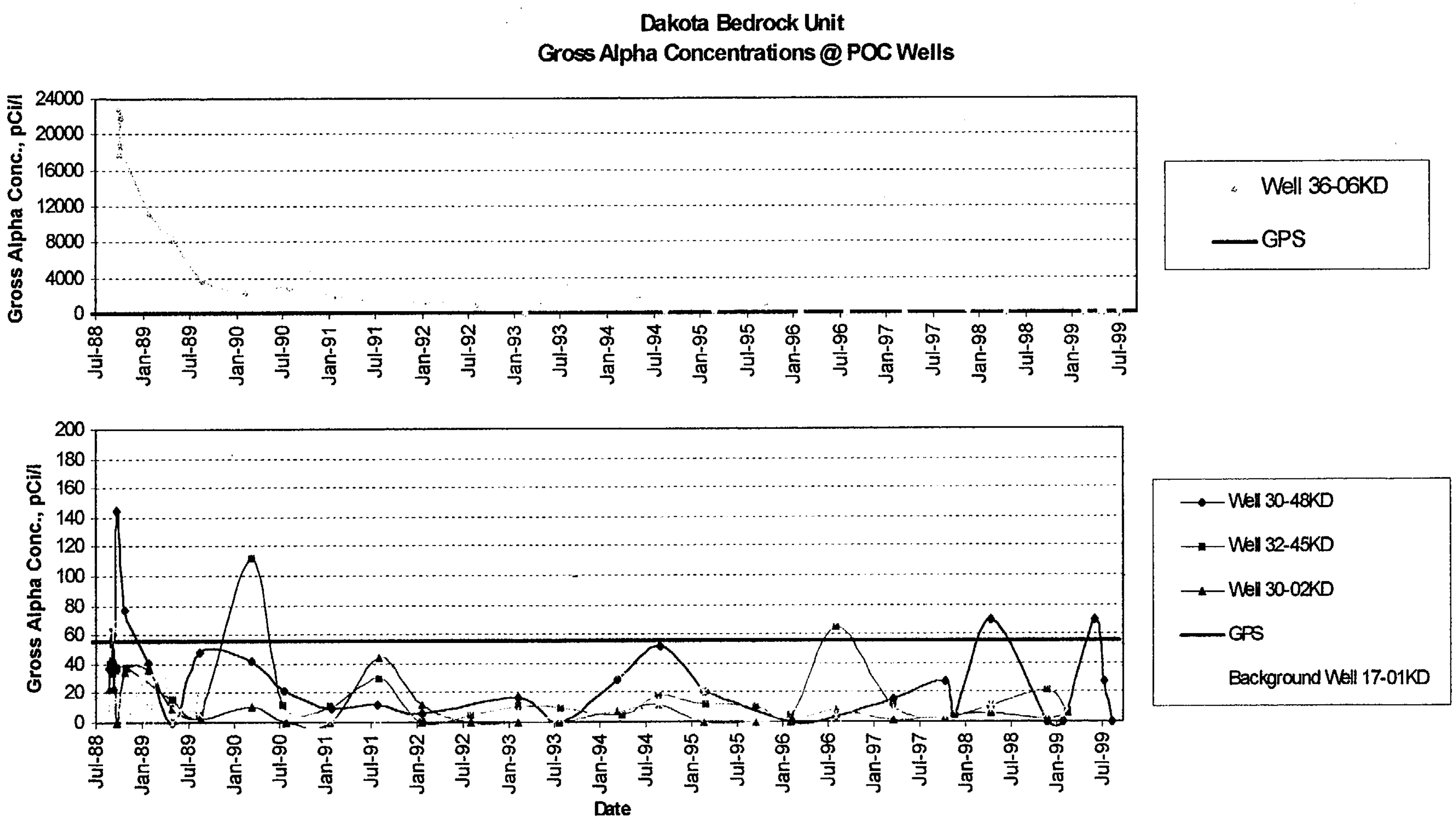

Dakota Bedrock Unit
Gross Alpha Concentrations @ POC Wells
Gross Alpha Conc., pCi/l
24000
20000
16000
12000
8000
4000
0
Well 36-06KD
GPS
Jul-88 Jan-89 Jul-89 Jan-90 Jul-90 Jan-91 Jul-91 Jan-92 Jul-92 Jan-93 Jul-93 Jan-94 Jul-94 Jan-95 Jul-95 Jan-96 Jul-96 Jan-97 Jul-97 Jan-98 Jul-98 Jan-99 Jul-99
200
180
160
140
120
100
80
60
40
20
0
Well 30-48KD
Well 32-45KD
Well 30-02KD
GPS
Background Well 17-01KD
Date

Figure 2-32

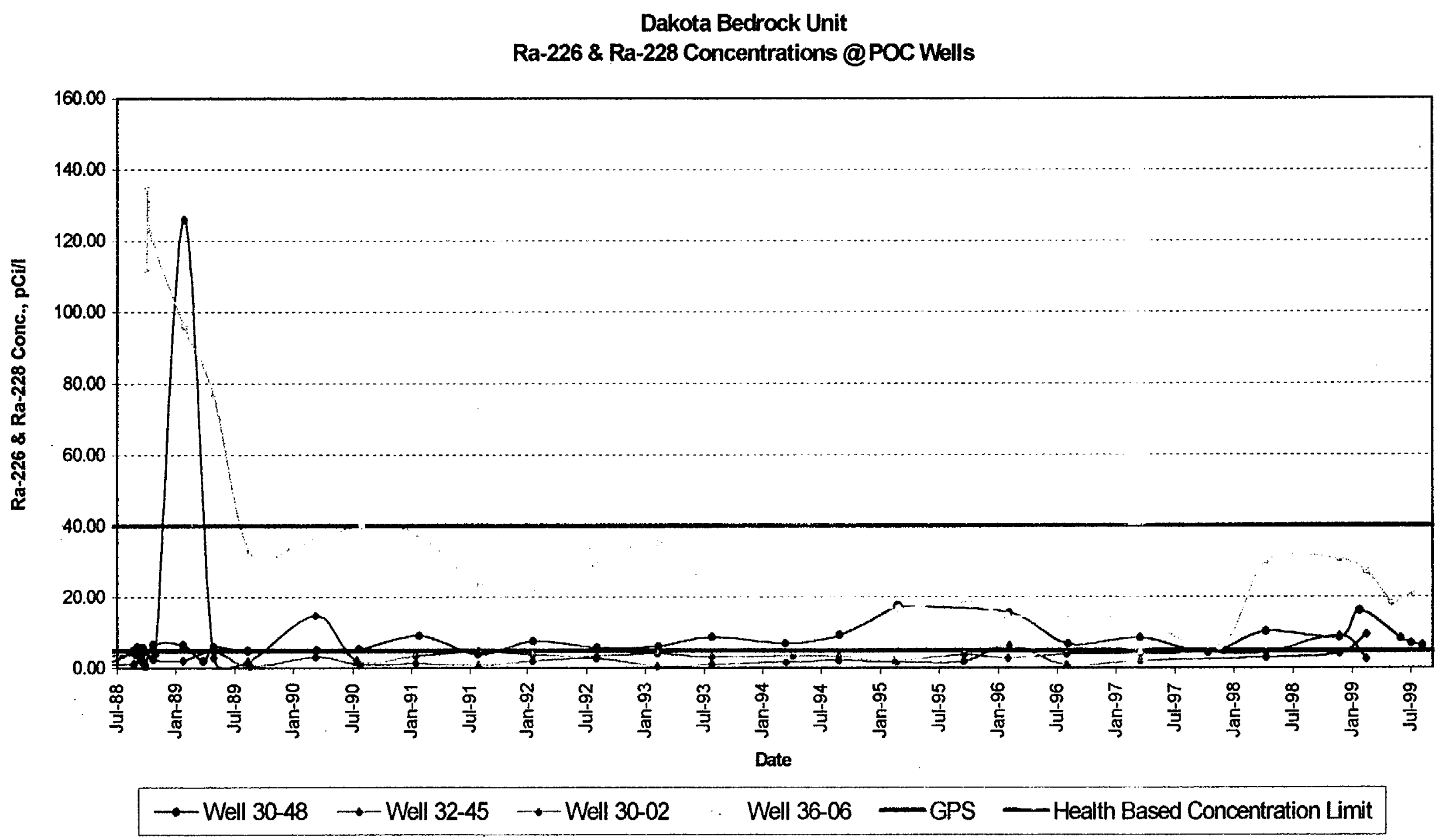

Dakota Bedrock Unit
Ra-226 & Ra-228 Concentrations @ POC Wells
Ra-226 & Ra-228 Conc., pCi/l
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
Jul-88
Jan-89
Jul-89
Jan-90
Jul-90
Jan-91
Jul-91
Jan-92
Jul-92
Jan-93
Jul-93
Jan-94
Jul-94
Jan-95
Jul-95
Jan-96
Jul-96
Jan-97
Jul-97
Jan-98
Jul-98
Jan-99
Jul-99
Date
Well 30-48
Well 32-45
Well 30-02
Well 36-06
GPS
Health Based Concentration Limit

Figure 2-33

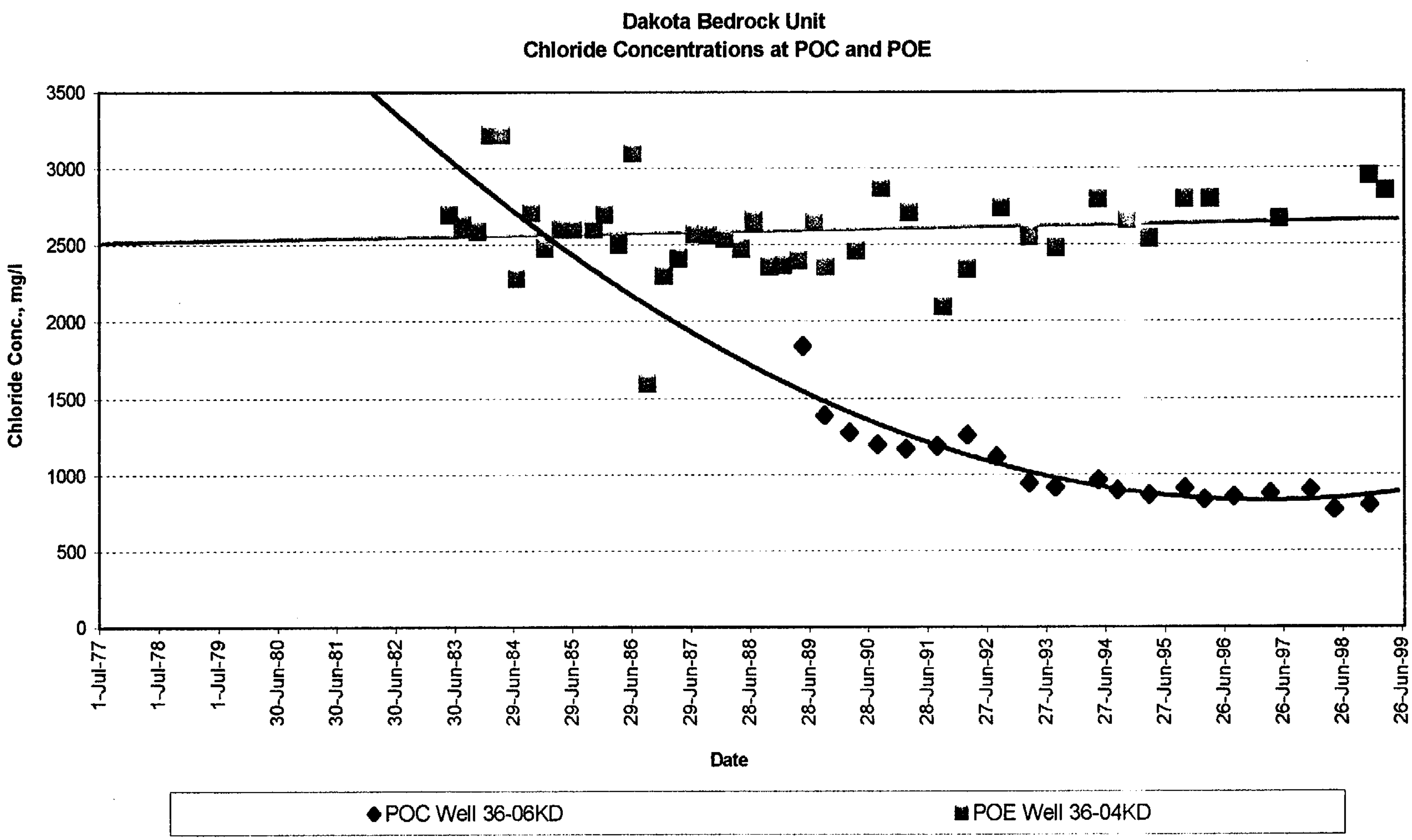

Dakota Bedrock Unit
Chloride Concentrations at POC and POE
Chloride Conc., mg/l
3500
3000
2500
2000
1500
1000
500
0
1-Jul-77
1-Jul-78
1-Jul-79
30-Jun-80
30-Jun-81
30-Jun-82
30-Jun-83
29-Jun-84
29-Jun-85
29-Jun-86
29-Jun-87
28-Jun-88
28-Jun-89
28-Jun-90
28-Jun-91
27-Jun-92
27-Jun-93
27-Jun-94
27-Jun-95
26-Jun-96
26-Jun-97
26-Jun-98
26-Jun-99
Date
POC Well 36-06KD
POE Well 36-04KD

Figure 2-34

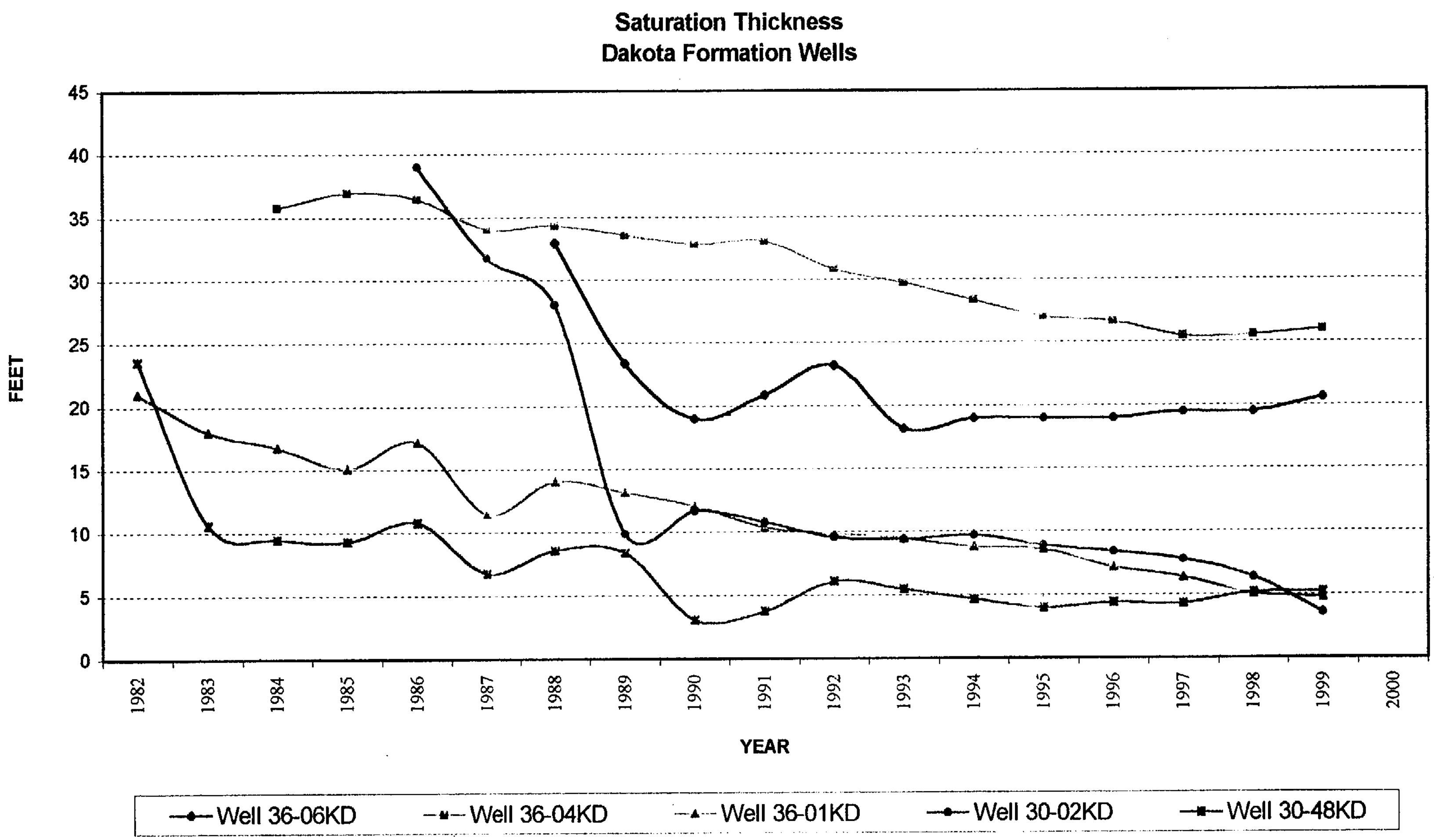

Saturation Thickness
Dakota Formation Wells
FEET
45
40
35
30
25
20
15
10
5
0
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
YEAR
Well 36-06KD
Well 36-04KD
Well 36-01KD
Well 30-02KD
Well 30-48KD

Figure 2-35

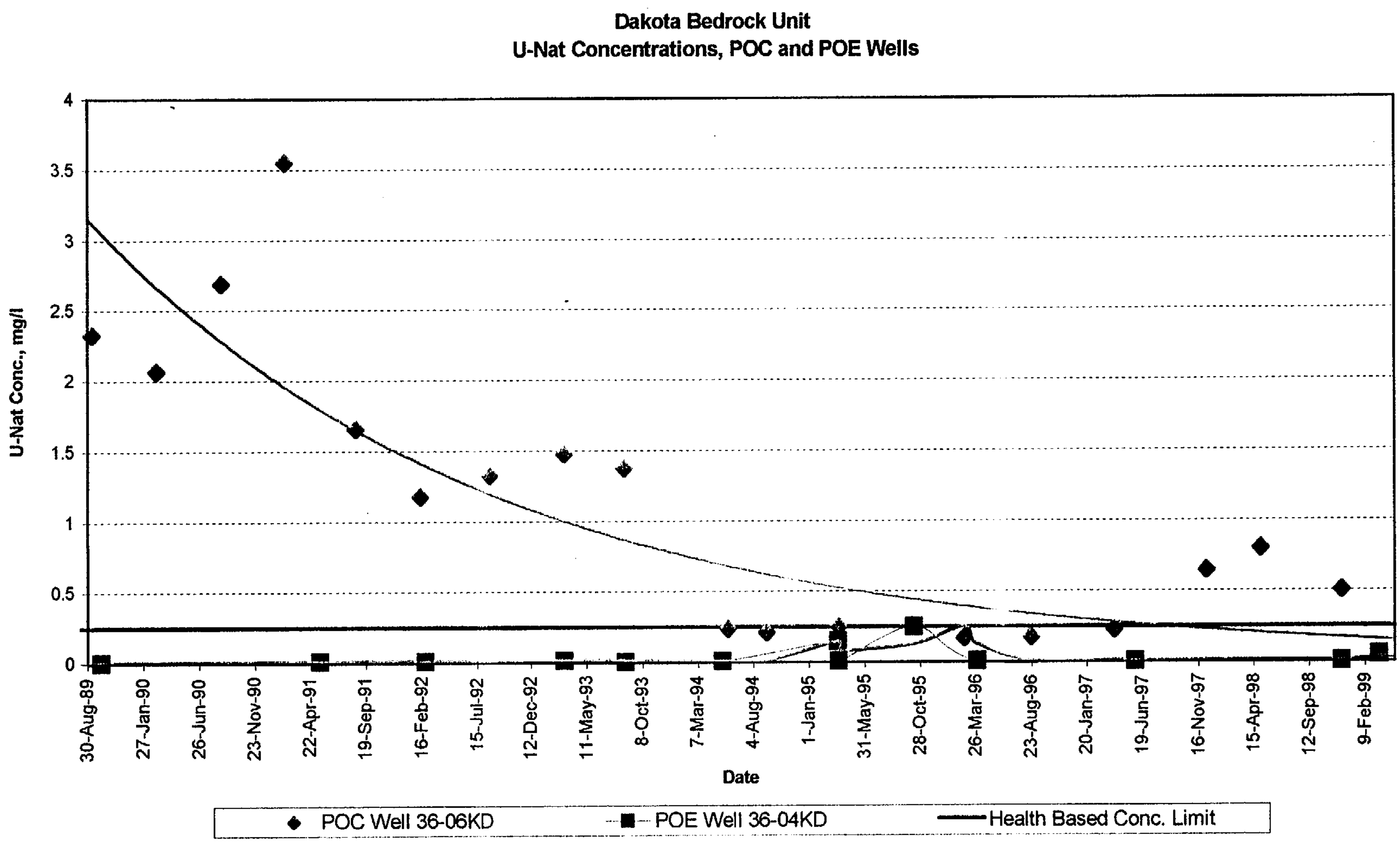

Dakota Bedrock Unit
U-Nat Concentrations, POC and POE Wells
U-Nat Conc., mg/l
4
3.5
3
2.5
2
1.5
1
0.5
0
30-Aug-89
27-Jan-90
26-Jun-90
23-Nov-90
22-Apr-91
19-Sep-91
16-Feb-92
15-Jul-92
12-Dec-92
11-May-93
8-Oct-93
7-Mar-94
4-Aug-94
1-Jan-95
31-May-95
28-Oct-95
26-Mar-96
23-Aug-96
20-Jan-97
19-Jun-97
16-Nov-97
15-Apr-98
12-Sep-98
9-Feb-99
Date
POC Well 36-06KD
POE Well 36-04KD
Health Based Conc. Limit

Figure 2-36

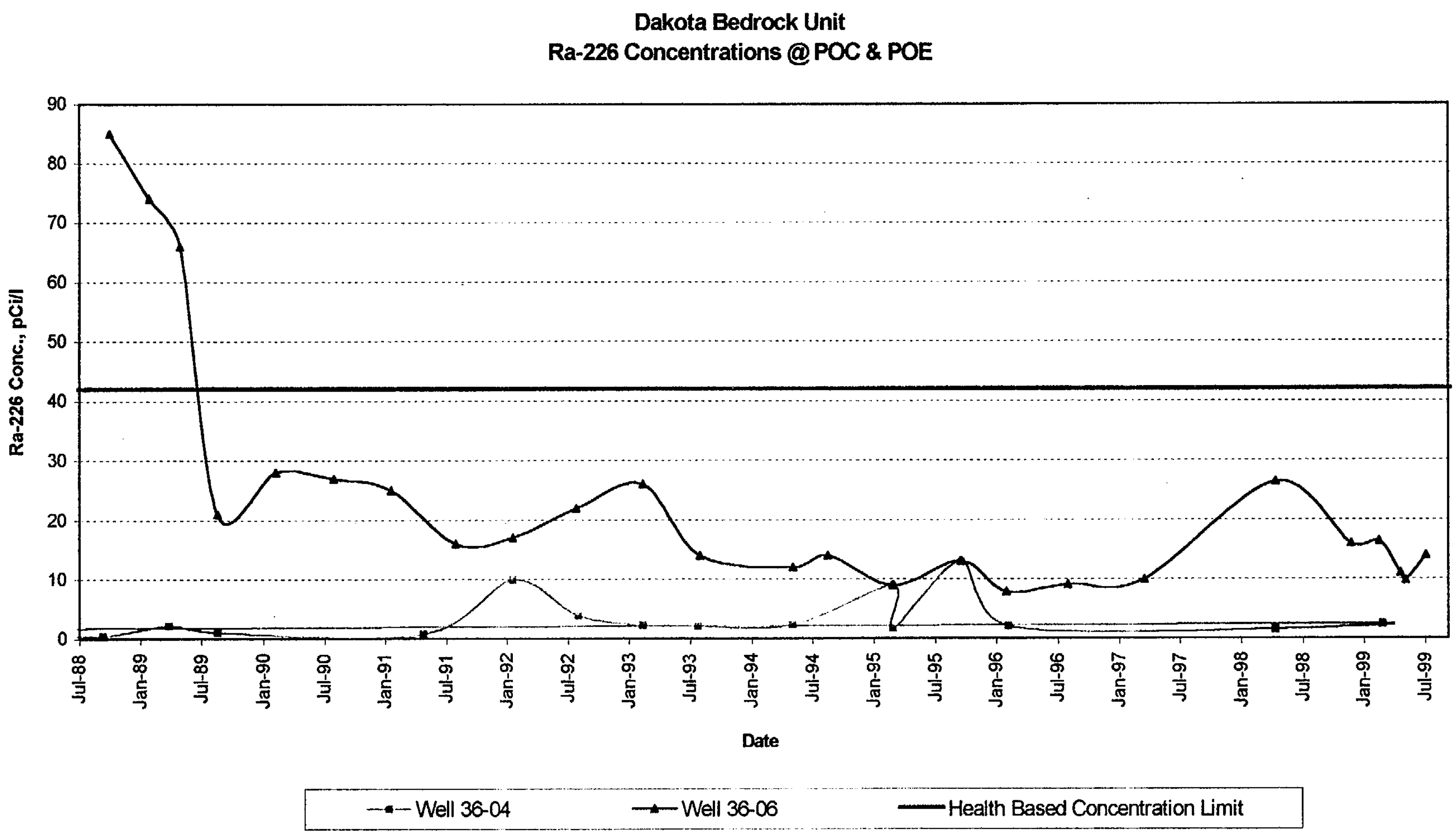

Dakota Bedrock Unit
Ra-226 Concentrations @ POC & POE
Ra-226 Conc., pCi/l
0
10
20
30
40
50
60
70
80
90
Jul-88
Jan-89
Jul-89
Jan-90
Jul-90
Jan-91
Jul-91
Jan-92
Jul-92
Jan-93
Jul-93
Jan-94
Jul-94
Jan-95
Jul-95
Jan-96
Jul-96
Jan-97
Jul-97
Jan-98
Jul-98
Jan-99
Jul-99
Date
Well 36-04
Well 36-06
Health Based Concentration Limit

Figure 2-37

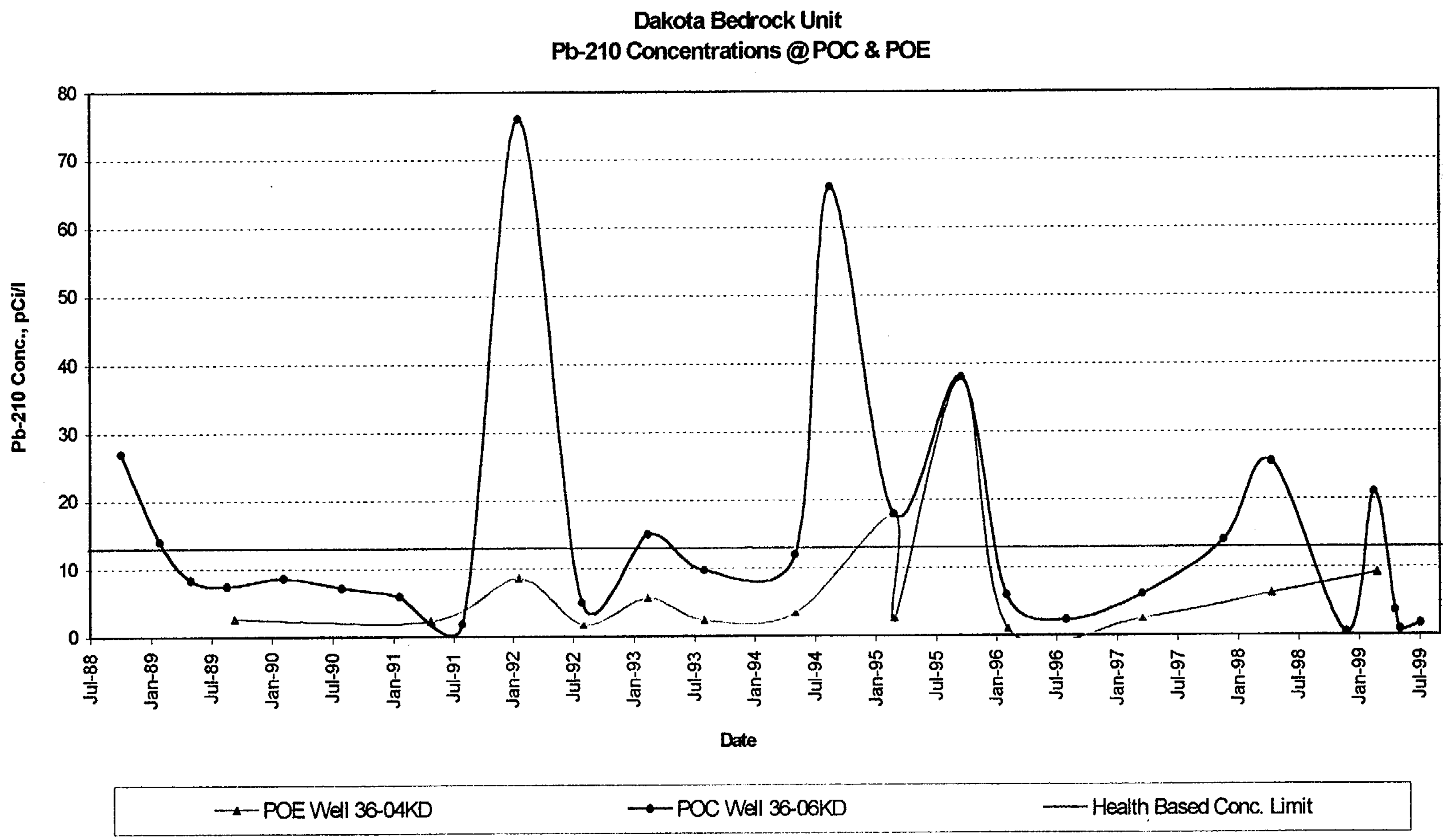

Dakota Bedrock Unit
Pb-210 Concentrations @ POC & POE
Pb-210 Conc., pCi/l
0
10
20
30
40
50
60
70
80
Date
Jul-88
Jan-89
Jul-89
Jan-90
Jul-90
Jan-91
Jul-91
Jan-92
Jul-92
Jan-93
Jul-93
Jan-94
Jul-94
Jan-95
Jul-95
Jan-96
Jul-96
Jan-97
Jul-97
Jan-98
Jul-98
Jan-99
Jul-99
POE Well 36-04KD
POC Well 36-06KD
Health Based Conc. Limit

Figure 2-38

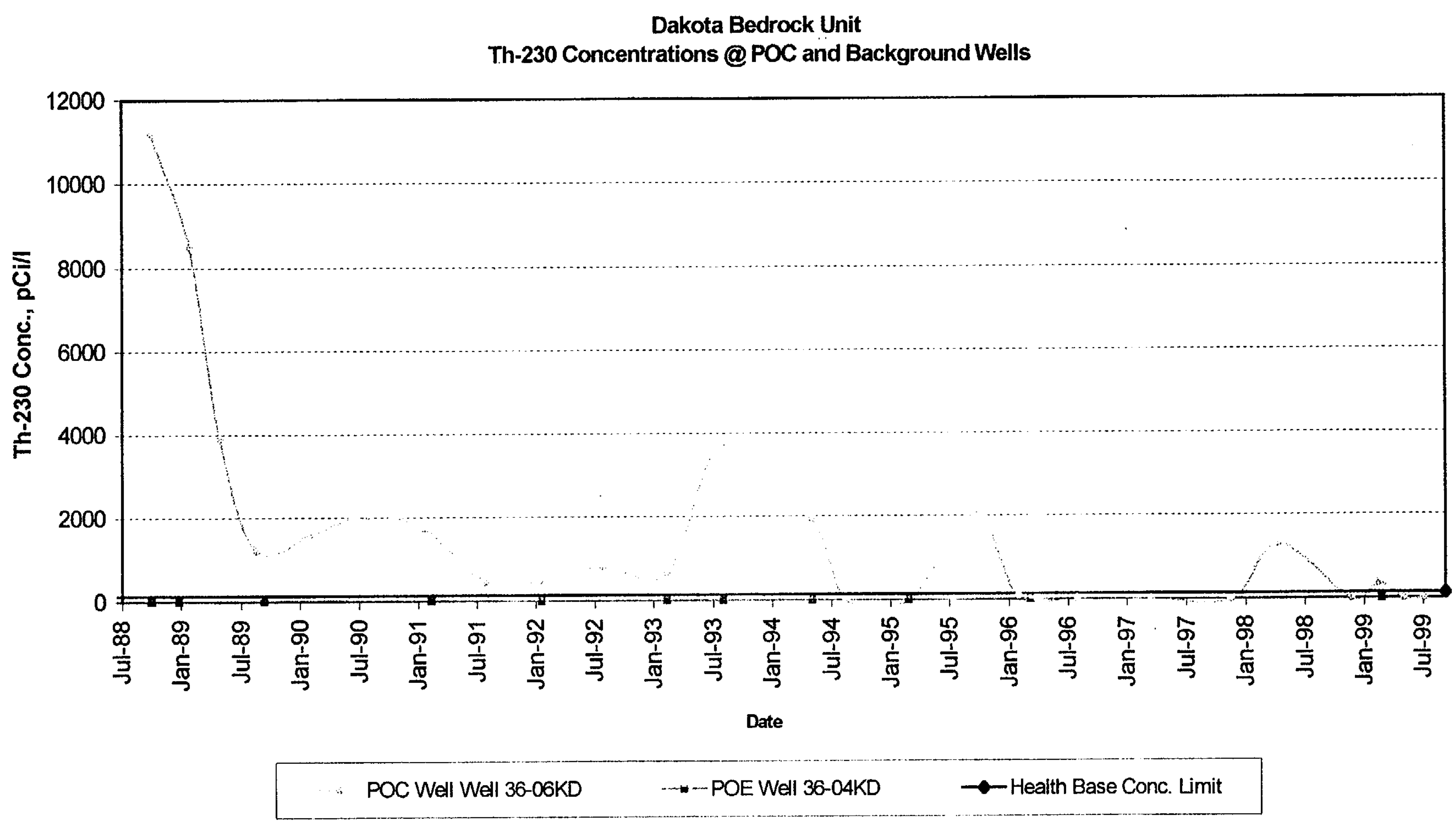

Dakota Bedrock Unit
Th-230 Concentrations @ POC and Background Wells
12000
10000
8000
6000
4000
2000
0
Th-230 Conc., pCi/l
Jul-88
Jan-89
Jul-89
Jan-90
Jul-90
Jan-91
Jul-91
Jan-92
Jul-92
Jan-93
Jul-93
Jan-94
Jul-94
Jan-95
Jul-95
Jan-96
Jul-96
Jan-97
Jul-97
Jan-98
Jul-98
Jan-99
Jul-99
Date
POC Well Well 36-06KD
POE Well 36-04KD
Health Base Conc. Limit

Figure 2-39

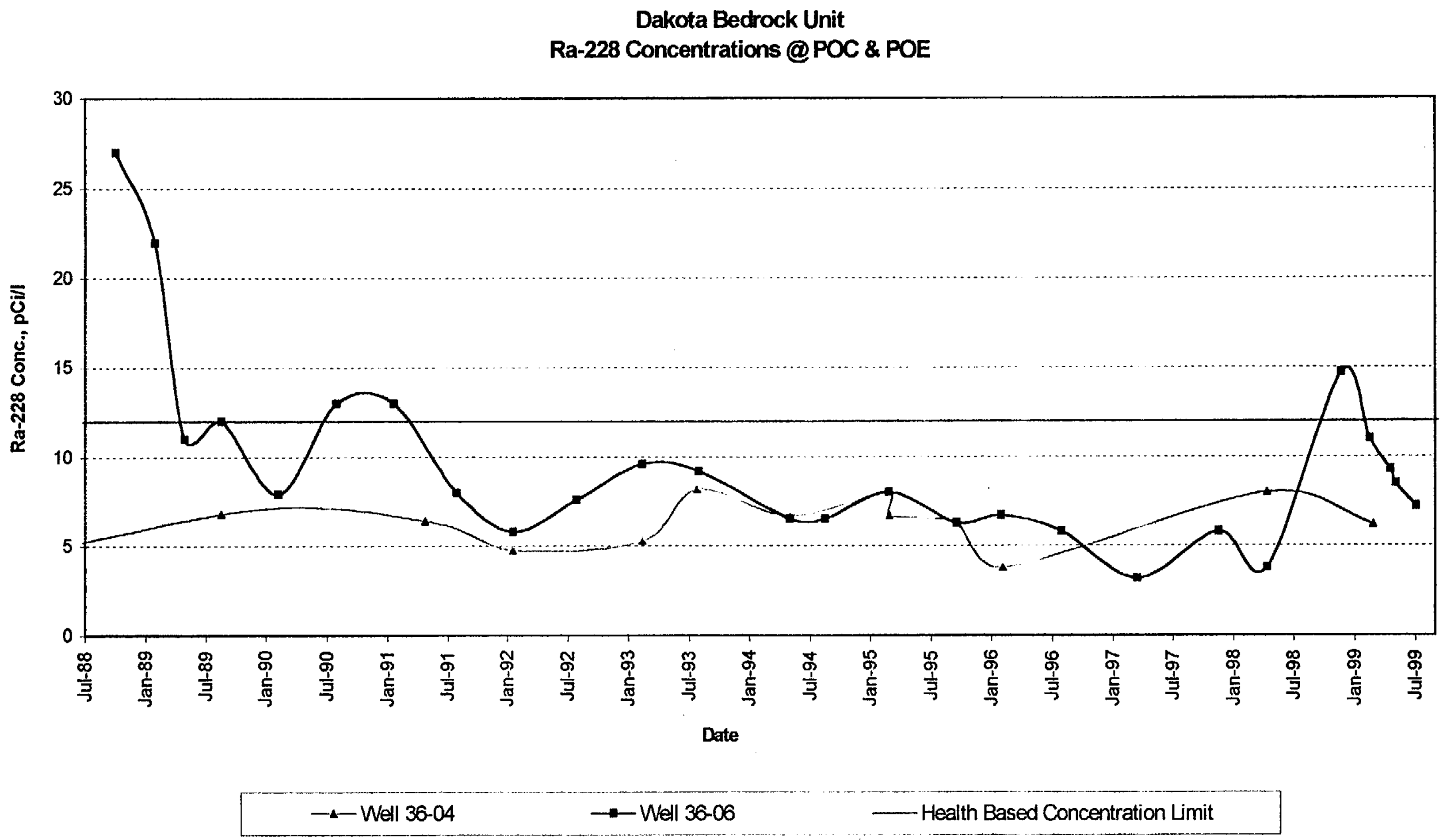

Dakota Bedrock Unit
Ra-228 Concentrations @ POC & POE
Ra-228 Conc., pCi/l
30
25
20
15
10
5
0
Jul-88
Jan-89
Jul-89
Jan-90
Jul-90
Jan-91
Jul-91
Jan-92
Jul-92
Jan-93
Jul-93
Jan-94
Jul-94
Jan-95
Jul-95
Jan-96
Jul-96
Jan-97
Jul-97
Jan-98
Jul-98
Jan-99
Jul-99
Date
Well 36-04
Well 36-06
Health Based Concentration Limit

Figure 2-40

Modeled Chloride Concentrations, Dakota Aquifer

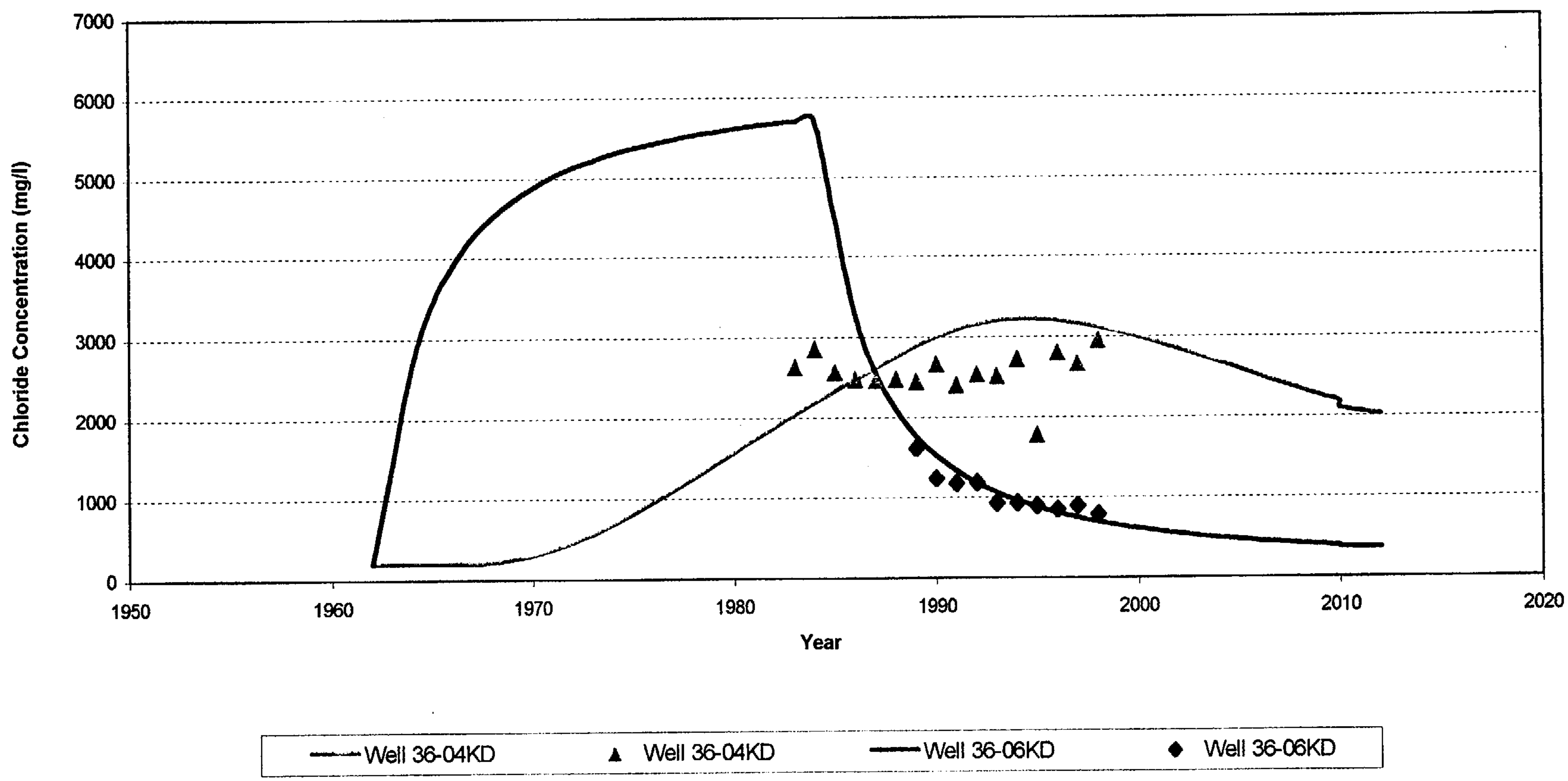
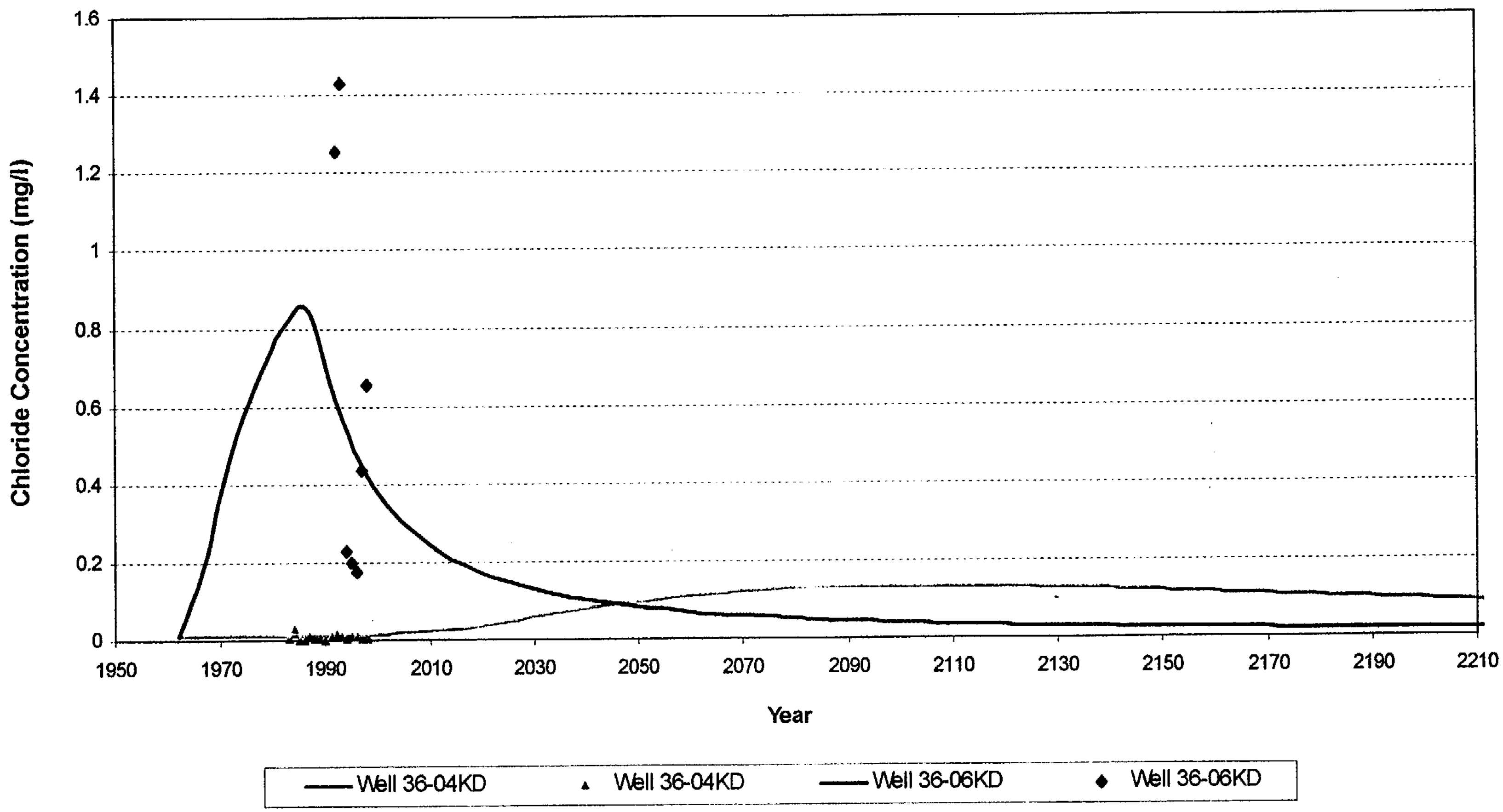


Figure 2-41

Modeled Uranium Concentrations, Dakota Aquifer



3.0 CORRECTIVE ACTION ASSESSMENT

3.1 Previous Corrective Action

In 1959, soon after initiation of milling operations at the Quivira Mining Company (QMC) Ambrosia Lake Uranium Facility (Facility), a trench was excavated at a location east of pond #3 to prevent seepage from Tailings Impoundment #1 from reaching the channel of Arroyo del Puerto. In 1972, this interceptor trench was deepened to increase its effectiveness for seepage collection. The unlined ponds #4, #5, and #6 were not used during the years 1960 to 1975. Instead, the water was diverted to ponds atop Tailings Impoundments #1 and #2 and to the unlined ponds #7 and #8 which were built in 1961.

In 1976, after monitoring well information showed that seepage was occurring from the Tailings Impoundments and evaporation ponds (ponds) at the Facility, synthetic lined ponds #9 and #10 were constructed to accommodate and evaporate excess tailings solutions. In early 1977, additional treatment capacity was added with the construction of the synthetic-lined ponds #11 through #15 located approximately 2 miles southeast of the mill. Also in 1976, the stream course of Arroyo del Puerto was realigned at a location further from the main Tailings Impoundment and unlined ponds #4, #5 and #6 in order to minimize seepage into the channel.

As part of the Assurance of Discontinuance with the New Mexico Water Quality Control Commission, all free tailings solution was removed from unlined ponds #3 through #8. These ponds and lined pond #10 were taken out of service in 1983. Also, the interceptor trench located down gradient of Tailings Impoundment #1 was expanded and excavated into bedrock in 1984. Alluvial material was removed down to the underlying Mancos shale or sandstone contact. The completed trench extends approximately 6,200 feet on the down dip gradient side of Tailings Impoundment #1 along the northern, eastern, and southern toe of Tailings Impoundment #1 as shown on Map 1-1. The interceptor trench has effectively captured seepage from the tailings pile and thereby minimized any migration of tailings seepage to the Alluvium.

Past corrective actions, including minimizing the amount of free water, use of lined ponds, removal of standing tailings solution, construction and operation of the interceptor trench, and construction of the tailings cover, have reduced seepage of tailings fluid to groundwater. Reduced seepage has, in turn, resulted in reduced concentrations of hazardous constituents in groundwater at the Point of Compliance (POC).

3.2 Results of Groundwater Corrective Action Program

Since groundwater protection standards for several constituents are exceeded at the POC in the bedrock and Alluvial units at the Facility, the U. S. Nuclear Regulatory Commission (NRC) required QMC to implement a groundwater Corrective Action Program (CAP). The approved groundwater CAP for each of the bedrock aquifer units is briefly described below.

Since this Alternate Concentration Limits (ACLs) Petition does not request ACLs for the Alluvium, the approved CAP for the Alluvium will continue. This CAP for the Alluvium involves continued operation of the seepage interceptor trench, as shown on Map 1-1. The interceptor trench collects the seepage from the Tailings Impoundment #1 and #2 that is migrating through the weathered bedrock (saprolite) toward the Alluvium of Arroyo del Puerto. The effectiveness of the CAP for the Alluvium will continue to be evaluated in the Annual Reports for the Corrective Action Plan.

3.2.1 Dakota Sandstone

The approved groundwater CAP for the Dakota involves continuation of mine water pumping from the Westwater Canyon Member of the Morrison Formation at the Section 30 and Section 30 West mines. The cone of depression from mine dewatering intercepts any groundwater in the overlying Dakota Sandstone (Dakota) as a result of drainage into ventilation holes mine shafts and mine subsidence induced fractures. The pumped mine water is treated at the Facility and discharged pursuant to the National Pollution Discharge Elimination System (NPDES) permit for mine water discharge.

The results of several downhole surveys of shafts and ventilation holes conducted by QMC, on-going monitoring of water levels in bedrock wells, a bedrock modeling study performed by QMC, and a study conducted by Hydro-Engineering (1992) show that the bedrock groundwater migrating in the Dakota down dip of the Tailings Impoundment and ponds is being intercepted by the mine shafts, ventilation holes and subsidence induced fractures connecting the Westwater Canyon member with the overlying bedrock units. The Dakota unit down gradient of the QMC has an average thickness of about 80 feet. Yet, in the vicinity of the Section 30 and Section 30 West mining areas, the saturated thickness of the Dakota drops to only a few feet of basal saturation as noted in the downhole investigations performed by QMC in 1989. The rate of drainage from the Dakota into the mine workings diminished from 129 gpm in 1983 to 12.5 gpm in 1989.

The residual groundwater in the Dakota in the vicinity of the Section 30 and Section 30 West mines has reached a minimum. As reported to the NRC by QMC in the CAP Annual Report for 1997, the drainage from the Dakota resulting from the mine vent holes and mine shafts has dropped from an estimated amount of almost 6.6 million gallons per year in 1989-1990 to less than 10,000 gallons by 1997. Likewise, uranium recovery has dropped from 8.91 lbs during the 1991-1992 period to essentially zero after 1997, as shown in Figure 3-1.

The approved CAP for the Dakota insures that the groundwater in the Dakota down dip of the mine vent holes and shafts is not impacted by tailings seepage. However, the approved CAP for the Dakota does not protect groundwater in the Dakota in the portions of Sections 36 and 25 located between ponds #7 and #8 and the mine vent holes. Nevertheless, the availability of groundwater in Dakota in this area will continue to diminish due to elimination of ponds in the outcrop and subcrop areas in the vicinity of former ponds #7 and #8 and dewatering of the unit by mine shafts and vent holes in Section 30.

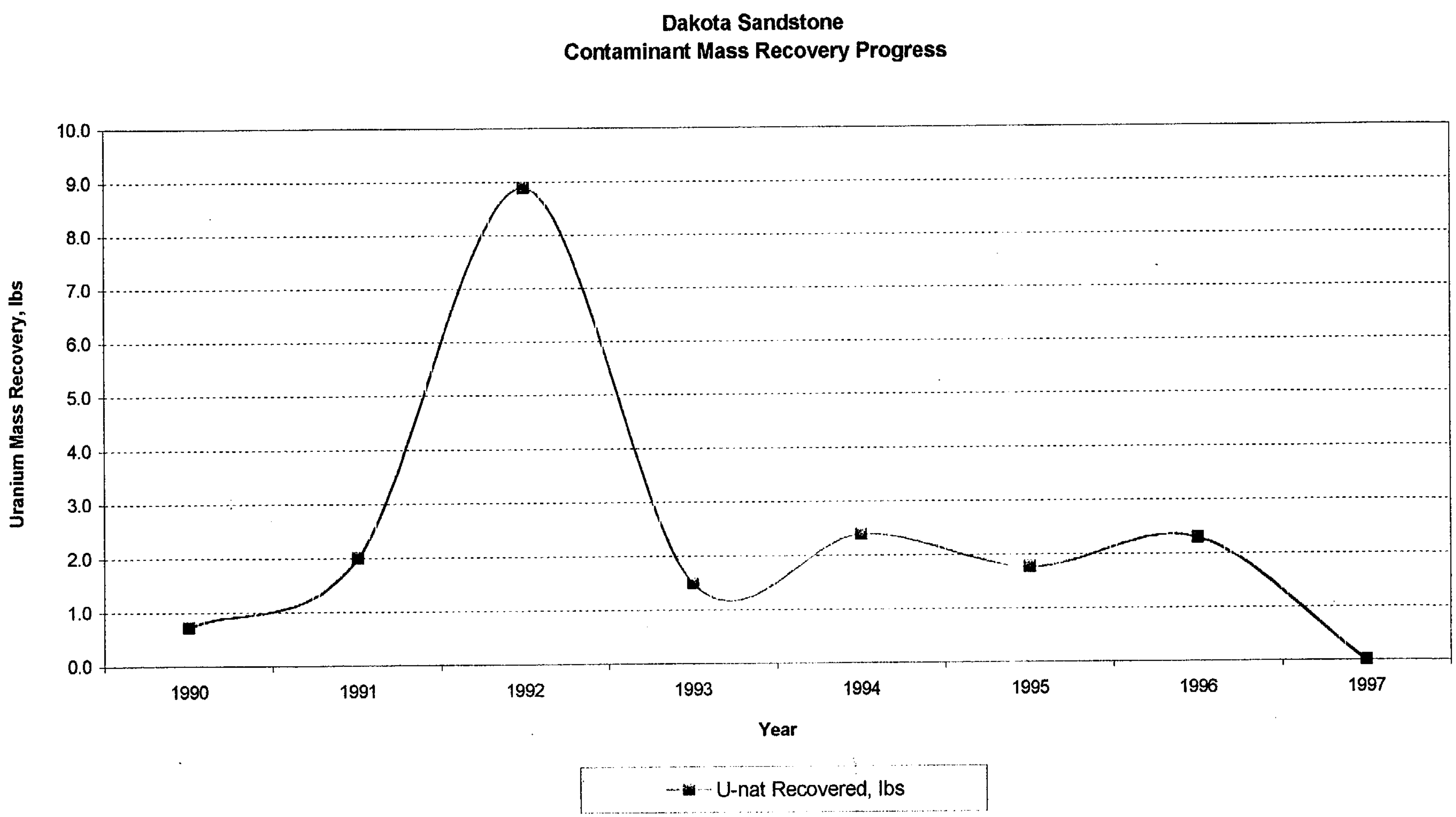
The effectiveness of removal of liquids and byproduct material from ponds #7 and #8 is clearly indicated by the significant decline in the concentration of hazardous constituents at the Dakota POC well 36-06KD. Also as described in Section 2, the saturated thickness down gradient from ponds #7 and #8 has dropped quickly following removal of tailings solution from these ponds.

3.2.2 Tres Hermanos A and Tres Hermanos B Sandstone Units

The approved groundwater CAP for the Tres Hermanos A Sandstone Units (TRA) and Tres Hermanos B Sandstone Units (TRB) also requires continuation of mine water pumping from the Section 30 and Section 30 West mines. The cone of depression from mine dewatering intercepts any groundwater in the overlying TRA and TRB bedrock units as a result of drainage into ventilation holes mine shafts and subsidence induced fractures. A dewatering trench was also installed between pond #7 and pond #2 to intercept seepage entering the TRA from ponds #2 and #7. This dewatering trench is pumped and the produced water is routed to the seepage interceptor trench included in the corrective action plan for the Alluvium.

Since reclamation of the Tailings Impoundments, the dewatering trench collects very little seepage. Likewise, uranium recovery has dropped from 2,200 lbs during the 1989-1990 period to about 25.9 lbs

Figure 3-1


Dakota Sandstone
Contaminant Mass Recovery Progress
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Uranium Mass Recovery, lbs
1990
1991
1992
1993
1994
1995
1996
1997
Year
U-nat Recovered, lbs

during the 1996-1997 period, as shown in Figure 3-2. The dewatering trench is thought to have been effective because the TRA unit, which subcrops in the vicinity of pond #7, has shown very little impact from the Facility operations. However, with the significant drop in recovery from this dewatering trench following reclamation, it is no longer needed or effective.

The drainage of the TRB and TRA by the mine vent holes and shafts serves to prevent possible exposure to groundwater in the TRB and the TRA because it has effectively dewatered the affected portions of the TRB and TRA units down gradient of the long-term institutional control boundary. This feature of the approved CAP also insures protection of the groundwater in the TRB and the TRA units down gradient of the mine vent holes and shafts.

The results of several downhole surveys of shafts and ventilation holes conducted by QMC, on-going monitoring of water levels in bedrock wells, and a study conducted by Hydro-Engineering (1992) show that the bedrock groundwater migrating in the TRB unit down dip of the Tailings Impoundment and ponds is being intercepted by the mine shafts and ventilation holes. The rate of drainage from the TRB unit into the mine workings has diminished from 6 gpm in 1983 to 1.9 gpm in 1989. The monitoring of vent hole 19VH-2 where the flow rate from the TRB had dried up by 1997 indicates further declines in flow rates in the TRB.

The residual groundwater in the TRA and TRB in the vicinity of the Section 30 and Section 30 West mines has reached a minimum. As reported to the NRC by QMC in the CAP Annual Report for 1997, the drainage from the TRB resulting from the mine vent holes and mine shafts has dropped from an estimated amount of almost 1 million gallons per year in 1990 to about 0.11 million gallons by 1997. Likewise, uranium recovery has dropped from 1.2 lbs/year during the 1991-1992 period to about 0.24 lbs/year in the 1996-1997 period, as shown in Figure 3-3.

3.3 Feasibility of Bedrock Groundwater Corrective Action Alternatives

Alternative groundwater corrective action technologies were previously considered for potential implementation at the bedrock units at the Facility in the Proposed Corrective Action Plan (September 25, 1989) and Corrective Action Plan Supplemental Information (December 21, 1989). Mine water pumping from the Section 30 and Section 30 West Mines was selected as the most practicable and effective groundwater corrective action for the bedrock units at the Facility. Continuation of

Figure 3-2

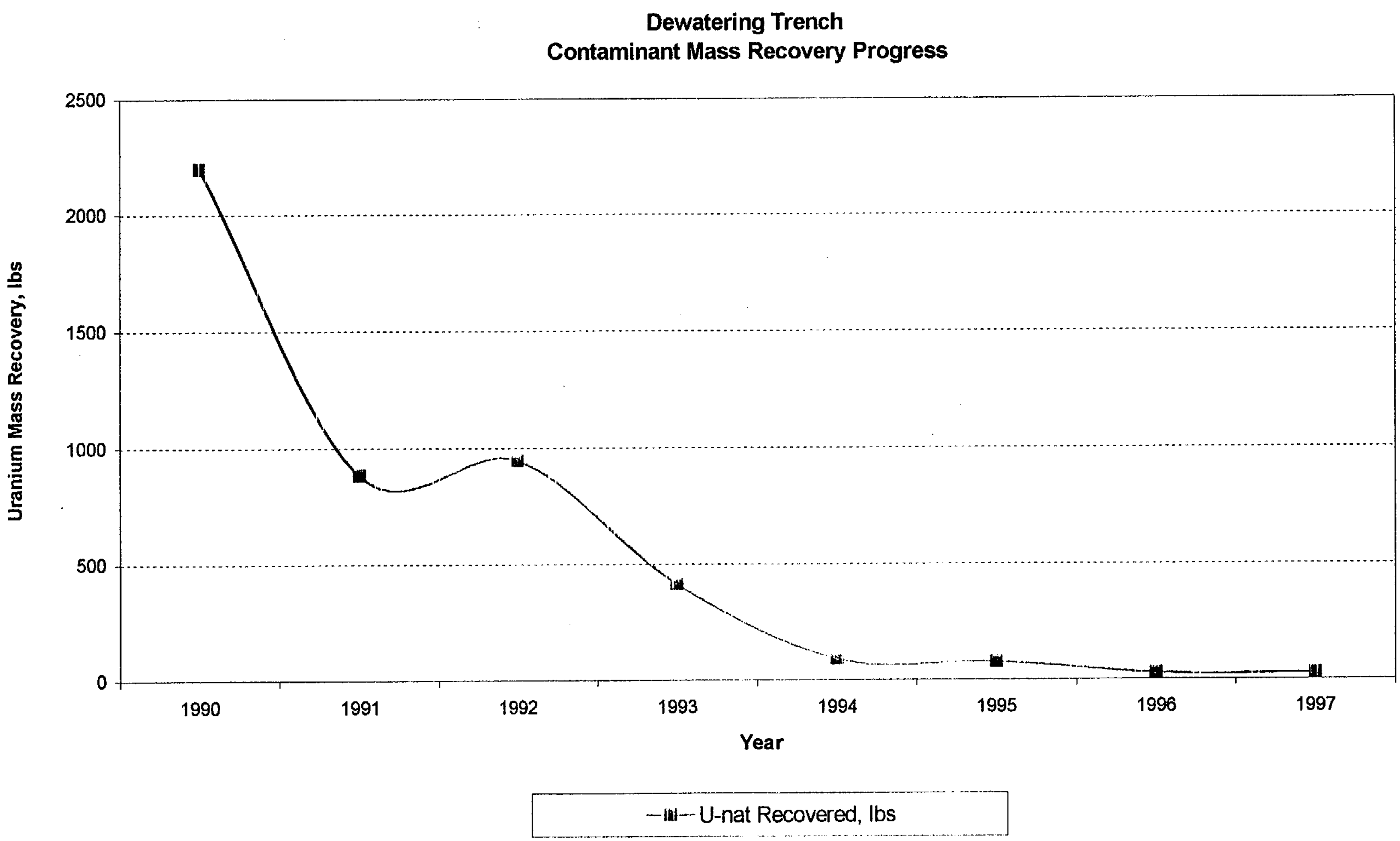
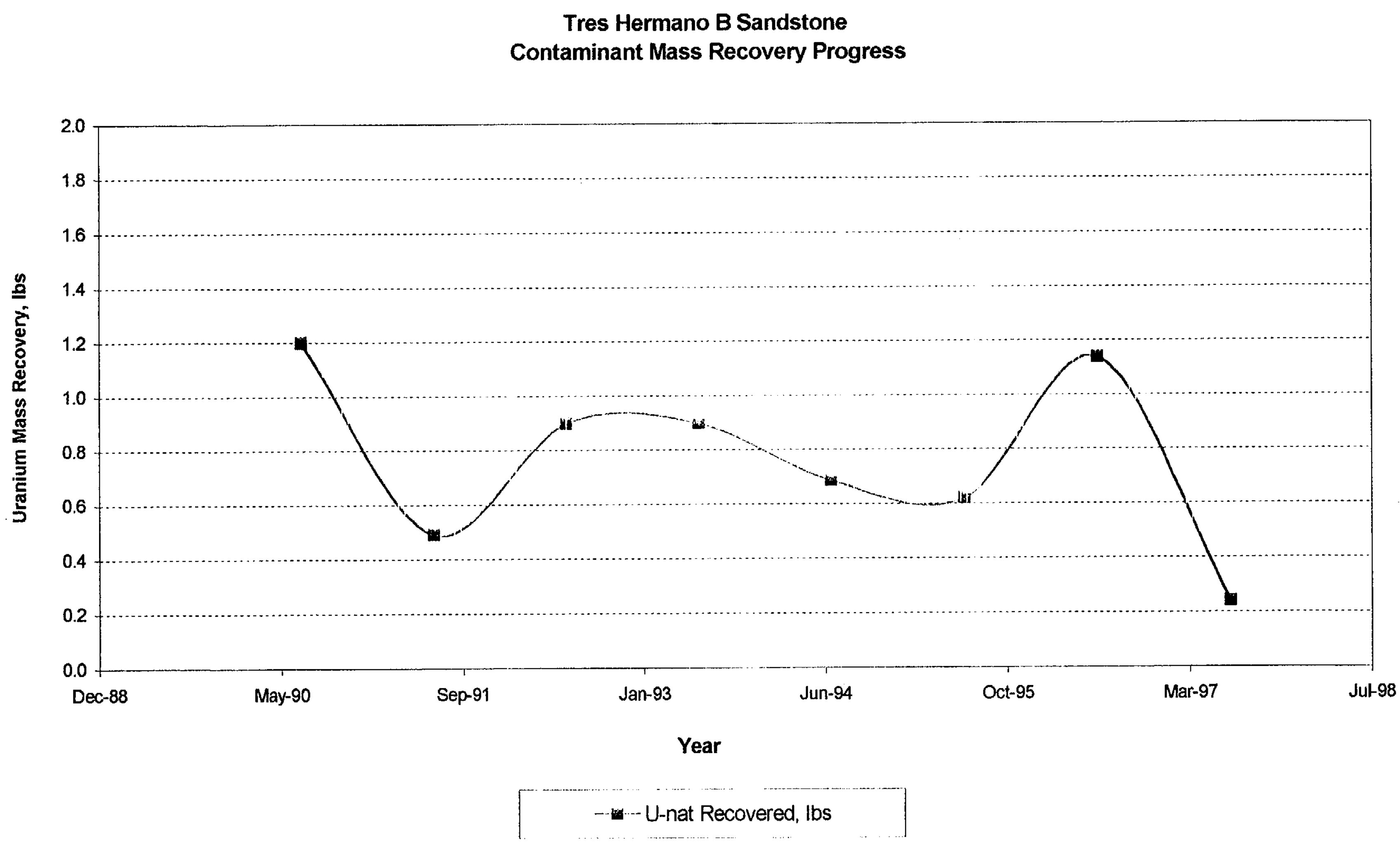

Dewatering Trench
Contaminant Mass Recovery Progress
2500
2000
1500
1000
500
0
Uranium Mass Recovery, lbs
1990
1991
1992
1993
1994
1995
1996
1997
Year
U-nat Recovered, lbs

Figure 3-3


Tres Hermano B Sandstone
Contaminant Mass Recovery Progress
Uranium Mass Recovery, lbs
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Dec-88
May-90
Sep-91
Jan-93
Jun-94
Oct-95
Mar-97
Jul-98
Year
U-nat Recovered, lbs

mine water pumping insures that groundwater in the bedrock units continues to be intercepted by the mine shafts and ventilation holes that drain into the vast network of mine workings within the Westwater Canyon Member of the Morrison Formation.

With final reclamation at the QMC nearing completion, the range of other practical groundwater corrective action alternatives for the bedrock units is limited. Several alternative technologies are re-examined for potential feasibility and effectiveness as corrective action measures for the shallow bedrock units at the Facility. The potentially feasible alternatives to the continuing the current CAP for the bedrock units include the following:

- enhanced tailings dewatering,
- groundwater interception and treatment,
- tailings reclamation and termination of mine water pumping and treatment.

Groundwater barriers are not considered to be cost-effective corrective action alternatives because they need to be combined with groundwater extraction in order to be effective and they do not provide greater effectiveness than the groundwater interception and treatment measures. The evaluation of the potentially feasible alternatives and the selection of the recommended actions are presented below.

3.3.1 Enhanced Tailings Dewatering

With the exception of the main Tailings Impoundments #1 and #2, all the unlined ponds and pond residues containing byproduct material have been removed. The main Tailings Impoundments will slowly dewater from completion of tailings reclamation and construction of the low permeability cover.

Enhanced dewatering of the main Tailings Impoundments #1 and #2 would require numerous pumping wells installed through the cap. Furthermore, extraction of fluids from the tailings slimes would not be feasible. Based on the experience with dewatering of tailings sands at the Bluewater Mill, it is estimated that about 50 dewatering wells would be needed and that pumping could be sustained for about 4 years. However, since the radon barrier and reclamation cover has been placed on Tailings Impoundments #1 and #2 and some of the tailings fluids have been compressed and drained from the tailings, further tailings liquids extraction would be reduced and the pumping period may be considerably shorter than 4 years. Any tailings liquids recovered by this process would need to be treated at the mill to recover uranium and the treated liquid would be disposed in the existing ponds. Construction of additional ponds for these liquids was not included in the cost estimation for this alternative, although further analysis would be needed to verify this assumption

Penetration of the cap for the installation of wells would increase the potential rate of infiltration through the cap. Also, most of the tailings solution seeping from the main Tailings Impoundment is already captured and removed by the interceptor trench, a key component of the groundwater CAP for the Alluvial aquifer. This conclusion is based on the 446,300,000 gallons of water containing high concentrations of U-nat; Ra-226, Pb-210, and Th-230 compared to the relatively negligible increase in these constituents in the TRB groundwater down gradient of the main Tailings Impoundments.

3.3.2 Groundwater Interception and Treatment

All practicable groundwater interception and treatment options have already been implemented at the Facility. The seepage interceptor trench shown on Map 1-1 will continue to be operated as a component of the approved CAP for the Alluvium. Several interception drains have also been constructed along the southeast side of Tailings Impoundment #1 to intercept seepage to the Alluvium of Arroyo del Puerto. As discussed in Section 3.2.2, a dewatering trench was installed between pond #7 and pond #2 to prevent seepage from entering the TRA from ponds #2 and #7.

Because of the difficulty and cost involved in constructing an interception trench into the unweathered bedrock, interception wells would provide the only practicable means for intercepting groundwater flow in the bedrock units down gradient of the Facility. Interception wells placed in the Dakota down gradient of ponds #7 and #8 would not be an effective groundwater corrective action because Section 36 wells are not capable of producing sufficient water as indicated in the May 14, 1990 letter from NRC to QMC (NRC 1990). Furthermore, with removal of byproduct materials from the pond #7 and #8 locations, the seepage source has been removed. Thus, interception wells would provide no reduction in the concentrations of constituents in the Dakota since there is no continuing seepage source to intercept. Also, with the removal of the tailings solution from ponds #7 and #8, the saturated thickness in the Dakota has declined. Interception wells placed down gradient of POC well 36-06KD would only serve to accelerate the rate of water level decline in Dakota down gradient of ponds #7 and #8 and would not be effective for reducing concentrations of hazardous constituents in the Dakota

Interception wells could be placed in the TRB unit down gradient of the main Tailings Impoundments #1 and #2 in an effort to intercept the minor amount of tailings seepage reaching the TRB. The saturated thickness in the TRB down gradient of Tailings Impoundment has dropped over time and is currently about 12, 16, and 75 feet at wells 36-02trb, 31-66 and 31-67, respectively.

An approximate well spacing needed to insure capture can be estimated from the procedure of Keely and Tsang (1983). Effective capture occurs as long the velocity toward the pumping well ($v_{pumping}$) is always greater than the natural velocity in the aquifer ($v_{natural}$). The stagnation point occurs where $v_{pumping} = v_{natural}$, and the maximum effective radius for capture by the well, r, can be determined as follows:

$$v_{natural} = v_{pumping} = Q/(2\pi r h \phi)$$

or $$r_{(feet)} = Q/(2\pi h \phi\ v_{natural})$$

where Q is pumping rate in cubic feet/day,
h is saturated thickness in feet
ϕ is effective porosity, and
$v_{natural}$ is the natural velocity in the aquifer in feet/day

In Section 2.3.1, the average groundwater velocity in the TRB down gradient of the Facility was estimated to be 0.67 ft./day based on an effective porosity of 0.05. The saturated thickness in the TRB immediately down gradient of the TRB appears to vary from about 10 to 75 feet. The pumping rates that may be sustained from wells completed in the TRB is likely to range from about 0.2 gpm to perhaps as high as 1 gpm in the locations with greater saturated thickness. From these values the capture effective radius for a well appears to vary from about 20 to 40 feet. Using the maximum radius of 40 feet or a spacing between wells of about 80 feet, approximately 50 wells would be needed to insure capture groundwater through the 4000 foot segment between POC wells 36-02trb and 31-67. Based on this analysis, the initial pumping rate from all 50 wells would be almost 20 gpm but would decline as the saturated thickness in the TRB continues to drop.

3.3.3 Tailings Reclamation and Termination of Mine Dewatering

The Reclamation Plan with termination of mine dewatering is considered as the Base Case, the alternative against which other corrective action measures are compared. Decommissioning and reclamation of the Facility is being completed in accordance with NRC standards. Removal of byproduct material from the locations of ponds #3 through #8, and the installation of the radon barrier and low permeability cover on

Tailings Impoundments #1 and #2, will effectively eliminate the facility as a future active source of groundwater contamination.

Termination of mine dewatering is included in base case because pumping of mine water is no longer effective and necessary to accomplish the interception of groundwater from the shallow bedrock units for a considerable length of time into the future. Regional groundwater modeling studies (USGS, Phillips, Mobil and Conoco) demonstrate that it will take hundreds of years for the mine dewatering centers to recover following termination of mine pumping in order for the down-dip flow toward the northeast to be re-established in these bedrock units (Bostick 1985). Thus, the effectiveness of the bedrock groundwater CAP will be maintained for several centuries after active mine pumping is terminated.

3.4 Corrective Action Costs

This section summarizes and compares the costs of alternative corrective actions. Present values of the feasible corrective action were calculated to facilitate an equitable evaluation of total costs in comparison with benefits. Cost estimates for the additional corrective actions were prepared to a feasibility level of accuracy, i.e. +/- 25 percent. Present values were calculated assuming a net discount rate of 2% (interest rate minus operating cost inflation rate). All capital costs are assumed to be incurred in the first year. The estimates in the Present Value Calculation are in 1999 dollars.

3.4.1 Cost of Mine Pumping for the Bedrock CAP

The current cost for maintaining the CAP for the bedrock units is budgeted by QMC at $700,000 per year. For long term operation, the cost would surely increase due to the need to replacement of pumps, mine shafts, or mine water treatment components. For instance, in May 1998, the Section 30 shaft experienced a cave-in at a depth of 370 feet from the surface resulting in complete sealing of the shaft. An additional pump was installed in the Section 30 West shaft to maintain the production needed for mine dewatering. Further cave-ins can be expected during long term operations that would require installation of new shafts and pumps. Thus, a total cost of about $1 million per year (1999 dollars) is a reasonable estimate for the annual operation and maintenance of the bedrock CAP.

The groundwater CAP for the bedrock units would need to continue for about 50 years to achieve any significant extension in the time period for groundwater to recover in the bedrock units. The present net value of continuing the mine pumping for an additional 50 years at an annual operating and maintenance cost of $1,000,000 per year is approximately $32,050,000.

3.4.2 Cost for Tailings Dewatering

Brief summaries of the major capital and operating cost components for tailings dewatering are summarized in Table 3-1. In the present value calculations, it is assumed that would occur over a 4-year period. The actual time period could be shorter as some of the tailings fluids have been compressed and drained from the tailings since placement of the radon barrier and cap.

Table 3-1 Potential Future Corrective Action Capital and Operating Costs Tailings Dewatering

Corrective Action Component	Capital Cost	Annual Operating Cost	Present Value (Year 1999)
Installation of 50 Wells to depth of 55 ft	$ 140,000.		$ 140,000.
Installation electrical supply & 50 pumps	$ 300,000.		$ 300,000.
Installation of Headers & Piping (10,000 ft.)	$ 300,000.		$ 300,000.
Water Treatment System Upgrade	$ 150,000.		$ 150,000.
O&M of Pumps & Piping (4 years)		$ 300,000.	$ 1,142,000.
Water Treatment O&M (4 years)		$500,000.	$ 1,904,000.
Net Present Value			$ 3,936,000.

3.4.3 Cost for Groundwater Interception and Treatment

Brief summaries of the major capital and operating cost components for Groundwater Interception and Treatment are summarized in Table 3-2. For cost estimation purposes it is assumed that this corrective action is operated for a period of about 20 years. After that period of time the TRB unit between the main Tailings Impoundments and the mine vent holes and shafts in Section 30 would be essentially dewatered.

**Table 3-2 Potential Future Corrective Action Capital and Operating Costs
Groundwater Interception and Treatment**

Corrective Action Component	Capital Cost	Annual Operating Cost	Present Value (Year 1999)
Installation of 50 Wells to depth of 100 ft	$ 200,000.		$ 200,000.
Installation electrical supply & 50 pumps	$ 300,000.		$ 300,000.
Installation of Headers & Piping (7,000 ft.)	$ 210,000.		$ 210,000.
Water Treatment Upgrade	$ 150,000.		$ 150,000.
O&M of Pumps & Piping (20 years)		$ 200,000.	$ 3,336,000.
Water Treatment & Disposal (20 years)		$50,000.	$ 190,000.
Net Present Value			$ 4,386,000.

3.4.4 Cost for Tailings Reclamation and Termination of Mine Water Pumping

Since this is the base case, a cost estimate for this alternative was not developed. Instead, costs were developed for the other corrective action alternative, which would be an addition to the base Case.

3.5 Corrective Action Benefit

3.5.1 Benefit of Mine Pumping for the Bedrock CAP

The approved CAP for the bedrock units serves to prevent possible exposure to groundwater in the TRB and the TRA because it has effectively dewatered the affected portions of the TRB and TRA units down gradient of the long-term institutional control boundary. The approved CAP for the bedrock units also insures protection of the Dakota, the TRB, and the TRA units down dip of the mine vent holes and shafts. However, the approved CAP for the Dakota unit does not protect groundwater in the Dakota in the portions of Sections 36 and 25 located between ponds #7 and #8 and the mine vent holes.

As demonstrated in Section 3.3.3, pumping of mine water is not necessary to accomplish the interception of groundwater from the shallow bedrock units for a considerable length of time into the future because of the slow rate of groundwater level recovery in Westwater Canyon member of the Morrison Formation and the overlying bedrock units. Furthermore, nearly all the health risk-based concentration limits are already being met at the POC wells for the bedrock units. Where the health risk-based standards are not currently being met at a bedrock unit POC well, attenuation of the concentrations between the POC and any potential POE location beyond the long-term institutional control boundary will insure that health risk-based concentrations will be met for any groundwater migration to potential Point of Exposure (POE) locations.

Therefore, the continuation of the groundwater CAP for the bedrock units provides no additional protection of public health and the environment, especially given that groundwater levels will not recover at most of the potential POE locations for hundreds of years. The drawdown in the mine dewatering centers will take several centuries to recover before groundwater in the TRA and TRB bedrock units down gradient of the Facility can support limited use or migrate down gradient through the bedrock units beyond the mine dewatering centers. In the Dakota, the approved CAP is not effective in reducing concentrations of hazardous constituents at the POC or at the potential POE located in the portions of Sections 36 and 25 located between ponds #7 and #8 and the mine vent holes.

3.5.2 Benefit of Enhanced Tailings Dewatering

Enhanced dewatering of the Tailings Impoundments #1 and #2 using approximately 50 pumping wells would extract liquids from the tailings sands but would not recover fluids from the tailings slimes. The primary benefit of this alternative would be to shorten the time period required to operate interceptor trench included in the CAP for the Alluvial aquifer since most of the tailings solution seeping from the main Tailings Impoundment is captured by this trench. This conclusion is based on the 446,300,000 gallons of water containing high concentrations of U-nat; Ra-226, Pb-210, and Th-230 recovered by the interceptor trench since 1989 compared to the relatively minor increase in these constituents observed in the TRB groundwater down gradient of the main Tailings Impoundments. Also tailings solution would continue to slowly seep from the tailings slimes and from the residual fluid in the tailings sands that cannot be practically recovered by pumping.

While tailings dewatering may provide minor reduction in tailings seepage reaching the TRB, it would, at best, result in only marginal changes in the concentrations in the TRB down gradient of the Facility and it would have no affect on the concentrations in the Dakota and TRA. As discussed in Section 2, recent concentrations of hazardous constituents in POC wells in the TRB have been below the health risk-based concentration limits. Thus, enhanced dewatering of the main Tailings Impoundment would not be a cost-effective corrective action for the bedrock units at the Facility. The penetration of the tailings reclamation cover and the handling of tailings water and treatment residuals would pose far greater risk and potential environmental concern than any minor change in hazardous constituent concentrations in the TRB which already meet health risk-based limits at the POC.

3.5.3 Benefit of Groundwater Interception and Treatment

Interception wells placed in the TRB unit down gradient of the main Tailings Impoundments #1 and #2 would not be a cost-effective groundwater corrective action because of the minor amount of tailings seepage reaching the TRB as demonstrated by the relatively low concentrations of hazardous constituents in the POC wells installed in the TRB. Furthermore, with the reclamation of Tailings Impoundments #1 and #2, which overlie the outcrop and subcrop of the TRB unit, the seepage of tailings solution into this unit will decline. Like tailings dewatering, installation and operation of interception wells in the TRB unit would likely produce little change in the concentrations of constituents in the TRB down gradient of the Facility.

Since recent concentrations of hazardous constituents in POC wells in the TRB down gradient of the main Tailings Impoundments #1 and #2 have been below the health risk-based concentration limits, the corrective action would accomplish little other than to accelerate the rate of dewatering of the TRB within the long-term institutional control area. Finally, the interception of groundwater flows in the TRB unit by the mine shafts and ventilation holes provides a greater degree of effectiveness than would be achieved by the installation and operation of a bedrock interception trench or interception wells installed in the TRB closer to the main tailings facility. By dewatering of the TRB down gradient of the Facility within the closest POE location, the dewatering by the mineshafts and ventilation holes precludes any potential exposure to groundwater in the TRB.

3.5.4 Benefit of Tailings Reclamation and Termination of Mine Dewatering

The reclamation activities already performed at the Facility have reduced seepage impacts significantly. With the removal of byproduct material at the locations of unlined ponds #7 and #8, which overlie the Dakota outcrop and subcrop, the source for leaching of hazardous constituents into the Dakota has been eliminated. Also, the rate of seepage into the Dakota from these pond locations has dropped dramatically, as indicated by the decline in water levels in the Dakota after tailings solutions were removed from these ponds in 1983. These measures have led to a reduction in the availability of groundwater in Dakota between former ponds #7 and #8 and the POE well 36-04KD. Furthermore, the concentrations of hazardous constituents at POC well 36-06KD in the Dakota have also declined along with the drop in water levels.

These measures have accomplished all that can be achieved with any other feasible groundwater CAP for the Dakota. The reclamation activities, the designation of ACLs for the Dakota, and the establishment of the long-term institutional control area boundary proposed in this ACL Petition provides protection of public health and the environment and insures that the groundwater in the Dakota down gradient of the institutional control boundary will continue to meet health risk-based standards.

With the installation of the radon barrier and low permeability cover over Tailings Impoundments #1 and #2, recharge to the tailings will be minimal and the amount of future seepage from Tailings Impoundments #1 and #2 will diminish and will be small in comparison to past seepage. The main pathway for seepage migration from over Tailings Impoundments #1 and #2 is through the weathered bedrock (saprolite) toward the interceptor trench that is part of the approved groundwater CAP for the Alluvium. A minor fraction of this seepage will continue to reach the TRB bedrock unit where the concentrations of hazardous constituents will be attenuated by neutralization, precipitation, dilution and dispersion, adsorption, biological degradation or assimilation, radioactive decay, and matrix diffusion. Little or no seepage from Tailings Impoundment #1 and #2 will reach the TRA or Dakota units as these units are separated from the TRB by low permeability shales.

Reductions in the rate of seepage of tailings solution from Tailings Impoundments #1 and #2 will result in eventual reduction in the concentrations of hazardous constituents at the POC wells in the TRB unit. The reclamation activities, the designation of ACLs for the TRB and TRA units, and the establishment of the long-term institutional control area boundary proposed in this ACL Petition provide protection of public health and the environment. The analysis provided in this ACL Petition demonstrates that the groundwater migrating from the POC through the TRB or the TRA units will meet health risk-based standards at potential POE locations even though groundwater levels will not recover in these units at the potential POE locations for hundreds of years.

As discussed previously in this Chapter, pumping of mine water is not necessary to accomplish the interception of groundwater from the shallow bedrock units for a considerable length of time into the future. Therefore, the continuation of the groundwater CAP for the bedrock units provides no benefit. The drawdown in the mine dewatering centers will take several centuries to recover before groundwater in the bedrock units down gradient of the Facility can support limited use or migrate down gradient through the bedrock units beyond the mine dewatering centers.

3.6 Demonstration of ALARA Principles

The evaluation of the results of previous corrective actions indicates that the hazardous constituents in the bedrock aquifer units are at levels which are as low as reasonably achievable (ALARA). Past actions have included:

- construction of lined ponds.
- installation of the dewatering trench,
- installation of the interceptor trench and several interceptor drains:
- removal of byproduct materials from the unlined ponds #3 through #8;
- removal of standing waters from Tailings Impoundments;
- placing a cap over the main Tailings Impoundments #1 and #2; and
- implementation of the groundwater CAP for each of the aquifer units.

These corrective action measures have been implemented to maintain future hazardous constituent concentrations at levels which are as low as reasonably achievable.

The corrective action evaluations described above showed that it would not be practicable or cost-effective to implement tailings dewatering of impoundments #1 and #2 or groundwater interception and treatment in the bedrock units in an effort to further reduce the concentrations of hazardous constituents at the POC wells in the bedrock units. These corrective action measures would entail treatment of tailings solution or contaminated groundwater. The cost of these alternative and the environmental concern and potential exposure associated with handling and disposal of the recovered water and treatment residuals would outweigh any benefit resulting from possible minor changes in hazardous constituent concentrations in the TRB which already meet health risk-based limits. As discussed, these alternatives would provide no benefit for the Dakota because byproduct materials have been removed from the pond #7 and #8 locations and there is no continuing seepage source to remove or intercept.

Recent concentrations of hazardous constituents in POC wells in the TRB down gradient of the main Tailings Impoundments #1 and #2 have been below the health risk-based concentration limits. Tailings dewatering would, at best, result in a slight increase in the rate at which hazardous constituent concentrations will decline in the POC wells in the TRB relative to the reclamation base case. Likewise, interception wells in the TRB unit would likely produce only minor changes in the concentrations of constituents in the TRB down gradient of the Facility.

The drawdown in the mine dewatering centers will take several centuries to recover before groundwater in the TRA and TRB bedrock units down gradient of the Facility can support limited use or migrate down gradient through the bedrock units beyond the mine dewatering centers. Removal of byproduct material from the locations of ponds #3 through #8 and the installation of the radon barrier and low permeability cover on Tailings Impoundments #1 and #2, has effectively eliminated the facility as a future active source of groundwater contamination in the bedrock units.

Table 3-3 summarizes the costs and benefits of alternative corrective actions relative to the base case of Tailings Reclamation and Termination of Mine Dewatering. Benefits are summarized in terms of the estimated reduction in U-nat concentrations at the POC. Estimated cost of each corrective action alternative and the cost per unit U-nat concentration reduction at the POC as a measure of the cost-effectiveness of the alternative.

It is uncertain how much the concentrations of hazardous constituents might be reduced at the POC in the TRB as a result of the alternatives of enhanced tailings dewatering or groundwater interception and treatment. The estimated 50% reduction in the U-nat concentration at the POC in the TRB was considered the most optimistic reduction that could be expected. For the other hazardous constituents (Pb-210, Th-230, and Ra-226) in groundwater at the POC well, any reduction in concentration would be within the wide variation in the concentrations of these constituents observed at POC wells. Nevertheless, a 50% reduction in the average concentration since 1997 measured in well 31-66 was assumed for these constituents in order to perform an ALARA analysis. This POC well featured the highest concentration of U-nat for all the TRB POC wells.

Marginal changes in the concentrations of hazardous constituents at POC wells in all the bedrock units resulting from either enhanced tailings dewatering or groundwater interception would be minor compared to the changes that have resulted from the corrective actions alternatives already implemented. The effectiveness of corrective action activities already implemented at the Facility have reduced seepage impacts significantly as demonstrated by the significant downward trends observed in several of the bedrock monitor wells at the Facility.

Table 3-3 Summary of Cost-Effectiveness of Corrective Action Activities Relative to Base Case

Corrective Action Alternative	Estimated Present Value Year 1999 ($)	Estimated Groundwater Concentrations Reductions							Other Benefits
		@ Dakota POC	@ TRA POC	@ TRB POC*					
				U-nat mg/l	Pb-210 pCi/l	Th-230 pCi/l	Ra-226 pCi/l	Ra-228 pCi/l	
Enhanced Tailings Dewatering	$3,936,000	0	0	.084	3.2	2.4	3.5	5.3	Reduces time period needed to operate the interceptor trench for the Alluvium CAP
Groundwater Interception & Treatment	$4,386,000	0	0	.084	3.2	2.4	3.5	5.3	Accelerates rate of dewatering of TRB within the long-term institutional control area
Continued Mine Dewatering	$32,000,000	0	0	0	0	0	0	0	Extends the recovery of groundwater in the bedrock units down gradient of the Facility an additional 50 years

* The estimated change in U-nat concentration at the POC in the TRB was based on a very optimistic 50% reduction in the concentration observed at POC well 31-66 which featured the highest concentration of U-nat for the TRB POC wells.

Continuation of the mine-dewatering program for the bedrock CAP will not further reduce groundwater concentrations in the uppermost bedrock units. Further dewatering of the uppermost bedrock units will continue beyond the boundary of the land to be transferred for long term institutional control until water levels in deeper bedrock units recovers sufficiently. Groundwater level recovery sufficient to support use in the bedrock units down gradient of the institutional control boundary is not likely to occur for hundreds of years due to the slow rate of groundwater recovery within the bedrock formations after mine dewatering is terminated (Bostick 1985). The time series plots of mass recovery presented in Figures 3-1 to 3-3 demonstrates that the CAP is no longer significantly effective in removing hazardous constituents. Continuing the CAP, consisting of mine water pumping at a cost of nearly one million dollars per year, will not further reduce the concentrations of hazardous constituents in groundwater in the bedrock units at the POC or the POE.

Any further resources expended towards the uppermost bedrock units CAP will provide no appreciable benefit or reduction of hazard to human health or the environment. As demonstrated in Section 2.5.2, with the completion of reclamation activities the current uppermost bedrock groundwater poses trivial risk to the human health or the environment.

As shown in Table 3-3, the alternative corrective actions considered would not significantly reduce groundwater concentrations. An analysis was performed to determine potential dose averted by the alternative corrective actions for ALARA evaluation consistent with the NRC's draft regulatory guide DG-4006 (NRC 1998b). The collective averted dose that would result from the alternative corrective action for each of the constituents was determined using the following method:

The intake of hazardous constituents averted from consumption of groundwater as drinking water for lifetime was calculated as follows:

$$I_{dw} = (C_{gw})((IW)(EF)(ED)$$

Where:

I_{dw} = Intake from drinking groundwater, uCi
C_{gw} = groundwater concentration reduced by alternative corrective action, uCi/l
IW = average daily water intake = 1.11 liters (l) per day (Shleien 1992)
EF = exposure frequency = 350 day/year (EPA 1998b)
ED = exposure duration, 30 years

The total annual intake of hazardous constituents averted from all food sources (I_{fd}) potentially impacted by groundwater at constituent concentrations reduced were calculated using the same method in Section

2.5.2.3. The annual intake in pCi per year was converted to uCi per lifetime by multiplying the annual intake in pCi by 1.0E-6 (uCi/pCi) and 30 years for lifetime exposure duration.

The Total Intake (I_{tot}) from all sources was calculated by summing the I_{dw} and I_{fd}.

The collective averted dose (AD) was then calculated as follows:

$$AD = (I_{tot})(CF)(P)$$

Where:

AD = collective averted effective dose equivalent, person-rem
I_{tot} = total intake of a constituent by an individual
CF = intake to dose conversion factor, mrem/uCi (Handbook 1992)
P = number of person exposed = 4. A hypothetical family of four people is assumed for an unlikely scenario of consuming groundwater at potential POE for domestic purposes.

The averted dose due to potential reduction in groundwater concentrations by alternative corrective actions was calculated for each hazardous constituent using the above method. The results are summarized in Table 3-4.

Table 3-4 Averted Collective Dose Calculation Summary

Constituent	Conc. Reduced (C_{gw}) pCi/l	Averted intake from ingestion of groundwater (I_{dw}) uCi	Averted intake from food impacted by groundwater (I_{fd}) uCi	Total averted intake (I_{tot}) uCi	Intake to dose Conversion factor mrem/uCi	Averted Collective Dose (AD) Person-rem
U-nat	56.9	0.663	0.012	0.675	268.9	0.73
Pb-210	3.2	0.037	0.002	0.039	5365	0.83
Th-230	2.4	0.028	0.000	0.028	547.6	0.06
Ra-226	3.5	0.041	0.010	0.051	1324.6	0.27
Ra-228	5.3	0.062	0.014	0.076	1435.6	0.44
Total						2.33

At the estimated present value of four million dollars for alternative corrective action, the cost of one person-rem averted by implementing the alternative corrective action would be approximately $1.7 million dollars. This would exceed by far the NRC's ALARA guidance of $2,000 per person-rem specified in NRC's draft regulatory guide DG-4006 (NRC 1998b). Furthermore, the $1.7 million for averting one per person-rem also exceeds the $20,000 per person-rem for demonstration of "Prohibitively Expensive" criteria. Therefore, the uppermost bedrock unit groundwater concentrations at the Facility are ALARA.

4.0 PROPOSED ALTERNATIVE CONCENTRATION LIMITS

Past corrective actions, as described in the previous section, have significantly reduced seepage impacts on the uppermost bedrock units as evidenced by the decreasing constituent concentrations. The removal of tailings fluids and byproduct materials from unlined ponds #3 through #8 and the installation of dewatering trench between Tailings Impoundment #2 and pond #7 were particularly effective in substantially reducing seepage source term for the uppermost bedrock units.

Despite these corrective actions, it has not been possible to attain the groundwater protection standards for some constituents at some of the Point of Compliance (POC) wells. The evaluations presented in previous sections of this Alternate Concentration Limits (ACLs) Petition demonstrate that continuing groundwater pumping of the uppermost bedrock units through the mine dewatering program is not necessary and would not achieve U. S. Nuclear Regulatory Commission's (NRC) groundwater protection standards at the POC in a time frame shorter than would occur without the mine dewatering program. Because of continuous drainage of the uppermost bedrock units to the Westwater Canyon member units of the Morrison Formation through numerous vent holes and shafts, resaturation of the uppermost bedrock units is not expected for hundreds of years because of the extremely slow rate of groundwater recovery in the deeper units following cessation of mine water pumping.

The evaluation of alternative corrective action presented in Section 3 showed that it would not be practicable or cost-effective to implement alternative corrective actions. These alternatives would provide no benefit for the Dakota Sandstone unit (Dakota) and the Tres Hermanos Sandstone A unit (TRA) sandstone because byproduct materials have been removed from the potential seepage source locations for these units. Furthermore, hazardous constituent concentrations in the Tres Hermanos Sandstone B unit (TRB) already meet health-based limits. It is unlikely that any additional corrective action would result in significant changes in hazardous constituent concentrations in the TRB. Furthermore, continuation of the current Corrective Action Program (CAP) or implementation of additional corrective action for the bedrock units involves high cost, little benefit and creates potential exposure potential associated with handling and disposal of the recovered water and treatment residuals. Thus, groundwater concentrations in the bedrock units are as low as reasonably achievable (ALARA).

Furthermore, the evaluation of human health hazards provided in the previous section demonstrates that present and estimated future concentrations of constituents at the Point of Exposure (POE) do not pose a substantial human health hazard. Therefore, Quivira Mining Company (QMC) requests approval, in the form of a license amendment, this Groundwater Alternate Concentration Limit Petition for uppermost bedrock units at the Ambrosia Lake Facility.

4.1 Proposed Alternate Concentration Limits

An ACL may replace the groundwater protection standard at the POC, when meeting the standard may not be practical or achievable, and the groundwater concentration does not pose a substantial present or potential hazard. Establishing an ACL at POC based on a health risk-based concentration limit at the POE, and contaminant attenuation factor between POC and POE, would be protective of human health and the environment.

QMC has limited the proposed ACLs for most of the constituents to the health-based concentrations. The ACLs requested for hazardous constituents at POC wells in the TRA and the TRB have been set at the health risk-based concentrations. For the hazardous constituents in the Dakota, the relationship between certain hazardous constituent concentrations at the POC and the POE have been established based on hydrogeologic information, monitoring data, and transport modeling evaluations. Conservative estimates of the attenuation factors for relevant hazardous constituents in the Dakota were determined from these relationships and are summarized in Table 2-8. Using the health risk-based concentration limits calculated in Section 2.6, and the conservative attenuation factors for hazardous constituents in the Dakota, POC concentration limits that are protective of human health and the environment are estimated as shown in Table 4-1:

Table 4-1 Calculation of Protective Concentration for POC Wells in the Dakota

Aquifer Unit	Constituent	Health Risk-Based Concentration Limit @ POE	POC to POE Constituent Attenuation Factor	Human Health Protective Concentration Limit @ POC
Dakota Sandstone Unit	U-nat (mg/l)	0.25	0.16	1.56
	Pb-210 (pCi/l)	13	0.16	81
	Ra-226 and -228 (pCi/l)	41	0.16	256
	Th-230 (pCi/l)	139	0.16	869
	Nickel (mg/l)	0.1	0.16	0.625

Even though the above concentration limits at the POC are protective of human health and the environment, the proposed ACLs are reduced further below the protective limits based on the concentrations that has been attained through implementation of practical corrective actions. The proposed ACLs for the Dakota were set at the higher of either the health risk-based concentration, or the value of the mean plus two standard deviations determined from monitoring results from 1994 to present at the Dakota POC wells.

However, in no case was an ACL established at a concentration higher than the estimated protective concentration. The health risk-based concentration, value of mean plus 2 standard deviations and the protective concentrations used to derive the proposed ACLs for the Dakota Sandstone are provided in Table 4-2.

Table 4-2 Development of Proposed ACLs for the Dakota Sandstone

Hazardous Constituent	Health Risk-Based Concentration	Mean+2σ Groundwater Concentrations	Protective Concentration	Proposed ACLs
Pb-210 (pCi/l)	13	57.3	81	57
Ra-226 and -228(pCi/l)	41	33.5	256	41
Th-230 (pCi/l)	139	2288*	869	869
U-nat (mg/l)	0.25	0.81	1.56	0.81
Nickel (mg/l)	0.1	0.12	0.625	0.12

*The calculated mean + 2σ value for Th-230 at well 36-06 for the period is not representative of Th-230 groundwater concentrations at the POC location due to several very high results determined from a total analysis of samples that contained sediments.

The ACLs requested for hazardous constituents in the TRB were set at the health-based concentrations, except for nickel, as shown in Table 4-3. The proposed ACL for nickel was set at the mean plus two standard deviations value of 0.37 determined from monitoring results from 1994 to present at the TRB POC wells, which is less than the 0.625 mg/l estimated protective concentration calculated in Section 2:3.2.2. The value of the mean plus two standard deviations determined from the monitoring results from 1994 to present at the POC and background wells in the TRB and the current GPS for the TRB are included in Table 4-3 for comparison.

Table 4-3 Proposed ACLs for the TRB Sandstone Unit

Hazardous Constituent	Health Risk-Based Concentration	Mean + 2σ Groundwater Concentrations	GPS	Proposed ACLs
Pb-210 (pCi/l)	13	19.6[a]	0.9	13
Ra-226 and -228(pCi/l)	41	28.3	7.4	41
Th-230 (pCi/l)	139	14.8	2.2	139
U-nat (mg/l)	0.25	0.21	0.02	0.25
Nickel (mg/l)	0.1	0.37[b]	.06	0.37

[a] Highest value for mean +2σ of Pb-210 determined at the background wells.

[b] The calculated mean +2σ of nickel is higher than the health risk-based concentration due to elevated detection limits.

The ACLs requested for hazardous constituents in the TRA were set at the health-based concentrations as shown in Table 4-3. The value of the mean plus two standard deviations determined from the monitoring results from 1994 to present at the POC and background wells in the TRA and the current GPS for the TRA are included in Table 4-4 for comparison.

Table 4-4 Proposed ACLs for the TRA Sandstone Unit

Hazardous Constituent	Health Risk-Based Concentration	Mean + 2σ Groundwater Concentrations	GPS	Proposed ACLs
Pb-210 (pCi/l)	13	20.1[a]	4.1	13
Ra-226 and –228(pCi/l)	41	15.6	5	41
Th-230 (pCi/l)	139	7.34	4.3	139

4.1.1 Demonstration of Health and Environmental Protection

Hazardous constituent concentrations have been decreasing significantly and already meet New Mexico Environmental Department standards throughout uppermost bedrock aquifer units. Groundwater concentrations meet even more stringent health risk-based levels proposed herein (see Section 2.3) at current and foreseeable future points of exposure (see Section 2.2.4.3). The proposed ACLs for all constituents for the uppermost bedrock units at the Facility insure that the justifiable human health and the environment protective limits continue to be attained at all potential points of exposure.

The proposed ACLs for Pb-210, U-nat, and nickel in Dakota have been set at a concentration level based on a statistical evaluation of recent concentrations in groundwater at the POC (see Section 4.1.2). The proposed ACL for these constituents is below the limit needed to be protective of human health and the environment as shown in Table 4-2. Likewise, the proposed ACL for Ra-226 and -228 in Dakota has been set at the health risk-based concentration level. The ACL for Th-230 is set at the concentration level determined to be protective of human health and the environment based on attenuation between the POC and POE.

The proposed ACLs for the TRB and TRA units have been set at the health risk-based concentration levels. These levels are protective of human health and the environment even without any attenuation between the POC and POE.

[a] Highest value for mean +2σ of Pb-210 determined at the background wells.

4.1.2 Demonstration of ALARA Principles

The evaluation of results of previous corrective actions indicates that the hazardous constituents in the uppermost bedrock units are at levels that are ALARA. QMC has routinely taken corrective actions to control hazardous constituents from seeping into groundwater, including the operation of the dewatering trench and the interceptor trench, placing caps over the Tailings Impoundments, and implementation of the groundwater pumping through the mine dewatering program. These corrective action measures have been implemented to maintain hazardous constituent concentrations at levels that are as low as reasonably achievable. The groundwater concentrations will continue to decline with completion of reclamation activities at the Facility.

Continuation of the mine dewatering program for the uppermost bedrock units CAP will not further reduce groundwater concentrations in the uppermost bedrock units any more than termination of the mine dewatering. Further dewatering of the uppermost bedrock units will continue beyond the boundary of the land to be transferred for long term institutional control until potentiometric levels in deeper bedrock units recovers sufficiently to resaturate the uppermost bedrock units. Resaturation of the uppermost bedrock units is not expected for hundreds of years because of the extremely slow rate of groundwater recovery in the mine workings of the Westwater Canyon member of the Morrison Formation after mine dewatering is terminated. Continuation of mine water pumping, at a cost of nearly one million dollars per year, will not further reduce the concentrations of hazardous constituents in groundwater in the bedrock units at the POC or the POE.

As discussed in Section 3.6, alternative corrective actions evaluated would not change the concentrations of hazardous constituents in the Dakota and TRA units. It was concluded that either enhanced tailings dewatering or groundwater interception wells might achieve a negligible reduction in the concentrations of constituents at the POC in the TRB. Each alternative was estimated to cost approximately four million dollars. Any benefit would be minor and uncertain, and be offset by the risks associated with the penetration of the tailings reclamation cover and the handling of extracted fluids and treatment residuals.

Nevertheless, maximum reductions of 50% in the concentration of radiological constituents were used as the most optimistic scenario for the ALARA analysis presented in Section 3.6. This analysis was conducted in accordance with NRC's draft regulatory guide DG-4006 (NRC 1998b) and assumed that a family of four obtained its water from a well completed in the TRB at a potential POE location. However, since the POE location is currently dewatered, the concentrations of radiological constituents used in the analysis was determined from the POC well location with the highest concentrations. The analysis determined that alternative corrective actions would cost at least $1.7 million to avert one person-rem. The

$1.7 million per person-rem averted far exceeds the $2,000 to $20,000 per averted person-rem range specified in NRC's draft regulatory guide DG-4006 (NRC, 1998b). Thus, groundwater concentrations are ALARA.

To meet the ALARA requirement, the proposed ACLs that are above the health risk-based concentration have been established at the lower of either the calculated protective concentration or the concentration that has recently been attained in the aquifer unit based on a statistical evaluation of recent concentrations of groundwater at the POC. The results of the statistical analysis are included in Appendix F and are summarized in Table 4-2 for the Dakota in Table 4-3 for the TRA and TRB units.

The proposed ACLs represent concentrations that can assure attainment of health risk-based concentrations at any potential point of exposure. The ACLs are also determined based on the concentrations that can be achieved through implementation of all practicable corrective action measures at the Facility and are thus determined to meet the ALARA provision of the regulations.

5.0 REFERENCES

REFERENCES

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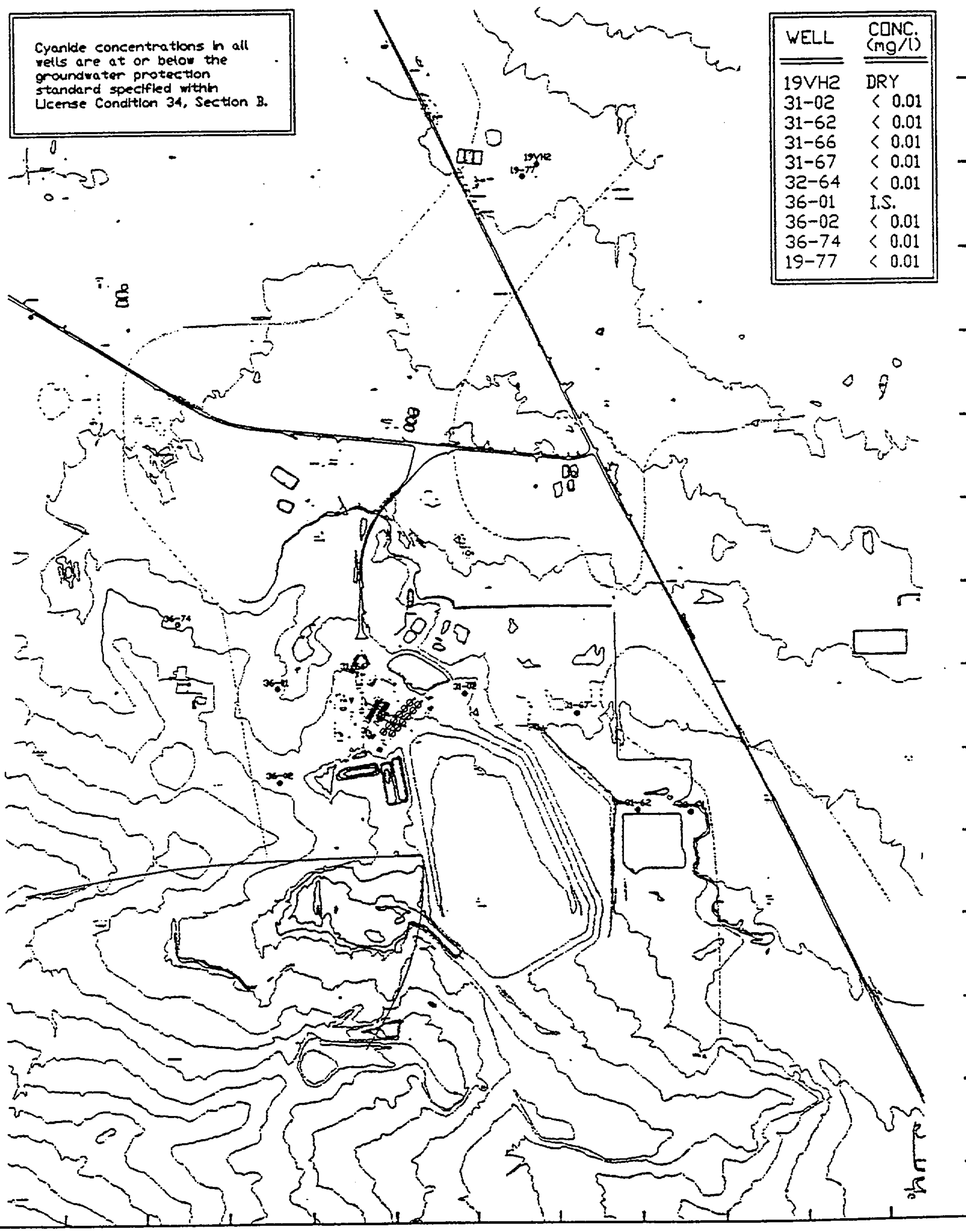
APPENDIX A

Tres Hermanos B Sandstone
1998 Groundwater Concentration Isopleth Plots and Monitoring Results Summary Tables

CYANIDE
1998 CONCENTRATION ISOPLETH
NRC GROUNDWATER STANDARD – 0.01 mg/l

Cyanide concentrations in all wells are at or below the groundwater protection standard specified within License Condition 34, Section B.

WELL	CONC. (mg/l)
19VH2	DRY
31-02	< 0.01
31-62	< 0.01
31-66	< 0.01
31-67	< 0.01
32-64	< 0.01
36-01	I.S.
36-02	< 0.01
36-74	< 0.01
19-77	< 0.01



31-62 WELL
ZERO SATURATION – TRES HERMANOS B
FORMATION LIMIT – TRES HERMANOS B

TRES HERMANOS B

QUIVIRA MINING COMPANY – AMBROSIA LAKE FACILITY

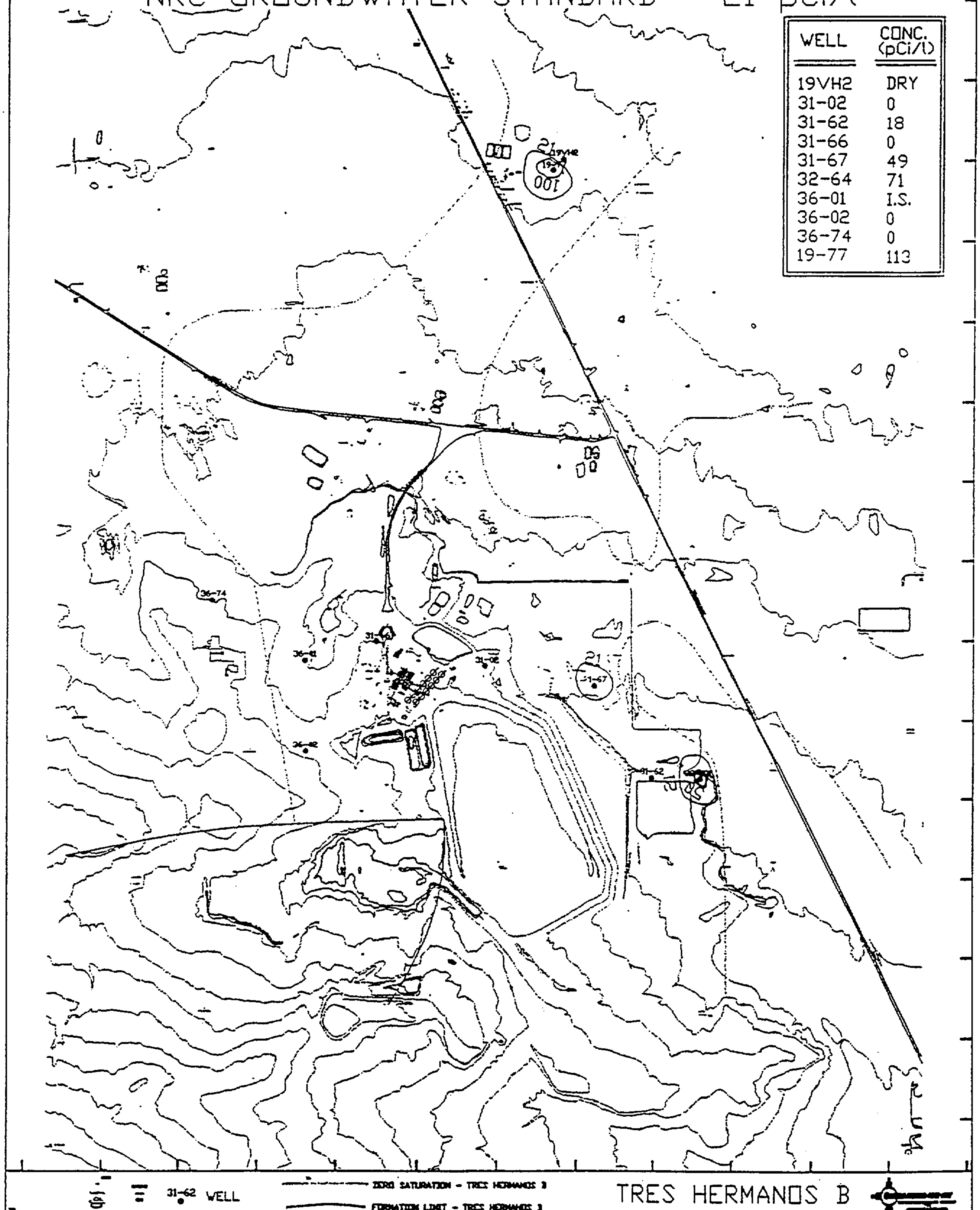
LICENSE SUA-1473 : DOCKET 40-8905

GROSS ALPHA

(EXCLUDING URANIUM AND RADON)

1998 CONCENTRATION ISOPLETH

NRC GROUNDWATER STANDARD - 21 pCi/l

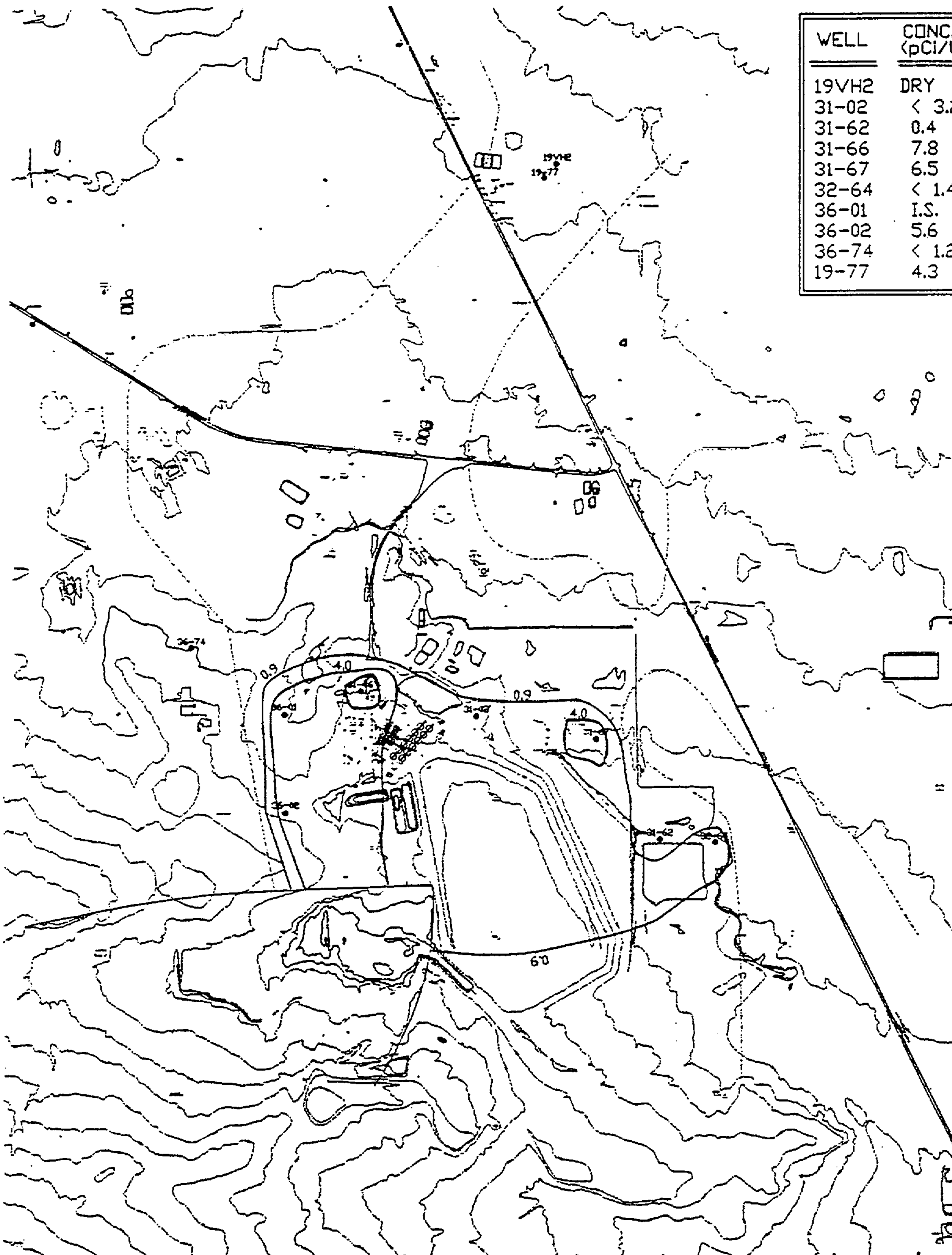


WELL	CONC. (pCi/l)
19VH2	DRY
31-02	0
31-62	18
31-66	0
31-67	49
32-64	71
36-01	I.S.
36-02	0
36-74	0
19-77	113

QUIVIRA MINING COMPANY - AMBROSIA LAKE FACILITY   LICENSE SUA-1473 : DOCKET 40-8905

LEAD-210
1998 CONCENTRATION ISOPLETH
NRC GROUNDWATER STANDARD - 0.9 pCi/l

WELL	CONC. (pCi/l)
19VH2	DRY
31-02	< 3.2
31-62	0.4
31-66	7.8
31-67	6.5
32-64	< 1.4
36-01	I.S.
36-02	5.6
36-74	< 1.2
19-77	4.3



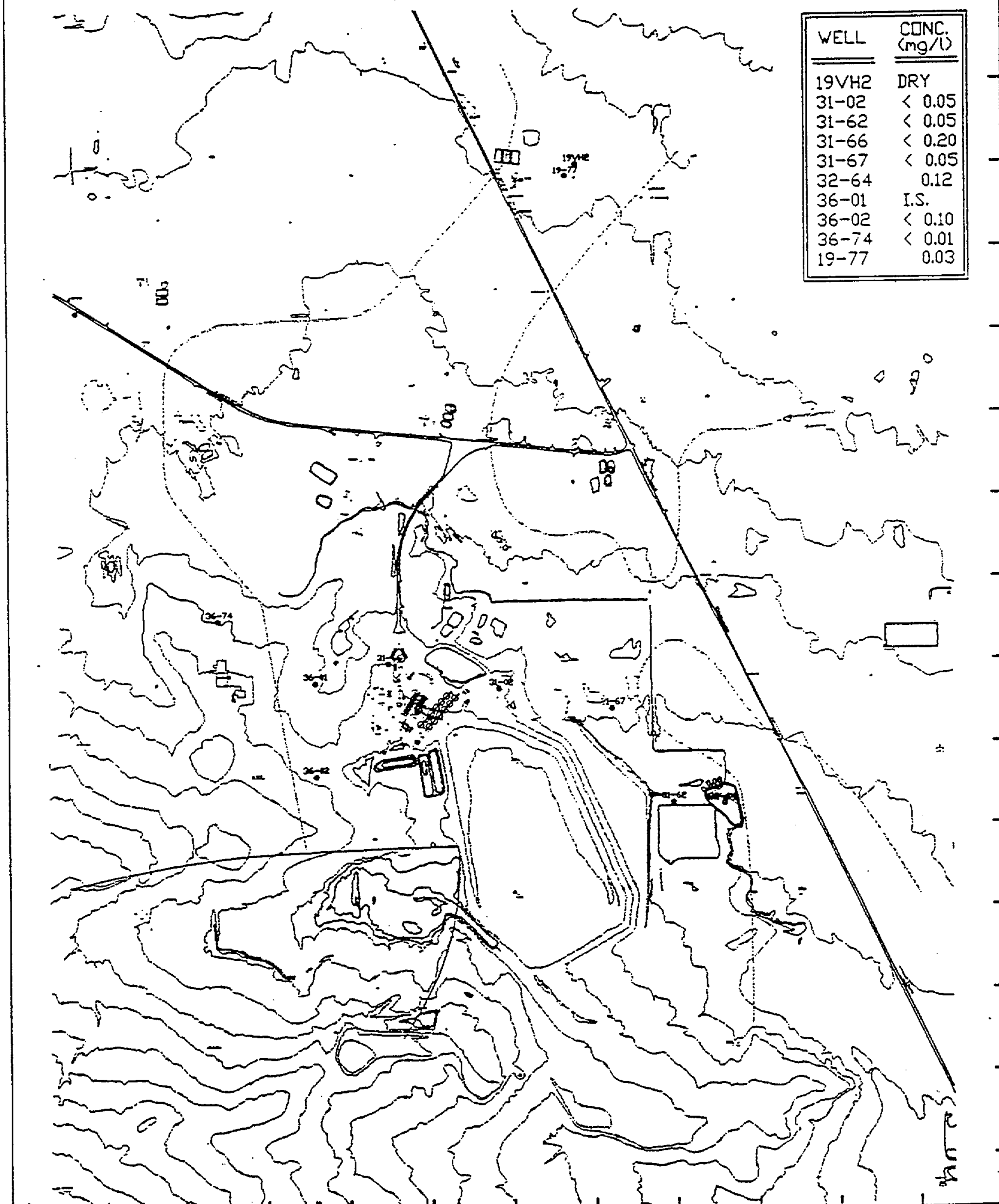
TRES HERMANOS B

QUIVIRA MINING COMPANY - AMBROSIA LAKE FACILITY

LICENSE SUA-1473 , DOCKET 40-8905

MOLYBDENUM
1998 CONCENTRATION ISOPLETH
NRC GROUNDWATER STANDARD - 0.08 mg/l

WELL	CONC. (mg/l)
19VH2	DRY
31-02	< 0.05
31-62	< 0.05
31-66	< 0.20
31-67	< 0.05
32-64	0.12
36-01	I.S.
36-02	< 0.10
36-74	< 0.01
19-77	0.03



31-62 WELL
ZERO SATURATION - TRES HERMANOS B
FORMATION LIMIT - TRES HERMANOS B

TRES HERMANOS B

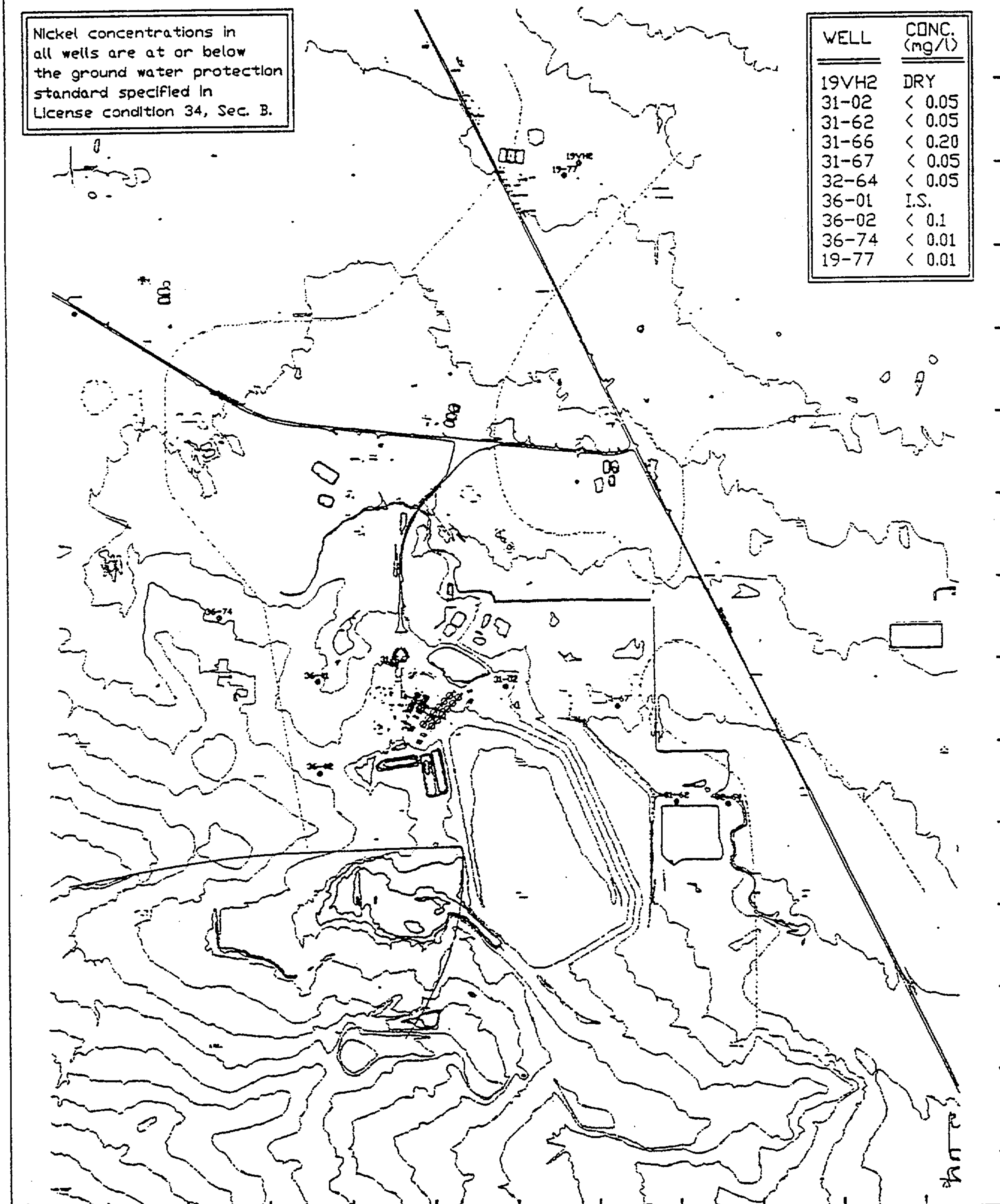
QUIVIRA MINING COMPANY - AMBROSIA LAKE FACILITY

LICENSE SUA-1473 | DOCKET 40-8905

NICKEL
1998 CONCENTRATION ISOPLETH
NRC GROUNDWATER STANDARD - 0.06 mg/l

Nickel concentrations in all wells are at or below the ground water protection standard specified in License condition 34, Sec. B.

WELL	CONC. (mg/l)
19VH2	DRY
31-02	< 0.05
31-62	< 0.05
31-66	< 0.20
31-67	< 0.05
32-64	< 0.05
36-01	I.S.
36-02	< 0.1
36-74	< 0.01
19-77	< 0.01



31-62 WELL
ZERO SATURATION - TRES HERMANOS B
FORMATION LIMIT - TRES HERMANOS B

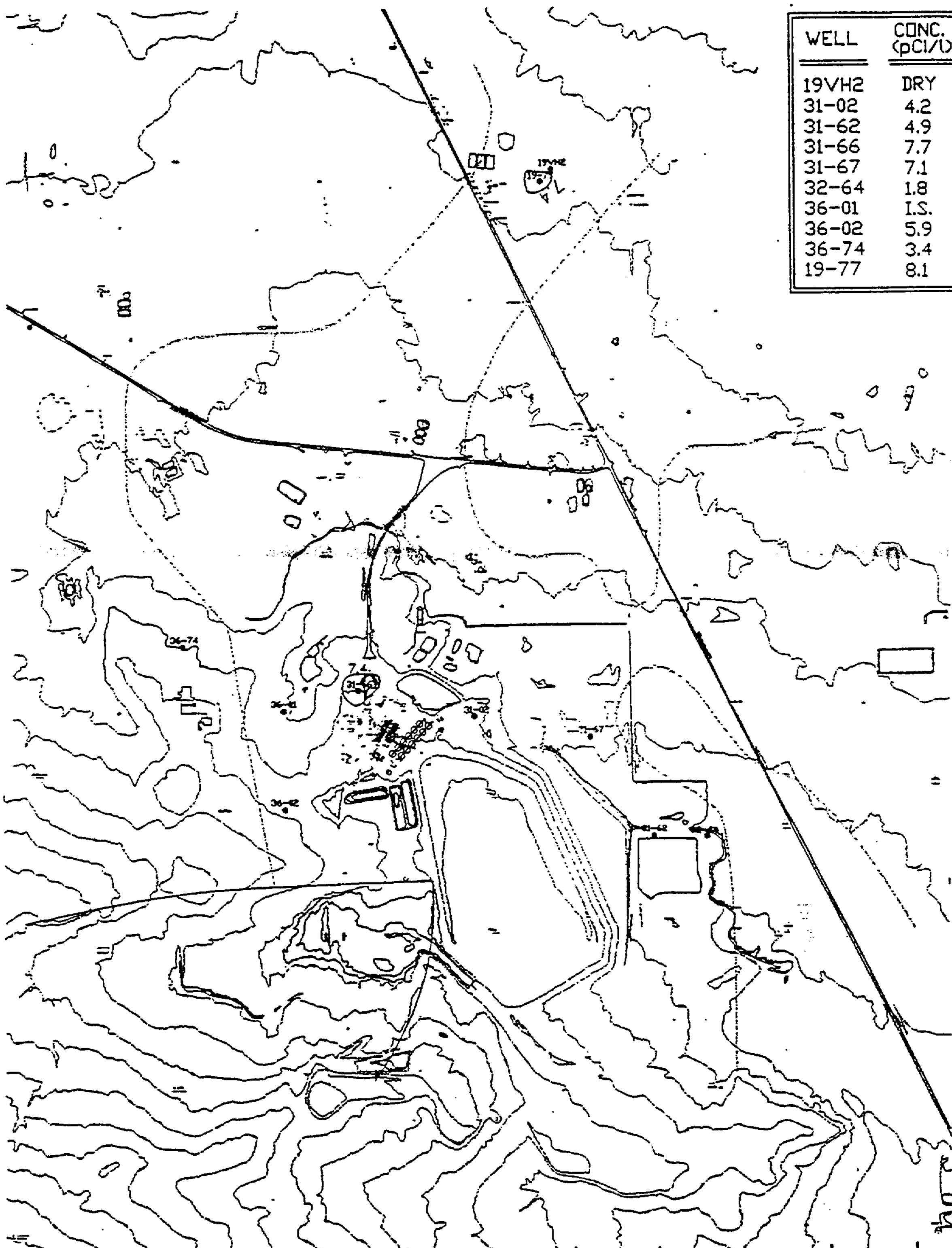
TRES HERMANOS B

QUIVIRA MINING COMPANY - AMBROSIA LAKE FACILITY

LICENSE SUA-1473 | DOCKET 40-8905

RADIUM 226/228
1998 CONCENTRATION ISOPLETH
NRC GROUNDWATER STANDARD - 7.4 pCi/l

WELL	CONC. (pCi/l)
19VH2	DRY
31-02	4.2
31-62	4.9
31-66	7.7
31-67	7.1
32-64	1.8
36-01	I.S.
36-02	5.9
36-74	3.4
19-77	8.1



31-62 WELL

ZERO SATURATION - TRES HERMANOS 3

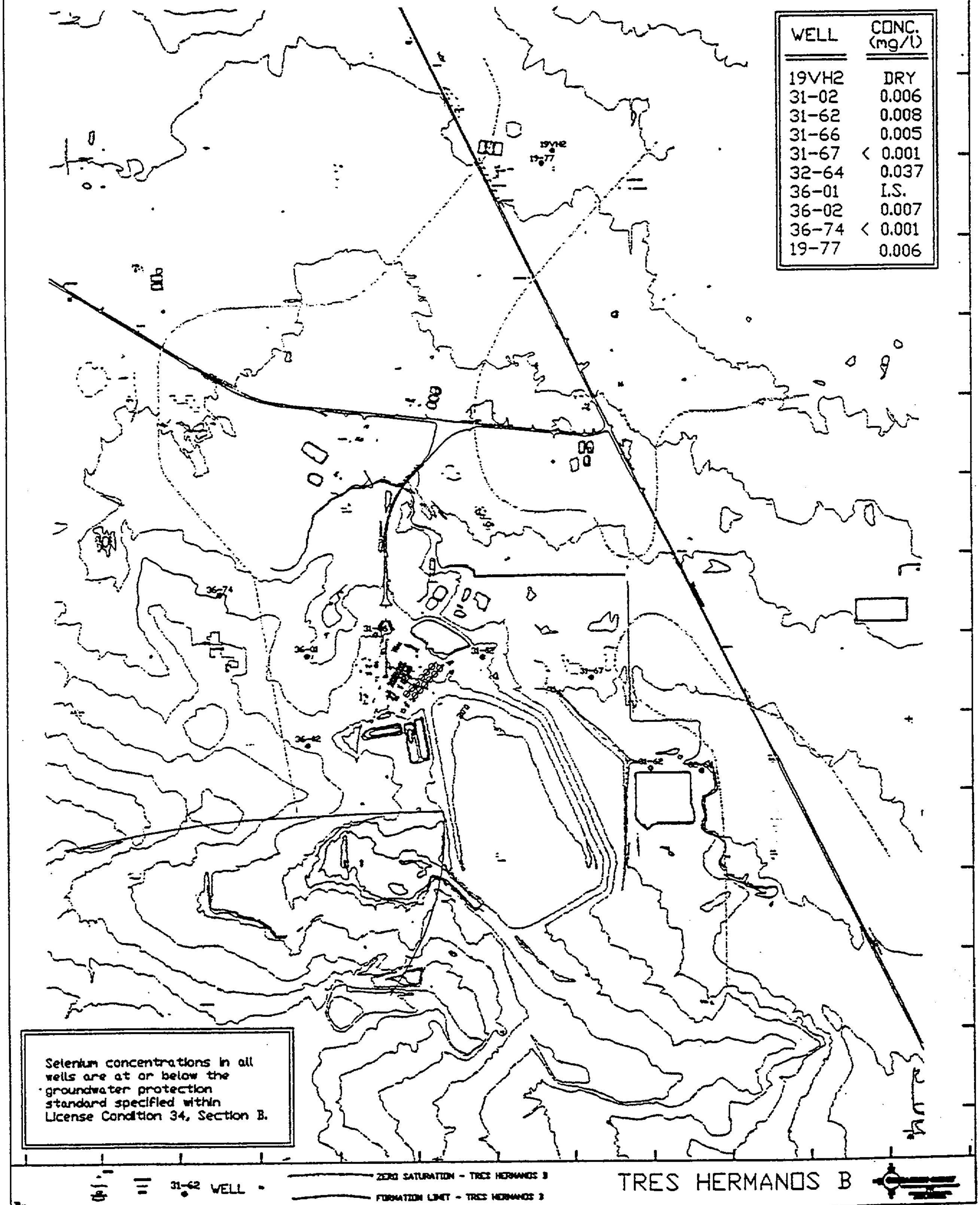
FORMATION LIMIT - TRES HERMANOS 3

TRES HERMANOS B

QUIVIRA MINING COMPANY - AMBROSIA LAKE FACILITY

LICENSE SUA-1473 DOCKET 40-8905

SELENIUM
1998 CONCENTRATION ISOPLETH
NRC GROUNDWATER STANDARD - 0.04 mg/l



WELL	CONC. (mg/l)
19VH2	DRY
31-02	0.006
31-62	0.008
31-66	0.005
31-67	< 0.001
32-64	0.037
36-01	I.S.
36-02	0.007
36-74	< 0.001
19-77	0.006

Selenium concentrations in all wells are at or below the groundwater protection standard specified within License Condition 34, Section B.

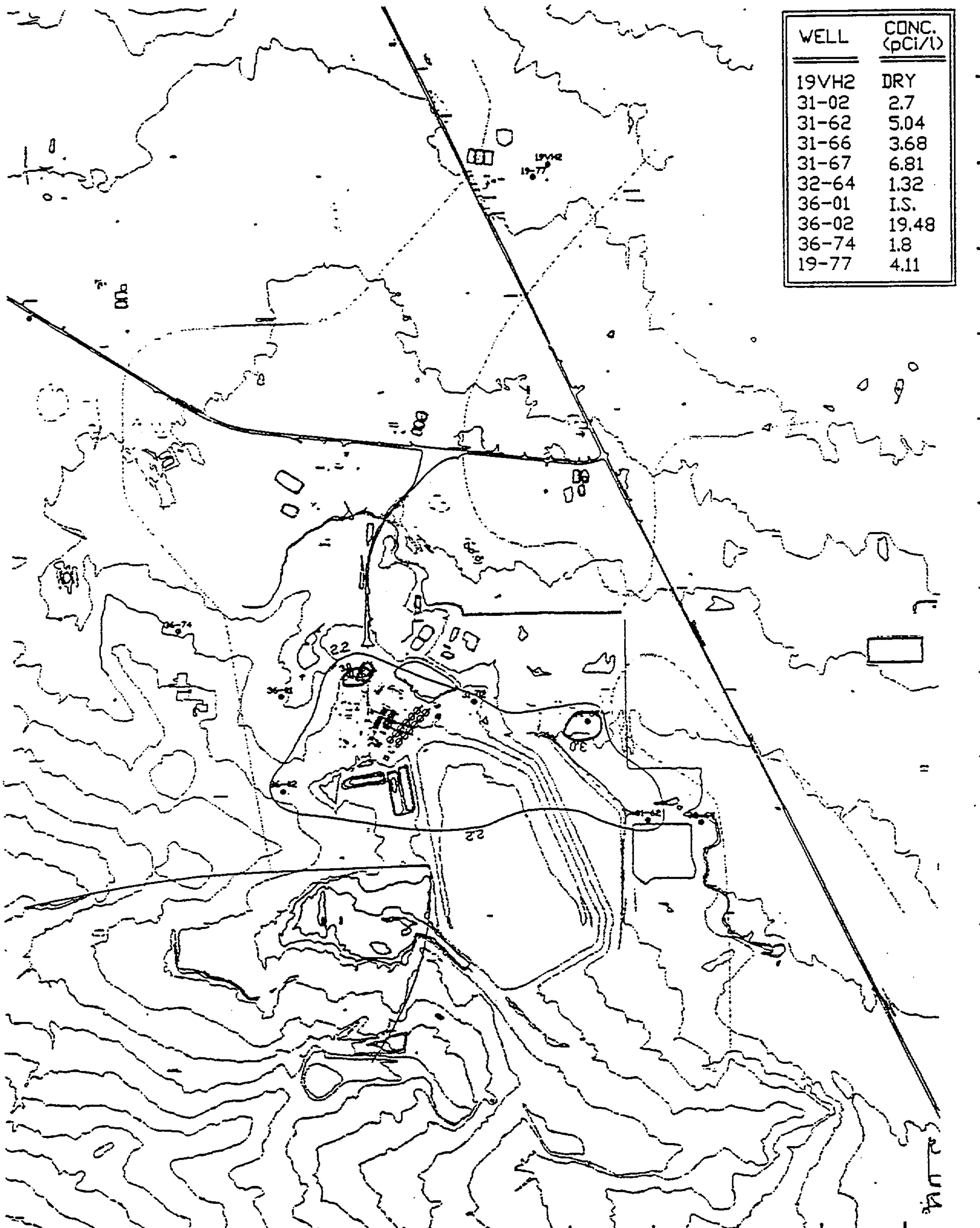
TRES HERMANOS B

QUIVIRA MINING COMPANY - AMBROSIA LAKE FACILITY

LICENSE SUA-1473 | DOCKET 40-8905

THORIUM-230
1998 CONCENTRATION ISOPLETH
NRC GROUNDWATER STANDARD - 2.2 pCi/l

WELL	CONC. (pCi/l)
19VH2	DRY
31-02	2.7
31-62	5.04
31-66	3.68
31-67	6.81
32-64	1.32
36-01	I.S.
36-02	19.48
36-74	1.8
19-77	4.11



31-62 WELL

ZERO SATURATION - TRES HERMANOS B

FORMATION LIMIT - TRES HERMANOS B

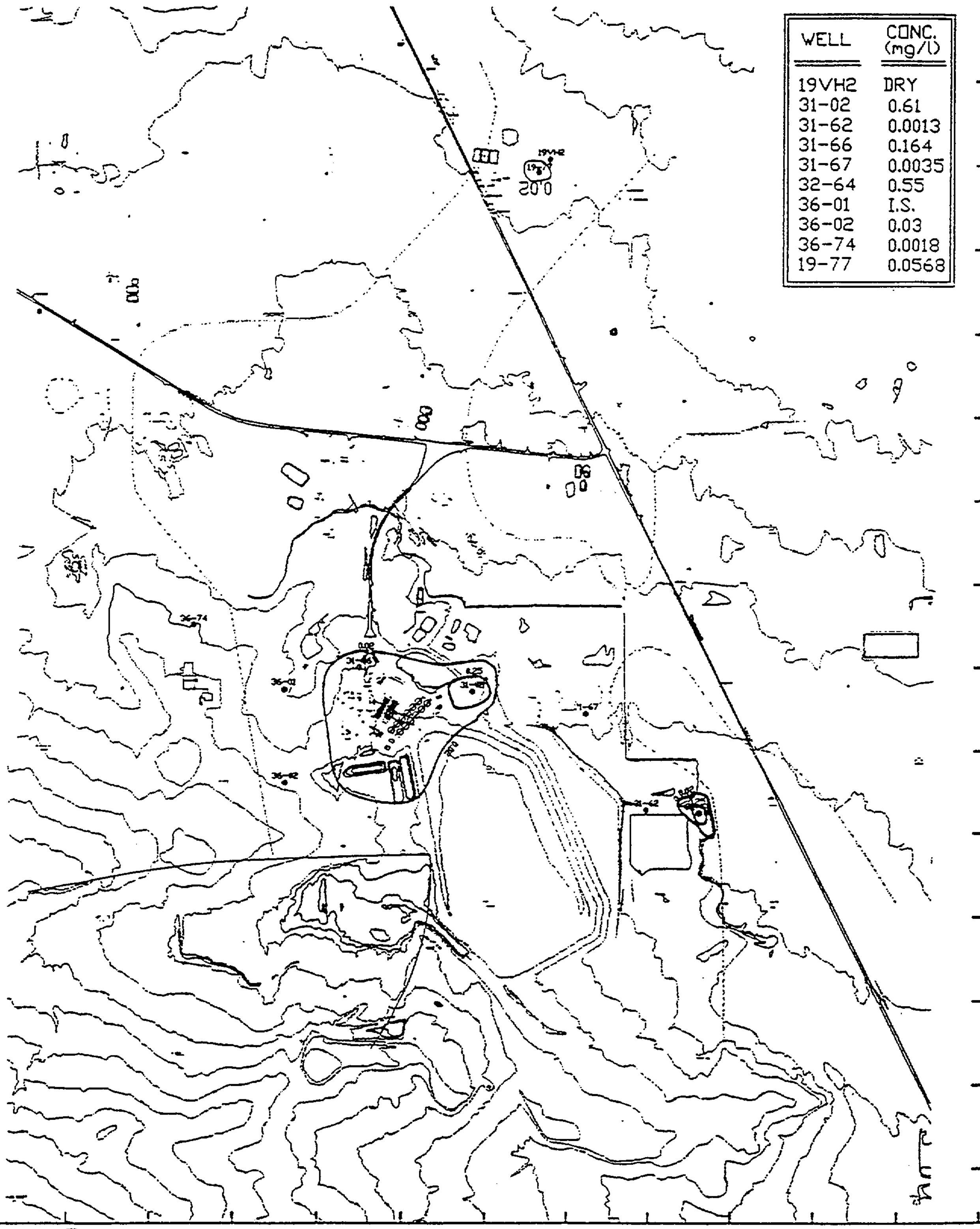
TRES HERMANOS B

QUIVIRA MINING COMPANY - AMBROSIA LAKE FACILITY

LICENSE SUA-1473 DOCKET 40-8905

NATURAL URANIUM
1998 CONCENTRATION ISOPLETH
NRC GROUNDWATER STANDARD - 0.02 mg/l

WELL	CONC. (mg/l)
19VH2	DRY
31-02	0.61
31-62	0.0013
31-66	0.164
31-67	0.0035
32-64	0.55
36-01	I.S.
36-02	0.03
36-74	0.0018
19-77	0.0568



31-62 WELL

ZERO SATURATION - TRES HERMANOS B

FORMATION LIMIT - TRES HERMANOS B

TRES HERMANOS B

QUIVIRA MINING COMPANY - AMBROSIA LAKE FACILITY

LICENSE SUA-1473 : DOCKET 40-8905

Quivira Mining Company
Ambrosia Uranium Mill Site
Ground Water Monitoring Results

Well 31-66, Tres Hermanos B Unit, POC

Date	Depth To Water feet	Spec. Cond. uohm/cm	pH	As (mg/l)	Be (mg/l)	Cd (mg/l)	Cl (mg/l)	CN (mg/l)	Mo (mg/l)	Ni (mg/l)	NO3 (mg/l)	Pb (mg/l)	Pb-210 (pCi/l)	Ra-226 (pCi/l)	Ra-228 (pCi/l)	Sb (mg/l)	Se (mg/l)	SO4 (mg/l)	TDS (mg/l)	Th-230 (pCi/l)	Unat (mg/l)	Gross Alpha (pCi/l)
18-Feb-88	109.26	12500	6.1	0.007		<0.01	4960		0.48	0.37	<0.1	0.05		1.3			0.065	3640	16400	0.4	0.265	
31-May-88	109.55	7500	6																			
15-Aug-88	110.7	11400	6.2				4530											4030	15400			
20-Sep-88				0.013	<0.01	<0.005		<0.01	0.22	0.36		0.03	7.7	1.1	4.9	0.021	0.339			9.5	0.194	190
26-Sep-88				0.04	<0.01	<0.005		<0.01	0.21	0.32		0.05	5	1	4.5	0.013	0.245			1.3	0.206	120
03-Oct-88				0.012	<0.01	<0.005		<0.01	0.24	0.33		0.03	4.5	0.7	5.2	0.02	0.384			0.7	0.202	210
11-Oct-88				0.019	<0.01	<0.005		<0.01	0.26	0.35		0.06	5.6	0.3	4.5	0.14	0.025			1	0.26	260
21-Nov-88				0.029	<0.01	<0.005		<0.01	0.25	0.32		0.04	9.5	1.2	5.4	0.02	0.031			1.1	0.367	150
08-Dec-88	109.78	11900	5.9																			
21-Feb-89	109.81	11000	5.9	0.035	<0.01	<0.005		<0.01	<0.01	<0.15		<0.02	7.7	1.9	0.9	0.038	0.041			2.4	0.238	200
16-May-89	109.4	16250	5.9	0.043	<0.01	<0.005	4680		0.04	0.17	0.1	0.03					0.038	5170	16800		0.198	
18-May-89	109.64	13750	6.1	0.008	<0.01	<0.005		<0.01	<0.01	0.13		<0.02	6.5	0.8	5.7	0.044	0.113			3.2	0.2	19
11-Sep-89	109.65	14800	6.3	0.007	<0.01	0.008	4870	<0.01	0.05	0.23	<0.1	<0.02	3.8	0.7	7.1	0.036	0.021	5100	7900	0.2	0.149	100
27-Feb-90	111.62	14900	5.7	0.022	<0.01	0.006	5720	<0.01	<0.01	0.17	<0.1	<0.02	6.3	7	11	0.023	0.002	4500	16500	5.1	0.142	300
22-Aug-90	110.35	14600	6.2	<0.01	<0.01	<0.005	4030	<0.01	0.07	0.12	<0.1	<0.02	4.7	0.5	7.7	<0.003	<0.003	4260	13700	1	0.035	90
15-Feb-91	110.02	12700	6.2	0.003	<0.01	0.007	3390	<0.01	0.13	0.13	0.5	<0.02	5	1.4	8.1	0.003	0.002	4080	11800	1.9	0.0848	92
16-Aug-91	110.26	14800	6.2	0.006	<0.01	<0.005	3410	<0.01	0.19	0.13	7.2	<0.02	6.1	1.2	6.6	<0.003	0.002	3590	11200	1.8	0.116	91
14-Feb-92	110	12400	7.3	<0.001	<0.01	<0.005	3330	<0.01	0.22	0.11	7.1	<0.02	11	2.4	6	<0.003	<0.002	3780	12350	4.1	0.117	130
17-Aug-92	110.38	14000	6	<0.001	<0.01	<0.02	4300	<0.01	<0.01	0.08	2.5	<0.02	6.5	0.5	6.7	<0.003	0.008	4100	13400	3	0.103	160
08-Mar-93	110.45	14000	6.6	<0.001		<0.05	4620	<0.01	<0.1	0.14	<0.1	<0.2	6.3	2.2	7.4		0.007	4410	13300	0.9	0.121	0
31-Aug-93	110.48	13250	6.6				4190	<0.01	<0.1	0.2	0.1		8.4	3.1	10		0.019	4090	13800	6.5	0.0859	15
28-Apr-94	111	11000	6.2				3900	<0.01	<0.01	0.13	0.2		4.4	4	8.6		0.002	3990	12200	4.1	0.0814	75
05-Sep-95	111.78	20000	6.5				7090	<0.01	<0.05	<0.2	<0.5		9.5	4.5	11		<0.05	4730	17900		0.146	35
20-Feb-96	111.63	17300	6.8				7300	<0.01	<0.05	<0.2	0.4		12	3.2	9.1		<0.1	4600	18800	3.6	0.13	147
20-Aug-96	111.92	21000	6.5				7650	<0.01	<0.1	<0.4	0.3		4.3	4.5	9.5		<0.025	4880	18800	5.6	0.11	117
03-Apr-97	111.68	20000	6.6				8640	<0.01	<0.05	<0.2	0.2		7.7	3.2	8.4		<0.025	4580	20800	3.1	0.13	38
26-Apr-98							9820	<0.01	<0.2	<0.2	0.3		7.8	6	1.8		0.005	4800		3.7	0.164	0
18-Dec-98									<0.2	<0.02	0.43		4.8	13.1	16.1		0.007	5230	29100	4	0.179	0
09-Feb-99							12900	<0.01	<0.2	<0.2	0.85		4.7	5.54	16		0.006	4520	29300	8.8	0.194	220
24-May-99							35300	<0.01	0.002	0.167	1.88		5.2	4.6	24		0.01	5440	33000	0.2	0.214	110
26-Jul-99							18200	<0.01	<0.01	0.18	1.64		1.8	3.6	14			6400	36200	0.3	0.212	180

Quivira Mining Company
Ambrosia Uranium Mill Site
Ground Water Monitoring Results

Well 31-67, Tres Hermanos B Unit, POC

Date	Depth To Water feet	Spec. Cond. uohm/cm	pH	As (mg/l)	Be (mg/l)	Cd (mg/l)	Cl (mg/l)	CN (mg/l)	Mo (mg/l)	Ni (mg/l)	NO3 (mg/l)	Pb (mg/l)	Pb-210 (pCi/l)	Ra-226 (pCi/l)	Ra-228 (pCi/l)	Sb (mg/l)	Se (mg/l)	SO4 (mg/l)	TDS (mg/l)	Th-230 (pCi/l)	Unat (mg/l)	Gross Alpha (pCi/l)
31-May-88	19.22	4225	6.2																			
15-Aug-88	19.71	4375	6.2				872											2930	6330			
20-Sep-88				0.017	<0.01	<0.005		<0.01	0.13	0.15		0.04	14	2	11	0.02	0.154			9	0.004	39
26-Sep-88				0.017	<0.01	<0.005		<0.01	0.12	0.13		0.04	7	1	9.8	0.012	0.067			2.6	0.0045	50
04-Oct-88				0.018	<0.01	<0.005		<0.01	0.13	0.13		0.02	7.1	0.9	8.8	0.019	0.11			2	0.0036	19
11-Oct-88				0.007	<0.01	<0.005		<0.01	0.13	0.13		0.02	4.5	0.7	8.4	0.047	0.02			2.5	0.0035	20
21-Nov-88				0.004	<0.01	<0.005		<0.01	0.15	0.14		0.02	27	3.3	9.9	0.014	0.024			7.2	0.0069	58
07-Dec-88	19.86	4350	6.5																			
22-Feb-89	20.58	4500	6.2	0.006	<0.01	<0.005		<0.01	<0.01	<0.01		<0.02	16	2	8.4	0.009	0.034			16	0.0044	120
18-May-89	19.96	5200	6.2	0.01	<0.01	<0.005		<0.01	<0.01	<0.01		<0.02	14	1.3	10	0.013	<0.001			45	0.0069	57
18-Jun-89	19.96	5200	6.2																			
06-Sep-89	20.59	5000	6.5	0.004	<0.01	<0.005	725	<0.01	0.04	0.03	<0.1	<0.02	22	3.8	14	0.003	0.013	3010	6300	36	0.0065	240
05-Jun-90	20.97	4900	6.6	0.003	<0.01	0.005	744	<0.01	0.01	<0.01	<0.1	<0.02	12	1	7.3	0.004	<0.001	3010	6680	6.1	0.007	59
24-Aug-90	19.69	4950	6.5	<0.01	<0.01	<0.005	765	<0.01	0.06	0.01	<0.1	<0.02	2.5	0.6	7.3	<0.003	<0.003	2950	5950	4.2	0.0075	42
15-Feb-91	17.41	4810	6.6	0.003	<0.01	<0.005	265	<0.01	0.11	0.02	79.2	<0.02	2.1	1.2	7.4	<0.003	<0.002	2990	5770	1.2	0.0045	0
16-Aug-91	17.45	4775	6.6	0.002	<0.01	<0.005	1020	<0.01	0.1	0.01	7.2	<0.02	18	0.9	8.3	<0.003	<0.002	2860	5600	4.7	0.0129	0
14-Feb-92	17.75	4680	7.4	<0.001	<0.01	<0.005	678	<0.01	0.13	<0.01	0.9	<0.02	15	4.5	8.2	<0.003	<0.002	3230	5750	8.6	0.0171	68
17-Aug-92	19.23	4875	6.5	0.002	<0.01	0.008	690	<0.01	<0.01	<0.01	0.6	<0.02	7	1.3	6.5	<0.003	0.009	2980	5710	6.4	0.0029	36
08-Mar-93	19.85	4550	7	0.004		<0.005	662	<0.01	<0.01	<0.01	0.4	<0.02	8.4	1.4	4.8		<0.002	291	5460	6.5	0.0066	0
31-Aug-93	21.15	4400	6.9				634	<0.005	<0.1	<0.1	660		12	4.2	8		<0.002	2870	5630	2.3		4
27-Apr-94	21	4100	7				633	<0.01	<0.01	<0.01	0.9		6.4	2.8	6.2		<0.002	2940	5620	9.4	0.0073	0
04-Oct-94	20.05	4800	6.7	<0.001		<0.005	646	<0.01	<0.01	<0.01	0.8	0.007	6	4	7.7		<0.002	2900	5510	1.9	0.0043	42
04-Oct-94	111.45	16000	6.2	<0.005		<0.05	5230	<0.01	<0.1	<0.1	1.2	0.007	6.8	4.8	9.7		<0.01	4260	14800	4.2	0.0479	115
09-Mar-95	20.02	4900	7.2	<0.005			660	<0.01	<0.01	<0.04	<0.5	<0.01	8.1	3.7	8.5		<0.005	2760	5490	1.1	0.0079	50
24-Aug-95	19.87	5000	6.4				675	<0.01	<0.01	<0.04	0.5		8	3.1	6.8		<0.005	2940	5530	2.5	0.0032	31
20-Feb-96	18.21	4280	7.1				610	<0.01	<0.01	<0.04	0.1		5.2	1.5	6.7		<0.05	2800	5480	1.3	0.0088	17
20-Aug-96	19.46	4400	6.8				623	<0.01	<0.01	<0.04	0.1		5.8	6.9	6.4			2940	5390	7.7	0.0052	57
02-Apr-97	19.65	4375	7.5				655	<0.01	0.02	<0.04	<0.1		6.8	1.8	7.3		<0.005	2980	5640	10	0.0051	17
02-Dec-97	20.13	4625	7.03				693	<0.01	<0.01	<0.04	0.6		2.5	2.7	3.3		<0.005	3100	5400	2.8	0.0049	125
25-Apr-98							580	<0.01	<0.05	<0.05	0.1		6.5	3.9	3.3		<0.001	2880		6.8	0.0035	49
07-Dec-98							670	<0.01	<0.05	<0.05	0.42		<1.1	4.34	7.27		<0.001	3120	6470	6.2	0.0043	1
09-Feb-99							660	<0.01	<0.05	<0.05	0.20		1.8	2.21	4.3		<0.001	2850	5860	1.8	0.004	16

Quivira Mining Company
Ambrosia Uranium Mill Site
Ground Water Monitoring Results

Well 36-01TRB, Tres Hermanos B Unit

Date	Depth To Water feet	Spec. Cond. uohm/cm	pH	As (mg/l)	Be (mg/l)	Cd (mg/l)	Cl (mg/l)	CN (mg/l)	Mo (mg/l)	Ni (mg/l)	NO3 (mg/l)	Pb (mg/l)	Pb-210 (pCi/l)	Ra-226 (pCi/l)	Ra-228 (pCi/l)	Sb (mg/l)	Se (mg/l)	SO4 (mg/l)	TDS (mg/l)	Th-230 (pCi/l)	Unat (mg/l)	Gross Alpha (pCi/l)
05-May-77	40.8		7.2				2300											4320	13000			
24-Jul-77	42.7		6.6				2010											3830	9490			
09-Feb-78	42.2						2250											3700	8090			
08-Jul-78	42.5		2.91				1641											3686	9990			
07-Oct-78	42.3																					
06-Mar-79	41.8		4.2				2707											4131	10549			
14-Jul-79			7.8				2448											5558	12924			
12-Oct-79	41.2		4.4				2480											4125	10069			
10-Jan-80	41.2		3.6				2736											4706	11390			
09-Apr-80	42		4.29				2566											4648	10600			
19-Jul-80	41.9		4.27				2700											4950	12700			
15-Nov-80	44.8		6.08				2512											5342	12328			
14-Jan-81	44.9		4.21				2700											5050	12320			
24-Apr-81	44.4		4.08				2600											5171	10880			
23-Jul-81	44.78		7.08				786											2153	5672			
11-Oct-81	44.51																					
09-Jan-82	44.47		5.83				2177											368	9798			
09-Apr-82	44.03																					
08-Jul-82	43.82																					
16-Oct-82	43.25																					
04-Jan-83	42.98		6.64				1251											4472	10511			
24-May-83			6.2	0.21		0.017	1840	<1	0.031	0.075	6	0.27		0.77	-1.1		0.24	7630	12700		0.08	
24-May-83			6.2	0.21		0.017	1840	<1	0.031	0.075	6	0.27		0.77	-1.1		0.24	7630	12700		0.08	
03-Jul-83	43.03																					
01-Oct-83	43.82		6.04				1809											7089	14544			
06-Apr-84			6.98				380.1											2638.7	6126			
01-Nov-84	38.73	5300	4.81				1125											4194	8622			
29-Jan-85	43.8	5200	7.53				910											3706	8594			
25-Apr-85	43.9	5200	8.28				3240											4403	11930			
08-Nov-85	44.21																					
13-Jan-86	44.48																					
16-Apr-86	44.4	5200																				
09-Jul-86	43.93	4000	3.64				461											3024	5278			
02-Oct-86	44.45	5100																				
18-Mar-87	43.49	4610																				

Quivira Mining Company
Ambrosia Uranium Mill Site
Ground Water Monitoring Results

Well 36-01TRB, Tres Hermanos B Unit

Date	Depth To Water feet	Spec. Cond. uohm/cm	pH	As (mg/l)	Be (mg/l)	Cd (mg/l)	Cl (mg/l)	CN (mg/l)	Mo (mg/l)	Ni (mg/l)	NO3 (mg/l)	Pb (mg/l)	Pb-210 (pCi/l)	Ra-226 (pCi/l)	Ra-228 (pCi/l)	Sb (mg/l)	Se (mg/l)	SO4 (mg/l)	TDS (mg/l)	Th-230 (pCi/l)	Unat (mg/l)	Gross Alpha (pCi/l)
16-Apr-87	44.9	6000																				
15-Jul-87	45.08	6800	6.5	<0.005	<0.1	<0.001	1473															
15-Jul-87	44.48	7790	6.9																			
15-Jul-87				<0.001		<0.005	1260		0.33	<0.01	<0.1	0.02					0.002	4460	8850			
13-Sep-88				0.019	<0.01	<0.005		<0.01	0.29	0.29		0.07	12	1.7	0.9	0.021	0.032			1.8	0.0044	23
23-Sep-88				0.016	<0.01	<0.005		<0.01	0.36	0.45		0.18	45	5.5	0.8	0.025	0.074			11	0.0298	120
22-Feb-89	50.63	3600	6.7	0.007	<0.01	<0.005		0.01	<0.01	<0.01		<0.02	3.2	0.8	0.6	0.004	0.029			2	0.0109	31
27-Mar-89	51.35	3800	6.7																			
18-May-89	52.65	5000	7	0.008	<0.01	<0.005		<0.01	<0.01	0.02		<0.02	9.9	0.8	0.5	0.01	<0.001			3.7	0.0055	0
18-Jun-89	52.65	5000	7																			
11-Sep-89	53.38	5000	7.2	0.004	<0.01	0.005	1040	0.03	0.02	0.06	<0.1	<0.02	14	1.3	1.5	<0.003	0.017	3280	6920	7.6	0.011	78
27-Feb-90	56.08	5000	6.3	<0.001	<0.01	<0.005	1430	<0.01	<0.01	0.02	<0.1	<0.02	121	21	4.8	<0.003	<0.001	3090	6430	66	0.053	560
22-Aug-90	55.97	5300	6.6	<0.01	<0.01	<0.005	1680	<0.01	0.06	0.02	<0.1	<0.02	4.8	0.5	0.7	0.05	<0.003	3210	6780	1	0.011	65
16-May-91	56.6	5100	6.7	<0.001	<0.01	<0.005	1520	<0.01	<0.01	0.01	<0.1	<0.02	14	1.1	0	<0.003	<0.002	2580	6270	1.7	0.0146	0
19-Aug-91	57.17	5200	6.9	0.001	<0.01	<0.005	1380	<0.01	0.12	0.03	<10	<0.02	22	0.8	3.6	<0.003	<0.002	2270	5150	2.6	0.0275	58
14-Feb-92	55.92	4500	7.5	<0.001	<0.01	<0.005	1190	<0.01	0.14	<0.01	2.2	<0.02	2.8	4.6	0	<0.003	<0.002	2130	4910	2.6	0.0179	0
20-Aug-92	55.1	5050	6.7	0.002	<0.01	<0.005	1240	<0.01	<0.01	<0.01	1	0.02	2.7	0.7	0.7	<0.003	0.005	2400	5310	0.6	0.0093	0
08-Mar-93	54.77	5010	6.7	0.002		<0.005	1250	<0.01	<0.01	<0.01	<0.1	0.02	3.7	5.8	1.2		<0.002	3290	5830	1.7	0.0159	0
31-Aug-93	55.25	5300	6.9				1240	0.02	<0.01	<0.01	2		3.8	1.1	1.1		<0.002	2930	5970	1.4	0.0078	8
28-Apr-94	55.1	4750	6.6				1240	0.01	<0.01	<0.01	1.4		6.6	2.7	1.2		<0.002	3480	5490	5.5	0.0087	34
04-Oct-94	56.48	5500	6.2																			
13-Mar-95	57.31																					
24-Aug-95	56.03																					
20-Feb-96	57.28																					
20-Aug-96	55.64	5000	6.3				1460	<0.01	<0.01	<0.04	0.5		7.9	1.3	0		<0.005	1830	4390	8.9	0.0027	17
03-Apr-97							1520	<0.01	<0.01	<0.04	<0.1		6	2	0.7		<0.005	1930		0	0.0017	10
19-Dec-97	56.86																					
26-Apr-98																						
08-Dec-98							1430	<0.01	<0.02	<0.02	0.11		9.9	3.22	1.41		<0.001	240	2960	7.7	0.0027	24

Quivira Mining Company
Ambrosia Uranium Mill Site
Ground Water Monitoring Results

Well 36-02, Tres Hermanos B Unit, POC

Date	Depth To Water feet	Spec. Cond. uohm/cm	pH	As (mg/l)	Be (mg/l)	Cd (mg/l)	Cl (mg/l)	CN (mg/l)	Mo (mg/l)	Ni (mg/l)	NO3 (mg/l)	Pb (mg/l)	Pb-210 (pCi/l)	Ra-226 (pCi/l)	Ra-228 (pCi/l)	Sb (mg/l)	Se (mg/l)	SO4 (mg/l)	TDS (mg/l)	Th-230 (pCi/l)	Unat (mg/l)	Gross Alpha (pCi/l)
03-Feb-84	33.25	5500	6.32				1424											3622	8381			
17-Apr-84	32.75	6500	6.41	<0.11		<0.007	1360		0.025	0.082		<0.068		0.43			0.17	4785.3	11444		0.12	
18-Jul-84	37.4	1750	9.8				140											300	1250			
17-Oct-84		12900	6.1				2410											4500	11700			
11-Jan-85	33.5	12200	6.8				2080											4010	10600			
22-Apr-85		16200	6	<0.001		<0.0002	2300		<0.1	0.29	1.8	<0.001		1.2			<0.001	5540	12500		0.0004	
08-Jul-85			5.3				2500				0.2							5850	14100			
08-Nov-85	35.06	10000	5.69				2500				0.45							6080	12300			
13-Jan-86	35.53	9100	5.73				2500				<0.1							5710	13100			
11-Apr-86	34.9	10000	5.39	<0.001		<0.0001	2500		0.1	0.15	3	<0.001		0.8			<0.001	6140	13100		0.0006	
08-Jul-86	34.6	10500	7.8				3000				8.5							6020	13700			
07-Oct-86	36.77	8000	7.7				480				0.2							5730	12100			
15-Jan-87	36.72	6500	7.2				2300				0.1							5520	12200			
15-Apr-87	37	15000	6.92	0.003		<0.001	2720		<0.1	0.01		<0.001		0.4			0.003	5510	14700		0.0097	
16-Apr-87	37	8000	7.31	0.006		<0.001	2780		<0.1	0.01		<0.001		0.3			<0.002	6080	13500		0.0128	
15-Jul-87	36.08	11000	7	0.001		<0.005	2840		0.41	<0.01	<0.1	<0.01					0.002	5570	13600			
15-Jul-87	36.08	10200	6.88	<0.005	<0.1	<0.001	2700		<0.1	<0.1	<0.08	<0.01					<0.005	5780	14218			
06-Nov-87	35.94	9200	7				2700				<0.1							5680	12500			
21-Jan-88	36.11	8500	7.3		<0.01		2680	<0.01			<0.1							5670	11800	0.1		
05-May-88	37.58	9200	7	0.02		<0.005	2960		0.31	0.23	<0.1	<0.02		0.6			0.119	5740	14690	0.1	0.0024	
19-Jul-88	37.95	9000	6.9				2930				<0.1							4160	15200			
20-Sep-88				0.019	<0.01	<0.005		<0.01	0.32	0.31		0.02	5.5	0.1	2.2	0.026	0.286			1.6	0.0037	6
23-Sep-88				0.016	<0.01	<0.005		<0.01	0.32	0.28		0.05	3.9	0.6	0.7	0.049	0.242			1.2	0.0049	0
03-Oct-88				0.021	<0.01	<0.005		0.02	0.35	0.28		0.03	3.1	2	1.2	0.587	0.165			1.2	0.0062	53
11-Oct-88				0.012	<0.01	<0.005		0.01	0.37	0.33		0.08	4.5	0.3	1.7	0.119	0.022			1.5	0.0044	51
26-Oct-88	37.65	10200	6.9	0.005			2960		0.4		<0.1			0.1			0.051	5400	14000	0	0.2	
18-Nov-88				0.018	<0.01	<0.005		<0.01	0.39	0.31		0.06	99	1.4	0	0.016	0.104			3.6	0.0095	12
18-Jan-89	38	9300	6.9				2530				<0.1							5630	13600			
21-Feb-89	38.21	8800	6.8	0.015	<0.01	<0.005		<0.01	<0.01	<0.01		<0.02	7.3	1	1.8	0.061	0.028			1.3	<0.0003	32
20-Apr-89	38.48	10000	6.7	0.007		<0.005	2520		0.05	<0.01	0.1	<0.02		3.7			0.03	6390	14000	25	0.0218	
18-May-89	38.46	11125	6.9	0.014	<0.01	<0.005		<0.01	<0.01	<0.01		<0.02	4.7	0.7	1	0.038	<0.001			1.4	0.0026	44
27-Jul-89	38.7	11000	6.7				2820				<0.1							5980	14800			
11-Sep-89	38.6	10000	7	0.012	<0.01	<0.005	2930	<0.01	<0.01	0.13	<0.1	<0.02	3.5	0.8	0	0.033	0.017	3220	13200	1.5	0.0069	51
27-Feb-90	39.3	9300	6.5	0.004	<0.01	0.005	2990	<0.01	<0.01	0.02	<0.1	<0.02	19	4.3	2.1	0.022	0.002	3320	13000	10	0.091	27
22-Aug-90	40.24	10050	7.1	<0.01	<0.01	<0.005	2560	<0.01	0.03	0.04	<0.1	<0.02	9.1	0.6	1.7	<0.003	<0.003	5410	13800	1.5	0.0078	29

Quivira Mining Company
Ambrosia Uranium Mill Site
Ground Water Monitoring Results

Well 36-02, Tres Hermanos B Unit, POC

Date	Depth To Water feet	Spec. Cond. uohm/cm	pH	As (mg/l)	Be (mg/l)	Cd (mg/l)	Cl (mg/l)	CN (mg/l)	Mo (mg/l)	Ni (mg/l)	NO3 (mg/l)	Pb (mg/l)	Pb-210 (pCi/l)	Ra-226 (pCi/l)	Ra-228 (pCi/l)	Sb (mg/l)	Se (mg/l)	SO4 (mg/l)	TDS (mg/l)	Th-230 (pCi/l)	Unat (mg/l)	Gross Alpha (pCi/l)
15-Feb-91	39.57	9300	7.7	0.004	<0.01	<0.005	2130	<0.01	0.23	0.04	3.7	<0.02	4.8	1.3	1.9	<0.003	0.002	4880	10600	2.7	0.0053	35
19-Aug-91	39.45	8800	7.4	0.001	<0.01	<0.005	2490	<0.01	0.28	0.03	<10	<0.02	2.8	0.8	1.7	<0.003	0.002	4660	11200	0.9	0.0065	0
14-Feb-92	39.32	9000	8.1	<0.001	<0.01	<0.005	2540	<0.01	0.32	0.02	1.4	<0.02	6.6	5.8	0.6	<0.003	<0.002	4400	10300	5.2	0.0243	5
17-Aug-92	40.43	9900	7.3	0.049	<0.01	0.011	2500	<0.01	<0.01	0.03	2.7	0.04	2.9	1.2	0	<0.003	0.003	4600	10100	1.6	0.0068	27
08-Mar-93	38.26	8800	7.2	<0.001		<0.025	2520	<0.01	<0.05	<0.05	<0.1	0.04	5.1	3.6	0.2		0.004	4350	9630	1	0.0137	10
31-Aug-93	39.97	10800	7.6				2600	0.02	<0.1	<0.1	0.1		4.1	1.4	1.5		<0.002	4970	11900	12	0.0097	0
28-Apr-94	38.27	8800	7.4				2720	0.02	<0.02	<0.02	0.3		1.9	1.3	1.4		0.003	5150	11400	2.5	0.007	0
04-Oct-94	38.48	10500	7	<0.005		0.05	2740	<0.01	<0.1	<0.1	1.2	0.008	4.2	0.9	1.5		<0.01	4860	11100	1.1	0.0053	13
13-Mar-95	40.09	10100	7.1	<0.02			2630	<0.01	<0.1	<0.4	0.2	<0.01	1.3	1.4	3.5		0.007	4210	11100	1.7	0.0057	0
24-Aug-95	41.94	11000	7.2				2600											4500	10300			
20-Feb-96	41.85	8500	7.3				2580	<0.01	<0.02	<0.08	0.4		5.2	2.6	1.8		<0.005	4570	11300	3.5	0.0088	98
20-Aug-96	40.22	9500	7.2				2680	<0.01	<0.02	<0.08	0.1		2.8	1.5	1.8		<0.025	4610	10700	0.3	0.0048	0
03-Apr-97	41.87	8100	7.5				2810	<0.01	0.03	<0.08	0.2		4.8	1.2	1.4		<0.025	4760	11200	1.5	0.0044	0
02-Dec-97	40.23	9900	7.25				2680	<0.01	<0.02	<0.08	1.4		2	1.4	0.4		<0.025	4490	10400	1.3	0.0066	25
25-Apr-98							2450	<0.01	<0.1	<0.1	0.3		5.6	2.6	3.3		0.007	4470		19.5	0.003	0
08-Dec-98									<0.1	<0.1	2.43		-3.1	1.65	2.92		0.013	4320	11700	1.2	0.004	30
09-Feb-99							2570	<0.01	0.1	<0.1	0.98		6	0.74	4.2		0.011	4450	11000	0	0.006	32

Quivira Mining Company
Ambrosia Uranium Mill Site
Ground Water Monitoring Results

Well 19-VII2-TRB, Tres Hermanos, B-Unit - Background

Date	Depth To Water feet	Spec. Cond. uohm/cm	pH	As (mg/l)	Be (mg/l)	Cd (mg/l)	Cl (mg/l)	CN (mg/l)	Mo (mg/l)	Ni (mg/l)	NO3 (mg/l)	Pb (mg/l)	Pb-210 (pCi/l)	Ra-226 (pCi/l)	Ra-228 (pCi/l)	Se (mg/l)	SO4 (mg/l)	TDS (mg/l)	Th-230 (pCi/l)	Unat (mg/l)	Gross Alpha (pCi/l)
01-Apr-84		5640	7.8	<0.11			35		<0.02			0.072					2510	3900			
23-Apr-85		6080	7.91	<0.001		<0.0001	36		<0.1	0.07	1.9	<0.001		1.1		<0.001	2630	4570		0.0167	
22-Apr-86		4500	7.75	<0.001		<0.0001	46		0.2	0.05		<0.001		2.5		<0.001	2480	4180		0.0145	
22-Apr-87		4500	7.72	0.005		<0.001	53.5		0.1	0.01		<0.001		1		<0.002	2470	4150		0.0265	
26-Apr-88		2790	7.2	0.013		<0.005	41		0.05	0.04	20	<0.02		0.4		0.041	2770	4140	0	0.0153	
13-Sep-88				<0.001	<0.05	<0.05		<0.005	<0.1	<0.05		<0.05	1.7	4.9	-1	0.008			5.2	0.0153	20
13-Sep-88				0.021	<0.01	<0.005		<0.01	0.05	0.06		<0.02	0.7	2.3	7.5	0.036			1.1	0.0192	16
05-Oct-88				0.039	<0.01	<0.005		<0.01	0.05	0.06		<0.02	0.2	0.9	5.4	0.1			0.5	0.0174	38
05-Oct-88				<0.001	<0.05	<0.01		<0.005	<0.1	<0.05		<0.05	<1	3	6.3	0.009			2	0.025	9.3
21-Apr-89		3500	7.59	0.025		<0.005	46.6		0.02	0.01	22.2	<0.02		0.9		0.019	2660	4200	0	0.0155	
15-Sep-89		4000	7.2	0.008	<0.01	<0.005	41.3	<0.01	0.02	0.02	15.6	<0.02	2.4	0.3	4.8	0.011	2230	4050	0	0.015	30
24-Apr-90		3450	6.8	0.004	<0.01	<0.005	46	<0.01	0.01	0.02	15	<0.02	10	1.1	5.4	0.001	2620	4090	0	0.012	54
09-Oct-90		3520	7.4	0.009	<0.01	<0.005	44	<0.01	0.02	<0.01	123	<0.02	26	0.9	4.5	0.002	2590	4230	0	0.0821	90
01-May-91	279	3900	7.1	<0.001	<0.01	<0.005	45	<0.01	<0.01	<0.01	13.9	<0.02	9.7	0.6	3.4	0.003	2440	3990	0	0.0172	28
02-Oct-91	279	3650	7.1	<0.001	<0.01	<0.005	33	0.08	0.05	0.03	11.4	<0.02	7.9	0.8	6	0.003	2320	4080	0.3	0.0156	20
01-May-92		3690	7.4	<0.001	<0.01	<0.005	40	0.08	0.05	0.01	<10	<0.02	3.8	1.9	3.9	0.004	2600	3740	105	0.203	130
02-Oct-92		3700	7.6	<0.001	<0.01	<0.005	41	<0.01	<0.01	<0.01	7.7	<0.02	3.6	1.3	6.3	0.004	2390	3860	0	0.0207	17
27-May-93		3600	7.4				39	<0.01	<0.01	<0.01	11.5			1.8	6.1	0.007	2610	3940	2.2	0.0183	24
15-Oct-93		3250	7.4				39	<0.01	0.01	<0.01	11			2.7	5.2	0.006	2490	3820	1.6	0.0169	36
03-Jun-94		3300	7.4				40	<0.01	<0.01	<0.01	9.8		0.7	1.1	4.4	0.003	2580	3460	1	0.0155	89
09-Nov-94		3750	7.4				40	<0.01	0.01	<0.02	8.1		4.9	1.2	4.8	<0.005	2670	3740	0.2	0.0192	4
28-Jun-95		3825	7.6	<0.005	<0.004	<0.005	39	<0.01	<0.01	<0.02	7.7	<0.005	3.4	1.5	4.8	0.008	2500	3760	0.1	0.0176	24
24-Oct-95		3690	7.4				42	<0.01	<0.01	<0.03	6.9		0.6	1.1	4.9	<0.005	2540	3800	0.1	0.0154	32
14-May-96		3800	7.6				36	<0.01	0.01	<0.03	5.9		19	2.6	5.4	<0.005	2700	3740	0.1	0.017	41
10-Oct-96		3500	7.7				45	<0.01	<0.01	<0.02	5.1		81	21	38	<0.005	2490	3800	3.4	0.02	297
21-May-97																					
15-Oct-97																					

Quivira Mining Company
Ambrosia Uranium Mill Site
Ground Water Monitoring Results

19-77, Tres Hermanos B, Background Well

Date	pH	As (mg/l)	Be (mg/l)	Cd (mg/l)	Cl (mg/l)	CN (mg/l)	Mo (mg/l)	Ni (mg/l)	NO3 (mg/l)	Pb-210 (pCi/l)	Ra-226 (pCi/l)	Ra-228 (pCi/l)	Se (mg/l)	SO4 (mg/l)	Th-230 (pCi/l)	Unat (mg/l)	Gross Alpha (pCi/l)
14-May-96	7.6				17	0.01	0.02	<0.03	0.3	4.6	2.1	3.9	<0.005	2200	0.4	0.014	38
15-Oct-96	7.5				19	<0.01	0.01	<0.02	0.5	2.1	1.6	2.8	<0.005	2180	0.05	0.019	27
21-May-97	8.3				222	<0.01	0.02	<0.01	0.4	7.5	1.7	12	<0.005	1970	1.2	0.02	45
28-Dec-97	7.2				23	<0.01	0.02	<0.04	0.8	23	6.1	4.4	<0.005	2250	2.2	0.068	149
08-Jun-98	9.9				21	<0.01	0.03	<0.01	0.6	4.3	5.5	2.6	0.006	2170	4.1	0.0568	113
18-Dec-98	8.8				4	<0.01	0.04	<0.02	0.56	12	4.5	3.1	<0.001	2230	5.5	0.04	92
08-Mar-99	7.3				19	<0.01	<0.02	<0.02	0.69	9.6	2.69	3.2	0.002	1980	0.82	0.027	36

Quivira Mining Company
Ambrosia Uranium Mill Site
Ground Water Monitoring Results

Well 36-74, Tres Hermanos, Unit B - Down Gradient

Date	Depth To Water feet	Spec. Cond. uohm/cm	pH	As (mg/l)	Be (mg/l)	Cd (mg/l)	Cl (mg/l)	CN (mg/l)	Mo (mg/l)	Ni (mg/l)	NO3 (mg/l)	Pb-210 (pCi/l)	Ra-226 (pCi/l)	Ra-228 (pCi/l)	Sb (mg/l)	Se (mg/l)	SO4 (mg/l)	TDS (mg/l)	Th-230 (pCi/l)	Unat (mg/l)	Gross Alpha (pCi/l)
04-Jun-90	152.13																				
06-Aug-90	153																				
28-Feb-91	147.44	1380	6.7				12										756	1350			
16-May-91	147.15	1550	7.5	<0.001	<0.01	<0.0005		<0.01	0.02	<0.01	0.1	0	0.1	1.6	<0.003	<0.002			0.6	0.0064	4
23-Sep-91	146.08	1550	6.7				20										95	1600			
21-Feb-92	145.61	1575	7.4	<0.001	<0.01	<0.005	18	<0.01	0.06	0.02	0.3	3.4	1.2	1.6	<0.003	<0.002	954	1640	1.9	0.0097	16
26-Sep-92	145.88	1600	6.8				16										913	6590			
04-May-93	145.91	1520	7	0.002		<0.005	17	<0.01	<0.01	<0.01	0.3	4.1	1.6	0		<0.002	903	1570	2.3	0.0103	26
14-Sep-93	146.19	1525	6.9				16										901	1630			
28-Apr-94	146.21	1390	6.7				18	<0.01	<0.01	<0.01	0.2	2.5	1.5	1.5		<0.002	786	1380	0.9	0.0051	6.6
31-Oct-94	146.34	1410	6.9	<0.005		<0.01	17										746	1360			
05-Jun-95	146.14	1425	7.4	<0.005		<0.005	17	<0.01	<0.01	0.02	0.1	3.1	0.8	1.8		<0.005	695	1290	1.1	0.0047	3.2
25-Oct-95	146.26	1425	6.9				15										720	1360			
12-Mar-96	146.21	1380	7.1				16	<0.01	<0.01	<0.04	<0.1	1.6	0.7	3		<0.005	730	1290	1.1	0.0045	1.9
02-Jun-97	145.75	1375	7.1				22	<0.01	<0.01	<0.01	0.2	13	0.5	4.2		<0.005	729	1290	1.8	0.0055	46

Quivira Mining Company
Ambrosia Uranium Mill Site
Ground Water Monitoring Results

Well 19-VH5-TRB, Tres Hermanos, Unit B - POE

Date	Depth To Water feet	Spec. Cond. uohm/cm	pH	As (mg/l)	Be (mg/l)	Cd (mg/l)	Cl (mg/l)	CN (mg/l)	Mo (mg/l)	Ni (mg/l)	NO3 (mg/l)	Pb-210 (pCi/l)	Ra-226 (pCi/l)	Ra-228 (pCi/l)	Sb (mg/l)	Se (mg/l)	SO4 (mg/l)	TDS (mg/l)	Th-230 (pCi/l)	Unat (mg/l)	Gross Alpha (pCi/l)
24-Apr-90		2250	7.1	0.003	<0.01	<0.005	37	<0.01	<0.01	<0.01	<0.1				0.006	<0.001	1570	2560		0.0013	
01-May-91	250	2700	7.3	<0.001	<0.01	<0.005	33		<0.01	<0.01					<0.003	<0.002	1270	2420			

APPENDIX B
Tres Hermanos A Sandstone
Monitoring Results Summary Tables

Quivira Mining Company
Ambrosia Uranium Mill Site
Ground Water Monitoring Results

Well 31-01, Tres Hermanos A Unit, POC

Date	Depth To Water feet	Spec. Cond. uohm/cm	pH	As (mg/l)	Be (mg/l)	Cd (mg/l)	Cl (mg/l)	CN (mg/l)	Mo (mg/l)	Ni (mg/l)	NO3 (mg/l)	Pb (mg/l)	Pb-210 (pCi/l)	Ra-226 (pCi/l)	Ra-228 (pCi/l)	Sb (mg/l)	Se (mg/l)	SO4 (mg/l)	TDS (mg/l)	Th-230 (pCi/l)	Unat (mg/l)	Gross Alpha (pCi/l)
16-Aug-83			7.4	<0.1		0.008	510	<0.1	0.019	0.072	<1	0.18		9.65	-1.8		0.17	1650	2940		0.016	
14-Nov-83			7.4	0.06		<0.007	14	<1	<0.018	<0.038	1	0.029		0.004	-4.8		0.025	870	1460		0.006	
03-Feb-84	195.48	1920	7.4				17											810	1550			
17-Apr-84	205.41	2400		<0.11		<0.007	80		<0.018	<0.038		<0.068		0.73			<0.1	780	1500		0.019	
18-Jul-84	205.45	1440	7.4				52											790	1380			
17-Oct-84	204.9	1880	5.4				12											720	1550			
11-Jan-85	203.92	1870	7.4				13											640	1480			
22-Apr-85	205.3	2100	7.6	<0.001		<0.0002	14		<0.1	0.1	<0.1	<0.001		0.7			<0.001	951	1590		0.0014	
08-Jul-85	206.1	1425	7.2				14				0.2							984	1560			
07-Nov-85	204.1	1450	6.73				13				2.5							1040	1620			
13-Jan-86	204.5	3380	7.35				20				0.5							994	1660			
10-Apr-86	204.8	3375	7.5	<0.001		<0.0001	30		0.1	0.04	3.5	<0.001		1.7			<0.001	966	1630		0.0014	
08-Jul-86	205.5	3500	7.99				53											992	1670			
07-Oct-86	204.7	1500	7.55				14				0.6							985	1560			
15-Jan-87	205.5	1350	7.61				13				0.2							977	1550			
15-Apr-87	205.8	1210	7.6	0.002		<0.001	13.2		<0.1	0.01		<0.001		0.4			<0.002	1010	1550		0.01	
15-Apr-87	205.8	1210	7.51	0.004		<0.001	12.3		<0.1	0.01		<0.001		0.5			<0.002	988	1630		0.0106	
15-Jul-87	205.1	1750	6.9	0.002		<0.005	13.1		0.04	<0.01	<0.1	<0.01					0.007	966	1580			
15-Jul-87	205.1	1750	6.13	<0.005	<0.1	<0.001	<5		<0.1	<0.1	0.05	<0.01				<0.1	<0.005	988	1638			
19-Oct-87	203.1	1400	7.5				13.8				0.40							987	1570			
20-Jan-88	204.4	1550	7.1		0.01		12.7	<0.01			<0.1							1100	1570	0		
25-May-88	204.7	1400	7.3	0.012		<0.005	30		0.03	0.02	1.00	<0.02		0.6			0.013	952	1670	0	0.01	
18-Jul-88	204.7	1400	7.3				10.8				<0.1							992	1720			
21-Sep-88				0.015	<0.01	<0.005		0.01	<0.01	0.02		<0.02	1.9	1.2	1.2	0.006	0.025			0.3	0.0031	20
28-Sep-88				0.022	<0.01	<0.005		<0.01	0.03	0.07		0.02	2.9	1	2	0.007	0.034			1.2	0.0037	16
10-Oct-88				0.024	<0.01	<0.005		0.01	0.03	0.04		<0.02	8.4	1.8	3	0.025	0.005			2.1	0.0029	26
13-Oct-88				0.025	<0.01	<0.005		<0.01	0.03	0.03		0.02	3.7	0.5	2.5	0.03	0.018			0.6	0.005	22
21-Oct-88	204.8	1425	7.1	0.001			12.7		0.04		<0.1			0.2			0.024	975	1680	0.4	0.0051	
17-Nov-88				<0.001	<0.01	<0.005		<0.01	0.04	0.05		0.02	19	1.2	0.4	0.005	0.012			8		30
17-Jan-89	204.7	1375	7.3				11.5				0.3							995	1630			
22-Feb-89	204.7	1430	7	0.001	<0.01	<0.005		<0.01	<0.01	<0.01		<0.02	2.3	0.6	2.1	<0.003	0.01			2.3	0.0034	18
20-Apr-89	204.58	1400	7	0.003		<0.005	14.7		0.17	<0.01	0.3	<0.02		2			0.01	1080	1620	4.6	0.0084	
22-May-89	204.7	1500	7.4	0.001	<0.01	<0.005		<0.01	0.02	<0.01		<0.02	2.1	1.4	1.8	0.004	0.014			2.4	0.0036	7.8
26-Jul-89	204.35	1450	7.2				13.2				<0.1							1050	1620			

Quivira Mining Company
Ambrosia Uranium Mill Site
Ground Water Monitoring Results

Well 31-01, Tres Hermanos A Unit, POC

Date	Depth To Water feet	Spec. Cond. uohm/cm	pH	As (mg/l)	Be (mg/l)	Cd (mg/l)	Cl (mg/l)	CN (mg/l)	Mo (mg/l)	Ni (mg/l)	NO3 (mg/l)	Pb (mg/l)	Pb-210 (pCi/l)	Ra-226 (pCi/l)	Ra-228 (pCi/l)	Sb (mg/l)	Se (mg/l)	SO4 (mg/l)	TDS (mg/l)	Th-230 (pCi/l)	Unat (mg/l)	Gross Alpha (pCi/l)
11-Sep-89	204.5	1450	7.2	0.002	<0.01	<0.005	12	<0.01	0.01	<0.01	<0.1	<0.02	1.8	0.5	1.8	<0.003	0.008	1000	1620	0.5	0.0037	1.7
09-Mar-90	204.13	1410	7.5	<0.001	<0.01	<0.005	15	<0.01	0.02	<0.01	0.1	<0.02	6.2	2.3	3.9	0.005	<0.001	1020	1540	2.6	0.004	24
06-Sep-90	205	1490	7.2	0.001	<0.01	<0.005	15	0.01	0.03	<0.01	<0.1	<0.02	2.3	0.5	6	<0.003	<0.002	977	1570	0	0.0052	14
13-Feb-91	204.5	1450	7.1	0.001	<0.01	<0.005	13	<0.01	0.04	<0.01	<0.1	<0.02	1.4	1.1	0.4	<0.003	<0.002	1020	1580	0.4	0.0076	0
19-Aug-91	204.2	1450	7.2	<0.001	<0.01	<0.005	60	<0.01	0.02	<0.01	0.9	<0.02	3.1	1	1.4	<0.03	<0.002	900	1550	0.3	0.0048	11
13-Feb-92	204.3	1400	7.8	<0.001	<0.01	<0.005	21	0.02	0.04	<0.01	0.5	<0.02	14	6.1	3.3	<0.003	<0.002	994	1440	3.2	0.0101	58
14-Aug-92	204.5	1490	7.3	<0.001	<0.01	<0.005	13	<0.01	<0.01	<0.01	0.4	<0.02	6	5.5	1.4	<0.003	0.006	991	1460	1.4	0.005	26
06-Mar-93	204.2	1350	7.6	<0.001		<0.005	13	<0.01	<0.01	<0.01	<0.1	<0.02	4.9	4.9	1		<0.002	992	1460	3.1	0.0159	2.7
23-Aug-93	204.2	1450	7.4				27	0.03	<0.01	<0.01	<0.1		3.4	1.2	3		<0.002	1670	2390	9.1	0.0054	5
26-Apr-94	203.8	1350	7.6				13	<0.01	<0.01	<0.01	0.1		9	3.1	1.7		<0.002	1070	1460	1.6	0.0077	31
06-Oct-94	203.85	1550	7.2	<0.001		<0.005	34	<0.01	<0.01	<0.01	0.3	<0.15	5.8	4.3	4.4		<0.002	998	1490	2	0.0056	59
13-Mar-95	203.82	1450	7.6	<0.005			24	<0.01	<0.01	0.04	<0.1	0.006	3	0.7	4.5		<0.005	984	1440	1.6	0.0079	23
27-Sep-95	203.78	1600	7.4				38	<0.01	<0.01	<0.04	<0.1		5.2	3.6	3.3		<0.005	952	1540	1.8	0.0039	43
22-Feb-96	203.65	1525	6.9				33	<0.01	<0.01	<0.02	<0.1		2.3	2.2	2.8		<0.005	1020	1580	0.8	0.0057	14
22-Aug-96	203.73	1550	7.4				41	<0.01	<0.01	<0.04	<0.1		2.4	2.2	7.1		<0.005	989	1670	2.2	0.0062	19
07-Apr-97	203.6	1400	7.6				25	<0.01	<0.01	<0.01	<0.1		5.4	1.4	1.9		<0.005	1040	1560	0.1	0.0099	16
04-Dec-97	203.24	1440	7.68				47	<0.01	<0.01	<0.04	<0.1		3.4	5	6.2		<0.005	1120	1530	0.6	0.006	135
26-Apr-98							68	<0.01	<0.01	<0.01	0.1		2.1	6	3.6		<0.001	1040		1.5	0.0043	25.1
18-Dec-98							48	<0.01	<0.01	<0.01	0.03		3.8	8	8.8		<0.001	1010	1720	5.1	0.0041	62
08-Mar-99		1450	7.5				29		<0.01	<0.01	0.03		3.8	1.14	4.3		<0.001	990	1670	0.41	0.004	14.4

Quivira Mining Company
Ambrosia Uranium Mill Site
Ground Water Monitoring Results

33-01, Tres Hermanos A, Background Well

Date	Depth To Water feet	Spec. Cond. uohm/cm	pH	As (mg/l)	Be (mg/l)	Cd (mg/l)	Cl (mg/l)	CN (mg/l)	Mo (mg/l)	Ni (mg/l)	Pb (mg/l)	Pb-210 (pCi/l)	Ra-226 (pCi/l)	Ra-228 (pCi/l)	Sb (mg/l)	Se (mg/l)	SO4 (mg/l)	Th-230 (pCi/l)	Unat (mg/l)	Gross Alpha (pCi/l)
03-Feb-84	169.28	1102	8.5				9										380			
17-Apr-84																				
08-Jul-84																				
17-Oct-84	175.5	3660	13				20										250			
11-Jan-85																				
22-Apr-85																				
08-Jul-85																				
07-Nov-85	176.3	2210	6.91				30										1740			
14-Jan-86	174.1	2250	7.28				34										1660			
10-Apr-86	173.3	3500	7.43	0.2		<0.0001	27		0.1	0.06	0.002		0.7			<0.001	1610		0.0058	
08-Jul-86	172.8	2500	7.82				130										1630			
07-Oct-86	170.2	2500	7.68				14										1630			
17-Mar-87	161.2	2350	7.11				29										1610			
15-Apr-87	161.3	2290	7.02	0.005		<0.001	34.7		<0.1	0.01	<0.001		0.4			<0.002	1620		0.0144	
15-Apr-87	161.3	2150	7.44	0.004		<0.001	28		<0.1	0.01	<0.001		1.1			<0.002	1560		0.0143	
21-Jul-87	168.7	2400	7.5				27.9										1650			
21-Oct-87	169.88	2350	7.4				23.1										1690			
20-Jan-88	173.8	2275	7.3		<0.01		28.7	<0.01									1720		0.2	
05-May-88	168.2	2450	7.3	0.018		<0.005	29		0.04	0.03	<0.02		0.4			0.027	1800	0.3	0.004	
20-Jul-88	164.61	2350	7.3				25.5										1770			
13-Sep-88				0.015	<0.01	<0.005		<0.01	0.02	0.03	<0.02	1.1	1.4	2.4	0.004	0.018		1	0.0052	0
23-Sep-88				0.015	<0.01	<0.005		<0.01	0.03	0.05	0.02	8.3	1.7	2.2	0.012	0.068		2	0.0071	31
03-Oct-88				0.015	<0.01	<0.005		<0.01	0.03	0.04	<0.02	3.1	1.9	1.7	0.016	0.038		1.7	0.0101	27
11-Oct-88				0.005	<0.01	<0.005		<0.01	0.03	0.09	0.09	3.3	0.8	2.8	0.035	0.009		14	0.0095	27
26-Oct-88	175	2400	7.2	0.002			31.5		0.05				1.1			0.012	1770	0.5	0.0125	
17-Nov-88				0.005	<0.01	<0.005		<0.01	0.04	0.04	<0.02	4.9	1.1	1.9	0.013	0.029		2.8	0.0164	7
17-Jan-89	172.95	2300	7.2				31										1800			
20-Jan-89	174.98	2175	7.2	0.007	<0.01	<0.005		<0.01	<0.01	0.02	0.05	15	2.1	3.1	0.003	0.013		9.5	0.0119	80
22-Feb-89	174.08	2400	7	0.006	<0.01	<0.005		<0.01	<0.01	<0.01	<0.02	2.5	1.5	2.7	0.008	0.013		2.7	0.0051	15

Quivira Mining Company
Ambrosia Uranium Mill Site
Ground Water Monitoring Results

33-01, Tres Hermanos A, Background Well

Date	Depth To Water feet	Spec. Cond. uohm/cm	pH	As (mg/l)	Be (mg/l)	Cd (mg/l)	Cl (mg/l)	CN (mg/l)	Mo (mg/l)	Ni (mg/l)	Pb (mg/l)	Pb-210 (pCi/l)	Ra-226 (pCi/l)	Ra-228 (pCi/l)	Sb (mg/l)	Se (mg/l)	SO4 (mg/l)	Th-230 (pCi/l)	Unat (mg/l)	Gross Alpha (pCi/l)
21-Mar-89	174.73	2425	7.3	0.005	<0.01	<0.005		<0.01	<0.01	<0.01	<0.02	8.6	1.9	1.3	0.023	0.017		0.1	0.0199	34
20-Apr-89	175.2	2450	7	0.008	<0.01	<0.005		<0.01	0.03	<0.01	0.02	4.6	2.7	1.8	0.013	0.017		3.9	0.0484	50
20-Apr-89	175.2	2450	7	0.004		<0.005	50.9		0.16	0.03	0.24		32			0.01	1940	32	0.0583	
19-May-89	178.07	2725	7.1	0.006	<0.01	<0.005		<0.01	0.02	<0.01	0.03	18	4.2	2.2	0.014	0.018		13	0.0424	91
13-Jun-89	178.6	2750	7.2	0.006	<0.01	<0.005		<0.01	0.02	0.02	<0.02	19	1.2	1.9	0.015	0.016		10	0.035	77
28-Jul-89	176.05	2580	7.3	0.008	<0.01	<0.005		<0.01	<0.01	<0.01	0.03	9.3	5.1	3.4	0.003	0.006		5.2	0.011	40
28-Jul-89	176.05	2580	7.3				37.8										1890			
30-Aug-89	175.66	2700	7.4	0.006	<0.01	<0.005		0.01	0.01	0.01	<0.02	1.3	1.3	2.2	0.003	0.01		1	0.012	39
11-Sep-89	178.26	2675	7.1	0.002	<0.01	<0.005	38	<0.01	0.02	<0.01	<0.02	1	0.9	1.3	<0.003	0.008	1840	0.8	0.013	24
06-Mar-90	166.88	2450	7.2	0.001	<0.01	<0.005	31	<0.01	0.02	<0.01	<0.02	5.9	0.7	2.7	0.022	0.001	1720	3.6	0.0054	35
08-Aug-90	159.9	2620	7.1	<0.001	<0.01	<0.005	31	<0.01	<0.01	<0.01	<0.02	1.8	0.6	1.4	<0.003	<0.002	1710	0.3	0.005	9
13-Feb-91	151.47	2480	7.1	0.001	<0.01	<0.005	31	<0.01	0.04	<0.01	<0.02	6	0.6	2.1	<0.003	<0.002	1770	0.6	0.0062	1
19-Aug-91	146.46	2490	8	<0.001	<0.01	<0.005	75	<0.01	0.02	0.02	<0.02	7.9	0.4	2.3	<0.003	<0.002	1530	0.3	0.0269	14
13-Feb-92	138.4	2375	7.8	<0.001	<0.01	<0.005	29	1.1	0.03	<0.01	<0.02	5.3	1.7	2.6	<0.003	<0.002	1700	0.9	0.0109	17
14-Aug-92	137.74	2525	7.6	<0.001	<0.01	<0.005	28	<0.01	<0.01	<0.01	<0.02	13	9	2.2	<0.003	0.004	1680	1.2	0.006	42
06-Mar-93	136.63	2375	7.6	0.001		<0.005	28	<0.01	<0.01	<0.01	<0.02	20	6.3	0		<0.002	1650	8.3	0.0247	32
24-Aug-93	136.46	2400	7.3				13	0.02	<0.01	<0.01		11	3.3	1.5		<0.002	952	1.9	0.0073	22
27-Apr-94	135.7	2280	7.7				27	<0.01	<0.01	0.02		7.2	3.1	1.9		<0.002	1650	1.5	0.0046	25
06-Oct-94	135.92	2510	7.3	0.001		<0.005	29	<0.01	<0.01	<0.01	0.05	52	6.9	2.2		<0.002	1630	2	0.0066	72
13-Mar-95	135.94	2450	7.8	<0.005		<0.005	27	<0.01	<0.01	<0.04	<0.002	8.1	2.7	2.1		<0.005	1590	1.1	0.004	17
25-Sep-95	135.36	2525	7.5				28	<0.01	<0.01	<0.04		13	5.3	2.3		<0.005	1510	2	0.006	41
22-Feb-96	133.75	2300	7				54	<0.01	<0.01	<0.04		15	1.3	3.7		<0.005	1000	2.4	0.003	45
22-Aug-96	126.84	2425	7.9				38	<0.01	<0.01	<0.04		22	6.6	1.4		<0.005	1650	5.2	0.0069	49
07-Apr-97	123.3	2300	8.1				35	0.01	0.01	<0.01		10.1	3.1	1		<0.005	1700	2.6	0.0083	23
04-Dec-97	121.88	2375	8.09				41	<0.01	<0.01	<0.04		7.2	1.5	2.7		<0.005	1800	1.4	0.0055	86
28-Apr-98							28	<0.01	<0.01	<0.01		4.1	1.5	0.6		<0.001	1680	0	0.0024	
18-Dec-98							29	<0.01	<0.02	<0.02		8.1	2.97	2	<0.001		1760	8.3	0.006	47
09-Feb-99							37	<0.01	<0.02	<0.02		9.6	3.37	1.7		<0.001	1550	2.7	0.058	53

Quivira Mining Company
Ambrosia Uranium Mill Site
Ground Water Monitoring Results

Well 30-01, Tres Hermanos, A Unit, Down Gradient

Date	Depth To Water feet	Spec. Cond. uohm/cm	pH	As (mg/l)	Cd (mg/l)	Cl (mg/l)	CN (mg/l)	Mo (mg/l)	Ni (mg/l)	NO3 (mg/l)	Pb (mg/l)	Pb-210 (pCi/l)	Ra-226 (pCi/l)	Ra-228 (pCi/l)	Se (mg/l)	SO4 (mg/l)	TDS (mg/l)	Th-230 (pCi/l)	Unat (mg/l)	Gross Alpha (pCi/l)
01-May-77	166.5					72										630	1080			
01-Jul-77	204.1					56										354	1290			
01-Feb-78	178.6					66										600	1190			
01-Jul-78	169.3					18										538	2528			
01-Oct-78	169.5																			
01-Mar-79	160.4					79										689	1263			
01-Jul-79	162.1					49										728	1328			
01-Oct-79	164.9					67										586	1487			
01-Jan-80	160.1					73										315	1221			
01-Apr-80	165.1					51										803	1230			
01-Jul-80	164.7					70										680	6400			
01-Oct-80	168.05					109										687	1254			
01-Jan-81	169					52										523	1202			
01-Apr-81	170.05					10.6										465	1130			
01-Jul-81	168.82					44.6										447.4	1178			
01-Oct-81	171.22					62.25										229.22	1138			
01-Jan-82	170.78																			
01-Apr-82	173.75																			
01-Jul-82	170.28																			
01-Oct-82	176.3					40.9										304	1022			
01-Jan-83	177.8					49.9										409	1117			
01-May-83	175.6					26.5										383.6	1084			
25-May-83			9	<0.1	<0.01	51	16	0.046	<0.08	<1	0.05		1.6	<2.4	0.088	450	1080		0.002	
01-Oct-83	175.2					41.7										438	1083			
06-Apr-84	174.4		9.02			63.1										472.8	1141			
01-Jul-84	170.7					70.9										502	1152			
01-Nov-84	168.9	1100	8.54			60.5										494	1140			
02-Feb-85	167.9	1025				78										500	1200			
25-Apr-85	166.9	1050	8.68			77										546	1170			
08-Nov-85	164.4																			
13-Jan-86	164.92																			
21-Apr-86	164.8	1200																		

Quivira Mining Company
Ambrosia Uranium Mill Site
Ground Water Monitoring Results

Well 30-01, Tres Hermanos, A Unit, Down Gradient

Date	Depth To Water feet	Spec. Cond. uohm/cm	pH	As (mg/l)	Cd (mg/l)	Cl (mg/l)	CN (mg/l)	Mo (mg/l)	Ni (mg/l)	NO3 (mg/l)	Pb (mg/l)	Pb-210 (pCi/l)	Ra-226 (pCi/l)	Ra-228 (pCi/l)	Se (mg/l)	SO4 (mg/l)	TDS (mg/l)	Th-230 (pCi/l)	Unat (mg/l)	Gross Alpha (pCi/l)
09-Jul-86	165.3																			
02-Oct-86	166.5																			
30-Jan-87	168.2	1200																		
06-May-87	164.3	1150																		
10-Sep-87	162	1140	8.5			99										467	1130			
28-Oct-87	163.1	1150	8.5																	
03-Mar-88	165.4	1100	8.7																	
08-Jun-88	166.3	1150	8.8																	
05-Dec-88	166	1210	9.1			126										4	42			
06-Dec-88	166.8	1225	8.9																	
31-Mar-89	165.85	1300	9																	
20-Jun-89	165.8	1350	8.7																	
21-Aug-89	166.7	1350	8.7	<0.001	<0.005	145	0.05	0.03	<0.01	<0.1	<0.02	9.1	3.7	0	0.009	532	1240	0.7	0.007	29
28-Sep-89	169.85	1400	8.2	<0.001	0.008	152	0.62	0.05	0.01	<0.1	<0.02	4	0.8	0.4	0.002	581	1310	1.3	0.0039	14
06-Apr-90	169	1480	8.4			213										672	1420			
24-Sep-90	169.39	1600	8.3	0.002	<0.005	225	0.92	0.04	0.01		<0.02				<0.002	586	1060			
24-Sep-90	169.39	1600	8.3	0.002	<0.005	225	0.92	0.04	0.01		<0.02				<0.002	586	1060			
21-Feb-91	170.66	1790	8.5			233										470	1530			
17-May-91	171.3	1800	8.6	<0.001	<0.005		0.42	<0.01	0.02	<0.1	<0.02	0.8	1.2	0	<0.002			0.4	0.0093	15
27-Aug-91	172.02	1910	8.3			274										744	1400			
21-Feb-92	171.49	2020	8.5	<0.001	<0.005	292	0.77	0.06	0.04	0.3	0.02	4	3.2	0.2	<0.002	920	1850	5.2	0.0144	26
26-Sep-92	171.35	2200	8.5			379										990	1990			
01-Apr-93	170.8	2230	8.4	<0.001	<0.005	415	0.49	0.01	<0.01	0.2	0.02	3.1	4.6	0	<0.002	1020	2060	0.9	0.0077	0
09-Sep-93	173.31	2375	8.3			429										1170	2020			
28-May-94	172.05	2400	8.2			429	0.38	<0.01	0.02	0.1		5.1	3.6	1	<0.002	1190	2380	4.4	0.0085	23
01-Nov-94	174.46	2600	8.5	<0.005	<0.01	465					<0.005					1210	2440			
06-Jun-95	175.28	2250	8.3	<0.005	<0.005	490	0.05	<0.01	<0.02	<0.1	<0.005	7.6	1.7	0.7	<0.005	1240	1380	2.1	0.0134	27
26-Oct-95	179.05	2650	8.3			464										1100	2550			
14-Mar-96	181.14	2480	7.9			440	0.33	<0.01	0.03	0.1		6.2	5.9	2.1	<0.005	1200	2390	5.1	0.012	33
12-May-97	180.58	2425	8.6			476	0.29	<0.01	0.02	<0.1		3.3	4	2.1	<0.005	851	2370	4.3	0.011	33
29-May-98	180.58	2425	8.6			354	0.29	<0.01	0.02	0.1		1.66	2.48	0.76	<0.005	970	2210	1.24	0.0028	8.4
19-Mar-99		2200	8.9			430	0.22	<0.02	<0.02	0.08		4.6	1.38	2.07	<0.001	910	2100	1	0.003	4.8

Quivira Mining Company
Ambrosia Uranium Mill Site
Ground Water Monitoring Results

Well 36-02TRA, Tres Hermanos, A Unit, Down Gradient

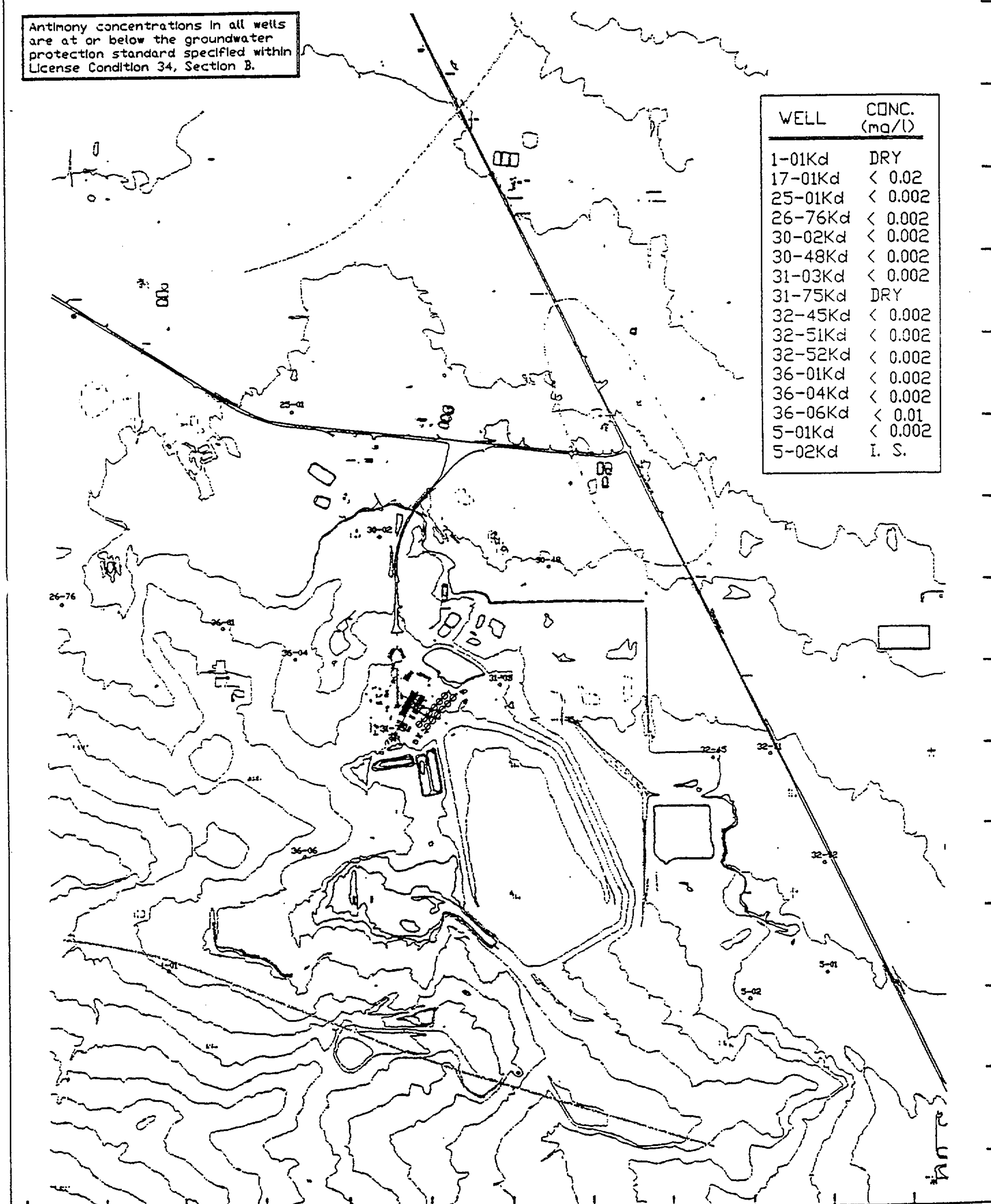
Date	Depth To Water feet	Spec. Cond. uohm/cm	pH	As (mg/l)	Cd (mg/l)	Cl (mg/l)	CN (mg/l)	Mo (mg/l)	Ni (mg/l)	NO3 (mg/l)	Pb (mg/l)	Pb-210 (pCi/l)	Ra-226 (pCi/l)	Ra-228 (pCi/l)	Se (mg/l)	SO4 (mg/l)	TDS (mg/l)	Th-230 (pCi/l)	Unat (mg/l)	Gross Alpha (pCi/l)
20-Jun-89	233.4																			
23-Aug-89	233.4																			
27-Sep-89	233.5																			
07-Jun-90	235																			
12-Dec-90	233.2																			
06-Mar-91	233																			
27-Sep-91	232.7	1220	9.8			26										37	1150			
24-Feb-92	234.2																			
23-Sep-92	234.3																			
11-Mar-93	234.1																			
28-Sep-93	234																			
28-Apr-94	234																			
07-Nov-94	233.8																			
13-Jun-95	233.92																			
02-Nov-95	233.98																			
15-Mar-96																				
03-Apr-97						2810				0.2		4.8	1.2	1.4		4760	11200	1.5	0.0044	
29-May-97																				
02-Dec-97	233.96					2680				1.4		2	1.4	0.4		4490	10400	1.3	0.0066	25
18-Mar-99		980	10.2			18	0.01	0.02	<0.01	1.6		2.8	0.32	1.76	0.042	20	1100	1.4	0.014	9.6

APPENDIX C

Dakota Sandstone
1998 Groundwater Concentration Isopleth Plots and Monitoring Results Summary Tables

ANTIMONY
1998 CONCENTRATION ISOPLETH
NRC GROUNDWATER STANDARD – 0.05 mg/l

Antimony concentrations in all wells are at or below the groundwater protection standard specified within License Condition 34, Section B.



WELL	CONC. (mg/l)
1-01Kd	DRY
17-01Kd	< 0.02
25-01Kd	< 0.002
26-76Kd	< 0.002
30-02Kd	< 0.002
30-48Kd	< 0.002
31-03Kd	< 0.002
31-75Kd	DRY
32-45Kd	< 0.002
32-51Kd	< 0.002
32-52Kd	< 0.002
36-01Kd	< 0.002
36-04Kd	< 0.002
36-06Kd	< 0.01
5-01Kd	< 0.002
5-02Kd	I. S.

ZERO SATURATION – DAKOTA

5-01 WELL

I.S. = Insufficient water in well for sample collection.

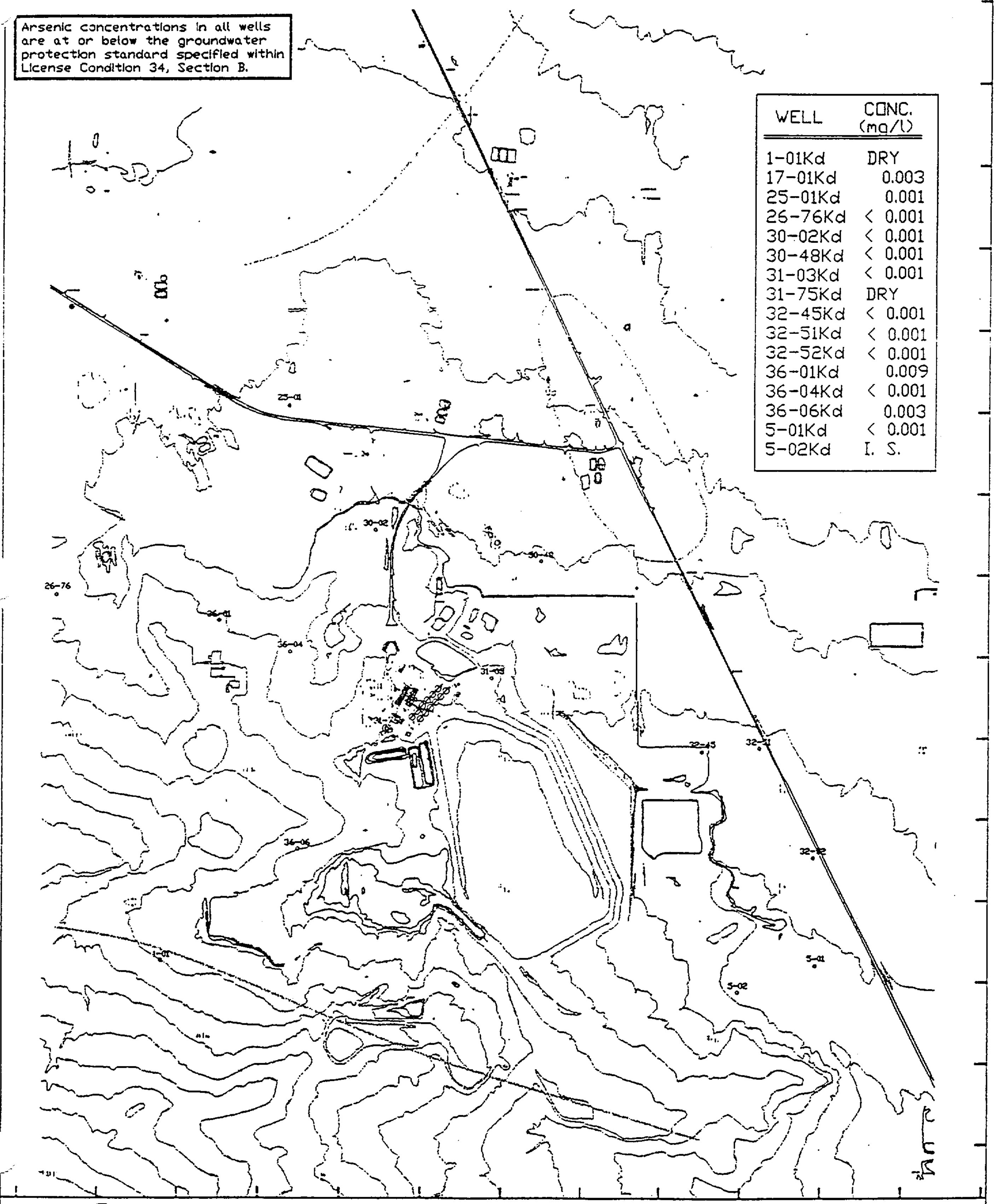
DAKOTA

QUIVIRA MINING COMPANY – AMBROSIA LAKE FACILITY   LICENSE SUA-1473   DOCKET 40-8905

ARSENIC
1998 CONCENTRATION ISOPLETH
NRC GROUNDWATER STANDARD - 0.1 mg/l

Arsenic concentrations in all wells are at or below the groundwater protection standard specified within License Condition 34, Section B.

WELL	CONC. (mg/l)
1-01Kd	DRY
17-01Kd	0.003
25-01Kd	0.001
26-76Kd	< 0.001
30-02Kd	< 0.001
30-48Kd	< 0.001
31-03Kd	< 0.001
31-75Kd	DRY
32-45Kd	< 0.001
32-51Kd	< 0.001
32-52Kd	< 0.001
36-01Kd	0.009
36-04Kd	< 0.001
36-06Kd	0.003
5-01Kd	< 0.001
5-02Kd	I. S.



ZERO SATURATION - DAKOTA

5-01 WELL

I.S. = Insufficient water in well for sample collection.

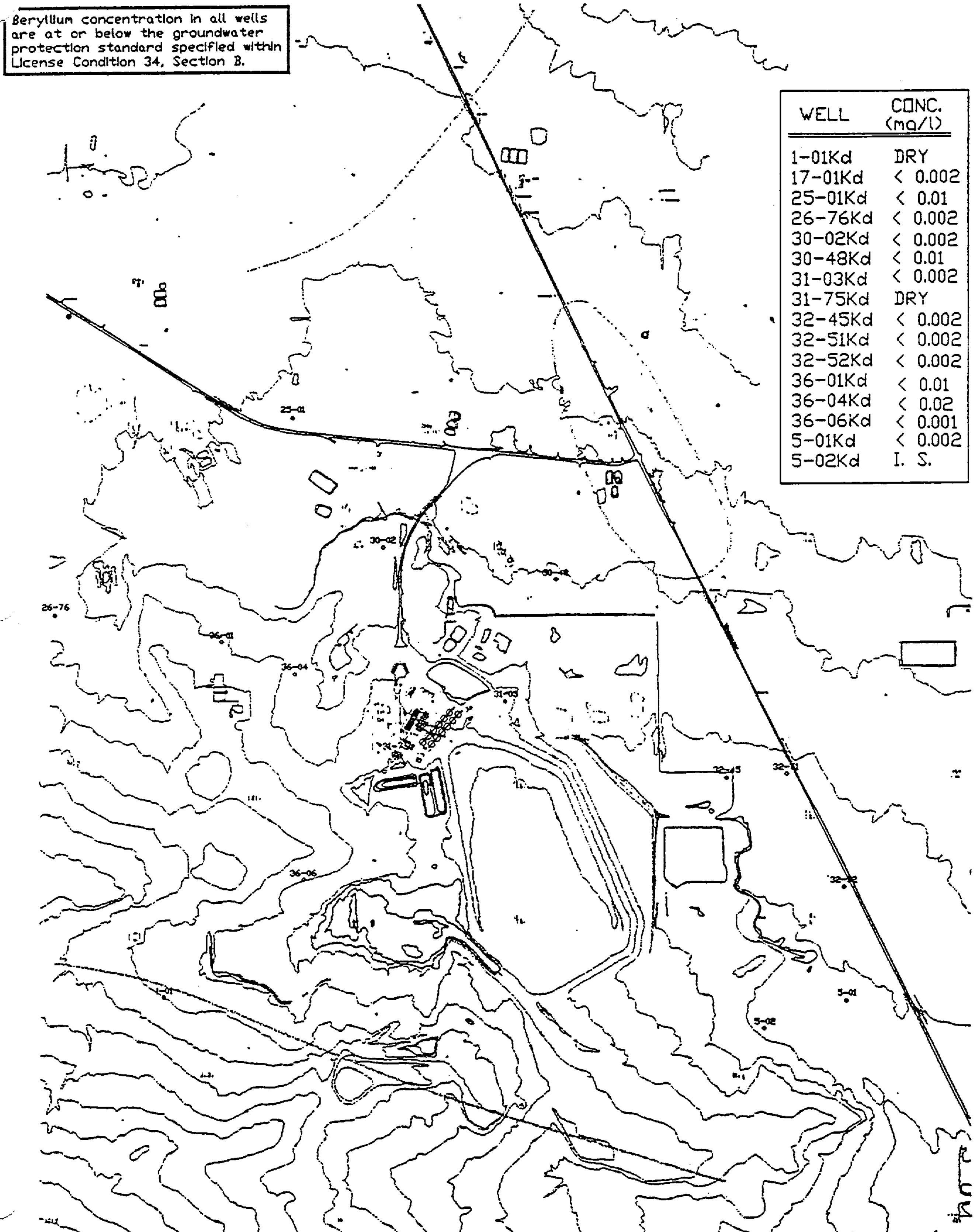
DAKOTA

QUIVIRA MINING COMPANY - AMBROSIA LAKE FACILITY LICENSE SUA-1473 : DOCKET 40-8905

BERYLLIUM
1998 CONCENTRATION ISOPLETH
NRC GROUNDWATER STANDARD - 0.01 mg/l

Beryllium concentration in all wells are at or below the groundwater protection standard specified within License Condition 34, Section B.

WELL	CONC. (mg/l)
1-01Kd	DRY
17-01Kd	< 0.002
25-01Kd	< 0.01
26-76Kd	< 0.002
30-02Kd	< 0.002
30-48Kd	< 0.01
31-03Kd	< 0.002
31-75Kd	DRY
32-45Kd	< 0.002
32-51Kd	< 0.002
32-52Kd	< 0.002
36-01Kd	< 0.01
36-04Kd	< 0.02
36-06Kd	< 0.001
5-01Kd	< 0.002
5-02Kd	I. S.



ZERO SATURATION - DAKOTA

5-01 WELL

I.S. = Insufficient water in well for sample collection.

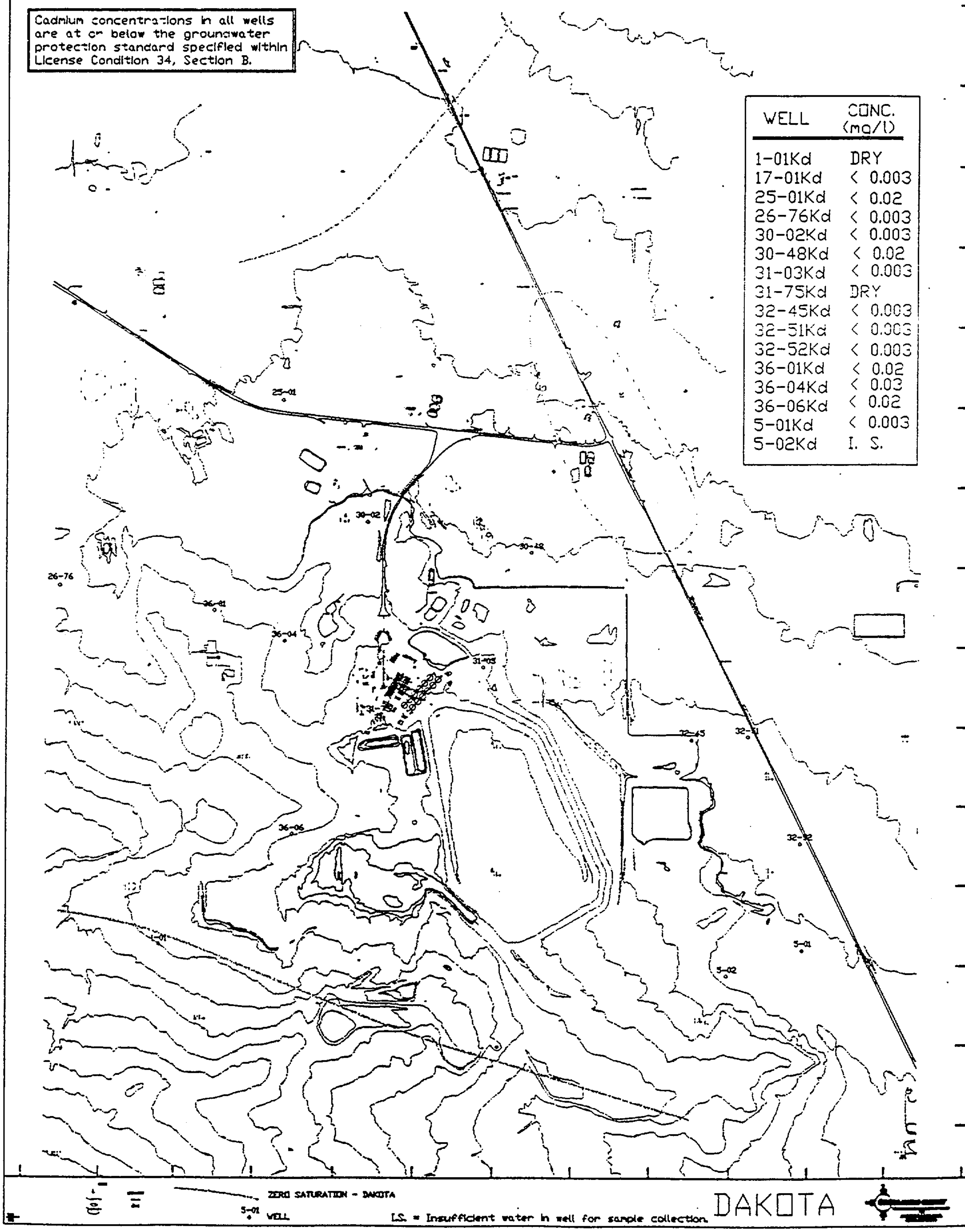
DAKOTA

QUIVIRA MINING COMPANY - AMBROSIA LAKE FACILITY LICENSE SUA-1473 DOCKET 40-8905

CADMIUM

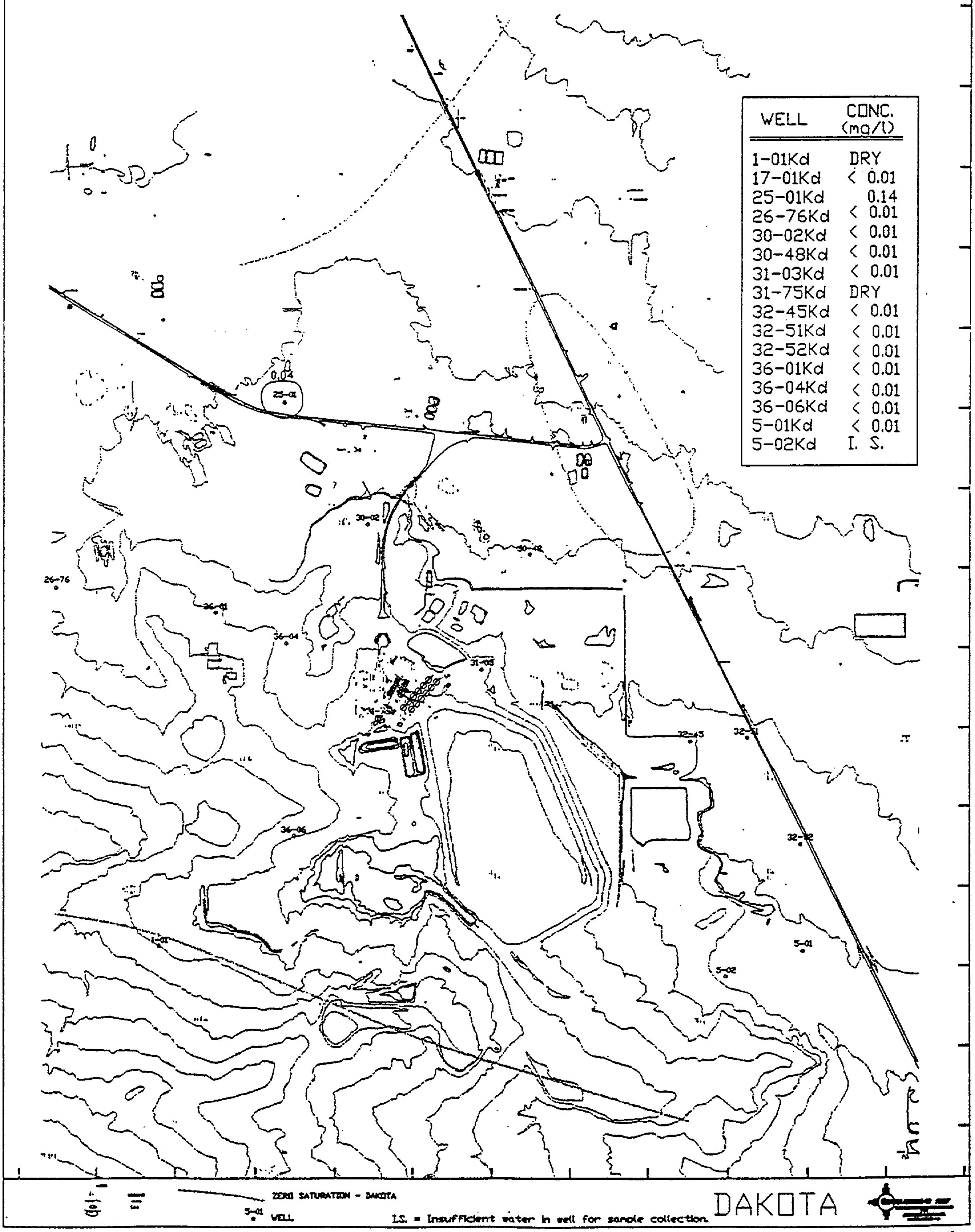
1998 CONCENTRATION ISOPLETH

NRC GROUNDWATER STANDARD - 0.01 mg/l



WELL	CONC. (mg/l)
1-01Kd	DRY
17-01Kd	< 0.003
25-01Kd	< 0.02
26-76Kd	< 0.003
30-02Kd	< 0.003
30-48Kd	< 0.02
31-03Kd	< 0.003
31-75Kd	DRY
32-45Kd	< 0.003
32-51Kd	< 0.003
32-52Kd	< 0.003
36-01Kd	< 0.02
36-04Kd	< 0.03
36-06Kd	< 0.02
5-01Kd	< 0.003
5-02Kd	I. S.

CYANIDE
1998 CONCENTRATION ISOPLETH
NRC GROUNDWATER STANDARD - 0.04 mg/l



WELL	CONC. (mg/l)
1-01Kd	DRY
17-01Kd	< 0.01
25-01Kd	0.14
26-76Kd	< 0.01
30-02Kd	< 0.01
30-48Kd	< 0.01
31-03Kd	< 0.01
31-75Kd	DRY
32-45Kd	< 0.01
32-51Kd	< 0.01
32-52Kd	< 0.01
36-01Kd	< 0.01
36-04Kd	< 0.01
36-06Kd	< 0.01
5-01Kd	< 0.01
5-02Kd	I. S.

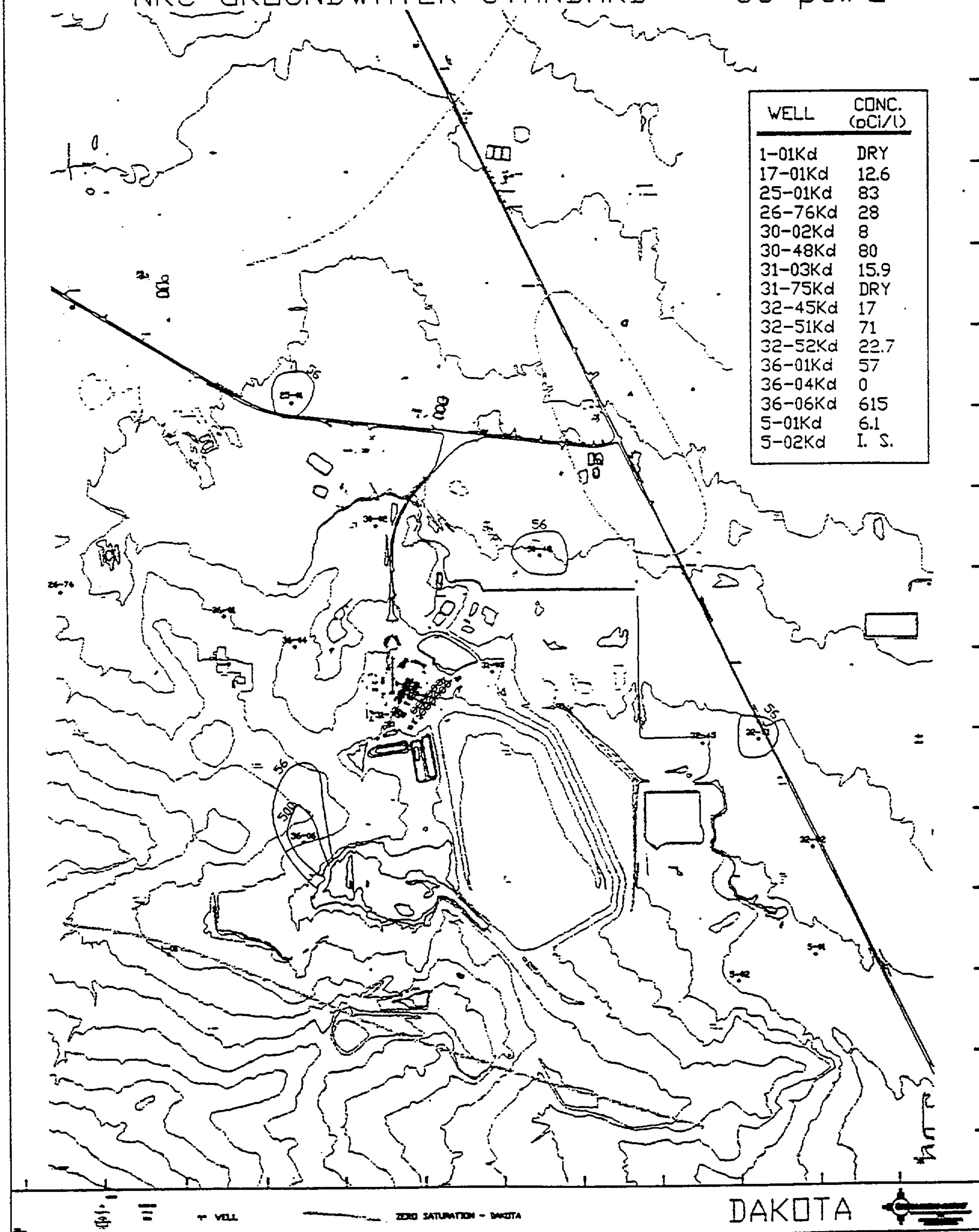
QUIVIRA MINING COMPANY - AMBROSIA LAKE FACILITY   LICENSE SUA-1473 | DOCKET 40-8905

GROSS ALPHA

(EXCLUDING URANIUM AND RADON)

1998 CONCENTRATION ISOPLETH

NRC GROUNDWATER STANDARD - 56 pCi/L



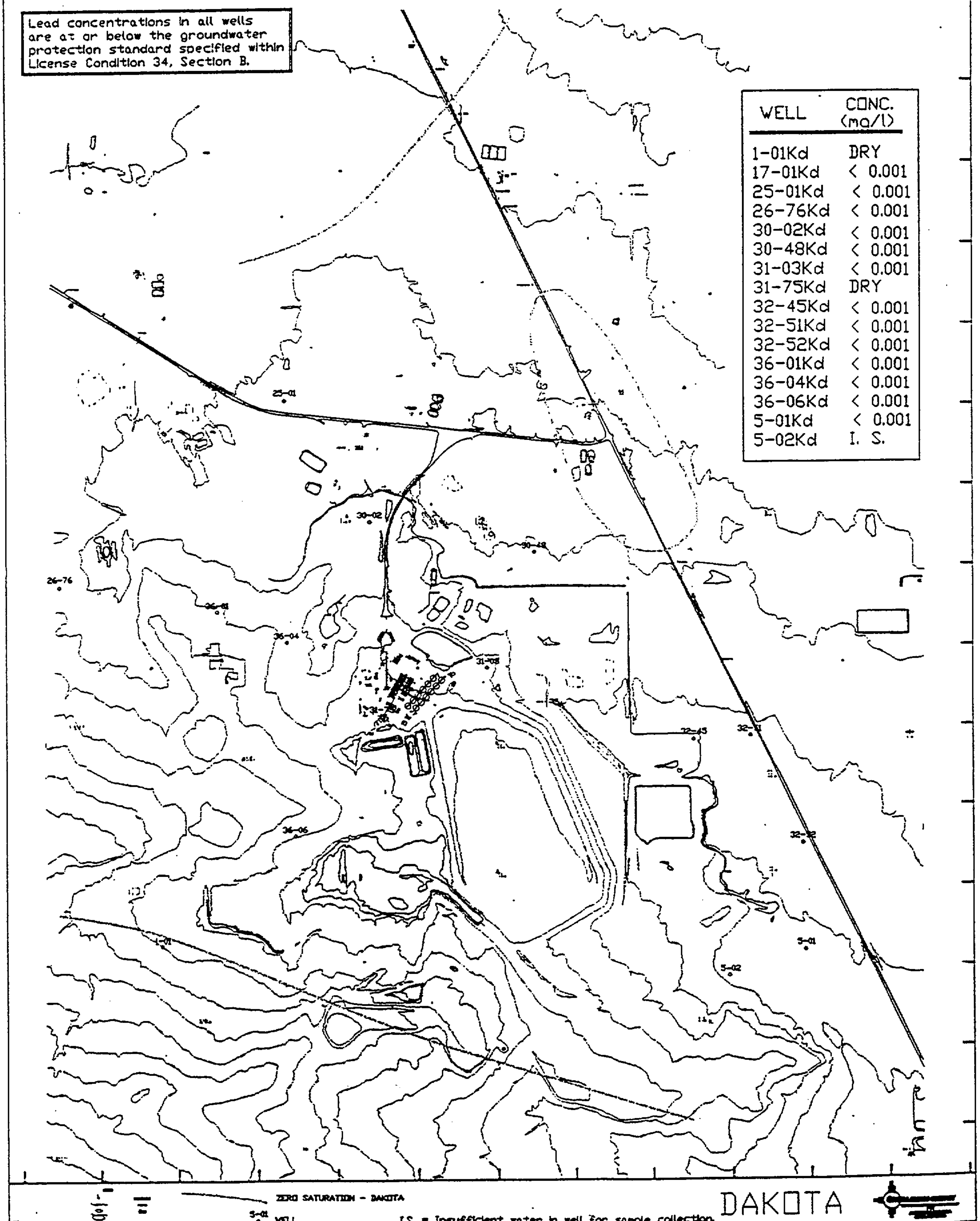
WELL	CONC. (pCi/l)
1-01Kd	DRY
17-01Kd	12.6
25-01Kd	83
26-76Kd	28
30-02Kd	8
30-48Kd	80
31-03Kd	15.9
31-75Kd	DRY
32-45Kd	17
32-51Kd	71
32-52Kd	22.7
36-01Kd	57
36-04Kd	0
36-06Kd	615
5-01Kd	6.1
5-02Kd	I. S.

QUIVIRA MINING COMPANY - AMBROSIA LAKE FACILITY   LICENSE SUA-1473 : DOCKET 40-8905

LEAD
1998 CONCENTRATION ISOPLETH
NRC GROUNDWATER STANDARD - 0.14 mg/l

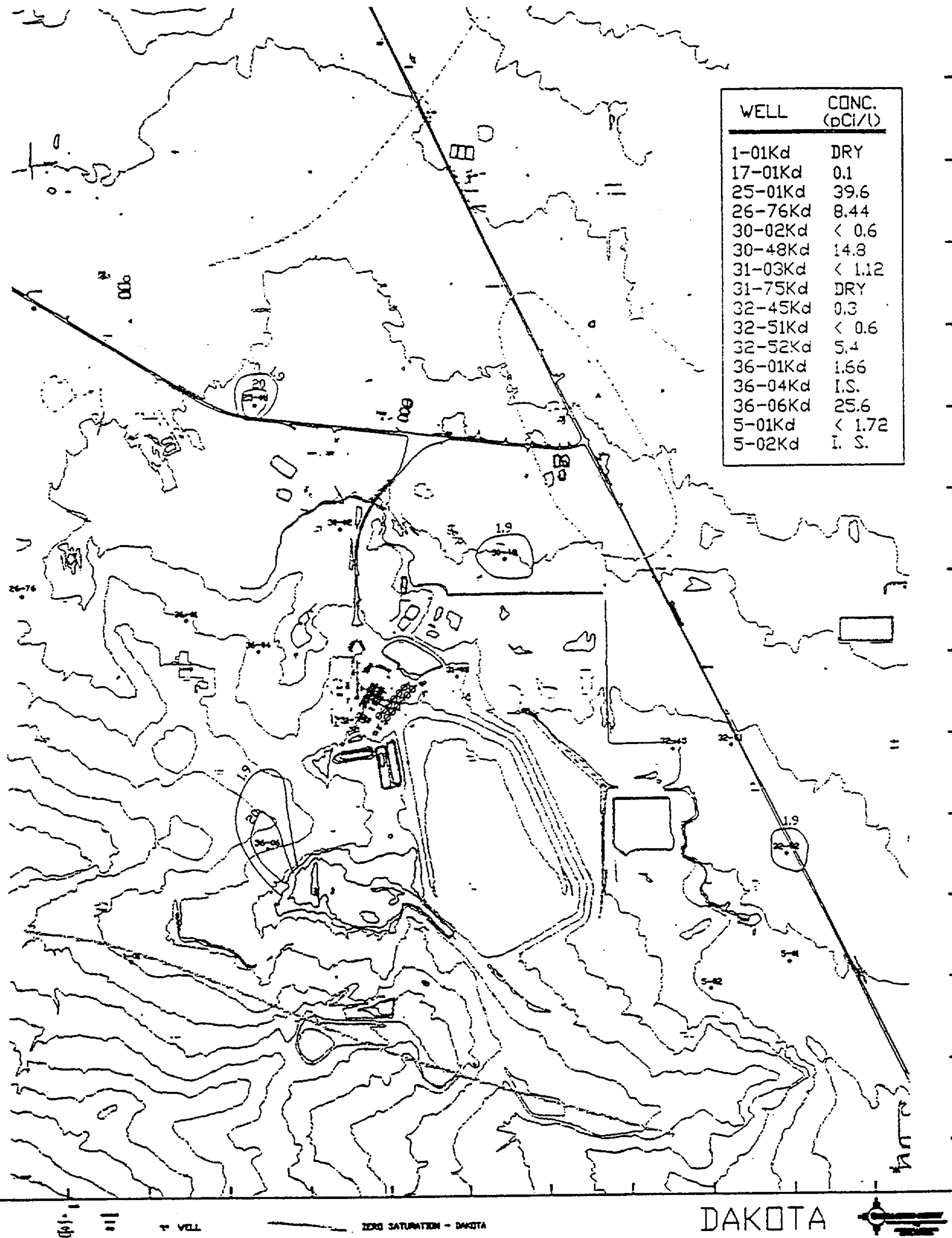
Lead concentrations in all wells are at or below the groundwater protection standard specified within License Condition 34, Section B.

WELL	CONC. (mg/l)
1-01Kd	DRY
17-01Kd	< 0.001
25-01Kd	< 0.001
26-76Kd	< 0.001
30-02Kd	< 0.001
30-48Kd	< 0.001
31-03Kd	< 0.001
31-75Kd	DRY
32-45Kd	< 0.001
32-51Kd	< 0.001
32-52Kd	< 0.001
36-01Kd	< 0.001
36-04Kd	< 0.001
36-06Kd	< 0.001
5-01Kd	< 0.001
5-02Kd	I. S.



QUIVIRA MINING COMPANY - AMBROSIA LAKE FACILITY LICENSE SUA-1473 DOCKET 40-8905

LEAD-210
1998 CONCENTRATION ISOPLETH
NRC GROUNDWATER STANDARD - 1.9 pCi/L

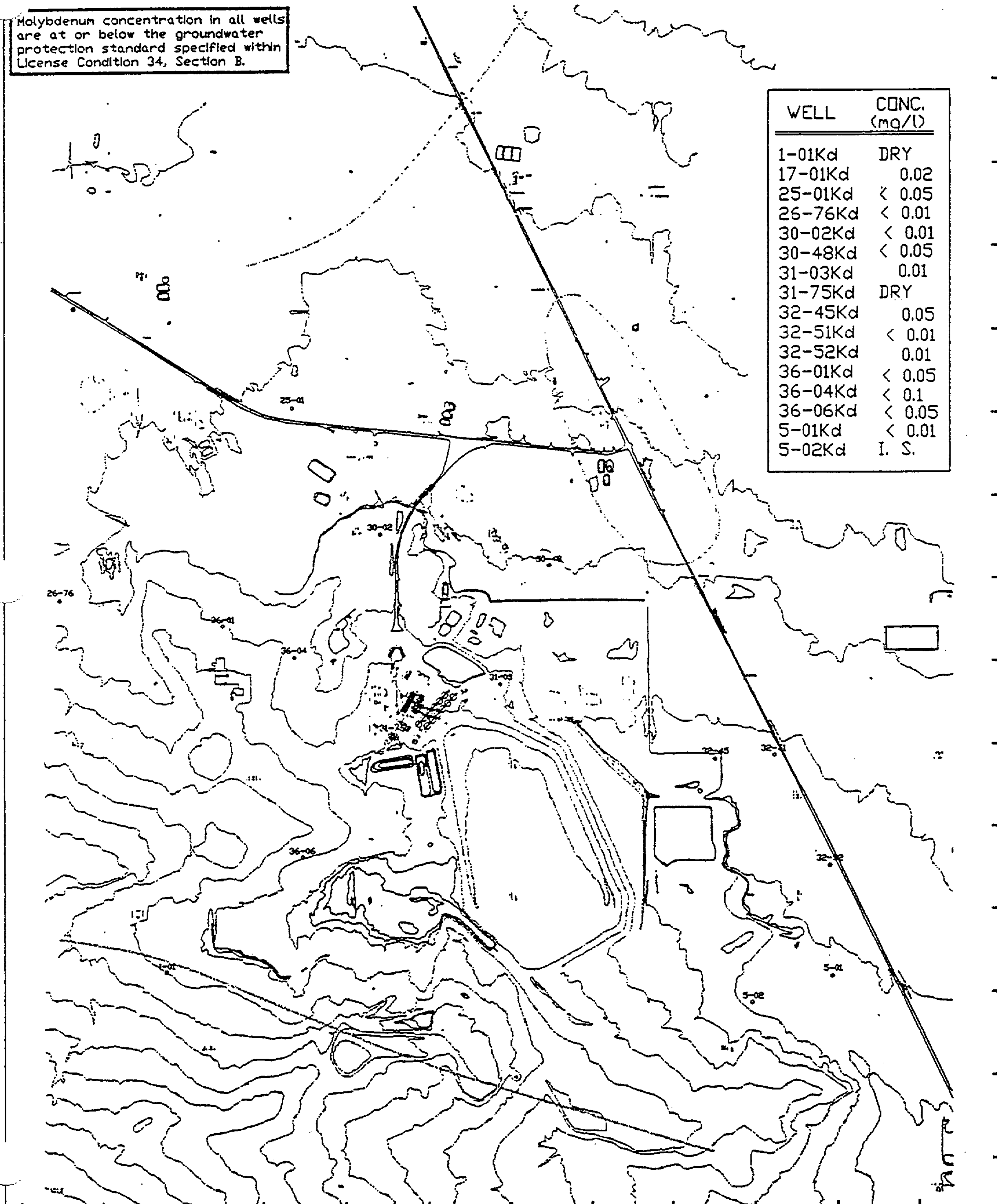


WELL	CONC. (pCi/l)
1-01Kd	DRY
17-01Kd	0.1
25-01Kd	39.6
26-76Kd	8.44
30-02Kd	< 0.6
30-48Kd	14.8
31-03Kd	< 1.12
31-75Kd	DRY
32-45Kd	0.3
32-51Kd	< 0.6
32-52Kd	5.4
36-01Kd	1.66
36-04Kd	I.S.
36-06Kd	25.6
5-01Kd	< 1.72
5-02Kd	I. S.

QUIVIRA MINING COMPANY - AMBROSIA LAKE FACILITY

LICENSE SUA-1473 : DOCKET 40-8905

MOLYBDENUM
1998 CONCENTRATION ISOPLETH
NRC GROUNDWATER STANDARD - 0.06 mg/l



WELL	CONC. (mg/l)
1-01Kd	DRY
17-01Kd	0.02
25-01Kd	< 0.05
26-76Kd	< 0.01
30-02Kd	< 0.01
30-48Kd	< 0.05
31-03Kd	0.01
31-75Kd	DRY
32-45Kd	0.05
32-51Kd	< 0.01
32-52Kd	0.01
36-01Kd	< 0.05
36-04Kd	< 0.1
36-06Kd	< 0.05
5-01Kd	< 0.01
5-02Kd	I. S.

ZERO SATURATION - DAKOTA

5-01 WELL

I.S. = Insufficient water in well for sample collection.

DAKOTA

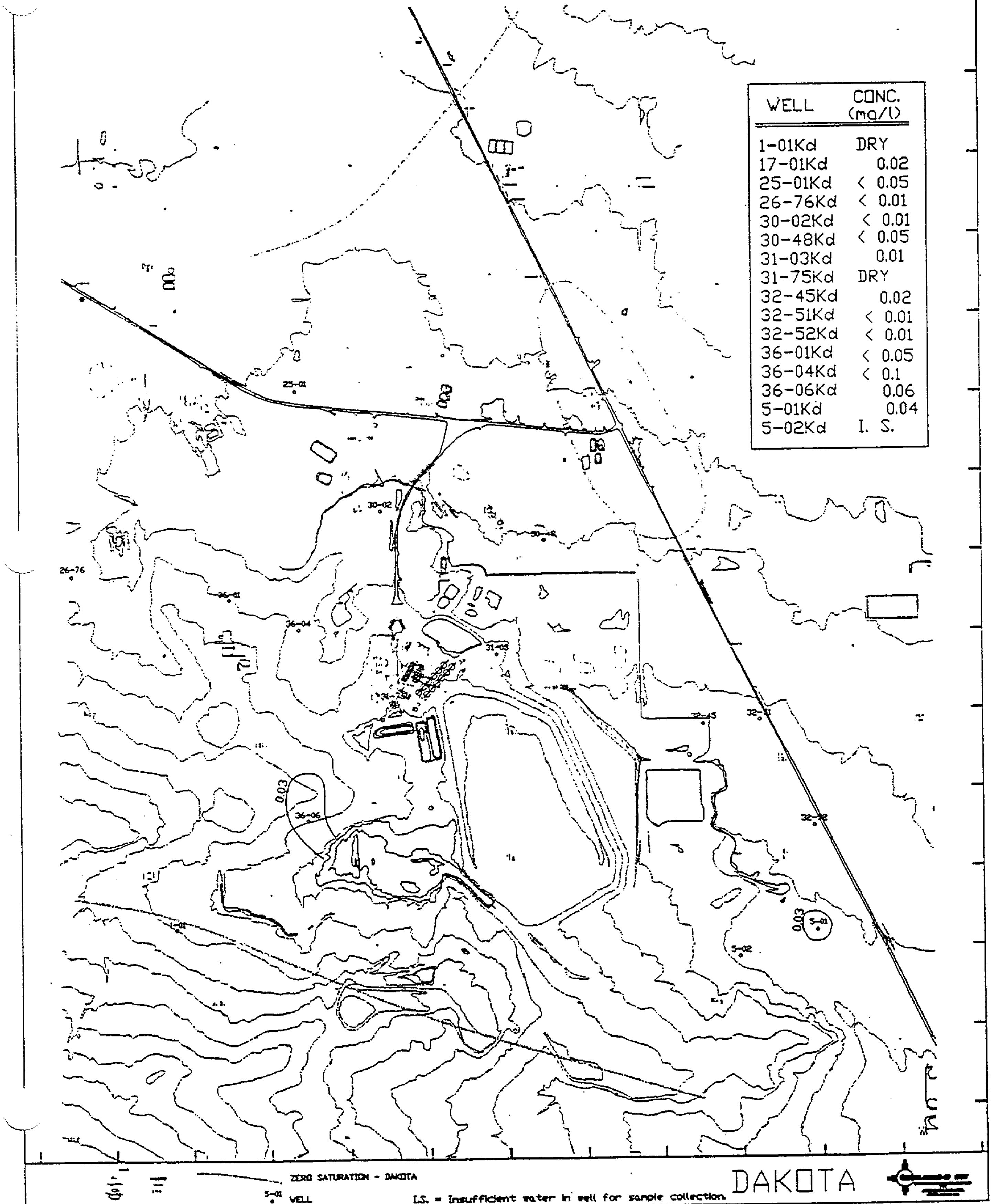
QUIVIRA MINING COMPANY - AMBROSIA LAKE FACILITY

LICENSE SUA-1473 · DOCKET 40-8905

NICKEL

1998 CONCENTRATION ISOPLETH

NRC GROUNDWATER STANDARD - 0.03 mg/l

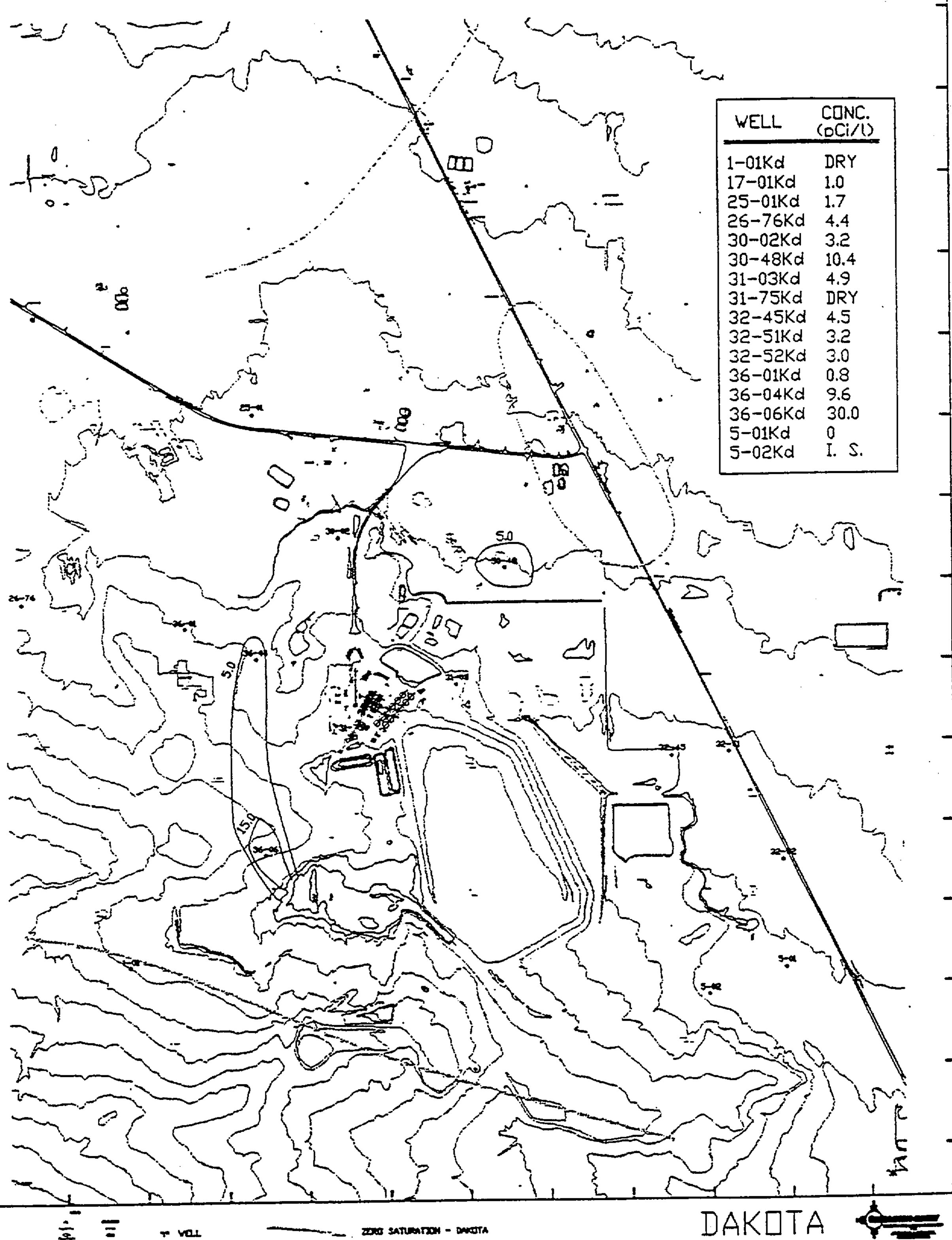


WELL	CONC. (mg/l)
1-01Kd	DRY
17-01Kd	0.02
25-01Kd	< 0.05
26-76Kd	< 0.01
30-02Kd	< 0.01
30-48Kd	< 0.05
31-03Kd	0.01
31-75Kd	DRY
32-45Kd	0.02
32-51Kd	< 0.01
32-52Kd	< 0.01
36-01Kd	< 0.05
36-04Kd	< 0.1
36-06Kd	0.06
5-01Kd	0.04
5-02Kd	I. S.

QUIVIRA MINING COMPANY - AMBROSIA LAKE FACILITY   LICENSE SUA-1473 : DOCKET 40-8905

RADIUM 226/228
1998 CONCENTRATION ISOPLETH
NRC GROUNDWATER STANDARD - 5.0 pCi/L

WELL	CONC. (pCi/l)
1-01Kd	DRY
17-01Kd	1.0
25-01Kd	1.7
26-76Kd	4.4
30-02Kd	3.2
30-48Kd	10.4
31-03Kd	4.9
31-75Kd	DRY
32-45Kd	4.5
32-51Kd	3.2
32-52Kd	3.0
36-01Kd	0.8
36-04Kd	9.6
36-06Kd	30.0
5-01Kd	0
5-02Kd	I. S.



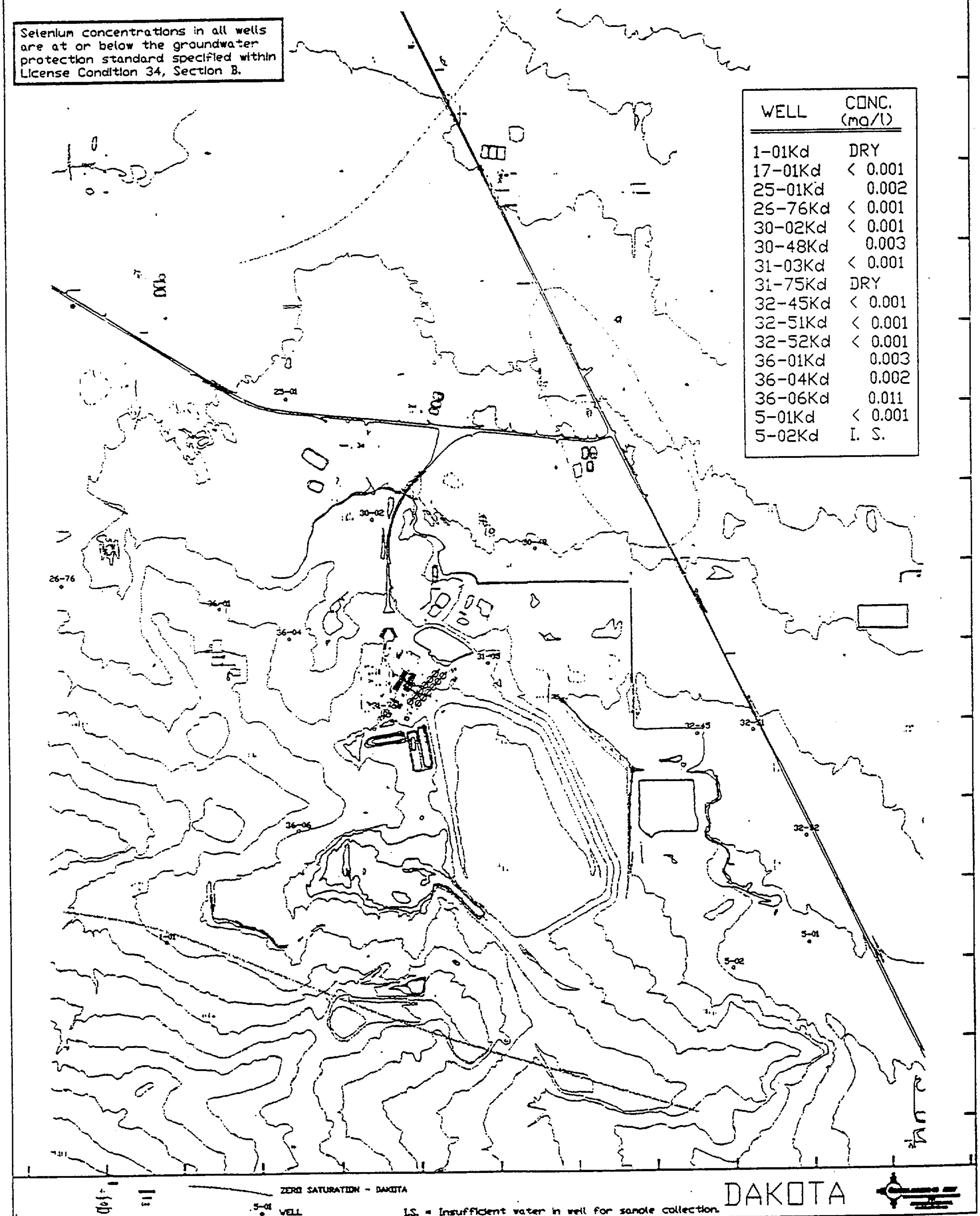
QUIVIRA MINING COMPANY - AMBROSIA LAKE FACILITY

LICENSE SUA-1473 : DOCKET 40-8905

SELENIUM
1998 CONCENTRATION ISOPLETH
NRC GROUNDWATER STANDARD - 0.04 mg/l

Selenium concentrations in all wells are at or below the groundwater protection standard specified within License Condition 34, Section B.

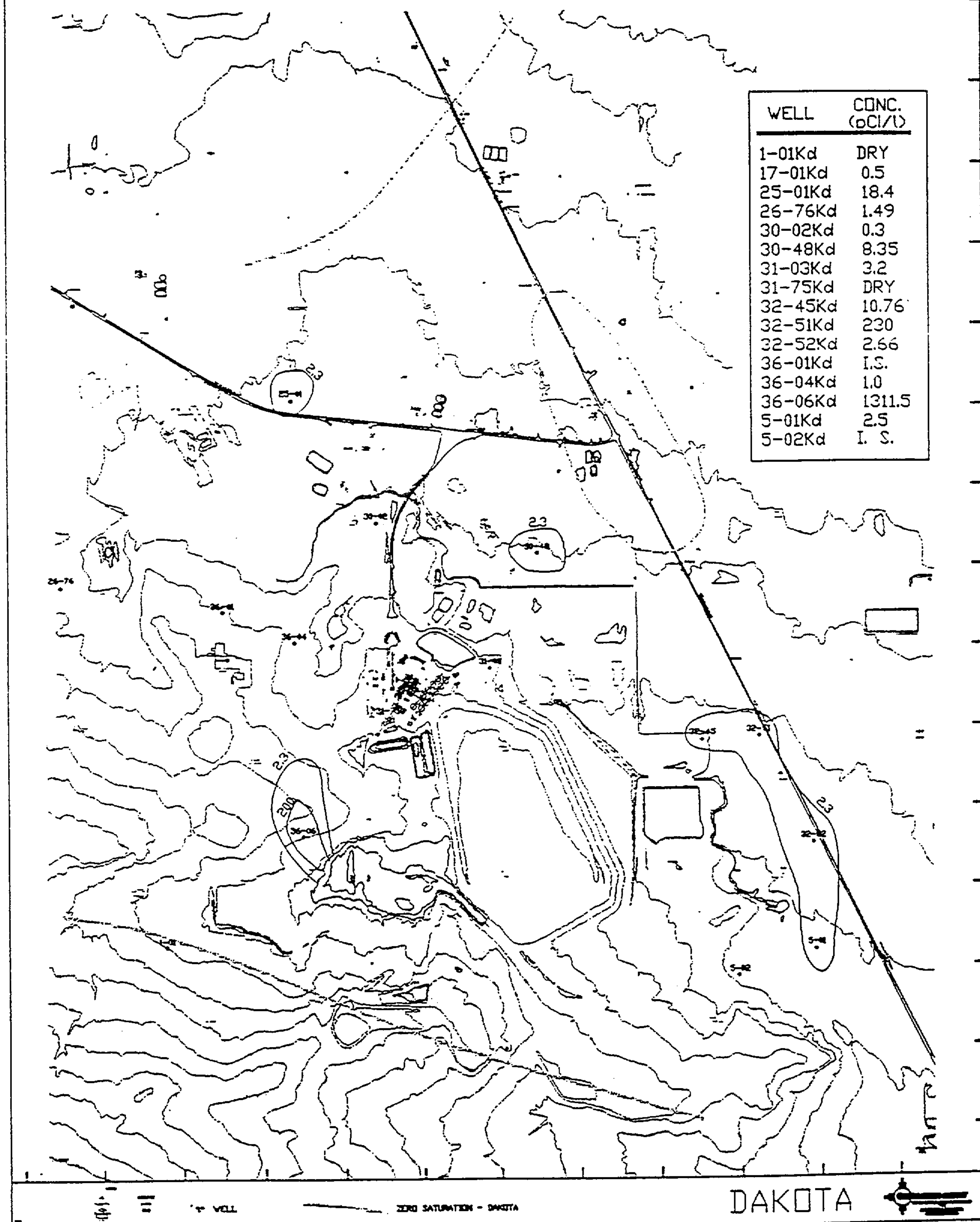
WELL	CONC. (mg/l)
1-01Kd	DRY
17-01Kd	< 0.001
25-01Kd	0.002
26-76Kd	< 0.001
30-02Kd	< 0.001
30-48Kd	0.003
31-03Kd	< 0.001
31-75Kd	DRY
32-45Kd	< 0.001
32-51Kd	< 0.001
32-52Kd	< 0.001
36-01Kd	0.003
36-04Kd	0.002
36-06Kd	0.011
5-01Kd	< 0.001
5-02Kd	I. S.



QUIVIRA MINING COMPANY - AMBROSIA LAKE FACILITY

LICENSE SUA-1473 DOCKET 40-8905

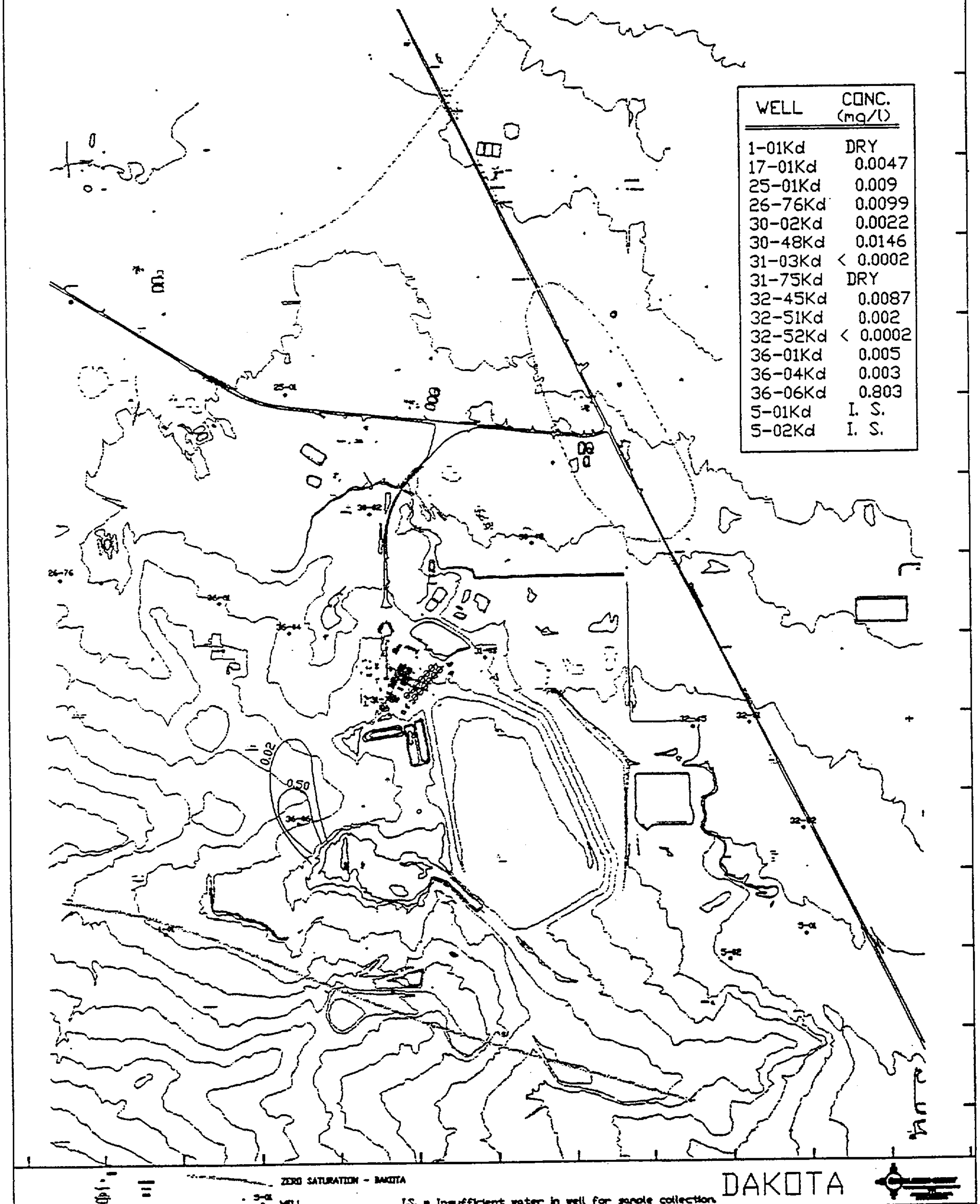
THORIUM-230
1998 CONCENTRATION ISOPLETH
NRC GROUNDWATER STANDARD - 2.3 pCi/L



WELL	CONC. (pCi/L)
1-01Kd	DRY
17-01Kd	0.5
25-01Kd	18.4
26-76Kd	1.49
30-02Kd	0.3
30-48Kd	8.35
31-03Kd	3.2
31-75Kd	DRY
32-45Kd	10.76
32-51Kd	230
32-52Kd	2.66
36-01Kd	I.S.
36-04Kd	1.0
36-06Kd	1311.5
5-01Kd	2.5
5-02Kd	I. S.

QUIVIRA MINING COMPANY - AMBROSIA LAKE FACILITY   LICENSE SUA-1473 : DOCKET 40-8905

URANIUM
1998 CONCENTRATION ISOPLETH
NRC GROUNDWATER STANDARD – 0.02 mg/l



WELL	CONC. (mg/l)
1-01Kd	DRY
17-01Kd	0.0047
25-01Kd	0.009
26-76Kd	0.0099
30-02Kd	0.0022
30-48Kd	0.0146
31-03Kd	< 0.0002
31-75Kd	DRY
32-45Kd	0.0087
32-51Kd	0.002
32-52Kd	< 0.0002
36-01Kd	0.005
36-04Kd	0.003
36-06Kd	0.803
5-01Kd	I. S.
5-02Kd	I. S.

QUIVIRA MINING COMPANY – AMBROSIA LAKE FACILITY

LICENSE SUA-1473 | DOCKET 40-8905

Quivira Mining Company
Ambrosia Uranium Mill Site
Ground Water Monitoring Results

Well 30-48KD, Dakota Unit

Date	Depth To Water feet	Spec. Cond. uohm/cm	pH	As (mg/l)	Be (mg/l)	Cd (mg/l)	Cl (mg/l)	CN (mg/l)	Mo (mg/l)	Ni (mg/l)	NO3 (mg/l)	Pb (mg/l)	Pb-210 (pCi/l)	Ra-226 (pCi/l)	Ra-228 (pCi/l)	Sb (mg/l)	Se (mg/l)	SO4 (mg/l)	TDS (mg/l)	Th-230 (pCi/l)	Unat (mg/l)	Gross Alpha (pCi/l)
01-Jul-75	345.4																					
01-May-77	328						1170											1180	3420			
01-Jul-77	331.7						223											1690	3260			
01-Apr-78							250											1910	3430			
01-Jul-78	331.2						134											1448	3193			
01-Oct-78	331.5																					
01-Mar-79	323						176											1526	2708			
01-Jul-79	324.8						165											1910	3114			
01-Oct-79	322.9						267											1874	4267			
01-Jan-80	323.1						303											1899	3966			
01-Apr-80	322.7						338											2388	4200			
01-Jul-80	323.3						420											2400	4500			
01-Oct-80	323.3						581											2780	5000			
01-Jan-81	324.3						613											642	5042			
01-Apr-81	322.8						507											3256	5340			
01-Jul-81	322.1						641											2163	5572			
01-Oct-81	322.08																					
01-Jan-82	321.82						559											2600	4782			
01-Apr-82	334.7																					
01-Jul-82	320.88																					
01-Oct-82	336.3						646											2355	5380			
01-Jan-83	336.9						437											2142	4297			
01-May-83	334.8						378											1811	3925			
25-May-83			6.7	0.3		0.021	650	<1	0.041	<0.08	<1	0.34		1.34	-1.9		0.35	2630	5070		0.02	
15-Aug-83			6.7	0.45		0.02	770	<0.1	0.055	0.14	<1	0.39		1.71	-3.3		0.49	2590	5380		0.038	
01-Oct-83	336.6						732											2740	6409			
14-Nov-83			7	0.033		<0.007	910	<1	<0.018	0.045	<1	0.1		0.19	-2		0.12	2840	5660		0.008	
03-Feb-84	336.3	5650	6.7				810											2620	5120			
17-Apr-84	335.8						870											2700	5510			
17-Apr-84	335.8	7610	6.7	0.13		<0.007	810		<0.018	0.064		0.1		0.85			0.16	1700	5510		0.045	
18-Jul-84	336.6	5770	6.6				940											2250	5500			
17-Oct-84	335.9	5310	6.8				600											1810	4770			
01-Jan-85	336	4680	6.6				600											1470	4020			
01-Feb-85	336						420											1470	4020			
22-Apr-85	335.9	7500	7.2	<0.001		<0.0002	770		<0.1	<0.04	1.1	<0.001		0.4			<0.001	2630	5750		0.013	
08-Jul-85	336.4	6000	6.95				940				0.1							2950	6710			
13-Nov-85	334.4	3000	6.59				450				1.8							2030	3970			
14-Jan-86	334.2	4000	6.72				650				<0.1							2210	4681			
10-Apr-86	337.1	4000	7.22	<0.001		<0.0001	780		0.1	0.12	2.5	<0.001		2.5			<0.001	2820	5770		0.0092	
01-Jul-86							817											2570	6200			
08-Jul-86	339.3	4800	7.72				630				0.2							1960	3960			
07-Oct-86	338.1	4000	7.2				500				0.2							2670	5290			
17-Mar-87	337.4	4200	6.65				750				<0.1							2650	5580			
16-Apr-87	338.4	5000	7.41	0.005		<0.001	846		<0.1	0.01		<0.001		0.7			<0.002	2890	6070		0.0221	
21-Jul-87	336	5900	6.7				817				<0.1							2570	6200			
21-Oct-87	334.1	6000	6.9				954				0.80							3060	6700			
20-Jan-88	335.4	4775	6.9		<0.01		784	<0.01			<0.1							2870	5960	0		

Quivira Mining Company
Ambrosia Uranium Mill Site
Ground Water Monitoring Results

Well 30-48KD, Dakota Unit

Date	Depth To Water feet	Spec. Cond. uohm/cm	pH	As (mg/l)	Be (mg/l)	Cd (mg/l)	Cl (mg/l)	CN (mg/l)	Mo (mg/l)	Ni (mg/l)	NO3 (mg/l)	Pb (mg/l)	Pb-210 (pCi/l)	Ra-226 (pCi/l)	Ra-228 (pCi/l)	Sb (mg/l)	Se (mg/l)	SO4 (mg/l)	TDS (mg/l)	Th-230 (pCi/l)	Unat (mg/l)	Gross Alpha (pCi/l)
05-May-88	335.9	5500	6.8	0.012		<0.005	670		0.11	0.1	0.40	<0.02		0.6			0.011	2150	5160	0.7	0.0221	
19-Jul-88	335.7	4275	6.8				691				<0.1							2570	5550			
15-Sep-88				0.016	<0.01	<0.005		<0.01	0.13	0.13		0.03	3	1.4	3.5	0.006	0.009			0.7	0.0209	51
28-Sep-88				0.038	<0.01	<0.005		<0.01	0.15	0.18		0.14	8.4	1.9	4.2	0.015	0.072			2.2	0.0466	97
06-Oct-88				0.041	<0.01	<0.005		<0.01	0.14	0.14		0.1	1.4	1.1	4.6	0.007	0.073			0.7	0.0385	49
14-Oct-88				0.043	<0.01	<0.005		<0.01	0.17	0.16		0.05	0.9	1.2	4.5	0.049	0.031			4.8	0.052	180
21-Oct-88	335.6	5990	6.4	0.007			756		0.18		<0.1			0.6			0.027	2840	6570	0	0.0162	
15-Nov-88				0.007	<0.01	<0.005		<0.01	0.17	0.18		0.22	2	1.3	5.3	0.015	0.08			4.9	0.0317	99
17-Jan-89	336.1	4580	6.8				764				<0.1							2880	6030			
17-Feb-89	336.1	5050	6.7	0.007	<0.01	<0.005		<0.01	<0.01	<0.01		0.03	4.1	2.1	4.4	0.009	0.033			1.4	0.0194	54
20-Apr-89	336.2	5500	6.7	0.008		<0.005	809		0.12	<0.01	<0.1	0.06		2			0.03	3260	6320	4.1	0.0432	
22-May-89	336.3	6000	6.9	0.005	<0.01	<0.005		<0.01	0.05	<0.01		0.02	1.7	1.8	4.3	0.017	0.027			2.1	0.0359	18
26-Jul-89	336.3	5800	6.9				827				<0.1							3090	6100			
06-Sep-89	336.2	5900	6.9	0.003	<0.01	<0.005	796	<0.01	0.04	0.04	<0.1	<0.02	3.8	1.2	3.7	0.003	0.012	3000	6230	0.5	0.027	66
05-Apr-90	336.9	5500	6.7	<0.001	<0.01	<0.005	743	<0.01	<0.01	<0.01	<0.1	<0.02	8.9	0.9	4.2	0.023	0.001	2680	5490	0.8	0.016	53
14-Aug-90	337	5300	6.6	0.002	<0.01	<0.005	787	<0.01	0.04	0.02	<0.1	<0.02	2.7	1	4.4	<0.003	<0.002	2900	5960	0.3	0.03	42
18-Feb-91	336.3	5200	8	0.002	<0.01	<0.005	265	<0.01	0.1	0.01	<0.1	<0.02	1.9	3.7	5.5	<0.003	<0.002	3090	6170	0.5	0.0435	39
21-Aug-91	335.9	4600	6.8	<0.01	<0.01	<0.005	540	<0.01	0.1	0.01	0.2	<0.02	4.9	1.8	2.1	<0.003	<0.002	2090	4840	1.8	0.0321	34
12-Feb-92	336.4	4270	6.8	<0.001	<0.01	<0.005	576	<0.01	0.13	<0.01	0.8	0.02	15	3.4	4.2	<0.003	<0.002	2600	4630	0.7	0.292	26
26-Aug-92	336.7	4200	6.8	<0.001	<0.01	<0.005	584	<0.01	<0.01	<0.01	0.6	<0.02	3.6	2.7	3.1	<0.003	0.008	2280	4460	1.5	0.0246	0
05-Mar-93	336.9	4325	7	<0.001	<0.01	<0.005	546	<0.01	<0.01	<0.01	<0.1	<0.02	3.5	2.5	3.7	<0.05	<0.002	2360	4810	3	0.0278	36
18-Aug-93	337	4600	6.9	<0.001	<0.01	<0.005	530	<0.01	<0.01	0.02	<0.1	<0.02	0.7	2.6	6.1	<0.003	<0.002	2320	4720	0.4	0.0485	15
05-Apr-94	337.5	3910	7.2	<0.001	<0.01	<0.005	495	<0.01	<0.01	<0.01	0.2	<0.02	13	3.2	3.8	<0.05	<0.002	2360	4460	0.4	0.0394	56
19-Sep-94	337.5	4290	7	0.001	<0.01	<0.005	505	<0.01	<0.01	0.01	0.2	0.03	4.3	4.1	5.2	<0.05	<0.002	2220	4700	0.4	0.0331	74
16-Mar-95	337.8	5500	7.3	<0.005	<0.004	<0.005	516	<0.01	<0.01	<0.04	<0.2	<0.01	11	13	4.4	<0.05	0.005	2400	4830	0.6	0.0315	42
21-Mar-95	337.8	5500	7.3	<0.005	<0.004	<0.005	516	<0.01	<0.01	<0.04	<0.2	<0.01	11	13	4.4	<0.05	0.005	2400	4830	0.6	0.0315	42
28-Feb-96	337.4	4210	7	<0.003	<0.002	<0.005	480	<0.01	<0.01	<0.04	<0.1	<0.005	4.4	4.5	11	<0.05	<0.005	2300	4960	0.4	0.042	32
27-Aug-96	337.1	4500	7.1	<0.005	<0.004	<0.005	484	<0.01	<0.01	<0.005	<0.1	<0.005	3.4	2.1	4.8	<0.05	<0.005	2400	5040	0.3	0.027	22
08-Apr-97	337.4	4200	7.4	<0.005	<0.004	<0.005	474	<0.01	<0.01	<0.01	<0.1	<0.005	5	4.4	4.2	<0.02	<0.005	2280	4590	0.4	0.027	34
04-Nov-97	337.8	4850	7.1	<0.003	<0.002	<0.005	443	<0.01	<0.01	0.04	<0.1	<0.01	5.5	1.9	2.5	<0.05	<0.005	2090	4220	0.6	0.02	41
08-Dec-97	307.4	2550	7.92	<0.005	<0.004	<0.005	971	<0.01	<0.01	<0.02	<0.1	<0.025	3.1	0	0	<0.03	<0.005	4	1620	0	0.0071	10
03-May-98				<0.001	<0.01	<0.02	460	<0.01	<0.05	<0.05	0	0	14.8	8.7	1.7	<0.002	0.003	2930		8.4	0.0146	80
27-Dec-98				<0.001	<0.002	<0.02	500	<0.01	<0.01	<0.01	0.09	<0.001	7.9	6.6	2.2	<0.002	0.002	1280		7.8	0.861	526
16-Feb-99		3300	6.8	<0.001	<0.004	<0.006	436	<0.01	<0.02	<0.02	0.36	<0.001	16	3.23	13	<0.002	<0.001	1550	3370	1.2	0.484	390
22-Jun-99				<0.005	<0.0005	<0.0005	430	<0.01	0.005	0.004	1.64	<0.001	8.1	3	5.4	<0.002	0.001	2780	5130	0.12	0.221	220
26-Jul-99							432	<0.01	0.002	0.003	0.07		8.3	2.2	4.8		<0.001	2680	4900	0.2	0.103	98
30-Aug-99													0.58	2.5	3.9					0.012	0.069	34

Quivira Mining Company
Ambrosia Uranium Mill Site
Ground Water Monitoring Results

Well 30-02KD, Dakota Unit

Date	Depth To Water feet	Spec. Cond. uohm/cm	pH	As (mg/l)	Be (mg/l)	Cd (mg/l)	Cl (mg/l)	CN (mg/l)	Mo (mg/l)	Ni (mg/l)	NO3 (mg/l)	Pb (mg/l)	Pb-210 (pCi/l)	Ra-226 (pCi/l)	Ra-228 (pCi/l)	Sb (mg/l)	Se (mg/l)	SO4 (mg/l)	TDS (mg/l)	Th-230 (pCi/l)	Unat (mg/l)	Gross Alpha (pCi/l)
28-May-83			5	0.18		0.029	1070	<1	0.04	0.18	2	0.46		2.86	-1.1		0.26	2770	4880		0.004	
08-Apr-84	285.4		5.73				712											2260.9	5589			
17-Jul-84	286.8						1108											2174	6164			
01-Nov-84	293.6	5000	5.31				1265											2400	6110			
02-Feb-85	292	4400	5.35				1370											2140	6030			
25-Apr-85	292.4	4225	5.8				1328											2134	6086			
17-Jul-85	293.1																					
08-Nov-85	283.7																					
13-Jan-86	279.6																					
21-Apr-86	277.3	5000																				
09-Jul-86	279.5	6000	8.44				1150											2854	6904			
02-Oct-86	279.3	5200																				
30-Jan-87	280.1	5000																				
06-May-87	280.4	6600																				
10-Sep-87	278	6250	7.4				1270											2400	7010			
28-Oct-87	278	6500	7.4																			
03-Mar-88	280.9	5800	7.3																			
08-Jun-88	286.7	5300	7.2															1960	5680			
15-Sep-88	293.3	4700	8.6				1370															
15-Sep-88				0.016	<0.01	<0.005		0.02	0.18	0.22		0.45	2.1	0.4	0.9	0.01	0.055			0.6	0.0052	27
28-Sep-88				0.035	<0.01	<0.005		0.02	0.21	0.3		0.92	13	4.3	0.9	0.025	0.143			4.1	0.0219	58
10-Oct-88				0.04	<0.01	<0.005		<0.01	0.2	0.27		0.39	3.2	1.9	0.2	0.044	0.113			1.5	0.0079	46
14-Oct-88				0.132	<0.01	0.009		0.04	0.35	0.42		3.63	11	5.1	0	0.045	0.028			5.9	0.183	110
15-Nov-88				0.01	<0.01	<0.005		0.01	0.33	0.25		0.15	1.8	0.8	1.8	0.024	0.094			2.2	0.0115	43
08-Dec-88	309.8	5500	8.5																			
17-Feb-89	305.1	5000	7.5	0.01	<0.01	<0.005		<0.01	<0.01	0.06		0.15	15	1.5	0.8	0.02	0.022			1.5	0.008	42
17-Mar-89	305.1	5000	7.5																			
23-May-89	303.8	5300	8	0.024	<0.01	<0.005		0.03	0.04	0.11		2.08	16	4.8	0.1	0.011	0.023			3.7	0.0485	43
11-Sep-89	303.5	4900	8.8	0.004	<0.01	<0.005	1420	0.06	0.09	0.09	<0.1	<0.02	3	0.2	0.5	<0.003	0.009	786	3880	0.5	0.0047	6
02-Apr-90	302.87	4400	7.9	0.001	<0.01	<0.005	1490	<0.01	0.04	0.05	<0.1	<0.02	5.1	1.6	1.5	0.004	<0.001	272	3410	1.5	0.004	14
17-Aug-90	304.7	4310	8.4	0.026	<0.01	0.007	1360	<0.01	0.09	0.04	<0.1	<0.02	0.6	0.6	0.5	<0.003	0.003	94	3250	0.4	0.0042	0
08-Feb-91	304.1	4290	8	<0.001	<0.01	<0.005	1301	0.02	0.12	0.02	<0.1	<0.02	1.6	1.3	0.6	<0.003	<0.002	7	2880	0.1	0.0036	2
22-Aug-91	304.3	4110	8.3	<0.001	<0.01	<0.005	1280	<0.01	0.12	0.04	0.2	<0.02	4.6	0.9	0.7	<0.003	<0.002	8.8	3130	1.3	0.0053	48
11-Feb-92	304.4	3825	8	<0.001	<0.01	<0.005	1320	<0.01	0.13	0.04	1.3	0.03	10	1.8	0.3	<0.003	0.002	44	2660	0.8	0.007	17
25-Aug-92	304.4	3900	8.5	<0.001	<0.01	<0.005	1360	0.02	0.04	0.03	0.9	<0.02	3.6	2.7	0.2	<0.003	<0.002	200	2620	2.9	0.0094	0
03-Mar-93	305.1	3725	8.8	<0.001	<0.01	<0.005	1250	0.01	0.04	0.03	<0.1	0.03	5.6	0.5	0.2	<0.05	0.006	262	2640	1.5	0.0044	0
18-Aug-93	304.7	3700	8.4	<0.001	<0.01	<0.005	1150	0.04	0.03	0.04	<0.1	<0.02	0.6	0.1	1	<0.003	<0.002	70	2540	1.5	0.0076	4
08-Apr-94	305	3350	7.8	<0.001	<0.01	<0.005	1060	0.04	<0.01	<0.01	<0.1	<0.02	0.8	0.8	1	<0.05	<0.002	2	2240	3.7	0.0038	10
16-Sep-94	305.4	3005	8.2	<0.001	<0.01	<0.005	1070	<0.01	<0.01	0.03	<0.1	0.02	2.5	0.9	1.3	<0.05	<0.002	2	2080	0.2	0.0021	13
16-Mar-95	305.9	3425	7.9	<0.005	<0.004	<0.005	971	<0.01	<0.01	<0.04	<0.2	<0.005	3	1.2	0.5	<0.05	<0.005	<2	1980	-0.3	0.0015	0
09-Oct-95	305.6	3200	7.8	<0.005	<0.004	<0.005	920	<0.01	<0.01	<0.02	<0.2	<0.005	1.8	0.9	1	<0.03	<0.005	3	1980	0.4	0.0031	0
27-Feb-96	306.3	2980	7.5	<0.002	<0.002	<0.005	940	0.02	<0.01	<0.04	<0.1	<0.005	1.2	1.4	5.1	<0.05	<0.005	<1	1750	0.4	0.0076	3
23-Aug-96	306.3	2890	8.2	<0.003	<0.002	<0.005	1010	<0.01	<0.01	<0.04	0.1	<0.002	1.4	1	0	<0.05	<0.005	5	1720	0.2	0.0023	10
08-Apr-97	306.8	1400	8.3	0.006	<0.004	<0.005	1030	<0.01	<0.01	0.05	<0.1	<0.005	2.3	1.4	0.7	<0.02	<0.005	3	1710	0.1	<0.0009	1
08-Dec-97	307.4	2550	7.92	<0.005	<0.004	<0.005	971	<0.01	<0.01	<0.02	<0.1	<0.025	3.1	0	0	<0.03	<0.005	4	1620	0	0.0071	10
02-May-98				<0.001	0	<0.003	770	<0.01	<0.01	<0.01	0	0	<0.6	2.9	0.4	<0.002	<0.001	40	0	0.3	0.0022	8
28-Dec-98				<0.001	<0.002	<0.003	1190	<0.01	<0.01	0.06	0.04	<0.001	8	2.85	1.5	<0.002	<0.01	520		0.83	0.019	15
08-Mar-99		4600	6.8	<0.001	<0.005	0.001	1660	<0.01	0.003	0.051	0.1	<0.001	5.4	3.26	6.2	<0.002	<0.001	970	3860	0.58	0.016	17

Quivira Mining Company
Ambrosia Uranium Mill Site
Ground Water Monitoring Results

Well 32-45KD, Dakota Unit

Date	Depth To Water feet	Spec. Cond. uohm/cm	pH	As (mg/l)	Be (mg/l)	Cd (mg/l)	Cl (mg/l)	CN (mg/l)	Mo (mg/l)	Ni (mg/l)	NO3 (mg/l)	Pb (mg/l)	Pb-210 (pCi/l)	Ra-226 (pCi/l)	Ra-228 (pCi/l)	Sb (mg/l)	Se (mg/l)	SO4 (mg/l)	TDS (mg/l)	Th-230 (pCi/l)	Unat (mg/l)	Gross Alpha (pCi/l)
25-May-83			11.4	<0.1		<0.01	210	<1	<0.16	<0.08	<1	0.027		0.71	-2		0.053	220	820		0.006	
06-Apr-84			11.17				168.8											260.9	831			
31-Oct-84	253.3	1225	10.74															233	786			
21-Feb-85	252	1100	11.2				170											220	850			
25-Apr-85	252.4	1175	8.59				189											176	858			
07-Nov-85	251.7																					
14-Jan-86	251.6																					
21-Apr-86	251.8	1100																				
09-Jul-86	253.4	1200	10.96				133											576	878			
07-Oct-86	252.3	1150																				
30-Jan-87	251.8	1200																				
15-Apr-87	253.5	1050																				
27-Aug-87	252.5	1100	10.7				215											300	846			
28-Oct-87	251.2	1250	10.5																			
24-Feb-88	252.6	1100	10.3																			
07-Jun-88	253	1180	10.7																			
21-Sep-88				0.014	<0.01	<0.005		<0.01	0.07	0.03		0.29	7	3.4	0.4	0.009	0.006			2.9	0.0315	62
21-Sep-88	252.7	1180	11				197											373	466			
28-Sep-88				0.016	<0.01	<0.005		0.01	0.08	0		0.24	7	2.8	1.4	0.003	0.032			2.8	0.0223	49
10-Oct-88				0.018	<0.01	<0.005		<0.01	0.07	0.02		0.26	7.4	3.1	0.8	0.021	0.034			1.5	0.0137	46
14-Oct-88				0.026	<0.01	<0.005		<0.01	0.07	0.04		0.51	7.1	3	1.8	0.029	0.017			2.4	0.0314	59
21-Nov-88				0.007	<0.01	<0.005		0.01	0.07	0.04		0.4	6.3	3.2	0.8	0.008	0.015			3.4	0.0256	55
06-Dec-88	258.9	1375	10.9																			
20-Feb-89	253.7	1500	10.1	0.002	<0.01	<0.005		0.12	0.03	0.02		0.29		89	37	0.001	0.034			74		2900
20-Feb-89	253.7	1500	10.1																			
22-May-89	252.8	1650	10.7	0.003	<0.01	<0.005		<0.01	0.15	<0.01		<0.02	4.1	2.2	0.8	<0.003	0.01			2.6	0.0012	17
22-Jun-89	252.8	1650	10.7																			
06-Sep-89	252.5	1675	10.8	0.004	<0.01	<0.005	225	<0.01	0.07	<0.01	<0.1	<0.02	0.5	0.5	1.4	<0.003	0.008	585	1290	0.7	0.0032	7.3
02-Apr-90	252.14	1430	10	<0.001	<0.01	<0.005	268	<0.01	0.08	0.02	<0.01	<0.02	19	6.1	8.8	<0.003	<0.001	594	638	13	0.042	140
07-Aug-90	252.7	1520	9.9	0.002	<0.01	<0.005	225	<0.01	0.07	0.02	<0.1	<0.02	4.5	0.4	2	<0.003	<0.002	584	1310	1.3	0.0041	15
08-Feb-91	252.8	1460	10	0.001	<0.01	<0.005	201	0.01	0.09	<0.01	1.1	<0.02	8.2	0.7	2.8	<0.003	<0.002	562	1260	2.9	0.026	29
22-Aug-91	252.3	1480	9.9	0.002	<0.01	<0.005	210	<0.01	0.07	<0.01	0.3	<0.02	11	3.5	1.5	<0.003	<0.002	510	1210	3.8	0.0249	47
11-Feb-92	252.3	1400	8.8	<0.001	<0.01	<0.005	199	<0.01	0.06	<0.01	0.5	0.03	12	2	1.8	<0.003	<0.002	569	1120	3	0.0221	2.1
25-Aug-92	252.6	1475	9.4	0.003	<0.01	<0.005	225	0.02	0.06	<0.01	0.5	<0.02	7.8	2.9	0.6	<0.003	0.003	624	1210	4	0.0238	21
03-Mar-93	252.2	1420	9.4	0.001	<0.01	<0.005	219	0.01	0.06	<0.01	<0.1	<0.02	7.7	3.1	1.1	<0.05	<0.002	619	1170	2.9	0.017	22
19-Aug-93	252.7	1500	8.9	<0.001	<0.01	<0.005	209	<0.01	0.06	0.01	0.1	<0.02	7.8	1.8	1.4	<0.003	<0.002	628	1240	3.8	0.0102	17
26-Apr-94	252.4	1410	8.4	0.004	<0.01	<0.005	205	<0.01	0.06	<0.01	<0.1	<0.02	6.9	2.1	1.4	<0.003	<0.002	633	1300	2.9	0.0154	15
16-Sep-94	252.4	1400	8.7	0.002	<0.01	<0.005	216	0.02	0.06	<0.01	0.4	0.02	8.4	2.2	1	0.05	<0.002	633	1300	2.3	0.009	24
20-Mar-95	252.4	1575	8.7	<0.005	<0.004	<0.005	208	<0.01	0.05	<0.04	<0.1	<0.005	8	0.5	1.8	<0.05	<0.005	642	1360	1.7	0.014	22
10-Oct-95	252.4	1550	7.5	0.008	<0.004	<0.005	196	0.02	0.05	<0.02	0.2	<0.005	2	1.2	2.6	<0.03	<0.005	629	1350	0	0.0047	14
23-Feb-96	252.3	1475	7.2	<0.003	<0.002	<0.005	200	<0.01	0.05	<0.04	<0.1	<0.005	2.5	1.5	1.3	<0.05	<0.005	660	1330	0.2	0.012	13
22-Aug-96	252.04	1600	7.5	<0.003	<0.002	<0.005	193	<0.01		0.05	0.2	0.003	19	3.3	0.6	<0.05	<0.005	684	1240	11	0.013	74
08-Apr-97	252.2	1550	7.9	0.005	<0.004	<0.005	222	<0.01	<0.01	<0.02	<0.1	<0.005	2	1.8	2.3	<0.02	<0.005	788	1470	0.4	0.0022	12
04-Nov-97	252.2	1590	8.3	0.003	<0.002	<0.005	223	<0.01	0.03	<0.04	<0.1	<0.002	2.7	3.8	0.6	<0.05	<0.005	808	1390	0.4	0.0059	6
03-May-98				<0.001		<0.003	210	<0.01	0.05	0.02			0.3	4.2	0.3	<0.002	<0.001	1000		10.8	0.0087	17
26-Dec-98				<0.001	<0.002	<0.003	200	<0.01	0.03	<0.01	0.1	<0.001	12	5	4.2	<0.002	<0.001	760		6.6	0.012	30
08-Mar-99		1625	7.8	<0.001	<0.002	<0.003	206	<0.01	0.03	<0.01	0.02	<0.001	0.69	1.27	1.4	<0.002	<0.001	770	1550	0.41	0.004	9.9

Quivira Mining Company
Ambrosia Uranium Mill Site
Ground Water Monitoring Results

Well 32-45KD, Dakota Unit

Date	Depth To Water feet	Spec. Cond. uohm/cm	pH	As (mg/l)	Be (mg/l)	Cd (mg/l)	Cl (mg/l)	CN (mg/l)	Mo (mg/l)	Ni (mg/l)	NO3 (mg/l)	Pb (mg/l)	Pb-210 (pCi/l)	Ra-226 (pCi/l)	Ra-228 (pCi/l)	Sb (mg/l)	Se (mg/l)	SO4 (mg/l)	TDS (mg/l)	Th-230 (pCi/l)	Unat (mg/l)	Gross Alpha (pCi/l)
25-May-83			11.4	<0.1		<0.01	210	<1	<0.16	<0.08	<1	0.027		0.71	-2		0.053	220	820		0.006	
06-Apr-84			11.17				168.8											260.9	831			
31-Oct-84	253.3	1225	10.74															233	786			
21-Feb-85	252	1100	11.2				170											220	850			
25-Apr-85	252.4	1175	8.59				189											176	858			
07-Nov-85	251.7																					
14-Jan-86	251.6																					
21-Apr-86	251.8	1100																				
09-Jul-86	253.4	1200	10.96				133											576	878			
07-Oct-86	252.3	1150																				
30-Jan-87	251.8	1200																				
15-Apr-87	253.5	1050																300	846			
27-Aug-87	252.5	1100	10.7				215															
28-Oct-87	251.2	1250	10.5																			
24-Feb-88	252.6	1100	10.3																			
07-Jun-88	253	1180	10.7																			
21-Sep-88				0.014	<0.01	<0.005		<0.01	0.07	0.03		0.29	7	3.4	0.4	0.009	0.006			2.9	0.0315	62
21-Sep-88	252.7	1180	11				197											373	466			
28-Sep-88				0.016	<0.01	<0.005		0.01	0.08	0		0.24	7	2.8	1.4	0.003	0.032			2.8	0.0223	49
10-Oct-88				0.018	<0.01	<0.005		<0.01	0.07	0.02		0.26	7.4	3.1	0.8	0.021	0.034			1.5	0.0137	46
14-Oct-88				0.026	<0.01	<0.005		<0.01	0.07	0.04		0.51	7.1	3	1.8	0.029	0.017			2.4	0.0314	59
21-Nov-88				0.007	<0.01	<0.005		0.01	0.07	0.04		0.4	6.3	3.2	0.8	0.008	0.015			3.4	0.0256	55
06-Dec-88	258.9	1375	10.9																			
20-Feb-89	253.7	1500	10.1	0.002	<0.01	<0.005		0.12	0.03	0.02		0.29		89	37	0.001	0.034			74		2900
20-Feb-89	253.7	1500	10.1																			
22-May-89	252.8	1650	10.7	0.003	<0.01	<0.005		<0.01	0.15	<0.01		<0.02	4.1	2.2	0.8	<0.003	0.01			2.6	0.0012	17
22-Jun-89	252.8	1650	10.7																			
06-Sep-89	252.5	1675	10.8	0.004	<0.01	<0.005	225	<0.01	0.07	<0.01	<0.1	<0.02	0.5	0.5	1.4	<0.003	0.008	585	1290	0.7	0.0032	7.3
02-Apr-90	252.14	1430	10	<0.001	<0.01	<0.005	268	<0.01	0.08	0.02	<0.01	<0.02	19	6.1	8.8	<0.003	<0.001	594	638	13	0.042	140
07-Aug-90	252.7	1520	9.9	0.002	<0.01	<0.005	225	<0.01	0.07	0.02	<0.1	<0.02	4.5	0.4	2	<0.003	<0.002	584	1310	1.3	0.0041	15
08-Feb-91	252.8	1460	10	0.001	<0.01	<0.005	201	0.01	0.09	<0.01	1.1	<0.02	8.2	0.7	2.8	<0.003	<0.002	562	1260	2.9	0.026	29
22-Aug-91	252.3	1480	9.9	0.002	<0.01	<0.005	210	<0.01	0.07	<0.01	0.3	<0.02	11	3.5	1.5	<0.003	<0.002	510	1210	3.8	0.0249	47
11-Feb-92	252.3	1400	8.8	<0.001	<0.01	<0.005	199	<0.01	0.06	<0.01	0.5	0.03	12	2	1.8	<0.003	<0.002	569	1120	3	0.0221	2.1
25-Aug-92	252.6	1475	9.4	0.003	<0.01	<0.005	225	0.02	0.06	<0.01	0.5	<0.02	7.8	2.9	0.6	<0.003	0.003	624	1210	4	0.0238	21
03-Mar-93	252.2	1420	9.4	0.001	<0.01	<0.005	219	0.01	0.06	<0.01	<0.1	<0.02	7.7	3.1	1.1	<0.05	<0.002	619	1170	2.9	0.017	22
19-Aug-93	252.7	1500	8.9	<0.001	<0.01	<0.005	209	<0.01	0.06	0.01	0.1	<0.02	7.8	1.8	1.4	<0.003	<0.002	628	1240	3.8	0.0102	17
26-Apr-94	252.4	1410	8.4	0.004	<0.01	<0.005	205	<0.01	0.06	<0.01	<0.1	<0.02	6.9	2.1	1.4	<0.003	<0.002	633	1300	2.9	0.0154	15
16-Sep-94	252.4	1400	8.7	0.002	<0.01	<0.005	216	0.02	0.06	<0.01	0.4	0.02	8.4	2.2	1	0.05	<0.002	633	1300	2.3	0.009	24
20-Mar-95	252.4	1575	8.7	<0.005	<0.004	<0.005	208	<0.01	0.05	<0.04	<0.1	<0.005	8	0.5	1.8	<0.05	<0.005	642	1360	1.7	0.014	22
10-Oct-95	252.4	1550	7.5	0.008	<0.004	<0.005	196	0.02	0.05	<0.02	0.2	<0.005	2	1.2	2.6	<0.03	<0.005	629	1350	0	0.0047	14
23-Feb-96	252.3	1475	7.2	<0.003	<0.002	<0.005	200	<0.01	0.05	<0.04	<0.1	<0.005	2.5	1.5	1.3	<0.05	<0.005	660	1330	0.2	0.012	13
22-Aug-96	252.04	1600	7.5	<0.003	<0.002	<0.005	193	<0.01		0.05	0.2	0.003	19	3.3	0.6	<0.05	<0.005	684	1240	11	0.013	74
08-Apr-97	252.2	1550	7.9	0.005	<0.004	<0.005	222	<0.01	<0.01	<0.02	<0.1	<0.005	2	1.8	2.3	<0.02	<0.005	788	1470	0.4	0.0022	12
04-Nov-97	252.2	1590	8.3	0.003	<0.002	<0.005	223	<0.01	0.03	<0.04	<0.1	<0.002	2.7	3.8	0.6	<0.05	<0.005	808	1390	0.4	0.0059	6
03-May-98				<0.001		<0.003	210	<0.01	0.05	0.02			0.3	4.2	0.3	<0.002	<0.001	1000		10.8	0.0087	17
26-Dec-98				<0.001	<0.002	<0.003	200	<0.01	0.03	<0.01	0.1	<0.001	12	5	4.2	<0.002	<0.001	760		6.6	0.012	30
08-Mar-99		1625	7.8	<0.001	<0.002	<0.003	206	<0.01	0.03	<0.01	0.02	<0.001	0.69	1.27	1.4	<0.002	<0.001	770	1550	0.41	0.004	9.9

Quivira Mining Company
Ambrosia Uranium Mill Site
Ground Water Monitoring Results

Well 36-06KD, Dakota Unit

Date	Depth To Water feet	Spec. Cond. uohm/cm	pH	As (mg/l)	Be (mg/l)	Cd (mg/l)	Cl (mg/l)	CN (mg/l)	Mo (mg/l)	Ni (mg/l)	NO3 (mg/l)	Pb (mg/l)	Pb-210 (pCi/l)	Ra-226 (pCi/l)	Ra-228 (pCi/l)	Sb (mg/l)	Se (mg/l)	SO4 (mg/l)	TDS (mg/l)	Th-230 (pCi/l)	Unat (mg/l)	Gross Alpha (pCi/l)
25-Oct-88	166.4	19800	3.3	0.872	0.23	0.038		0.2	0.78	2.35		0.38	27	85	27	0.252	0.336			11200	7.87	23000
28-Oct-88				1.050	0.24	0.052		0.01	0.89	2.61		0.47	42	117	18	0.37	0.405			12200	9.27	29000
02-Nov-88				0.775	0.23	0.046		0.01	0.84	2.46		0.46	22	105	27	0.204	0.582			15300	9.09	28000
04-Nov-88				1.15	0.21	0.047		<0.01	0.8	2.31		0.36	18	99	24	0.093	0.346			15200	6.2	23000
20-Feb-89	159.3	12750	3.5	0.76	0.11	0.018		<0.01	<0.01	1.15		0.22	14	74	22	0.309	0.499			8500	5.51	15000
16-May-89	176.2	13500	3.9	0.277	0.09	0.018	1840		0.23	0.96	2.4	0.69					0.556	14500	22900		4.45	
23-May-89	172	12500	3.9	0.779	0.01	<0.005		<0.01	0.22	0.9		<0.02	8.4	66	11	0.037	0.359			3900	3.86	10800
11-Sep-89	179.3	10500	4.1	0.426	0.07	0.015	1390	<0.01	0.08	0.73	0.30	<0.02	7.4	21	12	0.226	0.191	6600	5520	1220	2.33	5300
02-Mar-90	180.2	8000	3.7	0.142	0.05	0.02	1280	<0.01	<0.01	0.52	0.4	<0.02	8.6	28	7.9		0.032	7520	12200	1620	2.07	3800
23-Aug-90	205.63	8050	4.4	0.091	0.06	0.023	1200	<0.01	0.13	0.45	0.1	<0.02	7.2	27	13	<0.03	0.1	6880	11300	2060	2.69	4700
12-Feb-91	178.3	8100	4.1	0.01	0.06	0.012	1172	0.35	0.19	0.48	<0.1	<0.02	5.9	25	13	<0.003	0.008	7100	10700	1740	3.55	4400
22-Aug-91	176.3	8700	4.2	0.022	0.06	<0.005	1190	<0.01	0.63	0.51	0.1	0.46	1.9	16	8	<0.003	0.011	7320	11700	450	1.66	2400
12-Feb-92	175.94	7700	4.1	<0.001	0.05	<0.005	1260	<0.01	0.55	0.47	0.4	0.34	76	17	5.8	<0.003	<0.002	6910	10800	490	1.18	2200
20-Aug-92	176.14	7200	3.8	0.025	<0.01	<0.005	1120	<0.01	<0.01	0.31	1	0.03	5	22	7.6	<0.003	0.026	5500	8670	830	1.33	1800
06-Mar-93	176.25	5800	5.8	0.024	0.02	0.021	946	<0.01	<0.01	0.23	<0.1	<0.02	15	26	9.6	0.09	0.023	4400	7010	670	1.48	580
24-Aug-93	176.06	5700	4.2	0.025	0.01	<0.005	918	<0.01	<0.01	0.19	0.4	0.03	9.7	14	9.2	<0.003	0.034	4600	6680	3790	1.38	4300
26-Apr-94	173.8	4900	4.7	0.012	<0.01	<0.005	966	<0.01	<0.01	0.13	0.8	0.08	12	12	6.5	<0.003	0.006	4500	5840	1940	0.241	2200
08-Sep-94	176.7	4750	4.5	0.003	<0.01	<0.005	900	<0.01	<0.01	0.1	0.4	0.018	66	14	6.4	<0.006	0.01	3100	5410	7.6	0.215	382
20-Mar-95	176.1	4975	5.4	<0.005	<0.004	<0.005	870	<0.01	<0.01	0.05	<0.2	<0.005	18	8.9	8	<0.05	0.005	2850	5240	4.8	0.147	222
09-Oct-95	175.95	5100	5.2	0.008	<0.004	<0.005	915	<0.01	<0.01	0.07	<0.2	<0.005	38	13	6.3	<0.03	0.005	2970	5740	2080	0.252	1350
22-Feb-96	175.55	4325	5.6	<0.003	<0.002	<0.005	840	<0.01	<0.01	0.06	<0.1	<0.005	6	7.9	6.7	<0.05	<0.005	2900	4520	96	0.17	158
22-Aug-96	175.95	4675	5.8	<0.003	<0.002	<0.005	856	<0.01	<0.01	<0.04	0.3	<0.002	2.3	9.1	5.8	<0.05	<0.005	2830	4800	31	0.18	180
07-Apr-97	175.84	4325	5.6	0.005	<0.004	<0.005	881	<0.01	<0.01	0.05	<0.1	<0.005	6.1	10	3.2	0.13	<0.005	2810	4520	16	0.23	133
08-Dec-97	175.58	4200	5.48	<0.005	<0.004	<0.005	901	<0.01	<0.01	0.05	<0.1	<0.025	14	0	5.8	<0.03	<0.025	3120	4790	0.3	0.65	686
03-May-98				0.003	0	<0.02	770	<0.01	<0.05	0.06	0	0	25.6	26.4	3.8	<0.01	0.011	1570		1311.5	0.803	615
14-Dec-98				<0.002	<0.01	<0.02	800	<0.01	<0.05	<0.05	0.08	<0.001	0.42	16	14.7	<0.002	0.005	2760		400	0.509	1065
08-Mar-99		4700	4.9	<0.004	<0.01	0.008	850	<0.01	0.003	0.065	0.09	0.001	21	16.3	11	<0.002	0.003	2850	5260	370	0.545	456
10-May-99													3.6	11	9.3						0.05	110
26-May-99				<0.001	<0.0005	0.005	870	<0.01	0.003	0.016	0.05	<0.001	0.83	9.8	8.5	<0.002	0.002	210	4680	0.15	0.128	98
26-Jul-99				<0.001	0.003	0.003	926	<0.01	0.002	0.078	0.24	0.001	1.68	14	7.2	<0.002	<0.001	2860	5900	3	0.213	170

Quivira [illegible]g Company
Ambrosia Uranium Mill Site
Ground Water Monitoring Results

17-01KD, Dakota Background Well

Date	Depth To Water feet	Spec. Cond. uohm/cm	pH	As (mg/l)	Be (mg/l)	Cd (mg/l)	CN (mg/l)	Mo (mg/l)	Ni (mg/l)	Pb (mg/l)	Pb-210 (pCi/l)	Ra-226 (pCi/l)	Ra-228 (pCi/l)	Sb (mg/l)	Se (mg/l)	Th-230 (pCi/l)	Unat (mg/l)	Gross Alpha (pCi/l)
04-Mar-88	676.4	1525	10.4															
03-Jun-88	676.2	1600	10.5															
15-Sep-88				0.09	<0.01	<0.005	0.05	0.06	0.02	0.1	1.9	0.5	0.3	<0.003	0.016	1.5	0.0041	12
15-Sep-88	677.2	1500	11.07															
28-Sep-88				0.145	<0.01	<0.005	0.07	0.08	0.05	0.29	3.9	3	1.4	<0.003	0.046	2.4	0.0162	78
06-Oct-88				0.107	<0.01	<0.005	0.02	0.07	0.02	0.1	0.6	0.5	0.6	<0.003	0.041	0.8	0.0037	66
14-Oct-88				0.105	<0.01	<0.005	0.03	0.07	0.02	0.08	0.3	0.3	0.6	0.02	0.036	2.1	0.0038	93
15-Nov-88				0.041	<0.01	<0.005	0.04	0.01	0.05	0.15	2.7	0.7	0.6	0.004	0.043	4.8	0.0531	31
06-Dec-88	677	1510	11															
19-Jan-89	677.4	1475	11	0.055	<0.01	<0.005	0.05	0.02	0.02	0.98	8.5	3.1	0.5	<0.003	0.026	2.8	0.0133	38
20-Feb-89	677.5	1500	10.7	0.031	<0.01	<0.005	0.02	<0.01	<0.01	0.22	4.7	1.1	0.6	<0.003	0.027	0.6	<0.0062	8
20-Mar-89	677.5	1500	10.7															
21-Mar-89	680	1425	10.4	0.042	<0.01	<0.005	0.01	0.02	<0.01	<0.02	18	0.8	0.2	0.079	0.039	0.8	0.0074	35
25-Apr-89	678.9	1575	10.9	0.035	<0.01	<0.005	0.04	<0.01	0.01	0.13	6.7	1		0.011	0.015	1.7	0.0064	38
23-May-89	679.3	1550	10.6	0.033	<0.01	<0.005	0.03	0.04	0.01	0.12	1.7	2.1	0.2	<0.003	0.009	0.7	0.0053	2.6
13-Jun-89	679.6	1525	10.6	0.023	<0.01	<0.005	0.02	0.03	0.01	0.26	5.2	0.5	0.1	0.015	0.018	1.2	0.0063	12
31-Jul-89	679.8	1500	10.5	0.015	<0.01	<0.005	0.06	<0.01	<0.01	0.04	5.7	0.5	0	0.003	0.014	1.2	0.0014	12
30-Aug-89	679.6	1500	10.3	0.019	<0.01	<0.005	0.07	<0.01	<0.01	0.03	2.1	0.2	0	<0.003	0.002	0.2	0.0013	8.1
11-Sep-89	679.8	1500	10.1	0.012	<0.01	0.007	0.07	0.05	<0.01	<0.02	1.7	0.3	1.7	0.009	0.004	0.9	0.0029	24
05-Apr-90	680	1490	9.9	<0.001	<0.01	<0.005	0.01	0.04	<0.01	<0.02	2.9	1	1.1	0.017	0.014	0.4	0.001	0
17-Aug-90	680.2	1500	9.7	<0.001	<0.01	0.01	0.01	0.04	<0.01	<0.02	1.8	0.3	1.1	<0.003	0.004	0	0.0033	8
07-Feb-91	679.6	1490	8.8	0.001	<0.01	<0.005	0.03	0.05	<0.01	<0.02	4.5	0.8	2.1	<0.003	<0.002	0.4	0.0036	5.4
21-Aug-91	679.9	1550	9.9	<0.001	<0.01	<0.005	<0.01	0.04	0.01	<0.02	4.7	0.3	0	<0.003	<0.002	1.3	0.0078	8.2
12-Feb-92	680.4	1480	8.8	<0.001	<0.01	<0.005	<0.01	0.04	<0.01	0.03	4.3	1.3	1	<0.003	<0.002	0.3	0.0062	0
18-Aug-92	681.1	1525	9.7	<0.001	<0.01	<0.005	0.01	0.02	<0.01	<0.02	3.3	0.3	0.1	<0.003	0.002	0	0.0116	0
02-Mar-93	681.3	1480	10.1	<0.001	<0.01	<0.005	0.02	0.01	<0.01	<0.02	11	1.1	1	<0.05	<0.002	2	0.0051	10
17-Aug-93	681.5	1580	10.1	<0.001	<0.01	<0.005	0.03	<0.01	0.01	<0.02	0.5	0.6	0.7	<0.003	<0.002	1.6	0.011	11
05-Apr-94	681.3	1590	10.5	<0.001	<0.01	<0.005	0.03	0.01	<0.01	<0.02	30	1.7	0.6	<0.05	<0.002	1.1	0.0076	39
15-Sep-94	682.1	1590	10.4	<0.005	<0.01	<0.005	0.02	0.01	0.02	0.02	11	0.9	0.8	<0.05	<0.002	0.6	0.0045	16
14-Mar-95	682.6	1600	10.3	<0.005	<0.004	<0.005	0.02	<0.01	<0.04	<0.005	9	1.2	1.1	<0.05	<0.05	1	0.0056	24
10-Oct-95	682.7	1700	10.2	<0.005	<0.004	<0.005	0.01	0.02	<0.02	<0.005	11	1.8	0.6	<0.03	<0.005	0.9	0.0067	0
27-Aug-96				<0.005	<0.004	<0.005	0.01	<0.01	0.02	<0.005	2.3	0.4	0.8	<0.05	<0.005	0.3	0.0049	7.5
10-Apr-97				<0.005	<0.004	<0.005	0.02	0.01	<0.01	<0.01	3.4	0.9	1.7	<0.02	<0.005	0.1	0.0059	11
03-Nov-97				<0.003	<0.002	<0.005	<0.01	<0.01	<0.04	0	5.8	2.3	0.7	<0.05	<0.005	0.1	0.011	13
02-May-98				0.003	0	<0.003	<0.01	0.02	0.02	0	0.1	0.9	0.1	<0.02	<0.001	0.5	0.0047	13
27-Dec-98				<0.001	<0.002	<0.003	<0.01	0.01	0.03	0.003	3.4	0.5	3.1	<0.004	<0.001	0.41	0.007	11.2
16-Feb-99		1925	10.8	<0.001	<0.002	<0.003	0.01	0.02	0.01	<0.001	16	3.2	3.8	<0.002	<0.001	0.88	0.009	11

Quivira Mining Company
Ambrosia Uranium Mill Site
Ground Water Monitoring Results

Well 36-01KD, Dakota Unit, Down Gradient

Date	Depth To Water feet	Spec. Cond. uohm/cm	pH	As (mg/l)	Cd (mg/l)	Cl (mg/l)	CN (mg/l)	Mo (mg/l)	Ni (mg/l)	NO3 (mg/l)	Pb (mg/l)	Pb-210 (pCi/l)	Ra-226 (pCi/l)	Ra-228 (pCi/l)	Se (mg/l)	SO4 (mg/l)	TDS (mg/l)	Th-230 (pCi/l)	Unat (mg/l)	Gross Alpha (pCi/l)
06-Jul-77			6.9			2510										6010	13700			
28-Feb-78						2700										6040	13290			
09-Aug-78						1478										6910	14224			
26-Oct-78			7.4			2074										6066	13584			
08-Mar-79			7.6			2744										5581	13024			
19-Jul-79			7.8			2448										5558	12924			
17-Apr-80			7.39			2586										6341	13500			
29-Sep-80			5.5			2805										7560	14500			
14-Jan-82			6.97			1665										3080	13450			
15-Apr-82	319.9	14000	7			3590										6580	14180			
25-Oct-82		14500	6.37			2787										6951	15470			
25-May-83			7.3	0.36	<0.01	2960	<1	0.034	<0.08	10	0.17		0.36	-1.8	0.34	6050	13500		0.08	
26-May-83			7.3			2960				10						6050				
10-Oct-83			6.04			1808.6										7089	14554			
06-Apr-84			7.92			2272.2										4552.7	12865			
24-Jul-84			7.23			2465.2										4079	12548			
30-Oct-84	321.4	12000				2723										4679	12106			
29-Jan-85	322.3	9900	7.94			2773										3775	11538			
25-Apr-85	323.1	9000	7.85			1551										5716	12514			
08-Nov-85	319.9																			
13-Jan-86	320.2																			
01-Apr-86	321	10000																		
10-Jul-86	322.6																			
02-Oct-86	320.7																			
30-Jan-87	321.7																			
07-May-87	322.6	12000																		
09-Sep-87																				
12-Oct-87	319.6	11300	6.8																	
01-Mar-88	321.1	10500	6.9																	
07-Jun-88	321.3	10500	6.6																	
01-Dec-88	321.5	11200	6.7			3270										4470	11400			
06-Dec-88	323.3	11200	6.5																	

Quivira Mining Company
Ambrosia Uranium Mill Site
Ground Water Monitoring Results

Well 36-01KD, Dakota Unit, Down Gradient

Date	Depth To Water feet	Spec. Cond. uohm/cm	pH	As (mg/l)	Cd (mg/l)	Cl (mg/l)	CN (mg/l)	Mo (mg/l)	Ni (mg/l)	NO3 (mg/l)	Pb (mg/l)	Pb-210 (pCi/l)	Ra-226 (pCi/l)	Ra-228 (pCi/l)	Se (mg/l)	SO4 (mg/l)	TDS (mg/l)	Th-230 (pCi/l)	Unat (mg/l)	Gross Alpha (pCi/l)
31-Mar-89	322	11500	6.6																	
20-Jun-89	321.9	1275	6.7																	
23-Aug-89	322.5	13000	6.6	0.078	<0.005	3270	<0.01	<0.01	<0.01	<0.01	<0.02	0	1.5	0.1	0.022	4860	13100	0	0.0036	0
28-Sep-89	322.5	13500	6.3	0.054	0.044	2680	<0.01	0.02	0.1	<0.1	<0.02	2.3	1.2	0.7	0.029	5860	12900	0.5	0.0035	7
10-Apr-90	322.2	12900	6.3			3570										5800	13000			
14-Sep-90	322.5	13200	6.4	<0.001	<0.005	3430	<0.01	0.14	0.04		<0.02				0.004	5560	13100			
06-Mar-91	322.2	12200	6.8			3480										5800	11800			
18-May-91	322.7	12200	6.5	<0.001	<0.005		0.01	<0.01	0.02	<0.1	<0.02	1	0.5	1.4	0.004			0.9	0.0058	0
27-Sep-91	322.7	12500	6.5			2950										4010	13200			
24-Feb-92	322.9	12200	7.1	<0.001	<0.005	2000	0.02	0.39	0.03	1.5	0.02	6.8	2.5	0.4	<0.002	4060	9620	0.5	0.0081	70
22-Sep-92	322.8	12500	6.6			3390	<0.01	<0.01			<0.02	2	4.2			4580	11100			78
11-Mar-93	323.2	11750	14.1	<0.001	<0.025	3170	<0.01	<0.05	<0.05	<0.1	<0.1	3.2	0.5	0.6	0.004	4710	10600	1.1	0.0003	30
19-Aug-93	323.3	12500	7.1	<0.001	<0.005	2930	<0.01	<0.01	<0.01	0.8	<0.02	0.5	1.2	2.2	<0.002	4040	10500	0.2	0.005	0
10-May-94	323.3	10500	6.9	<0.001	<0.02	3440	<0.01	<0.02	0.03	<0.1	<0.02	1	1.4	0.9	<0.002	3820	9630	0.3	0.0064	38
03-Nov-94	323.5	11500	7			3210										3530	9410			
23-Mar-95	323.6	11500	7.2	<0.005	<0.005	3100	0.01	<0.05	<0.2	<0.5	<0.005	1.2	2	0.8	0.005	3340	9320	0.2	0.0155	56
25-Oct-95	324.1	11500	7			3080										3460	10300			
29-Mar-96	323.9	10900	7	0.012	<0.01	3000	<0.01	<0.02	<0.04	0.5	<0.005	0.6	7.2	1.6	<0.025	3200	9510	0.4	0.0035	15
03-Apr-97						1520				0.1		6				1930	4400		0.0017	10
29-May-97						2610				1		1.2				3020	9540		0.0051	
19-Dec-97																				
08-May-98						1430	<0.01	<0.02	<0.02	0.11		9.9	3.22	1.41	<0.001	240	2960	7.7	0.0027	24
18-Mar-99		11100	7.2	<0.002	<0.03	2800	<0.01	0.003	0.013	0.53	<0.002	15	6.24	3.3	0.005	2680	10300	2.5	0.005	26

Quivira Mining Company
Ambrosia Uranium Mill Site
Ground Water Monitoring Results

36-04KD, Dakota Bedrock Unit, POE

Date	Depth To Water feet	Spec. Cond. uohm/cm	pH	As (mg/l)	Be (mg/l)	Cd (mg/l)	Cl (mg/l)	CN (mg/l)	Mo (mg/l)	Ni (mg/l)	NO3 (mg/l)	Pb (mg/l)	Pb-210 (pCi/l)	Ra-226 (pCi/l)	Ra-228 (pCi/l)	Sb (mg/l)	Se (mg/l)	SO4 (mg/l)	TDS (mg/l)	Th-230 (pCi/l)	Unat (mg/l)	Gross Alpha (pCi/l)
24-May-83			4.6	0.21		0.062	2700	<1	0.035	0.14	7	0.45		1.36	-1.3		0.27	3900	9690		0.002	
16-Aug-83			4.6	0.26		0.042	2630	<0.1	0.058	0.17	<1	0.46		1.59	-2.3		0.43	3770	9320		0.003	
14-Nov-83			4.7	0.036		0.03	2590	<1	<0.018	<0.038	<1	0.016		0.22	-2.2		0.025	3930	9440		0.004	
03-Feb-84	306.3	12200	5				3220											4320	9360			
17-Apr-84	305.8	11700	4.2	0.13		0.02	3220		0.025	0.082		<0.068		0.48			0.17	3630	9830		0.028	
18-Jul-84	305.4	11600	4.9				2280											3460	9320			
17-Oct-84	304.9	12000	5.4				2710											4100	10100			
11-Jan-85	304.9	12300	4.6				2480											3160	9190			
22-Apr-85	305.4	13300	4.3	<0.001		0.0035	2600		<0.1	0.38	1.2	<0.001		0.9			<0.001	3920	10200		0.0005	
08-Jul-85	306.4	10500	3.9				2600				0.2							4070	9960			
08-Nov-85	304.1	9900	6.42				2600				0.3							4250	10000			
13-Jan-86	304.5	10000	5.18				2700				0.4							4130	10600			
10-Apr-86	305.4	10050	5.01	<0.001		<0.0001	2500		0.1	0.12	75	<0.001		2.2			<0.001	3350	10700		0.0015	
08-Jul-86	306.7	11000	4.95				3100				14							4680	10800			
07-Oct-86	305.7	8000	6.45				1600				<0.1							4580	10100			
15-Jan-87	306.4	10000	7.08				2300				2.7							4480	10400			
15-Apr-87	306.9	9900	7.02	0.005		<0.001	2410		<0.1	0.01		<0.001		0.7			0.005	4880	10500		0.0093	
21-Jul-87	305.9	11000	6.3				2570				4.1							5160	12000			
12-Oct-87	304.1	11250	6.9				2560				0.40							5130	11900			
20-Jan-88	305.8	9900	7.1		<0.01		2540	<0.01			<0.1							5170	11600	0.5		
05-May-88	306.2	9800	6.9	0.023		<0.005	2470		0.18	0.15	0.90	<0.02		0.6			0.137	3820	11600	0	0.0018	
18-Jul-88	306.1	9800	6.6				2660				<0.1							4670	12600			
26-Oct-88	307.3	12000	6.7	0.014			2360		0.25		<0.1			0.4			0.037	4890	11200	1.4	0.009	
17-Jan-89	307	9700	6.6				2370				<0.1							5090	11600			
20-Apr-89	307	10100	6.9	0.006		<0.005	2400		0.16	0.01	<0.1	<0.02		2.2			0.03	5390	11700	4	0.0077	
26-Jul-89	307.2	11500	6.6				2650				<0.1							5420	11900			
04-Oct-89	307.2	11000	6.8	0.043	<0.01	0.006	2360	<0.01	<0.01	0.1	<0.1	<0.02	2.6	1	6.8	0.017	0.028	5130	10600	19	0.0042	9
10-Apr-90	307.6	10500	6.6				2460											5870	11700			
14-Sep-90	308.4	11600	6.9	<0.001		<0.005	2870	<0.01	0.1	0.02		<0.02					<0.002	4960	11600			
06-Mar-91	307.4	10700	6.8				2710											4760	10300			
18-May-91	308	10400	6.8	<0.001	<0.01	<0.005		0.01	<0.01	0.02	<0.1	<0.02	2.3	0.8	6.4	<0.003	0.002			0.5	0.0111	0
27-Sep-91	307.9	11000	6.4				2100											4120	11200			
24-Feb-92	308.3	10900	7.1	<0.001	0.009	<0.005	2340	<0.01	0.31	0.03	0.3	<0.02	8.6	10	4.8	<0.003	<0.002	4590	13000	0.2	0.0133	11

Quivira Mining Company
Ambrosia Uranium Mill Site
Ground Water Monitoring Results

36-04KD, Dakota Bedrock Unit, POE

Date	Depth To Water feet	Spec. Cond: uohm/cm	pH	As (mg/l)	Be (mg/l)	Cd (mg/l)	Cl (mg/l)	CN (mg/l)	Mo (mg/l)	Ni (mg/l)	NO3 (mg/l)	Pb (mg/l)	Pb-210 (pCi/l)	Ra-226 (pCi/l)	Ra-228 (pCi/l)	Sb (mg/l)	Se (mg/l)	SO4 (mg/l)	TDS (mg/l)	Th-230 (pCi/l)	Unat (mg/l)	Gross Alpha (pCi/l)
22-Sep-92	308.1	11200	6.7				2740		<0.01				1.8	3.9				4690	10700			0
11-Mar-93	308.9	10250	7.2	0.002	<0.05	<0.025	2550	<0.01	<0.05	<0.05	<0.1	<0.1	5.7	2.3	5.3	<0.25	<0.002	4540	10500	0.2	0.0159	0
23-Aug-93	309.1	10800	7.2	<0.001	<0.01	<0.005	2480	<0.01	<0.01	<0.01	0.4	<0.02	2.4	2.1	8.2	<0.003	0.003	4530	10500	0.3	0.0055	0
10-May-94	309.5	10000	7	<0.001	<0.02	<0.01	2800	<0.01	<0.02	<0.02	<0.1	<0.02	3.5	2.4	6.7	<0.1	<0.002	4780	10300	0.4	0.0068	39
03-Nov-94	309.7	11000	7				2660											4340	10100			
22-Mar-95	309.9	10900	7.3	<0.005	<0.02	<0.005	2540	<0.01	<0.05	<0.2	<0.5	<0.005	2.6	1.7	6.7	<0.25	<0.005	4110	10000	0.5	0.0073	34
25-Oct-95	310.1	11000	7				2800											4400	10400			
29-Mar-96	309.9	10700	7	<0.005	<0.008	<0.01	2800	<0.01	<0.02	<0.04	1.4	<0.005	1	2.1	3.8	<0.06	<0.025	3900	9750	0.5	0.0073	0
29-May-97							2670				0.1		2.5					3790	10100			
02-Jun-97																						
28-May-98										<0.1			6.2	1.55	8.04		<0.002					
18-Mar-99		10800	6.8	0.017	0.01	<0.0005	2850	<0.01	0.024	0.026	0.03	<0.002	9.1	2.33	6.2	<0.002	0.011	1850	9920	1.2	0.052	22

APPENDIX D
Analytical Model (SOLUTE) Data

```
*******************************************************
*                                                     *
*      INTERNATIONAL GROUND WATER MODELING CENTER     *
*      Indianapolis, USA - Delft, The Netherlands     *
*                                                     *
*              S O L U T E   version 2.00             *
*                                                     *
*       ANALYTICAL MODELS FOR SOLUTE TRANSPORT        *
*                                                     *
*******************************************************
```

```
PROJECT......... = Chloride Transport, Dakota
USER NAME....... = apo
DATE............ = 11/15/99
DATA FILE....... = a:DAK-CL.DAT
```

INPUT DATA:

```
GROUNDWATER (SEEPAGE) VELOCITY =  182 [ft/y]
LONGITUDINAL DISPERSIVITY..... =  1200 [ft]
RETARDATION FACTOR............ =  1.4
INITIAL CONCENTRATION......... =  0 [mg/l]
CONCENTRATION AT SOURCE....... =  5867 [mg/l]
LENGTH OF TIME STEP........... =  1 [y]
NUMBER OF TIME STEPS.......... =  50
NUMBER OF OBSERVATION POINTS.. =  3
    1  DISTANCE (from source). =  800 [ft]
    2  DISTANCE (from source). =  4700 [ft]
    3  DISTANCE (from source). =  9100 [ft]
DURATION OF SOLUTE PULSE...... =  22 [y]
HALF-LIFE (0 if no decay)..... =  0 [y]
DECAY CONSTANT (lambda)....... = .0000D+00 [1/y]
```

CONCENTRATION C [mg/l]

TIME [y]	1 DISTANCE 800.00 [ft]	2 DISTANCE 4700.00 [ft]	3 DISTANCE 9100.00 [ft]
1.0000	1223.7447	0.0000	0.0000
2.0000	2476.1961	0.0001	0.0000
3.0000	3220.0395	0.0457	0.0000
4.0000	3709.1865	0.9745	0.0000
5.0000	4056.7616	6.1869	0.0000
6.0000	4317.2805	21.3653	0.0000
7.0000	4520.1665	51.9734	0.0002
8.0000	4682.7551	101.4643	0.0018
9.0000	4815.9716	170.9322	0.0116
10.0000	4927.0665	259.5994	0.0521
11.0000	5021.0550	365.4993	0.1777
12.0000	5101.5275	486.0643	0.4939
13.0000	5171.1246	618.5412	1.1723
14.0000	5231.8361	760.2512	2.4575
15.0000	5285.1923	908.7340	4.6639
16.0000	5332.3896	1061.8138	8.1631
17.0000	5374.3787	1217.6182	13.3653
18.0000	5411.9238	1374.5688	20.6977
19.0000	5445.6483	1531.3578	30.5829
20.0000	5476.0642	1686.9187	43.4200
21.0000	5503.5969	1840.3941	59.5688
22.0000	5528.6037	1991.1064	79.3385
23.0000	4327.6408	2138.5301	102.9801
24.0000	3096.0018	2282.2659	130.6832
25.0000	2371.2209	2421.9758	162.5748
26.0000	1899.5747	2556.6170	198.7219
27.0000	1568.1019	2682.6556	239.1348
28.0000	1322.4286	2794.3335	283.7720
29.0000	1133.2552	2886.1598	332.5463
30.0000	983.3554	2954.6922	385.3294
31.0000	861.8994	2998.8765	442.0439
32.0000	761.7218	3019.5565	502.3065
33.0000	677.8822	3018.7808	565.9355
34.0000	606.8572	2999.2172	632.5985
35.0000	546.0659	2963.7256	701.8853
36.0000	493.5724	2915.1023	773.3047
37.0000	447.8941	2855.9291	846.2922
38.0000	407.8778	2788.5056	920.2250
39.0000	372.6121	2714.8314	994.4434
40.0000	341.3681	2636.6115	1068.2757
41.0000	313.5543	2555.2807	1141.0598
42.0000	288.6879	2472.0310	1212.1660
43.0000	266.3700	2387.8418	1281.0115
44.0000	246.2672	2303.5117	1347.0745
45.0000	228.1008	2219.6838	1409.9020
46.0000	211.6354	2136.8711	1469.1125
47.0000	196.6702	2055.4770	1524.3983
48.0000	183.0334	1975.8136	1575.5235
49.0000	170.5780	1898.1181	1622.3197
50.0000	159.1763	1822.5655	1664.6810

```
*******************************************************
*                                                     *
*      INTERNATIONAL GROUND WATER MODELING CENTER     *
*      Indianapolis, USA - Delft, The Netherlands     *
*                                                     *
*              S O L U T E   version 2.00             *
*                                                     *
*       ANALYTICAL MODELS FOR SOLUTE TRANSPORT        *
*                                                     *
*******************************************************
```

```
PROJECT.......... = Uranium Transport in Dakota
USER NAME....... = apo
DATE............ = 11/15/99
DATA FILE....... = a:DAK-UNAT.DAT
```

INPUT DATA:

```
GROUNDWATER (SEEPAGE) VELOCITY =  182 [ft/y]
LONGITUDINAL DISPERSIVITY..... =  1200 [ft]
RETARDATION FACTOR............ =  10
INITIAL CONCENTRATION......... =  0 [mg/l]
CONCENTRATION AT SOURCE....... =  2 [mg/l]
LENGTH OF TIME STEP........... =  5 [y]
NUMBER OF TIME STEPS.......... =  50
NUMBER OF OBSERVATION POINTS.. =  3
    1  DISTANCE (from source). =  800 [ft]
    2  DISTANCE (from source). =  4700 [ft]
    3  DISTANCE (from source). =  9100 [ft]
DURATION OF SOLUTE PULSE...... =  22 [y]
HALF-LIFE (0 if no decay)..... =  0 [y]
DECAY CONSTANT (lambda)....... = .0000D+00 [1/y]
```

CONCENTRATION C [mg/l]

TIME [y]	1 DISTANCE 800.00 [ft]	2 DISTANCE 4700.00 [ft]	3 DISTANCE 9100.00 [ft]
5.0000	0.2394	0.0000	0.0000
10.0000	0.6172	0.0000	0.0000
15.0000	0.8753	0.0000	0.0000
20.0000	1.0557	0.0000	0.0000
25.0000	1.1138	0.0001	0.0000
30.0000	0.8093	0.0005	0.0000
35.0000	0.5889	0.0018	0.0000
40.0000	0.4485	0.0047	0.0000
45.0000	0.3542	0.0098	0.0000
50.0000	0.2877	0.0174	0.0000
55.0000	0.2387	0.0277	0.0000
60.0000	0.2015	0.0399	0.0000
65.0000	0.1725	0.0536	0.0000
70.0000	0.1494	0.0678	0.0000
75.0000	0.1307	0.0819	0.0000
80.0000	0.1152	0.0954	0.0001
85.0000	0.1023	0.1079	0.0002
90.0000	0.0915	0.1192	0.0003
95.0000	0.0822	0.1291	0.0005
100.0000	0.0742	0.1377	0.0008
105.0000	0.0673	0.1448	0.0012
110.0000	0.0613	0.1508	0.0018
115.0000	0.0560	0.1554	0.0025
120.0000	0.0514	0.1590	0.0035
125.0000	0.0472	0.1616	0.0046
130.0000	0.0436	0.1633	0.0059
135.0000	0.0403	0.1642	0.0075
140.0000	0.0373	0.1644	0.0093
145.0000	0.0346	0.1640	0.0113
150.0000	0.0322	0.1631	0.0135
155.0000	0.0300	0.1617	0.0159
160.0000	0.0280	0.1599	0.0184
165.0000	0.0262	0.1579	0.0211
170.0000	0.0246	0.1555	0.0239
175.0000	0.0230	0.1529	0.0268
180.0000	0.0216	0.1502	0.0298
185.0000	0.0203	0.1473	0.0329
190.0000	0.0191	0.1442	0.0360
195.0000	0.0180	0.1411	0.0391
200.0000	0.0170	0.1380	0.0422
205.0000	0.0161	0.1348	0.0453
210.0000	0.0152	0.1315	0.0484
215.0000	0.0144	0.1283	0.0514
220.0000	0.0136	0.1250	0.0544
225.0000	0.0129	0.1218	0.0573
230.0000	0.0122	0.1186	0.0601
35.0000	0.0116	0.1155	0.0627
240.0000	0.0110	0.1123	0.0653
245.0000	0.0105	0.1093	0.0678
250.0000	0.0100	0.1063	0.0701

APPENDIX E

Groundwater Wells Data
U. S. Geology Survey
Water Resource Division

United States Department of the Interior

U.S. GEOLOGICAL SURVEY

Water Resources Division
4501 Indian School Road NE, Suite 200
Albuquerque, NM 87110-3929

August 11, 1998

Peter Luthinger
Quivira Mining
P.O. Box 218
Grants, NM 87020

Dear Mr. Luthinger:

Enclosed is a 9 page printout with ground-water data within a 25 mile radius of 35°26'00 North Latitude and 107°48'00 West Longitude. The level status codes are as follows: P = pumping; O = obstruction; R = recently pumped; S = nearby well pumping; D = dry; X = affected by surface water; W = well destroyed; E = recently flowing; Z = other.

Water levels proceeded by a "-" mean the water level is above land surface (flowing wells shut in and psi converted to feet above land surface).

The aquifer codes are as follows:

110AVMB	Alluvium
220ENRD	Entrada Sandstone
313SADG	San Andres Limestone and Glorieta Sandstone
313SADR	San Andres Limestone
231CHNL	Chinle Formation
310YESO	Yeso Formation
111MCCR	McCarly's Basalt Flow
310GLRT	Glorieta Sandstone
221WSRC	Westwater Canyon Sandstone Member of Morrison Formation
211DKOT	Dakota Sandstone or Formation
211GLLP	Gallup Sandstone
211CRVC	Crevasse Canyon Formation of Mesa Verde Group

If you have any questions, please call me at (505) 262-5326.

Sincerely,

M Root for

Roy Cruz

Enclosure

SITE-ID	LOCAL WELL NUMBER	LATITUDE (DEGREES)	LONGITUDE (DEGREES)	ALTITUDE OF LAND SURFACE (FEET)	DEPTH OF WELL (FEET)	AQUIFER CODE	WATER-LEVEL DATE	WATER LEVEL (FEET)	WATER-LEVEL STATUS
350603107485801	10N.09W.17.113	350603	1074858	6439.00	77	110AVMB	02-02-94	47.40	-
350431107470301	10N.09W.21.444	350431	1074703	6400.00	100	220ENRD	01-31-94	51.10	-
350615107524601	10N.10W.10.433	350613	1075245	6450.00	200	313SADG	07-20-90	20.95	-
							07-19-95	25.68	-
350514107502701	10N.10W.24.212	350514	1075027	6445.00	70	110AVMB	02-02-94	42.00	-
351104107534701	11N.10W.04.211	351304	1075351	6542.00	150	313SADG	07-20-90	70.50	-
							01-27-94	79.50	-
							07-20-95	75.14	-
351237107541901	11N.10W.04.311	351238	1075418	6543.00	1000	313SADG	07-20-90	72.18	-
							07-20-95	73.75	-
351216107541701	11N.10W.04.333	351216	1075417	6539.00	198	313SADG	07-24-90	73.32	-
							02-24-94	74.90	-
							07-20-95	74.02	-
351209107552502	11N.10W.08.111	351209	1075525	6552.00	150	313SADG	07-20-90	85.07	-
							01-27-94	85.80	-
							07-19-95	84.60	-
351213107545401	11N.10W.08.122	351213	1075454	6536.00	150	313SADR	03-02-94	83.91	-
351213107542701	11N.10W.08.221	351213	1075427	6538.00	165	313SADG	03-02-94	76.13	-
351125107550401	11N.10W.08.344	351125	1075504	6526.00	100	313SADG	07-20-90	63.44	P
							07-19-95	64.41	-
351211107532901	11N.10W.09.221	351211	1075329	6535.00	480	313SADG	07-20-90	68.48	-
							01-27-94	72.50	-
							07-20-95	70.86	-
351117107542301	11N.10W.17.222	351117	1075423	6525.00	125	313SADG	07-20-90	58.96	-
							01-27-94	60.10	-
							07-19-95	59.55	-
350923107522701	11N.10W.27.241	350923	1075227	6480.00	158	313SADG	02-09-90	22.30	-
							07-18-90	22.67	-
							02-22-91	22.68	-
							07-09-91	25.05	-
							02-25-92	22.02	-
							08-10-92	24.44	-
							02-05-93	22.74	-
							08-02-93	25.96	-
							02-08-94	23.56	-
							07-11-94	25.54	-
							02-02-95	22.35	-
							07-19-95	26.58	-
							02-23-96	21.53	-
							08-02-96	23.95	-

SITE-ID	LOCAL WELL NUMBER	LATITUDE (DEGREES)	LONGITUDE (DEGREES)	ALTITUDE OF LAND SURFACE (FEET)	DEPTH OF WELL (FEET)	AQUIFER CODE	WATER-LEVEL DATE	WATER LEVEL (FEET)	WATER-LEVEL STATUS
350923107522701	11N.10W.27.241	350923	1075227	6480.00	158	313SADG	03-07-97	23.02	-
							08-12-97	25.90	-
							07-21-98	28.42	-
350911107535301	11N.10W.28.322	350911	1075353	6550.00	151	313SADG	07-20-90	92.29	-
							07-26-95	93.80	-
350819107523201	11N.10W.34.4122	350819	1075232	6520.00	61.5	313SADG	07-20-90	51.18	-
							07-19-95	53.16	-
350758107524501	11N.10W.34.433	350758	1075245	6590.00	187	313SADG	07-20-90	133.81	-
							07-19-95	134.05	-
351736107550701	12N.10W.05.341A	351736	1075510	6700.00	725	313SADG	07-30-90	--	O
351452107552301	12N.10W.20.333A	351452	1075523	6570.00	275	313SADR	07-24-90	106.37	R
							01-26-94	103.98	-
							07-19-95	101.79	-
351519107513901	12N.10W.23.233	351519	1075139	6592.00	865	313SADR	07-24-90	131.30	-
							01-31-94	127.40	-
							07-19-95	131.38	-
351425107522101	12N.10W.27.244	351425	1075221	6574.00	371	110AVMB	01-31-94	82.76	-
351402107531901	12N.10W.27.333	351402	1075319	6557.00	551	313SADG	03-02-94	80.75	-
351304107543701	12N.10W.29.434	351304	1075437	6552.00	205	110AVMB	02-09-90	76.58	-
							02-22-91	79.62	-
							07-09-91	78.63	-
							02-24-92	80.42	-
							08-10-92	86.40	S
							02-05-93	81.15	-
							08-02-93	80.54	-
							03-02-94	91.60	-
							07-11-94	79.24	-
							02-02-95	79.64	-
							07-24-95	78.66	-
							02-23-96	77.96	-
							08-02-96	78.26	-
							03-07-97	79.27	-
							08-12-97	80.62	-
							07-21-98	81.14	-
351304107543702	12N.10W.29.434A	351304	1075437	6554.00	398	313SADR	01-27-94	81.00	-
351419107553101	12N.10W.30.421	351419	1075531	6576.00	245	313SADG	01-26-94	114.55	-
351357107561001	12N.10W.31.121	351357	1075610	6575.00	164	313SADR	07-25-90	117.74	-
							07-19-95	112.27	-
351354107552401	12N.10W.32.111	351354	1075524	6566.00	253	313SADG	01-26-94	105.00	-
351323107552401	12N.10W.32.313	351323	1075524	6578.00	210	313SADG	07-25-90	123.69	-

SITE-ID	LOCAL WELL NUMBER	LATITUDE (DEGREES)	LONGITUDE (DEGREES)	ALTITUDE OF LAND SURFACE (FEET)	DEPTH OF WELL (FEET)	AQUIFER CODE	WATER-LEVEL DATE	WATER LEVEL (FEET)	WATER-LEVEL STATUS
351323107552401	12N.10W.32.313	351323	1075524	6578.00	210	313SADG	07-20-95	120.51	R
351331107523401	12N.10W.34.412	351331	1075234	6557.00	843	313SADG	01-27-94	61.27	-
351737107593001	12N.11W.03.332	351737	1075930	6655.00	280	313SADG	07-25-90	--	D
351743108010601	12N.11W.05.413	351743	1080106	6710.00	357	231CHNL	01-25-94	181.00	-
351715108003001	12N.11W.09.114A	351715	1080030	6662.00	523	313SADG	07-26-90	139.04	-
							01-25-94	118.20	-
							07-20-95	113.33	-
351719107594901	12N.11W.09.221	351719	1075949	6649.00	--	313SADR	07-26-90	129.68	-
							02-08-94	115.20	-
							07-20-95	106.28	-
351651107594501	12N.11W.09.424	351651	1075945	6642.00	370	310YESO	02-09-90	93.58	-
							07-25-90	98.77	-
							10-31-90	101.08	-
							11-23-90	102.39	-
							12-28-90	100.87	-
							01-24-91	100.26	-
							02-22-91	102.56	-
							03-26-91	102.73	-
							04-30-91	103.17	-
							05-30-91	100.45	-
							06-20-91	100.24	-
							07-09-91	99.80	-
							07-23-91	99.42	-
							08-22-91	98.48	-
							09-30-91	98.25	-
							10-29-91	97.67	-
							11-21-91	98.09	-
							12-17-91	98.55	-
							01-29-92	99.15	-
							02-19-92	99.49	-
							03-26-92	99.62	-
							04-23-92	99.85	-
							05-21-92	99.38	-
							06-24-92	99.34	-
							07-29-92	99.44	-
							08-10-92	98.69	-
							08-20-92	98.54	-
							09-24-92	98.67	-
							10-28-92	98.66	-
							12-02-92	99.85	-

SITE-ID	LOCAL WELL NUMBER	LATITUDE (DEGREES)	LONGITUDE (DEGREES)	ALTITUDE OF LAND SURFACE (FEET)	DEPTH OF WELL (FEET)	AQUIFER CODE	WATER-LEVEL DATE	WATER LEVEL (FEET)	WATER-LEVEL STATUS
351651107594501	12N.11W.09.424	351651	1075945	6642.00	370	310YESO	01-20-93	100.74	-
							02-23-93	100.47	-
							03-25-93	99.88	-
							04-27-93	99.91	-
							05-26-93	98.63	-
							06-24-93	98.27	-
							07-21-93	98.13	-
							08-31-93	98.29	-
							09-22-93	97.41	-
							10-20-93	97.13	-
							10-29-93	.13	-
							11-23-93	100.93	-
							12-22-93	96.63	-
							01-27-94	95.97	-
							02-28-94	95.30	-
							02-28-94	95.30	-
							03-22-94	94.68	-
							03-22-94	94.68	-
							05-26-94	99.97	-
							05-26-94	99.97	-
							06-28-94	99.84	-
							06-28-94	99.84	-
							07-27-94	97.87	-
							07-27-94	97.87	-
							08-24-94	97.34	-
							08-24-94	97.34	-
							09-21-94	98.61	-
							09-21-94	98.61	-
							10-18-94	96.71	-
							11-21-94	92.55	-
							12-20-94	91.19	-
							01-23-95	96.73	-
							02-23-95	94.01	-
							03-27-95	101.19	-
							04-27-95	92.24	-
							05-22-95	97.59	-
							06-16-95	98.23	-
							07-20-95	90.35	-
							08-24-95	100.24	-
							09-26-95	99.66	-

SITE-ID	LOCAL WELL NUMBER	LATITUDE (DEGREES)	LONGITUDE (DEGREES)	ALTITUDE OF LAND SURFACE (FEET)	DEPTH OF WELL (FEET)	AQUIFER CODE	WATER-LEVEL DATE	WATER LEVEL (FEET)	WATER-LEVEL STATUS
351651107594501	12N.11W.09.424	351651	1075945	6642.00	370	310YESO	10-30-95	89.75	-
							11-21-95	90.82	-
							01-18-96	92.51	-
							02-21-96	93.10	-
							03-19-96	93.43	-
							04-16-96	93.81	-
							05-21-96	93.35	-
							06-18-96	92.44	-
							07-23-96	93.06	-
							08-20-96	94.64	-
							09-25-96	95.37	-
							11-26-96	90.84	-
							12-16-96	91.83	-
							01-27-97	98.60	-
							02-25-97	98.12	-
							07-12-97	116.26	-
							07-21-98	100.28	-
351636107591301	12N.11W.10.344	351636	1075913	6635.00	378	313SADR	07-25-90	118.44	R
351630107572801	12N.11W.14.213	351630	1075728	6605.00	130	111MCCR	02-09-90	83.40	-
							02-22-91	85.60	-
							07-09-91	86.10	-
							02-24-92	85.95	-
							08-10-92	86.06	-
							02-05-93	85.84	-
							08-02-93	85.66	-
							01-25-94	84.97	-
							07-11-94	84.45	-
							02-02-95	83.84	-
							07-24-95	82.55	-
							02-23-96	83.29	-
							08-02-96	83.82	-
							03-07-97	84.92	-
							08-12-97	85.78	-
							07-21-98	86.64	-
351554107591501	12N.11W.15.341	351554	1075915	6627.00	457	310GLRT	07-26-90	111.43	-
							01-27-94	95.40	-
							07-20-95	78.80	X
351514107590701	12N.11W.22.322	351514	1075907	6635.00	583	313SADG	07-26-90	128.73	P
							07-20-95	124.19	-
351526107580001	12N.11W.23.231	351526	1075800	6607.00	300	231CHNL	01-26-94	69.51	-

SITE-ID	LOCAL WELL NUMBER	LATITUDE (DEGREES)	LONGITUDE (DEGREES)	ALTITUDE OF LAND SURFACE (FEET)	DEPTH OF WELL (FEET)	AQUIFER CODE	WATER-LEVEL DATE	WATER LEVEL (FEET)	WATER-LEVEL STATUS
351416107571001	12N.11W.25.313	351416	1075710	6592.00	365	313SADG	07-24-90	133.69	-
							01-26-94	99.25	-
							07-20-95	87.99	Z
351416107565801	12N.11W.25.413	351416	1075658	6595.00	190	313SADG	07-26-90	132.16	-
							07-19-95	127.90	-
351445107584201	12N.11W.27.222	351445	1075842	6630.00	--	313SADG	07-26-90	157.45	-
							01-26-94	--	W
							07-20-95	152.31	-
352023107473201	13N.09W.21.4123	352023	1074732	6785.00	155	221WSRC	05-18-90	76.83	-
							10-31-90	77.73	-
							11-23-90	77.82	-
							12-28-90	77.98	-
							01-24-91	78.10	-
							02-22-91	78.19	-
							03-26-91	78.19	-
							04-30-91	79.85	-
							05-30-91	81.15	-
							06-20-91	78.65	-
							07-23-91	80.65	-
							08-22-91	78.87	-
							09-30-91	79.05	-
							10-29-91	79.08	-
							11-21-91	79.17	-
							12-17-91	79.39	-
							01-29-92	79.51	-
							02-19-92	79.52	-
							03-26-92	79.52	-
							04-23-92	81.29	-
							05-21-92	79.77	-
							06-24-92	79.79	-
							07-29-92	79.12	-
							08-20-92	78.81	-
							09-24-92	80.25	-
							10-28-92	79.21	-
							12-02-92	80.63	-
							01-20-93	80.93	-
							02-23-93	81.06	-
							03-25-93	81.34	-
							04-27-93	81.36	-
							05-25-93	82.04	-

4 miles SSE of mill

[illegible]

SITE-ID	LOCAL WELL NUMBER	LATITUDE (DEGREES)	LONGITUDE (DEGREES)	ALTITUDE OF LAND SURFACE (FEET)	DEPTH OF WELL (FEET)	AQUIFER CODE	WATER-LEVEL DATE	WATER LEVEL (FEET)	WATER-LEVEL STATUS
352023107473201	13N.09W.21.4123	352023	1074732	6785.00	155	221WSRC	06-23-93	81.65	-
							07-21-93	81.86	-
							10-20-93	82.30	-
							11-23-93	82.44	-
							12-22-93	81.64	-
							01-27-94	82.72	-
							02-28-94	82.94	-
							03-22-94	82.93	-
							04-28-94	83.33	-
							05-26-94	83.47	-
							06-28-94	83.70	-
							07-27-94	83.85	-
							08-24-94	85.40	-
							09-21-94	86.83	-
							10-18-94	84.32	-
							11-21-94	82.65	-
							12-20-94	84.68	-
							01-23-95	84.63	-
							02-23-95	84.88	-
							03-27-95	85.19	-
							04-27-95	85.39	-
							05-22-95	85.34	-
							06-16-95	85.61	-
							07-24-95	85.85	-
							08-24-95	86.07	-
							09-26-95	86.20	-
							10-30-95	86.37	-
							11-21-95	86.62	-
							01-18-96	86.90	-
							02-21-96	87.10	-
							03-19-96	88.89	-
							04-16-96	87.34	-
							05-21-96	87.58	-
							06-18-96	87.75	-
							07-23-96	87.90	-
							08-20-96	89.63	-
							09-25-96	90.13	-
							11-26-96	86.60	-
							01-27-97	88.90	-
							07-22-97	89.65	-

SITE-ID	LOCAL WELL NUMBER	LATITUDE (DEGREES)	LONGITUDE (DEGREES)	ALTITUDE OF LAND SURFACE (FEET)	DEPTH OF WELL (FEET)	AQUIFER CODE	WATER-LEVEL DATE	WATER LEVEL (FEET)	WATER-LEVEL STATUS
352023107473201	13N.09W.21.4123	352023	1074732	6785.00	155	221WSRC	02-24-98	90.98	-
							07-21-98	91.60	-
352037107465701	13N.09W.22.112	352037	1074657	6830.00	297	221WSRC	05-18-90	81.42	-
352135108014801	13N.11W.17.123	352135	1080148	6802.00	790	313SADR	08-08-90	218.50	-
							07-20-95	205.44	-
352330108093401	13N.13W.01.2223	352330	1080934	7005.00	--	313SADG	07-31-90	9.40	-
							07-20-95	13.49	-
							02-24-97	23.04	-
352037108123701	13N.13W.22.1333	352037	1081237	7420.00	300	313SADG	08-13-90	-5.54	E
							07-24-95	-3.46	-
352433107462101	14N.09W.28.441	352433	1074621	6982.00	3275	313SADG	07-30-90	0	Z
							07-24-95	530.20	-
352532107524901	14N.10W.22.414	352532	1075249	7030.00	3081	313SADR	08-08-90	560.00	-
							07-24-95	557.80	-
							02-24-97	559.35	-
352418107513401	14N.10W.35.221	352418	1075134	7010.00	760	221MRSN	05-18-90	525.79	-
							02-25-92	528.14	-
							02-24-97	528.66	-
353103108132301	15N.13W.21.14	353103	1081323	7610.00	1305	220ENRD	02-26-92	643.65	-
353016108100401	15N.13W.25.1423	353016	1081004	7485.00	3102	313SADG	05-21-90	634.00	-
							08-08-90	637.40	-
							07-31-95	645.00	-
353700107563901	16N.10W.18.133B	353700	1075639	6923.97	1888	211DKOT	05-18-90	385.15	-
							02-25-92	388.94	-
							02-24-97	469.57	-
353659107564101	16N.10W.18.133D	353659	1075641	6924.00	2094	221WSRC	05-18-90	455.78	-
							02-25-92	462.36	-
353645108011501	16N.11W.17.4322	353645	1080115	7070.00	570	211GLLP	05-18-90	275.72	-
							02-27-92	289.34	-
							03-18-93	289.78	P
							08-02-93	291.56	P
							03-10-94	291.65	P
							07-11-94	283.36	-
							02-02-95	260.84	-
							07-26-95	261.17	-
							02-23-96	254.76	-
							07-31-96	255.73	-
							02-24-97	252.31	-
							08-12-97	252.55	-
							07-21-98	252.18	-

1½ miles west of mill.
into westwater.

not in use - possible
use could be stockwater

SITE-ID	LOCAL WELL NUMBER	LATITUDE (DEGREES)	LONGITUDE (DEGREES)	ALTITUDE OF LAND SURFACE (FEET)	DEPTH OF WELL (FEET)	AQUIFER CODE	WATER-LEVEL DATE	WATER LEVEL (FEET)	WATER-LEVEL STATUS
354013108024201	17N.11W.30.431	354013	1080242	6765.00	478	211CRVC	05-21-90	38.66	R

14N 9W 18 800' TD Westwater well.
'Berryhill Ranch well'

data Available
dated 1962

62 wells

APPENDIX F

Statistical Analysis of Groundwater Monitoring Results

Dakota Bedrock Unit, Nickel Concentrations, mg/l

Date	Well 30-48KD	Well 32-45KD	Well 30-02KD	Well 36-06KD	Background Well 17-01KD
5/25/83	0.08	0.08			
5/26/83			0.18		
8/15/83	0.14				
10/1/83					
11/14/83	0.045				
2/3/84					
4/6/84					
4/17/84	0.064				
7/17/84					
7/18/84					
10/17/84					
10/31/84					
11/1/84					
1/1/85					
2/1/85					
2/2/85					
2/21/85					
4/22/85	0.04				
4/25/85					
7/8/85					
11/13/85					
1/14/86					
4/10/86	0.12				
7/1/86					
7/8/86					
7/9/86					
10/7/86					
3/17/87					
4/16/87	0.01				
7/21/87					
8/27/87					
9/10/87					
10/21/87					
1/20/88					
5/5/88	0.1				
7/19/88					
9/15/88	0.13		0.22		0.02
9/21/88		0.03			
9/28/88	0.18	0.032	0.3		0.05
10/6/88	0.14				0.02
10/10/88		0.02	0.27		
10/14/88	0.16	0.04	0.42		0.02
10/21/88					
10/25/88				2.35	
11/15/88	0.18		0.25		0.05
11/21/88		0.04			
1/17/89					0.02
2/17/89	0.01		0.06		
2/20/89		0.02		1.15	0.01
3/21/89					0.01
4/20/89	0.01				0.01

Dakota Bedrock Unit, Nickel Concentrations, mg/l

Date	Well 30-48KD	Well 32-45KD	Well 30-02KD	Well 36-06KD	Background Well 17-01KD
5/16/89				0.96	
5/22/89	0.01	0.01			
5/23/89			0.11	0.9	0.01
6/13/89					0.01
7/26/89					0.01
8/30/89					0.01
9/6/89	0.04	0.01			
9/11/89			0.09	0.73	0.01
3/2/90				0.52	
4/2/90		0.02	0.05		
4/5/90	0.01				0.01
8/7/90		0.02			
8/14/90	0.02				
8/17/90			0.04		0.01
8/23/90				0.45	
2/8/91		0.01	0.02		0.01
2/12/91				0.48	
2/18/91	0.01				
8/21/91	0.01				0.01
8/22/91		0.01	0.04	0.51	
2/11/92		0.01	0.04		
2/12/92	0.01			0.47	0.01
8/20/92				0.31	0.01
8/25/92		0.01	0.03		
8/26/92	0.01				
3/3/93		0.01	0.03		0.01
3/5/93	0.01				
3/6/93				0.23	
8/18/93	0.02	0.01	0.04		0.01
8/19/93					
8/24/93				0.19	
4/5/94	0.01				0.01
4/6/94			0.01		
4/26/94		0.01			
5/26/94				0.13	
9/8/94				0.1	
9/16/94		0.01	0.03		0.02
9/19/94	0.01				
3/16/95	0.04		0.04		0.04
3/20/95		0.04		0.05	
3/21/95	0.04				
10/9/95			0.02	0.07	
10/10/95		0.02			0.01
2/22/96				0.06	
2/23/96		0.04			
2/27/96			0.04		
2/28/96	0.04				
8/22/96		0.05		0.04	
8/23/96			0.04		
8/27/96	0.005				0.02
4/7/97				0.05	
4/8/97	0.01	0.02	0.05		0.01

Dakota Bedrock Unit, Nickel Concentrations, mg/l

Date	Well 30-48KD	Well 32-45KD	Well 30-02KD	Well 36-06KD	Background Well 17-01KD
11/4/97	0.04	0.04			0.04
12/8/97	0.02		0.02	0.05	
5/3/98	0.05	0.02	0.01	0.06	0.02
12/14/98	0.01	0.01	0.06	0.05	0.03
2/16/99	0.02	0.01	0.051	0.065	0.03
7/31/99					

	Column1			*Column1*	*Column1*	
Mean	0.02	0.02	0.03	0.07	0.02	Mean
Standard Error	0.00	0.00	0.01	0.01	0.00	Standard Error
Median	0.02	0.02	0.04	0.06	0.02	Median
Mode	0.01	0.01	0.04	0.05	0.01	Mode
Standard Deviation	0.02	0.02	0.02	0.03	0.01	Standard Deviation
Sample Variance	0.00	0.00	0.00	0.00	0.00	Sample Variance
Kurtosis	-1.79	-1.43	-1.21	2.84	-1.23	Kurtosis
Skewness	0.28	0.53	-0.09	1.76	0.34	Skewness
Range	0.05	0.04	0.05	0.09	0.03	Range
Minimum	0.01	0.01	0.01	0.04	0.01	Minimum
Maximum	0.05	0.05	0.06	0.13	0.04	Maximum
Sum	0.30	0.27	0.37	0.73	0.23	Sum
Count	12.00	11.00	11.00	11.00	10.00	Count
Confidence Level(95.0%)	0.01	0.01	0.01	0.02	0.01	Confidence Level(95.0%)

mean + 2 sd	0.06	0.05	0.07	0.12	0.05

Dakota Bedrock Unit, Pb-210 Concentrations, pCi/l

Date	Well 30-48KD	Well 32-45KD	Well 30-02KD	Well 36-06KD	Background Well 17-01KD
4/5/94	13				30
4/6/94			0.8		
4/26/94		6.9			
5/26/94				12	
9/8/94				66	
9/16/94		8.4	2.5		11
9/19/94	4.3				
3/16/95	11		3		9
3/20/95		8		18	
3/21/95	11				
10/9/95			1.8	38	
10/10/95		2			11
2/22/96				6	
2/23/96		2.5			
2/27/96			1.2		
2/28/96	4.4				
8/22/96		19		2.3	
8/23/96			1.4		
8/27/96	3.4				2.3
4/7/97				6.1	
4/8/97	5	2	2.3		3.4
11/4/97	5.5	2.7			5.8
12/8/97	3.1		3.1	14	
5/3/98	14.8	0.3	0.6	25.6	0.1
12/14/98	7.9	12	8	0.42	3.4
2/16/99	16	0.69	5.4	21	26
7/31/99					

Column1					
Mean	8.28	5.86	2.74	19.04	10.20
Standard Error	1.35	1.74	0.66	5.76	3.20
Median	6.70	2.70	2.30	14.00	7.40
Mode	11.00	2.00			11.00
Standard Deviation	4.66	5.75	2.20	19.11	10.11
Sample Variance	21.76	33.12	4.86	365.21	102.30
Kurtosis	-1.40	1.45	2.53	3.05	0.56
Skewness	0.48	1.30	1.61	1.66	1.27
Range	12.90	18.70	7.40	65.58	29.90
Minimum	3.10	0.30	0.60	0.42	0.10
Maximum	16.00	19.00	8.00	66.00	30.00
Sum	99.40	64.49	30.10	209.42	102.00
Count	12.00	11.00	11.00	11.00	10.00
Confidence Level(95.0%)	2.96	3.87	1.48	12.84	7.24

mean + 2 sd	17.61	17.37	7.14	57.26	30.43

Dakota Bedrock Unit, Ra 226 + 228 Concentrations, pCi/l

	Well 30-48			Well 32-45			Well 30-02			Well 36-06			Background Well 17-		
Date	Ra-226	Ra-228	Total	Ra-226	Ra-228	Total	Ra-226	Ra-228	Total	Ra-226	Ra-228	Total	Ra-226	Ra-228	Total
25-May-83	1.34	-1.9	-0.56	0.71	-2	-1.29									
26-May-83							2.86	-1.1	1.76						
15-Aug-83	1.71	-3.30	-1.59												
14-Nov-83	0.19	-2.00	-1.81												
17-Apr-84	0.85		0.85												
22-Apr-85	0.40		0.40												
10-Apr-86	2.50		2.50												
16-Apr-87	0.70		0.70												
05-May-88	0.60		0.60												
15-Sep-88	1.40	3.50	4.90				0.40	0.90	1.30				0.50	0.30	0.80
21-Sep-88				3.40	0.40	3.80									
28-Sep-88	1.90	4.20	6.10	2.80	1.40	4.20	4.30	0.90	5.20				3.00	1.40	4.40
06-Oct-88	1.10	4.60	5.70										0.50	0.60	1.10
10-Oct-88				3.10	0.80	3.90	1.90	0.20	2.10						
14-Oct-88	1.20	4.50	5.70	1.80	2.40	4.20	5.10		5.10				0.30	0.60	0.90
21-Oct-88	0.60		0.60												
25-Oct-88										85.00	27.00	112.00			
15-Nov-88	1.30	5.30	6.60				0.80	1.80	2.60				0.70	0.60	1.30
21-Nov-88				3.20	0.80	4.00									
19-Jan-89													3.10	0.50	3.60
17-Feb-89	2.10	4.40	6.50				1.50	0.80	2.30						
20-Feb-89				89.00	37.00	126.00				74.00	22.00	96.00	1.10	0.60	1.70
21-Mar-89													0.80	0.20	1.00
20-Apr-89	2.00		2.00										1.00		
22-May-89	1.80	4.30	6.10	2.20	0.80	3.00									
23-May-89							4.80	0.10	4.90	66.00	11.00	77.00	2.10	0.20	2.30
13-Jun-89													0.50	0.10	0.60
31-Jul-89													0.50	0.00	0.50
30-Aug-89													0.20	0.00	0.20
06-Sep-89	1.20	3.70	4.90	0.50	1.40	1.90									
11-Sep-89							0.20	0.50	0.70	21.00	12.00	33.00	0.30	1.70	2.00
02-Mar-90										28.00	7.90	35.90			
02-Apr-90				6.10	8.80	14.90	1.60	1.50	3.10						
05-Apr-90	0.90	4.20	5.10										1.00	1.10	2.10
07-Aug-90				0.40	2.00	2.40									
14-Aug-90	1.00	4.40	5.40												
17-Aug-90							0.60	0.50	1.10				0.30	1.10	1.40

Dakota Bedrock Unit, Ra 226 + 228 Concentrations, pCi/l

	Well 30-48			Well 32-45			Well 30-02			Well 36-06			Background Well 17-		
23-Aug-90										27.00	13.00	40.00			
08-Feb-91				0.70	2.80	3.50	1.30	0.06	1.36				0.80	2.10	2.90
12-Feb-91										25.00	13.00	38.00			
18-Feb-91	3.70	5.50	9.20												
21-Aug-91	1.80	2.10	3.90										0.30	0.00	0.30
22-Aug-91				3.50	1.50	5.00	0.90	0.07	0.97	16.00	8.00	24.00			
11-Feb-92				2.00	1.80	3.80	1.80	0.30	2.10						
12-Feb-92	3.40	4.20	7.60							17.00	5.80	22.80	1.30	1.00	2.30
20-Aug-92										22.00	7.60	29.60	0.30	0.10	0.40
25-Aug-92				2.90	0.60	3.50	2.70	0.20	2.90						
26-Aug-92	2.70	3.10	5.80												
03-Mar-93				3.10	1.10	4.20	0.50	0.20	0.70				1.10	1.00	2.10
05-Mar-93	2.50	3.70	6.20												
06-Mar-93										26.00	9.60	35.60			
18-Aug-93	2.60	6.10	8.70				0.10	1.00	1.10				0.60	0.70	1.30
19-Aug-93				1.80	1.40	3.20									
24-Aug-93										14.00	9.20	23.20			
05-Apr-94	3.20	3.80	7.00										1.70	0.60	2.30
06-Apr-94							0.80	1.00	1.80						
26-Apr-94				2.10	1.40	3.50									
26-May-94										12.00	6.50	18.50			
08-Sep-94										14.00	6.50	20.50			
16-Sep-94				2.20	1.10	3.30	0.90	1.30	2.20				0.90	0.80	1.70
19-Sep-94	4.10	5.20	9.30												
05-Mar-95				0.50	1.80	2.30									
16-Mar-95	13.00	4.40	17.40				1.20	0.50	1.70				1.20	1.10	2.30
20-Mar-95										8.90	8.00	16.90			
21-Mar-95	13.00	4.40	17.40												
09-Oct-95							0.90	1.00	1.90	13.00	6.30	19.30			
10-Oct-95				1.20	2.60	3.80							1.80	0.60	2.40
22-Feb-96										7.90	6.70	14.60			
23-Feb-96				1.50	1.30	2.80									
28-Feb-96	4.50	11.00	15.50												
27-Feb-96							1.40	5.10	6.50						
22-Aug-96				3.30	0.60	3.90				9.10	5.80	14.90			
23-Aug-96							1.00		1.00						
27-Aug-96	2.10	4.80	6.90										0.40	0.80	1.20
07-Apr-97										10.00	3.20	13.20			
08-Apr-97	4.40	4.20	8.60	1.80	2.30	4.10	1.40	0.70	2.10				0.90	1.70	2.60

Dakota Bedrock Unit, Ra 226 + 228 Concentrations, pCi/l

	Well 30-48			Well 32-45			Well 30-02			Well 36-06			Background Well 17-		
04-Nov-97	1.90	2.50	4.40	3.80	0.60	4.40							2.30	0.70	3.00
08-Dec-97											5.80	5.80			
03-May-98	8.70	1.70	10.40	4.20	0.30	4.50	2.90	0.04	2.94	26.40	3.80	30.20	0.90	0.10	1.00
14-Dec-98	6.60	2.20	8.80	5.00	4.20	9.20	2.85	1.50	4.35	16.00	14.70	30.70			
31-Dec-98													0.50	3.10	3.60
16-Feb-99	3.23	13.00	16.23										3.20	3.80	7.00
31-Jul-99															

			Column1			*Column1*			*Column1*			*Column1*			
Mean	5.88	5.20	11.08	2.56	1.62	4.18	1.48	1.39	2.72	13.03	6.73	18.46	1.38	1.33	2.71
Standard Error	1.21	1.08	1.41	0.46	0.37	0.60	0.27	0.55	0.57	1.89	0.99	2.38	0.28	0.38	0.54
Median	4.40	4.40	9.30	2.15	1.35	3.85	1.20	1.00	2.10	12.00	6.40	17.70	1.05	0.80	2.35
Mode	13.00	4.40	17.40		0.60		0.90	1.00			6.50		0.90	0.60	2.30
Standard Deviation	4.02	3.57	4.69	1.45	1.17	1.89	0.82	1.57	1.70	5.67	3.13	7.53	0.88	1.20	1.70
Sample Variance	16.15	12.74	21.97	2.10	1.37	3.58	0.67	2.45	2.90	32.20	9.80	56.72	0.77	1.44	2.88
Kurtosis	-0.11	1.62	-1.54	-0.94	1.54	6.74	0.24	6.10	2.53	4.04	5.36	0.29	0.65	0.95	4.96
Skewness	1.09	1.55	0.30	0.38	1.19	2.38	1.34	2.34	1.64	1.86	1.98	0.38	1.03	1.40	1.99
Range	11.10	11.30	13.00	4.50	3.90	6.90	2.10	5.06	5.50	18.50	11.50	24.90	2.80	3.70	6.00
Minimum	1.90	1.70	4.40	0.50	0.30	2.30	0.80	0.04	1.00	7.90	3.20	5.80	0.40	0.10	1.00
Maximum	13.00	13.00	17.40	5.00	4.20	9.20	2.90	5.10	6.50	26.40	14.70	30.70	3.20	3.80	7.00
Sum	64.73	57.20	121.93	25.60	16.20	41.80	13.35	11.14	24.49	117.30	67.30	184.60	13.80	13.30	27.10
Count	11.00	11.00	11.00	10.00	10.00	10.00	9.00	8.00	9.00	9.00	10.00	10.00	10.00	10.00	10.00
Confidence Level(95.0%)	2.70	2.40	3.15	1.04	0.84	1.35	0.63	1.31	1.31	4.36	2.24	5.39	0.63	0.86	1.21
mean + 2 st. dev.	13.92	12.34	20.46	5.46	3.96	7.97	3.12	4.53	6.12	24.38	12.99	33.52	3.13	3.73	6.11

Dakota Bedrock Unit, Th-230 Concentrations, pCi/l

Date	Well 30-48KD	Well 32-45KD	Well 30-02KD	Well 36-06KD	Background Well 17-01 KD
5/5/88	0.7				
7/19/88					
9/15/88	0.7		0.6		1.5
9/21/88		2.9			
9/28/88	2.2	2.8	4.1		2.4
10/6/88	0.7				0.8
10/10/88		1.5	1.5		
10/14/88	4.8	2.4	5.9		2.1
10/21/88					
10/25/88				11200	
11/15/88	4.9		2.2		4.8
11/21/88		3.4			
1/17/89					2.8
2/17/89	1.4		1.5		
2/20/89		74		8500	0.6
3/21/89					0.8
4/20/89	4.1				1.7
5/16/89					
5/22/89	2.1	2.6			
5/23/89			3.7	3900	0.7
6/13/89					1.2
7/26/89					1.2
8/30/89					0.2
9/6/89	0.5	0.7			
9/11/89			0.5	1220	0.9
3/2/90				1620	
4/2/90		13	1.5		
4/5/90	0.8				0.4
8/7/90		1.3			
8/14/90	0.3				
8/17/90			0.4		0
8/23/90				2060	
2/8/91		2.9	0.1		0.4
2/12/91				1740	
2/18/91	0.5				
8/21/91	1.8				1.3
8/22/91		3.8	1.3	450	
2/11/92		3	0.8		
2/12/92	0.7			490	0.3
8/20/92				830	0
8/25/92		4	2.9		
8/26/92	1.5				
3/3/93	3	2.9	1.5		2
3/5/93					
3/6/93				670	
8/18/93	0.4		1.5		1.6
8/19/93		3.8			
8/24/93				3790	
4/5/94	0.4				1.1
4/6/94			3.7		
4/26/94		2.9			

Dakota Bedrock Unit, Th-230 Concentrations, pCi/l

Date	Well 30-48KD	Well 32-45KD	Well 30-02KD	Well 36-06KD	Background Well 17-01 KD
5/26/94				1940	
9/8/94				7.6	
9/16/94		2.3	0.2		0.6
9/19/94	0.4				
3/16/95	0.6		0.3		1
3/20/95		1.7		4.8	
3/21/95	0.6				
10/9/95			0.4	2080	
10/10/95					0.9
2/22/96				96	
2/23/96		0.2			
2/27/96			0.4		
2/28/96	0.4				
8/22/96		11		31	
8/23/96			0.2		
8/27/96	0.3				0.3
4/7/97				16	
4/8/97	0.4	0.4	0.1		0.1
11/4/97	0.6	0.4			0.1
12/8/97				0.3	
5/3/98	8.4	10.8	0.3	1311.5	0.5
12/14/98	7.8	6.6	0.83	0	0.41
2/16/99	1.2				0.88
7/31/99					

Column1						*Column1*	
Mean	1.92	4.03	0.71	548.72	0.59	Mean	463.97
Standard Error	0.93	1.45	0.38	275.07	0.12	Standard Error	292.57
Median	0.60	2.30	0.30	23.50	0.55	Median	16.00
Mode	0.40	0.40	0.20		0.10	Mode	
Standard Deviation	3.07	4.36	1.14	869.84	0.37	Standard Deviation	877.72
Sample Variance	9.42	18.97	1.30	756623.31	0.13	Sample Variance	770391.04
Kurtosis	2.03	-0.77	8.14	-0.48	-1.51	Kurtosis	0.77
Skewness	1.90	0.96	2.82	1.20	-0.02	Skewness	1.62
Range	8.10	10.80	3.60	2080.00	1.00	Range	2080.00
Minimum	0.30	0.20	0.10	0.00	0.10	Minimum	0.00
Maximum	8.40	11.00	3.70	2080.00	1.10	Maximum	2080.00
Sum	21.10	36.30	6.43	5487.20	5.89	Sum	4175.70
Count	11.00	9.00	9.00	10.00	10.00	Count	9.00
Confidence Level (95.0%)	2.06	3.35	0.88	622.25	0.26	Confidence Level(95.0%)	674.68

mean + 2sd	8.06	12.74	2.99	2288.40	1.32		2219.41

Dakota Bedrock Unit, U-nat Concentrations, mg/l

Date	Well 30-48KD	Well 32-45KD	Well 30-02KD	Well 36-06KD	Background Well 17-01KD
5/25/83	0.02	0.006			
5/26/83			0.004		
8/15/83	0.038				
11/14/83	0.008				
4/17/84	0.045				
4/22/85	0.013				
4/10/86	0.0092				
4/16/87	0.0221				
5/5/88	0.0221				
7/19/88	0.0209				
9/15/88	0.0209		0.0052		0.0041
9/21/88		0.0315			
9/28/88	0.0466	0.0223	0.0219		0.0162
10/6/88	0.0385				0.0037
10/10/88		0.0137	0.0079		
10/14/88	0.052	0.0314	0.183		0.0038
10/21/88	0.0162				
10/25/88				7.87	
11/15/88	0.0317		0.0115		0.0531
11/21/88		0.0256			
1/19/89					0.0133
2/17/89	0.0194		0.008		
2/20/89				5.51	0.0062
3/21/89					0.0074
4/20/89	0.0432				0.0064
5/16/89				4.45	
5/22/89	0.0359	0.0012			
5/23/89			0.0485	3.86	0.0053
6/13/89					0.0063
7/31/89					0.0014
8/30/89					0.0013
9/6/89	0.027	0.0032			
9/11/89			0.0047	2.33	0.0029
3/2/90				2.07	
4/2/90		0.042	0.004		
4/5/90	0.016				0.001
8/7/90		0.0041			
8/14/90	0.03				
8/17/90			0.0042		0.0033
8/23/90				2.69	
2/8/91		0.026	0.0036		0.0036
2/12/91				3.55	
2/18/91	0.0435				
8/21/91	0.0321	0.0249			0.0078
8/22/91			0.0053	1.66	
2/11/92		0.0221	0.007		
2/12/92	0.292			1.18	0.0062
8/20/92				1.33	0.0016
8/25/92		0.0238	0.0094		
8/26/92	0.0246				
3/3/93		0.017	0.0044		0.0051
3/5/93	0.0278				
3/6/93				1.48	
8/18/93	0.0485		0.0076		0.011

Dakota Bedrock Unit, U-nat Concentrations, mg/l

Date	Well 30-48KD	Well 32-45KD	Well 30-02KD	Well 36-06KD	Background Well 17-01KD
8/19/93		0.0102			
8/24/93				1.38	
4/5/94	0.0394				0.0076
4/6/94			0.0038		
4/26/94		0.0154			
5/26/94				0.241	
9/8/94				0.215	
9/16/94		0.009	0.0021		0.0045
9/19/94	0.0331				
3/16/95	0.0315		0.0015		0.0056
3/20/95		0.014		0.147	
3/21/95	0.0315				
10/9/95			0.0031	0.252	
10/10/95		0.0047			0.0067
2/22/96				0.17	
2/23/96		0.012			
2/27/96			0.0076		
2/28/96	0.042				
8/22/96		0.013		0.18	
8/23/96			0.0023		
8/27/96	0.027				0.0049
4/7/97				0.23	
4/8/97	0.027	0.0022	0.0005		0.0059
11/4/97	0.02	0.0059			0.011
12/8/97	0.0071		0.0071	0.65	
5/3/98	0.0146	0.0087	0.0022	0.803	0.0047
12/14/98	0.861	0.012	0.019	0.509	0.007
2/16/99	0.484	0.004	0.016	0.545	0.0087
7/31/99					

	Column1					*Column1*	
Mean	0.13	0.01	0.01	0.36	0.01	Mean	0.01
Standard Error	0.08	0.00	0.00	0.07	0.00	Standard Error	0.00
Median	0.03	0.01	0.00	0.24	0.01	Median	0.00
Mode	0.03	0.01				Mode	
Standard Deviation	0.26	0.00	0.01	0.23	0.00	Standard Deviation	0.01
Sample Variance	0.07	0.00	0.00	0.05	0.00	Sample Variance	0.00
Kurtosis	5.53	-1.40	1.10	-0.47	1.00	Kurtosis	1.10
Skewness	2.45	-0.20	1.48	0.97	1.09	Skewness	1.48
Range	0.85	0.01	0.02	0.66	0.01	Range	0.02
Minimum	0.01	0.00	0.00	0.15	0.00	Minimum	0.00
Maximum	0.86	0.02	0.02	0.80	0.01	Maximum	0.02
Sum	1.62	0.10	0.07	3.94	0.07	Sum	0.07
Count	12.00	11.00	11.00	11.00	10.00	Count	11.00
Confidence Level (95.0%)	0.17	0.00	0.00	0.15	0.00	Confidence Level(95.0%)	0.00

mean + 2 sd	0.66	0.02	0.02	0.81	0.01

Tres Hermanos Bedrock Unit A, Pb-210 Concentrations, pCi/l

Date	Well 31-01	Background Well 33-01
21-Sep-88	1.9	1.1
23-Sep-88		8.3
28-Sep-88	2.9	
03-Oct-88		3.1
04-Oct-88		
10-Oct-88	8.4	3.3
13-Oct-88	3.7	
17-Nov-88	19	4.9
21-Nov-88		
20-Jan-89		15
21-Feb-89		
22-Feb-89	2.3	2.5
21-Mar-89		8.6
20-Apr-89		4.6
16-May-89		18
22-May-89	2.1	
13-Jun-89		19
28-Jul-89		9.3
30-Aug-89		1.3
06-Sep-89		
11-Sep-89	1.8	1
27-Feb-90		
09-Mar-90	6.2	5.9
22-Aug-90		1.8
06-Sep-90	2.3	
13-Feb-91	1.4	6
16-May-91		
16-Aug-91		
19-Aug-91	3.1	7.9
13-Feb-92	14	5.3
14-Feb-92		
14-Aug-92	6	13
20-Aug-92		
06-Mar-93	4.9	20
23-Aug-93	3.4	11
26-Apr-94	9	7.2
28-Apr-94		
06-Oct-94	5.8	5.2
09-Mar-95		
13-Mar-95	3	8.1
05-Sep-95		
27-Sep-95	5.2	13
22-Feb-96	2.3	15
22-Aug-96	2.4	22
02-Apr-97		
07-Apr-97	5.4	10.1
02-Dec-97		

Tres Hermanos Bedrock Unit A, Pb-210 Concentrations, pCi/l

Date	Well 31-01	Background Well 33-01
04-Dec-97	3.4	7.2
26-Apr-98	2.1	4.1
18-Dec-98	3.8	8.1
09-Feb-99	3.8	9.6
31-Jul-99		

Column1		
Mean	4.20	9.96
Standard Error	0.62	1.53
Median	3.80	8.10
Mode	3.80	7.20
Standard Deviation	2.04	5.09
Sample Variance	4.17	25.89
Kurtosis	2.01	2.28
Skewness	1.34	1.42
Range	6.90	17.90
Minimum	2.10	4.10
Maximum	9.00	22.00
Sum	46.20	109.60
Count	11.00	11.00
Confidence Level(95.0%)	1.37	3.42

mean +2SDV	8.28	20.14

Tres Hermanos Bedrock Unit A, Ra 226 + 228 Concentrations, pCi/l

Date	Ra-226	Ra-228	Well 31-01	Ra-226	Ra-228	Background Well 33-01
16-Aug-83	9.7	-1.8	7.9			
14-Nov-83	0.004	-4.8	-4.8			
17-Apr-84	0.7		0.7			
22-Apr-85	0.7		0.7			
10-Apr-86	1.7		1.7	0.7		0.7
15-Apr-87	0.4		0.4	0.4		0.4
16-Apr-87						
18-Feb-88						
25-May-88	0.6		0.6	0.4		0.4
13-Sep-88				1.4	2.4	3.8
21-Sep-88	1.2	1.2	2.4			
23-Sep-88				1.7	2.2	3.9
28-Sep-88	1.0	2.0	3.0			
03-Oct-88				1.9	1.7	3.6
04-Oct-88						
10-Oct-88	1.8	3.0	4.8	0.8	2.8	3.6
13-Oct-88	3.7	0.5	4.2			
21-Oct-88	0.2		0.2	1.1		1.1
17-Nov-88	1.2	0.4	1.6	1.1	1.9	3.0
21-Nov-88						
20-Jan-89				2.1	3.1	5.2
21-Feb-89						
22-Feb-89	0.6	2.1	2.7	1.5	2.7	4.2
21-Mar-89				1.9	1.3	3.2
20-Apr-89	2.0		2.0	2.7	1.8	4.5
16-May-89				4.2	2.2	6.4
22-May-89	1.4	1.8	3.2			
13-Jun-89				1.2	1.9	3.1
28-Jul-89				5.1	3.4	8.5
30-Aug-89				1.3	2.2	3.5
06-Sep-89						
11-Sep-89	0.5	1.8	2.3	0.9	1.3	2.2
27-Feb-90						
09-Mar-90	2.3	3.9	6.2	0.7	2.7	3.4
22-Aug-90				0.6	1.4	2.0
06-Sep-90	0.5	6.0	6.5			
13-Feb-91	1.1	0.4	1.5	0.6	2.1	2.7
16-May-91						
16-Aug-91						
19-Aug-91	1.0	1.4	2.4	0.4	2.3	2.7
13-Feb-92	6.1	3.3	9.4	1.7	2.6	4.3
14-Feb-92						
14-Aug-92	5.5	1.4	6.9	9.0	2.2	11.2
20-Aug-92						
06-Mar-93	4.9	1.0	5.9	6.3		6.3
23-Aug-93	1.2	3.0	4.2	3.3	1.5	4.8
26-Apr-94	3.1	1.7	4.8	3.1	1.9	5.0
28-Apr-94						
06-Oct-94	4.3	4.4	8.7	6.9	2.2	9.1
09-Mar-95						

Tres Hermanos Bedrock Unit A, Ra 226 + 228 Concentrations, pCi/l

Date	Ra-226	Ra-228	Well 31-01	Ra-226	Ra-228	Background Well 33-01
13-Mar-95	0.7	4.5	5.2	2.7	2.1	4.8
05-Sep-95						
27-Sep-95	3.6	3.3	6.9	5.3	2.3	7.6
22-Feb-96	2.2	2.8	5.0	1.3	3.7	5.0
22-Aug-96	2.2	7.1	9.3	6.6	1.4	8.0
02-Apr-97						
07-Apr-97	1.4	1.9	3.3	3.1	1.0	4.1
02-Dec-97						
04-Dec-97	5.0	6.2	11.2	1.5	2.7	4.2
26-Apr-98	6.0	3.6	9.6	1.5	0.6	2.1
18-Dec-98	8.0	8.8	16.8	2.97	2.0	5.0
09-Feb-99	1.1	4.3	5.4	3.37	1.7	5.1
31-Jul-99						

Column1						
Mean			7.84			5.45
Standard Error			1.16			0.60
Median			6.90			5.00
Mode						5.00
Standard Deviation			3.86			2.01
Sample Variance			14.91			4.03
Kurtosis			1.81			0.06
Skewness			1.25			0.49
Range			13.50			7.00
Minimum			3.30			2.10
Maximum			16.80			9.10
Sum			86.24			59.94
Count			11.00			11.00
Confidence Level (95.0%)			2.59			1.35
mean+2SDV			15.56			9.46

Tres Hermanos Unit A, Th-230 Concentrations, pCi/l

Date	Well 31-01	Background Well 33-01
05-May-88		0.3
31-Jul-88		
21-Sep-88	0.3	1
23-Sep-88		2
28-Sep-88	1.2	
03-Oct-88		1.7
04-Oct-88		
10-Oct-88	2.1	14
13-Oct-88	0.6	
21-Oct-88	0.4	0.5
17-Nov-88	8	2.8
21-Nov-88		
20-Jan-89		9.5
21-Feb-89		
22-Feb-89	2.3	2.7
21-Mar-89		0.1
20-Apr-89	4.6	3.9
16-May-89		13
22-May-89	2.4	
13-Jun-89		10
28-Jul-89		5.2
30-Aug-89		1
06-Sep-89		
11-Sep-89	0.5	0.8
27-Feb-90		
09-Mar-90	2.6	3.6
22-Aug-90		0.3
06-Sep-90	0	
13-Feb-91	0.4	0.6
16-May-91		
16-Aug-91		0.3
19-Aug-91	0.3	
13-Feb-92	3.2	0.9
14-Feb-92		
14-Aug-92	1.4	1.2
20-Aug-92		
06-Mar-93	3.1	8.3
23-Aug-93	9.1	1.9
26-Apr-94	1.6	
28-Apr-94		1.5
06-Oct-94	2	2
09-Mar-95		
13-Mar-95	1.6	1.1
05-Sep-95		
27-Sep-95	1.8	2
22-Feb-96	0.8	2.4
22-Aug-96	2.2	5.2
02-Apr-97		

Tres Hermanos Unit A, Th-230 Concentrations, pCi/l

Date	Well 31-01	Background Well 33-01
07-Apr-97	0.1	2.6
02-Dec-97		
04-Dec-97	0.6	1.4
26-Apr-98	1.5	
18-Dec-98	5.1	8.3
09-Feb-99	0.41	2.7
31-Jul-99		

Column1		
Mean	1.61	2.92
Standard Error	0.41	0.70
Median	1.60	2.20
Mode	1.60	2.00
Standard Deviation	1.35	2.21
Sample Variance	1.81	4.88
Kurtosis	4.61	3.80
Skewness	1.81	1.98
Range	5.00	7.20
Minimum	0.10	1.10
Maximum	5.10	8.30
Sum	17.71	29.20
Count	11.00	10.00
Confidence Level (95.0%)	0.90	1.58

mean+2SDV	4.30	7.34

Tres Hermanos Bedrock Unit B, Nickel Concentrations, mg/l

Date	Well 36-01TRB	Well 36-02	Well 31-66	Well 31-67	Background Well 19-VH2 & 19-77
24-May-83	0.075				
01-Oct-83					
03-Feb-84					
06-Apr-84					
17-Apr-84		0.082			
18-Jul-84					
17-Oct-84					
01-Nov-84					
11-Jan-85					
29-Jan-85					
22-Apr-85		0.29			0.07
25-Apr-85					
08-Jul-85					
08-Nov-85					
13-Jan-86					
11-Apr-86		0.15			0.05
08-Jul-86					
09-Jul-86					
07-Oct-86					
15-Jan-87					
15-Apr-87		0.01			
16-Apr-87		0.01			0.01
15-Jul-87	0.01	0.01			
06-Nov-87					
21-Jan-88					
18-Feb-88			0.37		
26-Apr-88					0.04
05-May-88		0.23			
19-Jul-88					
15-Aug-88					
13-Sep-88	0.29				0.05
20-Sep-88		0.31	0.36	0.13	
23-Sep-88	0.45	0.28			
26-Sep-88			0.32		
03-Oct-88		0.28	0.33		
04-Oct-88				0.13	0.06
11-Oct-88		0.33	0.35	0.13	
26-Oct-88					
18-Nov-88		0.31			
21-Nov-88			0.32	0.15	
18-Jan-89					
21-Feb-89		0.01	0.15		
22-Feb-89	0.01			0.01	
20-Apr-89		0.01			0.01
16-May-89	0.02		0.17		
18-May-89		0.01	0.13	0.01	
27-Jul-89					
06-Sep-89				0.04	
11-Sep-89	0.06	0.13	0.23		0.02
27-Feb-90	0.02	0.02	0.17		
24-Apr-90					0.02
05-Jun-90				0.01	
22-Aug-90	0.02	0.04	0.12		
24-Aug-90				0.06	
09-Oct-90					0.01
15-Feb-91		0.04	0.13	0.11	
16-May-91	0.01				0.01
16-Aug-91		0.03	0.13	0.1	
19-Aug-91	0.03				

Tres Hermanos Bedrock Unit B, Nickel Concentrations, mg/l

Date	Well 36-01TRB	Well 36-02	Well 31-66	Well 31-67	Background Well 19-VH2 & 19-77
02-Oct-91					0.03
12-Feb-92					
14-Feb-92	0.01	0.02	0.11	0.13	
01-May-92					0.01
17-Aug-92		0.03	0.08	0.01	
20-Aug-92	0.01				
02-Oct-92					0.01
08-Mar-93	0.01	0.05	0.14	0.01	
27-May-93					0.01
31-Aug-93	0.01	0.1	0.2	0.1	
15-Oct-93					0.01
27-Apr-94				0.01	
28-Apr-94	0.01	0.02	0.13		
03-Jun-94					0.01
04-Oct-94		0.1		0.01	
09-Nov-94					0.02
09-Mar-95				0.01	
13-Mar-95		0.4			
28-Jun-95					0.02
24-Aug-95				0.01	
05-Sep-95			0.2		
24-Oct-95					0.03
20-Feb-96		0.08	0.2	0.01	
14-May-96					0.03
20-Aug-96	0.04	0.08	0.4	0.01	
15-Oct-96					0.02
02-Apr-97				0.02	
03-Apr-97	0.04	0.08	0.2		
21-May-97					0.01
02-Dec-97		0.08		0.01	
03-Dec-97			0.2		
28-Dec-97					0.04
26-Apr-98		0.1	0.2	0.05	
08-Jun-98					0.01
08-Dec-98	0.02	0.1	0.02	0.05	
18-Dec-98					0.02
09-Feb-99		0.1	0.2	0.05	0.02
24-May-99			0.167		
26-Jul-99			0.18		
01-Sep-99					

Column1					
Mean	0.03	0.11	0.19	0.02	0.02
Standard Error	0.01	0.03	0.03	0.01	0.00
Median	0.03	0.09	0.20	0.01	0.02
Mode	0.04	0.10	0.20	0.01	0.02
Standard Deviation	0.02	0.10	0.09	0.02	0.01
Sample Variance	0.00	0.01	0.01	0.00	0.00
Kurtosis	-3.90	8.64	4.26	-0.88	-0.16
Skewness	-0.37	2.82	0.71	1.10	0.61
Range	0.03	0.38	0.38	0.04	0.03
Minimum	0.01	0.02	0.02	0.01	0.01
Maximum	0.04	0.40	0.40	0.05	0.04
Sum	0.11	1.14	2.10	0.24	0.21
Count	4.00	10.00	11.00	11.00	10.00
Confidence Level(95.0%)	0.02	0.07	0.06	0.01	0.01

mean +2sd	0.06	0.32	0.37	0.06	0.04

Tres Hermanos Bedrock Unit B, Pb-210 Concentrations, pCi/l

Date	Well 36-01TRB	Well 36-02	Well 31-66	Well 31-67	Background Well 19-VH2 & 19-77
13-Sep-88	12				1.7
20-Sep-88		5.5	7.7	14	
23-Sep-88	45	3.9			
26-Sep-88			5	7	
03-Oct-88		3.1	4.5		
04-Oct-88				7.1	0.2
11-Oct-88		4.5	5.6	4.5	
26-Oct-88					
18-Nov-88		99		27	
21-Nov-88			9.5		
21-Feb-89		7.3	7.7		
22-Feb-89	3.2			16	
20-Apr-89					
16-May-89					
18-May-89	9.9	4.7	6.5	14	
06-Sep-89				22	
11-Sep-89	14	3.5	3.8		2.4
27-Feb-90	121	19	6.3		
24-Apr-90					10
05-Jun-90				12	
22-Aug-90	4.8	9.1	4.7		
24-Aug-90				2.5	
09-Oct-90					26
15-Feb-91		4.8	5	2.1	
16-May-91	14				9.7
16-Aug-91			6.1	18	
19-Aug-91	22	2.8			
02-Oct-91					7.9
12-Feb-92					
14-Feb-92	2.8	6.6	11	15	
01-May-92					3.8
17-Aug-92		2.9	6.5	7	
20-Aug-92	2.7				
02-Oct-92					3.6
08-Mar-93	3.7	5.1	6.3	8.4	
31-Aug-93	3.8	4.1	8.4	12	
27-Apr-94				6.4	
28-Apr-94	6.6	1.9	4.4		
03-Jun-94					0.7
05-Sep-95			9.5		
04-Oct-94		4.2		6	
09-Nov-94					4.9
09-Mar-95				8.1	
13-Mar-95		1.3			
28-Jun-95					3.4
24-Aug-95				8	
24-Oct-95					0.6
20-Feb-96		5.2	12	5.2	
14-May-96					4.6
20-Aug-96	7.9	2.8	4.3	5.8	

Tres Hermanos Bedrock Unit B, Pb-210 Concentrations, pCi/l

Date	Well 36-01TRB	Well 36-02	Well 31-66	Well 31-67	Background Well 19-VH2 & 19-77
15-Oct-96					2.1
02-Apr-97				6.8	
03-Apr-97	6	4.8	7.7		
21-May-97					7.5
02-Dec-97		2		2.5	
03-Dec-97			6.2		
28-Dec-97					23
26-Apr-98		5.6	7.8	6.5	
08-Jun-98					4.3
08-Dec-98	9.9	-3.1	4.8	-1.1	
18-Dec-98					12
09-Feb-99		6	4.7	1.8	9.6
31-Jul-99					

Column 1					
Mean	7.60	3.07	6.82	5.09	6.61
Standard Error	0.86	0.87	0.89	0.86	1.96
Median	7.25	3.50	6.20	6.00	4.60
Mode					
Standard Deviation	1.73	2.74	2.67	2.85	6.49
Sample Variance	2.98	7.51	7.11	8.13	42.14
Kurtosis	-0.16	1.89	0.11	0.82	3.70
Skewness	0.92	-1.25	0.94	-1.20	1.79
Range	3.90	9.10	7.70	9.20	22.40
Minimum	6.00	-3.10	4.30	-1.10	0.60
Maximum	9.90	6.00	12.00	8.10	23.00
Sum	30.40	30.70	61.40	56.00	72.70
Count	4.00	10.00	9.00	11.00	11.00
Confidence Level(95.0%)	2.75	1.96	2.05	1.92	4.36

meaqn +2sd	11.05	8.55	12.16	10.80	19.59

Tres Hermanos Bedrock Unit B, Ra 226 + 228 Concentrations, pCi/l

	Well 36-01			Well 36-02			Well 31-66			Well 31-67			Background Well 19-VH2 & 19-77		
Date	Ra-226	Ra-228	Total	Ra-226	Ra-228	Total	Ra-226	Ra-228	Total	Ra-226	Ra-228	Total	Ra-226	Ra-228	Total
16-Aug-83	0.77	-1.10	-0.33												
14-Nov-83															
17-Apr-84				0.43		0.43									
22-Apr-85				1.20		1.20							1.10		
11-Apr-86				0.80		0.80							2.50		
15-Apr-87				0.40		0.40									
16-Apr-87				0.30		0.30							1.00		
18-Feb-88							1.30		1.30						
26-Apr-88													0.40		
05-May-88				0.60		0.60									
13-Sep-88	1.70	0.90	2.60										4.90	1.00	5.90
20-Sep-88				0.10	2.20	2.30	1.10	4.90	6.00	2.00	11.00	13.00			
23-Sep-88	5.50	0.08	5.58	0.60	0.70	1.30									
26-Sep-88							1.00	4.50	5.50	1.00	9.80	10.80			
03-Oct-88				2.00	1.20	3.20	0.70	5.20	5.90						
04-Oct-88										0.90	8.80	9.70	0.90	5.40	
11-Oct-88				0.30	1.70	2.00	0.30	4.50	4.80	0.70	8.40	9.10			
13-Oct-88															
26-Oct-88				0.10		0.10									
18-Nov-88				1.40		1.40									
21-Nov-88							1.20	5.40	6.60	3.30	9.90	13.20			
21-Feb-89				1.00	1.80	2.80	1.90	0.90	2.80						
22-Feb-89	0.80	0.60	1.40							2.00	8.40	10.40			
20-Apr-89				3.70		3.70							0.90		
16-May-89															
18-May-89	0.80	0.05	0.85	0.70	1.00	1.70	0.80	5.70	6.50	1.30	10.00	11.30			
22-May-89															
06-Sep-89										3.80	14.00	17.80			
11-Sep-89	1.30	1.50	2.80	0.80		0.80	0.70	7.10	7.80				0.30	4.80	5.10
27-Feb-90	21.00	4.80	25.80	4.30	2.10	6.40	7.00	11.00	18.00						
24-Apr-90													1.10	5.40	6.50
05-Jun-90										1.00	7.30	8.30			
22-Aug-90	0.50	0.07	0.57	0.60	1.70	2.30	0.50	7.70	8.20						
24-Aug-90										0.60	7.30	7.90			
06-Sep-90															
09-Oct-90													0.90	4.50	5.40
15-Feb-91				1.30	1.90	3.20	1.40	8.10	9.50	1.20	7.40	8.60			
16-May-91	1.10		1.10										0.60	3.40	4.00

Tres Hermanos Bedrock Unit B, Ra 226 + 228 Concentrations, pCi/l

	Well 36-01			Well 36-02			Well 31-66			Well 31-67			Background Well 19-VH2 & 19-77		
16-Aug-91	0.80	3.60	4.40				1.20	6.60	7.80	0.90	8.30	9.20			
19-Aug-91				0.80	1.70	2.50									
02-Oct-91													0.80	6.00	6.80
13-Feb-92															
14-Feb-92	4.60		4.60	5.80	0.60	6.40	2.40	6.00	8.40	4.50	8.20	12.70			
01-May-92													1.90	3.90	5.80
17-Aug-92				1.20		1.20	0.50	6.70	7.20	1.30	6.50	7.80			
20-Aug-92	0.70	0.70	1.40												
02-Oct-92													1.30	6.30	7.60
08-Mar-93	5.80	1.20	7.00	3.60	0.20	3.80	2.20	7.40	9.60	1.40	4.80	6.20			
27-May-93													1.80	6.10	7.90
31-Aug-93	1.10	1.10	2.20	1.40	1.50	2.90	3.10	10.00	13.10	4.20	8.00	12.20			
15-Oct-93													2.70	5.20	7.90
27-Apr-94										2.80	6.20	9.00			
28-Apr-94	2.70	1.20	3.90	1.30	1.40	2.70	4.00	8.60	12.60						
03-Jun-94													1.10	4.40	5.50
04-Oct-94				0.90	1.50	2.40				4.00	7.70	11.70			
09-Nov-94													1.20	4.80	6.00
09-Mar-95										3.70	8.50	12.20			
13-Mar-95				1.40	3.50	4.90									
28-Jun-95													1.50	4.80	6.30
24-Aug-95										3.10	6.80	9.90			
05-Sep-95							4.50	11.00	15.50						
27-Sep-95															
24-Oct-95													1.10	4.90	6.00
20-Feb-96				2.60	1.80	4.40	3.20	9.10	12.30	1.50	6.70	8.20			
14-May-96													2.10	3.90	6.00
20-Aug-96	1.30		1.30	1.50	1.80	3.30	4.50	9.50	14.00	6.90	6.40	13.30			
15-Oct-96													1.60	2.80	4.40
02-Apr-97										1.80	7.30	9.10			
03-Apr-97	2.00	0.70	2.70	1.20	1.40	2.60	3.20	8.40	11.60						
07-Apr-97															
21-May-97													1.70	1.20	2.90
02-Dec-97				1.40	0.40	1.80				2.70	3.30	6.00			
03-Dec-97							6.60	9.80	16.40						
28-Dec-97													6.10	4.40	10.50
26-Apr-98				2.60	3.30	5.90	6.00	1.80	7.80	3.90	3.30	7.20			
08-Jun-98													5.50	2.60	8.10

Tres Hermanos Bedrock Unit B, Ra 226 + 228 Concentrations, pCi/l

	Well 36-01			Well 36-02			Well 31-66			Well 31-67			Background Well 19-VH2 & 19-77		
08-Dec-98	1.30	0.00	1.30	1.65	2.92	4.57	13.10	16.10	29.20	4.34	7.27	11.61			
18-Dec-98													4.50	3.10	7.60
09-Feb-99				0.74	4.20	4.94	5.54	16.00	21.54	2.21	4.30	6.51	2.69	3.20	5.89
31-Jul-99															
	21.00	4.80	25.80	5.80	4.20	6.80	13.10	16.10	29.20	6.90	14.00	17.80	6.10	6.30	

Column1				*Column1*			*Column1*			*Column1*			*Column1*			*Column1*
Mean	1.83	0.63	2.30	1.53	2.22	3.75	5.63	7.68	15.66	3.36	6.16	9.52	2.64	3.69	6.29	Mean
Standard Error	0.34	0.35	0.63	0.20	0.38	0.43	1.01	0.71652	2.11	0.45	0.53	0.74	0.61	0.39	0.59	Standard Error
Median	1.65	0.70	2.00	1.40	1.80	3.85	4.50	7.4	14.00	3.10	6.70	9.10	1.65	4.15	6.00	Median
Mode	1.30		1.30	1.40	1.40		4.50	4.5			3.30		1.10	4.40	6.00	Mode
Standard Deviation	0.67	0.60	1.25	0.63	1.19	1.36	3.04	3.5826	6.33	1.49	1.76	2.44	1.94	1.23	1.97	Standard Deviation
Sample Variance	0.45	0.36	1.57	0.39	1.42	1.86	9.24	12.835	40.02	2.23	3.10	5.98	3.78	1.50	3.88	Sample Variance
Kurtosis	-1.29	#DIV/0!	-1.95	0.21	-0.87	-1.39	5.47	1.06532	1.97	2.38	-0.63	-1.27	-0.64	0.15	1.59	Kurtosis
Skewness	0.85	-0.49	0.73	0.95	0.31	0.07	2.19	0.62584	1.31	1.23	-0.75	0.06	1.09	-0.94	0.58	Skewness
Range	1.40	1.20	2.60	1.86	3.80	4.10	9.90	15.2	21.40	5.40	5.20	7.30	5.00	3.70	7.60	Range
Minimum	1.30	0.00	1.30	0.74	0.40	1.80	3.20	0.9	7.80	1.50	3.30	6.00	1.10	1.20	2.90	Minimum
Maximum	2.70	1.20	3.90	2.60	4.20	5.90	13.10	16.1	29.20	6.90	8.50	13.30	6.10	4.90	10.50	Maximum
Sum	7.30	1.90	9.20	15.29	22.22	37.51	50.64	192	140.94	36.95	67.77	104.72	26.40	36.90	69.19	Sum
Count	4.00	3.00	4.00	10.00	10.00	10.00	9.00	25	9.00	11.00	11.00	11.00	10.00	10.00	11.00	Count
Confidence Level(95.0%)	1.07	1.50	2.00	0.45	0.85	0.97	2.34	1.47882	4.86	1.00	1.18	1.64	1.39	0.88	1.32	Confidence Level(95.0%)

mean +2sd	3.17	1.84	4.81	2.78	4.60	6.48	11.71	14.85	28.31	6.35	9.68	14.41	6.53	6.14	10.23

Tres Hermanos Bedrock Unit B, Th-230 Concentrations, pCi/l

Date	Well 36-01TRB	Well 36-02	Well 31-66	Well 31-67	Background Well 19-VH2 & 19-77
13-Mar-95		1.7			
28-Jun-95					0.1
24-Aug-95				2.5	
05-Sep-95					
24-Oct-95					0.1
20-Feb-96		3.5	3.6	1.3	
14-May-96					0.4
20-Aug-96	8.9	0.3	5.6	7.7	
15-Oct-96					0.05
02-Apr-97				10	
03-Apr-97	0	1.5	3.1		
21-May-97					1.2
02-Dec-97		1.3		2.8	
03-Dec-97			6.1		
28-Dec-97					2.2
26-Apr-98		19.5	3.7	6.8	
08-Jun-98					4.1
08-Dec-98	7.7	1.2	4	6.2	
18-Dec-98					5.5
09-Feb-99		0	8.8	1.8	0.82
31-Jul-99					
	66	25	8.8	45	

Column1					
Mean	5.53	3.26	4.88	4.68	1.49
Standard Error	1.97	1.83	0.67	1.02	0.60
Median	6.60	1.40	4.05	2.80	0.70
Mode					0.10
Standard Deviation	3.94	5.79	1.89	3.39	1.90
Sample Variance	15.55	33.56	3.57	11.51	3.61
Kurtosis	1.44	9.19	1.99	-1.59	1.06
Skewness	-1.30	2.99	1.48	0.47	1.44
Range	8.90	19.50	5.70	8.90	5.45
Minimum	0.00	0.00	3.10	1.10	0.05
Maximum	8.90	19.50	8.80	10.00	5.50
Sum	22.10	32.60	39.00	51.50	14.85
Count	4.00	10.00	8.00	11.00	10.00
Confidence Level(95.0%)	6.27	4.14	1.58	2.28	1.36

mean+2SD	13.41	14.846	8.65	11.47	5.29

Tres Hermanos Bedrock Unit B, U-nat Concentrations, mg/l

Date	Well 36-01TRB	Well 36-02	Well 31-66	Well 31-67	Background Well 19-VH2 & 19-77
24-May-83	0.08				
17-Apr-84		0.12			
22-Apr-85		0.0004			0.0167
11-Apr-86		0.0006			0.0145
15-Apr-87		0.0097			
16-Apr-87		0.0128			0.0265
18-Feb-88			0.265		
26-Apr-88					0.0153
05-May-88		0.0024			
13-Sep-88	0.0044				0.0153
20-Sep-88		0.0037	0.194	0.004	
23-Sep-88	0.0298	0.0049			
26-Sep-88			0.206	0.0045	
03-Oct-88		0.0062	0.202		
04-Oct-88				0.0036	0.0174
11-Oct-88		0.0044	0.26	0.0035	
26-Oct-88		0.2			
18-Nov-88		0.0095			
21-Nov-88			0.367	0.0069	
21-Feb-89		0.00015	0.238		
22-Feb-89	0.0109			0.0044	
20-Apr-89		0.0218			0.0155
16-May-89			0.198		
18-May-89	0.0055	0.0026	0.2	0.0069	
06-Sep-89				0.0065	
11-Sep-89	0.011	0.0069	0.149		0.015
27-Feb-90	0.053	0.091	0.142		
24-Apr-90					0.012
05-Jun-90				0.007	
22-Aug-90	0.011	0.0078	0.035		
24-Aug-90				0.0075	
09-Oct-90					0.0821
15-Feb-91		0.0053	0.0848	0.0045	
16-May-91	0.0146				0.0172
16-Aug-91			0.116	0.0129	
19-Aug-91	0.0275	0.0065			
02-Oct-91					0.0156
12-Feb-92		0.0243			
14-Feb-92	0.0179		0.117	0.0171	
01-May-92					0.203
17-Aug-92		0.0068	0.103	0.0029	
20-Aug-92	0.0093				
02-Oct-92					0.0207
08-Mar-93	0.0159	0.0137	0.121	0.0066	
31-Aug-93	0.0078	0.0097	0.0859		
15-Oct-93					0.0169
27-Apr-94				0.0073	
28-Apr-94	0.0087	0.007	0.0814		
03-Jun-94					0.0155
05-Sep-95			0.146		
04-Oct-94		0.0053		0.0479	

Tres Hermanos Bedrock Unit B, U-nat Concentrations, mg/l

Date	Well 36-01TRB	Well 36-02	Well 31-66	Well 31-67	Background Well 19-VH2 & 19-77
09-Nov-94					0.0192
09-Mar-95				0.0079	
13-Mar-95		0.0057			
28-Jun-95					0.0176
24-Aug-95				0.0032	
24-Oct-95					0.0154
20-Feb-96		0.0088	0.13	0.0088	
14-May-96					0.014
20-Aug-96	0.0027	0.0048	0.11	0.0052	
15-Oct-96					0.019
02-Apr-97				0.0051	
03-Apr-97	0.0017	0.0044	0.13		
21-May-97					0.02
02-Dec-97		0.0066		0.0049	
03-Dec-97			0.12		
28-Dec-97					0.068
26-Apr-98		0.003	0.164	0.0035	
08-Jun-98					0.0568
08-Dec-98	0.0027	0.004	0.179	0.0043	
18-Dec-98					0.04
09-Feb-99		0.006	0.194	0.0043	
31-Jul-99					
	0.08	0.2	0.367	0.0479	

	Column1				
Mean	0.00	0.01	0.14	0.01	0.03
Standard Error	0.00	0.00	0.01	0.00	0.01
Median	0.00	0.01	0.13	0.01	0.02
Mode	0.00		0.13	0.00	
Standard Deviation	0.00	0.00	0.04	0.01	0.02
Sample Variance	0.00	0.00	0.00	0.00	0.00
Kurtosis	3.62	0.44	-0.45	10.43	0.54
Skewness	1.87	0.47	0.04	3.20	1.40
Range	0.01	0.01	0.11	0.04	0.05
Minimum	0.00	0.00	0.08	0.00	0.01
Maximum	0.01	0.01	0.19	0.05	0.07
Sum	0.02	0.06	1.25	0.10	0.29
Count	4.00	10.00	9.00	11.00	10.00
Confidence Level (95.0%)	0.01	0.00	0.03	0.01	0.01

mean+2sd	0.01	0.01	0.21	0.04	0.07

THIS PAGE IS AN OVERSIZED DRAWING OR FIGURE,

THAT CAN BE VIEWED AT THE RECORD TITLED:

1-1 : MAP 1-1 QMC FACLILITY AREA AND UPPER MOST BEDROCK GROUNDWATER MONITORING MAP

WITHIN THIS PACKAGE...OR,

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