



## GE Corporate Environmental Programs

Roy S. Blickwedel  
Remedial Project Manager

640 Freedom Business Center  
King of Prussia, PA 19046  
USA

T 610 992 7935  
F 610 992 7898  
Roy.Blickwedel@corporate.ge.com

12 October 2005

William von Till  
11545 Rockville Pike  
Two White Flint North  
Rockville, Maryland 20852-2738  
Mail Stop T-8A33

Mark Purcell  
Superfund Division (6SF-LP)  
U.S. Environmental Protection Agency  
1445 Ross Avenue, Suite 1200  
Dallas, TX 75202-2733

Subject: United Nuclear Corporation Church Rock Site  
Gallup, New Mexico

Dear Mr. von Till and Mr. Purcell:

Please find enclosed for your information a copy of a document entitled: *In Situ Alkalinity Stabilization Pilot Study* (Pilot Study) dated October 2005 and prepared on behalf of United Nuclear Corporation (UNC) by Blasland, Bouck & Lee, Inc. The Pilot Study presents a procedure to evaluate the use of alkalinity injection to improve the ongoing remediation of Zone 3 groundwater at the UNC Church Rock Site in Gallup, New Mexico (site).

As described in the enclosed document, UNC is currently conducting a bench scale test to evaluate the use of non-tailings-impacted alluvial groundwater from the site to stabilize and/or improve the recovery of tailings-impacted groundwater from Zone 3. In addition, during the last quarter of 2005, UNC will install the injection and recovery wells identified in the Pilot Study document. UNC anticipates implementing the remainder of the Pilot Study during the first quarter of 2006. Results of the Pilot Study will be reported to the U.S. Nuclear Regulatory Commission and U.S. Environmental Protection Agency in 2006.

Please contact me if you have any questions.

Sincerely,

A handwritten signature in black ink, reading "Roy S. Blickwedel". The signature is written in a cursive style with a large, stylized "R" and "B".

Roy S. Blickwedel  
Remedial Project Manager

cc: Larry Bush, UNC  
Margaret Carillo-Sheridan, BBL

Enclosure

# REPORT

## *UNC Church Rock Site In-Situ Alkalinity Stabilization Pilot Study*

**United Nuclear Corporation  
Gallup, New Mexico**

**October 2005**

**BBL<sup>®</sup>**  
BLASLAND, BOUCK & LEE, INC.  
engineers, scientists, economists

# REPORT

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# 1. Introduction

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## 1.1 Problem Statement and Objectives

As discussed in the Record of Decision (ROD), United States Environmental Protection Agency ([USEPA], 1988) groundwater within the Zone 3 aquifer has been impacted by metals and radioactive substances including Radium-226/228 and gross alpha. The current site remedy includes removal of the Zone 3 groundwater and treatment via evaporation. According to the USEPA, First- and Second Five-year Review Reports (USEPA, 1998; USEPA, 2003), the current remedy will not meet the remedial objectives for Zone 3 listed in the ROD and the Unilateral Administrative Order (UAO) (USEPA docket # Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA] 6-11-89). Therefore, this In-Situ Alkalinity Stabilization Pilot Study (Pilot Study) will evaluate an alternative approach to enhance the ongoing Zone 3 remediation.

This Pilot Study will evaluate the use of alkalinity injection wells to enhance the ongoing remediation of Zone 3 in addition to using extraction wells alone at the United Nuclear Corporation (UNC) Church Rock Site (site) located in Gallup, New Mexico. This Pilot Study has been prepared on behalf of UNC by Blasland, Bouck & Lee, Inc. (BBL).

The planned studies will test the injection of alkalinity-rich groundwater from an unimpacted part of the Southwest Alluvium into the Zone 3 aquifer. The injected water (hereinafter referred to as "fixiviant") will then flow through the Zone 3 formation to recovery wells where the fixiviant will be pumped to the surface for treatment and disposal. Theoretically, injection of the alluvium groundwater (i.e., fixiviant) into Zone 3 would effect the following changes:

1. The pH of the Zone 3 groundwater would increase;
2. Groundwater migration of target Zone 3 groundwater constituents of concern (such as cadmium, cobalt, nickel, radium-226/228, Th-230 and gross-alpha) would be reduced or eliminated via changes in aqueous/solid partitioning and precipitation reactions as a result of the increased pH conditions; and
3. Groundwater and fixiviant withdrawn by the extraction wells would recover uranium (and other chemical species) in solution, which could then be handled via the existing evaporation system.

The specific pilot study described herein will be conducted to assess the effectiveness of this proposed remedial approach. In addition, information obtained from the pilot study will be used to prepare a full-scale design, if groundwater remediation via injection is deemed a viable and effective remedy for the Zone 3 aquifer.

In October 2004, MWH, on behalf of UNC, developed a Supplemental Feasibility Study (SFS) (MWH, 2004) which evaluated several alternative remedies. The remedies that were evaluated included in-situ geochemical fixation via the injection of alkalinity-laden solutions into the acidic, tailings-impacted groundwater. The in-situ geochemical remediation was removed from the potential alternatives during the first phase of the SFS due to lack of reliability of the approach. The SFS indicated that the alternative is limited by hydraulic conditions within the Zone 3 hydrostratigraphic unit which might:

- limit the effective radius of influence of the reactant introduced into the system due to the moderate permeability of formation;

- 
- cause fouling and blocking of the aquifer due to the blockage of pore spaces by precipitated minerals; and/or
  - result in spreading the seepage-impacted groundwater to unimpacted regions.

This approach presented in this document is different from the in-situ geochemical remediation that was discussed in the SFS because it includes recovery wells. By combining injection with recovery, the issues associated with the in-situ geochemical remediation discussed in the SFS are minimized. Significantly better control over the movement of both the fixiviant and the seepage-impacted groundwater can be realized using such an approach. It is akin to the hydraulic concepts used for in-situ leach mining, but with very different geochemical goals (see Section 3).

The introduction of the alluvial water to Zone 3 and collection of the fixiviant would ultimately flush out the current groundwater located in Zone 3. The alluvial water will replace the lower pH water with high alkalinity water and cause the dissolved Zone 3 constituent (metals) to precipitate out of Zone 3 (this is why the hazardous constituents have not migrated very far away from the tailings impoundments.) This alternative is controlled hydraulically by controlling the rate at which the alluvial water is injected and the rate at which the fixiviant is extracted. By controlling the amount of water that is injected and recovered, the saturation thickness can be maintained and the effective radius of influence increased.

The SFS also indicated that in-situ remediation might not be effective because of the potential for fouling and blocking off of the aquifer due to the blockage of pore spaces by precipitated materials. Because of the increased hydraulic control of the proposed remedy, the amount of precipitation can be more easily managed. Even if precipitation of metals and radionuclides did not occur, the combined injection-recovery scheme presented in this document represents a major improvement in handling the problems that rendered the recovery-only remedy to be impractical. The main problem has been that recovery well yields decline over time, and are inadequate to recover the core of seepage-impacted water, especially as saturated thicknesses decline. Over time, the recovery wells have been relocated further downdip into previously unimpacted parts of Zone 3 to maintain the desired yields. This resulted in the unintended advance of seepage-impacted water (Earth Tech, 2001).

## **1.2 Background Information**

### **1.2.1 Hydrogeologic Setting**

The site is located approximately 17 miles northeast of Gallup, New Mexico, in McKinley County (Figure 1-1). The site operated as a uranium mill and an unlined tailings pond area from 1977 until early 1982. The site is located in an arid, remote setting.

The stratigraphy at the site is made up of the following units (MWH, 2004):

- Alluvium
- Dilco Coal Member of Crevasse Canyon Formation
- Upper Gallup Sandstone, comprised of:
  - Zone 3, upper sandstone
  - Zone 2, shale and coal

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- Zone 1, lower sandstone

- Mancos Shale

Mine water in the alluvium percolated into the underlying Zone 3 hydrostratigraphic unit. In the absence of a naturally-occurring shallow aquifer, the temporary saturation caused by the mine water discharged from the alluvium (prior to tailing disposal) is considered by National Research Council (NRC) and USEPA to be the background water for Zone 3 (USEPA, 1988; 1998). The background water was later impacted by acidic seepage from mine tailings. The seepage fluids contained elevated (i.e., above background conditions) concentrations of metals, radionuclides, and major ions including sulfate and chloride.

Zone 3 water levels from October 2004 are shown on the piezometric surface map on Figure 1-2. Water level data from 1989 through the fourth quarter of 2004 indicate groundwater flows toward the north and northeast, approximately parallel with the eastern limit of Zone 3 saturation (Veolia, 2004). Since the Pipeline Arroyo ceased discharging in 1986, Zone 3 groundwater flow directions have shifted from easterly-to-northerly to north-northeasterly-to-northeasterly as recharge from, and groundwater mounding within, the alluvium to the southwest and west have decreased (Veolia, 2004). The Zone 3 effects from alluvium recharge and extraction-well pumping drawdowns have largely dissipated, and the rates of water level change are mostly very small (Veolia, 2004). Extraction wells temporarily accelerated the local rates of water level decline until the saturated thickness was reduced to less than 25 feet, after which substantial losses in well yield occurred (Earth Tech, 2001).

In January 2004, UNC submitted the results of a study undertaken to evaluate the potential for the covered, tailings to still provide recharge to Zone 3 via leakage (USFilter, 2004). The report concluded that it was very unlikely, but recommended that additional investigation be conducted in one area where possible leakage could not be ruled out with certainty. In July 2004, two piezometers (Z3 M-2 and Z3 M-1) were installed north of the northeastern boundary of the Central Cell. Water levels were measured in October 2004 and indicated that the piezometers Z3 M-1 and Z3 M-2 were effectively dry and the southeasterly portion of Zone 3 appears to be entirely unsaturated (Veolia, 2004). As indicated in Veolia's 2004 annual report, the piezometer installation and groundwater monitoring data collected from 1989 through the fourth quarter of 2004 indicate that neither groundwater recharge nor seepage impact into Zone 3 are occurring (Veolia, 2004).

Figure 1-3 shows the general location of the recharge area, located to the north and northeast of the North Cell, where mine water in the alluvium percolated into the underlying Zone 3 hydrostratigraphic unit. This figure shows the saturated portion of the alluvium/Zone 3 contact as well as the unsaturated portion of this same contact zone.

### 1.2.2 Remedial History and Current Status

Several remedial activities have been conducted at the site to address tailings seepage in groundwater. The remedial activities that have taken place in Zone 3 of the site are briefly discussed below. Additional information may be obtained in the following documents:

- *Reclamation Engineering Services, Geohydrologic Report* (Canonie Environmental, 1987);
- *Record of Decision* (USEPA, 1988);

- *Memorandum, Change in Zone 3 Saturation, United Nuclear Church Rock Site, Gallup, New Mexico* (Earth Tech, 2001);
- *Five-Year Review Report, Second Five-Year Review Report for the United Nuclear Corporation Ground Water Operable Unit* (USEPA, 2003);
- *Annual Review Report – 2004 Groundwater Corrective Action* (Veolia, 2004); and
- *Supplemental Feasibility Study Zone 3 Hydrostratigraphic Unit* (MWH, 2004).

Following placement on the National Priorities List (NPL), the USEPA conducted a Remedial Investigation from 1984-1987. On September 30, 1988, the USEPA issued a ROD which presented a site remedy that included pumping impacted groundwater from Zone 3 and disposing of the water in evaporation ponds. On June 29, 1989, the USEPA issued a UAO Docket No. CERCLA 6-11-89 to UNC requiring UNC to implement the site remedy selected in the ROD. In August 1989, the USEPA-selected remedy of extracting groundwater from Zone 3 and pumping the groundwater to evaporation ponds was implemented; 12 new extraction wells were installed and operated.

The performance of the remedial activities were monitored as described in the USEPA- and NRC-approved Corrective Action Plan (UNC, 1989a), Remedial Design Report (Canonie, 1989a), and Remedial Action Plan (UNC, 1989b). Several modifications were made to the monitoring program and are discussed in the annual reports (Canonie, 1989b, 1990, 1991, 1992, 1993, and 1995; Smith Technology, 1995 and 1996; Rust, 1997; and Earth Tech, 1998, 1999, 2000a, 2002a and 2002c), to adjust the monitoring requirements as the corrective action has taken effect.

On July 30, 1999, NRC, USEPA, and New Mexico Environment Department (NMED) approved the decommissioning of 10 Zone 3 wells because they met the decommissioning criteria of producing less than 1 gallon per minute (gpm). In May 2000, UNC submitted a license amendment request to shut off remaining Zone 3 pumping wells (Earth Tech, 2000b). The request was based on the conclusion that that the operation of the Zone 3 pumping wells increased the hydraulic gradient and accelerated the rate of downgradient plume migration. Zone 3 system was shut down in June 2000 for maintenance and repairs. Prior to the Zone 3 system being brought back on line, the USEPA and NMED agreed with the license amendment submitted in May 2000. The NRC amended the license to shut off the remaining Zone 3 pumping wells (NRC, December 29, 2000 License Amendment). This amendment included a provision for UNC to submit a modified corrective action plan, an application for Alternate Concentration Limits (ACLs), or an alternative to the specific requirements of 10 CFR Part 40, Appendix A if the license standards are not achievable.

At the request of the USEPA (2004), An SFS (MWH, 2004) was conducted by MWH on behalf of UNC. The SFS was conducted to develop conceptual alternatives and/or enhancements to the existing remedy that would better contain, and ideally withdraw, seepage-impacted groundwater. The report presented the following information:

- Groundwater modeling of the Zone 3 sandstone unit;
- Pilot-hole hydrofracturing study results;
- An analysis of remedial alternatives; and
- Conclusions and recommendations for enhancing or optimizing remedies for Zone 3.

UNC is conducting an ongoing, extended pilot investigation to evaluate the suitability of hydrofracturing to enhance the extraction potential within the impacted area of Zone 3 and to prevent seepage-impacted

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groundwater from migrating offsite (MACTEC, 2003). The pilot investigation included installing and hydrofracturing several new wells. Preliminary data suggest that the new wells are better positioned to capture tailing-impacted water, but that the yields are not any different without hydrofracture.

## **2. Regulatory Considerations**

### **2.1 Permitting/Regulatory Approval Requirements**

In accordance with 42 USC 9621.121(e) of CERCLA, the procurement of permits from federal, state, or local authorities is not required for the implementation of remedial action activities at a NPL site. However, the remedial activities are required to be implemented in a manner that complies with the substantive requirements of applicable permits and authorizations. Described below is the approval/permitting process required by the State of New Mexico for injection of water into the subsurface.

According to federal regulations (subpart 147.1600 of Title 40 of the Code of Federal Regulations [40 CFR 147.1600]), in New Mexico the underground injection control (UIC) program is administered by the State of New Mexico and approved by the USEPA. The UIC program was established by the Safe Drinking Water Act to regulate underground injection (i.e., the placement of fluids underground).

The New Mexico regulations indicate that the type of injection wells UNC is proposing are Class V Wells (in situ groundwater management injection wells used to inject a fluid that facilitates groundwater remediation). According to 20.6.2.1201 of the New Mexico Regulations, any person intending to inject fluids into a well shall file a notice with the Groundwater Quality Bureau. The notice shall state the following:

- The name of the person making the discharge
- The address of the person making the discharge;
- The location of the discharge
- An estimate of the concentration of water contaminants in the discharge; and
- The quantity of the discharge.

Based on the information provided in the notice of intent, the Groundwater Quality Bureau will notify the person proposing the discharge if a discharge permit is required and if the injection activity is prohibited or not. According to 20.6.2.5004, the injection of the alluvial water would be allowed.

Based on the data collected from well 509D, (which screens the alluvial zone) a discharge permit would most likely be required to inject alluvial water into Zone 3. As part of the discharge permit, a discharge plan would need to be submitted to the Secretary of the Groundwater Quality Bureau for approval following notice from the Secretary (of the Groundwater Quality Bureau) that a discharge permit is required. The discharge plan presents the details of the discharge method, the characteristics of the injection fluid, the current groundwater conditions, an operational plan, a monitoring plan, a contingency plan and also a closure plan. The relevant permit information is provided by this Pilot Study.

Also, the State of New Mexico (under 20.6.2.3108) requires that public notice be made (for Class V wells) to the general public in the locale of the proposed discharge. Under CERCLA, the public has been and will be informed of the activities that take place at the site.

According to the New Mexico Regulations (20.6.3101) the purpose of the discharge permit process is to control the discharge to the groundwater so that there is no degradation of the groundwater beyond the existing concentrations. The purpose of injecting the alluvial water is to improve the groundwater quality in Zone 3. The permit process regulated by the New Mexico Government also requires reporting and monitoring of the

injection wells. This Pilot Study details the monitoring activities to be documented and submitted to USEPA, NRC, and NMED.

Therefore, while the activities planned in this Pilot Study would require a permit under current regulations, the operations, monitoring and documentation activities presented in this Pilot Study would meet the substantive UIC permit requirements. Attachment A provides a completed (in draft form) State of New Mexico UIC permit.

## 2.2 Site-Specific Groundwater Quality Standards

The site-specific groundwater quality standards are the Applicable or Relevant and Appropriate Requirements (ARARs) presented in the ROD (USEPA, 1988). The table below presents the ARARs for this site. Several Maximum Contaminant Levels (MCLs) have been revised since the issuance of the ROD (USEPA, 1988) and the most current MCLs are presented in this table below. Also presented in the table is the average of most recent data obtained (from quarterly sampling conducted in 2004) from monitoring well 509 D (which represents the source of injection water) and wells 517 and 518 (which represent Zone 3 groundwater). As presented in the table below, the groundwater quality of the alluvial water located in the vicinity of monitoring well 509D meets the ARARs for the site with the exception of manganese, chloride, total dissolved solids and uranium.

Contaminant	Groundwater Protection Standards mg/L	Source of ROD Standard	Average Concentrations measured in Well 509D	Average Concentrations measured in Wells 517 and 518
Aluminum	5.0	New Mexico Water Quality Control Commission (NMWQCC)	0.125	39.375
Arsenic <sup>b</sup>	0.010	MCL	<0.001	<0.001
Barium	1.0	MCL, NMWQCC	NA	NA
Beryllium <sup>c</sup>	0.004	Health-based	<0.1	0.0325
Cadmium <sup>d</sup>	0.005	MCL, NMWQCC	<0.005	0.0066
Chromium	0.05	MCL, NMWQCC	NA	NA
Cobalt	0.05	NMWQCC	<0.01	0.88
Copper	1.0	NMWQCC	NA	NA
Iron	5.5	Background Level	NA	NA
Lead	0.05	MCL, NMWQCC	<0.05	<0.5
Manganese	2.6	Background Level	2.85	12.0
Mercury	0.002	MCL, NMWQCC	NA	NA
Molybdenum	1.0	NMWQCC	<0.01	<0.1
Nickel	0.2	NMWQCC	<0.05	0.8525
Selenium	0.05	MCL	<0.001	<0.001
Silver	0.05	MCL, NMWQCC	NA	NA
Vanadium	0.7	Health-based	<0.1	<0.1
Zinc	10	NMWQCC	NA	NA
Chloride	250	NMWQCC	362	42.48

Contaminant	Groundwater Protection Standards mg/L	Source of ROD Standard	Average Concentrations measured in Well 509D	Average Concentrations measured in Wells 517 and 518
Sulfate <sup>e</sup>	2,125	Background Level	1847.5	4,113.75
Nitrate <sup>e</sup>	190	Background Level	19.65	0.963
TDS <sup>e</sup>	4,800	Background Level	5,470	6,193.75
Radium -226 and -228	5 pCi/L	MCL	0.25	13.09
Uranium -238 <sup>f</sup>	0.03	NMWQCC	0.208	0.15
Thorium -230 <sup>g</sup>	15 pCi/L	MCL	<0.2	3.6
Gross Alpha	15 pCi/L	MCL	<1	14

**Notes:**

- a) In milligrams per Liter (mg/L), except as noted.
- b) Arsenic MCL of 0.01 mg/L published since ROD issuance.
- c) Beryllium MCL of 0.004 mg/L published since ROD issuance.
- d) Cadmium MCL reduced to 0.005 mg/L since ROD issuance.
- e) Background standards proposed in 1996 NRC Report.
- f) Uranium MCL reduced to 0.03 mg/L, effective 12/03, Proposed NMWQCC for uranium: 0.007 mg/L.
- g) Based on 15 pico Curies per Liter (pCi/L) gross alpha.
- h) NA = not available.
- i) Average concentrations measure in Well 517 based on data collected during sampling events held in January 2004, April 2004, July 2004, and October 2004. Average concentrations measured in Well 518 based on data collected during sampling events held in April 1999, July 1999, October 1999, and January 2000.
- j) Average concentrations measured in Well 509D based on data collected from sampling events that were conducted during January 2004, April 2004, July 2004, and October 2004.

Of the Groundwater Protection Standard exceedances, the alluvial water to be injected (well 509-D type) is of better quality than the receiving water (well 517 and 518 type) for all constituents except uranium and chloride. However, the uranium concentrations are lower in the alluvial water to be injected than they are in the seepage-impacted part of Zone 3 when taken as a whole. UNC believes that the State of New Mexico will consider the removal of hazardous metals and radionuclides in Zone 3 groundwater as a benefit that outweighs the increases in chloride that will occur.

## 3. Geochemical Principals and Calculations

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### 3.1 Background

Historical milling operations at the site involved application of strong sulfuric acid to extract uranium from ore materials. By-products from the ore processing were discharged to the tailings ponds. Acidic solutions associated with the tailings ponds seeped into partially saturated alluvium and sandstone formations. The alluvium and sandstone formations in the tailings area originally had been unsaturated prior to commencement of mining activities. Partial saturation of the formations resulted from mine-dewatering discharge, which is referred to as post-mining, pre-tailings water, and which represents background groundwater at the site (as previously discussed in Section 1).

The proposed pilot studies described herein involve approaches to reduce concentrations of Constituents of Concern (COCs) derived from the tailings ponds that seeped into the post-mining, pre-tailings background water. Historical monitoring indicate that the background groundwater contains relatively high concentrations of inorganic constituents, particularly calcium, sodium, sulfate, nitrate, uranium, molybdenum, thorium, and total dissolved solids (TDS). Elevated concentrations of these background constituents can influence the geochemical behavior of target COCs, due to complex formation, competition for available surface adsorption/exchange sites on solid phases, and influences on precipitation/dissolution and redox reactions. Review of historical monitoring results suggests that exceedances of groundwater criteria for COCs within Zone 3 within and beyond areas of seepage impacts reflect geochemical influences from the relatively saline background water. For example, Table 3-1 presents a summary of recent (2004 average) groundwater quality data, including:

- monitoring well NBL-01, which is located within Zone 3 downgradient of seepage impacts;
- monitoring well 613, located within Zone 3, in the core area of seepage impacts, closest to the tailings ponds;
- monitoring well 517, located within Zone 3, within an area of seepage impacts, nearest the planned pilot study; and
- monitoring well 509D, located in the alluvium (which represents alluvium groundwater from NA-02).

The majority of the tailings ponds are constructed on alluvium, whereas portions of the central and northern ponds are in direct contact with the partially saturated sandstone formations. The alluvium contains sufficient calcium carbonate and other minerals that serve to buffer/neutralize the acidic seepage from the tailings ponds. Zone 3 of the upper Gallup Sandstone, which represents the target area for the pilot studies, however, has comparatively less buffering capacity than the southwest alluvium or Zone 1 of the upper Gallup.

Historical groundwater quality monitoring of Zone 3 has documented the migration of the low-pH front. Figure 3-1 presents concentration-versus-time plots for bicarbonate for two monitoring wells (EPA 14 and 504b) located within the area of seepage impacts. The plot for EPA 14 illustrates how a relatively gradual increase in bicarbonate ion, indicative of dissolution of carbonate minerals, has been followed by a rapid decrease in bicarbonate and pH as the buffering capacity of the formation is exhausted. The plot for 504b illustrates how once the buffering capacity of the formation is exhausted, acidic conditions remain without some type of natural or human-induced neutralizing process. The low pH associated with the migrating front will tend to maintain

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elevated concentrations of target COCs, unless processes (either natural or human-induced) act to change the acidic conditions.

Thermodynamic speciation calculations using programs such as PHREEQC and MINTEQA2 have indicated that gypsum (hydrated calcium sulfate) ranges from at or near equilibrium to slightly oversaturated everywhere in the alluvium and sandstone formations, including regions not impacted from tailings seepage. Widespread occurrence of gypsum indicates that relatively high aqueous concentrations of calcium, sulfate, and TDS will likely remain in groundwater absent some relatively dilute solutions that could migrate through the formations to dissolve all the gypsum, and ultimately remove/reduce aqueous concentrations of these inorganic constituents. Such a scenario, however, is unlikely if not impossible, because of the widespread natural occurrence of gypsum within the geologic formations. Infiltration of virtually any aqueous solution when combined with gypsum's presence and reactive geochemical behavior will result in mineral dissolution and relatively high concentrations of calcium, sulfate, and TDS. This Pilot Study therefore does not attempt to mitigate the natural processes that produce exceedances of groundwater protection standards.

### 3.2 Pilot Study Strategy

The approach to be tested by the Pilot Study involves injecting alkaline groundwater into areas where seepage-induced acidic conditions exist. The alkaline solutions will serve to neutralize the acidic water along a mixing front, and ultimately will entirely displace the seepage-impacted groundwater. Recovery wells located hydraulically downgradient of injection locations will remove the seepage-impacted groundwater as well as that mixed with the injected solutions. Increased groundwater pH associated with the injected alkaline groundwater will serve to greatly reduce migration and/or completely immobilize COCs via chemical precipitation and surface adsorption reactions.

Monitoring well NA-02 has been identified as the water source to be used as the injected water. Water quality in this area, as represented by monitoring well 509D (Table 3-1), is characterized by: moderate pH (approximately 6.5); salinity (TDS) near 5,500 mg/L; low to non-detectable concentrations of metals and radionuclides; chloride concentrations of approximately 360 mg/L; and perhaps most importantly high alkalinity, evidenced by bicarbonate concentrations of approximately 2,300 mg/L. The relatively high chloride concentrations (367 mg/L) compared to Zone 3 groundwater near well 517 (48 mg/L Cl), where the pilot test will occur, should serve as an effective conservative tracer during the testing to assist in monitoring solute migration of the injectant. Review of data presented in Table 3-1 also indicates that water quality of the injected water is of superior quality with respect to COCs compared to background Zone 3 water represented by NBL-01.

Preliminary geochemical modeling has been performed using PHREEQC, to evaluate how injection of water from NA-02 (using data from 509D) may react with materials within the area of low-pH seepage impacts, represented by monitoring well 613. Well 613 is an excellent representation of water-quality located within the core of the seepage-impacted zone (Table 3-1 and Figure 1-2).

Results for PHREEQC simulations including various mixing ratios and batch reactions, the latter of which include precipitation of various solid phases, are presented in Table 3-2, Figures 3-2 through 3-6, and in Attachment B. Data in Table 3-2 identify resulting pH and mineral phases allowed to precipitate, if oversaturated, according to the various mixing fractions. The column labeled "mix pH" identifies the predicted equilibrium pH if the solutions mix but no mineral phases precipitate. The column labeled "ppt pH" identifies the predicted equilibrium pH if upon mixing the phases identified in the column "Phases ppt" are allowed to precipitate.

PHREEQC modeling results summarized in Table 3-2, Figures 3-2 through 3-6 and in Attachment B provide insight regarding potential reactions and geochemical changes that will occur during the pilot test. The data suggest that a moderate target pH near 6 may not be achieved until most of the ambient groundwater is displaced by the injectant solution (Figure 7). However, once replacement of the seepage-impacted groundwater by the injectant occurs, it is likely that COCs, especially radionuclides such as radium (Figure 3-3), thorium (Figure 3-4), and uranium (Figure 3-5) will be immobilized and/or reduced in concentration and mobility through precipitation and sorption on to solid phases.

PHREEQC simulations of aqueous mixing, and mineral precipitation reactions if oversaturated, assume thermodynamic equilibrium. Consequently, although the modeling results may indicate that specific mineral phases should precipitate, they may not precipitate over the time frame involved in the pilot studies due to kinetic factors and other limitations of the thermodynamic modeling approach. For example, Table 3-2 indicates that uraninite should precipitate under all mixing simulations. Resulting U concentrations under these conditions are predicted to be on the order of 0.0001 mg/L, which is roughly three orders-of magnitude less than background U concentrations in Zone 3. An objective of the laboratory batch testing described in subsection 3.3 is to evaluate whether uraninite and/or other uranium mineral phase will indeed precipitate over the applicable time frames.

In addition, appropriate thermodynamic data used in PHREEQC modeling are not available for all species of interest, for example, a  $\text{RaCO}_3$  mineral. Modeling results for Ra predicted in Figure 3-3 indicate simple mixing of the end-member solutions. In reality,  $\text{RaCO}_3$  may precipitate as a distinct solid phase, and/or should be incorporated into the calcite lattice as a substitute for Ca ions, and thus will likely decrease in concentration to a greater extent than indicated in Figure 3-3. Table 3-2 indicates that calcite should precipitate and it is well known that calcite precipitation at earth-surface temperatures is relatively rapid; consequently, aqueous Ra concentrations are likely to decrease by this mechanism.

Figure 3-6 presents predicted changes in chloride concentrations as a function of mixing between well 613 and well NA-02 (using existing data from well 509D). The mixing curve shows a linear increase to slightly more than double the initial concentration, with increasing fraction of well NA-02 water. Such behavior is to be expected for these mixing calculations as well as in the field during the pilot testing, with a geochemically conservative species like chloride. Sampling from the recovery wells for chloride analysis will occur frequently during the pilot test in order to evaluate the travel time of the solutions from the injection wells. Chloride will be more sensitive in detecting injectant migration apparent from Figure F, because chloride in the vicinity of the pilot testing is on the order of 50 mg/L (well 517, Table 3-1), compared to a chloride concentration of 170 mg/l at well 613 applied in the PHREEQC simulations.

Mixing plots for other chemical constituents presented in Appendix B illustrate either simple mixing phenomena (linear increases or decreases), or non-linear variations which reflect mineral precipitation. It should be noted that the mixing simulations do not account for processes such as ion-exchange and surface adsorption reactions. Consequently, it is anticipated that during the field-testing, constituents may be removed to an even greater extent than the predictions illustrated in the figures. Results from the laboratory batch testing will provide further insight regarding sorption and ion-exchange processes likely to occur during the field tests.

It is also worth noting that PHREEQC simulations were also performed in which highly alkaline (pH = 11) solutions (sodium bicarbonate and hydroxide) were mixed with NA-02-type water prior to injection. Results from these simulations suggest that little benefit would be gained from including such additives to the injected water, as the ultimate pH was only slightly higher than without the alkalinity enhancement.

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### 3.3 Batch-Testing Experiments

A series of laboratory batch-mixing experiments have been designed to evaluate potential geochemical reactions likely to occur during the pilot testing, especially those that were not quantified in the PHREEQC simulations. The approach will be to mix groundwater from well 613 (or well 517) with well NA-02 groundwater using several mixing ratios, to compare with the PHREEQC results. Mixing ratios will be: 0.1 to 0.9; 0.5 to 0.5; and 0.9 to 0.1. Surficial outcrop samples of the Zone 3 Gallup Sandstone from the site area will be crushed to sand-size and smaller particles and added to separate aliquots containing the same water mixtures described above.

The samples will be placed in closed containers and subjected to mild agitation for a minimum one-week period. Table 3-3 identifies the sampling and analysis to be performed during the investigation. Aqueous subsamples from the mixtures will be collected daily for analysis of pH and specific conductance. After a one-week period, filtered aliquots will be analyzed for the constituents identified in Table 3-1, which correspond to those analyzed as part of the on-going monitoring program at the site. If sufficient solid materials precipitate within the mixed samples that did not initially contain added solids, they will be analyzed via X-ray diffraction to identify crystalline mineral phases. In addition, a sample of well NA-02 groundwater will be analyzed to confirm the quality of this water.

## 4. Pilot Study

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### 4.1 Technology Review

The remedial approach and pilot study described in this document are hydraulically similar to in-situ leach (ISL) technology and “groundwater sweeping” or aquifer flushing used by the mining industry. ISL and aquifer flushing offers some useful insight into the hydraulics and configuration of the pilot study. Accordingly, a literature review summarizing select ISL technology-related documents relevant to the current site conditions and pilot study are presented below. Design and operational considerations follow in subsequent sections.

The geochemical objectives between ISL mining and the current in-situ alkalinity stabilization pilot study described herein are different. In very simple terms, the objective of ISL mining is to mobilize a valued commodity from solid minerals. Our application has the objective of fixing and/or displacing and recovering hazardous constituents from tailings-impacted groundwater.

ISL technology, also known as in-situ solution mining, involves leaving the ore in the ground formation and using liquids, which are pumped through the formation, to recover the minerals out of the ore by leaching. ISL mining was first tried on an experimental basis in Wyoming during the early 1960s for extracting uranium from sandstone rocks. The first commercial uranium mine, using ISL, began operating in 1974. As of June, 2003, about a dozen projects are licensed to operate in the U.S. (Nuclear Issues Briefing Paper 40, June 2003).

Deposits suitable for ISL occur in permeable sand or sandstones. A schematic of the in-situ leach mining process, showing an injection well with a production well, is presented by the U.S. Nuclear Regulatory Commission and is included as Figure 4-1. A schematic of the “groundwater sweep” or aquifer flushing process, whereby contaminated ground water from the ISL mining operation is removed by pumping, is presented by the United States Department of Energy (USDOE) and is included as Figure 4-2.

A thorough field case history of ISL technology, “The Smith Ranch Project: a 1990s In Situ Uranium Mine”, was presented at the Uranium Institute 24<sup>th</sup> Annual International Symposium in 1999 (Freeman and Stover, 1999). The Smith Ranch Project explored ISL technology through a series of pilot tests to determine production parameters, such as well spacing and injection flow. The pilot tests were arranged as 5-spot patterns, and various lixiviant chemistries were evaluated. Following the success of the pilot studies, the production scale well field layout and design was completed, including the leaching of uranium and the ultimate restoration of the aquifer by aquifer flushing. Regulatory reviews and licensing followed, and the Smith Ranch proceeded to full-scale production, including environmental restoration by aquifer flushing.

In the article “Groundwater Restoration at Wyoming Uranium Solution Mining Sites”, (Catchpole, Garling, and Neumann), two successful case histories are presented that are relevant to the pilot study at the Church Rock site: Bison Basin and Reno Creek. The Bison Basin project used sodium carbonate/bicarbonate as the lixiviant and oxygen as the oxidant to release uranium and maintain its mobility. The pilot well field consisted of four injection wells and three recovery wells arranged in a line-drive configuration, and operated at a flow rate of 25 gallons per minute. The test was conducted for three months. The baseline concentration, post restoration concentration, and DEQ restoration requirements were presented and compared in the article. The uranium leach was successful, and the DEQ restoration requirements were met using aquifer flushing.

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The Reno Creek project followed a similar protocol, but utilized a 5-spot configuration for more efficient injection and extraction. Again, the uranium leach and the aquifer restoration by aquifer flushing were successful.

A Final Environmental Statement (FES) prepared by the NRC for the Bison Basin commercial-scale license application concluded that "...the applicant has demonstrated that restoration of the aquifer to its original potential use condition is achievable." These two case histories, along with the Smith Ranch project, show that ISL and aquifer flushing can be used in an environmentally acceptable manner that can clean up land and water resources for future use. This pilot study utilizes a combined ISL and post-ISL aquifer flushing approach for aquifer restoration.

## **4.2 Well Injection and Recovery Network**

Assuming that the batch test meets its objectives, a pilot study will be conducted in the field to assess the effectiveness of injection remediation for the Zone 3 groundwater. Figure 4-3 presents the pilot study location in relation to the general site layout, and a detailed layout appears in Figure 4-4. The pilot study will occur downgradient of the contaminant source and will use some of the wells already in place. Based on current information, existing wells 0608, 0517, and 0518 will be used in the pilot study, and six new wells will be installed by UNC contractors for use during the pilot study. The pilot test well field is a nine-spot pattern, which builds upon the five-spot layout traditionally used by the ISL industries, with the addition of four hydraulic-control extraction wells on the perimeter of the well field. The net rates of injection and production are nearly balanced across the well field (with slightly higher withdrawal to injection rates), such that fluid flow away from the well field is eliminated. The pilot study well field includes a central extraction well (EW-1) surrounded by four, to-be-installed injection wells (IW-1 through IW-4). The central extraction well will provide the primary monitoring location to evaluate the effectiveness of the technology in terms of removing and/or immobilizing the target COCs. The four surrounding injection wells will provide a means to inject fixiviant. In addition, the injection wells will hydraulically isolate the central extraction well from the surrounding groundwater flow system, and provide a controlled, closed hydraulic system for monitoring the effectiveness of treatment over time during the pilot test. The four outer extraction wells (wells 608, 517, 518, and EW-2) will provide overall hydraulic control during the pilot study. Attachment C shows the schematic layout of the pilot test area, and presents pertinent hydraulic parameters, estimated pilot test pumping rates, calculated time for initial breakthrough of injected water at the central extraction well, and calculated time for 1 pore-volume exchange within the zone surrounding the central extraction well. These calculations are based on the hydraulic parameters in the MWH (2004) modeling report, with extraction and injection wells screened over the entire saturated thickness of Zone 3; drawdown to within 3 feet of the base of Zone 3 inside each extraction well; and assumed well efficiency of 50%. The pilot study well field design can be summarized as follows:

- 9 wells (3 existing, 6 new), relative spacing and locations shown on Figure 4-4 and in Attachment C;
- 5 extraction wells with a combined rate of approximately 4.0 gpm;
- 4 injection wells with a combined rate of 3.3 gpm;
- net pumping rate = 0.7 gpm (net extraction to maintain hydraulic control);
- time for initial breakthrough of injected water at central extraction well estimated as 14 days; and
- time for one complete pore volume exchange between injection wells and central extraction well estimated as 37 days.

In the event that the pilot study indicates that the remedial approach presented in this document is effective, a full-scale approach to remediation will be designed. In this case, the plume will most likely be covered by a grid

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pattern of injection and extraction wells. Groundwater modeling will likely be used to assist in designing the grid spacing and distribution based on the bench-scale and pilot study results.

#### **4.3 Well Design and Installation**

The well design and installation approach will be consistent with prior well installation practices at the site. The proposed wells will consist of a 6 inch-diameter PVC type casing of Schedule 40 or 80 rating, extending approximately 10 feet into the top of the Gallup Sandstone (Zone 3), and a 5 ¾" diameter open borehole extending from the bottom of casing to just below the top of the coal seam at the base of Zone 3. The general well installation procedure will include the following steps:

- Drill a rotary hole of 9 7/8" or 10 ½" diameter to a depth determined from previous geologic data obtained from 517, 518, and 608, which will be at least 10' into the Gallup (Zone3) Sandstone.
- Set a capped 6 1/2" OD diameter PVC casing of Sch. 40 or 80 material and cement it from the bottom upward using a neat cement. The cement will be allowed to set 24 hrs. or longer as the conditions dictate.
- Drill out the cap with a 5 7/8" rotary bit and finish the hole to just below the top of the coal seam at the base of Zone 3.

The local drilling contractor for UNC will assist in determining the final design and installation approach for the injection and recovery wells. Well construction details depicting the anticipated design of the extraction and recovery wells are included on Figure 4-5. It is expected that the newly-installed wells will have open-borehole construction, however the proposed design allows sufficient room to install a 4-inch diameter well-screen and sand pack if the open borehole is determined to be unstable or yields excessive sediment during development. The casing sizes and borehole diameters may be modified, if the pump criteria dictate a need for more room for cooling or for fit.

#### **4.4 Groundwater Monitoring During Pilot Test**

The hydraulic head in the injection and recovery wells will be precisely monitored during the test. The injection rates will most likely range between 1-3 gallons per minute, and the recovery rates will be spread around the recovery wells to balance the injection rates. The rates calculated in Attachment C will be the starting point based on the estimated hydraulic parameters. They will be revised in the field as necessary.

Groundwater samples will be collected from the injectant source and from recovery wells during the pilot test. Samples will be collected at frequent intervals (twice weekly) to monitor the quality of the injectant and to identify arrival and breakthrough of the injectant at the recovery wells. The suite of chemical constituents analyzed as part of the on-going monitoring program, identified in Table 3-1, will be analyzed after each pore volume of injectant has migrated to the recovery wells.

Preliminary estimates of travel times from the injection wells to the recovery wells indicate pore volume removal can be achieved in approximately 37 days (Attachment C). Evaluation of daily analytical results for pH and chloride should assist in identifying when pore volume removal is achieved. If the results suggest significantly different travel times than originally estimated, adjustments will be made for sampling and analyses for Table 3-1 constituents.

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The schedule for sampling and analysis during the pilot test includes:

- Twice weekly samples collected from the storage tank containing the injectant solution, and the recovery wells. Samples will be analyzed for: pH, TDS, specific conductance, and chloride;
- Sampling from recovery wells following unit pore-volume removal. Samples will be analyzed for constituents identified in Table 3-1, which correspond to those analyzed as part of the on-going monitoring program for Zone 3 groundwater.

#### **4.5 Field Procedures**

The general field procedures for conducting the pilot study are as follows:

1. Install pilot injection and extraction wells as described in Section 4.3. Convert existing wells to be used as extraction or injection wells as appropriate, using the necessary piping, fittings, equipment, and instrumentation.
2. Stage an approximately 5,000-gallon, insulated polyethylene tank at the injection site to store groundwater collected from the alluvial aquifer (well NA02), to be used for injection. The storage tank should include level instrumentation for high and low level alarms and on/off control of the source water pump.
3. Install necessary piping, fittings, and instrumentation to allow alluvial water to be gravity-injected from the storage tank to the four injection wells. Due to the potential for sub-freezing temperatures, the installation of buried piping may be warranted. Above-ground piping will be heat traced and insulated.
4. Install piping as necessary to convey groundwater from the extraction wells to the existing surge tank for discharge to the on-site evaporation pond. Due to the potential for sub-freezing temperatures, the installation of buried piping may be warranted. Above-ground piping will be heat traced and insulated.
5. Convert well NA02 to a groundwater extraction well using existing pumping equipment supplied by UNC.
6. Connect water supply for injection from source well NA02 (i.e., the same water supply source used for the bench-scale study) to the injection water storage tank. Due to the distance of the well from the injection site, and the potential for sub-freezing temperatures, the installation of buried piping between the well and the storage tank may be warranted. Above-ground piping will be heat traced and insulated. Electrically connect level controller at storage tank to pump control panel for automatic on/off pump control.
7. Perform single-well pumping tests (i.e., specific-capacity tests of approximately one to two hours each) at the nine wells within the pilot study well field to determine the pre-pilot hydraulic conductivity values and well yields.
8. Fill the injection water storage tank with alluvial groundwater from well NA02 using the installed pumping system.
9. Gravity feed alluvial groundwater from the storage tank to the pilot injection well in accordance with pre-determined operating parameters (i.e., flow rate, pressure, etc.) and procedures (the amounts and chemistry of the injection water will be based on the results of the bench-scale test).

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10. Begin monitoring, sampling, and analysis based on flow velocities and modeling predictions. Upon the start of the pilot study, monitoring will commence immediately for determining the pre-modified chemistry of the groundwater. Samples will be collected based on anticipated travel times but at a minimum on a weekly basis. The species and parameters to be monitored include: pH, U, TDS, Ni, Co, Mo, As, Al, Mn, SO<sub>4</sub>, Ra-226/228, Gross Alpha, Be, Cd, Th-230, and Chloride. Twice weekly sampling for analyses of select constituents such as pH, specific conductance, and chloride will be performed to monitor groundwater migration. Laboratory analysis will be subcontracted by BBL.
  11. Perform single-well pumping tests (specific-capacity tests of approximately one to two hours each) at the nine wells within the pilot study well field to determine the post-pilot hydraulic conductivity values and well yields; these data will be compared to the pre-pilot data to evaluate whether any reduction in well yield and/or hydraulic conductivity may have occurred during the pilot study. These post-pilot hydraulic tests will be performed at the same pumping rates and for the same duration as the pre-pilot pumping tests.

The analysis of the laboratory results will be ongoing and begin immediately after sample collection during the pilot study so that the hydraulic front, indicated by increased alkalinity and rising pH, and the chemical reaction front (indicated by changes in metal and radionuclide concentrations) can be determined.

#### **4.6 Pilot Study Results**

Following completion of the Pilot Study, BBL will prepare a report presenting the results. The report will include the following information:

- Introduction and Site Background;
- Description of Pilot Study Activities;
- Pilot Study Results;
- Summary and Conclusions; and
- Recommendations.

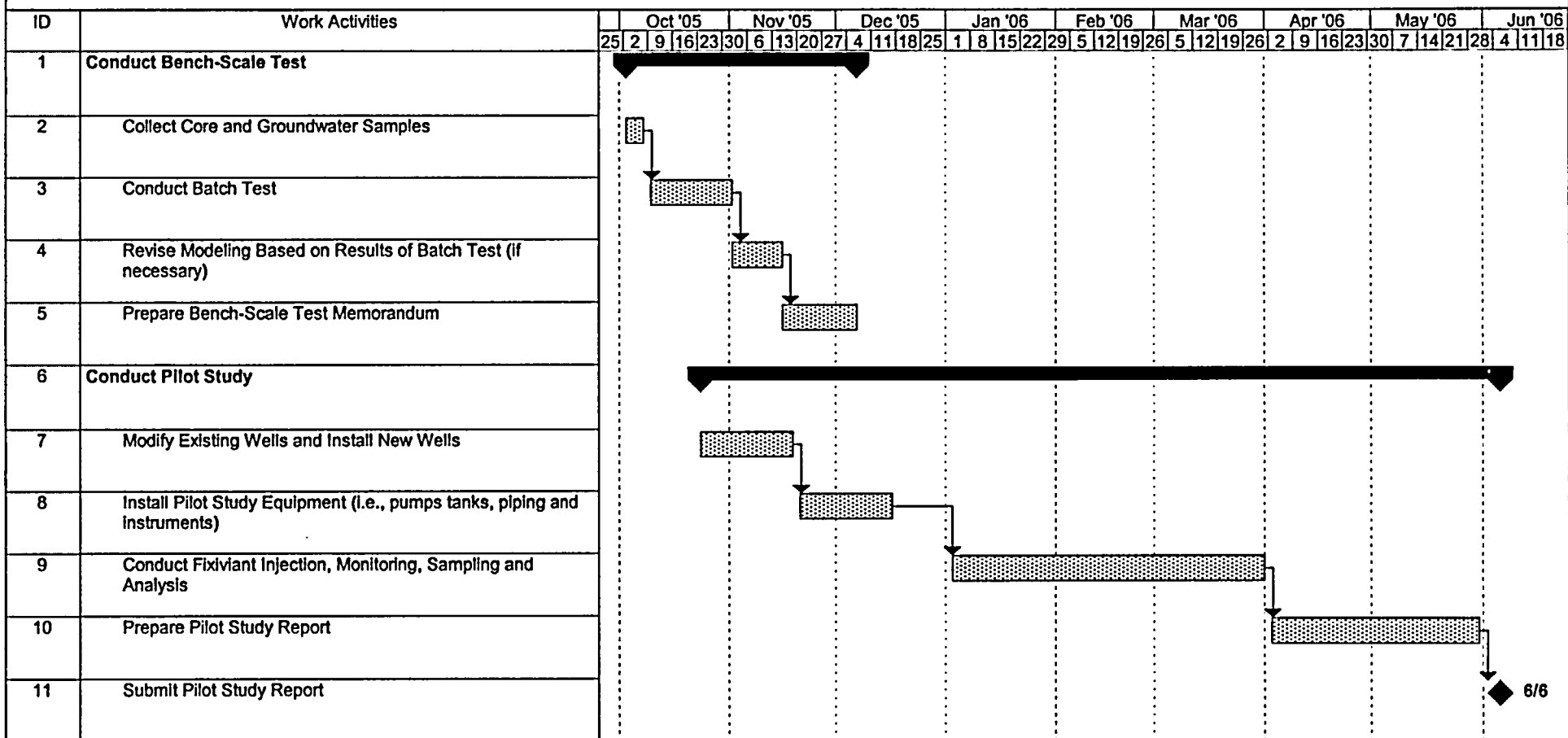
The Pilot Study Results Report will also include validated analytical data and figures presenting the area of the pilot study and graphical representation of select analytical data.

## ***5. Schedule***

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The anticipated schedule for the bench-scale test and pilot study is attached.

# In-Situ Alkalinity Stabilization Pilot Study Project Schedule



## Note:

1. Pilot Study is dependent upon weather conditions and may be delayed until Spring 2006.

Project: Church Rock Schedule101105

Date: Tue 10/11/05

Task



Summary



Milestone



# ***Acronyms and Abbreviations***

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**ACLs** – Alternate Concentration Limits  
**ARARs** – Applicable or Relevant and Appropriate Requirements  
**BBL** – Blasland, Bouck & Lee, Inc.  
**CERCLA** – Comprehensive Environmental Response, Compensation, and Liability Act  
**COC** – Constituent of Concern  
**DEQ** – Department of Environmental Quality  
**FES** – Final Environmental Statement  
**gpm** – gallons per minute  
**ISL** – in-situ leach  
**mg/L** – milligrams per liter  
**MCLs** – Maximum Contaminant Levels  
**NMED** – New Mexico Environment Department  
**NMWQCC** – New Mexico Water Quality Control Commission  
**NPL** – National Priorities List  
**NRC** – National Research Council  
**pCi/L** – pico Curies per liter  
**P&ID** – Piping and Instrumentation Diagram  
**ROD** – Record of Decision  
**SFS** – Supplemental Feasibility Study  
**TDS** – total dissolved solids  
**UAO** – Unilateral Administrative Order  
**UIC** – underground injection control  
**UNC** – United Nuclear Corporation  
**USDOE** – United States Department of Energy  
**USEPA** – United States Environmental Protection Agency

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## ***Tables***

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TABLE 3-1

UNC CHURCH ROCK  
CHURCH ROCK, NEW MEXICO

IN-SITU ALKALINITY STABILIZATION PILOT STUDY

2004 AVERAGE WATER QUALITY

Constituent	Units	NRC Standard	EPA Standard	Formation:	Zone 3	Zone 3	Zone 3	Alluvium
				Water Type:	Seepage-Impacted (PHREEQC Modeled)	Seepage-Impacted (Pilot Test)	Background	Injectant
				Monitoring Wells				
				613	517	NBL-01	0509 D	
Field pH	SU	NA	NA	2.82	4.28	6.44	6.38	
Lab TDS	mg/l	NA	4800	12950	4820	3800	5470	
Ca	mg/l	NA	NA	462	502	662	896	
Mg	mg/l	NA	NA	734	446	202	367	
Na	mg/l	NA	NA	307	156	131	298	
K	mg/l	NA	NA	1.1	12.2	7.7	13.3	
HCO <sub>3</sub>	mg/l	NA	NA	< 1	< 1	288	2270	
SO <sub>4</sub>	mg/l	NA	2125	9523	3213	2315	1915	
Chloride	mg/l	NA	250	170	48	37	362	
NH <sub>4</sub> as N	mg/l	NA	NA	296	11	0.46	3.11	
NO <sub>3</sub> as N	mg/l	NA	190	11.9	0.81	< 0.10	19.6	
Chloroform	mg/l	0.001	NA	0.13	0.005	< .001	< .001	
Al	mg/l	NA	5	744	7	< 0.1	< 0.1	
As	mg/l	0.05	0.05	< 0.001	< 0.001	0.79	< 0.001	
Be	mg/l	0.05	0.017	0.17	< 0.01	< 0.01	< 0.01	
Cd	mg/l	0.01	0.01	0.030	0.005	< 0.005	< 0.005	
Co	mg/l	NA	0.05	1.84	0.65	0.073	< 0.01	
Pb	mg/l	0.05	0.05	< 0.05	< 0.05	< 0.05	< 0.05	
Mn	mg/l	NA	2.6	55.4	6.9	2.8	2.8	
Mo	mg/l	NA	1	< 0.1	< 0.1	1.75	< 0.1	
Ni	mg/l	0.05	0.2	1.70	0.58	0.117	< 0.05	
Se	mg/l	0.01	0.01	< 0.001	< 0.001	< 0.001	< 0.001	
V	mg/l	0.1	0.7	2.43	< 0.1	< 0.1	< 0.1	
U	mg/l	0.3	5	1.48	0.0557	0.14	0.208	
Rad-226	pci/l	NA	NA	10.7	7.9	7.1	0.125	
Rad-228	pci/l	NA	NA	< 1.0	10.5	3.9	< 1.0	
Rad Total	pci/l	5	5	10.7	18.3	10.9	0.125	
Th-230	pci/l	5	NA	411	0.325	< 0.2	< 0.2	
Pb-210	pci/l	1	NA	< 1.0	< 1.0	< 1.0	< 1.0	
Gross Alpha	pci/l	15	15	33.8	14.2	8.1	< 1.0	

Notes:

1. mg/l = milligrams per liter.
2. NA = not applicable.
3. pci/l = pico curies per liter.
4. SU = standard units.

TABLE 3-2

UNC CHURCH ROCK  
CHURCH ROCK, NEW MEXICO

IN-SITU ALKALINITY STABILIZATION PILOT STUDY

PHREEQC MIXING CALCULATIONS

Well 613 Fraction	Well 509D Fraction	mix pH	ppp pH	Phases ppt
1.00	0.00	3.04	N/A	N/A
0.90	0.10	3.26	3.18	Alunite, Uraninite
0.67	0.33	4.08	3.62	Alunite, Uraninite, Boehmite, Gypsum
0.50	0.50	4.21	3.68	Alunite, Uraninite, Boehmite, Gypsum
0.33	0.67	4.48	3.89	Alunite, Uraninite, Boehmite, Gypsum
0.10	0.90	6.13	5.98	Uraninite, Boehmite, Gypsum, Calcite, Thorianite
0.00	1.00	6.4	N/A	N/A

<u>Phase</u>	<u>Formula</u>
Alunite	$KAl_3(OH)_6(SO_4)_2$
Boehmite	$AlO_2H$
Calcite	$CaCO_3$
Gypsum	$CaSO_4 \cdot 2H_2O$
Thorianite	$ThO_2$
Uraninite	$UO_2$

TABLE 3-3

UNC CHURCH ROCK  
CHURCH ROCK, NEW MEXICO

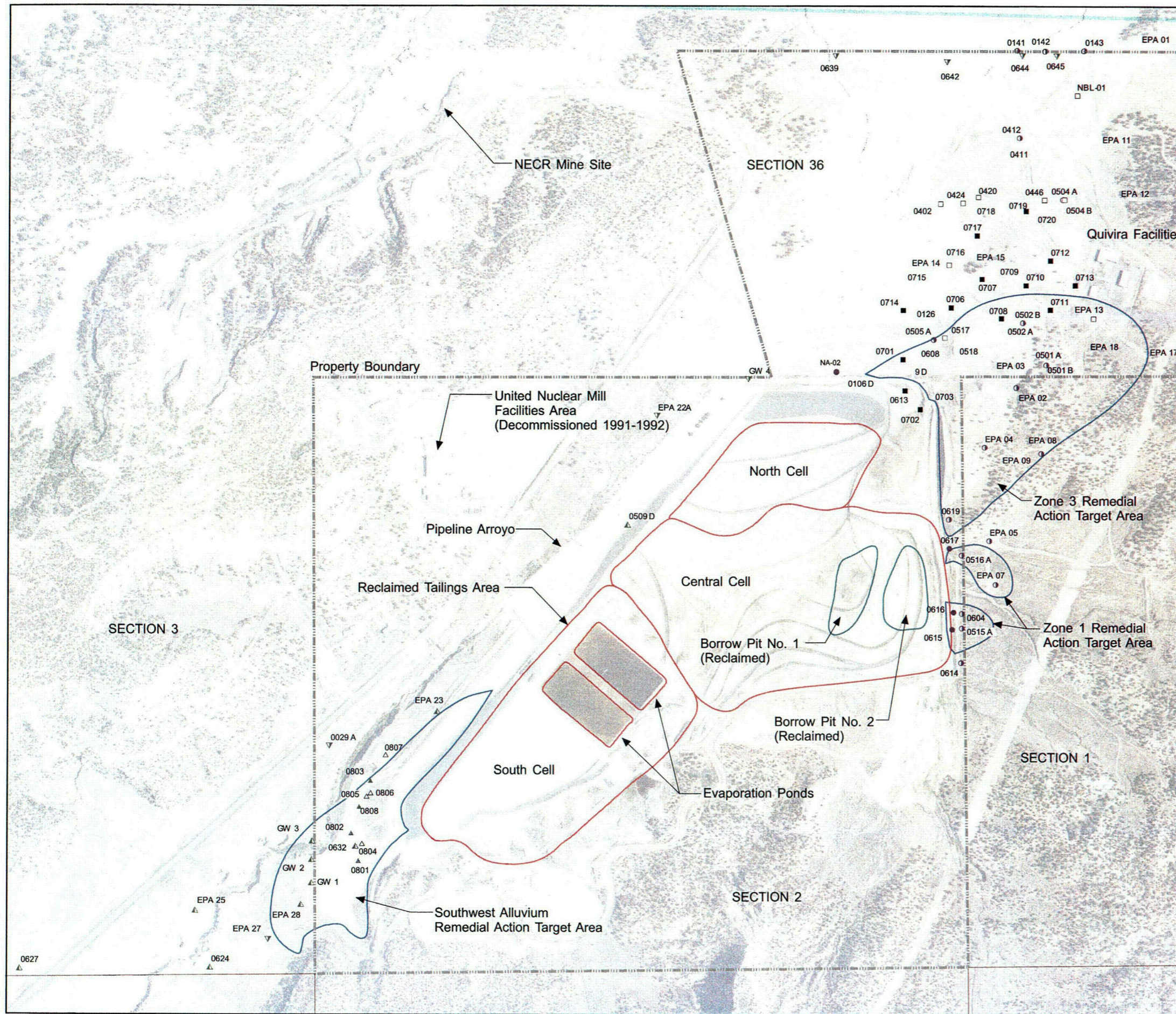
IN-SITU ALKALINITY STABILIZATION PILOT STUDY

LABORATORY BATCH-MIXING EXPERIEMENTS

Fraction Well 613 (or 517)	Fraction Well 509D	Added Solids	Daily Analyses	Weekly Analyses
0	1	No	N/A	Table A constituents
1	0	No	N/A	Table A constituents
0.9	0.1	No	pH, Sp. Conductance	Table A constituents; XRD
0.9	0.1	Yes	pH, Sp. Conductance	Table A constituents
0.5	0.5	No	pH, Sp. Conductance	Table A constituents; XRD
0.5	0.5	Yes	pH, Sp. Conductance	Table A constituents
0.1	0.9	No	pH, Sp. Conductance	Table A constituents; XRD
0.1	0.9	Yes	pH, Sp. Conductance	Table A constituents

## *Figures*

---



# **LEGEND:**

## **Southwest Alluvium**

- ▲ Idled Extraction Well
- ▲ Monitoring Well
- △ Water Level Monitoring Well
- ▼ Dry Monitoring Well

## **Zone 3**

- Idled Extraction Well Used for Monitoring
- Decommissioned or Idle Extraction Well
- Monitoring Well
- Dry or Decommissioned Monitoring Well

## **Zone 1**

- Decommissioned Extraction Well
- Decommissioned Monitoring Well
- Monitoring Well

# **NOTES:**

1. Figure taken from *Annual Review Report - 2004 Groundwater Corrective Action* by NA Water Systems, dated December 2004.

0 400 800 1,600  
Feet

UNC CHURCH ROCK  
CHURCH ROCK, NEW MEXICO  
**IN-SITU ALKALINITY  
STABILIZATION PILOT STUDY**  
**SITE LAYOUT AND PERFORMANCE  
MONITORING WELL LOCATIONS  
2004 OPERATING YEAR**

**BBL**  
BLASLAND, BOUCK & LEE, INC.  
engineers, scientists, economists

**FIGURE  
1-1**

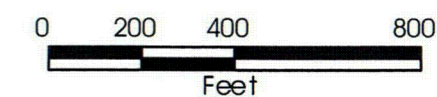


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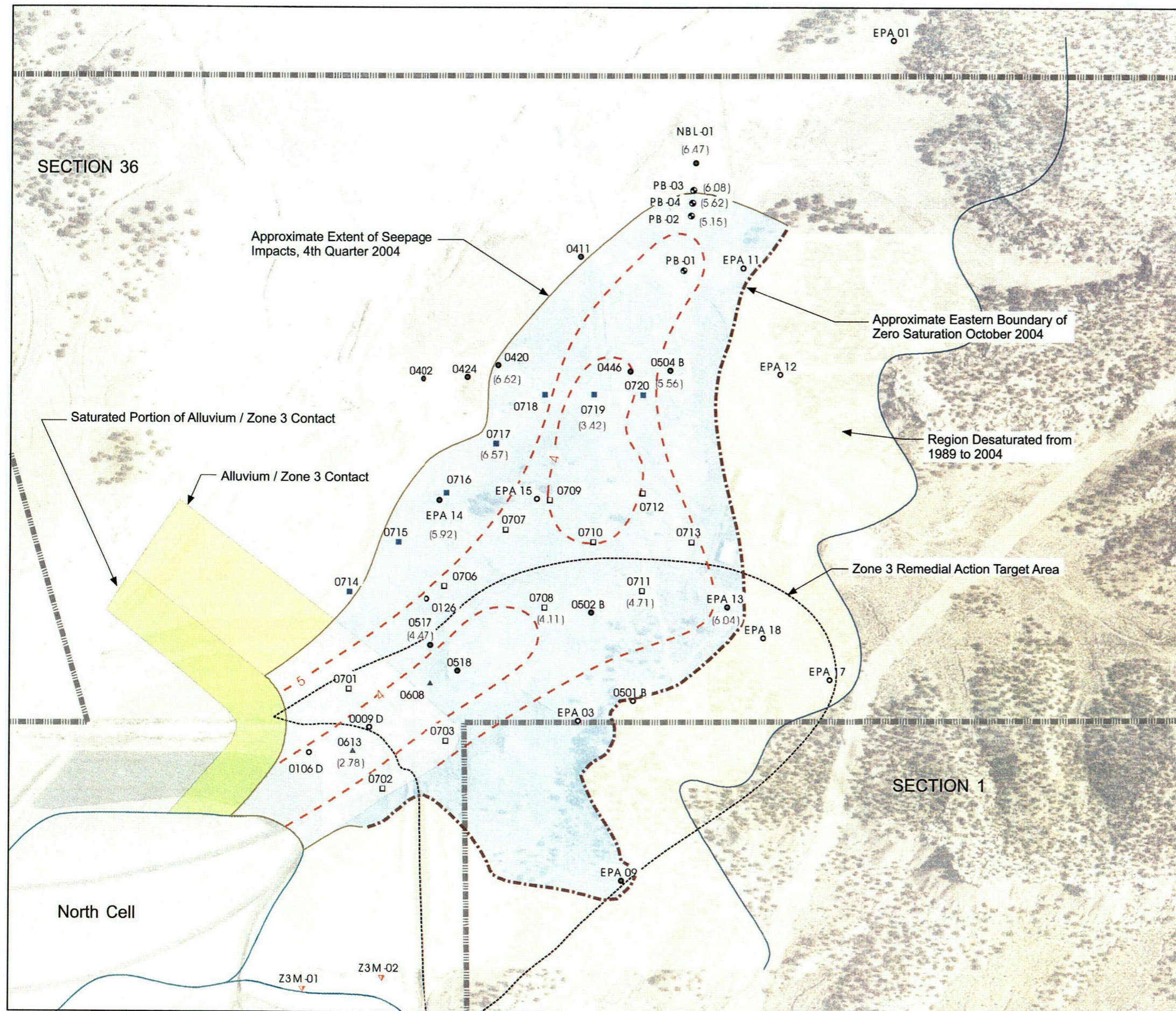
- Well Names
- Cell Boundaries
- Property Boundary
- Approximate Eastern Boundary of Zero Saturation
- Groundwater Elevation Contour
- Inferred Groundwater Elevation Contour

# **NOTES:**

1. Groundwater elevation values are displayed in feet above mean sea level.
2. Well names are displayed with black text.
3. Groundwater elevations are shown with blue text.
4. Aerial photo taken on August 1, 1996.
5. Figure taken from *Annual Review Report - 2004 Groundwater Corrective Action by NA Water Systems*, dated December 2004.



UNC CHURCH ROCK CHURCH ROCK, NEW MEXICO <b>IN-SITU ALKALINITY          STABILIZATION PILOT STUDY</b>	
<b>ZONE 3 POTENTIOMETRIC          SURFACE MAP - OCTOBER 2004</b>	
 <small>BLASLAND, BOUCK &amp; LEE, INC. engineers, scientists, economists</small>	<b>FIGURE 1-2</b>



#### LEGEND:

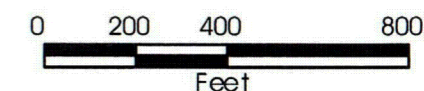
- Property Boundary
- Zone 3 Target Remediation Action Area
- Section Boundary
- Cell Boundary
- Approximate Area Impacted by Tailings Seepage
- pH Contour

#### WELLS:

- Monitoring
- Dry Monitoring
- Stage I Extraction
- Stage II Extraction
- Plume Boundary
- Northeast Pump-Back
- Piezometer
- Approximate Eastern Boundary of Zero Saturation

#### NOTES:

1. All locations are approximate.
2. Values for field measured pH are shown with purple text and enclosed in parentheses.
3. Aerial Photo taken August 1, 1996.
4. Figure taken from *Annual Review Report - 2004 Groundwater Corrective Action* by NA Water Systems, dated December 2004.



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CHURCH ROCK, NEW MEXICO  
**IN-SITU ALKALINITY  
STABILIZATION PILOT STUDY**

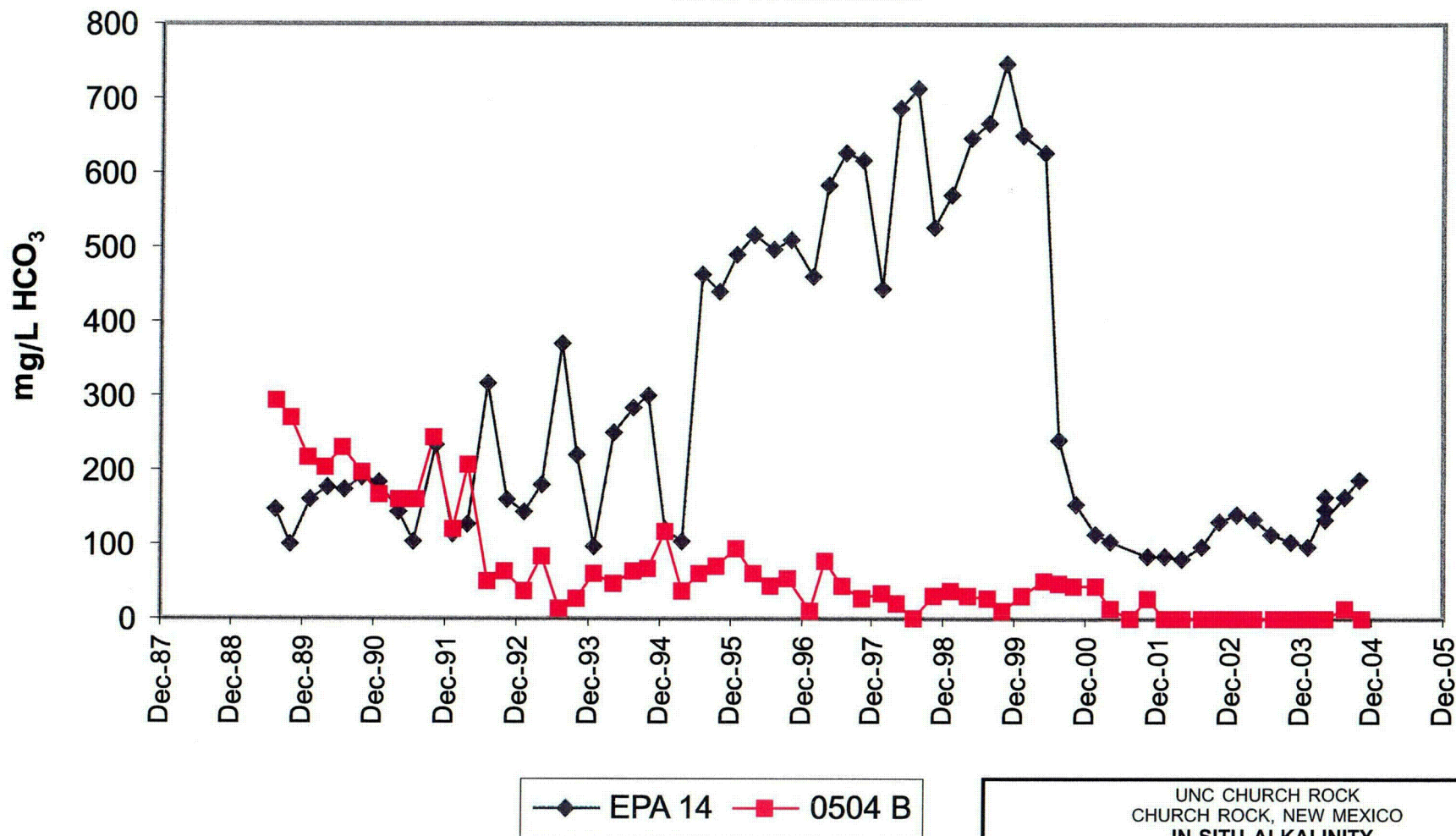
**ZONE 3 APPROXIMATE EXTENT OF  
SEEPAGE IMPACTS - OCTOBER 2004**

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engineers, scientists, economists

**FIGURE  
1-3**

# Bicarbonate vs Time

EPA 14 and 504b



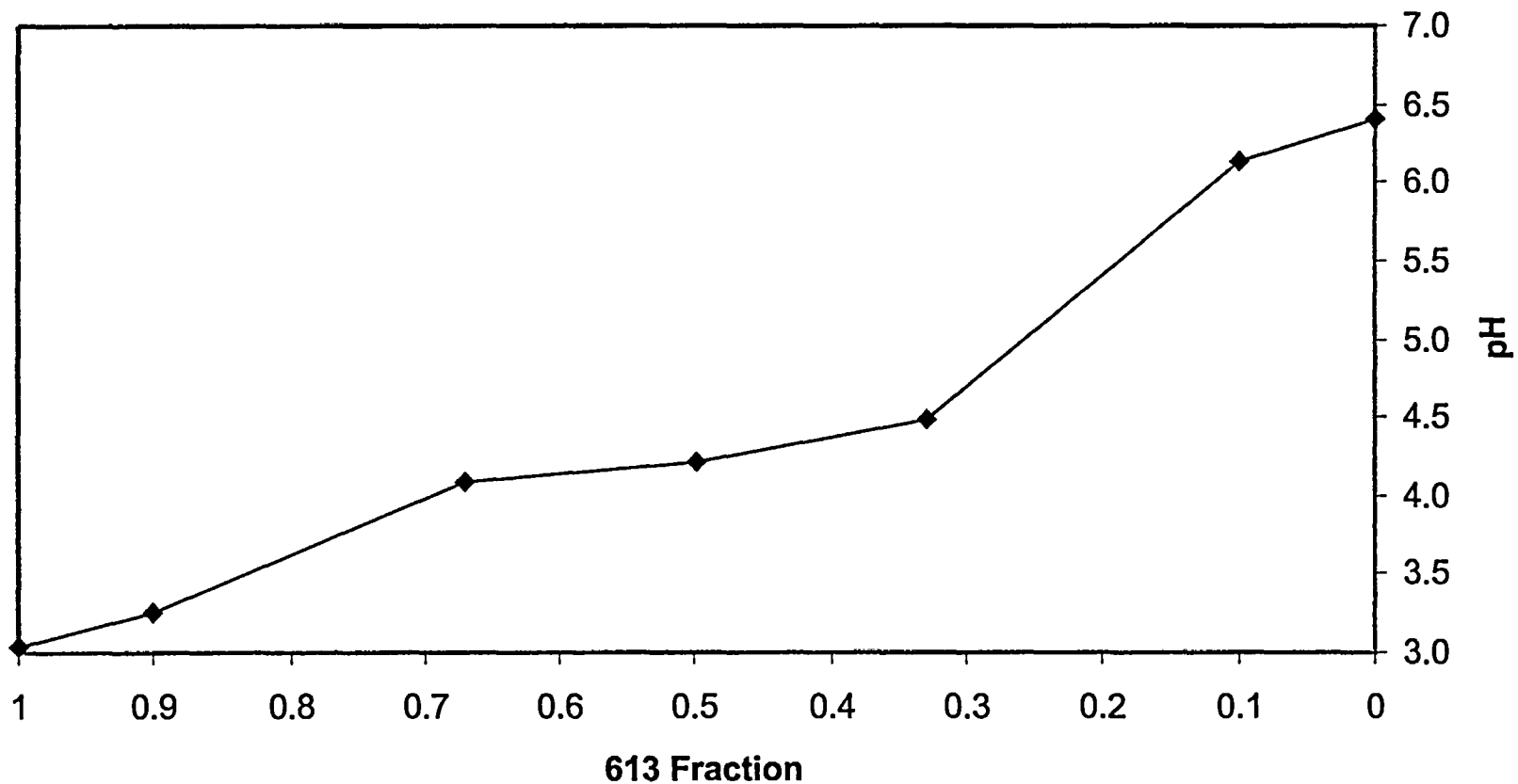
UNC CHURCH ROCK  
CHURCH ROCK, NEW MEXICO  
IN-SITU ALKALINITY  
STABILIZATION PILOT STUDY

BICARBONATE VS TIME

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FIGURE  
3-1

**pH**  
**PHREEQC Mixing w/Mineral Precipitation**

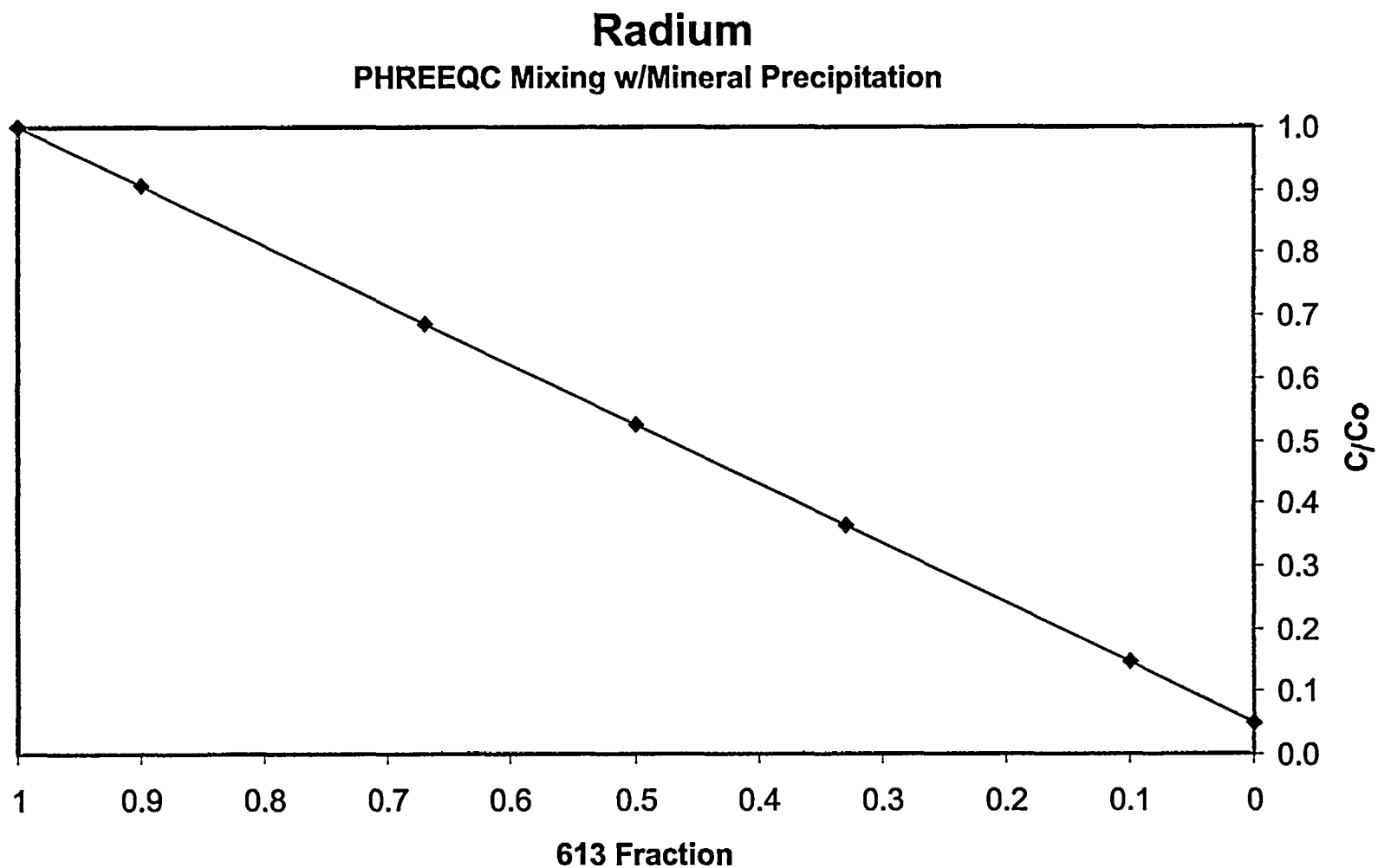


UNC CHURCH ROCK  
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IN-SITU ALKALINITY  
STABILIZATION PILOT STUDY

pH  
PHREEQC MIXING WITH  
MINERAL PRECIPITATION

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FIGURE  
**3-2**



UNC CHURCH ROCK  
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IN-SITU ALKALINITY  
STABILIZATION PILOT STUDY

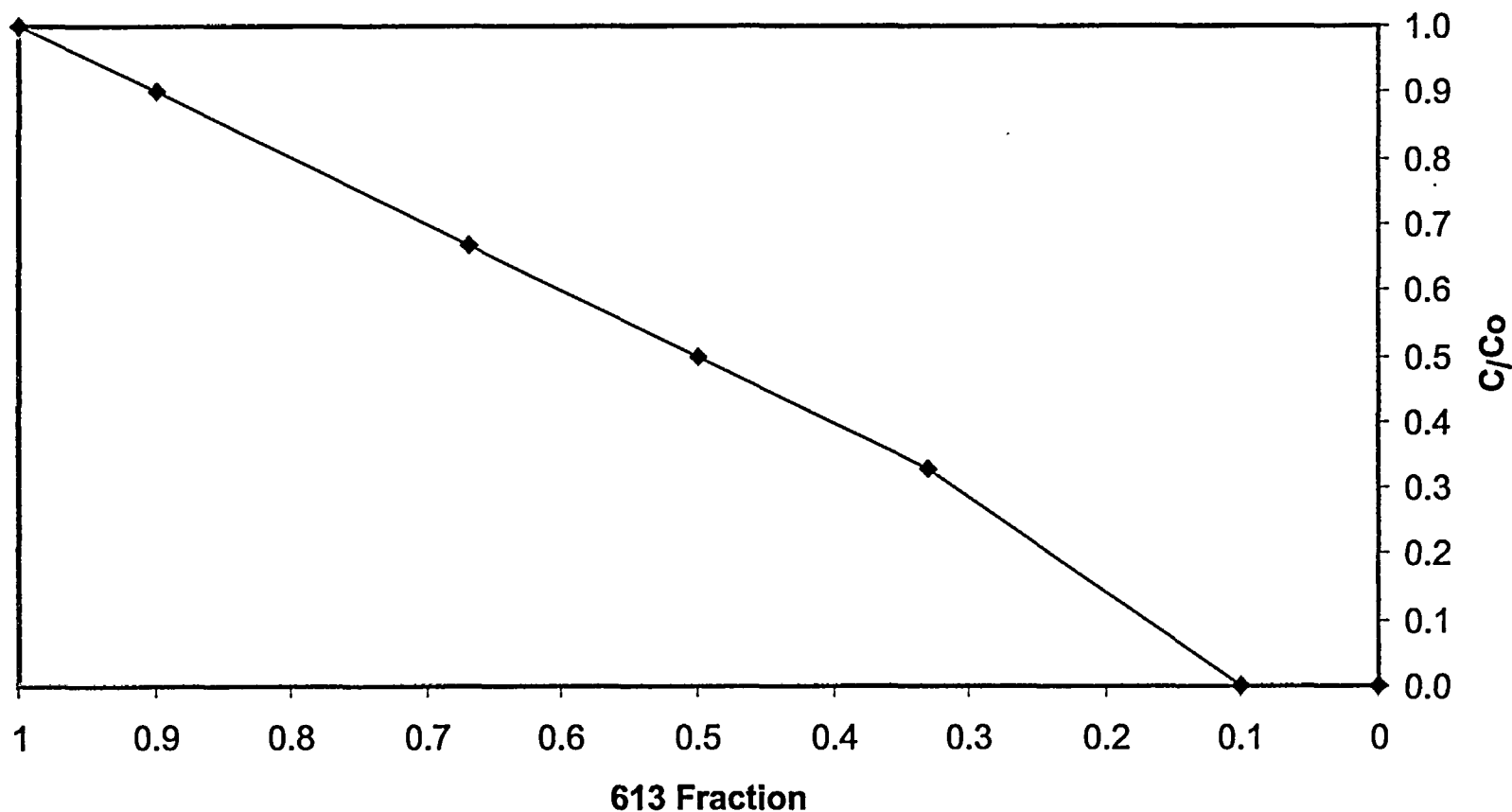
**RADIUM**  
PHREEQC MIXING WITH  
MINERAL PRECIPITATION

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FIGURE  
**3-3**

# Thorium

## PHREEQC Mixing w/Mineral Precipitation



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CHURCH ROCK, NEW MEXICO  
IN-SITU ALKALINITY  
STABILIZATION PILOT STUDY

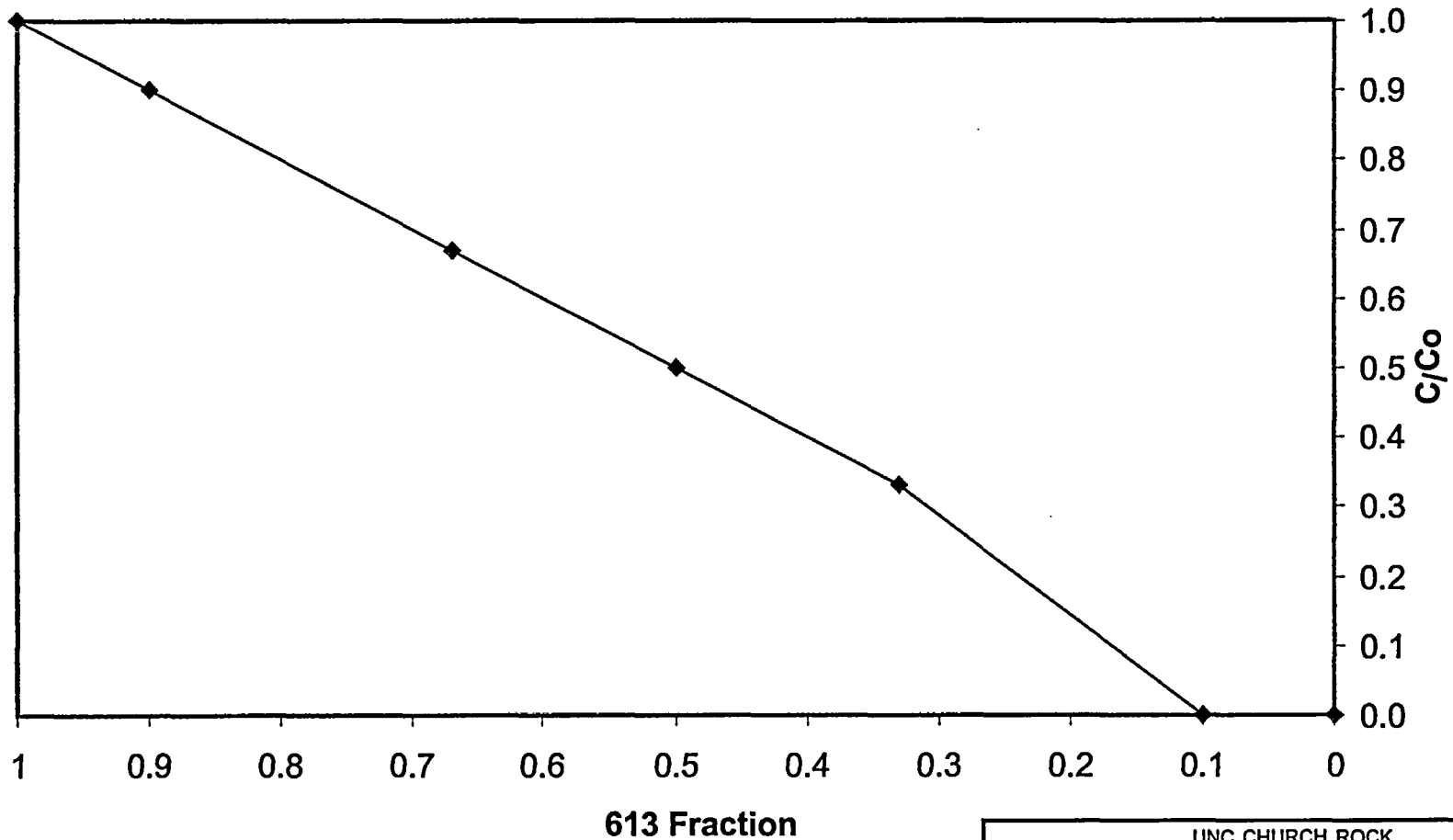
**THORIUM**  
**PHREEQC MIXING WITH**  
**MINERAL PRECIPITATION**

**BBL**  
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engineers, scientists, economists

FIGURE  
**3-4**

# Uranium

## PHREEQC Mixing w/Mineral Precipitation



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IN-SITU ALKALINITY  
STABILIZATION PILOT STUDY

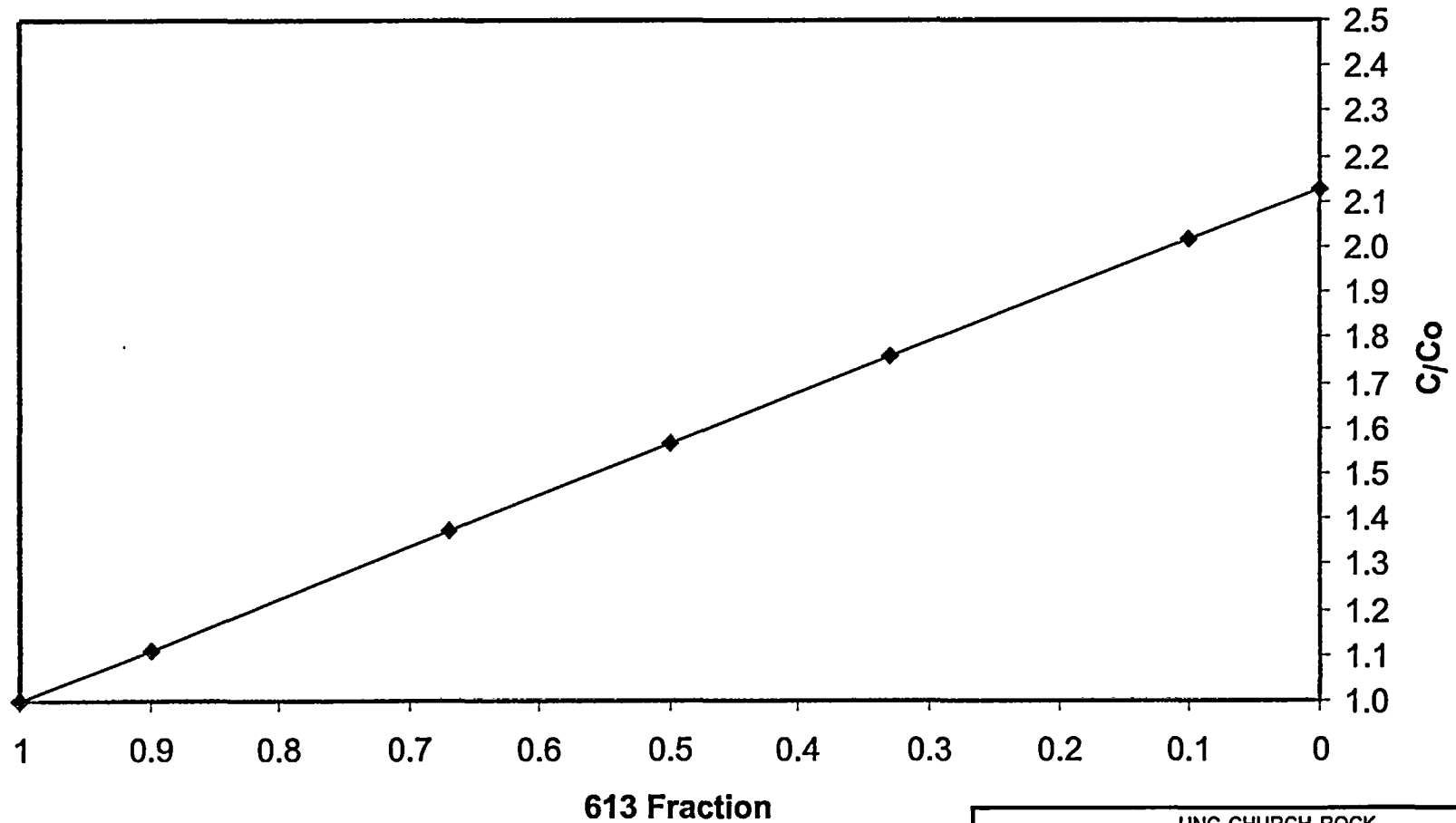
URANIUM  
PHREEQC MIXING WITH  
MINERAL PRECIPITATION

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engineers, scientists, economists

FIGURE  
3-5

# Chloride

## PHREEQC Mixing w/Mineral Precipitation

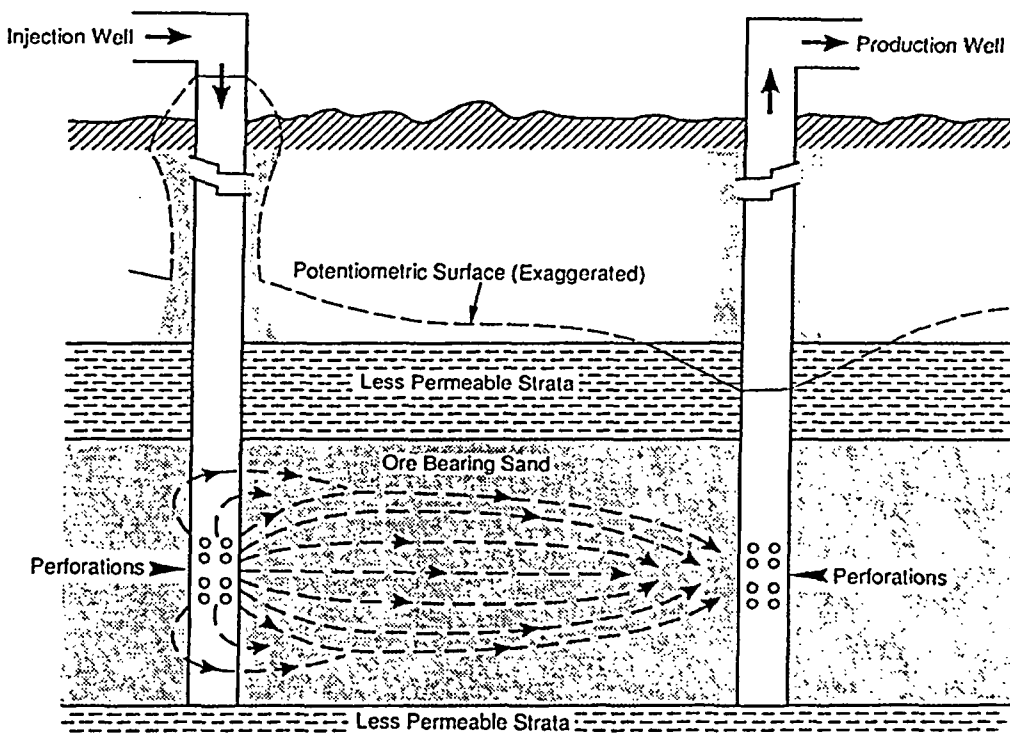


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IN-SITU ALKALINITY  
STABILIZATION PILOT STUDY

CHLORIDE  
PHREEQC MIXING WITH  
MINERAL PRECIPITATION

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FIGURE  
**3-6**



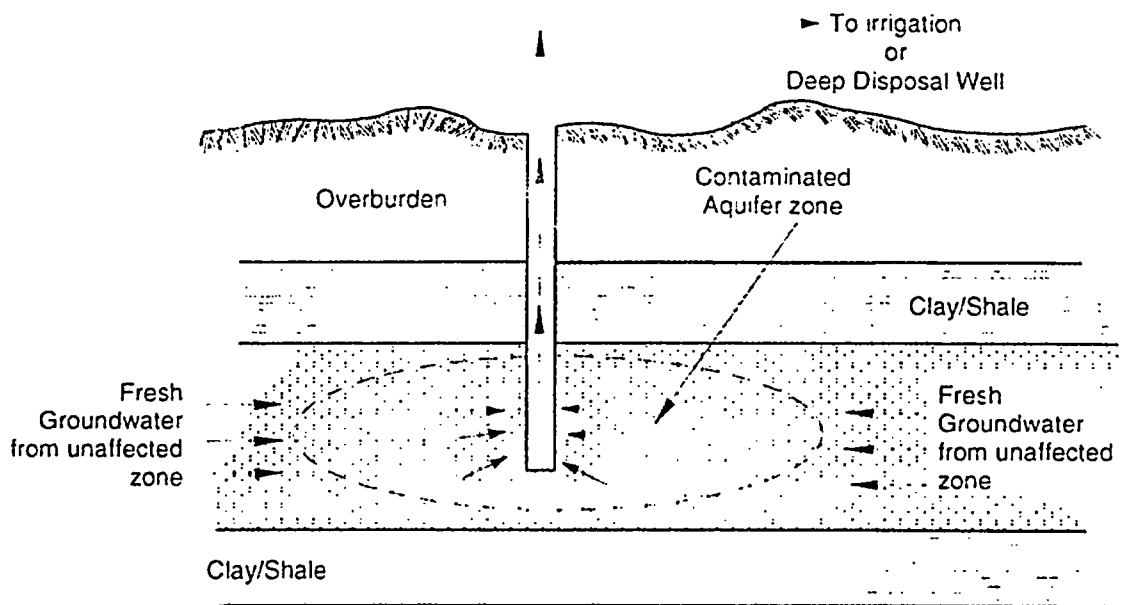
REFERENCE:  
FIGURE TAKEN FROM <http://www.nrc.gov/reading-rm/doc-collections/nuregs/contract/cr6870/cr6870.pdf>

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IN-SITU ALKALINITY  
STABILIZATION PILOT STUDY

TYPICAL SCHEMATIC OF THE  
IN-SITU LEACH MINING PROCESS

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BLASLAND, BOUCK & LEE, INC.  
engineers, scientists, economists

FIGURE  
4-1



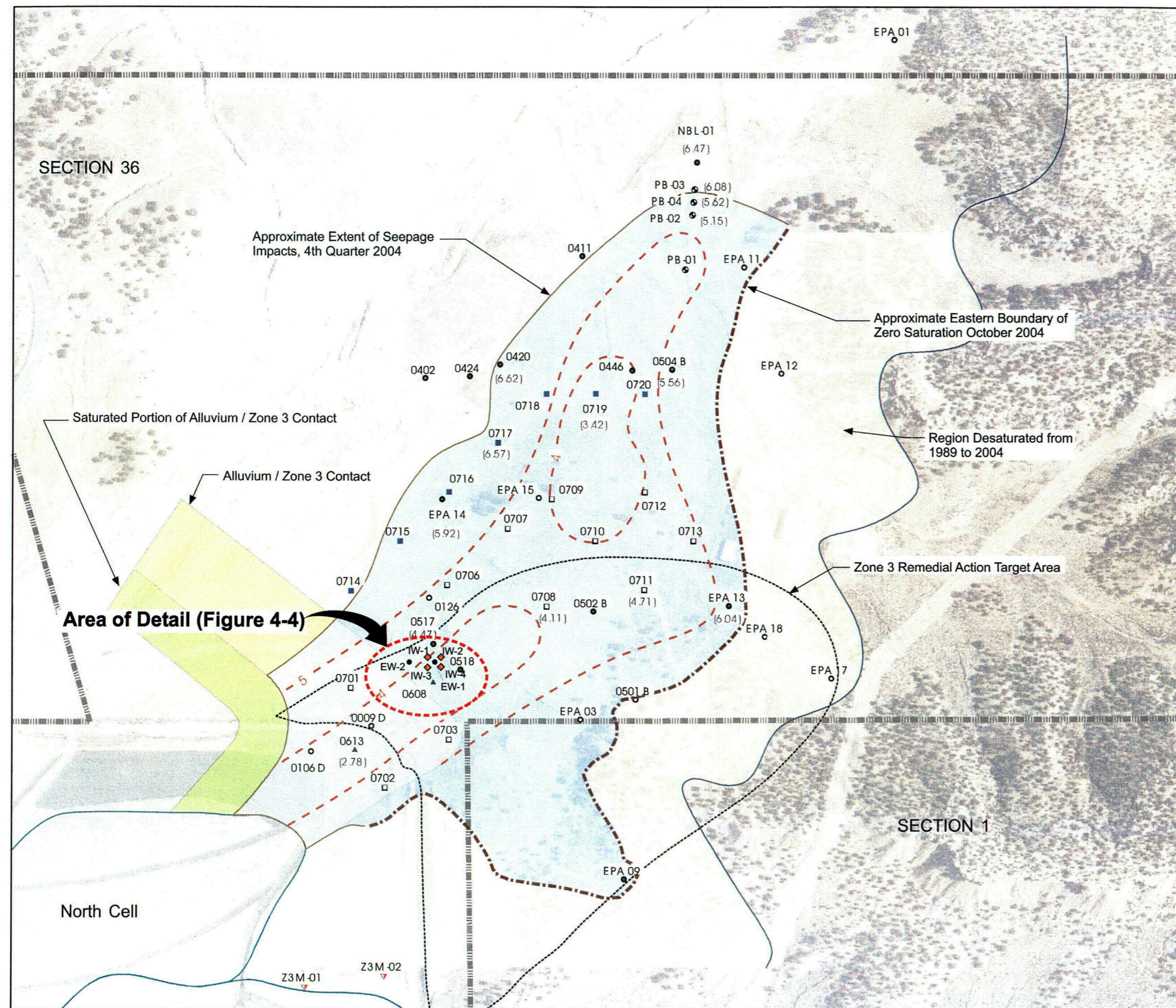
**REFERENCE:**  
FIGURE TAKEN FROM <http://www.nrc.gov/reading-rm/doc-collections/nuregs/contract/cr6870/cr6870.pdf>

UNC CHURCH ROCK  
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STABILIZATION PILOT STUDY

### SCHEMATIC OF THE GROUNDWATER SWEEP PROCESS

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FIGURE  
**4-2**



# **LEGEND:**

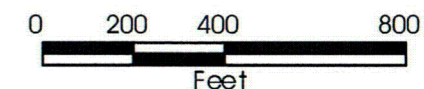
- Property Boundary
- Zone 3 Target Remediation Action Area
- Section Boundary
- Cell Boundary
- Approximate Area Impacted by Tailings Seepage
- pH Contour

## **WELLS:**

- Monitoring
- Dry Monitoring
- Stage I Extraction
- Stage II Extraction
- Plume Boundary
- Northeast Pump-Back
- Piezometer
- Proposed Extraction Well
- Proposed Injection Well
- Approximate Eastern Boundary of Zero Saturation

## **NOTES:**

- All locations are approximate.
- Values for field measured PH are shown with purple text and enclosed in parentheses.
- Aerial Photo taken August 1, 1996.
- Figure taken from *Annual Review Report - 2004 Groundwater Corrective Action* by NA Water Systems, dated December 2004.

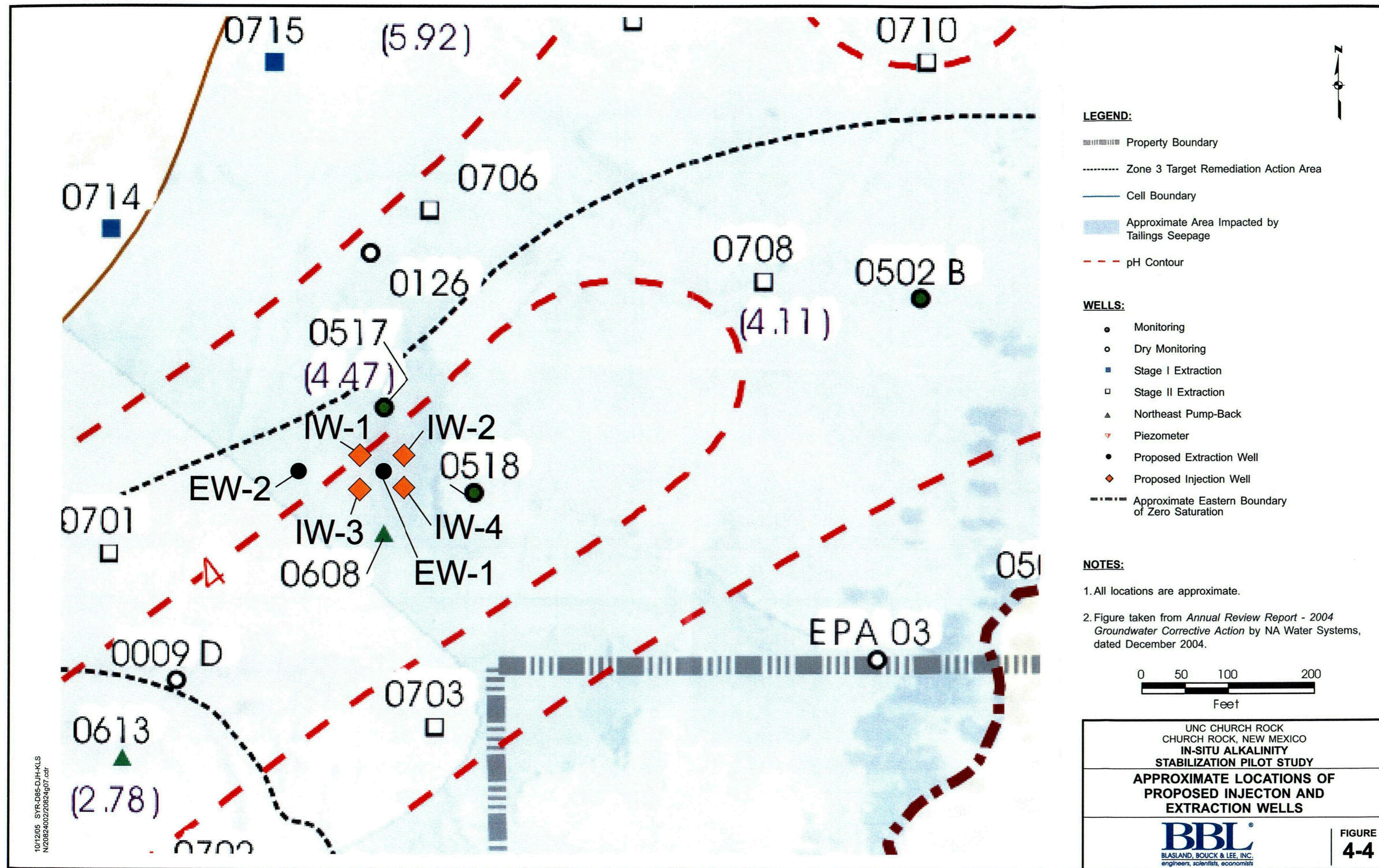


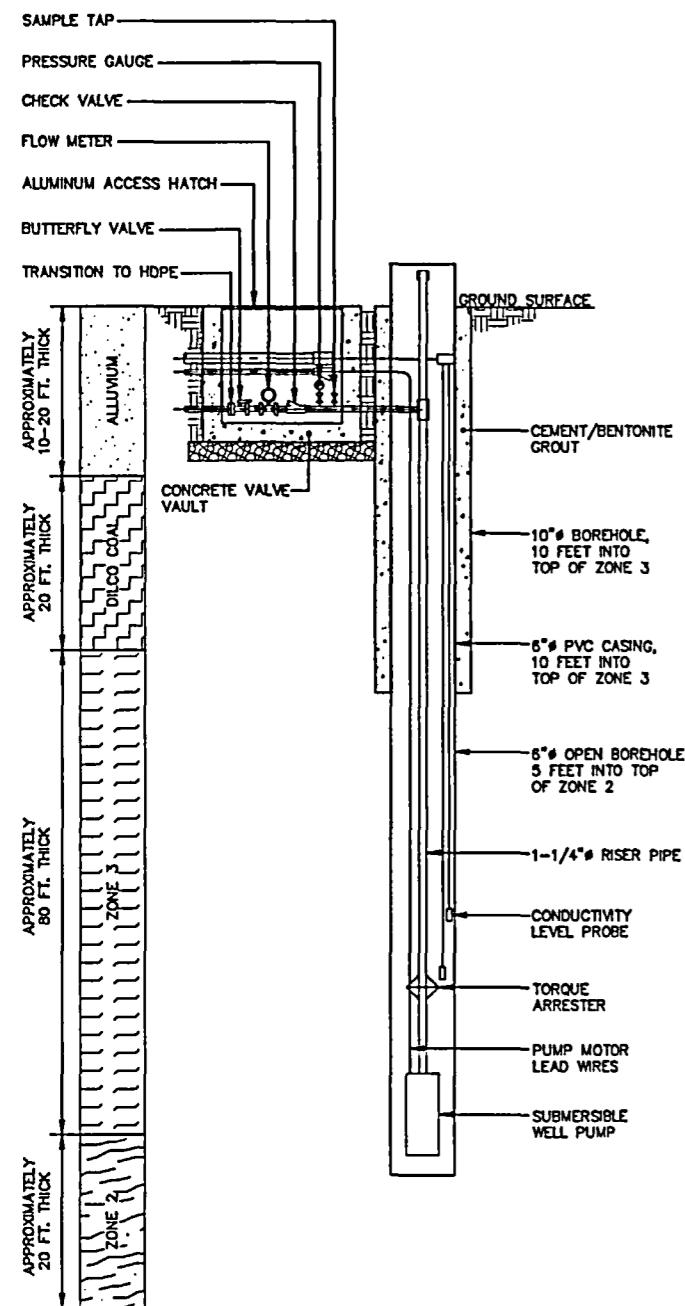
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**IN-SITU ALKALINITY  
STABILIZATION PILOT STUDY**

## **PILOT STUDY LOCATION**

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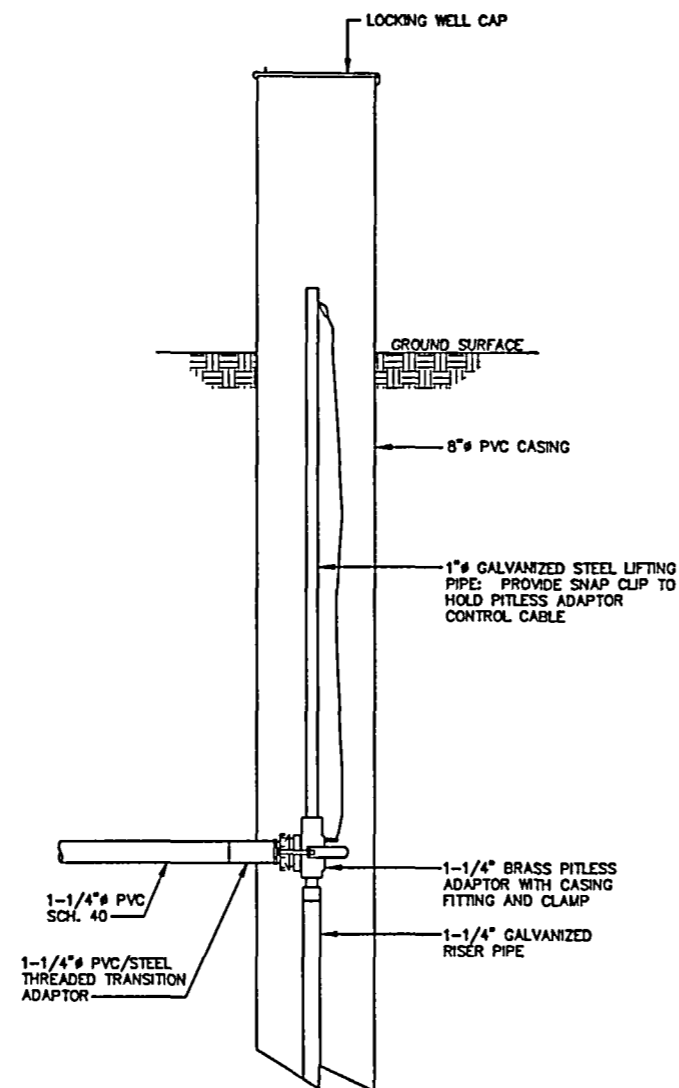
**FIGURE  
4-3**





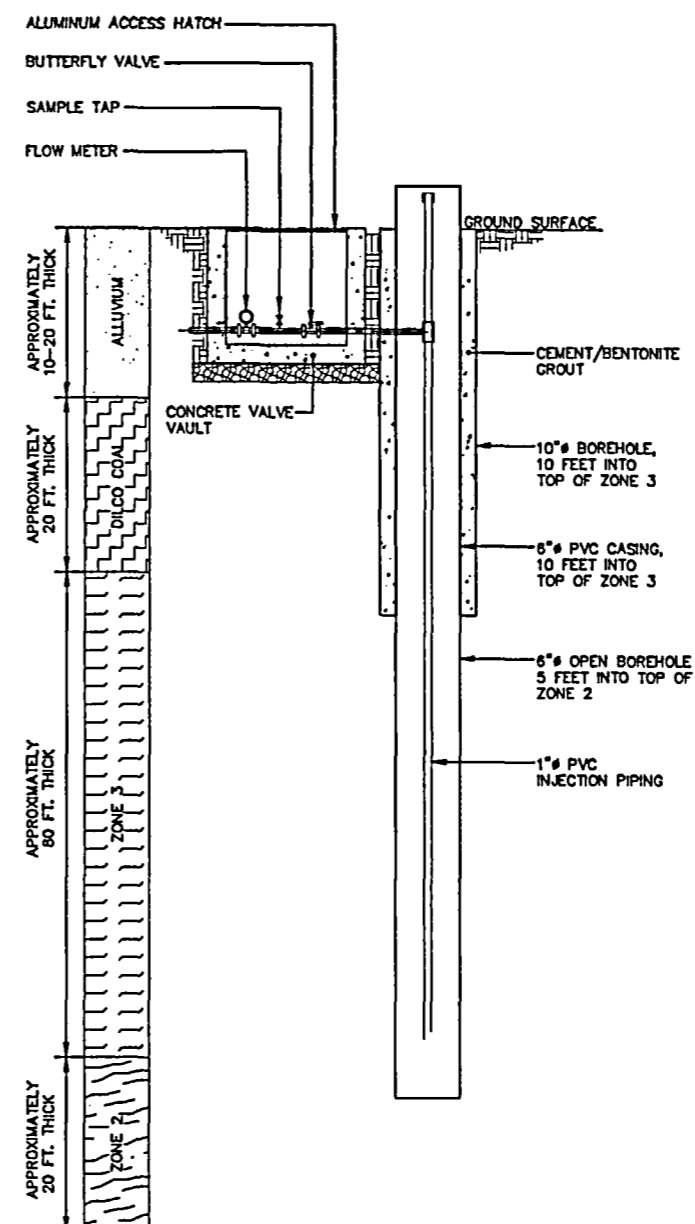
**EXTRACTION WELL DETAIL**

NOT TO SCALE



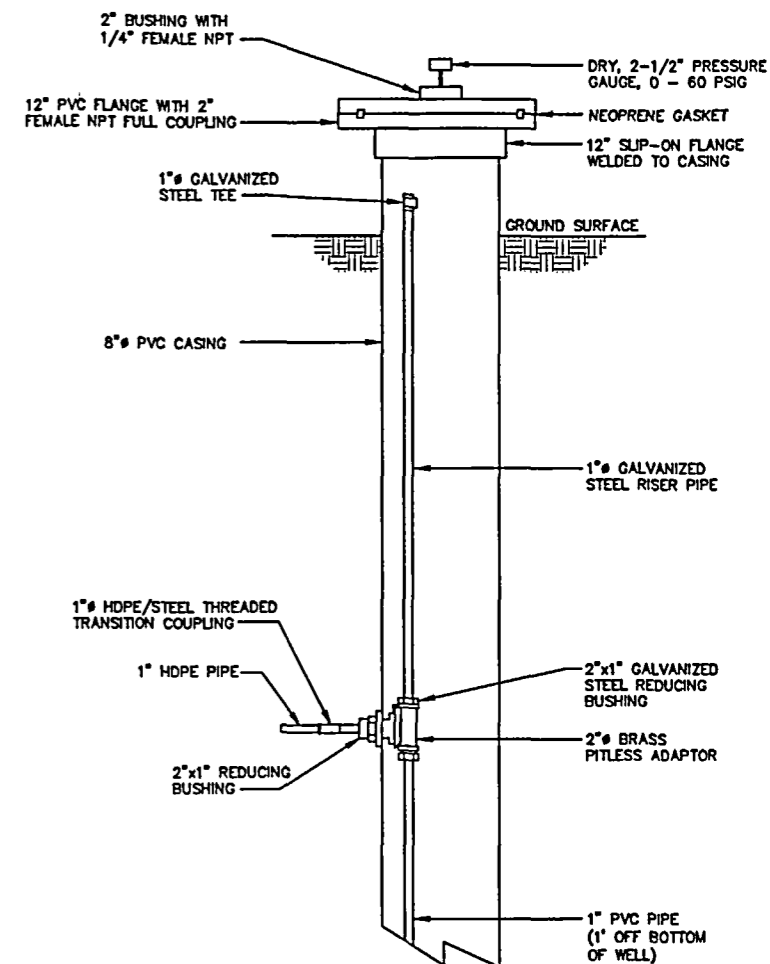
**EXTRACTION WELL HEAD DETAIL**

NOT TO SCALE



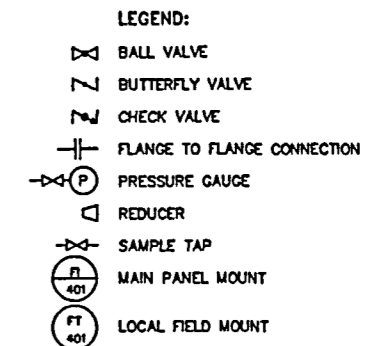
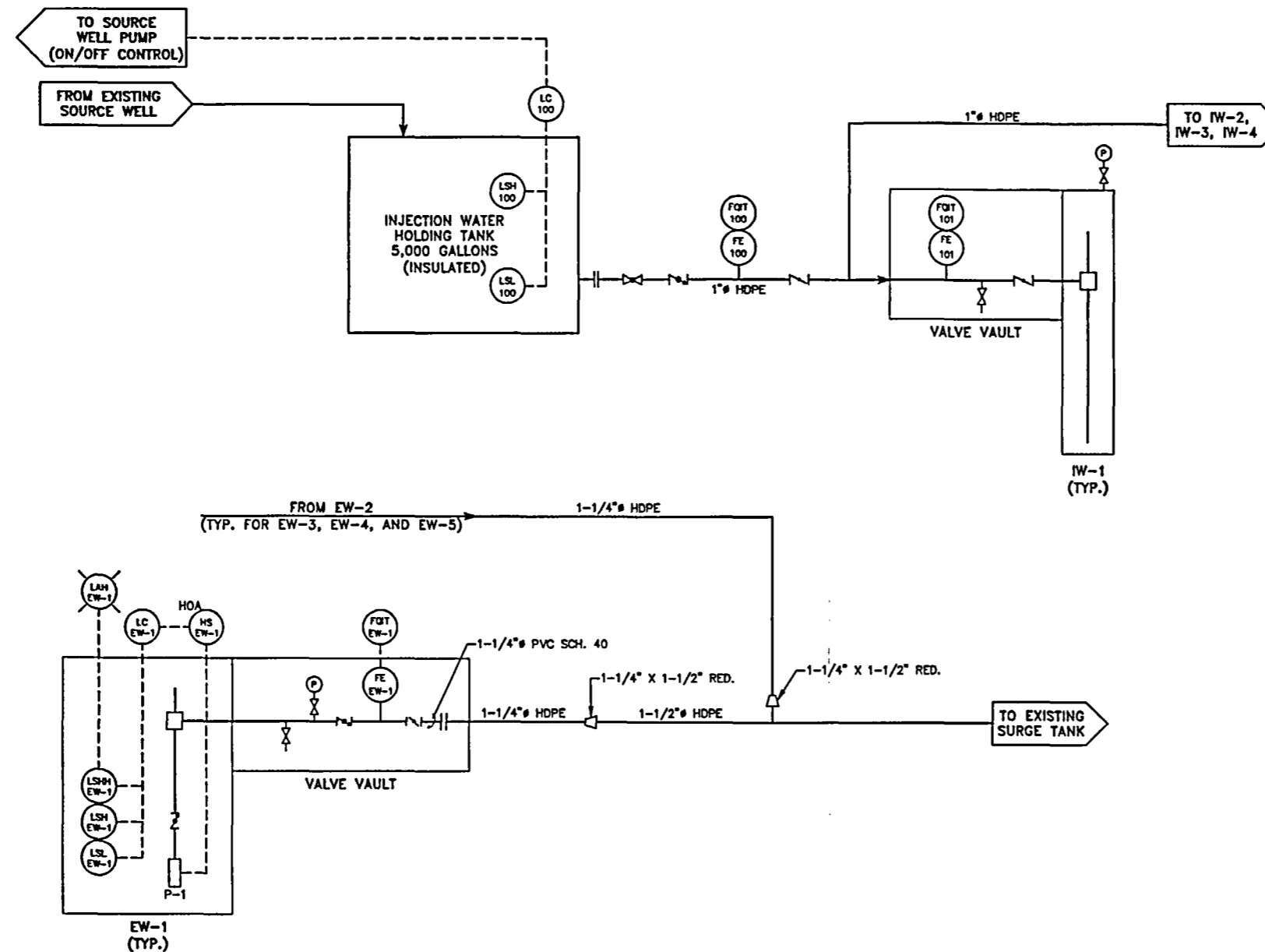
**INJECTION WELL DETAIL**

NOT TO SCALE



**INJECTION WELL HEAD DETAIL**

NOT TO SCALE



ABBREVIATIONS:

- EW EXTRACTION WELL
- FE FLOW ELEMENT
- FQIT TOTALIZING FLOW TRANSMITTER
- HOA HAND-OFF-AUTO
- HS HAND SWITCH
- IW INJECTION WELL
- LC LEVEL CONTROLLER
- LAHH LEVEL ALARM HIGH-HIGH
- LSH LEVEL SWITCH HIGH
- LSHH LEVEL SWITCH HIGH-HIGH
- LSL LEVEL SWITCH LOW
- RED. REDUCER
- SCH. SCHEDULE
- TYP. TYPICAL

#### SPECIFICATIONS:

1. EXTRACTION WELL PUMPS SHALL BE GRUNDFOS MODEL 10RED-F103-140 OR EQUAL, CAPABLE OF A MINIMUM OF 1 GPM WHILE OPERATING WITH 150' OF TOH, WITH 1/3HP, 230V, SINGLE PHASE MOTOR.
2. FLOW METERS SHALL CONSIST OF SIGNET 2536 PADDLEWHEEL SENSOR OR EQUAL WITH POLYPROPYLENE BODY, VITON O-RINGS AND PVDF ROTOR CONNECTED TO A SIGNET MODEL 8550 DISPLAY WITH RATE AND TOTAL CAPABILITIES, ONE SENSOR INPUT AND ONE 4-20 MA OUTPUT.

#### NOTE:

1. HEAT TRACE AND INSULATE ALL ABOVE GROUND PIPING.

X: NONE  
L: ON=\*, OFF=\*\*REF\*  
P: PAGESET/PLT-DL  
10/10/05 SYR-B5-BGP  
N/20824002/20824001.DWG

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IN-SITU ALKALINITY  
STABILIZATION PILOT STUDY

### PIPING AND INSTRUMENTATION DIAGRAM

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engineers, scientists, economists

FIGURE  
**4-6**

## ***Attachment A***

---

### **Substantive UIC Permit**



BILL RICHARDSON  
GOVERNOR

*State of New Mexico*  
**ENVIRONMENT DEPARTMENT**

*Ground Water Quality Bureau*  
*Harold Runnels Building*  
1190 St. Francis Drive, P.O. Box 26110  
Santa Fe, New Mexico 87502-6110  
Telephone (505) 827-2900  
Fax (505) 827-2965  
[www.nmenv.state.nm.us](http://www.nmenv.state.nm.us)



RON CURRY  
SECRETARY

DERRITH WATCHMAN-MOORE  
DEPUTY SECRETARY

**GROUND WATER DISCHARGE PERMIT APPLICATION**

Enclosed is a Ground Water Discharge Permit Application Form (Form) and checklist. Section 20.6.2.3104 NMAC of the NM Water Quality Control Commission Regulations (20.6.2 NMAC) requires that any person proposing to discharge effluent or leachate so that it may move directly or indirectly into ground water must have an approved discharge permit, unless a specific exemption is provided for in the Regulations. The enclosed Form is a general guideline for use by applicants to ensure that an application is complete and provides all of the information required by sections 20.6.2.3106, 20.6.2.3107, 20.6.2.3108, and 20.6.2.3109 NMAC.

Mail **three complete copies** of your application with a **\$100 filing fee** check made payable to the New Mexico Environment Department (NMED) at the address below:

George Schuman, Program Manager  
Ground Water Pollution Prevention Section  
NM Environment Department  
P. O. Box 26110  
Santa Fe, NM 87502

Pursuant to Regulation 20.6.2.3108 NMAC, NMED will, within thirty (30) days of deeming the application administratively complete, publish a public notice and allow 30 days for public comment before taking final action on a discharge permit. A public hearing will be held if NMED determines that there is significant public interest. It takes approximately 180 days to process a complete application and issue a discharge permit if no public hearing is held.

All applications must be accompanied by a filing fee of \$100. **An additional fee will be assessed prior to permit issuance** to cover the estimated cost to the NMED for investigation, and, issuance of the permit. **Permit fees are listed in the Regulation 20.6.2.3114 NMAC.**

**If you have any questions about this discharge permit application, call the Ground Water Pollution Prevention Section at 505-827-2900**

### COMPLETION CHECKLIST

<input type="checkbox"/>	All portions of the Ground Water Discharge Permit Application Form have been addressed. (The application will not be considered complete if there are omissions, which will delay publication of the public notice and issuance of the permit.)
<input type="checkbox"/>	Submitter has included operational, monitoring, contingency, and closure plans that are appropriate for the proposed treatment and disposal system, and meet the site-specific conditions for the proposed facility.
<input type="checkbox"/>	Plans and specifications for the entire effluent or leachate conveyance, collection, treatment, distribution, and disposal system have been included as required by Regulation 20.6.2.1202 NMAC. For septic tank/leachfield systems, designs should be consistent with NMED's guidelines for Plans and Specifications for Discharge Permit Applications Using Septic Tank/Leachfields.
<input type="checkbox"/>	The application has been signed and dated by the responsible party, generally the owner or lessee.
<input type="checkbox"/>	If your facility site includes an archeological site on the State Register of Cultural Properties or National Register of Historic Places, the State Historic Preservation Office has the authority to require an archeological or historical study prior to NMED taking final action on your discharge permit.
<input type="checkbox"/>	Four maps have been included: 1) area United States Geological Survey (USGS) topographic map that includes the location of the facility and all of the information required in the application item 7.b, 2) local road map clearly defining the location of the facility and the route to get to the facility, 3) detailed site map that includes all discharge locations (lagoons, leachfields, land application areas, outfalls...), all water supply and monitoring wells, all water courses on the property and all buildings and 4) United States Department of Agriculture (USDA) soils map.
<input type="checkbox"/>	Three copies of all required information have been enclosed.
<input type="checkbox"/>	A filing fee check in the amount of \$100, has been enclosed, made payable to the NM Environment Department at the address on page 1.
<input type="checkbox"/>	The SUMMARY OF APPLICANT'S PUBLIC NOTICE REQUIREMENTS has been reviewed and the option for Public Notice Has been selected on the application page 3.

## ADMINISTRATIVE COMPLETENESS

To be deemed administratively complete for publication of a public notice, the following information must be provided. [20.6.2.3106, 20.6.2.3108 NMAC]

Review the SUMMARY OF APPLICANT'S PUBLIC NOTICE REQUIREMENTS (attached) to select an option below.

☐ Public Notice Option 1   ☐ Public Notice Option 2   ☐ Public Notice Option 3

**1.     Name of the proposed discharger and facility [20.6.2.3106, 20.6.2.3108.C.1 NMAC]:**

**Type of facility or operation** (dairy, municipal wwtp, mining, school, etc.): mining

	Name	Address*	City	State	Zip	Telephone & Fax
<b>Facility*</b>	United Nuclear Corporation (UNC) Church Rock Site		Gallup	NM		
<b>Owner</b>	United Nuclear Corporation					
<b>Responsible Party</b>						
<b>Facility Representative</b>	Roy Blickwedel	640 Freedom Business Center	King of Prussia	PA	19406	(610) 992-9935
<b>Consultant</b>	Blasland, Bouck & Lee, Inc. (BBL)	6723 Towpath Road, PO Box 66	Syracuse	NY	13214	P(315)446-9120 F(315)449-4111
<b>Other (specify)</b>						

\*For the facility address, enter physical address- not mailing address.

**2.     Locations of the Discharges [20.6.2.3106.C.2 and 20.6.3108.C.2 NMAC]:**

List the locations of the discharges covered by this permit. Add rows as necessary to include all discharge locations. Sections should be described to the nearest ¼ of a ¼ of a ¼ section (please see attachment).

Discharge Location (lagoons, leachfields, land application areas, outfalls, etc.)	County	Township	Range	Section	Latitude	Longitud
Injection wells (IW-1, IW-2, IW-3, and IW-4)	Refer to Figure 4-4 of the In-Situ Alkalinity Stabilization Pilot Study (Pilot Study).					

**3. Brief Description of Discharge [20.6.2.3108.C.3 NMAC]:**

Briefly describe the activities which produce the discharge(s) including the treatment and disposal methods. Attach additional pages as necessary.

The activities producing the discharge include injection of alkalinity-rich groundwater from an unimpacted portion of the Southwest Alluvium into injection wells located within the Zone 3 aquifer. The injected alluvium groundwater would then flow through the Zone 3 formation and increase pH, which will reduce or eliminate groundwater constituents of concern from migrating (based on geochemical reactions between the alluvium and Zone 3 groundwater). The mixture of injected alluvium groundwater would then be extracted. The extracted alluvium groundwater will be placed into existing evaporation ponds.

**4. Discharge Characteristics [20.6.2.3106.C.1 and 20.6.2.3108.C.4 NMAC]:**

**4.a. Quantity:**

Peak design discharge rate* in gallons per day (gpd) (design capacity of the treatment and disposal system):	4,752 gpd
Average discharge rate on annual basis in gpd (actual flow):	4,752 gpd
Methods used to meter or calculate discharge volume:	

\*Peak design discharge rate is the maximum volume of wastewater the system was designed to treat on a daily basis. This is generally based on the capacity of the different components of the system (size of lagoons, volume of tanks, etc.)

**4.b. Quality:** Add rows as necessary to include all contaminants and toxic pollutants.

Contaminant(s) or Toxic Pollutant(s) generally associated with facility type (contaminants of concern are listed in 20.6.2.7. and 20.6.2.3103 NMAC)	Effluent Concentration (mg/L)
See Section 2.2 of the Pilot Study	To Be Determined

**4.c. Flow Characteristics:**

Number of days per week discharge occurs:	7
Number of months per year discharge occurs (specify months):	Approximately 3 months

Is flow continuous or intermittent:	Continuous
-------------------------------------	------------

**5. Ground Water Conditions [20.6.2.3106.C.3 and 20.6.2.3108.C.5 NMAC]:**

Sources for this information may be the New Mexico State Engineers Office, NMED, GWPPS web site ([www.nmenv.state.nm.us](http://www.nmenv.state.nm.us)), and USGS reports. If you do not have a TDS value, take a sample from the nearest well to the discharge location and submit the results from the analysis.

Depth to ground water below the discharge site:	Depth to Zone 3 groundwater: 60 feet below ground surface
Flow direction of ground water below the site:	Northeasterly – Zone 3
Flow gradient of ground water below the site:	0.035 feet per foot in area of injection
Reference* or source for depth, direction and gradient:	Geohydrologic Report (Canonie Environmental, 1987).

\* If determined from well logs, please provide photocopies of well logs with application. If depth is derived from a report include copies of appropriate pages and complete reference to report including author, title, and publication date.

Total Dissolved Solids (TDS) concentration (mg/L) of ground water below the site:	6,193.75
Reference or source for TDS:	Average concentration for 2004 sampling of representative wells 517 and 518

### TECHNICAL ADEQUACY

To be deemed technically adequate, for purposes of issuing the discharge permit, the following information must be provided. [20.6.2.3106, 20.6.2.3107, 20.6.2.3109 NMAC]. Operational, monitoring, contingency, and closure plans must be submitted and must be appropriate for the proposed treatment and disposal type and meet the site specific conditions for the proposed facility.

**6. Permit Plans [20.6.2.3106.C.7, 20.6.2.3107.A, and 20.6.2.3109.C NMAC]:**

**6.a. Operational Plan [20.6.2.3106.C.7 and 20.6.2.3109.C NMAC]:**

The operational plan must describe how the system(s) for conveyance, collection, treatment, distribution, and disposal of wastewaters or other discharges will be constructed, operated, inspected, and maintained. The operational plan must demonstrate that ground water standards will not be exceeded.

**6.a.i.** In the following table, identify all proposed conveyance, collection, treatment distribution, and disposal units included in the operational plan. Add rows as necessary to include all units.

<b>Treatment/Storage/ or Disposal Unit</b> Treatment units (lagoon, mechanical treatment plant, manure separator, clarifier, etc.) Disposal Units (land application area, leachfield, evaporative lagoon, leachstockpile, etc.)	<b>Construction Material</b>	<b>Volumetric Capacity*/Area</b> (gallons or cubic yards/ acres)
Refer to Sections 4.3 and 4.5 of Pilot Study.		

\*Volumetric Capacity must be provided for all tanks, chambers, and impoundments or other storage units.

\*Area must be provided for all land application areas, leachfields or other area features.

**6.a.ii.** Describe in detail the operational plan, including all conveyance, collection, treatment, distribution and disposal systems. Attach additional pages as necessary:

Refer to Sections 4.3 and 4.5 of the Pilot Study.

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**6.a.iii.** Describe the operations and maintenance plan that will be followed to ensure the system is maintained as described. At a minimum the plan must include monthly inspections of all wastewater treatment and disposal units. Attach additional pages as necessary.

Refer to Section 4.7 of the Pilot Study.

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**6.b. Monitoring Plan** [20.6.2.3106.C.5 and 20.6.2.3107.A.1-9 NMAC]:

The monitoring plan must describe how the facility will be monitored to ensure the discharge will not adversely impact ground water quality. The plan must include all monitoring locations (effluent sampling, monitoring wells, lagoons, soil sampling, plant tissue analysis, etc.). Monitoring locations must be included on the facility map.

**6.b.i. Monitoring Locations.** In the following tables, identify all monitoring locations. Add additional rows as necessary to include all monitoring locations.

### Flow, Effluent and Ground Water Monitoring

Monitoring Location	Lat	Long	Northing	Easting	Elevation (also specify at what point in well casing)	Sampling Frequency per year	Reporting Frequency per year	Water or Soil Contaminant Type (please refer to 20.6.2.7.uu, and 20.6.3103 NMAC)
flow meter 1	See Figure 4-4 of the Pilot Study.							(volume measurement)
flow meter 2								(volume measurement)
effluent quality*								
monitoring well 1*								
monitoring well 2*								
monitoring well 3*								

\*Identify the sampling locations as designated or named by the facility.

### Soil, Plant Tissue and Other Sampling

Monitoring Location*	Lat	Long	Sampling Frequency per year	Reporting Frequency per year	Water or Soil Contaminant Type
land application area soil sampling	Not Applicable				
land application area plant tissue analysis					
Other					
Other					

**6.b.ii.** Describe in detail the sampling protocols that will be used for sample collection at all monitoring locations. Attach additional pages as necessary.  
Refer to Section 4.6 of the Pilot Study.

**6.b.iii. Standard Monitoring Requirements:** The following paragraphs are standard permit conditions. Please read the condition and check the boxes that you will comply with as a condition of your permit.

- ☒ All monitoring wells will be installed according to NMED Monitoring Well Construction and Abandonment Guidelines (copy enclosed).
- ☒ All monitoring wells (if 3 or more monitoring wells are on site) will be surveyed to a common permanent benchmark and that the survey will be submitted to the NMED, GWQB within 60 days of installation of all monitoring wells. Survey data will include northing, easting, and elevation to the nearest hundredth of a foot. One of the wells may be used as the benchmark.
- ☒ This facility will measure the depth to ground water in each monitoring well to the nearest hundredth of a foot prior to purging and sampling, and that three well volumes will be purged from each monitoring well prior to sample collection.
- ☐ NA This facility will complete land application data sheets (LADS, copy enclosed) documenting the amount of nitrogen applied to each land application area if applicable. The LADS will incorporate the wastewater volume and analytical results of the wastewater testing to determine total nitrogen applied to each field.

**6.c. Contingency Plan [20.6.2.3107.A.10 NMAC]:**

The contingency plan must describe the actions to be taken if Regulation 20.6.2.3103 NMAC ground water standards are exceeded or if toxic pollutants are present (20.6.2.7.uu) as a result of discharges regulated under the proposed permit, and to cope with failure of the discharge permit or system.

**6.c.i. Standard Contingency Requirements:** The following paragraphs are standard permit conditions. Please read the condition and check the boxes that you will comply with as a condition of your permit.

- ☐ NA This Facility will comply with the following contingency language:

In the event that monitoring indicates ground water standards are violated or may be violated during the term of the discharge permit or upon post closure monitoring, this facility will collect a confirmation sample from the monitoring wells within 15 days to confirm the initial sampling results. Upon confirmation of contamination, all ground water monitoring will be conducted monthly and a corrective action plan will be submitted to the NMED. The corrective action plan will include a site investigation to define the source, nature and extent of ground water contamination and a proposed abatement option; and a schedule for implementation. The site investigation and abatement option must be consistent with the requirements and provisions of Regulations 20.6.2.4101, 20.6.2.4103, 20.6.2.4106.E, 20.6.2.4107, and 20.6.2.4112 NMAC. The corrective action plan will be submitted to NMED for approval within 30 days of confirmation of ground water contamination, and will be initiated within 30 days of NMED approval.

☒ This facility will comply with the following contingency language:

In the event of a spill or release that is not as prescribed in the approved discharge permit, this facility will take immediate corrective action to contain or mitigate the damage caused by the discharge and will initiate the notifications and corrective actions as required by Regulation 20.6.2.1203 NMAC. Within 24 hours discovery of the incident, this facility will verbally notify NMED and provide the information outlined in Regulation 20.6.2.1203.A.1. NMAC. Within 7 days of discovering the incident, this facility will submit a written verifying the oral notification and providing any additional pertinent information or changes. Within 15 days of the incident, this facility will submit a corrective action plan describing actions taken and/or to be taken to remedy the impact of the unauthorized discharge.

**6.c.ii. Specific Contingency Plan:**

Describe any additional specific corrective actions or contingencies that will be taken to cope with failure of the discharge system: Attach additional pages as necessary.

Refer to Section 4.5 of the Pilot Study.

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**6.d. Closure Plan [20.6.2.3107.A.11 NMAC]:**

The closure plan must describe the closure actions to be taken to prevent Regulation 20.6.2.3103 NMAC ground water standards from being exceeded, or the introduction of a toxic pollutant in ground water after cessation of operations. At a minimum, the closure plan must include a description of closure measures, post closure monitoring plans, and financial assurance (if required by NMED).

**6.d.i. Specific Closure Plan:** Describe the specific closure activities to ensure that ground water quality will be protected after cessation of operations. The plan shall include plugging, removal, and/or filling of all conveyance, collection, treatment, distribution and disposal features in order to prevent future discharges at the facility. The plan must also describe how all liquid and solid wastes will be removed and disposed of according to local, state, and federal laws. The plan must also describe how disturbed areas will be backfilled to blend with the original surface topography to prevent future ponding and to prevent a discharge at the facility from occurring after the cessation of operations. Attach additional pages as necessary.

Not applicable.

**6.d.ii. Standard Closure Requirements:** The following paragraphs are standard permit conditions. Please read the condition and check the boxes that you will comply with as a condition of your permit.

- ☒ This facility will comply with the following closure requirements:
- The discharger will notify NMED at least 30 days prior to cessation of operations and will provide a schedule for implementation of the closure plan.
- ☐ This facility will conduct post closure monitoring at the frequency and locations prescribed under the active permit for a period approved by NMED. If Regulation 20.6.2.3103 NMAC ground water standards are violated or toxic pollutants are present during post closure monitoring, this facility will implement the contingency plan required in the active permit.
- ☒ All monitoring wells will be plugged and abandoned in accordance with NMED Monitoring Well Construction and Abandonment Guidelines once NMED has agreed in writing that post closure ground water monitoring may cease.
- ☐ Once NMED has approved all closure activities, this facility will submit a letter requesting termination of the discharge permit.

### TECHNICAL SUPPORT

The following information must be submitted as required by Regulation 20.6.2.3106, and 20.6.2.3109 NMAC.

**7. Other Discharge Locations [20.6.2.3106.C.2 NMAC]:**

- 7.a.** List the locations of any other discharges at this facility not covered by this permit but permitted under the New Mexico Liquid Waste Disposal Regulations, Hazardous Waste Management Regulations, Federal Clean Water Act (NPDES), and any un-permitted discharges. Add rows as necessary to include all other discharge locations.

Discharge Type (septic tank/leachfields, surface water discharges, etc.)	Permit Identification	Discharge Location Description
Not applicable.		

- 7.b. Area Map:** On the appropriate United States Geological Survey (USGS) 7.5 minute topographic quadrangle map, identify the location of all water supply wells, injections wells, seeps, springs, bodies of water, and watercourses within one mile of the outside perimeter of the discharge site.

**8. Flooding Potential [20.6.2.3106.C.4 NMAC]:**

- 8.a.** Describe the flooding potential of the discharge site based on the latest Federal Emergency Management Agency flood plain map or site specific analysis:

Based on the FEMA flood plain map date July 4, 1978 (effective date), the discharge area is located within Section 36 which does not have an associated flooding potential.

Source for Information: FEMA flood plain map

- 8.b.** Describe the methods used to control flooding, run-on and run-off at the discharge site (berms, diversion channels, etc.):

**9. Geologic and Soil Information [20.6.2.3106.5 NMAC]:**

**9.a. Lithology:** Describe the lithology and thickness of each geologic unit below the discharge site and indicate which units bear water. This information may be obtained from a driller's log or geologic report. Include photocopies of all well logs with the application. Add rows as necessary to include all units.

Unit Description	Thickness (feet)	Water Bearing (Y/N)
Alluvium	0 – 150 feet	Y
Dilco Coal Member of Crevasse Canyon Formation		Y
Upper Gallup Sandstone:		Y
- Zone 3, upper sandstone	70 – 90 feet	Y
- Zone 2, shale and coal	15 – 20 feet	Y
- Zone 1, lower sandstone	80 – 90 feet	Y
Mancos Shale	130 feet	Y

Source for Information: Geohydrologic Report (Canonie Environmental, 1987)

**9.b. Soil Map:** Attach a copy of the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) soil survey map and descriptive information for soil(s) associated with the discharge site.

**10. Signatures:**

**Owner:** I certify that I am the legal owner of the property in which all discharges will occur. I certify that I am knowledgeable about the information contained in this application, and believe the information is true, complete and accurate.

Print Name: \_\_\_\_\_

Signature: \_\_\_\_\_ Date \_\_\_\_\_

**Responsible Party\*** (if property is leased or operated by someone other than the owner):

I certify that I am knowledgeable about the information contained in this application, and believe the information is true, complete and accurate.

Print Name: \_\_\_\_\_

Signature: \_\_\_\_\_ Date \_\_\_\_\_

- 
- \* Enclose a signed copy of the lease agreement between the responsible party and the owner of the property on which the proposed discharge will occur. Lease agreement should be valid for the duration of the discharge permit or until the discharge permit is modified to reflect a new lessee.

## SUMMARY OF APPLICANT'S PUBLIC NOTICE REQUIREMENTS FOR GROUND WATER DISCHARGE PERMITS

The New Mexico Water Quality Control Commission Regulations (20.6.2 NMAC) public notice requirements of 20.6.2.3108 NMAC were revised **effective September 15, 2002** to require the applicant to provide notice to neighboring properties during the discharge permit application process. This document summarizes the applicant's public notice requirements and provides answers to frequently asked questions.

The Water Quality Control Commission Regulations are available on the New Mexico Environment Department's (NMED) internet web site. The web site address is:

[www.nmenv.state.nm.us](http://www.nmenv.state.nm.us)

Click on the heading "Environmental Protection Regulations", then "Water Quality-- Ground and Surface Water Protection". The public notice regulations are in Section 20.6.2.3108 NMAC. You can also call the Ground Water Quality Bureau at (505) 827-2900 and we will mail you a copy of the regulations.

### STEP 1 – SELECTING AND IMPLEMENTING A PUBLIC NOTICE OPTION

Anyone applying for a new permit or renewing or modifying an existing permit must provide public notice to neighboring properties (See FAQs). The applicant must select one of three public notice options by checking the selected box on page 3 of the Ground Water Discharge Permit Application. **When the NMED receives the application and deems it administratively complete, we will send the applicant the instructions and materials necessary to implement the selected public notice option.** The applicant must implement the public notice option within 30 days of submitting their application to the NMED. The applicant's public notice options are:

#### Public Notice Option 1

Posting a sign: The sign must be prominently posted in a conspicuous public location at or near the existing or proposed facility for 30 days. The sign should be visible so that passersby are likely to see it. The sign will be a synopsis of the full public notice prepared by NMED.

and

Sending direct notice to adjacent property owners: The public notice prepared by NMED must be sent to all "adjacent property" "owners of record" by certified mail, return receipt requested.

and

Sending direct notice to the owner of the discharge site: If the applicant is not the owner of the discharge site, the applicant must send the public notice prepared by NMED to the owner, by certified mail, return receipt requested.

#### Public Notice Option 2

Posting a sign: The sign must be prominently posted in a conspicuous public location at or near the existing or proposed facility for 30 days. The sign should be visible so that passersby are likely to see it. The sign will be a synopsis of the full public notice prepared by NMED.

and

Placing a display advertisement: The display ad must be at least two inches by three inches in size and must be published in a newspaper of general circulation in the location of the proposed discharge. The display ad will be a synopsis of the full public notice prepared by NMED.

and

Sending direct notice to the owner of the discharge site: If the applicant is not the owner of the discharge site, the applicant must send the public notice prepared by NMED to the owner, by certified mail, return receipt requested.

### **Public Notice Option 3**

Sending direct notice to property owners within 1/2 mile of the discharge site: The public notice prepared by NMED must be sent to all property "owners of record" within 1/2 mile of the discharge site by certified mail, return receipt requested.

and

Sending direct notice to the owner of the discharge site: If the applicant is not the owner of the discharge site, the applicant must send the public notice prepared by NMED to the owner, by certified mail, return receipt requested.

## **Step 2 - Providing Proof that the Applicant Completed Public Notice**

### **Proof of Notice**

Within 15 days of completion of the public notice requirements above, the applicant must submit proof of notice to NMED. Depending on the option selected, proof of notice may include list of property owners' names and addresses, copies of certified mail return receipts, a copy of the published display ad indicating the newspaper and date of publication, and an affidavit of sign posting. If the department determines that the notice provided is inadequate, the department may require additional notice in accordance with the requirements above.

### **Important Definitions**

The following definitions are excerpted from the Water Quality Control Commission regulations, 20.6.2 NMAC.

**"adjacent properties"** means properties that are contiguous to the discharge site or property that would be contiguous to the discharge site but for being separated by a public or private right of way, including roads and highways.

**"discharge site"** means the entire site where the discharge and associated activities will take place.

**"owner of record"** means an owner of property according to the property records of the tax assessor in the county in which the discharge site is located.

## Frequently Asked Questions

### **Where can I get a copy of the new public notice regulations?**

The Water Quality Control Commission Regulations are available on the New Mexico Environment Department's (NMED) internet web site. The web site address is:

[www.nmenv.state.nm.us](http://www.nmenv.state.nm.us)

Click on the heading "Environmental Protection Regulations", then "Water Quality-- Ground and Surface Water Protection". The public notice regulations are in Section 20.6.2.3108 NMAC.

You can also call the Ground Water Quality Bureau at (505) 827-2900 and we will mail you a copy of the regulations.

### **When do the new public notice regulations go into effect?**

September 15, 2002

### **Do the new public notice regulations apply to me?**

The regulations apply to all applications for new permits, renewals, and modifications that are submitted to NMED on or after September 15, 2002. Page 3 of the application has a section for the applicant to select one of three public notice options. If you submitted an application for a new discharge permit, renewal or modification before September 15, 2002, then the regulations will not apply to you until you renew or modify your permit, even if your permit has not yet been issued.

### **Where at my facility should the sign be posted?**

In many cases the sign should be posted in a location near the front entrance to the facility where it is likely to be seen by passersby. Other conspicuous public locations can be approved in advance by the Ground Water Quality Bureau if they are more likely to provide notice to the public. You can contact the Ground Quality Bureau at the number below to obtain approval for an alternate sign posting location.

### **Where do I get the sign that will be posted at my facility?**

When the NMED receives the application and deems it administratively complete, we will send the applicant the instructions and a laminated poster with an invoice for \$15.00.

### **How long do I have to keep the sign up at my facility?**

The sign must be posted for 30 days.

### **What properties are considered to be "adjacent" to my property?**

"Adjacent properties" are those properties that are contiguous to the discharge site or that would be contiguous to the discharge site except for being separated by a public or private right of way, including roads and highways.

**Who are property "owners of record" and where can I find their names and addresses?**

An "owner of record" is an owner of property according to the property records of the tax assessor in the county in which the discharge site is located. You can call your county tax assessor and they can, in most cases, provide names and addresses of owners of record within 24 hours. You will need to provide the tax assessor with the location of your discharge site and ask for names and addresses of adjacent properties.

**Is there a letter format I should use for the direct notice to property owners?**

When the NMED receives the application and deems it administratively complete, we will send the applicant the instructions and materials necessary to provide direct notice to property owners.

**What if there are no adjacent properties other than properties I own?**

If the applicant owns the adjacent properties, then they must implement Option 2 by posting a sign, placing a display ad and notifying the property owner if the owner is different from the applicant.

**Is there a required format for the display advertisement?**

When the NMED receives the application and deems it administratively complete, we will send the applicant the instructions and materials necessary to place a display advertisement.

**What proof must I provide to the NMED to demonstrate that I provided public notice in accordance with the new regulations?**

Within 15 days of completion of the public notice requirements, the applicant must submit proof of notice to NMED. Depending on the option selected, proof of notice may include a list of property owners' names and addresses, copies of certified mail return receipts, a copy of the published display ad indicating the newspaper and date of publication, and a signed affidavit that the sign was posted. If the department determines that the notice provided is inadequate, the department may require additional notice in accordance with the new regulations.

**Who do I contact if I have additional questions?**

You may contact Jerry Schoeppner, Chief of the Ground Water Quality Bureau or Maura Hanning, Manager of the Ground Water Pollution Prevention Section at (505) 827-2900.

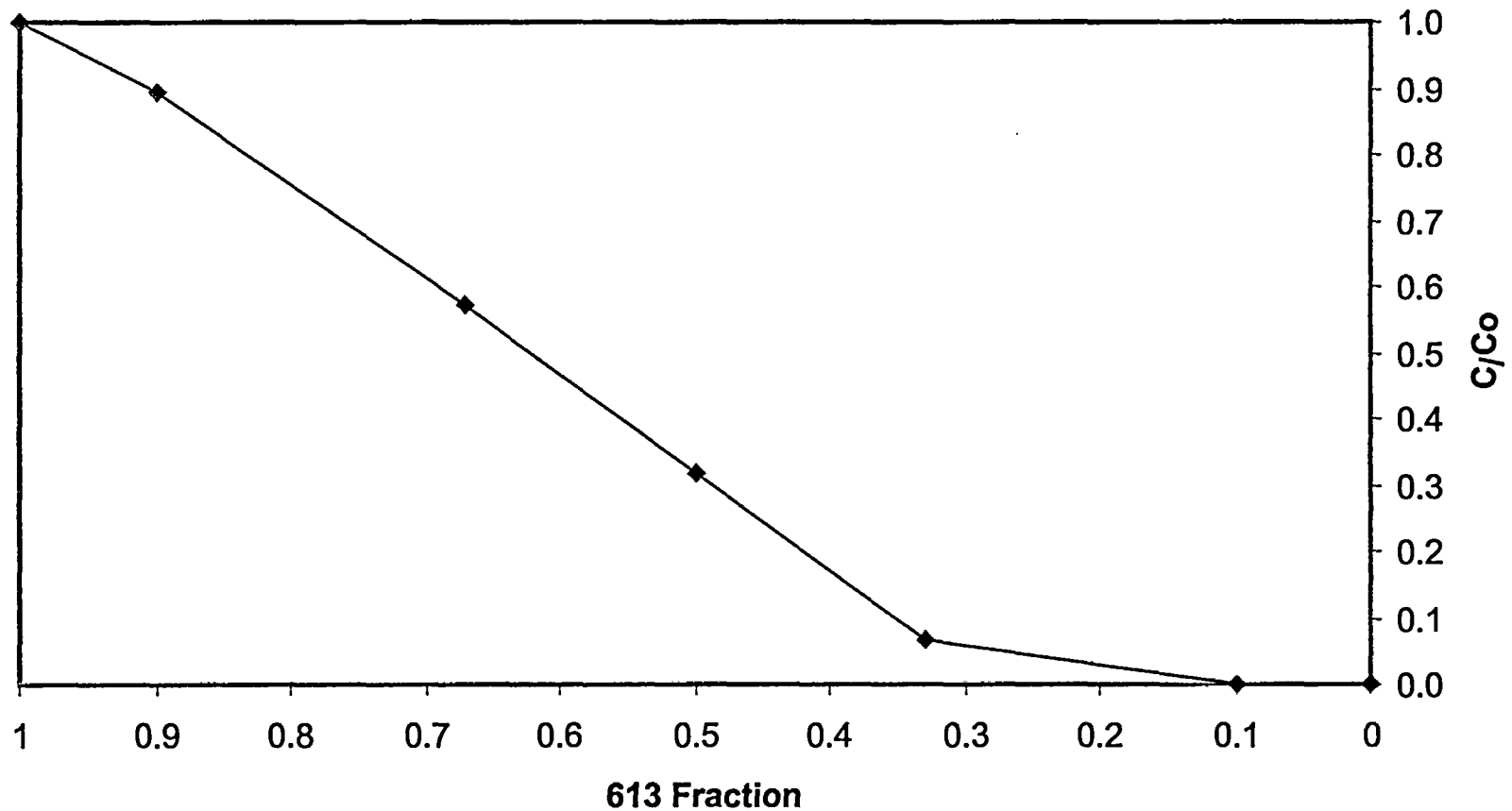
## ***Attachment B***

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# **Geochemical Modeling**

# Aluminum

## PHREEQC Mixing w/Mineral Precipitation



UNC CHURCH ROCK  
CHURCH ROCK, NEW MEXICO  
IN-SITU ALKALINITY  
STABILIZATION PILOT STUDY

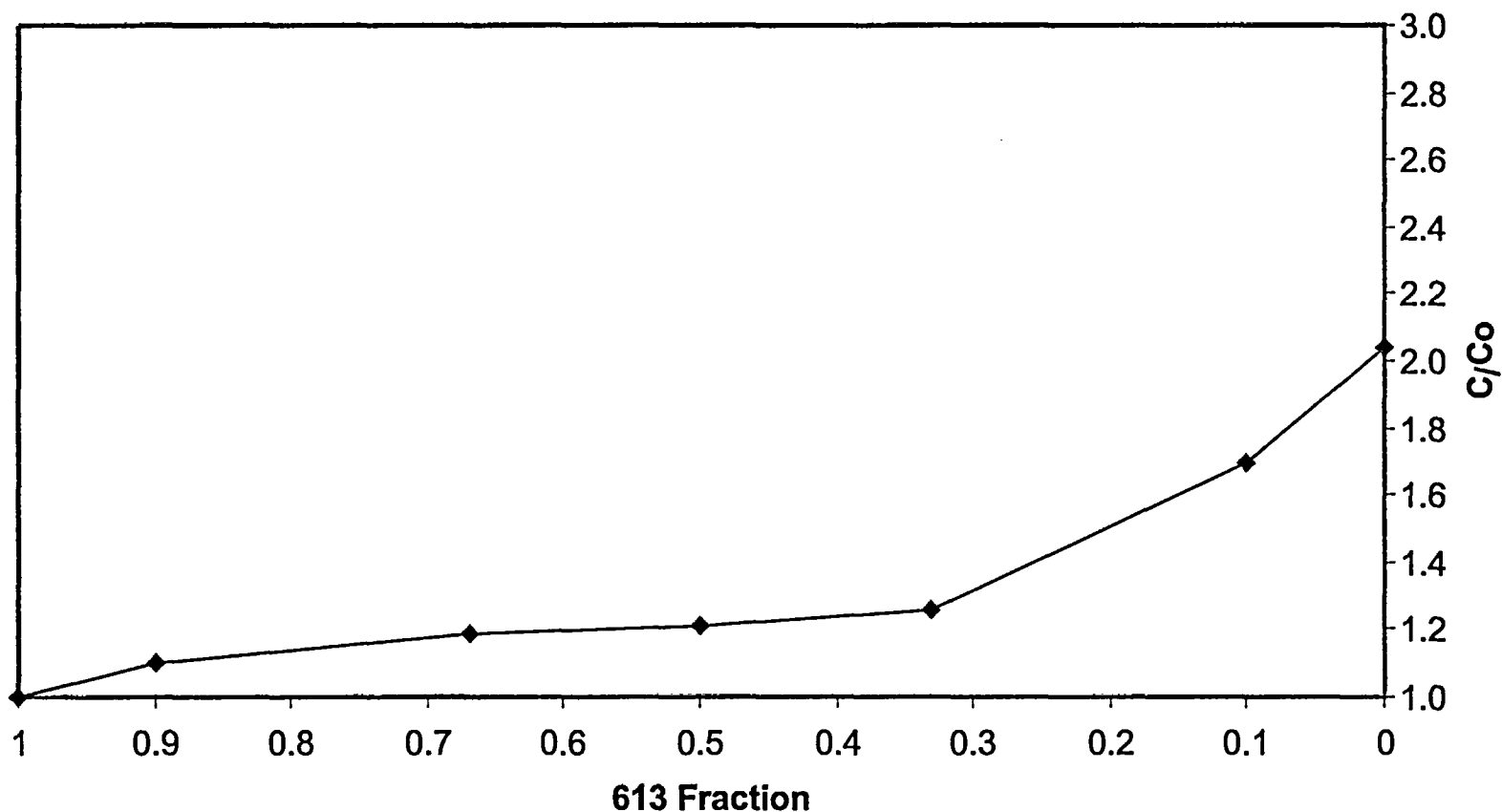
ATTACHMENT B -  
GEOCHEMICAL MODELING  
ALUMINUM

**BBL**  
BLASLAND, BOUCK & LEE, INC.  
engineers, scientists, economists

FIGURE  
**B-1**

# Calcium

## PHREEQC Mixing w/Mineral Precipitation



UNC CHURCH ROCK  
CHURCH ROCK, NEW MEXICO  
IN-SITU ALKALINITY  
STABILIZATION PILOT STUDY

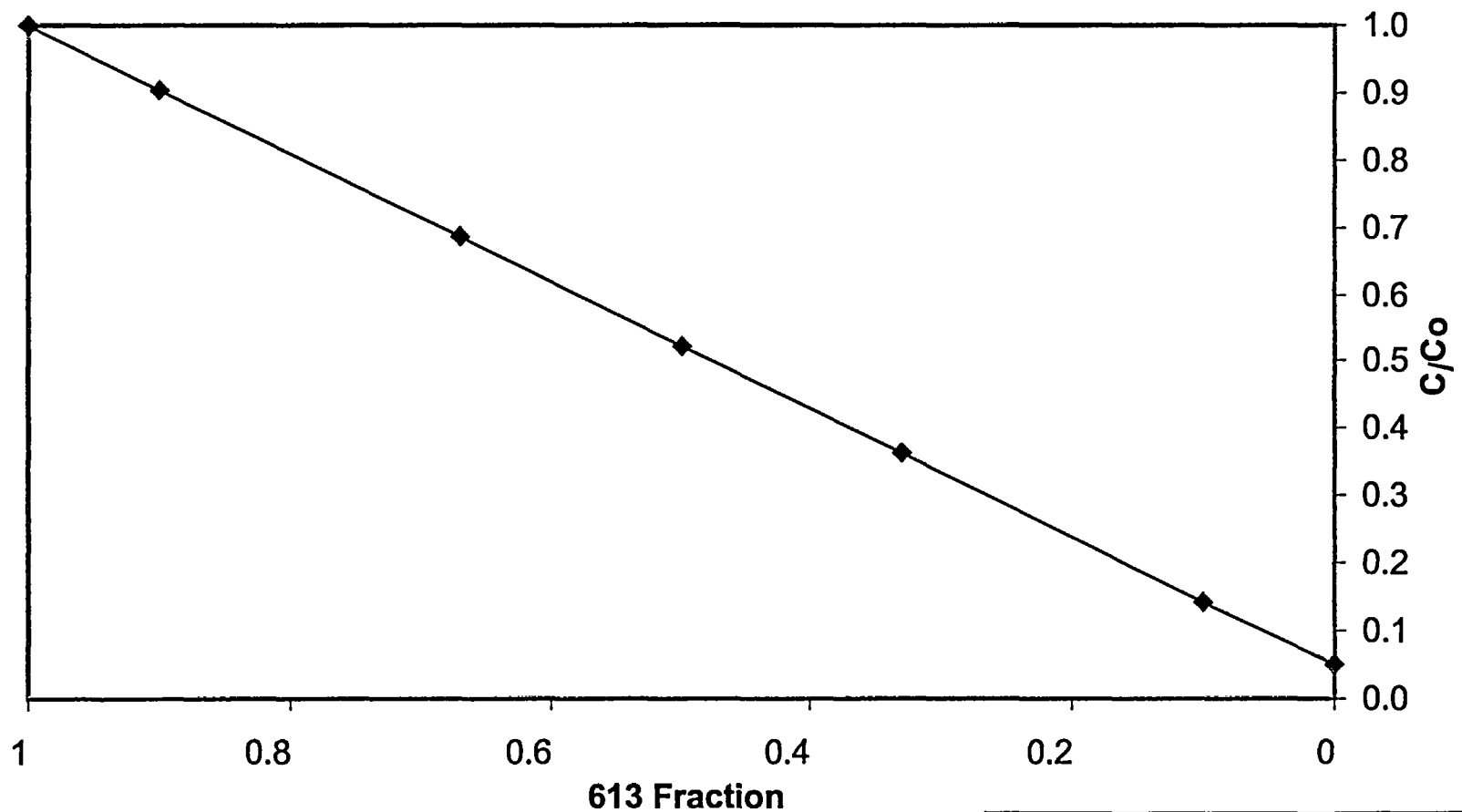
ATTACHMENT B -  
GEOCHEMICAL MODELING  
CALCIUM

**BBL**  
BLASLAND, BOUCK & LEE, INC.  
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FIGURE  
**B-2**

# Manganese

## PHREEQC Mixing w/Mineral Precipitation



UNC CHURCH ROCK  
CHURCH ROCK, NEW MEXICO  
IN-SITU ALKALINITY  
STABILIZATION PILOT STUDY

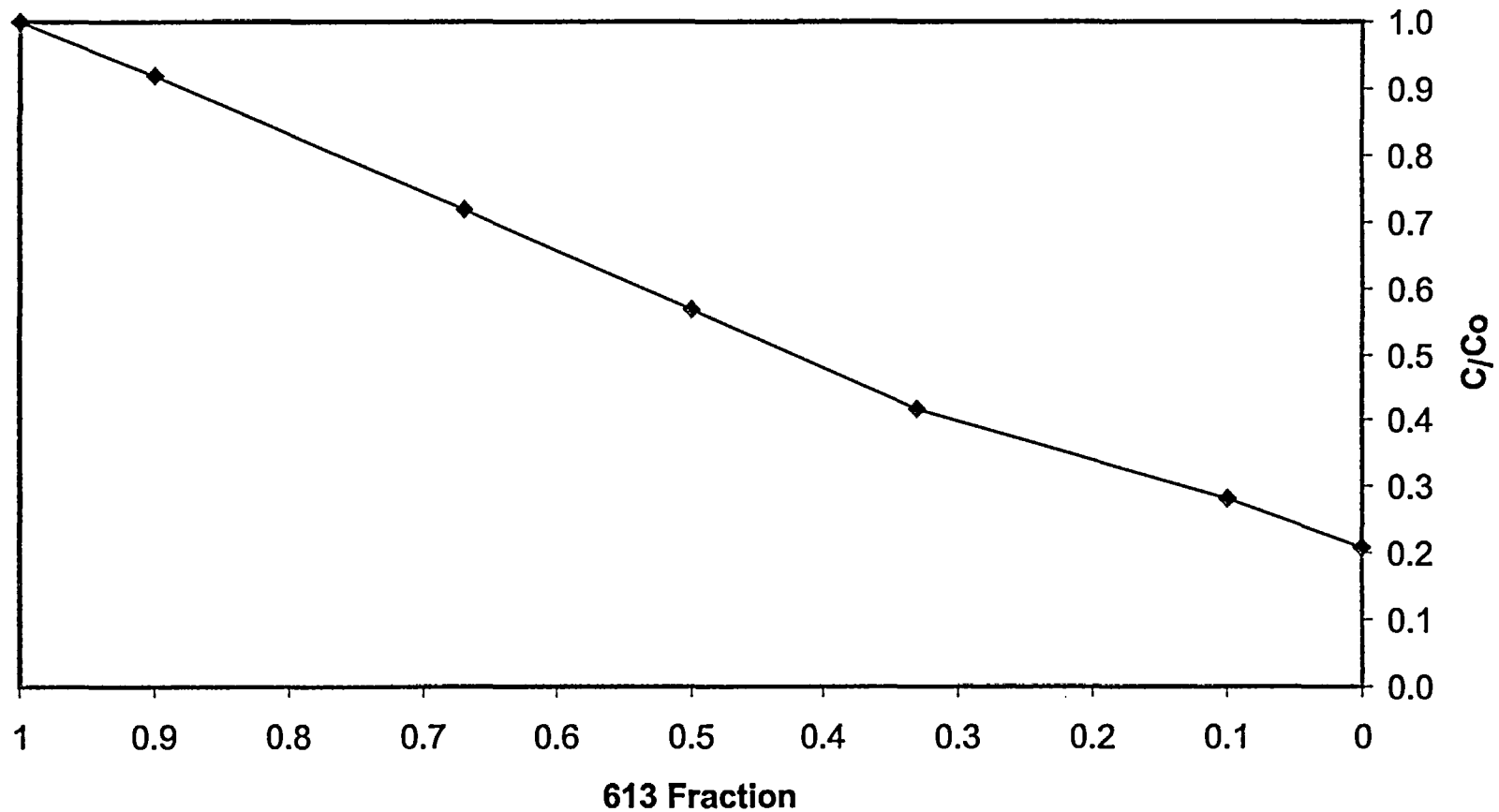
ATTACHMENT B -  
GEOCHEMICAL MODELING  
MANGANESE

**BBL**  
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FIGURE  
**B-3**

# Sulfate

## PHREEQC Mixing w/Mineral Precipitation



UNC CHURCH ROCK  
CHURCH ROCK, NEW MEXICO  
IN-SITU ALKALINITY  
STABILIZATION PILOT STUDY

ATTACHMENT B -  
GEOCHEMICAL MODELING  
SULFATE

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FIGURE  
**B-4**

## ***Attachment C***

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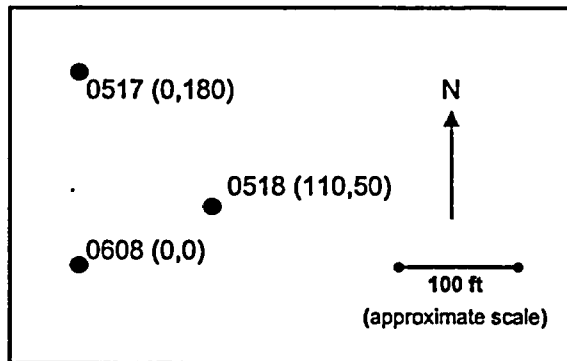
### **Pilot Study Wellfield Design**

# UNC Church Rock Site Church Rock, New Mexico

## Pilot Study Well Field Design

### Pilot Study Target Area

Vicinity of wells 0517, 0518, and 0608



### Zone 3 Hydraulic Parameters

$$K = 5E-4 \text{ cm/sec} = 1.4 \text{ ft/day}$$

$$H = 14 \text{ ft}$$

$$T = K H = 20 \text{ sqft/day} = 150 \text{ gal/day/ft}$$

$$S_y = 0.15 \text{ (insensitive parameter, decreasing 10-fold reduces } Q \text{ at central EW by 2\%)}$$

$$I = 14/400 = 0.035$$

$$s(iw) = \pm 11 \text{ ft (+ for extraction, - for injection)}$$

$$\text{well efficiency} = 50\%$$

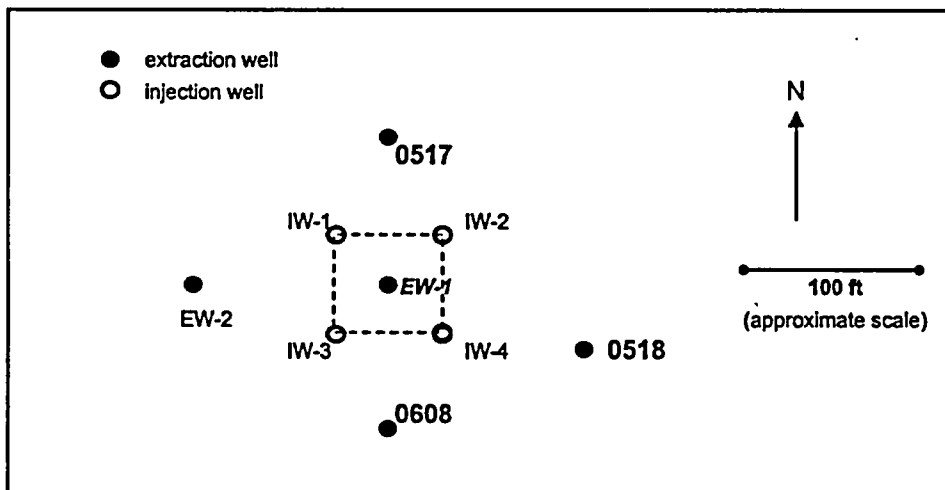
$$s(ow) = \pm 6.5 \text{ ft (+ for extraction, - for injection)}$$

$$h(ow) = 14 - 6.5 = 7.5 \text{ ft (extraction wells)}$$

$$h(ow) = 14 + 6.5 = 20.5 \text{ ft (injection wells)}$$

$$t = 30 \text{ days (for } Q \text{ estimate)}$$

### Pilot Study Wellfield Layout - 9 Spot



### Hydraulic Assessment

	Well	X (ft)	Y(ft)	s(ow) (ft)	Q, calc (gpm)
1	0608	0	0	6.5	0.75
2	0517	0	180	6.5	0.78
3	0518	110	50	6.5	0.70
4	EW-1	0	90	6.5	1.05
5	EW-2	-110	90	6.5	0.71
6	IW-1	-30	120	-6.5	-0.83
7	IW-2	30	120	-6.5	-0.81
8	IW-3	-30	60	-6.5	-0.83
9	IW-4	30	60	-6.5	-0.84

(calculated using ISINKFLO.EXE, Theis solution  
for wellfield with specified drawdown)

**Total Extraction Rate = 4.0 gpm**

**Total Injection Rate = 3.3 gpm**

Pore Volume Within Square =  $(60 \times 60 \times 14) \times 0.15 = 7560 \text{ cf} = 57,000 \text{ gal}$

Extraction Rate @ EW-1 = 1.05 gpm

Time for 1 Pore Volume Exchange Within Square =  $57,000 / 1.05 = 54,000 \text{ min} = 37 \text{ days}$

### Initial Breakthrough (Travel-Time) Calculation

Pre-Pumping Gradient = 0.035

Pre-Pumping dH in Square =  $0.035 \times 60 = 2.1 \text{ ft}$

Pre-Pumping dH Between EW-1 and IWs =  $2.1 / 2 = 1.05 \text{ ft}$

Pumping-Induced dH Between EW-1 and IWs = 13 ft

Net dH from IW-3 and IW-4 to EW-1 =  $13 + 1.05 = 14.05 \text{ ft}$

Net pumping gradient from IW-3 and IW-4 to EW-1 =  $14.05 / 42 = 0.335$

$v = K_i / n = 1.4 \text{ ft/day} (0.335) / 0.15 = 3.1 \text{ ft/day}$

Distance from IWs to EW-1 = 42 ft

Travel Time =  $42 / 3.1 = 14 \text{ days}$