

# Tables

---

**TABLE 1**  
Southwest Alluvium Performance Monitoring Program, 2010 Operating Year  
United Nuclear Corporation, Church Rock Site  
Church Rock, New Mexico

Well	Use <sup>1</sup>	Water Level	Water Quality	NRC POC	Purpose
509 D	Monitor	X	X	Y	Seepage extent
624	Monitor	X	X		Downgradient background, seepage extent
627	Monitor	X	X		Downgradient background, seepage extent
632	Monitor	X	X	Y	Seepage extent
801 <sup>2</sup>	Pumping (idled)	X	X		Seepage and saturation extent
802	Pumping (idled)	X	X		Seepage and saturation extent
803	Pumping (idled)	X	X		Seepage and saturation extent
805	Monitor	X			Water level only
807	Monitor	X			Water level only
808 <sup>3</sup>	Pumping (idled)	X	X		Seepage extent
EPA 23	Monitor	X	X	Y	Problematic completion
EPA 25	Monitor	X	X		Downgradient background, seepage extent
EPA 28	Monitor	X	X	Y	Seepage extent
GW 1	Monitor	X	X	Y	Seepage extent
GW 2	Monitor	X	X	Y	Seepage extent
GW 3	Monitor	X	X	Y	Downgradient background, seepage extent
Total		16	14		

Eliminated From Monitoring				Reason for Elimination
GW 4	X	X		Dry
EPA 22A			Y	Dry
29A				Dry
639				Dry
642				Dry
644				Dry
645				Dry
804				Not needed, use 632
806				Not needed, use 805
EPA 27				Dry

Notes:

- 1 Pumping wells turned off in January 2001 after final baseline samples were collected. Well 801 is the exception, see Note 2.
- 2 Well 801 was turned off at the end of July 1999 because it met decommissioning criteria. Sample collection ceased after the first quarter 2000. Well 801 water quality is included in the test program, therefore sampling recommenced January 2001 and has continued through 2003.
- 3 Well 808 was not included in the Performance Monitoring Program prior to the NA Test, therefore no data are available prior to January 2001.

**TABLE 2**  
 Zone 3 Performance Monitoring Program, 2010 Operating Year  
 United Nuclear Corporation, Church Rock Site  
 Church Rock, New Mexico

Well	Water Level	Water Quality	NRC POC	Purpose
<b>Continue Monitoring</b>				
420	X	X		Postmining-pretailings background, track plume.
711	X	X	Y	Track saturation and plume, replace 502 B based on results of low flow purge testing performed in January 2000.
504 B	X	X		Track saturation and plume, extensive data set.
517	X	X	Y	Track plume, extensive data set.
EPA 9	X			Extent of saturation, water quality not necessary.
EPA 13	X	X		Extent of saturation. Water quality added 2nd quarter 2001.
EPA 14	X	X		Postmining-pretailings background, track plume.
702	X			Water level only, track saturation.
710	X			Water level only.
712	X			Water level only.
713	X			Water level only.
714	X			Water level only.
613	X	X	Y	Extensive data set, track saturation and source.
701	X			Water level only (decommissioned pumper).
706	X			Water level only (decommissioned pumper).
707	X			Water level only (decommissioned pumper).
708	X	X	Y	Added to program 2nd quarter 2001.
717	X	X		Water level. Water quality added 2nd quarter 2001.
719	X	X		Water level. Water quality added 2nd quarter 2001.
<b>Additional Wells, Not Included In Original Performance Monitoring Program</b>				
402	X			Long-term water level for migration path.
424	X			Long-term water level for migration path.
446	X			Long-term water level for migration path.
NBL-01	X	X		Well drilled and installed June 2001. Water level and water quality to track downgradient extent of seepage.
Total	23	11		

<b>Eliminated From Monitoring</b>				<b>Reason For Elimination</b>
9 D				Dry
106 D				Dry
411				Oil, cannot get water level or sample.
501 B			Y	Dry
EPA 1				Dry
EPA 3			Y	Dry
EPA 11				Unuseable since 1990 - water level below pump, pump cemented in well.
EPA 12				Dry
EPA 15				Dry
EPA 17				Dry
EPA 18				Dry
126				Dry
502 B				Failed low-flow test, use 711
518			Y	Failed low-flow test, use 517
608				Not needed (formerly water level only)
703				Not needed (formerly water level only)
715				Not needed (formerly water level only)
709				Not needed (decommissioned pumper)
716				Not needed (pumper)
718				Not needed (pumper)
720				Not needed (decommissioned pumper)

Notes:

NRC POC = Nuclear Regulatory Commission Point of Compliance well

Source: Earth Tech, December 2002, Table 3.2



**TABLE 3**

Zone 1 Performance Monitoring Program, 2010 Operating Year  
 United Nuclear Corporation, Church Rock Site  
 Church Rock, New Mexico

Well <sup>1</sup>	Water Level <sup>2</sup>	Water Quality <sup>2</sup>	NRC POC	Purpose
<b>Continue Monitoring</b>				
515 A	X	X		Track transition area
604	X	X	Y	Track center of seepage
614	X	X	Y	Track transition area
EPA 2	X	X		Postmining-pretailings background water quality
EPA 4	X	X	Y	Postmining-pretailings background water quality
EPA 5	X	X	Y	Track transition area
EPA 7	X	X	Y	Track transition area, edge of saturation
EPA 8	X			Track edge of saturation
142	X	X		Premining background
143	X			Water level only, use 142
<b>Additional Wells, Not Included In Original Performance Monitoring Program</b>				
505 A	X			Long-term water level for migration path
502 A	X			Long-term water level for migration path
501 A	X			Long-term water level for migration path
504 A	X			Long-term water level for migration path
412	X			Long-term water level for migration path
Total	15	8		

<b>Eliminated From Monitoring</b>			<b>Reason For Elimination</b>
141			No longer useable, plugged during arroyo flooding
516 A		Y	Failed low-flow testing
619			Anomalous water quality and water level
615			Decommissioned pumper, not needed - use 515 A
616			Decommissioned pumper, not needed - use 604
617			Decommissioned pumper, not needed

Notes:

1. No wells within the tailings reclamation cap were included.
2. Water level and water quality monitored on a quarterly basis.



**TABLE 4**  
Southwest Alluvium Monitoring Well Construction  
United Nuclear Corporation, Church Rock Site  
Church Rock, New Mexico

Well Number	Date	Ground elev	TOC elev	Easting	Northing	Total depth	Casing dia	Screen from	Screen to	Sand pack from	Sand pack to
0509 D	11/24/1981	6947.69	6949.44	58462.62	74359.82	110	2	90	110	87	110
0624	9/18/1984	6898.16	6898.57	55070.89	70764.45	85	6	32	77	29	84
0627	9/20/1984	6891.81	6892.22	53503.7	70752.3	78	6	36	71	35	78
0632	4/17/1985	6901.74	6903.492	56249.65	71750.35	85	2	22	67	20	85
0801	8/24/1989	6900.85	6904.32	56273.79	71630.35	61.5	4.5	39	59	33	59
0802	8/25/1989	6904.02	6905.837	56215.05	71854.39	82	4.5	51.5	81.5	40	81.5
0803	8/23/1989	6921.49	6922.582	56369.62	72280.56	123	4.5	58	118	52	118
0808	6/14/1991	6908.80	6910.67	56279.71	72069.79	132	4.5	50	125	45	125
EPA 23	2/14/1985	6923.06	6926.312	56909.85	72843.76	140	6	40	120	35	140
EPA 25	2/2/1985	6900.58	6903.383	54947.29	71227.15	72	4	40	70	38	72
EPA 28	2/12/1985	6915.16	6917.861	55806.14	71276.12	90	4	45	85	41	90
GW 1	11/15/1976	6914.46	6916.46	55890.38	71452.92	80	4	60	80	0	80
GW 2	11/15/1976	6910.37	6912.88	55891.41	71640.73	95	4	65	95	0	95
GW 3	11/11/1976	6908.97	6910.04	55896.52	71793.78	80	4	to be filled	to be filled	to be filled	to be filled
SBL-01	7/12/2004	6894.53	6896.31	54688.04	70442.73	63.65	5	43.65	63.65	38.65	63.65

Notes:  
TOC = top of casing.  
Elevations are in feet above mean sea level.  
Easting and Northing values are in the Site coordinate system.  
Total depth, screen from, screen to, sand pack from, and sand pack to are all in feet below ground; casing diameter is in inches.



**TABLE 5**  
Zone 3 Monitoring and Pumping Well Construction  
United Nuclear Corporation, Church Rock Site  
Church Rock, New Mexico

Well Number	Date	Ground elev	TOC elev	Easting	Northing	Total depth	Casing dia	Screen from	Screen to	Sand pack from	Sand pack to
0402	2/6/1981	6966.79	6968.23	61003.84	76957.91	154	6	117	147	77	154
0420	3/25/1981	6981.72	6982.48	61309.74	77011.9	170	2	116	156	105	161
0424	3/31/1981	6972.23	6972.623	61185.43	76964.25	154	6	89	149	43	154
0446	4/14/1981	6997.49	6998.31	61850.83	76989.05	174	6	108	158	75	168
0504 B	11/12/1981	6999.98	7001.71	62014.26	76992.96	172	2	120	170	120	170
0517	4/14/1982	6968.02	6971.293	61038.96	75873.96	111	2	79	111	77	111
0613	8/11/1983	6958.38	6960.89	60716.34	75446.26	96	6	47	87	45	93
0701	6/14/1989	6958.99	6961.28	60699.84	75699.94	104	6	78	98	73	98
0702	6/29/1989	6971.99	6974.25	60839.53	75294.75	96	6	69	89	57.5	89
0703	6/28/1989	6976.70	6978.92	61100.32	75489.83	114	6	77	107	72	107
0706	6/26/1989	6969.69	6972.119	61091.46	76119.06	134	6	108	128	103	128
0707	6/21/1989	7002.11	7005.21	61340.18	76349.32	173	6	148	168	139	168
0708	5/24/1989	7010.38	7012.311	61500.17	76032.3	172	6	137	167	131	167
0709	5/17/1989	7001.01	7003.536	61520.85	76469.3	173	6	138	168	133	168
0710	5/22/1989	7014.18	7016.363	61699.35	76299.53	180	6	143	173	137	173
0711	5/9/1989	7040.00	7042.6	61899.37	76100.38	206	6	168	198	158	198
0712	5/15/1989	7019.72	7022.155	61900.6	76498.98	185	6	149	179	144	179
0713	6/19/1989	7021.28	7024.188	62100.03	76300	178	6	143	173	135.5	173
0714	5/31/1991	6960.43	6962.536	60701.12	76097.29	120	6	86	116	79	116
0715	5/24/1991	6962.44	6963.92	60900.48	76299.99	129.5	6	93	123	85	123
0716	5/22/1991	6963.45	6964.935	61100	76500.47	142	6	108	138	101	138
0717	5/30/1991	6970.16	6972.515	61300.62	76700.28	153	6	118	148	113.5	148
0718	6/5/1991	6993.63	6995.061	61499.44	76899.57	179	6	144	174	134	174
0719	6/7/1991	7000.40	7002.024	61700.44	76899.92	178	6	144	174	134	174
0720	6/12/1991	7000.27	7001.781	61900.19	76899.53	175	6	139.5	169.5	134	169.5
EPA 09	3/11/1985	7072.91	7076.612	61820.31	74917.44	188	4	129	175	124	188
EPA 13	2/22/1985	7030.47	7032.707	62247.88	76030.6	197	6	135	175	130	180
EPA 14	2/8/1985	6962.61	6965.61	61073.3	76463.98	145	6	95	135	92	145
IW-A	5/25/2010	6991.15	6992.77	62246	77927	201	6	171	200	158.6	201
MW-2	2/1/2005	6994.69	6996.94	61615.15	76710.22	176	5	160	170	150	170
MW-3	2/1/2005	6984.13	6986.36	6994.69	77320.44	179	5	167	177	157	177
MW-4	2/1/2005	6990.87	6993.01	62168.3	77349.07	183	5	162	172	152	172
MW-5	2/1/2005	6986.29	6990.51	62147.5	77516.77	186	5	168.5	178.5	153.3	178.5
MW-6	5/27/2010	6988.68	6990.94	62212	77866	198	6	168	197	163	198
MW-7	6/4/2010	6986.50	6988.82	62101	78001	205.5	6	175	205	170.5	205.5
NBL-01	7/23/2001	6988.60	6992.118	62115.83	77833.48	204	6	163	195	158	195
NBL-02	3/27/07	to be filled	6975.61	61586.37	77666.71	187.25	6	167.25	187.25	162.25	187.25
NW-1	9/26/2008	6994.47	6997.15	62276.47	77825.17	198.82	6	178.52	198.52	174	199
NW-2	9/16/2008	6986.79	6989.76	62122.17	77896.8	202.86	6	182.56	202.56	178	203
NW-3	9/10/2008	6982.52	6985.57	61968.71	77939.61	202.62	6	182.32	202.32	178	203.5
NW-4	9/19/2008	6988.40	6990.13	62177.77	77805.34	201.13	6	180.83	200.83	176	201
NW-5	9/11/2008	6982.82	6985.85	62030.61	77861.43	202.93	6	182.63	202.63	177	203
PB-01	6/14/2002	6987.21	6989.587	62064.91	77401.86	179.83	4.96	157.4	177.4	152	180
PB-02	6/18/2002	6987.31	6989.698	62094.84	77623.56	190.08	4.96	167.4	187.4	153	188
PB-03	6/22/2002	6987.50	6990.38	62104.23	77727.42	194.75	4.96	172.4	192.4	158	193
PB-04	6/24/2002	6987.45	6990.362	62100.23	77675.34	193.92	4.96	170.4	190.4	154	191
RW-11	9/11/2004	6982.19	6983.73	61662.01	77335.34	175.9	5	162.3	175.3	170	175
RW-12	9/18/2004	6985.98	6987.62	61882.24	77307.37	172.5	5	163.2	171.9	168.5	172.5



**TABLE 5**  
 Zone 3 Monitoring and Pumping Well Construction  
 United Nuclear Corporation, Church Rock Site  
 Church Rock, New Mexico

Well Number	Date	Ground elev	Toc elev	Easting	Northing	Total depth	Casing dia	Screen from	Screen to	Sand pack from	Sand pack to
RW-13	9/11/2004	6987.76	6989.71	62081.95	77370.91	172.5	5	161.9	171.9	167.5	172.5
RW-14	9/11/2004	6995.25	6997.7	62233.28	77293.94	176.4	5	165.8	175.8	171.5	176.4
RW-15	9/18/2004	6963.52	6966.07	61129.02	76595.56	143	5	132.4	142.4	138	143
RW-16	9/18/2004	6987.43	6979.73	61430.63	76660.53	153.5	5	142.9	152.9	148.5	153.5
RW-17	9/19/2004	7010.27	7012.78	61729.49	76572.87	177.4	5	166.8	176.8	172.4	177.4
RW-A	to be filled	to be filled	6983.23	61764.83	77423.81	184.75	6	164.75	184.75	159.75	184.75
Z3 M-01	7/14/2004	6994.00	6996.34	60514.66	74477.5	68.5	to be filled	to be filled	to be filled	to be filled	to be filled
Z3 M-02	7/15/2004	7007.66	7009.31	60837.73	74523.41	77.25	to be filled	to be filled	to be filled	to be filled	to be filled

Notes:

TOC = top of casing.

Elevations are in feet above mean sea level.

Easting and Northing values are in the Site coordinate system.

Total depth, screen from, screen to, sand pack from, and sand pack to are all in feet below ground; casing diameter is in inches.



**TABLE 6**  
 Zone 1 Monitoring Well Construction  
 United Nuclear Corporation, Church Rock Site  
 Church Rock, New Mexico

Well Number	Date	Ground elev	TOC elev	Easting	Northing	Total depth	Casing dia	Screen from	Screen to	Sand pack from	Sand pack to
0142	9/7/1980	6981.50	6978.5	61852.89	78190.53	320	2	295	310	10	320
0143	9/9/1980	6988.27	6989.59	62168.48	78194.76	330	2	305	320	10	330
0412	2/25/1981	6978.32	6979.41	61645.42	77490.5	280	2	200	270	109	280
0501 A	11/4/1981	7046.02	7048.04	61865.91	75655.56	265	2	192	227	187	227
0502 A	11/5/1981	7023.55	7025.3	61675.04	75995.86	260	2	207	244	203	242
0504 A	9/11/1981	6999.78	7001.37	61999.06	76992	260	2	194	236	188	237
0505 A	11/9/1981	6961.14	6963.1	60947.91	75858.91	175	2	136	166	133	167
0515 A	11/23/1981	7007.08	7008.68	61184.84	73521.41	116	2	80	115	75	115
0604	4/15/1982	7004.33	7006.4	61184.55	73640.21	121	5	76	118	70	118
0614	8/2/1984	7011.03	7011.91	61178.56	73241.39	126	6	82	115	77	113
EPA 02	12/3/1984	7016.91	7019.485	61621.36	75472.76	200	4	155	195	152	218
EPA 04	1/12/1985	7066.30	7069.798	61364.36	74989.45	240	4	190	230	173	245
EPA 05	1/6/1985	7008.54	7011.444	61404.46	74230.64	142	4	97	137	92	142
EPA 07	2/23/1985	7008.66	7011.662	61458.81	73875.42	172	4	85	160	0	172
EPA 08	3/11/1985	7072.63	7076.402	61827.35	74939.89	263	4	188	258	183	263

Notes:

TOC = top of casing.

Elevations are in feet above mean sea level.

Easting and Northing values are in the Site coordinate system.

Total depth, screen from, screen to, sand pack from, and sand pack to are all in feet below ground; casing diameter is in inches.



**TABLE 7**  
Detected Constituents in Southwest Alluvium, October 2010  
United Nuclear Corporation, Church Rock Site  
Church Rock, New Mexico

Chemical Name	Action Level	Unit	0509 D	0624	0627	0632	0801	0802	0803	0808	EPA 23	EPA 25
ALUMINUM	5	mg/l				0.2						
AMMONIA (AS N)		mg/l	4.8 D	0.07	0.06	0.66	3.54		2.86	0.32	3.48	0.05
ARSENIC	0.05	mg/l	0.001									0.001
BICARBONATE (HCO3)		mg/l	2690	1570	618	2020	1570	2200	1950	2030	1330	1160
CALCIUM		pci/l	882	666	524	610 D	540	604	648	710	642	736
CHLORIDE	250	mg/l	359 D	195 D	38 D	218 D	197 D	174 D	163 D	171 D	93 D	91 D
COBALT	0.05	mg/l	0.01									
GROSS ALPHA	15	mg/l				1.3						
LEAD-210	1			1.7		2.6	1.9					
MAGNESIUM		mg/l	424	395	230	801	638	926	710	638	386	224
MANGANESE	2.6	mg/l	4.44	0.17	0.05	2.58	4.17	1.27	1.97	1.02	4.98	0.2
NICKEL	0.05	mg/l										
NITRATE (NO3)	190	mg/l	9.2 D	74 D	97 D	75 D	5.0 D	97 D	45 D	101 D	16 D	75 D
PH (FIELD)		su	6.41	6.53	6.94	6.41	6.45	6.46	6.41	6.43	6.82	6.82
PH (LAB)		su	7.37	7.6	7.59	7.42	7.48	7.31	7.02	7.46	7.63	7.43
POTASSIUM		mg/l	14	6	6	10	12	6	14	5	11	7
RADIUM-226		pci/l	0.23			0.54	0.38	0.18	0.18		0.21	
RADIUM 226 & 228	5	pci/l	0.23	1.4		2.54	0.38	0.18	0.18		0.21	
SELENIUM	0.01					0.002					0.001	
SODIUM		mg/l	418	271	478	412 D	344	366	294	320	157	180
SULFATE (SO4)	2125	mg/l	2040 D	2210 D	2410 D	3320 D	3410 D	3780 D	3410 D	3030 D	2380 D	1800 D
THORIUM-230	5											
TOTAL DISSOLVED SOLIDS	4800	mg/l	5570 D	5340 D	4550 D	7400 D	6510 D	8080	6920 D	6840 D	4880 D	4260 D
TOTAL TRIHALOMETHANES	80	ug/l				2.86	2.65	18	7.52	4.92		
URANIUM	0.3	mg/l	0.312	0.0355	0.0209	0.0803	0.0396	0.138	0.118	0.121	0.0328	0.122

**TABLE 7**

Detected Constituents in Southwest Alluvium, October 2010  
 United Nuclear Corporation, Church Rock Site  
 Church Rock, New Mexico

Chemical Name	Action Level	Unit	EPA 28	EPA 28 FD	GW 1	GW 2	GW 3	SBL-01
ALUMINUM	5	mg/l					0.8	0.1
AMMONIA (AS N)		mg/l	0.07	0.05	0.91	0.07	0.09	0.15
ARSENIC	0.05	mg/l						
BICARBONATE (HCO <sub>3</sub> )		mg/l	843	728	1990	2360	1590	467
CALCIUM		pci/l	522	530	710 D	613 D	890	486 D
CHLORIDE	250	mg/l	125 D	116 D	228 D	193 D	166 D	85 D
COBALT	0.05	mg/l				0.01	0.01	0.02
GROSS ALPHA	15	mg/l	0.8					
LEAD-210	1		2.6	2.2	2	1.9	2.7	1.8
MAGNESIUM		mg/l	470	462	662	1080	272	1110
MANGANESE	2.6	mg/l	0.71	0.64	0.08	1.44	1.64	3.2
NICKEL	0.05	mg/l						0.07
NITRATE (NO <sub>3</sub> )	190	mg/l	30 D	27 D	90 D	16 D	100 D	42 D
PH (FIELD)		su	6.76	6.78	6.57	6.27	6.59	6.5
PH (LAB)		su	7.68	7.65	6.85	7.15	7.18	7.53
POTASSIUM		mg/l	12	11	7	14	9	14
RADIUM-226		pci/l	0.18	0.23				0.3
RADIUM 226 & 228	5	pci/l	1.68	1.53	1.1	1.3	2.2	2.9
SELENIUM	0.01							
SODIUM		mg/l	227	231	410 D	402 D	336	300 D
SULFATE (SO <sub>4</sub> )	2125	mg/l	2960 D	2960 D	3190 D	4550 D	2240 D	5890 D
THORIUM-230	5					0.4		
TOTAL DISSOLVED SOLIDS	4800	mg/l	5410 D	5180 D	7200 D	8770 D	5420 D	9080 D
TOTAL TRIHALOMETHANES	80	ug/l			2.37	5.68		
URANIUM	0.3	mg/l	0.0503	0.0453	0.122	0.0882	0.215	0.0142



**TABLE 8**  
Detected Constituents in Zone 3, October 2010  
United Nuclear Corporation, Church Rock Site  
Church Rock, New Mexico

Chemical Name	Action Level	Unit	0420	0504 B	0517	0613	0708	0711	0711 DUP	0717	0719	EPA 13	EPA 14	NBL-01	NBL-02
ALUMINUM	5	mg/l		12.6	6.8	646	24.4	0.2	0.2	120	1.5		105	27.8	
AMMONIA (AS N)		mg/l	0.14	0.8	11.5 D	219 D	2.86	0.79	0.74	66 D	1.17	0.64	44 D	5.1 D	
ARSENIC	0.05	mg/l	0.001	0.003				0.004	0.009			0.023 D	0.001	0.149 D	
BERYLLIUM	0.017	mg/l				0.13	0.02			0.09			0.13	0.02	
BICARBONATE (HCO3)		mg/l	547									65			411
CADMIUM	0.01	mg/l			0.009	0.037				0.017			0.008		
CALCIUM		mg/l	668	491	462	433 D	434	472	476	473	496	483	474	572	610
CHLORIDE	250	mg/l	47 D	25 D	35 D	128 D	22 D	13 D	13 D	62 D	28 D	36 D	58 D	34 D	46 D
COBALT	0.05	mg/l	0.02	0.25	0.91	1.94	0.47	0.31	0.31	0.94	0.42	0.07	0.94	0.37	0.04
GROSS ALPHA	15	pci/l	4.4	13.4	15.9	120	15.5	4.6	5.4	27.9	5.4	6.8	37.6	51.6	7.2
LEAD-210	1	pci/l				2.1				4.6			3.3	13.3	
MAGNESIUM		mg/l	133	604	458	706	566	447	441	522	614	812	556	254	184
MANGANESE	2.6	mg/l	1.5	6.34	10.3	52.8	12	5.41	5.33	19.2	5.6	6.78	17.1	5.88	1.34
MOLYBDENUM	1	mg/l	0.6	1.2					0.2			0.2		3.8	0.2
NICKEL	0.05	mg/l		0.32	0.9	1.89	0.52	0.28	0.27	0.83	0.47	0.18	0.86	0.44	
NITRATE (NO3)	190	mg/l				5.3 D				24 D			22 D		17 D
PH (FIELD)		su	6.54	3.88	3.72	2.93	3.57	3.05	3.05	4.23	4.62	5.89	4.26	2.97	6.59
PH (LAB)		su	7.42	4.94	2.97	3.06	2.95	3.23	4.19	4.33	3.71	7.19	4.33	3.14	7.31
POTASSIUM		mg/l	7	12	12		14	10	10	13	13	13	12	11	7
RADIUM-226		pci/l	3.8	8	7.6	12	8.8	4.7	5.9	18	5.9	6.2	6.8	8.8	4.8
RADIUM 226 & 228	5	pci/l	15.8	22	18.6	12	13	13	14.5	42	14.2	11	26.8	18.8	12.5
SELENIUM	0.01	mg/l				0.001									
SODIUM		mg/l	150	173	155	270 D	124	102	99	178	149	160	176	143	155
SULFATE (SO4)	2125	mg/l	1960 D	3930 D	3930 D	9330 D	4110 D	3610 D	3640 D	4440 D	3890 D	4680 D	4450 D	2980 D	2140 D
THORIUM-230	5	pci/l		0.6	1.3	946								20.4	
TOTAL DISSOLVED SOLIDS	4800	mg/l	3540	5570 D	5270 D	12300 D	6090 D	4850 D	4500 D	6220 D	5470 D	6540 D	6610 D	4250 D	3640
TOTAL TRIHALOMETHANES	80	ug/l			4.16	85.6				0.68			1.01		
URANIUM	0.3	mg/l	0.425	0.12	0.0636	1.2	0.0706	0.0189	0.0131	0.0168	0.0114	0.014	0.0156	0.225	0.18
VANADIUM	0.1	mg/l				2.1									



**TABLE 8**  
Detected Constituents in Zone 3, October 2010  
United Nuclear Corporation, Church Rock Site  
Church Rock, New Mexico

Chemical Name	Action Level	Unit	NW-1	NW-2	NW-3	NW-4	NW-5	PB-02	PB-03	PB-04	RW-11	RW-A
ALUMINUM	5	mg/l						4.6	0.3		0.3	
AMMONIA (AS N)		mg/l						1.01	1.6		2.45	4.74
ARSENIC	0.05	mg/l						0.001			0.001	
BERYLLIUM	0.017	mg/l										
BICARBONATE (HCO3)		mg/l	143	449	577	175	667	50	272		242	276
CADMIUM	0.01	mg/l										
CALCIUM		mg/l						562	546		561	586
CHLORIDE	250	mg/l	23 D	42 D	52 D	27 D	57 D	27 D	29 D	25 D	35 D	35 D
COBALT	0.05	mg/l						0.49	0.1		0.18	0.19
GROSS ALPHA	15	pci/l						17	6.8		12.4	14.5
LEAD-210	1	pci/l										
MAGNESIUM		mg/l						461	239		278	270
MANGANESE	2.6	mg/l						6.1	3.68		3.93	4.82
MOLYBDENUM	1	mg/l						0.6	0.6		0.8	0.2
NICKEL	0.05	mg/l						0.56	0.12		0.2	0.21
NITRATE (NO3)	190	mg/l							0.1			
PH (FIELD)		su	6.17	6.50	6.49	6.12	6.84	5.29	7.12	2.89	5.97	5.99
PH (LAB)		su	7.42	7.56	7.42	6.29	7.42	6.75	7.68	2.94	6.56	7.48
POTASSIUM		mg/l						11	10		10	10
RADIUM-226		pci/l						13	5.9		10	12
RADIUM 226 & 228	5	pci/l						31	11.7		27	28
SELENIUM	0.01	mg/l										
SODIUM		mg/l						151	134		144	145
SULFATE (SO4)	2125	mg/l						3620 D	2300 D		2630 D	2640 D
THORIUM-230	5	pci/l						1.6				
TOTAL DISSOLVED SOLIDS	4800	mg/l	4350 D	3690	3830	4240 D	3710	4940 D	3540	4280 D	3970	3940
TOTAL TRIHALOMETHANES	80	ug/l										
URANIUM	0.3	mg/l						0.0811	0.338		0.246	0.106
VANADIUM	0.1	mg/l										



**TABLE 9**  
**Zone 3 Saturated Thickness, October 2010**  
**United Nuclear Corporation, Church Rock Site, Church Rock, New Mexico**

Well Number <sup>1</sup>	Saturated Thickness		Change (feet)	Change
	3rd Quarter 1989	4th Quarter 2010		
402	--	18.64	--	--
411	62.5	--	--	--
420	56.3	7.16	-49.1	-87%
424	--	19.94	--	--
446	--	6.92	--	--
501 B	20.2	--	--	--
502 B	48.5	--	--	--
504 B	40.1	5.43	-34.7	-86%
517	42.7	11.22	-31.5	-74%
518 <sup>2</sup>	37.2	--	--	--
613 <sup>3</sup>	67.2	19.46	-47.7	-71%
EPA 01	14.7	--	--	--
EPA 03	8.3	--	--	--
EPA 09	8.1	3.65	-4.4	-55%
EPA 11	30.8	--	--	--
EPA 12	10.7	--	--	--
EPA 13	24.8	8.29	-16.5	-67%
EPA 14	76.3	26.50	-49.8	-65%
EPA 15	60.8	--	--	--
EPA 17	1.4	--	--	--
EPA 18	2.5	--	--	--
701	46.1	15.89	-30.2	-66%
702	24.1	8.91	-15.2	-63%
703	32.6	19.12	-13.5	-41%
705	--	--	--	--
706	--	16.93	--	--
707	58.8	13.40	-45.4	-77%
708	49.8	15.00	-29.8	-60%
709	56.1	13.28	-42.8	-76%
710	45.5	12.28	-33.2	-73%
711	43.7	18.90	-24.8	-57%
712	39.1	4.84	-34.3	-88%
713	34.2	9.01	-25.2	-74%
714 <sup>4</sup>	50.1	15.76	-34.3	-69%
715 <sup>4</sup>	47.6	9.88	-37.7	-79%
716 <sup>4</sup>	58.3	18.09	-40.2	-69%
717 <sup>4</sup>	57.6	20.01	-37.6	-65%
718 <sup>4</sup>	51.1	16.78	-34.3	-67%
719 <sup>4</sup>	39.9	7.48	-32.4	-81%
720 <sup>4</sup>	33.1	2.01	-31.1	-94%
NBL-01 <sup>5</sup>	--	12.30	--	--
Average	37.3	13.00	-32.3	-71%

**Notes:**

- <sup>1</sup> Wells 9 D and 106 D were not included because they appear to be completed above the bottom of Zone 3. Measurements of saturated thickness in these wells may be less than actual conditions. Well 126 was not included because it was completed above the bottom of Zone 3. Measurements of saturated thickness in this well are less than actual conditions. Wells 600, 610 and 672 were not included because they were used solely as pumping wells, therefore no water level data are available. Well 608 was not included because no water level data were available in 1989 and the last water level measurement was in February 2000.
- <sup>2</sup> Water level for Well 518 last measured in January 2000.
- <sup>3</sup> Water level for Well 613 measured in 1983 before pumping started. Water level data for 1989 are not available because the well was pumpin
- <sup>4</sup> Water levels for the Stage II wells were measured June 1991 when wells were installed. Not included in 1989 average saturated thickness calculation.
- <sup>5</sup> Well NBL-01 installed in July 2001 and first water level measured in August 2001.
- Shading indicates saturated thickness greater than 25 feet.
- " indicates that no data is available.



**TABLE 10**

Detected Constituents in Zone 1, October 2010  
 United Nuclear Corporation, Church Rock Site  
 Church Rock, New Mexico

Chemical Name	Action Level	Unit	0142	0515 A	0604	0614	EPA 02	EPA 02 DUP	EPA 04	EPA 05	EPA 07
ALUMINUM	5	mg/l	0.3	0.6	2.4						0.4
AMMONIA (AS N)		mg/l	0.32	41.5 D	0.35	95 D	0.46	0.47	0.89	10.5 D	0.19
BICARBONATE (HCO <sub>3</sub> )		mg/l	298	365	26	1440	320	348	153	74	665
CALCIUM		mg/l	48	463 D	452	567 D	358	364	560	465	509 D
CHLORIDE	250	mg/l	15	286 D	55 D	279 D	18 D	16 D	31 D	37 D	197 D
COBALT	0.05	mg/l		0.02	0.19					0.04	0.03
GROSS ALPHA	15	pci/l		1.6	2.3	0.9	1.3	1.3	1.9	2.7	0.9
LEAD-210	1	pci/l				2.3			2.4		
MAGNESIUM		mg/l	24	975	799	673	155	162	373	480	1040
MANGANESE	2.6	mg/l	0.03	16.6	7.52	0.72	0.9	1.3	3.19	1.15	2.82
NICKEL	0.05	mg/l		0.17	0.27						
NITRATE (NO <sub>3</sub> )	190	mg/l	0.1	52 D	67 D	113 D			0.9	10 D	115 D
PH (FIELD)		su	7.76	7.13	5.24	7.21	6.75	6.74	6.64	5.94	6.00
PH (LAB)		su	7.74	6.35	5.67	7.22	7.81	7.69	7.51	7.09	7.53
POTASSIUM		mg/l	4	18	12	13	6	7	9	8	9
RADIUM-226		pci/l	0.83	2.5	1.3	0.47	1.4	1.6	1.3	2	0.78
RADIUM 226 & 228	5	pci/l	0.83	5.9	6.3	3.97	3.7	4.8	4.6	5.6	1.98
SODIUM		mg/l	344	540 D	307	487 D	203	215	194	119	396 D
SULFATE (SO <sub>4</sub> )	2125	mg/l	695 D	5370 D	4590 D	3330 D	1790 DH	1780 D	3210 D	3460 D	5220 D
TOTAL DISSOLVED SOLIDS	4800	mg/l	1260	7880 D	6520 D	6910 D	2800	2750	3560 D	3720 D	7610 D
TOTAL TRIHALOMETHANES	80	ug/l		158	9	38					0.76
URANIUM	0.3	mg/l		0.0027	0.0007	0.0516	0.0013	0.0015	0.0004	0.0014	0.0023

**TABLE 11**

**Southwest Alluvium and Zone 1 Wells  
Having Samples Representative of Background Water Quality**

<b>Southwest Alluvium</b>	<b>Zone 1</b>
29 A	619
624 (Jul 89 - Oct 95)	EPA 2
627	EPA 4 (POC)
639	EPA 8
642	
645	
EPA 22 A	
EPA 25 (Jul 89 - Oct 95)	
EPA 27	
EPA 28 (POC)	
SBL 1	

**Notes:**

POC = Point-of-Compliance Well.

The following wells were included only for the  
pre-July 1989 metals results:

GW 4 and 623 (SWA)

EPA 5 (Zone 1)

**TABLE 12**

**Zone 3 Wells Having Samples Representative of Background Water Quality**

<b>Well</b>	<b>Sampled Time Period</b>
411	Jul 89 - Jan 98
504 B	Jul 89 - Apr 92
517 (POC)	Jul 89 - Apr 91
EPA 01	Jul 89 - Oct 97
EPA 03	Jul 89 - Oct 91
EPA 11	Jul 89 - Apr 90
EPA 12	Jul 89 - Apr 92
EPA 14	Jul 89 - Apr 95
EPA 15	Jul 89 - Apr 95
EPA 17	Jul 89 - Apr 92
NBL-01	Aug 01 - Jan 04

Note: POC = Point-of-Compliance well.



**Table 13: Contaminant-Specific Groundwater ARARs**

Contaminant	ROD ARAR <sup>A</sup>	Source of ROD ARAR	Cleanup Level or ARAR Currently Exceeded in Impacted Wells Outside Section 2? <sup>J</sup>	Cleanup Level or ARAR Currently Exceeded in Background Wells Outside Section 2? <sup>K</sup>
Aluminum	5.0	NMWQCC <sup>J</sup>	Yes (Zone 3)	No
Antimony <sup>B</sup>	0.014	Health-based	NOT ANALYZED	NOT ANALYZED
Arsenic <sup>C</sup>	0.05	MCL	Yes (Zone 3)	No
Barium	1.0	MCL, NMWQCC	NOT ANALYZED	NOT ANALYZED
Beryllium <sup>D</sup>	0.017	Health-based	Yes (Zone 3)	No
Cadmium <sup>E</sup>	0.01	MCL, NMWQCC	Yes (Zone 3)	No
Chromium <sup>F</sup>	0.05	MCL, NMWQCC	NOT ANALYZED	NOT ANALYZED
Cobalt	0.05	NMWQCC	Yes (Zone 3)	No
Copper	1.0	NMWQCC	NOT ANALYZED	NOT ANALYZED
Iron	5.5	Background Level	NOT ANALYZED	NOT ANALYZED
Lead	0.05	MCL, NMWQCC	No	No
Manganese (Mn)	2.6	Background Level	Yes (Zone 3)	Yes (SWA) <sup>L</sup>
Mercury	0.002	MCL, NMWQCC	NOT ANALYZED	NOT ANALYZED
Molybdenum	1.0	NMWQCC	Yes (Zone 3)	No
Nickel	0.2	NMWQCC	Yes (Zone 3)	Yes (SWA)
Selenium	0.01	MCL	No	No
Silver	0.05	MCL, NMWQCC	NOT ANALYZED	NOT ANALYZED
Thallium <sup>G</sup>	0.014	Health-based	NOT ANALYZED	NOT ANALYZED
Vanadium	0.7	Health-based	No	No
Zinc	10	NMWQCC	NOT ANALYZED	NOT ANALYZED
Chloride (Cl)	250	NMWQCC	No	No
Sulfate (SO <sub>4</sub> )	2,160	Background Level	Yes (in all 3 units)	Yes (SWA, Zone 1)
Nitrate	30	Background Level	Yes (SWA, Zone 1)	Yes (SWA)
Total Dissolved Solids (TDS)	3,170	Background Level	Yes (in all 3 units)	Yes (SWA, Zone 1)
Radium 226 and 228	5 pCi/l	MCL	Yes (Zone 3, Zone 1)	No
Uranium <sup>H</sup>	5.0 mg/L	NMWQCC	No	No
Thorium-230 <sup>I</sup>	15 pCi/l	MCL	Yes (Zone 3)	No
Gross Alpha	15 pCi/l	MCL	Yes (Zone 3)	No

Notes:

- (A) In mg/l, except as noted – two rightmost columns benchmarked to October 2010.
- (B) Antimony MCL of 0.006 mg/L published since ROD issuance.
- (C) Arsenic MCL of 0.010 mg/L published since ROD issuance.
- (D) Beryllium MCL of 0.004 mg/L published since ROD issuance.
- (E) Cadmium MCL reduced to 0.005 mg/L since ROD issuance.
- (F) Thallium MCL of 0.002 mg/L published since ROD issuance.
- (G) Chromium MCL of 0.1 mg/L published since ROD issuance.
- (H) Uranium MCL reduced to 0.03 mg/L since ROD issuance.
- (I) Based on 15 pCi/l gross alpha.
- (J) NMWQCC = New Mexico Water Quality Control Commission.
- (K) No background wells are presently sampled in Zone 3.
- (L) SWA = Southwest Alluvium.

**Table 14: Compounds Exceeding Standards**  
(Source: ROD; EPA, 1988c)

<b>Contaminant</b>	<b>Zone 3</b>	<b>Zone 1</b>	<b>Southwest Alluvium</b>
Aluminum	X	X	
Arsenic	X	X	
Cadmium	X	X	X
Cobalt	X	X	X
Manganese	X	X	X
Molybdenum	X	X	X
Nickel	X	X	X
Selenium	X	X	X
Nitrate	X	X	X
Total Dissolved Solids (TDS)	X	X	X
Radium 226 and 228	X		
Gross Alpha	X	X	X



TABLE 15  
Contaminant-Specific Groundwater Cleanup Levels and Other Comparison Values  
United Nuclear Corporation, Church Rock Site  
Church Rock, New Mexico

Source	Standards Used for 3rd 5-Year Review (September 2008, Table 3-1) and ROD (September 1988)				NRC Source Materials	Potential ARARs				Standard Compared to in 2010 Annual Review		Current Health-Based Criteria (+)			
	New Mexico WQCC Standards	Health-based	Maximum Concentration Limit (MCL)	Background Level		License Compliance Standards	NRC Appendix List*	New Mexico WQCC Standards		EPA Drinking Water		EPA	NRC	Health-Based Criterion	Source
								MCL	Other**						
Sulfate				2160			2125***			2125***					SO4
Total Dissolved Solids				3170			4800***			4800***					TDS
NO3 as N				30			190***		10	190***			10	MCL	NO3
Manganese				2.6			0.2	O		2.6			0.88	RSL	Mn
Chloride	250						250	O		250					Cl2
Aluminum	5						5	I		5			37	RSL	Al
Antimony		0.014							0.006				0.006	MCL	Sb
Arsenic			0.05		0.05	0.05	0.1	HH	0.01	0.05	0.05		0.01	MCL	As
Barium	1		1			1	1	HH	2				2	MCL	Ba
Beryllium		0.017			0.05				0.004	0.017	0.05		0.004	MCL	Be
Cadmium	0.01		0.01		0.01	0.01	0.01	HH	0.005	0.01	0.01		0.005	MCL	Cd
Chromium	0.05		0.05			0.05	0.05	HH	0.1				0.1	MCL	Cr
Cobalt	0.05						0.05	I		0.05			0.011	RSL	Co
Copper	1						1	O	1.3	MCLG & TT			1.3	MCL(++)	Cu
Iron				5.5			1	O					26	RSL	Fe
Lead	0.05		0.05		0.05	0.05	0.05	HH	0.015	MCLG & TT	0.05	0.05	0.015	MCL(++)	Pb
Mercury	0.002		0.002			0.002	0.002	HH	0.002				0.002	MCL	Hg
Molybdenum	1						1	I		1			0.18	RSL	Mo
Nickel	0.2				0.05		0.2	I		0.2	0.05		0.73	RSL	Ni
Selenium			0.01		0.01	0.01	0.05	HH	0.05	0.01	0.01		0.05	MCL	Se
Silver	0.05		0.05			0.05	0.05	HH					0.18	RSL	Ag
Thallium		0.014							0.002	MCLG = 0.0005			0.002	MCL	Tl
Vanadium		0.7			0.1					0.7	0.1		0.18	RSL	V
Zinc	10						10	O					11	RSL	Zn
TTHMs****					0.08		0.1	HH	0.08	MCLG = 0.07****		0.08	0.08	MCL	TTHMs
Uranium	5				0.3		0.03	HH	0.03	5	0.3		0.03	MCL	U
Radium 226 and 228			5 pCi/l		*****	5 pCi/l	30 pCi/l	HH	5 pCi/l	5 pCi/l	*****		5 pCi/l	MCL	comb Ra
Lead-210					1 pCi/l						1 pCi/l		0.0601 pCi/L	PRG	Pb-210
Thorium-230			15 pCi/l		5 pCi/L						5 pCi/l		0.581 pCi/l	PRG	Th-230
Gross Alpha			15 pCi/l		15 pCi/l	15 pCi/l			15 pCi/l	15 pCi/l	15 pCi/l		15 pCi/l	MCL	GA

Notes:

Units = mg/L unless otherwise noted

Yellow cells = constituents not analyzed since site active remediation started in 1989, per EPA FS (August 1988) and ROD (September 1988)

\* 10 CFR Appendix A to Part 40

\*\* "Other" includes non-zero Maximum Contaminant Level Goals (MCLG) or Treatment Technology Action Levels (TT)

\*\*\* New Mexico Environment Department recommended background values (letter to EPA of January 6, 1998); EPA has not formally adopted these revisions

\*\*\*\* TTHMs (total trihalomethanes) include chloroform; TTHMs MCL = 0.08 mg/L; in addition, chloroform has an MCLG = 0.07 mg/L

\*\*\*\*\* Combined radium NRC Site Groundwater Protection Standards are 5.0 pCi/L for Zone 3; 5.2 pCi/L for Southwest Alluvium (background); and 9.4 pCi/L for Zone 1 (background)

(+) Sources of health-based criteria include the November 2010 EPA Regional Screening Level (RSL) Summary Table (tapwater RSLs) and August 2010 EPA Preliminary Remediation Goals for Radionuclides (PRGs) (resident tapwater PRGs). For those contaminants with federal MCLs, the MCL is shown as the health-based screening level, per January 25, 2008 letter from EPA to UNC (General Comment 5).

(++) Lead and copper are regulated by a Treatment Technique that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed the action level, water systems must take additional steps. For copper, the action level is 1.3 mg/L, and for lead is 0.015 mg/L.

HH = Human Health Standard

I = Irrigation Standard

O = Other Standards for domestic water supply

green = "Comparison Values" column in N.A. Water Systems report (2008b): Calculation of Background Statistics with Comparison Values (also see Appendix B Tables 7, 8, and 9 in the present report)



**TABLE 16**  
**Summary Statistics for COPCs and Trace Metals in Southwest Alluvium Background Groundwater**  
 United Nuclear Corporation Church Rock Site  
 Church Rock, New Mexico

Parameter	Units	Total Data	Percent Nondetect	Minimum Detected	Maximum Detected	Mean of Detected	Median of Detected	UCL95 of Mean
Al	mg/L	391	94.6%	0.1	0.6	0.182	0.14	0.107
As	mg/L	391	93.1%	0.001	0.01	0.00237	0.001	0.00116
Be	mg/L	389	100.0%	N/A	N/A	N/A	N/A	N/A
Cd	mg/L	391	96.9%	0.006	0.07	0.0255	0.01	0.0108
Co	mg/L	391	81.6%	0.01	0.06	0.0186	0.02	0.0121
Pb	mg/L	388	99.5%	0.05	0.07	0.06	0.06	0.0502
Mn	mg/L	389	11.8%	0.01	3.35	0.339	0.13	0.414
Mo	mg/L	391	99.5%	0.03	0.03	N/A	N/A	N/A
Ni	mg/L	391	96.4%	0.05	0.17	0.08	0.08	0.0613
Se	mg/L	390	50.5%	0.001	0.195	0.00708	0.003	0.00516
V	mg/L	391	100.0%	N/A	N/A	N/A	N/A	N/A
Cl	mg/L	391	0.0%	9.8	169	74.82	67.8	83.72
SO4	mg/L	391	0.0%	605	5830	2401	2420	2468
NO3_as_N	mg/L	391	1.3%	0.09	1225	99.54	74.1	137.4
U	mg/L	390	0.3%	0.001	0.367	0.0419	0.031	0.0459
Chloroform	ug/L	391	100.0%	N/A	N/A	N/A	N/A	N/A
Lab_TDS	mg/L	390	0.0%	1310	10530	4630	4795	4745
Rad-226	pCi/L	391	34.3%	0.2	9.4	0.979	0.6	0.798
Rad-228	pCi/L	391	67.8%	1	7	2.55	2.2	1.611
Rad_totl	pCi/L	391	25.3%	0.2	12	1.9	1.3	1.621
Th-230	pCi/L	391	91.8%	0.2	14.3	2.841	1.6	0.509
Pb-210	pCi/L	391	78.3%	1	14.2	2.845	2.2	1.513
Gross_Alpha	pCi/L	391	70.6%	0.4	17.8	3.35	2.1	1.693
Sb	mg/L	0	N/A	N/A	N/A	N/A	N/A	N/A
Ba	mg/L	26	100.0%	N/A	N/A	N/A	N/A	N/A
Cr	mg/L	37	97.3%	0.29	0.29	N/A	N/A	N/A
Cu	mg/L	13	84.6%	0.01	0.01	N/A	N/A	N/A
Fe	mg/L	19	79.0%	0.06	1.4	0.418	0.105	0.275
Hg	mg/L	8	100.0%	N/A	N/A	N/A	N/A	N/A
Ag	mg/L	21	100.0%	N/A	N/A	N/A	N/A	N/A
Tl	mg/L	0	N/A	N/A	N/A	N/A	N/A	N/A
Zn	mg/L	25	40.0%	0.02	0.429	0.0891	0.05	0.0949



**TABLE 17**  
**Summary Statistics for COPCs and Trace Metals in Zone 1 Background Groundwater**  
 United Nuclear Corporation Church Rock Site  
 Church Rock, New Mexico

Parameter	Units	Total Data	Percent Nondetect	Minimum Detected	Maximum Detected	Mean of Detected	Median of Detected	UCL95 of Mean
Al	mg/L	234	86.8%	0.1	0.6	0.185	0.14	0.117
As	mg/L	234	83.8%	0.001	0.004	0.00174	0.002	0.00117
Be	mg/L	234	100.0%	N/A	N/A	N/A	N/A	N/A
Cd	mg/L	234	98.7%	0.005	0.01	0.00733	0.007	0.0051
Co	mg/L	234	89.7%	0.01	0.06	0.0171	0.01	0.0112
Pb	mg/L	234	99.6%	0.05	0.05	N/A	N/A	N/A
Mn	mg/L	234	0.4%	0.66	4.15	2.434	2.65	2.519
Mo	mg/L	234	97.9%	0.03	0.27	0.12	0.13	0.132
Ni	mg/L	230	98.7%	0.06	0.07	0.0667	0.07	0.0602
Se	mg/L	234	95.7%	0.001	0.004	0.0019	0.0015	0.00107
V	mg/L	234	100.0%	N/A	N/A	N/A	N/A	N/A
Cl	mg/L	234	0.0%	19.4	252	37.13	37.9	39.03
SO4	mg/L	234	0.0%	1410	3882	2703	2952	2773
NO3_as_N	mg/L	233	71.7%	0.01	51.8	1.767	0.16	1.754
U	mg/L	233	16.7%	0.0004	0.975	0.00862	0.0013	0.0255
Chloroform	ug/L	234	99.6%	0.91	0.91	N/A	N/A	N/A
Lab_TDS	mg/L	234	0.0%	2490	5610	4225	4569	4319
Rad-226	pCi/L	233	1.7%	0.2	5.4	1.269	1.2	1.314
Rad-228	pCi/L	234	29.9%	1	13.8	3.457	3.1	2.946
Rad_totl	pCi/L	234	0.9%	0.2	14.8	3.618	3.35	3.841
Th-230	pCi/L	234	91.9%	0.2	4.9	0.974	0.7	0.403
Pb-210	pCi/L	234	80.8%	1.1	9.1	2.58	2.1	1.579
Gross_Alpha	pCi/L	234	35.0%	0.9	14	2.757	2	2.361
Sb	mg/L	0	N/A	N/A	N/A	N/A	N/A	N/A
Ba	mg/L	14	78.6%	0.079	0.091	0.0847	0.084	0.091
Cr	mg/L	11	100.0%	N/A	N/A	N/A	N/A	N/A
Cu	mg/L	4	75.0%	0.026	0.026	N/A	N/A	N/A
Fe	mg/L	12	8.3%	0.25	14	6.386	6.2	8.701
Hg	mg/L	0	N/A	N/A	N/A	N/A	N/A	N/A
Ag	mg/L	11	100.0%	N/A	N/A	N/A	N/A	N/A
Tl	mg/L	0	N/A	N/A	N/A	N/A	N/A	N/A
Zn	mg/L	16	56.3%	0.01	5	0.784	0.046	3.583

**TABLE 18**  
**Summary Statistics for COPCs and Trace Metals in Zone 3 Background Groundwater**  
 United Nuclear Corporation Church Rock Site  
 Church Rock, New Mexico

Parameter	Units	Total Data	Percent Nondetect	Minimum Detected	Maximum Detected	Mean of Detected	Median of Detected	UCL95 of Mean
Al	mg/L	186	68.28%	0.1	1.68	0.422	0.31	0.231
As	mg/L	186	26.88%	0.001	1.01	0.121	0.0235	0.175
Be	mg/L	186	100.00%	N/A	N/A	N/A	N/A	N/A
Cd	mg/L	186	95.16%	0.01	0.09	0.02	0.01	0.0113
Co	mg/L	186	9.14%	0.01	0.53	0.0835	0.06	0.0877
Pb	mg/L	185	97.84%	0.05	0.08	0.065	0.065	0.0701
Mn	mg/L	186	0.54%	0.42	7.5	3.25	3.3	3.436
Mo	mg/L	184	14.13%	0.02	75	11.88	3.76	17.43
Ni	mg/L	186	39.25%	0.05	0.67	0.173	0.12	0.14
Se	mg/L	186	77.42%	0.001	0.015	0.0026	0.001	0.00159
V	mg/L	186	100.00%	N/A	N/A	N/A	N/A	N/A
Cl	mg/L	186	0%	15	66	31.62	30.85	32.65
SO4	mg/L	186	0%	1319	4674	2588	2651	2674
NO3_as_N	mg/L	186	17.20%	0.01	61	11.34	4.785	15.61
U	mg/L	186	1.08%	0.0007	0.38	0.0791	0.039	0.107
Chloroform	ug/L	186	99.46%	1.1	1.1	N/A	N/A	N/A
Lab_TDS	mg/L	186	0%	2244	6930	4115	4237	4239
Rad-226	pCi/L	186	11.83%	0.2	23.7	5.01	4.5	4.996
Rad-228	pCi/L	185	29.19%	1	22.3	5.34	4.3	4.509
Rad_totl	pCi/L	185	9.73%	0.2	40.9	9.099	7.9	10.66
Th-230	pCi/L	186	89.78%	0.2	57	6.705	2.3	1.426
Pb-210	pCi/L	186	69.35%	1	11	2.549	2	1.618
Gross_Alpha	pCi/L	186	15.59%	1	69	8.191	5.4	8.217
Sb	mg/L	1	100.0%	N/A	N/A	N/A	N/A	N/A
Ba	mg/L	36	94.4%	0.54	0.54	N/A	N/A	N/A
Cr	mg/L	37	100.0%	N/A	N/A	N/A	N/A	N/A
Cu	mg/L	13	76.9%	0.028	0.06	0.042	0.038	0.06
Fe	mg/L	23	39.1%	0.03	67	9.682	1.45	12.16
Hg	mg/L	4	100.0%	N/A	N/A	N/A	N/A	N/A
Ag	mg/L	29	100.0%	N/A	N/A	N/A	N/A	N/A
Tl	mg/L	0	N/A	N/A	N/A	N/A	N/A	N/A
Zn	mg/L	31	19.4%	0.02	6.859	0.766	0.193	3.539



**TABLE 19**  
**Summary Comparisons of Parameter Concentrations in Southwest Alluvium Background Groundwater to Comparison Values**  
 United Nuclear Corporation Church Rock Site  
 Church Rock, New Mexico

Parameter	Units	Comparison Value <sup>1</sup>						Single Sample Hypothesis Test <sup>3</sup> H0: Site Median >= CV		Potential Clean-up Level
			Max RL <sup>2</sup>	UCL95	UCL95>CV?	Max RL>=CV?	Percent < RL	Sign Test	Wilcoxon Signed	
Al	mg/L	5	0.1	0.107	NO	NO	95%	Reject	Reject	
As	mg/L	0.01	0.001	0.00116	NO	NO	93%	Reject	Reject	
Be	mg/L	0.004	0.1	NA	N/A	YES	100%	N/A	N/A	
Cd	mg/L	0.005	0.01	0.0108	YES	YES	97%	Do not Reject	Reject	0.0108
Co	mg/L	0.05	0.01	0.0121	NO	NO	82%	Reject	Reject	
Pb	mg/L	0.05	0.05	0.0502	YES	YES	99%	Do not Reject	Reject	0.0502
Mn	mg/L	0.2	0.01	0.414	YES	NO	12%	Reject	Reject	0.414
Mo	mg/L	1	0.1	NA	N/A	NO	99%	Reject	Reject	
Ni	mg/L	0.2	0.05	0.0613	NO	NO	96%	Reject	Reject	
Se	mg/L	0.05	0.001	0.00516	NO	NO	51%	Reject	Reject	
V	mg/L	0.1	0.1	NA	N/A	YES	100%	N/A	N/A	
Cl	mg/L	250	N/A	83.72	NO	N/A	0%	Reject	Reject	
SO4	mg/L	2125	N/A	2468	YES	N/A	0%	Do not Reject	Do not Reject	2468
NO3_as_N	mg/L	30	0.1	137.4	YES	NO	1%	Do not Reject	Do not Reject	137.4
U	mg/L	0.03	0.0003	0.0459	YES	NO	0%	Do not Reject	Do not Reject	0.0459
Chloroform	ug/L	80	1	NA	N/A	NO	100%	N/A	N/A	
Lab_TDS	mg/L	3170	N/A	4745	YES	N/A	0%	Do not Reject	Do not Reject	4745
Rad_totl	pCi/L	5	0.2	1.621	NO	NO	25%	Reject	Reject	
Th-230	pCi/L	5	0.2	0.509	NO	NO	92%	Reject	Reject	
Pb-210	pCi/L	1	1	1.513	YES	YES	78%	Do not Reject	Reject	1.513
Gross_Alpha	pCi/L	15	1	1.693	NO	NO	71%	Reject	Reject	
Sb	mg/L	0.006	N/A	NA	N/A	N/A	N/A	no data	no data	
Ba	mg/L	2	0.1	NA	N/A	NO	100%	Reject	Reject	
Cr	mg/L	0.05	0.05	NA	N/A	YES	97%	Reject	Reject	
Cu	mg/L	1	0.02	NA	N/A	NO	85%	Reject	Reject	
Fe	mg/L	1	0.1	0.275	NO	NO	79%	Reject	Reject	
Hg	mg/L	0.002	0.001	NA	N/A	NO	100%	N/A	N/A	
Ag	mg/L	0.05	0.05	NA	N/A	YES	100%	N/A	N/A	
Tl	mg/L	0.002	N/A	NA	N/A	N/A	N/A	no data	no data	
Zn	mg/L	10	0.1	0.0949	NO	NO	40%	Reject	Reject	

**Note:**

1. See Table 15 of the present document for sources of Comparison Values (CV)
2. RL is an abbreviation of reporting limit
3. Single sample hypotheses tests are not applicable to datasets having 100% censored data



**TABLE 20**  
**Summary Comparisons of Parameter Concentrations in Zone 1 Background Groundwater to Comparison Values**  
United Nuclear Corporation Church Rock Site  
Church Rock, New Mexico

Parameter	Units	Comparison Value <sup>1</sup>						Single Sample Hypothesis Test <sup>3</sup> H0: Site Median >= CV		Potential Clean-up Level
			Max RL <sup>2</sup>	UCL95	UCL95>CV?	Max RL>=CV?	Percent < RL	Sign Test	Wilcoxon Signed	
Al	mg/L	5	0.1	0.117	NO	NO	87%	Reject	Reject	
As	mg/L	0.01	0.001	0.00117	NO	NO	84%	Reject	Reject	
Be	mg/L	0.004	0.05	N/A	N/A	YES	100%	N/A	N/A	
Cd	mg/L	0.005	0.01	0.0051	YES	YES	99%	Do not Reject	Reject	0.0051
Co	mg/L	0.05	0.01	0.0112	NO	NO	90%	Reject	Reject	
Pb	mg/L	0.05	0.05	N/A	N/A	YES	100%	N/A	N/A	
Mn	mg/L	0.2	0.01	2.519	YES	NO	0%	Do not Reject	Do not Reject	2.519
Mo	mg/L	1	0.1	0.132	NO	NO	98%	Reject	Reject	
Ni	mg/L	0.2	0.05	0.0602	NO	NO	99%	Reject	Reject	
Se	mg/L	0.05	0.001	0.00107	NO	NO	96%	Reject	Reject	
V	mg/L	0.1	0.1	N/A	N/A	YES	100%	N/A	N/A	
Cl	mg/L	250	N/A	39.03	NO	N/A	0%	Reject	Reject	
SO4	mg/L	2125	N/A	2773	YES	N/A	0%	Do not Reject	Do not Reject	2773
NO3_as_N	mg/L	30	0.1	1.754	NO	NO	72%	Reject	Reject	
U	mg/L	0.03	0.0004	0.0255	NO	NO	17%	Reject	Reject	
Chloroform	ug/L	80	1	N/A	N/A	N/A	100%	N/A	N/A	
Lab_TDS	mg/L	3170	N/A	4319	YES	N/A	0%	Do not Reject	Do not Reject	4319
Rad_totl	pCi/L	5	0.2	3.841	NO	NO	1%	Reject	Reject	
Th-230	pCi/L	5	0.2	0.403	NO	NO	92%	Reject	Reject	
Pb-210	pCi/L	1	1	1.579	YES	YES	81%	Do not Reject	Reject	1.579
Gross_Alpha	pCi/L	15	1	2.361	NO	NO	35%	Reject	Reject	
Sb	mg/L	0.006	N/A	N/A	N/A	N/A	N/A	no data	no data	
Ba	mg/L	2	0.1	0.091	NO	NO	79%	Reject	Reject	
Cr	mg/L	0.05	0.05	N/A	N/A	YES	100%	N/A	N/A	
Cu	mg/L	1	0.02	N/A	N/A	NO	75%	Do not Reject	Do not Reject	
Fe	mg/L	1	0.1	8.701	YES	NO	8%	Do not Reject	Do not Reject	8.701
Hg	mg/L	0.002	N/A	N/A	N/A	N/A	N/A	no data	no data	
Ag	mg/L	0.05	0.05	N/A	N/A	N/A	100%	N/A	N/A	
Tl	mg/L	0.002	N/A	N/A	N/A	N/A	N/A	no data	no data	
Zn	mg/L	10	0.1	3.583	NO	NO	56%	Reject	Reject	

**Note:**

1. See Table 15 of the present document for sources of Comparison Values (CV)
2. RL is an abbreviation of reporting limit
3. Single sample hypotheses tests are not applicable to datasets having 100% censored data



**TABLE 21**  
**Summary Comparisons of Parameter Concentrations in Zone 3 Background Groundwater to Comparison Values**  
 United Nuclear Corporation Church Rock Site  
 Church Rock, New Mexico

Parameter	Units	Comparison Value <sup>1</sup>						Single Sample Hypothesis Test <sup>3</sup> H0: Site Median >= CV		Potential Clean-up Level
			Max RL <sup>2</sup>	UCL95	UCL95>CV?	Max RL>=CV?	Percent < RL	Sign Test	Wilcoxon Signed	
Al	mg/L	5	0.1	0.231	NO	NO	68%	Reject	Reject	
As	mg/L	0.01	0.001	0.175	YES	NO	27%	Do Not Reject	Do Not Reject	0.175
Be	mg/L	0.004	0.05	N/A	N/A	YES	100%	N/A	N/A	
Cd	mg/L	0.005	0.01	0.0113	YES	YES	95%	Do Not Reject	Reject	0.0113
Co	mg/L	0.05	0.01	0.0877	YES	NO	9%	Do Not Reject	Do Not Reject	0.0877
Pb	mg/L	0.05	0.05	0.0701	YES	YES	98%	Do Not Reject	Reject	0.0701
Mn	mg/L	0.2	0.01	3.436	YES	NO	1%	Do Not Reject	Do Not Reject	3.436
Mo	mg/L	1	0.1	17.43	YES	NO	14%	Do Not Reject	Do Not Reject	17.43
Ni	mg/L	0.2	0.05	0.14	NO	NO	39%	Reject	Reject	
Se	mg/L	0.05	0.001	0.00159	NO	NO	77%	Reject	Reject	
V	mg/L	0.1	0.1	N/A	N/A	YES	100%	N/A	N/A	
Cl	mg/L	250	N/A	32.65	NO	N/A	0%	Reject	Reject	
SO4	mg/L	2125	N/A	2674	YES	N/A	0%	Do Not Reject	Do Not Reject	2674
NO3_as_N	mg/L	30	0.1	15.61	NO	NO	17%	Reject	Reject	
U	mg/L	0.03	0.0003	0.107	YES	NO	1%	Do Not Reject	Do Not Reject	0.107
Chloroform	ug/L	80	1	N/A	N/A	NO	99%	Reject	Reject	
Lab_TDS	mg/L	3170	N/A	4239	YES	N/A	0%	Do Not Reject	Do Not Reject	4239
Rad_totl	pCi/L	5	0.2	10.66	YES	NO	10%	Do Not Reject	Do Not Reject	10.66
Th-230	pCi/L	5	0.2	1.426	NO	NO	90%	Reject	Reject	
Pb-210	pCi/L	1	1	1.618	YES	YES	69%	Do Not Reject	Reject	1.618
Gross_Alpha	pCi/L	15	1	8.217	NO	NO	16%	Reject	Reject	
Sb	mg/L	0.006	0.05	N/A	N/A	YES	100%	N/A	N/A	
Ba	mg/L	2	0.1	N/A	N/A	NO	94%	Reject	Reject	
Cr	mg/L	0.05	0.1	N/A	N/A	YES	100%	Reject	Reject	
Cu	mg/L	1	0.02	0.06	NO	NO	77%	Reject	Reject	
Fe	mg/L	1	0.1	12.16	YES	NO	39%	Do not Reject	Do not Reject	12.16
Hg	mg/L	0.002	0.0002	N/A	N/A	NO	100%	N/A	N/A	
Ag	mg/L	0.05	0.05	N/A	N/A	YES	100%	N/A	N/A	
Tl	mg/L	0.002	N/A	N/A	N/A	N/A	N/A	no data	no data	
Zn	mg/L	10	0.1	3.539	NO	NO	19%	Reject	Reject	

**Note:**

1. See Table 15 of the present document for sources of Comparison Values (CV)
2. RL is an abbreviation of reporting limit
3. Single sample hypotheses tests are not applicable to datasets having 100% censored data

**TABLE 22**  
**ROD Background Concentrations Compared to Updated Potential Background Levels**  
 United Nuclear Corporation Church Rock Site  
 Church Rock, New Mexico

<b>COPC</b>	<b>ROD Background Concentrations</b>	<b>Statistical Background Levels for Southwest Alluvium</b>	<b>Statistical Background Levels for Zone 1</b>	<b>Statistical Background Levels for Zone 3</b>
Sulfate (mg/L)	2160	2468	2773	2674
TDS (mg/L)	3170	4745	4319	4239
NO3 as N (mg/L)	30	137.4		
Manganese (mg/L)	2.6	0.414	2.519	3.436
Iron (mg/L)	5.5		8.701	12.16
Arsenic (mg/L)				0.175
Cadmium (mg/L)		0.0108	0.0051	0.0113
Cobalt (mg/L)				0.0877
Lead (mg/L)		0.0502		0.0701
Molybdenum (mg/L)				17.43
Uranium (mg/L)		0.0459 <sup>1</sup>		0.107
Total Radium (pCi/L)		5.2	9.4	10.66
Lead-210 (pCi/L)		1.513	1.579	1.618

**Notes:**

ROD = EPA Record of Decision (1988c); COPC = Constituents of Potential Concern.

Potential background levels determined solely from statistical analyses and are largely taken from

N.A. Water Systems (2008b): Southwest Alluvium (Table 7); Zone 1 (Table 8); and Zone 3 (Table 9). In addition, background levels for total radium in the Southwest Alluvium and Zone 1 were determined by alternate statistical analyses presented in N.A. Water Systems (2006) and are the current NRC License Groundwater Protection Standards.

Iron was removed from the site COPC list (see the EPA Feasibility Study, 1988a) and has not been analyzed since 1989.

Footnote 1: It is important to note that the statistically calculated background value for uranium in the Southwest Alluvium (Table 22) does not agree with the evaluation of uranium presented by GE (2006). GE (2006) evaluated uranium in a geochemical, as opposed to statistical, context, and emphasized the typical covariance between uranium and alkalinity concentrations. Mine-water discharge was permitted to contain uranium concentrations as high as 2 mg/L, and in the Southwest Alluvium relatively high background concentrations were adsorbed onto the grains of the sediment. If EPA selects the uranium MCL (0.03 mg/L) as a new cleanup level, by addressing only the statistical context, then the uranium goal would be unattainable in the Southwest Alluvium.



**TABLE 23**

**Wells Having Samples Representative of  
Impacted Water Quality, July 2006 - April 2008**

United Nuclear Corporation Church Rock Site  
Church Rock, New Mexico

<b>Southwest Alluvium</b>	<b>Zone 1</b>	<b>Zone 3</b>
509 D (POC)	515 A	504 B
624	604 (POC)	517 (POC)
632 (POC)	614 (POC)	613 (POC)
801	EPA 5 (POC)	708 (POC)
802	EPA 7 (POC)	711 (POC)
803		717
808		719
EPA 23 (POC)		EPA 13
EPA 25		EPA 14
GW 1 (POC)		NBL 1
GW 2 (POC)		
GW 3 (POC)		

Notes:

POC = Point-of-Compliance Well.

TABLE 24

**Summary Statistics for COPCs and Trace Metals in Southwest Alluvium Impacted Groundwater**  
United Nuclear Corporation Church Rock Site  
Church Rock, New Mexico

Parameter	Units	Total Data	Percent Nondetect	Minimum Detected	Maximum Detected	Mean of Detected	Median of Detected	UCL95 of Mean
Al	mg/L	96	93.8%	0.1	0.3	0.167	0.15	<b>0.109</b>
As	mg/L	96	86.5%	0.001	0.01	0.00885	0.01	<b>0.00256</b>
Be	mg/L	96	100.0%	N/A	N/A	N/A	N/A	N/A
Cd	mg/L	96	100.0%	N/A	N/A	N/A	N/A	N/A
Co	mg/L	96	99.0%	0.01	0.01	N/A	N/A	N/A
Pb	mg/L	96	100.0%	N/A	N/A	N/A	N/A	N/A
Mn	mg/L	96	0.0%	0.03	5.4	1.865	1.83	<b>2.8</b>
Mo	mg/L	96	100.0%	N/A	N/A	N/A	N/A	N/A
Ni	mg/L	96	100.0%	N/A	N/A	N/A	N/A	N/A
Se	mg/L	96	99.0%	0.001	0.001	N/A	N/A	N/A
V	mg/L	96	100.0%	N/A	N/A	N/A	N/A	N/A
Cl	mg/L	96	0.0%	79	374	187.8	181	<b>199.6</b>
SO4	mg/L	96	0.0%	1510	4330	2745	2820	<b>2867</b>
NO3_as_N	mg/L	96	0.0%	0.3	160	65.08	76	<b>94.42</b>
U	mg/L	96	0.0%	0.0229	0.246	0.104	0.111	<b>0.128</b>
Chloroform	mg/L	96	49.0%	0.00061	0.0155	0.00479	0.00309	<b>0.00338</b>
Lab_TDS	mg/L	96	0.0%	3880	8250	6044	6245	<b>6250</b>
Rad-226	pCi/L	96	61.5%	0.1	1	0.435	0.4	<b>0.267</b>
Rad-228	pCi/L	96	77.1%	0.3	4.3	1.786	1.75	<b>0.86</b>
Rad_totl	pCi/L	96	57.3%	0.1	5.2	1.351	0.7	<b>0.828</b>
Th-230	pCi/L	96	89.6%	0.2	1.6	0.69	0.5	<b>0.29</b>
Pb-210	pCi/L	96	100.0%	N/A	N/A	N/A	N/A	N/A
Gross_Alpha	pCi/L	96	69.79%	1	2.4	1.317	1.2	<b>1.141</b>
Sb	mg/L	0	N/A	N/A	N/A	N/A	N/A	N/A
Ba	mg/L	0	N/A	N/A	N/A	N/A	N/A	N/A
Cr	mg/L	0	N/A	N/A	N/A	N/A	N/A	N/A
Cu	mg/L	0	N/A	N/A	N/A	N/A	N/A	N/A
Fe	mg/L	0	N/A	N/A	N/A	N/A	N/A	N/A
Hg	mg/L	0	N/A	N/A	N/A	N/A	N/A	N/A
Ag	mg/L	0	N/A	N/A	N/A	N/A	N/A	N/A
Tl	mg/L	0	N/A	N/A	N/A	N/A	N/A	N/A
Zn	mg/L	0	N/A	N/A	N/A	N/A	N/A	N/A

**Notes:**

N/A - insufficient data to make an estimate.

UCL95 statistics highlighted in yellow may be of questionable reliability.

Listed UCL statistics for Mn and NO3\_as\_N are at 97.5% confidence level



TABLE 25

**Summary Statistics for COPCs and Trace Metals in Zone 1 Impacted Groundwater, Recent 8 Quarters  
3rd Qtr. 2006 - 2nd Qtr. 2008, Excluding Samples from Section 2 Wells 0515 A, 0604, 0614**

United Nuclear Corporation Church Rock Site  
Church Rock, New Mexico

Parameter	Units	Total Data	Percent Nondetect	Minimum Detected	Maximum Detected	Mean of Detected	Median of Detected	UCL95 of Mean
Al	mg/L	16	56.3%	0.2	1.3	0.457	0.3	0.44
As	mg/L	16	75.0%	0.001	0.003	0.00175	0.0015	0.00145
Be	mg/L	16	100.0%	N/A	N/A	N/A	N/A	N/A
Cd	mg/L	16	100.0%	N/A	N/A	N/A	N/A	N/A
Co	mg/L	16	0.0%	0.02	0.06	0.0363	0.03	0.0557
Pb	mg/L	16	100.0%	N/A	N/A	N/A	N/A	N/A
Mn	mg/L	16	0.0%	0.95	2.96	1.656	1.47	1.95
Mo	mg/L	16	100.0%	N/A	N/A	N/A	N/A	N/A
Ni	mg/L	16	81.3%	0.05	0.06	0.0533	0.05	0.0519
Se	mg/L	16	93.8%	0.001	0.001	N/A	N/A	N/A
V	mg/L	16	93.8%	0.2	0.2	N/A	N/A	N/A
Cl	mg/L	16	0.0%	48	221	131.5	128.5	214.3
SO4	mg/L	16	0.0%	2960	4760	3778	3955	4049
NO3_as_N	mg/L	16	0.0%	16.2	200	80.5	72.75	152*
U	mg/L	16	0.0%	0.0012	0.0022	0.00161	0.0015	0.00174
Chloroform	mg/L	16	87.5%	0.0006	0.00076	0.00068	0.00068	0.00063873
Lab_TDS	mg/L	16	0.0%	4620	7860	6208	6120	6843
Rad-226	pCi/L	16	18.8%	0.4	1.8	1.138	1.2	1.213
Rad-228	pCi/L	16	56.3%	1	4	2.286	1.9	2.087
Rad_totl	pCi/L	16	12.5%	0.6	5.2	2.2	1.6	2.8
Th-230	pCi/L	16	87.5%	0.6	0.7	0.65	0.65	0.621
Pb-210	pCi/L	16	100.0%	N/A	N/A	N/A	N/A	N/A
Gross_Alpha	pCi/L	16	18.8%	1.2	4.1	2.146	2	2.319
Sb	mg/L	0	N/A	N/A	N/A	N/A	N/A	N/A
Ba	mg/L	0	N/A	N/A	N/A	N/A	N/A	N/A
Cr	mg/L	0	N/A	N/A	N/A	N/A	N/A	N/A
Cu	mg/L	0	N/A	N/A	N/A	N/A	N/A	N/A
Fe	mg/L	0	N/A	N/A	N/A	N/A	N/A	N/A
Hg	mg/L	0	N/A	N/A	N/A	N/A	N/A	N/A
Ag	mg/L	0	N/A	N/A	N/A	N/A	N/A	N/A
Tl	mg/L	0	N/A	N/A	N/A	N/A	N/A	N/A
Zn	mg/L	0	N/A	N/A	N/A	N/A	N/A	N/A

**Notes:**

\*95% Chebyshev (Mean, Sd) UCL chosen for NO3\_as\_N in lieu of ProUCL recommended UCL 99 statistic, which exceeded the maximum observed detection.

N/A - insufficient data to make an estimate.

UCL95 statistics highlighted in yellow may be of questionable reliability.



TABLE 26

**Summary Statistics for COPCs and Trace Metals in Zone 3 Impacted Groundwater, Recent 8 Quarters  
3rd Qtr. 2006 - 2nd Qtr. 2008, Excluding Samples from Section 2 Well 0613**

United Nuclear Corporation Church Rock Site  
Church Rock, New Mexico

Parameter	Units	Total Data	Percent Nondetect	Minimum Detected	Maximum Detected	Mean of Detected	Median of Detected	UCL95 of Mean
Al	mg/L	70	17.1%	0.1	163	16.14	2.45	39.15
As	mg/L	70	31.4%	0.001	2.5	0.206	0.025	0.412
Be	mg/L	70	87.1%	0.01	0.09	0.0589	0.06	0.0202
Cd	mg/L	70	77.1%	0.005	1	0.0713	0.0095	0.0075
Co	mg/L	70	0.0%	0.05	0.95	0.381	0.35	0.439
Pb	mg/L	70	100.0%	N/A	N/A	N/A	N/A	N/A
Mn	mg/L	70	0.0%	3.33	23.7	9.836	7.485	10.89
Mo	mg/L	70	54.3%	0.1	5	1.084	0.3	0.739
Ni	mg/L	70	0.0%	0.11	0.89	0.377	0.31	0.489
Se	mg/L	70	95.7%	0.001	0.01	0.00433	0.002	0.0014
V	mg/L	70	92.9%	0.1	0.2	0.18	0.2	0.111
Cl	mg/L	70	0.0%	14	98	43.66	37.5	48.01
SO4	mg/L	70	0.0%	2630	5260	3599	3545	3717
NO3_as_N	mg/L	70	61.4%	0.1	44.8	17.15	24	16.09
U	mg/L	70	0.0%	0.0011	0.138	0.0287	0.0219	0.0431
Chloroform	mg/L	70	81.4%	0.00093	0.00676	0.00441	0.00444	0.00326
Lab_TDS	mg/L	70	0.0%	3980	6680	5289	5290	5441
Rad-226	pCi/L	70	0.0%	2	27.6	9.823	7.9	11.14
Rad-228	pCi/L	70	0.0%	3.8	56.1	15.73	13.55	17.84
Rad_totl	pCi/L	70	0.0%	6.8	73.3	25.55	20.8	29.14
Th-230	pCi/L	70	91.4%	0.2	1.3	0.533	0.4	0.259
Pb-210	pCi/L	70	91.4%	1.8	8.1	4.883	4.9	2.287
Gross_Alpha	pCi/L	70	0.0%	2.4	35.2	12.62	10.55	14.25
Sb	mg/L	0	N/A	N/A	N/A	N/A	N/A	N/A
Ba	mg/L	0	N/A	N/A	N/A	N/A	N/A	N/A
Cr	mg/L	0	N/A	N/A	N/A	N/A	N/A	N/A
Cu	mg/L	0	N/A	N/A	N/A	N/A	N/A	N/A
Fe	mg/L	0	N/A	N/A	N/A	N/A	N/A	N/A
Hg	mg/L	0	N/A	N/A	N/A	N/A	N/A	N/A
Ag	mg/L	0	N/A	N/A	N/A	N/A	N/A	N/A
Tl	mg/L	0	N/A	N/A	N/A	N/A	N/A	N/A
Zn	mg/L	0	N/A	N/A	N/A	N/A	N/A	N/A

**Notes:**

N/A - insufficient data to make an estimate.

UCL95 statistics highlighted in yellow may be of questionable reliability.

Listed UCL statistics for Al, As, and NO3\_as\_N are at 97.5% confidence level



**TABLE 27**

**COPCs Lacking Sufficient Data to Estimate UCL95 Statistics  
for Impacted Water Quality, July 2006 - April 2008**  
United Nuclear Corporation Church Rock Site  
Church Rock, New Mexico

Southwest Alluvium	Zone 1	Zone 3
Be*	Be*	Pb*
Cd*	Cd*	
Co***	Pb*	
Pb*	Mo*	
Mo*	Se**	
Ni*	V	
Se**	Pb-210*	
V*		
Pb-210*		

Notes:

\* no detected results in 8 quarters of sampling.

\*\* one detected result at or below MCL in 8 quarters of sampling.

\*\*\* one detected result at or below New Mexico WQCC standard  
in 8 quarters of sampling.

**TABLE 28**

**COPCs Having Estimated UCL95 Statistics of Questionable Reliability  
for Impacted Water Quality, July 2006 - April 2008**

United Nuclear Corporation Church Rock Site  
Church Rock, New Mexico

<b>Southwest Alluvium</b>	<b>Zone 1</b>	<b>Zone 3</b>
Al <sup>***</sup>	Ni <sup>**</sup> Chloroform* Th-230*	Se <sup>**</sup> V

**Notes:**

\* 2 detected results at or below MCL or NRC compliance license standard in 8 quarters of sampling.

\*\* 3 detected results at or below MCL or New Mexico WQCC standard in 8 quarters of sampling.

\*\*\* 6 detected results at or below New Mexico WQCC standard in 8 quarters of sampling.



**TABLE 29**  
Rationale and COC Selection from the  
Updated Human Health Risk Assessment (Chester Engineers, 2011b)  
United Nuclear Corporation Church Rock Site  
Church Rock, New Mexico

Hydrostratigraphic Unit	COCs Identified in "Table 10s"	Non-carcinogen or Carcinogen	Selected as COC	COC Selection Rationale
Southwest Alluvium	Arsenic	Carcinogen	No	Similar to background concentrations; below MCL
Southwest Alluvium	Cobalt	Non-carcinogen	No	One detected result in impacted water; background concentrations higher than impacted water concentrations
Southwest Alluvium	Manganese	Non-carcinogen	Yes	HI = 8.7 (Child)
Southwest Alluvium	Uranium	Non-carcinogen	Yes	HI = 2.7 (Child)
Southwest Alluvium	Chloroform	Carcinogen	Yes	Risk = 1.7E-06 – Ingestion and dermal Risk = 2.1E-06 – Inhalation
Southwest Alluvium	Uranium isotopes	Carcinogen	Yes	Risk > 1E-04
Southwest Alluvium	Radium-226	Carcinogen	No	Background concentrations higher than impacted
Southwest Alluvium	Radium-228	Carcinogen	No	Background concentrations higher than impacted
Zone 1	Cobalt	Non-carcinogen	Yes	HI = 11.9 (Child)
Zone 1	Manganese	Non-carcinogen	No	Background concentrations higher than impacted
Zone 1	Vanadium	Non-carcinogen	No	Hazard based on only one historical detection in seepage impacted water
Zone 1	Arsenic	Carcinogen	No	Similar to background concentrations; below MCL



Hydrostratigraphic Unit	COCs Identified in "Table 10s"	Non-carcinogen or Carcinogen	Selected as COC	COC Selection Rationale
Zone 1	Radium-226	Carcinogen	No	Background concentrations higher than impacted water concentrations
Zone 1	Radium-228	Carcinogen	No	Background concentrations higher than impacted water concentrations
Zone 1	Thorium-230	Carcinogen	No	Risk = 1.1E-06, within background radiological risk
Zone 3	Aluminum	Non-carcinogen	Yes	HI = 2.5 (Child)
Zone 3	Arsenic	Carcinogen and Non-carcinogen	Yes	HI = 88.4 (Child) Risk 9.3E-03
Zone 3	Cadmium	Non-carcinogen	Yes	HI = 9.1 (Child)
Zone 3	Cobalt	Non-carcinogen	Yes	HI = 94.2 (Child)
Zone 3	Manganese	Non-carcinogen	Yes	HI = 33.8 (Child)
Zone 3	Molybdenum	Non-carcinogen	No	Background concentrations higher than impacted water concentrations
Zone 3	Nickel	Non-carcinogen	Yes	HI = 1.6 (Child)
Zone 3	Vanadium	Non-carcinogen	Yes	HI = 2.3 (Child)
Zone 3	Uranium	Non-carcinogen	No	Background concentrations higher than impacted water concentrations
Zone 3	Chloroform	Carcinogen	Yes	Risk = 1.6E-06 – Ingestion and dermal Risk = 2.0E-06 – Inhalation
Zone 3	Uranium Isotopes	Carcinogens	No	Background concentrations higher than impacted water concentrations
Zone 3	Radium-226	Carcinogen	Yes	Risk = 8.5E-05 – Ingestion Risk 1.2E-02 Inhalation



Hydrostratigraphic Unit	COCs Identified in "Table 10s"	Non-carcinogen or Carcinogen	Selected as COC	COC Selection Rationale
Zone 3	Radium-228	Carcinogen	Yes	Risk = 3.5E-04 – Ingestion
Zone 3	Lead-210	Carcinogen	Yes	Risk = 5.5E-05 – Ingestion

Notes:

Shading indicates COPCs that were not selected as COCs.

"Table 10s" in header for second column refers to Tables 10.1.RME to 10.9.RME in the Updated Baseline Human Health Risk Assessment (Chester Engineers, 2011b).

HI = Hazard Index, which is equal to the sum of the Hazard Quotients evaluated within an exposure scenario (relevant to non-carcinogens only).

**Table 30**  
Compliance Status  
Constituents Exceeding EPA and NRC Site Standards for Each Hydrostratigraphic Unit  
Based on October 2010 Groundwater Quality Data  
United Nuclear Corporation Church Rock Site  
Church Rock, New Mexico

Constituent	EPA Standard in ROD	NRC Standard in License	Southwest Alluvium	Zone 1	Zone 3	Comments
aluminum	5.0	None			X	
arsenic	0.05	0.05			X	only Zone 3 well NBL-1
beryllium	0.017	0.05			XO	
cadmium	0.01	0.01			XO	
cobalt	0.05	None			X	
lead	0.05	0.05				
molybdenum	1.0	None			X	
nickel	0.2	0.05	X	O <sup>2</sup>	X	Zone 1 POC well 604 (inside section 2); only SWA well is SBL-1 (background)
selenium	0.01	0.01				
vanadium	0.7	0.1			O	only Zone 3 well 613 (POC in Section 2)
chloride	250	None				
manganese	2.6	None	X	X	X	only SWA well is SBL-1 (background)
nitrate	30	None	X	X		impacted & background
sulfate	2,160	None	X	X	X	impacted & background
TDS	3,170	None	X	X	X	impacted & background
radium 226+228	5.0 pCi/L	unit specific <sup>1</sup>		X	XO	
uranium	5.0	0.3	O		O	SWA well 509D (POC in Section 2)
TTHMs	None	0.8			O	only Zone 3 well 613 (POC in Section 2)
thorium-230	15 pCi/L	5 pCi/L			XO	
lead-210	None	1 pCi/L	O	O	O	unexpected large number of exceedances in October 2010; impacted and background
gross alpha	15 pCi/L	15 pCi/L			XO	

Notes:

All units in mg/L unless noted otherwise.

TTHMs refers to total trihalomethane compounds (effectively chloroform).

1 = NRC standards for combined radium are 5.2 pCi/L for Southwest Alluvium; 5.0 pCi/L for Zone 3; and 9.4 pCi/L for Zone 1.

2 = the "O" for nickel in Zone 1 has been addressed by submittal of an

Alternate Concentration Limits application to the NRC (N.A. Water Systems, 2008d).

"X" indicates an exceedance of the EPA ROD standard outside of Section 2.

"O" indicates an exceedance of the NRC License standard in Point-of-Compliance (POC) wells (inside and/or outside of Section 2).

SWA = Southwest Alluvium.



TABLE 31  
Summary of COPC Maximum Detections, Exposure Point Concentrations, Site Cleanup Levels, Background, Potential ARARs, and Health-Based Criteria  
United Nuclear Corporation, Church Rock Site, Church Rock, New Mexico

Source		UNC Site Master Database (July 1989 to January 2011)			N.A. Water Systems (2008c)			ROD Cleanup Levels (EPA, September 1988)				N.A. Water Systems (2008b)			Sources Specified Below		Sources Specified Below		
Contaminant	Units	Maximum Detected in Each Hydrostratigraphic Unit			UCL95 Exposure Point Concentration			New Mexico WQCC Standards	Health- based	MCL	Background Level	Updated Potential Background Levels			Current Health-Based Criteria (+)		NRC License Standards	NRC Appendix List*	New Mexico WQCC Standards
		SWA	Zone 1	Zone 3	SWA	Zone 1	Zone 3					SWA	Zone 1	Zone 3	Criterion	Source			
Sulfate	mg/L	6250	16,950	10,900	2867	4049	3717				2160	2468	2773	2674					2125**
Total Dissolved Solids	mg/L	10,530	25,732	13,900	6250	6843	5441				3170	4745	4319	4239					4800**
NO3 as N	mg/L	1225	953	67	94.42	152	16.09				30	137.4			10	MCL			190**
Manganese	mg/L	45.3	195	73.8	2.8	1.95	10.89				2.6	0.414	2.519	3.436	0.88	RSL			0.2 O
Chloride	mg/L	483	952	247	199.6	214.3	48.01	250											250 O
Aluminum	mg/L	0.014	0.009	2.5	0.109	0.44	39.15	5							37	RSL			5 I
Antimony	mg/L	N/A	N/A	N/A	N/A	N/A	N/A		0.014						0.006	MCL			
Arsenic	mg/L	0.01	0.08	0.68 D	0.00256	0.00145	0.412			0.05				0.175	0.01	MCL	0.05	0.05	0.1 HH
Barium	mg/L	0.15	0.091	0.058	N/A	N/A	N/A	1		1					2	MCL		1	1 HH
Beryllium	mg/L	483	952	247	N/A	N/A	0.0202		0.017						0.004	MCL	0.05		
Cadmium	mg/L	0.018	3.558	0.168	N/A	N/A	0.0075	0.01		0.01		0.018	0.0051	0.0113	0.005	MCL	0.01	0.01	0.01 HH
Chromium	mg/L	0.029	N/A	0.26	N/A	N/A	N/A	0.05		0.05					0.1	MCL		0.05	0.05 HH
Cobalt	mg/L	22.9	210	254	N/A	0.0557	0.439	0.05							0.011	RSL			0.05 I
Copper	mg/L	0.01	0.026	0.06	N/A	N/A	N/A	1							1.3	MCL(++)			1 O
Iron	mg/L	1.95	14	116	N/A	N/A	N/A				5.5		8.701	12.16	26	RSL			1 O
Lead	mg/L	45.3	195	73.8	N/A	N/A	N/A	0.05		0.05		0.0502		0.0701	0.015	MCL(++)	0.05	0.05	0.05 HH
Mercury	mg/L	0.07	N/A	N/A	N/A	N/A	N/A	0.002		0.002					0.002	MCL		0.002	0.002 HH
Molybdenum	mg/L	1225	953	67	N/A	N/A	0.739	1						17.43	0.18	RSL			1 I
Nickel	mg/L	9.4	14.5	144	N/A	0.0519	0.489	0.2							0.73	RSL	0.05		0.2 I
Selenium	mg/L	6250	16950	10900	N/A	N/A	0.0014			0.01					0.05	MCL	0.01	0.01	0.05 HH
Silver	mg/L	N/A	N/A	20	N/A	N/A	N/A	0.05		0.05					0.18	RSL		0.05	0.05 HH
Thallium	mg/L	N/A	N/A	N/A	N/A	N/A	N/A		0.014						0.002	MCL			
Vanadium	mg/L	0.1	0.2	6.0	N/A	N/A	0.111		0.7						0.18	RSL	0.1		
Zinc	mg/L	0.429	5	6.859	N/A	N/A	N/A	10							11	RSL			10 O
TTHMs***	ug/L	0.018	3.558	0.168	0.00338	0.000639	0.00326								80	MCL	0.08		0.1 HH
Uranium	mg/L	0.602	0.975	197.1	0.128	0.00174	0.0431	5				0.0459		0.107	0.03	MCL	0.3		0.03 HH
Radium 226 and 228	pCi/L	15.3	33.4	205.4	0.828	2.8	29.14			5		5.2	9.4	10.66	5	MCL	****	5	30 HH
Lead-210	pCi/L	14.2	28	90	N/A	N/A	2.287					1.513	1.579	1.618	0.0601	PRG	1		
Thorium-230	pCi/L	14.3	33.9	976	0.29	0.621	0.259			15					0.581	PRG	5		
Gross Alpha	pCi/L	22.9	210	254	1.141	2.319	14025			15					15	MCL	15	15	

Notes:  
N/A = not applicable due to insufficient data.  
Yellow cells = constituents not analyzed since 1989 (ROD, September 1988); gray cells indicate UCL95 Exposure Point Concentration Statistics may be of questionable value (N.A. Water Systems, 2008c); green cells indicate updated potential background levels (N.A. Water Systems, 2008b) that are greater than ROD background levels and current health-based criteria.  
\* 10 CFR Appendix A to Part 40  
\*\* New Mexico Environment Department recommended background values (letter to EPA of January 6, 1998); EPA has not formally adopted these revisions.  
\*\*\* TTHMs (total trihalomethanes) include chloroform; per January 25, 2008 letter from EPA to UNC (General Comment 5), since concentrations outside Section 2 are less than the MCL of 80 ug/L, TTHMs (chloroform) will be dropped from the list of COPCs or COCs.  
\*\*\*\* Combined radium NRC Site Groundwater Protection Standards are 5.0 pCi/L for Zone 3; 5.2 pCi/L for Southwest Alluvium (background); and 9.4 pCi/L for Zone 1 (background). The latter two values are highlighted in green as updated potential background levels.  
(+) Sources of health-based criteria include the November 2010 EPA Regional Screening Level (RSL) Summary Table (tapwater RSLs) and August 2010 EPA Preliminary Remediation Goals for Radionuclides (PRGs) (resident tapwater PRGs). For those contaminants with federal MCLs, the MCL is shown as the health-based screening level, per January 25, 2008 letter from EPA to UNC (General Comment 5).  
(++) Lead and copper are regulated by a Treatment Technique that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed the action level, water systems must take additional steps. For copper, the action level is 1.3 mg/L, and for lead is 0.015 mg/L.  
HH = Human Health Standard; I = Irrigation Standard; O = Other standards for domestic water supply.



**TABLE 32**  
Summary of Maximum Detections in All Hydrostratigraphic Units  
United Nuclear Corporation Church Rock Site  
Church Rock, New Mexico

Source		UNC Site Master Database (Data July 1989 to January 2011)			UNC Site Master Database (Data July 2006 to April 2008)			UNC Site Master Database (Data July 1989 to January 2011)		
Contaminant	Units	Maximum Detected in Each Hydrostratigraphic Unit			Maximum Detected in EPC Dataset			Maximum Detected in Background Dataset		
		SWA	Zone 1	Zone 3	SWA	Zone 1	Zone 3	SWA	Zone 1	Zone 3
Sulfate	mg/L	6250	16,950	10,900	4330	4760	5260	6250	3882	4674
Total Dissolved Solids	mg/L	10,530	25,732	13,900	8250	7860	6680	10,530	5610	6930
NO3 as N	mg/L	1225	953	67	160	200	44.8	1225	51.8	61
Manganese	mg/L	45.3	195	73.8	5.4	2.96	23.7	3.72	4.15	7.5
Chloride	mg/L	483	952	247	374	221	98	169	252	66
Aluminum	mg/L	0.014	0.009	2.5	0.3	1.3	163	1.7	0.6	1.68
Antimony	mg/L	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Arsenic	mg/L	0.01	0.08	0.68 D	0.01	0.003	2.5	0.01	0.004	1.01
Barium	mg/L	0.15	0.091	0.058	N/A	N/A	N/A	N/A	0.091	0.054
Beryllium	mg/L	483	952	247	N/A	N/A	0.09	N/A	N/A	N/A
Cadmium	mg/L	0.018	3.558	0.168	N/A	N/A	0.015	0.074	0.01	0.09
Chromium	mg/L	0.029	N/A	0.26	N/A	N/A	N/A	0.029	N/A	N/A
Cobalt	mg/L	22.9	210	254	0.01	0.06	0.95	0.06	0.06	0.53
Copper	mg/L	0.01	0.026	0.06	N/A	N/A	N/A	0.01	0.026	0.06
Iron	mg/L	1.95	14	116	N/A	N/A	N/A	1.4	14	67
Lead	mg/L	45.3	195	73.8	N/A	N/A	N/A	N/A	N/A	N/A
Mercury	mg/L	0.07	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Molybdenum	mg/L	1225	953	67	N/A	N/A	5	0.1	0.27	75
Nickel	mg/L	9.4	14.5	144	N/A	0.06	0.89	0.19	0.07	0.67
Selenium	mg/L	6250	16950	10900	0.001	0.001	0.01	0.274	0.004	0.015
Silver	mg/L	N/A	N/A	20	N/A	N/A	N/A	N/A	N/A	N/A
Thallium	mg/L	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Vanadium	mg/L	0.1	0.2	6.0	N/A	0.2	0.02	N/A	N/A	N/A
Zinc	mg/L	0.429	5	6.859	N/A	N/A	N/A	0.429	5	6.859
TTHMs	ug/L	0.018	3.558	0.168	0.0155	0.00076	0.00676	N/A	0.00221	0.0011
Uranium	mg/L	0.602	0.975	197.1	0.246	0.0022	0.138	0.367	0.975	0.3797
Radium 226 and 228	pCi/L	15.3	33.4	205.4	5.2	5.2	73.3	15.3	14.8	40.9
Lead-210	pCi/L	14.2	28	90	N/A	N/A	8.1	14.2	9.1	11
Thorium-230	pCi/L	14.3	33.9	976	1.6	0.7	1.3	14.3	4.9	57
Gross Alpha	pCi/L	22.9	210	254	2.4	4.1	35.2	22.9	14	69

Notes:

Including the background dataset, maximums were derived from July 1989 to January 2011 for most COPCs except for the trace metals highlighted in yellow which were derived from sampling prior to July 1989 (except for five samples analyzed for iron in 2000 of which all were nondetect). EPA October 2007 sample results for trace metals are not included.

Maximums detected in each hydrostratigraphic unit derived from dataset from July 1989 to January 2011 including the trace metals highlighted in yellow (pre-1989 trace metal data excluded).



**TABLE 33**  
**Identification and Applicability of General Response Actions for Groundwater Remediation**  
United Nuclear Corporation Church Rock Site, New Mexico

General Response Actions	Description	Associated Groundwater Remedial Technologies	Applicability
No Further Action	No further actions taken at the site to remediate impacted target area(s) (excluding long-term surveillance monitoring by DOE under UMTRCA Title II).	None.	Retained for consideration. Will not meet goals in Zone 3.
Hydraulic Containment with Extraction and Evaporation	Pumping control of impacted are with constituent removal and evaporation.	Groundwater extraction and evaporation. Directional/horizontal wells. Vertical wells.	Retained for consideration. See footnote 1. See Section 4.1.4.1 and pages 49-51.
Enhanced Extraction	Rapid dewatering to reduce volume of impacted water.	Relatively large number of vertical wells.	Retained for consideration. May be useful for groundwater containment and rapid mass removal. If total pumpage volume exceeds capacity of evaporation ponds, discharge to Pipeline Canyon after treatment may be required (see Table 41 for summary). See footnote 1. See Section 4.1.4.2 and page 51.
Physical Barriers	Physical or hydraulic barriers to prevent migration of seepage-impacted water.	Vertical engineered physical barriers. Hydraulic barriers or “fences” from vertical injection-well arrays.	Zone 3 and Zone 1 are too deep for physical vertical barriers but retained for consideration in Southwest Alluvium (SWA). Hydraulic barriers retained for consideration. May be useful for containment. See footnote 1. See Section 4.1.3.1 and pages 41-43; Section 4.1.4.3 and pages 52-59.
Permeable Reactive Barriers (PRBs)	Contaminated water is channeled between impervious vertical walls to naturally flow through a permeable reactive barrier where constituents are passively treated in situ.	Overlaps with treatment GRA. Typically emplaced by trenching (excavate-and-fill). Reactive medium sometimes can be emplaced by jetting or hydraulic fracturing.	Retained for consideration in SWA. See Section 4.1.3.2 and pages 43-46.
Passive Treatment Wells	Non-pumped well arrays are filled with reactive media through with the contaminated water flows with constituents passively treated in situ.	Overlaps with treatment GRA. Specialized non-pumped well construction fosters through-flow of contaminated water. Reactive media in wells can be easily replaced.	Retained for consideration in SWA and Zone 3. See Section 4.1.3.3 and page 46.
Hydraulic Flushing with Extraction and Evaporation	Water injection matched with controlled extraction and evaporation.	Amended injection water for in-situ constituent stabilization plus displacement and extraction of seepage-impacted water. Injection water potentially from deep wells in Dakota Formation or Westwater Canyon Formation. Injection water solely for displacement and extraction of seepage-impacted water.	Retained for consideration in SWA. Injected water will geochemically equilibrate to exceed ROD cleanup levels for sulfate, TDS, and nitrate. See Section 4.1.4.6 and pages 59-60.
Treatment	Methods to reduce the mobility, toxicity, or volume of impacted water.	Alkalinity amendments to injection water for in-situ stabilization and flushing. Reverse osmosis (RO) treatment of injection water for flushing and/or hydraulic barrier. All injection and flushing envisioned as combined with extraction and evaporation.	Overlaps with flushing and PRB GRAs. RO cost too high to meet demand. Retained for consideration. May be useful for containment or groundwater restoration. See Section 4.1.4.7 and pages 60-61; Appendix F.
Bioremediation	The remedial technology and process option of stimulating the indigenous microbial population to effect desired changes in contaminant chemistry, such as a reduction in mobility.	Amended injection water, vertical injection wells, groundwater monitoring.	Screened out for all three hydrostratigraphic units due to potential significant limitations in its long-term effectiveness. See Section 4.1.3.4 and page 47.
Institutional Controls	Legal or governmental controls taken to prevent contact with seepage-impacted water.	Action and use restrictions. Offsite groundwater monitoring.	Retained for consideration. Will not meet goals. Can be used as mechanism to prevent contact with water and establish environmental rights-of-way. See Section 4.1.4.8 and page 60.

Note 1: ROD cleanup levels will not be met in any of the three hydrostratigraphic units for sulfate, total dissolved solids, manganese, radium, or nitrate; nickel (Zone 3); or uranium (SWA, if EPA adopts the MCL as an ARAR).



**TABLE 34**  
**Screening of Technology and Process Options**  
*Shading Indicates Not Applicable for Further Screening*  
 United Nuclear Corporation Church Rock Site, New Mexico

General Response Actions	Remedial Technology	Process Option	Technical and Administrative Implementability Screening Comments
No Further Action	None	Not Applicable	Required for consideration by National Contingency Plan. Potentially applicable in Southwest Alluvium (SWA) and Zone 1. <b>Eliminated for Zone 3 because it will not meet PRGs.</b>
Hydraulic Containment with Extraction and Evaporation	Groundwater Extraction + Evaporation + Containment Analysis	Vertical Wells	Potentially applicable. Most similar to current remedy. See footnote 1. See Section 4.1.4.1 and pages 49-51.
		Directional Wells	In Zones 3 and 1, unreliable performance due to high probability of well fouling. Would require at least two redundant wells resulting in excessive cost. Vertical wells provide equivalent or better performance. Technically infeasible for SWA. See Section 4.1.4.1 and pages 49-51.
		Tunnels	Excessive cost. Inability to effectively manage large volumes of generated waste material. See Section 4.1.4.1 and pages 49-51.
Enhanced Extraction	Relatively Large Number of Vertical Wells + Extraction + Evaporation	Vertical Wells	Potentially applicable. See footnote 1. See Section 4.1.4.2 and page 51.
Physical Barriers	Vertical Physical Barriers	Soil-Bentonite Slurry Wall	Potentially applicable in SWA if combined with either PRB (combines with treatment GRA) or new extraction pumping to avoid spillover of barrier. See footnote 1. See Section 4.1.3.1 and pages 41-43; Section 4.1.4.3 and pages 52-59.
		Cement-Bentonite Slurry Wall	
		Vibrating Beam	
		Grout Curtains (Including Jet Grouting)	
		Sheet Piling	
		Chemical Grouting	
		Ground Freezing	
		Deep Soil Mixing	
	Hydraulic Barriers from Injection Wells	Arrays of Vertical Injection Wells	Potentially applicable in SWA and Zone 3; can be combined with extraction pumping. Screened out for Zone 1 due to low hydraulic conductivity. See footnote 1. See Section 4.1.4.3 and pages 58-59.
Permeable Reactive Barriers	Passive In-Situ Treatment	Funnel and Reactive-Medium Gate System	Potentially applicable in SWA; combines with Treatment GRA. Bench-scale treatability study is appropriate. See Section 4.1.3.2 and pages 43-46.
Passive Treatment Wells	Passive In-Situ Treatment	Arrays of Non-Pumped Wells Containing Reactive Medium	Potentially applicable in SWA and Zone 3; combines with Treatment GRA. See Section 4.1.3.3 and page 46.
Hydraulic Flushing with Extraction and Evaporation	Alkalinity-Amended Injection Water	Arrays of Vertical Injection Wells	Combines with Treatment GRA. Feasible for northern part of Zone 3 (part of current remedy). Injection wells not suitable for Zone 1 because of low hydraulic conductivity. Not applicable for relatively alkaline waters of SWA. See Section 4.1.4.6 and pages 59-60.
	Injection Water from Deep Wells in Dakota Formation or Westwater Canyon Formation, to Meet State Water Quality Standards	Arrays of Vertical Injection Wells	Potentially applicable in SWA. Injected water will geochemically equilibrate to exceed ROD cleanup levels for sulfate, TDS, and nitrate. Based on previous pilot testing the core of Zone 3 may not be amenable to injection, but retained as potentially applicable.
Treatment	Injection + In-Situ Treatment + Flushing + Extraction + Evaporation	Alkalinity Amendments to Injection Waters	Feasible for northern part of Zone 3 (part of current remedy). Injection wells not suitable for Zone 1 because of low hydraulic conductivity. Not applicable for relatively alkaline waters of SWA. See Section 4.1.4.7 and pages 60-61; Appendix F.
	Pre-Injection Water Purification + Injection + Flushing + Extraction	Reverse Osmosis Treatment of Injection Waters	Excessive cost to meet demand. See Section 4.1.4.7 and page 60-61; Appendix F.



	Treatment of Groundwater Pumped for Hydraulic Containment or Enhanced Extraction	Multiple Alternatives – See Appendix F	Potentially applicable to any enhanced extraction GRA that produces pumped volumes exceeding capacity of site evaporation ponds. See Section 4.1.4.7 and pages 60-61.
Institutional Controls	Access and Use Restrictions	Navajo Tribal Land-Use Restrictions Environmental Right-of-Way	Navajo have not responded (since February 2000) on proposed tribal resolution and environmental right-of-way for offsite monitoring. Applicable for UNC property when turned over to DOE. See Section 4.1.4.8 and page 61.

Note 1: ROD cleanup levels will not be met in any of the three hydrostratigraphic units for sulfate, total dissolved solids, manganese, radium, or nitrate; nickel (Zone 3); or uranium (SWA, if EPA adopts the MCL as an ARAR).



**TABLE 35**  
**Summary of Potential Remedial Alternatives for the Southwest Alluvium**  
*Shading Indicates Not Applicable for Further Screening*  
 United Nuclear Corporation Church Rock Site, New Mexico

Alternative	Remedial Alternative Description	Comments
Alternative 1	No Further Action (except for Long-Term Stewardship by DOE)	Source control previously accomplished (USFilter, 2004; GE, 2005); no more tailings seepage. Will not attain select EPA 1988 ROD cleanup levels or comparison values outside of Section 2. Offsite area of seepage-impacted water has quality better than background water. All offsite hazardous constituents meet current ROD cleanup levels within impacted water (see footnote 1).
Alternative 2	Enhanced Extraction	Rapid dewatering of seepage-impacted groundwater leaving lower quality background water in its place. All infiltrating water will geochemically equilibrate to exceed ROD cleanup levels for sulfate, TDS, nitrate, and the uranium MCL (should it be adopted). See footnote 1. See Section 4.1.5.1 and page 62.
Alternative 3	Hydraulic Containment Using Vertical Pumping Wells	Background water has higher sulfate and TDS than offsite seepage-impacted water. See footnote 1.
Alternative 4	Passive Treatment Wells	Modeling or other analyses recommended to evaluate optimum configuration of well array (number, spacing, and alignment of wells) to determine if this technology could effectively treat entire volumetric flux of contaminated groundwater. Treated pass-through water will geochemically equilibrate to exceed current and potential ROD cleanup levels for sulfate, TDS, nitrate and the uranium MCL (should it be adopted). See footnote 1.
Alternative 5	Vertical Physical Barrier	Only appropriate in combination with upgradient extraction pumping. Slurry wall, grout curtain, sheet piling, or deep-soil mixing are the selected process option alternatives, but concerns exist about sufficient barrier continuity in deeper parts of the alluvium sediments and the possibility for damage or destruction of the barrier by occasional high-energy flooding and sediment transport. Provides no additional benefit above hydraulic containment, but is more costly. Will not achieve current or potential ARARS (see footnote 1). See Section 4.1.5.1 and page 62.
Alternative 6	Hydraulic Barrier from Injection Wells	Must be used in combination with upgradient extraction pumping, but provides less benefit because of the possibility of expanding seepage-impacts. The result would be mixing of the injected and seepage-impacted waters that would produce water that still exceeds the standards. See footnote 1. See Section 4.1.5.1 and page 62-63.
Alternative 7	Permeable Reactive Barriers	PRBs can be emplaced by trenching as part of slurry wall installation or as funnels. Vertical barriers defining funnel walls installed as grout curtains or sheet piling do not involve trenching. Jet grouting of reactive media slurries has been used to emplace PRBs. The particle sizes and viscosity of any such reactive media slurries would have to be carefully evaluated in any potential application to the Southwest Alluvium. Funnel walls cannot be constructed across the entire breadth of the impacted water below the Nickpoint, because of the topography of Pipeline Canyon. Concerns exist about sufficient barrier (funnel wall) continuity in deeper parts of the alluvium sediments and the possibility for damage or destruction of the barrier by occasional high-energy surface water flow and sediment transport. Target contaminants will drive choice of reactive media; e.g., sulfate removal may use organic carbon while radionuclide removal may use zero-valent iron. A bench-scale treatability study is appropriate. Media will become fouled after some years requiring periodic reinstallation. Would not meet current or potential ARARs (see footnote 1). Incompatible COC's (PRBs that control some COCs would exacerbate others). Has no benefit above hydraulic containment using wells, but is more costly. See Section 4.1.5.1 and pages 62-65.
Alternative 8	Hydraulic Flushing	To complete one full flushing circuit downgradient from the Nickpoint to the boundary of Section 2 would require 60 years. Injected water will geochemically equilibrate to exceed ROD cleanup levels for sulfate, TDS, and nitrate



		and uranium (see footnote 1). Less beneficial than hydraulic containment using wells because of the possibility of expanding seepage impacts. See Section 4.1.5.1 and pages 55-56.
--	--	---

Note 1: ROD cleanup levels will not be met for sulfate, total dissolved solids, manganese, radium, or nitrate; or uranium (if EPA adopts the MCL as an ARAR).



**TABLE 36**  
**Summary of Potential Remedial Alternatives for the Zone 1 Hydrostratigraphic Unit**  
*Shading Indicates Not Applicable for Further Screening*  
United Nuclear Corporation Church Rock Site, New Mexico

Alternative	Remedial Alternative Description	Comments
Alternative 1	No Further Action (Except for Long-Term Stewardship by DOE)	Source control already accomplished (USFilter, 2004); no more tailings seepage. Former pumping locations met decommissioning criteria. Former pumping did not improve groundwater quality. Decreasing area of seepage-impacted water occurs intrinsically. Offsite hazardous constituents meet ROD cleanup levels and are expected to keep improving.
Alternative 2	Institutional Controls	Potentially administratively infeasible for Section 1.
Alternative 3	Hydraulic Containment with Extraction and Evaporation.	Extraction well history indicates it is not possible to fully desaturate Zone 1 by pumping – some impacted water will remain. ALARA demonstration test and long-term groundwater quality data indicate that pumping did not improve water quality. See Section 4.1.5.2 and page 67.
Alternative 4	Enhanced Extraction	Rapid dewatering of seepage-impacted groundwater. Within UNC Section 2 property, only a very narrow strip of land exists between the eastern edge of the Central Cell and the western boundary of Section 1 to the east; not well suited for large number of extraction wells. Extraction well decommissioning history indicates it is not possible to fully desaturate Zone 1 by pumping – some impacted water will remain. See Section 4.1.5.2 and page 67.

Note 1: ROD cleanup levels will not be met for sulfate, total dissolved solids, manganese, radium, nitrate, or nickel.



**TABLE 37**  
**Summary of Potential Remedial Alternatives for the Zone 3 Hydrostratigraphic Unit**  
***Shading Indicates Not Applicable for Further Screening***  
United Nuclear Corporation Church Rock Site, New Mexico

Alternative	Remedial Alternative Description	Comments
Alternative 1	No Further Action (Except for Long-Term Stewardship by DOE).	Source control already accomplished (USFilter, January 2004); no more tailings seepage. Will not attain select EPA 1988 ROD cleanup levels or PRGs (comparison values from Table 15) outside of Section 2. See footnote 1.
Alternative 2	Institutional Controls (ICs) for Section 36 if Needed.	ICs for Section 36 (UNC property outside of Section 2) have not yet been formally proposed. Appendix H of ROD (Responsiveness Summary), Response to Comment 6 states: "The exact area to be deeded to the Department of Energy has not been determined."
Alternative 3	Passive Treatment Wells	Unlikely to treat entire flux of contaminated groundwater. Should be combined with Alternative 4 (current remedy in Zone 3). Modeling or other analyses recommended to evaluate potentially optimum configuration of well array (number, spacing, and alignment of wells). See Section 4.1.3.3 and page 46.
Alternative 4	Hydraulic Containment with Extraction and Evaporation.	This is the current remedy in Zone 3. Extraction well history indicates it is not possible to fully desaturate Zone 3 by pumping – some impacted water will remain. See footnote 1. Merits of extraction with evaporation using spray misters into ponds were addressed by UNC contribution to Appendix H of the EPA 1988 Feasibility Study. See Section 4.1.4.1 and pages 49-51; Section 4.1.5.3 and page 68.
Alternative 5	Enhanced Extraction.	Rapid dewatering of seepage-impacted groundwater. Extraction well history indicates it is not possible to fully desaturate Zone 3 by pumping – some impacted water will remain. See footnote 1. Previous pumping conditions revealed that increased rates of pumping only serve to draw in unimpacted water or expand the extent of seepage-impacted water into unimpacted areas where higher pumping rates can be achieved (NRC concurrence December 2000).
Alternative 6	Hydraulic Barrier from Injection Wells for Containment.	Downgradient hydraulic barrier requires sufficient source of higher quality water than currently exists in the seepage-impacted area of Zone 3. Only some of the hydraulic barrier injection water would be recovered; some will flow north onto Navajo land. This is part of the Remedial Design Report that is presently being implemented to enhance the current remedy (Alternative 4). See Section 4.1.4.3 and pages 58-59; Section 4.1.5.3 and page 68.

Note 1: ROD cleanup levels will not be met for sulfate, total dissolved solids, manganese, radium, nitrate, nickel, arsenic, cobalt, or molybdenum.



**TABLE 38**  
**Selection of Representative Process Options**  
United Nuclear Corporation Church Rock Site, New Mexico

General Response Actions	Remedial Technology	Process Option	Summary of Effectiveness, Implementability, Cost Screening <sup>1</sup>
No Further Action	None	Not Applicable	Required for consideration by National Contingency Plan. Potentially applicable in Southwest Alluvium (SWA) and Zone 1. Will not alleviate continued plume migration in Zone 3.
Hydraulic Containment with Extraction and Evaporation	Groundwater Extraction + Evaporation + Containment Analysis	Vertical Wells	Most similar to current remedy in Zone 3. Potentially effective for removing all COCs in impacted water, but will not address background water quality (see footnote 2). Current corrective action program indicates Zone 1 and Zone 3 extraction wells usually have effective durations of a few years. Site history has demonstrated effectiveness of evaporation for treatment of impacted water. Moderate cost, moderate operations & maintenance (O&M) (see footnote 1).
Physical Barriers	Hydraulic Barriers from Injection Wells	Arrays of Vertical Injection Wells	Potentially applicable in Zone 3; can be combined with extraction pumping. Potentially effective for hydraulic containment of impacted water. See footnote 2. Water source of sufficient quality has been established for Zone 3. If one or more new deep supply wells required, high cost, moderate O&M (see footnote 1).
Passive Treatment Wells	Non-Pumped Wells Filled with Reactive Media to Passively Filter Groundwater Contaminants	Arrays of Vertical Non-Pumped Wells	Potentially applicable in SWA and Zone 3; can be combined with extraction pumping. Moderate cost, low O&M after installation (see footnote 1).
Institutional Controls	Access and Use Restrictions	Navajo Tribal Land-Use Restrictions Environmental Right-of-Way	Potentially applicable in SWA and Zone 1. Means to prevent access to impacted water and background water. Navajo have not responded (since February 2000) on proposed tribal resolution and environmental right-of-way for offsite monitoring. Effectiveness depends on future implementation. Applicable for UNC property when turned over to DOE. Low cost, low O&M (see footnote 1).

Note 1: For numeric cost estimates see Appendix G.  
Note 2: ROD cleanup levels will not be met in any of the three hydrostratigraphic units for sulfate, total dissolved solids, manganese, radium, or nitrate; nickel (Zone 3); or uranium (SWA, if EPA adopts the MCL as an ARAR).



**TABLE 39**  
**Summary of Response Actions, Technologies and Representative Process Options Selected for Further Development**  
 United Nuclear Corporation Church Rock Site, New Mexico

Response Actions	Technologies and Representative Process Options	Use of Response Actions, Technologies, Process Options in Developing Remedial Alternatives	Shading Indicates Used Together For Groundwater Remedial Alternatives
No Further Action		Used alone as a no further action alternative. Applicability varied by hydrostratigraphic unit.	
Institutional Controls	Access and use restrictions.	May be used as an individual remedial alternative (unshaded to right) or with other options to prevent contaminated groundwater use (shaded to right). Applicability varied by hydrostratigraphic unit.	
Passive Treatment Wells	Non-pumped wells containing reactive media for in-situ treatment. Downgradient monitoring to evaluate effectiveness.	Used for in-situ treatment of groundwater. Configuration should be evaluated by modeling or other analyses. Applicability varied by hydrostratigraphic unit.	
Physical Barriers	Hydraulic barriers from arrays of vertical injection wells.	Used for hydraulic containment of contaminated groundwater. Configuration varied by remediation program and hydrostratigraphic unit. See footnote 1.	
Hydraulic Containment	Extraction + evaporation + containment analysis. Vertical wells.	Used for extraction of contaminated groundwater + removal of contaminants. Configuration varied by remediation program and hydrostratigraphic unit. See footnote 1.	
Institutional Controls	Access and use restrictions.	Used in combination with other options to prevent contaminated groundwater use.	

Note 1: ROD cleanup levels will not be met in any of the three hydrostratigraphic units for sulfate, total dissolved solids, manganese, radium, or nitrate; nickel (Zone 3); or uranium (SWA, if EPA adopts the MCL as an ARAR).



**TABLE 40**  
**Operable Unit Site-Wide Remedy with Combined Remedial Alternatives**  
*Shading Indicates Components INCLUDED in Alternative*  
 United Nuclear Corporation Church Rock Site, New Mexico

COMBINED REMEDIAL ALTERNATIVES	COMPONENTS OF COMBINED REMEDIAL ALTERNATIVES																		
	SOUTHWEST ALLUVIUM (SWA)						ZONE 3						ZONE 1						Evaporation
	No Further Action	ICs	Containment	Extraction	Passive Treatment Wells	Hydraulic Barrier	No Further Action	ICs	Containment	Extraction	Passive Treatment Wells	Hydraulic Barrier	No Further Action	ICs	Containment	Extraction	Passive Treatment Wells	Hydraulic Barrier	
No Further Action																			
Institutional Controls (ICs) Onsite and Offsite																			
1. In SWA and Zone 3, Hydraulic Containment and Extraction Onsite																			
2. • In SWA and Zone 3, Hydraulic Containment and Extraction Onsite; • In SWA and Zone 1, ICs Offsite																			
3. • In Zone 3, Hydraulic Barrier Containment (including alkalinity amendment) and Extraction Onsite Plus Passive Treatment Wells Plus ICs in Section 36; • In SWA and Zone 1, ICs Offsite																			

Note: EPA views ICs as potentially useful if the Navajo Nation concurs. Otherwise, EPA has indicated it can proceed with remedy modification absent ICs (as discussed at the multi-agency technical meeting held on May 5, 2005, at the Church Rock site).