CBRLicenseRenPEm Resource

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CROW BUTTE RESOURCES, INC.

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August 7, 1998

Mr. Joseph J. Holonich, Chief
Uranium Recovery Branch
Division of Waste Management
Office of Nuclear Material Safety and Safeguards
Mail Stop T-7-J-8
U.S. NUCLEAR REGULATORY COMMISSION
11545 Rockville Pike
Rockville, Maryland 20850

Re: Docket No. 40-8943
License No. SUA-1534
Response to Request for Additional Information

Dear Mr. Holonich:

Crow Butte Resources, Inc (CBR) is providing this letter in response to your Request for Additional Information dated July 8, 1998. In this request, the U.S. Nuclear Regulatory Commission (NRC) staff requested additional information related to CBR's April 29, 1998 submittal concerning groundwater remediation efforts associated with the leak from well I-196-5. CBR is providing the enclosed response, which should supply NRC with the requested information.

CBR has not plugged the shallow wells in the vicinity of well I-196-5. CBR has continued to actively pump selected wells and sample in accordance with the remediation plan since our submittal in April 1998. Additional recent monitoring data for the remediation wells is provided in our response.

If you have any questions or require further information, please do not hesitate to contact me at (308) 665-2215.

Sincerely,
CROW BUTTE RESOURCES, INC.

Michael L. Griffin
Manager of Environmental and Regulatory Affairs

Enclosures: As Stated

cc: Steve Collings – CBR, Denver
Leland Huffman – CBR, Crawford
Rhonda Grantham – CBR, Crawford

Response to Request for Additional Information

Groundwater Remediation for Casing Failure at Crow Butte In-Situ Leach Facility

On April 29, 1998 Crow Butte Resources, Inc. (CBR) submitted the results of groundwater remediation efforts conducted in the vicinity of an excursion of mining solutions from well I-196-5[1]. This excursion of mining solutions was caused by a well casing leak that was discovered on March 29, 1996 during the routine 5-year Mechanical Integrity Test (MIT). Previous submittals in 1996 and 1998 have described the remedial actions taken by CBR to recover the mining solutions from the shallow aquifer. The April 29, 1998 submittal provided data that compared the most recent analytical results from the contaminated remediation wells with the baseline water quality data established from the uncontaminated excursion delineation wells. All of these wells were installed by CBR immediately following discovery of the excursion.

As discussed in CBR's Remediation Plan for this excursion[2], CBR conducted sampling for the five approved excursion parameters (sodium, chloride, sulfate, alkalinity and conductivity) as well as uranium (as U_3O_8). The plan for excursion remediation and sampling was prepared in accordance with the requirements of SUA-1534 Amendment 34, License Condition 45. Similar requirements are now contained in CBR's renewed license SUA-1534, License Condition 11.2.

The following additional information concerning the effectiveness of the remedial action is provided in response to the request of the NRC dated July 8, 1998.

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[1] Huffman, L., 1998, Letter to Joseph Holonich (NRC) from Leland Huffman (CBR), April 29.

[2] Bartels, C. S., 1996, Letter to Joseph Holonich (NRC) from Craig S. Bartels, (CBR), May 29.

NRC Question Number 1) ***CBR must demonstrate achievement of the primary restoration goal for the water quality parameters identified in License Condition 10.3.***

Determination of Restoration Goals

The baseline groundwater quality for the upper aquifer in Mine Unit 2 was determined in 1992. Monitoring was performed in accordance with SUA-1534, Amendment 13, License Condition 44 and the Nebraska Department of Environmental C (NDEQ) Underground Injection Control (UIC) Permit. Shallow monitor wells for the upper aquifer were completed in the first water-bearing sandstone overlying the production zone. For Mine Unit 2, CBR determined the baseline groundwater quality from data collected from three shallow monitor wells identified as SM2-1, SM2-2, and SM2-3. The groundwater quality data, determination of restoration standards and upper control limits (UCLs) for Mine Unit 2 was approved by NRC in Amendment 13 to SUA-1534.

As discussed further in the response to Question Number 3, the excursion area impacted by the casing failure in Well I-196-5 is in the upper Brule aquifer. This is the same hydrostratigraphic unit that was sampled using the shallow monitor wells during the preoperational monitoring for Mine Unit 2. The results of this preoperational monitoring were used to determine the primary restoration goals for the shallow aquifer in Mine Unit 2.

CBR has noted that the water-bearing sands in the upper Brule aquifer can exhibit groundwater quality that varies with the depth from the surface. The shallow monitor wells for Mine Unit 2 are installed at depths ranging from 179 to 263 feet. This is the first water-bearing sandstone overlying the production zone in this Mine Unit. The leak from I-196-5 occurred at a depth of approximately 40 feet. Due to this difference in depth and the natural variation in groundwater quality within the water-bearing sandstones in the upper Brule, the uncontaminated excursion delineation wells in this area exhibited significantly lower values for the excursion parameters than the Mine Unit 2 restoration goals determined by the shallow monitor wells.

Table 1 compares excursion cleanup targets that could be appropriate to apply to the I-196-5 excursion area. The approved restoration goals for the upper Brule in Mine Unit 2 are shown compared with the baseline monitoring results from sampling the nine excursion delineation wells. The average and the range of excursion constituents for the upper Brule from all shallow monitor wells installed in Mine Units 1 through 5 is provided for comparison. The baseline monitoring results from the delineation wells are well below the restoration goals for Mine Unit 2. The results are also well below the average for excursion parameters for all upper Brule monitor wells from Mine Units 1 through 5. However, the results are within the expected or demonstrated range for the upper Brule. Based upon this data, CBR set the baseline averages from the delineation wells as the excursion cleanup targets as discussed in the CBR Remediation Plan (Bartels, 1996).

CBR has achieved cleanup of the groundwater quality in the impacted area to levels that are well below the approved restoration goals determined for Mine Unit 2. CBR has used the delineation wells installed around I-196-5 to represent baseline in the immediate area of the impacted zone. As a result, CBR has performed remediation in an attempt to meet these more stringent excursion cleanup targets. CBR's determination that these delineation wells represented pre-contamination background is discussed further in the response to Question Number 2.

Table 1

Excursion Cleanup Target Comparison

Analytes	Units	I-196-5 Excursion Delineation Wells (Average)	Mine Unit 2 Approved Restoration Goals	Typical Upper Brule, MU 1 - 5 (Average)	Typical Upper Brule, MU 1 - 5 (Min to Max)
Sodium	mg/l	22.0	124.6	123.6	87 to 199
Sulfate	mg/l	18.0	48.6	53.4	23 to 109
Chloride	mg/l	4.0	25.7	23.0	2 to 96
Conductivity	µmho/cm	471	633	617	420 to 1020
Alkalinity	mg/l	209	216	210.8	84 to 385
pH	S.U.	7.57	9.5	9.1	7.36 to 11.13
Uranium	mg/l	0.093	0.010	0.008	<0.001 to 0.086

At the time of the excursion, CBR did not analyze samples from the delineation wells for any parameters other than the required excursion indicators. This action was in accordance with the excursion monitoring requirements of SUA-1534. The primary goal of sampling was to determine the areal extent of contamination and confirm that mining fluids were not migrating further during remediation activities. This approach was discussed in the CBR Remediation Plan. CBR has continued to monitor the down gradient delineation wells during remediation efforts in accordance with the remediation plan. This monitoring did not include analysis for the full suite of analytes from License Condition 10.3(B). Therefore, baseline data from the I-196-5 delineation wells is not available for these analytes.

CBR's environmental monitoring program requires sampling of all private wells within 1 kilometer (Km) of the wellfields on a quarterly basis. These 1-Km wells were initially sampled as part of the preoperational monitoring program performed by CBR from 1982 through 1989. The purpose of the preoperational monitoring program was to determine the baseline concentrations of radiological and nonradiological constituents prior to mining activities. Results of the preoperational monitoring program were submitted to NRC in the commercial license application[3]. Monitoring of these 1-Km private wells has continued since 1989 as part of the operational environmental monitoring program and are reported to NRC in the Semiannual Effluent and Environmental Monitoring Reports.

Data from the CBR environmental monitoring program may be used to determine whether the excursion remediation has been successful for all of the restoration constituents from License Condition 10.3(B). CBR has determined that five of the nearby 1-Km private wells closely approximate the groundwater quality in the vicinity of the excursion from I-196-5. These wells are in relatively close proximity to Well I-196-5, are completed in the upper Brule aquifer and have a similar average water depth of 35 to 40 feet. The five similar wells are identified as Wells Number 17, 19, 25, 26, and 27 in the commercial license application. Table 2 is a summary of the average preoperational baseline sampling results from these five 1-Km wells from 1982 through 1989. The preoperational monitoring for these wells was performed for all parameters required in License Condition 10.3(B).

Figure 1 shows the geographical location of these five 1-Km private wells in relation to the I-196-5 excursion area.

[3] Ferret Exploration of Nebraska, Inc., *Application and Supporting Environmental Report for USNRC Commercial Source Material License*, September 1987.

Table -

Preoperational Monitoring for Selected 1-Km Wells

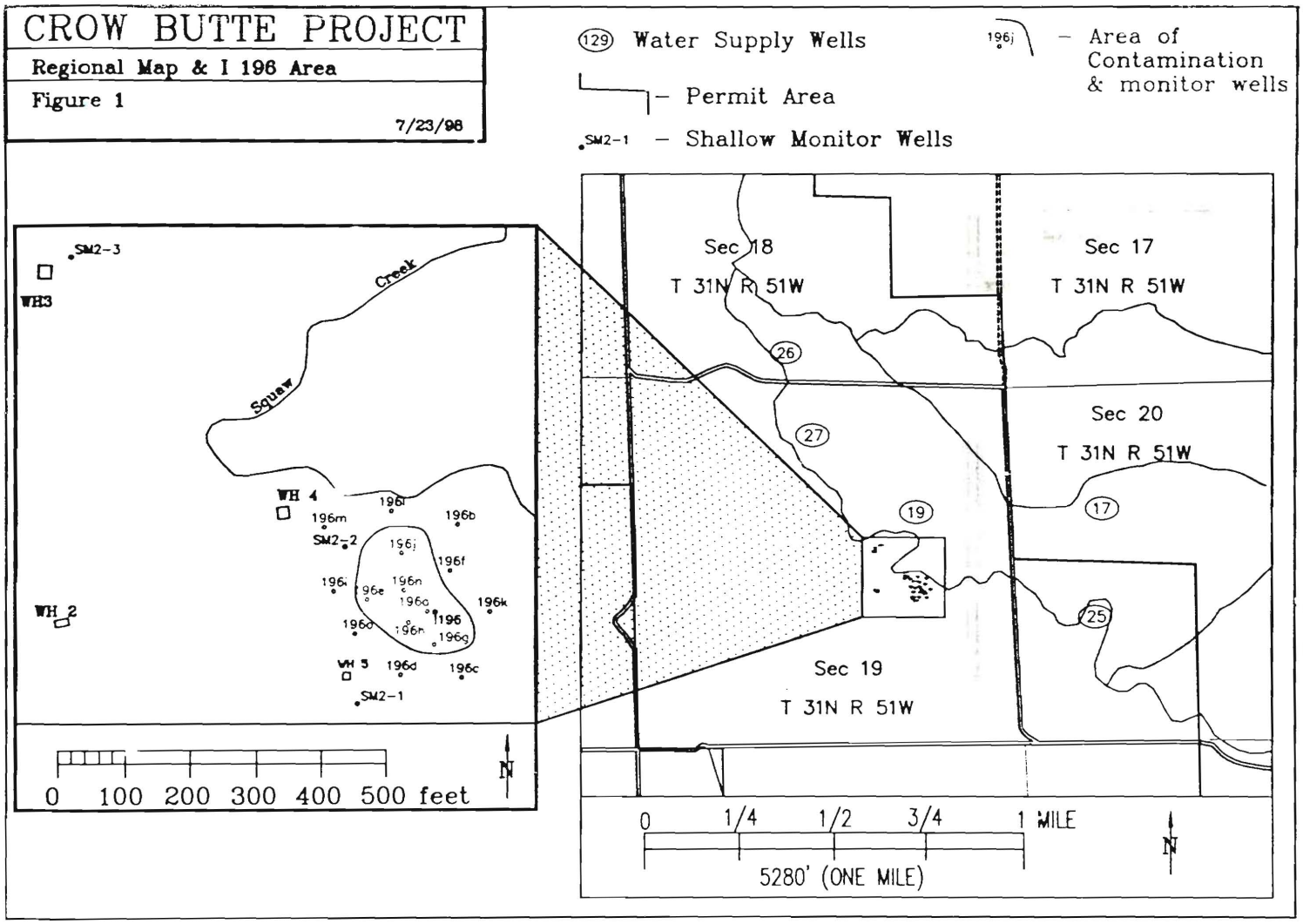
Sample Location			Well # 17	Well # 19	Well # 25	Well # 26	Well # 27			
Surface Elevation (ft MSL)			3910	3890	3905	3820	3850			
Well Depth			80	80	75	80	80			
Average Water Level (ft. MSL)			3863	n/a	3870	n/a	n/a			
	Major Ions		Average Preoperational Baseline Sampling Results (1982 through 1989)					Average	Std. Dev.	Average + 3 S.D.
calcium	Ca	mg/l	59.2	78.0	78.8	122.5	70.3	81.8	21.5	146.4
magnesium	Mg	mg/l	7.9	10.6	10.8	15.1	9.2	10.7	2.4	18.0
sodium	Na	mg/l	17.3	11.2	13.3	15.3	16.6	14.7	2.2	21.4
potassium	K	mg/l	4.4	4.7	4.6	6.5	5.1	5.1	0.8	7.3
carbonate	CO3	mg/l	1.5		1.5	1.5	<1	1.5	0.0	1.5
bicarbonate	HCO3	mg/l	240.7	253.4	282.5	339.4	269.0	277.0	34.2	379.7
sulfate	SO4	mg/l	11.0	11.1	7.6	28.2	16.5	14.9	7.2	36.6
chloride	Cl	mg/l	3.7	6.5	7.4	30.6	4.3	10.5	10.1	40.9
ammonium	NH4	mg/l	<0.05	0.06	0.05	<0.05	<0.05	0.05	0.0	0.06
nitrite	NO2	mg/l	0.007	0.007	0.006	0.006	0.005	0.006	0.0	0.008
nitrate	NO3	mg/l	1.2	10.2	7.3	16.66	2.58	7.6	5.6	24.3
fluoride	F	mg/l	0.7	0.6	0.7	0.62	0.78	0.7	0.06	0.85
silica	SiO2	mg/l	58.9	49.7	52.8	49.2	54.2	52.9	3.5	63.5
	Non-Metals									
total dissolved solids	TDS	mg/l	287	364	344	500	320	363	73.3	583
conductivity (umhos/cm)	Cond	umho/cm	408.455	527	517.8	774	471	540	124.7	914
alkalinity as CaCO3	Alk	mg/l	201	298	232	282	224	229	28.7	315
pH (std units)	pH	std. units	7.7	7.7	7.6	7.59	7.75	7.7	0.1	7.9
	Trace Metals									
aluminum	Al	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0	n/a
arsenic	As	mg/l	0.004	0.004	0.006	0.004	0.004	0.004	0.001	0.006
barium	Ba	mg/l	0.200	0.275	0.259	0.290	0.183	0.241	0.042	0.368
boron	B	mg/l	0.063	0.030	0.059	0.067	0.085	0.061	0.018	0.114
cadmium	Cd	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0	n/a
chromium	Cr	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.0	n/a
copper	Cu	mg/l	<0.01	<0.01	<0.01	0.014	<0.01	0.014	0.000	0.014
iron	Fe	mg/l	0.292	0.015	0.028	0.031	0.036	0.080	0.106	0.399
lead	Pb	mg/l	<0.005	0.006	<0.005	<0.005	<0.005	0.006	0.0	0.006
manganese	Mn	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.0	n/a
mercury	Hg	mg/l	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0	n/a
molybdenum	Mo	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.0	n/a
nickel	Ni	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.0	n/a
selenium	Se	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0	n/a
vanadium	V	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.0	n/a
zinc	Zn	mg/l	0.021	0.348	0.195	0.037	0.030	0.126	0.128	0.510
	Radiometric									
uranium natural (mg/l)	U-nat	mg/l	0.004	0.004	0.004	0.006	0.005	0.004	0.001	0.0068
radium 226 (pCi/l)	Ra226	pCi/l	0.3	0.9	0.3	0.5	0.5	0.5	0.220	1.1

CROW BUTTE PROJECT

Regional Map & I 196 Area

Figure 1

7/23/98



CBR has compared the results of the preoperational monitoring from the five selected 1-Km wells with the parameters monitored from the I-196-5 delineation wells. This comparison indicates that the groundwater quality from the five 1-Km private wells is very similar to that found in the delineation wells installed around I-196-5.

Table 3 presents the results of this comparison. The first column provides the preoperational data from the five 1-Km private wells. The average, standard deviation, and average plus three standard deviations are listed for all of the monitored constituents. The second column provides similar data for the excursion parameter monitoring performed immediately after discovery of the excursion on the I-196-5 uncontaminated delineation wells. These wells are identified as 196b, 196c, 196d, 196f, 196i, 196k, 196l, 196m, and 196o. Finally, the third column presents the approved restoration goals for the upper Brule in Mine Unit 2.

The baseline data available from the delineation wells is comparable with the preoperational baseline monitoring results for the selected 1-Km wells. Due to this similarity in water quality, CBR believes that it is reasonable to compare the results of remediation efforts around I-196-5 with the data from the selected 1-Km wells. It should be noted that the data presented in Table 3 for the 1-Km wells represents seven years of accumulated quarterly preoperational monitoring. This data provides a better statistical evaluation of the quality of the water in similar sands in the upper Brule than would be obtainable from the excursion delineation wells.

Table 3

Baseline Comparison

Sample Location			1Km Well Preoperational Baseline (Wells 17, 19, 25, 26, 27)			I-196 Uncontaminated Baseline (Wells I-196b,c,d,f,i,k,l,m,o)			Shallow Monitor Baseline (Wells SM2-1, 2-1, and 2-3)		
			Average	Std. Dev.	Average + 3 S.D.	Average	Std. Dev.	Average + 3 S.D.	Average	Std. Dev.	Average + 3 S.D.
Major Ions											
[illegible]	Ca	mg/l	81.8	21.5	146.4				9.8	4.0	22.0
[illegible]	Mg	mg/l	10.7	2.4	18.0				1.6	1.2	5.1
[illegible]	Na	mg/l	14.7	2.2	21.4	22.0	0.03	22.1	124.6	11.2	158.3
[illegible]	K	mg/l	5.1	0.8	7.3				10.8	0.9	13.5
[illegible]	CO3	mg/l	1.5	0.0	1.5				40.7	22.0	106.6
[illegible]	HCO3	mg/l	277	34.2	380				182.5	53.5	343
[illegible]	SO4	mg/l	14.9	7.2	36.6	18.0	10.0	48.0	48.6	5.7	65.5
[illegible]	Cl	mg/l	10.5	10.1	40.9	4.0	2.0	10.0	25.7	7.5	48.1
[illegible]	NH4	mg/l	0.05	0.003	0.064				0.060	0.0	0.090
[illegible]	NO2	mg/l	0.006	0.0007	0.008				0.0037	0.0	0.020
[illegible]	NO3	mg/l	7.6	5.6	24.3				0.7	0.2	1.3
[illegible]	F	mg/l	0.7	0.06	0.8				0.65	0.0	0.7
[illegible]	SiO2	mg/l	52.9	3.5	63.5				55.7	12.7	93.8
Non-Metals											
[illegible]	TDS	mg/l	363	73.3	583				418	30.1	508
[illegible]	Cond	umho/cm	540	124.7	914	471	40.0	591	633	44.9	768
[illegible]	Alk	mg/l	229	28.7	315	209	25.0	284	216	17.6	269
[illegible]	pH	std. units	7.7	0.1	7.9	7.57	0.12	7.93	9.5	0.7	11.5
Trace Metals											
[illegible]	Al	mg/l	<0.001	0.0	0.000				0.065	0.1	0.000
[illegible]	As	mg/l	0.004	0.001	0.006				0.019	0.011	0.050
[illegible]	Ba	mg/l	0.241	0.042	0.368				0.003	0.006	0.021
[illegible]	B	mg/l	0.061	0.018	0.114				0.079	0.068	0.284
[illegible]	Cd	mg/l	<0.001	0.0	0.000				0.000	0.0	0.000
[illegible]	Cr	mg/l	<0.005	0.0	0.000				0.002	0.0	0.000
[illegible]	Cu	mg/l	0.014	0.000	0.014				0.015	0.005	0.030
[illegible]	Fe	mg/l	0.080	0.106	0.399				0.010	0.017	0.062
[illegible]	Pb	mg/l	0.006	0.000	0.006				0.002	0.0	0.012
[illegible]	Mn	mg/l	<0.005	0.0	0.000				0.002	0.0	0.000
[illegible]	Hg	mg/l	<0.0002	0.0	0.000				0.000	0.0	0.000
[illegible]	Mo	mg/l	<0.01	0.0	0.000				0.003	0.0	0.000
[illegible]	Ni	mg/l	<0.01	0.0	0.000				0.003	0.0	0.000
[illegible]	Se	mg/l	<0.001	0.0	0.000				0.004	0.0	0.000
[illegible]	V	mg/l	<0.01	0.0	0.000				0.003	0.0	0.000
[illegible]	Zn	mg/l	0.126	0.128	0.51				0.118	0.090	0.39
Radiometric											
[illegible]	U-nat	mg/l	0.004	0.001	0.007	0.093	0.030	0.169	0.010	0.004	0.021
[illegible]	Ra226	pCi/l	0.5	0.22	1.1				3.7	4.335	16.7

Achievement of the Excursion Cleanup Targets for All Parameters

In April 1998 a sample was obtained from well 196a for full suite analysis in order to confirm that CBR's efforts had been successful in achieving remediation. Well 196a was selected for sampling because it is the remediation well closest to I-196-5 (approximately 12 feet away) and has historically exhibited some of the highest concentrations of excursion constituents. The results of this sample are compared to the baseline values from the five 1-Km private wells in Table 4. The cleanup targets are established by determining the average and adding three standard deviations as discussed in NUREG-1569[4]. Table 4 also lists the Maximum Contaminant Levels suggested by the NDEQ as appropriate for the remediation of Well I-196-5[5].

With the exception of sodium, sulfate and uranium, the data from the 196a sample for all other restoration analytes are well below the baseline values from the 1-Km wells. As noted, due to its proximity to well I-196-5, the analytical results for well 196a have been significantly above the average for all I-196-5 contaminated wells. This has been true throughout the course of the remediation efforts and can be seen in the data contained in Table 1 of the April 1998 submittal (Huffman, 1998). The graphs of excursion indicators over time for the remediation wells contained in Appendix A also support this contention. CBR believes that it is reasonable to project that if 196a meets the excursion cleanup targets, the excursion area, on average, also meets these targets for the restoration analytes.

[4] USNRC, *Draft Standard Review Plan for In-Situ Leach Uranium Extraction License Applications*, NUREG-1569 October 1997.

[5] Mills, F.L. 1996, Letter to Craig Bartels (CBR) from Frank Mills (NDEQ), May 31.

Table 4
1-Km Baseline and Well I-196a Comparison

Sample Location			1Km Well Baseline			Well I-196a	NDEQ MCLs
	Major Ions		Average	Std. Dev.	Average + 3 S.D.	Result	MCL
calcium	Ca	mg/l	81.8	21.5	146.4	55.0	
magnesium	Mg	mg/l	10.7	2.4	18.0	7.6	
sodium	Na	mg/l	14.7	2.2	21.4	79.0	20 (see Note 1)
potassium	K	mg/l	5.1	0.8	7.3	6.1	
carbonate	CO3	mg/l	1.5	0.0	1.5	<0.1	
bicarbonate	HCO3	mg/l	277	34.2	380	296.0	
sulfate	SO4	mg/l	14.9	7.2	36.6	55.0	250
chloride	Cl	mg/l	10.5	10.1	40.9	22.0	250
ammonium	NH4	mg/l	0.05	0.003	0.064	<0.05	10.0
nitrite	NO2	mg/l	0.006	0.0007	0.008	<0.1	
nitrate	NO3	mg/l	7.6	5.6	24.3	2.8	10.0
fluoride	F	mg/l	0.7	0.06	0.8	0.78	4.0
silica	SiO2	mg/l	52.9	3.5	63.5	49.0	
	Non-Metals						
total dissolved solids	TDS	mg/l	363	73.3	583	464	
conductivity (umho/cm)	Cond	umho/cm	540	124.7	914	655	
alkalinity as CaCO3	Alk	mg/l	229	28.7	315	243	
pH (std units)	pH	std. units	7.7	0.1	7.9	8.0	6.5-8.5
	Trace Metals						
aluminum	Al	mg/l	<0.001	0.0	0.000	<0.1	
arsenic	As	mg/l	0.004	0.001	0.006	0.006	0.05
barium	Ba	mg/l	0.241	0.042	0.368	0.140	1.0
boron	B	mg/l	0.061	0.018	0.114	<0.1	
cadmium	Cd	mg/l	<0.001	0.0	0.000	<0.005	0.005
chromium	Cr	mg/l	<0.005	0.0	0.000	<0.05	
copper	Cu	mg/l	0.014	0.000	0.014	0.010	1.0
iron	Fe	mg/l	0.080	0.106	0.399	<0.05	0.3
lead	Pb	mg/l	0.006	0.000	0.006	<0.05	0.05
manganese	Mn	mg/l	<0.005	0.0	0.000	<0.01	0.05
mercury	Hg	mg/l	<0.0002	0.0	0.000	<0.001	0.002
molybdenum	Mo	mg/l	<0.01	0.0	0.000	<0.1	0.04
nickel	Ni	mg/l	<0.01	0.0	0.000	<0.05	0.01
selenium	Se	mg/l	<0.001	0.0	0.000	0.006	0.05
vanadium	V	mg/l	<0.01	0.0	0.000	<0.1	0.2
zinc	Zn	mg/l	0.126	0.128	0.51	0.050	5.0
	Radiometric						
uranium natural (mg/l)	U-nat	mg/l	0.004	0.001	0.007	0.308	0.020
radium 226 (pCi/l)	Ra226	pCi/l	0.5	0.22	1.1	<0.2	5.0

Notes: 1 Value for sodium is based upon USEPA Lifetime Health Advisory

Current Status of Remediation

CBR has continued to pump and sample selected remediation wells since the April 1998 submittal. The analysis of these samples has been performed in accordance with the CBR Remediation Plan. Table 5 provides updated average analytical data for the six remediation wells from the latest full set of samples taken on July 30, 1998. The results of this data are compared to the average for April 16, 1998 previously reported to NRC (Huffman, 1998). This data is also compared to the baseline average determined by the excursion delineation wells.

Table 5

Remediation Well Monitoring Data Update

Analytes	Units	April 16, 1998 Remediation Well Average	July 30, 1998 Remediation Well Average	May 2, 1996 Delineation Well Baseline (Average + 3 S.D.)
Sodium	mg/l	39	33	55
Sulfate	mg/l	29	24	50
Chloride	mg/l	12	8	10
Conductivity	µmho/cm	517	485	591
Alkalinity	mg/l	209	208	283
Uranium (U_3O_8)	mg/l	< 0.1	<0.12	0.21

With continued remediation efforts during the past three months, there has been no significant change in the concentrations of the excursion indicators. Appendix A contains graphs that depict the concentrations of the excursion parameters from the six remediation wells over time since the discovery of the casing leak. A review of this data indicates that there has been minimal change in the concentrations of the excursion analytes since the early part of 1997.

CBR has pumped an estimated 4,668,000 gallons from the 196 remediation wells since efforts began in 1996 through the end of July, 1998. The estimated pore volume for the affected excursion area ranges from 112,600 gallons to 337,800 gallons (Bartels, 1996). Therefore, CBR has used an estimated 14 to 41 pore volumes of groundwater sweep during remediation efforts.

Based upon the results of the monitoring and the volume of water removed through groundwater sweep in this area, CBR believes that remediation efforts have been successful at returning the groundwater quality to a condition that meets the excursion cleanup targets that are appropriate for this area. CBR further believes that continued pumping would have no significant affect on the groundwater quality in the area of I-196-5.

NRC Question Number 2) ***CBR should derive a restoration goal as required by License Condition 10.3(C) and explain how it was obtained for the water quality parameters in License Condition10.3(B).***

As discussed in the response to Question Number 1, CBR determined restoration goals for the upper Brule aquifer in accordance with SUA-1534 and the NDEQ UIC Permit. These restoration goals were based upon the monitoring results from the Mine Unit 2 shallow monitor wells (SM2-1, SM2-2, and SM2-3). As noted, CBR believes that the use of the approved restoration goals for the upper Brule aquifer for Mine Unit 2 as excursion cleanup goals for the I-196-5 excursion is not appropriate due to fluctuations in water quality with depth from the surface.

In response to the discovery of this casing leak, CBR installed fifteen wells to determine the areal extent of contamination. The completion data, locations and elevations for these fifteen wells was previously submitted to NRC in the CBR Remediation Plan (Bartels, 1996). Six wells were identified as contaminated and nine wells were identified as uncontaminated, or background for this specific area.

The monitoring data for each well during the course of the initial remediation efforts in 1996 was presented to NRC in CBR's Remediation Plan. A comparison of the range of analytical results from the six contaminated remediation wells (196a, 196e, 196g, 196h, 196j, and 196n) with the nine uncontaminated delineation wells (196b, 196c, 196d, 196f, 196i, 196k, 196l, 196m, and 196o) supports CBR's determination that the delineation wells represent pre-contamination background. Table 6 summarizes the initial range for each of the monitored parameters for the six remediation wells and the nine delineation wells. This data is from the samples obtained in late April and early May 1996 during the immediate response to the excursion and prior to any active remediation efforts.

Table 6

196 Well Data Comparison

Analytes	Units	196 Contaminated Wells (Initial Range)	196 Excursion Delineation Wells (Initial Range)
Sodium	mg/l	48 – 1216	15 – 30
Sulfate	mg/l	178 – 1196	8 - 24
Chloride	mg/l	110 - 576	1.5 - 9
Conductivity	µmho/cm	1217 – 5540	379 - 541
Alkalinity	mg/l	290 – 950	175 – 255
Uranium	mg/l	0.8 – 27.6	<0.1 – 0.2

In addition to the significant differences between the initial ranges of analytical results for the I-196-5 remediation and delineation wells, the analytical data for each well over the course of the remediation supports CBR's initial designation of the wells as contaminated or uncontaminated. As shown in the graphs in Appendix A, the concentration of excursion parameters in each of the six contaminated wells steadily decreased with time during the initial stages of active remediation. A review of the data for the uncontaminated wells shows no significant change in the concentrations of any excursion parameters during the course of remediation. This would be expected for wells that were already at or near background water quality.

With groundwater sweep as the only remediation method available to CBR for the upper Brule aquifer, if any of the wells had been erroneously identified as uncontaminated, the influx of baseline-quality groundwater would have reduced the concentrations of excursion parameters. Table 7 compares the initial monitoring results from 1996 for the excursion parameters with the most recent data available for the nine delineation wells.

Table 7

Delineation Well Pre- and Post Remediation Analyses

Sample Location	Sample Da	U_3O_8 (mg/l)	Na (mg/l)	Cl (mg/l)	SO_4 (mg/l)	Conductivity (µmhos/cm)	Alkalinity (mg/l)
196b	18 Apr 96	0.1	21	1.5	13	430	215
	7 Aug 98	<0.1	18	1.6	7.7	436	220
196c	19 Apr 96	0.1	16	3.8	21	465	210
	7 Aug 98	<0.1	15	4.8	16	474	210
196d	19 Apr 96	0.1	15	1.5	13	379	175
	7 Aug 98	<0.1	16	2.8	13	411	190
196f	22 Apr 96	0.1	20	4.6	14	480	230
	7 Aug 98	<0.1	16	0.8	5.9	488	250
196i	29 Apr 96	<0.1	19	9	24	441	180
	23 Jul 98	<0.1	13	22	30	520	185
196k	25 Apr 96	<0.1	14	8	19	541	255
	7 Aug 98	<0.1	18	6.8	11	541	260
196l	30 Apr 96	0.2	14	2	14	435	210
	23 Jul 98	<0.1	14	0.4	<10	467	238
196m	2 May 96	0.2	30	2	8	529	210
	23 Jul 98	<0.1	15	6	16	460	200
196o	7 May 96	<0.1	18	2.3	18	443	200
	7 Aug 98	<0.1	14	3.2	18	446	190

Within the range of normal expected variation, there was no significant change in the concentrations of excursion indicators in any of the uncontaminated wells over the course of the remediation efforts.

Finally, as presented in the response to Question Number 1, Table 1 shows that a comparison of the concentrations of excursion parameters in the 196 uncontaminated wells is similar to nearby private wells completed in similar zones. These concentrations are at the lower expected range of values for all upper Brule monitor wells installed by CBR in Mine Units 1 through 5. The comparison of the data supports the use of these baseline values as excursion cleanup targets.

NRC Question Number 3) ***CBR should provide a description of the shallow aquifer in the excursion area and its relation (thickness, separating aquitards, etc.) to the mine zone and any overlying aquifers.***

Description of the Excursion Aquifer

The CBR submittal of April 1998 (Huffman, 1998) was not intended to suggest that the area affected by the excursion is a water table aquifer distinct from the upper Brule aquifer. The excursion aquifer is described as a silty sandstone lens within the upper portion of the Brule Formation. The Brule Formation contains a number of discontinuous sandstone and silty sandstone lenses within a brown to medium brown siltstone. The lenses are difficult to correlate over large distances and in some instances may contain water. The excursion aquifer and the Shallow Monitor Well (SM) zone represent two of these water-bearing lenses. Wells completed within these lenses are characterized by low pumping rates and similar water quality. The upper portion of the Brule Formation is considered a single hydrostratigraphic unit.

The I-196-5 excursion area delineation wells were drilled with air to minimize well bore damage and to prevent drilling fluid contamination of the horizon of interest. As a result, drill cuttings were mixed and the stratigraphic column was developed from other sources. Based upon geophysical logs of the excursion delineation wells and lithologies of mining wells within the area the excursion aquifer appears to be a light to medium brown, very fine to fine grained silty sandstone ranging from about 2 feet to 5 feet thick. The silty sandstone is immediately overlain and underlain by zones of lower relative permeability, most likely medium brown siltstone, which would effectively confine the aquifer. Above the lower permeability zone is a series of interbedded siltstones and silty sandstones. This series ranges in thickness from 20 feet to 30 feet. Overlying the interbedded silts and silty sandstones is from 0 to 15 feet of Quaternary Alluvium with from 5 feet to 15 feet of Topsoil above the Alluvium where present.

During airlift development of the excursion delineation wells, flow rates were noted as low with later pumping rates ranging from 0.4 gallons per minute (gpm) to 6 gpm. These rates are similar to flow rates of the SM wells that are completed in a deeper lens within the upper portion of the Brule Formation hydrostratigraphic unit.

Relationship of Excursion Aquifer to the Mine Zone

The excursion aquifer is located in the upper portion of the Brule Formation within a silty sandstone lens. The upper portion of the Brule Formation is primarily light brown to medium brown siltstones with occasional discontinuous sandstone and silty sandstone lenses. The upper portion of the Brule ranges in thickness from 180 feet to 265 feet in the excursion area. Underlying the upper portion of the Brule is a 300-foot thick sequence of siltsone, mudstone, and claystone of the lower portion of the Brule and the upper portion of the Chadron Formations. The sequence represents the upper confinement to the mining zone located within the basal Chadron Formation sandstone. Based on the original geophysical log for well I-196-5 the excursion aquifer is approximately 560 feet above the mining zone.

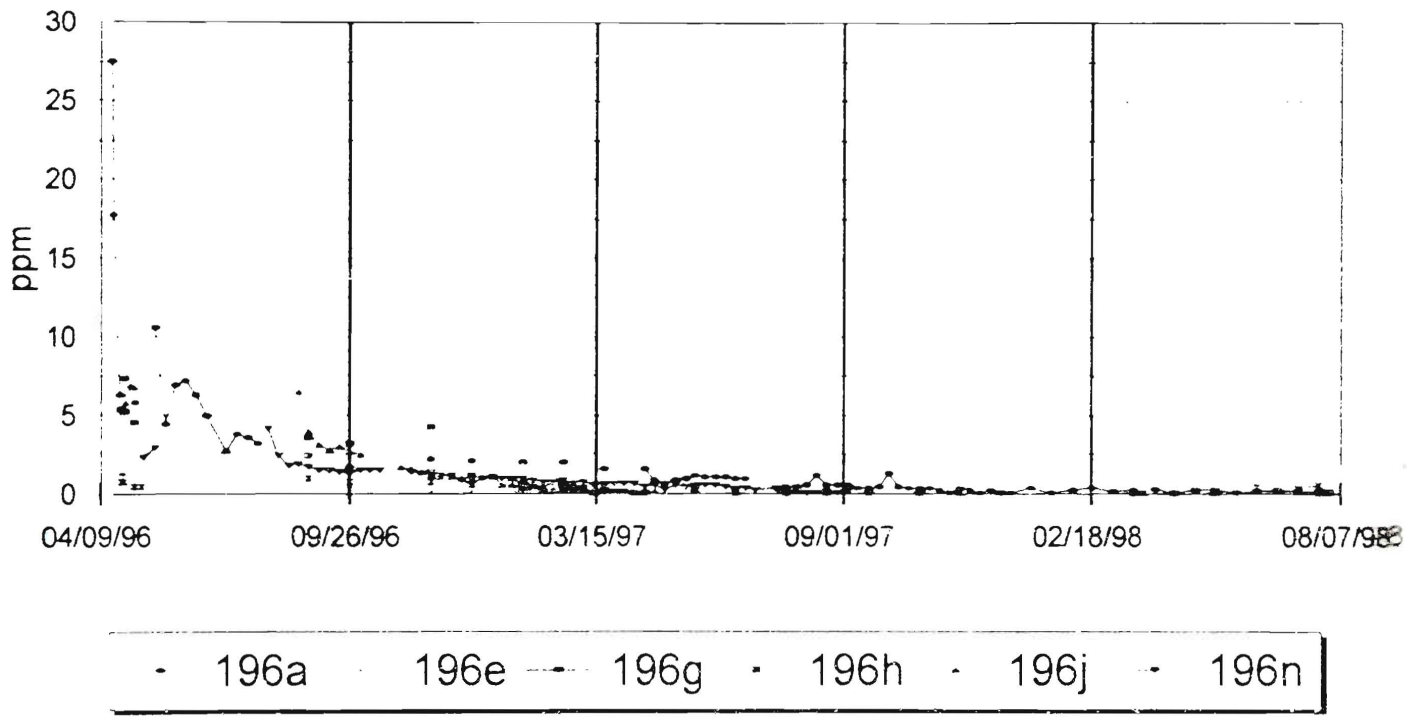
The excursion has not been detected in the shallow monitor wells for Mine Unit 2, indicating that the excursion was confined to the shallow water-bearing silty sandstone 40 feet below the surface. The excursion delineation wells installed in 1996 have effectively defined the areal extent of contamination within this silty sandstone.

Answers to Questions 4 and 5 are not provided since the area of the spill is not distinct from the upper aquifer (i.e., the upper Brule) routinely monitored by CBR.

Appendix A

Remediation Well Analytical Results

u3o8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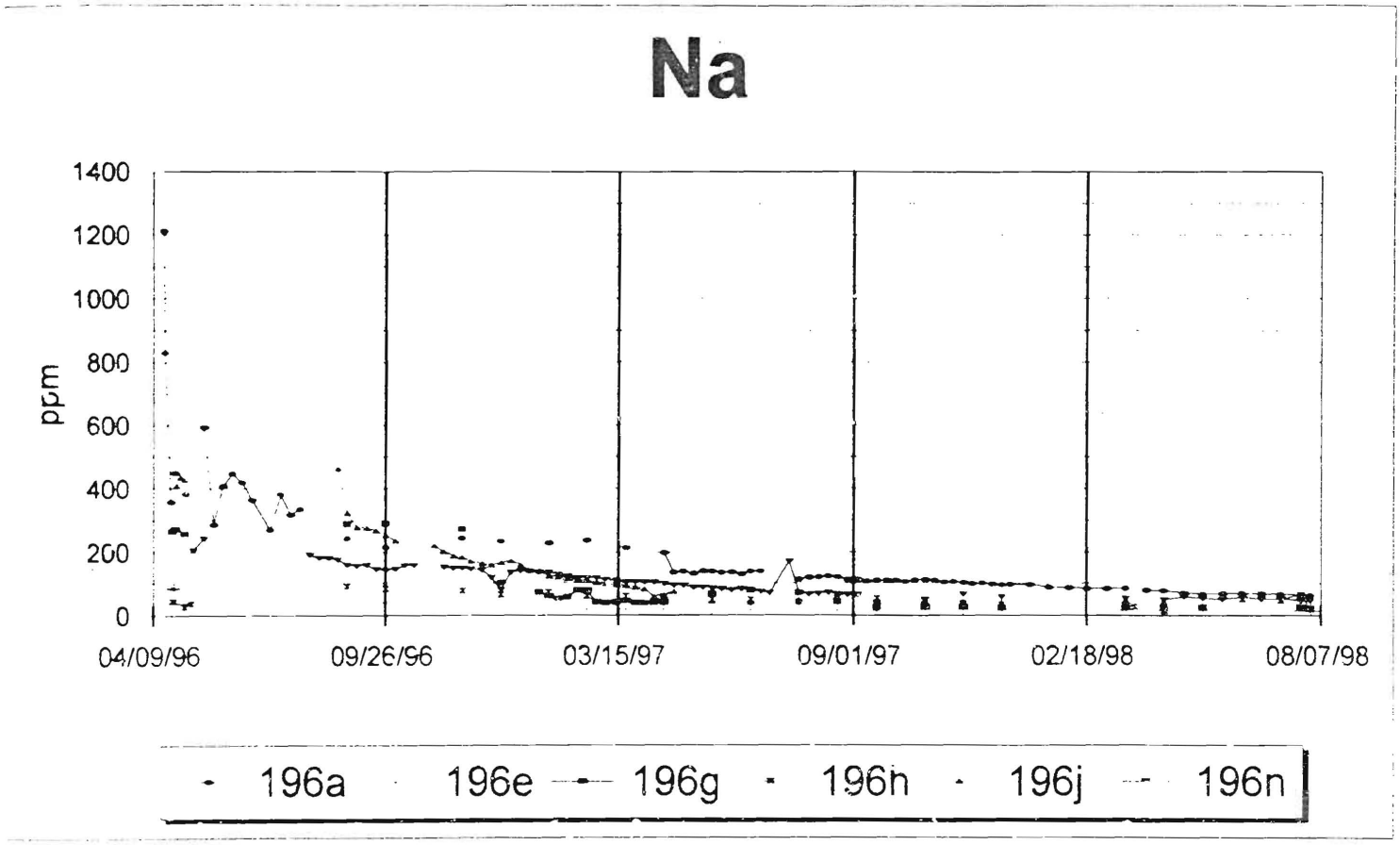
196a
196e
196g
196h
196j
196n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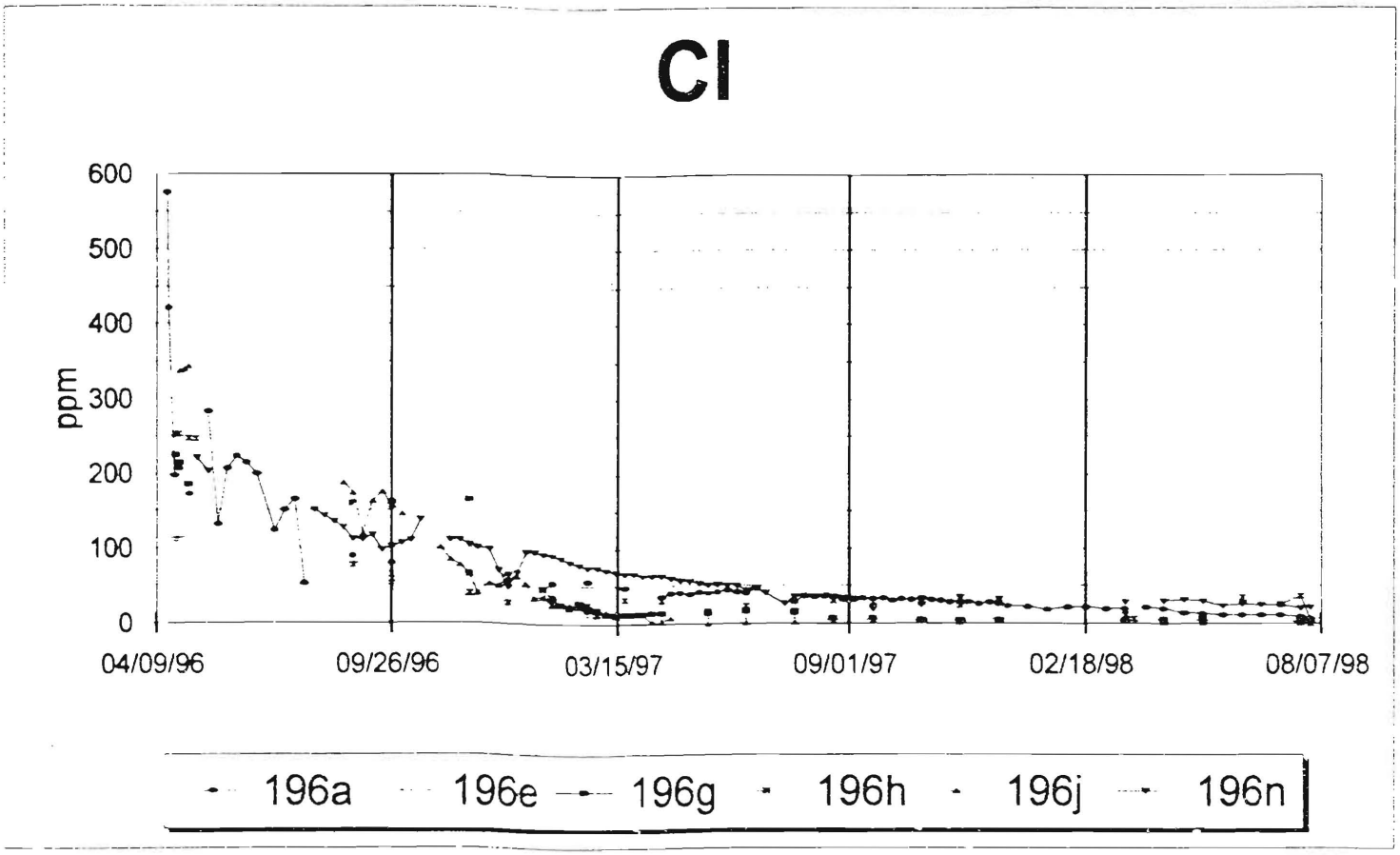
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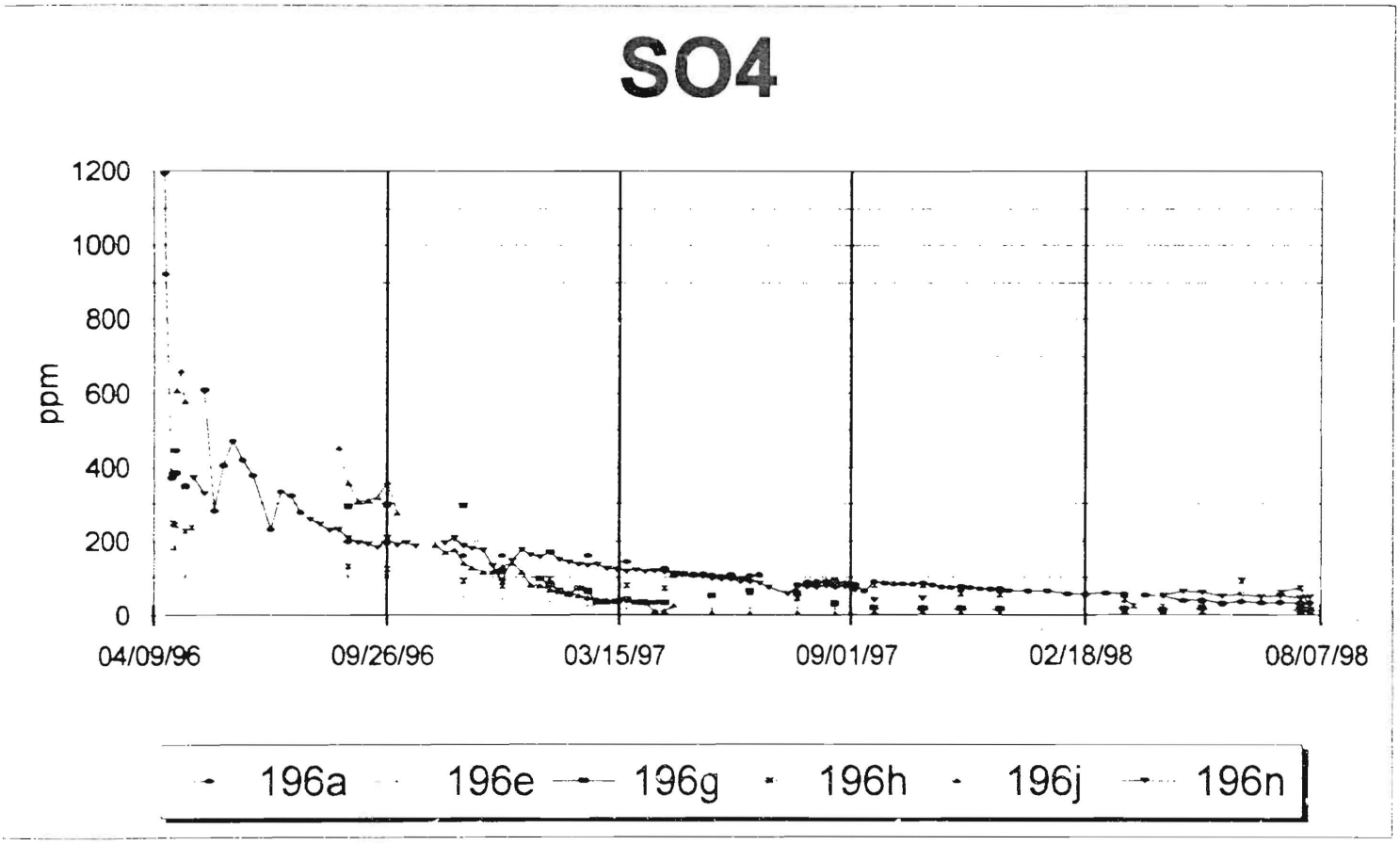
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196n

Conductivity