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July 8, 2008

Mr. Edgar Ethington  
Hazardous Materials and Waste Management Division  
Colorado Department of Public Health and Environment  
4300 Cherry Creek Drive South, B2  
Denver, CO 80246-1530

Ms. Sheila Gaston  
Remediation and Restoration Unit  
Federal Facilities Program  
Hazardous Materials and Waste Management Division  
Colorado Department of Public Health and Environment  
4300 Cherry Creek Drive South, B2  
Denver, CO 80246-1530

Re: Evaluation of Radiological Parameters, Landfill Zone (Operable Unit 2)  
Follow-up to June 10, 2008 submittal and June 23, 2008 phone call

Dear Mr. Ethington and Ms. Gaston,

As a follow-up to our submittal to the Colorado Department of Public Health and Environment (CDPHE) on June 10, 2008, and the phone conversation between Mr. Edgar Ethington (CDPHE), Dr. Donald Langmuir (Hydrochem Systems Corporation), and Elizabeth Sopher (Lowry Assumption, LLC (LAC)) on June 23, 2008, LAC is submitting this letter to clarify several issues as requested by Mr. Ethington.

As detailed in Dr. Langmuir's report (June 10, 2008) uranium mineral saturation indices were calculated for the landfill groundwater which demonstrate that elevated concentrations of uranium detected at the landfill are not the result of disposal of waste materials in the landfill. In the phone call on June 23, 2008, Mr. Ethington requested clarification on the following issues:

1. Does the geochemistry of the groundwater demonstrate that the upgradient and downgradient groundwaters have the same signature? And is there any significant trend in concentration along the flow path?
2. What does the aerial distribution of the saturation index data illustrate?

In response to these requests, LAC and Dr. Langmuir performed a further evaluation of data presented in the June 10, 2008 report, and provide the following responses.

1. The geochemistry data demonstrate that the up and down gradient groundwaters are part of the same system, as illustrated in the attached plots of major ions in the groundwater versus groundwater elevation under OU2, which trends from 5430 ft to 5390 ft above MSL from the south to the north side of OU2. Wells to the east and west of the landfill zone (OU2) were excluded from this analysis to focus specifically on groundwater flow in and under the waste materials. As shown in the attached charts, concentrations show no significant change with flow across the landfill which is represented by groundwater elevation. The  $r^2$  values for each data set are shown on the plots, and none is above 0.1 except sodium (0.35), all demonstrating poor correlation. The plots show that there is no statistically significant or systematic trend of concentrations of major ions in the direction of groundwater flow.
2. The saturation index data presented in the June 10, 2008 demonstrated that the system is generally strongly undersaturated with respect to uranium minerals both up and down gradient of the landfill zone. The only mineral that is within an order of magnitude of saturation is uraninite [ $\text{UO}_2$ ]. It is closest to saturation in groundwaters from the well cluster that includes the deep well LFPOC10 (in which SI (uraninite) = 0.8), and the shallow well LFPOC11 (in which SI (uraninite) = -0.7). These wells are in the center and deepest point in the paleochannel (see attached figure). Groundwater from the deeper well is more saturated with respect to uraninite than that from the shallow well. This is consistent with the uraninite being present in the Denver Formation near the base of the erosion channel (see Dr. Langmuir's report). If uraninite saturation was caused by the leaching of uranium waste materials disposed of in the landfill, then the greatest degree of saturation with uraninite (the highest SI value for uraninite) would be found in the shallowest well, which is the opposite of what is observed. As noted in Dr. Langmuir's report, uraninite in the Denver Formation is likely associated with lignite and other organic materials known to be present in that formation which have been exposed to leaching by alluvial groundwaters in the erosion channel.

With these responses, the outstanding questions asked by CDPHE with regard to the radiological evaluation have been addressed. LAC requests concurrence from the CDPHE that this issue has been satisfactorily addressed. LAC will continue to monitor gross alpha and gross beta values in the groundwater and perform detection monitoring as set forth in the CDPHE-approved post-closure monitoring program.

Sincerely,



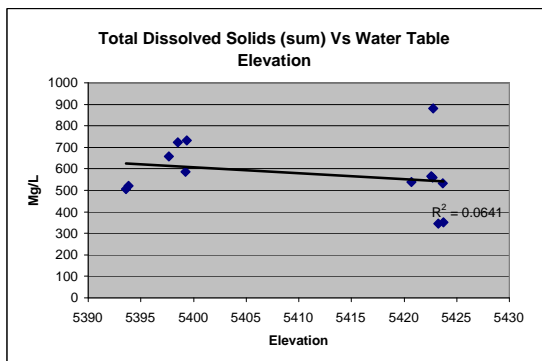
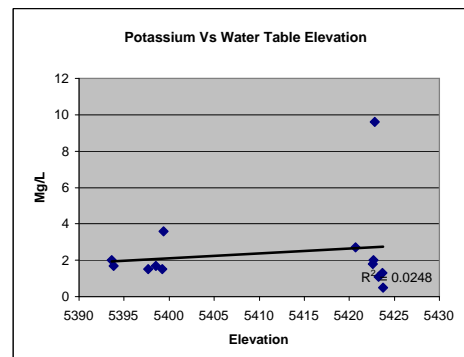
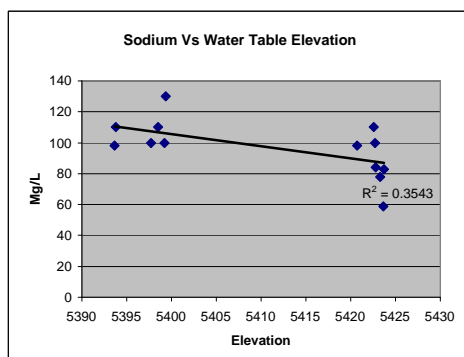
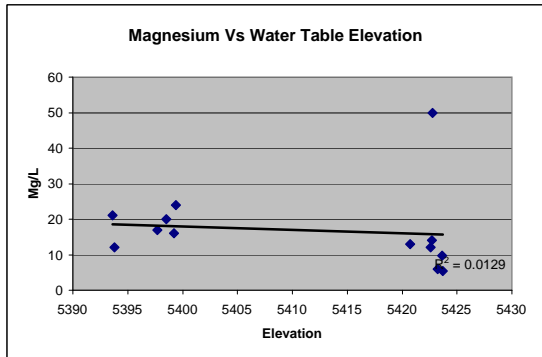
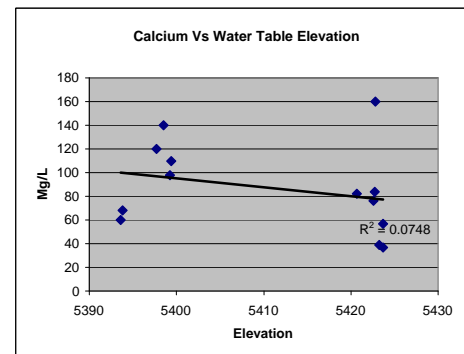
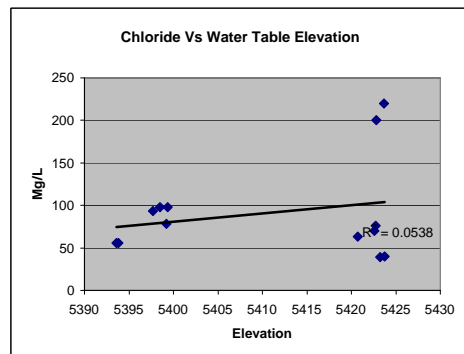
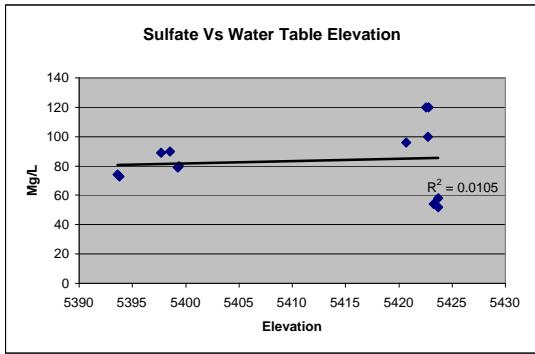
Elizabeth Sopher  
Senior Project Manager  
Attachments:  
Figure - Uraninite Saturation Indices  
Plots – Major ions vs. groundwater elevation

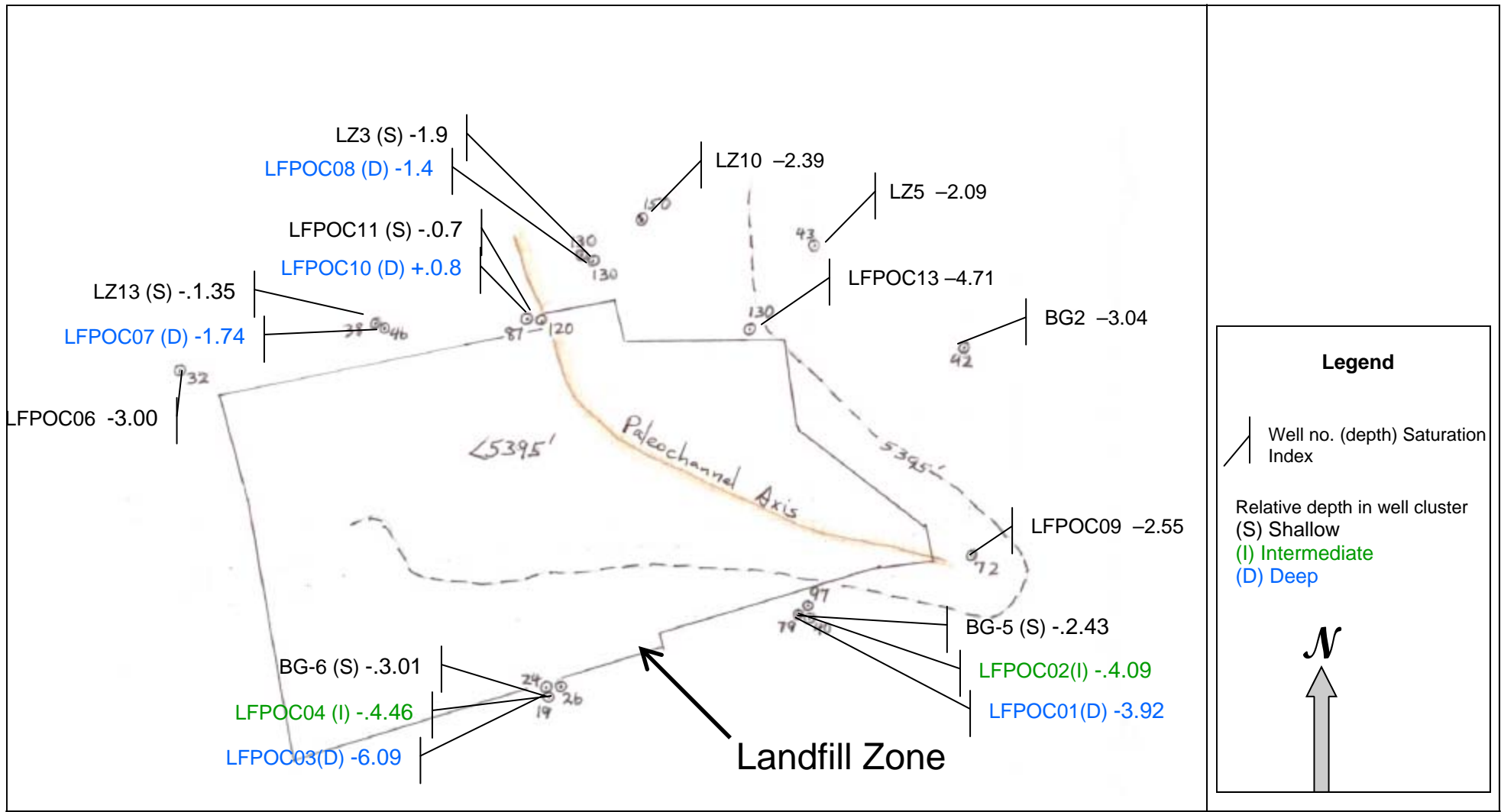
Distribution:  
Karen Hancock - Aurora  
David Erickson - CCOD  
Stanley Pehl - AFCEE (2)  
Paul Carroll - AFRPA/DC-Reese  
Pat Smith - EPA Region 8  
Monty Force - LRA  
Ann Wei - IRG  
Joe Aiken - LAC  
Lowry Project File

Major ion Data from D Langmuir

Water Elevation 02/05		T	as CaCO <sub>3</sub>	HCO <sub>3</sub>	SO <sub>4</sub>	Cl	Ca	Mg	Na	K	TDS sum	
ft (AMSL)	Well No	(oC)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	pH
5394	LZ13	6.2	320	195	74	56	60	21	98	2	506	7.24
5394	LFPOC07	7.9	330	201	73	56	68	12	110	1.7	522	7.59
5398	LFPOC08	10.8	390	238	89	93	120	17	100	1.5	658	6.8
5399	LZ3	10.1	430	262	90	98	140	20	110	1.7	722	7.12
5399	LFPOC10	12.8	350	214	79	78	98	16	100	1.5	586	6.97
5399	LFPOC11	12.6	470	287	80	98	110	24	130	3.6	732	7.55
5421	LFPOC09	14.9	300	183	96	63	82	13	98	2.7	538	7.27
5423	LFPOC01	14.3	290	177	120	70	76	12	110	1.8	567	7.47
5423	LFPOC02	14.6	300	183	100	76	84	14	100	2	559	7.58
5423	BG5	13.8	420	256	120	200	160	50	84	9.6	880	7.05
5423	LFPOC04	14.0	210	128	54	39	39	6	78	1.1	345	7.58
5424	BG6	14.3	220	134	52	220	57	9.7	59	1.3	533	7.46
5424	LFPOC03	13.8	210	128	58	40	37	5.4	83	0.5	352	8.51

Note - wells east and west of the landfill zone were excluded in order to evaluate flow path beneath waste materials





Source: LAC, 6/10/08, Attachment 1, Langmuir, D, Source of Uranium in Groundwaters under Operable Unit 2, Landfill Zone.

**Legend**

Well no. (depth) Saturation Index

Relative depth in well cluster  
 (S) Shallow  
 (I) Intermediate  
 (D) Deep

N

**Landfill Zone, Lowry AFB  
 Uraninite Saturation Indices  
 July 7, 2008  
 Follow-up to June 10 Letter  
 Lowry Assumption, LLC**