0051

ACT/007/004 #2

facsimile
TRANSMITTAL

to: Chris Hansen
fax #: (801) 561-1861
re: SAR Calculations
date: February 12, 1996
pages: 9, including this cover sheet.

1) The sodium-adsorption-ratio (SAR) is defined as $Na^{+}/(Ca^{++} + Mg^{++})/2)^{½}$, where Na^{+}, Ca^{++} and Mg^{++} refer to the concentrations of the designated soluble cations expressed in milliequivalents per liter. The exact procedure for SAR is found in USDA Handbook 60 (1953), pages 84, 88, 102 and 107. The saturation extract procedure is found in ASA Mono. No. 9, Part 2, (2nd edition), 1982, pages 167 through 170. As stated, the soil/water ratio is used because it is the lowest reproducible ratio for which enough extract for analysis can be readily removed from the soil and because it is often related in a predictable manner to field soil water contents. For the purpose of obtaining salinity related parameters (e.g., SAR) the saturation extract is the given procedure.

2) Analysis of the water soluble cations is found in ASA Mono. No. 9, Part 2, (2nd edition), 1982, pages 173 through 174. The water soluble ions are analyzed from the soil-water extract. As shown on page 174, the concentration of cations in the original sample using the saturation extract is calculated as meq/L in the book's procedure, not mg/Kg or meq/Kg. Our Soil Guidelines specifically mentions this section for the soluble Ca, Mg, and Na parameters and the Guidelines specifically request that the values be reported as meq/L.

3) As explained in the ASA Monograph and shown in the USDA Handbook (p. 107), saturation % is the value obtained from the saturation paste and is the resulting amount of water per unit of soil. Therefore, dividing the SP by 100 gives Xg-H_2O/g-soil. Using this value plus the equivalent weight for each of the cations, one can calculate from the given mg/Kg value the meq/L value as shown in the following:

Ca example

110 mg Ca / Kg soil	Kg / 1000g	g soil / 0.359gH2O	1g H2O / 1mL H2O	1000mL / Liter	g Ca / 1000mg Ca	mole Ca / 40.1 g Ca	2 eq Ca / mole Ca	1000 meq / eq	=	15.2 meq / Liter

From the desk of...

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Post-it® Fax Note 7671	Date 2-14	# of pages 4
To Bob Davidson	From Chris Hansen	
Co./Dept. UDOGM	Co. EARTHFAX	
Phone #	Phone # 561-1555	
Fax #	Fax # 561-1861	

ebruary 1996

A sampling and analysis plan was developed to evaluate the soils within the top four feet of the existing ground surface at the facilities area and in the 2 topsoil storage piles. Sampling and analyses addressed the existence of acid/toxic materials, the suitability of the soils as a growth medium, and the need for soil amendments. The samples were obtained as specified in the "Guidelines for Topsoil and Overburden Management" promulgated by the Division (1988). The samples were analyzed for the following parameters.

pH
Electrical Conductivity
Saturation Percentage
Particle Size Analysis
Soluble Ca, Mg, and Na
Sodium Adsorption Ratio
Selenium
Total Nitrogen
Nitrate
Boron
Maximum Acid Potential
Neutralization Potential
Organic Carbon
Exchangeable Sodium
Available Water Capacity
Rock Fragments

The analysis methods used by the laboratory to determine pH, electrical conductivity, soluble calcium, magnesium, and sodium, total nitrogen, and total organic carbon were not those recommended in Table 6 of the "Guidelines for Topsoil and Overburden Management". These parameters were determined using an EPA accepted laboratory method that allows for the use of soil sample extracts at soil/water ratios of 1:5. The Division guidelines recommend using approved ASA methods that require the use of saturated soil pastes. As described by Page (1982, page 168), though the paste extraction method is recommended for soil analyses used to determine soil characteristics and will provide more accurate results, the extracts of soil/water ratio of 1:5 can be used. Since the methods for analysis of the parameters listed in Table 6 of the guidelines are "recommended" but not required, the results of the analyses reported in the soil evaluation plan have been used to preliminarily determine the suitability

and quantity of the soils in Crandall Canyon to be used as substitute topsoil. The soil sampling program and the results of the sample analyses are included as Appendix 3.7S.

The area encompassed by Phase I reclamation is approximately 24.6 acres and includes the leach field, the leach field access road (A-1), and the facilities area (Exhibits 3.7-7A and 3.7-7B). It is anticipated that only the facilities area, approximately 18 acres, will require application of additional topsoil during reclamation. At a depth of 6 inches, this area would require approximately 14,520 CY of topsoil. Topsoil stockpiles No. 1 and No. 2 were surveyed in the spring of 1995 (Blackhawk Engineering), and the topsoil available from the 2 topsoil stockpiles is 7890 CY (see Exhibit 3.7-5C and Table 3.7-10). However, there is some concern that stockpile No. 1 contains noxious weed seed. Therefore, only the 6680 cubic yards from stockpile No. 2 was considered available for reclamation. Consequently, sufficient stored topsoil is not available to cover the facilities area.

The results of the soil sampling program indicate that the soils west of Shaft No. 2 and east of Shaft No. 1 (lower pad area) contain as much as 60% rock in the upper 12 to 18 inches of soil. At the time of the sampling program, vegetation appeared to be very sparse in the areas where excessive coarse fragments where found in the soils of the lower pad. Additionally, a soil sample (EF-1-3) was obtained from test pit EF-1 at a depth of 30" to 48" below ground surface, contained selenium at a concentration of 0.11 mg/kg. This concentration slightly exceeds the maximum allowable concentration of selenium, 0.10 mg/kg, as put forth in current UDOGM guidelines.

The current reclamation plan for this area of the facilities pad includes establishing the reclamation channel near the middle of the lower pad. To avoid using material as substitute topsoil that has excessive coarse rock fragments and elevated selenium concentrations as substitute topsoil, the applicant will sample soils in the lower pad area prior to reclamation construction activities. At least three samples will be obtained from the soils in the lower pad. The location of the samples will be chosen based on the vegetation cover and apparent coarseness of the soils. The worst case soils will be sampled and analyzed for the following parameters.

pH
Electrical Conductivity
Saturation Percentage
Particle Size Analysis
Soluble Ca, Mg, and Na
Sodium Adsorption Ratio

Selenium
Total Nitrogen
Nitrate
Boron
Maximum Acid Potential
Neutralization Potential
Organic Carbon
Exchangeable Sodium
Available Water Capacity
Rock Fragments

Soils found to be unacceptable to use as substitute topsoil will be used as backfill against cutslopes. In the unlikely event that none of the soils in the lower pad area are found to be acceptable substitute topsoil, the applicant will consider using the majority of the available topsoil from stockpile No. 2 to cover the area. The 6680 CY of topsoil in stockpile No. 2 would cover approximately 4 acres with 12 inches of topsoil.

The soils present west of Shaft No.2 and the LP tanks (middle and upper pads) appear to sustain moderate vegetative growth. The chemical and physical results of the soil study indicate that these soils could be considered, with the proper amendments, as substitute topsoil. However, the vegetation currently present in these areas may not be of sufficient quality and/or quantity to meet the standards of the reference area described in Section 3.7-5(6). This may be due to several factors including over compaction of the soils, poor vegetative diversity, excessive grazing by wildlife, or adverse climatic conditions.

To determine the reason(s) for the apparent less-than-satisfactory establishment of vegetation in the middle and upper pads, a vegetation field study will be conducted in the spring or summer of 1996. The study will include qualitatively assessing the vegetation in selected areas of the middle and upper pads. Based on the qualitative assessment, a vegetation sampling program will be implemented in the middle pad, upper pad, and appropriate reference area. Statistical comparisons of the vegetative cover in the middle and upper pads with the reference area will be made. If the results of the comparison indicate adequate cover productivity is present to meet reclamation standards, no further work will be done. If the results of the comparison demonstrate inadequate vegetation, field trials may be conducted to establish the proper reclamation techniques needed to be implemented in those areas where soil from the middle and upper pads is used as substitute topsoil.

To further determine the suitability of the soils in the middle and upper pad to be used as substitute topsoil, Cyprus will sample these soils prior to reclamation construction

Existing text

activities. A random number table will be used to select 10 sample points from a grid which shall be established over the middle and upper pads on 100 foot centers. The samples will be analyzed for the parameters listed in Table 6 of the Division's "Guidelines for Topsoil and Overburden Management" using the recommended analyses methods. The suitable topsoil identified in the upper, middle, and lower pad areas will be used to supplement the existing 6680 CY of topsoil and make-up for the shortfall of approximately 7840 CY of available topsoil for reclamation. Amendments to the soils based on the soils investigation, included as Appendix 3.7S, may be necessary. However, the soil samples obtained prior to reclamation construction will be analyzed and a final determination of the necessary amendments to be added will be made at that time.

New text

During reclamation construction, soil sampling will be performed at a rate of 1 sample for every 2.5 acres of soil (at a depth of 6 inches). The following parameters will be analyzed according to Division guidelines: pH, electrical conductivity, texture, total nitrogen, available phosphorus, and potassium. Soil amendments will be added to the topsoil based on the results of the final soil analyses.

If adequate volumes of suitable substitute topsoil can not be located during reclamation construction, the operator may use soils from the south side of the leach field area to supplement the soils from the topsoil stockpiles. Immediately prior to the start of Phase I reclamation, the soil in stockpile No. 1 will be evaluated for noxious weed seed content. If the soil is deemed acceptable, it will be used in the Phase I reclamation area. The mass-balance calculations for topsoil are summarized in Table 3.7-10.

Prior to spreading topsoil, all accessible regraded areas will be scarified to a depth of 18 to 24 inches by deep ripping or other appropriate methods. These efforts will reduce the potential for slippage of the topsoil, increase moisture retention, and promote root penetration. The seed bed will be prepared using the mechanical treatments described in Section 3.7-5(4)(6). Seeding will commence immediately after seed bed preparation to minimize the potential for erosion damage. If seeding is expected to be delayed more than one month from the completion of final grading, then mulch will be applied at the rate of 2 tons per acre to protect the soil from wind and water erosion.

The main access road (P-1) will be reclaimed during Phase II reclamation activities. As indicated in Section 3.7-5(3)(1), topsoil used for reclamation of the road will be obtained from the outslopes and base of the road. The available topsoil will be sampled and analyzed at the

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TRANSACTION REPORT

FEB-14-96 WED 02:41 PM

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DATE	START	RECEIVER	TX TIME	PAGES	TYPE	NOTE	M#	DP
FEB-14	02:39 PM	5611861	1'37"	2	SEND	(M) OK	153	
		TOTAL	1M 37S	PAGES:	2			

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date: February 14, 1996
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FYI - included with this fax is a table containing the SAR values for the 1:5 soil:water extracts and calculated SAR values extrapolated for the saturation paste extracts. Note that all the calculated SAR values are withing DOGM guidelines. (I assumed 35% saturation for the first four samples.)

Comments on soils sections (your 12:19pm, 2/14/96 fax). All comments are in relation to using the 1:5 soil:water extract data for pH, EC, soluble Ca, Mg, and Na, and SAR instead of DOGM's approved soil guideline methods using saturated paste extracts as explained by your clarifier supplied on pp3.7-47:

- **pp 3.7-48, last ¶, lower pad area text ...** - Was the lower pad area included in the soil sampling data found in appendix 3.7s using the 1:5 extracts? If so, then we need to indicate the same 1:5 clarifier.
- **pp 3.7-49, last ¶, middle and upper pad ...** - Are the middle and upper pad areas the same as the "existing ground surface at the facilities area" ? If they are, then I feel that additional clarification is needed for sampling within the top 4' and for using DOGM's approved/recommended soil paste extract procedure. Do we need to also mention here that the two topsoil storage piles will be re-sampled since

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- **pp 3.7-50, first ¶, line 4, "... using the recommended analyses methods ..."** - Could we expand the new text to say "... using the recommended analyses methods and saturated soil extract procedure for pH, EC, soluble Ca, Mg, and Na, and SAR."
- **Appendix 3.7s, pp 9, last ¶, Analytical Results section** - Need to add the 1:5 clarifier.
- **Appendix 3.7s, pp 10, first ¶, line 2, and pp10, second ¶, line 4. SAR values** - The SAR values need to be corrected with the 1:5 soil:water extract SAR values.
- **Table 2, PHSIO-CHEMICAL PROPERTIES OF CRANDALL CANYON OVERBURDEN AND TOPSOIL. Soluble Ca, Mg, Na meq/L values and SAR values.** - Add corrected data for soluble Ca, Mg, and Na in meq/L and corrected SAR values. Include footnote to Table 2 to indicate that EC, pH, soluble Ca, Mg, and Na, and SAR are taken from 1:5 soil:water extract and reference EPA procedure.

From the desk of...

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1:5 soil:water extract as received								extrapolated - saturation paste extract calculated				
Ca mg/Kg	Mg mg/Kg	Na mg/Kg	wt % (H2O/soil)	Ca meq/L	Mg meq/L	Na meq/L	SAR	wt % (H2O/soil)	Ca meq/L	Mg meq/L	Na meq/L	SAR
317	45.10	6.50	500.00	3.16	0.74	0.06	**0.04**	35.00	45.20	10.61	0.81	**0.15**
79	21.00	4.80	500.00	0.79	0.35	0.04	**0.06**	35.00	11.26	4.94	0.60	**0.21**
633	86.40	5.90	500.00	6.32	1.42	0.05	**0.03**	35.00	90.25	20.32	0.73	**0.10**
97.1	17.30	2.80	500.00	0.97	0.28	0.02	**0.03**	35.00	13.84	4.07	0.35	**0.12**
110	29.00	56.90	500.00	1.10	0.48	0.49	**0.56**	35.90	15.29	6.65	6.89	**2.08**
126	31.00	85.60	500.00	1.26	0.51	0.74	**0.79**	32.60	19.29	7.83	11.42	**3.10**
236	38.00	97.40	500.00	2.36	0.63	0.85	**0.69**	36.20	32.53	8.64	11.70	**2.58**
271	48.00	2.20	500.00	2.70	0.79	0.02	**0.01**	33.10	40.85	11.94	0.29	**0.06**
112	14.00	8.20	500.00	1.12	0.23	0.07	**0.09**	33.00	16.94	3.49	1.08	**0.34**
168	20.00	15.60	500.00	1.68	0.33	0.14	**0.14**	31.20	26.87	5.28	2.17	**0.54**
410	39.00	19.80	500.00	4.09	0.64	0.17	**0.11**	31.10	65.78	10.32	2.77	**0.45**
65	14.00	20.40	500.00	0.65	0.23	0.18	**0.27**	30.50	10.63	3.78	2.91	**1.0[redacted]**
444	46.00	33.40	500.00	4.43	0.76	0.29	**0.18**	34.10	64.97	11.10	4.26	**0.69**
114	22.00	1.50	500.00	1.14	0.36	0.01	**0.02**	30.60	18.59	5.92	0.21	**0.06**
343	50.00	4.70	500.00	3.42	0.82	0.04	**0.03**	28.10	60.91	14.64	0.73	**0.12**
321	55.00	4.60	500.00	3.20	0.91	0.04	**0.03**	30.10	53.22	15.04	0.66	**0.11**
106	32.00	7.80	500.00	1.06	0.53	0.07	**0.08**	24.90	21.24	10.58	1.36	**0.34**
93	30.00	6.00	500.00	0.93	0.49	0.05	**0.06**	30.30	15.32	8.15	0.86	**0.25**
65	12.00	0.80	500.00	0.65	0.20	0.01	**0.01**	29.50	10.99	3.35	0.12	**0.04**
62	11.00	1.30	500.00	0.62	0.18	0.01	**0.02**	28.30	10.93	3.20	0.20	**0.08**
114	29.00	3.70	500.00	1.14	0.48	0.03	**0.04**	34.50	16.49	6.92	0.47	**0.14**
90	21.00	1.90	500.00	0.90	0.35	0.02	**0.02**	30.30	14.82	5.70	0.27	**0.09**
99	26.00	1.90	500.00	0.99	0.43	0.02	**0.02**	28.50	17.33	7.51	0.29	**0.08**
91	17.00	0.80	500.00	0.91	0.28	0.01	**0.01**	27.90	16.28	5.01	0.12	**0.04**
300	70.00	6.70	500.00	2.99	1.15	0.06	**0.04**	32.80	45.64	17.56	0.89	**0.16**
68	12.00	3.20	500.00	0.68	0.20	0.03	**0.04**	23.20	14.63	4.26	0.60	**0.20**
201	45.00	7.10	500.00	2.01	0.74	0.06	**0.05**	25.90	38.73	14.30	1.19	**0.23**
81	22.00	4.80	500.00	0.81	0.36	0.04	**0.05**	26.70	15.14	6.78	0.78	**0.24**
62	10.00	1.70	500.00	0.62	0.16	0.01	**0.02**	33.50	9.24	2.46	0.22	**0.0[redacted]**
77	9.00	11.80	500.00	0.77	0.15	0.10	**0.15**	34.00	11.30	2.18	1.51	**0.5[redacted]**
74	11.00	9.50	500.00	0.74	0.18	0.08	**0.12**	33.40	11.06	2.71	1.24	**0.47**
111	15.00	8.90	500.00	1.11	0.25	0.08	**0.09**	31.00	17.87	3.98	1.25	**0.38**
138	20.00	13.30	500.00	1.38	0.33	0.12	**0.13**	34.00	20.25	4.84	1.70	**0.48**
167	29.00	13.60	500.00	1.67	0.48	0.12	**0.11**	30.90	26.97	7.72	1.91	**0.46**