

---

---

MEMORANDUM

---

---

TO: JAY WINFIELD, RANGELAND MANAGEMENT SPECIALIST  
FROM: SUE FARLEY, SOIL SCIENTIST  
SUBJECT: PRELIMINARY REPORT ON SOIL CONDITION ASSESSMENT FOR RANGELANDS IN  
CLANCY-UNIONVILLE PROJECT AREA  
DATE: 11/14/2003  
CC: SHELLEY DOUTHETT AND VICKI MACLEAN

Helena NF  
Helena Ranger District

This memo is a preliminary report of soil quality monitoring conducted on primary rangelands within Clancy-Unionville project area allotments. This monitoring was completed during summer 2003 by four field crewmembers and myself. Soil monitoring focused on areas where "sensitive landtypes" (i.e. granitic soils or wet soils) overlap with primary rangelands.

Data from this monitoring serves as baseline information to document current soil conditions. Soil conditions are evaluated in this memo by comparing monitoring data for soil bulk density and percent ground cover to threshold values identified in scientific literature. Data for soil infiltration rate are evaluated using professional judgment, since no baseline values have been found for comparison in the scientific literature. Field data for plant root depth and abundance still needs to be compiled, and soil organic matter samples still need to be processed in the laboratory. Therefore, plant root depth and abundance, and soil organic matter content will not be discussed in this memo.

Thresholds for detrimental compaction are documented in the scientific literature, and are based on soil bulk density values that are growth-limiting for plants (Daddow and Warrington 1983). Bulk density values that limit plant growth vary, depending on soil texture. For loam or clay loam texture, soil bulk densities greater than 1.45-1.55 g/cc are growth limiting. For sandy loam texture, soil bulk densities greater than 1.55-1.65 g/cc are growth limiting. For loamy sand texture, soil bulk densities greater than 1.75 g/cc are growth limiting.

Soil bulk density data collected for rangelands show 19 of 21 sites sampled do not have growth-limiting values. Put another way, soil bulk density values are within the range for healthy plant growth on 19 of 21 sites sampled. For the other two sites, one site exceeds the threshold and one site is right at the threshold for growth-limiting values:

1. Sample plot number 03SF008 had average subsoil bulk density value of 1.60 g/cc, with a loam texture and platy structure. This site had evidence of past human occupation, along with placer mining and nearby timber harvest. In my professional judgment, compaction at this site is due to these other activities and does not result entirely from livestock grazing.
2. Sample plot number 03SF021 had average topsoil bulk density value of 1.55 g/cc, with a sandy loam texture. This value is right at the threshold where soil bulk density may become growth limiting for plants.

When evaluating ground cover data on rangelands, "The healthy end of the continuum consists of an unfragmented distribution of plants and litter with few bare areas" (National Research Council 1994, page 120). Researchers in Alberta documented when bare ground exceeds 15 percent on fescue grasslands a threshold is reached where adverse soil impacts can occur, such as reduced infiltration and increased runoff with potential for accelerated erosion (Naeth et al. 1991).

Soil cover data shows 16 of 20 sites had less than 15 percent bare ground. It is my professional judgment that these sites represent "the healthy end of the continuum" for primary rangelands.

The remaining four sites had bare ground ranging from 16 to 25 percent:

1. Sample plot number 03SF020 had the highest amount of bare ground, at 25 percent. This site had an average infiltration rate of 9,013 ml/32.5 minutes. No evidence of erosion was noted at this site. This infiltration rate does not indicate adverse impacts have occurred at this site.
2. Sample plot number 03SF011 had 19 percent bare ground. This site had an average infiltration rate of 13,257 ml/32.5 minutes. No evidence of erosion was noted at this site. This infiltration rate does not indicate adverse impacts have occurred at this site.
3. Sample plot number 03SF005 had 17 percent bare ground. This site had an average infiltration rate of 6,620 ml/32.5 minutes. The site was located on a relatively steep slope that showed evidence of previous accelerated erosion (i.e. plant pedestalling), indicating there have been past adverse effects to soils.
4. Sample plot number 03SF014 had 16 percent bare ground. This site had an average infiltration rate of 18,534 ml/32.5 minutes. No evidence of erosion was noted at this site. This infiltration rate does not indicate adverse impacts have occurred at this site.

Average soil infiltration rates ranged from 3,520 to 62,637 ml/32.5 minutes, and greater at one site (i.e. sample plot number 03SF010). For comparison, average infiltration rates for samples obtained on compacted native road surfaces in the Clancy-Unionville project area ranged from zero to 4,900 ml/32.5 minutes. (USDA FS 2002)

The lowest infiltration rate occurred on sample plot number 03SF008, where soil compaction was documented with soil bulk density data. Detrimental effects to soils have impaired water absorption capacity at site 03SF008. As mentioned previously, these detrimental effects likely result from past human occupation, placer mining, and nearby timber harvest.

Two other rangeland sites have infiltration rates comparable to values obtained on compacted native road surfaces in the area: sample plot numbers 03SF018 and 03SF019. Both these sites have adequate ground cover and bulk density values that do not limit plant growth. So, it is unclear if infiltration rates these two sites have been adversely affected by grazing.

In summary, soil data indicates soil quality is adequate to support healthy rangelands at 14 of 21 sites sampled. For the remaining 7 sites, soil quality may not be at levels desired for maintaining healthy rangelands:

- For two sites, soil quality has been impaired: sample plot number 03SF008 has been impacted by past occupation, mining and timber harvest; sample plot number 03SF005 has been impaired by past erosion, where the cause is not certain but may be grazing-related.
- On five sites, soil quality may be either slightly impaired or near the threshold for adverse impacts: sample plot numbers 03SF020, 03SF011 and 03SF014 had bare ground in excess of 15 percent; sample plot numbers 03SF018 and 03SF019 had infiltration rates comparable to values obtained on compacted native road surfaces in the area.

/s/ Susan R. Farley  
Susan R. Farley  
Soil Scientist

GPS Coordinates for Sample Site Locations

Rangeland Soil Quality Assessment

Clancy-Unionville Project Area

Field Samples Collected by Sue Farley, Adrian Johnson, Matt Johnson, Evette Allison & Ron Rice

Data Compiled by Sue Farley

Oct-03 10/2003

PLOT NO.	EASTING	NORTHING
03SF001	414190	5151724
03SF002	415880	5151013
03SF003	414650	5151462
03SF004	414650	5151462
03SF005	414288	5151277
03SF006	408311	5149486
03SF007	414408	5149500
03SF008	415378	5149933
03SF009	408720	5147355
03SF010	408495	5147202
03SF011	410681	5145450
03SF012	410522	5146495
03SF013	409499	5145014
03SF014		
03SF015		
03SF016	409655	5141317
03SF017	409308	5141479
03SF018	409294	5137798
03SF019		
03SF020	408799	5139776
03SF021	414761	5150608

CHECK W/ LIZ

Ground Cover Data  
 Rangeland Soil Quality Assessment  
 Clancy-Unionville Project Area  
 Field Samples Collected by Sue Farley, Adrian Johnson, Matt Johnson, Evette Allison & Ron Rice  
 Data Compiled by Sue Farley  
 Oct-03

PLOT NO.	PLANT LITTER	LIVE PLANT	WOODY MATERIAL	MOSS / LICHEN	ROCK FRAGMENTS	BARE GROUND	CHECK 100%
03SF003	No Data	No Data	No Data	0.0%	No Data	No Data	No Data
03SF020	62.7%	7.3%	0.9%	0.0%	3.6%	25.5%	100.0%
03SF011	32.7%	48.2%	0.0%	0.0%	0.0%	19.1%	100.0%
03SF005	29.1%	50.9%	0.0%	2.7%	0.0%	17.3%	100.0%
03SF014	51.8%	3.6%	0.0%	27.3%	0.9%	16.4%	100.0%
03SF016	53.0%	27.0%	0.0%	1.0%	6.0%	13.0%	100.0%
03SF013	66.0%	22.0%	0.0%	0.0%	0.0%	12.0%	100.0%
03SF017	49.0%	41.0%	0.0%	0.0%	0.0%	10.0%	100.0%
03SF007	67.3%	22.7%	0.0%	0.9%	0.0%	9.1%	100.0%
03SF019	54.5%	37.3%	0.0%	0.0%	0.0%	8.2%	100.0%
03SF021	77.3%	14.5%	0.0%	0.0%	0.0%	8.2%	100.0%
03SF009	41.8%	50.9%	0.0%	0.0%	0.0%	7.3%	100.0%
03SF004	30.9%	65.5%	0.0%	0.0%	0.0%	3.6%	100.0%
03SF015	88.2%	8.2%	0.0%	2.7%	0.0%	0.9%	100.0%
03SF001	51.8%	48.2%	0.0%	0.0%	0.0%	0.0%	100.0%
03SF002	13.6%	81.8%	1.8%	0.0%	2.7%	0.0%	100.0%
03SF006	12.7%	87.3%	0.0%	0.0%	0.0%	0.0%	100.0%
03SF008	47.3%	51.8%	0.0%	0.9%	0.0%	0.0%	100.0%
03SF010	38.2%	61.8%	0.0%	0.0%	0.0%	0.0%	100.0%
03SF012	62.0%	32.0%	1.0%	5.0%	0.0%	0.0%	100.0%
03SF018	32.7%	65.5%	0.0%	1.8%	0.0%	0.0%	100.0%

Soil Infiltration Rate Data

Rangeland Soil Quality Assessment

Clancy-Unionville Project Area

Field Samples Collected by Sue Farley, Adrian Johnson, Matt Johnson, Evette Allison & Ron Rice

Data Compiled by Sue Farley

Oct-03

PLOT NO.	LANDFORM	INFILTRATION TEST No. 1 (ml./32.5 min.)	INFILTRATION TEST No. 2 (ml./32.5 min.)	INFILTRATION TEST No. 3 (ml./32.5 min.)	AVERAGE INFILTRATION (ml./32.5 min.)	INFILTRATION STD. DEVIATION (ml./32.5 min.)
03SF008	FOOT SLOPE	3,140	3,700	3,720	3,520	329
03SF018		2,880	3,470	4,380	3,577	756
03SF019		3,720	5,060	3,880	4,220	732
03SF009	ROLLING UPLANDS	5,020	4,090	8,180	5,763	2,144
03SF005	UPPER SLOPE	3,860	6,120	9,880	6,620	3,041
03SF013	RIDGETOP	9,100	6,180	4,700	6,660	2,239
03SF021		10,220	7,160	2,900	6,760	3,676
03SF004	VALLEY BOTTOM	5,470	8,020	7,380	6,957	1,327
03SF020		7,020	15,880	4,140	9,013	6,119
03SF017		19,000	5,700	5,180	9,960	7,833
03SF011	UPPER SLOPE	11,520	14,680	13,570	13,257	1,603
03SF001	RIDGETOP	9,240	6,840	25,600	13,893	10,209
03SF015		14,660	15,000	13,860	14,507	585
03SF012	WET ASPEN GLADE	14,800	12,000	24,940	17,247	6,808
03SF014		19,680	17,240	18,710	18,543	1,229
03SF006	WET MEADOW	4,820	22,180	35,000	20,667	15,147
03SF016		22,540	19,180	22,200	21,307	1,850
03SF007	STREAM TERRACE	62,580	67,720	57,610	62,637	5,055
03SF002	VALLEY BOTTOM	12,300	No Test	No Test	NA	NA
03SF003	VALLEY BOTTOM	No Test	No Test	No Test	NA	NA
03SF010	WET ASPEN GLADE	65,220	>82,000	>66,000	NA	NA

Soil Bulk Density Data  
 Rangeland Soil Quality Assessment  
 Clancy-Unionville Project Area  
 Field Samples Collected by Sue Farley, Adrian Johnson, Matt Johnson, Evette Allison & Ron Rice  
 Data Compiled by Sue Farley  
 Oct-03

PLOT NO.	SOIL HORIZON SAMPLED	AVERAGE BULK DENSITY (grams/cubic cm)	BULK DENSITY STD. DEVIATION (grams/cubic cm)
03SF008	SUBSOIL (PLATY)	1.60	0.09
03SF016	TOPSOIL	1.59	0.05
03SF021	TOPSOIL	1.55	0.04
03SF014	TOPSOIL	1.45	0.10
03SF017	TOPSOIL	1.39	0.07
03SF011	TOPSOIL	1.38	0.06
03SF015	TOPSOIL	1.38	0.05
03SF009	TOPSOIL	1.34	0.02
03SF005	TOPSOIL	1.28	0.10
03SF019	TOPSOIL	1.28	0.05
03SF001	TOPSOIL	1.21	0.11
03SF020	TOPSOIL	1.19	0.15
03SF013	TOPSOIL	1.18	0.15
03SF004	TOPSOIL	1.06	0.07
03SF008	TOPSOIL	1.03	0.17
03SF012	TOPSOIL	1.02	0.22
03SF002	TOPSOIL	1.00	0.20
03SF018	TOPSOIL	0.94	0.08
03SF003	TOPSOIL	0.80	0.18
03SF006	TOPSOIL	0.77	0.19
03SF010	TOPSOIL	0.75	0.02
03SF007	TOPSOIL	0.74	0.09

Soil Bulk Density

Rangeland Soil Quality Assessment

Clancy-Unionville Project Area

Field Samples Collected by Sue Farley, Adrian Johnson, Matt Johnson, Evette Allison and Ron Rice

Lab Measurements Completed by Adrian Johnson, Matt Johnson, Evette Allison and Ron Rice

Data Calculations Compiled by Sue Farley

Jul-03

Plot I.D.	Sample I.D.	Horizon Sampled	soil weight without bag	Soil Volume (cubic centimeters)	Soil Bulk Density (grams/cc)	Average Bulk Density	Bulk Density Std. Dev.
03SF001	1 of 3	Topsoil	348.0	318.1	1.09		
03SF001	2 of 3	Topsoil	415.1	318.1	1.30		
03SF001	3 of 3	Topsoil	388.8	318.1	1.22	1.21	0.11
03SF002	1 of 3	Topsoil	350.9	318.1	1.10		
03SF002	2 of 3	Topsoil	337.9	318.1	1.06		
03SF002	3 of 3	Topsoil	240.7	318.1	0.76	1.0	0.2
03SF003	1 of 3	Topsoil	220.2	318.1	0.69		
03SF003	2 of 3	Topsoil	318.4	318.1	1.00		
03SF003	3 of 3	Topsoil	223.5	318.1	0.70	0.80	0.18
03SF004	1 of 3	Topsoil	361.1	318.1	1.14		
03SF004	2 of 3	Topsoil	325.9	318.1	1.02		
03SF004	3 of 3	Topsoil	320.9	318.1	1.01	1.06	0.07
03SF005	1 of 3	Topsoil	392.0	318.1	1.23		
03SF005	2 of 3	Topsoil	384.5	318.1	1.21		
03SF005	3 of 3	Topsoil	440.8	318.1	1.39	1.28	0.10
03SF006	1 of 3	Topsoil	314.3	318.1	0.99		
03SF006	2 of 3	Topsoil	209.9	318.1	0.66		
03SF006	3 of 3	Topsoil	214.8	318.1	0.68	0.77	0.19
03SF007	1 of 3	Topsoil	245.9	318.1	0.77		
03SF007	2 of 3	Topsoil	257.1	318.1	0.81		
03SF007	3 of 3	Topsoil	201.5	318.1	0.63	0.74	0.09
03SF008	1 of 5	Topsoil	326.4	318.1	1.03		
03SF008	2a of 5	Topsoil	380.4	318.1	1.20		
03SF008	3a of 5	Topsoil	273.1	318.1	0.86	1.03	0.17
03SF008	2b of 5	Subsoil (platy)	530.2	318.1	1.67		
03SF008	3b of 5	Subsoil (platy)	490.7	318.1	1.54	1.60	0.09
03SF009	1 of 3	Topsoil	458.3	318.1	1.44		
03SF009	2 of 3	Topsoil	399.4	318.1	1.26		
03SF009	3 of 3	Topsoil	419.2	318.1	1.32	1.34	0.02
03SF0010	1 of 3	Topsoil	233.4	318.1	0.73		
03SF0010	2 of 3	Topsoil	242.0	318.1	0.76		
03SF0010	3 of 3	Topsoil	243.1	318.1	0.76	0.75	0.02
03SF0011	1 of 3	Topsoil	454.3	318.1	1.43		
03SF0011	2 of 3	Topsoil	446.6	318.1	1.40		
03SF0011	3 of 3	Topsoil	416.1	318.1	1.31	1.38	0.06
03SF0012	1 of 3	Topsoil	248.6	318.1	0.78		
03SF0012	2 of 3	Topsoil	384.7	318.1	1.21		

Soil Bulk Density

Rangeland Soil Quality Assessment

Clancy-Unionville Project Area

Field Samples Collected by Sue Farley, Adrian Johnson, Matt Johnson, Evette Allison and Ron Rice

Lab Measurements Completed by Adrian Johnson, Matt Johnson, Evette Allison and Ron Rice

Data Calculations Compiled by Sue Farley

Jul-03

Plot I.D.	Sample I.D.	Horizon Sampled	soil weight without bag	Soil Volume (cubic centimeters)	Soil Bulk Density (grams/cc)	Average Bulk Density	Bulk Density Std. Dev.
03SF0012	3 of 3	Topsoil	343.5	318.1	1.08	1.02	0.22
03SF0013	1 of 3	Topsoil	321.1	318.1	1.01		
03SF0013	2 of 3	Topsoil	399.2	318.1	1.25		
03SF0013	3 of 3	Topsoil	404.2	318.1	1.27	1.18	0.15
03SF0014	1 of 3	Topsoil	490.9	318.1	1.54		
03SF0014	2 of 3	Topsoil	463.2	318.1	1.46		
03SF0014	3 of 3	Topsoil	427.7	318.1	1.34	1.45	0.10
03SF0015	1 of 3	Topsoil	421.4	318.1	1.32		
03SF0015	2 of 3	Topsoil	455.2	318.1	1.43		
03SF0015	3 of 3	Topsoil	442.8	318.1	1.39	1.38	0.05
03SF0016	1 of 3	Topsoil	501.1	318.1	1.58		
03SF0016	2 of 3	Topsoil	489.3	318.1	1.54		
03SF0016	3 of 3	Topsoil	522.5	318.1	1.64	1.59	0.05
03SF0017	1 of 3	Topsoil	424.7	318.1	1.34		
03SF0017	2 of 3	Topsoil	435.3	318.1	1.37		
03SF0017	3 of 3	Topsoil	467.9	318.1	1.47	1.39	0.07
03SF0018	1 of 3	Topsoil	284.0	318.1	0.89		
03SF0018	2 of 3	Topsoil	286.3	318.1	0.90		
03SF0018	3 of 3	Topsoil	327.9	318.1	1.03	0.94	0.08
03SF0019	1 of 3	Topsoil	423.3	318.1	1.33		
03SF0019	2 of 3	Topsoil	391.5	318.1	1.23		
03SF0019	3 of 3	Topsoil	409.5	318.1	1.29	1.28	0.05
03SF0020	1 of 3	Topsoil	391.0	318.1	1.23		
03SF0020	2 of 3	Topsoil	327.5	318.1	1.03		
03SF0020	3 of 3	Topsoil	417.6	318.1	1.31	1.19	0.15
03SF0021	1 of 3	Topsoil	502.7	318.1	1.58		
03SF0021	2 of 3	Topsoil	479.2	318.1	1.51		
03SF0021	3 of 3	Topsoil	501.1	318.1	1.58	1.55	0.04



# Infiltration vs. Bulk Density

