October 13, 1994

Mr. Thomas Bloom, HSRM-6J
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77 West Jackson Boulevard
Chicago, IL 60604-3590

Mr. David Douglas
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Groundwater and Solid Waste Division
520 Lafayette Road
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Re: Clean-up goals for Soils Operable Unit #2, NIROP Fridley, Minnesota

Dear Tom and David:

As agreed to following the TRC meeting held on September 8, 1994, RMT has been evaluating both the risk-based soil cleanup goals and soil clean-up goals developed using the MPCA Soil Leaching Model. As discussed during the TRC meeting, the intent of the soil clean-up goals is to prevent further degradation of the groundwater below OU#2 soils due to soil leaching, and to protect against unacceptable health risks to humans under future residential land use assumptions.

A discussion of the MPCA Soil Leaching Model Results is presented in Attachment 1. Input parameters to the leaching model that differed from MPCA's initial analysis for NIROP included the biodegradation half-life and the contaminant center of mass. Results of RMT's analysis indicate VOCs in the unsaturated soil are not a continuing significant source of contaminants to the groundwater. The dissolved concentrations of trichloroethene (TCE) and other constitutes of concern in groundwater are more likely a result of desorption of these compounds from soils below the water table and possibly from DNAPLs and/or unsaturated soils beneath the NIROP facility (O.U. #3).

A discussion of the Risk Assessment Clean-up Goal calculation is presented in Attachment 2. The risk assessment assumes future land use of the site is residential, and considers risks due to exposure from soil ingestion, dermal contact, soil inhalation, and soil pore gas inhalation. Target clean-up goals were back calculated from the conservative worst-case scenario of future residential land-use. Exposure pathways included soil ingestion, dermal contact, particulate inhalation, and soil pore gas inhalation. The risk assumptions used in the RI were applied to the back-calculations. In addition, the same data evaluation criteria utilized in the RI was applied to the metals and PAH concentrations as detailed in Attachment 2. There is a consistent lack of site related metals and PAHs at levels which exceed typical urban concentrations. Therefore, no cleanup goals have been proposed for these constituents and risk-based target levels were evaluated only for the site-specific VOC impacts.

Specific risk-based goals were calculated utilizing threshold target risks of 1×10^{-5} for carcinogens and a hazard index of 1. Target compositional soil concentrations were calculated for the ingestion, inhalation of particulates, and dermal contact pathways. Only one sample was found to exceed these criteria. Therefore compositional goals were not considered necessary at the site. Pore gas target goals were calculated based upon previously agreed to risk factors (see Attachment 2). The rates of

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mass transfer required to support these risk assumptions (i.e., rate of diffusion through basement walls, ground surface loses, etc.) were not included in the calculation. Based upon this conservative approach, the pore gas target cleanup goal were less than pore gas concentrations measured throughout Area A, and portions of Area D and E. Areas B and F contained essentially no pore gas concentrations above the target cleanup goals. Therefore, inhalation of soil pore gas containing VOCs poses the highest potential health risk in the future residential use scenario. The cleanup goals for the soil pore gas pathway were calculated to be 0.3 ppm trichloroethene (TCE) and 0.7 ppm tetrachloroethene (PCE) as pore gas. These values should not be confused with compositional soil concentrations. The pore gas concentration effects an analysis of the volatile constituents in the unsaturated zone and is a more accurate and direct measure of potential impacts on human receptors.

Comparing the results of the MPCA Soil Leaching Model with the VOC concentrations measured during the RI, indicates that none of the soils at NIROP contain concentrations of contaminants above levels that affect groundwater quality. However, since soil pore gas in Areas A, D, and E do contain TCE and PCE pore gas concentrations above levels that pose cancer risks greater than 10^{-5}, RMT is proposing, on behalf of the NAVY, that USEPA and MPCA consider target cleanup goals based on TCE and PCE in soil pore gas.

Protecting receptors against exposure to soil gas is consistent with application of soil vapor extraction as the presumptive remedy in the Fridley, NIROP site. This remedy directly controls the migration of soil vapor and controls potential heath impacts. Of course, it is understood that operational constraints may limit or delay accomplishing these target cleanup goals. Typically, SVE cleanup criteria are based upon a performance based standard identified as the best available control technology. The ability of SVE to effectively remove VOCs from the unsaturated soils and the associated operating constraints will be addressed more completely in the full feasibility study (FS) report.

To maintain the accelerated FS schedule we would appreciate review, discussion, and subsequent approval of these clean-up goals no later than October 20, 1994. Please call me at your earliest convenience to establish a date for a conference call when we can further discuss the information presented in this letter and the associated attachments. Thank you for you timely consideration. We look forward to discussing this approach in more detail with you and your staff members.

Sincerely,

Mark Briggs
Senior Project Engineer.

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Enclosure

ATTACHMENT 1

MPCA Soil Leaching Model Results

The MPCA soil leaching model was used to evaluate soil cleanup goals for the NIROP. Eight constituents of concern were identified by Mark Ferrey of the MPCA, as potential sources to the groundwater, in a letter dated June 23, 1994. These constituents include trichloroethene (TCE), tetrachloroethene (PCE), 1,2-dichloroethene (1,2-DCE), 1,1-dichloroethene (1,1-DCE), 1,1,1-trichloroethane (1,1,1-TCA), 1,1-dichloroethane (1,1-DCA), xylenes, and ethylbenzene. In the letter, Mark Ferrey discussed parameter values that he used in applying the MPCA soil leaching model to the NIROP site.

In evaluating the model, we have used the same model parameter values used previously by Mark Ferrey, except for biodegradation half-life values, and the distance from the center of contaminant mass to the water table. As discussed in the September 8, 1994 TRC meeting, there are few studies of biodegradation of the constituents of concern in soil, and published half-life values for biodegradation vary significantly (see Table 1). In order to choose a reasonable value for the model, several sources of data were evaluated. One of the most recent and thorough compilations of biodegradation information is the Handbook of Environmental Degradation Rates, by Howard et al. (1991). In general, the range of half-life values reported in Howard et al. (1991) were longer (more conservative) than those in another significant source, The Soil Chemistry of Hazardous Material (Dragun, 1988). Therefore, the midpoint in the range of values cited in Howard et al. (1991) for each constituent was used as a reasonable estimate of each constituent's biodegradation half life. The resulting half life values were lower than previously used by the MPCA. Half-life values for biodegradation used in the model are presented on Table 1.

The distance from the center of mass to the water table was also revised, to more accurately consider the large amount of data on soil chemistry that exists from the RI. The MPCA had previously calculated the center of mass of contamination by assuming that most of the contaminant mass was below a depth of 6 feet, and that it was distributed more or less uniformly from 6 feet to the water table (20 feet). However, this assumption is contradicted by the actual soil chemistry data from the RI, which show that there was significant contaminant mass above the 6-foot depth, that the distribution was not uniform with depth, and that most of the mass occurred at the intermediate depths of 6 to 12 feet.

TABLE 1 Biodegradation Half-Life Values in Soil (values in days)			
Constituent	**Howard et al (1991)**	**Dragun (1988)**	**Value used in Model**
TCE	180-365	2-300	274
PCE	180-365	2-300	274
1,2 - DCE	28-180	2-140	110
1,1 - DCE	280-180	4-110	110
1,1,1 - TCA	140-273	2-300	219
1,1 - DCA	32-154	10	91
Xylenes	7-28	7-37	602[a]
Ethylbenzene	3-10	7-37	180[a]

The value is identical to the value used by Mark Ferrey of the MPCA and does not affect the end result.

The contaminant center of mass has been calculated, based on actual soil concentration data reported in the RI report for O.U.#2 (RMT, 1993) for TCE in the shallow, intermediate, and deep soil zones. The mass of TCE, the major constituent of concern in the groundwater, was calculated to be 2 kg. in the shallow soil (0-5 feet), 9 kg. in the intermediate soil (6-12 feet), and 2 kg. in the deep soil (12-20 feet). The resulting calculation indicates that the center of mass is 8.7 feet below ground surface, and 11.3 feet above the water table. All calculations regarding the center of mass are found at the end of Attachment 1.

The revised parameter values for biodegradation half-lives and the distance from the center of mass to the water table result in revised soil cleanup goals from the MPCA soil leaching model. Figure 1 summarizes the input parameters and soil clean-up goals for the MPCA leaching model. The resulting clean-up goals are listed below:

TCE	1,940 mg/kg
PCE	NA
1,2-DCE	NA
1,1-DCE	NA
1,1,1-TCA	NA
1,1-DCA	4.4×10^5 mg/kg
XYLENES	NA
ETHYLBENZENE	NA

(NA = Values above 10^6 mg/kg; i.e., results of the model indicate that this constituent will not threaten groundwater based upon available data.)

The results of the MPCA soil leaching model indicate that, to be protective of groundwater, the soils must be cleaned up to 1,940 mg/kg for TCE, and 4.4×10^5 mg/kg for 1,1-DCA. The remaining six constituents of concern would not be a threat to groundwater quality, according to the model results.

Figure 1 Summary of Input Parameters and Spill Clean-up Goals Using the MPCA Soil Leaching Model

	enter feet	cm:
	9.1	2.77E+02

Soil Cleanup Calculations for VOCs in NIROP Soils Using the MPCA Leaching Model

Kd calculation:	Soil carbon adsorption coefficient (Koc)	Soil organic carbon content (%)	Soil Organic Matter content (%)	Soil adsorption coefficient, (Kd)	OC/OM conv.
TCE	105	0.3	0.50	0.315	0.61
PCE	312	0.3	0.50	0.936	
1,2-DCE	90	0.3	0.50	0.27	
1,1-DCE	65	0.3	0.50	0.195	
1,1,1-TCA	146	0.3	0.50	0.438	
1,1-DCA	21	0.3	0.50	0.063	
XYLENE	240	0.3	0.50	0.72	
ETHYLBENZENE	484	0.3	0.50	1.452	

Time of travel (t)	Thick-ness of organic matter in soil (cm) Z	Soil density, g/cu.cm ρ	Kd	Depth to ground water (cm) G	Soil Moisture content, percent θ	Recharge per year (cm/year) R	Time of travel (years) t
TCE	427	1.5	0.315	344	0.2	1.52E+01	15
PCE	427	1.5	0.936	344	0.2	1.52E+01	36
1,2-DCE	427	1.5	0.27	344	0.2	1.52E+01	14
1,1-DCE	427	1.5	0.195	344	0.2	1.52E+01	11
1,1,1-TCA	427	1.5	0.438	344	0.2	1.52E+01	19
1,1-DCA	427	1.5	0.063	344	0.2	1.52E+01	7
XYLENE	427	1.5	0.72	344	0.2	1.52E+01	29
ETHYLBENZENE	427	1.5	1.452	344	0.2	1.52E+01	54

	Half Life	Degradation rate constant k	exp(-kt)	Kd	Ground water ARAR RAL or MCL	Cleanup number (mg/kg)
TCE	0.75	0.92	8.101E-07	0.315	0.005	1.94E+03
PCE	0.75	0.92	2.968E-16	0.936	0.005	1.58E+12
1,2-DCE	0.3	2.31	1.995E-14	0.27	0.007	9.48E+10
1,1-DCE	0.3	2.31	7.037E-12	0.195	0.007	1.94E+08
1,1,1-TCA	0.6	1.16	1.98E-10	0.438	0.2	4.42E+08
1,1-DCA	0.25	2.77	9.938E-09	0.063	0.07	4.44E+05
XYLENE	1.65	0.42	5.369E-06	0.72	10	1.34E+06
ETHYLBENZENE	0.5	1.39	4.901E-33	1.452	0.7	2.07E+32

denotes RAL value (No MCL value)

Compound	Cleanup Number (ppm)
TCE	1.94E+03
PCE	1.58E+12
1,2-DCE	9.48E+10
1,1-DCE	1.94E+08
1,1,1-TCA	4.42E+08
1,1-DCA	4.44E+05
XYLENE	1.34E+06
ETHYLBENZENE	2.07E+32

* Results of the model indicate that this chemical will not threaten groundwater with the given data.

Comparison of the soil cleanup values based on the MPCA soil leaching model to actual concentrations in the soil shows that there are no measured values that exceed the cleanup goals for TCE or 1,1-DCA. This result indicates that the solvents in the unsaturated soil are not a continuing source of contaminants to the groundwater. The conclusion from the MPCA model results is consistent with the results of mass balance calculations that indicate that the mass of TCE that is below the water table far exceeds that which occurs above the water table, and the unsaturated soil from O.U.#2 is not a significant source of contaminants to the aquifer. For example, approximately 5000 kg. of TCE have been removed from the groundwater over two years of pumping (RMT, 1994), compared to an estimated 11* kg of TCE which exists in the soils of O.U.#2. The dissolved concentrations of TCE and other constituents of concern in the groundwater are a likely result of desorption of these compounds from soils below the water table, and possibly from DNAPLs and/or unsaturated soils beneath the NIROP facility (O.U.#3).

* We were discussing 20 kg why the change?
PAGE 7 of Report INDICATES 13 kg

Center of Mass of Contamination

Use chemical data from soils RI report for the NIROP

Use mass calculations for each depth interval (attached):

		Midpoint	Mass
Shallow soils	(0-5 ft)	2.5 ft.	2 kg.
Intermediate soils	(5-12 ft)	8.5 ft.	9 kg.
Deep soils	(12-20)	16 ft.	2 kg.

$$\text{Center of Mass} = \frac{\sum \text{(mass x depth below surface)}}{\sum \text{mass}}$$

$$= \frac{(2\text{ kg. x } 2.5\text{ ft.}) + (9\text{ kg. x } 8.5\text{ ft.}) + 2\text{ kg. x } 16\text{ ft.})}{(2\text{ kg.} + 9\text{ kg.} + 2\text{ kg.})}$$

$$= \frac{113.5}{13}\ \frac{\text{kg - ft}}{\text{kg}} = 8.7\text{ ft. below ground}$$

$$= 11.3\text{ ft. above water table}$$

$$= 344\text{ cm. above water table}$$

TCE Mass - Calculated using Geometric Mean Concentrations

Shallow Soils: (0' - 5' depth) Geometric Mean Conc. = 21 μg/kg TCE

Volume of Soil in Area A: (341,000 ft^2) x (5ft. depth) = 1.7×10^6 $ft.^3$

Mass of Soil = (1.7×10^6 $ft.^3$) $(30.48\ cm/ft)^3$ ($2\ g/cm^3$)

Soil Mass = 9.7×10^{10} g soil

TCE Mass = (9.7×10^{10} g soil) (21 μg/kg TCE) $\left(\frac{1kg}{1000g}\right)$

= 2.0×10^9 μg TCE = 2.0×10^3g

TCE Mass = 2 kg TCE in shallow soils

Intermediate Soils (5' - 12' depth) Geometric Mean Conc. = 72 μg/kg

Soil Layer Thickness = 7 ft.

Soil Mass = (9.7×10^{10} g soil) (7'/5') = 1.3×10^{11} g soil

TCE Mass = (1.3×10^{11} g soil) (72 μg/kg) $\left(\frac{1kg}{1000g}\right)$

= 9.4×10^9 μg TCE

= 9 kg TCE in intermediate soils

Deep Soils (12' - 22' depth) Geometric Mean Conc. = 9.7 μg/kg

Soil Layer Thickness = 10 ft.

Soil Mass = (9.7×10^{10} g soil) (10'/5') = 1.9×10^{11} g soil

TCE Mass = (1.9×10^{11} g soil) (9.7 μg/kg) (1 kg/1000g) = 1.8×10^9 μg TCE

= 2 kg TCE in deep soils

Total Mass TCE in unsaturated soils (0-22' depth)

2 + 9 + 2 kg = 13 kg TCE

This estimate is biased high, because most samples were taken in areas of higher concentration, not randomly spread over all of Area A.

TCE CONCENTRATION IN SHALLOW (0' - 5') SOILS[a]		
TCE Conc. μg/kg	Log Conc.	Boring #
< 11	0.74	AB040A
< 12	0.78	AB041A
< 11	0.74	AB042A
< 11	0.74	AB024A
920	2.96	AB025A
4100	3.61	AB025B
< 11	0.74	AB201A
0.9	0	AB202A
360	2.56	AB202B
75	1.88	AB222A
89	1.95	AB223A
< 11	0.74	AB230A
2	0.30	AB230B
36	1.56	AB035A
8	0.90	AB036A
0.8	0	AB037A
2	0.30	AB039A
0.8	0	AB209A
29	1.46	AB209B
1	0	AB210A
120	2.08	AB211A
1	0	AB211B
2	0.30	AB212A
21	1.32	AB212B
35	1.54	AB213A

TCE CONCENTRATION IN SHALLOW SOILS (con't)		
TCE Conc. µg/kg	Log Conc.	Boring #
130	2.11	AB213B
100	2	AB214A
12	1.08	AB215A
30	1.48	AB216A
91	1.96	AB217A
24	1.38	AB218A
18	1.26	AB231A
33	1.52	AB233A
3	0.48	AB234A
10	1.0	AB235A
23	1.36	AB236A
16	1.20	AB237A
< 11	0.74	AB238A
6	0.78	AB239A
3	0.48	AB240A
73	1.86	AB241A
140	2.15	AB242A
340	2.53	AB242B
< 11	0.74	AB244A
< 13	0.81	AB245A
6	0.78	AB246A
31	1.49	AB246B
210	2.32	AB247A
92	1.96	AB248A
5	0.70	AB251A

TCE CONCENTRATION IN SHALLOW SOILS (con't)		
TCE Conc. µg/kg	Log Conc.	Boring #
67	1.83	AB252A
< 11	0.74	AB253A
4100	3.61	AB254A
27	1.43	AT007A
9	0.95	AT008A
1500	3.18	AT009B
15	1.18	AB026A
50	1.70	AB027A
18	1.26	AB028A
190	2.28	AB029A
36	1.56	AB030A
9	0.95	AB031A
150	2.18	AB032A
300	2.48	AB033B
24	1.38	AB034A
4	0.60	AB038A
< 11	0.74	AB203A
20	1.30	AB203B
26	1.41	AB204A
4	0.60	AB204B
31	1.49	AB205A
2	0.30	AB206A
330	2.52	AB206B
15	1.18	AB207A
70	1.85	AB208A
< 11	0.74	AB219A
28	1.45	AB220A

TCE CONCENTRATION IN SHALLOW SOILS (con't)		
TCE Conc. μg/kg	Log Concentration	Boring #
< 12	0.78	AB221A
< 11	0.74	AB224A
2	0.30	AB226B
12	1.08	AB227A
5	0.70	AB228A
110	2.04	AB229A
< 11	0.74	AB243A
80	1.90	AB243B
31	1.49	AT001A
10	1.00	AT002A
35	1.54	AT002B
38	1.58	AT003A
290	2.46	AT003B
1	0	AT004A
47,000	4.67	AT004B
10	1.00	AT005A
5	0.70	AT006A
< 11	0.74	AT006B
$\sum$ = 125.72 (Log TCE Concentration)		
n = 95		
Log Geometric mean = $\frac{125.72}{95}$ = 1.32 μg/kg TCE Geometric Mean = 20.9 μg/kg TCE[b,c]		

[a] Based on Summary Data Tables from the Soil RI report (Appendix E).
[b] For concentrations below the detection limit, one-half the detection limit was used to calculate the Geometric Mean.
[c] For concentrations less than 1 μg/kg, 1 μg/kg was used to calculate the Geometric Mean.

TCE CONCENTRATION IN INTERMEDIATE (5 -12') SOILS[a]		
TCE Conc. µg/kg	Log Concentration	Boring #
< 10	0.7	AB040D
< 11	0.7	AB041C
5	0.7	AB222C
150	2.2	AB223C
9	1.0	AB037D
69,000	4.8	AB043D
11,000	4.0	AB044D
3	0.5	AB210D
7,700	3.9	AB214C
92	2.0	AB216D
700	2.8	AB217D
3	0.5	AB234D
18	1.3	AB237C
< 10	0.7	AB241C
20	1.3	AB247C
1,200	3.1	AB248C
4,000	3.6	AB251C
370	2.6	AB254C
280	2.4	AT007C
11,000	4.0	AT008D
120,000	5.1	AT009D1
8,800	3.9	AT009D2
5	0.7	AT009D3
7	0.8	AT009E1
3	0.5	AT009E2

TCE CONCENTRATION IN INTERMEDIATE SOILS (con't)		
TCE Conc. μg/kg	Log Concentration	Boring #
2	0.3	AB032D
5	0.7	AB034D
3	0.5	AT001C
8	0.9	AT005C
5	0.7	AT006A
< 11	0.7	AT006B
$\sum = 5.76$		
n = 31		
Geometric Mean = 72 μg/kg [b,c]		

[a] Based on Summary Data Tables from the Soil RI report (Appendix E).
[b] For concentrations below the detection limit, one-half the detection limit was used to calculate the Geometric Mean.
[c] For concentrations less than 1 μg/kg, 1 μg/kg was used to calculate the Geometric Mean.

TCE CONCENTRATION IN DEEP (12 - 22') SOILS*		
TCE Conc. μg/kg	Log Concentration	Boring #
< 10	0.7	AB042G
< 11	0.7	AB024G
< 10	0.7	AB201H
0.6	-0.2	AB039H
1,400	3.1	AB043H
2,300	3.4	AB044H
5	0.7	AB215H
31	1.5	AB218H
7	0.8	AB231H
< 10	1.0	AB233H
71	1.9	AB235H
14	1.1	AB236H
2	0.3	AB238H
19	1.3	AB239G
10	1.0	AB240H
4	0.6	AB244H
1	0	AB245G
3	0.5	AB252H
45	1.7	AB026G
5	0.7	AB027H
6,100	3.8	AB028G
89	1.9	AB029H
2	0.3	AB030G
2	0.3	AB031G
2	0.3	AB033H

TCE CONCENTRATION IN DEEP SOILS (con't)		
TCE Conc. μg/kg	Log Concentration	Boring #
9	1.0	AB038G
230	2.4	AB205G
3	0.5	AB207H
52	1.7	AB208H
< 11	0.7	AB219F
3	0.5	AB220G
0.8	-0.1	AB221G
0.9	0	AB224H
< 10	0.7	AB226G
0.9	0	AB227G
3	0.5	AB228F
3	0.5	AB229H
$\sum = 36.5$		
n = 37		
Geometric Mean = 9.7 μg/kg [b,c]		

[a] Based on Summary Data Tables from the Soil RI report (Appendix E).
[b] For concentrations below the detection limit, one-half the detection limit was used to calculate the Geometric Mean.
[c] For concentrations less than 1 μg/kg, 1 μg/kg was used to calculate the Geometric Mean.

ATTACHMENT 2

ATTACHMENT 2

Risk-Based Soil Cleanup Goals

Target cleanup goals based on human health risk (for carcinogens) and hazard (for non-carcinogens) have been calculated for constituents above background concentrations in areas that the RI Report concluded have been affected by disposal activities at the site. If the weight of evidence presented in the RI Report resulted in a conclusion that the area or a specific sample was not impacted, it has not been included in this evaluation, even if it contained constituents above the calculated background levels. This approach was followed to remain consistent with the conclusions of the RI which were based upon technical data that indicate even "background" soil can be above a background concentration that is calculated as a function of the mean.

Risk-based soil cleanup goals were calculated using the future residential land use assumptions and exposure variables described in Section 6 of the Remedial Investigation (RI) Report (RMT, 1993). Acceptable risk and hazard levels of 10^{-5} and 1, respectively, were used to back-calculate the target cleanup levels. The following routes of exposure were evaluated in accordance with those previously identified in the RI.

- Ingestion of chemicals in soil
- Dermal contact with chemicals in soil
- Inhalation of airborne chemicals in soil
- Inhalation of soil pore gas

Risk and hazard levels for the first three routes of exposure (shown above) were all based on compositional soil concentrations. Therefore, the lowest calculated target cleanup goal of the three (i.e., for the most sensitive route) was selected to represent the compositional soil cleanup goal for each chemical. Table 1 is a summary of the compositional target soil cleanup levels for carcinogens and non-carcinogens in the soil.

TABLE 1

NIROP RISK-BASED

COMPOSITIONAL SOIL CLEANUP GOALS

CHEMICAL PARAMETER	UNITS	10E-05 RISK CLEANUP GOAL	HAZARD CLEANUP GOAL
ANTIMONY	MG/KG		200
ARSENIC	MG/KG	6.0	150
BARIUM	MG/KG		3.9E+03
CADMIUM	MG/KG	150	490
CHROMIUM	MG/KG	23	7.0E+03
COPPER	MG/KG		5.2E+05
CYANIDE, TOTAL	MG/KG		9.8E+03
MANGANESE	MG/KG		3.9E+03
MERCURY	MG/KG		3.9E+03
NICKEL	MG/KG		9.8E+03
SELENIUM	MG/KG		7.0E+03
SILVER	MG/KG		2.4E+03
VANADIUM	MG/KG		3.4E+03
ZINC	MG/KG		4.2E+05
1,1,1-TRICHLOROETHANE	UG/KG		4.4E+07
1,1,2,2-TETRACHLOROETHANE	UG/KG	6.0E+04	
1,1,2-TRICHLOROETHANE	UG/KG	2.1E+05	2.0E+06
1,1-DICHLOROETHANE	UG/KG		4.9E+07
1,2-DICHLOROETHANE	UG/KG	1.3E+05	
1,2-DICHLOROETHENE, TOTAL	UG/KG		4.4E+06
2-BUTANONE	UG/KG		2.5E+07
4,4'-DDD	UG/KG	1.8E+04	
4,4'-DDE	UG/KG	1.3E+04	
4,4'-DDT	UG/KG	1.3E+04	9.1E+04
4-METHYL-2-PENTANONE	UG/KG		2.5E+07
ACENAPHTHENE	UG/KG		2.8E+07
ALDRIN	UG/KG	260	
ALPHA-CHLORDANE	UG/KG	3.4E+03	1.8E+04

TABLE 1 (con't)

NIROP RISK-BASED

COMPOSITIONAL SOIL CLEANUP GOALS

CHEMICAL PARAMETER	UNITS	10E-05 RISK CLEANUP GOAL	HAZARD CLEANUP GOAL
ANTHRACENE	UG/KG		8.4E+06
BENZENE	UG/KG	4.1E+05	
BENZO(A)ANTHRACENE	UG/KG	1.6E+03	
BENZO(A)PYRENE	UG/KG	1.6E+03	
BENZO(B)FLUORANTHENE	UG/KG	1.6E+03	
BENZO(G,H,I)PERYLENE	UG/KG		1.9E+07
BENZO(K)FLUORANTHENE	UG/KG	1.6E+03	
BIS(2-ETHYLHEXYL)PHTHALATE	UG/KG	8.5E+05	9.8E+06
CARBAZOLE	UG/KG	5.7E+05	
CHRYSENE	UG/KG	1.6E+03	
DIBENZ(A,H)ANTHRACENE	UG/KG	1.6E+03	
DIELDRIN	UG/KG	6.0E+04	
ENDRIN	UG/KG		5.5E+04
ETHYLBENZENE	UG/KG		4.7E+07
FLUORANTHENE	UG/KG		1.9E+07
FLUORENE	UG/KG		1.9E+07
GAMMA-CHLORDANE	UG/KG	3.4E+03	1.8E+04
HEPTACHLOR EPOXIDE	UG/KG	490	
INDENO(1,2,3-CD)PYRENE	UG/KG	1.6E+03	
PHENOL	UG/KG		8.4E+06
PYRENE	UG/KG		1.4E+07
TETRACHLOROETHENE	UG/KG	2.2E+05	4.7E+06
TOLUENE	UG/KG		9.4E+07
TRICHLOROETHENE	UG/KG	1.1E+06	3.0E+06
XYLENE, TOTAL	UG/KG		9.4E+08

Separate cleanup goals for soil pore gas were also calculated, to represent the fourth exposure route. Cleanup goals for pore gas were derived by first calculating exposure concentrations that would contribute a risk of 10^{-5} or a hazard index of 1. The exposure concentrations were then multiplied by 100 to arrive at the soil pore gas target cleanup goal in accordance with the RI assumption that one percent of the basement atmosphere is from soil pore gas which enters the basement foundation (RMT, 1993). The soil pore gas cleanup goals expressed in units of ppm of gas are shown in Table 2.

Individual soil samples containing concentrations of chemicals above the risk or hazard-based cleanup goals were then flagged. Soil samples containing chemicals at concentrations posing a risk between 10^{-5} and 10^{-6} were also flagged to evaluate potential cumulative effects when multiple chemicals were present. Flagged sample locations were tabulated and evaluated to determine if there were mappable areas requiring soil remediation based on unacceptable risk levels. The following paragraphs describe the results of this evaluation and the pattern of impacts which must be remediated.

Compositional Volatile Organic Compound Concentrations (VOCs) in Soil

One sample of 81 VOC samples collected in Sub-area A3 contained tetrachloroethane above the risk-based cleanup goal for compositional concentrations in soil. The sample (AT009D1) was collected from the removal action test pit; however, none of the remaining five samples collected from test pit AT009 contained tetrachloroethane above the cleanup goal. Two of the other five samples were collected from the same depth. None of the other samples collected in Area A, or in the remaining areas B, D, E, or F contained compositional VOC concentrations above the risk-based target cleanup levels. Based on this isolated occurrence, risk-based remediation of soils for compositional VOC concentrations is not needed. Additionally, this soil sample is in an area that will require remediation of soil pore gas for VOCs (see below) which will effectively reduce the compositional concentration of VOCs, as well.

Polycyclic Aromatic Hydrocarbons (PAHs) in Compositional Soils

Several surface soil samples collected in sub-areas A3 and A4 contained concentrations of PAHs above the risk-based soil cleanup goals. Concentrations of PAHs also exceeded the cleanup goals in two Area B samples, in one Area D sample, and in three Area E samples. However, the concentrations of many of the PAHs measured in NIROP soil samples are comparable to those measured in urban soils, as documented by the U.S. Department of Health and Human Services (1990). It is likely that the PAHs present in surface soils at the NIROP resulted from the use of typical

TABLE 2

NIROP RISK-BASED

PORE GAS SOIL CLEANUP GOALS

CHEMICAL PARAMETER	UNITS	10E-05 RISK CLEANUP GOAL	HAZARD CLEANUP GOAL
ETHYLBENZENE	PPM		27
TETRACHLOROETHENE	PPM	0.70	
TOLUENE	PPM		10
TRICHLOROETHENE	PPM	0.30	

construction materials such as asphalt and road tar, or from particulate redeposition from the incomplete combustion of fossil fuels. The PAHs are not related to disposal activities specific to the NIROP, or to a particular spill or release caused by on-site operations. The site-related risk associated with PAHs is likely equivalent to that of the general urban background. Therefore remediation of PAHs based on risk should not be conducted.

Trace Metals in Compositional Soils

Local concentrations of trace metals at the NIROP were calculated from background soil samples collected during the RI. Metal impacts in site soil samples were assessed by comparing individual constituent concentrations to the local background values, and by comparing overall trace metal chemistry in site samples to that in local background samples. Section 4 of the RI contains a detailed discussion on the calculation of local background trace metal concentrations and the calculation of an overall background trace metal score.

Soil samples containing concentrations of metals greater than the risk-based cleanup goals were tabulated and evaluated to determine whether the elevated constituent was above the local background value, and if so, whether the RI Report concluded that the sample's overall trace metal chemistry showed evidence of impacts from site activities. If all of the above criteria were met, the sample was considered for possible remediation.

Two of 61 samples analyzed for metals in Area A (AT005C DUP and AT007C) met the above criteria for manganese, since they contained manganese at concentrations above the hazard-based cleanup goal. However, although the duplicate from AT005C contained elevated manganese, the original

sample result was 10 times lower, and did not exceed the hazard cleanup goal. None of the borings in proximity to AT007C (AT009, AB037, AB044) contained elevated manganese, nor did the surface sample AT007A. The low frequency of exceedances and inconsistency in duplicate results does not support a need for manganese remediation on-site.

Three samples (AT008D, DB029A, and EB004A) contained chromium above the risk-based cleanup goal. The surface sample collected from test pit AT008 (AT008A) did not contain elevated chromium, and none of the remaining 61 samples analyzed from Area A contained elevated chromium. Additionally, none of the remaining eleven chromium samples from Area D or the remaining seven samples from Area E contained chromium above the cleanup goal. Again the sporadic occurrences and apparent lack of consistency for this inorganic constituent does not support the need for chromium consideration on-site. Therefore, it was concluded that risk-based remediation of soils for metals is not warranted based on the sparse occurrence of soil samples that exceed the calculated cleanup levels, and the lack of consistent evidence of site-specific impacts.

Pesticides, PCBs, and non-PAH Semivolatiles

None of the NIROP RI soil samples contained pesticides, PCBs or non-PAH semivolatiles above the risk-based cleanup goals. Therefore, no remediation is needed for these groups of compounds.

Volatile Organic Compounds in Soil Pore Gas

With the exception of sub-area A1, VOC concentrations in pore gas exceeded the calculated risk-based cleanup goals throughout Area and in portions of Areas A, D, and E. The risk is caused by elevated concentrations of trichloroethene and tetrachloroethene. Areas B and F each contained, out of a total of 124 samples, only one sample (BB002B, FB002C) with VOCs greater than the pore gas cleanup levels and therefore do not require remediation of the pore gas. However, widespread remediation of VOCs in the pore gas at areas A, D, and E is needed to reduce potential risks at the site.

Summary and Conclusion

The Remedial Action Objective of reducing risks associated with the Soils Operable Unit can be met by remediation of the VOCs in the site pore gas. The target cleanup goals for this remediation are listed in Table 2 (NIROP Risk-Based Pore Gas Cleanup Goals). This table lists the concentration that results in a 10^{-5} (one in one hundred thousand) risk level or a hazard index of one for individual compounds. Because the USEPA assumes that risk and hazard are cumulative, and because the constituents of interest often occur together, a cumulative risk could be slightly higher than 1×10^{-5} at the target cleanup goals. However, this would be unlikely at the NIROP because of the small number of constituents (PCE and TCE) in the pore gas risk calculation. Additionally, the ratio of TCE to PCE

concentrations in site soil is generally in the range of 5 to 1. Therefore, assuming TCE and PCE would be remediated at the same rate by an SVE system, cleanup to a target TCE pore gas concentration that corresponds to a 10^{-5} risk (0.30 ppm) should result in a PCE concentration of 0.30/5 = 0.06 ppm, which is more than 10 times lower than the 10^{-5} cleanup goal for PCE (0.70 ppm).

In summary, the individual target cleanup goals presented in Table 2, based on the 10^{-5} acceptable risk level are adequate to protect at a cumulative risk of 10^{-5}. There is no need to provide lower numbers to address cumulative risk since only two constituents are present, and clean-up of the dominant VOC will successfully lower the risk for both constituents. In addition, there is no unique solution to the cumulative risk equation for multiple contaminants. Therefore, it is recommended that the individual 10^{-5} soil cleanup goals be used. That is, the soil cleanup goals for the NIROP Soils Operable Unit pore gas concentrations are as follows:

- Trichloroethene 0.3 ppm
- Tetrachloroethene 0.7 ppm