LAB EXERCISES FOR: GEOLOGY, INVESTIGATION AND REMEDIATION AT A RAILROAD ENGINE REPAIR SHOP BROWNFIELD SITE ST. PAUL, MINNESOTA

BY
KATE KLEITER, P.G.
AMERICAN ENGINEERING TESTING, INC.
550 CLEVELAND AVENUE SOUTH
ST. PAUL, MN 55114
(651) 659-1319
KKLEITER@AMENGTEST.COM

GROUNDWATER EXERCISE
GROUNDWATER FLOW AT THE RAILROAD ENGINE REPAIR SHOP SITE
ST. PAUL, MINNESOTA

Exercise
Calculate groundwater elevations above mean sea level using data Table
Using ruler and 3 well elevations, calculate flow direction using trigonometry.

Materials:
Railroad Engine Repair Shop Site Map showing the groundwater monitoring network
Table with depth to water table from top of well riser pipe and riser pipe elevation
Ruler (10 scale engineers preferable)
Calculator

Example Problem:
D=Distance between two wells (MW-A and MW-B)
H=Elevation difference between two wells (MW-A and MW-B) 30-10 = 20 feet
h=elevation difference between third well (MW-C and MW-A)
Solve for d to calculate elevation distance between A and B

D/H = d/h

Draw contour line through Well C and elevation point on the line between MW-A and MW-B
Flow line is perpendicular to gradient contour. In this example flow is to northwest.

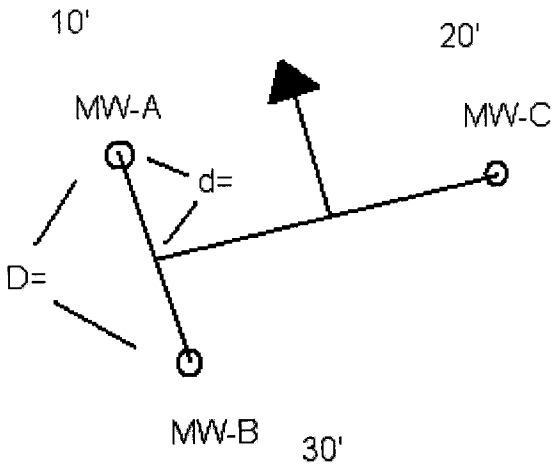


Table
Water Level Elevation Data

Well Nest	Monitoring Well	Type of Monitoring Well[1]	Top of Casing Elevation[2]	Screen Length (feet)	Total Well Depth (feet bgs)	Elevation of Top of Screened Interval[2]	March 1, 2004		September 10, 2004	
							Depth to Water (feet)	Water Elevation[2]	Depth to Water (feet)	Water Elevation[2]
NA	MW-18	Deep	863.14	10	39.91	830.79	12.25	850.89	11.09	852.05
MW-3	MW-3	Water Table	863.50	10	21.12	849.78	15.42		15.06	
	MW-25	Intermediate	863.19	5	24.99	841.01	15.04		14.65	
	MW-26	Deep	862.69	2.5	33.82	829.68	14.62		14.26	
MW-5	MW-5	Water Table	864.06	10	19.04	853.46	14.61		14.28	
	MW-20	Deep	864.47	2.5	32.88	832.12	15.17		14.86	
MW-6	MW-6	Water Table	862.89	10	18.07	852.63	14.29		13.96	
	MW-22	Deep	862.27	2.5	33.13	829.77	13.48		13.13	
MW-7	MW-7	Water Table	863.40	10	17.70	853.80	14.75		14.32	
	MW-23	Intermediate	863.01	5	27.69	838.81	14.29		13.91	
	MW-24	Deep	863.07	2.5	34.03	829.97	14.49		14.06	
MW-8	MW-8	Water Table	865.19	10	16.11	856.39	13.51		12.26	
	MW-8D	Deep	864.27	5	47.71	819.79	13.36		12.44	
MW-9	MW-9	Water Table	867.42	10	23.28	851.32	19.52		19.12	
	MW-9D	Deep	867.85	5	53.25	816.35	19.99		19.45	
MW-10	MW-10	Water Table	867.25	10	23.80	851.10	19.86		19.43	
	MW-10D	Deep	867.83	5	48.97	820.93	20.39		19.84	
MW-11	MW-11	Water Table	869.37	10	22.93	853.77	DRY		DRY	
	MW-27	Intermediate	869.21	2	30.29	838.41	21.31		20.89	
	MW-28	Deep	869.50	2	39.05	829.65	21.61		21.12	
NA	MW-12D	Deep	863.74	5	48.11	817.59	11.40		10.20	
NA	MW-15	Water Table	863.20	10	22.62	848.38	15.11		14.68	
MW-16	MW-16	Water Table	863.62	10	19.88	851.62	16.21		15.73	
	MW-16D	Deep	864.13	5	37.17	829.93	15.98		15.51	
NA	MW-17	Water Table	863.57	10	19.33	851.67	15.44		15.06	
MW-32D	MW-32D	Deep	863.89	5	32.01	833.99	14.34		14.04	
MW-33	MW-33S	Water Table	862.76	10	20.84	850.26	16.25		16.05	
	MW-33D	Deep	862.85	5	45.75	820.35	16.31		16.09	
MW-34	MW-34S	Water Table	864.40	10	20.00	852.90	17.23		17.03	
	MW-34D	Deep	863.49	5	47.21	820.69	16.30		16.11	
MW-35	MW-35S	Water Table	865.73	10	22.17	851.93	19.96		19.73	
	MW-35D	Deep	865.44	5	38.96	830.24	19.70		19.45	
MW-36	MW-36S	Water Table	861.43	10	21.49	848.71	16.49		16.19	
	MW-36D	Deep	861.46	5	43.86	821.24	16.49		16.19	
MW-38	MW-38S	Water Table	869.69	10	22.51	854.79	18.28		NM	
	MW-38D	Deep	869.37	5	48.03	824.17	18.78		NM	
NA	MW-40D	Deep	NS	5	49.50	NA	10.49		9.37	
NA	MW-44	Deep	861.46	5	33.49	831.61	9.81		8.59	
MW-45	MW-45S	Water Table	862.63	10	24.00	848.63	19.12		18.82	
	MW-45D	Deep	862.67	5	59.68	807.99	19.20		18.85	
MW-46	MW-46S	Water Table	855.58	10	18.45	847.13	11.33		10.99	
	MW-46D	Deep	855.35	5	41.12	819.23	11.10		10.80	

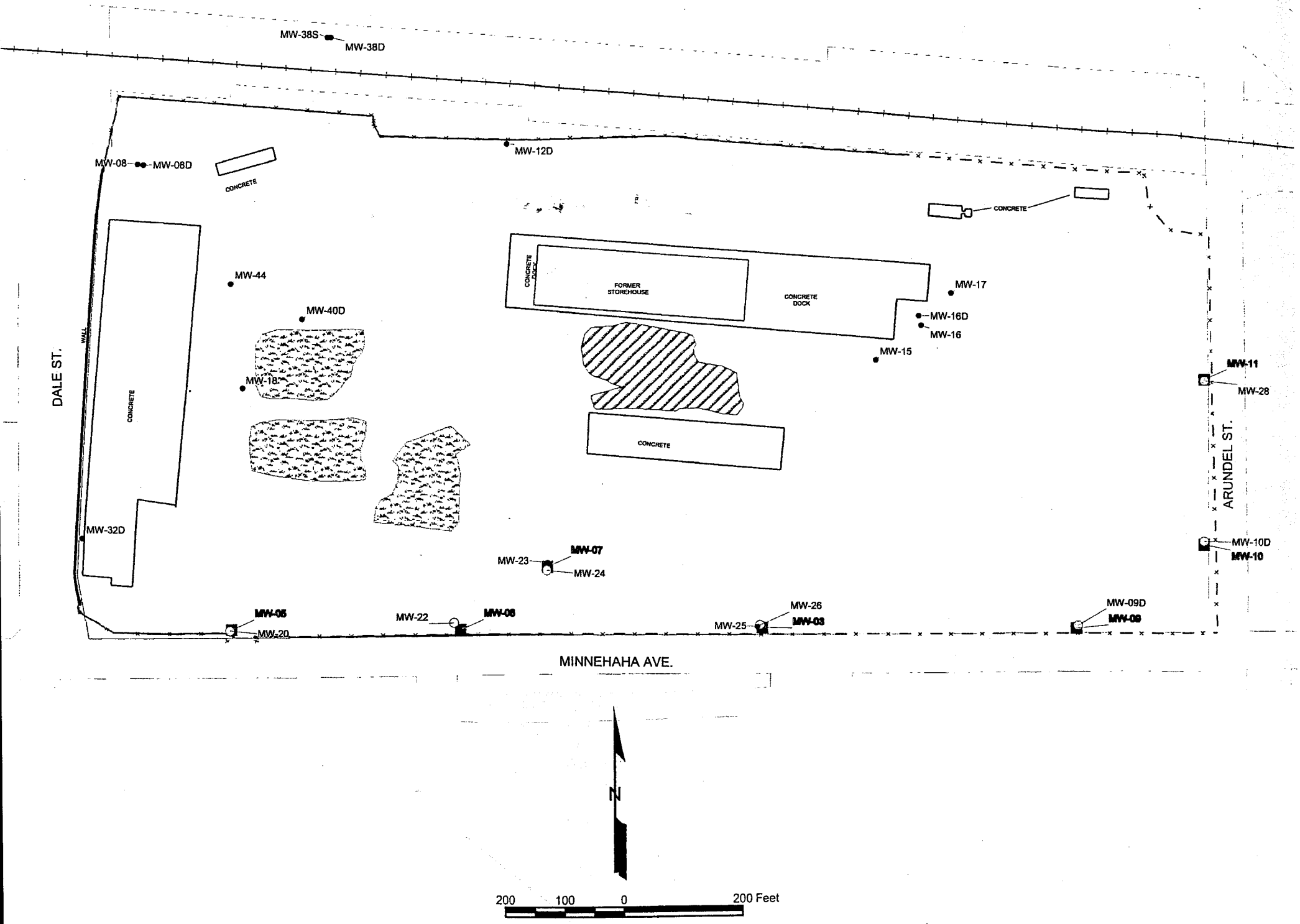
1 - Water table wells are screened to intersect the water table;
Intermediate wells are screened to intersect the Quaternary aquifer at approximately 20 to 24 feet below ground surface (bgs)
Deep wells are screened to intersect the Quaternary aquifer at approximately 30 to 34 feet bgs

2 - Elevation above mean sea level

NA - Not applicable

NS - Not surveyed due to damaged outer casing

NM - Not measured due to no track protection


MW-38S
MW-38D
MW-08
MW-08D
CONCRETE
MW-12D
CONCRETE
MW-44
MW-40D
MW-18
WALL
CONCRETE
CONCRETE DOCK
FORMER STOREHOUSE
CONCRETE DOCK
MW-17
MW-16D
MW-16
MW-15
CONCRETE
DALE ST.
MW-11
MW-28
ARUNDEL ST.
MW-32D
MW-23
MW-07
MW-24
MW-10D
MW-10
MW-05
MW-20
MW-22
MW-06
MW-25
MW-26
MW-03
MW-09D
MW-09
MINNEHAHA AVE.
N
200
100
0
200 Feet

INVESTIGATION PLANNING EXERCISE
RAILROAD ENGINE REPAIR SHOP SITE
ST. PAUL, MINNESOTA

Exercise:
Determine the best locations to drill borings and install monitoring wells for an investigation at the Site. Assume you have a budget for 30 borings and 8 monitoring wells
The purpose of the investigation is to determine the source and degree (not extent) of contamination that may be on the Site.
Scope the number and depth of the borings and monitoring wells.
Scope sampling depths for laboratory analysis

Materials:
Railroad Engine Repair Shop Site Map showing the site features
Sampling Plan Table
UST/AST Table

Some History
Quotes from former disgruntled employees:

Joe Engineer says "They used to dump tar in the northwest of the Section Gang Building.
Jim Greaseman said "There was an old pit located in the northeast corner of the Machine Shop building where we used to dump our used parts cleaner"
Mavis Clerk said "My office was next to the engine parts washer and it smelled like a dry cleaners all the time"
Jerry Janitor (JJ) said "Yup, I used to sweep up that lead solder dust on the Repair Shop floors and throw it out of the window or the nearest door"
Dan Demo said "After we demolished the Repair Shop we dumped a lot of stuff in the old transfer pit"

Table- Proposed Sampling Locations and Analytical Plan
RAILROAD ENGINE REPAIR SHOP SITE
St. Paul, Minnesota

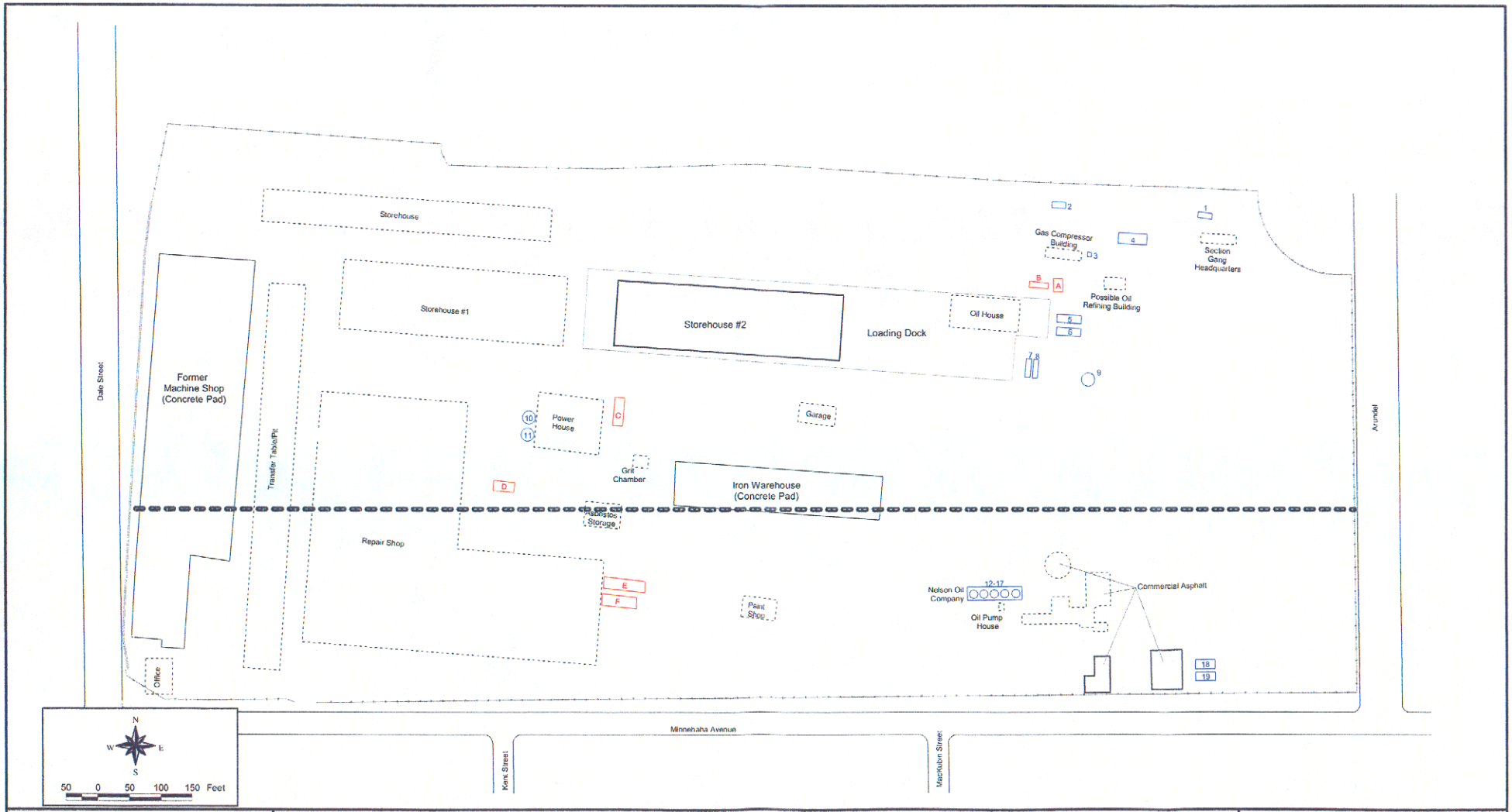
Boring # Well #	Sample Depth (feet)	Field and Lab Analysis										Rationale
		PID	XRF	DRO	GRO	VOCs	PAHs	PCBs	ACM	Creosote	Metals	

8 RCRA Metals (arsenic, barium, cadmium, chromium, lead, mercury, nickel, selenium)
GRO - Gasoline Range Organics
DRO - Diesel Range Organics
PAHs - Polynuclear Aromatic Hydrocarbons
PCBs- Polyclorinated Byphenols (oil in electric transformers
VOCs - Volatile Organic Compounds (in cleaning solvents, petroleum fuels)
Creosote (tar)
ACM - Abestos Containing Materials
PID - Photoionization Detector
XRF - X-ray flouresence analyzer

LIST OF FORMER ASTs AND USTs
DALE STREET SHOPS SITE

ABOVE GROUND STORAGE TANKS (ASTs)			
NO.	**SIZE**	**CONTENTS**	**LOCATION**
1	500	Gasoline	N of Gang Headquarters
2	1000	Unknown	N of Gas Compressor Building
3	2000	Diesel	200 ft SW of Gang Headquarters
4	20,000	Butane	100 ft SW of Gang Headquarters
5	Unknown	Fuel Oil	E of Oil House
6	Unknown	Fuel Oil	E of Oil House
7	3000	Unknown	E of Loading Dock
8	3000	Unknown	E of Loading Dock
9	65,000	Fuel Oil	100 ft E of Loading Dock
10	1500	Unknown	W side of Power House
11	1500	Unknown	W side of Power House
12	Unknown	Fuel Oil?	Nelson Oil
13	Unknown	Fuel Oil?	Nelson Oil
14	Unknown	Fuel Oil?	Nelson Oil
15	Unknown	Fuel Oil?	Nelson Oil
16	Unknown	Fuel Oil?	Nelson Oil
17	Unknown	Fuel Oil?	Nelson Oil
18	500	Diesel Fuel	E of Commercial Asphalt Office
19	500	Gasoline	E of Commercial Asphalt Office

UNDERGROUND STORAGE TANKS (USTs)			
NO.	**SIZE**	**CONTENTS**	**LOCATION**
A	1500	Gasoline	NE of Oil House on Loading Dock
B	6000	Used Oil	NE of Oil House
C	30,000	#6 Fuel Oil	NE corner of Power House
D	3000	Crude Oil	SE of Power House
E	25,000	Lube Oil	W of Paint Shop
F	12,000	Used Lube	W of Paint Shop



Legend
- ASTs-Blue (1-19)
- USTs-Red (A-F)
- Former Building Outline
- Fence
- Wall
- Proposed Property Boundary

AET No. 03-00939
0803-report apr 05/18/03

Figure 4
Location of Former ASTs, USTs, and Buildings

Response Action Plan
Dale Street Shops Site

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REMEDIATION PLANNING EXERCISE
LEAD CONTAMINATION AT THE RAILROAD ENGINE REPAIR SHOP SITE
ST. PAUL, MINNESOTA

Exercise

Calculate volume of lead contaminated soils in the proposed excavations shown on the attached figure. Assume a cleanup concentration of 700 ppm.

Calculate cost of lead contaminated soils to be excavated using the data shown below.

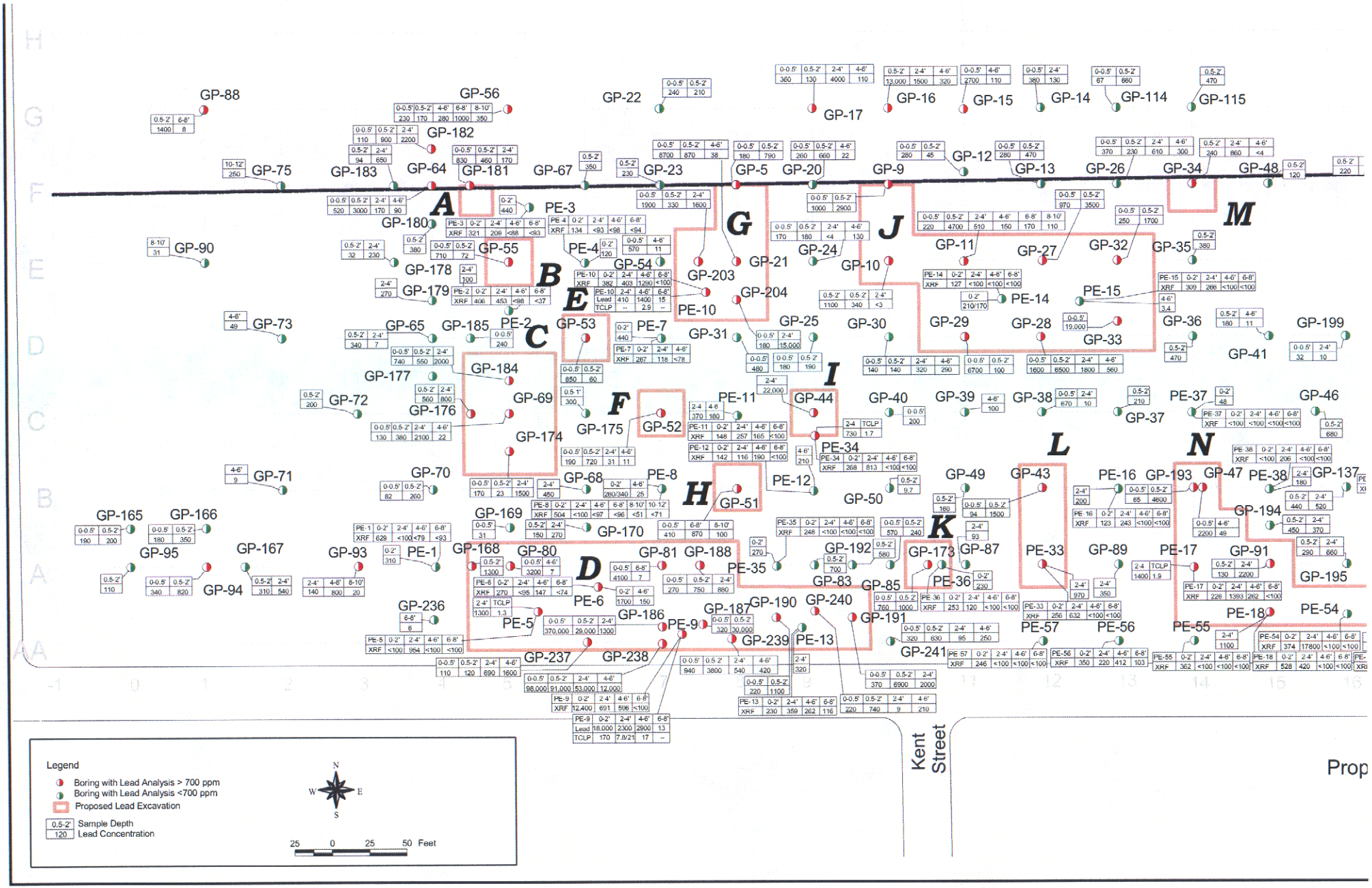
Landfill distance – 20 miles
Truck mileage - $1.00/mile
Truck load – 15 cubic yards
Backhoe charge (includes operator) - $5/cubic yard
Clean fill and compact (includes handling) - $8/cubic yard

Materials:

Railroad Engine Repair Shop Site Map showing the lead excavations A-N and lead concentrations
Ruler (10 scale engineers preferable)
Calculator

Conversions:

1 cubic yard = 27 cubic feet


A
B
C
D
E
F
G
H
I
J
K
L
M
N
Kent Street
Legend
Boring with Lead Analysis > 700 ppm
Boring with Lead Analysis <700 ppm
Proposed Lead Excavation
0.5-2' Sample Depth
120 Lead Concentration
N
W
E
S
25 0 25 50 Feet