Kirsten Pauly, PE/PG, *Principal*
Brian H. Mundstock, PE, *Principal*
Mike Kettler, PE, *Principal*

Consulting Civil Engineers

January 15, 2008

Steve Thorp
Scandia Code Official
City of Scandia
14727 209th Street North
Scandia, MN 55073

Re: Tiller Corporation Application Submittal

Dear Mr. Thorp:

Please find the enclosed additional information that you requested upon review of the Tiller Corporation application for a permit to mine sand and gravel in Scandia. We are providing you with two complete full sized sets of the plans and twenty copies of 11X17's which were revised in response to your request for additional information. Tiller Corporation will be submitting additional information under separate cover which will further describe the revisions that were made.

If you have any questions or require any additional information, please do not hesitate to give me a call.

Sincerely,

Kirsten Pauly, PE/PG
SUNDE ENGINEERING, PLLC

cc: Mike Caron

Kirsten Pauly, PE/PG, *Principal*
Brian Mundstock, PE, *Principal*
Mike Kettler, PE, *Principal*

Consulting Civil Engineers

April 23, 2008

Sherri Buss
City of Scandia Planner
TKDA
444 Cedar Street Suite 1500
Saint Paul, MN 551010-2140

Attached please find the additional information regarding Tiller Corporation's CUP for mining and processing operations requested in your March 27, 2008 memo.

1. Concept Ultimate Use Plan:

   This plan illustrates one potential use of the property after reclamation. This plan was prepared under Washington County's guidelines for cluster developments in conjunction with the preparation of an application a couple of years ago. While the City of Scandia's cluster requirements may vary from the County's, the plan does illustrate a feasible ultimate use of the site. It is understood this plan is conceptual and any final development will need to meet the requirements and obtain appropriate approvals in effect at that time.

   1a. Reclamation Sequencing C-3A: Attached is a reclamation sequencing plan that illustrates where slope stabilization has occurred and the areas of future reclamation. Backfilling and stabilization of sideslopes cannot occur until mining has progressed to the perimeter of the mining limits. The floor of the mining area will continue to be mined and be utilized for processing and stockpiling. Perimeter berms will be utilized in final restoration grading work. This plan will be reviewed and updated as needed as part of the annual operator's permit.

2. Soil Balance calculation:

   The volume of material to backfill the perimeter slopes from 1.5:1 excavation slopes to 4:1 in accordance with the reclamation plan is 1.77 million cubic yards mcy.

This material will come from overburden on areas which remain to be stripped, existing perimeter berms consisting of topsoil and overburden and reject material encountered through the normal course of excavation. (Reject materials are excess sand and material that contains too many fines to be incorporated into a final product.) Overburden ranges in thickness from 3-15'. An estimated 1.0 mcy of overburden remains on the site in future mining areas that have not yet been stripped. This is based on an average overburden depth of 9' and 62 acres of stripping remaining. On site stockpiles of overburden contain approximately 125,000 cy of material to be used in final reclamation. Reject material for this site typically runs at 10%. With 8-9 mcy of reserve remaining this will result in an additional 800,000-900,000 cy of material available for reclamation. Additional clean fill may be brought to the site for shaping and grading to establish final restoration grades and prepare for ultimate development.

3. Seed Mixtures:

The Mining and Reclamation Plan, C-3 has been revised to include seed mixture, seeding requirements and maintenance information.

4. Traffic Information:

The table illustrates below the estimated average daily traffic from the Tiller site based on both 300,000 and 400,000 cy of production per year. An additional 113 truck trips per day are generated to supply materials necessary for the production of asphalt. These additional truck trips are reflected in the table below.

The maximum daily truck traffic is estimated to be 750 truck trips per day

Volume CY	Tons	Truck loads/yr	Truck loads/day	Truck trips/day	Truck loads/hour	Truck trips/hr
300,000	420,000	31,150	173	346	15	28
400,000	560,000	38.150	212	424	18	35

Average traffic is based on an 8 month construction season
5 days a week, 180 working days, 12 hours/day
Avg of 20 tons/truck

Traffic patterns vary depending upon the location of particular jobs. However, based on past years activities, an estimated 70% of the traffic uses

Manning Avenue with 5% of these trucks heading north and 95% traveling South on Manning. Of the 30% that use Lofton Avenue, approximately 50% travel north and 50% travel south on Lofton. These numbers are based on the past several years' worth of activity. In any given year, a large project can skew these numbers considerably.

Approximately 30 trips are generated per day during the construction season from employees, service vehicles, etc.

5. Hydrogeologic information:

   This information is submitted under separate cover.

Kirsten Pauly, PE
Reg. No 21842

SUNDE ENGINEERING, PLLC

Tiller

1) Please provide well logs for the Production Well, Scale House Well, PZ-1, PZ-2, and PZ-3. What are their MN Unique ID #s?

   The logs of the test borings and the well logs on file at the MN Department of Health for PZ-1, PZ-2 and PZ-3 are attached. The unique numbers are:

   PZ-1: 436181
   PZ-2: 436182
   PZ-3: 436183

   Note that the location of the piezometers is incorrect on the County Well Index map.

   The log of the production well is attached. The MN Unique Well No. is 168714

   We do not have a copy of the scale house well. Both the production well and scale house well were installed by a previous property owner.

2) What is the proposed well construction and expected depths of PZ-4, PZ-5, and PZ-6? Are these to be completed in the sand and gravel? Bedrock?

   The wells are proposed to be 2" Sch 40 pvc wells and 10 foot slotted pvc screens with a plugged end. Filter pack will be installed around the screen to two feet above the top of screen, followed by a bentonite plug and cement grout. A protective casing set in neat cement with locking cap will be placed over the capped well. If any of the monitoring wells are in excess of fifty feet then a stainless steel screen may be used.

   We would propose to finish these wells in the Quaternary Drift, with ten foot screens intersecting the groundwater table. Because of the fluctuation of the groundwater table we would try to finish each well so that it intersects the upper two thirds of the ten foot screen. That way if the water table drops five feet due to seasonal fluctuations, water level measurements and samples would still be feasible. The depth will depend upon the final location of the wells, the surface elevation and estimated groundwater depths at the locations.

3) Are any of the existing wells completed in the bedrock or are they in sand and gravel?

   The piezometers and the production well are all completed in the sand and gravel. We do not know what the scale house well is finished in.

   Two wells that were associated with the homestead in the eastern portion of the property were sealed in accordance with Minnesota Department of Health rules. Both of these wells were bedrock wells. Copies of the sealing records are attached (H243537 and H175503).

4) Section O, page 9, 3rd paragraph states that Figure 5 illustrates locations of wells/piezometers and soil borings. The soil borings are not shown on Figure 5. Please provide a map showing the locations of the soil borings and provide the boring logs.

   A copy of Figure 5 is attached. The fourth soil boring is now shown. The soil boring locations are shown on this figure. The location or elevation of SB 11 was not surveyed in at the time it was drilled, therefore the water table elevation is approximate only and the water table recorded to the nearest five foot interval. Information from the previous permit applications from the Dresel site indicated a water level of 916 feet above mean

sea level (msl) at the Dresel site, so the information from SB 11 is consistent with other available data.

A copy of the boring log for SB 11 is attached.

5) Are the buildings on Figure 5, midway between the Production Well and PZ-1, the refueling area and asphalt plant? If not, please provide a map showing these site features and identify them as such.

The buildings referred to above are associated with the asphalt plant. Figure 5 has been revised to label the plant area.

6) Please provide historical groundwater level measurements from observation wells on site or adjacent to the site that have monitored by Tiller. Tabulated values or well hydrographs would be sufficient.

We are attaching a pdf of a 1988 groundwater investigation by Dr. Hans-Olaf Pfannkuch. This study was conducted in conjunction with the conversion of the wet scrubber pollution control system associated with the asphalt plant to a baghouse system which eliminated any wastewater discharge. As part of the conversion, the wet scrubber discharge pond was removed under guidance from the Minnesota Pollution Control Agency (MPCA). An investigation and the technical report was prepared and approved by the MPCA. The study contains historic groundwater level data from the three piezometers. The technical report concludes that flow directions near the plant area are in the northwesterly direction. As part of the study soil samples were taken to obtain laboratory values of hydraulic conductivity. Average bulk flow velocities were shown to be on the order of 35 - 50ft/year corresponding to bulk travel time for 1 mile of 100-150 years. Based on this information, it is clear that an on-site monitoring well network with properly located monitoring wells will be able to detect impacts to groundwater quality long before any off-site migration or impacts to residential wells could occur.

The county permit did not require water level readings so a continuum of water level readings does not exist. The production well was fitted with a port in 2006 to allow static water level reading. The scale house well could not be modified. Water level measurements of the production well and PZ-3 have been taken since September 2006. It should be noted that during the active mining season, the production well is utilized for dust control pumping anywhere from 15,000-25,000 gallons per day. This may have influenced some of the water level readings. Copies of the more recent water level readings are attached.

7) Are there survey data for the soil borings (i.e., grade elevation at the boring location when it was drilled)? If so, please provide. This will help determine/verify the accuracy of the groundwater elevations used to estimate flow direction.

The location and elevation of the measuring point of the piezometers was surveyed at the time of the Pfannkuch report. I could not find any information relative to the surface elevation. Construction logs are included and the length of pipe above ground is noted, so a reasonable estimation can be made.

Tiller also surveyed PZ-3, the production well and the scale house well more recently as part of starting to take water level readings in 2006. The survey information in Washington County Coordinates is as follows:

PZ-3:
X = 489110
Y=292899
Z= 952.23 (at measuring point)

Production well:
X=488770
Y=292904
Z=942.98 (at measuring point)

Scale house well
X=488986
Y=292681
Z=940.47 (top of well)

8) The EAW (Aug, 1999; Section 13) indicates the DNR Appropriations Permit Number for a 16" onsite well (Permit No. 86-6193, MN Unique ID #168714). Is this for the Production Well or Scale House Well? Is there a permit for the other well? If so, please provide the permit number. Also, as indicated above, please provide the MN Unique ID #s. The well log for CWI Unique ID # 168714 does not indicate the name of the well (Production Well or Scale House Well).

   The water appropriations permit is for the production well (unique # 168714). The scale house well is a potable well that does not meet requirements for an appropriations permit.

9) Are the drift and Prairie du Chien – Jordan aquifers hydraulically separated? If so, provide any site-specific data stratigraphic data and /or head data to indicate separation of the two flow systems.

   We do not have site specific data to determine whether or not the two aquifers are connected or not. Review of well log data in the area is inconclusive.

10) The Carnelian-Marine Watershed District (CMWD) completed a study of German Lake (indicated on page 4 of the April 21, 2006 letter from Barr to Ann Terwedo, Washington County). If this is available, please provide a copy? Were there any concluding statements as to the hydraulic connection between German Lake and the water table aquifer in this report?

    The CMWD should be able to provide you with a copy of their study. Attached is a memo from Stu Grubb, with Emmons & Olivier Resources, Inc., consultants for the CMWD. His memo indicates that German Lake is perched. We know that the elevation of the groundwater table in the active mining area is around an elevation of 916 feet above msl. The elevation of German Lake, approximately 2,300 feet to the west, is at an elevation of approximately 954. For the two systems to be connected a rather strong west to east gradient would be expected. The Pfannkuch study did not find this to be the case. Hopefully the installation of PZ-5 will be able to confirm the configuration of the water table in this area. In any event, the Barr study which evaluated the impact of mining below the water table on German Lake assumed that the two systems were connected. This would be the conservative assumption to use in analysis of this nature. If German lake is in fact perched, the impacts would be even less.

    There are several isolated wetland basins it the area between the active mining limits and German Lake. These basins are perched above the regional water table.

Tiller Corporation
Scandia, MN

Stormwater Management Calculations

03/2008

SUNDE ENGINEERING, PLLC.
10830 Nesbitt Avenue South
Bloomington, MN 55437-3100
Phone: (952) 881-3344
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Summary

Tiller Corporation operates an existing aggregate mining facility in the northwestern portion of the City of Scandia. The mining operation is situated on approximately 395 acres, of which a total of 155 acres will be mined and reclaimed at the conclusion of the mining operation. The site is located within two separate watershed districts, the Carnellian-Marine-St. Croix WD, which covers the western portion of the site and the Forest Lake-Comfort Lake WD, which covers the eastern portion of the site. The boundary between the two watershed districts is not based on a watershed divide. It is established based on parcel boundary lines.

Hydrologic computations have been prepared which evaluate the current condition of the site as well as the final reclamation condition of the site. Essentially the current condition also represents the interim or operating condition of the site. Past mining has redirected original site drainage to an internally drained condition over portions of the site that have been mined. The interim condition will continue to change as the remaining portion of the site is mined to completion. The final reclamation condition represents the biggest change to existing conditions, thus these two conditions were the only two for which hydrologic analysis was performed.

Existing (Interim) Condition:

The site has been actively mined since at least 1966. Ultimately the area to be disturbed by mining will encompasses 155 acres. Currently, the majority of the disturbed area drains internally to low areas within the site. Collected water infiltrates and evaporates and is not discharged from the site. The locations of these collection areas move throughout the site as mining activity progresses throughout the site.

Screening berms have been established around the perimeter of the site. The outer portions of these berms drain off-site. Existing berms are stabilized with well established vegetation. Several drainage areas around the perimeter of the site drain off-site. These are designated as drainage areas 5, 7, 12, 14, 17, 19, 20, 22, 29, 30, and 31 on the Existing Conditions Plan. The majority of these drainage areas (5, 7, 17, 20, 22 and 30) are located entirely outside of the mining limits. There will be no change in the hydrologic condition of these drainage areas during the remainder of the mining or final reclamation condition of the site. All or a portion of the remaining drainage areas (12, 14, 19 and 31) will be converted from draining off site to draining internally. The magnitude of these changes can be seen on Table 1, Existing/Proposed Conditions.

There are also areas around the perimeter of the site which currently drain onto Tiller property. These are identified as drainage areas 11, 18, 23 and 26 on the existing conditions plan. Future mining or reclamation activities will not impact or disrupt the current drainage patterns within these drainage areas.

Portions of the site that have been mined above the water table and some perimeter slopes have been stabilized and vegetation has been established.

The calculations illustrate the current watersheds/drainage areas and evaluate stormwater runoff entering the site, leaving the site, and remaining within the site. Drainage areas 21 and 23 were divided into sub-drainage areas in order to better model each wetland shown on the Existing and Proposed Conditions maps. Curve numbers of the mapped soil types per the Natural Resources Conservation Service were used for all drainage areas flowing offsite or that will be changed because of mining. Please refer to the Drainage Area Key exhibit. Drainage areas that do not change because of mining were assumed to have Type "A" soils and a curve number (CN) of 30 .

The pit, which includes the mine floor and stockpile area, (Drainage Area 27) in the Existing/Interim condition was assumed to be type "A" soils and a newly graded area which has a CN of 77. For the Final (Restoration) Condition, type "B" soils were assumed for a grassed area with greater than 75% grass cover (CN 61).

Final (Restoration) Condition:

Final reclamation will leave the site as open space with a lake which will have an approximate NWL = 916.00 feet above mean sea level. The perimeter slopes and floor of the mining operation will be stabilized with established vegetation. There will be no increase in rates of runoff leaving the site at any of the areas which currently drain off-site (Table 2). There will be no hard surfaces associated with the reclamation condition; therefore no permanent stormwater management facilities will remain on-site after reclamation. A portion of the Dresel site will be graded so as to drain towards the Tiller site.

When final development eventually occurs on this site, appropriate stormwater management, sedimentation and erosion control plans will be prepared in accordance with Watershed District rules and requirements in effect at that time.

Table 1 Existing/Proposed Conditions

					Peak Flows (cfs)							
	Existing		Reclamation		EXISITNG				RECLAMATION			
DA	Area (A)	Drainage	Area (A)	Drainage	2 Yr	5 Yr	10 Yr	100 Yr	2 Yr	5 Yr	10 Yr	100 Yr
1	4.60	internal	4.60	internal	0.00	0.00	0.01	0.13	0.00	0.00	0.01	0.13
2	8.23	internal	8.23	internal	0.00	0.02	0.08	1.42	0.00	0.02	0.08	1.42
3	5.77	internal	5.77	internal	0.00	0.00	0.02	0.33	0.00	0.00	0.02	0.33
4	6.42	internal	6.42	internal	0.00	0.01	0.03	0.97	0.00	0.01	0.03	0.97
5	5.24	offsite	5.24	offsite	0.57	1.51	2.80	7.06	0.57	1.51	2.80	7.06
6	14.60	internal	14.60	internal	0.00	0.04	0.14	2.58	0.00	0.04	0.14	2.58
7	4.58	offsite	5.04	offsite	1.47	3.52	6.00	13.64	1.38	3.50	6.14	14.35
8	8.16	internal	6.44	internal	2.45	4.12	5.99	11.28	5.26	8.60	12.24	22.38
9	2.99	internal			0.00	0.00	0.00	0.02				
10	20.58	internal	10.20	internal	0.01	0.11	0.47	5.64	0.11	0.73	2.13	8.41
11	8.26	internal	7.81	internal	0.42	1.59	3.42	10.11	0.53	1.82	3.76	10.59
12	11.94	offsite	8.51	offsite	3.57	7.50	12.21	26.56	2.24	4.90	8.16	18.19
13	12.50	internal			0.00	0.00	0.00	0.18				
14	39.51	internal/offsite	20.21	internal/offsite	30.00	46.91	65.08	114.86	17.14	26.76	37.14	65.43
15	7.98	internal	7.98	internal	0.00	0.00	0.03	0.47	0.00	0.00	0.03	0.47
16	1.68	internal	1.68	internal	0.00	0.02	0.10	1.27	0.00	0.02	0.10	1.27
17	26.08	internal/offsite	26.08	internal/offsite	20.36	31.39	43.16	75.20	20.36	31.39	43.16	75.20
18	4.13	into/through	4.13	into/through	0.65	1.96	3.71	9.37	0.65	1.96	3.71	9.37
19	8.12	offsite			0.00	0.00	0.00	0.06				
20	14.35	offsite	14.35	offsite	0.45	1.65	3.43	9.47	0.45	1.65	3.43	9.47
21a	4.17	internal	4.03	internal	1.61	3.71	6.29	14.14	1.56	3.59	6.08	13.67
21b	11.96	internal	11.96	internal	1.06	3.94	8.12	22.39	1.06	3.94	8.12	22.39
21c	4.30	internal	4.30	internal	0.01	0.05	0.31	2.87	0.01	0.05	0.31	2.87
21d	6.76	internal	6.76	internal	4.67	8.59	13.03	25.91	4.67	8.59	13.03	25.91
22	2.24	offsite	2.24	offsite	0.54	1.39	2.45	5.77	0.54	1.39	2.45	5.77
23a	6.23	into	6.23	into	0.00	0.00	0.03	0.47	0.00	0.00	0.03	0.47
23b	22.41	into	22.41	into	0.00	0.00	0.00	0.23	0.00	0.00	0.00	0.23
24	4.24	internal	4.24	internal	0.06	0.36	0.96	3.50	0.06	0.36	0.96	3.50
25	17.08	internal	15.44	internal	4.98	11.87	20.34	46.54	4.51	10.75	18.42	42.15
26	47.63	into/through	47.63	into/through	0.00	0.12	0.45	13.04	0.00	0.12	0.45	13.04
27	90.26	internal	160.11	internal	73.08	116.17	162.65	290.88	73.33	128.77	190.97	369.76
27a			39.72	into					20.73	33.58	47.60	86.70
28	12.17	internal	12.17	internal	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.17
29	29.99	offsite	29.99	offsite	17.24	30.09	44.44	85.48	17.24	30.09	44.44	85.48
30	1.33	offsite	1.33	offsite	5.55	6.97	8.39	12.02	5.55	6.97	8.39	12.02
31	4.43	offsite	2.18	offsite	0.01	0.04	0.31	4.14	0.15	0.95	2.16	6.23
Total	480.92		528.03		168.76	283.65	414.45	818.17	178.10	312.06	466.49	937.98

*See Attached Existing and Proposed Conditions Map for Details
**See Attached HydroCAD Output for Details

Type “A” soils (CN=30) were assumed over the entire site for the Existing Conditions per a letter from Daniel Fabian dated January 24, 2008. For areas draining directly offsite and drainage areas that would change in area from the existing to proposed conditions, mapped soil groups were used.

Type “A” soils for a newly graded area (CN=77) were assumed for Drainage Area 27 for the Existing Conditions. Type “B” soils for > 75% grass cover (CN=61) were assumed for Drainage Area 27 (Reclaimed Gravel Pit) for the Proposed/Reclamation Conditions.

Table 2 Offsite Drainage

	EXISITNG				RECLAMATION			
DA	2 Yr	5 Yr	10 Yr	100 Yr	2 Yr	5 Yr	10 Yr	100 Yr
5	0.57	1.51	2.80	7.06	0.57	1.51	2.80	7.06
7	1.47	3.52	6.00	13.64	1.38	3.50	6.14	14.35
12	3.57	7.50	12.21	26.56	2.24	4.90	8.16	18.19
14	30.00	46.91	65.08	114.86	17.14	26.76	37.14	65.43
17	20.36	31.39	43.16	75.20	20.36	31.39	43.16	75.20
19	0.00	0.00	0.00	0.06				
20	0.45	1.65	3.43	9.47	0.45	1.65	3.43	9.47
22	0.54	1.39	2.45	5.77	0.54	1.39	2.45	5.77
29	17.24	30.09	44.44	85.48	17.24	30.09	44.44	85.48
30	5.55	6.97	8.39	12.02	5.55	6.97	8.39	12.02
31	0.01	0.04	0.31	4.14	0.15	0.95	2.16	6.23
Total	79.76	130.97	188.27	354.26	65.62	109.11	158.27	299.20

Proposed/Reclamation conditions offsite drainage does not exceed pre-development/existing conditions offsite drainage.

Wetlands:

There are 22 wetland basins located entirely or partially on the site. Mining limits have been developed to minimize direct and indirect impacts to the wetland basins. Of the 22 basins located on site, mining will result in a minor decrease in drainage area to four of the basins. One of these basins (8) is located within the Carnellian-Marine-St. Croix Watershed District. Three of the basins, (9, 10 and 11) are located within the Forest Lake Comfort Lake Watershed District.

In order to assess the impacts to these wetlands basins the existing and final conditions were modeled. The majority of the soils removed from the drainage area were type A soils which result in very little runoff for the day to day storm events. Therefore, removal of drainage areas with permeable soils has very little impact during frequent day to day type rainstorm events. It is during less frequent (i.e. 100 yr) events where soils become saturated that there begins to be a substantial difference between the existing and proposed conditions.

The analysis shows that for frequent rainstorm events, the impacts to wetlands 8, 9, and 10, will not be significant. Because the more frequent events sustain the wetlands, there will be no substantial indirect impact to the wetland basins

as a result of the mining operation. Although basin 11 runoff conditions change substantially between existing and reclamation conditions, there is actually an increase in runoff towards the basin between pre-settlement and reclamation conditions. The curve number for the drainage area to basin 11 under current conditions is higher than pre-settlement conditions because of the current agricultural land use. Comparing pre-settlement conditions to reclamation conditions actually results in higher volumes of runoff in the reclaimed condition, even though the drainage area has been reduced. This is due to continuation of agricultural practices within this drainage area after reclamation is complete. Table 3 summarizes the changes in runoff to the wetland basins as a result of the mining operation.

Table 3 Wetlands Impacted by Mining

Wetland	Drainage Area (A) Existing	Drainage Area (A) Reclaimed	Volume of Runoff (cf) 2 Yr Event		Volume of Runoff (cf) 5 Yr Event		Volume of Runoff (cf) 10 Yr Event	
			Existing	Reclaimed	Existing	Reclaimed	Existing	Reclaimed
8	8.16	6.44	30,531	26,339	43,457	36,636	57,642	47,862
9	20.58	10.2	12,879	11,540	20,771	18,296	29,644	25,798
10	8.26	7.81	7,885	7,772	14,252	14,010	21,918	21,513
11	39.51	20.21	141,746	72,478	214,688	109,781	293,581	150,129

Wetland	Drainage Area (A) Existing	Drainage Area (A) Reclaimed	Volume of Runoff (cf) 2 Yr Event		Volume of Runoff (cf) 5 Yr Event		Volume of Runoff (cf) 10 Yr Event	
			Pre-Settlement	Reclaimed	Pre-Settlement	Reclaimed	Pre-Settlement	Reclaimed
11	39.51	20.21	31,162	72,478	65,868	109,781	109,790	150,129

Conclusions regarding wetland impacts are further substantiated by past review of the mining limits with respect to wetland impacts conducted by Washington County. As part of the 2000 repermitting with Washington County, which

included environmental review in the form of an Environmental Assessment Worksheet (1999 EAW), mining limits were adjusted to minimize impacts to western portion of the site where several high value resources exist. As a result mining limits adjacent to wetland 10 and 11 were adjusted as well. The revised limits (which are the same limits presented in the City application) were reviewed as part of the 1999 EAW. This document was distributed to all of the agencies on the EQB distribution list for review and comment.

The 1999 EAW review concluded that the project did not present a potential for significant environmental impact and the Washington County Planning Commission authorized approval of the 2000 Conditional Use Permit. A Motion for Reconsideration was filed with the Washington County Board of Commissioners listing concerns over the sustainability of the wetlands given the revised mining limits. The issue was reviewed by Jon Michels, Senior Environmental Specialist for Washington County, who concluded that due to the high infiltration rates of the soils associated with the area, the wetlands located immediately to the southeast of the proposed operation (Wetlands 9 and 10) should not be significantly effected by the mining operation. Based upon Mr. Michel's opinion and information supplied by Sunde Engineering, Inc. on Tiller's behalf, the County Board affirmed the Planning Commission's approval including the revised mining limits. These limits are identical to what is presented in the City application.

The following information addresses specific comments presented by the Comfort Lake Forest Lake Watershed District in their January 23, 2008 letter to the City of Scandia.

1) *There is very little information provided in order to evaluate the site's overall impact on the surrounding environment with respect to the goals and policies in the Comfort Lake – Forest Lake Watershed District's Watershed Management Plan:*

   With respect to the policies of the Comfort Lake Watershed District, the site has operated and will continue to operate in a manner to protect adjacent wetlands and waters from significant degradation and to protect wetlands and waters from significant wetland alteration, to maintain existing water uses, aquatic and wetland habitats and the level of water quality.

   Specific District goals relevant to this site include water management and wetland management. Water management goals include preservation and use of natural storage and retention areas to control excess volumes and rates of runoff, and preservation of groundwater recharge areas, measures to protect surface and groundwater quality, and monitoring of groundwater quantity and quality throughout the duration of mining operations.

The site operates under a Stormwater Pollution Prevention Plan. This plan has been developed to prevent stormwater that has contacted stripped areas or exposed soils from discharging from the site untreated. The mining operation creates storage and retention areas helping to control excess volumes and rates of runoff. The majority of stormwater is infiltrated, preserving groundwater recharge areas. Groundwater monitoring will be conducted to insure protection of groundwater quality.

Wetland goals include protection of District wetlands in accordance with existing rules and regulations.

2) *The site operates on two parcels on 395 acres of which 155 acres are proposed to be mined and eventually reclaimed. Two EAW's reviews have been completed for the mining facility, one in 1987 and one in 1999. The District has not been supplied either of the EAW's.*

The EAW's were distributed for review and comment to all applicable agencies during the EAW public comment period in accordance with EQB rules in effect at the time. The City has created pdf's of the EAW's which are included in this submittal on a disk. The City also has hard copies of the EAW available at the city hall for review.

3) *Because none of the on-site wetlands have been field delineated. In order to determine the types, sensitivities, and overall values of the wetlands on site, they all should be field delineated. Further, CLFLWD recommends that all wetlands be protected with buffer zone to be maintained outside the outer wetland boundary. The site maps do not indicate buffer zones.*

Mining will not impact the majority of wetlands or their drainage areas. Four of the 22 wetlands will be impacted. Basin 10 was field delineated as part of past County permitting work. The other three basins will be field delineated in the spring once conditions are appropriate. A minimum of a twenty foot wetland buffer will be established for the four basins that will have modified drainage areas. Vegetation will not be disturbed within the buffer area. Please refer to the Drainage and Erosion Control Plan for additional buffer information.

4) *There is no stormwater rate and volume modeling completed for the site. In order fulfill goals included within the District's Watershed Management Plan, interim and post-use (reclaimed) stormwater rates from the site for a 24-hour precipitation event with a return frequency of 2, 5, 10, or 100 years should not increase from pre-use conditions.*

Further, increased runoff volumes can cause downstream flooding or exacerbate existing flooding concerns and can alter the hydrology of downstream wetlands. In order to alleviate these concerns and fulfill goals included within the District's Watershed Management Plan, the project site (existing, interim and reclaimed) should be designed to maintain existing runoff volumes for the 2-year event (2.8 inches).

Stormwater rate and volume calculations have been performed. The results are presented in the Existing/Proposed Conditions section of this report. There is no increase in volume of runoff leaving the site. Summary information is provided above, HydroCad results include detailed information.

5) *There are no water quality models in order to determine pre-use, interim and post-use (reclaimed) phosphorus loads from the site. Submittal of a water quality modeling analysis of the site (using a model such as P8 or a method found in Appendix L of the Minnesota Stormwater Manual "Simple Method of Determining Phosphorus Export," for determining the pre-use and post-use nutrient loads from the site) would specifically address this concern.*

Currently there are no water quality models modeling phosphorus removal and loads because modeling them is based on ponding. There is no ponding proposed for the interim and post-use conditions for offsite drainage areas, therefore phosphorus loads are not able to be modeled. Off-site runoff is reduced between the existing and reclamation conditions.

What can be said generally about the phosphorus loads from the site are that as mining continues to the south and east phosphorus loads leaving the site will be reduced as the drainage areas are reduced in size. Ultimately the reclamation condition will have less of a phosphorus load leaving the site than the pre-mining and interim conditions.

6) *The site proposes the use of two stormwater ponds to control stormwater runoff rates and volume, as well as provide water quality treatment. There is, however, no design of the ponds in order to determine function and effectiveness, or no maintenance, monitoring, or inspection schedule for the proposed stormwater systems.*

Please see attached Stormwater Ponding Details. Maintenance and inspection is covered in the site's SWPPP as part of the NPDES permit.

7) *The watershed will also request design and construction details for the proposed BMP's mentioned in N. as well as detail as to where and when the BMP's will be used.*

Please see attached Stormwater Ponding Details plan for details regarding the design of the two stormwater ponds. Also, please refer to the Drainage and Erosion Control Plan for erosion and sedimentation control locations.

8) *In order to review the sites groundwater component/interaction, the watershed will request a copy of the groundwater monitoring plan, spill response and emergency response plans, and results of past groundwater monitoring that have been conducted.*

For Groundwater Protection and Groundwater Monitoring please refer to pages 9 to 13 in the Conditional Use Permit Application. Copies of the Spill response plan and past groundwater monitoring results will be forwarded under separate cover. Also, please refer to page 19 Contingency Response Plan.

9) *While the actively mined area of the site is not within the boundary of the Comfort Lake – Forest Lake Watershed District, future phases to the east are and the eventual mining of the "common mining border with the Dresel pit to the south could cause a hydraulic connection with the watershed.*

In the reclamation condition for both the Tiller site and the Dresel site, the Dresel site will ultimately drain into the Tiller property. The Dresel site is currently located in both Watershed Districts. The district lines are not watershed divides. We are unclear as to what is meant by "…could cause a hydraulic connection with the watershed." A hydraulic connection between the two watersheds?

With respect to specific items in the January 24, 2008 comment letter from the Carnelian – Marine – St. Croix Watershed District the following information is provided:

3) The submittal information received on January 18, 2008, is acceptable as far as general information on proposed operations and narrative requirements but lacks the specific information and detailed plans and design information the District will need to evaluate the project.

    a. *Provide wetland buffer plan. It was noted that the wetlands have not been field delineated. The District has inventoried most or all of the wetlands located within it's boundaries for this site. That inventory did not include an actual field delineation. This information typically required for a development and recommended by the District. If wetland delineation is not required by the City for this specific project the wetlands closest to the mining areas will still need to be field delineated at a minimum.*

Mining will not impact the majority of wetlands or their drainage areas. Four of the 22 wetlands will be impacted. Basin 10 was field delineated as part of past County permitting work. The other three basins will be delineated in the field in the spring once conditions are appropriate. A minimum of a twenty foot wetland buffer will be established for the four basins that will have modified drainage areas. Vegetation will not be disturbed within the buffer area. Please refer to the Drainage and Erosion Control Plan for additional buffer information.

b. *Provide detailed drainage plan and supporting computations documenting that rates and volumes discharge off site are not increased over pre-settlement conditions; for the interim mining phases and final site at completion of mining activity. To estimate pre-settlement conditions district will accept assumption of 2005 existing conditions topography, "A" soils or mapped existing soil types. A native prairie land cover should be assumed for the areas that are currently being mined. Drainage plan subwatershed maps and computations need to include off-site areas that drain to property.*

   Stormwater rate and volume calculations have been performed. There is no increase in volume of runoff leaving the site. Summary information is provided above, HydroCad results include detailed information. Assumptions are described in this summary and throughout the report.

c. *Design information for water quality features needs to be provided.*

   Please refer to Stormwater Ponding Details for more information. Please note that these are features that were constructed without formal design plans.

d. *District will expect drainage plan and models to be of sufficient detail to also evaluate expected impact to on-site wetlands.*

   Please refer to the following stormwater management calculations, exhibits and HydroCAD modeling.

e. *Drainage and erosion control plans need to include construction details for installation of stormwater management and erosion control practices (proposed BMP's). Design information on size of proposed practices and when they will be placed and how they will be maintained will also be required.*

Please refer to the Drainage and Erosion Control Plan. Currently screening berms are in place. Also, as mining progresses through the phases silt fence will be added per the Drainage and Erosion Control Plan.

f. *German Lake Area has several groundwater dependent natural resources including German Lake itself. Provide copies of the groundwater monitoring plan (include reports on past monitoring activities under previous County permit), spill response plan and emergency response plan.*

For Groundwater Protection and Groundwater Monitoring please refer to pages 9 to 13 in the Conditional Use Permit Application. Also, please refer to page 19 Contingency Response Plan. The SWPPP Plan and past groundwater monitoring results will be submitted under separate cover.

Tiller Corporation has been in contact with the Washington County Conservation District regarding development of a program to protect and enhance the quality of the wetlands located in the eastern portion of the site that are adjacent to existing agricultural practices. Tiller Corporation will work with the Conservation District in developing a program and will implement BMP's suggested by them in order to reduce the impact of agricultural practices on adjacent wetlands and downstream water bodies.

KEY:

MINING LIMITS

DRAINAGE AREA

SUB-DRAINAGE AREA

DRAINAGE AREA - DRAINING OFFSITE

DRAINAGE AREA - OFFSITE DRAINING ONSITE

APPROXIMATE LOCATION OF EXISTING CULVERT

APPROXIMATE LOCATION OF EXISTING CULVERT

24" RCP

APPROXIMATE LOCATION OF EXISTING CULVERT

24" RCP

APPROXIMATE LOCATION OF EXISTING CULVERT

18" CMP

APPROXIMATE LOCATION OF EXISTING CULVERT

24" RCP

18" CMP

MINING LIMITS

Forest Lake Comfort Lake WD

Carnelian – Marine – St. Croix WD

Deciduous Woodland

Oak Forest

Aspen-Birch Forest

Alder Swamp

PEMB

PEMC

PEMA

PEMBg

PSS1B

PEM/SS1B

PUBG

PUBC

PEMB SS1

CONVEYER

Sunde Engineering, PLLC.

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TILLER CORPORATION

HYDROLOGIC EVALUATION

SCANDIA MINING OPERATION

DATE	REVISION

I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION, OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.

KIRSTEN PAULY

DATE: 03/10/08 REG. NO.: 21842

INFORMATION:

PROJECT NO.: 93-253

DRAWN BY: NM

CHECKED BY:

APPROVED BY: KP

SCALE: GRAPHIC

DATE:

DESCRIPTION:

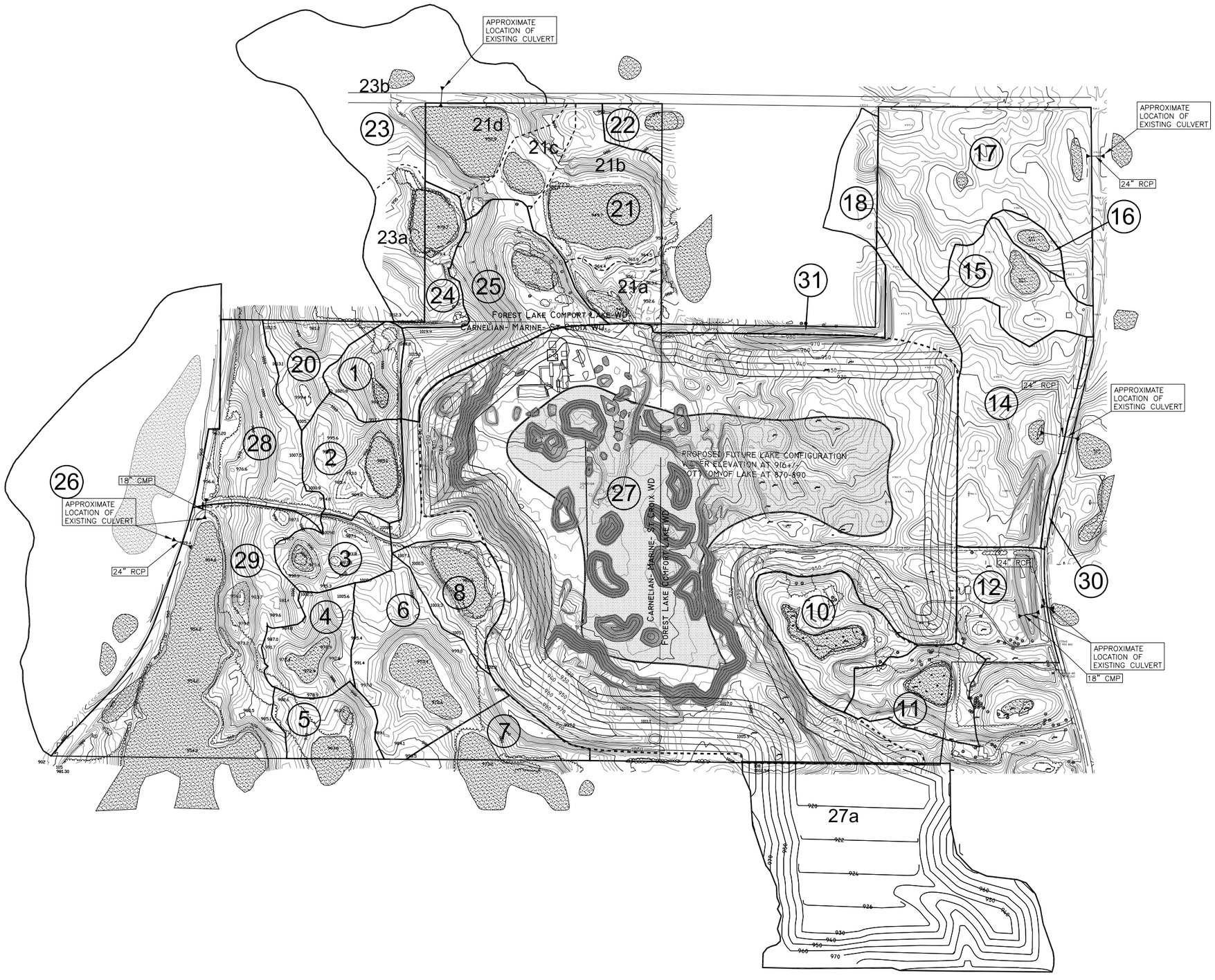
EXISTING CONDITIONS

SHEET NO:

C1

of

93-253 T.32 . 80 7.65. DRAWING: \\Kirstenspc\dwgs\Tiller – All\Tiller New Scandia\2007 permit application\Hydro\Drainage Areas (2-foot contours).dwg LAYOUT: Existing Conditions DA's XREF: 07044TILLER



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DATE:

DESCRIPTION:

PROPOSED CONDITIONS

SHEET NO:

C2

DENOTES AREAS WHERE TYPE "A" SOILS WERE ASSUMED (CN=30) (NO CHANGE IN CONDITION DUE TO MINING)

DENOTES AREAS THAT DRAIN OFFSITE. MAPPED HYDRAULIC SOIL GROUPS WERE USED. (TO MODEL OFF SITE FLOW REALISTICALLY)

DENOTES AREAS THAT CHANGED BETWEEN EXISTING AND PROPOSED CONDITIONS. MAPPED HYDRAULIC SOIL GROUPS WERE USED.

DENOTES AREAS OF MINING FACILITIES. NEWLY GRADED TYPE "A" SOILS WERE ASSUMED FOR THE EXISTING CONDITION.
GRASS COVERED TYPE "B" SOILS WERE ASSUMED FOR THE PROPOSED CONDITION.

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SCALE:
DATE:

DESCRIPTION:

DRAINAGE AREA KEY

SHEET NO:

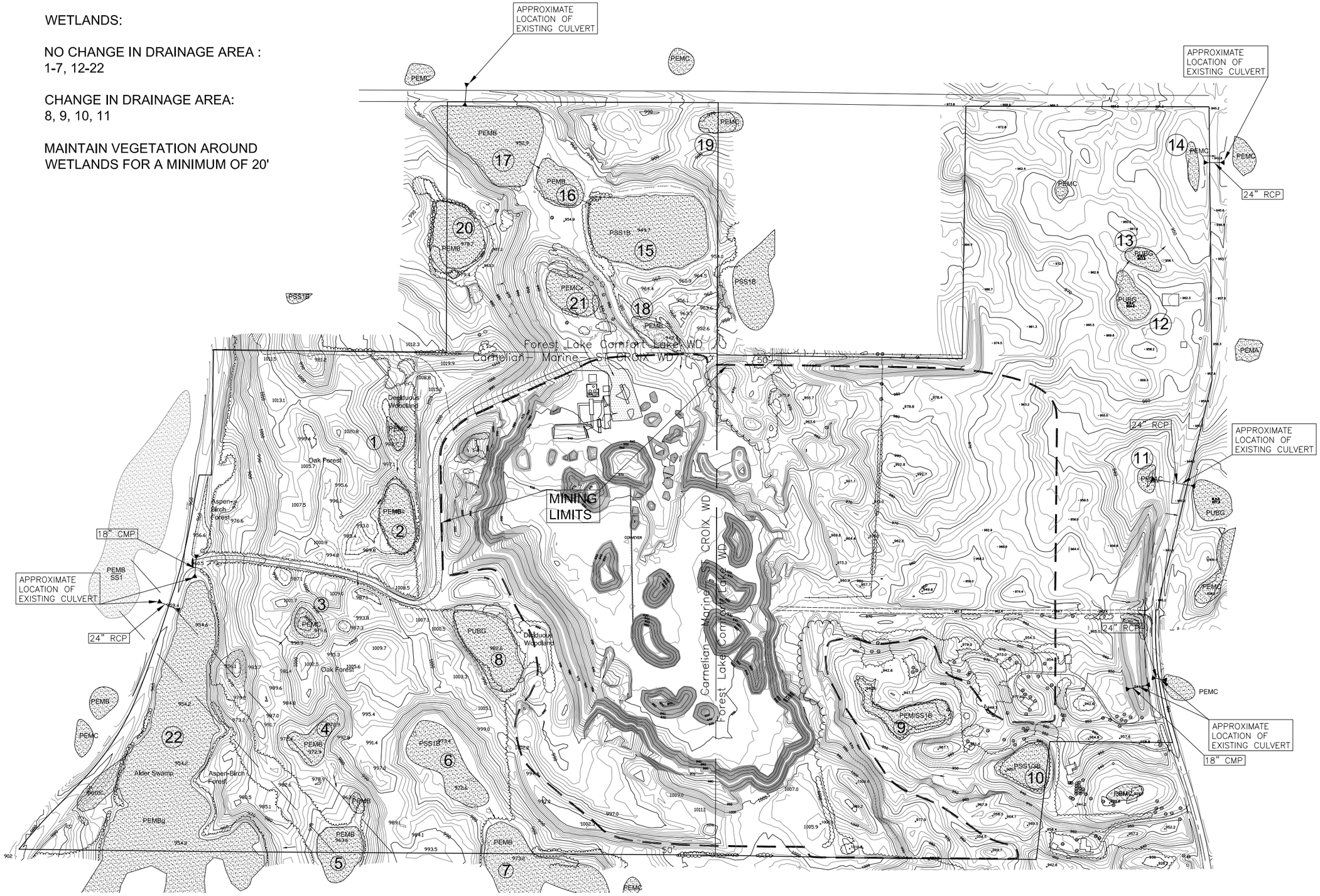
C3

WETLANDS:

NO CHANGE IN DRAINAGE AREA :
1-7, 12-22

CHANGE IN DRAINAGE AREA:
8, 9, 10, 11

MAINTAIN VEGETATION AROUND
WETLANDS FOR A MINIMUM OF 20'



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SCALE: GRAPHIC
DATE:

DESCRIPTION:

WETLANDS

SHEET NO:

C4

of

DIVERSION BERMS WILL BE PLACED AROUND THE PERIMETER OF THE WATER BODY AS MINING PROGRESSES INTO THE GROUND WATER TO PREVENT RUNOFF FROM UNVEGETATED AREAS FROM ENTERING THE WATER.

ADDITIONAL SILFENCE WILL BE PLACED AS NEEDED AS DRAINAGE PATTERNS AND STRIPPING OPERATIONS NECESSITATE.

KEY:
- DRAINAGE ARROW
- DRAINAGE DIVIDE
- SILTFENCE
- SEDIMENTATION PONDS
- WETLAND BUFFERS
- RECLAIMED AREA

RECLAIMED AREA

RECLAIMED AREA

MAIN HAUL ROAD - PAVED

100' SETBACK

VEGETATED SCREENING BERM

MINING LIMITS

STORMWATER SEDIMENTATION POND

SECONDARY SEDIMENTATION POND

Forest Lake Comfort Lake WD

Carnelian – Marine – St Croix WD

PHASE 1A

ACTIVE MINING FACE

PHASE 2B

STOCKPILE AND PROCESSING AREA

CONVEYER

PHASE 1B

Carnelian – Marine – St Croix WD

Forest Lake Comfort Lake WD

ACTIVE MINING FACE

PHASE 2A

PHASE 3B

PHASE 3A

HAUL RD. TO LOFTON RD.

VEGETATED SCREENING BERM

VEGETATED SCREENING BERM

MANNING AVENUE

LOFTON ROAD

RECLAIMED AREA

20' BUFFER

PHASE 1A

100' SETBACK

COMMON MINING BORDER

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Kirsten Pauly

Kirsten Pauly
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PROJECT NO.:
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DATE:

DESCRIPTION:

DRAINAGE AND EROSION CONTROL PLAN

SHEET NO:

C5

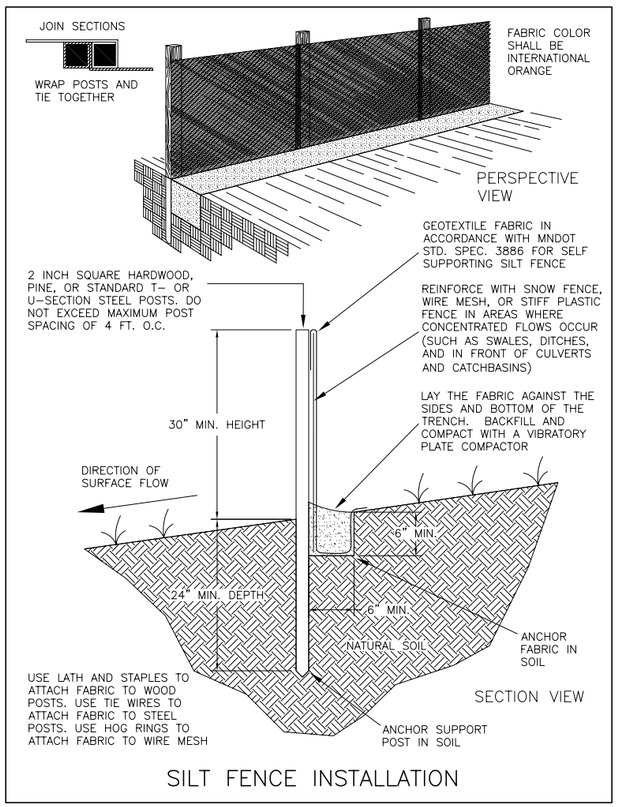
of

POLLUTION CONTROL:

1. Limit external washing of trucks and other construction vehicles to a defined area of the site. Wash vehicles only on an area stabilized with stone that drains into an approved sediment trapping device. Contain runoff and properly dispose of waste. Engine degreasing is prohibited.

2. Solid Waste: Properly dispose of collected sediment, asphalt and concrete millings, floating debris, paper, plastic, fabric, construction and demolition debris, and other wastes in compliance with Minnesota Pollution Control Agency requirements.

3. Hazardous Materials: Properly dispose of all waste and unused building materials (including garbage debris, cleaning wastes, oil, gasoline, paint, wastewater, toxic materials, and hazardous materials) off-site. Do not allow waste and unused building materials to be carried by runoff into a receiving channel or storm sewer system. Properly store oil, gasoline, paint, and other hazardous materials in order to prevent spills, leaks, or other discharge. Include secondary containment. Restrict access to storage areas in order to prevent vandalism. Storage and disposal of hazardous materials must be in compliance with MPCA regulations.



SILT FENCE INSTALLATION

STORMWATER POLLUTION PREVENTION:

1. Install all temporary erosion control measures including silt fence per plan and sedimentation basins prior to beginning site clearing, grading, or other land-disturbing activity.

2. Install silt fence along the contour (on a level horizontal plane) with the ends turned up (J-hooks) in order to help pond water behind the fence. Install the silt fence on the uphill side of the support posts. Provide a post spacing of 1.2 m (4 feet) or less. Drive posts at least 0.6 m (2 feet) into the ground. Anchor the silt fence fabric in a trench at least 152 mm (6 inches) deep and 152 mm (6 inches) wide dug on the upslope side of the support posts. Lay the fabric in the trench and then backfill and compact with a vibratory plate compactor. Make any splices in the fabric at a fence post. At splices, overlap the fabric at least 152 mm (6 inches), fold it over, and securely fasten it to the fence post. Silt fence supporting posts shall be 51 mm (2 inch) square or larger hardwood, pine, or standard T- or U-section steel posts. T- or U-section steel posts shall weigh not less than 1.8602 kg per meter (1.25 lb per lineal foot). Posts shall have a minimum length of 1524 mm (5 feet). Posts shall have projections to facilitate fastening the fabric and prevent slippage. Geotextile fabric shall meet the requirements of MNDOT Standard Specification 3886 for preassembled silt fence, furnished in a continuous roll in order to avoid splices. Geotextile fabric shall be uniform in texture and appearance and have no defects, flaws, or tears. The fabric shall contain sufficient ultraviolet (UV) ray inhibitor and stabilizers to provide a minimum two-year service life outdoors. Fabric color shall be international orange.

3. Clean the wheels of construction vehicles in order to remove soils before the vehicles leave the site. Wash vehicles only on an area stabilized with stone that drains into an approved sediment trapping device.

4. Remove all soils and sediments tracked or otherwise deposited onto adjacent property, pavement areas, and streets. Removal shall be on a daily basis throughout the duration of the mining. Clean paved roadways by shoveling or wet-sweeping. Do not dry sweep. If necessary, scrape paved surfaces in order to loosen compacted sediment material prior to sweeping. Haul sediment material to a suitable disposal area. Street washing is allowed only after sediment has been removed by shoveling or sweeping.

5. Where 10 or more acres of disturbed soil drain to a common location, install temporary (or permanent) sediment basins prior to the runoff leaving the construction site or entering surface waters.

6. Avoid removal of trees and surface vegetation wherever possible. Schedule phases in order to expose the smallest practical area of soil at any given time.

7. Inspect all erosion and sediment control devices, and stabilized areas on a daily basis until land-disturbing activity has ceased. Thereafter, inspect at least on a weekly basis until vegetative cover is established. Inspect all erosion and sediment control devices, and stabilized areas within 24 hours after a rainfall event greater than 0.5 inches in 24 hours. Remove accumulated sediment deposits from behind erosion and sediment control devices as needed. Do not allow sediment to accumulate to a depth of more than one-third of the height of the erosion and sediment control devices. Immediately replace deteriorated, damaged, rotted, or missing erosion control devices. Document inspections and dates of rainfall events. Maintain a written log of all inspection, maintenance, and repair activities related to erosion and sediment control facilities.

8. In areas to be permanently seeded, use native seed mixture equivalent to MNDOT No. 350. Apply seed mixture at a rate of 94.7 kg per hectare (84.5 lbs per acre) in accordance with MNDOT Standard Spec. 2575. Incorporate a fertilizer (slow release type with 10 week residual) consisting of 23-0-30 (%N-P-K) into the soil at an application rate of 224 kg per hectare (200 lbs per acre) by disking prior to seeding.

9. Establish native seed mix in accordance with MNDOT Standard Spec. 2575.3. Use a Truax type, or equal interseeder drill with at least two seed boxes: a small/fine seed box and a large/fluffy seed box. Drill large/fluffy seeds to a final planting depth of 10 mm (1/2 inch) to 25 mm (1 inch) deep from the large/fluffy seed box. Split the drill rates in half and make two passes over the site in order to decrease competition in drill rows. Scatter small/fine seeds over the soil surface by drop-seeding from the small/fine seed box, or broadcast. Coordinate with the seed vendor to keep the large/fluffy seeds separate from the small/fine seeds so that they may be installed from separate seed boxes. Lightly harrow or rake the site following the seeding operation. Pack the site following harrowing in order to ensure a firm seed-bed.

10. Comply with the requirements of MNDOT Standard Spec. Table 2575-2 for season of planting native seed mixtures. The appropriate dates for spring seeding are from April 15 through July 20. Fall seeding dates are from September 20 to October 20. Dormant seeding dates are from October 20 to November 15. Dormant seeding will only be allowed if the maximum soil temperature at a depth of 25 mm (1 inch) does not exceed 10 degrees C (50 degrees F) in order to prevent germination.

11. Maintain Areas Planted With Native Seeds: To reduce weed establishment, mow 2 to 3 times (30 days apart) during the first year with the mower deck about 6" – 8" off the ground. Mow one time during the 2nd year before weeds set their seeds. Mow once every 3 to 5 years following the initial 2 years of maintenance in order to remove dead plant material and stimulate new seed.

12. If dewatering is required and sump pumps are used, all pumped water must be discharged through an erosion control facility (temporary sedimentation basin, grit chamber, sand filter, upflow chamber, hydro-cyclone, swirl concentrator, or other appropriate facility) prior to leaving the site. Proper energy dissipation must be provided at the outlet of the pump system.

13. Maintain all temporary erosion and sediment control devices in place until the contributing drainage area has been stabilized (hard-surfaced areas paved and vegetation established in greenspace). Repair any rilling, gully formation, or washouts. After final establishment of permanent stabilization, remove all temporary synthetic, structural, and nonbiodegradable erosion and sediment control devices and any accumulated sediments. Dispose-of off site. Restore permanent sedimentation basins to their design condition immediately following stabilization of the site.

14. Clean sedimentation basins, ditches, and other drainage facilities as required in order to maintain their effectiveness.

15. Apply necessary moisture to the construction area and haul roads to prevent the spread of dust.

16. Wetland Seeding: In areas around the pond and disturbed areas around the wetlands, use MNDOT seed mixture 15A-Modified with Forbs Mix F-3. Follow MNDOT seeding procedure requirements.

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TILLER CORPORATION

HYDROLOGIC EVALUATION

SCANDIA MINING OPERATION

DATE	REVISION

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Kirsten Pauly

Kirsten Pauly

DATE: 3/10/08 REG. NO.: 21842

INFORMATION:

PROJECT NO.:

DRAWN BY: NM

CHECKED BY:

APPROVED BY: KP

SCALE:

DATE:

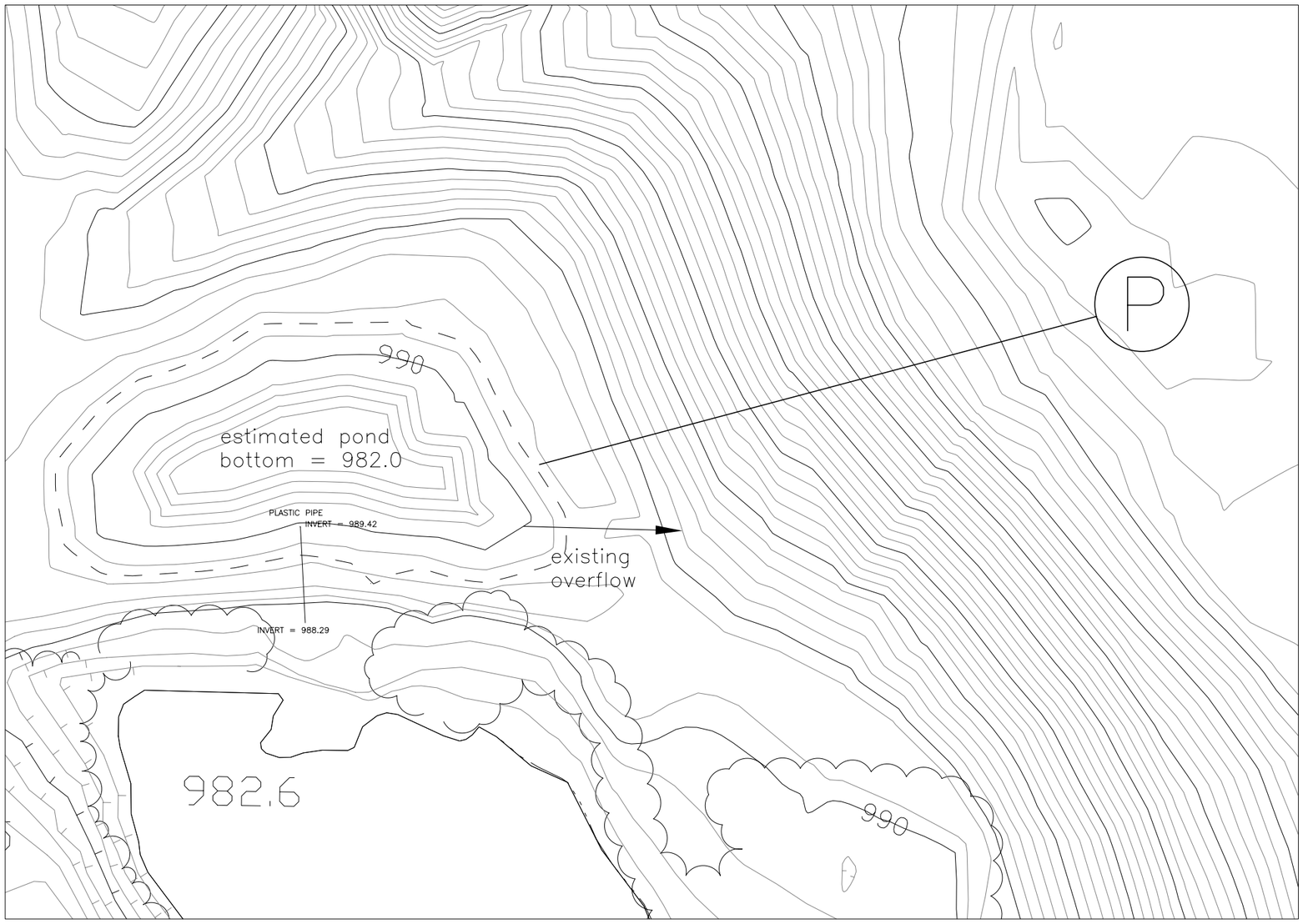
DESCRIPTION:

DRAINAGE AND EROSION CONTROL NOTES AND DETAILS

SHEET NO:

C6

of



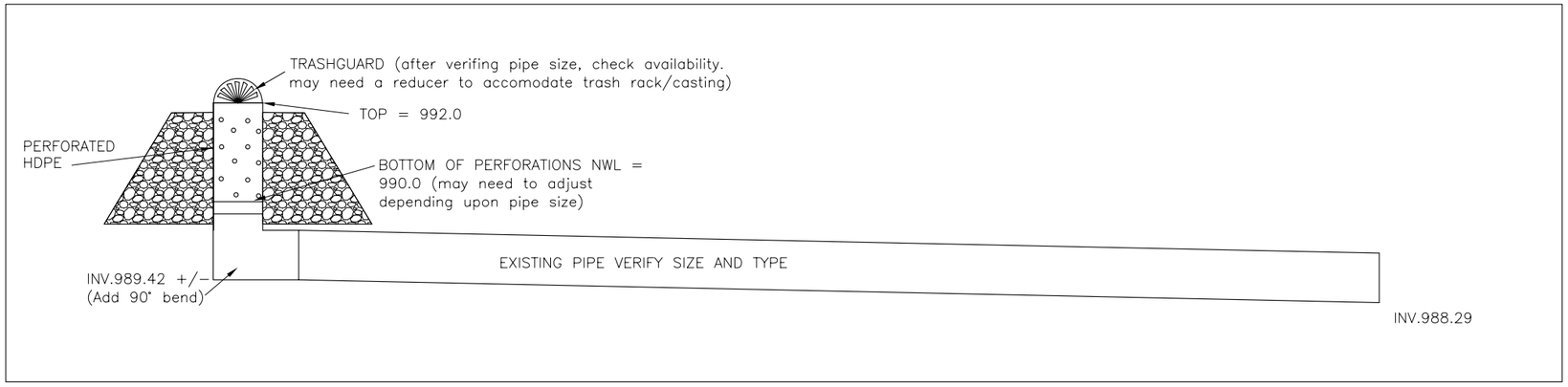
NOTES:

UPPER POND STORAGE = 1.763 AC-FT

LOWER POND STORAGE = 1.331 AC-FT

VOLUME OF UPPER POND BASED ON ESTIMATED POND BOTTOM.

POND IS MAINTAINED BY REMOVING SEDIMENT AS NEEDED.



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APPROVED BY:

SCALE:

DATE:

DESCRIPTION:

STORMWATER PONDING DETAILS

SHEET NO:

C7

of

Barton Sand & Gravel Co.

10633 89TH AVENUE NORTH OSSEO, MINNESOTA 55369 TELEPHONE: (612) 425-4191

March 9, 1988

Mr. Jim Strudell
Division of Water Quality
Minnesota Pollution Control Agency
520 Lafayette Road
St. Paul, MN 55155

Re: Groundwater Study Plan
New Scandia Township

Dear Mr. Strudell:

In accordance with your request, enclosed please find the Revised Groundwater Study Plan for our New Scandia Township operations. This plan has been prepared by Dr. Hans-Olaf Pfannkuch, Professional Hydrogeologist, American Institute of Hydrology, AIH Certificate No. 646.

This plan is a revision of our Groundwater Study Plan dated November 17, 1987. It is based on findings about the general geology and hydrology of the site obtained by field work on the site, interpretations of the data, and specific points raised in various discussions with MPCA staff and company representatives.

The plan is divided into two parts, the first of which consists of the recommendations based on current field work and earlier studies. The second part is a technical report dealing with the field work carried out at the site and its analysis.

After you and any other appropriate MPCA personnel have had a chance to review the revised plan, please contact me so that we can again schedule a meeting to sit down and discuss the new plan and procedures with you.

Thank you for your consideration and cooperation in this matter.

Yours very truly,

Susan B. Turner

Enclosure
SBT/lkr

Revised Groundwater Study Plan for Barton Sand & Gravel Co. Mining Operations in New Scandia Township

Dr. Hans-Olaf Pfannkuch

Submitted March 6, 1988

TABLE OF CONTENTS

Revised Groundwater Study Plan
for Barton Sand & Gravel Co. Mining Operations
in New Scandia Township
H.O. Pfannkuch

Executive Summary:

Field studies indicate that the vulnerability of the subsurface and groundwater systems at the New Scandia Pit to infiltration from contaminated scrubber effluent of the asphalt plant is considerably lower than first assumed. This is because there is reason to assume that the overflow pond (North Pond) is perched and isolated from the groundwater system; no immediate and direct influx of pond water is anticipated although some slow seepage undoubtedly occurs. This however gives time for biological degradation processes to operate in the pond.

The mobility of infiltrated conservative contaminants is low. It is linked to a bulk flow velocity of the groundwater of 30 to 50 feet per year. PAH's will move somewhat slower since they prefer to adsorb on granular materials.

Changes in the operational procedures (Baghouse filtration plant) will eliminate any further generation of contaminants in aqueous solution and their potential infiltration to the watertable. This further reduces the risk of contamination and the vulnerability of the site as a potential source of pollutants.

A stepwise incremental approach in the monitoring network and scheduling design is proposed. Findings at each step would trigger design and activities in the next step if deemed necessary.

This plan proposes as a first step to monitor and sample the plant supply well, and to analyze a broad spectrum of parameters.

If no traces of contaminants are found in the first two samples, the necessity to add any more monitoring points is highly questionable and should be discussed with MPCA in that event.

If contaminants are found, the level of new monitoring activity should also be discussed with MPCA as a function of the severity of the contamination found in the initial samples.

Basis for Report.

The revisions of the above mentioned groundwater Study Plan of November 17, 1987 is based on comments and discussion with MPCA staff, personnel of Barton's gravel mining operations, findings of field work carried out at the site, and changed operation procedures for the asphalt plant which change the groundwater pollution potential.

The technical data on which the conclusions are based are contained in a technical report with appendices containing the results of bore hole sampling, piezometer installation and laboratory analyses of hydraulic properties of collected samples, results from a land survey, and flow calculations.

A summary of the findings contained in the technical section is as follows:

1. Groundwater flow directions at the site have been established as approximately 30 degrees NNW, and gradients are less than a ft. per 1000 ft.

2. Hydraulic conductivity of the granular drift materials in the aquifer varies from K=1E-03 to 1E-02 cm/sec. The most conservative representative value for the calculations is K=1E-02 cm/sec. or 3.28 - E-04 ft./sec. or approximately 30 ft./day.

3. Based on the gradient and hydraulic conductivity and an average porosity of 30%, bulk flow velocities are 0.09 ft./day or 35 ft./year.

4. The area beneath the settling pond at the plant is the most likely source for any contaminants that might have infiltrated downward to the watertable. This area is also directly affected and covered by the drawdown cone of the pumped well (SPW). Samples taken from this well would be the most likely to contain contaminants, if indeed they have migrated downward to the watertable.

5. Water levels in the North Pond are significantly higher than the surrounding watertable, suggesting that the pond is perched and that an effective seal between its bottom and the watertable exists.

6. Degradation rates or removal ratios between contaminants found in the North Pond sample and the effluent are especially effective for the metals where reduction is down to a few percent, and to 20 to 30 percent for the hydrocarbons including phenol. This suggests an effective removal mechanism by aeration and adsorption to particulates in the sediment ponds as effluent is moved from the settling basin to the North Pond. The chemical data are from two samples taken by MPCA.

Furthermore, it needs to be pointed out that Barton Sand & Gravel Co. is changing its procedures for flue gas cleaning which will be done in a filter baghouse operation from the start of the next mining season. This will eliminate any further contaminant (PAH) loading to the groundwater. The company may also change the fuel for the burner in the asphalt process from waste oil to regular fuel oil. This would eliminate additional possible PAH's and heavy metals contained in the waste oil. These two changes would eliminate the potential for contaminant loading.

Analysis of the findings to date and the change to new procedures do not support any potential for massive PAH and heavy metal contamination of the groundwater underneath the site nor a high mobility of the contaminants. It is therefore reasonable to suggest a stepwise incremental approach in monitoring design, where the results from one level of activity will determine the intensity and scope of monitoring at the next level of involvement. In short, this would mean that if, for example, repeated sampling from the supply well show no detectable levels of contaminants of concern, only minimal, further monitoring activities need not be carried out. If contaminants are found, the severity of contaminant levels would determine the density of the monitoring network and frequency of sampling and analysis.

Detailed Discussion of Study Plan.

A. Ongoing Activities -

1.) Water level measurements in the present piezometers will continue on a bi-weekly basis until all parties are satisfied that flow directions and gradients remain stable in time.

2.) The water supply well is being equipped with an access port so that water levels in this well can also be measured and tied in with the piezometer network.

3.) A pumping test or at least a drawdown test of the supply well is scheduled for the week of March 6-11, 1988 in order to confirm drawdown response and hydrologic characteristics of the watertable aquifer.

B. MPCA Comments -

The following addresses in detail comments that were made by MPCA staff in December 1987 and summarized in points 1 to 14 as shown on Table R1. Part of the agreement with MPCA to address these points properly was to do the field work outlined in the technical report.

Item 1. The first step is to sample the plant water supply well. After the technical report has shown that samples would be representative of any contamination that could have occurred below the asphalt plant and the settling pond.

The compounds to be analyzed for are the PAH's (The sixteen priority pollutants, standard sweep according to code 470 MN Dept. of Health), the heavy metals arsenic, cadmium, chromium and lead, furthermore phenol, total dissolved solids, specific conductivities, Ph, Eh, TDL and DOC. This is as requested in item 11. At this time major ion and pesticide analyses would not be included in the analysis since they are not related to the contamination potential of the plant operations. Sampling including chain of custody procedures and analysis will be done by an accredited testing laboratory acceptable to MPCA (such as Twin City Testing, for example) according to standard procedures. These as well as the proposed methods of analysis for PAH's will be submitted to MPCA by the laboratory for approval. This addresses item 14C.

At least two samplings are proposed - one immediately and one at or after the spring recharge as determined by the well hydrographs of the piezometers. After the results of the analyses are available, further need for sampling and the number of parameters to be tested would have to be discussed with MPCA.

Item 2. Since Barton is changing to a baghouse filter plant no containment structures for the effluent pond are planned. Under the new operational plan (as well as under the condition of total retention of the scrubber effluent in a containment structure) no plant effluent will reach the watertable. Only minimal pumping will take place. The natural groundwater flow field would be undisturbed except for sampling periods. If any further monitoring wells are necessary, these would have to be located in accordance with the flow lines of the undisturbed flow field.

Item 3. The technical report and appendix C (calculations) show the impact of the supply well on the flow field. Hydrologically, after each pumping period (12 hours maximum) water levels in the well will recover before the next period. If any accumulated residual drawdown should persist during the work week, it would recover over the down

period during the weekend. The hydraulic impact of the supply well is that of periodic drawdown and recovery with no permanent impact on the natural groundwater flow. The technical report shows that the well would capture contaminants accumulated beneath the plant.

Item 4. The very low gradient of the watertable suggests that there is no noticeable relief on the watertable surface and therefore no vertical hydraulic gradients are expected. This will be tested when water levels can be measured in the supply well whose screen is set some 50 ft. below the water table. If a significant vertical hydraulic gradient exists this should show up in a marked difference of water levels between SPW and piezometers PZ#1 and PZ#3 which are very close because they lie almost on an equipotential line.

Item 5. The installation of the three piezometer wells was carried out under the supervision of a licensed engineer by Twin City Testing, and all Minnesota rules have been observed. Detailed soil boring and split spoon samples have been taken from all three piezometer borings. Their location, analyses and results are given in Appendix A. Samples of all collected materials have been retained and are accessible for further inspection or analysis.

Item 6. Sampling of pond bottom sediments will not be carried out since any results from such sampling would not have any impact on the need for groundwater monitoring in the vicinity of the asphalt plant.

Item 7. If any further monitoring wells are necessary split spoon samples from the aquifer certainly will be taken for the definition of stratigraphy - at similar intervals as for the piezometer borings. Grain size analysis would be done on samples below the water table for the assessment of hydrologic properties in the groundwater flow zone.

Item 8. The number of monitoring wells should be decided based on the outcome of the analyses from the supply well and in consultation with MPCA. From the results of the analyses, it should also be determined how to use the supply well as part of the permanent monitoring system.

Item 9. The location of any additional monitoring wells, if necessary, would be made on the basis of the ground water flow net construction shown in Figure 2 and in consultation with MPCA, including written permissions.

Item 10. As soon as the plan has been approved and after the results of analyses from the supply well have determined what level of monitoring network is necessary, purchase orders for monitoring well construction would be issued. The actual completion time would depend on the schedule of

the testing service or drilling company. It is necessary however to first analyze the sample from the supply well before the first round of monitoring well sampling. The crux of the stepwise approach is to first sample the supply well and then based on its findings decide whether further monitoring wells are necessary.

Item 11. This has been addressed under Item 1.

Item 12. It seems reasonable that the question as to how many samples are to be taken should be revised after the first two samples have been analyzed. Piezometer readings will be done on a bi-weekly basis for the next month. During the pit operating season, monthly piezometer level readings seem more appropriate, especially now that no scrubbing water is needed. Records of pumping will be kept for pumping periods exceeding two or three hours. This is not anticipated to occur very often since water at the plant would now only be used for incidental use and cleaning.

Item 13. Addressed under Item 1.

Item 14. All procedures, drilling, sampling, well installation, water sampling and analysis etc. will be done by licensed and accredited operators and laboratories that are acceptable to MPCA after discussion with MPCA staff. Obviously only those companies that are capable of high quality assurance and quality control in following the standard procedures will be chosen for this work. Once selected they should submit the details of their standard procedures to Barton and MPCA for acceptance.

TABLE R1- MPCA Comments on 11/17/87 Groundwater Study Plan (See Appendix B)

1. The first step in testing should be the water quality analysis of a sample taken from the plant water supply well. Such a sample should be analyzed before the first round of monitoring well sampling. Subsequent sampling of this well should be conducted simultaneously with sampling of the monitoring wells.

2. Barton mentioned in an October meeting that some type of containment structure for the scrubber effluent may be constructed at the site, so as to limit infiltration to ground water. How would Barton plan to address the changes resulting from such construction on the design and implementation of the ground water study?

3. The MPCA is not certain that Barton has assessed the possible impact of the plant water supply well on the flow field. You should detail how the study will account for such an impact, particularly in view of the variation in pumping rates during the year.

4. Barton will need to address vertical hydraulic gradients, by including some nested piezometer wells, and possibly some nested monitoring wells.

5. The installation of piezometer wells shall be installed and abandoned in accordance with the requirements for temporary observation wells in Minnesota Rules Parts 4725.2000 and 4725.3000. Detailed soil borings (for example, split-spoon samples) should be conducted in conjunction with the installation of at least one of the piezometer wells.

6. You have proposed sampling the bottom sediment for chemical analysis. This sediment may have been contaminated to near saturation prior to discharge. If solids are to be analyzed in this way, the MPCA prefers that samples be taken from both the sediment and the native material, beneath the accumulated scrubber sediment. Although the data from such samples may be useful, they will not of course preclude the need for ground water monitoring in the vicinity of the asphalt plant. Such sampling, if done, should be carried out during the winter. Costs could be minimized by sampling immediately following the installation of monitoring wells, rather than during a separate boring program. You may want to have these samples analyzed for solid and/or hazardous waste characteristics. If you consider this, we suggest that you contact the environmental committee of the Minnesota Asphalt Pavement Association.

7. The installation of monitoring wells shall be done in conjunction with detailed soil borings (for example, split-spoon samples) to better define the stratigraphy. Grain size analyses should be conducted on the soil boring samples.

8. You propose the installation of "up to 3" monitoring wells along "the principal flow line of ground water." The MPCA will require at least three wells, which should not necessarily be installed in a straight line.

9. On page 8, you note that monitoring well "siting decisions will be made. . . in consultation with the MPCA." Barton will need written approval from the MPCA of each well site before well installation begins.

10. By what period of time after MPCA approval of the plan do you propose to have the initial set of at least three monitoring wells installed?

11. The MPCA requests that you provide a more specific list of each parameter for which you propose to analyze water samples in the first round of testing. In particular, we would like to know which major ions and representative pesticides you intend to analyze for. You should include pH, specific conductance, Eh, total organic carbon (TOC) and dissolved organic carbon (DOC) on this list of analyses for the first test round.

12. The MPCA will require at least quarterly testing for the first year, regardless of whether or not contaminants are found. In addition, Barton shall measure water levels, weekly, in the piezometer and monitoring wells from the date of installation, and shall maintain daily records of make-up water pumping.

13. Your proposal to test for phenol as a precursor for polynuclear aromatic hydrocarbons (PAH's) is acceptable, although TOC and DOC should also be tested simultaneously with phenol.

14. Barton needs to provide details on the standard procedures proposed for: A) solid material sampling and analysis; B) well installation and development; C) water sampling and analysis. The MPCA is particularly interested in the proposed methods of analysis for PAH's.

The MPCA would like to emphasize that if the study adjacent to the asphalt plant indicates that the ground water has been significantly impacted, then additional well installation and/or some type of remedial action may be required.

Technical Report

Results of Field Study-
Barton Sand & Gravel Mining Operations, New Scandia Township

The purpose of the recent field work at the Scandia mine was to obtain information about geologic and hydrologic characteristics of the water bearing materials at the site. This was accomplished by drilling three boreholes and installing three piezometers on the site. A general site plan is shown on Figure 1.

The on-site work was carried out by Twin City Testing Corporation on January 8 and 11, 1988. Laboratory tests on soil samples were performed subsequently. The results are shown in the detailed reports in Appendix A. The piezometers (PZ#'s 1,2 and 3) and the supply well (SPW) were surveyed in for location and elevation by Lot Surveys Co. on February 11, 1988. The original plan is shown in Appendix B. Other data is summarized on Table 1. A site location sketch is given on Figure 2. Water levels and position of the watertable have been measured in the 3 piezometers on January 11, February 11 and March 1, 1988. These are preliminary results as more readings will be taken and the supply well is readied to permit access by tape for a complete survey of water levels. Water elevation of the North Pond was taken on February 11 and March 1. Watertable elevations are shown on Table 1. Calculated groundwater flow directions and watertable slopes or gradients I are shown on Figure 2 as a flow net construction for natural undisturbed flow.

Figure 3 shows a cross-section of the site indicating the position and depth of the piezometers and the supply well, summary boring logs, position and length of intake screen, and the water levels as taken on March 1, 1988, including that of the North Pond. Figure 4 shows the well hydrographs and lake level of the North Pond as a function of time for the dates measurements were taken. The measurement for Piezometer #3 on February 11 is out of line, but could be a measurement error; more measurements are needed to ascertain that #3 cofluctuates with the rest of the wells. Otherwise the water level declines steadily as would be expected for this time of year.

The extent and depth of the North Pond were measured on March 4, 1988. The average depth is 3.4 ft., the pond area approximately 50,000 sq. ft. (See Fig. 8).

Discussion on Drift Characteristics:

The unconsolidated material immediately underlying the New Scandia Pit is glacial drift material, outwash sand and gravel with some till material. SPW and PZ#1 encounter sandy material throughout, PZ#2 has some less permeable tilley, clayey material near the surface. This is borne out by the observation that the North Pond maintains a lake level difference of about 6 feet to the groundwater level, which could not be sustained in permeable material. PZ#3 also has till materials between depths of 5 and 12 feet approximately. The cross-section in Figure 3, however, shows that the bottom parts of the piezometer screens all finish in the same sandy, gravelly aquifer material.

With the existing data it is not possible to give a precise estimate of the total thickness of the unconsolidated drift material and the elevation of the bottom of the aquifer material in which the piezometers are finished and out of which SPW draws the water. The geological cross-section (A-Al) of Figure 4 in the Barr Report to the Washington County Planning Department is based on well logs approximately 6,000 feet south of the study site. It indicates a lower clay and sand layer that could be considered a lower confining base at an elevation of approximately 860 feet NGVD. Above this the more permeable sand and gravel aquifer is found. The bore hole logs on the Scandia Pit site, especially the supply well, suggest that the sand and gravel extends at least to the 840 feet elevation. A well penetrating to bedrock (#112603) at about 3400 feet west of the pit indicates that the bottom of the sand is at an elevation of 745 feet.

Hydrologic Parameters:

Hydrologic characteristics have been estimated on the basis of sample analysis and testing by Twin City Testing and samples tested for the Barr Report. The two samples taken for the Barr Report were taken from the present pit surface and are to be considered at the high end of hydraulic conductivity, K = 1 E-02 cm/sec to 4 E-02 cm/sec. Samples taken at depth and especially at or near the water-table tested by TCT gave results ranging from K=8 E-02 cm/sec

to K=5 E-07 cm/sec. The most representative values are taken to be K=1 E-02 and K=1 E-03 cm/sec., which will be the basis for the transport and bulk migration velocities. Exact values and depth at which samples were taken are given in Appendix A with the boring logs.

Porosity of the type of material encountered can be estimated at 0=30%. This is the same value used in the Barr Report. The specific retention Sy which is a measure of the storage coefficient for watertable aquifers can be estimated as between Sy = 10% to Sy = 20%. For the calculations a mean value of Sy = 15% will be used.

To estimate transmissivity, the saturated thickness (Ms) of the aquifer has to be known. The minimal value for this thickness is to assume that the bottom of the intake screen of the supply well is right on top of the lower impermeable or low permeability layer which overlies the bedrock. This gives a minimal thickness of 78 feet (Total depth of well 98 feet minus static waterlevel at construction 20 feet = 98 - 20 = 78). Based on interpolation estimates of present waterlevels at roughly 917 feet and bottom hole elevation of 836 feet, this estimate still holds. The saturated thickness will be taken as 80 feet. This value is conservative as it will tend to overestimate drawdown.

Watertable gradients or slopes are based on level measurements in the piezometers shown in Table 1 and Figure 4. Water levels decline as expected this time of the year,

except that the February 11 value for PZ#3 seems to be off. This could be the classical error of misreading the foot-marker in the hold position. Gradient calculations made for February 11 would still show a flow direction to the northwest with this value, however, if a 1 foot correction were carried out (- 1 foot), the value would fall exactly between PZ#1 and PZ#2 where it is expected.

All background data and the formula used to arrive at flow velocities etc. are summarized on Table 2. This shows that the average bulk flow velocity away from the site is 35 ft./year if K = 1 E-02 cm/sec., and even lower, 4 ft./year if K is 1E-03 cm/sec.

Drawdown around the pumped well has been calculated for a number of operating conditions from maximum pumping rates at maximum hours of daily operation (600 GPM for 12 hours) to more average conditions (300 GPM for anywhere between 6 and 8 hours operating time.

Only daily cycles of pumping are investigated. A well pumped out of an aquifer of large areal extent will take about the same time to recover to initial levels as pumping lasted. Even at 12 hours operating time the well should have ample opportunity to recover before the next morning shift starts. This is much more the case for shorter operating and longer idle times. In the worst case, whatever residual drawdown might still be noticeable as the accumulation of a well's activity would have enough time

to return to initial levels during the rest period over the weekend from 7 p.m. Friday to 7 a.m. Monday.

Figure 5 shows a cross-section through the cone of drawdown as a function of logarithmic distance and pumping time. Figure 6 shows an undistorted cross section of the cone for Q = 600 GPM. The point of these figures is to show that the cone reaches under the settling basin at the outlet of the wet scrubber system which is assumed to be a potential source of contamination if dissolved materials migrate vertically down due to infiltration. Figure 7 shows the situation when the cone of depression is superimposed on a regional flow and confirms that drawdown still will tend to pull the tracer particles into the pumped well although the general flow direction is away from it.

Summary.

Extensive fieldwork at the New Scandia pit has clarified the hydrologic picture of groundwater flow in and around the site. More field measurements will be collected in order to verify and enhance the reliability of the present conclusions.

1. Groundwater flow directions underneath the site have been calculated to be in a northwesterly direction, the flowlines intersecting the N-S line at an angle of 30°. This is supported by looking at the general regional groundwater flow field on a larger scale, and it has been calculated and estimated through a groundwater flow model (Barr

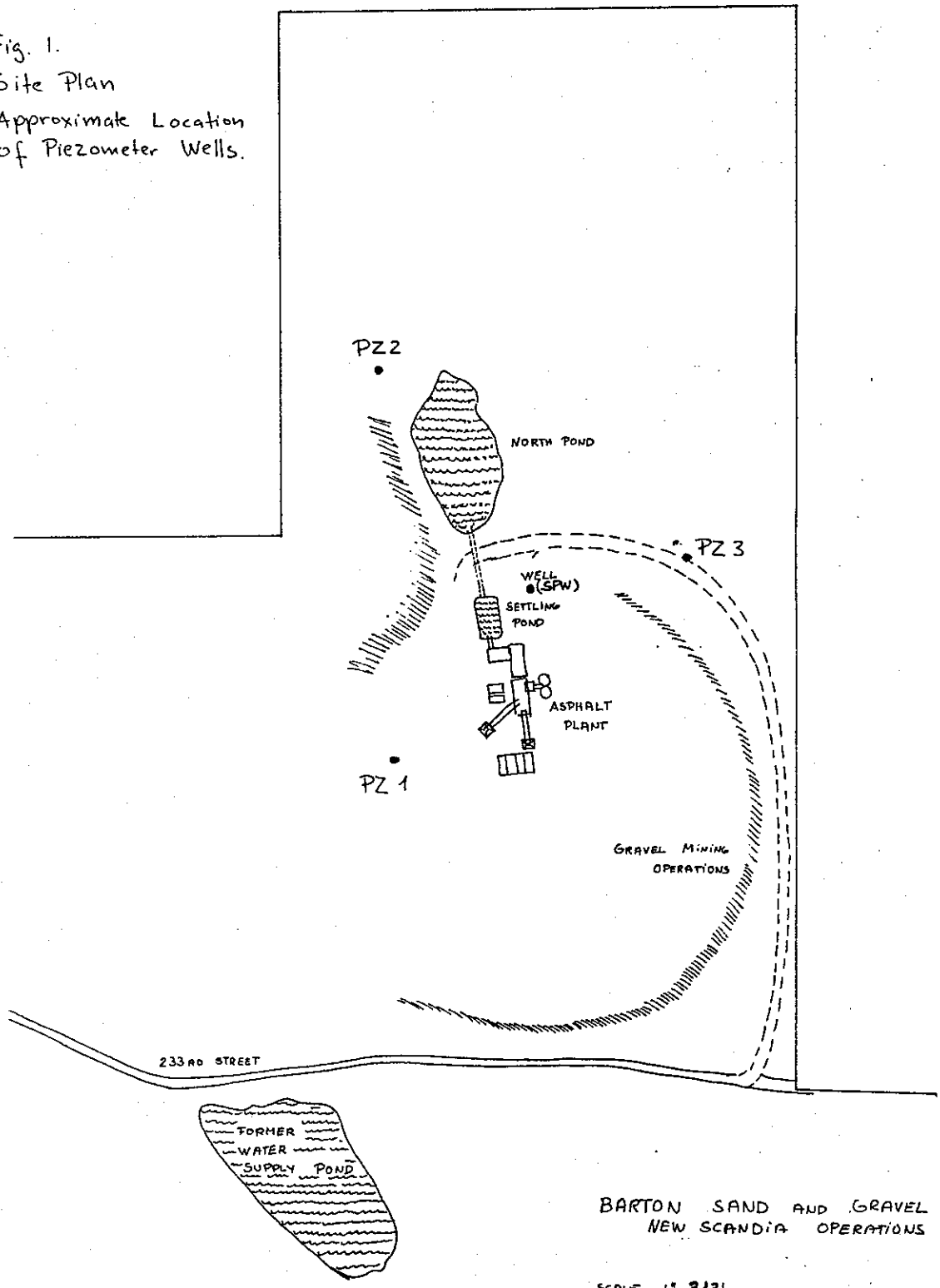
Report). Local measurements therefore confirm and correspond to the larger picture.

This finding is therefore in total contradiction to hypotheses asserted earlier that the Barton New Scandia Pit Operation is the source of alleged well contamination by selected PAH's in residential water supply wells approximately 1 mile southeast and southwest of the operations, respectively.

2. The gradient of the watertable under the site is low (I=1E-03) which implies low average bulk flow velocities, at approximately 35 to 50 feet per year. This is lower than the 500 feet per year estimated for the Barr Report, but it is based on hydraulic conductivities that are lower K=1E-02 cm/sec. as against 4E-02 cm/sec., and a gradient that has been measured to be 1/3 of the one shown in Figure 5 of the Barr Report. This explains the difference of about 1 order of magnitude. At the rate of 35-50 feet per year, bulk travel time for one mile would be between 100 to 150 years. Even at 500 feet per year, travel time for 1 mile is about 10 years. Because of adsorption of low solubility PAH's, their travel time would be even longer.

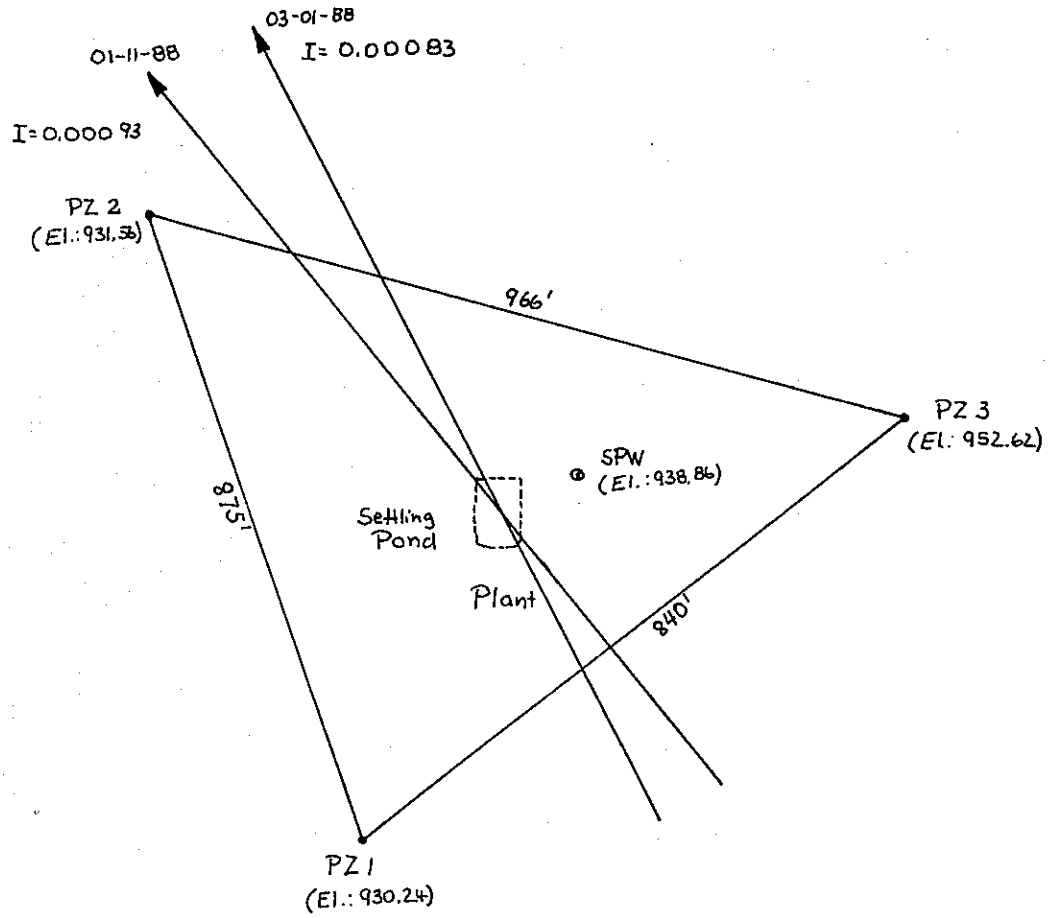
3. Under pumping, gradients are increased and flow greatly accelerated. Calculations based on the information available show that bulk flow from beneath the plant site (settling pond) and the North Pond (overflow pond) would be captured by pumping the supply well. Sampling of this well would therefore capture any contaminants and be representative of the contamination, if any, beneath the settling pond or North Pond. This statement is also corroborated by recommendation #1 under "Recommended Measures" from the Barr Report.

Fig. 1.
Site Plan
Approximate Location
of Piezometer Wells.



BARTON SAND AND GRAVEL
NEW SCANDIA OPERATIONS

SCALE 1"=312'



Groundwater Flow Directions
Gradient - I

Fig 2. Well Triangulation Survey

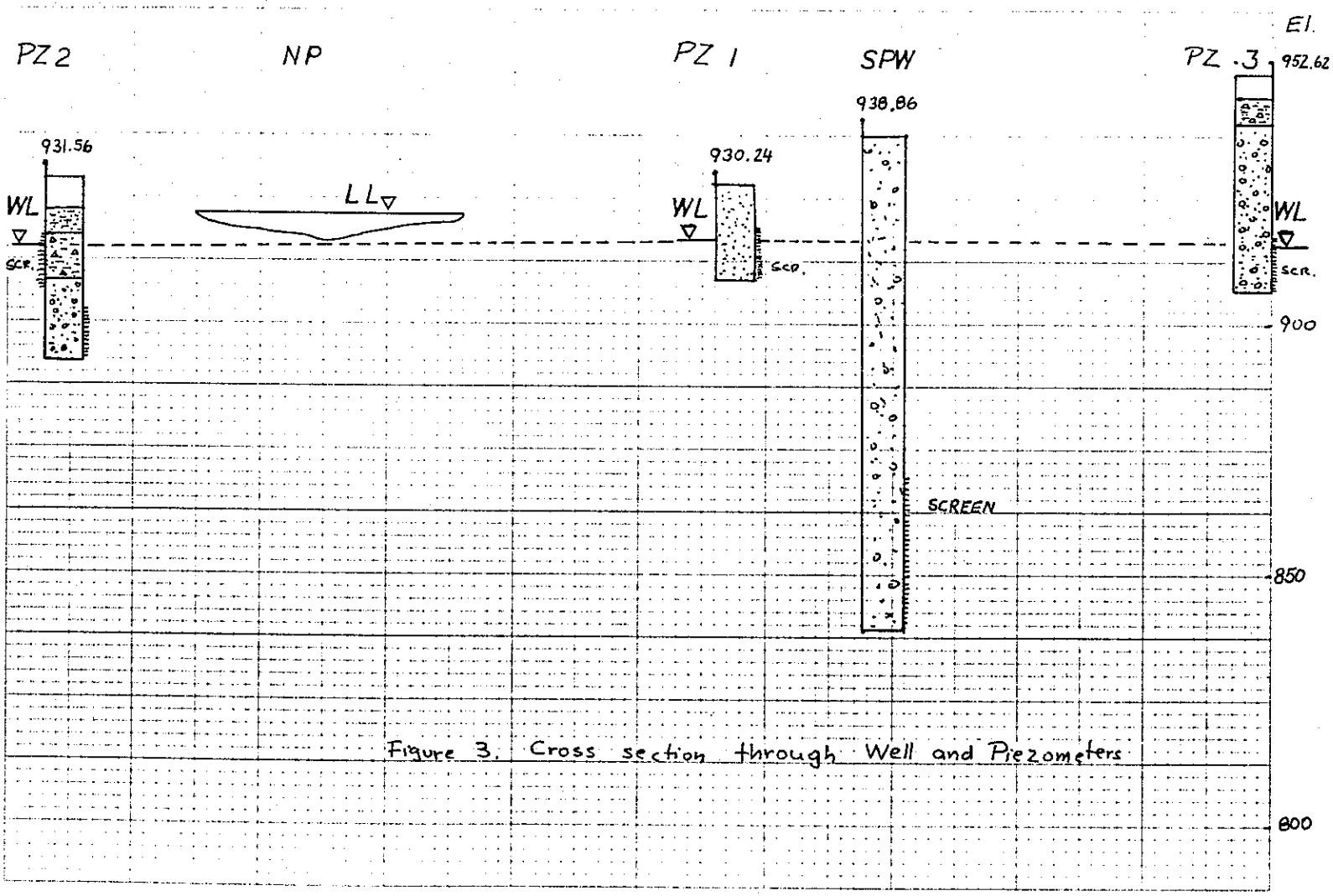


Figure 3. Cross section through Well and Piezometers

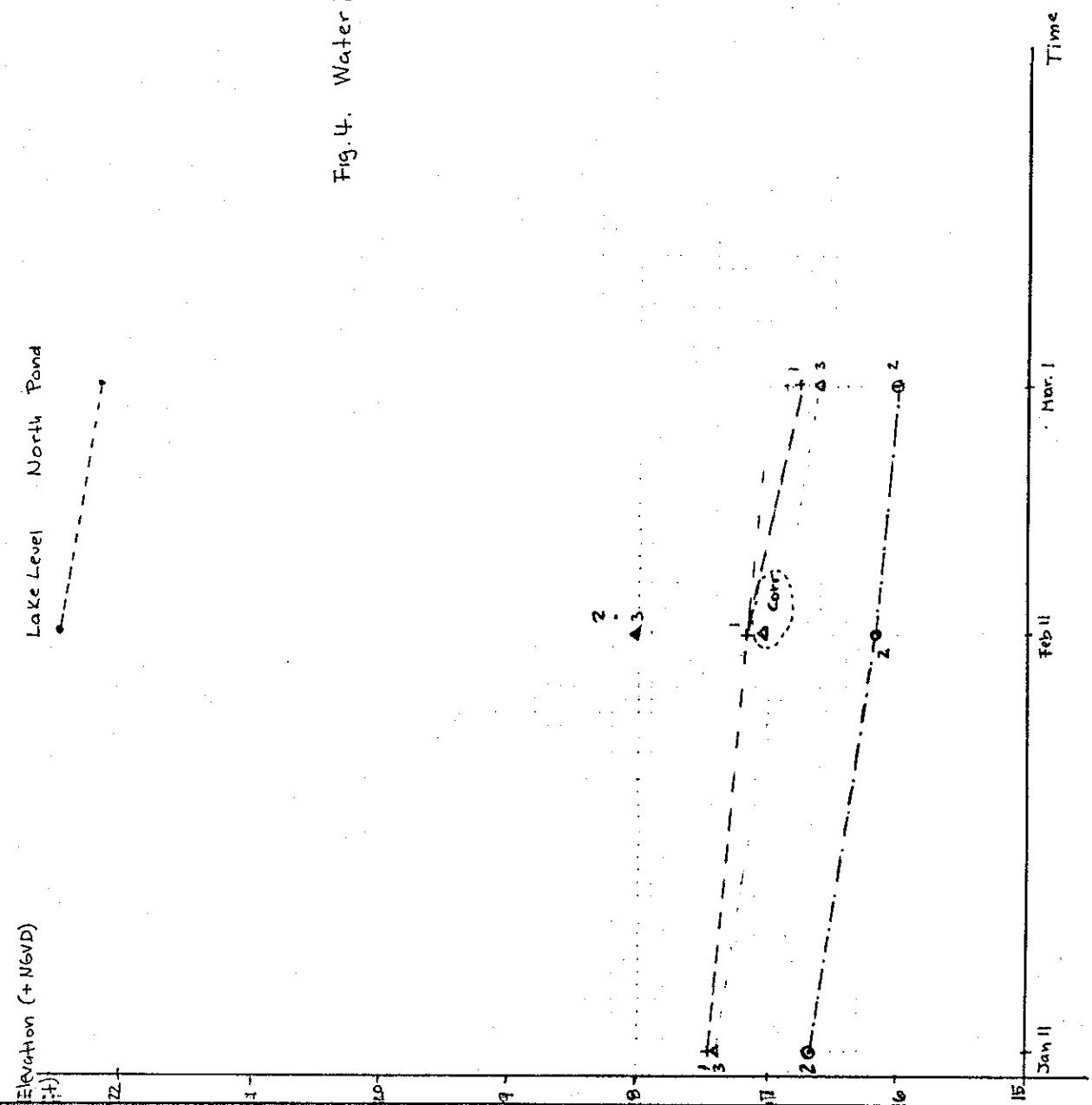


Fig. 4. Water level Hydrographs

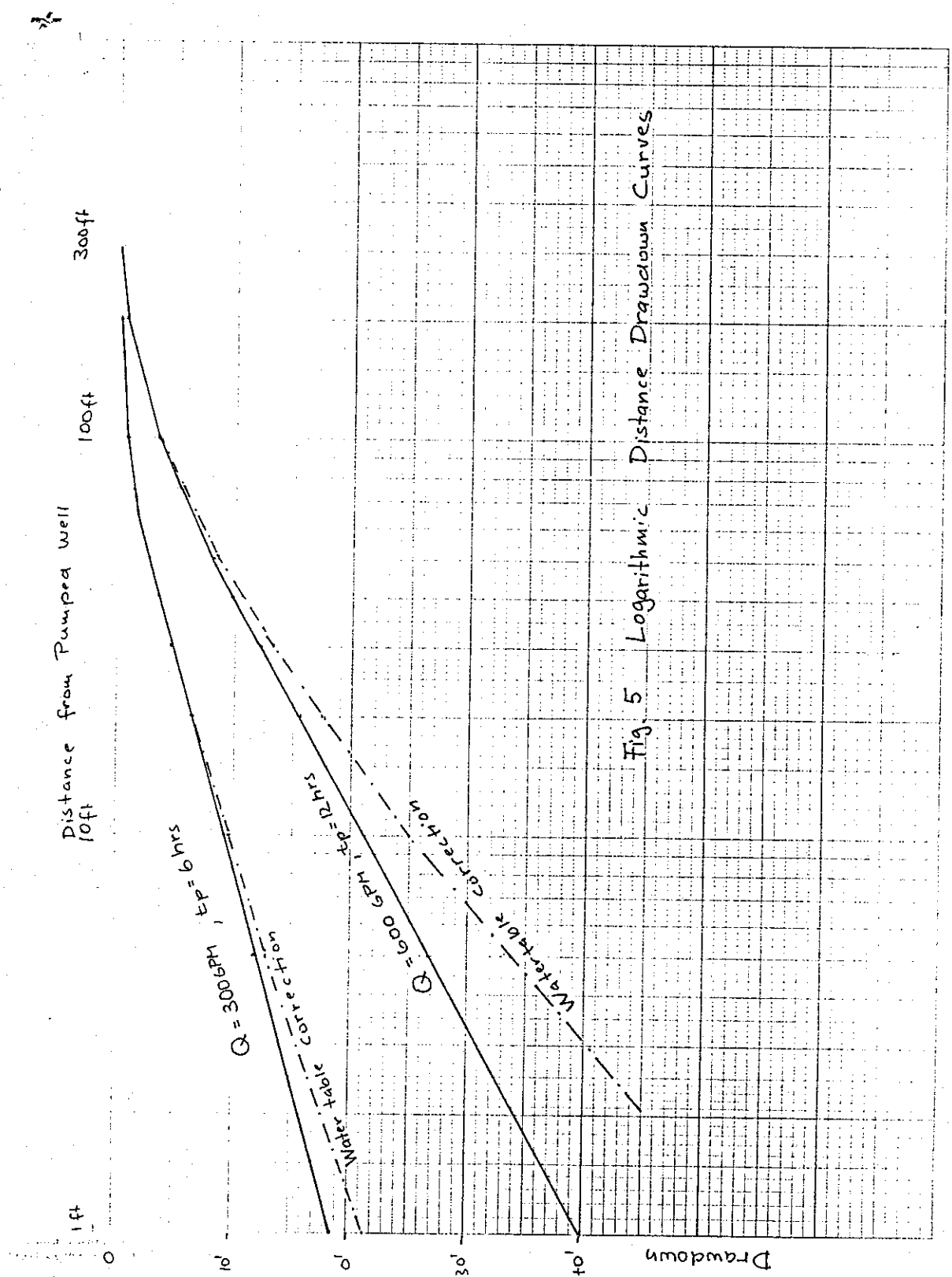


Fig. 5 Logarithmic Distance Drawdown Curves

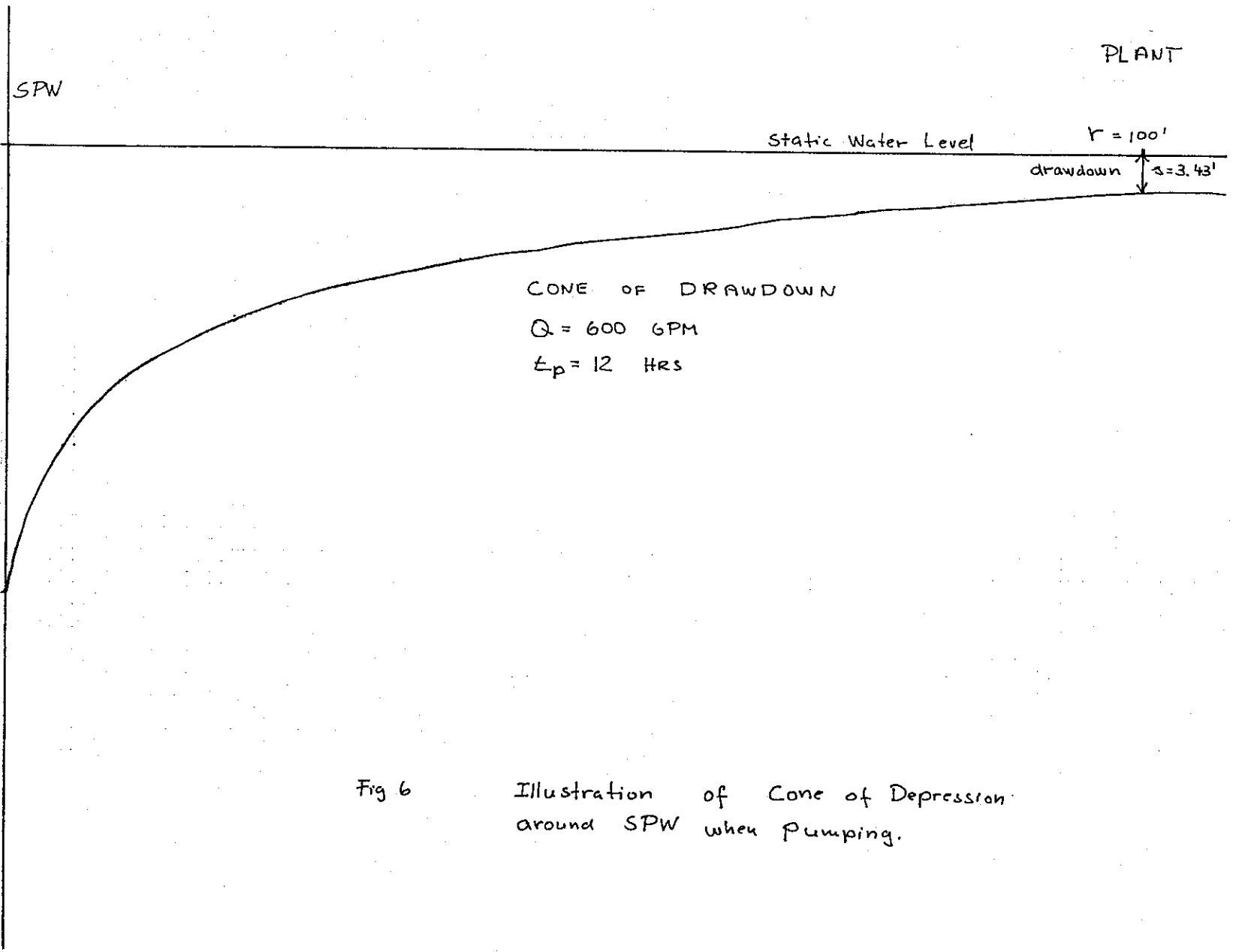


Fig 6 Illustration of Cone of Depression around SPW when Pumping.

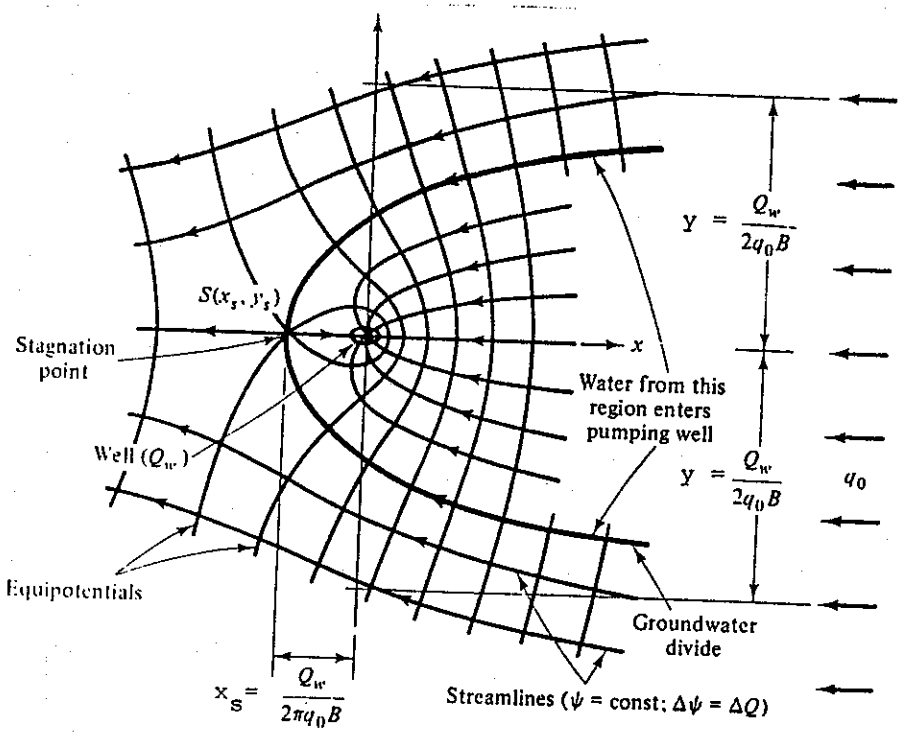


Figure 7. Area of influence of a pumped well in a flowing aquifer

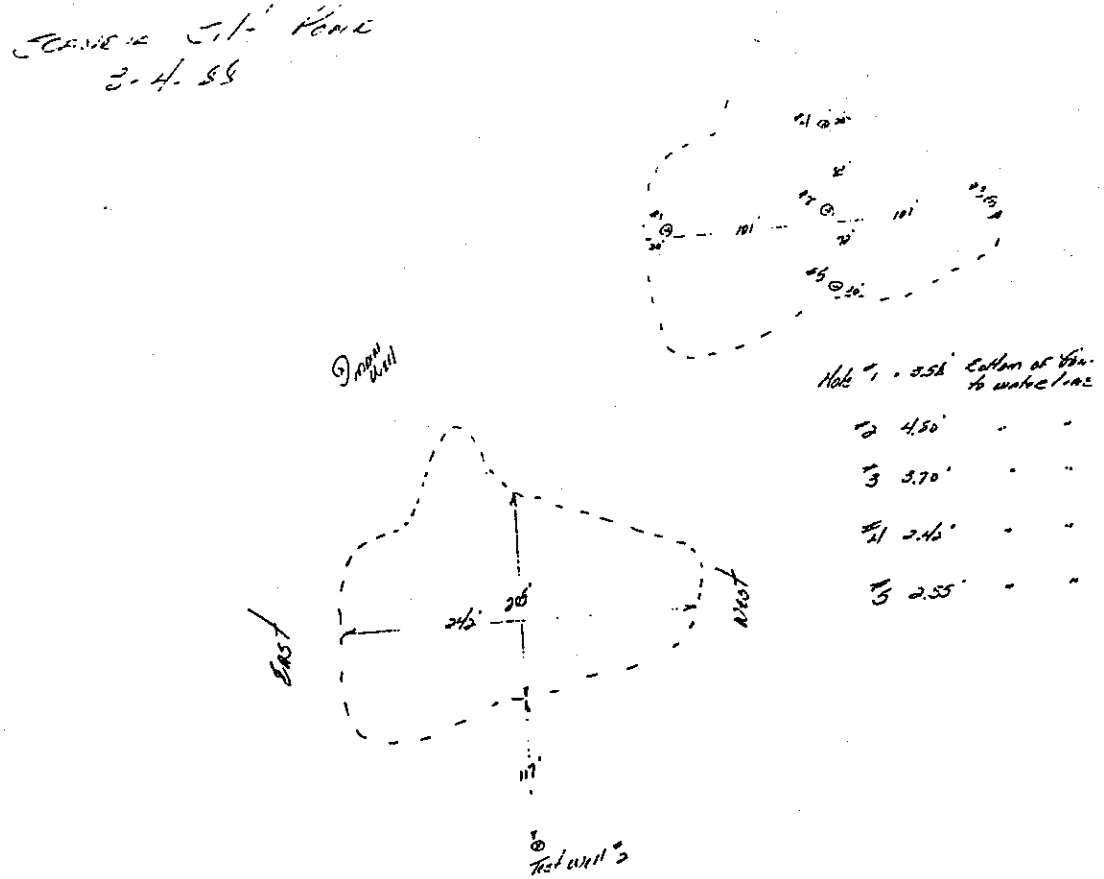


Figure 8 - North Pond
Surface Area and Depths

Table 1. WATER LEVEL ELEVATIONS

Well Design.	Elevation of Measuring Point	Date 01-11-88 Depth to Water	Elevation of Water	Date 02-11-88	Elevation of Water	Date 03-01-88	Elevation of Water
SPW	938.86						
PZ 1	930.24	12.8	917.44	13.07	917.17	13.3	916.77
PZ 2	931.56	14.95	916.67	15.40	916.16	15.5	916.06
PZ 3	952.62	35.2	917.42	34.60	918.02	36.0	916.62
Lake (NP)					922.47		922.17

Table 2

BACKGROUND DATA AND DEFINITIONS

Hydraulic Conductivity	$K = 10^{-2}$ cm/sec $= 3.28 \times 10^{-4}$ ft/sec
Storage Coefficient : Assumed	S = 0.10 - 0.20
Porosity (assumed)	ϕ = 0.3 or 30%
Saturated thickness of aquifer	Ms or D = 80 ft
Transmissivity	$T = K.D = 0.026$ ft^2/sec
Gradient	I = 0.001
Darcy Flux	$90 = K \times I = 3.28 \times 10^{-7}$ ft/sec
Average Bulk velocity	$v = \frac{90}{\phi} = 1.09 \times 10^{-6}$ ft/sec 0.09 ft/day = 34.5 ft/yr
Operating Conditions	Q = 600 GPM = 1.34 cfs 300 GPM = 0.67 cfs
Maximum hours per day Average	12 hrs 6-8 hrs
General Pump discharge	280 GPM

Yearly Operating Hours - 780, Total Permit 13.1 Million Gals/year
1.75 Million CF

APPENDIX A

twin city testing
corporation

662 CROMWELL AVENUE
ST. PAUL, MN 55114
PHONE 612/645-3601

January 27, 1988

Barton Sand & Gravel Company
10633 89th Avenue North
Maple Grove, MN 55369

Attn: Mr. Gary Sauer

SUBJ: Ground Water Study
Barton Sand and Gravel Company Site
New Scandia Township, Minnesota
TCT #4220 88-214

Gentlemen:

We have completed three soil borings, three piezometer installations, and laboratory tests of soil for the above referenced project. This work was authorized by Gary Sauer on December 29, 1987. We understand that the results of this work will be used in a ground water study required by the Minnesota Pollution Control Agency and Washington County. Instructions for the boring locations and piezometer construction were given to our drilling crew in the field by you or your consultant Olaf Pfannkuch. A representative from the MPCA was also present and furnished recommendations for the field work.

The soil boring and piezometer installation work was done on January 8 and 11, 1988. The borings were advanced using 3 1/4" hollow stem auger. Piezometers were installed in the boreholes. The borings were put down at the approximate locations #1, #2, and #3 as shown on Figure 2 entitled, "Proposed Piezometer Locations" furnished to us on December 29, 1987. We have not provided elevations of the borings or piezometers or a sketch of the locations as we understand this information will be furnished by you.

Logs of the soil borings, installation of piezometer data, and Minnesota Department of Health Water Well Records are attached. Portions of the soil samples recovered from the borings were given to Olaf Pfannkuch in the field.

Representative samples of the various layers of soil were selected for sieve and hydrometer analysis as an aid for estimating coefficients of permeability (hydraulic conductivities). Results of eight sieve analysis are given on the attached data summary sheets; the hydrometer analysis on the attached grain size distribution curve sheet. All tests were performed in general accordance with ASTM: D422 procedures.

Coefficient of permeability estimates (K) are presented on the attached boring logs. We emphasize these are estimates only, and that actual K rates may vary by a factor of 2-3 from the given estimates. These estimates are based on the test results and on previous experience with permeability test performed on similar soils.

Soil sampling was performed in accordance with ASTM: D 1586-84. Using this procedure, a 2" O.D. split barrel sampler is driven into the soil by a 140 lb weight falling 30". After an initial set of 6", the number of blows required to drive the sampler an additional 12" is known as the penetration resistance or N value. The N value is an index of the relative density of cohesionless soils and the consistency of cohesive soils.

As the samples were obtained in the field, they were visually and manually classified by the crew chief in accordance with ASTM: D 2487-85 and D-2488. Representative portions of the samples were then returned to the laboratory for further examination and for verification of the field classification. Logs of the borings indicating the depth and identification of the various strata, the N value, water level information and pertinent information regarding the method of maintaining and advancing the drill holes are attached. Charts illustrating the soil classification procedure, the descriptive terminology and symbols on the boring logs are also attached.

The soil samples will be held at this office for 30 days after the completion of this report. If you have any questions regarding this report, please contact John Gislason at 641-9381.

Very truly yours,

John F. Gislason, Jr, P.E.

JFG/djs

Encs.

LOG OF TEST BORING

JOB NO. 4220 88-214 VERTICAL SCALE 1" = 5' BORING NO. 1

PROJECT Groundwater Study - Sand & Gravel Site - New Scandia Township, Minnesota

DEPTH IN FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION ____)	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	LAB TESTS W	LAB TESTS K* CM/SEC	LAB TESTS Qu
	SAND W/A LITTLE GRAVEL, fine to medium grained, brown, moist, frozen to medium dense (SP/SP-SM)	COARSE ALLUVIUM			1	SB			
			9		2	SB		1×10^{-2}	MA
5					3	SB		5×10^{-3}	
	SAND W/SILT (See #1) (SP-SM)		4		4	SB		5×10^{-2}	MA
6½									
7½	SAND, fine (See #2) (SP)				5	SB		8×10^{-2}	
	SAND W/A LITTLE (See #3) (SP)		75		6	SB			
9				▼					
10	SAND, fine (See #4) (SP)				7	SB		5×10^{-2}	
	SAND W/SILT AND GRAVEL, medium grained, brown, waterbearing, very dense to medium dense (SP-SM)		32		8	SB			
			16		9	SB		5×10^{-3}	MA
			13		10	SB			
18	End of Boring								

#1 - AND GRAVEL, medium grained, brown, wet, very loose (SP-SM)

#2 - grained, brown, moist, medium dense (SP)

#3 - GRAVEL, medium to fine grained, brown, moist, very dense (SP)

#4 - grained, brown, moist to 9½' then waterbearing, dense (SP)

*Rates shown are only estimates

Note: Piezometer installed in boring. See attached "Installation of Piezometer" data sheet.

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
1-8	10:15	11½'	9½'	10½'	to	9½'
1-8	10:30	18'	18'		to	NMR
1-8	11:15		See Note		to	
					to	

START 1-8-88 COMPLETE 1-8-88

METHOD HSA 0'-18' @ 10:30

CREW CHIEF White

twin city testing corporation

SE-2 (77-B)-5

LOG OF TEST BORING

JOB NO. 4220 88-214 VERTICAL SCALE 1" = 5' BORING NO. 2

PROJECT Groundwater Study - Sand & Gravel Site - New Scandia Township, Minnesota

DEPTH IN FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION ____)	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	LAB TESTS W	LAB TESTS K** CM/SEC	LAB TESTS Qu
	SILTY SAND W/A LITTLE GRAVEL, fine grained, brown, moist, frozen to medium dense, (See #1) (SM)	COARSE ALLUVIUM			1	SB		5×10^{-4}	
2½	SAND W/SILT AND A LITTLE GRAVEL, fine grained, brown, moist, medium dense (SP-SM)		11		2	SB		2×10^{-3}	
5	SILTY SAND W/A LITTLE GRAVEL, fine grained, brown, moist, loose (SM)		6		3	SB		1×10^{-4}	
7	SILTY SAND W/A LITTLE GRAVEL, brown, moist, loose to very loose, a few lenses of sand (SM)	TILL OR COARSE ALLUVIUM	7		4	SB		2×10^{-5}	MA
			1		5	SB			
12	CLAYEY SAND W/A LITTLE GRAVEL, brown, soft, a few lenses of lean clay (SC)	TILL OR MIXED ALLUVIUM	1	▼	6	SB		5×10^{-7}	HYD
			1		7	SB			
19	SAND W/A LITTLE GRAVEL, medium grained, brown, (See #2) (SP)	COARSE ALLUVIUM	30		8	SB		8×10^{-2}	
21	NO SAMPLES TAKEN.								
	#1 - some lenses of sand (SM) #2 - waterbearing, dense (SP) #3 - brown, wet, very dense (SM)								
	Note: Piezometer installed in boring. See attached "Installation of Piezometer" data sheet.								
34½	SILTY SAND W/A LITTLE GRAVEL, a few cobbles, (See #3) (SM)	TILL OR COARSE*	47		9	SB			
36	End of Boring	*ALLUVIUM							
	**Rates shown are only estimates								

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
1-8	12:10	21'	19½'	18'	to	14'
1-8	12:30	36'	34½'	34½'	to	29½'
1-8	2:05	36'	34½'	34½'	to	13'
1-8	3:00		See Note		to	

START 1-8-88 COMPLETE 1-8-88

METHOD HSA 0'-34½' @ 12:30

CREW CHIEF White

twin city testing corporation

SE-2 (77-B)-5

LOG OF TEST BORING

JOB NO. 4220 88-214 VERTICAL SCALE 1" = 5' BORING NO. 3

PROJECT Groundwater Study - Sand & Gravel Site - New Scandia Township, Minnesota

DEPTH IN FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION ____)	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	LABORATORY TESTS W	K* CM/SEC	Qu
	SILTY SAND W/A LITTLE GRAVEL, fine to medium grained, dark brown to brown, moist, frozen to dense, a few lenses of sand (SM/SP-SM)	COARSE ALLUVIUM			1	HSA		5×10^{-4}	MA
			28		2	SB			
5	SANDY LEAN CLAY W/A LITTLE GRAVEL, reddish brown, rather stiff to stiff (CL)	TILL	12		3	SB		1×10^{-7}	
			27		4	SB			
9	SILTY SAND W/A LITTLE GRAVEL, reddish brown, moist, medium dense, a few lenses of silt and sand (SM)		14		5	SB		1×10^{-5}	MA
11½	SILTY SAND, fine grained, light brown, moist, dense, lenses of silt (SM)	COARSE ALLUVIUM	19		6	SB		5×10^{-5}	
14	SAND W/Gravel, medium grained, brown, moist, dense to medium dense to very dense (SP)		17		7	SB		8×10^{-2}	
			9		8	SB			MA
25	Continued on Next Page								

*Rates shown are only estimates.

LOG OF TEST BORING

JOB NO. 4220 88-214 VERTICAL SCALE 1" = 5' BORING NO. 3 (Cont.)

PROJECT Groundwater Study - Sand & Gravel Site - New Scandia Township, Minnesota

DEPTH IN FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION ____)	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	LABORATORY TESTS W	K* CM/SEC	Qu
25	SAND W/GRAVEL (Cont.) (SP)	COARSE ALLUVIUM (Cont.)	38		9	SB	NSR	8×10^{-2}	
27	SAND W/SILT AND GRAVEL, medium grained, brown, moist to 33½' then waterbearing, dense (SP-SM)		23	▼	10	SB		5×10^{-3}	
			17		11	SB			
			23		12	SB			MA
44	End of Boring								

Note: Piezometer installed in boring. See attached "Installation of Piezometer" data sheet.

*Rates shown are only estimates.

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
1-11	11:00	36'	34½'	35'	to	33½'
1-11	11:30	44'	44'		to	NMR
1-11	12:45		See Note		to	
					to	

START 1-11-88 COMPLETE 1-11-88

METHOD HSA 0'-44' @11:30

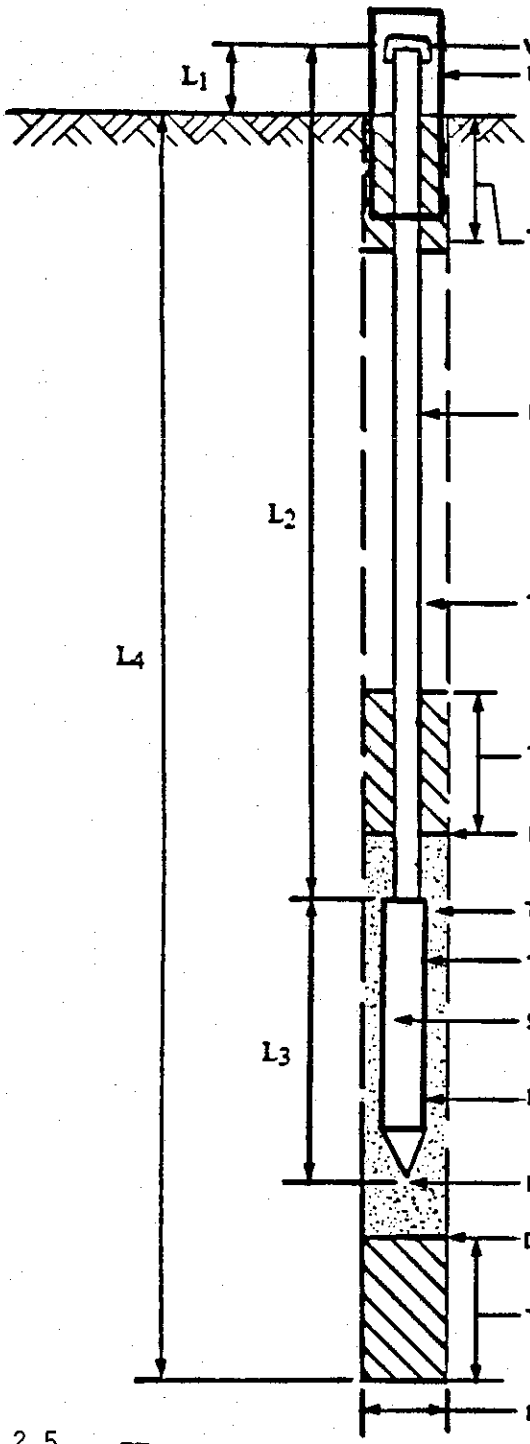
CREW CHIEF White

twin city testing corporation

INSTALLATION OF PIEZOMETER

JOB NO. 4220 88-214 PIEZOMETER NO. 1

GROUND SURFACE ELEVATION _____ TOP OF RISER PIPE ELEVATION (with cap removed) _____



VENTED CAP PROTECTIVE CASING Diameter and Type Total Length Length Above Ground	4" Steel 5.0' 2.8'
THICKNESS AND TYPE OF SEAL	0' to 5.2' Grout (Cement)
DIAMETER AND TYPE OF RISER PIPE	2" PVC Well Casing
TYPE OF BACKFILL AROUND RISER	N/A
THICKNESS AND TYPE OF SEAL	5.2' to 6.3' Bentonite Powder
DEPTH TO TOP OF FILTER SAND	6.3'
TYPE OF FILTER AROUND SCREEN	#1630 Silica Sand to 9.3' then Native Soil
TYPE OF PIEZOMETER	PVC
SCREEN GAUGE OR SIZE OF OPENINGS (SLOT NO.)	#10 Slot
DIAMETER AND LENGTH OF SCREEN	2" X 10'
DEPTH TO BOTTOM OF PIEZOMETER	16.5'
DEPTH TO BOTTOM OF FILTER SAND	18.0'
THICKNESS AND TYPE OF SEAL	None
DIAMETER OF BOREHOLE	7"

L_1= 2.5 FT

L_2= 9.0 FT

L_3= 10.0 FT

L_4= 18.0 FT

INSTALLATION COMPLETED:
Date 1-8-88 Time 11:15

PIEZOMETER WATER LEVEL MEASUREMENTS

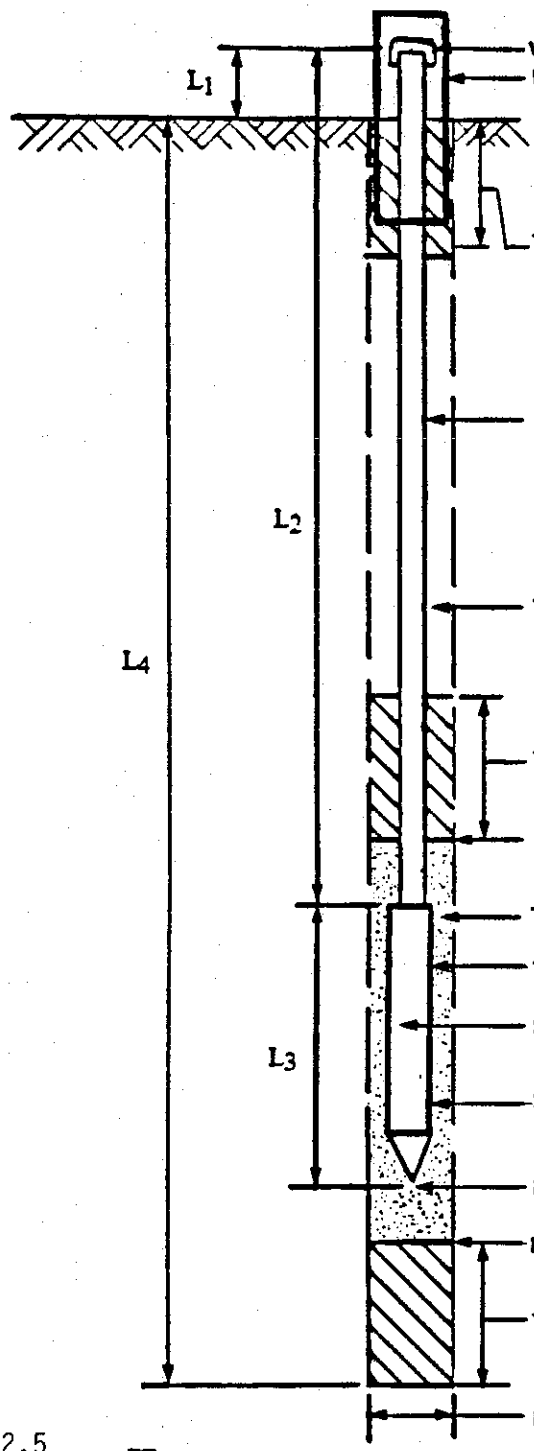
DATE	TIME	BAILED DEPTHS	WATER LEVEL (1)

(1) DEPTH BELOW TOP OF RISER PIPE

INSTALLATION OF PIEZOMETER

JOB NO. 4220 88-214 PIEZOMETER NO. 2

GROUND SURFACE ELEVATION _____ TOP OF RISER PIPE ELEVATION (with cap removed) _____



VENTED CAP PROTECTIVE CASING Diameter and Type Total Length Length Above Ground	4" Casing 5.0' 2.8'
THICKNESS AND TYPE OF SEAL	0' to 6.3' Grout (Cement)
DIAMETER AND TYPE OF RISER PIPE	2" PVC Well Casing
TYPE OF BACKFILL AROUND RISER	N/A
THICKNESS AND TYPE OF SEAL	6.3' to 8.2' Bentonite Powder
DEPTH TO TOP OF FILTER SAND	8.2'
TYPE OF FILTER AROUND SCREEN	#1630 Silica Sand to 20' then Native Soil
TYPE OF PIEZOMETER	PVC
SCREEN GAUGE OR SIZE OF OPENINGS (SLOT NO.)	#10 Slot
DIAMETER AND LENGTH OF SCREEN	2" X 10'
DEPTH TO BOTTOM OF PIEZOMETER	20.0'
DEPTH TO BOTTOM OF FILTER SAND	36.0'
THICKNESS AND TYPE OF SEAL	None
DIAMETER OF BOREHOLE	7"

L_1= 2.5 FT

L_2= 12.5 FT

L_3= 10.0 FT

L_4= 36.0 FT

INSTALLATION COMPLETED:
Date 1-8-88 Time 3:00

PIEZOMETER WATER LEVEL MEASUREMENTS

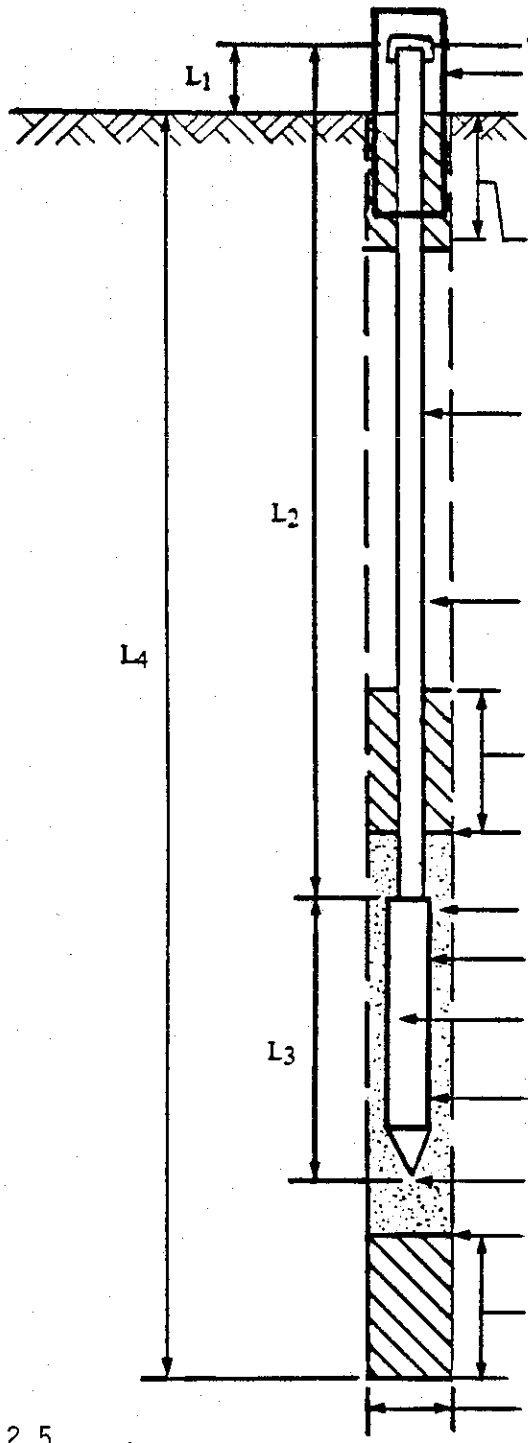
DATE	TIME	BAILED DEPTHS	WATER LEVEL (1)

(1) DEPTH BELOW TOP OF RISER PIPE

INSTALLATION OF PIEZOMETER

JOB NO. 4220 88-214 PIEZOMETER NO. 3

GROUND SURFACE ELEVATION _____ TOP OF RISER PIPE ELEVATION _____
(with cap removed)



VENTED CAP	
PROTECTIVE CASING	
Diameter and Type	4" Steel
Total Length	5.0'
Length Above Ground	2.8'
THICKNESS AND TYPE OF SEAL	0' to 15.7' Grout (Cement)
DIAMETER AND TYPE OF RISER PIPE	2" PVC Well Casing
TYPE OF BACKFILL AROUND RISER	N/A
THICKNESS AND TYPE OF SEAL	15.7' to 17.4' Bentonite Powder
DEPTH TO TOP OF FILTER SAND	17.4'
TYPE OF FILTER AROUND SCREEN	Native Soil
TYPE OF PIEZOMETER	PVC
SCREEN GAUGE OR SIZE OF OPENINGS (SLOT NO.)	#10 Slot
DIAMETER AND LENGTH OF SCREEN	2" X 10'
DEPTH TO BOTTOM OF PIEZOMETER	42.0'
DEPTH TO BOTTOM OF FILTER SAND	44.0'
THICKNESS AND TYPE OF SEAL	None
DIAMETER OF BOREHOLE	7"

L_1= 2.5 FT

L_2= 34.5 FT

L_3= 10.0 FT

L_4= 44.0 FT

INSTALLATION COMPLETED:
Date 1-11-88 Time 12:45

PIEZOMETER WATER LEVEL MEASUREMENTS

DATE	TIME	BAILED DEPTHS	WATER LEVEL (1)

(1) DEPTH BELOW TOP OF RISER PIPE

SIEVE ANALYSIS TESTS

PROJECT Groundwater Study-Barton Sand & Gravel Site DATE 1-14-88

New Scandia Township, Minnesota

REPORTED TO Barton Sand & Gravel Company JOB NO. 4220 88-214

BORING NO.		1	1	1	2
SAMPLE NO.		2	4	9	4
DEPTH (ft)		$2\frac{1}{2}$ - $3\frac{1}{2}$	5 - 6	15 - 16	$7\frac{1}{2}$ - $8\frac{1}{2}$
TYPE OF SAMPLE		SB	SB	SB	SB
CLASSIFICATION (ASTM: D 2487)					
Symbol		(SP/SP-SM)	(SP-SM)	(SP-SM)	(SM)
Description		Sand W/Silt and a Little Gravel	Sand W/Silt and Gravel	Sand W/Silt and Gravel	Silty Sand W/A Little Gravel
MECHANICAL ANALYSIS:					
Dry Weight of Total Sample (grams)		170	229	212	193
Based on Total Sample					
% Finer Than	3"				
	2"				
	1"				
	3/4"	100.0	100.0	100.0	100.0
	3/8"	98.8	88.6	90.7	97.5
	# 4	91.8	77.1	75.3	95.4
	# 10	83.1	61.4	53.7	92.8
	# 40	49.4	30.9	25.7	74.7
	# 100	12.6	12.2	8.6	40.4
	# 200	5.1	8.0	5.2	29.3

SIEVE ANALYSIS TESTS

PROJECT Groundwater Study-Barton Sand & Gravel Site DATE 1-14-88

New Scandia Township, Minnesota

REPORTED TO Barton Sand & Gravel Company JOB NO. 4220 88-214

BORING NO.	3	3	3	3
SAMPLE NO.	2	5	8	12
DEPTH (ft)	$2\frac{1}{2}$ - $3\frac{1}{2}$	10 - 11	20 - 21	40 - 41
TYPE OF SAMPLE	SB	SB	SB	SB
CLASSIFICATION (ASTM: D 2487)				
Symbol	(SM/SP-SM)	(SM)	(SP)	(SP-SM)
Description	Silty Sand W/A Little Gravel	Silty Sand W/A Little Gravel	Sand W/ Gravel	Sand W/Silt and Gravel
MECHANICAL ANALYSIS:				
Dry Weight of Total Sample (grams)	192	180	276	242
Based on Total Sample				
% Finer Than 3"				
2"				
1"		100.0	100.0	
3/4"	100	92.8	85.5	100
3/8"	95.7	89.9	67.2	82.7
# 4	88.8	85.7	60.8	62.4
# 10	81.4	77.4	52.0	46.4
# 40	58.7	56.1	19.0	28.8
# 100	19.3	34.6	3.1	11.6
# 200	11.3	27.6	1.9	7.4

GRAIN SIZE DISTRIBUTION CURVE

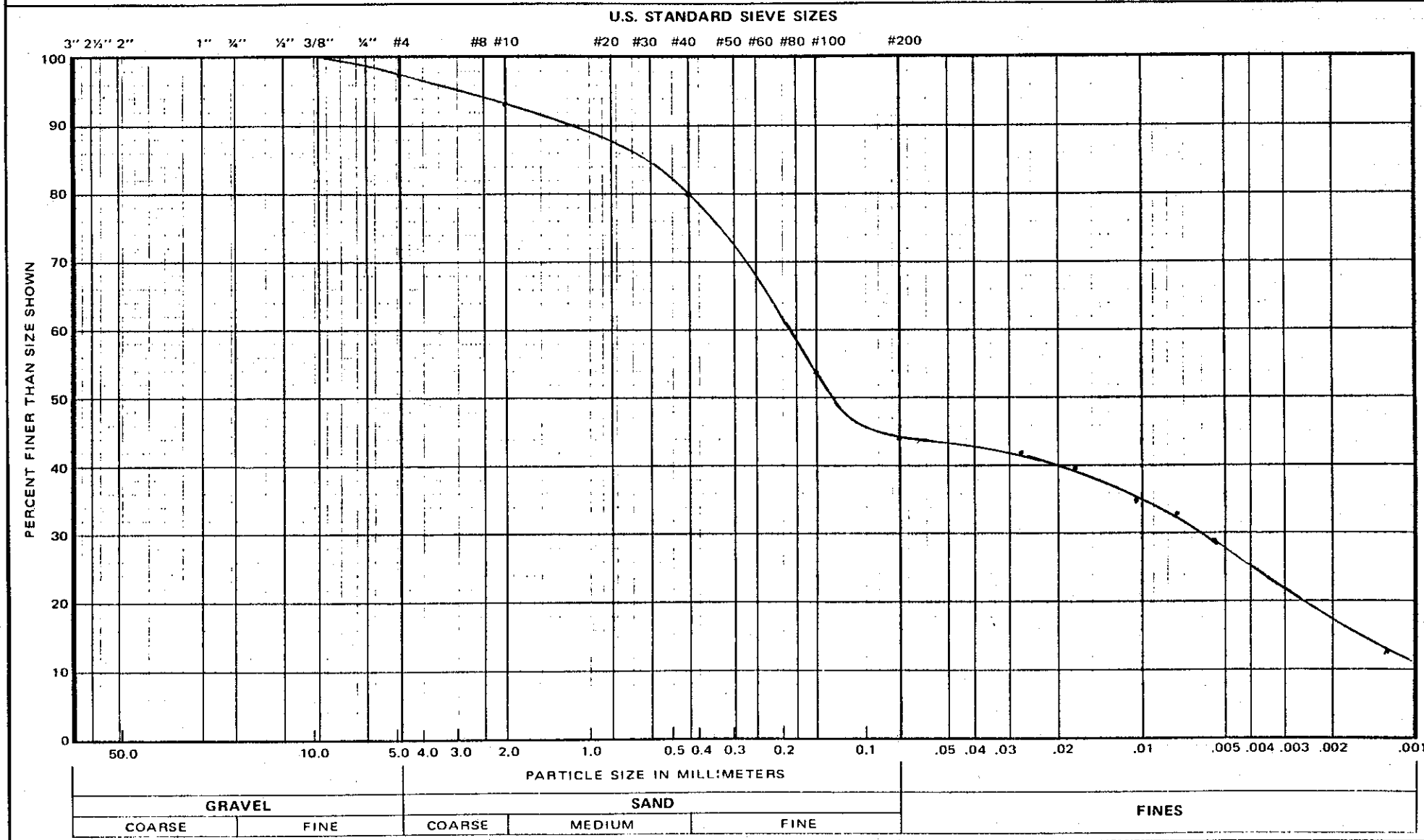
PROJECT Groundwater Study-Barton Sand & Gravel Site-New Scandia Township, MN

DATE January 19, 1988

REPORTED TO Barton Sand & Gravel Company

JOB NO. 4220 88-214

BORING NO. 2 SAMPLE NO. 6 DEPTH (FT) 12-13½ SOIL TYPE Clayey Sand W/A Little Gravel (SC)



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GENERAL NOTES

DRILLING AND SAMPLING SYMBOLS

SYMBOL	DEFINITION
HSA	3 1/4" I.D. Hollow Stem Auger
_FA	4", 6" or 10" Diameter Flight Auger
_HA	2", 4" or 6" Hand Auger
_DC	2 1/2", 4", 5" or 6" Steel Drive Casing
_RC	Size A, B, or N Rotary Casing
PD	Pipe Drill or Cleanout Tube
CS	Continuous Split Barrel Sampling
DM	Drilling Mud
JW	Jetting Water
SB	2" O.D. Split Barrel Sample
_L	2 1/2" or 3 1/2" O.D. SB Liner Sample
_T	2" or 3" Thin Walled Tube Sample
3TP	3" Thin Walled Tube (Pitcher Sampler)
_TO	2" or 3" Thin Walled Tube (Osterberg Sampler)
W	Wash Sample
B	Bag Sample
P	Test Pit Sample
_Q	BQ, NQ, or PQ Wireline System
_X	AX, BX, or NX Double Tube Barrel
CR	Core Recovery - Percent
NSR	No Sample Recovered, classification based on action of drilling equipment and/or material noted in drilling fluid or on sampling bit.
NMR	No Measurement Recorded, primarily due to presence of drilling or coring fluid.
▼	Water Level Symbol

TEST SYMBOLS

SYMBOL	DEFINITION
W	Water Content - % of Dry Wt. - ASTM D 2216
D	Dry Density - Pounds Per Cubic Foot
LL, PL	Liquid and Plastic Limit - ASTM D 4318
	Additional Insertions in Last Column
Qu	Unconfined Comp. Strength-psf - ASTM D 2166
Pq	Penetrometer Reading - Tons/Square Foot
Ts	Torvane Reading - Tons/Square Foot
G	Specific Gravity - ASTM D 854
SL	Shrinkage Limits - ASTM D 427
OC	Organic Content - Combustion Method
SP	Swell Pressure - Tons/Square Foot
PS	Percent Swell
FS	Free Swell - Percent
pH	Hydrogen Ion Content, Meter Method
SC	Sulfate Content - Parts/Million, same as mg/L
CC	Chloride Content - Parts/Million, same as mg/L
C*	One Dimensional Consolidation - ASTM D 2435
Qc*	Triaxial Compression
D.S.*	Direct Shear - ASTM D 3080
K*	Coefficient of Permeability - cm/sec
D*	Dispersion Test
DH*	Double Hydrometer - ASTM D 4221
MA*	Particle Size Analysis - ASTM D 422
R	Laboratory Resistivity, in ohm - cm - ASTM G 57
E*	Pressuremeter Deformation Modulus - TSF
PM*	Pressuremeter Test
VS*	Field Vane Shear - ASTM D 2573
IR*	Infiltrometer Test - ASTM D 3385
RQD	Rock Quality Designation - Percent

* See attached data sheet or graph

WATER LEVEL

Water levels shown on the boring logs are the levels measured in the borings at the time and under the conditions indicated. In sand, the indicated levels may be considered reliable ground water levels. In clay soil, it may not be possible to determine the ground water level within the normal time required for test borings, except where lenses or layers of more pervious waterbearing soil are present. Even then, an extended period of time may be necessary to reach equilibrium. Therefore, the position of the water level symbol for cohesive or mixed texture soils may not indicate the true level of the ground water table. Perched water refers to water above an impervious layer, thus impeded in reaching the water table. The available water level information is given at the bottom of the log sheet.

DESCRIPTIVE TERMINOLOGY

DENSITY TERM	"N" VALUE	CONSISTENCY TERM
Very Loose	0-4	Soft
Loose	5-8	Medium
Medium Dense	9-15	Rather Stiff
Dense	16-30	Stiff
Very Dense	Over 30	Very Stiff

Standard "N" Penetration: Blows Per Foot of a 140 Pound Hammer Falling 30 inches on a 2 inch OD Split Barrel Sampler

Lamination	Up to 1/2" thick stratum
Layer	1/2" to 6" thick stratum
Lens	1/2" to 6" discontinous stratum, pocket
Varved	Alternating laminations of clay, silt and /or fine grained sand, or colors thereof
Dry	Powdery, no noticeable water
Moist	Below saturation
Wet	Saturated, above liquid limit
Waterbearing	Pervious soil below water

RELATIVE GRAVEL PROPORTIONS

CONDITION	TERM	RANGE
Coarse Grained Soils	A little gravel	2 - 14%
	With gravel	15 - 49%
Fine Grained Soils		
15-29% + No. 200	A little gravel	2 - 7%
15-29% + No. 200	With gravel	8 - 29%
30% + No. 200	A little gravel	2 - 14%
30% + No. 200	With gravel	15 - 24%
30% + No. 200	Gravelly	16 - 49%

RELATIVE SIZES

Boulder	Over 12"
Cobble	3" - 12"
Gravel	
Coarse	3/4" - 3"
Fine	#4 - 3/4"
Sand	
Coarse	#4 - #10
Medium	#10 - #40
Fine	#40 - #200
Silt & Clay	-#200, Based on Plasticity

CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES
ASTM Designation: D 2487 - 85
(Based on Unified Soil Classification System)

SOIL ENGINEERING

			Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A]	Soil Classification: Group Symbol	Soil Classification: Group Name[B]
Coarse-Grained Soils More than 50% retained on No. 200 sieve	Gravels More than 50% coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines[C]	$Cu \geq 4$ and $1 \leq Cc \leq 3^E$	GW	Well graded gravel[F]
			$Cu < 4$ and/or $1 > Cc > 3^E$	GP	Poorly graded gravel[F]
		Gravels with Fines More than 12% fines[C]	Fines classify as ML or MH	GM	Silty gravel[F,G,H]
			Fines classify as CL or CH	GC	Clayey gravel[F,G,H]
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines[D]	$Cu \geq 6$ and $1 \leq Cc \leq 3^E$	SW	Well-graded sand[I]
			$Cu < 6$ and/or $1 > Cc > 3^E$	SP	Poorly graded sand[I]
		Sands with Fines More than 12% fines[D]	Fines classify as ML or MH	SM	Silty sand[G,H,I]
			Fines classify as CL or CH	SC	Clayey sand[G,H,I]
Fine-Grained Soils 50% or more passes the No. 200 sieve	Silts and Clays Liquid limit less than 50	inorganic	PI > 7 and plots on or above "A" line[J]	CL	Lean clay[K,L,M]
			PI < 4 or plots below "A" line[J]	ML	Silt[K,L,M]
		organic	$\frac{\text{Liquid limit - oven dried}}{\text{Liquid limit - not dried}} < 0.75$	OL	Organic clay[K,L,M,N] Organic silt[K,L,M,O]
	Silts and Clays Liquid limit 50 or more	inorganic	PI plots on or above "A" line	CH	Fat clay[K,L,M]
			PI plots below "A" line	MH	Elastic silt[K,L,M]
		organic	$\frac{\text{Liquid limit - oven dried}}{\text{Liquid limit - not dried}} < 0.75$	OH	Organic clay[K,L,M,P]
					Organic silt[K,L,M,Q]
Highly organic soils Fibric Peat > 67% Fibers		Primarily organic matter, dark in color, and organic odor Hemic Peat 33%-67% Fibers		PT	Peat Sapric Peat < 33% Fibers

[A] Based on the material passing the 3-in. (75-mm) sieve.

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols:
- GW-GM well-graded gravel with silt
- GW-GC well-graded gravel with clay
- GP-GM poorly graded gravel with silt
- GP-GC poorly graded gravel with clay

[D] Sands with 5 to 12% fines require dual symbols:
- SW-SM well-graded sand with silt
- SW-SC well-graded sand with clay
- SP-SM poorly graded sand with silt
- SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains $\geq$15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains $\geq$15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains $\geq$30% plus no. 200, predominantly sand, add "sandy" to to group name.

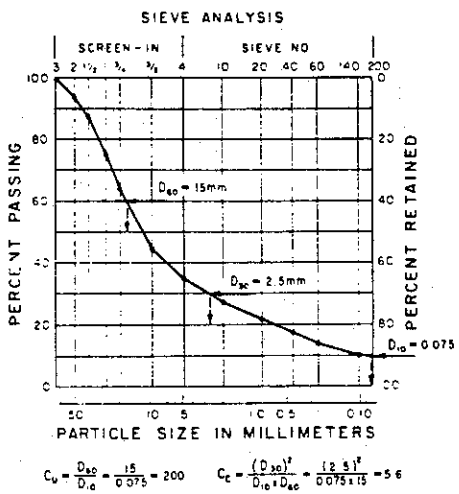
[M] If soil contains $\geq$30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI $\geq$ 4 and plots on or above "A" line.

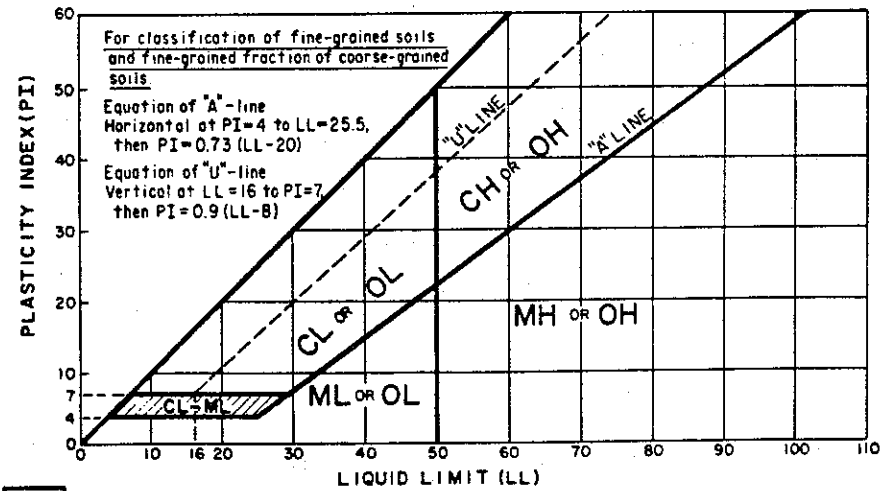
[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



$C_u = \frac{D_{60}}{D_{10}} = \frac{15}{0.075} = 200$ $\quad C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}} = \frac{(2.5)^2}{0.075 \times 15} = 5.6$



twin city testing
corporation

662 CROMWELL AVENUE
ST. PAUL, MN 55114
PHONE 612/645-3601

January 29, 1988

Barton Sand & Gravel Co
10633 89th Avenue North
Maple Grove MN 55369

Attn: Mr Gary Sauer

Gentlemen

Subj: Ground Water Study
Barton Sand and Gravel Company Site
New Scandia Township, Minnesota
#4220 88-214

This report is a supplement to our January 27, 1988 report for this project. The purpose of this supplemental report is to clearly describe the limitations of coefficient of permeability estimates contained in our January 27 report.

In accordance with the work scope authorized by you, we were asked to estimate permeabilities of the soils encountered in the borings. The coefficient of permeability estimates contained in the January 27 report are based on a number of particle size distribution (gradation) tests we performed on selected samples of the soils as well as previous experience by ourselves and published information by others. You should realize that those estimated permeability coefficient values are approximations at best. Actual field coefficients could vary by one or two orders of magnitude, depending on a number of factors, including particle size distribution, soil density and soil layering. A primary factor is the amount of -#200 material present. A 1-3% variation in the -#200 material can drastically change the permeability coefficient.

If you need a more accurate determination of the field permeability values, we recommend you consider additional testing, either in the field or by laboratory method. Field testing is preferred for the greatest level of accuracy, however, even then the measured values would probably be an approximation for the overall field conditions in similar soil types.

If you have any questions or need additional information, please contact me at 641-9381.

Very truly yours,

John F. Gislason, Jr.

John F Gislason Jr, P.E.

Donovan K. Stormoe

Donovan K Stormoe, P.E.
Senior Vice President
Geotechnical/Environmental Division

JFG/DKS/mlp

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Registered Professional Engineer under the Laws of the State of Minnesota.

Donovan K. Stormoe

DONOVAN K. STORMOE

Date 1/28/88 Reg. No. 10498

APPENDIX B

INVOICE NO. 21427
F. B. NO. 375-80
SCALE 1" = 100'
0 – DENOTES IRON

LOT SURVEYS COMPANY, INC.

LAND SURVEYORS

REGISTERED UNDER LAWS OF STATE OF MINNESOTA

7601 - 73rd Avenue North 560-3093

Minneapolis, Minnesota 55428

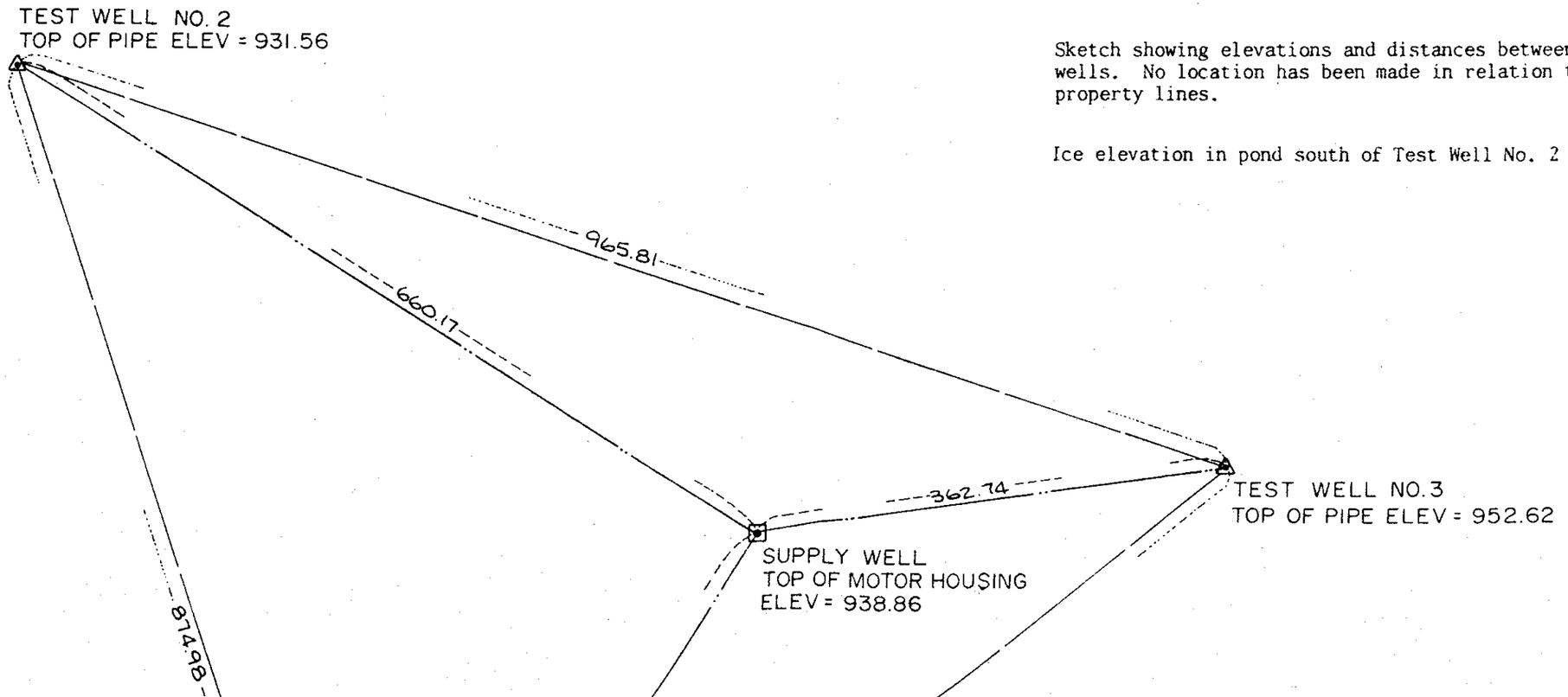
Surveyors Certificate

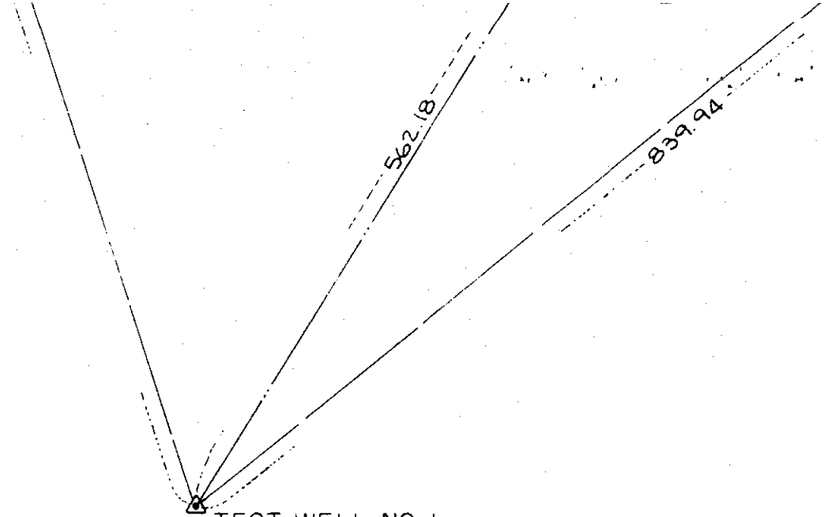
TILLER CORPORATION

Benchmark: Railroad spike in powerpole south side road at gate east entrance
Elevation = 1007.76 N.G.V.D. 1929 Adj.

Sketch showing elevations and distances between wells. No location has been made in relation to property lines.

Ice elevation in pond south of Test Well No. 2 = 922.47





Part of Section 7, Township 32, Range 20

The only easements shown are from plats of record or information provided by client.

We hereby certify that this is a true and correct representation of a survey of the boundaries of the above described land and the location of all buildings and visible encroachments, if any, from or on said land.

Surveyed by us this 11th day of February 19 88

Signed _____

Raymond A. Prasch, Minn. Reg. No. 6743

APPENDIX C

APPENDIX C

Calculations:

Drawdown around Pumping Well

Drawdown(s) has been calculated according to the Theis relations:

$$S = \frac{Q}{2\pi T} W(u)$$

and $(ur) \rightarrow W(u)r =$

with $$ur = \frac{S}{4Tt} r^2$$

S is assumed to be 0.15
T 0.026 $ft^2/sec.$

Calculations have been carried out for discharge rates Q at Q 1 = 600 GPM (1.34 cfs) and Q 2 = 300 GPM (0.67 cfs) and for pumping periods of 12 hours and 6 hours respectively. All drawdown data have been corrected for watertable conditions according to the Jacob formula for expected drawdown, s ex. under watertable conditions when calculations were carried out according to the Theis method for confined conditions.

$$s\ ex = D - \sqrt{D^2 - 2DS}$$

These corrections apply mostly to values in the intermediate radius range, values at distances of 100' and more are not affected. The drawdowns have been plotted on semi-log graphs and are shown on Figure 5 in the text. The main purpose is to demonstrate that the cone of depression reaches under the settling pond, the most likely site of contaminant infiltration.

Drawdown underneath the settling pond (at r = 100') is 3.51 ft. for a pumping rate of 600 GPM and continuous operating time of 12 hrs., 1.73 for a discharge of 300 GPM and 12 hrs, and 0.81 ft. for 300 GPM and 6 Hrs. operating time. At 100' away from the well the correction for the natural gradient (I=1E-03) is 1/10 ft. if the point of interest is exactly down gradient. The pond is almost on an equipotential line with SPW, and therefore the necessary correction would be even less.

The question of from where a well draws in contaminants can further be addressed by looking at the area of influence a pumped well has in a free flowing aquifer. This area is defined by a dividing streamline shown schematically in Figure 7. Simple calculations for steady state conditions show that the stagnation point, or the farthest point down gradient the pumped well will influence the flow field is given by

$$X = \frac{Qw}{2\pi Dqo}$$

this becomes 8000 or 4000 feet downgradient for pumping at 600 and 300 GPM respectively. The ultimate theoretical half width of the area from which the well samples is 25000 and 12000 ft. for the two respective pumping rates

$$y = \frac{Qw}{2\ Dqo}$$

The main purpose of this calculation is to show that the possible sources of direct infiltration are within the drawdown cone of the well. The large numerical values result from the fact that the natural gradient and hence the discharge velocity are very small.

Travel times: It is of interest to obtain an estimate of the travel time for a particle originating under the seepage pond. Bear and Muskat describe a method for this calculation when the point initially lies on a line of constant potential under confined conditions. The travel time to arrive at the pumped well is given by:

$$t = 2/3\ \pi\ \emptyset\ \frac{D}{Qw}\ r^2$$

with $\emptyset = 0.3$, $D = 80$ ft., $Qw = 1.34$ or 0.67 cfs, $r = 100'$

For the following pumping rates and operating conditions, the travel times are

$t_1 = 104$ hrs. (17 days) ; $Q_1 = 600$ GPM, $tp = 12$ hrs

$t_2 = 204$ hrs. (34 days) ; $Q_2 = 300$ GPM, $tp = 12$ hrs

$t_3 = 408$ hrs. (68 days) ; $Q_3 = 300$ GPM, $tp = 6$ hrs

These travel times are also applicable to intermittent pumping, where the particle moves down the cone of depression during pumping and vertically upward when the cone recovers overnight. During the inactive time and after recovery the particle would flow in the direction of the natural gradient, away from the pump. Since this backwards movement for the entire pumping period (t3) is only 6 ft., the net movement and travel time for a 94 ft. distance is 68 days, and only one day longer for the 100 ft. distance. The actual numerical values given above most likely are only approximations but the main purpose is to show that conservative particles originating under the settling pond would reach the pump during one working season.

Material Balance Considerations:

In order to pinpoint the area of greatest infiltration the amounts of scrubber fluid need to be estimated.

The total amount of water pumped yearly for operations is 13 million gallons (1.75 million cf). Of this a certain amount is lost to stack evaporation during operating hours, and due to evaporation from the pond surfaces as a continuous process. The amount of natural annual evaporation due to normal climatic conditions is about 2 ft. which translates into about 1 million gallons from the 60,000 sq. ft. surface of the two ponds. This corresponds to the amount of evaporative loss estimated in the Barr Report (2 GPM). However, this does not take into account the higher temperatures of the scrubber water (150°F) which would increase evaporation by a factor of approximately 5. This indicates that the total amount of infiltration is considerably less than estimated in the Barr Report, less than one-half of the 13 million gallons pumped per year is assumed to infiltrate. The holding capacity of the two ponds is between 1 to 2 million gallons. Since water level changes in the North Pond normally do not vary more than about 2 ft. per year, it must be assumed that most of the infiltration takes place from the settling pond at the outlet of the plant scrubber system. Otherwise the pond levels in the north pond would fluctuate much more. It is assumed that infiltration through the North Pond is very small, since it now maintains a perched pond level about 6 ft. above the watertable. This head difference could not be maintained in permeable materials.

The purpose of these calculations is to corroborate the statements in the recommendation 1 of the Barr Report to sample the supply well as being the most likely location to find PAH if present in the groundwater system.

APPENDIX D

Groundwater Study Plan for Barton Sand & Gravel Mining Operations in New Scandia Township

by H.O. Pfannkuch

Objective and Scope.

The objective of the present report is to assess the potential impact on groundwater quality due to past and present operations of gravel mining and asphalt production in the company's New Scandia Mine as requested by MPCA. In particular, the procedures, methodology and reasoning for the installation of a monitoring system will be developed and presented for discussion with MPCA.

The areal extent of this investigation focuses on the pit operation (Figure 1.) and surrounding landholdings of the company, located in the SW¼ Section 7, T32N, R20W in Washington County, Minnesota. Section 7 is found on the Forest Lake, MN 7½ minute quadrangle of the USGS topographic map. The adjacent sections 5,6,8,17 and 18 respectively, were also included in determining general hydrogeologic trends. The aquifer of interest is the surficial water table aquifer directly underlying the mine. The substances to be investigated are primarily PAH's (Polynuclear aromatic hydrocarbons) and heavy metals (As, Cd, Cr, Pb) because they potentially constitute the most likely health risks.

This report is based on literature and field investigations by the author, a general assessment and groundwater modeling study by Barr Engineering Co., Minneapolis, prepared for the Washington County Planning Department. ("Study and Report on the Effects of the Expanded Development of the Barton Sand and Gravel Pit," October 9, 1987.), and on water analyses performed by various laboratories, but most notably, those performed or commissioned by MPCA.

Potential Impact on Groundwater Quality.

General Approach.

In order to assess potential impacts of surface operations on groundwater it is necessary to identify the source, the release mechanisms of potential contaminants, the pathways taken to reach the groundwater and the processes such as adsorption and biological degradation along these pathways, the way the percolating contaminants enter the groundwater flow system and are carried away by it. Physical, chemical, biological and hydrological processes in the groundwater flow system determine the fate of the different contaminants and the extent to which they are carried away from the source area. Ideally, knowledge of all of these processes and the hydrogeologic parameters would permit an exact description of where and when contaminants appear. In practice, knowledge about the processes is limited and less is known about site specific conditions. It is therefore best to sample the groundwater directly at critical loca-

tions such as the perimeter of a suspected source area. This is the approach taken here.

Potential Contaminant Source.

1. Asphalt Manufacturing Operation: About 2,000 tons of hot mix asphalt are produced during a working day, using about 100 tons of asphalt and 2,000 to 3,000 gallons of fuel oil for drying and heating operations. The principal source of PAH's and metals is the effluent from a wet-scrubbing operation that eliminates particulates from the exhaust but that dissolves these contaminants to a certain degree.

Asphalt itself contains PAH's and in the heating process further distillation may take place to create new forms of PAH's. Incomplete combustion or residues from the fuel oil may further contribute to the PAH flow.

Combustion of waste oil, which contains high levels of metals, renders these metals into an easily water soluble form which also passes into the effluent.

2. General Plant Operations: Other plant operations comprise loading, trucking, hauling, lubricating, etc. All activities where some spillage is unavoidable. This would be in the same order of magnitude of any general trucking and hauling operation, but in view of the large quantities of hydrocarbons used in the production process, these sources can be neglected in comparison.

Potential Pathways.

The effluent is retained in a holding and settling basin where the particulates sediment out. Excess volumes are introduced into a holding pond north of the operations. It needs to be established in how close a contact this north pond is with the underlying groundwater body and whether it can act as a source region for contaminants. Depth to groundwater and its interconnection with the two ponds also has to be determined.

The geologic material underlying the site is fairly coarse sandy gravel and gravelly sand, in terms of pure hydraulic conductivity, this material is quite permeable both with respect to infiltration downward as well as horizontal flow in the saturated zone. It is of interest to obtain a simple grain size classification in order to assess the soil's capacity to absorb PAH's and metals.

Groundwater Transport of Contaminants.

In order to assess movement of contaminants with the groundwater and their potential migration to critical areas the best approach is to design and operate a monitoring well network which should give insight into the level and extent of contamination, if any. For this, first of all the groundwater flow field has to be known, that is flow directions, hydraulic gradients and flow velocities. The flow field is represented by depicting the water table surface via lines of equal head or elevation, that is equipotential lines.

First a general picture of the flow field is obtained based on data from the site and its surroundings. The model in the Barr Report results in equipotential lines that trend in a West-east direction in the vicinity of the ponds. This implies groundwater flow in a northerly to north-westerly direction. Interpretation of well logs with depth to water indication and making use of surface water body elevations in general confirms this trend although the data is not synoptic, and some of the surface water bodies may not be outcrops of the water table but rather perched entities.

A more site specific definition of groundwater flow direction is needed. This will be obtained by installing a number of simple and shallow piezometers, at least three. These could be drive points which are easy to install if depth to the water table is reasonably shallow, 15 to 25 ft. These wells would have to be installed outside the area of any potential surface contamination, so as not to act as conduits for surficial pollutants. Information from these less expensive wells will be used to properly site the more expensive monitoring wells from which periodic sampling will be carried out.

Study Plan and Monitoring Network Design.

It is important to stress that the plan as outlined below proceed according to an incremental design where decisions about the next step are based on the findings of the previous step and consultation between Barton and MPCA.

1. Piezometer Wells.

Figure 2 shows the proposed locations of four piezometers, No.'s 1,2, and 3 to form a triangle from which to determine flow directions and gradients by triangulation. Well #4 is an auxiliary point to construct a second triangle 1,2,4 to verify flow directions from the first triangle.

All wells are used to determine depth to the water table which also gives an idea about the thickness of the unsaturated zone which may act as a retardant to contaminant infiltration.

Wells 3 and 4 will also be used to determine if the North pond and the Southern Surface Water pond are part of the groundwater system or if they are perched by correlating water elevations in the observation wells with pond level elevations.

The idea at this point is to set the wells in low or excavated spots for shallow depth to the water table. If this strategy should not prove to be feasible, additional wells can be installed in alternate locations, until reasonable assurance about flow directions and depth to water information is reached. If the shallow well strategy does not hold up, then deeper wells would have to be constructed which will serve both as water level indicators as well as monitoring points.

In any case, well head elevations will have to be levelled in and at the same time it would be advantageous to establish the level of the ponds and some other water bodies in the mining area.

2. Definition of the Nature of the Source.

One more set of water quality analyses should be made of the possible source areas-the outflow from the scrubber, the settling pond, and the North pond. To obtain a better picture of average conditions in the north pond, a sample should be taken from a more central location.

At the same time one or two bottom sediment samples should be taken for chemical analysis to see if there is significant adsorption of PAH's or metals on the fines. pH measurements should be included in order to characterize the mobility environment of metals. Also a grain size analysis should be carried out to determine surface areas of the soil that are available for adsorption. A similar grain size analysis should be done on a representative sample obtained when constructing the monitoring wells.

3. Construction and Placement of Monitoring Wells.

Assuming that the simple piezometer method has given an acceptable definition of groundwater flow direction and gradients in the vicinity of the suspected source areas in the pit, then up to three monitoring wells would be constructed along the principal flow line of groundwater that passes directly beneath the area of greatest contamination potential. One well upstream to serve as a control point, the other two if necessary at different distances downstream of the critical area.

The exact locations will depend on groundwater flow direction, flow velocities which determines optimal distance

from the source, and on the constraints of the terrane. The control well would be the first one to be installed and sampled and inspection of the samples should give some indication about the hydraulic conductivity of the aquifer material from which average flow velocities under the given hydraulic gradients can be estimated. This will give some idea as to how far from the source the downstream wells should be installed to optimally intercept any potential pollutants. These siting decisions will be made based on prior information obtained and in consultation with the MPCA.

4. Operation and Scheduling of Monitoring System.

The compounds that should be tested in the samples are the 16 PAH's, the metals (As, Cd, Cr, Pb) and phenol as requested by MPCA.

The first round of sampling and testing should, however, include some basic geochemical tests such as the major ions to characterize the geochemical nature of the groundwater, and nitrates and/or representative pesticides in order to assess whether the aquifer is otherwise stressed by the rural environment.

The results of the first test round will be used to establish a schedule of sampling and testing. In case of heavy contamination more frequent testing may be indicated, even an extension of the monitoring well network. If no or minimal pollution is detected, testing would be carried out at greater intervals.

For the first year testing should be carried out at quarterly intervals to accommodate possible seasonal variations, unless of course no pollution is found.

One way of anticipating PAH contaminants in a relatively inexpensive way is to test for phenol, which is more conservative, i.e. it does not adsorb as easily as PAH's, and which may serve as a precursor for other organics. If even phenol is not seen, then only one of the downstream wells should be sampled for phenol once a year as a safeguard.

Summary of Proposed Groundwater Study Plan:

Phase I.

1. Emplacement of 3 to 4 piezometers to groundwater surface in order to define shape of water table, groundwater flow lines and direction of flow. This is preliminary work to better define location of more expensive monitoring wells.

This work could be done in-house with well points and driven wells if far enough away from central flow line so that metal casing will not interfere with metals analyses.

2. Analysis of samples from effluent, settling basin and a representative location in the North pond in order to define the most likely source area. This also includes bottom sediment samples to assess adsorption capacity of the material through which the infiltrating water passes.

Phase II.

1. Based on the flow net analysis of the groundwater flow field from item 1, up to 3 monitoring wells will be installed along the principal flow line passing underneath the area of highest suspected pollution potential, one well as control well upstream, possibly two wells to intercept the possible plume of migrating contaminants at two different distances from the source area downstream.

2. Based on samples taken from the first well (background well) general grain size and hydraulic conductivity estimates will be made to calculate flow rates and possible migration times of pollutants to better define well locations and sampling schedules.

Phase III.

1. Initial sampling of monitoring wells for full sweep, PAH's, metals, phenol, geochemical parameters (major ions) and anthropogenic parameters (nitrate, chloride, pesticides) to obtain a complete picture of the geochemical and potential contaminant situation.

2. Based on the initial sampling, a schedule of sampling intervals will be established. It will depend on the findings of item 1 (Ph. III), and would, at minimum, include quarterly sampling the first year, unless no or very low levels of contaminants are detected.

3. If low levels of the target compounds are measured, periodic analysis for conservative precursors (such as phenol) will be made to serve as an early warning system.

Time Plan.

Phase I.1	:	1 week after plan is agreed upon
I.2	:	Concurrently for sampling analysis according to turnaround time
Phase II 1	:	2 weeks after locations are agreed upon and after suitable driller has been contracted
II 2	:	Concurrent sampling of control well. 1 week for grain size analyses.
Phase III 1.	:	1 week for sampling after wells have been cleaned and conditioned first sample round - depends on availability of lab space and turnaround time (this can be several weeks).
2.		Quarterly sampling, if indicated.

Summary reports will be issued at the conclusion of each step of each phase, or as interim reports as requested by MPCA.

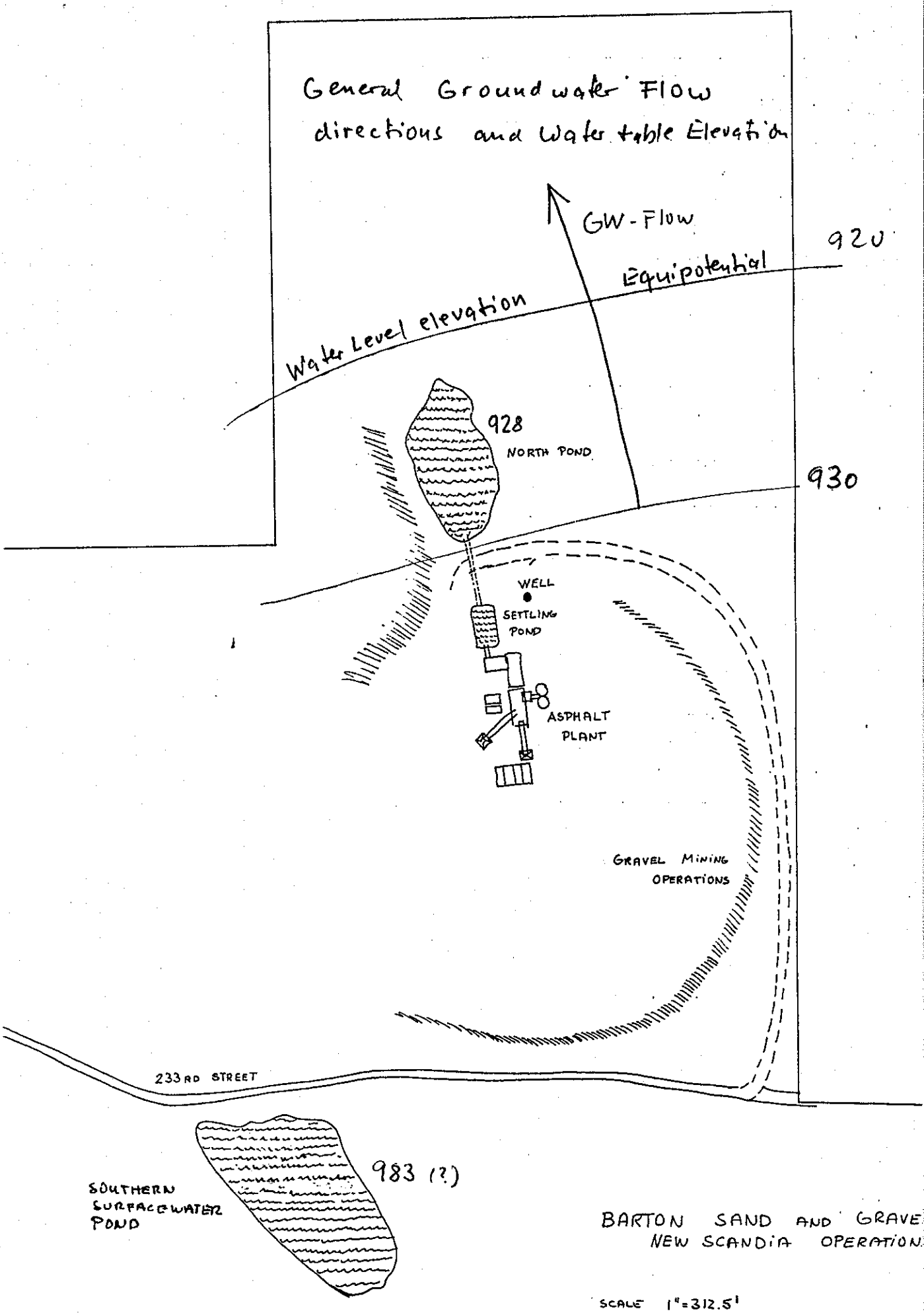

General Groundwater Flow directions and Water table Elevation
GW-Flow
920
Equipotential
Water Level elevation
928
NORTH POND
930
WELL
SETTLING POND
ASPHALT PLANT
GRAVEL MINING OPERATIONS
233RD STREET
983 (?)
SOUTHERN SURFACE WATER POND
BARTON SAND AND GRAVE
NEW SCANDIA OPERATION
SCALE 1"=312.5'

Figure 1

LOG OF TEST BORING

JOB NO. 4220 88-214 VERTICAL SCALE 1" = 5' BORING NO. 1

PROJECT Groundwater Study - Sand & Gravel Site - New Scandia Township, Minnesota

DEPTH IN FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION ____)	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	LAB TESTS W	LAB TESTS K* CM/SEC	LAB TESTS Qu
	SAND W/A LITTLE GRAVEL, fine to medium grained, brown, moist, frozen to medium dense (SP/SP-SM)	COARSE ALLUVIUM			1	SB			
			9		2	SB		1×10^{-2}	MA
5					3	SB		5×10^{-3}	
	SAND W/SILT (See #1) (SP-SM)		4		4	SB		5×10^{-2}	MA
$6\frac{1}{2}$									
$7\frac{1}{2}$	SAND, fine (See #2) (SP)				5	SB			
	SAND W/A LITTLE (See #3) (SP)		75		6	SB		8×10^{-2}	
9				▼					
10	SAND, fine (See #4) (SP)				7	SB		5×10^{-2}	
	SAND W/SILT AND GRAVEL, medium grained, brown, waterbearing, very dense to medium dense (SP-SM)		32		8	SB			
			16		9	SB		5×10^{-3}	MA
			13		10	SB			
18	End of Boring								

#1 - AND GRAVEL, medium grained, brown, wet, very loose (SP-SM)

#2 - grained, brown, moist, medium dense (SP)

#3 - GRAVEL, medium to fine grained, brown, moist, very dense (SP)

#4 - grained, brown, moist to $9\frac{1}{2}$' then waterbearing, dense (SP)

*Rates shown are only estimates

Note: Piezometer installed in boring. See attached "Installation of Piezometer" data sheet.

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
1-8	10:15	$11\frac{1}{2}$'	$9\frac{1}{2}$'	$10\frac{1}{2}$'	to	$9\frac{1}{2}$'
1-8	10:30	18'	18'		to	NMR
1-8	11:15		See Note		to	
					to	

START 1-8-88 COMPLETE 1-8-88

METHOD HSA 0'-18' @ 10:30

CREW CHIEF White

twin city testing corporation

SE-2 (77-B)-5

LOG OF TEST BORING

JOB NO. 4220 88-214 VERTICAL SCALE 1" = 5' BORING NO. 2

PROJECT Groundwater Study - Sand & Gravel Site - New Scandia Township, Minnesota

DEPTH IN FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION ____)	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	LAB TESTS W	LAB TESTS K** CM/SEC	LAB TESTS Qu
	SILTY SAND W/A LITTLE GRAVEL, fine grained, brown, moist, frozen to medium dense, (See #1) (SM)	COARSE ALLUVIUM			1	SB		5×10^{-4}	
2½	SAND W/SILT AND A LITTLE GRAVEL, fine grained, brown, moist, medium dense (SP-SM)		11		2	SB		2×10^{-3}	
5	SILTY SAND W/A LITTLE GRAVEL, fine grained, brown, moist, loose (SM)		6		3	SB		1×10^{-4}	
7	SILTY SAND W/A LITTLE GRAVEL, brown, moist, loose to very loose, a few lenses of sand (SM)	TILL OR COARSE ALLUVIUM	7		4	SB		2×10^{-5}	MA
			1		5	SB			
12	CLAYEY SAND W/A LITTLE GRAVEL, brown, soft, a few lenses of lean clay (SC)	TILL OR MIXED ALLUVIUM	1	▼	6	SB		5×10^{-7}	HYD
			1		7	SB			
19	SAND W/A LITTLE GRAVEL, medium grained, brown, (See #2) (SP)	COARSE ALLUVIUM	30		8	SB		8×10^{-2}	
21	NO SAMPLES TAKEN.								
	#1 - some lenses of sand (SM) #2 - waterbearing, dense (SP) #3 - brown, wet, very dense (SM)								
	Note: Piezometer installed in boring. See attached "Installation of Piezometer" data sheet.								
34½	SILTY SAND W/A LITTLE GRAVEL, a few cobbles, (See #3) (SM)	TILL OR COARSE*	47		9	SB			
36	End of Boring	*ALLUVIUM							
	**Rates shown are only estimates								

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
1-8	12:10	21'	19½'	18'	to	14'
1-8	12:30	36'	34½'	34½'	to	29½'
1-8	2:05	36'	34½'	34½'	to	13'
1-8	3:00		See Note		to	

START 1-8-88 COMPLETE 1-8-88

METHOD HSA 0'-34½' @ 12:30

CREW CHIEF White

SE-2 (77-B)-5

twin city testing corporation

LOG OF TEST BORING

JOB NO. 4220 88-214 VERTICAL SCALE 1" = 5' BORING NO. 3

PROJECT Groundwater Study - Sand & Gravel Site - New Scandia Township, Minnesota

DEPTH IN FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION ____)	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	LABORATORY TESTS W	K* CM/SEC	Qu
	SILTY SAND W/A LITTLE GRAVEL, fine to medium grained, dark brown to brown, moist, frozen to dense, a few lenses of sand (SM/SP-SM)	COARSE ALLUVIUM			1	HSA		5×10^{-4}	MA
			28		2	SB			
5	SANDY LEAN CLAY W/A LITTLE GRAVEL, reddish brown, rather stiff to stiff (CL)	TILL	12		3	SB		1×10^{-7}	
			27		4	SB			
9	SILTY SAND W/A LITTLE GRAVEL, reddish brown, moist, medium dense, a few lenses of silt and sand (SM)		14		5	SB		1×10^{-5}	MA
11½	SILTY SAND, fine grained, light brown, moist, dense, lenses of silt (SM)	COARSE ALLUVIUM	19		6	SB		5×10^{-5}	
14	SAND W/Gravel, medium grained, brown, moist, dense to medium dense to very dense (SP)		17		7	SB		8×10^{-2}	
			9		8	SB			MA
25	Continued on Next Page								

*Rates shown are only estimates.

LOG OF TEST BORING

JOB NO. 4220 88-214 VERTICAL SCALE 1" = 5' BORING NO. 3 (Cont.)

PROJECT Groundwater Study - Sand & Gravel Site - New Scandia Township, Minnesota

DEPTH IN FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION ____)	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	LABORATORY TESTS W	LABORATORY TESTS K* CM/SEC	LABORATORY TESTS Qu
25	SAND W/GRAVEL (Cont.) (SP)	COARSE ALLUVIUM (Cont.)	38		9	SB	NSR	8×10^{-2}	
27	SAND W/SILT AND GRAVEL, medium grained, brown, moist to 33½' then waterbearing, dense (SP-SM)		23	▼	10	SB		5×10^{-3}	
			17		11	SB			
			23		12	SB			MA
44	End of Boring								

Note: Piezometer installed in boring. See attached "Installation of Piezometer" data sheet.

*Rates shown are only estimates.

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
1-11	11:00	36'	34½'	35'	to	33½'
1-11	11:30	44'	44'		to	NMR
1-11	12:45		See Note		to	
					to	

START 1-11-88 COMPLETE 1-11-88

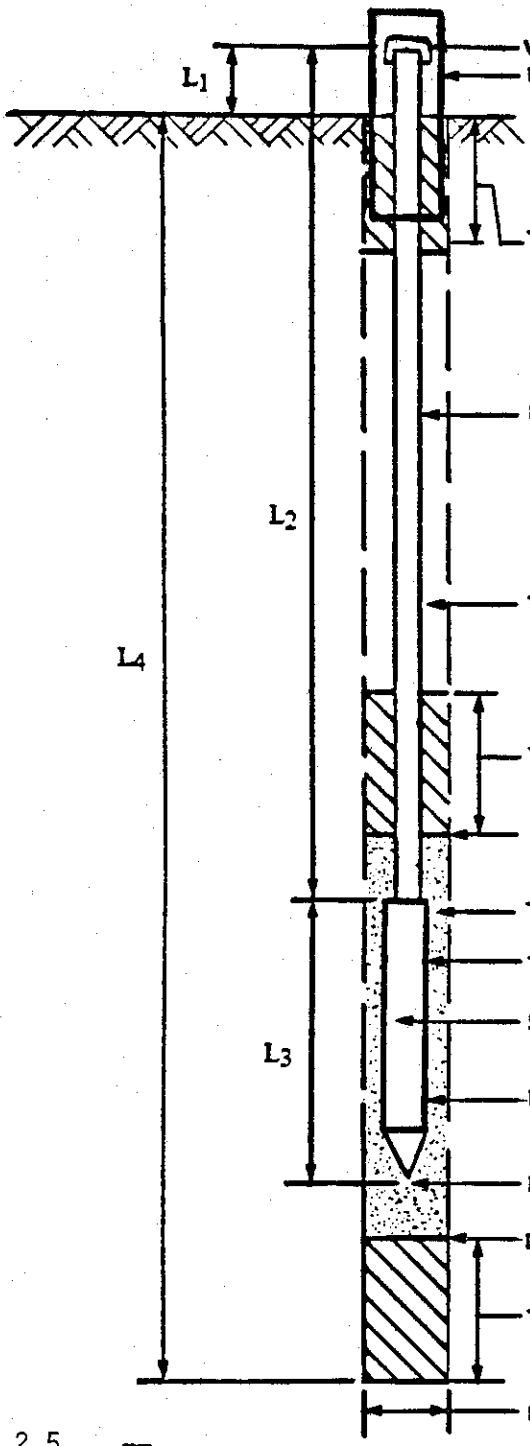
METHOD HSA 0'-44' @11:30

CREW CHIEF White

INSTALLATION OF PIEZOMETER

JOB NO. 4220 88-214 PIEZOMETER NO. 1

GROUND SURFACE ELEVATION _____ TOP OF RISER PIPE ELEVATION (with cap removed) _____



VENTED CAP	
PROTECTIVE CASING	
Diameter and Type	4" Steel
Total Length	5.0'
Length Above Ground	2.8'
THICKNESS AND TYPE OF SEAL	0' to 5.2' Grout (Cement)
DIAMETER AND TYPE OF RISER PIPE	2" PVC Well Casing
TYPE OF BACKFILL AROUND RISER	N/A
THICKNESS AND TYPE OF SEAL	5.2' to 6.3' Bentonite Powder
DEPTH TO TOP OF FILTER SAND	6.3'
TYPE OF FILTER AROUND SCREEN	#1630 Silica Sand to 9.3' then Native Soil
TYPE OF PIEZOMETER	PVC
SCREEN GAUGE OR SIZE OF OPENINGS (SLOT NO.)	#10 Slot
DIAMETER AND LENGTH OF SCREEN	2" X 10'
DEPTH TO BOTTOM OF PIEZOMETER	16.5'
DEPTH TO BOTTOM OF FILTER SAND	18.0'
THICKNESS AND TYPE OF SEAL	None
DIAMETER OF BOREHOLE	7"

L_1= 2.5 FT

L_2= 9.0 FT

L_3= 10.0 FT

L_4= 18.0 FT

INSTALLATION COMPLETED:
Date 1-8-88 Time 11:15

PIEZOMETER WATER LEVEL MEASUREMENTS

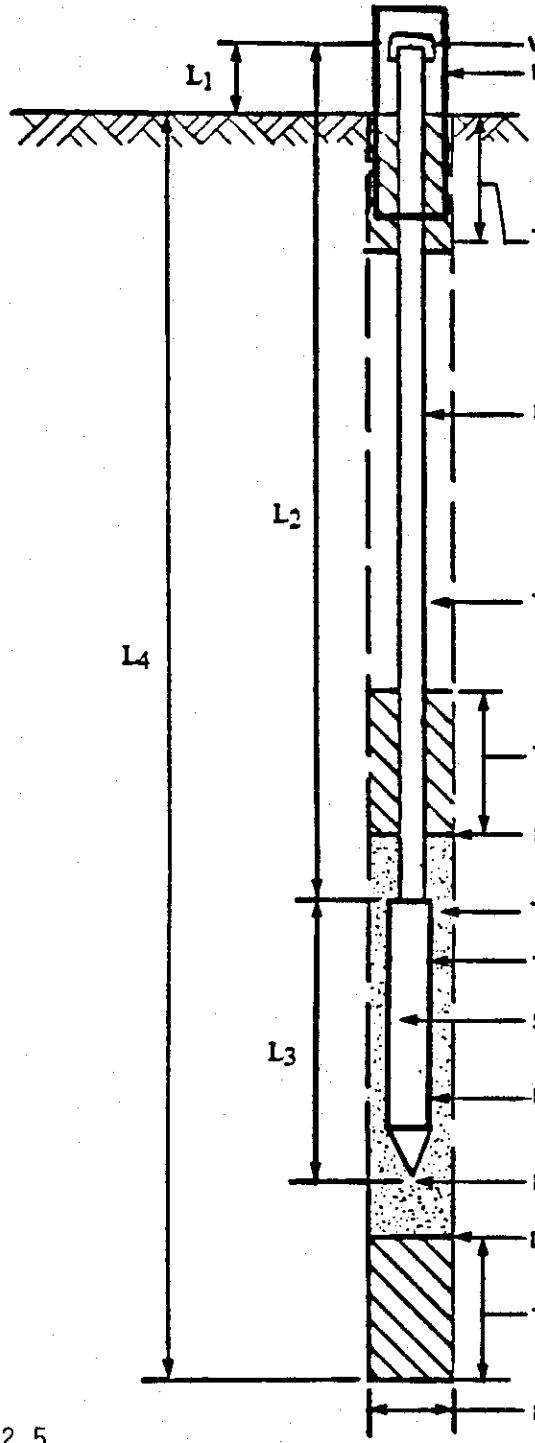
DATE	TIME	BAILED DEPTHS	WATER LEVEL (1)

(1) DEPTH BELOW TOP OF RISER PIPE

INSTALLATION OF PIEZOMETER

JOB NO. 4220 88-214 PIEZOMETER NO. 2

GROUND SURFACE ELEVATION _____ TOP OF RISER PIPE ELEVATION (with cap removed) _____



VENTED CAP PROTECTIVE CASING Diameter and Type	4" Casing
Total Length	5.0'
Length Above Ground	2.8'
THICKNESS AND TYPE OF SEAL	0' to 6.3' Grout (Cement)
DIAMETER AND TYPE OF RISER PIPE	2" PVC Well Casing
TYPE OF BACKFILL AROUND RISER	N/A
THICKNESS AND TYPE OF SEAL	6.3' to 8.2' Bentonite Powder
DEPTH TO TOP OF FILTER SAND	8.2'
TYPE OF FILTER AROUND SCREEN	#1630 Silica Sand to 20' then Native Soil
TYPE OF PIEZOMETER	PVC
SCREEN GAUGE OR SIZE OF OPENINGS (SLOT NO.)	#10 Slot
DIAMETER AND LENGTH OF SCREEN	2" X 10'
DEPTH TO BOTTOM OF PIEZOMETER	20.0'
DEPTH TO BOTTOM OF FILTER SAND	36.0'
THICKNESS AND TYPE OF SEAL	None
DIAMETER OF BOREHOLE	7"

L_1= 2.5 FT

L_2= 12.5 FT

L_3= 10.0 FT

L_4= 36.0 FT

INSTALLATION COMPLETED:
Date 1-8-88 Time 3:00

PIEZOMETER WATER LEVEL MEASUREMENTS

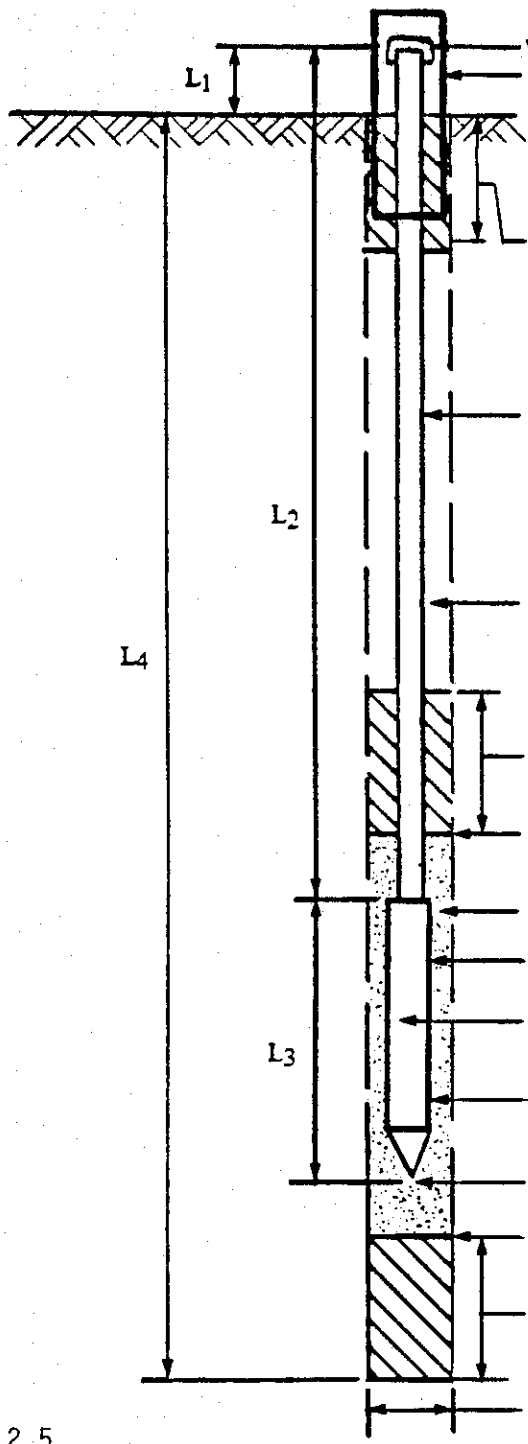
DATE	TIME	BAILED DEPTHS	WATER LEVEL (1)

(1) DEPTH BELOW TOP OF RISER PIPE

INSTALLATION OF PIEZOMETER

JOB NO. 4220 88-214 PIEZOMETER NO. 3

GROUND SURFACE ELEVATION _____ TOP OF RISER PIPE ELEVATION (with cap removed) _____



VENTED CAP PROTECTIVE CASING Diameter and Type	4" Steel
Total Length	5.0'
Length Above Ground	2.8'
THICKNESS AND TYPE OF SEAL	0' to 15.7' Grout (Cement)
DIAMETER AND TYPE OF RISER PIPE	2" PVC Well Casing
TYPE OF BACKFILL AROUND RISER	N/A
THICKNESS AND TYPE OF SEAL	15.7' to 17.4' Bentonite Powder
DEPTH TO TOP OF FILTER SAND	17.4'
TYPE OF FILTER AROUND SCREEN	Native Soil
TYPE OF PIEZOMETER	PVC
SCREEN GAUGE OR SIZE OF OPENINGS (SLOT NO.)	#10 Slot
DIAMETER AND LENGTH OF SCREEN	2" X 10'
DEPTH TO BOTTOM OF PIEZOMETER	42.0'
DEPTH TO BOTTOM OF FILTER SAND	44.0'
THICKNESS AND TYPE OF SEAL	None
DIAMETER OF BOREHOLE	7"

L_1= 2.5 FT

L_2= 34.5 FT

L_3= 10.0 FT

L_4= 44.0 FT

INSTALLATION COMPLETED:
Date 1-11-88 Time 12:45

PIEZOMETER WATER LEVEL MEASUREMENTS			
DATE	TIME	BAILED DEPTHS	WATER LEVEL (1)

(1) DEPTH BELOW TOP OF RISER PIPE

Minnesota Unique Well No. 168714

County Washington
Quad Forest Lake
Quad ID 134C

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING RECORD
Minnesota Statutes Chapter 103I

Entry Date 03/01/1989
Update Date 05/06/1996
Received Date

Well Name H & S ASPHALT
Township Range Dir Section Subsections Elevation 958 ft.
32 20 W 7 ADDCAB Elevation Method 7.5 minute topographic map (+/- 5 feet)

Well Depth	Depth Completed	Date Well Completed
98 ft.	98 ft.	05/02/1980

Drilling Method Cable Tool

Drilling Fluid --

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Commercial

Casing Type Steel (black or low carbon) Joint Welded Drive Shoe? ☑ Yes ☐ No Above/Below 1 ft.

Casing Diameter	Weight	Hole Diameter
16 in. to 69 ft.	lbs./ft.	

Well Address
SCANDIA MN

Open Hole from ft. to ft.

Screen YES Make JOHNSON Type stainless steel

Diameter	Slot/Gauze	Length	Set Between
10	30	31	69 ft. and 98 ft.

Geological Material	Color	Hardness	From	To
SAND & GRAVEL	BROWN		0	98

Static Water Level
20 ft. from Land surface Date Measured 05/02/1980

PUMPING LEVEL (below land surface)
42 ft. after hrs. pumping 800 g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

REMARKS
M.G.S. NO. 1549.

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material: Bentonite from 0 to ft. 0

Located Minnesota Geological Survey
Method Digitized - scale 1:24,000 or larger (Digitizing Table)

Unique Number Verification Information from owner
Date N/A

System *UTM - Nad83, Zone15, Meters* X: 509586 Y: 5013590

Nearest Known Source of Contamination
_feet _direction _type

Well disinfected upon completion? ☐ Yes ☐ No

Pump ☑ Not Installed Date Installed 06/20/1980
Manufacturer's name JACUZZI Model number 10MSA5 HP 40 Volts 230
Length of drop Pipe 50 ft. Capacity 600 g.p.m Type Turbine Material Steel (black or low carbon)

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☐ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

Cuttings Yes
First Bedrock
Last Strat Sand & larger-brown
Aquifer Quat. Water Table Aquifer
Depth to Bedrock ft.

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
Renner E.h. & Sons	02015	LEDBETRTER, B

County Well Index Online Report 168714 Printed 4/21/2008
HE-01205-07

Ground Water Elevations for Scandia - Pit #741

Production Well			
Top of Casing (TOC) Elevation=		942.98	
Date	Time	Depth to Water (ft btoc)	Ground-water Elevation (feet)
6-Sep-06	NM	27.31	915.67
2-May-07	15:00	28.12	914.86
13-Jun-07	11:44	28.33	914.65
19-Jul-07	11:15	28.41	914.57
11-Sep-07	11:00	28.58	914.40
11-Oct-07	9:45	28.54	914.44
8-Nov-07	11:15	28.48	914.50
12-Dec-07	13:30	28.70	914.28
9-Jan-08	9:15	28.88	914.10
22-Feb-08	9:15	29.02	913.96
28-Mar-08	10:30	29.11	913.87

Monitoring Well			
Top of Casing (TOC) Elevation=		952.23	
Date	Time	Depth to Water (ft btoc)	Ground-water Elevation (feet)
6-Sep-06	NM	36.43	915.80
2-May-07	15:05	37.22	915.01
13-Jun-07	11:44	37.42	914.81
19-Jul-07	11:20	37.51	914.72
11-Sep-07	11:05	37.69	914.54
11-Oct-07	9:50	37.65	914.58
8-Nov-07	11:20	37.59	914.64
12-Dec-07	13:35	NM	--
9-Jan-08	9:20	NM	--
22-Feb-08	9:20	38.15	914.08
28-Mar-08	10:35	38.22	914.01

NM = Not Measured (due to obstruction)
ft btoc = Feet Below Top Of Casing

Hole #11

0 – 5 OL (Organic material) Topsoil

5 – 20 CL (Lean clay) Brown silty lean clay

20 – 35 SP-SC (Poorly graded sand with clay) Brown clayey sand

**Water Table: 25 feet

MEMORANDUM

Date: March 25, 2008

To: CMSCWD Managers
Dan Fabian, PE

From: Stu Grubb, PG

Subject: Potential groundwater impacts
Review of Conditional Use Permit Application to the City of Scandia for Mining and Related Activities. Tiller Corporation. November 2007.

Groundwater Quantity

No apparent hydraulic connection exists between the regional water table (elevation approximately 920 ft) and German Lake or the nearby wetlands (water elevation approximately 953 ft). A confining layer apparently keeps the lake and wetlands perched above the regional water table. The cross sections and text of the permit application should show and discuss this feature.

It is unlikely that further excavation of the pit downward and to the east will have additional impacts to German Lake and the wetlands. Because there is no hydraulic connection between the pit and German Lake, the previous calculation or model indicating that the removal of water from the pit during mining operations will have minimal effect on German Lake is not relevant. The calculation does indicate that effects on water levels in nearby wells will be minimal, which is also important.

The perched aquifer system is unusual in the watershed district and Washington County, so the applicant should expect careful scrutiny of water levels in German Lake, the wetlands, and the pit. If falling water levels are noted in German Lake or the wetlands, the watershed district and others should re-examine the groundwater data and conceptual model in the area of the pit.

Groundwater Quality

Asphalt plant
Groundwater below the gravel pit is highly susceptible to contamination. A spill of petroleum products or other liquids would reach the groundwater almost immediately.

CMSCWD recommends that the City of Scandia carefully consider the risks associated with permitting an asphalt plant in the Tiller mine. The Washington County Groundwater 2007 Work Plan (p. 18) states that the County will require plans for servicing of equipment, waste disposal, and groundwater protection and will require a bond to assure clean-up of any pollution.

P# 741

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING SEALING RECORD

Minnesota Statutes, Chapter 103I

Minnesota Well and Boring Sealing No. H 185135

Minnesota Unique Well No. or W-series No. (Leave blank if not known)

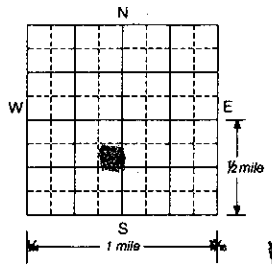
WELL OR BORING LOCATION

County Name: WASHINGTON

Township Name	Township No.	Range No.	Section No.	Fraction (sm. → lg.)
NEW SCANDIA	32	20	7	SE, NE, SW

Numerical Street Address or Fire Number and City of Well or Boring Location: 22303 MANNING TRAIL

Show exact location of well or boring in section grid with "X". N



Sketch map of well or boring location, showing property lines, roads, and buildings. Map on Back

PROPERTY OWNER'S NAME: TILLER CORPORATION ATTN: MIKE GARON

Property owner's mailing address if different than well location address indicated above.

7200 HEMLOCK LANE, SUITE #200
P.O. BOX 1480
MAPLE GROVE, MN 55311-6480

WELL OWNER'S NAME: SAME

Well owner's mailing address if different than property owner's address indicated above.

GEOLOGICAL MATERIAL	COLOR	HARDNESS OF FORMATION	FROM	TO
If not known, indicate estimated formation log from nearby well or boring.				
SAND/GRVL			0	5
FINE SAND			5	10
SAND/GRVL			10	18

REMARKS, SOURCE OF DATA, DIFFICULTIES IN SEALING

REMARKS:
GEOLOGY FROM: New Scandia Twp, test boring.
WATER LEVEL IN ABOVE WELL: 9.5'
DATE WATER LEVEL TAKEN: 01/08/88

SEALED
According to MN State Regulations

LOCAL COPY H 185135

Date Sealed: SEPTEMBER 10, 2001

Date Well or Boring Constructed: 1980'S

Depth Before Sealing: 18' ft.

Original Depth: ? ft.

AQUIFER(S)
☒ Single Aquifer ☐ Multiaquifer

WELL/BORING
☐ Water Supply Well ☒ Monit. Well
☐ Env. Bore Hole ☐ Other

STATIC WATER LEVEL
☒ Measured ☐ Estimated
17.5 ft. ☒ below ☐ above land surface

CASING TYPE(S)
☐ Steel ☐ Plastic ☐ Tile ☐ Other

CASING(S)

Diameter		Depth		Set in oversize hole?	Annular space initially grouted?
2"	in. from 0	to 8	ft.	☐ Yes ☒ No	☐ Yes ☐ No ☐ Unknown
	in. from	to	ft.	☐ Yes ☐ No	☐ Yes ☐ No ☐ Unknown
	in. from	to	ft.	☐ Yes ☐ No	☐ Yes ☐ No ☐ Unknown

SCREEN/OPEN HOLE
Screen from 8 to 18' ft. Open Hole from to ft.

OBSTRUCTIONS
☐ Rods/Drop Pipe ☐ Check Valve(s) ☐ Debris ☐ Fill ☒ No Obstruction
Type of Obstructions (Describe)
Obstructions removed? ☐ Yes ☐ No Describe

PUMP NONE
Type
☐ Removed ☒ Not Present ☐ Other

METHOD USED TO SEAL ANNULAR SPACE BETWEEN 2 CASINGS, OR CASING AND BORE HOLE:
☒ No Annular Space Exists
☐ Annular space grouted with tremie pipe
☐ Casing Perforation/Removal
in. from to ft. ☐ Perforated ☐ Removed
in. from to ft. ☐ Perforated ☐ Removed
Type of perforator
☐ Other

GROUTING MATERIAL(S) (One bag of cement = 94 lbs., one bag of bentonite = 50 lbs.)

Grouting Material						
PORTLAND	from 18	to	ft. 0	yards	1	bags
	from	to	ft.	yards		bags
	from	to	ft.	yards		bags
	from	to	ft.	yards		bags

OTHER WELLS AND BORINGS
Other unsealed and unused well or boring on property? ☐ Yes ☒ No How many?

LICENSED OR REGISTERED CONTRACTOR CERTIFICATION

This well or boring was sealed in accordance with Minnesota Rules, Chapter 4725. The information contained in this report is true to the best of my knowledge.

E. H. RENNER & SONS, INC. 71015
Contractor Business Name *License or Registration No.*

Authorized Representative Signature September 13, 2001 *Date*

KEVIN HOPPE / KEVIN SCHEITERLEIN
Name of Person Sealing Well or Boring

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING SEALING RECORD

Minnesota Statutes, Chapter 103I

Minnesota Well and Boring Sealing No. H 175503

Minnesota Unique Well No. or W-series No. (Leave blank if not known)

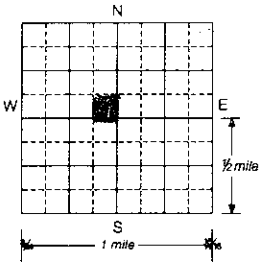
WELL OR BORING LOCATION

County Name: WASHINGTON

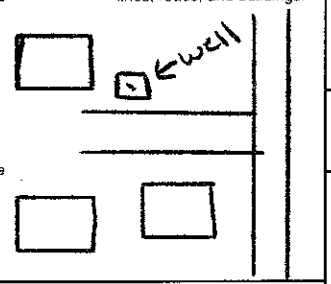
Township Name	Township No.	Range No.	Section No	Fraction (sm. → lg.)
NEW SCANDIA	32	20	8	SE SE NW

Numerical Street Address or Fire Number and City of Well or Boring Location: 22540 LOFTON AVENUE

Show exact location of well or boring in section grid with "X". N



Sketch map of well or boring location, showing property lines, roads, and buildings.



PROPERTY OWNER'S NAME: TILLER CORPORATION

Property owner's mailing address if different than well location address indicated above.

10633 89TH AVENUE N
MAPLE GROVE, MN 55369

WELL OWNER'S NAME: SAME

Well owner's mailing address if different than property owner's address indicated above.

GEOLOGICAL MATERIAL	COLOR	HARDNESS OF FORMATION	FROM	TO
If not known, indicate estimated formation log from nearby well or boring.				
CLAY	BROWN		0	32
SAND/CLAY	BROWN		32	89
SAND/GRAVEL	BROWN		89	102
EAU CLARE	GREEN		525	530

Date Sealed: OCT 10, 2000

Date Well or Boring Constructed: 1950's

Depth Before Sealing: 97 ft.

Original Depth: ? ft

AQUIFER(S): [X] Single Aquifer [ ] Multiaquifer

WELL/BORING: [X] Water Supply Well [ ] Monit. Well [ ] Env. Bore Hole [ ] Other

STATIC WATER LEVEL: [X] Measured [ ] Estimated 45 ft. [X] below [ ] above land surface

CASING TYPE(S): [X] Steel [ ] Plastic [ ] Tile [ ] Other

CASING(S)

Diameter	Depth	Set in oversize hole?	Annular space initially grouted?
4 in. from 0 to 94 ft.		[ ] Yes [X] No	[ ] Yes [ ] No [ ] Unknown
in. from to ft.		[ ] Yes [ ] No	[ ] Yes [ ] No [ ] Unknown
in. from to ft.		[ ] Yes [ ] No	[ ] Yes [ ] No [ ] Unknown

SCREEN/OPEN HOLE: Screen from 94 to 97 ft. Open Hole from to ft.

OBSTRUCTIONS: [ ] Rods/Drop Pipe [ ] Check Valve(s) [ ] Debris [ ] Fill [X] No Obstruction

Type of Obstructions (Describe):

Obstructions removed? [ ] Yes [ ] No Describe:

PUMP: Type SUBMERSIBLE

[ ] Removed [X] Not Present [ ] Other

METHOD USED TO SEAL ANNULAR SPACE BETWEEN 2 CASINGS, OR CASING AND BORE HOLE:

[X] No Annular Space Exists

[ ] Annular space grouted with tremie pipe

[ ] Casing Perforation/Removal

in. from to ft. [ ] Perforated [ ] Removed

in. from to ft. [ ] Perforated [ ] Removed

Type of perforator:

[ ] Other

GROUTING MATERIAL(S) (One bag of cement = 94 lbs., one bag of bentonite = 50 lbs.)

Grouting Material	PORTLAND	from 47	to 0 ft.	yards	bags 1
		from	to ft.	yards	bags
		from	to ft.	yards	bags
		from	to ft.	yards	bags

REMARKS, SOURCE OF DATA, DIFFICULTIES IN SEALING

GEOLOGY FROM: 15000 SCANDIA TRAIL, NS
WATER LEVEL IN ABOVE WELL: 165'
DATE WATER LEVEL TAKEN: 07/23/99
MAP CODE / MMM-2

SEALED
According to MN State Regulations

OTHER WELLS AND BORINGS

Other unsealed and unused well or boring on property? [ ] Yes [X] No How many?

LICENSED OR REGISTERED CONTRACTOR CERTIFICATION

This well or boring was sealed in accordance with Minnesota Rules, Chapter 4725. The information contained in this report is true to the best of my knowledge.

E.H. RENNER & SONS, INC. — Contractor Business Name

71015 — License or Registration No.

Authorized Representative Signature

10/16/00 — Date

KEVIN SCHEITERLEIN/KEVIN HOPPE — Name of Person Sealing Well or Boring

IMPORTANT: FILE WITH PROPERTY PAPERS-WELL OWNER COPY

H 175503

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING SEALING RECORD

Minnesota Statutes, Chapter 103I

Minnesota Well and Boring Sealing No. H 243537
Minnesota Unique Well No. or W-series No. (Leave blank if not known) 195708

WELL OR BORING LOCATION

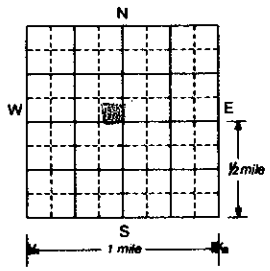
County Name: Washington

Township Name	Township No.	Range No.	Section No.	Fraction (sm → lg)
New Scandia	32N	20W	8	SE SE NW

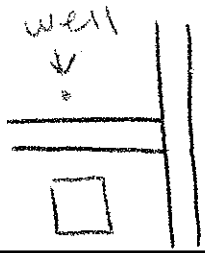
GPS LOCATION: Latitude ____ degrees ____ minutes ____ seconds; Longitude ____ degrees ____ minutes ____ seconds

Numerical Street Address or Fire Number and City of Well or Boring Location: 22540 Lofton Avenue North

Show exact location of well or boring in section grid with "X"



Sketch map of well or boring location, showing property lines, roads, and buildings.



Date Sealed: February 8, 2006

Date Well or Boring Constructed: November 15, 1983

Depth Before Sealing: 120 ft.

Original Depth: 125 ft.

AQUIFER(S): ☐ Single Aquifer ☒ Multiaquifer

WELL/BORING: ☒ Water Supply Well ☐ Monit. Well ☐ Env. Bore Hole ☐ Other ____

STATIC WATER LEVEL: ☒ Measured ☐ Estimated; 48 ft. ☒ below ☐ above land surface

CASING TYPE(S): ☒ Steel ☐ Plastic ☐ Tile ☐ Other ____

WELLHEAD COMPLETION

Outside: ☐ Well House ☒ Pitless Adapter/Unit ☐ Well Pit ☐ Buried

Inside: ☐ Basement Offset ☐ Well Pit ☐ Buried

PROPERTY OWNER'S NAME/COMPANY NAME: Tiller Corporation

Property owner's mailing address if different than well location address indicated above:

P.O. Box 1480
Maple Grove, MN 55311

WELL OWNER'S NAME/COMPANY NAME: Same

Well owner's mailing address if different than property owner's address indicated above:

CASING(S)

Diameter	Depth	Set in oversize hole?	Annular space initially grouted?
4 in. from 0 to 117 ft.		☒ Yes ☐ No	☐ Yes ☒ No ☐ Unknown
____ in. from ____ to ____ ft.		☐ Yes ☐ No	☐ Yes ☐ No ☐ Unknown
____ in. from ____ to ____ ft.		☐ Yes ☐ No	☐ Yes ☐ No ☐ Unknown

SCREEN/OPEN HOLE: Screen from ____ to ____ ft. Open Hole from 117 to 120 ft.

OBSTRUCTIONS: ☐ Rods/Drop Pipe ☐ Check Valve(s) ☐ Debris ☐ Fill ☒ No Obstruction

Type of Obstructions (Describe): ____

Obstructions removed? ☐ Yes ☐ No Describe ____

PUMP: Type: Submersible ☒ Removed ☐ Not Present ☐ Other ____

METHOD USED TO SEAL ANNULAR SPACE BETWEEN 2 CASINGS, OR CASING AND BORE HOLE:

☒ No Annular Space Exists ☐ Annular space grouted with tremie pipe ☐ Casing Perforation/Removal

____ in. from ____ to ____ ft. ☐ Perforated ☐ Removed

____ in. from ____ to ____ ft. ☐ Perforated ☐ Removed

Type of perforator ____

☐ Other ____

GROUTING MATERIAL(S) (One bag of cement = 94 lbs., one bag of bentonite = 50 lbs.)

Grouting Material: Neat Cement from 0 to 120 ft. ____ yards 8 bags

____ from ____ to ____ ft. ____ yards ____ bags

____ from ____ to ____ ft. ____ yards ____ bags

GEOLOGICAL MATERIAL	COLOR	HARDNESS OR FORMATION	FROM	TO
If not known, indicate estimated formation log from nearby well or boring				
Clay			0	12
Clay & Gravel			12	63
Clay			63	95
Boulders & Gravel			95	105
Limerock Sandrock			105	125

REMARKS, SOURCE OF DATA, DIFFICULTIES IN SEALING

Geology From: UN #195708
Map Code: MMM

SEALED
According to MN State Regulations

OTHER WELLS AND BORINGS

Other unsealed and unused well or boring on property? ☐ Yes ☒ No How many? ____

LICENSED OR REGISTERED CONTRACTOR CERTIFICATION

This well or boring was sealed in accordance with Minnesota Rules, Chapter 4725. The information contained in this report is true to the best of my knowledge.

E.H. Renner & Sons, Inc. — Contractor Business Name
71015 — License or Registration No.

Roger E. Renner — Authorized Representative Signature
02/09/06 — Date

Kevin Scheiterlein — Name of Person Sealing Well or Boring

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