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MEMORANDUM
January 5, 1987

To: Chris Haynes and Alan Newman

Through: Lynn Singleton

From: Joe Joy

Subject: Black Diamond Marshland Treatment System: Ground Water Data and Marshland Wastewater Sampling

INTRODUCTION

The failure of the Black Diamond marshland system to adequate remove effluent phosphorus has been shown (Beck, 1985; ERM, 1986; Joy, 1986). Data collected from Rock Creek below the marshland system before and after the treatment plant began operating show a definite phosphorus increase coinciding with effluent dispersal into the marsh. However, changes in Rock Creek inorganic nitrogen concentrations over the same period are inconclusive. In addition, intensive study data collected and interpreted for phosphorus, total nitrogen, BOD, and TSS removal efficiencies by Beck (1985) has been interpreted differently by ERM (1986).

Beck (1985) concluded that the marshland was failing to adequately remove phosphorus, nitrogen, BOD, and TSS. On the other hand, although ERM (1986) conceded that marshland phosphorus removal was ineffective, they concluded that nitrogen removal was probably better than depicted by Beck, and that BOD and TSS removal was effective.

One major source of difference between the two evaluations was how potential sources of phosphorus, nitrogen, BOD, and TSS other than wastewater effluent were used in a steady-state mass balance of the marshland. Not enough quality and quantity data were presented for a solid estimate of inputs from:

- o the marsh vegetation
- o ground water
- o precipitation
- o Palmer Spring
- o other surface drainages; e.g., stormwater and Morganville marsh

As a result, different interpretations occurred when different concentrations were assigned by the two firms to these inputs. The outcomes of the analyses became further divergent because the estimation of the marshland removal efficiencies for these other inputs were also treated differently by each firm.

The USEPA has asked for any additional data on these inputs, especially ground water. They would like to ensure that no source of wastes other than the wastewater effluent caused the observed phosphorus increase. They also want assurances that data are not readily available to perform a more complete mass balance of the marshland system; i.e., that it would be difficult, and not cost-effective at this time to sample and characterize the inputs from the other marshland nutrients, BOD, and TSS sources.

Ground Water

Ground water quality data and water table level information are not available for the Black Diamond or Rock Creek watershed. Few wells have been drilled northwest of the marsh in the city of Black Diamond because sandstone bedrock lies 20 to 40 inches below the surface (USDA, 1973; Luzier, 1969). Springs at the Green River, 2 1/4 miles southwest supply water to the community (Luzier, 1969). Population is sparse to the south and west, so no well data are available there, either. The only ground water quality data available from USGS, Washington Department of Social and Health Services (DSHS), and Ecology are for wells more than two miles away from the marsh area, and out of the Rock Creek watershed. Samples for the nearest wells do not contain phosphorus results since it is not a common ground-water parameter (J. Aden, DSHS, personal communication).

Ground water phosphorus concentrations in the marsh could be inferred from surface headwaters or springs because of the shallow water table. Few of these data are available (Table 1). Most of the surface water data are from areas of unknown land use influences or from lake source creeks.

It is doubtful that a major change in ground water quality occurred early in 1983 to coincide with the installation of the Black Diamond treatment system. If anything, the removal of septic systems from Black Diamond would have somewhat improved ground water quality from the northeastern portion of the watershed. Population growth in Black Diamond has not significantly changed in the past six years (Beck, 1985), so that no other detrimental influences on ground water would be expected.

Water table information is also lacking. Ground water was encountered in two of 16 soil borings performed in March 1979 (Appendix E of KCM [1979]). The borings were located one mile downstream of the marsh (Figure 1). Depth to water was two feet in TP-2 and 10.5 feet in TP-15. Elevations under TP-4 to TP-12 were estimated to be greater than 20 feet.

Within the marsh, the water table can be inferred to be at or near the surface. The height fluctuations above the surface have not been measured. Year-round saturated soil conditions would probably extend to the marsh and wet coniferous forest communities observed by KCM (1980) (Figure 2).

In summary, ground water data for the marsh area of Black Diamond are not available. Ground water phosphorus concentrations are probably between 0.005 and 0.06 mg/L. Ground water quality has probably slightly improved with the removal of septic systems in Black Diamond. The water table is at or above the ground surface in a large portion of the marsh, but actual height ranges have not been measured. Whether there is a need at this time for such data is discussed below.

The Efficacy of Further Marsh Sampling

There are three major reasons sampling of nutrient, BOD, or TSS inputs to the Black Diamond marsh would be difficult and ineffective at this time:

1. The seasonal variability of input quantity and quality is probably high and not well understood.

2. The ability of the marshland to effect changes on the inputs is seasonally and spatially variable.

3. The marshland is not well suited for a steady-state mass balance mode of interpretation, so that a few samples collected would not yield reasonable or definitive results.

The quantity of unaccounted water in the Beck (1985) survey of the Black Diamond marshland system varied from 26 to 64 percent of the total discharge recorded in Rock Creek below the system. Precipitation, ground water, other surface seepages, and changes in evapotranspiration rates were thought to be sources of the additional flow (Beck, 1985). Rock Creek above the WTP effluent discharge line was the largest input measured, and accounted for 30 to 68 percent of the downstream discharge in the Beck (1985) study. Data collected in 1980 - 1982 show an even wider annual variability in the relationship between the upper and lower Rock Creek discharges (Table 2). However, a case could be made that comparisons such as these are grossly inaccurate because they don't account for the time it takes for water to travel through the marsh; a time which would vary seasonally. These water balances assume a steady-state system. This was a major criticism by ERM (1986) to Beck's (1985) evaluation.

The collection of additional water balance information would require:

1. An accurate account of physical hydrology in the marsh, including time of travel for all major known inputs.

2. Additional data on their seasonal variability.

The relationship between upper Rock Creek water quantity to lower Rock Creek water quantity with travel time through the marsh would have to be first explored to determine the significance of other inputs. Then, if ground water or surface seepages were considered significant inputs, an estimate of their location and residence time in the marsh would be required. Evapotranspiration rates would need to be estimated. Several samples over various seasons could be required to determine variability in the system.

The water quality of these inputs could be evaluated only after their interaction in the marsh is known. Along with the initial range of concentrations expected in the inputs, the ability of the marsh to act upon phosphorus, nitrogen, or BOD is highly variable. According to Richardson and Nichols (1985), the ability of a natural marsh to treat wastewater (from a treatment plant or any source) is dependant upon:

o marsh hydrology - the degree of channelization in the marsh, the depth of water over the marsh surface, the flow rate of water through the marsh, the flooding and drying cycle frequency.

o vegetation and soil characteristics - vegetation types, growth cycles, and rates of uptake and input; soil adsorption capacities, mineral content, redox and pH characteristics, and soil contact time.

o wastewater loading rates - contact area of wastewater to marsh waste strength, number of years of application.

None of these elements is well described in the Black Diamond marshland system. Few data are available to any of the factors for any freshwater marsh systems in the Northwest (Horner, 1986). Also, extrapolation of results from one marsh system to another ". . .without due regard to differences in effluent quality, climate, wetland type, hydrology, and numerous other factors should be avoided." (Tilton and Kadlec, 1979)

CONCLUSION

In summary, collecting more ground water or marshland samples to show that the marsh is failing to remove adequate phosphorus, nitrogen, TSS, or BOD is not cost- or time-effective because:

1. Rock Creek phosphorus concentration increases below the marsh coincided with the installation of the WTP.

2. The actual quantity of ground water or seepage inputs to the marshland are unknown because the hydrology of the marsh is not understood.

3. Even if ground water and seepage inputs were substantial, land use and community growth in the upper watershed has not substantially changed in the past six years. Therefore, it is highly unlikely that ground water quality has significantly changed over that time and is now affecting the phosphorus concentrations in Rock Creek.

4. To develop a hydrological model of the marsh and then collect data on the quality and quantity for the inputs and outputs would require a large, site-specific sampling effort.

JJ:cp

Attachments

REFERENCES

Beck, R.W. and Associates, Inc., 1985. Marshand Wastewater Treatment Evaluation for the City of Black Diamond. September 19, 1985, Seattle, WA.

Ecology, Washington State Department of, 1982. Data received by the Northwest Regional Office, Redmond, WA. September 20, 1982, for samples collected in the vicinity of Black Diamond, 4 pp.

ERM, 1986. Black Diamond Washington Wastewater Treatment System. Environmental Resources Management Contract 68-01-7108 with USEPA Region 10 and USEPA Washington, D.C., September 1986, 33 pps + attachments.

Horner, R.R., 1986. "Water Quality Functions in Pacific Northwest Wetlands." A plenary paper presented to a wetland conference sponsored by the Washington Department of Ecology, April 30 - May 2, 1986, at Port Townsend, WA.

Joy, J., 1986. "Review of work relating to Black Diamond WTP." memorandum to Sandi Stephens, Ecology Municipal Grants Officer, Olympia, WA. December 15, 1986. 4 pp.

KCM, 1979. Black Diamond Wastewater Facility Planning Study and Environmental Assessment. Kramer, Chin and Mayo, Inc. contract 350-04/SA with King County Department of Public Works, June 1979.

_____, 1980. Addendum to the Black Diamond Facility Planning Study and Environmental Assessment, June 1980.

_____, 1981. Second addendum to the Black Diamond Facility Planning Study and Environmental Assessment, June 1981.

Luzier, J.E., 1969. Geology and Groundwater Resources of Southwestern King County, Washington. Dept. of Water Resources Water Supply Bulletin No. 28. Olympia, WA. 260 pp.

METRO, 1973. Quality of Local Lakes and Streams, 1973. Interim report for the Lake Washington and Green River drainage basins for the period July 1971 to October 1972. Seattle, WA. 99 pp.

Richardson, C.J. and D.S. Nichols, 1985. "Ecological analysis of wastewater management criteria in wetland ecosystems." pp 351-388 in Ecological Considerations in Wetland Treatment of Municipal Waste-Waters edited by P.J. Godfrey, E.R. Kaynor, and S. Pelezarski. Van Nostrand Rheinhold, Co., New York, NY 473 pp.

Thielen, J., 1978. "Effects of Black Diamond on Ginder Creek," memorandum to Ron Devitt, Ecology Northwest Regional Office, Redmond, WA. from Water Quality Investigations Section, November 21, 1985. 5 pp.

Tilton, D.L. and R.H. Kadlec, 1979. "The utilization of a freshwater wetland for nutrient removal from secondarily-treated wastewater effluent." J. Environ. Qual. Vol. 8, No. 3: 328-334

USDA, 1973. Soil Survey: King County Area, washington. Soil Conservation Service and Washington Agricultural Experiment Station, King Co. 100 pps + plates.

Table 1. Surface water phosphorus concentrations in the vicinity of the Black Diamond marshland treatment system.

Location and Number of Samples	Total Phosphorus (mg/L)	Reference
Ginder Creek between Ginder Lake and the town of Black Diamond (1)	0.06	Thielen, 1978
Jones Lake above marshland system, 1 meter depth (3)	0.02 - 0.06	Metro, 1973
Ravensdale Creek, 0.75 mile north of Black Diamond (16)	0.004 - 0.02	Ecology, 1982
Lake No. 12, 4 miles east of Black Diamond (4)	0.01 - 0.03	Metro, 1973

A.

Rock Creek, Abrams Rd Culvert
(middle of swamp)

	Flow		NH3-N		TKN		NO2-N		NO3-N		Total-P		Dissolved Ortho-P	
	cfs	mgd	mg/l	lbs/day	mg/l	lbs/day	ug/l	lbs/day	mg/l	lbs/day	mg/l	lbs/day	mg/l	lbs/day
8/4/80	0.93	0.60	0.059	0.30	0.49	2.5	2.8	0.014	0.13	0.66	0.056	0.28	0.012	0.060
9/18/80	1.4	0.91	0.15	1.14	0.54	4.1	2.8	0.021	0.19	1.4	0.054	0.41	0.046	0.35
10/15/80	1.1	0.72	0.046	0.27	0.62	3.7	3.0	0.018	0.47	2.8	0.074	0.44	0.093	0.56
12/8/80	19.0	12.4	0.042	4.3	0.30	31	11	1.1	1.3	130	0.040	4.1	0.015	1.5
1/27/81	9.8	6.4	0.040	2.1	0.31	16	6.8	0.36	0.81	43	0.049	2.6	0.012	0.64
3/4/81	15.9	10.3	0.048	4.1	0.58	50	10.7	0.92	0.62	53	0.057	4.9	0.017	1.5
4/1/81	7.7	5.0	0.031	1.3	0.54	23	4.7	0.20	0.58	24	0.036	1.5	0.014	0.58
4/30/81	7.4	4.8	0.26	10	0.70	28	4.2	0.17	0.53	21	0.029	1.2	0.012	0.48
5/21/81	9.6	6.2	0.40	21	0.54	28	7.0	0.36	0.38	20	0.062	3.2	0.017	0.89
8/31/81	1.6	1.0	0.036	0.31	0.97	8.4	3.4	0.029	0.17	1.5	0.080	0.69	0.012	0.10
10/7/81	-	-	0.067	-	0.81	-	-	-	0.56	-	0.040	-	-	-
11/11/81	3.1	2.0	0.072	1.2	0.73	12	4.3	0.072	0.34	5.7	0.075	1.3	0.028	0.47
12/9/81	21.0	14	0.10	11	0.82	93	4.9	0.56	1.3	150	0.76	87	0.005	0.57
1/12/82	12.4	8.1	0.069	4.6	0.51	34	0.77	0.052	1.3	87	0.029	1.9	ND	ND
2/10/82	8.2	5.3	0.040	1.8	0.52	23	5.9	0.26	1.5	67	0.027	1.2	0.003	0.13
3/17/82	17.0	11	0.013	1.2	0.40	37	2.6	0.24	1.2	110	0.018	1.7	0.008	0.74
4/23/82	-	-	0.085	-	0.60	-	3.3	-	0.45	-	0.040	-	0.005	-

B.

Rock Creek, Roberts Rd Box Culvert
west of Morganville
(site of flow monitoring station)

	Flow		NH3-N		TKN		NO2-N		NO3-N		Total-P		Dissolved Ortho-P	
	cfs	mgd	mg/l	lbs/day	mg/l	lbs/day	ug/l	lbs/day	mg/l	lbs/day	mg/l	lbs/day	mg/l	lbs/day
8/4/80	0.70	0.46	0.076	0.29	0.61	2.3	3.0	0.011	0.16	0.061	0.076	0.29	0.020	0.176
9/18/80	1.9	1.2	0.094	0.97	0.79	8.1	2.3	0.024	0.16	1.6	0.074	0.76	0.051	0.53
10/15/80	1.2	0.78	0.082	0.53	0.57	3.7	2.0	0.013	0.68	4.4	0.074	0.48	0.037	0.24
12/8/80	22	14	0.042	5.0	0.30	36	5.4	0.64	1.1	130	0.030	3.6	0.012	1.4
1/27/81	11.5	7.5	0.042	2.6	0.13	8.1	4.2	0.26	0.65	41	0.044	2.7	0.012	0.75
3/4/81	20.2	13	0.048	5.3	0.53	58	4.0	0.44	0.38	42	0.063	6.9	0.010	1.1
4/1/81	9.0	0.59	0.022	1.1	0.56	27	2.6	0.13	0.42	20	0.041	2.0	0.012	0.59
4/30/81	6.9	4.4	0.14	5.2	0.66	25	3.6	0.14	0.31	12	0.034	1.3	0.017	0.64
5/21/81	4.2	2.7	0.32	7.3	0.52	12	3.0	0.068	0.32	7.3	0.062	1.4	0.019	0.43
8/31/81	0.92	0.60	0.065	0.32	0.84	4.2	3.9	0.019	0.11	0.55	0.075	0.37	0.034	0.17
10/7/81	13.9	9.0	0.034	2.6	0.84	63	-	-	0.40	30	0.040	3.0	-	-
11/11/81	2.1	1.4	0.093	1.1	0.56	6.4	1.8	0.020	0.28	3.2	0.040	0.46	0.020	0.23
12/9/81	20.8	14	0.074	8.3	0.76	86	2.0	0.23	1.2	140	0.049	5.5	0.005	0.56
1/12/82	14.1	9.2	0.078	6.0	0.68	52	2.8	0.21	1.2	92	0.034	2.6	0.022	1.7
2/10/82	14.1	9.2	[illegible]	3.1	0.45	37	6.9	0.53	1.3	99	0.016	1.2	0.005	0.38
3/17/82	[illegible]	14	[illegible]	0.58	0.099	[illegible]	1.1	0.13	1.0	120	0.022	2.6	0.008	0.93
[illegible]	5.5	3.6	0.17	5.1	0.43	13	1.8	0.054	0.42	13	0.051	1.5	0.005	[illegible]

Table 2. Rock Creek data collected prior to the installation of the Black Diamond WTP in December 1982.

A Rock Creek at Abrams Road above the WTP site
B Rock Creek at Morganville Bridge, below the WTP.

Data: Ecology, 1982

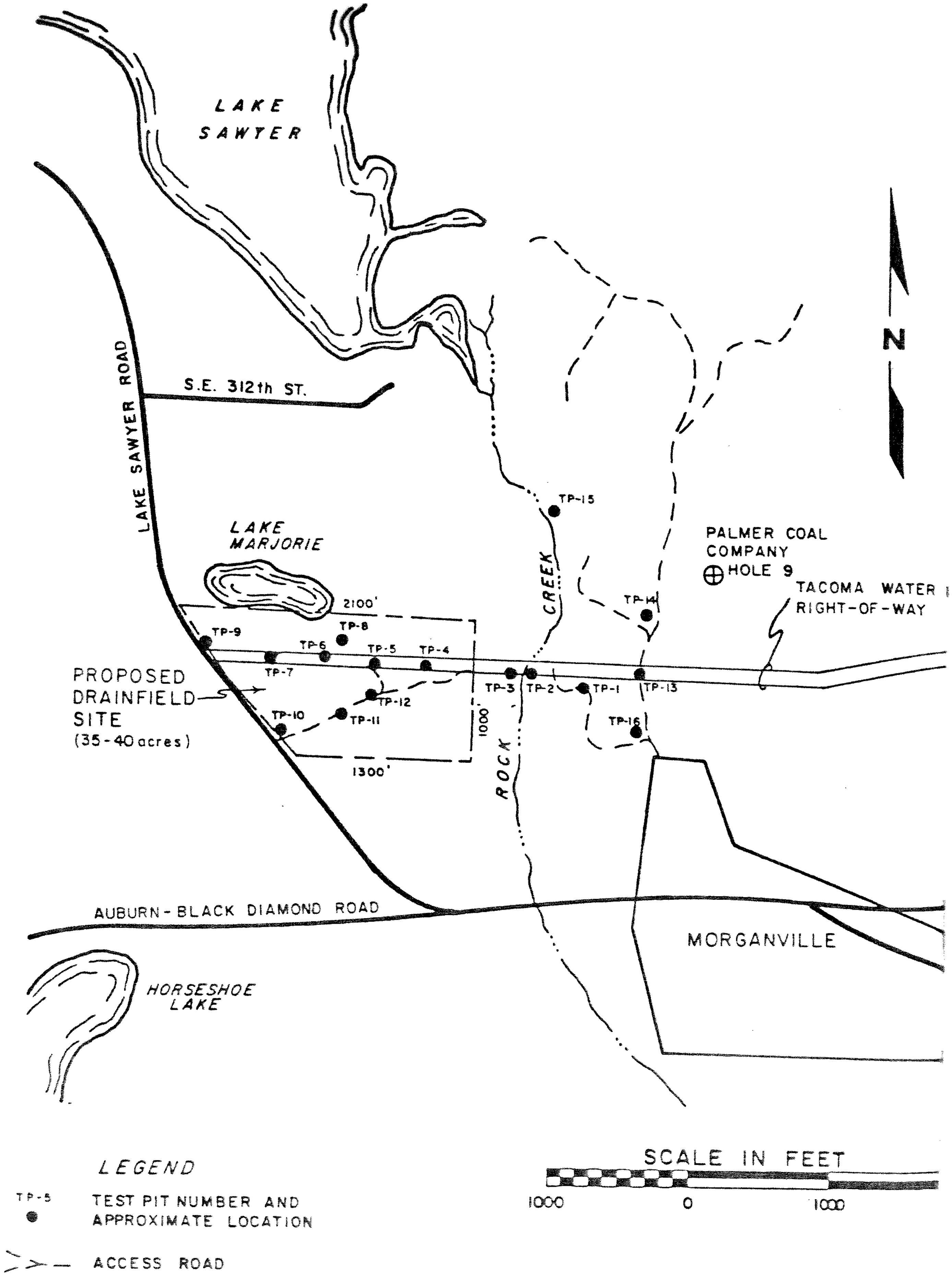

Figure 1. Map taken from the Black Diamond facilities plan document (KCM, 1979) showing the location of soil test pit explorations near Rock Creek.

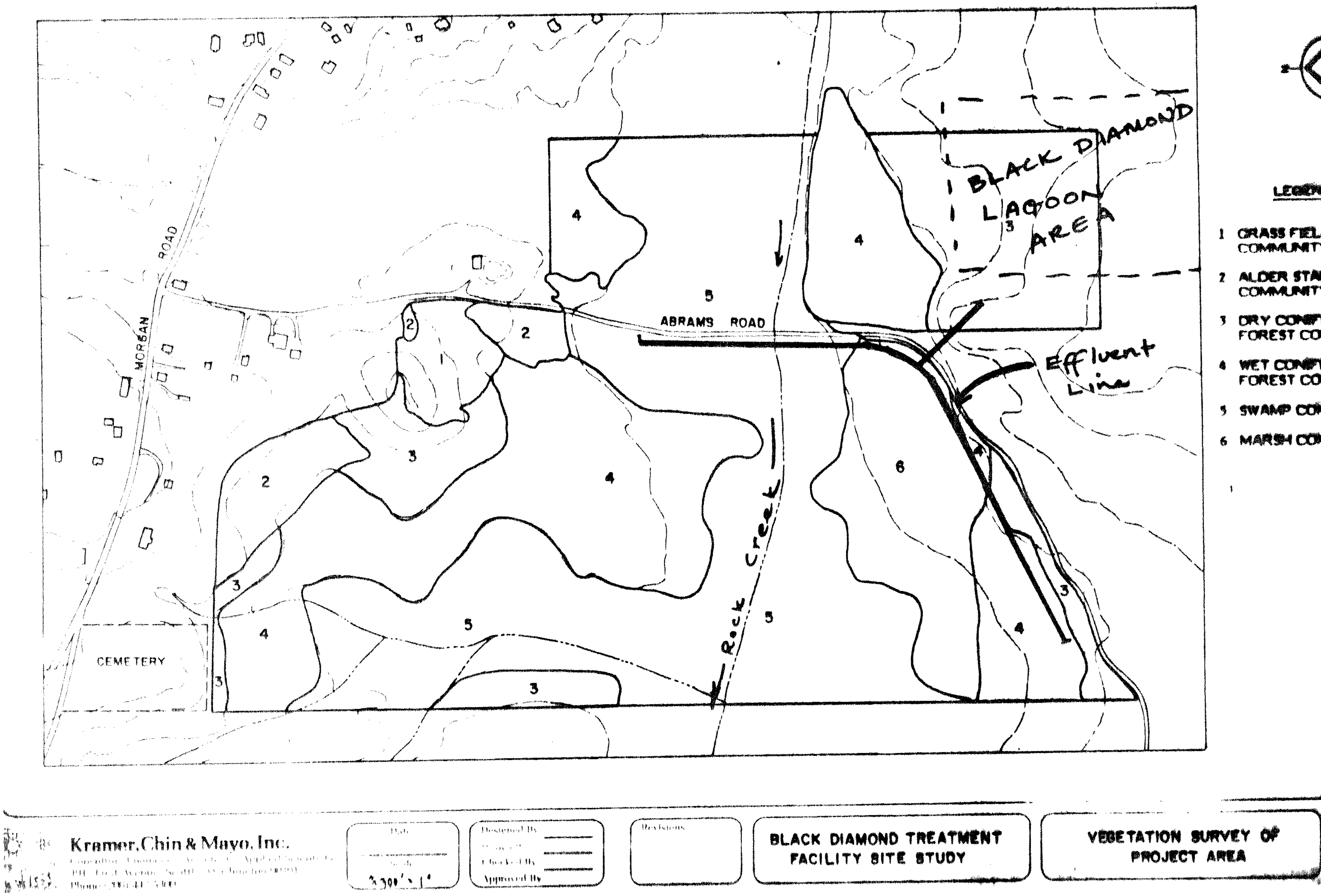

Figure 2. Map taken from the addendum to the Black Diamond facilities plan document (KCM, 1980) showing the vegetation survey results. Effluent line and lagoon area locations have been added for the purposes of the current report.