EFFECTIVENESS OF THE MITIGATED DETERMINATION OF NONSIGNFICANCE - BEAVER LAKE ESTATES PHASE II IN PREVENTING SIGNIFICANT ADVERSE IMPACTS TO THE AQUATIC ENVIRONMENT

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INTRODUCTION

At the request of the Friends of Beaver Lake, Community & Environmental Defense Services (CEDS) conducted an analysis of the potential effects of Beaver Lake Estates Phase II on the aquatic environment. The purpose of this analysis was to determine if the project would have a significant adverse impact on the aquatic resources associated with the site if built with the mitigation measures presented in the *Mitigated Determination of Nonsignficance (MDNS) for Beaver Lake Estates Phase II (E97E0190)*, which was issued by the King County Department of Development & Environmental Services (DDES) on April 21, 1999.

Beaver Lake Estates Phase II is proposed for a 34.7-acre site. The applicant, The Trossachs Group, has proposed developing the site as 42 townhomes and 58 detached single-family homes.

AQUATIC RESOURCE SETTING

The site is located in the watershed of Beaver Lake and Patterson Creek.

Beaver Lake is located 340 feet from the Beaver Lake Estates Phase II site. Beaver Lake is actually two lakes. The Beaver Lake Management Plan documented that upper Beaver Lake has poor water quality and the lower lake is of moderate quality based upon algae levels.[1] The plan identified phosphorus as the nutrient limiting algal growth within both lakes. The plan also noted that both Lakes exhibit significant dissolved oxygen deficiencies which restricts summertime fish populations to the upper 13 feet of the 50-foot deep lake.

Four wetlands are located on the site (Wetlands 1, 3, 17, and 18). Two of the four wetlands have been inventoried by King County. Wetland 3 is listed as Patterson Creek #17 (PC-17) on the inventory and Wetland 1 is listed as Patterson Creek 25 (PC-25).[2] Two off-site wetlands are also potentially impacted by the project: Patterson Creek 18 (PC-18) and Patterson Creek 23 (PC-23).[3] The off-site wetland PC-18 and the on-site wetland PC-17 (WL#3) both contain a sphagnum component. PC-23 is also known as Canyon Lake which is an impoundment formed by the Lindsley Dam.

A portion of the Beaver Lake Estates Phase II site drains to Patterson Creek via Canyon Creek. According to the MDNS "Patterson Creek constitutes an important downstream fishery resource and provides habitat for salmon." In fact, the *Patterson Creek Basin Reconnaissance Report*[4] stated that the:

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[1] *Beaver Lake Management Plan*, prepared by Entranco, November, 1993.

[2] *Wetland Determination, Impact Assessment, and Mitigation Measures for the Beaver Lake Estates, Phase II,* by David Evans & Associates, September 3, 1997.

[3] Exhibit 2 Drainage Basin Map.

[4] Published by the King County Surface Water Management Division, dated February 1993.

"Patterson Creek basin is a regionally significant basin that supports some of the best salmon habitat in western King County. As a major tributary of the Snoqualmie River, this basin contributes to the coho production of the Snohomish/Snoqualmie River system. In recent years, this river system has produced about one-third of the wild coho in the entire Puget Sound region."

The Reconnaissance Report also states that:

"The Patterson Creek system provides habitat for coho (Oncorhynchus kisutch) and chinook salmon (Oncorhynchus tschawytscha), and steelhead/rainbow (O. mykiss) and cutthroat trout (O. clarki). Although the mainstem provides extensive rearing habitat and some spawning areas, much of the fish production in this system likely occurs in the tributaries, including Canyon Creek (0382), tributary 0377, and the lowermost portions of the Ames Lake tributary (0376G)."

CUMULATIVE ADVERSE IMPACTS TO AQUATIC RESOURCES

A number of scientific investigations conducted in the Puget Sound area and elsewhere in North America have examined the cumulative effects of watershed development. These studies are summarized in Table 1 and have consistently shown that as watershed development increases, the quality of wetlands, streams, and lakes declines. Of the 23 studies presented in Table 1, five were conducted in the Puget Sound area.

Many of these studies used percent impervious area to quantify the degree of watershed development. Impervious area includes any surface that prevents precipitation from soaking into the soil and includes roads, buildings, sidewalks, parking lots, and so forth.

One of the five local studies, *Quality indices for urbanization effects in Puget Sound lowland streams* (May et al. 1997) noted that:

"As the level of basin development increased above 5% total impervious area (% TIA), results indicated a precipitous initial decline in biological integrity as well as the physical habitat conditions (quantity and quality) necessary to support natural biological diversity and complexity. The frequency, volume, and quality of large woody debris (LWD) decreased significantly as basin development and riparian encroachment increased. Loss of LWD due to washout and removal, as well as a reduction in LWD recruitment due to loss of mature riparian forest areas, were significant factors. As a result of the reduction in the quantity and quality of LWD, along with the effects of a modified hydrologic regime, coho rearing habitat was significantly reduced. Salmonid spawning habitat was also degraded by the cumulative effects of urbanization. Fine sediment in spawning gravels generally increased as urbanization increased, while intragravel dissolved oxygen

Table 1: Summary of Studies Concerning the Effect of Watershed Development upon Aquatic Communities

Area of Study	Aquatic Systems Studied	Parameters Studied	Nature of Effect of Increasing Watershed Development	Reference
Connecticut	wetlands	aquatic insects and other macroinvertebrates	A decline in various indicators of aquatic macroinvertebrate community health was observed in wetlands draining watersheds more than 3% impervious. The degradation became significant in most wetlands at an imperviousness of 8%-9%. This degradation was attributed to physical alterations of the wetlands, sedimentation, nutrients, elevated water temperature, reduced night time dissolved oxygen, elevated pH, and de-icing salts.	Hicks and Larson. 1997
Delaware	streams	aquatic insects and other macroinvertebrates	Dramatic drop in various indices of health of macroinvertebrate community health which are combined into an index of Biologic Integrity	Shaver et al. 1994
Georgia	streams	aquatic insects and other macroinvertebrates	As watershed development increased the number of macroinvertebrates species declined.	Benke et al. 1981
Maryland	streams rivers	fish, aquatic insects and other macroinvertebrates, and stream baseflow	Fish community Species Diversity Indexand stream baseflow declines as watershed imperviousness increases.	Klein 1979
	streams	aquatic insects and other macroinvertebrates and fish	Combined indexes of macroinvertebrate and fish community health showed declind	Kazyak et al. 1992
	streams	aquatic insects and other macroinvertebrates	As percent urban land use increased indicators of macroinvertebrate community health declined; increasing urban land use also correlated with decreasing stream bank stability.	Boward et al. 1995
	streams	aquatic insects and other macroinvertebrates and fish	Fish and macroinvertebrate diversity declined as watershed imperviousness increased.	Schueler and Galli, 1992
	tidal creeks	fish	Fish assemblages were less diverse in tidal creeks with watersheds dominated by urban land uses when compared to forest and wetland dominated watersheds; dissolved oxygen was lower in creeks draining urban watersheds when compared to forest-wetland dominated watersheds.	Carmichael et al. 1992
	tidal rivers	fish, macroinvertebrates, and plants	In general, the authors found that tidal tributaries draining more intensely developed watersheds exhibited greater toxicity to fish, benthic macroinvertebrates, and plants. Toxic effects were greatest where developed land uses occupied 25% to 36% of the watershed	Hartwell et al. 1995
Maryland and Virginia	tidal rivers	aquatic insects and other macroinvertebrates and water quality	As watershed urbanization increased the health of benthic communities declined; as the proportion of the watershed in forest increased, so did the condition of benthic communities.	Ranasinghe et al. 1994
Minnesota	streams	aquatic insects and other macroinvertebrates	As watershed development increased, macroinvertebrate community diversity decreased.	Richards and Host 1994

Table 1: Summary of Studies Concerning the Effect of Watershed Development upon Aquatic Communities

Area of Study	Aquatic Systems Studied	Parameters Studied	Nature of Effect of Increasing Watershed Development	Reference
New Jersey	wetlands	plants	As watershed development increased indigenous plant species declined due to water quality changes and invasion by upland and exotic species.	Ehrenfeld and Schneider 1991
	stream	aquatic insects and other macroinvertebrates	Diversity and abundance declined dramatically as a stream flowed through a heavily developed area.	Garie and McIntosh 1986
New York	nontidal and tidal streams	fish, dissolved oxygen	Alewife herring egg and larval densities decreased as the extent of watershed development increased; dissolved oxygen was more variable in streams draining urbanized vs. undeveloped watersheds.	Limburg and Schmidt 1990
Ontario, Canada	streams	fish	Index of macroinvertebrate community health declined as the degree of watershed development increased.	Steedman 1988
Virginia	streams	aquatic insects and other macroinvertebrates	As watershed development increased pollution sensitive macroinvertebrates became less abundant.	Jones and Clark 1987
		fish	Comparisons of fish communities in a stream over a 32-year period showed that watershed development resulted in a significant decline in species diversity.	Weaver and Garman 1994
		aquatic insects and other macroinvertebrates and algae	Macroinvertebrate diversity s and algal species decrease as watershed development increased.	Mangun 1988-89
Washington (state)	streams	fish habitat	Quality of fish habitat declines with increasing watershed development.	Booth and Jackson 1994
	streams	fish, fish habitat, flood frequency, zinc, dissolved oxygen	As watershed development increases indices of salmonid health decline, zinc concentrations increase, 2-Year peak discharge increases, and dissolved oxygen decreases. This investigation also documented that stormwater management measures, which were mostly ponds, did not significantly reduce the adverse impacts of watershed development.	Livingston et al. 1999
	streams	fish habitat, fish, aquatic insects and other macroinvertebrates	As watershed development increases indices of salmonid health declines, zinc concentrations increase, 2-year peak discharge increases, stream baseflow decreases along with dissolved oxygen. This investigation also documented that stormwater management measures, which were mostly ponds, did not significantly reduce the adverse impacts of watershed development.	May et al. 1997
	streams	aquatic insects and other macroinvertebrates	Macroinvertebrate community in a rural stream was twice as diverse when compared to a stream draining an urbanized watershed.	Pederson and Perkins 1986
	wetlands	amphibians, water-level fluctuations, and water quality	Significant decline in the number of amphibian species as the degree of watershed development increased; significant increase in water-level fluctuations; conductivity, suspended solids, and fecal coliform bacteria were higher in wetlands draining most developed watersheds.	Reinelt and Horner 1991

(IGDO) also decreased during the period of salmonid embryo development. Chemical constituents (primarily metals) of water quality during base flow conditions, as well as storm events, were insufficient to have produced adverse effects in streams with low to moderate % TIA, but increased markedly in highly urbanized basins (TIA>45%).

· Results suggest that resource management should place a high priority on preservation and protection of high quality stream ecosystems (TIA <5%) that currently support natural salmonid populations (coho and cutthroat). Mature, riparian forests dominated by coniferous trees should be the long-term management goal. A wide (>30 m) and near-continuous (<2 breaks/km) riparian zone appears to be a necessary, although not a wholly sufficient condition for a natural level of stream quality and biotic integrity. Restoring the natural hydrologic regime should be a primary goal for rehabilitation and enhancement efforts. A set of stream quality indices and instream habitat target conditions are proposed for monitoring and managing PSL [Puget Sound Lowland] *streams."*

Data presented in the *Patterson Creek Flood Plain Management Study*[5] indicates that the watershed is presently 2.9% impervious which is well below the 5% TIA significant impact threshold cited above. At build-out the Patterson Creek watershed would be 7.5% impervious.[6]

According to a December, 1998 memo from Goldsmith & Associates[6], 12% of the Patterson Creek watershed is within the Urban Growth Area (UGA). A much larger portion of the Canyon Creek watershed is within the UGA. So at build-out, the imperviousness of the Canyon Creek watershed will be much higher than that of Patterson Creek. The Beaver Lake Estates Phase II site will be 50% to 55% impervious once development is completed.[7]

Adjoining properties (Beaver Lake Estates Phase I, Belvedere, High Country, and Trossachs) have been developed at a level of imperviousness approaching that of Beaver Lake Estates Phase II. The watershed of several wetlands associated with site is contained mostly within the site. The imperviousness of the watershed of these wetlands could approach that of the site itself - 50% to 55%. Another Puget Sound study noted a decline in wetland quality at a watershed imperviousness above 4% (Reinelt and Horner 1991).

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[5] Prepared by the U.S. Soil Conservation Service, dated March 1994.

[6] Memo dated December 1, 1998, from the applicant's consultant, Hugh G. Goldsmith & Associates, entitled *Impervious Surfaces within the Patterson Creek Basin*.

[7] This figure was obtained from item B.1.b. of the applicant's Environmental Checklist.

From the preceding discussion it is clear that Beaver Lake Estates Phase II in and of itself will create a level of imperviousness sufficient to cause a significant adverse impact to the aquatic resources associated with the site. When combined with the effects of other similar, anticipated development projects in the watershed of Canyon Creek and Patterson Creek, the project will also cause a significant adverse impact to both of these streams.

Beaver Lake Estates Phase II and other projects proposed for the watershed will be built with various mitigation measures intended to reduce or eliminate the effects of impervious surfaces upon the aquatic environment. A number of these measures are specified in the *Mitigated Determination of Nonsignficance (MDNS) for Beaver Lake Estates Phase II*. This brings us to the question which is the focus of this report:

> *Will the mitigation measures presented in the MDNS off-set the effects of Beaver Lake Estates II sufficiently to reduce the level of adverse environmental impact to an insignificant level?*

Several recent studies provide a generic answer to this question. These studies show that the measures routinely used to mitigate aquatic resource effects in King County do not resolve significant adverse impacts (Horner and May 1999; Livingston et al. 1999). These studies shows that mitigation measures presently in use do not significantly reduce adverse environmental.

Horner and May (1999) at 30 streams in the Puget Sound Lowland Ecoregion. Approximately a third of the streams drained watersheds developed without stormwater Best Management Practices (BMPs) and the other two-thirds drained development with BMPs, which were mostly ponds of various designs. For the more intensely developed watersheds, the authors found that the BMPs did not significantly reduce the adverse impacts of development upon salmonid populations. The same lack of BMP effectiveness has been documented in studies conducted throughout the United States: Austin, Texas (Livingston et al. 1999); Delaware (Maxted and Shaver 1996); Montgomery County, Maryland (Livingston et al. 1999); and Northern Virginia (Jones et al. 1996).

Horner and May did identify options for reducing aquatic resource impacts by improving the way watershed development is regulated. Some of these options are called for in the MDNS for Beaver Lake Estates Phase II. But as will be seen later in this report, substantial uncertainty surrounds how effective these options will be. In fact, it is not even clear if these options will actually be applied to the project. To understand why the MDNS measures may not mitigate project effects it is necessary to look at the specific impacts which cause the cumulative decline in aquatic resource quality as a watershed becomes increasingly more impervious.

SPECIFIC ADVERSE IMPACTS TO AQUATIC RESOURCES

The *Patterson Creek Basin Reconnaissance Report* identified a number specific impacts resulting from development of the watershed. The MDNS for Beaver Lake Estates Phase II identified other impacts as did the five Puget Sound studies referenced in Table 1. Following is a listing of the specific impacts.

- increased entry of sediment during the construction phase of development,
- loss of riparian vegetation;
- increased water temperature;
- a decline in the amount of large woody debris in stream channels;
- a decline in groundwater recharge with a reduction in summer stream flows and inflow to wetlands,
- an increase in water level fluctuations within wetlands;
- an increase in floodwater flows and channel scour;
- a decline in dissolved oxygen;
- an increase in nutrient inputs; and
- toxicity caused by the release of copper, lead, and zinc;

The analysis presented in this report focuses on the following specific impacts.

A. Effects of impervious surfaces on groundwater recharge and inflow to the sphagnum bog wetlands associated with the Beaver Lake Estates Phase II site.

B. Effects on increased phosphorus inputs to the sphagnum bog wetlands.

C. Effects of increased phosphorus inputs to Beaver Lake.

Following is discussion of the information which supports our conclusion that each of these issues will cause a significant adverse environmental impact to the aquatic resources associated with the site.

Impervious Surfaces, Diminished Groundwater Recharge, & Inflow to Sphagnum Bogs
Within a few days following a storm, surface runoff diminishes to the point where most of the water entering a wetland or stream channel is groundwater. This water originates as precipitation falling upon the surrounding watershed, which infiltrates into the soil, and travels through the earth to enter a wetland or stream via a spring, a seep, or some other discharge point. This process is known as groundwater recharge and discharge.

A number of studies have shown that as impervious area increases in a watershed, groundwater recharge declines (Klein 1979; Hammer 1973; Simmons and Reynolds 1982; Watson et al. 1979; Horner and May 1999; and Harbor 1994). Horner and May presented data in their study of Puget Sound Lowland streams which showed that as watershed imperviousness increased winter baseflow in streams decreased. The *Patterson Creek Basin Reconnaissance Report*[8] cited a decline in summer stream flows as one of the consequences of further development of the watershed. In *Geohydrology and Ground-Water Quality of East King County, Washington*[9] , the U.S. Geological Survey cited increases in impervious surfaces as one of the factors causing diminished groundwater recharge.

The sphagnum bog wetland on the site was inventoried as Patterson Creek-17 (PC-17) and is also identified as Wetland 3 and Wetland 17 on the applicant's plans. This 2.87-acre wetland complex consists of a central open water area (up to 3' deep) surrounded by vegetation adapted to boglike conditions.[10] Wetland PC-17 formed in a depression in the till soil underlying the site. The depression is filled with up to 17 feet of peat. Outside of PC-17 the low-permeability till is overlain by 2 to 15 feet of higher permeability outwash soil (sandy-gravelly material).

The water supporting PC-17 enters in two ways: 1) direct precipitation onto the wetland surface, and 2) runoff from the surrounding watershed..[11] Figure 1, which follows this page, shows PC-17 as the Wetland 3/17 complex. This figure was derived from a map of the site presented in a September 8, 1998 letter from Terra Associates to the applicant. Added to Figure 1 is a broken line defining the surface runoff drainage basin for PC-17. This line follows the ridges and other high points which separates the land surface draining to PC-17 from that draining to other aquatic resources.

While the area shown in Figure 1 would be that which would contribute surface runoff to the wetland, the area contributing groundwater inflow is different. The soils on the site consist of highly permeable glacial outwash overlying less permeable glacial till. When precipitation falls upon the soil surface it tends to infiltrate rapidly through outwash until the till layer is reached. At that point the infiltrated precipitation begins flowing laterally along the outwash-till contact (while a portion permeates into the till). So any area of the site where the contact tilts towards PC-17 is a potential source of groundwater inflow to this wetland.

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[8] Published by the King County Surface Water Management Division, dated February 1993.

[9] Water Resources Investigations Report 94-4082, U.S. Geological Survey, Tacoma, Washington.

[10] *Beaver Lake Water Quality Protection: Wetland Condition of East Lake Sammamish 21 and Patterson Creek 17*, by Elissa Ostergaard, King County Department of Natural Resources, April 19, 1999.

[11] *Beaver Lake Water Quality Protection: Wetland Condition of East Lake Sammamish 21 and Patterson Creek 17*, by Elissa Ostergaard, King County Department of Natural Resources, April 19, 1999.

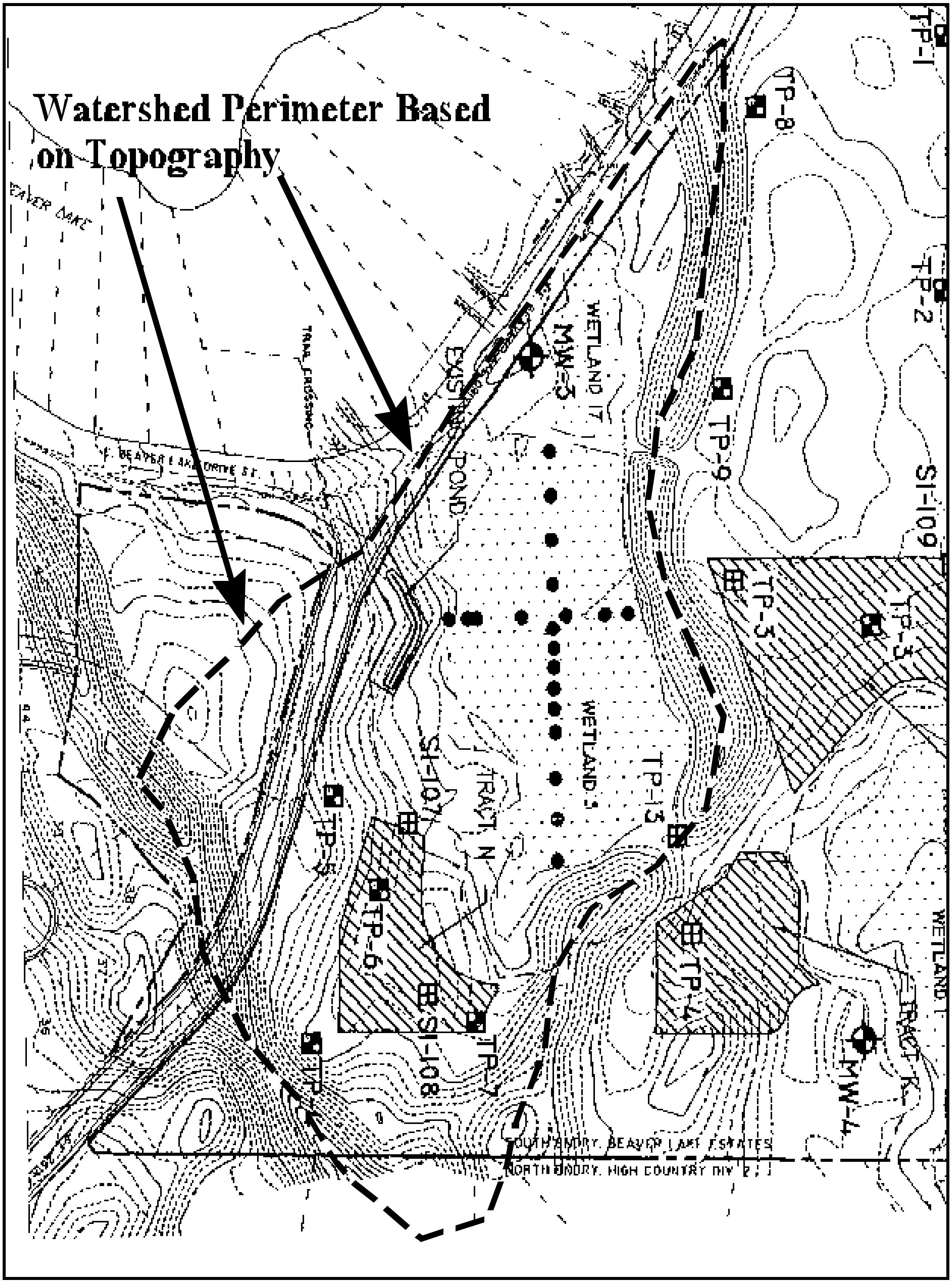

Figure 1: Patterson Creek-17 Drainage Area Based on Surface Topography

Two documents prepared by Terra Associates were reviewed to determine what areas of the site might contribute groundwater to PC-17. These documents were:

- Exhibit 4, in the Environmental Checklist, *Preliminary Geotechnical Report, Beaver Lake Estates, Phase II*, prepared by Terra Associates, Inc., dated August 29, 1997.

- Letter from Terra Associates to Pacific Properties, dated September 9, 1998.

The test pit and monitoring well logs presented in both reports were reviewed to determine the depth at which the outwash-till contact occurs. Next, the easternmost test pits were paired with the test pits or monitoring wells to the west. In this manner four sections were established. These sections are shown in Figure 2. Finaly, the land surface elevation and the elevation of the outwash-till contact for each section was graphed. These graphs are shown in Figure 3.

For three of the four sections, Figure 3 shows that the outwash-till contact tilts towards the west and southwest in the direction of PC-17 and Beaver Lake. It is only the Test Pit-2 (TP-2) to TP-3(98) to TP-3(91) section where the tilt is away from PC-17. This data indicates that groundwater flows from the northeast portion of the site towards PC-17 and Beaver Lake. This area of groundwater contribution is shown in Figure 4.

The area of groundwater contribution shown in Figure 4 includes 8.7 acres of Sub-Basin CC-6B. This is the Sub-Basin in which the single-family detached home lots are located. This Sub-Basin will be 53% impervious when Phase II is completed.[12] Therefore the 8.7-acre area will contain 4.6-acres of impervious surfaces.

The area of contribution also includes 1.72 acres of Sub-Basin CC-4 located on the west side of the site along the proposed extension of S.E. 22nd Street. The portion of this Sub-Basin within the area of groundwater contribution will consist of four single-family lots and 0.60 acres of road and sidewalk area. The applicant's plans show that the homes proposed for all four lots will be fitted with measures to infiltrate roof runoff, so the effects of the impervious area created by the four roofs should be eliminated.[13] Only the road impervious area will affect recharge and groundwater inflow to PC-17. So the existing 1.72 acre area of contribution will become 34% impervious and will contain 0.58 acres of impervious surfaces.

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[12] Based upon Appendix D of the applicant's Level One Downstream Analysis, revised September 1998.

[13] Based upon Exhibit 3 - Proposed Overall Drainage Plan for Beaver Lake Estates, Phase II, dated Preliminary September 10, 1998.

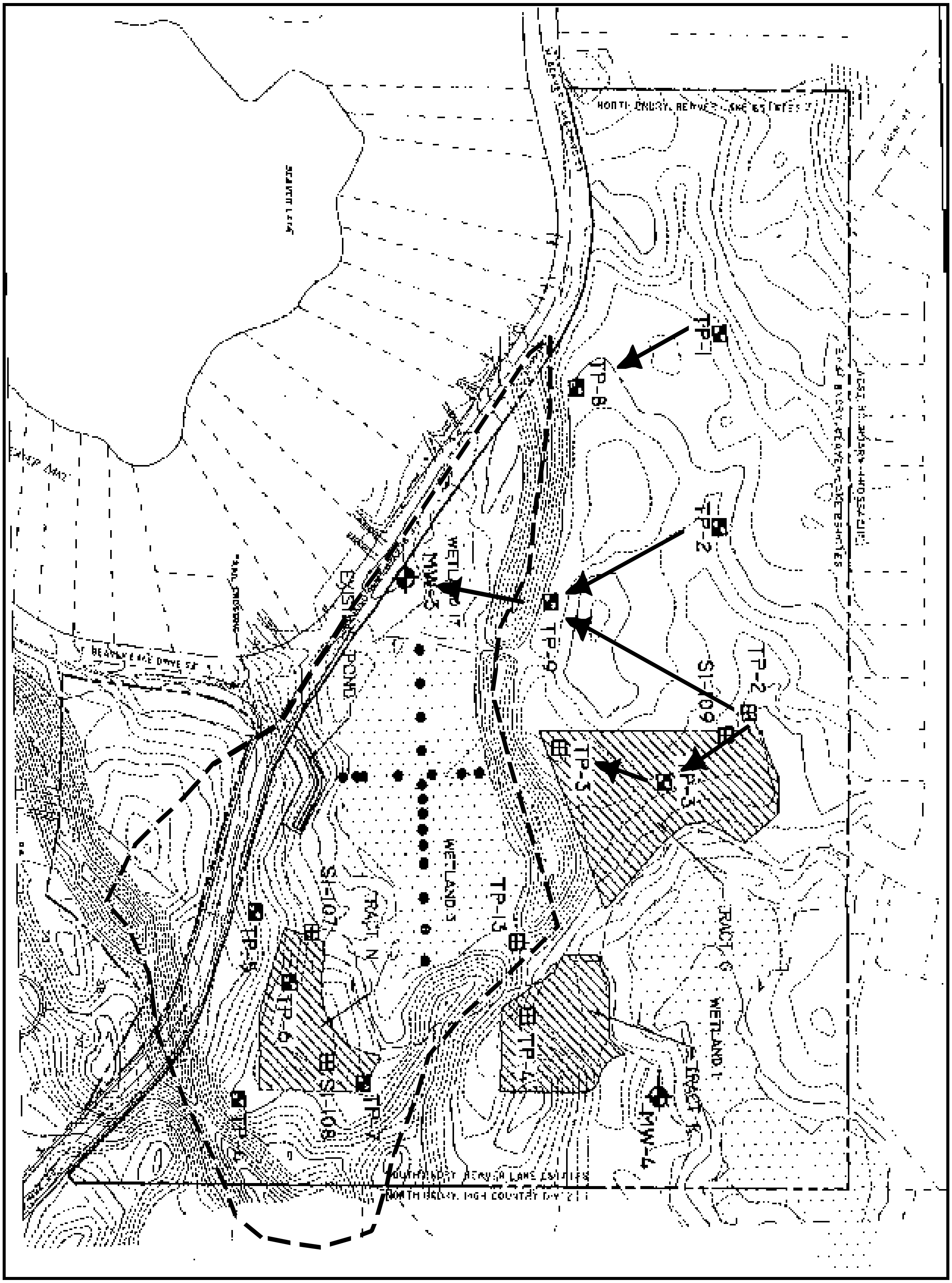

Figure 2: Location of Outwash-Till Sections

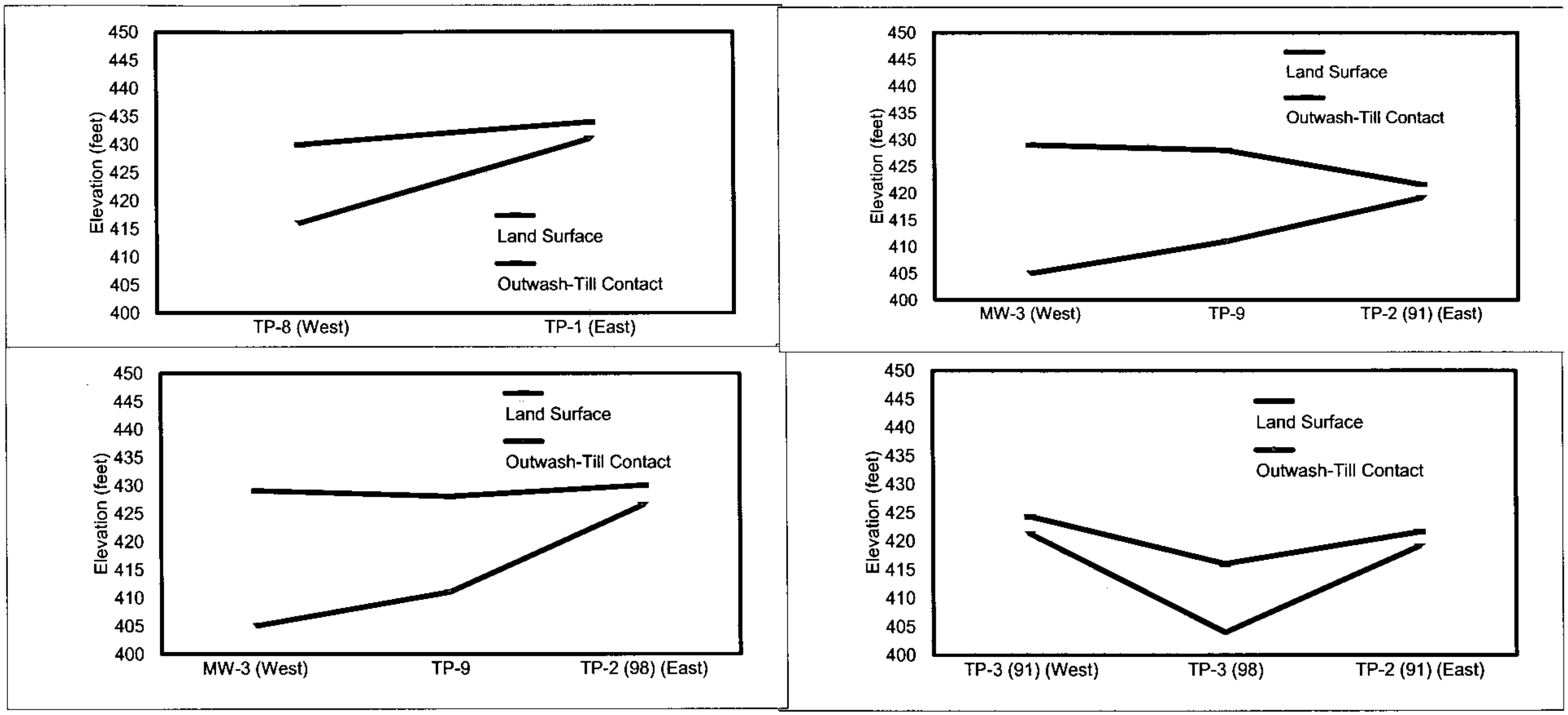

Figure 3: Profiles of Land Surface & Outwash-Till Elevations at Test Pits & Monitoring Wells

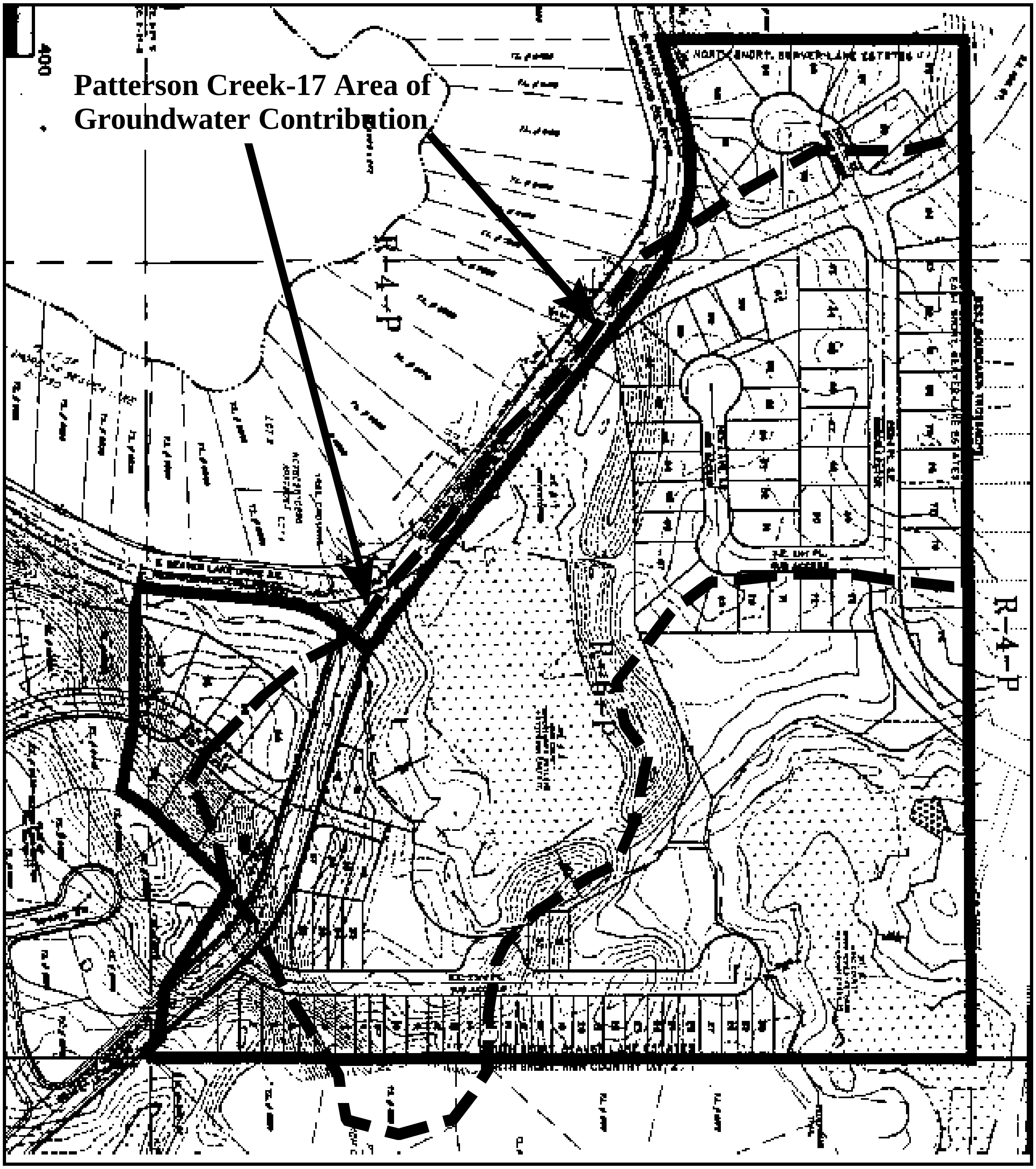

Figure 4: Area of Site that Contributes Groundwater Inflow to Patterson Creek-17

Sub-Basin CC-5 contains townhouse lots 6-13 and 33-42. This Sub-Basin has an area of 2.18 acres and will become 50% impervious. Thus about 1.09 acres of impervious surface will be created.

Combined, these three portions of the area of groundwater contribution to PC-17 will contain 6.27 acres of impervious area. The entire area of contribution is 16.92 acres. If Beaver Lake Estates Phase II is developed as proposed, then the area of PC-17 groundwater contribution will become 37% impervious. The existing impervious surfaces within the area are about one-acre in size for an imperviousness of 6%.

Covering such a large portion of the area of groundwater contribution with impervious surfaces will cause a very substantial reduction in inflow to the Patterson Creek-17 sphagnum bog. This will cause a reduction in the open water area with the bog which lead to a decline in the unique qualities of this wetland.

The *Mitigated Determination of Non-Significance* (MDNS) *for Beaver Lake Estates Phase II* contains several requirements which could have the same off-setting effects on impervious area as the four rooftop infiltration measures shown on the applicant's plans.

These requirements are:

Requirement 3.B: Rain gardens or infiltration trenches shall be used to the extent feasible to evaporate and/or infiltrate roof runoff. Rain gardens are basins or depressions planted with trees or shrubs that tolerate very wet conditions, such as willow, spirea, etc., and to which runoff water is directed before it is collected in the regular engineered drainage system. If rain gardens are used, a planting plan shall be submitted to DDES for review and approval, prior to engineering plan approval. The applicant shall post a bond to assure the installation of required plantings, and their survival for a period of three years.

Requirement 3.C : Porous pavement or other permeable surface materials shall be used for all patios, walkways and paved surfaces outside of the road right of way and not intended for vehicular traffic within the Patterson Creek Basin. A note to this effect shall be placed on the final plat and engineering plans. The final plat and engineering plans shall graphically show the portion of the subject plat to which this requirement applies.

During review of the engineering plans, the applicant and King County shall determine the feasibility of using porous pavement alternatives to traditional concrete for roads, driveways and sidewalks in the road right of way in the Patterson basin. If determined appropriate by the County, porous pavement shall be utilized. In addition, minimum road widths allowable per King County Road Standards shall be used to reduce the amount of impervious surface in the basin.

Unfortunately, the applicant's plans only show four rooftops which will benefit from requirement 3.B. The language of 3.B. includes the phrase *"to the extent feasible"* which makes it very unclear just how many roofs might benefit from this measure.

The language in the first part of Requirement 3.C. sounds very firm but the applicant's plans do not show any patios, walkways or other paved areas to be constructed of permeable materials. Additionally, the King County Department of Natural Resources determined that Patterson Creek-17 drains to Beaver Lake except when water levels become very high in the wetland.[14] Requirement 3.C. only applies to the portions of the project draining to Patterson Creek. So the extent to which this requirement applies to the site is uncertain since a large part drains to Beaver Lake.

The language in the second part of Requirement 3.C. calls for building roads and driveways of permeable materials, but only if this is deemed feasible by a future review of engineering plans. The likelihood of County road officials approving this measure is unknown and past experience indicates not very good.

In summary, the project will cause a significant adverse impact to the environmental quality to the Patterson Creek-17 sphagnum bog due the the loss of groundwater recharge and inflow. The requirements set forth in the *Mitigation Determination of Non-Significance* will not resolve these impacts. Thus King County erred in making the threshold determination that the project would not have a significant adverse impact.

Increased Phosphorus Inputs to Patterson Creek-17 Sphagnum Bog

Sphagnum bogs, such as Patterson Creek 17, are an infertile environment. Because these wetlands receive much of their water from precipitation falling directly on their surface and from groundwater inflow from a rather small forested watershed, nutrient inputs are usually quite low. The infertility resulting from low nutrient inputs makes bogs suitable only to plants specially adapted to these conditions. An increase in nutrient inputs will allow other vegetation to invade a bog. These plants may then out-compete the specialized species adapted to low fertility.

In Appendix E, of Chapter 14 - *Wetlands & Stormwater Management Guidelines*, of the King County Water & Land Resources Division publication *Wetlands & Urbanization*, a table appears which shows that the concentration of the nutrient total phosphorus ranges from 5 to 50

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[14] See page 12, *Beaver Lake Water Quality Protection: Wetland Condition of East Lake Sammamish 21 and Patterson Creek 17*, by Elissa Ostergaard, Water & Land Resources Division, King county Department of Natural Resources, April 19, 1999.

micrograms per liter (Fg/l) in a sphagnum bog. This table also shows that in typical wetlands the total phosphorus concentration range is ten times higher or 50 to 500 Fg/l.

The *Beaver Lake Management Plan*[15] states that runoff from forested areas has an average total phosphorus concentration of 39 Fg/l, which is slightly above the mid-point presented in the King County *Wetland & Stormwater Management Guidelines* for sphagnum bogs. The Beaver Lake Plan also states that runoff from impervious surfaces has a total phosphorus concentration of 236 Fg/l. The applicant's plans show that all but a small portion of the proposed impervious surfaces will discharge away from Patterson Creek 17. However, substantial areas of lawn and other open space will be located within the 16.92-acre area of the site draining to Patterson Creek 17. Approximately a fourth of the area will become lawn or other open space area. The *Beaver Lake Management Plan* presented an average total phosphorus concentration of 100 Fg/l for open space areas.

Much of the groundwater inflow to Patterson Creek 17 will originate as infiltration occurring on open space areas once Beaver Lake Estates II is completed. Therefore, the total phosphorus concentration in groundwater will rise from the 5-50 Fg/l range suitable for sphagnum bogs and extend into the 50-500 Fg/l range of other, less nutrient-sensitive wetlands.

In and of itself, the increase in total phosphorus inputs would have a significant adverse impact to the environmental quality of the Patterson Creek 17 sphagnum bog. When combined with the loss of recharge and groundwater inflow, it is exceedingly unlikely this wetland will continue to support a bog community. In the next section of this report, which also deals with phosphorus, MDNS requirements are reviewed which could reduce phosphorus inputs to PC-17. As will be seen, uncertainties associated with these requirements make it highly questionable whether phosphorus inputs will be reduced.

Increased Phosphorus Inputs to Beaver Lake

In the *Beaver Lake Management Plan*, King County presented their finding that the upper lake is of poor quality and the main lake is of moderate quality. For both portions of the lake, water quality problems are a result of excessive nutrient inputs which causes algae populations to proliferate. The algal blooms in turn lead to dissolved oxygen deficiencies, diminished fish populations, and other conditions which reduce public enjoyment of this extremely valuable aquatic resource.

These conditions prompted the County to establish a *non-degradation policy* for Beaver Lake. The principle tool presented in the plan for implementing the non-degradation policy was a cap on total phosphorus loadings to the lake. The cap was set at 146 kilograms of total phosphorus per year (kg/yr). When the plan was published in 1993 the loadings were estimated to be 142 kg/yr of

[15] Published by King County Surface Water Management November 1993.

total phosphorus. Thus future changes in the watershed of the lake could only add another 4 kg/yr of total phosphorus.

No mention is made in the *Mitigated Determination of Non-Significance* of phosphorus contributions from Beaver Lake Estates II to Beaver Lake. It appears that the MDNS was drafted with the assumption that the site would not drain to Beaver Lake. As shown above, under the discussion of groundwater inflow to PC-17, the outwash-till layer tilts towards Beaver Lake under much of the site. This area certainly contributes groundwater to Beaver Lake.

Figure 5, which follows this page, shows the path of three profiles extending through the site and into Beaver Lake. Figure 6 is a plot of the land surface elevation, the surface of Beaver Lake, and the bottom of beaver Lake along these three profiles. These profiles show that the site is located at a considerably higher elevation above the surface of Beaver Lake and the Lake bottom.

Even more informative is a plot of water table elevations on the site. Exhibit 4, in the Environmental Checklist, *Preliminary Geotechnical Report, Beaver Lake Estates, Phase II*, prepared by Terra Associates, Inc., dated August 29, 1997, contains data on water table elevations at six locations on the site. Four of these locations follow profile C-C' shown in Figure 5. Figure 7 shows a line running past these four locations, which are Monitoring Well 4 (MW-4), Test Pit 4 (TP-4), TP-13, and MW-3 (closest to Beaver Lake).

Figure 8 provides a plot of the water table elevations measured at these four locations on three dates. The highest water table elevation consistently occurred at TP-13, which is located along the eastern perimeter of Patterson Creek 17. From TP-13 west to MW-3 the water table elevation drops towards Beaver Lake. In other words, on these dates the direction of groundwater flow was towards Beaver Lake. Had water level measurements been made in other areas where the outwash-till contact tilts toward Beaver Lake, this same pattern would have been seen.

Clearly, groundwater from substantial portions of the site flows to Beaver Lake. Any phosphorus contained within these groundwaters will also enter Beaver Lake. Under the section above on phosphorus inputs to PC-17, it was stated that the *Beaver Lake Management Plan* assumed that groundwater originating in open space areas would be transporting phosphorus at a concentration 2.5 times higher than the natural, background concentration (39 Fg/l from forest vs. 100 Fg/l from open space). Therefore groundwater originating from these open space area will result in significant quantities of phosphorus entering Beaver Lake from this project.

In Table 2, which follows this page, total phosphorus loadings to Beaver Lake are computed. These loadings are based upon the assumptions presented above as applied to the 16.92-acre area contributing groundwater to Beaver Lake. Table 2 shows that Beaver Lake Estates Phase II would release 1.56 kilograms of total phosphorus per year to Beaver Lake.

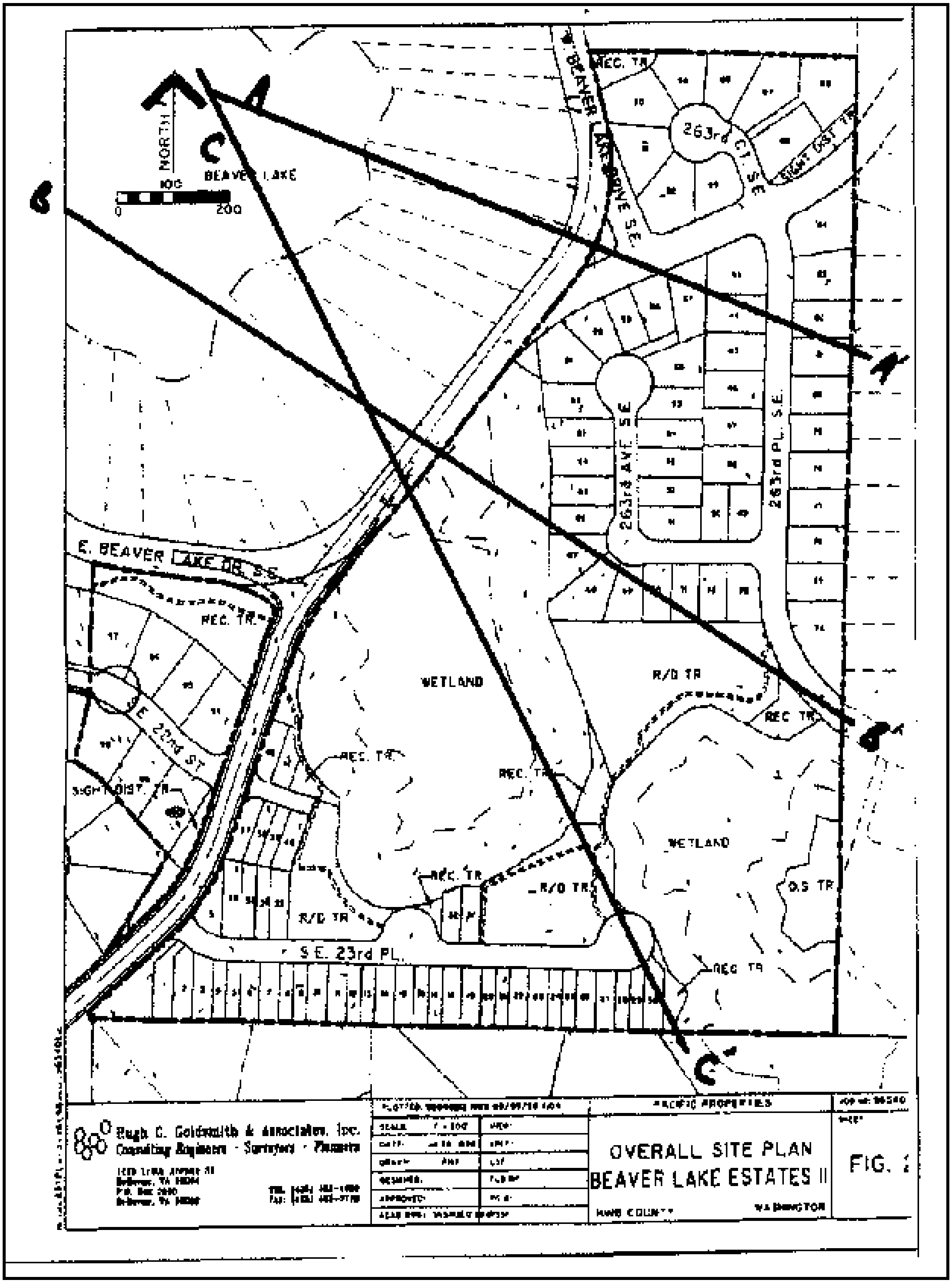

Figure 7: Profiles

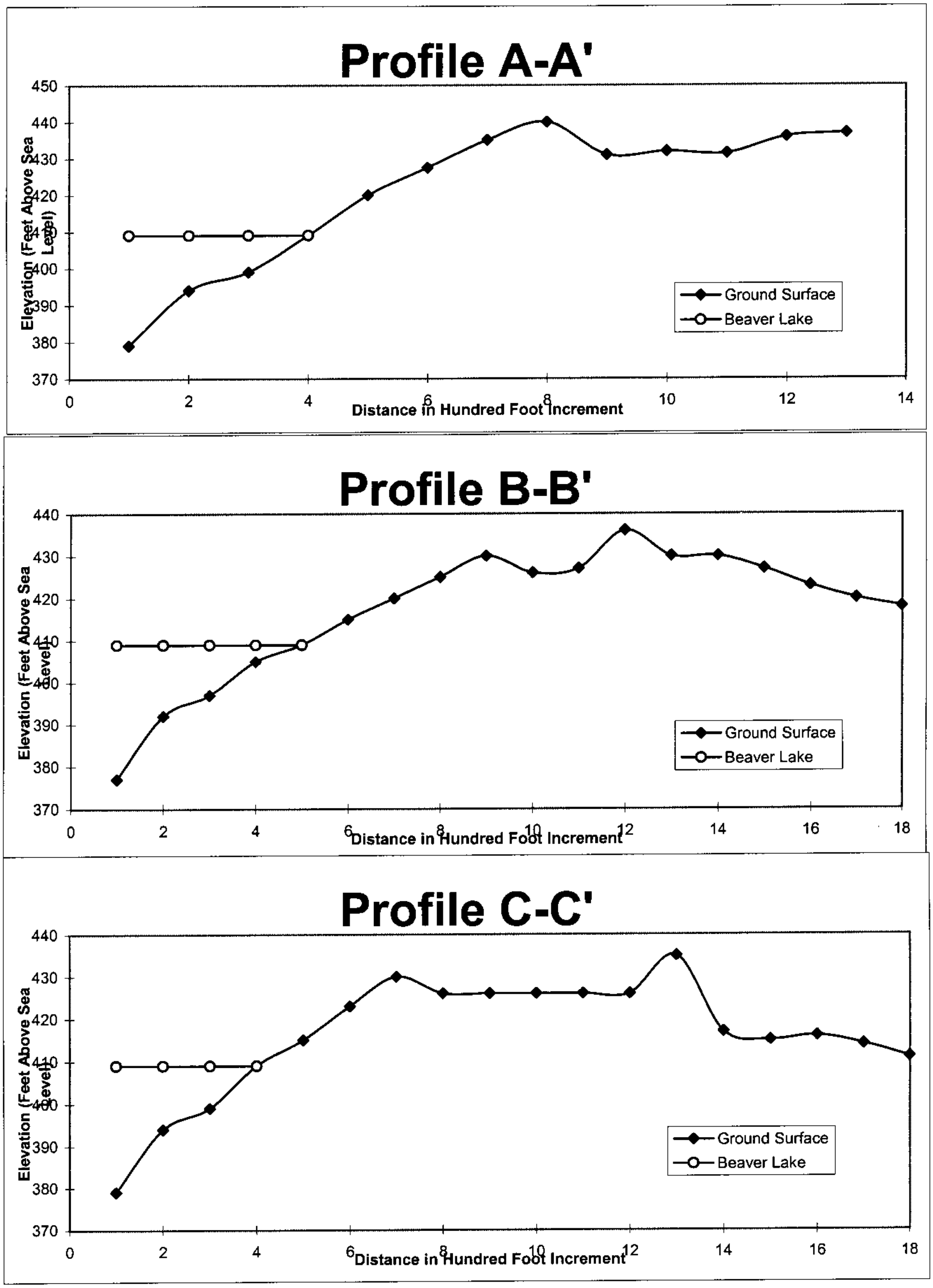

Figure 6: Profiles of Site & Beaver Lake

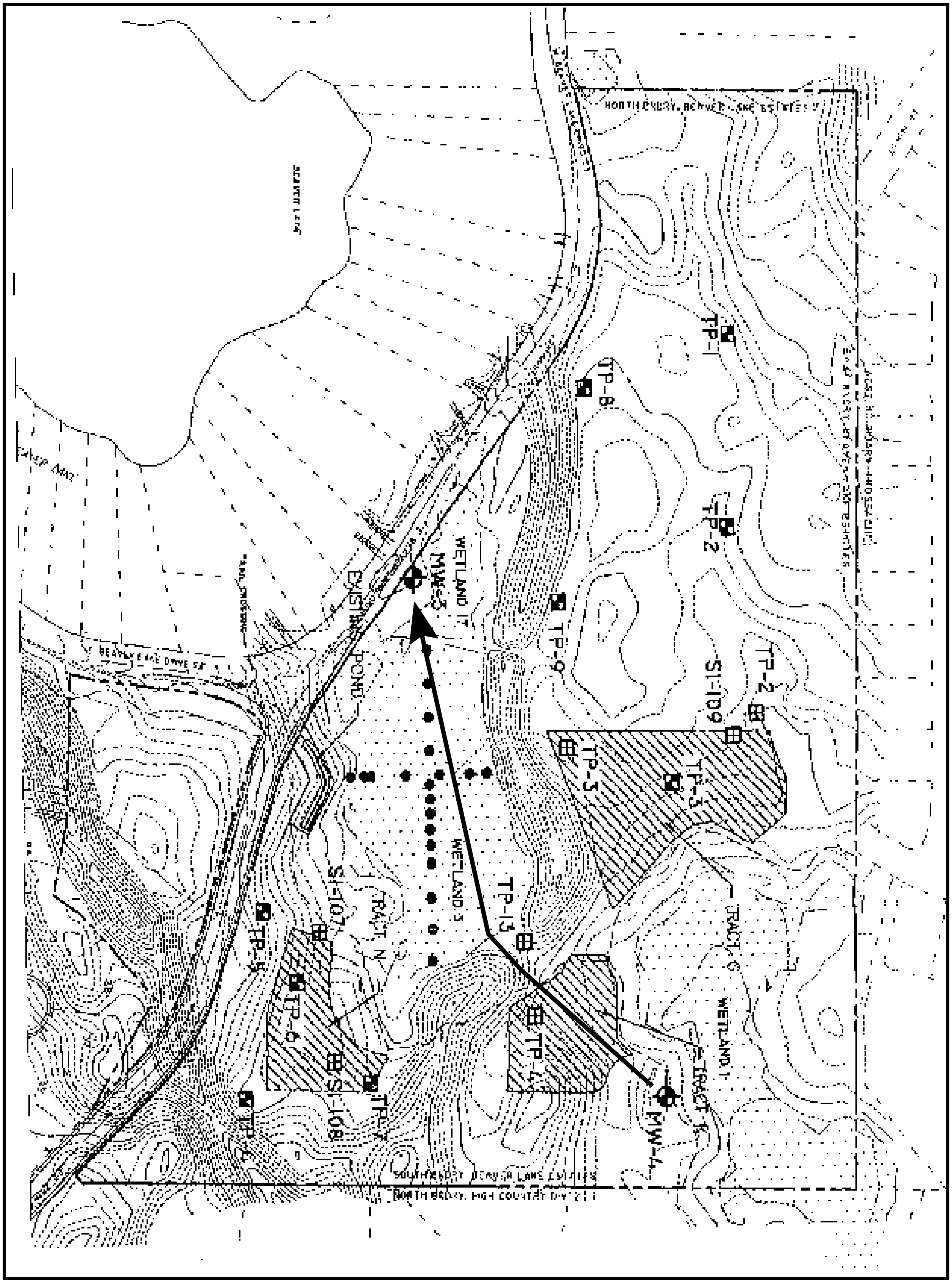

Figure 7: Water Table Elevation Profile Path

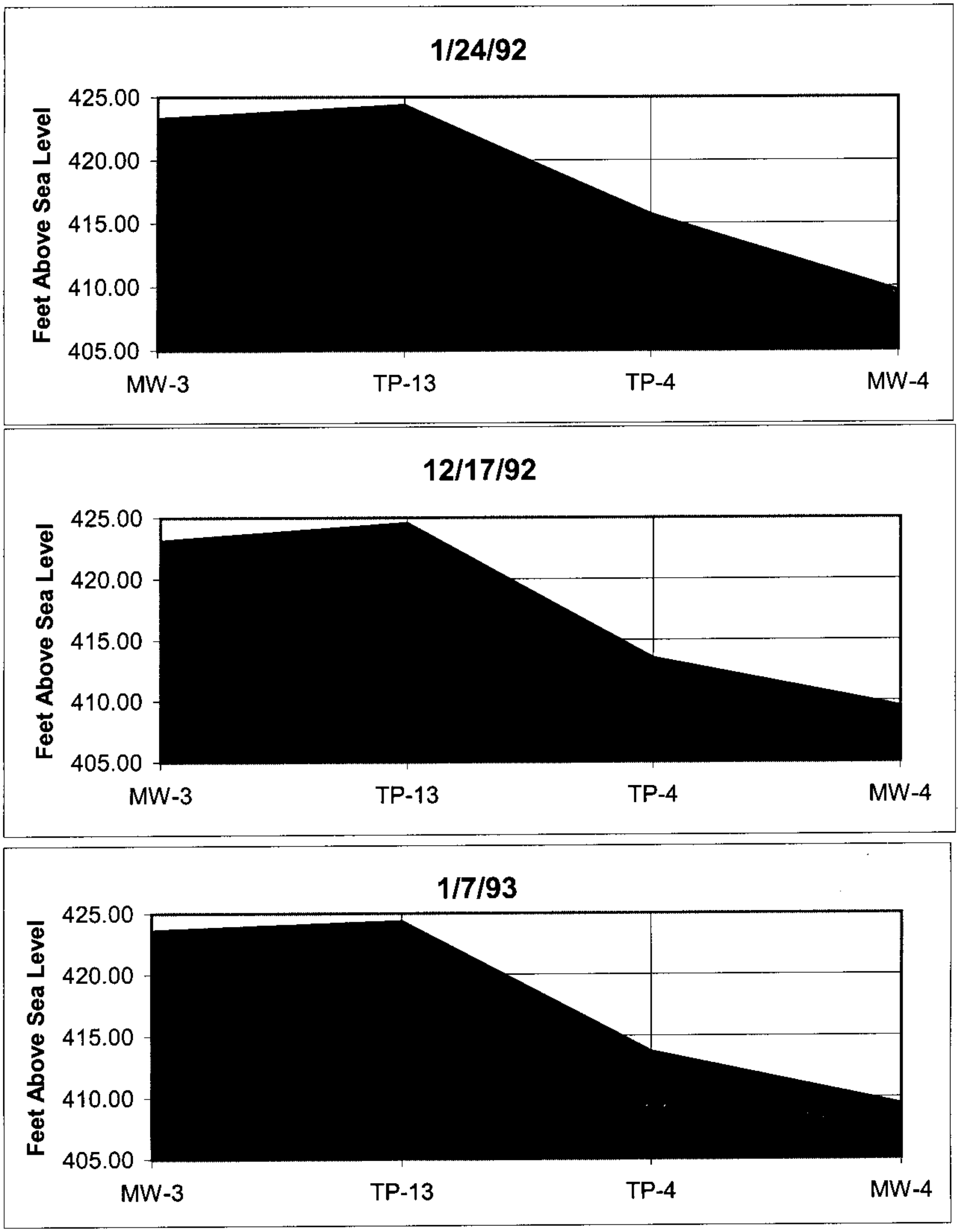

Figure 8: Water Table Elevations

Table 2: Total Phosphorus Loadings to Beaver Lake

Land Use	Acres	Annual Runoff Volume to Beaver Lake [1] (acre-feet)	Total Phosphorus Concentration (Fg/l)	Mitigation Measure Removal Efficiency	Total Phosphorus Loading to Beaver Lake (kilograms/year)
Forest [2]	3.52	4.43	39	0	0.21
Wetland [3]	2.87	4.19	39	0	0.20
Open Space [4]	4.23	8.92	100	0	1.10
Townhouses Rooftops (Lots 33-42) [5]	0.14	0.46	236	67	0.04
Other Impervious Areas [6]	6.16	0.00	236		0.00
Total	16.92				1.56

1.. Runoff volume computed using KCRTS with the same assumptions presented in the applicant's Level One Downstream Analysis (historical Landsburg data with a Regional Rainfall Factor of 0.92, till soils).
2. Total phosphorus concentration from forest of 39 Fg/l is based upon the *Beaver Lake Management Plan*.
3. Though the *Beaver Lake Management Plan* recommends a total phosphorus concentration of 70 39 Fg/l for wetlands, 39 39 Fg/l because the wetlands involved are infertile sphagnum bogs. Appendix E of *Wetlands & Urbanization* shows that sphagnum bogs have a total phosphorus concentration of 5-50 39 Fg/l.
4. Total phosphorus concentration from open space of 100 Fg/l is based upon the *Beaver Lake Management Plan*.
5. Townhouse lots 33-42 are assumed to have an average roof area of 600 square feet. It is assumed these rooftops will drain to the detention facility and infiltration trench shown on Exhibit 3. A total phosphorus concentration of 236 Fg/l is assumed based upon the *Beaver Lake Management Plan*. A 67% total phosphorus removal efficiency is assumed for the infiltration trench based upon *National Pollutant Removal Performance Database for Stormwater Best Management Practices*, by Brown and Schueler, 1997, Center for Watershed Protection, 8391 Main Street, Ellicott City, MD 21043. (410) 461-8323.
6. It is assumed runoff from all other impervious area will be diverted into the Patterson Creek watershed.

If Beaver Lake Estates II were the only other development project anticipated in the Beaver Lake watershed and no other new sources of phosphorus input were foreseen, then the 1.56 kg/yr addition would be well within the 4 kg/yr margin established in the *Beaver Lake Management Plan*. But this is not the case. There are a number of other projects including Norris Estates on the opposite side of Beaver Lake. Norris Estates alone would add 8.02 kg/yr of total phosphorus to Beaver Lake.[16] An Environmental Impact Statement is presently being prepared for Norris Estates. This EIS was ordered by Hearing Examiner Stafford Smith to address phosphorus inputs to Beaver Lake. Combined, Beaver Lake Estates II plus Norris Estates would exceed the 4 kg/yr margin by 150%.

Requirements are contained in the *Mitigated Determination of Non-Significance* which could reduce phosphorus releases from the project. These requirements are:

> **Requirement 3.A.** All lawn and landscaped areas shall be amended with 4 inches of well-rotted compost. The compost shall be tilled into the native soil to a depth of 6 to 8 inches. Compost shall either comply with guidelines for compost quality on page 6-44 of the King County Surface Water Design Manual, September 1998 draft, or Ecology guidelines for Grade A compost quality (publication 94-38).
>
> In areas where tilling is not feasible, a 6-inch layer of hog fuel or shredded wood (not to be confused with beauty bark) shall be applied on top of the ground surface. Slopes with a slope of 2:1 or greater must use biodegradable erosion control blankets (usually made from coconut fiber, wheat straw, jute, etc.,) with no more than 10% open surface to secure the mulch layer. Where slopes are less than 2:1, and erosion control concerns are minimal (e.g. ditches that do not receive flashy, seasonal, and/or intermittent high volume flows), the mulch layer, at a minimum, must be secured with jute matting with 1/4 inch mesh. However, erosion control blankets are preferred.
>
> Special construction inspection shall be required prior to installation of final landscaping on any lot. A performance bond shall be posted prior to issuance of a building permit to ensure compliance with this condition. A note to the effect shall be placed on the final plat.

There are several concerns with this requirement. First, a review of the literature shows little information on the effectiveness of incorporating compost or other organic materials into soils in terms of phosphorus removal. This lack of data makes it is very difficult to determine the reduction in

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[16] *Summation of Total Phosphorus Issue - Norris Estates/Beaver Lake* and *Effects of Norris Estates upon Phosphorus Loadings to Beaver Lake***,** prepared by Richard D. Klein.

phosphorus loads achieved with this practice. Second, it is unclear how long the benefits of the compost-organic material would last and how it would be replaced once it decomposes from private lawns and other open space areas. Third, the incorporation of compost language is qualified by “where tilling is feasible”. This indicates uncertainty about just how much of the site would benefit from this practice.

> **Requirement 4.A:** Except for roof runoff, runoff entering the bog by surface flow shall be treated with a treatment option from the sphagnum bog protection menu in the September 1998 King County Surface Water Design Manual.

This requirement appears to apply to impervious surfaces other than rooftops. The applicant has already proposed diverting all impervious surface runoff (except for 10 townhouse rooftops) into the Patterson Creek drainage. Table 2 reflects the benefits of this requirement by showing no phosphorus loadings from impervious surfaces, other than the ten townhouses roofs.

> **Requirement 4.B:** Roof runoff or runoff entering the bog via interflow or infiltration shall be treated with a treatment option from the basic water quality menu in the September 1998 King County Surface Water Design Manual. If the cation exchange capacity (CEC) of the soils in the infiltration zone is less than 5 me/100mg, then a 5% (by volume) mix of peat and sand shall be worked into the top two feet of soil. Soil amendment shall not be required if it is subsequently determined that only roof runoff will enter the infiltration facility.

This requirement has been applied to the 10 townhouse rooftops presented in Table 2.

In closing, even with the mitigation measures presented in the MDNS, the project will cause a significant increase in phosphorus loads to Beaver Lake. The cumulative effect of phosphorus releases from this project and others in the Beaver Lake watershed will exceed the 4 kg/yr margin established by the *Beaver Lake Management Plan*. This will, in turn, result in a further decline in the quality of Beaver Lake and a violation of the non-degradation policy established by King County. This constitutes a significant adverse impact to the environmental quality of Beaver Lake. Therefore, the County erred in issuing the threshold determination that significant adverse impacts would not occur.

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