APPENDIX A

PRELIMINARY MANAGEMENT GUIDELINES for *Sphagnum*-dominated peatlands

Sphagnum-dominated peatlands are unique wetland resources. In King County, they comprise only about 3% of the total number of wetlands of the county. In and of themselves, *Sphagnum*-dominated peatlands have intrinsic value. These wetlands were initiated shortly after the retreat of the glaciers and could be viewed as one of the most ancient living ecosystems in the Northwest. The plant communities of *Sphagnum*-dominated peatlands are unique, as are the invertebrates that are supported by those communities. In addition to living plant communities, peatlands are a storehouse of pollen and seeds of ancient plant communities. Much of what we know of the paleo-botanical record comes from peatland cores.

In addition to their intrinsic value, peatlands also perform functions that are of value to people. Peatlands, perhaps more than any other wetland type, act as a sponge, soaking up rainwater and allowing it to filter slowly through the upper peat layers, regulating flood pulses. The water stored in peatlands in winter is released slowing through the summer drought, increasing summer low flows in streams lower in the watershed.

Another reason for protecting peatlands is to protect downstream lakes from excess nutrients. In Chapter 3 we saw the consequences in the Pine Lake watershed of allowing peatland decomposition to accelerate. Peatlands act as carbon and nutrient sinks, storing the organic production of centuries but arresting decomposition of that material. Looked at another way, peatlands act as nutrient time-bombs. Since the nutrients of past millennia are stored in the peat, conditions that increase the rate of decomposition allow the release of this ancient store of nutrients. Eutrophication of lakes downstream is the inevitable result. In King County, many of the lakes currently being managed for nutrient enrichment have peatlands in the watershed that have been destabilized. This is true of Green Lake (a former peatland), Cottage lake, Lake Sammamish, and Lake Desire.

Lastly, *Sphagnum*-dominated peatlands are of great concern in their potential role relative to global climate change. Increasing decomposition rates not only releases nutrients. The oxidation of peat creates carbon dioxide ($CO_{2)}$, a greenhouse gas. Control of greenhouse gases should be considered in the overall strategy to reduce CO_2 emissions to the atmosphere.

For these intrinsic and practical reasons, then, it is desirable to protect *Sphagnum*-dominated peatlands. To understand how to do this, we must first look at the underlying factors that affect these systems.

Underlying factors that influence *Sphagnum* peatland processes and guidelines to prevent impacts

In general, guidelines for wetland management seek to prevent significant adverse changes as human influences in the watershed intensify. Guidelines are typically based on the best available scientific information, but best professional judgement is often required to interpret scientific information. The information in this Phase 1 Community Profile is not complete, and a comprehensive set of management guidelines is therefore premature. In particular, a review of pathways by which human could impact acid peatlands is planned for Phase 2. Lacking this detailed examination, guidelines offered at this point should be regarded as preliminary. However, human-caused impacts to peatlands are currently occurring in western Washington, particularly in the Puget Sound lowlands, an area of fast growth. Therefore, the physical, chemical and biotic processes already developed in this Phase 1 report will be used as a basis for the preliminary management guidelines offered here.

Physical factors: Hydrology is one of the most important physical factors that could be altered by human activity in the watershed of *Sphagnum*-dominated peatlands. Many investigators have emphasized that stabilization of the local water table was a key factor in initiating the development of peatlands. Malmer (1986) observed that bogs experience water level fluctuations of about 12 cm (4.7 inches), whereas fens have fluctuations of about 20 cm (7.8 inches). Stable water tables, along with stable watershed landscapes, are necessary for low seasonal water level fluctuation. If water levels fluctuate significantly, oxygenation of organic detritus is accelerated, making peat accumulation impossible. A stable water level allows the acrotelm position to remain relatively stationary, assuring decomposition of organic material is arrested close to the surface and maintaining conditions that allow for peat accumulation. In addition to having stable water levels, having stagnant conditions has also been noted as a prerequisite for bog formation. Thus avoiding conditions that increase water level fluctuation due to changing groundwater or watershed characteristics, or enhancing flows into or within a peatland is important in avoiding impacts.

A related hydrological factor that affects *Sphagnum*-dominated peatlands is the length of the summer drought and the lowering of the water table. Malmer also observed that the summer water table in bogs is no more than 0.8 meters (2.6 feet) below the surface. If the summer water table is too far below the surface, the *Sphagnum* dries out, and woody shrubs and trees grow rapidly, eventually shading out the *Sphagnum.*

Guidelines to prevent physical effects:

1. Create a comprehensive plan for mining and peat extraction activity. Only harvest systems of low biological value. In general, it is recommended that no more than 0.5% of peat resources be harvested in a 20-year time period. If permits are granted for filling small peatlands, encourage extraction and use of the peat before filling.

Guidelines to maintain stable hydrology:

2. If possible, maintain the existing forested cover in the entire watershed of the peatland. The most effective way to protect and maintain a stable hydrology is to preserve forest cover. Evapotranspiration can account for 30% of the annual water budget (ref). Loss of forest cover increases the surface runoff on sloping terrain, and on flat terrain, can increase height of the local water table if soils are not highly infiltrative.

3. If logging or land-use conversion in the watershed cannot be avoided, do not increase or decrease pre-developed weekly flow volume or the annual flow volume reaching the peatland. Estimate flow volume with a continuous hydrological model (HSPF or KCRTS). If modeling shows that surface runoff will be increased, attempt to infiltrate as much flow as possible back into the ground. Route the excess flows to an area downstream from the *Sphagnum* areas in the peatland. In doing so, avoid backwater effect that could flood *Sphagnum* areas. Summer water levels should not decrease more than 12 cm (4.5 inches) from the base winter water level. If greater drawdown is modeled, consider engineered infiltration trenches or gravel-filled reservoirs to augment summer flows.

4. Keep flows dispersed to the extent possible. Do not concentrate flows unless there are no alternatives. If flows are concentrated, do not introduce them into a *Sphagnum*-dominated peatland in a piped discharge. Design a flow dispersal system at the outer edge of a 200-foot wetland buffer. Use soil bioengineering techniques to re-enforce potential flow sheet paths with vegetation so that no erosion takes place.

5. Roads can have impacts for both hydrological and chemical impacts of *Sphagnum*-dominated peatlands. Road beds are compacted, and interfere with the movement of shallow groundwater. Dust and the combustion of petrochemicals introduce cations, nutrients and toxic materials from both wash-off and aerial deposition. If possible, roads should not be routed through the watershed of a *Sphagnum*-dominated peatland. Particularly if the road is unpaved, it should be situated as far from the peatland as possible, preferably downwind of the resource. Lenses that allow groundwater to pass under the road should be engineered into the design. Road runoff should be dispersed and treated through properly sized filter strips rather than concentrated. The King County Surface water Design Manual (1998) has a sizing methodology for filter strips.

6. Although education and appreciation by people is important, the weight of a human can compress the *Sphagnum* mat. Access impacts can be controlled by building either a low-impact trail through a portion of the *Sphagnum* mat, or building a viewing platform above the mat. Materials used for trail-building should contain no calcium or soil and be resistant to acidic conditions (cedar is a good choice). The pathway design should allow light to penetrate to the mat to the maximum extent possible.

<u>Chemical factors</u>: In addition to hydrological factors, chemistry of acid peatlands is unique, serving, along with plant communities, to define peatland type. Of primary importance are the pH and cation concentrations. Bogs are acidic and at the same time have low cation concentrations, especially calcium, magnesium and potassium. In addition, a buffering system of organic acids supplied by decomposition of *Sphagnum*, and aluminum which plays a vital role in the maintenance of acidity are important components of the chemistry of bog waters. Nutrient enrichment of bogs and poor fens is also a concern. Fertilization experiments have shown that enrichment by nitrogen and phosphorus have complex and interactive effects. Many investigators, however, believe that in general nitrogen is the critical limiting nutrient for *Sphagnum* growth and health, and that nitrogen over-enrichment causes *Sphagnum* to die. Maintaining the chemistry of these key constituents within the very low natural concentrations found in *Sphagnum*-dominated peatlands is important. If cations concentrations become too high, the exchange sites in the *Sphagnum* can be exhausted, and the *Sphagnum* will die.

Guidelines to maintain stable chemistry:

7. Treat any runoff that is infiltrated or reached the peatland via surface flow. Treatment should be designed to remove over 90% of the total settleable solids and as much of the nutrient content of the water as possible[1]. Alkalinity of the discharge should be less than 10 mg/L, calcium concentrations should be less than 2 mg/L and pH no greater than 6.0. Introduction of organic acids should be maximized by use of constructed wetlands and leaf compost filtration for treating runoff. The best method for treating runoff is a multi-facility treatment train which includes sand filtration as one of the facilities. The King County Surface Water Design Manual (1998) has more information about treatment trains for use in the watershed of *Sphagnum*-dominated peatlands.

8. Use in the watershed of calcium-containing materials (such as Portland cement, whitewash, etc.) should be avoided. Cement structures should not be used, as cement continues to leach small amounts of calcium throughout it's life.

9. Fertilization of forests and lawns within the watershed of *Sphagnum*-dominated peatlands should be avoided. In particular, aerial application of urea fertilizer should not occur on forested lands.

10. No land disturbing activities in the watershed, including logging, should take place in the rainy season. Any dry-season land disturbing should be revegetated before the rainy season to prevent soil transport to the peatland.

Biological factors: Biotic factors can also affect *Sphagnum*-dominated peatlands. One of the characteristic of the vegetation community typical of bogs and poor fens is the *Ledum*, *Kalmia*, *Vaccinium* association. These shrubs are evergreen, contributing relatively little organic material to the litter in leaf-fall. Normally these shrubs are low (less than 90 cm or 3 feet) when growing on a *Sphagnum* mat and do not provide significant shading. If the summer water table becomes too low, growth accelerates and these shrubs as well as stunted trees grow taller, shading the *Sphagnum*. Since *Sphagnum* is shade intolerant, it is displaced by other mosses if tree and shrub growth becomes too tall.

Guidelines to reduce biotic impacts:

11. Prevent shading of *Sphagnum* mosses by maintaining conditions that prevent shrub growth. A high summer water table and the avoidance of nutrient enrichment will help prevent rapid shrub and tree growth.

12. Discourage invasion of the *Sphagnum* mat by marsh species such as cattail by keeping water level fluctuations low and preventing mineral-rich water from entering the peatland.

13. Interpretive signs about the sensitivity of peatlands to soil and outside seed sources should be used at all access trails. The sign should advise people to clean their footwear of seeds, especially seeds of reed canarygrass and other other invasives, before proceeding into the peatland.

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[1] Using well-engineered passive stormwater treatment facilities such as sand filters, normally about 50% of the total phosphorus and somewhat less nitrate can be removed.

Appendix A : Community Profile of *Sphagnum*-dominated Peatlands in Western Washington